SELF-RECORDING INSTRUMENTS

(RICHARD'S)

FOR

Scientific, Engineering & Industrial Purposes.

CASELLA & CO.,
11–15 ROCHESTER ROW,
LONDON, S.W.

Telegraphic Address: "ESCUTCHEON, LONDON."

PRICE ONE SHILLING.

1907

LIST, WITH NOTES,

OF

SELF-RECORDING INSTRUMENTS

(RICHARD'S)

FOR

Scientific, Engineering and Industrial Purposes.

CASELLA & CO.,

SCIENTIFIC INSTRUMENT MAKERS,

MECHANICAL AND ELECTRICAL ENGINEERS

TO

THE ADMIRALTY, ORDNANCE, WAR OFFICE, BOARD OF EDUCATION, BOARD OF TRADE, OFFICE OF WORKS, AND OTHER HOME DEPARTMENTS. TO THE GOVERNMENTS OF INDIA, CANADA, NEW ZEALAND, THE UNITED STATES OF AMERICA, GERMANY, FRANCE, ITALY, SPAIN, PORTUGAL, JAPAN, BRAZIL, ETC. TO THE UNIVERSITIES OF OXFORD, CAMBRIDGE, LONDON, MANCHESTER, TO THE MCGILL AND MANY FOREIGN UNIVERSITIES. TO THE OBSERVATORIES OF KEW, GREENWICH, CAPE OF GOOD HOPE, WASHINGTON, LISBON, TORONTO, CALCUTTA. TO THE PRINCIPAL ENGLISH AND FOREIGN RAILWAY COMPANIES, TRINITY HOUSE, THE NORTHERN LIGHTHOUSE BOARD, IRISH LIGHTS OFFICE, ETC., ETC.

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INTRODUCTION.

Before proceeding to deal with the individual instruments, it will be well to understand thoroughly some portions which are common to many of them.

Recording Cylinder. This is a very compact arrangement. The driving clock is inside the brass cylinder, around which is wrapped the chart on which the record is made. One pinion wheel projects through the end of the cylinder, and engaging with a wheel fixed to the base plate, the clock turns itself round, and in so doing turns also the paper covering its circumference. The clockwork is carefully (but not hermetically) enclosed; the bottom of the cylinder is closed by a sheet of brass, except that there is a hole just large enough to let the steel axle of the above-mentioned pinion wheel go through. The top is also of brass with two sliding plates, one covering the arbor for winding, and the other covering the regulator. Proof of the efficacy of these arrangements is afforded by the fact that many of these clocks have been known to run five or more years out of doors and in dirty atmospheres without either oiling or cleaning. It is hardly fair treatment, but the result has been satisfactory. While upon this subject it may be pointed out that Richard's instruments being largely machine-made the parts are interchangeable, and an extra clock (applicable while any other is being cleaned) can be had for a little over £2. Clocks can be had to complete a revolution in any time desired, but those for six hours, twelve hours, twenty-four hours, and a week, are kept in stock.

Attachment of Paper. For most of the instruments special charts have been printed, both with English and metric scales. They are usually 8 inches by 3 inches, and have merely to be wrapped round the cylinder with their ends placed under a little brass spring.

The Pen. This is a very important feature in the apparatus, and must receive careful treatment. It is much the shape of the lower half of the beak of a bird, and its extremity, like that of a pen, is split. The pen must be kept clean, and this should be done, not by scraping or hard rubbing, but by washing in water with a camel's hair brush. If any particles of hair or fluff are seen near the nib, it may be cleansed by cutting off (*not* tearing) a small piece of writing paper and drawing it gently through the slit of the nib. The fineness or the coarseness of the trace depends chiefly upon the cleanness of the pen.

The Pressure of the Pen upon the Paper. In nearly every pattern the pen is slipped on to the end of a long aluminium arm, and near the other end will be seen a brass screw. As a rule this screw should not be touched, because the instrument is adjusted before despatch; but if, owing to transit, on arrival the pen does not touch the cylinder, or presses hard upon it, the brass screw should be so turned that the pen just lightly touches the paper, the less the better provided the ink will flow, because if made to press hard, friction is produced, and the full delicacy of the instrument is not obtained.

The Ink. This being largely composed of glycerine, will not dry up at all readily, and works perfectly in most climates, but in very wet and foggy ones it absorbs moisture from the air, and if the pen be very full of ink, the additional moisture *may* make it overflow, and the extra dilution may make the ink pale. In exceptional localities it is therefore well to fill the pen only three-quarters full, and if the trace becomes very pale to dry up the pen with a spill of blotting paper, not fluffy, and fill with fresh ink.

LONDON, 1907.

BAROGRAPHS.

A Self-recording Barometer was in former times a large and very costly apparatus, to be found only in some of the best observatories. Richard's pattern has changed all this, and now in factories and private houses, in mail steamers and yachts, in balloons and in coal mines, continuous records of the barometer are to be found.

The simplest pattern is shown by Fig. 1. Near the centre will be a seen series of discs; these are really vacuum boxes, such as (singly) are used in ordinary aneroid barometers; they are so arranged that their total dilation or compression is communicated to the long white arm, which falls when the

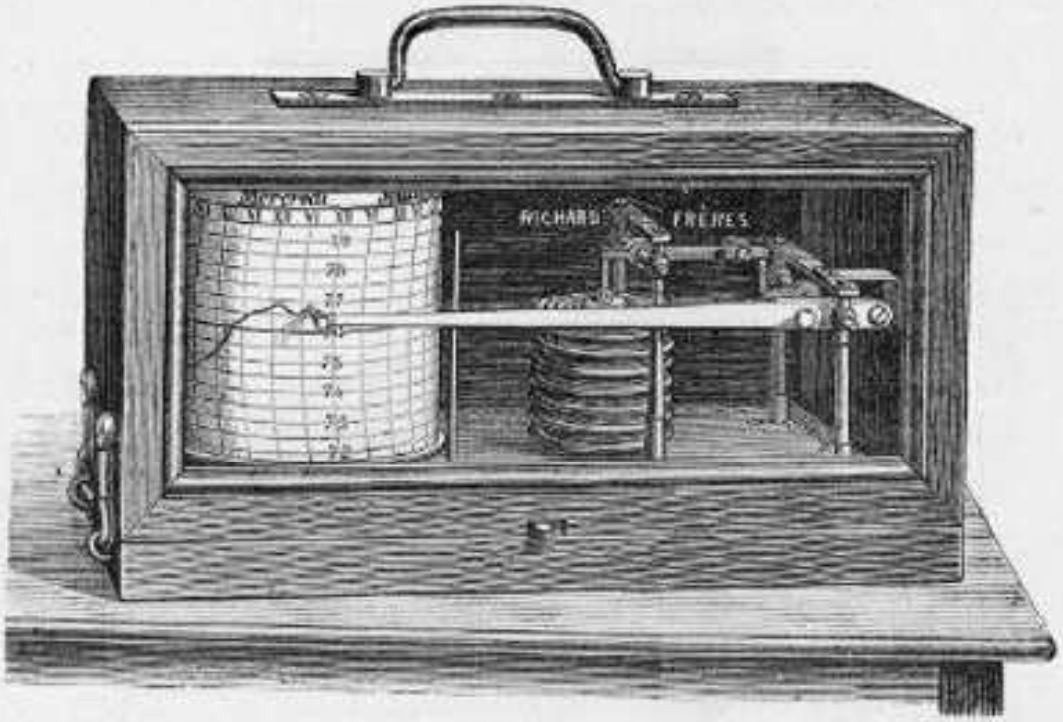


FIG. 1.

atmospheric pressure decreases, and rises when it increases. As engraved, the pen is showing the pressure of 766 millimetres at 8 p.m. on a Wednesday. Papers can be had with either French or English scales. The 766 mm. would be 30·16 inches. A little lever will be seen projecting through the bottom of the case near the middle, and a white vertical rod will be seen near the cylinder; these two are connected, and their object is to bring the pen sufficiently away from the cylinder to enable it to be removed when a new paper has to be put on.

DIMENSIONS AND NET WEIGHT OF INSTRUMENTS.

	Length. ins.	Height. ins.	Depth. ins.	Weight. lbs.
Small Model	7	$4\frac{3}{4}$	$4\frac{1}{4}$	$3\frac{3}{4}$
Medium	$11\frac{1}{2}$	$6\frac{3}{4}$	$5\frac{1}{2}$	$9\frac{1}{2}$
Large	16	$9\frac{3}{4}$	$7\frac{3}{4}$	16

For prices see page 7

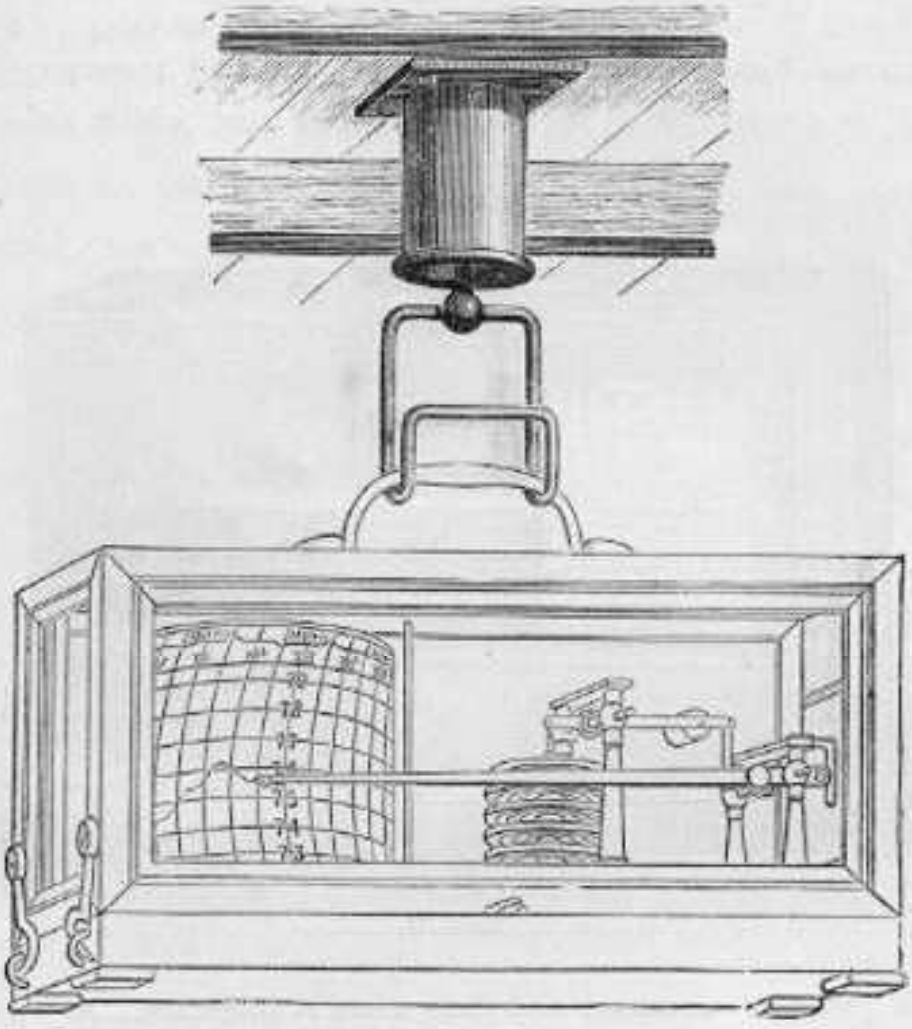


Fig. 1a.

Price.—Spring Suspension for fixing to beams and ceilings of cabins, etc., on board both sailing and steam vessels £1 2 0

If a Barograph of a more ornate kind is required, the instrument is mounted on a gilt bronze stand, with a cover of similar metal, and 5 strong glass windows. This makes a very handsome-looking instrument.

DIMENSIONS AND NET WEIGHT OF BAROGRAPH WITH 5 GLASSES ON COVER AND GILT BRONZE MOUNTING.

	Length. ins.	Height. ins.	Depth. ins.	Weight. lbs.
Small Model	$7\frac{1}{2}$	$5\frac{1}{2}$	5	$6\frac{1}{2}$
Medium ,, ...	11	6	$5\frac{1}{2}$	$11\frac{3}{4}$
Large ,, ...	15	$9\frac{3}{4}$	7	30

For prices see page 7.

Marine Suspension. The above and some of the following instruments being well adapted for marine purposes, some suitable means of protecting them from the vibrations of the vessel had to be thought out, and the Spring Suspension (see Fig. 1A) fulfils this want most satisfactorily.

Long Duration Observations. Under special conditions where, instead of the daily or weekly charts, it is preferred to have long ones, a continuous paper is used which need only be changed at long intervals, and for this purpose an instrument has been designed, the working of which is actuated by a Bourdon tube, and gives most excellent results. In this apparatus it is only necessary to remove the roll of paper every six months, the clock being wound up once a fortnight, and the pen being filled with ink about once a month. The instrument works horizontally.

PRICE, complete, from £20 0 0

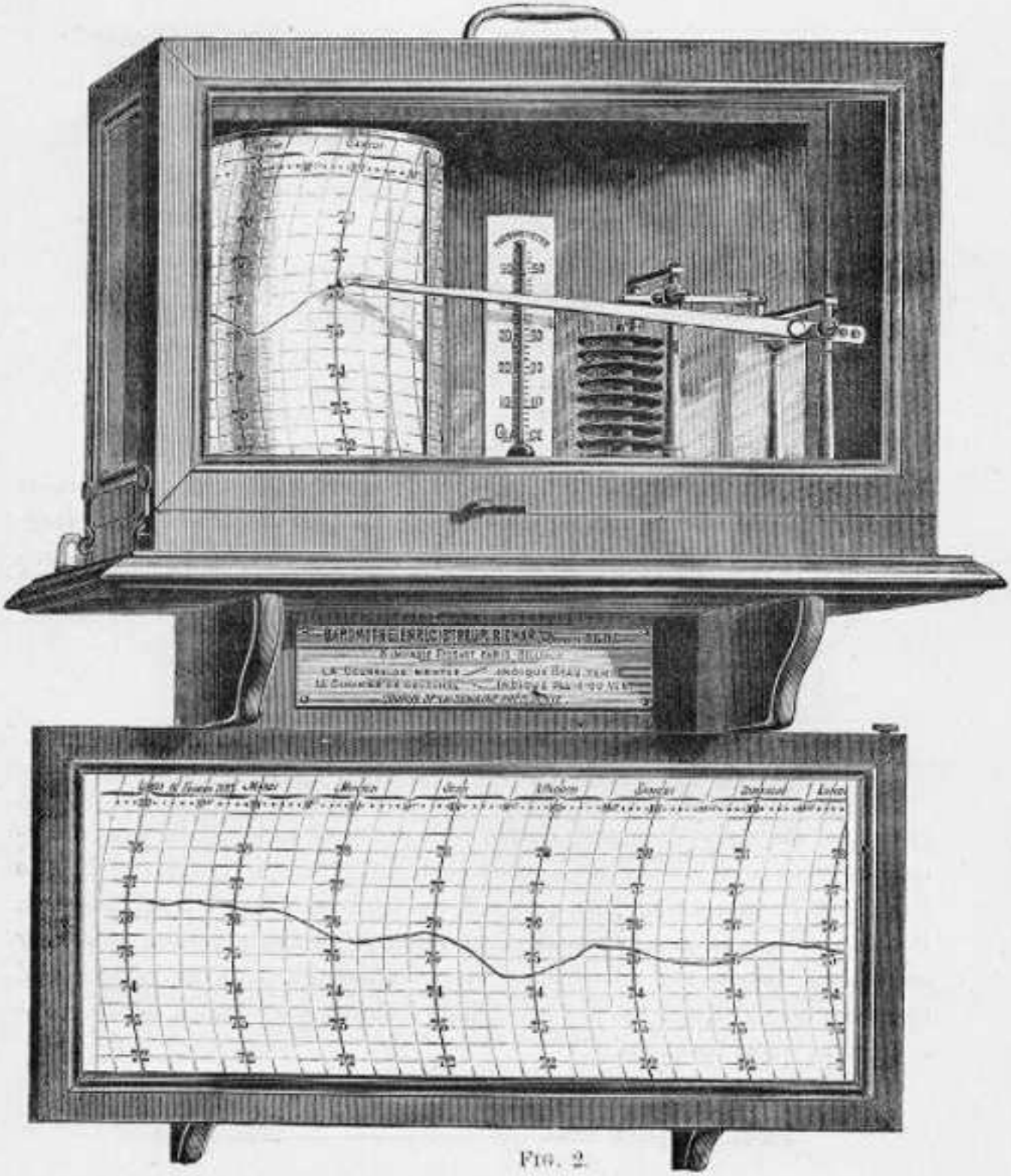


FIG. 2.

Modifications. At seaside stations, and in clubs and public libraries, it is desirable to exhibit, along with the actual record for the time, that for the previous week. This object is met by Fig. 2.

DIMENSIONS AND NET WEIGHT OF BAROGRAPHS, WITH BRACKET AND FRAME FOR DIAGRAMS.

	Length. ins.	Height. ins.	Depth. ins.	Weight. lbs.
Small Model	9½	12	6	5½
Medium ,, ...	13	15¾	7½	11½
Large ,, ...	18½	23¾	9½	26½

Warning. It is sometimes desirable, both on board ship and in order to ensure special care in coal mines, that a barometer should not merely record the pressure of the atmosphere, but call attention to its changes. This has been arranged, and patterns have been devised which will ring an electric bell, either on the barometer reaching any desired point, or on its rate of fall attaining a certain value. The advantage of this, both as regards the advent of storms and the escape of inflammable gas in mines, need not be enlarged upon. The bell can be at any desired distance from the barometer.

PRICES OF SELF-RECORDING BAROMETERS.

	£	s.	d.
FIG. 1.—Barograph, in case of polished mahogany, hinged or hook-on cover, with nickel-plated mountings, **small size**	4	10	0
Ditto ditto 3 glasses to cover	4	15	0
FIG. 2.—Ditto, 3 glasses, on bracket for wall, and frame for chart of preceding week or day	5	15	0
Ditto, with bronze pedestal and framework, gilt and bevelled-glass cover	6	15	0
FIG. 1.—Barograph as above, polished mahogany case, hinged or hook-on cover, with nickel-plated mountings, etc., **medium size**	5	10	0
Ditto, with thermometer, and 3 glasses to cover	5	15	0
FIG. 2.—Ditto, 3 glasses, on bracket for wall, and frame for chart of preceding week or day	7	10	0
Ditto, with bronze pedestal and framework, gilt and bevelled-glass cover	8	10	0
FIG. 1.—Barograph, with thermometer, **large size**, 1-in. on scale = ½-in. mercury	10	0	0
FIG. 2.—Ditto, 3 glasses and thermometer, with wall bracket and frame for preceding chart	13	0	0
FIG. 2.—Ditto, with bronze pedestal & frame for chart, glass cover, etc.	15	0	0

Barographs made in Aluminium if desired, thus giving greater portability for travelling, etc., or mounted in Enamelled Zinc Cases for resisting the weather, at an increased cost.

NOTE.—The above prices include, besides the Instruments, 1 Special Pen, 1 bottle of Ink, 1 set of Charts in cardboard case, 1 Key with double end, for winding up clock and adjusting aneroid, etc.

STATOSCOPE or EXTRA-SENSITIVE BAROGRAPH.

The Statoscope consists of a series of very sensitive boxes (somewhat like the vacuum chambers of aneroids), contained in a hermetically sealed reservoir, which is placed in a box thickly surrounded by wool so as to prevent the disturbing influence of change of temperature during any experiments. It is, in fact, an air barometer from which the normal pressure (15 lbs. per square inch) of the atmosphere is excluded. With this instrument a change of $\frac{1}{1000}$th of an inch of the barometer is represented by a motion of the needle of 0·025-inch, or twenty-five times as great; consequently, if the instrument is raised three feet the indicating pen traverses an angular space of nearly a tenth of an inch.

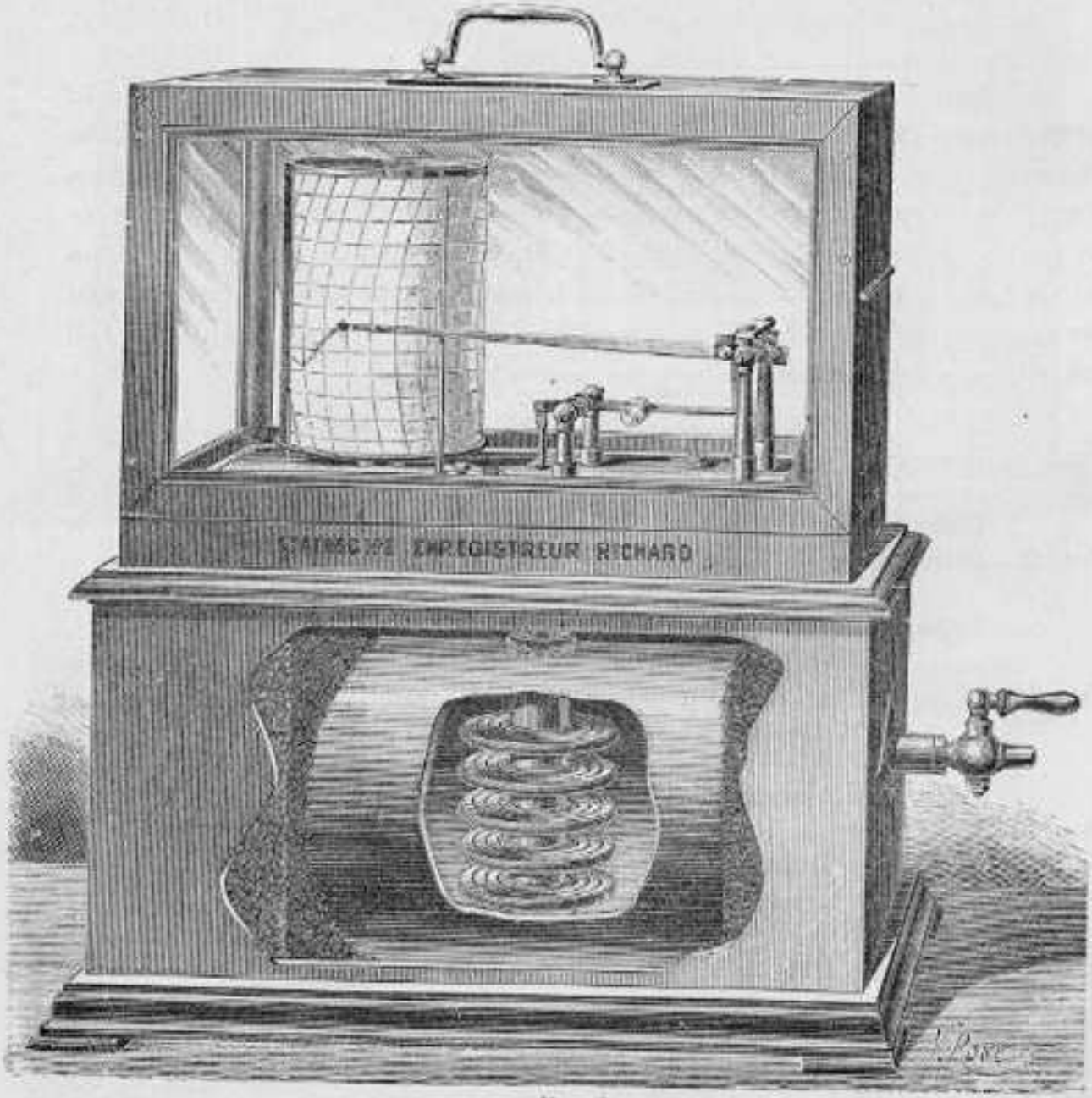


Fig. 3.

This instrument is extremely valuable for the study of the sudden changes of pressure which occur during gales, thunderstorms, and other meteorological phenomena.

In the Brontometer constructed by us for Mr. G. J. Symons, F.R.S., the Statoscope is so delicate that a variation of pressure of 0·0001-in. is easily seen: and the mere opening or closing of the door of a room in which it is, will cause the pen to swing from its normal position by from a quarter to half an inch.

Statoscope.—Fig. 3 .. .. £15 15 0

THERMOGRAPHS and PYROMETERS.

As with the barometer so with the thermometer, the introduction of the Richard system has rendered the obtaining of a continuous record of the temperature of any place during every minute of a day or a week very easy and very inexpensive. We must justify these statements after explaining how it is done. The simplest form of the Thermograph is shown in Fig. 4. Outside of the case will be seen a flattened tube, curving downwards and having a small straight rod leading into the recording case. This curved tube is filled with a liquid, and as when it expands with heat the tube becomes straighter, it will be seen that the rod so acts on the short end of the lever, that as the temperature rises the pen rises, and as the temperature falls the pen falls, and thus by an arrangement identical with that already described for the barometer, we get the continuous record for a day or a week. The lifting of the pen off the cylinder, the care of the pen, the winding of the clock, the putting on of the new paper, being identical with the arrangements for the barometer, need not be again explained.

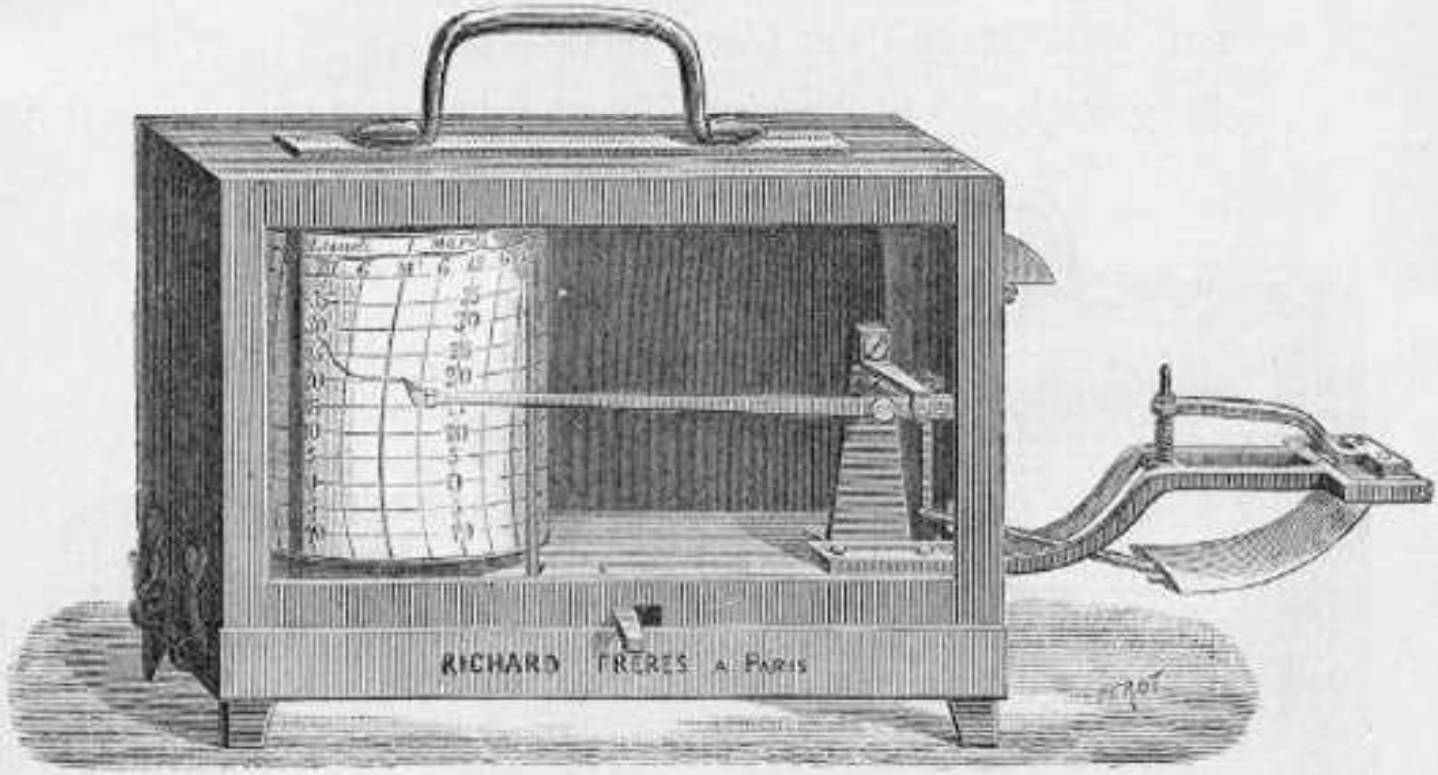


Fig. 4.

Adjustment. The instruments being adjusted before despatch, it is rarely wise for observers to touch them; but in cases where it is certain that they read either too low or too high, the following course should be adopted: first, by repeated comparisons between a verified mercurial thermometer and the scale

readings of the Richard Thermograph, ascertain exactly how much it requires to be raised or lowered. Take the instrument into a room in which the temperature changes little and slowly, let the thermograph run for say an hour until you have a clear horizontal line. Then put the small end of the winding key of the clock on the square head of the screw, which will be seen just outside the case; do not in the least press upon it, but turn it very slightly, perhaps a tenth of a turn, and watch the trace until it has risen or fallen by the amount which it was previously in error; remove the key, and leave the instrument for half an hour to see that precisely the proper alteration has been made. The adjustment itself can be made in half the time that it takes to read this description.

PRICES OF SELF-RECORDING THERMOMETERS.

	£	s.	d.
FIG. 4.—Thermograph, **small model,** mounted in japanned iron or zinc case	4	10	0
Ditto, in mahogany case with glass on three sides, bracket and frame for preceding diagram	5	15	0
Ditto, **medium size,** mounted in japanned iron or zinc case	7	10	0
Ditto, ditto, mahogany case, with bracket and frame as above	8	10	0
Ditto, **large model,** mounted in japanned iron or zinc case	12	0	0
Ditto, ditto, mahogany, with bracket and frame as above ..	13	10	0

Thermographs made in Aluminium if desired, cost being extra.

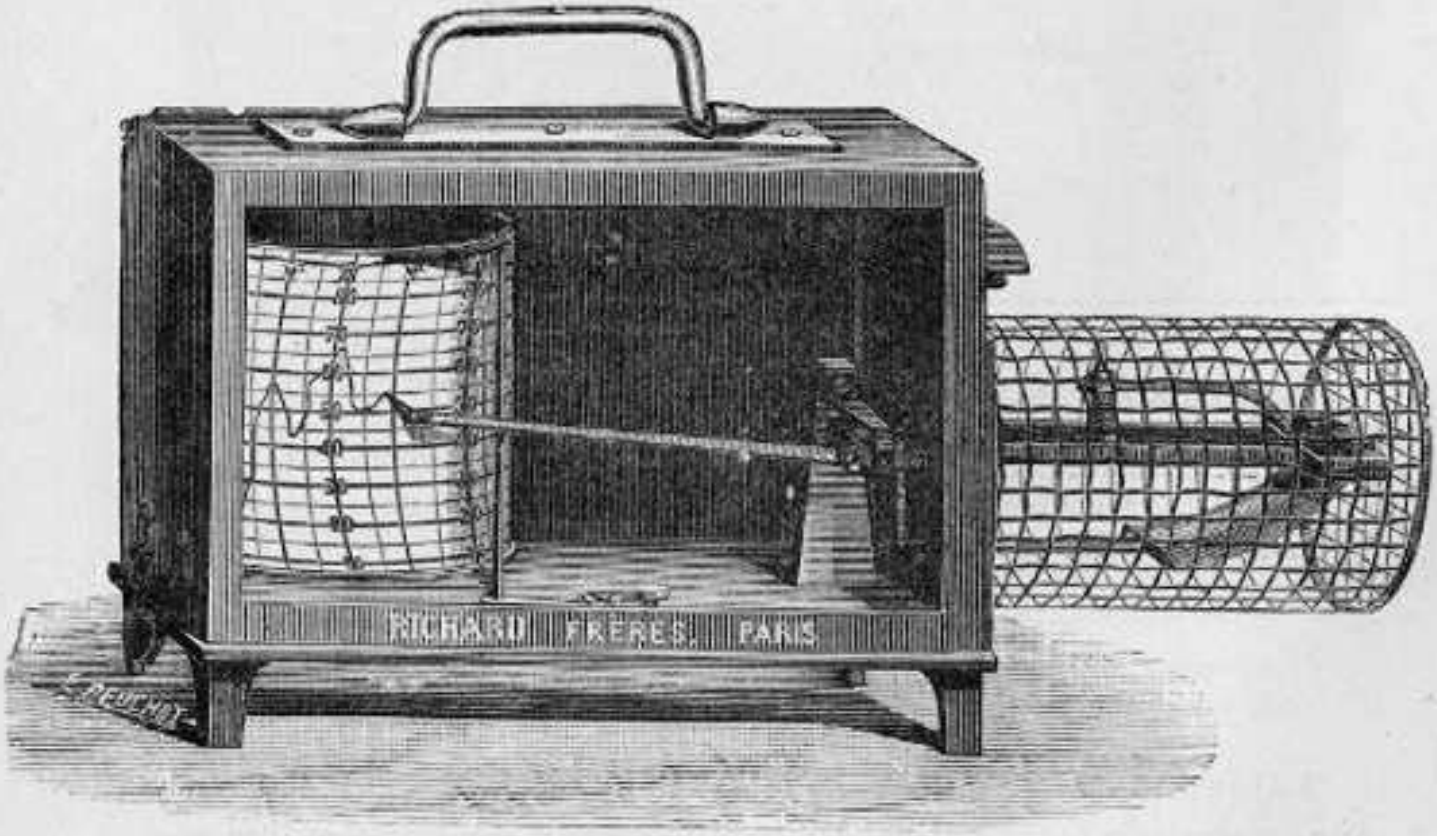


FIG. 5.

Thermometer with Wire-work Guard over Bulb; see p. 11.

The Thermograph shown above, Fig. 5, is a most suitable form for factories, etc., or where the instrument is likely in any way to be interfered with, as the bulb which projects from the body of the instrument is protected by a strong metal framework covered with wire, the case is of enamelled metal, and fitted with a padlock.

Prices.	£	s.	d.
Fig. 5.—Thermograph	6	5	0
Ditto, with wire screen	6	12	0
Ditto, with maximum and minimum contacts	8	0	0

Note.—In ordering, please state desired range of temperature. The above instruments are suitable for temperatures under about 230° Fahrenheit.

Other forms of Thermographs and Pyrometers suitable for all kinds of industrial purposes, etc. These are so numerous that it is impossible to describe all, and special ones are frequently being devised. The first to be mentioned is the above arrangement with added adjustable contacts, whereby at the discretion of the owner the instrument, in addition to producing the complete record in ink, will ring a bell directly any given extremes of temperature are reached. Suppose, for instance, that a room is to be kept between 55° and 65°, the thermograph would show exactly when and by how much these limits had been exceeded, and would ring a bell as long as the limit was exceeded in either direction: or if preferred would ring a bell of one note if the temperature rose too high, and another bell if it fell too low. The advantages of these instruments for hospitals, and for many trade purposes, for greenhouse work, as fire alarms, and for almost an infinity of objects, is self-evident.

Alarm Thermometer. Fig. 6.—A series of small vacuum boxes (like those used for aneroids) filled with a gas and packed in a stout iron tube, makes an excellent and very cheap alarm thermometer for what may be called inaccessible places, such as coal bunks, silos, fodder sheds, boilers, baths, ovens, &c. The arrangement as represented in Fig. 6 rings the bell at any required point; it does not show the temperature, but can easily be made to do so, as in Fig. 7. This pattern (Fig. 7) is only made with a straight tube. Another pattern shows the present temperature, and rings the bell (or bells) at any points desired, but produces no record (see *Deal Thermometers, pp. 13–15*).

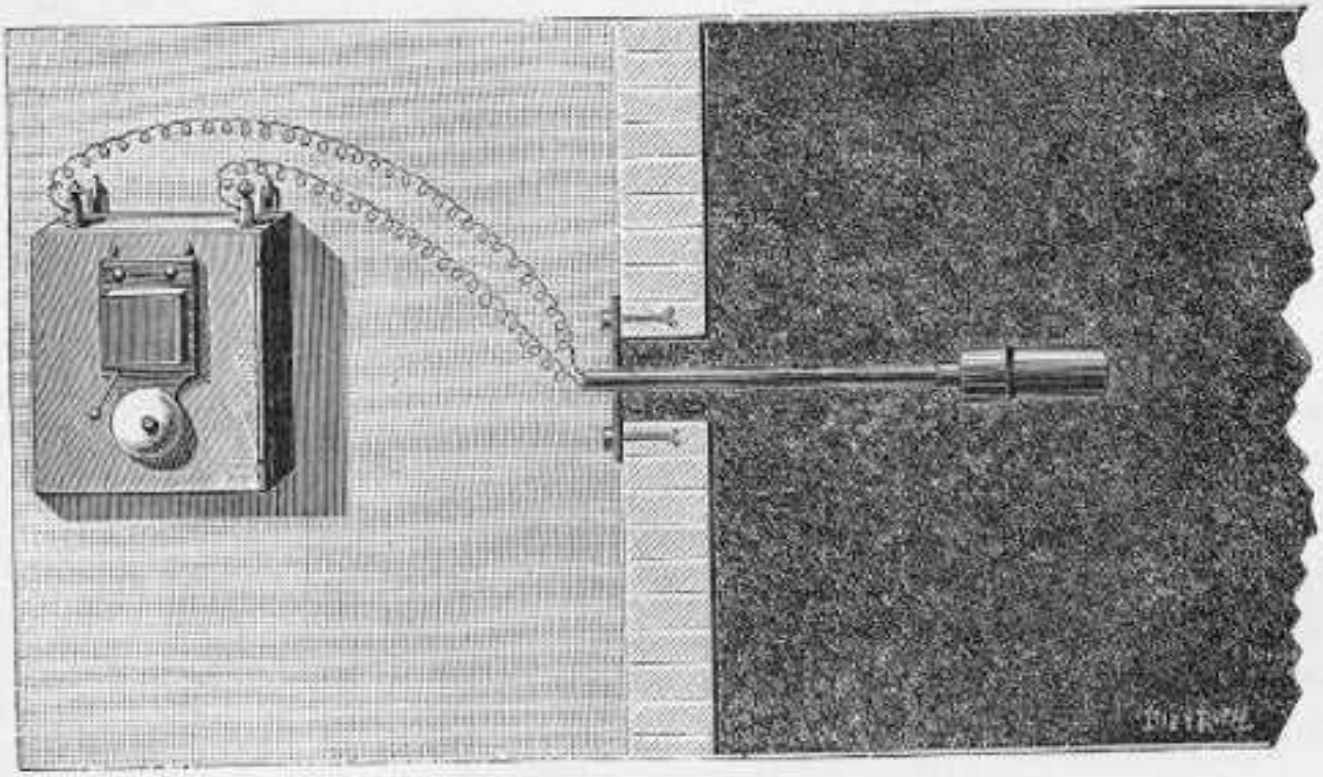


Fig. 6.

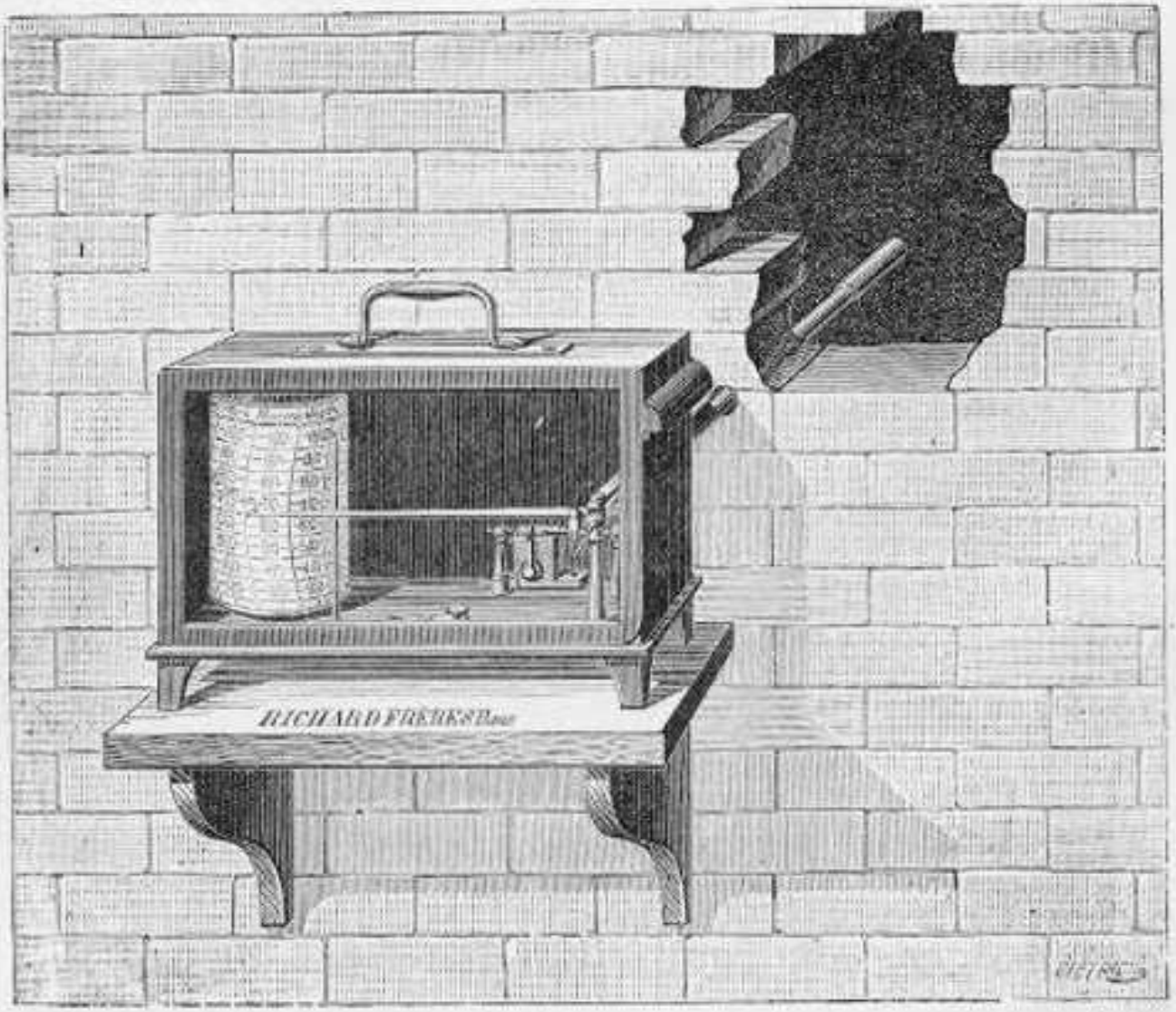


Fig. 7.

	£	s.	d.
Fig. 6.—Tube Thermometer, maximum or minimum, without accessories	1	2	0
Ditto, maximum and minimum, for 1 bell	1	7	0
Ditto, ditto, for 2 bells	1	12	0

These prices do not include Cells, Bells, etc.

The Tube can be made to be used up to a temperature of 110° C. or 230° Fahr.

Thermograph. Fig. 7.—For use in damp chambers, drying stoves, and all situations to which access is difficult, and where the indicating and recording mechanism must be placed at a distance from the thermometer itself.

With this instrument only a rigid tube can be used, but that part of the tube in the region under observation may be either vertical or horizontal.

In the case of air and other gases the instrument shows the correct temperature in 8 or 10 minutes, and in case of liquids, 3 or 4 minutes; it can, however, be made with a higher sensibility, at a slightly increased cost.

PRICE, with tube 3 feet long £8 0 0

Electric Thermometer with Dial. In the construction of these thermometers the principle of the expansion of a liquid is utilized, as in the case of the recording thermometers.

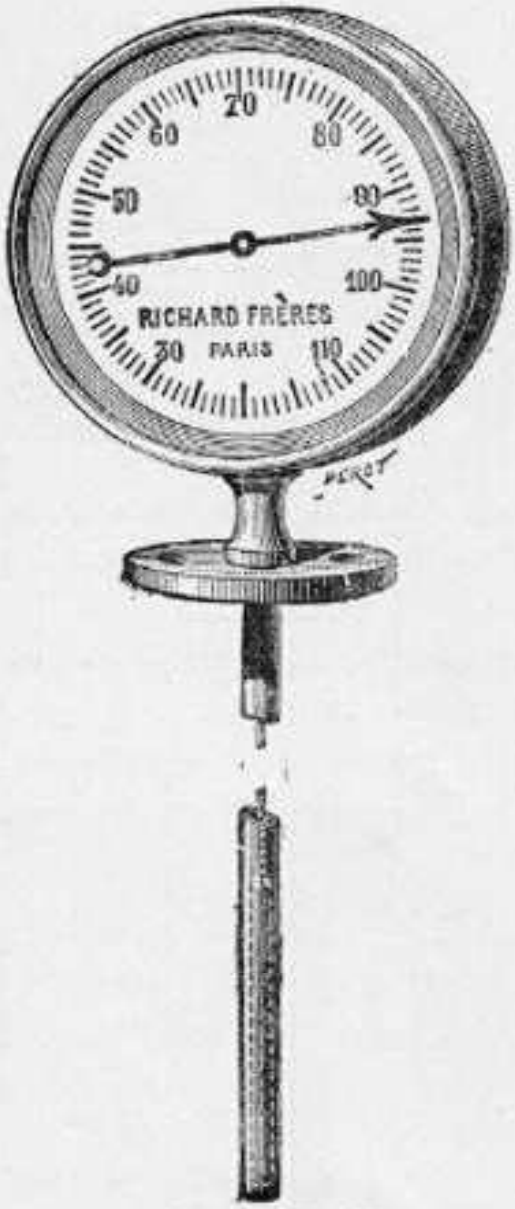
This instrument has been adopted in most industrial establishments, for giving the temperatures of stoves, drying-rooms, malting chambers, purifiers, hot-houses, heating chambers, workshops, hospitals, sick rooms, refrigerating rooms for the preservation of meats, etc.

The instrument can be put in connexion with two bells or alarms, one adjusted to the high temperature and the other to the low temperature, above and below which the temperature is not desired to go; or, if preferred, with one bell only for the two cases. It can be adjusted for all temperatures from about — 45° F. to 230° F.

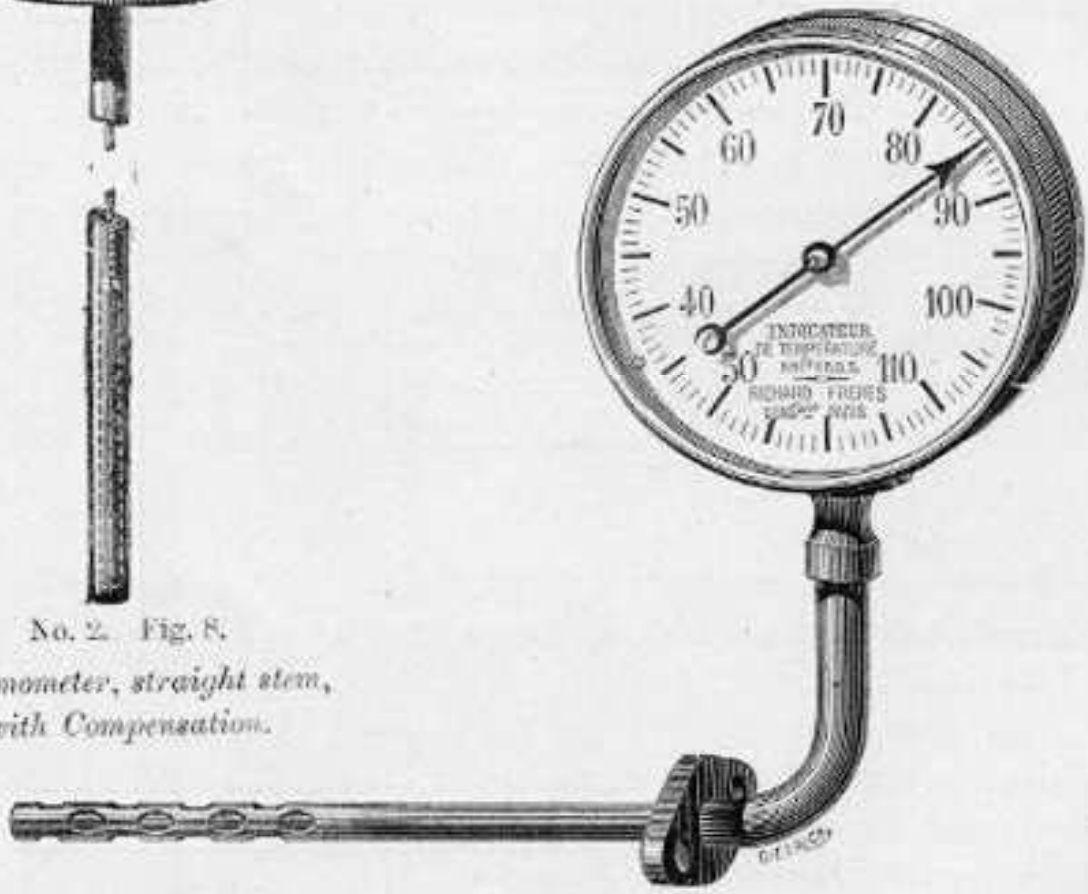
	£	s.	d.
Price of the above Thermometer, maximum and minimum, from 16° F. to 120° F.	1	2	0
Ditto, ditto, ditto, ditto, 16° F. to 212° F.	1	8	0
One Leclanché cell and one bell	0	15	0
One ,, two bells	1	0	0

Dial Thermometers.

The working of these Thermometers is based upon the principle of the expansion of liquids by heat, which is constant and always comparable. They consist of a receptacle communicating, through a very small tube, with a Bourdon pressure tube. The whole is filled with an expansible liquid. The liquid, on expanding, enters the Bourdon tube, the movement of which is communicated to the dial hand by means of a very simple system of levers, Figs. 8 and 9.



No. 2. Fig. 8.
Thermometer, straight stem, with Compensation.



No. 3. Fig. 9.
Bent Thermometer, with Compensation.

These Thermometers are superior to those the construction of which is based upon the expansion of a metallic rod or upon the elasticity of bi-metallic springs, or upon the pressure of the steam. In the first-named two cases, the expansion acts upon the molecular state of the spring, and in the third one leakages soon occur through which the vapour escapes.

In this system the extensible tube is directly acted upon by the expansion of the liquid, and this with much power and certainty, because the said liquid is

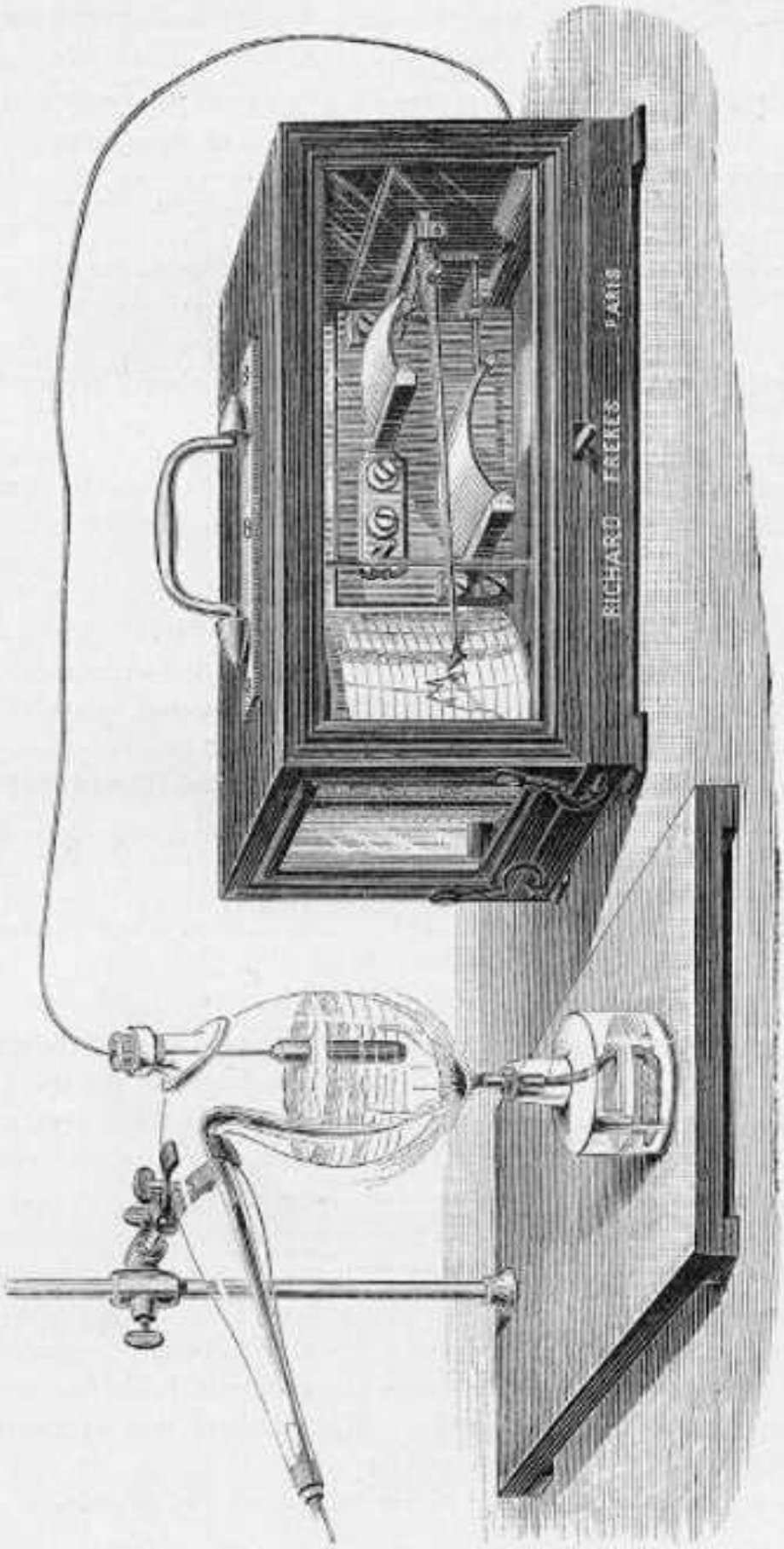


Fig. 10.
Thermometer with a pliable tube.

deprived of air and is incompressible. The instruments can work in any position, and the receptacle containing the liquid can be placed above the dial and even 10 feet away. The instrument is easily rendered self-recording.

Prices:	£	s.	d.
Thermometer, expansion of liquid system, dial 4 in. diam.	3	0	0
Ditto, compensation, straight or bent, dial 7 in. diam., range to 230° F., model 2 or 3, Figs. 8 and 9	4	5	0
Thermometer, compensation, straight or bent, dial 7 in. diam., range to 330° F. (150° C.)	5	0	0
Thermometer, compensation, straight or bent, dial 7 in. diam., range to 650° F. (350° C.)	7	0	0

A double dial increases the price by 10/-.

The addition of a system of alarm contacts to any of the above Thermometers increases the price by 15/-.

The above prices are for instruments with a 3-feet stem; if, however, the stem is above 1 yard in length, and anything up to 3 yards, that being the longest length efficient on these instruments, the price is 10/- per yard, or part thereof, extra.

Recording Compensated Thermometer. Fig. 10. This is very sensitive and particularly suitable for air stoves, in which the variations of temperature may be very rapid. The indications can be conveyed by a pliable tube (see Fig. 10), or by straight rods.

This pattern is made for temperatures ranging between 0° and 680° Fahr., or 370° Cent.

Price £12 0 0

Note.—The above price is for instruments with pliable tubes about 40 inches long; if longer and up to the limit of 120 inches, which cannot be increased, the price is 10/- for each additional 40 inches.

Recording Pyrometer, capable of resisting and recording temperatures up to 700° C. or 1,300° F. (about that of red hot iron). This instrument, the principle of which is based upon the expansion of gases by heat, consists of a sealed iron tube filled with pure, dry nitrogen, connected by means of a capillary tube with a pressure tube. Though the principle of this instrument is by no means a new one, it was never successfully carried into industrial practice until MM. Richard introduced their important improvements. One serious drawback of earlier pyrometers of this design was that the iron tube was filled with air, and naturally, when the plunger became red hot, the iron absorbed part of the oxygen of the air, and thus made the records at the higher temperatures quite unreliable. MM. Richard use, as stated, pure dry nitrogen, which is not absorbed by red hot iron.

This pyrometer can be supplied for either daily or weekly records.

Price, Self-Recording £15 0 0
" with Dial only £9 9 0

Note.—It is particularly desired that the length of the plunger tube should be given when ordering.

Recording Pyrometer for High Temperatures, up to 4500° Fahr. For sugar refineries records of much higher temperatures are needed, and for one of the large Paris makers MM. Richard constructed apparatus on the Saintignon system, giving a continuous curve up to 2500° C. (about 4500° Fahr., or beyond that of melting platinum). If indication of the temperature on a dial is sufficient, the cost is less by one-half.

PRICE, complete £34 0 0

Fuller particulars on application.

HYGROGRAPHS.

We have tried many patterns of hygrometer, but now recommend two only—the dry and wet bulb and the hair hygrometer; but neither of these is at all like anything previously made.

The Hair Hygrometer is shown in Fig. 12. The black line outside the frame, starting from the two uprights and forming a < with a hook in the angle, represents a bundle of human hairs clamped at each end by the said uprights, and pulled laterally by a weighted lever. As hair shortens by moisture and lengthens with dryness, it will be evident that the lever will rise with increasing humidity and will fall with increasing dryness. All the recording details are the same as have been already described.

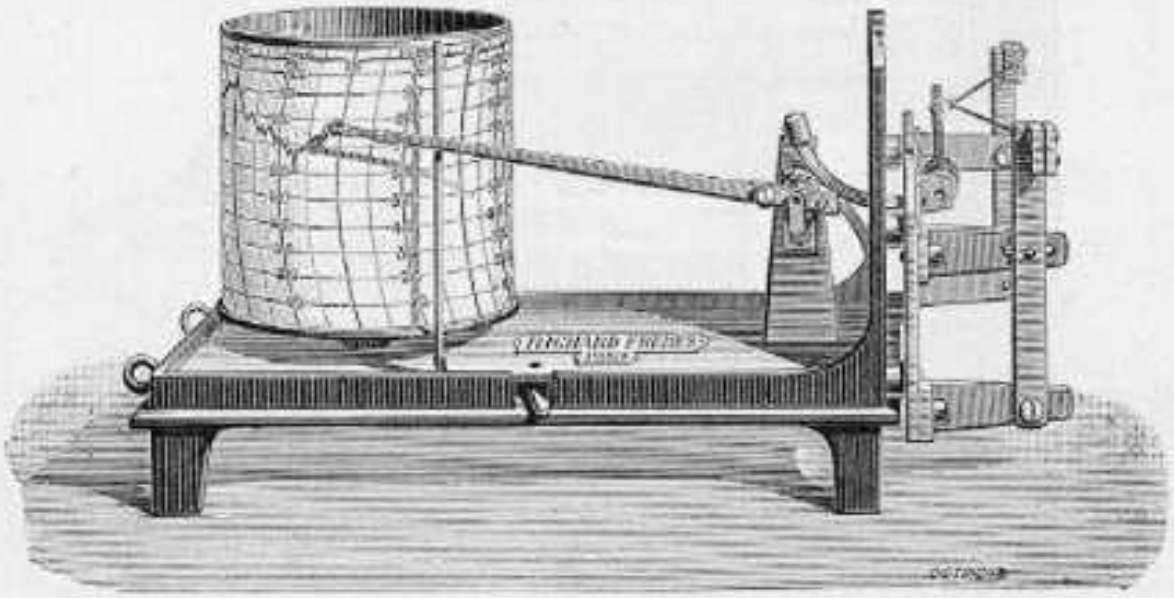


FIG. 12

PRICES OF SELF-RECORDING HAIR HYGROMETERS.

		£	s.	d.
FIG. 12.—**Small** model, cylinder 2½ inches		5	0	0
Medium „ „ 3¾ „	with metal case	6	5	0
„ „ „ „ „	mahogany box	7	0	0
Large „ „ 5 „	with metal case	12	0	0

This same system has been adapted to the Dial Hygrometers, of which there are two sizes, viz.:

	£	s.	d.
Hygrometer with dial, watch form, 1¼ in. diam.	1	0	0
Ditto 4 in. diam.	0	16	8

The above instruments are supplied with a table, giving the weight of water vapour contained in the air.

Dry and Wet Bulb Thermograph. Fig. 13. This is a double thermograph, the two bulbs recording on one cylinder, but one bulb being sewn up in muslin kept wet by dipping into a trough of water. The temperature recorded by it is below that shown by the dry bulb by an amount proportional to the hygrometric state of the air. As there might be some trouble from the two pens colliding when the air is very damp and the difference less than 1°, it is usual to set the wet bulb 10° too low, a difference so large that it cannot lead to mistake.

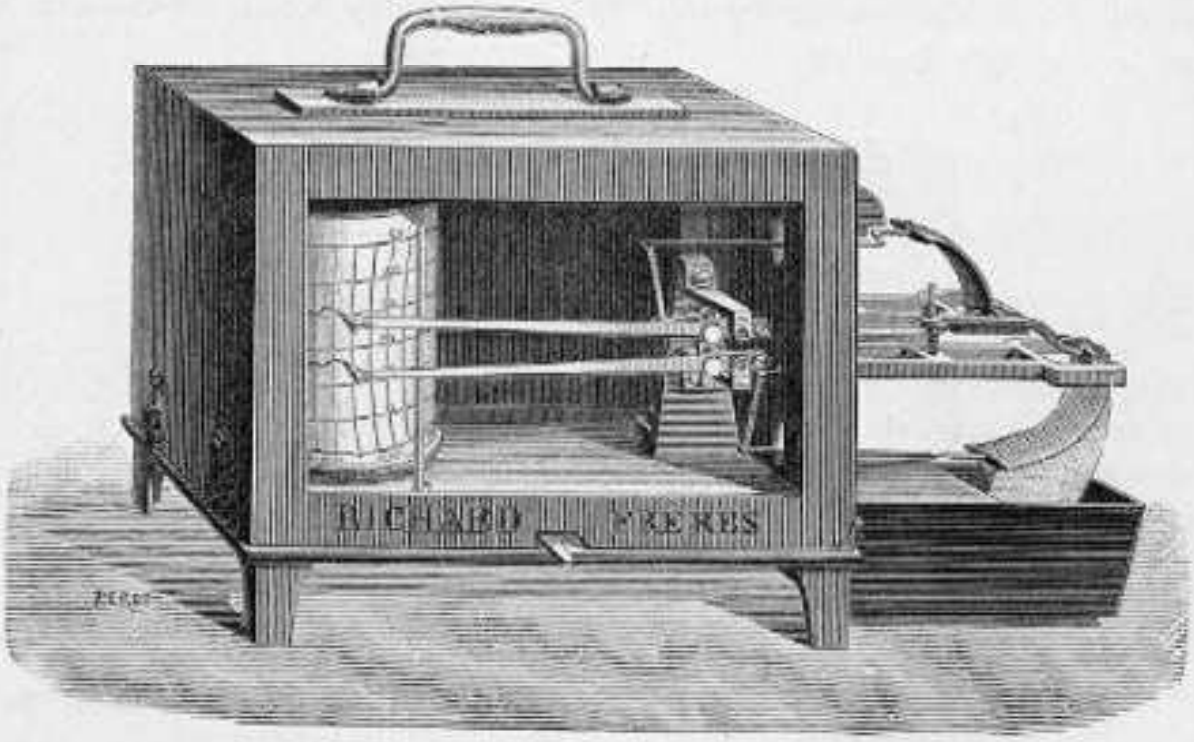


Fig. 13.

Fig. 13.—In Enamelled Iron or Zinc Case £10 0 0

Note.—This instrument can be supplied in wood case, and also in a larger size, at an extra cost.

BARO-THERMOGRAPH for Balloons, Kites, etc.

There having arisen a demand for various instruments—notably, self-recording—for use in balloons and on kites, etc., two new arrangements have been made; in the first the Barograph and Thermograph are combined in one instrument, and in the second, the Barograph, Thermograph, and Hygrograph. The indications are recorded on the same cylinder, which is about 2⅝ in. diameter. The special conditions required having been carefully taken into consideration, there were numerous difficulties to be overcome, such as the proper and sure working of the clock, the lubricating of the various parts (as no oil remains liquid under —23° C.), the necessity of using an ink which would not congeal or corrode, the compensation of the barometer, and the lightness and portability of the instrument. The above and other difficulties were duly overcome, and an instrument constructed which fulfils all the conditions required. The size of the case containing the instrument is—width, 11 inches; height, 7¾ inches; depth, 4¼ inches.

RECORDING BARO-THERMOGRAPH.

	£	s.	d.
Price of the Recorder in aluminium, with box in wood, weight about 2 lbs.	12	0	0
Ditto, ditto, with box in aluminium	13	10	0

BARO-THERMO-HYGROGRAPH.

The Baro-Thermograph brought into demand a desire for a triple instrument, namely, the Baro-Thermo-Hygrograph, which has been successfully constructed, and now meets all the desires of those interested in studying the higher regions of the atmosphere. The instrument has been used, among other observers, by Mr. Rotch, late Director of the Blue Hill Observatory, in his interesting and elaborate experiments.

The chart used with this instrument is No. 263 and for the Barometer is divided from 0 to 3,500 metres; for the Thermograph from —20° to +40° C.; and for the Hygrograph, in percentage of water vapour; the time scale can be used either for a 26, or 13, or 8-hour cylinder. Charts with English Scale if desired. The pen in this instrument records on smoked charts made of thin aluminium.

BARO-THERMO-HYGROGRAPH.

WEIGHT ABOUT 28 LBS.		£	s.	d.
PRICE, with scale for reading and comparing the diagrams		16	16	0
Aluminium Charts	per 100	0	10	0

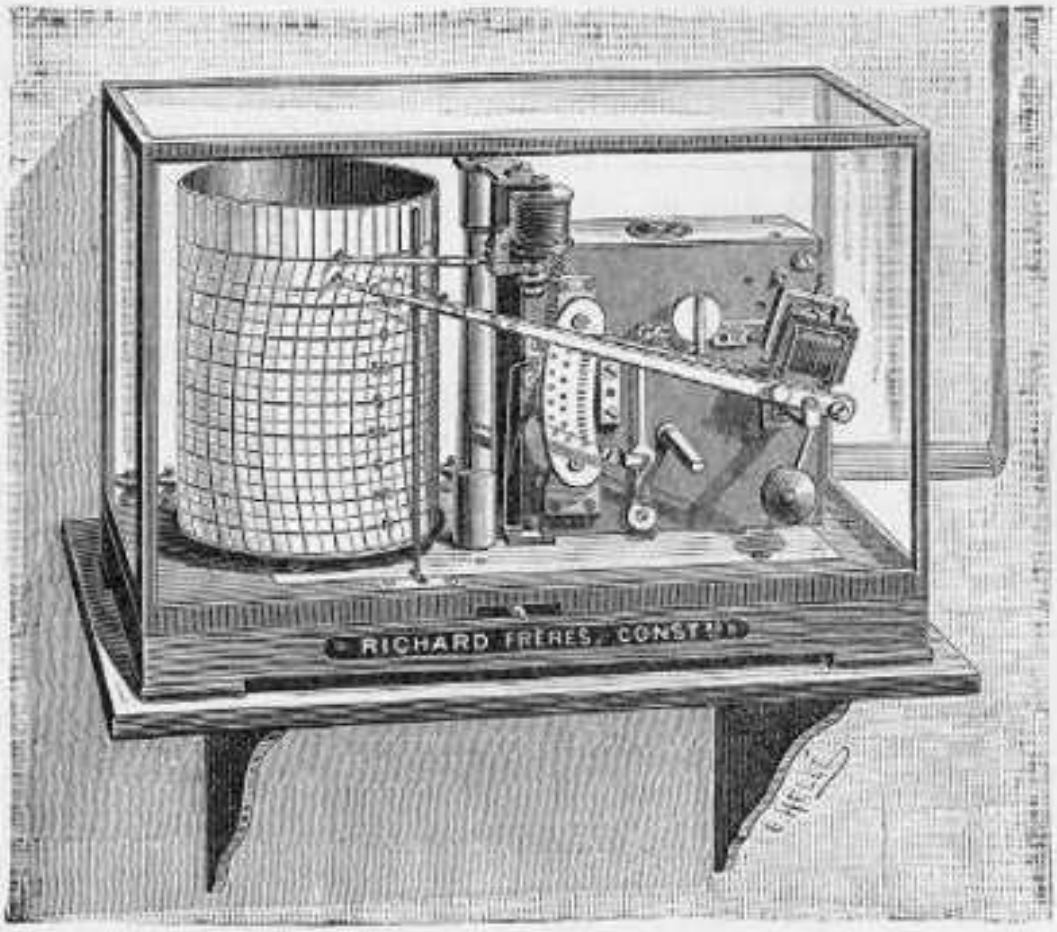


Fig. 14.

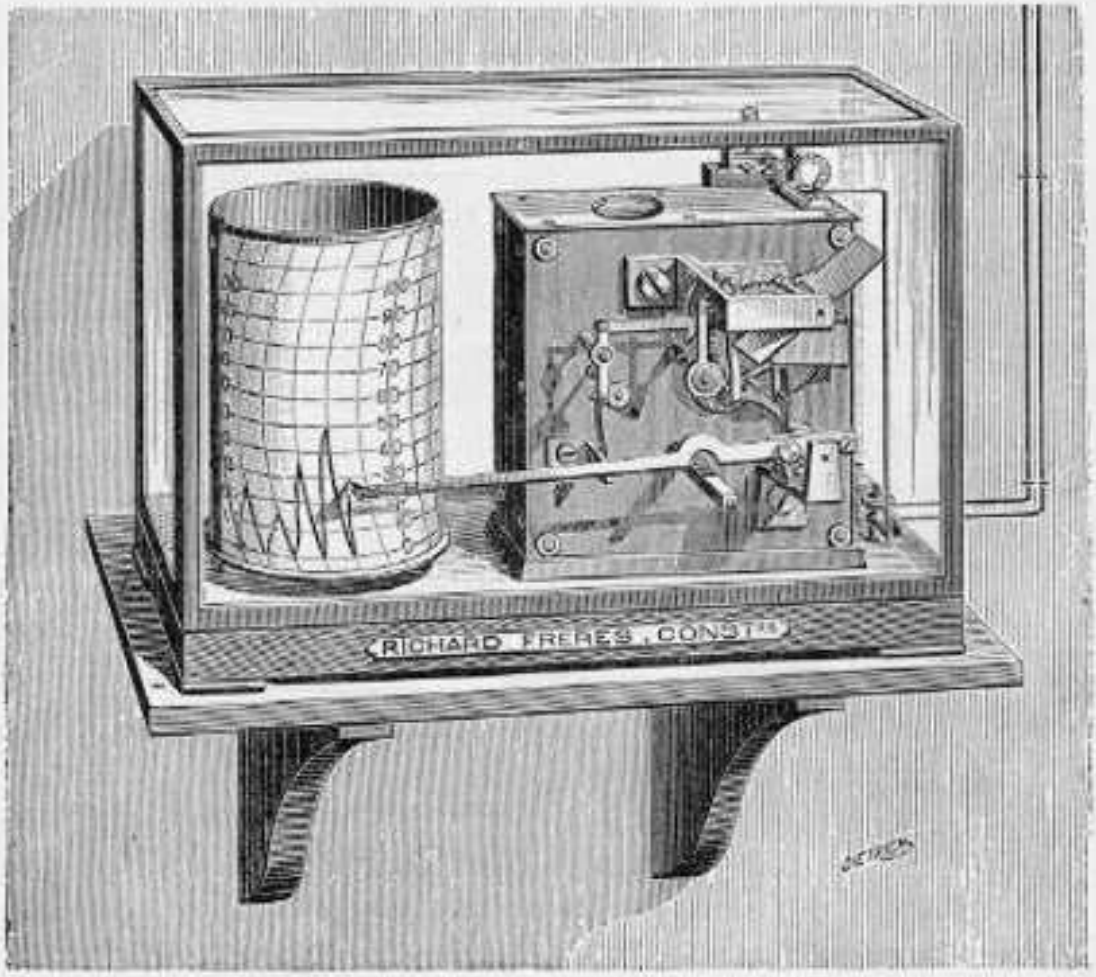


Fig. 15.

ANEMOMETERS.

It is curious that MM. Richard Frères and Mr. W. H. Dines have independently and simultaneously arrived at the opinion that some form of helicoid makes the best anemometer. It is, in fact, a modification of the pattern known as Whewell's, and when of a large size used to keep the sails of a windmill perpendicular to the wind; but very different in the details, as will be seen. The plates are not rectangular but oval, they are not flat but helicoidal, so that each turn of the vane represents one foot of passing wind, They are as light as possible, being made of sheet aluminium, so that their friction and momentum are almost nil. The revolving blades are kept perpendicular to the wind by a swallow-tailed vane. Inside the horizontal box, the axis of the revolving fans carries an endless screw which, by suitable gearing, causes the rotation of a shaft, which carries an insulated contact maker, and sends a current for each 1, 25, 100, 1000, or 5,000 feet of wind as desired.

For direction a swallow-tailed fan is usually employed, and an electric cable with 16 wires (really 17, as one is needed for the velocity indication). The arrangements for recording the results are numerous.

Anemometer, helicoidal blades, and swallow-tailed direction vane, with suitable contact maker, for 1, 25, 100, 1,000 or 5,000 feet, mounted on iron tube, 5 feet long £12 0 0

Ditto. Three contacts, 1, 25, and 5,000 feet £15 0 0

Recording Mechanism for the above. In Fig. 14 we have the lower pen continually recording the direction, and the upper one making a short stroke on the passage of each half mile of wind. In Fig. 15 we have no record of direction, but the total motion of the wind in each hour, and by the acuteness or flatness of the trace the velocity at any particular moment.

FIG. 14. PRICE £48 0 0

FIG. 15. PRICE £9 9 0

Chronograph-Totaliser, Fig. 16, for recording the total number of miles or kilometres of wind in 8 days or 24 hours.

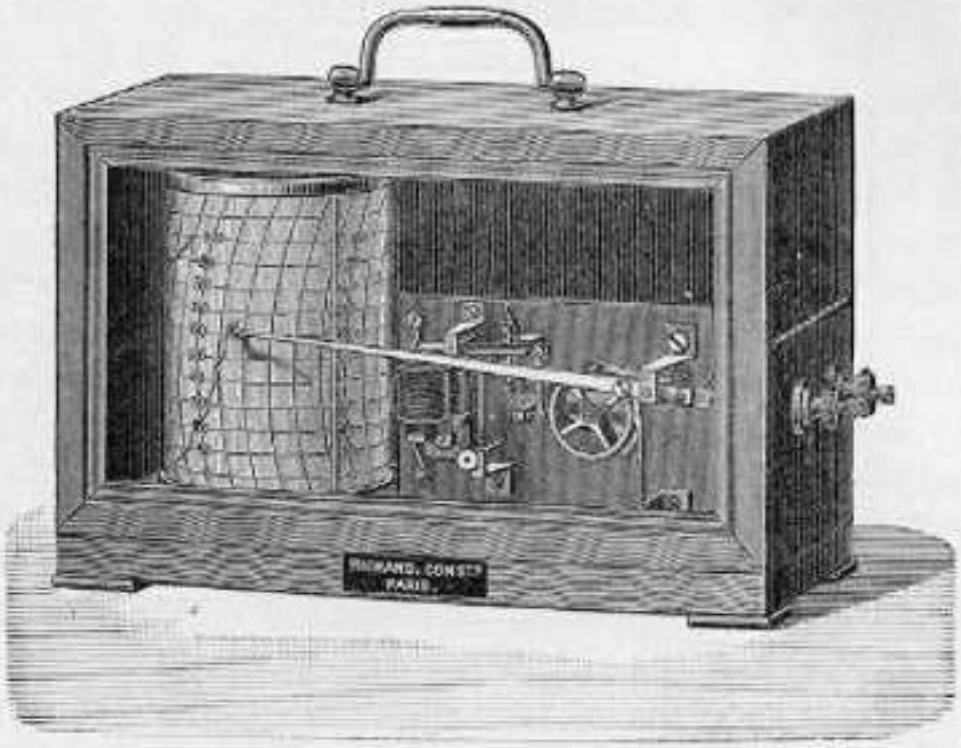


Fig. 16.

	£	s.	d.
Price.—Magnet falling automatically	8	10	0
„ „ lowered by hand	6	5	0

Anemo-Cinemographs. These are a speciality of the firm, and the following brief description will explain their working. The effect of the cinemograph is to constantly show the velocity, that is to say, $\frac{\text{metres of wind passing}}{\text{time.}}$ This is effected in an extremely ingenious way. A train of clockwork, kept isochronous by a Foucault or a Breguet governor, causes two wheels to turn in opposite directions with equal and constant velocity. Between them is a steel castor, roller, or small wheel, on one extremity of a long axis. Evidently the action of the wheels will draw this roller to the centre and keep it there, unless some greater power draws it out. This power is sent by the currents coming from the anemometer, or from any revolving shaft of which it is desired to record the velocity.* Each current, by an electro magnet, releases one tooth of an escapement which draws the steel roller away from the centre; therefore, the more frequent the currents, the further the roller is kept from the centre, and the position of the roller represents absolutely the result of $\frac{\text{frequency}}{\text{time.}}$ This valuable result being obtained all that remains is to record the position of the roller, and this can be done in various ways.

One pattern, Fig. 17, with endless paper running $1\frac{1}{4}$ inches a minute, has

* *See also pp. 45 to 47.*

been made for the Bureau Central Météorologique de France for studying the storms on the top of the Eiffel Tower; another forms part of the apparatus called the Brontometer, made for the study of thunderstorms.

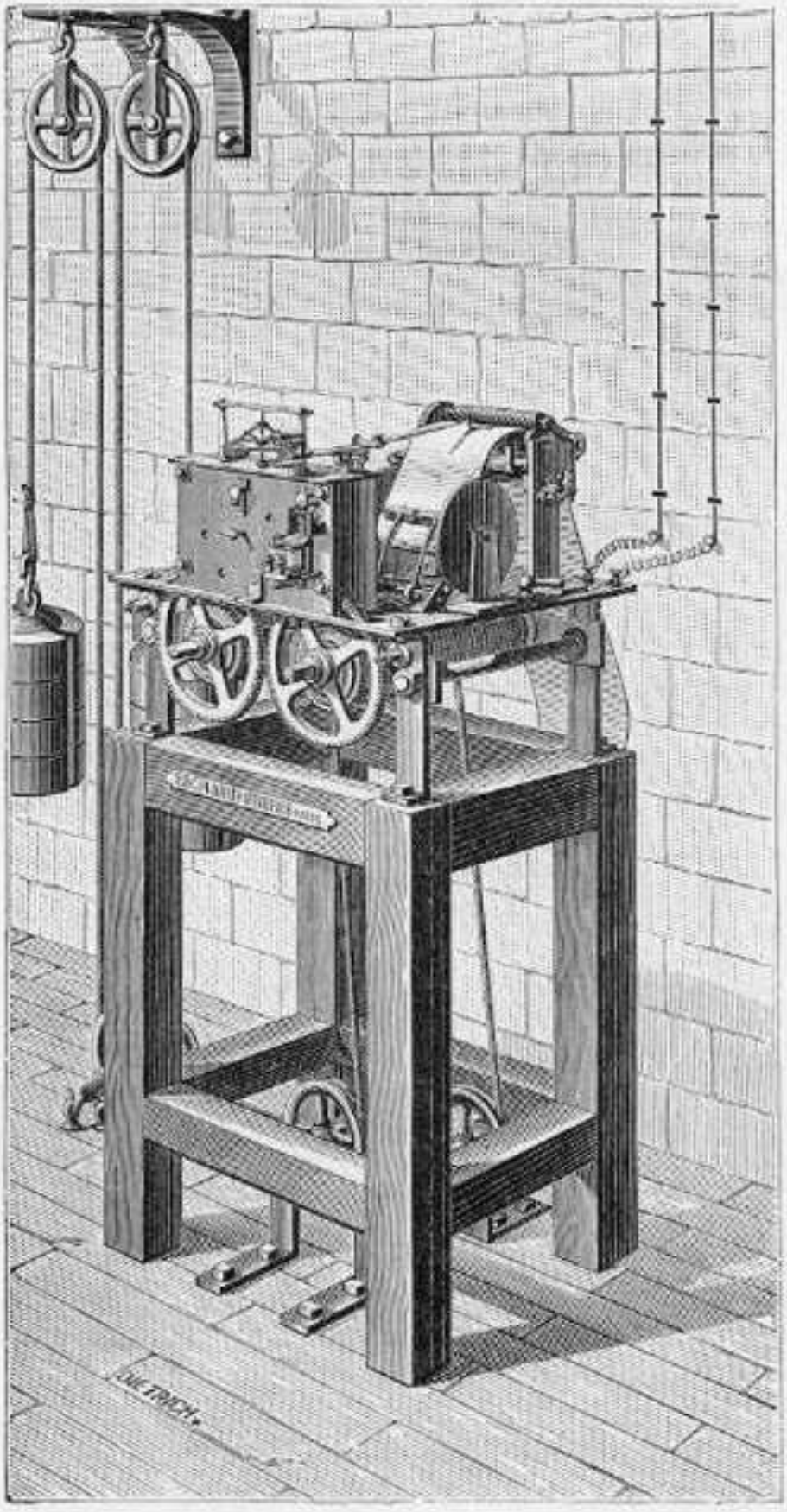


Fig. 17.

Price £125 0 0

RECORDING EVAPORATORS.

Model No. 1. There are several arrangements for recording the loss of water by evaporation. Fig. 18 shows the mode of recording the difference

Fig. 18

between the loss from a pot of earth, and one with a plant in it. As the evaporation proceeds more rapidly through the action of the plant that pan will become lighter, and the amount and time of decrease will be shown on the cylinder in the recording part of the instrument.

Fig. 18.—Price £16 0 0

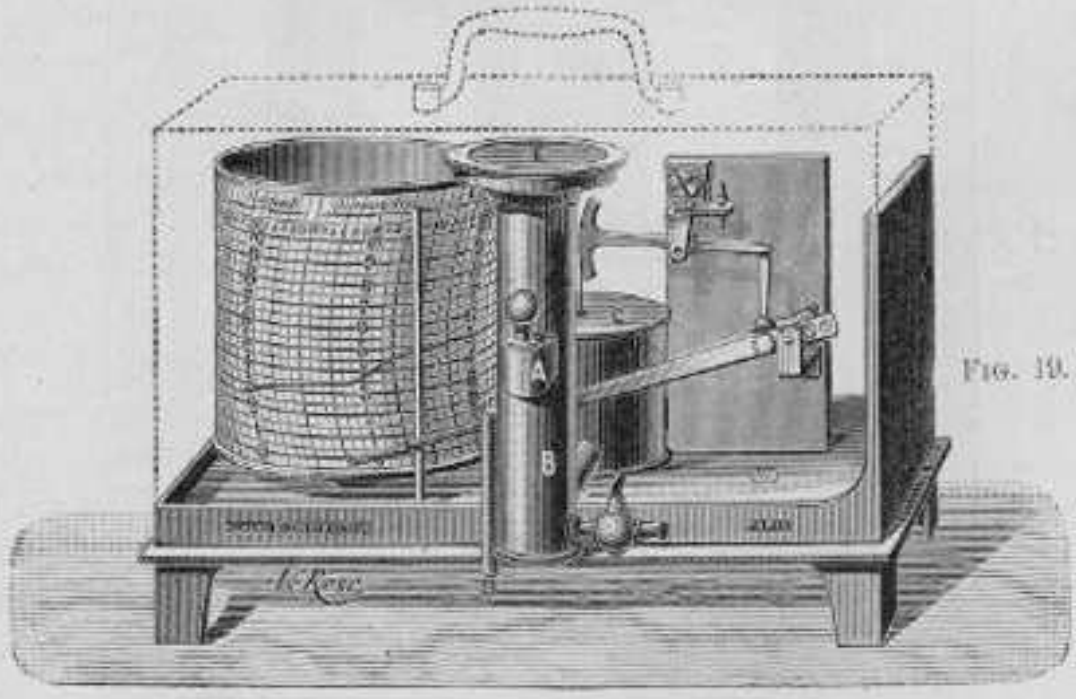


Fig. 19.

Model No. 2. Fig. 19 is Houdaille's self-recording form of Piche's instrument. **E** is a sheet of blotting-paper kept wet by a wick descending the tube **B**, which is partly filled with water; **B** and **C** are connected by a pipe, and **C** has a float attached to the lever. As water is evaporated from **E** the level in **C** sinks, and the recording pen rises.

Fig. 19.—Price £3 5 0

RAIN GAUGES.

Float Pattern. Two entirely different patterns of Self-recording Rain Gauges are here figured and described.

The cheaper (Float Pattern, Fig. 19A) consists of a funnel about 8 inches in diameter from which the rain falls behind the drum into a cylinder of one-fourth the area of the funnel and in which therefore the water rises four times its natural depth. On this water rests a float, which rises as the rain falls and at the same time raises the pen recording on the cylinder. When 0·40 in. has fallen, a stud on the arm rising from the float touches the spring attached to a magnet, completes a circuit, and the float is so plunged into the water that a syphon in the collecting vessel is discharged, the vessel emptied, the pen brought back to zero, and all is ready for another fall of 0·40 in.

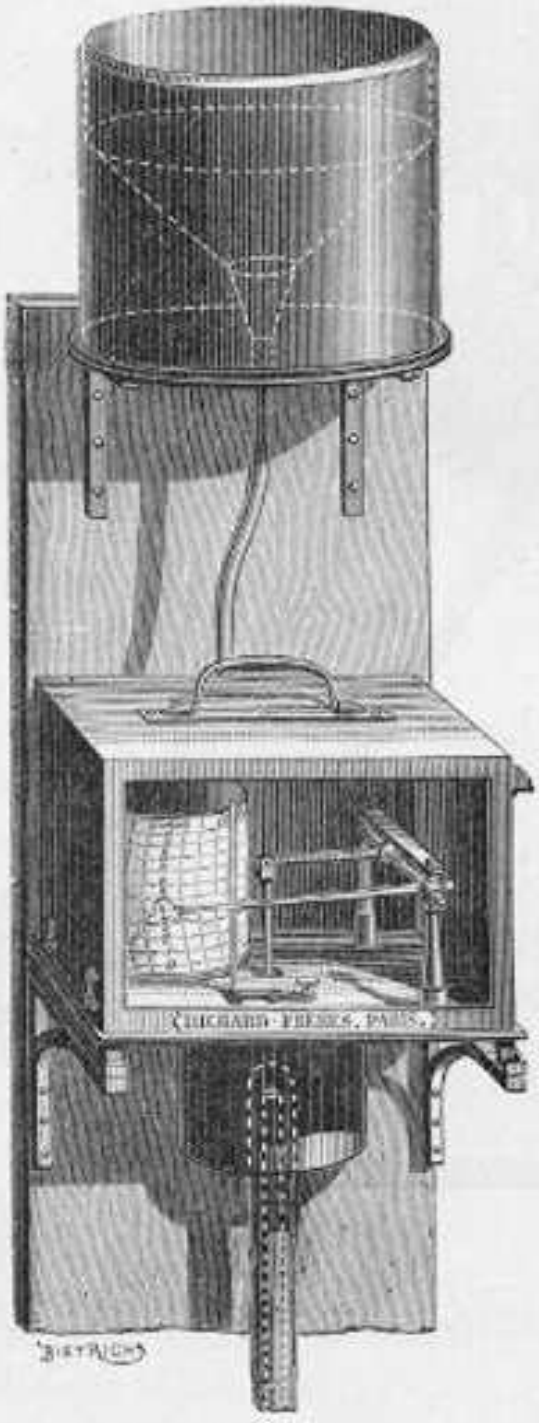


Fig. 19A.

This figure shows the general principle, but not the electrical details.

Price: Float Pattern, Fig. 19A, £12 0 0

(Battery and Wire extra.)

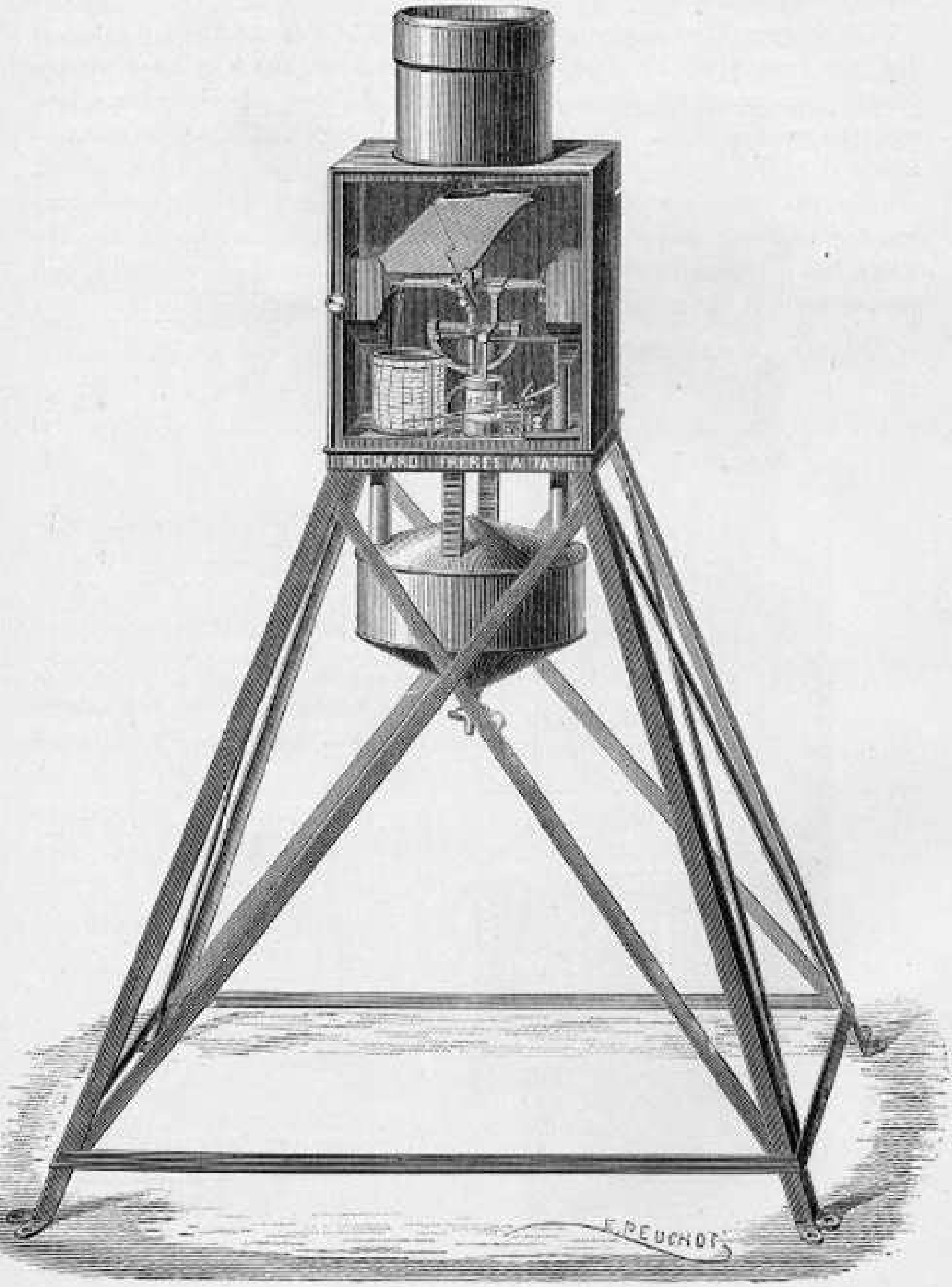


FIG. 19B.

Bucket Pattern. The larger (Bucket Pattern, Fig. 19B) has been adopted by various observatories and public institutions, both in England and abroad. The rain falls into one of two compartments of an oscillating bucket; this compartment is then depressed, and at the same time raises the pen on the chart until 0·40 inches of rain has fallen, when the other compartment is brought into action and a similar quantity of rain recorded. This process is continued by each bucket alternately. The water is discharged into the receptacle below, whence it can be drawn off for measurement.

PRICE: Bucket Pattern, Fig. 19B £24 0 0
(Battery and Wire extra.)

*** Each of these two patterns is usually supplied with a cylinder rotating in seven days, but if a more open scale be desired, it is equally easy to supply them with a cylinder rotating once in twenty-four hours. So with respect to the depth of rain, they are commonly made to record it on a scale about ten times that of nature, *i.e.*, 0·10 in. of rain would occupy an inch of paper; but this can be made greater or less as desired, at a slight extra cost.

RECORDING ACTINOMETERS.

Solar Heat. The Richard system for recording this is partly based on the researches of Professor Violle. The two thermometers, the bulb of one of which is bright and of the other dull black, are protected by glass spheres, and record on a single sheet, so that the difference between the two and also the times of their respective maxima can be easily seen. As far as we are aware this had never been previously attempted, except at the Montsouris Observatory, and it is not known that any results from the Montsouris instrument have been published.

	£	s.	d.
PRICE: Double Bulb Instrument, viz., bright and black bulbs ..	26	0	0
Single „ „ .. bright or black bulb ..	17	0	0

Solar Light. This pattern of Sunshine Recorder consists of a cylinder furnished with an elongated V-shaped slit, turning with the sun in front of a paper sensitized by ferro-prussiate, which produces a record dark in proportion to the intensity of the light.

PRICE £8 15 0

AEROSCOPES for BACTERIOLOGY.

Dr. Miquel's Aeroscope. This is a simple arrangement, not likely to get out of order. A train of clockwork in H, Fig. 20, draws a slab of glass coated with a sticky substance past the aperture above C. As air is, by an aspirator, being withdrawn through T, fresh air must enter at C, and the floating bodies will adhere to the portion of the glass immediately above C: and the rate of progression of the glass being known, the time of any particular deposit can be ascertained.

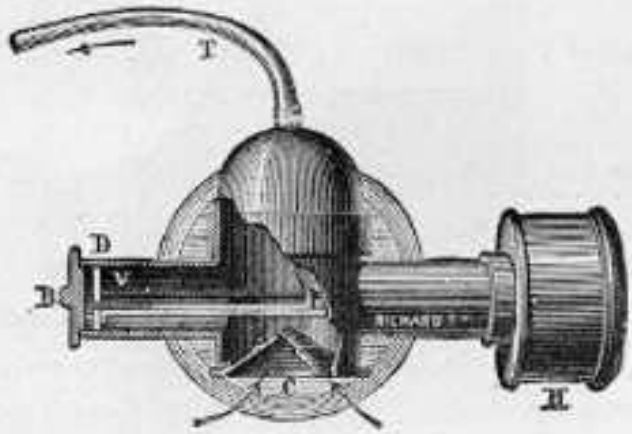


FIG. 20.

FIG. 20.—PRICE £4 0 0

Recording Aeroscope. This apparatus consists of a bell-glass, with a slit which acts as a window, and allows atmospheric air to enter at F f, (Fig. 21), and strike upon the face of the drum H H, which is opposite to F f.

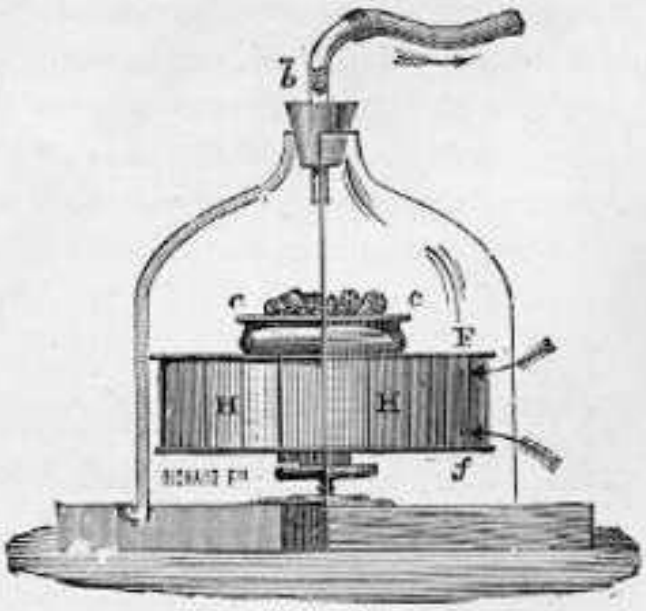


FIG. 21.

The drum, which rotates in a day or an hour, is covered with paper saturated with material suitable for the development of colonies of bacteria. As the air passes out through the tube beyond b, its place is supplied by fresh air entering at F f; and when the paper is removed, it is easy to see at what time the greatest number of bacteria have entered the apparatus.

FIG. 21.—PRICE £7 10 0

WATER LEVEL INDICATORS and TIDE GAUGES.

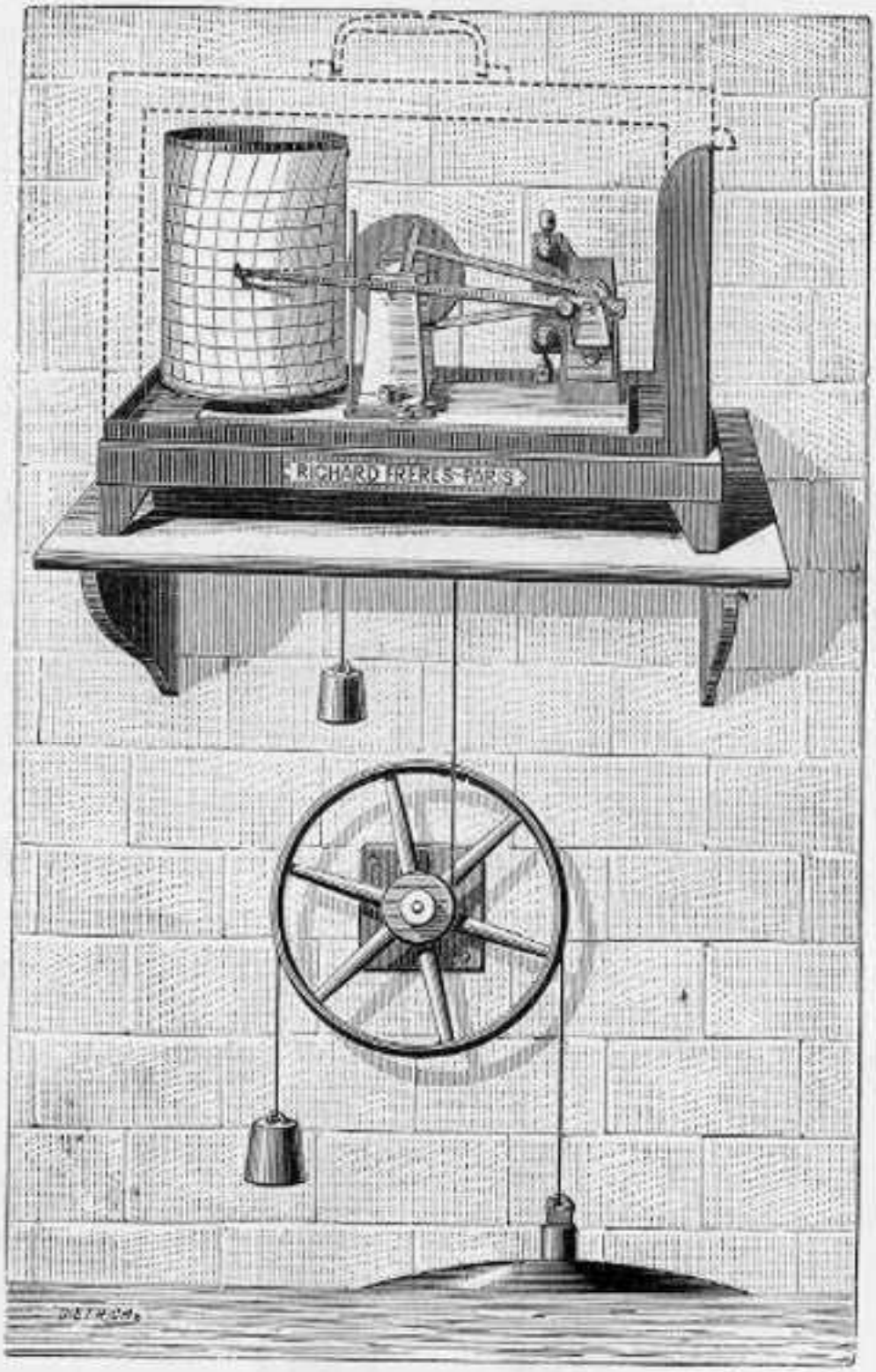
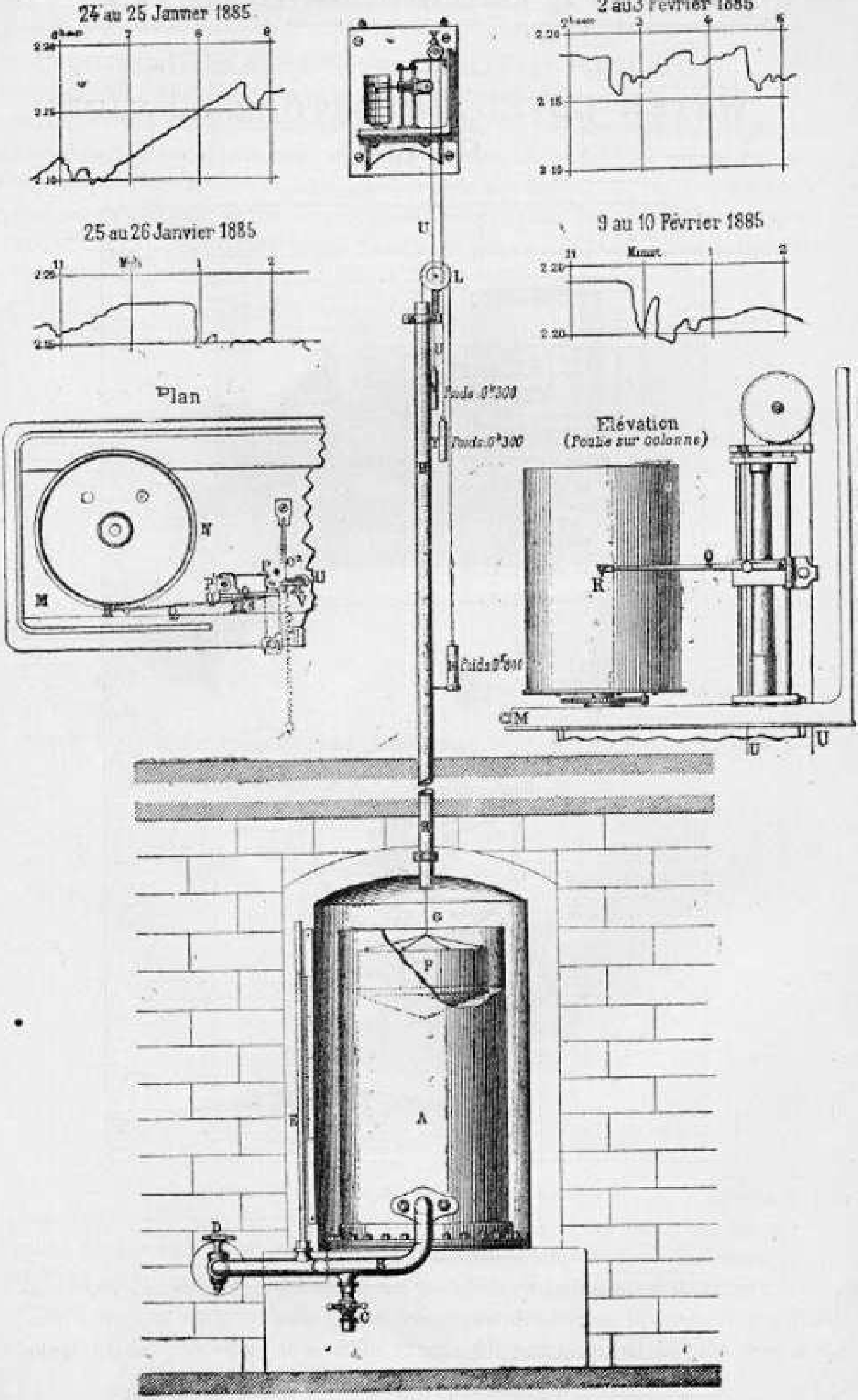


Fig. 22.

Fig. 22, although primarily designed for indicating and recording the variation in the level of water in canals, reservoirs and tanks, and the heights of tides, is well adapted for recording the change of level in large evaporating tanks.


24 au 25 Janvier 1885
25 au 26 Janvier 1885
2 au 3 Février 1885
9 au 10 Février 1885
Plan
Élévation
(Poulie sur colonne)
Poids 0k300
Poids 0k300
Poids 0k300
U
L
N
M
V
R
G
F
A
D
C

It would also give an indisputable record of the use of locks, and of storm overflows; in fact, of the time and amplitude of any change in a water level.

To a depth of 3 feet the working of instrument is controlled direct by the float.

		£	s.	d.
Fig. 22.—Price:	Recording Part	7	10	0
„	Float	0	15	0
„	Counterpoise	0	1	6

Beyond 3 feet it is necessary to add a reducing gear. The illustration shows the instrument with exterior reducing gear; this can, however, be placed inside the case, thus simplifying the installation.

		£	s.	d.
Price:	Reducing gear, interior or exterior, 3 to 15 ft.	1	5	0
„ „	„ 15 to 30 ft.	2	0	0

If with contacts, maximum and minimum, 25/- extra.

Fig. 23 is rather more complicated, and is used in the large reservoirs for the City of Paris. It gives a rectilinear instead of a curved diagram. Further particulars on application.

		£	s.	d.
Fig. 23.—Price:	With cylinder $3\frac{3}{4}$ in. diameter, 8 in. high ..	7	10	0
„	„ 5 in. „ 8 in. „ ..	9	9	0
„	Float	0	15	0
„	Counterpoise	0	1	6

Adjustable electrical contracts extra.

LEVEL RECORDERS FOR ACTING AT LONG DISTANCES.

FIGS. 24 & 25 (MODEL B).

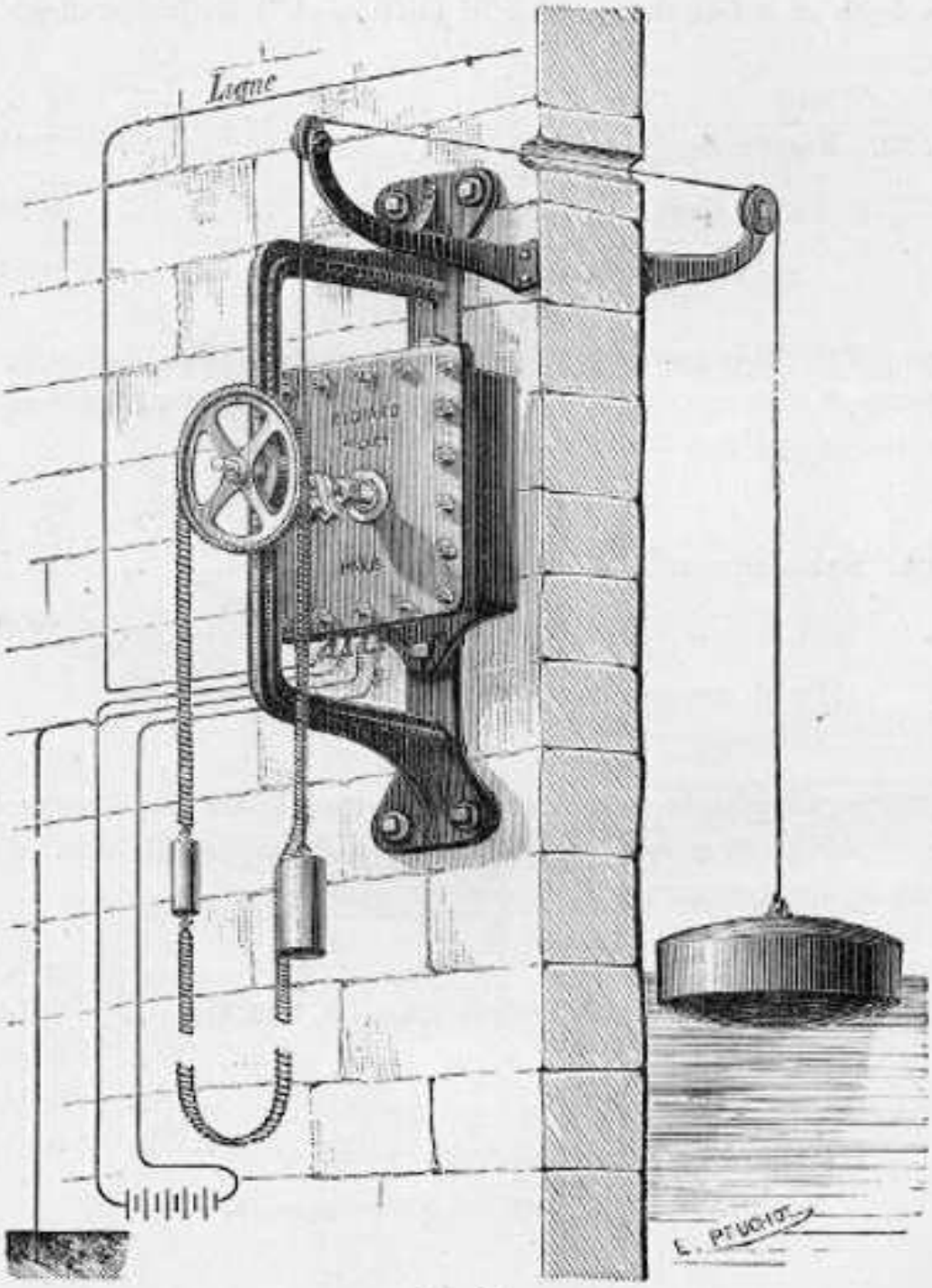


FIG. 24.

There are two forms of this very accurate instrument, viz., Model A and Model B. Model A is worked with three wires, and Model B with one wire. Both instruments are equally reliable in their working. Model B (one wire) is the more costly, and is used when the distance between the transmitter and receiver is more than a 1,000 yards, because the saving effected in the installation of the wire gives it an advantage over the other for long distances. Model A is used for shorter distances than 1,000 yards.

The indicator, Fig. 25, may be miles away from the water of which it shows the level. Fig. 24 shows the arrangement at the reservoir, and Fig. 25 that at the office. The wire can if desired, be switched off and used for a telephone.

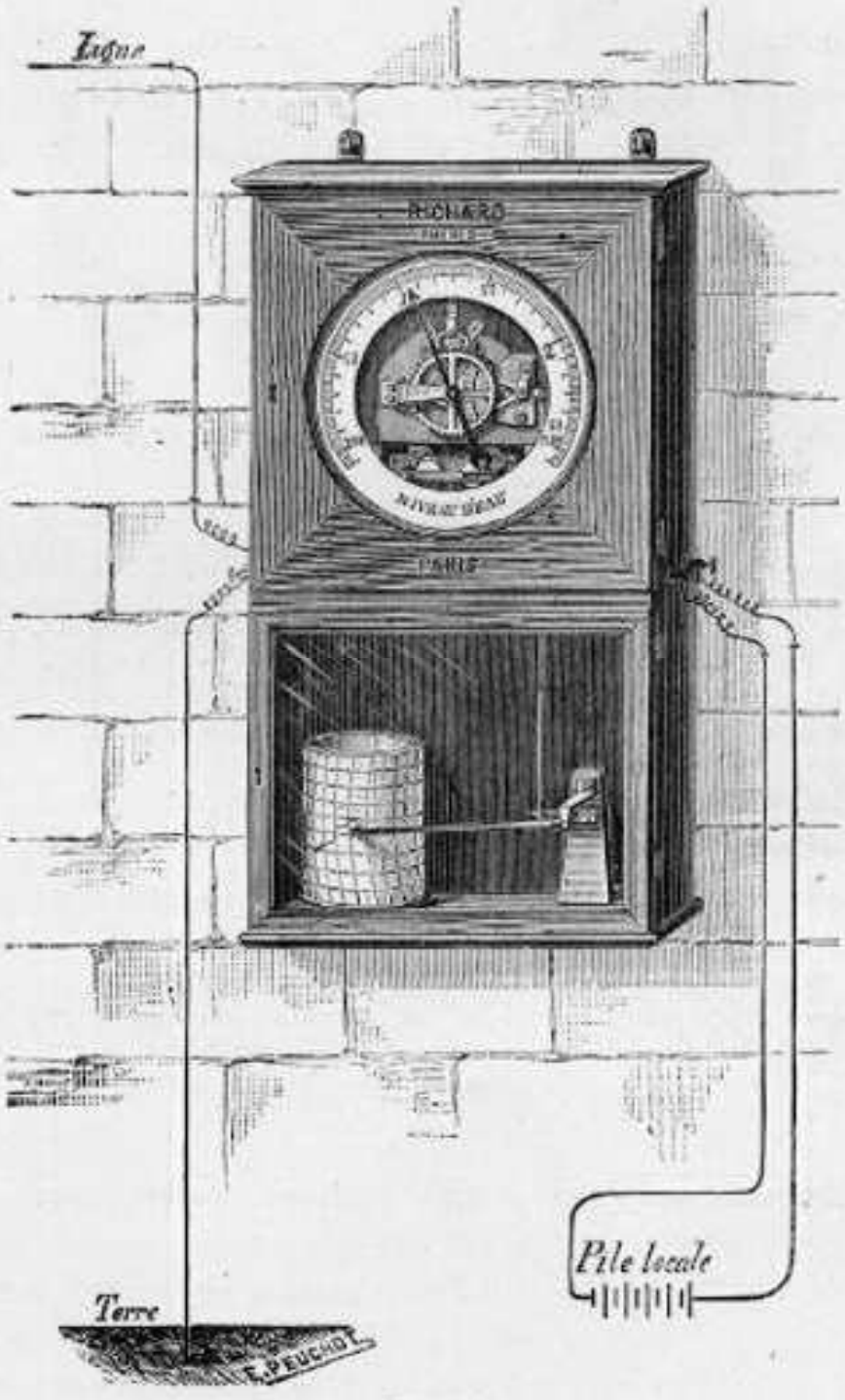


Fig. 25.

PRICE OF MODEL A WITH THREE WIRES.

	£	s.	d.
Transmitter	8	0	0
Receiver with Dial	10	0	0
„ „ „ and Recording Cylinder added, extra	3	10	0
Float	0	15	0
Three Counterpoises	0	5	0
Chain, special, per yard	0	2	0

PRICE OF MODEL B (GRIVOLA'S SYSTEM) WITH ONE WIRE.

	£	s.	d.
Transmitter	24	0	0
Receiver with Dial	14	0	0
„ „ and Recording Cylinder added, extra	5	10	0
Float	0	15	0
Counterpoises	0	5	0
Chain, special, per yard	0	2	0
Contacts, maximum and minimum	1	5	0

Batteries and Wire extra.

NOTE.—Telephone Apparatus complete for working on the above wires, each station, £12 10 0

Particulars and Prices of other Patterns on application.

LEVEL RECORDERS FOR ACTING AT SHORT DISTANCES—SAY 100 METRES, OR 110 YARDS.

Self-Recording or Direct Reading.

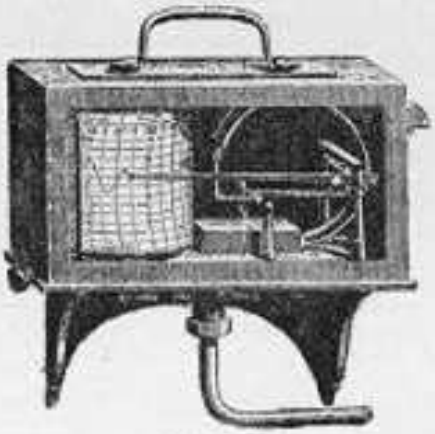


Fig. 26.

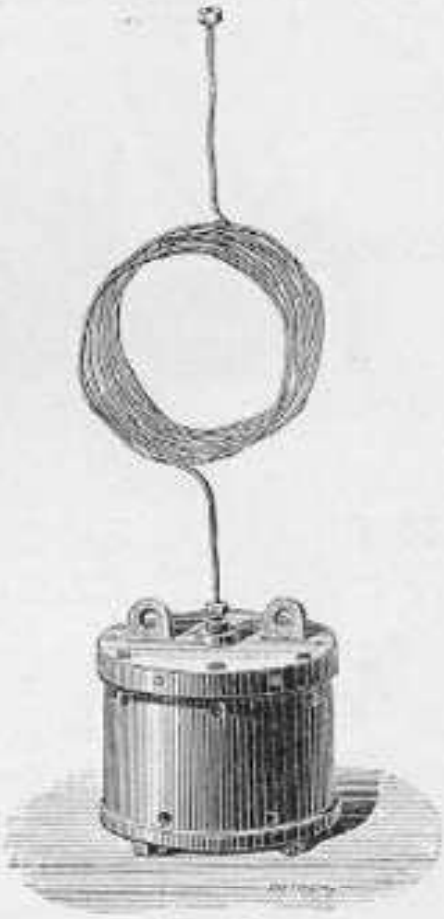


Fig. 27.

These instruments consist of an iron case, Fig. 27, perforated with holes, and containing an india-rubber bag filled with air. The bag is connected by means of a copper tube with a self-recording pressure gauge, and the case is immersed in the liquid. The air-pressure, and consequently the height of the liquid, is indicated and recorded by the pressure gauge and recording cylinder in Fig. 26.

If preferred, a Pressure Gauge (Fig. 28) can be used with Fig. 27, or both it and Fig. 26 can be used.

Prices.	£	s.	d.
Cast Iron Plunger with Air Bag and Connexion for Tube, Fig. 27	1	0	0
Gauge with Dial, direct reading, Fig. 28	1	15	0
Recording Part in Metal Case, &c., Fig. 26	7	10	0
Special Copper Tube for connecting the different parts, per yd. ..	0	0	9
Large Size Model	11	0	0

For Sugar Refineries, &c., this instrument is much used—and gives great satisfaction—for measuring the syrup passing from the vats, thus enabling one to know whether the work has been going on with regularity.

Fig. 28.

Arranged for very Delicate and Accurate Work. The Admiralty requiring for special purposes a Tide Gauge of very great accuracy and delicacy, and having made various suggestions with regard to the above instrument, Messrs. Casella, in conjunction with Messrs. Richard Frères, carried out numerous modifications, and succeeded in bringing out a gauge which fulfilled in a most satisfactory manner the conditions laid down by the Admiralty, so that several of the new type were ordered, and are now in full work. A Special Official Document describing the instrument was issued by the Department.

Prices and particulars on application.

LONG DISTANCE RECORDING INSTRUMENTS, ELECTRIC.

Fig. 29.

Many, if not the majority, of these instruments can be made to record at any distance to which a telegraph wire can be carried. But besides this, instances of which have already been quoted, the following apparatus, specially designed for working at a distance, may be recommended.

These Instruments are intended for the transmission, to any distance, of the indications of the various instruments fitted with indicating hands.

They comprise two stations, the first one perceiving and transmitting the indications, and the second receiving and registering the same.

At the transmitting station is an instrument either indicating or registering. The style moves in front of a dial, between the two prongs of a fork carried by the indicator. As soon as the style moves in one or the other direction it makes a contact, sending an electric current in the corresponding direction. This current travels along the electric wires and closes the circuit of an electro-magnet situate at the receiving or registering station. The armature of this electro-magnet is, therefore, attracted, and causes a ratchet wheel to advance one tooth.

As this ratchet wheel carries the hand which indicates or registers what occurs at the sending station, it will easily be understood that for each contact occurring at the sending station the hand at the receiving station will be correspondingly displaced by one division one way or the other.

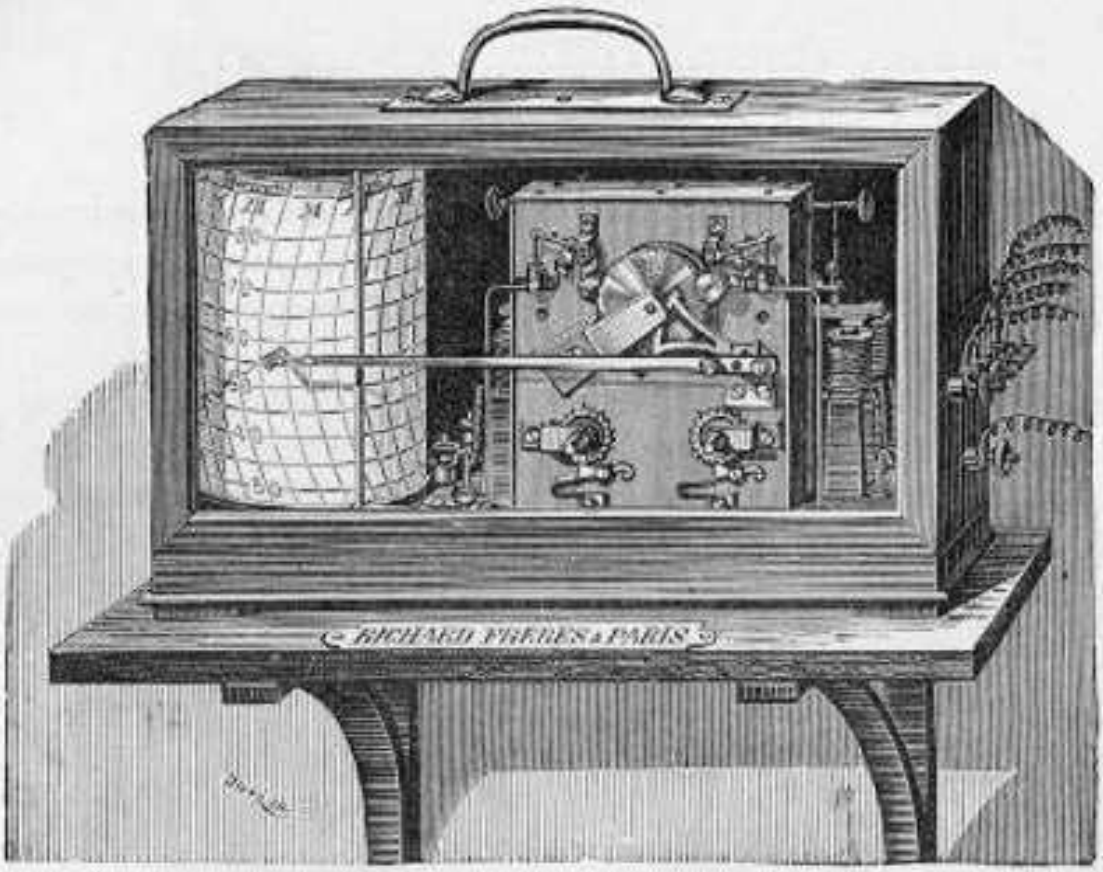


FIG. 30.

At the same time that the circuit is closed at the sending station, the hand is brought back to its normal position, in which it does not touch the prong of the fork.

Should the hand of the instrument at the sending station continue to move in the same direction, the hand coming again into contact with the prong, another current is sent to the receiving station, and the receiver is made to advance one further division.

A contact in the opposite direction at the sending station causes, through the same agency, the hand of the receiving instrument to travel backward by one division. It will, therefore, be seen that the hand of the receiving station instrument moves correspondingly to that of the sending station. The two instruments, therefore, are working in an absolutely synchronous manner.

This arrangement can be applied to all kinds of instruments provided with a hand or pointer, be they merely indicating or registering, such as:—

PRESSURE GAUGES.	SPEED INDICATORS.
VACUUM INDICATORS.	PYROMETERS.
WATER LEVEL INDICATORS.	THERMOMETERS, &c.

FIGS. 29 & 30.—PRICE: Transmitter with Thermometer and Recording Receiver .. £33 0 0

ELECTRIC SCRUTINISER.

This apparatus is designed especially for those responsible for the heating of many rooms, ovens, etc., giving at a distance the different points of temperature registered by a dial instrument. Any number of thermometers, Fig. 32, can be

Fig. 31.

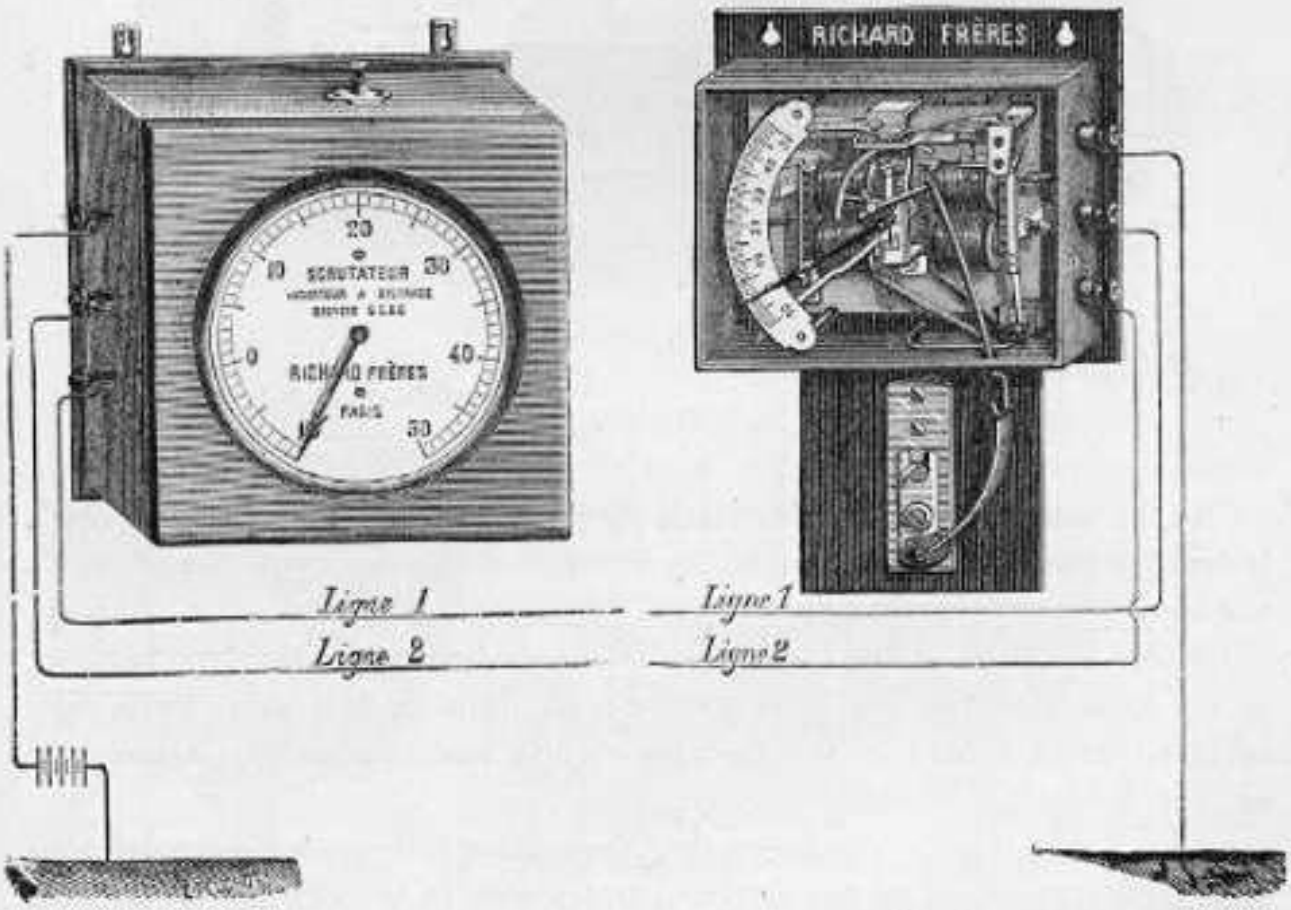


Fig. 32.

placed one in each room, and wires led from them to a single dial in the superintendent's room; he has only to turn a pointer to the number of the room, and its temperature is at once shown on the dial, Fig. 31.

The same principle can be applied to any instrument which registers by the passage of a hand over a dial, such as a level indicator, a hygrometer, a manometer, etc.

The apparatus is strong, simple, and not easily put out of order.

Fig. 31—Price: Receiver	£6	5 0
Fig. 32— „ Transmitter	£6	5 0

UNIVERSAL CONTROLLING CHRONOGRAPHS.

In industrial processes it is often desired to have an instrument capable of registering an operation or a motion in proportion to the time; as, for example, the *number of revolutions of an engine, the opening of a door of a furnace, the charging of a blast furnace, the passing of railway trains, the rounds of a night watchman*, or, in other words, *the instant and the duration of any given experiment, as well as in astronomical, physiological, gun firing, and other observations.*

The Self-Registering Chronograph, which makes a stroke on a recording sheet each time that a contact is established, by causing the closing of the electric circuit of a battery connected with the apparatus, absolutely meets this desideratum.

The instrument is composed of an electro-magnet carrying a pen which traces

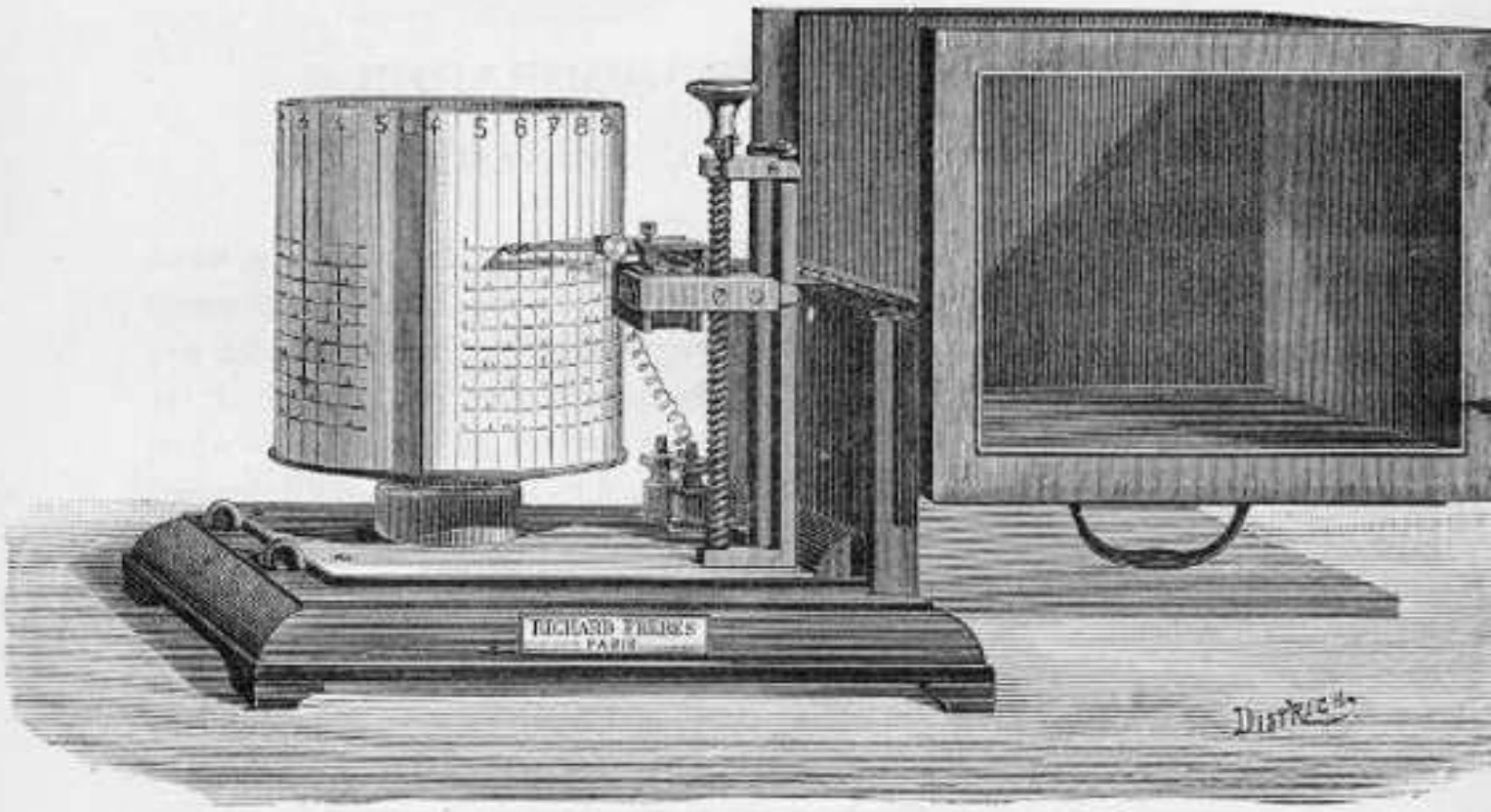


FIG. 35.

a continuous line. Every time the process under observation closes the circuit and establishes a current the pen traces a vertical line, and the duration of the process and the exact moment at which it occurred, are given by the diagram so produced.

The cylinder, as in all our instruments, can revolve in any time desired.

Amongst the many uses for which this instrument is adapted, it has been successfully applied in connexion with the Speed Indicators, now so extensively adopted in factories. The adaptation is very simple; an electric contact being placed on one of the wheels of the indicator, enables one, according to the wheel on which the contact is placed, to register the units, tens, or hundreds, etc.

PRICES:

	£	s.	d.
Universal Controlling Chronograph, magnet falling automatically, Fig. 33	9	0	0
Ditto, ditto, magnet lowered by hand..	6	6	0

PRECISION CHRONOGRAPHS.

(For Astronomy, Pyrotechnics, Physiology, etc.)

These Chronographs consist of a cylinder worked by a clock movement, which is regulated in a most perfect manner by an isochronous regulator of the Foucault kind, perfected and patented by the maker. A small carriage fitted with two electro-magnets each carrying a pen, works according to the rotating of the cylinder, and thus traces a helical line on the paper. In certain cases where electricity cannot be used, the magnets are replaced by membranes or diaphragms, worked pneumatically by an indiarubber ball. According to the model, the cylinder can turn in eight minutes, one minute, six seconds, or one second, and give out a length of paper of one, ten, or fifty centimetres per second. In this last case $\frac{1}{1000}$ of a second is represented by half a millimetre. For higher velocities to ten millimetres per second, the trace is made on smoked paper.

PRICES OF PRECISION CHRONOGRAPHS:

	£	s.	d.
With cylinder, 12·5 cm. diameter, to work pneumatically or electrically	27	0	0
With cylinder, 19 cm. diameter, one turn per minute	28	0	0
With cylinder, 19 „ „ one turn in six seconds	31	0	0
With cylinder, 16 „ „ one turn in one second	42	0	0

PLANIMETER.

(For totalling the results of diagrams.)

This Planimeter is so devised that there is no contact between the paper and the totalising mechanism: it is, moreover, easily manipulated. The desired result has been obtained by means of the application of a laminated roller between two spring discs.

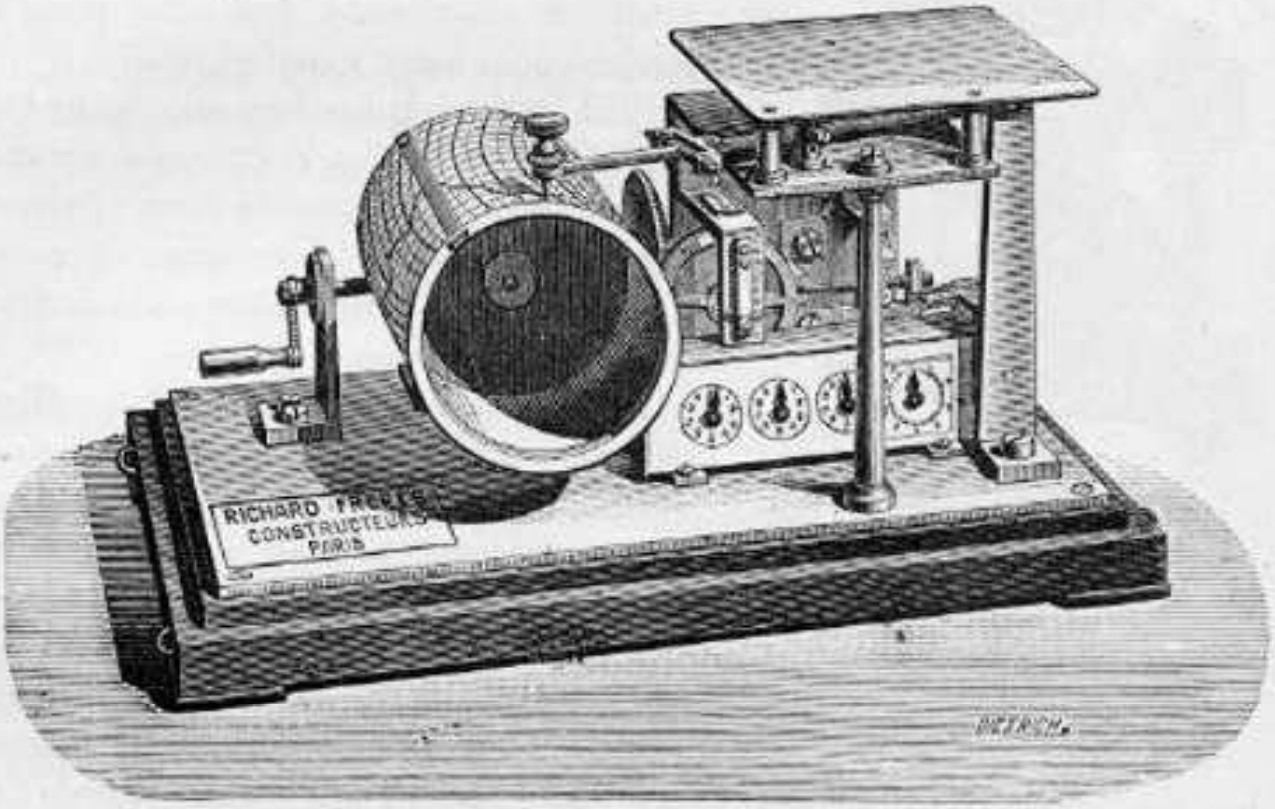


Fig. 34.

In order to find the surface included in a perimeter traced upon paper, the latter is fixed upon the drum of the instrument and all the indicators are put to zero. The knob, held in the right hand, is pressed against the flange at the bottom part of the cylinder, and the small crank turned until one of the ordinates, passing through any point of the diagram, comes under the pointer of the knob. The starting point of the diagram is then spotted by means of a pencil mark, and, after bringing the point of the knob on to the pencil mark, the crank is turned in one or another direction, following the curve, until the starting point is again reached. The guiding pointer is then brought against the flange, and the surface of the diagram can be read in square millimetres or inches on the indices.

The manipulation of the instrument is extremely simple, and its indications are independent of the nature of the paper.

	Diameter of cylinder.	£	s.	d.
Fig. 34.—Price of the Planimeter	$3\frac{5}{8}$ in. ..	24	0	0
,, ,, ...	4 in. ..	31	0	0

TRACTION DYNAMOMETERS.

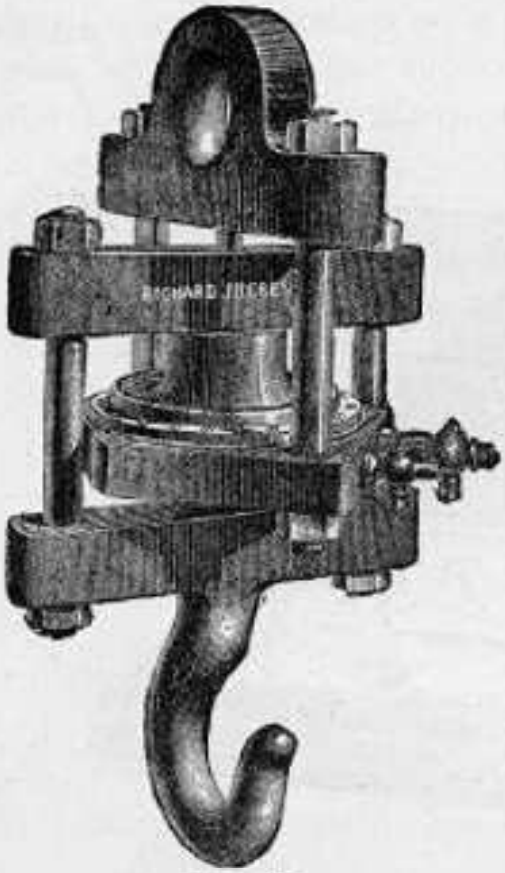


Fig. 35.

MM. Richard manufacture a Traction Dynamometer which is springless, gives excellent results, and is applicable to all kinds of experiments, from the smallest strains up to many tons.

This instrument has been adopted by the French Service of *Ponts et Chaussées*, for the measurement of the tractive force of steam tugs hauling various descriptions of cargo boats, on cranes to determine loads, and in various manufactories.

It is composed of a hollow chamber filled with water and closed by a diaphragm, upon which a disc connected to a second chamber exerts a pressure as soon as any tractive effort takes place, Fig. 35. The effect of the traction is to compress the liquid, and the effects thus developed are conveyed, through a flexible tube mounted on the hollow chamber, to an indicating or self-recording pressure gauge, Fig. 36, which records the variations of pressure on a diagram. This instrument is extremely sensitive, and can be adapted to a great variety of experiments upon strains by providing it with a more or less sensitive pressure gauge.

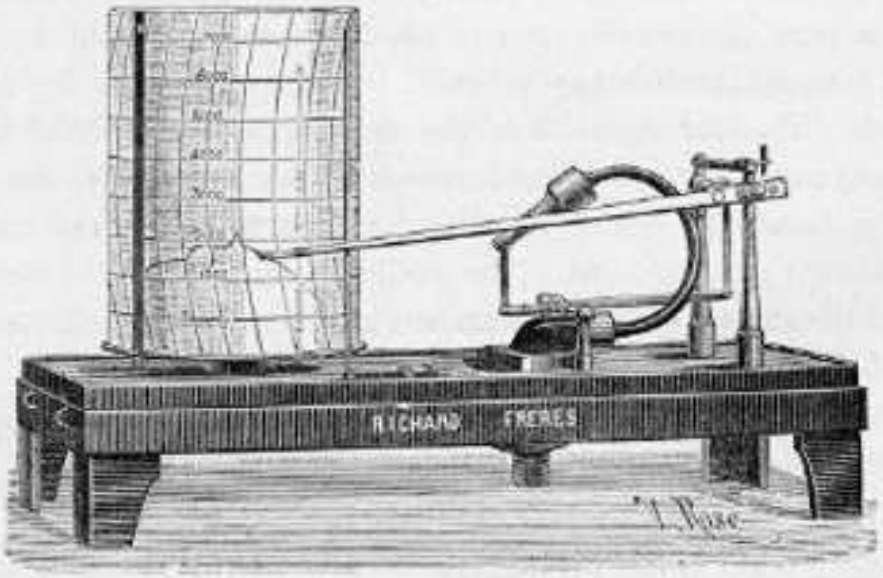


Fig. 36.

PRICES OF THE TRACTION DYNAMOMETER.

The following prices include the Dynamometers with dial gauge mounted on one side of the chamber:—

	£	s.	d.
Dynamometers from 0 to about 1, 2, and 5 cwt.	11	0	0
" " 0 to about 9 and 18 cwt.	12	0	0
" " 0 to ½ ton or 2 tons	16	0	0
" " 0 to 10 or 11 tons	17	0	0
" " 0 to 15 tons	20	0	0
Recording Pressure Gauge giving trace of the strain:			
With paper 11 inches long by 3½ inches deep	7	10	0
" " 11 " 5 "	8	10	0
" " 15½ " 6¾ "	11	0	0
If with paper 35½ inches long, extra	1	5	0
Dial Pressure Gauge only	1	15	0

If it is desired to have the readings given at a distance from the Dynamometer, special copper tube or wired rubber tubing is supplied, capable of resisting a pressure of 100 kilos per square centimetre.

Price of tube, in copper .. .. per yard	0	3	6
" wired rubber .. .. "	0	8	0

In some cases it is desirable to connect the Dynamometer with two gauges of different pressures. In this case a T-piece with 3 taps is necessary, thus enabling one to use either of the gauges.

Price of T-piece with 3 taps	2	0	0

ROTARY DYNAMOMETERS.

MM. Richard have designed a system of Rotary Dynamometers which is particularly suitable for measuring the amount of power used.

It consists of a Dynamometer (White system) with differential gearing, in which the power tends to act on the differential wheel, which moves on a cup filled with water, similar to the Traction Dynamometers.

A recording gauge registers the pressure, that is, the number of pounds corresponding to the tangential force developed by the belting, and on the same cylinder a Recording Cinemometer (see p. 47) registers the speed of this belting in yards per second. It is, therefore, only necessary to multiply the two corresponding readings to learn the number of pounds exerted.

Amongst the advantages of this instrument, we would particularly point out the entire removal the effects of inertia, which give rise to considerable errors in the readings of the ordinary instruments of this kind.

In all the dynamometers in which the force is balanced by a weight on a spring, the differential wheel is inclined to give way before the start (or power) to advance as soon as the force is overcome, thus causing oscillations which make

the readings very difficult: from a mechanical point of view the resulting sudden movements backwards and forwards are seriously prejudicial. On the other hand, in this dynamometer the differential wheel is never out of its proper position, and the quantity of water necessary for the working of the gauge is very small. One can, by closing the tap more or less, completely stop the oscillation of the hand.

Prices according to strength etc., required.

RECORDING INSTRUMENTS for Testing Strength of Various Materials.

Various models of Recorders have been fully studied with a view to adapting them to the testing of materials of various kinds; the types of those mostly in use are:—

1st. Recorders for the Testing of Rubber, Threads of Flax, Hemp, etc., and suitable for very delicate strains, 30 kilos(=72 lbs.) at the most. The cylinder turns during the lengthening of the material being tested, the pen meanwhile ascending the cylinder according to the force exerted; the curve resulting from the two movements giving all the necessary data by which the strength of the resistance of the material can be estimated. The instrument is furnished with a small windlass arrangement, thus enabling one to obtain the necessary force in the experiments.

PRICE £11 0 0

In cases where a greater force than 30 kilos has to be used, as in cables, etc., the Traction Dynamometer (Fig. 35) is used, but arranged in such a way that the cylinder is turned by the lengthening of the material.

2nd. Differential Recorder for Testing Metals.—This apparatus is among the machines based on the compression of a liquid. Lengthening of metals being generally very slight, we have designed a differential system which only allows the cylinder to turn quickly by the lengthening caused between the two marks traced on the gauge. Errors caused by the moving, etc., of the tongs or grippers are thus avoided. A recording gauge, in connexion with the receiver of the instrument, traces the curve of force.

PRICE OF THE DIFFERENTIAL RECORDER .. £13 10 0

APPARATUS for TESTING METALS.

This apparatus is made on two principles, *viz.*, on the hydraulic or on the steelyard principle. It is for testing metals or other materials for elasticity, pliability, or compressibility, and is constructed to work up to 50 tons, and furnished with a differential recorder in connection with the gauge, which registers the various strains, etc., thus giving all data required.

Prices according to power required. Particulars on application.

SPEED INDICATORS or CINEMOMETERS.

Indicating or Recording the Number of Revolutions, &c., per Minute.

One of these instruments is shown in Fig. 37. It has the special advantage that it may be placed in the engineer's office, so that, if a switchboard is fixed by its side, the engineer may be able to make the cinemograph indicate the speed of any one of ten or a dozen different engines running.

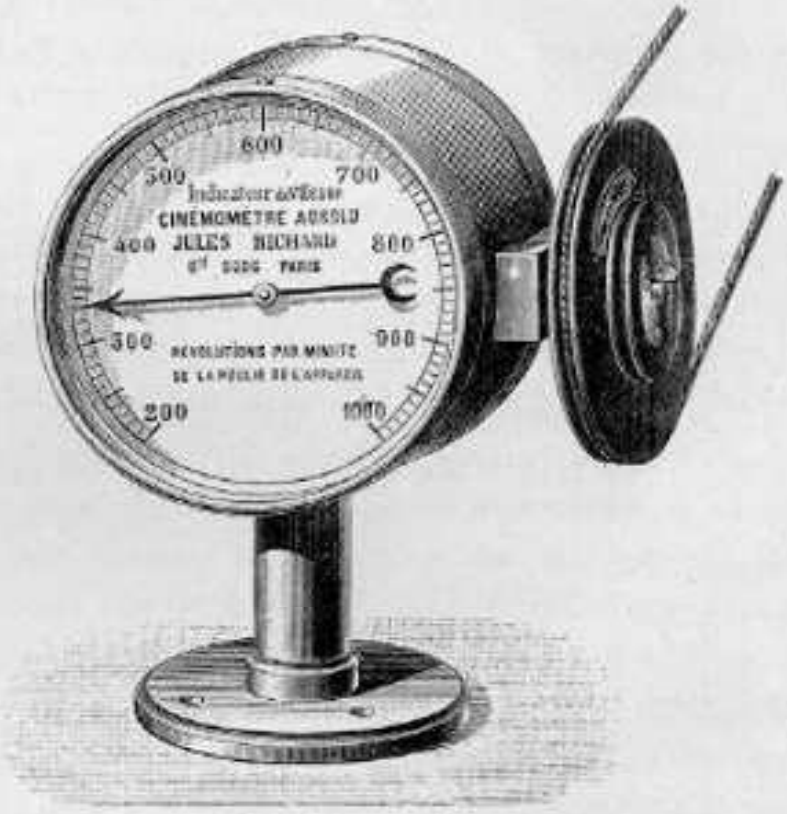


FIG. 37.

When the number of turns per minute made by the shaft of a machine is required to be known, one uses a counter and a seconds watch, the number of revolutions divided by the number of minutes giving the required result.

MM. Richard Frères have invented an instrument which gives the above continuously and automatically, and which indicates either the number of turns per minute by means of a hand on a dial, or records the curve of velocity, the apparatus being fitted with the self-recording system.

The apparatus, represented in Fig. 37, gives accurately the result, which properly speaking is the continuous solution of the equation:

$$\frac{\text{Distance run}}{\text{Time}} = \text{Velocity } \left(V = \frac{de}{}\right).$$

It consists of two discs turning in opposite directions in a certain time, and causing the roller to revolve between their surfaces, this roller being kept at a distance from the centre proportionate to the number of turns of the machine.

This distance is obtained by means of a wheel with helicoidal slit, which acts after the manner of a pinion guiding a toothed bar on an endless screw, the roller being concealed on the extension of the latter. The discs, driven by a small movement caused by the machine, and having a speed strictly regulated by a Foucault regulator, have the effect, by causing the roller to turn upon itself, of unscrewing the endless screw in the helicoidal wheel in the same manner as a movable screw in a fixed box, they therefore tend to bring back the roller to their centre.

This latter is therefore subjected to a double movement: 1, it is brought rapidly towards the periphery of the discs in proportion to the number of revolutions of the machine: 2, it is brought back to the centre of the discs in proportion to the time.

The result is that it takes a position of equilibrium on the discs, which corresponds to the ratio of the two factors, that is to the exact quotient of the number of revolutions by the time. This quotient is expressed by the momentary distance from the plane of the roller to the centre of the discs, which is shown by the hand on the dial, or marked off on a self-recording instrument.

If the working of this apparatus is thoroughly understood, it will be seen that the indications it furnishes may be considered absolute, as the number of revolutions of the machine are reduced to a constant and absolute speed by means of the Foucault Regulator, which is perfectly isochronous. These indications are proportional. The Cinemometer can be provided with an ordinary revolution-counter which serves as a totaliser.

The advantage of this apparatus is that it gives exact results, whatever may be the degree of lubrication of the mechanism, is free from inertia, and does not require any power from the motor on which it is placed, the power necessary to work it being very trifling. These latter properties are precisely those which are not found in any of the Tachometers.

In fact, all Tachometers recording velocity being actuated by centrifugal force, counterbalanced by a weight or spring, it is easily understood that the lubrication of the mechanism changes, the constant of friction likewise varies and consequently enters into the calculation and falsifies the indications to an amount which may be considerable. In the Cinemometer, on the contrary, equilibrium being produced by two equivalents of movements, equal and opposite, passive force cannot come into play, for the roller must always take up such a position on the disc that its distance from the centre, multiplied by the time, which is necessarily constant, is exactly equal to the number of revolutions of the pulley.

The indications given by the hand on the dial are the rates of speed in "revolutions per minute" of the pulley of the apparatus. If we had to measure greater or lesser speeds, it would be sufficient to govern the pulley of the

This distance is obtained by means of a wheel with helicoidal slit, which acts after the manner of a pinion guiding a toothed bar on an endless screw, the roller being concealed on the extension of the latter. The discs, driven by a small movement caused by the machine, and having a speed strictly regulated by a Foucault regulator, have the effect, by causing the roller to turn upon itself, of unscrewing the endless screw in the helicoidal wheel in the same manner as a movable screw in a fixed box, they therefore tend to bring back the roller to their centre.

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RECORDING MANOMETERS and EXTRA SENSITIVE PRESSURE GAUGES.

FIG. 39.

EXTRA SENSITIVE PRESSURE GAUGE.

FIG. 39.—PRICE £2 5 0

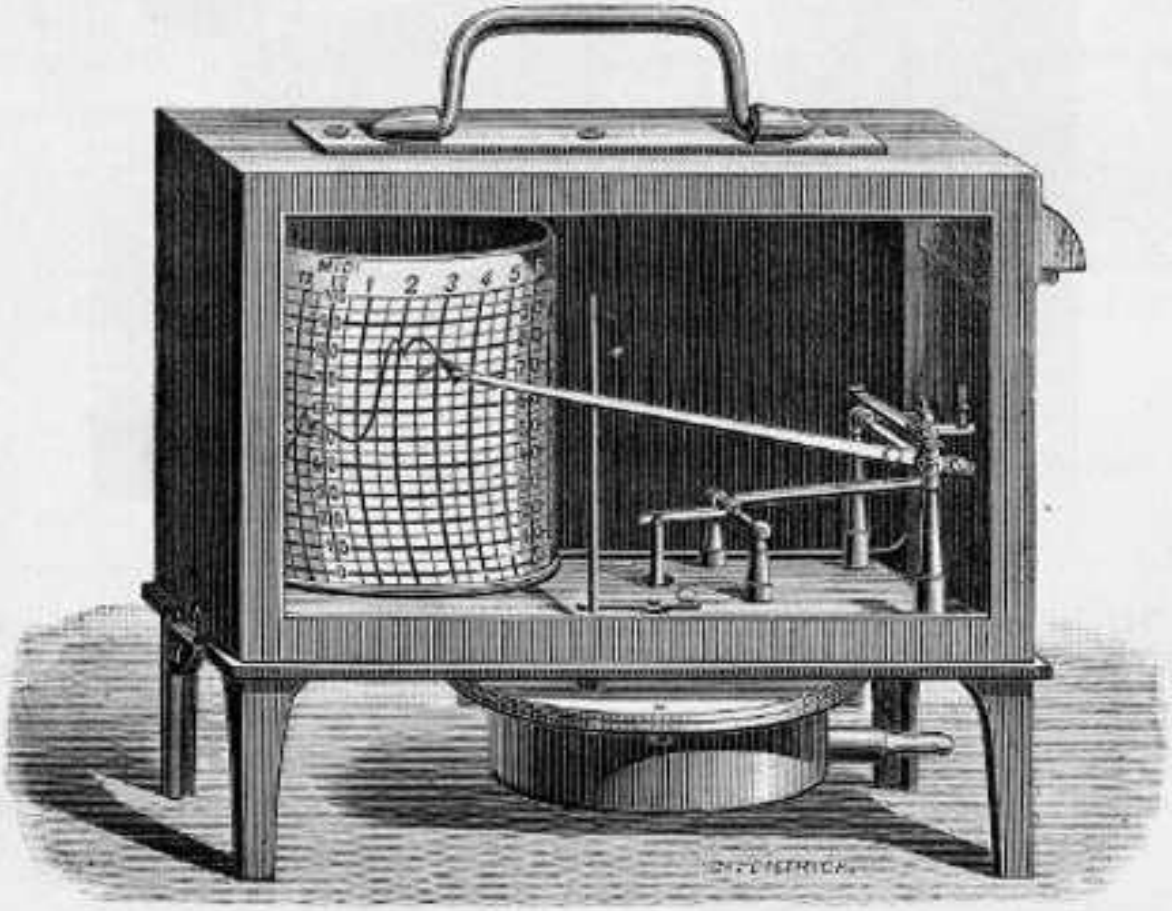

FIG. 40.

FIG. 40.—PRICE £7 10 0

These instruments are capable of showing differences of pressure far less than 0·001 in. of mercury. They are mostly used in connection with the measurement of gas pressure in towns, and in testing the draught of factory chimneys.

They are of various patterns, the one, Fig. 39, being merely an indicator, the others producing a continuous diagram, Figs. 40, 41 and 42.

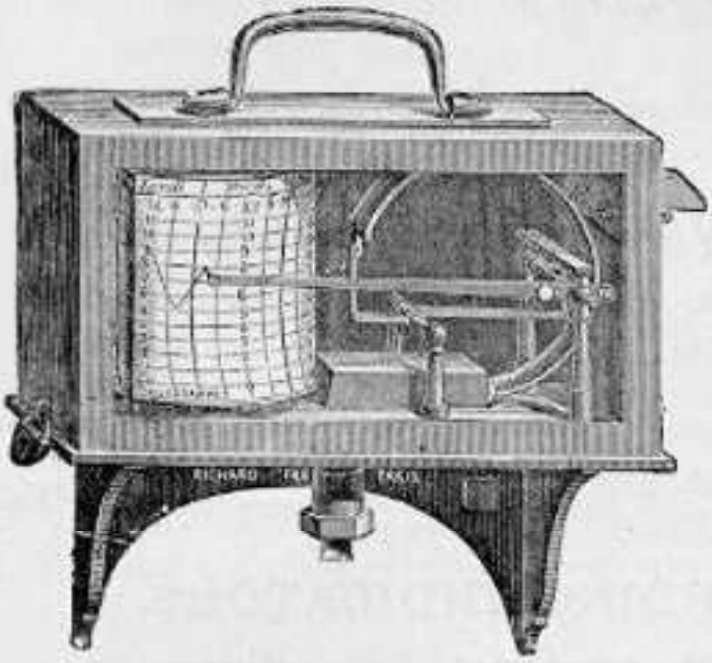

Fig. 41.

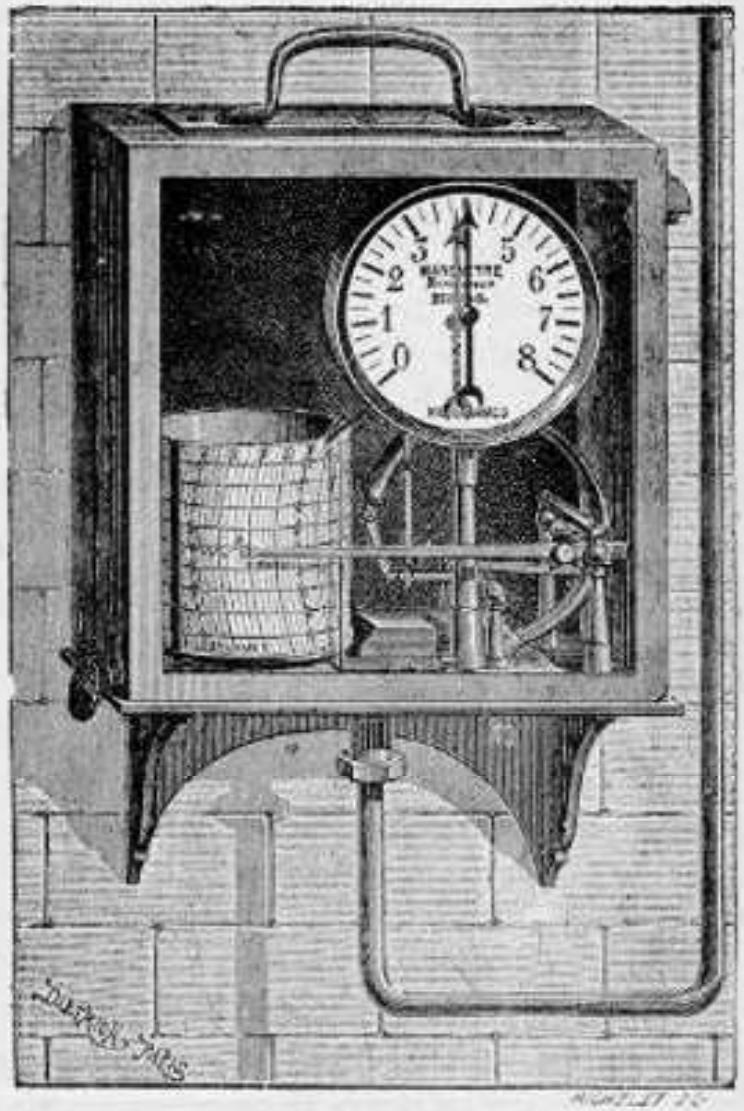

Fig. 42.

Fig. 41. Size.—Height, 9 in.; Length, 9½ in.; Depth, 5¼ in.
Fig. 42. „ „ 13 in; „ 24 in.: „ 5¼ in.

Another very important use is as recorders of the pressure of steam in boilers. The fact of there being a permanent, incessant, and unfalsiable record of the pressure throughout each day, tends greatly to ensure good stoking and the economical use of coal, so that the instrument pays for itself in a few weeks; and if thought expedient, gratuities to the stokers can be granted according to the diagrams, out of the great economies effected.

Moreover, these indicators tend to prevent explosions. The engineer can neither tamper with his safety valves nor neglect the stoking without the fact being recorded.

But their uses are almost innumerable; they will record the pressure in gas or water mains, the pressure kept up by hydraulic power companies, the pressure in hydraulic presses, &c., &c.

The Bourdon Tubes are either of Steel or Phosphor Bronze.

PRICES OF THE RECORDING GAUGES.

	£	s.	d.
Recording Gauge in case complete, size 12 × 3½ in.	7	10	0
" " " " 12 × 5 "	8	10	0
" " " " 15¾ × 6½ "	11	0	0
If for Hydraulic Pressure, extra	1	5	0
Dial fitted to any of the above, extra	1	5	0

SELF-RECORDING VACUUM GAUGES.

These instruments are constructed and arranged on the same basis as the above Recording Gauges for Pressure, &c., and are the same prices, sizes, &c., &c.

WATER LEVEL RECORDING INDICATORS.

These recorders may be regarded as the complement of the indicators of steam pressure; they give a continuous record of the water level, and therefore of the working of the feed-pump, and afford an additional protection against explosions. They can be arranged to produce their indications either close to the boiler or at any distance.

Prices, sizes, etc., as preceding instruments.

The Authorities of Trinity House requiring to have an exact record of the working of the Sirens, both as to time and pressure, in the various lighthouses under their charge, consulted Mr. Casella as to the best means of obtaining such data. Mr. Casella suggested a Richard Self-Recording Pressure Gauge, but with several alterations and modifications. Such an instrument was duly made, and was tried against some other patterns during a period extending over eight months, and was finally adopted by the above department. This instrument is now in general use, and has been taken up by the Northern Lighthouse Board and by the Irish Lights Office. The charts are about four feet long, are timed for 24 hours, and show a pressure of 0 to 40 lbs., but any other scales can be adopted.

Prices and particulars on application.

SPEED RECORDERS FOR AUTOMOBILES.

The Speed Recorder, which was constructed for automobiles, is based on the same principle of recorder, which we have made for many years, for recording the number of revolutions made by various machines. It only differs from it in that it is better adapted for lighter work, as is necessary in conveyances.

It is particularly suited to checking journeys, as it records the diagram of the route of the automobile which has to carry out a special service, to follow a fixed route, and to stop at stated times, such as is the case with carriers' carts, tramways, etc.

For these purposes it is useless to put it under the eye of the chauffeur, it should be fixed under the car in such a way as to ensure thorough connection with the driving shaft; a suitable lock to the case prevents any interference with the working of the instrument on the part of the driver.

Description. The Speed Recorder consists of a snail-cone which turns round its axle in conjunction with the number of turns made by the vehicle, and which raises a recording pen, of which the ascent is proportional to the distance run by the carriage.

The cone is acted upon by a worm-wheel and toothed-wheels, calculated to make one complete turn for 20,000 turns of the pulley. This cone raises the pen by means of a pin which is fastened into an arm fixed to the same rotating arbor as the arm carrying the pen, the two thus moving simultaneously.

The pen traces the diagram on a chart on the recording cylinder, in which is the clock. The cylinder turns round once in 13 hours, but other cylinders giving different lengths of time can be substituted, thus 6½ or 26 hours, etc.

The diameter of the pulley in the recorder and of that of the driving shaft of the car are in such relation that the total ascent of the pen, or what comes to the same thing, one turn of the cone, corresponds to a run of 11 miles. It is therefore necessary, in the arrangement of these two pulleys, to know either the diameter of the wheels, or the number of turns of the driving shaft corresponding to the distance of one mile.

A second pen serves to record any particular event, view, etc., during the run, and when the apparatus is under the control of the conductor. He has only to press a button when the pen traces a small vertical line on the upper part of the chart. The stoppages are shown on the chart by horizontal lines; the steeper the curve traced, the greater the speed.

The instrument can be put in and out of gear at will, and the pens put to zero with ease when starting. All is enclosed in a japanned metal case, thus protecting the mechanism from damp, dirt, etc. Dimensions are as follows:—Length, 6½ ins.; depth, 4 ins.; height, 4¼ ins.

PRICE OF THE SPEED INDICATOR £11 10 0

SPEED and DISTANCE (Traversed) RECORDER.

This instrument is of the greatest interest and utility to drivers of motors, as it shows at any moment the speed being run, thus enabling the driver to keep within the limits prescribed by the police regulations, besides which it shows at any moment the distance completed. Size of the apparatus same as the preceding one.

PRICE OF SPEED AND DISTANCE (TRAVERSED) RECORDER .. £21 0 0

DIRECT-READING GAUGES

for use with the pump, to ensure the proper circulation of the water in petrol motors.

Diameter of dial 2¼ inches £1 2 0

STEAM-PRESSURE GAUGE for Steam Motors.

£0 18 0

MISCELLANEOUS.

Speed of Railway Trains. This can be effected in two entirely different ways. By placing one of the Speed Indicators or a Cinemograph (Fig. 38) on the train, the record can be taken off when the journey is completed. But on the *Paris-Lyon-Méditerranée* Railway another system, constructed by us, has been adopted. At certain places a recording instrument is placed, provided with endless paper; on this a series of pens produces horizontal lines, but each pen is controlled by a pedal by the side of the rails; these pedals are at known distances apart. The wheels of a passing train depress the pedals, and the time elapsing between the depression of two successive pedals, which can be read off from the diagram, shows the speed of the train when passing. For the *Compagnie des Chemins de Fer d'Orléans* MM. Richard have, in collaboration with the engineer (M. Sabouret), designed and constructed a similar but portable and low-priced apparatus, which can be attached to the rails at any point and in a few minutes, so that no driver can tell where one may be.

PRICE .. .. from £9 0 0

Vibration of Bridges. We have a very simple apparatus, which is supplied with two recording cylinders (interchangeable), one of which gives about one inch of paper per minute, and the other one inch in about two-and-a-quarter seconds. The recording apparatus is fixed to a solid pier, the indicating portion is attached to the vibrating member, and all the details of the vibration are clearly recorded.

PRICE .. .. from £12 0 0

Self-Recording Ship's Log. This new idea has been carried out by MM. Richard in conjunction with Dr. Haro. The principal part of the apparatus consists of two balls, one exposed to the pressure produced by the forward motion of the vessel, the other protected from that pressure.

PRICE .. .. from £16 0 0

INDEX.

Other Instruments manufactured by Casella & Co.

Engineering and Surveying. Transit Theodolites and Theodolites—Tacheometers—Dumpy and other Levels—Pocket Altazimuths—Azimuth Compasses—Repeating Circles—Tide Gauges—Current Meters—Mountain Barometers—Hypsometers—Aneroids (Field's and others)—Circumferentors—Miners' Dials—Levelling Staves—Chains—Pentagraphs—Planimeters—Station Pointers—Protractors—Computing Scales—Plotting Scales—Drawing Instruments—Parallel Rulers—Architects and Engineers' Curves—Steam and Pressure Gauges—Richards' and other Indicators—Gun and Torpedo Directors.

Meteorological. Barometers (Standard, Photographically Recording, King's Recording, Aneroids, Fortin's, Kew pattern, Long-range)—Thermometers (Standard, Max., Min., Earth, Sun, Radiation, Photographically Recording, Pocket)—Hygrometers (Dry and Wet, Daniell's, Regnault's, Dines')—Anemometers (Dines', Robinson's, Beckley's, Embossing)—Helio-Pyrometer—Rain Gauges (Ordinary, Engineering, Recording)—Actinometers—Sunshine Recorders—Cathetometers.

Nautical. For Ships and Yachts—Sextants—Marine Barometers—Aneroids—Compasses—Artificial Horizons—Quadrants—Logs—Deep-sea Thermometers—Sounders—Hydrometers—Telescopes—Chronometers—Binoculars.

Electrical and Physical Apparatus. Galvanometers—Electrometers—Resistance Coils—Keys—Batteries—Mechanical and Mercurial High Vacuum Pumps, &c., &c.

Magnetic. Magnetographs—Magnetometers—Dip Circles—Fox's Circles—Goolden-Casella Dipping Needle Instrument, &c., &c.

Astronomical. Telescopes—Equatorials—Transit Circles—Chronographs—Sun Dials—Spectroscopes.

Medical. Clinical Thermometers—Air Meters—Spirometers—Microscopes and accessories.

*** This list is naturally far from complete, but it illustrates the chief classes of instruments made by Messrs. Casella & Co., who will be happy to answer any enquiries concerning the above or any other apparatus or instruments.*

A SELECTION, FROM CASELLA & CO.'S CATALOGUES, OF A FEW OF THE MANY INSTRUMENTS CONSTRUCTED BY THEM FOR THE USE OF METEOROLOGISTS, ENGINEERS, SURVEYORS, AND SCIENTIFIC MEN IN GENERAL.

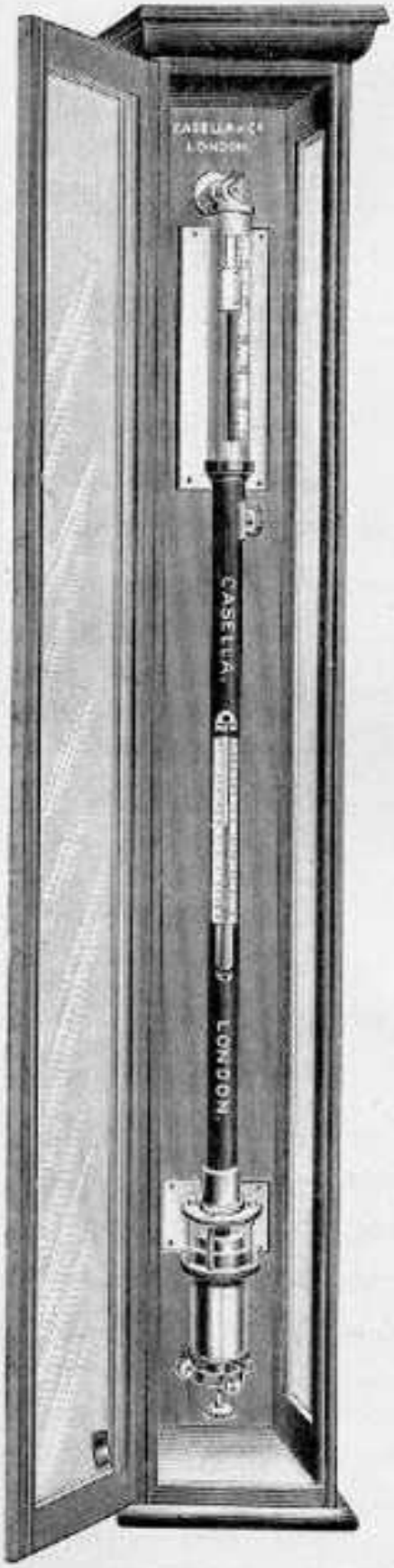

FIG. 1.

Standard Barometers. Figure 1 illustrates a Standard Fortin Barometer in ebonized case with glass door. The tube has an internal diameter of 0·45 in.; the difference between the level of the mercury in the tube and that in the cistern—*i.e.*, the height of the barometer—is obtained by means of a thumb-screw acting on the flexible base. The vernier reads to 0·002 in., or by estimation to 0·001 in. These barometers, as well as those on the Kew Principle, are supplied either mounted on a polished mahogany or other wooden board, or in a dust-proof case, as figured. The case may be ebonized, or in natural walnut, oak, etc., plain or ornamental. Casella & Co. enjoy a world-wide reputation for the accuracy, good workmanship, and finish of their mercury barometers.

PRICES from £5 5 0

Full particulars of the above, and of the Kew Pattern, and Marine Barometers, on application.

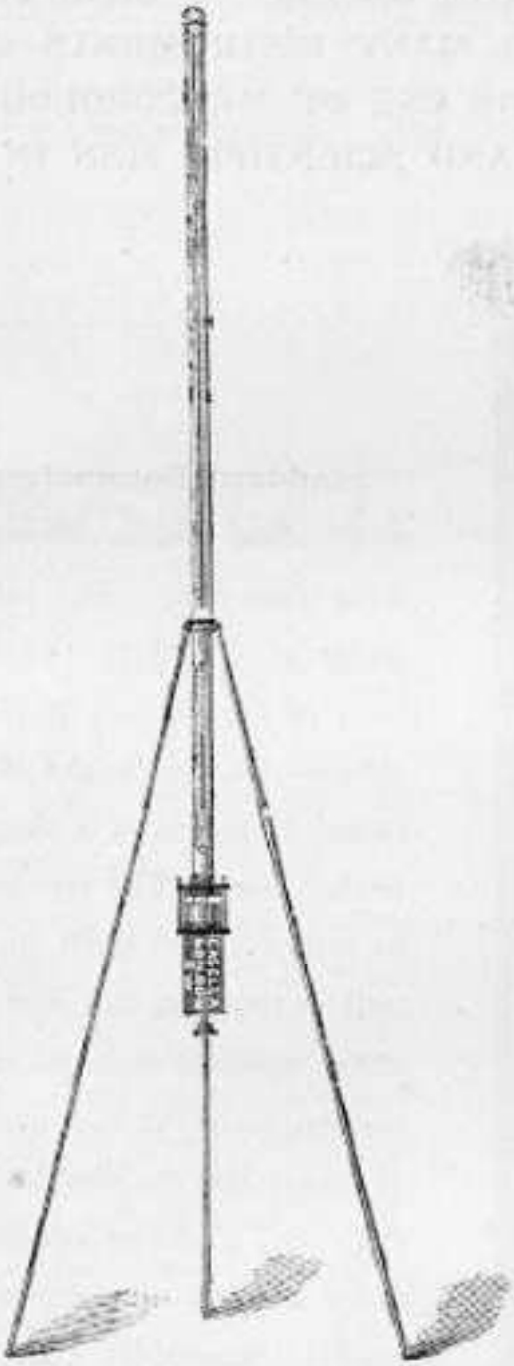

Fig. 2.

Standard Mountain Barometer (Fig. 2), the same as the Standard Fortin Barometer, but much reduced in size of frame and tube, by which it is rendered so portable as to remove nearly every difficulty hitherto found by travellers in carrying a mercurial barometer. Two scales—English and metric. With tripod stand, in improved leather-covered shield case, complete £10 10 0

**** *Kew Verification, if required, at an extra charge of 10s. 6d.*

The Mercurial Pocket Standard Barometer,

OR

Boylean Mariotti Barometer.

PATENT.

This pocket barometer, the action of which depends on the laws of Mariotti and Boyle, consists of a short centre glass tube, a lower open air tube, or bulb, with diaphragm joined to it, with a vulcanite covering for insulation, and a brass tube, or shield, which covers the glass tube, and on which the graduations and figures are engraved. Attached to this is a cistern filled with mercury, which has a stopcock and a coarse screw adjustment.

The total length of the Mariotti Barometer is from 12 to 15 inches; but, for convenience of carriage, the cistern may be detached at pleasure and carried separately.

The weight and pressure of the atmosphere is determined accurately, at each observation, by an uniform volume of air being admitted to the cistern, and compressed by the advance of the mercury to a fixed point, or zero, so that no accumulation of error is possible; and the reading will be equally accurate for all times and for all places.

It is not necessary that the same quantity of mercury be always used, so that the loss of a little is of no moment, and it need not be boiled.

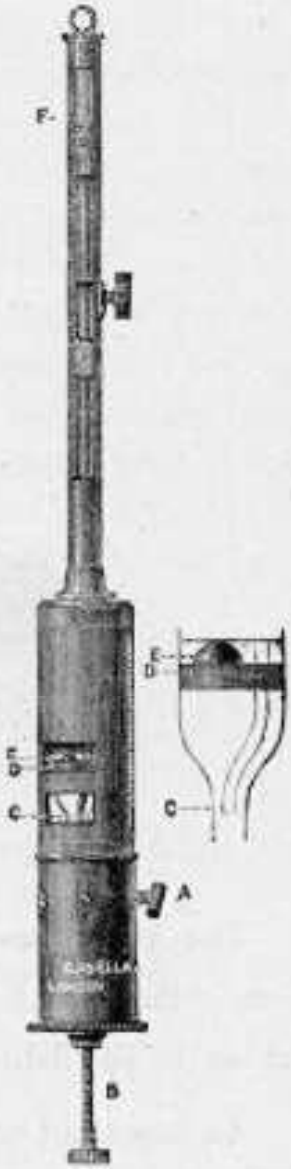

Fig. 3.

The readings are taken from 2 points as in Fortin's barometer, and the scale is read to hundreths of an inch by means of a vernier.

This instrument is equally accurate at the bottom of a mine and at the top of a mountain, and it is in the fact that this really Portable Barometer needs no adjustment that its great merit lies; hence its value to travellers and residents in foreign countries, where a Mercurial Standard cannot be easily referred to.

Fig. 3. Price, in Case £10 10 0

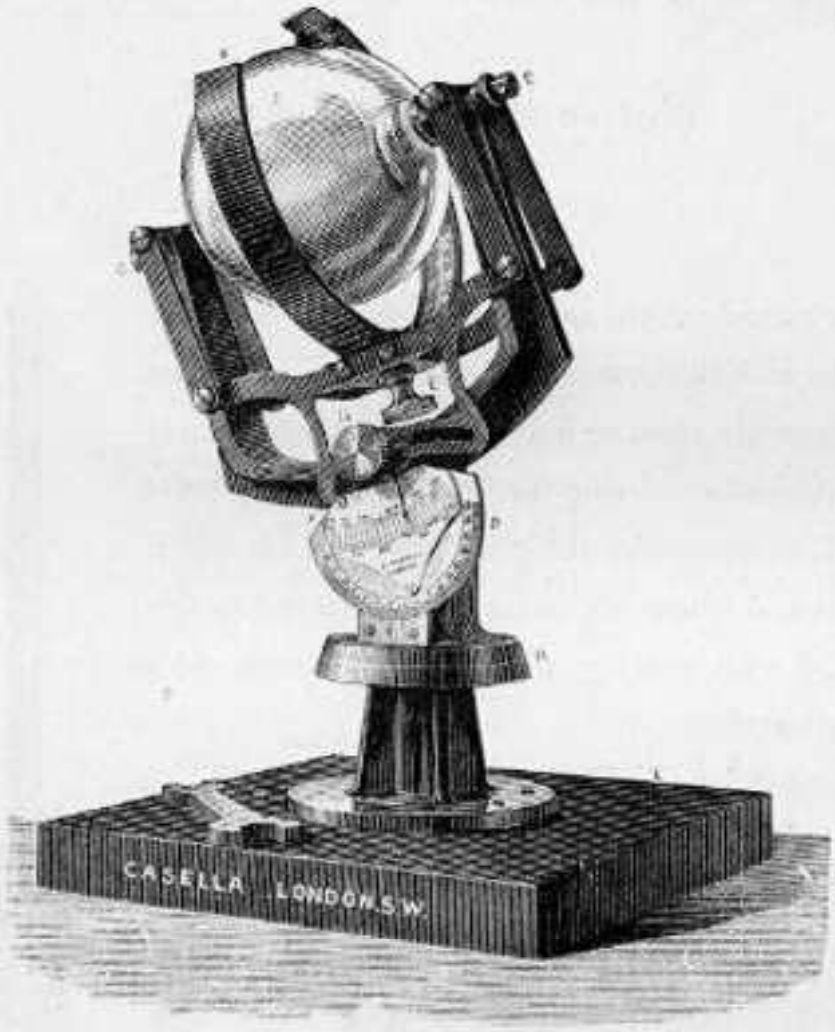

FIG. 4.

The Whipple-Casella-Universal Sunshine Recorder. An improved form of Sunshine Recorder fitted with an adjustment enabling it to be instantly set up in any latitude.

An important advantage of this instrument over other forms lies in the fact that only one, and that a straight card is required, instead of three cards of different shapes and sizes. The trouble of inserting curved cards—a real trouble in rainy weather—is thus obviated, and, apart from this convenience, the mere saving effected by the use of cheaper cards largely counterbalances the slight increase in original cost.

FIG. 4. PRICE £15 0 0

Fixed Station Sunshine Recorder £9 9 0

PHOTOGRAPHIC DITTO. *Prices on application.*

Seismograph for recording the movements of the earth's surface (Fig. 12).

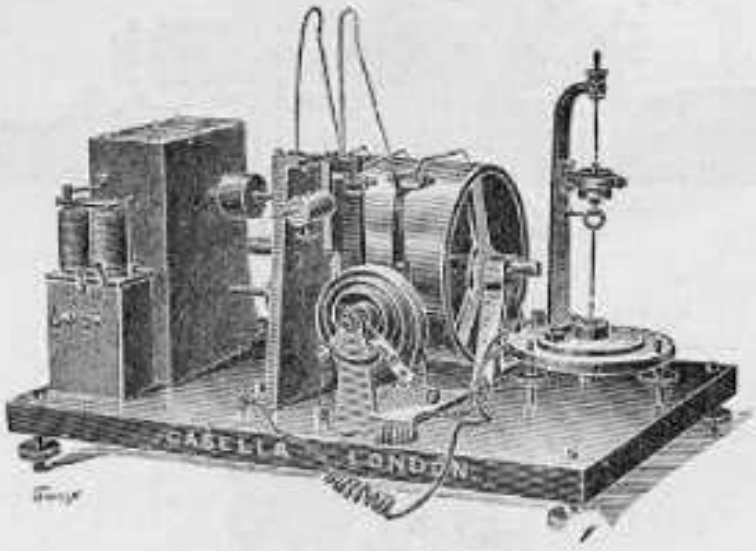

Fig. 12.

With right and left pendulums for recording the horizontal components, and a coiled or other spring device for the vertical motion. This is an improved and more recent form of the apparatus adopted by the Imperial Government of Japan, and is used in many observatory stations in various parts of the world.

*** Casella & Co. make several other instruments for recording vibrations particularly the vibrations in buildings caused by machinery, particulars of which they will be glad to send to anyone interested in the subject.

Goolden's Portable Dip Circle.

Fig. 5.

This instrument is intended to meet the want of a Dip Circle, of moderate cost, which will not only illustrate the magnetic dip, but also be capable of some exactitude in measurement.

A 3½ inch needle, provided with adjustable counter-poises ingeniously contrived so as to bring the centre of gravity very accurately into the axis of support, is carried in jewelled centres on a horizontal axis. The inclination of the needle to the horizon is read upon a metal circle, graduated on both sides, and the whole is enclosed in an air-tight box with glass faces, revolving about a vertical axis. In order to facilitate the adjustment of the needle to the magnetic meridian, the vertical axis of the instrument is furnished with a spring arm which can be clamped to it, and there are four metal studs on the stand at right angles to each other into which the head of the spring arm fits when pressed down with the finger. The stand is further provided with levelling screws, and a small level is carried in the mahogany box into which the instrument is fitted for transport.

Messrs. Casella & Co. have supplied a considerable number of these Dip Circles to the Indian Government, and to many Public Institutions in this country and abroad.

Fig. 5. Price £5 10 0

Standard Dip Circles, Magnetometers, Magnetographs, &c.

Prices and Particulars on application.

Casella's Pocket Altazimuth.

ORIGINATED BY

FRANCIS GALTON, Esq., F.R.S.,

and much improved by L. Casella.

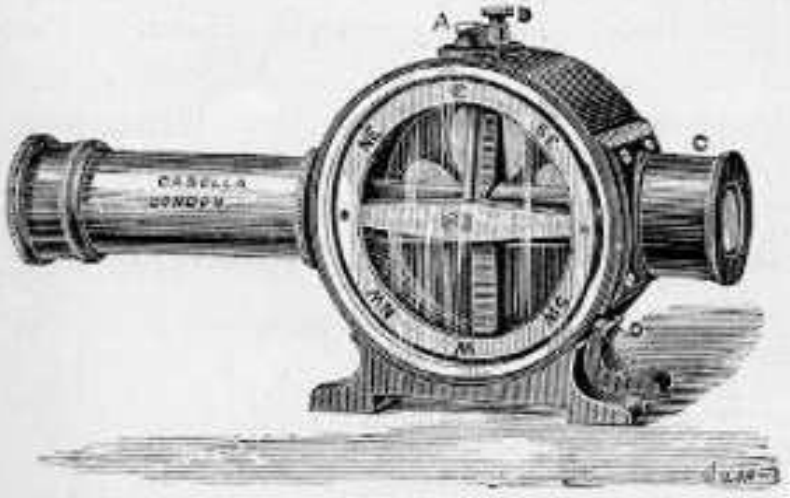

Fig. 6.

An accurate, compact instrument, weighing only 8 oz., which can be used for altitudes, azimuths, compass bearings, clinometric degrees, and levels. Both the clinometer and the compass discs are graduated to degrees; a careful observer can read to tenths.

Fig. 6. Price, in case for the pocket £6 6 0

Dines' Patent Pressure Portable Anemometer.

Fig. 7.

This instrument meets a want long felt in the shipping interest; it is very compact, and with moderate care is not likely to be damaged or to get out of order. It shows accurately the velocity and force of the wind, the scales having been calibrated by direct experiment, the scale on the right hand side of the glass tube showing the velocity in miles per hour, and that on the left the pressure in pounds per square foot. (The instrument shown in the illustration is not fitted with the latter scale.)

To use the Anemometer, hold the case and pull up the projecting nozzle as far as it will go, the case then forms a convenient handle; unscrew the milled head at the top a few turns, and hold the instrument in a vertical position with the nozzle facing the wind. The velocity is then shown on the scale by the height of the coloured liquid in the glass tube. Before replacing in its case and putting away, screw down the milled head gently until the rubber washer inside seals the end of the glass tube, taking care not to screw too hard for fear of breaking the glass.

When using the instrument be careful to choose a fully exposed situation, and stand facing the wind, holding it at least one foot in front of the body. The nozzle should face the wind as nearly as possible, but the registration is not affected so long as it points within 15 to 20 degrees of the right direction.

If bubbles get accidentally formed in the glass tube, they may be dislodged by gently sucking the nozzle.

When the milled head is unscrewed and the instrument is held vertically in still air, the liquid should stand at zero, if it does not, a little must be added or subtracted to make it do so; but the anemometers are sent out with the right amount of liquid in them, and there is no reason why this adjustment should be required. If it is necessary to add more liquid, fix the instrument in a vertical position, then remove the milled head, exposing the top of the glass tube, and slowly pour in two or three drops of the liquid sent in the small bottle. It is advisable to let the instrument stand for some little time in order that all the liquid added may join the column at the bottom.

It is desirable, though not necessary, to keep these instruments with the upper end of the scale highest, hence a loop has been provided so that they may be kept hung on a nail. The milled head should be screwed down before the instrument is removed from the vertical position.

Fig. 7. Price £3 10 0

Dines' Self-Recording Anemometer.

Prices on application.

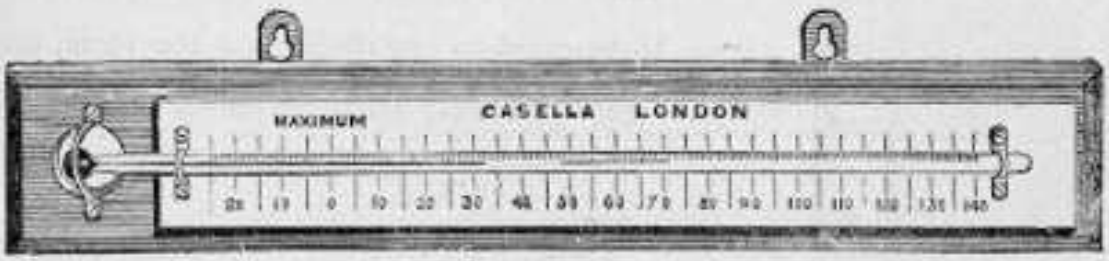

Fig. 8.

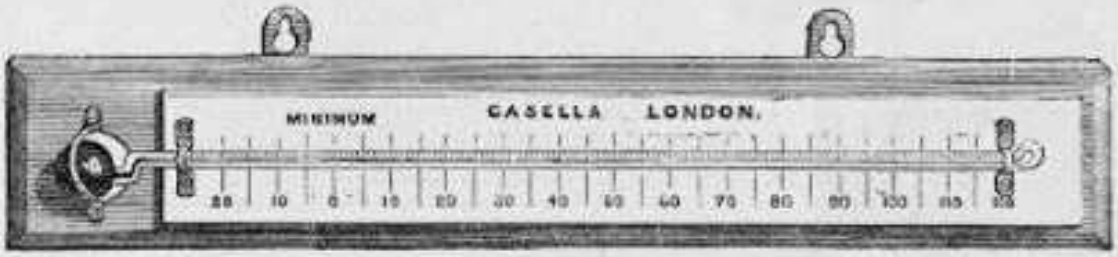

Fig. 9.

Standard Maximum Thermometer (Fig. 8), for registration of temperature in the shade: engine divided on the stem to single degrees, and indelibly figured on Casella's improved opal glass scale, which effectually resists frost and all effects of weather.

12 inch £1 0 0

Standard Minimum Thermometer (Fig. 9), filled with pure alcohol, for ordinary registration; engine divided on the stem to single degrees. Mounted to correspond with the standard maximum thermometer above.

12 inch £1 0 0

Either of these thermometers may be had with scales divided to fifths of a degree at an extra cost of 2s. 6d., or may be mounted as desired.

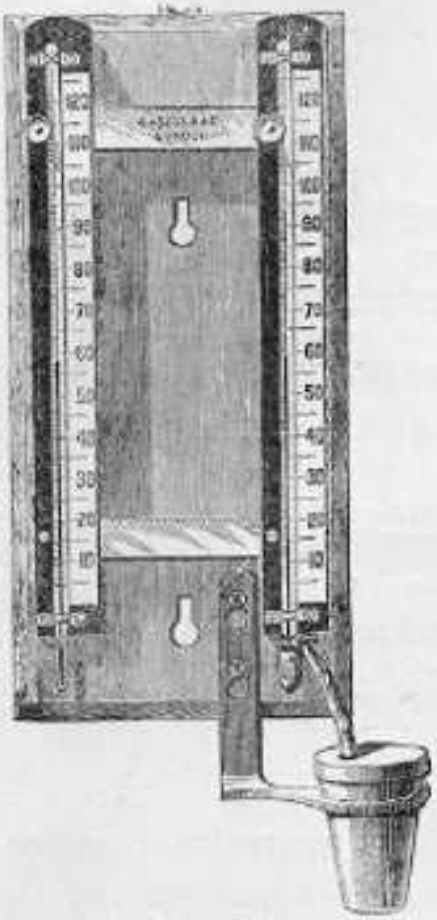

FIG. 10.

Mason's Hygrometer (Fig. 10). Kew Pattern, with opal glass scale, mounted on polished mahogany board for suspension. The thermometers are divided on the stem, and the figures indelibly burnt in on opal scales.

£1 15 0

Ditto, with metal scales as supplied to various Government Departments, the India Office, etc.

£2 5 0

Cheaper patterns from 9s. 6d. Kew Verifications extra.

For recording hygrometers see pp. 17 & 18.

Particulars of other instruments of this type, such as Dines', Daniell's, etc., on application.

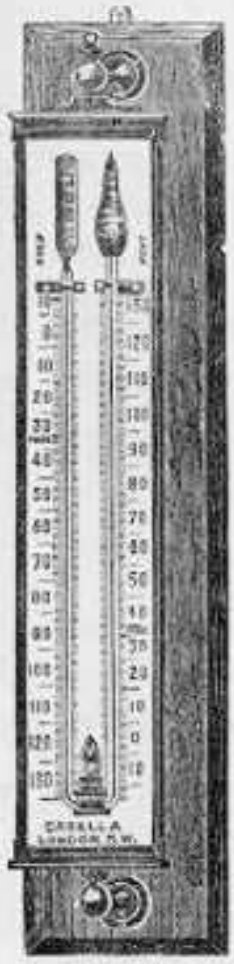

FIG. 11.

Six's, or Maximum and Minimum, Thermometer (Fig. 11), showing present temperature and *registering* both extremes of heat and cold. Mounted on bronzed metal brackets, fitted to oak or mahogany board, for fixing outside the window. Graduations and figures indelibly burnt into opal glass scale.

	£	s.	d.
10 inch scale	2	0	0
12 „ „	2	10	0

Ditto, in metal case, japanned white or black, opal glass scale.

10 inch	1	1	0
12 „	1	5	0

Prices of other patterns quoted on application.

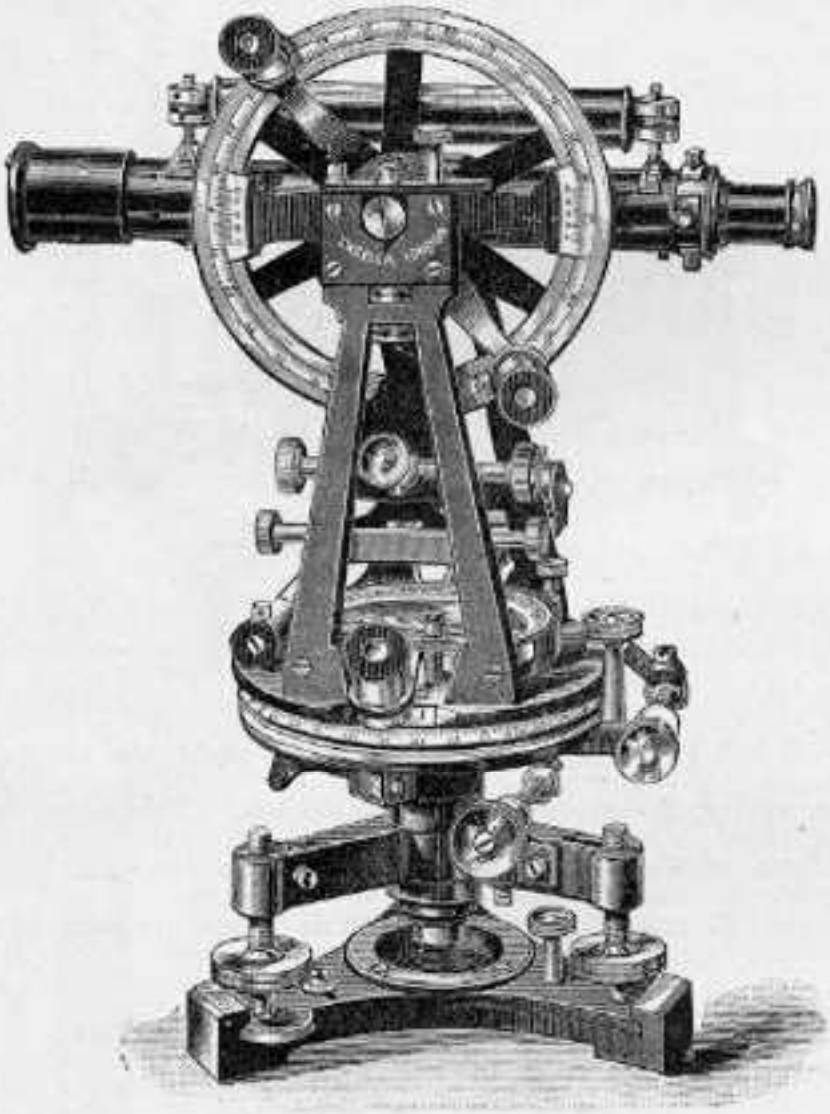

Fig. 13.

Transit Theodolite, as illustrated above, fitted with all the most recent improvements.

Prices of this and other theodolites furnished on receipt of requirements.

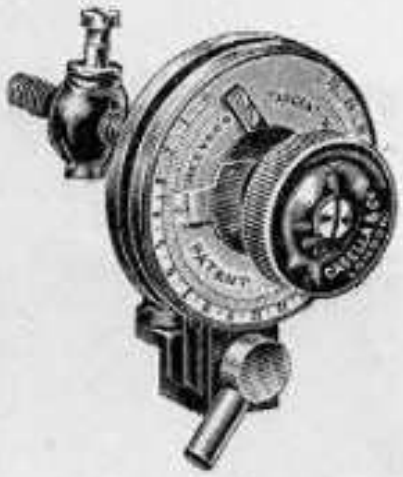

Fig. 14.

Reeves' Patent Micrometer.

A new and ingenious device for greatly increasing the facility and accuracy with which angles can be measured.

It can be fitted to any theodolite, sextant, or other instrument for the exact reading of angular measurements. By its use time and trouble are saved, and absolute accuracy ensured.

Reeves' Patent Tacheometer.

A new, portable instrument for measuring distances, which has the advantage over many tacheometers that it only requires one person to use it. Surveyors, Army Officers, and others who require to measure distances, will find Reeves' Tacheometer a most convenient, portable, and accurate pattern, in which the possibility of accidental error is reduced to a minimum. The distances are read off without the necessity for calculations.

Particulars of the size and other details, with prices, will be furnished on application.

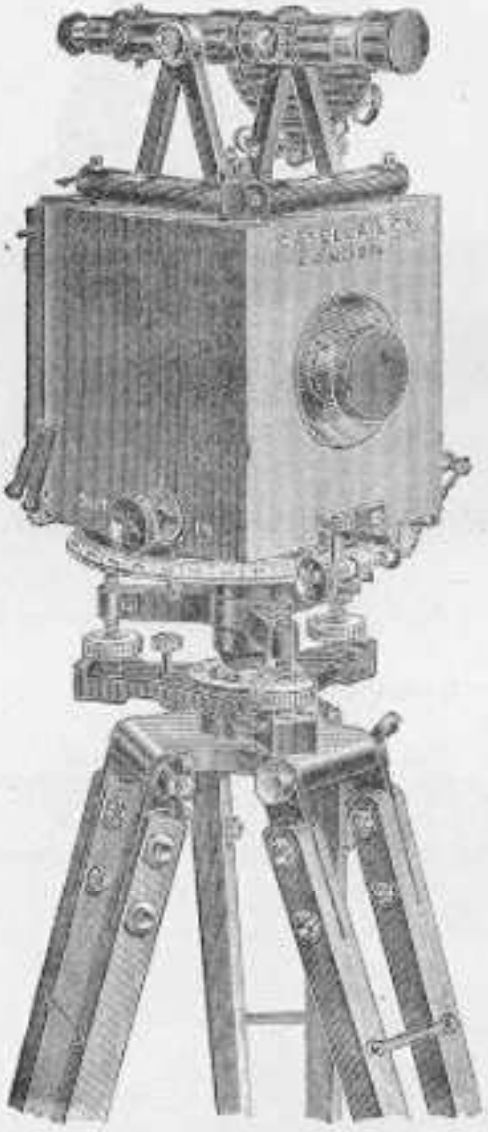

Fig. 15.

Photo Theodolite (Fig. 15). This instrument is designed to give true photographic perspectives in a vertical plane, and at constant distance, and is furnished with special mechanism for recording on the negative the information necessary for interpreting the photographs and plotting the ground plans. In rough and mountainous districts photographic surveys are much superior to all others. This method is quicker and cheaper than any other, and has been used with notable success by surveyors and explorers in all parts of the world, especially in Canada and South America, where many thousands of miles have been surveyed in this manner.

Fuller particulars on application.

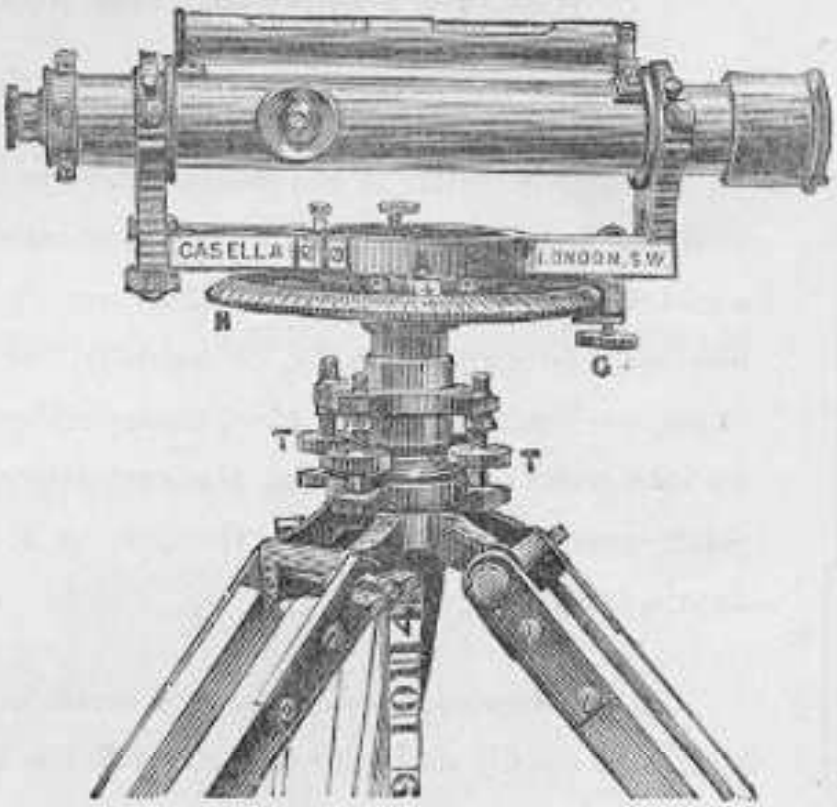

Fig. 16.

Gradient Telemeter Level (Fig. 16). An ingenious instrument for taking gradients, measuring or setting out distances, and obtaining differences in level, all of which it does by one and the same observation.

It performs these operations with singular accuracy and ease to the observer, enabling a *much greater* quantity of work to be got through in the same space of time compared with the usual methods employed by engineers and surveyors. The linear distances can be obtained far more accurately than with the land chain, and this regardless of rough or broken ground or the existence of a stream, or other water, between the observer's station and the distant object.

Particulars and prices furnished on application.

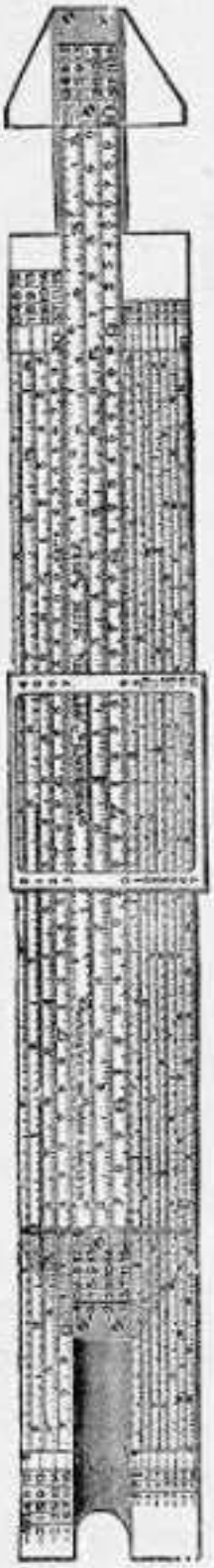

Fig. 17.

Anderson's Improved Slide Rule.

This rule is similar to the ordinary slide rule, and consist, of upper and lower limbs between which travels the slides a glazed cursor with hair-line working over all. The scales, however, instead of actually, or mentally, forming a series in one horizontal line, as in the ordinary slide rule, are split up into series of parallel lines, the graduations of each line being separated from those of the next by a common geometric ratio.

The instrument is *eight times* as accurate as the ordinary slide rule, equally simple to use, and with the aid of conversion tables can be made available for calculations other than decimal (duodecimal for quantity surveyors, for example).

A Special Handbook (price, separate, 1s. 6d.) with useful conversion and other tables and figures accompanies each slide rule, which is packed in a neat cardboard box.

Fig. 17. Price Complete £1 1 0

Box and Postage, 6d. extra.

C. F. Casella's Patent Recording Anemometer.

(See figure on back cover.)

In this instrument, the velocity of the wind and the total mileage are each recorded on a chart fixed to a drum rotated by clockwork. The number of miles is also registered on a separate dial.

PRICE .. .. £30.

C. F. Casella's Patent Wind Direction Recorder.

Corresponding in size and general appearance with the above Anemometer.

PRICE .. .. £35.

INDEX.

Other Instruments manufactured by Casella & Co.

Engineering and Surveying. Transit Theodolites and Theodolites —Tacheometers—Dumpy and other Levels—Pocket Altazimuths—Azimuth Compasses—Repeating Circles—Tide Gauges—Current Meters—Mountain Barometers—Hypsometers—Aneroids (Field's and others)—Circumferentors—Miners' Dials—Levelling Staves—Chains—Pentagraphs—Planimeters—Station Pointers—Protractors—Computing Scales—Plotting Scales—Drawing Instruments—Parallel Rulers—Architects and Engineers' Curves—Steam and Pressure Gauges—Richards' and other Indicators—Gun and Torpedo Directors.

Meteorological. Barometers (Standard, Photographically Recording, King's Recording, Aneroids, Fortin's, Kew pattern, Long-range)—Thermometers (Standard, Max., Min., Earth, Sun, Radiation, Photographically Recording, Pocket)—Hygrometers (Dry and Wet, Daniell's, Regnault's, Dines')—Anemometers (Dines', Robinson's, Beckley's, Embossing)—Helio-Pyrometer—Rain Gauges (Ordinary, Engineering, Recording)—Actinometers—Sunshine Recorders —Cathetometers.

Nautical. For Ships and Yachts—Sextants—Marine Barometers—Aneroids—Compasses—Artificial Horizons—Quadrants—Logs—Deep-sea Thermometers—Sounders—Hydrometers—Telescopes—Chronometers—Binoculars.

Electrical and Physical Apparatus. Galvanometers—Electrometers—Resistance Coils—Keys—Batteries—Mechanical and Mercurial High Vacuum Pumps, &c., &c.

Magnetic. Magnetographs—Magnetometers—Dip Circles—Fox's Circles —Goolden-Casella Dipping Needle Instrument, &c., &c.

Astronomical. Telescopes—Equatorials—Transit Circles—Chronographs —Sun Dials—Spectroscopes.

Medical. Clinical Thermometers—Air Meters—Spirometers—Microscopes and accessories.

*** *This list is naturally far from complete, but it illustrates the chief classes of instruments made by Messrs. Casella & Co., who will be happy to answer any enquiries concerning the above or any other apparatus or instruments.*

C. F. CASELLA'S PATENT ANEMOMETER.

DIRECT READING AND RECORDING.