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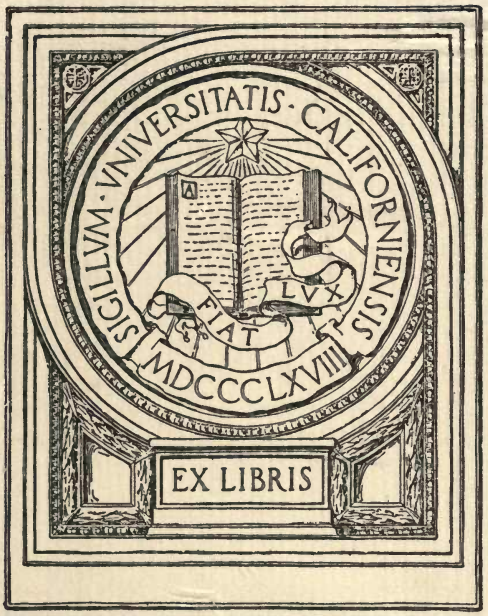
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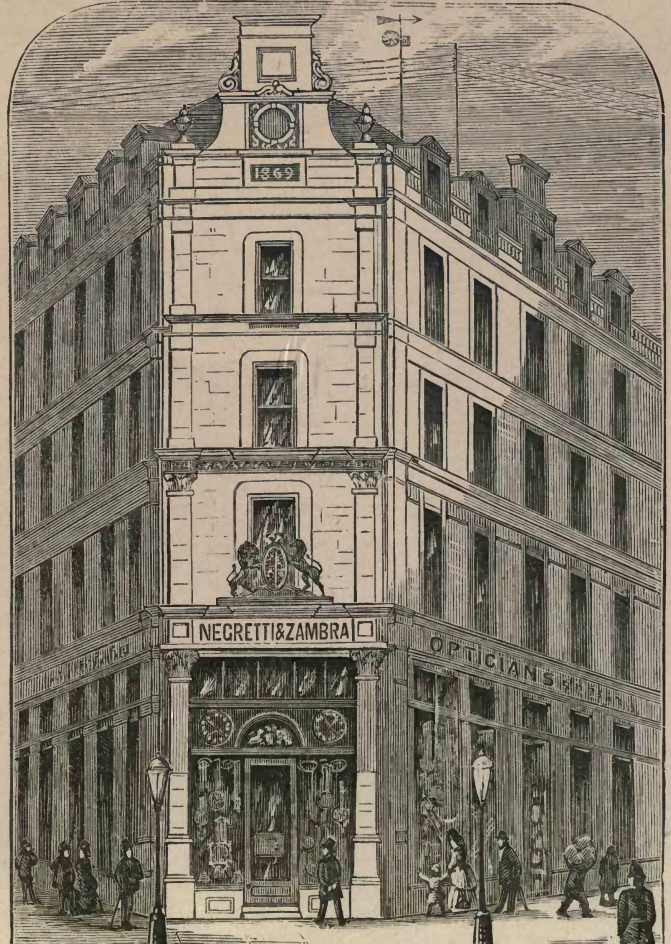

NEGRETTI & ZAMBRA'S

ENCYCLOPÆDIC

ILLUSTRATED AND DESCRIPTIVE

REFERENCE

CATALOGUE

OF

OPTICAL, MATHEMATICAL, PHYSICAL, PHOTOGRAPHIC,

AND

STANDARD

METEOROLOGICAL INSTRUMENTS,

MANUFACTURED AND SOLD BY THEM.

NEGRETTI AND ZAMBRA,

Opticians and Scientific Instrument Makers to

HER MAJESTY THE QUEEN;

H.R.H. THE PRINCE OF WALES;

THE ROYAL OBSERVATORY, GREENWICH; THE ADMIRALTY; BOARD OF TRADE;

THE ROYAL BRITISH METEOROLOGICAL SOCIETY; THE

OBSERVATORIES, KEW, TORONTO, WASHINGTON, VICTORIA; AND CAPE OF GOOD HOPE.

HOLBORN VIADUCT, E.C.,

45, CORNHILL, E.C., and 122, REGENT STREET, W.,

PHOTOGRAPHERS TO THE CRYSTAL PALACE, SYDENHAM.

LONDON.

PRICE FIVE SHILLINGS AND SIXPENCE.

Revised and Corrected Edition.

HAYMAN BROTHERS AND LILLY,
PRINTERS,
HATTON HOUSE, FARRINGDON ROAD.
LONDON, E.C.

CRYSTAL PALACE, SYDENHAM.

HONORARY AWARDS TO NEGRETTI AND ZAMBRA.

1851. *The only Prize Medal for Meteorological Instruments was awarded to Negretti and Zambra.*

1855. *"Honourable Mention."—Paris Exhibition.*
The Kew Committee exhibited among their Apparatus one of N. & Z's. Patent Maximum Thermometers; the Jury awarded an Honourable Mention for this Instrument. Negretti and Zambra not having exhibited at all.

The "Austrian Gold Medal."—For Stereoscopic Photographic Views on Glass.

1862. *Two Prize Medals.—I. Meteorological Instruments.—The terms of the Award being as follows:—"For many important inventions and improvements, together with accuracy and excellence in objects exhibited."*

II. Photographic Transparencies, "for beauty and excellence of, and adaptation of Photography to Book Illustrations."

1875. *A Prize Medal.—Santiago, Chili, awarded for their exhibited collection of Optical and Physical Instruments.*

1876. *Three Prize Medals.—Philadelphia, "for Meteorological Instruments;" "for Thermometers" and "for Microscopes."*

1878. *A Gold Medal, Paris. The only Gold Medal awarded for Meteorological Instruments in the British Section.*

1881. *Fisheries Exhibition, Norwich. A Silver Medal and Diploma for Deep Sea Recording Thermometers and Sextants.*

1882. *Fisheries Exhibition, Edinburgh. A Silver Medal for Deep Sea Recording Thermometers, &c.*

1883. *Buitenzorg, Batavia, Java Exhibition. A Gold Medal for general excellence of Optical Instruments exhibited.*

1883. *International Fisheries Exhibition, London. A Gold Medal for Meteorological Instruments. A Silver Medal for Deep Sea Recording Thermometers. A Bronze Medal for Current Meter. A Gold Medal for Standard Barometers.*

1884. *International Health Exhibition, London. A Gold Medal for Hourly Recording and other Registering Thermometers.*

NEGRETTI AND ZAMBRA'S
INVENTIONS AND IMPROVEMENTS.

1.—*Enamelling the centre or back of Thermometer Tubes. By this invention, Negretti and Zambra have been enabled to make Thermometers at least twenty times more sensitive than heretofore. The delicate Clinical Thermometers now so extensively used could never have been efficiently constructed without the aid of the enamelled tube. See Sensitive Thermometers, pages* 32 *and* 160.

2.—*Negretti and Zambra's Patent Self-Registering Maximum Thermometer. Pp.* 36 *to* 45. *For a Report on the value of this Thermometer by the Kew Committee see pages* 37 *and* 38.

3.—*The Application of Porcelain and Enamelled White Glass Scales to Barometers and Thermometers, the divisions being permanently etched or painted thereon; a plan now universally adopted by all makers.*

4.—*Negretti and Zambra's Patent Mercurial Minimum Thermometers (two patents). See pages* 47 *to* 50.

5.—*Negretti and Zambra's Patent Self-Registering Maximum Thermometer, specially arranged for obtaining underground temperatures, Mines, Springs, &c., Marine service, Solar Observations, &c., &c. See pages* 42, 44, 145, 171, *and* 172.

6.—*FitzRoy's Marine Gun Barometer, constructed for use in Her Majesty's Navy, by Negretti and Zambra, the only one adopted and in use in Her Majesty's vessels. See pages* 11 *and* 12.

7.—*FitzRoy's Storm or Life-Boat Service Barometer. See page* 143.

8.—*Pocket and Watch-sized Aneroid Barometer. The first Pocket Aneroid ever produced was manufactured by Negretti and Zambra for the late Admiral FitzRoy. See pages* 24 *to* 27.

9.—*The Double Bulb Deep Sea Thermometer, first constructed and supplied to Her Majesty's Navy by Negretti and Zambra in* 1862. *For full particulars and the history of this important invention see pages* 63, 64, 65, *and* 173.

10.—*Improved Standard Mercurial Deep-Sea Thermometer, the only Instrument capable of giving correct temperatures of the bottom or any intermediate depth of the sea. See pages* 66 *and* 67.

11.—*Negretti and Zambra's Patent Strengthened Glass Hydrometer. See page* 194.

12.—*A Portable form of the Open Range Glycerine Barometer. See page* 18.

13.—*Self Recording Aneroid Barometers with various Improvements.*
See pages 27 *and* 28.

14.—*Improved Self-Recording Barographs, Thermographs, Hygrometers.*
See pages 30, 53 *to* 56, 130.

15.—*Negretti and Zambra's Patent Apparatus for recording Hourly Temperatures.*
See pages 55 *and* 78.

16.—*Recording Anemometers, Electrical. Various arrangements constructed by Negretti and Zambra.*

CONTENTS.

PREFACE.

In again submitting to our numerous friends and patrons a greatly enlarged and revised edition of our Encyclopædic Catalogue, we do so with some degree of pride,—firstly, that all previous editions have been such as to command the extensive patronage bestowed upon them; and, secondly, from the award made known at the "Great International Exhibition at Paris," that the superiority and excellence of our instruments, which gained for us the only Prize Medal in 1851, is still maintained, and manifested by the fact that at Paris in 1878 we had awarded to us the ONLY GOLD MEDAL given for our class of instruments in the British Section.

This is further confirmed by the award of THREE GOLD MEDALS, SILVER, and BRONZE MEDALS at the International Exhibitions, London, 1883-1884, and other awards specified on page iii.

In this edition, as in all that have preceded it, our endeavour has been to make the the work, not merely a list of prices, but in reality a guide for those who are purchasing Scientific Instruments and Apparatus generally. All instruments are well described, some more fully than others, depending upon the importance of the apparatus or article under consideration.

Our Meteorological Instruments we particularly recommend to those who are about to commence making observations in the science of Meteorology as being the most recently improved and reliable that can possibly be produced. In confirmation of this we have only to state that for nearly forty years our firm have had the honour of supplying Standard Instruments to all the most important Meteorological Observatories, Scientific Institutions, and Governments of the World; most of the Geographical and Deep Sea Exploring Expeditions of the last thirty years have been supplied with our Instruments.

To enumerate our various inventions and improvements here would be, with few exceptions, to repeat all that has been said in previous editions; as it would be tedious, we specify these Inventions and Improvements on page iv., and indicate the section or page in the Catalogue where they will be found fully described. Our doing so must not be taken as an act of egotism; but for the special purpose of placing on record that we are the Inventors and Improvers of such instruments, as many of our inventions have been appropriated by manufacturers, and sold without the slightest acknowledgment of their origin.

Our extensive business knowledge and experience in each of the various sections of our Trade enables us to obtain full and correct information respecting any new Instruments or Inventions; hence we are in a position to supply to our Correspondents any Specialities made and sold by other firms at their advertised or Catalogue prices.

At page v. will be found a Table of Contents, referring to the pages where any particular section or class of apparatus will be found, and at page 567 an extensive general Index, giving the marginal number or page for each Instrument: these, combined with upwards of Thirteen Hundred Wood Engravings (a large proportion of them new), will assist the reader in searching for any particular item.

When Orders are transmitted in Foreign Languages, N. & Z. advise their friends to send verbatim copies of such orders in the original language, as it often occurs that where the order has been translated and copied by persons unacquainted with the nature or use of the articles written for, serious errors arise in the carrying out their correspondents' commands.

Correspondents may, if preferable to them, write in French, Italian, Spanish, or German.

A liberal commission allowed to Merchants, Shippers, or Agents on large transactions. Merchants favouring us with copies of their clients' orders will have special quotations furnished to them if desired.

Full and explicit instructions should accompany orders as to the Address, mode of Conveyance, Shipment, Insurance, Consular Forms, and Declarations, etc., etc. Foreign or Country orders must be accompanied by an adequate Remittance or Order for Payment, or Satisfactory Reference in London.

Every possible care being taken in packing Apparatus and Instruments to insure safety in carriage, *we cannot be responsible for any damage that may occur in transit after the goods leave our establishment.*

The probable expense of Packing Cases, Tin or Zinc-lined, may be taken at say from 5 to 10 per cent. on the value of articles of ordinary dimensions and weight. Very bulky or extremely heavy goods can hardly be estimated for; but N. & Z. will undertake that all packages, &c., shall be supplied at the lowest possible net charge.

All communications from abroad should be directed to the Chief Establishment, **Negretti & Zambra, Holborn Viaduct, E.C., London.** Letters for their **Branches** to be specially addressed **45, Cornhill, E.C.; 122, Regent Street, W.**; or, **Negretti & Zambra's Photographic Department, Crystal Palace, Sydenham, S.E.**

The compilation and revision of this New Edition of our Catalogue has again been entrusted by us to Mr. R. WILLATS, the Manager of our retail department at Holborn Viaduct; and we hope that both as a Price List and a Book of Reference it will be found much superior to its predecessors.

NEGRETTI & ZAMBRA.

ERRATA.

PAGE.

7 Last line 0·45 *should read* 0·6.

20 Fig. 21. Price *should read* £27 10s.

27 Last line, 18s., *should read* 15s.

32 No. 39. For $\frac{1}{10}$th of degree *read* $\frac{3}{10}$ths.

58 Last line, 20s., *should read* 7s.
(This instrument has been considerably improved since catalogue was printed. Full particulars forwarded on application.)

65 The line "1 Cubic Foot of Sea Water" *should read* "Fresh Water" (see page 558).

67 Price of Magnaghi Pattern Deep Sea Thermometer, £5 10s.

75 No. 98. 63s. *should read* 50s.

94 No. 133 is no longer made, having been superseded by No. 132.

102 No. 144. 4-inch Anemometer, 63s. *should read* 60s.

114 No. 158 is no longer made.

124 No. 1 Set of Instruments, instead of £330 to £450, *read* £170 to £250.

131 Dip Circle No. 136. £35 *should read* £40.

132 Prices of Charts for figures 21 and 29. 25s. *should read* 21s.
For fig. 28 *read* 15s.
For Anemometers and Tide Gauges *read* 35s.

133 Negretti and Zambra's Treatise and Kæmtz's Meteorology are both out of print.

143 No. 171. FitzRoy Barometer, £6 10s., *should read* £6 6s.

146 Fig. 182 *should read* 183.
Fig. 183 *should read* 182.

149 No. 199 can also be supplied at £5 5s.

157 No. 267 14-inch, 10s., *should read* 8s. 6d.

159 No. 299. 400° *should read* 140°.
No. 300. 600° *should read* 212°.
No. 301 *should read* to 600°.

162 The Thermometers, Nos. 313, 314, and 315, are not to be recommended, and are superseded by Nos. 316 and 317.

163 No. 316 are also supplied on Boxwood Scales at 5s. 6d. and 7s. 6d.
Porcelain Scale in Japanned Metal Case, 10s. 6d. *should read* 7s. 6d.
No. 317. 12s. 6d. *should read* 10s. 6d.
No. 321. 10s. 6d. *should read* 7s. 6d.
No. 322. 12s. 6d. *should read* 10s. 6d.

168 No. 366. 16s. 6d. *should read* 15s.

169 No. 386. 130° *should read* 110°.

177 No. 423. 27s. 6d. *should read* 21s.

186 No. 485. 16s. 6s. *should read* 12s. 6d.
No. 486. 10s. 6d. *should read* 7s. 6d.

188 No. 510 is no longer made.
No. 514. Fig. 466 *should read* 514.
No. 515. Fig. 467 *should read* 515.
No. 517. Fig. 469 *should read* 517.

196 No. 559. "Vacuum Gauge" *should read* "Pressure Gauge."
Fig. 459 *should read* 559.

199 Fig. 578 *should read* 587.

201 Fig. A *should read* C.
Fig. C *should read* A.
Small Machine Counter "with 4 figures at 63s." *should read* "with 6 figures and reciprocating."

ERRATA.

PAGE.	
223	Fig. 697 *should read* 679.
226	Fig 40 *should read* 740.
250	No. 859, referred to as fig. 859, *should read* fig. 861.
251	No 861 *should read* 859.
252	No. 864. For 190 diameters *read* 100.
253	No. 866. £8 8s. *should read* £8.
254	No. 868. £8 8s. *should read* £8.
	No. 871. £14 *should read* £14 10s.
	„ £200 *should read* £190.
	„ £300 *should read* £280.
	„ £400 *should read* £390.
268	No. 925. $\frac{1}{6}$th Object Glass £4 10s., *should read* £6 10s.
	„ $\frac{1}{8}$th ditto £5 *should read* £7 10s.
272	No. 995 6s. *should read* 5s.
275	No. 1042. £8 8s. *should read* £7 7s.
	No. 1044. 10s. 6d. *should read* 6s. 6d.
	No. 1045. 12s. 6d. *should read* 8s. 6d.
280	No. 1075 are also supplied at 5s. and 7s. 6d.
285	No. 1115. 20 seconds *should read* 30.
291	No. 1155. £18 18s. *should read* £19 10s.
292	No. 1165. 36s. *should read* 35s.
297	No. 1186. £3 3s. *should read* £3 10s.
307	30-inch Pentagraph, £10 10s., should read £9 10s.
308	No. 1293. 5-inch *should read* 6-inch.
317	No. 1345. £3 3s. *should read* £2 2s.
325	No. 1404. 5s. *should read* 3s.
	No. 1407. 1s. *should read* 1s. 9d.
	No. 1418. 1s. *should read* 1s. 6d.
356	No. 1761. £12 12s. *should read* £10 10s.
397	No. 2167.* 16s. *should read* 10s. 6d.
398	No. 2181 is no longer made.
412	No. 2380. 9-inch at 63s. *should read* 10-inch
432	Fig. 1888 *should read* 2564.
434	No. 2554. No. 1 size, 5s. 6d. *should read* 4s. 6d.
	„ No. 2 size, 4s., *should read* 3s. 6d.
	„ No. 3 size, 3s. 6d., *should read* 3s.
439	No. 2604 has now been superseded by machines of improved construction.
447	Fig. 2079 *should read* 2709.
448	No. 2709 is no longer made.
458	No. 2784. 32s. *should read* 30s.
477	No. 2912. Fig 2612 *should read* 2912.
479	Fig. 9240 *should read* 2940.
481	Fig. 2995 *should read* 2955.
483	No. 2951. Fig. 2251 *should read* 2951.
	No. 2954. No. 2144 *should read* fig. 3044.
490	No. 3009. Figs. 2109 and 2109* *should read* figs. 3009 and 3009*.
493	Fig. 2694 *should read* 3042.
517	No. 3159. For $\frac{1}{4}$ plate at £3 3s. *read* $\frac{1}{2}$ plate.
545	No. 3282. £5 15s. *should read* £6 5s.

NEGRETTI AND ZAMBRA'S

DESCRIPTIVE CATALOGUE.

STANDARD

METEOROLOGICAL INSTRUMENTS.

THE practical usefulness of Meteorological Instruments as weather indicators, and their increasing employment for Scientific and Sanitary investigation, render a knowledge of their construction and principles desirable to all. Impressed with the idea that we shall be supplying a want, in giving simple descriptions of those now in use, we have endeavoured to condense such information regarding the instruments used in Meteorology in the present section of our Catalogue.

Every Meteorological Instrument of any practical value being described, with plain instructions for using them, purchasers will be enabled to select such as seem to them most suited to their requirements.

For convenience of reference and comparison we arrange and describe the different instruments used for Meteorological observation under the following headings, viz.: Instruments to show, 1st, the pressure of the atmosphere; 2nd, the temperature of the air; 3rd, the absorption and radiation of the sun's heat by the earth's surface; 4th, the humidity of the air; 5th, the amount and duration of rainfall; 6th, the direction, the horizontal pressure, and the velocity of winds; 7th, the electric condition of the atmosphere, the prevalence and activity of ozone, magnetic, and tidal phenomena, &c., &c.

BAROMETERS.

1. Principle of the Barometer.—The first instrument which gave the exact measure of the pressure of the atmosphere was invented by Torricelli, a Florentine pupil of Galileo, in 1643. It is constructed as follows: A glass tube, C D (fig. 1), about 34 inches long, and from two to four-tenths of an inch in diameter of bore, having one end closed, is filled with mercury. In a cup, B, a quantity of mercury is also poured. Then, placing a finger securely over the open end, C, invert the tube vertically over the cup, and remove the finger when the end of the tube dips into the mercury. The mercury in the tube then partly falls out, but a column, A B, about 30 inches in height, remains supported. This column is a weight of mercury, the pressure of which upon the surface of that in the cup is precisely equivalent to the corresponding pressure of the atmosphere. As the atmospheric pressure varies, the length of this mercurial column also changes. It is by no means constant in its height; in fact, it is very seldom stationary, but is constantly rising or falling in the tube. It is, therefore, an instrument by which the fluctuations taking place in the pressure of the atmosphere, arising from changes in its weight and elasticity, can be shown and measured. It has obtained the name *Barometer*, or measurer of heaviness, —a word certainly not happily expressive of the utility of the invention. If the bore of the barometer tube be uniform throughout its length, and have its sectional area equal to a square inch, it is evident that the length of the column, which is supported by the pressure of the air, expresses the number of cubic inches of mercury which compose it. The weight of this mercury, therefore, represents the statical pressure of the atmosphere upon a square inch of surface.

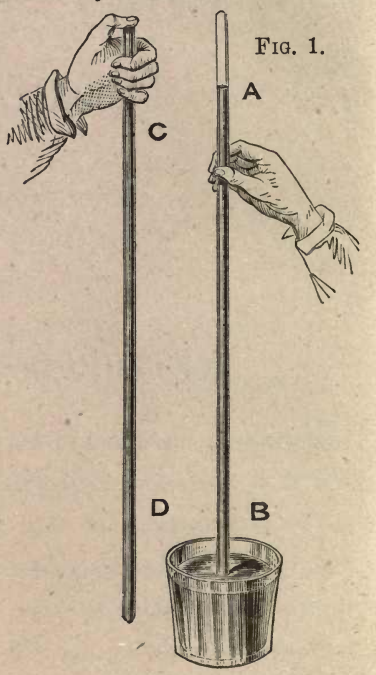

FIG. 1.

In England the annual mean height of the barometric column, reduced to the sea-level, and to the temperature of 32° Fahrenheit, is about 29·95 inches. A cubic inch of mercury at this temperature has been ascertained to weigh 0·48967 lbs. avoirdupois. Hence $29{\cdot}95 \times 0{\cdot}48967 = 14{\cdot}67$ lbs., is the mean

value of the pressure of the atmosphere on each square inch of surface, near the sea-level, about the latitude of 50 degrees. Nearer the equator this mean pressure is somewhat greater; nearer the poles, somewhat less. For common practical calculations it is assumed to be 15 lbs. on the square inch. When it became apparent that the movements of the barometric column furnished indications of the probable coming changes in the weather, an attempt was made to deduce from recorded observations the barometric height corresponding to the most notable characteristics of weather. It was found that for fine dry weather the mercury in the barometer at the sea-level generally stood above 30 inches; changeable weather happened when it ranged from 30 to 29 inches, and when rainy or stormy weather occurred it was even lower. Thus, it became the practice to place upon barometer scales words (Fair, Change, Rain, &c.), indicatory of the weather likely to accompany, or follow, the movements of the mercury; and the instruments bearing them obtained the name "Weather Glasses."

COMPARISON

OF THE

ENGLISH AND METRICAL SCALES OF BAROMETERS

AT ALL

TEMPERATURES *COMMON TO BOTH.*

BY F. F. TUCKETT, Esq.

Inches.		Millimétres.	Inches.		Millimétres.
32	—	812·5312	16	—	406·2656
31	—	787·1396	15	—	380·8740
30	—	761·7480	14	—	355·4824
29	—	736·3564	13	—	330·0908
28	—	710·9648	12	—	304·6992
27	—	685·5732	11	—	279·3076
26	—	660·1816	10	—	253·9160
25	—	634·7900	9	—	228·5244
24	—	609·3984	8	—	203·1328
23	—	584·0068	7	—	177·7412
22	—	558·6152	6	—	152·3496
21	—	533·2236	5	—	126·9580
20	—	507·8320	4	—	101·5664
19	—	482·4404	3	—	76·1748
18	—	457·0488	2	—	50·7832
17	—	431·6572	1	—	25·3916

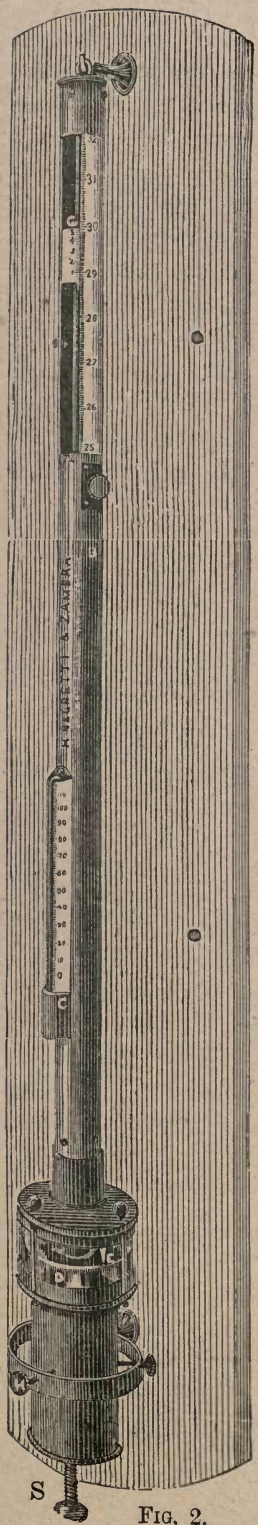

Fig. 2.

INSTRUMENTS FOR ASCERTAINING THE ATMOSPHERIC PRESSURE.

STANDARD BAROMETERS.

2. **Negretti & Zambra's Standard Barometers** are constructed on Fortin's principle,* which has been proved to be the most reliable and convenient arrangement yet introduced. The level of the mercury in the cistern being adjusted previous to each observation to a fixed zero point of ivory, loss of mercury from leakage or oxidation is of little or no importance, and does not affect the accuracy of the readings of the instrument. The tubes are of varying internal diameter, according to the price of each barometer. These tubes are filled with pure mercury, very carefully boiled in the tube to perfectly expel all air or moisture.

The barometer tube is mounted in a brass tubular frame, extending throughout its whole length; the upper portion of it has two longitudinal openings; on one side of the front opening is the barometrical scale of English inches, divided to show, by means of a vernier, $\frac{1}{500}$th of an inch; on the opposite side is sometimes divided a scale of French millimetres, reading also by a vernier to $\frac{1}{10}$th of a millimetre. The reservoir or cistern of the barometer is of glass, closed at bottom by means of a leather bag, acted upon by a thumb-screw passing through the bottom of an arrangement of brass-work, by which it is protected. A delicate thermometer with the scale divided on its stem, so arranged as to give as accurately as possible the temperatures of the column of mercury, is attached to the brass tube. A mahogany board, with brass bracket and ring, with three adjusting screws for suspending and adjusting the barometer, is supplied with each instrument.

* This form of barometer, now universally adopted by all makers, was originally introduced by Negretti and Zambra.

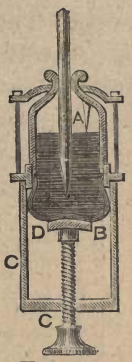

FIG. 3.

Fortin's barometer cistern shown in section by fig. 3, is formed of a glass cylinder, which allows of the level of the mercury within being seen. The bottom of the cylinder is made of flexible leather, like a bag, so as to allow of being pushed up or lowered by means of a screw, D B, worked from beneath. This screw moves through the bottom of a brass cylinder, C C, which is fixed outside, and protects the glass cylinder containing the mercury. At the top of the interior of the cistern is fixed a small piece of ivory, A, the point of which exactly coincides with the zero of the scale. This screw and moveable cistern-bottom serve also to render the barometer portable, by confining the mercury in the tube, and preventing its descending into the cistern.

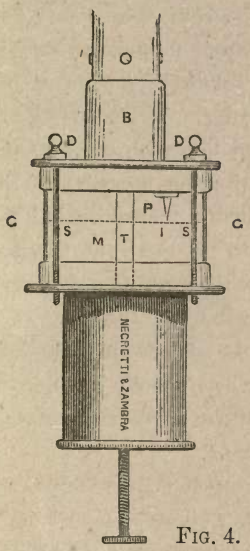

FIG. 4.

Fig. 4 exhibits the external construction of the cistern portion of a standard barometer. S S are metal screws that secure the glass cylinder or cistern G G partly filled with mercury, M, through this the tube T passes down into the flexible leather bag, with which the instrument is adjusted or made portable by the screw, D B, as previously described. At P is shown the white ivory zero point to which the level of the mercury in the glass cistern is always corrected previous to reading off the height of the mercurial column. This ivory point is seen at A in the section fig. 3, and at P in fig. 4.

Directions for fixing the Barometer.—In selecting a position for a barometer care should be taken to place it so that the sun cannot shine upon it, and that it is not affected by direct heat from a fire. The cistern should be from two to three feet above the ground, which will give a height for observing convenient to most persons. Having determined upon the position in which to place the instrument, fix the mahogany board as nearly vertical as possible; and ascertain if the barometer is perfectly free from air, in the following manner:—lower the adjusting screw at the bottom of the cistern several turns, so that the mercury in the tube, when held upright, may fall two or three inches from the top; then slightly incline the instrument from the vertical position, and if the mercury in striking the top elicit a sharp tap, the instrument is perfect. If the tap be dull, or not heard at all, there is air above the mercury; this must be driven into the cistern by partially rescrewing and then *inverting the instrument, and gently tapping it with the hand.* The barometer being in perfect condition,

suspend it on the brass bracket, its cistern passing through the ring at bottom, and allow it to find its vertical position ; after which firmly clamp it by means of the three clamping screws.

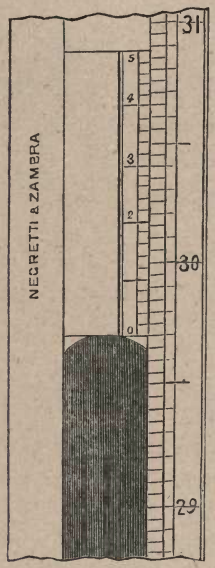

Fig 5.

Directions for taking an Observation.—Having taken the temperature by the attached thermometer, the mercury in the cistern must be raised or lowered by means of the thumb-screw (s), fig. 2, until the ivory point (e), and its reflected image in the mercury (d), are just in contact; the vernier is then moved by means of the milled head, until its lower edge just excludes the light from the *middle* and *uppermost* point of the mercurial column as seen in fig. 5 ; the reading is then taken by means of the scale on the limb and the vernier. In observing, the eye should be placed in a right line with the fore and back edges of the lower termination or edge of the vernier. A small white reflector placed behind the barometer will assist in throwing the light through the brass frame and the glass tube ; and the observer's vision may be further assisted by the use of a magnifying lens. The great object in standard barometers, is to obtain exact readings, which can only be done by having the eye, the front of the zero edge of the vernier, the top of the mercurial column, and the back of the vernier, in the same horizontal plane.

To remove the Instrument.—If it should be necessary to remove the barometer, first, by means of the adjusting screw (s), fig. 2, drive the mercury to the top of the tube, turning the screw gently when the mercury approaches the top, and stop turning directly any resistance is experienced ; next remove the instrument from the bracket, slowly *invert* it, and in carrying keep the cistern end uppermost.

3. The Barometer Vernier.—The *Vernier*, an invaluable contrivance for measuring small spaces, was invented by Peter Vernier, about the year 1630. The barometer scale is divided into inches and tenths. The vernier enables us to accurately sub-divide the tenths into hundredths, and, even to thousandths of an inch. It consists of a short scale made to pass along the graduated fixed scale by a sliding or rack-and-pinion adjustment.

The scales of standard barometers are usually divided into half-tenths, or ·05, of an inch, as represented, in fig 6, by A B. The vernier, C D, is made equal in length to twenty-four of these divisions, and divided into twenty-five equal parts ; consequently one space on the scale is larger than one on the vernier, by the twenty-fifth part of ·05, which is ·002 inch, so that such a vernier shows

differences of ·002 inch. The vernier of the figure reading upwards, the lower edge, D, will denote the top of the mercurial column; and is the zero of the vernier scale. In fig. 6, the zero being in line exactly with 29 inches and five-tenths of the fixed scale, the barometer reading would be 29·500 inches. It will be seen that the vernier line, *a*, falls short of a division of the scale by, as we have explained, ·002 inch; *b*, by ·004; *c*, by ·006; *d*, by ·008; and the next line by one hundredth. If, then, the vernier be moved so as to make *a* coincide with *z*, on the scale, it will have moved through ·002 inch; and if 1 on the vernier be moved into line with *y* on the scale, the space measured will be·010. Thus, the figures 1, 2, 3, 4, 5 on the vernier measure hundredths, and the intermediate lines even thousandths of an inch. In fig 6*, the zero of the vernier is between 29·65 and 29·70 on the scale. Passing the eye up the vernier and scale, the second line above 3 is perceived to lie evenly with a line of the scale. This gives ·03 and ·004 to add to 29·65, so that the actual reading is 29·684 inches.

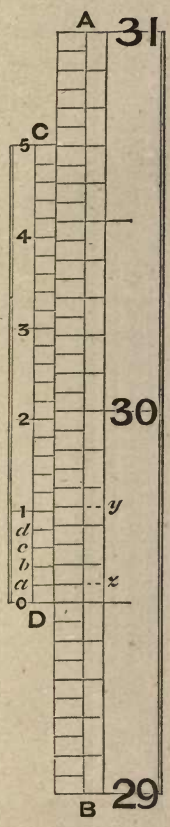

FIG 6.

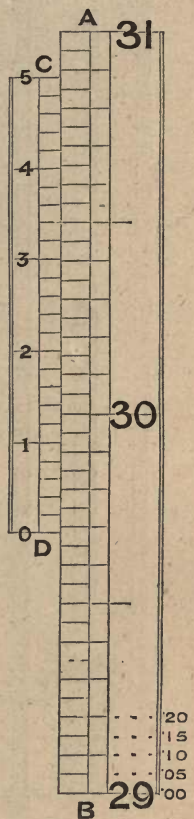

FIG 6*.

For the ordinary purposes of the barometer as a "weather glass," such minute measurement is not required. In household and marine barometers, the scale is only divided to tenths, and the vernier constructed to measure hundredths of an inch. This is done by making the vernier either 9 or 11-10ths of an inch long, and dividing it into ten equal parts. The lines above the zero line are then numbered from 1 to 10; sometimes the alternate divisions only are numbered, the intermediate numbers being very readily inferred. Hence, if the first line of the vernier agrees with 1 on the scale, the next must be out one-tenth of a tenth, or ·01 of an inch from agreement with next *scale* line; the following vernier line must be ·02 out, and so on. Consequently, when the vernier is set to the mercurial column, the difference shown by the vernier from the tenth on the scale is the hundredths to be added to the inches and tenths of the scale.

Fig. 7.

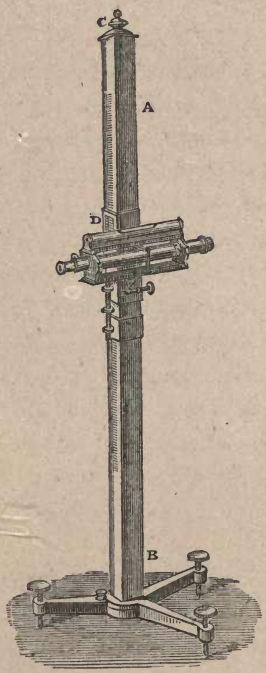

Fig. 9.

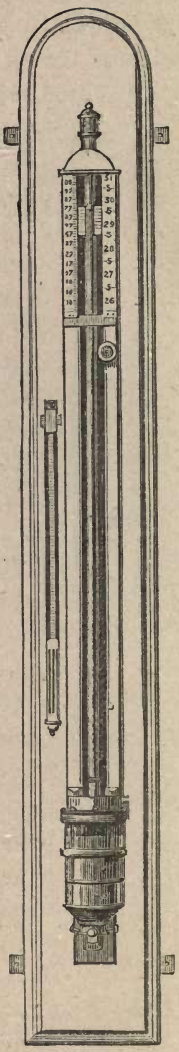

Fig. 8.

4. **Large Standard Barometers** with attached Thermometer suited for Observatories and Public Institutions. The tubes are $\frac{6}{10}$ths internal diameter, and the bulbs of the thermometers are of the same dimensions.

Price, Fig. 7, £21 0 0

5. **Observatory Standard Barometers** with *extra large* tube and cistern, arranged for observations being taken by the Cathetometer for extreme precision, as used at the Greenwich and Kew Observatories.

Price, Barometer, Fig. 8, . £25 0 0 £30 0 0
Cathetometer, Fig. 9 . . . £35 0 0

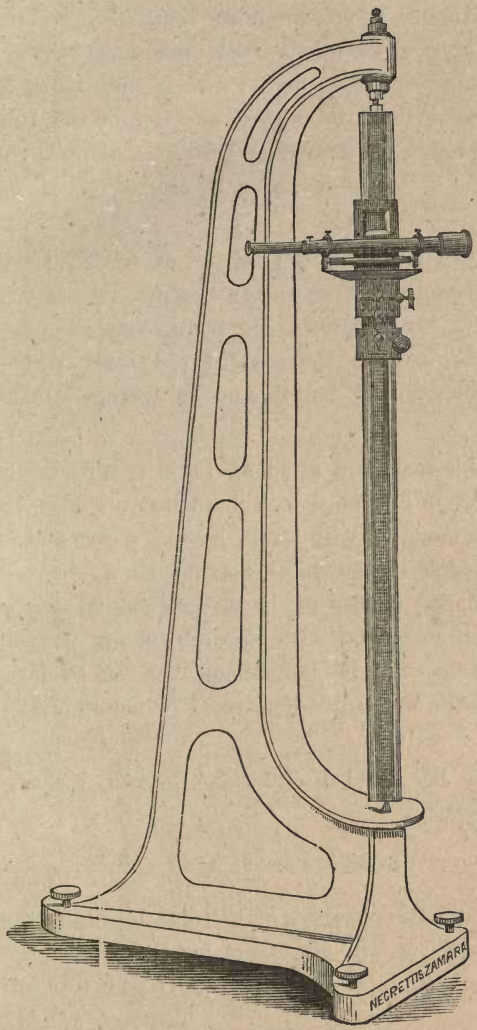

FIG. 10.

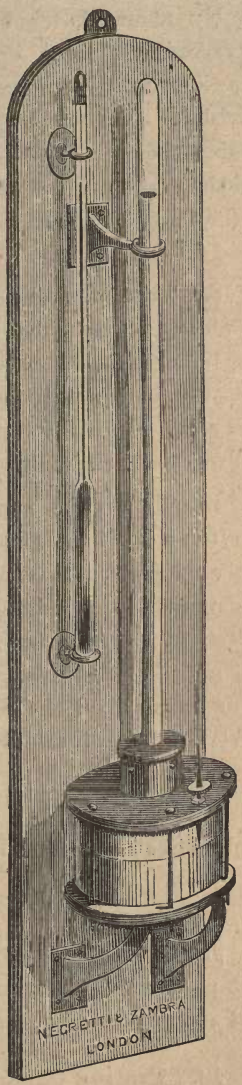

FIG. 11.

6. **Cathetometer,** (fig. 10.) Improved arrangement, suited for Observing Stations of the First Class. Price £50 to £80; varying with the fineness and accuracy of the divisions and the number of adjustments attached to the instrument.

7. **Observatory Standard Barometer**, fig. 11, of the highest class suitably mounted, for being read off with the Cathetometer, with a tube of exceedingly large internal diameter, the cistern also being of very large area—especially arranged for taking observations with the most extreme precision. Our woodcut shows the Barometer to be *without* any scale, the readings being obtained by observing the level of the mercury in the tubes and the upper point of the cistern index, (or zero screw) through the telescope of the Cathetometer. *Price*, as fig. 11, £50 0 0 to 70 0 0

8. **The Cathetometer**, shown in fig. 9, is used for ascertaining with the utmost accuracy the space or distance between any two points. A brass rod or cylinder is firmly supported on a heavy base having three arms, each arm furnished with adjusting screws for setting the upright rod truly vertical. This rod is accurately divided throughout its length, and so arranged that it will revolve horizontally.

Exactly at right angles to this scale and attached to it is a framework carrying a small Achromatic Telescope furnished with fine wire or spider lines in the eye-piece. This telescope is mounted with levels, having coarse and fine adjustments with clamps, &c., much in the same manner as a Theodolite Telescope. The distance between the points to be ascertained is observed through the telescope, which can be moved with its adjustments vertically up or down upon the divided scale—and its indications read off by means of verniers, which sub-divide the scale to the five-hundredth or one-thousandth part of an inch.

The Cathetometer scale may be divided either in English inches or Centimetres and Millimetres as desired.

Price of Cathetometer, as fig. 9, £35 0 0

9. **Glass Cases for Standard Barometers** of polished ebonized wood with plate glass sides and door with secure fastenings for the exclusion of dust and preserving the instrument from injury. *Price* £5 5 0 to £10 10 0

10. **Testing Chamber** with double-action Air Pump for testing Standard Barometers, as used at the Kew Observatory. £70 0 0

11. **Negretti and Zambra's Mountain Barometer** (fig. 12), on Fortin's principle, is more portable, and less liable to derangement than ordinary mountain barometers. The arrangement of the flexible leather cistern is so simple that should the mercury become oxidized, it can be quickly removed, cleaned, and returned to the cistern without fear of affecting the correctness of the indications. The vernier reads to ·002 of an inch, and the whole

FIG. 13.

instrument is arranged in the most compact and convenient form for safety in travelling, and obtaining very accurate altitude measurements.

Price, Including Brass Tripod Stand (as fig. 12) and Travelling Case for the Barometer, with English or Millimetre Scale £10 10 0

12. **Standard Mountain Barometer** of simpler form and smaller tube. *Price* £8 8 0

13. **Standard Syphon Barometer** (Gay Lussac's), divided on the glass tube, suited for **Laboratory use** (fig. 13), mounted on mahogany board, with thermometer and two verniers. *Price* £5 5 0

14. **Standard Syphon Tube Mountain Barometer** (Gay Lussac's), with attached thermometer, and improvement in the tube for excluding air. This is shown in fig. 14, and known as Gay Lussac's Air Trap: its use being to arrest any air that may pass up between the glass and the mercury. The bubbles of air are stopped and collected at the shoulder of the trap at K, and cannot possibly get up into the tube. This barometer is light and convenient for travelling. The graduations are upon the brass tube with verniers at each extremity reading from the centre. By adding the two readings together the correct height of column is obtained to $\frac{1}{500}$th of an inch.

Price of Barometer, in leather travelling case, with Brass Tripod Stand (fig. 15) £8 8 0

This Syphon Barometer does not require correction for either capillarity or capacity, as each surface of the mercury is equally depressed by capillary attraction, and the quantity of mercury which falls from the long limb of the tube occupies the same length in the short one. The barometric height must, however, be corrected for temperature, as in the cistern barometer.

FIG. 14.

15. **Board of Trade Standard or Kew Marine Barometer,** bronzed brass frame, with iron cistern, and mounted on mahogany board, as in fig. 16. The graduations on the scale are so arranged that the exact reading can be obtained at once, without any previous adjustment of the level of the mercury in the cistern, as in the Fortin barometer. *Price* £5 5 0

16. **Meteorological Office Station Barometer,** Bronzed metal frame, with iron cistern and glass scales mounted on mahogany board. Exact readings can be taken without any previous adjustment of the mercury, fig. 17. *Price*, £7 7 0

17. **Board of Trade Marine Barometer,** similar to No. 16, but mounted on arm, with gymbal ring, instead of a mahogany board. *Price*, Packed in travelling case . £4 4 0

18. **FitzRoy's Marine Gun Barometer,** constructed by Messrs. Negretti & Zambra under the *immediate superintendence, and named by permission of,* the Admiral for the special use of Her Majesty's navy, mounted with vulcanised India-rubber packing to prevent concussion and breakage caused by gun-firing.

Packed in case	£5 10 0
Extra tube for ditto	1 15 0

See also Section Marine Barometers.

Trials of the FitzRoy Marine Barometer under Fire of Guns.—Some of the first barometers made by Messrs. Negretti and Zambra on Admiral FitzRoy's principle were severely tried under the heaviest naval gun firing, on board H. M.S. *Excellent;* and under all the circumstances they withstood the concussion. The purpose of the trials was "to ascertain whether the *vulcanised India-rubber packing* round the glass tube of a *new marine barometer* did check the vibration caused by firing, and whether guns might be fired close to these instruments without causing injury to them." In the first and second series of experiments, a marine barometer on Admiral FitzRoy's plan was tried against a marine barometer on the Kew principle, both instruments being new, and treated in all respects similarly. They were "hung over the gun, under the gun, and by the side of the gun,—the latter both inside and outside a bulkhead; in fact, in all ways that they would be tried in action with the bulkheads cleared away." The result was that the Kew barometer was broken and rendered useless, while the new pattern barometer was not injured in the least. In a third series of experiments, Mr. Negretti being present, five of the new pattern barometers were subjected to the concussion produced by firing a 68-pounder gun with shot, and 16lbs. charge of powder. They were suspended from a beam immediately under the gun, then from a beam immediately over the gun, and finally they were suspended by the arm to the bulkhead, at the distance of only 3ft. 6in from the axis of the gun; and the result was, according to the official report, "that all these barometers, however suspended, would stand, without the slightest injury, the most severe concussion that they would ever be likely to experience in any sea-going man-of-war." These trials were conducted under the superintendence of Captain Hewlett, C.B., and the guns were fired in the course of his *usual* instructions. His reports to Admiral FitzRoy, giving all the particulars of the trials, are published in the "Ninth number of *Meteorological Papers,*" issued by the Board of Trade.*

* With reference to these barometers, we have received the subjoined testimonial, with permission to use as we please.

"*Meteorologic Office, June 12th,* 1863.

"MESSRS. NEGRETTI AND ZAMBRA,

"The barometers which you have lately supplied to Her Majesty's ships through this Office are much approved, being good for general service, afloat or on land.

"(Signed) R. FITZROY."

Admiral FitzRoy writes :—

"This marine barometer, for Her Majesty's service, is adapted to *general* purposes.

"It differs from barometers hitherto made in points of details, rather than principle :— 1. The glass tube is packed with vulcanised India-rubber, which checks vibration from concussion, but does not hold it rigidly, or prevent expansion. 2. It does not oscillate (or pump), though extremely sensitive. 3. The scale is porcelain, *very legible,* and not liable to change. 4. There is no iron anywhere (*to rust*). 5. Every part can be unscrewed, examined, or cleaned, by any careful person.

"These barometers are graduated to hundredths, and they will be found accurate to *that* degree, namely, the second decimal of an inch."

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19. **Negretti & Zambra's Short Tube Barometer,** specially constructed by N. & Z. for **Balloon** experiments, Altitude Measurements, or for use at elevated mountain stations. *Price* £7 7 0

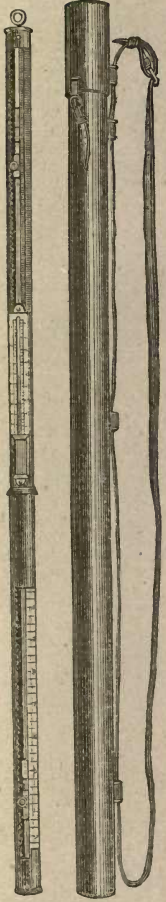

FIG. 15.

FIG. 17.

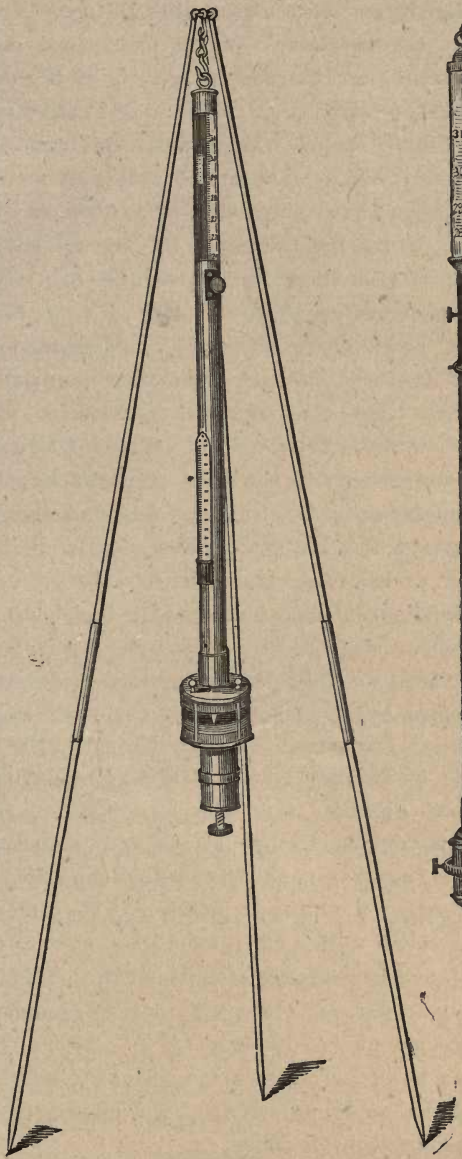

FIG. 12.

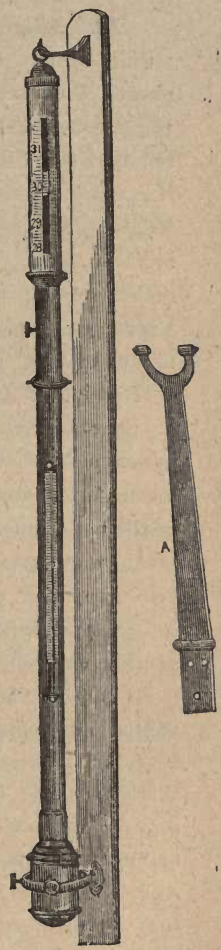

FIG. 16.

20. **Negretti and Zambra's Students' Standard Barometer.** In laying off and dividing the scale of this instrument, allowances have been made to compensate for the ordinary rise and fall of the mercury, making it sufficiently accurate for observers who do not wish to incur the expense of Fortin's arrangement for adjusting to a Zero Point. Fig. 16. *Price* £5 5 0

21. **Magnifying the Barometer Range.**—The limit within which the barometric column oscillates, does not exceed four inches for extreme range, while the ordinary range is confined to about two inches; and it has often been felt that the utility of the instrument would be much enhanced if by any means the scale indications could be increased in length. This object has been sought to be obtained by bending the upper part of the tube from the vertical, so that the inches on the scale could be increased in length. Such an instrument was invented by Sir S. Moreland, in 1772, and named by him "the Diagonal Barometer." Another variation of Barometer, invented by M. Cassini, and improved by M. J. Benoulli, about the same date, was constructed with the upper part of the tube expanded into a large Bulb, and the lower part of the tube giving the scale is very much contracted in the bore, and bent at a right angle. From this the instrument was termed the Horizontal Rectangular Barometer. The upper part of the Barometer tube has also been formed into a Spiral, with the scale placed along it, which is thus greatly enlarged.

Another form of Extended Range Barometer was invented and made by M. Amontons in 1695, and named by him the Pendent Barometer. It is a Mercurial Barometer, the upper half of the tube (the indicating portion) being of *smaller* internal diameter than the lower half. By this arrangement, an extended range of scale is obtained. The *lower* end of this tube *is open*, and the mercury supported in it at varying distances by the upward pressure of the atmosphere, very similar in action to that of Howson's Barometer.

Like the previously described instruments, this Barometer can only be regarded as a scientific curiosity, and is very subject to become out of adjustment in transit. This is unfortunate, as these Barometers are curiously sensitive, or perhaps we should more properly say, the movements of the mercury are rendered more visible.

These methods of enlargement Barometer indications are not so convenient as Dr. Hook's elegant arrangement employed in the ordinary Dial or Wheel Barometer. Therefore they are now very little used, and are of very little practical utility.

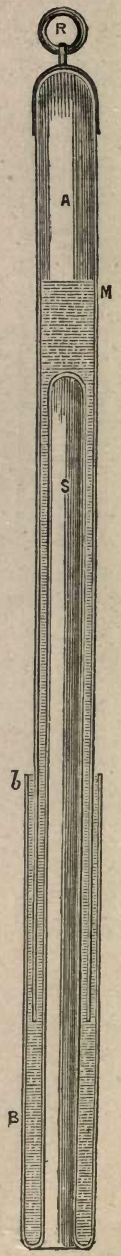

FIG. 18.

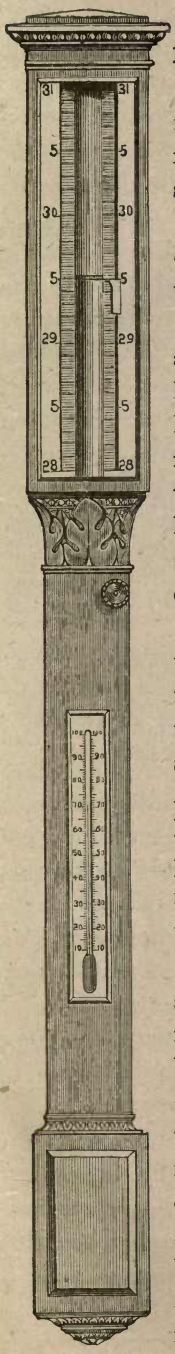

FIG. 18*.

22. **Negretti and Zambra's Howson's Patent Long Range Barometer.**

"The object of this instrument is to add to the sensitiveness of the ordinary mercurial column, by giving it an increased range, a desideratum which it appears to accomplish with simplicity and efficiency.

"The principle of construction will be understood on reference to the diagram, fig. 18, which represents a section of the working parts of the barometer divested of its case.

"A is the barometer tube, which is of large dimensions, and of greater length than usual in proportion to the additional length of range which it is intended to apply to it. The cistern, B, is of a tubular shape, so as to contain a fixed depth of mercury, also determinable by the range. To the bottom of this cistern is attached, concentrically, a light glass stem or long hollow tube, S, hermetically sealed, springing to a height of about 28 inches above the fixed level of the mercury in the cistern.

"When all the parts are *in situ*, as in the diagram, fig 18*, the tube A being freely suspended, and the whole filled with the requisite quantity of mercury, the immediate result of the arrangement is that the cistern hangs in suspension without any fixed support. The stem C, it will be observed, passes up the tube A, and terminates a little below the upper level of the mercury M: its upper end is therefore exposed to no more downward pressure than that caused by the weight of the mercury above it, and consequently there is an excess of upward pressure from the atmosphere exteriorly which tends to raise the cistern.

"If we suppose, for instance, the area of the stem to be half a square inch, and its top to be covered with 1 inch in depth of mercury (the space above being of course a vacuum), there will be a pressure tending to push the cistern downwards of only $\frac{1}{4}$ lb. or thereabouts, while the atmosphere will be pressing upwards on an equal area with a force of 7 lbs. or more. Thus it will be seen that when the excess of upward pressure is exactly balanced by the weight of the cistern with its stem, and contained mercury up to the level *b*, an equilibrium will be established which will keep the cistern stationary. If from any cause the cistern should become lighter, it will ascend: if it should become heavier, it will descend, and the extent to which it will move in either case will be limited by the immer-

sion or emersion of the tube A, or rather of the glass which bounds it. This is precisely the action which takes place under the influence of the fluctuations of atmospheric pressure. For, let the internal area of the tube A be supposed to be 1 square inch, and let a barometric rise take place equal to 1 inch by the ordinary standard, it is evident that a cubic inch of mercury will under these conditions leave the cistern, pass into the tube, and accumulate above the top of the stem: consequently the cistern, being relieved of a portion of its weight, will be pushed upwards until the cubic inch is replaced by the immersion of the glass of the tube A. As soon as this point has been reached it will become stationary; but in the meantime, in the act of rising, it will have pushed up the entire column before it; so that the total rise of the top of the column will be compounded of two motions, viz., of the ordinary barometric rise, and the rise of the cistern. The converse of this takes place on the occurrence of a diminution of atmospheric pressure. When the column moves, the cistern follows it, and when the cistern moves, it drags the entire column with it.

"The instrument has been in use for many years, and its movements have been found to follow with accuracy those of the best standard Barometers. Its sensitiveness and activity during storms is conspicuous. There is also another advantage which this construction confers, viz., that the cistern is self-adjusting with regard to its level. Readings may be taken to three places of decimals without a vernier, and without any adjustment for variation of level in the cistern. At the same time, the error due to temperature is of an almost inappreciable amount." * *Price*, in Ornamental carved Oak Case as fig. 18*. £14 14 0

23. **McNield's Long Range Barometer.**—A barometer designed on a directly opposite principle to the one just described. The tube is made to float on the mercury in the cistern. It is filled with mercury, inverted in the usual manner, then allowed to float, being held vertically by glass points or guides. By this contrivance, the ordinary range of the barometer is greatly increased. As the mercury falls in the tube with a decrease of pressure, the surface of the mercury in the cistern rises, and the floating tube rises also, which causes an additional descent in the column, as shown by graduations on the tube. With an increase of pressure, mercury will leave the cistern and rise in the tube, while the tube itself will fall, and so cause an additional ascent of mercury.

Price, £12 12 0

Both Howson's and McNield's Barometers are constructed by Negretti and Zambra with scales of from five to eight times that of the ordinary standard. Their sensitiveness is consequently increased in an equal proportion, and they have the additional advantage of not being affected by differences of level in the cistern.

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* *Extract from the Proceedings of the British Meteorological Society, Nov. 20th*, 1861. Vol. i. p. 81.

Negretti and Zambra's Self-compensating Standard Barometer consists of the usual form of standard instrument, but attached to the vernier is a double rack moved by one pinion, so that when adjusting the vernier in one position, the second rack moves in the opposite direction, carrying along with it a plunger (the exact size of the internal diameter of the tube) dipping in the cistern, so that whatever displacement has taken place in the cistern, owing to the rise or fall of the mercury, it is exactly compensated by the plunger being more or less immersed in the mercury, consequently no capacity correction is required. *Price*, £18 18 0

Standard Barometer, with Electrical Adjustment.—This barometer consists of an upright glass tube dipping into a glass cistern of mercury, so contrived, that an up-and-down movement, by means of a screw, can be imparted to it. Through the top of the tube a piece of platinum wire is passed and hermetically sealed. The cistern also has a metallic connection, so that by means of copper wires (in the back of the frame) a galvanic circuit is established; another connection also exists by means of a metallic point dipping into the cistern. The circuit, however, can be cut off from this by means of a switch placed about midway up the frame. On one side of the tube is placed a scale of inches; with a small circular vernier, divided into 100 parts, connected with the dipping point, and working at right angles with this scale.

For taking an observation, a galvanic battery is connected by two binding screws at the bottom of the frame. The switch is turned upwards, thereby disconnecting the dipping point; the cistern is then screwed up, so that the mercury in the tube is brought into contact with the platinum wire at the top; the instant this is effected a *magnetic needle* arranged as a galvanometer on the barometer board will be deflected. The switch is now turned down; by so doing the connection with the upper platinum wire is cut off, and established between the dipping point carrying the circular vernier and the bottom of the cistern; the point is now screwed by means of the milled head until the *needle* is again deflected, and the line on the vernier cutting the division on the scale is the exact reading of the barometer. *Price*, £18 18 0

The two Barometers above-mentioned were exhibited by Negretti and Zambra at the Meeting of the Royal Meteorological Society, March, 1886.

24. **The Water Barometer** first constructed by Professor Daniell of King's College for the Royal Society in 1830 was fitted up under his superintendence at their rooms in Somerset House. It consisted of a glass tube 40 feet in length and about one inch in diameter. This barometer was in action at Somerset House for some two years, and a series of observations made with it showed "that the Water Barometer preceded by one hour the indications of a mercurial instrument having a column of mercury of $\frac{1}{2}$ inch diameter."

On the removal of the Royal Society from Somerset House this Water Barometer was taken down by Messrs. Negretti and Zambra, refilled, and mounted by them at the Crystal Palace, Sydenham, where for a short time it excited considerable interest, but owing to various causes the indications were found to be incorrect scientifically. Eventually the instrument was destroyed by fire during the winter of 1866. At the suggestion of Dr. D. Price another Water Barometer was erected by Mr. Jordan for the Crystal Palace Company; but although the Water Barometer is of great interest as a weather glass, its indications were again found to be of but little scientific value, owing to the effect of varying temperature on the aqueous vapour above the column of water. This difficulty led to the substitution by Mr. Jordan of glycerine for water, and the construction of the now well-known Jordan Glycerine Barometer, one of which is erected at the *Times* office and one also at the Kew Observatory by a grant from the Royal Society. Mr. Whipple, the director at Kew, states the records obtained by it are fairly satisfactory.

The tube of the Glycerine Barometer is composed chiefly of ordinary composition gas tubing of $\frac{5}{8}$ inch internal diameter: to this is very carefully joined and cemented about four feet of glass tube one inch internal diameter. The upper end of this tube is formed into a funnel-shaped cup, having a conical shaped stopper of India-rubber arranged for conveniently filling and adjusting the instrument. The glass portion of the tube is the indicating part of the barometer. Suitable divided scales are placed at the sides of the glass portion of the tube, one showing inches and tenths of absolute measure, and on the opposite side another scale of equivalent values of a column of mercury at a temperature of 60° Fahrenheit.

R. H. Scott, Esq., of the Royal Meteorological Society, writes that during the continuance of a violent gale and storm, "a fall of more than 16 inches of glycerine has been noted." "The movements of the glycerine column are 10·76 times greater than those of the mercurial column at the standard temperature, 333·57 inches of glycerine being equivalent to 31 inches of the mercurial barometer." We are chiefly indebted for these details of the Glycerine Barometer to Mr. Jordan's Pamphlet,* to which we refer our readers for further particulars as to the construction and use of the instrument.

* *The Glycerine Barometer with Plate and Table of Corrections for Temperature*, by James B. Jordan, Mining Record Office Museum of Practical Geology. Price, One Shilling.

It will be seen that owing to the great length of the tube, viz., 27 feet, Jordan's Barometer can only be fitted up in very few buildings. To gain the advantage of so extended a range of scale in a convenient sized instrument, Messrs. Negretti and Zambra have constructed their

NEW LONG RANGE MERCURIAL AND GLYCERINE BAROMETER.

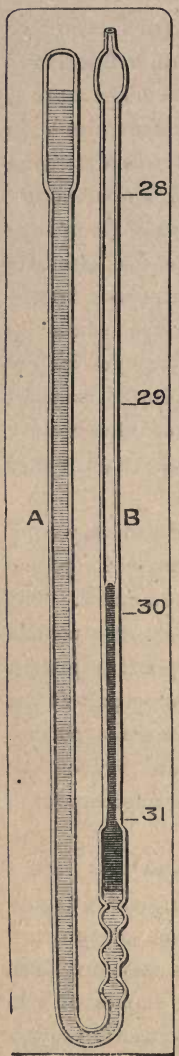

FIG. 19.

24*. The Long Range or Open Scale Barometer is shown in section in fig. 19. It consists of a glass tube of the syphon form; one side of the syphon, A, or closed end, being about 33½ inches long, and the other only a few inches in length. To this short end is joined a length of glass tubing, B, of a much smaller (internal) diameter; both tubes are of equal length, the smaller one being open at the top. The large tube, A, is filled with Mercury, and the small tube, B, partly filled with Glycerine, a fluid many times lighter in specific gravity than Mercury; the rising and falling of the mercurial column in the large tube having a lighter fluid to balance, and that dispersed over a larger space by reason of the difference in the diameter of the two tubes, a longer range is obtained, *due both to the unequal capacity of the two tubes and the difference in the specific gravity of Mercury and Glycerine.*

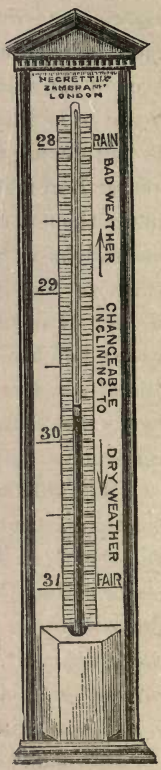

FIG. 20.

The range of these barometers is from six to ten inches to the inch of the ordinary Mercurial Barometer. $\frac{1}{100}$ of an inch can easily be observed without the use of a vernier. It is a most interesting instrument, as from the extremely extended scale the slightest variation is plainly visible. The actual size and form is about that of an ordinary Barometer, as seen in fig. 20; extreme length about 40 inches.

Price, as fig. 20	£5 5 0
Do., with Portable Stop Cock . .	5 10 0

SELF-REGISTERING BAROMETERS.

For many years a good and accurate self-recording barometer was much desired. This want is now satisfactorily supplied, not by one, but by several descriptions of apparatus. The first was the design of Admiral Sir A. Milne, who himself constructed, in 1857, we believe, the original instrument, which he used with much success.

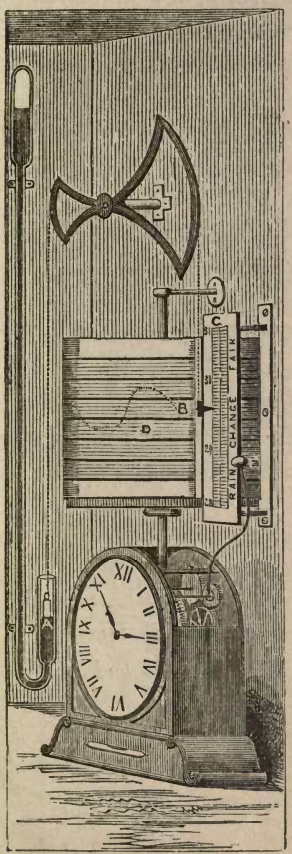

FIG. 21.

25. **Negretti and Zambra's improved Self-Registering Mercurial Barometer or Barograph.**—In this instrument the various parts of the mechanism have been so modified and arranged that the record on the papers is obtained with the greatest precision and delicacy. The engraving (fig. 21) will give the general details. It should, however, be mentioned, that it *is not a picture of the outward appearance of the instrument.* The position of the barometer should be behind the clock; it is represented on one side merely for the purpose of clearly illustrating the arrangement. The instrument has a large syphon barometer tube, in which the mercurial column is represented. On the mercury at *A*, floats a glass weight, attached to a silk cord, the other end of which is connected to the top of the arched head on the short arm of a lever-beam. The long arm of this beam is twice the length of the short arm, for the following reason. As the mercury falls in the long limb, it rises through an equal space in the short limb of the tube, and *vice versa.* But the barometric column is the difference of height of the mercury in the two limbs; hence the rise or fall of the float through half-an-inch will correspond to a decrease or an increase of the barometric column of one inch. In order, then, to record truly the movements of the mercurial column, and not those of the float, the arm of the beam connected with the float is only half the radius of the other arm. From the top of the large arched head a piece of watch-chain descends, and is attached to the marker, *B*, which properly counterpoises the float, *A*, and is capable of easy movement along a groove in a brass bar, so as to indicate the barometric height on an ivory scale, *C*, fixed on the same vertical framing. On the opposite side of the marker, *B*, is a metallic point, which faces the registration sheet and is nearly in

contact with it. The framing, which carries the scale and marker, is an arrangement of brass bars, delicately adjusted and controlled by springs, so as to permit of a quick horizontal motion being communicated to it by the action of the hammer, *E*, of the clock, whereby the point of the marker is caused to impress a dot upon the paper. The same clock gives rotation to the cylinder, *D*, upon which is mounted the registering paper. The clock must be re-wound when a fresh paper is attached to the cylinder, which may be daily, weekly, or monthly, according to construction; and the series of dots impressed upon the paper shows the height of the barometric column every hour by day and night. The space traversed by the marker is precisely equal to the range of the barometric column.

Price, in an Ornamental Oak Case, fig. 21 £18 18 0 and 22 0 0

26. **King's Self-Registering Barometer.** Mr. Alfred King, Engineer of the Liverpool Gas-Light Company, designed, in 1854, a barometer to register, by a continuous pencil-tracing, the variations in the weight of the atmosphere; and a highly-satisfactory instrument, on his principle, and constructed under his immediate superintendence, was erected at the Liverpool Observatory.

Fig. 22 is a front elevation of this Barometer. *A*, the barometer tube, is three inches internal diameter, and it floats freely (not being fixed as usual) in the fixed cistern, *B*, guided by friction-wheels, *W*. The top end of the tube is fastened to a chain, which passes over a grooved wheel, turning on friction rollers. The other end of the chain supports the frame, *D*, which carries the tracing pencil. The frame is suitably weighted and guided, and faces the cylinder, *C*, around which the tracing paper is wrapped, and which rotates once in twenty-four hours by a clock movement. For one inch change in the mercurial column the pencil is moved through five inches, so that the horizontal lines on the

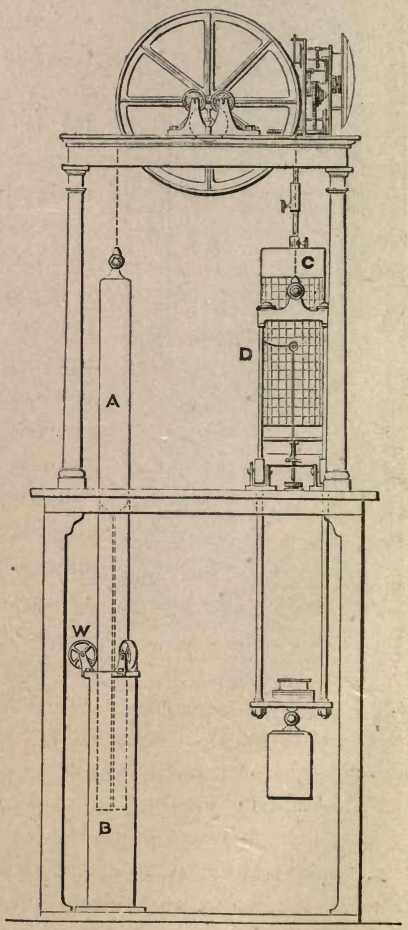

Fig. 22.

tracing, which are half an inch apart, represent one-tenth of an inch change in the barometer. The vertical lines are hour lines, and being nearly three-quarters of an inch apart, it will be seen that the smallest appreciable change in the barometer, and the time of its occurrence, are recorded. The barometer in this instrument is similar to Mr. McNeild's "Long-Range Barometer," described page 16. Constructed to order £280 to £300

THE ANEROID BAROMETER.

27. **The Aneroid Barometer.** The extremely ingenious instrument called the *Aneroid*, is no less remarkable for the scientific principles of its construction and action, than for the nicety of its mechanism. As its name implies, it is constructed "without fluid." It was invented by M. Vidi, of Paris. In the general form in which it is made it consists of a brass cylindrical case about five inches in diameter and two inches deep, faced with a dial graduated and marked similarly to the dial-plate of a "wheel-barometer," upon which the index or pointer shows the atmospheric pressure in inches and decimals in accordance with the mercurial barometer. Within the case, is placed a flat metal box made of German Silver, generally not more than half an inch deep and about two inches or a little more in diameter, from which nearly all the air is exhausted. The top and bottom of this box is corrugated in concentric circles, so as to yield inwardly to external pressure, and return when it is removed. The pressure of the atmosphere continually changes, and with this varying pressure, the top and bottom of the box approach to and recede from each other by a small quantity; but the bottom being fixed to the base, nearly all this motion takes place on the top. The top of the box is elastic, and rises and falls according as the compressing force lessens or increases. To the eye these expansions and contractions are not perceptible, so small is the motion. But they are rendered very evident by a delicate mechanical arrangement, communicating with a system of levers; and, by the intervention of a piece of watch-chain and a fine spring passing round the arbour, turning the index to the right or left, according as the external pressure increases or decreases. Thus, when by increase of pressure the vacuum box is compressed, the mechanism transfers the movement to the index, and it moves to the right; when the vacuum box expands under diminished pressure, the motion is reversed, and the index moves to the left. As the index traverses the dial, it shows upon the scale the pressure corresponding with a good mercurial barometer.

The Aneroid being placed under the receiver of an air pump the scale is laid off to correspond with a Mercurial Barometer Gauge, and afterwards compared and corrected by a Standard instrument.

The engraving (fig. 23) represents the latest improved mechanism of an aneroid. The outer casing and face of the instrument are removed, but the index hand is left attached to the arbour. *A* is the corrugated vacuum box which has been exhausted of air through the tube *J*, and hermetically sealed by soldering. *B* is a powerful curved spring, resting in gudgeons fixed on the base-plate, and attached to a socket behind, *F*, in the top of the vacuum box. A lever, *C*, joined to the stout edge of the spring, is connected, by the bent lever at *D*, with the chain, *E*, the other end of which is coiled round, and fastened to the arbour, *F*. As the box, *A*, is compressed by the weight of the atmosphere increasing, the spring, *B*, is tightened, the lever, *C*, depressed, and the chain, *E*, uncoiled from *F*, which is thereby turned so that the hand, *H*, moves to the right. In the meanwhile the spiral spring, *G*, coiled round *F*, and fixed at one extremity to the frame-work, and by the other to *F*, is compressed. When, therefore, the pressure decreases, *A* and *B* relax, by virtue of their elasticity; *E* slackens, *G* unwinds, turning *F*, which carries the index hand, *H*, to the left. Near *J* is shown an iron pillar, cast as part of the stock of the spring, *B*. A screw works in this pillar through the bottom of the plate, by means of which the spring, *B*, may be so adjusted to the box, *A*, as to set the index, *H*, to read on the scale in accordance with the indications of a Mercurial Barometer. In the higher class of aneroid barometers, the lever, *C*, is formed of a compound bar of brass and steel, so skilfully arranged as to perfectly compensate for the effects of extreme variations of temperature.

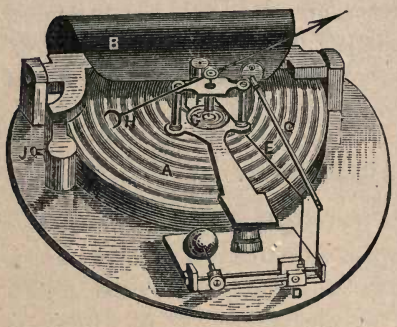

FIG 23.

The greatest perfection in Aneroids is now attained by having as perfect and dry a Vacuum as possible. Compensation being obtained by the compound metal bar previously mentioned.

A Thermometer is sometimes attached to the Aneroid, as it is convenient for indicating the present temperature of the air, but for accuracy and safety from breakage, N. and Z. recommend the use of a separate Thermometer.

Admiral FitzRoy, in his *Barometer Manual*, writes: "The Aneroid is quick in showing the variation of atmospheric pressure; and to the navigator who knows the difficulty, at times, of using barometers, this instrument is a great boon, for it can be placed anywhere, quite out of harm's way, and is not affected by the ship's motion, although faithfully giving indication of increased or diminished pressure of air. In ascending or descending elevations, the hand of the Aneroid may be seen to move (like the hand of a watch), showing the

height above the level of the sea, or the difference of level between places of comparison."

Aneroid barometers, if occasionally compared with a mercurial standard, are similar in their indications, and valuable; but it must be remembered that for exact scientific observation, the Aneroid barometer cannot be put into comparison with the mercurial column for strict accuracy, although its convenient size and great sensibility render it most useful for obtaining observations where a mercurial instrument is inconvenient to carry.

Col. Sir H. James, R.E., in his *Instructions for taking Meteorological Observations,* says of the Aneroid: "This is a most valuable instrument, it is extremely portable. I have had one in use for upwards of ten years."

One of the objects of Mr. Glaisher's experiments in balloons was "to compare the readings of an Aneroid barometer with those of a mercurial barometer." In the comparisons the readings of the mercurial barometer were corrected for index-error and temperature. Speaking of Aneroid indications,* Mr. Glaisher remarks:—

"A third (Aneroid) graduated down to five inches, and most carefully made and tested under the air-pump before use, read the same as the Mercurial Barometer throughout the high ascent to seven miles, September 5th, 1862.† I have taken this instrument up with me in every subsequent high ascent, and it has always read the same as the Mercurial Barometer. These experiments prove that an Aneroid can be made to read correctly at low pressures.

FIG. 24.

"I may mention that on several occasions, Aneroid Barometers have been taken whose graduations have been too limited for the heights reached: these have not broken or become

* *Travels in the Air.* By F. Glaisher. Page 89. The Aneroid Barometer.

† Wolverhampton to Cold Weston, near Ludlow, September 5th, 1862.

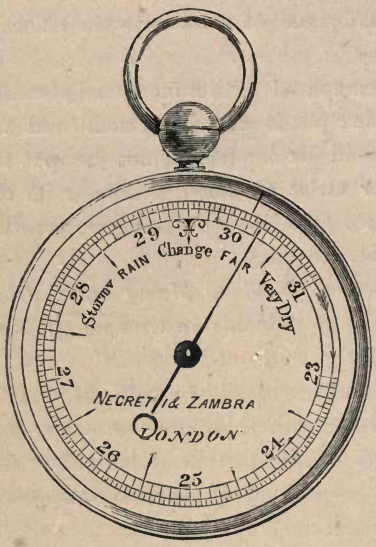

FIG. 25.

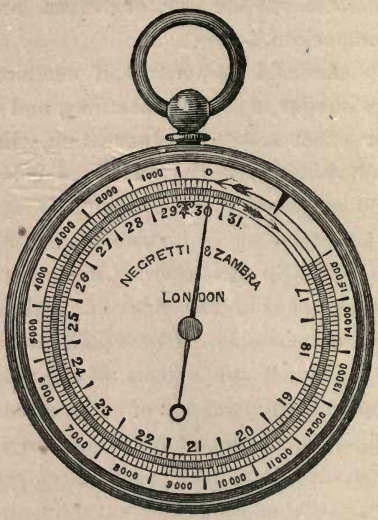

FIG. 26.

deranged by being subjected to a much less pressure than they were prepared for, but have resumed their readings on the pressure again coming within their graduations." The Aneroids used by Mr. Glaisher were made for him by Messrs. Negretti and Zambra.

Directions for using the Aneroid.—Aneroids are generally suspended with the dial vertical; but if they be placed with the dial horizontal, the indications differ a few hundredths of an inch in the two positions. Therefore, *if their indications are to be recorded, the instrument should be read off always in the same position.*

As before observed, the Aneroid will not answer for exact scientific purposes, as its error of indication changes slowly, and hence the necessity of its being set from time to time with the reading of a Standard Barometer. To allow of this being done, at the base of the outer case is a screw in connection with the spring attached to the vacuum box. By applying a small screw-driver to this screw, the spring of the vacuum box may be tightened or relaxed, and the index hand adjusted to the right or left on the dial, as in correcting a watch.

28. **Pocket Aneroid Barometers.**—The patent for the Aneroid having expired, Admiral FitzRoy urged upon Messrs. Negretti and Zambra the desirability of reducing the size of the instrument as then made, as well as of improving its mechanical arrangement, and compensation for temperature. They accordingly at great expense, labour, and experiment, succeeded in reducing its dimensions to two inches in diameter, and an inch and a quarter thick. The exact size and appearance of these Aneroids is shown by fig. 24.

For prices of Aneroid Barometers see page 29.

29. **Watch Aneroid.**—Negretti and Zambra have still further reduced the size of the Aneroid to that of an ordinary watch, our engravings, figs. 25, 26 showing their exact size. By a beautifully simple contrivance, a milled rim is constructed to move round, and carry with it the index or pointer over the scale engraved on the dial, for the purpose of marking the reading, so that any increase or decrease of pressure may be readily seen. These very small instruments are found to act quite as correctly as the largest, and are much more convenient. Besides serving the purpose of a weather-glass in the house or away from home, if carried in the pocket, they are admirably suited to the exigencies of tourists and travellers. They may be had with scale sufficient to measure heights of 20,000 feet; with a scale of elevation in feet, as well as of pressure in inches, engraved on the dial. The scale of elevation, which is for the temperature of 50°, was computed by Professor Airy, late Astronomer Royal, who kindly presented it to Messrs. Negretti and Zambra, for publication.* Moderate-sized Aneroids, fitted in leather sling cases, are found very serviceable to pilots, fishermen, and for use in coasting and small vessels, where a mercurial barometer cannot be employed, because requiring too much space."

Negretti and Zambra's Watch-sized Aneroid Barometers, figs. 25 and 26, have now for many years been fully tried and tested, as ordinary Weather Indicators, for obtaining Altitude Measurements, and also for Mining purposes. From the very extensive patronage afforded to them by Government authorities (for Military and Naval service), Engineers, Surveyors, and Scientific Observers, &c., N. and Z. feel justified in giving their unqualified recommendation to these instruments, for Travellers' use, as being both accurate and convenient.

30. Our woodcuts, figs. 24, 25, 26, show form and actual size of the most useful Aneroid Barometers. Fig. 24 being our Pocket size. Fig. 25 our Watch size, with the simple Barometer Scale of inches and 20ths of an inch. This same size instrument is manufactured with Altitude Scales ranging from 10 to 20 thousand feet. Fig. 26 is of similar size to the preceding, but has the *Altitude Scale arranged to revolve*, so that the zero or 0 of this scale being set to the point occupied by the Index at the commencement of the ascent, the elevation attained above the starting point may be at once seen in a *rough way* on the scale. The divisions of this scale not being absolutely similar all round, causes an error in the reading, therefore, *where exact observations are desired*, the zero of the scale should be placed opposite to the 31 point, and the indications read off in the usual manner by inches and fractions, their value being known by reference to the Altitude Tables sent with the instrument, so that this form of Aneroid combines both methods of observing in one instrument.

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* See List of Books on Meteorology at end of this section.

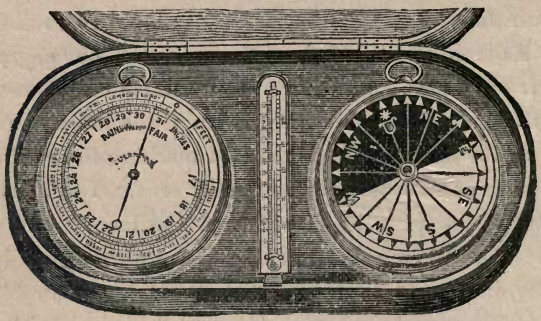

FIG. 27.

Our fig. 27 shows one of the most convenient arrangements yet introduced, viz., a Watch-sized Aneroid, with a reliable Thermometer and Compass. The hinged leather case containing the three instruments, being but little larger than an ordinary portemonnaie. *Price*, see page 29.

31. **Measurement of Heights by the Aneroid.**—The dial of the Watch Aneroid for determining altitudes is engraved with two scales in concentric circles, the inner circle being divided into inches and tenths of an inch, corresponding with the scale of the Mercurial column of a Standard Barometer. The outer circle is divided into spaces representing 100 feet, each tenth division being numbered as 1,000, 2,000, &c. The zero point of this circle corresponds with 31 inches of the Barometer scale, for this reason, that the Barometer never rises so high as 31 inches, consequently, our scale of feet is always outside the weather range. The zero of the feet scale has nothing whatever to do with the sea-level, that is a variable point and must be determined at the time of observation either by actual measurement at half tide level, or by computation from a known height.

32. **Measurement of Altitudes above Sea Level.**—In order to determine the height of any station above the sea-level with this instrument, we must notice at what point it stands at the shore; we then ascend, and on reaching the desired point, observe the position of the index on the dial. We then deduct the number of feet opposite the reading on starting from that against the reading at the elevated station, this gives the height above the level of the sea. Thus, if at sea-level, the barometer stands at 30 inches, and at the elevation it stands at 26 inches we get 900 feet, deducted from 4,800 feet, giving us a height of 3,900 feet, and so on for the other points of the scale.

When great accuracy is required, simultaneous observations must be taken at the two stations to obviate any error that might arise from a change of weather between the times of observation.

Further instructions for altitude measurement will be found in Negretti and Zambra's Treatise on Meteorological Instruments.

33. "Great storms are invariably preceded by a fall in the barometer of from ·05 to ·10 of an inch per hour. Storms from the eastward sometimes give less *local* warning, but they are well foretold by the increase of *statical force*. Storms of a cyclonic character travel, it has been found, on an average about 20 miles an hour towards some point between NE. and SE., generally towards the former. They, therefore, take about twenty-four hours to traverse the British Isles, from the time of their commencement in the west of Ireland. The east coasts may thus be warned one day in advance by the telegraph; and as the approach of a storm can be foreseen at the place threatened hours before its advent, notice of gales may usually be given from one to two days in advance. As regards the exact time and locality, the prognostication of storms must necessarily present much difficulty. The forecaster must be guided in these respects rather by experience, to be gained by practice, than by principles; little information can be given without going into a complete examination of particular storms, each of which would present points of difference."

Strachan's Weather Forecasts.

NEGRETTI AND ZAMBRA'S SELF-RECORDING ANEROID BAROMETERS.

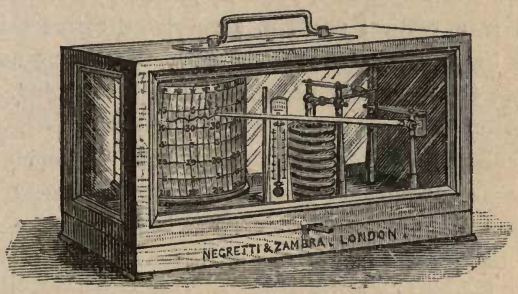

FIG. 28.

34. This instrument registers automatically with ink upon a ruled paper chart attached to a vertical cylinder revolved for seven days by means of a Clock movement inside it. The fluctuations of atmospheric pressure act upon seven Aneroid vacuum chambers, connected by an exceedingly simple mechanical contrivance to a long lever arm carrying the Pen, by which a magnified diagram is produced upon the paper on the cylinder of the rise or fall or present height of the Barometric column. These papers are ruled to represent inches and tenths of the Mercurial Barometer Scale. A small Thermometer is mounted upon the base of the instrument.

Price, in a Glazed Cabinet, as shown in fig. 28 . . £7 10 0

Ruled Papers, per Hundred, for above . . . 18 0

NEGRETTI AND ZAMBRA'S

SELF-RECORDING ANEROID BAROMETER.

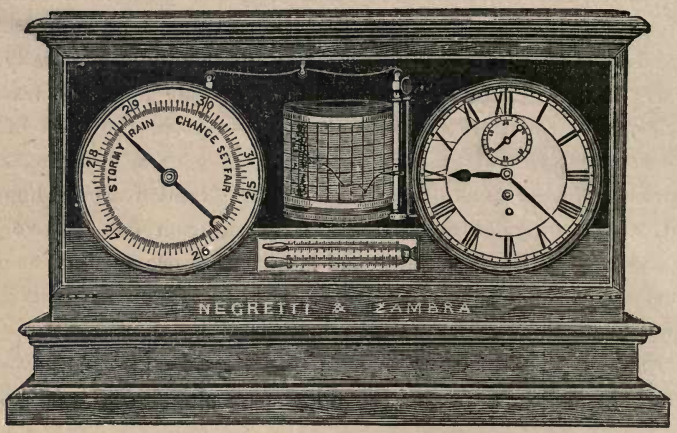

Fig. 29.

35. These Instruments are arranged to show the various fluctuations that have taken place in the Barometer during the absence of the observer. They consist of a carefully finished Aneroid, and an eight-day Clock; between these is placed in a vertical position, a revolving cylinder having a metallic paper attached to it ruled to coincide with the inches and tenths of the barometer scale. Close to this paper, is a pencil mounted on a metallic rod and is moved up and down as the variation of atmospheric pressure acts upon the vacuum chamber of the Aneroid; at every hour this pencil is made to mark the paper by simple mechanism in connection with the clock.

By this means a black dotted curved line is produced on the paper, showing at a glance the present height of the barometer—whether it is falling or rising—for how long it has been doing so, and at what rate the change has taken place—if falling or rising at the rate of one-tenth of an inch per hour, or one-tenth in twenty-four hours; all of which are particulars most essential to know when foretelling the weather, and which can only be obtained from an ordinary barometer by very frequent and regular observations.

Our engraving (fig. 29.) shows the full mounting of the Registering Aneroid, combining a reliable Timepiece with an exceeedingly interesting Meteorological Instrument, of a suitable and convenient size for a library or dining room mantel-shelf.

Recording Aneroid Barometer with Thermometer, as shown fig. 29			
Price,	£22	0	0
Large size ditto ditto with more Ornamental Mounting .	27	10	0
Ruled charts for the above, per Hundred	1	1	0

STANDARD ANEROID BAROMETERS.

Compared and Corrected Scale Aneroid, Compensated for temperature, as supplied to the Royal Navy and Meteorological Department	5	5	0
Surveyors' or Engineers' Aneroid Barometer for Altitude Measurements, Compensated for temperature, with Revolving Ring, carrying Index, range of Scale, 10,000 feet, 4½ inches diameter	7	7	0
Full Range Engineers' Altitude and Surveying or Balloon Aneroid, corrected and Compensated for temperature, with 20,000 feet, Altitude scale (See engraving in Surveying Instrument Section)	8	8	0
Mining Surveyors' Aneroid Barometer, with a Scale reading to 7,000 feet above the Sea Level to 2,000 feet below . .	5	10	0
Leather Case with Sling Strap, for any of the above . .	0	12	6
Pocket-Sized Aneroid, with Revolving Ring carrying Index (size shown in fig. 24)	4	4	0
Mountain Aneroid Barometer, Pocket-Size, for measuring Altitudes to 10,000 feet, Compensated for temperature	5	5	0
Ditto ditto ditto to 20,000 feet, fig. 24 . . .	6	6	0
Watch-Sized Aneroid Barometer, of best Construction, Compensated for temperature, for Meteorological Observations or Altitude Measurements to 10,000 feet, (size shown in fig. 26)	5	5	0
Watch-Sized Aneroid Barometer, to 20,000 feet . . .	6	6	0
Watch-Sized Aneroid Barometer, with *Revolving* Altitude Scale for 10,000 or 20,000 feet (*See page* 25) . . £5 10 0	6	10	0
Watch-Sized Aneroid Barometers, with **Thermometer and Compass,** in Morocco Pocket Case (fig. 27.) . £7 7 0 and	8	8	0
Watch-Sized Aneroid Barometers in Solid Gold Cases £15 15 0 *to*	21	0	0
Ditto ditto in Stout Silver Cases . . £6 6 0 and	7	7	0

Aneroid Barometers may be had with the French Metrical Scale, or with the English and corresponding French Scale engraved on the same instrument.

In the Section of our Catalogue "Household Barometers"—will be found an illustrated price list of Aneroid Barometers in Ornamental Mountings, suited for the Drawing Room, Library or Hall, Ships or Yachts, &c.

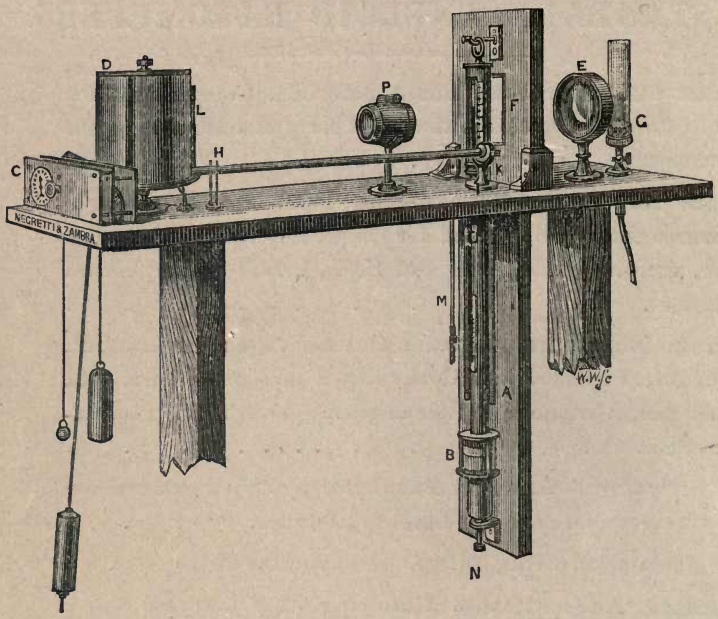

Fig. 30.

36. **Recording Mercurial Barometer or Barograph**—for automatically recording the variations of atmospheric pressure by Photography. Recommended by the Meteorological Committee of the Royal Society, and used by many of the principal Meteorological Observatories.

Fig. 30. exhibits the general arrangement of this Barograph. B is a Standard Mercurial Barometer mounted upon a mahogany board and table, facing it is a Drum D, to which is attached the sensitised Photographic Paper. This cylinder is revolved once in 24 or 48 hours by the clock C. A Condensing Lens, E, projects the light from the Gas Burner G through the space F over the edge of the mercurial column, and thence to the photographic combination lens P, by which an image of the mercurial column is formed upon the sensitive paper on the drum for a regulated space of time. A screen or shutter L acted upon by the clock cuts off this image for the space of four minutes every two hours, leaving white lines upon the photographic paper representing intervals of two hours. At the side of the barometer tube are placed two zinc rods attached to the barometer board at the lower ends at A. These rods are connected at their upper ends with a delicate mechanical arrangement H and K, so contrived as to compensate for varying Thermometric changes in the mercurial column, these variations of temperature being also recorded upon the sensitive paper.

Attached to the apparatus is, a glass cylinder, M, (of the same internal diameter as the Barometer tube), partly filled with mercury, into which is placed a sensitive Standard Thermometer for giving the temperature of the surrounding air. B is an adjusting screw for regulating the height of the barometer upon its support. The apparatus when in action is enclosed in a light tight box.

The Barograph is constructed to special order, the cost varying from Sixty to Seventy Guineas.

INSTRUMENTS FOR ASCERTAINING THE TEMPERATURE OF THE AIR.

THERMOMETERS.

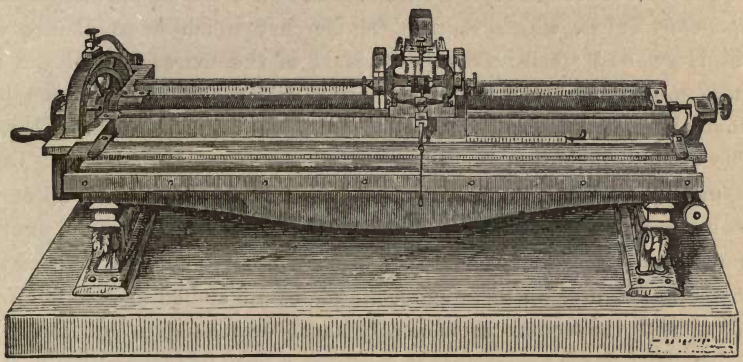

FIG. 31.

37. Undoubtedly there is no instrument the use of which has so greatly increased in the past few years as the Thermometer: not only is it now essential to the scientific observer, the meteorologist, the physician, and the chemist; but both for domestic uses and manufacturing processes a really accurate thermometer is indispensable. The following is a list of the various forms of Standard Thermometers manufactured by Negretti and Zambra; all of these, to ensure extreme accuracy, have their scales divided by the Prize Dividing Engine (fig. 31) to which was awarded a Prize Medal at the Great Exhibition of 1851, and is described in the Report of the Jurors as follows:—

"This is a beautifully contrived Divider on Ramsden's principle, with a long fine steel screw. The novelties are—first, the wheel at the screw head, which is divided into 400 parts, and has cut upon its circumference (which is made broad) a helix screw, in the thread of which runs a detent, carried along by the run of the thread till it meets a stop clamped on the helix at a definite point. This arrests the screw at this point of the motion. A Prize Medal was awarded."

Messrs. Negretti and Zambra supply Dividing Engines made on the above principle both for circular and straight line divisions.

Price . . £35 to £150

NOTE.—From Report of the Juries of the Exhibition of 1851. "Negretti and Zambra are the only exhibitors in the British portion who have sent *Thermometers with their stems graduated*—the only safe instruments for delicate experiments."

STANDARD THERMOMETERS.

Two important improvements in the Tubes and Scales of Thermometers and Barometers, first introduced by Negretti and Zambra, have become so extensively used that N. and Z. deem a short notice necessary to secure to themselves the credit of the inventions.

The first improvement is the introduction of a white Enamel at the back of Thermometer Tubes, which renders the mercury much more plainly visible both in large and small-bore tubes. Most of the extremely delicate Thermometers now in use would have been almost useless but for this enamelling.

This invention has also been applied to the back of Barometer Tubes.

The second invention is the use of Porcelain for Scales and Dials of Thermometers, Barometers, &c., in place of metal, ivory, or wood, all of which so soon become soiled and tarnished, and eventually the divisions and figures are obliterated by the action of the atmosphere, sea-water, or damp. The divisions and figures on these porcelain plates are etched in with fluoric acid, and the colour permanently burnt or melted in by fire. That these are important inventions may be inferred from their use in all thermometers and barometers supplied to the Board of Trade and other Government departments.

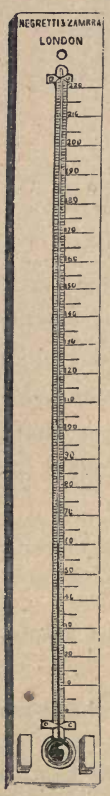

FIG. 32.

38. **Independent Standard Thermometer** (fig 32), with Negretti and Zambra's Enamelled tube, and Engine-divided into either Fahrenheit or Centigrade scales, the divisions engraved on its own stem and mounted on silvered brass, boxwood, or Negretti and Zambra's Patent Porcelain Scales.

Price, £5 5 0
Kew Certificate for above Thermometer 0 5 0

39. **Comparative Standard Thermometers** (fig. 33). These Thermometers are made by comparison with great care, from an accurate standard, correct to $\frac{1}{10}$ of a degree. Engine-divided Enamelled Tubes mounted on Silvered Brass or Negretti and Zambra's Patent Porcelain Scales, with Mahogany or Oak framing. *Price*, £2 2 0 and £2 10 0


FIG. 33.

N. & Z's Standard Thermometers are made from selected tubes, the internal diameter of which is ascertained by very carefully conducted experiments. They are also strictly tested for index error, and a copy of the corrections, if any, furnished with each instrument, if required.

We recommend the Standard Thermometers not to be mounted in any way, but the tube to be enclosed in a strong outer glass jacket; the bulb dipping

FIG. 35.

FIG. 34.

FIG. 36.

into a reservoir of mercury, and the whole hermetically sealed, as in our Standard Deep-sea Thermometers; by these means the bulb is effectually protected from the pressure of the atmosphere, either from barometrical changes or difference in altitude, and the divisions on the stem are so covered by the outer glass tube that they cannot be effaced or become invisible.

40. **Board of Trade Thermometer.**—It consists of a carefully compared thermometer with Negretti and Zambra's enamelled tube divided on its stem to degrees, which are sufficiently large to admit of sub-division into tenths of degrees and ranging from 0° to 130°. The scale is of Negretti and Zambra's Patent Porcelain, having the figures etched upon it, and burnt in a permanent black. It is a reliable comparative or reference thermometer, adapted for almost any ordinary purpose, and cannot be injuriously affected by any chemical action arising from air or sea-water. (Fig. 34). This thermometer is employed in

the Royal Navy and for the observations made at sea for the Board of Trade and Meteorological Department.

Price, in Neat Japanned Case	0 10 6
Ditto Copper Case	0 12 6
A set of 6 Ditto ditto, in Copper Cases, fitted in a Mahogany Box .	£2 10 0

41. **Thermometers of Extreme Sensitiveness.**—Negretti and Zambra's Instantaneous Thermometer, with Gridiron form of bulb, and divided upon the stem, as shown in the International Exhibition of 1862, used by Mr. Glaisher in his Balloon ascents to obtain very rapid thermometric readings. (Fig. 35) *Price*, £3 3 0 *to* £6 6 0

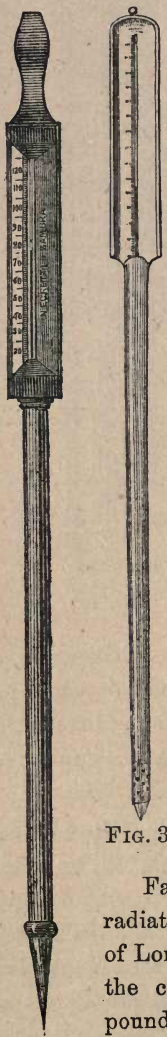

FIG. 37.

FIG. 38.

42. **Thermometers, very delicate,** with Spiral or Coiled bulbs, engine-divided upon the stem, mounted on boxwood, metal, or opal glass scales. Fig. 36.

Price, £2 2 0 *and* £3 3 0

43. **Earth Thermometer**—for ascertaining the temperature of the soil at various depths. The tube is about five feet long, enclosed in stout wood, protected and strengthened by metal mountings and a pointed cap. The scale is of Negretti and Zambra's Patent Porcelain with enamelled and burnt-in divisions and figures. Figs. 37 and 38. *Price*, £1 15 0 *and* £2 2 0

44. Earth Thermometers in series for inserting into the ground at depths of 6 inches, 12 inches, 24 inches, 48 inches and 120 inches. These thermometers are arranged with a scale about 6 inches above the earth.

Price for the series £7 7 0

45. The temperature of the soil is a very important element in the consideration of climate especially in connection with the growth of vegetation.—"It has been calculated by Mr. Raikes, from experiments made at Chat Moss, that the temperature of the soil when drained averages 10° higher than it does when undrained; and this is not surprising when we find that 1lb. of water evaporated from 1,000 lbs. of soil will depress the whole by 10°, owing to the latent heat which it absorbs in its conversion into vapour."

Faraday has calculated that the average amount of heat radiated in a day from the sun on each acre of earth in the latitude of London, is equivalent to that which would be produced from the combustion of thirteen thousand four hundred and forty pounds of coal.

"The extremes of temperature in the different climates of the

earth are widely separated from each other, and the range of the thermometer is always greatest in the interior of the continents within the tropics. Mr Campbell, in the country of the Botchuanas, saw the thermometer at 8 a.m. at 28°, and at 84° at noon. Mr. Bruce records a temperature at Gondar of 113°. The thermometer at Benares rises to 118°; at Sierra Leone the thermometer on the ground has been seen to rise to 138°, and Humboldt gives many instances of the temperature of the torrid zone rising to 118°, 120°, and 129°. At one time he found the temperature of a loose, coarse-grained granite, in the sun, 140·5. In the Dukhun at a height of 3,090 feet above the sea, Col. Sykes once saw the thermometer in the shade at 105°, the range of the thermometer generally being from 93°.9 to 40°.5."

Slightly beneath the surface of the earth in the tropics, Humboldt states temperatures of 162° and 134° are frequently noted, and in white sand at Orinoco 140°, whilst at the Cape of Good Hope under the soil of a bulb garden a temperature of 150° is recorded by Herschell. In China, the temperature of water of the fields was found to be by Meyer 113° and adjacent sand much hotter. These extremes of temperature, which would cause the specific gravity of the air to vary from 1167 to 863, may serve as a kind of measure of the disturbing causes which interfere with the velocity and local direction of atmospheric currents and other phenomena, the calculation of which has been founded upon mean results.—*Daniell's Meteorology.*

It is stated that *below the layer of constant temperature* (estimated at about 80 to 90 feet from the earth's surface), the temperature is found to increase one degree Centigrade for every 100 feet.

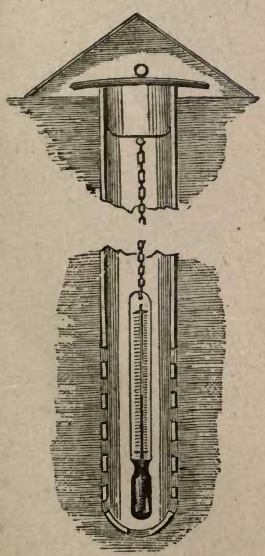

FIG. 39.

46. **Earth Thermometer, Symons' Arrangement,** with NEGRETTI & ZAMBRA'S Slow Action Thermometer. An iron tube closed at the lower end is forced down into the earth, and secured at the desired depth, and the thermometer lowered down into it by a cord or chain to the bottom, and allowed to remain a sufficient time; when the temperature is to be noted, it is quickly drawn up and its indication observed. The great advantage of this method of obtaining Earth Temperatures is that the thermometer can at any time be *compared with a Standard,* which is a difficult if not almost impossible operation to be carried out with Thermometers of great length (fig 39). *Also see fig.* 49, *page* 42.

Price, according to length, £1 1 0 £1 5 0
£1 10 0, £2 2 0.

By means of these instruments it has been found that variations depending on the hour of the day are

scarcely sensible at a depth of 2 or 3 feet, and that those which depend on the time of year decrease gradually as the depth increases, but still remain sensible at the depth of 25 feet, the range of temperature during a year at this depth being usually about 2 or 3 degrees Fahr.

The mean rate of increase of temperature downwards is about 1 degree Fahr. for each 55 feet.

SELF-REGISTERING THERMOMETERS FOR HEAT.

Negretti and Zambra's Patent Self-registering Maximum Thermometer.

The only Instrument of the kind adapted for transmission to India and the Colonies.

47. Previous to the Great Exhibition of 1851, all persons interested in meteorological observations were constantly annoyed by the inconvenience arising from the imperfect construction of Maximum Thermometers; and although Messrs. Negretti and Zambra at that time exhibited one or two new forms of instruments, nothing new in *principle* was brought forward. A thermometer, *old in principle*, greatly improved by Negretti and Zambra, wherein a *bubble of air* caused a separation in the mercurial column to form an index, was exhibited by them; but as the air bubble at different temperatures assumed different lengths it was *not approved* by the Jury appointed to examine Meteorological Instruments. The instruments invented by Dr. Rutherford and Six, as Maximum Thermometers, had both proved inefficient for the purposes required; and although the best and most correct forms of these were also exhibited by Negretti and Zambra, they still saw that a great want would be met if a perfect instrument could be invented to indicate *Maximum* temperatures, all the above being imperfect—Rutherford's from the tendency of the index to plunge in the mercury, Six's from the different expansive properties of the alcohol, mercury, &c., of which it is composed, and the one already alluded to, not only from the defects before noticed, but also from its liability to resolve itself into an ordinary thermometer when used, unless in the hands of a skilful manipulator. How far the New Patent Maximum Thermometer of Negretti and Zambra has supplied all these deficiencies may be judged from the fact that in all the principal Observatories throughout the world it is used, *to the exclusion of all others, unless for the purposes of comparison.* They are now in the hands of all our most scientific men, and have given universal satisfaction. The simplicity of their construction enables the most uninitiated in thermometers to use them with confidence and safety; and another important feature in them is the impossibility of putting them out of order, for nothing short of actual breakage can in any way cause them to fail.

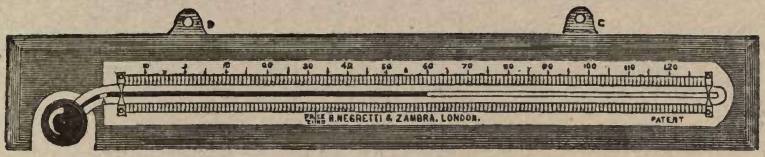

FIG 40.

48. **Negretti and Zambra's Patent Self-registering Standard Maximum Thermometer,** consists of a tube of mercury mounted on an engraved scale, as shown in fig 40. The thermometer tube above the mercury is entirely free from air; and at the point (A) in the bend above the ball, is inserted and fixed with the blow-pipe a small piece of solid glass, or enamel, which acts as a valve, allowing mercury to pass on one side of it when heat is applied; but not allowing it to return when the thermometer cools. When mercury has been once made to pass the valve, which nothing but heat can effect, and has risen in the tube, the upper end of the column registers the maximum temperature. To return the mercury to the bulb, we must apply a force equal to that which raised it in the tube; the force employed is gravity, and is applied by simply lowering the bulb end of the thermometer, when the gravity of the mercury in the tube will be sufficient to unite it with that in the bulb, and thus prepare the instrument for future observation.

Price, mounted with Negretti and Zambra's enamelled tube and Patent Porcelain or Opal glass Scale, fig. 40 . . . . . £1 1 0

The following is an extract from the *Report of the Astronomer Royal*, published shortly after the invention of the instrument—it, however, applies more strongly now, inasmuch as the intervening years have fully proved the efficiency and value of this invention:—

Report of the Astronomer Royal, May, 1852.

"We have for several years been very much troubled by the failures of the Maximum Self-Registering Thermometers, especially those exposed to the sun: the part of the tube in which the index ought to slide becomes foul, apparently lined with a coat of metal, and the index is immovable. A construction invented by Messrs. Negretti and Zambra appears likely to evade this difficulty. The mercury in its expansion is forced past an obstruction in the tube and does not return past in its contraction. No index is required in this construction. The specimens of this instrument which we have tried answer well."

In the *Quarterly Report of the Registrar General*, about the same time, there is the following annotation:—

"The form of instrument adopted during the past quarter for maximum temperature is that of Negretti and Zambra, which is found to act admirably."

J. GLAISHER, Esq., F.R.S., in his *Lectures on the Results of the Great Exhibition*, delivered at the Society of Arts, at the suggestion of his late Royal Highness the Prince Consort, when speaking of Meteorological Instruments (page 363) says:—

"In maximum and minimum thermometers there was nothing new exhibited, although great need had long existed for an effective Maximum Thermometer. Thanks to the exhibition, however, this want has

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* The whole of Negretti and Zambra's Standard Thermometers have their improved enamelled back tubes and are Engine-divided on the stem.

since been supplied. Messrs. Negretti and Zambra have invented a thermometer, the construction of which is as follows: a small piece of glass is inserted in the bend, near the bulb and within the tube, which it nearly fills: at an increase of temperature, the mercury passes this piece of glass; but on a decrease of heat, not being able to recede, it remains in the tube, and thus indicates the maximum temperature. After reading, it is easily adjusted. Four of these instruments I have had at work for upwards of a month, two in ordinary observations, and two subject to severe tests, and all have answered admirably. Hitherto every series of meteorological observations has been more or less broken by the frequent plunging of the steel index into the mercury, or becoming otherwise deranged. Messrs. Negretti and Zambra have, in their Maximum Thermometer, supplied a want long felt." *

Extract from the *Report of the Council of the British Meteorological Society*, read at a General Annual Meeting of its Members, 1852:—

"Negretti and Zambra's Thermometer, for the determination of maximum temperature, is one of the good results of the Great National Exhibition, which proved itself, as regarded meteorological instruments, a most useful exponent of the insufficiency of those sold to the general public; *this Thermometer is the best which has yet been constructed for maximum temperatures, and particularly for sun observations*; for as the reading is determined by the entire mercurial column being detained at its highest point by a simple contrivance within the tube, the necessity for an index is avoided, and with it the constant and distressing recurrence of derangement attendant upon the employment of those generally in use. This thermometer, constructed and brought into operation since the close of the Exhibition, has been for some time in the hands of Members of the Council, but only recently among its meteorological contributors, from its having been esteemed desirable that the Council should be well informed, by actual experiment, of the well-working of the instrument before sanctioning its general circulation. Accordingly, in the early part of the year, for some months several of Negretti and Zambra's Maximum Thermometers were subjected by our Secretary to severe tests, and as the results were highly satisfactory, *the Council have not only viewed this instrument as an addition to the practical meteorologist, but strongly recommended its adoption and general use.*"

Copy from the *Report of the Kew Committee of the British Association* 1853-4:—

"The very ingenious instrument of Messrs. Negretti and Zambra has one quality, which, as regards durability, places *it above every other form of Maximum Thermometer*, for when once well-constructed, it can never get out of order,—the observer having first satisfied himself as to its correctness, may ever afterwards use it with confidence, relying that his register will not be interrupted by any of those annoyances to which he may have been accustomed *in other forms of this instrument.*"

From E. J. Lowe, Esq., F.R.A.S., F.G.S., &c., &c., to Messrs. Negretti and Zambra.

"Gentlemen,—It affords me the greatest pleasure in being enabled to speak with praise regarding your Patent Maximum Thermometer. I have used a dozen of them for some time at both my observatories, and of these several since the date of their invention. In no single instance has there been any cause of complaint. Within the last few months I have carefully tested them in various ways, yet always with the most satisfactory results. I can therefore say with truth that your patent instrument is the best Self-Registering Maximum Thermometer which has ever passed through my hands; indeed, no observer can do without it."

Highfield House Observatory, near Nottingham.

Fig. 41.

49. **Negretti and Zambra's Patent Solar Radiation Thermometer** (fig. 41).—Consists of a mercurial thermometer with a blackened bulb, the

* The thermometers have now been used with equal satisfaction for thirty-five years.

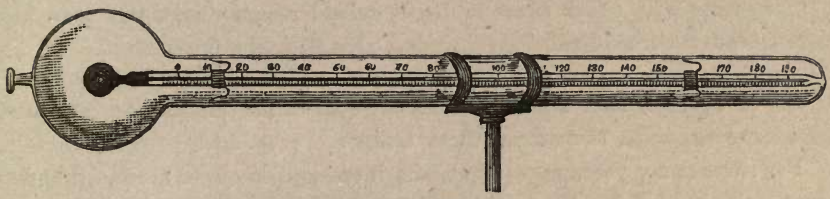

FIG. 42.

scale is engine-divided on the stem, and the divisions protected by a glass shield. In use, it should be placed horizontally, with its bulb in the full rays of the sun, resting on grass, and, if possible, so that lateral winds should not strike the bulb. The directions for use are identical with those for the determining of the temperature of the air. Fig. No. 41. *Price*, £1 1 0

50. **Vacuum Solar Radiation Thermometer** (fig. 42).—This instrument consists of Negretti and Zambra's blackened bulb Radiation Thermometer, enclosed in a glass tube and globe, from which all air is exhausted, as suggested by Sir John Herschel in the Admiralty Manual of Scientific Enquiry, in 1849. Thus protected from the loss of heat which would ensue if the bulb were exposed, its indications are from 20° to 30° higher than when placed side by side with a similar instrument with the bulb exposed to the passing air. At times when the air has been in rapid motion, the difference between the reading of a thermometer giving the true temperature of the air in the shade, and an ordinary solar radiation thermometer, has been 20° only, whilst the difference between the air temperature and the reading of a radiation thermometer in vacuo has been as large as 50°. It is also found that the readings are almost identical at distances from the earth varying from six inches to eighteen inches. By the use of this improved Solar Radiator the amounts of solar radiation at different places are rendered comparable; with the exposed bulb Thermometer, (fig. 41) the results could not be compared, as the bulbs of the thermometers would be under very different conditions as to exposure and currents of air. This new arrangement gives the readings very much more uniform, and is found to be a decided improvement. *Price*, £1 5 0

Instructions for use same as No. 48.

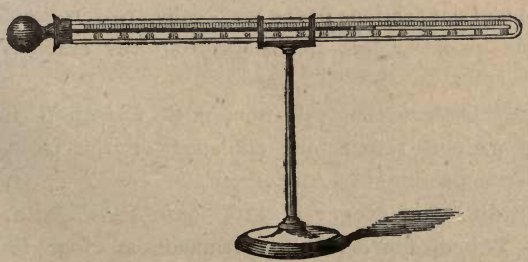

FIG. 43.

51. **Negretti and Zambra's Patent Registering Maximum Thermometer** with either *black* or *bright* bulbs for experiments on *radiant* or *reflected* heat, the scale divided on the stem, mounted on a brass stand.

Fig. 43. *Price*, £1 10 0

52. **Negretti and Zambra's Improved Solar Radiation Vacuum Thermometer, with Mercurial Test Gauge.** (Fig. 44.)

For some many years most important investigations have been in progress in connection with Solar Heat, and as it is evident that all such inquiry should be carried out with the utmost precision, a question arose as to the perfection of the vacuum in different Solar Radiation Thermometers, and hence a ready means of testing these instruments became desirable for the purposes of comparison.

Fig. 44.

Although this want had been repeatedly pointed out, no attempt had been made to remedy the defect. At last, we produced a Solar Radiation Thermometer with a small mercurial vacuum gauge inside the outer covering, which gives the exact amount of vacuum, or, it might more properly be called, the exact amount of air left in the space around the thermometer. The insertion of this small test gauge in the manner that it has been effected, is one of the most beautiful arrangements ever effected by the skill of the glass-blower. As a matter of course, having pointed out the road, other tests were devised. Among others, an electrical test, by inserting metal wires and connections in the two ends of the glass shield, by which a current of electricity from a Rhumkorf's Induction Coil can be passed through the tube, and the colour, &c., &c., of the electric discharge be observed. This test has two defects, viz., that coils and batteries are not always available, and also that the metal connections in the glass tube are very liable to fracture, and consequent leakage of air into the tubes from the cracking of the glass around the wires.

We need hardly observe that this is a most important invention and improvement, for, without satisfactory evidence of the perfection of the vacuum, strict experiment cannot be carried out. *Price*, £1 16 0

53. **Wood Stand for Negretti and Zambra's Patent Vacuum Solar Radiation Thermometer,** for experiments at four feet from the

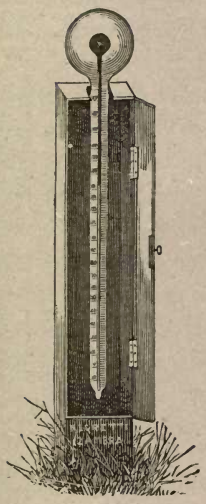

FIG. 46.

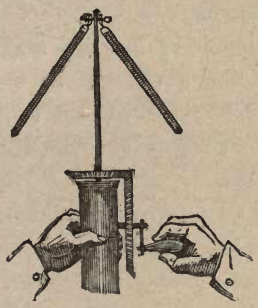

FIG. 47.

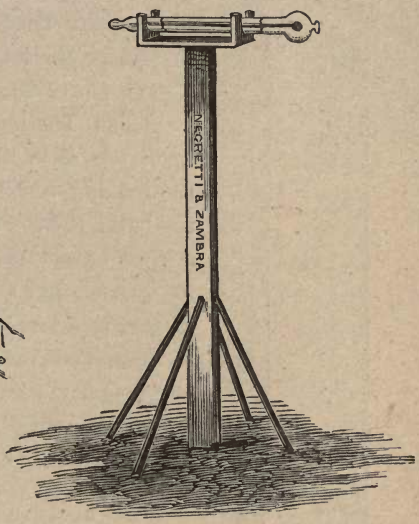

FIG. 45.

ground. Suggested and recommended by the Rev. F. W. Stow, who advises that the bulb end of the thermometer should be placed facing the S.E., and in such a manner that the air may circulate freely round it. Strict shade temperature should also be noted by a good Thermometer, so as to obtain the Maximum in sun and shade, and from these the amount of Solar Radiation may be deduced. Fig. 45. *Price*, £1 1 0

54. Fig. 46 shows a new arrangement of Negretti and Zambra's Patent Solar Radiation Maximum Thermometer in vacuo. It will be seen in the woodcut that the bulb of the Thermometer is exposed to the sky in a vertical position, with its stem enclosed by a light case or box. The scale is on the stem of the Thermometer, but, as in No. 57 the scale is figured the *reverse* of an ordinary instrument, the reading *commencing* from the *end* of the tube and *not* at the bulb. This arrangement has been introduced by N. and Z. to meet some requirements in connection with observations on solar temperatures where it has been supposed that a perfect sphere presented to the solar rays would give far more accurate indications than a projecting bulb such as seen in figs. 41 and 43. Fig. 46. *Price*, £1 15 0

55. **Negretti and Zambra's Patent Registering Clinical Thermometers** of various sizes and forms will be described in future sections with prices and illustrations.

56. **Babinet's Apparatus,** Sling Thermometer or Thermometer Fronde, for ascertaining the temperature of the Air by the rapid rotation of two sensitive Thermometers. Price with Thermometers. (Fig. 47.) £2 10s.

Fig. 48.

Fig. 49.

57. **Negretti and Zambra's Patent Self-Registering Maximum Thermometer,** for recording the Temperature of Mines, Thermal or Boiling Springs, Atmospheric or Earth Temperature, &c., &c.

This Thermometer has its scale divided and figured upon the stem, the REVERSE of an ordinary Thermometer—the reading *commencing* from the *end* of the tube and *not* at the bulb. The stem or tube is mounted in and protected by a stout glass shield, the bulb of the Thermometer being uppermost, and all mercury passing the bend or contraction in the tube will by gravity fall to the opposite end, and be detained and measured. The whole instrument is conveniently mounted in a round copper or brass case, with a handle or ring attached to the top for suspending the Thermometer. Fig. 48.

In use, the Instrument is suspended by the ring attached to the top of the metal mounting, and as it enters a heated atmosphere the mercury in the bulb expands into the tube, passing the *bend* or *contraction** near the bulb; whatever quantity of mercury passes the bend will remain in the tube, and *not recede when the temperature cools;* should thirty or forty degrees of mercury pass, it will of its own weight, fall to the end of the tube; should it *not do so*, hold the Thermometer in an *oblique* position, the *bulb end being lowest* so that the mercury in the tube may *very gradually* descend until it touches any mercury at the bend,† if now the bulb end be raised the mercury will again descend carrying with it any small particles that have passed the bend. When the mercury has all been collected at the end of tube, read off in degrees on the thermometer scale its indication, and that will be the Maximum Temperature.

To re-set the Thermometer hold it *bulb downwards*, and swing it backwards and forwards, to force back the excess of mercury, beyond the present temperature, into the bulb. This precaution should *always* be observed before commencing to take an observation.

Price, in Strong Metal Mountings, £1 10 0

57*. In our Section, "Thermometers for Special Purposes," will be found woodcuts of several other forms of these Instruments, with details as to their construction and use, and of fig. 49, for obtaining the temperature of Springs or Wells or Earth Temperatures, see also No. 46.

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* Sometimes a bend and sometimes a contraction is used to separate the indicating mercurial column.

† The tube should not be held upright, or portions of the mercury may pass by the bend into the bulb.

The following extract from the Fourth Report of the Committee on Underground Temperature, British Association for Advancement of Science, 1871, will sufficiently prove the advantages of Negretti and Zambra's Patent Maximum Thermometer without further comment:—

"The Thermometer which the Committee have been employing for the last three years is a Phillips's Maximum, having so fine a bore that the detached column of mercury which serves as the index is sustained in the vertical position by capillary action, and will bear a moderate amount of shaking without slipping down. Numerous instances, however, have occurred in which the *index has slipped* in consequence of jerks or concussions sustained by the thermometer in hauling it up from a depth. During the past six months the Secretary has been in correspondence with Messrs. Negretti and Zambra respecting a proposed modification of the Maximum Thermometer known by their name, which occurred to him more than a year ago, and was described by him privately to some meteorological friends at the last Meeting of the Association. It was then supposed to be new, but it now appears that Messrs. Negretti and Zambra have made something of the kind for the last fifteen years. Several changes, however, were necessary before the thermometer was adapted to the uses of the Committee, and the first complete instruments were received in June last. They are enclosed, like the thermometers previously used, in hermetically sealed tubes, for protection against pressure, and they have the advantages (1) *of being able to bear severe jolts without derangement of their indications, and* (2) *of presenting to view a much broader column of mercury, so as to be more easily read in a dim light.*

FIG. 50.

58. **Mercurial Thermometer, with large Cup shaped Bulb,** (fig. 50), convex on the one side and concave on the other, exposing a very large surface, suited for experiment on Radiant or Accumulated heat.

Price, Engine-divided on the Stem £1 5 0

59. **Negretti and Zambra's Patent Marine Maximum Thermometer,** (fig. 48.) As all other marine thermometers are liable to give false indications from the movements of the vessel in rough weather, this instrument becomes a most important improvement. It is constructed and used in a similar manner to No 57, the bulb of the thermometer being uppermost; and no oscillation, however violent, can disturb the indications. It is mounted in a strong wood or metal frame, suitable for sea service. *Price*, £1 1 0

60. **Helio-Pyrometer.** Mr. T. Southall, of Birmingham, has published some very remarkable results obtained with a Standard Maximum Registering Thermometer, having a Blackened Bulb placed within a shallow box lined throughout with black velvet, and having a soft cushion of the same material in the bottom. Upon this cushion the Thermometer is to be placed, and covered over as closely as possible by a piece of plate glass. Thus arranged, Accumulated Sun Temperatures have been noted by

Mr. Southall varying from 216 to nearly 232 degrees of temperature. In fact Mr. S. states he has, with this apparatus, caused Water *to boil* rapidly by Solar Heat.

Negretti and Zambra's Patent Maximum Thermometer will be found eminently suited for experiment with the Helio-Pyrometer, as there is no fear of the thermometer being spoilt by derangement of the index, as is the case with both Rutherford's and Phillips's instruments.

Price of complete Apparatus with N. and Z.'s Patent Maximum Thermometer £2 2 0

Extract from the *Report of the Council of the British Meteorological Society*, read at a General Annual Meeting of its Members, 1852 :—

"Negretti and Zambra's Thermometer, for the determination of maximum temperature, is one of the good results of the great National Exhibition, which proved itself, as regarded meteorological instruments, a most useful exponent of the insufficiency of those sold to the general public; **this Thermometer is the best which has yet been constructed for Maximum temperature, and particularly for Sun observations.**

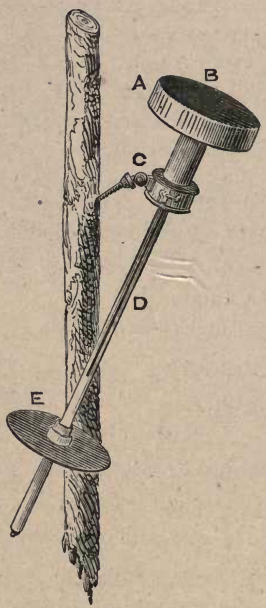


Fig. 51.

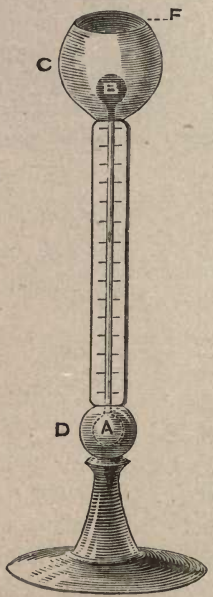


Fig. 52.

61. **Pyrheliometer** (Pouillett's) (fig. 51), for ascertaining the effect of the sun's heat upon a given area by the number of degrees of heat imparted to mercury in five minutes. *Price*, £5 5 0

This instrument is composed of a shallow cylinder of steel, *A*, fig. 51, which is filled with mercury. Into the cylinder a thermometer, *D*, is introduced, the stem of which is protected by a piece of brass tubing. We thus obtain the temperature of the mercury. The flat end of the cylinder is to be turned towards the sun, and the surface, *B*, thus presented is coated with lamp black.

There is a collar and screw, *C*, by means of which the instrument may be attached to a stake driven into the ground, or into the snow, if the observations are made at considerable heights. It is necessary that the surface which receives the sun's rays should be perpendicular to the rays; and this is secured by appending to the brass tube, which shields the stem of the thermometer, a disk, *E*, of the same diameter as the steel cylinder. When the shadow of the cylinder accurately covers the disc, we are sure that the rays fall, perpendicular, on the blackened surface of the cylinder.

"The surface on which the sun's rays here fall is known; the quantity of mercury within the cylinder is also known; hence we can express the effect of the sun's heat upon a given area, by stating that it is competent, in five minutes, to raise so much mercury so many degrees in temperature."—*Dr. Tyndall's "Heat considered as a Mode of Motion."*

62. **Æthrioscope** (Leslie's) (fig. 52.) The celebrated philosopher, Sir John Leslie, was the inventor of this instrument, the purpose of which is to give a comparative idea of the radiation proceeding from the surface of the earth towards the sky. It consists, as represented in fig. 52, of two glass bulbs united by a vertical glass tube, of so fine a bore that a little coloured liquid is supported in it by its own adhesion, there being air confined in each of the bulbs. The bulb, *A*, is enclosed in a highly polished brass sphere, *D*. The bulb, *B*, is blackened and placed in the centre of a metallic cup, *C*, which is well gilt on the inside, and which may be covered by a top, *F*. The brass coverings defend both bulbs from solar radiation, or any adventitious source of heat. When the top is on, the liquid remains at zero of the scale. On removing the top and presenting the instrument to a clear sky, either by night or by day, the bulb, *B*, is cooled by terrestrial radiation, while the bulb, *A*, retains the temperature of the air. The air confined in *B*, therefore, contracts; and the elasticity of that within *A* forces the liquid up the tube, to a height proportionate to the intensity of the radiation. Such is the sensitiveness of the instrument, that the smallest cloud passing over it checks the rise of the liquid.

Fig. 52. *Price*, £1 10 0

SELF-REGISTERING THERMOMETERS FOR COLD.

Fig. 53.

63. **Negretti and Zambra's Standard Minimum Thermometer.** (Fig. 53.) consists of an enamelled glass tube, the bulb and parts of the bore of which is filled with perfectly pure colourless Spirits of Wine, in which floats freely a

black glass index. The tube is engine divided and mounted as shown in fig. 53. on either N. and Z.'s patent Porcelain or Opal Glass Scales.

Directions for using Minimum Thermometers, for the Determination of the Minimum Temperature of the Air.—Having caused the black index to flow to the end of the column of spirit, by slightly tilting the Thermometer, bulb uppermost, suspend the instrument, (*in the shade* with the air passing freely to it on all sides) by the two plates attached for that purpose,—in such manner that the bulb is about half an inch lower than the end of the Thermometer furthest from the bulb,—then on a *decrease* of temperature, the spirit will descend, carrying with it the index towards the bulb; on an *increase* of temperature, the spirit will ascend in the tube beyond the index, leaving that end of the index furthest from the bulb indicating the extreme of cold or Minimum temperature. To re-set the instrument, simply raise the bulb end of the Thermometer a little, as before observed, and the index will again descend to the end of the spirit, ready for future observation.

Price, in mounting as fig. 53 £1 1 0

FIG. 54.

64. **Negretti and Zambra's Standard Terrestrial Radiation Thermometer.** (fig. 54).—The bulb of this instrument is transparent, with the divisions engraved on its stem similar to that for solar radiation. In use, to be placed with its bulb fully exposed to the sky, resting on grass, with its stem supported by little forks of wood. *Price*, £1 1 0

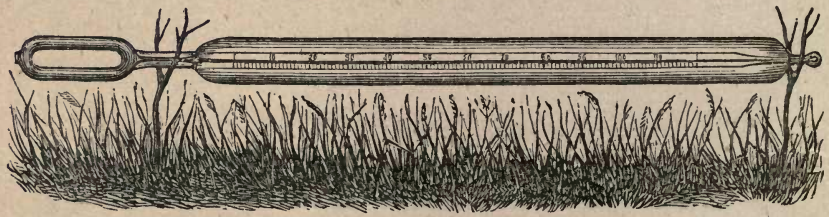


FIG. 55.

65. **Negretti and Zambra's Link shaped Bulb Minimum Thermometer,** mounted either as a Terrestrial Radiation instrument, fig. 55, or on a Porcelain scale as fig. 53. This peculiar form of bulb was devised by Negretti and Zambra to obtain extreme sensitiveness by the large surface exposed to air.

Price, £1 5 0

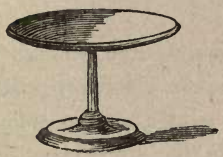


FIG. 57.

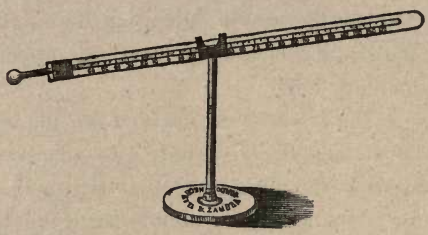


FIG. 56.

66. **Negretti and Zambra's Minimum or Terrestrial Radiation Thermometer with Brass Stand.** (fig. 56). *Price*, £1 5 0

67. **Concave Metallic Reflector on a Brass Stand for use with Terrestrial Radiation Thermometer** (fig. 57). *Price*, 5s. 6d.

N.B.—As Alcohol Thermometers have a tendency to read lower by age, owing to the volatile nature of the alcohol allowing particles in the form of vapour to rise and lodge in the tube, it becomes necessary to compare them occasionally with a Mercurial thermometer whose index error is known; and if the difference be more than a few tenths of a degree, *examine well the upper part of the tube* to see if any alcohol is in the bore, if so, detached portions can be joined to the main column by swinging the thermometer sharply backwards and forwards with a pendulous motion, keeping the *bulb downwards*. When all the detached portions are joined, allow it to stand upright for an hour before again suspending it for observations.

FIG. 58.

68. **Negretti and Zambra's Patent Mercurial Minimum Thermometer,** represented by fig. 58, has a cylindrical bulb of large size. The reason for having the bulb large is to allow the internal diameter of the thermometer tube to be greater than that generally used for thermometrical purposes, so that a steel index, pointed at both ends, may move freely within when required.

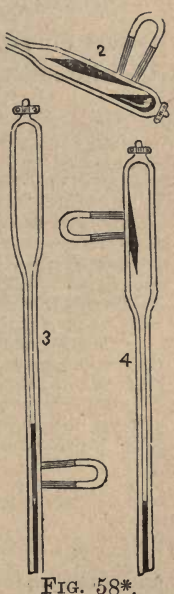


FIG. 58*.

In use, the Thermometer is suspended perpendicularly with the steel index resting on the surface of the mercurial column. As the mercury in the cylinder contracts from the effect of cold, that in the tube descends, and the index, of its own gravity, follows it; on the contrary, as the mercury expands and rises in the tube, it passes the index on one side, and in rising, exerts a lateral pressure on the needle, and jambs it to one side of the tube, where it remains firmly fixed, leaving the upper

point of the needle indicating the minimum temperature. In this thermometer the reading is always from the upper point of the needle, and not from the mercury itself.

To extricate the needle from the mercury, a magnet is used, when, if the needle is embedded only a few degrees, it can readily be withdrawn without altering the position of the instrument. Should the magnet not be sufficient for the purpose, we simply turn the thermometer from the upright position, slightly elevating the bulb (58*2). The mercury and index will then flow into the small reservoir (58*). Should the index not freely leave the tube with the mercury, assist it with a magnet and when the mercury and index are in the upper bulb (58*2), apply a magnet outside, which will attract and hold fast the index; and whilst thus holding it, again bring the thermometer to the upright position, when the mercury will immediately fall back into the tube, leaving the index attached to the magnet (fig. 4), with which it is guided down to the surface of the mercury, ready for another observation.

Price, £2 10 0

The value of these instruments may be estimated from the following letters, received from gentlemen by whom the thermometers have been tested since their invention.—

LEWISHAM, 1856, February 27.

"GENTLEMEN,—In reply to your note just received, I beg to say that your new Mercurial Minimum Thermometer was suspended by the side of two Minimum Thermometers of the best kind of the ordinary construction, on the day I received it from you, viz., 1855, November 21, and it has been examined and read every day since, during which interval of time the temperature has varied from 15° to 60°. It has acted equally well within this range. In the course of the experiments, it was found that at times differences amounting to 2° and 3° existed in the minimum readings between those of the new mercurial and old spirit thermometers. These differences were found due to two causes. The one occurred at low temperatures, and on reference to independent registers, it was found that the readings of the mercurial were right, the difference being attributable to the sluggishness of the alcohol; and, in the other case, it was found that the index of the ordinary thermometer had unduly moved towards the bulb, the instrument having been shaken by the wind.

"I consider the new Minimum Thermometer a very important addition—indeed a more important one than the Maximum Thermometer of your invention, as by its means we can register all observations of temperature by the use of one fluid, and that the recognised standard for the measurement of heat.

"With respect to your Maximum Thermometer, it acts admirably, and leaves scarcely anything to be desired. It has never been out of order during the four years* I have had it in constant use, and it does not seem possible to put it out of order, except by the destruction of the instrument.

"I am, Gentlemen, your obedient Servant,

"JAMES GLAISHER, F.R.S.

"Messrs. NEGRETTI and ZAMBRA, Opticians." "Secretary to the British Meteorological Society.

The following is an extract from a letter to the inventors, Messrs. NEGRETTI and ZAMBRA, from E. J. LOWE, Esq., dated *Observatory, Beeston, near Nottingham:*

"Your Patent Mercurial Thermometer is an admirable invention. I have worked it to my entire satisfaction. I have tested its usefulness in many different ways, every one of which has been perfectly satisfactory. It is certainly a meteorological triumph for which meteorologists must return you thanks."

Care must be taken not to withdraw the magnet until the index is in contact with the mercury, for, if released before touching, it might plunge too deeply and give a false indication. The rule for re-setting it will be to bring

* It is now more than twenty-nine years, and still the thermometer is perfect.

the needle-point in contact with the mercury, and then withdraw the magnet, having previously ascertained that no particles of mercury are attached to the index.

It may sometimes, though rarely, happen that, from the time a minimum temperature is registered by the index, and the time an observation is made, the mercury may have risen so high in the tube as to completely pass the index, as shown (fig. 3). Should it so happen, the space which the index occupies will readily be observed, as it will be pressed to one side of the tube, causing a different appearance in that part, although the point of the needle may not be seen. If such be the case, apply a magnet to the spot where you see the index is fixed: this will hold the needle firmly. Then, by slightly tilting the thermometer bulb uppermost, the mercury will flow into the top bulb, leaving the index attached to the magnet, and quite uncovered. Having taken the reading, draw the needle into the top bulb, and hold it there whilst you adjust the thermometer by again bringing it to the upright position.

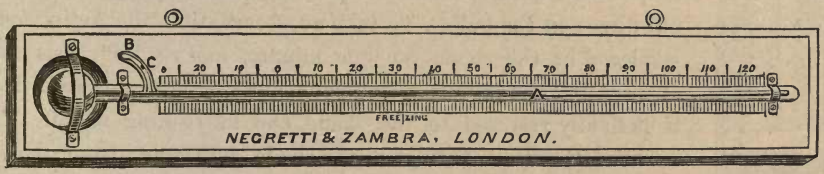
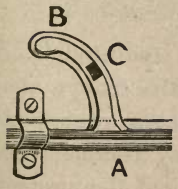


FIG. 59.

68. **Negretti and Zambra's Patent Mercurial Minimum Thermometer.** The Patent Mercurial Minimum Thermometer is constructed as follows: A is the thermometrical or indicating tube, and B is a small vertical tube connected to it at right angles, about one inch from the bulb. In the tube B, at the point C, is inserted a platinum plug, which does not entirely fill the bore, as may be seen by elevating either end of the instrument, as the mercury will then flow in the tube A, either to or from the bulb, depending upon which end of the thermometer is elevated or depressed.



To set for Observation, and use the Patent Mercurial Minimum Thermometer.—Hold the thermometer with the bulb downwards until the bulb and tube B are quite full of mercury; then raise the bulb end of the thermometer, and the mercury will flow from the tube B into the tube A, until it reaches the plug C, where it will be checked by the mercury adhering to the platinum plug —the affinity of platinum for mercury being sufficient to arrest the flow of mercury, if not allowed to flow too rapidly. Should it overshoot the mark and go to the end of the tube A repeat the operation more carefully.

Suspend the thermometer horizontally, and on a *decrease* of the temperature the mercury will fall in the tube A until it attains its minimum

temperature; and on an *increase* of temperature the mercury will rise in the tube B, leaving the indicating column in A, registering the extreme degree of cold, or minimum temperature. To re-set the instrument for future observation, simply raise the bulb end of the thermometer until the mercury again comes in contact, and is checked, by the platinum plug.

This form of Mercurial Minimum Thermometer has one very great advantage over the preceding instrument, viz., it is much less liable to injury or breakage in transit. *Price*, fig. 59. £2 2 0

Fig 60.

69. **Actinometer, Sir John Herschell's** (fig. 60), for ascertaining the absolute heating effect of the solar rays, in which *time* is considered one of the elements of observation. The Actinometer consists of a large cylindrical thermometer bulb, with a scale considerably lengthened, so that minute changes may be easily seen. The bulb is of transparent glass, filled with a deep blue liquid, which is expanded when the rays of the sun fall direct on the bulb. To take an observation, the Actinometer is placed in the shade for one minute, and read off, it is then exposed for one minute to sunshine, and its indication recorded; it is finally restored to the shade, and its reading noted. The mean of the two readings in the shade, subtracted from that in the sun, gives the actual amount of expansion of the liquid produced by the sun's rays in one minute of time. For further information see "*Report of the Royal Society on Physics and Meteorology.*" *Price*, £7 7 0

70. **Negretti and Zambra's improved Isolated Glass Mountings for protecting Thermometer Scales from moisture.** Many observers having found much trouble in reading the indications of Terrestrial Radiation and exposed Thermometers from the condensation of moisture on the inside of the protecting glass tubes or shields, Messrs. Negretti and Zambra have succeeded in perfecting a method of mounting up such instruments that quite obviates the difficulty. This improvement consists in so melting an external glass cylinder round both ends of the thermometer as to render the shield perfectly air-tight, in fact, to hermetically seal up the instrument in it—so that no moisture can possibly accumulate inside the tube, whilst the bulb of the thermometer is perfectly exposed to the air.

Negretti and Zambra are now applying this improvement with great advantage to Thermometers, Hygrometers, and many other instruments required for out of door exposure. These isolating mountings will make a slight addition to the cost of such Thermometers.

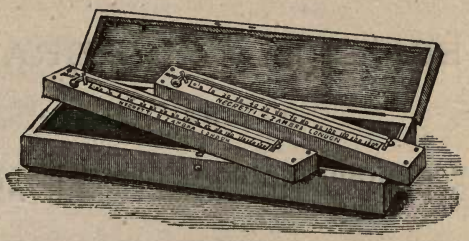


FIG. 61.

71. **Portable Patent Maximum and Minimum Registering Thermometers.**—Negretti and Zambra's Small Patent Maximum and Minimum Registering Pocket Thermometers, fitted into a secure and convenient pocket case, special for travellers. (fig. 61.) *Price* £2 2 0

Larger Standard size ditto 2 10 0

The construction and use of the Portable Registering Thermometers is identical with N. and Z.'s larger Standard instruments, Nos. 40 and 53. These are the only Registering Thermometers that will travel without derangement. Explicit printed instructions for use accompany each set.

72. **Marie Davy's Actinometer,** consisting of two Thermometers in vacuo, one with a bright and the other with a black bulb, both divided on the stems and mounted upon a suitable stand for out-door exposure. *Price*, £3 3 0

RULES FOR CONVERTING THERMOMETER READINGS.

To convert Fahrenheit readings to Centigrade.

Subtract 32 and multiply the remainder by $\frac{5}{9}$

e.g. 68° F.=(68—32)$\times\frac{5}{9}$= 20° C.

To convert Fahrenheit readings to Reaumur.

Subtract 32 and multiply the remainder by $\frac{4}{9}$

e.g. 68° F.=(68—32)$\times\frac{4}{9}$ = 16° R.

To convert Centigrade readings to Fahrenheit.

Multiply by $\frac{9}{5}$ and add 32.

To convert Reaumur degrees to Fahrenheit.

Multiply by $\frac{9}{4}$ and add 32.

To convert Centigrade to Reaumur.

Multiply by $\frac{4}{5}$

To convert Reaumur to Centigrade.

Multiply by $\frac{5}{4}$

NOTE.—All of Negretti and Zambra's Standard Thermometers may be had with Centigrade or Reaumur Scales to order.

NEGRETTI & ZAMBRA'S

PATENT

HOURLY RECORDING THERMOMETRICAL APPARATUS.

FIG. 62a.

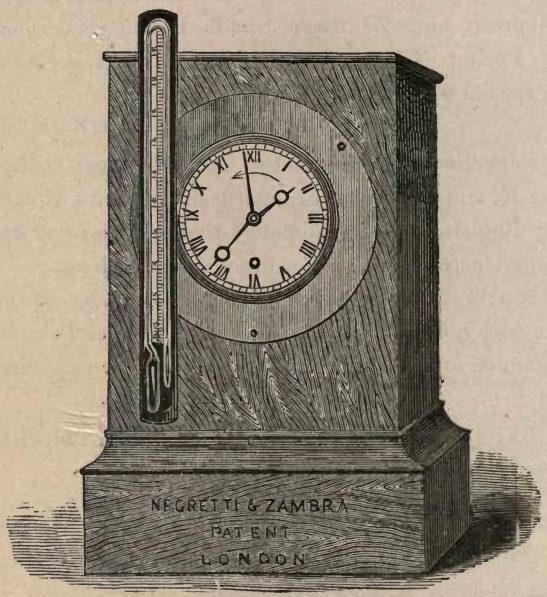


FIG. 62.

73. **Negretti and Zambra's Patent Atmospheric Recording Thermometer** (fig. 62). For any hour determined upon, the clock carrying the Thermometer is set (similar to an alarum clock), and when the hands arrive at this point of time, the movement of the clock releases a catch or detent, and the Thermometer* with its scale is revolved, the mercury then records the temperature of the air for that exact moment in a similar manner to those mentioned in the next page. These Recording Instruments are found to be a most important addition to our Meteorological Instruments, and no slight boon to observers in many parts of the world who are engaged in taking simultaneous observations with our own at fixed hours. *Price*, as fig. 62. £4 4 0

* *The Thermometer used with this apparatus is shown by fig.* 62a, *and is fully described on page* 53.

NEGRETTI AND ZAMBRA'S

PATENT HOURLY RECORDING THERMOMETRICAL APPARATUS.

An instrument for obtaining automatic thermometer readings at stated intervals of time having long been sought for—after many experiments, NEGRETTI & ZAMBRA have invented and constructed one both simple and accurate.

74. **Negretti & Zambra's Patent Hourly Recording Thermometrical Apparatus.** This new instrument consists of twelve Thermometers, mounted on a suitable stand, a good Clock, and a Galvanic Battery. The advantages are—simplicity of manipulation, both in taking the recorded readings and setting the thermometers for future observations; the most important one, being able to expose the thermometers *at any distance from the clock and battery*—the only limit being the length of the conducting wires and the strength of the battery.

Before describing the mechanical and electrical arrangements of the apparatus, we proceed to explain the construction and action of the thermometers themselves. This will be best understood by reference to the engraving, fig. 63.

FIG. 63.

The bulb is cylindrical, and Mercury is the thermometrical fluid. The neck of the bulb is contracted at A, and upon the shape and fineness of this construction the success of the instrument depends. Beyond A the tube is bent, and a small catch reservoir is formed at B, for a purpose to be presently explained. At the end of the tube a small receptacle, C, is provided. When the bulb is downward it contains sufficient mercury to fill the tube and a part of the reservoir, C, leaving sufficient space in C for the expansion of the mercury. In this position no scale would be possible, as the apparent movement of the mercury would be confined to the space C. When the thermometer is held bulb upward, the mercury breaks off at A, and by its own weight flows down the tube, filling C and a portion of the tube above C, in relation to the existing temperature. The scale accordingly is made to read upwards from C. To set the instrument for observation, it is only necessary to place it bulb downward, then the mercury takes the temperature just as an ordinary thermometer. Whenever the existing temperature is required, all that has to be done is to turn the thermometer bulb upward; the mercury will then break off at A, falls to

end C, and in this position the temperature can be noted. The engraving, fig. 63, shows the thermometer after it has been inverted.

This reading may be taken at any time after the thermometer has been turned over, for the quantity of mercury in the lower part of the stem, which gives the reading, is too small to be sensibly influenced by a change of temperature, while that in the bulb will continue to contract with greater cold and to expand with greater heat, and in the latter case some mercury will pass the contraction A, and may fall down and lodge at B, but it cannot go further so long as the bulb is upward, and thus the temperature to be read off will not be vitiated. It must be clearly understood that the thermometer is only intended to give the temperature at the time when it turned over. The divisions and figures are engraved upon the stem of these thermometers.*

It will be seen in the accompanying drawing that twelve thermometers are mounted on the stand; each one is sustained upon a metal arm in such a manner that it will fall over and become inverted by the release of a stop or detent from the joint action of the clock and galvanic battery.

In the drawing, six of the twelve thermometers are shown inverted, the bulbs being upwards, the clock at each of the six successive hours having made contact and completed the galvanic circuit, and by the action of an electro-magnet released the detents, and allowed the thermometers to fall over and record the temperature for that moment. This action is produced by simple mechanism on the back of the clock dial, the contact being made at each hour It will be evident that the thermometers could be made to record half-hourly, or they might, by increasing the number, be made to register every fifteen minutes, or less, the only limit being the number of thermometers used.

When the thermometers are all reversed, the readings may be quickly taken and the thermometers re-turned to their original positions, *bulbs downwards.*

Attached to the back of the clock dial, and in its centre, is a disc of ebonite, about two inches in diameter, with a hole in the centre to allow the spindle to pass on which the clock hands are fixed. Round the edge of this disc are twelve platina studs, one being opposite each hour on the clock dial; each stud is separately connected to one of twelve terminals in the order of 1 to 12 at back of clock, viz.: The stud opposite 12 o'clock on the dial is carried to No. 12 terminal, &c., &c. Immediately behind the hour hand, at the back of the dial, and attached to the same spindle, is a metal spring which touches each stud in succession as the hour hand travels round. This spring is not insulated from the metal work of the clock; consequently the current runs to the clock.

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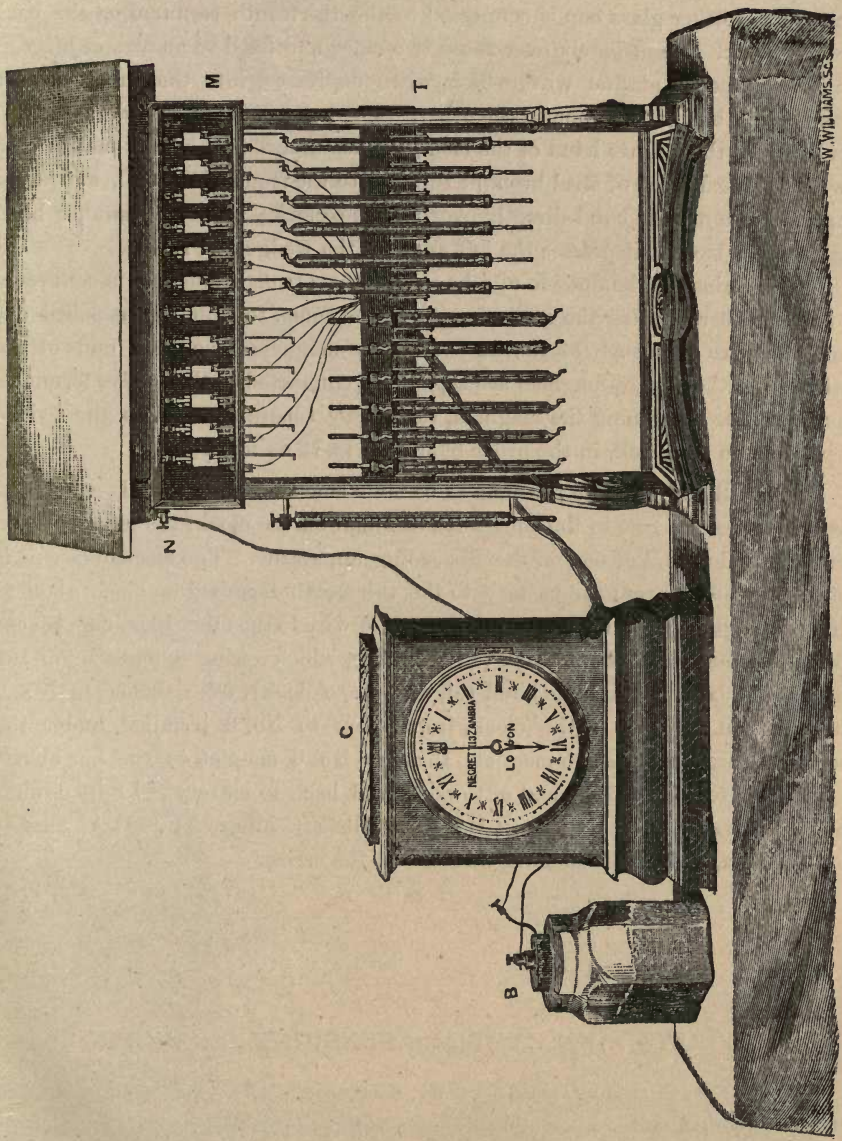
* These Thermometers are divided with either Fahrenheit or Centigrade Scales, and their number may be increased to special order.



Negretti and Zambra's Patent Apparatus for Recording Hourly Temperatures. (FIG. 64.)

Fixed at the back of the clock dial, near its outer edge, are two little glass cups containing mercury, one of which is connected to the metal work of the clock; the other glass cup is connected to the thirteenth terminal on the back of the clock. Immediately over these two cups, and fixed to an arm or lever, is a forked piece of platina wire, which, when depressed into the cups, forms a connecting bridge from one to the other. The lever is depressed when one end is lifted by the minute hand of the clock. This is accomplished by means of a wedge-shaped piece of steel brought through to the front of the dial, and acted upon by the minute hand directly over twelve o'clock; when the minute hand approaches twelve, it presses the left angle of the wedge and lifts it.

A terminal at the outside of a box containing twelve magnets is connected to a metal bar running the entire length of the same, to which is attached one end of a wire from each of the twelve electro-magnets; the other ends of the wires from the electro-magnets are separately connected to the twelve terminals *under the box* containing the magnets, thence by separate wires to the twelve terminals on the clock, in the order of from 1 to 12 as marked.

We will now suppose the time to be six o'clock. The battery is connected as follows:—*One pole* to the thirteenth terminal on the clock, the other pole to the terminal at end of box on the Recording apparatus. The electric circuit is now complete. From the battery to the thirteenth terminal on clock, then to one of the glass cups, over the little bridge of wire to the other glass cup, thence through metal work of the clock to the spring, which spring touches upon the stud at the back of the hour hand (at, say six o'clock), from thence to No. 6 terminal on the back of the clock, from there to No. 6 terminal under the box containing the electro-magnets, through No. 6 magnet to the bar above, then to the terminal at the end of the box, and back to battery. In its circuit, No. 6, magnet attracts its keeper, the catch falls, and allows No. 6 thermometer to turn over, and in like manner throughout the series.

Price, fig 64. £52 10 0

NEGRETTI AND ZAMBRA'S SUNSHINE RECORDER.

75. This instrument shown by fig. 65 consists of a glass sphere ground perfectly true, mounted upon a brass frame, with suitable adjustments for placing its axis parallel with the axis of the earth; it has also a divided semi-circle arranged to adjust the apparatus for use in any latitude.

Surrounding one-half of the glass sphere is placed a concentric metal plate, for holding the prepared and divided paper cards, upon which the record is burned by the concentrated Solar rays.

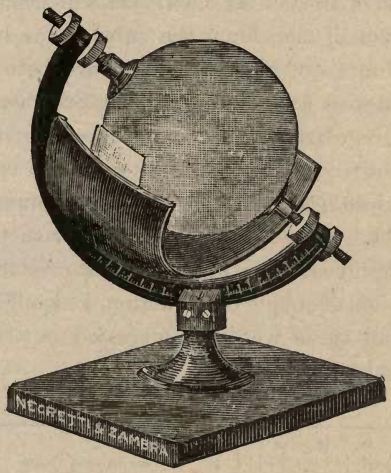


FIG. 65.

Two grooves are formed upon the concentric plate, by which the position of the divided cards can be varied to suit the elevation of the sun at different seasons of the year.

In use, the Sunshine Recorder should be placed geographical North and South, similar to a sun dial.

Price, fig. 65. £12 12 0

A supply of prepared cards sufficient for one year's use £1 12 0

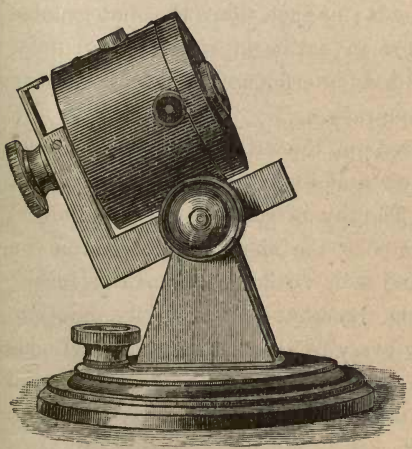


FIG. 66.

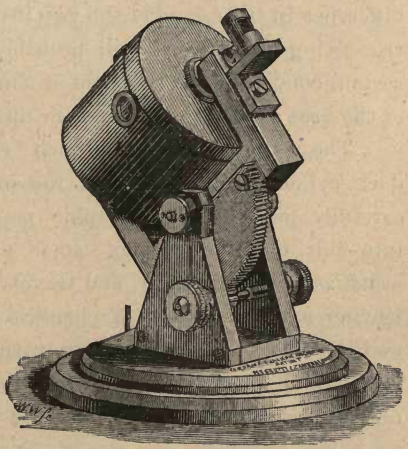


FIG. 67.

76. **Jordan's Sunshine Recorder (Patent), made and supplied only by Negretti and Zambra.**

Since the invention in 1853 of Mr. CAMPBELL'S instrument for automatically registering the duration of Sunshine, the subject has become of increasing interest, and improved forms of his instrument have been generally adopted at the principal Observatories and Meteorological Stations where the hours of bright Sunshine are regularly observed and registered. These ingenious instruments are perfect recorders of Sunshine so long as the sky is clear, but are too costly to come into general use by the greater number of observers now interested in the subject. It is to meet this difficulty that the instrument now introduced has been designed. We believe that it meets all the requirements; it is accurate in its action, of simple construction, and sufficiently cheap to come within the means of all those who are interested in this comparatively new branch of meteorological science.

Half Size.

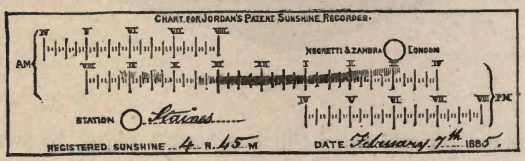


FIG. 68.

The action of Mr. JORDAN'S Sunshine Recorder differs entirely from that of the instrument above referred to, inasmuch as the results are obtained by means of photography, instead of by the burning power of the concentrated solar rays; it is, however, only on days when the atmosphere is a little hazy, or the sun slightly obscured by thin, filmy cloud, that there is any important difference in the record of the two instruments; at such times the photographic registering instrument will probably show an excess of sunshine, as under certain conditions the thin film of cloud or haze interferes more with the action of the heat rays than it does with the actinic rays.

The new instrument—which is figured on the other side—consists of a dark cylindrical chamber, on the inner circumference of which is placed a carefully prepared photographic paper. The ray of sunlight being admitted into this chamber through small apertures in the side, is received on the sensitized paper or chart, and travels around it by virtue of the earth's rotation, leaving a distinct trace of chemical action, thereby registering its duration, and the degrees of its intensity, varied by every passing cloud. The cylinder is mounted on a suitable stand, having simple means of adjustment, for the different seasons of the year, and for the use of the instrument in any latitude.

Price, Sunshine Recorder—Fig. 66 . . . . . £3 3 0
Ditto —Fig. 67, with rackwork adjustment and clamping screws 5 5 0
A Box containing 100 prepared CHARTS, with instructions—
Fig. 68 . . . . . 1 0 0

The Charts are printed upon sensitized paper, ruled with vertical lines, representing the hours and minutes of the day; they are supplied, ready for use, in boxes containing 100 each. The records obtained are rendered permanent by simply washing the papers for a few minutes in cold water and afterwards drying them between blotting-paper.

INSTRUCTIONS FOR FIXING JORDAN'S SUNSHINE RECORDER.

77. Select a suitable position which has the full range of the sun at all seasons of the year. Provide a firm support with a perfectly level top, place the Instrument upon it (*the lid of the cylinder facing north*), and when the sun is on the meridian (12 o'clock) turn the instrument on its base until the shadow of the pin on the lid of the cylinder coincides with the vertical line on the white glass behind it. When this adjustment has been correctly made, the instrument may be permanently screwed down to its support, then incline the cylinder on its horizontal axis, by means of the milled head at the side, until the point of the shadow of the aforesaid pin falls on the point of intersection of the two lines, and clamp securely by means of the opposite milled head, the ray of sunlight passing through the central aperture will then fall on the twelve o'clock division of the chart. This adjustment will require to be altered occasionally as the seasons vary, the necessity for alteration being shown by the position of the trace above or below the central line of hour divisions on the chart.

The charts should be inserted in the cylinder each day after sunset, ready for the following day, the ends being placed against the stops provided for the purpose. On removing the charts from the instrument after the day's observation the number of hours recorded should *at once* be tabulated*, the trace may then be rendered permanent by immersing the chart for a few minutes in cold water, until the surface becomes white and the trace a bright blue colour; it should then be removed and dried between blotting paper. Care must be taken not to expose the sensitized charts to the daylight longer than is necessary for removing and inserting them in the cylinder. The cylinder being held in position on the frame by a clamping screw can be easily removed for the purpose of changing the chart, which may be done either at the place of observation or indoors

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* This precaution is necessary that any very faint traces on the chart may not be lost before registering, by too long immersion in water, or it may be advisable to mark with a pencil the limits of the trace before placing in water.

NEGRETTI & ZAMBRA'S RECORDING DEEP SEA THERMOMETERS.

78. **Deep Sea Sounding Thermometers, Self-Registering,** the original *double tube principle,* invented by Negretti and Zambra, specially constructed for the Board of Trade and Admiralty. Warranted to stand a pressure of 450 atmospheres. *Price* £2 10 0

This manner of protecting the bulb was invented by Messrs. Negretti and Zambra in 1857, and is described by the late Admiral R. FitzRoy, in the first number of *Meteorological Papers,* p. 55, published July 5th, 1857, as follows :

"Referring to the erroneous readings of all thermometers, consequent on their delicate bulbs being compressed by the great pressure of the ocean, he says :—'With a view to obviate this failing Messrs. Negretti and Zambra undertook to make a case for the weak bulbs, which should transmit temperature, but resist pressure. Accordingly a tube of thick glass is sealed outside the delicate bulb, between which and the casing is a space all round, which is nearly filled with mercury. The small space not so filled is a vacuum, into which the mercury can be expanded, or forced by heat or mechanical compression, without doing injury to or even compressing the inner or much more delicate bulb.'"

The bulb of the Thermometer thus protected resists the pressure of the ocean, which varies according to its depth—that of three thousand fathoms being something like three tons pressure upon the square inch.

79. **Negretti and Zambra's Small Deep Sea Sounding Thermometers,** the so-called Dr. Miller's pattern in Copper Case. *Price* £2 10 0 £3 3 0

R. H. Scott, Esq., F.R.S., in a paper published in the Journal of the Meteorological Society, January 17th, 1872, speaking of Negretti and Zambra's Deep-Sea Thermometers, described by Admiral FitzRoy in the first number of *Meteorological Papers,* published July 5th, 1857, says :—

"The number of the thermometers of this particular pattern, which was supplied to the Meteorological Department of the Board of Trade by Messrs. Negretti and Zambra, the makers, was upwards of fifty, and they were supplied to several ships in the Royal Navy, especially those employed on certain well-known deep-sea sounding expeditions. I was not able to find any record of any of these thermometers having been tested in an hydraulic press, and, accordingly, as soon as the Miller pattern thermometer had been definitely adopted by the Hydrographer, it was resolved to subject one of the old thermometers (Negretti and Zambra's) in the Meteorological Office to the same test as that which the new instruments were made to undergo, in order to see whether or not the construction of the original instruments offered sufficient security against alteration of the shape of the bulb, owing to pressure. The experiments were carried out on the 28th of September, 1869, in

the presence of Capt. Toynbee and Mr. Strachan, and the results of the testing have been published in the report of the Meteorological Committee of the Royal Society for 1869. The concluding sentence of this report was as follows (page 32) :—

'"The foregoing experiments are sufficient to show that the original thermometers described by Admiral FitzRoy were good and trustworthy instruments, in so far as regards their capability of resisting pressure.'"

NEGRETTI AND ZAMBRA'S

NEW RECORDING DEEP-SEA THERMOMETERS.

80. These Instruments differ from all other Recording Thermometers in the following important particulars :—I. The Thermometer contains pure mercury only, without any alcohol or other fluid. II. It has no indices or springs, and its indications are by the column of mercury only. III. It can be carried in any position, and cannot be put out of order except by breakage. And chiefly, it will indicate and record the exact temperature at any depth of the sea, irrespective of either warm or cold currents or stratum through which the Thermometer may have passed in its descent or ascent. This last very special quality renders N. and Z.'s Thermometers superior for Deep Sea temperature to any others ; for those used in the *Challenger* expedition *are* liable to give erroneous indications, owing to their indices slipping, and otherwise getting defective (this was proved by Messrs. Negretti and Zambra at a Meeting of the British Meteorological Society) ; and *under certain conditions of temperature* it is not possible by these old Thermometers to obtain true temperatures at certain depths which might be required.

The construction of Negretti and Zambra's original Deep Sea Thermometer is as follows :—

In shape it is like a syphon with parallel legs, having a continuous communication, as seen in the annexed figure, 69. The mounting of the Thermometer is pivoted on a centre, and being attached in a perpendicular position to a simple apparatus (which will be presently described), is lowered to any depth in the water that may be desired. In its descent the Thermometer acts as an ordinary instrument, the mercury rising or falling according to the temperature of the stratum through which it passes ; but so soon as the descent ceases, and a reverse motion is given to the line, so as to pull up the apparatus towards the surface, the Thermometer turns once on its centre, first bulb uppermost, and afterwards bulb downwards. This causes the mercury, which was in the left-hand column, first to pass into the dilated syphon bend at the top, and thence into the right hand tube, where it remains, indicating on a graduated scale the exact temperature at the time it was

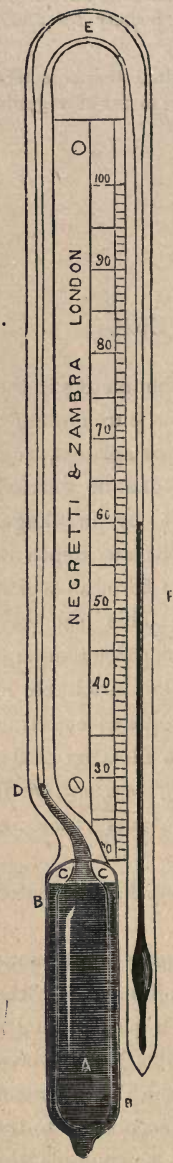

FIG. 69.

turned over. Fig. 69 shows the position of the mercury *after* the instrument has been thus turned on its centre. A is the bulb; B *the outer coating or protecting cylinder;* C *is the space of rarefied air, which is reduced if the outer casing be compressed;* D is a small glass plug on the principle of Negretti and Zambra's Patent Maximum Thermometer, which cuts off, in the moment of turning, the mercury in the tube from that of the bulb, thereby insuring that none but the mercury in the tube can be transferred into the indicating column; E is an enlargement made in the bend so as to enable the mercury to pass quickly from one tube to another in revolving; and F is the indicating tube or Thermometer proper. In its action, as soon as the Thermometer is put in motion, and immediately the tube has acquired a slightly oblique position, the mercury breaks off at the point D, runs into the curved and enlarged portion E, and eventually falls into the tube F, when this tube resumes its original perpendicular position.

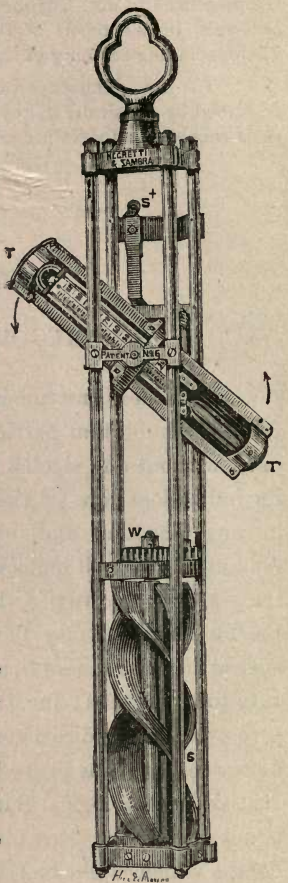

FIG. 70.

The contrivance for turning the Thermometer over may be described as a metal frame with a vertical screw propeller; to this frame (fig. 70) the instrument is attached. In its descent through the water the screw is lifted out of gear and revolves freely on its axis; but so soon as the apparatus is pulled up towards the surface the screw falls into gear and revolves in the contrary direction, turning the Thermometer over once, and then becoming locked and immovable, the temperature is recorded for that moment. *Price* £10 10 0

This arrangement of Deep Sea Thermometer (fig. 70) having been found defective, Negretti and Zambra have abandoned its manufacture—it being now quite superseded by their recently improved Thermometers, particulars of which will be found in the following pages. Our description is therefore only inserted as a matter of history in connection with the invention of Deep Sea Recording Instruments.

NEGRETTI & ZAMBRA'S

NEW PATENT STANDARD

MARINE REGISTERING THERMOMETERS.*

81. "The most successful Deep-Sea Thermometer hitherto has been Six's Thermometer, with the bulb protected from pressure, as invented by NEGRETTI AND ZAMBRA in 1857. Nevertheless there are several disadvantages inherent in the principle of construction of Six's instrument. The indices are unreliable, as, however carefully fitted, they may slip down by gravity, and even shift upward by sudden lifting motion; so that the observations are always more or less liable to error: the index error also is very liable to alter by the shifting of the spirit, or by bubbles of spirit getting among the mercury; and unless the observer is well-trained in its management, and takes care to compare it with a correct ordinary thermometer every time it is used, there is no guaranteeing its accuracy of indication. Further, its accuracy in its best condition does not attain to fractions of a degree, as it cannot be read off closer than about half a degree. Then it must be kept in the vertical position, or it is certain to become more or less deranged in transit.

"However, so long as it sufficed to observe the nearest degree of temperature, the improved protected Six's answers the purpose of a deep-sea thermometer, with careful management and checking; but lately the bottom temperature of shallow seas and of rivers has come under investigation, and for this purpose Six's instrument is unsuitable.

"Between the temperature of the surface of the sea and that at the depth of a few fathoms, the differences to be determined are found to be not degrees of the thermometer, but *fractions* of a degree; hence, the observations to be worth anything at all, must be made with an undoubtedly accurate thermometer.

"During the last two or three years systematic observations of the surface and bottom temperatures have been taken from the various lightships off the British coasts, under the direction of the Meteorological Office. This investigation of the temperatures of the British seas has been urged upon the Government by naturalists and physicists interested in the question of the food supply of the people as affected by the take of fish. What is required to be made evident is, whether any, and what, effect temperature has upon the habits and migrations of fish, so as to tend to a right understanding of the conditions favourable for the development of the various species of fish, and the best seasons and temperature indications for their capture. This investigation, commenced with Six's Thermometers, has at present only shown that such instruments are not sufficiently reliable for the purpose; and it was represented by the Government to Messrs NEGRETTI AND ZAMBRA, that a more perfect and stable deep-sea thermometer was a desideratum. They accordingly turned their attention to the matter, and the result is the new STANDARD DEEP-SEA THERMOMETER.

"The construction of this thermometer will be readily understood by reference to the sketch diagram fig. 71. The bulb is cylindrical, and mercury is the thermometrical fluid. The neck of the bulb is contracted in a peculiar manner at A, and upon the shape and fineness of this contraction the success of the instrument mainly depends. Beyond A the tube is bent, and a small catch reservoir is formed at B, for a purpose to be presently explained. At the end of the tube a small receptacle, C, is provided. When the tube is downward, the glass contains sufficient mercury to fill the bulb, tube, and a part of the reservoir C, if the temperature is high, leaving sufficient space in C for the expansion of the mercury. In this position no scale would be possible, as the apparent movement of the mercury would be confined to the space C. When the thermometer is held bulb upward, the mercury breaks off at A, but by its own weight flows down the tube, filling C and a portion of the tube above C, in relation to the resisting temperature. The scale accordingly is made to read upwards from C. To set the instrument for observation it is only necessary to place it bulb down-

* Description condensed from "ENGINEERING," March 22nd, 1878.

DESCENDING.

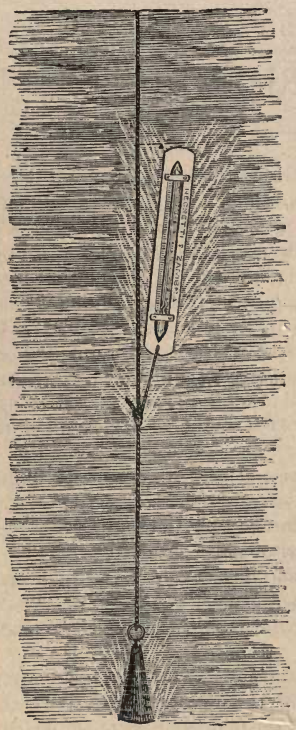

FIG. 72.

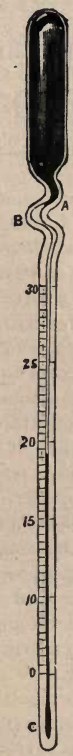

FIG. 71.

ASCENDING.

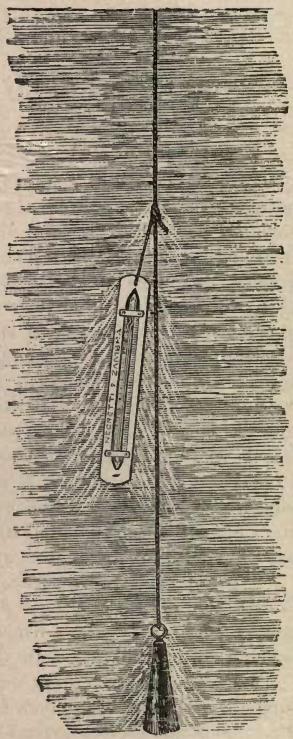

FIG. 73.

ward, then the mercury takes the temperature just as an ordinary thermometer. When at any time or at any place the temperature is required, all that has to be done is to turn the thermometer bulb upward, and keep it in this position until read off.

"The reading may be taken at any time after, for the quantity of mercury in the lower part of the stem which gives the reading is too small to be sensibly influenced by a change of temperature, unless it is very great, while that in the bulb will continue to contract with greater cold and to expand with greater heat, and in the latter case some mercury will pass the contraction A, and may fall down and lodge at B, but it cannot go further so long as the bulb is upward, and thus the temperature to be read off will not be vitiated. Now, whenever the thermometer can be handled, it can readily be turned bulb upward for reading off the existing temperature. At a depth in the sea, some contrivances must be provided for turning the thermometer bulb upward. For this purpose the thermometer is fitted into a hollow wooden frame, loaded with shot, free to move from end to end of it, and sufficient to render the whole instrument just vertically buoyant in sea-water.

"In using the thermometer a cord is rove through the hole in the frame *nearest* the bulb, and the instrument is fastened by this cord to the sounding line. In descending the thermometer will be pulled down with the bulb downwards; but upon being pulled up, the instrument, owing to the resistance through the water, and consequent displacement of its centre of gravity, will turn over and come up bulb uppermost, the temperature of the spot where it turned over will then be indicated, as shown in the illustrations. See figures 72 and 73.

"As regards the thermometer itself it was necessary, in order to make it perfectly satisfactory, to protect it against pressure, even if intended for shallow seas, as well as for

the deepest. For whether used in deep or shallow water, unless withdrawn from pressure, its indications would always be more or less in error. Like an ordinary thermometer it is devoid of air, and so quite different from Six's, which, containing compressed air, has a certain internal resistance. Hence it would be more affected by pressure than Six's, however thick the glass of the bulb. By the simple expedient of placing the thermometer entirely in a shield of glass hermetically sealed (*see* fig. 4 on next page), the effect of external pressure is entirely eliminated. The shield must of course be strong, but need not be exhausted of air. It must, however, render the enclosed thermometer more difficult to be affected by changes of temperature; in other words, it will make it sluggish.

"To counteract this sluggishness, in that portion of the shield surrounding the bulb, some mercury is introduced, and confined there by a partition cemented in the shield around the neck of the thermometer bulb. This mercury acts as a carrier of heat from the exterior of the shield to the interior of the thermometer: and the efficacy of this arrangement has been experimentally determined, the instrument thus protected being, in fact, far superior in sensibility to Six's thermometer.

"So long as the shield withstands the pressure, that is, does not break, the thermometer will be unaffected by pressure, and there is abundant experience to show that such a shield will stand the pressure of the deepest ocean. The greatest pressure can never affect a thermometer so protected. Doubtless the shield will be compressed a little under great pressure, but this can never exert an internal pressure sufficient to have an appreciable effect upon the thermometer. This method of shielding is quite efficacious, and deep-sea thermometers so protected do not require to be tested for pressure in the hydraulic press. The thermometer will simply require to be tested for sensitiveness and for errors of graduation very accurately; because it is a standard instrument adapted to determine very small differences of temperature as well as large ones, even one or two-tenths of a degree in shallow waters. The test for sensitiveness should determine how many seconds the instrument requires to take up a change of 5 deg. rise or fall; and the time has been found from 5 to 10 seconds.

"A considerable number of these instruments have already been tested at the Kew Observatory with perfectly satisfactory results, which place beyond doubt their value as Standard Deep-sea Thermometers.

"This instrument possesses great advantages. It has no attached scale, the figuring and graduations are distinctly marked on the stem itself, and the shield effectually preserves them from obliteration by sea-water. The part of the stem which forms the background to the graduations is enamelled white,* to give distinctness to the mercury.

"The hole at the *top* of the frame is for the purpose of lowering and keeping the thermometer upright until it has reached the water. This is effected by putting a cord through the hole, and both ends of it kept in the hand until the thermometer has reached the water, then one end is let go and the cord pulled on board; this operation is *not* imperative, but it saves the thermometer from being knocked about previous to reaching the water."

Negretti and Zambra's Patent Standard Marine Thermometer (fig. 72) . *Price* £2 10 0

* *Enamelling the back of Thermometer Tubes is an important invention by Negretti and Zambra. Most of the extremely sensitive Thermometers that are now made (such as Clinical Thermometers) would have been almost useless but for this improvement.*

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1 cubic foot of Sea Water weighs 62·425 lbs.=557 cwt, or 0·028 of a ton.

Sea Water freezes at 28°. Boils at 213 2; variable with the density.

80 miles from the Island of St. Thomas, at a depth of 3 875 fathoms, the temperature of the Sea was found to be 34½° Fahrenheit; the pressure at this depth 4¼ tons to square inch.

The pressure at 100 feet is found by Divers difficult to bear for any lengthened period. Man cannot sustain a greater pressure than 6 Fathoms, or 120 feet. Weights of 6 or 8 hundredweight require two Hours to fall through 3 miles of Sea Water. owing to the friction of the water on the rope or wire.—Dr. CARPENTER.

NEGRETTI & ZAMBRA'S

PATENT IMPROVED-FRAME STANDARD DEEP-SEA THERMOMETER.

FIG. 1.

FIG. 3.

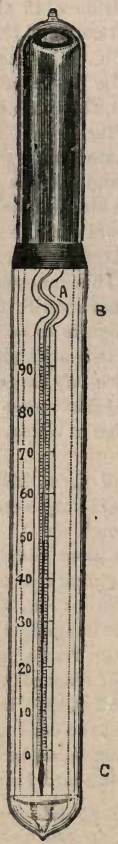

FIG 4.

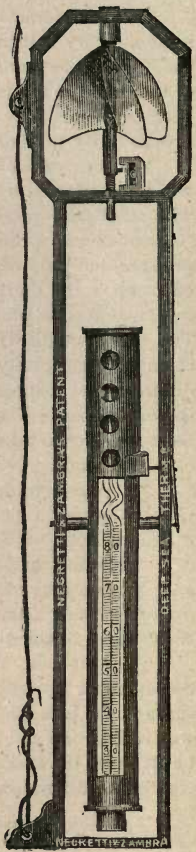

FIG. 2.

82. NEGRETTI & ZAMBRA'S Improved Standard Deep-sea Thermometer has been abundantly proved to be the only thermometer that ought to be used in researches into the temperature of the sea below the surface. It is quite applicable for testing the temperature of the surface water, but merely for this purpose a less expensive instrument would usually be employed. For taking temperatures at moderate depths, from a few feet to a few hundred fathoms, NEGRETTI AND ZAMBRA'S *Wooden Float* form amply suffices and is quite suitable. The only objection that has been raised to this wooden float is, that in sounding to great depths a check upon the line, caused by the motion of the ship due to the heave of the sea, may make it turn over and register, so that the temperature at the desired depth is not obtained. In very deep soundings it is often desirable to have a series of thermometers

upon the line at different depths; and in this case the frequent checks and stoppages upon the line during the hauling up, either from the pitching of the ship or in detaching the thermometers as they arrive at the surface, lead to some uncertainty in the results. To do away with all doubt as to the accuracy of the record brought up by each thermometer is the object of the new form of the Standard Deep-sea Thermometer. The improvement is due to suggestions kindly furnished to NEGRETTI AND ZAMBRA by Commander MAGNAGHI, of the Royal Italian Navy. By means of it the thermometer may be attached to any part of the line during the descent; and after the first regular haul in of from 10 to 80 feet, according to adjustment, any number of stoppages or any amount of line may be afterwards run out without altering the temperature obtained at the commencement of hauling up. *Several thermometers can now be fastened upon the line and serial temperatures obtained at any required depth with certainty.*

The apparatus will be best understood by reference to the accompanying figures (Nos. 1 and 2). A is a metallic frame in which the case B, containing the thermometer, is pivoted upon an axis H, but not balanced upon it. C is a screw-fan attached to a spindle, one end of which works in a socket D, and on the other end is formed the thread of a screw E, about half an inch long, and just above it is a small pin or stop F on the spindle. G is a sliding stop-piece against which the pin F impinges when the thermometer is adjusted for use. The screw E works into the end of the case B the length of play to which it is adjusted. The number of turns of the screw into the case is regulated by means of the pin and stop-piece. The thermometer in its case is held in position by the screw E, and descends into the sea in this position (Fig. 1), the fan C not acting during the descent because it is checked by the stop F. When ascent commences the fan revolves, raises the screw E, and releases the thermometer, which then turns over and registers the temperature at that spot, owing to the axis H being below the centre of gravity of the case B as adjusted for the descent. Each revolution of the fan represents about 10 feet of move-ment through the water upwards, so that the whole play of the screw requires 70 or 80 feet ascent; therefore the space through which the thermometer should pass before turning over must be regulated at starting. If the instrument ascends a few feet by reason of a stoppage of the line while attaching other thermometers, or through the heave of the sea, or any cause whatever, the subsequent descent will cause the fan to carry back the stop to its initial position, and such stoppages may occur any number of times provided the line is not made to ascend through the space necessary to cause the fan to release the thermometer. When the hauling-in has caused the turnover of the thermometer the lateral spring K forces the pin L into a slot in the case B and clamps it (as seen in fig. 2) until it is received on board so that no change of position can occur in the rest of the ascent from any cause. The case B is cut open to expose the scale of the thermometer, and is also perforated to allow the free entry of the water.

The construction of the Thermometer will be understood by referring to Figs. 3 and 4 and also to the description given on page 63 (fig. 71)

Price for NEGRETTI AND ZAMBRA'S New Patent Improved Frame Standard Deep-Sea Thermometer, as fig. 1.

The Hydrographic Bureau at Washington published lately the following results of a series of observations carried out in order to determine the length, depth, and duration of ocean waves :—

The longest wave hitherto observed is said to have had a length of half-a-mile, and to have spent itself in 23 seconds. During storms in the North Atlantic waves sometimes extend to a length of 500 ft. and 600 ft., and last from 10 to 11 seconds.

The most careful measurements of the height of waves give from 44 to 48 feet as an extreme limit; the average height of great waves is about 30 ft.

These measurements refer to ordinary marine action, and do not relate to earthquake action or other exceptional agencies.

INSTRUMENTS FOR ASCERTAINING THE HUMIDITY OF THE ATMOSPHERE.

THE instruments used for observing the amount of moisture contained in the atmosphere are called Hygrometers. They are without doubt of all Meteorological instruments the most useful and valuable.

To ascertain with exactness the Hygrometric condition of the air is of the utmost importance both to the Physician and Agriculturist. By observing the varying amount of vapour or moisture in the air, the one is enabled to regulate its condition as best suited to his patient's requirements, and the other by closely watching the movements of the Barometer in connection with the Hygrometer can anticipate probable atmospheric changes that may prove beneficial or injurious to his crops.

There are many Hygrometers constructed as Weather Indicators only, simply showing the approximate condition of the air if it be wet or dry. Such instruments, however ingenious, are not of any scientific value. For more exact and precise observation the Hygrometers of Daniell, Regnault, and Mason are chiefly used—the latter, viz., Mason's, from its extreme simplicity is now universally in use, and in connection with the valuable tables compiled by James Glaisher, Esq., F.R.S., the dew point can be ascertained with great exactness and ease.

In connection with the Hygrometer, the dew point will be frequently spoken of. This may be described in a few words as the amount of water which the air can sustain in an invisible form increasing with the temperature; but for every definite temperature there is a limit to the amount of vapour which can be thus diffused. When the air is cooled the vapour present may be more than it can sustain; part will then be condensed either in the form of dew, rain, hail, or snow. The temperature which the air has when it is so fully saturated with vapour that any excess will be deposited as dew, is called the *dew-point.*

"To measure the quantity of dew deposited each night, an instrument is used called a *Drosometer.* The most simple process consists in exposing to the open air bodies whose exact weight is known, and then weighing them carefully when covered with dew. According to Wells, locks of wool, weighing about eight grains, are preferred, divided into spherical masses of the diameter of about two inches."—*Kæmtz.*

83. **Saussure's Hygrometer** (fig. 74), for showing changes in the hygrometric condition of the atmosphere on a graduated arc, by the contraction and elongation of a human hair, this acting the reverse of string or cord, stretching when moist and contracting when dry. A thermometer is attached to the scale.

Price, £1 10 0

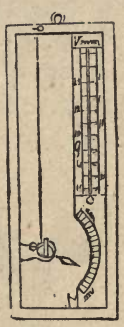

FIG 74.

Although a most elaborate Treatise on the construction and use of this Hygrometer was written by its inventor, M. Horace Benedict de Saussure, Professor of Philosophy, at Geneva, in 1783, this instrument may be regarded more as an ornamental curiosity than of any scientific value.

84. **Leslie's Thermometric Hygrometer** (fig 75). It will be seen that Leslie's instrument is the elementary form of Mason's Wet and Dry Bulb Hygrometer, by which it is entirely superseded.

This instrument consists of a glass tube, terminated with a bulb at each end, as fig. 75. The tube is partly filled with sulphuric acid, tinged by carmine. One of the balls is covered with muslin, and kept continually moistened with water, drawn from a vase placed near it by the capillary attraction of a few strands of cotton-wick. The descent of the coloured liquid in the other stem will mark the diminution of temperature caused by the evaporation of the water from the humid surface. The drier the ambient air is, the more rapidly will the evaporation go on; and the cold produced will be greater. When the air is nearly saturated with moisture, the evaporation goes on slowly; the cold produced is moderate, because the ball regains a large portion of its lost heat from surrounding bodies. The degree of refrigeration of the ball is an index of the dryness of the air.

When this hygrometer stands at 15°, the air feels damp; from 30° to 40°, we reckon it dry; from 50° to 60°, very dry; and from 70° upwards, we should call it intensely dry. A room would feel uncomfortable, and would probably be unwholesome, if the instrument in it did not reach 30°. In thick fogs it keeps almost at the beginning of the scale. *Price*, £1 1 0

85. **Daniell's Hygrometer**, for ascertaining the dew-point by direct observation (fig. 76), invented about the year 1820, by the late Professor Daniell, of King's College, London.

It consists of a glass tube, bent twice at right angles, and terminating, at each end, in a bulb. In the long limb of the tube is enclosed a delicate thermometer, which descends to the centre of the bulb, which is about three-parts filled with sulphuric æther. All the other parts of the tube are carefully freed from air, so that they are occupied by the vapour of the æther. This bulb is made of black glass; the other bulb on the shorter limb is transparent, and

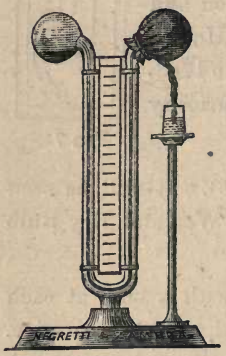

FIG. 75.

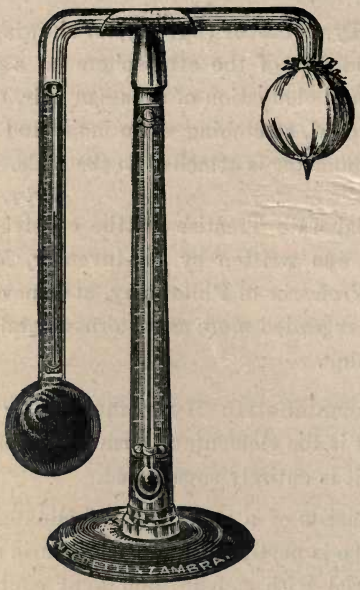

FIG. 76.

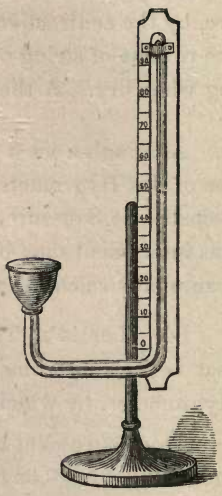

FIG. 77.

covered with a piece of fine muslin. The support for the tube has a delicate thermometer attached, to show the temperature of the external air.

This instrument gives the dew-point by direct observation, and is to be used at an open window facing the north in the following manner:—Having fixed the tube upon the stand, with the bulbs vertically downward, the Æther is all caused to flow into the lower ball by inclining the tube. The temperature of the air is noted by the exposed thermometer. Then some Æther is poured upon the muslin-covered bulb. The rapid evaporation of this Æther cools the bulb and causes condensation of the Æthereal vapour in its interior. This gives rise to rapid evaporation of the Æther in the lower bulb, whereby its temperature is greatly reduced. The air in the vicinity is deprived of its warmth by the cold bulb, and is soon cooled to the temperature at which it is perfectly saturated with the vapour which it contains. Cooled ever so little below this temperature, some aqueous vapour will be condensed, and will form a dew upon the black-glass bulb. At the first indication of the deposit of dew the reading of the internal thermometer is taken: which is the dew-point. In very damp or windy weather the Æther should be slowly dropped on the bulb, otherwise the descent of the mercury in the Thermometer is so rapid as to render it difficult to be certain of the temperature. Should this occur, the observation may be repeated by watching the temperature at which the ring of dew disappears, the mean of the two readings will be the correct point of precipitation. The greatest difference observed by Mr. Daniell in the course of four months' daily experiments between the external thermometer and the internal one at the moment of

precipitation in the natural state of the atmosphere was twenty degrees. When Daniell's Hygrometer is required to act merely as a weather-glass, to predict the greater or less probability of rain, &c., the difference between the constituent temperature of the vapour (shown by the interior thermometer), and the temperature of the air (shown by the exterior thermometer), is all that is necessary to be known. The probability of rain or other precipitation of moisture from the atmosphere, is in inverse proportion to this difference. There are several difficulties connected with the use of Daniell's Hygrometer that are in a great measure overcome in Regnault's Instrument. Fig. 76 *Price*, £3 3 0

86. **Jones's Hygrometer** (fig. 77). This instrument is the same in principle as Daniell's Hygrometer, but simpler in its construction. The tube of the Mercurial Thermometer is bent so as to bring its bulb vertical and parallel with its stem. This bulb is one inch long, and of a conical shape, with a flattened top or surface of black glass projecting a little beyond the sides. Below the flat surface this bulb is covered with black silk. The Hygrometer is mounted and supported on a brass stand in such a manner that the black surface can be inclined towards the light. When used the temperature of the air is first to be noted. Æther is to be poured on to the silk cover of the bulb, and the condensation of moisture takes place upon the black surface of the bulb. Then, by again noting the temperature, the dew point may be known.

Price, £2 10 0

87. **Regnault's Condenser Hygrometer**, (fig. 78), for ascertaining by direct observation the dew-point, is superior to Daniell's, from its being more certain in its indications, and economical in use. It consists of two highly-polished silver cylinders, into the upper part of which are cemented thin glass tubes; these have brass covers, arranged to receive and support two delicate Standard Thermometers, the bulbs of which descend nearly to the bottom of the silver portion of these chambers. Each chamber has a small internal tube carried down from the brass cap to within a short distance of the bottom, to admit the passage of the air, which is drawn through both chambers by an Aspirator, (fig. 78*) connected to the base of the hollow upright and arms supporting the cylinders.

To use this Hygrometer, æther is poured into one chamber sufficient to cover the bulb of the thermometer, and then the thermometers being inserted into both cylinders the instrument is now connected to the aspirator, and by it the air is drawn through both cylinders down the internal tubes, passing in one chamber in bubbles through the æther, and in the other chamber simply around the thermometer. The tube in this empty cylinder is of such a diameter as to ensure similar quantities of air passing through each chamber.

After a short time the passage of the air through the æther will cool it down to the dew-point temperature and the external portion of the silver chamber containing the æther will become covered with moisture. The degree shown

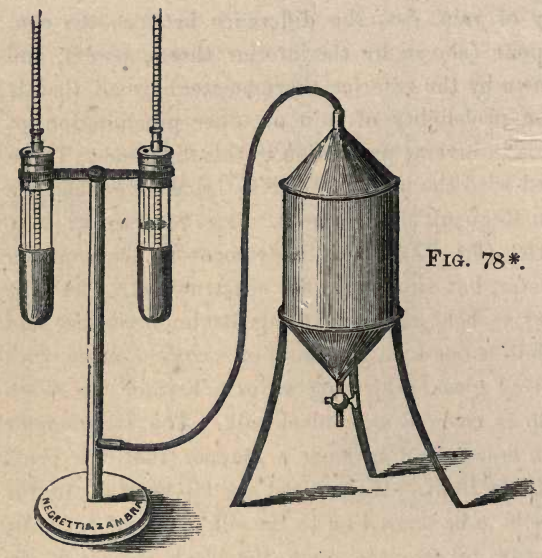

FIG. 78.

FIG. 78*.

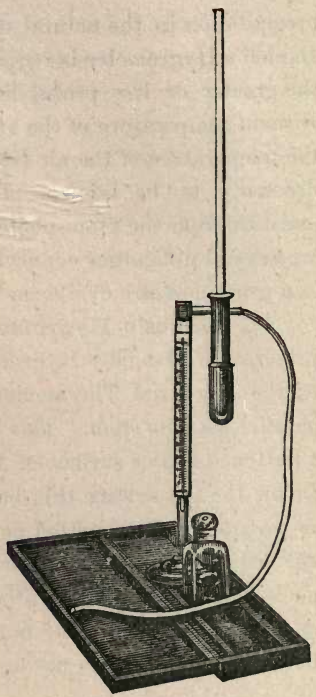

FIG. 79.

by the thermometer in the æther at that instant will be the temperature of the dew-point; the second thermometer showing the temperature of the air at the time of observation.

Price, in case £5 5 0
Aspirator for ditto (fig. 78*) . . . . . £1 15 0 to 2 15 0

88. **Regnault's Condenser Hygrometer** (fig. 56), of simpler form, only one cylinder or chamber being used. The air in this arrangement is blown through the æther by the mouth. A small thermometer is attached to the stand to show the temperature of the external air.

Price, in Case, with Æther Bottle (fig. 79) £3 10 0

For practical utility and convenience in use the Wet and Dry Bulb Hygrometer is vastly superior to all others. The engravings, Nos. 80 to 86, will show the various forms of Negretti and Zambra's Hygrometers from the simplest to the Standard instruments as manufactured by Negretti and Zambra for the various Scientific Observatories and Societies, the Government Meteorological Stations, the Metropolitan and County Hospitals, &c., &c. Most of these Hygrometers have Negretti and Zambra's Patent Porcelain Scales and Enamelled Tubes.

89. **Wet and Dry Bulb Hygrometer,** simple form, on a stand (fig. 80) for table or shelf. *Price*, 12s. 6d., 16s., and £1 1 0

90. **Ditto Ditto Ditto** plain, portable, brass stand and metal cover (fig. 81). *Price*, £1 10 0

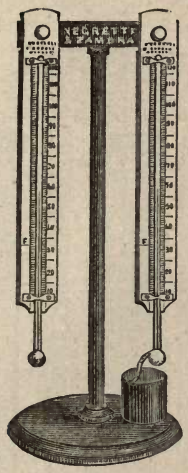

FIG. 80.

FIG. 82.

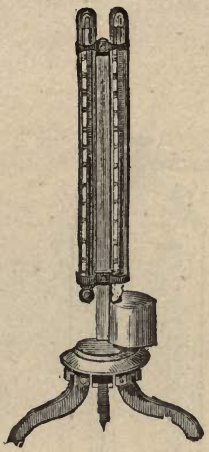

FIG. 83.

91. **Wet and Dry Bulb Hygrometer** with Wood or Zinc Scales, mounted in a Japanned Metal Case, suited for out-door use, the Greenhouse or Conservatory (fig. 82). *Price*, £0 14 0

92. * **Ditto Ditto** with Negretti and Zambra's Patent Porcelain Scale, in Japanned Case, as fig. 82. *Price*, £1 1 0

93. **Mason's Hygrometer**, portable brass-jointed tripod-stand and metal cover (fig. 83). *Price*, £3 3 0

94. **Negretti and Zambra's Standard Dry and Wet Bulb Hygrometer, or Psychrometer** (fig. 84), consists of two parallel Thermometers, as nearly identical as possible, mounted on a wooden bracket, one marked *dry*, the other *wet*. The bulb of the wet thermometer is covered with thin muslin and round the neck of the stem is twisted or tied, as seen in fig. 84*, conducting-threads of lamp-wick, or common darning-cotton, these pass down into a vessel of water, placed at such a distance as to allow a length of conducting-thread of about three inches; the cup or glass being placed on one side, and a little beneath, so that the water within may not affect the reading of the *Dry Bulb Thermometer*. In observing, the eye should be placed on a level with the top of the mercury in the tube, and the observer should refrain from breathing whilst taking an observation. The temperature of the air and of the evaporation is given by the readings of the *two thermometers*, from which can be calculated the dew point, Tables being furnished for that purpose with the instrument.

The *dry* bulb thermometer indicates the temperature of the air itself; while the *wet* bulb, cooled by evaporation, shows a lower temperature according to the amount of and rapidity of evaporation.

This instrument is used by the Members of the British Meteorological Society, and supplied to them by Negretti and Zambra (fig. 84) *Price* £2 2 0

Glaisher's Tables for ditto 0 2 6

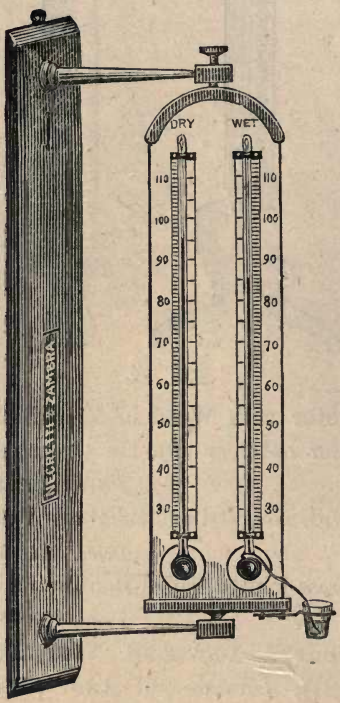

FIG. 85.

FIG. 84*.

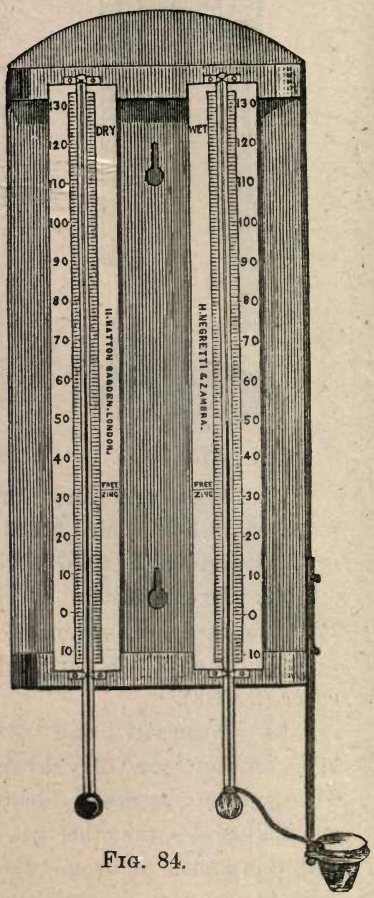

FIG. 84.

95. **Wet and Dry Bulb Hygrometer** for external Window use, with engraved Opal Glass or Porcelain Scales, mounted on a substantial and ornamental wood and metal bracket, fitted with a clamping screw for setting the scale at any convenient angle for observation, as fig. 85.

Price £2 10 0 and £3 3 0

96. **Portable Wet and Dry Bulb Hygrometer.** (fig. 86.) A most compact and convenient form of Hygrometer, invented by Negretti and Zambra, as a companion instrument to their Small Patent Maximum and Minimum Registering Thermometers and Pocket Aneroid Barometer (figs. 26 and 61), pages 26 and 51. The Hygrometer, with stand and water cistern, is fitted into a neat Pocket case.

Price £2 2 0

Larger Standard size . 2 10 0

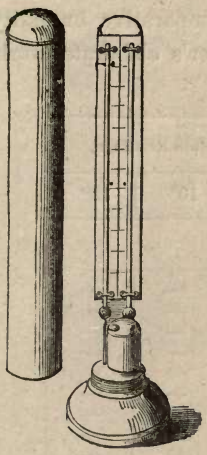

FIG. 81.

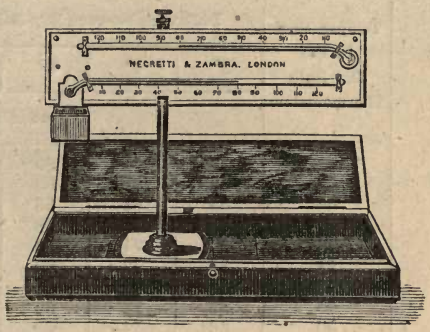

FIG. 86.

97. **Dines' Hygrometer.** We notice this apparatus chiefly as a matter of record. It is fully described along with an account of some remarkable results obtained from its use by its inventor, George Dines, Esq., in the Journal of the Meteorological Society; but, like Daniell's, Regnault's, and Jones's Hygrometers, it is not self-acting, and not so simple in its use as the Wet and Dry Bulb Instrument. Therefore, this Apparatus will only be supplied to special order. *Price*, £2 12 6 to 3 3 0

98. **Registering Hygrometer**, constructed with Negretti and Zambra's Patent Maximum and Minimum Registering Thermometers, each fitted up as a wet-bulb thermometer, to record the highest and lowest temperature of evaporation during any interval of time. *Price*, £3 3 0

99. **Hygrometer Screen.** The engraving (fig. 89), page 79, shows one of the best methods of fixing up and protecting the Hygrometer, the louvre boarded case affording free passage to the air and at the same time protection from rain, snow, the sun's rays, or radiated heat from surrounding bodies. This Screen should be fixed at about four feet from the ground, the door facing due North. If fixed against a wall, there should be left a space between the back of the Screen and the wall, at least three or four inches, to insure a free circulation of air. It need hardly be pointed out that the Screen must be securely fastened to its support, wherever used, to prevent vibration or injury from wind. This arrangement is specially recommended by the Board of Trade for Marine Service both for Hygrometers and Thermometers.

Price, £1 1 0, or made to Order.

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100. From the readings of the two thermometers, the dew-point can be deduced by formulæ (that known as Apjohn's is considered the most theoretically true), or from the valuable Hygrometric Tables by J. Glaisher, Esq., F.R.S.

101. For practical purposes in estimating the comparative humidity, the annexed table, which is a reduction from Mr. Glaisher's elaborate work, will be sufficient.

Temperature by the Dry Bulb Thermometer.	Difference between Dry-Bulb and Wet-Bulb Readings.					
	2°	4°	6°	8°	10°	12°
	Degree of Humidity.					
34°	79	63	50	—	—	—
36	82	66	53	—	—	—
38	83	68	56	45	—	—
40	84	70	58	47	—	—
42	84	71	59	49	—	—
44	85	72	60	50	—	—
46	86	73	61	51	—	—
48	86	73	62	52	44	—
50	86	74	63	53	45	—
52	86	74	64	54	46	—
54	86	74	64	55	47	—
56	87	75	65	56	48	—
58	87	76	66	57	49	—
60	88	76	66	58	50	43
62	88	77	67	58	50	44
64	88	77	67	59	51	45
66	88	78	68	60	52	45
68	88	78	68	60	52	46
70	88	78	69	61	53	47
72	89	79	69	61	54	48
74	89	79	70	62	55	48
76	89	79	71	63	55	49
78	89	79	71	63	56	50
80	90	80	71	63	56	50
82	90	80	72	64	57	51
84	90	80	72	64	57	51
86	90	80	72	64	58	52

The total quantity of aqueous vapour which at any temperature can be diffused in the air being represented by 100, the percentage of vapour actually present will be found in the table opposite the temperature of the dry-bulb thermometer, and under the difference between the dry-bulb and the wet-bulb temperatures. The degree of humidity for intermediate temperatures and differences to those given in the table can be easily estimated sufficiently accurately for most practical purposes.*

This table will be found serviceable to Horticulturists, since it will enable them to estimate the chilling effect of dew or hoar-frost on tender plants.

In England the usual difference between the thermometer readings,—in the open air, shaded from the sun, reflected heat, and currents of air,—ranges from one to twelve degrees. In hot and dry climates, as India and Australia, the range out of doors has been found as much as 30°.

* A still more comprehensive but simple Dew-Point or Humidity Table has been recently published by William Marriott, Esq., F.M.S., price 6d.

The Summer and Autumn of the year 1859 were specially remarkable for a most unusual Thermometric and Hygrometric condition of atmosphere, and Londoners will long remember the state of the River Thames during that period. Deficiency of water supply during 1858 and 1859, and great evaporation (often to *fourteen* degrees of thermometrical difference in Mason's Hygrometer), caused a condition of its stream excessively offensive, if not actually pestilential and unhealthy. Everywhere a want of water was felt, and this had been of considerable duration. In August the heat reached 92° (in places where usually summer heat is not above 80°), and the temperature of evaporation was 78°, by the same hygrometer.

INSTRUCTIONS FOR THE USE OF THE WET AND DRY BULB HYGROMETER.

102. The muslin on the bulb of the Hygrometer should be washed occasionally by pouring water over the bulb; and it should be *replaced by a fresh piece at least once a month.* Accuracy depends very much upon keeping the wet bulb clean, free from dust, and *not too* wet.

When the bulb is frozen, some cold water should be taken from under ice, being cautious to raise its temperature as little as possible, and the thermometer bulb should be wetted with it by means of a camel-hair brush or feather. After waiting a few minutes, the temperature of evaporation may be observed. The water should be either distilled or rain water, or if this be not procurable, the softest pure water which can be had. The water vessel should be replenished *after*, or some little time *before*, observing; because observations are incorrect if made while the water is either colder or warmer than the air.

In connection with the barometer, the Wet and Dry Bulb hygrometer is very useful, not only on land, but especially at sea, where other kinds of hygrometers cannot be practically used. A fall in the Barometer is indicative of coming wind or rain; if the hygrometer shows increasing dampness by the difference of the readings becoming smaller,—rain may be anticipated. On the contrary, if the hygrometer shows continuing or increasing dryness, a stronger wind is probable, without rain.

The Hygrometer is eminently useful in regulating the moisture of the air of apartments; a difference in the thermometer readings of from 5° to 8° being considered healthy. Many diseases require that the temperature and humidity of the air which the invalid breathes should be very carefully regulated. In a room, the hygrometer should be placed away from the fire, but not exposed to draughts of air.

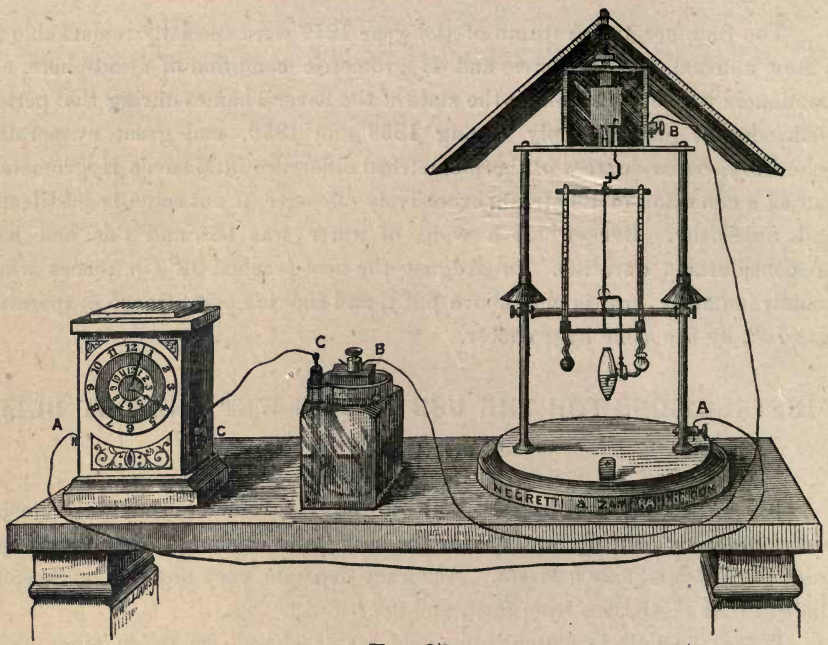

FIG. 87.

103. **Negretti and Zambra's Self-Recording Hygrometer**, fig. 87. The Thermometers in this Hygrometer are similar in construction to those used in Negretti and Zambra's Patent Hourly Recording Thermometric Apparatus. No. 64, Page 55. It will be seen by the drawing (fig. 87) that two Thermometers are, with a Water Cistern, mounted upon a metal frame in such a manner that they will fall over and become inverted from the joint action of a Clock and Galvanic Battery.

The most important improvement in this Self-Recording Hygrometer is that it can be freely exposed at any distance from the regulating clock. Our wood engraving exhibits the Clock, A, with an adjusting index upon its dial, enabling the observer to arrange the release of the detent, B, at any appointed time, thus allowing the frame supporting the Hygrometer to turn over, and by inverting the Thermometers record the temperature of both the Wet and Dry bulb instruments at the moment.

The escapement is an Electro Magnet, seen at B, in connection with a Galvanic Battery, B, the Clock at C and C, and the Wire A and A. At the arranged time the circuit is completed by the clock, and the electrical current acting upon the soft iron magnet releases the detent and the Hygrometer turns over.

The instrument is re-set for another observation, by turning back the frame with the Thermometers into its original vertical position (as shown in the engraving) and by adjusting the index of the Clock. *Price* £10 10 0

The peculiar construction of the two Thermometers is fully described on page 63, and fig. 71.

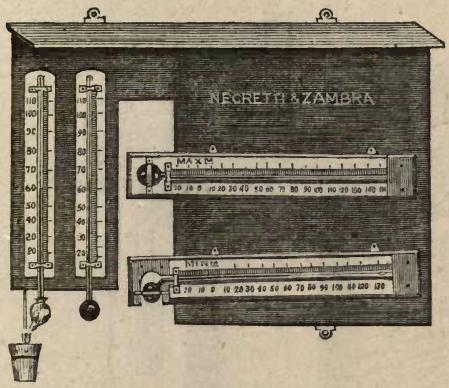

FIG. 88.

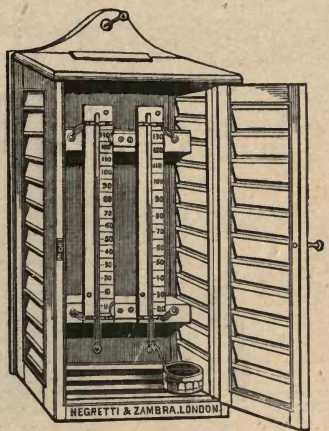

FIG. 89.

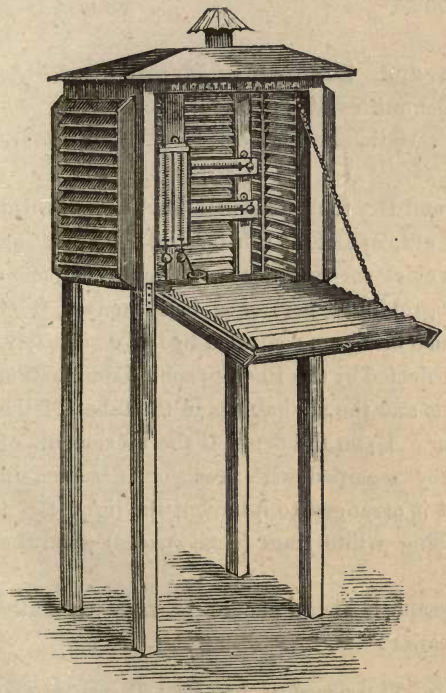

FIG. 90.

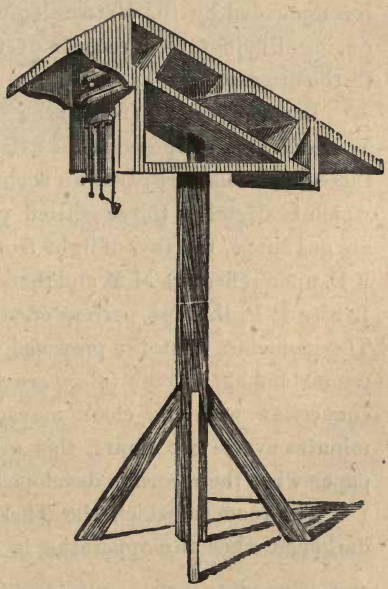

FIG. 91.

104. **Screens for Thermometers and Hygrometers.**

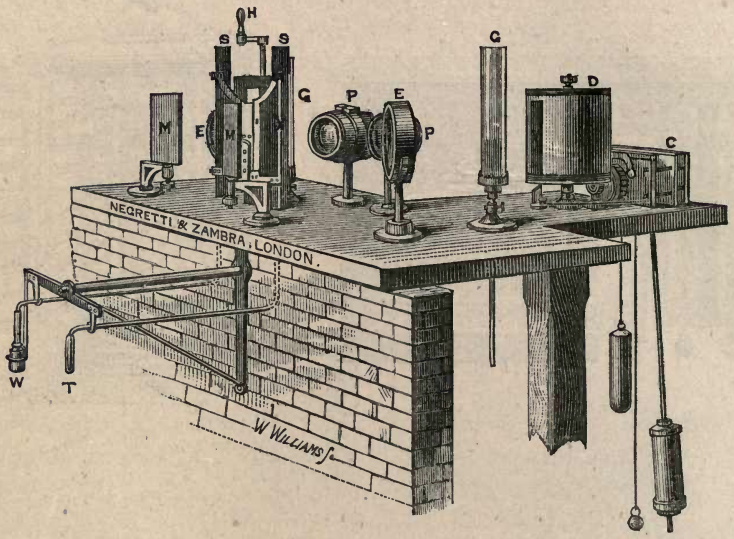

FIG. 92.

104. **Beckley's Thermograph and Recording Hygrometer.**—As recommended by the Meteorological Committee of the Royal Society for producing Photographic records of the variations of temperature and moisture in the atmosphere.

In the engraving (fig 92) the Wet and Dry Bulb Thermometers are shown at W and T. freely exposed to the external atmosphere, at H is a screw for adjusting these Thermometers; C is an accurate clock for rotating the cylinder D (upon which is stretched the sensitised photographic paper) once in 48 hours; G G are gas lamps, the rays of light from them being concentrated by two condensers, E E, upon reflectors M M and thence projected by the Photographic Combination Lenses P P, through perforated screens and the air bubbles in the tubes of the Thermometers upon the prepared paper. Upon the drum D the movements of the air bubble in both tubes are hereby recorded with precision, a screen in connection with the clock movement is arranged to intercept the light for 4 minutes every two hours, this producing white lines (time spaces) upon the paper when the record is developed.

The room in which the Thermograph is placed should be most carefully darkened when the apparatus is in action.

Price, £125, *complete with two Standard Thermometers, two Bent Thermometers, Clock Movement, &c., &c.. complete, made to order.*

105. It is hardly possibly to over-estimate the value and importance of carefully compiled statistics of the Rainfall. The two great sanitary questions of the day, viz., the Water supply and Sewage of large towns, are in a very great measure connected with the amount of rain falling during a given period, and reliable particulars of the rainfall are specially valuable both to the Civil and Hydraulic Engineer.

The Farmer and commercial Financier are also both deeply interested in the results of a probable dry or wet season influencing the growth, amount, and value of various crops and produce of the earth. We subjoin a few facts we think may prove useful and interesting.

Fall of Rain at the Royal Observatory, Greenwich.

Taking December, January, and February as the winter months; March, April, and May as the spring months; June, July, and August as the summer months; September, October, and November as the autumn months, the quantities which fell in the different seasons were as follows:

—	1842.	1843.	1844.	1845.	1846.	1847.	Mean.
	Inches.	Inches.	Inches.	Inches.	Inches	Inches.	Inches.
Winter .	2·81	4·14	5·16	5·33	5·42	4·77	4·60
Spring .	4·42	5·98	3·59	4·27	5·43	3·16	4·47
Summer .	5·69	7·34	6.63	6·84	6·00	4·12	6·10
Autumn .	9·65	7·01	9·58	5·90	8·44	5·56	7·69
Total .	22·57	24·47	24·96	22·34	25·29	17·61	22·86

The quantity of rain which fell at the Royal Engineers' stations during the year 1853–4, was as follows:

	Inches.		Inches.
Edinburgh . . .	23·15	Barbadoes	68·24
Guernsey . . .	32·77	Ceylon	71·63
St. John's . . .	55·05	Mauritius . . .	39·52
Gibraltar . . .	47·29	Fremantle	33·94
Malta	28·08	New Zealand . . .	48·42
Jamaica . . .	34·31		

Lincoln is the dryest recorded station in England, the mean annual rainfall being 20 inches. The wettest recorded station is Stye, at the head of Borrowdale in Cumberland, where the mean annual rainfall amounts to 165 inches. A fall of rain measuring a tenth of an inch in depth is equal to a deposit of about forty hogsheads per acre.

POSITION FOR RAIN GAUGES

106. From the observations made at the Royal Observatory at Greenwich, the fact is clearly established that in the lower regions of the atmosphere, the quantity of rain which falls diminishes with the altitude above the ground.

The height for placing the receiving surface of a rain gauge is somewhat open to a difference of opinion. Mr. Glaisher's gauge is directed to be "half sunk in the ground." This would place the edge of the gauge about 8 inches from the surface of the ground. Mr. Symons gives 12 inches as most correct, 10 inches as a mean between these will be perhaps the best to adopt. Rain gauges should be placed on a level piece of ground, and not on a slope or terrace, away from walls or trees, as many feet from their base as their height, the edge of the funnel should be set quite level. Unless for special observations Rain Gauges should not be placed on roofs or any very elevated position. It is very important that Rain Gauges be occasionally examined to see that the Receiving Funnel be not choked up by dust or leaves, and that at very wet stations the receiving portion of this Gauge be sufficiently large to hold any possible rainfall;—even the probable occurrence of a water-spout might be provided for in hilly or very exposed situations. Gauges should be well supported to prevent their being knocked down or blown over by the wind, and after snow or frost the gauges should be placed in a warm room until the collected contents are melted and can be measured. In measuring off the quantity of collected rain, the graduated glass should be held quite upright, and the reading taken midway between the two apparent surfaces of the water. The rain should never be collected in the graduated measure, especially in winter, to avoid risk of breakage by frost.

107 **Measurement of Rain.** The Rain Gauge should be examined every day, at nine a.m., and the amount of water collected by it entered in the register, as having fallen on the previous day; for if we measure at nine a.m. to-day, it is probable, under ordinary conditions, that more of the Rain collected by the Gauge will have fallen during the fifteen hours of the previous day up to midnight than during the nine hours extending from midnight to nine o'clock of the following morning.

A vast amount of interesting and most valuable information respecting Rain Gauges and the Rainfall will be found in Negretti and Zambra's *Treatise on Meteorological Instruments*, and Mr. G. J. Symons' eminently useful publications as enumerated in our list of books at the end of this section.

INSTRUMENTS USED FOR MEASURING THE RAINFALL.

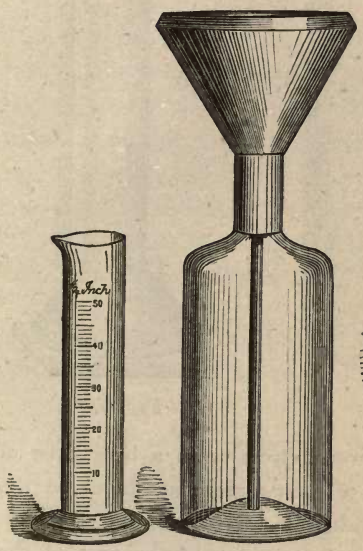

FIG. 93.

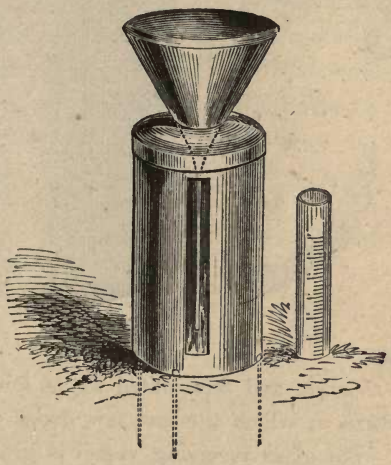

FIG 94.

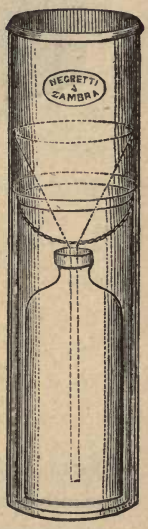

FIG. 95

108. **Howard's Rain Gauge,*** (fig. 93). The simplest form of the instrument constructed and used by the celebrated meteorological writer, Luke Howard, from whom it derives its name; it has a 5-inch Copper Funnel, with a turned brass Rim, fitted to a stoneware or glass bottle, with a glass graduated measure divided to hundredths of an inch. *Price*, £0 10 6

109. **Symons' Rain Gauge,** (fig. 94). This instrument has a glass receiving bottle protected by a metal case, with openings at the side for the convenience of observing the collected rainfall without disturbing the frame, which is firmly supported in the ground by strong spikes. The measure holds half an inch of rain for a 5-inch area subdivided into hundredths.

Price, with graduated measure . . £0 10 6
Ditto, in Copper 0 15 0

See also Symons' Snowdon Rain Gauge, No. 118, *Page* 85.

110. **Glaisher's Rain Gauge,** (fig. 96).—This gauge is eight inches diameter, and arranged for the reception of the water only which falls upon its receiving surface, and for the prevention of loss by evaporation. The rain is first collected in a funnel, the receiving surface of which is accurately

* Pluviometer, Ombrometer, Udometer.

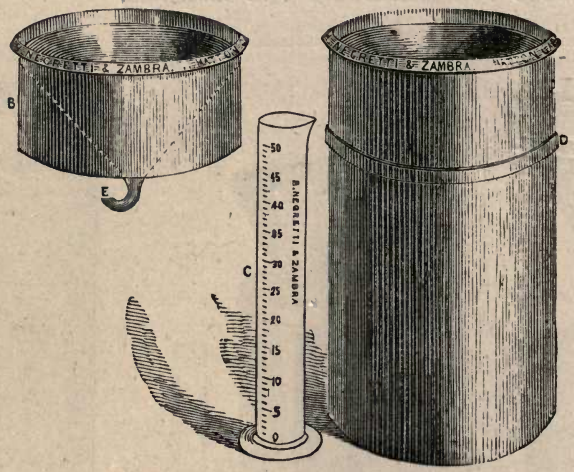

FIG. 96.

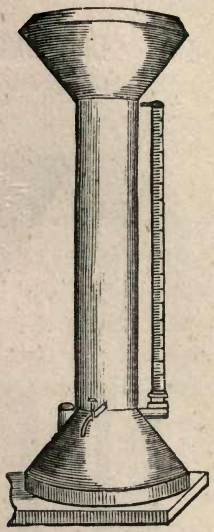

FIG. 97.

turned in a lathe, and terminated at its lower extremity in a bent tube of small aperture, in which the last few drops of rain remain as shown in the engraving. The glass receiving vessel is graduated to hundredths of inches according to the calculated weight of water, as determined by the area of the receiving surface. In use, the gauge is partly sunk below the surface of the soil, so that the receiving surface is about eight inches above it. Thus situated, no water escapes by evaporation in any month of the year. If placed differently, the readings must be taken daily.

Price, in Japanned Tin . £1 1 0
in Copper . . 1 10 0

RECEIVING VESSEL FOR GLAISHER'S GAUGE.—*Price*, in Japanned Tin or Copper, 2s. & 3s. 6d.

As some meteorologists have objected that the curved tube at the base of the funnel is liable to be choked up with dust, Messrs. Negretti and Zambra, if desired, supply these Rain Gauges with a straight tube of sufficient length to reach very nearly the bottom of the receiving vessel, thus obviating this difficulty, and at the same time preventing evaporation.

111. **Glashier's Rain Gauge**, with extra large receiving vessel, mounted with a convenient tap for drawing off the water, suited for Tropical countries or stations where there is an excessive rainfall. *Price*, in Copper, £3 3 0

The 8-inch Glaisher's and the Meteorological office Rain Gauges are now considered by scientific men the best, and consequently are almost universally adopted as Standard instruments, but at the same time we would observe that most valuable results have been obtained by the use of Mr. Symons' 5-inch gauge in many parts of the United Kingdom.

112. **Rain Gauge** (fig 97), having a receiving surface of 12 inches diameter, and graduated glass tube divided to inches, tenths, and hundredths of an inch, showing by simple inspection, without the use of a graduated measure, the amount of rain fallen. In japanned metal, with tap for emptying the gauge.

Price . . . £2 10 0 Ditto, ditto, in Copper . 3 10 0

113. **Rain Gauge**, a similar but rougher form of No. 112, without brass mountings, and instead of the graduated glass tube, it is fitted with a boxwood scale, attached to a metal float inside the gauge, on which can be read off, by simple inspection, the amount of rain fallen. *Price*, complete, £2 2 0

The **Rain Gauges** (Nos. 112 and 113), are not suitable for measuring small quantities, but are useful where the rainfall is excessive.

114. **Admiral FitzRoy's Rain Gauge**, with graduated glass dipping tube, steadying rods or supports, and frame, now very rarely used.

Price, in Stout Copper £3 3 0

115. **Pocket Rain Gauges**, with 3-inch receiving surface and corresponding measuring glasses, have been made by Messrs. Negretti and Zambra, but they cannot be recommended.

116. **Square Rain Gauge**, having a receiving surface of 10 inches by 10 inches, and about 12 inches in height, made of stout copper—with a graduated glass measure divided into one hundredths of an inch, as described in Col. Sir H. James's instructions for taking meteorological observations for the use of the Royal Engineers; the Gauge is shown partly in section, (fig 98.) *Price*, £2 10 0

117. **Meteorological Office Rain Gauge.** Our woodcut (fig. 99.) shows a recent form of 8-inch Rain Gauge introduced and recommended by the London Meteorological Office. It will been seen that essentially this form of gauge is the same as Glaisher's, but with an additional vertical cylinder about 6 inches above the funnel—its use is to prevent in splashing and also most especially to collect and measure Snow. *Price*, with graduated measure, in Japanned Metal £2 2 0

Ditto in Copper 2 15 0

118. **The Snowdon Rain Gauge.** Mr. Symons has made some improvements in the arrangement of his Gauge, these are chiefly the addition of a vertical cylinder above the funnel and doing away with the openings in the external case enclosing the receiving bottle; also Mr. S. advises that the gauge be almost entirely plunged below the surface of the earth as a protection from evaporation by heat, and breakage by frost—another advantage of the close cylinder is that should the collecting bottle be broken by frost or otherwise its contents will be saved to the observer. The form of this Gauge is that of fig. 95. with a collecting funnel and cylinder of 5 inches diameter. This instrument is named by Mr. Symons the Snowdon Rain Gauge.

Price, complete in Galvanised Metal, with graduated measure . £0 12 6

Ditto, ditto in Copper . , . . 1 5 0

Mr Symons' Certificate for either of the above, 2s. 6d.

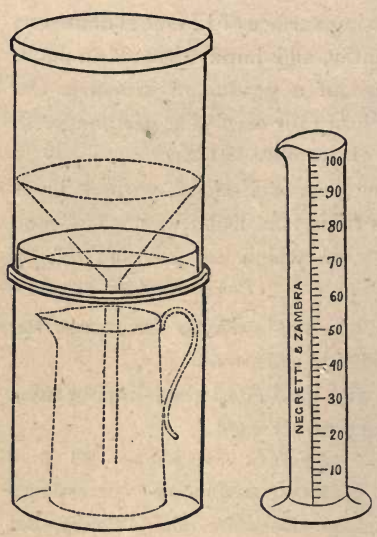

FIG. 99.

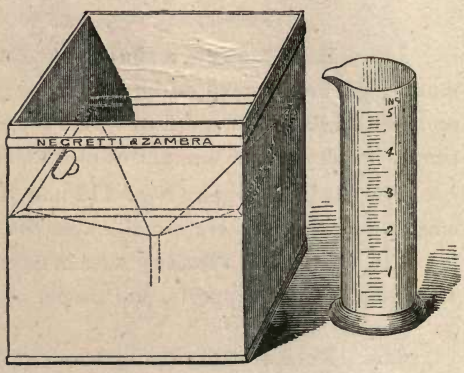

FIG. 98.

119. **Negretti and Zambra's Tropical Rain Gauge,** similar in form to No. 99, but of extra large size, to hold 50 inches of rain, with a metal tap for drawing off the collected water.

Price, complete with receiving vessel and graduated measuring jar in japanned metal £2 10 0
Ditto Ditto in Stout Copper 3 5 0

120. **Crossley's Registering Rain Gauge** (fig. 100.) is a 10-inch square guage, the receiving area being equal to 100 superficial inches. The water collected by the funnel passes down a tube to a vibrating bucket connected with and giving movement to a train of wheels communicating with three dials recording the amount of rain passing through the gauge, in inches, tenths, and hundredths. The mechanism is simple, and if occasionally examined and kept clean it will give a faithful record to $\frac{1}{20}$th of an inch depth of rain. A small test measure, holding 5 cubic inches of water, is sent with each instrument for the purpose of testing and correcting the gauge, and full printed instructions for fixing, reading off the dials, &c., &c., accompany each instrument. Under careful management this registering gauge will be found very useful. *Price,* £4 12 0

Great care should be taken to prevent the edge of the collecting or receiving funnels of Rain Gauges being bent or dented, for should the area be not a true circle the full amount of rain will not be collected. Circular Rain Gauges are preferred to Square ones, the latter being more liable to get out of shape than the former.

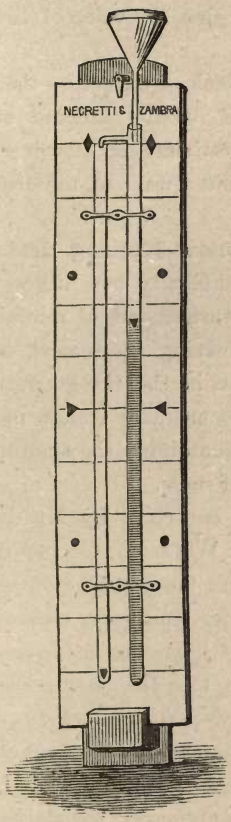

Fig. 101.

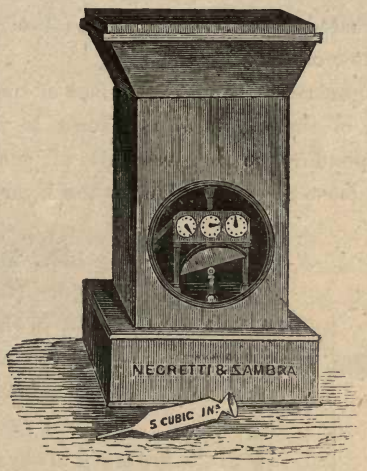

Fig. 100.

121. **Symons' Storm Rain Gauge**, (fig. 101). This instrument the inventor states he constructed, not as a standard or thoroughly accurate instrument, but as very convenient for observing the rate of rainfall minute by minute without either measuring or going out of doors.

The area of the funnel as compared with that of the glass tube is so large that an inch of rain is about 2 feet long on the tube, therefore, as each tenth of an inch is about 3 inches long, the water can be seen gradually rising in the tube as the rain continues, and the quantity in any interval, however short, may be easily noted. In order to facilitate reading at a distance floats are placed in each tube, and these being white while the board is black are clearly visible at a great distance. Each division on the scale is a tenth of an inch, and it will be seen that the first being filled up to the top line (*i.e.*, ten tenths, or one inch) the rain flows into the second and that float begins to rise until two inches of rain have fallen.

The Gauge is emptied by turning the button (A) and then inverting the Gauge, the floats cannot fall out. In frosty weather it is advisable to empty out all water from the Gauge and place a cover over the collecting funnel.

Price for Symons' Storm Rain Gauge £2 2 0

A larger form of Registering Rain Gauge (Pluviograph) will be described in connection with Osler's Anemometer.

122. The measurement of Snow or Hail is to be effected by thawing the quantity collected in the funnel of the rain gauge, and measuring the water resulting therefrom. The rain gauge recommended by the Meteorological Office (No. 99), is specially contrived and adapted for this purpose, the snow or hail collected being thawed by a known quantity of hot water. This quantity

being subtracted from resulting amount of water will give the value of the collected snow or hail.

"It is generally stated that a foot of snow gives an inch of water; so that one-twelfth of the depth of the snow in inches would be the amount of rain corresponding to a given fall of snow. This estimate is, however, only a very loose approximation, as the layer of snow is not always of uniform density."

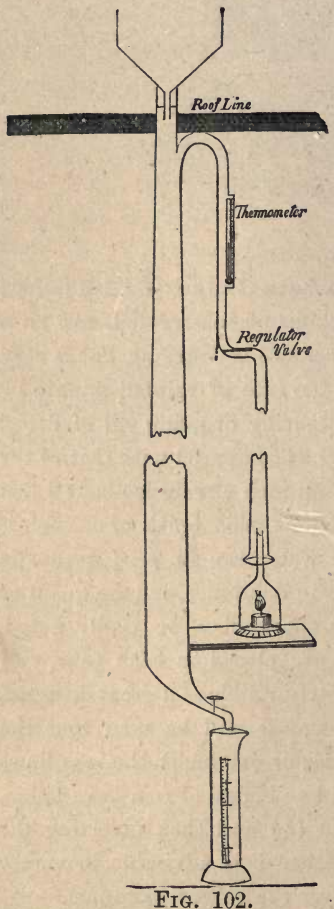

FIG. 102.

123. **Bentley's Snow-Melting Rain Guage.** (fig.102 .) A difficulty has hitherto existed in the exact admeasurement of rainfall —viz., the necessity of leaving snow, sleet, or hail, whenever they occur, in the Gauge until they can be melted; the ordinary Gauge not being always capable of containing the amount of a long-continued fall of snow.

This apparatus was contrived by Mr. R. Bentley, at Upton (near Windsor), for use in connection with an 8-inch Guage situated on a roof inaccessible under ordinary circumstances. On reference to the accompanying diagram, it will be seen that the distinguishing feature of this Gauge *is the melting of any snow or sleet immediately on its reception.* This arrangement makes it very useful in connection with any automatic registering apparatus, or where the Gauge, from its position, is not easily accessible, and at night.

The action of the Gauge is briefly thus: The rain or snow fall is received in the usual 8-inch funnel, from the bottom of which it falls by gravity to the end of the tube (of whatever length that may be) *without touching the sides.* This is a very important point, and is gained by fitting a short guide-pipe, of some six inches in length, to the bottom of the funnel, and by the internal diameter of the long tube being gradually slightly increased in proportion to the length of the tube. At the bottom of the tube (which is within the house) is placed a tap and measuring-glass. If preferred, the tap can be left open or removed, and an automatic recording apparatus substituted.

By the side of the main tube, but sufficiently distant from it for any heat not to be conveyed sideways, is the melting tube. The hot air is furnished by a gas jet or lamp—or even a candle or night-light—and being regulated to a

temperature of from about 40° to 46° Fahrenheit, by the thermometer enclosed in the tube (and exposed to view by means of a piece of glass inlet), ascends through the funnel, and gradually melts the snow, etc., as it falls in. Too high a temperature should not be employed, as being conducive to evaporation.

An additional protection may also be afforded by the employment of a self-acting valve midway in the heating tube, to expand with any access of heat, in so doing partly to close the way, and at the same time to push open a small trap-door, letting out some of the hot air and admitting some cooler air from the outside. As soon as the proper temperature has been by this means restored, the valve would contract into its normal position. This arrangement, however, owing to the delicacy of the adjustment, is very apt to get out of order.

Messrs. Negretti and Zambra construct the above apparatus to order; but no exact prices can be quoted, as the cost would vary greatly according to the extent and nature of the work and the position in which it is to be placed.

A small piece of very open wire-work might be placed across the receiver, *half way down*, in case of leaves, &c., falling in. In the construction of the Gauge, Copper should be employed.

124. **Marine Rain Gauges.** Negretti and Zambra have constructed several different forms of Rain Gauge for use on board of ship. One arrangement having gimbal mountings similiar to a steering compass has been found the best, but the records obtained by their use at sea have been unsatisfactory and not considered of any scientific value.

EVAPORATION.

125. Mr. R. H. Scott, of the Meteorological Office, writing on this subject, remarks that it "is one of very great importance, especially as regards its connection with Rainfall and Water supply, and well deserves especial attention; but it cannot as yet be said that the results hitherto obtained merit much confidence as regards their applicability to the evaporation occurring in nature, owing to the exceptional manner in which the observations have been made."

Atmometers of many forms have been invented and constructed, both in this country and on the Continent, but, at present, nothing satisfactory has been devised; hence the difficulty of making any very accurate observations in connection with evaporation from the surface of water.

126. **Evaporation Gauge.** (fig. 103), (Evaporometer), for showing the amount of evaporation from the earth's surface. This gauge consists of a brass vessel, of eight inches diameter, corresponding with Glaisher's Gauge, the area or evaporating surface of which is accurately determined; and also a glass cylindrical measure, graduated into inches, tenths, and hundredths of inches. In use, the Evaporating Gauge is nearly filled with water, the quantity having been previously measured by means of the glass cylinder; it is then placed out

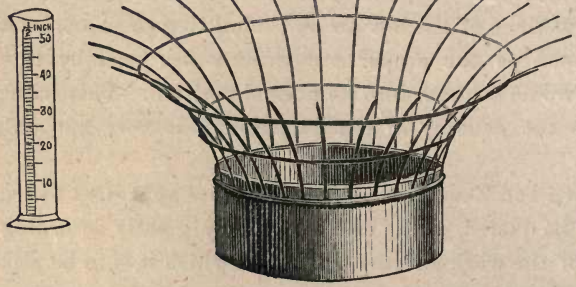

Fig. 103.

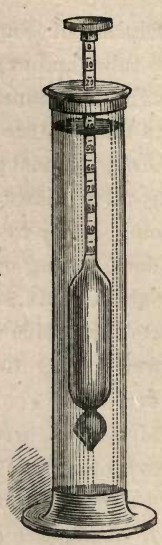

Fig. 104.

of doors, freely exposed to the action of the atmosphere; after exposure, the water is again measured, and the difference between the first and second measurement shows the amount of evaporation that has taken place. If rain has fallen during the exposure of the evaporating dish, the quantity collected by a rain gauge must be deducted from the amount of the measured contents of the evaporating dish when the observation is made. The wire cage round the gauge is to prevent animals, birds, &c., from drinking the water.

Price, with Graduated Measure . . . £1 3 6

127. **Atmidometer*** (Dr. Babington's), fig. 104 for measuring the evaporation from water, *ice* or *snow*. Consists of an oblong hollow bulb of glass or copper, beneath which, and communicating with it by a contracted neck, is a second globular bulb, duly weighted with mercury or shot. The upper bulb is surmounted by a small glass or metal stem, having a scale graduated to grains and half-grains; on the top of which is fixed horizontally a shallow metal pan. The bulbs are immersed in a vessel of water having a circular hole in the cover through which the stem rises. Distilled water is then gradually poured into the pan above, until the zero of the stem sinks to a level with the cover of the vessel. Thus adjusted, as the water in the pan evaporates, the stem ascends, and the amount of evaporation is indicated in grains. This instrument affords

* Mr. Scott suggests that Leslie's term Atmidometer is more classically correct, but that Atmometer has the advantage of being shorter, without being absolutely incorrect,

a means of measuring evaporation from *ice or snow*. An adjustment for temperature is necessary. *Price*, £2 2 0

Ditto, large size with Copper Tank 3 10 0

128. **Glaisher's Thermometer Stand** (fig. 91).—The Thermometer Stand consists of a horizontal board as as a base, of a vertical board projecting upwards from one edge of the horizontal board, and of two parallel inclined boards, separated from each other by blocks of three inches in thickness connected at the top with the vertical board, and at the bottom with the horizontal board, and the air passes freely about and between all these boards; on the top of the inclined boards is a small projecting roof to prevent, as much as possible, the rain or snow falling on the bulbs of the instruments which are mounted on the front of the vertical board. The bulbs of the Thermometers, &c., all project below the edge of the vertical board, in order that the air may pass freely over them from all directions. The whole frame is constructed to revolve on an upright post firmly fixed to the ground, as shown in the engraving; and in use, the inclined side should always be turned towards the sun.

Price, . . . £3 3 0

129. **Stevenson's Thermometer Screen**, shown in fig. 90. The louvres in this arrangement are double, sloping in opposite directions, so that whilst there is free access of air to the interior, the radiant heat and rain are excluded. This form of Screen is now found to be the best of any yet invented, for climates similar to the British Islands; but is not suitable for climates subject to great extremes, such as India or Canada.

This Screen should stand on open ground and be strongly supported, not under the shadow of trees or houses, and at least twenty feet from any wall, and the floor of the screen to be about four feet above the ground. The door of the Screen should face due north. *Price* . . . £3 3 0

130. **Negretti and Zambra's** Set of Standard Instruments on a Screen. Includes N. and Z's. Patent Standard Maximum Registering Thermometer, Standard Minimum Registering Thermometer, and Standard Wet and Dry Bulb Hygrometer, Mounted on Mahogany Board. fig. 88. £5 5 0

Kew Certificates for above . . . 10 0

The best position for placing the Thermometer Board or Screen is facing the North, at about five feet from the ground, supported firmly to prevent vibration from wind and away from all walls or trees, or if this board be supported by a wall it should be well blocked out from it at least 8 or 12 inches to allow a free current of air to circulate behind it.

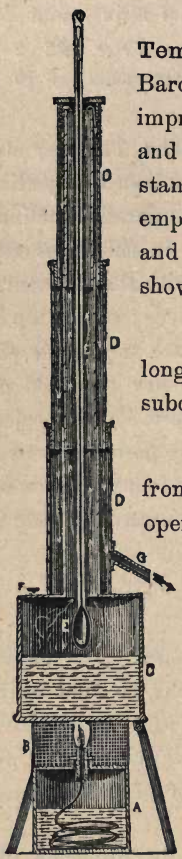

FIG. 105.

131. **Apparatus for Determining Elevations by the Temperature of the Boiling-point of Water.**—The Barometrical Thermometer, or Hypsometrical Apparatus, is an improved form of Wollaston's Apparatus constructed by Negretti and Zambra, to meet the requirements of travellers in circumstances where the mercurial barometer cannot be conveniently employed. The instrument is very portable, and affords a ready and accurate means of measuring heights. The apparatus is shown in section (fig. 105). It consists :—

First,—of a very sensitive thermometer, about 12 inches long, the scale ranging from 180° to 212°, having each degree subdivided so as to show distinctly 0° 1.

Secondly,—a metal boiler (c) mounted on a small tripod stand; from the boiler proceeds three double tubes (E E E) and (D D D), open at the top; screwed on the top of the boiler; the outer tube has two openings, one at the top, through which the Thermometer (E E) is inserted, passing down to within an inch of the water in the boiler, and supported by means of an india-rubber washer, as shown in fig. 105; the second opening forming an outlet for the steam, as shown at (G). These double tubes are now constructed to separate at the joints by a simple slide fitting, so that any length of the Thermometer Stem can be made visible varying with the elevation at which the tubes are adjusted. The object of the double tube is to ensure a steady boiling-point, in which it would be impossible to obtain in open air-experiments, were only a single tube employed. (A) is a metallic spirit lamp, surrounded with wire gauze (B) to prevent the flame being extinguished when experimenting in the open air.* The whole instrument when packed in a leather case for travelling is shown in fig. 105*. Each instrument is furnished with a carefully computed set of tables, from which may be obtained, by an easy calculation, the elevation corresponding to any observed boiling-point between the temperatures of 180° and 212°.

FIG 105*.

* A Russian spirit furnace, surmounted by a small spirit lamp, is sometimes furnished. The object of the Russian furnace is to cause the water to boil rapidly; when that has been accomplished, the small lamp is lighted, and placed over the blast from the furnace, which it extinguishes, at the same time its flame is sufficient to keep the water boiling.

To use the Boiling Point Apparatus, it is simply necessary to pour into the boiler, through the small opening (F) on its surface, a sufficient quantity of water to fill it about one-third, and afterwards close it by means of the screw for that purpose; the lighted spirit lamp is then applied, and when the water is made to boil, the steam rises, surrounding the bulb and tube, and descending between the two tubes, issues from the opening at (G.) After a few seconds, the mercury in the thermometer will rise and become stationary; the degree indicated by it must then be noted, when, by reference to the tables, the elevation of the spot where the experiment has been performed may be obtained.

The Temperature of the Air should be observed by a reliable Thermometer at the same time.

Price, with Spirit Lamp, in Sling Case, £5 5 0
Extra Standard Thermometer . 1 10 0
Extra Thermometer for Air Temperature . 0 10 6

The following table expresses very nearly the elevation in feet corresponding to a fall of 18° in the temperature of boiling water:—

Boiling Temperatures between	Elevation in Feet for each Degree.
214° and 210°	520
210 and 200	530
200 and 190	550
190 and 180	570

Rule for computing heights from observations with the Boiling Point Apparatus or Mountain Thermometer, by Negretti and Zambra's Boiling Point Tables.

From Table I. take out the heights in feet corresponding to the boiling-points observed at the upper and lower stations respectively. The difference between these two numbers, multiplied by the factor in Table III. for the mean temperature of the air, is the difference in height required.

EXAMPLE:

At upper station, boiling-point = 187°·3; temp. of air = 26°.
At lower station, boiling-point = 210°·4; temp. of air = 68°.
Boiling-point = 187°·3; height from Table I. = 13495 feet.
Boiling-point = 210°·4; height from Table I. = 905.

Difference = 12590

Mean temp. of air = 47°; factor from Table III. 1·033.
Required difference between the two stations = 12590 × 1·033 = 13005 feet.

To determine a height with accuracy, it is necessary that pure water should be used, distilled water if possible, and a similar observation should be made at the same time at a lower station, not very remote laterally from the upper, and both should be many times repeated. When such observations have been very carefully conducted, the height of the upper station above the lower may be ascertained with great precision, as has been repeatedly verified by subsequent trigonometrical measurement of elevations so determined. If the lower station be at the sea level, the absolute height of the upper is at once obtained.

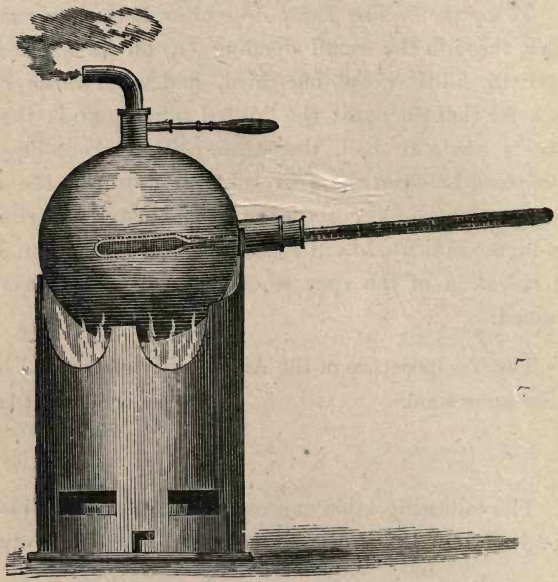

FIG. 106.

132. **Negretti and Zambra's New Pocket Boiling-Point Apparatus,** (fig. 106) consists of a small globular metal boiler, mounted upon a metal support or stand. In the base of this stand is formed a receptacle for holding and burning spirits of wine, by which water in the boiler is rapidly heated up to the boiling-point. On the top of the boiler is a tube for the escape of steam during the operation, and on one side is seen another tube (horizontal), into which is inserted one of Negretti and Zambra's Patent Maximum Registering Thermometers, very finely and carefully divided upon its stem, of sufficient range for all possible elevations to be ascertained by the boiling-point of water.

The boiler having been charged with a small quantity of water, and the receptacle filled with sufficient spirit, the boiler is placed upon its support above the burning alcohol, with the Thermometer bulb inserted into the side tube. In a few minutes the boiling point will be attained, and the mercury in the Thermometer will rise to this point, *and remain in the tube* until it is convenient to note the temperature thus obtained.

If, after the experiment has been made, the Thermometer be carefully withdrawn from the boiler, and *carried with the bulb-end uppermost*, the record of the temperature may be read off hours, or even days, afterwards. The advantages of this apparatus are great simplicity, rapidity in use, and portability.

Price, in a portable case, with an extra Thermometer for Air Temperatures, £3 0 0

133. **Pocket Hypsometric Apparatus,** as constructed by Negretti and Zambra for Dr J. D. Hooker, of a very simple and conveniently portable form, with one corrected Thermometer. Suited for rough exploring expeditions.

£2 10 0

APPARATUS EMPLOYED FOR REGISTERING THE DIRECTION, PRESSURE, AND VELOCITY OF THE WIND.

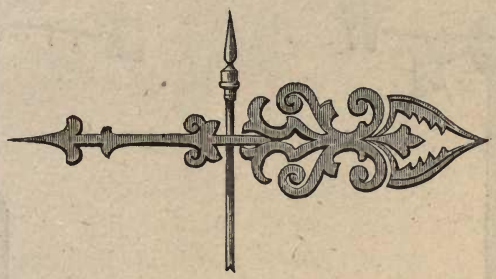

FIG. 107.

THE records obtained by the use of various forms of Anemometers are equally interesting and valuable.

The amount of pressure and velocity of the wind are now registered with such precision, that it enables Millwrights and Engineers to make their calculations and arrange their machinery in accordance with the amount of work required to be done, and also to test and compare the expected with the actual results.

Meteorologists are equally interested in Anemometer records. The points of direction and the duration of the wind in particular quarters and seasons have very much to do with the Rainfall and Evaporation in different countries and localities. The late Admiral FitzRoy in his *Weather Manual* repeatedly indicates the great importance of careful observations on the various phenomena of the wind in connection with Marine and Sea Coast Meteorology.

134. **Wind Vane**, for indicating the direction of the wind. See next page.

It is important to note that the North point of the Vane should be carefully adjusted to the *Geographical or true North*, and *not* to the Magnetic North. See Compass Variations in Appendix at the end of the volume.

135. **Anemoscope.**—Dr. Halleur's Portable Wind Vane and Magnetic Compass, for showing the direction of the wind to half a point of the compass. This instrument is very similar in form and size to Lind's Wind Guage, shown on page 98. Fig 109. *Price* £2 5 0

WIND VANES, FOR INDICATING THE DIRECTION OF THE WIND.

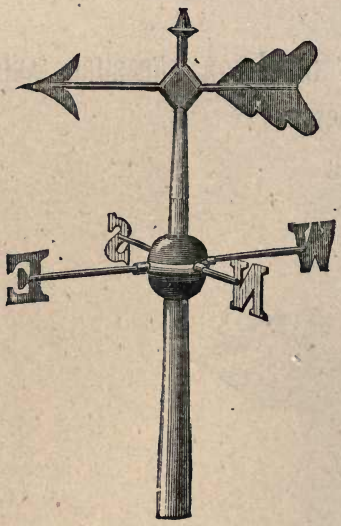

FIG. A.

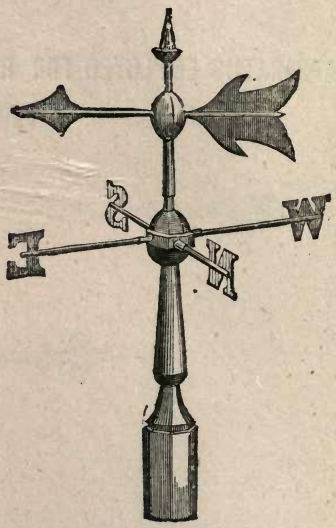

FIG. B.

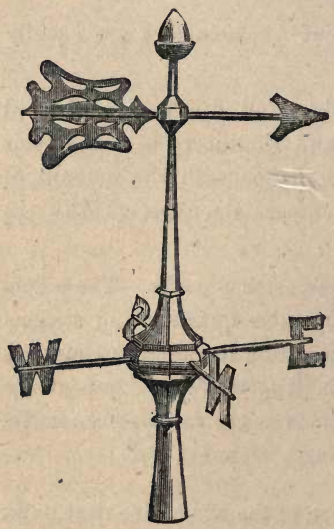

FIG. C.

136. NEGRETTI & ZAMBRA construct Wind Vanes of various dimensions and designs to suit the positions in which they are to be placed, the cost varying with the amount of work and ornament upon them.

As Fig. A. 2 feet 3 inches high . .	£1 5 0
5 feet	3 12 6
As Fig. B. 4 feet high	3 3 0
5 „ „	4 12 6
As Fig. C. 3 feet high . . .	2 5 0
6 „ „	5 5 0

These prices do not include fixing, for which special estimates will be furnished.

These Vanes are japanned in plain colour—Black, Red, Yellow or Blue. Gilding the Vane and Arrow extra, 14/6. Gilding the Direction Letters, 14/-.

N. & Z., fit up Wind Vanes arranged to show the varying direction of the Wind upon a Dial in the interior of Mansions or Public Offices. The cost for erecting such Wind Indicators depending much on the height of the building, and the position in which the Vane is to be placed, no positive prices can well be quoted; estimates given upon particulars being sent.

Wind Vanes are frequently fitted upon buildings in connection with Lightning Conductors, particulars will be found in another section.

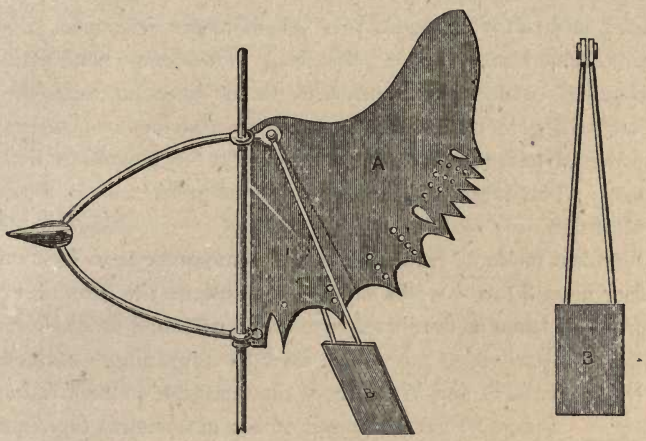

FIG. 108.

137. **Negretti and Zambra's Improved Pendulum Anemometer** invented by Dr. Prestel to exhibit at any moment in a most simple manner the direction and comparative pressure of the wind.

By the action of the peculiar shaped vane A, the surface of the swinging pressure plate, B, is always kept facing the point from which the wind is blowing, and consequently exposed to its influence. During a calm the pendulous plate, B, will hang quite vertical in a line with the axis of the vane plate indicating zero or calm. As the wind increases in force the pressure indicator will be raised to various points between 1 and 10 of the vane.

The holes are drilled through the plate of sufficient size to be plainly visible at a considerable height from the ground; and to facilitate the reading, the 5 and 10 are of a larger conical form, so that the position of the pressure plate can be quickly observed.

The subjoined table gives in English and French measures the value of the indications. The Metrical scale is calculated to show the pressure of wind in kilogrammes on the square meter, and the English scale pounds on the square foot.

I.					II.
Scale of P. A.	Pressure in Kilgr. on S. M.	Manheim Scale.	Elevation of Pendulum.	Description of Wind.	Pressure in lbs. on the Sqre. foot.
0.	0	0	0	Calm.	0
1.	1	0·5	5°	Gentle motion of air.	0·2044
2.	4	1·0	20°	Light breeze.	0·8176
3.	9	1·5	35°	Fresh ,, (top gallant W.)	1·8396
4.	15	2·0	45°	Stiff ,, (strong top gallant W.)	3 0660
5.	25	2·5	54°	Very Stiff breeze (top sail W.)	5·1110
6.	36·8	3·0	60°	Strong rushing W. (to house top glt.)	7·5119
7.	49	3·5	64°	Stormy W. (to house top sails.)	10·0156
8.	64	4·0	67°	Gale of Wind.	13·0816
9.	81·6	4·5	69½°	Strong Gale.	16·6790
10.	100	5·0	70°	Hurricane.	20·4408
	143·6	—	74½°		29·3518

French Measure. English Measure.

Negretti and Zambra think this Anemometer will meet a want often expressed to them, viz., a simple self-acting Wind-gauge; for with very little more mechanical combination than a common direction vane, the Pendulum Anemometer will give sufficiently accurate results for unscientific observers. It has also the advantages of extreme simplicity, for beyond a little oil to the moving parts and an occasional coat of paint for protection, it does not require the least attention. *Price*, fig. 108, £6 6 0

The simplest mode of mounting this Anemometer is to fit it on the top of a flag-staff or mast 30 to 40 feet high, well sunk in the ground, strengthened and supported by three or four wire rope stays, attached to small sunk posts in the earth; these wire ropes might be used as Lightning Conductors. Arms with the letters N. E. S. and W. to show the direction of the wind as on fig. A page 96 can be placed on the mast below the Anemometer.

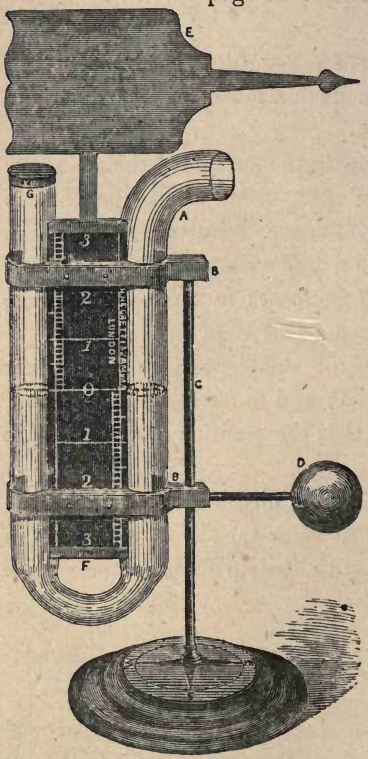

FIG. 109.

138. **Lind's Anemometer or Wind Gauge** (fig. 109), invented in the year 1775, for observing the pressure of the wind, consists of a glass syphon, the tubes are parallel to each other, and each tube is of the same diameter. One end of the syphon is bent at right angles to the general direction of the tubes, so as to present a horizontal opening to the action of the wind. A graduated scale, divided to inches and tenths, is attached to the syphon tube, reading either way from a zero point in the centre of the scale. The whole instrument is mounted on a spindle, surmounted by a vane, and is moved freely in any direction by the wind, always presenting the open end of the tube towards the quarter from which the wind blows. To use the instrument it is simply filled up to the zero point with water, and then exposed to the wind; the difference in the level of the water gives the force of the wind in inches and tenths, by adding together the amount of depression in one limb, and elevation in the other, the *sum of the two* being the height of a column of water which the wind is capable of sustaining at that time. At the base of the instrument is a brass plate, upon which are engraved the principal points of the compass, for indicating the direction of the wind. *Price*, £2 2 0

The bend of the syphon is contracted internally to diminish the jumping movement of the water produced by sudden gusts of wind.

No. 139. **Negretti and Zambra's Registering Lind's Anemometer.** Several modifications of Lind's Wind Gauge have at various times been invented by Sir W. Snow Harris, Mr. Wood and others, with a view to make it self-recording, but the only one that proves satisfactory in actual service, is an arrangement manufactured by Negretti and Zambra at the suggestion of Mr. Forbes, of Inverness. The improvement consists of a third tube of the same internal diameter, connected by a bend at the Zero point of the instrument, into which the water overflows and is collected from the leeward tube of the syphon. The water thus collected being the maximum amount of depression produced in the syphon representing the extreme force of the wind.

Table showing the Force of wind on a square foot, for different heights of the column of Water in Lind's Wind-Gauge.

Inches.	Force in lbs.	Common designation of such Wind.
6	31·75	A Hurricane.
5	26 04	A violent Storm.
4	20·83	A great Storm.
3	15·62	A Storm.
2	10·42	A strong Wind.
1	5·21	A high Wind.
·5	2·60	A brisk Wind.
·1	·52	A fresh Breeze.
·05	·26	A gentle Breeze.
0·	0·	A Calm.

Price, £3 3 0

140. **Improved Portable Air Meter,** for measuring the velocity of currents of Air in Coal Mines and Ventilators, Flues, &c., of Public Buildings, Hospital and Prison Wards, &c., &c. (figs. 110 and 111.)

By means of this Air Meter, the rate at which a current of Air is moving can be ascertained in a few minutes. The Instrument shows from one foot to ten million feet.

The long hand marks up to 100 feet; each division on the large circle represents one foot traversed by the current of air. In setting down a reading of the hands, the long hand takes the units and tens places. The five other hands follow respectively.

EXAMPLE.

	Millns.	100 thds.	10 thds.	thds.	hds.	long hand.
Places the hands take when set down in figures	0 0	0	0	0	0	0 0
Reading of the above diagrams . . .	1	0	9	0	9	9 9

In setting down the position of the hands observe the following rule :—No hand can mark a figure unless the foregoing hand has arrived at the "0." For example, suppose the long hand pointed to 99, the hundreds' hand would appear to point to a figure, but it could not mark the figure until the long hand pointed to the zero. The same rule applies to all the hands. When a hand appears to be between the divisions, write down the lowest figure next the hand.

The catch on the rim of the instrument will stop or allow the hands to run without affecting the action of the fans.

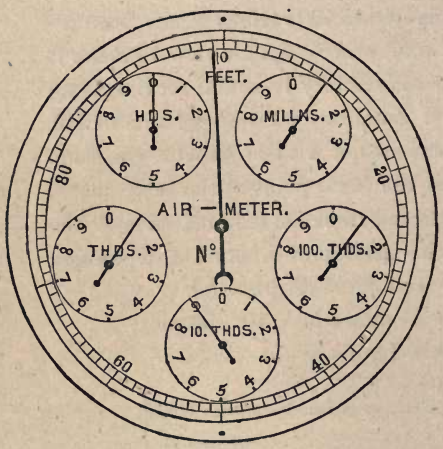

FIG. 110.

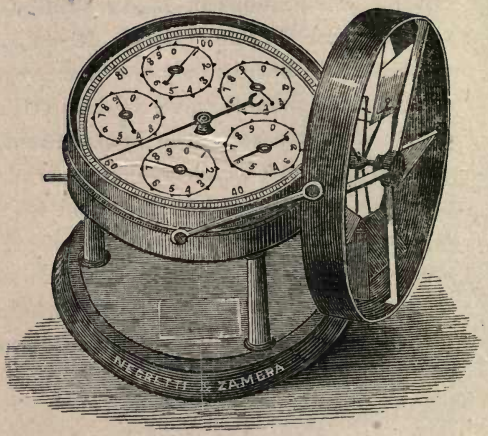

FIG. 111.

The above engraving of the Dial is the exact size of the Dial of the Instrument.

The Meter may be fixed in the current on a rod, fitted into the socket, which screws into the bottom of the instrument.

To take a measurement fix the position of the hands (by moving the catch) write down the reading, and place the Meter in the current of air to be measured. Now put the hands in action by again moving the catch at the same moment, note the time by the second hand of a watch, allow the fans to run in the current for one minute, at the end of which time again put the hands out of action, and again read their position, subtract the first reading from the second, and the result gives the velocity of the air in feet per minute (uncorrected).

The Meter may be allowed to run in the current of air for any convenient length of time; but, if for longer than one minute, the difference of the first and second readings must be divided by the number of minutes of the running. This gives the (uncorrected) velocity of air for one minute.

A table is supplied with each instrument, showing the necessary correction for friction, &c., at various velocities per minute. In the second column of this table will be found the correction (opposite the velocity shown by the Meter in the first column). This correction, if applied to a measurement of more than one minute, must be multiplied by the number of minutes of the measurement, and added to or subtracted from (according to the sign) the difference of the two readings.

EXAMPLE.

Suppose the first reading to be	5260	
And the second after a running of ten minutes is		11060
		5260
The running per minute would be		580
Say the correction for 580 shown by the meter per minute is . . .		82
The real or corrected velocity per minute would be		662

And the real velocity during the running of ten minutes is 6620 feet.

The measurement of the current of air in feet per minute, divided by 88, will give the measurement or velocity in miles per hour.

NOTE.—In taking a measurement the fans must always face the wind, and care should be taken not to bend or injure them.

Price of the Improved Air Meter in a neat Box, figs. 110 and 111 £4 4 0

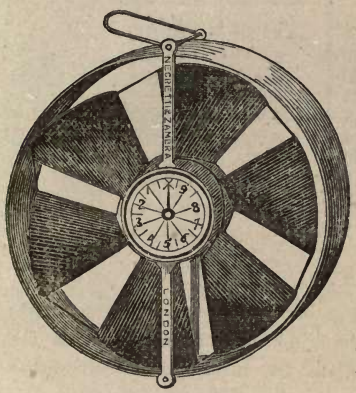

FIG. 112.

141. Lowne's Patent Colliery Air Meter constructed expressly for use in Coal Mines or Air Shafts.

The improvements consists of—1st, a large clear Dial; 2nd, the Fan is constructed of a light and anti-corrosive material; 3rd, the Indicating parts are perfectly protected from dust and smoke (this is done by a practical mechanical arrangement); and, 4th, a Lever is placed in a convenient position, to enable the observer to throw the Indicating Wheels in or out of gear from the Fan, for the purpose of taking short observations with accuracy. 6-inch Air Meter, as fig. 112, *Price*, £4 10 0

INSTRUCTIONS FOR USING THE IMPROVED AIR METER.

Press the Lever home to the left hand, and the Fans will revolve without moving the Registering Works. Now take a careful reading of the instrument, and write it down; hold the Air Meter in the current by the ring at the top of the Instrument; allow the Fans to run freely for a short time. Now observe the Watch. When the Second Hand reaches the Minute, press the Lever to the right, and the works will be in gear. When the minute is up, again press the Lever to the left hand, to throw the works out of gear; take a reading of the dial and write it down above the first reading, subtract the first reading from the second, and the difference, after the correction is added, will be the velocity of the current in feet per minute, thus :—

Second Reading	9,260
First Reading	8,920
	340
Add Correction, say—	40
Rate of current	380 feet per minute.

For measuring currents for a longer space of time, the Air Meter should be suspended on a bar, or fixed in any convenient manner in the current.

The Fans must always face the current, and great care should be taken never to stop them suddenly.

NOTE.—Any one not familiar with Metric Dials must observe that the figures read rationally: thus, if the feet hand is at, say, nine, the tens hand will be near the figure it is approaching. This figure must not be taken, but the previous one that is passed.

Table showing the number of miles per hour at velocities per minute.

Feet per Minute.	Miles per hour.	Feet per minute.	Miles per hour.	Feet per minute.	Miles per hour.
10	·113	200	2·272	3,000	34·090
20	·227	300	3·409	4,000	45·454
30	·340	400	4·545	5,000	56·818
40	·454	500	5·681	6,000	68·181
50	·568	600	6·818	7,000	79·545
60	·681	700	7·954	8,000	90·909
70	·795	800	9·090	9,000	102·272
80	·909	900	10·227	10,000	113·636
90	1·022	1,000	11·363		
100	1·136	2,000	22·727		

"When inquiring into the causes of air currents, either from or within drains, it was suggested that the variable flow of sewage has a powerful influence on the air within the drain, whilst that produced by rainfall has still greater, and the variations of temperature are another cause of displacement and renewal of drain air. A series of observations were taken at the outlets of drains by the Anemometer at the point of connection with the sewer, and the results proved that up and down currents of air are constantly passing to and fro. Whenever an up-current issues through a drain-opening it must be manifest that some of the inlets of such drains are untrapped, and therefore sewer air must be escaping through such untrapped inlets, to the danger of those who reside in the house."

142. **Biram's Anemometers,** for registering the velocity of currents of air in mines, &c., by means of a light vane, the revolutions of which are recorded upon a dial in the centre of the instrument.

12-in., £5 0 0; 6-in., £4 0 0; 4-in., £3 3 0; 2¼-in., £2 10 0

These Anemometers will register the velocity of Air through any passage of a Mine or Air Shaft in which they are placed.

For the purpose of trying and regulating the proportions of Air to the several divisions of a mine, and for the convenience of Overlookers, the three small instruments, 6 inches, 4 inches, and 2¼ inches, are recommended. These sizes will also be found convenient for use in large gun or rifle practice.

To ascertain the rate at which air is moving, proceed thus—suppose 100 revolutions=200 feet per minute.

88] 200 [2.27.

Say 2¼ miles per hour—88 being 1-60th of a mile.

To find the force of Wind, multiply the square of the velocity of the wind in feet per second by ·0023.

NOTE.—The velocity of the wind in feet per minute, divided by 88, will give the velocity in miles per hour. (*See above example.*)

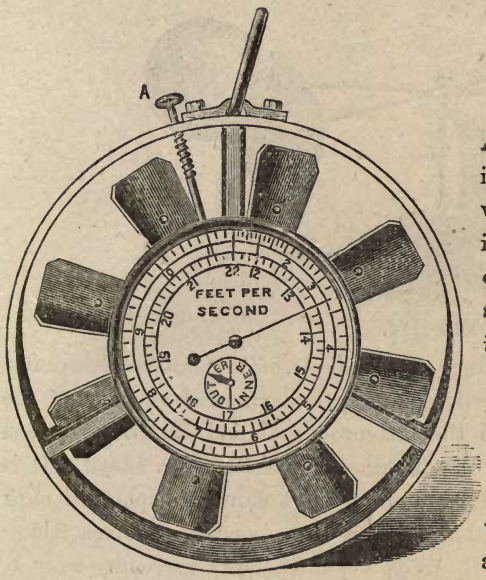

FIG. 113.

143. New Self-Timing Anemometer (Patent). This improved instrument dispenses with the use of a watch. By holding the Anemometer in the current of air to be measured for a few seconds it will correctly indicate its velocity per second.

Price, fig. 113. £5 0 0

INSTRUCTIONS FOR USE.

This instrument is held up with its back facing the current of air to be measured. When the vanes have revolved for a few seconds, press the spring button at A, the large hand then indicates feet per second. When read release the spring button. Should the velocity be such that the hand travels more than one revolution, then read the inner circle of figures. The small hand shows whether the outer or inner circle should be read.

NOTE.—*As every instrument is graduated at each unit by actual experiment, no allowance has to be made for friction.*

Feet per min.	Feet per sec.	Miles per hour.	Force in lbs per square foot.	Description.
50	·83	·568	·0016	Hardly perceptible.
100	1·66	1·136	·0061	Just perceptible.
200	3·33	2·272	·0255	
300	4·99	3·408	·0574	Gentle breeze.
400	6·66	4·544	·1021	
500	8·33	5·680	·1595	
750	12·50	8·522	·3593	Pleasant breeze.
1000	16·66	11·363	·6388	
2000	33·33	22·726	2·5553	Brisk gale.
3000	49·99	34·089	5·6982	High wind.
4000	66·66	45·452	10·2214	Very high wind.
5000	83·33	56·815	16·4429	Storm.
6000	99·99	68·178	22·9954	Great storm.
7000	116·66	79·541	31·3019	Hurricane.
8000	133·32	90·904	40·8807	
9000	149·99	102·267	51·6920	
10000	166·66	113·630	60·8837	

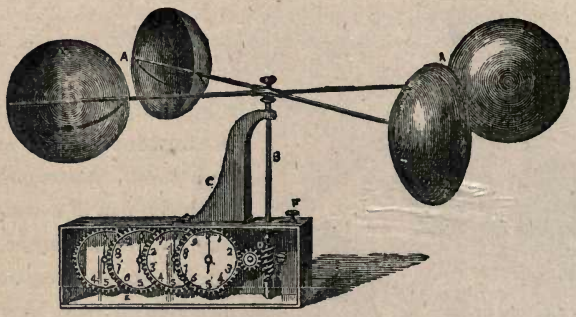

FIG. 114.

144. **Robinson's Anemometer.**—*Dr. Robinson*, of Armagh, is the inventor of this very useful anemometer, for determining the horizontal velocity of the wind. It was first used in 1850, in the meteorological and tidal observations made on the coast of Ireland under the direction of the Rev. Dr. Lloyd. It is represented in its simplest form by fig 114. Four hollow hemispherical cups *AA*, are extended upon strong metal arms, with their concave services facing the same way upon a vertical axis, *B*, which has at its lower extremity an endless screw, *D*. The axis is supported and strengthened at *C*, and constructed so as turn with as little friction as possible. The endless screw on the vertical shaft is placed in gear with a train of wheels and pinions. Each wheel revolves past a fixed index, and the figures and graduations are marked upon the wheels themselves.

The readings on the dials of the Anemometer are as follows : one complete revolution of the *first* engraved index-wheel equals $\frac{1}{10}$ of a mile; the *second*, 1 mile; the *third*, 10 miles; the *fourth*, 100 miles; the *fifth* 1,000 miles; necessarily in noting such reading it must be done backwards, according to the indications on the instrument.

Dr. Robinson has proved by theory and experiment that the centre of any one of the cups mounted as fig. 114 revolves with one-third of the wind's velocity. Therefore allowance has been made for this in graduating the circles, and a true reading is at once obtained. *Price*, fig. 114 £3 3 0 and 4 4 0

145. **Robinson's Anemometer.** Negretti and Zambra's improved arrangement for recording the velocity of the wind, as described by Colonel Sir H. James, Royal Engineers. This is a modified form of the Robinson instrument previously described, our engraving (fig. 115) will show the general details of the mechanism.

It consists of four arms at the end of which there are four light hemispherical hollow metal cups, the concave surfaces facing in one direction and revolving with one-third of the velocity of the current of wind acting on them. On the vertical axis which carries the arms, there is an endless screw, which communicates its real velocity of rotation to a circular dial.

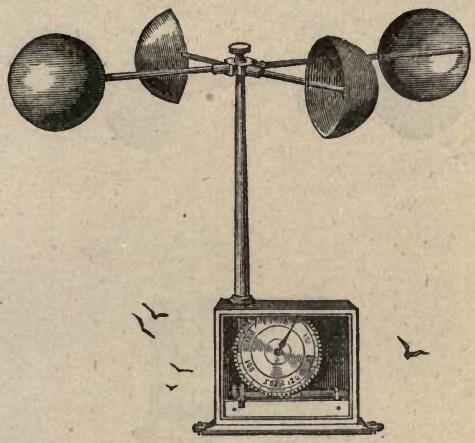

FIG. 115.

This Anemometer is furnished with two graduated circles, the *outer one* being divided into five miles and tenths of a mile, and each division on the *inner circle* represents five miles. One revolution of this circle recording from five to five hundred and five miles. The *fixed* pointer or index recording on the *outer circle* miles and tenths of a mile to five miles; and the *moving* index records every five miles up to five hundred. If for example the movable hand stands between 15 and 20 on the *inner* circle, and the fixed hand indicates 3 miles and five-tenths the length of the current of air which has passed the station is equivalent to 18 miles and five-tenths.

The velocity of the wind at any particular moment is found by observing the index before and after a certain interval of time as one or five minutes, and then multiplying the rate by 60 or 12 to find the velocity in miles per hour.

The pressure in lbs. per square foot can then be ascertained by reference to tables mentioned in our list of books at the end of this Section. A mill-headed screw at the back of the instrument (fig. 89) turns the movable index, which should be brought back to zero after the observation is registered.

Price, fig. 115, £4 10 0

The Anemometer frame is arranged for screwing on the instrument to a firmly-supported post.

146. **Robinson's Anemometer**, (fig. 116). This drawing shows a further improvement in the recording movement, a *second* dial being added for the convenience of obtaining extended readings.

The left hand dial of this Anemometer is divided and figured exactly the same as in the previously described instrument, and the indications read off in a similar manner. The second dial has 10 divisions, each of these divisions being equal to 505 miles, which is sub-divided by the readings of the left hand dial.

Price, fig. 116, 5 15 0

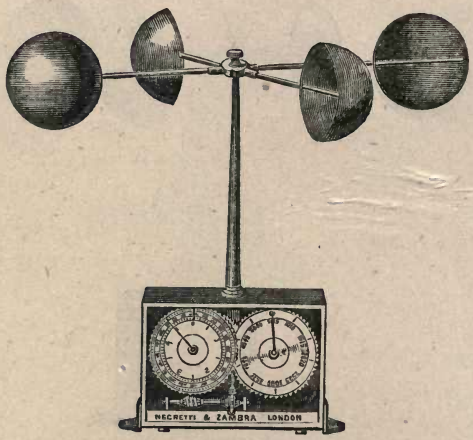

FIG 116.

147. **Robinson's Anemometer**, mounted in gimbals for Marine Service. This instrument not having been found of much practical value will only be made to order.

Robinson's Anemometers should be fixed in an exposed situation, as high above ground as may be convenient for reading. It can be made very portable by having the arms which carry the cups being fitted to unscrew or to fold down.

148. **Whewell's Self-registering Anemometer**, for recording the amount of horizontal movement in the air, with the direction, for twenty-four hours. A full description of this Anemometer will be found in Negretti and Zambra's Treatise on Meteorological Instruments. It is now rarely used, Osler's and Beckley's arrangements having been found more practically useful.

Price, £25 0 0

Any of these Anemometers can be supplied metrically divided if desired.

149. **Osler's Self-registering Anemometer and Rain Gauge** (fig. 117). This improved arrangement of Anemometer was shown by Messrs. Negretti and Zambra at the International Exhibition, 1862, having Robinson's Cup Anemometer added to it, so that the pressure and velocity appear on the same sheet on which a line, an inch in length, is recorded at every 10 miles. The Improved Anemometer shows the Direction, Pressure, and Velocity of the Wind, also the amount of Rainfall upon one Sheet of paper. Our woodcut is not given as an actual working drawing of Osler's Anemometer, but simply to exhibit the relative position of its several parts. The mechanism may be variously modified, but the following is a description of the most recent and improved arrangement.

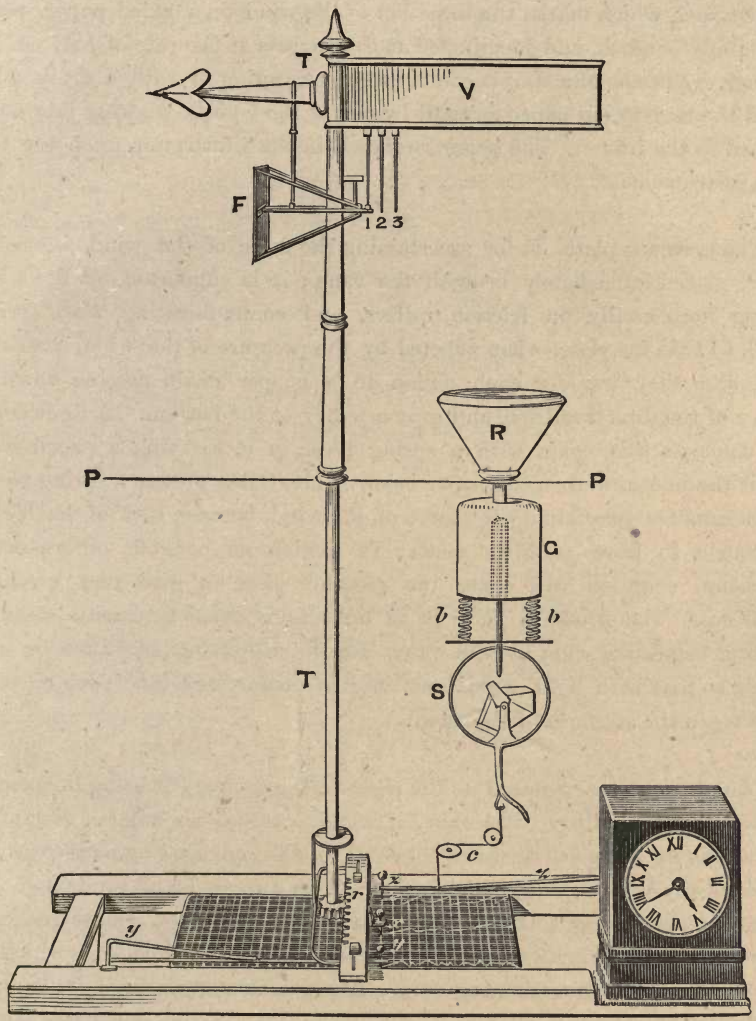

FIG. 117.

Osler's Self-registering Anemometer and Rain Gauge.

Osler's instrument (fig. 117) consists of the vane, *V*, of a wedge-shaped form, which is found to answer better than a flat vane; for the latter is always in a neutral line, and is therefore not sufficiently sensitive. At the lower end of the tube, *TT*, is a small pinion, working in a rack, *r*, which is moved backwards

and forwards as the wind alters the position of the vane. To this rack a pencil, *x*, is attached, which marks the direction of the wind on a ruled paper, placed horizontally beneath, and so adjusted as to progress at the rate of half an inch per hour, by means of a simple contrivance connecting it with a clock, which carries the registering paper forward by one of the wheels working into a rack attached to the frame. The paper is shown in the illustration upon the table of the instrument.

The pressure plate, *F*, for ascertaining the force of the wind, is one foot square, placed immediately beneath the vane ; it is supported by light bars, running horizontally on friction rollers, and communicating with springs, 1, 2, 3, so that the plate, when affected by the pressure of the wind, acts upon them, and they transfer such action to a copper chain passing down the interior of the direction tube, and over a pulley at the bottom. A light copper wire connects this chain with a spring lever, *y y*, carrying a pencil which records the pressure upon the paper below. Mr. Osler prefers a spring to any other means for ascertaining the force of the wind, because it is of the highest importance to have as little matter in motion as possible, otherwise the momentum acquired will cause the pressure plate to give very erroneous indications. The pressure plate is as light as is consistent with strength. It is kept before the wind by the vane, and is urged out by three or more springs, so that with light winds one only is compressed, and two, or more, according to the strength of the wind.

The pluviometer is placed on the right in the figure, *PP* being the plane of the roof of the building. The rain funnel, *R*, exposes an area of about two hundred square inches. The water collected in it is conveyed by a tube through the roof of the building into a glass vessel, *G*, so adjusted and graduated as to indicate a quarter of an inch of rain for every two hundred square inches of surface, *i.e.*, 50 cubic inches. *G* is supported by spiral springs, *b b*, which are compressed by the accumulating rain. A glass tube, open at both ends, is cemented into the bottom of *G*, and over it is placed a larger one closed at the top like a bell glass. The smaller tube thus forms the long leg of a syphon, and the larger tube acts as the short leg. The water, having risen to the level of the top of the inner tube, drops over into a little copper tilt, *t*, in the globe, S, beneath the reservoir. This tilt is divided into two equal partitions, and placed upon an axis not exactly balanced, but so that one end or the other preponderates. The water drops into the end of the tilt which happens to be uppermost, and when quite full it falls over, throwing the water into the globe, S, from which it flows away by the waste pipe. In this way an imperfect vacuum is produced in the globe, quite sufficient to produce a draught in the

small tube of the syphon, or the long leg; and the whole contents of the reservoir, *G*, immediately run off, and the spiral springs *b b*, elevate the reservoir to its original position. To produce this action, a quarter of an inch of rain must have fallen. The registration is easily understood. A spring lever, *z*, carrying a pencil, is attached by a cord, *c*, to S. This spring always keeps the cord tight, so that as the apparatus descends during the fall of rain, the spring advances the pencil more and more from the zero of the scale upon the paper beneath, until a quarter of an inch has fallen, when the pencil is drawn back to zero by the ascent of the reservoir.

The registration trace for twenty-four hours is readily understood. The direction is recorded on the centre part; the pressure on one side, and the rain on the other. Lines parallel to the length of the paper show no rain, steady wind, and constant pressure. On the rain-trace, a line parallel to the width of the paper, shows that the pencil had been drawn back to zero, a quarter of an inch of rain having fallen. The hour lines are in the direction of the width of the paper.

Price, for Osler's Self-registering Anemometer and Rain Gauge, fig. 117, from £84 to £150.

150. **Beckley's Anemometer.**—Mr. R. Beckley, of the Kew Observatory, has devised a self-registering anemometer, which consists of three principal parts: Robinson's cups for the determination of velocity; a double fan, or windmill governor, for obtaining the direction; and a clock to move a cylinder, around which registration paper is wrapped. The paper records the time, velocity, and direction of the wind for twenty-four hours, when it must be replaced. It has a cast-iron tubular support, or pedestal, to carry the external parts—the cups and the fan,—which must be erected upon the roof of the building upon which it is desired to mount the instrument.

The fans keep their axis at right angles to the wind; and with any change of direction they move, carrying with them an outer brass tube, which rests upon friction balls on the top of the pedestal, and is attached to a tubular shaft passing through the interior of the pedestal, and terminating with a mitre wheel. The mitre wheel, working with other cogged wheels, communicates the motion of the direction shaft to a cylinder carrying a pencil, to record the direction.

The shaft carrying the cups is supported upon friction balls, placed in a groove formed on the top of the direction shaft, and passing through the interior of that shaft, comes out below the mitre wheel, where it is terminated in an endless screw, or worm.

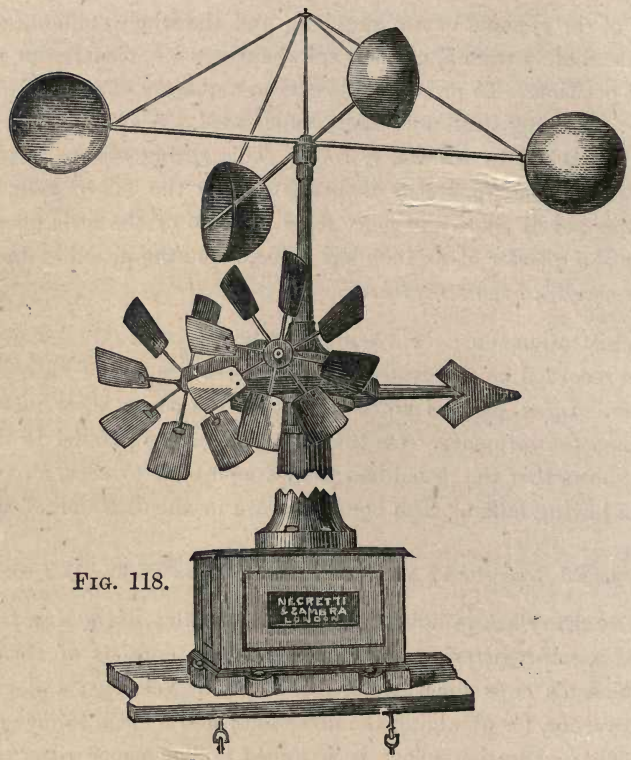

FIG. 118.

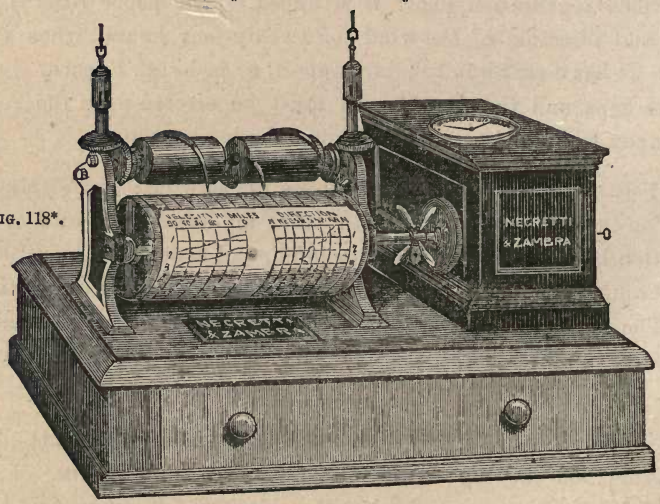

FIG. 118*.

Beckley's Recording Anemometer.

Upon the wind moving the cups motion is given to the innermost shaft, thence to the wormwheel, whence motion is given to a pencil which registers the velocity.

De La Rue's metallic paper is used in registration, it having the property of receiving a trace from a brass pencil: The pencils can, therefore, be made in the most convenient form. Mr. Beckley forms each pencil of a strip of brass wrapped round a cylinder, making a very thin threaded screw, so that the contact of the pencil cylinder and the clock cylinder is a mere point of the metallic thread. The pencil cylinders are placed side by side upon the drum turned by the clock, and require no spring or other appliance to keep them to their work, but always make contact with the registration paper by their own gravity. They therefore require no attention, and being as long as the trace which they make they will last a considerable time.

The velocity pencil has only one turn on the cylinder, and its pitch is equal to a scale of fifty miles upon the paper. The direction pencil has likewise one turn on its cylinder, its pitch being equal to a scale of the cardinal points of the compass upon the paper. The Clock gives a uniform motion of half an inch per hour to the Drum upon which the paper is secured.

In the Report of the British Association for 1858, Mr. Beckley has given a detailed description of his Anemometer, with drawings of all the parts. Our engravings (figs. 118 and 118*) show the general arrangement and details.

The price of Beckley's Anemometer depends so much upon the fittings and the amount of work required to suit it to the building upon which it is to be fixed that Negretti and Zambra can only quote £80 to £120 as the probable cost of the instrument.

151. Negretti and Zambra's Anemometer as erected on their Holborn Viaduct Establishment, shewing Direction and Pressure on Dials in the base of the building. Cost according to position in which it is to be fixed.

Special Estimates given for numbers.

152. Our List of Registering Anemometers will hardly be deemed complete without the mention of some exceedingly ingenious contrivances for obtaining records of the movements of the wind by the use of a Galvanic current so arranged that any alteration in the direction or force of the wind is instantly carried down to a dial or revolving drum or other mechanical contrivance for receiving the indications.

A very elaborate description will be found in Kaemtz's *Meteorology*, of Professor Wheatstone's *Electro-Magnetic Meteorological Register*, and in several foreign meteorological publications will also be found details of many similar applications of the electric current.

Louis J. Crossley, Esq., of Halifax, has devoted a very large amount of time and attention in perfecting a recording modification of Robinson's Anemometer, in connection with a galvanic receiving and transmitting apparatus with considerable success; but owing to the difficulty of maintaining the connections and contact breaks in perfect working order, and the consequent probability of defects in the registration, the Electro-Magneto Anemometers are but rarely used.

N. and Z. have recently fitted up several different arrangements of Electrical Anemometers to special order and drawings, these under careful supervision are now performing satisfactorily.

APPARATUS FOR TESTING THE ELECTRIC CONDITION OF THE ATMOSPHERE.

153. **Ozone***.—During the action of a powerful electric machine, and in the decomposition of water by the voltaic battery, a peculiar odour is perceptible, which is considered to arise from the generation of a substance to which the term *Ozone* has been given, on account of its having been first detected by smell, which for a long time after its discovery was its only known characteristic. A similar odour is evolved by the influence of phosphorous on moist air, and in other cases of slow combustion. It is also traceable, by the smell, in air,—where a flash of lightning has passed immediately before.

Ozone according to Faraday is oxygen is an allotropic condition, and from the observations of Mr. Glaisher is to be found almost always present in the atmosphere; the quantity depending on the elevation above the surface of the earth, and the prevalence of particular winds, being more abundant during southerly than during northerly winds, and at a high elevation than at the surface of the earth. It is more abundant at the sea-side than inland, and is almost absent in thickly-populated towns. This may seem, remarks Admiral FitzRoy, in *The Weather Book*, to point to some connection between Ozone and Chlorine gas, which is present in and over sea water, and is no doubt brought inland by any wind blowing from the sea.

Ozone plays an important part in the purification of the atmosphere, and its continued presence in a locality indicates a pure and healthy climate. More and careful observations are however required before its true functions can be determined.

M. Howzeau states: That the amount of Ozone in the air is variable, the maximum being about one volume of Ozone in 700,000 of air. Ozone possesses the property of bleaching blue litmus paper without previously reddening it, and it is found present most in Spring, less in Summer, diminishing in quantity in Autumn, and very little in Winter. Generally it may be detected during Wet and Stormy weather, and largely augmented in quantity after heavy Snow Storms.

Dr. B. W. Richardson, F.R.S., in a Lecture on Vital Air, delivered at the Society of Arts, states, as an undoubted fact, that he found that oxygen which had been rendered prejudicial to animal life from repeated breathing was restored by means of an electric discharge to its original exhilarating state, and was again capable of supporting animal life. So that there is, possibly, a very close relation between the electrical condition of the atmosphere and the amount of ozone present, as indicated by the Ozonometer. The ozone is usually

* Discovered by Schonbein in 1848.

in excess during disturbed electrical weather, and in a deficiency during calm and settled periods. We cannot lay too great a stress on the fact that where different kinds of ozone tests are made use of by different observers, no uniformity in results can be attained. Having this in view, we have prepared our ozone tests (see No. 157) on a formula, by which we can obtain uniformity in the indication and results that can be compared no matter how far the stations may be removed from one another. It is important to note this, as we often receive complaint of the failure of other Ozone Test Papers. It is recommended to take observations every twelve hours where practicable, as there is a marked difference in the amount of ozone registered in the day and night.

APPARATUS FOR PRODUCING OZONE.

A simple method of producing Ozone is passing sparks from an Electrical Machine through a confined portion of Air in a glass vessel.

154. **Ozone Tube.**—A convenient form of apparatus for the production of Ozone. It consists of a glass tube about $\frac{3}{4}$ of an inch diameter, and five or six inches in length, coated outside with tinfoil and enclosed in an outer tube, also covered outside with tinfoil. These tubes are so arranged that the intervening space between the tubes shall be as small as possible; the coating of the *inner* tube being put into connection with the terminal of the secondary coil of an inductorium, and the outer coating connected with the other terminal of the same coil. The apparatus forms, in fact, a kind of Leyden Jar, and air or oxygen passing between the tubes when the coil is in action becomes very strongly ozonised. The air to be operated on is either to be drawn or forced through the apparatus by the aid and use of an Aspirator or Gasometer.

Price for the above, conveniently mounted . . . £1 5 0

155. Ozone may also be made by passing a current of dry air or oxygen from a gasometer through a narrow glass tube, bent for convenience like the letter U, about three feet in length, and containing a platinum wire two feet in length, inserted into the interior of the tube, and one end of which communicated with the outside through the wall of the tube. Round the whole external surface of this U-shaped tube a spiral of copper wire is to be coiled, and an induction current (from a coil giving half-inch sparks), is to be passed between the external copper to the internal platinum wire, so as to have the platinum wire as the *negative pole* in the interior of the glass tube. After a stream of gas is ozonised by the transmission of the induction-current, it is to be washed by passing it through a bulb tube containing caustic potash, when air is employed; or water, when pure oxygen is used; in order to eliminate any traces of nitrous and nitric acids that may have been formed. By means of a gasometer the volume of gas passing through the tube may be exactly ascertained.

The apparatus described at No. 155 was used by Mr. Dewar and Dr. McKendrick in carrying out some experimental research on the Physiological Action of Ozone, the results being communicated by them to the Royal Society of Edinburgh. In their paper the authors point out that little was known regarding the action of Ozone, except its peculiar smell and the irritating effect it had on the mucous membrane of the respiratory tract. Schönbein had shown that a mouse died in five minutes in an atmosphere highly charged with Ozone; and it was this distinguished investigator who asserted that there was a relation between the quantity of Ozone in the air and the prevalence of epidemic diseases.

The result of Messrs. Dewar and McKendrick's experiment was, that a full grown, healthy mouse lived nineteen minutes after the introduction of ozone into the confining vessel, and that in ozonised oxygen, instead of dying at the end of fifteen or twenty minutes, (as happened to mice in ozonised *air*), they lived for forty or sixty minutes.

In concluding the paper the authors stated that it would be premature, at this stage of the inquiry (which opened up many points of interest in the physiology of respiration), to generalise between physiological action and the physical and chemical properties of ozone. Series of researches are still being prosecuted (*a*) on the action of smaller percentages of ozone; (*b*) on the action of ozone on noxious gases and effluvia; and (*c*) on any therapeutical or hygienic influences it may have on the origin and treatment of zymotic diseases.

156. Dr. Moffatt's Ozonometer consists of strips of paper prepared with Iodide of Potassium and Starch; these papers are suspended in a box so as to be exposed to the free access of air, protected from the direct rays of the sun and also from rain. The paper when affected by Ozone is tinged with various shades of brown, the intensity of which is measured by a scale of ten gradations furnished with the test papers.

157. **Negretti and Zambra's Ozonometer.** These tests are now prepared on a new formula, by which uniformity in the indications is secured together with great sensitiveness and keeping qualities.

In Tin Boxes sufficient for 12 months' observations, with Colour scale and full instructions for use . . . . . *Price*, 8s. 6d.

158. **Schönbein's Ozone Tests** *Price*, 6s. 6d.

159. **Ozone Box**, constructed of painted deal on the plan recommended by Dr. Moffatt. *Price*, £1 1 0

160. **Sir James Clarke's Ozone Case** (fig. 119), consists of two cylinders of very fine wire gauze, one fitting into the other; the wire gauze being of such a fineness as to permit the free ingress of air, at the same time that it shuts out all light that would act injuriously on the test paper, which is suspended by a clip or hook attached to the upper part of the inner cylinder. *Price*, £0 18 0

Ditto in Copper £1 5 0

161. **Lowe's Ozone Case**, Spiral form, japanned zinc. *Price*, £0 18 6

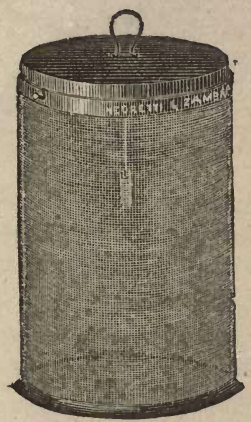

FIG. 119.

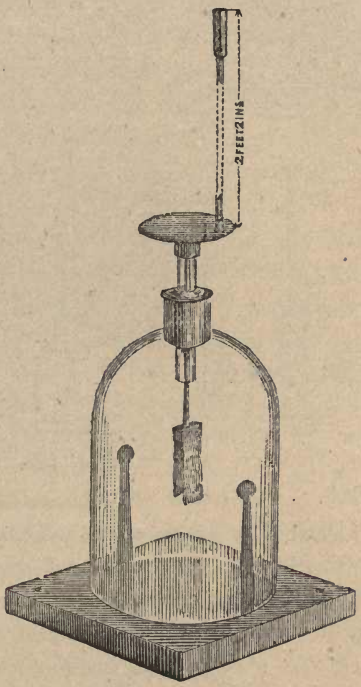

FIG. 120.

162. **Atmospheric Electricity.**—The *general* electrical condition of the atmosphere is *positive* in relation to the surface of the earth and ocean, becoming more and more positive as the altitude increases. When the sky is overcast, and the clouds are moving in different directions, it is subject to great and sudden variations, changing rapidly from positive to negative, and the reverse. During fog, rain, hail, sleet, snow, and thunderstorm, the electrical state of the air undergoes many variations. The intensity of the electricity increases with hot weather following a series of wet days, or of wet weather coming after a continuance of dry days. The atmospheric electricity, in fact, seems to depend for its intensity and kind upon the direction and character of the prevailing wind, under ordinary circumstances. It has an annual and a diurnal variation. There is a greater diurnal change of tension in winter than in summer. By comparing observations from month to month, a gradual increase of tension is perceived from July to February, and a decrease from February to July. The intensity seems to vary with the temperature. The diurnal variation exhibits two periods of greatest and two of least intensity. In summer, the *maxima* occur about 10 a.m. and 10 p.m.; the *minima* about 2 a.m. and noon. In winter, the *maxima* take place near 10 a.m. and 8 p.m.; the *minima* near 4 a.m. and 4 p.m.

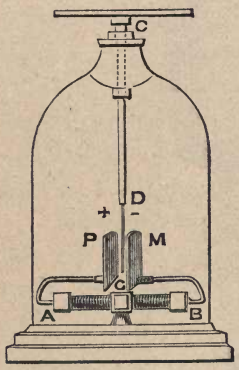

Fig. 121.

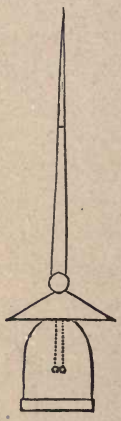

Fig. 122.

Fig. 123.

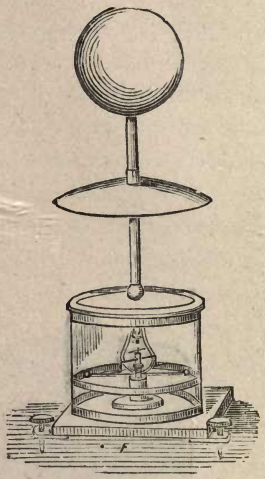

Fig. 124.

163. **Singer's Electrometer for Atmospherical Electricity.** (fig. 120).—This instrument is arranged with a brass rod about two feet in length and a clip for the reception of a lighted cigar fusee; the electricity is collected by the flame, and conducted down the rod to a pair of gold leaves, which separate according to the amount; the kind is determined by the effect of either a stick of excited sealing-wax, or a glass rod, supplied with the instrument

A glass rod when rubbed produces *positive* electricity; a stick of sealing-wax similarly treated produces *negative*; if, therefore, when the leaves are separate, we apply an excited glass rod, and they separate still further, the electricity is *positive;* if they approach it is *negative;* on the contrary, if we use a stick of sealing-wax, the leaves will separate if they are charged with *negative* electricity, and converge if *positively* charged, from the fact that all bodies similarly electrified repel each other, whilst those oppositely electrified attract each other.

£1 1 0

A book containing strips of gold leaf, to replace the gold leaves when torn or broken in use. *Price* £0 1 6

To mount fresh gold leaves, unscrew and withdraw the brass plate to which is attached the rod supporting the leaves: then moisten with the breath the flat piece of brass, and press it gently down on one strip of gold, whilst the book is only partly opened; the second leaf is attached in the same manner.

164. **Bohnenberger's Electroscope** (fig. 121), with Zamboni's Dry Piles, arranged with adjustments for regulating the distance between the gold leaf and the polar plates, an exceedingly delicate instrument for indicating the presence and quality of electrical currents.

It can be mounted with a metallic conductor, and used with great advantage for observing atmospheric electricity. The principal parts of the instrument, as improved by Becquérel, are the following:—*A B*, fig. 96, is a small

Zamboni's dry galvanic pile of 800 pairs, about a quarter of inch in diameter; and when the plates are pressed together, $2\frac{1}{2}$ inches in length. The bent wires above the pile terminate in two plates, *P* and *M*, which are the poles of the pile. These plates are parallel and opposite to each other. Their opposite sides are slightly convex, and gilded; between is suspended a fine gold leaf, *D G*, which is attached to the metal conductor, *C D*. If the leaf hang exactly between the two plates, it is equally attracted by each, and will be in a state of repose. The apparatus is protected by a glass shade, having an opening at the top through which the metal wire, *C D*, passes, insulated by being contained in a glass tube, which is cemented to the glass shade by means of shellac. A metal plate is attached to the wire rod in connection with the gold leaf to convey to it the electricity to be tested. The electricity to be tested will be conveyed by the metal wire to the gold leaf, and the latter will immediately move towards the plate which has the opposite polarity. This electroscope is, beyond doubt, one of the most delicate ever constructed, and is well adapted to show small quantities of positive and negative electricity. *Price*, £8 8 0

165. **Volta's Straw Electrometer**, with graduated Arc, for estimating the amount of electric force by degrees of divergence. *Price*, £2 2 0

166. **Cavallo's Pith Ball Electroscope**, (fig. 122) with graduated Arc for estimating the amount of electric force . . . . *Price*, £1 10 0

167. **Ditto ditto** with Stopcock, fig. 123 . . 2 2 0

168. **Peltier's Tension Electrometer**,* (fig. 124) according to Mr. Latimer Clark, was in all its essential parts first described and illustrated by Dr. Thomas Milner in the year 1733. The instrument described as the invention of Peltier in the Report of the British Association, 1849, and termed the Induction Electrometer, is constructed as follows:—

It consists of a light metal ball of about $4\frac{1}{2}$ inches diameter mounted on a brass rod, terminating in a flattened oval or heart-shaped aperture. In the centre of this aperture is placed a fine steel point on which is suspended a light copper or aluminium wire needle, with a small magnetic needle mounted on it at right angles. Two light metal rods or arms are extended from opposite sides of the support of the ball of the same length as the copper needle. Below these rods is a graduated circle, for estimating the value of the deflection of the needle in degrees. The support of the ball and centre of the needle is very carefully mounted and insulated on ebonite, and the whole mounted on a mahogany base with three adjusting screws. A cylindrical glass cover is placed over the graduated circle and indicating needle to protect them from currents of air, dust, &c.

In use this electrometer is very carefully placed in such a position that the magnetic needle shall cause the light copper wire index needle to lie parallel

* Peltier's Electrometer as used by Professor Palmieri at the Observatory on Mount Vesuvius.

with and almost touching the two brass arms, when, if the apparatus has been properly adjusted, if any cloud or portion of air in its vicinity be in an electrical condition it will act by induction upon the metal ball, and the needle will be deflected according to the amount and tension of the electricity.

The quality of the electricity, if positive or negative, may be ascertained by the use of a rod of glass or shellac as described in directions for using the gold leaf instrument. (No. 163)

In atmospheric observations the instrument may either be charged with free electricity and the indications of this needle noted at certain intervals, or it may be brought to the same degree of tension as the earth, and the inductive effects of the atmosphere upon it observed. Owing to its greater convenience the former method is now generally adopted, but the variations of the needle under atmospheric influences are far from being understood or reduced to a system.

In use the Induction Electrometer is placed upon a stand about six feet from the ground, and to bring it into equilibrium of tension with the earth, touch the base of the stem with a conducting wire. When the instrument is removed from the inductive influence it indicates the presence of free electricity by the deflection of the needle.

A regular and uninterrupted series of atmospheric observations with the Peltier instrument were made by M. Quetelet at the Royal Observatory at Brussels from August, 1844, till December, 1848.

A strong inductive influence was generally noticed at the approach or cessation of rain. The maximum of atmospheric electricity was indicated in January, the tension of the atmospheric charge progressively diminishing until June, when it attained its minimum. The difference of the tension in these two months was in the proportion of 13 to 1. The results obtained by Mr. R. Birt at Kew are closely in accordance with those of M. Quetelet.

Peltier's instrument is now constructed with a smaller ball, and without the metal shade as shown in our engraving, and the whole apparatus carefully insulated with ebonite (vulcanite), in place of shellac and resin. *Price*, £5 5 0

169. **Thomson's Quadrant Electrometer** complete with Lamp and Scales, including directions for use, in Mahogany Case, with Lock and Key. £36 0 0

170. **Professor Sir W. Thomson's Portable Atmospheric Electrometer** (attracted disc), fully described in Negretti and Zambra's *Treatise on Meteorological Instruments*, paragraph 135, pp. 130 and 131.

Price with Electrophorous fitted in Mahogany Box £12 0 0

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171. We have still to note the want of a portable and simple, but at the same time, accurate instrument to denote the electrical condition of the atmosphere. Many forms of Electrometers lately devised are but of little use to ordinary observers from their complex construction.

172. **Collection of Electricity.**—"A simple rough method of doing this is to shoot a metallic arrow upwards into the air, the arrow being tied to one end of a conducting string, the lower end of which carries a ring which rests upon the electroscope. The arrow being shot upwards, the electroscope will be found to be electrified, as it mounts; and when the ring leaves the plate, the instrument will indicate the state of electrification of the air at that point where the arrow is at the time.

"This manner of observing is simplified by substituting a long conductor reaching upwards; a gilded fishing rod may be employed, its lower extremity being insulated.

"The usual method employed, however, is Volta's, in which the electricity is collected by means of a flame, burning at a height, either in a lantern hung to mast, and connected to the electroscope by a wire, or, by a slow burning match attached to the top of a long metal rod.

"The electricity of the air in the neighbourhood of the flame, by its inductive action upon the conductor, causes electricity of the opposite nature to accumulate at the upper extremity, where it is constantly carried off by the convection currents in the flame, leaving the conductor charged with electricity of the same kind and potential as the air."*

173. "The principle of Volta's method has been made use of by Sir W. Thomson in his Water-dropping Collector, now employed in observatories, and found to be extremely useful for the observation of atmospheric electricity.

A copper can is placed on an insulating support, which may be of ebonite, having the surface thinly coated with paraffin; or of glass surrounded with pumice stone soaked in sulphuric acid. From the can a small pipe projects a considerable distance into the air, and terminates in a fine orifice. The can being filled with water, and the tap which opens into the jet pipe turned on, a small stream of water is allowed to flow out, care being taken that it is so small that it shall break into drops immediately after leaving the nozzle of the tube.

In half a minute from the starting of the stream the can will be found to be electrified to the same potential as the air at the point of the tube.

This Collector cannot be employed during the time of frost, unless means are adopted to prevent the freezing of the water in the jet pipe. When observations are to be made with a portable instrument, a slow burning match should be used. Sir William Thomson recommends for this purpose blotting paper, steeped in a solution of nitrate of lead, dried, and rolled into matches.

As to the position of the Collector, since electrical density is greater on projecting surfaces, and less on hollow surfaces than on planes, the Collector should not be near trees or houses, nor within a closed space."*

* Robert H. Scott, Esq., Meteorological Office.

174. **Tide Gauge, Self-registering, Negretti and Zambra's Improved Newman's** (fig. 125), for recording the rise and fall of the tide, by a lined traced with a pencil on a ruled paper, wound on a cylinder moved round by a clock once in twenty-four hours. The paper showing the rise and fall in feet and inches, and also the time in hours. An exceedingly valuable instrument for places where the phenomena of tides, and the construction of accurate tide tables are of the utmost importance. Such observations should also be accompanied with the registration of atmospheric phenomena.

The tide-gauge, shown in the illustration (fig. 125) consists of a cylinder, *A*, which is made to revolve once in twenty-four hours by the action of the clock *B*. A chain, to which is attached the float, *D*, passes over the wheel, *C*, and on the axis of this wheel, *C* (in about the middle of it), is a small toothed wheel, placed so as to be in contact with a large toothed wheel carrying a grooved pulley, *E*, over which passes a small chain. This chain, passing along the upper surface of the cylinder, *A*, and round a second pulley, *F*, at its further end, is acted on by a spring so as to be kept in a constant state of tension. In the middle of this chain a small tube is fixed for carrying a pencil, which, being gently pressed down by means of a small weight on the top of it, marks on the paper placed round the cylinder the progress of the rise or fall of the tide as the cylinder revolves, and as it is drawn by the chain forward or backward by the rise or fall of the float. The paper is prepared with lines equi-distant from each other, to correspond with the hours of the clock, *A*, crossed by others showing the number of feet of rise and fall.

The cylinder while in action revolves from left to right to a spectator facing the clock, and the pencil is carried horizontally along the top of this cylinder; the large wheel, *C*, is caused to revolve by the rise and fall of the float, which turns the wheel with the small pulley, *E*, attached to it. If the tide is *falling*, the small chain is wound round the cylinder, *E*, and the pencil is drawn towards the large wheel; but if the tide is *rising*, the small chain is wound on the cylinder, *F*, by means of the spring contained in it. Thus, by means of the rise and fall of the tide, a lateral progress is given to the pencil, while the cylinder is made to revolve on its axis by the clock, so that a line is traced on the paper showing the exact state of the tide continuously, without further attention than is necessary to change the paper once every day, and to keep the pencil carefully pointed; or a metallic pencil may be used. As indicated, it is self-recording, requiring very little attention—a few minutes every day being sufficient.

These gauges are now in action in several parts of the world, *faithfully* recording the rise and fall of the tides.

Price, fig. 125, N. and Z's. Improved arrangement, from £50 0 0

NOTE.—The price for the Ruled Papers or Charts used with this Apparatus and No. 175, along with Charts for other Recording Instruments, will be found on page 132.

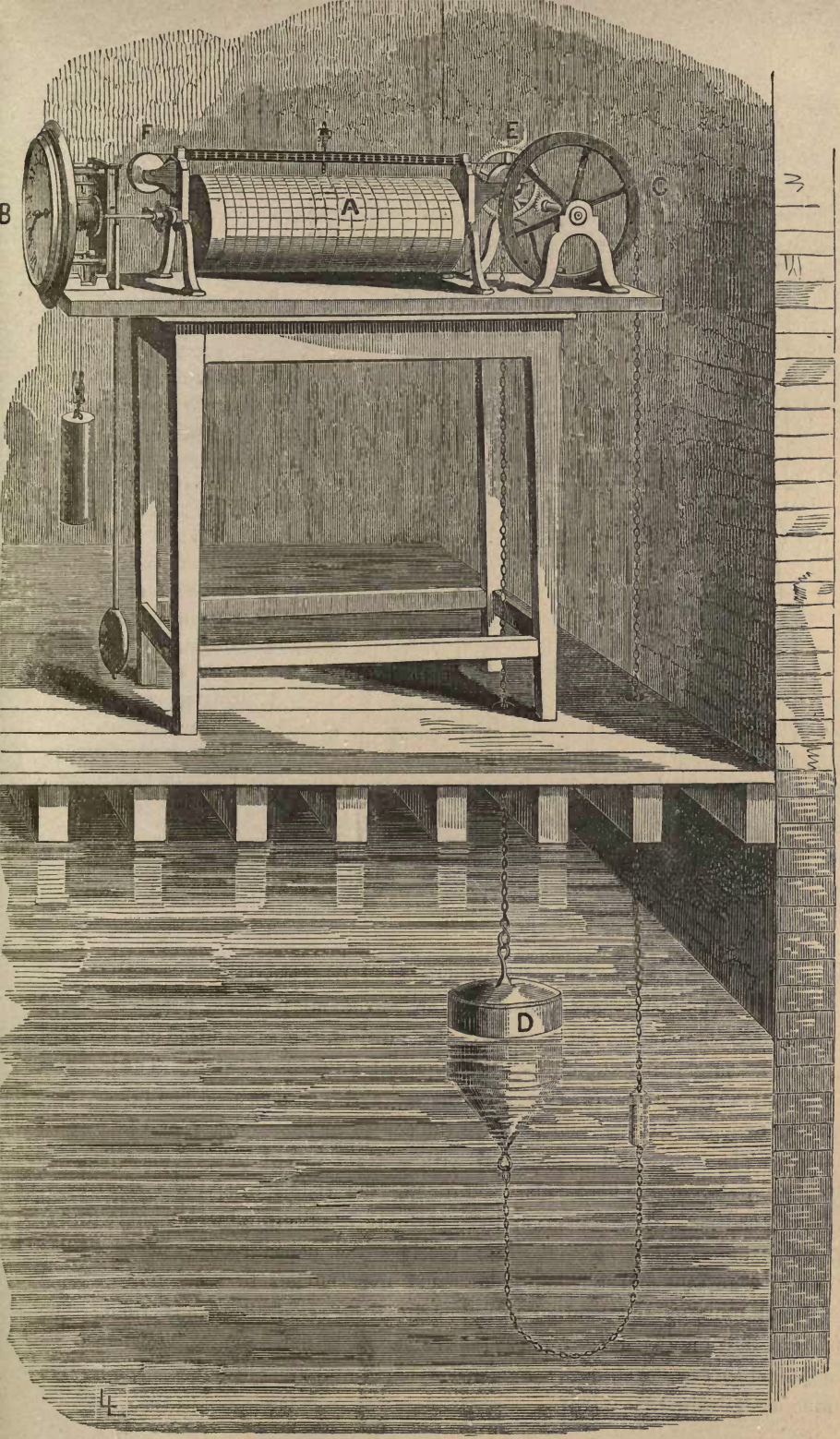
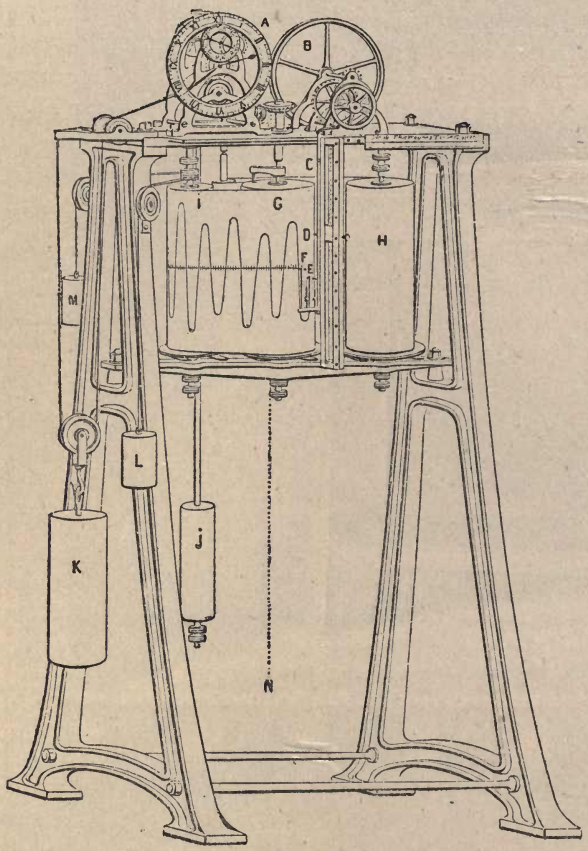


FIG. 125. NEGRETTI AND ZAMBRA'S
IMPROVED NEWMAN'S SELF-RECORDING TIDE GAUGE.



A. Dial of clock.
B. Float-wheel.
C. Guide for recording pencil.
D. Recording pencil.
E. Hourly marker on datum lines.
F. Datum lines and registering pencil.
G. Main Drum driven by clock.
H. Reel of paper.
I. Haul-off drum.
J. Pendulum of clock.
K. Driving weight of clock.
L. Driving weight of haul-off drum.
M. Haul-off drum winder.
N. Platinum wire to float.

FIG. 126.

SIR WM. THOMSON'S TIDE-GUAGE.

175. The instrument consists of an astronomical clock, float-wheel and gear work for reducing the scale, and three drums, the whole fitted on a suitable plate and supporting standards, and requiring no further fixing. The clock is fitted with a six-spur gravity escapement and compensated pendulum, and serves to show the time and to drive the centre or main drum of the instrument. The float wheel is provided with a right-angled groove in which the platinum wire of the float coils itself during the rising tide. The right-hand drum receives a reel of paper, and the paper is fitted to the instrument without further fixing. The haul-off drum receives the paper records after it has passed round the main drum. The paper may be left to accumulate almost without limit on the haul-off drum, or can be removed at any time. The datum line on the record paper is traced by a fixed pencil, which can be adjusted to any level. Any number of horizontal lines can be ruled in this manner if desired.

Immediately at the side of the datum line registering pencil, is a pencil actuated by the clock, which causes it to trace a short vertical line at each hour, through the datum lines, the mark for noon and midnight being somewhat different. In this case the pencil is arrested for two minutes when in marking it has reached the level of the datum line, when it is allowed to complete the marking. The distinction is introduced in order to facilitate the subsequent noting of the times and dates upon the record. The pencil tide recorder is made to counterbalance the float-wire when the scale is not too greatly reduced, in which case the weight of the float-wire is partially relieved by a counterpoise weight acting on the axis of the float-wheel. The system of making the recording pencil balance the float-wire is a great advantage over the system generally employed, and greater accuracy of recording is secured. The employment of a continuous roll of paper obviates the necessity of continually applying fresh paper to the recording drum, and the tide-gauge can thus be left untended, except for the purpose of winding the clock, for an indefinite period. The system also of ruling the paper by fixed pencils and marking the hourly times by the clock constitutes a marked improvement, no error can thus occur from the wrong setting of the paper.

Prices. The Tide-guage with three barrels and continuous paper complete, best finish £95
Ditto with single barrel and extra finish . . . . fig. 126. £80
Ditto ditto to be used with previously divided paper . £54

Larger engravings of some improvements in Thomson's Tide Gauge sent upon application.

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176. **Negretti and Zambra's Portable Set of Meteorological Instruments.** A small, but at the same time really useful and reliable set of Standard Meteorological Instruments has long been inquired for by observers on foreign stations, and others who are frequently travelling to different parts of the world. To meet this demand, Messrs. Negretti and Zambra have arranged sets of Meteorological Instruments to pack up into a very small space. The set contains Negretti and Zambra's Patent Maximum and Minimum Registering Thermometers, Wet and Dry Bulb Hygrometer, Aneroid Barometer for Altitude measurements, Negretti and Zambra's Improved Registering Maximum Thermometer with high range of scale, for Hot Springs, Solar Radiation Thermometer, Terrestrial Radiation ditto, Improved Boiling Point Apparatus, Rain Gauge and Graduated Measure, a Clinometer, Magnetic Compass, and Tape Measure. The whole arranged in a strong case, with lock and key. *Price* £18 18 0

These sets can be varied, or other Instruments added, to meet the wishes and requirements of purchasers. See also pages 106 and 107.

Further details of the construction and use of Meteorological Instruments will be found in Negretti and Zambra's TREATISE, *with very many valuable and useful Tables of corrections, &c., &c.* *See page* 133.

ESTIMATES FOR SETS OF METEOROLOGICAL APPARATUS.

177. The Meteorological Congress of Vienna, recognising three classes of Observing Stations, we subjoin estimates for Sets of Meteorological Instruments suited to their requirements.

No. 1.—For an Observatory or Station of the First Order.

In which independent meteorological observations are conducted, of the greatest precision, either by hourly readings or with the use of Self-Recording Apparatus.

One Large Observatory Standard Barometer.
One Independent Standard Thermometer.
One Negretti and Zambra's Patent Standard Maximum Registering Thermometer.
One Negretti and Zambra's Patent Standard Maximum Thermometer,—
Exposed Black Bulb.
One Ditto Ditto Bright Bulb.
One Negretti and Zambra's Improved Patent Maximum Thermometer, in Vacuum, with Test Gauge, No. 37. With Stand for ditto.
One Negretti and Zambra's Standard Minimum Thermometer.
One Ditto Ditto Ditto Mercurial.
One Ditto Ditto Standard Terrestrial Radiation Thermometer.
One Standard Wet and Dry Bulb Hygrometer.
One Stevenson's Thermometer and Hygrometer Screen.
One Glaisher's Rain Gauge, the New Pattern, complete, Copper.
Two Extra Graduated Measures for above.
A Series of Thermometers for Earth Temperatures at varying depths.
One Negretti and Zambra's Maximum Thermometer, for Earth or Springs.
One Gold Leaf Electrometer.
One Anemometer, with two recording Dials.
Recording Mercurial Barometer.
Recording Thermograph.
Recording Hygrometer.
Recording Anemometer and Rain Gauge.
Sunshine Recorder.

Cost for the whole of above Kew verified, £330 to £450.

In first class Observatories it is advisable to have duplicate instruments, where there is any liability of fracture, to avoid breaking off the continuity of the recorded observations.

The No. 1 Set of Meteorological Apparatus can be much extended if it be desired, to make comparative or experimental observations.

No. 2.—Estimate for a Meteorological Observatory of the Second Order.

One Standard Barometer.
One Negretti and Zambra's Patent Standard Maximum Thermometer.
One Ditto Ditto Standard Minimum Thermometer.
One Solar Radiation Thermometer in Vacuo, with Negretti and Zambra's Improved Test Gauge.

One Solar Radiation Thermometer, with Exposed Bulb.
One Terrestrial Radiation Thermometer.
One Glaisher's Rain Gauge, Copper, complete.
One Anemometer, with two dials.
One Wet and Dry Bulb Hygrometer.
One Stevenson's Thermometer and Hygrometer Stand.

Cost for the above Set of Apparatus, £22 to £25.

No 2 Set of Apparatus is strongly recommended to *private observers*, where complete and regular observations are taken of Barometric Pressure, Temperature, Humidity, Rain, Wind, and Electrical phenomena.

The series can be reduced to form a *Third Class* set at £12 12s., where only a few of the more important meteorological observations are taken, or other instruments can be added to meet the requirements of the observer.

It will be as well to note here that all observations should be made *punctually at fixed hours*. The Meteorological Office recommend that, at Observing Stations of the second order, observations be made *at least* twice a day, at homonymous * hours, for which 9 a.m. and 9 p.m. (local time), have been most generally approved of. In *unsettled weather* occasional observations should be made of any special meteorological facts that may occur.

VERIFICATION OF STANDARD METEOROLOGICAL INSTRUMENTS.

178. The Kew Committee of the Royal Society undertaking the testing and verification of Meteorological Instruments by their Standards, Negretti and Zambra subjoin a list of the charges. At the same time, Negretti and Zambra would observe that, having absolute *Standard Instruments* of their own manufacture which have been compared both with Greenwich and Kew Observatory Standards, they are prepared to compare and give certificates with their *own* instruments *free of charge*,

The Kew Committee wish it to be noted that they do not undertake the verification of inferior instruments, such as Barometers mounted on Wood Frames, and Thermometers *not* graduated on the Stem, and also that the Superintendent may at his discretion decline to receive instruments he may consider unfit for Scientific observation.

	Each.
Standard Barometers with attached Thermometer	10s. 6d.
Marine Barometers in Metal Mountings	15s. 0d.
Aneroid Barometers for Altitude Measurements compensated	15s. 0d.
Thermometers	2s. 6d. to 5s. 0d.
Rain Gauges	2s. 6d.

* The term "homonymous" signifies hours of the same name, as 9 and 9, or 12 and 12. The most suitable hours are, to a certain extent, to be determined by the locality and climate.

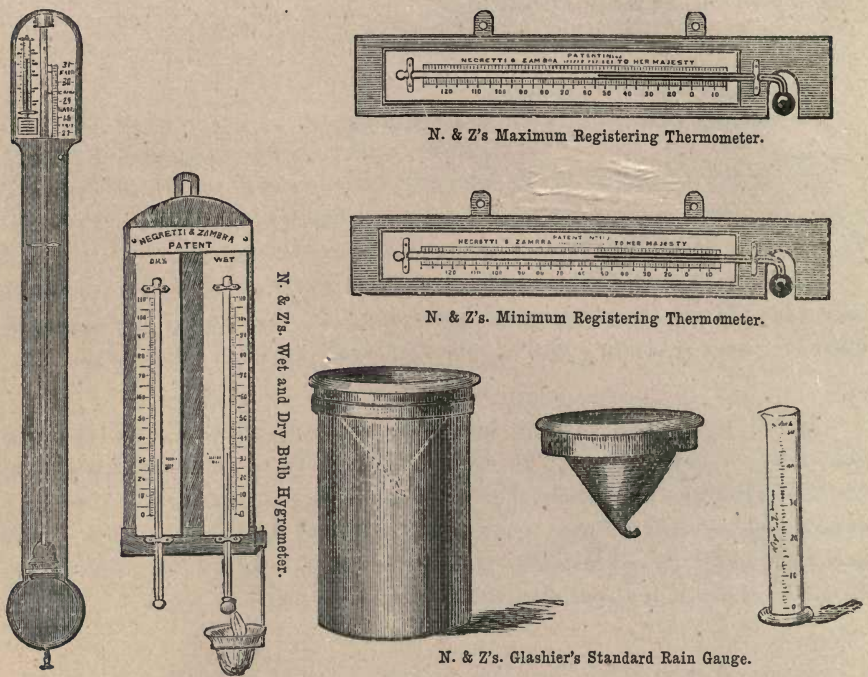


FIG. 127.

179. NEGRETTI AND ZAMBRA'S FIVE GUINEA SET OF METEOROLOGICAL INSTRUMENTS

consists of a Mercurial Barometer with attached Thermometer having Fahrenheit and Centigrade Scales, Registering Maximum Thermometer, Registering Minimum Thermometer, Rain Gauge and Graduated Measure, and a Wet and Dry Bulb Hygrometer, fig. 127.

The whole of these instruments are very carefully manufactured and tested to ensure sufficient accuracy for ordinary observers at a moderate price. One important feature in this set is that the various instruments will travel securely, as, although they are not strictly a standard set, they have all Negretti and Zambra's improvements and Patents adapted to them, and are compared and verified by Negretti and Zambra, and, if desired, Certificates given.

This set of meteorological instruments can be modified, and extended, to meet the wishes of our customers. Descriptive particulars of the construction and use of these instruments will be found in the previous pages, or in Negretti and Zambra's *Treatise on Meteorological Instruments*. See page 133.

LIGHTNING CONDUCTORS AND FITTINGS.

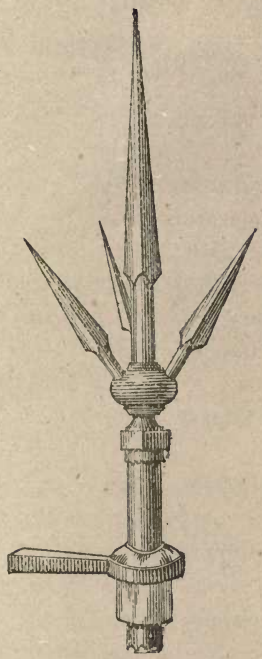


FIG. 128.

180. Lightning Conductors should be pointed at the top, and extend a few feet above the highest point of the building or mast. They are best made of *Solid Copper Rods* or Copper Bands of sufficient diameter and thickness to convey the discharge without melting. *Wire Rope of Copper* is now much used, owing to its convenient adaptability to uneven surfaces, *but* great care must be taken to have it of sufficient diameter to prevent fusion, and that both solid rods and wire rope should be *perfectly continuous and unbroken throughout the entire length*, and carried down some considerable distance into the earth, which should be *moist*, or better still, carried down a well some distance beneath the surface of the water, or the conductor should terminate in several branches on a large sheet of stout copper. In large towns these conductors are carried down and connected with the large water pipes. *On no account should Lightning Conductors be connected with Gas pipes; it is exceedingly dangerous.* Where a building is large, *several conductors* should be used, and all large and detached masses of metal in the fabric connected together and then united with capacious conductors leading directly from the highest points of the structure to the earth or sea. In applying such conductors to ships, each mast should have its own conductor, of sufficient size, permanently fixed, and connected with bands of stout copper passing through the sides of the ship under the deck beams, and with the large bolts leading through the keels and keelson to the water, including in the circuit all the principal masses of metal used in the construction of the vessel.

It is of the *utmost importance*, that Lightning Conductors be periodically examined to see that they are in perfect condition, as any defects in continuity of the metal rod or wire may lead to serious results. Several instances of most destructive damage both to buildings and ships having lately occurred, arising from defective conductors, we cannot too strongly urge the attention to this caution.

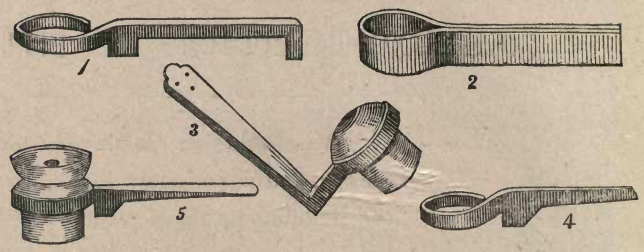
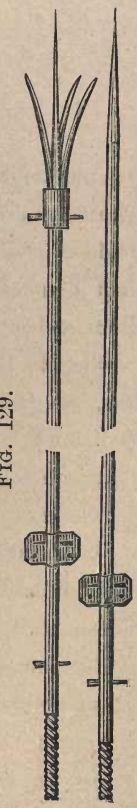


Fig. 131.

Fig. 129.

Fig. 130.



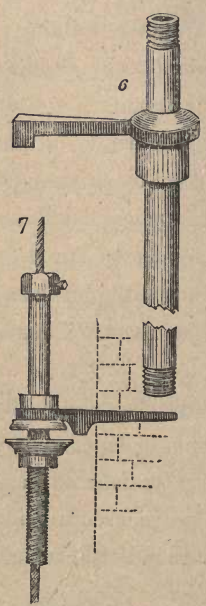


Fig. 130*.

Solid Copper Point Lightning Conductor with 3 Attractors, as fig. 129, Copper elevating tube 5 feet long, Couplings, Straining Bolt, Insulators, and Holdfasts, all complete with 50 feet Solid Copper Rope $\frac{3}{8}$ inch diameter . . . 4 10 6

Ditto Ditto, with 75 feet Solid Copper Rope $\frac{3}{8}$ inch diameter 5 15 0

Ditto Ditto, with 100 feet Solid Copper Rope $\frac{3}{8}$ inch diameter. 7 0 0

Ditto Ditto, with 150 feet Solid Copper Rope $\frac{3}{8}$ inch diameter 9 12 0

Ditto Ditto, with 50 feet Solid Copper Rope $\frac{1}{2}$ inch diameter. 5 5 0

Ditto Ditto, with 75 feet Solid Copper Rope $\frac{1}{2}$ inch diameter 6 16 0

Ditto Ditto, with 100 feet Solid Copper Rope $\frac{1}{2}$ inch diameter 8 7 6

Ditto Ditto, with 150 feet Solid Copper Rope $\frac{1}{2}$ inch diameter 11 10 0

Ditto Ditto, with 100 feet Solid Copper Rope $\frac{5}{8}$ inch diameter 9 16 0

Ditto Ditto, with 150 feet Solid Copper Rope $\frac{5}{8}$ inch diameter 13 17 6

Plain Point Solid Copper Rod Lightning Conductor, for Copper Rope $\frac{5}{16}$ inch diameter, no Insulators or Tightening Bolt (fig. 130) 1 5 0

Plain Spear Point Solid Copper Lightning Conductor with Coupling for Rope End and Copper Elevating Tube 4 feet long (fig. 130*) 1 12 0

	Each. £	s.	d.
Solid Copper Lightning Conductor fitted with Point and three Attractors, as fig. 129, with 7 Holdfasts, 7 Insulators, and 1 Straining Bolt, complete	2	14	0
Ditto Ditto, with 11 Holdfasts and 11 Insulators . . .	3	0	0
Ditto Ditto, with 15 Holdfasts 15 Insulators . . .	3	6	0
Ditto Ditto, with 24 Holdfasts and 12 Insulators . . .	4	4	0
If the Points are wished tipped with Platinum, there will be an extra charge, according to the size and weight. Price variable.			
Galvanised Iron Holdfast, to build in, No. 1, fig. 131, per doz.	0	9	6
Ditto Ditto to Drive No. 4 Do. per doz.	0	9	6
Ditto Ditto for passing along Slated Roof, No. 3 Do. per doz.	0	11	6
Ditto Ditto extra strong, for supporting Rod or Straining Bolt . . . . No. 2 Do. per doz.	0	10	0
Copper Elevating Rod, No. 6, fig. 130*, showing Holdfast and Glass Insulator, to steady the same	0	8	6
Straining Bolt, No. 7, fig. 130*, with Glass Insulator and Holdfast complete for $\frac{5}{8}$ $\frac{1}{2}$ $\frac{3}{8}$ inch diameter Rope 12s. 6d., 10s. 6d., 7s. 6d., per set.			
Tension Bolt, for tightening and straightening the wire, of a simple form . . . . . 8s. 6d.	0	10	6
Glass Insulators annealed with lock nibs . per doz. 10s. and	0	14	0
Solid Copper Wire Rope, $\frac{5}{8}$ inch diameter. Price per 100 feet .	6	10	0
Ditto Ditto $\frac{1}{2}$ inch diameter. Price per 100 feet .	5	5	0
Ditto Ditto $\frac{3}{8}$ inch diameter. Price per 100 feet .	3	16	0

NOTE.—The prices for Copper goods vary according to the market value of the metal. At a small increase of cost the Points can be strongly gilt.

FIG. 132.

Estimates given for fitting up Lightning Conductors, either with Copper Wire Rope, Solid Copper Rod or Bands.

181 Lightning Conductors.

The celebrated American philosopher, Franklin, in the year 1749, first discovered the means of averting the destructive and fatal effects of lightning by the use of pointed metallic rods attached to high and exposed buildings, his experiments having proved that the electric fluid will always follow the path of least resistance to the earth.

In confirmation of the value of Lightning Conductors as a safeguard, we quote the following from Sir W. Snow Harris :—

"It appears from the records of the Navy, that the destructive effects of lightning on H.M. ships involved in former years an expenditure of not less than from £6,000 to £10,000 annually. In 200 cases only, 300 seamen were either killed or hurt, and above 100 large masts valued at the time at from £1,000 to £1,200 each entirely ruined. Between 1810 and 1815, 35 sail of the line, 35 frigates and smaller vessels were completely disabled.

"Since the system of Lightning Conductors has been fully carried out in all H.M. Ships, it appears damage by lightning has almost vanished from the records of the Navy."

TERRESTRIAL MAGNETISM.

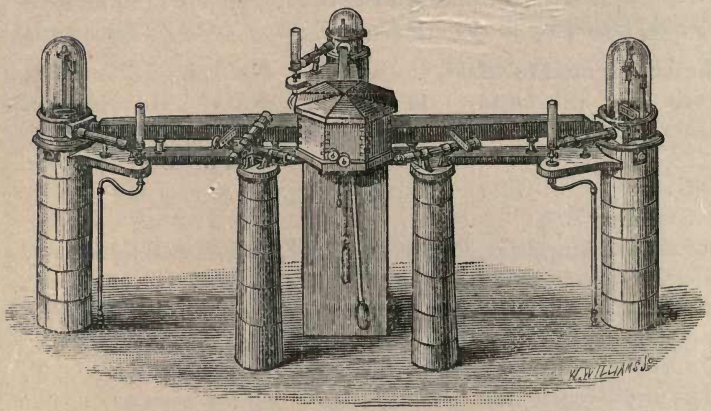


FIG. 133.

134. **Magnetograph or Self-Recording Magnetometer** (fig. 133), recommended by the Meteorological Committee of the Royal Society and used at Kew Observatory. This apparatus, invented and arranged by Mr. Beckley, records the variations continually occurring in the Earth's Magnetism by the aid of photography. Three drums or cylinders, to which are attached sheets of sensitised paper, are revolved by a clock movement (seen in the centre of the engraving), and receive the rays of light projected from small mirrors attached to each of the three magnets so arranged as to exhibit all the variations of Magnetic Force, Inclination, Direction, and Intensity. The lights used are Gas Burners or Paraffin Lamps.

Our limited space will not permit our giving full details of the various mechanical contrivances made use of in this apparatus, which in many respects are somewhat similar to those employed in the Recording Barograph, Thermograph, and Hygrometer shown on pages 30 and 78.

The Magnetograph is supplied by Negretti and Zambra to special order.

Price £350 to £500

135. **Unifilar Magnetometer,** Kew Pattern, Portable arrangement, packed in two boxes complete. *Price,* £70 0 0

136. **Kew Pattern Dip Circle, or Inclinometer,** of the most recently improved arrangement, complete, with Lloyd's Total Force Apparatus and Kew Verification. *Price,* £35 0 0

137. **Seismograph,** Professor Palmeri's recently improved arrangement for recording and measuring the various Volcanic and subterranean tremors and disturbances of the Earth. *Price* complete in Glass Cases, £150 0 0

138. **Van Rysselberghe's Universal Meteorograph.** For recording by the aid of Electricity the indications of Meteorological Instruments at regulated periods of time. These records are registered upon a metallic surface every 15 minutes, and from them any number of copies can be produced. Similar to N. & Z's. Recording Thermometers and Hygrometers, Nos. 74 and 103, the Meteorograph can be constructed to register indications of meteorologic apparatus in action at a great distance from the observing station. The simplest arrangement of this apparatus includes a Barometer, Hygrometer, Rain Gauge, and Anemometer, with Direction Vane. Complete with Galvanic Batteries and a supply of Sheets of Zinc, &c. *Price,* £240 0 0

This price will vary with the number of Instruments of which records are desired.

139. **Solar Intensity Apparatus,** Padre Secchi's, for measuring the comparative heat of the Sun's Rays.

Price complete with three Thermometers, £4 4 0

140. **Piché's Evaporimeter** with graduated glass Tube.

Price, £0 13 0

141. **Pocket Spectroscope,** for observing the Rain Band, fixed slit, in Leather Case. *Price,* £1 15 0

142. **Ditto Ditto** with adjustable slit and Leather Case.

Price, £2 10 0

143. **Direct Vision Rain Band Spectroscope,** larger size, of very great dispersive power, in Leather case. *Price,* £5 5 0

For further description and prices of Electrical Galvanic, Magnetic and Electro-Magnetic Instruments and Apparatus, see special sections at end of this Catalogue.

NEGRETTI AND ZAMBRA'S BAROMETER AND THERMOMETER CHARTS.

"THE DAILY TELEGRAPH" BAROMETER CHART.

[FROM NEGRETTI AND ZAMBRA'S SELF-REGISTERING BAROMETER.]

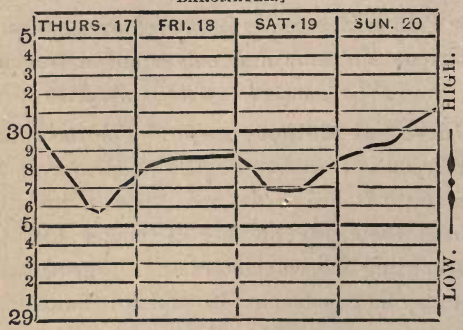


FIG. 134.

The above chart represents the movement of the barometer, corrected for sea-level and reduced to 32° F., during the last four days ending midnight, May 20-21.

GENERAL REMARKS.—A return of a north-easterly wind, accompanied by occasional showers of drizzling rain, caused the weather yesterday to be very bleak and unseasonable. The barometer rose throughout the day, the reading at midnight being 30·11.

DOVER.—Fine and cold; wind S.W.; sea rough; bar. steady.

The method of keeping the Barometer and Thermometer Charts is well shown in our diagram, (fig. 134). This is an *actual reprint* from a Chart published in the *Daily Telegraph* newspaper, of the morning of May 21st, 1877.

By a most ingenious arrangement of fixed and movable types *invented by Negretti and Zambra*, the rise and fall of the mercury in the Barometer tube (as indicated by Negretti and Zambra's Recording Barometer) is published every morning in the *Daily Telegraph*, the diagram exhibiting the indications of the Barometer for the previous four days and to within a few hours of going to press.

Modifications of this method of publishing a daily Barometrical record have been carried out by the firm for several other daily papers, and in varying forms are now used by almost every daily and weekly newspaper.

144. CHARTS FOR KEEPING A RECORD OF THE VARIATIONS OF THE BAROMETER AND THERMOMETER.

Each sheet is ruled and figured for one month's observations; twelve of these sheets are neatly mounted on a card, so that when one month's readings are ended the sheet can be removed by cutting round the edge with a sharp knife, and a fresh sheet will be exposed. These records form a most interesting and valuable reference for comparing present and past weather.

Price of each pad of 12 sheets,	for Barometer,		2s. 6d.
Ditto	ditto	for Thermometer,	2s. 6d.
Combined	ditto	for Barometer, Thermometer, Hygrometer, Rainfall, &c.,	2s. 6d.

These Pads of Charts can be forwarded by Book Post for Fourpence.

Ruled Charts or Diagrams for the Recording Barometer, fig. 21, and Recording Aneroid Barometer, figs. 28 and 29	price, per hundred	£1	5 0
Ditto Ditto, for Recording Anemometers, figs. 117, 118 and 118*	„	1	5 0
Ditto Ditto, Ditto, Tide Gauges, figs. 125 and 126	„ „	1	1 0

METEOROLOGICAL PUBLICATIONS.

ELEMENTARY METEOROLOGY. ROBT. H. SCOTT, Esq., M.A., F.R.S. Price 5s.

A TREATISE ON METEOROLOGICAL INSTRUMENTS, Explanatory of their Scientific Principles, Method of Construction, and Practical Utility, by NEGRETTI AND ZAMBRA. Numerous Tables of Reference in connection with Meteorology. Illustrated with 100 Engravings. Price 5s.

HYGROMETRICAL TABLES, Adapted to the use of Negretti and Zambra's Wet and Dry Bulb Thermometer, by J. GLAISHER, Esq., F.R.S. Price 2s. 6d.

TABLES OF THE CORRECTIONS FOR TEMPERATURES, to reduce observations to the 32° Fahrenheit, for Barometers with Brass scales extending to the top of the mercurial column. By J. GLAISHER, Esq., F.R.S. Price 1s. 6d.

TABLE OF THE DIURNAL RANGE OF THE BAROMETER. By JAMES GLAISHER, Esq., F.R.S. New Edition. Price 1s. 6d.

TABLES FOR CALCULATION OF HEIGHTS from Observations on the Boiling Point of Water, arranged for use with Negretti and Zambra's Boiling Point or Hypsometric Apparatus. By the late Mr. WELCH, of the Kew Observatory. Price 1s.

BAROMETER MANUAL, OR HOW TO FORETELL WEATHER, compiled by Admiral FITZ-ROY, F.R.S., &c., for the Board of Trade. Published by NEGRETTI AND ZAMBRA with permission Price 6d.

TABLE SHOWING THE READINGS OF THE BAROMETER, Corresponding Numbers of Elevation in English Feet, and of Readings of Aneroid or Corrected Barometer in English Inches; (the Mean of Atmospheric Temperatures being 50° Fahrenheit). Compiled by the late Astronomer Royal for NEGRETTI AND ZAMBRA. Price 6d.

L. F. KÆMTZ'S COMPLETE COURSE OF METEOROLOGY. Translated by C. V. WALKER, Esq. Price 12s. 6d.

POCKET METEOROLOGICAL REGISTER AND NOTE BOOK. (Strachan's) with Diagrams for exhibiting the Fluctuations of the Barometer, Thermometer and Hygrometer. NEGRETTI AND ZAMBRA. Price 2s. 6d.

SYMONS', G. J. British Rainfall (published annually since 1865). each 5s.

Monthly Meteorological Magazine, Vols. I. to XIX. each 5s.

SYMONS', G. J. Meteorological Register, with Instructions, for one year, 2s.

" " " for five years, 7s. 6d.

SYMONS', G. J. Blank Diagrams for Barometer and Thermometer, for one year, 1s.

SYMONS', G. J. Blank Rainfall Register for one year, 3d.

DIAL AND PEDIMENT BAROMETERS.

THE ordinary household Barometers or Weather Glasses are constructed in two forms, viz., the Wheel or Dial Barometer, and the Pediment or Upright Barometer. The former reading by an extended circular scale, and the latter from the actual mercurial column.

The Dial Barometer is mounted with the syphon form of tube as shown in our Diagram, the shorter limb of the syphon being about six or eight inches long. This obviates the use of a cistern, for with sufficient mercury in the short tube, that in the longer one will be balanced at a varying height in accordance with the increased or diminished pressure of the atmosphere.

This form of Barometer was first constructed by the celebrated philosopher Dr. Hook, in 1667; the principal advantage of the dial arrangement is that by it a small movement in the mercurial column is magnified and made very apparent, a tenth of an inch rise or fall being represented by the index moving over nearly one inch on the dial; this enables the unscientific observer to notice quickly if the Barometer be rising or falling and estimate the probability of fine or wet weather.

On the top of the mercury in the short limb of the tube is suspended a glass float, by a silk cord which passes two or three times round a small brass wheel or pulley; at the other end of this silk cord is placed a counterpoising glass weight, moving freely in a second tube placed at the side of the syphon for the purpose of steadying the weight.

The axis of the pulley is carried through the wood frame of the Barometer to the front of the instrument, where the movement of the mercury is shown by a light index hand attached to it, traversing a divided dial.

As the mercury in the Barometer tube rises, the silk cord descends, causing the index hand to move to the right; on the contrary, as the mercury falls the index will be carried in the reverse direction to the left.

The graduations on the dial represent the actual inches of a Standard Barometer Scale, extended as previously described, giving what is termed a very open scale.

If the mercury rises half an inch in the long tube it will fall half an inch in the shorter one. Therefore, as the mercury rises half an inch in the one tube and falls half an inch in the other, the length of the barometrical column has increased one inch,—but the movement has only been through half an inch —this amount of movement transferred to the pulley causes the index hand to indicate an inch movement on the dial, say from twenty-nine to thirty inches.

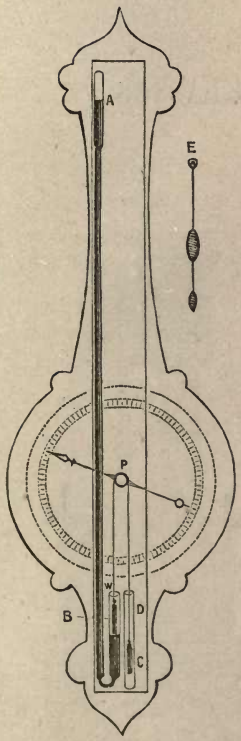


FIG. 135.

145. Our engraving (fig. 135) exhibits the general internal arrangement of the Dial Barometer.

A B is the mercurial syphon tube, and at W is seen the glass weight or float attached to a silk cord. This weight floats upon the surface of the mercury rising or falling in the tube in accordance with the movement of the mercurial column; by the side of the syphon is a second guide tube, D, for the counterpoise weight C, at P is shown the pulley over which the silk cord passes giving movement to the index hand over the Dial as previously described.

At the side of the diagram we show a wire plug, E, used for making these barometers portable for travelling or exportation. It is simply a stiff wire covered with cotton throughout its whole length, and as will be seen in the drawing, it has sufficient cotton wound round the lower end to fit the mercurial tube tightly at *two* points,

TO MAKE THE DIAL BAROMETER PORTABLE.

146. By inclining the Barometer the mercury is caused to fill the tube *entirely*, the float is then withdrawn from the mercurial tube W (carefully avoiding disturbing the silk cords,—most of Negretti and Zambra's Barometers are now fitted with a brass clamp to secure the cords), and then the plug E is forced slowly down the tube until the mercury is perfectly secured. The glass float being placed at the side of the syphon and secured with a little soft packing carefully placed round it and the glass tubes, the instrument is now made portable or secure for transit.

We need hardly point out that the Dial Barometer must not be regarded as an instrument of precision, but simply as a weather indicator or household Barometer.

Instructions for setting the Barometer in action will be sent with each instrument if it has been made portable.

The absolute height of the Barometer, at any moment, does not always indicate present weather. The rise or fall of the mercurial column supplies the information of coming weather or change.

A rapid rise or fall indicates changeable and unsettled weather.

A falling Barometer and rising Thermometer, are commonly and quickly followed by rain.

"The longer the time between the signs and the change they foretell, the longer will the altered weather last; and the shorter between the warning and the change, the shorter the continuance of the changed weather."

"A fall, with a low Thermometer, foretells Snow."

When the Barometer falls with the wind S.E., it is generally followed by long continued Rains.

A rapid fall of the Barometer is usually followed by much wind as well as Rain.

For further hints *How to foretell the Weather* see N. and Z's. *Barometer Manual*, compiled for them by Admiral FITZ-ROY. Price, post free, Sixpence.

DIAL BAROMETERS, OR WEATHER GLASSES.

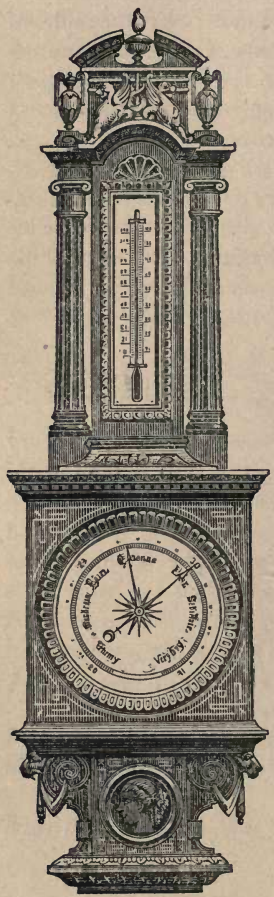


FIG. 159.

FIG. 158.

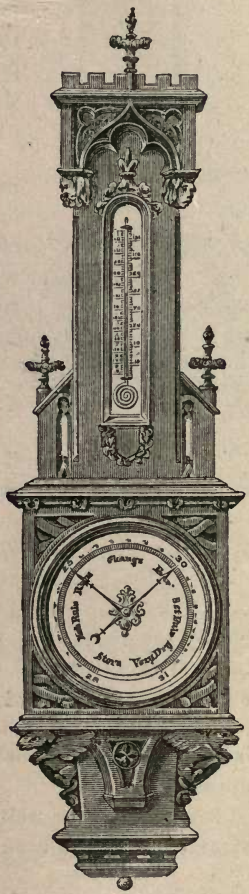


FIG. 159*.

BAROMETERS being now mounted in so many varied styles, both plain and carved, the following are given as a few specimens of those most in demand. Large stocks of these instruments are always kept at all of NEGRETTI and ZAMBRA'S establishments of most of the patterns shown in the engravings. Barometers supplied to order of any style of Architecture, to correspond with the furniture of Libraries, Halls, &c,

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NOTE.—*The marginal Nos. from this page will as far as possible correspond with those of the woodcuts.*

FIG. 153.

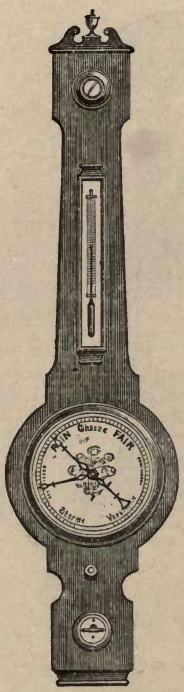


FIG. 151.

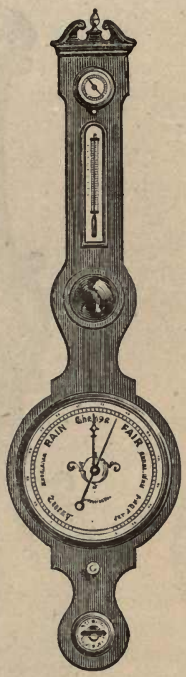


FIG. 150.

FIG. 154.

		Each. £ s. d.	Each. £ s. d.
147	8-inch **Silvered Brass Dial Barometer**, common, mounted in mahogany or rosewood frame, with or without mirror, hygrometer, and level . . .		1 10 0
148	8-inch ditto ditto, square bottom	2 2 0	2 10 0
149	Ditto, ditto, superior finish, engraving, and large tube		3 10 0
150	10-inch **Silvered Brass Dial Barometer**, in common mahogany or rosewood frame, with or without mirror, hygrometer and level (fig. 150)	2 2 0	3 3 0
151	Ditto, Ditto, square bottom (fig. 151)	2 10 0	3 10 0
152	Ditto, Ditto, Extra best both as regards frame, dial, engraving and tube (figs. 151 or 154)	3 10 0	4 4 0
	12-inch Dial Barometers of the same patterns, 15s. to £1 5s. extra.		
153	8-inch **Scroll Pattern Dial Barometer**, best mounted mahogany, oak, walnut, or rosewood frames, silvered brass dial, with Thermometer (fig. 153) . . .	3 3 0	4 4 0
	10 and 12-inch Scroll Pattern Barometers, 20s. to 50s. extra.		
154	8-inch **Dial Barometer**, with ornamental figures, letters, and divisions on PATENT ENAMELLED GLASS DIAL (fig. 154)		5 5 0
155	8-inch **Dial Barometer**, rosewood frame inlaid with PEARL or METAL, with silvered brass dial		8 8 0
156	10-inch ditto, best rosewood frame inlaid with PEARL or METAL, the dial of silvered metal, with Thermometer, superior finish Nos. 155 & 156 *fitted up to order* (fig. 156)		12 12 0
	12 and 14-inch Dial Barometers ditto, at proportionate prices.		

FIG. 156.

FIG. 157.

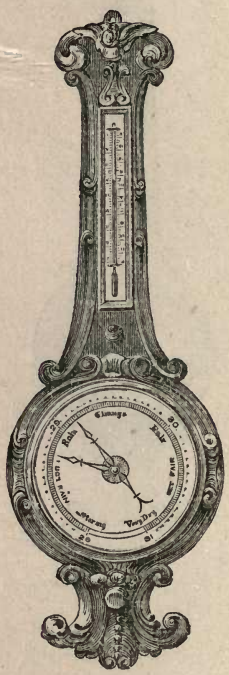


FIG. 158*.

		Each. £ s. d.
157	14-inch **Dial Barometer,** best rosewood frame inlaid with PEARL or METAL, the dial of silvered metal, and an eight-day **Clock** fitted in the frame, Thermometer, &c. (fig. 157) *fitted up to order* . .	25 0 0
158	8 and 10-inch **Dial Barometers,** plain carved, in solid oak, mahogany, rosewood, or walnut frame, double basil ring, and polished-edge plate glass, of the very best construction and superior engraving, as figs. 158 and 158* . . . . . £5 5s. £6. 6s. to	8 8 0
159	**Dial Barometers,** 10, 12, and 14-inch, of the very best construction, in richly carved solid frames of Gothic, Mediæval, Elizabethan, Egyptian, Chippendale or other designs, in Oak, Mahogany, or Walnut-wood (figs. 159 and 159*) . . £10 10s. £16 16s. to	25 0 0

Suitable for Club-houses, Mansions, &c.

N.B.—DIAL BAROMETERS required for transmission to distant parts, such as India or the Colonies, should be ordered *expressly*, as in that case they will be rendered portable by plugging the tube as described page 135, and shown in diagram fig. 135.

The prices quoted for the more elaborate forms of Dial Barometers are subject to variations dependent upon the amount and quality of the ornamental carving and engraving.

PEDIMENT BAROMETERS.

NEXT to a Standard instrument the Pediment Barometer must be regarded in a scientific point of view as the most accurate form of Barometer, the actual weight or pressure of the atmosphere being exhibited by the varying length of the mercurial column itself, subject to a few corrections that need not be noticed by ordinary observers. At pages 2 and 3 will be found the general principles of the straight tube or Pediment Barometer.

The cistern of the Pediment Barometer is made of boxwood, with sufficient internal area to allow of a fall of at least two-thirds of the mercury contained in the tube when the Barometer is in action without materially interfering with the correctness of the readings. It should also contain sufficient mercury to prevent air passing up into the tube. The bottom of the cistern is formed of flexible leather, so as to admit of the use of a screw to render the Barometer *portable*, as described in the paragraph—Standard Barometer, pages 4 and 5.

It will be seen that most of these Barometers are furnished with *two* Verniers, or indices. The use of the *second* Vernier is to record on the left hand scale of the instrument the previous reading of the Barometer, and show at a glance any alteration that may have taken place by the difference of the readings of the two Verniers.

In taking a reading or observation by the Pediment Barometer the Vernier carrying the Index Pointer is to be moved gently up or down, until its edge is exactly in a line with the centre of the top of the mercurial column as shown in fig. 5, page 6. If when adjusted the edge of the index is *exactly* in a straight line with, say, the division marked 30, then the height or length of the mercurial column is exactly thirty inches. The value of this column is given on pages 4 and 5; also on pages 6 and 7 will be found a description of the use of the Vernier, especially at the foot of page 7, where the Vernier of the ordinary Household Barometer is spoken of as subdividing the inch scale into hundredths.

If the division 1 in the Vernier coincides with the line at 29 inches on the scale, then the reading would be 29·11; if division 2 coincides with the line below that marked 29 inches, then the reading would be 29·12; that is twenty-nine inches and eleven hundredths or twenty-nine inches and twelve hundredths, or it may be read twenty-nine inches one tenth and one hundredth, and so on. The allowance to be made for height of the Station above the sea-level is, as stated by Admiral Fitz-Roy, as under.

The *average* height of the barometer, in England, at the sea-level, is about 29·94 inches, and the *average* temperature of air is nearly 50 degrees.

Every ten feet of elevation above the sea lowers the Barometer about ten or eleven thousandths of an inch.

Add one-tenth of an inch to the observed height for each hundred feet the Barometer is *above* the mean sea-level. This sea-level should be that of the ocean itself, at mean half-tide, a level which should be the universal standard line of reference.

The Thermometer falls about one degree for each three hundred feet of elevation *above* more than fifty feet from the ground.

PEDIMENT BAROMETERS.

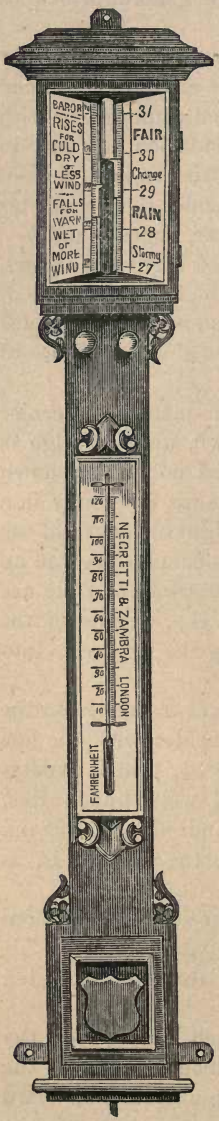


FIG. 168.

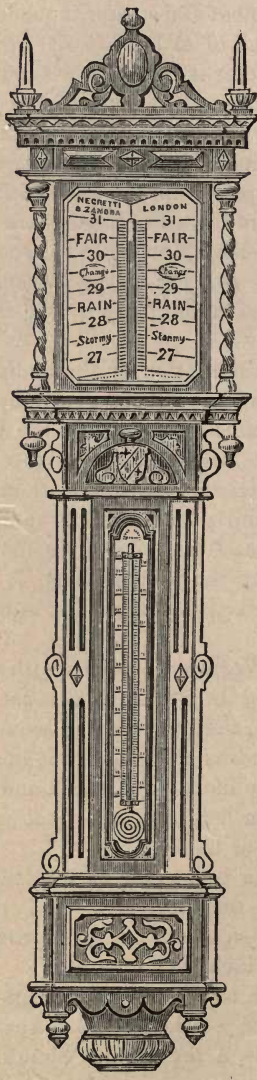


FIG. 169.

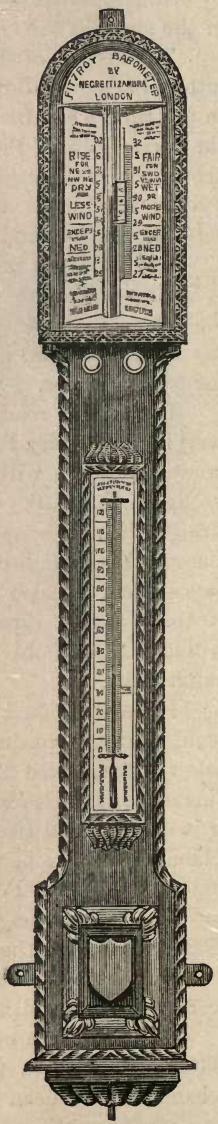


FIG. 168*.

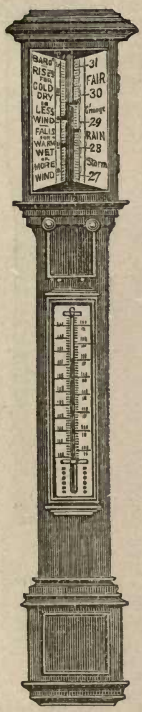


FIG. 165.

FIG, 161.

FIG. 164.

FIG. 163.

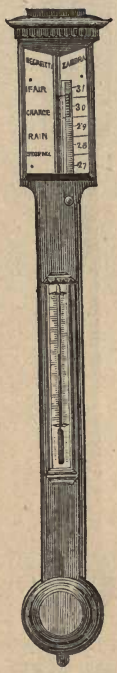


FIG. 164*.

PORTABLE PEDIMENT BAROMETERS.

		Each. £ s. d.	Each. £ s. d.
160	**Model Barometer**, with vernier and thermometer, also screw, to render it portable		1 1 0
161	**Pediment Barometers**, with ivory scales, thermometer, SLIDING VERNIER, the tube visible throughout the whole length, and portable screw, (fig. 161) . .	2 2 0	2 10 0
162	**Pediment Barometer**, with glass cover over the face, rackwork vernier and thermometer, exposed tube .		2 15 0
163	**Portable Pediment Barometer**, Round Top Frame in, Oak, Mahogany or Rosewood, the tube covered entirely, rackwork Vernier, and a Thermometer on the front (fig. 163)		3 3 0
164	Ditto ditto, with Square Moulded Top, large tube, and one Vernier (figs. 164 and 164*)	3 10 0	4 10 0
165	Ditto ditto, with extra large tube, 2 rackwork verniers, ivory scales, with Thermometer, in Oak, Mahogany, Walnut, or Rosewood frame (fig. 165)	5 5 0	6 6 0

FIG. 166.

FIG. 167.

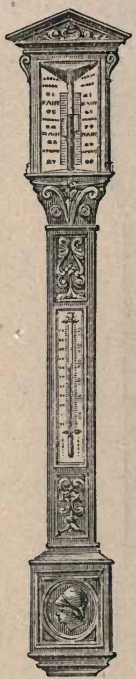


FIG. 167A.

FIG. 167B.

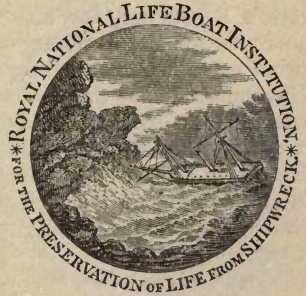
FIG. 167C.

FIG. 167D.

		Each. £ s. d.
166	**Portable Pediment Rosewood Barometer,** elegantly inlaid with pearl or metal, thermometer in front, ivory scale, rackwork vernier (fig. 166). . . . . fitted up to order	7 7 0
167	**Portable Pediment Barometers,** with two Verniers, best Carved oak, Rosewood, Walnut, or Mahogany frames, of various elegant designs, fitted up in the very best manner (figs. 167 and 167 A, B, C, D). with Opal Glass or Ivory Scales £6 6s. £8 8s.	10 10 0
168	**Large Pediment Barometers,** handsomely mounted in Oak, Walnut, or Ebonised frames, the tube of large internal diameter, and the cistern presenting a large area, to insure uniformity in reading, Ivory, Opal Glass, or Silvered Metal Scales, with engraved ornamental letters and two Verniers (figs. 168 and 168*) £8 8s. £10 10s. £12 12s.	15 15 0
169	Ditto ditto, **Ebonised Wood** frames with Ivory or Opal Glass Scales, and two Verniers very handsomely carved (fig. 169) . . . . . £18 18 0 to	26 0 0

Extra sized Pediment Barometers, suitable for Public Institutions or Club Houses, specially designed and made with English or French and English Scales to order.

A large and varied Stock of Household Barometers will always be found at all of Negretti and Zambra's Establishments.



170 The **FITZ-ROY STORM BAROMETER**, or **FISHERMAN'S** and **LIFE BOAT STATION BAROMETER**, as made by Negretti and Zambra especially for the Board of Trade and Royal Life Boat Institution, to be fixed at all the principal Seaports, Fishing and Life Boat Stations.

fig. 170. Price, £5 5s.

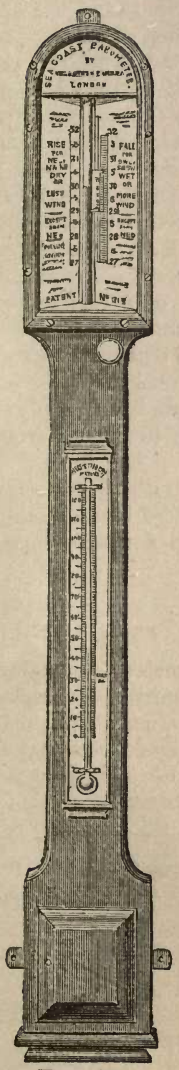


FIG. 171.

This Barometer consists of a tube with very large bore, and an accurate Thermometer, mounted in a solid oak frame, firmly screwed together, with scales and figures, &c., permanently engraved on *Porcelain*, by Negretti and Zambra's Patent process, the Vernier reading to 100-ths of an inch. It is strongly recommended as a good, sound working instrument, admirably adapted for use in Public Institutions.

Extract from Admiral Fitz-Roy's Reports of the Meteorologic Office of the Board of Trade, 1864 :—

"In my last Report, I stated how highly the Board of Trade 'Fishery' Barometers have been valued on the coasts. They are now eighty in all, specially *lent, under due control and care.* Two only of this number have become slightly defective, and have been exchanged. Not one has been injured in carriage, singular to say, between Cornwall and the Shetland Isles, Ireland and Yorkshire. It may be more readily *estimated* mentally than accurately proved, to what extent these simple instruments (all reliably made† and tested) have already been the means of saving life and property. Explanatory manuals and blank forms for diagrams have been extensively circulated among the coasters and fishermen, who are all, now, much influenced by, and very thankful for, the benefits of this act of their Government. Many are the local instances of similar beneficence by individuals—especially the Duke of Northumberland, who has placed no less than fourteen barometers."

Messrs. Negretti and Zambra would specially caution the Public against purchasing cheap and worthless imitations of Admiral Fitz-Roy's Barometers as leading to disappointment. Full details both as to the construction and use of the true Fitz-Roy instrument will be found in Negretti and Zambra's Barometer Manual, compiled by Admiral Fitz-Roy for the Board of Trade; post free, 6d.

171 **Fitz-Roy Barometers** with two Verniers . . £6 10 0

172 Ditto ditto, in Ornamental Carved Oak, Walnut, or Mahogany frames (fig. 168*) . . 8 8 0

Barometers in solid frames, mounted with Ivory or Opal Glass Scales, having the Fitz-Roy Weather Rules on one side and the ordinary words, Fair, Change, Rain, and Stormy on the other, at the same prices as No. 168*. These instruments are very suitable for Public Institutions.

† *By Messrs. Negretti and Zambra.*

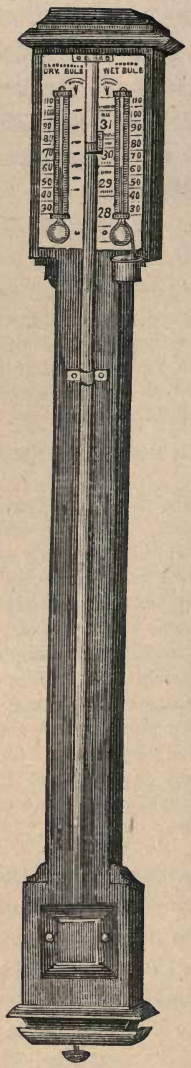


FIG. 173.

173 **Negretti and Zambra's Farmer's Barometer,** for ascertaining the humidity of the atmosphere, the general character of the weather, and the approach of wind or rain. The Farmer's Barometer combines three distinct instruments—the Barometer, the Thermometer, and the Hygrometer, and is equally valuable to the Agriculturist and the Invalid, a difference of 5° to 8° being considered a healthy amount of moisture in the air of dwelling rooms. The action is very simple, and so long as a sufficient supply of water is kept in the cistern, the Hygrometric condition of the atmosphere can be known at any moment.

It is a well-known fact that the Barometer is as much, or even more affected by a change of wind as it is by rain, and the objection raised against a simple Barometer reading, as leaving the observer in doubt whether to expect rain or wind, is entirely removed in the instrument now offered to the Public by the addition of the Hygrometer, an instrument indicating the comparative degree of dryness or dampness of the air;—a most important item in the determination of the coming weather.

Hitherto the use of scientific instruments of this class has been confined to very few observers. Nevertheless, through the instrumentality of James Glaisher, Esq., F.R.S., as Secretary of the British Meteorological Society, multitudes of observations have been taken with extreme accuracy, and duly registered; and it is from these carefully collected data that we are enabled in a measure to interpret the various changes that we feel and see going on in our atmosphere, and by the aid of well-constructed instruments, are in a position to predict with a great degree of certainty the weather that is likely to prevail from time to time.

Instructions for using the Wet and Dry Bulb Hygrometer will be found at page 77. And at page 76 will be found a table giving the value of Hygrometric readings in a simple form, sufficient for the use of ordinary observers.

The **Farmer's Barometer** as fig. 173 . . . . £2 10s.
Ditto, ditto, in Ornamental Mountings £5 5s. £6 6s.

174 **Negretti and Zambra's Miners' Barometer.**—It having been observed, that explosions of gas in mines mostly occur when the Barometer is very low (showing diminished atmospheric pressure), it is important that a good Barometer should be at hand, for observation by the Managers and others. For this purpose Negretti and Zambra make strong and sufficiently accurate Barometers, as fig. 174, at . . £1 1s. £2 2s. £3 3s.

175 **Aneroid Barometers for Miners' use,** exceedingly convenient and sensitive, with Extended Scale . . . . . £2 10s. £3 10s. £4 4s.

176 **Miners' Pocket Aneroids,** see also page 148.
£3 3s. £4 4s. £5 5s.

STANDARD AND MOUNTAIN BAROMETERS (see pages 1 to 13).

FIG 174.

FIG. 177.

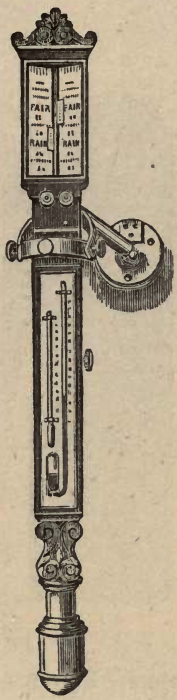


FIG. 181.

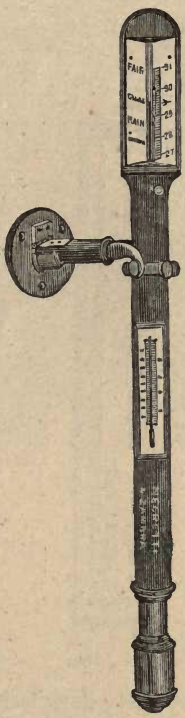


FIG. 180.

FIG. 179.

MARINE BAROMETERS.

		Each £ s. d.	Each. £ s. d.
177	**Marine Barometer**, plain mahogany frame, with Ivory scales, sliding vernier, Thermometer, and Brass arm gimbal, for suspension (fig. 177)	2 2 0	2 10 0
178	**Marine Barometer**, round, moulded, or carved top, with rack-work to vernier, Thermometer, capillary tube to prevent the ingress of air into the column, even during the most violent oscillations of a storm, Brass arm gimbal, &c.		3 3 0
179	Ditto ditto, in **Carved** frame (fig. 179)		4 4 0
180	**Marine Barometer**, best mounted as fig. 180 . . .		5 5 0
181	**Marine Barometer**, best, with SYMPIESOMETER in front; the sympiesometer constructed and laid off with the greatest accuracy by actual experiments, Brass gimbal, &c. (fig. 181)		6 6 0
182	**Board of Trade Standard or Kew Marine Barometer**, figs. 16 (*see page* 11) and 182.		
183	**Fitz-Roy's Marine Gun Barometer**, fig. 183, (*see page* 12).		

FIG. 183.

FIG. 186.

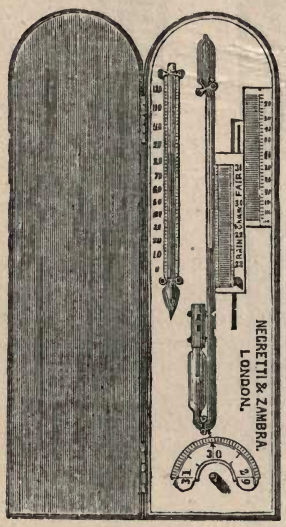


FIG. 187.

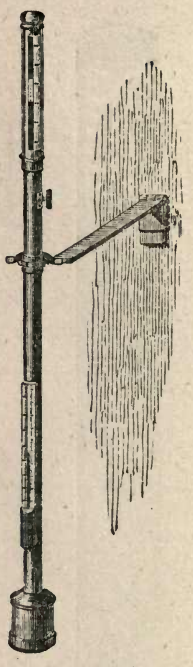


FIG. 188.

184 **Sympiesometers.** Previous to the invention of the Aneroid Barometer, the Sympiesometer, from its extreme sensibility and convenient size, was much used for Marine observations; but owing to its liability to be put out of adjustment in transit, it is now rarely used except as an instrument of comparison. Being partly acted upon by the pressure and partly by the temperature of the air, its correct name would be a Thermo-Barometer.

Directions for using the Sympiesometer.—It should be always carried top upwards, to prevent the air mixing with the liquid. Care should always be taken to screen it from the heat of the sun or cabin fire. To ascertain the atmospheric pressure by the Sympiesometer, note first the temperature of the mercurial thermometer; secondly, adjust the pointer of the pressure scale to the same degree of temperature on the scale of the air column; thirdly, read the height of the liquid on the sliding scale, the divisions and figures representing the inches and tenths of the Barometer scale.

		Each. £ s. d.
185	**Sympiesometer,** in wood frame, with registering index and plate glass front	2 10 0
186	Ditto ditto, with Rackwork Movement, large size and best make, Oak or Rosewood Frame (fig. 186) . .	4 10 0
187	**Pocket Sympiesometer,*** suitable for travelling, and taking altitudes, or mountain service, in leather hinged case (fig. 187)	3 15 0
188	Ditto ditto, in leather case with strap for **Mountain service**	4 4 0

* The use of the Pocket Sympiesometer is now quite superseded by the Aneroid Barometer.

FIG. 190.

FIG. 189.

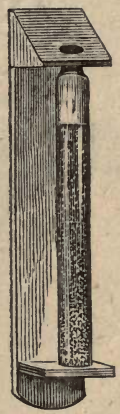


FIG 192.

		Each. £ s. d.	Each. £ s. d.
189	**Storm Glass or Chemical Weather Glass,** for prognosticating changes in the weather, by sea or land, particularly high winds, storms, or tempests (fig. 189) . . .	0 4 6	0 5 6
190	Ditto ditto mounted on a Boxwood Scale, with a Thermometer (fig. 190) . . . . 7s. 6d.	0 10 6	0 12 6
191	Ditto ditto . . plain Window Bracket . .		0 12 6
192	Ditto ditto best, mounted on Window Bracket (fig. 192)	1 1 0	1 15 0

This curious instrument appears to have been invented more than a hundred years ago. The original maker is not known; but doubtless it is an accidental discovery of some of the old Alchemists, who were constantly experimenting with the substances composing the solution with which it is made. It is simply a long glass vial, nearly filled with an alcoholic solution of camphor, to which is added crystals of nitrate of potassa and muriate of ammonia, with a small proportion of distilled water. Air fills the upper part of the vial, the mouth of which is corked or hermetically closed.

The various appearances presented in the liquid and crystals have been noticed to prognosticate atmospheric changes, and rules have been deduced from careful study and comparison of the glass and weather. Instructions for using the Chemical Storm Glass sent with each instrument.

Admiral Fitz-Roy, in *The Weather Book,* writes of this instrument as follows:—

"Since 1825, we have generally had some of these glasses, as curiosities rather than otherwise; for nothing certain could be made of their variations until lately, when it was fairly demonstrated that if fixed undisturbed in free air, not exposed to radiation, fire, or sun, but in the ordinary light of a well-ventilated room, *preferably,* or in the outer air, the chemical mixture in a so-called storm-glass varies in character with the *direction* of the wind—not its force, *specially* (though it *may* so vary in *appearance,* only from another cause, *electrical tension*)."

Some curious information connected with the *Camphor Glass* will be found in two pamphlets written by Charles Tomlinson, Esq., of King's College, London, on The Movements of Camphor on Water, and The Motion of Camphor towards Light. From these papers it would appear that the changes observed in the Storm Glass are due solely to variations of light and heat.

ANEROID BAROMETERS.

FIG. 194.

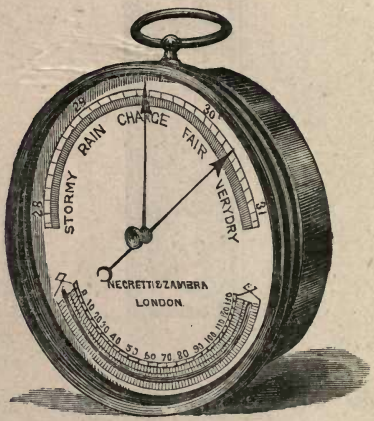


FIG. 195

			Each. £	s.	d.
193	**Aneroid Barometer**, Metal Case about 5 inches diameter. Enamelled Card Dial, stout Glass front, in hinged Leather Case . . .		2	10	0
194	Ditto	ditto, with Silvered Metal Dial (fig. 194)	3	0	0
195	Ditto	ditto, with Thermometer (fig. 195)	3	10	0

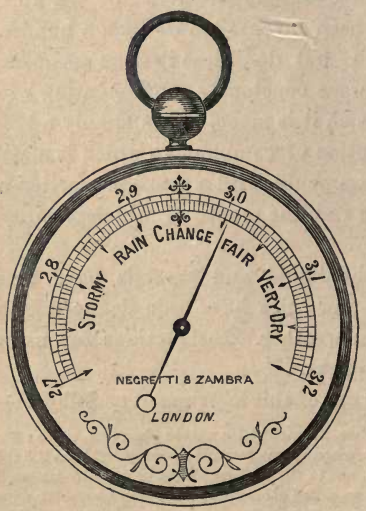


FIG. 196.

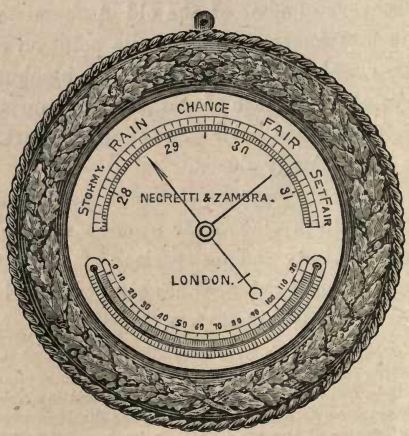


FIG. 199.

196 **Boat Aneroid**, the engraving fig. 196 represents the exact size of Negretti and Zambra's Pocket instrument. The metal case and the covering glass is made suitably strong for the use of Captains or Pilots of small Coasting vessels. Price, in Stout Case, £3 3 0

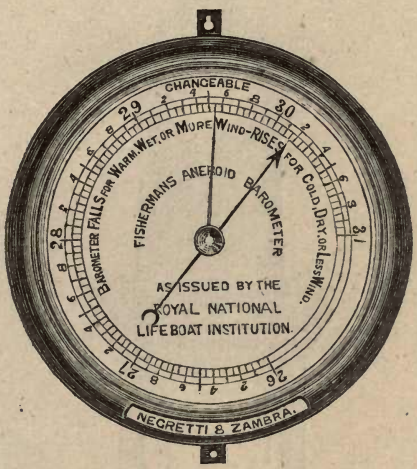


FIG. 201.

197 **Ship or Yacht Aneroid Barometers** in strong plain Metal or ornamentally carved Wood mountings. Extreme convenience of size, combined with great sensibility and reliability, have made these instruments very popular for state cabins of Sea-going Vessels and Steam Ships.

198 **Ships' Aneroids,** plain Circular Bronzed Metal Mountings, with Thermometer on the dial . . £3 3 0 5 5 0 6 6 0

199 **Ships' Aneroids** in handsomely Carved Wood Frame with Thermometer (fig. 199) 6 6 0 8 8 0

200 **Ships' Aneroids,** . . . smaller sizes £3 3 0 3 10 0 4 4 0

At pages 21 to 29 will be found a full description of the construction and use of various forms of Aneroid Barometers.

201 **Negretti & Zambra's new Fisherman's Aneroid Barometer** (fig. 201). No trouble or expense has been spared to obtain a trustworthy instrument at a moderate cost. It is mounted in a stout metal case, with a plate glass covering, the dial is of enamelled metal and 5 inches diameter. The range of scale is 26 to 31 inches, subdivided into tenths, corresponding with the scale of the Mercurial Barometer. Price, £1 15 0

It will be noted that at the top of the Dial is placed the word CHANGEABLE; to the right and left of this word is printed a condensed form of Admiral Fitz-Roy's rules for prognosticating the coming weather.

Should the Blue Index move to the right fine weather may be anticipated; on the contrary, should it recede to the left, bad and stormy weather is indicated.

These movements correspond with those of the Mercurial Barometer, hence the Aneroid, like the Mercurial Instrument, is said to be Rising, Falling, or Steady.

201* Negretti and Zambra's Farmers' Aneroid, mounted in frames, similar to fig. 154. £4 4s., £4 10s.

FIG. 203.

FIG. 202.

FIG 204.

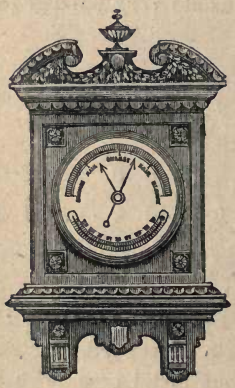


FIG. 205.

202 **Aneroid Barometers, in Ornamental Mountings.** Since the publication of the early editions of our Illustrated Catalogue we have introduced the Aneroid for use as a household Barometer, mounting it in variously designed ornamental frames, suited either for the Mantel Shelf or for Suspension in the Hall or Library. Our engravings exhibit a few of the series we have had specially designed to suit these instruments.

One very important advantage of the Aneroid movement thus mounted is that there is *very little fear of damage in transport;* therefore these Barometers can be safely sent abroad to places where hitherto it has been almost impossible to send a mercurial instrument with safety; for beyond careful packing (the Aneroid does not want any screwing up or making portable) nothing is required but to unpack the instrument and hang it up, and it will at once be in action, and show the atmospheric pressure at the place where suspended.

For the saloons of Sea-going Vessels and Yachts, these Aneroid Barometers are admirably adapted, being conveniently small in size, and very accurate.

New patterns are being constantly added to our stock, and we would observe that many of our Dial. Barometer Frames can be mounted with Aneroid Barometers instead of Mercurial Tubes.

Aneroid Barometer, as fig. 203, 5-inch dial, £5 5s.; fig. 203, 8-inch dial, £10 10s.; fig. 204, 5-inch, £6 6s.; fig. 204, 8-inch, £11 11s.; fig. 205, £5 10s.; fig. 205, with Clock, £10 10s.; fig. 202, £18 10s. and £22; fig. 206, £6 10s.; figs. 207 and 208, £5 5s. and £6 10s.; fig. 209, £18 18s.; Carved frames as figs. 158, 158*, pages 136 and 138, £6 6s., £7 7s. and £8 8s.

FIG. 206.

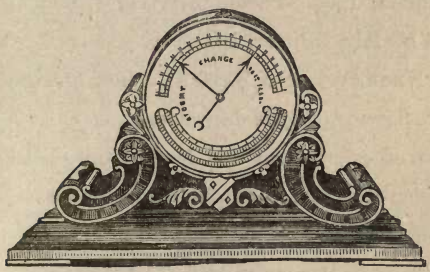


FIG. 207.

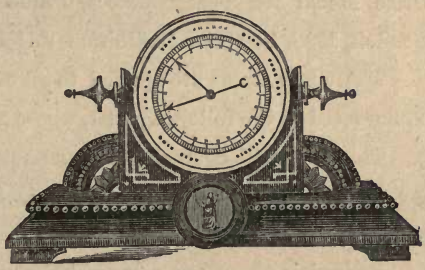


FIG. 208.

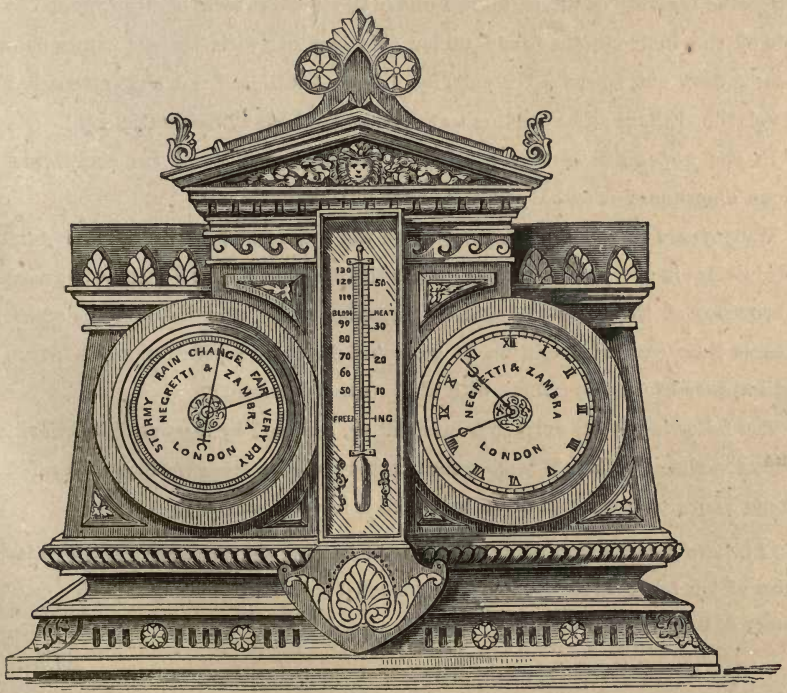


FIG. 209.

NEGRETTI AND ZAMBRA'S DESIGNS
FOR LIBRARY, DINING-ROOM, OR HALL ANEROID BAROMETERS.

THERMOMETERS AND HYDROMETERS.

At pages 31 and 32 will be found described many important improvements in the construction of Thermometers invented and Patented by Negretti and Zambra. Also the process for Engine-dividing the Scales and Tubes, for which a Prize Medal was awarded to Negretti and Zambra at the Great Exhibition of 1851 (see fig. 31); a second award of Two Medals in 1862, for many important improvements and inventions; a Prize Medal, Santiago, Chili, 1875; and also a Prize Medal for Thermometers, Philadelphia, 1876. Paris, 1878, Gold Medal; London, 1883, Fisheries Exhibition, 2 Gold Medals, 1 Silver, 1 Bronze.

These inventions are applied to all of Negretti and Zambra's instruments enumerated in the following List, where precise accuracy is desirable.

This List will comprise Thermometers of every form and description, suited for Domestic, Medical, Horticultural, Scientific, and Manufacturing purposes, arranged as far as practicable in separate divisions.

Following these are arranged the various instruments used for ascertaining the Specific Gravity of fluids, known under the general term of Hydrometers; the whole of the instruments found under this heading with various names showing the same fact, *viz.*, Specific Gravity, by differing scales, from the extremely light and volatile Æthers and Paraffins to the dense and heavy Sulphuric Acid.

In the appendix to this catalogue will be found Rules for comparing the various Thermometer and Hydrometer Scales in general use.

Many years of practical experience in the manufacture of Thermometers and Hydrometers in every variety of shape enables Negretti and Zambra to guarantee the accuracy of these instruments, as regards testing and dividing the scales; at the same time, careful attention is bestowed on their construction, to insure the most improved forms combined with the greatest durability.

The following is an extract from a letter, received by Messrs. Negretti and Zambra, written by Mr. Whipple, the manager of Kew Observatory, with reference to some Thermometers sent down by the firm for comparison.

"I believe I may again assert with confidence, that we have never yet had so large a number of low range Thermometers pass through our hands exhibiting so high a degree of accuracy at the melting point of mercury."

THERMOMETERS.







FIG. 221. FIG. 240. FIG. 217. FIG. 214. FIG. 213. FIG. 219. FIG. 217*.

		Each. £ s. d.	Each. £ s. d.
210	6 or 8-inch **Thermometer, Boxwood Scale** . . .		0 1 0
211	8-inch ditto, with French polished scale		0 1 6
212	8-inch ditto, superior. A good reliable instrument, suited for Dormitories, Hospital wards, Wine cellars, Stables, &c.		0 2 6
213	8-inch ditto, **with Enamel tube**, (fig. 213)		0 3 0
214	8-inch ditto, **with Enamel tube**, the scale bevelled at the edges, with double scales, either Fahrenheit and Centigrade, or Fahrenheit and Reaumur (fig. 214) .	0 3 6	0 4 6
215	10-inch Best Mounted Single Scale Thermometers .	0 5 6	0 7 6
216	12-inch best **Mounted Boxwood Scale Thermometer**, with double scales . . . . 10s. 6d. 12s. 6d.	0 15 0	1 1 0
217	8-inch, 10-inch, and 12-inch Negretti and Zambra's **Patent Porcelain Scale Thermometer**, strongly and neatly mounted on Oak, Very durable and suited for outdoor exposure (figs. 217 and 217*) . . 5s. 6d.	0 7 6	0 10 6
218	Ditto ditto, with Opal Glass Scales . . /s. 6d.	0 10 6	0 12 6

HALL OR DRAWING ROOM THERMOMETERS.

219	6 or 8-inch **Thermometer**, elegantly engraved **Ivory Scale on Ebony Back**, with German Silver Mountings and double scales (fig. 219) . . . . 10s. 6d.	0 12 6	0 16 0
220	10-inch ditto with very bold figures and divisions		1 1 0
221	12-inch ditto, best mounted, **extra large** (fig. 221) £1 10s.	1 15 0	2 2 0

FIG. 228.

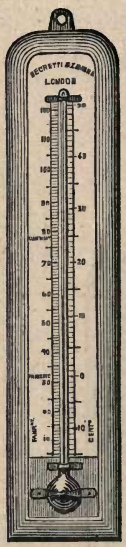


FIG. 222.

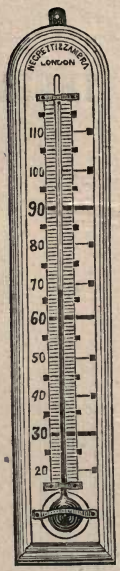


FIG. 223.

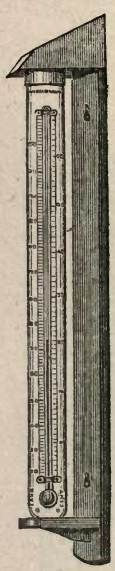


FIG. 226.

		Each. £ s. d.	Each. £ s. d.
222	10 or 12-inch **Thermometers, Opal Glass Scale,** with German Silver Mountings, superior workmanship, and elegant appearance, on Oak, Mahogany, or **Ebonised** backs, with Negretti and Zambra's Patent Enamelled Tubes, suited for **Halls, Dining Rooms, Libraries, &c.** (figs. 219 and 222), the divisions and figures very plainly marked. **Spirit or Mercurial** . 21s. 25s.	1 10 0	2 2 0
223	**Porcelain Scale Thermometers,** having extra large tubes, with very legible scales and words (fig. 223) :—		

		Single Scales.	Double Scales.
8-inch.	Tubes filled with Mercury .	£0 6 6	£0 7 6
10 „	„ „ .	0 7 6	0 8 6
12 „	„ „ .	0 9 6	0 10 6
15 „	„ „ .	0 14 6	0 16 6
8 „	„ Coloured Spirit .	0 5 6	0 6 6
10 „	„ „ .	0 6 6	0 7 6
12 „	„ „ .	0 8 6	0 9 6
15 „	„ „ .	0 12 6	0 14 6
20 „	„ „ .	1 5 0	1 10 0

WINDOW THERMOMETERS FOR OUT-DOOR USE.

224	**Window Thermometers,** Porcelain Scales on **Wood Brackets**	0 10 6	0 12 6
225	**Window Thermometers,** 8-inch Ivory or Glass Scales, enclosed in glass cylinders, on **Oak Brackets,** with metal tops	0 12 6	0 15 0
226	10-inch ditto ditto (fig. 226)		0 18 0
227	12-inch ditto ditto	1 5 0	1 10 0

FIG. 236.

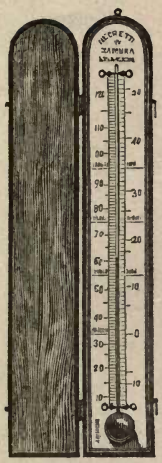


FIG. 231. FIG. 238. FIG. 237. FIG. 247. FIG. 232. FIG. 235. FIG. 230.

		Each. £ s. d.	Each. £ s. d.
228	**Window Thermometers**, 10, 12, or 14-inch, Opal Glass scales, divided by engine, and handsomely mounted on **Oak Brackets**, with brass supports for fixing at any angle (fig. 228) . . . . . 21s.	1 10 0	2 2 0

PORTABLE OR POCKET THERMOMETERS.

229	3 or 4-inch **Ivory or Metal Scale Pocket Thermometer**, in morocco leather hinged case (fig. 230) . . .	0 4 6	0 5 6
230	6-inch ditto . . . . . ditto (fig. 230)	0 6 6	0 7 6
231	8-inch ditto . . . . . ditto (fig. 231)	0 10 6	0 12 6
232	**Oval Boxwood Pocket or Dressing Case Thermometer**, with tube and bulb sunk in the solid Wood, to prevent breakage in travelling . . . . (fig. 232)		0 7 6
233	Ditto ditto . . . . . larger		0 10 6
234	**Oval Ivory** ditto ditto .		0 16 0
235	Ditto ditto larger size (fig. 235)		1 4 0
236	**Negretti and Zambra's Improved Travelling Thermometer**, in Metal or Silver Case (fig. 236) , .	0 10 6	1 1 0

Not larger than a pencil case; accurately divided on its own stem. Can be arranged as a small Clinical Thermometer.

237	**Negretti and Zambra's Pocket Travelling Thermometer**, German silver Revolving Case, and Ivory scale (fig. 237)	0 10 6	0 15 0
238	Ditto, ditto, ... extra large (fig. 238)		0 18 6
239	**Pocket Thermometer in Slide Lid Wood Cases**, with Ivory or Metal scale (fig. 240) . . . 6s. 6d.	0 10 6	0 12 6
240	**Circular Pocket Thermometer** with **Ivory** scale, in leather hinged case, 2 inches in diameter . . .		0 18 6
241	Ditto, 3 inches in diameter, with **Compass** in centre .		1 5 0
242	Ditto, 3 inches in Diameter, with **Compass and Sun Dial** in centre	1 10 0	1 16 0

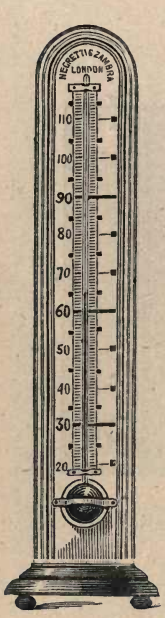


FIG. 243.

FIG. 246.

FIG. 249.

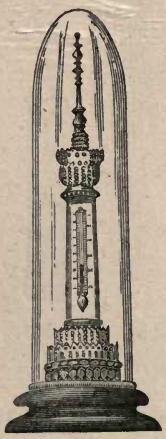


FIG. 246*.

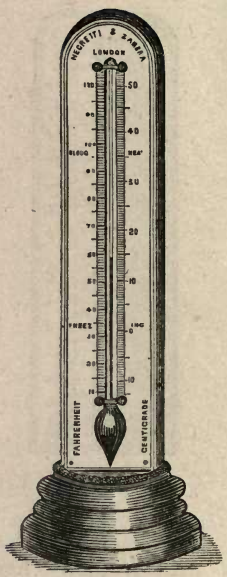


FIG. 248.

MANTEL OR TABLE THERMOMETERS.

		Each. £ s. d.	Each. £ s. d.
243	Boxwood Scale Thermometer, on Boxwood Stand (fig. 243).	0 7 6	0 10 6
244	Ivory Scale Thermometer on Ebony Stand, with glass shade . . . . . 10s. 6d.	0 12 6	1 10 0
245	Ditto, on Solid Ivory stand , . . . (fig. 245)	1 12 6	2 2 0
246	Ivory Mantel Thermometers, handsomely engine-turned, and ornamented in numerous designs (figs. 246 & 246*) £2 10 0	3 3 0	5 5 0
247	Ditto, with Compass or Sun Dial at top (fig. 247) . .	1 16 0	2 2 0
248	Ivory Scale Mantel Thermometers, mounted on Ebony with solid marble base (as fig. 248) 16s., 21s.	1 10 0	1 15 0
249	Marble Mantel Thermometer, as fig. 249, Obelisk and various other patterns from	1 10 0	2 2 0
250	Ditto Ditto Serpentine Marble . . £2 2s.	2 10 0 to	5 5 0

HORTICULTURAL AND BOTANICAL THERMOMETERS.

251	8-inch Botanical Thermometer, Boxwood Scale, in japanned metal cases, range of scale 0 to 120° or 150° Enamel Tube.		0 3 6
252	Ditto ditto ditto 10-inch		0 7 6
253	Ditto ditto 12 to 14-inch Boxwood Thermometers, do. do. 10s. 6d.	0 12 6	0 13 6

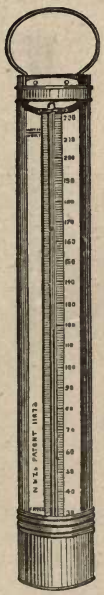


FIG. 282. FIG. 267.

FIG. 292.

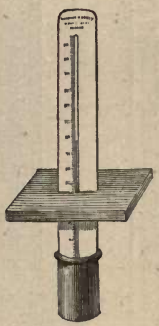


FIG. 290.

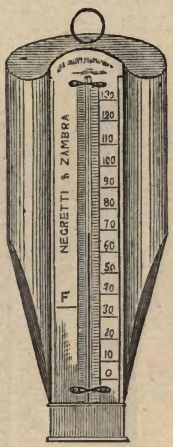


FIG. 291.

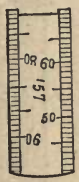


FIG. 280*.

FIG. 280.

		Each. £ s. d.	Each. £ s. d.
254	8-inch **Thermometers on Negretti and Zambra's Patent Porcelain Scales**, not affected by damp, &c., in japanned metal cases		0 5 6
255	10-inch ditto ditto		0 7 6
256	12-inch ditto ditto		0 10 6
257	14-inch ditto ditto		0 12 6
258	**Hot-bed Thermometer**, small size, for Mushroom Beds .		0 10 6
259	**Hot-bed Thermometer**, in plain metal mounting (fig. 259)		0 12 6
260	Ditto ditto in mahogany frame, encased in Brass Cylinder.	1 5 0	1 10 0
261	Ditto ditto, with Thermometer on the Door (fig. 261) .		1 10 0
262	**Ground Thermometer**, for ascertaining the temperature of the earth (figs. 261 and 259). See also page 34 .	0 10 0	0 15 0
263	**Delicate Thermometers**, for inserting in the stems and flowers of growing plants, divided on the stem . .		0 10 6

BREWERS' THERMOMETERS.

264	8-inch **Brewers' Thermometer**, Silvered Metal scales, in japanned metal case	0 2 6	0 3 6
265	10-inch ditto ditto . . .	0 3 6	0 4 6
266	12-inch ditto . . .	0 4 6	0 6 6
267	14-inch ditto ditto (fig. 267) . . .	0 5 6	0 10 0
268	8-inch Enamelled Tubes, in **Copper Cases** . . .		0 5 6
269	10-inch ditto ditto . . .		0 6 6
270	12-inch ditto ditto		0 10 0
271	14-inch ditto ditto		0 12 0

FIG. 261.

FIG. 259.

FIG. 289.

FIG. 296.

FIG. 298.

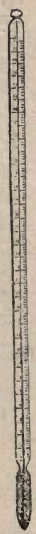


FIG. 300.

FIG. 305.

FIG. 286.

		Each £ s. d.	Each. £ s. d.
271*	8-inch Brewers' Thermometer, PORCELAIN SCALES, Negretti and Zambra's Patent, range of scale, 212°, in japanned metal cases as fig. 267		0 5 6
272	10-inch ditto ditto . . .		0 7 6
273	12-inch ditto ditto . . .		0 10 6
274	14-inch ditto ditto . . .		0 12 6
275	8-inch ditto Brewers' Thermometers, Patent Porcelain Scales, in Copper Cases (fig. 267)		0 7 6
276	10-inch ditto ditto . . .		0 8 6
277	12-inch ditto ditto . . .		0 12 6
278	14-inch ditto ditto . . .		0 14 0
279	Best Mounted Brewers' Thermometer, extra stout scales and Scoop shape, rivetted case, as fig. 280 . . .	0 12 6	0 16 0
280	Brewers' Thermometers, Best Mounted with Blind Scales, in Stout Copper cases (figs. 280 and 280*)		0 18 0
281	Ditto ditto lettered instead of figured		0 18 0
282	Brewers' Standard Reference Thermometers (fig. 282) .	1 1 0	2 2 0
	Stout Rivetted Copper Cases at a slight advance on above.		
283	Gyle Tun Thermometers, according to length, strong Wood mountings with N. and Z.'s Patent Porcelain Scales and enamelled tubes. 3ft., 36s.; 4ft., 42s.; 5ft., 50s.; 6ft., 60s.		

		Each. £ s. d.	Each. £ s. d.
284	Vatting Thermometers, Metal Scale and Wood mountings, 3 feet stem		1 10 0
285	Ditto, ditto 4 feet do.		1 16 0
286	Mash Tun Thermometers, Patent Porcelain Scales in strong Metal mountings (fig. 286)	3ft., 45s.;	5ft., 50s.;
287	Saccharometer Thermometer with expansion scale, enamelled tube on stout Metal Mounting		0 12 6
288	Brewery Yard Thermometers Registering heat and cold. See Nos. 287 to 288	0 15 0	to 2 10 0
289	Malt Kiln Thermometer, stout Oak mount and Brass fittings (fig. 289‡)	0 10 6	0 12 6

BATH THERMOMETERS.

BATH THERMOMETERS, WITH SILVERED METAL, OR NEGRETTI AND ZAMBRA'S PATENT PORCELAIN SCALES, IN JAPANNED METAL, OR COPPER CASES, SAME PRICE AND FORM AS BREWERS' THERMOMETERS. PAGE 157.

290	Floating Bath Thermometers, for keeping constantly in water (fig. 290)		0 7 6
291	Improved form of ditto ditto, with Porcelain Scale (fig. 291)		0 15 0
292	Bath Thermometer (fig. 292) Porcelain Scale in strong Wood mounting		0 12 6
293	Dairy Thermometers, with Ivory and Boxwood Mountings		0 8 6
294	Dairy Thermometer N. and Z.'s Patent Porcelain Scales with Silver Mountings	0 12 6	0 15 0
295	Ditto ditto in Isolated Glass Tube 3s. 6d.	0 5 6	0 7 6

The Isolated Thermometers are made entirely of glass, and moderate in price; they are easily cleaned, and eminently adapted for common dairy, nursery, or culinary purposes.

CHEMICAL AND SURGICAL THERMOMETERS.

296	Chemical Thermometers with Plain Boxwood Scale, graduated to 300°, the bulb projecting below the scale (fig. 296)		0 5 6
297	Ditto, with Brass hinge jointed Boxwood scale, to 300°		0 8 6
298	Ditto, superior enamel tube, and French polished, 600° (fig. 298)		0 12 6
299	Chemical Thermometer, graduated on stem for inserting in the tubulure of Retorts, to 400°		0 5 6
300	Ditto ditto to 600° (fig. 300)		0 7 6
301	Ditto, best make Enamelled tube, and engine divided		0 10 6
302	Ditto ditto, very finely divided to half degrees and tenths	0 15 0	1 1 0
303	Standard Thermometers (fig. 282) see page 32		2 2 0
304	Thermometers Isolated in Glass Cylinders, for Acids or Corrosive liquids 40° to 300°		0 5 6
305	Ditto, ditto 40° to 600° (fig. 305)		0 7 6
306	Thermometers of extreme delicacy, various forms, for Physical investigation	0 10 6	0 15 0
307	Ditto, Negretti and Zambra's patent Self-registering ditto	0 10 6	1 1 0

NEGRETTI & ZAMBRA'S

IMPROVED PATENT CLINICAL THERMOMETERS.

FIG. 1.

FIG. 2.

308 THE importance of ascertaining and watching carefully the variations of temperature in disease is now daily becoming more apparent. Hitherto one of the great drawbacks to the general use of Thermometers by Medical Men has been the fact that sufficiently portable and reliable instruments have not been obtainable, the bubble of air used in Aitken's Thermometer being frequently found to be shaken out, and the instrument disabled, when its use has been most urgently needed. This difficulty is now overcome in the Clinical Thermometers invented and manufactured by Messrs. Negretti & Zambra;—they are, in fact, a portable form of NEGRETTI AND ZAMBRA'S PATENT STANDARD MAXIMUM THERMOMETERS, universally adopted in all parts of the world. The important advantage of this Clinical Thermometer is the *Indestructible Index*—nothing except breakage disturbing the reliabilty and accuracy of its indications—for the *Column of Mercury* itself forms the index (without any intervening air-bubble or needle)—simply shaking down the mercury *below* the divisions on the tube after use at once adjusts the Thermometer ready for future observation. Thus the Practitioner may now with the greatest confidence and convenience carry about with him a valuable aid in Physical Diagnosis, without any fear whatever of his Thermometer failing at a critical moment,—all other Clinical Thermometers being subject to the defect of having their Indices shaken down into the bulb by concussion in carrying about, and thus rendered useless.

DIRECTIONS FOR USING NEGRETTI & ZAMBRA'S PATENT CLINICAL THERMOMETERS.—Holding the instrument firmly, with a rapid swing of the hand and arm shake or jerk down the column of mercury until it sinks below the line of divisions on the stem of the Thermometer, as shown in Fig. 1, at 90°. The instrument is now ready for use, and being applied to the body of the patient for a sufficient time, will indicate the maximum temperature by the position of the top of mercury in the tube, as seen in Fig. 2. It is not requisite that this Thermometer be read off whilst in contact with the body of the patient, for it may be removed and laid aside until a convenient opportunity occurs for noting its indication. These Thermometers are divided to Fahrenheit's scale, each degree being subdivided into fifths, or by the Centigrade scale, sub-divided into tenths.

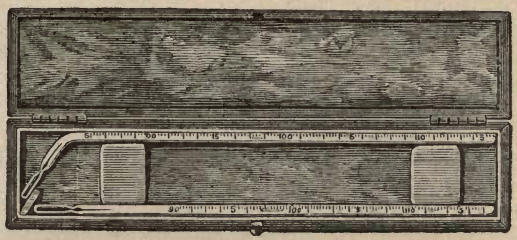


FIG. 309.

GENERAL REMARKS.

I. The index must be set *before* commencing to take an observation.

[N.B.—The index is a portion of mercury detached from THE COLUMN IN THE STEM OF THE INSTRUMENT.]

1. After the index has thus been set, the bulb of the instrument may then be applied to the axilla, or any part which is completely covered; and, being retained in close apposition with the surrounding soft parts for a period of not less than *three minutes*, the instrument is to be carefully and gently removed, when the *top of the index—i.e.*, the end furthest from the bulb—will denote the *maximum temperature* during the period the instrument has been in perfect contact with the patient.

II. THE OBSERVATIONS ought to be continuous daily, and regularly taken at the same hour every day throughout the whole period of sickness. The most useful periods for observation are—1. Between 7 and 9 o'clock in the morning; 2. At noon; 3. Between 5 and 7 o'clock in the evening; 4. At midnight.

III. In all observations of temperature, the Pulse and the Respirations should be noted at the same time.

The normal temperature of the human body, at complete sheltered parts of its surface, amounts to 98·5° Fahr., or a *few tenths* more or less; and a rising above 99·5° Fahr., or a depression below 97·3° Fahr., are sure signs of some kind of disease, *if such increase or depression is persistent.*

The average temperature of the trunk of the body in the Tropics is nearly *one degree* higher than in temperate regions.

The increase of temperature above 99° Fahr., *as measured by the Thermometer*, is *the best index* of the amount of fever present in any disease.

The temperature of the body in disease is much more readily and rapidly influenced than either the pulse or the respiration.

The co-relation of the pulse, respiration and temperature, is of the utmost importance to be known in many diseases. *For example, in Pneumonia*, if the mean of the temperature is not above 104° Fahr., and that of the pulse is not above 120 in a minute, and the mean of the respirations not over 40 in the same time, the case must be considered a slight one; and if the patient is otherwise healthy he will surely begin to get well in from 8 to 10 days, without any medical treatment beyond attention to diet and rest.

Each disease which runs a definite course (*e.g.*, *scarlet fever*, *measles*, *small-pox*, *typhus fever*, *typhoid fever*, *rheumatism*, *acute phthisis*, and the like,) has a characteristic and distinctive range of temperature.

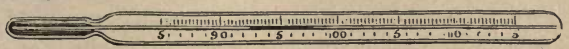


FIG. 309*.

Printed instructions for use given with the Clinical Thermometers, and further particulars of their practical application may be found in "*Aitken's Science and Practice of Medicine.*"

FIG. 310*.

PRICES OF NEGRETTI & ZAMBRA'S CLINICAL THERMOMETERS.

		Each. £ s. d.	Each. £ s. d.
310	Clinical Thermometers, of large size for Hospital use, in Mahogany case		1 5 0
	Clinical Thermometer, 4, 5, or 6-in., long, straight, self-registering, in pocket case as figs. 1 and 2		0 7 6
	Ditto ditto, with Magnifying Index	0 7 6	0 10 6
	Sterling Silver Case for ditto extra (fig. 310*)		0 5 0
	German Silver Case for ditto ,,		0 1 0
	Clinical Thermometer, curved, in hinged leather case		0 10 6
	Pair of Clinical Thermometers, 1 straight and 1 curved, in hinged leather case (fig. 309)		1 1 0
	Kew Certificate of Clinical Thermometer, extra		0 2 0

Clinical Thermometers with Centigrade Scales at same prices as above list.

FIG. 312.

311	Veterinary or Cattle Plague Thermometers, large and strongly mounted, in stout Pocket Case	0 12 6
312	Ditto, ditto, in ditto, with Metal Protecting Sheath (fig. 312)	0 14 0

These Thermometers are a large form of Negretti & Zambra's Clinical instruments, and are identical in their construction and use.

Disinfecting Thermometers; see Special Thermometer Section.

HONORARY AWARDS TO NEGRETTI & ZAMBRA.

1851. *Prize Medal for Meteorological Instruments, London.* 1855. "*Honourable Mention.*"—*Paris Exhibition. The "Austrian Gold Medal."* 1862. *Two Prize Medals, London.* 1875. *A Prize Medal.—Santiago, Chili.* 1876. *Three Prize Medals,—Philadelphia.* 1878. *A Gold Medal, Paris. The only Gold Medal awarded for Meteorological Instruments in the British Section.*

1881. *Silver Medal, Norwich.* 1882. *Silver Medal, Edinburgh.* 1883. 2 *Gold Medals,* 1 *Silver,* 1 *Bronze, Royal International Fisheries Exhibition, London.*

1883. *A Gold Medal, Buitenzorg, Batavia, Java.* 1884. *International Health Exhibition, London, 3 awards and Gold Medal.*

SELF-REGISTERING THERMOMETERS FOR HEAT.

313	Rutherford's Maximum Thermometer, on Boxwood or Metal scale, with Steel or Graphite index	0 5 6	0 7 6	0 10 6
314	Phillip's Maximum Thermometer, on Boxwood Scale, with Air Index			0 10 6
315	Ditto ditto, on Negretti and Zambra's Patent Porcelain or Metal Scale			0 12 6

FIG. 317.

		Each. £ s. d.	Each. £ s. d.
316	Negretti and Zambra's Patent Maximum Thermometer,* on Boxwood Scale		0 10 6
	Ditto ditto, Patent Solid Porcelain Scale . .		0 10 6
	Ditto ditto, Patent Porcelain, or Zinc Scale in Japanned Metal Case		0 10 6
317	Ditto, ditto, on Negretti and Zambra's Metal Scales with Oak mounting, (fig. 317)		0 12 6

SELF-REGISTERING THERMOMETERS FOR COLD.

FIG. 322.

318	Minimum Thermometer, Rutherford's, on Boxwood or Metal Scale . . . . . 3s. 6d.	0 5 6	0 7 6
319	Ditto, ditto, superior mountings		0 10 6
320	Ditto, on Negretti and Zambra's Patent Solid Porcelain Scale		0 10 6
321	Minimum Thermometer, mounted on Negretti and Zambra's Patent Porcelain or Zinc Scale in a Japanned metal Case		0 10 6
322	Ditto ditto, on Metal Scales with Oak mounting (fig. 322)		0 12 6
323	Negretti and Zambra's Vertical Minimum Thermometer, a most convenient Window instrument for exhibiting Present and Lowest temperature.	0 12 6	0 15 0

* This Instrument is the only Maximum Thermometer that can be recommended, as unless it be broken it cannot be put out of adjustment; all others are liable to become defective in transit. It is fully described under the head of Standard Maxima Thermometers, pages 36 and 38, and at page 45 will be found particulars of the construction and use of Minima Thermometers.

FIG. 324.

324 NEGRETTI AND ZAMBRA'S CELEBRATED

HORTICULTURAL SELF-REGISTERING THERMOMETER.

For determining the greatest cold during the night or absence of the observer. This instrument is a Spirit Minimum Thermometer, similar in construction to No 53, page 45. The lowest temperature being recorded by a black glass index floating in the spirit. The scale is made of stout zinc, enclosing the tube; the figures and divisions being boldly marked for *quickly* and *easily* reading the indications.

(fig. 324) *Price*, 3s. 6d.

Strongly recommended in all the leading Horticultural Journals as the cheapest and best registering thermometer of the kind for garden purposes.

Many hundreds of grosses of these registering thermometers have been sold, giving universal satisfaction. Instructions for use given with each instrument.

SELF-REGISTERING THERMOMETERS FOR HEAT AND COLD.

One of the most elegant and ingenious Registering Thermometers is that invented many years back by James Six, Esq., of Canterbury.* It records the highest and lowest temperature (or heat and cold, as it is commonly termed) during any given period of time in an exceedingly simple and convenient manner, and also at any moment showing present temperature.

325 NEGRETTI & ZAMBRA'S IMPROVED SIX'S SELF-REGISTERING THERMOMETER FOR HEAT AND COLD.

Consists of a long cylindrical bulb united to a smaller tube of more than twice its length, bent round each side of it in the form of a syphon, and terminating in a small pear-shaped bulb, as shown in the engraving (fig. 325). The lower portion of the bent tube is filled with Mercury; and the long bulb, the upper parts of the tube, and part of the small bulb, with highly-rectified Alcohol. In the tubes will be found two steel needles or indices, terminated at top and bottom with a bead of glass, to enable them to move with the least possible friction. These needles would, from their weight, rest upon the mercury; but each has a fine hair tied to its upper extremity and bent against the interior of the tube, acting as a spring with sufficient elasticity to keep the index supported in the spirit at any point to which they may be raised in the tube by the mercury.

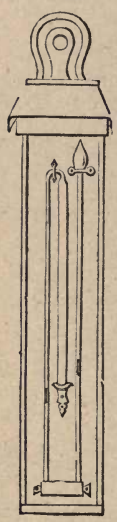


FIG. 325.

The instrument acts as follows:—A rise of temperature causes the spirit in the long bulb to expand, and pressing the mercury down the left-hand tube causes it to rise in the opposite one, raising the index with it until the highest temperature is attained. The lower end of the index then indicates upon the engraved scale the Maximum temperature. As the temperature falls, the spirit and the mercury contract, and in returning towards the long bulb the opposite index is carried up by the mercury until the lowest temperature occurs, where it is left indicating upon the scale the Minimum temperature.

* See "Philosophical Transactions" for the years 1782 and 1790. By some writers the name is spelt Sixe, and of Colchester.

The scale on the right hand is an ascending one, and on the left descending, as will be seen in our engraving (fig. 336). The thermometer is set for observation by drawing the indices down to the surface of the mercury by a small magnet, which attracts the steel through the glass, so that it is easily moved up or down. They should be drawn nearly to the top of the tubes when it is desired to remove the instrument, which should be *carefully carried in the vertical position*; for should it be inverted, or laid flat, it may become put out of order. For transmission by ordinary conveyances, it requires that attention be given to *keep it vertical*. Six's Registering Thermometers should be always hung *strictly in the shade*.

These Thermometers, when carefully made and adjusted to a standard thermometer, are recommended as very convenient for ordinary purposes, where strict scientific accuracy is not required.

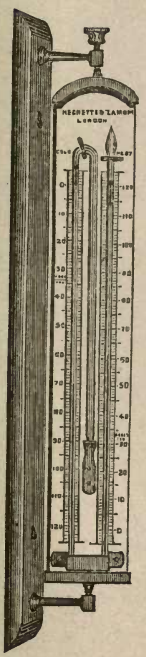


FIG. 335.

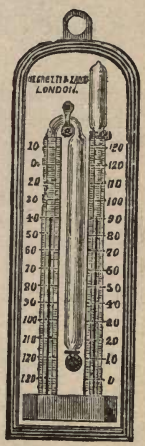


FIG. 333.

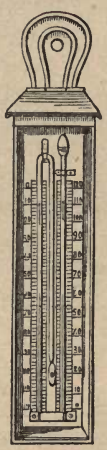


FIG. 331.

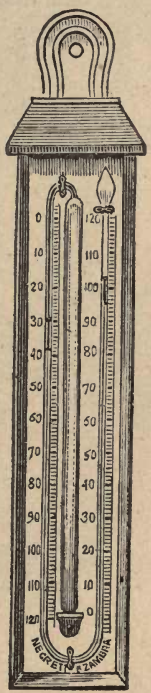


FIG. 336.

			Each. £ s. d.	Each. £ s. d.
326	**Six's Registering Thermometer,** 8-inch Boxwood Scale, plain tube			0 7 6
327	Ditto	ditto, enamelled tube		0 8 6
328	Ditto	ditto, with bevelled edges		0 10 6
329	Ditto	with 8-inch Zinc or Boxwood scale, in Japanned Metal case		0 10 6
330	Ditto	ditto, 10-inch		0 15 0
331	Ditto	ditto, 12-inch, Porcelain Scale (fig. 331)		1 1 0
332	**Six's Registering Thermometers,** with Opal Glass scales, in japanned Metal cases (figs. 331 and 336)	12s. 6d., 21s.	1 10 0	2 2

Copper cases, 3s. extra.

		Each. £ s. d.	Each. £ s. d.
333	Six's Registering Thermometers, with Opal Glass Scale, and the divisions and figures enamelled and burnt in, mounted on Oak and other woods, suited for Halls, Libraries, Dining rooms, &c. (fig. 333) 15s., 21s.	1 10 0	2 2 0
334	Six's Thermometers, with NEGRETTI AND ZAMBRA'S Patent Bulbs . . . . . 25s.	1 10 0	2 5 0
335	Six's Registering Thermometers, Opal Glass scales, fitted on Bronzed Metal brackets and Oak or Mahogany board for suspending outside a window, (fig. 335) . . . . . 25s.	2 2 0	3 3 0
336	Six's Thermometers with extra large size Patent Porcelain or Opal Glass Scale, and very legible figures and divisions (fig. 336) and Various Mountings . .	3 3 0	3 10 0

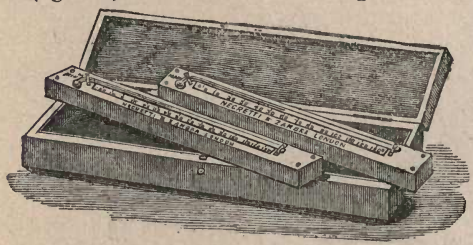


FIG. 337.

337 Negretti and Zambra's small size Patent Maximum and Minimum Thermometer. The Tubes divided on the Stem, arranged in a mahogany case, suited for travellers to whom bulk and weight is an object (fig. 337) Pocket-size 2 2 0

338 Ditto ditto, larger Standard size, see also page 51 . . . 2 10 0

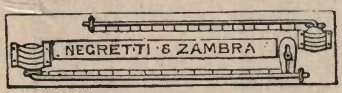


FIG. 339.

339 Day and Night Registering Thermometer, Rutherford's,* on a Boxwood scale, with a Magnet (fig. 339) . . 0 15 0 1 10 0

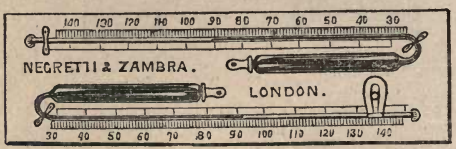


FIG. 340.

340 Day and Night Registering Thermometer, with *Cylinder Bulbs* and enamel tubes of large internal diameter. The Maximum Thermometer, Negretti and Zambra's Patent arrangement, and each tube mounted on a separate scale, but joined together with a screw in order that the Thermometers can be used either combined or alone (fig. 340) 2 2 0

341 Negretti and Zambra's large sized Maximum and Minimum Sea Coast Registering Thermometers, with Porcelain Scales, as constructed for Admiral Fitz-Roy . . . . . each 2 2 0

FOR STANDARD SELF-REGISTERING THERMOMETERS, see pages 31 to 51.

* This Thermometer is very liable to get out of order, hence it is now but seldom used.

FIG. 372.

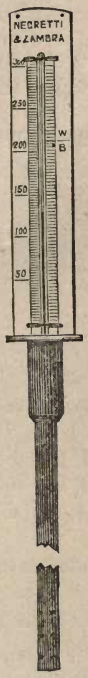


FIG. 379*.

FIG. 362.

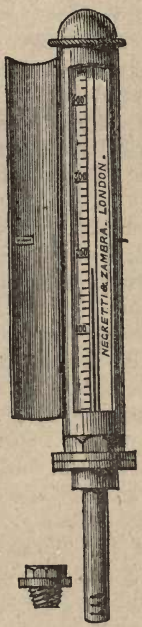


FIG. 367.

FIG. 364.

FIG. 348.

FIG. 347.

THERMOMETERS FOR SPECIAL PURPOSES.

		Each. £ s. d.	Each. £ s. d.
342	**Oven Thermometers** for high temperatures, on heavy Cast Iron Stand to equalise the acquired temperature, range of scale about 50° to 300° Fah.	0 14 0	1 6 0
343	Ditto, Negretti and Zambra's Patent self-registering .	1 1 0	1 10 0
342*	**Pit Thermometers**, (Mining) Strongly mounted . .	0 2 6	0 12 0
343*	**Dairy Thermometers**, with Ivory mountings, various		See Nos. 293 to 295.
344	**Beehive Thermometers.** See No. 235. Boxwood . .	0 7 6	0 10 6
345	**Soap Boilers' Thermometers**		0 10 6
346	**Dentists' Thermometers**, for Vulcanising process 7s. 6d.	0 12 6	1 5 0
347	**Sugar-boiling Thermometer**, 3 to 4 feet long, graduated to 300°, strongly mounted . . . . (fig. 347)	1 12 0	2 2 0
348	**Sugar-boiling Thermometer**, 14-inch stout metal scales, divided from 300°F. to 600°F. in stout rivetted Copper Cases (fig. 348)		0 16 0
349	**Confectioners' Thermometers**, isolated Glass Tubes, to 212°F.	0 3 6	0 7 6
350	**Chemical Manufacturers' Thermometers**, suited for Acid or Corrosive liquids, or general Laboratory use. See page 159, 300° to 600°		0 10 6

		Each. £ s. d.	Each. £ s. d.
351	**Confectioners' Sugar-boiling Thermometers,** in Round Brass Cases, strongly mounted, range of scale 400°F. to 600°F.		0 10 6
352	**Vinegar Makers' Thermometers,** various . . .	0 3 6	0 5 6
353	Ditto ditto without any Metal mountings, as fig. 292 .	0 10 6	0 15 0
354	**Varnish Makers' Thermometers,** with strong Metal mountings, 3 feet long, form as fig. 347 . 1 16 0	2 2 0	2 10 0
355	**Hay Stack Thermometers, or "Rick" Temperature Tester,** 7 to 8 feet long, strong Iron Mounting, with N. and Z's. Patent Registering Thermometer . .		1 10 0
	Extra Thermometer for ditto		0 12 6
356	**Boiling Point Thermometers,** for determining heights by observing the Boiling point of water. See page 93		1 10 0
357	**Alarm or Valve-regulating Thermometers,** mounted on a Mahogany board or Brass stand . . . from		2 2 0
358	**Thermostat** or Metallic Thermometer, for similar purposes as above, an arrangement of Metallic bars of different metals		made to order.
359	**Leslie's Differential Thermometers,** for delicate experiments on Radiant Heat, &c. (See page 187) . . .	1 10 0	2 2 0
360	**Air Thermometers** for ditto ditto	0 15 0	1 1 0
	Boyle's arrangement, one of the earliest forms of Thermometer used.		
361	**Still Thermometers** of various lengths and mountings		figs. 379 and 347 made to order.
362	**Steam Pressure Thermometers** (or Thermo-Pressure Gauge), in strong Brass case (fig. 362)	1 5 0	1 15 0
363	Ditto ditto with Hinged Door and plug for closing the boiler when the Thermometer is not in use (fig. 367) .		2 2 0
364	**Hot Water Thermometers,** for low pressures, small size (fig. 364) for attaching to Hot Water Warming apparatus, &c.	0 18 0	1 4 0
365	**Cooking or Culinary Thermometers,** of various forms, see also 342 343 and 348 . . . . . 10s. 6d.	0 12 6	1 1 0
366	**Fryometer,** as used at the National Training School of Cookery, South Kensington. Copper Mountings .		0 16 6
367	**Vacuum Pan Thermometers,** stout Brass mounting with hinged or Revolving Door, as fig. 367	2 2 0	2 10 0
368	**Hot Air Thermometers,** for Turkish Baths, various forms 16s. 1 1 0	1 5 0	1 16 0
369	**Upcast Shaft Thermometers,** Self-Registering, from 50° to 600° enclosed in round Copper Case . . , .		1 12 0
370	Ditto ditto, or **Hot Blast Thermometer,** for High temperatures in furnace shafts (fig. 372) . . .		1 10 0
371	**Registering Air Shaft Thermometers,** Negretti and Zambra's Improved, for ditto ditto See page 170 .		2 2 0
372	**Super Heated Steam Thermometers,** with Patent Porcelain Scales, in strong japanned Iron mountings (fig. 372)		1 10 0
373	Ditto ditto ditto smaller size.		1 5 0
374	**Super Heated Steam Thermometers,** with Brass mountings, as figs. 362 and 367	2 2 0	2 10 0

		Each. £ s. d.	Each. £ s. d.
377	Oil Testing Thermometers, for testing the Heat of Bearings, the Lubricating quality of Oils, &c., made to Order and Drawings.		
378	Thermometers for Hot Rollers, ditto		ditto
379	Salinometer Thermometer. See Salinometer . .		0 6 6
378°	Stout Copper Trial Pots for ditto, with division . .		0 8 6
379*	Disinfecting Thermometers, for Hospital, Workhouse, or Mortuary use, simple form, (fig 379°) . . . 16s.	1 5 0	1 16 0
380	Ditto ditto, Bent form, of any length of Tube or Scale		*to special Order* and drawings.
381	Reference *Standard* Thermometers. See page 158, fig. 282, and page 32 . . . . . from		2 2 0
382	Hydrometer Thermometer, with Ivory Scale . . .		0 7 6
383	Saccharometer Thermometer, with Expansion Scale on Silvered Metal (fig. 348)		0 14 0
384	Incubating Thermometers, Low range on long Metal Scale 98° to 100°		0 3 6
385	Ditto ditto, High range, Short Metal Scale 190° to 210° . .		0 3 6
386	Ditto ditto, Low range divided on the Stem 90° to 130° . .		0 2 6
387	Ditto ditto, High range divided on the Stem 150° to 220° .		0 3 6
388	Ditto ditto, 8-inch Metal Scale Thermometer, in japanned case		0 2 6
389	Ditto ditto, 10-inch ditto ditto, without case . . .		0 3 6
390	Ditto ditto, Small Bent Tube in Metal Mounting . . .		0 4 6
391	Incubating Thermometers, extra sensitive, for Experimental purposes.		*Made to order.*
392	Thermometers, Extreme Low range, for Refrigerating Chambers, ditto ditto.		
391*	Petroleum Testing Thermometers (fig. 391*)		0 10 6

393 **The Elaeometer**, for testing Olive oil or Oil of Almonds. The O at the bottom of the scale is the point at which this instrument floats in *Pure Oil of Poppy Seeds.* The point at which it floats in *Pure Olive Oil* is made the 50th degree, and the space between these two points is divided into 50 equal parts and numbered accordingly. It floats at 38 or 38½° in Pure Oil of Almonds. Price, 5s. 6d.

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394 COMPARISON OF THERMOMETER SCALES.

Fahrenheit.	Centigrade.	Reaumur.
+212°	+100°·0	+80°·0
100·	37·8	30·2
50·	10·	8·0
32·	0·0	0·0
+10·	−12·2	−9·8
0·	−17·8	−14·2
−10·	−23·3	−18·6
−20·	−28·9	−23·1
−50·	−45·5	−36·4
−70·	−56·6	−45·3

Value of one degree of these Scales.

1° Fahrenheit = $\frac{5}{9}$ Centigrade = $\frac{4}{9}$ Reaumur
1° Centigrade = 1·8 Fahrenheit = 0·8 Reaumur
1° Reaumur = 2·25 Fahrenheit = 1·25 Centigrade

Elementary Meteorology, R. H. SCOTT, F.R.S.

FIG 395.

FIG. 395.

FIG. 396.

395 **Paraffin Testing Apparatus,** with Thermometer and Spirit Lamp (fig. 395) . . . . . £ s. d. 0 15 6

Fig. 395 shows a simple Apparatus for testing Petroleum to ascertain the temperature at which it gives off inflammable vapour. It consists of a sheet-iron vessel to hold the Petroleum to be tested; this is placed in an outer vessel to hold water (somewhat in the manner of an ordinary gluepot) with a metal support, so arranged that the water can be gradually heated by a Spirit Lamp, and the temperature of the Petroleum conveniently observed by a reliable Thermometer.

396 **Petroleum Testing Apparatus,** for testing the Flashing Point of Illuminating Oils. Sir Frederick Abel's Government Pattern, as supplied to the Government Inspectors under the Petroleum Act, 1879.

Complete in Box, for use with Oil or Gas only (fig. 396)	6 10 0
Do. do., arranged for use with either Oil or Gas .	7 10 0

Including Verification at Standard Department.

An Act to continue and amend the Petroleum Act, 1871. [August 11th, 1879.]

1. This Act may be cited as the Petroleum Act, 1879.

This Act shall be construed as one with the Petroleum, 1871, and together with that Act may be cited as the Petroleum Acts, 1871 and 1879.

2. Whereas by the Petroleum Act, 1871, it is enacted that the term "petroleum to which this Act applies" means such of the petroleum defined by that Act as, when tested in manner set forth in Schedule One to the Act, gives off an inflammable vapour at a temperature of less than one hundred degrees of Fahrenheit's thermometer, and it is expedient to alter the said test: Be it therefore enacted that—

In the Petroleum Act, 1871, the term "petroleum to which the Act applies" shall mean such of the petroleum defined by section three of that Act as, when tested in manner set forth in Schedule One to this Act, gives off an inflammable vapour at a temperature of less than seventy-three degrees of Fahrenheit's thermometer.

Every reference in the Petroleum Act, 1871, to Schedule One to that Act shall be construed to refer to Schedule One to this Act.

Petroleum Act of 1879 *giving description of the above Apparatus and instructions for using it, price per post,* 6*d.*

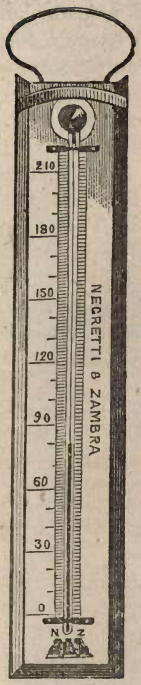

FIG. 398.

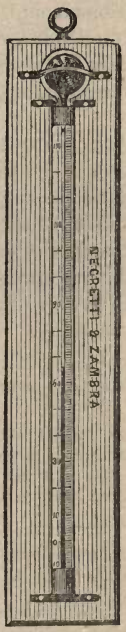

FIG. 399.

FIG. 400*.

FIG. 400.

FIG. 402.

NEGRETTI AND ZAMBRA'S
PATENT SELF-REGISTERING MAXIMUM THERMOMETER

For ascertaining Underground Temperature, the Temperature of Mines, Thermal or Boiling Springs, Air Shafts, Atmospheric Temperature, &c., &c.

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397 The above engravings represent various forms of **Negretti and Zambra's Patent Self-Registering Thermometers,** each adapted to a special purpose; these can be made available in many other ways not here specified. The principle on which these instruments is constructed, and the manner of using them, are fully set forth on pages 42 and 43.

Particular instructions are supplied with each Thermometer.

398 Fig. 398 represents a **Brewer's or Drying Room Self-Registering Thermometer,** by which accurate temperatures may be ascertained in positions inconvenient of access, or where **Steam, Heat,** or **Darkness** render the true readings of an ordinary Brewer's Thermometer almost impossible to be obtained.

Price in Stout Copper Case, £1 1 0

399 Fig. 399 shows another form of the Thermometer divided on its stem, arranged in a Glass Sheath mounted on a Mahogany Board or Metal Plate, for ascertaining temperatures in Hot Air or Drying Chambers, Baths, Ovens, &c., &c., serving as a check on temperatures during absence; or, as described pages 43 and 46, as a Marine Atmospheric Maximum Thermometer.

Price, £1 1 0

400 Fig. 400 and fig. 400* are other arrangements of this Thermometer, made by Negretti and Zambra under special instructions from Professor Everett, for the Committee of the British Association on Underground Temperatures,

401 Fig. 401 is the Thermometer, enclosed in a Glass Tube or Sheath, fitting into a hinged Copper Protecting Case (Well Thermometer), as seen in fig. 400*.

Price, £1 10 0

402 Fig. 402 is a Thermometer of very Slow Action for taking direct Earth Temperatures. The bulb of this Thermometer is shown in its Glass Sheath surrounded by a good non-conducting substance as suggested by Professor Everett. The Thermometer being lowered down to the desired depth by a cord, is allowed to remain a considerable time in the earth so as to attain the existing Temperature. It is then withdrawn quickly, and the reading noted, the non-conductor around the Bulb preventing any rapid change taking place for a sufficient time to ensure accuracy. *Price*, £0 18 6

See also pages 35 *and* 43.

The Range of Scale of these Maximum Thermometers can be varied to suit the requirements of the experiments to be carried out.

At the meeting of the British Association in 1872 (Brighton), Prof. Phillips when speaking on the subject of the use of his own form of Thermometer for ascertaining underground temperatures, said, "There would be difficulty in using such instruments where the light was bad, and he thought the instrument exhibited by Prof. Everett (Negretti's Vertical Thermometer) was better adapted to the purposes of the Committee."

Beneath the surface of the Earth the Temperature *increases* at the rate of 1° Fah. for every sixty feet. Another authority states it 1° Fah. for every forty-nine feet. The temperature for the first sixty feet is influenced by the Seasons.

In deep caverns, the effect of the great heat of summer has been only felt at mid-winter, and *vice-versa*, the cold of winter only reaches them at mid-summer.

The subjoined list of Temperatures compiled from various reliable authorities is inserted as well illustrating the above observations.

Artesian Well, Hanwell, 290 ft. deep, 55°.
Grotto del Cane, Italy, 68°.
Earth Yokutsk, 50 ft. deep, 18°.
Hecla Earth at Summit, 153°.
Geyser Springs, Iceland, 179°.
Thermal Spring, Tajurah and Shoa, 152°.
Thermal Spring, Island of Lucon, 174°.
Volcanic Mud, Jorullo, South America, 203°.
Ournastok Spring, Greenland, 103°.
Comagillas, Mexican Springs, 205°.
Eaux Bonnes, Pyrenees, 89°.
Aix-la-Chapelle Spring,
Maximum Temperature. 180°.
Aix-la-Chapelle Spring, Spa, 143°.
Baden Baden Springs,
Maximum Temperature, 157°.
Bagnères-de-Bigore Spring, 123°.
Mariana Springs, South America, 138°.
Wiesbaden Spa, 149°.
San Germano Bath, Naples, 181°.
Buxton Spring, 82°.
Matlock Spring, 66°.
Bristol Spa, 66°.
King's Bath, Bath, 114°.
Hot Pump, Bath, 116°.
Bath Springs, Maximum Temperature 117°.
supposed depth, 3,350 ft.
Monkwearmouth Mine, 1,500 ft. deep, 72°.
Consol Mine, Cornwall, 1,740 ft. deep, 93°.
Cumberland Coal Mine, 600 ft. deep, 66°.
Salt Mine, Cracow, 730ft. deep, 50°.
Guanaxato Mines, 1,700 ft. deep, 99°.

On page 48 of Mr. Scott's Book on Elementary Meteorology will be found a Chronoisothermal Diagram representing the Monthly Mean Temperature at Greenwich for every hour of the day through the range of years 1849 to 1868. "This diagram was devised by M. Leon Lalanne—it exhibits many most interesting facts in connection with the climate of London, amongst others, that the highest *mean* temperature (70) only occurs in the latter part of July and between one o'clock and half-past three p.m., and the lowest *mean* temperature (38) is observed during the night-time from about January 5th, to March 20th.

Also it will be seen that the coldest time in summer is from three to five in the morning, while in winter there is not much change between four in the afternoon and eleven in the morning. It will be also noticed how much colder the Spring equinox is than the Autumnal, for on April 1st the temperature ranges from 40° to 50° F., while on October 1st the range is from 50° to 61° F."

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† Prof. Everett, D.L.C., of Belfast.

MARINE THERMOMETERS.

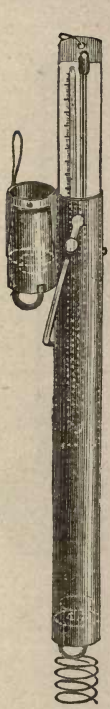


FIG. 407.

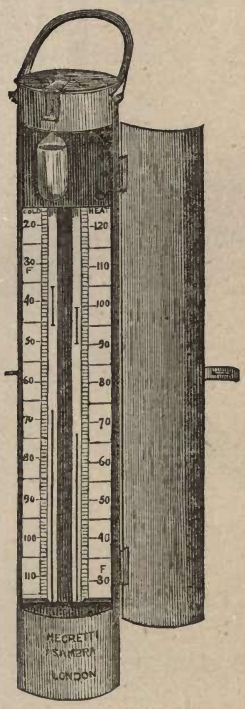


FIG. 408.

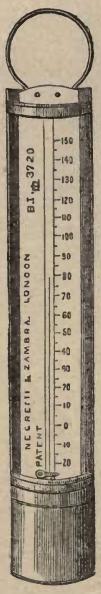


FIG. 404.

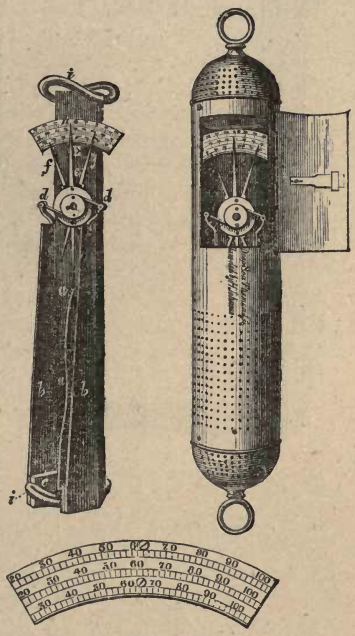


FIG. 406.

SELF-REGISTERING THERMOMETERS, ADAPTED FOR DEEP SEA SOUNDINGS.

403 **Board of Trade Marine Thermometer,** the scale divided on its stem, and mounted on Negretti and Zambra's PATENT PORCELAIN SCALES, in japanned Metal Case . . . . . Each. £ 0 s. 10 d. 6

404 ditto in COPPER CASE (fig. 404) 0 12 6

405 **Board of Trade Marine Thermometer,** in round Copper case . . 1 10 0

406 **Johnson's Registering Metallic Marine Thermometer.** The indications are obtained by the varying expansion of brass and steel bars acting upon an index on the principle of the Thermostat (fig. 401) . . . 5 5 0
For description see N. and Z.'s *Treatise on Meteorological Instruments.*

407 **Deep Sea Sounding Thermometers, Self-Registering,** the *original double tube principle,* as invented by Negretti and Zambra, specially constructed for and supplied to the Board of Trade and Admiralty (fig. 407). Warranted to stand a pressure of 450 atmospheres 2 10 0

Many have been the contrivances for obtaining correct deep sea indications. Thermometers and machines of various sorts have been suggested, adopted, and eventually abandoned as only approximate instruments. The principal reason for such instruments failing to give correct or reliable indications has been that the weight or pressure at great depths has interfered with the correct reading of the Instrument. Thermometers have been enclosed in strong, water-tight cases to resist the pressure; but this contrivance has only had the tendency to retard the action, so much as to throw a doubt on the indications obtained by the instrument so constructed.

408 **Negretti and Zambra's Small Deep Sea Sounding Thermometer,** Dr. Miller's pattern in Copper Case (as fig. 403). Price £2 10s. £3 3s.

The Deep Sea Sounding Thermometers (Nos. 406, 407 and 408) having all been found defective in their indications, their use is not recommended for reasons stated in pages 60 to 70.

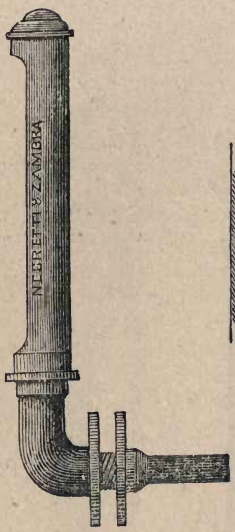


FIG. 414.

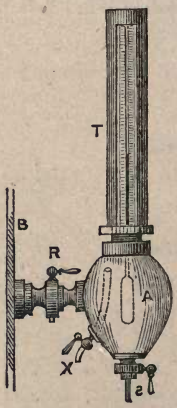


FIG 416.

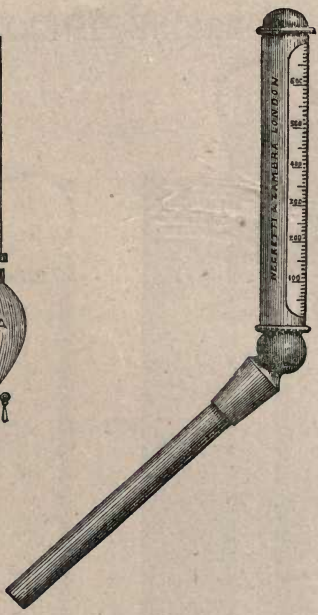


FIG. 415.

FIG. 414*.

STEAM PRESSURE GAUGES.

409 The almost daily occurrence of frightful accidents from the explosion of steam boilers calls for the utmost vigilance and care from owners and employers of steam power. One of the most important precautions is that of having *accurate and reliable gauges*. Too much stress cannot be laid upon this point, for if, from motives of false economy, cheap and carelessly made gauges are used, their indications can never be depended upon, and their use may lead to fatal and costly results. It has frequently come under the notice of Messrs. Negretti and Zambra that Steam Gauges have been supplied or repaired by persons without the slightest knowledge of their construction, or having any means of proving or testing; consequently they have been found fearfully in error, and worse than useless because unsafe.

		£	s.	d.
410	**Steam Gauges**, Mercurial, from 10 to 140 lbs., with union joint at either side of the frame, in polished Mahogany frame . . .	2	2	0
411	Ditto, ditto, Brass ditto	3	3	0
412	**Thermometric Pressure Gauge**, for showing the pressure of Steam by taking its temperature (fig. 372), Iron mountings . . .	1	10	0
413	Ditto ditto, Brass mountings (figs. 362 and 367)	2	10	0
414	Ditto ditto, ditto with *Bent tubes*, as figs. 409 and 409*, screw flanges and stuffing boxes, &c., for high pressures from	3	3	0
415	**Angle Thermometers**, for Vacuum Sugar Pans, Brass Mounted (fig. 415)	1	16	0
416	**Thermometric Pressure Gauges** with Temperature and Pressure Scales made of any length to order or drawings, with either English or French divisions.			

417 **Negretti and Zambra's Saturometre or Thermometrical Salinometer** for determining the amount of Salt held in solution in the water of Marine Boilers.

It is well known that pure water boils at 212° Fahr. at the level of the sea, and if water is impregnated with salt, the point of ebullition is materially raised; hence the water in a marine boiler can be accurately tested as to its saline properties by observing at what temperature the ebullition is taking place within the boiler. The apparatus consists of a metal reservoir attached to the boiler by a stopcock, R, and union joint, B; this reservoir carries a thermometer, T, whose bulb, A, reaches nearly to the bottom of the chamber; the graduations on the scale commence at 212°, the boiling point of pure water. At the bottom of the reservoir is an outlet tap, S, and there is also a tap, X, inserted a little above the bottom of the reservoir, with a tube connected with it reaching nearly to the top of the interior of the reservoir.

The apparatus is used as follows: the reservoir having been emptied by the tap S, it should be closed, and the taps R and X opened; the water from the boiler will then flow into the chamber A, partly fill it, and pass out by the pipe and tap X. After the water has been allowed to escape for a few seconds, the thermometer is to be examined, and according to the temperature indicated so will be the specific gravity of the water in the boiler, or, in other words, the percentage of salt dissolved in it. This fact is quickly and conveniently ascertained by simply opening three taps and reading the thermometer (fig. 416) £4 4 0

Our table in connection with the description and use of Salinometers (page 189) will give the relative degrees of Saltness and Temperature.

Messrs. Negretti and Zambra very strongly advise the use of the Thermometric Pressure Gauges (No. 409) in conjunction with the Mercurial and Spring Gauges as a comparative and precautionary measure of safety. When steam is generated and confined in a boiler, the pressure upon the boiling water may be twice or thrice that of the atmosphere. Experimentally it has been found, that if the pressure in the boiler be 25lbs. on the square inch, the temperature of the boiling water, and of the steam likewise, is raised to 241°; and under the exhausted receiver of an air-pump, water will boil at 185°, when the pressure is reduced to 17 inches of mercury. The following table, compiled by Dr. A. S. Taylor, gives the relative temperatures and pressures up to 12 atmospheres or 180 lbs. pressure.

388

Water boils.		Barometer 30 inches.	
212 degrees Fahr.		1	Atmosphere.
234	„	1·5	„
251	„	2	„
267	„	2·5	„
275	„	3	„
285	„	3·5	„
295	„	4	„
300	„	4·5	„
307	„	5	„
315	„	5·5	„

Water boils.		Barometer 30 inches.	
320 degrees Fahr.		6	Atmospheres.
327	„	6·5	„
332	„	7	„
337	„	7·5	„
342	„	8	„
351	„	9	„
359	„	10	„
368	„	11	„
374	„	12	„

ON COMBINED STEAM. By the Hon. J. WETHERED.

"In its passage through the super-heating apparatus a portion of steam is raised by the waste heat to a temperature of 500° or 600° Fahrenheit. The heat thus arrested is conveyed to and utilised in the cylinders by its action on the other portion of the steam from the boiler, which is more or less saturated, according to circumstances. The combined steam is used in the cylinder at from 300° to 450° Fahrenheit, at which steam is generally employed, The effect of using the two kinds of steam is, that the super-heated steam yields a portion of its excess of temperature to the ordinary steam, converting the vesicular water which it always contains into steam, and expanding it several hundred-fold; whilst at the same time, the ordinary steam yields a portion of its excess of moisture, converting the steam gas into a highly rarefied elastic vapour—in other words, into pure steam at a high temperature."

HYDROMETERS, &c.

418 HYDROMETERS, or Areometers, are instruments constructed to determine the specific gravity of fluids. Their use has been traced back to a date about 300 years before Christ, the invention being ascribed to Archimedes, the Sicilian philosopher. Their action is dependent upon the law "that a body immersed in any liquid sustains a pressure from below upwards equal to the weight of the volume of liquid displaced by such body."

First on our list of Hydrometers we place those showing *Specific Gravity*, because all other Hydrometer scales are referable to it; and as the figures indicated are absolute and definite quantities, or values without possibility of dispute, it is the best both for scientific and manufacturing purposes.

The Specific Gravity of Fluids may simply be described in a few words.

A very light glass flask is accurately adjusted and stoppered to hold exactly 1,000 grains of pure distilled water at a temperature of 60° Fahrenheit. If this flask be filled with highly rectified æther, and then carefully weighed in a delicate balance, it will be found that the flask instead of holding 1,000 grains will only weigh say 713 or 715 grains at 60 degrees of temperature. This is the specific gravity of pure æther, or as written in chemical language, 0·713 or 0·715. On the contrary, if the flask be filled with concentrated sulphuric acid it will be found to hold 1842 or 1845 grains, or specific gravity, 1·842 or 1·845, at 60 degrees temperature. In these readings water is represented by one thousand, 1·000.

All other fluids (save Mercury) will be found to be of intermediate specific gravity, say between 600 and 2·000.

Our list embraces the whole of the Hydrometers in use in the United Kingdom and most of the Foreign instruments. The comparative value of these may be ascertained by reference to a valuable series of carefully compiled tables described at the end of Hydrometer Section.

As a rule all Hydrometers made in England are adjusted to a temperature of 60° Fahrenheit, but if they are required for use in the East or West Indies, they must be specially adjusted at 84° Fahrenheit, and should be ordered accordingly.

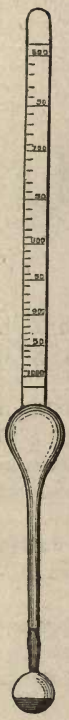


FIG. 419


FIG. 481.


FIG. 424.


FIG. 423.

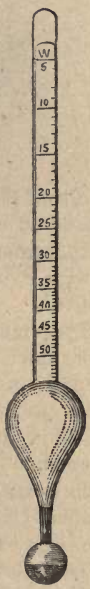


FIG. 436.


FIG. 420.

		Each. £ s. d.	Each. £ s. d.
419	**Hydrometer** from 700 to 1·000 for Specific Gravities lighter than water (fig. 419)		0 6 6
420	**Hydrometer** from 1·000 to 1·850 or 2·000, for fluids heavier than water (fig. 442)		0 6 6
421	**Beaume's Hydrometer** ·0 to ·70, for fluids lighter than water		0 5 0
422	Ditto **Hydrometer**, ·0 to ·40, for cane-juice and similar fluids heavier than water (fig. 422) . .		0 5 0
423	**Beaume's Saccharometer**, Brass Gilt, for sugar boiling, range ·0, ·40		1 7 6

Beaume's Hydrometers are used extensively in England as well as in France, and are applicable for testing all kinds of liquids.

There are two distinct instruments, one for fluids lighter than water, and the other for fluids heavier than water.

The latter is for distinction called the Acidometer or Saccharometer *(pèse-acide* or *pèse-sirop)*, the former the Spirit Hydrometer *(pèse-esprit)*.

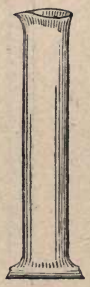


FIG. 425*.

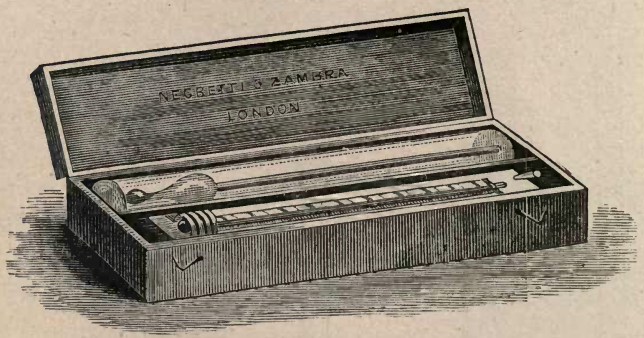


FIG. 425.

		£	s.	d.
424	**Government Proof Hydrometer, Glass,** showing percentages of proof spirit from 60 over proof to 40 under proof (fig. 397) . . .	0	5	6
425	Ditto ditto **Hydrometer, Glass, in mahogany box** with Thermometer (fig. 398) with Printed instructions for use	0	15	0
426	Ditto ditto, with Ivory sliding Computing Scale . .	1	1	0

427 **Sikes'* Hydrometer** is the instrument used by the government officers in the collection of the spirit revenue in the United Kingdom. It is made entirely of metal, usually strongly gilt to prevent corrosion.

It consists of a globular float with an upper and lower stem. The upper stem is flattened and divided into ten parts, numbered 1, 2, 3, &c. These are again subdivided into five parts.

The lower stem is tapering, and terminating by a pear-shaped bulb. There are nine weights numbered from 10 to 90, each weight being pierced in the centre, so that it can be placed on the conical stem at the smaller end and slid down towards the bulb until it becomes securely fastened.

428. **Sikes' Hydrometer** is adjusted to spirit Specific Gravity ·825 at 60° Fahr., this being considered *Standard Alcohol.* In this spirit the instrument floats at the first division 0 on the stem without a weight. In weaker spirit, having a greater density, the Hydrometer will not sink so low, and should the density be greater, one of the weights must be added to cause the entire immersion of the bulb of the instrument.

Each weight represents so many principal divisions of the stem. Thus the heaviest weight, marked 90, is equal to ninety divisions of the stem, and the instrument with this weight attached floats at 0 in distilled water.

Each principal division on the stem being divided into five, the Hydrometer has a range of 500 degrees between alcohol, sp. gr. ·825 and water.

On one side of the upper stem, near to the division 1, will be found a line, at which the instrument will float with the weight 60 attached in spirit exactly of the *strength of proof* at a temperature of 51° Fahr., and if the *square* weight (sent with the instrument) be placed on the top of the stem, the weight 60 still being attached to the lower stem, the instrument will float at the side line in distilled water of the same temperature. This square weight being precisely one-twelfth part of the total weight of the hydrometer and weight 60, the above indication is in conformity with the definition of *proof spirit* stated in the act of parliament, "Proof spirit to weigh at 51° temperature exactly twelve-thirteenth parts of an equal bulk of distilled water."

In using Sikes' Hydrometer, it is immersed in the spirit and pressed down to 0 until the whole of the divided stem be wet. The amount of force required to

* We have consulted several authorities for the correct spelling of this name; Dr. Ure and Professor Redwood spell it *Sikes*. An act of parliament, 26th June, 1858, 18 and 19 Vict., has *Sykes*—many writers adopt this. The same difference occurs with the name of the inventor of a Maximum and Minimum Registering Thermometer—*Six* or *Sixe*. In both cases there appears to be some doubt which is correct.

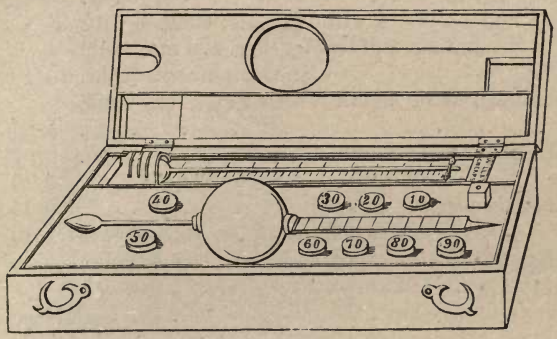


FIG. 429.

FIG. 429*.

sink it will determine the selection of the requisite weight to be attached to the lower stem. Again immerse the hydrometer in the spirit, and allow it to float freely and settle, and then keeping the eye in a line with the surface of the spirit, notice the division cut by the surface as seen from below. The number indicated by the stem is added to the numbers of the weight, and the sum of these, together with temperature of the spirit (which should be very carefully noted) will, by reference to a Book of Tables accompanying the instrument, give the required strength per cent. of the spirit under test.

The strength is expressed in numbers denoting the excess or deficiency per cent. of proof spirit in any sample, and the number itself having its decimal point removed two places to the left, becomes a factor, whereby the gauged contents of a cask of such spirit being multiplied, and the product being added to the gauged contents if *over* proof, or deducted from it if *under* proof, the result will be the actual quantity of proof spirit contained in such vessel.

The commercial term *above or below proof* is partly derived from the government having fixed a certain strength of spirit as mentioned above as *Proof Spirit* by which the strength of all spirit is comparable. It is also said that the term *proof* is derived from an ancient method of testing the strength of spirit by pouring the sample over gunpowder in a metal cup and then setting fire to the spirit; if, when the spirit had burnt away, the powder exploded, the spirit was said to be *over proof;* if, on the other hand, the gunpowder did not ignite, owing to the large portion of water left behind, it was said to be *under proof.*

The weakest spirit capable of firing gunpowder by this method was called proof spirit, but it required a spirit of nearly the strength of what is now called rectified spirit to stand this test.

The *Standard Proof Spirit* of the excise is defined by law (56 Geo. III. cap. 140) to be "*that which at a temperature of* 51° *Fahrenheit's Thermometer, weighs exactly twelve-thirteenth parts of an equal measure of distilled water.*"

This will have a specific gravity of ·923 at 51° Fahrenheit, or about ·920 at 60° Fahrenheit.

The *Standard Alcohol* of the Excise is spirit of the specific gravity ·825 at 60° Fahrenheit. By "Spirit 60 degrees over proof" is understood a spirit 100 measures of which added to 60 measures of water will form *Standard Proof Spirit,* specific gravity ·920.

By "Spirit 10 degrees under proof" is understood a spirit 100 measures of which mixed with 10 measures of standard alcohol, specific gravity ·825, will form *Standard Proof Spirit.*

NOTE.—We are indebted to Professor Redwood for most of the figures given in connection with Sikes' Hydrometer. The *British Pharmacopœia* of 1864 orders that the Specific Gravity of liquids is to be taken at a temperature of 60 degrees by Fahrenheit's Thermometer, and gives the Specific Gravity of absolute Alcohol as 0·795, *Rectified Spirit* (Spiritus Rectificatus) as 0·838, and *Proof Spirit* (Spiritus Tenuior) as 0·920, at a temperature of 60 degrees Fahrenheit.

		Each. £ s. d.
429	**Sikes' Hydrometer,** Double Gilt Metal, with silver soldered joints, as used by the Excise and Customs, with weights, enamel tube Thermometer, Test Glass, and Book of Tables (figs. 429 and 429*)	4 0 0
430	Ditto ditto, with Comparative Rules	4 10 0
431	**Sikes' Hydrometer** Standard, Gilt Metal, 5-inch range on stem, divided to 1-10ths	5 5 0
	Book of Tables for use with Sikes' Hydrometer to 80° Fahr . .	0 7 6
	Ditto ditto ditto to 100° Fahr. . .	0 10 6
432	**Sikes' Pocket Hydrometer** in German Silver	0 15 0
433	Ditto with Thermometer, jar and case	1 10 0
434	**Dicas's and Allan's Hydrometers** are very similar in construction to Sikes' instrument, but are now very rarely used.	

Saccharometer for Brewer's use. Shows the weight of wort per barrel heavier than water. Thus 36 gallons of water weighs 360 lbs., but 36 gallons of wort of specific gravity 1·050, weighs 18 lbs. heavier than water, *viz.*, 378 lbs.

Printed instructions for use accompany each Saccharometer.

436	**Brewer's Saccharometer** Glass, showing pounds per barrel (fig. 436)	0 5 6
437	Ditto ditto with Extra Scale showing Specific Gravity and lbs. per barrel	0 7 6
438	Ditto ditto Glass Testing Jar with Tables of Temperature Corrections, in Mahogany box, with Thermometer as fig. 425 .	0 15 6
439	**Saccharometers, Glass** Standard, comprising two instruments in mahogany case, one Saccharometer ranging from 0 to 25 lbs., and the other 25 lbs. to 50 lbs., very carefully adjusted . . .	2 2 0

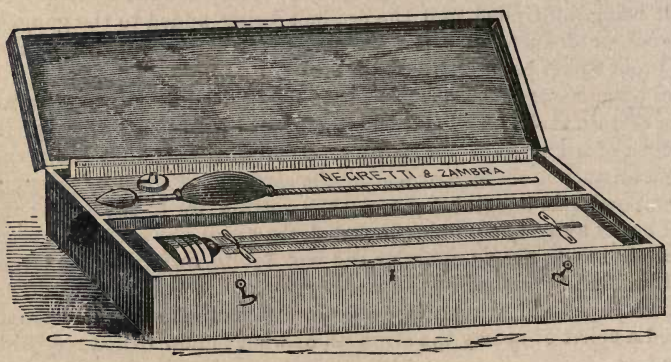


FIG. 440.

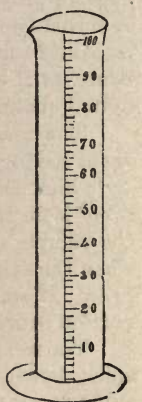


FIG. 441*.

440	**Saccharometer, Double Gilt Metal,** with silver soldered joints, with one weight, metal scale, enamelled tube, compared Thermometer, with expansion scale and rule, in mahogany case, with lock and key, Glass assay jar (figs. 440 and 441*), and book of directions for use . . .	5 0 0

This Saccharometer can be strongly recommended both for strict accuracy and the very highest class of workmanship.

441	**Saccharometer, Metal,** Improved with double Scales extending from water to 25 lbs. per barrel on one side of the upper stem, and by the use of the weight, the opposite scale will test wort from 25 lbs. to 52 lbs. per barrel not Gilt, Glass assay jar	3 3 0
442	Ditto, ditto, Double Gilt, including Thermometer, Rule, and Book of instructions, in box	4 0 0

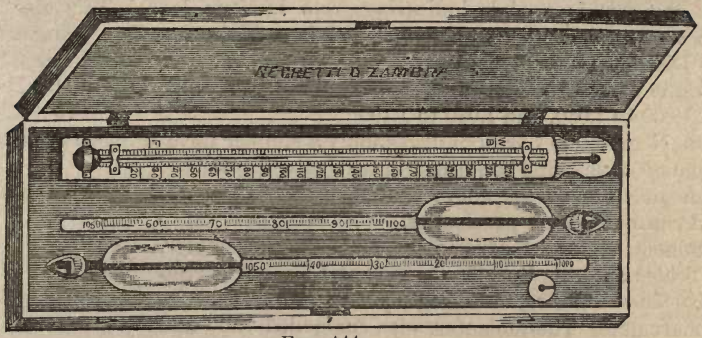


FIG. 444.

444 **Negretti and Zambra's Patent Saccharometers,** as supplied to the Excise Department of the Inland Revenue.

The changes in the scale divisions of Saccharometers, required by the New Beer Act, having been completed, Messrs. Negretti and Zambra are now prepared to supply their **Patent Glass Saccharometers,** and also a **new form of Brass instrument,** made in accordance with the models supplied by them to the Excise Department of Inland Revenue. Negretti and Zambra having been favoured with instructions to furnish designs for special instruments, have introduced those mentioned above, each kind being of Standard accuracy, and moderate in price.

Fig. 444 consists of two Patent Standard Glass Saccharometers, *with strengthening rods,* one with divided scale ranging from 1,000 to 1,050 Specific Gravity; the other from 1,050 to 1,100 Specific Gravity; also a brass scale Thermometer. The three instruments are fitted in a strong, well-made Mahogany Box *as supplied to the Excise* . . . . . Price £2 2 0

A set of *three* Patent Glass Saccharometers, the scales ranging from 995 to 1,150, also a Brass scale Thermometer. The four instruments fitted as above £2 15 0

Glass Saccharometers being much more accurate than those made of metal, Negretti and Zambra strongly recommend their use, especially as the risk of breakage is now much diminished by the introduction of their Patent arrangement for strengthening the weak parts of the instruments.

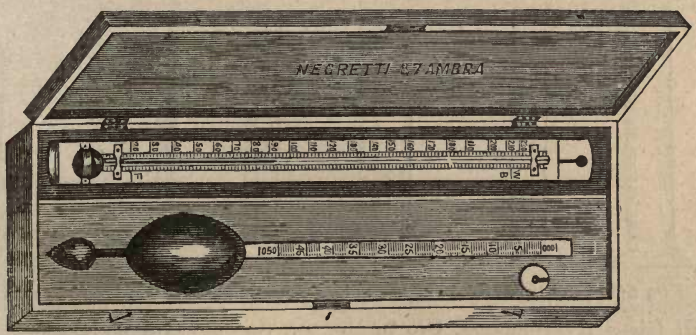


FIG. 445.

In most of the large breweries the *Standard* instruments used are invariably Glass ones, as greater reliance can be placed upon them, more especially when indicating the fractional parts of gravity.

Fig. 445 is a Gilt Metal Saccharometer, the scale on one side of its stem ranging from 995 to 1,025 Specific Gravity; and on the opposite side, by the addition of a

Poise (or Weight) is a scale indicating from 1,025 to 1,060. This also has a Thermometer supplied with it, and is fitted in a Mahogany Box, being arranged for use in Distilleries (fig. 445) . . . . . Price £2 5 0

The same instrument is supplied with a range of scale suitable for Brewers' use, *viz.:* 1,000 to 1,050, and 1,050 to 1,100 . . . . . Price £2 10 0

Messrs. Negretti and Zambra also supply a simpler form of Saccharometer, the whole range of scale being contained in one instrument.

Any modification of the above arrangements can be made to suit the requirements and convenience of purchasers.

		Each. £ s. d.	Each. £ s. d.
446	**Combined Glass Hydrometer and Saccharometer,** 2 Scales showing Specific Gravity and lbs. per barrel, with Thermometer, in mahogany case		2 2 0
447	**Saccharometer Thermometer,** with enamelled tube and expansion scale, mounted on Silvered Brass Scale .		0 14 0
448	**Saccharometer Can,** for testing Wort, Copper, tinned inside		0 10 6
449	Ditto, ditto Tin Japanned		0 4 0
450	**Glass Saccharometer testing or sample jars** (fig 417)	0 2 6	0 3 6
450*	**Graduated Glass Blending Jars,** for wine, spirits, or beer (figs. 450 and 441*) . . . . . 4s. 6d.	0 5 6	0 7 6
451	**Small Glass Hydrometer,** specific gravity scale, with sample glass and thermometer in case (figs. 418 & 418*)		0 15 0

452 Small Glass Hydrometers in Pocket cases of various scales and range made to order.

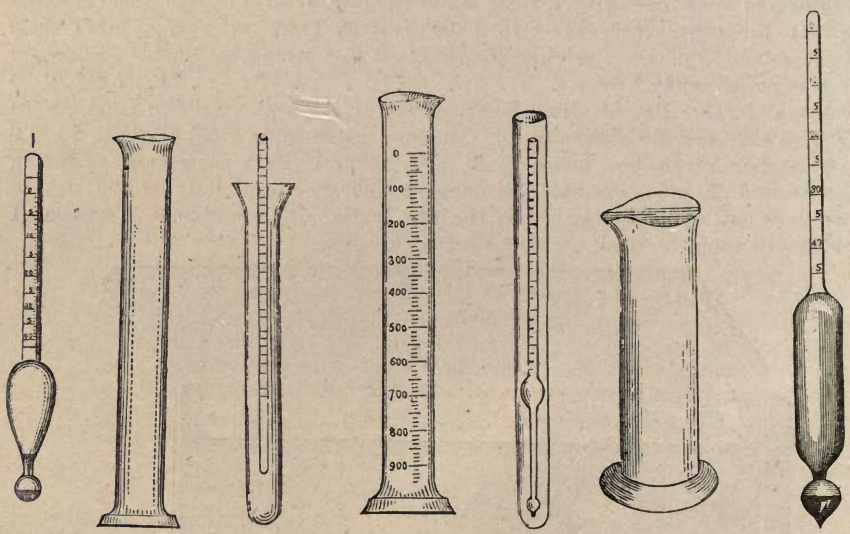


FIG. 456. FIG. 512. FIG. 453. FIG. 450. FIG. 453*. FIG. 512. FIG. 462.

453	Small Glass Hydrometers, two in the set, Specific Gravity Scale, from water to sulphuric æther, or from water to sulphuric acid, in neat case with Thermometer and Test jar (figs. 453 and 342*) .	1 10	0
454	Sets of eight small Glass Hydrometers, specific gravity, full range from æther to sulphuric acid, with Thermometer and sample jar in case	3 10	0
456	**Twaddell's Hydrometers,** Nos. 1, 2, 3 (fig. 456) . . each	0 3	6
457	Ditto ditto, Nos. 4, 5, and 6 . . . . . do.	0 4	0
458	**Set of six Twaddell's Hydrometers,** in mahogany case with Thermometer graduated on the stem, and test glass . . .	2 2	0

459 **Twaddell's Hydrometers,** so named after their inventor, Mr. Twaddell of Glasgow, are very largely used by Dyers, Bleachers, and Paper manufacturers, the six instruments having an extended or very open scale, figured from 0, Water, to 170, about the gravity of the strongest Sulphuric Acid. Each degree or division of Twaddell's scale being equal to five degrees of specific gravity.

460 Comparative Scale showing the values of Twaddell's Hydrometers, Nos. 1 to 6 in Specific Gravity.

No.	Twaddell's Scale.	Specific Gravity.
1	0 to 25	1·000 to 1·125.
2	25 „ 50	1·125 „ 1·250.
3	50 „ 75	1·250 „ 1·375.
4	75 „ 100	1·375 „ 1·500.
5	100 „ 125	1·500 „ 1·675.
6	135 „ 170	1·675 „ 1·850.

Twaddell's Hydrometers if for use in hot climates are specially tested and adjusted at 84° Fahrenheit at an extra cost of 6d. on each instrument.

		Each. £	s.	d.
461	**Aquarium Hydrometer,** for showing the density of Salt or Sea Water (fig. 424[a])	0	3	6
462	**Board of Trade, Marine Hydrometers,** for taking the specific gravity of Sea Water ·0 to ·40 (fig. 462)	0	5	6
463	Ditto ditto, 2 Hydrometers with very open scale, 0 to 40° and 20 to 40°	0	10	0

464 Sea Water ranges in Specific Gravity from 1·020 to 1·036, the ordinary gravity varying between 1·026 to 1·028. Mediterranean Sea Water about 1·030, and that of the Caribbean Sea, 1·040. The water of the Dead Sea has the extraordinary density of 1·200 to 1·250, the saltest water known.

THE SALTNESS OF SEA-WATER.—Professor Chapman, of University College, Toronto, says that the object of the saltness of sea-water is to regulate evaporation. If any temporary cause raises the amount of saline matter in the sea to more than its normal value, evaporation goes on more and more slowly. If the value be depreciated by the addition of fresh water in undue excess, the evaporation power is the more increased. He gives the results of various experiments in reference to evaporation on weighed quantities of ordinary rain-water and water holding in solution 2·6 per cent of salt. The excess of loss of the rain-water compared with the salt solution was, for the first twenty-four hours, 0·54 per cent., at the close of forty-eight hours, 1·46 per cent; and so on in an increasing ratio.

Analysis of sea-water taken from the English Channel:—

Chloride of Sodium	1891·6
Chloride of Magnesium	228·4
Chloride of Potassium	47·8
Iodide and Bromide of Magnesium . . .	15·4
Sulphate of Magnesia	145·4
Sulphate of Lime	94·5
Grains per gallon .	2423·1

These quantities vary with the locality as well as the percentage of Organic Matter also found in Sea Water.

The ordinary surface Temperature of the Sea in temperate climates is 45° to 51·5° Fahr.

"In most parts of the world the average temperature of the ocean's superficial water is nearly that of the air upon its surface. In the tropics the temperature of the sea water ranges from 70° to 80° Fahr. or more, and the air is much the same. In some limited parts of the globe the surface water is as warm as 86°, for instance, near the Galapagos Islands;

and in some very confined localities even *more than* 90°, as for example in parts of the Red Sea and Indian Archipelago. But although so warm on the surface it is very much colder at a few hundred fathoms below, the temperature decreasing to 35°, and even less."

		£	s.	d.
465	**Universal Hydrometer**, for all fluids from ·700 to 1·900 . . .	0	12	0
466	**Confectioners' Hydrometer** for Ice making . . . 3s. 6d. and	0	5	6
467	Ditto ditto for Syrups (see also No. 396) . . .	0	5	6
468	**Hydrometer** for Brine. A saturated solution of sea salt varies between 1·1962 and 1·205 at 60° Fahrenheit	0	5	6
469	**Hydrometer** for British Wines (Roberts' scale, 0 to 26°) . . .	0	5	6
470	Ditto, for Syrups (Specific Gravity)	0	5	6
471	Ditto, for Soap (Beaumé's)	0	5	6
472	Ditto, for Soap Lye (Specific Gravity)	0	5	6
473	**Olaeometer**, for fixed oils, such as Sperm, Linseed, Rape, &c. . .	0	5	6

From a competent authority we quote the following gravities:—

474

Linseed Oil	0·9347	Olive Oil	0·9176
Almond Oil	0·9180	Rape Seed Oil . . .	0·9136
Castor Oil	0·9611	Colza Oil	0·9136
Palm Oil	0·968	Nut Oil	0·9260
Oil of Turpentine . . .	0·870	Whale Oil	0·923

475	**Acidometer**, for estimating the strength of Acids (fig. 420) . .	0	6	6
476	**Acetometer** (or Acetimeter), for Vinegar	0	6	6

"Specific Gravity if determined by a Sensitive Hydrometer is a good test of the strength of genuine Vinegar. The following table of Messrs. Taylor is nearly correct, or sufficiently so, for commercial transactions.

"Revenue Proof Vinegar, called by the English manufacturer No. 24, has a Specific Gravity of

1·0085,	and contains of	real acid	in 100 . . .	5
1·0170	„	„	„	10
1·0257	„	„	„	15
1·0320	„	„	„	20
1·0470	„	„	„	30
1·0580	„	„	„	40

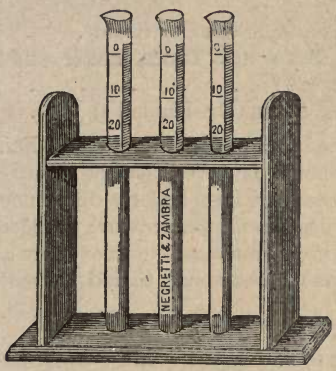
DR. URE."

It should be observed that all Malt Vinegars contain mucilage, gluten, or saline particles, which would, to a certain extent, veil the indications of the Hydrometer; therefore, if precise accuracy be required, recourse must be had to Chemical Tests such as will be found described in all modern Chemical Books.

477	**Barktometer Glass** for Tanner's use, from 0 to 50	0	7	6
478	Ditto ditto, 0 to 80, divided to ½ degrees	0	10	6
479	**Barktometer, Gilt Metal**, 0 to 80, divided to ½ degrees with Thermometer, in Mahogany Box	3	3	0
480	**Citrometer**, for Lime or Lemon Juice, as used by the Commissioners of Customs, specific gravity scale from 0 to 100 in two instruments for greater accuracy, complete with computing rule, and a delicate Thermometer in a case	1	16	0

Like Vinegar, Lime or Lemon Juice often contains a very large percentage of mucilage, so that the indications of the Citrometer should only be regarded as approximate and not absolute. We also find that by the Act of Parliament August 26th, 1867, 30 & 31 Vict., cap. 124, Lime or Lemon Juice for ship's use *is to contain "fifteen per centum of proper and palatable proof spirits."* Chemical Tests must therefore be resorted to where definite results are desired.

481	**Negretti and Zambra's Hydrometer** with Thermometer in the stem showing density and temperature in one instrument. Fig. 481 .	1	10	0



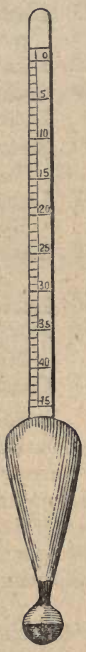


FIG. 482. FIG. 491. FIG. 486. FIG. 489. FIG. 484.

NEGRETTI AND ZAMBRA'S LACTOMETERS FOR ASCERTAINING THE DIFFERENT QUALITIES OF MILK.

IT is a matter of great importance in rural and domestic economy that we have a ready means of ascertaining the Quality of Milk yielded by different cows. The richness of milk, depending upon the quantity of *oil or butter*, and *curd or cheese* which it contains, it becomes necessary that we be able to determine these quantities with facility and precision.

To attain these ends, Messrs. NEGRETTI & ZAMBRA have introduced a simple form of Lactometer, by which the richness of milk may be determined by simply taking its *temperature* and *specific gravity*.

The Lactometer consists of a glass ball and stem containing a graduated scale ranging from 0° (water) to 40° specific gravity, *adjusted to a temperature of* 60° Fahrenheit. A Glass Jar and Thermometer usually accompany the instrument.

482 **Lactometer** of a simple form for household use. The top of the scale is marked O and W, indicating water, and at the lower end P signifying pure milk. Intermediate between these two points are marks indicating ¼ milk and ¾ water, ½ milk and ½ water, ¾ milk and ¼ water. These marks must not be taken as absolute, for pure milk will vary in quality or density according to the particular kind of food upon which the cows have been feeding (fig. 482) . . . £0 3 6

483 **Lactometer** similar to above but with an additional scale on the back showing specific gravity £0 5 0

484 **Lactometer,** Negretti and Zambra's Lactometer of superior accuracy, with absolute Specific Gravity scale, with printed instructions for use (fig. 484) £0 5 0

		Each. £ s. d.
485	**Lactometer Tubes**, or Creamo-meters, graduated to show the percentage of cream; a set of six in mahogany frame . . .	0 16 6
486	Ditto, a set of three tubes in frame (fig. 486) . . .	0 10 6
489	**Cream Test Jars**, graduated to show percentage (fig. 489) .	0 5 6
	Ditto ditto, smaller	0 3 6
490	**Thermometer**, add or subtract, for use with above. (See also Dairy Thermometers)	0 7 6
491	**Lactometer Glass**, with **Thermometer and Test Jar**, in Mahogany Box (as fig. 425)	1 5 0
492	**Thermometers** for Dairy Use entirely mounted in glass (fig. 492) 3s. 6d. and	0 5 6
493	**Lactometer, Gilt Metal**, Specific Gravity Scale . . . 12s. 6d.	1 5 0
494	Ditto, ditto Gilt Metal with **Thermometer and Test Jar**, in Mahogany Box (as fig. 425)	2 2 0
495	**Centesimal Galactometer, Glass** (Dr. Hassall's)	0 10 6

Lactometers being adjusted to a temperature of 60° Fahr., all trials must be made at that temperature. Should, however, that be inconvenient, then for every five degrees of difference in temperature, make a difference of one degree on the Lactometer scale, adding the degrees of temperature if above 60°, and subtracting them if below 60°. For greater convenience, Thermometers are made by NEGRETTI and ZAMBRA to show at a glance the amount to *add* or *subtract* for difference of temperature.

FROM EXPERIMENTS MADE, IT IS FOUND THAT THE SPECIFIC GRAVITY INDICATED BY

496 THE LACTOMETER SHOULD BE AS FOLLOWS:

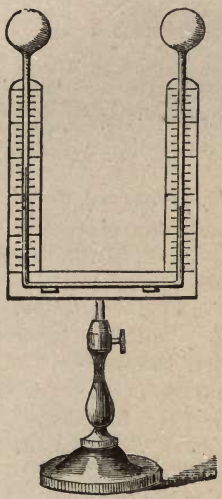
For Cows' Milk	26 to 38	For Goat's do. (house-fed) . .	30 — 34
„ Cows' do. (grass-fed) before being Creamed . . .	— — 32	„ Milk of Ewes (grass-fed) before being creamed. .	— — 36
„ Cows' milk (grass-fed) the cream being taken off .	— — 38	„ Ditto ditto, the cream being removed	— — 46
„ Woman's ditto . . .	28 — 38	„ Mare's milk	— — 36
„ Ass's ditto	30 — 34		DR. HASSALL.

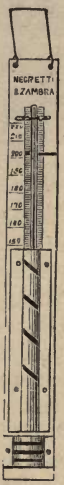
497 **Sheffer's Hydrometers**, one from ·700 to 1000, the other from 1000 to 1·900 with solution tube, per pair (figs. 453 and 453*) 0 15 0

498 **Cartier's Hydrometer**, chiefly used in France for testing fluids lighter than water. It is a modification of Baumé's spirit hydrometer, the same point being taken as the zero of the scales. The space which in Baumé's scale is divided into 32°, is in Cartier's divided into 30° 0 6 0

499 **Gay Lussac's Alcohometer or Hydrometer**, for testing the strength of spirits—mostly used in France. The scale is divided into 100 parts, the lowest division, marked 0 at the bottom of the scale, denotes the specific gravity of pure water at a temperature of 15° Cent. or 59 Fahr. The highest division at the top of the scale indicates the specific gravity of absolute alcohol of sp. gr. ·796 at the same temperature. The intermediate degrees indicate the number of volumes of such alcohol in 100 volumes of the spirit tried 0 6 0

500 Baumes' Saccharometer floats at 30° in a solution the Specific Gravity of which is 1·26—this is the density of Simple Syrup when boiling; hence if the Saccharometer floats at 30° in a solution of Sugar, when boiling it is inferred that such solution will be exactly saturated when cold. The scale is sometimes graduated to indicate the proportion of Sugar in the solution under examination.





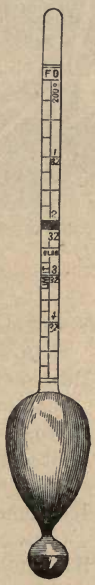


FIG. 492. PAGE 168. FIG. 514. FIG. 517. FIG. 513.

501 **Fahrenheit's Hydrometer** has two glass bulbs blown on a tube similar to the ordinary hydrometer, the upper bulb being the larger. The top of the stem is terminated by a small cup or dish. The lower bulb is weighted with mercury sufficient to cause the partial immersion of the instrument when placed in water without any weights being placed in this cup. In the middle of the stem is a mark, to which point the hydrometer is adjusted in water by placing weights in the cup. Its use is similar to that of Nicholson's Gravimeter. £0 10 6

502 **Densimeter**, a modification of Fahrenheit's instrument, chiefly used in France 0 12 6

503 **Richter's and Tralle's Hydrometer**, with Thermometer . . . 0 15 6

504 **Normal Alcoholometer**, Tralle's, used in Prussia and the United States, has a scale figured from 0° to 100°, each degree representing one per cent. by volume of Alcohol, Specific Gravity 0·7939 in any mixture of Alcohol and Water at 60 degrees temperature Fahrenheit 0 14 0

505 **Wooley's Hydrometer.** This instrument has 2 scales, *viz.*, Government Proof and Specific Gravity 0 6 6

506 A set of five **Standard Glass Hydrometers.** Government Proof Scale, forty under Proof to sixty over Proof, with a very accurate Thermometer in a Mahogany Box, with Book of Tables as used with the metal Hydrometer 4 0 0

507 **Hermbstadt's Hydrometer and Saccharometer**, having two Scales, one showing Specific Gravity, 1·000 to 1·321 and percentage of Sugar 0 to 67 . . . . . 0 6 6

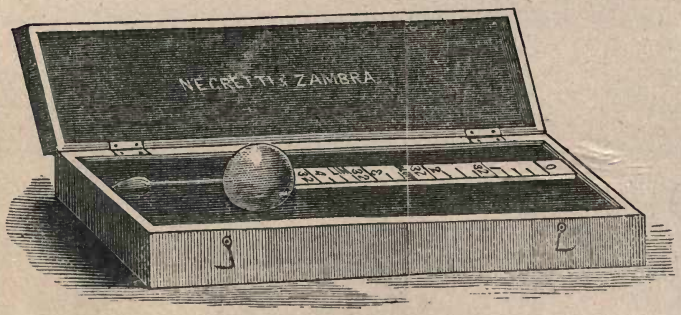


FIG. 515.

FIG. 515*.

		Each £ s. d	Each £ s. d.
508	**Volumeter** (Gay Lussac's), for liquids lighter or heavier than water		0 6 6
509	**Densimetre** (Gay Lussac's), for liquids lighter or heavier than water, in two spindles simple form . . .		0 8 6
510	Ditto (Rousseau), for ditto ditto ditto .		0 8 6
511	**Photographic Hydrometer**, or Argentometer, showing grains per ounce of nitrate of silver in solution . .		0 3 6
512	**Hydrometer Test Glasses**, or Jars, on foot (figs. 512 and 515*) . . . . . 2s.	0 3 6	0 5 6
513	**Salinometer Glass**, for ascertaining the density of salt water in steam boilers, to prevent incrustation (fig 471.)		0 5 6
514	Ditto ditto, **Gilt Metal**, in tin case (fig. 466)		0 18 0
515	Ditto Ditto, **Gilt Metal or German Silver** in Box, fig. 467		1 1 0
516	Ditto with **Thermometer** in Mahogany box . . .		1 12 0
517	**Salinometer Thermometer** (fig. 469)		0 6 6
518	Ditto, **Testing Pot, Stout Copper**, with division for Thermometer.		0 8 6

The Salinometer used for testing the density of water in Marine Steam Boilers has a scale with five principal divisions marked upon it, the first division on the top of the stem is marked 0, representing pure water, the others marked $\frac{1}{32}$ $\frac{2}{32}$ $\frac{3}{32}$ and $\frac{4}{32}$ signify that when the Salinometer floats at any of these divisions, that the water contains 1, 2, 3, or 4 parts of saline or solid matter in 32 of water.

Between $\frac{2}{32}$ and $\frac{3}{32}$ is engraved the word *Blow*, indicating that when the Boiler Water has reached that density, a portion of it should be blown out of the boiler and replaced with fresh water. The temperature at which the water is to be tested is 200° Fahr.

At the $\frac{2}{32}$ the word "**Limit**" is marked, when, at that indication, it becomes dangerous to work it beyond that strength or density.

Thus, this Instrument purports to indicate the precise time at which Marine Steam Boilers should be blown off, not only to prevent waste by blowing off too frequently, but to avoid the possibility of the Boiler being injured by the deposition or incrustation of the salt, which is a bad conductor of heat, and frequently the cause of the Boiler being burst. The engineer, by merely looking at the scale of the Salinometer as it floats in the water, can at once ascertain the saline density of the water with the greatest accuracy.

TO USE THE SALINOMETER.

519 Fill the Assay Jar from the Boiler, suspend the Thermometer in the side partition of it, and immerse the Ball in the water; then at whatever division on the stem it rests level with the surface, will be the degrees of saline matter contained in the water at the temperature of 200°; but if the heat of the water varies below that degree, the following scale of temperature will be the blowing-off point:—

TEMPERATURE. 200° $\frac{2}{32}$ } at surface for Blowing-off point.
180° $\frac{2\frac{1}{4}}{32}$ }
160° $\frac{2\frac{1}{2}}{32}$ }

Under the circumstances at which fresh water boils at 212°, sea water boils at 213·2°. The boiling temperature is raised by the chemical solution of any substance in the water, increasing with amount of matter dissolved. For this reason, marine engineers use a Thermometer to determine the amount of salts held in solution by the water in the boilers of sea-going steamers. Common sea water contains about $\frac{1}{33}$ of its volume of salt and other earthy matters. As evaporation proceeds, the solution becomes proportionally stronger, and more heat is required to produce steam. The following table by Messrs. Main and Brown shows the relation between the boiling point under the mean pressure of the atmosphere, or 30 inches of mercury, and the proportion of matter dissolved in the water.

When the salts in solution amount to $\frac{1}{33}$ the water is saturated. It has also been ascertained that, when a solution of $\frac{4}{33}$ is attained, incrustation of the substances commences on the boiler. Hence it is a rule with engineers to expel some of the saturated water, when the thermometer indicates a temperature of 216° F, and replace it with fresh water, in order to prevent incrustation and injury to the boiler.

---

520 The Boiling point of *Saturated* Solution of Salt varies from 218 degrees to 226 Fahr.

Proportion of Salt in 400 parts of water		Boiling point	
0	. .	212°	
„	„ $\frac{1}{33}$ . .	„	213·2
„	„ $\frac{2}{33}$ . .	„	214·4
„	„ $\frac{3}{33}$ . .	„	215·5
„	„ $\frac{4}{33}$ . .	„	216·6
„	„ $\frac{5}{33}$ . .	„	217·9
„	„ $\frac{6}{33}$ . .	„	219·0
„	„ $\frac{7}{33}$ . .	„	220·2
„	„ $\frac{8}{33}$ . .	„	221·4
„	„ $\frac{9}{33}$ . .	„	222·5
„	„ $\frac{10}{33}$ . .	„	223·7
„	„ $\frac{11}{33}$ . .	„	224·9
„	„ $\frac{12}{33}$ . .	„	226·0

For further information on this subject, see Temperature Thermometer in conjunction with pressure gauges, page 151.

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521 Salinometer, or Salt Water Guage, (How's Patent), constructed of strong Gun Metal and Brass, for attaching to the Boilers of Marine Steam Ships, to ascertain at any moment the specific gravity of the water contained in the Boiler. Complete, with Metal Salinometer, Thermometer, and Lamp; best finished Gun Metal Tap Unions and Valves. £8 8 0

522 Salinometer, Saunders £8 8 0

523 Ditto, Gambles £8 8 0

524 **Spirit Gravity Beads** are small light hollow spheres made of white or coloured glass about half-an-inch in diameter, with a stem or tail of about a quarter of an inch in length. The use of this stem is for adjusting each bead to a certain degree of Specific Gravity, or to a given degree of Sike's Hydrometer Scale. The degrees are engraved upon each Bead, thus forming them into rough Hydrometers for ascertaining the Gravity of various Fluids of Spirits. When the Bead floats about half-way in any sample of liquid to be tested, the density or specific gravity of such liquid is indicated by the figures or numbers engraved upon the bubble.

525 **Salt Water Beads**, or bubbles, for Aquaria . . . in pairs £0 2 0

The average Specific Gravity of Sea Water is 1·026 to 1·028.

Gravity Beads for Aquaria are made of different coloured glass, one adjusted to float upon the surface of the water, and the other to remain at the bottom of the tank when the water is of suitable density for the healthy growth of fish or plants.

		Each. £ s. d.
526	**Specific Gravity Beads**, (or Spirit Bubbles, Glasgow Beads), for showing the strength of spirits, set of twelve, in japanned tin box	0 6 6
527	Ditto, ditto . . . . set of eighteen	0 10 6
528	**Specific Gravity Beads**, for heavy and light fluids, such as æther, alcohol, ammonia, oil, naphtha, acids, each .	0 1 0
529	**Specific Gravity Bottles**, 1,000 grains' capacity, in tin case with counterpoise weight. (See also Chemical Section.)	0 10 6
530	Ditto ditto 500 grains	0 8 6
531	Ditto ditto 250 grains	0 6 6
532	**Nicholson's Gravimeter**, for ascertaining the specific gravity of metals or other solid substances, Japanned tin (fig. 532) with Metal Case . . .	0 10 0
533	**Nicholson's Gravimeter**, larger size, accurately made in BRASS, fitted in case, with weights ranging from 1-10th to 1,000 grains (fig. 533)	3 3 0

FIG. 532.

FIG. 533.

Nicholson's Hydrometer or Gravimeter is a modification of Fahrenheit's instrument, and is made either of very light tin japanned, or gilt brass; its form will be seen in fig. 532. A mark is made on the stem supporting the cup to which the instrument is adjusted by weight to float in water. The weight of the loaded instrument when sunk to this point is *the weight of the volume of liquid displaced by it.* It gives, therefore, the relative weights of equal volumes of the liquids into which it is placed. The Gravimeter is usually made to displace 3,000 or 4,000 grains of water, and is sensible to the tenth of a grain in this quantity. With this instrument the specific gravity of *solids* may also be ascertained. By placing the solid to be tested in the cup on the top of the stem and adjusting the additional weights required to sink the Hydrometer, the weight of such solid body *in air* is found. Then by placing the solid in the *lower* cup immersed in the water, and again adjusting the weights as before, the weight of the solid in *water* is ascertained; and from these two results the specific gravity is calculated.

DIRECTIONS FOR USING NICHOLSON'S GRAVIMETER.

534 To find the specific gravity of a mineral or other solid, place weights in the upper cup sufficient to sink the Hydrometer to the mark on the stem when the Hydrometer is floated in distilled water, and call this weight A. Now take a piece of mineral *of less weight than* A; place this in the upper cup, and add weights until the Hydrometer sinks to the same mark as before. Call the weights added B. Remove the solid from the upper cup to the lower, allowing the weights to remain in the upper cup. Add weights until the Hydrometer sinks to the mark on the stem, and call the additional weights C. Subtract B from A, and divide the remainder by C, and the quotient is the specific gravity.

Thus, suppose the specific gravity of a specimen of fluor-spar is required. First, on trial, we find that 460 grains placed in the upper cup will sink the Hydrometer to the mark on the stem when floated in distilled water—consequently, A is equal to 460 grains; and that when the fluor-spar is placed in the upper cup, 92 grains must be added to sink the Hydrometer to the same level as before—then B is equal to 92 grains. Now, on removing the fluor-spar to the lower cup, 115 grains must be added to the 92 grains still remaining in the upper cup to sink the Hydrometer to the same mark as before; therefore C is equal to 115 grains. Then

```
460
 92
115)368(3·2
  345
  230
  230
```

Censequently, 3·2 is the specific gravity required.

In our Chemical Section will be found and described Balances arranged to exhibit the same facts with extreme precision.

URINOMETERS.

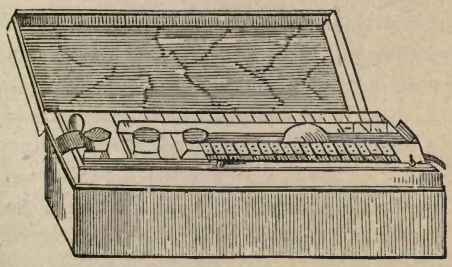

FIG. 539.

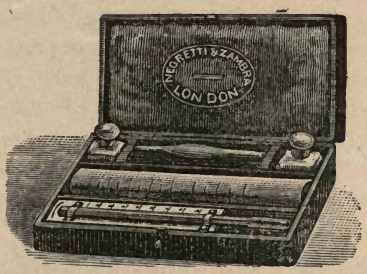

FIG. 538.

		£	s.	d.
535	**Urinometer,** for ascertaining the Specific Gravity of Urine, of two forms, figs. 444 and 444*	0	3	6
536	Ditto, ditto, in round leather pull-off case, with graduated test glass	0	6	6
537	Ditto ditto, in hinged leather case	0	7	6
	Ditto ditto, with test glass and thermometer,	0	12	6
538	Ditto, ditto, in hinged **Leather case,** fitted up with thermometer, spirit lamp, acid bottle, test tubes, dropping tube, graduated jar, test papers, &c. (fig. 538)	1	10	0
539	**Urinometer,** larger case, and more complete, with extra stoppered and cut test bottles and evaporating dishes, tube holder, &c. (fig. 539)	2	2	0
540	**Metal Urinometer, Gilt or Plated,** in pull-off case	0	15	0
541	**Urinometer Test Papers,** various . . . . . per book	0	0	2

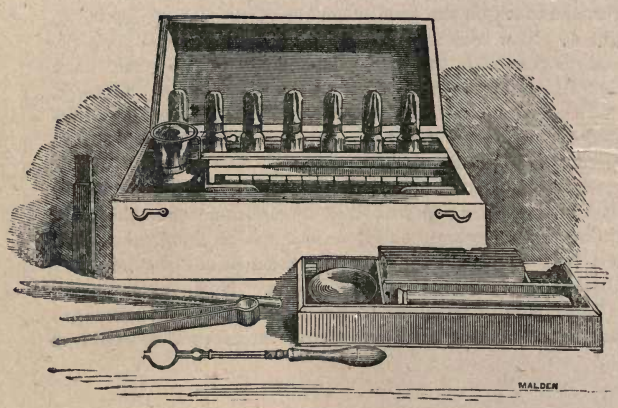

FIG. 445.

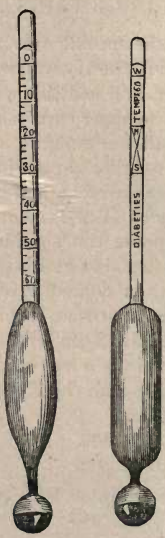

FIG. 444. FIG. 444*.

FIG. 449.

544 The Urinometer originally suggested by Dr. Prout for ascertaining the density of urine has a scale divided into 60 degrees, the zero being the point at which the instrument floats in distilled water at a temperature of 60° Fahrenheit.

The numbers on the scale added to 1,000 (the assumed specific gravity of water) give the specific gravities at the respective points. If the number cut by the surface of the fluid under test be 30, it indicates a specific gravity of 1·030. On the reverse side of this scale will be found the letter W at the top, on the same line as the 0 indicating water. Lower down the scale is a space marked H, signifying *healthy standard*, which ranges from 10° to 20° of the scale. The space from 30° to 60° is marked *diabetes*, the urine of diabetic patients generally ranging between these points. See figs. 444 and 444*.

545 **Dr. Lionel Beale's Clinical Cabinet** arranged as a companion to Dr. Beale's work, *The Microscope in its Application to Urinary Analysis. &c., &c.*

CONTENTS :—Urinometer in sheath, 2 oz. graduated measure, glass pipette, stirring rod, test tubes, watch glasses, glass slips, and thin glass covers, glass spirit lamp, test tubes, holder, test papers, 8 improved capped dropping bottles (fig. 489) in ebonite rack, for containing the following re-agents: acetic acid, nitric acid, ammonia, potash, nitrate of barytes, nitrate of silver, oxalate of ammonia, &c. (fig. 445) . £3 3 0

546 **Urea Tubes** divided to 100ths of a cubic inch 0 7 6

547 **Improved Dropping Bottles**, fig. 447 . . . . . 0 1 6

547* Dropping Tubes or Pippettes Glass 6d., 8d. 0 1 0

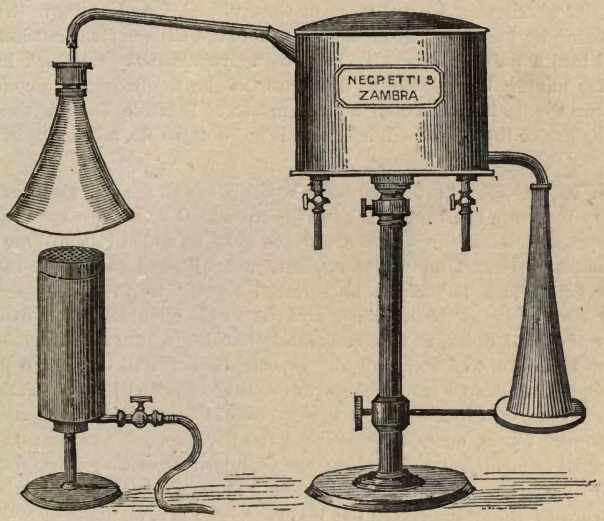

FIG. 551.

FIG. 550.

FIG. 552.

FIG. 557.

548 **Alcoholometer, Field's Patent,** for ascertaining the original gravity of every description of ale, stout, or porter, at any period after fermentation. This apparatus is useful for testing comparatively various samples of beer, returned beer, and also beer for export. Price, complete in mahogany box, with directions for use, and correction tables of variation . £6 0 0

549 **Wine or Spirit Analyser, Long's Patent,** for ascertaining the quantity of alcohol in wines, cordials, &c., in accordance with Treasury Order of July 12, 1853, fixing the maximum of spirit in wine at 33 per cent. £4 10 0
Graduated Glass Measure Standard for use with above . . £0 3 6

550 **Distilling Apparatus; or, Phillips' Revenue Standard Still,** for ascertaining the original gravity of Beer after fermentation, &c.; of strong brazed copper, with two Trial Jars and Thermometer, Pipette or Dropping Tube, &c. (fig. 550) £5 5 0

This apparatus is also used for the **Alcoholic Wine Test** by the Board of Customs for estimating the amount of Alcohol contained in Wines and Liqueurs.

551 **Gas Burner,** improved for above (fig. 551) £0 12 6

552 **Gilt Metal Hydrometer,** pocket size for use with above apparatus, in neat case (fig. 552) £0 16 0

553 **Gilt Metal Saccharometer,** pocket size for ditto in case . . £0 16 0

554 **Glass Flasks for Still,** with metal screw fittings £0 4 6

555 **Sikes' Hydrometers,** for use in connection with the above, see pages 178, 179.

METHOD OF USING THE DISTILLING APPARATUS.

556 Attach the water supply, which may be a Cistern or Cask placed four feet above the Condenser, the connection being by Flexible Tube from the Tap of the Cistern; the outflow of water is to be conducted into a pail, the quantity used being regulated by the Cock in the Cistern; and the water having been found to flow through the Condenser in a continuous stream, the Gas Lamp should be connected also by means of Flexible Tube, with a Gas Pipe, and lighted on the top of the Gauze. Where Gas is not obtainable, a large Spirit Lamp can be used.

To Test a Sample of Wine.—Fill the Measure Flask with Wine to the highest mark, adjusting the exact quantity by using the Pipette; pour the measured Wine into the Still Flask, rinsing out the Measure with a few drops of water which must be added to the Wine; the measure being quite clean, is placed upon the bracket, and adjusted to receive the Distilled Wine Spirit; the Still Flask is then to be screwed tightly to the condenser, interposing an Indiarubber Washer between the Flask and the metal shoulder of the Still Pipe; put the Lamp under the Still Flask, at first moderately burning, afterwards increase the flame; in a few minutes the Wine will boil, and the vaporised Spirit will begin to condense, falling into the Measure. Repeated experiments have proved that with weak Wine, such as contain under 26 per cent. of Proof Spirit, it is only necessary to distil over one-half the bulk; but stronger Wines, containing much extractive matter, require the operation to be continued until two-thirds are distilled; the Standard Measure is therefore graduated at two-thirds as well as one-half. When the required point on the Measure is obtained, the original measure of the Wine (up to the highest mark) is to be made up with Water, then poured into the Trial Glass and stirred well, so that the Spirit and Water may be perfectly mixed: with the Thermometer the temperature should be observed, the strength being taken by Sikes' Hydrometer according to the usual tables.

To insure extreme accuracy, it is necessary that the temperatures of the Wine before distillation, and the Spirit and Water before taking the strength by the Hydrometer, should be the same, that the two bulks may be identical.

Accurate Balances and Weights, Specific Gravity Bottles, Test Jars, Graduated Measuring Glasses, &c., &c., for use with the Distilling Apparatus. See sections "Thermometers," "Hydrometers," and "Chemical Apparatus."

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557 **Negretti and Zambra's Patent Strengthened Glass Hydrometer,** fig. 557 Of all glass instruments required by the exigencies of Science, the Glass Hydrometer is the most delicate and fragile. Very many of these instruments are broken in carriage, and very recently the Government of India requiring a large number of Hydrometers for fiscal purposes, applied to Messrs. Negretti and Zambra for assistance in procuring an Hydrometer which could be safely sent to the interior of India. Messrs. Negretti and Zamba submitted some instruments, which so far fulfilled the conditions required, that 20,000 of Messrs. Negretti and Zambra's Patent Hydrometers were ordered and supplied. The novelty consists in inserting an inner tube down the stem, and reaching to the bottom, and there being fastened securely to the neck of the lower bulb; it will be seen that by these means the weight of the instrument is supported from the bottom, and not at the juncture of the stem with the large bulb, where usually the breakage of the old form of Glass Hydrometers took place.

Any form of Hydrometer described in the preceding pages can be constructed with Negretti and Zambra's improvement *to order* at a slightly increased expense.

558 **Comparative Scales** (Baker's) compiled from tables of eminent authorities, for the use of Chemists, Distillers, Brewers, Dyers, Bleachers, Paper makers, British Wine makers, Confectioners, &c., &c.

It Comprises Specific Gravity Scale, Twaddell's, Baumé's, Cartier's, Gay Lussac's, Saccharometer scale of lbs. weight per barrel, Extract per barrel, and the Government Proof Spirit scale. Several percentage scales for Spirits, Acids, Chlorine, Ammonia, Solutions of Potash, Soda, and four comparative Thermometer Scales; *viz.*, De Lisle, Centigrade or Celsius, Fahrenheit, and Reaumur,—in all 34 scales, containing a vast amount of most valuable and useful information. Price 2s. each.

Recent Acts of Parliament in connection with the adulterations of food, drugs, &c., &c., will often necessitate strict investigation; in such matters, therefore, Messrs. Negretti and Zambra cannot too strongly impress upon the minds of their customers the great importance of accuracy in all apparatus used for analysing or testing the purity or strength of the articles under examination.

For such purposes, N. & Z., from their great experience in this special branch of their trade, can confidently recommend their instruments.

The various **Areometers**, &c., &c., used on the Continent to ascertain the density of Liquids, made to order.

GAUGING INSTRUMENTS, RULES, &c. *See Scales and Rules.*

Specific Gravity of *fluid* Mercury. The density of this Metal at 39·2° F., is 13·588, according to Kupffer. Hence its Specific Gravity near the point of congelation will be 13·694.—MESSRS PLAYFAIR AND JOULE.

The Specific Gravity of *solid* (frozen) Mercury is stated by Kupffer and Cavallo to be about 14·0.

According to Dufour, the Specific Gravity of Ice is 0·9178; Bunsen states it at 0·91674.

"Sea Water freezes at—2·5° to—0° C.; the ice which forms is quite pure, and a saturated solution remains. If water contains Alcohol, precisely analogous phenomena are observed; the ice formed is pure, and all the Alcohol is contained in the residue."—GANOT.

"M. Despretz by the cold produced with a mixture of liquid Protoxide of Nitrogen, Solid Carbonic Acid, and Æther has reduced Alcohol to such a consistence, that the vessel containing it could be inverted without losing the liquid."

Lowest artificial cold produced by Chemical Combination, 187° below Zero F.—A. S. TAYLOR.

Ditto ditto 140° C.—GANOT.

Mercury freezes, 37·9 Fah.—Kew. Carbonic Acid Gas Solid at 148° below 0°, F.

We are informed that lower temperatures have been recently produced by Chemical action.

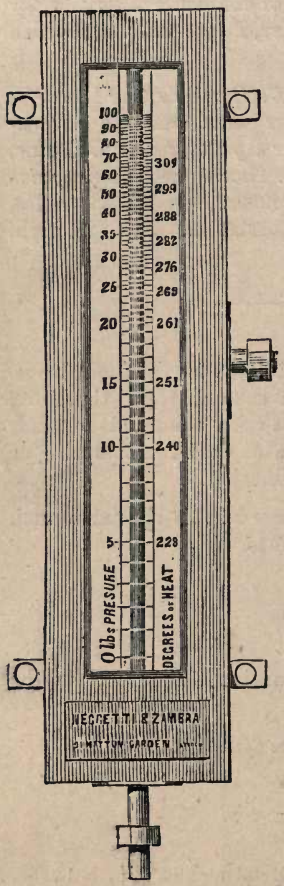


FIG. 559.

FIG. 562.

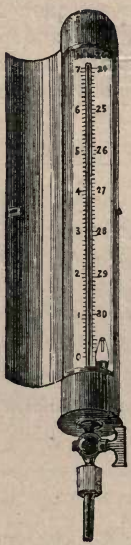


FIG. 563.

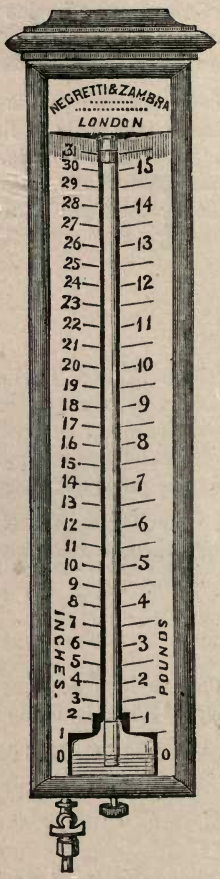


FIG. 564.

MERCURIAL VACUUM GAUGES.

		Each £	s.	d.
559	**Vacuum Gauge,** in Mahogany or Oak frame, form as fig. 459 . .	2	2	0
560	Ditto ditto in Plain Brass frame . . .	2	10	6
561	**Marine Vacuum Gauge,** in Oak frame, iron cistern, stout glass tube, gun metal unions, and OPAL GLASS SCALES, divided to 1-100th of an inch	4	4	0
562	**Vacuum Gauge.** The tube and scale are enclosed in stout Glass cylinder and Brass frame, with stop-cock and union (fig. 562) .	1	10	0
563	**Sugar Pan Vacuum Gauge,** as above, in Brass case, with Hinged Door, ground plug, fitting with Stop-Cock, &c. (fig. 563) . .	2	10	0
564	**Vacuum Gauge,** to show 30 inches, in handsome Mahogany case, with plate glass front, adjusting glass cistern, Gun Metal Tap, &c., suited for First-class Engine Rooms (fig. 564)	5	5	0

For Circular Vacuum Gauges, see **Bourdon's Gauges,** *pages* 206 *to* 209.

GUN METAL WATER GAUGES.

565 On an improved principle, with Ebony handle spanners, complete with glass tube and vulcanised rubber rings :—fig. 565.

$\frac{3}{8}$-in. 30s, $\frac{1}{2}$-in. 35s. $\frac{5}{8}$-in. 40s. $\frac{3}{4}$-in. 42s.

GAUGE TUBES.

566 **Gauge Tube**, for Steam Boilers, &c., of stout annealed glass, manufactured expressly for this purpose. Various lengths and diameters cut to order, average 1d. per inch

GAUGE TUBES of the best quality :—

SIZES.	PER DOZ. s. d.	SIZES	PER DOZ. s. d.	SIZES	PER DOZ. s. d.
10 by $\frac{7}{16}$	6 0	10 by $\frac{5}{8}$	8 0	13 by $\frac{3}{4}$	11 0
12 „ $\frac{7}{16}$	7 0	12 „ $\frac{5}{8}$	9 0	14 „ $\frac{3}{4}$	12 0
10 „ $\frac{1}{2}$	7 0	13 „ $\frac{5}{8}$	9 6	15 „ $\frac{3}{4}$	12 6
12 „ $\frac{1}{2}$	7 6	14 „ $\frac{5}{8}$	10 0	16 „ $\frac{7}{8}$	16 6
14 „ $\frac{1}{2}$	8 0	15 „ $\frac{5}{8}$	10 6	18 „ $\frac{7}{8}$	17 6
10 „ $\frac{9}{16}$	8 6	16 „ $\frac{5}{8}$	11 0	16 „ 1	20 0
12 „ $\frac{9}{16}$	9 0	12 „ $\frac{3}{4}$	11 6	18 „ 1	22 6
14 „ $\frac{9}{16}$	10 0	*Estimates given for large quantities.*			

India Rubber Washers for Packing Water Gauges supplied to order.

GAS PRESSURE GAUGES.

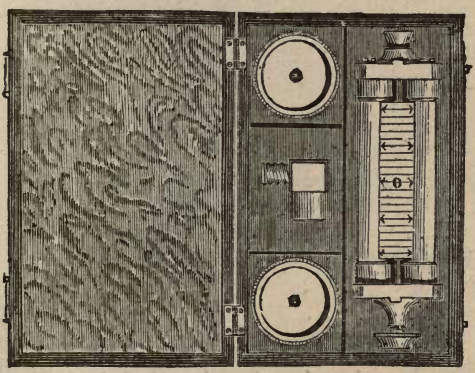


FIG. 572.

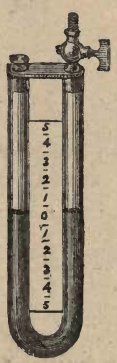


FIG. 568.

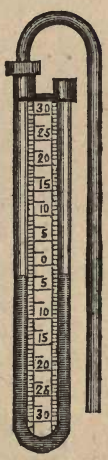


FIG. 570.

		Each. £ s. d.
567	**Gas Pressure Gauge**, with 6-inch glass syphon, Wood Scale divided to inches and tenths, and brass mountings	0 5 6
568	Ditto ditto, with **Stopcock**	0 10 6
569	Ditto, with Ivory Scale and Stopcock (fig. 568), best finish	0 14 0
570	**Gas Pressure Gauge**, large size (fig. 570), with Stopcock and Union	1 5 6
571	Ditto, of superior finish, as supplied to the Metropolitan Board of Works, in Brass Mountings, with stopcock	1 10 0
572	**Gas Inspector's Gauge**, with fittings complete, in leather pocket case (fig. 572)	2 2 0

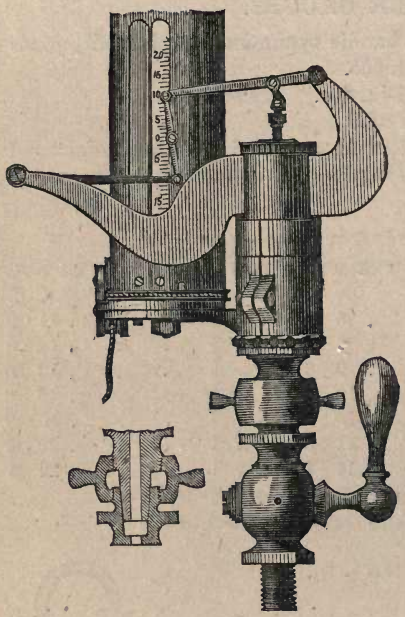


FIG. 575.

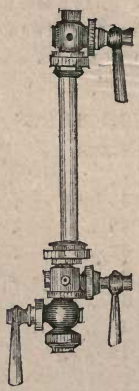


FIG. 565.

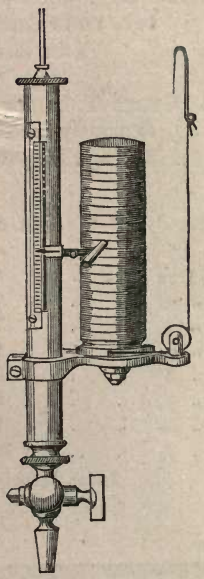


FIG 573.

		£	Each s.	d.
573	Steam Engine Indicator, in *gun metal*, for ascertaining the amount of power exerted during any part of the stroke, Low Pressure (fig. 573)	5	5	0
574	Ditto ditto High Pressure	6	6	0
575	Richard's Indicator with one Spring (fitted with Darke's Patent Detent and Cord Adjuster) fig. 575.	8	10	0
576	Extra Springs, ten varying scales . . . . . each	0	10	0
577	Paper Cylinder Spring	0	1	6
578	Arrangement for Oscillating Engines	0	10	0
579	Metallic Paper . . . . . per packet	0	4	0
580	Treatise on Indicator . . . . . New Edition	0	9	0
581	Extra Stop Cock	0	8	0

582 A 3-way Cock for taking diagrams from top and bottom of cylinders without shifting the Indicator made to order. Connecting Pipes made to order. Elbow for attaching the Indicator to Horizontal Engines made to order.

583 Reducing Gears, for reducing the stroke of the Engine down to that of the Indicator. Made to order.

584 Small size with Pulleys for strokes varying from 4 ft. 6 in. down to 1 ft. 6 in., price, £4 17s. 6d., can be attached direct to the Indicator.

Larger size for strokes from 6 ft. down to 1 ft. 6 in., £5 17s. 6d.

These instruments are packed in mahogany cases with their necessary attachments.

585	Old Indicators (Richard's), fitted with Detent at	1	10	0
586	Patent Cord Adjusters	0	5	6

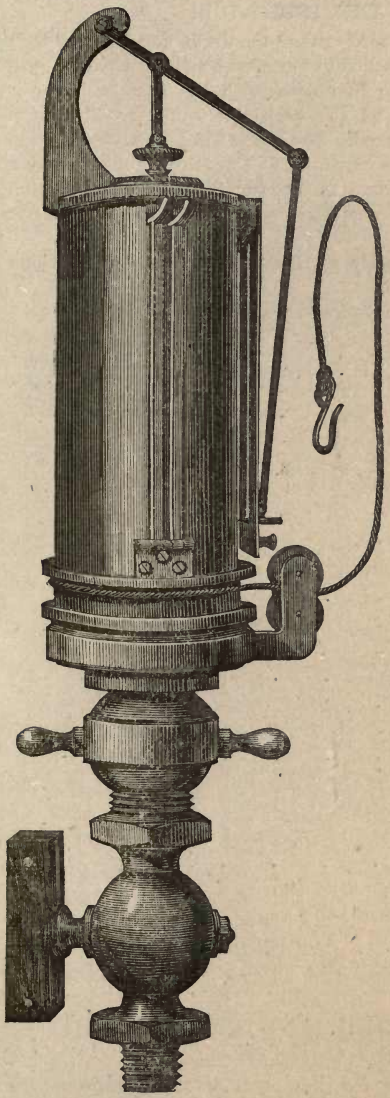


FIG. 578.

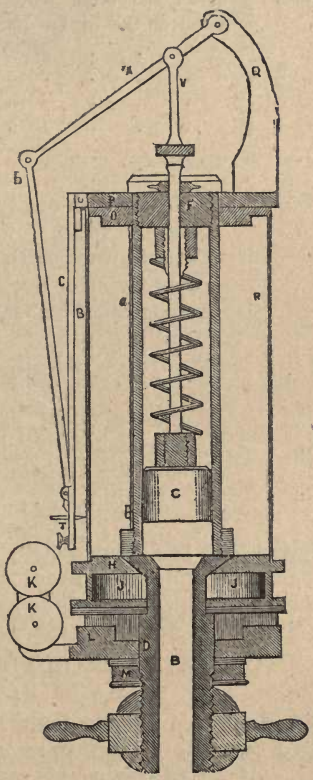


FIG. 587*.

587 **The Patent "Concentric" Steam Engine Indicator.** (figs. 587 & 587*) Negretti and Zambra call the attention of Engineers to great improvements in the new "Concentric" Indicator, which reduces the vibration of the instrument to a minimum.

The paper drum is arranged in such a manner that it revolves concentrically with the piston cylinder. The pull action is direct upon the coupling which connects it to the cylinder of the engine. This arrangement causes less vibration to the instrument than if the drum were fixed on an arm, as in the ordinary form of Richard's Steam Engine Indicator.

A small instrument is made especially for high speeds, to which this indicator is particularly adapted.

DIRECTIONS FOR USING THE INDICATOR.

588 Before working, a sheet of metallic paper is placed around the drum, and fastened to it by means of the two clips. The cord is then attached to the most convenient part of the piston rod—or other part of the engine working in unison with it. The Indicator is fastened to the cylinder of the engine by means of the cock and coupling. The small leading wheels may be turned in any direction required. To change the spring, unscrew the nut at top, through which the piston rod (of Indicator) works, and by lifting the arm which supports the parallel motion, the piston rod will come out. The pencil can be removed from or pressed against the paper by lifting or pressing the stud connected to the slotted bar which the pencil works.

It will be necessary, in sending orders, to specify particularly the number of springs required and the pressure they will have to indicate.

All the springs will fit every instrument, and they can be readily changed by any one.

The springs are made to ten scales, as follows :

No. 1	$\frac{1}{8}$-in. on the scale represents 1-lb. pressure on the square in., indicates from	15 to + 10	No. 5	$\frac{1}{24}$	15 „ +	60
„ 2	$\frac{1}{12}$	15 „ + 22	„ 6	$\frac{1}{30}$	15 „ +	80
„ 3	$\frac{1}{16}$	15 „ + 35	„ 7	$\frac{1}{32}$	Atmosphere „ +	100
„ 4	$\frac{1}{20}$	15 „ + 47	„ 8	$\frac{1}{40}$	„ +	125
			„ 9	$\frac{1}{48}$	„ +	150
			„ 10	$\frac{1}{56}$	„ +	175

PRICES.

	£	s.	d.
Indicator with one spring, &c., in box, fig. 587	7	10	0
Ditto ditto, Smaller size	7	0	0
Extra Springs (with scales) each	0	10	0
Paper Cylinder Spring	0	1	6
Arrangement for Oscillating Engines	0	10	0
Metallic Paper per packet	0	4	0
Treatise on Indicator New Edition	0	9	0
Extra Stop Cock	0	8	0
Three-way Cocks for taking diagrams from top and bottom of Cylinder without shifting the Indicator	2	0	0
Elbow, for attaching the Indicator to horizontal Engines	0	6	6

Connecting Pipes made to order.

Spring No 1 has been specially adapted to indicate the vacuum on a large scale in engines or pumps which work at high pressures. The springs showing pressures above 80-lbs. will be made to indicate the vacuum also when so ordered, and springs will be made also to any other scale desired.

COUNTING, TALLYING, MEASURING, AND REGISTERING MACHINES, OR ENGINE COUNTERS.

589 **Improved Engine Counter**, for counting Oscillating motion, Reciprocating Strokes, or Revolutions in machines.

	£	s.	d.
4 figures, counts up to 10,000	2	16	0
5 „ „ 100,000	3	3	0
6 „ „ 1,000,000	3	10	0
7 „ „ 10,000,000	4	10	0

590 **Harding's Patent Speed Indicator.**—This instrument has been designed for showing without counting or the use of a watch, by the position of an index on a dial, the actual rate of speed at which any Machine or Engine is at any moment revolving.

The Speed Indicator enables the Engineer to see at a glance the variation in the rate of speed at which his machinery is running and detect causes of irregularity and run his engine at normal speed, *Price*, £5 10 0

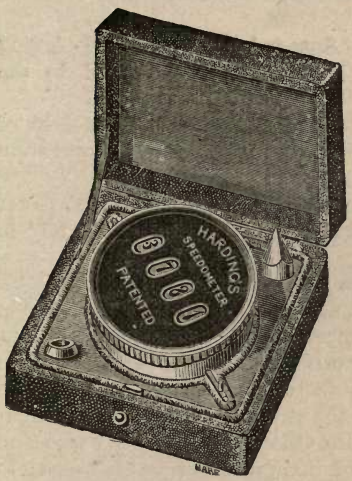


FIG. A.

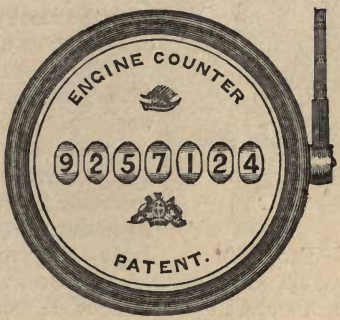


FIG. C.

HARDING PATENT CIRCULAR DIAL ENGINE COUNTER.

591 The ease with which the record of these Counters can at any time be read off is a great advantage which they possess over all *dial* counters (such as those on water and gas meters), in the difficult reading of which important errors are often made.

Other advantages of these Counters are,—great simplicity of parts and solidity of construction, in consequence of which it is almost impossible for the apparatus to get out of order.

It consists in an ingenious combination of wheels and pinions. Each number wheel carries on the right edge of its rim twenty teeth, and on the left edge only two. The pinions are provided with eight unequal teeth, four being as broad and four half as broad as the pinion. Thus, as each number wheel completes its revolution, it moves the next one on one-tenth, and all the wheels are safely locked, except at the moment when they are being moved forward by their pinions. Some idea of the perfection of this arrangement may be gathered from the fact that the Pocket Counter or Speedometer, of which the mechanism is a mere reduction of that of the large Counters, may be used at speeds over 5,000 per minute.

PRICE LIST FOR CIRCULAR AND SQUARE ENGINE COUNTERS.

	£	s.	d.
No (A) **Large Engine Counter**, 7 figures, to count to ten millions, with rotary or reciprocating motion, and arranged so as to readily set back to zero (fig. A)	5	10	0
Square Engine Counter, ten inches long, 5 figures	5	10	0
Ditto Ditto with superior **Clock** lever movement for use in Marine Engine rooms. The Patent Enamelled Number Wheels shew indelible black figures on a white ground specially useful in dark positions	11	11	0
No. (B) **Small Machine Counters** (with rotary action only), with 6 figures	2	10	0
Ditto ditto with 4 figures	3	3	0
No. (C) **Pocket Counter or Speedometer** (plated, and in handsome case), with 4 figures, and steel friction bits (fig. C)	2	10	0
No. (D) **Turnstile Counters**, 5 figures	3	15	0

Harding's Improved Engine Counters to suit customers' special requirements made up to order. Full details should be supplied as to what is desired.

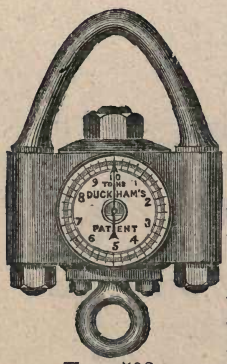


FIG. 592.

592 **Duckham's Patent Suspended and Self-Acting Weighing Machines and Dynamometers,** adapted to the Standards of all nations.

They are entirely self-acting, and indicate the weight of even the most ponderous goods, during the ordinary operation of loading or unloading.

They combine extreme simplicity and unlimited power with general utility, accuracy, low price, and economy in working.

They are invaluable to MERCHANTS, SHIPPERS, DOCK AND RAILWAY COMPANIES, as a ready and costless means of ascertaining the weight of merchandise in transit; to IRON-MASTERS, that they may ascertain the weight of material even during the process of manufacture; to CHAIN, WIRE, AND ROPE MANUFACTURERS AND PURCHASERS, that the strength as well as the weight of such material may be proved; to SHIP OWNERS, that the weight of cargo and stores may be checked by the simple operation of lifting the same on board; to ENGINEERS, BOILER-MAKERS, HARD-WOOD MERCHANTS; and in fact, to ALL and any who deal with goods by weight, or are interested in knowing the strength of materials or machinery, that the goods may be weighed, and strains and strengths tested, by a process which is entirely free of expense.

"The inventor provides an open-top cylinder, which is filled with water or oil, and fitted with a piston and pressure gauge. For the purpose of weighing goods the cylinder is slung from an ordinary crane hook. The goods are attached to the piston rod, and immediately these are lifted as in process of loading or unloading ships or wagons the weight is denoted on the dial. *Nothing can be more simple."—Mechanic's Magazine.*

PRESENT PRICES FOR PATENT SUSPENDED WEIGHING MACHINE.

				£	s.	d.
12 cwt. to 3 tons capacity,	45 lbs.	weight		17	17	0
5 tons	ditto	56 „		24	0	0
10 tons	ditto	85 „		30	0	9
30 tons	ditto	280 „		50	0	0

593 **Hearson's Strophometer, or Revolution Indicator.** This Instrument indicates, by means of a pointer on a marked dial, the number of revolutions per minute an Engine is, at the time, revolving.

It is so designed that when Engines are subject to incessant momentary fluctations of speed, the needle points steadily at a number expressing the mean velocity.

It will be found particularly useful for Locomotives (the dial being graduated in miles per hour), for Spinning Machinery, and for Ships.

The Instrument is worked by means of a rope passing round a pulley on the shaft of the Engine, or in connection with a friction roller against a coupling of the shaft.

For description of the Instrument see paper read at the Institute of Naval Architects, and published in the Transactions for 1874, and also article in No. 4 Annual of Royal School of Naval Architecture.

PRESENT PRICES.

	£	s.	d.
Strophometer with 9-inch Dial	10	10	0
Leading Pulleys for ditto	0	3	6
Connecting Arrangements for ditto . . . . from	2	10	0

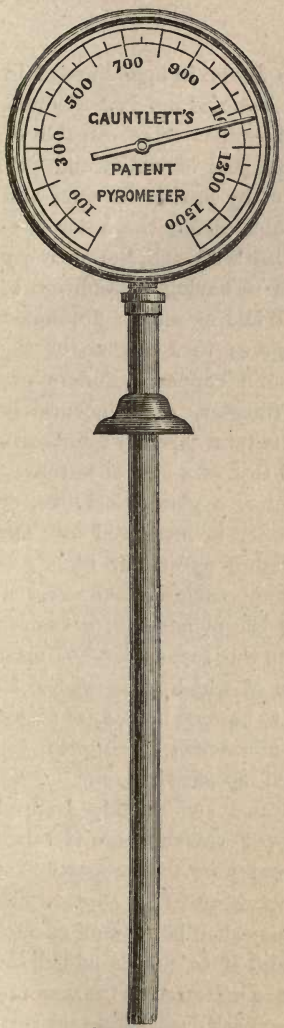


FIG. 594.

PYROMETERS.

	Each £	s	d.
594 **Gauntlett's Pyrometer.** — This Pyrometer is constructed of metal bars expanding in a different ratio upon the application of heat, by which can be ascertained temperatures above the range of the mercurial thermometer. Its form is that of a long tube, surmounted by a dial with an index or pointer to indicate to 300° for fluids, or to 1,009° for furnaces, ovens, &c. (fig. 594)	4	4	0
595 **Chronometrical Pyrometer Thermometer** (Gauntlett's), with 8-day time-piece to indicate to 300° or 1,009°	8	10	0
596 **Daniell's Pyrometer**, for indicating high temperatures, such as the melting point of metals, temperature of furnaces, &c., by the expansion of a bar of Platinum enclosed in a black lead cylinder, and measured by an index arranged with a spring and lever, to show upon a divided arc very small changes . .	5	5	0
597 **Wedgwood's** ditto, for the same purpose, by the expansion of a Cylinder of earthenware	5	5	0
598 **Ferguson's** ditto, for showing the difference of expansion in metals, suited for the lecture table as an experimental instrument .	5	5	0
599 **Hydro Pyrometer**, Captain O. Byström's (Swedish Artillery), for ascertaining the heat of furnaces, &c. A ball of platinum, or other metal, is arranged upon a metal rod in such a manner that it can be inserted into the furnace to be tested, and when heated equal to the temperature of the furnace quickly withdrawn and dropped into a given quantity of water. By observing the temperature of the water before and after the above-mentioned procedure, the difference obtained will be the value or amount of heat of the furnace	1	15	0

This Pyrometer is the most simple and practically useful of any of the above at very high temperatures. Price for Thermometer, Copper Bolt and Wooden Water Vessel.

Further details respecting Pyrometers will be given in our section on Chemical Apparatus.

SIEMENS' WATER PYROMETER.

Fig 1.

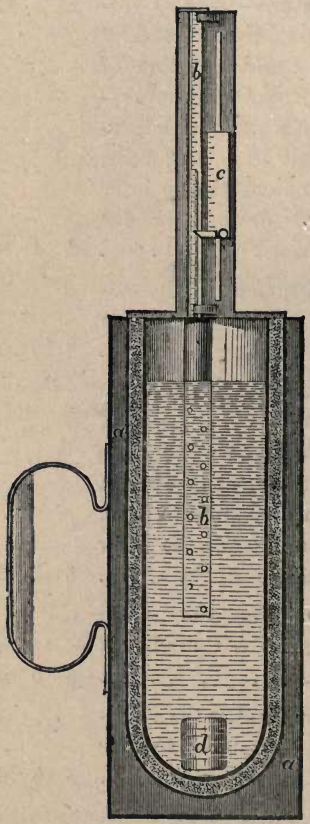
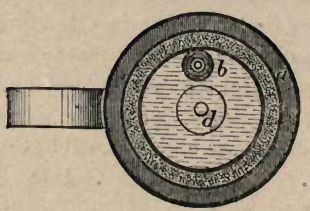


Fig. 2.



600 The PYROMETER is shown in figs. 1 and 2 in margin (fig. 1 being a vertical, and fig. 2 a horizontal section), and consists of a copper vessel capable of holding rather more than a pint of water, and well protected against radiation by having its sides and bottom composed of a double casing, the inner compartment of which is filled with felt. A mercury thermometer, *b*, is fixed in it, having, in addition to the ordinary scale, a small sliding scale *c*, graduated and figured with 50 degrees to 1 degree of the thermometer scale; 6 solid copper cylinders are provided with the Pyrometer, each accurately adjusted in size, so that its total capacity for absorbing heat should be 1-50th that of a pint of water.

In using the Pyrometer, a pint (0·568 litre, or 34·66 cubic inches) of water is measured into the copper vessel, and the sliding pyrometer scale *c* is set with its zero at the temperature of the water as indicated by the mercury thermometer *b*; a **Copper Cylinder** *d* is then put into the furnace or hot blast current the temperature of which it is wished to ascertain, and is allowed to become heated for a time varying from 2 to 10 minutes according to the intensity of the heat to be measured.

It is then to be withdrawn and quickly dropped into the water in the copper vessel, where it raises the temperature of the water in the proportion of 1° for each 50° of the temperature of the copper. The rise of the temperature may then be read off at once on the pyrometer scale, and if to this is added the temperature of the water as indicated on the mercury thermometer before the experiment, the exact temperature required is obtained.

For very high temperatures Platinum cylinders may be employed instead of Copper.

Price of Siemens' Water Pyrometer, with Thermometer and six copper cylinders, complete £4 4 0

Water Pyrometer, with Thermometer and six wrought-iron cylinders, complete £4 0 0

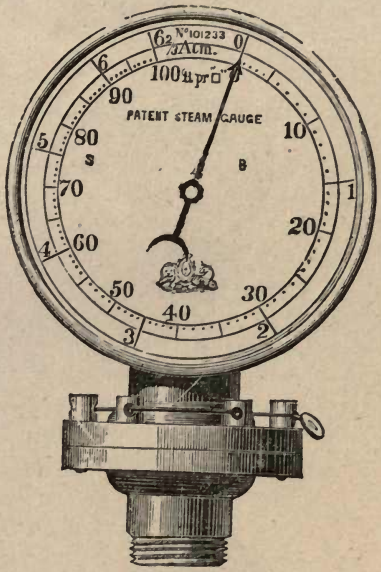


FIG. 602.

SCHAFFER'S STEAM PRESSURE AND VACUUM GAUGES.*

Gauges of any Pressure not exceeding 300 lbs. per square inch, 800 feet of water, and Vacuum Gauges:

		Each £	s.	d.
601	**For Portable Engines,** Brass Case. 4-inch with wire guard.	1	15	0
602	**No. 1. In Metal Case,** with Brass Rim 6-inch dial	2	2	6
	No. 2. In Brass Case . . . (fig. 602) „	2	10	0
603	**No. 3. In Metal Case,** with Brass Rim 7 „	2	7	6
	No. 4. In Brass Case . . . . „	2	10	0
604	**No. 1. Patent Steel Tube Metal Case,** with Brass Rim, above 300 lbs. up to 1,000 lbs. . . 6-inch dial	2	15	0
605	**No. 2. Ditto Brass Case,** above 300 lbs. up to 1,000 lbs. . . . . 6 „	3	3	0
606	**12-Inch with Transparent Dial for Dark Engine Rooms,** Metal Case, with Brass Rim.	3	3	0
507	**Combined Pressure and Vacuum Gauges,** at a slight increase of these prices.			
608	**Hydraulic Gauge,** above 1,000 lbs. up to 10 tons, with Maximum Pointer and loose nuts for connecting 10-inch Dial	5	5	0
	Ditto ditto . . . . 6-inch Dial	4	10	0
	Ditto ditto to 4 Tons	4	0	0

For each additional ton, 5s. extra. Maximum Finger applied to any gauge, 10s. extra.

609 **Dynamometer, Schaffer's.** The dial showing the weight is accurately divided, by applying dead weight. Two solid curved steel bars act as springs. Weight or strain applied has the tendency to straighten these springs, and the slightest motion of the same is multiplied and transferred by a suitable arrangement to a pointer which indicates the correct weight on the dial. Two strong rods outside the springs, moving loosely in their joints, act as safeguards in case the springs break.

Price, up to 20 tons . . £25 0 0

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* *Schaffer's Gauges, &c., not kept in stock, but are supplied to order.*

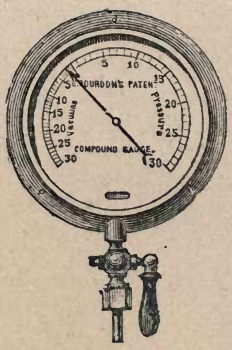


FIG. 4.

FIG. 5.

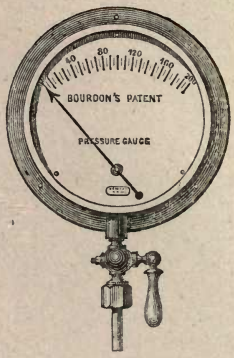


FIG. 2.

FIG. 7.

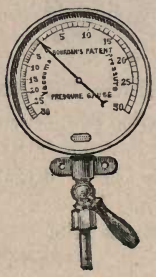


FIG. 8.

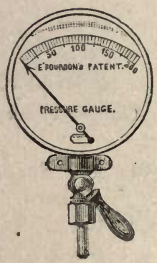


FIG. 6.

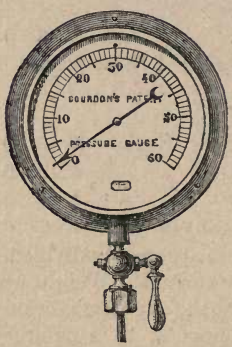


FIG. 1.

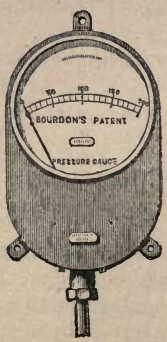


FIG. 9.

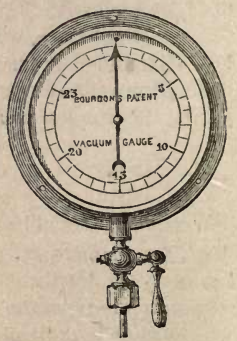


FIG. 3.

E. BOURDON'S STEAM PRESSURE AND VACUUM GUAGES.

610

PRICES FOR

E. BOURDON'S

OWN-MAKE STEAM AND VACUUM GAUGES.

TRADE 

MARK.

Gauges not bearing above Trade Mark are not of M. Bourdon's Manufacture.

Diameter of Dial.	PRESSURE GAUGES.				Vacuum Gauges, Figs. 3 and 7.	Compound Gauges, Figs. 4 and 8.
	Number.	With Eccentric Hand. Figs. 2 and 6.	Number.	With Central Hand. Figs. 1 and 5.		
		Each.		Each.	Each.	Each.
10 inches.	No. 0	£2 18 0	No. 0	£3 0 0	£3 2 0	£3 13 0
7 "	No. 3	1 16 0	No. 4	2 0 0	2 2 0	2 6 0
6 "	No. 5	1 14 0	No. 5c	1 18 0	1 18 0	2 4 0
5 "	No. 8	1 8 0	No. 8c	1 10 0	1 10 0	1 14 0
4 "	No. 7	1 5 0	No. 7c	1 7 0	1 7 0	1 12 0
3 "	No. 6	1 4 0	No. 6c	1 5 0	1 5 0	1 10 0
	Above Gauges in round cases of polished brass with or without flange, graduated to all pressures up to 300 lbs. per square inch, and fitted with gun-metal cocks and union complete. Gauges *above* 300 lbs. per square inch are *without* cocks.					
5 inches.	No. 2, Fig. 9, Oblong Iron case (9 × 6 in.) with connecting screw joint, each, £1 6 0					

Above prices are for all pressures up to 300 lbs. per square inch. From 300 to 1,400 lbs. pressure per square inch there will be an additional charge of Two Shillings for every 100 lbs. above 300 lbs.

Cocks for 5 in., 7 in., and 10 in. Gauges, for pressure above 300 lbs. per square inch, up to 1,400 lbs. will be Twelve Shillings each.

NEGRETTI & ZAMBRA,

AGENTS, LONDON.

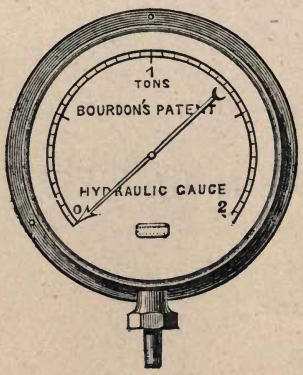


FIG. 10.

FIG. 14.

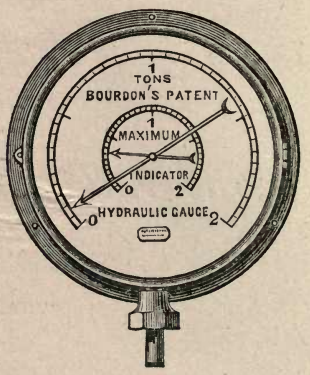


FIG. 11.

E. BOURDON'S HYDRAULIC GAUGES.

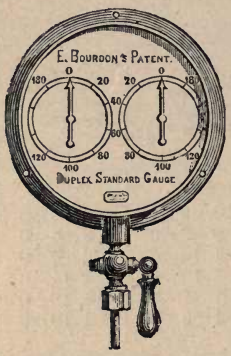


FIG. 16.

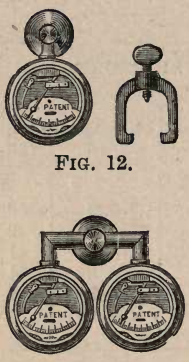


FIG. 12.

FIG. 13.

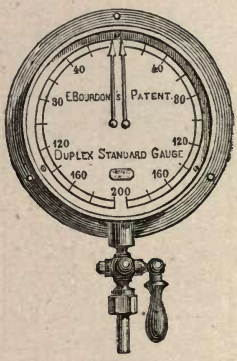


FIG. 15.

E. BOURDON'S STANDARD AND DUPLEX GAUGES.

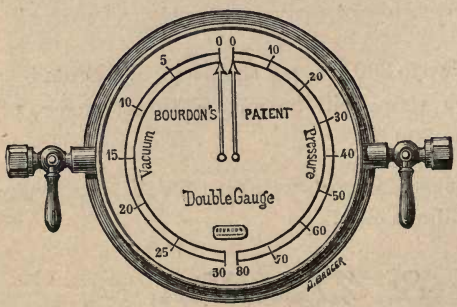


FIG. 18.

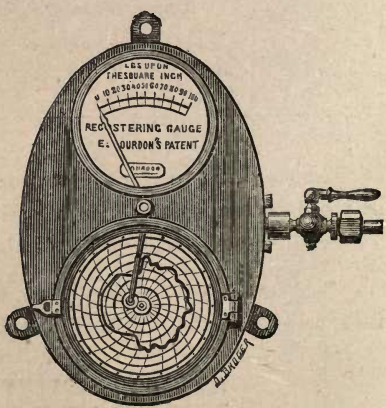


FIG. 17.

611 E. BOURDON'S DOUBLE AND REGISTERING GAUGES.

612 **BOURDON'S HYDRAULIC GAUGES*.**

With Central Hands, divided from 300 lbs. up to 5 tons per square inch.

Diameter of Dials.	With Connecting Screw Joint. Fig. 10.	With Maximum Pointer. Fig. 11.	With Valve, Union, and Maximum Pointer.	With Valve, Union, and Electrical Contact.
	Each.	Each.	Each.	Each.
10 inch.	£4 0 0	£4 10 0	£5 10 0	£6 0 0
7 „	3 5 0	3 10 0	4 8 0	5 0 0
5 „	2 10 0	2 16 0	3 8 0	4 0 0

Cocks for above Gauges (if required) 30s. each, extra.

613 **BOURDON'S STANDARD AND DUPLEX GAUGES.**

Used by Inspecting Engineers for Testing Gauges and Boilers.

	Diameter. 3 inches. £ s. d.	5 inches. £ s. d.
Fig. 12. **Pocket Standard Gauge**, with open face, in polished brass case, engraved dial, graduated to 300 lbs. per square inch, in morocco case and clamp screw each	2 8 0	3 0 0
Fig. 13. **Two Gauges** as the preceding, but fixed on the same union and in a mahogany box . . . per pair	6 3 0	7 13 0
Fig. 14 **Pocket Standard Duplex Gauge**, in polished brass case (5 inches diameter) engraved dial graduated to 300 lbs. per square inch, in Leather case with clamp screw . . . . . each		6 5 0
	7 inches.	10 inches.
Fig. 15. **Standard Duplex Gauge**, with two concentric hands, polished brass case, graduated to 300 lbs. per square inch, with gun-metal cock . . . . each	3 16 3	5 0 0
Fig. 16. **Standard Duplex Gauge**, with independent hands, &c., as last	3 14 0	4 15 0

EXTRA CHARGES.

Diameter of Gauge.	Maximum or Minimum Pointer.	Second Scale of Feet of Water or Atmospheres.	For 3-way Cock	Writing Name on Dial.	Open Face
	Each.	Each.	Each.	Each.	Each.
10 inch.	s. d.	s. d.	s. d.	s. d.	s. d.
7 „	10 0	5 0	2 0	1 0	10 0
6 „	7 0	5 0	2 0	1 0	10 0
5 „	7 0	5 0	2 0	1 0	8 0
4 „	5 0	3 0	2 0	1 0	8 0
3 „	5 0	3 0	2 0	1 0	8 0
	5 0	3 0	2 0	1 0	8 0

614 Fig. 17. **Bourdon's Registering Gauge**, in japanned case, graduated to 100 lbs. per square inch, with gun-metal Cock and Union, and 100 printed cards £7 15 0

Extra cards, (if required) per 100 . . . . . 0 8 0

615 Fig. 18. **Bourdon's Double Gauge**, to be set in Engine-rooms, and showing on the same dial (10 inches diameter) pressure of Steam in the Boiler, and the amount of Vacuum in the Condenser, Polished brass case, and two Cocks with Union £6 0 0

* A Table of Hydraulic Pressure will be found in the Appendix.

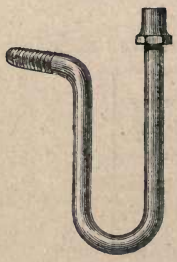


FIG. 24.

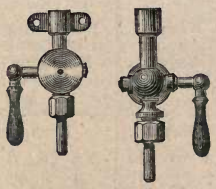


FIG. 20. FIG. 21.

FIG. 19.

FIG. 23. FIG. 22.

616 FITTINGS AND CONNECTIONS FOR BOURDON'S GAUGES.

			£	s.	d.
Fig. 19.	Connecting Screw Joint	each	0	1	6
Figs. 20 & 21.	Gun Metal Cock	„	0	4	0
Figs. 22 & 23.	Three-way Cock for Standard Test Gauges . .	„	0	6	0
Fig. 24.	Iron Syphon, with Union	„	0	4	0
Fig. 24.	Copper Syphon, with Union	„	0	4	6

Purchasers are desired to examine and compare M. Bourdon's Gauges. They will find the works to be constructed and finished like a watch, whilst the majority of imitations are put together ROUGH FROM THE CASTINGS, consequently liable to adhere and give erroneous indications.

NEGRETTI & ZAMBRA, SOLE AGENTS FOR BOURDON'S GAUGES.

GUN-METAL FITTINGS FOR MARINE, LOCOMOTIVE, AND OTHER STEAM ENGINES AND BOILERS.

Gun-metal Steam and Water Taps of all sizes and shapes, Safety Valves, Steam Whistles, Gauge Taps, High Pressure Water and Steam Valves, Gas Valves, Boiler Fittings of all kinds, Feed Pumps and Valves, Wrought Iron Steam, Gas, and Water Tubes, Boiler Tubes, Hand Force Pumps, Fire Engine and Brewery fittings, Pump fittings, Caps and Screws of every form, Hydraulic Presses and Force Pumps, Hydraulic Rams of various sizes and construction, Turning Lathes and Tools, Portable Forges and Smiths' Tools, &c., &c., Fencing Wire, Railway Metal Bars, Tools and appliances of all kinds supplied to order by Negretti and Zambra, of the very best manufacture.

Foreign Correspondents sending particulars of their requirements to Negretti and Zambra may rely upon the personal attention of the Firm in carrying out commissions entrusted to them in this special branch of their Shipping Business.

At pages 95 to 110. will be found Anemometers for testing Ventilating or Furnace Shafts and Wind Pressure, Recording Anemometers, and Tide Gauges, &c.

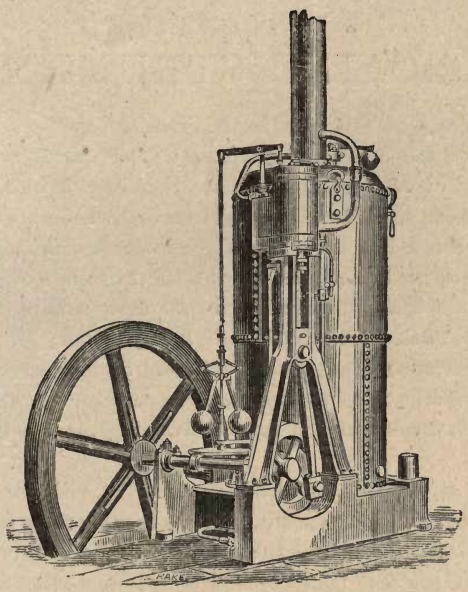


FIG. 617.

617 **Improved Combined Portable Steam Engine and Boiler.** These Engines are fitted with governor, throttle valve, safety valve, feed pump, water and steam gauge, &c., &c., *complete, ready for immediate use.* Recommended for simplicity and economy; well suited for Exportation.

Consumption of fuel, 7½ lbs. of coal } per horse power,
Ditto ditto water, 1 cubic foot } per hour

*Horse Power	Cylinder. Diameter.	Stroke.	Boiler.	Height.	Diameter.			
2	4-in.	10-in.	„	5-ft. 0-in.	2-ft. 4-in.	£73	0	0*
3	4¾-in.	10-in.	„	5-ft. 6-in.	2-ft. 4-in.	85	0	0*
4	5½-in.	12-in.	„	7-ft. 0-in.	2-ft. 4-in.	105	0	0
6	6½-in.	14-in.	„	8-ft. 0-in.	2-ft. 8-in.	165	0	0

* 2 and 3, if not fitted with Governors, less £5.

The fly-wheel shaft is made sufficiently long to admit of a drum being fixed on if required, which can be supplied (to any diameter ordered) along with the Engine, at an extra cost according to size.

The above Engines occupy a very small space, and will be found admissible in places where no other form of engine and boiler could be fixed. They are constructed in an exceedingly substantial and simple manner, every part being perfectly easy of access, and consequently can be readily understood and managed.

The boilers are fitted up with strong welded tubes (varying in number according to the size of the boiler), intersecting the fire-box, and a mud hole is placed opposite each tube, for the purpose of cleaning them out. They are tested up to 200 lbs. pressure to the square inch.

The foundation plate answers the purpose of feed water tank, in which the water is heated before passing into the boiler; and also of an ashpit.

No brickwork or foundation is required.

N. and Z. will forward special quotations to Foreign Correspondents for Steam and Gas Engines or other Machinery upon receiving details of the nature and amount of work to be performed.

OPTICAL INSTRUMENTS.

THE science of Optics, which consists in the examination of the phenomena of light and vision, is one of the most important and most useful branches of physical science. By the aid of its appliances we are permitted to obtain a glimpse of the immensity of the universe, and are enabled to reveal wonders of creation, of which but for this power granted to us we should be in perfect ignorance. By means of the **Telescope** we are made acquainted with the existence of spheres and worlds floating in boundless space, illustrating in the most sublime manner the perfect harmony that exists in the motions of the heavenly bodies.

The **Microscope** affords an insight into the minute structure of animal and vegetable life, and discloses to the wondering spectator forms of life, the variety and beauty of which display in the most convincing manner the infinite power of the Great Creator.

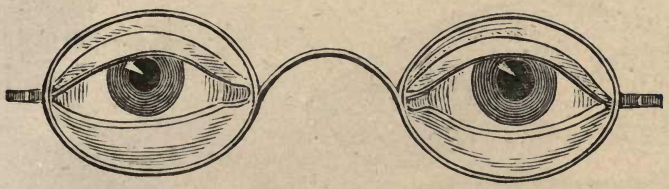
But of all the gifts which science has so freely lavished on humanity, and all tending to its benefit and improvement, perhaps there is none that can rank higher than the means afforded of assisting the natural vision, and of enabling us to correct in a most simple and perfect manner the irregularities of sight, which are consequent on alterations silently going on in the structure of that wonderful and delicately constructed organ, the Eye. The sight has in all time been justly accounted the greatest of blessings, and it deserves our strictest attention in order that the advantages of it may not be lost to us at an earlier period than is absolutely necessary from physical decay.

Those beginning to require the aid of **Spectacles** are obliged, before distinct vision can be obtained, to hold the candle or to have the source of light between the eye and the book they read, in order to force the pupils of their eyes into a proper state of contraction, that they may see distinctly the characters before them. Now this is a state of things that should never occur, for if indulged in, and the eye be tampered with, it will eventually lead to great impairment of vision. The power of adjustment in the eyes varies exceedingly in different individuals and also at different periods in the life of each person; being strongest in youth, and gradually diminishing with advancing years.

From this circumstance it is easy to see the reason of the fatigue caused by the strain on the ciliary process of the eye in bringing it to a proper adjustment for objects at different distances, and an individual who has habitually to make an effort to adjust his eye to these variations of circumstances, should lose no time in applying to the Optician to obtain assistance from the use of glasses.

From what we have said above, let it not be supposed that the indiscriminate use of Spectacles is recommended; very far from it. We must, before resorting to Spectacles, ascertain the nature of the defect in the visual organs, and then have the amount, and only the exact amount of correction applied; just in the same manner as with a telescope, we are obliged to draw out the eye-tube until a perfect image appears in the field of view, nothing more or less will suffice to this end.

SPECTACLES.



READING & EYE GLASSES, EYE PRESERVERS, &c.,

TO SUIT ALL AGES AND SIGHTS, GLAZED WITH THE FINEST BRAZILIAN PEBBLES OR BEST OPTICAL CROWN GLASS.

NOTICE.

N. & Z. devote especial care and attention to Oculists' Prescriptions, and no advance in prices is made unless extra deep lenses, Cylindrical lenses, or Prisms are ordered. N. & Z. cannot specify within the limits of this List the various combinations which influence the price, but if desired, the price may always be ascertained before ordering.

The greatest care taken that the Pebble, or Glass Lenses, are correctly worked and polished, as well as carefully tested and suited to the sight of the Purchasers, and also that the Frames are formed to fit the face.

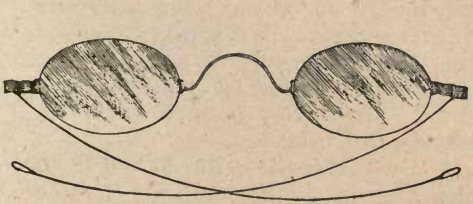


FIG. 618.

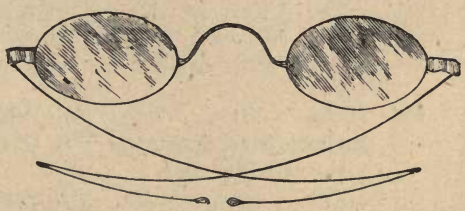


FIG. 618*.

		Each. £ s. d.	Each. £ s. d.
618	**Fine Blue or Bronzed Steel Spectacles,** with straight or turn pin sides (figs. 618 and 618*)	0 10 6	0 12 6
619	Ditto ditto ditto, with Pebbles . 15s.	0 17 6	1 1 0
620	**Fine Blue or Bronzed Steel Spectacles,** with straight or turn pin sides (figs. 618 and 618*), extra large lenses .	0 12 6	0 15 0
621	Ditto ditto ditto, extra large Pebbles .		1 5 0
622	**Blue Steel Spectacles,** with straight sides (fig. 618) .	0 2 6	0 3 6
623	Blue or Bronzed ditto ditto	0 5 6	0 7 6
624	**Cataract Spectacles,** in various mountings . 10s. 6d.	0 15 0	1 1 0

Cataract Spectacles are mostly made specially to meet the requirements of the Patient.

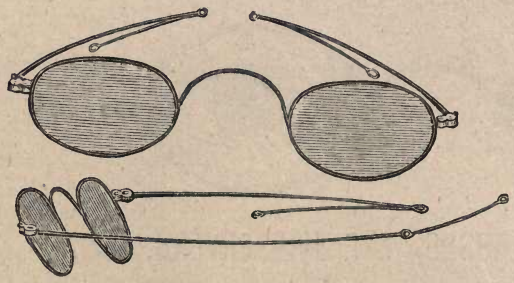


FIG. 619.

FIG. 619*.

619 The **Patent Pantoscopic Spectacles** are so constructed as to enable the wearer to read or write with comfort. When the Spectacles are on the face, the position of the lenses is such that the light passes through them at right angles to their urfaces, and the upper part of the lenses being slightly straightened, enables the earer to converse with anyone, or see distant objects, without looking through he lenses or drawing the Spectacles down upon the face. Figs. 619 and 619*. N. & Z. strongly recommend this form of Spectacles.

		Each. £ s. d.	Each. £ s. d.
620	**Patent Pantoscopic Spectacles**, in light blue steel, for ladies or gentlemen, with the best Periscopic Lenses		0 10 6
621	Ditto ditto, with best Brazil Pebbles . . .	0 15 6	1 1 0
622	Ditto ditto, in Solid Gold, with best Brazil Pebbles 42s.	2 10 0	3 3 0
623	Ditto ditto, in Solid Silver, with ditto .	1 1 0	1 10 0
624	**Invisible Steel Spectacles**, blue or bronzed, with straight sides. The lenses are grooved to receive the frame, which, being extremely light, is scarcely visible. These Spectacles are specially adapted for Concave lenses worn by short-sighted persons. Straight or turn pin sides 10s. 6d., 12s. 6d., 15s.		
625	Ditto ditto ditto, with Pebbles . . . 15s.	0 18 0	1 5 0
626	**Invisible Steel Spectacles**, with Curled sides to fit behind the ears (fig. 626) . . . . . 10s. 6d.	0 12 6	0 18 0
627	Ditto ditto ditto, with Pebbles . . . 15s.	0 18 0	1 5 0

628 **Gold Spectacles**, fitted with Pebbles, Light Frames :—

	10 Carat.	12 Carat.	15 Carat.	18 Carat.
Single Sides	£1 7s. 6d.	£1 17s. 6d.	£2 12s. 6d.	£3 15s. 0d.
Turn Pin do.	£1 11s. 6d.	£2 4s. 0d.	£3 0s. 0d.	£4 5s. 0d.

629 Ditto ditto ditto, Strong Frames :—

Single Sides	£1 11s. 6d.	£2 8s. 0d.	£3 0s. 0d.	£4 4s. 0d.
Turn Pin do.	£1 17s. 6d.	£1 12s. 6d.	£3 7s. 6d.	£5 0s. 0d.

630 Ditto ditto ditto, Extra Stout Frames :—

Single sides	£2 2s. 0d.	£2 15s. 0d.	£3 15s. 0d.	£5 0s. 0d.
Turn Pin do.	£2 5s. 0d.	£3 3s. 0d.	£4 10s. 0d.	£5 15s. 0d.

631 *Either of the above Spectacles may be had with Patent Pantoscopic Frames without extra cost, as Fig.* 619.

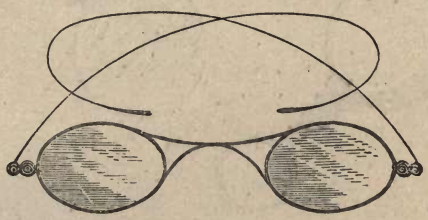


FIG. 626.

632 **Invisible Gold Spectacles,** with Curled Sides to fit behind the ears.

The lenses grooved to receive the frame (as Fig. 626), 12 Carat, with glasses £1 to £2, with Pebbles, £2 to £2 10s.

N. & Z. do not recommend a higher quality gold for these Spectacles, it being too soft for durability.

633 **Sterling Silver Spectacles—**

12s. 6d. 15s. £1, and upwards, according to weight.

634 Ditto ditto, with Pebbles, 18s. £1 1s. £1 5s. „ „

Gold and Silver Spectacles are strongly recommended to persons residing in Tropical Climates, or at the Seaside, as they resist the action of moisture.

635 **Gold Double Eye Glasses,** (folding).—The frames and the springs are of Gold throughout, and with shell placquets to those parts which touch the nose. Fitted with Pebbles.

Light Frames :—

	10 Carat.	12 Carat.	15 Carat.	18 Carat.
Figs. 640* & 640†	£1 1s. 0d.	£1 10s. 0d.	£2 2s. 0d.	£2 10s. 0d.
Fig. 640	£1 5s. 0d.	£1 15s. 0d.	£2 5s. 0d.	£3 0s. 0d.

Strong Frames :—

Figs. 640* & 640	£1 15s. 0d.	£2 0s. 0d.	£2 10s. 0d.	£3 5s. 0d.
Fig. 640	£2 0s. 0d.	£2 7s. 6d.	£3 3s. 0d.	£4 0s. 0d.
Fig. 646	£2 2s. 0d.	£2 10s. 0d.	£3 5s. 0d.	£4 4s. 0d.

Extra Stout Frames :—

Figs. 640* & 640	£2 5s. 0d.	£3 3s. 0d.	£3 15s. 0d.	£4 15s. 0d.
Fig. 644	£2 15s. 0d.	£3 10s. 0d.	£4 4s. 0d.	£5 10s. 0d.
Fig. 646	£3 3s. 0d.	£4 0s. 0d.	£5 0s. 0d.	£6 6s. 0d.

FIG. 636.

FIG. 636*.

636 **Gold Double Eye Glasses** (folding), with round or oval eyes, with **Pebbles**. (Figs. 636 and 636*).

Strong Frames :—

10 Carat.	12 Carat.	15 Carat.	18 Carat.
£2 5s. 0d.	£2 15s. 0d.	£3 15s. 0d.	£4 15s. 0d.

Extra Strong Frames :—

£2 10s. 0d. £3 3s. 0d. £4 0s. 0d. £5 10s. 0d.

637 Ditto ditto ditto, with Spring and Catch, round or oval eyes, with **Pebbles**, (Figs. 636 and 644). Extra Strong Frames :—

£2 15s. 0d. £3 10s. 0d. £4 5s. 0d. £5 15s. 0d.

638 Ditto ditto ditto, with Rigid Bridge, folding, but used open and held in the hand. Round eyes only, with **Pebbles** (Fig. 636*).

Extra Stout Frames :—

£3 15s. 0d. £4 4s. 0d. £5 5s. 0d. £6 6s. 0d.

FIG. 640†.

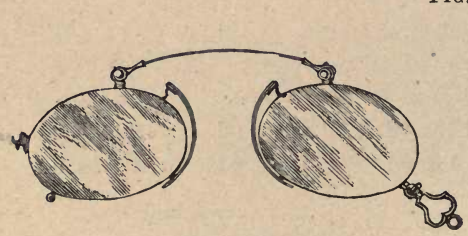


FIG. 640.

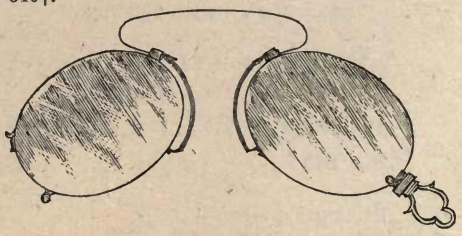


FIG. 640*.

DOUBLE EYE GLASSES (Folding).

VARIOUSLY-CONTRIVED SPRINGS TO SUIT DIFFERENT FORMS OF FACE.

		Each. £ s. d.	Each. £ s. d.
639	**Blue or Bronzed Steel Double Eye Glasses** (Fig. 640*) .	0 3 6	0 5 6
640	**Best Nickel Plated Steel Ditto ditto** (Figs. 640 and 640†) having Shell Placquets to those parts which touch the nose . . . . . 5s. 6d.	0 7 6	0 10 6
641	Ditto ditto ditto, with **Pebbles** . 12s. 6d.	0 15 0	1 1 0

		Each. £ s. d.	Each. £ s. d.
642	**Best Nickel Plated Steel** (Figs. 640 and 640*), highly finished invisible frames, with Grooved lenses . .	0 10 6	0 12 6
643	Ditto ditto ditto with **Pebbles** . . 15s.	0 18 0	1 5 0

FIG. 650.

FIG. 646.

FIG. 644.

644	**Tortoise-shell Double Eye Glasses** (Fig. 644) Round or Oval . . . . . 7s. 6d.	0 10 6	0 12 6
645	Ditto ditto ditto, with **Pebbles** 12s. 6d.	0 15 0	0 17 0
646	**Tortoise Shell Double Eye Glasses** (Fig. 646), with Solid Steel Bridge . . . . . 12s. 6d.	0 15 0	0 17 6
647	Ditto ditto ditto, with **Pebbles** . . .	1 1 0	1 5 0
648	Ditto ditto ditto, with Solid Gold Bridge .	1 5 0	1 10 0
649	Ditto ditto ditto, with **Pebbles** . . .	1 10 0	1 15 0
650	Ditto ditto ditto (Fig. 650), Round or Oval Eyes . . . . . 7s 6d.	0 10 6	0 12 6
651	**Vulcanite Double Eye Glasses** (shape as Figs. 644 and 650) 2s. 6d. 3s. 6d.	0 4 6	0 5 6

652 Figs. 640, to 650 show recent improvements in **Clip-Nose, (Pince-Nez) Spectacles, or Folders.** The Cushions, or Placquets, on the inner edges of the Frame distribute the pressure over a large surface, causing the Folder to fit exceedingly firm on the face, and parallel to the eyes. These forms of Folders, known as Chinese, Japanese, American Extension, or Non-Pressure, are found to be the most comfortable in wear yet introduced.

SINGLE EYE GLASSES.

FIG. 653.

FIG. 654.

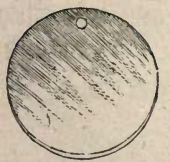


FIG. 657.

		Each.			Each.		
		£	s.	d.	£	s.	d.
653	**Gold Eye Glasses**, single (fig. 653), fitted with Pebbles for short sights, according to quality and substance 10s. 6d.	0	12	6	0	15	0
654	**Gold Eye Glasses**, single (fig. 654), fitted with Pebbles for long sights, ditto ditto, 21s., 30s.	2	0	0	2	10	0
655	**Shell Rim Eye Glasses**, (fig. 653), fitted with Convex or Concave glasses . . . . . 2s.	0	2	6	0	3	6
656	Ditto ditto ditto, (fig. 654), fitted with Convex or Concave glasses . . . . . 3s. 6d.	0	5	6	0	10	6
657	**Rimless Eye Glasses**, (fig. 657), Concave or Convex glass				0	1	0
658	Ditto ditto ditto, Meniscus Concave or Convex glass	0	1	6	0	2	6

GOLD HAND SPECTACLES (Folding).

FIG. A.

FIG. B.

FIG. C.

FIG. D.

659 **Gold Hand Spectacles** (folding), with Spring Joints, richly engraved, chased, enamelled or inlaid; fitted with **Pebbles** for long or near sights—10 Carat, £4 4s.; 12 Carat, £5 5s., £5 10s., £6 6s.; 15 Carat, £6 6s., £6 10s., £7 7s.; 18 Carat, £7 7s., £8 8s. and upwards (figs. A, B, C, D).

660	**Silver Gilt** ditto ditto ditto, fitted with Pebbles (figs. A, B, C, D) . . . . . 40s., 45s.	2	10	0	3	3	0
661	**Tortoise-shell or Mother-o'-Pearl Fronts**, with Silver-gilt settings, fitted with Glasses . . 18s., 21s., 25s.	1	10	0	2	0	0

SPECTACLES AND EYE PROTECTORS FOR PRESERVING THE EYES FROM EXCESSIVE LIGHT, GLARE FROM SNOW, AND FROM WIND OR DUST.

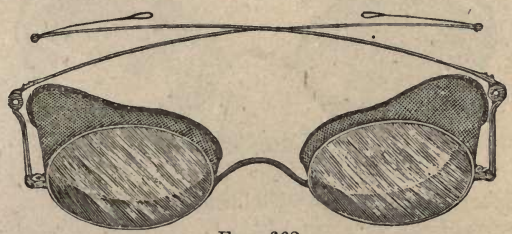


FIG. 662.

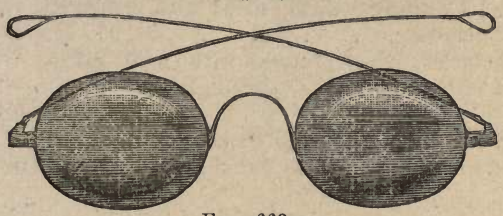


FIG. 663.

		Each. £ s. d.	Each. £ s. d.
662	**Best Solid Steel Frame Eye Protectors or Dust Spectacles,** (fig. 662) with wire gauze or crape cups, and fitted with smoke or blue tinted *flat glasses* of the finest quality . . . . . 10s. 6d.	0 15 0	1 1 0
663	**Best Solid Steel Frame Eye Protectors,** (fig. 663) with wire gauze cups, and fitted with large smoke or blue tinted Cup Shaped or *Spherical Glasses* of the finest quality . . . . . 10s. 6d.	0 15 0	1 1 0
664	**Best Steel Spectacles,** (fig. 663), fitted with large smoke or blue tinted *spherical glasses* of the finest quality 10s. 6d.	0 12 6	0 15 0
665	Ditto ditto, fitted with large smoke or blue tinted *spherical glasses* . . . . . 7s. 6d.	0 10 6	0 12 6

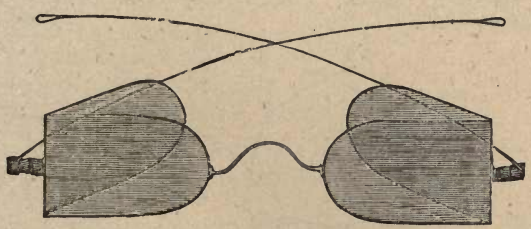


FIG. 666.

666	**Best Steel Frame D Eye Preservers,** (fig. 666) fitted with best smoke or blue tinted glasses, both in front and at the sides . . . . . 10s. 6d.	0 12 6	0 15 0
667	**Ordinary Steel Frame D Eye Preservers,** fitted with smoke or blue tinted glasses and with gauze side shades 5s. 6d.	0 6 6	0 7 6

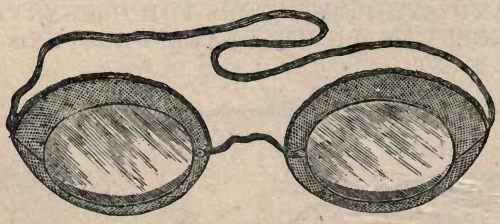


FIG. 671.

		Each. £ s. d.	Each. £ s. d.
668	**Best Steel Spectacles,** (fig. 618) with large smoke or blue tinted glasses of the finest quality	0 7 6	0 10 6
669	**Ordinary Steel** ditto ditto fitted with smoke or blue tinted glasses . . . . 2s. 6d., 3s.	0 3 6	0 5 6
670	**Goggle Spectacles,** steel frame, with wire gauze cups, fitted with smoke or blue tinted glasses 3s. 6d., 5s. 6d.	0 6 6	0 7 6
671	**Goggles,** (fig. 671) to fit the head by means of an elastic band, fitted with smoke or blue tinted glasses from	0 1 6	to 0 10 6

FIG. 682.

FIG. 689.

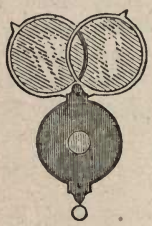


FIG. 683.

672	**Best Nickel Plated Steel Folding Eye Glasses,** (fig. 640*) with smoke or blue tinted *Cup Shape or spherical glasses*	0 10 6	0 12 6
673	Ditto ditto ditto, with smoke or blue tinted *flat glasses*	0 7 6	0 10 6

FIG. 675.

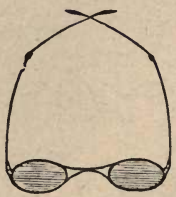


FIG. 678.

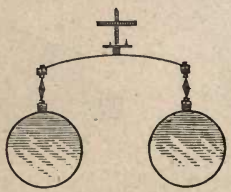


FIG. 676.

674	**Steel Folding Eye Glasses,** with smoke or blue tinted glasses	0 3 6	to 0 5 6
675	**Shooting or Hunting Eye Glasses,** steel mounted, with joints and screws for attaching to the **Hat** (fig. 675) .	0 7 6	0 10 6
676	Ditto ditto ditto double (fig. 676) .		1 5 0

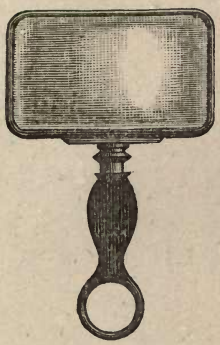


FIG. 687.

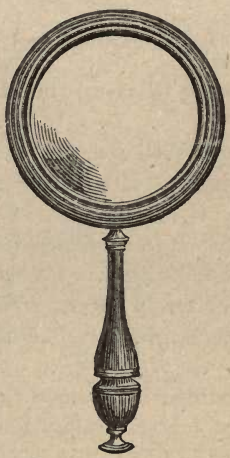


FIG. 686.

FIG. 685.

		Each. £ s. d.		Each. £ s. d.
678	**French Pattern Spectacles,** (fig. 678) with Single or Double sides, Gold	1 10 0	to	3 3 0
679	Ditto ditto ditto Best Steel . .	0 10 6		0 12 6

It is not generally known that what are termed "Pebbles," as used in the construction of spectacle lenses, are cut from Rock Crystal. For such no better substance is obtainable when free from impurities, being much harder and brighter than glass. The difficulty, however, of obtaining "Pure Pebbles" is great, and not until much labour has been expended in cutting and polishing can any of the many defects be discovered which ultimately cause their rejection. It is in consequence of a large percentage of loss in the production of "Pebble Lenses" that the cost is so much greater than glass; but it is only apparent, as the advantages of a higher polish, the non-liability to scratch or break, well compensate for the outlay.

For the information of those who sometimes imagine their Spectacles no longer serviceable, Negretti & Zambra beg to say that a little expense will often, for all practical purposes, make them equal to new. The re-working of a pair of pebbles to a higher power, a new glass, soldering a broken frame, or a new spring to an eye glass, will frequently accomplish this end.

These repairs are executed at moderate charges and returned by post in the shortest possible time from their receipt with instructions.

Spectacles made to order of any shape or material, and fitted with lenses worked to any particular form. Pebbles re-worked and altered to suit the variation of sight.

Spectacles or Eye Protectors, Gilt Plated or Nickeled, to prevent rust, at a slight advance on prices quoted.

Spectacles suited to the Sight by sending an old Lens or piece of a broken one.

---

680 "SPECTACLES, WHEN TO WEAR AND HOW TO USE THEM:" addressed to those who value their sight. Published by NEGRETTI AND ZAMBRA.
Price (post-free), 6d.

		Each. £ s. d.	Each. £ s. d.
681	**Spectacle Cases**, Leather, various forms and mountings 6d.	0 1 0	0 5 0
682	**Oval and Round Reading Glasses**, in Horn cases (fig. 682) . . . . . 2s. 6d.	0 5 0	0 7 6
683	Ditto ditto Tortoise-shell case (fig. 683) . .	1 10 0	2 2 0
684	Ditto ditto in Pearl, with Silver mountings (fig. 682)	1 1 0	2 2 0
685	**Cylindrical Lenses**, in oblong Horn, Vulcanite, or Metal Frames (fig. 685) . . . . 15s. 6d.; 17s. 6d.	1 1 0	1 5 0
686	**Print Lenses**, of various sizes, in turned Wood Frames, for viewing large Maps, Engravings, Photographs, &c. (fig. 686) . . . . . 21s.	1 11 0	2 2 0
687	**Magnifying Lenses**, mounted in German Silver, with Wood Handles, suited for examining Photographs, Engravings, &c. (fig. 687) 2s. 6d., 3s., 3s. 6d., 4s. 6d., 5s. 6d., 7s. 6d., 8s. 6d., 10s. 6d., 12s. 6d.	0 15 0	1 5 0
688	Ditto ditto with Ivory Handles and Gilt mountings 6s. 6d., 8s. 6d., 10s. 6d., 12s. 6d., 15s. 6d.	1 1 0	1 5 0
689	Ditto ditto mounted in buffalo Horn or Ebonite (fig. 689) 3s. 6d., 4s. 6d., 5s. 6d., 6s. 6d., 7s. 6d.	0 10 6	0 12 6

NEGRETTI & ZAMBRA'S THERMOSCOPIC SPECTACLES,

FOR THE RELIEF OF WEAK, DIM, AND IMPERFECT VISION.

Enabling the wearer to read or work with comfort by Gas or Candle-light.

690 These Spectacles are the result of a series of experiments, undertaken with the view to the manufacture of a glass that should possess the power of arresting the heat that proceeds from gas-light and other sources of artificial illumination.

This desirable end having been attained by Messrs. NEGRETTI AND ZAMBRA, they are enabled to supply Spectacles, the glasses of which possess this peculiarity; that is to say, that the great heating power of gas and other artificial light is rendered imperfectly inert as far as regards vision, and the amount of light that enters the eye nearly equal to that which would do so through ordinary glasses; by this means the unsightly dark glasses are superseded, and greater comfort is secured while reading or working by gas-light; at the same time the sight is preserved from the pernicious effects of the heat, and the eyes are kept as cool as when reading by ordinary daylight. The Thermoscopic Spectacles will be found, therefore, to recommend themselves to those whose avocations require great application to the desk, more especially during the winter months, in the banks and public offices generally, where of necessity a vast amount of writing and accountants' work has to be done by gas-light.

Price, in Best Steel Frames, with either Convex or Concave Lenses

£0 15 0 to 1 1 0

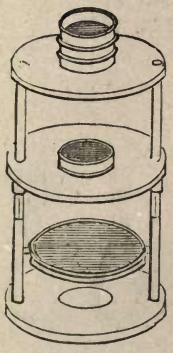


FIG. 696.

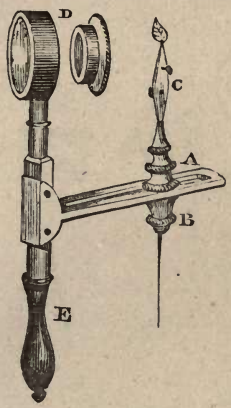


FIG. 691.

FIG. 700.

FIG. 700*.

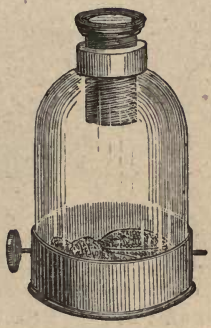


FIG. 695.

MAGNIFIERS AND POCKET MICROSCOPES.

		Each £	s.	d.	£	s.	d.
691	**Flower Microscopes**, folding up into convenient size, with neat cases for the pocket (fig. 691) . . .	0	7	6	0	10	0
692	**Gardener's Microscope** in case (fig. 692)	0	2	6	0	5	0
693	**Seed Microscopes**, with glass body, in case . . 2s.	0	4	6	0	7	6
694	**Beetle or Insect Microscopes**, convenient for examining living insects . . . . . 3s. 6d.	0	4	6	0	7	6
695	Ditto ditto large size, best mounted (fig. 695)	0	10	6	0	15	0
696	**Botanical Microscopes**, with three powers, mirror, &c., in pocket case (fig. 696)				1	1	0

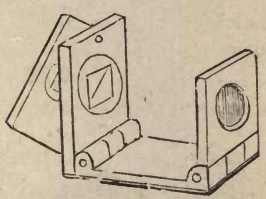


FIG. 698.

FIG. 692.

FIG. 698*.

FIG. 697*.

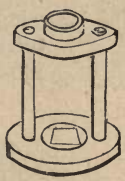


FIG. 697.

697	**Cloth Microscopes or Linen Provers**, for ascertaining the number of threads in a given space of linen, cloth, &c., in round case (figs. 679 and 697*) . . .				0	2	6
698	Ditto ditto folding for Pocket (figs. 698 and 698*) 2s. 6d.	0	3	0	0	5	6
699	Ditto ditto for Coarse Goods, extra large . .	0	5	6	0	7	6
700	**Watchmakers' and Engravers' Magnifiers** (fig. 700) 1s.	0	1	6	0	2	6
701	**Pocket Magnifiers**, in Horn mountings (fig. 701) . .	0	2	0	0	2	6
702	Ditto ditto two lenses	0	3	6	0	4	6
703	Ditto ditto, three ditto (fig. 703) . . . 3s.	0	4	0	0	5	0
704	Ditto ditto one, two, or three lenses, in Tortoise-shell mountings (fig. 704) . . . . . 5s. 6d.	0	10	6	0	15	0
705	Ditto ditto Tortoise-shell and Gold. Pearl and Silver mountings with Single or Double lenses, (fig. 705).				*Prices various.*		

FIG. 701.

FIG. 705.

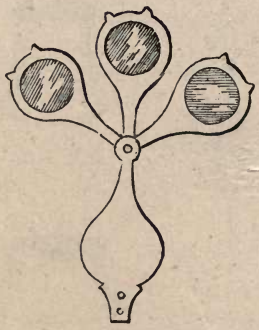


FIG. 703.

FIG. 706*.

FIG. 706.

FIG. 708.

		Each. £ s. d.	Each. £ s. d.
706	**Stanhope Lenses**, in German Silver mountings (figs. 706 and 706*)	0 3 6	0 5 0
	Ditto ditto in Tortoise-shell ditto . . .	0 10 6	0 12 6
707	Ditto ditto, in Silver ditto	0 10 6	0 15 0

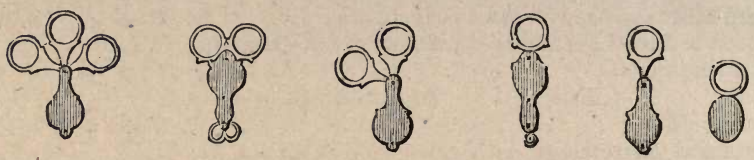


FIG. 704.

708 **Stanhope Lens**, mounted with shade for the eye, and tube for improving the definition, magnifying power 180 diameters (fig. 708) 0 12 6

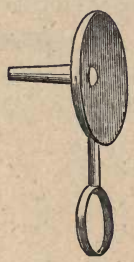


FIG. 708.

This powerful and convenient lens is the invention of Lord Stanhope. The portability, low price, and the facility with which it can be used, recommend it strongly. With it may be seen the animalculæ in water, eels in paste and vinegar, farina of flowers, the down of moths, &c.; and if a drop of solution of salt be spread lightly over the end of the lens, and viewed without delay, the formation of crystals will be beautifully seen.

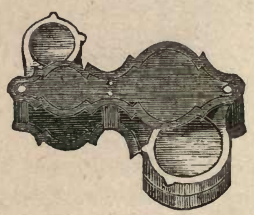


FIG. 712.

709	**Coddington's Spherical Lens**, in German silver Mounting . . . . . 3s. 6d.	0 5 0	0 10 6
710	Ditto ditto in Tortoise-shell	0 10 6	0 15 0
711	Ditto ditto in Silver	0 15 0	1 5 0
712	**Pocket Magnifier**, with two plano-convex lenses, diaphragm, and a Stanhope or Coddington lens, in Tortoise-shell mountings (fig. 712). . 12s. 6d.,	0 16 6	1 5 0

The most useful pocket magnifier or microscope introduced, magnifying power 10 to 80 diameters.

VARIOUS OPTICAL INSTRUMENTS.

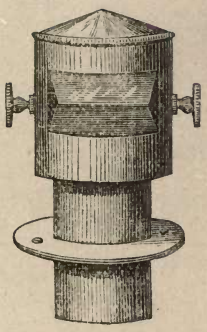


FIG. 743.

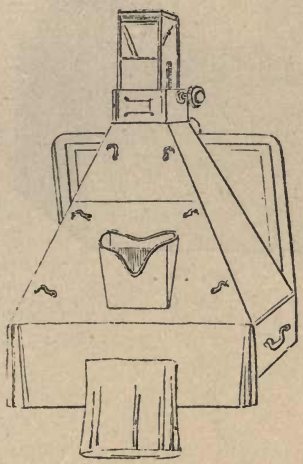


FIG. 741.

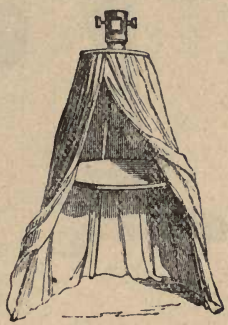


FIG. 742.

		Each. £ s. d.	Each. £ s. d.
713	**Concave and Convex Mirrors**, Silvered Glass, in turned Wood Frames 16s., 21s.,	2 2 0	5 0 0
714	**Multiplying Mirrors** . . . . . 10s. 6d.	1 5 0	1 10 0
715	**Black Mirrors**, for Artists	1 1 0	1 16 0
716	**Burning Glasses**, in Horn mountings . . . 2s.	0 2 6	0 5 0
717	**Glass Prisms**, for showing Decomposition of Light, of various sizes . . . . . 2s. 6d., 5s.	0 10 6	1 6 0
718	**Glass Prisms**, two in a neat box for exhibiting the Decomposition of Light into the Prismatic Colours and their Recomposition into White Light, &c. .		0 6 6
719	**Prism Compound** of Flint, Crown, and Plate Glass .		1 10 6
720	**Prisms** mounted with Ball and Socket joint adjustment on Brass foot	1 16 0	2 2 0
721	**Hollow Glass Prism**, for experiments on the refraction of Fluids, and for Spectroscopes	1 1 0	1 10 0
722	**Multiplying Lenses**, in frame . . . . 2s. 6d.	0 3 0	0 5 0
723	**Claude Lorraine Glasses**, for studying the effect of colour upon Landscapes, &c.	0 15 6	1 1 0
724	**Colour Tops**, a simple contrivance for exhibiting the recomposition of white light from colours . .		0 10 6
725	**Apparatus** for ditto ditto, on a larger scale, with multiplying wheel, on Stand with Circular Prismatic Disc (fig. 725)		2 10 0
726	**Kaleidoscopic Colour Top**, with perforated discs and coloured diagrams, complete; in box . . .	0 12 6	1 1 0
727	**Concave Lenses**, in frame, for viewing Engravings, &c.	0 10 6 to	2 2 0

FIG. 725.

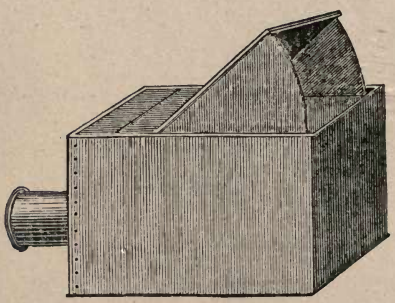


FIG. 740.

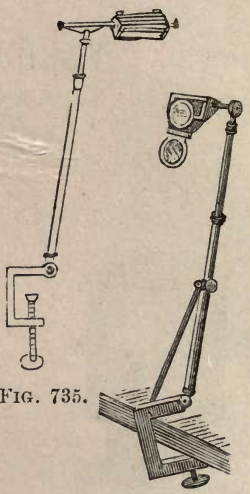


FIG. 735.

FIG. 736.

		Each. £ s. d.	£ s. d.
728	Graphoscopes, see page 228		
729	Diagonal Print Machines, for viewing Prints, &c. . .		3 3 0
730	Cosmoramic Frames and Lenses	0 15 0	2 2 0
731	Print or Map Lenses, various mountings and sizes, see page 222		
732	Cylindrical Magnifying Lenses, in Vulcanite mountings, 10s. 6d., 12s., 14s., 16s., 21s., 25s., 30s., 35s.	2 2 0	3 3 0
733	Cylindrical Mirrors, with 6 diagrams		1 10 0
734	Mirrors, Conical, with 12 diagrams		1 15 0
735	Camera Lucida, Wollaston's *(Chambre Claire)*, for drawing in true perspective, in case (fig. 735) . .	1 10 0	2 10 0
736	Ditto ditto, best form with Shades, &c., (fig. 736) .	3 3 0	5 5 0
737	Portable Stand for ditto		2 2 0
738	Camera Lucida, for Microscope	See Micro Section	
739	Beale's Neutral Tint Camera or Reflector, *for ditto.*	*See also*	
740	Draughtsman's Camera Obscura (*Chambre Noire*), for sketching (fig. 740) . . . . . 21s.	1 15 0	2 2 0
741	Ditto ditto improved Portable (fig. 741) . .		6 6 0
742	Cosmorama or Camera Obscura, for Gardens, &c., fitted up to order (fig. 742)		
743	Prisms, Plano-Convex, in Brass mountings, with sliding adjustment (fig. 743) for constructing Garden Cameras (as fig. 742), of various dimensions and foci . . . . . 38s., 45s.	2 10 0	5 10 0

FIG. 760.

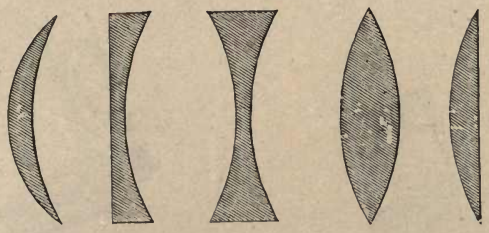


FIG. 744.

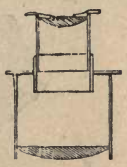


FIG. 761.

		Each. £ s. d.	£ s. d.
744	**Set of Five Lenses** of various forms and curves, (fig. 744), with a small Prism to illustrate the Science of Optics, in a hinged case	1 5 0	1 16 0
745	**Model of the Human Eye**, showing the position of various humours and Lenses, and for demonstrating the cause of Presbyopia or Long Sight; Myopia, Short or Near Sight, &c., &c. In Mahogany Box . .		6 6 0
746	**Kaleidoscopes**, with two or three reflecting planes 2s. 6d.	0 5 6	1 10 0
	Ditto ditto, on Table Stand 7s. 6d., 10s. 6d.	0 15 0	1 1 0
747	**Chromeidoscope**, a modification of the Kaleidoscope .	1 10 0	2 2 0
748	**Debuscope**, or Table Kaleidscope, with Plated Metal Reflectors		0 10 6
749	**Spectroscope**, for Chemical research. See Chemical Section		
750	**Photometers**, Wheatstone's	2 10 0	3 3 0
751	Ditto for Gas Testing . . See Chemical Section		
752	**Radiometer**, Crook's . . . ditto ditto		
753	**Goniometer, Wollaston's**, for measuring the angles of Crystals		5 5 0
754	**Anorthoscope**, with twelve diagrams (fig. 725) . .		2 2 0
755	**Praxinoscope**, a novel and pleasing arrangement of the above with six coloured pictures . . . 16s.	1 5 0	1 15 0
756	**Polemiscope**, by means of which any object may be seen, though an opaque body be placed before it . .		3 3 0
757	**Phantascope**, for exhibiting the illusion effected by a concave mirror, projecting figures in air . . .		4 4 0
758	**Polyorama**, with six views, so constructed that day and night effects are produced by means of reflected and transmitted light		2 2 0
759	**Videoscope**, for Reading, Drawing, Engraving, &c., having a clamp to screw the Instrument to the table, with joint and sliding adjustment with clamp . .		1 10 6
760	**Visuometer, Photographic** (fig. 760), for enabling the artist to judge the effect of a landscape, folding for the pocket		0 4 6
761	**Focussing Glass, Photographic** (fig. 761), for obtaining a perfectly sharp image on the focussing Screen of the Camera	0 12 6	0 16 0

Lenses or Prisms of all kinds made to order.

Models and Diagrams to explain and demonstrate the Elementary Laws of Optics, the Theory of Vision, the construction of Refracting and Reflecting Telescopes, Simple, Compound, and Solar Microscopes, &c., &c., supplied to order.

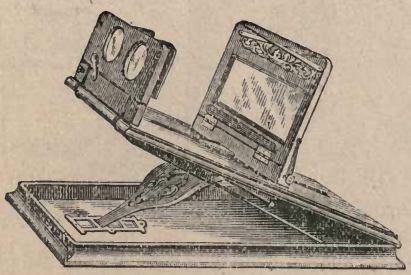


FIG. 762.

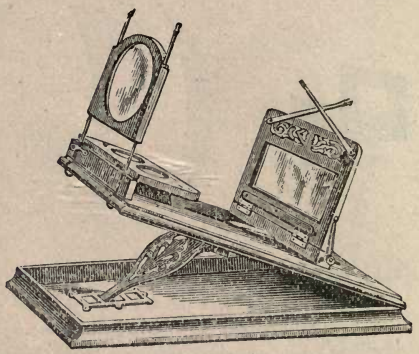


FIG. 762*

NEGRETTI AND ZAMBRA'S GRAPHOSCOPE,

FOR VIEWING PHOTOGRAPHS, DRAWINGS, AND PICTURES OF EVERY KIND,

As constructed and Patented by its Inventor, Mr. C. J. ROWSELL, and shown in the class "Scientific Inventions," at the **International Exhibition** (1871).

So simple is this instrument, that little need be said as to the mode of using. It can be focussed to suit any sight—the oldest or youngest, the longest or shortest. Plain or Coloured Photographs, when viewed through the Large Lens, will be found to stand out with the roundness and reality of natural objects. It occupies little space, cannot get out of order, and is an ornament to any drawing-room. The Graphoscope may be used either by day or night.

In the beautiful **Photographic "Nature Printing,"** there is much that the unassisted eye cannot perceive, but which appears among the distincter portions portrayed, as a dark or light mass only. The **Graphoscope**, by a simple but effective arrangement, and a powerful Lens easily adapted to any focus, "**brings out**" and gives a **Stereoscopic** life-like effect to this, and to the whole subject in a very pleasing and beautiful manner; also, by a simple combination, it forms a perfect **Stereoscope** for both Opaque and Transparent views. The **Graphoscope**, with an appropriate selection of Coloured or Plain Photographs, forms a **most elegant Wedding or other Present.**

		Each. £ s. d.	Each. £ s. d.
762	**No. 1. Graphoscope, Ordinary Size, with Stereoscope,** *Mahogany* (figs. 762 and 762*)		2 12 6
763	**No. 2.** do. do. *Walnut* . .		3 3 0
764	**No. 3. Large Size** do. *do.* . .		5 5 0
	No. 3*. Extra do. do.	6 6 0	7 7 0
765	**No. 4. The Piccolo, a small Instrument** . . .	1 10 0	1 16 0

Negretti and Zambra have always in Stock a collection of Photographic Views of London and various parts of the World—Photographic Flowers and views of the Crystal Palace, Sydenham—both coloured and plain, Statuary, &c., &c.

766 Plain Photographic Views, 2s. 6d., 4s. 6d.; Coloured Flowers and Views, 4s. and 5s.

A vase containing a bouquet of Natural Flowers placed in the field of the large lens forms an exceedingly interesting object. When the Graphoscope is used for this purpose it should have the easel turned down flat upon the base.

Cartes de Visite, Portraits, &c., are very effective under the Instrument.

STEREOSCOPES.

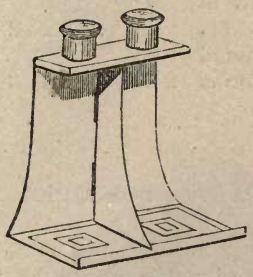


FIG. 767.

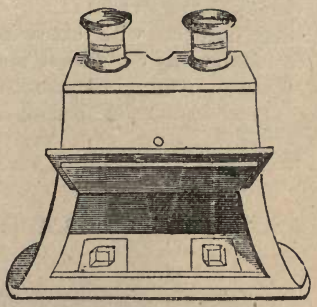


FIG. 768.

		Each. £	s.	d.
767	**Stereoscopes**, plain metal or mahogany (fig. 767) . .	0	5	6
768	Ditto ditto mahogany, with adjusting eye-pieces (fig. 768) .	0	10	6
769	**Stereoscopes**, divided form (fig. 769), papier maché body, covered with leather, and brass adjusting mounts, with glass mirror .	1	1	0
770	Ditto ditto Walnut or other woods, with ornamental mountings	2	2	0

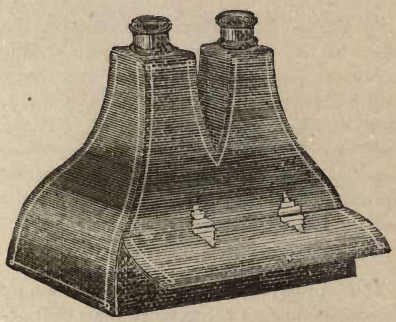


FIG. 769.

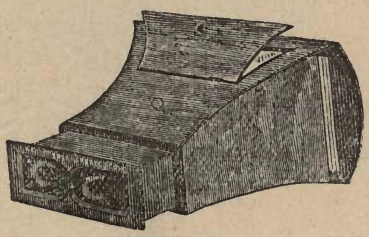


FIG. 771.

PATENT COSMORAMIC STEREOSCOPES.

771	**Cosmoramic Stereoscopes**, Mahogany or Walnut wood, with Prismatic Lenses (fig. 771) 7s. 6d., 10s. 6d.	0	15	0	1	1	0
772	Ditto ditto **Japanese Mounting** (fig. 772)				1	1	0

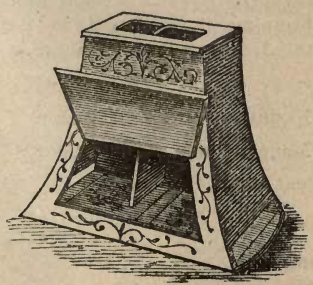


FIG. 772.

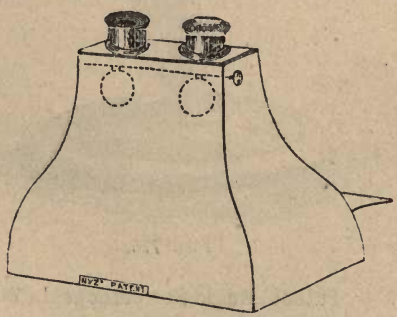


FIG. 773.

PATENT STEREOSCOPES WITH ADDITIONAL LENSES ADAPTED FOR SHORT SIGHT.

		Each. £ s. d.	Each. £ s. d.
773	Stereoscope, with extra Lenses for Short Sight, in Mahogany or Walnut wood (fig. 773) . . .		2 2 0
774	Ditto ditto in Papier Maché, divided form, covered with leather and ornamental mounts of various forms	2 10 0	3 3 0

NEGRETTI AND ZAMBRA'S PATENT MAGIC STEREOSCOPES.

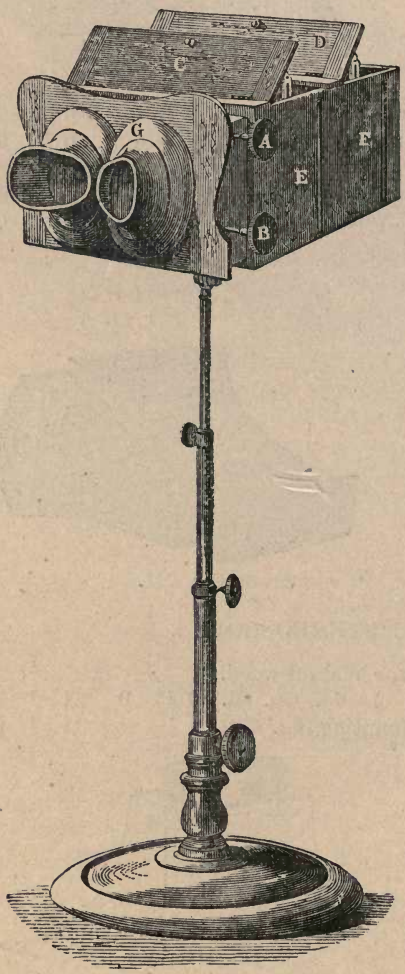


FIG. 775.

The great advantage offered by the "Magic Stereoscope" over all other descriptions of the instrument is its power of enlarging the slides seen through it to such an extent as to render them perfectly real in appearance, as though the scenes themselves were actually presented to view.

Speaking of the Magic Stereoscope, the writer in the *Art Journal* says:—"This instrument possesses advantages over every modification which we have yet examined. After a careful examination of all the conditions of the Magic Stereoscope, we are bound to state that it is by far the greatest improvement which has been made in this most interesting instrument."

The prominent position the Magic Stereoscope has now for more than twenty-five years held, the favourable opinion expressed of its merits by its numerous purchasers, and the steady and increasing demand, not only in Great Britain, but in all our Colonies, in America, and on the Continent, and, moreover, the entire absence to the present time of any competing instrument of higher pretensions,—all combine to establish its great superiority, and to confirm the opinion concerning it expressed in the critique in the *Art Journal* quoted above.

Messrs. NEGRETTI AND ZAMBRA are the Sole Manufacturers of Mr. COOK'S Patent Magic Stereoscope.

774* **Patent Magic Stereoscope**, in Walnut, with Achromatic Lenses, on sliding telescopic stand (fig. 774*), with rackwork adjustment for focussing 10 10 0

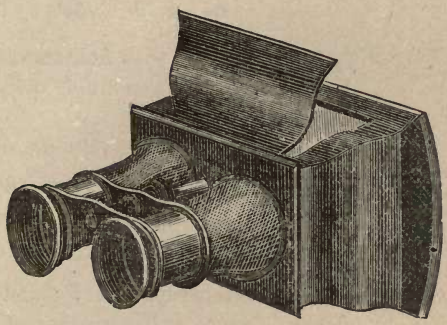


FIG. 776.

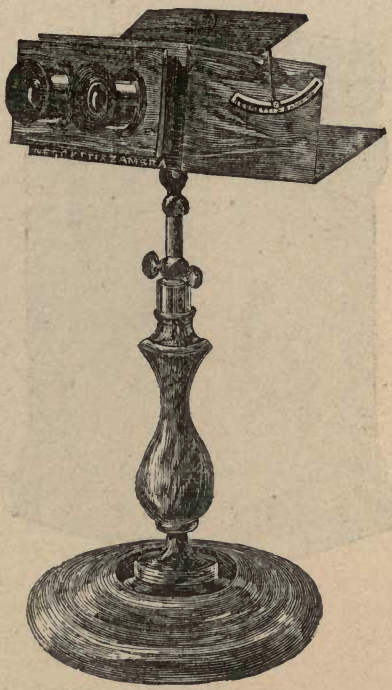


FIG. 780.

		Each. £ s. d.	Each. £ s. d.
775	**Negretti and Zambra's Patent Magic Stereoscope,** in its most perfect form, with Extra Sized Lenses throughout, the intermediate lenses, Patent Cylindrical, for insuring a perfectly flat, colourless field and freedom from distortion (as fig. 775) . . from		18 18 0

NEGRETTI AND ZAMBRA'S ACHROMATIC STEREOSCOPES.

776	**Achromatic Stereoscopes,** with **Opera Glass adjustment** (fig. 776), in various plain mountings . . 25s.	1 15 0	2 2 0
777	Ditto ditto ornamental mountings . . .	2 2 0	3 3 0
778	**Achromatic Stereoscopes, with Rackwork Adjustment** and extra large Achromatic Lenses, high magnifying power, suited for **Glass** Stereoscopic views . .	2 10 0	3 3 0
779	Ditto ditto mounted on **Adjusting Stand** . . .	4 4 0	5 5 0

780	**The Cabinet Form Stereoscope,** in Walnut with Rackwork adjustment, mounted on adjusting stand, with Brass Slides and Clamps (fig. 780) . . .	5 5 0	6 6 0

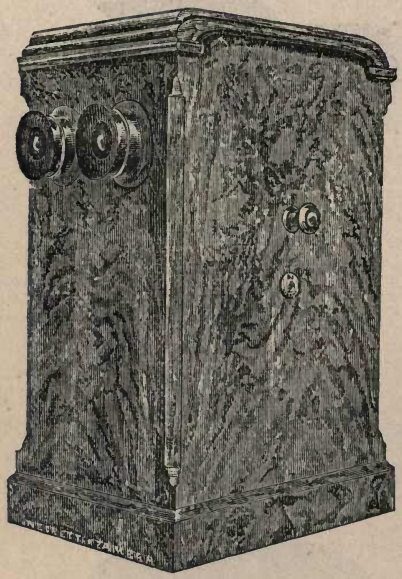


FIG. 782.

PATENT REVOLVING OR MAGAZINE STEREOSCOPES.

781 **Magazine Stereoscopes,** to hold and exhibit twenty-five transparent Glass, or fifty Paper Slides.
£4 4 0 £5 5 0

782 Ditto ditto with **Achromatic Lenses** (fig. 782), to hold fifty Glass Views.
£7 7 0 £8 8 0 £10 10 0

783 **Magazine Stereoscope,** to hold 100 Glass Views, with convenient adjustments . from £12 12 0

783* **Magazine Stereoscope,** very handsomely Carved and Ornamented, to hold 100 Glass Views.
£25 0 0 to £30 0 0

FIG. 784

		Each. £ s. d.	Each. £ s. d.
784	**Hand Stereoscope** (fig. 784), for rapidly looking over a series of Stereographs		0 15 6
784*	**Folding or Book Stereoscope,** with Leather cases . .	0 10 6	0 15 0

GLASS STEREOSCOPIC VIEWS.

785 **Negretti and Zambra's Series of Glass Stereoscopic Views,** Price 3s. 6d. and 5s. each :—

England.	Venice.	Egypt and Nubia.
London and Environs.	Germany and the Rhine.	Holy Land and Syria.
Scotland.	Belgium and Holland.	China.
Ireland.	Denmark.	Japan.
France.	Norway.	Siam.
Spain.	Sweden.	Moluccas.
Italy.	Russia.	Java.
Rome.	Constantinople and Athens.	India.
Switzerland.	America.	Pompeii.

STEREOSCOPIC VIEWS OF THE CRYSTAL PALACE.

786 **Negretti and Zambra's Collection of Crystal Palace Views**, upon Glass and Paper, comprising all the most interesting views of the building and various Courts, Statuary, &c.

Glass	£0 3 6 each
Paper	£0 1 0 „

PAPER STEREOSCOPIC VIEWS.

787 **Paper Stereoscopic Views** of the following places, price 1s. each.

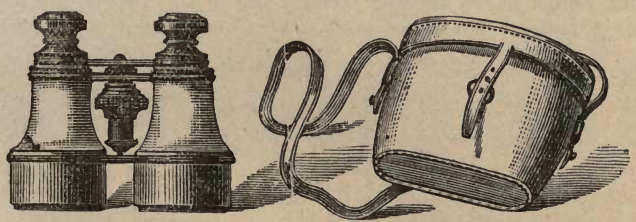
England.	Holy Land.	France.
London and Suburbs.	India.	Belgium.
Scotland.	China.	Spain.
Wales	Italy.	Holland.
Ireland.	Switzerland.	Pompeii and Herculaneum.
Egypt and Nubia.	America.	&c., &c.

BOXES AND CABINETS FOR PRESERVING STEREOSCOPIC PICTURES.

		Each. £ s. d.		Each. £ s. d.
788	**Plain Mahogany Boxes**, to hold 100 Paper Views . .	0 10 6	to	1 5 0
789	Ditto ditto better quality for Glass Views .	2 2 0		3 3 0
790	**Elegant Cabinet Boxes**, to hold a **Stereoscope** with a selection of Glass and Paper Views, &c., &c.; of various forms and mountings . . . £3 3s.	4 4 0		5 5 0

Messrs. Negretti and Zambra received a **Prize Medal**, 1851.
Honourable Mention, Paris, 1855. The Austrian **Gold Medal**
For Stereoscopic Views on Glass.
Two Prize Medals, 1862, "For beauty and excellence of Photographic Transparencies, and adaptation of Photography to Book Illustration;" and
"**For many Important Inventions and Improvements, together with accuracy and excellence in Objects Exhibited.**"

790* NEGRETTI & ZAMBRA'S NEW MILITARY BINOCULAR.



This Binocular is specially designed for Service in the Field. Optically, is of high power; gives a large field of view, abundance of light, and perfect definition.

A Glass, to be really useful for Active Service, should possess the characteristics of mechanical strength, optical perfection, and be handy either on foot or in the saddle; these qualities are pre-eminently united in the **New Military Binocular.**

For Price, See Series IV., No. 796, page 236.

NEGRETTI & ZAMBRA'S
OPERA, RACE, FIELD, AND MARINE GLASSES.

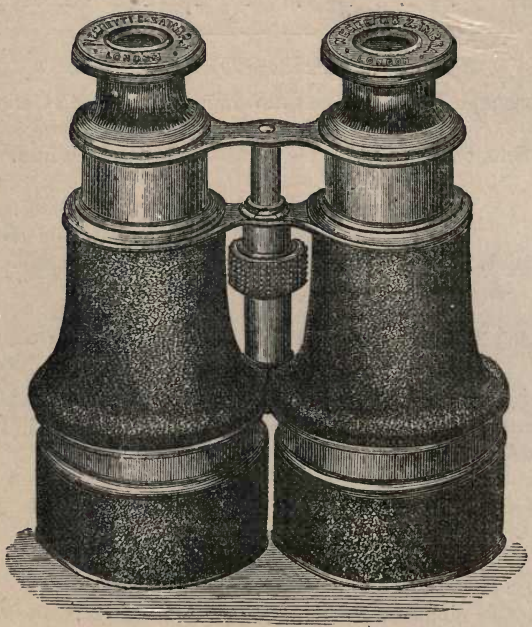


FIG. A. & 791.

NOTICE.

All Binocular Glasses named in the present List are comprised in Series and Numbers, ranging from 1 to 7; but as some of the numbers are omitted in certain Series, it will assist in the selection of any particular Glass if reference is made to the following Table, where the approximate size of the Object Lenses is marked opposite each Number. These Numbers apply to any one of the Fourteen Series.

Glass No.	1	.	.	.	Size of Object Lenses,	$1\frac{1}{8}$	inch.
,,	2	.	.	.	,, ,,	$1\frac{3}{8}$	,,
,,	3	.	.	.	,, ,,	$1\frac{1}{2}$	,,
,,	4	.	.	.	,, ,,	$1\frac{3}{4}$	,,
,,	5	.	.	.	,, ,,	$1\frac{7}{8}$	,,
,,	6	.	.	.	,, ,,	$2\frac{1}{8}$	,,
,,	7	.	.	.	,, ,,	$2\frac{3}{8}$	,,

791 **Twelve-lens Achromatic Binocular Race Glass** (fig. A), (having Triple Combination Eye and Object Lenses) very powerful, great field of view, with Solid Leather Case and Strap £6 6 0

Aluminium ditto ditto £12 12 0

See also No. 6, Series I.

A B C

SERIES I.

792 **Binocular Field or Race Glasses, 12-lens Combination.** The eye-lenses in these Glasses being larger than those usually supplied, a much greater field of view is obtained. They are mounted in bronzed metal, the bodies covered with leather, and are made in seven sizes, all equally adapted for land, sea or in-door use. (Fig. C.)

Nos. 1, 2, and 3 are supplied in Soft Leather Cases, and admit of being carried in the pocket, where larger glasses would be inconvenient.

No. 1	£2	10	0	No. 5	£5	5	0
„ 2	3	3	0	„ 6	6	6	0
„ 3	3	15	0	„ 7	6	15	0
„ 4	4	4	0				

No. 6, fitted with **Double-Draw Arrangement**, giving higher power, (fig. B.) £7 7 0

No. 4, 5, 6, and 7 are supplied in Solid Leather Cases, with sling straps.

D E F

These Glasses are also mounted in ALUMINIUM (about half the weight of those in ordinary metal). (Fig. E and F.)

No. 1	£5	5	0	No. 4	£8	8	0
„ 2	6	6	0	„ 5	10	10	0
„ 3	7	7	0	„ 6	12	12	0

No. 6, fitted with DOUBLE-DRAW ARRANGEMENT, £14 14 0. (Fig. D.)

SERIES II.

793 **Binocular Glasses for Races and general out-door use,** fitted with 12 lenses, giving very great power and definition. (Fig. A.)

They are mounted in metal, Enamelled black. The bodies and sunshades covered with leather.

These Glasses are made in 3 sizes, and supplied in Solid Leather Cases with sling straps.

No. 4	£4 4 0
„ 5	5 5 0
„ 6	6 6 0

If mounted in **Aluminium** (either bright or Enamelled black)

No. 4	£8 8 0
„ 5	10 10 0
„ 6	12 12 0

794 **Binocular Glasses,** with MOVEABLE CENTRES to change the position of the lenses to adapt them to suit the width between different eyes, from 10s. to 15s. each extra.

G H I

SERIES III.

795 **The "Staff-Officer" Binocular Field Glass, 12-lens** Combination. This celebrated Glass is made in No. 6 size only.

It has great power and gives very fine definition. N. & Z. strongly recommend this Glass to Officers in the **Army,** where there are no restrictions as to size.

The mounting and sunshades are of bronzed metal, and the bodies covered with Russia Leather. Price, including Solid Leather Case, £7 7 0. (Fig. H.)

Ditto with **Double-Draw arrangement,** giving higher power, £8 8 0. (Fig. G.)

SERIES IV.

796 **The "New Military" Binocular.**—This is made in the fifth size only, to fit the Army Regulation Pouch. (Fig. I.)

The mountings and shades are of bronzed metal. The bodies covered with black or buff leather, with Solid Leather Cases to match. Price, £5 5 0

Ditto, in **Bronzed Aluminium,** £9 9 0. An allowance of 7s. 6d. is made if the Case is not required.

Regulation Pouches supplied to order.

J K L

SERIES V.

797 **Binoculars, for Marine, Field or Theatre use.** The magnifying power and field of view of these Glasses can be varied to suit near or distant objects by means of a Revolving Eye-Piece containing Three Powers. (Fig. K.)

The mounting is metal, japanned black. The bodies covered with Black leather.

These Binoculars are all supplied in Solid Leather Cases and are made in four sizes.

No 3	£4	4	0	No. 5	£6	6	0
„ 4	5	5	0	„ 6	7	7	0

Ditto in Aluminium—

No. 3	£8	8	0	No. 5	£12	12	0
„ 4	10	10	0	„ 6	14	14	0

SERIES VI.

798 **Binoculars intended chiefly for Marine Service.**—Fitted with 6-lens combination, and strong bronzed metal mounting, No. 7 size, £5 5 0. (Fig. J.)

Ditto, **12-lens** Combination, Government Pattern, No. 7 size, £5 5 0. (Fig. L.)

Ditto, **6-lens** Combination, No. 6 size, £4 4 0.

All Glasses in this Series are supplied in Solid Leather Cases, with Strap.

The Glasses in Series I. are also adapted for Marine purposes.

SERIES VII.

799 **Binocular Field Glasses.**—6-lens Combination, fitted with extra long adjusting tubes, by which greater power is obtained. (Fig. Q.)

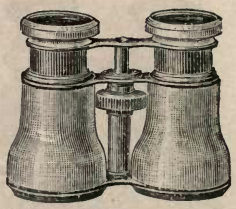
N. & Z. recommend this Series where a 12-lens Glass would be too costly. They are mounted in metal, japanned black, and the bodies covered with leather. Prices, including Solid Leather Cases, with Strap :—

No. 3 size	£2	2	0	No. 5 size	£3	3	0
„ 4 „	2	10	0	„ 6 „	4	4	0

OPERA GLASSES.

M

N



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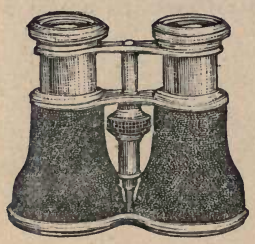
SERIES VIII.

800 **Opera Glasses**, very highest quality, fitted with **12-lens combination**, and mounted in ALUMINIUM. The bodies covered either with Mother-o'-pearl or Tortoiseshell. (Figs. M. and N.)

These Glasses are very suitable for **Wedding or Birthday Presents**, and are made in 5 sizes.

No. 1	£5	5	0	No. 3	£7	7	0
„ 2	6	6	0	„ 4	8	8	0
				„ 5	10	10	0



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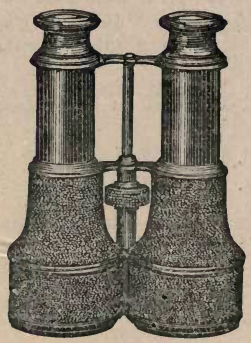


Q

R

SERIES IX.

801 **Opera Glasses**, similar to those in Series VIII., but mounted in ALUMINIUM (either bright or enamelled black) the bodies being covered with Morocco leather. (Fig. P.)

No. 1	£4	10	0	No. 3	£6	10	0
„ 2	5	10	0	„ 4	7	10	0
				„ 5	8	10	0

An elegant Morocco leather or Velvet Flexible Case given with each of the above Opera Glasses.

SERIES X.

802 **Negretti & Zambra's** best quality **Opera Glasses**, with **Ivory bodies** and **Gilt Metal Mountings**, fitted with **12-lens combination**. Suitable for presents where aluminium mounted glasses are too expensive. (Fig. O.)

No. 1	£2	10	0	No. 4	£5	5	0
„ 2	3	3	0	„ 5	6	6	0
„ 3	4	4	0				
Ditto with 6-lens combination.				No. 3	£2	10	0
No. 1	£1	10	0	„ 4	3	3	0
„ 2	2	2	0	„ 5	4	4	0

SERIES XI.

803 **Opera Glasses,** best quality, with Mother-o'-pearl bodies and Gilt Metal Mountings, fitted with 12 Lenses.

No. 1	£3	3	0	No. 3	£5	5	0
„ 2	4	4	0	„ 4	6	6	0

Ditto with Dark Pearl Bodies and Mountings Enamelled Black.

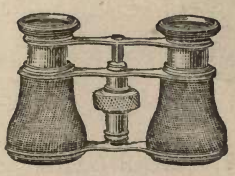
No. 1	£2	10	0	No. 3	£4	4	0
„ 2	3	3	0	„ 4	5	5	0

SERIES XII.

804 **Negretti & Zambra's new pattern, 12-lens Achromatic Opera Glasses.** (Fig. R.) The mountings are Bronzed Metal and the bodies covered with Morocco leather.

N. & Z. strongly recommend this Series, where a best instrument is required in plain but strongly made mountings.

No. 1 size	£2	2	0	No. 3 size	£3	3	0
„ 2 „	2	10	0	„ 4 „	3	10	0
				„ 5 „	4	4	0



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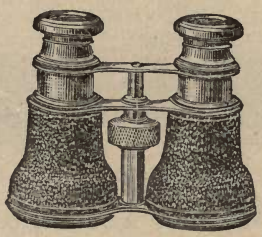

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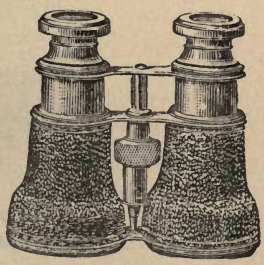

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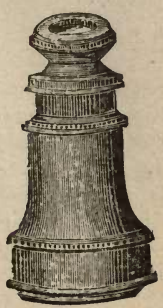
SERIES XIII.

805 **Negretti & Zambra's 6-lens Opera Glasses,** made in 5 sizes. either of which can be recommended as a good and useful glass for general purposes. (Figs. S T U.)

No. 1 size	£1	1	0	No. 4 size	£2	2	0
„ 2 „	1	5	0	„ 5 „	3	3	0
„ 3 „	1	15	0				



V

SERIES XIV.

806 **Monocular Field or Opera Glasses,** best quality, mounted in metal, japanned black, and body covered with Morocco leather. (Fig. v.)

No. 1 size	£0	10	6	No. 5 size	£1	10	0
„ 2 „	0	15	0	„ 6 „	1	15	0
„ 3 „	1	1	0	„ 7 „ (Fig. v.)	2	2	0
„ 4 „	1	5	0				

Prize Medal, 1851. Two Prize Medals, 1862.

FOR MANY IMPORTANT INVENTIONS, ACCURACY, AND EXCELLENCE.

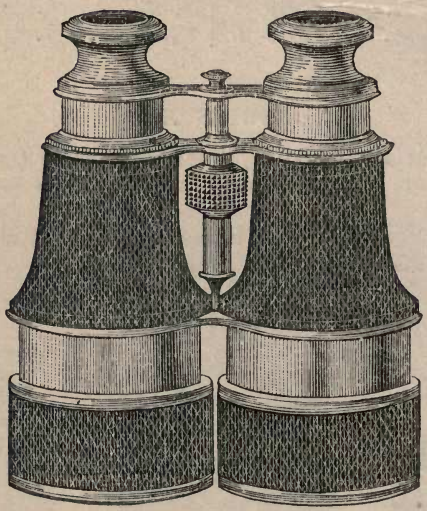


FIG. 810.

NEGRETTI AND ZAMBRA'S ALUMINIUM BINOCULARS.

807 The only novelties in Opera and Field Glasses exhibited at the International Exhibition of 1862 were two by Messrs. Negretti and Zambra; *viz.*, the use of Rock Crystal for lenses, and Aluminium for the mountings; the extreme hardness and brilliancy of the one, and the wonderful lightness of the other, render them eminently useful in the construction of Field Glasses, &c.

The principal use of Rock Crystal is for instruments required for service in Tropical climates, where the great heat, combined with moisture, cause the ordinary glass lenses to become dull and stained. The Rock Crystal retains its polish, gives a very brilliant image, and is not so liable to become scratched as Glass.

808 **Rock Crystal 12-lens Combination Binocular Field Glasses**, with Solid Leather Sling Cases and strap £10 10 0

The difference of weight between Aluminium and the usual metal mountings of Field Glasses, &c., is so great as always to excite astonishment, certainly one-third less; so that a very large instrument can be used with the greatest ease and comfort. This extraordinary lightness is very valuable in hot climates, where the slightest exertion becomes distressing, and a useful instrument is often thrown aside on account of its weight. Negretti and Zambra are now manufacturing Aluminium Opera and Field Glasses in a variety of sizes and forms, fitted with the very finest lenses, weighing about one-third less than the ordinary instruments.

809 **Aluminium Opera Glasses.** See Series VIII. and IX.

810 **Ditto Field Glass**, as fig. 810 . . . . £10 10 0 12 12 0

NEGRETTI & ZAMBRA'S

IMPROVED YACHTING AND DEER-STALKING

"Binocular" Telescopes.

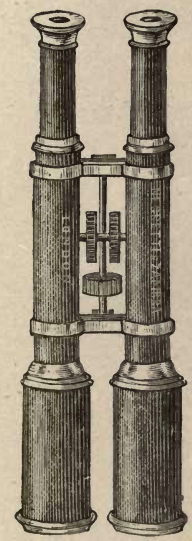


FIG. 811.

811 These Binocular Telescopes are, from the adjustments, suitable to every sight and width of eyes. The Field is large and clear, with an abundance of Light, while the Magnifying Power is great. By the new adjustment, the circles of the two Fields are made to coincide exactly, so that all strain is taken from the eyes in looking through them; while the breadth of the Field enables the observer to "pick up" any object at once.

Negretti and Zambra recommend their Binocular Telescopes for Yachting, Deer-Stalking, Military Service or general Field use.

PRICES. (Fig. 811.)

IN BRONZED METAL.

	Magnifying Power.	Diameter of Object Lens.	Height when Closed up.	£	s.	d.
No. 1, Binocular with Leather Sling Case	100 times	1¼-in.	9⅝-in.	8	5	0
„ 2 „ „ „	150 „	1⅜ „	10¾ „	9	15	0
„ 3 „ „ „	200 „	1⅝ „	11½ „	11	10	0
„ 4 „ „ „	250 „	1⅞ „	14¼ „	13	10	0

IN ALUMINIUM.

(*About half the Weight of those in Ordinary Metal.*)

No. 1, Binocular with Leather Sling Case	100 times	1¼-in.	9⅝-in.	12	15	0
„ 2 „ „ „	150 „	1⅜ „	10¾ „	16	0	0
„ 3 „ „ „	200 „	1⅝ „	11½ „	18	10	0
„ 4 „ „ „	250 „	1⅞ „	14¼ „	20	5	0

FIG. 812.

812 Negretti and Zambra's new "Binocular" Telescope. By a further improvement in the arrangement and combination of Lenses NEGRETTI & ZAMBRA have now produced a Glass of only eight inches in length, possessing all the advantages of the largest Binocular Telescopes.

Great Reduction of bulk and weight, combined with High Magnifying Power, and large Field of View are the special points recommending these New Binocular Telescopes.

PRICES. (Fig. 812)

Mounted in Bronzed Metal, with Leather Sling Case.	£12	10	0
Mounted in Aluminium „ „ „	16	10	0

NOTE.—Negretti & Zambra also manufacture a smaller Binocular Telescope, No. O, *with Object Lenses* 1 *inch diameter; but the field of view being extremely limited, they recommend in preference their* 12*-Lens Binocular Field Glasses, No.* 6, *at* £6 6*s. and* £7 7*s. See Series* 1 *and* 3, *pages* 234 *and* 236.

TELESCOPES.

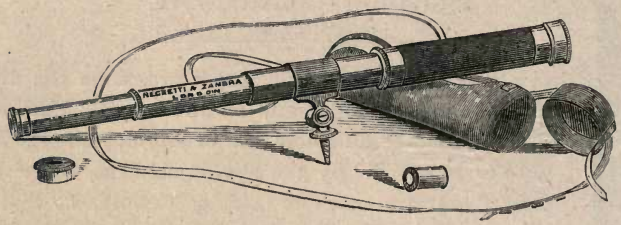


FIG. 817.

POCKET TELESCOPES.

		Each. £ s. d.	Each. £ s. d.
813	**Perspective Glasses**, with mahogany or japanned body, and one, two, or three draws . . 1s. 6d., 2s. 6d.	0 3 6	0 7 6
814	**Pocket Telescopes**, two or three draws, with Achromatic object lens, Mahogany or Leather Covered body (figs. 814)	0 10 6	0 12 6
815	Ditto ditto . . . . . with Sun Shade	0 15 0	0 16 0

FIG. 814.

FIG. 819.

FIG. 814.

816	**Achromatic Telescopes**, with Leather Case and Sling Strap	1 5 0	1 10 0
817	**Achromatic Telescopes**, with Screw and Jointed Clip for fixing to a tree or at side of Window, &c. (fig. 817) . . . . . 21s.	1 5 0	1 10 0
	Ditto Ditto with Astronomical Power, in a neat Mahogany Box		1 5 0
818	**Pocket Rifle Telescope, Achromatic**, one draw, body covered with leather, with light sling, small, portable, and very powerful, to show Bullet marks at 300 to 500 yards	1 10 0	2 2 0
819	**Pocket Achromatic Telescope**— 3 draws 24-inch, $1\frac{3}{8}$-inch Object Lens (fig. 819) .		2 2 0
820	Ditto, ... with Sun Shade		2 10 0
821	**Pocket Achromatic Telescope**— 3 draws 30-in., $1\frac{5}{8}$-inch Object Lens . . .		3 3 0

FIG. 822.

		Each. £ s. d.	Each. £ s. d.
822	**Pocket Achromatic Telescopes,** with Mahogany or Rosewood body (fig. 822):— Two, three, or four draw Brass Telescopes with Lenses of the VERY FINEST QUALITY AND BEST MOUNTING—		
	12-inch		1 15 0
	18-inch ditto ditto		2 10 0
	24-inch ditto ditto		3 10 0
	30-inch ditto ditto	4 4 0	5 5 0
	36-inch ditto 4-draw, Extra Large Object Lens		7 10 0
823	**Pocket Achromatic Telescope — solid German Silver Mountings,** with Sun Shade, 24-inch three draw, best quality (fig. 822)		4 10 0
824	Ditto Ditto 30-inch		5 10 0
825	**Pancratic Eye Tubes** (Dr. Kitchener's), to above extra	0 12 6	1 1 0

822 and 823 are very suitable for Rifle Prizes, especially if fitted with Pancratic Eye Tubes.

826 **Solid Leather Cases and Sling Straps** for any of above, from each extra 0 10 6

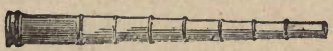


FIG. 827.

827 **12-inch Pocket Military Reconnoitring Telescopes,** best quality, six draws, very portable, brass tubes . 1 10 0

Ditto	ditto	German Silver tubes (fig. 827) .	2 2 0
18-in.	ditto	six-draw Brass tubes . . .	2 10 0
24-in.	ditto	seven-draw ditto	3 10 0
30-in.	ditto	eight-draw ditto	4 10 0

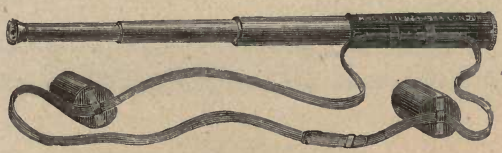


FIG. 828.

828 **Negretti and Zambra's Improved Achromatic Military Reconnoitring or Deer-Stalking Telescope,** two or three draws, with Sun Shade, bronzed tubes, and mounted in strong leather body with sling strap, or in Leather Case with Sling (fig. 828)

No. 1	£1 15 0	No. 4	£5 5 0
„ 2	2 10 0	„ 5	6 10 0
„ 3	4 4 0	„ 6	8 8 0

Nos. 3, 4, 5, *and* 6 *are fitted with Pancratic Eye-pieces.*

THE "MAC LEOD" DEER-STALKER.

		Each. £ s. d.	Each. £ s. d.
829	Fitted with three draws, Taper Body, with Sun Shade and Pancratic Eye-Piece, Object Glass 2¼-in. diameter. Supplied in solid leather case, with sling strap		6 10 0
	Ditto, ditto Bronzed German Silver, with Leather Case and Sling, exceedingly light but strong . .		8 10 0

N. & Z. recommend this pattern as being one of the finest Telescopes it is possible to employ for Deer Stalking.

830	**Aluminium Telescopes,** two or three draws, very light, Large Object Lenses. Suitable for Presents, or for Ladies' use, fitted in leather cases, with sling straps .	10 10 0	12 12 0

MARINE TELESCOPES.

FIG. 832.

831	**Marine or Day and Night Achromatic Telescopes,** yielding a large field and full body of light, adapted for Coast Service . . . . . 21s., 30s., 40s.	2 10 0	3 3 0
832	**Day or Night Achromatic Pilot Telescopes,** with one, two, or three draws (fig. 832)	2 2 0	2 10 0

FIG. 833.

833	**Pilot Telescopes,** One draw with Shade Tube (fig. 833)	3 3 0	4 4 0
834	**Erect Night Telescope,** with one draw and Shade Tube, Object Lens of large diameter and best quality .	5 5 0	6 6 0
835	**Large Inverting Night Telescopes**		5 5 0

FIG. 838.

836 **Navy Telescopes,** Taper Bodies, covered with leather, bronzed Tubes, and Sunshades, one draw tube, best Achromatic Object Glasses.

No.	Length when closed.	Diam. of O. G.	Price.
1	12 inches	1¼ inches	£2 2 0
2	15 „	1⅝ „	2 10 0
3	18 „	1¾ „	3 0 0
4	21 „	1⅞ „	3 10 0
5	24 „	2 „	4 10 0
6	26 „	2¼ „	5 5 0
7	30 „	2½ „	6 10 0
8	45	2⅝ „	7 10 0

837 **Navy Telescopes** as above, but with polished German Silver tubes and Sunshades. £3 3 0, £4 4 0, £5 5 0, £6 6 0 and £8 8 0

838 **Deck Telescopes,** one draw with Spray shade, as fig. 838.

No. of Draws.	Diameter of Object Glass.	Body covered with leather.	or Mahogany.
1	1½ inches	£1 16 0	£2 2 0
1	1¾ „	2 10 0	3 3 0
1	2 „	3 10 0	4 10 0

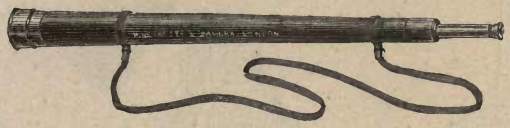


FIG. 840.

		Each. £ s. d.	Each. £ s. d.
839	**Deck Telescopes,** large sizes of above with Rackwork and Sliding adjustment (fig. 839) £5 10 0 £7 10 0	8 10 0	10 10 0
840	**Midshipman's Telescope,** 18-inch Brass taper body covered with leather, and Navy Signals inserted, sling strap (fig. 840)	1 16 0	2 2 0
841	Ditto Ditto, Regulation pattern, German Silver, with Navy Signals, Sun Shade, and sling strap		3 3 0
842	**Marryat's Code of Signals** fitted to Telescopes		0 10 0
843	**Navy Code of Signals** to ditto		0 10 6
844	**Straps and Slings** to ditto		0 10 6
845	**Mariners' Compass,** with Bar Needle or Floating Card fitted to cap of Telescopes, to order from		0 18 0

FIG. 839.

846 **Signal Station** or **Target Practice Telescopes,** for Telegraphic and Look-out puposes, or for distinguishing bullet marks on targets at the longest ranges with one draw, the bodies covered with leather, and with *rackwork* and sliding adjustments to eye-pieces (fig. 839).

No.	Size of Object Glass.	Price.
1	2 inches	£4 10 0
2	2¼ „	5 10 0
3	2½ „	8 10 0
4	2¾ „	10 10 0
5	3 „	12 10 0

Tripod Stands for above, see over.

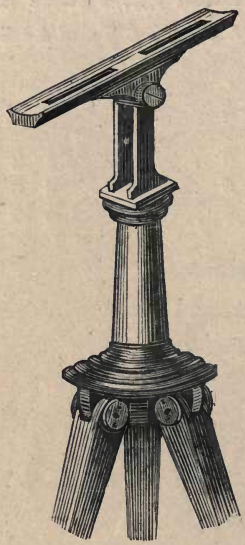


FIG. 848.

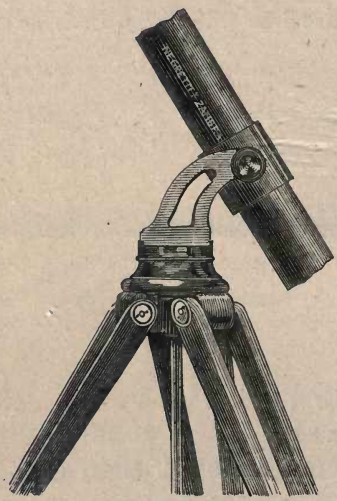


FIG. 850.

FIG. 849.

		Each. £ s. d.	Each. £ s. d.
847	**Portable Tripod Stands for Telescopes, of Wood,** with Brass Bolts and Nuts	1 12 6	1 16 0
848	Ditto ditto with Vertical and Horizontal adjustments (fig. 848)		2 10 0
849	Ditto ditto Brass head, with jointed Clip, or Cradle Telescope-holder, mahogany legs (fig. 849) . .	3 3 0	4 10 0
850	**Improved Alt-Azimuth Stand** (fig. 850), for Astronomical Telescopes, well suited for Telescopes Nos. 853, 856, and 857; Strong Metal Mountings, very rigid, and conveniently portable	12 0 0	15 0 0

851 **Captains' or Pilots' Binocular Night or Look-out Glasses** (see pages 234 to 237).

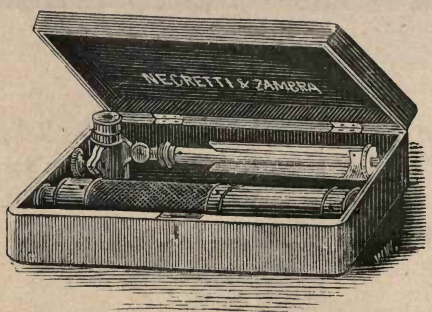


FIG. 852.

852 **Negretti & Zambra's Traveller's Telescope** consists of a highly-finished portable Telescope, with Folding Table Stand (fig. 852).

It is fitted with Terrestrial or day eye-piece of high magnifying power and brilliant definition, and one Astronomical eye-piece of sufficient power to exhibit all the phenomena of the planets and divide the more easily resolved of the double stars.

The whole instrument is compactly arranged in a mahogany box with lock and key, forming one of the most useful and convenient Telescopes for Tourists or Sea coast visitors.

It can be used without the stand, as an ordinary *pocket* Telescope.

Price, complete in case £7 7 0, £8 8 0, £10 10 0

ASTRONOMICAL TELESCOPES.

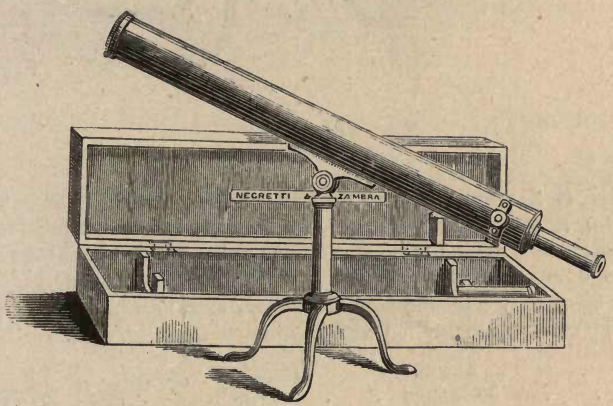


FIG. 853.

853 **Negretti & Zambra's Universal Telescope** (fig. 853), with 2½-inch Object Glass, brass body, japanned black, fitted in case £5 5 0

Ditto, with 3-inch Object Glass £6 6 0

Ditto, with polished brass body and extra Astro. eye-piece . . £8 8 0

N. & Z., in view of the increasing demand for Astronomical Telescopes of moderate price, have constructed one that, while it accomplishes effectually all required in an elementary study of the heavenly bodies, is equally useful as a Telescope for Terrestrial objects, or for marking in Rifle practice.

It will show Jupiter's moons, Saturn's ring and moons, and resolve some of the double stars; while for terrestrial objects, it will define well at a distance from 10 to 15 miles, and will show bullet marks on a target at the longest ranges.

For Astronomical purposes, an *extra* eye-piece can be had, magnifying 80 diameters, price 12s. 6d. Can be added at any time.

Firm Garden Stands for above, see page 246.

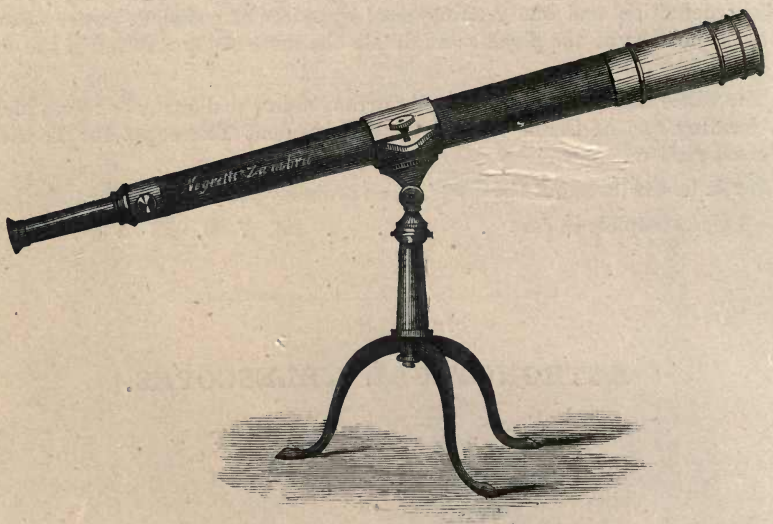


FIG. 854.

854 **Negretti & Zambra's Signal Station or Telegraph Look-out Telescope,** having **Rackwork and Sliding Adjustments** to the eye-tube, mounted on a strong steady tripod table stand, with universal movements and hinged clip for holding the Telescope, so contrived that when not in use, the Telescope can be quickly removed from its stand, and both be securely packed away in the stout case supplied with the instrument (fig. 854).

No.	Length.	Diam. of O. G.	Price.
1	30 inches	2 inches	£8 8 0
2	36 „	2¼ „	10 10 0
3	40 „	2½ „	12 12 0
4	44 „	2¾ „	14 14 0
5	48 „	3 „	16 16 0

These Telescopes have sufficient magnifying and defining power for distinguishing bullet or shot marks on a target at the longest ranges. Also well suited for Coast-Guard stations, or as a Sea-Side Look-out-glass.

855 **Achromatic Astronomical and Terrestrial Telescope** (fig. 855), bright Brass Body, Rackwork and Sliding Adjustment to eye-piece, mounted on a pillar and brass claw Table Stand, having Horizontal and Vertical motions; fitted in polished mahogany case, with lock and key.

Size of Object Glass.	Eye-pieces. Terres.	Astro.	Power. With Terres. Eye-piece.	With Astro. Eye-piece.	Price.
2 inches	1	1	20 diameters	45 diameters	£10 10 0
2¼ „	1	1	30 „	55 „	11 11 0
2½ „	1	1	40 „	70 „	14 14 0
3 „	1	1	50 „	85 „	18 18 0

Tripod Out-of-Door Stands suited for above, see page 246.

FIG. 855.

ACHROMATIC ASTRONOMICAL AND TERRESTRIAL TELESCOPE, No. 855.

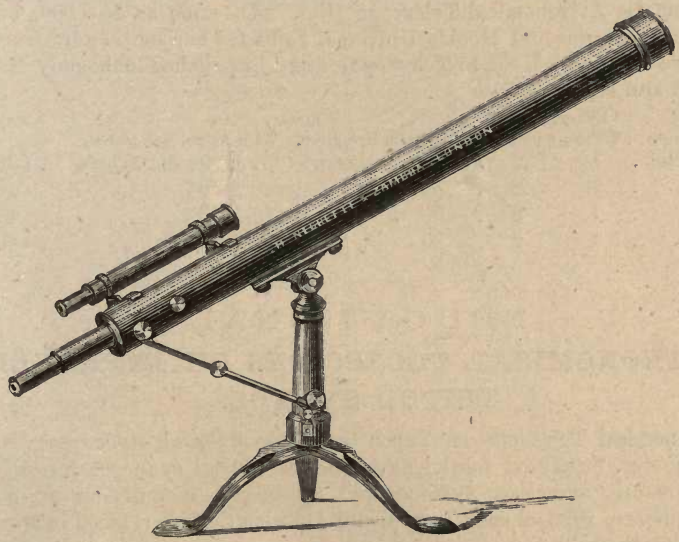


FIG. 856.

856 **Achromatic Astronomical Telescope** (Fig. 856), on handsome brass pillar and claw Table Stand, with **Rackwork** and Sliding Adjustments to Telescope, elevating and steadying rod, and Achromatic Finder, fitted in polished mahogany case, with lock and key.

Size of Object Glass.	Eye pieces. Terres.	Astro.	Power With Terres. Eye-piece.	With Astro. Eye-pieces.	Price.
3 inch	1	2	45 diameters	65 & 80 diameters	£25 0 0
3¼ „	1	2	50 „	75 & 90 „	30 0 0
3½ „	1	2	60 „	80 & 95 „	35 0 0

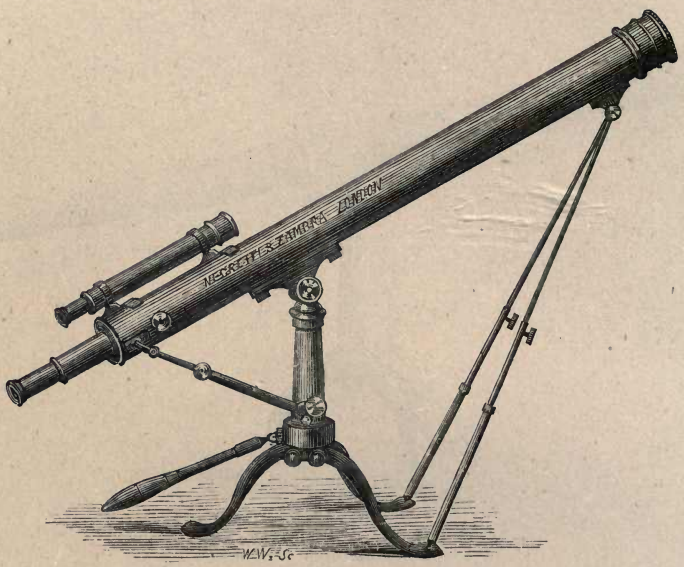


FIG. 857.

857 **Achromatic Astronomical Telescope** (Fig. 857), same as No. 856, but with Tangent Screw and Hook's Universal Joint for horizontal adjustment, and extra Steadying Rods to Telescope; fitted in polished mahogany case, with lock and key.

Size of Object Glass.	Eye-pieces. Terres.	Astro.	Power. With Terres. Eye-piece.	With Astro. Eye-pieces.	Price.
$3\frac{1}{4}$ inch	1	2	50 diameters	75 & 90 diameters	£36 0 0
$3\frac{1}{2}$ „	1	2	55 „	80 & 95 „	42 0 0
$3\frac{3}{4}$ „	1	2	60 „	85 & 105 „	48 0 0
4 „	1	2	70 „	90 & 110 „	66 0 0

EDUCATIONAL

ASTRONOMICAL TELESCOPES ON IMPROVED TRIPOD STANDS.

858 **Astronomical Telescope,** on Taper Iron Tripod Stand, object glass 3 inches diameter, 3-ft. 9-in. focal length, one Terrestrial eye-piece magnifying 20 diameters, and two Astronomical eye-pieces, magnifying 60 and 125 diameters, vertical rack motion and Achromatic finder, fitted in stout case, with lock and key £25 0 0

859 Ditto ditto, on improved Tripod Stand, with object glass $3\frac{3}{4}$-in. diameter, 4-ft. 9-in. focal length, one Terrestrial eye-piece, magnifying 25 diameters, and three Astronomical eye-pieces magnifying 80, 155 and 230 diameters. Fig. 859. . . . . £45 0 0

860 Ditto ditto, but with object glass $4\frac{1}{4}$-in diameter, 5-ft. 3-in. focal length, one Terrestrial eye-piece, magnifying 30 diameters, and three Astronomical eye-pieces magnifying 85, 170 and 255 diameters £60 0 0

861 **Telescope Stand,** similar to Fig. 861, for large instruments, complete, with Vertical rack, Steadying rod and Horizontal tangent rack . £15 15 0

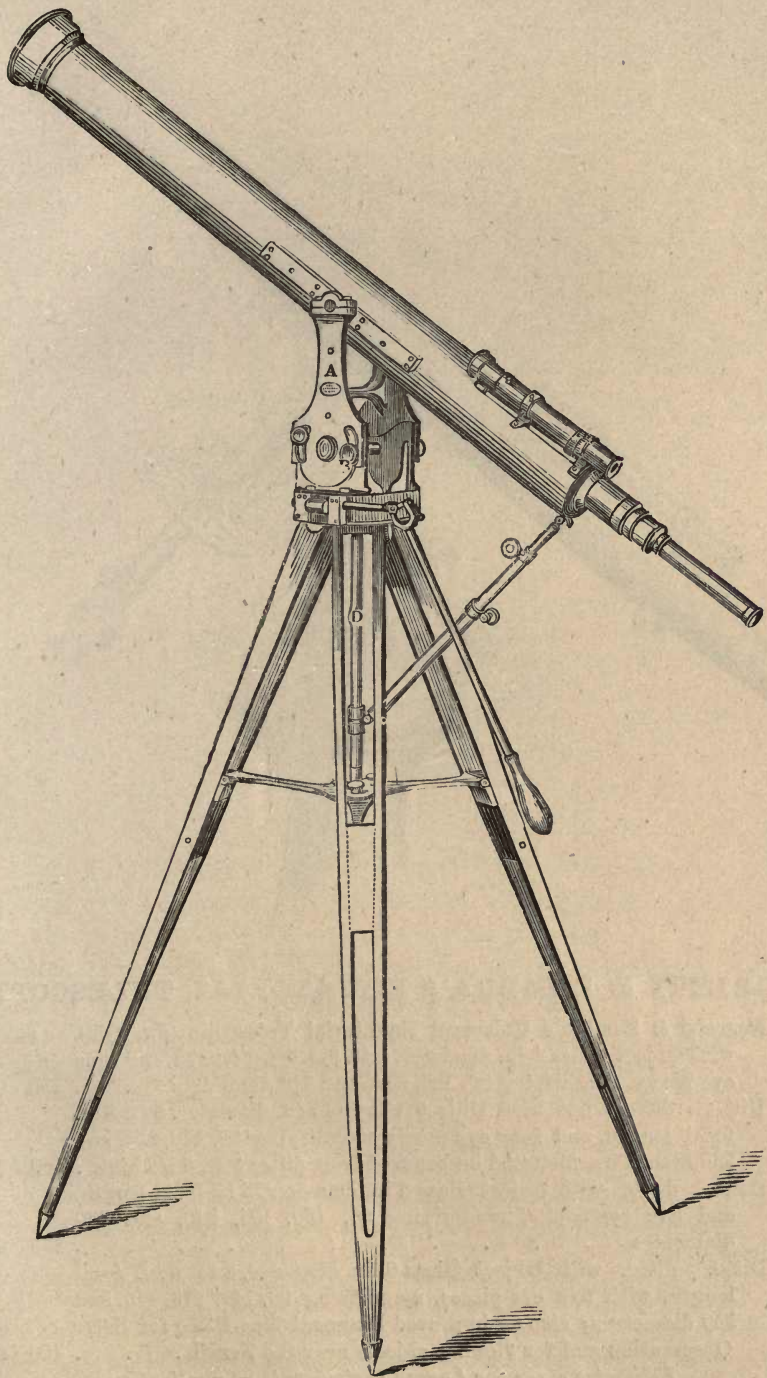


FIG. 861.

861 **Negretti and Zambra's Educational Astronomical Telescope, No, 861, with** Vertical and Horizontal screw adjustments, Steadying Rod, &c.

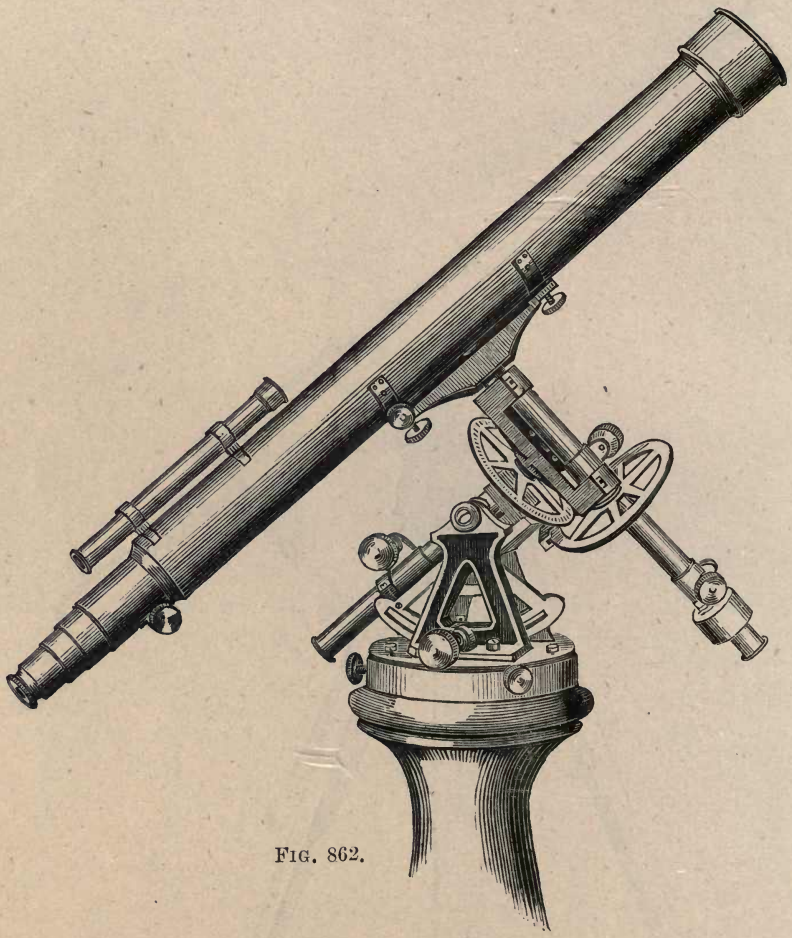


FIG. 862.

NEGRETTI & ZAMBRA'S EQUATORIAL TELESCOPES.

		Each. £	s.	d
862	**Negretti & Zambra's Universal Equatorial Telescope** (fig. 862), with Object Glass 4-in. diameter, 4-ft. 9in. focal length, and four eye-pieces, magnifying 80, 155, 230, and 310 diameters . .	150	0	0
863	Ditto, ditto, but with Object Glass 4½ in. diameter. 5 ft. 3 in. focal length, and four eye-pieces, magnifying 85, 170, 255, and 350 diameters, mounted on bronzed iron pillar 5 ft. 6 in. high .	200	0	0
864	Ditto, ditto, with Object Glass 5 in. diameter, 6 ft. focal length, and five eye-pieces, magnifying 65, 190, 195, 240, and 390 diameters	275	0	0
865	Ditto, ditto, with Object Glass 6 in. diameter, 8 ft. 6 in. focal length, with five eye-pieces, magnifying 90, 140, 275, 410, and 550 diameters; also an improved Diagonal Eye-Piece for Solar Observation and for viewing objects near the Zenith . . .	420	0	0
	Estimates given for Larger Instruments on application.			
	Equatorial Telescope Stands . . . . . From	42	0	0

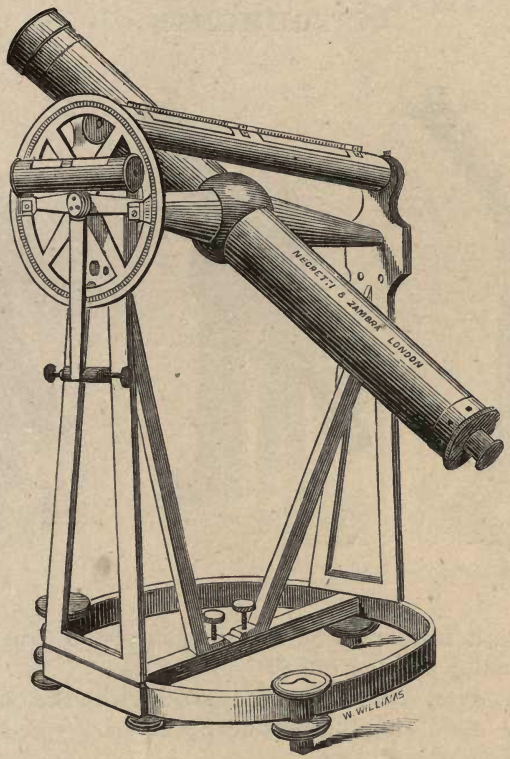


FIG. 867.

		Each. £	s.	d.
866	**Transit Instrument,** 14 in., with Telescope having $1\frac{1}{8}$ in. aperture	8	8	0
	Ditto ditto 24 in., on portable Iron Stand, with engine divided circle, Spirit Levels and Tangent Screw Adjustments . .	27	0	0
867	Ditto ditto 30 in., with Telescope having $2\frac{3}{4}$ in. aperture (fig. 867)	50	0	0
	Ditto ditto with two Setting Circles and Brass Stand . .	60	0	0
868	Ditto ditto 36 in.	70	0	0
869	**Astronomical Clock,** dead beat escapement, jewelled pallets, and Compensated Pendulum, with steel rod and Mercurial Cistern, in Plate Glass Case for hanging on wall	42	0	0
870	**Mean and Sidereal Time Clock,** showing both times on the same dial with dead beat escapement and jewelled pallets, with compensated pendulum and small bell to strike the minutes, in case, with Plate Glass top, sides and front	88	0	0
871	**Small Equatorial Star Finder,** for the use of Students, 4-in divided circles, achromatic Telescope, with $1\frac{1}{8}$ in. object glass . .	12	12	0

With this instrument any Star or Planet can be found with facilty, and many important facts in astronomical science demonstrated.

NEGRETTI & ZANBRA'S IMPROVED TRANSIT INSTRUMENTS.

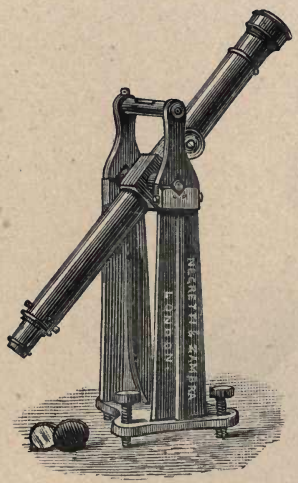


FIG. 868.

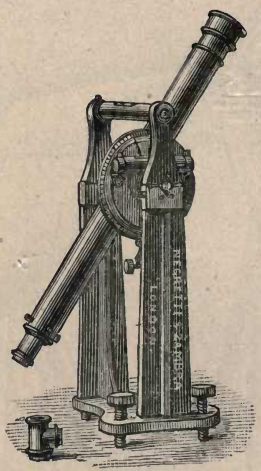


FIG. 869.

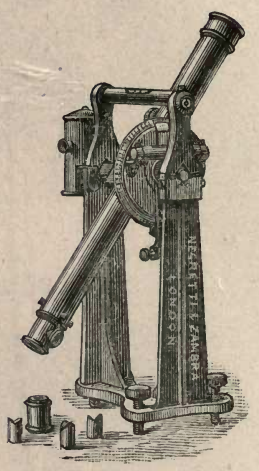


FIG. 870.

		£	s.	d.
868	**Portable Transit Instrument** for the Determination of True Time. Plain Mounting with Box (fig. 868) . . . . Price	£8	8	0
869	Ditto ditto ditto, with vertical divided Circle, with Box (fig. 869)	12	12	0
870	Ditto ditto ditto, with Illuminating Apparatus, the most complete form (fig. 870) with Box	15	15	0

Full instructions for setting up and using the above Transit Instruments will be found in *A Treatise on the Transit Instrument*, by Latimer Clark, M.I.C.E., &c., price 5s.

871 **Object Glasses,** *best* quality, for Astronomical Telescopes, mounted in brass cells.

1 inch clear aperture	1	5	0
2 „ „	2	2	0
2¼ „ „	3	5	0
2½ „ „	4	15	0
2¾ „ „	7	0	0
3 „ „	9	10	0
3½ „ „	14	0	0
4 „ „	22	0	0
5 „ „	42	10	0
6 „ „	75	0	0
7 „ „	125	0	0
8 „ „	200	0	0
9 „ „	300	0	0
10 „ „	400	0	0

Quotations for larger sizes may be had on application.

		Each £	s.	d.
871*	**Telescope Eye-Pieces, Huyghenian** . . . . . 16s. to	1	5	0
872	„ „ Dawe's Solar	8	0	0
873	„ „ Transit	3	0	0
874	„ „ Terrestrial	1	15	0
875	„ „ Comet	1	10	0
876	„ „ Diagonal	4	10	0
877	**Sunshade and Brass Cap fitted to eye-piece**	0	6	0
878	**Micrometer, Double Image, with Eye Pieces, &c., in Box** . .	20	0	0
879	**Micrometer, with Position Circle, &c.**	15	0	0
880	**Reflecting Telescopes**, for Students' use, mounted on improved stand, with endless screw motion to follow the stars with Equatorial Motion, Silvered Glass Speculum, 5¼ in. diameter, with two eye-pieces	25	0	0
881	Ditto, Ditto on Equatorial stand, with 6½ in. speculum .	80	0	0
882	Ditto, Ditto with 8½ in. Speculum and three eye-pieces .	110	0	0
883	**Silvered Glass Specula** (unmounted) best quality.			
	5¼ inch diameter	7	10	0
	6½ „ „	9	0	0
	8½ „ „	17	10	0
	10 „ „	38	0	0

Prices of larger sizes may be had on application.

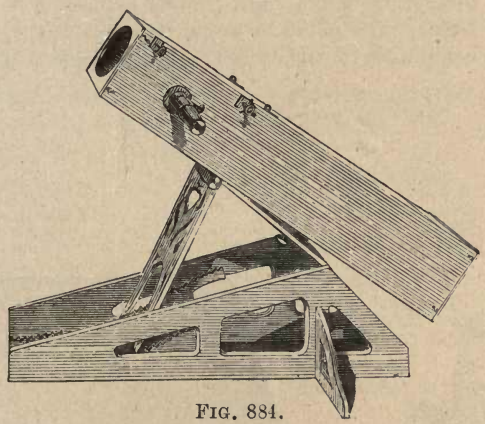


FIG. 884.

884 **Foucault's Reflecting Telescope**, for Terrestrial or Astronomical observations. The improvements of this telescope are principally in the use of a Glass Speculum coated upon the surface with pure Silver. The eye-piece is an achromatic microscopic arrangement of lenses mounted on the side of the telescope, the image being received from the large speculum by a prism, and the reflected image examined by the Microscope Eye-Piece, which is fitted with rack-work adjustment. With these arrangements, high powers can be used, and large field of view, combined with light, obtained. Mounted on a table stand, with simple adjustments (fig. 884).

Supplied to order . . £20 0 0

With simple instructions for re-silvering the speculum.

Gregorian or Newtonian Reflecting Telescopes constructed to order.

NEGRETTI & ZAMBRA'S
MICROSCOPES.

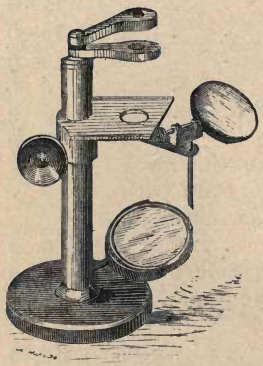


FIG. 886.

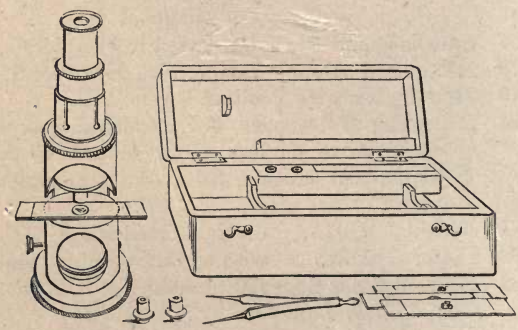


FIG. 889.

SIMPLE AND COMPOUND MICROSCOPES.

		Each £ s. d.	Each £ s. d.
885	**Botanic or Dissecting Microscope,** Simple Lenses, a variety of forms, with pillar to screw into the top of the box containing the apparatus . 11s. 6d., 16s.,	0 17 0	1 10 0

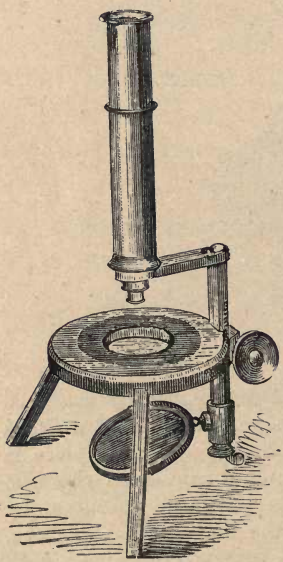


FIG. 892.

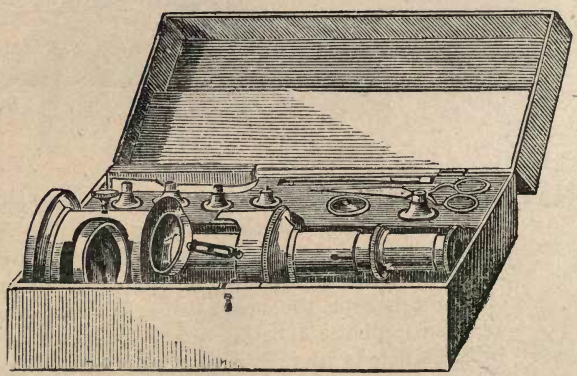


FIG. 891.

886	**Botanic or Dissecting Microscope,** with Rackwork adjustment and apparatus, in Mahogany Box (fig. 886)	1 5 0	1 10 0

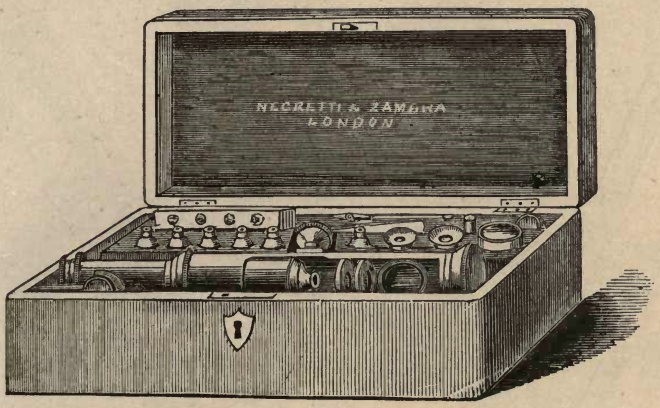


FIG. 891.

		Each. £ s. d.	Each. £ s. d.
887	**Compound Microscope,** with sliding tube adjustment, mirror, eye-piece, and magnifying power, forceps, and one microscopic object; in a Mahogany hinged box		0 10 0
888	**Compound Microscope,** with three magnifying powers and two objects and stage glass for holding water. &c., in Mahogany box (fig. 888)	0 16 0	0 18 0
889	**Compound Microscope,** with three magnifying powers, a mounted lens for condensing the light on opaque objects; in Mahogany box (fig. 889) . 1 1 0	2 2 0	2 10 0
890	**Compound Microscope,** with sliding tube adjustment, mirror, four powers, objects, forceps, water trough, insect box, stage plates, glass tube, &c. (fig. 890) .		3 3 0
891	**Large Compound Microscope, Martin's Improved,** best finish, and lenses, with Rackwork adjustment (fig. 891)		4 4 0
892	**Dissecting or Mounting Microscope,** improved form, arranged for medical or botanical investigation. The stage plate is made of stout glass, set in a circular brass rim supported on three legs; beneath the stage is a mirror, with convenient adjustment. This Microscope is fitted with three simple powers, ½-inch, 1-inch, and 2-inch focus. Arranged in a neat mahogany box, with brass forceps, &c. . . .		2 2 0
893	**Dissecting Microscope,** similar to No 892, but with Compound Body, as fig. 892, having Rackwork adjustment, also 1-inch and ¼-inch Achromatic Powers, in Mahogany Box, with brass forceps, &c. . . .		4 4 0

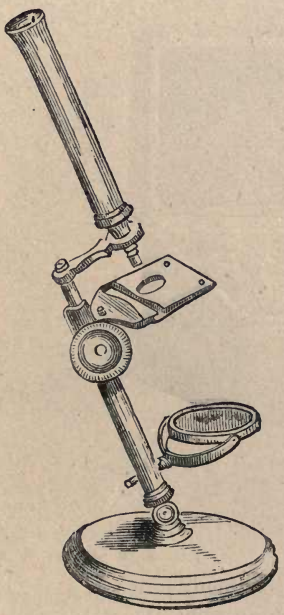


FIG. 894.

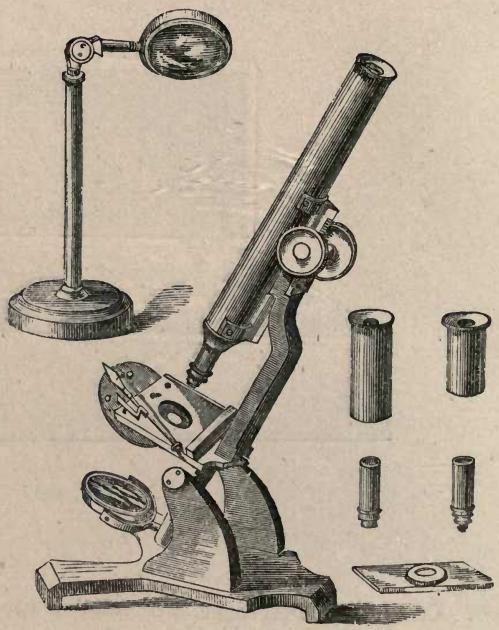


FIG. 895*.

ACHROMATIC MICROSCOPES.

894 **Achromatic Microscope,** with Jointed Pillar, and firm circular foot, Rackwork adjustment to the body, sliding clamp for objects on the stage, with a set of Achromatic lenses, brass forceps, &c.; in Mahogany case (fig, 894)
In three sizes, £1 10 0 £2 2 0 3 3 0

---

895 **Negretti and Zambra's No. 1 Microscope** (suited for elementary instruction or amusement). Bronzed Stand, rack adjustment to the body, slide holder and diaphragm to the stage, forceps, stand condenser, two eye-pieces, and two sets of **Achromatic Powers,** in Mahogany cabinet . . £3 10 0

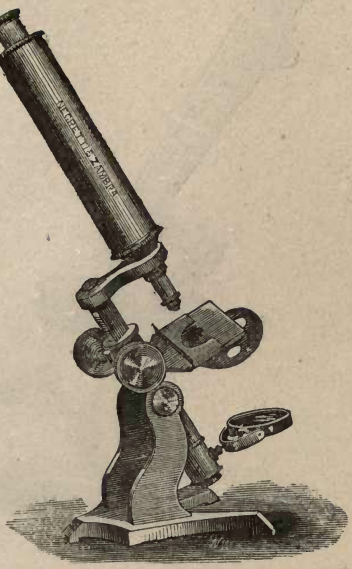
895* **Negretti and Zambra's No. 2 Microscope,** similar to No. 1, with Fine Adjustment to the body, and 1-inch and ¼-inch **Achromatic Powers** (fig. 895*) £4 10 0

896 **Negretti and Zambra's No. 3 Microscope,** similar to No. 2, and fitted with **Polarising Apparatus** £6 10 0

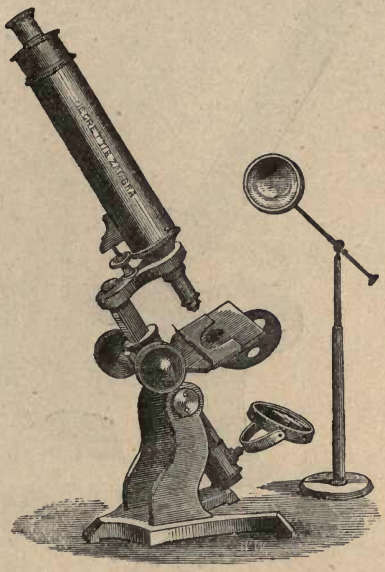
---

897 **Negretti and Zambra's No. 1A College Microscope,** with Brass stand, rackwork adjustment to the body, sliding object stage and holder, diaphragm plate, Achromatic object lens, dividing to ½-inch and ¼-inch, in brass box, Live Box, brass forceps, &c.; in Mahogany cabinet with lock and key and drawer . . . . . (Fig. No. 1A), £3 10 0

898 Ditto Ditto Ditto, with Stand Condenser, Stage, Forceps . £4 4 0



No. 1 A



No. 2 B

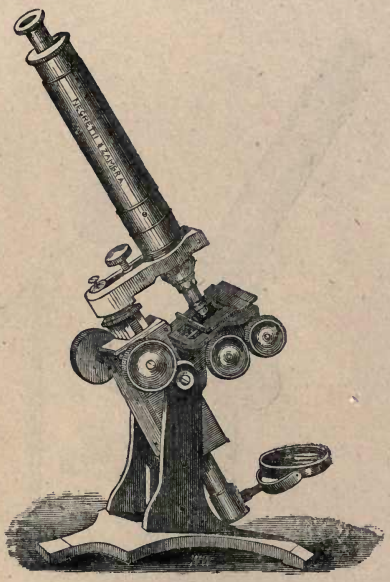
899 **Negretti and Zambra's No. 2 B College Microscope,** as 898, but with fine adjustment and lengthening tube to the body, separate object lenses, 1-inch and ¼-inch, in brass boxes ; in Mahogany Cabinet . . £5 0 0

900 **Negretti and Zambra's No. 3 C College Microscope,** with **Mechanical Stage,** giving adjustment in two directions, as No. 2 B, in Mahogany Cabinet with Lock and Key £8 10 0

901 **Negretti and Zambra's No. 4 D College Achromatic Microscope,** similar to No. 3 C, but with **Polarising** Apparatus 10 10 0

902 **Negretti and Zambra's College Achromatic Microscope,** No. 5. Brass stand, with **Mechanical Stage,** Rackwork Adjustment and Lengthening Tube, to the body, Fine adjustment for the Object lens, rotating object holder, and diaphragm to the stage, two eye-pieces, three Achromatic Powers, 1 inch, ½-inch, and ¼-inch, Polarising Apparatus with Selenite Spotted Lens, Stand, Condensing Lens, Animalculæ Cage, Stage Condenser and Forceps, Curved Forceps, Dipping Tubes, Stage Glasses, &c., &c.; in Mahogany Cabinet £18 18 0

902* **Negretti and Zambra's Student's Binocular Microscope,** with convenient adjustment for width of eyes, Plain Stage, two Eye-Pieces, and 1-inch and ½-inch Achromatic Object Lenses, Stand Condenser, Live Box, brass forceps, &c.; in Mahogany cabinet £8 8 0



No. 3 C.

No. 4 D.

903 **Student's Binocular Microscope,** as 902*, with **Rackwork Adjustment** to eye-pieces, and an extra pair of eye-pieces (fig 4 D.) . . . £10 10 0

904 **Negretti and Zambra's Student's Binocular Microscope,** as No. 903, but with extra ¼-inch Power £12 12 0

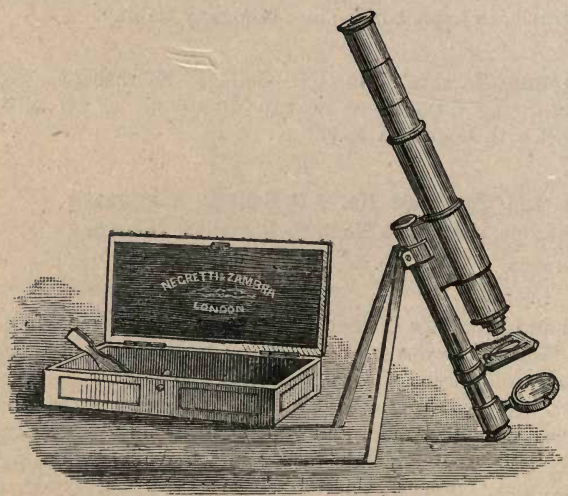


FIG. 905.

905 **The Naturalist's Portable Field Microscope,** mounted on Folding Brass Tripod, with 1-inch Achromatic Object Lens, complete with Forceps, &c., in Mahogany Box (fig. 905) £3 10 0

906 Ditto ditto having 1-inch and ¼-inch Achromatic Lenses, Live Box, Forceps, Fishing Tubes, Stage Glasses, Stand Condenser, &c., &c., in Mahogany Box, very compact, invaluable to Mineralogists, Botanists, Geologists, Entomologists or Travellers £4 10 0

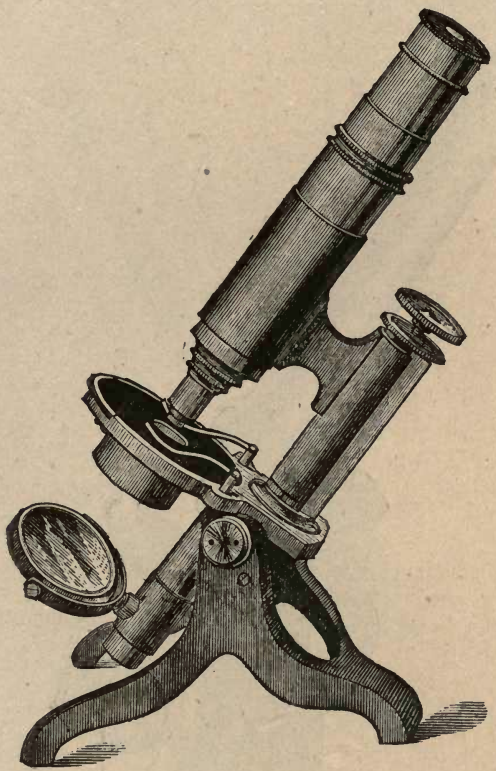


FIG. 907.

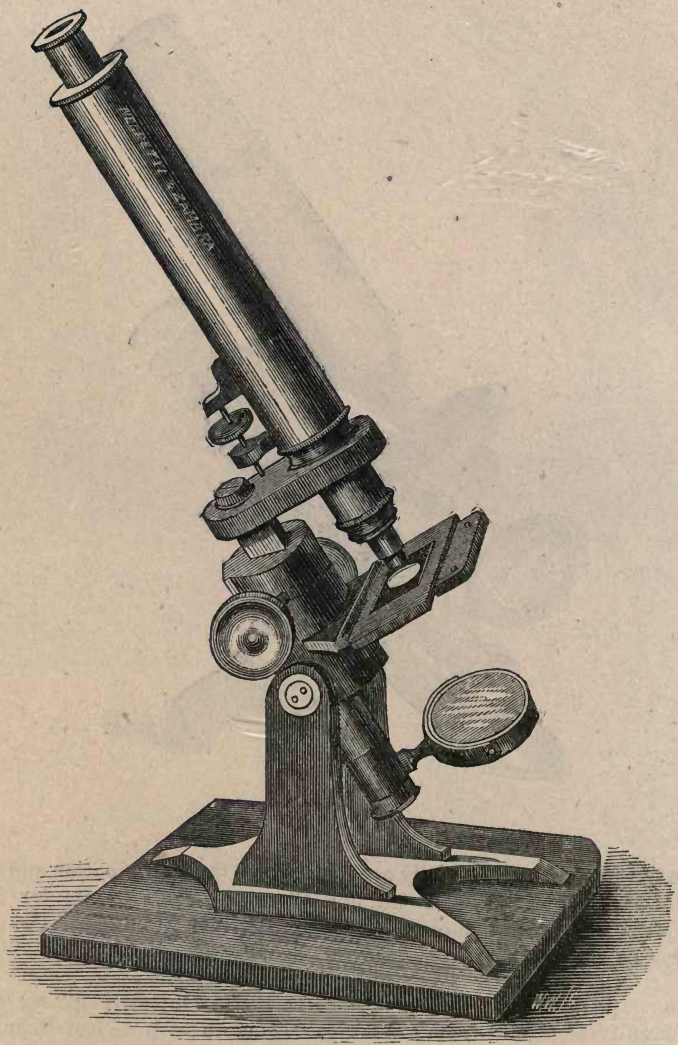
907 **Brewer's Microscope**, specially constructed for the Examination and Selection of Hops, Yeast, Malt, Sugar and Water previous to use for Brewing. Fitted with one Eye-piece, 1-inch and ¼-inch Achromatic Powers, Condenser, &c., &c., in Cabinet complete as fig. 907 . . . £8 8 0

908 Ditto ditto, one Extra Eye-piece and ⅛ Objective giving increased Magnifying Power from 425 to 525 Diameters with perfect Definition and Penetration, Extra Apparatus in Cabinet £15 15 0

The Microscopes Nos. 895 to 908 have been constructed to supply instruments of moderate price, but with good workmanship, and solid mechanical arrangements.

Larger and more perfect forms of Microscope are described in the following pages.

Instruments and Apparatus for Brewers' use will be found described with prices in Sections, Thermometers, page 153; Hygrometers, page 68; Hydrometers and Saccharometers, Glass and Metal, with Excise and Government scales, page 176; Polarising Saccharometers, page 278; Distilling Apparatus, page 193; also an extended list of Chemical Apparatus at the end of this Catalogue.



No. 911.

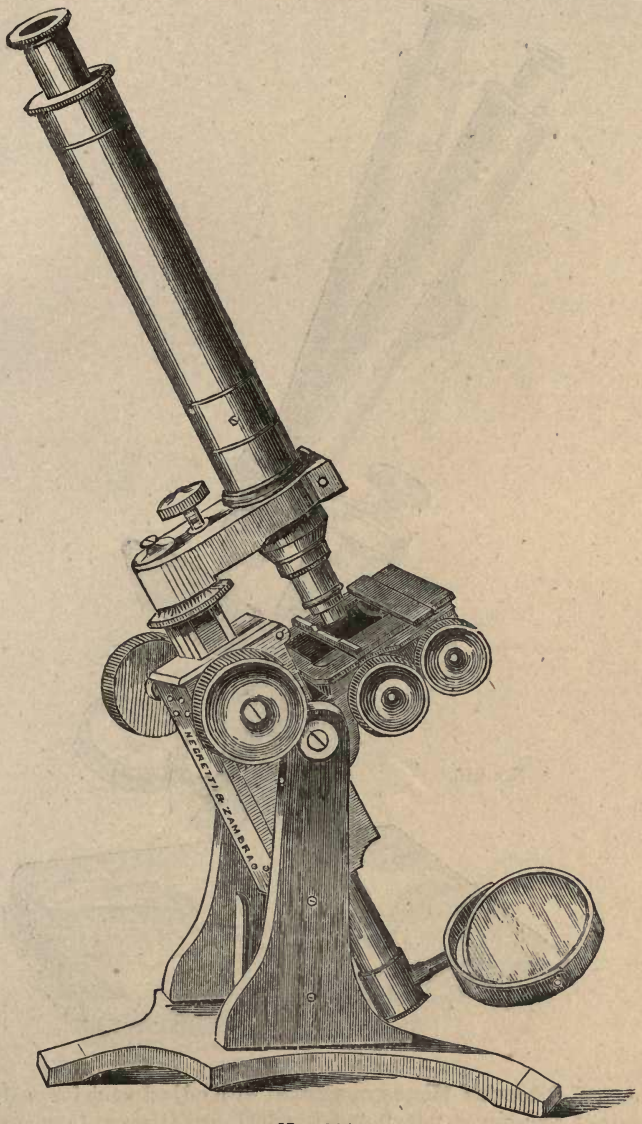
909 **Student's Microscope** on Brass Stand, with one Eye-piece, one Object Glass giving two powers, Live Box and Brass forceps, packed in Mahogany Cabinet £5 5 0

910 **Student's Microscope,** similar to No. 909, but with two Eye-pieces, two Object Glasses, Condensing Lens on Stand, &c. £7 7 0

911 **Student's Microscope,** similar to No. 910, but with Fine Adjustment to the Body, 2-inch, 1-inch, and ¼-inch Object Glasses, fig. 911 . . £8 15 0

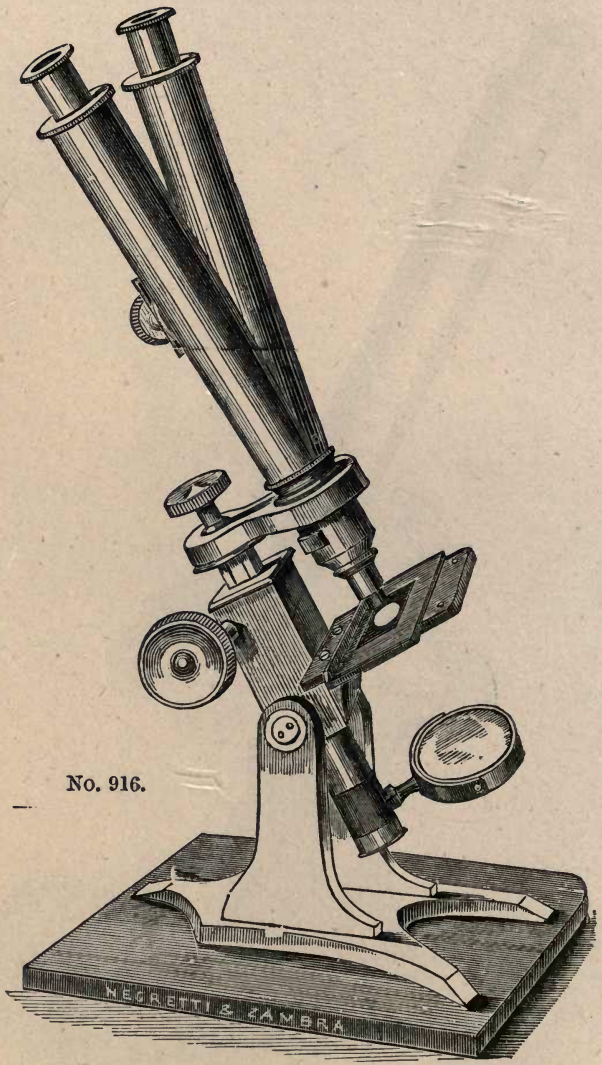
912 **Larger size Student's Microscope,** similar to No. 911, but finished in the best possible manner £13 13 0

913 **Student's Microscope,** similar to No. 912, but fitted with Polarising Apparatus, Spot Lens, &c. £16 16 0



No. 914.

914 **Negretti and Zambra's Student's Best Full-sized Monocular Microscope.** Brass stand, with **Mechanical Stage**, Rackwork adjustment and Lengthening Tube to the body, Fine adjustment for the Object Lens, sliding and rotating Object Holder, and Diaphragm to the stage, two eye-pieces, A and B, three Best Achromatic Object Lenses, 1-inch, ½-inch, and ¼-inch, Polarising Apparatus, with Selenite Plate, Spot Lens, Camera Lucida, large Condensing Lens on Stand, two Live Boxes or Animalculæ Cages, Stage Condenser and Stage Forceps, plain and curved Brass Forceps, Dipping Tubes, Stage Glasses, &c., &c.; in Solid polished Mahogany Cabinet, with lock and key, fig. 914 . . . . . £25 0 0



No. 916.

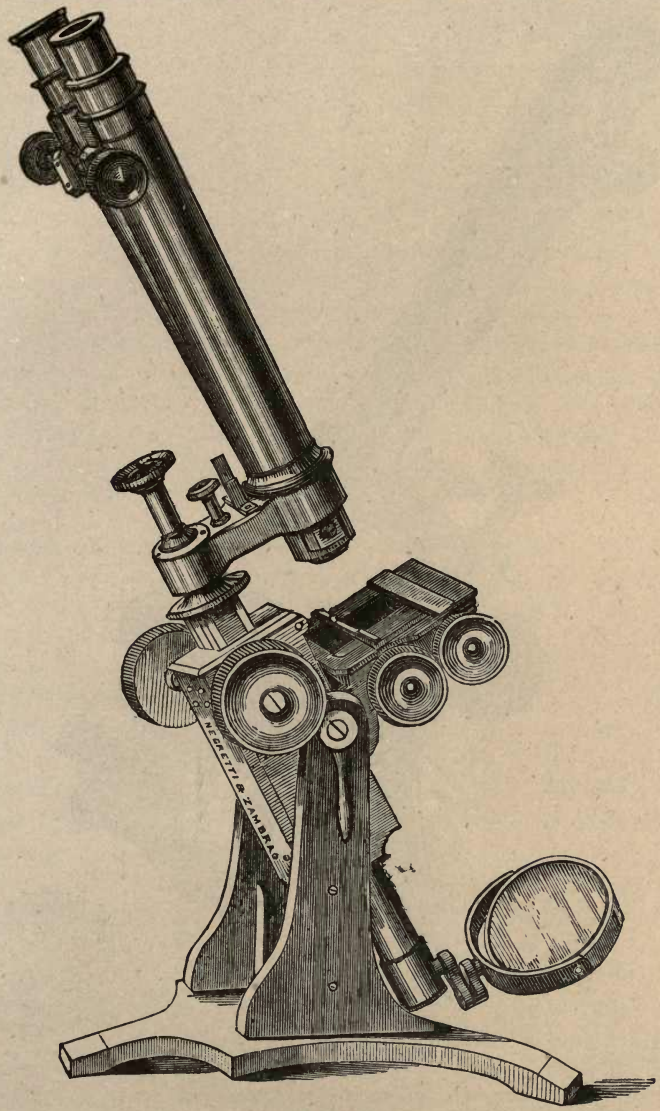
915 **Student's Binocular Microscope**, fitted with adjustment for width of eyes, a pair of Eye-pieces, 2-inch and 1-inch Object Glasses, Condensing Lens on Stand, Live Box, Forceps, &c., packed in Mahogany Case . £12 12 0

916 **Binocular Microscope**, similar to No. 915, but finished in superior manner, and with 1-inch, 1-inch and ¼-inch Object Glasses (fig. 916) . £18 18 0

917 **Binocular**, similar to No. 916, but fitted with Polarising Apparatus, two pairs of Eye-pieces, Spot Lens and Selenite Plate, &c. . . . £22 0 0

918 **Binocular**, similar to No. 917, but with Mechanical Stage, Fine Adjustment, &c. £25 0 0

920 **Binocular**, similar to No. 918, but with **Larger Stand**, Sliding and Rotating object holder, spring side clamp, Clamping Arc for fixing at any angle, extra large Condensing Lens on Stand, Glass Trough, two Stage Plates Fishing Tubes, Frog Plate, &c., in Mahogany Cabinet . £42 0 0



No. 921.

921 **Binocular Microscope,** with Mechanical Stage, having rectangular motions, sliding and rotating object holder, spring clamp slide, revolving Diaphragm, Flat and Concave Mirrors arranged to give an oblique pencil of light, Clamping Arm for fixing the instrument at any angle, Coarse and Fine Adjustments, two A and two B Eye-pieces, one C Eye-piece, Micrometer Eye-piece, four best achromatic Objectives 1½-inch, 1-inch, ½-inch, ¼-inch. Polarising Apparatus, Rotating Selenite, Spot Lens, Stand Condenser, Stage Condenser, Side Reflector, Camera Lucida, Reversible Compressorium, Frog Plate, two Live Cages, two Glass Stage Plates, Stage Micrometer, Stage Forceps, Straight and Curved Hand Forceps, and Dipping Tubes in Case, complete in Solid Mahogany Cabinet with Plate Glass door, fig. 921. . . . . £65 10 0

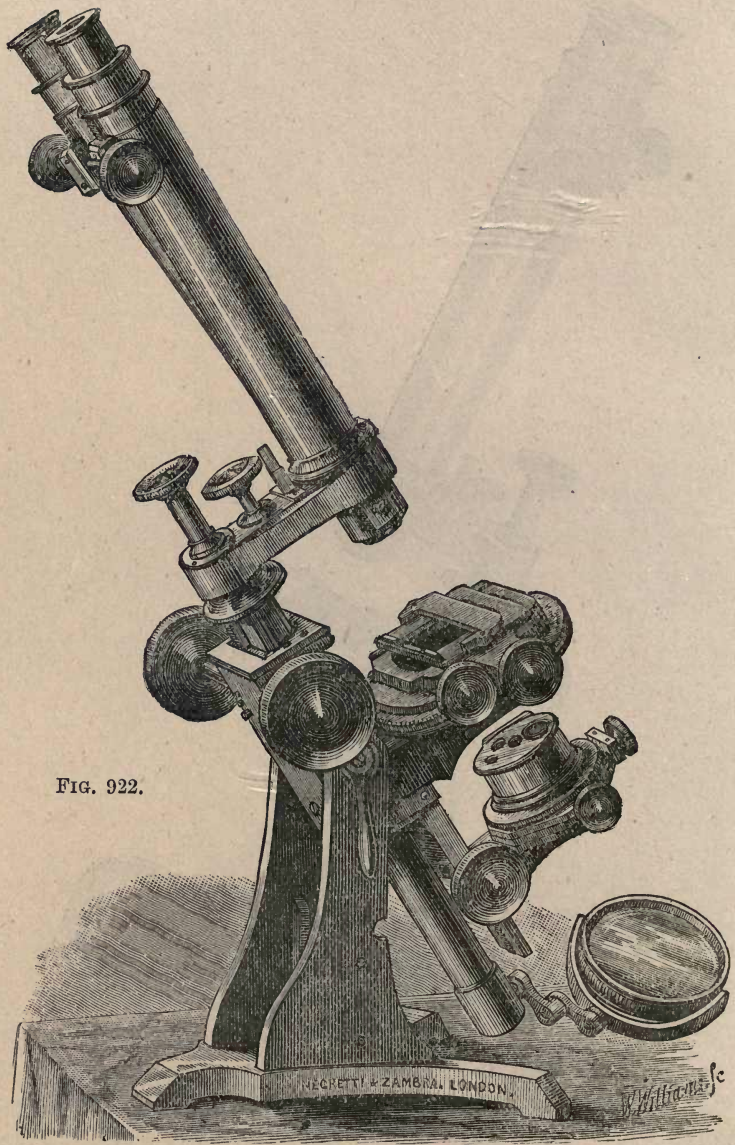


FIG. 922.

922 **Negretti and Zambra's Large Binocular Microscope,** with Mechanical Stage, having motion in rectangular directions, Sliding and Rotating Object holder, Spring Slide Clamps, Sub-stage with rectangular motions, revolving diaphragm, flat and concave Mirrors, clamping arm to fix instrument at any angle, coarse and fine adjustments, two A, two B, one C, one D, and one Micrometer Eye-pieces, six Best Achromatic Object Glasses, *viz.*, 3-inch, 1½-inch, 1-inch, ½-inch, ¼-inch, and ⅛-inch. Polarising Apparatus, Darker's revolving Selenite Stage, Paraboloid, Spot Lens, Stand and Stage Condenser, Side reflector, Brook's double Nose-Piece, Camera Lucida, Reversible Compressorium, Frog Plate, large and small Live Boxes, two Stage Plates, Stage Micrometer, Stage Forceps, straight and curved Forceps, Dipping Tubes in case, fitted in Solid Mahogany Cabinet with Plate Glass door (fig. 922) £90 0 0

923 **Negretti and Zambra Large Binocular Microscope,** with graduated rotating Goniometer stage with rectangular motions, graduated rotating Sub-stage, flat and concave Mirrors, clamping arm to fix instrument at any angle, coarse and fine adjustments, two A, two B, one C, one D, one Micrometer and one Kellner's Orthoscopic Eye-pieces, eight best Achromatic Object Glasses, *viz.*, 3-inch, 2-inch, 1½-inch, 1-inch, ½-inch, ¼-inch, ⅙-inch, ⅛-inch, three Lieberkuhns, Gillett's Achromatic Condenser, large Paraboloid, large Spot Lens, Stand and Stage Condensers, side Illuminator, Polarising Apparatus, Darker's Revolving Selenite Stage, Brook's double Nose-piece, Lister's Dark Wells, Reversible Compressorium, High Power Compressorium, large and small Live Boxes, Camera Lucida, Stage Forceps, Stage Micrometer, straight and curved Forceps, two Glass Troughs, two Stage Plates, two Dissecting Plates, Frog Plate, three Modifiers, Dipping Tubes in case. Fitted in Solid Mahogany Cabinet for the instrument and flat Case for the apparatus, with draw for containing Mounted Objects, Form of Stand, &c., as fig. 922 . . . £150 0 0

924 **Extra Large Binocular Microscope,** with Goniometer Stage, Diaphragm and seven Eye-pieces, 2 A, 2 B, 2 C, two C Orthoscopic Eye-pieces, one D, one E Achromatic Eye-piece, one Centreing Eye-piece, best 4-inch, 3-inch, 2-inch, 1½-inch, 1-inch, ½-inch, ¼-inch, ⅙-inch, ⅛-inch, $\frac{1}{12}$inch Achromatic Objectives, 2-inch, 1½-inch, 1-inch, ½-inch Lieberkuhns in box, Silver Side Reflector, Reversible Compressorium, Best Compressorium, Spring Compressorium, Spring Compressorium for high powers, large, second size, and small Live Boxes, Frog Plate, Brook's Double Nose-piece, Best Screw Micrometer, Field's Ratio Polariscope with Rotating Body Prism, Large Spot Lens, Large Paraboloid, Read's Hemispherical Condenser, Gillett's Achromatic Condenser, Lister's Dark Wells and fittings, Amici's Prism, Micro. Spectroscope, Stage Condenser, Stage Forceps, two pair Brass Forceps, one Curved Bottle Forceps, Stage Micrometer in brass mount in morocco case, Maltwood's Finder in case, two Glass Troughs, one Glass Polyp's Trough, thin front, three Dissecting Plates, two Stage Plates, six Tubes in case, box of Thin Covering Glasses, three Modifiers in box, Large Stand Condenser with Double Rod, Camera Lucida with Dark Shades, Large Flat Walnut Case for Apparatus, with chased work, and Mahogany Cabinet, with glazed door, for Microscope, and flat Case for the apparatus. £200 0 0

No. 924 can be supplied to special order in a Solid Spanish Mahogany-winged Case, with Plate Glass doors; the wings having a series of Drawers, having Porcelain Tablets and numbered Knobs, for holding 1,000 Microscopic Objects lying flat. Price Extra £22 0 0

The Microscopes Nos. 922, 923, *and* 924, *are especially suited for Presentation Instruments.*

925. ENGLISH ACHROMATIC OBJECT GLASSES.

BEST QUALITY.

	Object Glass	Angular Aperture	Magnifying Power with the various Eye Pieces. A	B	C	D	E	F	Price £ s. d.
	4 in.	9 degs.	12	16	30	40	62	80	1 10 0
	3 „	13 „	18	25	38	56	84	112	2 10 0
	2 „	15 „	25	35	52	70	100	140	2 10 0
	1½ „	20 „	30	45	70	105	150	190	2 10 0
	1 „	25 „	40	63	97	140	220	285	2 10 0
	½ „	90 „	95	150	230	320	475	635	4 10 0
With adjustment for covered and uncovered objects.	¼ „	100 „	210	310	520	780	1100	1400	5 0 0
	1/8 „	140 „	320	510	700	910	1380	1830	4 10 0
	⅛ „	140 „	425	600	900	1200	1830	2400	5 0 0
	1/10 „	160 „	530	820	1200	2024	2900	4400	15 15 0
	1/12 „	170 „	650	970	1500	3000	4000	5300	18 18 0
	1/16 „		800	1000					27 0 0
	1/25 „		1250	2050					56 10 0

Immersion arrangement to 1/6th or 1/8th powers, 42s. extra.

The 1/16th, 1/12th, 1/16th, and 1/25th, are all of the very highest class of Optical workmanship.

926. SECOND QUALITY.

Object Glass.	Angular Aperture	Magnifying Power with the various Eye Pieces. A	B	C	D	E	F	Price £ s. d.
3 in.	10 degs.	18	25	38	56	84	112	1 10 0
2 „	14 „	25	35	52	70	100	140	1 10 0
1½ „	15 „	30	45	70	105	150	190	1 10 0
1 „	16 „	40	63	97	140	220	285	1 10 0
½ „	55 „	95	150	230	320	475	635	2 10 0
¼ „	75 „	210	310	520	780	1100	1400	2 10 0
*1/6 „	120 „	320	510	700	910	1380	1830	5 10 0
*⅛ „	130 „	425	600	900	1200	1830	2400	6 10 0

Those marked (*) have adjustments for covered and uncovered objects, and all the screws are cut to the Standard Gauge of the London Microscopic Society.

927 Sets of Achromatic Object Lenses, for Microscopes of French or German manufacture, combined focus, 1-inch £1 0 0

Ditto ditto, ½-inch 1 5 0

Ditto ditto, ¼-inch 1 10 0

928 **Field's Differential or Ratio-Micro Polariscope**, an instrument for the mathematically-exact application of Polarised light in Microscopical research; price, with new rotating body prism, packed in mahogany cabinet £17 10 0

Only adapted for Instruments having Sub-Stages.

929 **Improved Micro Spectroscope.** Showing two Spectra in the field of view at the same time; the small prism by means of which the second spectra is produced is made to remove from the field of view when only one spectra is required: this instrument is supplied with two adjustable slits at right angles to each other, with adjustments for regulating the width of slit required, and the eye lens is also furnished with rack and pinion adjustment for focussing the spectra and lines under examination. The stage for holding Sorby's tubes, wedge cells, &c., for showing the spectra bands, are made to remove with the reflecting mirror from the body of the instrument when not required: this spectroscope with achromatic lens to eye-piece, complete as described above, fitted to any microscope £7 7 0

For Pocket Microscopes and Hand Magnifiers see pages 223 and 224.

APPARATUS, ETC., FOR MICROSCOPES.

		Each. £ s. d.	Each. £ s. d.
930	Eye Pieces, Huyghenian (figs. 930 and 930*)	0 10 0	0 15 0
931	Ditto ditto Best A, B, C, and D, E, and F	0 16 0	1 1 0
932	Ditto, Erecting, for Dissecting	0 15 0	1 0 0
933	Ditto Achromatic		1 12 0
934	Micrometer Eye Pieces		1 4 0
935	Kellner's Orthoscopic Eye Pieces, giving larger field		1 10 0
936	Ross's Centreing Glass		0 15 0
937	Indicator to Eye-piece		0 6 6
938	Brook's Double Nose Piece, for rapidly changing the Object Lens or power of a Microscope		1 10 0
940	Stand Condensers, small (fig. 940)	0 10 6	0 16 0
941	Ditto ditto with Large Lens and convenient adjustments (fig. 941) 22s.	1 10 0	1 16 0
942	Shadbolt's Parabolic Condensers, in brass mountings	1 14 0	2 15 0
942*	Amici's Prisms		2 10 6
943	Achromatic Condenser, plain		2 5 0
944	Ditto ditto Gillet's		7 0 0
945	Achromatic Eye Pieces, D		0 16 0
946	Ditto ditto E		0 18 0
947	Kingsley's Illuminator		3 18 0
948	Reade's Hemispherical Condenser		2 2 0
949	Lieberkuhn, or Cup Reflector 10s. 6d.	0 16 0	1 0 0
950	Rectangular Prism, for use instead of a mirror	1 10 0	2 10 0
951	Rainey's Light Modifier		0 7 6
952	White Cloud Illuminator		0 12 6

FIG. 930.

FIG. 930*

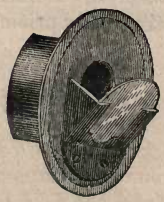


FIG. 962.

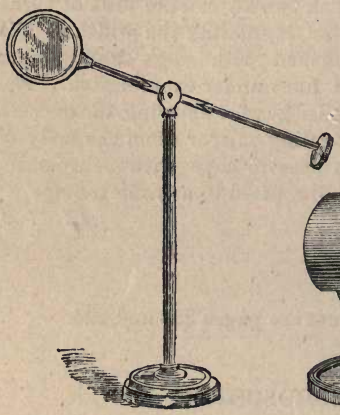


FIG. 940.

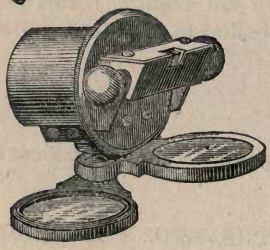


FIG. 961.

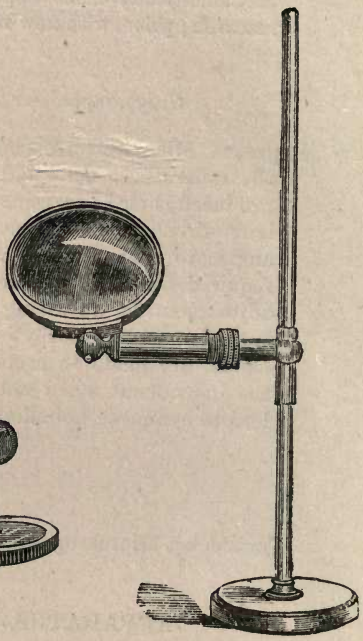


FIG. 941.

		Each. £ s. d.	Each. £ s. d.
953	**Stage Condenser or Side Illuminator,** mounted on jointed arm . . . . . 7s. 6d.	0 12 6	1 1 6
953*	**Nachet's Prism,** for Oblique Illumination . . .		2 2 0
954	**Side Speculum Reflector,** mounted as ditto (fig. 954) .	1 1 0	1 12 0
954*	**Dark Wells or Stops,** three sizes on jointed holder .		0 12 6
954†	**Micrometer for Stage,** divided on glass, $\frac{1}{100}$th and $\frac{1}{1000}$th of an inch		0 10 6
955	**Maltwood's Finder**		0 8 6
956	**Polarising Apparatus** fitted to Microscope . . .	2 10 0	3 15 0
957	**Tourmalines,** mounted to fit eye-tube, price according to quality and size . . . . . from		0 12 6
958	**Selenite,** mounted for Stage	0 2 0	0 2 6
959	Ditto ditto in Brass Mount		0 7 6
960	**Camera Lucida,** Wollaston's, for drawing magnified image, mounted to fit microscope		1 5 0
961	Ditto ditto with additional lenses and shades (fig. 961) .		1 14 0
962	**Beale's Neutral Tint Reflector** (fig. 962) . . .		0 10 6
963	**Improved Argand Oil Lamp,** adapted for Microscopic purposes (fig. 963)		1 10 0
964	**Paraffin Microscopic or Reading Lamps,** in various mountings (fig. 964)	1 10 0	1 15 0

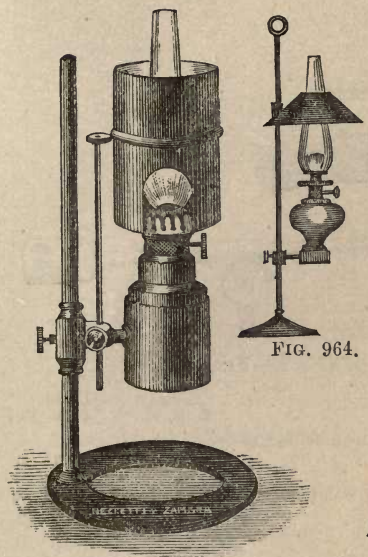


FIG. 964.

FIG. 965.

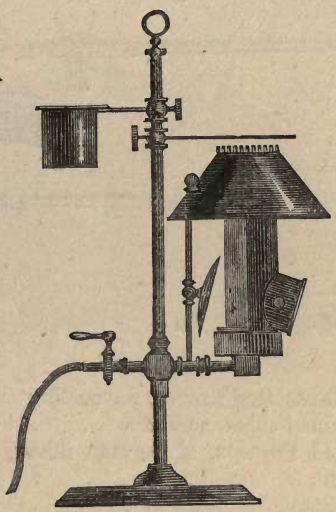


FIG. 964*.

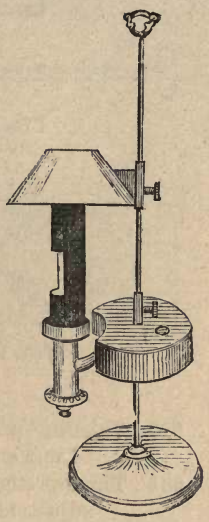


FIG. 963.

		Each. £ s. d.	Each. £ s. d.
964*	**Microscopic Argand Gas Lamp**, with Improved illuminating lens and chimney, and the stand conveniently arranged for various purposes connected with preparing and mounting microscopic objects. This Lamp can also be used as a Reading Lamp or for Chemical Operations (fig. 964*)		3 3 0
965	**Paraffin Microscopic Lamps**, with Porcelain Shade, vertical adjustment to both Stand and Shade (fig. 965)		0 10 6
966	Ditto ditto in Polished Pine Cabinet . . .		0 18 6
967	**Bochett's Microscopic Lamp** (Paraffin) Brass Mounted, with Condenser, Reflector, Shade, and universal adjustments; in Mahogany case		3 3 0
968	**Porcelain Shade**, for Microscopic Lamp . . .		0 1 6
969	**Lamp Glasses**, for do.		0 0 8
970	**Forceps**, of several forms, for taking up small objects, dissections, &c. . . . . 2s. 6d.	0 3 6	0 5 0
971	Ditto ditto **Curved for Phials**	0 3 6	0 6 6
972	**Wood Forceps**, Page's, for mounting objects . .		0 2 6
973	**Stage Mineral Holder**		1 1 0
974	**Stage Forceps**, with jointed arm, very useful for holding objects while under examination in the microscope (fig. 975)	0 10 6	0 12 6
975	**Dissecting Needles**, or Needle holders	0 1 6	0 5 0
976	**Dissecting Scissors**	0 3 6	0 6 6
977	Ditto ditto **Curved**		0 6 6
978	Ditto ditto **Spring**		0 10 6
979	**Dissecting Knives**	0 2 6	0 3 0

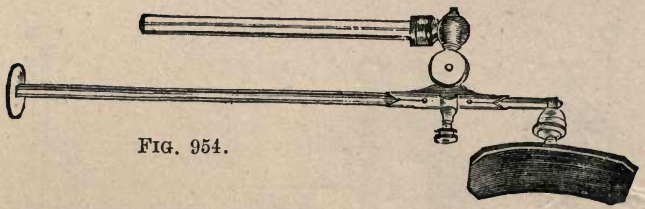


FIG. 954.

FIG. 985.

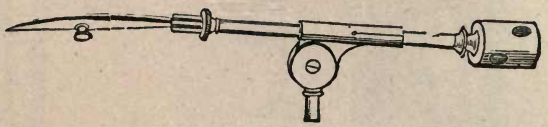


FIG. 975.

		Each. £ s. d.	Each. £ s. d.
980	**Valentine's Dissecting Knives**, for cutting thin sections of soft animal substances, &c.	0 17 6	1 1 0
981	**Three-pronged Forceps, of German Silver**, with screw adjustment		0 17 6
982	Ditto ditto plain mounting		0 15 0
983	**Microscopic Dissecting Instruments**, in neat case . .	1 1 0	2 10 0
984	**A Selection of all the Necessary Materials for** Mounting Objects, arranged in a mahogany box .	3 3 0	4 4 0
985	**Glass Cell**, round, for holding fluids, viewing circulation in plants, polyps, &c. (fig. 985)		0 1 6
986	**Animalculæ Cage or Live Box**, for conveniently examining water containing animalculæ, living insects, &c. (fig. 986) . . . . . 5s. 6d.	0 7 6	0 10 6
987	**Animalculæ Box**, Varley's Pattern, with raised centre (fig. 987)	0 12 6	0 16 0

FIG. 986.

FIG. 987.

988	**Compressorium**, for similar purposes, where the object requires greater pressure	0 15 0	1 1 0
989	Ditto ditto **Best Lever**		1 16 0
990	**Frog Plate**, for holding Frogs, Fish, &c., to exhibit the circulation of the blood	0 10 6	0 12 6
991	**Glass Rings, Cells, Circles, Squares**, &c., of various sizes and thicknesses, for mounting injections, &c., from per doz.	0 3 0	0 4 0
992	**Plate Glass Stage Plates**, with Oval or Round cells per doz.		0 4 0
993	**Glass Sides**, with ground edges for mounting objects, of the best quality, 3-in. by 1-in. . . . per doz.		0 1 0
994	**Thin Microscopic Glass**, cut in Squares, per oz.		0 3 6
995	Ditto ditto cut in **Circles**	0 6 0	0 10 0

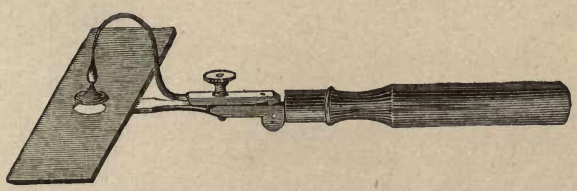


FIG. 1010.

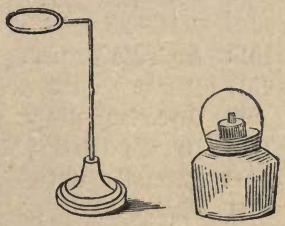


FIG. 1014. FIG. 1013.

996 **Coloured Paper Mountings for Slides,** from 1s. per dozen.

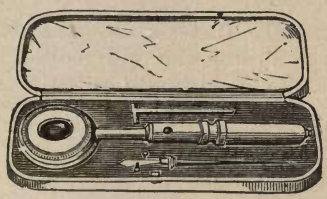


FIG. 997.

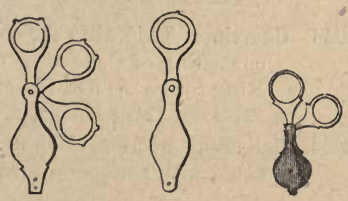


FIG. 998.

		Each. £ s. d.	Each. £ s. d
997	**Collector's Pocket Microscope,** with two powers and forceps for holding the object, in neat hinged case (fig. 997) . . .		0 10 6
998	**Pocket Microscopes or Magnifiers;** for prices, &c., see pages 223, 224 fig. 998.		
999	**Animalculæ Tubes,** or Collecting Bottles, fitted with corks, for collecting specimens . . . per doz.		0 3 6
1000	Ditto ditto in sets and pocket cases . . .	0 10 6	0 15 0
1001	**Sets of 3 Animalculæ Fishing Tubes,** in case . .		0 2 6
1002	**Ditto** 6 ditto ditto		0 5 0
1003	**Writing Diamonds**		0 10 6
1004	**Cutting Ditto** . . . . . 16s.	1 1 0	1 10 0
1005	**Instrument for cutting Circles of Thin Glass** . .	1 10 0	4 10 0
1006	**Turn Tables** for preparing circular Gold Size Cells .		0 10 6
1007	**Section Cutters,** for wood, bone, &c.	1 10 0	2 2 0
1008	**Air Pump** for preparing objects (see also Pneumatic Section)	1 1 0	1 10 0
1009	**Brass Injecting Syringe** for ditto	0 10 6	1 10 0
1010	**Mounting Apparatus or Compressorium,** for preparing Microscopic objects in Canada Balsam, &c. (fig. 1010)		0 12 6
1011	**Canada Balsam**	per bottle	0 1 0
1012	**Turpentine**	„	0 1 0
1013	**Spirit Lamps** (fig. 1013) various sizes, see Chemical Section	0 2 6	0 3 6
1014	**Metal Support for Mounting**		0 2 6

		Each. £ s. d.	£	Each s.	d.
1015	Gold Size	per bottle	0	1	0
1016	Asphalte Varnish	„	0	1	0
1017	Damar ditto	„	0	1	6
1018	Glycerine Jelly	„	0	1	0
1019	Deane's Gelatine Medium		0	2	0
1020	Farrant's ditto		0	2	0
1021	Marine Glue		0	1	0
1022	Æther, Acetic Acid, Liquor Potassæ, Solution of Chromic Acid, Turpentine, Carmine Solution, Logwood Solution, &c., &c.,	per bottle, from	0	1	0

APPARATUS FOR COLLECTING MICROSCOPIC OBJECTS, &c.

1023 **Complete Apparatus for collecting Animalculæ, Diatoms, Desmids, &c. &c.,** consisting of Collecting or Pond Stick, Spring Clip with bottle, Metal Ring for gauze net, Spoon and Weed Knife to screw into collecting stick, Strainer, Drag Hooks, &c. £2 2 0

1024 **Collecting Bottles,** clear white glass, with welted necks fitted with corks and turned wood tops—

Capacity	1	2	3 ounces
Per doz.	3s.	3s. 6d.	4s.

1025 **Set of 6 Collecting Bottles,** in japanned tin pocket case 0 5 0

1026 **Pipettes** 0 0 3 0 0 6

All other Chemical Tests, Reagents, &c., &c., required for Microscopic Mounting supplied to order.

SPECTRUM APPARATUS FOR THE MICROSCOPE.

1027 **Sorby's Micro-Spectroscope** 5 10 0

1028 Ditto ditto with Rackwork motion to the Eye-piece 5 15 0

1029 Ditto Standard Spectrum Scale 1 1 0

See also No. 929, *page* 281.

MICROSCOPIC OBJECTS.

1030 **A Set of Twenty-four Microscopic Objects,** Transparent and Opaque, dry mounted and named; in a neat box 0 3 6

1031 **An extensive Assortment of Balsam Mounted Microscopic Objects,** of English and French mounting 0 1 0 0 1 6

These objects consist of insects, parts of insects, such as wings and wing-cases, stings, tongues, eyes, dissections of the trachea and bronchial tubes, antennæ, legs, the scales of butterflies and moths, zoophytes, ferns, fuci, mosses, madrepores, sections of recent woods, leaves, petals, and farina of plants, feathers, hairs, exuviæ of spiders and aquatic insects, algæ or sea weeds, sponges, echinus' spines, shells.

		Each. £ s. d.	Each. £ s. d.
1032	**Test Objects**, Balsam Mounted—Podura, Hair of Mouse and Bat, Navicula Hippocampus, &c. . .	0 1 6	0 2 0
1032*	**Entomological Preparation**—Various Insects, Acara Parasites, &c., **mounted in Canada Balsam**, showing the respiratory, digestive, and nervous systems, and their modifications for terrestrial and aquatic habits 1s.	0 1 6	0 2 0
1033	**Vegetable Preparations**, showing spiral vessels, ducts, tissues, raphides, cells and spores in plants; sections of wood, seeds, leaves, petals, fungi, &c. . . .	0 1 6	0 2 0
1033*	**Polarising Objects**, consisting of crystalline salts, hoofs, horn, skin, tendon, fish scales, palates of mollusca, vegetable substances, starches, &c.	0 1 6	0 2 0
1034	**Anatomical Preparations**, Transparent and Opaque, muscular fibre tissues, blood discs, pigment cells, &c.	0 2 0	0 3 0
1035	Ditto ditto Bacteria, Bacilli, &c., prices various		
1036	**Sections of Fossil Woods**, Exogenous, cut in three directions		0 10 6
1037	Ditto ditto Endogenous, cut in two directions .		0 7 6
1037*	**Sections of Limestone, Oolite' Flint**, containing sponges, fish scales, and fossil infusoria		0 4 0
1038	**Sections Longitudinal and Traverse**, of recent and fossil bones, fossil and recent Teeth, **Sections of Flint** containing Xanthidium	0 2 0	0 3 0
1039	**Diatomaceæ**: Recent and Fossil, numerous varieties of Navicula, Campylodiscus, Cocconema, Epithemia, Desmidiæ, &c., from various parts of the World .	0 1 6	0 2 0
1040	**Cabinet** of polished Mahogany for containing **Microscopic Objects**, fitted with drawers and divisions		3 3 0
1041	**Cabinet** ditto Spanish Mahogany, to hold 1,000 objects		6 6 0
1042	Ditto ditto with Plate Glass doors . . .		8 8 0
1043	**Polished Pine Wood Boxes**, with trays to hold three dozen objects		0 4 6
1044	Ditto ditto for six dozen ditto		0 10 6
1045	Ditto ditto for six dozen ditto with lock and key		0 12 6
1046	Mahogany Racks for holding objects, per foot, 1s.		
1047	**Cardboard Boxes**, with wood racks, to hold 1 dozen 1s., 2 dozen, 2s.		
1048	**Microscopic Tables**, of polished Rosewood, Walnut, or Mahogany, the top covered with leather or cloth .	8 8 0	10 10 0

A SPECIAL MEDAL

AWARDED TO

NEGRETTI AND ZAMBRA

FOR

MICROSCOPES.

Philadelphia International Exhibition, 1876.

CROOKES' RADIOMETER.

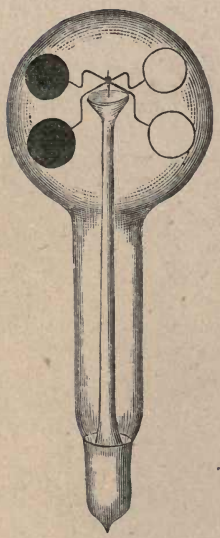


FIG 1049.

This Instrument demonstrates the supposed conversion of Light into Mechanical Motion, invented by Mr. William Crookes, F.R.S., and first exhibited by him at the Soirée of the Royal Society, *April 7th*, 1875, and described by him in the *Quarterly Journal of Science*, for *July*, 1875, as follows:—

"The Instrument which I have called a Radiometer, shown in fig. 1049, consists of four arms, of some light material, suspended on a hard steel point resting in a cup, so that the arms are able to revolve horizontally upon the centre pivot, in the same manner as the arms of Dr. Robinson's Anemometer revolve. To the extremity of each arm is fastened a thin disc of roasted mica or pith, white on one side and lamp-blacked on the other, the black surfaces of all the discs facing the same way. The whole is enclosed in a thin glass globe, which is then exhausted to the highest attainable point and hermetically sealed.

"The arms of this Instrument rotate with more or less velocity under the action of radiation, the rapidity of revolution being directly proportional to the intensity of the incident rays. Placed in the Sun, or exposed to the light of burning Magnesium, the rapidity is so great that the separate discs are lost in a circle of light. Exposed to a Candle 20 inches off another instrument gave one revolution in 182 seconds. With the same Candle placed at a distance of 10 inches off the result is one revolution in 45 seconds; and at 5 inches off one revolution was given in 11 seconds. Thus it is seen that the mechanical action of radiation is inversely proportional to the square of the distance. At the same distance 2 Candles give exactly double, and 3 Candles give three times, the velocity given by 1 Candle, and so on up to 24 Candles. A small Radiometer was found to revolve at the velocities shown in the following table, when exposed to the radiation of a standard Candle 5 inches off.

Time Required for One Revolution.

Source of Radiation.	Time in Seconds.
1 candle, 5 inches off, behind green glass	40
" 5 " " blue "	38
" 5 " " purple "	28
" 5 " " orange "	26
" 5 " " yellow "	21
" 5 " " light red,	20

"The position of the light in the horizontal plane of the Instrument is of no consequence, provided the distance is not altered; thus two Candles, 1 foot off, give the same number of revolutions per second, whether they are side by side or opposite to each other. From this it follows that if the radiometer is brought into a uniformly lighted space it will continue to revolve.

"In diffused daylight, the velocity was one revolution in from 1·7 seconds to 2·3 seconds, according to the intensity of the incident rays. In full Sunshine, at 10 A.M., it revolved once in 0·3 second, and at 2 P.M. once in 0·25 second.

"When heat is cut off by allowing the radiation to pass through a thick plate of Alum, the velocity of rotation is somewhat slower."

1049 **Crookes' Radiometer**, with Black and White Discs (as fig. 1049) on Stand £0 10 6

Ditto ditto, with Double Vanes Rotating in opposite directions, on Stand £1 1 0

For further details of Preliminary Experiments and Researches, &c., &c., see Pamphlet, *Crookes' Radiometer*. Price 1s.

FIG. 1053*.

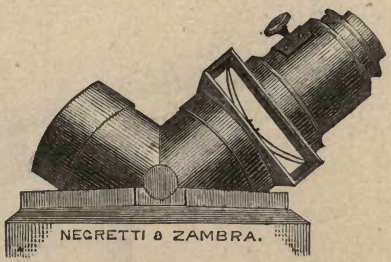


FIG. 1053.

POLARISCOPES AND POLARISING APPARATUS.

		Each. £ s. d.	Each £ s. d.
1050	**Tourmaline Polariscope**, elementary form—two plates of tourmaline arranged in Spring Wire Forceps for holding any crystal to be examined between them, very useful for testing Pebble Lenses in Spectacles .		1 5 0
1051	**Reflecting Polariscope**, Malus's. The Polarising and Analysing bundles are formed of very thin plates of Glass mounted in brass frames on a metal stand, adjustable at any desired angle. Between these Bundles or Mirrors is a stage for holding Crystals, &c., to be examined, this stage having horizontal movement, with a graduated circle for noting the angle of rotation, &c.		3 3 0
1052	**Biot's Improved Black Mirror Polariscope.** In this instrument Black Glass Mirrors are used instead of the Bundles of Glass, and these Mirrors are fitted with Divided Arcs for adjusting them to any angle. The rotating stage has also a Divided Circle and a spring clip object holder to support the crystals, &c., under examination. Complete with Tourmaline Plate of Selenite of uniform thickness, Double Image Prism, brass frame for showing polarising structure produced by unequal pressure in a piece of annealed glass, with diaphragm of greyed glass, &c.; in Cabinet . .		7 10 0
1053	**Woodward's Table Polariscope** (fig. 1053), for conveniently illustrating the interesting phenomena of Polarised Light; fitted either with a Bundle of thin glass or a black mirror. Large and small stage with spring object holder, Rack-work adjustments to eye-tube, Powers, &c., &c., complete in a Cabinet forming a Stand for the instrument		10 10 0

Woodward's Polariscope can be supplied for use with the Oxy-Hydrogen Microscope, at a slight additional cost.

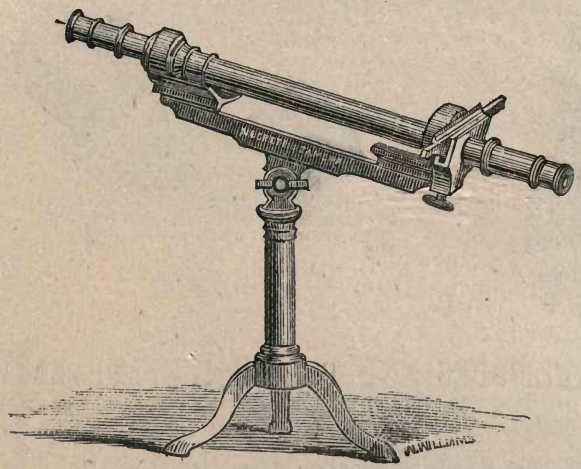


FIG. 1055.

1054 **Tourmaline Polariscope,** a frame, having a revolving disc carrying a series of Crystals, which may be successively brought between the Tourmalines; each of the latter can be made to revolve in its own plane, and thus place their axes parallel or perpendicular to each other at pleasure, and vary the phenomena of each crystal £4 10 0

1055 **Soleil's Polariscope or Saccharometer,** improved by **Duboscq,** for estimating the value of fluids, &c., with the most recent improvements (fig. 1055) . . . 16 0 0

1056 **Laurent's New Shadow Polarising Saccharometer,** having two series of divisions, one for the percentage of Sugar, and the other graduated for general Laboratory Work. Complete with one Gas Burner, fitted with two Jets, three Glass Tubes, &c., &c., mounted on a Bronzed Adjusting Stand. . . . . Price in Box 18 0 0

1057 **Ditto, ditto,** of the most complete form, having all recent improvements, Gas Burner with two Jets, four Glass Tubes, &c., (fig. 1057) Price in Box 30 0 0

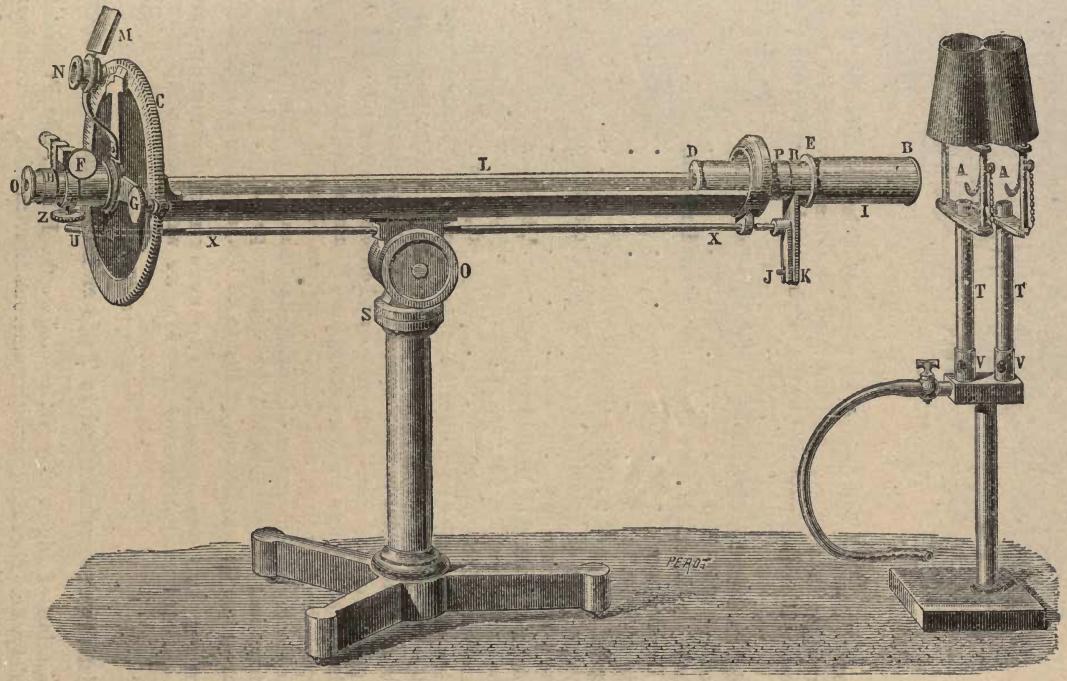
This Saccharometer is of much greater accuracy than previous arrangements, and is now adopted by the French Government. In ordering the Saccharometer the approximate pressure of Gas to be used should be stated.

1058 **Eolipyle.**—If Gas is not available, or if the pressure be feeble and irregular, it is advisable to use the Eolipyle, burning Spirit instead of Gas. (fig. 1058) Price . . £3 3 0

Instructions for use are sent with each instrument.

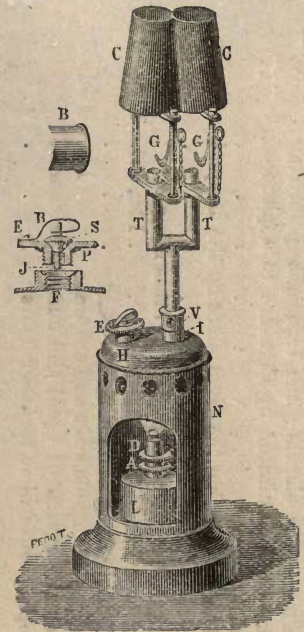
1059 **Double Image Prism,** Selenite Disc of equal thickness, and Three-hole Slider for ditto, for showing the production of white light by the union of the complementary colours £1 1 0

1060 **Unannealed Glass,** various shapes, for showing the permanent polarising structure of glass that has been uniformly heated and suddenly cooled . . . 0 5 6



LAURENT'S SHADOW POLARISING SACCHAROMETER, (fig. 1057).

The Letters in this Engraving refer to the Descriptive Book supplied with each Saccharometer.



EOLIPYLE, (fig. 1058).

		Each. £ s. d.	Each. £ s. d.
1061	**Brass Frame,** for showing the transient polarising structure communicated by Pressure to a piece of annealed glass		0 10 0
1062	**Apparatus,** for showing the same effect by the unequal application of Heat		0 8 6
1063	**Polarising Eye-piece** of thin glass, in brass mount .		0 5 6
1064	**Nicol's Single Image Calc-Spar Prism** . . 12s., 15s.	1 10 0	2 2 0
1065	**Nicol's Double Image Prism of Calc-Spar** . . .		0 18 0
1066	**Tourmalines** of various sizes and colours . . 10s.	0 12 6	1 10 0
1067	**Thin Selenite Plates** of equal and unequal thickness, developing uniform or various colours . . .	0 3 0	0 4 0

1 2 3

FIG. 1068.

1068 **Selenite Designs** are formed of pieces of Selenite different in thickness arranged in a variety of forms, such as cubes or stars, for showing the beautiful colours produced by the varying thickness of the film of Selenite. each 10s. 6d. £1 10 0

1069 **Design in Selenite,** with motto on ribbon, "Forget-me-not"—1 (fig. 1068) 0 18 6

1070 **Thistle, in Selenite,** with motto on coloured ribbon, "Dinna Forget"—3 . . . . . 0 18 6

1071 **Tulip in Selenite**—2 . . . . . 0 18 6

1072 **Selenite Design** of a Gothic Church Window . . 4 4 0

1073 **Circular Plate of Selenite,** ground Concave, to develop the colours in rings 0 16 0

1074 **Rhombs of Iceland or Double Refracting Spar,** to show the multiplication of images afforded by peculiar structure of the crystal . . 5s. 6d., 7s. 6d. 0 10 6 1 10 0

1075 **Plates** of Quartz, Arragonite, Amethyst, Topaz, Calc-Spar, Borax, Nitre, Beryl, Rochelle Salts, Sugar, Bi-chromate of Potass, Sulphate of Iron, cut at right angles to their axes, for exhibiting coloured rings, compound figures, bars and cross-bars, screws, and crosses, &c. 10s. 6d. 1 1 0 2 0 0

1076 **Sliders,** with fish fins and scales, laminæ of human cuticle, sections of teeth, bones, hoofs, horns, and tendon, various chemical salts and vegetable productions, &c., preserved in Canada Balsam, to exhibit their polarising structure; adapted for the Table Polariscope . . 0 1 6 0 2 6

1076* Microscopic Quartz Lenses, £2 10s. to £6 10s., according to Diameter.

GLASS, QUARTZ, AND OTHER PRISMS, AND EVERY DESCRIPTION OF APPARATUS OR OBJECTS PREPARED FOR EXPERIMENT WITH POLARISED LIGHT.

Polarising Apparatus fitted to Table or Lime Light Microscopes.

Polarisation of Light. By W. Spottiswoode, L.L.D., late President of the Royal Society, &c. New Edition with numerous Illustrations. Crown 8vo. 3s. 6d.

SPECTRUM APPARATUS.

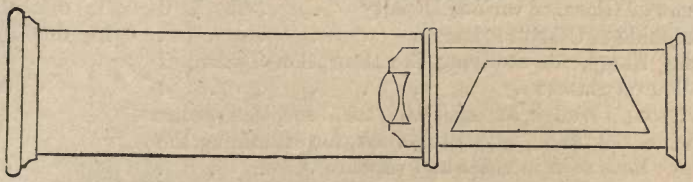


FIG. 1078.

		Each. £ s. d.	Each. £ s. d.
1077	**Negretti & Zambra's Pocket Spectroscope**, in Brass Mountings, plain Slit		1 15 0
1078	**Pocket Spectroscope**, for observing the Rain Band, with adjustable slit, will show many of Fraünhofer's lines (fig. 1078)		2 10 0
1079	**Direct Vision Rain-Band Spectroscope**, larger size, of very great dispersive power		5 5 0
1080	**Table Spectrum Apparatus** (or Spectroscope), simple form for Chemical Analysis		7 10 0

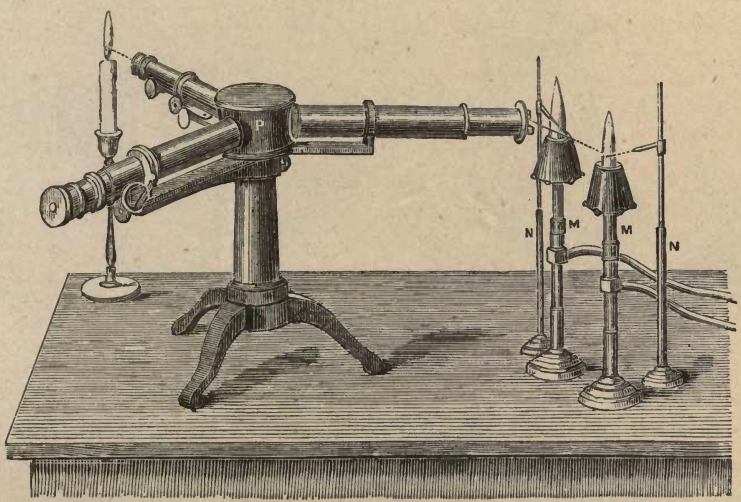


FIG. 1081.

1081	**Spectroscope**, Duboscq's arrangement, one Prism, horizontal Telescope, and transparent Micrometer, Gas Burner, and forceps; on adjusting Stand, (as fig. 1081)	£16 10 0
1082	**Table Spectroscope**, with one Prism, Eye-piece, and divided Circle	10 10 0
1083	Ditto ditto, with Two Prisms	17 10 0
1084	Ditto ditto, with Four Prisms	35 0 0
1085	**Table Spectroscope**, with two Prisms, high and low Power, divided Circle, Comparison Prism, Micro Scale, two Eye-pieces in Box	14 0 0

		Each. £ s. d.	Each. £ s. d.
1086	**Prisms of Glass**, of various Density . . £1 1 0	2 2 0	3 3 0
1087	**Bisulphide of Carbon Prisms**	0 15 0	1 1 0
1088	**Spring Stage**, for studying the absorption Spectra of coloured glasses		0 12 0
1089	**Gladstone's Wedge**, for exhibiting the absorption spectra		1 12 0
1090	**9-inch Glass Tube**, with Stop-Cock, for examining the dark lines seen in gases and vapours		0 12 6
1091	**A Divided Tube**, with two compartments and two flasks, connectors, stop-cock &c., for exhibiting the increase of dark lines with increased temperature and length of vapour		2 2 0
1092	**Bunsen's Steatite Burner**, with Copper Cone, mounted on a stand (M fig. 1081)		0 12 6
1093	**Spectroscope Forceps** (or Pincettes), on an adjusting support (N fig. 1081)		0 11 0

1094 Rock Salt Prisms and Lenses, Quartz and Iceland Spar Lenses or Prisms supplied to order.

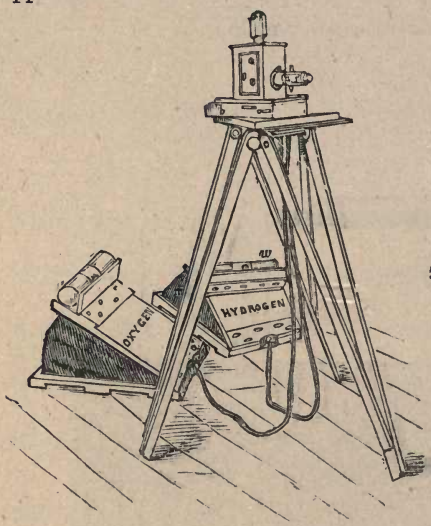


FIG. 1095.

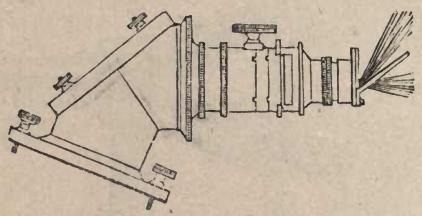


FIG. 1096.

PORTABLE OXY-HYDROGEN GAS POLARISCOPE.

1095 Complete with Apparatus for producing and Purifying the Gases. Full size Gas Bags and Pressure Boards. Flexible Conducting Tubes. Brass Connections, &c., &c. Best Lime Clock. Mahogany Portable Tripod Stand, as shown in fig. 1095 . . . . . £34 0 0

1096 Ditto ditto with Microscope (fig. 1096) . . £42 0 0

1097 Professor Roscoe's *Lectures on Spectrum Analysis* (Third Edition), largely Illustrated. Six Lectures on Spectrum Analysis and its Applications, delivered before the Society of Apothecaries. Price £1 1s.

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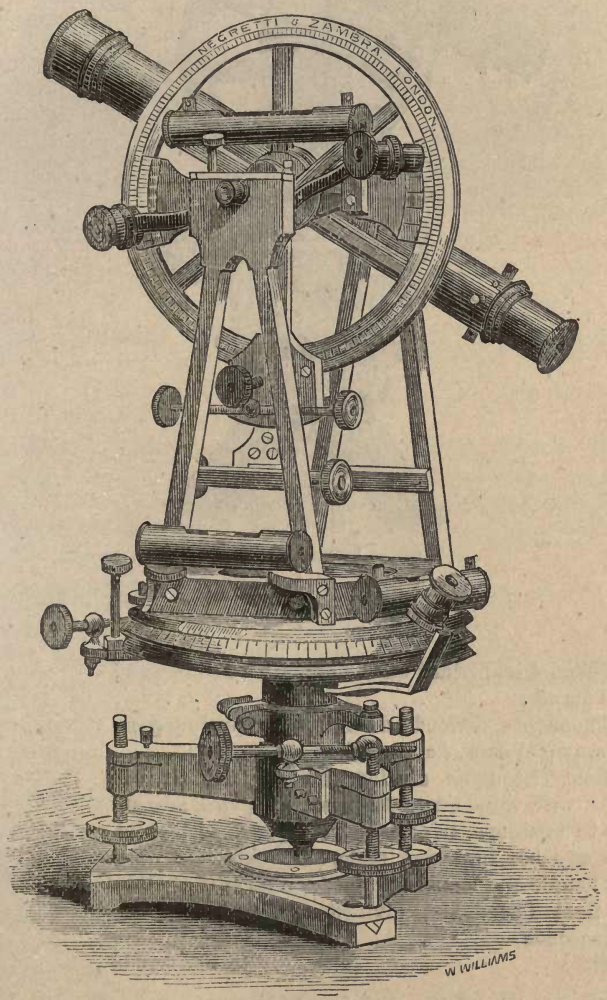
* See Section Electric Light for Lantern Spectrum Apparatus.

SURVEYING INSTRUMENTS, THEODOLITES, LEVELS, CIRCUMFERENTERS, COMPASSES, ETC.



Negretti and Zambra's Improved 7-inch Azimuth and Altitude Instrument, or Transit Theodolite (Fig. 1107). *See page* 285.

The construction and accuracy of the instruments enumerated in this section being of the first importance, Messrs. NEGRETTI AND ZAMBRA devote special attention to this particular branch of manufacture, to insure the most perfect finish and precision that can be obtained by modern improvements in machinery, dividing engines, &c.

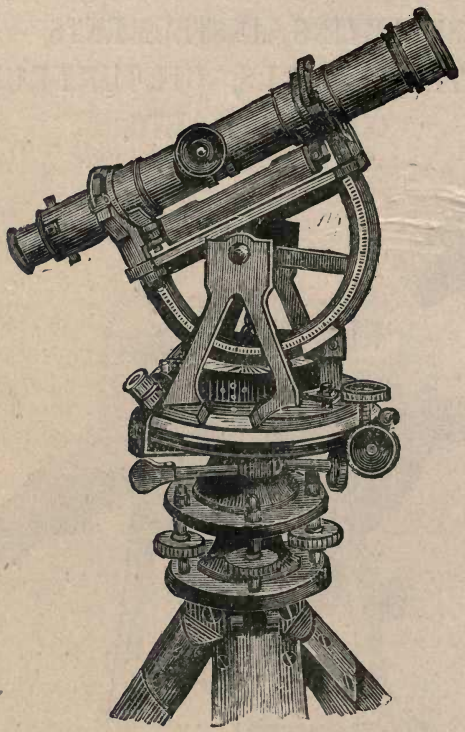


FIG. 1100.

THEODOLITES.

		Each £	s.	d.
1098	**3-inch Theodolite, divided on Silver,** with Telescope and tripod stand	18	18	0
1099	**4-inch Theodolite, divided on Silver,** with three tangent screws, tripod staff, &c., complete	21	0	0
1100	**5-inch Best Theodolite, divided on Silver,** reading to 1 minute, with three tangent screws, rackwork adjustment to telescope, tripod staff, complete; with stout mahogany box, improved screwed packings, strong brass handle and loops adapted for a strap (fig. 1100)	24	0	0
1101	**6-inch Best Theodolite, divided on Silver,** reading to 20 seconds	31	10	0
1102	**7-inch ditto ditto** to 10 seconds	35	10	0
1102*	**3-inch Transit Theodolite** with Tripod Staff . .	21	0	0
1103	**4-inch ditto ditto** reading to 1 minute . .	25	0	0
1103*	**5-inch ditto ditto** best, *divided on Silver*, reading to 1 minute, with Diagonal Eye Piece (fig. 1103*). The tangent and clamping adjustments are of the most approved construction .	29	0	0
1104	**5-inch ditto ditto** *divided on Silver*, reading to 1 minute, complete with Illuminated Axis, Lamp, and other Astronomical Appendages	33	0	0

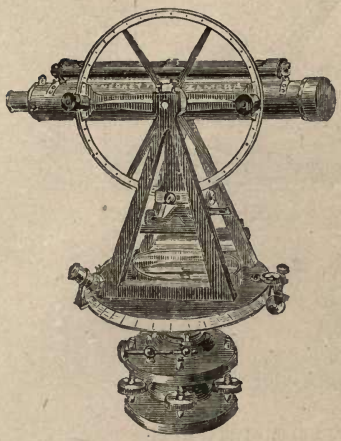


FIG. 1103*.

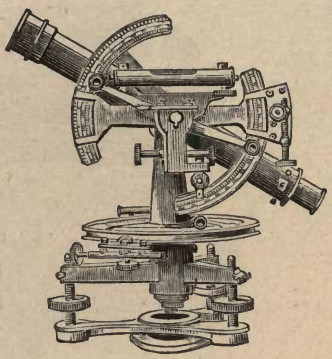


FIG. 1114.

		Each. £	s.	d.
1105	**Transit Theodolite,** 6-inch, best, divided on Silver, reading to 20 seconds	36	0	
1106	**Ditto ditto,** 6-inch, reading to 10 seconds, with Astronomical Appendages	41	0	0
1107	**Ditto ditto, 7-inch or Alt-Azimuth and Altitude Instrument** The vertical and horizontal circles are divided on Silver, reading to 10 seconds, improved magnifying readers to the divided circles, inverting erecting and diagonal eye-pieces, tangent screw adjustment levels, locking plates, with tripod stand and Mahogany Cabinet for the instrument, with lock and key (fig. 1107)	48	10	0
1108	**Alt-Azimuth and Altitude Instrument,** 8-inch Illuminated Axis, with Lamp, &c., complete as above	56	0	0
1109	**Ditto ditto** 10-inch, with ditto	90	0	0
1110	**Ditto ditto** 10-inch with Micrometer to Declination Circle	95	0	0
1111	**Ditto ditto,** 12-inch, with Ditto	110	0	0
1112	**Ditto ditto,** 12-inch, with Micrometer to Declination Circle .	120	0	0
1113	**Transit Theodolite,** 5-inch, as specially made for the War Office, with Solid Vertical Circle and covered Arcs, having three horizontal and two Vertical Verniers, fitted on Locking Plate in stout Mahogany Box, and with firm Tripod Stand	30	0	0
1114	**Everest's Theodolites,** 4-inch, divided on Silver reading to 30 seconds, with triangular locking plate (fig. 1114) with Tripod Stand	22	0	0
1115	**Ditto ditto,** 5-inch ditto 20 seconds	26	10	0
1116	**Ditto ditto,** 6-inch, reading to 20 seconds	33	0	0
1117	**Ditto ditto,** 7-inch, reading to 10 seconds	37	0	0
1118	**Ditto ditto,** 10-inch, reading to 10 seconds, with open braced stand, lantern, and axis level	63	0	0

Instruments more finely divided, 21s. extra.

For description and prices of larger Transit instruments, &c., &c., see Section Astronomical Instruments.

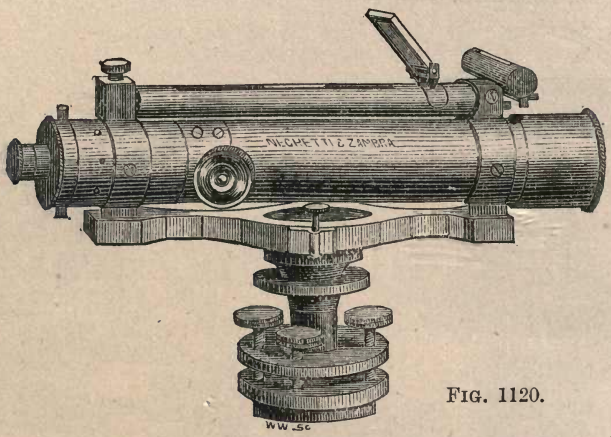


FIG. 1120.

SURVEYING AND DRAINAGE LEVELS:

1119 **10-inch best Dumpy or Gravatt's Level**, with Achromatic Telescope and rackwork adjustment, divided Silver Ring Compass, mirror and cross Level, strong brass parallel plates, with mahogany tripod staff, and case £13 13 0

1120 **12-inch ditto** (fig. 1120) . . . 14 14 0

1121 **14-inch ditto** ditto . . . 16 16 0

1122 **18-inch ditto** ditto . . . 18 18 0

1123 **24-inch ditto** ditto . . 22 0 0

Dumpy or Gravatt's Levels, without Compasses:—

1124 **10-inch** ditto ditto . . . 12 10 0

1125 **12-inch** ditto ditto . . . 13 10 0

1126 **14-inch** ditto ditto . . . 15 10 0

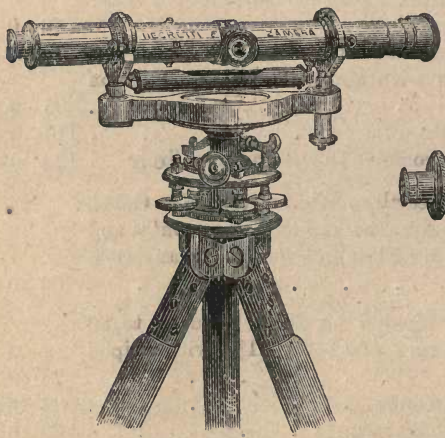


FIG. 1127.

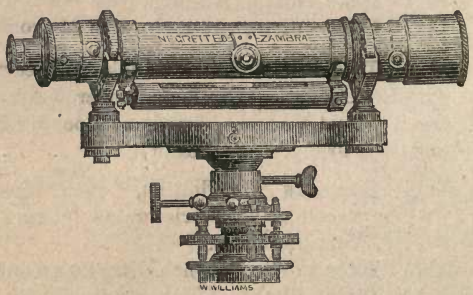


FIG. 1130.

1127 **Best Y Level**, with 12-inch Achromatic Telescope and rackwork adjustment, Compass, tangent screw adjustment, parallel plates, in case, with tripod staff (fig. 1127) £17 17 0

1128 **Best Y Level**, with 18-inch Telescope 18 18 0

1129 **Ditto ditto**, with 24-inch Telescope 22 0 0

1130 **Negretti and Zambra's Improved Ordnance Pattern 15-inch Dumpy Y Level**, with reversing and adjusting Y's to telescope, divided Level, Silver ring Compass, Tangent Screw and Clamp on limb, parallel plates, mahogany tripod stand and Box with strap (fig. 1130).

£18 18 0

Ditto ditto 24-inch 22 0 0

Theodolites and Levels mounted with improved **Locking Plates**, as fig. 1114, at about 35s. to 50s. extra charge, according to the size of the instrument.

1131 **Solid Leather Cases** for Theodolites, with Straps, 35s. £2 0 0 2 5 0

FIG. 1135.

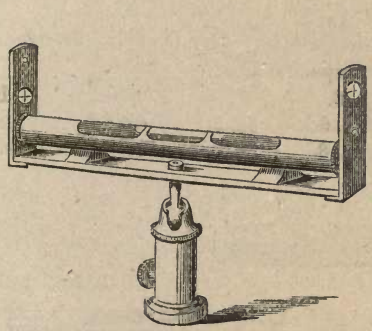


FIG. 1132.

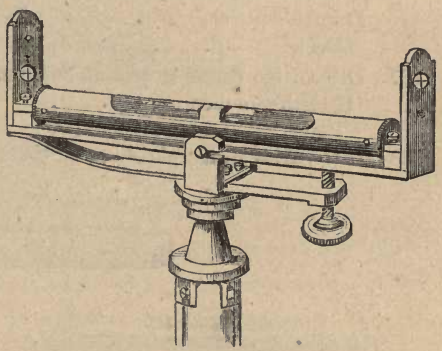


FIG. 1134.

		Each £ s. d.	Each £ s. d.
1132	**Drainage Level**, of Brass, with plain sights, ball-and-socket joint (fig. 1132).	1 15 0	2 10 0
1132*	**Ditto** ditto with Tripod Stand . . .		3 3 0
1133	**Improved Drainage Level**, with adjustment to the sights, ball-and-socket joint, and tripod stand . .		4 4 0
1133*	**4-inch Pocket Spirit Level, or Clinometer**, brass frame, with sights and graduated arc for determining the inclination of strata, &c., with socket for staff, in mahogany box (see also Inclinometer) . . .		3 10 0
1134	**Drainage Level, Ordnance Pattern**, best mounted, with plain sights, spring adjustments to level, in mahogany box (fig. 1134) with tripod stand		5 5 0

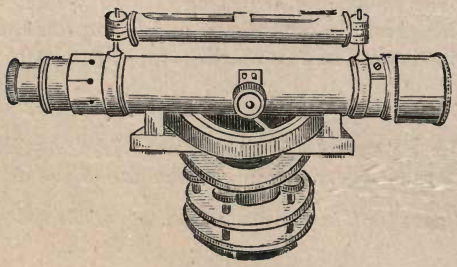


FIG. 1136.

1135 **8-inch Drainage Level,** with rackwork adjusting Telescope, parallel plates, in mahogany case and tripod stand without **Compass** (fig. 1135) £6 6 0

1136 **8-inch Drainage Level,** with rackwork adjusting Telescope, with **Compass,** Cross Level, parallel plates, in mahogany case and tripod stand (fig. 1136) £8 8 0

HAND LEVELS, FOR BUILDERS, ENGINEERS, ETC.

1136* **Spirit Levels,** mounted in polished mahogany frames, with brass top (fig. 1136):—

Length—inches	4.	5.	6.	7.	8.	9.	10.	12.
Price	2s. 6d.	3s.	3s. 6d.	4s.	4s. 6d.	5s.	5s. 6d.	6s.

1137 Ditto ditto **Brass-tipped at bottom.** Superior finish.

Length—inches	6.	8.	10.	12.
Price	4s. 6d.	5s. 6d.	6s. 6d.	7s. 6d.

1138 Ditto ditto **Brass-plated at Bottom** 5s. 6d. 6s. 6d. 8s. 6d. 10s. 6d.

FIG. 1136.

FIG. 1141.

FIG. 1140.

1139 **Spirit Levels,** rosewood frames, and German silver mountings:—

Length—inches	6.	8.	10.	12.	18.
Price	6s. 6d.	7s. 6d.	10s. 6d.	12s. 6d.	16s. 6d.

1140 **Spirit Levels,** plain Brass mountings (fig. 1140):—

Length—inches	4.	5.	6.	8.	10.	12.
Price	2s.	2s. 6d.	3s. 6d.	5s.	7s. 6d.	10s

1141 **Spirit Levels,** Brass mountings, with adjusting screws and **best ground tubes** (fig. 1141):—

Length—inches	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Price	6s.	8s.	10s.	12s.	14s.	16s.	18s.	20s.	22s.	24s.

If with divided tubes, extra.

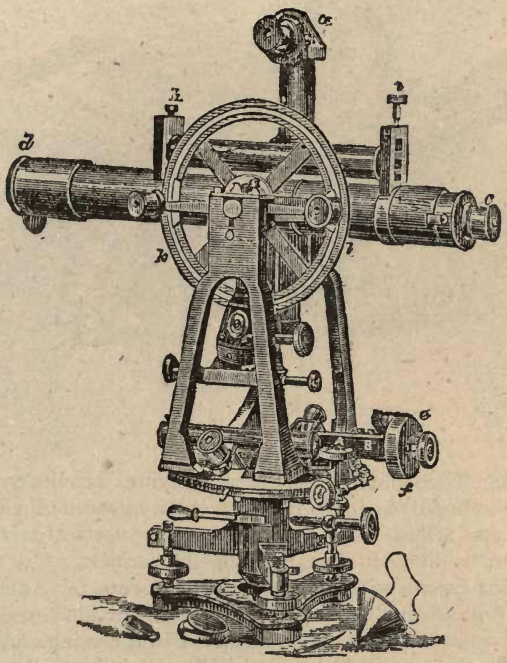


FIG. 1142.

ECKHOLD'S PATENT OMNIMETER.

1142 This important Surveying Instrument, as shown fig. 1142, measures distances and altitudes with accuracy and great economy of time, it accomplishes the work of Theodolite, Level and Chain, and can be used as a Transit Theodolite.

		£	s.	d.
	Eckhold's Patent Omnimeter, 5-inch, reading to one minute . .	45	0	0
	Ditto ditto 6-inch, reading to 20 seconds . . .	50	0	0
1143	**Taochiometer,** 5-inch, complete in Stout Mahogany Box . .	36	0	0
	Ditto ditto 6-inch	40	0	0

Printed instructions for use supplied with each instrument.

		Each. £	s.	d.	Each. £	s.	d.
1144	**Spirit Level Tubes,** plain, marked and warranted, per inch				0	0	3
1145	Ditto ditto ditto best ground . . ,,				0	0	6
1146	Ditto ditto ditto best ground and graduated ,,				0	0	6
1147	**American Universal Hand Level,** for levelling floors, ceilings, or walls				0	16	0
1148	**Circular Pocket Spirit Level** (fig. 1148)				0	6	6

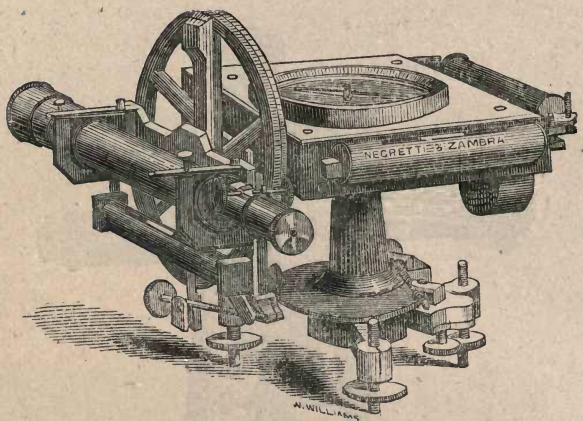


FIG. 1149.

1149 **Under-ground Theodolite** for Mining, Surveying, Levelling, or Military Service (fig 1149). Combining in one instrument, the conveniences of a Y or Dumpy Level, Circumferenter, and a Theodolite. On the top of the vertical axis of the instrument is a Compass with divided ring reading by verniers. On two sides of this compass are Spirit Levels with the usual adjustments for Azimuth observations. Attached to the limb of the instrument is a vertical divided circle, upon which is a Telescope with Rackwork adjustment mounted in reversing and adjusting Ys. A Spirit Level is placed upon the Telescope similar to a Theodolite. Vertical angles are obtained and read off on the vertical divided circle by two arms and a vernier scale attached to the axis of the Telescope.

The Telescope has cross wires in the Eye Tube. Clamps and tangent screws are attached to the horizontal and vertical movements. Tripod Stand and mahogany box for the instrument . . . . . *Price* . £22 0 0

Plain Sights to fit on the Compass box or Telescope, Astronomical and Diagonal Eye Pieces, Dark Glass Caps for Sun observations,—supplied *to order* at an extra cost.

CIRCUMFERENTERS, OR MINER'S DIALS, CROSS SIGHTS, ETC.

		£	s.	d.
1150	**Circumferenter**, or Miner's Dial, 4-inch **Ordnance pattern**, divided and figured on raised rim to 360°, and also the quarters figured below to 90°, folding sights, ball-and-socket joint with clamping screws, bar needle and agate centre, the dial lettered the same as a Theodolite, jointed legs. In 2 cases for compass and stand	7	7	0
1151	Ditto ditto, 5-inch, with Cross Levels	8	8	0
1152	**Circumferenter**, 5-inch, with rackwork adjustment and vernier to dial, bar needle, folding sights, ball-and-socket joint, divided cover for vertical angles, jointed legs, complete in two cases	9	9	0
1153	**Circumferenter**, 6-inch, with rackwork adjustment and vernier to dial, bar needle, folding sights, divided cover for hypo and base, cross levels, with tripod staff, jointed extra points for use at half length, and ball-and-socket joint with plummet, &c., in two cases complete (fig. 1153)	12	12	0

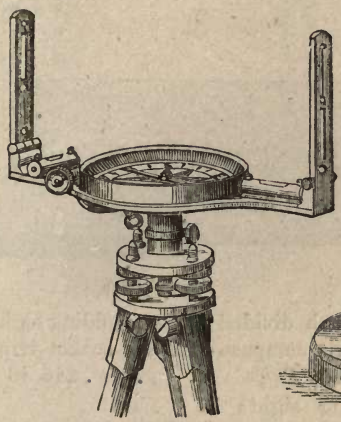


FIG. 1153.

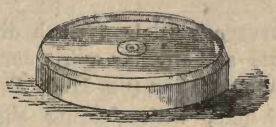


FIG. 1148.

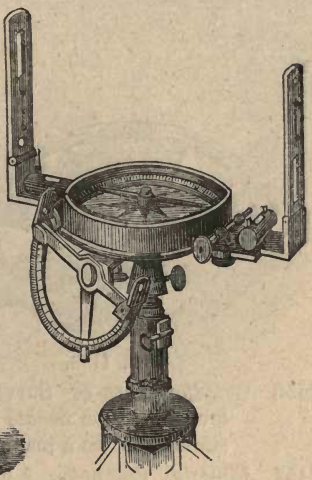


FIG. 1154.

1154 **Circumferenter**, 6-inch, or Hedley's inclining dial, improved form, folding sights, two spirit levels, bar needle with agate centre, rack adjustment to dial, two verniers reading to three minutes of a degree, tangent screw adjustment, divided arc for hypo and base, with plain sights, complete with ball-and-socket stand, joint legs for use at half length, extra points, plummet, &c., &c., in case complete (fig. 1154) £17 17 0

Circumferenter, Hedley's Improved, with **Telescope**, parallel plates 25 0 0

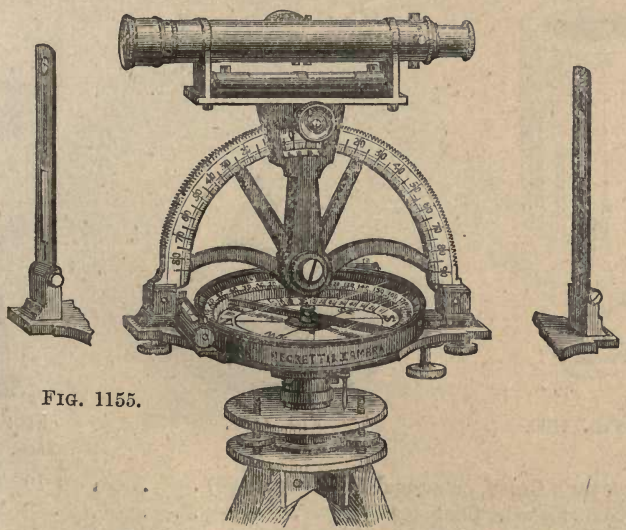


FIG. 1155.

1155 **Circumferenter**, Lean's 6-inch, improved, with **Telescope**, for surface surveying, centre quadrant, with level, shifting sights; vernier reading to two minutes, bar needle, cross levels, rackwork adjustments, arc divided on one side 90° each way and on reverse for hypo and base, jointed stand with extra points, &c. fig. 1155 . . . . . 18 18 0

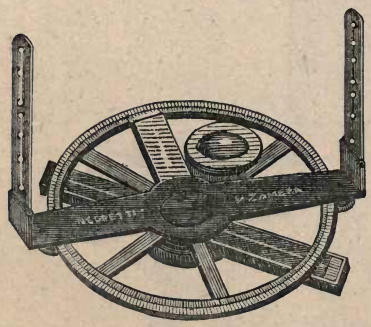


FIG. 1156.

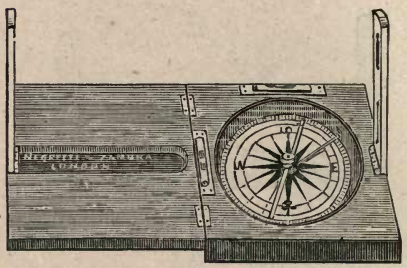


FIG. 1157*.

1156 **Graphometers or Surveyor's Dials**, 7½-inch divided circles, folding sights, level and bar needle and circular spirit compass, ball-and-socket tripod stand, &c. In a mahogany box (fig. 1156) *Price* . . . £16 16 0

1157 **Miner's Compass**, 4-inch, with folding sights in mahogany case £1 10 0 2 10 0

1157* Ditto ditto, with Spirit Levels, &c., mahogany box (fig. 1157) 2 10 0 3 0 0

1158 **Pocket Mining Compass**, plain, with Sights, round brass box, bar needle, and stop (fig. 1158) 0 16 0

1159 Ditto ditto, in round gilt metal case, with bar needle, and stop (fig. 1159) without sights . . . 15s. 0 18 0 1 5 0

See also Pocket Compasses.

FIG. 1160.

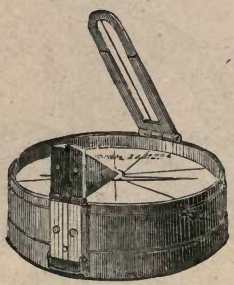


FIG. 1166.

FIG. 1162.

		Each. £ s. d.	Each. £ s. d.
1160	**Surveyor's Cross**, octagonal form (fig. 1160) . . .	0 10 6	0 12 6
1161	Ditto ditto, with **Compass**		1 5 0
1162	Ditto ditto (or Pantométre), with **movable** head and Divided Circle and Compass (fig. 1162) of the best construction		2 10 0
1163	Ditto ditto, with **Tripod Stand**, with ball-and-socket joint		4 10 0
1164	**Optical Squares**, for showing right angles . . .		1 1 0
1165	Ditto ditto, with adjustment in case		1 16 0

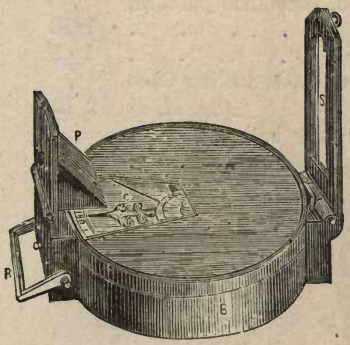


FIG. 1174.

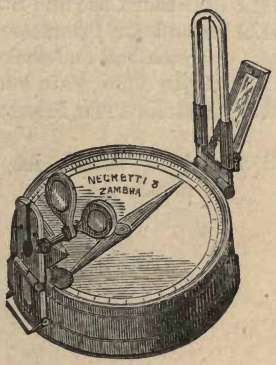


FIG. 1170.

PRISMATIC MILITARY SURVEYING COMPASSES.

1166 **Prismatic Compass (Kater's)**, plain sights and Card dial (fig. 1166)
2-inch, 30s. 2½-inch, 42s. 3-inch, 50s.

1167 **Prismatic Compass, 3-inch** diameter, with Shades and Mirror, Card dial, in Leather Sling Case £3 3 0

1168 Ditto ditto, with engine divided Silver or Aluminium ring and Case 3 10 0

1169 Ditto ditto, best, 4-inch with Sun Shades, Card Dial and Case . 4 4 0

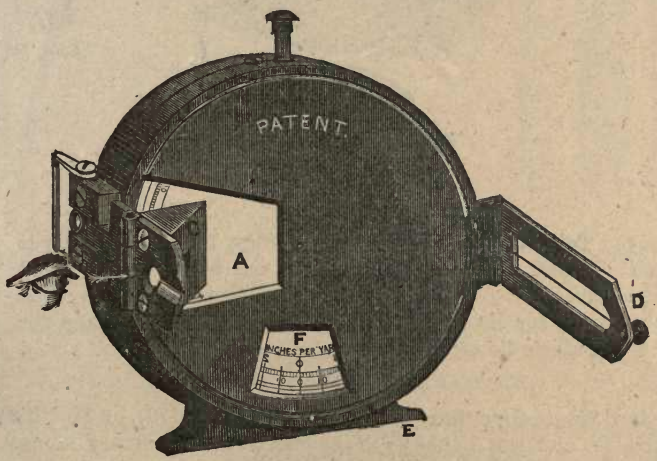


FIG. 1170.*

1170 **Prismatic Compass, 4-inch** best engine divided Silver or Aluminium ring, with Sun Shades and Azimuth Glass, with Case (fig. 1170) 5 5 0

1170* **Combined Altitude Instrument and Prismatic Compass.** Best mounted, with Aluminium divided Ring, in Leather Case with Straps (fig. 1170*) 6 10 0

		£	s.	d.	£	s.	d.
1171	Leather Case and Strap for Prismatic Compass . .	0	7	6	0	10	6
1172	Stand for Prismatic Compass, best mounted, Ordnance pattern, with ball-and-socket joint				1	16	0
1173	Ditto ditto, plain horizontal movement				1	8	0
1174	Hutchinson's Prismatic Compass, 3-inch, in Leather Sling Case (fig. 1174)				2	10	0
1175	Tripod Stand for Prismatic Compass, with ball-and-socket movement				1	12	0

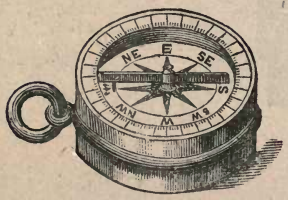


FIG. 1159.

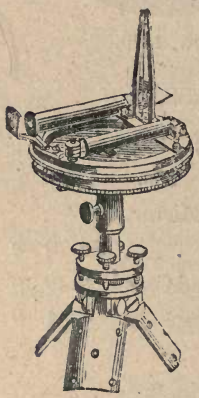


FIG. 1177.

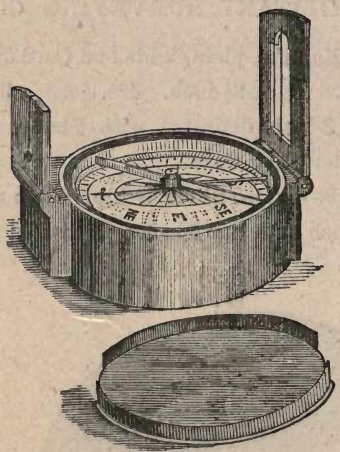


FIG. 1158.

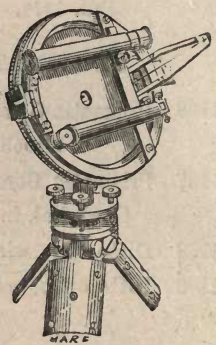


FIG. 1177*

1177 **Improved Telescopic Prismatic Compass** (figs. 1177, 1177*). By it both Vertical and Horizontal Angles can be taken with speed and accuracy Price in Mahogany Box 12 12 0

1178 **Tripod Stand** for ditto with ball-and-socket movement suited for either of above Compasses 1 16 0

See also Section Pocket Compasses.

1179 **Standard Mountain or Surveying Barometer** (fig. 1179), on Fortin's principle, is more portable, and less liable to derangement than ordinary Mountain Barometers. The arrangement of the flexible leather cistern is so simple, that should the mercury become oxidized, it can be quickly removed, cleaned, and returned to the cistern without fear of affecting the correctness of the indications. The vernier reads to ·002 of an inch, and the whole instrument is arranged in a compact and convenient form for safety in travelling, and obtaining the most accurate Altitude measurements.

Price, including Tripod Stand (as fig. 1179, or fig. 12, page 13) and stout Leather Travelling Case for the Barometer, &c. £10 10 0

See also page 10, *Meteorological Instruments.*

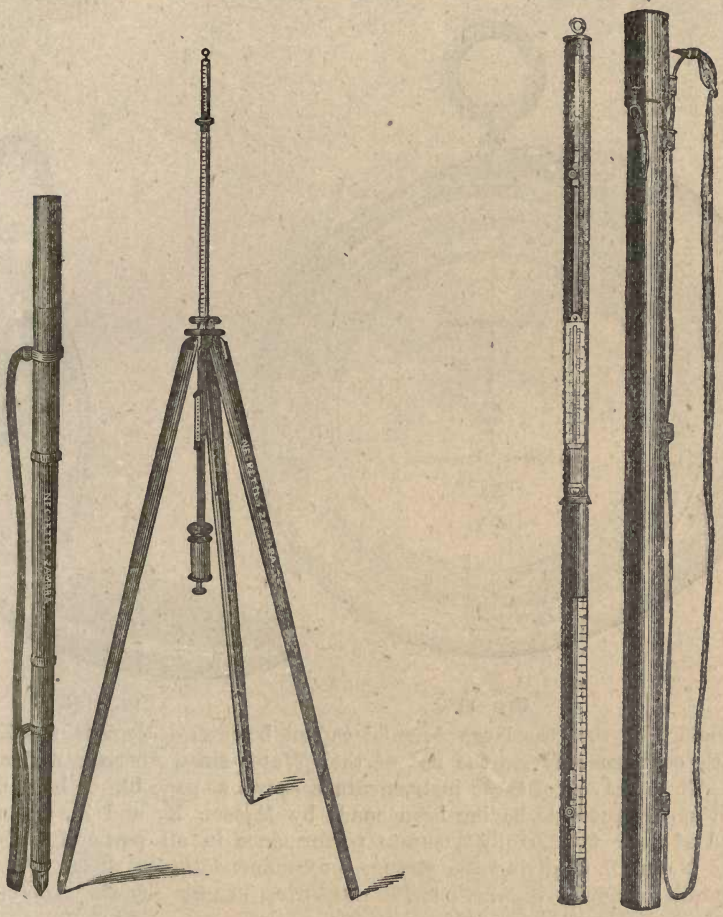


FIG. 1179.

ANEROID BAROMETERS FOR MEASURING ALTITUDES OR SURVEYING.

1180 Owing to the inconvenient size of Mercurial Standard Barometers, and also from the great risk of breakage in transit, it often occurs that their use has been abandoned by surveyors where otherwise they would have been invaluable for strict altitude measurements.

This difficulty is almost entirely overcome by the use of Negretti and Zambra's Altitude and Surveying Aneroid Barometers. These instruments are now constructed with such precision that very small elevations may be ascertained with great exactitude. The scale of the altitude aneroid is laid off by actual experiment in a vacuum chamber, the readings being noted both backwards and forwards, such readings being repeated at long intervals, and the observed differences corrected, before finally dividing the scale on the dial. Several tests are also applied to the instrument in order to compensate for errors arising from varying extremes of temperatures.

Where it can be conveniently carried, Negretti and Zambra would in all cases recommend their full-sized Altitude Aneroid (fig. 1180) for observers' use; as from the large diameter of the divided circle, exceedingly minute movements of the index hand may be seen with ease.

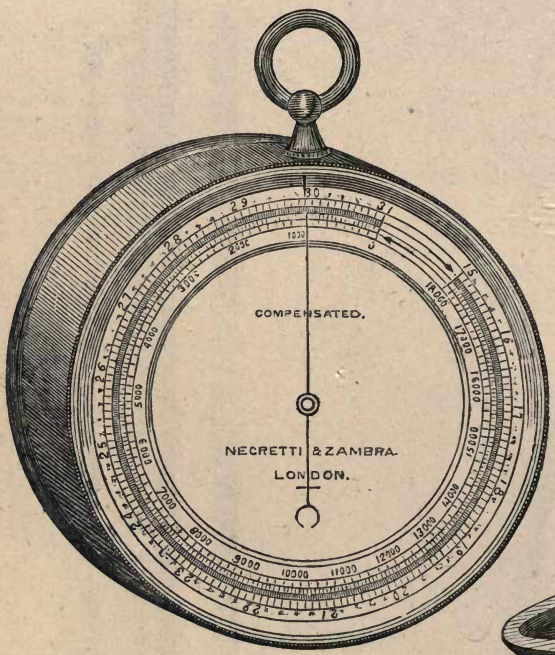


FIG. 1180.

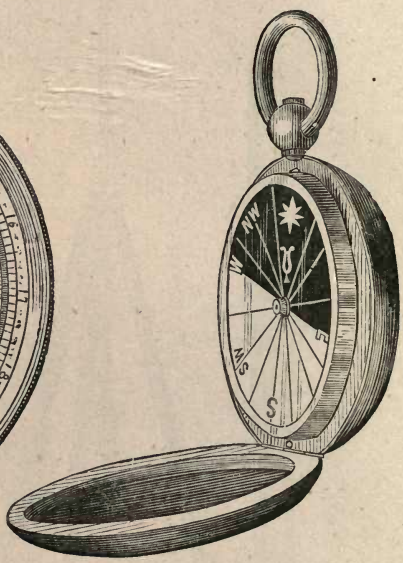


FIG. 1184.

Should it be that the large Aneroid cannot be carried, Negretti and Zambra can with confidence advise the use of their **Watch-sized Aneroids** with altitude scales. The *exact* size of these instruments is shown at page 19. A large number of such small Aneroids having been made by Messrs. N. and Z., and reports received of their wonderfully accurate performance in all parts of the world, warrant N. and Z. in giving the strongest recommendation to them. At page 3 and 26 will be found instructions for measuring heights by the Aneroid, and comparative tables of the French and English scales.

A copy of Professor Airy's Altitude Tables supplied with each instrument.

1180 **Negretti and Zambra's full range Altitude and Surveying Aneroid Barometer** (Orometer), Compensated for temperature, the Scale divided to Inches and Hundredths or Millimetres, with Altitude Scale to 20,000 feet, or about 15 inches of the barometer scale (fig. 1180) in hinged leather case £8 8 0

Solid leather case with Sling strap for Ditto 0 12 6

1181 **Pocket Aneroid Barometer**, with Altitude Scales to 5,000 feet, moderate elevations; see *ante*, page 29 (fig. 24) 5 5 0

1182 **Watch-sized Pocket Aneroid Barometers**, Compensated with Altitude scale to 10,000 feet; see *ante*, page 24 (fig. 26) . . 5 5 0

Ditto ditto, to 20,000 feet 6 6 0

Ditto ditto, to ditto in **Stout Silver case** . . . 7 7 0

Aneroid Barometers *with adjusting altitude scales* 10s. each extra.

1183 **Anemometer, Pocket, Biram's, and Lown's**, for registering the velocity of currents of air in mines, air shafts, drains, &c., &c. For full description and instructions for use, see pages 100 to 103.

4-inch size, £2 10s.; 2¼-inch 2 2 0 4 4 0

1184 **Surveyor's Pocket Compass**, with Bar Needle or Singer's Card Dial, in Silver Watch Case (fig. 1184) £2 10s. 3 3 0

See also Section Pocket Compasses.

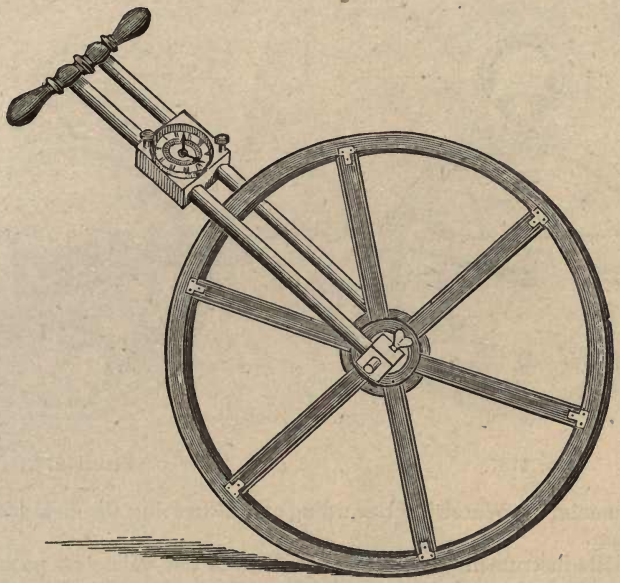


FIG. 1185.

1185 **Perambulator,** for measuring the length of roads, streets, &c., consists of an accurately framed Mahogany Wheel, Brass Clamped, the circumference of which is carefully ascertained; the axis of this Wheel is connected by a series of toothed wheels and pinions to a dial, upon which the number of revolutions of the Wheel are recorded. The divisions upon the dial are English Measures; but any Foreign scale can be substituted to order. Price, Best mounted and finished (fig. 1185) . . . £16 16 0

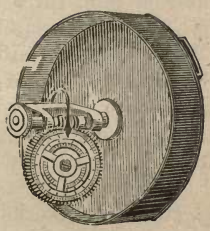


FIG. 1186.

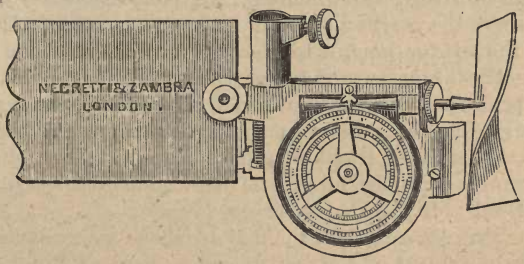


FIG. 1190.

1186 **Trocheameter,** Negretti and Zambra's Improved construction for registering the revolutions of a Carriage Wheel and by this ascertaining distances travelled; it is also applicable for counting the revolutions of fly wheels, paddle wheels, &c., up to 10,000 revolutions, or nearly 23 miles distance, travelled by a coach wheel of 12 feet circumference. These numbers can be repeated by re-setting the instrument, which is very easily done, by removing a nut, and turning back the divided wheels to the 0 point. The Trocheameter is contained in a strong case, with a leather strap for attaching it to the wheel, &c. (fig. 1186) . £3 3 0

1187 **The Dipleidescope.†** A Pocket instrument for obtaining the **Correct Time** with great facility, by observing the Transit of the Sun across the Meridian . . . . . best form £10 10 0

† *See also N. & Z's. Improved Transit Instruments, page 254.*

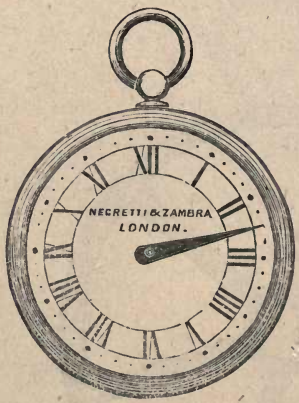


FIG. 1187.

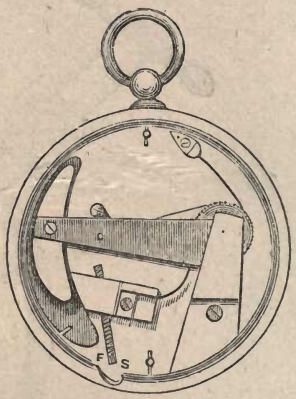


FIG. 1187*.

1187 **Pedometer** or Watch for Recording and Measuring the distance travelled by a Pedestrian.

This little instrument is generally carried in the waistcoat pocket or in the fob, or else attached to a belt or to a button; the hook attached to the ring must be so fastened to the slit of the pocket or elsewhere that the instrument be always in a *Vertical Position.*

It never requires any winding up, the first step of the Pedestrian sets the works in motion; they continue to act as long as he moves, and stop when he stops. The dial is divided into twelve divisions, which represent so many Miles, but can be adapted to record Kilometres or any other measure of distance. The Pedometer is corrected by means of an adjusting screw, which is square-headed, so as to be turned by a watchkey; all that is necessary to do is to walk a mile, and then observe the position of the index hand upon the dial; the regulator is then turned to the left for *Slow*, or to the right for *Fast*, until one division on the dial represents exactly the measure of distance chosen, Mile or Kilometre, &c. This of course will depend upon the length of stride of each individual, and must be regulated accordingly. The dots between the figures represent *Quarter miles.* When about to start, the Index Hand should be placed at Zero, by moving it either backwards or forwards with the finger. If the Pedometer is not required to act, it should be carried with the Pendant ring downwards.

FIG. 1187 exhibits the dial or face of the Pedometer, and fig. 1187*, the interior and movement of the instrument. *Price*, in Stout Silver with case . £2 15 0

Ditto ditto *Price*, in Nickel Plated with case . 2 2 0

Ditto ditto *Price*, in German Silver with case 1 1 0

1188 **Passometer or Step Measurer**, is a similar sized instrument to the Pedometer, arranged to record the number of paces or steps taken by the wearer. These are indicated on the face of the instrument by a small circle (similar to the seconds dial of an ordinary watch) up to 50, and then on the large dial by a series of divisions, each equally 50 paces up to 2,500; the readings on the dial are continuous as in the Pedometer. *Price*, in Stout Silver Case . . £5 5 0

1189 **Chronograph.** Without stopping the movement of the watch the long seconds' hand of this instrument records on the Dial the interval between two given events, with unfailing accuracy. *Price*, in Gold Case, 60 guineas; Silver Case, 45 guineas; or to go for two hours only, Gold, £20, Silver £12 12s.

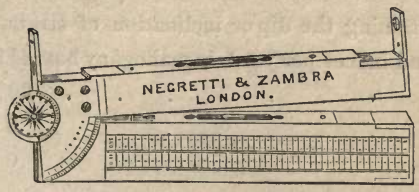


FIG. 1197.

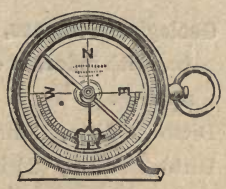


FIG. 1201.

1190 **Current Meter**, for ascertaining the tidal rate or flow of streams or rivers, in Miles, Furlongs, and Feet; the amount of Water delivered per hour in Cubic Gallons and inches; and the Dynamic force of the Current. This instrument can also be used as a Log, to determine the rate of a ship's speed. The scales on the divided wheels are laid off by careful experiment (fig. 1190). Price in mahogany box £6 6 0 7 7 0

1191 **4-inch Pocket Inclinometer**, Brass mounted, with Sights and Graduated Arc for determining the inclination of strata, &c., with socket for staff; in mahogany box (fig. 1191) , ... 3 10 0

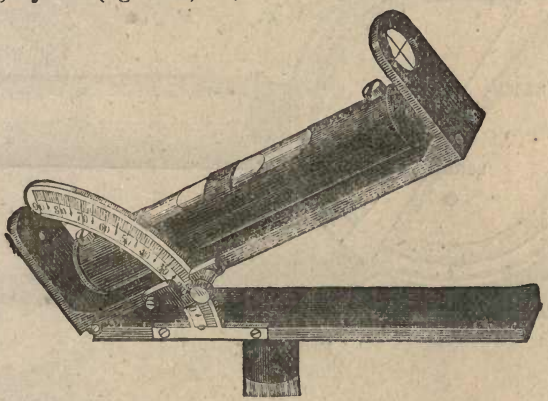


FIG. 1191.

1192 **Clinometer or Inclinometer**, 12-inch, plain boxwood, with divided semi-circle and plumb, for ascertaining the inclination of roads, drains, strata, &c., in a rough way. The divisions on the arc show degrees and inches per yard; it has also an inclination scale. Price, in pull-off case 0 16 6

1193 **Clinometer**, 12-inch boxwood, brass jointed, with divided arc and inclination scale, forming a pocket rule 1 1 0

1194 **Clinometer**, 6-inch, plain-jointed, without Sights or Compass 1 1 0

1195 **Clinometer**, 6-inch, with Spirit Level, Magnetic Compass, and Inclination Scale 1 18 0 2 2 0

1196 Ditto ditto, Bar Needle Compass, and two levels . . 2 10 0

1197 Ditto ditto, with best Bar Needle and Agate Centre Compass in the joint (fig. 1197) 3 3 0

The inclination scale placed upon these Clinometers, &c., gives the value of any angle, as follows,—The angle having been ascertained from the divided arc upon the instrument, refer to that degree in the column marked *Angle*, and opposite, in another column, will be found the rise or fall in any given measured distance; for instance, say the degree shown on the divided arc is 18, opposite to this number on the scale is 3, this indicating one part rise or fall in three, or one mile in three miles, one foot in three feet, &c.

1198 **Geological Compass,** for ascertaining the dip or inclination of strata, hills, &c., with index, in degrees and inches per yard, in mahogany box, 4½ inches square £0 10 6

1199 Ditto ditto, 3 inches 0 7 6

1200 Ditto ditto, 2½ inches 0 7 0

1198 to 1200, if with best Bar Needles, 2s. 6d. each extra.

1201 **Geological Compass,** Brass mounted, with best Bar Needle and leather case (fig. 1201) . . 30s. 42s. 2 10 0 3 10 0

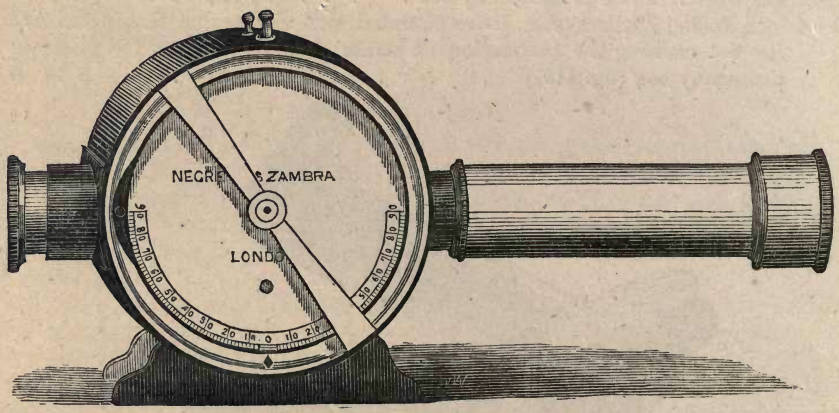


FIG. 1202.

1202 **Pocket Alt-Azimuth Instrument,** improved by Francis Galton, Esq., F.R.S., is a combined Compass and Pendulum or Wheel Clinometer. A most convenient and portable instrument for obtaining, in a ready manner, Angles, Levels, &c., similar to No. 1170*. The Telescope renders this instrument available for observing, at a considerable distance from the Station, either Magnetic Bearings, Horizontal or Vertical Angles, &c.. &c.

Price in case, as fig. 1202 . . . . . £6 6 0

Pocket Alt-Azimuth without Telescope 5 10 0

Our woodcut shows the Clinometer side of the instrument, with the Telescope as drawn out for use

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1202* **Hydroscope or Telemeter,** a simple apparatus constructed by Negretti and Zambra for the Government Ordnance Department for use in Marine Forts, to estimate the distance of vessels and other objects . 5 0 0

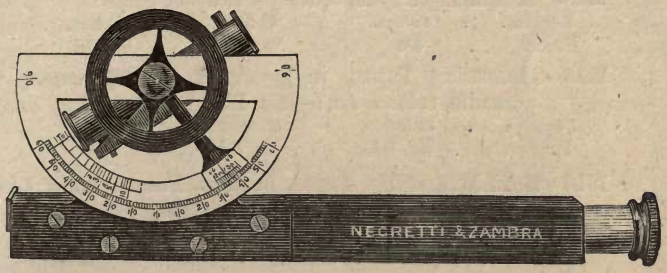


FIG. 1203.

1203 **Abney's Contouring Reflecting Level or Pocket Altimeter.** Improved form with divided arc to show gradients, &c., (Fig. 1203). Price in case . £2 2 0

Fig. 1202 and Fig. 1203 are very nearly the actual size of the instruments described above.

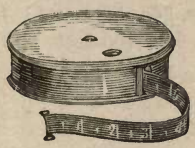


FIG. 1219

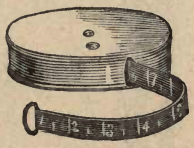


FIG. 1220.

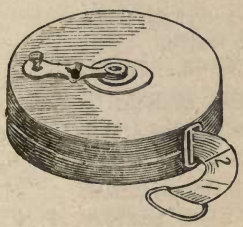


FIG. 1215.

FIG. 1209.

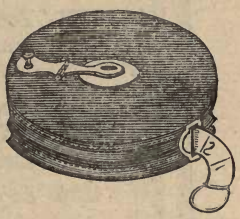


FIG. 1216.

LAND MEASURING CHAINS, TAPE MEASURES, ETC.

1204	**Land Chain,** Iron, 50 feet, and 10 Arrows . . .	0 11 6
1205	Ditto, ditto, 100 feet, and 10 Arrows	0 14 6
1206	**Land Chain,** 100 feet, best Steel Wire with ditto . .	1 2 0
1207	**Gunter's Iron Measuring Chain,** sixty-six feet, or four poles in length. Light wire	0 12 6
1208	Ditto dito, Stouter, Galvanised	0 15 6
1209	**Gunter's Iron Measuring Chain,** *best* quality, Steel Wire, with three sawed oval rings between each link, and swivel in middle, and stout Brass swivel handles and marks—Galvanized (fig. 1209)	0 18 6
1210	**Twenty-metre Chains,** Centimetre links, best make .	0 18 6
	Arrows, set of Ten Steel wire, Pointed and Numbered for Ditto, 15 inches long and $1\frac{3}{4}$-inch eye . . .	0 2 0
1211	**Standard Chain,** 50-feet, best stout Steel Wire . .	4 10 0
1212	Ditto ditto 66-feet	6 6 0
1213	Ditto ditto 100-feet	8 10 0

1214 **Measuring Tapes**, common, Leather cases:

Length . :	33-feet.	50-feet.	66-feet.	100-feet.
Price .	4s.	5s. 6d.	6s. 6d.	10s. 6d.

1215 **Measuring Tapes**, in japanned Leather cases, with folding handle, rollers, &c.:—(fig. 1215.)

Length . .	33-feet.	50-feet.	66-feet.	100-feet.
Price . .	5s. 6d.	6s. 6d.	8s.	11s.

1216 **Best Measuring Tapes**, in Best Patent Solid Leather Cases, Black or Brown, folding handles, rollers, scale marked on one side only (fig. 1216.)

Length .	33-feet.	40-feet.	50-feet.	66-feet.	100-feet.
Price .	8s.	9s.	10s. 6d.	11s. 6d.	15s.

1217 **Best Measuring Tapes**, as No. 1216, with English and Metre Scales, or English and Varas. (fig.).

Length .	10-feet.	15-feet.	20-feet.	25	30-Metres.
Price .	8s. 6d.	9s. 6d.	12s. 6d.	14s.	16s. 6d.

1218 **Patent Elastic Steel Tapes**, leather case, flush handles, marked on both sides—33-feet, or 2 poles, 24s. 50-feet £1 15 0
66-feet, or 4 poles, 45s. 100-feet 3 3 0

1219 **Patent Pocket Spring Measuring Tapes**, in Brass Case, (fig. 1219) 3-feet 2s. 6d., 0 3 6 0 4 6
6-feet 5s. 6d., 0 7 6 0 9 0

1220 **Patent Elastic Steel**, ditto—3-feet 0 6 6
(fig. 1220) 6-feet 0 8 6
9-feet 0 12 6

1221 **Pocket Spring Tapes**, in German Silver Cases, with stops and rollers, English yard, and French metre, 3-feet, 6-feet, and 9-feet . 4s., 5s. 6d., 7s. 6d. 0 10 6

1222 **Measuring Tapes** made to order with French, Spanish or Portuguese and other Scales in various lengths and mountings.

1223 **Levelling or Station Staff**, common form . . . 1 10 0

1224 **Sopwith's Station Staff**, 14-feet improved three-jointed, best socket fittings, each 2 2 0 per pair 4 4 0

1225 Ditto ditto, **best Painted** scale, sliding in three lengths, put together with brass screws, mountings and springs (fig. 1225) each 2 12 6 per pair 5 5 0

1226 Ditto Ditto, Metrically divided, same price as above.

1227 **Station Staff**, 14 feet three-joint **half-round Ordnance** pattern, per pair 7 10 0

1228 **Levelling Staves**. Lieut.-Col. Strange's arrangement.

Fig. 1225.

The foot is divided into alternate black and white spaces, each representing half a tenth of a foot. All the figures, both those indicating the feet and those indicating tenths of a foot, are on the same side of the scale. The object of this is to obtain more ground surrounding the figures, as on this condition their visibility in a great measure depends.

The forms of the figures have been carefully studied. The figures denoting tenths of a foot, are small. It was found that those usually employed are needlessly large. The size now adopted is the result of trial at 10 chains, at which distance they can be easily read with a good 14-inch Telescope. Price per pair, £8 8 0

		£	s.	d.
1229	**French Pattern Station Staves**, 4-Metres long with plain metal mountings . . . . . per pair	4	4	0
1230	Ditto ditto, 5-Metres, fully divided scale, and inverted figures with best brass mountings	5	5	0
1231	**Papers for Level Staves**, ... per foot	0	0	3

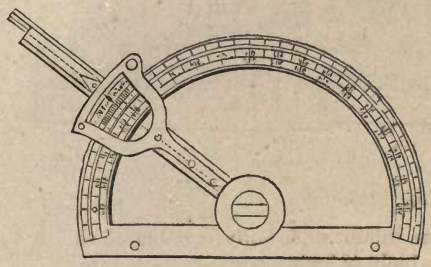


FIG. 1241.

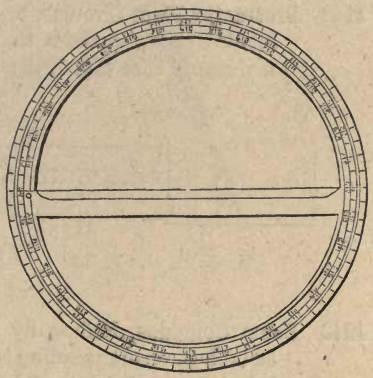


FIG. 1242.

ORDNANCE PATTERN MEASURING RODS, SCALES, &c.

1232	**24-inch Scale, Boxwood**, 25 inches long, 1¾ broad, square at the edges, having 1 and 2-inch diagonal scales on two edges, the inch in tenths and eighths, the foot into decimal parts, and a scale of chords to a radius of 12-inches to be used with Beam Compasses	0	10	6
1233	**Architect's Scale, Boxwood**, 12½-inches long, 1⅛-inch broad, and the inch and half-inch to a foot on one edge, and the quarter and three quarters to the foot on other edge	0	4	0
1234	**Surveying Scale, Boxwood**, 12½-inches long, 1⅛-inch broad, and chamfered alternately, with diagonal scales, and scales on the edges, also scales of yards and paces to 2, 4, and 6 inches to a mile	0	4	0
1235	**10-feet Rod**, 1¼-inch square deal painted, divided into feet and quarters on all sides, and figured from both ends alternately, shod with brass	1	0	0
1236	**Link Staff**, 1¼-inch square, deal painted black, divided into 10 links on all sides, the centre division marked with a star, shod with brass	0	12	6
1237	**5-feet Surveyor's Measuring Rods**, lance wood, tipped with brass, divided on one side into feet and quarters, and on the other into feet, inches, and one-eighths	0	8	6
1238	**2-feet Rule, Boxwood**, 4-fold Gun and Shot Gauge, and the inch divided into 10, 8, and 12 parts	0	12	0
1239	**Standard Measure, Yellow Dial**, 43 inches long, 2½-inch wide, ½-inch thick, with edge bar along the middle, with four brass plates let in; on the top and edge of one side, 3 standard feet are accurately marked off, and on the other sides two brass plates marked, 5 standard links. In a deal case	1	10	0

		£	s.	d.
1240	**Levelling Staff**, 14-feet, mahogany sliding in 3 lengths, with brass spring and fittings, Painted Scale, per Pair £5 5 0 see No. 1225.			
1241	**Protractor Semicircular**, brass, 6-inch, figured to 180° and to 360°. The arm $6\frac{1}{8}$-inch long, with vernier reading to minutes with clamp screw, and magnifying glass in mahogany case, both sides of the arm parallel to the centre and zero (fig. 1241) . . .	3	3	0
1242	**Protractor Plain Circular**, brass, 8-inch, figured outside to 360°, and inside each quarter to 90°, divided to half-degrees. In mahogany case (fig. 1242)	2	2	0

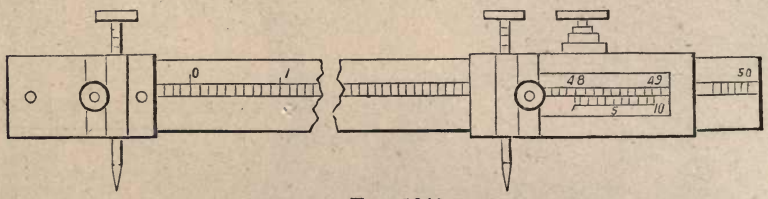


FIG. 1243.

1243	**Beam Compass**, Mahogany beam inlaid with holly, graduated to 50 inches, vernier reading to $\frac{1}{100}$ inch, 48 inches between the points, ink and pencil points and clamping screws, in deal case (fig. 1243)	3	12	6
1244	**T Square**, mahogany, 12 by 25 inches having the stock and blade flush on one side	0	12	0
1245	Ditto ditto 12 by 52-inch	0	16	0
1246	**Angles**, 6-inch, pear-tree, Set Square 45°	0	2	0
1247	Ditto 9-inch ditto ditto 30°	0	3	0
1248	**Straight Edge, Steel**, best London make, 2 inches wide, 42-inch, in deal case	1	4	0
1249	Ditto ditto ditto 52-inch, in ditto . . .	1	10	0
1250	**Parallel Rules**, 15-inch, best **Ebony rolling**, plain edges . . .	0	16	6
1251	Ditto ditto 12-inch ditto ditto	0	12	6
1252	Ditto ditto 9-inch ditto ditto	0	10	6
1253	**Chain** 100 feet with 3 oval rings between each link, stout brass marks, best stout iron	1	2	0
1254	Ditto ditto four, Pole Gunter's	0	18	6
1255	**Arrows**, set of 10 by 14-inch, $1\frac{3}{4}$-inch eye	0	2	0
1256	**Dark Glass Horizon**, in Brass Frame with 3 adjusting screws and Spirit Bubble ground on one side, in Mahogany Box . . .	2	5	0
1257	**Centrolinead**, for drawing buildings, &c., in perspective, the instrument giving the line of direction of the vanishing point .	3	3	0
1258	**Elipsographs**, for striking Ovals 3 3 0	5	5	0
1259	Ditto ditto, German Silver	4	12	6
1260	**Planimeter**, Amsler's Patent Brass for computing areas . . .	3	15	6
1261	**Integrator, Ansler's**	18	0	0
1262	**Goniometer, Wollaston's Reflecting**, for measuring the Angles of Crystals	5	5	0
1263	**Eidograph**, capable of reducing any proportion from 1 to 6 inches in box complete . . . . . £11 0 0 £12 12 0 and	15	0	0
1264	**Computing Scale**. Universal, as used by H.M. Tithe Commission Office, containing 1, 2, 3, 4, 5, 6 chains to the inch, and 6 inches and 5 feet to the Mill in Mahogany box	3	12	0
1265	Extra Scales fitted to above	0	5	6
1266	**Computing Form Papers**, 10, 20, 30, 40, 50, or 60 per sheet . .	0	5	0

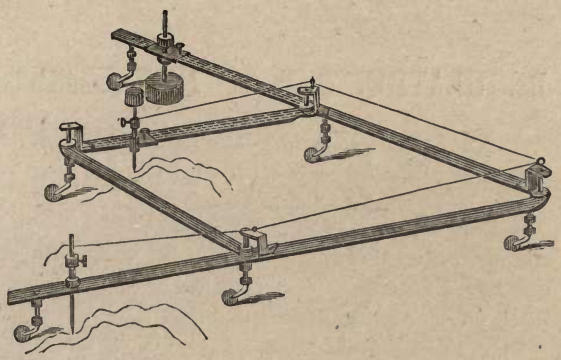


FIG. 1266.

		£	s.	d.
1266*	**Pentagraph or Pantograph, in Brass,** of the best construction, for reducing or enlarging plans to any proportion :—			
	18-inches . . . . . from	6	6	0
	24-inches	7	10	0
	30-inches, Ordnance size and Pattern with improved Leg and Wheel	9	10	0
	36-inches	10	10	0
	42-inches	11	11	0
	48-inches (fig. 1266)	13	10	0
1277	**Pentagraph, Ebony** . . . . . from	5	5	0
1278	Ditto, common White Wood . . . . . 10s 6d.	1	5	0

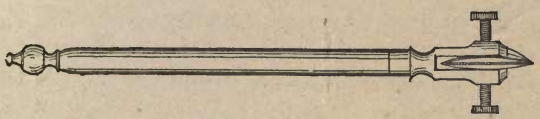


FIG. 1280.

FIG. 1283

1279 **Opisometer or Map Meter,** for measuring Curved lines on Plans or Charts, &c. 0 3 6

1280 Ditto ditto Improved, (fig. 1280) 4s. 6d. 0 5 6

1281 **Chartometer** for measuring and registering distances on Maps. The Chartometer is about the size of a watch, with a small wheel partly projecting from the lower end of the case. To measure any line, the instrument is held upright, and the little rolling wheel is run along the line to be measured; as the wheel advances an index hand registers on a dial the distance passed over in miles, yards, &c., according to the scale of the map. It can be used for maps of different Scales by a simple substitution of one dial plate for another, a variety of those adapted to the ordnance measurements being contained in the case of the instrument.

1282 **Chartometer** with Set of Dials, in neat Leather Case . . . 1 1 0

1283 Ditto ditto German Silver Plated, complete in Case (fig. 1283) 1 12 0

1284 Ditto ditto Gold plated best finish, complete in Case . . 2 2 0

1285 **Wealemefna,** a Pocket Instrument for measuring lines or distances on a map, Nickel Plated, 7s. 6d., 10s. 6d.; Silver, 10s. 6d., and 12s. 6d.; Gold ditto, 30s. and 50s.

For further particulars of Drawing Instruments, Rules, Scales, &c., see Section Mathematical Drawing Instruments.

1286 REGULATION SET OF INSTRUMENTS,

AS SUPPLIED TO NAVAL CADETS.

Metal Sextant, in Mahogany Box £8 8s. or £10 10s.
Achromatic Telescope, 1 draw £2 10s.
Ditto ditto, German Silver Mounted £3 3s.
Ebony Parallel Rule, 18-inch, best, 6s. 6d.
Mathematical Drawing Instruments, Brass complete, with Rules and Scales, in polished Mahogany Box £2 15s. and £3 10s.
Ditto ditto ditto, German Silver £4 10s. £5 5s.
Binocular Look-out Glass, in solid Leather Case, with Strap, £4 4s. and £5 5s.

1287 REGULATION SET OF INSTRUMENTS,

AS SUPPLIED TO THE ROYAL ENGINEERS.

Best Pocket Sextant with Telescope, Silver Arc, &c., in Leather Case with Sling Strap, as No. 1303. £5 5s.
Best Prismatic Compass with Sun Shades and Azimuth Mirror, in Leather Case, with Sling Strap. as Nos. 1167 and 1170 £3 3s. and £5 5s.
Sketching Protractor 7s. 6d.
50-feet best Tape Measure, as No. 1216 12s. 6d.
18-inch Ebony Parallel Rule 6s. 6d.
Binocular Field Glass in solid Leather Case, with Strap, £4 4s. and £5 5s.
Achromatic Reconnoitring Telescope £3 10s. and £4 4s.
Mathematical Drawing Instruments, Brass, with Rules and Scales, Mahogany Box, £3 10s.
Ditto ditto ditto, German Silver £4 4s.

Scales, Rules, Tapes, and Chains made to all Foreign Measures to order.

Heliographs for Military Signalling, Universal Sun Dials both for North and South Latitudes, Improved Binocular Telescopes, Aneroid Barometers for Altitude Measurements, &c., &c., see the various sections in this Catalogue.

1288 ESTIMATE FOR A SET OF

ORDNANCE PATTERN SURVEYORS' AND ENGINEERS' INSTRUMENTS,

AS SUPPLIED BY NEGRETTI AND ZAMBRA FOR GOVERNMENT SERVICE.

A 5-inch best Theodolite, divided on Silver, with Tripod Stand, as fig. No. 1100, £24

A 15-inch Dumpy Y Level, with ditto, ditto, as fig. No. 1130 £18 18s.

Pocket Compass, 3½ square, mahogany box. 2 circles of divisions, one, 360°, the other figured 4·90°. Best bar needle, 16s.

Surveying Cross, round, on Ash staff, as fig. No. 1160, 12s. 6d.

Drainage Level, with Tripod Stand, fig. 1134 £5 5s.

A 4-inch Circumferenter, folding sights, ball and socket joint, with jointed tripod stand, as No. 1150 £7 7s.

Ordnance Pattern Drawing Boards :—

Antiquarian .	55 by 33 inches.	Atlas . .	37 by 28 inches.
Double Elephant	43 by 29 „	Imperial .	32 by 24 „

Prices various.

Prismatic Surveying Compass. 3-inch card, with Silver ring, in *Pocket* case, as No. 1168 £3 10s.

Best Pocket Sextant with Telescope, divided on Silver arc with Leather Case and Strap as No. 1303 £5 5s.

100 feet best Stout Chain, Brass handles, &c., as No. 1206 £1 2s.

4-pole best Gunter's ditto ditto, as No. 1209 18s. 6d.

1 set 10 14-inch Arrows with eye 1⅛ inch diameter as No. 1210*, 3s.

1 case of Brass Drawing Instruments :— £2 10s. and £3 3s.

Mahogany box with Tray containing 6-inch ivory scale, 6-inch ebony parallel rule, 6-inch compasses with pen and pencil points, lengthening bar, pen and pencil bow, large and small ivory handle drawing pens, set screw, 6 drawing pins, &c. £3 3s.

Best Mercurial Horizon, complete in box £4 10s.

6-inch Sextant divided on Silver to 10 seconds, with plain tube, two Telescopes with additional power and dark glasses in mahogany case, £10 10s. and £11 11s.

Tripod Stand for ditto, with jointed legs £3 3s. and £5 5s.

30-inch brass Pentagraph, as fig. 1266, in mahogany box £10 10s.

Mountain Barometer in solid Leather case and brass stand, as No. 1179, £10 10s.

Aneroid Barometer or Orometer, as No. 1180 for Altitude measurements, £8 8s.

Pocket Thermometer, Oval Boxwood, 7-inches long, 0 to 140° Fahrenheit and Centigrade Scales . . . . See also Section Thermometers 12s. 6d.

Altitude Tables for use with above, sent with each instrument.

Boiling Point Apparatus and Tables, see page 92.

NAUTICAL INSTRUMENTS.

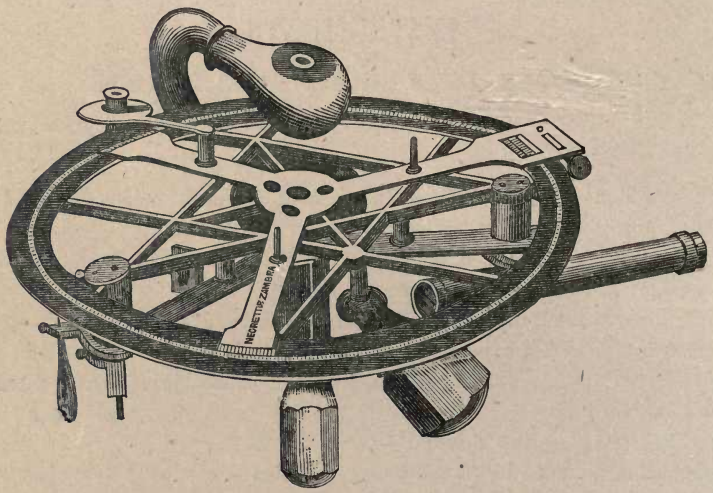


FIG. 1290.

SEXTANTS.

		£	s.	d.
1589	**Reflecting Circle** (Troughton's Pattern) 10-inch	25	0	0
1290	Ditto ditto, 12-inch (fig. 1290)	30	0	0

This instrument perfectly corrects the error of the centre by the readings of the three branches of the index; this property, combined with that of observing both ways, reduces the errors of dividing one-sixth part of their simple value. With this Circle angles may be measured as far as one hundred and fifty degrees.

1291	**Ebony Sextant,** 8-inch, best, with Ivory arch Achromatic Telescopes, &c., in mahogany case . .	6	10	0
1292	**Metal Sextant,** 6-inch (Cadets') Circular pattern, divided on Silver reading to ten seconds, three Telescopes, in mahogany case (fig. 1292)	8	8	0
1293	**Metal Sextant,** best, 5-inch (Cadets') Triangular pattern, divided on Silver, reading to 10 seconds extra power to Telescope, strapped horizon adjustments in Box .	9	9	0
1294	**Metal Sextant,** 8-inch, Edge Bar Pattern, bronzed limb divided on Silver, reading to ten seconds, in mahogany box	10	10	0
1295	**Metal Sextant,** 8-inch, Oval pattern, bronzed limb divided on Silver reading to ten seconds, stump and block adjustment and glass reflector to vernier . .	11	11	0
1296	**Metal Sextant,** Oval, Triangular, or other patterns, best, bright or bronzed limb, Neutral Tint Shades, and extra power for Telescopes, Glass Reflector, &c., in square polished mahogany case with screwed fittings	12	12	0

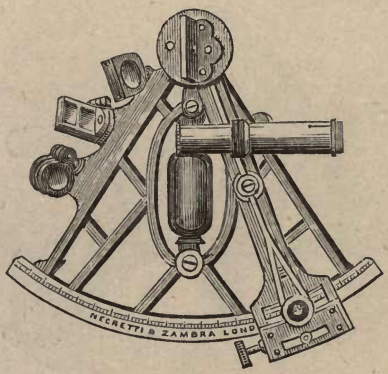


FIG. 1297.

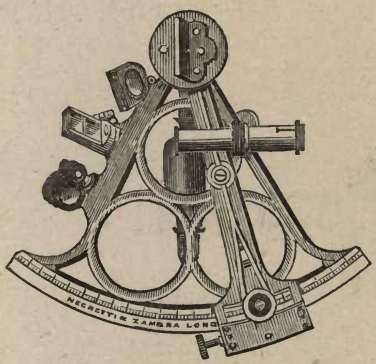


FIG. 1292.

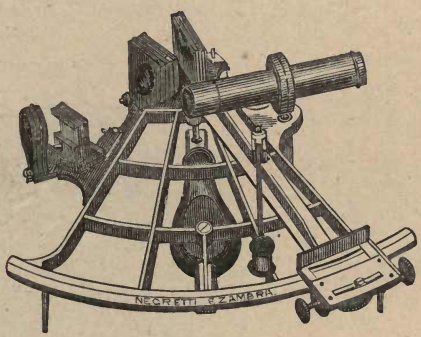


FIG. 1297*.

1297 **Metal Sextant,** 8-inch, Best Edge Bar or Triangular Pattern bridge handle divided on Silver reading to ten seconds, bright or bronzed limb, cup and ball tangent screw, swing horizon, and capped adjustmeuts, Neutral Tint Shades, and extra power to Telescopes, and of the most accurate finish, and with all recent improvements, in square mahogany case (figs. 1297 or 1297*) . . . . . Price £13 13 0

1298 **Lunar Sextant,** I-inch, best make, bridge handle, triangle pattern. Extent of arch 150 degrees. Vernier reading to ten seconds, with excess divisions, strapped and capped adjustments, Neutral tint shades; large size Telescopes, with extra power; star telescope; magnifier, &c. In square mahogany box, with lock and key 14 14 0

1299 Gold or Platinum Arch to either of above 2 12 0

1300 **Tripod Stands for Sextants,** with jointed legs, horizontal and vertical action and clamping screw, in deal case 5 5 0

Quadrants or Octants and Sextants can be supplied of an inferior quality, at slightly lower prices, but they cannot be recommended.

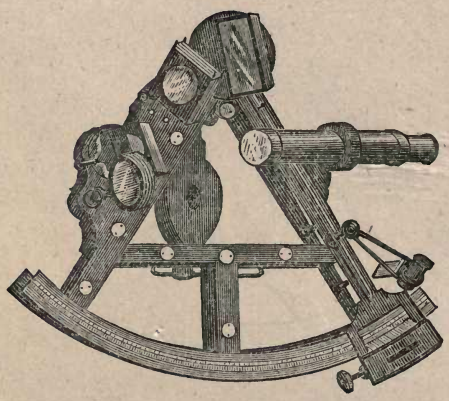


FIG. 1301.

1300 **Pillar or Double Plated Sextant,** 8-inch, reading to ten seconds, with additional power to telescope and Reflectors to verniers, &c., of the very best quality, in Best Square Polished mahogany case (fig. 1301) . £17 17 0

POCKET SEXTANTS.

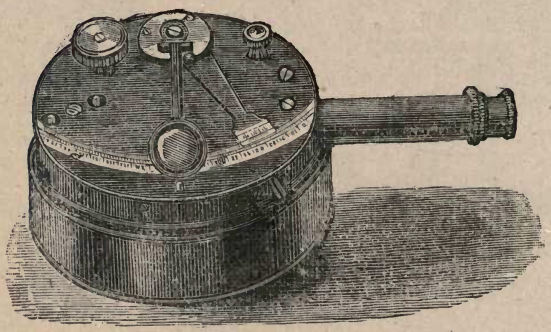


FIG. 1303.

1302	**Pocket or Box Sextant,** with Rack-work adjustment .	4 4 0
1303	**Pocket Sextant,** best quality, divided on Silver, with Telescope and Tangent adjusting screw, &c. (fig. 1303), with leather case and strap	5 5 0
1304	Ditto, ditto, with Cover, divided, hypo and base . .	5 15 0
1305	**Horizon Glasses,** for Quadrants . . . per doz.	0 12 0
1306	**Index** ditto for ditto	1 4 0
1307	**Coloured Shades,** for ditto . . . per set of 7	0 14 0
1308	**Horizon Glasses** for Sextants . . . per doz.	1 10 0
1309	**Index Glssses** for ditto	2 2 0
1310	**Neutral Coloured Shades,** best parallel, per set of 7 .	1 6 0
1311	**Sets of 3 Achromatic Telescopes** for Sextants, best .	1 1 0
1312	Extra Power for ditto	0 6 0
1313	**Star Telescopes** for Sextants	0 15 0
1314	**Horn (Index) Magnifiers** . . . . per doz.	0 15 0

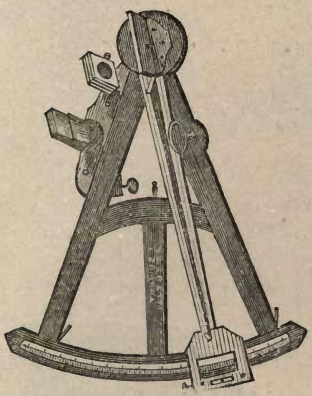


FIG. 1316.

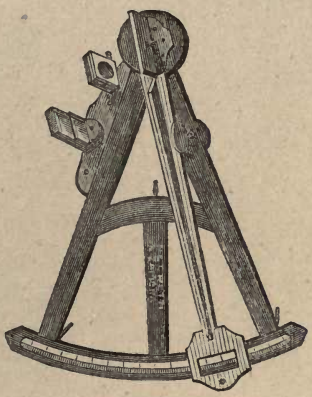


FIG. 1315.

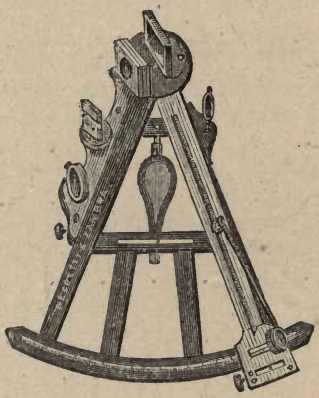


FIG. 1320.

QUADRANTS OR OCTANTS.

		£	s.	d
1315	**Ebony Quadrant**, with Tangent screw to index, in oak case (fig. 1315)	2	10	0
1316	Ditto ditto with two Tangent screws, and bar to index and vertical screw (fig. 1316)	3	3	0
1317	Ditto ditto ditto, with six shades .	3	10	0
1318	Telescope with shutter to above, extra	0	6	6
1319	**Ebony Quadrant**, with two Telescopes, reading to 30 seconds, long centre, and seven shades in box . .	4	10	0
1320	**Metal Quadrant**, best quality, divided on Ivory, with Achromatic Telescopes, long centre, seven shades and index magnifier, in mahogany box (fig. 1320) .	5	5	0
1321	**Metal Quadrant, or Half Sextant**, best quality, divided on Silver, with Two Telescopes, long centre, seven shades and index magnifier, in mahogany box . .	6	6	0
1322	Ditto, ditto, with extended Arc	6	10	0

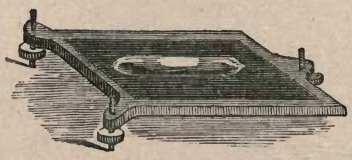


FIG. 1322.

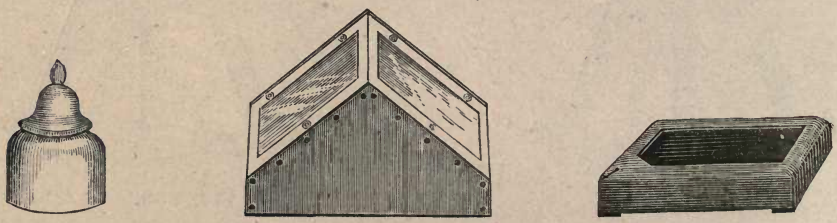


FIG. 1324.

ARTIFICIAL HORIZONS.

		£	s.	d.
1322	**Black Glass Plane, or Artificial Horizon,** with three Levelling Screws, and Ground Spirit Level in box (fig. 1322)	2	10	0
1323	**Artificial or Roof Horizon,** with Wood Mercury bottle and Trough	3	10	0
1324	**Artificial Horizon,** Ordnance Pattern, with two Troughs, turned Iron Mercury Bottle, complete in mahogany box (fig. 1324)	4	10	0

SUN-DIALS.

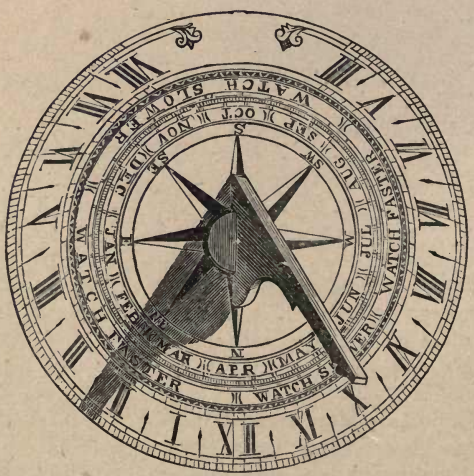


FIG. 1325.

1325 **Sun Dials,** circular, best Brass, full divided to 5 minutes, with Equation Table, and handsomely engraved (fig. 1325):—

Diameter	10-in.	12-in.	14-in.	18-in.
Price .	84s.	115s.	160s.	263s

1326 **Vertical Sun Dial** of Stout Slate Figures and Divisions engraved and Gilt. Gilt Iron Rod Gnomon, from £10 10 0

1327 Ditto ditto, of Slate as above, but with Stout Gun-metal Gnomon (fig. 1327) £14 10 0

Designs and Drawings of Vertical Sun Dials furnished to Architects or Builders, with estimate of Cost.

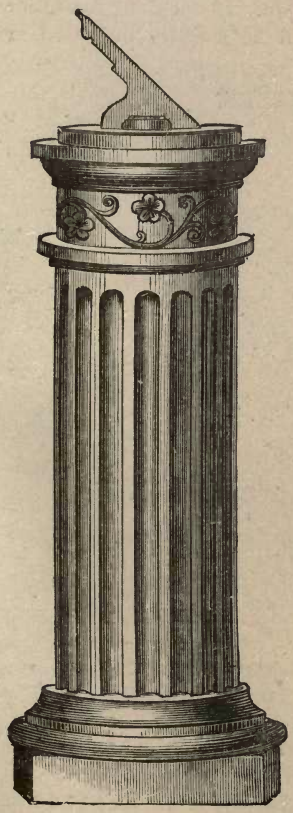


FIG. 1328.

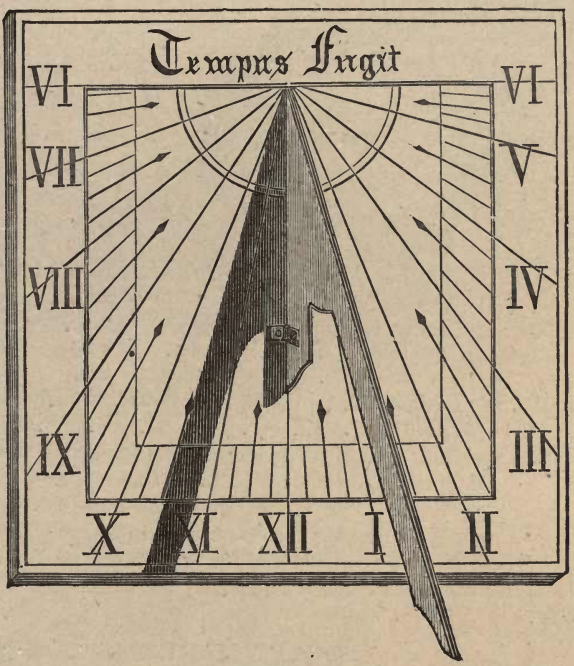


FIG. 1327.

Gnomons of any description, for Vertical Sun Dials, supplied to order.

N.B. When ordering Sun Dials full particulars should be given of size and form of Dial desired, and also the Latitude and Locality where to be fixed up.

Skilled workmen sent to take Bearings or fix any description of Sun Dials.

PEDESTALS FOR SUN DIALS.

1328 Pedestal of Terra Cotta (fig. 1328) Height 3-ft. 6-in., suited for a Dial 12 to 14 inches diameter £4 4 0

Ditto, ditto of Bath Stone . . 7 12 6

Estimates given for Pedestals of any design or material.

1329 **Globe Sun Dial** or Armillary sphere, 24-inch diameter, Gilt Metal hoops, with hour circle, on the inside of this are painted the hours and divisions, the figures being outlined with gold, nickel-plated rod and terminals. The whole mounted on a solid painted Iron stand . . . . from £25 0 0

FIG. 1330.

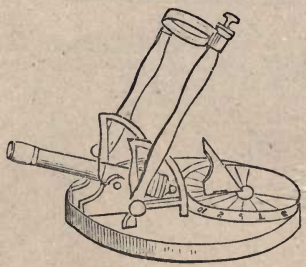


FIG. 1332.

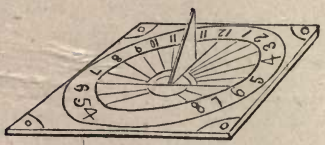


FIG. 1331.

1330 **Sun Dials**, with Circular Brass slab and style (fig. 1330):—

Diameter	6-in.	8-in.	10-in.	12-in.	14-in.
Price	42s.	52s.	63s.	100s.	120s.

1331 **Sun Dials on Slate**, the style of Brass, 12 inches Square (fig. 1331) £3 3 0

1332 **Sun Dial**, with burning lens so arranged that the Sun's rays are thrown on the priming of a small loaded Cannon, and cause it to be fired at noon precisely. The mounting of the lens has a scale corresponding to the sun's declination for every week in the year (fig. 1332) £3 12 6 4 10 0

These dials are constructed for the latitude of London. If required for other localities they must be made specially to order, and will be slightly increased in cost.

POCKET MARINERS' COMPASSES.

FIG. 1334.

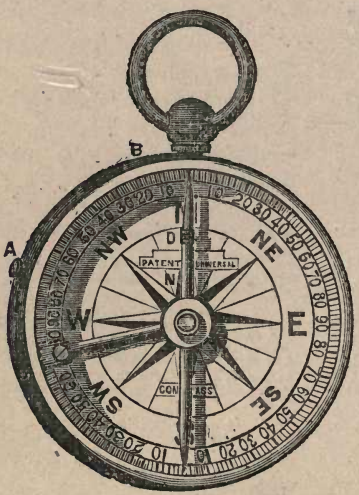


FIG. 1340*.

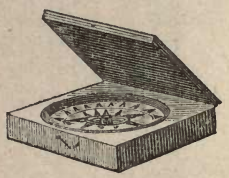


FIG. 1335.

		£ s. d.	£ s. d.
1333	**Pocket Compasses**, Plain Needle, in square mahogany cases, with stops . . . . 3s. 6d. 4s. 6d.	0 5 6	0 6 6
1334	Ditto ditto, mounted with best Bar Needles and Agate centres (fig. 1334) . . . 6s. 6d. 7s. 6d.	0 10 6	0 12 6
1335	Ditto ditto, mounted with Floating Card and Agate centres (fig. 1335) . . 6s. 6d. 7s. 6d.	0 10 6	0 12 6
1336	**Small Pocket Compasses**, Round metal cases . 2s.	0 2 6	0 3 6

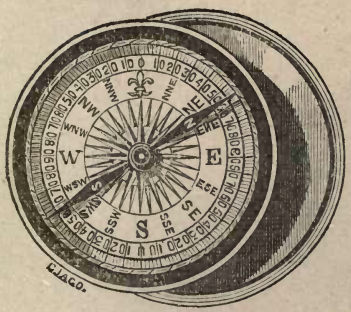


FIG. 1337*.

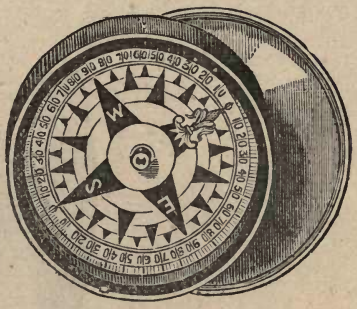


FIG. 1337.

		£	s.	d.	£	s.	d.
1337	Pocket Compasses, in Circular Brass boxes with covers, Magnetic Needles, or Floating Cards, with stops (figs. 1337 and 1337*) 6s. 6d., 7s.6 d.,	0	10	6	0	12	6
1338	Ditto ditto, with Agate centre, and Bar Needle 12s. 6d.	0	15	0	1	1	0

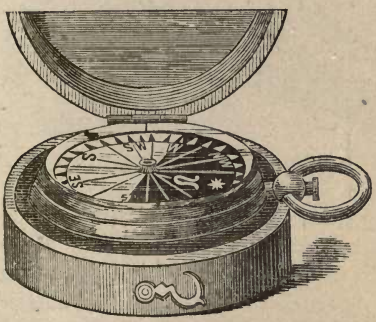


FIG. 1340.

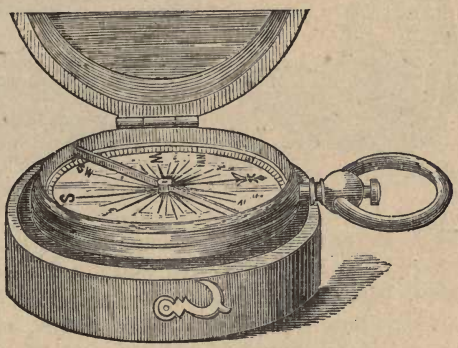


FIG. 1341.

GEOLOGICAL AND SIGHT COMPASSES. See also page 300.

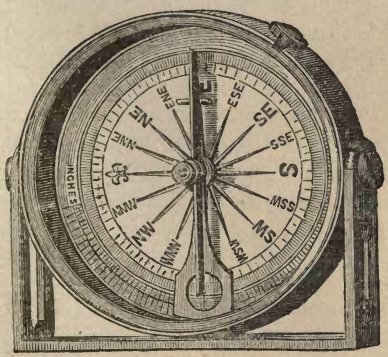


FIG. 1342.

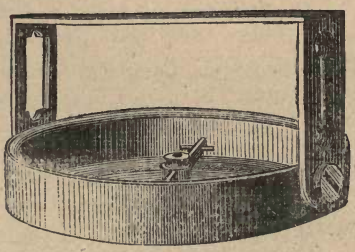


FIG. 1343.

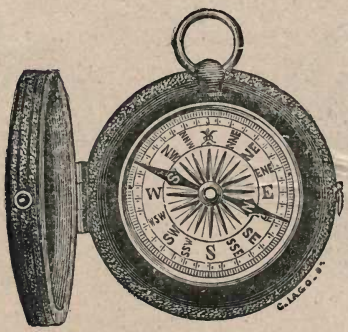


FIG. 1339.

FIG. 1344.

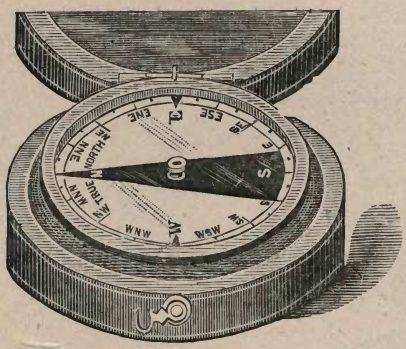


FIG. 1363.

FIG. 1344.

1339 **Brass Gilt Pocket Compasses,** in leather cases, Plain Needle, or Floating Card (fig. 1339) 6s. 8s. 6d, 10s. 6d. £ s. d. 0 12 6 £ s. d. 0 15 0

1340 **Pocket Compasses, with Enamelled dials,** in Gilt Metal or Nickeled cases, Bar Needles, or Floating Cards, with Agate centres and stops, in leather cases (figs. 1340 and 1341) . . . 15s., 18s. 6d. 1 1 0 1 10 0

These Pocket Compasses are recommended for use in Tropical Climates. The Dials being Enamelled similar to a watch-face, remain clean and readable, where silvered metal or card would become tarnished or obliterated.

1340* **Patent Universal Compass,** Gilt Metal Case with Pendant Ring 1 10 0

1341 **Singer's Patent Compasses,** with floating Pearl or Enamelled Card Dials, One-half of the compass card being Black, the points are ascertained with ease at night in the open air. Pocket sizes in various mountings, (figs, 1340, 1344) 10s. 6d., 12s. 6d., 16s. 6d., £1 1s. 1 10 0 1 15 0

1342 **Geological Compass,** for ascertaining the dip or inclination of strata, hills, &c., Best Bar Needle with Clinometer Scale (fig. 1342), showing the inclination in degrees and inches per yard, in Round Brass box, 4½ inches, 1 15 0 2 2 0

1343 **Pocket Compass,** plain, folding, with Sights, round brass box, Bar Needle, and stop (fig. 1343) see also page 330 1 1 0 1 10 0

1344 **Watch Compasses,** in Bronzed Metal Hunting Case (figs. 1334 and 1344*) 21s. 1 5 0 1 10 0

1345 **Starlight or Moonlight Compasses**, with transparent glass dial and bar needle, for the use of travellers by night, or by the light of a match or cigar, held beneath it, in leather case £3 3 0

FIG. A.

FIG. E.

FIG. F.

FIG. B.

1345* **Magnetic Trinket or Charm Compasses**, mounted in Gold and Silver in great variety of forms, as shown in figs. A to F including the new **Transparent Pebble Mountings** (figs. F and B), the Needle being poised between the two Pebbles. These Pebbles are so worked upon their surfaces as to form a **Magnifying Lens** or **Burning Glass.** These Prices vary with the quality of the Gold or Silver and the design of the frame. Fig. A 60s.; fig. B 70s.; fig. E 70s.; fig. F 29s.

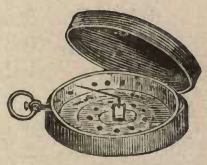


FIG. 1346.

1346 **Oat Beard Hygrometer**, or Pocket Damp Detector, Strongly gilt in morocco case (fig. 1346) . . . 0 10 6 1 1 0

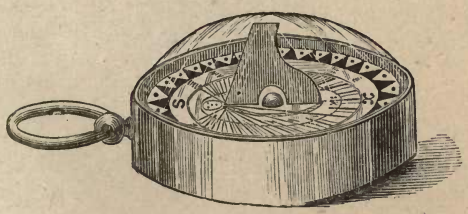


FIG. 1359.

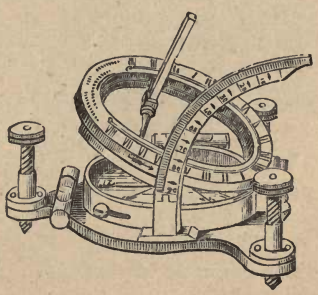


FIG. 1350.

		£	s.	d.
1347	**Universal Joint Sun Dial and Compass**, with divided Arc, in cases 2½-inches	3	3	0
1348	Ditto ditto 3½-inches	4	4	0
1349	Ditto ditto 4½-inches	6	6	0
1350	**Universal Sun Dial and Compass**, for both N. and S. Latitudes, 2½ inches, with **Levels** and Adjusting Screws, in leather case (fig. 1350)	4	4	0
1351	Ditto ditto, 4½-inches, best mounting and dividing	7	7	0
1352	**Watch Compasses**, in Silver Hunting Cases . . 2 10 0	3	3	0
1353	Ditto ditto . . . . German Silver, 25s. 1 10 0	2	2	0

FIG. 1356.

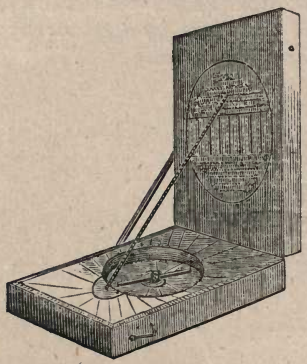


FIG. 1355.

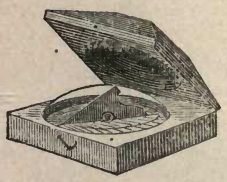


FIG. 1357,

		£	s.	d.	£	s.	d.
1354	**Pocket Sun Dial Compassses, in oblong Boxwood case,** with Equation Table				0	11	0
1355	Ditto with best Bar Needle ditto (fig. 1355) . . .				0	12	6
1356	**Sun Dial Compasses,** in common round wood case (fig. 1356)				0	2	6
1356*	Ditto ditto, best Mounted				0	11	0
1357	Ditto ditto, in Square Wood case, Agate Centre, best mounting (fig. 1357)	0	12	6	0	15	0
1358	Ditto ditto, **Round Metal Case,** with cover and stop .				0	12	6
1359	Ditto ditto, German silver Nickel Plated as (fig. 1359)				0	16	6
1360	**Starlight or Moonlight Compasses,** with transparent glass dial, and bar needle, for the use of travellers by night, or by the light of a match or cigar, held beneath it, in leather case				2	2	0
1361	**Gregory's Compass for Equestrians,** the Needle or Card being mounted on two centres to prevent oscillation, plain mount	1	1	0	1	15	0
1362	Ditto ditto, best mounted in Silver Hunting case, watch form as fig. 1344				3	10	6
1363	**Symons' Patent True North Compass,** in Square Mahogany Box, with Agate Cap and Stop (fig. 1363)	0	10	6	0	12	6
	Ditto Ditto, Trinket or Charm Form, Gold £2 10s.; Silver, £1 2s.						

The true Magnetic Westerly Variation of the Compass (November, 1885) for London is 18° 20′ at Kew, 18° Greenwich. The Annual decrease, 8′ The daily Oscillation 10′.

Maximum Easterly Variation yet recorded was observed by Burroughs in 1580, viz., 11° 17′.

Maximum Westerly Variation observed by Colonel Beaufoy in 1815, 24° 27′ 18″.

Years of no Variation, 1657 to 1662.

"As regards the *Direction* of the Wind, it is hardly necessary to observe that this should always be given according to *True and* NOT *to Compass Bearings.* The amount of Variation of the Compass in the British Islands being, roughly speaking, two points to the westward."

SHIPS' OR POCKET COMPASSES REPAIRED AND ADJUSTED.

BOAT AND SHIPS' COMPASSES.

		£ s. d.	£ s. d.
1363	Boat Steering Compass, Plain mounted, 5-inch, in Square Oak box with slide lid	0 13 0	0 16 6
1364	Brass Cone Boat Compass, in turned Wood Case (fig. 1364)		0 14 0

FIG. 1364.

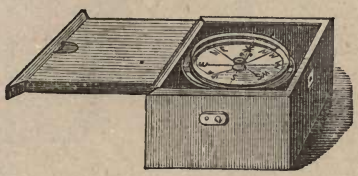


FIG. 1368.

FIG. 1365.

1365	Boat Compass, Round Brass Box, in Gymbals (fig. 1365)	1	5	0	1	12	0
1367	Ditto ditto, Square Oak Box, with gymbals . . .				1	10	0
1368	Ditto ditto, Best Mounted (fig. 1368)	1	16	0	2	2	0
1369	Ditto ditto, Polished Mahogany hinged box with Singer's Card (fig. 1369)				2	2	0

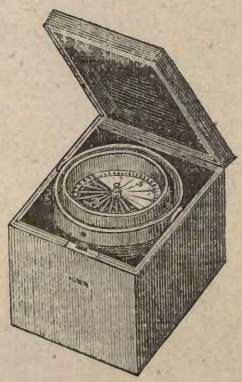


FIG. 1369.

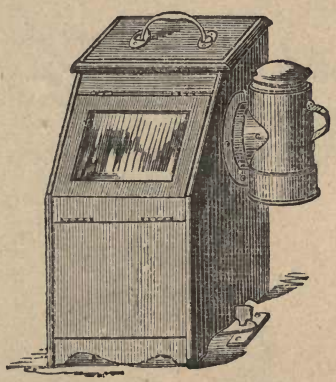


FIG. 1370.

1370 Improved Yacht or Boat Compass, with Singer's Patent or Ordinary Card, with or without Binnacle or Lamps (figs. 1369 and 1370).

Size of Compass Box.	Diameter of Card.	Price of Compass complete.	Price of Compass, with Binnacle.	Price of Compass, with Binnacle & Lamp
		£ s. d.	£ s. d.	£ s. d.
No. 1—4½ inches square	2½ inches	0 14 0	1 14 0	2 16 0
No. 2—5½ inches square	3 ,,	0 16 0	2 0 0	3 3 0
No. 3—6½ inches square	3½ ,,	0 18 0	2 6 0	3 10 0

FIG. 1372.

FIG. 1376.

1371 **Ship's Steering Compasses**, in Wood box :—

Inches	7.	8.	9.	10.	11.	12.
Price, each	8s.	9s.	10s.	11s.	12s.	14s.

1372 **Ship's Steering Compasses, best make**, Agate Cap to Needle, with Brass bowls in gymbals, and oak box (fig. 1372) :—

Size of Box outside, Inches	7.	8.	9.	10.	11.	12.
Price, each	14s.	15s.	17s. 6d.	20s.	21s.	23s.

1373 **Storm Compasses**, 10-inch £1 10 0
1374 Ditto ditto 11-inch 1 14 0
1375 **Storm Compasses, double dipping Needles**, best mounted, 10-inch, Transparent Storm Card 2 10 0
1376 Ditto ditto „ 11-inch (fig. 1376) . 2 15 0

Box Ships' Compasses are measured by the outside of Box.

1377 **Amplitude Compass**, brass caps, and steel centres, with Sights, Agate, centre 11-inch 1 16 0
1378 Ditto ditto 10-inch 1 10 0
1379 Ditto ditto, divided Silver Ring and Folding Sights in Polished Mahogany Box (fig. 1379) 4 10 0 5 10 6

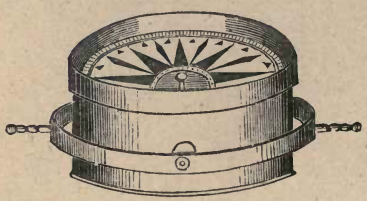


FIG. 1381.

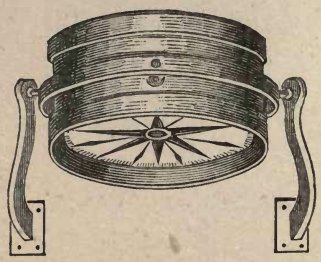


FIG. 1382.

		£	s.	d.	£	s.	d.
1380	**Hanging or Cabin Compass**, small size, best mounted, japanned Brass				1	10	0
1381	Ditto ditto, full size ditto, ditto, bright Brass (fig. 1381)				2	12	6
1382	Ditto ditto, Brass, turned arms, and best Transparent card (fig. 1382) . . . . . 42s.	2	10	0	3	0	0
1383	Ditto ditto, Brass ditto, with **Double Dipping Needles**	3	3	0	3	10	0

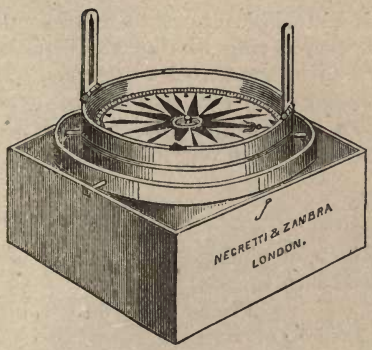


FIG. 1384.

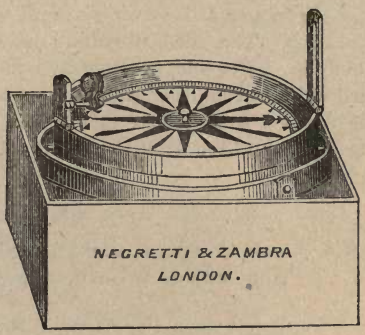


FIG. 1385.

		£	s.	d.
1384	**Prismatic Azimuth Compass**, with Card Dial & Sights	6	6	0
1385	**Best** do. do. with divided Metal Ring and Shades, arranged for Iron Ships (fig. 1385)	8	8	0
1385*	**Tripod Stands** for above . . . . . from	2	2	0
1386	**Prismatic Azimuth Compass**, with double Needles, Copper ring, inside bowl (SNOW HARRIS'S arrangement), best mounted in mahogany box, specially suited for **Iron ships**, with extra Box for Card and Iron feeders to preserve the magnetism	8	0	0

RITCHIE'S PATENT LIQUID COMPASS.

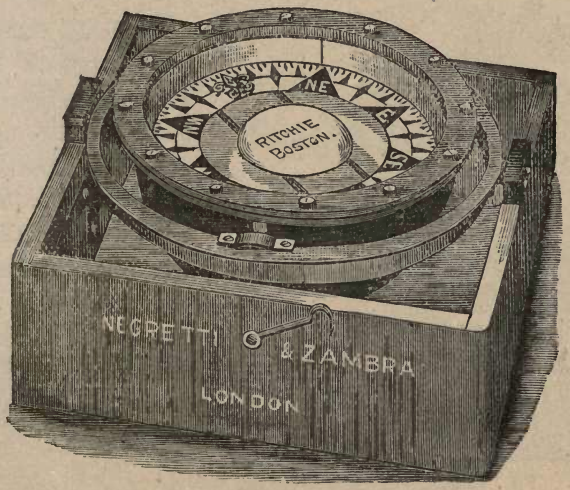


FIG. 1387*.

1387 The principle on which the RITCHIE'S LIQUID COMPASS is constructed, is the enclosing of the magnetic needles in metallic cylinders, and connecting with the needles and the card a closed air-chamber, by the buoyancy of which, in the liquid the bowl is filled with, the weight resting upon the pivot is reduced to less than a single gramme, preventing all friction and wear at the point of the pivot. The resistance of the liquid gives to the card far greater steadiness than can be

Cabin and Transparent Compasses are measured by the bowl.

possible in any other compass, and the card, if disturbed, returns to rest in much less time. The card is usually made with a curved ring bearing the *divisions*, which is preferable, except when it is desired to be graduated to degrees. The card with *degrees* is engraved upon a plane annular ring; for use when the courses are desired to be given in degrees rather than by points, and which is necessary for azimuth observations. It has ERECT figures, which are very legible.

	Flat Ring Graduated to Degrees. £ s. d.	Curved Ring. £ s. d.
1387* 7-inch Compass; diameter of card 6¾-inch, of gimbal ring outside 9¾-inch, mahogany box 11-inch square, Price	4 5 0	4 10 0
8-inch Compass; Diameter of card 7½-inch, of ring outside 10¾-inch, mahogany box 12-inch square (fig. 1387*)	5 0 0	5 5 0
9-inch Compass; Diameter of card 8¾-inch, of ring outside 12¼-inch, mahogany box 13¾-inch square .	6 0 0	6 10 0
10-inch ditto ditto, diameter of card 9½-inch .		8 0 0
All Compasses, with graduated card, are arranged for use with Azimuth Circle.		
Azimuth Circles for above, 7-inch to 9-inch . . each		4 0 0
Ditto 10-inch		4 10 0

Prices for any size Compasses, or specially fitted up to the requirements of any Government, sent upon application.

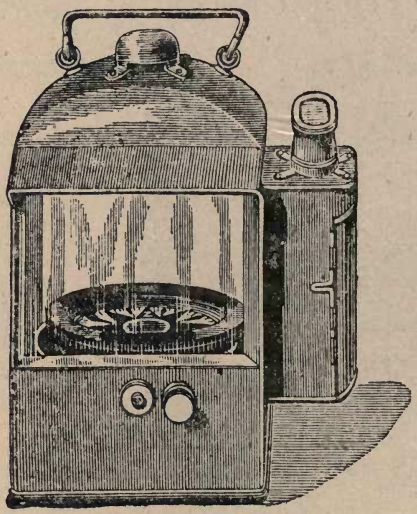


FIG. 1388.

1388 **5-in. Boats' Compass,** mounted with Ritchie's Patent Liquid Compasses, in box . 3 0 0

5-in. ditto ditto in Binnacle with Lamp (fig. 1388) . . 5 10 0

6-in. ditto ditto in box . 4 4 0

6-in. ditto ditto, Binnacle 7 7 0

7-in. Pole Compass, complete with Support . . . 6 10 0

8-in. ditto ditto . 7 10 0

9-in. ditto ditto . 8 10 0

7-in. Transparent ditto, with Arms 6 6 0

Binnacle, Cabin, or Saloon, Engine-room, Boiler, and Forecastle Lamps. Hand, Gimbal, or Hanging Lanterns, &c., &c., of every form. Supplied to order.

Green and Ruby Glasses, Lenses, and Prisms, Reflectors, Fittings for Ships Lamps, &c., &c. Deck Glasses, Flat, Prismatic, or Round, Glass Deck Lights, Round and Square Glasses for Scuttles, at per lb.

Harbour and Pier Head Lights. Prices according to size, colour, and power of the light. Supplied to order.

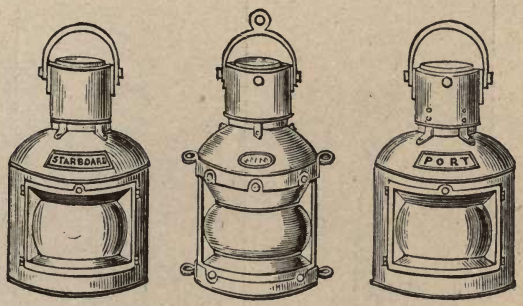


FIG. 1389.

SHIPS' LIGHTS AND SIGNAL LAMPS, &c.

No. 1 *size for Vessels up to* 300 *Tons.* *No.* 2 *size above* 300 *Tons to* 536 *Tons.*
No. 3 *size* 600 *Tons to largest Vessels built.*

		£ s. d.	£ s. d.	£ s. d.
1389	Port and Starboard Lamps, Japanned . . . per pair	1 12 6	2 2 0	2 15 0
	Ditto ditto, Copper, (fig. 1389) .	2 15 0	4 0 0	5 0 0
	Ditto ditto, best quality, Japanned per pair	2 0 0	2 10 0	3 0 0
	Ditto ditto, best Copper „	4 0 0	5 0 0	6 0 0
	Globular Anchor, Japanned, best each	0 13 0		
	Ditto ditto, Copper . . „	1 4 0		
	Circular Anchor, Japanned, best each	0 18 6	1 4 0	1 10 0
	Ditto ditto, Copper . . „	2 0 0	2 12 0	3 0 0
	Mast Head Lamps, Japanned, best each	1 10 0	2 10 0	3 3 0
	Ditto ditto, Copper . . „	1 10 0	3 10 6	4 12 6
	Tricolour, Telegraph, or Steering Lamp, Japanned . . each	1 10 6	2 2 0	2 12 0
	Ditto ditto, Copper . . „	2 10 0	2 18 0	3 10 0

In our Appendix will be found instructions for truly fixing or setting Sun Dials; also Tables of the Equation of Time, the Difference of Time between various localities East and West of Greenwich. The Height in feet of the rise of Spring Tides in various parts of the world, &c., &c.

FIG. A 4.


FIG. A 1.


FIG. A 2.

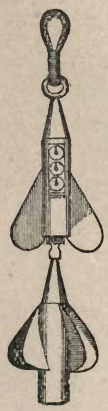


FIG. A 3.

		£	s.	d.
1390	Walker's Patent Harpoon Ship-Log (fig. A 1.) . .	3	10	0
1391	Ditto ditto (fig. A 2.)	3	3	0
1392	Ditto ditto, Detached Ship-Log (fig. A 3.) . . .	3	3	0
1393	Ditto Harpoon Sounding Machine (fig. A 4.) without Lead	3	3	0
1393*	Lead for Sounding Machine	1	1	0


FIG. A 5.

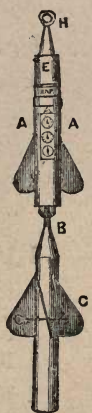


FIG A 6.

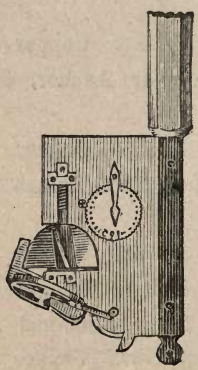


FIG A 7.

1394	Massey's Patent Ship-Log (fig. A 5.)	3	10	0
1395	Ditto, Improved ditto, ditto (fig. A 6.)	2	15	0
1396	Massey's Sounding Machine (fig. A 7.), with Lead .	4	0	0

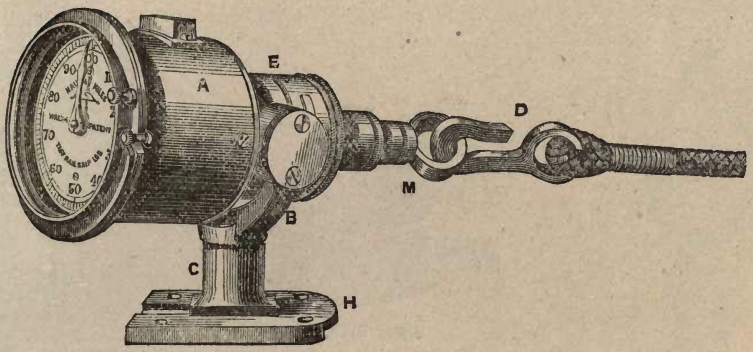


FIG. 1397.

		£	s.	d.
1397	Walker's Cherub Taffrail Log (fig. 1397) . . .	3	10	0
1398	Iron Governor Wheel, for use with above . . .	0	7	6
1399	Log Line for ditto	0	17	0
1400	Bliss and Co.'s Taffrail Log, complete with Line . .	5	5	0
1401	The Pendent Log supplied to order.			

LOG AND TIME GLASSES.

		£	s.	d.	Each. £	s.	d.
1402	Log Glasses, in Wood frames, 14 seconds, per dozen	0	15	6			
1403	Log Glasses, 28 seconds, per dozen	0	15	6			
1404	Ditto ditto, 14 and 28 seconds, best Brass frames .				0	5	0
1405	One-minute Glasses, in plain Wood frames . . .				0	1	6
1406	Three-minute ditto ditto				0	1	8
1407	Five-minute ditto ditto				0	1	0
1408	Quarter-hour Glasses				0	1	6
1409	Half-hour Glasses				0	2	0
1410	One-hour ditto				0	3	6
1411	Two-hour ditto				0	4	0
1412	Quarter-hour Glasses, in Rosewood or Boxwood frame .				0	8	6
1413	Half-hour ditto ditto				0	12	0
1414	One-hour ditto ditto				0	16	0
1415	Quarter-hour Glasses in Brass frames				0	11	0
1416	Half-hour Glasses ditto				0	16	0
1417	One-hour ditto ditto				1	1	0
1418	Tea Brokers' Sample Glasses, plain Wood frame . .				0	1	0
1419	Auctioneers' One-minute Glasses, Wood Pocket case .	0	10	6	0	15	6
1420	Time Glasses, mounted in Ivory or Fancy Wood frames and for any time. To order.						

FIG. 1422.

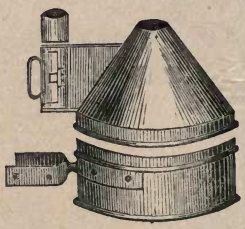


FIG. 1428.

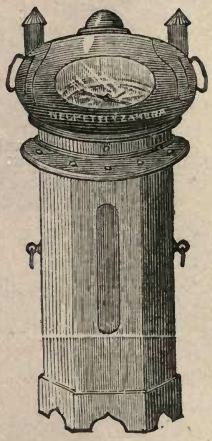


FIG. 1423.

SHIPS' BINNACLES.

		Each. £ s. d.	Each. £ s. d.
1421	**Yacht Binnacle all Brass,** short Urn shape . . .		7 7 0
1422	**Ship's Binnacles** (fig. 1422), all bright Brass, best make, with two Lamps, bolts, and plates for deck, &c. 10-inch bowl £12 12s. 11-inch £13 13s. 12-inch £15 15s.		
1423	**Ships' Binnacle** (fig. 1423), Globe shape, Brass top, with lamps on French polished Mahogany Stand, 11-inch	9 9 0	10 10 0
1424	**Brass Binnacle Tops,** of Globe, Light-house or Helmet form, *with two best Lamps.* For a 10-inch Compass £5 11-inch £6 12-inch £7 13-inch £8 14-inch £9		
1425	**Brass Binnacle,** Urn shape, with lion's head handles, adapted for Yachts and Steamers, on octagon polished Mahogany stand, with two lamps in shade for a 10-inch compass		12 12 0
1426	**Brass Dolphin Pattern Binnacles,** and other ornamental patterns . . . . . £12 12s.	15 15 0	16 16 0
1427	**Chain Boxes** for Binnacles . . . . . extra		0 15 0
1428	**Masthead Binnacles,** with band for Mast and one Lamp (fig. 1428.) (See also Pole Compass, page 322.)		5 5 0

Note—**The Compasses are not included in any of the above prices.**

Extra cost for Compass 18s., 38s., to 40s. each.

1429	**Captain Friend's Pelorus,** with German silver Dials, for testing Compasses	6 10 0

Prices for Ritchie's Patent Liquid Compasses, See page 322.

		Each. £ s. d.	Each. £ s. d.
1430	**Speaking Trumpets, Japanned**	0 5 0	0 15 0
1431	Ditto ditto, Brass . . . . . 8s. 6d.	0 15 0	0 18 6
1432	**Fog Horn, Brass** . . . . . 5s., 6s.	0 12 6	0 14 0
1433	Ditto ditto, Japanned . . . . 2s. 6d., 4s.	0 5 6	0 7 6
1434	**Hand Fog Bells,** turned edge and crown :— 5-inch, 9s.; 6-inch, 12s.; 7-inch, 21s. each.		
1435	**Key's Patent Fog Signals,** giving a louder and more prolonged blast than the fog horn, with Brass horns to screw on bellows	0 14 0	0 16 0
1436	Ditto ditto, Tin ditto, fixed in ditto	0 12 0	0 14 0
1437	**Ships' Chronometers,** (8 days), of the very best construction		42 0 0
1438	**Marine Clinometer** in Round Metal Case . . .		3 10 0
1439	**Marine Inclinometer,** Admiralty Pattern . . .		6 6 0
1440	**Bar Magnets,** for correcting Compasses . per lb.		0 1 9
1441	**Pitchometer,** for measuring the angle of Screw-Propeller Blades or Bevel Wheels. Supplied to order.		

Admiralty and Official Charts, Maps of all parts of the World, Nautical Almanacs, Admiralty Sailing Directions, Log Books, Cargo Books, Journals, and other Nautical Publications. To order.

Bunting of all widths and qualities, Signal Flags, various Codes, in sets roped and toggled complete, in painted boxes, Royal Standards, Ensigns, Union Jacks, and all other English and Foreign Flags. To order.

Ship's Compasses and Barometers repaired and adjusted.

Ships' or Pilot's Telescopes, Binocular Look-out Glasses or Horizon Sweeps, Marine Barometers, Drawing Instruments, &c., &c. See Sections.

COMPASS VARIATIONS. *From "Mechanics' Magazine," March 16th*, 1865.

	Days.	Minutes.	Yearly Rate of Change. Min.
1576	11	15	E . . . 7
1622	6	15	E . . . 11
1657	0	0	True North . 12
1672	2	30	W . . . 13
1720	13	0	W . . . 9
1765	20	0	W . . . 5
1819	24	41	W Max. W . 0
1852	22	18	W . . . 4
1865	20	38	W . . . 7

GLOBES AND ORRERIES.

FIG. 1442.

FIG. 1443.

FIG. 1443*.

FIG. 1444.

FIG. 1445.

1442 **Pocket Globes**, 3-inch diameter, in hinged case (fig. 1442) . . . . . 10s. 6d. to 16s.

1443 **Pedestal Globes**, mahogany base, with semi-circular brass meridian and Quadrant of Altitude (figs. 1443 and 1443*) :—

Diameter	9-in.	6-in.	4½-in.	3-in.
Each .	21s. 24s.	9s. 10s. 6d.	6s. 7s.	4s. 5s.

1444 **Table Globes**, black stained wood frames, with brass meridian and Quadrant of Altitude (fig. 1454)

Diameter	15-in.	12-in.	9-in.
Per Pair	£6 6s.	£4 4s.	£3 3s.

1445 **Table Globes**, mahogany frame, with brass meridian and Quadrant of Altitude (fig. 1445) :—

Diameter	20-in.	15-in.	12-in.	9-in.	6-in.
Per Pair .	£10 10s.	£6 18s.	£4 15s.	£3 12s.	£2 4s.

FIG. 1446.

FIG. 1446*.

FIG. 1447.

FIG. 1448.

1446 **Globes mounted Chair high, best Plain mounted pillar and claw**, with compass and Quadrant of Altitude (figs. 1446 and 1446*) :—

Diameter	25-in.	20-in.	15-in.	12-in.
Per Pair .	£25	£14	£9 9s.	£6 6s.

1447 **Globes mounted Chair high, Superior Carved** and polished pillar and claw frames, with Compass, Quadrant of Altitude, and double hour circles (fig. 1447) :—

Diameter	25-in.	20-in.	15-in.	12-in
Per Pair .	£31 10s.	£16	£11	£7 10s.

1448 **Globes mounted Chair high**, on highly finished and carved tripod frames, of polished Spanish mahogany, with Compasses, Quadrant of Altitude, and double hour circle, with all recent improvements (fig. 1448) :—

Diameter	25-in.	20-in.	15-in.	12-in.
Per Pair .	£36 15s.	£18 18s.	£13	£8 10s

1449 **School Globes**, mounted to suspend from the ceiling with Quadrant of Altitude (fig. 1449)

Diameter	25-in.	20-in.	15-in.	12-in.
Each .	£7 7s.	£3 10s.	£2 2s.	£1 5s.

1450 **Globes** mounted in rosewood, walnut-wood, satin-wood, &c., at 10 to 20 per cent. increase on the above prices. Any particular style of frame made to order.

1451 **Covers for Globes** of Leather Cloth for high frames :—

For 25-inch Globe.	20-inch Globe.	15-inch Globe.	12-inch Globe.
42s.	32s.	22s.	14s.

1452 **Brass Quadrants of Altitude** :—

For 25-in. Globe.	20-in. Globe.	15-in. Globe.	12-in. Globe.	9-in. Globe.	6-in. Globe.
11s.	7s.	5s.	4s. 6d.	3s. 6d.	2s. 6d.

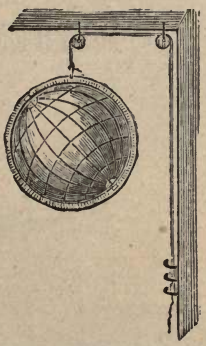


FIG. 1449.

Old Globes repaired and re-covered with modern maps, and the brass mountings cleaned and re-lacquered, rendering them equal to new.

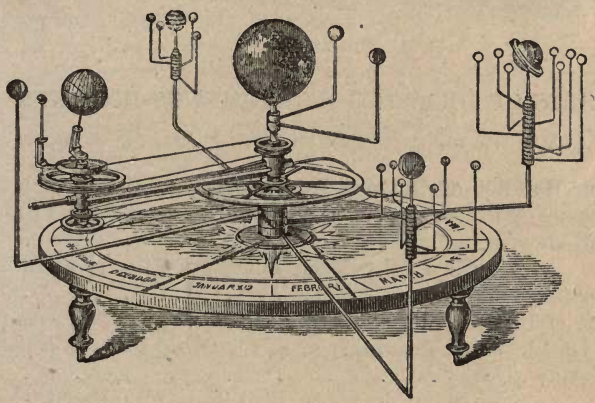


FIG. 1454.

		£	s.	d.	£	s.	d.
1453	**Orrery Planitarium, or Tellurian**, Plain mounting to move by hand, showing the relative positions of the planets and their satellites, &c.				8	8	0
1454	**Orrery**, exhibiting the relative positions of all the principal planets and their satellites; the diurnal and annual motion of the earth; the moon's phases and nodes, &c.; to move with a train of wheel work and winch handles (fig. 1454)	10	10	0	16	16	0
1455	**Complete Orreries**, representing the motions of all the Planets and their satellites; the various movements of the earth and moon; the Sun rotating on its axis, &c.; arranged with very superior clock-work motion, in a mahogany and brass frame . . to order, from				60	0	0

1456 **Diagrams**, illustrating the Sciences of Astronomy, Geography, Geology, &c., &c., for Class teaching, or suited to Lectures, supplied to order.

MATHEMATICAL DRAWING INSTRUMENTS.

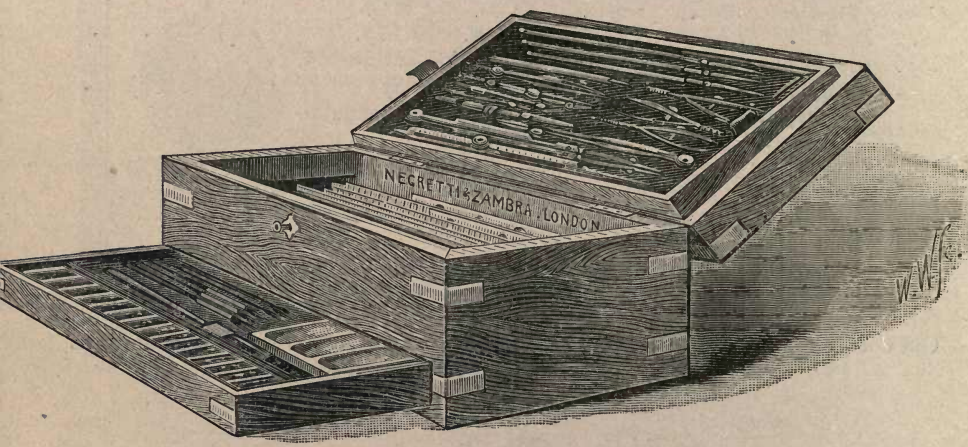


FIG. 1486.

SETS OF DRAWING INSTRUMENTS IN CASES,

FOR TEACHING ELEMENTARY DRAWING, &c., IN SCHOOLS, &c.

		£	s.	d.
1457	**Small or Half-Set of Drawing Instruments,** consisting of brass compasses, with pen and pencil points, boxwood scale and pencil, in pull-off case	0	6	6
1458	Ditto similar to No. 1 set, but with extra dividers and feeder (fig. 1458)	0	8	6
1459	**Half-Set of Instruments,** consisting of brass compasses, with pen and pencil points, drawing pen and boxwood scale, in polished mahogany case	0	10	6
1460	Ditto with extra bow pen, and bow pencil, and ebony parallel rule (fig. 1460)	0	16	6

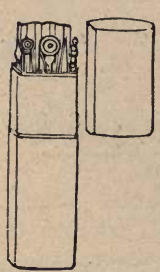


FIG. 1458.

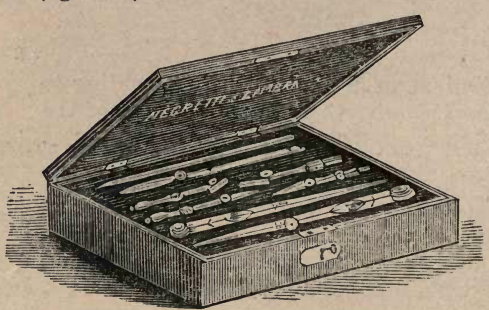


FIG. 1463.

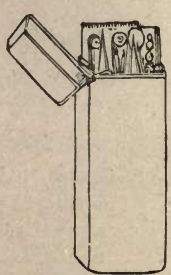


FIG. 1460.

1461	**Set of Instruments,** consisting of brass compasses, with pen and pencil points, lengthening bar, bow pen and bow pencil, drawing pen, ebony parallel rule and boxwood protractor, fitted in mahogany case	1	1	0
1462	Ditto with extra dividers	1	5	0

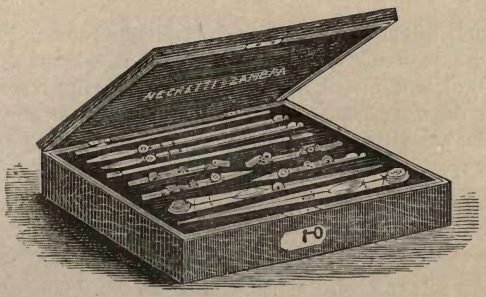


FIG. 1467.

		£	s.	d.
1463	**Set of Instruments,** consisting of brass sector-joint compasses, with pen and pencil points, lengthening bar, bow pen and pencil, jointed drawing pen, ebony parallel rule, and boxwood protractor, fitted in mahogany case, with lock and key (fig. 1463) . .	1	10	0
1464	**Set of German Silver Instruments,** consisting of compasses with pen and pencil points, lengthening bar, dividers, bow pen, and bow pencil, plain drawing pen, boxwood protractor, sector and ebony parallel rule, fitted in mahogany case, with lock and key . .	1	15	0
1465	Ditto, similar to No. 1464 set, but with knee-joint compass, and jointed drawing pen	2	2	0

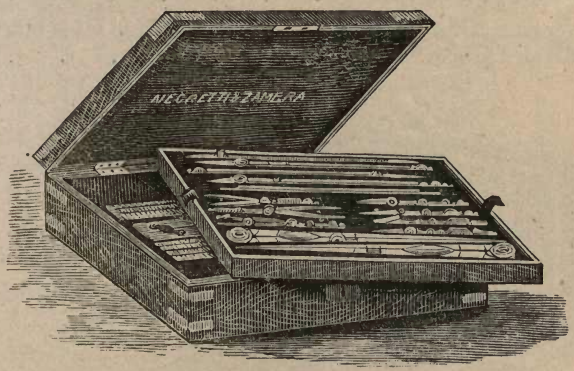


FIG. 1470.

1466	**Set of German Silver Instruments,** consisting of sector-joint compasses and hair dividers pen and pencil points, lengthening bar, bow pen and bow pencil, jointed and plain drawing pens, boxwood protractor and sector, and ebony parallel rule, fitted in oak, rosewood or mahogany case, with lock and key . . .	2	10	0
1467	**Set of German Silver Instruments,** consisting of knee-joint compass, as fitted with set of three spring bows and plain drawing pen, fitted in oak or mahogany case, with lock and key (fig. 1467)	3	3	0
1468	**Set of German Silver Instruments,** similar to No. 1466 set, but with extra set of three best spring bows	3	10	0

		£	s.	d.
1469	**Set of German Silver Instruments,** best finished sector-joint compasses and hair dividers, pen and pencil points, lengthening bar, bow pen and bow pencil, set of three best spring bows, jointed and plain drawing pens, needle holder, ivory protractor, sector and parallel rule, fitted in oak, rosewood or mahogany case, with lock and key	4	4	0
1470	**Set of German Silver Instruments,** similar to Fig. 1470, but with best knee-joint compass, and with brass bound case, with best silk linings	5	5	0
1471	**Set of German Silver Instruments,** similar to No. 1470 set, but with set of colours, brushes, &c.	5	15	0
1472	**Set of German Silver Instruments,** consisting of best double-jointed and needle-pointed compasses, hair dividers, pen and pencil points, lengthening bar, bow pen and bow pencil, set of three best spring bows, jointed and plain drawing pens, ivory protractor, sector and parallel rule, fitted in brass bound case, with lock and key	6	6	0
1473	**Set of German Silver Instruments,** similar to No. 1472 set, but with needle holder, and set of best colours, brushes, &c. . . .	7	7	0
1474	**Set of German Silver Instruments,** similar to No. 1473, but fitted in extra finished Case, with German Silver caps and corners, &c., suitable for presentation	8	8	0
1475	**Set of German Silver Instruments,** similar to No. 1474, but with fully divided proportional compass	9	9	0

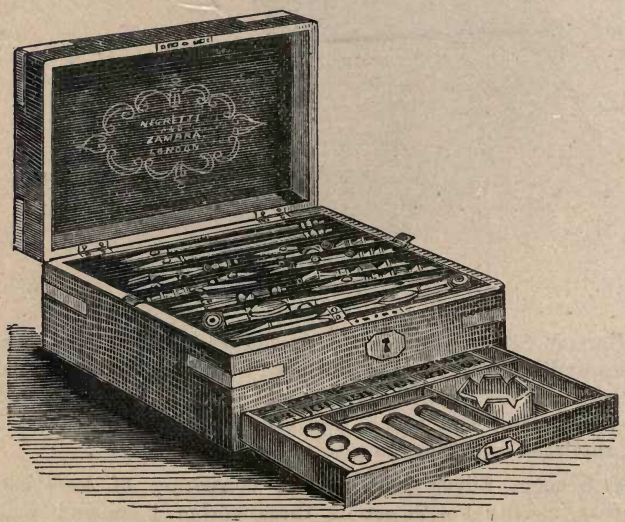


FIG. 1474.

1476	**Set of German Silver Instruments,** similar to 1475, but with dotting and road pens	10	10	0

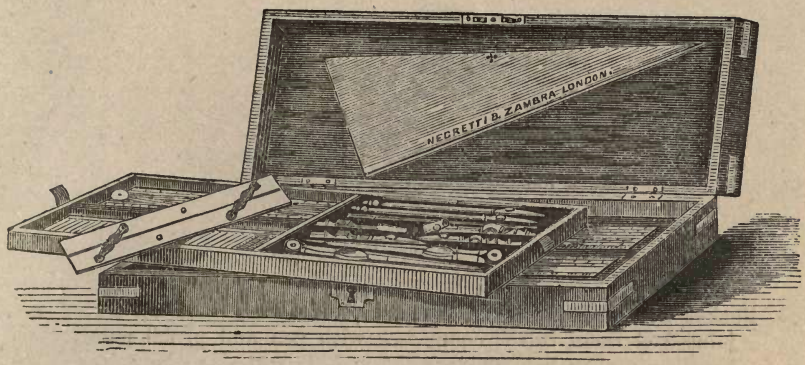


FIG. 1478.

		£	s.	d.
1478	**Addiscombe Cadets' Set of Drawing Instruments,** consisting of brass sector joint compasses, with pen and pencil points, lengthening bar, hair dividers, bow pen and bow pencil jointed and plain drawing pens, ivory red line protractor, sector and parallel rule, boxwood marquoise scales and angle, in oak case, with lock and key	3	10	0
1478*	Ditto ditto in German Silver, rosewood case . . .	4	10	0

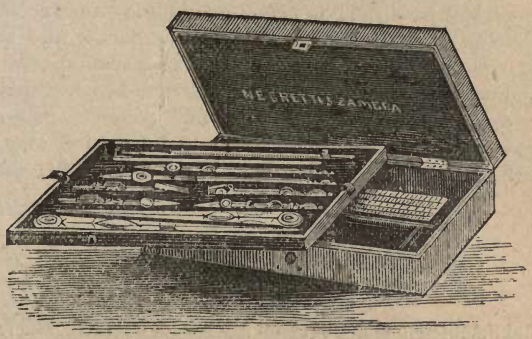


FIG. 1481.

1479	**Ordnance Pattern Set of Drawing Instruments,** consisting of brass sector joint compasses with pen and pencil points, lengthening bar, dividers, bow pen and bow pencil, jointed and plain drawing pens, ivory protractor sector, and parallel rules and drawing pins in mahogany case with snap fastening				2	10	0
1480	Ditto ditto in German Silver, with hair dividers . .				3	3	0
1481	**Set of Mathematical Drawing Instruments,** as used at the Royal Military College, Woolwich . . .				3	3	0
1482	**Set of Mathematical Drawing Instruments,** as used at King's College and College of Civil Engineers .	2	15	0	3	10	0

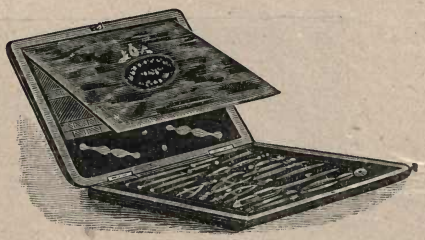


FIG. 1485.

		£	s.	d.
1484	**Pocket Set of Drawing Instruments,** consisting of small sector jointed German Silver compasses, with pen and pencil points, lengthening bar, hair dividers, jointed drawing pen, and ivory protractor, fitted in Morocco case	2	10	0
1485	**Pocket Set,** consisting of best double jointed and needle pointed German Silver compasses, with pen and pencil points, lengthening bar, hair dividers, bow pen and bow pencil, jointed and plain drawing pens, ivory protractor, sector, and parallel rule, fitted in Morocco case (fig. 1485)	4	10	0
1486	**Magazine Cases of Mathematical and Engineering Drawing Instruments,** of our very best manufacture, in German Silver. These sets include proportional compasses, beam compasses, various sizes of drawing, road, and wheel pens, dividers, sets of the best spring bows, bow pens and bow pencils, complete sets of architects' scales, plotting or chain scales and off-sets, curves and angles, plain and rolling parallel rules, circular and semi-circular protractors, drawing pins, set of water colours, brushes, palettes, saucers, &c.; arranged in brass-bound polished mahogany, oak, or rosewood cabinets, best locks and keys with trays and drawers (fig. 1486) . . . . £15 15s.; £22; £25 and	30	0	0

DIVIDERS, COMPASSES, DRAWING PENS, SPRING BOW PENS, ETC.

		Each. £	s.	d.	Each. £	s.	d.
1487	**Dividers, Brass-jointed,** 5 and 6-inch . from per doz.				0	12	0
1488	**Dividers, Steel-jointed** . . . . each 1s. 6d.	0	2	6	0	3	0
1489	**Five and Six-inch best Brass Sector-joint Dividers** .	0	4	6	0	5	0
1490	Ditto ditto, German Silver . . . (fig. 1490)	0	5	0	0	6	0
1500	**Five and Six-inch Hair Dividers, Brass**	0	7	0	0	8	6
1501	Ditto ditto ditto, German Silver . (fig. 1501)	0	8	6	0	10	6
1502	**Pocket Dividers, with sheath**	0	7	6	0	10	0
1503	**Double-jointed Dividers, with Needle Points, German Silver**				1	18	0

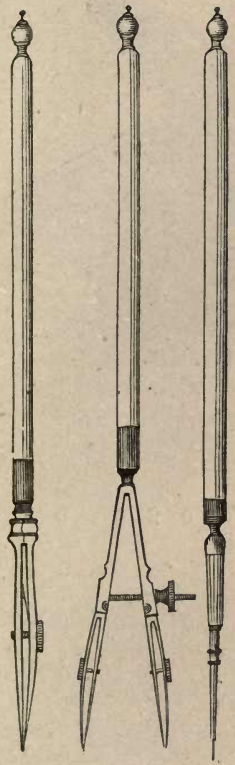


FIG. 1523.

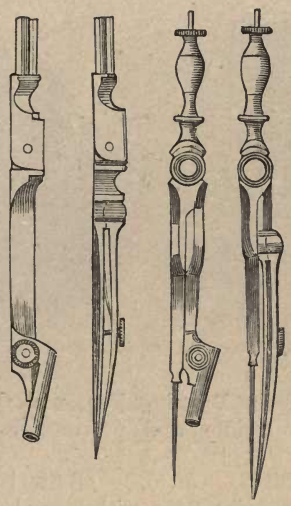


FIG. 1505. FIG. 1510.

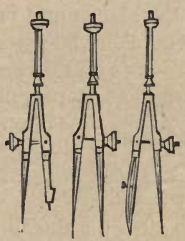


FIG. B. C. A.

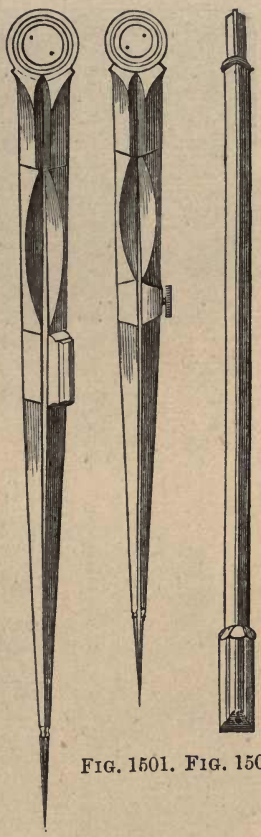


FIG. 1501. FIG. 1505.

FIG. 1490.

		£	s.	d.	£	s.	d.
1504	**Compasses or Dividers,** best brass, 6-inch, with pen and pencil joint, and lengthening bar . . .				0	15	0
1505	Ditto ditto German silver best, (figs. 1490 and 1505)				1	1	0
1506	**Pocket Turn-in Dividers,** brass				0	7	6
1507	Ditto ditto ditto, German silver	0	10	6	0	13	0
1508	**Spring Dividers,** all Steel, with Adjusting screw . .	0	7	6	0	10	6
1509	**Bow Pens, or Bow Pencils,** Brass				0	3	6
1510	Ditto ditto, best (fig. 1510) German silver . .				0	5	6
1511	Ditto ditto . . . . with **Extra Joints** .				0	10	6
1512	**Steel Spring Bow Pens** (fig. A.) with best Needle Points				0	6	6
1513	Ditto ditto **Pencils** (fig. B)				0	6	6
1514	Ditto ditto **Dividers** (fig. C)				0	6	6
1515	Ditto ditto best **Swiss** . . . . . each				0	10	6
1516	**Set of Spring Bow Dividers,** Pen and Pencil, in Pocket Case				0	16	0
1517	Ditto ditto, best, with **Needle Points** (fig. 1517) .				1	1	0
1518	**Double-pointed Bow Pen,** with Turn-over pen, pencil; and point, in case				0	18	0

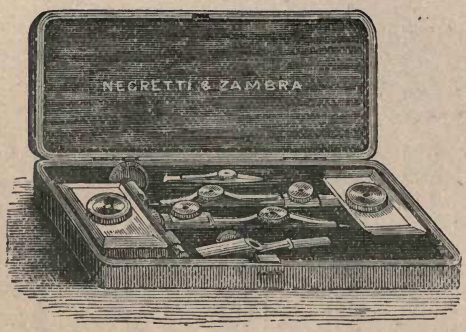


FIG. 1548.

FIG. 1517.

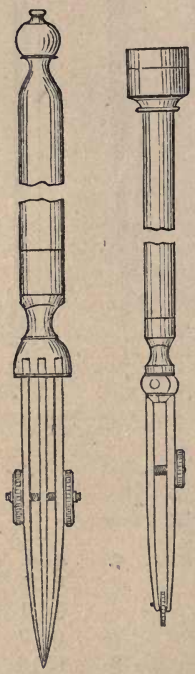


FIG. 1524. FIG. 1525.

		£	s.	d.	£	s.	d.
1519	**Plain Drawing Pen**, with brass handle and protracting pin from				0	2	6
1520	Ditto ditto, all Steel .				0	3	6
1521	**Drawing Pens**, with Ivory handle	0	2	6	0	3	0
1522	Ditto ditto, with lift Brass joints to the blades, and Ivory handle				0	4	6
1523	**Drawing Pens**, best German Silver lift joints and spring (fig. 1523)	0	5	6	0	6	6
1524	**Drawing or Bordering Pens**, for very thick lines (fig. 1524) .				0	10	6
1525	**Dotting Pen**, with Ivory handles and Wheels (fig. 1525) . .	0	10	6	0	16	0
1526	**Road Pen**				0	10	6
1527	Ditto ditto for Pencil . . .				0	10	6
1528	**Needle Holder**, or Pricking Point				0	3	0
1529	Ditto ditto, best improved (fig. 1529)				0	3	6
1530	**Map Meter or Opisometer**, for measuring Curved lines on plans or charts (fig. 1280) see page 305. 2s. 6d.	0	3	6	0	4	6
1531	**Triangular Compasses**, Brass .				1	1	0
1532	Ditto ditto, German silver, with shifting leg				1	10	0
1533	**Elliptical Compasses** or Trammel	2	10	0	4	4	0

FIG. 1545.

FIG. 1535.

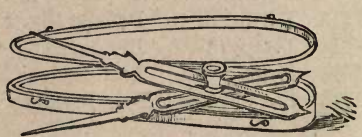


FIG. 1536.

1534	**Proportional Compasses**, common Brass . . .				0	12	6
1535	Ditto ditto, with Rackwork Adjustment (fig. 1535) .				1	10	0
1536	Ditto ditto, full divided, German Silver (fig. 1536)				1	12	6

FIG. 1538.

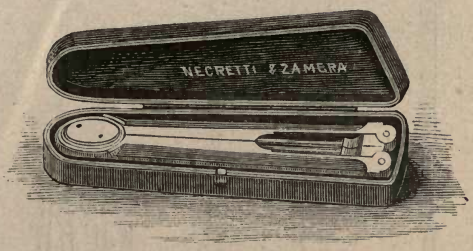


FIG. 1539.

		£	s.	d.	£	s.	d.
1537	**Proportional Compasses**, full divided, best make, Tangent Screw, Screw Adjustment, in hinged Leather Case				3	3	0
1538	**Pocket Divider**, with turn-in points (fig. 1538)	0	7	6	0	10	6
1539	**Napier's Pocket Compasses**, with Revolving pen and pencil points, in neat hinged case (fig. 1539)	1	1	0	1	5	0
1540	Ditto ditto Best Mounted				1	15	0

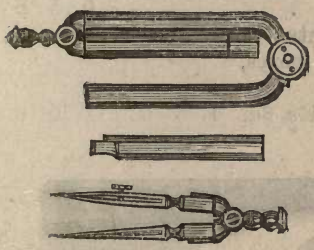


FIG. 1543.

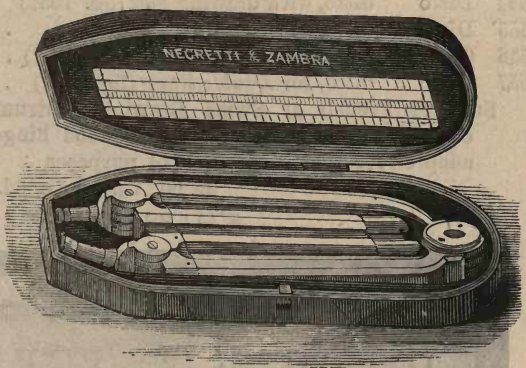


FIG. 1544.

1541	**Pillar Compasses**, in Brass	0	15	0	1	5	0
1542	Ditto ditto, German Silver, in case				1	5	0
1543	Ditto ditto, with Lengthening Bars, in case (fig. 1543)				2	0	0
1544	Ditto ditto . . with Ivory scale, in ditto (fig. 1544)				2	5	0

The Pillar Compasses form a most convenient pocket set of Drawing Instruments for travellers, comprising a large pair of dividers, with pen and pencil joint, also a bow pen and bow pencil. Nos. 1543 and 1544 have *lengthening bars*, by which *very large* circles and curves may be drawn either in ink or pencil.

1545	**Whole and Half Compasses** (fig 1545)				1	1	0
1546	**Tube Beam Compasses**				2	15	0
1547	**Beam Compass fittings**, plain, for any bar	1	5	0	1	10	0
1548	Best ditto ditto, with **Tangent Screw** and Pen and Pencil points (fig. 1548) in case				2	5	0
1549	**Tube Compasses**, with case and scale				2	2	0
1550	Ditto ditto . . . best Sector-jointed, in case				2	12	0
1551	**Callipers, Proportional**, 12-inch	2	2	0	2	12	6
1552	Ditto ditto . . 9-inch	1	16	0	2	2	0

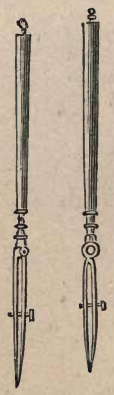
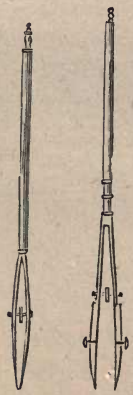


FIG. 1556.



FIGS. 1556* 1557

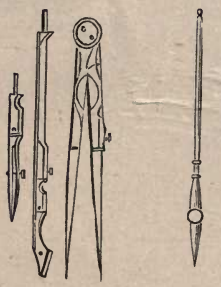


FIG. 1553*

FIG. 1554.

1553 **Small sets of Drawing Instruments,** *without boxes.*

		£	s.	d.	£	s.	d.
1553*	Compasses with pen and pencil joint and lengthening bar (fig. 1553*) . . . . . per set				0	2	6
1554	Ditto ditto, with drawing pen (fig. 1554) per set				0	3	6
1555	Ditto ditto, *Steel-jointed*				0	6	6
1556	Common Ruling pens (figs. 1556 and 1556*) . . each	0	1	6	0	2	6
1557	Ditto ditto, for *Double lines* (fig. 1557) . . .				0	5	6
	Sets of French or Swiss Drawing Instruments, in convenient flat mahogany or rosewood hinged boxes, adapted for Elementary School purposes 3s. 6d., 5s. 6d., 8s. 6d., 10s. 6d,	1	5	0	1	10	0

SCALES, RULES, &c.

FIG. 1558.

1558 **Parallel Rules, Ebony,** Plain Brass Bars:—(fig. 1558)

6-in.	9-in.	12-in.	15-in.	18-in.	24-in.
1s.	1s. 9d.	2s. 6d.	3s. 6d.	4s. 6d.	7s 6d.

1559 **Ditto ditto, Ebony, Brass Edged—**

6-in.	9-in.	12-in.	15-in.	18-in.	24-in.
5s.	6s. 6d.	9s.	12s.	14s. 6d.	18s. 6d.

FIG. 1560.

1560 **Parallel Rules, Rolling, Ebony, Plain:**—(fig. 1560)

6-in.	9-in.	12-in.	15-in.	18-in.
7s.	8s.	10s. 6d.	14s.	16s.

FIG. 1561.

		Each. £ s. d.	Each. £ s. d.
1561	Rolling Parallel Rules, best, with full divided Ivory or Metal Edges and Rollers :—(fig. 1561) 6-in. 9-in. 12-in. 15-in. 18-in. 13s. 16s. 6d. 21s. 25s. 30s.		
1562	Parallel Rules, Rolling Brass, best :— 6-in. 12-in. 18-in. 24-in. 12s. 6d. 25s. 38s. 50s.		
1563	Ditto ditto, German Silver :— 6-in. 12-in. 18-in. 24-in. 18s. 36s. 55s. 72s.		
1564	Mahogany Case for ditto :— 6-in. 12-in. 18-in. 24-in. 4s. 6d. 6s. 8s. 10s.		
1565	Architects' Scales, 12-inch Boxwood		0 3 6
1566	Ditto ditto 12-inch Boxwood, fully divided .		0 6 0
1567	Ivory Architects' Scales, 12-inch (fig. 1567) . . .		0 12 6
1568	Ditto ditto 6-inch		0 6 6
1569	Ivory Architects' Scales, 12-inch *best*, fully divided, from $\frac{1}{8}$ to 3 inches, containing 16 scales		0 16 6

FIG. 1567.

1570	Six-inch ditto ditto		0 10 6
1571	Chain or Plotting Scales, Best Ivory, 12-inch 80 to 100		0 15 0
1572	Off-sets for ditto . Best Ivory, 2-inch		0 3 6
1573	Chain or Plotting Scales, best Ivory, 12-inch, 10 to 60 chains to the inch		0 10 6
1574	Six-inch ditto ditto, best Ivory . . .		0 6 0
1575	Off-set Scales, Ivory, 10 to 60 . . . from		0 3 0
1576	Chain or Plotting Scales, best Boxwood, 12-inch, 10 to 60		0 3 0
1577	Ditto ditto, 12-inch Best Boxwood, ditto 80 to 100 .		0 5 0
1578	Ditto ditto, 6-inch Boxwood ditto		0 2 6
1579	Off-sets, Boxwood, 10 to 60		0 1 0
1580	Off-sets, Boxwood, 80 to 100		0 1 6
1581	Complete sets of best Ivory Plotting Scales and Off-sets, 12-inch, from 10 to 100 chains to the inch, in mahogany case, with lock and key . . .		6 6 0
1582	Complete sets of best Boxwood Plotting Scales, 12-inch with off-sets, 10 to 100 chains, in Mahogany box		2 2 0
1583	Set of Six ditto		1 10 0
1584	Six-inch Ivory Parallel Rules, German Silver Mounts .	0 5 0	0 6 0

		Each. £ s. d.	Each. £ s. d.
1585	Six-Inch Ivory Sector Scales	0 6 0	0 8 0
1586	Six-inch Ivory Protractors	0 5 0	0 6 0
1587	Ditto best full divided Ivory ditto		0 8 6
1588	Twelve-inch Ivory Protractors, full divided		1 6 0
1589	Red-line Protractor, best for Military Drawing		0 6 6
1590	Ditto ditto, Ivory best with scale of feet		0 10 0
1591	Six-inch Boxwood ditto Sectors		0 2 6
1592	Six-inch Boxwood Protractors	0 1 0	0 2 6
1593	Six-inch Ivory best Navigation Scales, full divided		0 10 6
1594	Six-inch Military best Ivory Scales		0 10 6
1595	One-foot Gunter's Scales, Boxwood		0 3 0
1596	Two-feet ditto ditto		0 5 0
1597	Two-feet Sliding Gunter's Scales, (Donn's)		0 10 6
1598	Marquois Scales, Boxwood, in case complete		0 10 6
1599	Ditto ditto, without case		0 8 6
1600	Ditto ditto Ivory		3 10 0
1601	Ditto ditto Metal		4 4 0
1602	Gunner's Rules		0 10 6
1603	Negretti and Zambra's 2-foot 4-fold Ivory Pocket Rule, combining the Protractor, Sector, and a 2-foot rule, best, full divided, in leather case		3 10 0

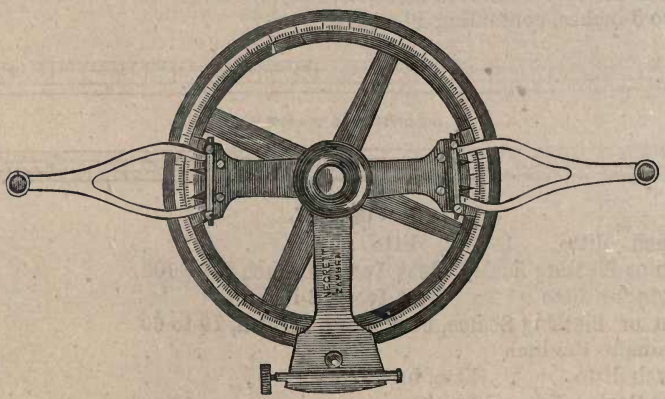


FIG. 1611.

		3-in. 6d.	3½-in 8d.	4-in. 10d.	5-in. 1s. 6d.	6-in. 2s.
1604	Protractors, in Horn, semi-circular, transparent, very convenient for roughly measuring angles on paper, &c.: Divided into degrees					
1605	Card Protractors, Ordnance Pattern					0 3 6
1606	Brass Protractors, plain Semi-Circular				0 7 6	0 10 6
1607	Brass Semi-Circular Protractors, plain divided to ½ degs. or 30 minutes				1 1 0	1 10 0
1608	Brass Semi-Circular Protractors, 6-inch, with Arm and Vernier, transparent centre (see fig. 1241, page 303), in Box					3 3 0

		Each. £ s. d.
1609	**Brass Circular Protractors,** plain— 6-in 8-in. 10-in. 25s. 32s. 42s.	12-in. 50s.
1610	**Circular Protractors,** Brass, 6-inch, (fig. 1610) with Tangent screw adjustment and clamp to Vernier, in mahogany box . . .	4 15 0
1611	Ditto ditto best 6-inch, divided on Silver, with Folding Arms (fig. 1611)	6 6 0
1612	Ditto ditto 7-in.	7 7 0
1613	Ditto ditto 8-in.	8 8 0

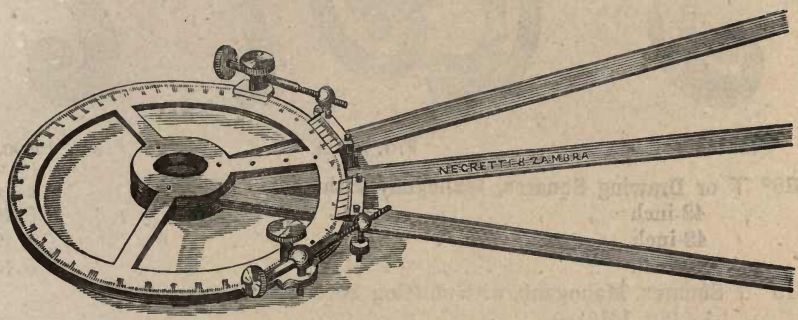
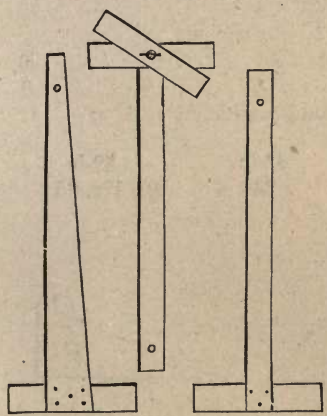


FIG. 1615.

1614	**Station Pointers for Hydrographical Surveys,** 6-inch plain, divided on Brass, with 12-inch arms . .	7 15 0
1615	Best ditto 6-inch, with Silver divided Circles and Verniers, Tangent Screw adjustments (as fig. 1615), with arms lengthening to 18 inches, in mahogany case	11 0 0
1616	7-inch ditto ditto, arms lengthening to 24 inches .	13 0 0
1617	8-inch ditto ditto . . . . to 30 inches .	15 15 0



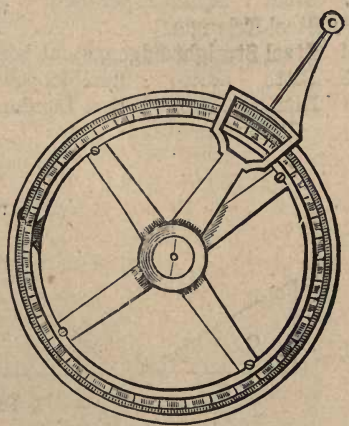


FIG. 1618*. FIG. 1619. FIG. 1618. FIG. 1610.

1618	**T or Drawing Squares, Mahogany,** with Ebony Edges :—	
	12-inch plain (fig. 1618) 3s. 6d., with bevel (fig. 1618*)	0 4
	18-inch „ . . 4s. „ . . .	0 5 0
	24-inch „ . . 6s. „ . . .	0 6 0
	36-inch „ . . 4s. „ . . .	0 7 6

FIG. 1630A. FIG. 1630B. FIG. 1630C.

		£	s.	d.
1618*	**T or Drawing Squares, Mahogany,** with Ebony Edges :—			
	42-inch „	0	10	6
	48-inch „	0	12	6
	54-inch „	0	15	0

1619 **T Squares, Mahogany,** with shifting bevel and clamp, best (fig. 1619) :—

18-in.	24-in.	36-in.	42-in.
5s. 6d.	7s. 6d.	10s.	12s.

1620 **T Squares, Ebony,** plain :—

18-in.	24-in.	36-in.
6s. 6d.	8s. 6d.	13s 6d.

1621 **T Squares, Ebony,** with shifting bevel and clamp :—

18-in.	24-in.	36-in.
8s. 6d.	10s. 6d.	15s. 6d.

1622	**Steel T Squares,** per inch	0	0	8
1623	**Steel Triangles,** . . . . . various			
1624	**Steel Straight-edges,** stout best, per foot . . .	0	4	6
1625	Ditto ditto flexible, per foot	0	3	0
1626	Ditto ditto best London make, 2 inches wide, in Pine Case :—			

42-in.	52-in.
24s.	£1 12s. 6d.

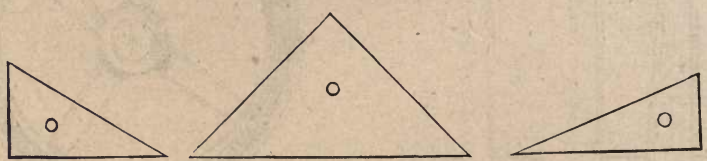


FIG. 1627.

1627	**Ivory, Ebony, or Boxwood Acute, Obtuse, and Right Angles, or Set Squares,** various (fig. 1627), from 1s.	0	2	6	0	7	6
1629	**Mathematical Curves or Scrolls,** Pear Tree Set of 12 .				0	12	6
1630	**Architectural Curves,** 30 different forms (figs. 1630 A B C) 1s.	0	2	0	0	3	
1631	**Set of Radii Curves** (fig. 1631)	1	1	0	5	0	0

		Cardboard	Peartree	Vulcanite
1632	**Railway Curves, in Cases:—**			
	Set of 25	£0 11 6	£1 0 0	£1 15 0
	Set of 50	1 3 0	1 15 0	3 10 0
	Set of 100	2 2 0	3 5 0	5 15 0
1633	**Ship Curves, in Cases:—(fig. 1633)**			
	Set of 15		0 12 6	1 10 0
	Set of 40		1 15 0	3 17 9
	Set of 80		3 10 0	7 10 0

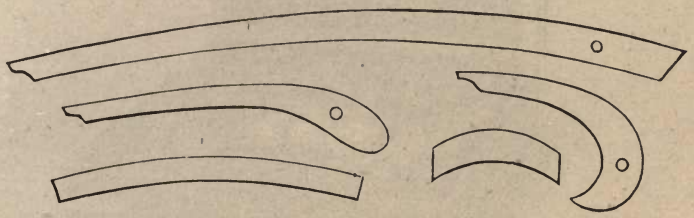


FIG. 1633. FIG. 1631.

1634 **Ebonite Scales, Rules, Set Squares, Curves, Slopes, and Batters for Railway Embankments, &c., at a slight advance on the price of Boxwood.**

1635 **Mitford's Double Set of Ivory Pocket Scales,** arranged for Engineers, Architects, &c. The length of each scale, six inches; the form of a single scale, a right-angled triangle, two making a square or set; the two sets are packed in a leather case, and the ends of each scale stamped with its value. The triangular form enables all the scales to be conveniently placed on the edges. The scales are seventeen in number fully divided, *viz.*, 2, 3, 4, 6, 8, and 10 chains to the inch; 66 feet and 6 inches to the mile; $\frac{1}{16}$, $\frac{1}{8}$, $\frac{1}{10}$, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$-inch, and French Metre; the Ordnance scale and a line of chords; a number of constants carefully worked out, are placed on the faces of each scale.

	Price for complete set, in case			£3 3 0
1636	**Horn Centre Pieces** per doz.			0 3 0
1637	**Drawing Pins,** Brass „ 1s.	0 1 6		0 2 0
1638	Ditto ditto, German Silver „ 1s. 6d.	0 2 0		0 2 6
1639	**Drawing Pencils,** all kinds and colours. To order.			
1640	**Small Pencils for Mathematical Instruments,** per doz.	0 2 0		0 2 6
1641	**Crayon Holders** from			0 1 0
1642	**Drawing Boards** 5s. 6d., 8s. 6d., 12s. 6d., 15s.			1 5 0
1643	**Black Board Compasses,** Wood and Metal	0 10 6		0 12 6
1644	**Tracing Paper** per sheet, 3d., 4d.	0 0 6		0 1 0
1645	**Ditto Cloth** per yard		variable.	
1646	**Pen Machines** for making or mending Quill Pens	0 12 6		0 15 0
1647	**Cutting Compasses of Steel,** with Screw adjustment and three knives, for cutting Circles of Cardboard to 4 inches diameter			1 4 0
1648	**Paper Weights** for holding drawings or papers flat on a table. Circular			0 2 0
1649	Ditto ditto, Oblong, leather covered			0 3 0
1650	**Brass Clamps** to fasten Straight-edge to drawing board			0 4 0
1651	**Erasing and Pen Knives** 1s. 6d.	0 6 0		0 7 6
1652	Lamps with Shades for Drawing Table or Board, either for Gas, Oil, or Paraffin	1 6 0		2 10 0

Engraving name on Case of Drawing Instruments with date, 2s. 6d. to 5s.; Crests or Monograms, 5s. to 10s. 6d.; Presentation Inscriptions varying according to the Length and Style of engraving, ornamentation, &c.

FIG. 1658.

PREPARED WATER COLOURS BY THE MOST APPROVED MAKERS.

		£	s.	d.	£	s.	d.
1653	**Mahogany Slide Lid Boxes,** Half Cakes . 5s. 6d.	0	7	6	0	10	6
1654	Ditto ditto Whole Cakes	0	10	6	0	15	0
1655	**Twelve-cake Water Colour Box,** mahogany, with lock and key				1	1	0
1656	**Twelve-cake** ditto ditto, with drawer containing saucers, brushes, pencils, &c.				1	5	0
1657	**Eighteen-Cake Water Colour Box,** caddy lid, mahogany, with drawer containing inkstone, palettes, cut water glass, extra brushes, pencils, &c.	1	10	0	2	2	0
1658	**Twenty-four and Thirty-Cake** ditto ditto, handsome Spanish mahogany, brass clamped, and with superior fittings, (fig. 1658)	4	4	0	5	5	0
1659	**Thirty-Cake Water Colour Box,** with a complete set of German Silver Drawing Instruments, Ivory Rules and Scales, Rosewood or Oak, German Silver bound, very handsome, Suitable for Presentation . . .				15	15	0

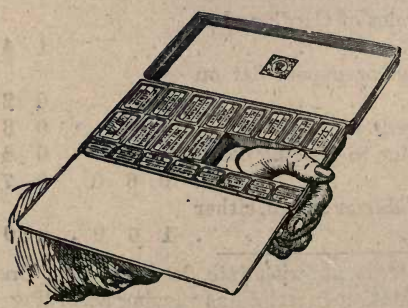


FIG. 1660.

1660 **Moist Water Colours in Japanned Tin Box,** with selected list of Improved Moist Colours for Photographic Portraiture, &c., Best Sable and Camel Hair Brushes. &c. (as fig. 1660)
£1 1s.; £1 10s.; £2 2s.

Any special Colours supplied to order.

1661 **Lock Mahogany Box,** with velvet Palette, Brushes, Stumps, Shells, &c.. with 24 Colours for colouring or Tinting Photographs, £2 2s.

GAUGING RULES AND INSTRUMENTS FOR DISTILLERS, MALTSTERS, OR WINE AND SPIRIT MERCHANTS, &c.

1662 **Gauging Instruments**, as used by the Board of Customs, a Complete Set, consisting of Long Calliper, Cross Calliper, Bung Rod, with brass slider, 4-feet, and Head Rod, with book of instructions for use, adapted for Spirit or Oil-gauging . . . . . Price, £4 4 0

1663 **Gauging Rods**, straight, with line of inches and tenths, diagonal line. Dips for every sized spirit and beer casks.

Lancewood.	4 ft.	5 ft.	6 ft.
	6s. 6d.	8s. 6d.	9s. 6d.

1664 **Dipping Wine and Spirit Rules**, with similar scales and divisions as above.

	s.	d.		s.	d.
3 feet, 4 fold . . .	6	6	5 feet, 8 fold . . .	12	0
3 „ 6 „ . . .	8	6	6 „ 6 „ . . .	12	0
4 „ 4 „ . . .	7	6	6 „ 8 „ . . .	14	0
4 „ 6 „ . . .	9	6	6 „ 12 „ . . .	22	0
5 „ 6 „ . . .	10	6			

1665 **Double Diagonal Rods**, Imperial and Old measure, with table of Outs of Casks.

1666 **Double Diagonal 5-feet Gauging Rod**, with table . . 0 8 6

1667 Ditto, ditto 4 ditto ditto . . 0 6 6

1668 **Spile Rods**, Boxwood, screw jointed. For gauging the dip of a cask through the spile hole.

6-feet Spile Rod, screw joints	0	14	6
5-feet ditto ditto	0	12	6
4-feet ditto ditto	0	10	6
3-feet ditto ditto	0	8	6

1669 **Spile Rod**, without joints 0 3 6

1670 **Proof or Temperature Slide Rules**, 6-inch, boxwood, for use with Sykes' hydrometer 0 4 6

1671 **Comparative or Reducing Slide Rule**, showing the number of gallons of water required to reduce spirits from a high to a low strength, &c., &c., as supplied with Sykes' Hydrometer, 6-inch, boxwood 0 9 6

1672 **Sliding Rule**, for correcting the indications of the Hydrometer, when the temperature of the spirit is either above or below 55 degrees of Fahrenheit. The rule is composed of two parts, the long scale being divided similar to the Hydrometer, ranging from 45 under to 70 over proof, the small moving scale representing temperatures from 30 to 80 degrees Fahrenheit. This Rule is used as follows. Having placed the Hydrometer in the spirit to be tested and noted, the reading on the scale—say, for example, 20 over proof: take the temperature—say it is 70. Now move the sliding scale until the star is directly opposite 20 O.P. on the long scale, and opposite the 70 of the temperature scales will be found 15 over proof, which is the strength of the spirit. Price, 4s. 6d.

1673 **Ullage Rules**, Plain, for use with dip rod or rules.

12-in.	18-in.	24-in.	36-in.
7s.	10s. 6d.	14s. 6d.	18s. 6d.

1674 **Gauging, Ullaging, Reducing and Valuing Rule**, with two slides . . . . . .

In conjunction with a dip rod, this rule will gauge the contents of any cask, and give the value of spirits.

9-in.	12-in.	18-in.	24-in.
10s. 6d.	12s. 6d.	14s. 6d.	18s. 6d.

		£ s. d.
1675	Book of Instructions for using Nos. 1134 and 1234 .	0 2 0
1676	**Float Rod or Bung Gauge**, plain mounted, 3 to 20 feet. 3 ft. 7s. 6d. 4 ft. 10s. 6d. 5 ft. 13s. 6d. 10 ft. 26s.	
1677	Ditto ditto, 100 inches, with improved Joints . .	2 5 0
1678	**Oil Rods**, round steel, divided into inches, tenths, and diagonals 3 feet, 25s.; 6 feet	1 10 0
1679	**Screw Sticks**, 9-inch joint. See Spile Rods, No. 1236.	
1680	**Malt Rods or Sticks**, round wood, divided into inches, tenths, and diagonals. 30-in. 5s. 6d. 36-in. 6s. 6d. 48-in. 7s. 6d. 60-in. 8s. 6d.	
1681	**Malt Rods or Sticks**, Round Brass, per foot, 6s. 6d.	
1682	Ditto ditto flat ditto 5s. 6d.	
1683	**Malt Receivers**, for sampling malt from a bin or sack, 4s. 6d., 7s. 6d., and 10s. 6d.	
1684	**Malt House Steel Cistern Rod**, strong Brass mountings, showing to 50 inches	0 15 6
1685	**Malt House Couch Rod**	0 7 6
1686	**Gauging Tape Measure**, or Malt Tapes. 400-in. 8s. 6d. 500-in. 10s. 6d. 600-in. 12s. 6d.	
1687	**Verie's or Veroe's Malt Gauging or Ullaging Rule, Two Slide** . . . . . 9-inch, 8s. 6d.; 12-inch, 10s.	

Ivory Gauging Rules made to order.

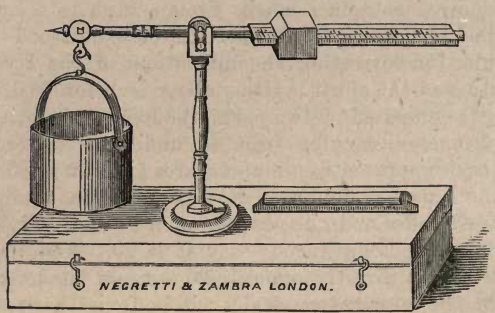


FIG. 1688.

1688	**Chrondrometer, or Corn Balance**, for ascertaining the differential value of Corn, Barley, Malt, Seeds, &c.; in mahogany box, with instructions for use, and Table of average weights of grain and seeds (fig. 1234) :—	
	$\frac{1}{8}$th of a pint	2 2 0
	$\frac{1}{4}$ „	2 12 6
	$\frac{1}{2}$ „	3 3 0

ENGINEERS' AND CARPENTERS' POCKET RULES, TIMBER AND ROPE GAUGES, &c.

1689	**Carpenters' Rules**, Boxwood, 2-feet, 2-fold	£0	2	6	£0	3	6
1690	Ditto ditto best Boxwood, 2-feet, 4-fold and joint	0	4	6	0	8	6
1691	**Pocket Rules**, Boxwood, 1-foot folding	0	2	0	0	4	6
1692	Ditto ditto Boxwood, 2-feet, best, full divided	0	10	6	0	12	6
1693	**Pocket Rules**, Ivory, 1-foot folding, German silver mounts	0	8	6	0	12	6
1694	Ditto ditto full divided	0	16	0	1	5	0
1695	Ditto ditto 2-feet folding. ditto ditto 16s.	1	5	0	1	10	0
1696	**Pocket Rules**, Ivory, four-fold, full divided, in case	2	2	0	2	10	0
1697	Ditto ditto, **French Metre**, divided to Decimetres, Centimetres, and Millimetres; on the reverse side the English yard—inches and 1-8ths, and on the edge French inches and lines, 4-fold, best Boxwood	0	16	0	1	1	0
1698	**Improved Engineers' Slide Rule**, in Boxwood, for calculating, squaring, &c., with Routledge's book of instructions 10s. 6d.	0	12	6	1	1	0
1699	Ditto ditto, in Ivory	2	2	0	2	10	0
1700	**Ivory Pocket Rule**, 12-inch four-fold, with English, French, Spanish, and Rhineland scales				0	12	6
1701	**Hull Callipers**, for Square timber measuring, 12-inch				1	10	0
1702	Bow ditto Round ditto 10-inch				0	18	6
	Larger sizes of these Callipers at about 1s. 6d. to 2s. per inch, according to size.						
1703	**Timber, Plank and Cubing Rules, Measuring Rods**, and Tapes marked with inches and quarter girt	various prices.					
1704	**Scribing Iron**	0	3	6	0	5	6
1705	**Rope Gauge**, Boxwood and Brass				0	8	6
1706	Ditto ditto German Silver and Ivory				0	15	6
1707	**Rule or Gauge for Measuring Horses**, to close up in the form of a walking stick				1	1	0
1708	**Cattle Gauge**, with Tape Measure, giving solid contents				0	8	6
1709	**Radii Curves** cut to order in Vulcanite, Brass, or German Silver, any radius up to 100 feet.						
	Templates of Rails made in Metal *to order*.						

MISCELLANEOUS INSTRUMENTS.

1710	**Cavalry Sketching Board**, fitted with rollers for continuous paper, 7 by 7½ inches				1	7	0
	Larger sizes supplied to order.						
1712	**Plane Table**, simple form, as used by the School of Military Engineering				8	8	0
1713	**Plane Table**, Mahogany, with Compass and Sighted Rule and Tripod Stand				10	10	0
1714	Ditto ditto Best Mounted, with Telescope				24	10	0
1715	**Standard 10-foot Rods**, Pine, inlaid with Brass				2	17	0
1716	**Steel Band Chain**, in Metal Frame mounting, 50 feet £1 14s., 100 feet				2	10	0
1717	**Standard Yard of German Silver**, in Pine Case, plainly divided				6	10	0
1718	Ditto ditto German Silver, fully divided English and Metric Scales, with Thermometer, in Mahogany Box	12	12	0 to 25	0	0

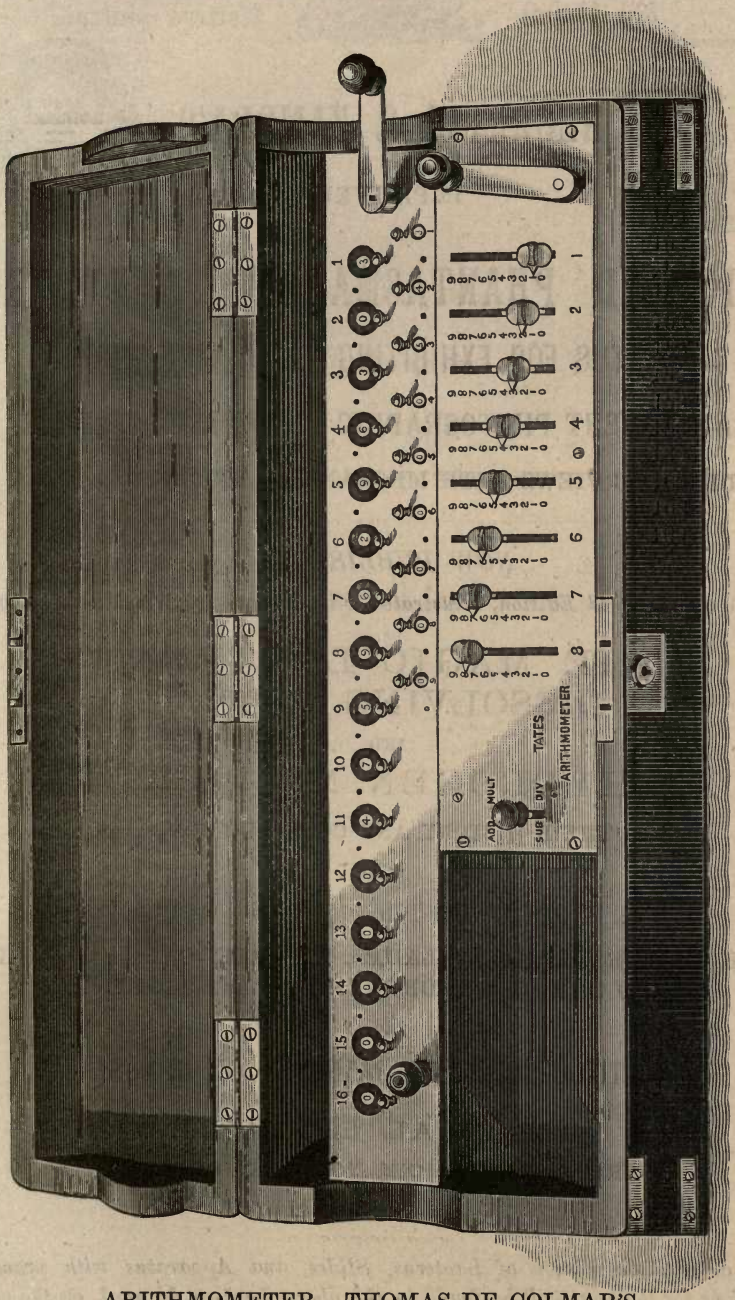
		£	s.	d.
1719	**Stadiometer**, as used in the Army	3	0	0
1720	**Spherometer**, to measure the diameter of bullets, &c., divided into 0·001 of an inch and millimetres . .	5	10	0
1721	**Wire Gauge of German Silver**, for measuring the diameter of Wires to ·001 of an inch	1	15	0
1722	Ditto ditto of larger size, to measure to ·01 of a millimetre or ·001 of an inch	1	15	0
1723	**Patent Wire Gauge (Milner's)**, to read outside and inside to ·002 of an inch, circular form	2	10	0
1724	Ditto ditto flat form	3	3	0
1725	**Off-set Rod**, shod with Point, 10-link	0	4	0
1726	Ditto ditto 10-link to part in centre with Point and Hook	0	9	6
1727	Ditto ditto 10 feet, jointed, to part in centre, ends plain ferrules	0	11	0
1728	**Pickets or Ranging Poles**, painted three colours, with Iron Strap Shoes, 6 feet . . . per dozen	1	15	0
1729	Ditto ditto 8 feet . . . . per dozen	2	2	0
1730	Ditto ditto 10 feet	3	10	0
1731	**Flags, White and Red**, fixed to Picket Poles or loose, per dozen 6s., 9s., 11s. 6d. and	0	16	6
1732	**Sounding Chain**, Stout Iron, welded inch links with heavy lead (in Stout Case) 50 feet £7 7s., 100 feet .	11	0	0
1733	**Sounding Lines for Coast Survey**, with weight, 50 feet,	1	1	0
1734	Ditto ditto 100 feet	1	10	0
1735	**Negretti and Zambra's Improved Portable Heliographs**, for Military Signalling, Surveying, &c. 3 inch, per pair 10 10 0 — 8 inch, per pair 17 17 0; 5 „ „ 14 14 0 — 10 „ „ 25 0 0			
1736	**Lanterns on Stands** for Night Signalling, with key and shutter . . . . . each	5	5	0
1737	**Heliostat Spencers**, local, with one Mirror . . .	9	9	0
1738	Torpedo and Gun Directors as specially constructed by Negretti and Zambra for the Admiralty and her Majesty's Navy. Supplied to order.			

ARITHMOMETER OR CALCULATING MACHINE. Fig. 1738.

In the present age, when so many calculations are required, it is a matter of surprise that mechanical aids to abridge the mental labour involved are not more used. The efforts made by inventors and manufacturers to perfect machines, and the numbers that have been made, proves that many are alive to the facilities they afford; but it is undeniable that calculating machines, and foremost among them the Arithmometer, are not so generally employed as their utility warrants. When it is considered that by means of the Arithmometer long operations in the fundamental Rules of Arithmetic can be performed with rapidity, unfailing accuracy, and without appreciable mental effort, it should be in general use by Accountants, Astronomers, Bankers, Electricians, Engineers, Surveyors, Merchants and others. Members of the Actuarial profession early discovered the benefits to be derived from the use of the Arithmometer, and they have constructed sets of Tables, and made other calculations on it for some years past.

As an instance of the rapidity with which results may be obtained, it may be mentioned that, with the improvements lately introduced, eight figures can be multiplied by eight figures in about fifteen seconds, and larger operations in proportion.

NEGRETTI & ZAMBRA'S IMPROVED ARITHMOMETER.



Price of the Machine giving 16 Figures in Product, 50 guineas. (Fig. 1738)

ARITHMOMETER. THOMAS DE COLMAR'S.

Giving the product of 12 figures, Complete for use with Quotient Effacer £17 17 0

Ditto ditto, 16 figures 24 0 0 Ditto Ditto, 20 figures . 38 0 0

Instructions for use sent with the Instrument.

By Royal Letters Patent.

NEGRETTI & ZAMBRA'S

IMPROVED

MAGIC AND PHANTASMAGORIA LANTERNS,

APPARATUS FOR EXHIBITING DISSOLVING VIEWS,

TRANSPARENT PHOTOGRAPHIC VIEWS AND STATUES,

DIORAMIC VIEWS WITH MECHANICAL EFFECTS, &c., &c.

NOW PUBLISHED,

A New and Revised Edition, Illustrated with Seventy-five Wood Engravings.

THE MAGIC LANTERN, DISSOLVING VIEWS,

AND

OXY-HYDROGEN MICROSCOPE,

THEIR HISTORY AND CONSTRUCTION,

ALSO

DIRECTIONS FOR USE,

WITH OIL OR PARAFFIN LAMPS, THE OXY-CALCIUM LIGHT AND THE OXY-HYDROGEN OR LIME LIGHT.

ALSO

INSTRUCTIONS FOR PAINTING ON GLASS.

SPECTRAL EFFECTS

DESCRIBED, AND HOW TO PRODUCE THEM.

Price (Post Free) One Shilling.

A detailed description of Lanterns, Slides, and Apparatus with practical instructions for their use will be found in the above Lantern Manual, on the pages indicated at the top of each section of the List.

Special List of Negretti & Zambra's *Photographic Views for the Lantern* supplied upon application.

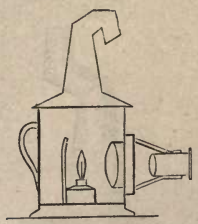


FIG. 1739.

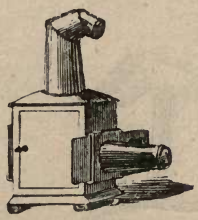


FIG. 1740*.

MAGIC LANTERNS FOR EXHIBITING COMIC AND AMUSING SUBJECTS.

(Page 7.)

1739 **Magic Lantern and one dozen Comic Sliders,** in a box with about fifty figures— (fig. 1739)

No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
7s. 6d.	10s. 6d.	23s.	30s.	42s.

1740 Extra Slides for above: 4s. 6d. 5s. 6d. 12s. 6d. 16s. 21s.

1740* **Magic Lantern No. 6,** in a box, with Solar Argand Lamp, one dozen Comic sliders (fig. 1740*) . . £ 3 s. 3 d. 0

1741 **Astronomical Slides** for above Lanterns :—

No. 1.	No. 2.	No. 3.	No. 4.	Nos. 5 & 6.
11s.	13s.	30s.	40s.	50s.

1742 Views suited to Nos. 4, 5, and 6 . . . 2s. 6d. 0 3 0 — 0 4 6

1743 Comic Slip Slides for Nos. 4, 5, and 6 . . . each 0 1 6 — 0 2 0

1744 **Estimate A.**—No. 6 Magic Lantern, with a selection of Sliders sufficient for an entertainment, including a box of 12 Humorous slides, about 50 figures : 6 moving Comic slides, a Fairy tale 6 slides, 1 Chromatrope, and one of Negretti and Zambra's Photographic Statues 5 5 0

1745 **Estimate B.**—A similar set to the above, but with 6 additional Coloured Views, 1 Lever Slide, and 2 Negretti and Zambra's Photographic Statues . . 6 16 0

PHANTASMAGORIA LANTERNS.—(pp. 12 to 22.)

FOR BURNING SPERM OR COLZA OIL.

1746 **Phantasmagoria Lantern,** same size as No. 6, with a Microscope to attach to front, and six Microscopic Objects, Water Trough, &c., in case 5 5 0

1747 **Superior Phantasmagoria Lantern,** with two Condensing Lenses 3-inch diameter, mounted in Brass Cells, Sliding tubes for adjusting the focus, **Fountain Argand Lamp** and Reflector, &c., complete; will give a disc of 8 feet diameter 2 12 6

1748 Ditto ditto with Rackwork Adjustment . . 3 0 0

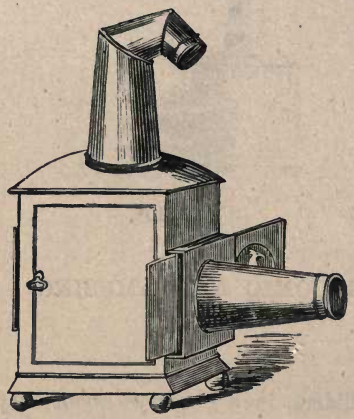


FIG. 1750.

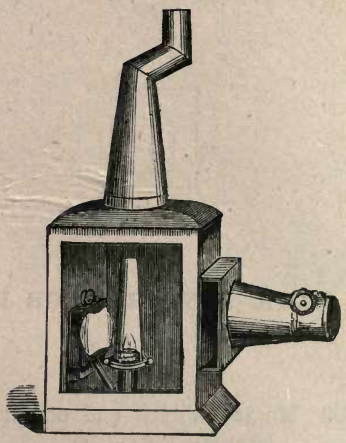


FIG. 1751

		Each. £ s. d.	Each. £ s. d.
1749	**Very Superior large-sized Phantasmagoria Lantern**, with 3½-inch condensing lenses, sliding tube for adjusting the focus, improved **Fountain Argand Lamp**, with Reflector complete, of the very best construction; to show a 3-inch painting on a disc of 10 feet diameter (fig. 1750)		3 3 0
1750	Ditto ditto with **Rackwork** adjustment		3 12 6
1751	Ditto ditto, 4-inch, with ditto ditto (fig. 1751)		4 4 0

These Lanterns are so much improved, and used with such facility, that they may be recommended with the greatest confidence, giving a perfectly defined figure, with a well illuminated fiel o view, from 6 to 10 feet in diameter. Combined with **Negretti and Zambra's Coloured Photographic Slides**, they present a delightful mode of instruction with amusement. To Schools, Mechanics' Institutes, &c., they offer peculiar advantages, and are extensively used by the conductors of these institutions for illustrating almost every branch of scientific information.

1751* **Estimate for Sets of Lantern Sliders.**—a box of 12 best Comic sliders, 12 movable Comic slip slides, 2 sets of Fairy stories, 2 best Chromatropes, 2 lever sliders, 6 Coloured views, and 3 Negretti and Zambra's Photographic Statues.

With Phantasmagoria Lantern as—

No. 1749		11 11 0
No. 1750 ditto ditto		12 12 0
No. 1751 ditto ditto		14 14 0

1752 **A Microscope** adapted to the above Lanterns, at £2 2 0 additional, will show small objects brilliantly enlarged on a disc 4 feet in diameter.

1753 **Balsam-Mounted Microscopic Objects**, suited for above, 2s. to 2s. 6d. each.

1754 An Improved form of Paraffin Lamp can be supplied with the Lanterns Nos. 1749 to 1751, in place of Oil Lamps, as described on future pages.

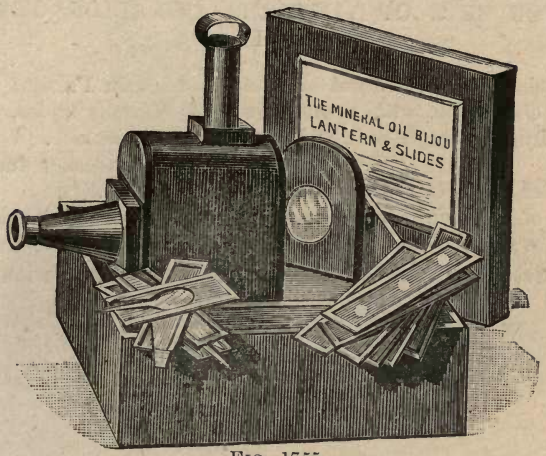


FIG. 1755

1755 **The Bijou Magic Lantern and Slides.** Improved Shape Mineral Oil Lantern, fitted with Brass Paraffin Lamp, with Reflector and Lamp Glass, 12 Slides comprising 4 Comic, 4 Nursery Tales, and 4 Mechanical Slides, in all 36 Subjects, complete in Box,

No. 1.	2.	3.	4.	5.
12s. 6d.	18s.	26s.	32s. 6d.	37s. 6d.

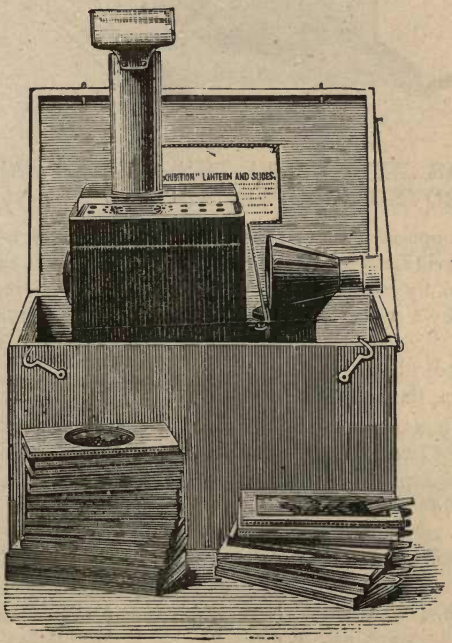


FIG. 1756.

1756 Ditto ditto larger sized Lantern, with 24 superior Slides, 72 Subjects, complete in Box,(fig. 1756)

No. 1.	2.	3.	4.	5.
15s	20s.	30s.	36s	45s.

ESTIMATE FOR SETS OF LANTERNS AND SLIDES FOR PARAFFIN LIGHT.

1757

No. 1. Comprising Improved form of Lantern to burn Paraffin or Mineral Oil, 3-inch Condenser, with a selection of 24 Various Slides, consisting of a Fairy Tale, Moving Comic Slides and Views, in Box . . . £4 4 0

No. 2. Ditto ditto ditto with 3½-inch Condenser and a selection of 36 Slides, and 1 Chromatrope in a Box 5 10 0

No. 3. A Pair of Improved Lanterns as above, with Paraffin Lamps and a selection of Slides as No. 2, and 4 Sets of Dioramic Views, in a Box . . 12 12 0

This Set forms a very Complete Entertainment for Parlour Use.

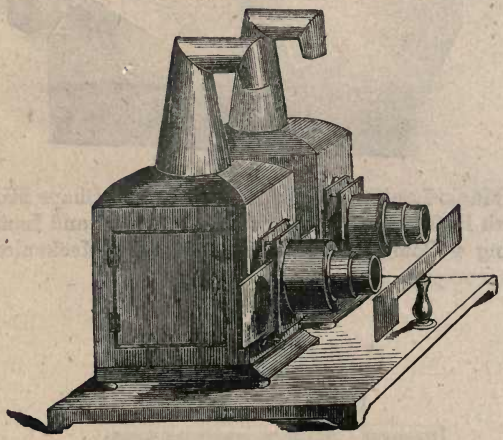


FIG. 1758.

APPARATUS FOR EXHIBITING THE DISSOLVING VIEWS, WITH IMPROVED FOUNTAIN ARGAND OIL LAMPS.

The enchanting optical effect termed Dissolving Views is produced by means of two Phantasmagoria Lanterns, so arranged on a stand that the centre of the discs or pictures projected by each are coincident, and the dissolving or blending of the pictures is effected by a contrivance in front of the two Lanterns, which gradually shuts off the image thrown from one Lantern, whilst the other becomse gradually clearer, until a perfect picture is seen on the disc; a fresh picture being put into the darkened lantern, the action is reversed.

		£ s. d.	£ s. d.
1758	**Dissolving View Apparatus,** adapted for parlour use, consisting of two of Negretti and Zambra's Superior Lanterns of Japanned Metal with Rackwork adjustment to the front Lenses, mounted, with Dissolving Apparatus. Fig. 1758, or mounted as fig. 1765, page 358. In this arrangement the views are exhibited with clearness and brilliancy on the screen, from 6-feet to 10-feet diameter, by improved Fountain Argand Oil lamps and Reflectors. It is simple in use, and well adapted for private exhibition . .	8 8 0	10 10 0

Messrs. Negretti and Zambra can confidently recommend the Apparatus at £10 10s. as being of the most improved construction, and particularly adapted for the purpose of instruction or amusement, where the expense or trouble of the Oxy-Calcium or Oxy-Hydrogen Light cannot be undertaken. If desired, *Paraffin* lamps can be supplied to these Lanterns, as mentioned on the previous page, in place of Oil Lamps.

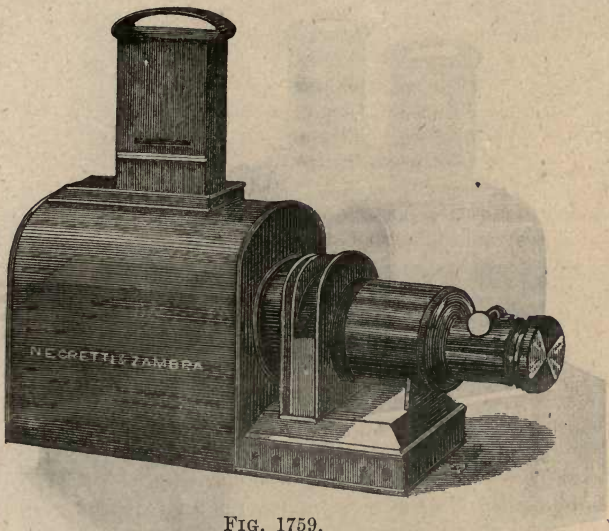


FIG. 1759.

1759 **Improved form of Three-Wick Russian Iron Paraffin Lantern,** with 4-inch Condensers, Achromatic front Lens, with Rack work adjustment, in Box (fig. 1759) £4 10 0

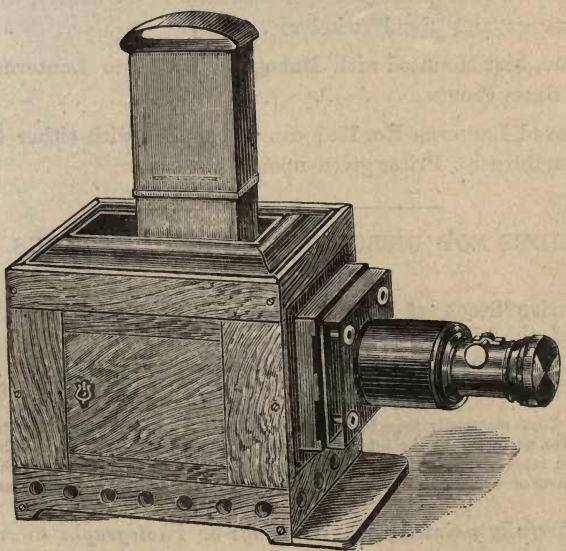


FIG. 1760.

1760 Ditto ditto fitted with Polished Mahogany Body, 4-inch Condensers, Achromatic front Lens, &c., &c., (fig. 1760) . . . 5 10 0

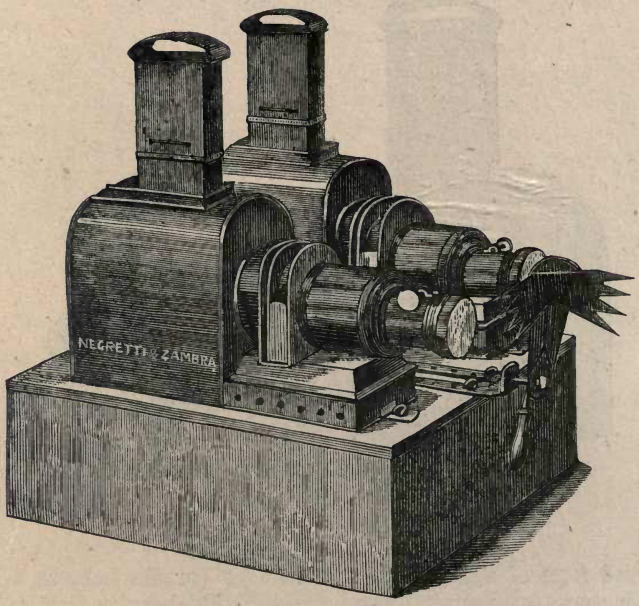


FIG. 1761.

1761 **Dissolving View Apparatus**, consisting of two Improved **Three Wick Paraffin Lanterns**, with 4-in. Condensers, Achromatic Front Lenses, with Rackwork Adjustments, and Dissolver in box £12 12 0

1762 Ditto Ditto, best Mounted with Mahogany Bodies to Lanterns and all Brass Fronts £16 16 0

These Improved Lanterns No. 1761 can be supplied with either Oxy-Calcium or Oxy-Hydrogen Burners. Prices given upon application.

SLIDES FOR DISSOLVING VIEW APPARATUS.

(Page 61.)

1763 **An Extensive Stock of Hand Painted Views** of all parts of the World, 3¼-inch Circles, adapted for either the Single Lantern, or Dissolving View Apparatus 8s. 0 10 6 1 5 0

These paintings differ materially from the common lantern slides, requiring first-rate artistic talent to make them effective, as, owing to the intensity of the light, the slightest defect is developed. They therefore require the most scrupulous care with regard to the minutest details. Subjects may be painted to suit the taste or view of the purchaser, varying in price according to the subject and size of the painting.

Slides carefully painted from Drawings or Photographs to order.
Engravings, Drawings, Maps, &c., copied by Photography for the Magic Lantern, &c.

DIORAMIC AND MECHANICAL EFFECTS.

See pages 365 to 368.

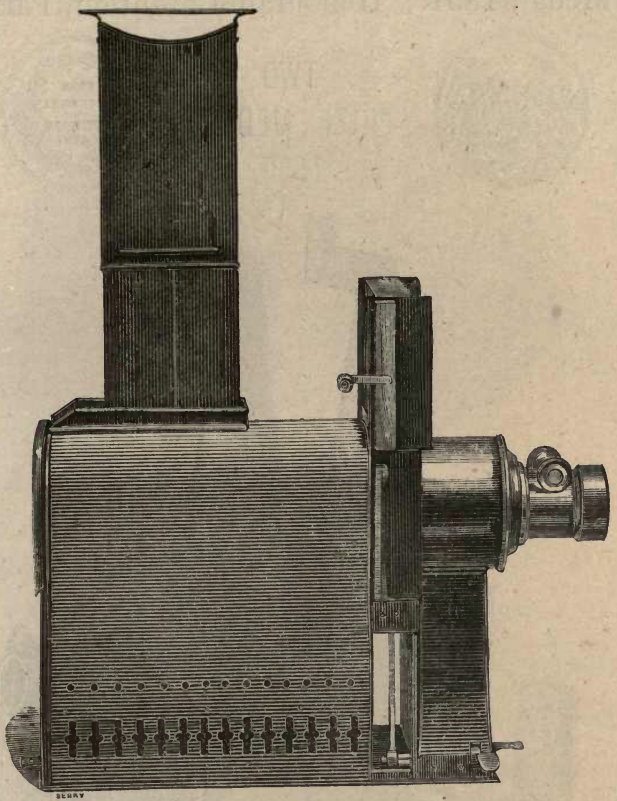


FIG. 1764.

PATENT IMPROVED LANTERN.

1764 The great advantage of this Lantern is, that by means of its *double changing holder, working vertically,* any framed slides (such as Rackwork, Lever Action, Changing Comic, &c,) can be shown one after another without any interval, thus doing away with the unsightly white disc of light seen on the screen while changing the slides in the ordinary single Lantern.

With the Patent Lantern any Mechanical Slide can be introduced into a Lecture set of Photographic Slides used with a carrier frame, without taking out the carrier, by simply placing the Mechanical Slide in the bottom stage and raising it when required into position, and then lowering the stages again to their former position; without having, during the change, shown any white light on the Screen, which is impossible to do with an ordinary single Lantern.

The Changing Holder is raised and lowered by a *Lever* which enables the operator to either raise it slowly, so as to make the Slides exhibited appear like a Panorama, or to raise it so quickly that the change from one slide to another is almost imperceptible.

The Patent Lantern is fitted with a 4-inch Condenser and Achromatic Combination Front Lens, *with large size lenses to the back combination* (thus giving greater light) and *double pinions* to the rack adjustment. It has a 4-wick Paraffin lamp, *with wicks 2 inches wide* (arranged to form 2 wedges, thus W, this preventing the flicker of the wicks, seen on the Screen, when they are placed parallel to one another), and a tall jointed Chimney, complete in Box. (fig. 1764) Price £8 8 0

Prize Medal, 1851. Honourable Mention, Paris, 1855.

TWO
PRIZE MEDALS.
1862.

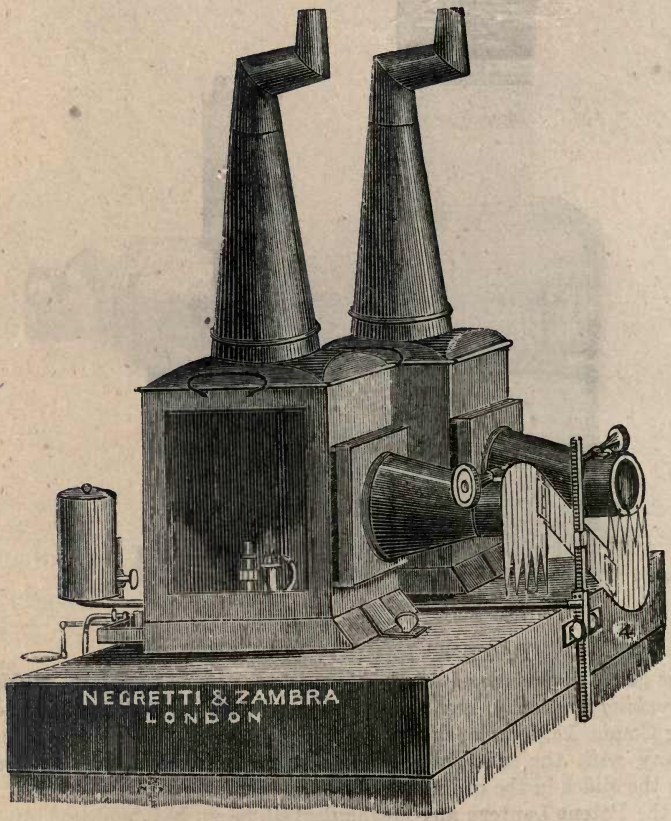


FIG. 1768.

THE OXY-CALCIUM LIGHT.

Messrs. Negretti and Zambra would call especial attention to the **Oxy-Calcium Light**, which, at a trifling advance on the expense of the best Argand Oil lamps, gives a light very nearly equal to the Oxy-hydrogen Light. It is perfectly safe, easily managed, and occupies small space; very cleanly in use, all grease and smoke being avoided. With the Oxy-Calcium Light a brilliantly illuminated disc may be obtained 14 to 16 feet diameter.

		£	s.	d.
1765	**A best Phantasmagoria Lantern**, with 3¼-in. Condensing Lenses, with Rackwork Adjustment to front Lenses, fitted with the			
1766	**Oxy-Calcium Light.** Apparatus for making the Oxygen gas, Gas Bag, and Pressure Board, Conducting tube, &c., complete; in box	9	9	0
	A ditto ditto with four 4-inch Condensing Lenses, &c., complete; in box	11	11	0

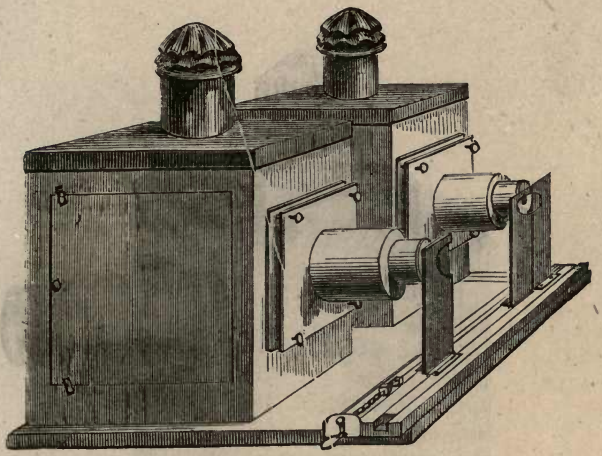


FIG. 1770.

1767 **Oxy-Calcium Light Dissolving View Apparatus**, fitted with condensing lenses, 3½-inch diameter, complete with apparatus . . . £14 14s.

1768 Ditto ditto with Rackwork Adjustments (fig. 1768) . . £15 15s.

1769 **Dissolving View Apparatus**, fitted with **Oxy-Calcium Light**, condensing lenses, 4-inch diameter, Rackwork Adjustments, complete with apparatus, £17 17s.

Argand Oil Lamps are supplied with the above marked thus * for use when the Oxy-Calcium Light is not convenient.

The Lanterns Nos. 1765 and 1767, and Dissolving View sets 1758 to 1761, can be fitted with the Oxy-Calcium *Gas* jets (as shown fig. 1776), in place of the Spirit Burners at the same cost.

The light obtained by this arrangement is almost equal to the Oxy-Hydrogen, and is **Quite Safe.** Wherever Coal Gas is laid on to the house or building we should advise the use of this jet, being far superior to the Oxy-Calcium; but where pictures of more than 20 feet diameter are desired, the Oxy-Hydrogen Light must be used.

THE OXY-HYDROGEN LIGHT.

1770 **Dissolving View Apparatus**, illuminated by the **Oxy-Hydrogen Lime Light**, giving a brilliant and distinct picture on the disc 30 feet diameter. Consists of two Mahogany Lanterns with best condensing lenses, 4½-inch diameter, Brass fronts and slide holders, mounted on a stand; dissolving apparatus, improved Oxy-Hydrogen Jets and Limeholders; flexible connecting Tubes, with stopcocks; gas-bags with Pressure Boards; Hydrogen Generator and Purifier; Oxygen Retort and Conducting Tubes, &c, complete with **Clock Work Motions** (best manufacture), adapted to the limeholders, for keeping the lime cylinders slowly revolving and exposing a fresh surface to the action of the gases. **The best form of Apparatus for Exhibiting the Photographic Views** (fig. 1770) . . . £47 0 0

This Apparatus is supplied either as shown in fig. 1770 or fig. 1765 as may be desired.

Dissolving View Apparatus, fig. 1768, if mounted with **Mahogany Lanterns**, as fig. 1770, will be 42s. the pair extra.

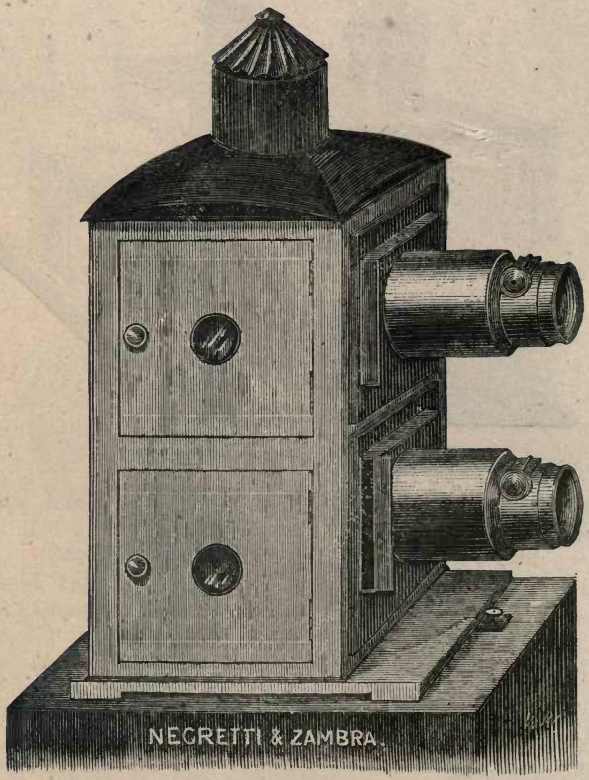


FIG. 1771.

NEGRETTI AND ZAMBRA'S IMPROVED BI-UNIAL OXY-HYDROGEN LIME LIGHT DISSOLVING VIEW APPARATUS.

1771 **Mahogany Lantern Lined with Tin** (as fig. 1771), having 3½ inch Condensing Lenses, Brass Mounts to Front Lenses with Rackwork Adjustments, Japanned Tin Sliding Front to vary distance between Lantern and Screen. Complete with Apparatus for making and purifying the Gas. Full size Gas Bags and Pressure Boards. Flexible conducting Tubes and Connectors, &c., &c. To give a brilliant Disc of 12 to 16 feet in diameter from Paintings 3¼ inch diameter £27 0 0

1772 Ditto ditto as above, but with 4-inch Condensing Lenses for producing a Disc of 16 to 20 feet diameter £31 10 0

Handsome Brass Fronts to either of the above Sets with Extra Lenses and mountings for projecting a smaller picture at great distance.
each extra £3 0 0

The arrangement of Lanterns (as fig. 1771) can only be effectively used with the Oxy-Hydrogen Lime Light, the vapour or smoke given off in the lower Lantern injuriously affecting the Light in the upper one.

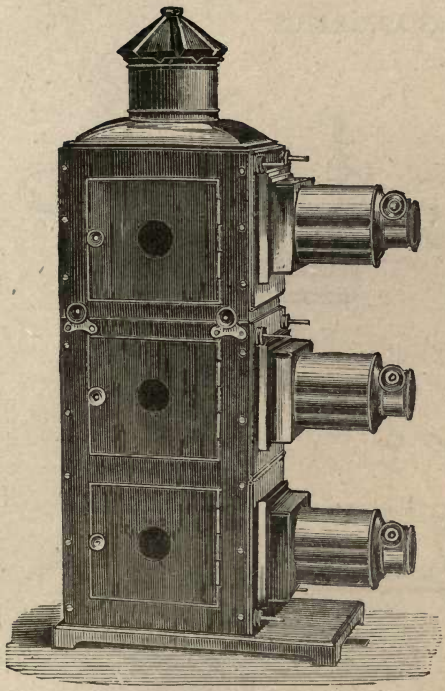


FIG. 1772.

1772 **Negretti and Zambra's Improved Tri-Unial Lantern** (fig 1772) for exhibiting Dissolving Views and Effects by the Oxy-Hydrogen Lime-Light. Best 4-inch Condensors. Polished Mahogany Lanterns, with Brass Fronts, Rackwork and Sliding Tubes for adjusting the Front Lenses for varying distances from the screen. A set of 3 Achromatic Lenses being supplied giving pictures at a range of from 20 to 120 feet.

Price for the set in its most complete form, including Gas generating and Purifying Apparatus, 2 stout Gas Bags, &c., &c. (fig. 1772)

Price £46 10 0

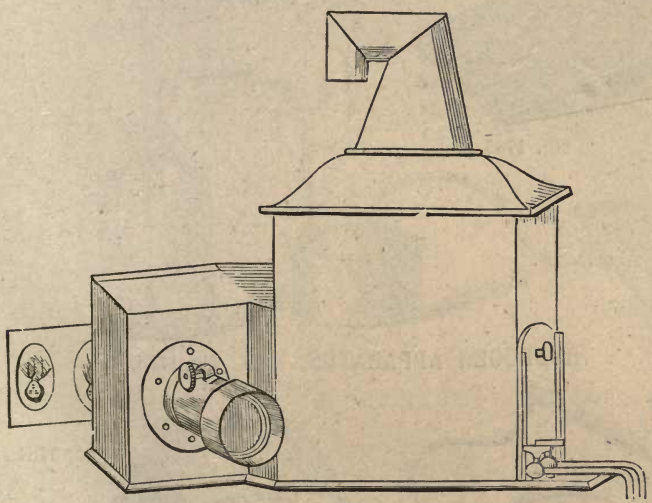


FIG. 1773.

FIG. 1774.

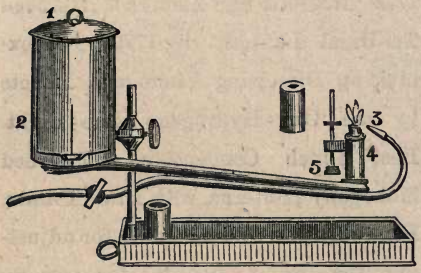
1773 **Improved Apparatus** for exhibiting **OPAQUE OBJECTS,** magnified by the Oxy-Hydrogen Light, upon a Screen in their natural colours (fig. 1773), Complete £26 5 0

1774 **The Aphengescope,** a small modified arrangement of the above Apparatus, adapted for use with a pair of Dissolving View Lanterns . £2 2 0

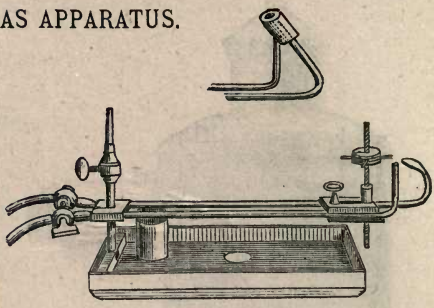
Ditto ditto for a Single Lantern (fig. 1774) . . . 0 18 6

These effects can only be well exhibited by the Oxy-Hydogen or Oxy-Calcium Lights.

OXY-HYDROGEN AND OXY-CALCIUM GAS APPARATUS.



No. 1775.



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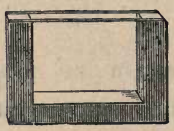

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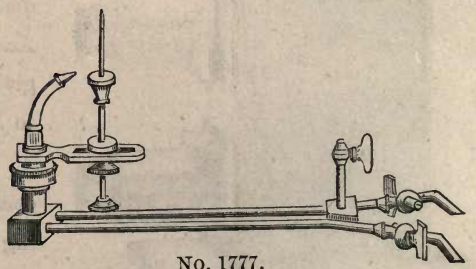
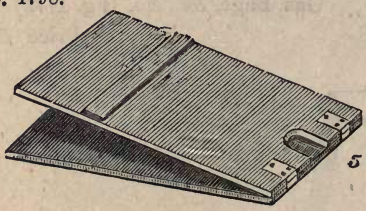
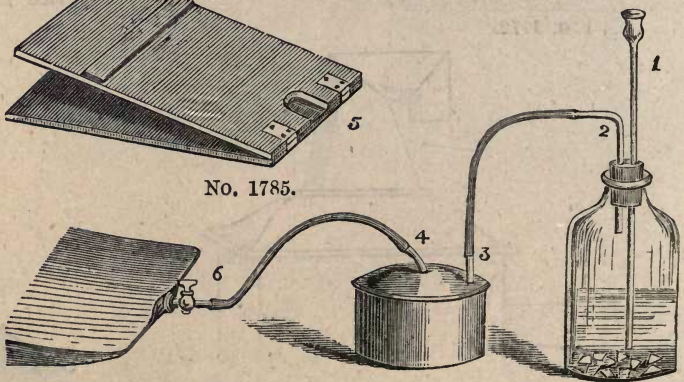


No. 1777.



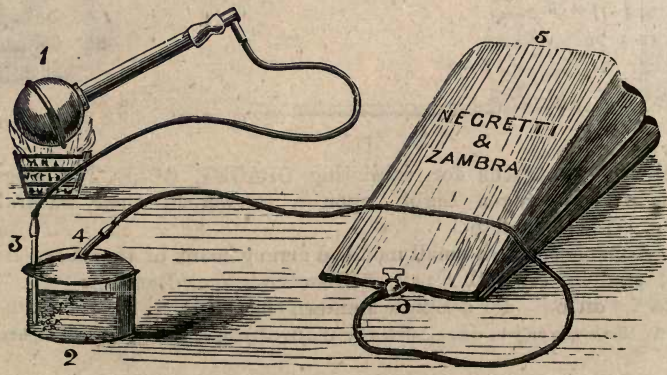
No. 1785.



HYDROGEN APPARATUS.

No. 1780.

No. 1779.



No. 1784.

No. 1782.

OXYGEN APPARATUS.

(Pages of Lantern Manual, 19 to 93.)

		Each. £ s. d.	Each. £ s. d.
1775	**Oxy-Calcium Spirit Lamp'** . . . (page 24)		0 15 6
1776	**Oxy-Calcium safety Gas or Blow-through Jet** („ 31)		1 5 6
1777	**Oxy-Hydrogen Burner** with Platinum Jets . („ 32)		2 0 0
1778	**Oxygen Retort**. . . . . , . („ 24)		0 15 0
1779	Ditto ditto **Stout Copper**, with Cap and Flexible Tube		1 1 0
1780	**Hydrogen Generator**, Stout Lead (page of Book 34) .		0 13 6
1781	**Zinc Purifier** . . . . Do. do. . .		0 7 6
1782	**Copper** ditto, Stout		0 12 6
1783	***Gas Bags** for Oxy-Calcium Light . . (page 42)		2 15 0
1784	*Ditto ditto Large and Stout, for Oxy-Hydrogen Light (fig. 1784) . . . . . (page 42)		3 10 0
1785	**Pressure Board** (fig. 1785) . . . . (page 29)	1 5 0	1 15 0
1786	**Flexible Tube** ¼-in. inside (page 38) . . per foot		0 0 8
1787	**Darker's Safety Valves** for Oxy-Hydrogen Light, each		0 5 0
1788	Cog Wheel Lime Adjuster (registered) to Nos.	4s. each extra.	
1789	**Mahogany Slide Holders** for Photographic Lantern Views . . . . . per doz.		0 6 0
1790	**Improved Oxydating Lamp Glasses** . . per doz.		0 9 0
1791	**Opaque Screens of Oil Cloth**, from 3 to 9 yards square,	made to order.	
1792	**Transparent Screens of all sizes**, (page 63). 8-ft. square, 21s , 10-ft. square, 25s., 12-ft. square, 35s., 20-ft. feet square, 105s.		

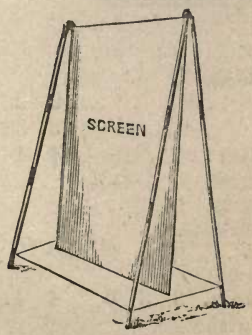


FIG. 1793.

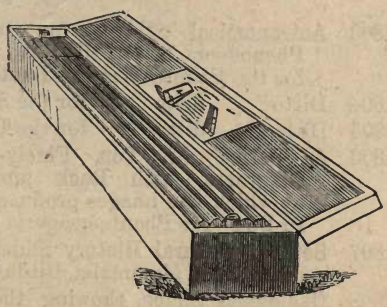


FIG. 1793.*

1793	**Portable Frames for Screens**, in Box (figs. 1793 and 1793*) . . . . . 42s.	2	10	0	4	4	0
1794	**Oxygen Gas Mixture**, variable . . . per lb.				0	1	6
1795	**Best Lime Cylinders** for Oxy-Calcium Light per bot.	0	3	6			
1796	Ditto ditto for Oxy-Hydrogen Light . . .	0	5	0			
1797	**Magnesium Wire** . . . . . per foot				0	0	3
1798	**Glass Water Trough**	0	2	6	0	5	0

All the Accessories and Scientific Apparatus for use with the Lantern as described and figured in the Lantern Manual, supplied to order.

OXY-HYDROGEN MICROSCOPES AND POLARISCOPES.

(See No. 1095, page 282.)

SLIDES FOR MAGIC LANTERNS.—(pp. 48 to 62.)

FIG. 1799.

		£	s.	d.	£	s.	d.
1799	**Large size Best Comic Slides**, One Dozen in box, about fifty figures (fig. 1799)	2	10	0			
1800	Fourteen-inch ditto	1	10	0	2	2	0
1801	Twelve-inch ditto				1	4	0
1802	**Fairy and Nursery Tales**, painted on three-inch circles :— Cinderella, Robinson Crusoe, Blue Beard, John Gilpin, Robin Hood, Jack the Giant Killer, Jack and the Beanstalk, Tale of a Tub, Whittington and his Cat, St. George and the Dragon, &c., &c. Per set of eight, ten, or twelve slides £1 1s.	1	10	0	2	2	0

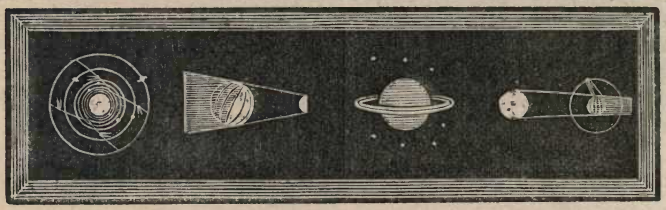


FIG. 1805.

1803	**Astronomical Sliders**, for illustrating the various Phenomena of the Heavens, with Descriptive Book, for the Phantasmagoria Lantern				2	2	0
1804	Ditto ditto for the Second Size . . ,				3	3	0
1805	Ditto ditto for the Large Size (fig. 1805) .				4	4	0
1806	**A Series of Ten Finely-painted Astronomical Diagrams, with Rack and Pinion Movements**, by which the images produced are made to revolve; In Box—for Phantasmagoria Lanterns . 6 6 0	8	8	0	10	10	0
1807	**Sets of Natural History Slides**, consisting of correct drawings of Mammalia, Birds, Fishes and Reptiles 42s.	3	3	0	4	4	0
1808	**Geological Slides**, showing the Earth's Strata, with figures of Fossil Animals and Plants				4	4	0
1809	**Photographic Portraits of Celebrated Individuals**, in Frames				0	3	6

FIG. 1810

FIG. 1810*.

1810 **Comic Movable and Shifting Glass Slides**, (or Slip Slides)—a diversity of Subjects, by which the magnified images appear to have life and motion (figs. 1810, 1810*) . 1s. 6d. 2s. 2s. 6d. 0 3 6

FIG. 1811.

		£ s. d.	£ s. d.
1811	**Panoramic Landscapes, Marine Views and Railways,** Shipping, Railway Trains, &c. (fig. 1811) . 7s. 6d.	with Moving 0 10 6	Figures, 0 16 0

FIG. 1812.

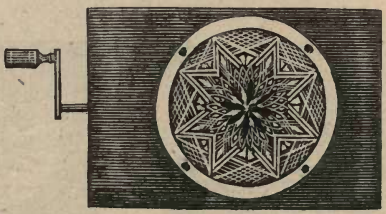


FIG. 1815*.

1812	**Lever Slide,** representing the movements of Animals, Birds, &c., such as a Stag or Swan drinking 5s. 6d.	0	6	6	0	10	6
1813	**Mechanical Slide** representing a **Dog Begging,** with a pipe taken from the mouth of his master and placed in the dog's mouth				0	12	6
1814	Ditto ditto, with moving Smoke effect—two slides				1	5	0
1815	**Mechanical Slide,** representing the Rat Eater . .				0	12	6
1815*	**Chromatropes,** (best painting) a variety of Beautiful and Brilliant Designs (fig. 1815*)	0	11	6	0	12	6
1816	Ditto, Small				0	8	6
1817	Ditto, with Motto or Design in the centre . . .	0	14	0	0	16	0
1818	**Rackwork Slides,** to represent Wind and Water mills in motion on the screen—best paintings . . .	0	12	6	0	14	0
1819	**A Rackwork Slide,** to show the Aurora Borealis, with a View in the Polar Regions				1	4	0
1820	**A Rackwork Slide,** with View and Rainbow Effect .				1	1	0

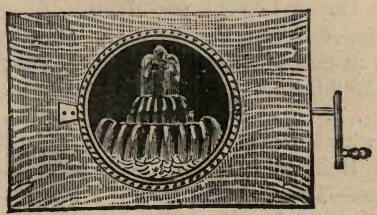


FIG. 1821.

1821	**Rackwork Fountain Effect** . . . .(fig. 1821)	0	12	6	0	14	0
1822	**Kaleidoscope for the Lantern, for Oxy-Hydrogen** Light				2	10	0

		£ s. d.	£ s. d.
1823	**Mechanical Slide,** to represent the Effects of a Snow Storm		0 12 6
1824	Ditto ditto Moving Water, simple effect .		0 10 6
1825	Ditto ditto Shipping with Moving Waves, and Birds, best painting		1 10 0
1826	Ditto ditto for Curtain Effect . . .		0 15 0
1827	Ditto ditto an Aquarium with moving Fish .	0 12 6	0 14 0
1828	Ditto ditto a Scene at a Fair, with moving Swing (lever motion)		0 10 6
1829	Ditto ditto Destruction of Pompeii, with Rackwork Effect	0 12 6	0 14 0

DIORAMIC EFFECTS FOR DISSOLVING VIEW APPARATUS.

FIG. A.

FIG. B.

FIG. C.

They are arranged in sets of two, four, six, and sometimes ten. We give a list of a few of the most striking. Two prices are quoted, regulated by the quality of the paintings and the amount of fine detail.

The following prices are for 3¼-inch circular paintings, suited for the 3½ or 4-inch lanterns. *Larger sizes are painted to order at proportionate price.*

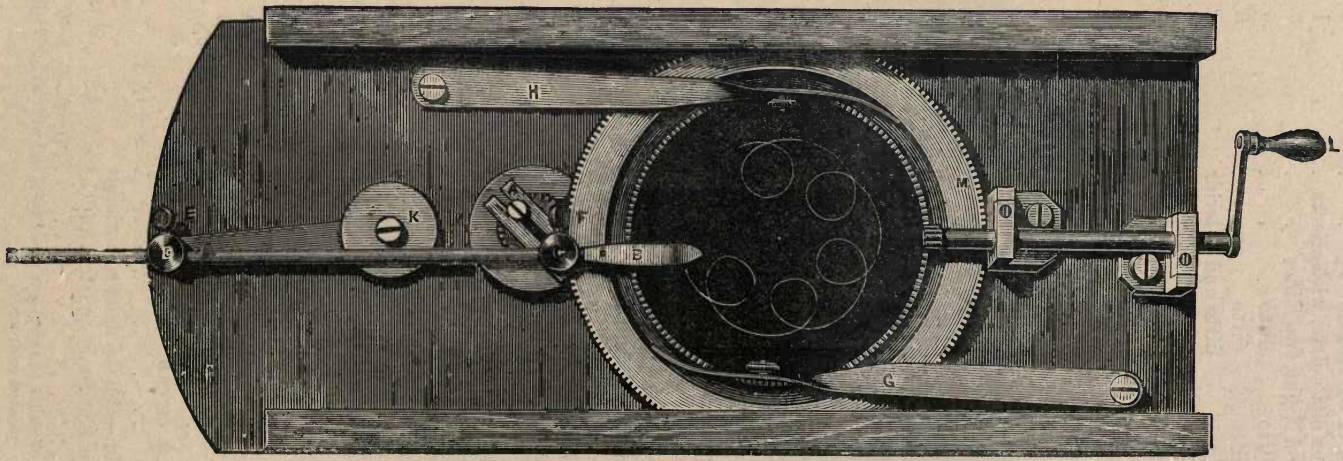
1830	**Mount Vesuvius.**—Three slides, Day and Night, and an Eruption	1 4 0	1 16 0
1831	Ditto ditto.—Three slides, with Rackwork to exhibit the Smoke and Lava in Motion		2 16 0
1832	**Rustic Scene.**—Three slides, Watermill, Summer, ditto Winter, and Moonlight	1 4 0	1 16 0
1833	**Rustic Scene.**—Three slides, Watermill in motion, a Swan moving along the Water, Summer changing to Winter by Moonlight; the clouds move, lights appear in the windows of the mill, with ripples on the water		3 3 0
1834	**Landscape.**—Three slides, with Rain Storm, Lightning, and Rainbow Effects	1 1 0	1 10 0
1835	**Castle of Chillon** by Day and Night, two slides . .	0 16 0	1 5 0
1836	**The Emigrant Ship.**—Six slides. The Ship leaving Port; at Sea; Full Sail by Moonlight; the Storm; Ship struck by Lightning; Ship on Fire; the Raft with Survivors		2 2 0
1837	Ditto ditto with Moving Effects . . .	3 3 0	5 5 0
1838	**Mount Ararat,** with Rainbow effect		0 16 0
1839	**The Soldier's Dream.**—Two slides	0 16 0	1 5 0
1840	**Arctic Regions.**—Three slides, Mock Sun and Aurora Borealis effects	1 4 0	1 16 0
1841	**Farm House.**—Three slides, Summer, Winter and Moonlight	1 4 0	1 16 0

1842	Niagara Falls.—Two slides with Rainbow . . .	£0	12	6	£0	15	6
1843	St. Peter's, Rome.—Three slides, Day and Night, with Fireworks from the Tower of St. Angelo . . .	1	4	0	2	2	0
1844	Interior of ditto.—Two slides ditto ditto, with effects .				1	8	0
1845	Milan Cathedral by Day and Night, two slides . .				0	12	6
1846	The Rialto, Venice ditto ditto . .				0	12	6
1847	Holyrood Palace ditto ditto . .				0	12	6
1848	St. Paul's Cathedral ditto ditto and Interior				1	5	0
1849	The Old Royal Exchange, London, by Day, by Night, on Fire, and the present Royal Exchange; three slides	1	16	0	2	2	0
1850	A Storm at Sea and the Life Boat	0	16	0	1	5	0
1851	Mount Hecla, with Lava and Smoke in Motion, two slides				1	12	0
1852	The Magician's Cave and effect				1	10	0
1853	The Magic Mirror.—Two slides, and effect . . .				1	10	0
1854	Faust and Mephistophiles, with effect, Vision of Marguerite, two slides				1	10	0
1855	Mosque of Omar.—Two slides, Day and Night effect .				0	16	0
1856	The Four Seasons, Spring, Summer, Autumn, and Winter				1	12	0
1857	The Serenade.—Moonlight Scene with Gondola . .	0	14	0	1	5	0
1858	The Angel's Whisper.—Two slides				1	5	0
1859	London.—St. Paul's and the Thames, Day and Night .				1	5	0
1860	Virginia Water, Moving Swan and Night effect, three slides				1	10	0
1861	Osborne House, by Day and Night and effects, Windows lit up				0	18	6
1862	Old London in 1666, Day View and the great Fire, with Rackwork effect, Smoke and flames, three slides				2	2	0
1863	The Port of Alexandria, with Shipping in motion, Smoke, Moonlight, and ripple on the Water . .				1	10	0
1864	Esquimaux Village.—Snow Huts, with Aurora, &c., three slides				1	1	0
1865	The Overland Route.—A series of twelve views, each view	0	8	0	0	12	0
1866	Mount Blanc.—A series of eighteen views. The Ascent from Geneva to the summit, and the Descent to Chamouni, each view	0	8	0	0	12	0
1867	The Arctic Regions.—A series of twelve views, each view	0	8	0	0	12	0
1868	Natural Phenomena.—A series of eighteen slides, each view	0	8	0	0	12	0
1869	The Bottle.—Eight slides, each Painting . . .	0	10	6	0	12	0
1870	The Drunkard's Children.—A series of views, each painting	0	10	6	0	12	0
1871	The Pilgrim's Progress.—A series of twelve, each painting	0	10	6			
1872	A Journey Round the World.—All the most remarkable and interesting views in the four quarters of the Globe, each slide	0	8	0	0	12	6

Nos. 1865 to 1868. These series can be extended to thirty-one views each, and with No. 1872 will be painted to order.

NEW MECHANICAL LANTERN SLIDE.

Size of Slide, 4¼in. wide, ⅛in. thick.



Photographed and Engraved half the size of the Slide.

NEGRETTI AND ZAMBRA, HOLBORN VIADUCT, E.C.,

THE CYCLOIDOTROPE, OR THE INVISIBLE DRAWING MASTER.

(Fig. 1873) *Will trace an infinite variety of Geometric Designs upon the Screen.*

Those Slides are always pleasing in which there is movement, or something is done. This Slide is made to carry a circular piece of smoked glass, and upon the handle being turned the design is traced on the glass, showing a white line upon the screen. The pattern is easily varied by a slight alteration of the different adjustments, six in number; as soon as one design is finished it can be removed, and another glass introduced, Glasses can be carried ready smoked in a suitable box, supplied with the instrument.

The Price of the Instrument is 30s. Directions for use supplied with each slide.

NEGRETTI AND ZAMBRA'S

TRANSPARENT PHOTOGRAPHIC VIEWS AND STATUES,

PRINTED ON ALBUMEN, †

FOR EITHER MAGIC LANTERNS OR DISSOLVING VIEWS.

The award of the only PRIZE MEDAL by the Jury of the International Exhibition of 1862 to NEGRETTI & ZAMBRA'S Photographic Transparencies sufficiently stamps their value as aids in the advancement of Science and Education without further comment.

The following extract from CHAMBERS' JOURNAL will describe these Photographs exhibited by the Lantern:—

"Unquestionably, however, the most important use which has yet been made of this new process (illuminated dissolving Photographs) was the exhibition through the whole of the winter, at the Manchester Mechanics' Institution, of a series of Egyptian Photographs. The most remarkable feature of these series of pictures was the *solidity* and *reality* with which they were invested, which were almost sufficient to cheat the beholder into the belief that, by some optical glamour, he was transported bodily to the mystical banks of the Nile. Most of us are familiar with these scenes through the medium of David Roberts' paintings, but whilst we willingly pay them the tribute of our admiration, gratefully remembering the pleasant hours we have spent in studying them, we must admit that they fall short of producing the interest and effect which result from Photographs of the same scenes shown in this manner."

(See also Page 56 of N. & Z.'s Manual.)

Negretti and Zambra's Photographic Lantern Slides include Views of the most remarkable places in the Globe, Photographic Statues, &c., &c.

REDUCED PRICES.

	£	s.	d.
Price of Photographic Views, printed with Albumen, Uncoloured, mounted in Frame each	0	2	6
Ditto ditto Coloured, ditto ditto	0	5	6
Photographic Statues . . . . . ditto ditto	0	2	6
Mahogany Frames or Holders for above . . ditto ditto	0	0	6

LIST OF STATUES

PHOTOGRAPHICALLY PRINTED ON ALBUMEN.

1873 CRYSTAL PALACE SERIES.

3 A Nymph preparing for the bath
3C Apollo discharging his bow
4 The Tired Hunter
4C Eve Listening
5 Una and the Lion
5A Dorothea
6A Jane Shore
6B Maid of Saragossa
7 Andromeda
7* A Naiad
9 Mercury
10 Flora
11 Boy with Tambourine
12* Venus
13 Venus Vincitrice
14 Flora
16 The Laocoon
17 Minerva of Farnese
18 Aurora
19 Demosthenes
22 Diana
27 Ariadne
28 Minerva
31 Posidippus
32 Neranda

---

† Messrs. Negretti and Zambra beg to caution purchasers of Photographic Slides against pictures printed with Collodion, as definition and clearness, fit for exhibition, are only to be obtained from **Albumen** prints.

33* Children and Pony
34 The Emigrant
37 Samson
37* Minerva
38 Musidora
39 The Massacre of the Innocents
40 Milo
40* Minerva
41 Satan
42 Ariel
44* David
46 The Mourners
47 Andrómeda
47* The Borchesse Flora
48 Ulysses
49 The First Whisper of Love
51 Sabrina
52 Zephyr and Aurora
53 Geoffrey Chaucer
54 A Nymph of Diana
55 Mercury
56 Shakspeare
57 Lavinia
58 Highland Mary
62A Diana
62C Night
62D Morning
63 Æsculapius
64 Psyche
64* Pomona
66 A Fawn wlth Cymbals
67 Angel watching
67* David
68 Venus and Cupid
75 Diana
78 Cupid and Psyche
79 Thalia
80 Zephyr wooing Flora
80* Augustus
80A A Roman
81 Apollo
81* A Victory
82 Penelope
83 Venus at the Bath
83* A Bacchante
84 A Victory
85 Penelope and Telemachus
89 Bacchus
90 Æsculapius
91* A Hunter
92 Julian the Apostate
93 The Three Fates
94 The Chase
96 The First Cradle
98 A Neapolitan Dancer
99 A Neapolitan Improvisatore
100 Cain

Virginius
Jason
A Day Dream
The Dying Gladiator
Eve at the Fountain

101 A Bather
102 Milo of Crotona
115 Eurydice
115**Night
115* Charity
116 Venus disarming Cupid
121 Charity
120-29* Pudicita
130 Ceres
131 Venus leaving the Bath
135 Mars and Venus
155 Hope
138 Magdalen
152 The Murder of the Innocents
142* A Vestal Virgin
146 David
147 A Girl Knitting
148 First Steps
149 Italy
150 Veritas
150* Eve
152 Melancholy
156 Esmeralda
160 Ishmael
162 Minerva protecting a Warrior
163 A Child Christ
155-65* Juno
167 A Nymph
168 A Girl bearing Fruit
169 A Vase
170 Pomona
171 Medicine
171A Maria F. Malibran
176 Homer
177 Thucydides
178 Guardian Angel
185-7-8 A Victory
191 An Eagle
195 Priest of Bacchus
196 A Pieta
196* Melpomene
201 Madonna of Munich
201* A Violin Player
201 Iris Hecate of Lucifera
202 A Nymph
204 Ceres and Proserpine
308 Angel
212 A Knight
223 Love
224 Venus
229 Julia
230 Musician
231 Victory
232 A Youth
233B Voltaire
234 Camillus

Love Triumphant
Europa
Toilet of Atalanta
Titania
The Greek Slave

239 Urania
250 Psyche
251 Belvidere Apollo
253 Eros
255 Ariadne
259 Iphigenia
261-270 Diana
262 Hagar
263 A Hunter
264 Hunter defending his family
265 Abraham Duquesne
267 A Nereid
269 Winter
271 A Flower Girl
279A Chateaubriand
286 Trajan
295 A Fawn
308A Louis XIV.
313 Peter Paul Rubens
314 Antinous
321 Demosthenes
327 Zeno
385 Gothold EphraimLessing
251 Pallas
358 Cupid encircled by a Dolphin
362 Venus di Medici
3 7 A Fawn
374 Urania
407 Shakspeare
412* William Wordsworth
431 Humphrey Chetham
449 Earl of Chatham
0-1 Massacre of the Innocents
0-2 Mattabuz and Camilla
0-3 Aurora
0-4 Sleeping Children
0-5 Godiva
0-6 Ajax praying for Light
0-7 A Girl with Triangle
0-8 Music's Martyr
0-9 The Pieta ; by Bermine
0-10 The Minstrel
0-11 Michael Angelo
0-12 Jonah
0-13, 0-14, 0-15 Virgin and Child
0-16 Marriage of Virgin
0-17 Girl with Pet Bird
0-19 Bas Relief—The Last Supper
0-20 Bas Relief—The Adoration of the Magi
0-21 Bas Relief—Virgin and Child
0-24 John Bunyan
0-23 St. George
0-25 St. Andrew
0-26 St. John

Wrestlers
Ancient Briton
A Warrior
The Son of Niobe
Salmacis

1874 LIST OF VIEWS IN EGYPT AND NUBIA,

Photographically Printed on Albumen.

309-2-28 Views of the Temple of Dendera
301 The Granite Quarries of Syene
300-4 The Rock Temple of Derr, the chief town in Nubia
305 The Rock of Abouseer and the second Cataract
306 Kalet Adde, a ruined Saracenic town
307-9 The Façade of the Great Rock Temple at Aboo-Simbel in Nubia
310 The smaller Rock Temple of Aboo-Simbel, time of Rameses the Great, B.C. 1400
311 Girgeh, Upper Egypt
312 The Temple of Amada near Derr
313, 314 The Temple of Wady Saboda
315-317 The temple of Dacke, founded by Ergamun, about 2000 years ago
316 Temples at Makarraka in Nubia
318-19 The Portico of the Rock Temple of Gerf Hossayn or Gyrche
320 The Temple of Dendoor, built in the reign of Augustus Cæsar
321-2-3-4 The Temple of Kalabshee, Nubia
325 Traveller's Nile boat or "Dahabeah"
326-7 Wady Kardassy in Nubia
229-30-31 Views in the Island of Philæ
333-4 The Principal Court of the Large Temple at Philæ
335 Crocodile on a sand bank in the Nile
336 Principal Corridor of the Island of Philæ
337-8 Views from the Island of Philæ
339-41-42 Hypæthral Temple at Philæ, usually called "Pharaoh's Bed"
340 View between the upper portions of the Two Principal Pylons at Philæ
343 View of an Arab Village and ruins, Island of Biggeh, opposite Philæ
344 Ruined Mosque of Mishdd, with distant view of Philæ
345 Remarkable Granite Formation between the first Cataract and Philæ
346 The River Wall and South End of Philæ
347 North Approach to Philæ
348 Assouan, Upper Egypt
349-88 The Sphinx and Great Pyramid at Geezeh
550-51 The Temple of Kom-Ombo
352-3-4 Grottoes and Rock Cuttings in the Sandstone Quarries at Hagar Silisili
355-56 Temple of Edfou, Greek Period
357-8 The Temple of Erment, near Thebes
359-60-61 Views of Luxor
362-3 The Approach to Karnac, the Avenue of Sphinxes, and the Ptolemaic Pylon
364-6-7 The principal Ruins of Karnak
365 General View of Karnak
368-9 The Two Obelisks, and part of the Hall of Columns at Karnak
370 Remains of the Granite Pylon and two Colossi at Karnak
371-95-6-7-8-9 Six views of the tombs of the Memlook Kings at Cairo
372-3-4-93-4 Views of Portions of the Great Hall of Columns at Karnak
372 Rock Tombs under the Great Pyramid at Geezeh
376-89 The Two large Pyramids at Geezeh
377 The Colossi of the Plain, the celebrated Statues of Memnon, at Thebes
378 The Temple Palace of Goorneh, at Thebes, commenced by Sethos, some 3000 years ago
379-80-01 The Memnonium at Thebes
382-3-4-5-6 Medeenet Haboo, the Temple Palace of Rameses III. at Thebes, about 1300 B.C.
387 The Valley of the Tombs of the Kings, at Thebes
390-91 The entrance to the Great Temple at Luxor
392 The Court of Sheshonk (the Shishak of the Scriptures) at Karnak

1876. HOLY LAND.

400 Gaza. The Modern Town
400D Gaza. The Old Town
401 Samson's Gateway. (Gaza)
402-3 Ramleh, the ancient Arimathæa
404 Village of Aboo Gosh, Kuriat el Enab, the ancient Kirjath Jearim
405-6 Jerusalem from the Mount of Olives
407 Jerusalem. Pool of Bethesda
408 Jerusalem. Church of St. Anne
439 Jerusalem, from the north-east corner of the present city
410 En Rogel; or, the fountain-head of Rogel
411 Jerusalem, from fortification on Sion
412 Jerusalem, from the south part of the city wall
413 Jerusalem, from the chief tower of the Citadel
414 Jerusalem. View from the south wall on Mount Sion
415 Jerusalem. View taken within the present city
416 Tomb of Absalom, at the foot of the Mount of Olives
417 Jerusalem, from the south-east
418 Jerusalem, from the top of the Mount of Olives
419-20 Jerusalem, from the top of the Citadel
421 Jerusalem, English Protestant Church
422 Jerusalem, from the Mount of Olives
423 Tomb of Rachel, from the north-north-east
424 Bethany, from the south
425 Bethlehem, from the north-east
426 Hebron. Southern half of the city
427 Hebron, the Pool of David

428 Hebron. Northern half of the city
429 The Dead Sea, seen from its northern shore, looking west-south-west
430 Monastery of St. Saba
431-2-3-4 Banias, the ancient Paneas and Cæsarea Philippi
435 The Ford of the Jordan, the site of the Baptism
436 Distant View of Damascus
437 The Old Wall of Damascus
438 Damascus. The East Gate
439 Panorama of Damascus, looking west
440 Panorama of Damascus, looking south-west
441 Panorama of Damascus, looking east
442 Damascus, Roman gateway and street view
443 Nazareth, from the south-east
444 Nazareth, from the north-west
445-6 Nablous (ancient Sichem or Sechem)
447 Nablous, seen from the south-west; Mount Ebal is seen to the left, and Mount Gerizim to the right
447D Sebustieh, the ancient Samaria
448 Tiberias, seen from the south, on the shore of the lake
449-50 Baalbec, the ancient Heliopolis, or City of the Sun. The Six Great Columns and the smaller Temple
451-52 Baalbec. View from the north-west and the south-east
453 Baalbec. The Temple proper
454 Baalbec. The Octagon Temple
455-6-7 Cedars of Lebanon

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458 Cairo. Group of Tombs and Citadel, from the Mukattan Hills
459 Cairo. Ruined Mosques, with Cufic writing on the Mukattan hills
460-61-64 Cairo. The Mosque of Sultan el Hakem
462-65-90 Cairo from the citadel
463 Cairo. Gateway of the Ruined Palace of the Grand Vizier, and Mosque of ditto
466-91 Cairo. The Mosques of Mardani and Sultan Hassan, City Walls and General View, looking south-west
467-8 Cairo. Modern Painted Tombs, near Cairo,—Tombs of the Caliphs in the distance
469 Boulac. The Port of Cairo
470-74 Cairo. Tombs of the Caliphs
471-72 Cairo. Street Scene on the Way to the Citadel
473-75 Cairo. Gateway of the Citadel
466 Cairo. View in the Roumaleah Square, and Mosque of Mahmoudieh, with Camels
477-8-9 Belzoni's Pyramid at Geezeh
480-82-85½ The Pyramids of Dashour
481 Arab Sportsman and Cook
483 The Pyramids of Sakkara
484 The Three Pyramids of Geezeh
485 Cairo. The Babel-el-Nasr, or Gate of Victory
486-7-8 Cairo. Tombs of the Mamelukes
489 The Mosque of Emeer Akoór
492 Cairo. From the Citadel Fort, with distant View of the Tombs of the Caliphs
493 Cairo. View from the Citadel Fort
494 Camels and Prickly-pear Orchard
495 Suez, on the Red Sea
496 Peninsula of Sinai. The Wady Bahala
497 Peninsula of Sinai. Sculptured Stones at Sirabit-el-Rhadem
498-9 Peninsula of Sinai. The Wady Mukatteb, or Written Valley, and Sinaitic Inscriptions in this Wady
500-1-2-3 Peninsula of Sinai. View of Mount Serbul from Wady Feiran
504-5 Peninsula of Sinai. View in the Wady Feiran
506-7 Peninsula of Sinai. The Convent of Sinai, and the distant plain of El-Raheh
508-9 Peninsula of Sinai. Bird's-eye View of the Convent of Mount Sinai
510-11 Peninsula of Sinai. Mount Sinai (Horeb) with the Convent. From the Plain of El-Raheh (the Place of the Assemblage)
512 Peninsula of Sinai. Gebel Mousa (Sinai) from the Wady-es-Sebaiych
513 The Island of Grayia
514 Jerusalem. Façade at the Church of the Holy Sepulchre
515 Jerusalem. Street in Jerusalem, with Church of the Holy Sepulchre
516 Jerusalem. The Village of Siloam, and Valley of Kidron
517 Jerusalem. Ancient Tombs in Valley of Jehoshaphat
518 Jerusalem from Mount Scopus
519-20-21-22 Jerusalem from the Mount of Olives
523 Mount of Olives. The Church of the Ascension

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Sacrifice of Isaac
Jacob and Laban
Jacob's Dream
Rebecca at the Well
Departure of Rebecca
Arrival of Rebecca
Joseph sold by his Brethren
Joseph interpreting Pharaoh's Dream
Worship of the Golden Calf
Pharoah's daughter finding Moses
Moses striking the Rock
The Brazen Serpent
The Angel appearing to Balaam
Ruth in the corn fields
Ruth and Boaz
Samson slaying the Lion
The Death of Samson
Jael and Sisera
Samuel and Eli
Samuel praying
Saul and the Witch of Endor
David with the Head of Goliath
The Judgment of Solomon
Mordecai's Triumph
Daniel in the Den of Lions
The Handwriting on the Wall
Job and his Three Friends
The Angels appearing to the Shepherds
The Nativity
The Adoration of the Magi
The Flight into Egypt
The Murder of the Innocents
Christ with the Doctors in the Temple
The Holy Family
The Baptism of Christ
Christ at the Well with the Woman of Samaria
Christ giving sight to the Blind
Christ healing the Sick
Christ blessing Little Children
The Miracle at the Marriage Feast at Cana
Christ and the Tribute Money
Christ weeping over Jerusalem
Christ's entry into Jerusalem
Mary anointing Jesus's feet
Christ raising Lazarus
The Miraculous Draught of Fishes
Christ walking on the Sea

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The Unjust Steward
Dives the Rich Man
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The Good Samaritan
The Widow's Mite

Christ's Agony in the Garden
The Last Supper
Christ before Pilate
Ecce Homo
The Crown of Thorns
Christ bearing His Cross
The Crucifixion
The Dead Christ
The Descent from the Cross
Mary at the Sepulchre
The Ascension
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Panorama of Canton
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Chinese Boatmen
Ditto ditto fighting Quails
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Winding the Cocoons
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Chinese Joss House
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Chinese Capmaker's Shop
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Celebration of Meeting the Spring
Kite Flying on the 9th day of the 9th moon
An Itinerant Doctor
Ditto Barber
Raree Show
A Street in Canton
Western Gate, Pekin
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The Five-storied ditto
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Panorama of London
The Marble Arch
Buckingham Palace
Westminster Abbey
Houses of Parliament
Victoria Tower
Clock Tower
The Horse Guards
Trafalgar Square
St. Martin's Church
The British Museum
Temple Bar
Waterloo Bridge
Somerset House
St. Paul's
Guildhall
The Post Office
The Bank
The Royal Exchange
The Monument
London Bridge
The Custom House
The Tower
The Royal Mint
The Trinity House
St. Katherine's Docks
Victoria and Albert Embankment

1882 **Crystal Palace.** Comprising all the Courts and objects of interest.

1883 **Java, Sumatra, Japan, Siam, Manilla, Moluccas;** a series illustrating Tropical Scenery.

1884 **Prepared Colours for Painting on Glass,** 12 Colours, with Brushes, Palette Knife, Varnish and Turpentine, in neat japanned tin case, 24s. and 42s.

1885 **Single Colours for Painting on Glass,** 1s., 1s. 6d., and 2s. each.

1886 **Varnish,** prepared for ditto, 1s. 6d. per bottle

These Lists comprise only a very small portion of Negretti and Zambra's Photographic Series that can be conveniently described within the limits of a Catalogue.

Engravings, Drawings, Maps, &c., copied by Photography for Projection by the Lantern.

Instructions for Painting Lantern Slides will be found at page 94 in N. & Z.'s Lantern Manual.

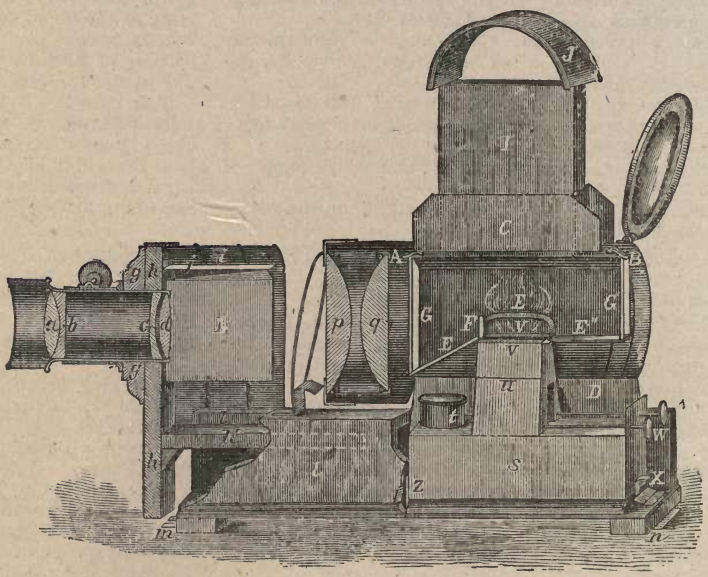


FIG. 1887.

The wood engraving (fig. 1887), exhibits in section the general arrangements of the improved 3 Wick Parrafin Lanterns. P and Q are the Condensing Lenses, A, B, and C the Achromatic Combination of Front Lenses, having Rackwork Adjustment, S, U, V, the Lamp, I and J Chimney and Cap, O O Spring Clamp for holding the picture, G, Flame Chamber Glasses, B, Reflector closing down on the back of the Lamp Chamber. The Slide Holder is open at the top and is adjustable, admitting of a variety of chemical and other experiments being performed and exhibited upon the screen.

CHEMICAL APPARATUS.

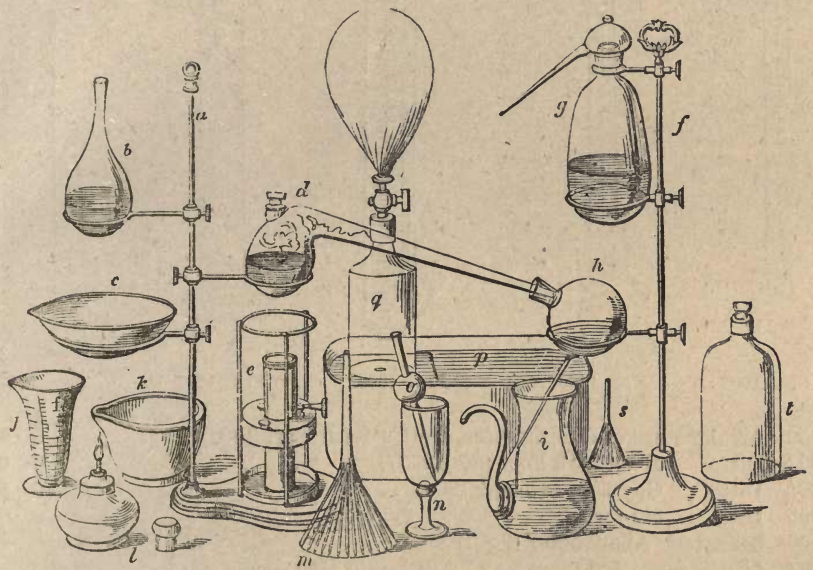


FIG. 1888.

GLASS, PORCELAIN, EARTHENWARE, &c.

		£ s. d.	£ s. d.
1889	Adapters for connecting retorts to receiver, small tube, straight, 8 oz. and 16 oz.	0 0 9	0 0 10
1890	Ditto ditto, bent, 8 oz. and 16 oz.	0 0 10	0 1 0
1891	Adapters, full size, for large operations . . various		
1892	Air Jar Tubes, for experiments on the gases:—		

Long .	2-in.	3-in.	4-in.	6-in.	6-in.
Width .	½-in.	⅝-in.	⅞-in.	¾-in.	1-in.
Price .	3d.	4d.	6d.	9d.	10d.

1893	Air Jar Tubes, Cylindrical, per nest of six . . .							0 8 6	0 10 6	
1894	Air or Gas Jars, stout bell glass, with ground edges—									
		½-pts.	pts.	qts.	3 pts.	4 pts.				
1895	Narrow Mouth, plain (fig. *t*)	1s. 3d.	2s.	3s.	4s. 6d.	6s.				
		½-pts.	pts.	qts.	3 pts.	4 pts.				
1896	Air or Gas Jars, Stoppered (*t*)	2s.	3s.	4s.	5s.	7s.				
1897	Ditto ditto mounted with Brass Cap	2s. 6d.	3s. 6d.	5s. 6d.	6s. 6d.	8s. 6d.				
1898	Air or Gas Jars, Wide Mouth, Plain	1s. 6d.	2s. 6d.	4s.	5s.	7s. 6d.				
1899	Ditto, ditto Stoppered	2s. 6d.	3s. 6d.	5s.	6s.	8s. 6d.				
1900	Air or Gas Jars, mounted with Brass cap, two Stop-cocks, Connecting-piece, and Bladder Ferrule from								0 18 0	
1901	Air or Gas Jars, Graduated into Cubic Inches and Decimal parts, for mixing gases, Capped or Stoppered from								0 5 6	

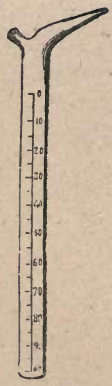


FIG. 1902.

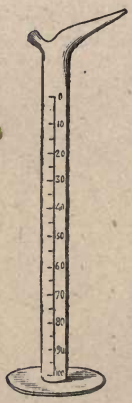


FIG. 1903.

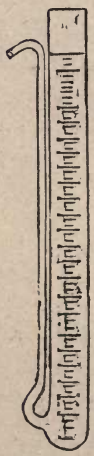


FIG. 1904.

FIG. 1907.

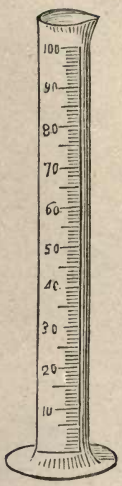


FIG. 1907*.

		£ s. d.	£ s. d.
1902	**Alkalimeters or Chlorimeters**, Bink's form (fig. 1902)		0 5 6
1903	Ditto ditto, with Foot (fig. 1903)		0 6 6
1904	Ditto Gay Lussac's (fig. 1904)		0 5 6
1905	Ditto old form		0 6 0
1906	**Schuster's Alkalimeter** (fig. 1906)		0 2 0
1907	**Alkalimeter**, 1000 grains, divided into 100 parts of equal capacity, for Volumetric Analysis (figs. 1907 and 1907*)	0 6 6	0 8 6
1908	**Alembics**—		
		4 oz. 8 oz. 16 oz. qrt.	
	Earthenware . . .	2s. 6d. 3s. 6d. 4s. 6d. 6s. 6d.	
	Glass (fig. 1908) . . .	6s. 6d. 7s. 6d. 12s. 14s.	
1909	**Alembics** of German Glass, 4 oz. and 6 oz. capacity, for experimental distillations		0 2 6
1910	**Alembics**, Berlin ware, with movable head, for distillation of substances at very high temperatures . .		0 12 6
1911	**Arsenic Tubes**, of hard German Glass, Berzelius', Clark's, Liebig's, or Rose's form (fig. 1911) per doz.		0 1 6
1912	**Aspirators**, Glass, see Water Bottles.		
1913	**Barometer Standard**, for Laboratory use, entirely of Glass, Gay Lussac's syphon form, the scale divided on the tube either inches or millimetres . . .	3 3 0	5 5 0

See ante, page 11.

1914 **Basins, Evaporating**, of Berlin ware, flat bottoms, with spout, shallow form; depth, one-fourth the diameter:—

Contents .	1-oz.	2-oz.	3½-oz.	5-oz.	8-oz.	12-oz.	18-oz.
Price .	9d.	10d.	1s.	1s. 3d.	1s. 6d.	2s.	2s. 6d.

1915 **Basins, Berlin Porcelain**, small and thin, for Analytical Experiments, uniform in substance:—

Contents .	⅛-oz.	¼-oz.	⅜-oz.	1-oz.	1½-oz.	2-oz.
Price .	3d.	5d.	6d.	8d.	10d.	1s.

FIG. 1908.

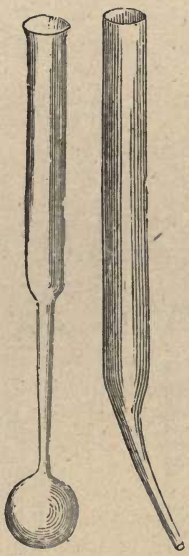


FIG. 1911.

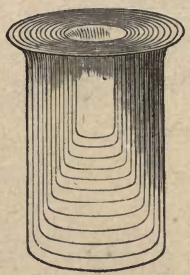


FIG. 1916.

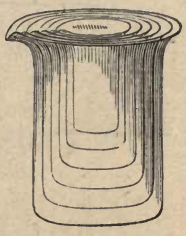


FIG. 1917.

FIG. 1906.

FIG. 1918.

1916 **Beaker Glasses**, (fig. 1916), Cylindrical form, the glass uniformly thin and well annealed, of German manufacture;

Sets of	3	5	8	12
Price	2s.	3s.	5s. 6d.	11s. 6d.

1917 **Beaker Tumblers**, with spout, for hot solutions, &c., being shorter, are easier cleaned than beakers, and precipitates more easily removed. In sets of six (fig I917) . . . . . £ 0 s. 6 d. 0

1918 **Bottles**, best Flint glass, London Stoppered (fig. I918):—

			£	s.	d.
¼-oz., ½-oz., and 1 oz., narrow mouth, per doz.	4s.	wide mouth per doz.	0	5	0
2-oz. . . . „	5s.	„ „	0	6	0
3-oz. . . . „	6s.	„ „	0	7	0
4-oz. . . . „	7s.	„ „	0	8	6
6-oz. . . . „	8s.	„ „	0	9	6
8-oz. . . . „	9s. 6d.	„ „	0	10	6
10-oz. . . . „	10s. 6d.	„ „	0	11	6
16-oz. . . . „	11s. 6d.	„ „	0	13	0
20-oz. . . . „	13s. 6d.	„ „	0	15	0

1919 **Bottles**, Green glass, Stoppered:—

¼-pint, narrow mouth, per doz.	5s.	wide mouth, per doz.			0	6	0
½-pint „ „	5s. 6d.	„ „			0	6	6
1-pint „ „	6s.	„ „			0	7	6
2-pint „	7s.	„ „			0	11	0

1920 **Bottles**, Acid, with elongated stoppers . . . . from 0 1 6

1921 Ditto, **Capped**, for Æther, &c.

1-oz.	2-oz.	4-oz.	8-oz.
2s.	2s. 6d.	3s.	3s. 6d.

1922 Ditto, Capped, and fitted into turned wood boxes, various, from 0 1 6

1923 **Bottles**, small Tube, for containing rare specimens, plain, per doz. 0 2 0

1924 Ditto ditto, Stoppered 0 8 0

1925 **Bottles**, Specific Gravity, Grains or Grammes, see Specific Gravity.

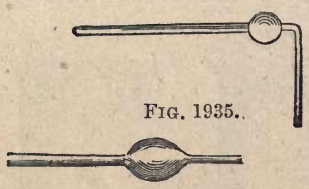


FIG. 1935.

FIG. 1935.

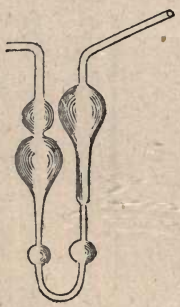


FIG 1969.

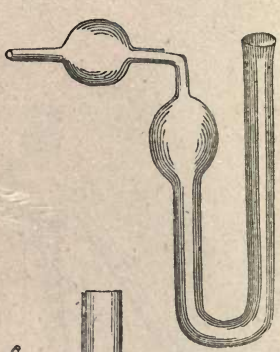


FIG. 1936.

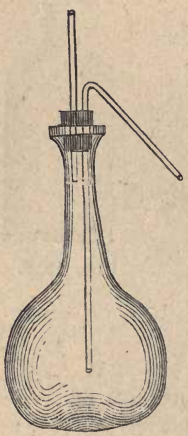


FIG. 1926.

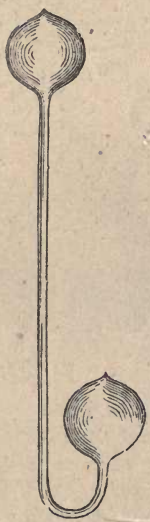


FIG. 1948.

FIG. 1946.

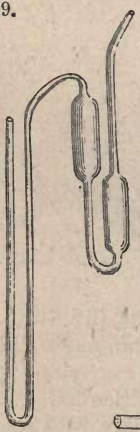


FIG. 1969*.

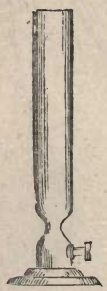


FIG. 1965.

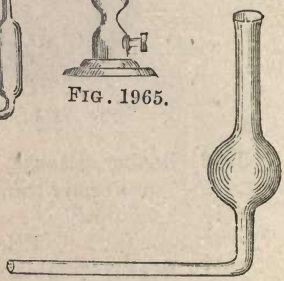


FIG. 1932.

1926	**Bottles**, washing, Gmelin's (fig. 1926) . . . . . from	£0 1 6
1927	Ditto ditto, with Handle for hot water, &c.	0 4 0
1928	**Capsules**, glass	0 0 3 0 0 6
1929	**Capsules**, of Berlin Porcelain, with spout and handle, very light:—	
	Contents . . . . . 1-oz. 2½-oz. 4-oz.	
	Price . . . . . 10d. 1s. 1s. 2d.	
1930	**Bulb Tubes** for weighing Oxide of copper . each	0 0 8
1931	**Brunner's Aspirator**, consisting of a Glass Bottle, one gallon capacity, with tap	1 4 0
	For other sizes of this useful article, see Water Bottles.	
1932	**Connecting Tubes**, Bent (fig 1932) . . each	0 1 0
1933	**Combustion Tube** of Hard German Glass, very infusible . . . . . per lb.	0 3 0
1934	**Combustion Tubes** prepared from the above Glass per doz.	0 10 0
1935	**Chloride of Calcium Tubes**, for absorbing moisture from gases, with straight or bent point (figs. 1935) each	0 0 6
1936	Ditto ditto U shaped, with two bulbs (fig. 1936) .	0 1 6
1937	**Crucibles**, real Hessian, triangular shape, in nests:—	
	Nest of 3 Crucibles, Nos. 2 to 4	0 0 6
	„ 5 „ 1 to 5	0 1 0
	„ 6 „ 1 to 6	0 1 6
	„ 8 „ 1 to 8	0 2 6

1938 **Crucibles, London Made, Fire-Clay,** round form, capable of resisting high temperatures :—

Height, without covers	3-in.	4-in.	4½-in.	5-in.	6-in.	7-in.	8-in.
Price . . .	2d.	2½d.	3d.	4d.	5d.	8d.	1s.

Covers at the same prices as the Crucibles.

FIG. 1949. FIG. 1950.

1939	**Crucible Cases, or Jackets and Covers,** of fire-clay, to protect platinum crucibles, and raise them to where the heat is the most intense . . .	£0	1	0	£0	1	6
1940	**Crucibles,** Wedgwood Ware . . .	0	0	8	0	1	0
1941	Ditto, Skittle shape 3 to 12 inches high, from	0	0	4	0	1	6
1942	*Ditto, Round, with Covers . . .				0	1	6
1943	Ditto, Berlin Porcelain, various from				0	1	0
1944	Ditto ditto, not glazed, with perforated covers	0	0	8	0	1	8
1945	**Calcining Pots,** to open in the middle .	0	0	6	0	2	0
1946	**Cooper's Receiver,** for collecting Gases over mercury (fig. 1946) . . .				0	1	6
1947	Ditto ditto, Graduated				0	7	6
1948	**Cryophorous,** Wollaston's, or Frost Carrier or Bearer (fig. 1948) . .				0	4	6
1949	**Cubic Inch Tubes,** graduated into 10ths and 100ths (fig. 1949)				0	4	0
1950	Ditto ditto on Round Foot (fig. 1950) . .				0	6	0
1951	**Cubic Inch Bottles,** (see Specific Gravity Bottles).						

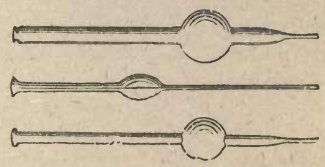


FIG. 1961.

FIG. 1963.

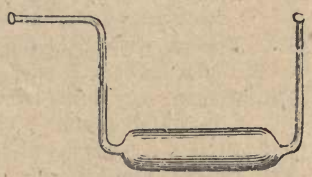


FIG. 1952.

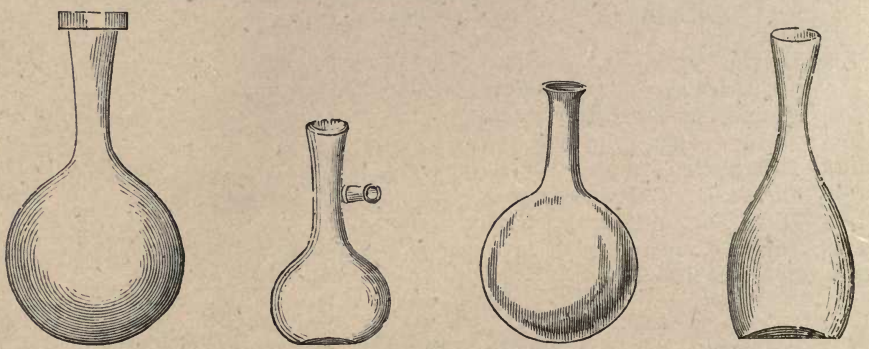
1952	**Drying Tube,** (fig. 1729) a bent tube in which substances to be analysed are placed to dry them, each				0	1	6
1953	**Drainers for Crystals,** Porcelain				0	2	6
1954	Ditto ditto shallow form				0	2	0
1955	**Deflagrating Jars,** (see Gas Receivers)						
1956	**Dishes,** Glass, various shapes . . . from				0	2	6
1957	Ditto, Evaporating, Berlin ware, various.						
1958	**Dishes,** Evaporating, Wedgwood ware, not liable to stain or crack :—						

Diameter .	2-in.	3-in.	4-in.	5-in.	6-in.	7-in.
Price .	4d.	6d.	9d.	1s.	1s. 4d.	1s. 8d.
Diameter .	8-in.	9-in.	10-in.	11-in.	12-in.	
Price . . .	2s.	2s. 6d.	3s.	3s. 9s.	4s. 6d.	

1959	**Dishes,** Sulphuric Acid, for desiccating purposes . .				0	5	0
1960	Ditto, Washing, flat Porcelain (see Photographic Apparatus).						
1961	**Dropping Tubes,** or Pipettes (fig. 1961) 4d., 6d., and				0	0	8
1962	Ditto ditto Graduated to grains, &c. . .	0	3	0	0	7	6
1963	**Dropping Bottles** (as fig. 1963)	0	2	0	0	2	6
1964	**Dialysers,** Graham's Glass, with Welt top and bottom 1s.	0	1	6	0	2	0

FIG. 1978.

		£	s.	d.	£	s.	d.
1965	**Desiccating Jars**, for drying gases by the aid of Chloride of Calcium (fig. 1965)	0	7	6	0	11	0
1967	**Desiccating Tubes**, with one bulb, and the end straight or bent (fig. 1935)					0	6
1968	**Evaporating Dishes** (see Dishes).						
1969	**Ettling's Gas Transferers**, various forms (figs. 1969, 1969*)				0	3	6
1970	**Eudiometer, Volta's**, graduated to 200 divisions=2 Cubic Inches (figs. 1970 and 1970*)	0	7	6	0	12	6
1971	**Eudiometer, Ure's U-shape** (fig. 1971), graduated to 200 divisions=2 Cubic Inches				0	10	6
1972	**Flasks**, Florence				0	0	4
1973	**Flasks**, White Flint Glass wide and narrow mouthed, with round and flat bottoms, from 1-oz. to 1-qt., from	0	0	4	to 0	4	0
1974	**Flasks**, with Side Neck, for Fractional Distillation, (fig. 1974) . . . . 1 pint, 2s. 6d. 2 pints,				0	5	0
1975	**Flasks**, very light, mounted with **Brass Stop-Cock** for weighing gases				0	12	6
1976	**Flasks**, Graduated to hold 1 Pint Imperial . . .				0	3	6
1977	**Flasks**, Graduated to hold exact quantities—Grains, Cubic Inches, or Cubic Centimetres	0	2	6	0	5	6



FIGS. 1974, 1978*.

1978 **Flasks of Hard German Glass**, capable of resisting extreme and sudden changes of temperature; flat or round bottoms (figs. 1978 and 1978*):—

Contents .	2oz.	4oz.	6oz.	8oz.	12oz.	16oz.	24oz.	40oz.
Price .	4d.	5d.	6d.	8d.	10d.	1s. 3d.	1s. 6d.	2s.

1979 **Filter and Funnel Rings** of Porcelain (fig. 1979) 4d. and 6d.

FIG. 1980. FIG. 1985. FIG. 1984.

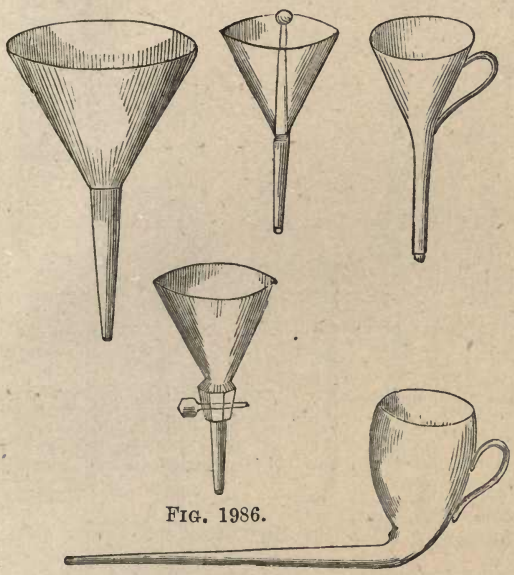


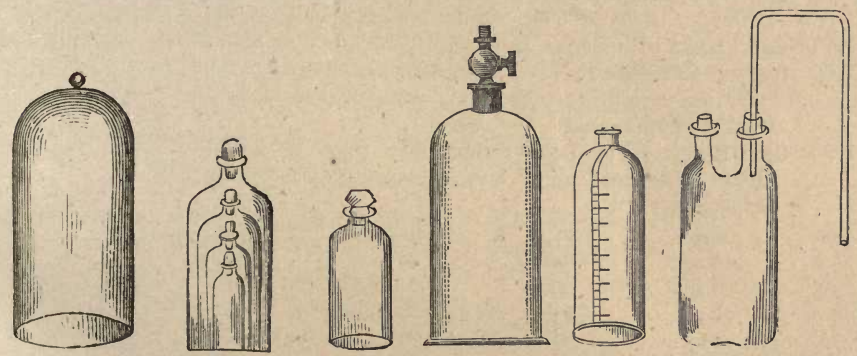
FIG. 1986.

FIG. 1984. FIG. 1982. FIG. 1983. FIG. 1983*.

1980 **Funnels**, of Glass (fig. 1980):—

Diameter .	1½ in.	1¾ in.	2 in.	2½ in.	3 in.	4 in.	5 in.	6 in.
Price	3d.	4d.	5d.	6d.	8d.	1s.	1s. 6d.	2s.

1981 **Funnels**, Wedgwood ware, best quality, from 2-oz. to 2-qts. from £0 0 9



FIGS. 1993. and 1993*. FIG. 1994. FIG. 1995. FIG. 1990.

1982 **Funnels**, long tube, thistle-headed for gas bottles, &c. of blown glass (1982):—

Length .	4 in.	13 in.	18 in.	20 in.	24 in.
Price .	4d.	6d.	9d.	1s.	1s. 3d.

1983 **Funnels**, for filling plain Retorts without soiling the neck (figs. 1983 and 1983*) £0 2 6

1984 **Funnels**, with Handle, for introducing substances into tubes without soiling the sides (fig. 1984) . . . £0 2 6 0 3 6

1985 Ditto with Stopper (fig. 1985) 0 4 6

1986 Ditto with Glass Stop-Cock (fig. 1986) 0 12 6

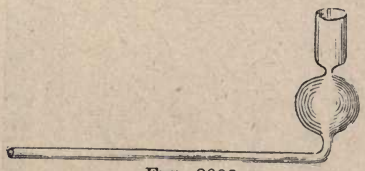


FIG. 2088.

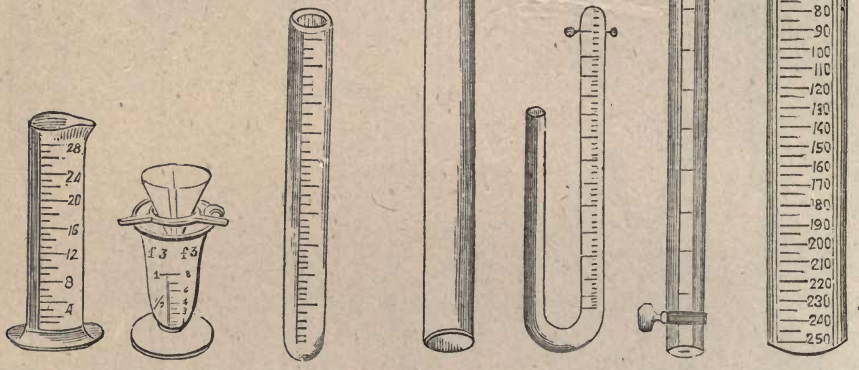


FIG. 2017. FIG. 1979. FIG. 1998*. FIG. 1970. FIG. 1971. FIG. 1970*. FIG. 1998.

		£	s.	d.	£	s.	d.
1989	**Gas Bottle, Clark's,** for preparing Sulphuretted Hydrogen,				0	2	6
1990	**Gas Bottle,** with bent glass tube, for generating Hydrogen, Sulphuretted Hydrogen, Carbonic Acid, or Chlorine Gases (fig. 1990) . . . complete						
	10 oz. 16 oz. 20 oz. 40 oz.						
	Price . . 1s. 6d. 2s. 2s. 6d. 3s.						
1991	**Gas Flasks** with Bent tubes as fig. 1763 . . .				0	2	6
1992	**Oxygen Gas Retort,** of hard glass, with bent tube, for making pure Oxygen from Chlorate of Potash and Oxide of Manganese				0	1	6
1993	**Gas Receivers or Deflagrating Jars** (figs. 1993 and 1993*) for containing and preserving Gases for experiment:						

Height.	Width.	Price Plain.	Price Stoppered.
5 in. .	3 in. .	1s. .	1s. 6d.
7 in. .	4 in. .	1s. 9d.	3s.
9½ in. .	5¼ in. .	2s. 6d.	5s.
11½ in.	6¼ in. .	4s. 6d.	7s. 6d.

1994	**Gas Receivers** mounted with brass cap, stop-cock and bladder ferrule, (fig. 1994)						
	about 7 in. high . . . 4 in. wide . .				0	10	6
	„ 9 in. „ . . . 5 in. „ . .				0	12	6
1995	**Gas Receiver** (fig. 1995), mounted with Brass Cap and Stop-cock, and Graduated into Cubic Inches . .				0	16	6
1996	**Globular Receiver,** with welted mouth, for showing the combustion of Phosphorous, &c., in Oxygen Gas .				0	6	6
1997	**Gas Jars, Cylindrical,** Stout Glass, for exhibiting the explosive nature of a mixture of Oxygen and Hydrogen						
	6d.	0	0	9	0	1	0

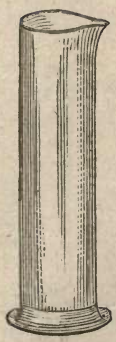


FIG. 2028.

FIG. 2098.

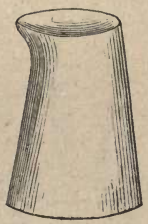


FIG. 2029.

FIG. 2028*.

FIG. 2099.

FIG. 2099*.

1998 **Graduated Gas Tubes**, for measuring Gases, &c., (figs. 1998 and 1998*):—

	£	s.	d.
4 in. $\frac{5}{8}$ in. about 1 cubic inch, showing 1-100ths cubic inch	0	4	6
6 in. $\frac{1}{2}$ in. „ 1 „ „ 1-100ths „	0	4	6
7 in. $\frac{3}{4}$ in. „ 3 cubic inches „ 1-50ths „	0	5	6
10 in. 1 in. „ 1 „ „ 1-10ths „	0	6	0
12$\frac{1}{2}$ in. 1$\frac{1}{4}$ in. „ 14 „ „ 1-10ths „	0	9	0

1999 **Dumas's Gas Tubes**, for Nitrogen determinations, 17 in. by 1$\frac{1}{4}$ in., containing about 20 cubic inches, and divided to either 1-10th of a cubic inch or cubic centimetres 0 12 6

2000 **Liebig's Gas Absorber**, for saturating a liquid with Gas, and useful in preparing a solution of any gas . . 0 1 6

2001 **Kerr's Gas Tube**, stoppered and graduated to 2 cubic inches, so as to show 1-10th of a cubic inch (fig. 2001) 0 6 0

2002 **Glass Plates**, ground, for covering Air Jars:—

Square .	2 in.	2$\frac{1}{2}$ in.	3 in.	4 in.	8 in.
Price .	8d.	10d.	1s.	1s. 6d.	2s.

2003 **German Glass Tubing**, free from lead, in lengths of about 36 or 18 inches, for convenience of packing:—

$\frac{1}{4}$ in. bore and under . . . . per lb.	0	2	6
$\frac{3}{4}$ in. $\frac{1}{2}$ in. „ down to $\frac{1}{4}$ in. . . . „	0	2	0

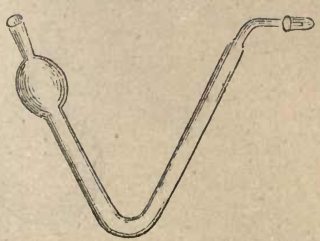


FIG. 2001.

FIG. 2012.

FIG. 2012*.

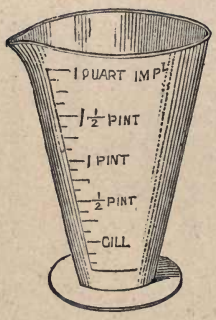


FIG. 2016.

FIG. 2014*.

FIG. 2014.

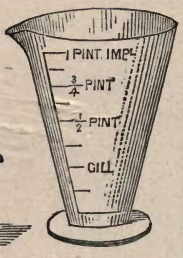


FIG. 2015.

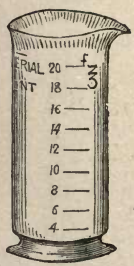


FIG. 2015*.

		£	s.	d.	£	s.	d.
2004	**Flint Glass Tubing**, very soft, easily bent and worked :—						
	¼ in. bore and under . . . . . per lb.				0	2	6
	1 in. ½ in, „ down to ¼ in. . . . . „				0	1	6
2005	**Combustion Tube**, German Glass . . . . . „				0	3	0
2006	**Gauge Tube**, for Steam Boilers, &c., according to diameter, see page 197 . . . . . per inch	0	0	1	0	0	2
2007	**Glass Rod**, of various diameters . . . per lb.	0	2	0	0	2	6
2008	**Glass Inhalers**				0	10	6
2009	**Lamp, Hydrogen**, Dobereiner's . . . 10s. 6d.	0	15	0	1	10	0
2010	**Lamps, Spirit**, glass, round tops and Brass mounts, (figs. 2010 and 2010*) . . . . . 2s., 3s.	0	4	0	0	6	6
2011	Ditto ditto, Common Mountings	0	1	6	0	2	6
2012	**Lixiviating Jars** (figs. 2012 and 2012*) of German Glass strong and convenient in shape, for cold fluids:—						

Contents . .	1 pt.	1½ pt.	2 pts.	3 pts.
Price . .	1s.	1s. 4d.	2s.	2s. 9d.

2013	**Liebig's Retort**, with extra neck for passing gases over any substance while heated for distillation, best hard Bohemian glass (fig. 2013)	0	5	6	0	7	6
2014	**Measures**, Graduated Glass, showing ounces and drachms (figs. 2014 and 2014*) :—						

Conical or Cylindrical Form	1-oz.	2-oz.	4-oz.	8-oz.	10-oz.
Price . .	1s.	1s. 2d.	1s. 9d.	2s.	2s. 6d.

2015	**Measures**, Glass, Graduated Imperial Pint (fig. 2015)				0	3	6
2016	Ditto ditto ditto Quart (fig. 2016)				0	5	0

2017 Measures divided to show equal parts, Grains, Cubic Inches, or Centimetres &c., to order (fig 2017). Price various.

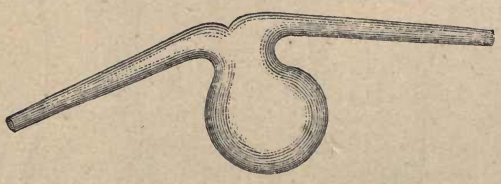


FIG. 2013.

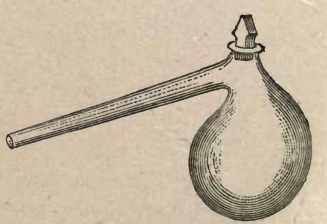


FIG. 2030.

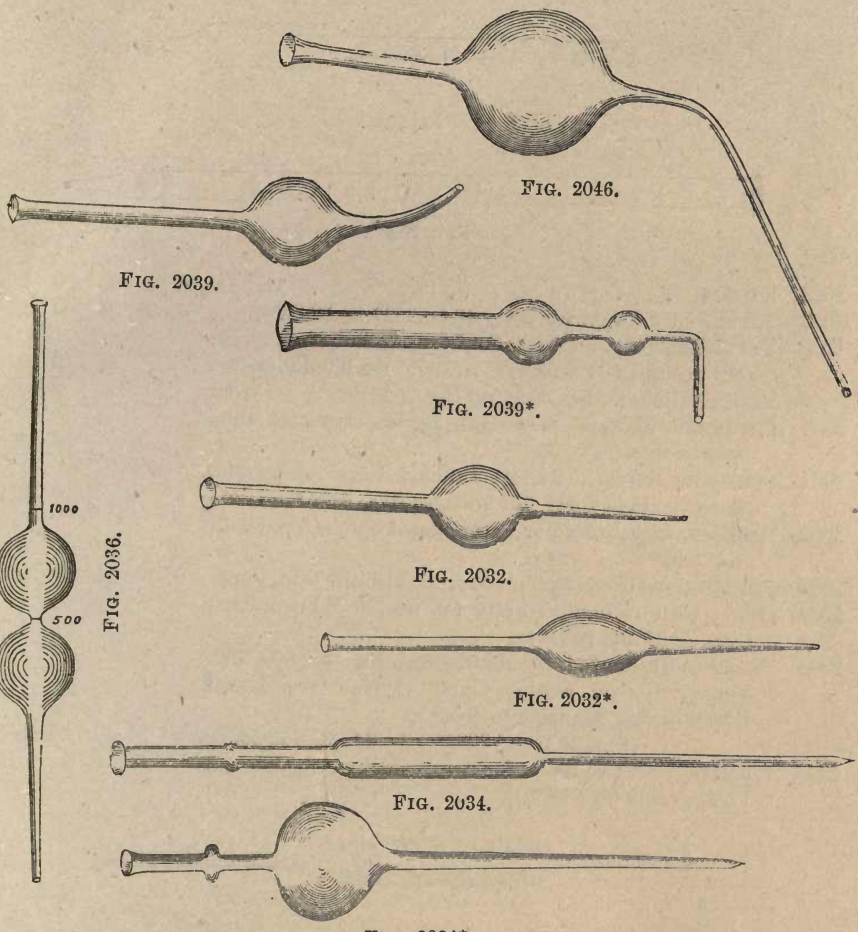


FIG. 2046.

FIG. 2039.

FIG. 2039*.

FIG. 2036.

FIG. 2032.

FIG. 2032*.

FIG. 2034.

FIG. 2034*.

		Each. £ s. d.	Each. £ s. d.
2018	**Measures, Glass,** one drachm, divided into drop or 60 minims (fig. 2014*)		0 1 2
2019	Ditto, Cubic Inch divided into 10ths (fig. 1950) . .		0 5 6
2020	**Mercurial Trough,** Porcelain (fig. 2030)	from 0 2 6	0 5 6
2021	**Mortars and Pestles,** Agate.		

The prices are only approximate, as they vary according to the soundness of the materials, as well as size :—

Diameter	1⅝-in.	1¾-in.	2-in.	2¼-in.	2⅔-in.	3-in.	4-in.	6-in.
Price	8s. 6d.	9s.	10s.	12s.	15s.	20s.	55s.	60s.

2022	**Mortars and Pestles,** Berlin porcelain . 1s. 6d., 2s. 6d.,	0 3 6	0 5 6
2023	**Mortars and Pestles,** best quality, Wedgwood ware :—		

Diameter	2¼-in.	2½-in.	3-in.	3½-in.	4¼-in.	6¼-in.
Price	1s.	1s. 4d.	1s. 6d.	2s.	2s.	2s. 6d.	5s.

2024	Ditto, in **Stout Glass** . 2s. 6d. 3s. 0d. 3s. 6d.	0 4 6	0 6 6
2025	**Mineralogical Anvils,** Hard steel, small square . .	0 7 6	0 10 6

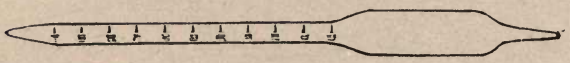


FIG. 2035.

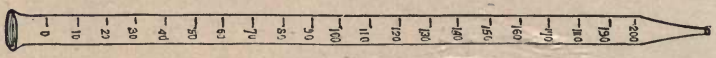


FIG. 2035*.

		Each. £ s. d.	Each. £ s. d.
2026	**Muffles** 9d. 1s	0 1 6	0 2 6
2027	**Mixing Jars** for Alcalimetry (figs. 2027 and 2027*) .	0 1 0	0 2 6
2028	**Test Mixers** (fig. 2028, 2028*), for preparing Test Acid; containing 1,000 septems, divided into 100 divisions .		0 9 0
2029	**Parting Glasses**, for assaying (fig. 2029) . . from		0 0 9
2030	**Pneumatic Trough**, mercurial, Berlin ware, for tube experiments (fig. 2030*)		0 4 0
2031	**Porcelain Retort**, (Berlin) tubulated and stoppered, contents about forty fluid ounces (fig. 2030) . .		0 13 6
2032	**Pipettes**, with Round or Pear shaped bulbs (figs. 2032 and 2032*)	0 0 6	0 0 8
2033	**Pipettes**, or Dropping Tubes, straight bulb, 6-in. long	0 0 6	0 0 8
2034	Ditto, with elongated bulb, for use in Edulcoration (figs. 2034 and 2034*)		0 1 0
2035	**Pipettes, Graduated**, for delivering exactly 1,000, 700, 500, 350, or 50 Grains, Cubic Centimetres, Equal Parts, or any quantity to order (figs. 2035 and 2035*), 2s. 6d. 3s. 6d., 5s. 6d.	0 7 6	0 10 6
2036	**Pipettes**, with two bulbs, for delivering exactly 500 and 1,000 grains (fig. 2036)		0 5 0

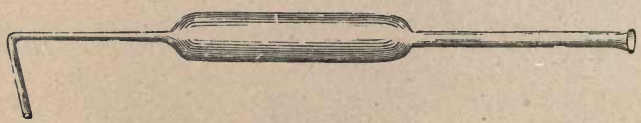


FIG. 2037.

2037	**Pipettes**, for passing a Solution of Potash into a Gas contained in a Tube over mercury (figs. 2037 and 2037*)		0 1 4

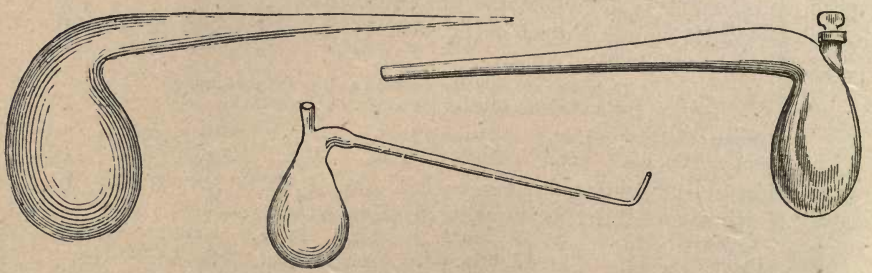


FIG. 2052. FIG. 2054. FIG. 2052*

2038 RETORTS, Glass, various forms and sizes, see also next page.

FIG. 2053.

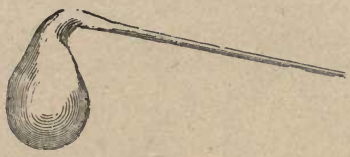


FIG. 2053*.

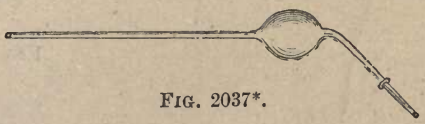


FIG. 2037*.

FIG. 2040.

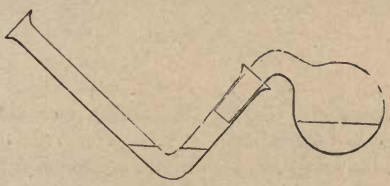


FIG. 2055.

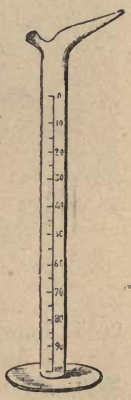


FIG. 2041.

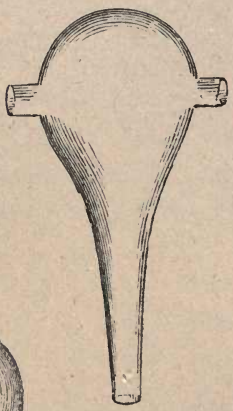
		Each. £ s. d.	Each. £ s. d.
2039	**Pipettes**, with bent points (figs. 2039 and 2039*) . .	0 0 8	0 1 0
2040	**Percolator Glass**, for preparing tinctures, &c. (fig. 2040)		1 15 0
2041	**Pourettes or Burettes**, divided into Grains, Grammes, Equal Parts or Cubic measures (fig. 2041) . .	0 5 6	0 7 6

		8-oz.	10-oz.	20-oz.		
2042	**Precipitating Glasses**, on foot (fig. 2027)	1/6	2/	2/6		
2043	Ditto ditto Philip's	/7	/8	/9	0 1 0	
2044	**Pulse Tubes**				0 1 6	
2045	**Reduction Tubes**, 12-in. tube, 1 or 2 bulbs, straight or bent	0 1 0			0 1 6	
2046	**Reduction Tubes**, with one bulb, the tube bent, for decomposing oxide of copper by heat, in hydrogen gas (fig. 2046)				0 1 6	
2047	**Retorts**, Earthenware, plain	0 1 6			0 2 6	
2048	**Retorts**, Earthenware, to open in the middle 2s. 6d.	0 3 0			0 4 0	
2049	Ditto, of hard glazed Stoneware, for Acids . from				0 7 6	
2050	Ditto, of Berlin Porcelain, for high temperatures, plain	0 4 6			0 7 6	
2051	**Retort**, Porcelain, Stoppered				0 10 6	
2052	**Retorts** of hard German glass (figs. 2052 and 2052*):—					

Contents	2-oz.	4-oz.	6-oz.	8-oz.	12-oz.	1-lb.	1½-lb.	2-lb.	3-lb.
Plain .	4d.	4d.	6d.	8d.	9d.	10d.	1s.	1s. 6d.	2s.
Tubulated	7d.	8d.	10d.	1s.	1s. 2d.	1s. 3d.	1s. 6d.	2s.	2s. 6d.
Stoppered		1s.	1s. 4d.	1s. 6d.	2s.	2s. 3d.	2s. 6d.	3s.	3s. 6d.

2053	**Retorts** (Small) of blown Glass, 2 to 4-oz. capacity, plain and stoppered (fig. 2053 and 2053*) . . .	0 0 9	0 1 6
2054	Ditto ditto, with bent point (fig. 2054) . . .		0 1 3

FIG. 2057.



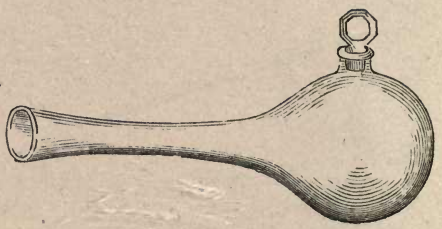


FIG. 2060.

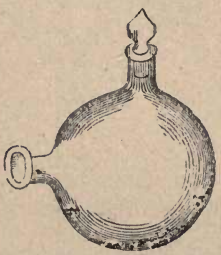


FIG. 2059.

FIG. 2062.

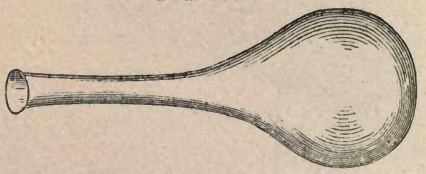


FIG. 2058.

		Each. £ s. d.	Each. £ s. d.
2055	**Retort and Receiver**, Clark's (fig. 2055), exceedingly useful in small distillation		0 1 6
2056	**Receivers**, of blown glass, 1-oz. to 2-oz. capacity, plain and tubulated (fig. 2056) . . . . . 6d.	0 0 9	0 1 0
2057	**Receivers**, Plain, bolt heads, short neck (fig. 2057);—		

Contents	4-oz.	8-oz.	12-oz.
Price	6d.	8d.	9d.

Contents	1-lb.	1½-lb.	2-lb.	3-lb.
Price	1s.	1s. 2d.	1s. 6d.	2s.

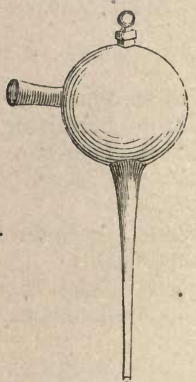


FIG. 2061.

2058 **Receivers**, with long neck (fig. 2058):—

Contents	1-lb.	1½-lb.	2-lb.	3-lb.
Price	1s.	1s. 2d.	1s. 6d.	2s.

2059 Ditto, with Tubulure Stoppered, the neck short (fig. 2059):—

Contents	4-oz.	8-oz.	1-lb.	2-lb.
Price	8d.	10d.	1s. 2d.	1s. 10d.

2060 **Receivers**, with Tubulure Stoppered, the neck long (fig. 2060):—

Contents	4-oz.	8-oz.	1-lb.	2-lb.
Price	1s. 2d.	1s. 4d.	1s. 10d.	2s. 6d.

2061	**Receivers** for preparing Nitric Acid (fig. 2061) . .			0 4 6	
2062	**Receivers** with three necks (fig. 2062) . . .	0 5 6		0 8 6	

FIG. 2027.

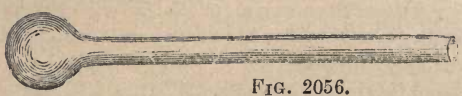


FIG. 2056.

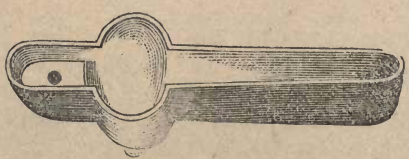


FIG. 2030*.

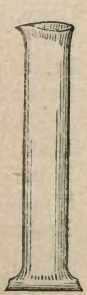
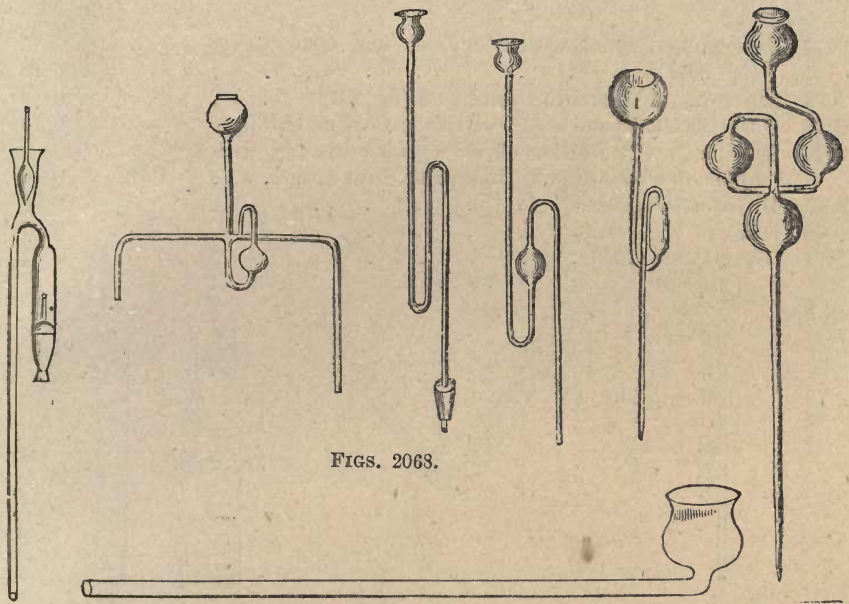


FIG. 2027*



FIGS. 2068.

FIG. 2070. FIG. 2067. FIG. 2069

		Each. £ s. d.	Each £ s. d.
2063	**Receivers**, V shaped, small size, of German glass (fig. 2063)	0 1 0	0 1 3
2064	Ditto, U shaped, large size, of German glass . .	0 1 6	0 2 6
2065	**Receivers**, with delivery tube (fig. 2065), for distilling small portions of substances that require the receiver to be surrounded by ice		0 3 6
2066	Ditto ditto fitted to a japanned copper vessel .		0 10 6
2067	**Funnel**, with bent tube for charging retorts (fig. 2067)		0 1 0
2068	**Safety Funnels** (Welter's), for gas bottles, retorts, &c., various forms (figs. 2068)	0 1 6	0 2 6
2069	Ditto, with four bulbs, preventing any fluid in the funnel reaching the retort by sudden condensation (fig. 2069)		0 3 6
2070	**Safety Funnel**, with two valves which obviate the necessity of using mercury or fluid in the funnel (fig. 2070)		0 5 6

FIG. 2072.

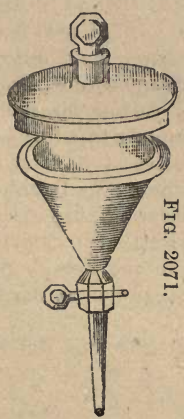


FIG. 2071.

FIG. 2073.

FIG. 2073*

		Each. £ s. d.	Each. £ s. d.
2071	Separating Funnel, with Stop-Cock and Glass Cover (fig. 2071)		0 16 0
2072	Separating or Florentine Receivers (fig. 2072)		0 4 6
2073	Ditto (figs. 2073 and 2073*) with Stop-Cock and Stopper		0 18 6
2074	Specific Gravity Bottles, of 1,000 grains capacity, with adjustable counterpoise, in japanned tin case		0 10 6
2075	Ditto, of 500 grains		0 8 6
2076	Ditto, of 250 grains		0 7 6
2077	Ditto, 1 cubic inch		0 7 6

FIG. 2063.

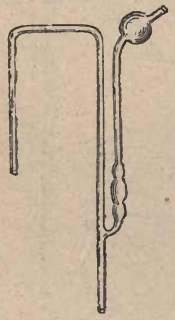


FIG. 2090*.

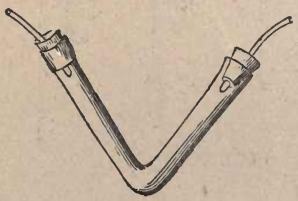


FIG. 2078.

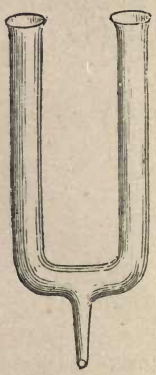


FIG. 2234.

FIG. 2091.

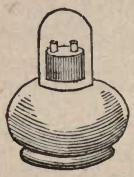


FIG. 2078*.

FIG. 2065.

2078	Spirit Lamps of Glass, with ground caps and Brass wick-holders (figs. 2078 and 2078*):—									
	Contents	2-oz.	4-oz.	8-oz.						
	Price	2s.	3s.	5s.						
	If with screw wick holders, 6d. extra.									
2079	Spoons, stout glass, for transferring small quantities of acid, &c., from one vessel to another						0	2	6	0 5 6
2080	Stirrers, of soft glass, that do not scratch glass vessels in which they are used:—									
	Length	4-in.	6-in.	9-in.	12-in.					
	Price (per doz.)	1s.	1s. 3d.	2s. 6d.	3s.					
2081	Stirrers, unprepared, in lengths of 18 or 24-in. per lb.									0 1 6
2082	Stone Ware Still and Worm, hard glazed, from 1 gall.									1 15 6
2083	Stone Ware Adapters and Taps, Acid Jugs, Ladles, Funnels, Bottles, Pots, Evaporating Dishes, and Coolers, &c., of various sizes and shapes									
2084	Stop-Cocks, solid Glass, accurately fitted, the open end straight and adapted to receive a tube fitted with cork									0 6 0
2085	Ditto, with Bent End, for running off a liquid									0 7 6
2086	Sulphuric Acid Dish, for desiccating purposes									0 4 6
2087	Sulphuretted Hydrogen Gas Bottle (fig. 2087)									0 3 0
2088	Suction Tube (fig. 2088), for filling Potash Apparatus and to ascertain if the connections are Air Tight									0 0 9
2089	Syphon of a simple form									0 1 0
2090	Ditto, with Suction Tube (figs. 2090 and 2090*)						0	2	6	0 3 0

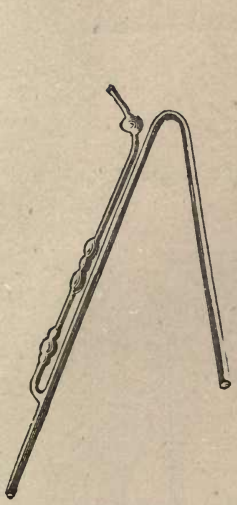


FIG. 2090.

FIG. 2112.

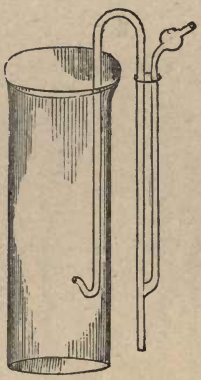


FIG. 2092.

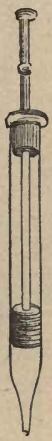


FIG. 2095.

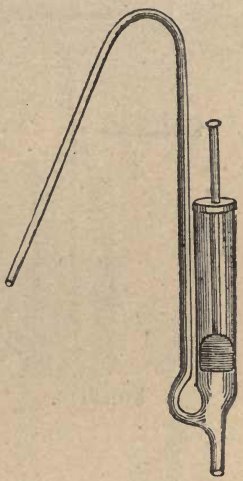


FIG. 2094

2091 **Syphon, Wurtemberg** (fig. 2091) . . 2s. 6d., 5s.
2092 **Syphon, Mitscherlich's**, suction tube with bulb, and the end bent upwards (fig. 2092) . . . 3s. 6d.
2093 Ditto, with Stopcock . . . . . 10s. 6d.
2094 **Syphon**, with Negretti and Zambra's adaptation of Syringe, useful where Acids, &c., are being drawn off (fig. 2094) . . . 5s. 6d.

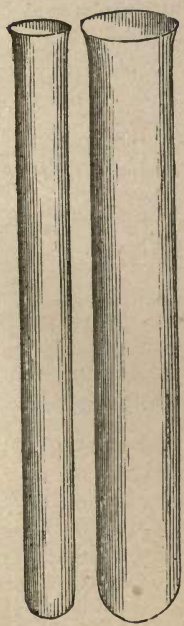


FIG. 2102.

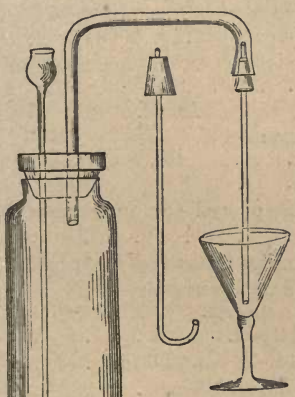


FIG. 2087.

FIG. 2095*. FIG. 2097.

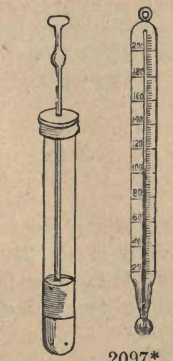


FIG. 2095*. 2097*

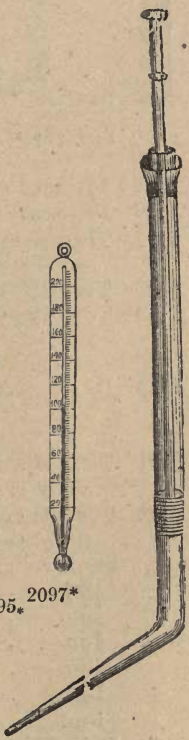


FIG. 2096.

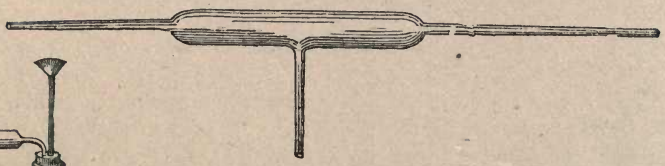


FIG. 2108.

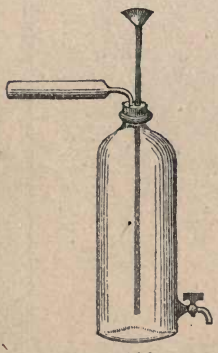


FIG. 2116.

FIG. 2116*.

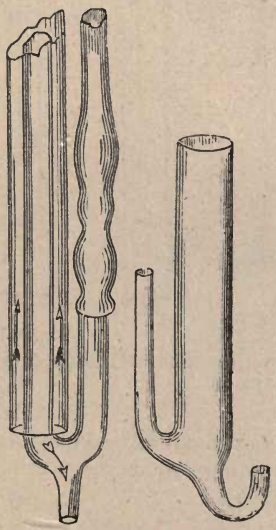


FIG. 2121.

FIG. 2118.

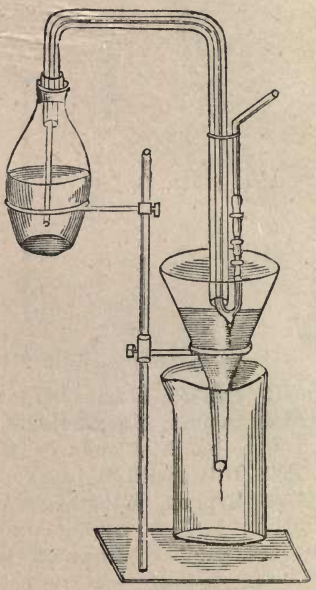


FIG. 2122.

		£	s.	d.	£	s.	d.
2095	Syringes of Glass (figs. 2095 and 2095*)	0	1	0	0	1	6
2096	Ditto, with bent point (fig. 2096)				0	2	0
2097	Thermometers, various, for chemical purposes (figs. 2097, 2097*) see also pages 153 to 175) insulated in glass tube 3s. 6d.	0	5	6	0	7	6
2098	Test Glasses, Conical, Clark's pattern (fig. 2098) .	0	0	8	0	0	9

2099 Test Glasses, Cylindrical, for lecture table (figs. 2099 and 2099*) :—

Capacity . .	12-oz.	8-oz.	4-oz.
	1s. 6d.	1s. 4d.	d.

2100 Ditto ditto Conical form :—

Contents . .	2-oz.	4-oz.	6-oz.	8-oz.
Price . . .	8d.	10d.	1s.	1s. 4d.

2101	Test Mixer, Graduated and Stoppered for quantitative analysis (fig. 2101)				0	8	6

2102 Test Tubes (fig. 2102), of German Glass, free from lead, carefully rounded at the closed end, and bordered at the mouth :—

Diameter.	Length.	Per Dozen.
¼-in. . . .	2 and 2½-in.	0 1 0
½-in. . . .	3, 3½. 4, 4½, 5, and 6-in. . .	0 1 6
⅝-in. . . .	4½, 5, 5½, and 6-in. . . .	0 2 0
¾-in. . . .	4, 5, and 6-in.	0 2 6
1-in. . . .	5 and 6-in.	0 3 0
1-in. . . .	7 and 9-in.	0 4 6

2103	Tube Flasks . . . . . per doz.	0	4	0	0	6	0
104	Tube Retorts . . . . . each	0	0	6	0	0	8

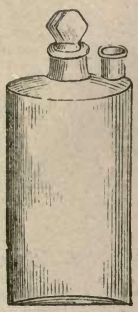


FIG. 2126.

FIG. 2126*.

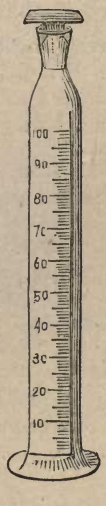


FIG. 2101.

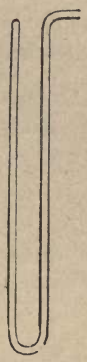


FIG. 2109.

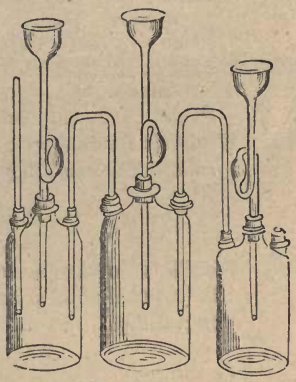


FIG. 2127.

2105 **Tubes** of Berlin Porcelain, for containing substances to be heated to redness :—

Length	18-in.	24-in.	18-in.	24-in.	18-in.	24-in.
Diameter	½-in.	½-in.	¾-in.	¾-in.	1-in.	1-in.
Price	4s. 6d.	5s. 6d.	7s. 6d.	7s. 6d.	10s. 6d.	12s.

2106	**Trays**, flat, Porcelain, for washing papers, &c.			1s. 6d.	£0	2	6	£0	4	6
2107	Ditto, shallow, Glass			from				0	3	6
2108	**Tubes**, three-limb and letter Z, for adjusting apparatus to the exhausting syringe (fig. 2108)				0	1	6	0	1	9
2109	**Tubes**, long Glass conducting U shape (fig. 2109) .							0	1	6
2110	**Turpentine Bulbs**, of glass, for containing volatile substances about to be analysed . . .		per doz.					0	1	0
2111	**Watch Glasses**		per doz.		0	2	0	0	4	0
2112	**Water Hammers** (fig. 2112)							0	4	0
2113	Ditto ditto, best make		5s. 6d.		0	8	6	0	12	0
2114	**Water Baths**, for drying precipitates or explosive compounds, stoneware or porcelain							0	3	6
2115	**Water or Oil Bath**, of Berlin Porcelain, especially adapted for drying a precipitate contained on a filter							0	4	6
2116	**Water Bottle**, stoppered, with glass tap, for holding distilled water, &c.; also useful as Aspirators (figs. 2116 and 2116*) :—									

Contents	4-lb.	6-lb.	8-lb.	12-lb.	20-lb.	24-lb.
Price	11s. 6d.	12s. 6d.	15s.	18s.	25s.	30s.

2117	**Washing Bottle**, Berzelius' Fountain, for washing precipitates by a continual jet of water . . .							0	2	6
2118	The Tube only (fig. 2118)							0	1	6
2119	**Washing Bottles**, Gmelin's, fitted to a 16-oz. flask .							0	2	6
2120	**Washing Bottle**, Syphon, improved form, in which a current of water is supplied continuously . . .							0	6	0
2121	The Tube only (fig. 2121)							0	4	9
2122	**Washing Bottle**, improved form, complete with support, funnel and receiving jar (as fig. 2122) . .							0	16	0

		£	s.	d.	Each. £	s.	d.
2123	**Volumeter**, 1,000 grains capacity, divided into 100 equal parts (fig. 2101)	0	5	6	0	7	6

2124 **Woulffe's Bottles**, well made plain necks, so as to cork easily; with two necks shape as fig. 2124 :—

Contents	½-lb.	1-lb.	2-lb.	4-lb.	6-lb.	8-lb.	10-lb.
Price .	1s.	1s. 6d.	2s. 6d.	3s. 8d.	5s.	7s.	8s. 6d.

2125 **Woulffe's Bottles**, with three plain necks, shape as fig. 2125 :—

Contents	½-lb.	1-lb.	2-lb.	4-lb.	6-lb.	8-lb.	10-lb.
Price .	2s.	2s. 6d.	3s. 4d.	4s. 8d.	6s.	9s. 6d.	11s. 6d.

2126 **Woulffe's Bottles**, with one neck, accurately Stoppered, as figs. 2126 and 2126* :—

	1-pint.	2-pints.	3-pints.
2-neck	3s. 2d.	3s. 8d.	4s. 6d.
3-neck	3s. 8d.	4s. 6d.	5s. 6d.

2127 **Woulffe's Bottles**, a set of three 1-pint, in a Mahogany tray, fitted with safety funnels, tubes and connectors (fig. 2127) 0 18 6

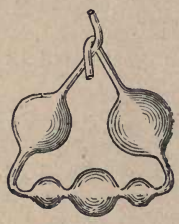


FIG. 2137.

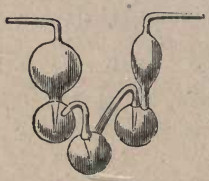


FIG. 2137*.

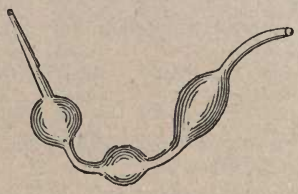


FIG. 2145.

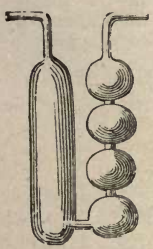


FIG. 2138.

APPARATUS FOR ORGANIC ANALYSIS, &c.

		£	s.	d.	£	s.	d.
2128	**Apparatus** for illustrating the Composition of Water Synthetically, by burning Hydrogen gas in atmospheric air				0	5	0
2129	**Berzelius' Sulphuretted Hydrogen Apparatus** (figs. 2129, 2129*)				0	8	6
2130	Ditto, ditto, with extra Washing Bottle, . . .				1	12	6
2131	**Cavendish's Apparatus** for detonating a mixture of Oxygen and Hydrogen Gas, illustrating the Composition of Water				2	12	6
2132	**Donavon's Apparatus** for Filtering Caustic Potash (fig. 2132)				1	10	0
2133	**Dobereiner's Extracting Apparatus** (fig. 2040) . .				1	15	0
2134	**Fritzch's Apparatus**, for Analysis of Carbonates (fig. 2234)				0	2	0
2135	**Glass Apparatus** for showing Diminished Bulk by mixing Sulphuric Acid and Water (fig. 2135) . .				0	5	0
2136	**Glass Apparatus**, for Exhibiting the Philosophical Candle and producing musical sounds by Hydrogen Gas . . . . . from				0	10	6
2137	**Leibig's Potash Apparatus**, made very light from German glass, free from lead (figs. 2137 and 2137*) .	0	2	6	0	3	6

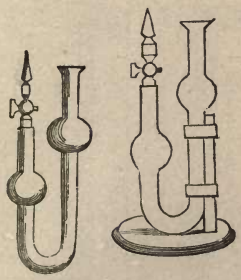


FIG. 2139. FIG. 2140.

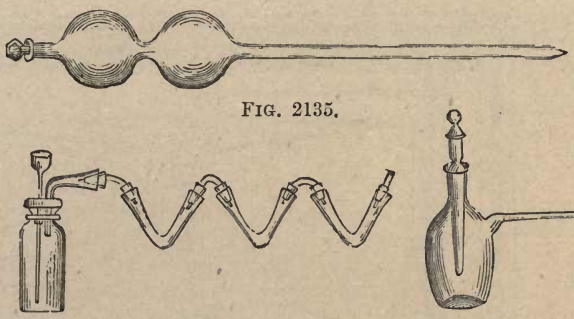


FIG. 2135. FIG. 2141. FIG. 2129.

		£	s.	d.	£	s.	d.
2138	**Mitscherlich's Potash Apparatus**, very light, (fig. 2138)				0	3	0
2139	**Marsh's Apparatus** for detecting Arsenic (fig. 2139) .				0	7	6
2140	Ditto, ditto, on Stand (fig. 2140)				0	9	6
2141	**Clark's Apparatus** for detecting Arsenic (fig. 2141) .				0	10	6
2142	**Percy's Apparatus**, for Analysis of Carbonates . .				0	7	0
2143	**Ure's Apparatus** for determining the quantity of Nitrogen	0	4	0	0	6	6

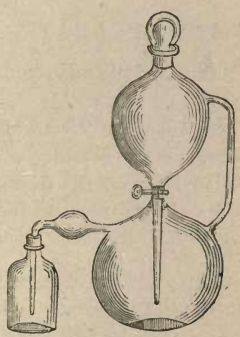


FIG. 2132

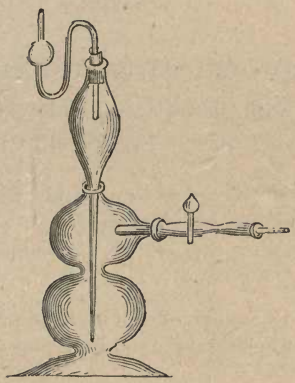
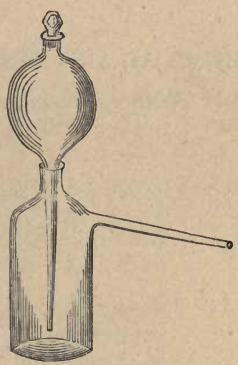


FIG. 2136.



FIG, 2129*.

2144	**Will and Varrentrap's Nitrogen Bulbs**				0	1	6
2145	**Nitrogen Bulb with Horsford's Modification** (fig. 2145)				0	3	0
2146	**Bell-Shaped Dialyser of Glass**, with two Flanges .				0	1	6
2147	**Cylindrical Glass Jars**, for using above . . .	0	3	6	0	5	6
2148	**Dialysers, Tube Form, Dr. Alfred S. Taylor's Form**, for testing Mineral Poisons				0	5	6
2149	**Parchment Paper**, for use with Dialyser, best quality 8½ by 6 inch, 1s. 6d.; 10½ by 6 inch, 2s.; 12 by 12 inch, 2s. 6d.; 14 by 12 inch, 3s. 6d. per dozen.						
2150	**Flat Conical Glass Basins**, with Spout for holding Distilled Water below the Dialyser, and collect the Diffusate . . . . . 3s. 6d.	0	5	6	0	6	6

Sets of Chemical Apparatus and Tests adapted for the Analysis of Soils, Manures, &c., &c., or for the examination of Adulterated Articles of Food fitted up to order. *See also end of Chemical Section, page* 411.

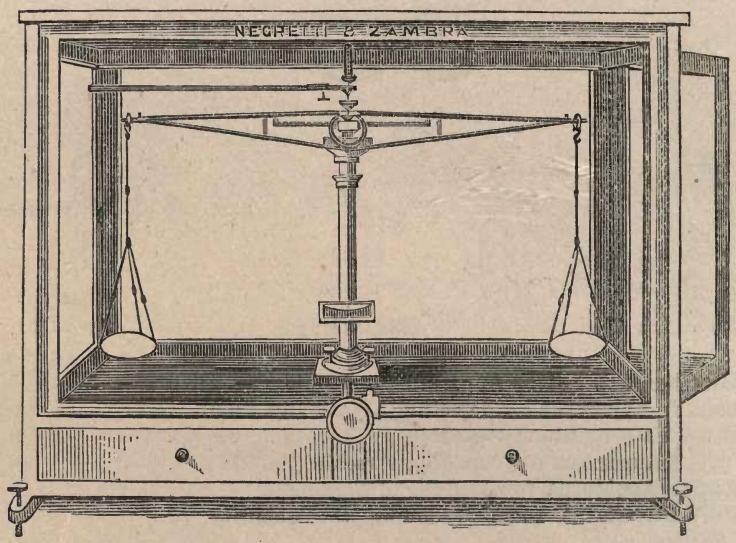


FIG. 2153.

CHEMICAL AND PHILOSOPHICAL INSTRUMENTS AND APPARATUS.

2151 **Balances, Chemical,** with Glass Cases, highly finished and carefully adjusted, to turn with $\frac{1}{100}$th of a grain or one Milligramme
£8 8s. 10 10 0 12 12 0

2152 **Balances, Assay,** with framed beam and steel knife, edges resting on Agate planes, sliding weight on beam, with adjustments, in **Glass Lantern,** with levelling screws, &c., of the most delicate accuracy, to turn with $\frac{1}{1000}$th of a grain 15 15 0 25 0 0

2153 **Balances, Assay or Chemical,** of the highest precision, fitted with all recent improvements, adjustments and appliances. Plate Glass for bottom of the case (fig. 2153) . . . . . £35 to £50 0 0

Decimal Weights, Sets of, see page 400.

2154 **Balance** (fig. 2154) for Assaying, Analysis, or Diamond weighing, will carry 500 grains and turn with $\frac{1}{10}$th of a grain; all bearings of Steel. In plain Glass Case, with key arrangement for lifting . . £6 6 0

Ditto ditto with Set Screws and Spirit Level . . £7 7 0

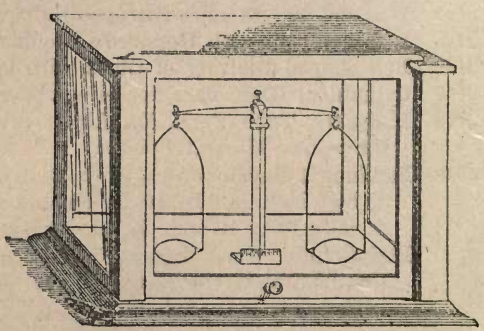


FIG. 2154.

2155 **Balance** for determining the Specific Gravity of Fluids, whether heavier or lighter than water, to the third place of decimals. This Balance consists of weigh-beam, a plunger to be immersed in the fluid; fitted with Thermometer, Set of Weights and Riders, Glass Solution Jar, &c., in wood case . . . . . price £4 10 0

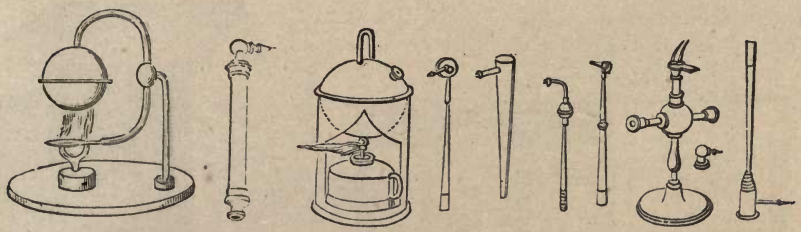


FIG 2170. FIGS. 2168, 2171, 2167*, 2165, 2167 2166 2169, 2167*

2156 **Balances and Scales with Weights**, for Commercial, rough Laboratory, or counter use, see pages 405, 408.

2157 **Balloons**, for inflation with Hydrogen or Coal Gas :—

Diameter	9-in.	10-in.	12-in.	16-in.	18-in.	20-in.	36-in.
Price	1s. 6d.	2s. 6d.	3s. 6d.	4s. 6d.	5s. 6d.	8s. 6d.	36s.

		Each. £ s. d.	Each. £ s. d.
2158	**Balloons**, oval shape, 3-ft. high and 2-ft. diameter		1 1 0
2159	**Balloons**, fish shape, 15-in. and 30-in. long		0 18 6
2160	**Bladders**, mounted with Ferrules		0 3 6
2161	Ditto ditto and Stop-Cock	0 7 6	0 10 6
2162	**Bar Compound**, for showing the unequal expansion of metals by heat	0 5 0	0 12 6
2163	**Bars of Antimony, Bismuth, Copper, Iron, Lead, Tin, and Zinc**, for precipitating metals from solution, from		0 0 4
2164	**Blowpipes**, common Brass	0 1 0	0 1 6
2165	Ditto, Black's (fig. 2165)	0 1 0	0 2 0
2166	Ditto, Bergman's improved (fig. 2166) with two jets		0 7 6
2167*	**Blowpipes**, various patterns: Berzelius' (fig. 2167); Pepy's (fig. 2167*) with movable Jet, for use at any angle; or **Wollaston's** Pocket form 2167* . . from	0 16 0	0 12 6
2168	**Blowpipe**, Hemming's Safety, Oxy-Hydrogen (fig. 2168)		0 12 6
2169	**Blowpipe, Oxy-Hydrogen**, complete with Lime-Holder, Stopcocks, &c., (fig. 2169)		2 10 0
2170	**Blowpipes**, Spirit, Self-acting, for bending glass tubes, strong Tin (fig.2170)		0 10 6
2171	Ditto ditto, Copper Ball (fig. 2171)		0 15 0
2172	**Blowpipe**, Self-acting, Gas and Steam, very convenient and powerful for small solderings, brazings, or fusions		2 2 0
2173	**Blowpipes**, Spirit, or Russian Furnace		0 15 0
2174	Ditto ditto, with ring and support		1 1 0
2175	**Blowpipe, Tilley's Water Pressure**, with jets, &c., complete, in japanned tin		1 12 6
2176	**Bruner's Aspirator**, Japanned Tin or Zinc (see fig. 78* page 72). See also Water Bottles		1 5 0
2177	**Glass Blower's Table**, with best double-action bellows, jointed motion to jet-holder, and two jets (fig. 2177).		3 3 0
2178	**Glass Blower's Lamps** (figs. 2178 and 2178*)	0 3 0	0 5 0
2179	**Spirit Lamps**, of glass (fig 2179)	0 2 6	0 3 6

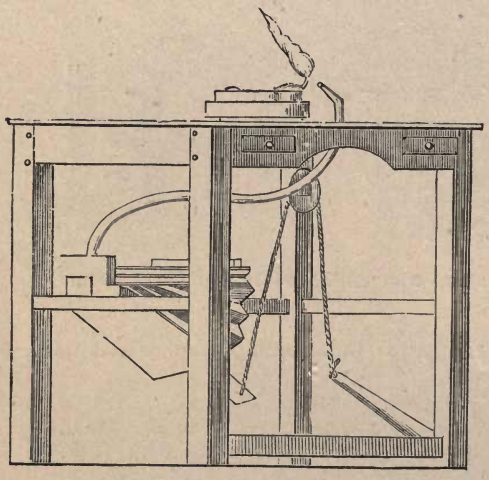


FIG. 2177.

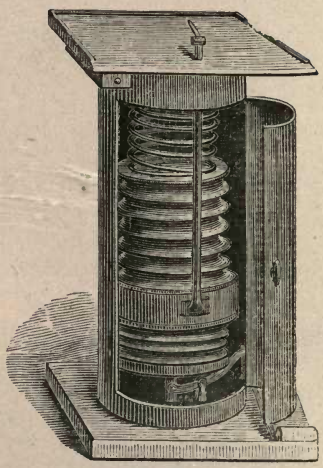


FIG. 2179.

2179* **Glass Blower's Apparatus, Patent,** consisting of a circular column of japanned zinc, table covered with zinc (having brass-bound edges) double-action circular bellows, drawer, and universal jointed jet (fig. 2179) £5 10 0

2179† Ditto ditto without Zinc cover to the table . 5 0 0

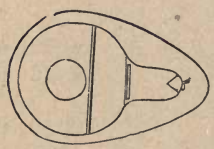


FIG 2178.

FIG. 2179.

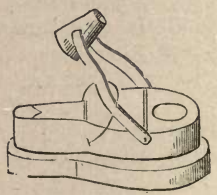


FIG. 2178*.

2180 **Hot Blast Blowpipe,** for temperatures above those obtained by the ordinary gas and air blowpipe. It will be seen by the wood-cut (fig. 2180) that the tube of the **Air Jet** is coiled round the gas tube, both being heated by a Bunsen Burner underneath, each being controlled by separate taps.

The jet when reduced down to a small point of flame is nearly equal in power to the Oxy-Hydrogen Jet, readily fusing a moderately thick Platinum Wire. It is a most useful arrangement for Chemical Soldering, and general Workshop use. Price 16s. 6d.

2181 **Hand Blower** (fig. 2181) for use with above . . . 0 16 6

2182 **Foot Blowers,** for Blowpipe work, Autogenous Soldering or Furnace use. 21s., 30s., 35s.

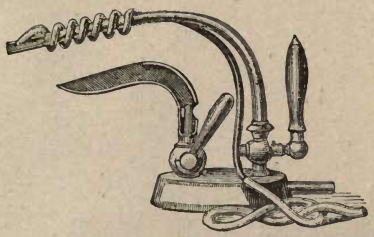


FIG. 2180.

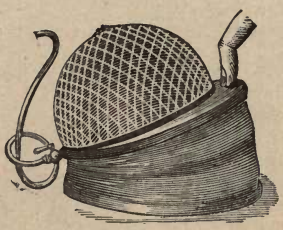


FIG. 2181.

		Each. £ s. d.	Each. £ s. d
2183	**Blowpipe Jets**, Platinum . . . . . from		0 2 6
2184	**Blowpipe Forceps** of Brass with fine points . .		0 2 6
2185	Ditto ditto Steel and Platinum Points . 5s. 6d.	0 7 6	0 10 6
2186	Ditto **Spoons**, Platinum or Silver . . . from		0 5 0
2187	**Blowpipe Apparatus**, for Pocket, containing requisites for Assaying metals, in case		1 10 6
2188	**Bellows**, portable Double, for table furnaces. from		1 10 0
2189	**Blowpipe, Mineral Fragments**, per box		0 12 0
2190	**Brass Tobacco Pipe**, for blowing Gas Bubbles . .		0 3 0
2191	**Brushes**, Test Tube . . . . . from		0 0 6
2192	Ditto, **Phial and Bottle** . . . . . 8d.	0 0 10	0 1 6
2193	**Caoutchouc** in sheets		0 1 6
2194	**Caoutchouc Gas Bags**, wedge shape, see also Lantern Section. . . . . from		1 10 0
2195	Ditto **Connectors**, for joining tube apparatus from		0 0 2
2196	Ditto, **Vulcanised Tube** . . . . per foot, from	0 0 6	0 2 0
2197	Ditto **Varnish** . . . . . per oz.		0 0 4
2198	Ditto **Water Bottles**	0 10 6	1 1 0
2199	**Capsules** of Platinum, Silver, Copper, &c., various.		
2200	**Chauffers** with cover and pipe for increasing heat .	0 10 6	0 12 6
2201	**Chemical Labels** . . . . . per set	0 0 8	0 3 0
2202	**Combustion Furnace** of stout Sheet Iron . . .		0 7 6
2203	**Cross** of Four Metals for showing unequal power of conducting heat		0 6 0
2204	**Connecting Pieces**, Brass Angle and T Pieces, Union Joints for uniting Stop-Cocks, &c. . 1s. 1s. 6d.	0 2 6	0 4 6
2205	**Connecting Ferrules**, Brass, for Bladders . . .	0 1 0	0 1 6
2206	**Crucibles**, Platinum, Silver, Iron, &c., various.		
2207	**Crucible Jacket**, iron plate, to hold any size Platinum Crucible		0 2 0
2208	**Crucible Stands and Supports**, various	0 0 2	0 0 8
2209	Ditto **Tongs**, straight, bent, &c., of various sizes 1s. 6d.	0 2 6	0 4 6
2210	**Fletcher's Blowpipes** and Furnace Apparatus supplied to order.		

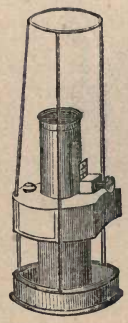


FIG. 2261.

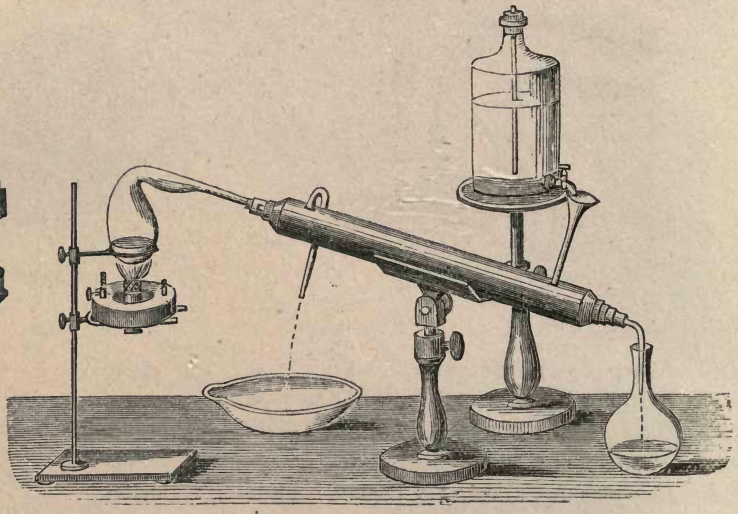


FIG. 2212.

		Each. £ s. d.	Each. £ s. d
2211	**Condensers, Liebig's form for Distillation** (fig. 2212) .		0 10 6
	The steam passes through a long Glass tube, inclosed in an outer Metal tube; in the intervening space water is made to flow continuously, and rapid condensation is effected.		
2212	**Support** for Liebig's Condenser, best make, in wood, capable of being elevated and inclined to any angle (see fig. 2212)		0 10 6
2213	Ditto ditto, Metal		0 16 0
2214	**Adjustable Wooden Stand** for water vessel (see fig. 2212)		
2215	**Cork Borers**, a set of four, without case . . .		0 2 6
2216	Ditto, of polished brass, set of six, in a case . .		0 4 6
2217	Ditto, a set of twelve	0 7 6	0 12 6
2218	**Deflagrating Spoon**, the bowl rivetted to the stem, with a sliding cover for the jar (fig. 2218)		0 0 8
2219	Ditto, Ground Cover, to fit the top of Glass Receiver .		0 2 6
2220	**Drying Apparatus**, or Hot Air Bath, on stand, japanned tin, from		1 1 0
2221	Ditto ditto of Copper, or Copper tinned . .	2 2 0	4 4 0
2222	**Decimal Weights**, from 1,000 grains to a 10th of a grain, in mahogany box		1 10 0
2223	Ditto, from 1,000 grains to 1-100th of a grain, the smaller weights of Aluminium or Platinum . .		2 2 0
2224	**Diamonds**, for Writing and Engraving on Glass from		0 10 6
2225	Ditto for Cutting ditto	0 15 6 to	2 2 0
2226	**Dishes, Evaporating**, Copper . . . . from		0 2 6
2227	Ditto ditto Copper tinned inside . .		0 3 0
2228	Ditto ditto Copper plated with silver . .		0 6 6
2229	Ditto ditto Silver . . . . from		0 12 6
2230	Ditto ditto Enamelled Iron . . .		0 2 6
2231	**Evaporating Capsules**, of Platinum :—		

Diameter .	½-in.	¾-in.	1-in.	1½-in.	2-in.	2½-in.	2¾-in.
Contents .	1-16th oz.	1-10th oz.	⅛-oz.	¼-oz.	⅝-oz.	½-oz	1½-oz.

Price variable, according to weight, about 35s. per oz.

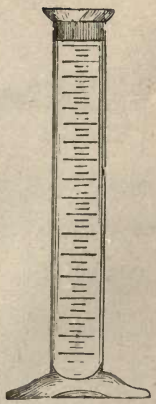


FIG. 2257†.

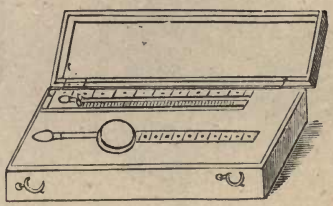


FIG. 2257*.

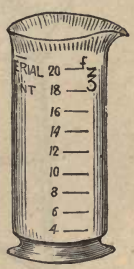


FIG. 2257†.

		Each. £ s. d.	Each. £ s. d.
2232	**Files**, for cutting Glass Tube, with wood handle . .		0 1 6
2233	**Files and Rasps**, for fitting Corks to tubes, with wood handle		0 1 6
2234	**Flexible Tube, Metal**, for conducting gases, from per foot		0 0 10
2235	Ditto ditto Vulcanised India Rubber . .	0 0 6	0 1 0
2236	**Filter Paper**, very thick and coarse		0 1 9
2237	**Filter Papers, Circular**, ready cut for use; give a very minute portion of ash, and filter rapidly; in packets of 100 :—		
	Diameter . 2½-in. 2¾-in. 2¾-in. 4½-in. 5½-in. 7¼-in.		
	Price per 100 . 3d. 5d. 7d. 8d. 1s. 1s. 4d.		
2238	**Filtering Paper**, superior quality, per quire . . .	0 1 6	0 2 0
2239	Ditto, **Swedish**, per quire, Munktell's Genuine . .		0 4 6
2240	**Filter Paper Boxes**, japanned, holding 200 filters :—		
	For No. 1 2 3 4 5 6 Filters.		
	7d. 8d. 9d. 1s. 1s. 3d. 1s. 6d.		
2241	**Funnels**, Gutta Percha . . . . . from		0 2 0
2241*	Ditto, Ebonite . . . . . each	0 2 0	0 3 6
2422	Ditto, Tin and Tinned Copper	0 1 6	0 2 6
2243	**Furnaces**, Aikin's blast		0 18 6
2244	**Furnaces**, Black's Universal, of Sheet Iron, with Cast Iron fittings, applicable to the reduction and assay of metallic ores, cupellation of silver, &c., full size .		5 10 0
2245	**Furnaces**, portable Table Earthen and Black lead, from	1 1 0	1 10 0
2246	Ditto, Black Lead, larger, for retorts or tubes, &c. .	2 2 0	4 4 0
2247	**Furnaces**, round Iron, lined with fire lute or brick, applicable for general chemical purposes . . .	3 3 0	5 5 0
2243*	**Furnace Blowers**, see page 398.		
2244*	**Forge**, improved single blast. These Forges possess great power, and are very portable . . Round	5 5 0	6 6 0
2245*	**Forge**, Patent double Deck or Rivet, having large powers of blast, insuring great and rapid heat (fig. 2245) Round		8 8 0

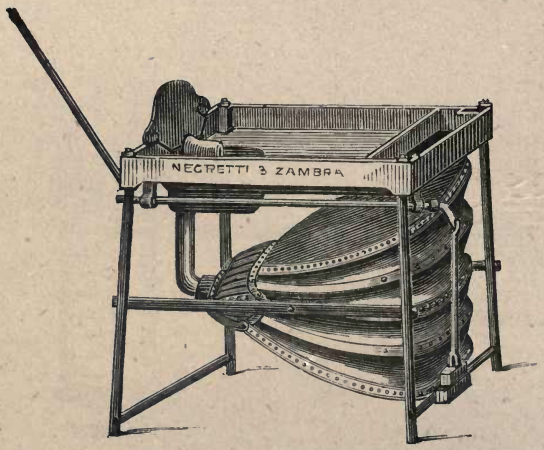


FIG. 2247*.

FIG. 2245*.

		Each. £ s. d.	Each. £ s. d.
2246*	**Forge**, improved Portable Iron, adapted for soldering and brazing purposes, jewellers' uses, and suited for amateur mechanics . . . . . Square	5 5 0	6 6 0
2247*	**Forge**, portable Iron, improved with double bellows, the whole fitted together with nuts and screws for convenience of packing, arranged with connecting screw and pipe for blast furnaces (fig. 2247*) . .		10 10 0
	A most useful article for persons residing in foreign parts, or Emigrants.		
2248	**Gas Apparatus**, complete, for making oxygen and hydrogen in quantities for the Oxy-Hydrogen Light (see page 363)		3 3 0
2249	**Gas Retort**, Copper, with **Conducting Tube**, for the preparation of Oxygen Gas, without Bag . . .	1 1 0	1 10 0
2250	Ditto, Wrought Iron		1 1 0
2251	Ditto, Iron, small		0 12 6
2252	**Gas Burners, or Furnace** (Bunsen's), adapted for burning common gas, mixed with air, without smoke; for boiling, distilling, &c. (figs. 2252, 2252*, 2252†) 5s. 6d.; 8s. 6d.	0 12 6	0 16 0
2253	**Gas Blowpipes**, see *ante*, page 398.		
2254	**Gas Lamp**, conveniently arranged on bronzed adjusting table stand as a reading lamp, a microscopic illuminating or preparing lamp, and also useful for chemical operations, see page 271 (fig. 364*) Microscope Section . . . . . price		3 0 0
2255	**Gauge Brass**, for showing the expansion of metals by heat, see also Section Phenomena of Heat . .		0 6 0
2256	**Gutta Percha Basins, Funnels, Troughs, Trays, Tube**, &c., &c., . . . various sizes and prices to order.		
2257	**Gutta Percha Bottles**, round, for Acids, &c.:—		

	2-oz.	4-oz.	8-oz.	16-oz.
Price . .	1s.	1s. 4d.	1s. 6d.	2s. 6d.

2257* Hydrometers for testing Heavy and Light fluids of all kinds, see pages 176 to 195.

2257† Graduated Test or Mixing Jars for use with above, 3s. 6d. and 6s.

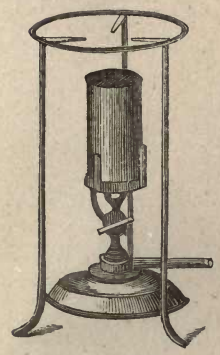


FIG. 2252.

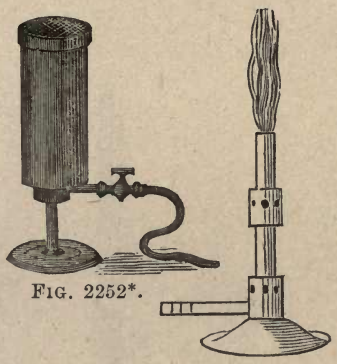


FIG. 2252*.

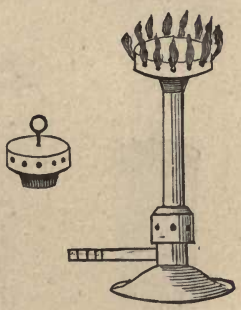


FIG. 2252†.

		Each. £ s. d.	Each. £ s. d.
2258	**Hammers, Mineralogical** . . . from		0 6 0
2259	**Iron Spheres**, strong; this apparatus shows the expansive force in the congelation of water . .		0 4 6
2260	**Ladles**, small Iron . . . . . from		0 0 8
2261	**Lamps**, Chemical Argand, for oil, with cottons and mandril, complete (fig. 2261) . . . 7s. 6d.	0 8 6	0 10 6
2262	Ditto ditto with double concentric wick . .		1 1 0
2263	**Lamp**, Argand Fountain, for Oil, with adjusting screws to fix on retort stand		0 18 0
2264	**Lamps, Davy's Safety**, for Miners		0 12 0
2265	Ditto ditto recently improved (fig. 2265) . .	0 15 0	1 5 0
2266	Ditto, **Bunsen's for Blowpipe**, with tray . . .		0 7 0
2267	**Lamps**, Spirit, small brass (fig. 2267)		0 6 6
2268	**Lamps**, Spirit, Brass, with two sliding rings, a convenient stand, for small evaporating dishes, &c. . .		0 16 0
2269	**Lamps**, Argand, Spirit, Brass with Circular Wick .		1 10 0
2270	**Lamps**, Hydrogen, Dobereiner's, for producing instantaneous light with a jet of hydrogen . .	1 6 0	1 10 0
2271	**Magnets**, Steel, Horse-shoe shape . 6d., 9d., 1s.	0 1 6	0 5 0
2272	**Magnetic Oxide of Iron, or Natural Loadstone**, Specimen pieces or slabs . . . . . from		0 4 6
2273	**Magnesium Wire** . . . . . per yard		0 0 6
	Masks, of Wire Gauze, for protecting the face . .		0 12 6
2274	**Magnifying Glasses**, Pocket, for examining minerals, crystals, &c. (See "Optical Section," page 224) 1s.6d.	0 3 6	0 4 6
2275	**Metallic Vessel**, Leslie's Cube, with polished and blackened surfaces, for showing the absorption and radiation of heat		0 5 6
2276	**Mercurial Troughs**, Iron and Mahogany . from		0 6 0
2277	**Mohr's Burettes**, with support (fig. 2277) . . .		0 16 0
2278	Ditto ditto without stand		0 7 6
2278*	**Mortars and Pestles**, of Cast Iron . . . from		0 4 0
2279	**Mortars of Steel**, for crushing hard minerals . .		1 12 0
2280	**Melting Tongs**, for Furnace Work	0 4 6	0 6 6
2281	**Nippers or Cutting Pliers**, for cutting wire . . .	0 2 6	0 3 6

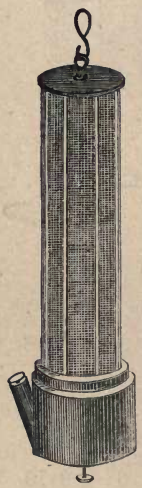


FIG. 2265.

FIG. 2267.

FIG. 2333.

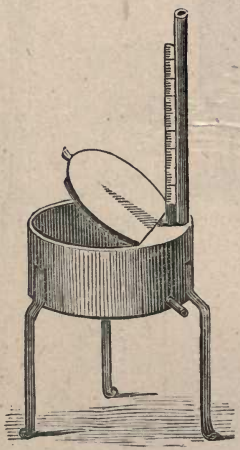


FIG. 2335.

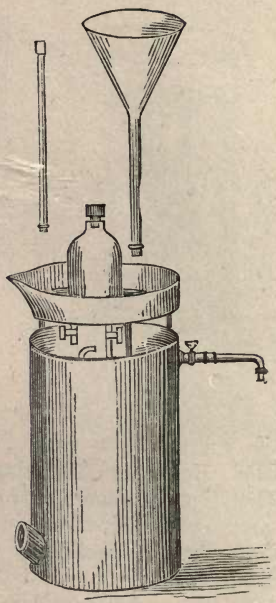


FIG. 2287.

		Each. £ s. d.	Each. £ s. d.
2282	**Platinum Crucibles, Basins, and Evaporating Dishes,** various sizes . . . . . about per oz.		1 15 0
2283	**Platinum Retorts,** half-pint . . . . . about		11 0 0
2284	Ditto ditto one pint		16 0 0
2285	**Platinum Forceps and Spoons** 1s. 6d. 3s. 5s. 6d.	0 8 0	0 12 0
	No exact prices can be given for Platinum Vessels, as the value varies considerably.		
2286	**Pepy's Gas Holder,** of japanned Tin or Zinc, with long pressure funnel, stopcocks and connectors complete, to hold about 2,000 cubic inches		3 3 0
2287	Ditto best mounted, Copper japanned (fig. 2287) with Graduated Gauge Tube		5 5 0
2288	**Pneumatic Troughs,** Japanned Tin, for collecting gases, small size, Round for Tube Experiments . . .		0 7 6
2289	**Pneumatic Troughs,** Oblong Shape, 1st size . . .		0 10 0
2290	Ditto ditto 2nd size		0 12 6
2291	Ditto ditto 3rd size . . . (fig. 2291)		0 18 6
2292	**Pneumatic Troughs,** of any size or shape, made to order, in Copper, Tin, or Zinc, &c.		
2293	**Reflectors,** highly polished metallic, for experiments on radiant heat . . . . . from, per pair		1 10 0
2294	Ditto, Plated Copper . . . . . from		2 10 0
2295	Ditto, Stands, for Reflectors and Iron Ball . . .	0 6 0	0 8 0
	See also section Phenomena of Heat.		
2296	**Retorts,** Lead, for Fluoric Acid, 16 oz.		0 10 6
2297	**Retort Stands,** small Iron foot . . . from		0 2 6

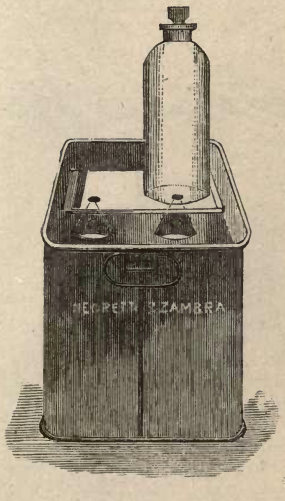


FIG. 2291.

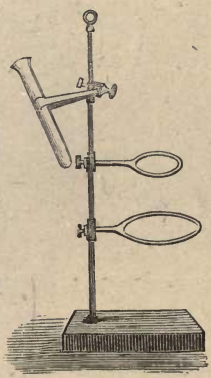


FIG. 2298.

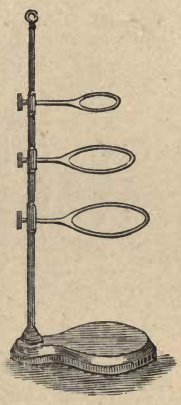


FIG. 2298*.

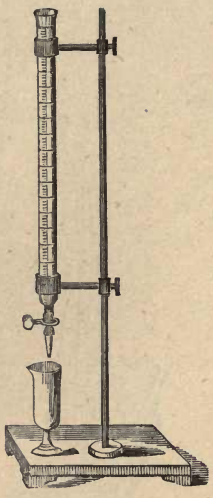


FIG. 2277.

		Each. £ s. d.	Each. £ s. d.
2298	**Retort Stands**, Iron foot and rod, 2 and 3 rings (fig. 2298 and 2298*) . . . . 2s. 6d., 5s.	0 7 6	0 14 0
2299	Ditto ditto Brass, large, with heavy foot (fig. *f*) page 375	0 16 0	0 18 6
2300	Ditto ditto, large with Fountain, Argand Oil Lamp, and three rings		1 15 6
2301	**Sand Baths**, small round Copper, for Retort Stands .	0 1 6	0 2 6
	Ditto ditto, in Copper and Iron, of various forms and sizes, for Furnaces.		
2302	**Stands or Supports** for ditto Tripod		0 7 6
2301*	**Scales and Weights**, in Pocket case, for Diamonds or Gold dust		2 2 0
2302*	**Scales**, for weighing Gold and Silver, &c., with Troy Weights (fig. 2302) . . . . . £1 10s.	2 2 0	3 10 0
2303	**Scales and Weights**, large, to stand on Counter or Table, for the rougher uses of the Laboratory £1 1s.	2 2 0	3 10 0
2304	Ditto ditto of greater precision, with Decimal Weights, &c	3 3 0	4 4 0
2305	**Scales**, Bullion, to weigh 300, 500, 1,000 to 2,000 ozs.	£30,	£40, £60, and £70.
2306	**Grain Scales**, Brass Pans, and a set of weights from 120 grains to ½-grain, in Oak box	0 2 6	0 3 6
	Ditto, superior make, in Mahogany box (fig. 2306) .		0 5 6
2307	Ditto, with Glass Pans, in Oak box		0 6 6
2308	Ditto, with Glass Pans and box-end beams, in Mahogany box	0 10 6	0 18 0
2309	**Grain Scales**, with Pillar, on Mahogany stand (fig. 2302)		1 10 0
2310	**Balances, Chemical.** with a set of Decimal Weights to the tenth of a grain, to carry 1000 grs. in each pan; and turn with the tenth of a grain when thus loaded; in Mahogany box (fig. 2310)	3 3 0	4 4 0

See also page 396.

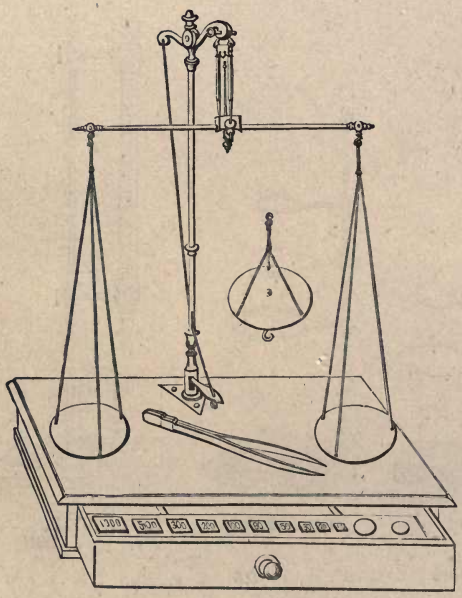


FIG. 2310.

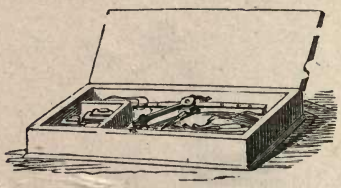


FIG. 2306

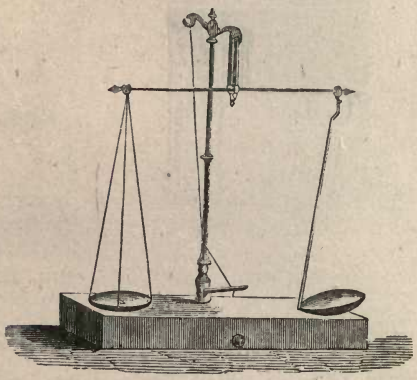


FIG. 2302.

		£	s.	d.	£	s.	d.
2311	**Shears**, Cutting, small	0	2	6	0	5	0
2312	**Sieves**, of hair, lawn, and wire, for straining or sifting .	0	1	6	0	4	6
2313	**Spatulas**, Steel, with handles . . . . . from				0	1	0
2314	Ditto Platinum . . . . . „				1	6	0
2315	Ditto Silver . . . . . „				0	10	0
2316	**Still, Working Model**, of Copper, handsomely japanned, suitable for the Lecture Table (fig. 2316) . . .	1	15	0	2	2	0
2317	**Stills**, small, of strong tin, with Argand Lamp and Worm Tube, 1 quart				0	11	0
2318	Ditto ditto 2 quarts				0	15	6
2319	**Stills**, portable, Strong Tin, with worm and tub, for preparing pure water for Chemical or Photographic purposes, for use on an ordinary fire, 1 gallon (figs. 2319, 2319*)	1	6	0	1	10	0

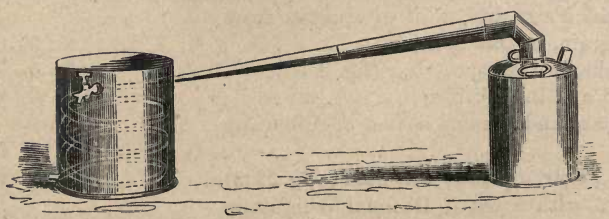


FIG. 2319.

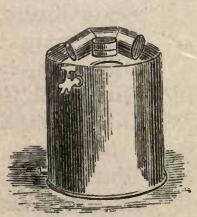


FIG. 2319*.

2320	**Stills**, Strong Tin, portable, 2 gallons				2	2	0
2321	Ditto, Copper, 1 gallon and 2 gallons	2	2	0	2	10	0

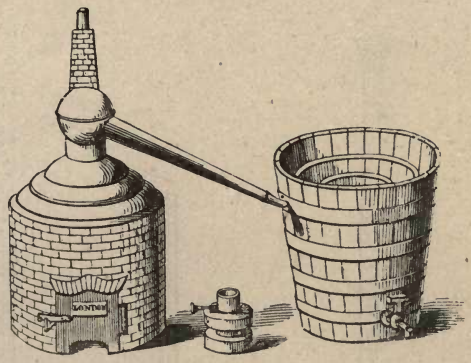


FIG. 2316.

		£ s. d.	£ s. d.
2322	**Stills**, Copper, best make, Portable Iron Frame and furnace, with pewter worm and tub, 2 gals. . .		5 5 0
2323	Ditto ditto 5 gals.		8 8 0
2324	Ditto ditto 10 gals.		13 13 0
2325	**Distilling Apparatus** for Ascertaining the Original Gravity of Beer after fermentation, or Alcoholic Wine Test, see page 193.		
2326	**Stopcocks**, common Brass		0 2 6
2327	Ditto, **Best** make, Brass		0 3 6
2328	Ditto, Iron, small		0 6 0
2329	**Syphon**, Pewter and Copper . . . . from		0 7 6
2330	Ditto ditto with Stopcock . . . . „		0 10 6
2331	**Syringes**, Exhausting or Condensing (see also Pneumatic Apparatus)	0 10 6	0 12 6
2332	**Supports**, various, for Tubes, Retorts, Receivers, &c. 3s. 6d.	0 5 0	0 14 0
2333	**Taper Holder** of wire, for experiments in Oxygen Gas, &c. (fig. 2333, the wire only)		0 0 6
2334	**Taylor's Hot Air Bath**, stout Sheet Iron, with double body and bottom, and long chimney		0 16 0
2335	Ditto ditto, Copper (fig. 2335)		1 15 0
2336	**Test Papers**, red or blue litmus, and Turmeric, per book		0 0 2
2337	Ditto Neutral (reddened by acids and turned blue by alkalies), very delicate . . . . . per book		0 0 2
2338	**Test Tube Brushes**, tipped with sponge . . .	0 0 6	0 1 0
2339	**Test Tube Holders**		0 0 8
2340	**Test Tube Stands**, for eight test tubes, with draining pegs (fig. 2340)		0 1 8
2341	Ditto ditto for twelve test tubes, with draining pegs		0 3 6
2342	**Test Tube Stands**, of Mahogany polished, with double set of holes, for twenty-four and thirty-six test tubes	0 5 0	0 6 6
2343	**Thermometer, Standard** (fig. 2343) see also page 32 .		2 2 0
2344	Ditto **Chemical**, with plain exposed bulb, graduated to 300° (fig. 2344)		0 5 6
2345	Ditto ditto with Brass Hinged Joint to scale (fig. 2345)	0 10 6	0 12 6

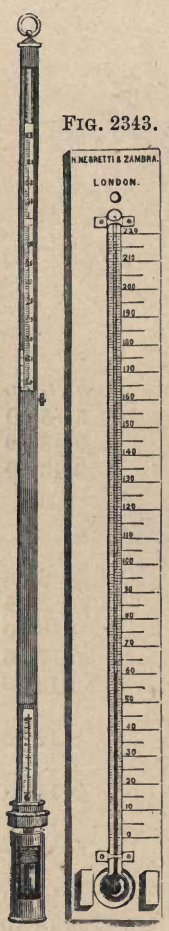


FIG. 2343.

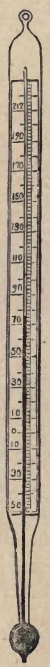


FIG. 2346.

FIG. 2346*.

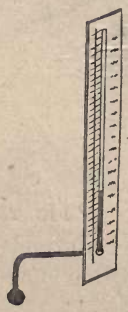


FIG. 2347.

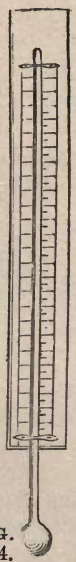


FIG. 2344.

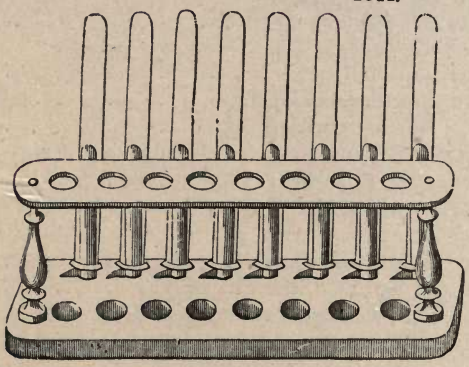


FIG. 2340.

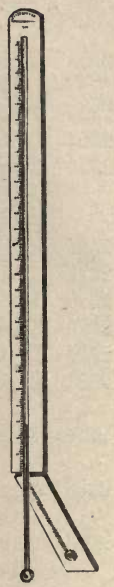


FIG. 2345.

FIG. 2362*.

		£	s.	d.	£	s.	d.
2346	**Thermometers,** Isolated for dipping in Acids, &c. (figs. 2346 and 2346*) (see also pages 153 to 174) . .	0	7	6	0	10	6
2347	**Thermometers,** with bent tube, for Hot Air Bath, Drying Chambers, &c. (fig. 2347)				0	10	6
2348	**Tubing,** Vulcanised India Rubber, per foot, 4d., 6d., 8d.,	0	1	0	0	2	0
2349	**Vice,** to fasten to Table	0	10	6	1	5	0
2350	**Wire Gauze,** for experiments on Flame, of various sizes, from				0	1	0
2351	**Weights,** Grains and Drachms . . per set, each				0	0	6
2352	Ditto Platinum, grains . . . per set				0	3	6
2353	Ditto Aluminum, 1 grain to 1-10th . . .				0	3	6
2354	Ditto Brass, 1,000 grains to 1-100th . . .				2	0	0
2355	ditto ditto 50 Grammes to 1 Milligramme .				1	18	0
2356	**Weights,** Sets of **Troy,** 10 ozs. to $\frac{1}{10}$th of an ounce .				3	10	0
2357	Sets of ditto ditto, 20, 30, 40, 50, and 100 oz. . .				5	10	0

		£ s. d.	£ s. d.
2358	**Standard Grain Weights**, in mahogany box, containing 10,000, 6,000, 3,000, 2,000, 1,000, 600, 500, 300, 200, 100, 60, 30, 20, 10, 5, 3, 2, 1, ·6, ·3, ·2, 1, ·06, ·03, ·02, ·01 .		4 4 0
2359	**Standard Grain Weights**, smaller sets	3 13 0	2 2 0
2360	**Gramme Weights**, 1 Kilogramme to 1 Milligramme, in Mahogany Box		4 4 0
2361	Ditto ditto, 100 Grammes to 1 Milligramme, in mahogany Box		2 10 6
2362	**1 Gramme** and its subdivisions in 1,000 parts in Platinum, for assaying Gold or Silver, in Box . .		1 15 0

English or Foreign Weights and Measures of all kinds supplied to order.
For Decimal Weights, see page 398.

2362* Standard Barometers (fig. 2243), for Laboratory use, see pages 8 to 11.

CHEMICAL CABINETS AND PORTABLE LABORATORIES.

FIG. 2366.

2364 **Youth's Chemical Cabinet**, containing sixty chemical preparations, and useful apparatus, without deleterious and dangerous articles; and adapted for exciting a taste for chemistry in the young. No. 1, in paper case £0 5 6

2365 **Youth's Chemical Cabinet**, No. 2, in cedar case, with hook fastening £0 7 6

2366 Ditto ditto No. 3, in stout mahogany case, French polished, and with lock and key (fig. 2366) 0 10 6

2367 **First Steps in Chemistry and Companion to the Youth's Chemical Cabinet**; containing a series of select, amusing, and instructive chemical experiments £0 0 6

2368 **Student's Chemical Cabinets**, containing a larger assortment of apparatus, in mahogany cabinets, with lock and key . £1 1 0 £1 11 6 £2 2 0

2369 **Student's Chemical Cabinet**, No. 5, contains the necessary re-agents and instruments for the various operations of qualitative analysis, testing in the humid way, and includes blowpipe apparatus, fluxes, and tests for the discrimination of ores, minerals, &c. The apparatus, &c., is conveniently arranged in a mahogany cabinet, with drawer, tray, lock and key £8 8 0

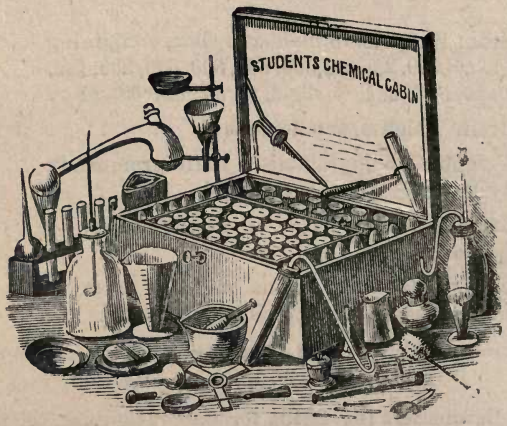


FIG. 2370.

2370 **Student's Chemical Cabinet** (fig. 2370), a good useful working chest; it contains upwards of 79 chemical preparations and re-agents, and a large assortment of apparatus, &c., in a mahogany cabinet, with lock and key £3 3 0

2371 **Agricultural Test Chests,** fitted with re-agents and apparatus for the qualitative analysis of soils, manures, &c. The tests are pure, and the apparatus of a useful size, carefully arranged in a cabinet, with lock, key, &c. £3 3 0 £5 5 0 £8 8 0

2372 **Toxicological Test Chests,** contains all the re-agents and apparatus necessary for the accurate analysis of any substance suspected of containing Poison, in accordance with the present advanced state of this branch of chemical science £5 5 0

These Chemical Cabinets and Portable Laboratories are specially arranged for the use of persons who have not convenient space for keeping such apparatus, or where portability combined with security is important. In all other cases, where ample and secure space can be devoted to the purpose, Messrs. Negretti and Zambra would recommend one of the following Sets of Apparatus, or purchasers to make their own selection from our Chemical Section.

2373 SETS OF CHEMICAL APPARATUS FOR ELEMENTARY EXPERIMENTS.

Adapted for illustrating the Theory and Practice of Chemistry, the Production and Examination of Gases, &c., &c.; suitable for Students studying Elementary Chemistry, and for verifying the main facts on which the Science is based.

2374 **Three Guinea Set of Apparatus.** Retort Stand, with three sliding rings; Two two-ounce retorts; Two half-pint retorts; Globular receiver; Black's blowpipe; Nest of Hessian crucibles; Apparatus for making oxygen gas over a spirit lamp; Glass Spirit Lamp; Gas bottle with acid funnel and delivery tube, for making Hydrogen gas, &c.; Balloon for Hydrogen gas; an assortment of six flasks, for solutions, digestions, &c.; Gas bottle, with bent delivery tube, for making Chlorine

and other gases; Pipette or dropping tube, &c.; Book test papers; Set of six cork borers, with file for sharpening them, and steel rod, in japanned case; Glass funnel, and supply of filtering paper; Funnel support, with movable arm; Balance, with a set of weights, from ¼ oz. to ½ grain, in box; Tall test glass, for precipitations; Two Clark's test glasses, for testing, &c.; Six Test tubes, of hard German glass; Test tube stand; Two stirring rods; Glass tubing, for fitting up gas bottles, for conducting tubes, &c.; Pneumatic trough, with movable shelf and tray; Two gas jars; One gas jar, with glass stopper; One transfer jar, mounted with brass cap, stopcock, bladder and bladder piece, and brass jet; Two porcelain evaporating basins; Graduated glass measure; Deflagrating ladle, with cover; Three watch glasses, for evaporations, &c.; File for cutting glass tubing; Glass plates, Porcelain mortar. Including a strong Packing Case.

2375 **Five Guinea Set of Apparatus.** Retort Stand, with iron foot and rod, and three sliding rings; Two plain retorts; Two tubulated retorts, one receiver; Set of four porcelain capsules, for evaporations, crystallizations, &c.; Pneumatic trough, with movable shelf and tray; Bell or transfer jar, mounted with brass cap and stopcock; Bladder, mounted with ferrule; One brass jet, for experiments on Oxygen; Pestle and Mortar; Glass tubing: Half-a-dozen glass stirrers: Two glass funnels, filtering paper; Three flasks, for solutions, digestions, &c.; Bars of zinc, copper, and iron, for use in testing, &c.; Two books of neutral test papers; One dozen hard German glass test tubes; Test tube stand for one dozen tubes; Tall test glass, for precipitations; Three Clark's test glasses, for testing, &c.; Black's blowpipe; Blowpipe lamp; Clark's gas bottle, for making sulphuretted hydrogen, &c.; Gas bottle, with bent glass delivery tube, for preparing Chlorine and other gases; Platinum foil and wire; Glass spirit lamp; Graduated glass measure, 4 oz.; Pipette; Improved apparatus for making Oxygen over a spirit lamp: Cylinder, for supporting flasks, basins, &c.; Sand bath, iron; Six watch glasses; Set of cork borers, in case; Two files, one for cutting glass tubing, and the other for enlarging holes in corks, Balance and set of weights; Nest of Hessian crucibles. Including a strong Packing Case.

2376 **Blowpipe Cabinet.** A complete Set of apparatus, &c., for the Mineralogist in Polished Box. Blowpipe with Platinum Jet, Forceps with Platinum Points, Platinum wire Foil and Capsule, Geological Hammer Steel, Steel Forceps and Spatula, Steel Crushing Mortar. Chisel, triangle File, Cutting Pliers, Pocket Magnifier, three Porcelain Capsules, Porcelain Slab, Glass Stirrers and Pipette, Hard Glass Tubes, Arsenic Tubes, Charcoal for Blowpipe. Blowpipe Lamp and Stand, Charcoal Supports and Tin foil. Re-agents: Carbonate of Soda, Borax, Murocosmic Salt, Bone Ash, Gypsum, Nitre-Silicia, Fluor Spar, Lead, Iron Wire Graphite, Starch, Rock Salt, Oxalate Nickel, Oxalate Potass, Boracic Acid, Potassium Broulphate, Potassium, Cobalt Nitrate, Hydrochloric Acid. Nitrate of Silver, Magnetic Needle, Test Papers assorted, &c. £5 5 0

Larger and more complete Sets fitted up to order. Ten to twenty Guineas.

PURE CHEMICALS, TESTS, OR RE-AGENTS SUPPLIED IN ANY QUANTITY AT THE LOWEST MARKET PRICES.

ELECTRICAL, GALVANIC, MAGNETIC, ELECTRO-MAGNETIC, AND THERMO-ELECTRIC APPARATUS.

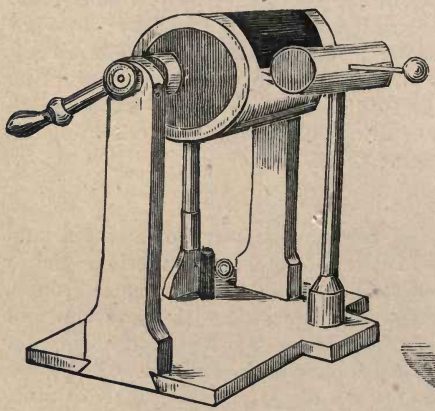


FIG. 2377.

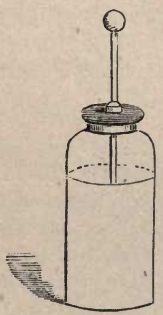


FIG. 2393.

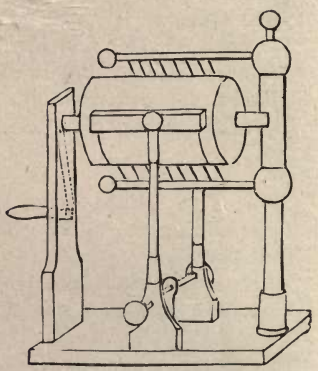


FIG. 2378.

FRICTIONAL ELECTRICITY.

		Each. £ s. d.	Each. £ s. d
2377	**Cylinder Electrical Machines (Nairne's Model)**, on Mahogany Stands, with Japanned Conductors . .	1 1 0	1 5 0
	Ditto with Brass Conductor		1 10 0
	Ditto second size, 6-in. by 4-in. . . .		1 10 0
	Ditto third size, 7-in. by 5-in.		2 2 0
	Ditto fourth size, 8-in. by 6-in. (fig. 2377) . .		3 3
	Ditto fifth size, 10-in. by 8-in.		5 5
2378	**Cylinder Electrical Machine**, with double rubbers and collecting forks, brass conductors, French polished mahogany stand (fig. 2378)	6 6 0	10 10 0
2379	**Cylinder Electrical Machines**, with a selection of the most instructive and interesting experiments with frictional electricity, Packed in a neat case . £4 4s.	5 5 0	10 10 0
2380	**Plate Electrical Machines** (Ramsden's arrangement, 1760) with Brass Conductor, mounted on polished Mahogany Frames, and finished in a superior manner.		
	Ditto 9-inch		1 12 0
	Ditto 9-inch		3 3 0
	Ditto 12-inch		4 10 0
	Ditto 12 inch, Plate Electrical Machine with Double Receiving Forks, best make		5 10 0
	Ditto 15-inch with ditto		6 10 0
	Ditto 18-inch (fig. 2380) with ditto		8 8 0
	Ditto 24-inch ditto		11 11 0

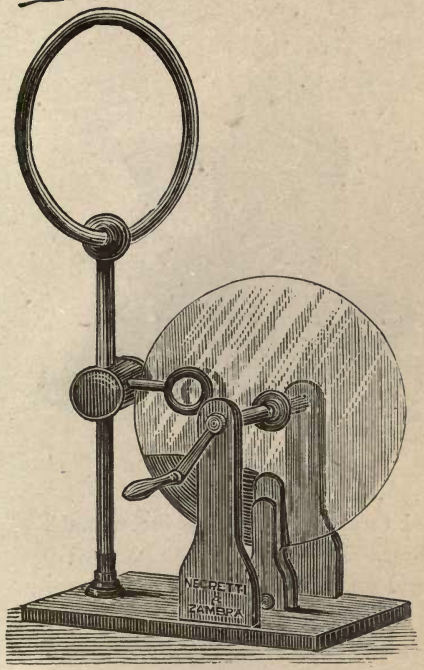


FIG. 2381.

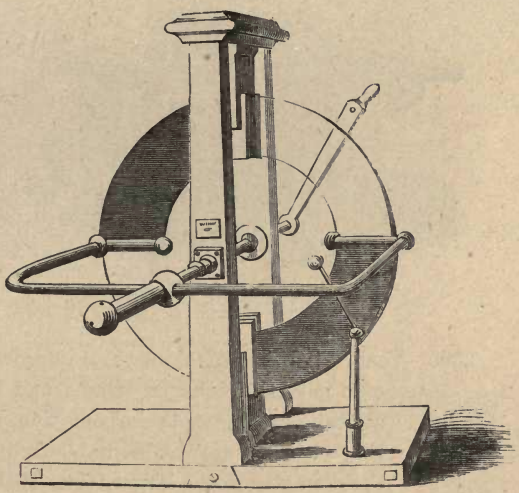


FIG. 2380.

2381 **Plate Electrical Machine.** — Winter's arrangement. The Plate in this machine is mounted upon an insulating Glass axis; this, in connection with a large wood-covered metal circle placed on top of the prime conductor, considerably increases the length of spark; from a 15-inch plate 6 to 8-inch sparks may be readily obtained (fig. 2381) £5 10 0

2382 **Woodward's Double 24-inch Plate Electrical Machine,** a very splendid and powerful instrument . . . 26 0 0

2383 **Holtz' Electrical Machine,** with 22-inch Vulcanite Plate 20 0 0

2384 **Holtz Machine,** mounted with 2 movable Plates . . 25 0 0

2385 **Plate Electrical Machines,** with a selection of Apparatus for exhibiting the most popular and interesting experiments in Frictional Electricity, Packed in a deal case, with lock and key . . £6 6s. 10 10 0 20 0 0

2386 **Volta's Electrophorus,** for obtaining the electric spark, a very useful instrument for the Laboratory, Resin Base with Brass Plate . . . from 0 12 6

2387 **Electrophorus,** cheap arrangement, 12-inch disc of Gutta Percha, and 10-inch disc of Tin Plate with a Glass Handle 0 8 6

2388 **Electrophorus, Improved,** with Vulcanite or Ebonite Base, with Brass Plate (fig. 2388) . 5-inch, £1 8s. 9-inch, 2 2 0

2389 **Cannon Electrophorus,** mounted with an electrical cannon, for firing mixtures of hydrogen and atmospheric air (fig. 2389) 2 12 6

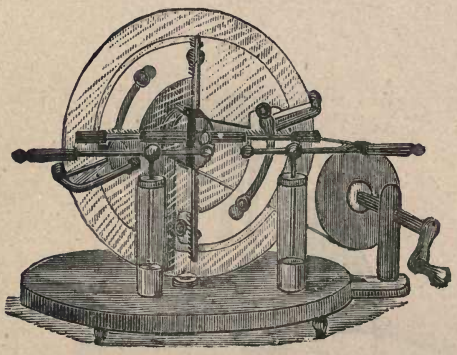


FIG. 2390.

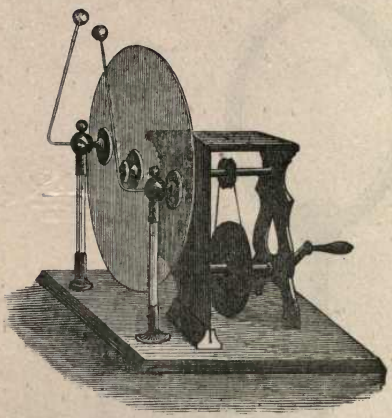


FIG. 2391.

2390 **Voss Electrical Machine** is an improved form of Holtz' Machine, mounted on a polished Mahogany frame and base. This machine can be used in almost any atmospheric condition, and under favourable circumstances the length of spark obtainable from it is more than two-thirds that of the diameter of the larger Glass Plate, with an exceedingly small amount of manual labour.

The excitement of the Voss Machine is produced by holding against the Glass Plate a flat piece of Vulcanite which has been previously electrically excited by rubbing it upon woollen cloth or cat's fur (fig. 2390). price £4 10 0

2391 **Piche's Electro-Static Induction Machine,** is a modified arrangement of Holtz's machine. It is composed of a circular plate of *Vulcanite*, in front of which are placed two collecting forks in metallic connection with two brass rods mounted on jointed insulated supports; these rods are so contrived that they can be moved in any direction, or the terminal balls brought close together. On one side and at a small distance behind the revolving plate is placed a flat oblong plate also of *Vulcanite*, termed the *Induction Plate.*

To put this machine in action the Induction Plate is withdrawn from its groove on the base of the stand, and excited by rubbing it briskly with a cat skin or a woollen cloth (Flannel), and quickly replaced in the groove, then upon rotating the circular Vulcanite plate by the handle and multiplying wheels, it will be found that one fork or comb will collect Positive, and the other Negative Electricity.

Price of Piche's Machine as fig. 2391, with 18-inch Vulcanite Plate £12 12 0

2391* Wimshurst's High Tension Electric Machines. An improved form of Nos. 2390 and 2391. These machines can be used in place of Induction Coils for illuminating Vacuum Tubes, Spectroscopic Experiments, &c. They are made of three sizes, including a packing case—

16-inch plate, £6; 12-inch, £5; 8-inch, £2 2s.

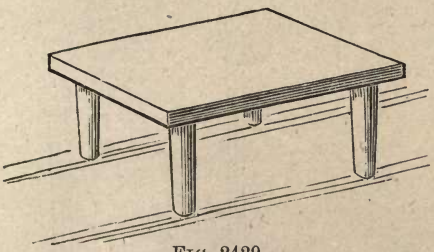


FIG. 2429.

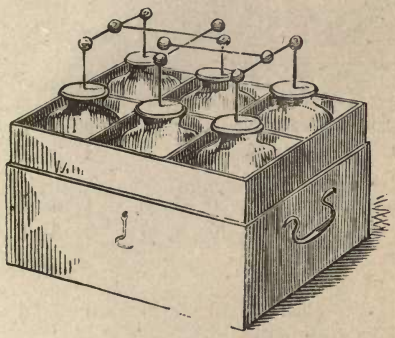


FIG. 2394.

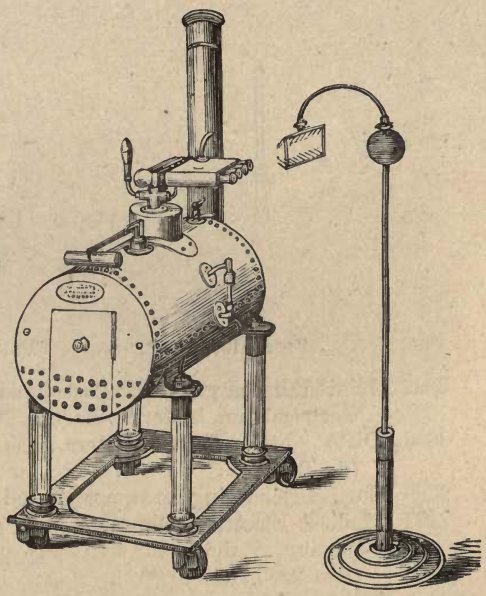


FIG. 2392.

£ s. d.

3392 **Armstrong's Hydro-electric Machine** (fig. 2392) 40 0 0

This apparatus consists of a very strong boiler, constructed to sustain great pressure, for evolving Electricity by the friction of water and steam against other substances. It is fitted with safety valve, water gauge, condensing tubes, jets, collecting and discharging rods, &c. The boiler is heated by a coke or charcoal fire, and supported on insulating glass legs with rolling castors.

2393 **Leyden Jars** (fig. 2393)—

Contents .	¼-pint.	½-pint.	1-pint.	2-pints.	4-pints.
Price .	2s. 6d.	3s. 6d.	6s.	8s. 6d.	15s.

2394 **Electrical Batteries**, consisting of 4, 6, 9, 12, or more Leyden jars, mounted in frames or cases, with brass conducting rods and balls (fig. 2394) £2 10s.; £3 3s. 6 6 0 10 10 0

2395 **Medical Leyden Jars**, mounted with Lane's Discharging Electrometer, to regulate the intensity of the shock given to a patient (fig. 2395) £0 12 6 0 18 0

3396 **Leyden Jars**, mounted, to show that the charge is not in the coatings, as those with which it is charged can be removed, and others put in their place, the glass retaining the electricity (fig. 2396) . . . 0 16 6

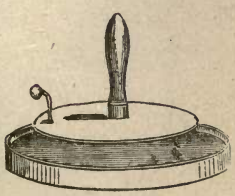


FIG. 2388.

FIG. 2427.

FIG. 2396.

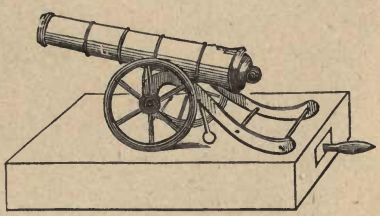
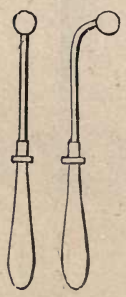


FIG. 2389.

FIG. 2397.



FIGS. 2400, 2400*.

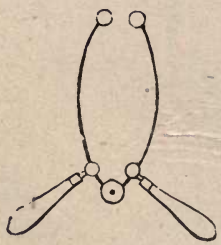


FIG. 2398.

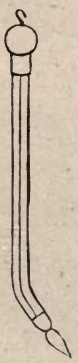


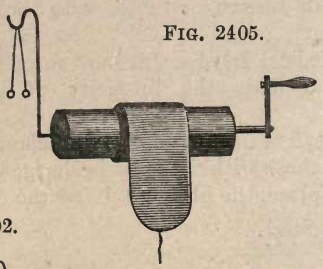
FIG. 2401.

FIG. 4201*.

		Each. £ s. d.	£ s. d.
2397	**Jointed Dischargers,** with glass handles, for discharging electrical jars, batteries, &c. (fig. 2397) . 8s. 6d.	0 11 6	1 1 0
2398	Ditto ditto **French** pattern, with two glass handles (fig. 2398)	0 15 0	1 4 0
2399	**Small Discharging Rods,** not jointed	0 3 6	0 5 0
2400	**Medical Electrical Directors,** with glass handles, for passing a shock through any part of the body (figs. 2400 and 2400*) . . . . . 3s. 6d.	0 5 6	0 7 6
2401	**Electrical Directors,** for the Eye and Ear (figs. 2401 and 2401*)	0 10 6	0 12 6
2402	**Two Jars,** mounted, for explaining the Franklinian theory (fig. 2402)		0 14 0
2403	Ditto ditto, with Insulated Stand, ball and wire (fig. 2403)		1 4 0
2404	**Biot's Apparatus,** for illustrating the distribution of electricity on the surface of insulated conducting bodies. It consists of a sphere of copper, supported on an insulating glass rod and stand, and two thin copper hemispheres of such a size as to enclose the sphere. The covers are fitted with glass handles, so that they can be removed from or placed over the sphere, without the hands touching the metal (fig. 2404) . . .		2 15 0

FIG. 2395.

FIG. 2405.



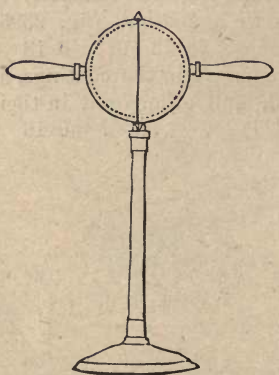


FIG. 2404.

FIG. 2402.

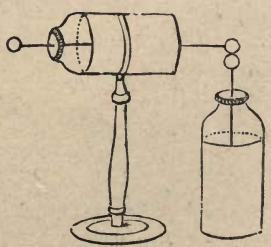
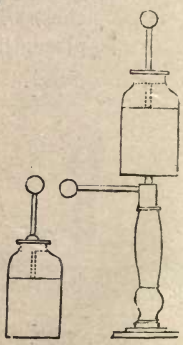


FIG. 2403.



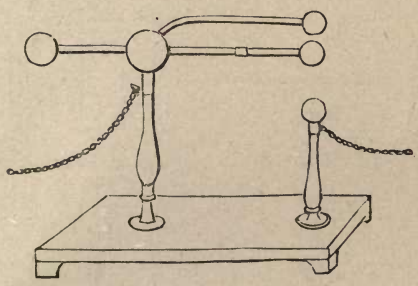


FIG. 2409.

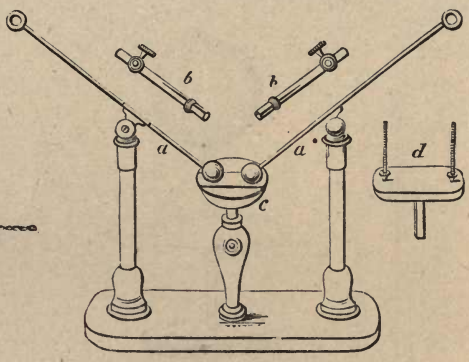


FIG. 2408.

2405 **Metal Roller**, with Glass Handle and a roll of Tin Foil, mounted upon an Insulating Stand, to show the effect of an expansion of surface in reducing the intensity of electrictity whilst the absolute quantity remains the same (fig. 2405) 1 12 6

2406 **Electrometer, Coulomb's Torsion.** This instrument measures very minute quantities of electricity, and with careful manipulation will give accurate values of the attractive and repulsive force of free electricity communicated to any body of known area 3 3 0

2407 **Henly's Universal Discharger**, with press and table, for deflagrating the metals by electricity, or exposing various substances to electrical action. 1 12 6

2408 Ditto, with **Carbon Forceps**, &c., adapted for Frictional or Voltaic electricity (fig. 2408) 2 2 0

FIG. 2412.

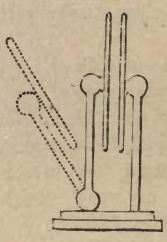


FIG. 2425.

FIG. 2413.

FIG. 2414.

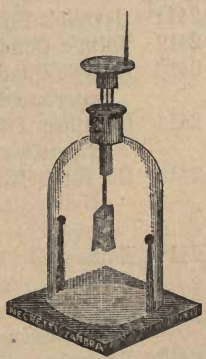


FIG. 2411.

2409 **Cuthbertson's Self-acting Balance or Steelyard Discharger** (fig. 2409), for indicating the force or strength of the discharge from an electric battery by the position of the shifting weight on the graduated balance arm 2 15 6

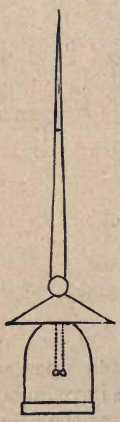


FIG. 2411*

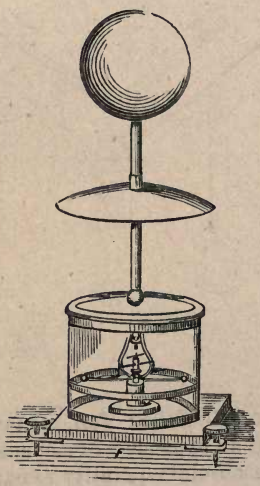


FIG. 2418.

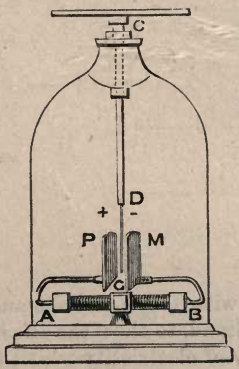


FIG. 2417.

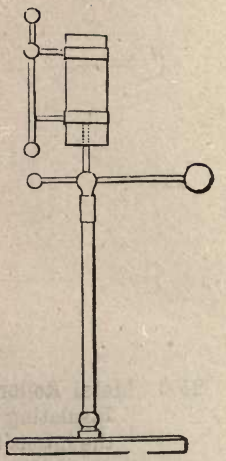


FIG. 2420.

2410 **Balance Electrometer**, or Electroscope, very simple and delicate. It consists of a light metal rod suspended on a point, insulated on a glass stand. The rod is mounted with pith balls on each end, which will be attracted or repelled according to the quality of the electricity affecting it £0 11 0

2411 **Bennet's Gold Leaf Electroscope** (Singer's improved form): used for showing very minute quantities of electricity (fig. 2411). See also page 115 . . . £1 1 0 1 10 0

2411* **Cavallo's Pith Ball Electroscope** 1 1 0

2412 **Volta's Condensing Electroscope** (fig. 2412), see page 425. 1 10 0

2413 **Henly's Quadrant Electrometer**, with graduated arc, for experiments with accumulated electricity (fig. 2413) . 0 7 6 1 10 6

2414 **Cavallo's Pith Ball Electroscope**, with stopcock for exhaustion (fig. 2414) 2 2 0

2415 **De Luc's Electric Column or Pile**, composed of discs of silver, zinc, and paper, mounted glass tubes with brass caps at the ends 1 14 0 3 3 0

2416 **Zamboni's Electric Pile.** The elements in this pile are silver, black oxide of manganese, and paper, insulated with sulphur: it is more energetic than De Luc's; mounted in glass tubes, terminated with brass caps . 1 10 0 3 3 0

2417 **Bohenburger's single leaf Electroscope**, for ascertaining the presence and quality of very feeble electrical currents (fig. 2417). See page 116 . . 8 8 0

2418 **Peltier's Electrometer** (or Dr. J. Milner's, 1733) for measuring the tension of electricity by the deflection of a needle; an extremely sensitive instrument (fig. 2418) 4 4 0 5 5 0

2419 **Harris's Balance Beam Electrometer**, for estimating in grain weights the attractive power exerted between two oppositely electrified surfaces 4 4 0

FIG. 2431.

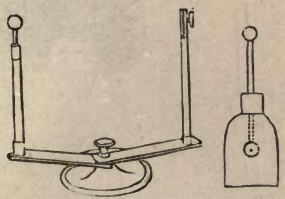


FIG. 2424. FIG. 2444.

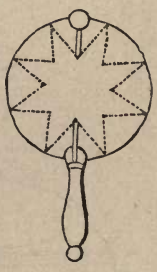


FIG. 2432.

FIG. 2434.

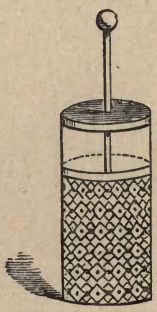


FIG. 2437.

		Each. £ s. d.	Each. £ s. d.
2420	**Harris's Unit Jar Electrometer,** with graduated slider, for charging Leyden jars, or batteries, with known quantities of electricity (fig. 2420)		1 15 0
2421	**Saussure's Electroscope,** for experiments on atmospheric electricity (fig. 2411*)		1 5 0
2422	**Harris's Electro-Thermometer,** for measuring the heating power of electricity		1 16 0
2423	**Kinnersley's Electrical Thermometer,** a modification of Harris's instrument for exhibiting the transient expansion of air by the passage of Electricity through it (fig. 2423, page 426)		1 0 0
2424	**Calorometer, Hare's,** or jointed insulated forceps, for conveniently supporting wires, through which it is wished to pass an electric current, to ascertain the heating power by the length of wire heated (fig. 2424)		1 10 0
2425	**Electrical Condenser,** consisting of two brass plates, one supported on a glass insulating stem, the other resting upon a conducting stem jointed at the bottom (fig. 2425)		0 18 0
2426	**Improved Electrical Condenser and Apparatus,** for experiments upon disguised or paralysed electricity, arranged to connect with a gold leaf electroscope (fig. 2426)		2 2 0
2427	**Magic Picture,** or Fulminating Pane, in frame, for giving slight shocks (fig. 2427)	0 7 6	0 10 6
2428	**Insulated Stools,** for medical and other purposes, where it is required to insulate a body from the ground .	0 10 6	0 16 0
2329	Ditto, with Mahogany top (fig. 2429) see page 415 .	1 1 0	1 10 0
2430	**Insulated Adjusting Table Stand,** with hollow Glass support, best make (fig. 2430) see page 426 . .		0 10 6

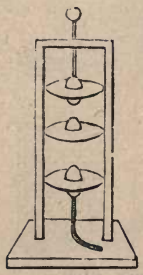


FIG. 2438.

FIG. 2440.

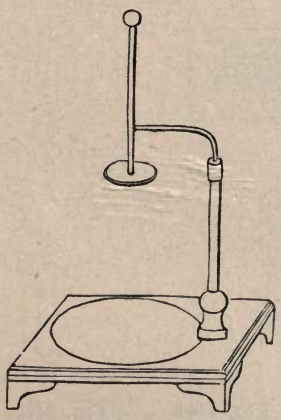


FIG. 2441.

FIG. 2445.

		Each. £ s. d.	Each. £ s. d.
2431	**Names or Words,** arranged upon glass, with pieces of tin foil, which may be rendered luminous in the dark by the agency of electricity (fig. 2431) . 7s. 6d.	0 10 6	1 5 0
2432	**Star,** formed of spangles of tin foil, on a flat glass (fig. 2432) . . . . . from		0 5 6
2433	**Bird,** formed of spangles of tin foil, on a flat glass from		0 5 6
2434	**Painted Glass Plane,** on Stand, in different colours, with devices of tin foil, for showing the electric light (fig. 2434)		0 14 0
2435	**Lightning Plate—De Londe's—**is constructed of a plate of glass mounted upon a firm base; one side of the glass is entirely coated with tin foil to within a short distance of its edge, and the opposite side is covered with small spangles of tin foil placed at a short distance from each other. This forms a modified Leyden jar: when charging the plate, the electricity darts about its surface in all directions, and when discharged a brilliant display of electric light is produced	1 1 0	2 2 0
2436	**Iron Chain,** for illuminating a darkened room by electricity . . . . . per yard		0 0 6
2437	**Diamond Spotted Jars,** showing a beautiful light when discharged in a dark room (fig. 2437) . . 8s. 6d.	0 15 0	1 10 0
2438	**Egg Stand,** for exhibiting eggs, &c., rendered luminous during the passage of electricity (fig. 2438) . .	0 8 6	0 16 0
2439	**Faraday's Improved Egg-Stand,** with Glass Cylinder .		0 15 0
2440	**Image Plates,** brass stand with hook, to connect to prime conductor, for pith figures, illustrating electrical attraction and repulsion (fig. 2440)	0 6 6	0 12 6
2441	**Image Plates,** with insulated glass support for the upper plate, connection being made from the prime conductor, the figures are removed from the attractive influence of the cylinder (fig. 2441)	0 15 0	0 18 6

FIG. 2446.

FIG. 2447.

FIG. 2450.

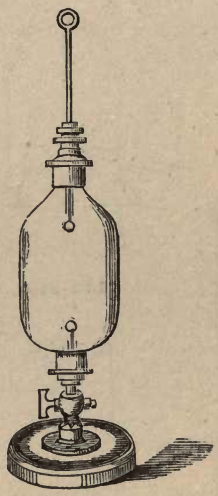


FIG. 2451.

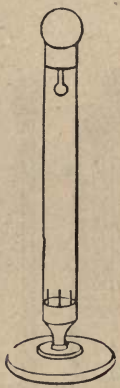


FIG. 2452.

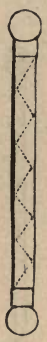


FIG. 2454.

		Each. £ s. d.	Each. £ s. d.
2442	**Dancing Figures**, made of elder pith, plain 1s., jointed	0 2 0	0 3 0
2443	**Pith Ball Stand**, another illustration of electrical attraction and repulsion		0 5 0
2444	Ditto, with ball and wire (fig. 2444)		0 8 0
2444*	**Pith Balls** . . . . . per doz.	0 1 0	0 1 6
2445	**Grotesque Carved Head**, with Hair, for illustrating the principle that bodies similarly electrified repel each other (fig. 2445)	0 4 0	0 6 6
2446	**Electrical Figure**, carved of cork, representing a swan, which, placed on the surface of a vessel of electrified water, will be attracted to any part by presenting the finger to it (fig. 2446)		0 4 6
2447	Ditto ditto, representing Neptune, sea-horses, &c., (fig. 2447) . . . . . from		0 7 6
2448	**Electrical Spider**, by electrifying which, and presenting a ball, will be attracted, but repelled by a point .		0 1 0
2449	**Coloured Glass and Paper Plumes**, to exhibit the repulsive action of similarly electrified bodies . .	0 2 6	0 5 6
2450	**Electrical Flask**, with brass cap and valve for exhaustion, to imitate the aurora borealis (fig. 2450) . .	0 7 6	0 12 6
2451	**Glass Globe**, with stop-cock, sliding wire, with forceps, &c., for showing the passage of electric light through a partial vacuum or different gases (fig. 2451) . .	2 2 0	2 12 6
2452	**Luminous Conductor**, or apparatus to exhibit the effect of a falling star, with valve for exhaustion (fig. 2452)		1 1 0
2452*	Ditto with **Stop Cock**, large size	2 2 0	3 3 0
2453	**Bucket and Syphon** to suspend from the prime conductor; this experiment shows that water, which previous to being electrified only fell in drops, when electrified runs in a stream, and in a dark room is luminous 3s. 6d., 5s. 6d		

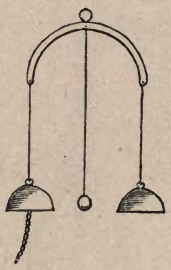


FIG. 2459.

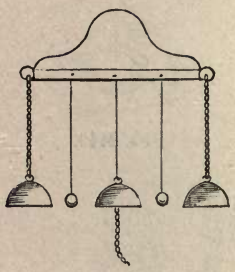


FIG. 2460

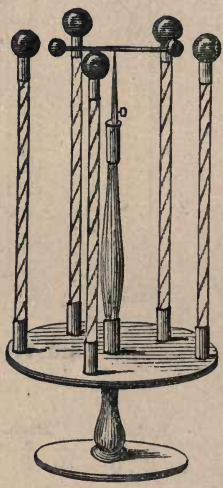


FIG. 2455.

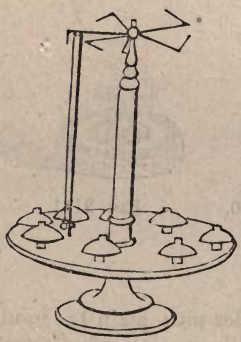


FIG. 2458.

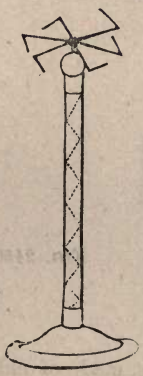


FIG. 2457.

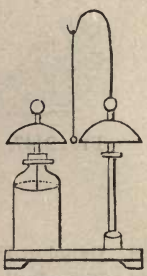


FIG. 2461.

2454 **Hand Spiral,** consisting of two glass tubes with brass caps, the inside one covered in a spiral form with spangles of tin foil, showing when presented to an excited conductor, a spiral stream of electrical light (fig. 2454) 3s., 4s., 5s. 6d

2455 **Set of Five Spirals,** Best, with coloured tubes (fig. 2455), on mahogany pedestal, with insulated revolving balls in the centre, which, by their motion, produce a splendid succession of spiral lines of light £2 2 0

2456 **Luminous Chain Experiment,** (fig. 2456) 0 15 0

2457 **Revolving Spiral,** on stand. The electric fly or whirl revolves by the dispersion of electricity from the points, presenting a very beautiful appearance in a dark room (fig. 2457) £0 16 6

FIG. 2462.

FIG. 2462*.

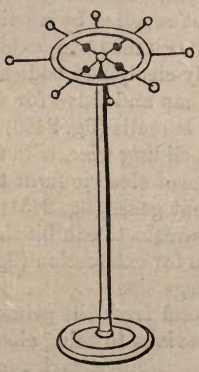


FIG. 2464.

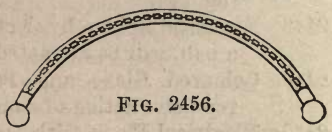


FIG. 2456.

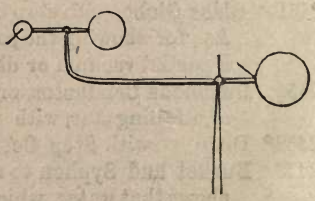


FIG. 2465.

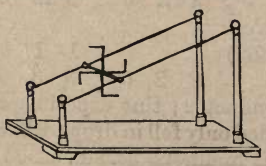


FIG. 2468.

FIG. 2466.

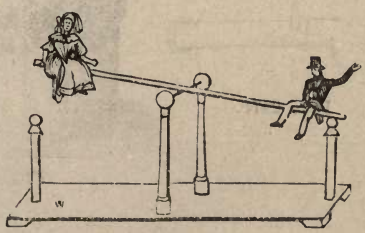
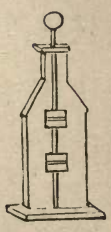


FIG. 2467.

FIG. 2469.

		Each. £	s.	d.	£	Each. s.	d.
2458	**Gamut of Bells.** This experiment consists of eight bells arranged on a stand, with an electrical fly or whirl carrying a clapper, which, in revolving, strikes each of the bells (fig. 2458)				2	2	0
2459	**Set of two Electrical Bells.** The simplest form of the experiment, one bell communicating with the prime conductor, the other with the ground, and made to ring by the alternate blows of a brass ball suspended between them by a silk cord (fig. 2459) . . .				0	3	6
2460	**Set of Three Bells,** on brass rod, to suspend from the conductor. The action of these is the same as the preceding (fig. 2460)				0	8	6
2461	**French Arrangement** for illustrating the chiming of bells by electrical action, one bell being connected with the inner, and the other with the outer coating of a Leyden jar (fig. 2461)				1	1	0
2462	**Electric Fly or Wheel,** for producing motion by the dispersion of electricity from points (figs. 2462 & 2462*)	0	3	6	0	7	6
2463	Three ditto on one stand				0	8	
2464	**Franklin's Electrical Self-moving Wheel,** with glass spokes, terminating with brass balls. Placing the wheel between a charged battery and a conductor to the earth, the wheel is caused to rotate by attraction and repulsion (fig. 2464)	2	2	0			
2465	**Electrical Orrery or Planitarium,** representing the motions of the sun, earth, and moon (fig. 2465) .	0	8	6			



FIGS. 2471*.

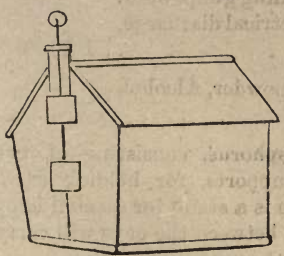


FIG. 2473.

FIG. 2472.

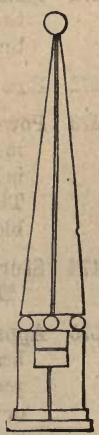


FIG. 2471.

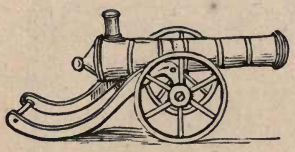


FIG. 2477.

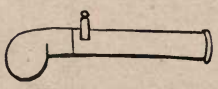


FIG. 2478.

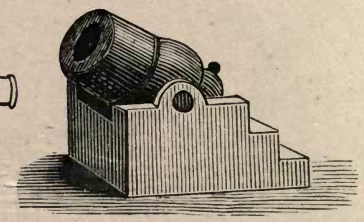


FIG. 2481.

		Each. £ s. d.	Each. £ s. d.
2466	**Electrical Mill,** showing rotation produced by electricity given off from the points of the vane (fig, 2466)		1 1 0
2467	**Electrical See-Saw,** illustrating electrical attraction and repulsion (fig. 2467)		0 15 0
2468	**Electrical Inclined Plane,** the fly revolving by the dispersion of electricity from the points, and ascending the incline (fig. 2469)		1 1 0
2469	**Apparatus** for explaining the theory of Thunder Clouds (figs. 2469)		1 5 0
2470	**Harris's Thunder Cloud Apparatus,** constructed of a light metal needle, balanced to turn very freely upon a vertical point connected with one coating of a large Leyden jar, or Electric Battery. One end of the needle is covered with light cotton wool, to represent a cloud, which can be arranged to approach either figs. 2471, or 2471*, and the discharge takes place; a very interesting experiment		1 0 0
2471	**Thunder House** (Dr. Priestley's), or Obelisk for showing the use of lightning conductors in protecting buildings (figs. 2471 and 2471*)	0 12 6	0 15 0
2472	**Fire House,** for illustrating the same fact (fig. 2472) .		1 4 0
2473	**Powder House,** for showing the necessity of a continuous metallic lightning conductor, which in this experiment is broken in the centre of a cup containing gunpowder. This is ignited and explodes by an electrical discharge, blowing down the house (fig. 2473)	1 10 0	2 0 0
2474	**Sturgeon's Apparatus** for igniting Gunpowder, Alcohol, Æther, &c., by electricity (fig. 2474)		0 12 6
2475	**Apparatus** for the ignition of Phosphorus, consisting of two brass cups, insulated upon glass supports, for holding small pieces of phosphorus; between these is a stand for a small lamp or candle; the passage of electricity between the cups will carry the flame towards the phosphorus, and ignite it (fig. 2475) . .		0 14 0

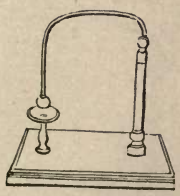


FIG. 2474.

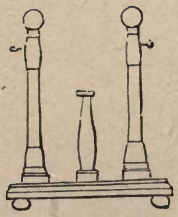


FIG. 2475.

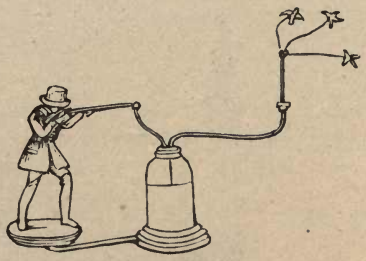


FIG. 2476.

2476 **Electrical Sportsman.** This popular experiment consists of a Leyden jar, and a figure carved to represent a Sportsman shooting; two wires are inserted in the jar, at the end of one some pith birds, the other is brought near the point of the gun. A chain from the prime conductor is connected with the wire communicating with the base of the jar, and as soon as the machine is put in action the birds rise, but fall as if shot immediately the jar is discharged (fig. 2476) £1 6 0 £1 15 0

2477 **Electrical Cannons,** for firing a mixture of Hydrogen gas and Atmospheric Air by an electric spark (fig. 2477) 0 16 0 1 1 0

2478 **Electrical Pistol,** for the same experiment (fig. 2478) . 0 7 6 0 10 6

2479 **Apparatus and Material** for charging ditto with Gas . 0 4 6 0 11 0

2480 **Electrical Powder Cannon,** for firing Gunpowder by charge of a Leyden Jar, similar to one figured in "Galvanic Section" . . . . . from 0 10 6

2481 **Electric Bomb, or Mortar,** of hard wood or ivory, having two wires so arranged that when a large Leyden jar or Electric Battery is discharged through them, a sudden expansion of the air in the Mortar is caused, and will expel with considerable force a small ball of cork placed nearly air-tight in the barrel of the bomb. If a drop of Æther be placed in the chamber the result is more violent (fig. 2481) 12s. 6d. 0 15 0

2482 **Eudiometrical Tube,** for exploding detonating mixtures of gas by the passage of an electric current or spark passed between two platinum wires. See also "Eudiometer," page 380 . . . . . 0 10 6

2483 **Volta's Condensing Electroscope** (fig. 2412), invented by Volta, is a modification of Singer's and Bennett's Gold Leaf Electroscopes. The metal wire to which the gold leaves are affixed, terminates in a flat metal plate, as seen in the wood-cut, and the instrument is supplied with a second metal plate of similar size, fitted with an insulating glass handle, the one being termed the collecting, and the other the condensing plate; both the plates are coated with insulating shellac varnish. Particulars of the method of using Volta's Electroscopes will be found in Ganot's Physics.

Price £1 10 0

Volta's Electroscope is sometimes mounted with Light Straws or small Pith Balls instead of Gold leaves.

FIG. 2423.

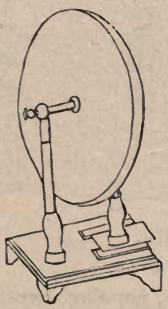


FIG. 2426.

FIG. 2430.

		Each. £	s.	d.
2485	**Insulating Table Stand** (fig. 2430), for supporting and insulating Electrical apparatus, 14-inches adjustment	0	7	6
	Ditto ditto Best make with heavy base	0	10	6
2486	**Faraday's Butterfly Net**, with Glass handle and Insulating Stand (fig. 2486)	0	8	6
2487	**Wire Gauze Cylinder** (fig. 2487), on Insulating Stand, with hollow ball for exhibiting that electricity is distributed only upon the surface of conductors similar to Biot's Experiment. No. 2404, page 416 . . . . . price	0	12	6
2488	**Electrical Conductors**, a set of three forms, consisting of a Sphere, Cone, and Cylinder of wood, covered with Tin Foil, and mounted upon Insulating stands (figs. 2488, 2488*, 2489.)			
2489	Elipsoidal Conductor, is for showing the unequal distribution of Electricity (fig. 2489) . . . . . price	1	10	0
2490	The three Conductors can be supplied with one Insulating Stand .	0	18	6

Most of the Electrical Apparatus catalogued in this section will be found fully described in *Noad's Lectures on Electricity*, *Noad's Student's Text Book*, *Ganot's Physics*, translated by Atkinson, and Tyndall's *Lessons in Electricity*.

FIG. 2488.

FIG. 2489.

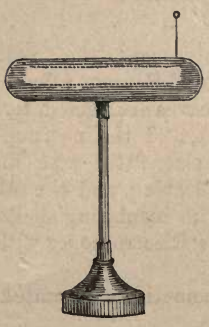


FIG. 2488*.

FIG. 2486.

FIG. 2487.

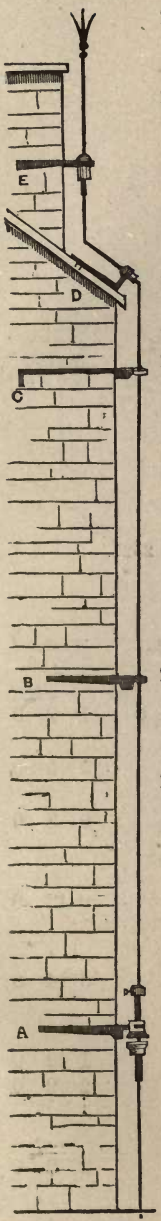


FIG. 2512.

2488	Cylinders, of Shellac, Sealing Wax, Sulphur or Vulcanite for illustrating Resinous excitation	£0	2	6	£0	6	6
2489	Apparatus for producing Lichenburg's Figures, consisting of a flat Resin cake, a bottle of Powdered Red Lead mixed with Powdered Sulphur, a square of Muslin Gauze; in a box .				0	12	6
2490	Cylindrical Glass Tubes, for exhibiting vitreous Electrical excitation . .	0	1	6	0	3	0
2491	Fur Rubber, or prepared Cat's Skin, for Electrical excitation . . .	0	10	0	0	18	6
2492	Fox Brush for ditto ditto . . .				0	2	6
2493	Cylinders, Electrical . . 3s. 6d., 4s. 6d.,	0	6	6	0	12	6
2494	Circular Glass Plates, for Electrical Machines, cut and polished :—						

Diameter	9-in.	12-in.	15-in.	18-in.	24-in.
Price .	6s.	12s.	21s.	30s.	66s.

2495 Circular Ebonite Plates :—for Electrical Machines.

Diameter	12-in.	15-in.	18-in.	24-in.	30-in.	36-in.
Price .	16s.	22s.	30s.	46s.	66s.	86s.

2496	Conductors for Electrical Machines, black japanned Tin or Zinc 3s. 6d.	0	5	6	0	6	6
2497	Ditto, Brass . . . . from				0	7	6
2498	Glass Jars, for coating, ½-pts. 1s., pts. 1s. 6d., qts. 2s., 3 pts.				0	3	0
2499	Glass Handles . . . 1s. 6d.,	0	2	0	0	3	6
2500	Gutta Percha Handles	0	1	6	0	2	6
2501	Glass Legs or Supports . 1s. 6d.,	0	2	0	0	2	6
2502	Glass Rod, for Electrical apparatus, per lb.				0	2	6
2503	Brass Balls . . . 9d., 1s., 1s. 6d.	0	2	0	0	2	6
2504	Ditto, with Collar and Wire, for Mounting up Leyden Jars . . . 2s.	0	2	6	0	3	6
2505	Amalgam, per box				0	1	0
2506	Brass Chain, per yard				0	0	6
2507	Flexible Conducting Wire, per yard, very convenient				0	0	6
2508	Strips of Gilt and Silvered Leather, to illuminate by the electric spark, per yard				0	2	0
2509	Balls of Ivory, Bone, Boxwood, and Ebony	0	1	0	0	2	0
2510	Brass Clamps, for fixing apparatus to table	0	3	0	0	4	6
2511	Strong Iron Clamps for Ditto . .				0	3	6
2512	Patent Copper Wire Rope, solid Copper Rod, or Flat Copper Band, Lightning Conductors, with the point and all staples, &c., complete for fixing (fig. 2512). For full description and prices, see pages 127 and 129.						

ESTIMATES GIVEN FOR FIXING OR REPAIRING LIGHTNING CONDUCTORS.

VOLTAIC ELECTRICITY.

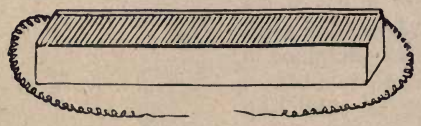


FIG. 2519.

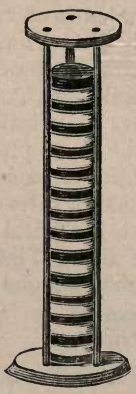


FIG. 2513.

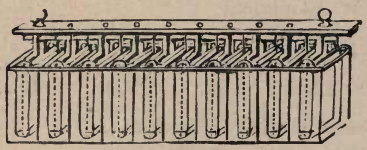


FIG. 2520.

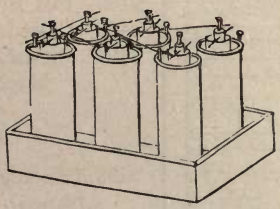


FIG. 2527.

VOLTAIC OR GALVANIC APPARATUS.

		Each. £ s. d.	£ s. d.
2513	**Volta's Pile of 50 pair of Zinc and Copper Plates,** soldered together, on a mahogany stand (fig. 2513) .	0 16 0	1 8 0
2514	**Zinc and Copper Plates,** circular, soldered together per doz.		0 5 0
2515	**Pairs of Silver and Zinc Wires,** soldered together, for *Volta's Couronne de tasse* . . . . . per doz.		0 8 0
2516	**Pair of Circular Zinc and Copper Plates,** with Glass handles, for showing the production of electricity by contact.		0 12 6
2517	**Zinc and Copper Sieves,** with Glass Handle, to illustrate the Electric Action produced by sifting metal filings on a delicate Electrometer . . . . . per pair		0 14 0
2518	**Cruikshank's Batteries,** Zinc and Copper, in mahogany troughs, for Medical purposes, 25 pairs of plates, 2¼-inch		1 10 0
2519	Ditto 50 pairs of plates, 2¼-inch (fig. 2519)		2 2 0
2520	**Wollaston's or Babington's Battery** of ten pairs of 4-inch plates, Zinc and Copper. with divided trough (fig. 2520)		2 2 0

2521 **Cruikshank's, Wollaston's, or Sturgeon's Batteries,** are charged with dilute Sulphuric acid in the proportion one part, by measure, strong acid, to fourteen parts Water; or, if very strong action be required for a short time the quantity of the acid may be increased, say 1 to 10. Dr. Fyfe found the use of a solution of Sulphate of Copper in these batteries increased their action.

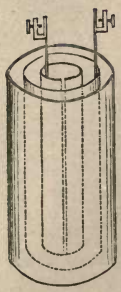


FIG. 2522.

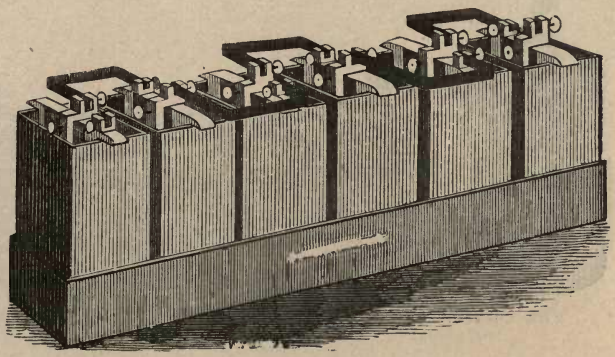


FIG. 2531.

		Each. £ s. d	Each. £ s. d.
2522	**Sturgeon's Cylindrical Battery**, of Copper and Zinc, in Stoneware pot (fig. 2511) a simple and cheap but very useful battery, for elementary class instruction; for feeble but continued action solutions of either common Salt or Hydrochlorate of Ammonia are to be used; and dilute Sulphuric Acid, one part strong acid to ten parts water, for stronger action	0 7 6	0 10 6
2523	**Calorimotor, Wollaston's**, 1 pair of 6-inch zinc and double copper plates, in a trough		0 10 6
2524	**Calorimotor, Hare's**, of extra large size . . .		10 0 0
2525	**Daniell's Sustaining Battery**, consisting of a cylinder of Zinc and Copper, separated from each other by a porous earthenware tube, and excited by a solution of Salt and Water, or diluted Sulphuric acid, one part acid to ten parts Water, in contact with the zinc, and a Saturated solution of Sulphate of Copper in the other cell. Price for single cells . . 5s. 6d.	0 8 0	0 11 0
2526	**Daniell's Battery**, containing six ½-lb. cells of the above, in mahogany tray		1 12 6
2527	Ditto ditto containing twelve 1-lb. cells, in mahogany tray (fig. 2527)		4 4 0

Daniell's Battery is the best arrangement for use where a steady and very uniform current is desired for any length of time; much used for Electro-plating, Gilding, and Electrotyping purposes.

2528	**Mullins Battery**, a modification of Daniell's Cell, consists of cylinders of Zinc and Copper, separated from each other by Bladder or Porous Earthenware; excited by a solution of common Salt and Water in contact with the Zinc and a solution of Sulphate of Copper in the other cell. Single cells . . 5s.	0 7 0	0 15 0

Larger sizes of Daniel's or Mullin's Batteries in single cells or series, to order.

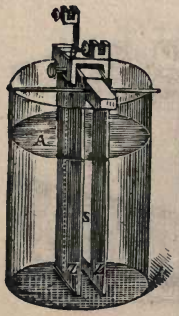


FIG. 2529.

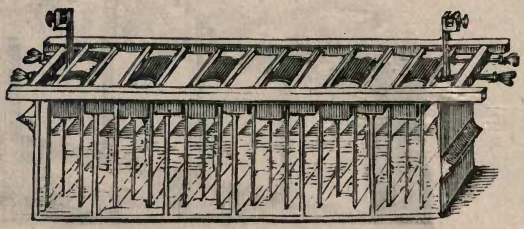


FIG. 2534.

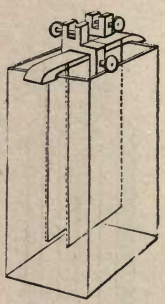


FIG. 2530.

2529 **Smee's Batteries,** in round Stoneware Pots, so arranged with brass clamps that the zincs can be easily removed for cleaning and amalgamating, and replaced (fig. 2529)—
½-pt. 5s. 6d. 1-pt. 8s. 6d. 2-pts. 11s. 6d. 3-pts. 14s.

Smee's Batteries are constructed with one plate of thin Platinized Silver, and two plates of Amalgamated Zinc. For charging Smee's Batteries one part by measure of strong Sulphuric Acid, to 10 or 12 parts of Water, will be found sufficient for slow and gentle action; for more powerful results, 1 part acid to 8 of water should be used. It should be noted that in making dilute sulphuric acid the strong acid should be *poured into* the water slowly and gradually.

The superiority and convenience of this Battery over all others consists in the little trouble required to put it in action, and the great power obtained. They are not obnoxious or disagreeable during their action, hydrogen only being evolved. One Battery with a piece of platinized silver two inches square, immersed in a tumbler of dilute acid, in connection with an electro-magnet, will support three hundred-weight.

		Each. £ s. d.	Each. £ s. d.
2530	**Smee's Batteries,** in flat Glass Cells (fig. 2530) . .	0 12 6	0 15 6
	Set of Six Half-pint Smee's Batteries, in round pots, and a mahogany tray		1 18 6

This set is so arranged, that it can be used for quantity or intensity effects, will show all the leading facts connected with galvanism, decomposing water, deflagrating metals, &c., &c., and is well adapted for the instruction of a small class. Smee's Batteries arranged in an intensity series, and excited with *exceedingly weak acid*, answer well for ringing signal bells or short telegraph lines, care being taken to keep the zinc plates well amalgamated.

2531	**Set of Six one-pint Smee's Batteries,** in flat Stoneware cells and mahogany tray (fig. 2531)		3 3 0
2532	**Set of Six two-pint ditto,** in ditto		4 4 0
2533	**Set of Six one-pint ditto,** in flat cells and mahogany tray, with counterpoise weights, or ratchet wheel, for suspending the battery when not in use . . .	3 15 0	5 5 0
2534	**Smee's Batteries,** Intensity Series (fig. 2534) . .		5 5 0

See also Sections Electric Light and Telegraph.

Grove's Batteries, the elements consist of a double plate of amalgamated Zinc, and a single plate of Platinum; a porous cell separates the metals; the former being excited by Sulphuric acid and Water (1 part strong sulphuric acid to 8 parts of water), the latter by concentrated Nitric acid. This is the most powerful of all voltaic arrangements, and is the best adapted for brilliant and showy experiments in public institutions, or where a powerful current is required. The action is very uniform for some considerable period. A De la Rive's Battery is a modification of Grove's, the Nitric acid being on the exterior in a large glass bottle. A porous cell or tube containing the Zinc and dilute Sulphuric Acid is inserted into the bottle; this is removed out of the glass bottle containing the Nitric Acid, and replaced by a Glass stopper when the Battery is not in use; by this arrangement a large quantity of Acid can be retained ready for use without the escape of acid fumes.

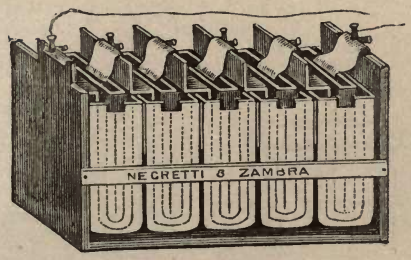


FIG. 2537.

FIG. 2535.

		Each. £ s. d.
2535	**Grove's Battery**, single cell (fig. 2535)	0 10 0
2536	**Set of Four Grove's Batteries**, with suitable metallic connections, porous cells, and earthenware troughs, in mahogany tray . . .	2 10 0
2537	**Set of Five Grove's Batteries**, in tray (fig. 2537)	3 3 0
2538	**Set of Eight** ditto, in mahogany tray	5 5 0
2539	**Set of Ten** ditto, in ditto	6 6 0
2540	**Grove's Gas Battery**, in which the active elements are Hydrogen and Oxygen gases; set of six gas batteries mounted on a stand . . .	6 10 0
2541	**Water Battery, Crosse's**, a Voltaic Combination of high intensity.	

Fitted up to order with any number of pairs of metallic elements, placed in glass or porcelain cells, from 200 to 2000. The apparatus is constructed with due regard to insulation, and, by means of binding-screws, the action of any number in the series may be examined with great convenience, and any cells removed without disturbing others.

2542	**Bunsen's Carbon Battery** (elements Zinc and Carbon) single cell, shown in section fig. 2542	0 10 6
2543	**Bunsen's Batteries**, a series of ten, arranged in a stout wood tray (fig. 2543)	5 5 0

The Carbon Batteries are excited by the same acids as Grove's arrangement (strong nitric acid and dilute sulphuric acid, 1 part strong acid to 7 or 8 of water), and will be found next to it in intensity and energy, at a much lower original cost.

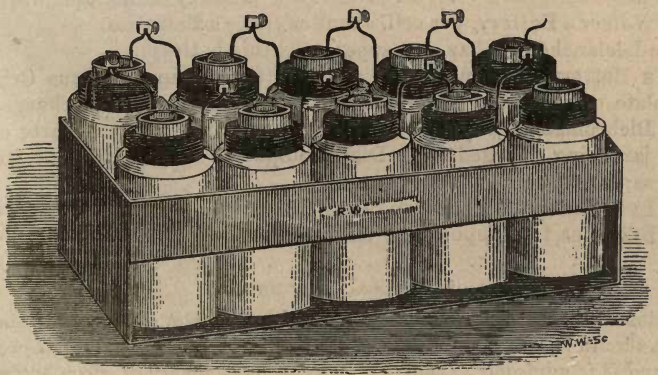


FIG. 2543.

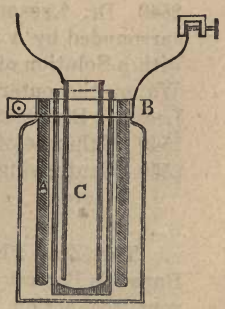


FIG. 2542.

FIG. 1888.

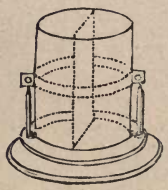


FIG. 2566.

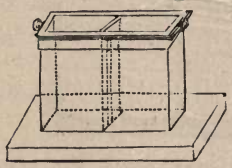


FIG. 2566*.

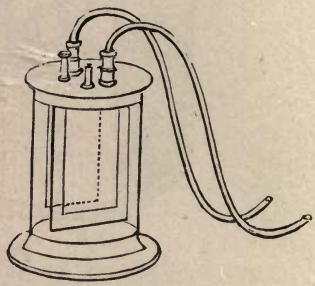


FIG. 2565.

		Each. £ s. d.	Each. £ s. d.
2544	**Callan's Cast Iron or Maynooth Batteries** . . 5s.	0 7 6	0 10 6
2545	**Sets of Five and Ten Cast Iron Batteries**, full size, in a Stout wood tray	2 15 0	5 10 0

The Maynooth Battery is composed of a Cast Iron Cell, a rectangular Porous Pot, and a stout plate of Amalgamated Zinc. The porous cell is charged with Dilute Sulphuric Acid, one part strong acid to eight parts Water, and the Iron Cell with strong Nitric and Sulphuric Acids, with a Saturated Solution of Nitrate of Potash in equal parts. This also is a very powerful form of battery, adapted to exhibit all galvanic phenomena with great brilliancy, and suited for rough Manufacturing or Mining Purposes. Professor Faraday found the efficiency and steady working of Callan's Battery much improved by using equal parts of strong Nitric Acid and strong Sulphuric Acid in the *Iron Cell*, omitting the Solution of Nitrate of Potash.

2546 **A Set of 25 Callan's or Maynooth Batteries**, sufficient for producing a very effective **Electric Light** for private exhibition.
In two strong trays 10 10 0

2547 **Walker's Battery** is similar to Smee's arrangement; but in place of the Platinized Silver (or Electro Negative Plate) slabs of Gas Graphite or Platinized Graphite are used, the other element being Amalgamated Zinc, the battery, like Smee's, being charged with Dilute Sulphuric Acid. This battery is economical and simple in use, has considerable Electro Motive force, and has been found very serviceable for Railway Telegraph work. Price for Walker's Battery, per cell, about as Smee's Batteries.
The Leclanché Cell has now superseded this battery.

2548 **Dr. Leeson's Battery** is formed of a plate of Copper in a Porous Cell, surrounded by a plate of zinc in a stoneware jar. The Porous Cell is charged with a Solution of Bichromate of Potash, one part of Bichromate to ten parts of Water, the outer jar being charged with Dilute Sulphuric Acid. Price of Dr. Leeson's Batteries same as Daniell's. See page 429.

2549 **Sulphate of Lead Battery.** Price per Pint Cell 0 5 0

2550 **Cauterising Batteries**, for Amputation, &c., supplied to order . . . . . 6 6 0 to 10 10 0

See also Section, Medical Instruments

The Zinc Plates of Smee's, Grove's, Callan's, Bichromate, Leclanché and Bunsen's Batteries should be examined now and then, and re-amalgamated to prevent local action, *and it is advisable to thoroughly wash with plenty of clean water all batteries before putting away, after use.*

BICHROMATE BOTTLE BATTERY.

One of the most elegant and convenient forms of galvanic battery yet introduced is that shown in our engraving (fig. 2551); it is a modification of Dr. Leeson's Bichromate Battery; the elements are two plates of Graphite or Gas Carbon, and a stout plate of Zinc. The exciting fluid is a saturated solution of Bichromate of Potass (about 2 ounces of bichromate potass to 1 pint of water), with one part by measure of strong Sulphuric Acid to every twelve parts of bichromate solution (nearly two fluid ounces of acid to an imperial pint, or twenty ounces). This acid should be added to the bichromate slowly: when the solution is cold, it is ready for use. It will be seen from the drawing that the glass bottle-shaped cell has a long neck. This is contrived for the purpose of withdrawing the zinc element from the exciting fluid when the battery is not in use, and thus stopping all action or waste. This zinc plate is placed between the two carbon plates, and is only half their length, by a stout wire rod attached to it; the zinc can be withdrawn from or immersed in the exciting fluid very conveniently, and rapidly sets in action any apparatus connected with it, such as an induction coil, a signal bell, or small telegraphic instrument. Its simplicity, combined with the absence of any fumes or smell, render the Bichromate Battery most useful for short action. The Bichromate Batteries may be combined either for quantity or intensity effects.

2551 **Bichromate Bottle Batteries** (fig. 2551).

Price, each . .	1-pt.	2-pts.	4-pts.
	10s.	18s. 6d.	32s.

2552 **Bichromate Battery,** in round Cell Quart Size (fig. 2552) . . . 0 16 0

2553 **Fuller's Constant Battery,** consists of a Plate of Carbon in an Earthenware Cell, and a Porous Tube in which is placed a Cylinder of Zinc, the lower part being surrounded with Mercury. This Porous Cell is filled with Dilute Sulphuric Acid, 1 part Acid to 8 of Water. The outer Cell is charged with a Solution of Bichromate of Potass with one-fourth its bulk of Sulphuric Acid. Per Cell 0 8 6

2554 **The Leclanché Battery.** The elements in this battery are a cylinder of Carbon, inserted into a round porous tube, closely surrounded by a mixture of small fragments of very pure Peroxide of Manganese and Coke. The top of the mixture in the porous pot is covered with wax. The porous cell and its contents are placed in a glass bottle, as seen in fig 2554, with a rod of Zinc (the Electro Positive element); and this glass cell is to be about half-filled with a solution of Chloro-hydrate of Ammonia (the Sal Ammoniac of commerce).

The Electromotive force of the Leclanché Cell is stated by Ganot to be $\frac{9}{10}$ that of a Daniell's Cell, and its resistance about $1\frac{1}{4}$ of a British Association Unit. For durability and cleanliness the Leclanché Cells are unequalled, requiring but a minimum of attention, whilst on the other hand, for cost of working they are the cheapest form of battery that is made, no local action taking place when not in actual use. They may therefore be specially recommended for all classes of intermittent work: the consumption of material being in direct proportion to the amount of work performed. For train signalling apparatus, and for ringing bells, these batteries have been found to answer well for long periods of time. The inventor states that the Electromotive Force is 75 per cent. greater than the Daniell Battery, whilst its resistance is 90 per cent. less: and gives the following instructions for charging, which should be carefully attended to.

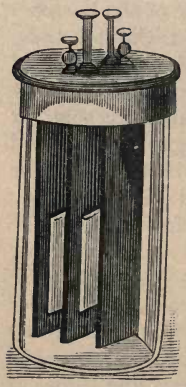


FIG. 2552.

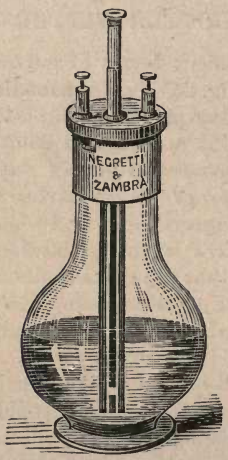


FIG. 2551.

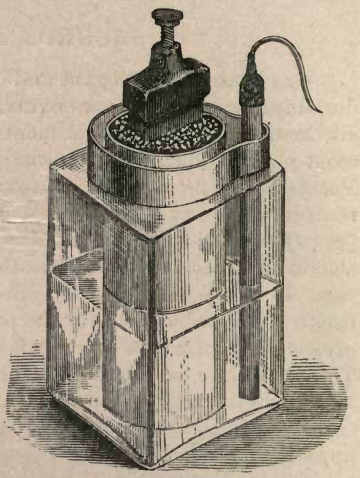


FIG. 2554.

Fill the glass cell about ½ an inch high with powdered Sal Ammoniac; put the porous cell in its place, and *half fill* the glass cell with water (say about 2 ounces of the crystal to 1 pint of water) pouring a *little* water into the porous cell at the same time through the holes in the top. The solution of Sal Ammoniac should always be strong, an excess of salt being kept in the cell.

The battery will remain in working order so long as the solution is clear, and in contact with the zinc. When the solution comes turbid or milky, add Sal Ammoniac, and in a few hours the battery will be as powerful as ever. It may be placed aside for months without much deteriorating, but if for a very long period it is best to remove to remove the porous cell. Special care should be taken that the porous cell never stands more than half its height in the liquid.

	Each. £ s. d.	£ s. d.
Price for the Leclanché Battery Cells (fig. 2554) .		
Each No. 1, 5s. 6d.; No. 2, 4s.; No. 3, .	0 3 6	
Extra Zincs for above . . . each .	1s. 0 0 8	0 0 6
Chloro-hydrate of Ammonia in Powder . per lb.		0 1 6

2555 **Insulated Stand,** for exhibiting the combustion of Carbon, fusion of wire, &c., with the Galvanic Battery 1 5 0

2556 **Insulated Stand,** with Henly's Universal Discharger and Press, two pairs of forceps, &c., applicable for both Voltaic and Frictional Electricity (see *ante*, page 417, fig. 2408) . . . 2 10 0

FIG 2553*.

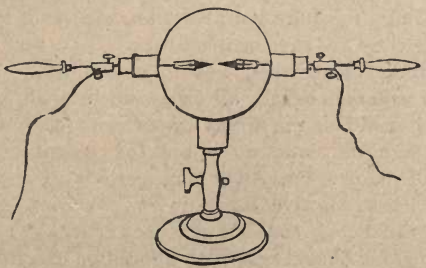


FIG. 2557.

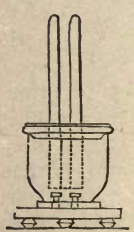


FIG. 2563.

FIG. 2567.

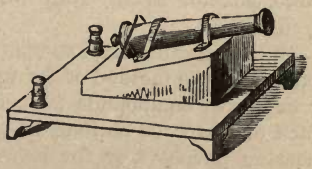


FIG. 2572.

FIG. 2567*.

		Each. £ s. d.	Each. £ s. d.
2557	**Glass Globe**, with Stopcock, brass caps, sliding forceps and balls, for showing Electrical Light *in vacuo*, and decomposing gases by the ignition of Carbon points with the galvanic battery (fig. 2557, see also fig. 2451) .		3 3 0
2558	**Lamp, Electric**, with self-regulating apparatus for the carbon points		12 12 0
2559	Ditto ditto **Duboscq's** arrangement . . .		13 0 0
2560	**Decomposition Apparatus**, with **Single Tube**, for collecting the gases combined . . . 7s. 6d.	0 15 0	1 1 0
2561	**Decomposition Apparatus**, with single **Graduated Tube** (fig. 2564)		1 5 0
2562	**Apparatus for Decomposing Water** (Volta-meter), with double tubes for collecting the Oxygen and Hydrogen gases separate, small size	0 10 6	0 16 0
2563	**Decomposition Apparatus, Double Tubes**, larger, suitable for lecture tables (figs. 2563 and 2563*) from	1 1 0	1 10 0
2564	**Decomposition Apparatus**, with **Double Tubes** graduated into 10ths and 100ths of a cubic inch .	1 10 0	2 2 0
2565	**Volta-Meter**, with large Platinum Electrodes, divided by a porous diaphragm, for experiments with large and very powerful batteries (fig. 2565)		3 3 0
2566	**Faraday's Apparatus**, for Electrical Chemical Decompositions, consisting of glass trough divided by a diaphragm (figs. 2566, 2566*)	0 14 6	1 1 0
2567	**V and U Tubes** for the decomposition of Neutral Salts (figs. 2567, 2567*).	0 5 0	0 10 6
2568	**Pieces of Platinum and Silver Wire** soldered together alternately; a strong voltaic current passed through causes the platinum to become red hot without heating the silver		0 12 6
2569	**Apparatus** to exhibit the increase of temperature produced by the passage of an electric current through a fine platinum wire enclosed in a glass tube, which prevents radiation, and a much greater length of wire is heated than if it be exposed without the tube .		3 0 0
2570	**Electro-Thermometer** (Harris's) for measuring the Calorific effects of electricity		1 18 0
2571	**Aurora Tube** for experiments with the tube exhausted of air, or charged with different gases (fig. 2571) . .		3 3 0

		Each. £ s. d.	Each. £ s. d.
2572	**Model Canon or Bomb,** mounted on mahogany stand, with binding screws, &c., for firing Gunpowder by Galvanic Battery (fig. 2572)		1 1 0
2573	**Model Apparatus for Submarine Explosions.** For explaining and exhibiting the method of firing gunpowder or other explosive compounds (Torpedoes) beneath the surface of water, or at long distances, either for Engineering purposes, or for Naval and Military warfare	0 15 6	2 2 0
2574	**Rectangular Battery Cells,** of hard glazed Porcelain, with porous jars, 6-in. high, 6½-in. wide, 2-in. thick .		0 4 6
2575	Ditto ditto 6-in. high, 4¼-in. wide, 2-in. thick .		0 3 6
2576	**Rectangular Battery Cells,** 5-in. high, 3¼-in. wide, 1⅞-in. thick		0 2 8
2577	**Glass Battery Cells,** of various dimensions . from		0 4 6
2578	**Ebonite,** ditto . . . . . from		0 4 6
2579	**Gutta Percha ditto Acid Holders,** various		
2580	**Platinized Silver** for Smee's Battery . . per oz.		0 12 6
2581	**Platinum Foil and Wire** of all thicknesses, variable. About per dram 5s. per oz.		1 15 0
2582	**Amalgamated Zinc Plates,** cut to various sizes, per lb.		0 1 6
2583	**Zinc Rods** for Daniell's Batteries, each 8d., or according to weight	0 1 0	0 1 4
2584	**Galvanic Conducting or Connecting Wires,** in pairs, of convenient length for experimental or Medical use, insulated with **Cotton or Gutta Percha,** various lengths and sizes . . . . . from per pair		0 2 6
2585	**Boxwood Charcoal,** for points . . . per oz.		0 0 6
2586	**Charcoal or Graphite Points,** for Electric Light, per pair		0 1 0
2587	**Carbon or Graphite Battery Plates.**		
	Inches 4×1¼ 6×1¼ 6×2 6×3 8×4 12×4		
	Price 9d. 1s. 1s. 4d. 1s. 8d. 2s. 3s. 6d.		
2588	**Gold, Silver, Platinum, Brass, Copper, Zinc, Iron, and Steel Wire and Foil,** for combustion, small reels .	0 0 6	0 2 6

2589 **A Series of Six Smee's Batteries,** in a tray; apparatus for decomposing water into oxygen and hydrogen; V tube for decomposing neutral salts, various metal wires and foils for igniting and deflagrating, and a glass trough fitted for depositing metals by the electrotype or electro-gilding process. A small useful set for the use of Schoolmasters, for instructing a class 3 10 0

2590 **Larger Series,** suited for Lecturers 5 5 0 6 6 0

The following values have been obtained for the Electro-Motive Force of the most useful battery combinations; they are the mean values of many careful determinations:—

Bunsen's Battery	839
Grove's ,, ...	829
Smee's ,, ...	210
Wollaston's ,, ...	208

GANOT.

ELECTRIC LIGHT.

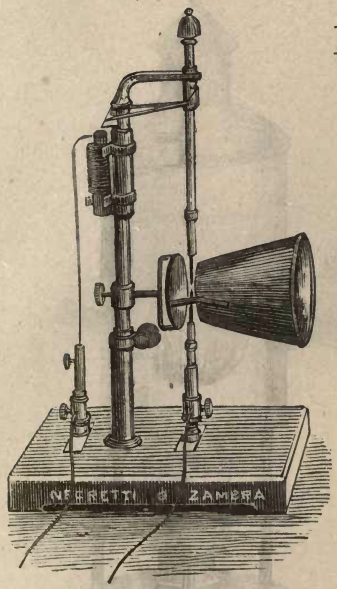


FIG. 2590

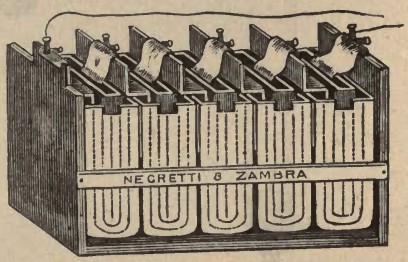


FIG. 2591.

IN 1801 the distinguished chemist SIR HUMPHRY DAVY first exhibited, at the Royal Institution of London, a series of brilliant experiments with the Electric Light, by means of a Battery of 2,000 plates, each 4 inches square; but it was not until the more permanent and powerful batteries of Daniell, Grove, and Bunsen were invented that the light became of any practical use.

As an illuminating agent for optical experiment it is invaluable; and it has been applied to Light-house service, with very considerable success, by Mr. Holmes, at Dungeness on the south-east coast of England, since June, 1862. This light is produced by a powerful Magneto-Electric Apparatus similar to one exhibited in action by Mr. Holmes at the Exhibition of that year.

The Apparatus we catalogue in this section is chiefly adapted for private experiment and the lecture-room; but by extending and enlarging the series of batteries an Electric Light can be supplied of sufficient intensity to illuminate a large area, for which special quotations will be given upon application giving particulars of what is required.

		Each. £	s.	d.
2591	A Set of 5 Grove's Batteries, in strong wood tray (as fig. 2591)	3	3	0
2592	A Set of 10 ditto ditto in tray	6	6	0
2593	A Set of 5 Bunsen's Carbon Batteries, in stout wood tray	2	15	0
2595	A Set of 10 ditto ditto in tray	5	5	0
2594	A Set of 5 Callan's Cast Iron Batteries, in stout wood tray	2	15	0
2595	A Set of 10 ditto ditto in tray	5	10	0

FIG. 2571.

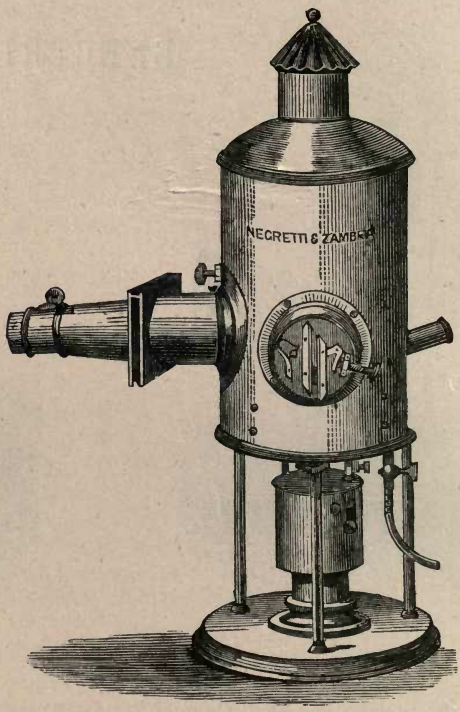


FIG. 2602.

		Each. £ s. d.
2596	**Self-acting Electric Lamp,** arranged on convenient stand (as fig. 2596), with adjustments to the Carbon Points	2 10 0
2597	**Electric Lamp,** without adjustments	2 2 0
2598	**Carbon Points or Rods** . . . . . from	0 1 6
2599	**Parabolic Reflectors,** for Electric Light, thickly plated, from each	2 2 0
2600	**Insulated (Gutta Percha)** Copper Wire, 8d. to 1s. 4d. per yard, price variable.	
2601	**Glass Tubes,** of large size, for exhibiting the Aurora Borealis; mounted with Stopcock and Metal terminals, for experimenting with various Gases, &c.; on a firm base (fig. 2571)	3 3 0
2602	**Electric Lantern,** an improved arrangement, having two sets of Condensers. With it the direct ray as well as the Spectrum may be projected upon the same screen without moving the Lantern. A gas jet is placed inside the Lantern, and suitable adjustments are provided for keeping the Carbon Points uniform in height. Price in the most complete form (fig. 2602)	25 0 0

45 Cells of Bunsen's Batteries are required for effectively working the Electric Light, or 45 Cells of Grove's Batteries; Price for 40 Bunsen's £20; 45 Grove's, £23.

For further particulars respecting Batteries, &c., see pages 428 to 432.

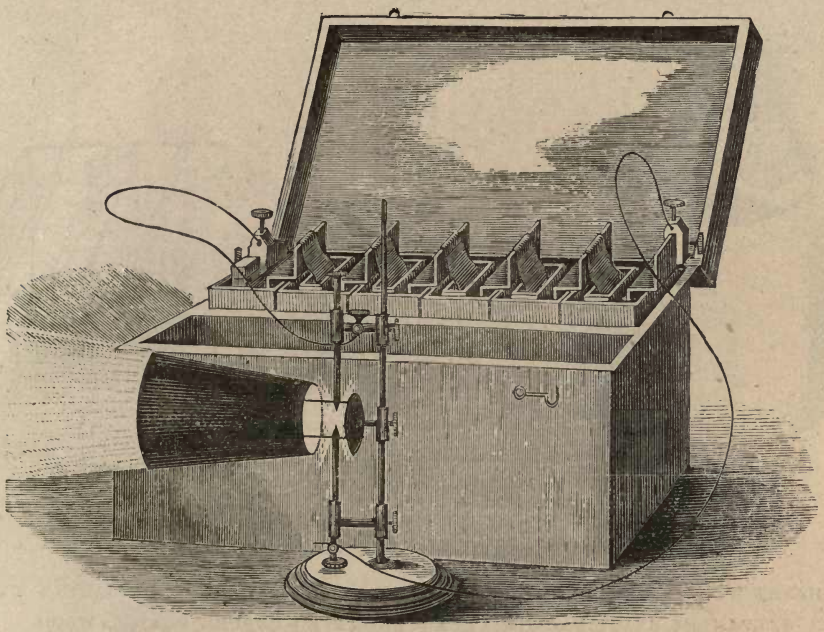


FIG. 2603.

2603 **Electric Light Apparatus** (fig. 2603) consisting of a Six Cell Grove's Battery with connections and conducting wires. Electric Lamp with Carbon Points; Parabolic Reflector having suitable adjusting and clamping Screws, the Carbon Points being regulated by an Electric Magnet.
Price for the complete Apparatus £6 10 0

2604 **Dynamo Magneto Electric Machine** (fig. 2604). This machine can be used for a variety of experimental purposes, as a substitute for the Voltaic Battery: it will heat to incandescence 12 inches of Platinum wire, ·01 diameter, or can be arranged to rapidly decompose water £28 0 0

2605 **Dynamo Magneto Electric Machine**, requiring ½ Horse Power; can be driven either by Steam or Gas Engine to light five 20-Candle Power Incandescent Lamps £15 10 0

2606 Ditto ditto to light twenty 20-Candle Power Lamps, requiring 3 Horse-power Engines £50 0 0

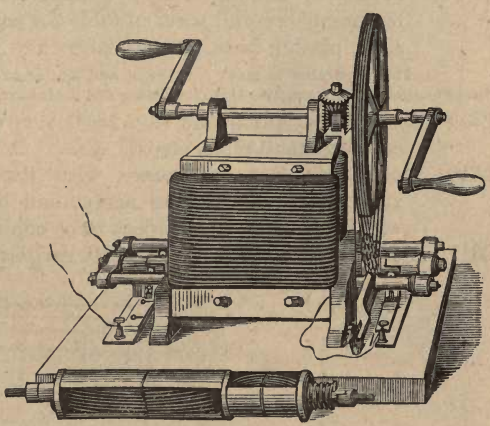


FIG. 2604.

The above prices do not include either Steam or Gas Engines. For the price of Steam Engines and Gas Engines see Mechanical Section at the end of the Book. Estimates for larger Dynamos and Engines supplied upon application stating the requirements.

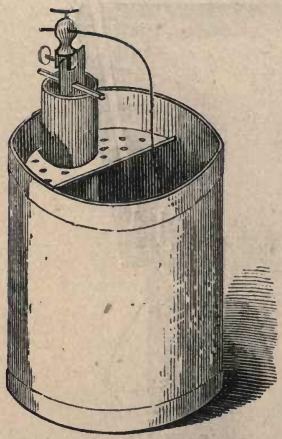


FIG. 2608.

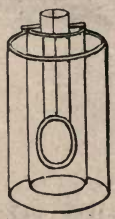


FIG. 2607.

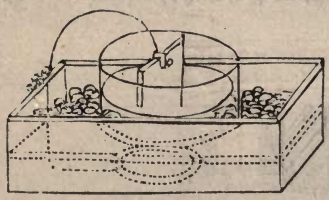


FIG. 2609.

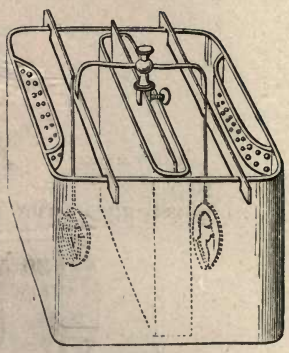


FIG. 2610.

ELECTRIC-METALLURGICAL APPARATUS.

ELECTROTYPE APPARATUS IS NOW EXTENSIVELY USED FOR OBTAINING BY GALVANISM EXACT FAC-SIMILES OF ENGRAVED COPPER PLATES, WOOD ENGRAVINGS, MEDALS, PLASTER CASTS, ELECTRO GILDING AND PLATING, ETC.

		Each. £ s. d.	Each. £ s. d.
2607	**Electrotype Apparatus,** consisting of earthenware jar, with porous pot, zinc and wire (fig. 2607) . . .	0 1 6	0 2 6
2608	**Round Glazed Stoneware Troughs,** not permeable to sulphate of copper, with porous cell, zinc plate, binding screw and wire, suitable for copying medals, seals, plaster casts, &c. (fig. 2608) . . 5s. 6d.	0 7 6	0 10 6

This apparatus is most convenient and simple in its operation, and particularly adapted for those commencing to practise this interesting and useful art.

2609	**Electrotype Apparatus** (fig. 2609) very convenient for copying small seals, medals, &c.		0 15 0
2610	**Electrotype Trough,** square, with flat porous cell, zinc plate and binding screw, and brass bars, on which to suspend the object to be copied (fig. 2610) .		0 16 0
2611	**Electrotype Trough,** as No. 2610, smaller size . .		0 12 6

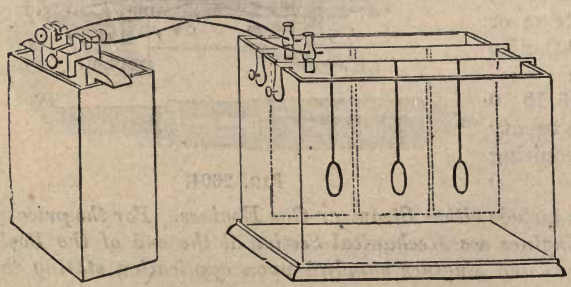


FIG. 2613.

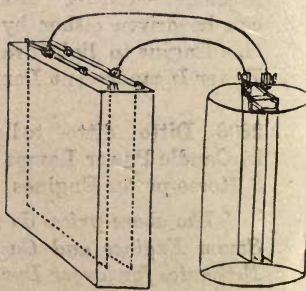


FIG. 2615.

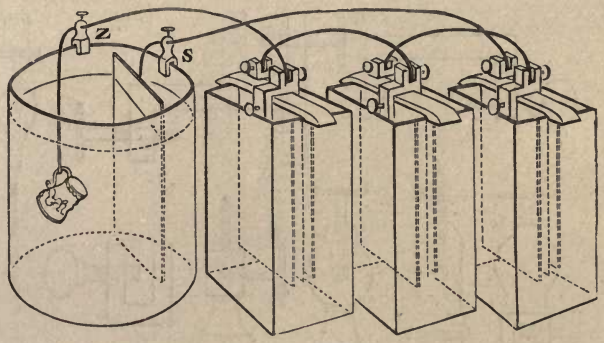


FIG. 2619.

		Each. £ s. d.	Each. £ s. d.
2612	**Single Smee's Battery**, with Precipitating Trough, for making a number of small medals . . from		1 1 0
2613	**Larger ditto** (fig. 2613)		2 2 0
2614	**Electrotype Precipitating Trough**, large sized oval shape, with brass connecting bars (fig. 2614) . .		1 16 0
2615	**Vertical Precipitating Trough**, with Smee's battery, for obtaining duplicates of large engraved Copper Plates, Maps, &c. (fig. 2615)	2 2 0	3 10 0
2616	**Single Cell Apparatus**, for Electro-gilding or Plating (fig. 2616)		0 10 6

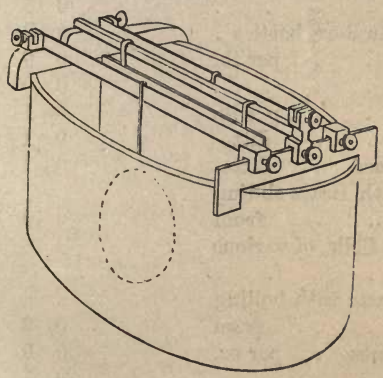


FIG. 2614.

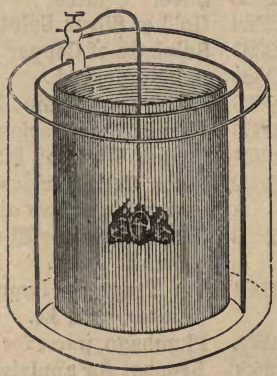


FIG. 2616.

2617	**Electro-Gilding and Plating Apparatus by the Battery Process**, with Glass precipitating trough, and one Smee's battery	0 18 6
2618	**Electro-Gilding and Plating Apparatus**, with 2 Smee's batteries	1 10 0
2619	Ditto ditto with 3 Smee's batteries (fig. 2619) .	2 0 0
2620	**Apparatus** for coating metallic surfaces with Aluminium and Silicium . . . . . from	0 10 6
2621	**Apparatus** for Nickel Plating fitted up to order.	

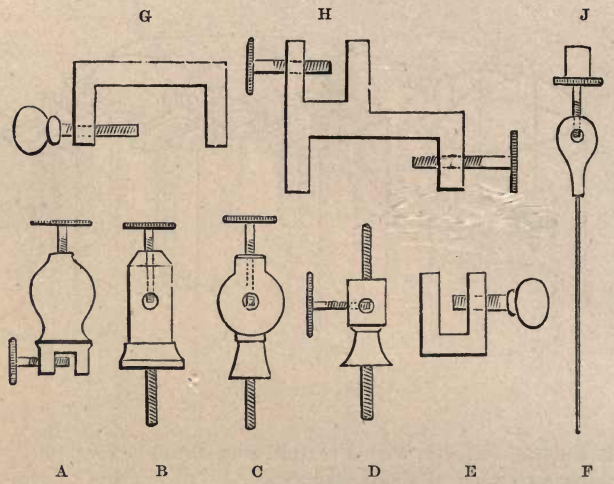


FIG. 2623.

		Each. £ s. d.	Each. £ s. d.
2622	**Platinized Silver**, for Smee's Batteries price variable, about per oz.		0 11 0
	This averages about 3-oz. to the square foot, but can be had of various thicknesses.		
2623	**Binding Screws**, or Terminals, of various forms and descriptions (fig. 2623):—		
	Figs. A 9d. B 8d. C 8d. D 1s. 8d. and E 1s. F 1s. 2d. G 1s. 6d. H 1s. 8d. and 2s.		
2624	**Gold Wire and Plate**, about . . . . per dwt.		0 8 0
2625	**Silver** ditto ditto		0 5 6
2626	**Gold or Silver Solution**, ready for use in 3-oz. bottles .		0 3 0
2627	**Sulphate of Copper** . . . . . per lb.		0 0 8
2628	**Sulphuric Acid**		0 0 4
2629	**Amalgamated Zinc Plates**, of all sizes . . per lb.		0 1 6
2630	**Zinc Rods**, of various lengths . . . . ditto		0 1 6
2631	**Copper Wire and Plate**, of all thicknesses . ditto		0 1 6
2632	**Glass Cells**, various sizes, mounted with Brass sliding bars for electro-gilding and plating . . from		0 10 6
2633	**Gutta Percha or Ebonite Precipitating Cells**, of various forms		
2634	**Tin Trays**, for impregnating plaster casts with boiling water, wax, &c. . . . . from		0 2 0
2635	**Plumbago**, pure, for Electrotype purposes . per oz.		0 0 4
2636	**Brushes** for applying Plumbago, &c.		0 1 6
2637	**Brushes** for Polishing and Bronzing electrotypes . .		0 9 0
2638	**Water of Air Stone**, for cleaning electrotypes . .		0 1 0
2639	**Porous Cells, Round**, of superior quality:—		

Height . .	2½-in.	3½-in.	4½-in	6-in.	12-in.	18-in.
Price . .	4d.	6d.	8d.	10d.	1s. 6d.	2s. 9d.

2640 **Porous Cells, Flat**—

Height . .	2-in	4-in.	2½-in	3½-in.	3½-in.	7-in.
Width . .	3½-in.	4½-in.	4¾-in.	5½-in.	6¾-in.	7-in.
Price . .	8d.	1s.	1s. 4d.	1s. 6d.	1s. 9d.	2s.

2641 **Very superior Plaster of Paris Medallions**, for reproduction by the Electrotype process—

3d. 4d. 6d. 8d. 1s. 1s. 6d., and 2s. 6d. each.

MAGNETISM.

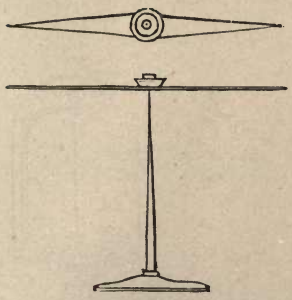


FIG. 2649.

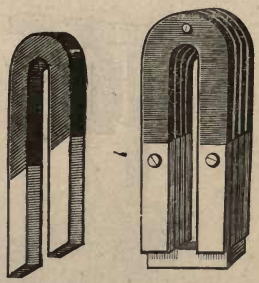


FIG. 2643. FIG. 2644.

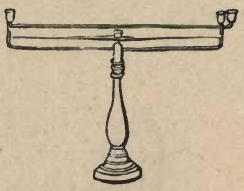


FIG. 2662.

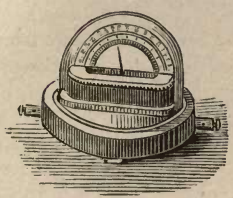


FIG. 2674.

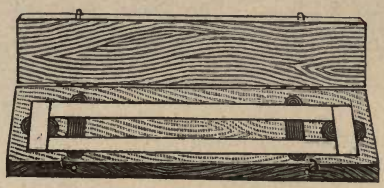


FIG. 2646.

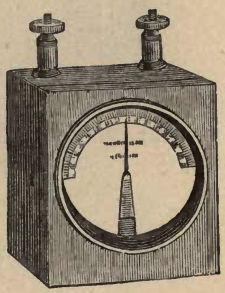


FIG. 2674*.

MAGNETIC AND ELECTRO-MAGNETIC APPARATUS.

		£	s.	d.	£	s.	d.
2642	**Loadstones,** or Natural Magnets, specimens each 5s; 7s. 6d.	0	10	6	1	1	0
2643	**Magnets,** Permanent, of Steel, Horse-shoe shape, from 1 to 10 inches in length (fig. 2643) each 6d., 1s., 1s. 6d.	0	2	6	0	5	0
2644	**Magnets,** Compound Horse-shoe form, of various sizes, with 2, 4, 6, or 8 Magnets, combined with soft Iron keepers (fig. 2644) . . . . 10s., 16s., 21s.	2	2	0	3	3	0
2645	**Magnet Bar,** 6 inches long, round or flat . each				0	2	6
2646	**Magnets, Bar,** in pairs, of flat shape 6-inch and 12-inches long; in wood box, with soft Iron keepers (fig. 2646)	0	10	6	1	1	0
2647	**Magnet Bar,** of large size, used for adjusting and correcting Ships' Compasses				0	16	0
2648	**Magnetic Needles,** mounted with Brass centres . .	0	3	0	0	6	0
2649	Ditto ditto Agate centres (fig. 2649) . . .	0	10	6	0	15	0
2650	**Stands or Supports** for ditto	0	1	6	0	2	6
2651	**Astatic Needles,** to suspend on a point, or by a silk fibre or hair	0	12	6	1	1	0
2658	**Dipping Needles,** with graduated Arc simple form .	1	5	0	1	10	0
2659	Ditto ditto with graduated Circle . . .	5	5	0	10	10	0
2660	**Dipping Needle,** extremely delicate, with divided vertical and azimuth circles, spirit level, and adjusting screws (fig. 2660)				15	15	0
2661	**Oersted's Apparatus or Experiment,** for showing the deflection of the magnetic needle by an electrical current passing above or below it, simple form .	0	7	6	0	10	6
2662	Ditto ditto (fig. 2662)	0	16	0	1	15	0
2663	**Oersted's Experiment,** of extra large size, the Needle mounted either vertical or horizontal, suited for Lecture Table				2	10	0

This apparatus will illustrate the principle of the electric telegraph in its most elementary and simple form

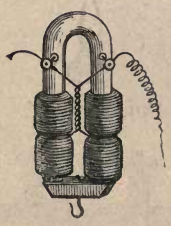


FIG. 2664.

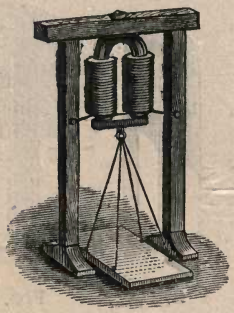


FIG. 2666.

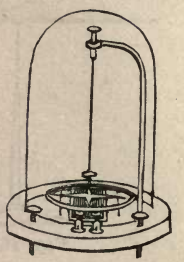


FIG. 2668.

2664	**Soft Iron Electro or induced Magnets**, consisting of a bent bar of soft iron, covered with insulated copper wire, forming, in connection with a galvanic battery, a powerful electro-magnet capable of supporting a great weight (fig. 2664) 5s. 6d., 14s.,	1	1	0	1	10	0
2665	**Soft Iron Electro-Magnet**, mounted on a tripod stand	1	1	0	1	10	0
2666	**Soft Iron Electro-Magnet**, large size, for sustaining immense weights, with Tripod, &c., as fig. 2666 . .				3	10	0
2667	**Galvanometer**, simple form, for measuring the force of electro-magnetic currents	0	15	0	1	1	0
2668	**Galvanometer**, with Astatic Needles, of low resistance, for Thermo-Electrical experiments, and for measuring the conductivity of wires, with levelling screws to glass shade (fig. 2668)	2	10	0	3	3	0
2669	Ditto ditto with attached Mirror . . .				2	10	6
2670	**Galvanometer**, with Astatic needles, index torsion key, movable coil, and levelling screws, very delicately adjusted with mirror about 1,500 ohms resistance (fig. 2670)				5	10	0
2671	**Galvanometer**, with an extremely fine and long coil of wire, as used by Du Bois Raymond in his researches on existence of electrical currents in animals (fig. 2671)				15	15	0

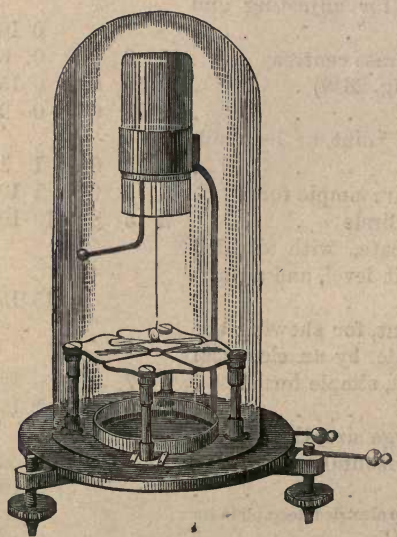


FIG. 2676.

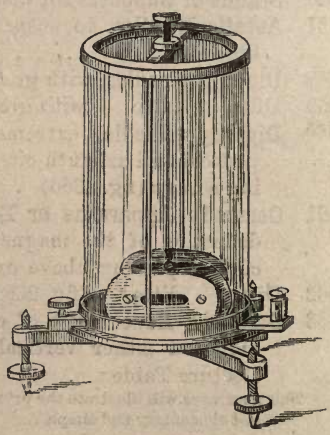


FIG 2670.

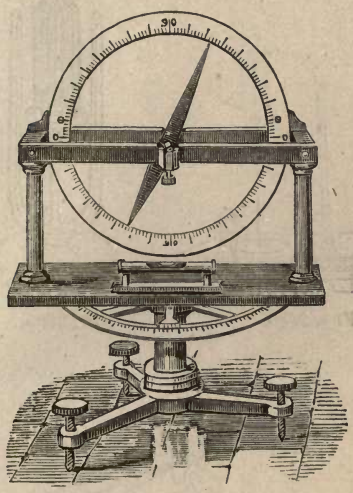


FIG. 2660.

FIG. 2677.

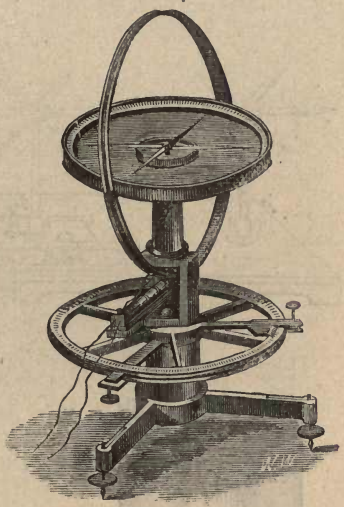


FIG. 2675.

2672 **Reflecting Galvanometer,** Sir W. Thomson's, with Astatic Needles, on Tripod Stand, short thick wire, with Lamp-stand and Scale £11 11 0

2673 Ditto ditto with about 2,500 ohms resistance . 13 13 0

2674 **Detector Galvanometer,** with Vertical Needle (fig. 2674) 3 10 6

2675 **Sine Compass or Galvanometer,** for measuring powerful galvanic currents (fig. 2675). For description of construction and use, see Ganot's *Physics* . Price 15 15 0

2676 **Quadrant Electrometer,** Thomson's arrangement, suited for Lecture Table, will show the tension of a single cell (fig. 2676) . 4 10 0

A delicate form of Electrometer for the quantitative measurement of electrical charge. The principles and use of Thomson's instrument will be found in detail at page 130 of Negretti and Zambra's *Treatise on Meteorological Instruments.* Price 5s.

2677 **Ritchie's Experiment,** exhibiting the rotation of an electro-magnet between the poles of a permanent horse-shoe magnet (fig. 2677) 0 14 0

2678 **Ritchie's Experiment,** with adjusting Screws . . 0 18 6

2679 **Gamut of Bells on Stand,** with Ritchie's Experiment, rotating in the centre, carrying a clapper which strikes the bells in succession similar to fig. 2458, page 422 3 3 0

2680 **De la Rue's Electrical Discharger,** a contrivance for using various differently prepared Carbon Points, &c. (fig. 2680) . . . 2 2 0

2681 **Sturgeon's Semi-spiral Disc,** for exhibiting the various coloured sparks evolved by different metals (fig. 2681) 2 12 0

2682 **Bain's Apparatus** for taking Soundings at Sea by means of an induced magnet (fig 2682) 4 0 0

2683 **Magnetic Toys,** consisting of fishes, ships, swans, &c., to illustrate magnetic attraction and repulsion each 0 1 6

2684 **Ampere's Apparatus,** for exhibiting the rotation of a cylindrical Galvanic Battery round the pole of a Magnet 1 0 0

2685 **Horse-shoe Magnet on Brass foot,** for ditto . . 0 12 0

2686 **De la Rive's Floating Battery** (fig. 2686) . . . 0 7 6

2687 Ditto ditto with elongated Helical Coil (fig. 2687) 0 7 6

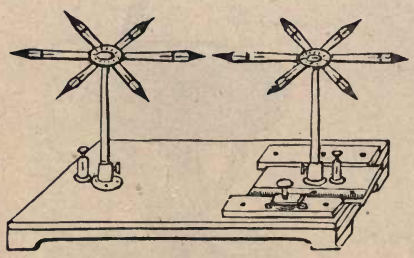


FIG. 2680.

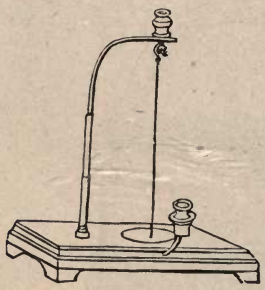


FIG. 2689.

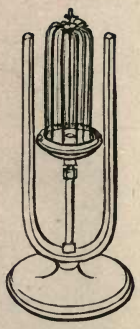


FIG. 2698.

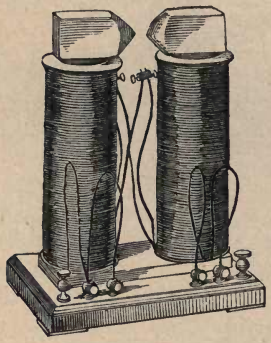


FIG. 2703.

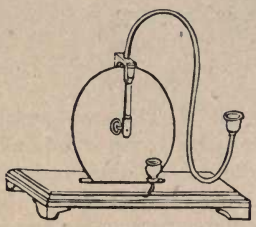


FIG. 2692.

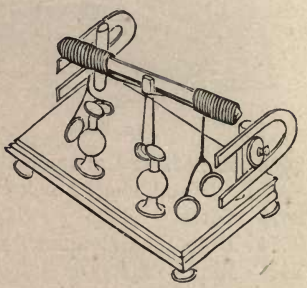


FIG. 2695.

		Each. £ s. d.	Each. £ s. d.
2688	**Marsh's Apparatus,** for showing the vibration of a Suspended Wire transmitting an electrical current when submitted to the influence of the poles of a magnet .		0 10 6
2689	**Faraday's Apparatus** for showing the rotatory motion of a wire transmitting an electrical current round the pole of a magnet (fig. 2689)		0 10 6
2690	**Faraday's Rotating Needle, and Marsh's Vibrating Wire,** in the same instrument		0 15 6
2691	**Terrestrial Rotating Magnet** (fig. 2691)		0 14 6
2692	**Sturgeon's Rotating Disc** (fig. 2692)		0 15 0
2693	**Magnetometer** (Sturgeon's), to exhibit the properties of different metals under the influence of a powerful magnet . . .		2 10 0

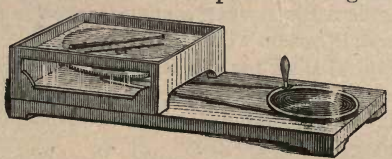


FIG. 2694.

2694	**Apparatus** to exhibit the influence of a rotating Copper Disc upon a magnet suspended above it, a thin sheet of parchment being placed between them (fig. 2694)	4 10 6
2695	**Dr. Golden Bird's Vibrating Electro-magnet** (fig. 2695)	2 10 0
2696	**Barlow's Stellar-formed Rotating Wheel** . . .	0 10 0

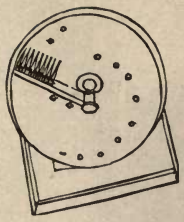


FIG. 2681.

FIG. 2700.

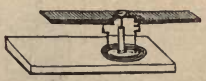


FIG. 2691.

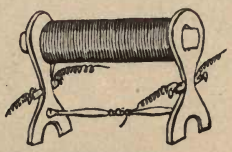


FIG. 2706

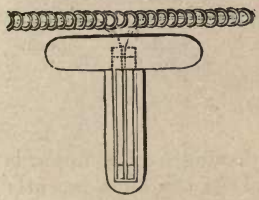


FIG. 2687.

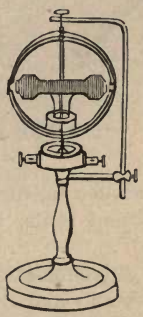


FIG. 2702.

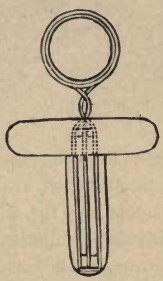


FIG. 2686.

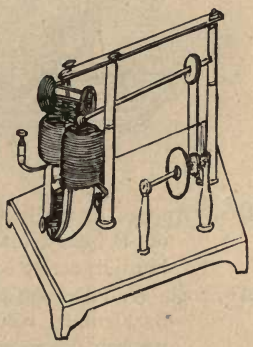


FIG. 2711.

		Each. £ s. d.	Each. £ s. d.
2697	**Double Wheel**, of the Stellar form		0 18 0
2698	**Apparatus**, exhibiting a Coil of Copper Wire rotating between the poles of a magnet (fig. 2698) . . .		0 16 0
2698*	**Glass Tube**, surrounded by a Coil of Copper Wire for magnetizing steel needles by induction . . .		0 2 6
2699	**Electrepeter or Commutator**, for reversing the direction of Galvanic or Electro-Magnetic currents . . .		1 10 0
2700	**Dr. G. Bird's Inversor** for ditto (fig. 2700) . . .		1 1 0
2701	**Bachoffner's Electrepeter**, for ditto (fig 2701) . .		1 6 0
2702	**Apparatus** for showing the opposite rotation of hooped permanent magnets and a straight electro-induced magnet (fig. 2702)		2 0 0
2703	**Powerful Electro or Induced Magnet**, having double wires, and movable coils for Dia-Magnetic experiments (fig. 2703)		12 12 0
2704	**Compound Electro-Magnetic Apparatus**, consisting of a horse-shoe magnet, on brass foot, with levelling screws and sliding pillar, two rotating armatures, rotating coil, Ampere's bucket, mobile wire frame, helical coil, rotating cylinder, and two flood cups.		3 10 0
2705	**Callan's Primary and Secondary Coils on Stand**		1 16 0

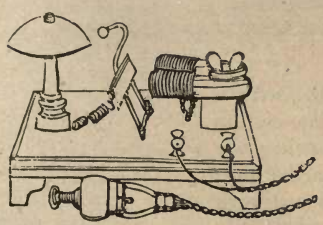


FIG. 2682.

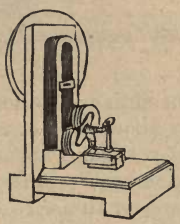


FIG. 2079.

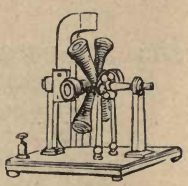


FIG. 2711.

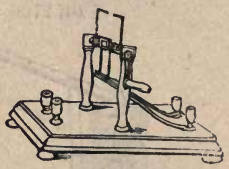


FIG. 2701.

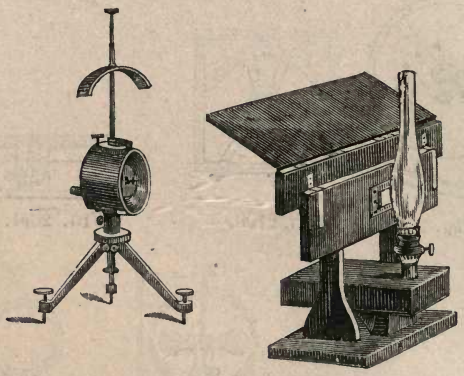


FIG. 2707.

		Each. £ s. d.	Each. £ s. d.
2706	**Apparatus** to illustrate the phenomena and construction of Primary and Secondary Induction Coils, with binding screw connections (fig. 2706)		2 2 0
2707	**Sir W. Thomson's Astatic Reflecting Galvonometer**, having 4 coils, upwards 5,000 ohms resistance, with Lamp-stand and Scale of the most recently improved construction (fig. 2707)		25 0 0
2708	**Set of Shunts** for above, $\frac{1}{9}$ $\frac{1}{99}$ and $\frac{1}{999}$ the resistance of the Galvanometer		4 4 0
2709	**Magneto-Electric Machine**, Clark's arrangement, consisting of a combination of highly charged permanent magnets, mounted on a stand, with multiplying wheel and rotating armatures, for obtaining Quantity and Intensity of effects. As described in Ganot's *Physics* (fig. 2709)		16 16 0
2710	**Model Electro-Magnetic Engine, driving a small Water Pump**	3 3 0	4 10 0
2711	**Model of Saw Mill driven by Electro-Magnetism**, consisting of a rotating armature, &c., as seen in fig. 2711	5 5 0	6 6 0
2712	**Electro-Magnetic Motive Engines**, as fig. 2711, of large size, worked by the combination of electro-magnetic forces, and Froment's arrangement as described by Ganot. Made to order.		

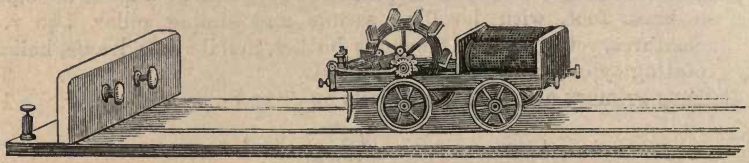


FIG. 2713.

2713	**Model Electro-Locomotive Engine** (fig. 2713), with a Straight Railway about four feet long. The engine has a self-acting reversing apparatus, causing the engine to run backwards and forwards on the line; Two cells of Callan's or Bunsen's Batteries will work this engine effectively. Complete, with two batteries	12 12 0

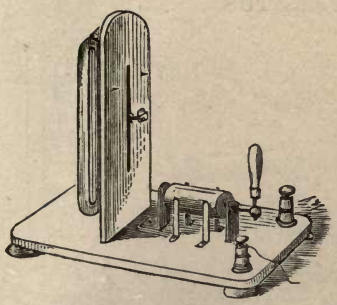


FIG. 2714.

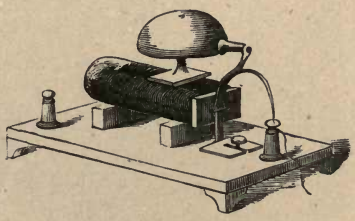


FIG. 2715.

		Each. £ s. d.	Each. £ s. d.
2714	**Model Electro-Magnetic Telegraph,** fitted with reversing brake, of a simple form, on a stand, suited for Lectures or the Class-room (fig. 2714) . . .		3 3 0
2715	**Model Electro-Magnetic Signal Bell,** for use in conjunction with above (fig. 2715)		1 12 0
2716	**Electro-Magnetic Bells,** for Household purposes, &c., see page 461.		
2717	**Copper Wire,** covered with **Cotton,** superior quality, in long lengths. The following prices are variable :—		

Nos. 12 to 14.	15 to 18.	19 to 22.	23 to 26.	30 to 32.
Per lb. 3s.	4s.	5s.	6s.	8s. 6d.

2718	**Copper Wire,** covered with **Silk,** to order,	per lb., variable.	
2719	Ditto ditto covered with **Gutta Percha,** in lengths of 100 feet and upwards of various sizes, from, per length		1 1 0
2720	**Assortment of Electro-Magnetic Apparatus,** packed in a strong Pine Case, to illustrate the first principles of the science	3 3 0	5 5 0

These sets are so arranged as to extend and complete those of Galvanic Apparatus, page 436.

Of the terms POSITIVE *and* NEGATIVE.—There is nothing which has a greater tendency to confuse the mind, with regard to voltaic apparatus, than the terms *positive* and *negative* end of a battery. "The fundamental principle," observes Mr. Walker, "which cannot be too strongly enforced, is that the passage of the electricity is from the zinc to the copper." This, of course, refers to the common forms of battery—Cruikshank's, Babington's, &c. In the arrangement of Smee, the passage of the electricity is from the zinc to the silver; in Grove's battery, from the zinc to the platinum. "The positive is the end where the electricity leaves the battery: the negative where it re-enters it. The direction taken by the current being ascertained by the mere inspection of the situations of the two metals in a cell, the other points follow as a necessary consequence." Now, taking the Smee's battery as an illustration, it must be clear, that as the electricity passes from the zinc to the silver, it would leave the battery by the wire attached to the silver plate, and having passed through the interposed apparatus, would return to the battery by the wire attached to the zinc plate; the silver, which is the *negative metal,* forming the *positive end* of the battery; and the zinc, the *positive metal,* forming the *negative end.* In like manner with all the batteries we have described, the zinc, though the *positive metal,* is the *negative pole.*

THERMO-ELECTRIC APPARATUS.

FIG. 2721.

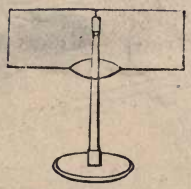


FIG. 2722.

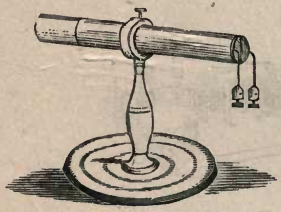


FIG. 2724.

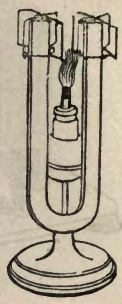


FIG. 2723.

		Each. £ s. d.	Each. £ s. d.
2721	**Rectangular Wire Frames**, with four branches composed of dissimilar metals, with a fine point on the rectangle, for suspending on the pole of a magnet, to show thermo-magnetic rotation (fig. 2721) . . .		0 15 6
2722	**Compound Frames and Wires** of the various metals, for exhibiting thermo-electric rotations (fig. 2722) from		0 12 6
2723	**Thermo-Rotating Compound Rectangular Frames**, composed of platina and silver wires, mounted on a horse-shoe magnet, complete, with spirit lamp (fig. 2723)		1 10 0
2724	**Compound Bar of Antimony and Bismuth**, mounted on a Brass Stand, for producing a Thermo-Electric current by the application of Heat to the extremity (fig. 2724)		1 1 0
2725	**Melloni's Thermo-Electric Pile** (fig. 2725) . . .	2 2 0	3 3 0

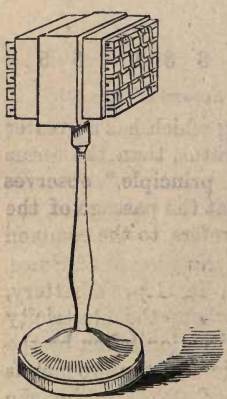


FIG. 2725.

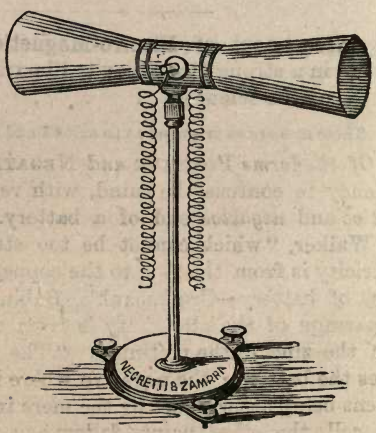


FIG. 2726.

2726 **Melloni's Thermo-Electric Pile or Battery** of 25 pairs of small bars of Antimony and Bismuth, in a convenient frame on a foot, with binding screws for connections fitted with cones, as used by Professor J. Tyndall, F.R.S., in his experiments with Caloric (fig. 2726) 4 4 0

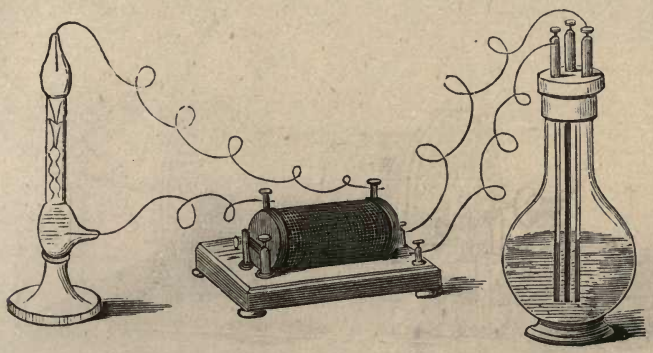


FIG. 2734.

INDUCTION COILS, VACUUM TUBES, &c.

		Each. £ s. d.	Each. £ s. d.
2727	**Rhumkorff Coils,** of small size		1 5 0
2728	Ditto ditto with Commutator		1 12 0
2729	Ditto ditto		2 2 0
2730	Ditto ditto	3 3 0	4 4 0
2731	**Geissler's Vacuum Tubes,** small size, various forms, each 2s. 6d. 5s.	0 7 0	0 10 6
2732	**Geissler's Tubes,** a set of four medium size, for use with the above coils		1 1 0
2733	**Whirling Apparatus for Gassiot's Star,** for small Vacuum tubes		1 16 0
2734	**A Set of Apparatus** as fig. 2734, including one small Rhumkorff's Induction Coil, one Bichromate Battery, and one Vacuum Tube on stand . . .		3 10 0
2735	**A Set of Apparatus,** consisting of one Induction Coil, one Bichromate Bottle Battery, five small Vacuum Tubes of various designs, and a Whirling Apparatus, with connecting wires, in Pine Box .		6 6 0
2736	**Electro-Motive Engine,** arranged for rotating small Geissler's Tubes, an exceedingly interesting and attractive model, the movement and the light being entirely produced by Electrical Agency . . .	4 4 0	5 5 0
2737	**Negretti and Zambra's Improved Large Sized Rhumkorff's Induction Coil** (Inductorium of the German Physicists) to give 3½-inch spark in air (fig. 2737)		15 15 0
2738	Ditto ditto to give 2½-inch sparks . . .		12 12 0
2739	Ditto ditto to give 1-inch sparks . . .		10 10 0
2740	Ditto ditto small size, ½-inch sparks . . .		5 5 0
2741	**Grove's Batteries for above,** see page 431.		

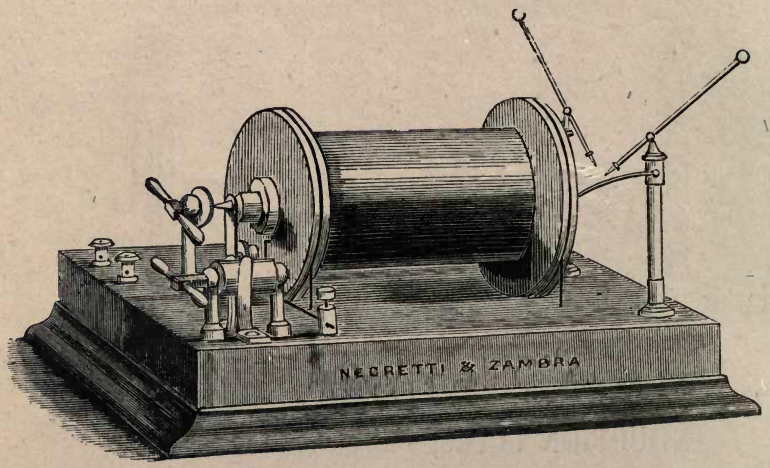


FIG 2737.

2742 **Gassiot's Vacuum Tubes,** of numerous shapes, for exhibiting the interesting electric stratification and brilliant coloured light produced by the passage of electricity through rarefied air, gases, &c. The metal terminals of these tubes are formed of Platinum or Aluminium wires. Price various 25s., 26s.

		Each. £ s. d.	Each. £ s. d.
2743	**Carbonic Acid Vacuum Tube,** with stick of Caustic Potash at one end	1 5 0	1 10 0
2744	**Carbonic Acid Vacuum Tube,** with Carbon Terminals		1 5 0

2745 **Geissler's Vacuum Tubes,** for Spectrum Analysis, hermetically sealed. All of these tubes have been filled with different gases, such as Hydrogen, Nitrogen, Oxygen, Carbonic Acid, Phosphoric Acid, Iodine, Bromine, Cyanogen, Hydrochloric Acid, Nitrogen Protoxide, Sulphuretted Hydrogen, &c., and then exhausted as perfectly as is possible, 4s. 6d. each.

Vacuum Tube,	A (fig. 2745)	£1 6 0	Vacuum Tube,	G .	£1 10 0
Ditto	D . .	0 15 0	Ditto	H .	1 5 0
Ditto	E . .	1 10 0	Single Garland Tube,	B .	1 10 0
Ditto	F . .	1 10 0	Double ditto	C .	2 0 0

2746 **Vacuum Tubes,** for exhibiting illuminated names or mottoes according to size and design, made to order . Price various.

2747	**Large-Sized Vacuum Tube,** with the words, "God save the Queen"		5 5 0
2748	Ditto ditto smaller		2 10 0
2749	**Diadem or Coronet Vacuum Tubes**	2 10 0	3 10 0
2750	**Siemen's Ozone Tube and Stand**		1 5 0
2751	**Apparatus** for showing the Rotation of a Spark round an Electro Magnet		3 10 0
2752	**Gassiot's Cascade,** large size		3 10 0

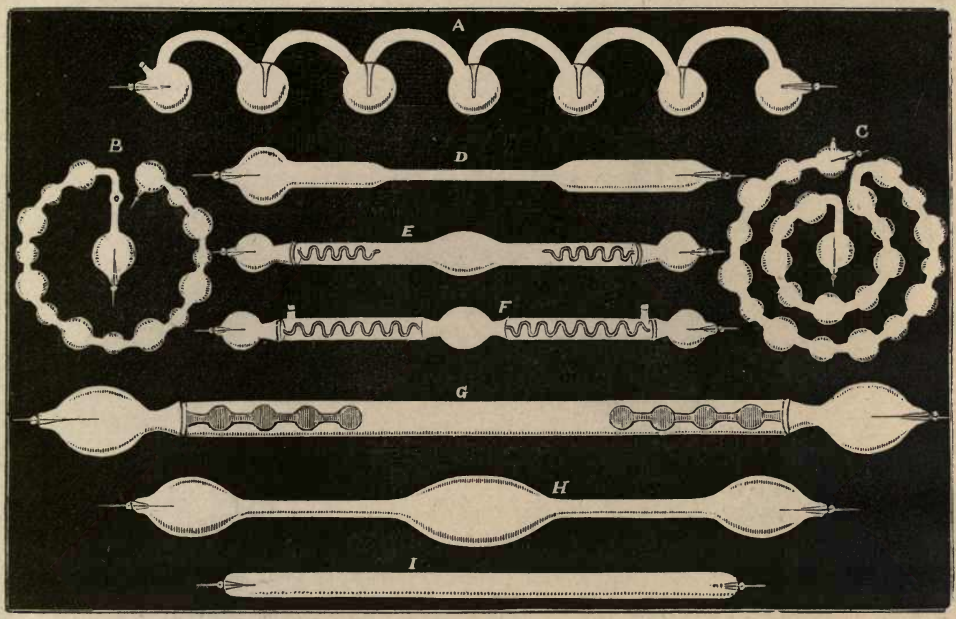


FIG. 2745.

2752 **Gassiot's Revolving Star**, best form £5 5 0

This apparatus is an adaptation of Sturgeon's Revolving Electrical Spiral. Attached to the axis of the machine is a piece of varnished wood or vulcanite, fitted at each end with metallic spring clips for holding securely the vacuum tube to be revolved. Two fine insulated wires in connection with the metal clips and terminal wires of the vacuum tube are carried down the back of the wood arm to the axis, and are in metallic connection with two binding screws on the base of the apparatus by which the induction coil is to be placed in contact. The connections having been carefully made, the tube is caused to be very rapidly revolved by the action of the large wheel on a small one placed at the axis, and the result is a beautifully iridescent star, the colours. &c., varying with the form of the tube employed.

2754 **Vacuum Tubes** for Medical use, illuminating the Throat, Ear, &c., various forms and prices, supplied to order.

		£	s.	d.
2755	**Incandescent Lamps**, 2½, 5, 10, 20 C. P. . each	0	6	0
2756	Ditto ditto, for Microscopic use . . .	0	5	6
2757	**Holders**, for ditto	0	2	0
2758	Ditto with Bracket Clip	0	4	0
2759	**Miniature Lamps** for Scarf Pins, &c. . . each	0	10	6
2760	**Portable Accumulator**, containing 3 Ebonite Cells, weight about 2 lbs.	2	0	0
2761	Ditto ditto with Lamp and Comb to wear in the hair	3	3	0
2762	**Apparatus** for exhibiting the Luminous Electric discharge in vacuo, (Aurora Borealis) (fig. 2762) from Carbon Points on Metal Terminals, sometimes called the Electrical Egg	3	3	0

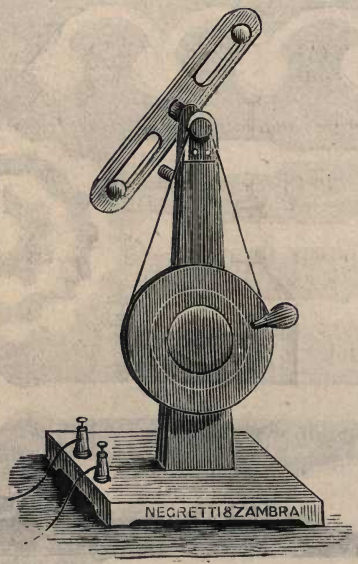


FIG. 2767.

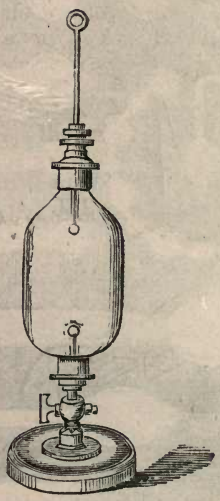


FIG. 2762.

		Each. £	s.	d.
2763	**Glass Tube** for similar experiments, fitted with a Stop-Cock, various lengths (see page 438) . from	2	2	0
2764	Ditto ditto of Uranium glass . . from	4	4	0
2765	**Eudiometer,** for use with Inductorium	0	7	6
2766	**Uranium Glass Vessel,** for showing Fluorescence from	0	10	6
2767	**Whirling Apparatus for Gassiot's Star,** for large sized Vacuum tubes (fig. 2767)	4	12	0
2767*	**Revolving Colour Disc,** for use with No. 2767, exhibiting white light, and proving that the induction spark is not continuous	0	10	6

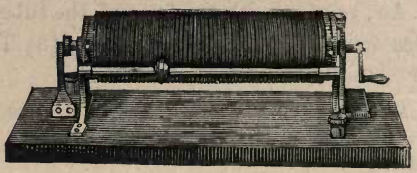


FIG. 2769.

2768	**Wheatstone's Rheostat,** for adjusting and regulating an electric current so as to obtain any constant degree of force	4	4	0
2769	**Wheatstone's Rheostat,** for ascertaining the amount of resistance offered by various lengths of wire to a given current of electricity (fig. 2769) . . .	5	5	0
2770	**Wheatstone's Apparatus,** for determining the Differential Resistance of various metal wires, &c. &c.	2	10	0

2771 **Conducting Wires**, covered with Cotton, various lengths . . £0 3 6
2772 Ditto ditto coated with Gutta Percha 0 5 0

Table of relative lengths and weights of Copper Wire, covered with Cotton, as used for Electric, Galvanic, Electro-magnetic, and Telegraphic purposes:

Nos.	6.	9.	12.	14.	18.	23.	32.	34.
Feet	8	18	39	48	130	360	1,300	2,000 to the lb. weight.

For the price, which is variable, see pages 449 and 459, No. 2717.

ELECTRO-GALVANIC MACHINES.

FOR ADMINISTERING MEDICAL GALVANISM.

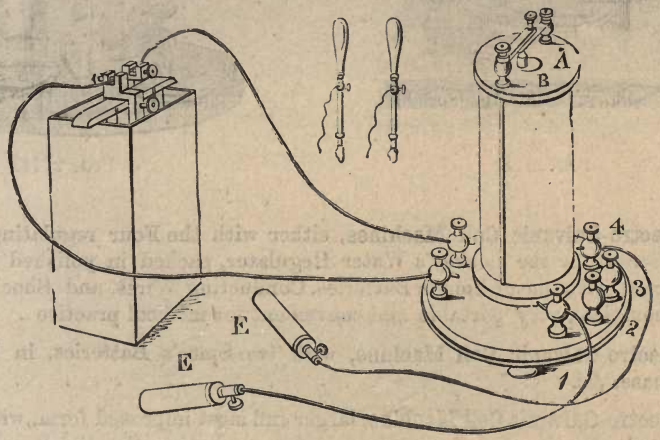


FIG. 2773.

THE scientific application of Electricity to medicine has made less progress than the success which has really, in many cases, attended its use, might have been justly expected to produce. It appears, from every trial of its powers hitherto made, that, under judicious management, its application has never been known to produce consequences decidedly injurious, while in many of the most distressing disorders, it has frequently been of considerable service. These are powerful recommendations; and when it is added that it is an external and by no means a painful remedy, and that it may be applied immediately to the affected part, without interfering with any other organ, its advantages must appear to be considerable. At the same time it must be remembered, that it is a remedy of such a nature, that often a long continuance of its application is in many cases necessary before any decided and beneficial results can be obtained.

		£ s. d
2773	**Electro-Galvanic Coil Machines** for Medical use, with four binding screws, to regulate the intensity of the shock, Nos. 1 and 2 being the lowest in strength, 1 and 3 the medium, and 1 and 4 the full power of current (Coil as shown in fig. 2773)	1 10 0
2774	**Electro-Galvanic Coil Machines**, with Lockey's Water Regulator, a very elegant method of controlling the force of the current, but perhaps not quite so definite as the previous arrangement (fig. 2774) . . .	1 10 0

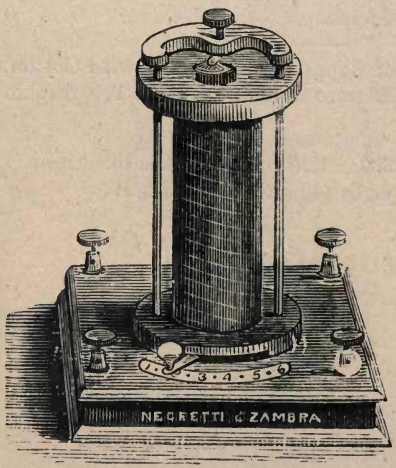


FIG. 2778.

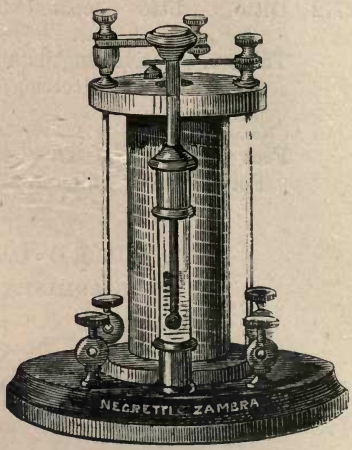


FIG. 2774.

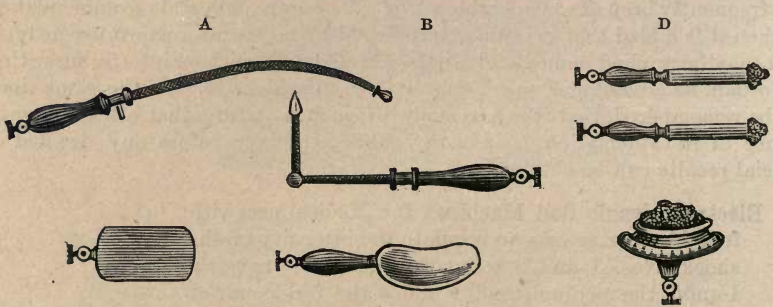
2775 **Electro-Galvanic Coil Machines**, either with the Four regulating Binding Screws, or the Lockey's Water Regulator, packed in polished Mahogany case, with one of Smee's Batteries, Conducting Wires, and Shock Handles, complete, very portable and convenient for medical practice . £3 3 0

2776 **Electro-Galvanic Coil Machine**, with two Smee's Batteries, in Mahogany case, &c. £4 4 0

2778 **Electro-Galvanic Coil Machine**, larger and most improved form, with a simple and effective Lever contrivance for regulating the shock, complete, in mahogany case, with two large Smee's Batteries, flexible Conducting Wires, Shock Handles, Directors, &c., with directions for use (fig. 2778) £6 6 0 £8 8 0

2779 **Larger Coils and Batteries** fitted to above, for Hospital use, made to order.

These instruments can be had of either Primary or Secondary arrangement or both combined in one coil.



2780 Various forms of Directors for use with Electrical Apparatus.

Full instructions sent with each apparatus, that will enable patients to use them with the greatest eas and convenience.

		Each. £ s. d.	Each. £ s. d.
2780*	**Sponge Directors** for the hands (fig. C) from, per pair		0 4 6
	Ditto ditto Flat, large surface (fig. F) . .		0 8 6
	Shock Handles, plain tubes and wires		0 2 6
	Curved and Bent Directors (or Rheophores), for the internal application of Electricity (figs. A & B) . .		0 10 6
	Flat and Curved Surface Director (figs. D & E) . .	0 5 6	0 7 6

FIG. 2781.

2781 **Faraday's Wire Brush Directors** with wood handles (fig. 2781) 0 5 6

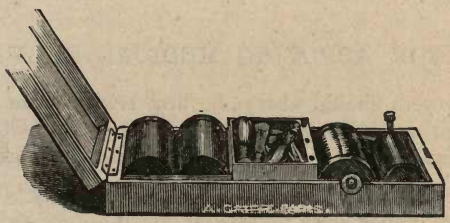


FIG. 2782.

2782 **Pocket Medical Induction Coil** (fig. 2782). In this apparatus the electro-motor used is Pile Marie Davy, a voltaic battery having bi-sulphate of mercury and carbon electrodes. The cell of this battery is made of vulcanite in the form of a tray about $1\frac{3}{4}$-inch square, and by 1-inch deep; into this tray is placed a slab of graphite, and above it a piece of zinc. Metal fittings are attached to the cell to connect the elements to the coil. To charge the battery, a small quantity of Bi-Sulphate of Mercury is placed on the Carbon, which is to be saturated with water, and then have the zinc plate placed upon it, observing that the zinc does not in any way touch the carbon. The battery will now be in action, and the vibrating contact break should be adjusted until steady vibrations are obtained. At the side of the box will be found metallic fittings, by which shock handles or directors are to be connected, and the current of electricity conveyed to any part of the person to be operated upon. The strength of the current is regulated by a brass tube, covering the bundle of iron wire in the centre of the coil. When this brass tube entirely covers the iron wire, the action of the coil is very feeble, but when it is fully drawn out, and the bundle quite uncovered, the maximum amount of power is obtained.

It is requisite frequently to clean out the battery when in constant use; this is simply done by washing in plenty of water the cell, carbon, and zinc (to remove all the yellow deposit), and then replace the elements, with a fresh charge of Bi-Sulphate of Mercury. In handling this preparation great care should be taken to prevent it coming in contact with any gold or silver articles, as the mercury would amalgamate with these metals, and be very troublesome to remove; in fact, delicate jewellery would be utterly spoilt. Various shock handles and directors and flexible wires for applying the galvanic current are supplied with each instrument.

2783 **Portable Medical Induction Coil** (fig. 2782) £4 4 0

2784 **Cruikshank's Battery** (see fig. 2519, page 428), for Medical use, where it is desirable to use the actual current without the interruption of a coil £1 12 0

2785 **Induction Coil Apparatus**, large size, similar to above, with Chloride of Silver and Zinc; Battery, for Hospital use £6 10 0

2786 **Galvanic Cautery Battery**, improved arrangement in Box, complete with Ecraseur, having Curved and Straight ends, Platinum Wire, &c., £12 12 0

HINTS FOR APPLYING MEDICAL GALVANISM.*

2787 "1. Feeble powers should always be first tried; these should be gradually augmented, and the use of such finally persisted in, as, without producing any violent effects, appear to make a decided impression on the disease.

"2. Galvanism, as a remedial agent, must not be hastily given up because of its beneficial effects not immediately appearing, for these, generally speaking, require considerable time to be developed.

"3. Electricity or Galvanism should not be relied on exclusively in the treatment of diseases, but should rather be considered as auxiliary to other methods of cure.

"4. To the preceding we shall add, that in cases where the continuous current may be deemed most advisable, it would be well to use batteries composed of plates having an extended surface, there being reason to believe that the curative influence of galvanism in this form depends, not upon its intensity, but upon the quantity of it set in motion."

To these principles we may add, that in all cases where it is necessary that the interrupted current should be administered, the electro-magnetic coil machine will be found much more manageable, much more portable, and equally powerful, if not more so than the galvanic battery itself; but in cases where the continuous current is required, the battery alone should be used.

Sig. Orrioli (an Italian Philosopher) recommends that before attempting to apply Electricity therapeutically, we should study the nature of the secretions produced, in order that we may be enabled to create in the secretory organ a proper electrical state for bringing about contrary effects. These secretions will be Acid, Alkaline, or Neutral. If they be acid or alkaline no difficulty will exist; if they are neutral, we should apply to the affected part the pole of the battery opposed to that electrical state which belongs to the normal condition of this part.

* G. T. Fisher's *Medical Electricity*.

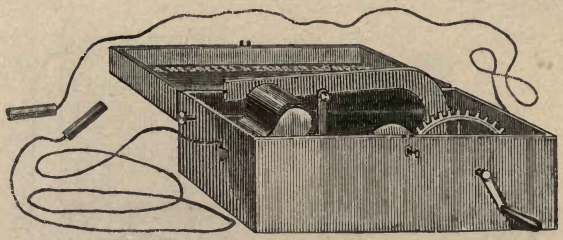


FIG. 2792.

MAGNETO ELECTRIC MACHINES.

2788 Our wood-cut, No. 2792, exhibits the modern improved form of Magneto Machine, specially arranged for **Medical Purposes.** This armature is rotated by a winch handle, setting up an induced current of electricity in the armature, this current being conducted to the patient by convenient flexible wires and directors or shock handles.

The strength or force of the current is regulated by the removal of the soft iron keeper entirely from the end or poles of the magnet, or gradually bringing it closer to the magnet, the most powerful action being obtained when the keeper is entirely removed, and the lowest action when the keeper is in close contact with the magnet.

2789 **Negretti and Zambra's Improved Magneto Electro Machine,** a most convenient and portable apparatus for the application of Medical Galvanism; *no acid required,* the instrument always ready for use, and the strength of the currents can be regulated from the most feeble to the highest intensity. Price, in strong Pine box, with directors . . . £1 5 0

2790 Ditto ditto, in Mahogany £1 10 0 2 2 0

2791 Ditto ditto, small pocket size, in Mahogany Box . 2 6 0

2792 **Magneto Electro Machines,** best finish, and Mahogany box (fig. 2792) 2 10 0

2793 Ditto with Double Magnet 3 0 0

2794 Ditto ditto, best finish, in Box, with drawer underneath containing 6 directors for the Face, Spine, Teeth, Ear, &c., and 1 pair of Shock Handles 3 10 0

2795 Ditto ditto, with external Dial Regulator . . 3 15 0

2796 **Electric Colliery Signal Bells,** in Dust Proof Boxes.

Price each 5-inch.	6-inch.	7-inch.	8-inch.
75s.	80s.	96s.	120s.

2797 **Pushes for ringing Colliery Signal Bells,** 12s. 6d. each.

2798 **Presselles, Press Buttons or Pushes, and Indicators,** for use with Electric Signal Bells for household and other purposes, of various forms and patterns. See page 464.

2799 **Gutta Percha Insulated Wire,** suitable for Colliery work, various sizes, £9 10s. to £19 10s. per English mile.

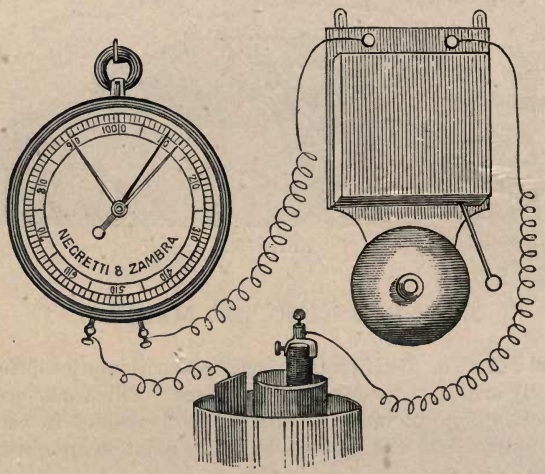


FIG. 2800.

METALLIC THERMOMETER'S ELECTRICAL ALARM.

2800 The engraving (fig. 2800) shows the general arrangement of the Metallic Alarm Thermometer, designed for regulating the temperature in incubating houses. hot-houses, green-houses, drying stores or rooms, hospital or prison wards, &c. They are also valuable as a fire-alarm, either in large buildings or warehouses or on board of *ship*, and they will notify any change of temperature taking place where the dial A is placed to almost any distance that may be desired.

The construction and action of the Alarm is as follows. At the back of the dial A is fixed a coiled metal spring, in such a manner that it is very sensitive to any changes of temperature, it being lengthened by increased heat, and shortened by cold: these movements are shown by an index in front of the dial A, which has upon it a scale graduated into degrees corresponding to a Thermometer either of Fahrenheit's, Centigrade, or Reaumur, as may be desired. On the glass cover of the dial are mounted two movable indices, in such a way that they can be turned round to any two points of the divided circle, and there fixed; these two hands represent the highest and lowest temperature required to be notified, the central or moving hand being in connection, by means of a metallic wire, with one pole of a galvanic battery B, and the other two indices being connected by another wire to the other pole of the battery C.

Now, should the temperature of the atmosphere surrounding the dial alter, the central hand will be moved either to the right or left, and the moment it touches either of the outer hands, contact will be made, and the galvanic circuit completed, causing the Bell to ring, and give notice to the watchman that the temperature of the building or vessel has undergone some alteration and requires attention.

The dial A may be fixed at any distance from the Alarm Bell B, dependent only on the amount of battery power used, one battery being sufficient to work the apparatus between any two portions of an ordinary sized building.

Price of Dial, Alarm Bell, and 1 Battery (fig. 2800) . . £5 5 0

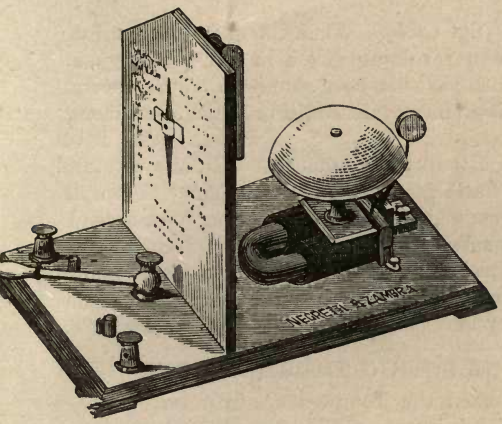


FIG. 2801.

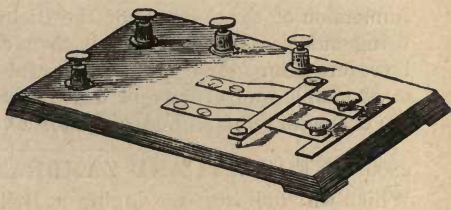


FIG. 2801*.

ELECTRIC TELEGRAPH APPARATUS.

2801 **Model Telegraph Instruments,** consisting of two Single Needle Instruments with Signal Bells and communicators, for exhibiting and explaining telegraphic communication (figs. 2801 and 2801*). These instruments will be found useful to learners of Telegraphy,

The complete Set of two Needle Instruments with Bells attached £5 10 0

2802 Leclanché Batteries for working the above through short distances, Single Cells, see also page . . . . . 8s. 6d. and 10s. 6d. each.

2803 **Six-Cell Smee's Batteries** (fig. 2803), for Telegraph use, conveniently arranged in a stout framed tray, with Ratchet Movement for immersing the elements to any desired depth in the acid according to the action required, or for entirely withdrawing them when out of use . . Price £4 10 0

Smee's Batteries when charged with extremely dilute acid will be found to act very well for some considerable time without much attention.

For particulars of Leclanché and other Batteries, see pages 428 to 434.

FIG. 2804.

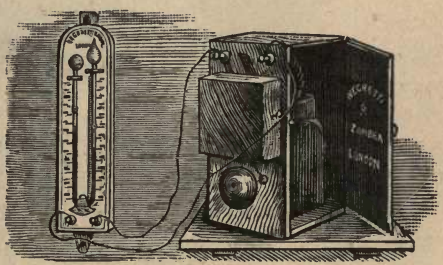


FIG. 2806.

2804 **Portable Sick Room and Invalid's Electrical Bell and Battery combined,** in a mahogany case, for temporary service. Specially adapted for the use of invalids, with 30 yards of flexible Wire Cord and Presselle, &c. (fig. 2804) £4 4 0

2805 **Electrical Indicating Signal Bell** (fig. 2805). When the alarm is put into action by the electrical current a revolving disc is moved, pointing out to the observer the particular bell that has been sounded: where several bells are in use at a station this is an important addition to the instrument.

Price £2 2 0

These Bells can be very economically fitted up in connection with one or more of the Leclanché or Bichromate Bottle Batteries (figs. 2551 and 2554). A simple immersion of the elements of the Bichromate Battery in the solution for a second. being sufficient to ring a bell to a considerable distance. The Leclanché has, however, becn found the most useful form of battery for this work; it being most simple and cleanly in use (no strong or corrosive acid being required), and the elements remain unimpaired for a very long period. See description, page 433.

2806 **NEGRETTI AND ZAMBRA'S ELECTRIC THERMOMETER,**

Which will indicate, by ringing a Bell, when the Temperature in a Greenhouse falls below or rises above the point at which injury would be caused to plants, &c., the Thermometer being placed in the Greenhouse, and the Bell in the gardener's cottage, or at any other convenient spot. It also indicates present temperature, as, an ordinary Thermometer, and can be used as an efficient Fire Alarm in Warehouses or in Private Dwellings. Price, including Bell, Battery, Thermometer, and 50 feet of Double Connecting Wire (fig. 2806) £1 10 0

Extra Double Wire, 2d. per Yard.

These Thermometers can be constructed to ring a bell at two or more different Temperatures, should such be required, at a slightly increased cost.

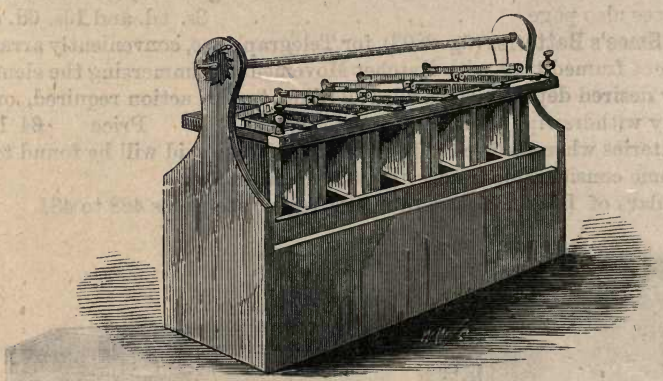


FIG. 2803

ELECTRIC BELLS.

2807 **Electric Bells,** on Polished Mahogany Mounting, horizontal or vertical action. For general House or Telegraph use (fig. 2807).

	Trembling.	Single stroke.	Continuous ringing.
Bell 2½ in.	each 10s.	each 9s.	each 10s. 6d.
„ 3 „	„ 12s.	„ 12s.	„ 12s.
„ 3½ „	„ 16s.	„ 15s.	„ 15s.
„ 4 „	„ 21s.	„ 20s.	„ 20s.
„ 5 „	„ 28s.	„ 27s.	„ 28s.
„ 6 „	„ 30s.	„ 32s,	„ 32s.

Estimates given for Telegraph or Household Signal Bells, Electrical Alarm Apparatus, fittings, &c., upon receipt of particulars.

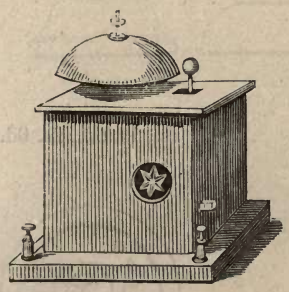


FIG. 2805.

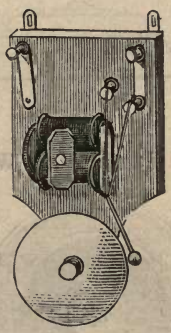


FIG. 2807.

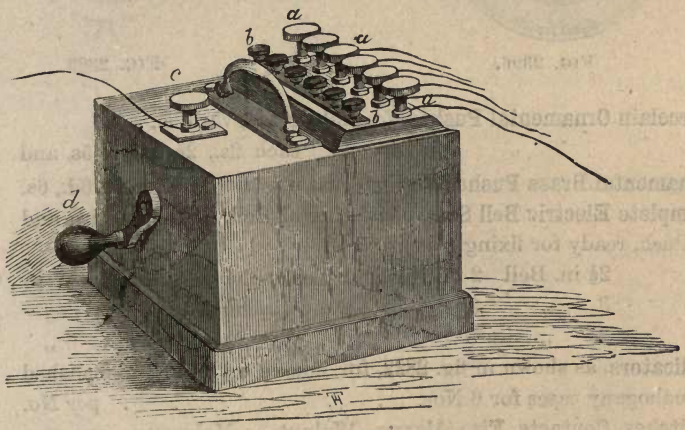


FIG. 2808.

2808 **Magneto Electro Exploder,** improved arrangement, in mahogany case, for firing Mines or Cannon by Electro-Magnetism; price according to the number of charges to be fired (fig. 2808) . . £12 12s. to £26 0 0

2809 **Fuses,** for use with the Exploder, Experimental, Mining, Blasting, Cannon and Submarine, supplied to order . . from, per dozen 5s. to 10s.

2810 **Induction Coils,** specially arranged for blasting purposes, where a number of charges are required to be fired simultaneously, in stout case . £13 0 0

2811 **Copper Wire,** insulated with **Gutta Percha,** for use with above, per 100 yards. Price variable, from £1 1s.

For Prices of Copper Wire covered with Cotton and Silk, see *ante*, page 455.

2812 **Vertical Action Electric Bell,** (fig. 2807), either trembling or single stroke, same price as horizontal action . . . . . .

2813 **Electric "House" Bell,** specially arranged as an efficient House or Warehouse Bell, with 3-inch loud tone Gong, nickel plated, in polished case, or fitted with continuous ringing action for Burglar and Fire Alarm . . . . . each £0 12 6

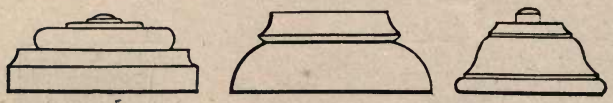


FIG. 2427.

			Each. £	s.	d.
2814	**Plained Turned Hard Wood Pushes** . .	1s., 1s. 6d., 2s. 6d.	0	3	6

FIG. 2396.

FIG. 2389.

2815	**Porcelain Ornamental Pushes,** for indoor use, various,	each 2s., 2s. 6d., to 5s. and	0	6	0
2816	**Ornamental Brass Pushes,** for external use	each 5s. 6d., 6s.	0	12	6
2817	**Complete Electric Bell Sets,** consisting of Bell, Battery, Wire and Push, ready for fixing.				
	2½ in. Bell 2 in. Push 1 Leclanché Cell 25 yds. Wire		0	10	6
	3 „ 3 „ 2 Leclanché Cells 30 „ „		0	16	0
	3½ „ 3 „ „ „ 40 „ „		1	1	0
2818	**Indicators,** as shown in fig. 2822, for houses or hotels, in polished mahogany cases for 6 Nos.	per No.	0	12	6
2819	**Switches, Contacts, Fire Alarms,** Walnut or Mahogany, one way Switch 2-way 3s., 3-way 4s. 6d., 4-way	6s. 6d.	0	10	6
2820	**Floor Contacts** 2s., **Door Triggers**		0	3	0
2821	**Sash or Door Contacts,** for Burglar Alarms, &c. .	each 3s. and	0	4	6

DIRECTIONS FOR CONNECTING AND FIXING ELECTRIC BELLS.

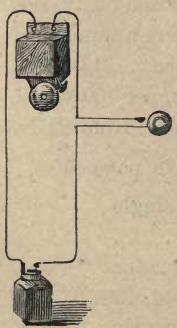


FIG. 1.

Fig. 1 represents a single "Circuit," in which one Bell, Push and Battery is employed.

A wire is carried from the Carbon Pole of the Battery to the Push, from the Push to the Bell, and from the Bell direct to the Zinc Pole of Battery.

Fig. 2 represents manner of enabling the same Bell to be rung from two distinct places.

The wire from Carbon Pole is carried to each Push by making a junction, as shown in the diagram, and then carried from each Push to the Bell, as shown by the dotted lines. On pressing the Push the Bell will ring.

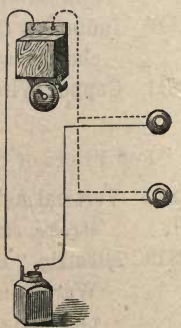


FIG. 2.

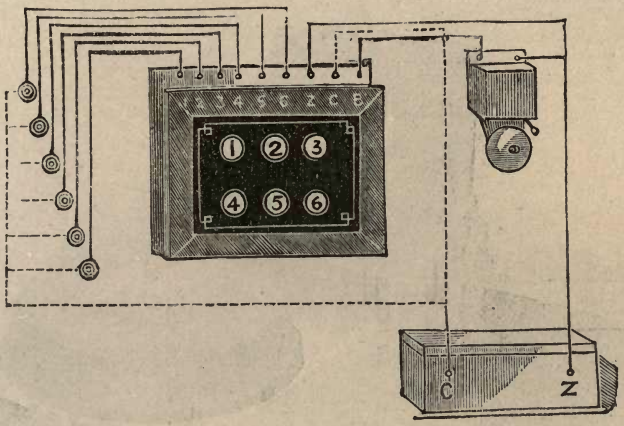


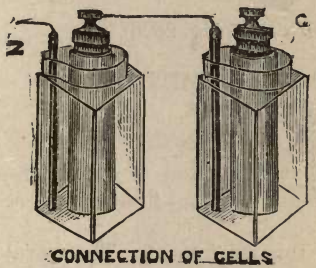
FIG. 2822.

2822 Diagram fig. 2822, showing how to connect up a number of Pushes to Indicator, Bell and Battery, one Wire from Battery to Bell.

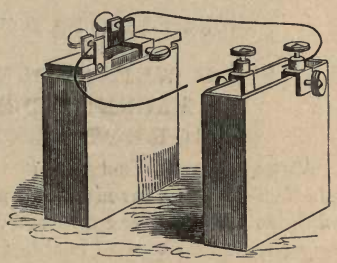
One wire from *each* Push to the corresponding terminal on the Indicator Frame.

One Wire from the Bell to *return* terminal on the Indicator.

One main wire from the Battery, to which one wire from each Push is to be connected.



LECLANCHÉ BATTERIES.



SMEE'S BATTERIES.

INSTRUCTIONS FOR CHARGING THE LECLANCHE BATTERY.

2823 Place the Sal-ammoniac sent, in the glass jar of Battery, and then add water to about three-parts fill the jar. Allow to stand for ten hours before use.

When the Battery becomes weak, fresh Sal-ammoniac and water should be used. *See also page* 434.

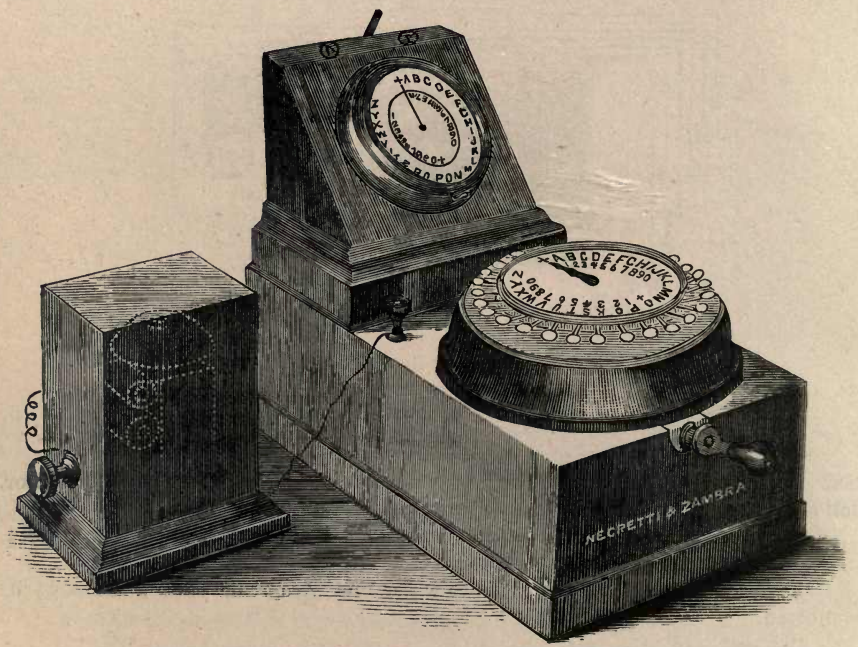
2824 **Clock**, arranged with Electric Alarum, to ring a Bell or Bells at any distance away. Price, with superior Clock £3 3 0

Electric Bell and Battery, for use with above 1 1 0

Conducting Wire covered with Gutta Percha, for use with above, specially suited for out-of-door use . . . . . per 100 yards 0 10 6

2825 **Time Clocks**, for Factory, to ring automatically at various working hours. The times can be altered when required. Price of best London made Clock £10 10 0 £12 12 0

Price of Bells, Connections, Wire, &c., as may be required. Estimates supplied.



Ordinary form of A B C Telegraph, with Bell (fig. 2826).

SIR C. WHEATSTONE'S PATENT ALPHABETICAL MAGNETO ELECTRIC TELEGRAPHS. NEGRETTI AND ZAMBRA, AGENTS.

2826 WHEATSTONE'S Instrument is a perfected modification of the *original* Alphabetic Telegraph, invented and patented by him in 1840, the first step-by-step telegraph instrument ever constructed.

Any person able to read is able to manipulate this instrument. The operator has merely to touch in succession, with the fingers of one hand, the keys corresponding with the letters forming the message he wishes to transmit, whilst he turns the handle with the other hand. In order to receive a message the operator has only to watch the letters pointed to by the hand of the indicator. The correspondence can be carried on at about twenty words per minute.

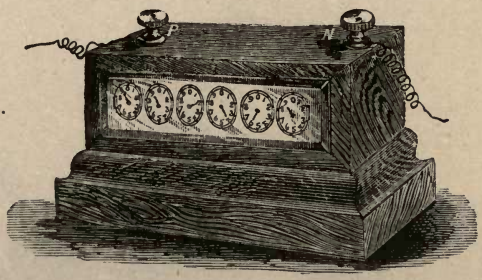
The electric currents which actuate this instrument are produced by the employment of a permanent magnet instead of a voltaic battery; so that chemical preparations are not required, and the instrument is therefore ready to be put in action at any moment, at whatever distant place it may be removed to, and notwithstanding however long it may have been in disuse.

In the absence of voltaic batteries and of working contacts, and in the application of finger keys, consists the essential superiority of these over all the other A B C instruments which have been hitherto introduced.

Fig. 2826 shows the ordinary arrangement for use on private lines.

Complete Telegraph for one Station, consisting of Communicator and Indicator	£21	0	0
Alarm Bell, to work with the above Telegraph	4	0	0
Communicator separately	14	0	0
Indicator separately	7	0	0

FIG. 2827.



2827 **Patent Magnetic Counter.** This instrument has been devised for the purpose of counting and registering the periodical movements of any machine, whether rotary or reciprocating. It may be applied either near to or *at any distance;* it is less cumbrous than mechanical registers. No battery is employed, the electric currents being produced by a small armature of soft iron oscillating before the poles of a permanent magnet.

The Magnetic Counters are made to count to	1,000,000	£9	9 0
	10,000,000	10	10 0

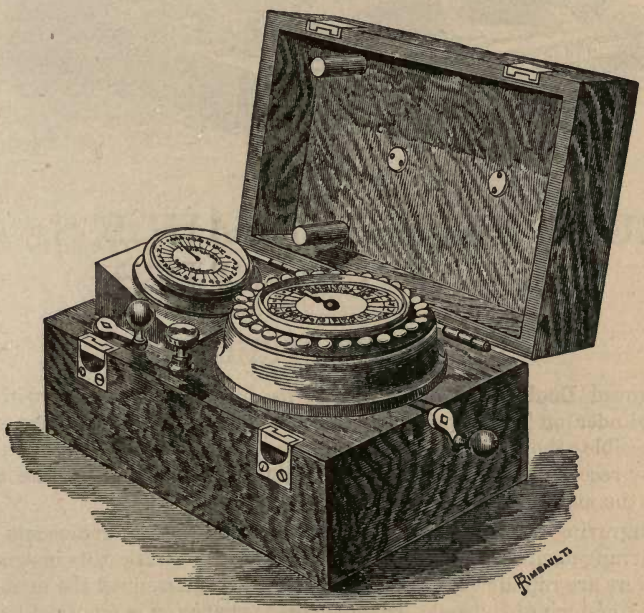


FIG. 2828.

2828	**Complete Military Telegraph,** in strong oak or mahogany case, with flush metal fastenings, suited for Field Service (fig. 2829)	22	0 0
2829	**Alarm Bell,** in oak or mahogany case for use with above . .	5	5 0
2830	**Complete Apparatus for the Duplex System,** by which these instruments may be worked in opposite directions simultaneously through a single wire. For the Double set . . . . . from	5	5 0
2831	**Switch on Mahogany Slab**	0	10 0

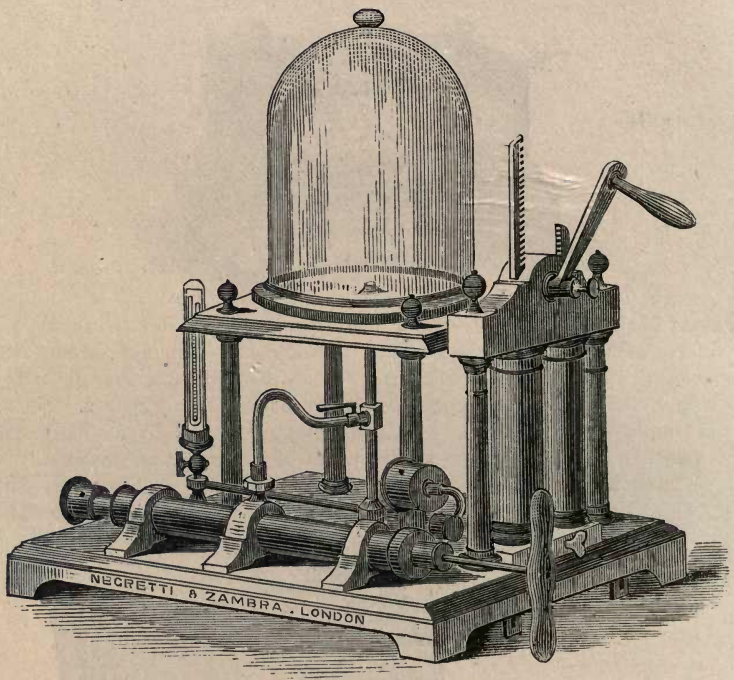


FIG. 2832.

PNEUMATICS, HYDRAULICS, AND HYDROSTATICS.

PNEUMATIC APPARATUS.

2832 **Improved Double-Barrel Air Pump**, as No 2832, combined with a Third Cylinder on Tate's principle for obtaining the most perfect exhaustion possible, the large vertical cylinders being used for rapidly exhausting any receiver, and the horizontal cylinder for completing the exhaustion to the most extreme point £17 10 0

Our engraving (fig. 2832) at the head of this section represents the most improved arrangement of Air Pump yet constructed. With this instrument very large receivers are rapidly exhausted in the usual manner, until the mercury in the gauge falls to ½-inch of the scale, when further exhaustion is obtained by using the Tate's pump placed at the side of the larger cylinders. At a temperature of 60 degrees of Fahrenheit an exhaustion as low as $\frac{1}{10}$th of an inch may be produced, and when the pump is in very perfect action, and the temperature very low, greater exhaustion may be obtained.

2833 **Largest Size Double-Barrel Air Pump**, on strong Mahogany Stool Stand, barometer gauge and cistern, with graduated scale divided to inches and tenths, Gun Metal ground receiver plate, or ground Plate Glass, 23-inches diameter, key and lever . . . £36 0 0

FIG. 2857.

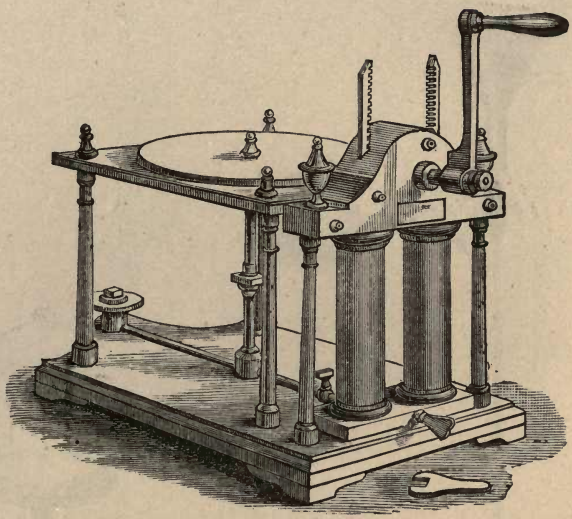


FIG. 2835.

		£	s.	d.
2834	**Large Size Double-Barrel Table Air Pump** with 11-inch plate, either of accurately-turned Gun Metal, or Ground Plate Glass, mounted on a stout Mahogany Stool Stand, with barometer gauge and graduated scale divided to inches and tenths . .	25	0	0
2835	Ditto ditto (fig. 2835), (Davenport's arrangement) with mercurial gauge, raised receiver plate, 8 inches diameter, Mahogany Mounting, brass clamp for fastening the pump to the table, and brass spanner .	12	12	0

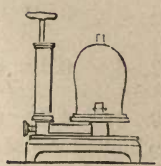


FIG. 2843.

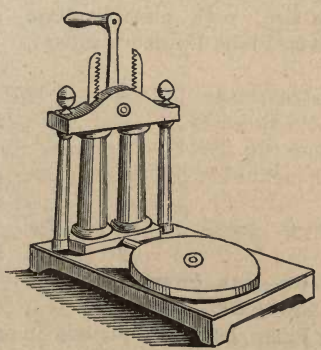


FIG. 2838.

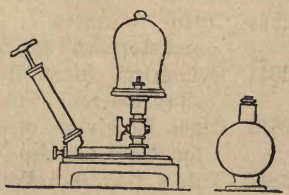


FIG. 2844.

2836	**Double-Barrel Table Air Pump**, second size ditto .	11	10	0
2837	Ditto, third size, with receiver plate, on stand, with gauge	8	10	0
2838	Ditto ditto, without gauge (fig. 2838) . .	7	10	0
2839	Ditto, fourth size	5	0	0
2840	Ditto, small size	4	0	0

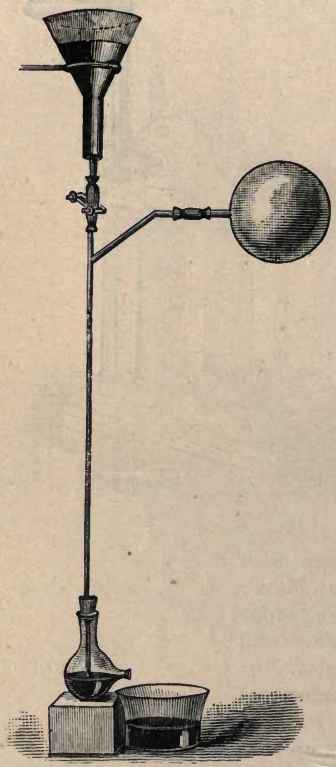


FIG. 2849.

FIG. 2861.

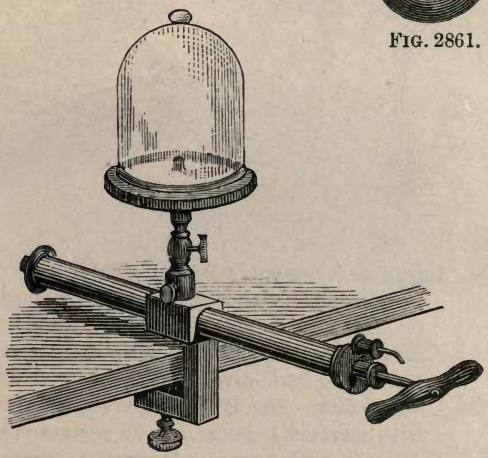


FIG. 2848.

		£	s.	d.	£	s.	d.
2841	**Newman's Improved Single-Barrel Air Pump**, for obtaining a most perfect exhaustion (*Council Medal awarded*, 1851) of large size, with metal valves, and Ground Glass Receiver Plate, 13 inches square, Mahogany Stool Stand				40	0	0
	For description of this Instrument see Catalogue of 1851 *Exhibition.*						
2842	**Single-Barrel Air Pump**, with Receiver	1	5	0	1	16	0
2843	Ditto ditto larger (fig. 2843) . . .				2	2	0
2844	Ditto ditto with inclined barrel, raised plate and stopcock (fig. 2844)	2	10	0	3	3	0
2845	**Cylindrical Glass Receivers**, closed at the top for single-barrel air pumps . . . 3s. 6d., 5s.	0	7	6	0	10	6
2846	**Glass Receivers**, open at top with ground welts, as fig. 2346; see also Nos 2899 to 2905, page 476. .	0	6	6	0	12	6

2847 **Tate's Double-Action Air Pump**, having 2 pistons in one cylinder, the air being drawn from the receiver in the middle of the cylinder, and expelled at the two ends. It is mounted on a strong metal clamp and screw, by which it can be firmly attached to any bench or table. The receiver plate is 7 inches diameter, carefully ground; the cylinder is 16 inches long, with $1\frac{1}{4}$-inch bore—length of stroke $8\frac{1}{2}$-inches. The exhausting power of this pump is very great, and it has a very simple contrivance, by which it can be also used for condensing. Its compact form renders this pump one of the most handy and useful for laboratory purposes.

Price, including Syphon Gauge and fittings, without the Receiver £4 4 0

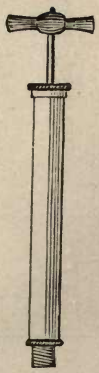


FIG. 2850.

FIG. 2868.

FIG. 2872.

FIG. 2869.

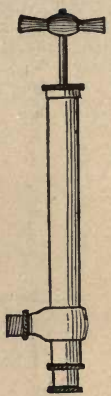


FIG. 2852.

2848 **Tate's Double-Action Air Pump,** with large cylinder, and very firm and strong metal mountings, complete (fig. 2848) £9 9 0

2849 **Sprengel's Air Pump,** constructed on the principle of converting the space to be exhausted into a Torricellian Vacuum; it may thus briefly be described: If a small hole be made in the top of a barometer tube, the mercury sinks and draws in air; if the experiment be so arranged as to allow air to enter along with mercury, and the supply of air is limited, while that of the mercury is unlimited, the air will be carried away, and a vacuum produced. The apparatus is chiefly composed of glass tubes, and is of such a nature that it can hardly be offered for sale, but must be arranged to meet the requirements of the operator. It has been much used in preparing Geissler's Vacuum Tubes, and will be found fully described in Ganot's Work on Physical Science. Supplied to Order.

2850	**Exhausting Syringes** (fig. 2850)	£0	8	6	£0	10	6
2851	**Condensing Syringes**	0	8	6	0	10	6
2852	**Condensing and Exhausting Syringes,** both in one instrument (fig. 2852)				0	16	0
2853	**Condensing and Exhausting Syringes,** of large size .				1	10	0
2954	**Condensing Pumps,** large, with Metal Valves . .	4	4	0	6	6	0
2855	**Single Transferrer** (fig. 2855)				0	16	0
2856	**Double Transferrer** (fig. 2856)				2	2	0
2857	**Vacuum or Pressure Gauge,** small, for attaching to Pneumatic Apparatus (fig. 2857). See also Gauges, page 196)	0	5	6	0	7	6
2858	**Flat Brass Plate,** ground for open receivers, with collar of leather and sliding wire (fig. 2858) . . .	0	15	0	1	5	0
2859	**Brass Syringe or Pocket Condenser,** for producing Heat and Light by rapid compression of air within the Brass Cylinder (fig. 2859)	0	5	6	0	8	6
2860	**Syringe and Lead Weight,** with ground glass plate for open receiver	0	10	6	0	15	0
2861	**Glass Globe and Stop-cock** (very light), for proving the density or weight of air and gases (fig. 2861) . .	0	12	6	0	15	0
2862	**Copper Bottle, Scale Beam and Stand,** with balance weight, for weighing air (fig. 2862)				3	3	0

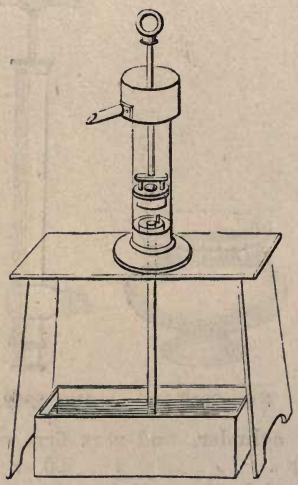


FIG. 2881.

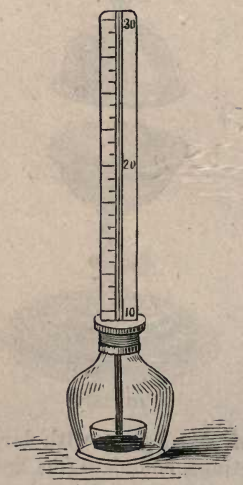


FIG. 2874.

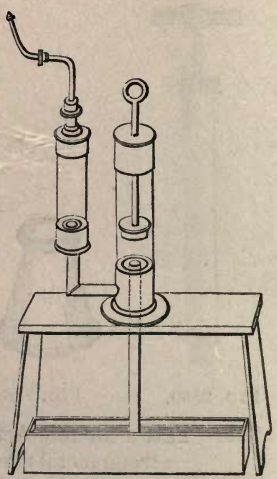


FIG. 2882.

		Each. £ s. d.	Each. £ s. d.
2863	**Scale Beam and Stand,** fitted with a light Glass Vessel graduated in Cubic Inches, by which a number of most instructive experiments can be exhibited, illustrating the specific gravity or weight of various fluids and gases		3 15 0
2864	**Filtering Cup,** with ground Brass Plate, for showing the porosity of wood, without receiver (fig. 2864) .	0 7 6	0 12 6
2865	**Fruit or Taper Stand,** for supporting shrivelled fruit, &c., under the receiver of an air pump . . .		0 3 6
2866	**Fountain in Vacuo** (fig. 2855)	0 7 6	0 15 0
2867	**Tall Fountain Glasses**		0 10 6
2868	**Bladder Glass** (fig. 2868)	0 3 6	0 5 0
2869	**Hand Glass** (fig. 2869)	0 2 0	0 4 0
2870	**Bell Experiment,** illustrating that air is essential to sound (fig. 2870)		0 10 6
2871	Ditto, best make, with a ratchet motion (fig. 2871) .		1 8 6
2871*	**Bell Experiment,** fitted with electro-magnetic break for ringing the bell by a galvanic battery . . .		3 3 0
2872	**Madgeburg Hemispheres** (fig. 2872), the invention of Otto de Guericke (1654), for illustrating the pressure of the atmosphere:— Small, 16s. Second size, 18s. Third size, 30s.		
2873	**Torricellian Experiment,** for illustrating the pressure of the atmosphere and construction of the barometer, simple form		0 15 6
2874	Ditto ditto *larger, with graduated tube,* best mounting and receiver, &c. (fig. 2874)		£2 2 0

At pages 2 and 3 will be found a full description of Torricelli's celebrated experiment, and also the construction of Standard Barometers.

FIG. 2876.

FIG. 2879.

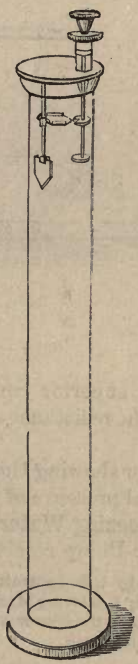


FIG. 2878.

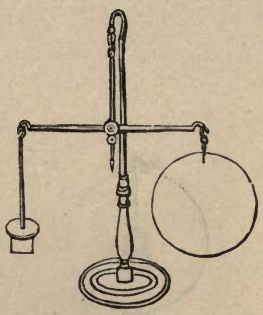


FIG. 2825.

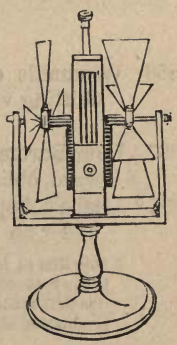


FIG. 2886.

		£	s.	d.	£	s.	d.
2875	**Student's or Laboratory Standard Barometer** . .				5	5	0
2876	**Observatory Standard Barometers**, with mounting board (fig. 2876) See also pages 4 and 5. . .	8	8	0	10	10	0
2877	**Guinea and Feather Apparatus**, 3 falls				1	10	0
2878	Ditto ditto 2 falls (fig. 2878) without the glass receiver				0	18	6
2879	**Guinea and Feather Tube** to demonstrate the law that *In a vacuum all bodies fall with equal velocity* (fig. 2879)				1	16	0
2880	**Model**, for showing the principle of the common water pump				1	5	0
2881	**Model**, for ditto, with glass barrel (fig. 2881), without the stand				1	12	6
2882	**Model of Forcing Pump** (fig. 2882), ditto . . .				2	15	0
2883	**Models of Lifting and Forcing Pumps**, mounted on mahogany stands, with water cistern . .				5	5	0
2884	**Model** to illustrate the arrangement and construction of Manual Fire Engines				6	6	0
2885	**The Baroscope**, an apparatus consisting of balance beam on a stand, a ball of cork suspended at one end, and a metal weight at the other, illustrating that two bodies balanced in the atmosphere are not so in a vacuum (fig. 2885)				0	15	0

FIG. 2870.

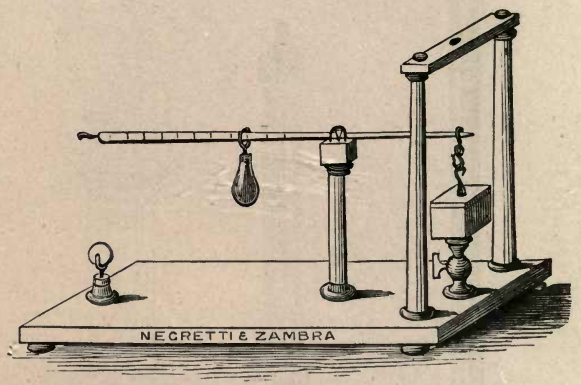


FIG. 2893.

		Each. £ s. d.	Each. £ s. d.
2886	**Windmills or Fans**, of a superior construction, with shifting vanes to show the resistance of air (fig. 2886) from		2 2 0
2887	**Four Barometer Tubes**, for showing the upward, downward, oblique, and lateral pressure of the atmosphere		0 10 6
2887*	**Leslie's Apparatus for Freezing Water** by evaporation under an exhausted Air-Pump receiver . . .		1 10 0

A thin film of ice may be formed by this apparatus in the warmest weather. Leslie's apparatus is the basis of many forms of Ice Producing Machines of the present day. Leslie's Experiment was first made in June, 1810, and is the converse of the experiment, No. 2859, page 471, viz., the production of heat by rapid compression.

2888	**Apparatus**, consisting of three glass vessels, for illustrating the mechanical properties of air . . .		0 12 6
2889	**Glass Flask**, mounted with Brass Stopcock, for illustrating the influence of diminished pressure in facilitating ebullition (fig. 2861)	0 12 6	0 15 0
2890	**Philosophical Water Hammer**, (fig. 2890), for exhibiting the force and solidity with which water falls in a Vacuum	0 4 6	6 7 6
2891	**Water Hammer**, V shaped, closed at one end, and having a brass mounting and stop-cock at the other for exhaustion by the Air Pump (fig. 2891) . .		0 12 6
2892	**Balloons of Gold Beaters' Skin**, for filling with Hydrogen Gas . . . . . from		0 3 6

2893 **Apparatus** for demonstrating the pressure of the atmosphere to be about 15 lbs. upon the square inch of surface, an improved form of the Magdeburgh Hemispheres. A brass box, one inch square, is fitted with a ground metal cover, and also a stopcock. When exhausted of air, the cover can be connected to a steelyard, which shows that a force equal to about 15 lbs. is required to remove the cover of the box; mounted on a convenient stand (fig. 2893) £3 10 0

This apparatus is so constructed that the exhausted box can be screwed into the cross bar on top of the upright pillars, and by means of the pulley and cord and a weight, it can be demonstrated that the pressure on the lid of the box is similar in both positions.

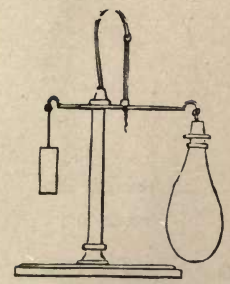


FIG. 2862.


FIG. 2858.

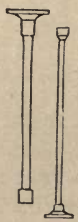


FIG. 2859.


FIG. 2855.

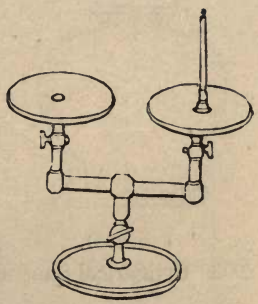


FIG. 2856.

		Each. £ s. d.	Each. £ s. d.
2894	**Bladder Frame and Lead Weights**, for illustrating the elasticity of the air	0 12 0	to 0 16 0
2895	**Lungs Glass**, for illustrating elasticity of air (fig. 2895)		0 8 6
2896	**Gun-Lock Experiment**, for striking flint and steel *in vacuo*		1 10 0
2897	**Breaking Squares**, of thin glass, to illustrate the pressure and also the expansive power of air . . .		0 2 6
2898	**Wire Cage**, for use with above, to protect the Glass Receiver		0 5 6

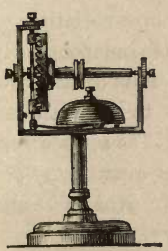


FIG. 2871.

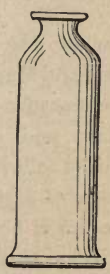


FIG. 2846.


FIG. 2890.


FIG. 2891.

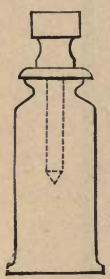


FIG. 2864.


FIG. 2895.

2899 **Receivers for Air Pumps**, well annealed Glass, with accurately ground, welted edges

2900 **Bell Shaped Close Receivers**, (fig. 2900 and 2900°), diameter across the welt :—

4-in.	5-in	6-in.	8-in.	10-in.	12-in.
5s.	8s.	10s. 6d.	16s. 6d.	25s.	34s.

2901 **Bell Shaped Open Receivers** (fig. 2901), including ground plate glass cover :—

Diameter	4-in.	5-in.	6-in.	8-in.	10-in.	13-in.
	6s.	9s.	12s.	18s. 6d.	28s.	42s.

2902 **Cylindrical Shaped Receivers, Close** :—

Diameter	4-in.	5-in.	6-in.	8-in.	10-in.	12-in.
	4s. 6d.	7s.	8s. 6d.	11s. 6d.	18s.	22s.

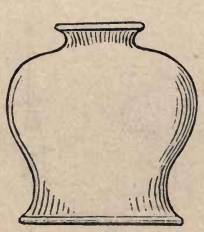


FIG. 2901.

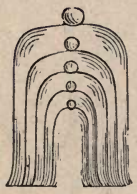


FIG. 2900.

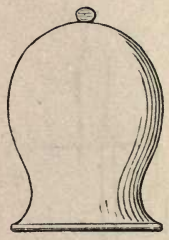


FIG. 2900*.

2903 **Cylindrical Shaped Receivers, Open** (fig. 2846)

Diameter	4-in.	5-in.	6-in.	8-in.
	6s. 6d.	7s. 6d.	12s. 6d.	15s. 6d.

2904 **Tall Cylindrical Glass Receiver, Open** (fig. 2878), for Guinea and Feather experiment £0 16 0 £1 10 0

2905 **Tall Glass for Fountain Experiment** . . 12s. 6d. 1 1 0 1 5 0

2906 **Air Gun**, complete with condensing syringe, bullet mould, &c., in case with lock and key. Made to order. Price 21 0 0

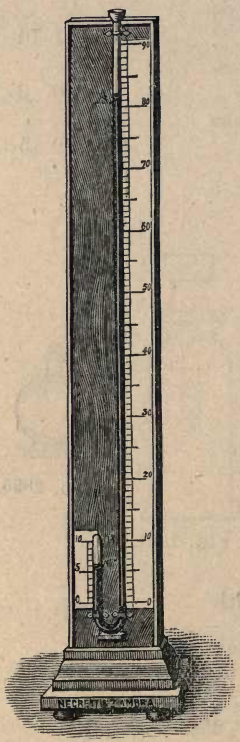


FIG. 2907.

2907 **Mariotte's Apparatus**, arranged to show that under the pressure of two atmospheres air is compressed into half its ordinary volume (fig. 2907) £1 10 0

2908 **Mariotte's Apparatus**, to exhibit that air expands to twice its ordinary volume under diminished pressure, equal to half an atmosphere £1 5 0

"Boyle's Law, The law of the compressibility of gases, was discovered by Boyle and Mariotte independently (about the year 1670). In consequence, it is in England commonly called Boyle's law, and on the Continent, Mariotte's Law. This Law is as follows: *The temperature remaining the same, the volume of a given quantity of gas is inversely as the pressure which it bears.* Nos. 2907 and 2908 are constructed for verifying this law.

"In experiments with Mariotte's Tube, as the quantity of air remains the same, its density must obviously increase as its volume diminishes, and *vice versâ*. The law may thus be enunciated: *For the same temperature the density of a gas is proportional to its pressure.*" Hence as Water is 770 times as heavy as Air, under a pressure of 770 atmospheres air would be as dense as water.

2909 **Sets of Pneumatic Apparatus**, packed in case, consisting of single or double barrel Air Pump, open and close receivers, fountain apparatus, pair of hemispheres, sliding wire and collar, syringe and lead weight, bladder, frame, and weight, filter cup and glass for mercury, hand glass and fruit stand . . . . . £5 5s.; £10 10s.; £21.

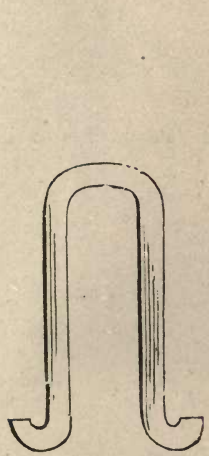


FIG. 2918*.

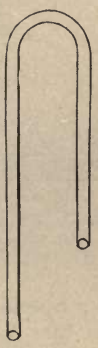


FIG. 2918.

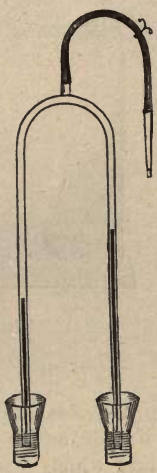


FIG. 2914.

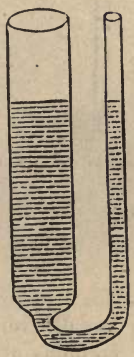


FIG. 2910.

FIG. 2913.

FIG. 2912.

HYDROSTATICS AND HYDRAULICS.

		Each. £ s. d.	Each. £ s. d.
2910	**Hydrostatic Paradox.** An apparatus to prove that a small column of water will support a much larger quantity, and also that fluids will rise and maintain the same level, whatever shape or size the channels through which they flow; in Glass (fig. 2910) from	0 2 6	0 5 6
2911	**Hydrostatic Paradox,** large size (fig. 2911), in japanned metal	4 4 0	5 5 0

FIG. 2915.

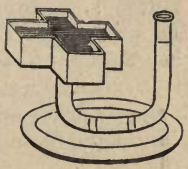


FIG. 2911.

FIG. 2921.

FIG. 2939.

FIG. 2919.

2912 **Hydrometer,** for testing the Specific Gravity of light or heavy fluids, various (see pages 176 to 195) (fig. 2612).

2913 **Gravimeter,** for ascertaining the Specific Gravity of Solids, Stone Minerals, Precious Stones, &c. (see also No. 533, page 190) (fig. 2913).

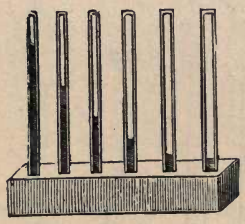


FIG. 2935.

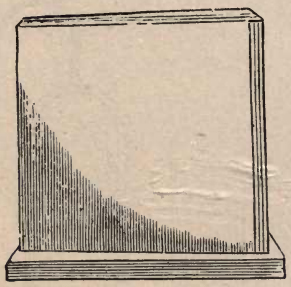


FIG. 2936.

FIG. 2938.

		Each. £ s. d.	Each. £ s. d.
2914	**Boyle's Tube,** for exhibiting the comparative Specific Gravity of two different liquids, or the law that the heights of columns of fluid which counterbalance each other under the ordinary atmospheric pressure are inversely proportional to the density of such fluids (fig. 2914)		0 11 6
2915	**Hydrostatic Bellows,** to illustrate that fluids press equally in all directions, and the pressure in proportion to the height of the vertical column of fluid (fig. 2915)	2 2 0	4 4 0
2916	**Artificial Fountains,** by Condensed Air, consisting of a Copper vessel, with condensing pump, and a variety of jets for fragrant waters, &c., packed in case from		3 3 0
2917	Extra jets for ditto, of various shapes	0 10 6	0 18 0
2918	**Pewter, Copper and Glass Syphons,** of various forms (see Chemical section) (figs. 2918, 2918*) . from		0 2 6
2919	**Tantalus Cup,** an illustration of the use of the Syphon (fig. 2919). A small syphon is concealed within the figure, so that water may be poured into the glass vessel until it nearly rises to the mouth, when the syphon commences to act and rapidly draws off the water		0 12 6
2920	**Apparatus** to explain the theory of Intermitting Springs		3 10 0
2921	Ditto ditto simple form in glass (fig. 2921) . .		0 7 6
2922	The Rope Pump of Vera, or Hydraulic Belt. This machine, the use of which has been revived within a few years, is one of the most simple and at the same time efficient of Water Elevators. and yet the most inexplicable in its action. In its ancient form it consisted of a number of hair ropes (for which a band of flannel or felt is now substituted), passing over two rollers, one at the bottom of the well and the other at the top. By means of the upper roller the band is set in very rapid motion, when the water in the well adheres to its surface in a layer, which is thicker the more rapidly the band moves, and becomes nearly half-an-inch thick when the velocity is 1,000 ft. per minute. The water follows the band to any height and is thrown off by centrifugal force in turning over the upper roller.		
2923	**Model of Chain pump**		
2924	**Persian or Bucket Wheel**		
2925	**Model of Eccentric Pump**		
2926	**Model of Water Pressure Engine**		

Models of Nos. 2922 to 2924, constructed to order.

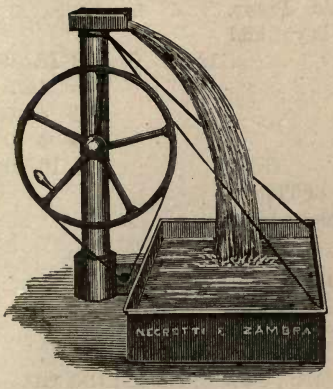


FIG. 2927.

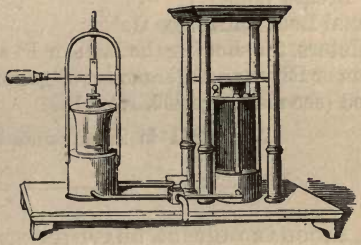


FIG. 9240.

FIG. 2934.

2927 **Model of Centrifugal Pump,** for raising water by means of Centrifugal force, combined with atmospheric pressure (fig. 2927) . £5 10 0

Appold's Pump has been most advantageously applied to drainage purposes, very large quantities of water being rapidly and easily raised by it to small heights. It has been found particularly useful for draining marshy or fen land.

This pump was worked on a grand scale at the Exhibition of 1851.

2928 **Model of Barker's Mill:** by this machine a rotatory motion is obtained by the centrifugal force of the water employed £3 10 0

2929 **Model of Archimedes' Screw, or Water Snail,** a machine for raising water to small heights requiring little power, with glass tube or worm 5 10 0

2930 **Model of Hero's Fountain,** invented 120 years B.C. . 2 10 0

2931 **Mongolfier's Water Ram:** this machine, by the momentum acquired from the flow of water through a pipe, forces a small column to a considerable height* . . 8 8 0

2932 **Apparatus** for illustrating the laws by which fluids Spout through various adjutages £3 3 0 5 5 0

2933 **Apparatus** for showing that more water flows from a short tube than through a simple aperture of equal diameter 1 1 0

2934 **Apparatus** for exhibiting and illustrating the Centre of Buoyancy and Meta-Centre as applied in ship-building (fig. 2934) 1 3 6 1 10 0

2935 **A Series of Six Glass Tubes,** of varying internal diameter, for showing capillary attraction (fig. 2935) 0 10 6

2936 **Two Plates of Glass,** arranged for showing the hyperbolic curve produced by capillary attraction (fig. 2936) 0 15 6

2937 **Hollow Glass Balloons and Figures, or Cartesian Divers,** for ascending and descending in a tall air-tight vessel of water, as the pressure on the surface is increased or diminished 0 2 0

2938 Ditto In Glass vessel complete (fig. 2938) . . . 0 5 6 0 12 6

2939 **Glass Model of Diving Bell,** with Syringe (fig. 2939) . 1 10 0 3 10 0

* *Now used on a large scale for raising Water to small heights where water is abundant.*

		£ s. d.	£ s. d.
2940	**Working Model of Bramah's Hydrostatic Press,** raising 400 lbs., brightly finished with keys and breaking irons complete (fig. 2940)	12 12 0	18 18 0
2941	**Model of Undershot Wheel**		4 4 0
2942	**Model of Overshot Wheel**		4 4 0
2943	**Model of Breast Wheel**		4 4 0
2944	**Model Canal Lock and Sluice Gates** . . from		10 10 0
2945	**Current Meters,** for showing the Rate or Flow of Tide in a Stream or River, and the amount of gallons per hour delivered (see also page 299, No. 1190) . . .	6 6 0	7 7 0

Nos. 2941 *to* 2944, *made to order.*

HYDROMETERS, SACCHAROMETERS, GRAVIMETERS, ETC., FOR DETERMINING THE SPECIFIC GRAVITY OF FLUIDS AND SOLIDS (SEE PAGES 176 TO 195)
HYDRAULIC PRESSURE GAUGES (SEE PAGES 205 TO 209).

WATER PRESSURE.

Pounds per Square Inch, at Different Heights.

Height in feet.	Pressure in lbs. per square inch.	Height in feet.	Pressure in lbs. per square inch.
5	2·17	100	43·3
10	4·3	120	51·9
20	8·6	140	60·6
30	12·9	150	65·0
40	17·3	160	69·3
50	21·6	180	77·9
60	25·9	200	86·6
70	30·0	250	108·3
80	34·6	300	129·9
90	38·9		

Each 33 feet vertical height of water equals one atmosphere, or 15 lbs. nearly.

In Sea Water sp. gr. 1·027, the pressure in descending increases at the rate of 280 lbs. upon the square inch for every 100 fathoms, or exactly 1 ton for every 800 fathoms.

ATMOSPHERIC PRESSURE.

Pascal's celebrated experiment was made at Rouen in 1646. He took a tube of nearly 50 feet long, closed at one end, and having filled it with water, placed it vertical with the open end in a vessel of water, and found that a column of water was supported in the tube of 34 feet long, and is 13·6 times higher than the mercury.

Mercury being 13·9 times heavier than water, the weight of this column of water was exactly equal to that of the mercury in Toricelli's experiment, and consequently it was the same force, viz., the pressure of the atmosphere, which supported the two fluids.

Assuming that the tube in Pascal's experiment is equal to a square inch in sectional area, and that the height of the mercurial column is 30 inches, this column will contain 30 cubic inches; and as a cubic inch of mercury weighs 3433·5 grains, or 0·49 of a pound, the pressure of this column on a square inch of surface will be found to be 14·7 pounds. The pressure of the atmosphere is in round numbers taken at 15 lbs. on the square inch. The pressure upon a square foot of surface containing 144 square inches is equivalent to 2,160 lbs., or very nearly 1 ton. The surface of a man's body of average size is equal to about 16 square feet; the pressure therefore exerted upon this area, 37,560 lbs., or upwards of 16 tons.

Air is 813·67 times lighter than water.

MODELS AND APPARATUS

FOR ILLUSTRATING

THE PHENOMENA OF HEAT, THE STEAM ENGINE, &c.

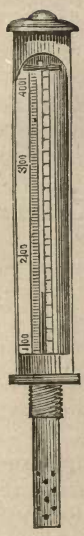


FIG. 2995.

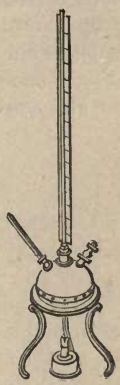


FIG. 2946.

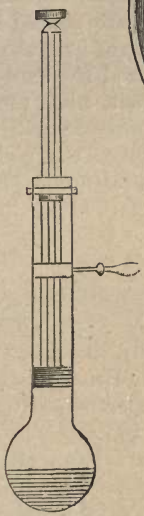


FIG. 2996.

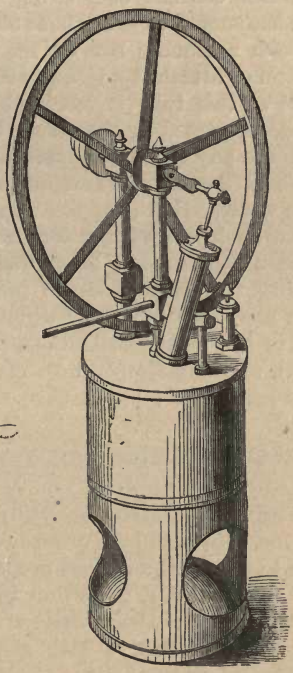


FIG. 3003.

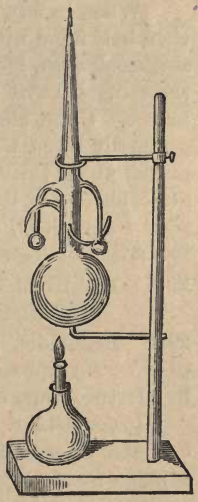


FIG. 2997.

HEAT.

"IN the study of nature two elements come into play, which belong respectively to the world of sense and to the world of thought. We observe a fact, and seek to refer it to its laws; we apprehend the law, and seek to make it good in fact. The one is Theory, and the other is Experiment, which when applied to the ordinary purposes of life becomes Practical Science. Nothing could illustrate more forcibly the wholesome inter-action of these two elements than the history of our present subject, viz., Heat. If the Steam Engine had not been invented, we should assuredly stand below the theoretic level which we now occupy. The achievements of heat through the steam engine have forced, with augmented emphasis, the question upon thinking minds: 'What is this agent, by means of which we can supersede the force of winds and rivers, of horses and men?'

"Heat can produce mechanical force, and mechanical force can produce heat; some common quality must therefore unite this agent and the ordinary forms of mechanical power. The relationship established, the generalising intellect could pass at once to the other energies of the universe, and it now perceives the principle which unites them all. Thus the triumphs of practical skill have promoted the development of philosophy. Thus by the inter-action of thought and fact, of truth conceived and truth executed, we have made our science what it is—the noblest growth of modern times, though as yet but partially appealed to as a source of individual and national might."—*Heat a Mode of Motion*, by JOHN TYNDALL, LL.D., F.R.S., Prof. of Nat. Philosophy in the Royal Institution of Great Britain.

2946 **Marcet's Apparatus**, for showing the Temperature and Elastic force of High Pressure Steam, and the most important facts connected with Latent Caloric (fig. 2946) . . . . . price £4 4 0

Marcet's Apparatus consists of a strong iron boiler, mounted on a tripod stand, with a stout barometer tube of about 33 inches in length, and open at both ends, passing through a stuffing box on the top of the boiler to within a short distance of the bottom: attached to the tube is a scale divided into inches and tenths; on one side of this tube is mounted a very accurate thermometer, and on the opposite side is placed a stop-cock, to which can be attached tubes for conducting the steam to any vessel or apparatus for experiment.

When in use, about 8 ounces of mercury are poured into the boiler, which is then half filled with water. By the application of heat the water is boiled with the stop-cock *open*, from which will issue steam, and the temperature indicated by the thermometer will be 212 degrees of Fahrenheit, when the barometer stands at 30 inches. Upon closing this stop-cock the pressure will be increased, and will gradually force the mercury from the bottom of the boiler up the tube, until it marks about thirty inches on the scale, the pressure being equal to one additional atmosphere (15 lbs.), and the temperature marked by the thermometer will be 250° Fahrenheit, showing the relation between pressure and temperature in the formation of steam.*

2947 **Dr. Ure's Steam Apparatus**, for demonstrating the same facts as Marcet's . . . . . price £4 4 0

2948 **Benevides' Steam Apparatus** (fig. 2948), shows a modified and larger form of Marcet's Apparatus, contrived by Professor Benevides, of Lisbon, for exhibiting in a lecture room or to a class the various properties of Steam.

It consists of a strong boiler, B, and on the top of it are three stuffing boxes, *b*, *c*, and *d*, with fittings for a thermometer, a barometer tube, and a mercurial syphon pressure-gauge, all mounted with suitable scales. A model of Giffard's injector, G, is also adapted to the boiler. At A is a stop-cock, for connecting any piece of apparatus to be experimented with. Among many important facts to be demonstrated by this apparatus is the amount of heat rendered latent when any given quantity of water is converted into steam and other phenomena of latent heat—the laws of ebullition, the influence of pressure over the boiling point of water, the connection between temperature and the elastic force of steam, the production of motion by the elastic force of steam, &c. The action of Giffard's injector is also very prettily illustrated, a small jet of water being easily projected 12 ft. with a good pressure of steam. Fig. 2948, Price £5 10 0

2948* "It is proved by experiment that the quantity of heat necessary to raise one pound of water one degree of Fahrenheit in temperature is equal to that generated by a pound weight falling from a height of 772 feet against the earth. Conversely, the amount of heat necessary to raise a pound of water one degree of temperature would, if all applied mechanically, be competent to raise a pound weight 772 feet high, or it would raise 772 pounds one foot high. The term '*foot-pound*' has been introduced to express in a convenient way the lifting of one pound to the height of a foot. Thus the quantity of heat necessary to raise the temperature of a pound of water one degree Fahrenheit being taken as a standard, 772 foot-pounds constitute what is called *the mechanical equivalent of heat*. If the degrees be Centigrade, 1,390 foot-pounds constitute the equivalent."—*Tyndall*.

* See Dr. A. S. Taylor's Thermometric Table.

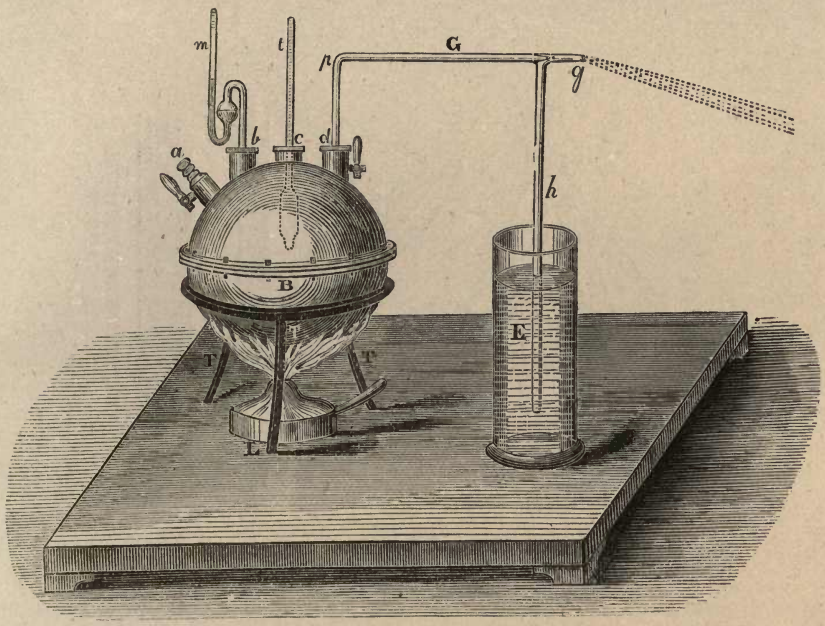


FIG. 2948.

		Each. £ s. d.	Each. £ s. d.
2949	**Glass Flask,** mounted with brass stop-cock, for experiments with heat under diminished pressure (fig. 2446, page 470)		0 10 6
2950	**Cubical Tin Vessel,** (Leslie's Cube), with stop-cock, to illustrate the expansion of water into steam by heat and contraction (or condensing) by cooling . .		0 10 6
2951	**Air Thermometer,** for ascertaining very small differences of temperature by the expansion of air. Invented by an Italian Physician, Santorio, in the Seventeenth Century (fig. 2251)	0 15 0	1 1 0
2952	**Leslie's Differential Thermometer** (fig. 2952) . .	1 10 0	2 2 0
2953	**Wollaston's Boiling Point Thermometers** (see pages 92 to 94.)		
2954	**Tyndall's Apparatus,** to demonstrate the production of Heat by friction. See also No. 2144, page 492 .		6 6 0
2955	**Thermometers** (fig. 2955), various, and for High Temperatures, Iron, Brass, or Copper mountings.		

(See page 167.)

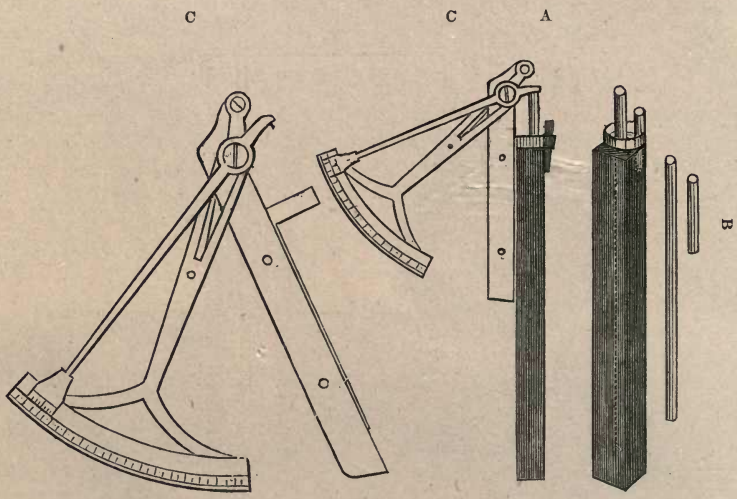


FIG. 2956.

PYROMETERS.

2956 **Pyrometer,** Professor Daniell's, is perhaps the most practically useful; fig. 2956 shows its general arrangement. The indications are obtained from the difference in the expansion by heat of an iron or platinum bar and a tube of well-baked black-lead ware, in which the bar is contained. The metal bar, A, is shorter than the tube, and a short plug of earthenware, B, is placed in the mouth of the tube resting upon the iron bar, and so secured by a strap of platinum and a little wedge that it slides with difficulty in the tube. By the expansion of the metal bar the earthenware plug is pushed outwards, and remains in its new position after the contraction of the metal bar on cooling. The expansion of the metal bar thus obtained is measured off by the instrument and index, C, which traverses over a divided circular scale S before the experiment, and after the earthenware plug has been moved outwards by the expansion of the metal bar B. The degrees marked on the scale are in each instrument compared experimentally with those of the mercurial scale, and the ratio marked on the instrument, so that its degrees are convertible into those of Fahrenheit. (*Philosophical Transactions*, 1830—31,) In use the black-lead cylinder, P, with its metal expansion bar, A, enclosed, is placed into the metal or furnace to be tested, the length of the metal bar being noted on the divided arc, S, previous to the operation, and after its exposure to the heat to be tested. Price £5 5 0

2957 **Ferguson's Pyrometer,** a lecture table instrument, for demonstrating the expansion of metals by heat, the relative amount of expansion of different metals being shown upon the divided Quadrant seen in fig. 2958
Price, simple form £4 4 0

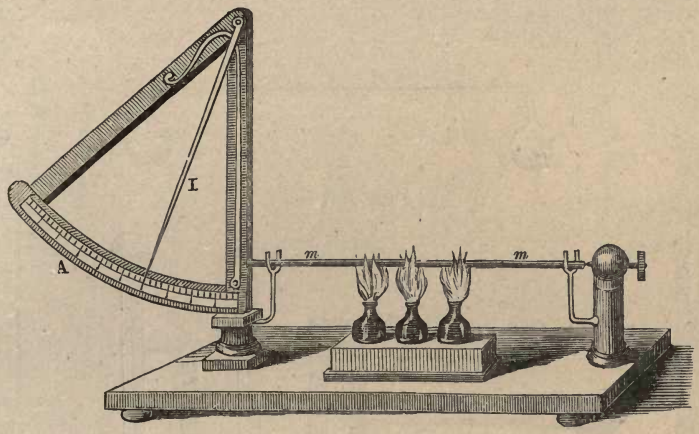


FIG. 2958.

2958 **Ferguson's Pyrometer,** in its most complete form, fitted up with an Oil or Water Bath for uniformly heating the metal rods under experiment, the Temperature of the Bath being shown by a delicate Thermometer fitted to it . . . Price, complete with Bath and Thermometer (fig. 2958) £5 10 0

2959 **Wedgewood's Pyrometer:** with this instrument the degree of heat is estimated by the permanent contraction of a prepared Cylinder of Pipe-Clay or Porcelain; but its indications (except for one or two special purposes) are found to be fallacious and of little practical value. Supplied to order.

For Gauntlett's, Bystrom's, and Siemen's Pyrometers, see pages 203 *and* 204.

2960 **Fire Syringe,** for exhibiting the evolution of Heat by the rapid Compression of Air. This is the converse of Leslie's experiment (page 475), in which Cold is produced by the rapid rarefaction of air . . . £0 5 6 0 8 6

2961 **Metal Bar and Gauge,** for showing, in a simple and conclusive manner, the expansion of metals by heat (fig. 2961) 0 7 6

The Metal Bar when at the ordinary temperature of the air will fit tightly into the gauge; but if it be warmed, the metal will be expanded, and prevent the bar from fitting into the gauge until it is again cooled.

2962 **Gravesand's Metal Ball and Ring,** for exhibiting the same fact 0 10 6

2963 **Compound Metal Bar,** to exhibit in a striking manner the Expansion and Contraction of metals by heating and cooling. This bar is made of two slips of metal of differing expansibility by heat (Iron and Brass). When Cold this bar is perfectly straight, but if heated by the flame of a Spirit Lamp it becomes curved . Price, for Bar only £0 6 0 0 8 6

2964 **Compound Metal Bar,** with Stand, large size, for Lecture Table 0 15 0

2965 **Compound Metallic Bar Thermometer,** (Brequet's), in the form of a **Watch** 4 4 0

See also the Metallic Clinical Thermometers, Medical Section, for an adaptation of Breguet's Instrument.

FIG. 2995.

FIG. 2970.

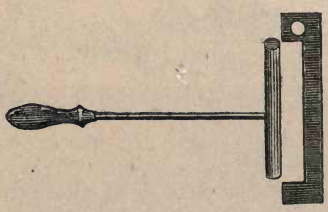


FIG. 2961.

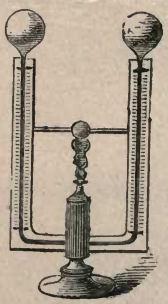


FIG. 2952.

FIG. 2951.

2966 **Spiral Metallic Thermometer**, of larger size, see page 460, Used for Alarm purposes, &c.

2967 **Hope's Apparatus** for determining the Maximum density of Water, consists of a cylindrical glass jar, with an external Copper vessel for holding a mixture of Ice and Salt, and two Thermometers with projecting bulbs. with attached scales, as shewn in the engraving, fig. 2967. *See Ganot.*
Price £0 14 0

2968 **Apparatus** to show that liquids expand by increase of temperature and become of a lighter specific gravity, consisting of a large glass tube, closed at one end, for holding water, on which floats a small hydrometer adjusted to a temperature of 60°. Upon warming the water over a spirit lamp the hydrometer will sink; but it will rise to the surface when the water cools to 60° £0 10 6

2969 **Apparatus** for showing the varying Expansion of Liquids, and the construction of Thermometers. It consists of five large Thermometer tubes, partly filled with Mercury, Alcohol, Ether, Oil, and Water; arranged on a stand with tin trough. Graduated scales are fitted to each tube, by which the relative expansion of the liquids in a given time can be observed, when the trough is filled with hot water . Price for Lecture Table size £3 3 0

2970 **Cryophorous, or Frost Bearer**, (fig. 2970, Dr. Wollaston's), is a glass tube with large bulbs at each extremity, as fig. 1948. These bulbs and tube are nearly exhausted of air, and a small portion of water, about half filling one bulb, left in it. If the empty bulb be surrounded with a mixture of pounded ice and snow the rapid evaporation taking place from the surface of the water will cause it quickly to freeze . . £0 4 6 £0 6 6

2971 **Apparatus** for showing the Conducting power of various metals 0 10 6

2972 **Cylinder** of Wood and Brass, to show Conduction by a strip of paper 0 3 6

2973 **Parabolic Reflectors**, of highly polished zinc, for Experiments on Radiant Heat . . . per pair 4 4 0 5 5 0

2974 **Stands** for ditto with simple adjustment . per pair 1 4 0

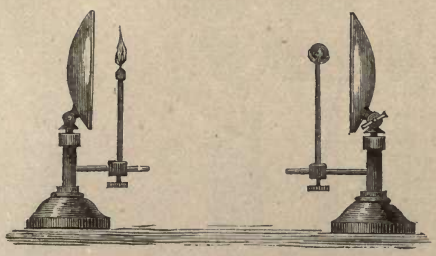


FIG. 2975.

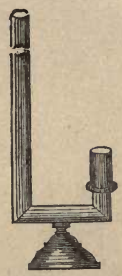


FIG. 2991.

		Each. £ s. d.	Each. £ s. d.
2975	**Stands** for Reflectors, best make, with jointed adjustments (fig. 2975) . . . . . per pair		2 12 6
2976	Ditto for . . . . . Iron Ball, &c.		0 8 6
2977	**Parabolic Conjugate Reflectors or Mirrors,** 18 inches diameter, Stout Silvered Copper, mounted on adjustable Stands, with Iron Ball and Stand		10 10 0
2978	**Leslie's Radiator,** or Cube, small size		0 5 6
2979	Ditto ditto larger, with adjusting Stand . .	0 15 0	1 1 0
2980	Leslie's Radiator is a square tin vessel, each of the four side surfaces being different. One is left bright, one roughened, one dull white, and the other black. The vessel being filled with boiling Water the various surfaces will be found by the use of Leslie's Differential Thermometer (No. 2952) to radiate or give off varying amounts of Caloric.		
2981	**A Set of Three Leslie's Cubes,** each having inserted a delicate Thermometer for noting the rate of cooling of the liquids in the vessels dependent upon their exterior surfaces. Price, for 3 best mounted Cubes		£2 10 0
2982	**Leslie's Pyroscope,** for ascertaining the comparative radiation of various bodies		1 10 6
2983	Ditto ditto an improved arrangement (fig. 2983) as described by Ganot		3 3 0
2984	**Radiation, Reflection, or Absorption of Heat Apparatus;** consisting of two flat metal discs, having one side blackened and the other bright, with small cups or shelf for holding pieces of Phosphorus. These discs being placed at equal distances from a heated Iron Ball, the Phosphorus will be inflamed on the black surface, whilst that on the bright one will remain unchanged . . .		0 18 6
2985	**Boutigny's Experiment** for exhibiting the spheroidal condition of water when in contact with a strongly heated surface, and also the non-conducting power of vapour		3 3 0
2986	**Silver Bottle and Stopper,** for exhibiting the sudden evolution of steam in Boutigny's experiment		2 2 0
2987	**Apparatus** to show the Imperfect Conducting Power of Water, consisting of a sensitive Air Thermometer, so arranged that Ether can be ignited upon the surface of water surrounding the air bulb, without producing any movement in the thermometer . .		1 1 0
2988	**U Shaped Glass Tubes,** for illustrating Convection . . .		0 5 0
2989	**Faraday's Convection Apparatus,** best form, on a stand, for illustrating the mode of heating buildings, &c., by hot water . . .		0 18 0
2990	**Tyndall's Geyser Apparatus,** of large size, with Zinc Trough and Copper Corners		7 0 0

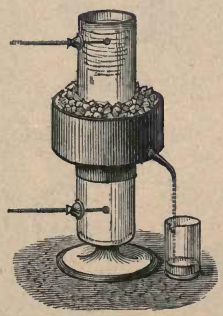


FIG. 2967.

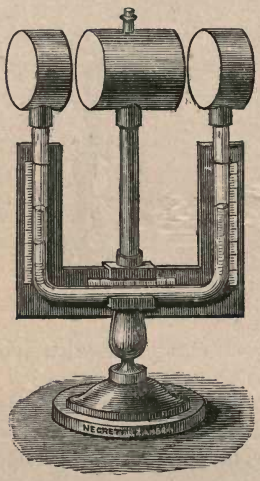


FIG. 2983.

FIG. 2993.

		£	s.	d.
2991	**Apparatus** to exhibit the principle of **Ventilation**, showing an ascending current of heated air and a descending current of cool air to supply its place (2991)	0	12	6
2992	**Fine Wire Gauze**, for experiments on Flame, demonstrating its inability to pass through a medium formed of Metal Threads, owing to their cooling or conducting power, for explaining the theory and action of Davy's Safety Lamp, 8 inches square	0	2	0
2993	**Improved Safety Lamps**, Universal Clanny, with Swivel and elastic ring, to allow for expansion of the Glass (fig. 2993*) . . 17s. 6d.	1	5	0
2994	**Glass Apparatus**, for exhibiting the evolution of latent heat by a mixture of two cold fluids. The glass vessel is partly filled with Water, and upon its surface is floated a small light capsule, into which a little piece of dry Phosphorus is placed; now if strong Sulphuric Acid be carefully poured into the water, sufficient heat will be produced to ignite the Phosphorus	0	8	6
2995	**Bunsen's Ice Calorimeter**, for experiments on Specific Heat, (fig. 2995, see Ganot)	0	15	0

Various other experiments illustrating the Phenomena of Heat, see Chemical Section.

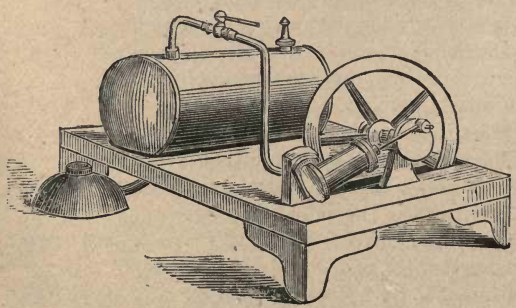


FIG. 3005.

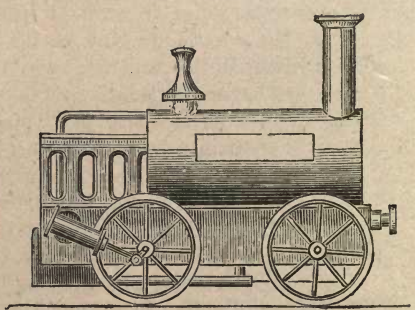


FIG. 3009.

* *See also page* 404.

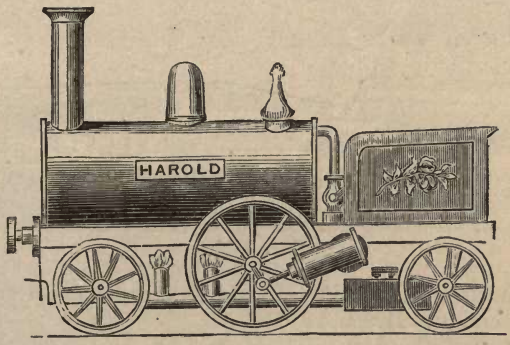


FIG. 3009*.

MODEL STEAM ENGINES.

2996 **Dr. Wollaston's Apparatus**, showing the production of motion by the generation and condensation of steam (fig. 2996) . £0 10 6 £0 15 6

2997 **Glass Models of Hero's Rotatory Steam Engine** (Eolipyle), mounted on stand, with Spirit Lamp (fig. 2997) 0 5 6 0 10 6

2998 **Toy Models of Branca's Engine** 0 5 0 0 7 6

2999 **Working Models of Hero's, De Caus', Branca's, Savery's, Papin's, Newcomen's, Hornblower's, and Cartwright's Steam Engines** . made to order.

3000 **Working Models of Sawing, Rolling, or Grinding Mills, Cranes, Pile Driving Engines, Steam Hammers, Pumps, &c., &c.** . . made to order.

3001 **Working Model of Watt's Low Pressure or Condensing Engine** 21 0 0

3002 **Ditto, Watt's High Pressure ditto** . . £5 5 0 10 10 0 15 15 0

3003 **Working Model of High Pressure Oscillating Engine**, with boiler and lamp attached (fig. 3003) £1 1 0 1 5 0 1 10 0

3004 **Ditto ditto larger and better finished, bright metal** 2 10 0

3005 **Horizontal Steam Engines**, as fig. 3005, with brass boiler, Oscillating Cylinder, steam cock, safety valve, fly wheel, on japanned stand with lamp £1 10 0

3006 **Ditto ditto larger, and of higher finish** . . £2 2 0 2 10 0

3007 **Horizontal Steam Engine**, with fixed cylinder and slide valve, eccentric motion, boiler, &c., &c., on mahogany stand . . £5 5 0 6 6 0

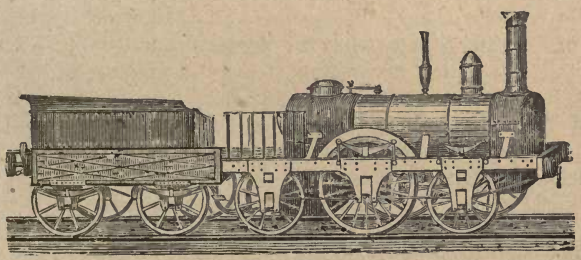


FIG. 3010.

3008 **Locomotive Engine, Working Model**, in cheap form, of japanned metal 2 2 0 2 10 0

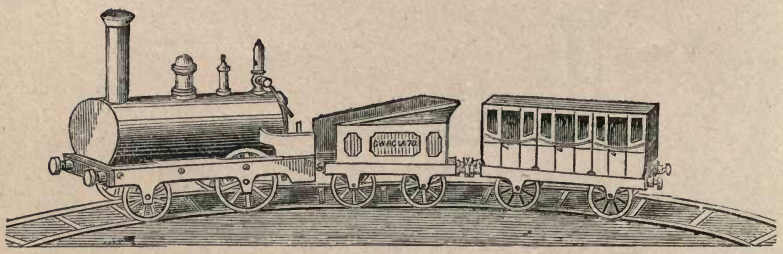


FIG. 3011.

3009 **Locomotive Engines, Working Models,** of superior finish and larger size, of Bright Metal (fig. 2109 and 2109*).

£3 3 0 £4 4 0 £5 5 0 £6 6 0 £8 8 0 £10 10 0

3010 Ditto ditto Six Wheels, with Tender, as fig. 3010 . . 14 14 0

3011 **Working Model Locomotive Engine,** of bright brass, highly finished, with japanned tender and carriage, and Circular Railway (fig. 3011).

£8 10 0 £10 10 £12 12 0

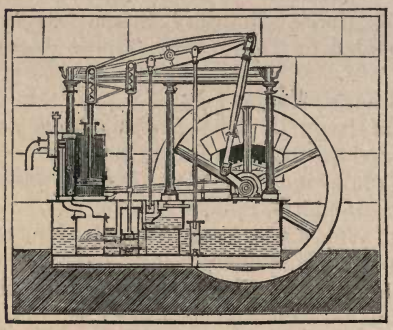


FIG. 3018.

		£	s.	d.	£	s.	d.
3012	**Working Model of Steam Fire Engine,** will throw a jet of water a considerable distance				15	15	0
3013	**Working Model of a Marine Beam Engine,** with paddle-wheels, &c.	25	0	0	30	0	0
3014	**Working Model of Penn's Vibrating Engine.** These engines, being simple and compact, are extensively employed in the Thames steam-boats . . from				20	0	0
3015	**Model Steam-Boats,** fitted with working engines and Paddle Wheels, or Screw Propeller . . £10 10 0	15	15	0	25	0	0
3016	**Model of Perkins' Steam Gun,** for projecting bullets, with a strong boiler, generating steam at a pressure of 200 lbs. per square inch				14	0	0
3017	**Painted Wooden Sectional Models** of High and Low Pressure Engines and Locomotives, of various constructions, showing the exterior of the engine, and the working of the parts, such as the cylinder, condenser, piston, valves, &c. . . . from	8	8	0	12	12	0
3018	**Small Sectional Working Model of Condensing Engine,** made of cardboard and metal (fig. 3018) . . .	2	10	0	3	3	0
3019	**Sectional Diagrams and Plans of Steam Engine, &c.,** suited for Lectures, various according to size,				to order.		

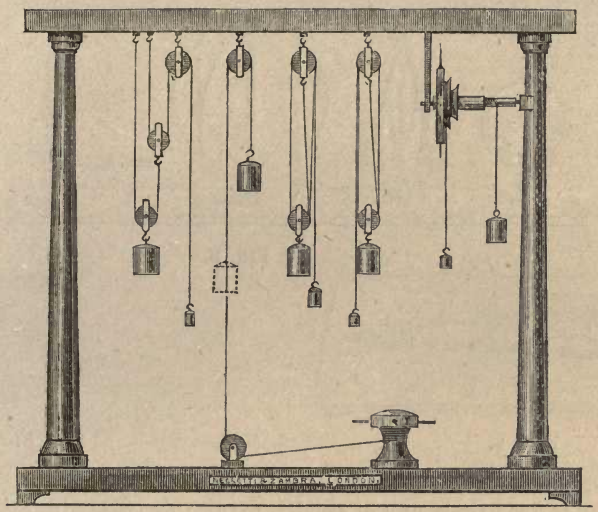


FIG. 3021.

MECHANICS AND DYNAMICS.

The Models, &c., detailed in this section will be found valuable aids to the teacher and student in studying the laws of motion and the science of Mechanics.

		Each. £ s. d.	Each. £ s. d.
3020	**Model Apparatus for exhibiting and illustrating the properties of the Mechanical powers,** viz., levers, simple and compound, pulleys of different kinds, wheel and axle, inclined plane, screw, wedge, capstan, &c., in mahogany and boxwood; in case, with weights complete	5 10 0	8 8 0
3021	**Mechanical Powers,** more highly finished, and complete with Brass pulleys, &c. (fig. 3021) . . .	10 10 0	21 0 0
3022	**Sets of Levers,** comprising the three orders, and the bent form		1 10 0
3023	Ditto ditto in Brass		5 5 0
3024	**Systems of Pulleys,** Simple and Compound . . .		2 2 0
3025	**Inclined Plane,** with Carriage and Weights . . .		1 10 0
3026	**Models,** to show the formation of the Screw and Nut, to illustrate the action of screws of different degrees of inclination, the endless screw and compound screws .	2 2 0	5 5 0
3027	**Adhesion Plates,** of Glass, with handles . . .		0 15 0
3028	**Inertia Apparatus,** with Brass ball, mounted on a stand	0 15 0	1 10 0
3029	**Apparatus** for showing the impenetrability of matter .		0 5 6
3030	**Apparatus** for determining the Centre of Gravity of variously shaped bodies . .	1 1 0	1 10 0

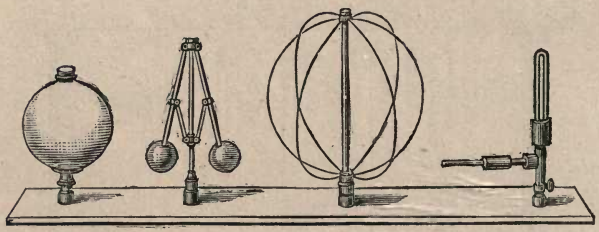


FIG. B.

FIG. A.

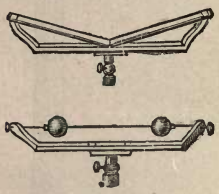


FIG. C.

		£	s.	d.	£	s.	d.
3031	**Apparatus** illustrating that the stability of a body depends upon the centre of gravity, see also No. 2934				0	12	6
3032	**Double Cone and Inclined Plane**, to show the descent of the centre of gravity, although the cone apparently moves upwards	0	10	6	0	16	0

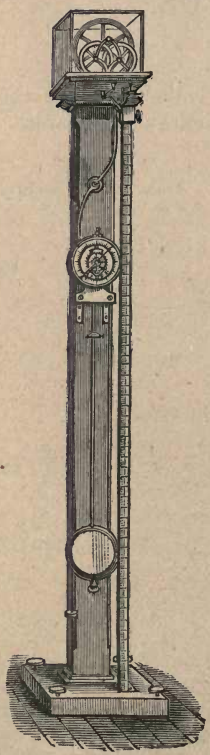


FIG. 3034.

3033	**Apparatus** for illustrating the Parallelogram of Forces, with weights, &c., of the best finish, complete				6	6	0
3034	**Attwood's Machine** for demonstrating the laws of falling bodies, with pendulum beating seconds, weights, &c., complete on stand, with best Clock and highly finished (fig. 3034)				25	0	0
3035	Ditto ditto simple form . . .				12	12	0
3036	**Apparatus** to show that a body takes the same time to descend the diameter or chord of a circle, whatever the length of that chord may be	2	2	0	4	4	0
3037	**Apparatus** to illustrate that the time required for the descent of bodies down an inclined plane is proportionate to its length	2	2	0	5	5	0
3038	**Apparatus** to illustrate the Composition of Force				3	3	0
3039	**Apparatus** to demonstrate that the time required for a falling body to reach the ground is the same, whatever be the force of projection	3	3	0	5	5	0

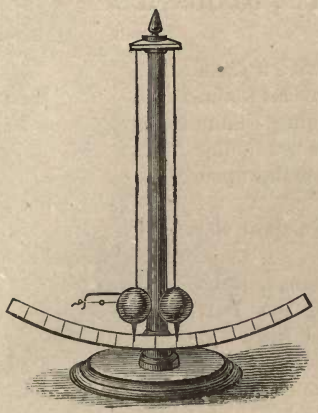


FIG. 2694.

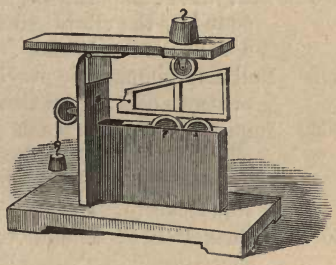


FIG. 3049*.

		Each. £	s.	d.	£	s.	d.
3040	**Apparatus** to illustrate the curve of quickest descent .	2	2	0	3	3	0
3041	Ditto to show the Parabolic Curve described by a projectile				2	2	0
3042	Ditto to illustrate the laws of Impact collision or percussion, with divided arc and ivory balls (fig. 3042)				3	3	0
3043	Ditto to illustrate the Equilibrium of Forces, complete				6	6	0
3044	**Whirling Table or Centrifugal Machine and Apparatus complete**, for illustrating the laws of Central Forces (fig. 3044, A, B, C.)				21	0	0
3045	**The Whirling Table only**, without apparatus. This can be used for Tyndall's experiment, No. 2954, page 483, for producing Heat by Mechanical Action or friction				6	6	0
3046	**Model** to illustrate the construction and properties of an Arch				2	2	0
3047	**Model** to show the properties of crown, spur, and bevel wheels, wheel and pinion, and rack and pinion . .				6	6	0
3048	**Model** to demonstrate the properties of Steelyard and Balance	1	1	0	2	2	0
3049	**Model of Capstan or Windlass**	1	10	0	2	2	0
3049*	**Model**, to demonstrate the principle of the Wedge—Metal Wedge and rollers in Mahogany Frame (fig. 3049*)				3	10	0
3050	**Glass Models**, for teaching Geometry and Crystallography				2	2	0
3051	**Small Sets of Geometrical Solids and Planes** . .				0	10	6
3052	**Larger Sets of ditto**, with sections of the Cylinder, Cone, and Sphere				1	10	0
3053	**Professor Maxwell's Dynamical Top**, for illustrating the phenomena of rotation, complete in Mahogany Box				6	10	0
3054	**The Gyroscope**, for description and price see page 495.						

EXPERIMENTS TO ILLUSTRATE ACOUSTICS.

		Each. £ s. d.	Each. £ s. d.
3056	**Apparatus** for producing Musical Sounds with a jet of Hydrogen Gas burning in a glass tube, Musical Flames		1 10 0
3057	**Apparatus** for exhibiting a Rotating Singing Flame	from	4 16 6
3058	**Trevyllian's Experiment, or Rocking Bar,** for producing sound by the vibrations of a Heated Copper Bar upon a Cold Block of Lead		0 18 0
3059	**Bell Experiment,** for proving sound depends upon the presence of Air (see also page 473)	0 15 0	1 10 0
3060	**Improved Arrangement of the Experiment,** with Electro Magnetic Apparatus for setting the Bell in motion, having a glass receiver, fitted with two stopcocks, for experimenting upon the different gases		4 10 0
3061	**Polarization of Sound,** Apparatus for demonstrating, consisting of a Tuning Fork and Glass Flask . .		0 10 6
3062	**Monochord,** of simple construction, with adjusting weights, for altering the tension of the vibrating string, for showing the relation and sub-division of musical sounds		6 10 0
3063	**Brook's Apparatus,** to show the relation between the tension of a chord and the time of vibration . .		2 10 0
3064	**Apparatus** for exhibiting the vibration of elastic membranes by sand upon their surfaces (or Chladni's Acoustic Figures)		1 12 0
3065	**Steel Spirals,** for producing various musical sounds, mounted on a sounding board, with a hammer . .		3 0 0
3066	**Syrene,** for ascertaining the number of impulses, in a given time, required to produce any particular note. This is done by a clockwork movement, arranged to record the movement of a disc of metal, perforated with a series of holes, through which a current of air is forced		5 5 0
3067	**Wheatstone's Kaleidophone,** to exhibit the principle of the superposition of small vibrations		1 10 0
3068	**Organ Bellows,** with double riser, wind chest, and sound board, with a set of wood and metal tongued pipes, for producing musical sounds		10 10 0

3069 **Vibration Telephone.** Not Electrical. Speaks Loudly and Clearly. Simple and cheap. In this apparatus a well-known principle of acoustics is practically applied. It consists of a Sound Box at each end, fitted with a properly insulated and stretched Wire between them. For distances of 30 to 1000 feet it will act well.

Vibration Telephone, with Electric Call arrangement. 2 Telephones, 6 Insulators, 200 feet of suitable Wire, 2 Bells, 2 Keys and 2 Batteries complete, with instructions for fixing up and use . . . £5 12 6

Telephones and Transmitters (except for Export) cannot be supplied.

The various Acoustic instruments, &c., invented and used by Messrs. Savart, Wheatstone, Biot, Tyndall, Konig, Helmholtz, Lissajous, Léon, Scott, and others, in their researches connected with Sound, described in Ganot's *Physics*, constructed and supplied *to order*, by Negretti and Zambra.

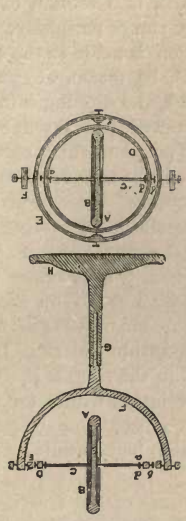


FIG. 3073.

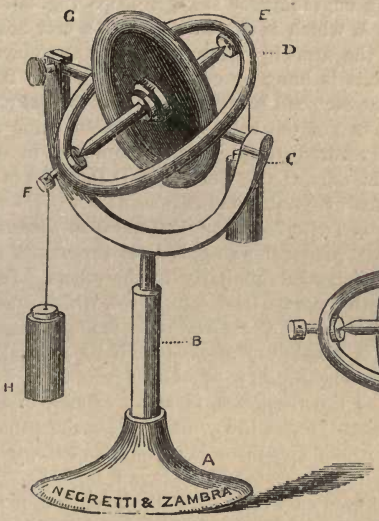


FIG. 3072.

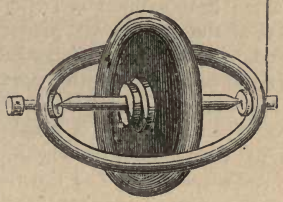


FIG. 3071.

3070 **The Gyroscope**, a modification of Bohnenberger's machine, introduced by M. Foucault, is an instrument arranged to illustrate the following principles:—

That inertia is a property of matter in motion, as well as of matter at rest.

That orbital and axial motion are intimately related, and that the speed of one may affect or regulate the other.

That the state of unstable equilibrium in which many bodies remain is to be explained by the fact of their rotation.

That bodies in motion endeavour to maintain their original plane of rotation.

That the power of resisting or overcoming the force of gravity possessed by shots fired from Armstrong's gun is due to the gyratory motion given to them by the peculiar formation of the gun.

It will also illustrate the precession of the Equinox.

		Each. £ s. d.
3071	**Gyroscope**, the simple form, with a stand (fig 3071)	1 10 0
3072	Ditto, of the best and most complete form (as fig. 3072), in mahogany cabinet	3 10 0

All other Instruments, Models, or Apparatus required to illustrate the Sciences for Educational or Lecturing purposes, constructed to order.

FOUCAULT'S EXPERIMENTS WITH THE GYROSCOPE.

3073 The following illustrated description of the Gyroscope from a paper read by M. Foucault, before the British Association, "Nouvelles Expériences sur le Mouvement de la Terre au Moyen du Gyroscope," is from the *Civil Engineer and Architects' Journal*.

"In the accompanying engraving [of the gyroscope (fig. 3073), A is a section of the periphery of the wheel, A A, which is constructed with a very heavy rim or periphery, and a light disc, B B, forming the arms by means of which the connection is made to the axis, C C, of the wheel. This axis is hung or connected to a ring, D D, by means of gymbal journals at *a a;* this axis at each end being brought to a conical point, and dipping into the conical recess made in the end of the bolts *b;* which bolts being screwed, pass through the brass hoop or ring, and are secured steadily by the jam-nut, *d*, in the position which permits of the free revolution of the axis, C C. This ring, D D, again is hung or connected to the brass ring, E E, by means of gymbal suspensions at *e e*. These gymbal suspensions are constructed in the same way (with bolts and jam-nuts) as those described suspending the axis C C, of the wheel A A. Again, this ring, E E, is suspended to the upper part, F F, of the stand, by another pair of gymbals similarly to the others. The box, F F, or upper part of the stand is provided with a prong, G, or long pivot, which dips into a socket on the top of the lower part of the stand, H. The apparatus so made is thus capable of the following motions: The wheel, A A, is capable of revolution on its axis, C C, within the ring, D D; the ring, D D, including the wheel A A, is capable of revolution within the ring, E E, round the gymbal suspensions, *e e;* the ring, E E, is again capable of revolution within the box, F F, or upper part of the stand, round the gymbal suspensions that connect it to the frame or stand; and finally the whole apparatus is susceptible of revolution horizontally on the pivot, G, which is inserted into the socket of the stand, H."

The same journal then goes on to say: "With the apparatus so constructed a variety of beautiful experiments can be performed, of which the following are the more interesting. Remove the ring, D D, carrying the wheel, A A, from the machine, set the wheel, A A, in rapid motion, which can be done by winding a piece of twine round the axis of the wheel, A A, and while holding the ring, D D, firmly in the hand, pull the twine violently, so as to uncoil it from the axis, C C; suspend the ring, D D, by a piece of line attached to itself, or what is better, to the projecting head of the bolt which is outside of the ring at the gymbal journal; and so long as the velocity of the wheel, A A, exceeds a certain amount, the ring, D D, will stand horizontally, though suspended on one side, or it will remain in any position forming an angle with the horizon in which it may be placed; and while so suspended will slowly revolve round the suspending twine as a centre of motion. Thus the revolving motion of the mass of the wheel and axis resists the action of gravity on the mass, both of the matter which is in motion and on that which is at rest.

"Another experiment is as follows: Place the ring, E E, perpendicular, the ring, D D, at right angles to it; set the wheel, A A, in rapid motion in the same way as before, and assuming that while the machine is at rest it is in exact equilibrium, suspend while it is in motion a small weight on the projecting head of the bolt, which forms the axis of the wheel, and a horizontal revolution of the whole mass round the pivot centre of the stand will take place. Suspend now a heavier weight at the other end of the axis of the wheel, and the motion will be reversed; that is, if with the light weight the revolution took place to the right or left hand, it will, after the addition of the heavier weight at the opposite end, revolve to the left or right hand, the direction being determined by the direction in which the wheel, A A, revolves.

"A third very interesting experiment is the following: When the whole machine is at rest, if a stand be slowly turned round on the table, the whole mass will turn with it, the weight of the machine causing sufficient friction on the pivot to produce this effect; but set the wheel in rapid motion as before, and the stand may be turned either way without disturbing the upper part of the machine, or altering the absolute direction of the axis of rotation. Thus, as with the pendulum experiment, can be shown the actual revolution of the earth, seeing that as the revolution of the earth takes place, it slowly revolves round under the gyroscope, the axis of which retains the same absolute direction in space. Instead of the ring, D D, being used to carry the axis of the wheel, A A, a semi-sphere is sometimes substituted, and in this form if the cup or semi-sphere be carried in the hand, the resistance which the moving mass offers to any change in the direction of the axis of rotation opposing any horizontal or perpendicular angular motion in the axis, gives the sensation as if the inanimate matter possessed life and will of its own."

PHOTOMETERS FOR TESTING ILLUMINATING POWER OF COAL GAS.

		Each. £ s. d.
3074	**Glass Tube Pressure Gauge**, with 6-inch Glass Syphon, with Stopcock, ivory scale, best finish	0 14 0
3075	Ditto ditto large size 12-inch Scale, best mounted . .	1 10 0
3076	**Gas Inspector's Gauge**, with best fittings complete, in Leather Pocket Case (see also page 197)	2 2 0
3077	**Sensitive Gas Thermometers**, 5-inch Ivory Scale, with projecting bulb for taking temperatures in gas mains, in Pocket Case .	0 10 6
3078	**Bunsen's Photometer**, for comparing and measuring the illuminating power of coal gas, and for testing the comparative value of various gas-burners	3 3 0
3079	**Dr. Letheby's 60-inch Photometer**, mahogany standards, gas pillar, with double cock, micrometer adjustment, slide for candle, wooden shades, &c.	8 8 0
3080	**Evans' Standard Photometer**, 100-inch scale, in polished pine case lined with black velvet, with disc frame, central adjustment, slide ventilators, velvet canopy, &c., &c.	17 17 0
3081	**Experimental Meter**, 144 cubic inches capacity, combination index, minute clock and gas index working on one dial, 5 feet hourly rate of consumption, and time circle, small circles showing 5 feet actual consumption, and 10 minutes. The minute clock with lever escapement dead beat provided with bell, which is struck every minute	12 12 0
3032	**Sight-hole Beam**, or brass cross-piece pillar, with brass chains and weights, scale for weighing two candles in candle holders whilst burning, grain weights 500 to ¼-grain, mounted on mahogany board	5 0 0
3083	**King's Pressure Gauge**, to show 100th part of an inch pressure, £3 3s.	4 4 0
3084	**Specific Gravity Apparatus**, for testing the gravity of Coal or other gases, consisting of a light glass flask of one Cubic Foot capacity, mounted with a Stop-cock and also a suitable Balance and grain weights, one grain being equivalent to 1·728 cubic inches of air .	3 3 0
3085	**Jet or Inferential Photometer (Lowe's)**, for testing and comparing the illuminating power of gas	4 4 0
3086	**Testing Gas Holder**, of 2 cubic feet capacity, with copper bell, double divided scale, balance wheel or friction rollers, cycloid and weights, gun metal taps, pressure gauge, &c., &c., complete for laboratory service	21 0 0
3087	Ditto ditto of larger size, with more finely divided scales and adjustments for testing meters	40 0 0

FOR GAS PRESSURE GAUGES, GAS TESTING THERMOMETERS, GRADUATED TUBES, SPECIFIC GRAVITY FLASKS, HYDROMETERS, &C., &C., SEE PAGES 153, 167, 176, 196, 206 AND 375.

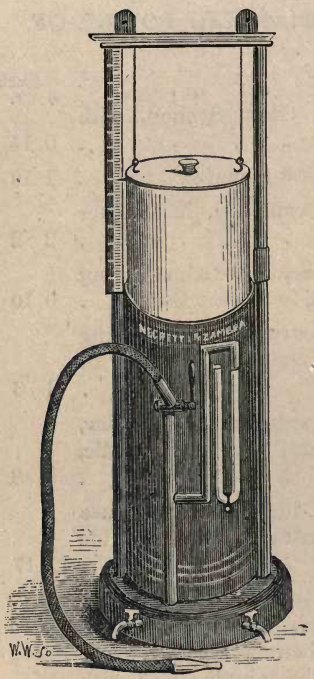


FIG. 3088.

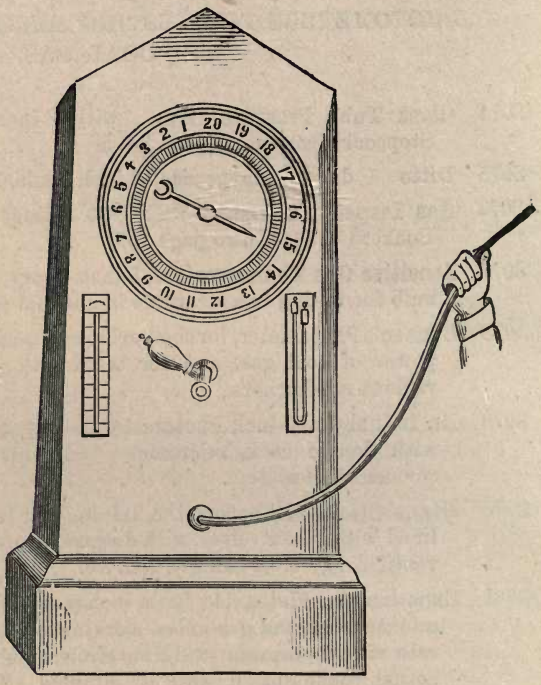


FIG. 3089.

MEDICAL, SURGICAL AND PHARMACEUTICAL INSTRUMENTS AND APPLIANCES.

		Each. £ s. d.	£ s. d.
3088	**Hutchinson's Spirometer**, for measuring the Vital Capacity of the Lungs (fig. 3088)		4 4 0
3089	Ditto ditto improved, with **Dial Indicator**, &c. (3089)	6 6 0	8 8 0
3090	**Measuring and Weighing Machine**, for use with the Spirometer	6 6 0	8 8 0

The object of this instrument is to measure that volume of breath expired from the lungs which is made by the deepest expiration immediately following the deepest inspiration. It has been determined by actual experiment upon 4,400 males, that this volume (or vital capacity) increases with the stature, quite irrespective of any other measurement upon the human frame. The law is—*For every inch of stature from* 5 *ft. to* 6 *ft., eight additional cubic inches of air, at* 60° *Fahrenheit, is (in the erect position) exhaled from the healthy lungs.* In Consumption this volume is diminished 33 per cent. in the first stage, and 53 per cent. in the second stage of that complaint.

As a man at 5 ft. 8 in. in health breathes 230 cubic inches, and a man in the first stage of Consumption breathes 154 cubic inches, so the healthy condition of the lungs differs from the pthisical lung. All diseases of the Chest diminish the healthy volume of expired air. For particulars see *Medico-Chirurgical Trans.*, vol. xxix., p. 137, and *Cyclopœdia of Anatomy and Physiology*, Art. THORAX.

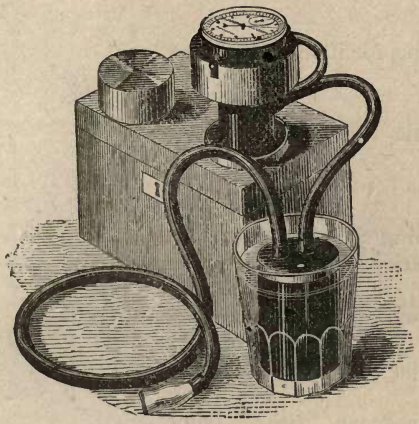


FIG. 3091.

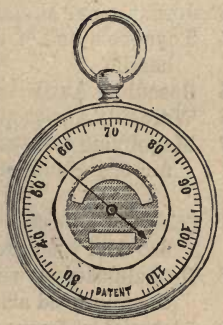


FIG. 3101.

3091 **Portable Medical Spirometer, Patent** (fig. 3091). This instrument from its very small size will be found a very useful addition to the consulting room of the physician, and to the physiological laboratory. The measurement of the vital capacity is obtained by measuring the velocity of the expired current during the time of expiration, and the instrument is arranged so as to reduce the velocity of the current to Cubic Measure.

Each Spirometer is experimentally Tested by means of a vessel filled with air immersed in water, the cubic contents of this vessel being known; the air is made to pass through the Spirometer at a pressure of six inches of water; the Spirometer is then regulated to show the cubic contents of the vessel. By this means it is found the error of the instrument seldom amounts to more than 2 per cent.

DIRECTIONS FOR USE.—Each instrument is provided with a condenser, which should be placed in a tumbler of cold water; the tube with the mouth-piece must be fixed to the orifice of the condenser, marked "*in*," and the instrument to that marked "*out*." The hands must then be set to zero by turning the milled head, at the same time pressing the spring forward. The patient is directed to take a deep breath, and then to expire steadily through the mouth-piece for as long as possible. The index hands register the number of Cubic Inches of Air expired.

The use of the condenser is to prevent the moist air entering the instrument. After repeated use it is necessary to empty the accumulated water. This is done by disconnecting the instrument and inverting the condenser. Price £4 10 0

Table of the Vital Capacity of the Lungs, compared in Health and in Consumption, at 60° Fahrenheit, upon 5,000 Cases (Male).

HEIGHT.				HEALTH.		CONSUMPTION.		
Ft.	In.	Ft.	In.	Mean.	Minimum.	First Stage.	Second Stage	Mixed.
5	0	to 5	1	174	146	117	82	99
5	1	— 5	2	182	153	122	86	102
5	2	— 5	3	190	160	127	89	108
5	3	— 5	4	198	166	133	93	113
5	4	— 5	5	206	173	138	97	117
5	5	— 5	6	214	180	143	100	122
5	6	— 5	7	222	187	149	104	127
5	7	— 5	8	230	193	154	108	131
5	8	— 5	9	238	200	159	112	136
5	9	— 5	10	246	207	165	116	140
5	10	— 5	11	254	213	170	119	145
5	11	— 6	0	262	220	176	123	149

		Each. £ s. d.	Each. £ s. d.
3092	**Vacuum Tubes, or Laryngoscope,** for illuminating the throat		1 1 0
3093	**Jordan's Ear Illuminator**		1 10 0
3094	**Toynbee's set of Silver Specula,** round or oval, with handle		1 1 0
3095	**Speculum Auris**—various forms	0 15 0	1 10 0
3096	**Warden's Auriscope**		0 10 6
3097	**Magnifying Lenses,** for examining Skin Diseases, &c., for the Hand or Pocket, various forms and prices (see pages 223 to 224).		
3097*	**Steinheil's Pocket Magnifier** with Aplanatic Lenses flat field with great power each 22s. 6d.,	1 7 0	2 5 0
3098	**Opthalmoscope,** with Lenses complete, in pocket case, the improved arrangement	1 5 0	2 2 0
3099	**Liebreich's Improved Opthalmoscope,** with 2 Lamp Chimneys, in mahogany case		5 10 0

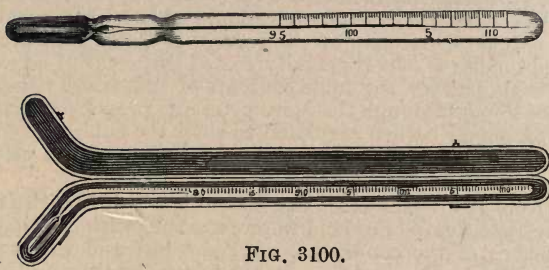


FIG. 3100.

NEGRETTI AND ZAMBRA'S IMPROVED CLINICAL THERMOMETERS.

3100 The importance of ascertaining or watching carefully the variations of temperature in disease is daily becoming more apparent. Hitherto one of the main drawbacks to the general use of the thermometer by practitioners has been the fact that sufficiently portable instruments have not been obtainable. This difficulty is now entirely overcome in the Clinical Thermometer originally devised by Dr. Aitkin, now improved by Negretti and Zambra. Each instrument is tested by a Standard Thermometer, before being issued. Its portability is the great point. The Thermometers are 3, 4, 5, or 6 inches in length, and can be conveniently carried in the pocket: with Negretti and Zambra's improvement they are Self-Registering, and may be read off at leisure. The important gain is this, that the practitioner may always carry a Thermometer with an indestructible index about with him; and thus find that he has a valuable aid, not only at ordinary, but at many chance times. Useful charts for daily recording the main points in physical Diagnosis have also been published. For prices and descriptive details, see pages 160 and 161.

Kew Certificate to a Clinical Thermometer, extra, 2s.

Negretti and Zambra's Clinical Thermometers are usually divided upon their stems with Fahrenheit or Centigrade scales; if both scales are desired upon the same instrument there will be an extra charge of 2s.

3101 **Patent Metallic Thermometers (Immisch's Patent)**, for Clinical and ordinary uses (fig. 3101).

The chief advantages that this instrument has over those in ordinary use are its convenient shape and size—like a miniature watch,—the readiness with which the temperature may be read off, and its comparative freedom from liability to in injury. It is sensitive and accurate. No shaking down being required, the instrument readily accommodates itself to altered temperatures. About 30 seconds elapses before the temperature last recorded is changed. This space of time is generally admitted to be sufficient to allow the Thermometer being taken to the light and its indications noted. These Thermometers are divided to both Fahrenheit and Centigrade Scales.

Price in neat Leather Case, Silver, £1 1s.; Gold, £2 10 0

3102 **Hygrometers**, for Hospital Wards, &c., 14s., 21s., fig. 3102, see also page 73.

3103 **Bath Thermometers**, with Dr. Forbes' specifications, in japanned Metal Cases, 5s. 6d.,, 6s. 6d. (fig. 3103).

3104 **Chemical, Bath and Ward Thermometers**, for particulars of various sizes and prices, see pages 153 and 159, and figs. A, B, and B*, next page.

3105 **Thermometers for Drying Rooms and Hot Water Apparatus**, see page 167.

3106 **Disinfecting Thermometers**, of various forms and size, as supplied to Government hospitals and other public institutions, see page 169.

3107 **Improved Dropping Bottles**, for Solutions of Nitrate of Silver, Acids, or other Medical Preparations, &c., &c., (see page 192, fig. 449).

These bottles made of glass, the stopper, which is carefully ground in, being formed of stout barometer tube drawn out to a point; over the stopper and neck is fitted a glass cap, also ground so as to be air-tight. The bottle being about two-thirds filled with the fluid to be used, is held in the hand inverted (the cap having been removed, when the warmth of the hand will expand the confined air, and expel the fluid through the perforated stopper, drop by drop. These Dropping Bottles have been found very useful both for Medical, Chemical, and Photographic uses. Price 1s. 6d. each, or in turned wood pocket case, 3s.

3108 LOWE'S TEST FOR SEWAGE IMPURITY IN WATER.

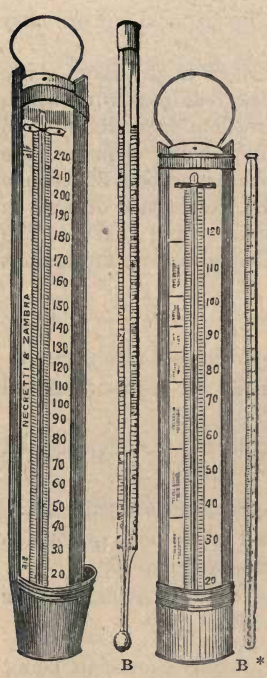
Mode of using the Test.—Break one of the glass balls by dropping it from a height of a foot into a clean wine glass. Fill the wine glass with the water to be tested.

The more dangerous kinds of impurity—ammoniacal products derived from sewage—if present in considerable amount, are at once detached, by the production of a yellow colour, or by a flocculent deposit, which becomes yellow or greenish after standing six hours (the glass being covered to exclude dust). Water of this description is unfit for use. If a copious white precipitate forms, or if any cloudiness ensues, the water should be submitted to analysis, and should in no such case be drunk without previous boiling.

If the water remains perfectly clear it may be used with safety.

Price, 2s. 6d. per dozen.

The greatest care should be taken that the wine glass, containing the test and broken glass, be emptied after using, and thoroughly cleansed, the Test being poisonous.



A FIG. 3103.

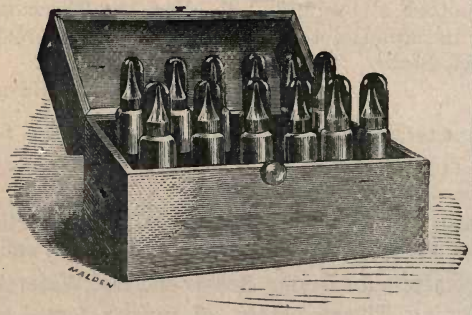
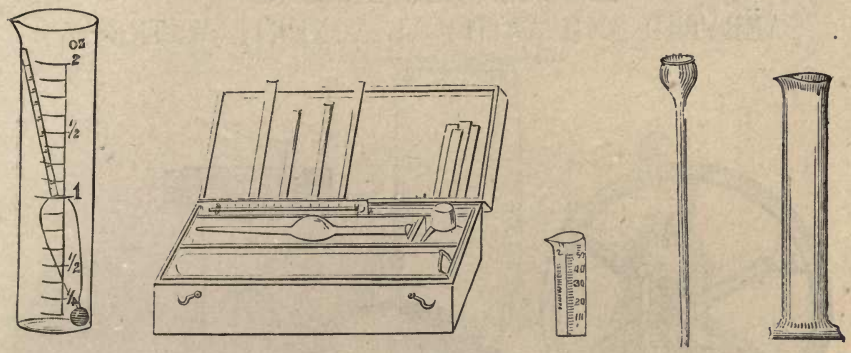


FIG. 3109.

FIG. 3102.

		Each. £ s. d.	Each. £ s. d.
3109	**Improved Dropping Bottles**, Set of 12 in case (fig. 3109)		1 5 0
3110	**Stethometer** (Dr. Quain's), for ascertaining the expansion of the chest		1 10 0
3111	**Dentists' Mirrors**, with powerful Magnifier, and hinge-joint, to make them portable . . . from		1 10 0
3112	**Optometer** (Smee's), for testing the Vision, and arranging lenses to supply any defect . . .		5 5 0
3113	**Complete Sets of Trial Sights**, having 36 pairs of Convex, and 36 pairs of Spherical Lenses, 18 Convex and 18 Concave Cylindrical Lenses, 12 Prisms, 2 Black Discs, 4 Discs with small apertures, a series of Tinted Glasses, and a Graduated Adjustable Frame in which the various Trial Sights are held by springs. Complete in Mahogany Box		£10 10 0
3114	**Eye Shades**, covered with Silk, Black or Green colour .	0 1 0	0 2 0
3115	**Occhiombra or Transparent Eye Shades**, with case .	0 11 0	0 16 0
3116	**Nitrous Oxide Gas Apparatus**, for Dental operations, complete with pure compressed gas, face-piece, two-way stop-cock, &c., &c.	10 10 0	16 16 0
3117	**Electrical, Galvanic, and Electro-Magnetic Apparatus**, for Medical Use.	See pages 455 and 459.	
3118	**Sick Room or Invalid's Telegraph and Signal Bell**, see *ante*, page 461.		



FIGS. 3119.

3119 **Urinometers and Apparatus** connected with their use, figs. 3119, also see pages 191, 192.

3120 **Galvanic Batteries,** in series, either Grove's or Bunsen's, arranged for igniting a Platinum Wire of sufficient length for applying **Actual Cautery,** with convenient Directors (*Ecraseurs*) and appliances for Surgical Use, &c., &c. £8 8 0 to £12 12 0, and supplied to order. See also page 455.

3121 **Galvanic Apparatus,** for supplying a constant battery current with 30 or 50 Leclanché Cells. £10 10 0 £13 13 0

3122 Stethoscopes. Enema Apparatus. Breast Pumps, Stomach Pumps, Injecting Apparatus. Pravaz's Hypodermic Syringe. Sphygmograph with improvements. Laryngoscope and Lamps for use with ditto. Cupping Instruments. Spray Producers, Gas Inhalers, (various), Respirators. Hearing Trumpets, Voice Conductors or Conversation Tubes. Gas Table Furnaces, and Enamelled Iron Evaporating Dishes for Pharmaceutical purposes, &c. Various forms and prices, with all recent improvements, to order.

3123 **COLLECTIONS OF MINERALOGY AND GEOLOGY.**

MINERALS.

		£ s. d.		£ s. d.
100	Well defined specimen Minerals, in Cabinet	1 10 0	to	3 3 0
200	Ditto ditto	2 10 0	to	7 7 0
300	Ditto ditto larger	7 7 0	to	10 10 0
500	Ditto ditto larger	10 10 0	to	50 0 0

All with name and locality, and arranged according to Dana's Mineralogy.

FOSSILS.

		£ s. d.		£ s. d.
100	Fossils, British and Foreign	1 10 0	to	3 10 0
200	Ditto ditto	2 10 0	to	7 7 0
300	Ditto ditto	6 6 0	to	10 10 0
500	Ditto ditto	10 10 0	to	30 0 0
1000	Ditto ditto	25 0 0	to	60 0 0

Arranged stratigraphically with name, geological position, and locality of each specimen.

ROCKS.

		£ s. d.		£ s. d.
100	Rocks, British and Foreign	1 10 0	to	3 10
200	Ditto ditto	2 10 0	to	7 7 0
300	Ditto ditto	6 6 0	to	10 10 0
500	Ditto ditto	10 10 0	to	30 0 0

According to size of Specimens. All with name and locality, and arranged according to Von Cotta.

Collections for special departments of Geology and Mineralogy, Casts of rare Fossils, &c. &c

MACHINERY FOR THE MANUFACTURE OF SODA WATER
AND ALL OTHER KINDS OF

AËRATED AND ARTIFICAL MINERAL WATERS.

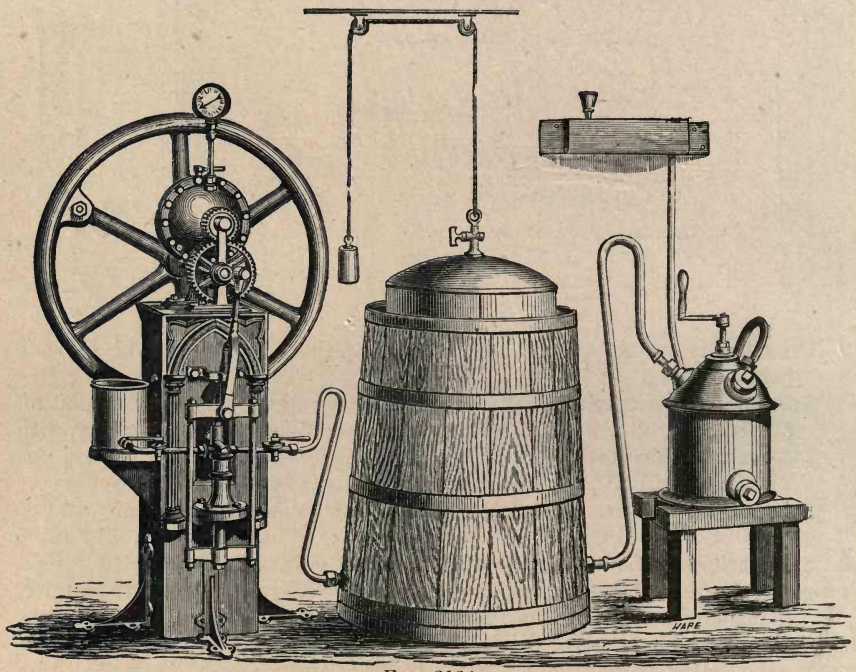


FIG. 3124.

3124 PATENT CONTINUOUS PROCESS SODA WATER MACHINE.

This small but effective apparatus has all the good fittings requisite to render it perfect; the Condenser takes apart; the Agitator has an outside support; it is fitted with a Dial Pressure Indicator, &c., and is complete in itself, requiring no extra stand or framing, being mounted on a cast-iron stand, as shown in the engraving, fig. 3124.

This machine is capable of producing about 100 dozen large bottles per day. It comprises a strong Gun-metal Pump with valve box at the top; a stout Copper globe, made to open if required, and fitted with blow-off valve, with connection for bottling machine: the Agitator driven by toothed wheels; Solution pan, &c., mounted on framed stand; a strong oak tub, iron bound; Copper bell with blow-off cock at top, pipes and connections forming gasometer; Stout Lead Generator, with tinned copper Agitator, gun-metal fittings and pipes; syphon box and pipe for supplying acid to Generator, and all necessary requisites, including spanners to fit every bolt and nut. The whole mounted complete on cast iron frame,

Price complete, ready for working, £36 0 0

Ditto for a larger size of above machine, complete with Gas apparatus, £70 and £85, to make from 600 to 1200 dozen bottles per day. Suitable Steam Engines for driving above supplied to order. Estimates given for complete sets of Mineral Water Machinery of the most recently improved construction.

We advise Foreign Correspondents to utilise vacant space in the Packing Cases by having them filled with *Corks*, thereby saving Freight.

An Illustrated Pamphlet sent with each Machine, containing full instructions for working them, and Recipes for making Soda Water and all Aërated Beverages.

IMPROVED DIVING APPARATUS.

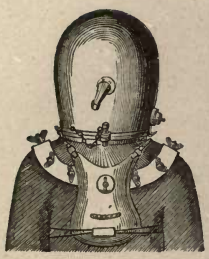


FIG. 3125*.

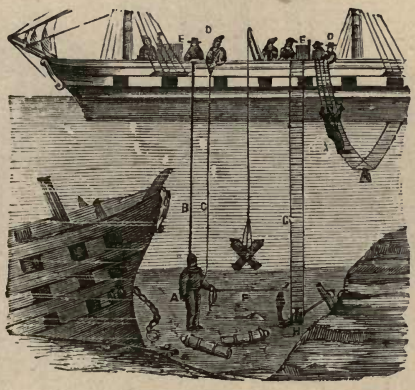


FIG. 3125.

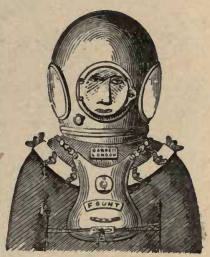


FIG. 3125†.

3125 **Improved Diving Apparatus**, for the recovery of Sunken Ships, &c., Building or Repairing Bridges, Pearl fishery, Sponge Diving, or any other Submarine operations. The engraving (fig. 3125) shows the general arrangement of the Diving Apparatus when in use :—

A Diver equipped in Water-tight dress, Copper Helmet with Glass Eyes, Boots with leaden soles, &c., figs.
B Tube for supplying Air to the Diver.
C Signal or Life-line.
D Attendants at Signal-line.
E Three-Barrel Atmospheric Air Engine (see also fig. 3127 next page.)
F Ladder-line, for use in Thick Water.
G Rope Ladder for Descending and Ascending to and from the vessel.
H Weight to steady the Ladder.
I Diver stopping a Leak under the Water-line.

Anchor, Guns, and Chain Cable to be slung and hoisted up to surface.

By the improvements now introduced, a Diver may remain hours under water without inconvenience.

With each Apparatus there is sent a Book containing a separate illustration and description of every part of the Air-Pump, Tubes, Helmet, Dress, &c.; so that when taken entirely apart, any person can put it together in thorough working order; also full and detailed directions for its use, and how to keep it always in good working order, it being in every respect effective and complete.

Price for Improved Diving Apparatus £140 to £230.

3126 **Sub-marine Lamp** (Denayrowze) large size . . . price £22 0 0
Ditto ditto, small size . . . . . „ 13 0 0

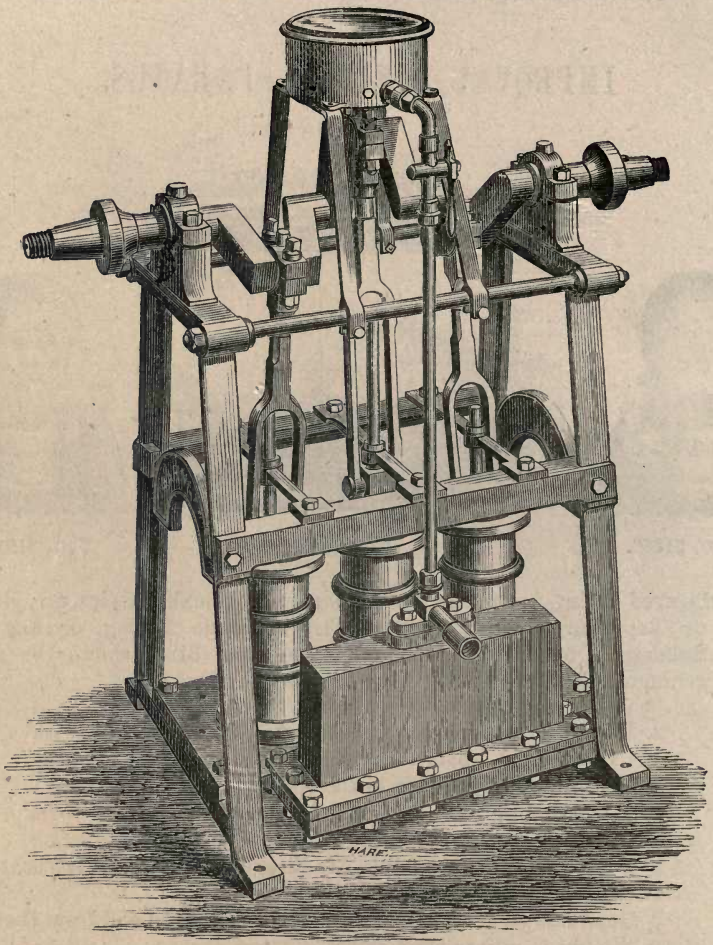


FIG. 3127.

3127 **Treble Barrel Air Pump** (fig. 3127) for the Diving Apparatus, of sufficient power to send down a plentiful and continuous supply of air to the Diver.

A Condensing Chamber.

B Dial Indicator, denoting depth of water and pressure.

The Diving Apparatus consists of a powerful treble-barrel air-engine (fig 3127), gun-metal cylinders, wrought-iron crank, fly-wheel and handles, spanners, tinned Copper Helmet with segment-screw joint, lead weights, vulcanised tube, metal unions, two diving dresses, suitable warm clothing, boots, signal line, ladder-line, &c., &c., complete, in strong and secure packages.

This Apparatus possesses the following advantages :—1. Should the Diver wish to raise himself without signalling the attendant, he can do so by simply placing his finger on the valve, which afterwards *rights itself*. 2. Without assistance he can open his own Helmet, which is so constructed that the front eye can *never be lost*, or become tight. 2. The Indicator always denotes the depth the Diver is at. 4. The condensing box secures a more continuous stream of air. 5. It also has a copper cooling cistern, for great depths.

Directions for use, and keeping in repair, sent with each Apparatus.

IMPROVED ICE MAKING MACHINE,

(Continuous Direct Acting.)

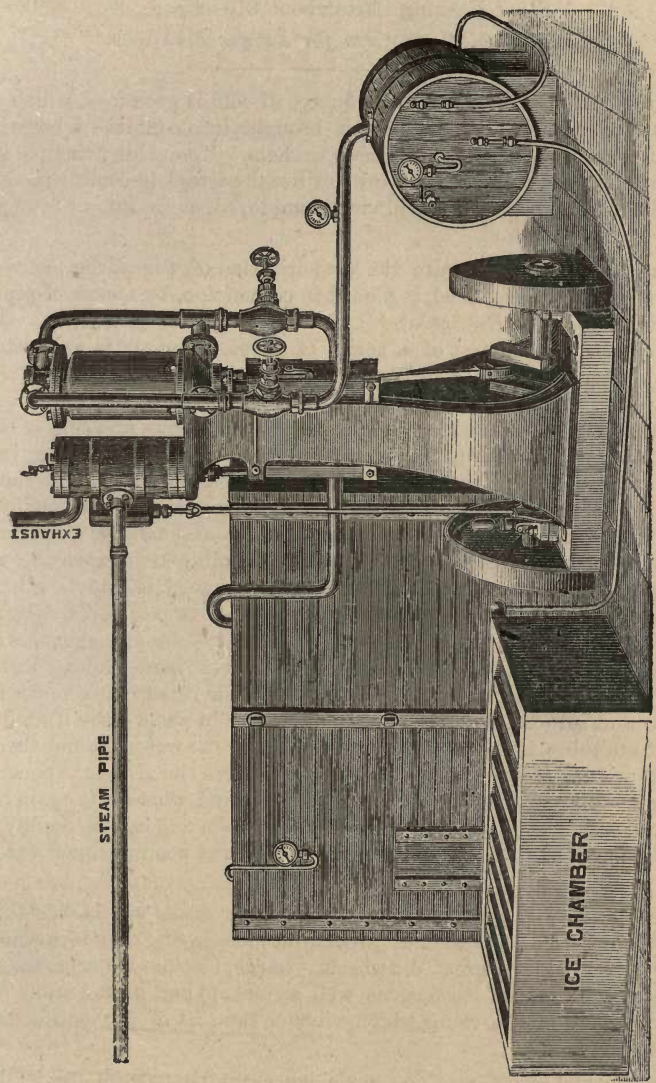


FIG. 3128.

3128 For producing Ice of the Clearest and Purest Description, in quantities of from 2 cwt. to 20 tons per day, at the most economical rate.

For description see next page.

3128 **The Continuous Direct-Acting Ice Machine,** (fig. 3128), with Vertical Engine and Air Pump, as shown in wood engraving, including Condenser, Refrigerator, Ice Chamber, and all necessary pipes and connections complete, ready for working, price £180, delivered in London.

Boiler and Fittings suited for above apparatus, price £46.

Stout Packing Cases about £10 extra.

Special Quotations given for Larger Machines.

By the evaporation of Æther a great degree of cold is produced, which absorbs from surrounding objects—with which it is brought into contact—a large amount of latent heat, causing a degree of coldness to them. Upon this principle is based the working of the Ice Machine, and to fully utilize the complete cooling power of the evaporated Æther the following machinery is employed, consisting of four primary parts:—

The Æther Pump, to accelerate the evaporisation of the Æther, as well as to remove the vapour when produced, is placed in connection, by means of pipes, with two chambers, named the *Refrigerator* and the *Condenser* (see Fig.), which are made of copper, and consist of a series of tubes. The air is exhausted from these by the Æther pump, and the *Refrigerator* then charged with Æther, which surrounds the outside of the tubes referred to. The Æther pump is then set working, causing the evaporation and removal of the Æther vapour, and cold is instantly produced, during which time a current of incongealable liquid (brine) is passed through the tubes of the refrigerator, and by the absence of heat in the Æther vapour, this liquid is rapidly cooled and becomes an agent for "transmitting the cold." This is then conveyed to and circulates in the ice chamber (containing ice-moulds) filled with fresh water to be made into ice, cooling in its turn the water in these moulds. When the cooling agent has thus traversed, abstracting heat from the water to be frozen, it is returned to the refrigerator to be re-cooled by passing through the tubes, the heat again abstracted from the cooling agent, which as before is circulated round the ice-moulds, and is thus kept moving until ice is produced therein. The Æther vapour drawn from the refrigerator is passed into the condenser and into a tubular chamber immersed in water; the heated vapour then enters these tubes, and—from the temperature of the water around them being much lower than that of the vapour—it quickly reduces the Æther vapour into its liquid nature, as originally put into the refrigerator, and where it is again returned for re-evaporation. The process is exceedingly simple, and can be readily understood, and may be carried on using the same Æther and cooling agent for months without appreciable loss or deterioration.

These machines will produce ice in large slabs from six inches thick and upwards, if required, but the tedious process accompanying the formation of ice beyond six inches thick is a great drawback. Large blocks also necessitate much labour in moving from the ice-box, as well as occupying considerable time in cutting up into small blocks, items which enhance the cost of production, and thus affect the profits.

The great advantage of machine-made ice over the natural ice is that it is purer, harder, and equally transparent, admitting of longer and closer storage, being made in blocks, and can be made for half the value of imported ice, the cost of production varying from 5s. to 10s. per ton, according to the size of the apparatus employed, a large machine producing it at much less cost than the smaller size.

The construction is reduced to the greatest simplicity, and requires only a few minutes to comprehend. The Boiler is made of the best Staffordshire plate-iron, its strength tested to 120 lbs. upon the square inch, and it is complete with all the usual fittings. No foundations are necessary. The space occupied is about 6½ feet long, 4 feet wide, and 5½ feet high. It is sent out ready for working, with a set of stoking-irons and 6 feet of Iron chimney.

The expense of working the Apparatus is the attendance of one person, and about 10 lbs. of coal hourly or its equivalent in wood fuel. Drawings, with book of reference and instructions, are supplied with each Machine.

It is advisable to have a spare set of Valves and Springs, these being the chief parts of the machinery influenced by constant wear and tear; also duplicates of other parts liable to derangement should be separately ordered with the apparatus. when for export, the cost averaging about £12. Price of Æther for use with Ice Machine, per gallon, 12s. 6d., in sealed Metal Cans and cases specially prepared for export. Price of Cans holding 4 gallons of Æther, fitted with Gun Metal Screw Caps, made extra secure against leakage, 12s. each.

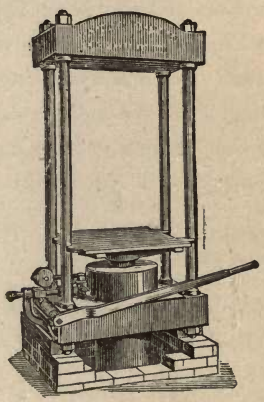


FIG. 3132.

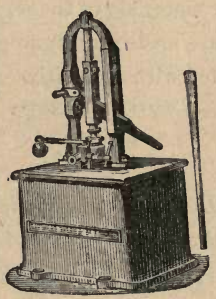


FIG. 3130.

HYDRAULIC MACHINERY.

3129 **Portable Proving Pumps**, for testing Boilers, Tubes, &c., with discharge Tap and Union, mounted on a strong Iron pail, complete, with Gauge to test to 200 lbs. per square inch 7 7 0 8 8 0

3130 **Hydraulic Press Pump**, (Bramah Pattern, fig. 3130). This Pump is fitted with Safety and Relief Valves of the most improved construction, and has been found by experience to be most convenient and durable, and not liable to get out of order under the most severe strains . . . 25 0 0

3131 **Hydraulic Press Pump** of larger and stronger pattern 28 0 0

Extra for knuckle joint, sleeve and pin for working the above Hydraulic Presses by Steam Power, £3 10 0

3132 **Hydraulic Presses**, of various sizes, adapted to different purposes, with Horizontal Pump attached direct to the press. The bed of the press serving for a cistern. These Pumps, as shown in fig. 3132, are provided with relief and safety valves, &c., of the best workmanship.
Price, £36 £50 £80. Power of these Presses 15 to 100 Tons.

GAS MOTORS.

THE NEW PATENT 5-MAN POWER VERTICAL "OTTO" GAS ENGINE.

VERY SUITABLE FOR DRIVING SMALL ELECTRIC INSTALLATIONS, AMATEUR WORKSHOPS, PUMPING WATER, &c., &c.

3133 *Gas Consumption.*—This Engine (fig. 3133), has been designed to meet the demand for a small Gas Engine that will consume Gas only at the same rate as the "Otto;" the smallest "Otto" Engine hitherto supplied being too large for many who want power. *Power.*—The Engine will give off one horse-power on the pulley; but, of course, the consumption of gas is in proportion to the power required; and if, say only one man-power is taken from the Engine, the Governor will cut off the gas to suit. This Engine is really well made. The crank is of steel, and other materials of the very best are used. All working parts are easily replaceable, and are made strictly to gauge. Unlike most small Gas Engines of other makes, it is fitted with a sensitive and patent Governor. It stands in a space of about 3ft. square by 4ft. 8in. high.

Lithographed Foundation Plans, giving Sizes of Pipes, Meter, &c., are supplied, together with a Book of Instructions for Working. Each Engine is sent off erected almost complete, only the Fly-wheel and Pulley being detached.

Price £45, with one set of Valves. (Water Vessel, 20s. extra.)

3134 **The 5-Man Power Vertical "Otto" Gas Engine** is also constructed in combination with a Dynamo Electric Machine, capable of working 6 to 8 Incandescent Lamps. The Dynamo is connected to the Engine by a simple mechanical arrangement, so that when not required for lighting it can be quickly thrown out of gear, and the Engine made available for other purposes. Our engraving (fig. 3134), shows on an enlarged scale the 5-Man "Otto" Engine with the Dynamo Machine attached.

Price, complete with Dynamo Electric Machine, as fig. 3134 . £75 0 0

3134* Ditto ditto, without the Dynamo £45 0 0

Estimates given for larger and more powerful Gas Engines.

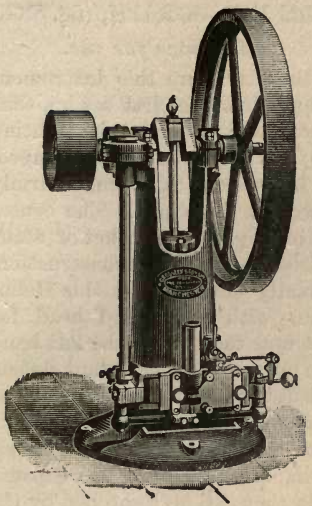


FIG. 3133.

The Patent 5-Man Power Vertical "Otto" Gas Engine (fig. 3133), is admirably adapted for amateur use, takes up but little floor space, Very Silent in action. No extra Insurance charged by leading Insurance Companies. No regular attendance required beyond oiling, cleaning and starting. Great economy as compared with small Steam Engines.

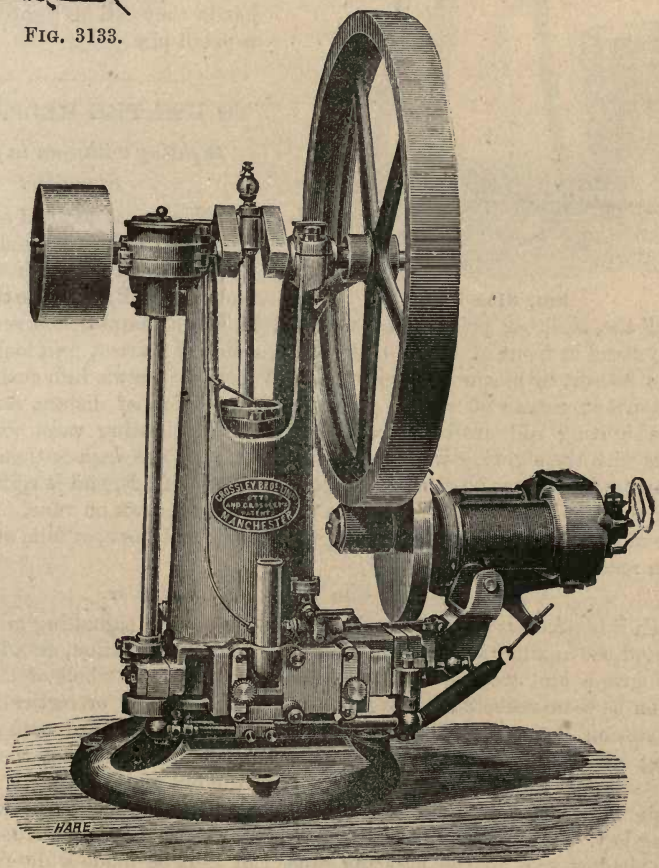


FIG. 3134.

The 5-Man Power "Otto" Gas Engine, with Dynamo Electric Machine (fig. 3134).

NEGRETTI & ZAMBRA'S IMPROVED PORTABLE HELIOGRAPH, (fig. 3135).

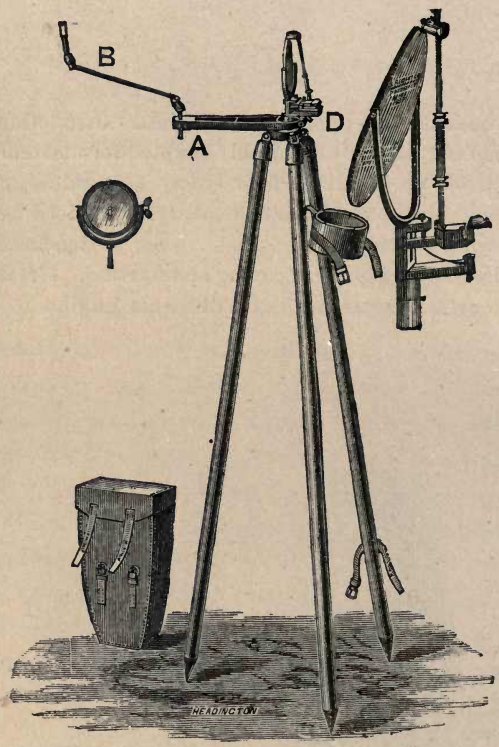


FIG. 3135.

Instructions for use.

In setting up this instrument the legs must be first set up, then the long arm (which carries sighting vane) put on and lightly clamped. The instrument can then be firmly screwed on the tripod. The centre is fitted tightly in socket of staff-head, which is of simple construction, especially designed for this Heliograph, with the milled head for horizontal motion on the left hand when mirror is facing distant station the length of flash can be regulated by means of capstan screw on saddle piece over the lever arm. As all the important screws are capstan heads they can be tightened by the capstan pin.

TO USE THE HELIOGRAPH.

Sighting with Sun in front of Signaller.

The usual method of directing the flash to the required point has been to look through the mirror from the back and move the sighting vane until the sighting point is exactly in line, but a simpler and very accurate way is to stand in front of but a little on one side of mirror, and looking into it bring the mirror, by means of horizontal and vertical screws, into such a position that the spot in centre of mirror cuts off the reflection of distant station; then move the sighting rod until the reflected image of sighting vane come into an exact line with the sighting vane and distant station. The flash is then thrown on to the vane (which must be firmly clamped and not shifted), and is rightly aligned when the dark shadow spot from centre of mirror is thrown on vane. The mirror must be moved up and down to the right or left until the spot falls on the vane; it is then ready for use.

Sighting with Sun behind the Signaller.

When it is necessary to use both mirrors, place the signalling mirror facing the sun and the auxiliary mirror inclining to the distant station, stand in front of the Heliograph and looking into the mirror, so that the whole of the auxiliary mirror can be seen reflected. Move the latter horizontally or vertically until the distant station, the spot on the auxiliary mirror, and the unsilvered spot on the signalling mirror are in the same line; the auxiliary mirror can then be firmly fixed in its socket, and the mirror clamped with the nut at the side.

In signalling the left hand is kept on the milled head and the right on the signalling key, the necessary adjustments to suit the motion of the earth, and keep the shadow spot on the sighting vane, can thus be made while in the act of signalling without interruption or delay. For prices, see page 348. (No. 1735.)

3135 **Dip Circle, or Inclinometer, Kew Pattern,** recently improved, with Lloyd's total force Apparatus, including verification (fig. 3135)

Price £40 0 0

N.B.—Price quoted for **Dip Circle** *on page* 131 *is an error, should be* **£40**.

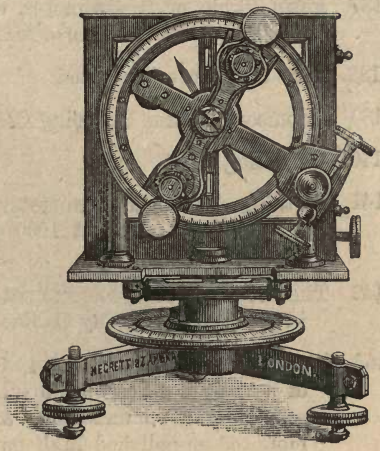


FIG. 3135.

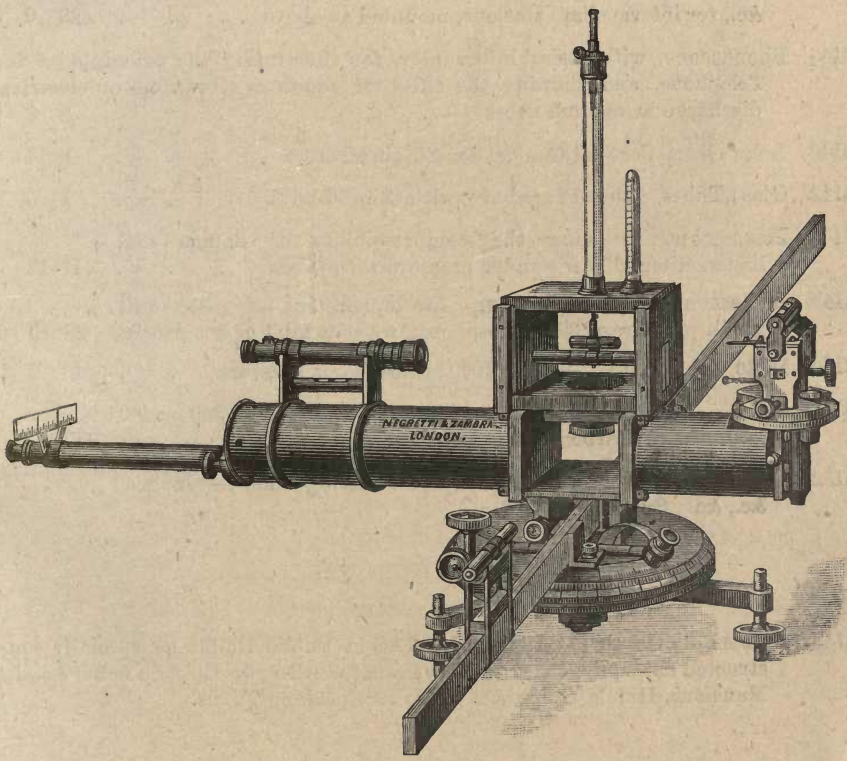


FIG. 3136.

3136 **Unifilar Magnetometer, Improved.** Kew arrangement (fig. 3136), for accurately ascertaining the horizontal component of the earth's magnetic force and also the declination, including verification . . . £70 0 0

3137 **Fox's Circle or Inclinometer,** as used on board of H.M.S. *Challenger,* and most Arctic Expeditions, for testing Terrestrial Magnetic force £38 0 0

3138 Kew Constants Computed 2 2 0

3139 **Thomson's Water Dropping Collector,** supplied to order.

3140 **Collecting Fuse,** do. do.

3141 **Portable Astatic Galvanometer,** in brass case, with jewelled centres, having a resistance of about 1000 ohms, with controlling Magnet. In Sling Leather Case £5 10 0

3142 **Thomson's Portable Electrometer,** (attracted disc) fitted with Electrophorous in polished Mahogany Cabinet £12 12 0

3143 **Morse Ink-recording Telegraph Instrument,** or Direct Ink-writer, consisting of a train of wheelwork driven by a spring. Transmitting key, galvanoscope, and commutator, &c., for terminal station correspondence mounted on polished Mahogany £21 0 0

3144 **Morse Ink-recording Instrument,** with key, two galvanoscopes, commutator, &c., for intermediate stations, mounted as above . . . £23 0 0

3145 **Phonoscope,** with Reiss' interrupter, for illustrating the principle of the Telephone, and showing the effect of sonorous vibrations on electrical discharge in vacuum tubes 8 8 0

3146 Long Glass Vertical Gas Jet for Singing Flame 0 14 0

3147 Glass Tubes, 4 tuned for above, with Clip Stand 1 5 0

3148 **Piezometer,** to show the compressibility of liquids and liquefaction of gases under pressure with tubes . . . 11 11 0

3149 **Cailletet's Compression Pump,** for liquefaction of gases, will give a pressure of 300 atmospheres, without table or accessories 28 10 0

3150 **Ditto ditto,** for 1000 atmospheres pressure . . 48 0 0

3151 **Ditto ditto,** improved, producing liquefaction of 300 or 400 grammes of Carbonic Acid per hour 117 0 0

3152 **Air and Water Compressing Pumps,** for Testing Boilers—Gauges, &c., &c. Supplied to Order.

3153 **APPARATUS FOR LIGHTING GAS** in Public Buildings, specially constructed as required. Estimates given for fitting up Electric Bells, &c., in Mansions, Hotels, Ships, &c. Also for Speaking Tubes.

TELEGRAPHIC TESTING APPARATUS, &c.

3154 Resistance Coils—Wheatstone's Bridge—Relays—Lightning Protectors—Condensors—Switches, &c., &c., to order.

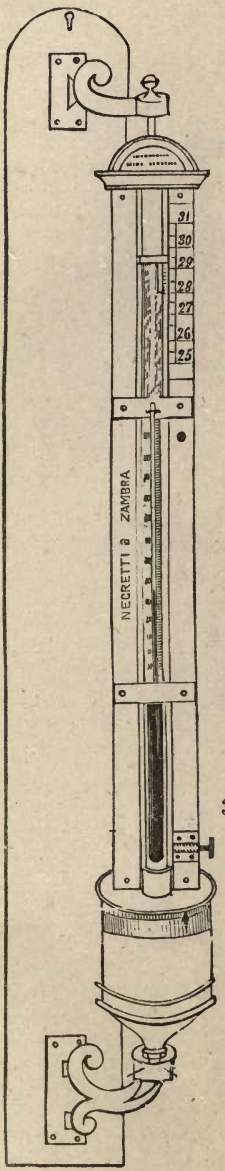


FIG. 3156

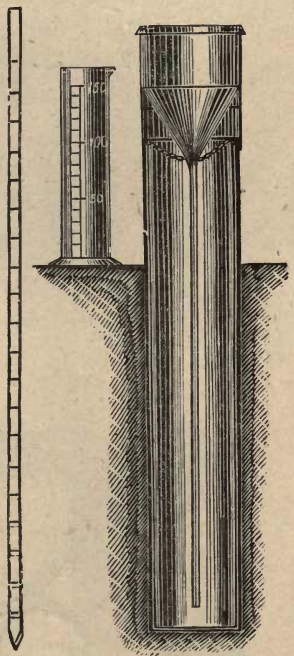


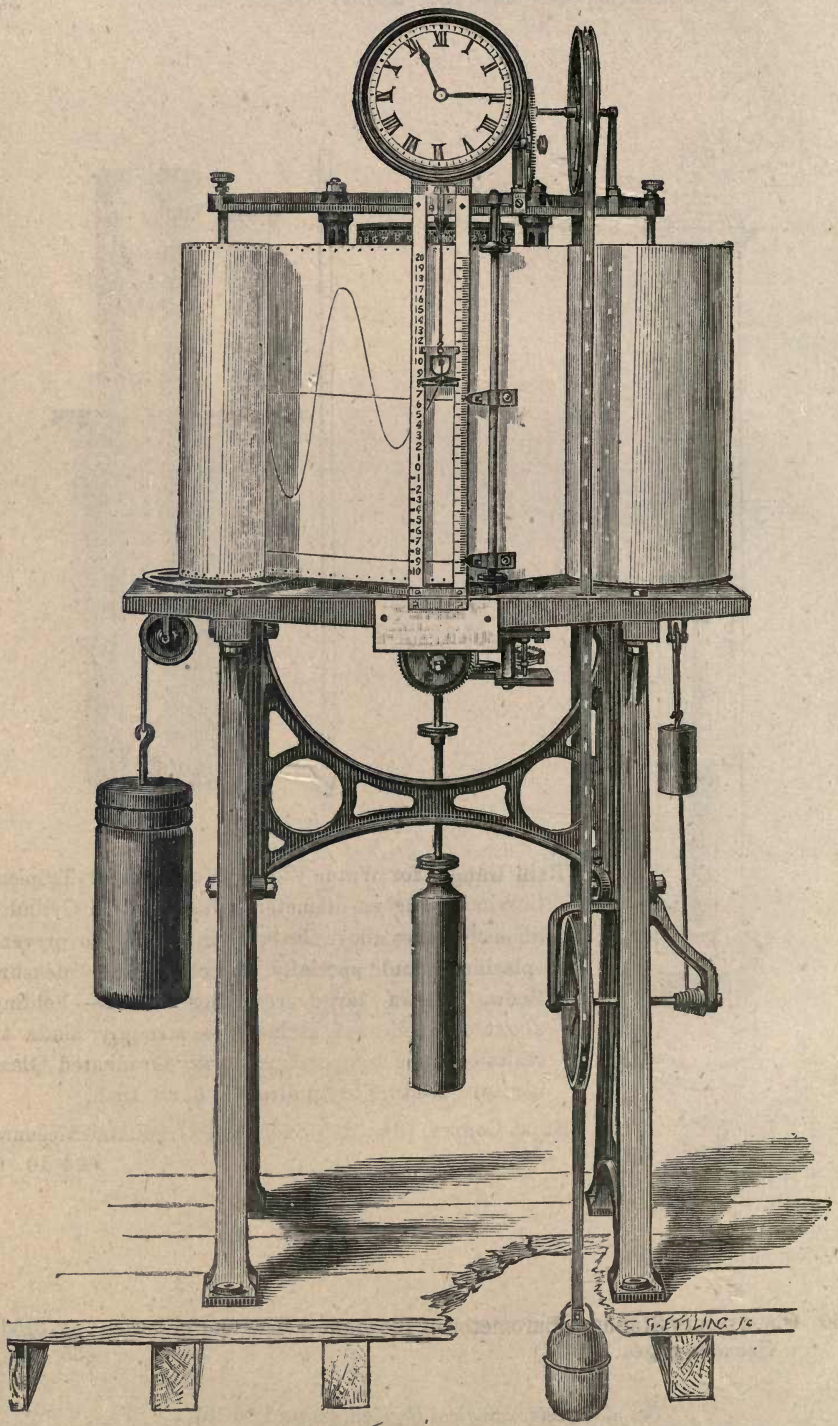
FIG. 3155

3155 **Rain Gauge**, for Water Works, Mountain, or Tropical Service, 8 Inches diameter, with Vertical Cylinder about 6 inches above the receiving funnel to prevent splashing, and specially to collect and Measure Snow. Extra large receiving vessel — holding about 48 inches of Rain-fall — strongly made to resist extreme temperatures, with Graduated Glass measure reading to hundredths of an Inch.

Stout Copper, (fig. 3155) including Graduated Measure £4 10 0

3156 **Observatory Standard Barometer** of the highest class and precision (fig. 3156 See also pages 1 to 11) £35 0

See also Meteorological Section, pages 1 to 131.



3157 **SIR WILLIAM THOMSON'S IMPROVED TIDE GAUGE.** (fig. 3157)
For general description, see pages 121 *and* 122 . . *price* £90 0 0

PHOTOGRAPHIC APPARATUS.

1851. PRIZE MEDAL awarded to NEGRETTI AND ZAMBRA.

1855. Honourable Mention, Paris.———The Austrian Gold Medal. For Stereoscopic Photographic Views upon Glass.

1862.

TWO PRIZE MEDALS,

"For many important Inventions and Improvements. Together with accuracy and excellence in objects exhibited."

FIG. 3159.

FIG. 3160.

FIG. 3158.

NEGRETTI AND ZAMBRA'S IMPROVED SERIES OF PHOTOGRAPHIC LENSES.

		£	s.	d.
3158	View Lenses (Fig. 3158) ¼ plate (4¼ by 3¼)	0	10	6
	" " " ½ " (6½ by 4¾)	1	1	0
	" " " 1 " (8½ by 6½)	2	2	0
	" " " with Rack Adjustment, ¼ plate	1	5	0
	" " " " ½ "	1	15	0
3159	Rapid Rectilinear Lenses, for Views or Portraits (Fig. 3159) ¼ plate	2	2	0
	" " " " " " ¼ "	3	3	0
	" " " " " " 1 "	5	5	0
	" " " " " " 10 by 8 plate	8	8	0
	" " " " " " 12 by 10 "	9	9	0
	" " " " " " 15 by 12 "	11	11	0
	" " " " " " 18 by 14 "	14	14	0
3160	Portrait Lenses (Fig. 3160) Rack-work Adjustment ¼ plate	1	15	0
	" " " " " ½ "	3	15	0
	" " " " " 1 "	8	15	0

Instantaneous Shutters of all kinds supplied to order.

PHOTOGRAPHIC LENSES AND PRISMS,

MADE BY

C. A. STEINHEIL SOEHNE, MUNICH.

Sole Agents—NEGRETTI AND ZAMBRA, LONDON.

NOTICE.—This List is a translation of Messrs. Steinheil's Catalogue. The exact equivalent focus is not guaranteed, as differences in refraction and in the thickness of the lenses have to be corrected.

N. and Z. will supply any instrument of C. A. Steinheil Soehne's make, at their catalogue prices, plus the carriage expenses from factory.

In order to meet the various requirements and to ensure in each special case as perfect work as possible we make lenses of different constructions.

The present catalogue comprises six different classes of photographic lenses, the capabilities and object of which are given in the order of their respective rapidities.

Departing from the order observed in our former catalogue, the lenses are not numbered consecutively in the present one, but are divided into Series. Each series commences with No. 1 and continues upwards. To avoid errors it is necessary in ordering to quote both the No. of the Series and the No. of the lens in the present catalogue.

To facilitate finding the distances of the subject and also of the focussing screen (ground plate) from the lens in *reducing or enlarging*, we have compiled tables which are sent with every lens.

Our different Antiplanets and Aplanats are free from disturbing reflections, and thus enable their employment for all purposes in the open air and for taking strongly illuminated subjects without producing flare or light spots. They are strictly corrected for spherical errors and chemical focus, and they give evenness and correctness of lines (without distortion) combined with equality of definition over the whole of the picture.

In "focussing" with these lenses it is advisable to use the largest stop, *even* when it is intended to work with the smallest.

We make a special point never to supply a lens which is capable of improvement, and for this purpose we test them all before sending them away.

The scientific basis of our establishment and the precise methods employed (the same in the manufacture of astronomical and photographic lenses) enable us to produce lenses of such uniform accuracy that we are unable, even with all the means for rigorous testing at our command, to detect the slightest differences.

Our photographic lenses, of which we give full description in the following pages, consist chiefly of two classes, *viz.*—**Antiplanetic and Aplanatic.**

ANTIPLANETIC LENSES.

Patented in Germany (*No. of Patent* 16354), *England and America.*

By means of these recent combinations, we have succeeded in correcting to a considerable extent—the hitherto greatest defect in Photographic Objectives, *viz.*, —"Astigmatism," and with the consequent rapid decrease of definition from the centre to the margin of the picture.

This advantage we have obtained by designing a special combination, differing widely from the usual forms. It consists of two entirely different halves, each of as great and diametrically opposed errors as possible. The foci are therefore different, and whilst the anterior lens has a shorter focus than the whole objective, that of the posterior lens is negative.

The above arrangement enables us to produce an objective which, whilst retaining the qualities of a good instrument, embodies the additional advantage of having "less astigmatism," by which greater sharpness and depth are produced and distributed thereby more equally over a larger and strictly even picture, before any decrease in definition is perceptible. Illumination, too, is more evenly distributed in consequence of the lenses being proportionately nearer to one another.

The perfectly correct delineation produced by these "Antiplanets," renders them particularly suitable for enlargements.

If small and very sharp originals are taken, and subsequently enlarged, depths are obtained, which, in larger pictures taken *direct*—with the same amount of light—would be unattainable; for this purpose (which probably will play an important part in photography), the Antiplanets are specially suitable. The same objective may be employed for direct work, and for enlargements, but in the latter case, the front lens of the Antiplanet should be turned towards the enlarged picture, and the back lens towards the object to be enlarged.

This construction is designed for strictly even and correctly delineated pictures, and all tilting of the Camera should be decidedly avoided, and a *movable* lens used instead.

Note.—The Lenses of Series I., II., III., IV., and VI., have Waterhouse Diaphragms.
„ „ V., have Rotating Diaphragms.

SERIES No. 1.

3161 ANTIPLANETIC LENSES FOR PORTRAITS.

The rapidity is the same as in the usual Portrait Objective, but there is more equality in the distribution of sharpness and illumination over the picture, and greater depth. These advantages combined render the lenses of this series specially suitable either for *Portraits* or for enlargements. They consist of two pairs, of which the anterior is cemented as positive, and the posterior is separated from the former, and negative.

No.	Diameter of Front Lens.		Focal Length.		Size.	Price.		
	Inches.	Millimet.	Inches.	Cent.		£	s.	d.
1	$\frac{5}{8}$	16	2	5	Busts—Locket Size	2	17	6
2	3	76	$9\frac{1}{2}$	24	C-de-V's	12	15	0
3	$3\frac{5}{8}$	92	$12\frac{5}{8}$	32	Cabinet	23	0	0
4	$5\frac{5}{16}$	1·34	$23\frac{5}{8}$	50	Promenade	46	0	0

Special Quotations for Larger Sizes.

SERIES No. II.

3162 **ANTIPLANETIC LENSES FOR GROUPS.**

(About double the rapidity of the Aplanats in Series III.)

These are for taking *Portraits* in a good light; *also Groups, Architecture, Landscapes, etc., etc.*; they have a greater depth and larger field, with more equal definition and illumination than the lenses of Series I. The *Group-Antiplanets* are an improvement over our *Group-Aplanats*, and possess all the advantages which can be fairly expected in a good objective—*simultaneously*—and therefore render them suitable for the various uses in the open air (*en-route*) and in the studio. They consist of two cemented pairs placed so closely together that there is only just room for the diaphragm.

No.	Diameter of Front Lens.		Focal Length.		Size of Picture according to stop used.	Price.		
	Inch.	Millim.	Inch.	Centim.		£	s.	d.
1	$\frac{11}{16}$	17	$3\frac{3}{8}$	9·5	$4\frac{1}{4} \times 3\frac{1}{4}$	2	15	0
2	1	25	$5\frac{1}{16}$	14·4	From $4\frac{1}{4} \times 3\frac{1}{4}$ to 5×4	3	10	0
3	$1\frac{5}{16}$	33	$7\frac{1}{4}$	18.4	„ 5×4 to $6\frac{1}{2} \times 4\frac{3}{4}$	4	15	0
4	$1\frac{11}{16}$	43	$9\frac{7}{16}$	24·0	„ $6\frac{1}{2} \times 4\frac{3}{4}$ to $8\frac{1}{2} \times 6\frac{1}{2}$	6	0	0
5	$1\frac{7}{8}$	48	$10\frac{7}{8}$	27·5	„ $8\frac{1}{2} \times 6\frac{1}{2}$ to 10×8	7	10	0
6	$2\frac{1}{2}$	64	$14\frac{1}{2}$	36·0	„ 10×8 to 12×10	12	0	0
7	$3\frac{1}{16}$	78	$17\frac{3}{4}$	44·0	„ 12×10 to 15×12	18	5	0

SERIES No. III.

3163 **APLANATS.**

These lenses are already well and favourably known for the good pictures they give and their adaptability for either **Architecture, Landscape,** or even for **Group Work** in the open air.

The aperture to focus is as 1·7, angle about 60°.

No.	Diameter of Front Lens.		Focal Length.		Size of Picture according to stop used.	Price.		
	Inch.	Millim.	Inch.	Centim.		£	s.	d.
1	$\frac{1}{4}$	7·0	$1\frac{5}{8}$	4·1	For enlarging . . .	2	2	0
2	$\frac{5}{8}$	15 8	$3\frac{3}{4}$	9·5	$4\frac{1}{4} \times 3\frac{1}{4}$	2	2	0
3	1	24·8	$5\frac{5}{8}$	14·2	From $4\frac{1}{4} \times 3\frac{1}{4}$ to 5×4	3	0	0
4	$1\frac{1}{4}$	31·6	$7\frac{1}{2}$	18 9	„ 5×4 to $6\frac{1}{2} \times 4\frac{3}{4}$	3	15	0
5	$1\frac{11}{16}$	42·9	11	27·7	„ $6\frac{1}{2} \times 4\frac{3}{4}$ to $8\frac{1}{2} \times 6\frac{1}{2}$	5	5	0
6	$2\frac{1}{16}$	51 9	$14\frac{1}{8}$	35·9	„ $8\frac{1}{2} \times 6\frac{1}{2}$ to 10×8	6	15	0
7	$2\frac{3}{8}$	60·9	$17\frac{3}{8}$	44·0	„ 10×8 to 12×10	10	5	0
8	$2\frac{15}{16}$	74·5	$21\frac{3}{16}$	53·8	„ 12×10 to 15×12	15	0	0
9	$3\frac{7}{16}$	88·0	25	63·6	„ 15×12 to 18×16	20	0	0
10	$4\frac{9}{16}$	115·0	33	83·9	„ 18×16 to 22×20	29	5	0

SERIES No. IV.

3164 **LANDSCAPE APLANATS.**

(Angle about 75°).

This class of Aplanatic Lens is specially constructed for Landscape work, but can also be advantageously used for copying; effective aperture $\frac{1}{12}$ — $\frac{1}{15}$; the field is even greater than in the Aplanats of Series III., so that with equal size of plate and corresponding number of Aplanat, subjects are obtained of sharp definition in the margin, which are not perceptible with lenses of Series III.

No.	Diameter of Front Lens.		Focal Length.		Size of Picture according to stop used.	Price.		
	Inch.	Millim.	Inch.	Centim.		£	s.	d.
1	$\frac{3}{16}$	5·5	$2\frac{3}{8}$	5·8	From 2 × $1\frac{1}{2}$ to 3 × $2\frac{3}{8}$	2	0	0
2	$\frac{3}{8}$	9	3	7·7	„ $2\frac{1}{2}$ × 2 to 4 × 3	2	10	0
3	$\frac{1}{2}$	12	$4\frac{3}{4}$	12·2	„ $3\frac{3}{4}$ × 3 to 6 × $4\frac{3}{4}$	3	0	0
4	$\frac{11}{16}$	17	$6\frac{3}{8}$	16·2	„ 5 × 4 to 8 × 6	3	15	0
5	$\frac{15}{16}$	23	$9\frac{1}{2}$	24	„ 7 × $5\frac{1}{2}$ to 11 × 8	5	5	0
6	$1\frac{7}{16}$	36	$15\frac{3}{8}$	39	„ 10 × 8 to $13\frac{3}{4}$ × 11	10	5	0
7	$2\frac{1}{8}$	54	$23\frac{5}{8}$	60	„ 14 × 11 to 20 × 16	20	0	0

In Landscape work it is frequently desirable to take the same subject in various size pictures from the same spot, and this is only attainable by the employment of objectives of different foci. For this work we have arranged a number of objectives in "sets," for which purpose the lenses of Series IV., owing to their closeness to one another, are most suitable. All the lenses of these sets fit into the same flange by means of a bayonet hinge, and each set is provided with a combination of five diaphragms or stops.

Set of four Landscape Aplanats, each of the same aperture of lens, 15-16in. (23 millimetres), but varying foci, say $9\frac{1}{2}$, $12\frac{5}{8}$, $15\frac{3}{4}$, 19 inches (24, 30, 40, and 48 centimetres) in lock-up case; size of picture with full aperture, $6\frac{15}{16}$ by $5\frac{1}{2}$ inches (17·5 × 13·8 centimetres), with smallest diaphragm, 11 × $7\frac{7}{8}$ inches (28 × 20 centimetres.) Price £20.

Note.—Sets of any number and class of Aplanats made to order at proportionate pric es.

SERIES No. V.

3165 **WIDE-ANGLE APLANATS FOR INTERIORS, ARCHITECTURE AND LANDSCAPES.**

Effective Aperture $\frac{1}{20}$ — $\frac{1}{25}$ *of their foci.*

The proportionately short focus and the large angle (about 100°) of these lenses make them particularly adapted for interior work and for very high broad objects taken from short distances.

By reducing the amount of light, an increase of "Sharpness," depth and angle of field is obtained.

No.	Diameter of Front Lens.		Focal Length.		Size of Picture.	Price.
	Inches.	Millim.	Inches.	Centim.	Inches.	
1	$\frac{3}{16}$	5·5	$3\frac{3}{4}$	9·6	5 × 5	3 0 0
2	$\frac{5}{16}$	7	$4\frac{3}{4}$	12·1	7 × 7	3 0 0
3	$\frac{7}{16}$	10·5	$7\frac{1}{4}$	18·2	$10\frac{1}{2} \times 10\frac{1}{4}$	5 0 0
4	$\frac{9}{16}$	14·5	$10\frac{3}{8}$	26 2	$12\frac{1}{4} \times 12\frac{1}{4}$	7 10 0

Special quotations for larger sizes.

SERIES No. VI.

166 **WIDE ANGLE APLANATS FOR COPYING.**

With a rapidity which is equal to Series V., these lenses give perfect flatness of picture and sharpness of definition, and have, at the same time, a considerable field. These qualities render them suitable for copying Maps, Charts, Pictures, Engravings, &c., &c., &c. For inverting work for the printing process, we have designed the prisms contained in Series VII.

No.	Diam. of Front Lens.		Focal Length.		Size of Picture.	Price.
	Inches.	Millim.	Inches.	Centim.	Inches.	
						£ s. d.
1	1	25	$14\frac{3}{8}$	36·5	10 × 10	9 0 0
2	$1\frac{3}{16}$	30	18	45·7	$13\frac{1}{4} \times 13\frac{1}{4}$	12 10 0
3	$1\frac{11}{16}$	43	$23\frac{5}{8}$	60·1	17 × 17	17 5 0
4	$2\frac{1}{2}$	63	$38\frac{3}{8}$	97·5	$23\frac{3}{8} \times 23\frac{3}{8}$	40 0 0
5	$2\frac{15}{16}$	75	$48\frac{1}{4}$	122·4	$27\frac{7}{8} \times 27\frac{7}{8}$	70 0 0
6	$3\frac{9}{16}$	90	56	142·3	$33\frac{3}{8} \times 33\frac{3}{8}$	100 0 0

Special quotations for larger sizes.

As a result of our experience, we beg to point out particularly the necessity of avoiding the slightest vibration during exposure with these wide angle Aplanats.

The passing of a cart, the working of a press on a contiguous floor, the marching of soldiers in step, have been quite sufficient to affect that sharpness of picture which is otherwise attainable with these objectives.

In taking fine even objects, it is advisable not to use too small a diaphragm, as the diffraction caused thereby veils the picture.

SERIES No. VII.

3167 **PRISMS.**

These prisms are all right angle, with silvered hypothenuse; they are centred in their mountings, and adjustable to the lens by means of a screw in place of the front ring of latter.

To obtain parellelism between the anterior side of the prism and the object, they are provided with an arrangement to turn the prism round its axis and to clamp it in any position.

No.	To work with Lenses, as follows :—	Price.
		£ s. d.
1	Ser. III., No. 2, Ser. IV., No. 3, Ser. IV., No. 4, Ser. V., No. 1. Ser. V., No. 2, Ser. V. No. 3, and Ser. V., No. 4	4 15 0
2	Ser. IV., No. 5, and Ser. VI., No. 1	5 5 0
3	Ser. III., No. 3, and Ser. VI., No. 2	5 15 0
4	Ser. II., No. 2, and Ser. III., No. 4	7 5 0
5	Ser. IV., No. 6	8 15 0
6	Ser. II., No. 3, and Ser. VI., No. 3	10 10 0
7	Ser. III., No., 5, and Ser. VI., No. 4	13 15 0
8	Ser. IV., No. 7	17 5 0
9	Ser. II., No. 4, Ser. III., No. 6, and Ser. VI., No. 5	21 5 0
10	Ser. VI., No. 6	25 15 0
11	Ser. III., No. 7	40 5 0
12	Ser. III., No. 8	69 0 0

Each Prism is accompanied by a short description of its use, with wide angle Aplanats.

SERIES No. VIII.

3168 **APLANATIC FOCUSSING LENSES.**

These are a combination of three Lenses, so constructed that, at a considerable focal distance and large field, they produce an even, undistorted picture, achromatic, both in and outside of the axis.

No.	Equivalent Focus. Inches.	Equivalent Focus. Millim.	Magnifying Power—Lineal.	Price.
				£ s. d.
1	$2\frac{3}{8}$	60·9	About $3\frac{1}{2}$ times.	1 10 0
2	$1\frac{5}{8}$	40·6	About 5 times.	1 5 0

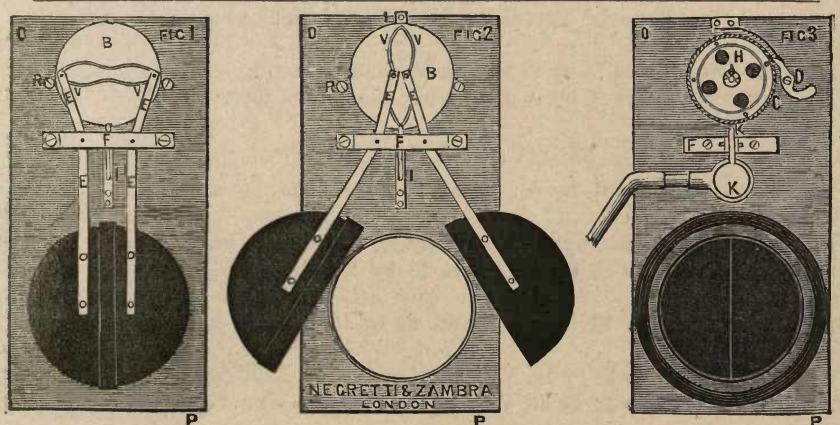


FIG. 3169.

P. ZSCHOKK'S PATENT PNEUMATIC SHUTTER.

FOR INSTANTANEOUS PHOTOGRAPHS.

3169 Messrs. Steinheil make these Shutters for all sizes of Lenses. Price including tube for Lenses up to 4 Inches (108 Millimetres) diameter of Lens, measured at the part on which the wooden flange M N is adjusted (see fig. 3) . . £3 12 0

Larger sizes supplied to order.

DALLMEYER'S PHOTOGRAPHIC LENSES.

Cash Prices of the principal Lenses, including Diaphragms.

PORTRAIT LENSES.

3170 EXTRA RAPID (C)—FOR CHILDREN.

2 C—2¾ inches diameter	4½ inch focus	£15	15 0
3 C—3½ „	6 inch „	26	5 0

3171 QUICK ACTING (B).

		distance.		
1 B—For Cards . .	2 inches diameter	12 feet . . .	£6	5 0
1 B—(Long) „ . .	2⅕ „	14 feet . . .	6	15 0
2 B—Ordinary Cards .	2¾ „	18 feet . . .	12	16 0
2 B—Patent „ .	2¾ „	18 feet . . .	13	5 0
3 B— „ for Cabinets	3⅓ „	18 feet . . .	20	0 0
4 B— „ „	4½ „	25 feet . . .	40	0 0

3172 ORDINARY INTENSITY (A).

1 A Patent—For Cabinets, in short rooms, diam. 2¾ in., distance 14 ft. .	£13	0	0
2 A Patent—For Cabinets up to 8½ by 6½, diam. 3½ in., distance 20 ft. .	18	0	0
3 A Patent—For Cabinets up to 9 by 7, diam. 4 in., distance 24 ft. .	27	5	0
4 A Patent—For Imperial Portraits and 10 by 8. diam. 4½ in., focus 14 in.	38	10	0
5 A Patent—For Plates 15 by 12 and under, diam. 5 in., focus 18 in. .	50	0	0
6 A Patent—For plates 20 by 16 and under, diam, 6 in., focus 22 in. .	60	0	0

3173 PORTRAIT AND GROUP (D).

3 D Patent—Portraits 8½ by 6½, Views 10 by 8, diam. 2⅛ in., focus 10½ in.	£9	10	0
4 D Patent—Portraits 10 by 8, Views 12 by 10, diam. 2⅞ in., focus 13 in.	13	10	0
5 D Patent—Portraits 12 by 10, Views 15 by 12, diam. 3¼ in., focus 16 in.	17	10	0
6 D Patent—Portraits 15 by 12, Views 18 by 16, diam. 4 in., focus 19½ in.	26	10	0
7 D Patent—Portraits 18 by 16, Views 22 by 20, diam 5 in., focus 24 in.	48	0	0
8 D Patent—Portraits 22 by 20, Views 25 by 21, diam. 6 in., focus 30 in.	58	0	0

3174 STEREOSCOPIC LENSES.

Patent Stereographic Lens, 4 in. focus	£4	5	0
Ditto with rack and pinion , ...	4	15	0
No. 1, Quick acting Single Combination Landscape Lens, 4½ in. focus	2	0	0
No. 2, Ditto ditto ditto, 6 in focus . . .	2	5	0
Rectilinear Stereo. Lens, 2½ in. focus	4	0	0

VIEW LENSES.

3175 **RAPID RECTILINEAR (PATENT).**

The best Lens for general use out of doors, and for Copying.

Size of View or Landscape.	Size of Group or Portrait.	Equivalent Focus.	Price, Rigid Setting.
*5 by 4 in.	4¼ by 3¼ in.	6 in.	£4 10 0
8 „ 5 „	5 „ 4 „	8¼ „	5 10 0
8½ „ 6½ „	6 „ 5 „	11 „	7 0 0
10 „ 8 „	8½ „ 6½ „	13 „	9 0 0
12 „ 10 „	10 „ 8 „	16 „	11 0 0
13 „ 11 „	French size.	17½ „	12 0 0
15 „ 12 „	12 by 10 in.	19½ „	15 0 0
18 „ 16 „	15 „ 12 „	24 „	20 0 0
22 „ 20 „	18 „ 16 „	30 „	27 0 0
25 „ 21 „	22 „ 20 „	33 „	32 0 0

* To be had in pairs for Stereoscopic Views.

3176 **WIDE-ANGLE RECTILINEAR (PATENT).**

For Architectural Views in Confined Situations.

No.	Largest Dimensions of Plate.	Back Focus.	Equivalent Focus.	Price.
*1AA	7¼ by 4½	3½ in.	4 in.	£4 10 0
1A	8½ „ 6½	4⅝ „	5¼ „	5 10 0
1	12 „ 10	6¼ „	7 „	7 10 0
2	15 „ 12	7½ „	8½ „	10 10 0
3	18 „ 16	11 „	13 „	14 0 0
4	22 „ 20	14 „	15½ „	20 0 0
5	25 „ 21	17 „	9 „	30 0 0

* To be had in pairs for Stereoscopic Views.

3177 **WIDE-ANGLE LANDSCAPE LENSES (PATENT).**

For Landscapes pure and simple.

No.	Size of Plate.	Equivalent Focus.	Price.
1A	5 by 4	5¼ in.	£3 5 0
1	7¼ „ 4½	7 „	3 15 0
2	8½ „ 6½	8½ „	4 10 0
3	10 „ 8	10 „	5 10 0
4	12 „ 10	12 „	7 0 0
5	15 „ 12	15 „	8 10 0
5A	15 „ 12	18 „	9 10 0
6	18 „ 16	18 „	10 10 0
7	22 „ 20	22 „	14 0 0
8	25 „ 21	25 „	19 0 0

ROSS' PORTRAIT AND VIEW LENSES.

3178 QUICK-ACTING C.D.V. LENSES.

These Lenses give very rapid results with brilliancy and exquisite definition. To obtain the best results it is desirable to use the No. 3 when the Studio exceeds 20 feet in length.

BRILLIANT DEFINITION AND GREAT RAPIDITY.

Nos.	1	2	3
Focus	4½-in.	4¾-in.	6-in.
Price	£5 15 0	£6 10 0	£11 10 0

3179 RAPID CABINET LENSES.

These Lenses have all the sharpness and good qualities of the Portrait Lenses, but, having a flatter field, give better marginal definition. To obtain the best results it is desirable to use No. 3 when the Studio exceeds 20 feet in length.

BRILLIANT DEFINITION AND GREAT RAPIDITY.

Nos.	1	2	3
Focus	6-in.	8-in.	10-in.
Price	£13 0 0	£17 10 0	£19 10 0

3180 IMPROVED PORTRAIT LENSES.

These Lenses give all the sharpness that can be optically obtained. They are admirably adapted for Half-lengths and Sitting Figures; but for Full-lengths the 'Cabinet" and "*Carte*" series give a flatter field.

Nos	3	3A	4	5	6
Focus	10-in.	12-in.	15-in.	20-in.	24-in.
Plate	6½ × 4¾	8½ × 6½	10 × 8	15 × 12	18 × 16
Price	£17 10 0	£26 15 0	£38 0 0	£42 10 0	£54 0 0

3181 UNIVERSAL LENSES.

For Groups, Portraits, or Studies in the Studio, Interiors, Copying, &c,

The "Universals" possess optical properties between ordinary Portrait Lenses and the Rapid Symmetricals; but are not equal to either of these Lenses for their special work. They are, however, fair substitutes for both in cases where one Lens only is desired.

Nos.	1	2	3	4	5
Focus	8½-in.	10¾-in.	13½-in.	16½-in.	20-in.
Views	8½ × 6½	10 × 8	12 × 10	15 × 12	18 × 16
Groups	7¼ × 4½	8½ × 6½	10 × 8	12 × 10	15 × 12
Price	£7 10 0	£9 0 0	£12 10 0	£16 10 0	£25 0 0

Larger sizes to order.

182 PORTABLE SYMMETRICAL LENSES.

For Landscapes and Architecture.

Since the introduction of Photography perhaps no lens for Landscapes and Architectural purposes has had so great a share of popularity as the Symmetricals. They are universally used by many of our most eminent photographers. This is, doubtless, attributable to their extraordinary definition and flatness of field, as well as to the exceedingly portable form in which they are constructed, the series fitting the same flange.

Nos.	1	2	3	4	5	6	7	8	9	10
Focus	3-in.	4-in.	5-in.	6-in.	7-in.	8-in.	9-in.	10 in.	12-in.	15-in.
Plate	3 × 3	4 × 3	5 × 4	7¼ × 4½	8 × 5	8½ × 6½	9 × 7	10 × 8	12 × 10	13 × 11
Price	£3	£3 5s.	£3 10s.	£4	£5	£6	£8	£9	£9	£10

3183 UNIFORM RATIO OF STOPS.

INTERMEDIATE STOPS SUPPLIED IF REQUIRED.

Nos.	1	2	3	4	5
Ratios	*f* 16	*f* 22·6	*f* 32	*f* 45·2	*f* 64

These Lenses are supplied accurately paired for Stereo. purposes.

3184 RAPID SYMMETRICAL LENSES.

For Groups, Views, Interiors, and every kind of Outdoor Photography.

The Rapid Symmetricals, being aplanatic, work with full aperture, and are, perhaps, the best and most useful Lenses an Amateur or Professional Photographer can possess for general outdoor purposes.

Views	3×3	4¼×3¼	5×4	6×5	8×5	8½×6½	9×7	10×8	12×10	13×11	15×12
Groups	—	Stero.	4¼×3¼	5×4	7½×4½	8×5	8½×6½	9×7	10×8	12×10	13×11
Focus	3 in.	4½ in.	6 in.	7½ in.	9 in.	10½ in.	12 in.	14 in.	16in.	18 in.	20 in.
Prices	£3 10s.	£4	£4 5s.	£5 5s.	£5 15s.	£6 10s.	£7 10s.	£8 10s.	£10 10s.	£11 10s.	£14 10s.

3185 UNIFORM RATIO OF STOPS.

INTERMEDIATE STOPS SUPPLIED IF REQUIRED.

Nos.	*0	1	2	3	4	5	6
Ratios	*f* 8	*f* 11·3	*f* 16	*f* 22·6	*f* 32	*f* 45·2	*f* 64

*0 *signifies the ratio of the Lenses to their foci.*

Ten per Cent Discount on Ross' Lenses when Remittance accompanies Order.

Lenses by any other Makers supplied at their List Prices.

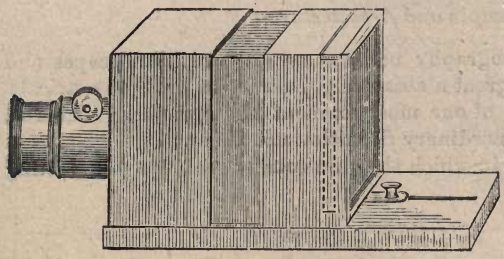


FIG. 3186.

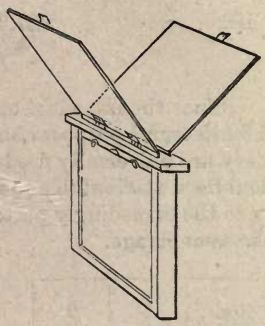


FIG. 3186.*

SLIDING BODY CAMERAS.

OF ORDINARY CONSTRUCTION, FOR TAKING PORTRAITS AND VIEWS EITHER ON GLASS OR PAPER, &c.

The following Prices are for Cameras only. The price and description of Lenses will be found on pages 517 *to* 523.

		£	s.	d.
3186	**Square Sliding Body Camera** (fig. 3186), of Polished Mahogany, with one single back (fig. 3186*), 5 inches Square, with two loose frames, for pictures $4\frac{1}{4}$ by $3\frac{1}{4}$ inches, and $3\frac{1}{4}$ by $2\frac{3}{4}$ inches, and focusing Screen .	1	10	0
3187	**Square Sliding Body Camera,** for plates 5 by 4 inches and $4\frac{1}{4}$ by $3\frac{1}{4}$ inches	1	16	0
3188	**Square Sliding Body Camera,** for plates 6 by 5 inches, and 5 by 4 inches; this size is suited to a single Carte de Visite or Cabinet size Picture . . .	2	10	6
3189	**Square Sliding Body Camera,** for plates $8\frac{1}{2}$ by $6\frac{1}{2}$ inches, 6 by 5 inches, and 5 by 4 inches	4	4	0
3190	**Square Sliding Body Camera,** for plates 12 by 10 inches, 10 by 8 inches, and $8\frac{1}{2}$ by $6\frac{1}{2}$ inches	7	7	0

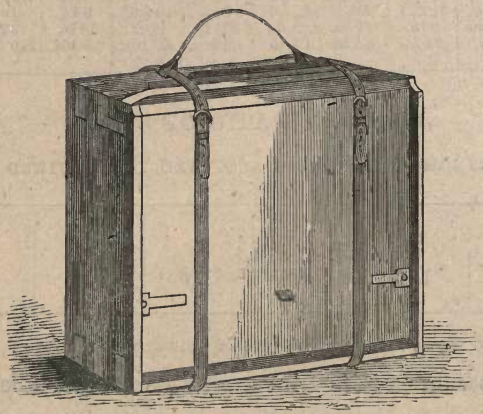


FIG. 3191*

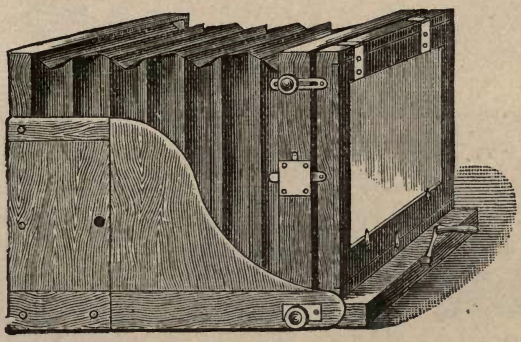


FIG. 3191.

IMPROVED MAHOGANY CAMERAS.

WITH PORTABLE BELLOWS BODIES.

3191 These Cameras are made of the very best seasoned Spanish mahogany, finished in the most careful manner, and are capable of adjustment for both Portrait and Landscape Lenses. They are made with parallel bellows, folding base, swing back and double fronts, as shown in fig. 3191. The focus is obtained by means of an endless screw, or rack and pinion movement, according to size.

The Price includes a focussing screen, but dark slides are *extra*, as given in the adjoining columns.

Fig. 3191 shews the Camera. Fig. 3191* packed up for travelling.

Cameras.									Dark Slides.								
For Plates.		Price.			Brass Binding extra.			Extension Bellows extra.			Double.			Single.			Brass Binding extra.		
		£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
4¼	by 3¼	3	15	0	0	18	0	1	0	0	0	17	6	0	15	6	0	4	0
5	„ 4	4	5	0	0	18	0	1	2	6	1	0	0	0	17	6	0	4	0
6½	„ 4¾	4	15	0	1	1	0	1	10	0	1	4	0	1	2	0	0	4	6
8½	„ 6½	6	0	0	1	2	6	1	13	0	1	7	6	1	4	6	0	5	0
8½	„ 8½	6	15	0	1	2	6	1	13	0	1	10	0	1	6	6	0	5	0
10	„ 8	7	5	0	1	7	6	1	17	6	1	15	0	1	10	0	0	5	6
10	„ 10	7	15	0	1	7	6	1	17	6	1	18	6	1	13	6	0	5	6
12	„ 10	8	8	0	1	12	6	2	2	0	2	5	0	1	15	6	0	6	6
12	„ 12	9	9	0	1	12	6	2	2	0	2	7	6	1	18	6	0	6	6
15	„ 12	10	10	0	2	2	0	2	10	0	3	0	0	2	10	0		7	0
15	„ 15	12	0	0	2	2	0	2	10	0	3	10	0	2	17	6	0	7	0
18	„ 16	17	10	0	2	12	6	3	0	0	4	10	0	3	12	0	0	8	0
18	„ 18	20	10	0	2	12	6	3	0	0	5	0	0	4	0	0	0	8	0
24	„ 20	28	0	0	3	10	0	4	10	0	6	10	0	5	10	0	0	9	0
24	„ 24	31	0	0	3	10	0	4	10	0	7	0	0	6	0	0	0	9	0

These can be had with Russia leather bellows at an extra cost of from £1 to £4 according to size.

Negretti and Zambra recommend the above Cameras as the best for all general purposes, but any other form can be supplied to order.

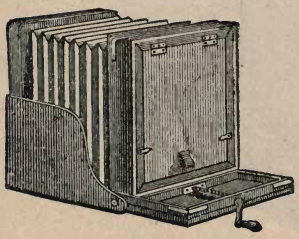


FIG. 3192.

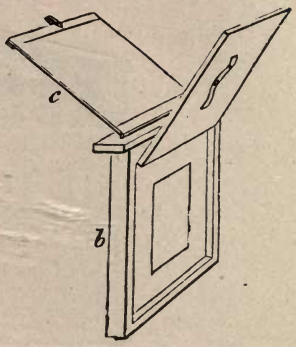


FIG. 3192*.

MAHOGANY CAMERAS.

SECOND QUALITY.

3192 These Cameras are made with portable bellows bodies and rack adjustments, similar to the preceding, but selected Honduras instead of Spanish mahogany is used, and the Swing Back Arrangement is charged extra, as shown below.

Cameras (fig. 3912.)			Dark Slides (fig. 3192*.)	
For Plates.	Price.	Swing Back extra.	Double.	Single.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
4¼ by 3¼	2 16 0	0 12 0	0 15 0	0 12 0
5 „ 4	3 0 0	0 12 0	0 16 0	0 13 6
6½ „ 4¾	3 12 6	0 15 0	0 17 6	0 15 0
8½ „ 6½	4 0 0	0 18 0	1 4 0	0 18 0
8½ „ 8½	4 15 0	0 18 0	1 4 0	0 18 0
10 „ 8	5 5 0	1 0 0	1 10 0	1 5 0
10 „ 10	6 0 0	1 0 0	1 10 0	1 5 0
12 „ 10	6 10 0	1 5 0	2 0 0	1 15 0
12 „ 12	7 10 0	1 5 0	2 0 0	1 15 0

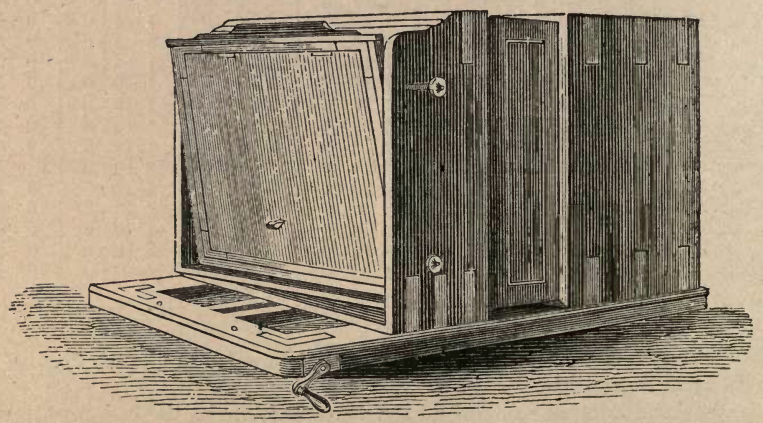


FIG. 3193.

3193 **Square Trunk Rigid Camera for Operating Room** (fig. 3194), Spanish Mahogany French polished, with long-screw adjustment, enabling the operator to use lenses of different focal lengths; and for copying, with swinging back, for bringing objects at various distances into correct focus; one single back, inner loose frames, and focusing screen:—

	Plain.	Framed and Panelled. Extra. Each.	Brass Bound. Extra. Each.
No. 1 for plates 12 by 10 in. . .	£14 10 0	£4 4 0	£2 2 0
No. 2 „ 18 by 16 in. . .	21 10 0	8 8 0	3 10 0

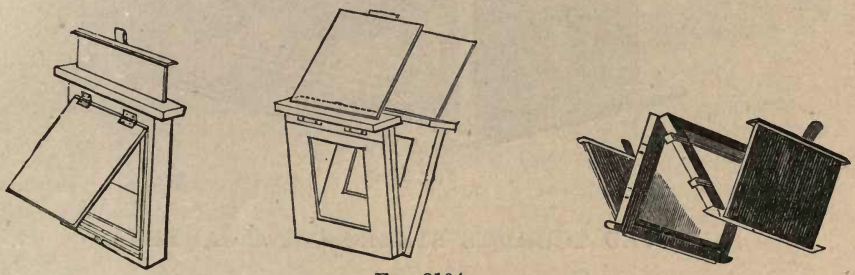


FIG. 3194.

3194 **Single or Double Backs for Cameras** (fig. 3194), for prices, see page 529.

3195 **Sliding Body Folding Camera.** Best Spanish Mahogany, French polished, with one Single Back, two loose frames, Focussing Glass, and with vertical Sliding Front for adjustment of foreground and sky (fig. 3195).

	Plain. (fig. 3195)	Brass Binding. (fig. 3195*) Extra.
No. 1 for plates 9 by 7 in.	£6 10 0	£1 6 0
No. 2 „ 10 by 8 in.	7 10 0	1 15 0
No. 3 „ 12 by 10 in.	10 10 0	1 15 0
No. 4 „ 15 by 12 in.	12 12 0	2 2 0

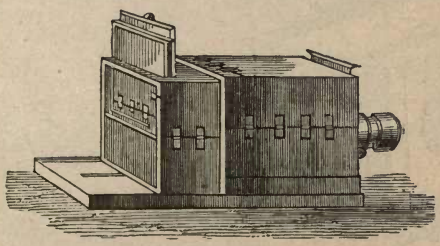


FIG. 3195.

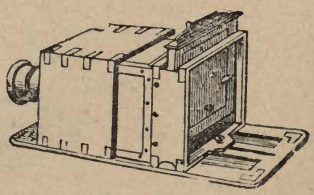


FIG. 3195*.

The above can be had framed and panelled, or with fine screw focussing adjustment, at an additional cost.

NEGRETTI AND ZAMBRA, being exclusively engaged as Photographers to the Crystal Palace Company, are enabled from great practical experience to supply such apparatus as will really be of service to a Photographer; and as the greater part of the articles enumerated are made under their own immediate superintendence, and finished with all the most recent and really serviceable improvements, they will be found to work so as to present the least possible chance of failure.

All Photographic Cabinet work intended for use in Tropical Climates should be made of Spanish Mahogany, and clamped with Brass, to insure durability.

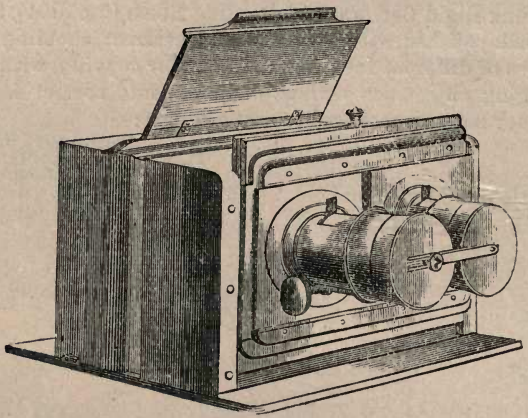


FIG. 3196.

IMPROVED TOURISTS' STEREOSCOPIC CAMERAS.

		Each. £ s. d.
3196	**Negretti and Zambra's Improved Tourists' Binocular Stereoscopic Bellows Body Camera** with Screw adjustment to Camera for focussing; three double backs, each for holding two prepared plates, size $6\frac{3}{4}$ by $3\frac{1}{4}$ inches, and one single back, for wet or dry process; focussing glass; very portable, packing into a Mahogany case; outside dimensions $8\frac{3}{4}$ by $5\frac{1}{2}$ inches, with two of Negretti and Zambra's Compound Achromatic Lenses with Waterhouse stops, for Portraits and Views (fig. 3196)	12 12 0

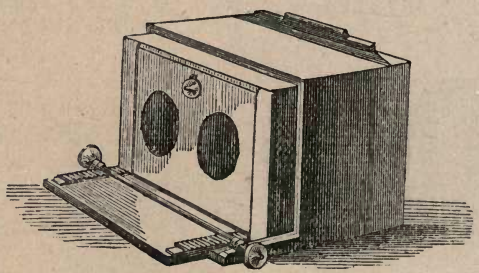


FIG. 3197.

CARTE DE VISITE CAMERAS.

3197	**Negretti and Zambra's Improved Double Lens Carte de Visite Camera**, as per fig. 3197, arranged for taking two pictures on one plate $6\frac{1}{2}$ in. by $4\frac{3}{4}$ in., for Operating Room, of best Spanish mahogany, with Rack adjustment, focussing from front, Rising Front, one single back and focussing glass, with Brass Binding .	5 12 0

For prices of suitable Lenses for above Cameras, see pages 517 to page 527 according to length of Operating Room.

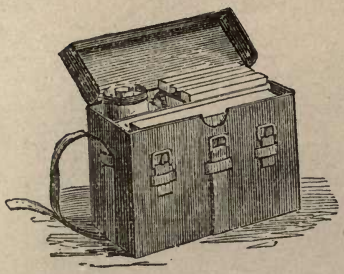


FIG. A.

FIG. B.

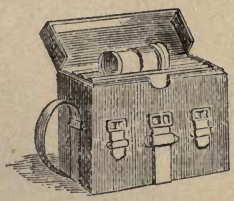


FIG. C.

3198 **Solid Leather Cases and Sling Straps**, for Plain, Folding, or Sliding Body Cameras, or for Lenses, (figs. 3198 A B and C) &c., &c., *made to order.*

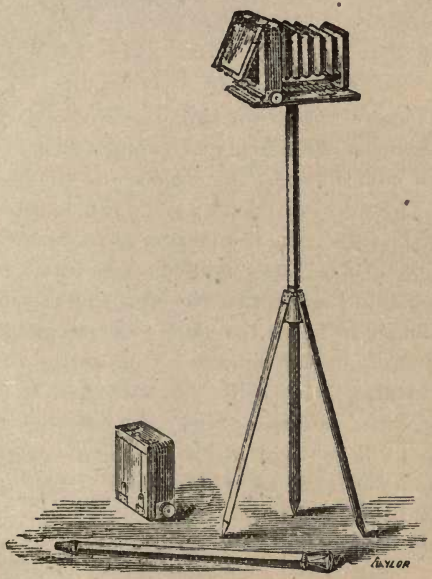


FIG. 3199.

3199 **The Pocket or Satchel Camera**, with Walking-Stick Tripod Stand, for working the Dry Plate Process (fig. 3199)

3200 **A Portable Pocket or Satchel Camera**, of the best construction, for plates 4¼ by 3¼ inches, with three double backs, portable Tripod Stand and View lens . . . £8 8 0

3201 The above Camera packed in a box with the necessary chemicals for developing dry plates. Developing Cups and Dish, Plate Box and Printing Frame £10 10 0

3202 **A Portable Satchel Camera**, as above, with three double backs, for plates 5 by 4 inches, portable Tripod Stand and View lens £10 10 0

3203 The above with Chemicals, &c., for developing Dry plates, packed in Box 12 12 0

3204 **A Portable Satchel Camera**, for Stereoscopic Pictures, with three double backs, and a pair of Lenses, and a portable Tripod Stand 12 12 0

The above, with Chemicals, &c., for developing dry plates, packed in Box 15 15 0

3205 **Prepared Dry Plates**, for use with the Satchel Camera 4¼ by 3¼ per dozen 2s. 6d. 0 3 0

3206 Ditto ditto 5 by 4 . . . „ 3s. 6d. 0 4 6

Also see end of Photo Section for various Prepared Plates.

3207 **Leather Sling Cases**, for either of the above Cameras, can be had at an extra charge of £1 1s., £1 12s. 6d., and £2 2s.

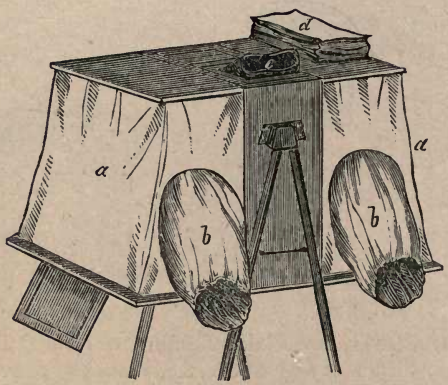


FIG. 3208.

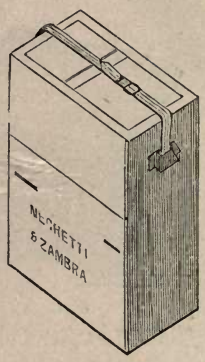


FIG. 3208*.

3208 **The Improved Developing Box** is constructed for working the Wet or Dry Collodion processes. To amateurs, especially, it offers many advantages over the ordinary Dark Tent, which is weighty and cumbersome. Fig. 3208 shows the box open, ready for use; Fig. 3208* closed. The sides *a a*, open up and down, and are kept in their position by two braces of wood inside. The hands enter at the sleeves as shown at *b b*. Fig. 1, and the mask, *c*, which is of black cloth on a wire frame, is set in the door, on top, under which is a plate of white glass to keep the vapour of the collodion from the eyes, and a sliding door under the glass to shut out the light when the face is withdrawn. The bath is let through the bottom at the left hand corner. The yellow glass window is directly opposite the operator. It is provided with a zinc or other kind of tray, with waste water pipe; also a cistern, *d*, of india-rubber, for water. Sufficient room will be found inside for the necessary bottles, and a plate draining box. The size of this box when closed and capable of manipulating a plate 8½ by 6½ with freedom is 15 by 13 by 7.

Prices according to size and arrangement of fittings, £4 10 0 to 6 6 0

3209 **Patent Automatic Changing Box.** By means of this apparatus a sensitised plate can be transferred from the Plate Box to the Camera with great facility, and without the possibility of its being affected by Light.

Price of Box to hold Twelve prepared Plates and Dark Slide.

For Plates	5 by 4 in.	£4	4	0	For Plates	8½ by 6½ in.	£5	5	0
„	6½ by 4¾ in.	4	10	0	„	10 by 8 in.	6	6	0
„	7½ by 5 in.	4	16	0	„	12 by 10 in.	7	7	0

Brass Binding above, for Tropical Service from £1.

3210 Leather cases for holding Changing Box and Dark Slide from £1 each extra.

3211 **Micro-Photographic Camera**, complete with Achromatic Lenses, for reducing pictures, &c. 10 10 0

3212 **Enlarging, Copying, or Solar Cameras** Made to Order.

FIG. 3213.

3213 **Improved Portable Dark Tent**, for working the Collodion Process in the open country (fig. 2213).

A good substitute for a dark room has long been a desideratum, and we have much pleasure in submitting the present invention to the notice of photographers generally, as combining all that can be required for the purposes of open-air work enabling them to work with as perfect ease and comfort as in their own laboratory at home.

The tent consists of a strong box forming a convenient table, mounted upon a firm tripod stand. The lid of the box is hinged, and thrown back at an angle. At each corner of the lid metal rods are fitted into sockets to extend the covering over the head, having also supports at each side, as shown in the engraving (fig. 3213). In the lid is a yellow glass sliding shutter for admitting light, or if pushed back, fresh air to the interior of the tent when desired. This tent has been in practical use for some time, and is found to answer perfectly and fulfil all requirements. The outside measurement, when packed up, is 31 by 21 by 4; weight, with stand and covering, 25lbs.

Size .	31 by 21 by 4	£6 6 0
„ .	26 by 19 by 4	5 5 0
Ditto with Water Tank fitted inside, &c., and other improvements		£8 8 0 to £12 12 0

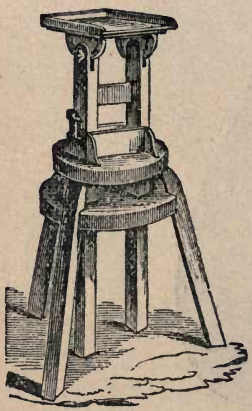


FIG. 3223.

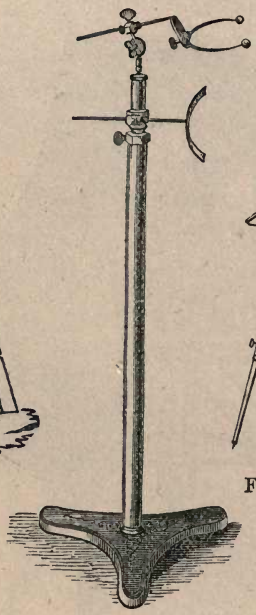


FIG. 3227.

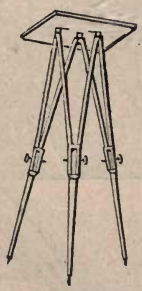


FIG. 3218*.

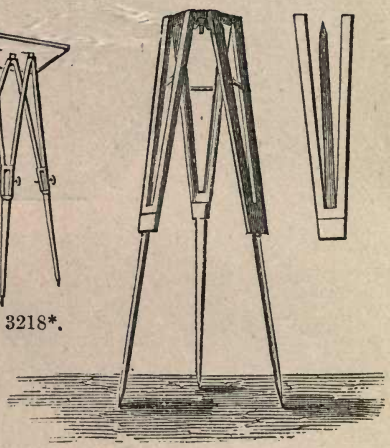


FIG. 3218.

CAMERA STANDS.

To insure success in taking either Portraits or Views, it is absolutely essential that the Camera should be perfectly steady. Lightness with freedom from vibration are combined in the stands offered in the following list:—

		Each. £ s. d.	Each. £ s. d.
3214	**Tripod Stand**, with round metal top, and bolt screw. Double legs of Ash for small Camera (fig. 3214). .		0 15 0
3215	**Tripod Stand**, with 4-inch triangular metal top (fig. 3215), with double legs and brass stretchers, bolt screw, and nut, with straps	1 1 0	1 6 0
3216	Ditto ditto very strong, with 6-inch triangular metal top, with bolt and screw, double legs of Ash, polished and hinged with brass stretchers . . .		1 10 0
3217	Ditto ditto larger, with 8-inch triangular head for large sized Camera, very firm		1 12 6
3218	**Folding Tripod Stand**, light and portable, three legs, as per figs. 3218 and 3218*, of new pattern, suitable for Stereoscopic Cameras. . . . 4-inch head		1 10 0
3219	Ditto ditto . . . . . 5-inch head		1 12 6
3220	Ditto ditto . . . . . 6-inch head		1 16 0
3221	**Improved Adjusting Tripod Stand**, the Legs having a sliding-up and clamp adjustment for height, firm and portable		2 2 0
3222	**Table Camera Stand**, for Operating Room, with adjustments for raising or depressing the Camera .		2 10 0
3223	**Table Camera Stands**, in polished oak, very strong, metal rack adjustment, with handle for raising or depressing Camera, also horizontal and vertical motion to top of stand (fig. 3223)		7 10 0

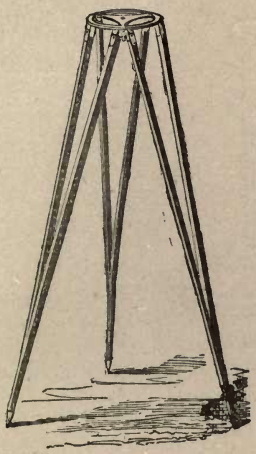


FIG. 3214.

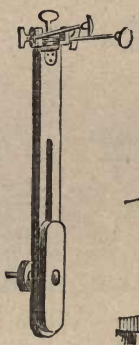


FIG. 3224.

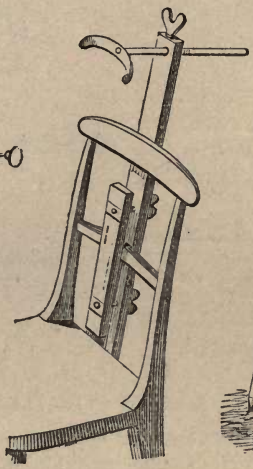


FIG. 3225.

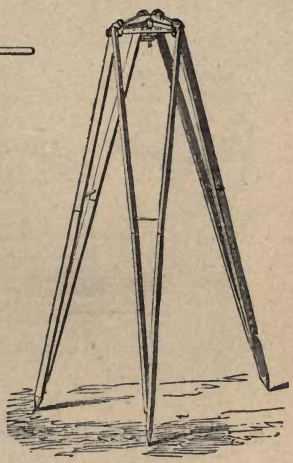


FIG. 3215.

HEAD RESTS.

		Each. £ s. d.	Each. £ s. d
3224	**Head Rests,** of simple form, with screw to attach to back of chair (fig. 3224)		0 3 6
3225	Ditto ditto with adjustments for raising and depressing with screw to attach to back of chair (fig. 3225) .		0 5 6
3226	**Negretti and Zambra's Universal Head Rest,** with means of adjustment for every position of the sitter, for attaching to chair		1 10 0
3227	**Universal Head or Body Rest,** with heavy iron foot, and brass sliding tube, which enables it to be used either for standing or sitting posture (fig. 3227) Of various sizes for Children or Adults	£2 10 0 3 3 0	4 4 0

3228 **Portable Stills** (fig. 3228). It is found convenient to have at hand the means of obtaining Pure Water. See page 406 for Prices and sizes, &c.

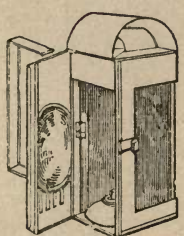


FIG 3231.

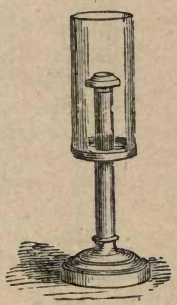


FIG. 3230.

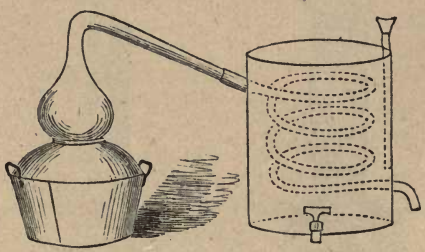


FIG. 3228.

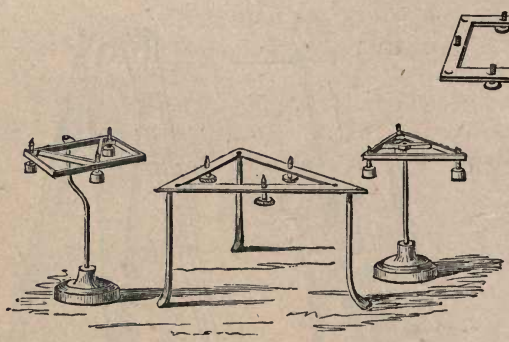


FIG. 3234.

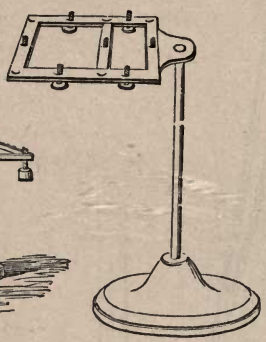


FIG. 3234*.

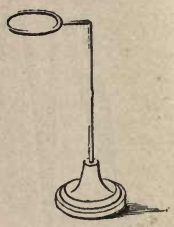


FIG. 3235.

Each.
£ s. d.

LAMPS FOR DARK ROOM.

3229 **Bunsen's Gas Burners**, for boiling or distilling; Gas Jets, with flexible tube, metal chimney, and gauze wire, for burning without smoke, various forms, see *ante*, page 403. . . . . .

3230 **Lanterns** furnished with Coloured Glass Shades, for use in dark room (fig. 3230) 0 4 6

3231 **Improved form of Photographic Non-Actinic Lamp**, where the yellow or ruby glass can be raised or depressed (fig. 3231) 0 10 6

3232 **Studio Lamp** with safety Spirit chamber . . . 0 12 6

3233 **Patent Lamp for the Magnesium Light** . . . 3 3 0

LEVELLING STANDS, TRIANGULAR PATTERN.

3234 With adjusting screws, for levelling plates with Albumen, and Developing and Fixing Collodion Pictures (figs. 3234) :—

For plates up to 5 by 5 inches 0 3 0

Ditto ditto 7 by 6 „ 0 4 6

Ditto ditto 9 by 7 „ 0 5 6

Ditto ditto 12 by 10 „ (fig. 3234*) . . . 0 10 6

3235 **Filter Supports** (fig. 3235), plain form 0 2 6

FIG. 3237‡.

FIG. 3237†.

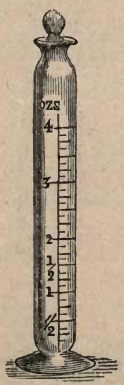


FIG. 3237*.

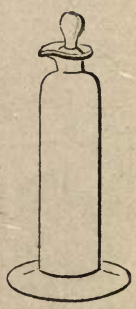


FIG. 3237.

3236 COLLODION BOTTLES POURERS, AND FILTERS.

The Collodion Bottles (figs. 3236 to 3237) can be used either for mixing the plain Collodion with the Iodiser, or for receiving the turbid portion of Collodion when it has been poured over the plate several times; from the shape of the bottle, it allows all particles to subside at the bottom, and enables the operator, after a short time, to pour away the clear Collodion within a very short distance of the deposit, without disturbing it.

3237 **Collodion Bottles or Pourer:—**

(Fig. 3237) Plain	2 oz.	4 oz.	6 oz.
Price	2s.	3s.	3s. 6d.
(Fig. 3237*) Graduated	2 oz.	4 oz.	6 oz.
Price	3s.	4s.	4s. 6d.

3237* **Cometless Collodion Bottle** (fig. 3237†). The tube in the neck of this bottle can be removed and cleaned as frequently as used, and so particles of dry Collodion prevented from being carried on to the plate . . £0 4 0

3237† **Collodion Filters** (fig. 3237‡) 5s. 6d. £0 7 6 0 10 6

3238 **Drop Bottles, Improved,** for adding small quantities of Nitrate of Silver Solution to developing or other solutions (see pages 192 and 502).

FIG. 3243.

FIG. 3246.

FIG. 3239.

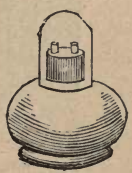


FIG. 3249.

		Each. £ s. d.	Each. £ s. d.
3239	**Developing Glasses,** nest of three, for pouring developing solution on to plates (fig. 3239)		0 4 0
3240	Ditto Graduated		0 5 6
3241	**Hydrometers,** for testing the Specific Gravity of Acids, Alcohol, Æther, &c.	(see pages 176 to 195)	
3242	**Argentometer,** for testing strength of Silver Bath, in case	0 2 6	0 3 6
3243	Ditto with glass solution Tube in case (fig. 3243) .		0 4 6
3244	**Dropping Tubes or Pipettes**	0 0 6	0 0 8
3245	**Dropping Tubes,** Graduated . . . . 1s. 6d.	0 2 6	0 5 6
3246	**Glass Graduated Measures,** accurately divided into Minims, Drachms, and Ounces; of either Cylindrical or Conical form, see page 384.		
3247	Scales and Weights see *ante,* pp. 396, 405, 406, 408.		
3248	**Filter Rings, or Supports,** as on top of fig 3246, very useful for filtering small quantities without a funnel	0 0 6	0 1 0
3249	**Glass Syringes,** for taking up small quanties of Liquids, Glass Spirit Lamps Glass Funnels, Glass Stirring Rods, see pages 381, 390, and 391.		
3250	**Thermometers, Chemical** and various, see pages 152 to 175.		

3251 **Wedgwood Ware Funnels**, ribbed inside, see page 381.

3252 **Ebonite Funnels**:—

Capacity	2 oz.	4 oz	8 oz.	16 oz.
Price	1s. 4d.	1s. 9d.	2s. 6d.	4s.

3253 **Filter Paper**, cut round, in packets of 100 each:—

Diameter	5½ in.	7½ in.	9½ in.	12 in.
Price	1s.	1s. 4d.	1s. 6d.	2s.

3254 **Pneumatic Plate Holder**, small, with lever . . . £0 3 0

3255 Ditto ditto large, with lever (fig. 3255) . 0 4 0

3256 **Cup Pattern Plate Holder** 0 4 6

3257 Ditto large size 0 5 0

3258 **Plate Cleaner**, with screw adjustment, for cleaning plates of various sizes (fig. 3258) £0 5 6 0 6 6

FIG. 3260.

FIG. 3261.

FIG. 3259.

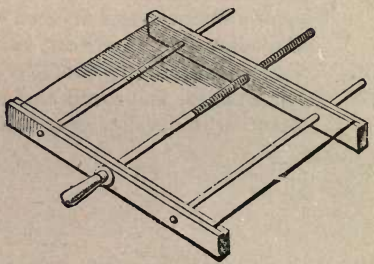


FIG. 3258.

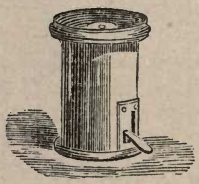


FIG. 3255.

3259 **Thermometers** for Studio or Operating Room (fig. 3259) 0 2 6 0 5 0

3260 Ditto ditto Registering (fig. 3260) . . . 0 14 0 1 1 0

3261 **Hygrometers** (fig. 3261) 0 14 0 1 1 0

COLLODION DIPPING BATHS.

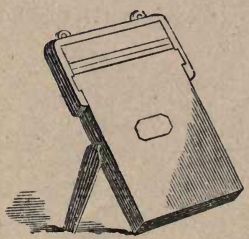


FIG. 3263.

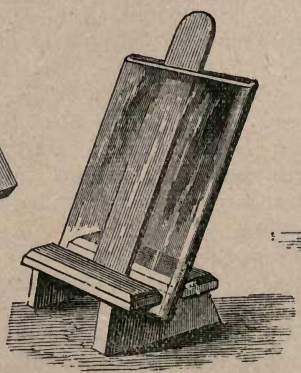


FIG. 3262.

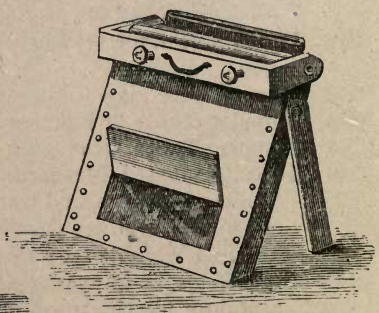


FIG. 3264.

3262 **Nitrate of Silver Dipping Baths**, of Solid Glass, with Stand and Glass Dipper (fig. 3262):—

For Plates	4¼ by 3¼ in.	.	£0	4	6	For Plates	7¾ by 4¼ in.	.	£0	8	6
„	5 by 4 in.	.	0	6	0	„	9 by 7 in.	.	0	10	6
„	6½ by 4¾ in.	.	0	7	6	„	10 by 8 in.	.	0	15	0
„	6 by 5 in.	.	0	7	6	„	12 by 10 in.	.	0	18	6
Stereoscopic	6¼ by 3¼ in.	.	.	.	.	.	.	.	0	6	6

3263 **Water-tight Glass Baths**, with Dipper, mounted in Polished Mahogany cases (fig. 3263):—

For Plates	5 by 4 in.	.	£1	2	6	For Plates	10 by 8 in.	.	£2	2	0
„	6½ by 4¾ in.	.	1	8	6	„	12 by 10 in.	.	2	8	6
„	8½ by 6½ in.	.	1	12	0	„	15 by 12 in.	.	3	13	0
„	9 by 7 in.	.	1	14	0	Stereoscopic	6¾ by 3¼ in.	.	1	5	0

3264 **Negretti and Zambra's Improved Water-tight Glass Baths** (fig 3264), with accurately fitted glass cover. The top is hinged, and when the bath is in use it can be turned over, as in figure, and at once be put into its place when the bath is out of use; a shutter is placed at bottom, lined with yellow glass, so that the bottom of bath can be examined as to its freedom from sediment; this contrivance will be found of great use in Tropical Climates (screwed and brass bound):

For Plates	5 by 4 in.	.	£1	12	6	For Plates	7¼ by 4½ in.	.	£2	7	6
„	6½ by 4¾ in.	.	2	3	6	„	11 by 9 in.	.	3	15	0
„	9 by 7 in.	.	2	10	6	„	12 by 10 in.	.	4	8	0
„	10 by 8 in.	.	3	3	0	„	15 by 12 in.	.	4	18	6
Stereoscopic Size	6¾ by 3¼ in.	.	.	.	.	.	.	.	1	18	6

3265 **Porcelain Dipping Baths**:—

			Bath.	Stand.	Dipper.	Complete.
No. 1	for Plates	4¼ by 3¼ in. .	2/	/8	/8	3/4
2	„	5 by 4 in. .	3/	/10	/11	4/9
3	„	6½ by 4¾ in. .	3/6	1/	1/2	5/8
4	„	8½ by 6½ in. .	4/	1/6	1/6	7/
5	„	9 by 7 in. .	5-6	1/8	1/8	9/
6	„	10 by 8 in. .	8/	2/	1/10	12/
7	„	12 by 10 in. .	11/6	2/6	2/	16/
8	„	15 by 12 in. .	23/	3/	3/	29/
9	Stereoscopic size	6¾ by 3¼ in. .	4/	1/	1/	6/

3265* **Patent Ebonite Baths**:—Various sizes supplied to *order*.

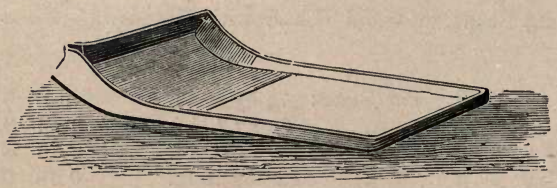


FIG. 3270.

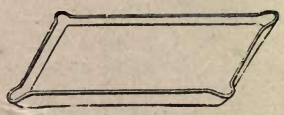


FIG. 3266

3266 **Porcelain Dishes**, with Spout for Sensitizing or Albumenizing Paper and for Washing Paper Pictures (figs. 3266 and 3266*):—

			Porcelain Pans Shallow.	Porcelain Pans Deep.
No. 1	For Paper	5 by 4 in.	£0 0 9	£0 0 11
2	Stereoscopic	6¾ by 3½ in.	0 1 0	0 1 3
3	For Paper	8 by 6 in.	0 1 3	0 1 6
4	„	9 by 7 in.	0 1 6	0 1 9
5	„	10 by 8 in.	0 1 9	0 2 0
6	„	11 by 9 in.	0 2 6	0 2 9
7	„	12 by 10 in.	0 3 0	0 3 6
8	„	13 by 11 in.	0 4 0	0 5 0
9	„	16 by 12 in.	0 6 6	0 7 6
10	„	16 by 13 in.	0 7 0	0 8 6
11	„	19 by 12 in.	0 9 0	0 10 6
12	„	20 by 16 in.	0 15 0	0 17 6
13	„	24 by 19 in.	1 1 0	1 5 0

3267 **Dippers, of Fluted Glass, for Collodion Baths**, in one piece, allowing the fluid to drain down from the back of the plate:—

Length 6 inches each	£0 0 8	Length 11 inches each	£0 1 2
„ 8 „	0 0 10	„ 13 „	0 1 6
„ 9 „	0 1 0	„ 16 „	0 1 10

3268 **Porcelain Dippers**, see No. 3265.

3269 **Silver Wire Dippers**, from 10s. 6d. upwards, according to size and Weight.

3270 **Well Porcelain Sensitizing, Developing, or Fixing Dishes.** These Dishes are very convenient for sensitizing wet or dry Collodion Plates, or for their subsequent manipulation, a very small quantity of solution being required. (fig. 3270)

For Plates 6¾ by 3¼ in.	£0 2 6	For Plates 10 by 8 in.	£0 7 6
„ 6½ by 5 in.	0 3 6	„ 11 by 9 in.	0 9 0
„ 8½ by 6½ in.	0 5 6	„ 12 by 10 in.	0 10 6
„ 9 by 7 in.	0 6 6		

3271 **Ebonite Trays**, of various sizes, supplied to order.

3272 **Moulded Glass Dishes** (fig. 3266). These dishes are entirely unacted upon by the chemicals employed, and can be used without risk:—

	Each.		Each.
Size, 7¼ by 3¾ by 1 in.	£0 2 6	Size, 10 by 8 by 1 in.	£0 6 6
„ 6 by 4½ by 1 in.	0 3 0	„ 11 by 9 by 1 in.	0 7 6
„ 8 by 6 by 1 in.	0 4 0	„ 12½ by 10½ by 1 in.	0 10 6
„ 9 by 7 by 1 in.	0 5 6		

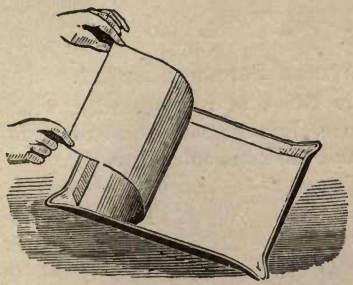


FIG. 3266*.

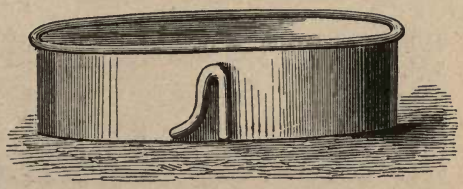


FIG. 3273

3273 **Elliott's Syphon Washing Trough**, in Porcelain (fig. 3273). Very useful for operators or amateurs, as by the use of it a number of prints may be subjected to the action of a continuous stream of water for any time. When the height of the water reaches the bend of the syphon, the water from the lower part of the pan passes away through the syphon which is then self-acting as long as the water is allowed to pass into the pan.

Price 14s. 6d. 17s. 6d. £1 1s.

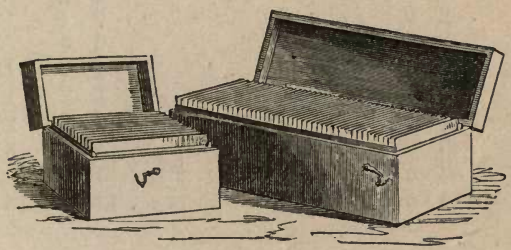


FIG. 3274.

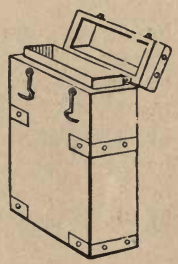


FIG. 3275.

3274 **Plate Boxes** (fig. 3275), for holding **Glass Plates**, in plain, well-seasoned Pine Wood :—

		For 12 Plates. £ s. d.	24 Plates. £ s. d.	50 Plates, £ s. d.
No. 1 for plates	3¼ by 2¾ in.	0 2 0	0 2 9	0 4 0
2 „	4¼ by 3¼ in.	0 2 6	0 3 3	0 4 6
3 „	5 by 4 in.	0 3 2	0 3 6	0 5 6
4 „	6½ by 4¾ in.	0 3 6	0 4 6	0 6 6
5 „	6¾ by 3¼ in.	0 3 6	0 4 6	0 6 6
6 „	6 by 5 in.	0 3 8	0 4 6	0 6 6
7 „	7 by 6 in.	0 4 0	0 4 6	0 7 6
8 „	8½ by 6½ in.	0 4 6	0 5 0	0 8 6
9 „	7¾ by 4¼ in.	0 3 9	0 4 6	0 7 6
10 „	7¼ by 4½ in.	0 3 9	0 4 6	0 7 6
11 „	9 by 7 in.	0 4 6	0 5 6	0 8 6
12 „	10 by 8 in.	0 5 0	0 7 0	0 9 6
13 „	11 by 9 in.	0 6 0	0 7 9	0 10 6
14 „	12 by 10 in.	0 6 6	0 7 9	0 12 6

3275 **Plate Boxes of Mahogany**, at a small advance on above prices (fig. 3275).

3276 **Pine Wood Grooving**, for storing Negatives, per foot 8d.

		12 Grooves.	24 Grooves.
3277	**Plate Draining Racks**, folding	£0 4 0	£0 5 0
3278	Ditto ditto large size for 12 by 10 Plates	0 6 0	0 9 6

3279 GLASS PLATES.

CHANCE'S FINEST PATENT PLATE.

	s.	d.
4¼ by 3¼ per doz.	2	0
5 by 4 „	3	0
6¾ by 3¼ „ Stereo	3	6
6½ by 4¾ „	4	6
7½ by 4½ „	4	9
7½ by 5 „	5	6
8½ by 6½ „	8	5
9 by 7 „	12	0
10 by 8 „	15	6
11 by 9 „	21	6
12 by 10 „	27	6

BEST CROWN GLASS, CLEANED.

	s.	d.
2½ by 2 per gross	2	0
3¼ by 2¾ „	3	6
4¼ by 3¼ „	7	0
5 by 4 „	11	6
6½ by 4¾ „	21	0
8½ by 6½ „	40	0
10 by 8 „	64	0
12 by 10 „	110	0

CRYSTAL POLISHED SHEET.

This Glass is recommended with confidence. It is almost as flat as Patent Plate, and the same substance.

	Per doz. s.	d.	Per gross. s.	d.
4¼ by 3¼	1	0	11	0
5 by 4	1	6	17	6
6½ by 4¼	2	2	26	0
6½ by 4¾	2	6	28	0
7¼ by 4½	2	8	—	
7½ by 5	3	0	34	0
8½ by 6½	4	6	52	0
9 by 7	6	0	70	0
10 by 8	6	8	78	0
12 by 10	12	0	130	0

BEST CROWN POLISHED.

	Per doz. s.	d.	Per gross. s.	d.
2½ by 2	0	4	3	3
3¼ by 2¾	0	6	5	3
4¼ by 3¼	1	0	11	6
5 by 4	1	5	16	6
6½ by 4¾	2	4	25	6
8½ by 6½	4	4	52	0
10 by 8	9	0	87	0
12 by 10	13	0	150	0

3280 FILTERING PAPERS.

	Each. £	s.	d.
White Filtering Paper	0	1	6
Ditto ditto extra thick, free from iron or other impurities	0	1	9
Swedish Filter Paper	0	4	0
Papier Joseph	0	1	4
Drying Boards, stout, white, 19½ by 25 in. per quire	0	5	0
Circular Filter Papers, in packets of 100 per ream	3	3	0

6 in., per packet 1s.; 10 in. 1s. 6d.; 13 in. 2s. 6d.

3281 PHOTOGRAPHIC PAPERS.

	Per quire £	s.	d.	Per ream. £	s.	d.
Plain Rive Paper, best quality	0	3	6	3	0	0
Plain Saxe Paper, 23 by 18	0	4	0	3	3	0
Prepared Wax Negative Paper	0	12	6	10	10	0
NEW SUPER-ALBUMENIZED, RIVE AND SAXE'S PAPERS (SELECTED).						
Saxe's Positive Thick	0	7	0	6	6	0
Ditto ditto Medium	0	7	0	6	6	0
Rive's Medium	0	6	6	6	0	0
Ditto Thick	0	6	6	6	0	0

The various Photographic papers of English manufacture supplied to order.

See next page, Formstecher's Albumenized Paper.

FORMSTECHER'S DIAMOND ALBUMENIZED PAPER.

JULIUS FORMSTECHER  & CHARLES SEIB.

TRADE MARK.
SCHUTZMARKE

OFFENBACH-ON-MAINE.

NEGRETTI & ZAMBRA, HOLBORN VIADUCT, LONDON, E.C.

Sole Agents for Great Britain, the Colonies, China, Japan, and South America.

3282 This Albumenized Paper possesses the advantage of giving prints of extraordinary softness and brilliancy of tone, the photograph being on the surface, and not in the body of the paper, as is the case with the ordinary quality.

REDUCED PRICES.

10 Kilo Rose . . . £6 0 0 per ream. Half Reams at £5 15 0 per ream,
10 Kilo Violet . . . £6 0 0 per ream. Ditto £6 5 0 „

Discount, 5 per cent for cash.

Sample quire sent on receipt of stamps or P.O.O. for 7s. 6d.

DIRECTIONS FOR USE OF FORMSTECHER'S DIAMOND ALBUMENIZED PAPER.

The Sensitizing Bath.—Nitrate of Silver, 1 ounce, Distilled Water, 10 ounces. If used stronger it drains unevenly from the paper. Floating should not be less than four minutes for thin, and five minutes for thick paper, otherwise the salting will not be completely converted into Chloride of Silver or the Albumen coagulated; and if this is not the case, the albumen partially dissolves in the subsequent washing, producing flat and spotty results. Prolonged floating has no injurious effects. The temperature of the bath ought not to be less than 66° Fah.

The sensitized paper should not be allowed to curl, or the surface will crack; it should be kept perfectly flat.

The paper will tone with any of the recognised formulæ, but the Chloride of Lime is recommended, which may be used a longer time than the ordinary baths, by adding additional gold as required. The prints should be washed in the usual way before toning.

The Toning Bath, No. 1.—Chloride of Gold, 15 Grains, Distilled Water, 10 drachms. **No. 2.** Chloride of Lime, half ounce; water, 40 ounces.

Take one ounce of No. 1, the same of No. 2, half a teaspoonful of chalk or whiting, and water 18 ounces; shake well and let stand three or four days, then filter for use. When the bath is exhausted, add more of No. 1, and a little chalk to neutralize the gold. No. 2 must seldom be added, and then only in small quantities, as an excess is injurious, producing cold grey tones and a bleaching effect.

The Fixing Bath.—Hyposulphate of Soda, one ounce, and Water, one pint. A weak solution is recommended, the fixing being equally perfect. A stronger solution tends to blistering. It is most important that all the solutions and washing waters should be the same temperature—70° Fah. Higher or lower temperature is apt to produce blisters, which are better avoided, although of little consequence in the finished picture. One ounce of common salt to one pint of water in the first washing water is a remedy against blistering.

IMPROVED PRESSURE, REVERSING, OR PRINTING FRAMES.

These frames are constructed that a uniform pressure may be obtained, thus insuring perfect contact between the positive paper and negative plate.

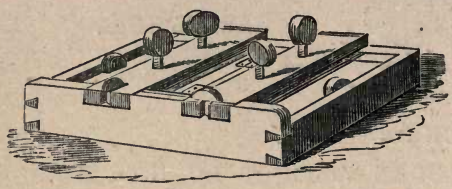


FIG. 3283.

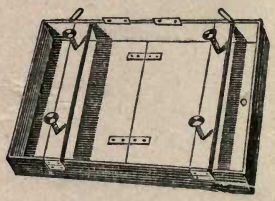


FIG. 3284.

3283 **Pressure Frames**, with jointed backs for examination whilst Printing, in Oak or French Polished Mahogany, of the best kind and make (fig. 3283) :—

		Oak Each. £ s. d.	Mahogany Each. £ s. d.
No 1 size of glass	9 by 7 in.	0 12 0	0 15 0
2 „	10 by 8 in.	0 14 0	0 16 6
3 „	11 by 9 in.	0 15 6	0 18 6
4 „	12 by 10 in.	0 17 6	1 1 0
6 „	15 by 12 in.	1 2 0	1 10 0

3284 **Pressure Frames**, of Common kind and make, with screws or springs, and hinged backboard and glass (fig. 3284) :—

Size for pictures,	7 by 6 in.	9 by 7 in.	10 by 8 in.	12 by 10 in.	14 by 12 in.
Price . .	7s. 6d.	9s. 6d.	13s. 6d.	16s. 6d.	21s.

3284* **Instantaneous Photographic Shutters** of different forms, Marshall's Patent Pneumatic arrangement, the Economic Patent, the Phantom Pneumatic, White's Shutter, &c., &c., supplied to order. Prices varying from 21s., 26s., 30s. to 38s. each.

A cheap Drop Shutter can be supplied at 12s.

3284† **Enlarging Lanterns.** Complete Enlarging Lantern, fitted with Paraffin Lamp, 5 Inch Condenser and Achromatic front Lenses, best mounting and finish £10 10 0

Ditto ditto 7 Inch Condenser 14 14 0

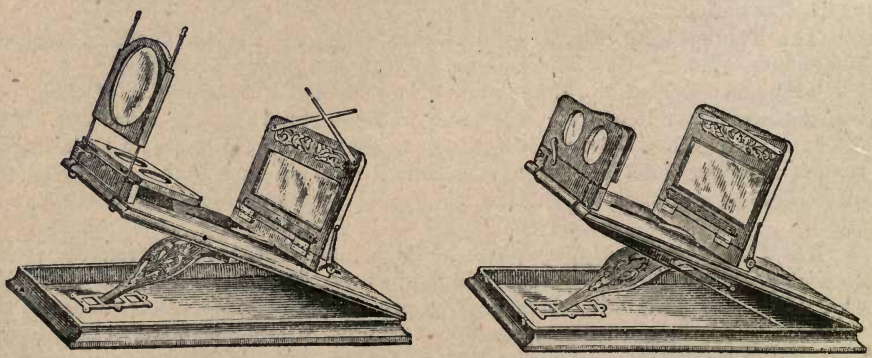


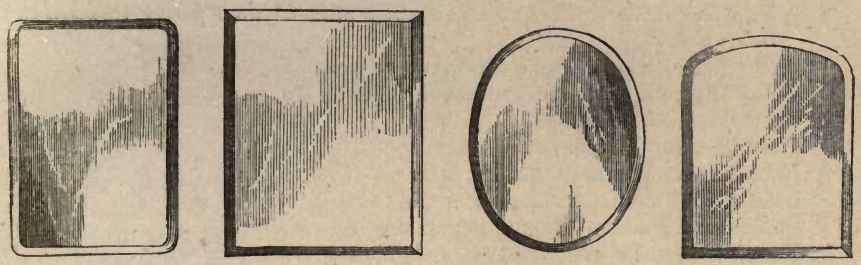
FIG. 3284‡.

3284‡ **Improved Graphoscopes**, for particulars and prices, see page 228.

3285 **Pressure Frames**, in White Wood, Common kind, with hinged backs, without Glass :—

	s.	d.	s.	d.		s.	d.	s.	d.
For plates $4\frac{1}{4}$ by $3\frac{1}{4}$ in. .	1	6	2	6	For plates 8 by 5 in. .	3	0	4	6
„ 5 by 4 in. .	2	0	3	0	„ $8\frac{1}{2}$ by $6\frac{1}{2}$ in. .	3	5	4	6
„ $6\frac{1}{2}$ by $4\frac{3}{4}$ in. .	3	0	4	0	„ 9 by 7 in. .	3	6	5	0
„ $7\frac{1}{2}$ by $4\frac{1}{2}$ in. .	2	0	4	6	„ 12 by 10 in. .	5	6	8	0

Stereoscopic $6\frac{3}{4}$ by $\frac{3}{4}$ in., 4s.



A B FIG 3286. C D

3286 **Glass Cutting or Shaping Plates**, with bevelled and polished edges. These plates are for placing over the positive paper prints before mounting, and are of four patterns—Oval, Square, Dome, and Cushion, being held firmly on to the picture. When the best position of the picture is obtained, a sharp-pointed knife is run along the outer polished edge of the shape; the picture is then ready to be placed on card-board.

Glass Cutting or Shaping Plates (figs. A B C D, No. 3286).

For Pictures $2\frac{1}{2}$ by 2 in. each	£0	0	6	For Pictures $6\frac{1}{2}$ by $4\frac{3}{4}$ in. each	£0	1	4
„ $3\frac{1}{4}$ by $2\frac{3}{4}$ in. „	0	0	8	„ $8\frac{1}{2}$ by $6\frac{1}{2}$ in. „	0	1	6
„ $4\frac{1}{4}$ by $3\frac{1}{4}$ in. „	0	0	9	„ 10 by 8 in. „	0	2	6
„ 5 by 4 in. „	0	1	0	Carte de Visite . . .	0	2	0

3287 **Cutting Knives**, for using with above . . . . . each 0 1 9

3288 **Vignette Plates**, for Portraits or Landscapes (fig. 3288) :—

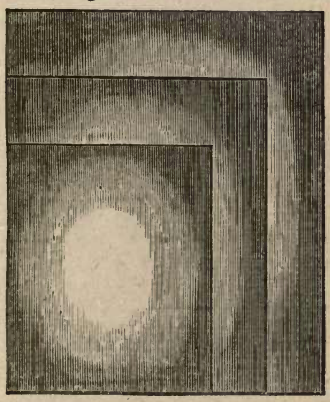


FIG. 3288.

Size $2\frac{1}{2}$ by 2 in. .	each	£0	0	6
„ $3\frac{1}{4}$ by $2\frac{3}{4}$ in. .	„	0	0	9
„ $4\frac{1}{4}$ by $3\frac{1}{4}$ in. .	„	0	1	0
„ 5 by 4 in. .	„	0	1	6
Carte de Visite .	„	0	1	0
„ $6\frac{1}{2}$ by $4\frac{3}{4}$ in. .	„	0	1	10
„ $8\frac{1}{2}$ by $6\frac{1}{2}$ in. .	„	0	2	2
„ 9 by 7 in. .	„	0	2	6
„ 10 by 8 in. .	„	0	3	0
„ 12 by 10 in. .	„	0	4	6

Double for Stereoscopic pictures, each 2s. 6d.

FIG. 3302.

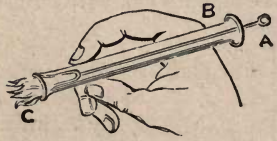


FIG. 3290.

FIG. 3300.

FIG. 3301.

		Each. £ s. d.	Each. £ s. d.
3290	**Buckle's Brushes** (fig. 3290), for spreading solutions on Paper; Glass Tube, B, Silver Wire Hook, A, which draws a piece of wool partly through the tube at C,		price 2s.
3290*	**Glass Rods**, for spreading solutions on to paper, 3d., 4d., 6d., 1s.		
3291	**Wood Clips**, for suspending sheets of paper to dry, 1s. 6d. per dozen.		
3292	**Glass Clips**, 3s. per dozen.		
3293	**Plate Cleaning Liquid**, per bottle 1s.		
3294	**India-Rubber Finger Stalls**, 6d. each.		
3295	**Leathers** for cleansing Glass plates, from 2s. ditto.		
3296	**Double Zinc Dish for Waxing Paper**, very convenient . . .		0 10 6
3297	**Horn Forceps**, for manipulating with Waxed or other Paper .		0 1 6
3298	**Boxwood Forceps**, for the same purpose		0 1 6
3299	**Silver Wire Hooks**, for lifting sensitive plates from dishes, from		0 2 6
3300	**Ebonite Forceps**, without rivets (fig. 3300)		0 1 9
3301	**Circular Spirit Level**, best make, for accurately levelling Cameras, or Glass Plates for developing (fig. 3301)		0 6 6
3302	**Photographic Visuometer** (fig. 3302) for enabling the tourist to judge of the effect of a landscape . .		0 4 6
3303	**Focussing Glass, or Eye-Piece**, for obtaining a perfectly sharp picture, see page 227 . . . . 5s. 6d.	0 12 6	0 16 0
3304	**Magnifying Lenses** for examining Photographs, &c., of various sizes and mountings (see pages 221 and 222).		
3305	**Instrument to count Seconds**	1 10 0	2 10 0
3305*	**Sabine's Photometer**, a very useful Instrument for the use of Photographers		0 12 6

3306 **PHOTOGRAPHIC BRUSHES.**

	Nos 1 and 2, Small Camel Hair . . per dozen		0 1 6
	Ditto, No. 3 . . . . . ,,		0 2 0
	Sables in Quills . . . . . each 4d.,	0 0 6	0 1 0
	Miniature Brushes . . . . . per dozen		0 4 6
	Sables in Albata, very fine	0 4 0	0 6 6
	Camel Hair Dusters . . . . . each		0 0 3
	Round Camel Hair Brushes in Tin . . each 6d.,	0 1 0	0 2 6
	Stumps . . . . . each	0 0 4	0 0 6

3307 **Camel Hair Brushes**, for spreading solutions on to paper, made without metal binding :—

Breadth .	1½ in.	2 in.	2½ in.	3 in.	4 in.	5 in.
Price, each	1s. 6d.	1s. 9d.	2s. 3d.	2s. 6d.	3s. 6d.	4s. 6d.

3308	Ditto, Thick Round, 1s. and 1s. 6d. each.		
3309	Ditto ditto bound with Silver Wire	£0 2 0	£0 2 6
3310	Gold, Silver or Alumina Shells . . . ,,		0 1 0

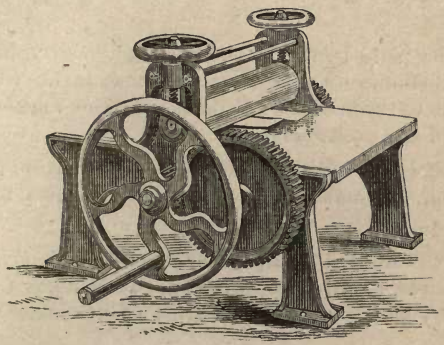


FIG. 3311.

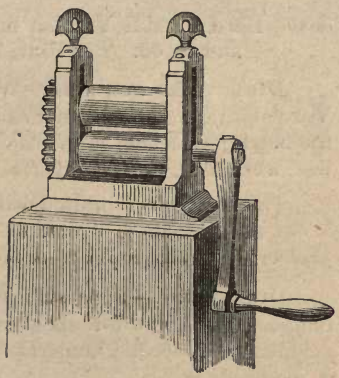


FIG. 3312.

3311 **Double Geared Rolling Machine, with Fly Wheel** (fig. 3311.)
Size of plate, 21 by 15 in., £10 10s.; 24 by 18 in., £14.

3312 **Amateur's Rolling Machine** (fig. 3312). Size of Plate 9 by 6 in. £3 5 0

3313 **Hot Rolling Machines** with Lamps and tubes; Single Geared with Steel Plate

12 in. by 7 in.	£6 10 0
18 in. by 13 in.	12 12 0
Ditto ditto Double Geared.	
20 in. by 16 in.	19 10 0
24 in. by 18 in.	25 0 0

3314 **Eureka Burnisher** can be heated with any kind of Lamp, Alcohol, Oil, or Gas.

Prices 6 in. Roll	£4 4 0	Prices 14 in. Roll	£8 8 0
„ 10 in. „	6 6 0	„ 20 in. „	11 0 0

3315 **Albums** for holding Carte de Visite or Cabinet Sized pictures in a variety of mountings, and of sizes to contain 10, 25, 50, 80, and 100 Pictures; price, according to number to contain and finish . 0 5 0 5 5 0

3316 **Backgrounds for the Operating Room**, sizes suited for the room painted to order:—

Size 6 by 4 feet	Price about 1 10 0	2 2 0
„ 7 by 6 feet	2 2 0	3 3 0

3317 STOPPERED BOTTLES FOR CHEMICALS.

Green Glass (narrow mouth).		White Glass (narrow mouth),		White Glass (wide mouth).	
5 oz capacity	5d.	1 oz.	4d.	1 oz.	5d.
10 „	6d.	2	6d.	2	7d.
16 „	7d.	4	8d.	4	9d.
20 „	8d.	8	9d.	8	1s.

3318 NITRATE OF SILVER.

These Prices are for Cash only, which must accompany the order, as credit cannot be given.

1 oz. and under	5 ozs.	per oz. 3s. 6d.
5 oz. „	10 ozs.	„ 3s. 3d.
10 ozs. „	25 ozs.	„ 3s.

3319 **Nitrate of Silver Bath**, prepared for Positive or Negative process. inclusive of bottles . . . . . per pint £0 8 0

3319* **Nitrate of Silver Baths**, 60 grains to the oz. of Distilled Water for sensitizing albumenized paper . . . . per pint 0 11 6

3320 **Hard Crystal Varnish for Collodion Negatives**, in bottles, 1s. 6d., 2s. 6d., and 4s. 6d. Per Pint, 7s.

DIRECTIONS FOR USE.—Warm the plate gently by the fire, and pour on the Varnish in the same manner as the Collodion, returning the superfluous quantity to the bottle; then hold the Varnished side to the fire for a few moments; the Varnish will, when cold, present a perfectly hard and even surface.

This Varnish if diluted with Alcohol (strength 62 O.P.) in the proportion of 5 ozs. of Varnish to 3 ozs. of Alcohol, will make an excellent print varnish for preserving Photographs from fading.

DIRECTIONS.—Pour sufficient of the diluted Varnish into a clean dish, then immerse the print for about two minutes, remove, and when dry it is ready for mounting. A second immersion in the Varnish will give the print a better surface if required.

3320* **Liquid Jet**, for applying to the back of the Collodion Positives, giving great brilliancy and lustre to the pictures. This preparation is not liable to crack. Price 6d. per 4 ounce bottle; 8 ounce ditto, 1s.

COLLODIONS FOR NEGATIVE AND POSITIVE PICTURES.

3321 **Thomas's Negative Collodion**, with Potassium Iodizer, Cadmium Iodizer, Bromo-Cadmium Iodizer, or Bromo-Potassium Iodizer. 1 pint 10s., ½-pint 5s.

3322 **Thomas's Positive Collodion and Iodizer**,, in pints 10s., ½-pints 5s., ¼-pints 3s.

3323 **Mawson's Negative and Positive Collodion**, ¼-pints 2s. 9d., ½-pints 5s, pints 10s.

3324 **Card Mounts**, for mounting Stereoscopic Paper pictures, per 100, 1s. 6d., 2s. 6d., and 5s.

3325 **Enamelled Stereoscopic Card Mounts**, per gross . . . £0 6 6

3326 **Card Mounts**, stout, for Carte de Visite Pictures, per 1,000, 10s. 6d. 0 12 6

PURE CHEMICALS AND PREPARATIONS.

USED IN THE PHOTOGRAPHIC PROCESSES.

		£ s. d. Per oz.
3327	**Acid, Acetic**, Glacial, Solid at 50° . . per lb., 2s.	0 0 3
3328	„ **Citric**, Crystals . . . . per lb., 3s.	0 0 4
3329	„ **Formic**	0 0 6
3330	„ **Gallic**	0 0 8
3331	„ **Hydrochloric**, Pure . . . per lb., 8d.	0 0 2
3332	„ **Nitric**, sp. gr. 1·450, pure . . per lb., 1s. 6d.	0 0 2
3333	„ **Pyrogallic**, pure English	0 4 0
3334	„ **Succinic**	0 5 6
3335	„ **Sulphuric** . . . . . per lb.	0 0 3
3336	„ pure . . . . . „	0 1 6
3337	„ **Tannic**, pure Soluble	0 1 0
3338	**Alcohol** . . . . . per pint, 4s. and 5s.	0 0 4
3339	„ **Absolute**, sp. gr. ·796 . . . „ 7s. 6d. .	0 0 6

		£	s	d. Per oz.
3340	Ammonia, sp. gr. ·880 . . . per lb., 1s. 6d. .	0	0	2
3341	Ammonium, Bromide, free from Iodide 3s. 6d. .	0	0	4
3342	„ Chloride, pure, free from Iron 2s. .	0	0	4
3343	„ Fluoride	0	0	9
3344	„ Iodide, pure	0	2	0
3345	„ Sulphide . . . . . per lb.	0	5	0
3346	Barium, Chloride . . . . . per lb., 1s.	0	0	3
3347	„ Iodide	0	3	0
3348	Baryta, Nitrate . . . . . per lb. 1s. 6d.	0	0	2
3349	Benzole . . . . . per pint	0	2	0
3350	Bromine, pure	0	2	6
3351	Cadmium	0	4	0
3352	„ Bromide, pure Crystal	0	2	6
3353	„ Iodide	0	2	6
3354	Calcium, Bromide	0	2	6
3355	„ Iodide, pure	0	3	0
3356	Charcoal, Animal . . . . . per lb. 1s. 8d.	0	0	5
3357	Chloroform . . . . . „ 10s. 6d.	0	1	0
3358	Collodions, various, see previous page			
3359	Cotton Wool, Best	0	0	3
3360	Dextrine . . . . . per lb., 1s. 3d.	0	0	2
3361	Æther, Sulphuric, sp. gr. ·720 . . „ 7s. 6d.	0	0	4
3362	„ „ „ ·750 . . „ 8s. 6d.	0	0	6
3363	Æther, Sulphuric, Methylated Spirit, sp. gr. ·720 per lb., 3s.	0	0	3
3364	Glycerine, pure distilled . . . „ 4s.	0	0	6
3365	Gold Chloride, in 15 gr. tubes ¼ drachm . each	0	2	6
	„ „ 30 „ ½ „ . . .	0	4	6
	„ „ 60 „ 1 „ . . .	0	8	6
3366	„ „ and Soda, non-deliquescent, neutral, 15 grs.	0	2	6
3367	Gun Cotton (Pyroxyline)	0	2	6
3368	„ Paper	0	4	0
3369	Iodine, pure (variable)	0	2	0
3370	„ Chloride	0	5	6
3371	Iron, Ammonio Citrate . . . . . per lb.	0	5	0
3372	„ Bromide	0	3	0
3373	Iron, Developer . . . . . per lb.	0	1	0
3374	„ Saccharo Sulphate . . . . . „	0	1	6
3375	„ Iodide	0	1	6
3376	„ Protosulphate . . . . per lb. 6d.	0	0	1
3377	Kaolin (China Clay), Washed . . „ 9d.	0	0	1
3378	Lime, Bromide	0	3	6
3379	„ Cylinders, for Oxy-hydrogen Light, see page 363			
3380	Lead, Nitrate	0	0	3
3381	„ Acetate	0	0	3
3382	Magnesium Wire . . . . . per foot	0	0	2
3383	Mercury, Distilled . . . . . per lb., 3s. 6d.	0	0	3
3384	„ Bichloride	0	0	6
3385	Naptha, Vegetable . . . . . per pint	0	1	3
3386	Platinum, Bichloride Solution . . . per dram	0	5	0

		£ s. d. Per oz.
3387	Potash, Bichromate	0 0 6
3388	„ Chlorate . . . . . per lb.	0 2 6
3389	„ Nitrate . . . . . „ 1s.	0 0 1
3390	Potassium, Bromide, pure	0 1 0
3391	„ Cyanide . . . in 1 lb. bottles, 4s.	0 0 4
3393	„ Fluoride	0 0 8
3394	„ Iodide, pure	0 1 6
3395	Plate Cleaning Solution . . . . per bottle 0 1 0	0 2 0
3396	Silver, Nitrate, see page	
3397	„ Oxide, pure	0 9 0
3399	Soda, Acetate . . . . . per lb., 1s. 6d.	0 0 2
4000	„ Hyposulphite . . . 28 lbs., 6s. 6d., per lb.	0 0 4
4001	„ Phosphate	0 0 2
4002	Sodium, Chloride, pure	0 0 2
4003	„ Fluoride	0 1 6
4004	Sugar of Milk	0 0 8
4005	„ Grape	0 0 6
4006	Tannin	0 1 0
4007	Test Paper, Blue Litmus, or Red . . . per book	0 0 2
4009	Tripoli	0 0 4
4010	Rouge, fine	0 0 6
4011	Rottenstone, prepared	0 0 6
4012	Uranium, Nitrate . . . . . per tube	0 3 0
4013	Varnish, Amber, in Chloroform	0 1 6
4014	„ Crystal Varnish . . . per bottle, 4s.	0 0 4
4015	„ Black Jet . . . . . per bottle 0 0 6	0 1 0
4016	„ Sohnee Freres . . . . „	0 1 9
4017	Spirit Varnish . . . . . per pint, 7s.	0 0 6
4018	Water, distilled, Chemically pure . . per gallon	0 0 8
4019	White Wax, free from Stearine . . . per lb.	0 4 0

These prices are subject to frequent variation.

All other Chemical Tests and Re-Agents supplied to Special Order.

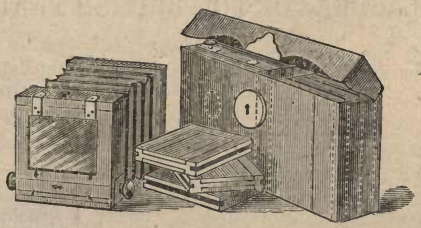
Messrs. Negretti and Zambra in republishing their Catalogue of Cameras, Lenses, and Apparatus used in the Photographic Art, wish to state, that being exclusively Photographers at the Crystal Palace, Sydenham, for over thirty years, they are enabled from their lengthened practical experience to supply such Instruments as will really be found of service to purchasers. The larger portion of the items in the List are made under N. & Z's. personal superintendence; and being finished with all the most recent and useful improvements they will be found to work with the least possibility of failure. Photographic Lenses or Apparatus supplied by Negretti and Zambra to customers can be if desired tested by their Operators at the Crystal Palace, and every explanation given as to Photographic Processes and Improvements that may be from time to time introduced.

INSTRUCTION IN PHOTOGRAPHY, by CAPTAIN ABNEY, Price 3s. 6d.

NEGRETTI & ZAMBRA'S ILLUSTRATED GUIDE TO PHOTOGRAPHY.

Austrian Gold Medal, for Photographic Stereoscopic Views on Glass.

ESTIMATES FOR SETS OF PHOTOGRAPHIC APPARATUS.



		£	s.	
4020	No 1 Set, consisting of portable Bellows Folding Camera for Plates $4\frac{1}{4}$ in. by $3\frac{1}{4}$ in., with three double backs; Compound Achromatic Lens, Portable Tripod Stand, and all necessary Chemicals and Apparatus for the Dry Plate Process. Packed in strong wooden case for travelling	10	10	0
4021	No, 2 Set, similar to No 1 Set, but for plates, 5 in. by 4 in. . .	12	12	0
4022	No. 3. Set, for plates $6\frac{1}{2}$ in. by $4\frac{3}{4}$ in.	16	16	0
4023	No. 4 Set, for plates $8\frac{1}{2}$ in. by $6\frac{1}{2}$ in.	25	0	0

4024 Leather Sling Cases for carrying Dark Slides and Lens made to order.

Estimates for larger Sets furnished on application.

4025

PREPARED DRY PLATES.

WRATTEN AND WAINWRIGHT'S

'LONDON" GELATINO-BROMIDE DRY PLATES.

SIZE OF PLATES.	PRICE PER DOZEN.	
	ORDINARY.	INSTANTANEOUS.
	s. *d.*	*s.* *d.*
$4\frac{1}{4}$ by $3\frac{1}{4}$	2 6	3 0
5 „ 4	3 6	4 6
$6\frac{3}{4}$ „ $3\frac{1}{4}$	4 9	5 9
$6\frac{1}{2}$ „ $4\frac{3}{4}$	5 6	6 6
$7\frac{1}{4}$ „ $4\frac{1}{2}$	6 6	7 6
$7\frac{1}{2}$ „ 5	7 0	8 6
8 „ 5	7 6	9 6
$8\frac{1}{2}$ „ $6\frac{1}{2}$	10 6	12 0
9 „ 7	11 0	13 6
10 „ 8	14 0	18 0
11 „ 9	16 0	21 6
12 „ 10	19 0	26 6
15 „ 12	36 0	45 0

Other sizes supplied to order. Kennett's, Swan's, Mawdsley's, and other makers' Dry plates at the advertised prices.

PLATE BOXES OF EVERY DESCRIPTION.

APPENDIX.

WEIGHTS AND MEASURES OF THE BRITISH PHARMACOPŒIA, 1867.

Weights.

1 Grain	gr.	. . . . .		Avoirdupois.
1 Ounce	oz.	. . . . .	=	437·5 Grains.
1 Drachm	drm.	. . . . .	=	37·343 Grains
1 Pound	lb.	. . . . .	=	16 Ounces or 7,000 Grains.
480·0 Grains	Troy	. . . . .	=	1 oz. Troy.
5760 „	„	. . . . .	=	1 lb. „
60 „	„	. . . . .	=	1 Drachm „
20 „	„	. . . . .	=	1 Scruple „

Measures of Capacity.

1 Minim	Min.			
1 Fluid Drachm	fl. drm.	. .	=	60 Minims.
1 Fluid Ounce	fl. oz.	. . .	=	8 Fluid Drachms.
1 pint O	O	. . .	=	20 Fluid Ounces.
1 Gallon C	C	. . .	=	8 Pints.

Measures of Length.

1 Line	=	$\frac{1}{12}$ Inch
1 Inch	=	$\frac{1}{39 \cdot 1393}$ Seconds Pendulum.
12 Inches	=	1 Foot.
36 Inches	=	3 Feet = 1 Yard.

Length of Pendulum, vibrating seconds of Mean Time in the latitude of London, in a Vacuum at the level of the sea, 39·1393 inches.

Relation of Measures to Weights.

1 Minim	is the measure of	0·91	Grains of Water.
1 Fluid Drachm	. . .	54·68	„ „
1 Fluid Ounce	. 1 Ounce or	437·5	„ „
1 Pint	. 1·25 Pounds or	8750·0	„ „
1 Gallon	. 10 Pounds or	70,000·0	„ „

WEIGHTS AND MEASURES OF THE METRICAL SYSTEM.

1 Milligramme = the thousandth part of one gramme, or 0·001 gramme.
1 Centigramme = the hundredth part of one gramme, or 0·01 gramme.
1 Decigramme = the tenth part of ditto, 0·1 gramme.
1 Gramme = weight of a Cubic Centimetre of Water at 4° Centigrade 1·0 gramme.
1 Decagramme = ten grammes, 10·0.
1 Hectogramme = one hundred grammes 100·0.
1 Kilogramme = one thousand grammes 1000·0.

Measures of Capacity.

1 Millilitre =	1	cub. centim., or the meas. of	1	gramme of water.
1 Centilitre =	10	ditto	ditto, or 10	ditto ditto.
1 Decilitre =	100	ditto	ditto, or 100	ditto ditto.
1 Litre =	1000	ditto	ditto, or 1000	ditto ditto, —1 kilometre.

Measures of Length.

1 Millimetre = the thousandth part of one metre, or 0·001.
1 Centimetre = the hundredth ditto ditto, or 0·01 metre.
1 Decimetre = the tenth ditto ditto, or 0·1.
1 Metre = the ten-millionth part of a quarter of the meridian of the earth.

RELATION OF THE WEIGHTS OF THE BRITISH PHARMACOPŒIA TO METRICAL WEIGHTS.

1 Pound	=	453·5925 Grammes.
1 Ounce	=	28·3495 „
1 Grain	=	0·0648 „

RELATION OF MEASURES OF CAPACITY OF THE BRITISH PHARMACOPŒIA TO THE METRICAL MEASURES.

1 Gallon	=	4·543487 litres.
1 Pint	=	0·567936 litres, or 567·936 cubic centimetres.
1 Fluid Ounce	=	0·028396 litres, or 28·396 „ „
1 Fluid Drachm	=	0·003549 litres, or 3·549 „ „
1 Fluid Minim	=	0·000059 litres, or 0·059 „ „

RELATION OF THE METRICAL WEIGHTS TO THE WEIGHTS OF THE BRITISH PHARMACOPŒIA.

1 Milligramme	=	0·015432 Grains.
1 Centigramme	=	0·15432 „
1 Decigramme	=	1·5432 „
1 Gramme	=	15·432 „

1 Kilogramme = 2 lbs. 3 oz., 119·8 grains, or 15432·348 „

RELATION OF THE METRICAL MEASURES TO THE MEASURES OF THE BRITISH PHARMACOPŒIA.

1 Millimetre	=	0·03937 Inches.
1 Centimetre	=	0·39371 „
1 Decimetre	=	3·93708 „
1 Metre	=	39·37079 „ or one yard 3·7 inches
1 Cubic Centimetre	=	15·432 grain measures.

1 Litre = 1 pint 15 oz. 2 drachms 11 minims, or 15432·348 grain measures.

COMPARATIVE TABLE OF ENGLISH AND FRENCH WEIGHTS AND MEASURES.

	Grains.
1 Drachm Avoirdupois	27·343
1 Pound Troy	5760
1 Ounce „	480
1 Drachm „	60

Myriagramme (10,000 grammes), 321⅔ Troy or 22·057 lbs. Avoirdupois.

Kilogramme (1000 grammes) 32⅛ oz. Troy or 2·2057 lbs. Avoirdupois.

Kilometre (1000 metres) 1093·63 yards, or 0·62138 miles.

Myriametre (10,000 metres) 10936·33 yards, or 6·21382 miles.

1 English Inch is equal to 25·39954 Millimetres.

30 English Inches = 762 Millimetres on the Barometer Scale.

OLD FRENCH LINEAL MEASURE.

				English Inches.
1 Douzième, or Point			=	0·0074
12 Points	=	1 Ligne	=	0·0888
12 Lignes	=	1 Pouce	=	1·065765
12 Pouces	=	1 Pied	=	12·7892
1 Pied			=	324·7 Millimetres.

Official Standard Bushel, containing the legal Weight of Aq. Destillata, at 62° F. Barometer at 30 Inches, 80 lbs. Avoirdupois.

½ Bushel	40 lbs. Avoidupois.	Gill	5 ozs. Avoidupois.
Peck	20 „ „	½ Gill	2½ „ „

January, 1870, ascertained error of Standard Bushel in Grains 83·343.

CARAT.—Diamonds and Pearls are weighed by the Carat, which contains 4 grains ; but 5 Diamond grains are only equal to 4 Troy grains ; the ounce Troy containing 150 Diamond Carats.

The Imperial Pound Troy, made in the year 1758, is that from which all other weights are obtained ; $\frac{1}{12}$ of it is the Troy ounce, $\frac{1}{20}$ is a pennyweight, and $\frac{1}{24}$ of the pennyweight is a grain, so that 5760 grains is a Pound Troy (12 Troy ounces) and 7000 such grains is a pound Avoirdupois, the grain in each case being identical.

WEIGHTS AND MEASURES.

480·0 grains Troy = 1 oz. Troy.
437·5 grains Troy = 1 oz. Avoirdupois.
5760·0 grains Troy = 1 lb. Troy.
7000·0 grains Troy = 1 lb. Avoirdupois.

MEASURES OF LENGTH.

Millimetre = 0·03937 inch.
Centimetre = 0·39371 inch.
Inch = 2·5399 centimetres.
Decimetre = 3·93708 inch.
Metre = 39·37079 inch.
Foot = 3·0479 decimetres.

MEASURES OF SURFACE.

Square inch = 6·4513 square centimetres.
Square foot = 9·2899 square decimetres.

MEASURES OF CAPACITY.

Cubic centimetre = 0·0610 cubic inch.
Ditto, ditto = ·00176 pint.
Cubic inch = 16·3861 cubic centimetres.
Litre, or Cubic Decimetre = 61·0270 cubic inch. or 1·760 pint.
Gallon = 4·5434 litres.

MEASURES OF WEIGHT.

Milligramme = 0·0154 grains.
Centigramme = 0·1543 grains.
Decigramme = 1·5432 grains.
Grain = 0·0647 grammes.
Gramme = 15·4323 grains.
Kilogramme = 15432·3488 grains.
Troy oz. = 31·1034 grammes.

TABLE FOR REDUCING ENGLISH FEET TO FRENCH METRES, AND FRENCH METRES TO ENGLISH FEET.

1 French Metre = 3·2808992 English Feet.

Metres or Feet.	English Feet and Decimal Parts.	French Metres and Decimal Parts.	Metres or Feet.	English Feet and Decimal Parts.	French Metres and Decimal Parts.
1	3·281	0·305	75	246·067	22·860
5	16·404	1·524	80	262·472	24·383
10	32·809	3·048	85	278·876	25·907
15	49·213	4·572	90	295·281	27·432
20	65·618	6·096	95	311·685	28·956
25	82·022	7·620	100	328·090	30·479
30	98·427	9·144	200	656·180	60·959
35	114·831	10·668	300	984·270	91·438
40	131·236	12·192	400	1312·360	121·918
45	147·640	13·716	500	1640·450	152·397
50	164·045	15·240	600	1968·539	182·877
55	180·449	16·764	700	2296·629	213·356
60	196·854	18·288	800	2624·719	243·835
65	213·258	19·812	900	2952·809	274·315
70	229·663	21·336	1000	3280·899	304·794

APPROXIMATE HEIGHT DUE TO BAROMETRIC PRESSURE.

Inches.	Feet.	Inches.	Feet.	Inches.	Feet.
31·0	0	24·5	6152	17·5	14349
30·9	84	24·0	6691	17·0	15707
—5	425	23·5	7242	16·5	16487
30·0	857	23·0	7803	16·0	17292
29·5	1296	22·5	8378	15·5	18122
29·0	1743	22·0	8966	15·0	18979
28·5	2198	21·5	9567	14·5	19865
28·0	2661	21·0	10182	14·0	20783
27·5	3132	20·5	10812	13·5	21734
27·0	3612	20·0	11458	13·0	22720
26·5	4100	19·5	12120	12·5	23746
26·0	4598	19·0	12799	12·0	24813
25·5	5106	18·5	13496	11·6	25700
25·0	5623	18·0	14212		

The English Standard of Length is the British Imperial Yard, which is the space included between two points of a certain Metal Bar when at the temperature of 60° Fahrenheit, or 15·5° Cent. A foot, which is the third part of this yard, is the unit generally employed.

A Metre, the French Standard of Length, is equivalent to the ten-millionth part of the Arc of the Meridian, extending from the Equator to the Pole.

"The Germans indicate inches by putting two accents after the number; lines by putting three accents. 27″ 3‴·85, means 27 inches 3 lines 85 hundredths of a line; more frequently they give the height in lines, and the preceding number becomes 327‴·85." —*Kaemtz.*

LIQUID MEASURES.

	Cubic Inches.	Grains of Distilled Water.
Imperial Gallon	277·274	70000 or 10 lbs.
„ Pint	34·65925	8750
„ Ounce	1·7329625	437·5
Cubic Inch in Air, temp. 62° Fahrenheit, Barometer at 30 inches . . .	1	252·458
Ditto ditto in Vacuo, temp. 62° .		252·722
Cubic Foot, in Air, at 62°, 62·3206 lbs. avoirdupois.		
Litre	61·02525	15432·
Decilitre	6·10252	1543·2

Diameter of a Cylinder containing a Gallon at one inch in depth, 18·78933 inches.

A Second of Time is the 86,400th part of a Mean Solar Day of 24 hours, and is used as the unit of Time.

A Degree of the Equator is 69·1613 miles, or 365,172 feet.

A Degree of the Meridian is 69·046 miles, or 364,565 feet.

A League is 3 miles.

A Fathom used in Sea Sounding is 2 yards, or 6 feet.

A Cable's Length is 120 fathoms, or 240 yards.

A Military Pace is 2½ feet.

The Portuguese Mile is 1·2786 English Miles.

The Legua (Spain) 8,000 Vara, or 22,256 feet, or 4·2152 miles.

The Swiss Meile is 26,666⅔ Fuss, or 8,548 Yards, or 4·8568 miles.

The Mil (Sweden and Norway) 6,000 Famn, or 11,690 Yards, or 6·6423 Miles.

A Russian Verst or Werst is 500 Sachines, or 3,500 English Feet, or 0·6629 Miles.
A German or Saxony Post-meile is 24,000 Fuss = 7,432 English yards, or 4·277 Miles.
Milan and Venice (New Decimal System of 1803). 1 Miglio = 1000 Metri, or 1,093·63 Yards, or 0·6214 Mile English.
Siam. 1 Vouah = 6·306 feet English, and the Roëneng = 2,000 Vouahs, or 12,612 Feet, or 2·3886 Miles English.
Argentine Vara, 34·10381 English Inches.
A Knot, or Nautical Mile, 6,082 feet.
An English Ordinary Mile, 5,280 feet, or 1760 yards.
A Geographical Mile, 6,080 feet.

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1 Cubic foot of Fresh water weighs 62·425 lbs. = ·557 cwt., or 0·028 of a ton.
1 Cubic foot of Sea water weighs 64·11 lbs. = ·572 cwt., or 0·0286 of a ton.
1 Cubic inch of water weighs 0·03612 lbs.
1 Cubic foot of water contains 6·24 gallons.
1 Cubic foot contains 1728 Cubic inches.
1 Ton of water contains 35·9 cubic feet or approximately 1 cubic metre.
1 Foot in head gives a pressure of 0·4335 lb. per square inch.
1 Inch of rain collected by an 8-inch circular gauge, = 29 oz. and 18 grains *Weight:* 12-inch circular gauge, 58 oz. 36 grains.

Inches of rainfall multiplied by 2323200 gives cubic feet per square mile.
Ditto ditto by 14500000 gives gallons per square mile.
Ditto ditto by 3630 gives cubic feet per acre.
1 Inch rainfall is approximately 100 tons 9 cwt. per acre.

TABLE SHOWING THE REDUCTION OF GRAMMES INTO GRAINS.

Grammes.		Grains.
1	equal to	15·432
2	,,	30·864
3	,,	46·296
4	,,	61·728
5	,,	77·160
6	,,	92·592
7	,,	108·024
8	,,	123·456
9	,,	138·883
10	(Decagramme)	154·323
100	(Hectogramme)	1543·234
1000	(Kilogramme)	15432·348

The *gramme* is the French unit of weight.

A Troy ounce is equal to 31·103 *grammes.*

An Avoirdupois ounce = 28·356 *grammes.*

TABLE SHOWING THE REDUCTION OF CUBIC CENTIMETRES INTO MINIMS.

Cubic Centimetres.		Minims.
1	equal to	16·896
2	,,	33·792
3	,,	50·688
4	,,	67·584
5	,,	84·480
6	,,	101·576
7	,,	118·272
8	,,	135·168
9	,,	152·064
10	,,	168·960
20	,,	337·920
30	,,	506·880
40	,,	675·840
50	,,	844·800
100	,,	1689·600
1000	= 1 litre, or 1·76 pint	16896·000

A cubic *centimetre* is the unit of French liquid measure; 1,000 cubic *centimetres* being equal to 1 *litre*, or 1·76 pint = 35¼ fluid ounces. A cubic *centimetre* of water measures nearly 17 minims: it weighs 1 *gramme*, or 15·4 grains.

A cubic inch is equal to 16·386 cubic *centimetres*, a gallon = 4·543 *litres.*

HORSE POWER OF STEAM ENGINES.

When Steam Engines were first introduced, they were commonly applied to work pumps or mills which had been previously wrought by horses. It was therefore convenient to be able to express the performances of these machines by comparison with animal power, to which miners and others had been accustomed. When an Engine was capable of performing the same amount of work in a given time as any given number of horses, such Engine was said to be of so many horses' power. This term having been long in use, it was retained; it only being requisite to determine upon some standard by which it could be defined. The performance of a horse of average strength working for eight hours a day was therefore selected as a standard or unit of Steam Engine power.

Smeaton estimated the amount of mechanical effect which the animal could produce at 22,916 pounds raised one foot per minute. Desaguliers makes it 27,500 pounds raised through the same height. Messrs. Boulton and Watt caused experiments to be made with the powerful horses used in London breweries, and from the result of these they assigned 33,000 pounds raised one foot per minute as the value of a horse's power; this estimate is now generally adopted, and when an Engine is said to be of so many horses' power, it means that when in good working order, and properly managed, it is capable of overcoming a resistance equivalent to so many times 33,000 pounds raised one foot high per minute. Thus an Engine of 10-horse power should be capable of raising 330,000 pounds one foot per minute.

It being explained that one horse power expresses 33,000 pounds raised one foot high per minute, 1,980,000 pounds raised one foot high per hour, it is required to determine the quantity of water which a boiler must evaporate per hour for each horse power of the Engine which it works. The quantity of water requisite to produce this result by evaporation will be found by considering that one cubic inch of water evaporated will produce a mechanical force equivalent to 2,160 pounds raised one foot high. If we divide 1,980,000 by 2,160, it will give the number of cubic inches of water that must be evaporated per hour to produce the mechanical effect expressed by 1 horse power; the result of this division is 916, which is therefore the number of cubic inches of water per hour whose evaporation is equivalent to one horse power. In actual practice it has been customary for engineers to allow one cubic foot of water per hour for each horse power, a cubic foot being 1,728 cubic inches, or about 11 per cent more than the above estimate.

Another authority gives the following :—

One nominal horse power requires approximately . . . { 5 gallons of water per hour / 15 pounds of coal . . . } { 1 square yard of heating surface. / 1 square foot of fire-bar surface. }

In practice one pound of coal or coke should evaporate about five pounds of water.

The nominal horse power of a cylindrical double or single flued boiler may be found approximately by the following rule :—The length multiplied by the diameter, and divided by 5.

Water Pressure. Height in feet.	Pressure in cwt. per square foot.	Water Pressure. Height in feet.	Pressure in cwt. per square foot.	Water Pressure. Height in feet.	Pressure in cwt. per square foot.	Water Pressure. Height in feet.	Pressure in cwt. per square foot.
1 .	·55	30 .	16·71	70 .	39·	150 .	83·6
5 .	2·78	35 .	19 5	80 .	44·5	175 .	97·5
10 .	5·57	40 .	22·3	90 .	50·1	200 .	111·
15 .	8·36	50 .	27·8	100 .	55·7	250 .	139·
20 .	11·14	60 .	33·4	125 .	69·6	300 .	167·
25 .	13·93						

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1 Atmosphere equals 14·71 lbs. per square inch or about 15 lbs. approximately.
Ditto ditto 29·22 inches Mercury.
Ditto ditto 33·9 feet Water.

HEAT DISENGAGED DURING COMBUSTION.

Hydrogen Gas	34462	Wood, dry	4025	Tallow	8000
Marsh Gas	13063	Wood, moist	3100	Diamond	7770
Olefiant Gas	11858	Carbonic oxide	2400	Absolute Alcohol	7180
Oil of Turpentine	10852	Sulphur	2220	Phosphorus	5750
Olive oil	9860	Anthracite	8460	Bisulphide of Carbon	3401
Æther	9030	Charcoal	8080	Iron	1576
Coke	7000	Coal	8000		

The experiments of MM. Favre and Silbermann are the most trustworthy, as having been executed with the greatest care. They agree very closely with those of Dulong. Taking as thermal unit the heat necessary to raise the temperature of a pound of water through *one* degree Centigrade, the above table gives the thermal units in round numbers disengaged by a pound of each of the substances in burning in oxyen.

The experiments of Dulong, of Despretz, and of Hess prove that a body in burning always produces the same quantity of heat in reaching the same degree of oxidation, whether it attains this at once or only reaches it after passing through intermediate stages. Thus a given weight of carbon gives out the same amount of heat in burning directly to carbonic acid as if it were first changed into carbonic oxide and then this burnt into carbonic acid.

GANOT.

Heat of a common fire 1141° ; Wind Furnace White Heat, 3300°, is stated as its highest temperature.

EXPANSION BY HEAT from 32° to 212° Fahrenheit :—

Mercury	0·0180180	Platinum	0·0008842 of the length.
Water	0·0433200, from 39° to 212°	Flint Glass	0·0008117 „ „
Alcohol	1·1100 „ 32° to 174°	Brass	0·0018708 „ „
Sulphuric Acid	0·0600		

The Expansion or Contraction of Liquids heavier than Water (except Mercury) is about 1 degree (or 5 grains) for every 10 degrees of temperature above or below 60° F., varying slightly with the specific gravity of the liquid.

Water boiling at	212° Fahrenheit.
Alcohol	174°, variable with its Specific Gravity.
Mercury boils	660° „
Sulphuric Acid	590° „
A Saturated solution of Sea salt	218° to 226°
Sea Water	213·2° variable.

Specific Gravity of a Saturated Solution of Sea Salt is 1·208 at 60°.

Average Specific Gravity of Sea Water is 1·026 to 1·028.

Vital Heat, 98·5 Fahrenheit. See also page 161.

Heat borne by Delaroche 228° Fah. Highest temperature borne by Sir Joseph Banks and Sir Charles Blagden in a prepared heated chamber 264° Fah.; notwithstanding the extraordinary degree of heat to which the experimenters were exposed for some considerable period, it is stated that the temperature of their bodies was not perceptibly raised. In some of the modern Turkish Baths Dry Air at a temperature varying from 250° to 300° Fah. is said to be used for short periods of time. Captain Nares and his companions, in the Polar Expedition of 1875-76, state the *lowest Temperature* experienced was 62° below Zero of Fahrenheit's scale. See also page 195.

Oxygen Gas, solid, at 130° Centigrade and under the pressure of 470 atmospheres.

Boiling-points under the pressure of an atmosphere.

	Centigrade.		Centigrade.
Sulphurous Acid	10 °	Turpentine	160 °
Æther	37 „	Strong Sulphuric Acid	325 „
Bisulphide of Carbon	48 „	Mercury	350 „
Bromine	63 „	Sulphur	447 „
Alcohol	78 „	Cadmium	860 „
Distilled Water	100 „	Zinc	1042 „

Laws of Ebullition— GANOT.

I. The temperature of ebullition, or boiling point, increases with the pressure.

II. For a given pressure, boiling commences at a certain temperature, which varies in different liquids, but which for equal pressures is always the same in the same liquid.

III. Whatever be the temperature of the source of heat, as soon as ebullition begins the temperature of the liquid remains stationary.

Thus, the boiling point of water under the ordinary atmospheric pressure being 212° F. or 100° Cen., it would not be heated beyond that point, whatever the intensity of the source of heat; the only effect of higher temperature being to hasten the rapidity of vaporisation; hence all the heat which passes from the source into the liquid is absorbed by the vapour disengaged.

SOLIDIFICATION OF OXYGEN.

At the Royal Institution, May 27th, 1886, Professor Darwar exhibited for the first time to a few friends, including the president of the Royal Society, the method he employs for the production of Solid Oxygen. The successful device employed by the Professor at the Royal Institution depends upon allowing liquid oxygen to expand into a partial vacuum, when the enormous absorption of heat which accompanies the expansion results in the production of the solid substance. Oxygen in this condition resembles snow in appearance, and has a temperature about 200° Centigrade below the freezing-point of water. A supply of this material will enable chemists to approach the absolute zero of temperature and to investigate many interesting changes in the physical properties of bodies under the primordial condition of the temperature of space.

INSTRUCTIONS FOR FIXING OR SETTING HORIZONTAL SUN DIALS.

It is most important that the plane upon which the Dial is to be fixed be truly horizontal, and the North and South line be accurately ascertained. The surface of the Dial may easily be made parallel to the horizon or level, with the aid of a good Spirit Level, by testing its surface in at least three directions across its diameter.

To find the true Geographical North and South or Meridian line for the place, it is requisite to have a good Mariner's Compass, and also to know the Variation of the Compass Needle for the locality at which the Dial is to be erected. For London the present variation is Westerly 18° 20′ at Kew, 18° Greenwich.

Now by the Compass bearings carefully mark off on the plane surface the true North and South points, and by them set the Sun Dial to correspond. This will then indicate Solar or True Time, which agrees with Mean Time (or that shown by a clock) only on four different days in the year. To find the mean time it is necessary to apply a correction called the Equation of Time, from a table which is mostly engraved upon the best constructed Sun Dials, or upon the wooden Artificial Horizon of Terrestrial Globes. Also see below.

A convenient season for setting Sun Dials by this method is about the time of the Vernal or Autumnal Equinox (March and September) when the Dial and clock very nearly agree.

COMPASS VARIATIONS. *From "Mechanics' Magazine," March 16th*, 1865. See p. 318.

Years.	Degrees.	Minutes.	Yearly Rate of Change. Min.
1576	11	15	E . . . 7
1622	6	15	E . . . 11
1657	0	0	True North . 12
1672	2	30	W . . . 13
1720	13	0	W . . . 9
1765	20	0	W . . . 5
1819	24	41	W Max. W . 0
1852	22	18	W . . . 4
1865	20	38	W . . . 7

EQUATION TABLE.

JAN.		FEBY.		MARCH.		APRIL.		MAY.		JUNE.		JULY.		AUG.		SEPT.		OCT.		NOV.		DEC.	
	M																						
1	Fast	4	1	Fast	14	1	Fast	13	3	Fast	3	1	Slow	3	4	Slow	2	4	Fast	4	10	Fast	5
3	5	21	13	3	12	7	2			9	1	10	5	15	4	7	2	7	12	20	14	5	9
6	6	27	12	7	11	11	1			14		21	6	20	3	10	3	10	13	24	13	7	8
8	7			11	10	15				20	Fast	1		24	2	13	4	14	14	27	12	9	7
10	8			15	9	20	Slow	1		24	2			27	1	16	5	19	15	29	11	11	6
13	9			18	8	24	2			29	3			31		18	6	27	16			13	5
16	10			21	7											21	7					15	4
19	11			25	6											24	8					17	3
22	12			28	5											27	9					19	2
27	13			31	4											30	10					21	1
																						24	
																						26	Fast 1
																						28	2
																						30	3

Fast means that the Clock should be faster than the Dial; Slow, slower.
For Fractional differences of Time consult the Nautical Almanack.

Table of the height in feet of the rise of SPRING TIDES *in various parts of the World.*

	Ft.		Ft.		Ft.		Ft.
Abbey Head, England	23	Corunna, Spain .	15	Heligoland , .	9½	Ramsgate . .	15
Aberdeen, Scotland .	12	Charlestown, U.S. .	6	Hong Kong . .	4¾	Rio Janeiro . .	4
Adelaide, Australia .	6	Dover . . .	18¾	Jersey, Chan. Islands	30¼	Ryde Bay . .	22
Aden Bay, Arabia .	7	Dungeness . .	21¾	St. John, Bay of Fundy	27	Sheerness . .	16
Agnes Pt., Scilly Isles	16	Dieppe . . .	27	Lowestoft . . .	6½	Swansea, Mumbles Lt.	27
Air Point, R.D., Eng.	25	Demerara, Guiana .	9	Lundy Island, Bristol		St. Malo . . .	25
Akyab, Bay of Bengal	9	Eddystone Light .	18	Channel . . .	27	San Francisco . .	4¾
Algoa Bay, Africa .	6½	Fleetwood . . .	26½	Margate . . .	15½	Sierra Leone . .	8
Beachy Head . .	20	Flatholm Islands .	37	Malaga, Spain . .	3	Sarawak, Borneo .	16½
Bridgewater Bar, Eng.	35	Folkestone . .	20	Melbourne, Australia	3	Singapore . . .	10
Bergen, Norway .	4	Foreland, N. . .	10	Maulmain, Bengal .	22	Shanghai . . .	10
Bombay . . .	12·17	Foreland, S. . .	18	Needles Point . .	7½	Sydney . . .	4¾
Boulogne . . .	25	Formby Point . .	28	New York, U.S. .	5	Trinidad . . .	4
Boston, U.S. . .	11½	Gravesend, Thames .	17½	Nelson, N.Z. . .	14	Table Bay . . .	5
Caermarthen, Wales.	26	St. Katherine Dock .	24	Philadelphia, U.S. .	6¾	Woolwich . . .	18½
Chatham . . .	17½	Carribbee Islands .	1½	Port Philip, Australia	4	Yokohama . . .	6¼
Cape Clear, Ireland .	9	Harwich . . .	11½	Port Royal, Jamaica	1	Zanzibar . . .	10
Calais	19½	Hastings . . .	24				

TABLE OF DIFFERENCE OF TIME BETWEEN GREENWICH AND THE FOLLOWING PLACES.

East of Greenwich.	Time Faster. H.	M.	S.
Algiers . .	0	12	16
Alexandria .	1	59	32
Athens (Greece)	1	35	0
Berlin . .	0	53	35
Bombay . .	4	52	0
Brindisi (Italy) .	1	12	0
Brussels . .	0	19	0
Calcutta . .	5	54	0
Canton . .	7	33	0
Cairo . .	2	5	12
Cape of Good Hope	1	14	0
Christiana .	0	43	0
Constantinople .	1	56	0
Genoa .	0	35	32
Geneva . .	0	24	37
Greenwich 12 o'clock noon . .	0	0	0
Jeddo . .	9	20	0
Madras . .	5	22	0
Manilla . .	8	4	8
Malta . .	0	58	0
Moscow . .	2	30	0
Munich . .	0	46	30
Naples . .	0	57	4

East of Greenwich.	Time Faster. H.	M.	S.
Paris . .	0	10	0
Pekin . .	7	46	0
Rome . .	0	50	0
Rotterdam . .	0	18	0
Singapore . .	6	56	0
Siam . . .	6	40	0
Suez . . .	2	10	16
Smyrna . .	1	49	0
St. Petersburg .	2	1	16
Venice . .	0	57	4
Vienna . . .	1	5	30
Warsaw . .	1	24	9

West of Greenwich.	Time Slower. H.	M.	S.
Baltimore . .	5	6	27
Barbadoes . .	3	50	28
Boston . .	4	44	14
Buenos Ayres .	3	53	28
Cape Horn .	4	19	4
Chicago . .	5	50	31
Cincinnati . .	5	37	58
Dublin . .	0	25	0
Glasgow . .	0	17	0

West of Greenwich.	Time Slower. H.	M.	S.
Gibraltar . .	0	21	28
Havana . .	5	29	25
Jamaica, Kingston	5	7	4
Lima . . .	5	8	24
Liverpool . .	0	12	0
Lisbon . .	0	36	36
Madrid . .	0	14	0
Monte Video .	3	45	0
Mexico . .	6	36	20
New Orleans .	6	0	0
New York, Sandy Hook . .	4	55	0
Panama . .	5	18	0
Philadelphia .	5	0	34
Quebec . .	4	44	49
Rio Janeiro .	2	56	36
Savannah . .	5	24	21
Salt Lake City .	7	28	24
San Francisco .	8	9	47
Sydney . .	10	16	0
St. Thomas .	4	19	41
Toronto . .	5	17	34
Valparaiso . .	4	47	0
Vera Cruz . .	6	24	34

VELOCITY OF LIGHT.

In 1675 and 1676 Olaf Rœmer, a Danish astronomer, first determined the velocity of Light from observations of the eclipses of Jupiter's first satellite as 192,500 miles per second

Bradley, at Kew, in 1723 determined the velocity of Light as 191,515 miles per second.

M. Foucault, by a modification of Wheatstone's revolving mirror, calculated the velocity at 185,177 miles per second.

M. Fizeau, at Paris, in 1849, by experiments carried on between Suresnes and Montmartre, found the velocity to be 194,677 miles per second.

More recent experiments by Foucault and Fizeau, 186,633 miles per second is stated.

By another experiment, the result is given as 196,000 miles per second.

The recent American determinations of the velocity of light, justly considered as of far superior precision to any others yet executed, give the following results :—

Michelson at Naval Academy, in 1879	299,910 km.
Michelson, at Cleveland, 1882	299,853 „
Newcombe, at Washington, 1882, using only results supposed to be nearly free from constant errors	299,860 „
Newcomb, including all determinations	299,810 „
To these are added for comparison :—	
Foucault, at Paris, in 1862	298,000 „
Cornu, at Paris, in 1874	298,500 „
Cornu, at Paris, in 1878	300,400 „
The same discussed by Listing	299,990 „
Young and Forbes, 1880–81	301,382 „

Prof. Newcomb's finally-concluded result is that light travels *in vacuo* at the rate of 299,860 – 30 kilometres per second. And the probable error of thirty kilometres, small as it is, has been liberally estimated.—*Measures of the Velocity of Light made during the years* 1881, 82, *by Professor S. Newcomb, U.S. Navy. See "Nature," June 24th*, 1886.

VELOCITY OF SOUND.

The velocity of Sound is 1,125 feet in a second, at a temperature of 61° Fahreheit, or 16·6 C; therefore a distance of 50 miles would be traversed in 4 minutes.

In 1823, on two hills, Kooltjesberg and Zevenboomen, near Amsterdam, accurate experiments were made to determine the velocity of sound by Moll and Van Beck. Making corrections for temperature, moisture, barometric pressure, and the action of the wind, the result of these experiments as corrected by Schröder Van der Kolk gives 1,092·78 feet as the velocity of sound per second in a dry atmosphere with the barometer reading 760 m.m., or 29·931 inches.

The velocity of sound increases with increase of temperature : this amounts to nearly two feet for every degree Centigrade. For the same temperature it is independent of the density of the air, and therefore of the pressure.

VELOCITY OF ELECTRICITY.

"This is so great that the most rapid motion that can be produced by art appears to be actual rest when compared with it. A wheel revolving with a rapidity sufficient to render the spokes invisible, when illuminated by a flash of electricity, is seen for an instant with all its spokes distinct as if it were in a state of absolute repose ; because, however rapid the rotation may be, the light has come and already ceased before the wheel has had time to turn through a sensible space.

"Let a circular piece of pasteboard be divided into three sections ; let one be painted *blue* another *yellow*, and a third *red*. Cause it to rotate rapidly, it will appear white, because a sunbeam consists of a mixture of these colours, and the rapidity of the motion causes the distinction of colours to be lost to the eye; but the instant the pasteboard is illuminated by the electric spark, it seems to stand still, and each colour appears as distinct as if the disc were at rest.

"By a beautiful application of this principle, Wheatstone contrived an apparatus by which he demonstrated that the light of the electric discharge does not last the *one-millionth part* of a second of time. His plan was to view the image of a spark reflected from a plane mirror, which, by means of a train of wheels, was kept in rapid rotation on a horizontal axis. The number of revolutions performed by the mirror was ascertained to be 800 in a second, during which time the image of a stationary point would describe 1,600 circles, because from the laws of reflection the image of an object in a revolving mirror has *twice the angular velocity* of the latter, and the elongation of the spark through half a degree would indicate that it exists $\frac{1}{1,632,000}$th part of a second. A jar was discharged through a copper wire half a mile in length, interrupted both in the middle and also at its two extremities, so as to give three distinct sparks. The deviation of half a degree between the two extreme sparks would indicate a velocity of 567,000 miles in a second. This estimated velocity is on the supposition that the electricity passes from one end of the wire to the other; it however, according to the *two fluid* theory, the two electricities travel simultaneously from the two ends of the wire, the two external sparks will keep their relative positions, the middle one alone being deflected, and the velocity measured will be only one-half that in the former case, *viz.*, 288,000 miles in a second."

There are, however, great discrepancies in the different measurements which have been recorded of the velocity of Electricity, thus :—

Walker (America) with Telegraph Iron wire makes it	18,780	miles	per second.
O'Mitchell (America) " " "	28,524	"	"
Fizeau and Gonnelle, Copper Wire, make it . .	112,680	"	"
" " Iron Wire " . .	62,600	"	"
* Astronomers of Greenwich and Brussels, Copper, London and Brussels telegraph, make it . .	2,700		
Astronomers of Greenwich and Edinburgh, Copper, London and Edinburgh telegraph, make it .	7,600		

NOAD.

LAWS OF FALLING BODIES.

"The *Velocity which is communicated to a body falling freely by Gravity.* Bodies falling freely near the earth's surface, have communicated to them *equal additions of velocity in equal times;* and since, by the first law of motion, none of these increments of the velocity are lost, but all accumulated in the falling body, it follows that its actual amount at any time must be proportioned to the time during which the body has fallen. If, for instance, a body has fallen through ten seconds, since in each second the attraction of the earth will have communicated to it the same addition of velocity, and since all these additions of velocity will be retained in it, its actual velocity must be ten times that which it would have had after falling one second.

"The velocity which gravity thus communicates to a falling body in *each second of time* near the earth's surface is $32\frac{1}{6}$ feet, so that after falling five seconds, its velocity will be five times this amount; after ten seconds ten times this amount; and so on. The velocity is so great, that it would never have been possible to ascertain its amount by direct observations on the fall of heavy bodies.

"Could we, however, by any contrivance, *neutralise* the gravitating tendency of a body to any known amount; reduce it, for instance, to *one-half* or *one-tenth* or *one-hundredth* of what it was; since we should diminish the *velocity* communicated to it in each second precisely to the same amount, we might thus render its motions so slow that they might be *observed* and *measured,* we might thus find the amount of the additional velocity actually communicated to it in each second, and this multiplied by the known number of times by which we had previously diminished the force of its gravity, would give us the velocity which that fall would communicate in each second when *undiminished.* This is the object of *Attwood's Machine.*" (Page 492)—*Illustrations of Mechanics, Moseley.*

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* *Athenæum,* January 14th, 1854,

OHM'S LAW.

Ohm assumed the passage of the electric fluid from one section to another of the connecting wire to be due solely to the difference of electric tension between the two sections; he further assumed the quantity of electricity transmitted to be proportional to this difference of tension, and from these fundamental assumptions he deduced the laws of the voltaic circuit. These laws may be briefly stated thus :—

a. The strength of the current is directly proportional to the electromotive force.

b. The strength of the current is inversely proportional to the resistance.

c. If the wire which unites the two poles of battery be of the same material, and of the same thickness throughout, the "electric fall" is the same throughout the wire.

d. If the wire be of the same material but of different thicknesses, the "fall" is steeper on the thin wire than on the thick. The 'fall" is inversely proportional to the cross section of the wire.

e. If the poles be connected by two wires of the same thickness but of different resisting powers, the "electric fall" is steeper on the more resisting wire. The "fall" is directly proportional to the specific resistances of the wires.*

It has been found that when the same current is passed respectively through a short and through a long wire of the same material, its action on the magnetic needle is less in the latter case than in the former. Ohm accordingly supposed that in the latter case there was a greater *resistance* to the passage of the current than in the former; and he proved that *the resistance is inversely proportional to the intensity* of the current.

On these principles Ohm founded the celebrated law which bears his name, that—

The intensity of the current is equal to the electromotive force divided by the resistance.

Which is expressed by the simple formula $I = \frac{E}{R}$

Where I is the intensity of the current, E the electromotive force, and R the resistance.†

ELECTRIC UNITS.

The *Unit of Resistance* is

1 Ohm = 1 British Association Unit = 1 B. A. U. = 10 Million Units of resistance, or :

1 Siemen's Unit = 1 S.E., the resistance of a prism of mercury, 1 metre long, and 1 square millimetre in section at 0° C.

1 Ohm = 1·070 S.E.

1 S.E. = ·935 Ohm.

1 Megohms = 1 million Ohms.

The *Unit of Tension* is = 1 Volt = 100,000 Units of Tension.

The *Unit* of Quantity = 1 Weber.

The Unit of Charge is = 1 Microfarad = 1 Millionth part of a Farad.†

† *Electric Testing of Telegraph Cables.* By Capt. V. Hoskiæv, Royal Danish Engineers.

1 Ohm = about one mile of Copper Wire, No. 16 B. W. Gauge; or 1 mile of No. 8 Iron Wire, B. W. Gauge—a rough definition by a Workman.

The laws of the voltaic circuit as enunciated by Ohm have been verified by Kohlrausch and others, and found to be in strict accordance with his theory.

THERMOMETER SCALES.

The Zero or Freezing Point of the Centigrade and of Reaumur's Scale correspond to 32° of Fahrenheit's Thermometer.

The Boiling Point of the Centigrade Scale is 100° of Reaumur's Scale, 80° being equivalent to 212° of Fahrenheit.

EASY RULES FOR THE CONVERSION OF SCALES.

To convert Fahrenheit degrees into Centigrade, substract 32, multiply by 5, and divide by 9.

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* See Tyndall's *Notes on Electricity.* † See Ganot's *Elementary Treatise on Physics.*

To convert Centigrade into Fahrenheit, multiply by 9, divide the product by 5, and add 32.
To convert Reaumur degrees into Centigrade, multiply by 5 and divide by 4.
To convert Reaumur degrees into Fahrenheit, multiply by 9, divide by 4, and add 32.

THERMOMETER TABLE.

Comparison of Centigrade and Fahrenheit.

Cent.	Fah.	Cent.	Fah.	Cent.	Fah.	Cent.	Fah.	Cent.	Fah.
−17.7	0	7	44·6	31	87·8	55	131	78	172·4
−16	3·2	8	46·4	32	89·6	56	132·8	79	174·2
−15	5	9	48·2	33	91·4	57	134·6	80	176
−14	6·8	10	50	34	93·2	58	136·4	81	177·8
−13	8·6	11	51·8	35	95	59	138·2	82	179·6
−12	10·4	12	53·6	36	96·8	60	140	83	181·4
−11	12·2	13	55·4	37	98·6	61	141·8	84	183·2
−10	14	14	57·2	38	100·4	62	143·6	85	185
− 9	15·8	15	59	39	102·2	63	145·4	86	186·8
− 8	17.6	16	60·8	40	104	64	147·2	87	188·6
− 7	19·4	17	62·6	41	105·8	65	149	88	190·4
− 6	21.2	18	64·4	42	107·6	66	150·8	89	192·2
− 5	23	19	66·2	43	109·4	67	152·6	90	194
− 4	24·8	20	68	44	111·2	68	154·4	91	195·8
− 3	26·6	21	69·8	45	113	69	156·2	92	197·6
− 2	28·4	22	71·6	46	114·8	70	158	93	199·4
− 1	30·2	23	73·4	47	116·6	71	159·8	94	201·2
0	32	24	75·2	48	118·4	72	161·6	95	203
1	33·8	25	77	49	120·2	73	163·4	96	204·8
2	35·6	26	78·8	50	122	74	165·2	97	206·6
3	37·4	27	80·6	51	123·8	75	167	98	208·4
4	39·2	28	82·4	52	125·6	76	168·8	99	210·2
5	41	29	84·2	53	127·4	77	170·6	100	212
6	42·8	30	86	54	129·2				

TABLE OF MEAN WINTER, MEAN SUMMER, AND ANNUAL MEAN TEMPERATURE FAHRENHEIT.

	Winter Mean Tempt.	Sum. Mean Tempt.	Annual Mean Tempt.		Winter Mean Tempt.	Sum. Mean Tempt.	Annual Mean Tempt.
London	39·5	63°	51°	Batavia	79	81	80·5
Dublin	40	66·5	49	Madras	76·5	86	82
Edinburgh	38·5	58·	47·5	Rio Janeiro	68·5	79	73·5
Paris	38	64·5	51·5	St. Croix (Teneriffe)	64·5	77	71·5
Rome	46·5	73·	60	Monte Video	57·5	77·5	67
Naples	50	75·5	62	Buenos Ayres	52·5	73	62·5
Gibraltar	57	73	64·5	Mexico	55·5	66·5	62
Berlin	30	63	47·5	Algiers	54·	74·5	64
Stockholm	26	61	42	Nangasaki	47·1	81·8	64·9
Warsaw	27·5	63·5	45·5	Cape of Good Hope	58·5	74°	66·5
New Archangel	33	55	44·5	New Orleans	53	80	67
Constantinople	40·5	73·5	57	Montreal	17·5	69	44
Madrid	42	74	58	Toronto	26·5	63·8	44·4
Cairo	58·5	84·5	72·5	Penzance	44	62	52
Calcutta	67·5	83·5	78·5	Pekin	26	83	55
Bombay	74	83	79	Quito	60	60	60
Singapore	78·5	81	80·5	Canton	55	82	70

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