

## 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. Some 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 Procelain 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 obliterated by the action of the atmosphere, sea-water, or damp. The divisions

and figures on these Procelain 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.

**33. Independent Standard Thermometer** (fig. 28), 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 Procelain scales.

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.

*Price, £5 5 0*

**34. Comparative Standard Thermometers** (fig. 29).—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. 28.



FIG. 29.

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. 30.\*



FIG. 30.

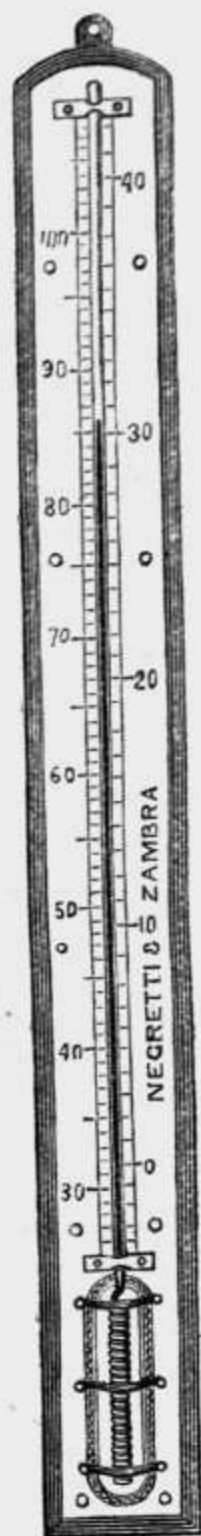


FIG. 31.

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.

35. **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 subdivision into tenths of degrees, and ranging from  $0^{\circ}$  to  $130^{\circ}$ . 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. 30). 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

36. **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. Glashier in his balloon ascents to obtain very rapid thermometric readings.

(Fig. 30.\*)

*Price*, £3 3 0 to £6 6 0

37. **Thermometers, very delicate**, with Spiral or Coiled bulbs, engine-divided upon the stem, mounted on boxwood, metal or opal glass scales. Fig. 31.

*Price*, £2 2 0 and £3 3 0

38. **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. 32 and 32\*.

*Price*, £1 15 0 and £2 2 0

39. **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

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  $10^{\circ}$  higher than it does when undrained; and this is not suprising when we find that 1lb. of water evaporated from 1,000 lbs. of soil will depress the whole by  $10^{\circ}$ , owing to the latent heat which it absorbs in its conversion

FIG. 32\*. 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

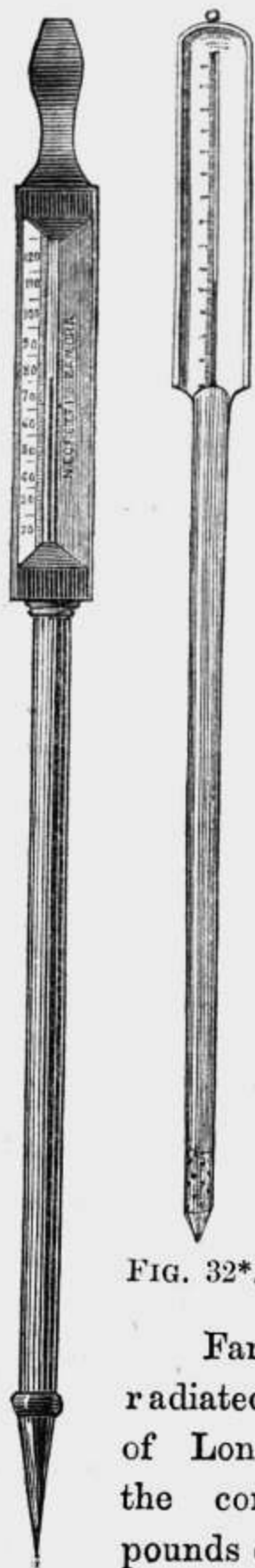


FIG. 32.



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  $28^{\circ}$ , and at  $84^{\circ}$  at noon. Mr. Bruce records a temperature at Gondar of  $113^{\circ}$ . The thermometer at Benares rises to  $118^{\circ}$ ; at Sierra Leone the thermometer on the ground has been seen to rise to  $138^{\circ}$ , and Humboldt gives many instances of the temperature of the torrid zone rising to  $118^{\circ}$ ,  $120^{\circ}$ , and  $129^{\circ}$ . 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  $105^{\circ}$ , 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  $162^{\circ}$  and  $134^{\circ}$  are frequently noted, and in white sand at Orinoco  $140^{\circ}$ , whilst at the Cape of Good Hope under the soil of a bulb garden a temperature of  $150^{\circ}$  is recorded by Herschell. In China, the temperature of water of the fields was found to be by Meyer  $113^{\circ}$  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.

#### Negretti and Zambra's

##### Patent Self-registering Maximum Thermometer.

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

40. 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 Sixe, 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

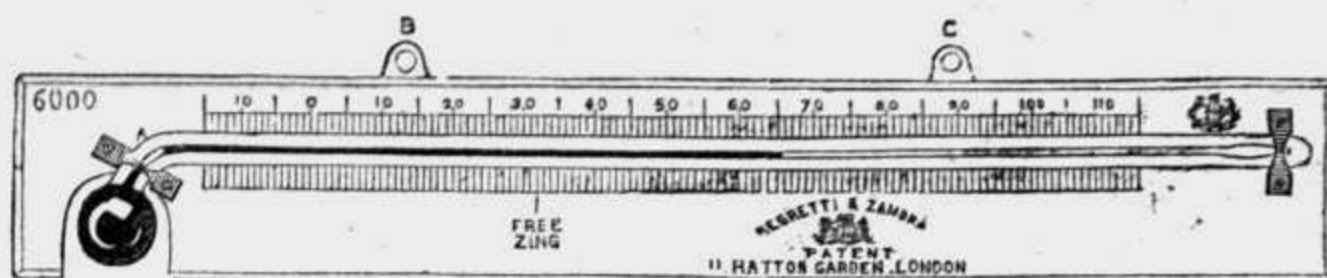


FIG. 33.

plunge in the mercury, Sixe'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.

40\* **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. 33. 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, figs. 33 and 34 . . . . . £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 :—

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





FIG. 34.

*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 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."

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

The following is from the late JOHN DREW, Ph. D., F.R.A.S., Author of *Practical Meteorology, &c., &c.*

"GENTLEMEN,—In my opinion your Maximum Thermometer, as it becomes more generally known, will supersede every other. The impossibility of the index getting out of place, how much soever the instrument may be agitated, will always give it the preference over every other maximum thermometer with a moveable index."

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,  
September 1st, 1856.

M. J. J. JOHNSON, Esq., to Messrs. NEGRETTI and ZAMBRA.

"GENTLEMEN,—I beg to state that your meteorological instruments, with glass mountings and graduated stems, have been in use at this Observatory since February, and I have every reason to be satisfied with their performance, both as regards the ordinary and the self-registering instruments; the Maximum Thermometer, in the latter class, is one of your own invention and construction."

RADCLIFFE OBSERVATORY, OXFORD,  
21st August, 1856.

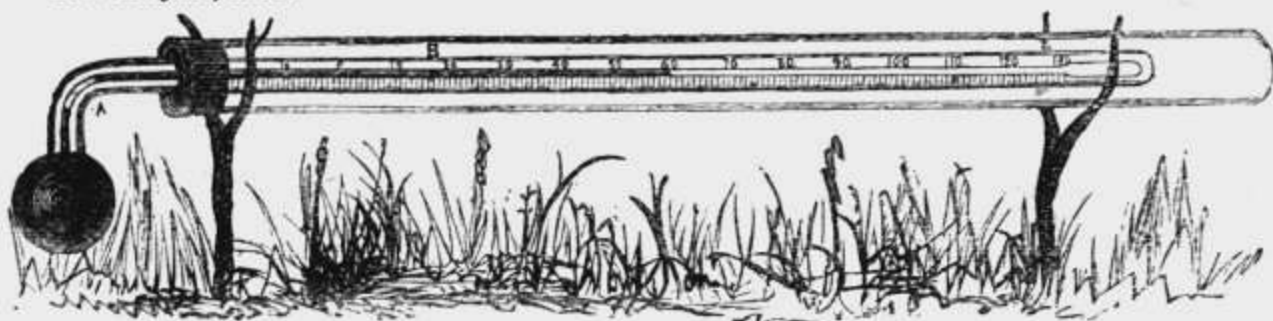


FIG. 35.

41. Negretti and Zambra's Patent Solar Radiation Thermometer (fig. 35).—Consists of a mercurial thermometer with a blackened bulb, the 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. 40\*.

Price, £1 1 0

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

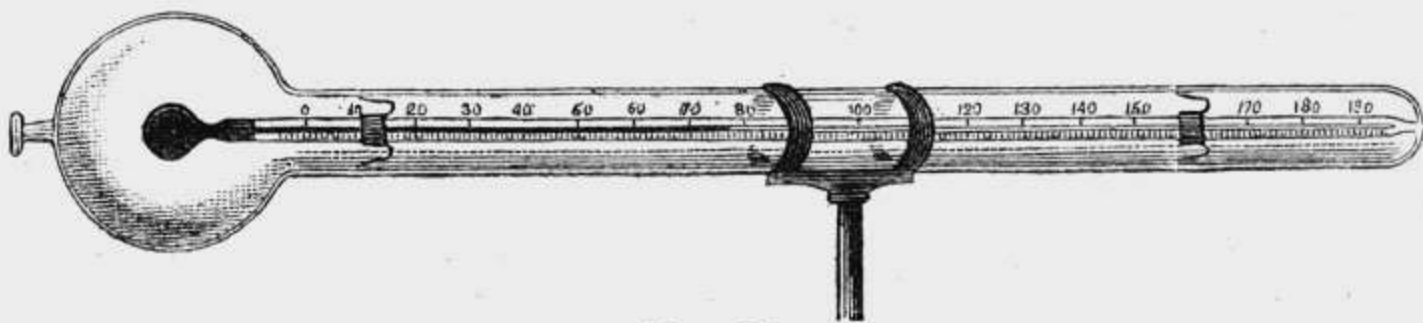


FIG. 36.

43. Vacuum Solar Radiation Thermometer (fig. 36).—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  $20^{\circ}$  to  $30^{\circ}$  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  $20^{\circ}$  only, whilst the difference between the air temperature and the reading of a Radiation Thermometer in *vacuo* has been as large as  $50^{\circ}$ . 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. 35) 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*

43. Negretti and Zambra's Improved Solar Radiation Vacuum Thermometer, with Mercurial Test Gauge. (Fig. 37.)

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

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 elec-

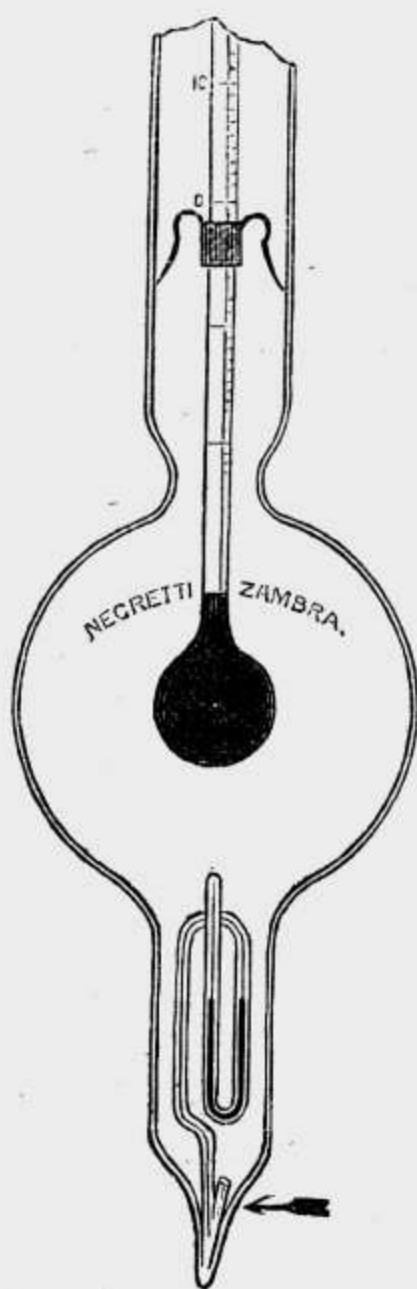


FIG. 37.



tricity from a Rhumkorf's Induction Coil can be passed through the tube, and the colour, etc., etc., 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

44. **Wood Stand for Negretti and Zambra's Patent Vacuum Solar Radiation Registering Thermometer**, for experiments at four feet from the 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. A wood engraving of this Thermometer stand will be found with others at the end of the Meteorological section, page 55.

Price, £1 1 0

45. **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.

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.

\* 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.

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 Mounting, £1 10 0*

In our Section, "Thermometers for Special Purposes," will be found woodcuts of several forms of these Instruments, with further details as to their construction and use.

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*.



46. Negretti and Zambra's Standard Minimum Thermometer. (Fig. 38.) 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. 38 on either N. and Z.'s patent Procelain 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. 38, £1 1 0



FIG. 39.

47. Negretti and Zambra's Standard Terrestrial Radiation Thermometer. (fig. 39).—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

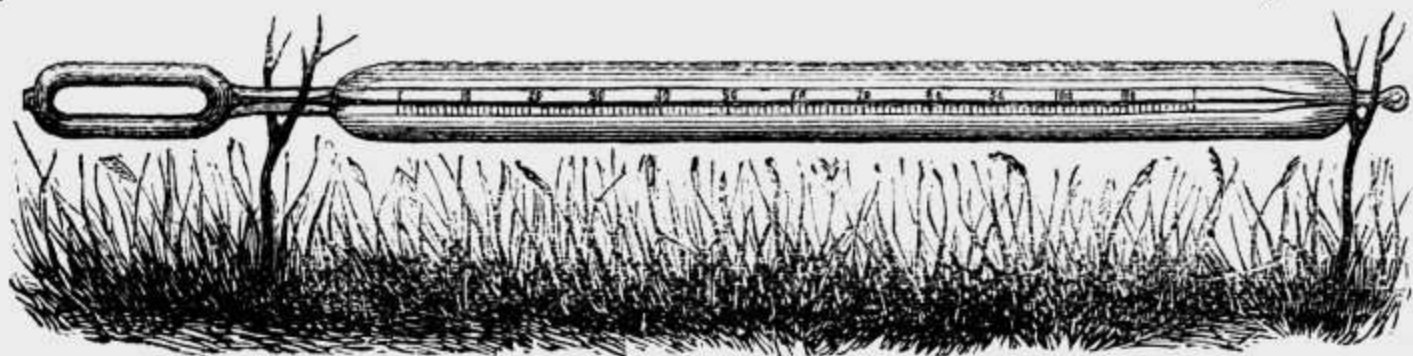


FIG. 40.

48. Negretti and Zambra's Link shaped Bulb Minimum Thermometer, mounted either as a Terrestrial Radiation instrument, fig. 40, or on a Porcelain scale as fig. 38. 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. 42.

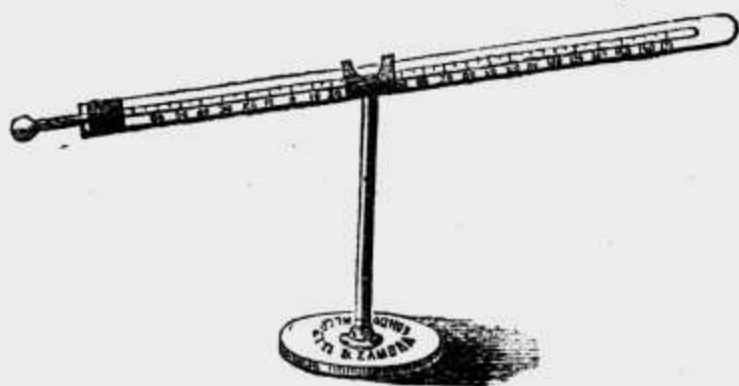


FIG. 41.

49. Negretti and Zambra's Minimum or Terrestrial Radiation Thermometer with Brass Stand. (fig. 41).

*Price*, £1 5 0

50. Concave Metallic Reflector on a Brass Stand for use with Terrestrial Radiation Thermometer (fig. 42).

*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.

51. **Negretti and Zambra's Patent Mercurial Minimum Thermometer**, represented by fig. 43, 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.

*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 jams 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 (fig. 2). The mercury and index will then flow into the small reservoir (D). 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 (fig. 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,

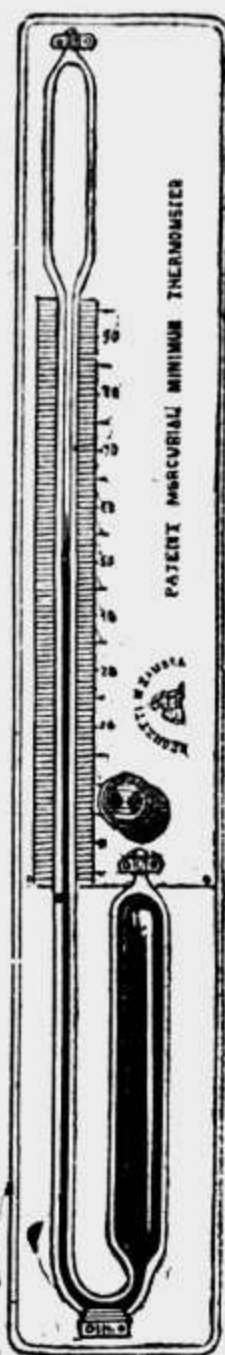
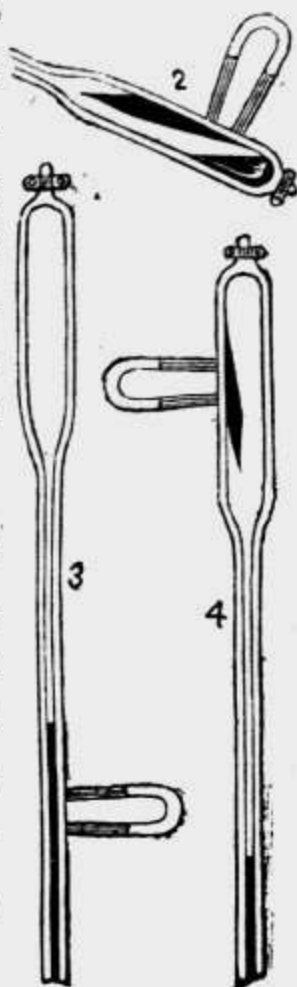


FIG. 43.





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."

The following is an extract from a paper read by Dr. LEE, President of the British Meteorological Society, before the British Association, Cheltenham, August 11th, 1856, when the Mercurial Minimum Thermometer was exhibited :—

"Dr. Lee observed, that one of these thermometers had been in the hands of the Secretary of the British Meteorological Society; another at the Royal Observatory, Greenwich; a third at Mr. E. J. Lowe's Observatory, Highfield House; and others had been used by various members of the British Meteorological Society, all of which had acted most accurately, and in two instances had corrected errors in the alcohol minimums which otherwise would have passed unnoticed."

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 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

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

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.

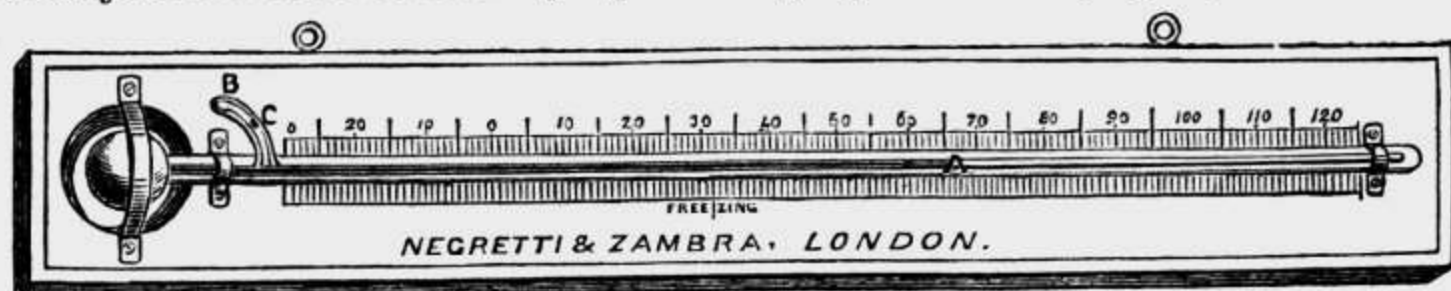
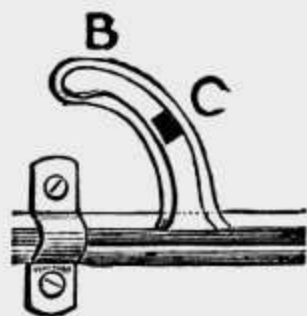


FIG. 44.

#### 52. 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 ball. In the tube B, at the point C, is inserted a platina 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 platina plug—the affinity of platina 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 platina 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. 44. £2 2 0



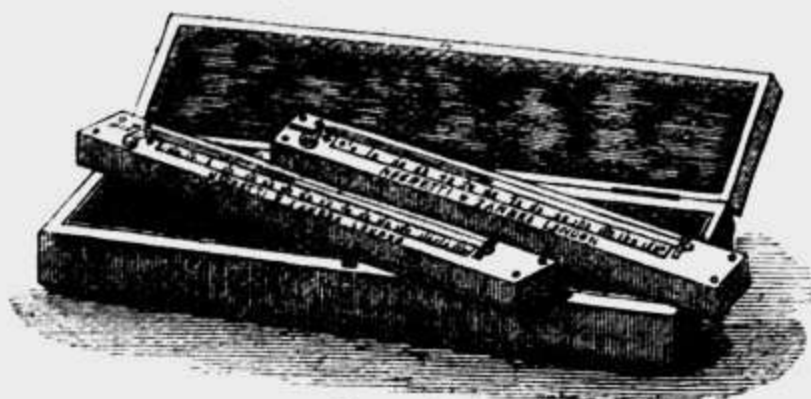


FIG. 45.

53. **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 mahogany or leather case, special for travellers. (Fig. 45.)

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 46. These are the only Registering Thermometers that will travel without derangement. Explicit printed instructions for use accompany each set of instruments.

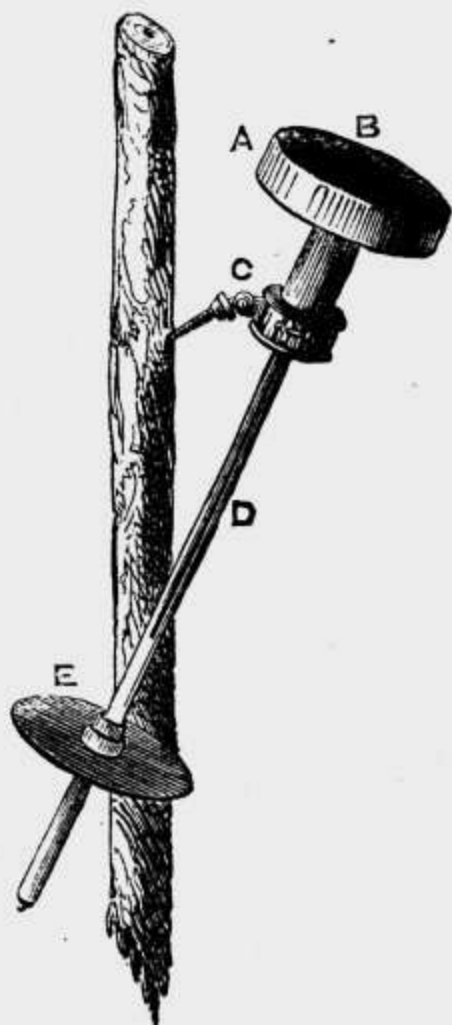


FIG. 46.



FIG. 49.

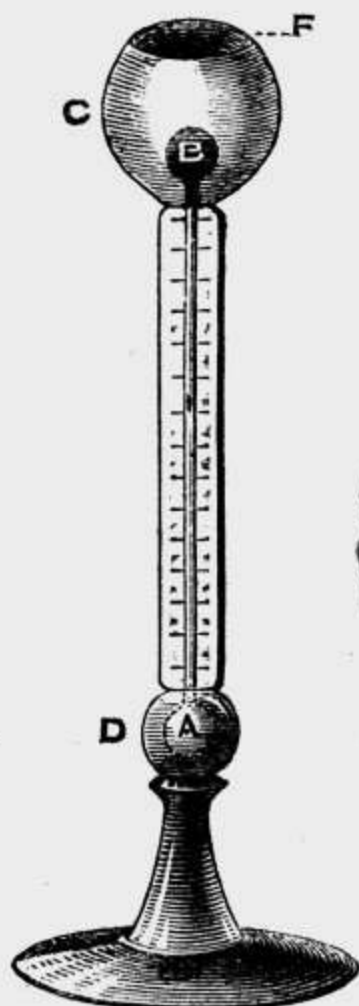


FIG. 47.

54. **Pyrheliometer (Pouillet's)** (fig. 46), 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

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