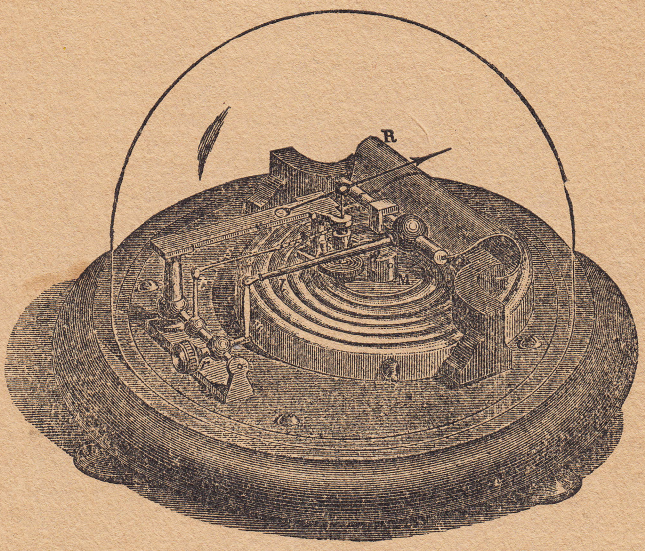
PRICED AND ILLUSTRATED CATALOGUE

OF

METEOROLOGICAL INSTRUMENTS



MADE, IMPORTED AND SOLD, WHOLESALE AND RETAIL

BY

QUEEN & CO., INCORP'D,

1010 Chestnut Street and 1011 Sansom Street,

PHILADELPHIA.

1905.

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All Instruments and materials sold by us are warranted perfect for the purposes intended; and if not found so upon receipt, should be returned and exchanged for others.

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QUEEN & CO., INCORPORATED.

PHILADELPHIA.

PRICED AND ILLUSTRATED

CATALOGUE

THERMOMETERS

AND

Meteorological Instruments

MADE, IMPORTED AND SOLD

BY

QUEEN & CO., INC.,

1010 Chestnut Street,

PHILADELPHIA.

PREFACE TO FIRST EDITION.

The growing importance of Meteorology as a science, the increasing extent to which it is practically applied, and the many departments of science and the arts in which meteorological instruments are employed, have induced us to give special attention to instruments of this class. In the catalogue which is now presented to the public, every meteorological instrument of practical value, from the simple household thermometer to the more costly standard thermometers and barometers will be found described.

The importance now attached by the medical profession to the indications of the CLINICAL THERMOMETER has impelled us to the production and selection of thermometers whose performance is nearly perfect, and which are far superior to the ordinary clinical thermometers now sold so largely throughout the country.

In our THERMOMETER FACTORY are made every kind and grade of thermometers from the accurate and finely divided instrument for the work of the laboratory divided into $\frac{1}{50}$ of one degree to the ordinary thermometer seen in every household.

Our ANEROID BAROMETERS, for altitude, made with special reference to their use by Engineers and Surveyors, are extremely sensitive and accurate, and the results obtai ed with them, in skilled hands, are wonderful examples of the perfection to which these instruments have been brought.

Our stock of STANDARD MERCURIAL BAROMETERS is now very large and complete, comprising examples of the best American and European forms.

Particular attention is given to ANEMOMETERS, for mines, for testing and adjusting which we have a special apparatus, and to MINERS' SAFETY LAMPS, for which we have arrangements with the best English makers.

The attention of chemists, manufacturers and others requiring HYDROMETERS and other instruments, for the determination of Specific Gravity, of accurate construction, is called to our stock of these instruments. Our very accurate Baumè Hydrometers, with a partial scale, divided to $\frac{1}{8}$ths, will be found very useful.

Within the limited space at our disposal for this purpose, in this catalogue, we have endeavored to give such explanations of the various instruments, and such instructions for their use, as might be of service to purchasers, and have added various tables and formulæ, which will be found of value.

PREFACE TO FIFTEENTH EDITION.

Since publishing the first edition of this catalogue the use of the thermometer in manufacturing processes has so greatly increased that we have found it impossible to classify under a distinct head, every kind of thermometer used for special purposes. We therefore solicit correspondence in reference to THERMOMETERS AND PYROMETERS for specific uses and shall be glad to suggest the form, in our judgment best adapted for special work.

QUEEN & CO., INCORPORATED.

JANUARY, 1905.

THE THERMOMETER.

This universally-known instrument, the name of which, from the Greek *thermos* "heat," and *metron* "measure," indicates its use as a measure of temperature, was probably first suggested by Cornelius Drebel, a Hollander, who, about the year 1630, proposed a method of noting variations of temperature by means of a glass bulb, with a small elongated stem, which was dipped into a liquid; as the air became heated, the liquid was depressed, a decrease of temperature causing a corresponding elevation. This instrument, from which the air thermometer originated, was, however, too large in size and too delicate for ordinary purposes. Boyle effected a great improvement by using alcohol in a closed tube, to which a scale was attached, and Sir Isaac Newton, taking advantage of the fact that the freezing and boiling-points of water furnish two fixed temperatures, divided the intermediate range into equal parts, thus giving the thermometer, substantially, its modern form.

The use of mercury, which possesses many advantages for thermometric purposes, was first suggested by Réaumur. Mercury has a wide range of liquidity, boils at a very high temperature, has a very equal rate of expansion, and can be obtained in a state of great purity. As, however, mercury freezes at a temperature of a little under —40° F., for very low temperatures alcohol is usually employed, that liquid never having been known to freeze.

The Thermometer, as usually made, consists of a long, glass tube, of small bore, closed at the end and blown into a bulb, which is filled with mercury or alcohol. The variations of temperature are measured by the expansion and contraction of the fluid in the tube, which is graduated and divided into *degrees*. There are, unfortunately, three different systems of graduation in use. In English-speaking countries, the scale employed is that introduced by Fahrenheit, in 1720. In this, the freezing-point is 32°, the zero being arbitrarily fixed at 32° below the freezing-point, and the range between that and the boiling-point of water being divided into 180 degrees—the point at which water boils at sea-level and under a barometric pressure of 30 inches, being 212°. For temperatures below zero, minus signs are used, thus, —3° —5°. In the scale suggested by Réaumur, and still largely in use in Russia and Germany, the space between the freezing and boiling-points is divided into 80°; the point at which ice melts being 0°, and that at which water boils, under normal conditions, being 80 degrees.

In the Centigrade Thermometer, introduced by Celsius, in 1742, and now universally used for scientific purposes, the range between the fixed points is divided into 100 degrees.

The degrees indicating the freezing-point, the intermediate range and the boiling-point, are as follows:

	Freezing-point.	Range.	Boiling-point.
Fahrenheit (F.),	32°	180°	212°
Réaumur (R.),	0°	80°	80°
Centigrade (C.),	0°	100°	100°

The three scales can be readily converted into each other by the following rules:

To reduce Fahrenheit readings to Centigrade, subtract 32° and multiply the remainder by $\frac{5}{9}$.

To reduce Fahrenheit readings to Réaumur, subtract 32° and multiply the remainder by $\frac{4}{9}$.

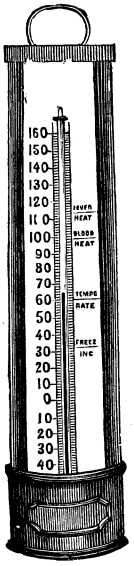
To reduce Centigrade readings to Fahrenheit, multiply by $\frac{9}{5}$ and add 32°.

To reduce Réaumur degrees to Fahrenheit, multiply by $\frac{9}{4}$ and add 32°.

To reduce Centigrade to Réaumur, multiply by $\frac{4}{5}$.

To reduce Réaumur to Centigrade, multiply by $\frac{5}{4}$.

Thermometers for General Use.



12000

Japanned Tin-Case Thermometers, Common Grade.

These thermometers are made for three ranges of temperature, viz: The ordinary scale, from about 40° below zero to 140° above; the water boils scale, from zero to 220°, and the high range scale, from 20° to 270°. Fig. 1.

In ordering designate which range is desired.

12000.	7 inch Thermometer, ...	$	15
12001.	8 " "		20
12002.	10 " "		25
12003.	12 " "		50

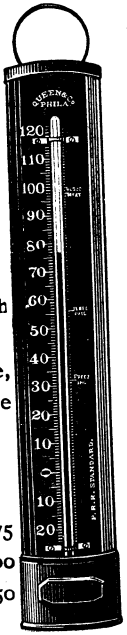
Japanned Tin-Case Thermometers, Standard Grade.

These thermometers are made from seasoned lens tubes, with extra heavy cases and scales. Their accuracy is guaranteed.

Made for two ranges of temperature, viz: The ordinary scale, from 20° below zero to 120°, graduated in single degrees, and the water boils scale, from 20° to 220°. Fig. 2.

Special ranges may be made to order.

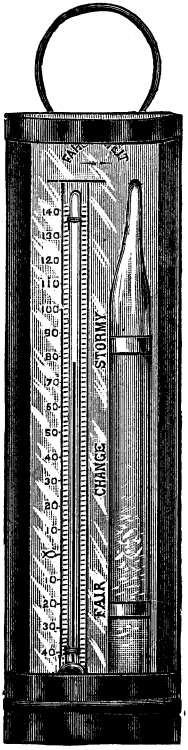
12017.	8 inch Thermometer, ...	$	75
12018.	10 " "		1 00
12019.	12 " "		1 50



12017

NOTE—The standard grade may be had with the black scale with white figures and graduations without additional cost. Red spirit tubes instead of mercury may also be had in the standard grade.

Storm Glasses or Cottage Barometers.



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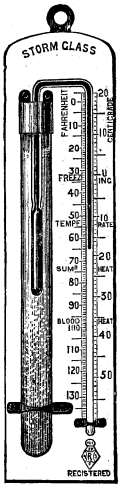

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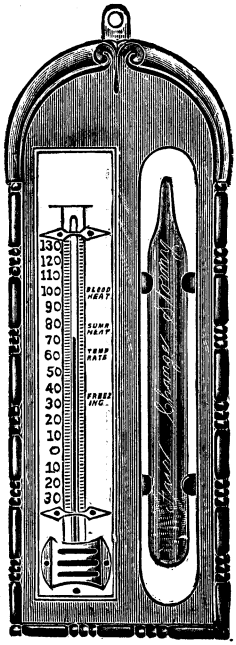


12022

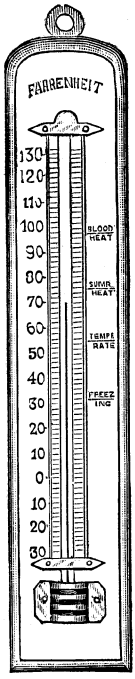
The Chemical Storm Glass has been in use for over a century, its invention being attributed to an Italian sailor. It consists of a glass tube, containing a mixture of camphor, nitre, sal-ammoniac, alcohol and water. When the solution is carefully made and the ingredients properly proportioned to each other the instrument is very usefnl as an aid to the barometer in weather predictions. Th late Admiral Fitzroy, writing of this instrument, says: "It was fairly demonstrated that, if fixed undisturbed in free air, not exposed to radiation, fire or sun, but in the ordinary light of a well-ventilated room, or preferably, in the outer air, the chemical mixture in a so-called storm glass varies in character with the direction of the wind."

It has been discredited by the large number of very inferior storm glasses that have been lately sold, but when made with proper care, it will be found a useful and interesting instrument.

No.		Price
12020.	Storm Glass, in strong tin case	$ 25
12021.	" wooden frame with metal scale	25
12022.	" carved oak frame, with very accurate thermometer,	1 50
12023.	" bottle only, 10 inches long, brass caps	1 00
12024.	" " 12 " "	1 50
12025.	Patent Storm Glass, having the bulb of the thermometer immersed in the liquid, boxwood scale	4 50
12026.	Weather House or Swiss Barometer, in metal frame	1 00

This instrument consists of a metal house with two figures standing at the open doors; it is so adjusted that during clear weather the woman is outside and preceeding and during a storm the man comes outside.

Wooden Back Theremomters for House and Porch Use.



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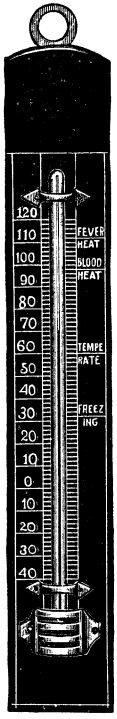

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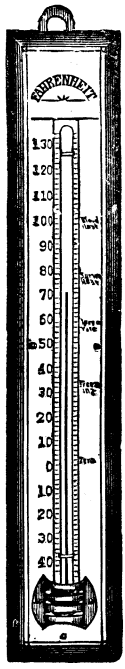
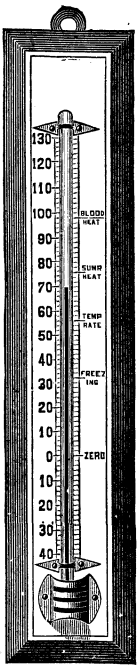


12031

No.		Price.
12027.	Boxwood Thermometer, tube set in groove, 10 inches long . . .	$0 50
12028.	" " " 12 " . . .	75
12029.	Pearwood Thermometer, tube set in groove, black enameled scale, 8 inches long	25
12030.	Pearwood Thermometer, same as No. 12029, white enameled scale, 8 inches long	25
12031.	Cabinet Thermometer, oak, walnut or poplar, back with silvered brass scale, 8 inches long	35
12032.	Cabinet Thermometer, oak, walnut or poplar, back with silvered brass scale, 10 inches long	50
12033.	Cabinet Thermometer, oak, walnut or poplar, back with silvered brass scale, 12 inches long	75
12034.	Porch Thermometer, basswood back, red spirit tube, very plain scale, 12 inches long	35

Parlor and Library Thermometers.

STANDARD GRADE.



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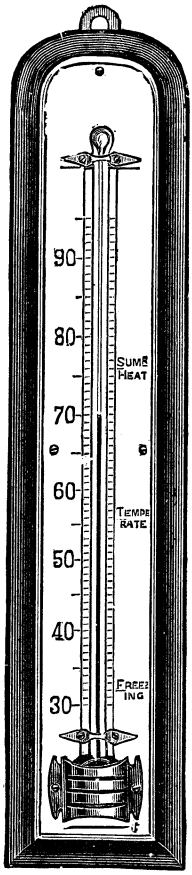

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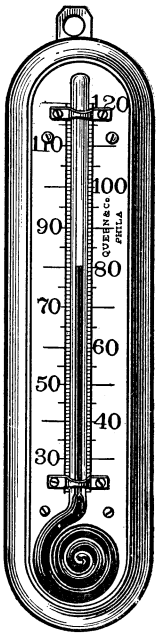
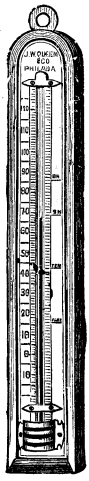


12040A

No.		Price.
12035A.	Parlor Thermometer, lens tube, on heavy silvered brass scale, mounted on either oak or ebony back, 6 inches long	$ 75
12035.	Parlor Thermometer, same as 12035A, 8 inches long	1 00
12036.	" " " " 10 " "	1 50
12037.	" " " " 12 " "	2 00
12038.	Library Thermometer, lens spirit tube, on heavy silvered brass scale and beveled back, 8 inches long	75
12038A.	Library Thermometer, same as 12038, 10 inches long	1 00
12038B.	" " " " 12 " "	1 50
12040A.	Standard Cabinet Thermometer, both ends round, 8 inches long	1 50

Household Thermometers.

STANDARD GRADE.



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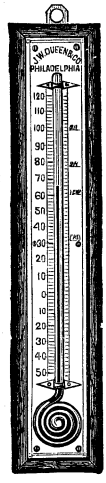
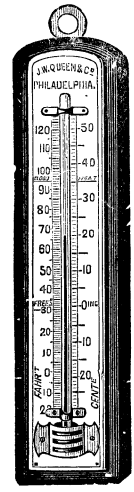


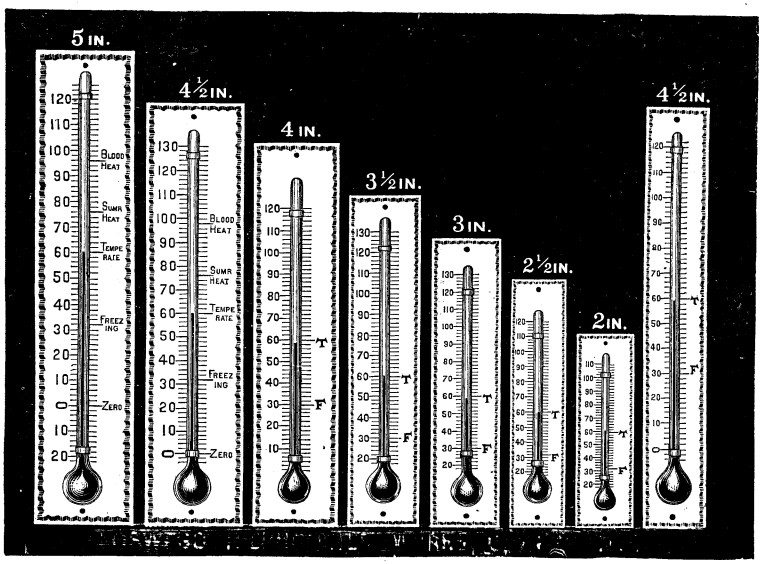
12045



12047

No.		Price
12041.	Boxwood Thermometer, lens tube, set in groove, bevel edges, highly polished, 6 inches long	$1 00
12042.	Same as 12041, 8 inches long	1 25
12043.	" 10 "	1 50
12044.	" 12 "	2 00
12045.	Cabinet Thermometer, lens tube, spiral bulb, silvered brass scale on walnut or mahogany back, either mercury or spirit tubes, 10 inches long	1 50
12046.	Cabinet Thermometer, same as 12045, but with plain round bulb,	1 00
12047.	" lens tubes, aluminium scale on ebony or oak back, 8 inches long	2 00
12048.	Cabinet Thermometer, same as 12047, 10 inches long	2 50
12049.	" " 12 "	3 00

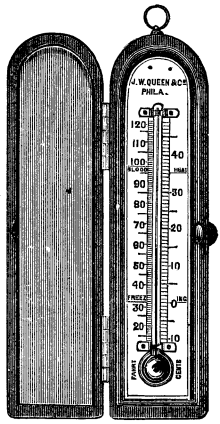
"Queen" Decorative Thermometers.



Thermometers, with Brass Scales, 2 inches long, each . . . . . 10c.
" " " " 2½ " " " . . . . . 10c.
" " " " 3 " " " . . . . . 10c.
" " " " 3½ " " " . . . . . 10c.
" " " " 4 " " " . . . . . 15c.
" " " " 4½ " " " . . . . . 15c.
" " " " 5 " " " . . . . . 15c.
" " " " 6 " " " . . . . . 15c.
" " " " 7 " " " . . . . . 15c.
" with Cardboard Scales, 4 inches long, each . . . . . 10c.

12052. Porcelain Back Library Thermometer, 8 inches long, each . . . $2.00
12053. " " " " 10 " " " . . . 2.50
12054. Porcelain Scale Thermometer, oak back, 8 inches long, each . . 2.00
12055. " " " " 10 " " " . . 2.50

POCKET THERMOMETERS.



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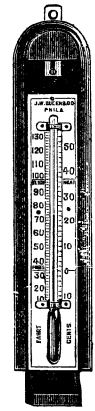
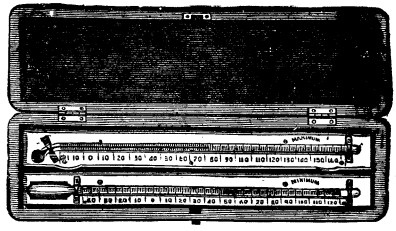
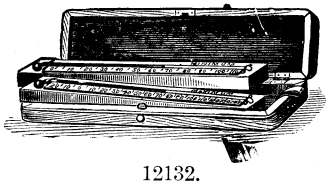


12122.

No.		PRICE.
12110.	POCKET THERMOMETER, 4 inches long, cylinder form, with paper scale, in fine brass case	$1 00
12111.	POCKET THERMOMETER, 4 inches long, in mahogany case, with metal scale	1 00
12112.	POCKET THERMOMETER, 4 in. long, in ebony case, with ivory scale.	1 25
12113.	Do. do. in maple case	1 25
12115.	POCKET THERMOMETER, enamel tube, double ivory scale, 3 inch	2 25
12116.	Do. do. do. do. 4 inch	2 75
12117.	Do. do. do. do 5 inch	3 00
12118.	Do. do. do. do. 6 inch	3 50
12120.	GERMAN SILVER POCKET REVOLVING THERMOMETER, enamel tube, ivory scale, on boxwood back 3 inch	4 00
12121.	Do. do do. do. 5 inch	4 50
12122.	POCKET THERMOMETER, enamel tube, silvered scale, in mahogany case, with sliding lid 4 inch	1 25
12123.	Do. do. do. do. 5 inch	1 50
12124.	Do. do. do. do. 6 inch	1 75



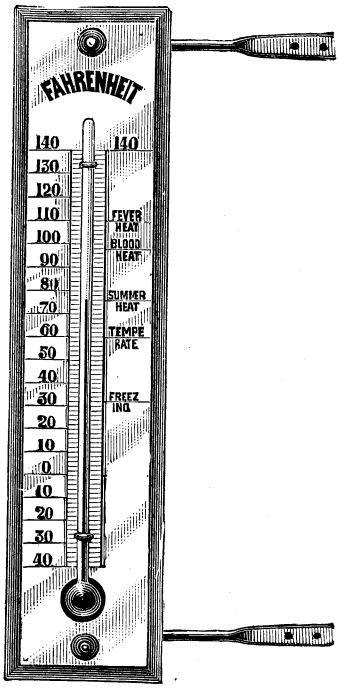
12131.



12132.

12130. POCKET MAXIMUM AND MINIMUM THERMOMETER, enamel tube, sunk in boxwood scales, engine divided on stem and figured on scale, 8 inch, in morocco case 10 50

Window Thermometers.



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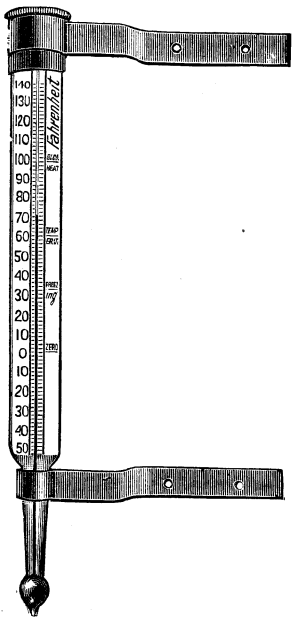
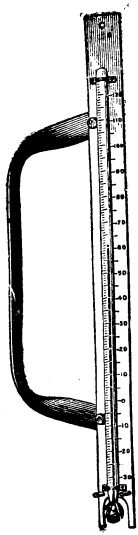


12149

No.		Price.
12140.	Window Thermometer, lens tubes, ground face, plain edges, with nickel plated supports, 8 inches long	$1 00
12141.	Same as No. 12140, 10 inches long	1 25
12142.	" " 12 "	1 50
12143.	Window Thermometer, lens tubes, heavy plate glass edge, white enamel front, which makes the figures very prominent, 8 inches long	1 50
12144.	Same as No. 12143, 10 inches long	1 75
12145.	" " 12 "	2 00
12146.	Window Thermometer, red glass with numbers etched through showing white, 8 inches long	1 50
12147.	Same as No. 12146, 10 "	1 75
12149.	Window Thermometer, cylindrical glass tube, with insulated porcelain scale, 10 inches long	1 00
12150.	Same as No. 12149, 12 inches long	1 50
12151.	Self-Registering Window Thermometer, Sixe's principle, on heavy plate glass, 10 inches long	5 00

12190.

12191.

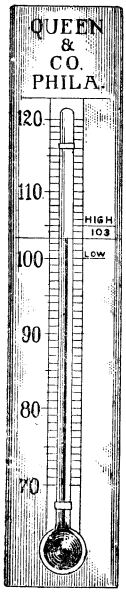


12191 a.

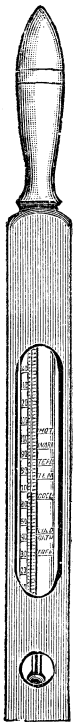
12192.

No.		Price
12190.	EXPOSED THERMOMETER (U. S. Weather Bureau pattern), 12 inches long, graduated and figured on the stem, mounted on aluminium plate with support. The lower part of the plate is cut away, exposing the cylindrical bulb. . . . Price,	$2 75
12191	EXPOSED THERMOMETER, 12 inches long, graduated on the stem, and figured on silvered brass plate which extends below the tube thus protecting it, with support, . . . Price,	2 75
12191a.	EXPOSED THERMOMETER, same as above, with support, holding it at right angles to the plane to which it is fastened. . . .	2 75
12192.	EXPOSED THERMOMETER, 12 inches long, graduated on the stem, the figures and every fifth line indellibly marked on a raised porcelain strip at the side. Scale projecting below the tube, thus affording protection, with support. . . . Price,	3 00

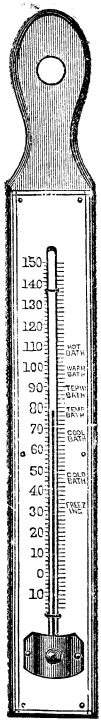
Bath Thermometers.



12187

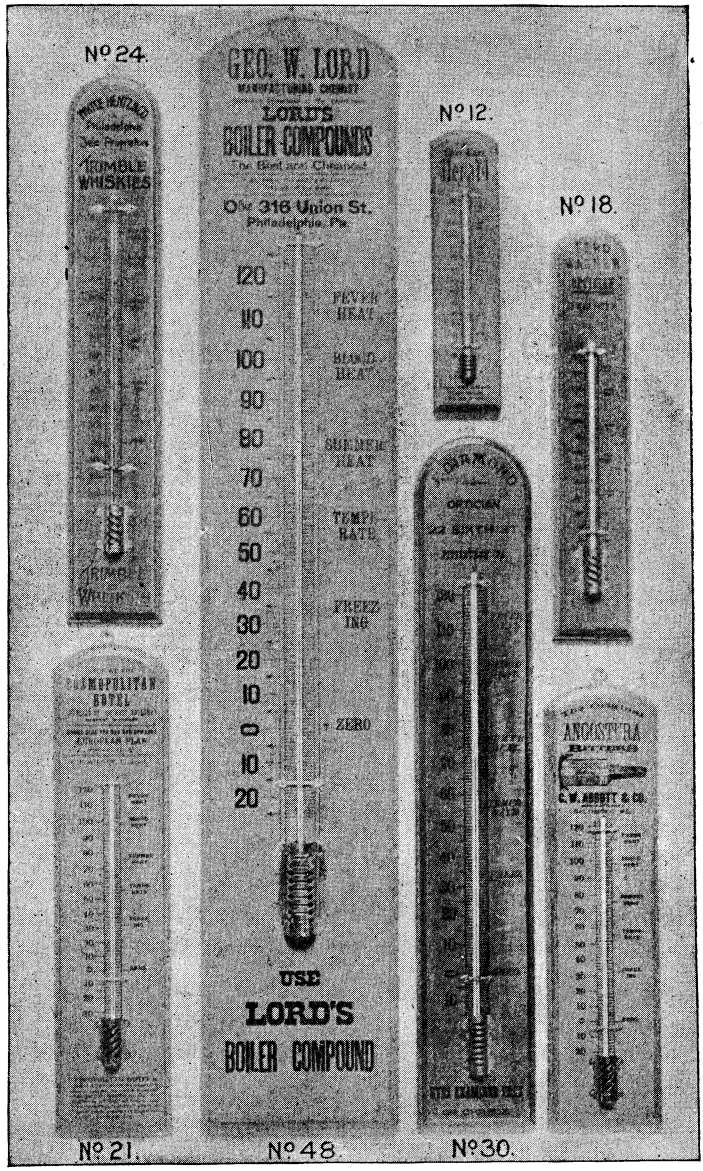


12125



12178

No.		Price.
12170.	Bath Thermometer, glass tube, with paper scale, 6 inches . . .	$ 25
12171.	" " " 8 " . . .	35
12172.	" " " 10 " . . .	50
12173.	" " " 12 " . . .	75
12175.	Bath Thermometer, glass tube, with paper scale, in square wooden frame, with handle, 10 inches	50
12176.	Same as No. 12175, 12 inches	75
12177.	" " 15 "	1 00
12178.	Bath Thermometer, oil finish, tube sunk flush with scale. Bath words according to specifications of Dr. Forbes. Ash frame, 10 inches long	75
12186.	All Glass Dairy Thermometer, 8 inches long, with paper scale . .	35
12187.	Incubator Thermometer, 5 inches long, graduated from about 60 to 120 in single degrees, very plain and accurate	75



In Lots of	12 inches each.	21 inches each.	24 inches each.	48 inches each.
25				$1 25
50		40c.	50c.	1 15
100	18c.	35c.	40c.	1 10
500	16c.	32c.	35c.	1 08
1000	15c.	30c.	33c.	1 05

12267. Show Thermometer, polished oak, very handsome, red spirit tube, 18 in. long $1 50
12268. Same as 12267, 24 in. long 2 25
12269. " " 30 " 4 00
12270. " " 36 " 5 00
12271. " " 48 " 7 50

CHEMICAL THERMOMETERS.

12274.

12280.

No.		Price.
12272.	ALL GLASS CHEMICAL THERMOMETER, with paper scale, graduated to about 220°,	$ 1 00
12273.	ALL GLASS CHEMICAL THERMOMETER, with paper scale, graduated to 400° Fahrenheit, 12 inches,	1 25
12274.	Do. do. graduated to 600° Fahrenheit,	1 50
12275.	ALL GLASS CHEMICAL THERMOMETER, with paper scale, 12 inches, graduated to 100° Centigrade,	1 00
12276.	Do. do. graduated to 200° Centigrade,	1 25
12277.	Do. do. do. 360° do.	1 50
12278.	ALL GLASS CHEMICAL THERMOMETER, with porcelain scale, 12 inches, graduated to 212° Fahrenheit,	1 25
12279.	Do. do. graduated to 400° Fahrenheit,	1 50
12280.	Do. do. do. 600° do.	1 75
12281.	ALL GLASS CHEMICAL THERMOMETER, porcelain scale, 12 inches, graduated to 100° Centigrade,	1 25
12282.	Do. do. graduated to 200° Centigrade,	1 50
12283.	Do. do. do. 360° do.	1 75
12284.	ALL GLASS CHEMICAL THERMOMETER, porcelain scale, brass cap, graduated to 212° Fahrenheit, 6 to 8 inches,	75
12285.	Do. do. do. 10 do.	1 00
12286.	Do. do. do. 12 do.	1 25
12287.	Do. do. do. 15 do.	1 50

CHEMICAL THERMOMETERS

12293.

No.		Price.
12288.	ALL GLASS CHEMICAL THERMOMETER, enamelled tube, graduated on glass, double degrees, to 212° Fahrenheit, . 12 inches,	$1 25
12289.	Do. do. do. 400° Fahrenheit, 14 do.	1 50
12290.	Do. do. do. 600° do. 14 do.	2 00
12294.	ALL GLASS CHEMICAL THERMOMETER, enamelled tube, graduated on glass to 100° Centigrade, ... 12 inches,	1 25
12295.	Do. do. graduated to 200° Centigrade, 14 do.	1 50
12296.	Do. do. do. 360° do. 14 do.	2 00
12300.	ALL GLASS ELBOW THERMOMETER, with paper scale, graduated to 240° Fahrenheit; length of arm, 11 inches; length of bend, 4 inches, ...	1 50
12301.	ALL GLASS CHEMICAL THERMOMETER, enamelled tube, graduated on glass to about 600° F. and 300° C., on one scale, . . .	2 50
12302.	ALL GLASS CHEMICAL THERMOMETER, enamelled tube, graduated on the glass for high degrees, filled with nitrogen to prevent the separation of the mercury column, 1000° F.	5 00
12303.	ALL GLASS CHEMICAL THERMOMETER, graduated on the tube from 0 to 100 Centigrade in $\frac{1}{5}$ degrees. . . . . each,	3 50
12304.	Do. do. 0 to 100 C. in $\frac{1}{10}$ degrees,	4 00
12305.	Do. do. 100° to 200° C., $\frac{1}{5}$ degrees,	3 50
12305.	Do. do. do. do. $\frac{1}{10}$ degrees,	4 00

Certificate of Corrections can be furnished for the Thermometer if desired.

STANDARD THERMOMETERS.

A thoroughly accurate thermometer is indispensable to the scientific observer, the chemist and the manufacturer, and the production of such an instrument is a work of the utmost difficulty, requiring extreme care and the highest degree of scientific knowledge and practical skill. A good standard thermometer should, when plunged into melting ice, indicate exactly 32° F (0° C.). When held in the steam arising from distilled water boiling in a copper vessel, with the barometer at 30 inches or 760 mm, it should indicate 212° F. (100 C.), and the degrees throughout the scale should be uniform for each increment of heat. To obtain this result, it is necessary that the tube should be carefully selected and the calibration accurately effected. To accomplish this, a small portion of mercury is introduced into the tube and carefully measured at different points throughout its length. If its size remains the same throughout the bore, the tube is assumed to be of uniform diameter. The introduction of moisture is avoided by blowing with an elastic caoutchouc ball containing air, instead of by the breath, and the mercury is of the utmost purity, freed from moisture and air by boiling. The bulb must be thick enough to resist atmospheric pressure, but not too thick, or too large, lest the sensitiveness of the thermometer should be impaired.

The freezing-point is easily ascertained by placing the bulb and part of the tube in melting ice until the mercury ceases to contract, when the position of the mercury is marked on the tube.

The *boiling-point* is a matter of more difficult determination. The normal boiling temperature of water is universally fixed under a normal barometric pressure of 29.922 inches of mercury, having the temperature of melting ice, in the latitude of 45° and at the sea level. If the atmospheric pressure when the thermometer is graduated does not equal this, the temperature will be higher or lower in the ratio of the varying pressure. It is therefore necessary to take a reading from a standard barometer which is corrected for errors and temperature and reduced for latitude, in order to compare the actual atmospheric pressure at the time, with the assumed normal pressure. Regnault's table, which is the most recent, and is considered the most accurate, gives the barometric reading, corresponding to every tenth of a degree near 100° Centigrade:

REGNAULT'S TABLE.

Boiling-Point. °Cent.	Reading of Barometer. Millim.	Boiling-Point. °Cent.	Reading of Barometer. Millim.
98.8	727.96	99.5	746.50
98.9	730.58	99.6	749.18
99.0	733.21	99.7	751.87
99.1	735.85	99.8	754.57
99.2	738.50	99.9	757.28
99.3	741.16	100.0	760.00
99.4	743.83	100.1	762.73

The corrections for barometric pressure having been made, the tube is placed in a copper boiler constructed for the purpose. Care is taken that the tube does not enter the water, the steam from the pure distilled water alone reaching it. This is necessary because the temperature of water increases with its depth owing to the pressure of the upper stratum. As the mercury rises, the tube is slowly passed in until the mercury becomes stationary, when the *boiling-point* is marked. The range between the freezing and boiling-points is then carefully divided: in the Centigrade into 100°, and in the Fahrenheit into 180°, and the thermometer compared at every 10 degrees. There still remains, however, a source of error, in the displacement of the freezing-point, owing to the contraction of the glass which is observed to take place for some time after a thermometer is made. It is therefore necessary, a year or two after a thermometer is graduated, to re-test it in order to verify the freezing-point, or establish the thermometer's constants of error.

STANDARD THERMOMETERS OF EXTREME PRECISION.

GRADUATED AND FIGURED ON THE STEM AND PROVIDED WITH LINED BRASS CASES.

FAHRENHEIT SCALE.

No.	Length of Tube.	Scale.	Divided into	Price.
12410	21 to 24 inches long	32 to 212	$\frac{1}{5}^\circ$	$20 00
12411	Do. do.	32 to 212	$\frac{1}{10}^\circ$	25 00
12412	Do. do.	30 to 120	$\frac{1}{5}^\circ$	15 00
12413	Do. do.	0 to 120	$\frac{1}{10}^\circ$	20 00
12414	Do. do.	0 to 400	$\frac{1}{2}^\circ$	10 00
12415	Do. do.	0 to 600	1°	10 00

CENTIGRADE SCALE.

No.	Length of Tube.	Scale.	Divided into	Price.
12416	21 to 24 inches	0 to 100	$\frac{1}{5}^\circ$	$15 00
12417	21 to 24 inches	0 to 100	$\frac{1}{10}^\circ$	20 00
12418	21 to 24 inches	—15 to + 50	$\frac{1}{10}^\circ$	15 00
12419	21 to 24 inches	0 to 360	$\frac{1}{2}^\circ$	10 00

NOTE.—We have also on hand constantly a full stock of Dr. Geissler's, Baudin's, and other celebrated makers' Thermometers.

We furnish any of the above (except Nos. 12414, 12415 and 12419) Thermometers mounted on metal scales, with every degree marked and every ten degrees figured on a raised metal strip ranged at the side of the tube. Price, $10.00 extra, including handsome leather covered case to suspend them in.

ALL GLASS THERMOMETERS.

MADE FROM WELL-SEASONED TUBES, AND WITH CYLINDRICAL BULBS OF OUR OWN SPECIAL GLASS.

GRADUATED AND FIGURED ON THE STEM AND PROVIDED WITH LINED BRASS CASES.

No.	Length.	Fahrenheit Graduated about	Graduated into	Price.	No.	Centigrade graduated about.	Graduated into	Price.
12435	6 in.	0 to + 120	1° F.	$2 25	12451	—15 to 50	½°C.	$2 25
12436	6 in.	32 to + 212	2° F.	2 25	12452	0 to 100	1°C.	2 25
12437	9 in.	—30 to 120	1° F.	2 50	12453	—35 to 50	½°C.	2 50
12438	9 in.	+32 to 212	1° F.	2 50	12454	0 to 100	½°C.	2 50
12439	12 in.	—30° to 120°	1° F.	3 00	12455	—35 to + 50	½°C.	3 00
12440	12 in.	—30° to 120°	½° F.	3 25	12456	+35 to 150	½°C.	3 50
12441	12 in.	+32° to 212°	1° F.	3 00	12457	0 to 100c	½°C.	3 50
12442	12 in.	+32 to 212	½° F.	3 25	12458	0 to 100	⅕°C.	5 50
12443	12 in.	+32 to 300	2° F.	3 00	12459	0 to 150	1°C.	3 00
12444	12 in.	+32 to 400	2° F.	3 25	12460	0to+200c	1°C.	3 25
12445	12 in.	+32 to 300	2° F.	3 50	12461	0 to 360	1°C.	3 50
12446	18 in.	—30 to 120	½° F.	5 00	12462	—35 to + 50	⅕°C.	5 00
12447	18 in.	+32 to 212	1° F.	5 00	12463	0 to 100	½°C.	5 00
12448	18 in	+32 to 212	½° F.	6 00	12464	0 to 100	⅕°C.	6 00
12449	18 in.	+32 to 400	1° F.	6 50	12465	0 to 200	½°C.	6 50
12450	18 in	+32 to 600	1° F.	7 50	12466	0 to 315	⅕°C.	7 50

The length of the Centegrade Thermometer is that of the Fahrenheit directly opposite, as 12451 and 12435, both 6 inches

We desire to call your attention to the fact that we are now prepared to manufacture Standard Thermometers of extreme accuracy of any desired range or length using the Jena Glass. As this glass does not change with age it precludes the possibility of any appreciable change of the zero point.

MAXIMUM AND MINIMUM THERMOMETERS.

These instruments, designed for registering the extremes of temperature for each day, are of the greatest importance in determining climatological conditions. It is now well understood that the mean daily temperature is of much less importance, in estimating the comparative agricultural possibilities, or the healthfulness of a climate than the extreme range of temperature. It is therefore absolutely necessary to find, with the utmost accuracy, the highest and lowest temperature of the twenty-four hours, the maximum being generally reached in the early afternoon, and the minimum in the early morning. It would be impossible with the ordinary form of thermometer, to exercise sufficient watchfulness or to make observations with sufficient frequency to obtain accurate results, and accordingly the subject of self-registering thermometers early occupied the attention of meteorologists, and various forms were devised.

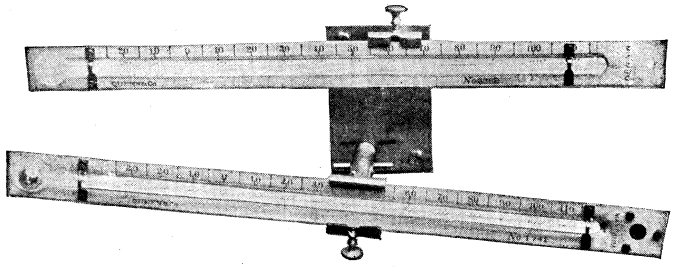
Of these, the Maximum Thermometer introduced by Prof. Phillips, the Maximum and Minimum Thermometer invented by Dr. John Rutherford, and the very elegant Maximum and Minimum Thermometer invented by Mr. James Sixe, are in most general use.

The Weather Bureau Maximum Thermometer is of the form usually known as the INDESTRUCTIBLE INDEX, the entire column forming a registering index, by rising above a construction in the tube to the point of temperature reached, where it remains until read and from which it is shaken back to the normal point for a new observation.

Consists of a glass tube arranged horizontally, and filled in the usual manner, but with alcohol instead of mercury, a black glass index moving freely *in* the fluid. The instrument is set by raising the bulb and allowing the index to float to the end of the column of alcohol.

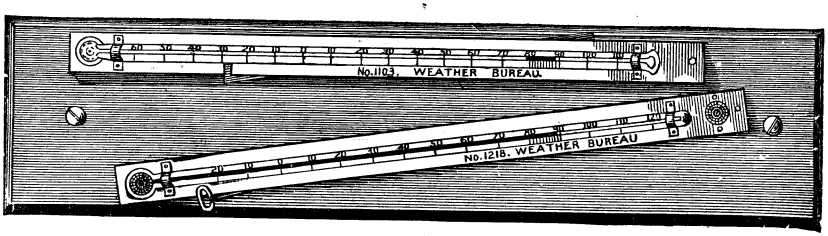
As the temperature decreases, the column recedes, carrying with it the index to the lowest point, where it remains, while on an increase of temperature, the alcohol alone reascends. The end of the index farthest from the bulb shows the lowest tempe ature reached.

U. S. WEATHER BUREAU PATTERN MAXIMUM AND MINIMUM THERMOMETERS.



12211. U. S. Weather Bureau Thermometers, No. 12196 and No. 12204 mounted on the Townsend Improved Support, complete . . $8 00

U. S. WEATHER BUREAU PATTERN MAXIMUM AND MINIMUM THERMOMETERS.



12210.

No.		Price.
12196.	U. S. Weather Bureau Maximum Thermometer, with graduations on glass tube and mounted on an aluminum back, 12 inches long, with supports complete	$4 50
12204.	U. S. Weather Bureau Minimum Thermometer, with graduations on glass tube and mounted on an aluminum back, 12tinches long, with supports	3 50
12210.	U. S. Weather Bureau Set of Maximum and Minfmum Thermometers, consisting of Nos. 12196 and 12204, mounted on suitable board	8 00

Instructions for setting up the Maximum and Minimum Thermemeters.

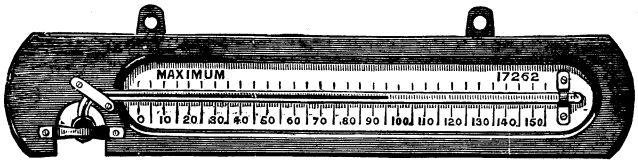
The Maximum Thermometer, which is the mercurial, is slipped upon the brass post and secured by means of the nut. The brass post is screwed into the board about 1 inch from the right hand end. The bulb end of the thermometer rests upon the pin at a slight angle.

To reset the thermometer, after taking a reading remove the pin and revolve the thermometer swiftly around the post several times. The centrifugal force drives the detached thread back to the mercury in the bulb.

The Minimum Thermometer which is made of alcohol is fastened on the long brass strip by the thumb screw at the right, and resting in the slot at the left hand end

To reset the instrument, raise the bulb until the needle moves down to the end of the column of alcohol.

MAXIMUM THERMOMETERS.

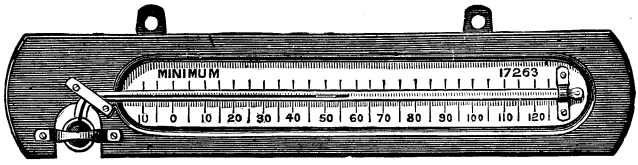


12194.

No.		Price
12193.	Maximum Thermometer, 10 inches long, Signal Service principle, silvered metal scale on wal ut back, with long bulb, . .	$2 75
12194.	Maximum Thermometer, 10 inches long, Signal Service principle, divided and figured on porcelain scale, in oak frame, . .	6 00

MINIMUM THERMOMETERS.

12200.

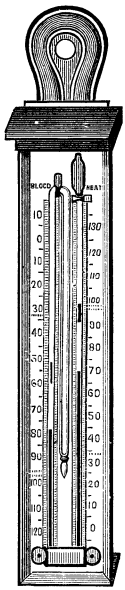


12203.

No.		Price.
12200.	Minimum Thermometer, Rutherford's principle, 10 inches long, spirit column, round bulb, metal scale, graduated from 60° below zero to 130° above, walnut back, ...	$2 00
12201.	Minimum Thermometer, same as No. 12200, but with elongated bulb, ...	2 25
12202.	Minimum Thermometer, Rutherford's principle, 10 inch porcelain scale, on oak frame, ...	5 00
12203.	Minimum Thermometer, same as No. 12202: 12 inches, . .	6 00

SIXE'S
SELF-REGISTERING MAXIMUM AND MINIMUM THERMOMETER.

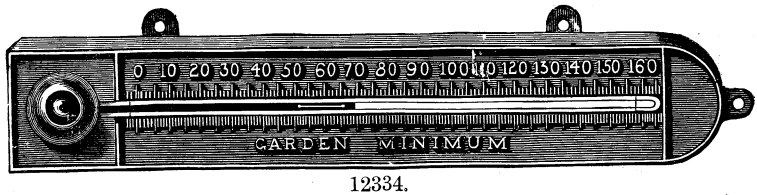
This beautiful and very ingenious instrument consists of a long cylindrical bulb, united to a tube of more than twice its length, bent round each side of it in the form of a syphon, and terminating in a smaller oval-shaped bulb. This bulb and part of the connecting tube are partly filled with pure spirit; the lower part of the syphon is filled with mercury, and the remainder of the tube and the long bulb are completely filled with spirit. A steel index, with hair-spring, moves in the spirit, in each arm, above the mercury. The action of the instrument is as follows: As the temperature increases, the spirit in the long bulb expands, forcing the mercury to rise in the right tube, where it also rises by its own expansion. As it thus advances the index is driven before and left at the highest point. As the temperature decreases, the mercury recedes, driving the index point in the left-hand tube before it, and leaving it at the coldest point. The left-hand tube is, therefore, graduated from zero at the top downward, while the right-hand scale is an ascending one, ranging from zero at the bottom to 130 at the top. The instrument is set by drawing the indices down into contact with the mercury by means of a small magnet which is passed down the outside of the tubes. When compared with standard instruments, and properly made, these are admirable thermometers, and are highly recommended for general observations.



12223.

12223. SIXE'S THERMOMETER, boxwood scale, enamelled tube, black japanned case, 8 inches, ... 2 50
12224. Do. do. do. do. 10 inches, 3 50
12225. Do. do. do. do. 12 do. 5 00
12226. SIXE'S THERMOMETER, boxwood scale, round top, enamelled tube, 8 inches, ... 2 50
12227. Do. do. do. do. 10 inches, 3 50
12232. SIXE'S THERMOMETER, enamelled tube, porcelain scale, in white japanned case, 8 inches, ... 4 50
12233. Do. do. do. do. 10 inches, 5 50
12234. Do. do. do. do. 12 do. 7 50
12235. Do. do. do. do. 14 do. 12 00

HORTICULTURAL THERMOMETERS.



12334.

No.		PRICE.
12330.	HORTICULTURAL MINIMUM THERMOMETER, 8 in., showing the coldest point reached, alcohol column, polished oakwood scale, plain tube, double degrees,	$0 75
12331.	HORTICULTURAL MINIMUM THERMOMETER, same as 12330, with enamelled tube,	1 00
12332.	HORTICULTURAL MINIMUM THERMOMETER, 8 in., alcohol column, polished boxwood scale, enamelled tube, single degrees,	1 25
12333.	Do. do. do. do. 10 inches,	1 50
12334.	HORTICULTURAL MINIMUM THERMOMETER, showing the coldest point reached, alcohol column, solid cast zinc frame, with raised figures and division graduated from 60° below zero to 120° above,	1 50

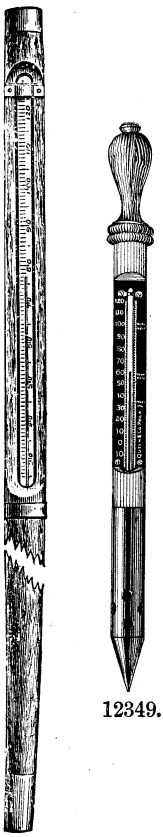
12335.

12337.

12335.	HOTBED THERMOMETER, plain mounting, 12 inches,	3 00
12336.	Do. do. do. 16 do.	3 50
12339.	SUBSOIL THERMOMETER, mahogany frame, inclosed in brass tube, with thermometer on door for temperature of air, 30 inches,	15 00

SOIL THERMOMETERS.

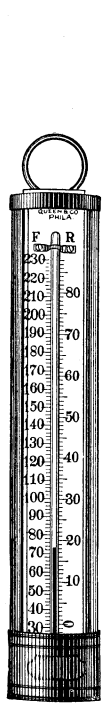
For ascertaining the temperature of the soil at various depths of the earth. This pattern is used by most of the Agricultural Colleges and experiment stations in the country. It consists of a stout thermometer, graduated and figured on stem, enclosed in a wooden case, the upper part of which is cut away, exposing the scale, which is about 10 inches long, this length being the same for all the thermometers.



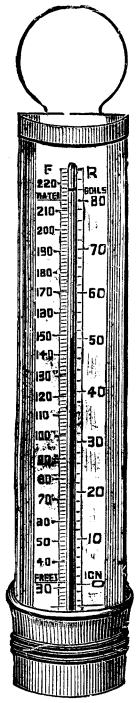
12349.

No	Inches deep.	Price.
12340.	1	$ 5 00
12341.	3	5 50
12342.	6	6 00
12343.	9	6 50
12344.	12	7 00
12345.	24	9 00
12346.	36	11 00
12347.	50	13 00
12348.	72	17 00
12349.	MUSHROOM THERMOMETER. Specially adapted for mushroom beds. Can be used also for hot-bed temperatures	2 00

BREWERS' AND DISTILLERS' THERMOMETERS.



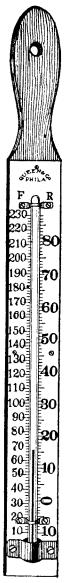
12350.



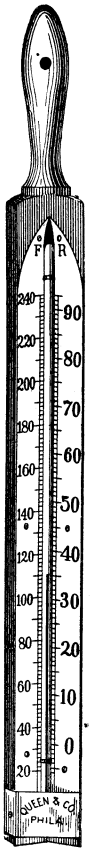
12356.

No.					PRICE.
12350.	BREWERS' THERMOMETER, heavy japanned tin case, extra heavy scale, large tube, graduated to Fahrenheit and Réaumur,			10 inches,	$1 25
12351.	Do.	do.	do.	12 do.	1 50
12352.	Do.	do.	do.	14 do.	2 00
12353.	BREWERS' THERMOMETER, copper case, graduated to Fahrenheit and Réaumur,			10 inches,	1 75
12354.	Do.	do.	do.	12 do.	2 25
12355.	Do.	do.	do.	14 do.	3 00
12356.	BREWERS' THERMOMETER, copper cup case, with stout silvered brass scale, graduated to Fahrenheit and Réaumur,			10 inches,	2 00
12357.	Do.	do.	do.	12 do.	2 50
12358.	Do.	do.	do.	14 do.	3 50
12359.	BREWERS' THERMOMETER, heavy copper cup case, porcelain scale, enamelled tube, Fahrenheit and Réaumur,			10 inches,	4 00
12360.	Do.	do.	do.	12 do.	4 50
12361.	Do.	do.	do.	14 do.	5 00

BREWERS' AND DISTILLERS' THERMOMETERS



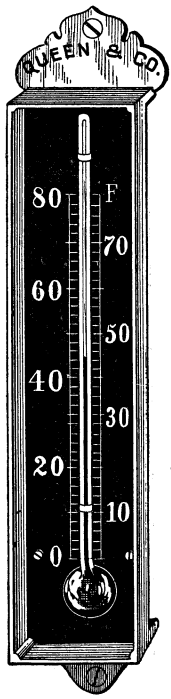
12363.



12368.

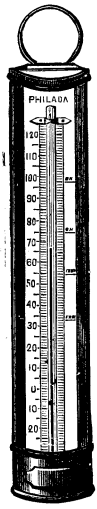
No.		Price
12362.	BREWERS' THERMOMETER, 12 inches, wood frame with handle, Fahrenheit and Réaumur scale,	$1 50
12363.	BREWERS' THERMOMETER, 12 inches, wood frame with handle, enamelled tube let into the frame,	2 00
12364.	BREWERS' THERMOMETER, 12 inches, brass frame with handle, heavy tube Fahrenheit or Réaumur scale,	3 00
12368.	BREWERS' THERMOMETER, V-shaped, ash case with handle, silvered scales, extra heavy scales and tubes, 12 inches long	2 00
12369.	Same as No. 12368, 14 inches long	2 50
12370.	BREWERS' THERMOMETER, V-shaped, wood back, same as 12368, but without handle, silvered scales, 10 inches long	1 25

Thermometers for Fermenting Cellar and Cold Storage Room.



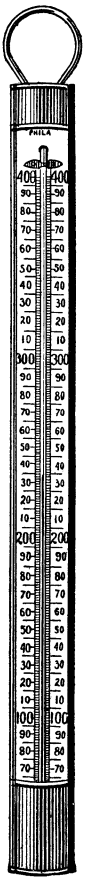
12372.

12371.



12374.

No.		Price.
12372.	Cellar or Cold Storage Thermometer, galvanized iron case, black oxidized scale with white figures and graduations, red spirit tubes (or mercury tubes if desired), graduated 0° to 80° Fahrenheit only, or 0° to 80° Fahrenheit and corresponding Reaumur, 8 inches long	$1 00
12373.	10 inches long	1 25
	This is a very practical style of thermometer; the scale is well let into frame which has screw holes at top and bottom to firmly secure it. It is strong, accurate and easily read. The cases are heavily galvanized, and should the tubes break from any cause reserve tubes can be had, which will fit the cases.	
12374.	Standard Tin Case Thermometer, graduated from 10° below to 120° above in single degrees. Mercury tubes, 8 inches long	75
12375.	Same as No. 12374, 10 inches long	1 00
12376.	" " 12 "	1 50
12371.	Meat Thermometers to measure the temperature of meat in cold storage. Bulb is strong and pointed so it can be pushed into the meat. Graduated from 20° to 80°	1 25



12377.

Thermometers

For Confectioners' Use.

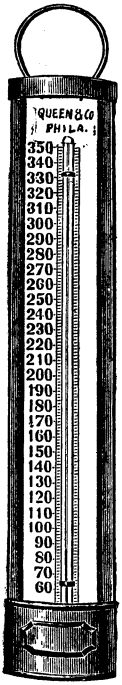
These thermometers are in heavy copper cases, riveted throughout, and are made with seasoned lens tubes. They are graduated for two ranges of temperature, viz: to 400° or to 450°. Fig 5.

No.		PRICE.
12377.	12 inch Thermometer, each	$2 00
12378.	14 " " "	3 50
12379.	24 " " "	6 00

Thermometers

For Fruit Evaporators, Japanning Ovens, Dry Kilns, Hop and Tobacco Curing, etc.

Japanned Tin Case, Standard Grade.



12380

These thermometers are made from seasoned lens tubes; the cases and scales are extra heavy.

Made for three ranges of temperature, viz: to 300°, to 350°, or to 400°. In ordering state which range is desired. Fig. 3.

No.		PRICE.
12380.	10 inch Thermometer, ...	$1 25
12381.	12 " "	1 75
12382.	14 " "	3 00

THE QUEEN KETTLE THERMOMETERS

Are made for Brewers' Mash Tubs and for Varnish, Linseed Oil, Printing Ink, Oil Cloth, Patent Leather, Insulating Compounds, etc.

12390.

THE QUEEN STANDARD MERCURY BATH KETTLE THERMOMETER.

Strong, Sensitive, Accurate and Legible.

This thermometer is 3, 4 or 5 feet long, as desired. The scale-case is of bright aluminum, with glass front over scales. The scales are black with white figures, as shown in cut, and are graduated with any range best suited for its particular use, not exceeding 650° F. The delicate glass bulb is enclosed in a steel mercury bath which protects it from jars or knocks and renders it easily kept clean. See page 33 for description of mercury bath.

A specially strong and well annealed glass is used in this thermometer, eliminating all danger of breakage from too sudden immersion into a hot liquid. This thermometer may be taken from room temperature and suddenly immersed into a hot liquid at a temperature of 600 without risk. It has an adjustable hook for kettle.

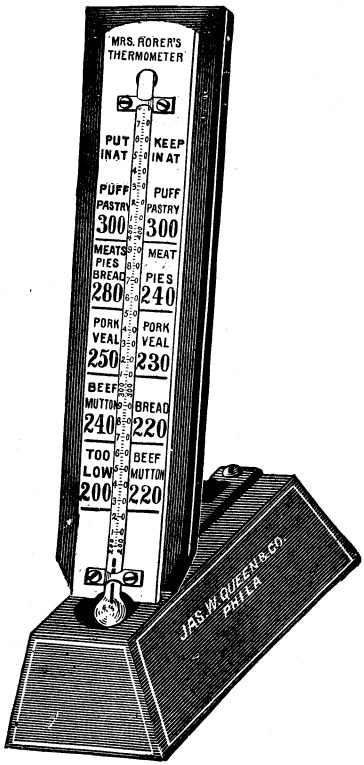
No. 12390.	Price,	3	ft. size	$15 00
" 12391.	"	4	"	16 00
" 12392.	"	5	"	17 00

Copper-Case Varnish Thermometer.

The case is of heavy copper and riveted throughout, same as No. 12379. The tube and scale are extra heavy. It is 24 inches long and is graduated to 650.

No. 12385. Price $7 50

MRS. RORER'S OVEN THERMOMETER.



12393.

12393A.

This Thermometer is at once a lesson in and guide to perfection in cookery.

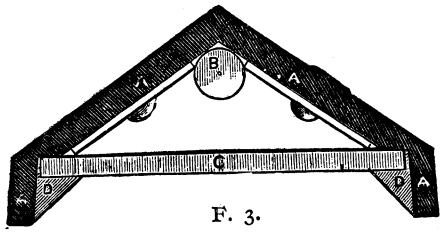
It is mounted on porcelain, in an iron frame, with base. The left side of the scale shows the correct temperature at which *food* should be put into the oven; the right side the temperature at which it should be *kept* to cook it, while etched on the tube itself are the degrees of heat to 600. The whole Thermometer, including base, is but 8 inches high, and can be put in any corner of the oven, out of the way of the cook. It fills a long felt need for a Perfect Oven Thermometer.

No. 12393. MRS. RORER'S OVEN THERMOMETER $3 00

12393 A. The Queen Bread Thermometer for measuring the temperature of bread-dough, 30–150 F., 12 inches long. Plain spirit tube 1 50

12393 B. Ditto, in wooden protecting frame with handle . . 2 00

Economizer Thermometer.



F. 3.

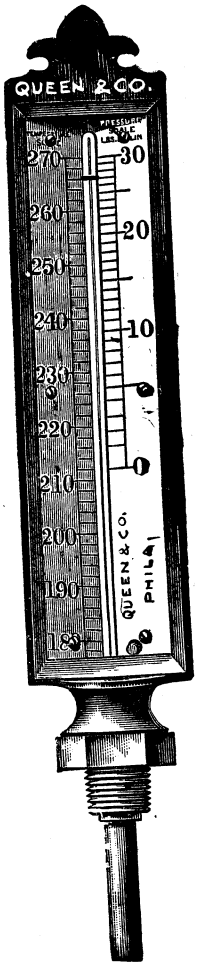


Fig. 1.

Scale about one-third. Made entirely of Special Bronze Metal.

Will not rust or Corrode.

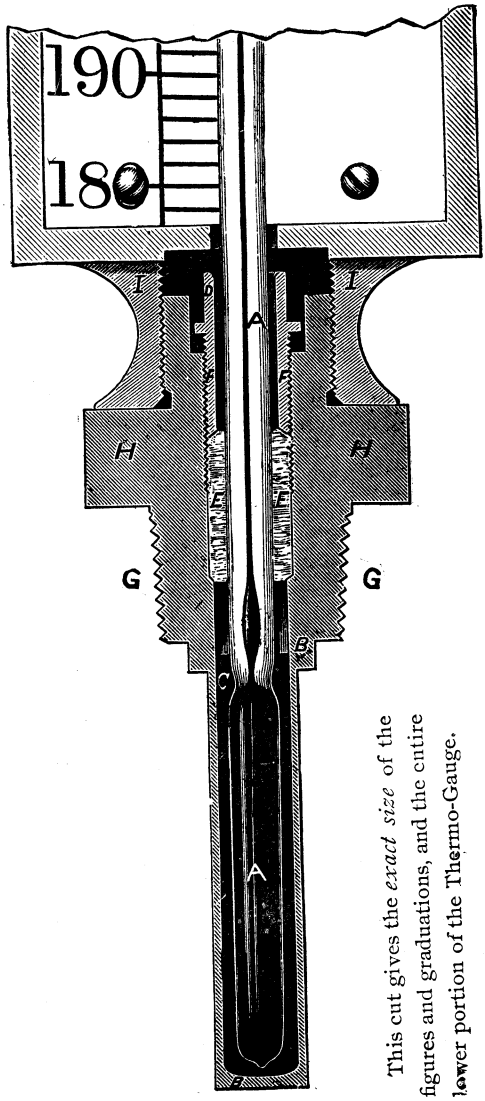


Fig. 2.

This cut gives the *exact size* of the figures and graduations, and the entire lower portion of the Thermo-Gauge.

These engravings give perspective and sectional views of the Standard Thermometer for Feed Water Pipes, Economizers, Brine Pumps, etc., and are exact representations of the same.

Fig. 1 gives a perspective view of the Thermometer, when complete and ready for attachment and use.

Fig. 2 gives a sectional view, illustrating the construction of the Mercury Bath, and the entire lower portion of the Thermometer, exposed to the steam or heat from whatever source derived, and also gives the exact size of the parts described.

A A designates the Thermometer Tube, with its cylindrical bulb, very sensitively constructed.

B B designates the Hollow Stem or Chamber, containing the Mercury bath, and enclosing the Bulb of the Thermometer Tube ; this shell, although extremely sensitive, will withstand any pressure to 200 lbs.

C C designates the Mercury surrounding the enclosed Bulb, forming the Mecury Bath and serving as the conducting medium of the heat, from the Shell B B to the Bulb A. Owing to the delicacy of the Shell and the construction of the cylindrical Bulb, this transmission is instantaneous.

D designates the Packing Screw for holding and packing the Thermometer Tube in a permanent position, and preventing the escape of Mercury from the Bath, when the instrument is heated, or during transportation. The tube being packed in this position and manner, is not affected by the expansion of the frame, and being held so firmly, cannot possibly break.

E designates the Stuffing Box, with the packing in it firmly pressed around the Tube A. We use no red lead or other cement. Patent Mineral Wool is used exclusively, being non-destructible in in any heat that the instrument can register.

F F designates the Thread by which the two parts of the Frame are screwed together.

G G designates the fitting by which the instrument is screwed into the Pipe or Tank. It is ¾ in. Standard Pipe Thread.

H H designates the Hexagon Head or Shoulders, upon which wrench is used.

I designates the upper part of Frame which encloses the Tube and scales.

Fig. 3 gives an end view of the top Frame cut across.

A A A A designates the shape and thickness of the Bronze Metal casting.

B designates the Thermometer Tube A.

C designates the heavy Glass Plate, hermetically sealing the Scales or Dials, thereby preventing corrosion and adding very largely to the protection of the Glass Tube and to the life of the instrument.

D D designates the Cement which holds the Glass Plate in position, and makes the frame air tight.

The two little knobs are screw heads, holding the scales or dials in place.

Black Scale.

Our thermometers are either furnished with the Silvered Brass Scale with black figures or our special Black Scale with white figures as illustrated by cut of thermometer, page 36. This Black Scale has the double advantage of being more easily read and not tarnishing. We make no extra charges for this Black Scale.

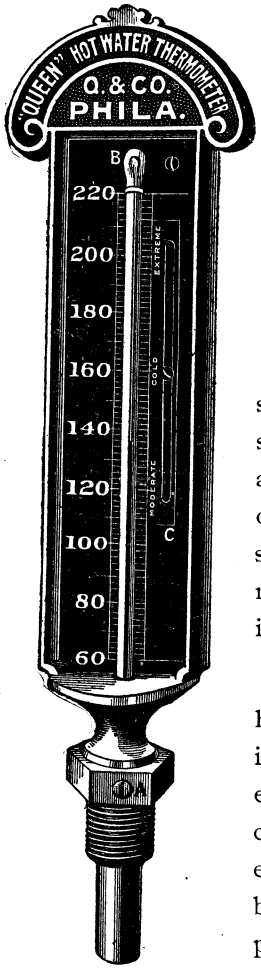
The Mercury Bath.

The construction of which is explained by the foregoing cuts adds greatly to the stability of thermometers without detracting in the least from their sensitiveness. We recommend it therefore on all Pipe Thermometers.

Thermometers for Heaters, Economizers, Flues, etc.

A thermometer should be on every feed water heater. The old way still employed by many of the drawing the water off in bucket or other vessel and then inserting a cheap thermometer is very faulty, in the first place a few degrees of heat must be lost between the water in the tube and the drawn off water; secondly, no dependence can be placed upon a cheap thermometer.

Heretofore thermometers for the purpose, have been made too flimsy but this feature has been eliminated by the mercury bath and our special strong frames—with the care given to a steam gauge, our Feed Water Thermometers should last a lifetime.



12394.

The Queen Separable Mercury-Bath Thermometer.

FOR HOT WATER HEATERS.

No. 12394.

The construction of this thermometer is similar to our Economizer Thermometer as described on page 32, except that its case is flat and without the glass cover. It may be lifted out of mercury bath by unscrewing the set screw, this is a special feature, avoiding the necessity of stopping or emptying the system in case of breakage.

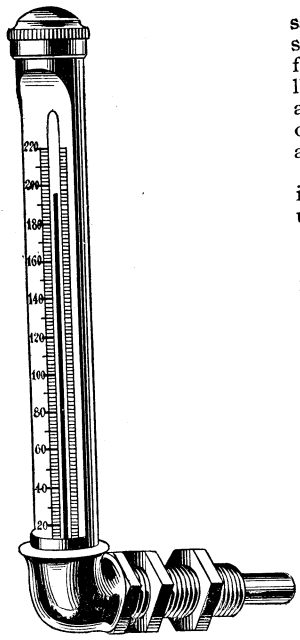
It is graduated from 60° to 260° but may have any range desired. The scale is 6¼ inches long, the mercury bath containing bulb extends 2½ inches from shoulder. The pipe connection is ½ inch. While this thermometer is designed primarily for hot water house-boilers, it will answer very well for feed water pipes. No. 12394 . . . . . Price, $4.00

Angle Thermometer for Hot Water Heater.

No. 12395.

This thermometer is same as No. 12394, except that it has an angle and has not the separable feature. It is graduated unless otherwise specified from 60° to 260°, and is intended for use where a straight one is not practical. No. 12395 . . . . . Price, $5.00

The Queen Steam-Gauge Thermometer.



12403.

This thermometer gauge is constructed the same as the Queen Hot Water Thermometer, described on the preceding page, but is graduated from 180° to 270° F., and show an equivalent of 30 lbs. pressure on the opposite side of the scale. The advantages this thermo-gauge possesses over the ordinary steam gauges, are its absolute accuracy and permanency of its readings.

The Queen Standard Feed Water Thermometer is the same as the thermo-gauge without the pressure scale.

No.		PRICE.
12396.	Steam-gauge Thermometer. . Each,	$4 50
12397.	" " angle form,	5 50
12398.	Standard Feed Water Thermometer	4 00
12399.	" " " angle form	5 00

Pipe Thermometer.

No. 12400.

This thermometer is enclosed in brass case with ½ inch pipe connection. The graduations are usually from 60° to 260° Fahrenheit, but it can have any range required. The tube extends from hexagon nut 4 inch, unless otherwise ordered.

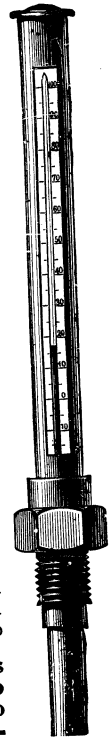
This thermometer has not the mercury bath over bulb and we therefore do not recommend it for use where it will be subject to much pressure . . . . . Price, $5 00

Pipe Thermometer.

No. 12401.

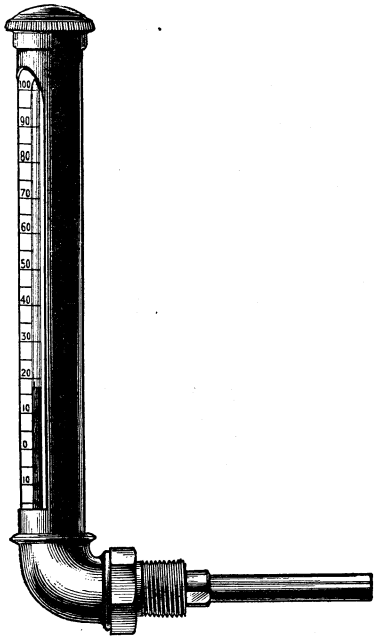
This thermometer is same as No. 12400, except that it has a sliding brass cover over case and has the mercury bath described on page 34, greatly strengthening it. We guarantee it to stand any pressure not exceeding 200 lbs. . . . . Price, $7 00

These two thermometers are used largely on Ice Machines and for that purpose we graduated them from 20° below zero to 75° above with Reaumur Scale if desired. They are also much liked by consulting engineers on account of their portability.



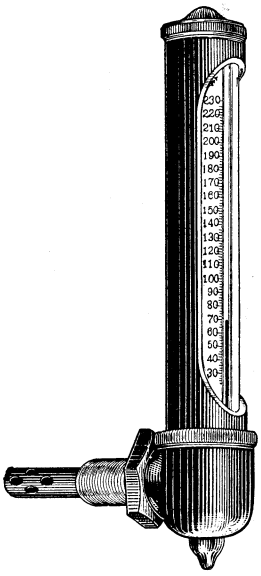
12400.

ANGLE PIPE THERMOMETERS.



12402.

12407.



12405.

12402. This Thermometer is same in construction as No. 12400, except that it has an angle and is intended for use where a straight Thermometer is not practical. It is graduated from 60° to 260°, and the tube extends from hexagon 4 inches unless otherwise ordered, but the degrees of heat and length of tube can be made to meet almost any requirements. This Thermometer has a Mercury Bath. **Price, $8 00**

12403. **Angle Mash-tub Thermometer,** with ¾-inch thread and two lock nuts, scale graduated from 30 to 240 F. and corresponding Reaumur. Bulb protected by Queen Mercury Bath. **Price, $9 00**

12404. **Shower Bath Thermometer,** ⅜-inch pipe connection, nickel-plated brass case, straight, 30–230 F. **Price, $4 00**

12405. **Shower Bath Thermometer,** same as 12404, angle form. **Price, $5 00**

12407. **Hotwell Thermometer,** brass case with sliding cover, scale graduated to 220° unless otherwise ordered. **Price, $25 00**

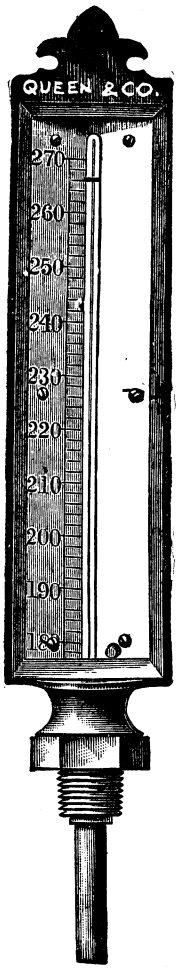


Fig. 1.

ECONOMIZER THERMOMETER.

This Thermometer is described fully on pages 32 and 33. The case is of non-corrosive Bronze Metal with glass cover. It is usually graduated from 60° to 350° but may be graduated higher or lower as may be required.

PRICE, $10.00

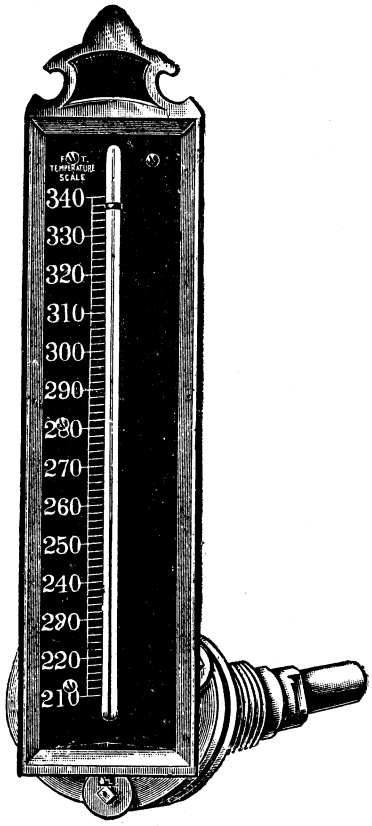


Fig. 6.

ANGLE THERMOMETER.

This Thermometer is same in construction as the Economizer Thermometer, but with angle. It is intended for use on pipes where it is practically impossible to use a straight Thermometer and also on Hot Water Tanks, Mash Tubs, etc.

Price with double flange, ... $15.00
With thread only, ... 12.00

The Queen Mercurial Pyrometer.

TO 1000° FAHRENHEIT.

No. 12426.

12426.

The Queen Mercurial Pyrometer has been on the market now for five years, and has given general satisfaction. We guarantee to the degree the accuracy to 950° Fahrenheit.

The instrument is essentially a mercurial thermometer, the tube, made of special glass, having a high melting point. It is filled with mercury in the usual manner of an ordinary thermometer, but above the mercury nitrogen gas is introduced into the tube. The gas exerting a pressure upon the mercury proportional to the increase of the volume of mercury in the tube, raises its Boiling Point to about 970°, to which point the instrument can be safely used. The co-efficient of expansion of the mercury is not changed by this additional pressure upon it. The tube may therefore be calibrated and accurately scaled to this point, 970°.

CONSTRUCTION.

The delicate glass tube is encased in a heavy case of brass. The upper portion, in which the graduations are placed, is V-shaped with a glass front. The lower portion is a heavy brass tube in which the delicate glass thermometer tube is carefully packed with an elastic non-combustible packing, while the thermometer bulb is enclosed in an inner tube or chamber, the outer tube having perforations to allow free circulation around the inner chamber. This construction will be seen to render the instrument strong, sensitive, and legible, **while the accuracy is guaranteed.**

This Pyrometer is adapted for either hot gases, metals, or liquids, and we recommend its use for all temperatures under 950° Fahrenheit.

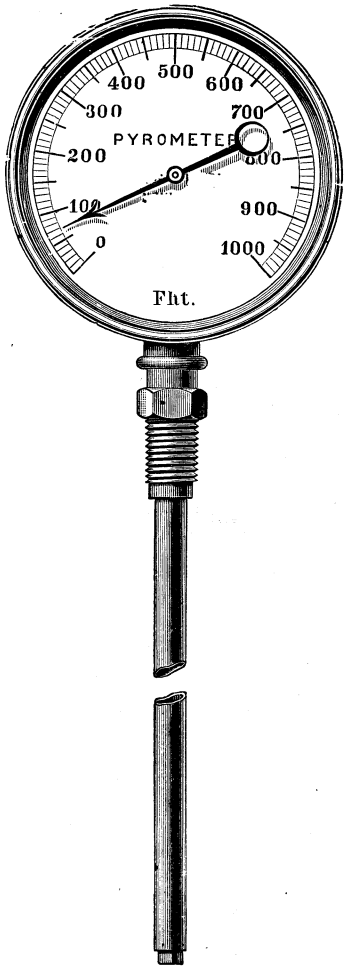
No. 12426. Pyrometer, 1000° F. . . . . Price, $25.00
No. 12427. Angle form . . . . . " 30.00

We also carry in stock a portable form of thermometer for flue gases and very high temperatures constructed on the same principle as the Mercurial Pyrometer. This thermometer is all glass, 14 inches long, graduated from 30° to 1000° F.

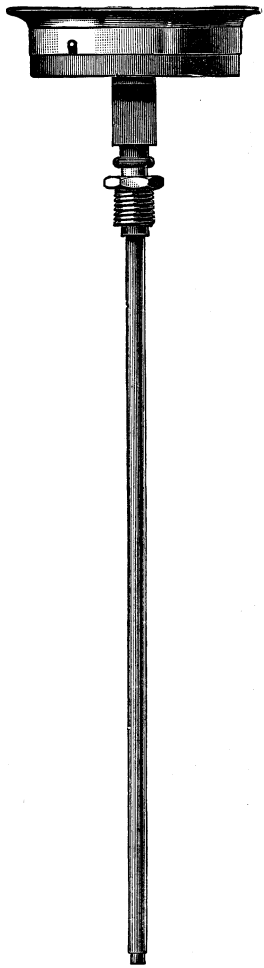
No. 12428. Thermometer to 1000° F $5.00
No. 12429. The same in protecting brass case with perforated end and slot cut out showing graduations 7.50

Metallic Pyrometers.

Gauntlett System.



12430.



12432.

Metallic Pyrometers.

Gauntlett System.

12430. 5-inch dial, dial graduated to 1,000°, 1,200°, or 1,500° Fahr. $25 00

12431. 7-inch dial, dial graduated to 1,000°, 1,200°, or 1.500° Fahr. 30 00

12432. 5-inch dial, dial graduated to 1,000°, 1,200°, or 1,500° Fahr. 25 00

12433. 7-inch dial, dial graduated to 1.000°, 1,200°, or 1,500° Fahr. 30 00

The construction of these instruments is based upon the expansion and contraction of two tubes of different metals. The difference in expansion of these two tubes when exposed to heat is transferred by a movement to the pointer indicating the temperature upon the dial.

They are designed for temperatures from 500° to 1,500° Fahr.

To insure correct indications, the entire stem, up to screw connection, of Pyrometer should be exposed to the heat.

We keep always in stock Nos. 12430 and 12432, with 36-inch stems, and with dials graduated to 1,000°, 1,200°, or 1,500° Fahr., and are prepared at short notice to make up any special lengths or ranges of temperature.

NOTE—These pyrometers have the peculiarity, when first exposed to the heat, that the pointer will run rapidly either forward or backward, depending upon which metal is on the outside, which is due, of course, to the outside tube being heated before the inside tube is affected. When the whole stem becomes thoroughly heated after awhile, the pointer will find its proper place and indicate the temperature correctly.

NOTE—Should the pointer, after the Pyrometer has been in use some time, not come back to the temperature of the atmosphere, which may be the case where high temperatures have been measured, changing somewhat the nature of the metal, the pointer may be readjusted.

The Le Chatelier Pyrometer.

No. 12475.

This Pyrometer, which was designed by M. Le Chatelier, is based upon the current produced by the heating of the junction of a Thermo-Electric Couple. It is capable of measuring very high temperatures; almost those approaching the melting point of platinum. It should therefore be found indispensable to the manufacturer who desires an accurate knowledge and control of his temperatures.

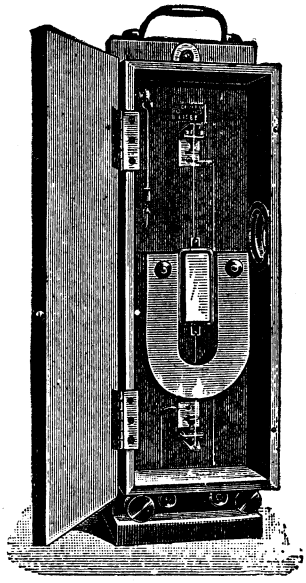


Fig. 1.

It consists of a Thermo-Electric Couple and a D'Arsonval Galvanometer. The wires which compose the couple are one of pure platinum, and the other platinum alloyed with 10 per cent. rhodium, both of which are perfectly homogeneous.

For use, the couple, which has been first connected with the galvanometer, is inserted into furnace or oven, when immediately a current is produced and measured on the galvanometer scale, from which the temperature is readily reduced.

The Pyrometer has the following advantages:

1. It is adapted for a very large range of temperature—*i. e.*, from 200° to 3,000° Fahr., but is intended more specially for high temperatures such as met with in the manufacture of metals, chemicals, porcelain ware, etc.

2. It is almost instantaneous in its indications, five seconds being sufficient time to subject the couple to any stationary temperature; or the couple may, if desired, be left permanently in the furnace or oven, indicating at all times the exact temperature, and thus enabling the operator to keep an hourly record of time.

3. The metals which compose the couple are not effected by gases, and hence will not become oxidized or react chemically on each other at high temperatures; nor are they altered in their thermo-electric properties by rough usage or bends.

From the above statements it will be readily seen that the instrument is of great accuracy and durability.

The measurement of the temperature is made by means of a D'Arsonval Galvanometer, contained in two wooden boxes, which are screwed against a central wall or slab, with handle for portability, as shown in Fig. 1.

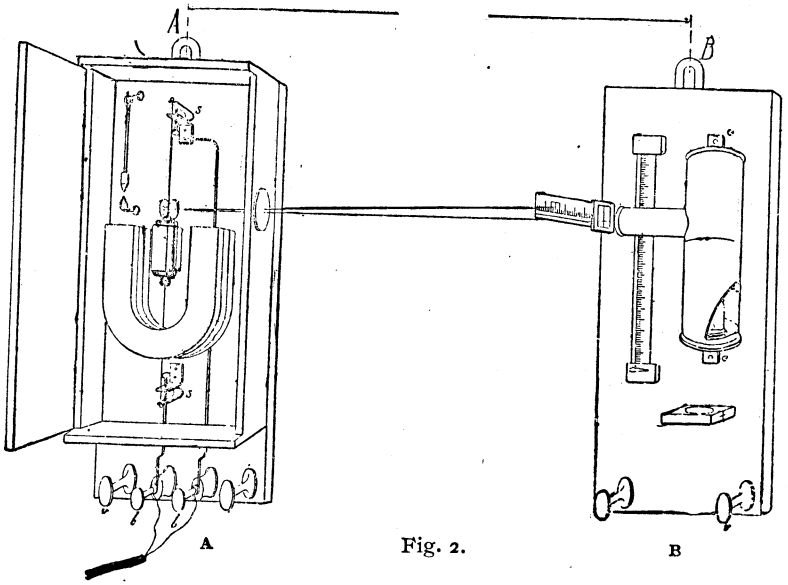


Fig. 2.

Fig 2. shows the two boxes unscrewed from the central slab and placed in their respective positions against the wall.

Box A contains the galvanometer proper, and is also provided with set-screws and a small plumb-bob, so that it may be set vertically.

Box B contains the lamp, having a lens and window with cross hairs for throwing an image upon the galvanometer mirror in box A which in turn reflects it back upon the scale in box B. Box B has also two set-screws for adjusting it vertically. The two boxes are set one meter apart.

The current set up by the thermo-electric couple (no battery is used) enters the galvanometer through the two binding posts, box A, and by deflecting the mirror causes a movement of the ray of light on the scale, box B. This scale is graduated in millimeters, and it is necessary, therefore, that a curve be made reducing these millimeters to degrees Fahrenheit or Centigrade. This curve is very simply made from known melting points given below.

From the above description this pyrometer may seem too scientific an instrument for everyday use, but such is not the case, and we recommend it to all manufacturers using high temperatures, which it is essential to control.

No. 12475. Price, complete $140.00

Water boils, 212° F.	Gold melts, 1,913 F°.
Lead melts, 617° F.	Palladium melts, 2,732 F°.
Zinc melts, 779° F.	Silver melts, 1,775 F°.

Siemens' Water Pyrometer.

No. 12480.

The pyrometer is shown in sections in the accompanying sketches. It consists of a cylindrical copper vessel provided with a handle, and containing a second smaller copper vessel with double walls. An air space (*a*) separates the two vessels, and a layer of felt the two walls of the inner one, in order to retard the exchange of temperature with the surroundings. The inner vessel holds a little over a pint of water. A mercury thermometer (*b*) is fixed close to the wall of the inner vessel, its lower part being protected by a perforated brass tube, whilst the upper projects above the vessel and is divided as usual, on the stem, into degrees, Fahrenheit or Centigrade, as desired. At the side of the thermometer there is a small brass scale (*c*), which slides up and down, and on which the high temperatnres are marked off in the same degrees into which the mercury thermometer is divided; on a level with the zero division of the scale a small pointer is fixed to it, which passes in front of the thermometer.

Short cylinders (*d*), of either copper, iron or platinum, are supplied with the pyrometer, which are so adjusted that their heat capacity at ordinary temperature is equal to one-fiftieth of that of the copper vessel filled with one pint of water. However, as the specific heat of metals increases with the temperature, allowance is made on the brass sliding scales, which are divided according to the metal used for the pyrometer cylinders (*d*). It will therefore be understood that a different sliding scale is required for each kind of metal. In order to obtain accurate measurements, each sliding scale should only be used in conjunction with its own thermometer, and in case the latter breaks, a new scale must be made and graduated for the new thermometer.

The water pyrometer is to be used as follows:

Exactly one pint (0.568 liter) of clean water, preferably distilled or rain water, is poured into the copper vessel, and the Pyrometer is left for a few minutes to allow the thermometer to attain the temperature of the water.

The brass scale (*c*) is then set with its pointer opposite the temperature of the water as shown by the thermometer. Meanwhile, one of the metal cylinders has been exposed to the high temperature which is to be measured, and after allowing sufficient time for it to acquire that temperature, it is rapidly removed and dropped into the pyrometer vessel without splashing any of the water out.

The temperature of the water will now rise, and after an interval the mercury of the thermometer will become stationary. When this is observed, the degree on the thermometer is read off, as well as the division on the brass scale (*c*) opposite the top of the mercury. These two values added together give the temperature of the flue, furnace or other heated space in which the metal cylinder has been placed. With cylinders of copper and iron, temperatures up to 1,800° F. (1,000° C.) can be measured, but with platinum cylinders the limit is 2,700° F. (1,500° C.).

For ordinary furnace work either copper or wrought-iron cylinders may be used. Iron cylinders possess a higher melting point and have less tendency to scale than those of copper, but the latter are much less affected by the corrosive action of the furnace gases; platinum is, of course, not subject to any of these disadvantages.

The weight to which the different metal cylinders are adjusted is as follows:

Copper,	137	grammes.
Wrought iron,	112	"
Platinum,	402.6	"

In course of time the copper cylinders lose weight by scaling; the table which now follows gives for the diminished weights the factor with which the readings on the brass scale have to be multiplied in order to obtain the correct temperature.

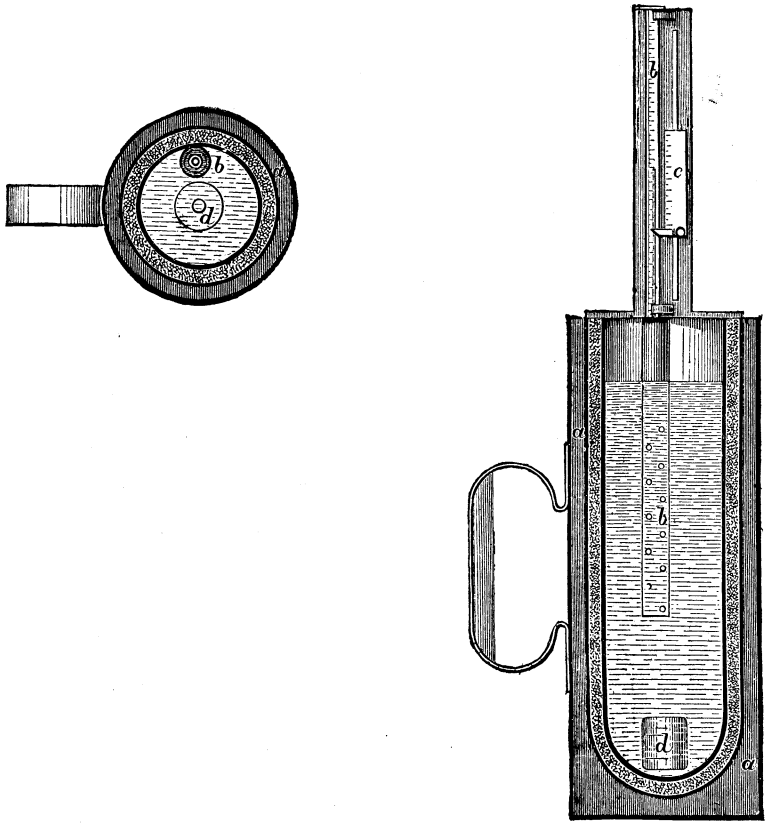


Table of Corrections for the Decrease in Weight of the Copper Cylinders.

Weight of Copper Cylinder in Grammes.	Multiplier for the Indications of the Sliding Scale.	Weight of Copper Cylinder in Grammes.	Multiplier for the Indications of the Sliding Scale.	Weight of Copper Cylinder in Grammes.	Multiplier for the Indications of the Sliding Scale.
137	1.000	131	1.046	125	1.096
136	1.007	130	1.054	124	1.105
135	1.015	129	1.062	123	1.114
134	1.022	128	1.070	122	1.123
133	1.030	127	1.078	121	1.132
132	1.038	126	1.087	120	1.142

12480. Price, complete, with extra thermometer . $50.00.

Mesuré & Nouel's Optical Pyrometer.

No. 12485.

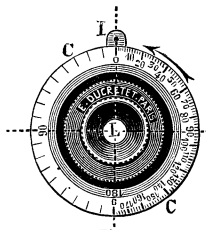


Fig. 2

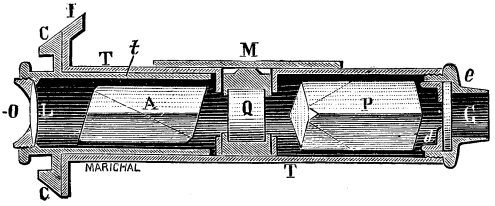


Fig. 1

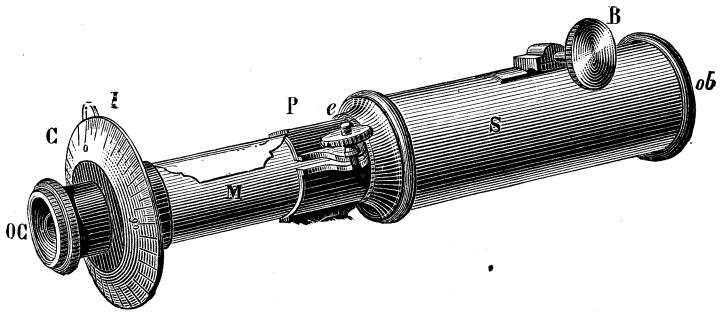


Fig. 2.

DESCRIPTION.

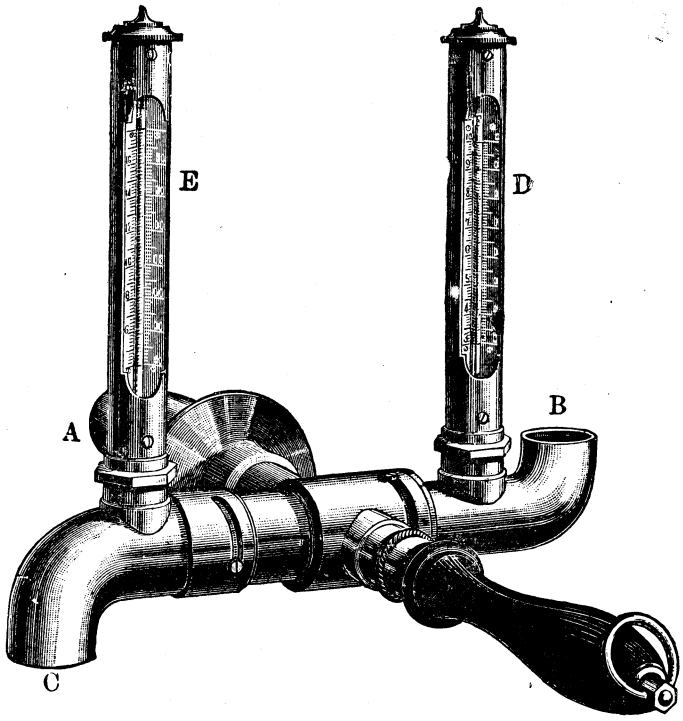
FIG. 1.—Shows the longitudinal view of the instrument.
FIG. 2.—The Eye-piece and the Graduated Scale.

No. 12485. Price, in leather sling case $50.00

It consists essentially of two Nicol Prisms, *p* and *a*, known as the polarizer and analyzer, respectively, between which is placed a quartz plate, *Q*, cut perpendicularly to its axis. The end, *G*, is closed by a parallel glass; at the other end, *O*, is the lens, *L*. *M* is a movable plate to verify the adjustment of the quartz plate or the prisms at any time. *C C* is a graduated disc revolving before the fixed index, *I*, and carrying with it in its motion the prism, *A*. The disc is divided into the degrees of the circle from a zero point. The two prisms are so adjusted that their planes are at an angle of 90° to each other when the zero of the graduated disc is opposite the fixed index, *I*. In this position, the quartz plate being removed, a ray of light passing through the prism, *P*, is polarized and is extinguished in *A*. But as the quartz plate, *Q*, cut perpendicularly to its axis, intercepts the polarized light, the light still remains polarized but proceeds in another plane—*i. e.*, is deflected. The angle between the original plane and the new plane is proportional to the thickness of the quartz plate, and nearly inversely proportional to the wave length. The quartz plate being of constant thickness, we have but two variables to deal with—the angle of deflection and the wave length. We can measure the angle of deflection produced in a ray of light by the quartz plate by simply rotating the second prism, *A*, from zero to the extinction of light. *The wave length is proportional to the intensity of the light, and the intensity is proportional to the temperature at which the light is emitted. The angle of rotation will therefore serve as a measure of the temperature.* The light from an incandescent body above a dark red heat is, however, not homogeneous—that is, as the intensity of the light increases, the more refrangible rays appear, until, with a dazzling white heat, we have the rays corresponding to all the colors of the spectrum. The rotation of the analyzer, *A*, now, instead of extinguishing the light, produces a series of colors varying in intensities. The rotation necessary to produce a given color is, however, proportional to the intensity of the light, and so still serves as a measure of the temperature. The lower the temperature the less angle of rotation.

No. 12490. Pyrometer Cones, Seeger's for use in ceramic industries, set of 20 numbered Cones, ranging from 950° to 2,000° Cent., 2 cts. each

HOBSON'S HOT BLAST PYROMETER.



12495.

The measurement of the hot blast temperature by this instrument is based upon the relative proportions of mixed hot blast and atmospheric air.

It consists of a brass chamber, having three arms and a handle. An opening through a jet in one of the arms admits the hot blast, another arm admits the atmospheric air, while the third arm is for the discharge of the mixed current of hot blast and atmospheric air. To this third arm is attached a thermometer, which indicates, by graduations on the stem, the temperature of the mixed current, and on a metal scale the temperature of the hot blast. A thermometer is also attached to the arm admitting the atmospheric air.

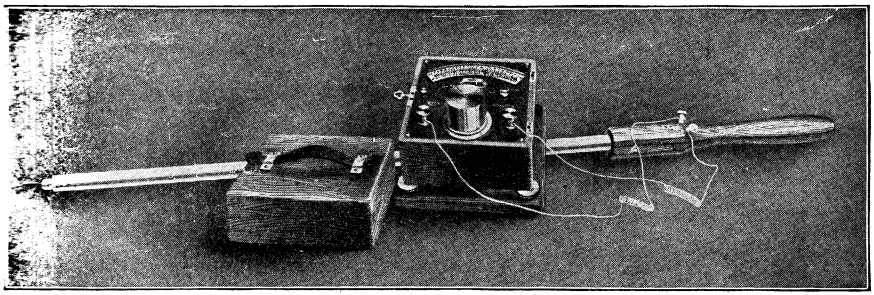
The size of the opening in the arm admitting the hot blast and the area of the air inlet are fixed so that the proportion of hot blast to the atmospheric air is always the same.

It has been found by experiment that the variation in the pressure of the hot blast will cause corresponding variation in the quantity of air induced, so that the indications may be relied upon as correct.

This Pyrometer can be used constantly to 2000° F. without danger of injury to it.

No. 12495. Price, including extra Thermometer, ... $50 00

THE QUEEN ELECTRICAL PYROMETER.



The Queen Electrical Pyrometer involves the same principle as the Le Chatelier Pyrometer; that is the measurement by means of a galvanometer of the current of electricity produced by heating the junction of platinum and platinum-rhodium wires.

The Pyrometer consists of a Galvanometer and the Thermo-electric element.

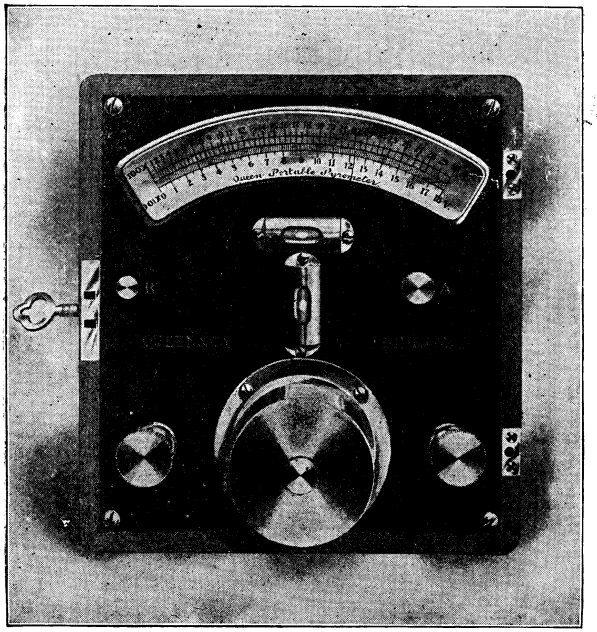
The Galvanometer is a decided improvement over all other forms of galvanometers used for this purpose.

It is small and very portable, and is graduated in either degrees Fahr. or Cent., requiring no calculation or adjustment.

The Thermo-electric element consists of the platinum and platinum-rhodium wires, the outer ends of which are fastened together. The wires pass through a porcelain or iron tube, and are insulated from each other by double-bored porcelain tubes. The other ends of the wires terminate at two binding posts on the wooden handle. Price, complete $140 00

Directions for Using the Pyrometer.

The Galvanometer should be set in some solid position, having as little vibration as possible, and then leveled by means of the two leveling screws and according to the two levels on the face of the Pyrometer.



The hand may now be unclamped by turning the milled nut *A* one or two turns to the left until the hand swings free. The button *B* also clamps the hand when the lid of the box is locked in place, and will be sufficient support for it except when the Pyrometer is subjected to very severe handling.

When the hand is free it should swing to the zero of the scale. If it does not, it can very easily be set by the adjustment on the top of the brass dome.

The Thermo-electric element should be connected with the Pyrometer, as shown in the cut, by connecting the four binding posts by insulated wire, not smaller than No. 14. (B. & S. gauge).

The element may then be put in the furnace and the temperature will be indicated at once on the temperature scale of the Pyrometer.

The element must never be inserted in any molten metal, as it destroys the electro-motive force of the wires.

The advantages of this Pyrometer are manifold. 1st. The quickness with which the instrument may be set up and readings taken, or it may be left permanently in the oven or furnace.

2d. The range of the instrument is from 200 F. to 3,000 F., but is intended specially for the higher ranges.

3d. The accuracy of the Pyrometer is guaranteed. Each element is standardized and the scale is graduated according.

When new elements are furnished, they are accompanied by a standardization curve, so they may be used on the same Pyrometer.

4th. The elements will not be affected by gases nor constant use at high temperatures.

The Queen Clinical Thermometers.

The demand for a good clinical thermometer which, whilst moderate in price, should be accurate in its indications, indestructible in its register, and easily read, has led to the production of the "Queen" Clinical, which is confidently recommended to the Medical Profession.

The advantages of the "QUEEN" Clinical Thermometer are:

The ACCURACY of its indications, each thermometer having been carefully CALIBRATED and compared with the KEW STANDARD, an accompanying CERTIFICATE showing the exact variation in ONE-TENTH OF A DEGREE Fahrenheit.

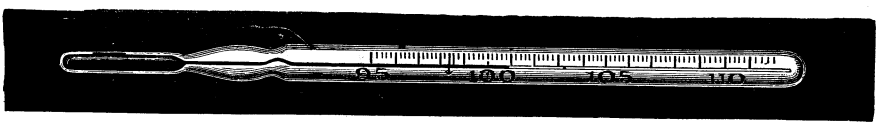
The INDESTRUCTIBLE INDEX. In this form the entire column forms a registering index, which, after a trial, may be shaken below the normal point and again used, all that portion of the mercury which rises above the constriction in the bore remaining up, until shaken back. it thus being impossible to destroy its self-registering property, and the annoyance of losing the register being entirely obviated.

The LENS TUBE, of which the "Queen" Clinicals are made is specially drawn for us by English manufacturers, with a view to the magnifying powers and evenness of the bore. The "Queen" Lens Clinicals magnify the column of mercury at least 6 diameters.

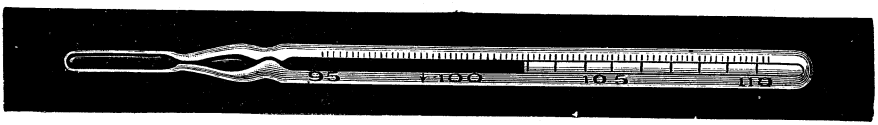
The INDELIBILITY of the graduation, which by the use of a special preparation, retains its distinctness and color.

The SPECIAL GLASS and PROLONGED SEASONING by which change, from age, of the zero point, is prevented.

Each thermometer is accompanied by a certificate.



12500. The "Queen" Clinical Thermometer, Plain front, with certificate . . $1 00



12501. The "Queen" Clinical Thermometer, lens ftont, with certificate . . . $1 25
Gold-Plated Case, with Chain . . . . . $ 50 extra.
Sterling Silver Case, with Chain, plain . . . 1 50
Sterling Silver Case, with Chain, repousse . 2 00

12502. The "Queen" One Minute Clinical Thermometer, lens front, with certificate 1 50

The Queen Hypodermic Syringes.

Our Hypodermic Syringes are all fitted with an oil cup or receptacle between the packing, which is filled with a drop of oil, and will always keep the syringe in fine working order, by preventing the drying up and shrinking of packing. A small screw cap covers the opening of each syringe. They are made of the best seamless material, by the best skilled mechanics, and each syringe is tested and guaranteed by us.

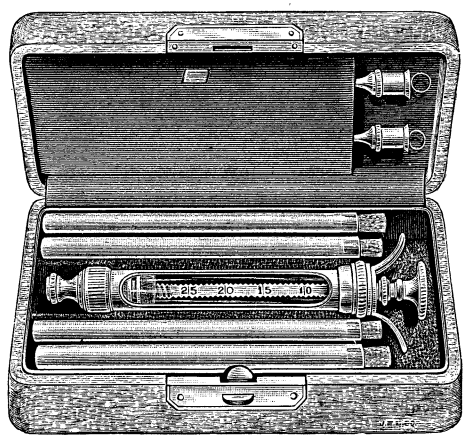
Our syringes are made so that tablets may be dissolved in them by simply unscrewing the cap from needle end.

12515 SYRINGE

has glass barrel protected by fenestrated metal cylinder with finger rests; is graduated on the piston and has two needles, and two vials for tablets. Put up in strong morocco covered case as shown in cut.

12516 SYRINGE

has glass barrel protected by fenestrated metal cylinder with finger rests; is graduated on the piston and has two needles, and four vials for tablets. The case has round corners, chamois skin covering, and is lined with silk and velvet, and is very strong and compact as shown in cut.



No. 12515.	Hypodermic Syringe, price complete	$1 50
" 12516.	" " "	2 00
" 12517.	" " same outfit as No. 12516, but packed in flexible morocco case, price	2 25
" 12518.	Hypodermic Syringe, same as No. 12516, packed in neat aluminium case	3 00
	Extra needles for syringes	35

HYPSOMETRICAL THERMOMETERS.

It is generally assumed that water boils at 212° Fahrenheit, but this is true only at sea-level, under a barometric pressure of 29.922, in latitude 45, at a temperature of 32° Fahrenheit, and with chemically pure water. The boiling-point, therefore, varies with the latitude, the height above sea-level, the pressure of the atmosphere and the temperature. Thus, at Philadelphia, under the mean barometric pressure of that locality, of 29.932 at 32° Fahrenheit, water boils at a temperature of 211.994 Fahrenheit. As there is an evident relation between the boiling-point and the elevation of a place as shown by the decreased barometric pressure as we ascend, it would seem a comparatively simple matter to measure the height of a mountain by the temperature at which the ebullition of water occurs. The barometric pressure, however, for the same place, is continually varying, and with it, the boiling temperature of fluids.

It follows, therefore, that in order to determine elevations with any degree of accuracy, by means of a Boiling-Point Thermometer, it is necessary, in the first place, that the thermometer employed should be accurately graduated and compared with the reading of a standard barometer, reduced for temperature and latitude. It is necessary, also, that observations should be made, with as little interval of time between as possible, at the lower point from which the elevation of the higher point is to be determined, as well as at the higher point itself, and that these observations be repeatedly made.

In relation to the necessity of a thoroughly accurate thermometer, Admiral Fitzroy says, in his "Notes on Meteorology:" "Each degree of the boiling-point thermometer is equivalent to about 550 feet of ascent, or one-tenth to 55 feet; therefore, the smallest error in the graduation of the thermometer itself, will affect the height deduced, materially." Having prepared to make observations with accuracy, it becomes necessary to ascertain the means of deducing the height from the observations made.

The following table gives very nearly the elevations in feet corresponding to a fall of 1°, in the temperature of boiling water:

Ebullition between	Elevation in Feet for each Degree.
214 and 210	520
210 " 200	530
200 " 190	550
190 " 180	570

It is assumed that the boiling-point will be diminished 1° for each 520 feet of ascent, until the temperature becomes 210°, then 530 feet of elevation will lower it one degree until water boils at 200°, and so on, the air being at 32° Fahrenheit. As, according to Regnault, air expands .002036 of its volume at 32° for each degree increase of temperature, it is necessary to find the mean temperature of the air between the two points and apply the correction due to the difference between that and 32°. The formula will then be as follows:

Let H represent the vertical height in feet between the stations; B and b the boiling-points of water at the lower and upper stations respectively; f, the factor found in the above table,

Then $H = f\ (B - b)$.

Let m be the mean temperature of the stratum of air between the stations. Calling the correction due to the mean temperature of air C, its value will be found from the equation

$$C = H\ (m - 32)\ .002036$$

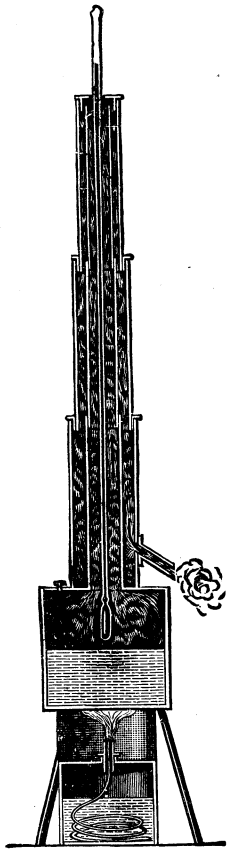
Calling the corrected height H', it will be found from the formula

$$H' = H + H\ (m - 32)\ .002036,$$

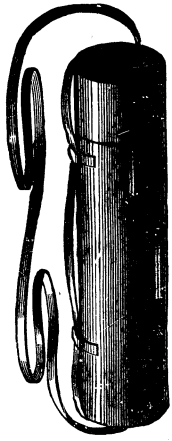
that is, $H' = H\,1 + (m - 32)\ .002036$.

When an accurately made and carefully compared thermometer is used in accordance with the foregoing instructions, very accurate and valuable results may be obtained with the hypsometrical apparatus. But it is manifest that with thermometers as ordinarily made, whose freezing-points have been fixed without regard to the conditions of a true zero, and with observations which leave entirely out of account many of the factors necessary to even approximate correctness, the results obtained must often be of little value.

HYPSOMETRICAL THERMOMETERS.

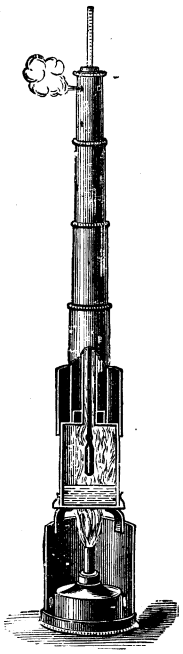


12554.



12554

No.		Price
12554.	WOLLASTON'S BOILING-POINT APPARATUS, with 12-inch thermometer packed in light metallic case, lined with India rubber; copper boiler, with three-draw telescopic chamber and tripod stand. The whole in leather case, with straps, ...	$40 00



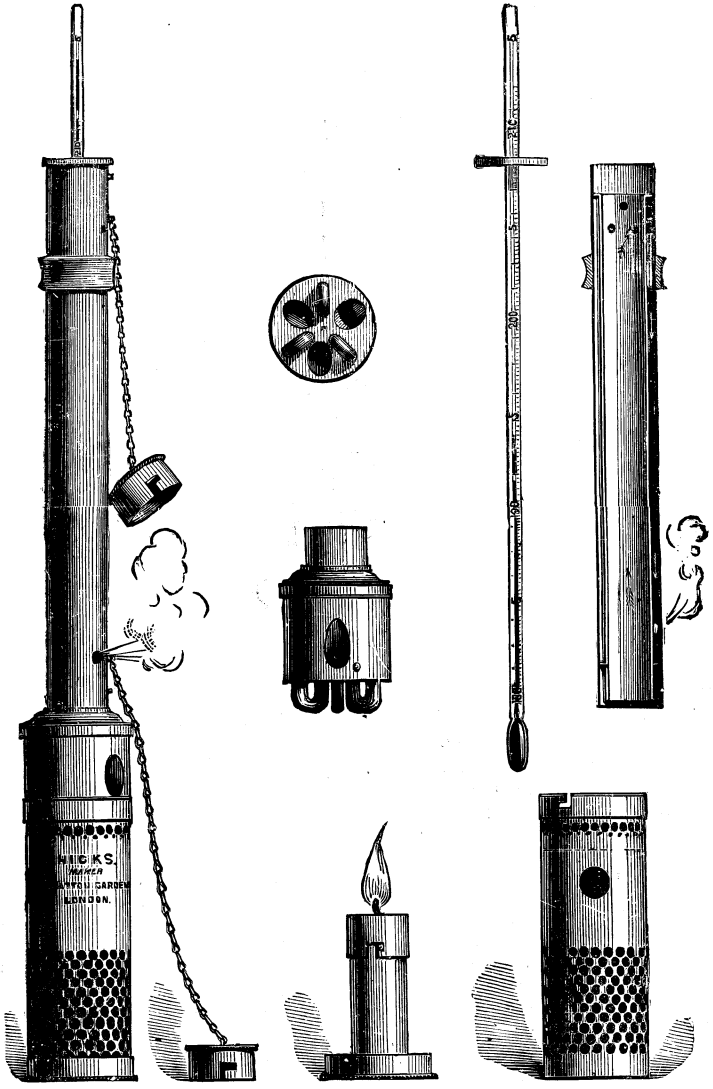
12555.

No. Price

12555. WOLLASTON'S POCKET BOILING-POINT APPARATUS. A more portable form of No. 12554, ... $25 00

WOLLASTON'S BOILING-POINT APPARATUS consists of a delicate thermometer, with engine divided scale, each degree being subdivided to one-tenth. To avoid errors from the cooling influence of atmospheric currents, the thermometer is suspended from an India rubber washer to within an inch and a half of the water inside a double three-draw telescopic chamber, to prevent current of air affecting the temperature, and thus the thermometer is surrounded by the vapor of boiling water only. The steam ascends the inner chamber, escaping by a hole at the top into the outer one, which it descends to reach the open air through the tube at the side. The mercury will soon be seen to ascend, and the division on the stem, at which it becomes stationary, shows the temperature, and a reference to the tables, supplied with each instrument, will give the elevation in feet above sea-level. The temperature of the surrounding air, as indicated by an extra thermometer, should be noted at the time of making the experiment.

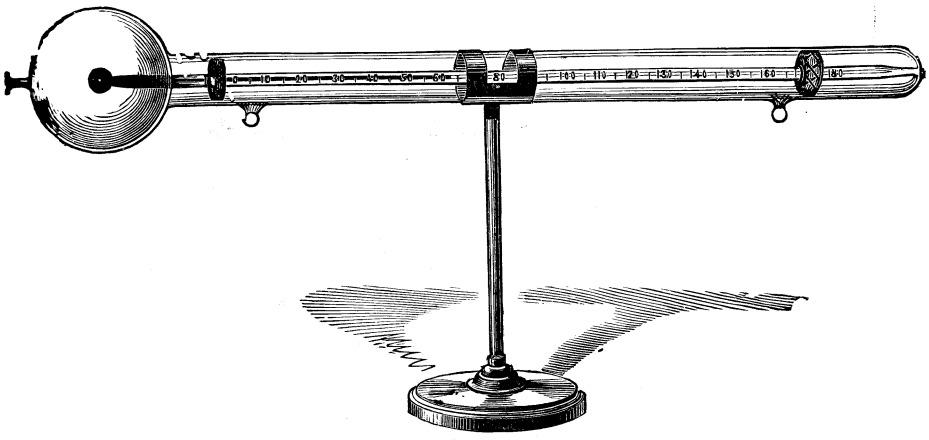
HENDERSON'S BOILING-POINT APPARATUS, while arranged on the general principle of Wollaston's apparatus, possesses the advantage of having a self-registering thermometer, and of dispensing with the use of a spirit lamp, the water being made to boil by the heat of a candle. A measured quantity of water being used—about ½ oz.—very uniform results are obtained. The brass tube forms the case for carrying the instrument.



No.		Price
12556.	HENDERSON'S SELF-REGISTERING BOILING-POINT THERMOMETER, arranged for candle. Complete, ...	$30 00

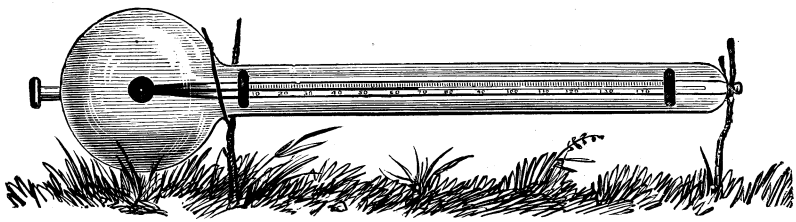
THERMOMETERS FOR SOLAR RADIATION.

Considering the fact that the actuating force of every movement in the physical world is Solar Radiation, that to it is due all the phenomena of rain, of wind, of dew, of ocean currents and of animal and vegetable life, it seems important that some attention be paid to the instruments of precision by which the amount and character of that power is measured. It is evident that observations from Radiation Thermometers, both as respects the direct solar radiation and the radiation from the earth must be of great consequence to meteorologists, and have a very important bearing upon questions of climatology.



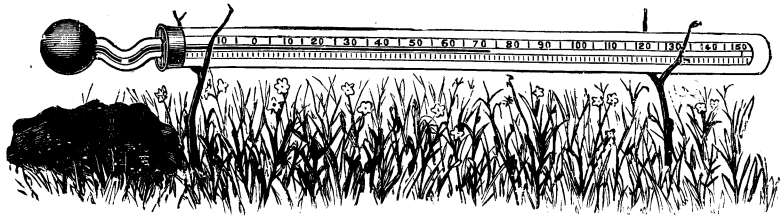
12575.

No.		Price.
12575.	Patent Solar Radiation Thermometer, registering maximum in vacuo; consisting of a self-registering maximum thermometer, inclosed in a glass chamber, exhausted of air, so that it is protected from the loss of heat which would occur if bulb were exposed. The bulb and neck of the tube blackened and the instrument mounted on stand, ...	$10 00



12576.

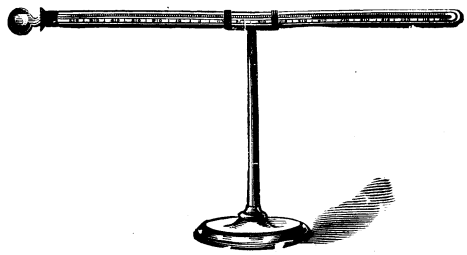
12576.	Solar Radiation Thermometer, registering maximum in vacuo, black bulb and stem. Arranged to be placed on Y's. . . .	$8 00



12577.

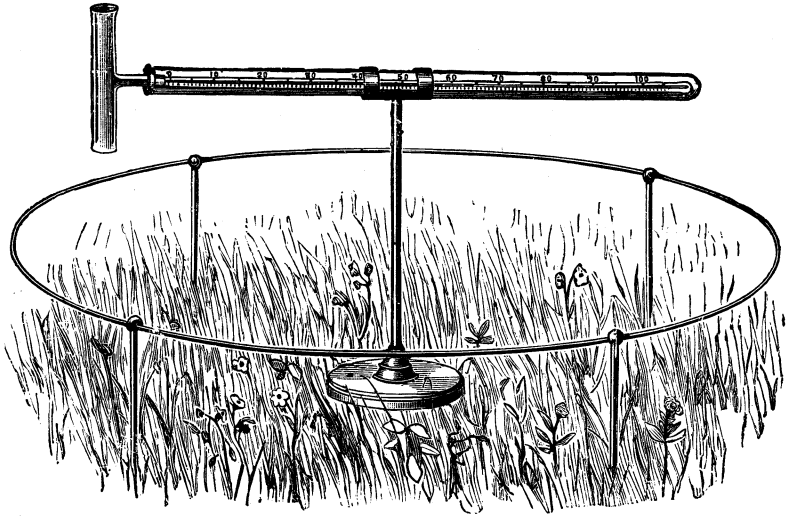
12577. SOLAR RADIATION THERMOMETER, self-registering, black bulb, in open air, ... $5 00

TERRESTRIAL RADIATION THERMOMETERS.



12580.

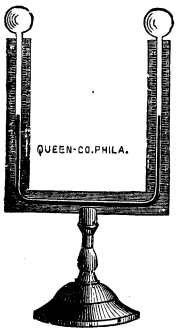
12580. TERRESTIAL MINIMUM THERMOMETER, on stand, for the grass, . 4 50
12581. Do. do. do. do. do. large size, 5 50



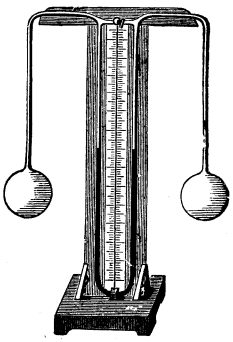
12582.

12582. PATENT CYLINDER JACKET TERRESTRIAL MINIMUM THERMOMETER, on brass stand, ... 8 50

DIFFERENTIAL THERMOMETERS.



12586.



12590.

No.		Price
12588.	Leslie's Differential Thermometer, on stand,	$3 00
12589.	Leslie's Differential Thermometer, with scales on both arms, on mahogany stand, complete,	5 00

The instruments are intended, as the name denotes, to show the *difference* of temperature between two places. They are very useful in making delicate experiments on radiation. They consist of a tube, bent twice at right-angles, terminating in two bulbs, partly filled with colored alcohol, and fixed upon a frame with stand.

12590.	Matthieson's Differential Thermometer, with boxwood scales, on mahogany stand,	10 00

This form of the Differential Thermometer has a short tube connecting the upright tubes near the top, by which the temperature of the two arms is more quickly equalized. The pendant position of the bulbs makes it very convenient for ascertaining the temperature of liquids.

Comparative Thermometers.

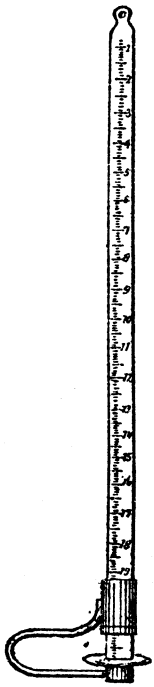
No.		Price.
12525.	Comparative Thermometer, 8 inches long, having the three scales —Centigrade, Réaumur and Fahrenheit	$1 00
12526.	Comparitive Thermometer, 8 inches long, with the three scales —Centrigade, Réaumur and Fahrenheit	2 50

Accurate and highly finished.

PICHÉ EVAPORIMETER.

The Piché Evaporimeter consists of a glass tube ni e inches in length, graduated to show the contents in cubic centimetres and tenths.

It is filled with water (preferably with distilled water) and suspended vertically by the eye at the top, see Fig. On the lower open end of tube is a disk of paper, kept in place by a brass spring, attached to a slitted collar that moves along the tube.



12697

Evaporation takes place from the surface of the paper. The amount, in cubic centimetres, in any time, is givenby the difference in the readings of the top of the column of water at the beginning and end of the time.

The amount of paper surface from which evaporation takes place varies slightly in the different instruments, depending on the diameters of the glass tubes, which vary from 14.0 to 15.5 millimetres. There are about 11 square centimetres of surface exposed.

The evaporation from a paper surface, such as is furnished with these instruments, is about one and one-half times greater than from an equal surface of water contained in a shallow dish.

The object of observations with these instruments is to ascertain the relation between the amount of evaporation and the mean daily temperature and dew-point, as determined by the whirled wet and dry thermometers and the wind velocity.

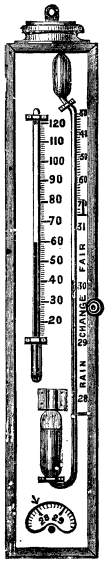
The reading should be made on the lowest part of the meniscus or convexity of the top of water column to the nearest tenth of a cubic centimetre.

A fresh paper disk will be put on every time the water in the tube is renewed. In dry places the tube may require filling every day. The tube should not be filled quite full; enough space should be left to have top of water column read somewhere between 1.0 and 2 0, *c*, *c*.

The instrument should not be exposed during September at places where the temperature is likely to fall below 32°, as the freezing of the water will break the glass.

No.		Price
12697.	Piche Evaporimeter, ...	$5 00

SYMPIESOMETERS.

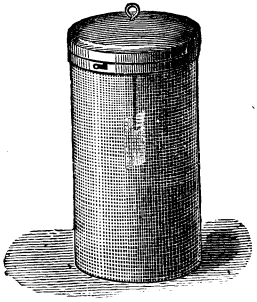


13091.

No.		Price
13090	SYMPIESOMETER, in rosewood or mahogany frame, plate-glass front, registering index,	$25 00
13091.	SYMPIESOMETER, same as 13090, with rack-work motion,	30 00

This instrument is used with Mercurial and Aneroid Barometers for purposes of comparison. To use it, observe the temperature of the attached thermometer, then adjust the metal pointer of the pressure scale, to the same degree as the thermometer at side; the height at which the colored fluid then stands, shows on the sliding scale the atmospheric pressure in inches and tenths of the barometer scale.

OZONOMETERS.



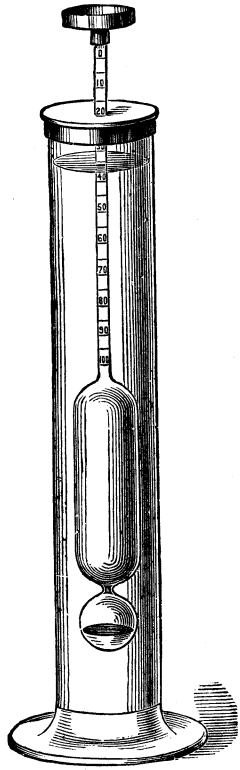
13094.

13092.	SCHOENBEIN'S OZONOMETER—a series of test-papers, inclosed in case, sufficient for 12 months, with set of 12 comparative tints,	4 00

No.		Price
13093.	MOFFAT'S OZONOMETER, test-papers, with 10 comparative tints, .	$4 50
13094.	CLARKE'S OZONE CAGE, in japanned metal, ...	4 50
13095.	CLARKE'S OZONE CAGE, in copper, ...	7 00

The Ozonometer consists of a series of test-papers, which, when freely exposed to the air, and afterwards immersed in water, undergo a discoloration, which, on comparison with a scale of tints, determines the amount of ozone in the atmosphere. An ozone cage is necessary to secure the proper exposure to the air and protection from sun and rain.

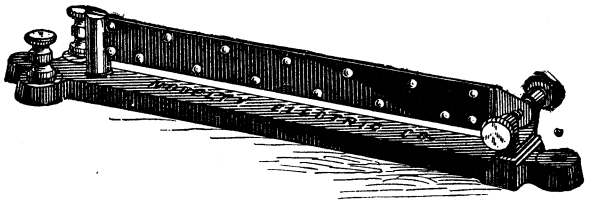
BABINGTON'S ATMIDOMETER.



13096.

13096. BABINGTON'S ATMIDOMETER, for measuring the rate of evaporation from water, ice or snow, ... 24 50

This instrument resembles a hydrometer, the stem, however, being surmounted by a light copper pan and graduated to grains and half-grains. In use, the Atmidometer is immersed in water in a glass vessel having a hole in the cover through which the stem protrudes. The copper pan is then placed on top, and sufficient water, ice, or snow, placed therein to sink the stem to the zero of the scale. As the evaporation proceeds the scale rises, showing the amount of evaporation in grains.



12537.

ELECTRIC THERMOMETERS.

No.		Price.
12530.	ELECTRIC THERMOMETER, with single tube, platinum wires and binding screws, divided and figured on boxwood scales, 7 inches,	$4 50
12531.	Do. do. do. 9 do.	5 00
12532.	ELECTRIC THERMOMETER, with double tubes, platinum wires and binding screws, for registering heat and cold, . . 7 inches,	6 50
12533.	Do. do. do. 9 do.	7 50
12534.	ELECTRIC THERMOMETER, single tube, in porcelain scale, divided to 500° Fahrenheit, for ovens, etc., ... 7 inches,	7 50
12535.	Do. do. do. 9 do.	9 00

These thermometers are arranged with platinum wires, so that the mercury, on reaching a given temperature, makes connection with and starts an alarm. They may be made extremely useful in manufactories, malt-houses, drying-rooms and places of the kind. To the nurseryman, who passes our severe winters in constant apprehension of danger to his plants, they are of great value. For his use they are arranged to make electrical connection at 50°, 45°, 40°, or whatever temperature is desired, with a wire which may pass into the sleeping room of the gardener, where an alarm bell is rung. The arrangement is extremely simple, requiring no special skill to manage, and not at all liable to get out of order.

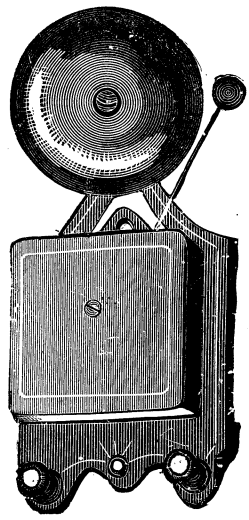
ELECTRIC THERMOSTAT.

The Electric Thermostat is handsome in appearance and reliable in action, has double contact, can be set at high and low temperature, and will ring a signal bell when temperature reaches either point. In this connection it is very valuable for use in green-houses, incubators, or in any position where such a tell tale is needed

12537. ELECTRIC THERMOSTAT. Price, each $2 25

NEW ELECTRIC THERMOMETER.

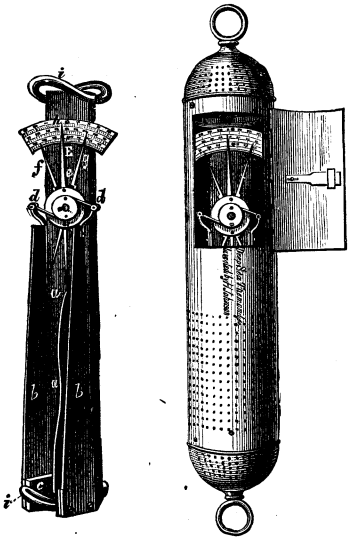
This is the only electrical thermometer which will give an alarm at different points above the normal temperature. The contact points are made above and below a contraction in the tube near to the bulb. To set the thermometer, heat it to the degree at which the alarm is desired to be given, the mercury above the construction will remain up the same as in the ordinany maximum Registering Thermometer, while that portion below the constriction will recede again into the bulb. When the proper temperature is reached, when it will join the rest of the column, thereby closing the circuit. To reset it, unhook the wires and shake the column down in the same manner as an ordinary maximum thermometer.



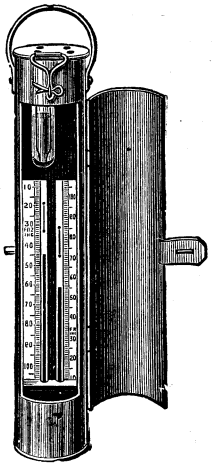
12540.

12538.	NEW ELECTRIC THERMOMETER, ...	$7 50
12540.	ELECTRIC VIBRATING BELL, 2½ inches, ...	1 50
12541.	LE CLANCHE PRISM BATTERY, complete, ...	1 20
	Wires for connecting bell with battery and thermometer, No. 18, sotton covered, ... per lb.	34cts.

Deep-Sea Thermometers.



12552.



12550.

No.		Price.
12550.	Deep-Sea Maximum and Minimum Thermometer; Sixe's principle, in ebonite mounting, divisions and figures on German silver raised scale at side, acting also as a protection to the thermometer, in round copper case, with hinged door and clasps	$20 00
12551.	Sixe's Thermometer, for Deep-Sea, 12 inches, on metal or porcelain scale in round copper case, with door and ring at bottom for weight, with valves	17 50

Thermometers for ascertaining the temperature of the sea's depths are made to register the maximum or minimum temperature, or both, and are usually constructed on the principle of Sixe's Thermometer, which is the only thermometer registering both extremes, in a vertical position. The pressure of the ocean depths being enormous—at a depth of two to three miles it being equal to about three tons to the square inch; "or, in sea water of sp. gr. 1.027, the pressure, in descending, increases at the rate of 280 pounds upon the square inch for every 100 fathoms, or exactly one ton for every 800 fathoms;" it was found that the resulting error in thermometric indications was very great. At a pressure equal to 2,500 fathoms equal three tons per square inch, the error equaled 12° to 13° Fahr. in excess with the deep-sea thermometer, while with ordinary self-registering thermometers, the error reached the extraordinary amount of 70° Fahr. in excess. To remedy this, Dr. Miller suggested an effective improvement, which is now universally adopted. Deep Sea Thermometers, as now made (No. 12550), are constructed on the Sixe principle, but with a shorter elongated bulb, which is incased in an outer bulb nearly filled with spirits, by which the pressure is resisted, the changes in temperature rapidly transmitted, and the whole instrument made stronger.

12552. Johnson's Metallic Deep-Sea Thermometer. $60 00

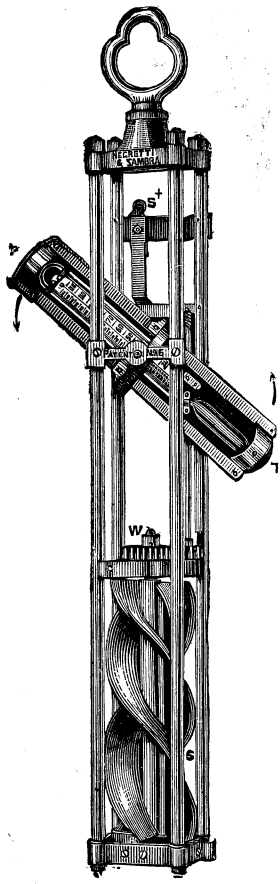
This instrument, which is altogether free from liability to error from compression by the surrounding water, though not quite so sensitive as the mercurial thermometer, depends for its indications upon the contraction and expansion of compound metallic bars.

It consists of strips of brass and steel, of the respective specific gravity of 8.39 and 7.81, riveted together, and by their unequal expansion, moving a pointer over a graduated arc.

Patent Deep-Sea Thermometer.

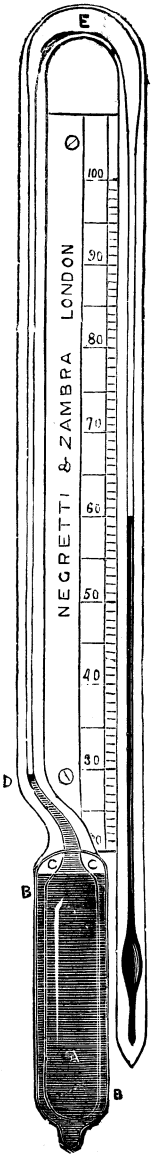
This ingenious instrument has no indices or springs, and its indications are by the column of mercury only. The bulb is protected as suggested by Dr. Miller, and the tube is in shape like a syphon, with parallel legs, and has a continuous communication, as shown in cut. The scale is pivoted on a centre, and is attached, in a perpendicular position, to a simple apparatus. In its descent the thermometer acts as an ordinary instrument; but so soon as the descent ceases, and a reverse motion is given to the line, the instrument turns once on its centre, first bulb uppermost and then bulb downwards. Fig 2 shows the portion of the mercury after the instrument has been thus turned on its centre. A is the bulb; B the outer coating or protecting cylinder; C is the space of rarified air, which is reduced, if the outer casing be compressed; D is a small glass plug, which insures that none but the mercury in the tube can be transferred to the indicating column; E is an enlargement made in the bend, to enable the mercury to pass quickly from one tube to another in revolving; and F is the indicating tube or thermometer proper. When the thermometer is put in motion, and immediately the tube has acquired a slightly oblique position (Fig. 1), the mercury breaks off at the point D, runs into the large and curved portion E, and eventually falls into the tube F, when the tube resumes its original position. The contrivance for turning the thermometer over at the bottom of the sea is a vertical propeller G (Fig. 1), to which the instrument is pivoted. The engraving shows the general arrangement. T being the thermometer, S a metal screw connected with the frame of the thermometer by a wheel and pinion movement at A; S* is a stop for arresting the movement of the thermometer when it has made one revolution.

FIG. 1



12553.

FIG. 2



12553.

HYGROMETERS.

There are various forms of Hygrometers used in ascertaining the amount of moisture in the atmosphere, which may be accomplished by observations based upon either the absorption of moisture, its condensation or its evaporation. On the first-named principle are Saussure's Hair Hygrometer (still employed in the shape of the instrument called a Damp Detector), and the various forms of Catgut, Seaweed and Grass Hygrometers, which are now rather curious toys than scientific instruments. To the second class belong Regnault's and Daniell's Hygrometers, which give very valuable results by direct observation, and in the third class are Leslie's Hygrometer, August's Psychrometer, and that modification of the latter, now so universally used, known as MASON'S HYGROMETER.

The Hygrometer is of infinite value for many purposes. In the sick chamber its use is evident, as by its aid, any kind of climate can be artificially produced, and that degree of dryness or humidity necessary for the health of the patient, obtained with ease. Hygrometrical observations are most valuable supplements to those of the barometer in meteorology. The relation of the hygrometer reading to that of the barometer will determine whether wind or rain is to be expected, while in climatology, the hygrometer is the exponent of all the differences of vegetable and climatological conditions. In many branches of manufacture the hygrometer will be found of great service, as in cotton carding, where it is important that the atmosphere be kept in an equable condition, cotton absorbing about five per cent. of its own weight when the air is very damp. In drying rooms the relative drying value of hot air currents of different pressures may be readily determined with the hygrometer; and in regulating the hygrometrical state of the air in warehouses, malting-houses, hot-houses, green-houses and in the laboratory it will be found most useful.

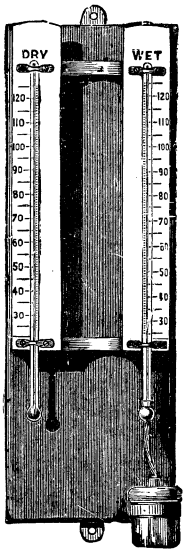
MASON'S HYGROMETER.

This is much the most convenient and satisfactory instrument for practical use. It consists of two thermometers, as nearly as possible alike, mounted parallel upon a frame and marked respectively "wet" and "dry." The bulb of the one marked *wet* is covered with thin muslin or silk, and kept moist from a fountain which is usually attached. The principle of its action is, that unless the air is saturated with moisture, evaporation is continually going on. And as no evaporation can take place without an expenditure of heat, the temperature of the wet bulb thermometer, under the evaporation from the moistened bulb, falls until a certain point is reached, intermediate between the dew-point and the temperature of the air, as shown by the dry bulb thermometer. To find the dew-point, the absolute dryness, and the weight in grains of a cubic foot of air, tables have been constructed empirically from experiments at Greenwich, combined with Regnault's tables of Vapor Tension.

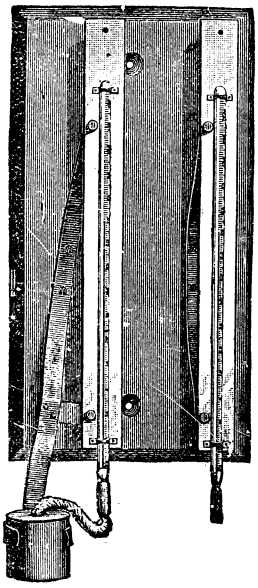
TO USE MASON'S HYGROMETER.

If the air be very dry, the difference between the two thermometers will be great; if moist, less in proportion, and when fully saturated, both will be alike. For different purposes, different degrees of humidity are required, and even in household use, that hygrometrical condition of the atmosphere most beneficial to one person, may frequently be found altogether unsuitable for another. "Dry" bulb 70° and "wet" bulb 62° to 64° indicate average healthful hygrometrical conditions: any other relative condition required may easily be found by experiment, and then, dispensing with calculations, or reference to tables, it is only necessary to see that the two thermometers stand in the required relation to each other.

MASON'S HYGROMETERS.



12600.



12611.

No.		Price
12600.	MASON'S HYGROMETER, walnut frame, with metal scales,	$2 00
12601.	MASON'S HYGROMETER, boxwood frame, polished front and bevelled edges, with fountain in centre,	4 50
12602.	MASON'S HYGROMETER, boxwood scales, in white japanned metal case,	6 75
12603.	MASON'S HYGROMETER, incorrodible porcelain scale, in japanned metal case,	8 00
12604.	MASON'S HYGROMETER, opal glass scale, in white japanned metal case,	8 00
12608.	PATENT HYGRODIKE, on the principle of Mason's Hygrometer, but arranged with dial and pointer so that the absolute and relative dryness and the dew-point may be read off without calculation,	15 00
12611.	U. S. WEATHER BUREAU HYGROMETER, consisting of two aluminium scale thermometers (12190), complete on wooden back,	6 00
12615.	U. S. WEATHER BUREAU WHIRLING APPARATUS, for giving the thermometer in 12611 a more perfect exposure to the air, price without thermometers	18 00
12616.	U. S. WEATHER BUREAU SLING PSYCHROMETER	6 50

Full instructions with tables will be furnished with each instrument.

Air Temperatures.	Difference Between the Dry and Wet Thermometers.																																		Air Temperatures.
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
30	100	89	78	67	57	47	36	26	17	7																												30
35	100	91	82	73	65	54	45	37	28	19	12	3																										35
40	100	92	84	76	68	60	53	45	38	30	22	16	8	1																								40
45	100	92	85	78	71	64	58	51	44	38	32	25	19	13	7	1																						45
50	100	93	87	80	74	67	61	55	50	44	38	33	27	22	16	11	6	1																				50
55	100	94	88	82	76	70	65	59	54	49	43	39	34	29	24	19	16	10	6	1																		55
60	100	94	89	84	78	73	68	63	58	53	48	44	39	34	30	26	22	18	14	10	6	2																60
65	100	95	90	85	80	75	70	65	61	56	52	48	44	39	35	31	28	24	20	17	13	10	6	3														65
70	100	95	90	86	81	77	72	68	64	60	55	52	48	44	40	36	33	29	26	23	19	16	13	10	7	4	1											70
75	100	95	91	87	82	78	74	70	66	62	58	55	51	47	44	40	37	34	31	27	24	21	19	16	13	10	7	5	2									75
80	100	96	92	87	83	79	75	72	68	64	61	57	54	51	47	44	41	38	35	32	29	26	23	20	18	15	13	10	8	6	3	1						80
85	100	96	92	88	84	80	77	73	70	66	63	60	56	53	50	47	44	41	38	36	33	30	28	25	22	20	17	15	13	11	9	6	4	2				85
90	100	96	92	88	85	81	78	75	71	68	65	62	59	56	53	50	47	44	41	39	36	34	32	29	26	24	22	20	17	15	13	11	9	7	5	3	2	90
95	100	96	93	89	86	82	79	76	72	69	66	63	60	58	55	52	49	47	44	42	39	37	35	32	30	28	25	23	21	19	17	15	13	11	10	8	6	95
100	100	97	93	90	86	83	80	77	74	71	68	65	62	59	57	54	51	49	47	44	42	39	37	35	33	31	29	27	25	23	21	19	17	15	14	12	10	100
105	100	97	93	90	87	84	81	78	75	72	69	66	64	61	58	56	53	51	49	46	44	42	40	38	35	33	31	30	28	26	24	22	20	19	17	15	14	105
110	100	97	94	90	87	84	81	78	76	73	70	67	65	62	60	57	55	53	50	48	46	44	42	40	38	36	34	32	30	28	27	25	23	22	20	19	17	110
115	100	97	94	91	88	85	82	79	76	74	71	69	66	64	61	59	57	54	52	50	48	46	44	42	40	38	36	34	33	31	29	28	26	24	23	21	20	115
120	100	97	94	91	88	85	83	80	77	75	72	70	67	65	62	60	58	56	54	51	49	47	45	44	42	40	38	36	35	33	31	30	28	27	25	24	22	120
125	100	97	94	91	88	86	83	80	78	75	73	70	68	66	64	62	59	57	55	53	51	49	47	45	43	42	40	38	37	35	33	32	30	29	27	26	24	125
130	100	97	94	91	89	86	83	81	78	76	74	71	69	67	65	62	60	58	56	54	52	50	49	47	45	43	42	40	38	37	35	33	32	31	29	28	27	130
135	100	97	94	92	89	86	84	81	79	77	74	72	70	68	65	63	61	59	57	55	53	51	50	48	46	45	43	41	40	38	37	35	34	32	31	30	28	135
140	100	97	95	92	89	87	84	82	79	77	75	73	71	68	66	64	62	60	58	56	55	53	51	49	48	46	44	43	41	40	38	37	35	34	33	31	30	140
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	

TABLES FOR THE USE OF MASON'S HYGROMETER.

TABLE OF DEGREES.

Mason's Hygrometer.	Degrees+excess x 2=absolute Dryness.		Leslie's Hygrometer compared with Mason's.	Mason's Hygrometer.	Degrees+excess x 2=absolute Dryness.		Leslie's Hygrometer compared with Mason's.
Degrees of Dryness Observed.	Excess of Dryness to be added.	Absolute Dryness existing.		Degrees of Dryness Observed.	Excess of Dryness to be added.	Absolute Dryness existing.	
0	0.0	0.0	0	11.5	1.9165	26.833	69
0.5	0.083	1.166	3	12	2.000	28.0	72
1	0.166	2.332	6	12.5	2.083	29.166	75
1.5	0.2495	3.499	9	13	2.166	30.332	78
2	0.333	4.666	12	13.5	2.2495	31.499	81
2.5	0.4165	5.833	15	14	2.333	32.666	84
3	0 300	7.0	18	14.5	2 4165	33.833	87
3.5	0.583	8.166	21	15	2.500	35.0	90
4	0.666	9.332	24	15.5	2 583	36.166	93
4.5	0.7495	10.499	27	16	2.666	37.332	96
5	0.833	11.666	30	16.5	2.7495	38.499	99
5.5	0.9165	12.833	33	17	2.833	39.666	102
6	1.000	14.0	36	17.5	2.9165	40.833	105
6.5	1.083	15.166	39	18	3.000	42.0	108
7	1.166	16.332	42	18.5	3.083	43.166	111
7.5	1.2495	17.499	45	19	3.166	44.332	114
8	1.333	18.666	48	19.5	3.2495	45.499	117
8.5	1.4165	19.833	51	20	3.333	46.666	120
9	1.500	21.0	54	20.5	3.4165	47.833	123
9.5	1.583	22.166	57	21	3.500	49.0	126
10	1.666	23.332	60	21.5	3.583	50.166	129
10.5	1.7495	24 499	63	22	3 666	51.332	132
11	1.833	25.666	66	22.5	3.7495	52.499	135

By the TABLE OF DEGREES is shown, *without calculation*, the Absolute Dryness of the Atmosphere, in Degrees of Fahrenheit's Thermometer.

Observe the NUMBER OF DEGREES THE TWO THERMOMETERS DIFFER, which are here called "Degrees of Dryness Observed," and found IN THE FIRST COLUMN of the table.

The *Second Column* merely contains the Figures which have been added to the Degrees of Dryness in the *First*, and multiplied by 2, to obtain THE ANSWER PUT DOWN IN THE THIRD COLUMN.

EXAMPLE.—Temperature of the Air 57, wet bulb 54=3 degrees of dryness observed; then add 0.5 excess of dryness=3.5 and multiply by 2, which will give 7 degrees of absolute dryness existing.

To find the Dew-point—Subtract the Absolute Dryness from the Temperature of the Air. Example. 57—7=50 Dew-point.

To find the actual quantity of Vapor by weight in the Atmosphere—Proceed as directed in the TABLE OF QUALITY.

The comparison of Mason's with the *Dew-point Hygrometer, and of Sir John Leslie's, will be seen in the same line of the 1st, 3d and 4th columns of the Table.

* Professor Daniel's Hygrometer is egistered by the 3d column.

To Find the Quantity of Vapor by Weight Existing in the Atmosphere.

PROBLEM.—The Temperature of the Atmosphere in the shade, and of the *Dew-point* being given, to find the quantity of vapor in a cubic foot of air.

If the Temperature of the Air and the *Dew-point* correspond, which is the case when both thermometers are alike, and the air consequently saturated with moisture, then in the *table of quantity* opposite to the temperature, will be found the corresponding weight of a cubic foot of vapor expressed in grains.

EXAMPLE.—Let the Temperature of the Air be 70° Fahr., and the *Dew-point* the same. Then opposite the temperature you have the weight of a cubic foot of vapor—8,392 grains.

But if the Temperature of the Air be different from the *Dew-point*, a correction is necessary to find the exact weight.

EXAMPLE.—Suppose the *Dew-point* be 70° Fahr., as before, but the Temperature of the Air in the shade be 80°, then the vapor has suffered an expansion due to an excess of 10°, which requires a correction.

We find in the *table of corrections* for 10° is 1.0208.

Then divide 8.392 grains at the *Dew-point*, viz., 70° by the correction, corresponding to the degrees of Absolute Dryness, viz., 10°, and you have the actual weight of vapor existing.

EXAMPLE.——— $\frac{8.3920}{1.0208}$ = 8.221 grains existing, which subtracted from the weight of vapor,

corresponding to the temperature of 80° Fahr., gives the number of grains required for saturation at that temperature.

EXAMPLE.—11.333 grains at the temperature of 80° Fahr.
8.221 grains contained in the air.

3.112 grains required for saturation.

To find the relations of these conditions on the natural scale of humidity [complete saturation being 1.000], divide the weight of vapor at the *Dew-point* by the weight at the temperature of the air, the quotient gives the parts of 1.000 the degrees of saturation.

EXAMPLE.——— $\frac{\text{8.392 grains at the } \textit{Dew-point}\text{—70°}}{\text{11.333 grains at the temp. of the air 80°}}$ =7.40 degrees of humidity, saturation being 1.000.

The principles of these calculations will be found in Professor Daniel's Meteorological Essays; in Mr. Anderson's Essays on Hygrometry; in the Edinburgh Encyclopædia, vol. XI, and in the Edinburgh Journal of Science, vol. VII, page 43, in an excellent article on the Dew-point Hygrometer, by Mr. Foggo, from which the table of corrections has been partly subtracted. The Table of Quantity by Weight has been taken from Professor Daniel's Work on Meteorology, to which the reader is referred for further particulars.

TABLE OF QUANTITY,

Showing the Weight, in Grains, of a Cubic Foot of Vapor, at Different Temperatures from 0 to 95° Fahrenheit.

Temp.	Weight in Grains.	Temp.	Weight in Grains.	Temp	Weight in Grains.	Temp.	Weight in Grains.
0	0.856	24	1.961	48	4.279	72	8.924
1	0.892	25	2.028	49	4.407	73	9.199
2	0.928	26	2.096	50	4 535	74	9.484
3	0.963	27	2 163	51	4.684	75	9.780
4	0.999	28	2.229	52	4.832	76	10.107
5	1.034	29	2.295	53	5.003	77	10.387
6	1.069	30	2.361	54	5 173	78	10.699
7	1.104	31	2.451	55	5.342	79	11.016
8	1.139	32	2.539	56	5.511	80	11.333
9	1.173	33	2.630	57	5.679	81	11.665
10	1.208	34	2 717	58	5.868	82	12.005
11	1.254	35	2.805	59	6.046	83	12.354
12	1.308	36	2.892	60	6.222	84	12.713
13	1.359	37	2.979	61	6.399	85	13.081
14	1.405	38	3.066	62	6.575	86	13.458
15	1.451	39	3.153	63	6 794	87	13.877
16	1 497	40	3.239	64	7.013	88	14.230
17	1.541	41	3.371	65	7.230	89	14.613
18	1 586	42	3.502	66	7.447	90	15.005
19	1.631	43	3.633	67	7.662	91	15.432
20	1.688	44	3.763	68	7.899	92	15.786
21	1.757	45	3.893	69	8.135	93	16.186
22	1.825	46	4.022	70	8.392	94	16.593
23	1.893	47	4.151	71	8.658	95	17.009

TABLE OF CORRECTIONS,

To be Used when the Term of Deposition, or Dew-Point, differs from the Temperature of the Air in the Shade.

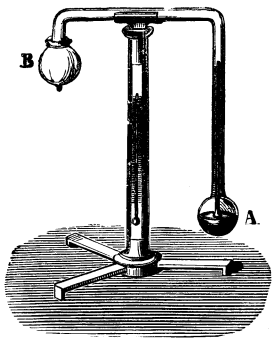
Diff. of Temp.	Correction.	Diff. of Temp.	Correction.	Diff. of Temp.	Correction.	Diff. of Temp.	Correction.
0	0.0000	13	1.0271	26	1.0542	39	1.0813
1	1.0020	14	1.0291	27	1.0562	40	1.0834
2	1.0041	15	1.0312	28	1.0583	41	1.0854
3	1.0062	16	1.0333	29	1.0604	42	1.0875
4	1.0083	17	1.0354	30	1.0625	43	1.0896
5	1.0104	18	1.0375	31	1.0646	44	1.0917
6	1.0125	19	1.0396	32	1.0667	45	1.0937
7	1.0146	20	1.0417	33	1.0687	46	1.0958
8	1.0167	21	1.0437	34	1.0708	47	1.0979
9	1.0187	22	1.0458	35	1.0729	48	1.1000
10	1.0208	23	1.0479	36	1.0750	49	1.1021
11	1.0229	24	1.0500	37	1.0771	50	1.1042
12	1.0250	25	1.0521	38	1.0792	51	1.1062
...	.....	...	... ...	...	.....	52	1.1083

RULE.—To find the weight of moisture in a cubic foot of air at any time. Divide the *Weight in Grains* found opposite to the *Temperature*, corresponding to the Dew-point at the time, in the *Table of Quantity*, by the *Correction* found opposite to *Difference of Temperature* in Table of Corrections, corresponding to the absolute dryness existing at the time.

MARRIOTT'S WET AND DRY BULB HYGROMETER TABLE.

Reading of Thermometer.	Difference between Dry and Wet Thermometers.														
	1°0	2°0	3°0	4°0	5°0	6°0	7°0	8°0	9°0	10°0	11°0	12°0	13°0	14°0	15°0
	Amount to be subtracted from the Wet Thermometers to obtain the Dew-Point.														
30°	3°2	6°3	9°5	12°6	15°8	18°9	22°1	25°2	28°4	31°5	34°7	37°8	41°0	44°1	47°3
31	2·7	5·4	8·1	10·8	13·5	16·2	18·9	21·6	24·3	27·0	29·7	32·4	35·1	37·8	40·5
32	2·3	4·6	7·0	9·3	11.6	13·9	16·2	18·6	20·9	23·2	25·5	27·8	30·2	32·5	34·8
33	2·0	4·0	6·0	8·0	10·0	12·1	14·1	16·1	18·1	20·1	22·1	24·1	26·1	28·1	30·2
34	1·8	3·5	5·3	7·1	8·9	10·6	12·4	14·2	15·9	17·7	19·5	21·2	23·0	24·8	26·6
35	1·6	3·2	4·8	6·4	8·0	9·6	11·2	12·8	14·4	16·0	17·6	19·2	20·8	22·4	24·0
36	1·5	3·0	4·5	6·0	7·5	9·0	10·5	12·0	13·5	15·0	16·5	18·0	19·5	21·0	22·5
37	1·4	2·8	4·3	5·7	7·1	8·5	9·9	11·4	12·8	14·2	15·6	17·0	18·5	19·9	21·3
38	1·4	2·7	4·1	5·4	6·8	8·2	9·5	10·9	12·2	13·6	15·0	16·3	17·7	19·0	20·4
39	1·3	2·6	4·0	5·3	6·6	7·9	9·2	10·6	11·9	13·2	14·5	15·8	17·2	18·5	19·8
40	1·3	2·6	3·9	5·2	6·5	7·7	9·0	10·3	11·6	12·9	14·2	15·5	16·8	18·1	19·4
41	1·3	2·5	3·8	5·0	6·3	7·6	8·8	10·1	11·3	12·6	13·9	15·1	16·4	17·6	18·9
42	1·2	2·5	3·7	4·9	6·2	7·4	8·6	9·8	11·1	12·3	13·5	14·8	16·0	17·2	18·5
43	1·2	2·4	3·6	4·8	6·0	7·2	8·4	9·6	10·8	12·0	13·2	14·4	15·6	16·8	18·0
44	1·2	2·4	3·5	4·7	5·9	7·1	8·3	9·4	10·6	11·8	13·0	14·2	15·3	16·5	17·7
45	1·2	2·3	3·5	4·6	5·8	7·0	8·1	9·3	10·4	11·6	12·8	13·9	15·1	16·2	17·4
46	1·1	2·3	3.4	4·6	5·7	6·8	8·0	9·1	10·3	11·4	12·5	13·7	14·8	16·0	17·1
47	1·1	2·2	3.4	4·5	5·6	6·7	7·8	9·0	10·1	11·2	12·3	13·4	14·6	15·7	16·8
48	1·1	2·2	3.3	4·4	5·5	6·6	7·7	8·8	9·9	11·0	12·1	13·2	14·3	15·4	16·5
49	1·1	2·2	3.2	4·3	5·4	6·5	7·6	8·6	9·7	10·8	11·9	13·0	14·0	15·1	16·2
50	1·1	2·1	3·2	4·2	5·3	6·4	7·4	8·5	9·5	10·6	11·7	12·7	13·8	14·8	15·9
51	1·0	2·1	3·1	4·2	5·2	6·2	7·3	8·3	9·4	10·4	11·4	12·5	13·5	14·6	15·6
52	1·0	2·0	3·1	4·1	5·1	6·1	7·1	8·2	9·2	10·2	11·2	12·2	13·3	14·3	15·3
53	1·0	2·0	3·0	4·0	5·0	6·0	7·0	8·0	9·0	10·0	11·0	12·0	13·0	14·0	15·0
54	1·0	2·0	2·9	3·9	4·9	5·9	6·9	7 8	8·8	9·8	10·8	11·8	12·7	13·7	14·7
55	1·0	1·9	2·9	3·8	4·8	5·8	6·7	7·7	8·6	9·6	10·6	11·5	12·5	13·4	14 4
56	0·9	1·9	2·8	3·8	4·7	5·6	6·6	7·5	8·5	9·4	10·3	11·3	12·2	13·2	14·1
57	0·9	1·8	2·8	3·7	4·6	5·5	6·4	7·4	8·3	9·2	10·1	11·0	12·0	12·9	13·8
58	0·9	1·8	2·7	3·6	4·5	5·4	6·3	7·2	8·1	9·0	9·9	10·8	11·7	12·6	13·5
59	0·9	1·8	2·7	3·6	4·5	5·3	6·2	7·1	8·0	8·9	9·8	10·7	11·6	12·5	13·4
60	0·9	1·8	2·6	3·5	4·4	5·3	6·2	7·0	7·9	8·8	9·7	10·6	11·4	12·3	13·2
61	0·9	1·7	2·6	3·5	4·4	5·2	6·1	7·0	7·8	8·7	9·6	10·4	11·3	12·2	13·1
62	0·9	1·7	2·6	3·4	4·3	5·2	6·0	6·9	7·7	8·6	9·5	10·3	11·2	12·0	12·9
63	0·9	1·7	2·6	3·4	4·3	5·1	6·0	6·8	7·7	8·5	9·4	10·2	11·1	11·9	12·8
64	0·8	1·7	2·5	3·3	4·2	5·0	5·8	6·6	7·5	8·3	9·1	10·0	10·8	11·6	12·5
65	0·8	1·6	2·5	3·3	4·1	4·9	5·7	6·6	7·4	8·2	9·0	9·8	10·7	11·5	12·3
66	0·8	1·6	2·4	3·2	4·1	4·9	5·7	6·5	7·3	8·1	8·9	9·7	10·5	11·3	12·2
67	0·8	1·6	2·4	3·2	4·0	4·8	5·6	6·4	7·2	8·0	8·8	9·6	10·4	11·2	12·0
68	0·8	1·6	2·4	3·2	4·0	4·7	5·5	6·3	7·1	7·9	8·7	9·5	10·3	11·1	11·9
69	0·8	1·6	2·3	3·1	3·9	4·7	5·5	6·2	7·0	7·8	8·6	9·4	10·1	10·9	11·7
70	0·8	1·5	2·3	3·1	3·9	4·6	5·4	6·2	6·9	7·7	8·5	9·2	10·0	10·8	11·6
71	0·8	1·5	2·3	3·0	3·8	4·6	5·3	6·1	6·8	7·6	8·4	9·1	9·9	10·6	11·4
72	0·8	1·5	2·3	3·0	3·8	4·5	5·3	6·0	6·8	7·5	8·3	9·0	9·8	10·5	11·3
73	0·7	1·5	2·2	3·0	3·7	4·4	5·2	5·9	6·7	7·4	8·1	8·9	9·6	10·4	11·1
74	0·7	1·5	2·2	2·9	3·7	4·4	5·1	5·8	6·6	7·3	8·0	8·8	9·5	10·2	11·0
75	0·7	1·4	2·2	2·9	3·6	4·3	5·0	5·8	6·5	7·2	7·9	8·6	9·4	10.1	10·8
76	0·7	1·4	2·1	2·8	3·6	4·3	5·0	5·7	6·4	7·1	7·8	8·5	9·2	9·9	10·7
77	0·7	1·4	2·1	2·8	3·5	4·2	4·9	5·6	6·3	7·0	7·7	8·4	9·1	9·8	10·5
78	0·7	1·4	2·1	2·8	3·5	4·1	4·8	5·5	6·2	6·9	7·6	8·3	9·0	9·7	10·4
79	0·7	1·4	2·1	2·8	3·5	4·1	4·8	5·5	6·2	6·9	7·6	8·3	9·0	9·7	10·4

DANIEL'S HYGROMETER OR DEW-POINT THERMOMETER.



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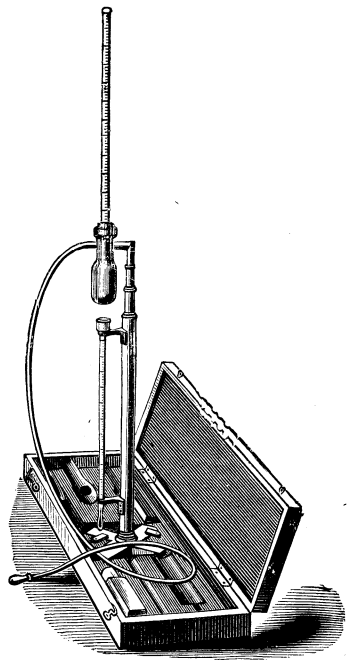


12622.

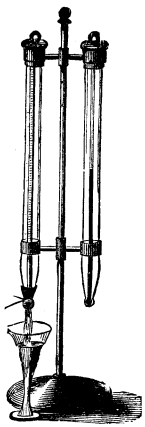
No. PRICE

12621. DANIEL'S HYGROMETER OR DEW-POINT THERMOMETER, on brass base, with silvered metallic post. The whole instrument 8 inches high, in morocco case lined with velvet, ... $16 00

This instrument consists of a glass tube, bent twice at right angles and terminating in two bulbs, one of which is of black glass and the other of clear glass covered with muslin. In the longer limbs of the tube is placed a very delicate thermometer; the bulbs are filled with ether and the tube exhausted of air. The tube is supported upon a stand, upon which is arranged a thermometer to show the temperature of the external air. To take an observation, pure ether is dropped slowly upon the muslin-covered bulb. The rapid evaporation which ensues, lowers the temperature until moisture is seen condensed upon the black bulb. The reading of the internal thermometer, at the first appearance of condensation, gives the dew-point.

REGNAULT'S HYGROMETER.

12622 REGNAULT'S HYGROMETER. For direct dew-point observation, with ether test, complete, in mahogany case, ... $40 00



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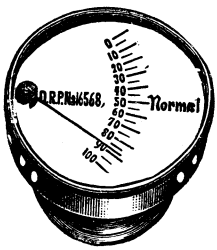

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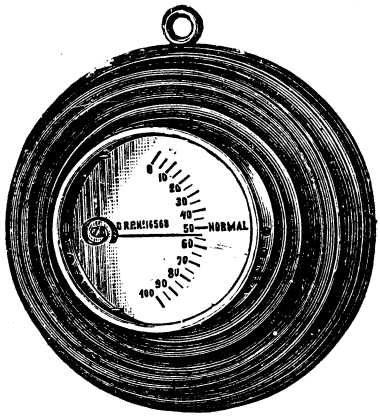


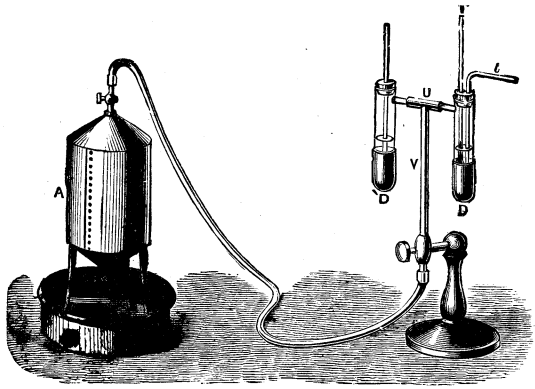
2630

No.		Price
12625.	LESLIE'S HYGROMETER, 9 inches high, on mahogany stand, . .	$12 50

This instrument consists of a tube bent in the shape of a syphon and terminating at the upper extremities in two bulbs turned outwards from each other. The tube is partly filled with a colored fluid, and one bulb is covered with thin muslin kept constantly moist by threads which dip into a vessel of water. The evaporation from this bulb will be in direct proportion to the dryness of the air; and as the temperature varies, the liquid rises or falls in the left hand stem of the instrument.

12626.	AUGUST'S PSYCHROMETER, on brass stand, with very accurate and delicate thermometer, graduated upon the tube to fifths of a degree Centigrade. In morocco case, lined with velvet, ...	25 00
12627.	SAUSSURE'S OR HAIR HYGROMETER, 9½ inches high, on brass frame, with delicate thermometer attached. The indications are obtained from the expansion and contraction of a prepared human hair, transferred to an index needle traversing the divided arc of a circle. In case . .	15 00
12630.	MITHOFF'S SPIRAL HYGROSCOPE, 2½ inches diameter, best make	2 50
12631.	" " " 2 " "	1 00

REGNAULT'S HYGROMETER, WITH ASPIRATOR.



12623.

No.		Price.
12623.	Regnault's Hygrometer, with Aspirator, by which instantaneous observations can be more easily made. Complete in case,	$75 00

These instruments consist of a thin and highly-polished tubular vessel of silver, having one end somewhat longer than the other. A very delicate thermometer is introduced into the tube at the smaller end, to which end of the tubular vessel, also, a flexible rubber tube with ivory mouth-piece is attached. A sufficient quantity of ether to cover the bulb of the thermometer, being poured into the silver vessel, the ether is agitated by breathing through the flexible tube. A rapid evaporation ensues until at the moment the dew-point is reached, the moisture is seen to condense upon the exterior surface of the polished silver tube. The reading of the thermometer at this precise moment gives the dew-point.

THE BAROMETER.

If a straight tube 32 or 33 inches long and closed at one end, is filled with mercury and the open end being stopped with the finger, immersed in a vessel filled with the same substance and the finger removed, the fluid will stand at about 30 inches above the level of the mercury in the vessel. The column of mercury in the tube is supported by the pressure of the atmosphere upon the surface of the mercury in the cup and it is therefore assumed that the weight of a column of mercury of uniform diameter, 30 inches high, is equal to the weight of a column of air of the same base, extending to the top of the atmosphere. This is the Barometer invented by Torricelli in 1643 and still used in essentially its original form. As every fluctuation of atmospheric pressure is faithfully shown by the varying height of the fluid in the Torricellian tube, the instrument is, as its name implies, a measure of the weight of the atmosphere, from the Greek *baros* "weight" and *metron* "measure."

The Barometer as usually made, consists of a glass tube about 34 inches long, closed at one end, filled with mercury and placed in a vertical position with the open end immersed in the mercury contained in a cup called a cistern.

A scale of inches and tenths, placed at the top of the column, enables the height of the mercury to be read and in the higher grade barometers a vernier facilitates the reading of the scale to hundredths. A thermometer is usually attached, so placed that its temperature shall be the same as that of the barometer column, by which the correction for temperature may be accurately made.

The tube should not be too small; to allow entire freedom of motion to the column it should have an internal diameter of from one-third to one-half inch. The mercury must be absolutely pure, freed from moisture and of the specific gravity of 13.594. Extreme care is necessary in excluding from the tube both air and moisture, the pressure of which filling the tube above the mercury and exerting a pressure upon the upper surface of the column, would depress it below the proper height. The tube should be absolutely clean and the mercury should be filtered and both should be heated in order to expel moisture. A small portion of mercury being carefully introduced into the tube, it is held over a charcoal fire until the mercury boils, the tube being held in an inclined position so that any air bells may readily escape. More mercury is added and the process of boiling repeated until the tube is filled.

When a barometer tube has been carefully filled and properly freed from air and moisture, the mercury will, when the tube is reversed, strike the top of the tube with a sharp metallic sound.

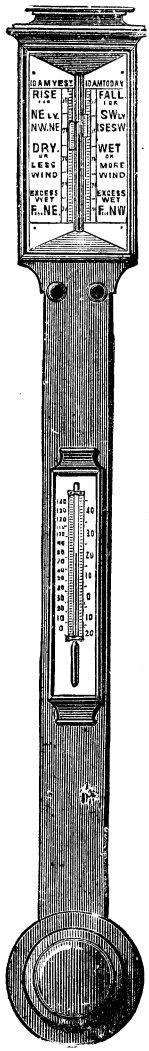
The barometer tubes are usually attached to wood frames of which there is an infinite variety in design and cost, but in Standard Barometers for strictly scientific purposes, a cylindrical brass frame is used, the index of expansion of that metal being more nearly the same as that of glass.

As now arranged, with adjusting screw below the cistern, the mercury can be forced up into the tube and the barometer rendered perfectly portable and in this condition it can be packed and sent in safety any distance.

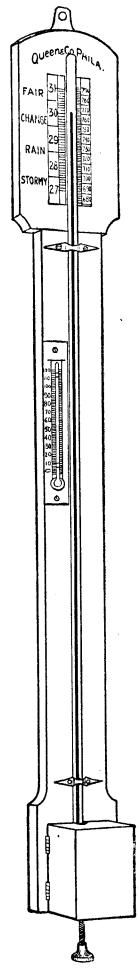
Mercurial Barometers.

FOR USE IN

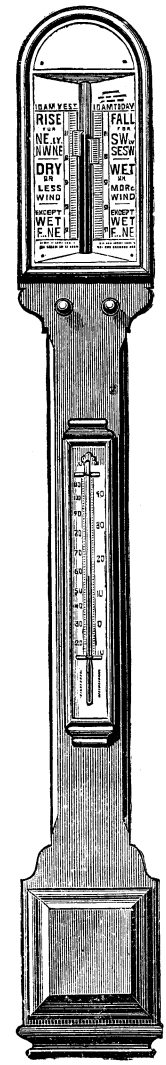
Library, Hall, Porch, Club House, Sea Shore, etc.



13009.



13000A.

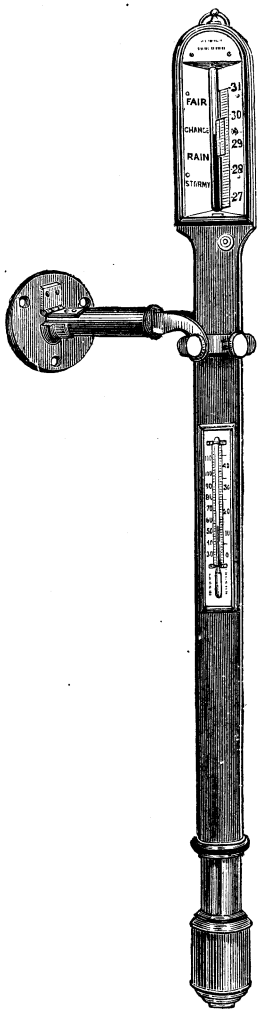


13015.

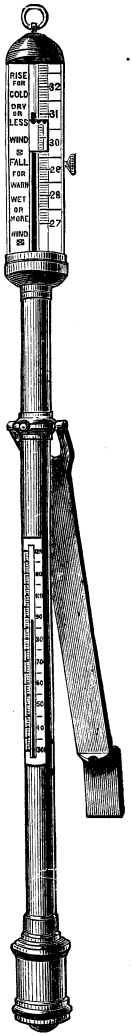
Mercurial Barometers.

No.		Price.
13000.	School Barometer, in oak case, inches and metric scales, adjustable cistern for the zero point	$6 50
13000A.	Same as 13000, with Thermometer	7 50
13001.	Model Barometer, in mahogany or walnut frame, ivory scales, tube visible throughout, with attached thermometer	8 50
13002.	Model Barometer, same as 13001, with ebonized wood frame	9 50
13003.	Library Barometer, in round-top walnut frame, with vernier and attached thermometer	13 00
13004.	Library Barometer, in round-top oak or rosewood frame, ivory scales, single vernier, with rack and pinion adjustments and attached thermometer	15 00
13005.	Library Barometer, plain walnut frame, with dome top, enamel scales, single vernier, with rack and pinion adjustments	25 00
13008.	Parlor Barometer, solid oak frame, square top, ivory scales, single vernier, with rack and pinion adjustments and attached thermometer	20 00
13009.	Parlor Barometer, solid oak frame, square top, ivory scales, double vernier, with rack and pinion adjustments, and attached thermometer	22 00
13010.	Carved Oak Barometer, enamel scales, double vernier, with rack and pinion adjustments and attached thermometer	25 00
13011.	Farmers' Barometer, on solid oak frame, small ivory scales, with sliding vernier	13 00
13012.	Farmers' Barometer, on solid oak frame, enamel scales, with sliding vernier, and wet and dry bulb thermometers, indicating temperature and moisture	17 50
13015.	Sea Coast Barometer, solid oak frame, round top, enamelled scales, double vernier with metal pointers and rack and pinion adjustments, with attached thermometer	40 00
13016.	Sea Coast Barometer, in solid carved oak frames, same as No. 13015	42 00
13017.	Mansion Barometer, carved solid oak frame, castellated top, enamelled scales, double vernier, with metal pointers, rack and pinion adjustments, attached thermometer, plate-glass fronts	50 00
13018.	Mansion Barometer, best carved solid oak frame, elaborate shell and scroll design, enamel scales, double vernier, with metal pointers and rack and pinion adjustment, with attached thermometer, plate-glass fronts	60 00
13020.	Miners' Barometer, in compact solid oak frame, strong glass face, enamelled scales, reading to 34 inches, with thermometer	12 50
13021.	Miners' Barometer, solid oak frame, open face, enamelled scales, sliding vernier, attached thermometer, India-rubber bag over cistern, the brass work and cistern coated with marine glue to prevent moisture penetrating, and reading to 34 inches	16 50

MARINE BAROMETERS.



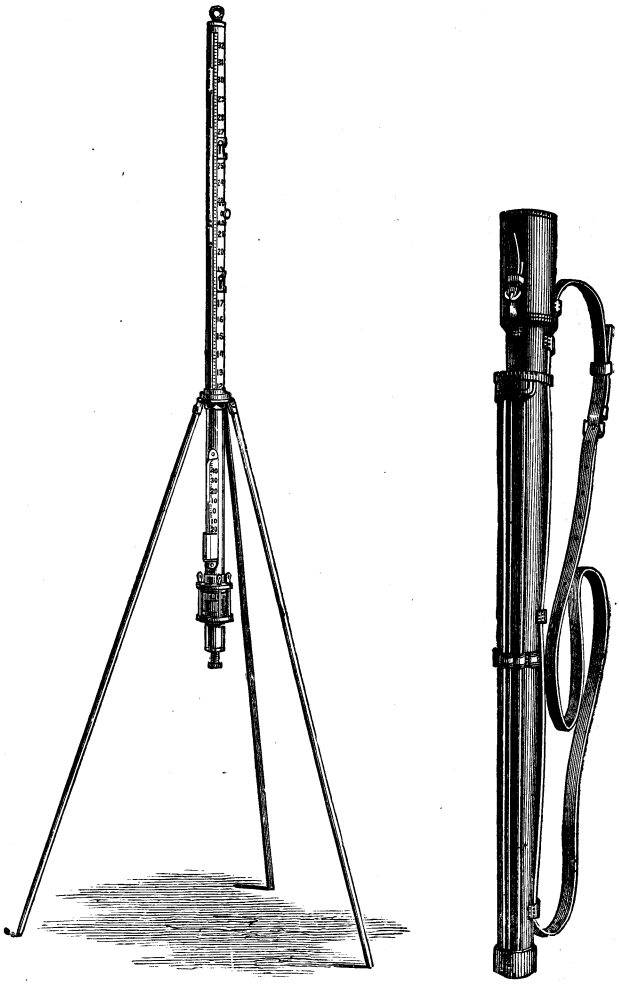
13025.



13026.

No.		Price.
13025.	MARINE BAROMETER, in solid rosewood frame, brass arm gimbals and attached thermometer complete, ivory scale (compensated) reads by vernier to $\frac{1}{500}$ths inch, ...	$18 50
13026.	MARINE STANDARD BAROMETER, on the Kew principle. In brass frame, with iron cistern; suspended in gimbals. The tube is contracted to prevent oscillation at sea. The scale reads to $\frac{1}{500}$th inch,	40 00

Mountain Barometers.

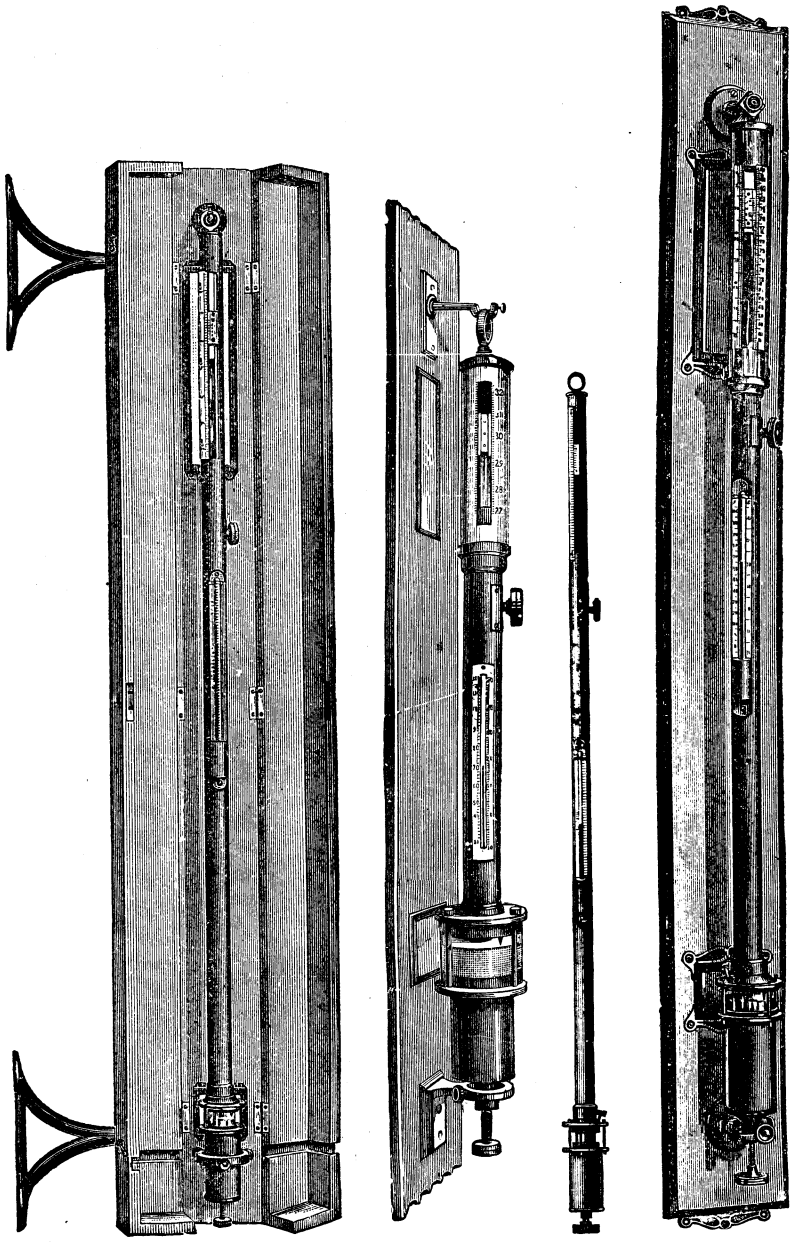


13034.

No.		Price.
13030.	Mountain Barometer, with scale extending down to 20 inches, with corresponding altitude scale 10,000 feet, divided into tenths of an inch, and reading by vernier to $\frac{1}{100}$; diameter of bore about $\frac{1}{4}$ inch.	$35 00
13031.	Mountain Barometer, same as No. 13030. Scale divided to twentieths of an inch and reading by vernier the $\frac{1}{500}$. . . .	40 00
13032.	Mountain Barometer, same as No. 13030, with scale extending down to 14 inches, with corresponding altitude scale to 18,000 feet, reading by the vernier to $\frac{1}{500}$ of an inch	50 00
13033.	Tripod for supporting Barometer, as shown in cut, including the cost of attaching ring to Barometer	10 00
13034.	Leather Sling Case for Mountain Barometer, containing pocket and sheath for Tripod	10 00

United States Weather Bureau Observatory Barometer.

(OR SMITHSONIAN STANDARD.)



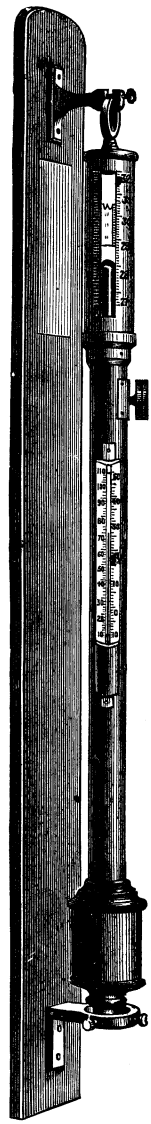
13045. 13043. 13040. 13041.

United States Weather Bureau Observatory Barometer.

(OR SMITHSONIAN STANDARD.)

No.		Price
13040.	UNITED STATES WEATHER BUREAU BAROMETER. The scale extends down to 27 inches, and is divided by the vernier to $\frac{1}{100}$ of an inch. The tube has a bore of 0.25 inch, and the mercury therein is perfectly free from air or moisture. † The attached Thermometer is graduated upon the tube, and is furnished with a certificate of correctness, ...	$30 00
13041.	STANDARD OBSERVATORY BAROMETER, with a millimeter scale in addition to the scale of inches, and having a tube with $\frac{3}{10}$ inch bore, without supports, ...	60 00
13042.	STANDARD OBSERVATORY BAROMETER, same as 13041, with bore of tube 0.60 inch, without supports, ...	100 00
13043.	STANDARD OBSERVATORY BAROMETER, same as 13041, with bore of tube 0.75, and reading by the vernier to $\frac{1}{1000}$ of an inch,	150 00
13044.	MAHOGANY BOARD FOR SUSPENDING BAROMETER, with hook to receive ring and steadying screws at the bottom, and having a piece of white enamel at either end, making a pleasant background for the mercury, ...	5 00
13045.	MAHOGANY BOX, with lock and key, and provided with iron brackets. The front and sides turn back the Barometer ready for use. Its fittings are the same as No. 13044, ...	8 50
13046.	BAROMETER CASE, with lock and key. Front and sides plate glass and containing Mahogany Board 13044, ...	15 00

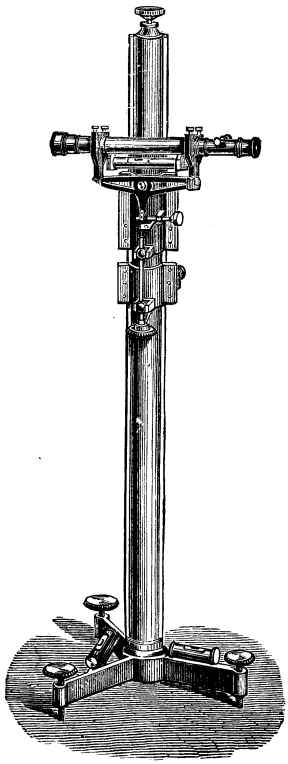
† Millimeter scale will be attached to the above for $4.00 additional.



13047.

No.		Price
13047.	STANDARD BAROMETER, on Kew principle for meteorological stations. Tube 0.5 inch diameter, mounted in brass, reading by vernier to $\frac{1}{500}$th inch and having the graduations so arranged as to compensate for the rise and fall of mercury in the cistern, obviating the necessity for adjustment to the zero point before reading as in the Fortin principle, ...	$60 00
13048.	STANDARD BAROMETER, same as No. 13047, tube $\frac{1}{4}$ths diameter,	45 00

CATHETOMETERS.



No.		Price
13050.	CATHETOMETER, for exact reading of Standard Barometer. On stand, with leveling screws and levels; the scale divided into millimetres, with vernier reading to $\frac{1}{10}$th mm; the telescope with cross hairs, is arranged to slide up and down the scale, the fine adjustment being made by a micrometer screw, ...	$45 00
13051.	CATHETOMETER, of very accurate construction, on stand, with leveling screws and levels; the scale divided into millimetres, with vernier reading to $\frac{1}{20}$th mm; the telescope with cross hairs, arranged to slide up and down the scale, and to be fixed by clamp and slow motion screw at any required height; fine adjustment made by micrometer screw, ...	150 00
13052.	CATHETOMETER, same as No. 13051, reading to $\frac{1}{50}$th of a millimetre.	225 00

THE FORTIN BAROMETER, OR THE STANDARD ADOPTED BY THE UNITED STATES SIGNAL SERVICE.

1. This barometer consists of a brass tube (Fig. 1), terminating at top in a ring A, for suspension, and at bottom in a flange B, to which the several parts forming the cistern are attached.

2. The upper part of this tube is cut through so as to expose the glass tube and mercurial column within, seen in Fig. 5. Attached at one side of this opening is a scale, graduated in inches and parts; and inside this slides a short tube *c*, connected to a rack-work arrangement, moved by a milled head D; this sliding tube carries a vernier in contact with the scale, which read off to $\frac{1}{500}$ (002) of an inch.

3. In the middle of the brass tube is fixed the thermometer E, the bulb of which being externally covered, but inwardly open, and nearly in contact with the glass tube, indicates the temperature of the mercury in the barometer tube, not that of the external air. This central position of the thermometer is selected that the mean temperature of the whole column may be obtained; a matter of importance, as the temperature of the barometric column must be taken into account in every scientific application of its observed height.

4. The cistern (Fig. 2) is made up of a glass cylinder F, which allows the surface of the mercury *q* to be seen, and a top plate G, through the neck of which the barometer-tube *t* passes, and to which it is fastened by a piece of kid leather, making a strong but flexible joint. To this plate, also, is attached a small ivory point *h*, the extremity of which marks the commencement or zero of the scale above. The lower part, containing the mercury, in which the end of the barometer-tube *t* is plunged, is formed of two parts *i j*, held together by four screws and two divided rings *l m*, in the manner shown in Figs. 2 and 3. To the lower piece *j* is fastened the flexible bag N, made of kid leather, furnished in the middle with a socket *k*, which rests on the end of the adjusting screw O. These parts, with the glass cylinder F, are clamped to the flange B by means of four long screws P and the ring R; on the ring R screws the cap S, which covers the lower parts of the cistern, and supports at the end the adjusting-screw O. G, *i*, *j*, and *k*, are of box-wood; the other parts of brass or German silver. The screw O serves to adjust the mercury to the ivory point, and also, by raising the bag, so as to completely fill the cistern and tube with mercury, to put the instrument in condition for transportation.

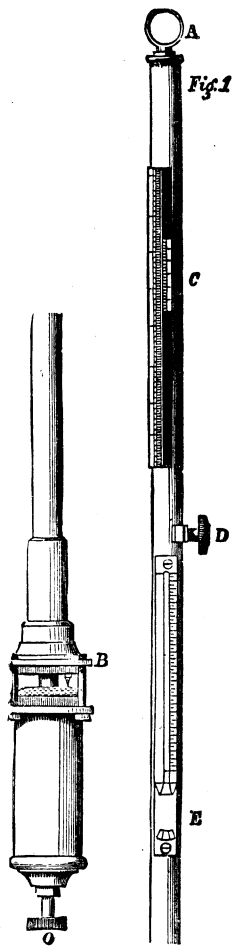


Fig. 1

[See cuts on next page.]

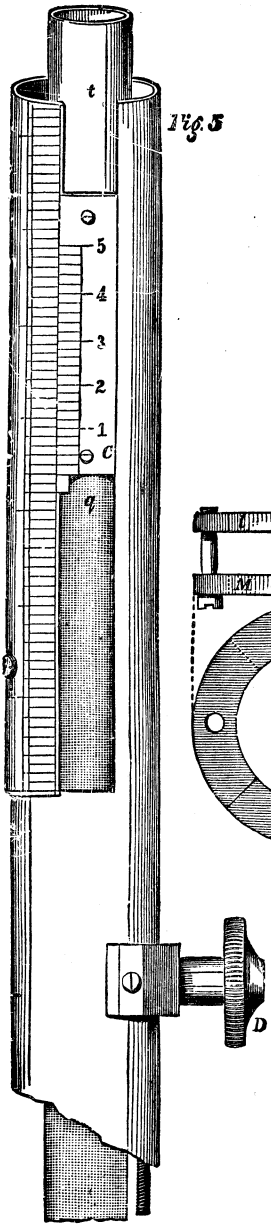


Fig. 3

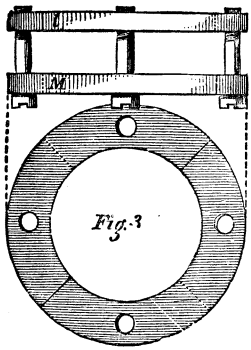
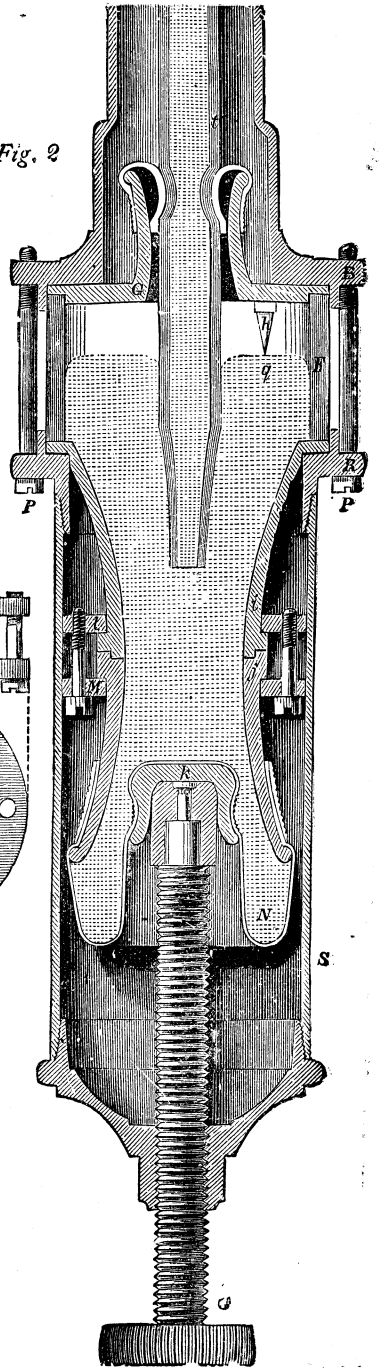
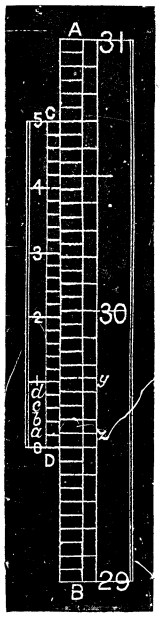


Fig. 2

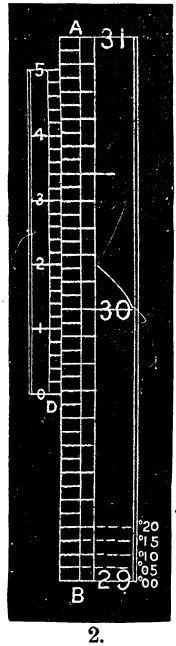


READING THE BAROMETER.

PRINCIPLE OF THE VERNIER. The *Vernier* is a movable scale for the purpose of measuring small spaces with precision. The barometer scale being divided into inches and tenths the vernier enables us to subdivide the tenths to hundreths and thousandths of an inch.



1.



2.

Figure 1 shows the scale of a standard barometer divided into half-tenths, or .05, of an inch, as A B. The vernier C D is made equal in length to twenty-four of these divisions and is divided into twenty-five equal parts; one space on the scale is larger, therefore, than one on the vernier by the one twenty-fifth part of .05 which is .002 inch, so that the vernier shows differences of .002.

The vernier reading upwards, the lower edge, D, indicates the top of the mercurial column and is the zero of the vernier scale.

In figure 1, the zero being exactly in line with 29 inches and 5-10ths of the fixed scale, the barometer reading would be 29.500 inches. The vernier line *a* falls short of a division of the scale by .002 inch; *b* by .004; *c* by .006; *d* by .008 and the next line by one-hundredth. If, then, the vernier be moved so as to make *a* coincide with *z* on the scale, it will have moved through .002 inch; and if 1 on the vernier be moved into line with *y* on the scale, the space measured will be .010.

Hence, the figures 1, 2, 3, 4, 5 on the vernier measure hundreths and the intermediate lines thousandths of an inch.

In figure 2 the zero of the vernier is between 29.65 and 29.70 on the scale. Looking up the vernier and scale, the second line above 3 is perceived to lie evenly with a line of the scale. This gives .03 and .004 to add to 29.65, so that the actual reading is 29.684 inches.

For the ordinary purposes of the barometer, such minute measurement is not required. In household and marine barometers the scale is only divided to tenths and the vernier constructed to measure hundredths of an inch. This is accomplished

by making the vernier either 9 or 11-10ths of an inch long and dividing it into ten equal parts.

To TAKE A READING. Place a piece of white paper behind the tube to reflect the light and aid in setting the vernier accurately. Adjust the surface of the mercury in the cistern carefully to the ivory point or zero of the scale. To determine the contact it will be found best to slightly immerse the point in the mercury first and then slowly lower the screw until the depression caused by this immersion disappears.

Tap the barometer with the hand to free the mercury from the sides of the tube. Sufficient force should be used to agitate the top of the column. Bring the lower edge of the vernier exactly on a level with the top of the mercurial column. When set properly, the front edge of the vernier, the top of the mercury and the back edge of the vernier should be in the line of sight, which line will thus just touch the middle and uppermost point of the column. Care must be taken to read with the eye exactly on a level with the top of the mercury.

The inches and tenths may then be read from the scale and the hundredths and thousandths from the vernier.

A reading of the attached thermometer should also be taken.

CORRECTION OF BAROMETRICAL OBSERVATIONS.

All readings of the barometer are subject to corrections, in order to eliminate various sources of error and to harmonize the indications of different instruments, so that the observations can be used for scientific purposes.

These corrections are for:

Index error,
Capacity,
Capillarity,
Temperature,
Altitude above sea level.

It is necessary to find the index error of each instrument by comparison with a standard instrument whose constant of error is known. This being determined, is a fixed quantity to be added or subtracted from each observation. In all barometers on the Fortin principle, the correction for capacity is made by the lifting screw. The Kew barometer requires no capacity correction. The Syphon barometer requires no correction for capillarity. All barometers require to be corrected for Temperature and Altitude.

CORRECTION FOR CAPILLARITY.

The capillary action of glass and mercury cause a depression of the mercury by a quantity very nearly in inverse proportion to the diameter of the tube.

The following table gives the corrections to be applied to tubes from 0.6 to 0.10 diameter, with boiled mercury:

Diameter of Tube.	Correction.
0.60 inch.	0.002 inch.
0.50 do.	0.003 do.
0.45 do.	0.005 do.
0.40 do.	0.007 do.
0.35 do.	0.010 do.
0.30 do.	0.014 do.
0.25 do.	0.020 do.
0.20 do.	0.029 do.
0.15 do.	0.044 do.
0.10 do.	0 070 do.

CORRECTION FOR TEMPERATURE.

As mercury expands $\frac{1}{5}\frac{1}{5}$ of its volume between the freezing and boiling-points of the Fahrenheit thermometer, it is necessary that all observations should be reduced to a uniform temperature, and for this purpose the barometer is always accompanied by a thermometer, which should be observed at each time that an observation is taken of the barometer itself.

It is universally agreed that the temperature to which all barometrical observations shall be reduced is 32° Fahr. For every degree of the thermometer, above 32° Fahr., we must subtract the ten-thousandth part of the observed height. If the temperature be below 32° this correction must be added.

CORRECTION FOR HEIGHT ABOVE SEA-LEVEL.

At sea-level, in latitude 45°, and at a temperature of 32° Fahr., the normal height of the mercurial column is about 29.922. As the pressure of the atmosphere diminishes as we ascend, it is evident that the length of the mercurial column will be less in proportion to the altitude of its station.

In order that observations may be intercomparable, they are reduced to the level of the sea.

The correction to be applied is for the height of the column of air extending from the sea-level to that of the station. But as the weight of the column of air varies with its temperature it is necessary to take this into consideration. Tables have been computed, giving corrections for every degree from 20° to 100°, and from sea-level to 1,500 or more feet.

THE BAROMETER AS A WEATHER GLASS.

The formulary still often found engraved upon barometer scales,

at 31	inches,	Very dry,
30.5	do.	Settled fair,
30	do.	Fair,
29.5	do.	Changeable,
29	do.	Rain,
28.5	do.	Much rain,
28	do.	Stormy,

has tended to discredit the barometer as an instrument for foretelling changes of weather. These words are useless and incorrect. The mere height of the barometer is no indication of the weather to be expected. The point to be observed is whether the barometer has risen or fallen or remained steady since the previous observation.

The late Admiral Fitzroy proposed the following words for barometer scales, which have been very generally adopted:

RISE.	FALL.
FOR	FOR
NORTH	SOUTH
N. W.–N.–E.	S. E.–S.–W.
DRY	WET
OR	OR
LESS WIND.	MORE WIND.
EXCEPT	EXCEPT
WET FROM NORTH.	WET FROM NORTH.

Generally, it may be said that when the barometer rises, owing to a change of wind, the weather gets colder and if it remains high (above 30) the weather will probably be fair.

If the barometer falls, owing to a change of wind and remains steady at about 29.5, the weather will be warmer and wet and cloudy.

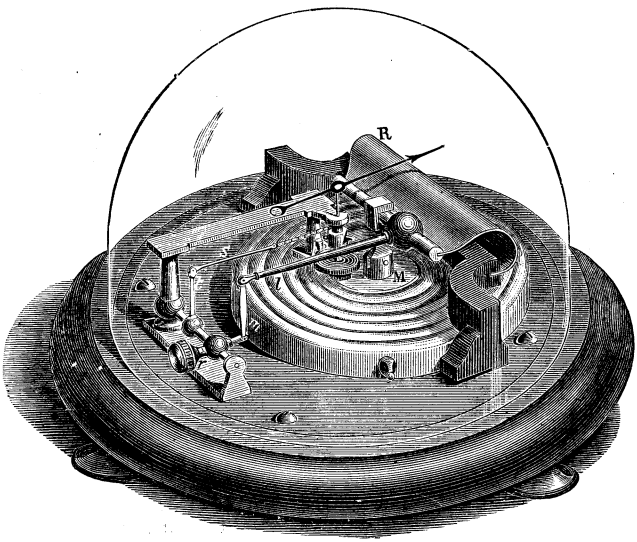
A gradual rise is an indication of continued fair weather, whilst a gradual fall indicates that prolonged bad weather is to be expected.

Either a very sudden rise or a sudden fall are dangerous, as they indicate a disturbance of atmospheric conditions and consequent unsettled weather.

In forecasting the weather it is important that the state of the thermometer and hygrometer be observed as well as the height of the barometer, and that the direction of the wind and the time of the year be considered

Reasoning from all these factors, it is undoubtedly possible to foretell local changes with great accuracy.

THE ANEROID BAROMETER.



The word *Aneroid*, from the Greek privative *a*, and *neros* wet, suggests the character of this instrument, whose indications are obtained by the pressure of the atmosphere upon a delicate metal box, exhausted of air, instead of, as in the Mecurial Barometer, by the height of a fluid column.

Invented about the beginning of the past century, it was not until about 1848 that the difficulties involved in the construction of such an instrument were overcome, and the present serviceable form devised by M. Vidie.

Since that time, the Aneroid has continued substantially the same; improvements being rather in the direction of more perfect workmanship in its parts, and in the more perfect adaptation of its metals, than in any change of form.

As shown in the illustration, the Aneroid consists of a flat cylindrical vacuum box, the upper surface of which is corrugated, in order that it may yield more readily to external pressure. The lower surface of the vacuum chamber is firmly fixed at the centre to a strong foundation plate, whilst at the centre of the upper surface is a metallic pillar M, which acts upon a powerful steel spring R.

The varying atmospheric pressure causes the surface of the vacuum chamber to rise and fall; these movements are transmitted to the spring, and thence by two levers, *l* and *m*, to a metallic axis *r*. From the latter rises a lever *t*, to whose extremity a chain *s* is attached, which turns a drum, the axis of which bears the index needle. A firm spiral spring keeps the chain constantly in proper tension. By this arrangement of multiplying levers, a very small movement of the surface of the vacuum chamber causes a large deviation of the needle; $\frac{1}{200}$ of an inch causing it to move through a space of 3 inches.

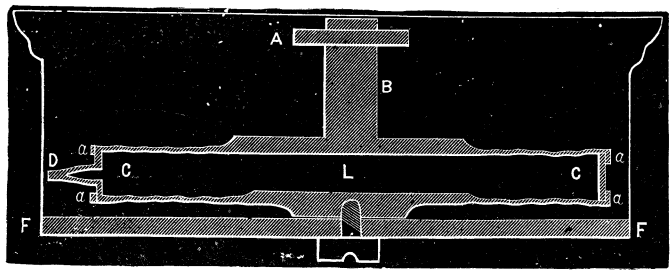


Figure A.

Figure A shows a section of the vacuum box; B being the pillar to which the mainspring is attached; L the attachment to foundation plate; D the tube through which the box is exhausted, and *a, a, a, a,* the overlapping thin German silver corrugated plates.

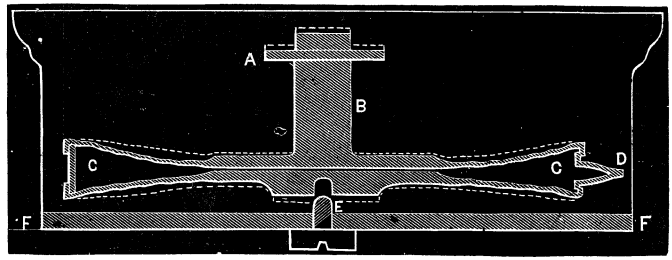


Figure B.

In figure B, we have the chamber exhausted of air; the dotted lines showing the tension to which the instrument is brought, and enabling it to be understood how readily the instrument may respond to the varying atmospheric pressure. Compensation for temperature is effected, as in chronometers, by an adjustment of brass and steel in the main lever, by whose unequal expansion and contraction the liability to error from change of temperature is overcome.

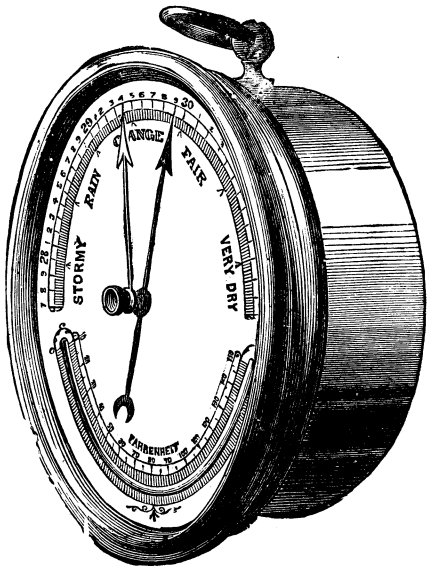
The dial is graduated arbitrarily to correspond with the mercurial barometer, after the instrument is tested under the air-pump to find the range. It is apparent, therefore, that the Aneroid can never be used as an independent standard, but must be frequently compared with the mecurial barometer When so compared, however, and adjusted by a Mercurial Standard, the Aneroid possesses several advantages over the former. It is extremely portable and can be carried in any way, or subjected to any motion without danger of disturbance of its indications. It is not at all liable to get out of order—is not easily broken, and lastly, *it is very much more sensitive* than the Mecurial Barometer.

The late Admiral Fitzroy, Mr. Glaisher the æronaut, and many other authorities, testify to the extreme sensibility of the Aneroid; the former particularly noting "its quickness in showing the variations of atmospheric pressure" Even in Observatories, therefore, where Mecurial Standards are in use, the Aneroid is most valuable in its capacity of giving earlier indications than can be obtained from the more sluggish mercurial column.

To the seaman, who nas often extreme difficulty in using the barometer from the pumping of the mercury caused by the vessel's motion, the Aneroid is indispensable; and from its greater delicacy, he can often prepare for a change in weather a considerable time before the Mecurial Barometer gives evidence of an impending storm.

The value of the Aneroid in ascertaining differences of altitude, is obvious, and of this we speak more fully in the succeeding pages.

ANEROID BAROMETERS.

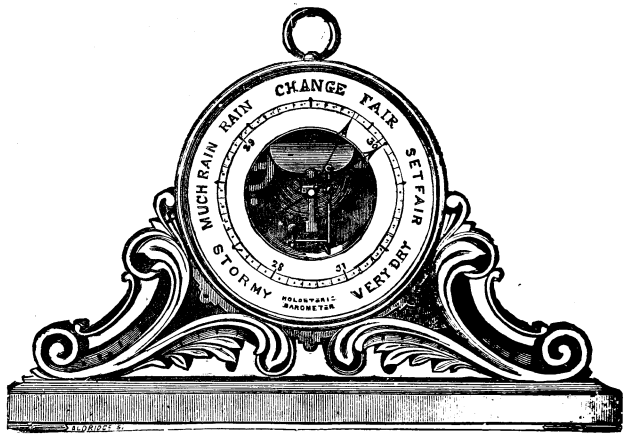


13454.

13450. ANEROID BAROMETER, 4 in. open enamelled card dial, nickel plated case, with feet, ... $ 6 50
13451. ANEROID BAROMETER, 5½ in. open enamelled card dial, nickel plated case, with feet. 8 50
13452. ANEROID BAROMETER, 5 in. enamelled card dial, brass case, . . 6 75
13453. ANEROID BAROMETER, 5 in. open enamelled card dial, brass case, . 8 25
13454. ANEROID BAROMETER, 5 in. enamelled card dial, brass case, with Thermometer, ... 9 00
13455. ANEROID BAROMETER, 5¼ in. open enamelled card dial, brass case, with Thermometer, ... 9 75
13456. ANEROID BAROMETER, 5 in. open metal dial, brass case, . . . 10 50
13457. ANEROID BAROMETER, 5 in. open metal dial, brass case, with Thermometer, ... 11 50
13458. ANEROID BAROMETER, 6 in. open metal dial, brass case, with Thermometer, ... 13 75
13459. ANEROID BAROMETER, 8 in. open metal dial, brass case, with Thermometer, ... 16 50
13460. ANEROID BAROMETER, 5 in. open black metal dial, gilt letters, brass case, ... 13 00
13461. ANEROID BAROMETER, 6 in. open black metal dial, gilt letters, brass case, ... 14 50
13462. ANEROID BAROMETER, 8 in. open black metal dial, gilt letters, brass case, ... 17 00
13463. ANEROID BAROMETER, 4½ in. fancy metal dial, which is adjustable, so that the words Rain, Change, Fair, etc., can be made always to read in the right direction, nickel plated case, ... 13 25
13464. ANEROID BAROMETER, 5 in. fancy metal dial, same as No. 13462, . 15 50
13465. ANEROID BAROMETER, 6 in. fancy metal dial, same as No. 13462, . 18 75

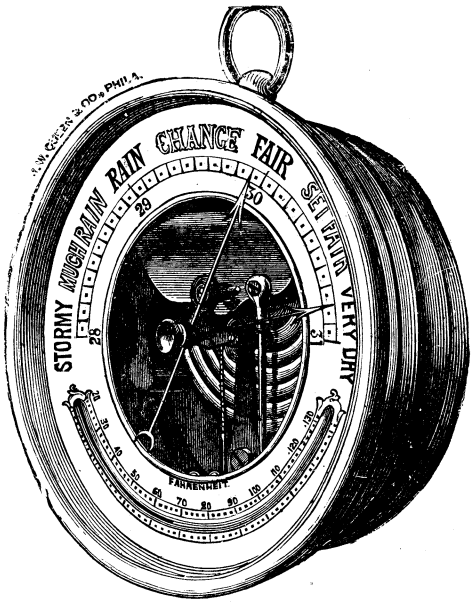
Library Aneroid Barometers.

As the style and finish of the Aneroids is constantly changing, it is not always possible to furnish instruments exactly as they are listed in the following pages, therefore we would ask your indulgence when ordering Aneroids, as using our judgment, we will always send the instrument most adapted to the use for which it is intended.

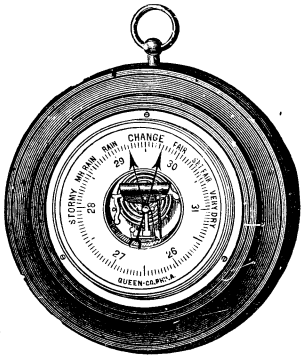


13415.

No.		Price
13415.	LIBRARY ANEROID, 5 inch open enamelled card dial, on oak stand	$10 50
13416.	LIBRARY ANEROID, 5½ inch open enamelled card dial, brass case, on oak stand, with thermometer	12 50
13417.	LIBRARY ANEROID, 6½ inch bevelled plate-glass dial, scale divided on the glass to $\frac{1}{50}$-inch—case silvered inside—all works visible, on polished ebony stand	20 00
13418.	LIBRARY ANEROID, 8-inch bevelled plate-glass dial, scale divided on the glass to $\frac{1}{50}$-inch, case silvered inside—all works visible, on polished ebony stand	23 00



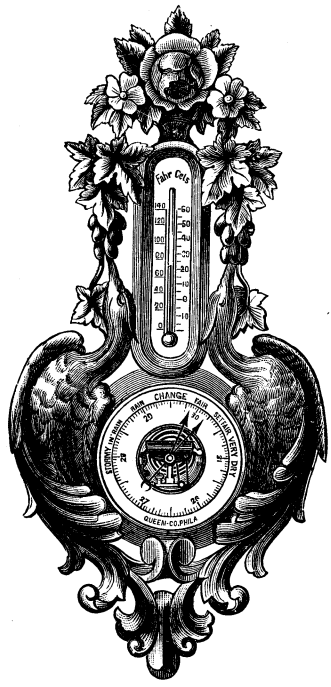
13455.



13474

No.		Price
13466.	ANEROID BAROMETER, 5 in plate glass dial, all works visible, brass case, gilded inside,	9 00
13467.	ANEROID BAROMETER, 5½ in. plate glass dial, same as No. 13466,	13 25
13468.	ANEROID BAROMETER, 6½ in. plate glass dial, all works visible, brass case, silvered inside.	13 00
13469.	ANEROID BAROMETER, 8 in plate glass dial, same as No. 13468,	14 00
13470.	ANEROID BAROMETER, 10 in. plate glass dial, same as No. 13468,	18 00
13471	ANEROID BAROMETER, 5 in. porcelain dial, bronze case,	10 75
13472.	ANEROID BAROMETER, 5 in. porcelain dial, bronze case, in oak frame,	12 00
13473.	ANEROID BAROMETER (Universal), 5 in. enamelled card dial, painted iron case,	5 50
13474.	ANEROID BAROMETER, 5 in. open enamelled card dial, ebonized wood case.	$7 50

PENDANT ANEROID BAROMETERS.



13478.

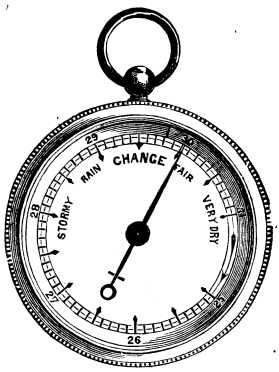
No.		Price.
13475.	ANEROID BAROMETER, 3½ in. open enamelled card dial, in carved wood frame 15 ins. long, with Thermometer attached, . .	$ 7 50
13476.	ANEROID BAROMETER, 5 in. open enamelled card dial, in carved wood case 17 ins. long, with Thermometer attached, . . .	13 50
13477.	ANEROID BAROMETER, 5 in. open enamelled card dial, in carved wood case 21 ins. long, with Thermometer attached, . . .	16 50
13478.	ANEROID BAROMETER, 5 in. open enamelled card dial, in carved wood case 21 ins. long, with Thermometer attached (carving very handsome), ...	19 50
13479.	ANEROID BAROMETER, 5½ in. open enamelled card dial, in carved wood frame, same as No. 13478, ...	22 50
13480.	ANEROID BAROMETER, 3½ in. porcelain dial, in porcelain frame 15 ins. long, with Thermometer, ...	8 00
13481.	ANEROID BAROMETER, same as No. 13480, with tinted porcelain frame.	8 50

VERY ACCURATE

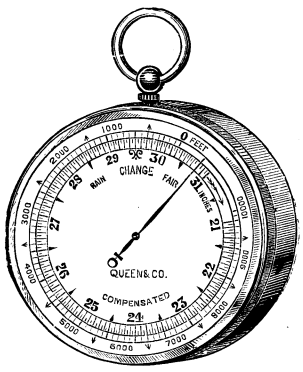
POCKET ANEROID BAROMETERS.

COMPENSATED AND SPECIALLY TESTED AND ADJUSTED FOR ENGINEERS' USE.

These Aneroids have movable altitude scales, with silver enameled dials, and are in morocco cases.



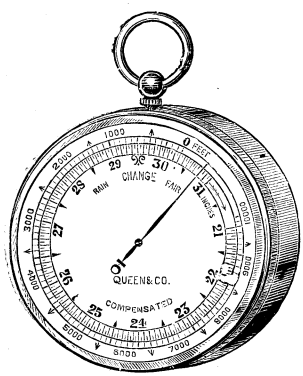
13500



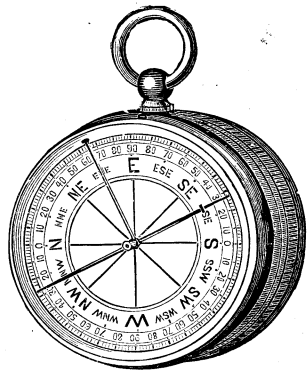
13505

13500.	PLAIN POCKET ANEROID, $1\frac{3}{4}$ in. diameter,				$15 00
13501.	Do.	do.	do.	$2\frac{1}{2}$ in.	17 00
13502.	Do.	do.	do.	$1\frac{3}{4}$ in. diameter, with thermometer,	20 00
13503.	Do.	do.	do.	$3\frac{1}{2}$ in. do. do.	21 00
13505.	POCKET MOUNTAIN ANEROID, compensated for temperature, $1\frac{3}{4}$ in. diameter, with altitude scale to 3000 feet,				18 50
13506.	Do.	do.	do.	5000 feet,	18 50
13507.	Do.	do.	do.	10,000 "	18 50
13508.	Do.	do.	do.	15,000 "	20 00
13509.	Do.	do.	do.	20,000 "	22 50
13510.	POCKET MOUNTAIN ANEROID, compensated for temperature, same as 13505, $2\frac{1}{2}$ inches diameter, with altitude scale to 3000 feet,				19 00
13511.	Do.	do.	do.	5000 feet,	19 00
13512.	Do.	do.	do.	10,000 "	19 00
13513.	Do.	do.	do.	15,000 "	20 50
13514.	Do.	do.	do.	20,000 "	23 50

GEOLOGICAL ANEROIDS.

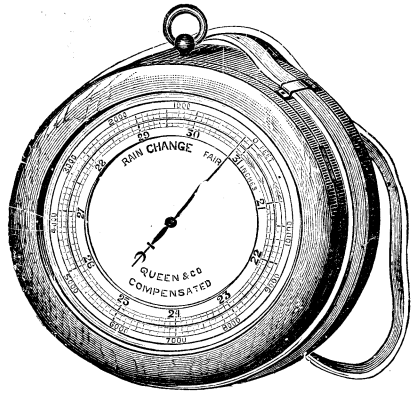


13515.
Front.



13515.
Back.

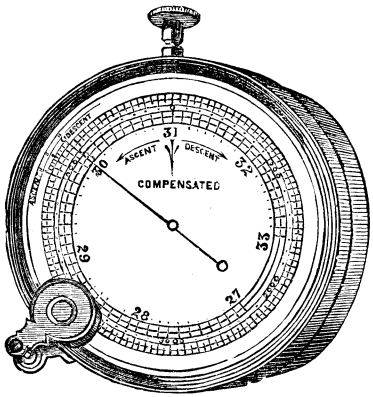
13515. GEOLOGICAL ANEROID, compensated for temperature, silvered metal dial, with needle compass at back, 2½ inches diameter, in leather sling case, with altitude scale to 5000 feet, ... $30 00
13516. Do. do. 10,000 feet, ... 31 00
13517. Do. do. 15,000 " 33 50



13520.

13520. GEOLOGICAL ANEROID, compensated for temperature, with silvered metal dial, 5 in. diameter, in mahogany open face case, with leather strap, with altitude scale to 3,000 feet, ... 33 00
13521. Do. do. 5,000 " 33 00
13522. Do. do. 10,000 " 35 00
13523. Do. do. 15,000 " 37 00
13524. Do. do. with thermometer, altitude scale to 3000 feet 35 00
13525. Do. do. 5,000 feet, ... 35 00
13526. Do. do. 10,000 " 37 00
13527. Do. do. 15,000 " 39 00

SURVEYING AND MINING ANEROIDS.



13530.

13530. SURVEYING ANEROID, 5 in. diameter, compensated for temperature, silvered metal dial, graduated to hundredths, and reading by vernier to single feet, with magnifier, in leather sling case, with altitude scale to 5,000 feet, ... $50 00

13531. Do do 10,000 feet, reads by vernier to 2 feet . . 55 00

13532. Do do 15,000 " " " 5 " . . 60 00

13534. MINING ANEROID, same as 13530, but arranged to register 2,000 feet below sea level to 4,000 above 50 00

THE SURVEYING AND MINING ANEROID has been designed and constructed specially for the use of Surveyors and Engineers, for the purpose of readily ascertaining slight variations in gradients, levels, &c., and from its extreme sensitiveness will be found of considerable utility in Mining and Surveying work generally.

Besides extreme sensitiveness, the specialty claimed for this Instrument is an arrangement of the Scale of Altitudes which admits of subdivision by a Vernier, hitherto impracticable, owing to the Altitude Scale in ordinary use being a gradually diminishing one, to which a Vernier cannot be applied. In the present Instrument the action has been so adjusted as to give accurate readings upon a regular Scale of Altitudes, the Barometrical Scale of Inches having been made progressive so as to afford the correct relative readings with the Scale of Altitudes.

For Mining purposes the entire circle of the dial is graduated to represent 6 inches of the mercurial column, *i.e.*, from 27 inches to 33. This scale will register about 2000 feet *below* sea-level to 4000 feet *above;* the finest divisions, hundredths of the Altitude Scale, represent 10 feet measurements, which can be again subdivided by the Vernier Scale to *single feet.* The Vernier Scale is moved by a rack-work adjustment, and a magnifying lens which rotates on the outer circumference of the Instrument facilitates the reading of minute quantities.

For Surface Surveying purposes, where it is not required to be used *below* sea-level, the Instrument is made with the scale divided from 25 to 31 inches, thus giving an Altitude Scale of 5000 feet above sea-level only, and with this open scale and the assistance of the Vernier, the same minute readings can be easily taken.

THE USE OF THE ANEROID FOR ALTITUDE.

From its portability, sensitiveness, and the ease with which approximate altitudes may be ascertained, the Aneroid Barometer is very valuable to the engineer. In preliminary surveys and reconnoissances it has been found extremely useful, and for these purposes it is largely employed. Carrying one of these little instruments, the size of which need not exceed two or three inches in diameter, the engineer, riding rapidly over a country, can speedily and with ease procure the data for the determination of the line of a survey. Holding an Aneroid in his hand, the traveller seated in the railroad car, can mark the changes of elevation as his train moves; the mountain climber can note, step by step, his gain in altitude; and the miner, with the new mining Aneroid, can measure his descent in single feet.

We have elsewhere explained the principle of the Aneroid and the manner in which its indications are obtained, and have referred to the necessity of accurate workmanship in its construction, and of intelligence and skill in its examination and adjustment. For hypsometrical work, it is especially important that the Aneroid should be absolutely accurate; that its compensation for effect of temperature on the metallic works be perfect, and that its indications should be identical with those of the mercurial column. The importance of compensation, particularly for Pocket Aneroids, is evident when it is remembered that the change from a room to the external atmosphere may frequently involve a difference in temperature of from 30° to 50° F., a difference, which, without proper compensation, may move the needle through a space equal to one hundred or more feet. It is also necessary that the Aneroid be tested for correspondence with the mercurial column. For this purpose we have an apparatus specially arranged, by which the Aneroid and a Standard Mercurial Barometer are subjected to identical changes of atmospheric pressure. Side by side, the two barometers, Mercurial and Aneroid, are moved through the entire range from normal pressure to complete vacuum. If the scale of the Aneroid be accurately divided and in accord with the instrument itself, the needle will move tenth by tenth, with the mercurial column, in perfect coincidence.

There are many good-working Aneroids in use, which do not thus correspond with the Mercurial Barometer, and whose constants of error being unknown, give inaccurate results. Such barometers could be used with satisfaction if their corrections were known; and all Aneroids require to be periodically tested—adjusted to accord with the Standard Mercurial Barometer, and their corrections, if any are necessary, ascertained. We have therefore arranged to make careful tests of any Aneroids submitted to us, to place them in adjustment with the Mercurial Standard and to furnish a certificate with corrections of error expressed in hundredths.

CORRECTIONS DEPENDENT UPON PHYSICAL LAWS.

In strictly accurate observations, it is necessary that the Aneroid, as well as the Mercurial Barometer, should be used with formulas for various corrections. The corrections, however, for gravity, for temperature of the mercury, and for capillary attraction are of course unnecessary with the Aneroid; and, indeed, for all ordinary work, the only correction required is that for the temperature of the atmosphere, which need only be considered when the temperature is above or below 50° F.

It must of course be remembered, in using a barometer of any kind for the purpose of ascertaining the altitude of a place, that while the normal barometric pressure is assumed to be represented by a mercurial column of about 30 inches at sea-level, it is but occasionally that this is actually attained. The variations of atmospheric pressure are continual, the periodic fluctuations being considerable, and the nonperiodic oscillations so great and so irregular, that it is only by taking the mean of a long series of observations that the periodical variations can be ascertained. It follows, therefore, that a single reading of the barometer can never, save by the rarest chance, indicate an absolute elevation.

Aneroids for altitudes may be used with the ordinary scale of inches and tenths, or, as they are now more usually arranged, with a graduated circle of feet in addition.

TO MEASURE ALTITUDES WITH ANEROID BAROMETER,

Without Altitude Scale.

Roughly speaking, the barometer falls one inch for every 900 feet of ascent; or at mean atmospheric pressure in this latitude.

Above sea-level				
917 feet,	the barometer falls	. . .	1	inch.
1860 "	" "	. . .	2	inches.
2830 "	" "	. . .	3	"
3830 "	" "	. . .	4	"
4861 "	" "	. . .	5	"

TO FIND THE RELATIVE HEIGHT OF TWO GIVEN PLACES.

Take a reading of the Aneroid at first station; subtract from this the reading at the second station. The product multiplied by 9 will give the difference of altitude in feet, thus:

First Station, ...	30 20
Second Station, ...	29 99
	21
	9
Difference of altitude, ...	189 feet.

This under ordinary pressures and with a temperature about 50° F. will give good results. If the temperature is over 70° F., multiply by 10.

The table prepared by Mr. Symons is more strictly accurate:

Mean Temperature.	30°	40°	50°	60°	70°	80°
Mean pressure, 27 inches.....	9.7	9.9	10.1	10.3	15.0	10.8
" " 28 "	9.3	9.5	9.8	10 0	10.2	10.4
" " 29 "	9 0	9.2	9.4	9.6	9.8	10.
" " 30 "	8.7	8.9	9.1	9.3	9.5	9.7

The best results may, however, be obtained by the use of the table prepared by Sir G. Airy, late Astronomer-Royal of England.

TO USE AIRY'S TABLE,

With mean temperature at 50°.

Take the reading in inches of the barometer scale, at the lower and upper stations. Find in the table the heights in feet, corresponding to the barometer readings. Subtract them and the remainder will be the height required.

When the mean temperature is above or below 50° F., the following correction must be applied; add together the temperature of the upper and lower stations. If the sum is greater than 100° F., *increase* the height by $\frac{1}{1000}$th part for every degree of the excess above 100°; if the sum is less than 100°, *diminish* the height by $\frac{1}{1000}$th part for every degree less than 100°. The complete formula is:

$$D=(H-h)\left(\frac{1+T+t-100}{1000}\right)$$

T and t are the observed temperatures; H and h are the heights in feet taken from the table.

AIRY'S TABLE.

Arranged for temperature of 50° F.

Height in Feet.	Aneroid, or Corrected Barometer	Height in Feet.	Aneroid, or Corrected Barometer	Height in Feet.	Aneroid, or Corrected Barometer	Height in Feet.	Aneroid, or Corrected Barometer	Height in Feet.	Aneroid or Corrected Barometer
ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
0	31·000	2400	28·387	4800	25·994	7200	23·803	9600	21·797
50	30·943	2450	28·335	4850	25·947	7250	23·760	9650	21·757
100	30·886	2500	28·283	4900	25·899	7300	23·716	9700	21·717
150	30·830	2550	28·231	4950	25·852	7350	23·673	9750	21·677
200	30·773	2600	28·180	5000	25·804	7400	23·629	9800	21·638
250	30·717	2650	28·128	5050	25·757	7450	23·586	9850	21·598
300	30·661	2700	28·076	5100	25·710	7500	23·543	9900	21·558
350	30·604	2750	28·025	5150	25·663	7550	23·500	9950	21·519
400	30·548	2800	27·973	5200	25·616	7600	23·457	10000	21·479
450	30·492	2850	27·922	5250	25·569	7650	23·414	10050	21·440
500	30·436	2900	27·871	5300	25·522	7700	23·371	10100	21·401
550	30·381	2950	27·820	5350	25·475	7750	23·328	10150	21·361
600	30·325	3000	27·769	5400	25·428	7800	23·285	10200	21·322
650	30·269	3050	27·718	5450	25·382	7850	23·242	10250	21·283
700	30·214	3100	27·667	5500	25·335	7900	23·200	10300	21·244
750	30·159	3150	27.616	5550	25·289	7950	23·157	10350	21·205
800	30·103	3200	27·566	5600	25·242	8000	23·115	10400	21·166
850	30·048	3250	27·515	5650	25·196	8050	23·072	10450	21·128
900	29·993	3300	27·465	5700	25·150	8100	23·030	10500	21·089
950	29·938	3350	27·415	5750	25·104	8150	22·988	10550	21·050
1000	29·883	3400	27·364	5800	25·058	8200	22·946	10600	21·012
1050	29·828	3450	27·314	5850	25·012	8250	22·904	10650	20·973
1100	29·774	3500	27·264	5900	24·966	8300	22·862	10700	20·935
1150	29·719	3550	27·214	5950	24·920	8350	22·820	10750	20·896
1200	29·665	3600	27·164	6000	24·875	8400	22·778	10800	20·858
1250	29·610	3650	27·115	6050	24·829	8450	22·736	10850	20·820
1300	29·556	3700	27·065	6100	24·784	8500	22·695	10900	20·782
1350	29·502	3750	27·015	6150	24·738	8550	22·653	10950	20·744
1400	29·448	3800	26·966	6200	24·693	8600	22·611	11000	20·706
1450	29·394	3850	26·916	6250	24·648	8650	22·570	11050	20·668
1500	29·340	3900	26·867	6300	24·602	8700	22·529	11100	20·630
1550	29·286	3950	26·818	6350	24·557	8750	22·487	11150	20·592
1600	29·233	4000	26·769	6400	24·512	8800	22.446	11200	20·554
1650	29·179	4050	26·720	6450	24·467	8850	22·405	11250	20·517
1700	29·126	4100	26·671	6500	24·423	8900	22·364	11300	20·479
1750	29·072	4150	26·622	6550	24·378	8950	22·323	11350	20·441
1800	29·019	4200	26·573	6600	24·333	9000	22·282	11400	20·404
1850	28·966	4250	26·524	6650	24·288	9050	22·241	11450	20·367
1900	28·913	4300	26·476	6700	24·244	9100	22·200	11500	20·329
1950	28·860	4350	26·427	6750	24·200	9150	22·160	11550	20·292
2000	28·807	4400	26·379	6800	24·155	9200	22·119	11600	20·255
2050	28·754	4450	26·330	6850	24·111	9250	22·079	11650	20·218
2100	28·701	4500	26·282	6900	24·067	9300	22·038	11700	20·181
2150	28·649	4550	26·234	6950	24·023	9350	21·998	11750	20·144
2200	28·596	4600	26·186	7000	23·979	9400	21·957	11800	20·107
2250	28·544	4650	26·138	7050	23·935	9450	21·917	11850	20·070
2300	28·491	4700	26·090	7100	23·891	9500	21·877	11900	20·033
2350	28·439	4750	26·042	7150	23·847	9550	21·837	11950	19·996
2400	28·387	4800	25·994	7200	23·803	9600	21·797	12000	19·959

MOUNTAIN ANEROIDS.

The majority of Mountain Aneroids now have Airy's table engraved around the dial, the circle bearing the scale of feet being generally movable. This movable circle, as its zero can be turned to correspond with the barometer reading for the time, is convenient for approximate work, as the elevation can be read directly off. The barometer scale, however, being a diminishing one, this mode of use would lead to grave inaccuracies. It is better, therefore, that the zero point be set at 31 inches of pressure and the two readings of feet subtracted to get the difference in height.

TO USE THE ANEROID, WITH ALTITUDE SCALE.

Find the height in feet at first station and subtract this from the height in feet at second station. If the mean temperature is greater or less than 50° F., apply correction for temperature as before given.

Example:

Aneroid at Station A, 1800 feet. Thermometer, 50°.
" " " B, 800 " " 70°.

The approximate height is 1000 feet. The sum of the temperature is 120. A correction of +20 is therefore applied. This is 20 feet.
The difference of elevation is therefore 1000+20=1020 feet.

SIZE OF THE ANEROID.

We can furnish Aneroids of the utmost accuracy, reading from 3000 to 20,000 feet, from $1\frac{3}{4}$ inches diameter to 5 inches diameter. The larger sizes of course permit the use of a more open scale, and are consequently more easily read. The smaller sizes are, however, extremely accurate, and their portability is a strong recommendation.

We are at all times prepared to give exact information about the individual performance of these instruments, and shall spare no pains to furnish the most accurate Aneroids attainable.

POSITION OF THE ANEROID IN USE.

It should be borne in mind that all Aneroids vary in their readings with the position in which they are held, reading somewhat higher in a horizontal position with face up than when vertical. As they are tested and adjusted in a horizontal position, it is better that they should be uniformly read from the horizontal dial.

Before a reading is taken, the face should be tapped slightly with the finger to bring the needle fairly into equilibrium.

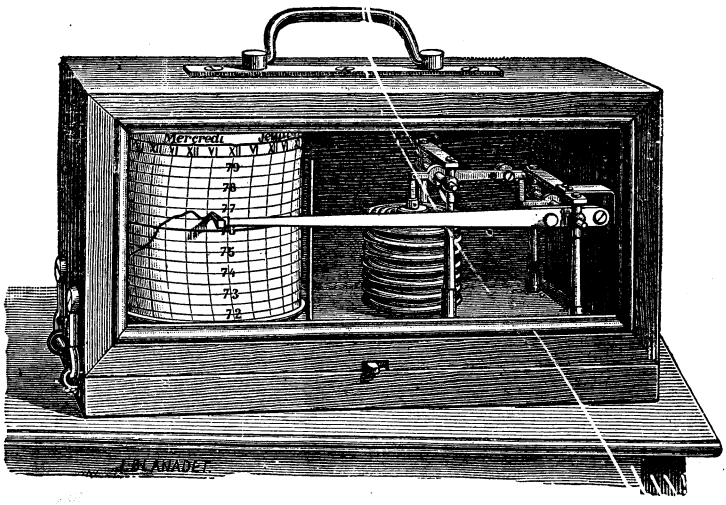
ATMOSPHERIC DISTURBANCE.

As there may be considerable atmospheric variation if any great interval of time elapses between two observations, engineers are now accustomed to use two matched barometers, one of which is kept in camp, where observations are taken at stated intervals, whilst the other is observed at corresponding times in the field. A correction can thus be applied for atmospheric oscillation. Where one barometer only is used, observations may be made repeatedly and the mean taken, or where it is inconvenient to take the higher elevation more than once, the lower reading can be taken *after* as well as before the higher, by which method a partial correction may be obtained.

SELF-RECORDING ANEROID BAROMETER,

FOR

ENGINEERS' USE IN CAMP.



13540.

No.		Price.
13540.	This instrument, the latest form of Self-recording Barometer, is remarkable for the simplicity of its construction and the accuracy of its work. It consists of an aneroid barometer, composed of a series of vacuum boxes, the movements of which are transmitted through a simple mechanism to a long lever, terminating in a metallic pen which touches a drum within which is an eight-day clock. This drum, around which is wound the record blank, makes one revolution in seven days, so that each diagram forms a complete barometric record for the week. After winding the clock and setting the barometer, the instrument requires no attention whatever, until the weekly record is finished. The pen retains enough ink to last for several weeks. In mahogany case, with glass front, ...	$40 00

The following advantages are claimed for the SELF-RECORDING ANEROID BAROMETER:

The unvarying accuracy and precision of the indications resulting from the parts specially employed.

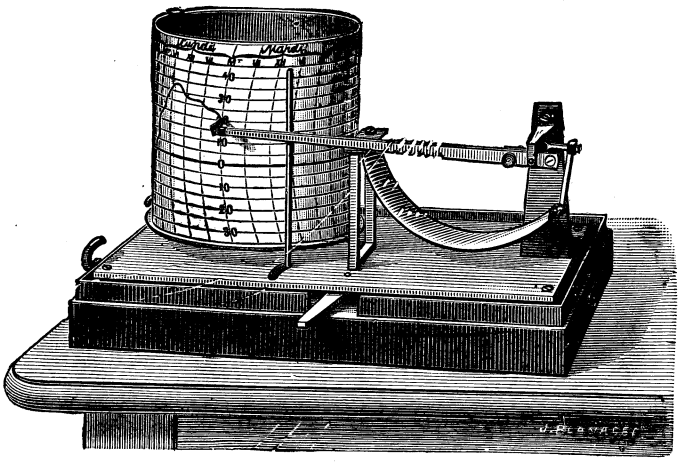
The absence of anything fragile in the apparatus, in consequence of which it is not liable to become deranged.

The facility with which the instrument is set in operation and the ease with which the record papers can be changed.

The regularity of the curves on the diagrams obtained, resulting from the special metal pen employed, which retains sufficient indelible ink to last for a month if necessary.

The small size and weight of the instrument rendering it most convenient for transportation.

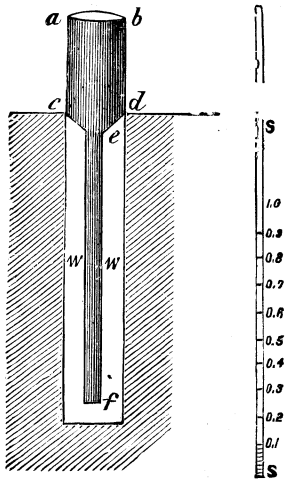
This Barometer has been tested at the office of the U. S. Signal Service, at Philadelphia, in comparison with the Standard Barometer there, and the results obtained were most satisfactory.



13541.

No.		PRICE.
13541.	SELF-RECORDING THERMOMETER, in same style as 13540, with metallic Thermometer, on Breguet's principle. In japanned tin case,	$40 00
13542.	SELF-RECORDING HYGROMETER, made in the same style as 13541,	45 00
	Blanks for the Recording Barometer, Thermometer or Hygrometer, per set, for one year,	2 50
	Pens for any of the above, each,	2 00
	Ink for any of the above, per bottle,	75

RAIN GAUGES.

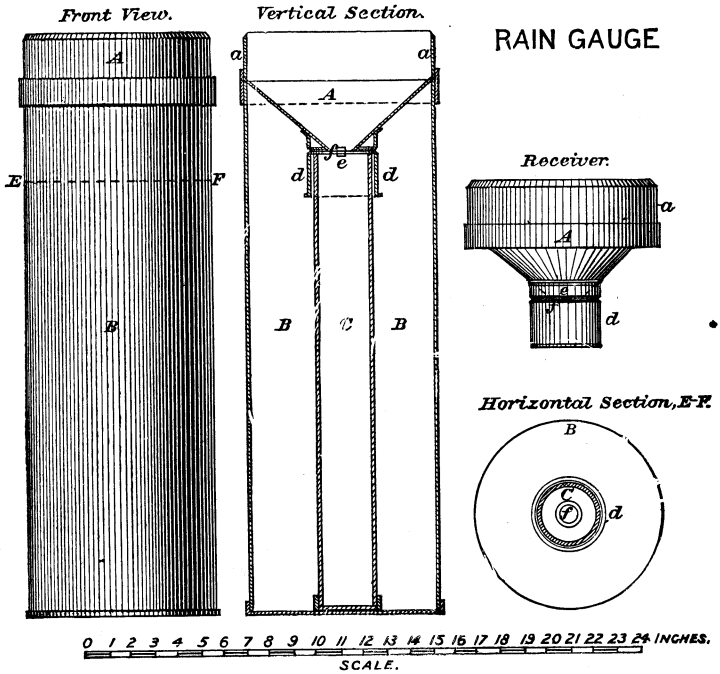


13600.

13603.

No.		Price
13600.	U. S. SIGNAL SERVICE RAIN GAUGE, 24 inches high, diameter of funnel 8 inches, galvanized iron, with measuring stick, holding 2 inches of rainfall,	$2 50
13601.	U. S. SIGNAL SERVICE RAIN GAUGE, same as 13600, in lacquered brass, with walnut socket,	15 00
13602.	SMITHSONIAN RAIN GAUGE, 10 inches high, diameter of funnel 1 inch, with measuring stick and walnut socket, same form as 13601, holding 1 inch rain,	5 00
13603.	HOWARD'S RAIN GAUGE, consisting of a vertical glass bottle, through the neck of which the terminal tube of a funnel, 5 inches in diameter, is inserted. A glass graduate, measuring to 100ths of an inch, is furnished with the instrument. In galvanized iron.	4 00
13605.	GLAISHER'S RAIN GAUGE, receiving funnel 8 inches diameter, terminating in a curved tube, which prevents evaporation. With graduated vessel, divided to 100ths of an inch, in galvanized iron	5 00
13606.	GLAISHER'S RAIN GAUGE, same as 13605, in lacquered brass	10 00
13607.	SYMON'S RAIN GAUGE. This gauge resembles Howard's, but has the glass receiver inclosed in a metal jacket, with openings permitting approximate observations. The metal jacket is furnished with spikes, by which the instrument is fastened firmly to the ground. With measure graduated to 100ths. In galvanized iron	7 00
13608.	HOWARD'S PEDESTAL RAIN GAUGE, 12 inches diameter, with glass tube graduated to inches, tenths and hundredths of an inch, showing by direct observations the amount of rainfall, without the use of a graduated measure. In japanned metal,	20 00

U. S. Weather Bureau Rain and Snow Gauge.



13611.

No.		Price.
13611.	U. S. W. B. Standard Rain and Snow Gauge	$5 00
13612.	U. S. W. B. Box Support for Standard Gauge.	1 50

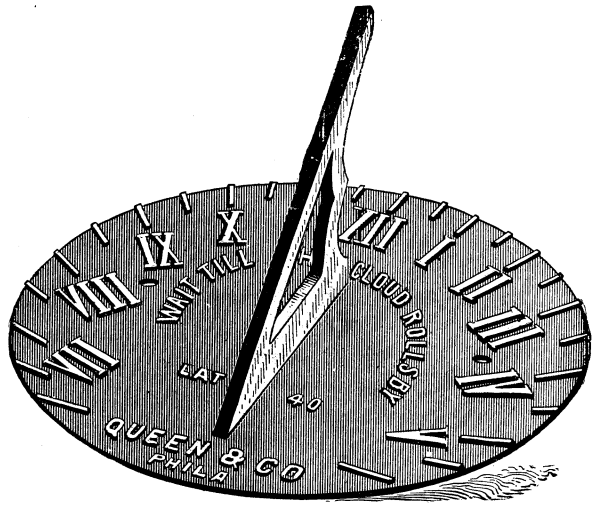
This gauge consists of four parts, the funnel A, the receiver C, overflow B and the measuring stick.

The rain collected by the funnel flows through the hole E into the receiver, which being much smaller in diameter than the funnel, the rain collects faster than it would in a straight cylinder. These gauges are so adjusted that the readings are magnified 10 times.

To take a reading insert the measuring stick through the hole C, and note how high it is moistened. The graduations are in inches, tenths and hundredths. 1 inch of rain being actually 10 inches on the stick.

To measure snow remove the funnel and receiver, and after collecting the snow let it melt, and pour it in the receiver and measure the same as rain; measure the full depth of the snow, as both readings are valuable.

Sundials.

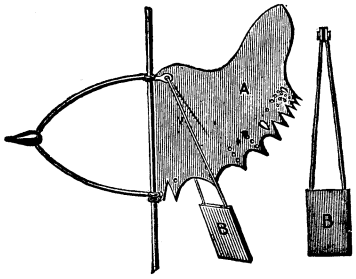


13615.

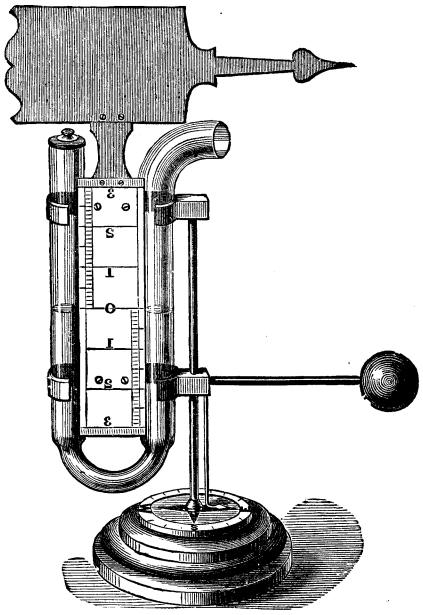
Sundials should be made according to the latitude in which they are placed.

No.		Price.
13615.	Sundial, horizontal, 12 inches diameter, japanned iron, latitude 40°, the latitude of Philadelphia and vicinity	$ 3 50
13616.	Sundial, same as No. 13615, in lacquered brass	7 50
13617.	Sundial, horizontal, japanned iron, any other latitude than 40° made to order.	12 00
13618.	Sundial, south vertical, made to order for any latitude	12 00
13619.	" north " " " " "	12 00
13620.	" south-declining vertical, made to order for any latitude, and facing any degree of the compass	15 00

ANEMOMETERS, OR WIND GAUGES.



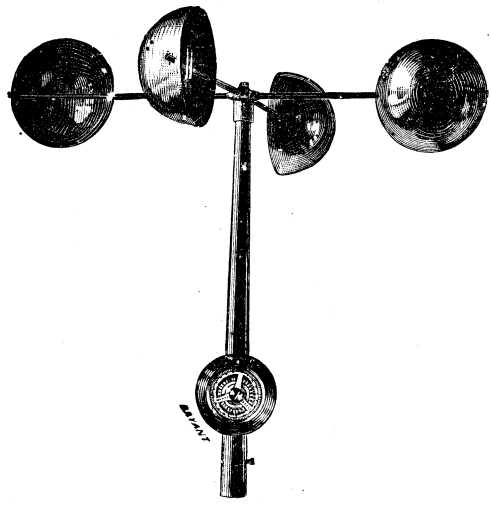
14000.



14001.

No.		Price.
14000.	PRESTEL'S PENDULUM ANEMOMETER, for showing the direction and pressure of the wind. The vane is arranged to keep the pressure-plate B always toward the wind. The pressure-plate hangs vertical during a calm, indicating zero, rising with increased pressure, through the various degrees of elevation from 0 to 10. The vane is perforated with holes large enough to be visible from the ground, the 5 and 10 being especially large, so that the angle of the pressure-plate may be more quickly seen, ...	$50 00
14001.	LIND'S ANEMOMETER, OR WIND GAUGE, for determining the force of the wind. This instrument consists of a glass syphon, with parallel limbs, mounted upon a vertical rod, on which it moves freely by the action of the vane which surmounts it. The upper part of one of the limbs is bent outward toward the wind. Between the limbs is a graduated scale, graduated from 0 to 3 in 10ths, the zero being in the centre of the scale. In use, the tube is filled with water to the zero of the scale and exposed to the action of the wind, by which the water is depressed in the one limb and raised in the other. The sum of the elevation and depression is the height of the column which the wind is capable of sustaining, . . .	20 00

United States Weather Bureau Anemometer.

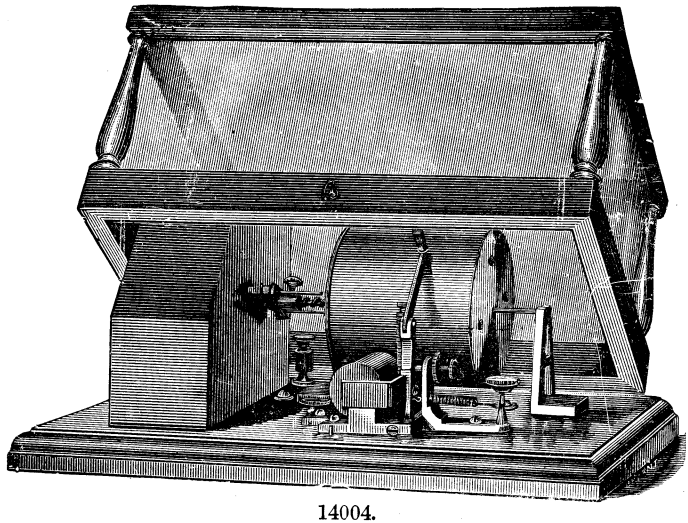


14003

14003. UNITED STATES WEATHER BUREAU ANEMOMETER, Robinson's pattern (for velocity) $22 50

Packing and boxing 75

14004. SINGLE ANEMOMETER REGISTER 35 00

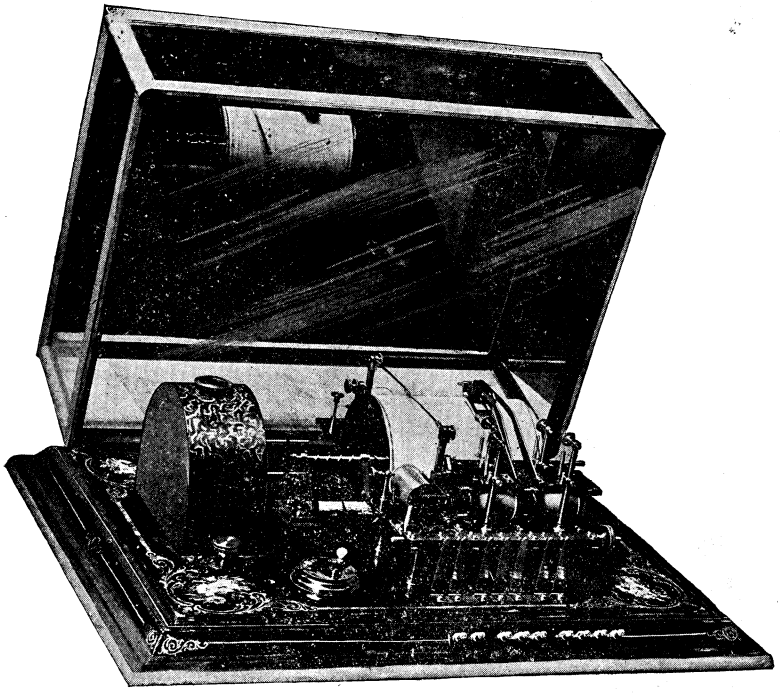


14004.

Full directions for setting up Anemometer accompany each instrument

Double and Triple Registers.

1897 PATTERN.



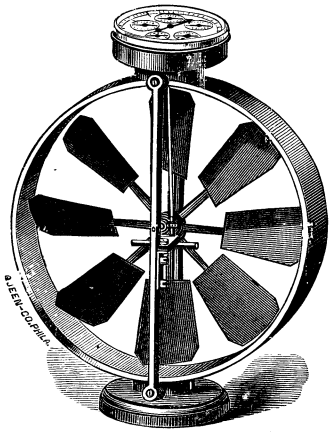
14010.

No.		Price.
14005.	Two Magnet Register, for simultaneously recording, an Anemometer, an Electrical Sunshine Recorder and a Tipping Bucket Rain Gauge	$ 50 00
14010.	Triple Register, for recording wind direction and velocity rainfall and sunshine, price complete, with ink, pens and charts	165 00
14011.	Tipping Bucket Rain Gauge	40 00
14012.	Electrical Sunshine Recorder	25 00
	Both Nos. 14011 and 14012 are used in connection with the double and triple registers. The records being made by one magnet.	
14013.	Photographic Sunshine Recorder, makes a continuous record on blue print paper, complete	25 00
14015.	Wind Vane, consisting of the vane and supports, also the latest pattern electrical contacts, complete	65 00
14016.	Electrical Contacts, separate	25 00
14018.	Standard Instrument Shelter, small size	17 50
14019.	" " " large "	30 00

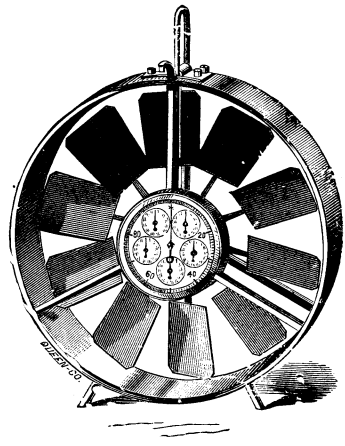
ANEMOMETERS.

For Measuring the Velocity of Currents of Air in Coal Mines, and Ventilators, Flues, etc., of Public Buildings.

The Anemometer, an instrument invented for the purpose of measuring the rate at which air moves in mines and ventilation passages, is now an indispensable adjunct of the former, the mining laws of most States requiring that a certain number of cubic feet of air shall be passed to the air-ways, and the Anemometer furnishing the most convenient and satisfactory mode by which the amount of air passing can be determined.

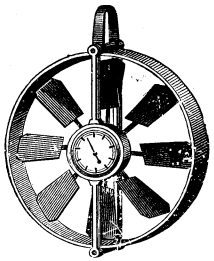


No. 14,500.



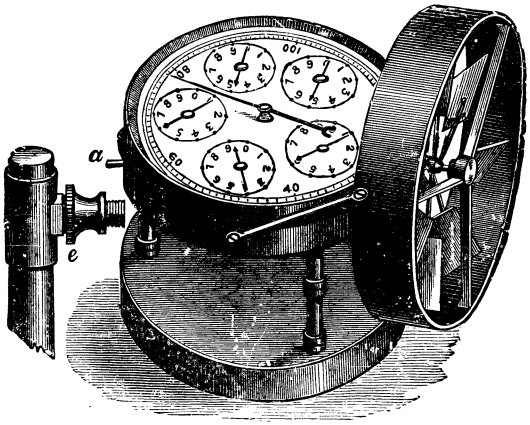
No. 14505.

14,500.	Biram's Anemometer, 6 inches diameter, reading to ten million feet, with disconnector, Fig. 1,	$40 00
14,501.	Biram's Anemometer, 5 inches diameter, same as 14,500.	39 00
14,502.	Biram's Anemometer, 4 inches diameter, same as 14,500,	37 50
14,505.	Biram's Anemometer, 12 inches diameter, reading to ten million feet, with disconnector,	45 00
14,506.	Biram's Anemometer, 6 inches diameter, same as 14,505,	40 00
14,507.	Biram's Anemometer, 4 inches diameter, same as 14,505.	37 50



No. 14,508

14,508. BIRAM'S ANEMOMETER, 6 inches diameter, reading to 1000 feet, with disconnector, ... 25 00
14,509. BIRAM'S ANEMOMETER, 6 inches diameter, reading to 1000 feet, without disconnector, ... 22 50
14,510. BIRAM'S ANEMOMETER, 4 inches diameter, reading to 100 feet, . 20 00
14,511. BIRAM'S ANEMOMETER, same as above, with disconnector, . . 22 50
14,512. BIRAM'S ANEMOMETER, 3 inches diameter, reading to 1000 feet 15 00



No. 14,515.

14,515. THE PORTABLE AIR METER, diameter of fan wheel $2\frac{3}{4}$ inches, with disconnector, which is extensively used for testing the ventilation of HOSPITALS, SCHOOLS and PUBLIC BUILDINGS, forms also, an admirable Pocket Anemometer for tourists. The indications are obtained by the revolution of a series of fans (similar to those of Biram's Anemometer) acting first, upon a long hand capable of recording the velocity of fifty feet per minute on the large dial, divided to 100 feet, and then successively, by a train of wheels on the indices of five smaller dials, recording respectively, 100, 1,000, 10,000, 100,000 and 10,000,000 feet, or 1,893 miles, ... 25 00
14,516. AIR METER, same as preceding, but reading only to 1,000 feet, . 20 00
14,517. WATCH ANEMOMETER, very small and sensitive, outside dimensions $2\frac{3}{4}$ in. in white metal hunting case, ... 40 00
14,518. WATCH ANEMOMETER, same as above, in silver hunting case, . 45 00

HOW TO USE THE ANEMOMETER.

THE ANEMOMETER consists of a series of vanes, which revolve with the action of the air current, the number of revolutions, or numbers proportioned to the revolutions, being registered by a pointer on the face of a dial, forming part of instrument itself. It is made of four sizes, 4, 5, 6 and 12 inches; is very portable, and not at all liable to get out of order. The mechanism is placed either in front of the wheel, as in No. 14,505, or in a small separate box over the fan-wheel, as in No. 14,500 and the registering apparatus consists of one or more dials, as it may read to 100 or more feet. Those reading to ten million feet have six small circles, marked respectively, X, C, M, XM, CM and M, the divisions on which denote units of the denomination of the respective circles; in other words, the X index in one revolution passes over its ten divisions and registers (10x10) or 100 feet; the C index in the same way, 1000 feet, and so on, up to ten million; so that an observer has only to record the position of the several indices at the first observation (by writing the lower of the two figures on the respective circles, between which the index points, in their proper order), and deduct the amount from their position at the second observation, to ascertain the velocity of the air which has passed in the interval. This multiplied by the area in feet of the passage, where the instrument is placed, will show the number of cubic feet which has passed during the same period.

Thus, suppose the observation of one minute gives:

Second Reading, ...	5,525
First Reading, ...	5,225
	300
Add correction, say . . .	30
	330

Size of passage in feet, 10x5x330=16,500 cubic feet per minute.

The correction added above is the value of the constant of friction, which must be found for each machine by actual experiment.

TO FIND THE VELOCITY

OF THE AIR IN THE PASSAGE,

Proceed thus:—Suppose the Anemometer indicates 330 feet per minute. 330÷88=3.75, $3\frac{3}{4}$ miles per hour, 88 being 1-60th of a mile.

To ascertain the force of the air current, multiply the square of the velocity of the air in feet per second by .0023.

CORRECTION OF ANEMOMETERS.

As it requires a certain initial velocity to overcome the resistance and friction of the instrument, and as this varies with each instrument, to obtain accurate results, it is necessary that each Anemometer should be specially tested to obtain the value of the corrections required to be employed. These corrections remain the same for the same instrument, so long as it remains in the same condition, and are independent of the velocities of the currents of air in which it is employed. The wear and tear of use, severe shocks or jars, and so on, may, however, be expected, in time, to alter these constants, and all Anemometers require to be periodically tested, in order to obtain thoroughly accurate results.

For this purpose we have the only Anemometer Testing Machine in this country. We are prepared to carefully test Anemometers, furnishing a certificate of corrections for each instrument. Anemometers sent to us to be tested should be numbered, carefully

packed and accompanied by directions for re-shipment. They will be returned in two days from date of reception. All Anemometers sent out from this establishment will be thoroughly tested and the constants required in the formula obtained and stated in accompanying certificate.

THE ANENOMETER IN PUBLIC BUILDINGS.

For use in regulating the ventilation in Hospitals, Prisons, Schools and Public Buildings, the Anemometer is extremely valuable, and it is extensively employed in Europe for this purpose. We have supplied a number of these instruments to various institutions of the kind in this country, and as illustrating the interest in this subject, we subjoin an extract from the report of the Board of Education of Detroit, Michigan, to whom we furnished Anemometers:

"Your Committee of Hygiene have under consideration the subject of the better heating and ventilating of our Public School buildings, and to aid them in their work, respectfully ask authority to purchase an air meter."

It is so obviously important that in all buildings where a number of persons are congregated, there should be some certain and satisfactory test of the ventilation, that we feel confident that it is only necessary to make the public acquainted with the possibility of making the test in an easy and convenient manner, to have these instruments put in universal use.

THE VENTILATION OF MINES.

We extract the following from the valuable circular issued by Mr. Wm. Wilcox, Inspector of Bituminous Coal Mines, First District of Pennsylvania:

"The law requires that all mines shall be thoroughly drained and ventilated, and therefore has fixed the amount of air that shall be circulated through the mines at one hundred feet per minute, for each and every person employed in the mine. This has been found by experience to be barely sufficient in all cases to dilute, carry off and render harmless the noxious gas generating in mines. All good mining authorities agree that this amount is required in all non-fiery mines. In many cases where explosive gas is generated, much more is required to render the workings safe and healthy. Of all the precautions taken to preserve the health and safety of workmen, proper ventilation and drainage are the most important.

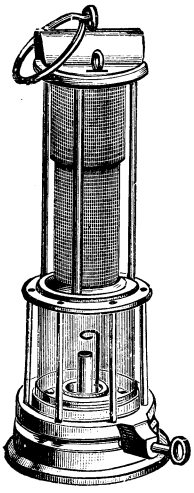
"The most important matter after a good supply of air has been produced, is to see that it is carried to the face of the workings; and to be able to do this, good airways must be provided of not less than forty feet area.

"It is absolutely necessary that more attention be paid to these matters, and that competent persons be placed in charge where incompetent ones are now filling the place; and that air measurements be taken regularly every week, and reported to the inspector of the district every month as the law requires. There are several ways of taking air measurements: by powder smoke, naked light, and by the Anemometer. None of these are absolutely correct, but the Anemometer is as nearly correct as science can make it, and is much the easiest way of taking measurements in mines.

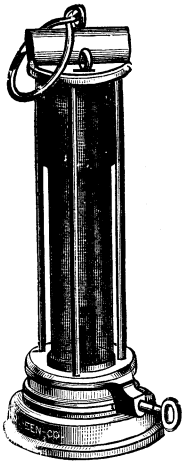
"To ascertain the amount of air circulating with a Biram Anemometer, select a place in the airtake or return airway, having a uniform section; let the instrument run a short time to gain full speed, then test it one minute by the watch and note the velocity. Next, ascertain the area of the heading, where the test was made. Say it is seven feet wide and six feet high. 6x7=42 square feet; and say the velocity is 350 feet per minute. Then multiply the area of the heading and the velocity together, thus: 42x350=14,700 feet per minute."

The Mining Law of Ohio provides that in all mines (in Pennsylvania, all bituminous mines), there shall be not less than one hundred cubic feet of air per man per minute, and as much more as the inspector may direct. At Wellston, in that State, the mine of the Milton Furnace and Coal Company has a furnace by which two hundred cubic feet of air per man per minute is made to traverse the workings.

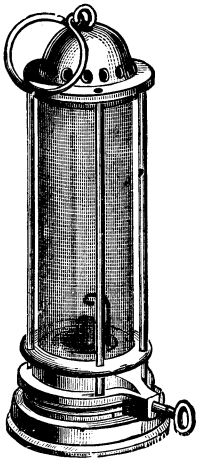
MINERS' SAFETY LAMPS.



14526.



14525.



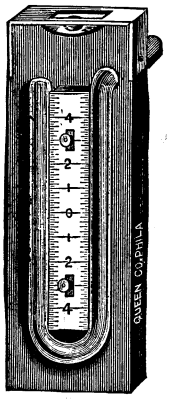
14528.

No.			Price.
14525.	Newcastle Davy Lamp,	per dozen,	$22 00
14526.	Universal Clanny Lamp,	do.	28 00
14527.	Cambrian Bonnetted Lamp,	do.	32 00
14528.	Stephenson Lamp, with glass tube inside wire gauze,	do.	35 00
14529.	Fireman's Lamp,	do.	22 00
14533.	Extra Gauzes for Davy or Clanny Lamps,	do.	3 25
14534.	Metallic Brushes for Cleaning Gauzes,	do.	3 50
14535.	Best Hair Brushes do. do.	do.	3 50
14536.	Ordinary Hair Brushes for do.	do.	2 50
14537.	Extra Glasses for Clanny Lamps,	do.	2 10
14538.	Extra Glass for Stephenson Lamps,	do.	3 00

Fire-Proof Brattice Cloth, for Gangways, Air Stoppings, &c., &c. This cloth, which is in very extensive use in English and American Collieries, is largely used as a substitute for wood bratticeing, over which its fire-proof qualities and the ease with which it can be erected and removed, give it great advantage. It is perfectly air-tight and very durable, and is made in widths of 6 feet, 7 feet and 8 feet, and in rolls of 100 to 200 yards.

14545.	No. 1,	Price per square yard,	38
14546.	No. 2,	do. do.	45
14547.	No. 3,	do. do.	50

MINERS' WATER GAUGE.



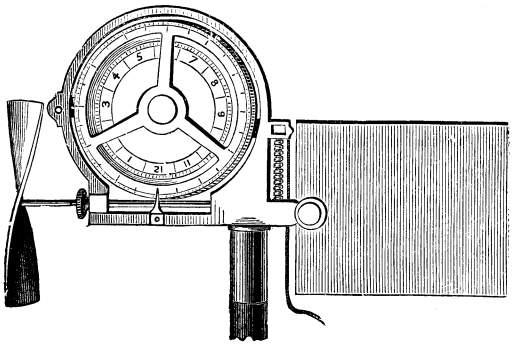
14550.

No.		Price.
14550.	WATER GAUGE, ...	$3 75

The Water Gauge is a glass tube, bent in the shape of the letter U, with an adjustable scale of inches and parts by which the difference between the height of the water in one arm and that in the other can be measured. It is provided with a spirit level, by which it can be accurately set. As air passes along an airway it loses the pressure, which is spent on the friction in its progress.

In use, the water gauge is placed in such a manner that the difference in pressure of the intake and return columns of air is shown, and consequently the amount of loss of pressure due to friction. According to Mr. Atkinson, the difference of level, which represents the ventilating pressure spent on the airways, lying beyond the place where it is taken, is seldom so much as three inches, and often only one inch in well-ventilated mines.

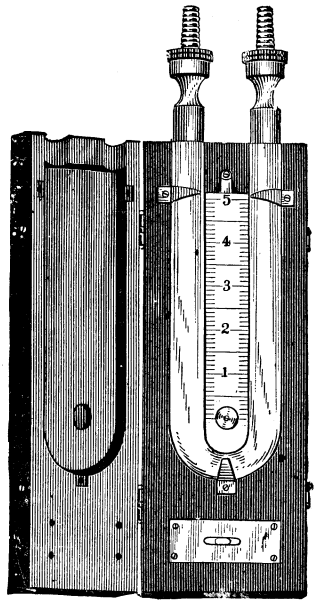
CURRENT METER.



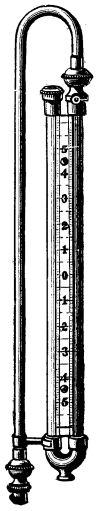
14551.

14551. CURRENT METER, for use in small rivers and streams, to show rate of flow of tide or number of gallons flowing from any reservoir or vessel $50 00

Draft Gauges.



14555.



14556.

No.		Price.
14555.	Inspectors' Gas Gauge, walnut case, with spirit level and handle,	$10 00

Siphon Pressure Gauges.

14556.	4 in. nickeled, each	2 50
14557.	6 in. " "	3 00
14558.	8 in. " "	3 50
14559.	10 in. " "	4 50
14560.	12 in. " "	5 50
14561.	14 in. " "	6 50
14562.	16 in. " "	7 50
14563.	18 in. " "	9 00
14564.	20 in. " "	12 00
14566.	24 in. " "	15 00

An inch of water column as shown by a water gauge, represents a pressure of about 5.21 lbs. per square foot.

To find the velocity of air in feet per second, divide the pressure in lbs. per sq. ft. by .0023 and then extract the square root, the result will be the velocity in feet per second; multiply the feet per second by $\frac{60}{88}$ the result will be miles per hour.

HYDROMETERS.

These instruments are designed to show the specific gravity of a liquid by the depth to which they sink in it.

The specific gravities of all liquids are referred to distilled water as a standard. For this purpose a very light glass flask is blown, holding exactly 1000 grains of pure distilled water at a temperature of 60° Fahr.

It is evident that if any other liquid be put into the flask, filling it exactly to the mark to which 1000 grains of distilled water reach, we shall have, by weighing the flask, the relative gravity of the two liquids. Thus, it will be found that if the flask is filled with oil of vitriol its weight will be about 1,845 grains, or nearly double the specific gravity of the water.

Referring to the Specific Gravity Flask as a standard, the Hydrometer has been constructed. It is simply a slender graduated stem with a bulb and counterpoise, and the principle of its operation is that of the law of floating bodies—*i. e.*, that when a body floats, the weight of the bulk of liquid displaced is equivalent to the weight of the body floated.

Hydrometers are usually made of glass, and weighted with mercury or shot. The scales are generally constructed after an arbitrary standard, so that the readings contain no decimals.

The Twaddle Hydrometer is so graduated that the number of degrees indicated, multiplied by 5 and added to 1000, gives the specific gravity of a liquid, with water as 1000.

The Hydrometer for sea-water has a range of 40 degrees, the numbers of degrees indicating the third place of decimals, in expressing specific gravities; thus 3 degrees indicate a gravity of 1.003; 18 degrees of 1.018, etc.

A variety of hydrometers, with arbitrary scales, are used for testing various liquids. Thus Tralle's Hydrometer (called Alcoholometer) is graduated to give the percentage of alcohol by volume in an alcoholic solution. This is now the official instrument for testing liquors in the United States.

Richter's Hydrometer reads in percentages by weight of alcohol. Balling's Hydrometer, which is extensively used by dyers and manufacturers, is graduated arbitrarily, its readings being converted into specific gravities by the formula

$$\text{Sp. gr.} = \frac{200}{200 \pm n}$$

n representing the reading of the hydrometer, the + sign being used when the liquid is lighter than water, the — sign when it is heavier.

The hydrometer which is most generally used, for all purposes, is that of Baumé, of which there are two kinds, one for liquids lighter than water and one for those heavier.

For liquids lighter than water, the zero point is the point to which the hydrometer sinks in a solution containing 10 parts of common salt in 90 parts of water, while the 10 mark is at the point to which the instrument sinks in pure water.

For liquids heavier than water, pure water is taken as the zero point, and 15 is the point to which the instrument sinks in a solution of 15 parts of common salt in 85 parts of water.

The hydrometer for liquids lighter than water is termed *pêse esprit*, or spirit, and is converted into specific gravities by the formula:

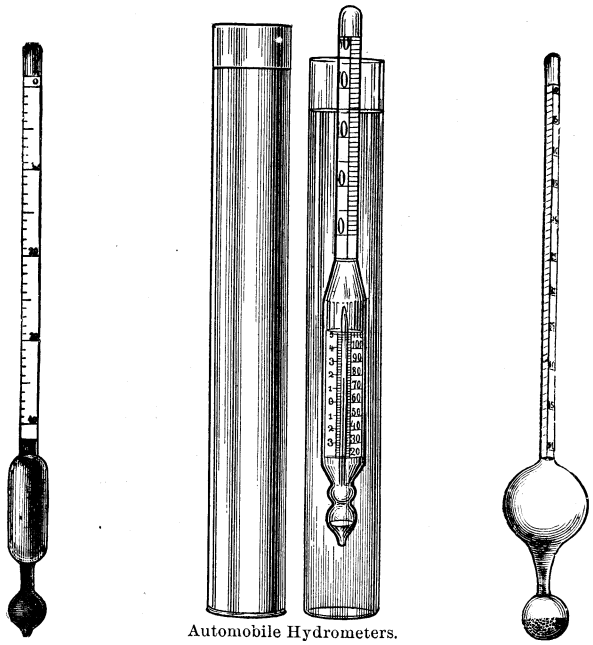
$$\text{Sp. gr.} = \frac{146}{136 + x}$$

That for liquids heavier than water is called *pêse acide*, or acid, and is converted into specific gravities by the formula:

$$\text{Sp. gr.} = \frac{152}{152 - x}$$

Cartier's Hydrometer is practically the same as that of Baumé. At 22°, the two instruments are alike; for other points above and below, 15 of the Cartier equal 16 of Baumé.

HYDROMETERS.



Automobile Hydrometers.

No.		Common. Price.	Our own Standard Make. Price.
14600.	Hydrometer for Acid,	$0 50	$0 75
14601.	Hydrometer for Ammonia,	50	75
14602.	Hydrometer for Alkali,	50	75
14603.	Hydrometer for Bark,	50	75
14604.	Hydrometer for Beer,	50	75
14605.	Hydrometer for Chlorine,	50	75
14606.	Hydrometer for Cider,	50	75
14607.	Hydrometer for Coal Oil,	50	75
14608.	Hydrometer for Milk,	50	75
14609.	Hydrometer for Oil,	50	75
14610.	Hydrometer for Salt,	50	75
14611.	Hydrometer for Shellac,	50	75
14612.	Hydrometer for Spirit,	50	75
14613.	Hydrometer for Sugar and Syrup,	50	75
14614.	Twaddel Hydrometer, No. 1, 0 to 24,	50	75
14615.	Twaddel Hydrometer, No. 2, 24 to 48,	50	75
14616.	Twaddel Hydrometer, No. 3, 48 to 72,	50	75
14617.	Twaddel Hydrometer, No. 4, 72 to 100,	50	75
14618.	Twaddel Hydrometer, No. 5, 100 to 134,	50	75
14619.	Twaddel Hydrometer, No. 6, 134 to 180,	50	75
14620	Hydrometer for Vinegar,	50	75
14621.	Hydrometer for Wine Must,	50	75
	Special Automobile Hydrometer, for Testing Gasoline	each	1 50

HYDROMETERS.

FOR LIQUIDS LIGHTER THAN WATER.

No.		Price.
14622.	Baume and Specific Gravity Hydrometer, 0.700 to 1000,	$1 00
14623.	Do. do. do. do. with Thermometer,	1 75
14624.	Do. do. do. do. 0.70 to 0.80, 0.80 to 0.90, 0.90 to 1000, each,	1 00
14625.	Do. do. do. do. 0.70 to 0.85, 0.85 to 1000, each,	1 00

HYDROMETERS.

FOR LIQUIDS HEAVIER THAN WATER.

No.		Price
14636.	Baume and Specific Gravity Hydrometer, 1000 to 2000,	$1 00
14637.	Do. do. do. do. with Thermometer,	1 75
14638.	Do. do. do. do, 1000 to 1200, 1200 to 1400, 1400 to 1600, 1600 to 1800, 1800 to 2000, each,	1 00
14639.	Do. do. do. do. 1000 to 1400, 1400 to 2000, each,	1 00
14640.	Hydrometer Universal, 0.700 to 2000,	1 75

We also make a full line of Metallic Hydrometers, using copper, silver or German silver. Prices can be had upon applicatlon.

HYDROMETERS IN SETS.

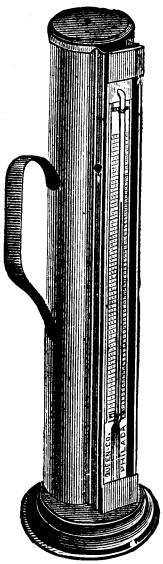
We desire to call attention to the superiority of our Hydrometers, and to ask those to whom accuracy is of primary importance to give them a trial, as we are satisfied that they will be satisfactory.

No.		Price.
14645.	Baume and Specific Gravity, complete set of two, one each for light and heavy liquids,	$1 75
14646.	Do. do. do. do. with Thermometer and Jar in lined case,	6 00
*14647.	Do. do. do. do. set of three, one for light and two for heavy,	2 75
14648.	Do. do. do. do. with Thermometer and Jar in lined case	7 00
14649.	Do. do. do. do. set of four, two for light and two for heavy liquids,	3 75
14650.	Do. do. do. do with Thermometer and Jar in lined case,	8 00
14651.	Do. do. do. do. set of five, two for light and three for heavy liquids,	4 50
14652.	Do. do. do. do. with Thermometer and Jar in lined case,	9 50
14653.	Do. do. do. do. set of six, three each for light and heavy liquids,	5 50
14654.	Do. do. do. do. with Thermometer and Jar in case,	10 50
14655.	Hydrometers for Sugar Brix's Scale, set of three, in half degrees, 0 to 30, 30 to 60, 30 to 90,	4 50
14655*a*.	Do. do. do. do. with Thermometer,	8 50

*14647 can be furnished, two for light or two heavy, if desired.

Hydrometers.

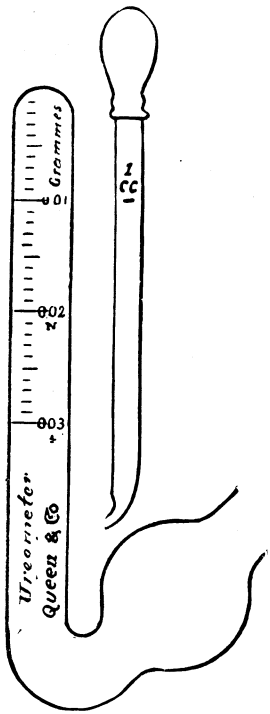
For Testing Whiskey.



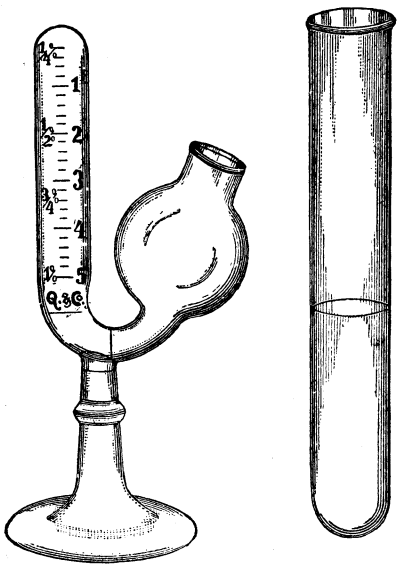
14658.

No			PRICE.
14656.	ALCOHOLOMETER, Tralles and Proof Scale, 12 inches,		$1 25
14657.	ALCOHOLOMETER, do. do. do. with Thermometer,		2 00
14658.	ALCOHOLOMETER, Hydrometer and Thermometer, in copper can,		5 00
14659.	ALCOHOLOMETER, do. do. do. with glass jar and McCulloch's book of calculations,		10 00
14660.	ALCOHOLOMETER, silver Hydrometer, with copper can and Thermometer, in morocco case,		21 00
14661.	KAYSER'S SACCHAROMETER and Thermometer combined,		2 00
14662.	BALLING'S SACCHAROMETER and Thermometer,		2 00
14663.	COPPER SACCHAROMETER CAN, with Thermometer,		4 50
14664.	**Set of Hydrometers, for inspectors' use, consists of 5 spindles and copper can, packed neatly in case**		15 00
14664 A.	Hydrometer Stem No. 1,	0°-100°	1 25
B.	" " " 2,	80°-120°	1 25
C.	" " " 3,	100°-140°	1 25
D.	" " " 4,	130°-170°	1 25
E.	" " " 5,	160°-200°	1 25

No.		Price
14667.	URINOMETER, Specific Gravity Scale, 1000 to 1060, in pull-off case, with jar,	$ 50
14668.	URINOMETER, set of two spindles, 1000 to 1020, 1020 to 1060,	2 00
14669.	Do. do. do. do. do. with Thermometer, morocco case, lined,	4 50
14670.	URINOMETER, 1000 to 1060, scale etched on enamel stem, with flat bulb, in pull-off case, with jar,	1 50
14671.	URINOMETER, as recommended by Dr. Squibbs, with Thermometer,	2 50
14672.	URINOMETER, according to Heller,	75
14673.	URINOMETER, set of two spindles, according to Vogel,	1 50
14674.	URINOMETER, set consisting of Urinometer, delicate Thermometer and Test Papers, and Jar, in case,	3 50
14675.	URINOMETER, set consisting of Urinometer, Jar, Test Tubes, Holder, Glass Rods, Support Spirit Lamp, Test Papers, Fehling's Test and Liquor Potassa,	4 00

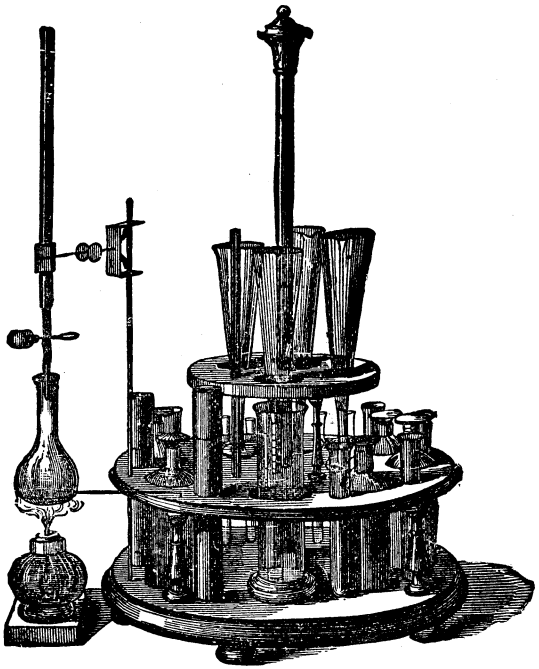


14676.



14677.

14676.	UREOMETER, according to Doremus, in grammes or grains, with pipette and stand, complete, in box,	$2 00
14677.	DR. EINHORN'S FERMENTATION SACCHAROMETER, two tubes,	1 50
14678.	HUEFNER'S UREOMETER, for estimating the percentage of nitrogen in urine,	5 00
14679.	ESBACH'S ALBUMENOMETER,	75
14680.	ESBACH'S ALBUMENOMETER, with No. 14676 or 14677 and Dr. Squibb's Urinometer, with Thermometer,	6 50



14681

14681 SET OF APPARATUS, for urinary test according to Roberts, improved by Lewis.

1. 1 SET NEUBAUER'S URINOMETERS, in two spindles, one ranging from 1000 to 1020, and one from 1020 to 1040, complete with cylinders.
2. 4 Conical Test Glasses with lip and foot.
3. ½ Dozen 5 inch, Test Tubes.
4. 1 Alcohol Lamp, 4 ounces.
5. 5 4-ounce Reagent Bot les, with engraved labels, containing the following reagents:
   Acetic Acid, Nitric Acid, Liquor Potassæ, Ammonia, Fehling's Solution.
6. 1 Mohr's Burette with pinchcock.
7. 1 Bunsen's Burette Clamp.
8. 3 Pipettes, 5 to 6 inches long.
9. 3 Stirring Rods.
10. 1 graduated Cylinder.
11. 1 Flask with flat bottom.
12. 1 Ring to support flask.
13. 1 book Litmus paper.

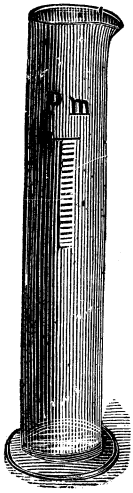
The whole arranged on a circular stand of two tiers, made of polished wood, price complete, ... $15 00

This set is arranged for physicians' use.

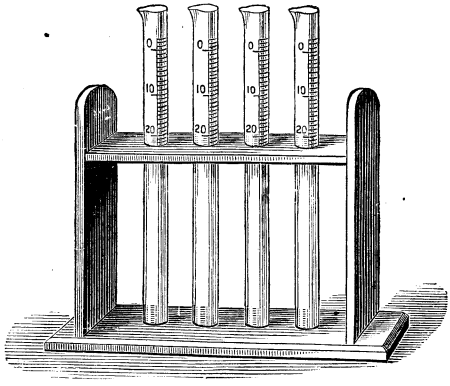
14682. SET OF APPARATUS, for urinary test according to Draper, complete on stand, ... 5 00

This set is arranged for students' use.

Apparatus for Milk Analysis.



14686.



14687.

14685. PHILADELPHIA BOARD OF HEALTH LACTOMETER, on the principle of the hydrometer, showing the purity of milk, graduated from 0 water to 100 pure milk, sp. gr. 1029, Temp. 60° F., $ 75

14686. CREAM GAUGE, showing the relative percentage of cream in milk 75

14687. SET OF FOUR CREAM GAUGES, for comparison, in japanned tin stand 3 00

14688. LACTOMETER, with thermometer 2 50

14689. LACTODENSIMETER, according to Quevenne 2 00

14690. LACTODENSIMETER, according to Soxhlet 2 00

14691. CREAMOMETER, according to Chevalier 1 00

14692. CREAMOMETER, according to Chevalier, with stopcock 2 00

14693. CREAMOMETER, CHEVALIER'S, with Quevenne's Lactodensimeter in lined box, with directions 6 00

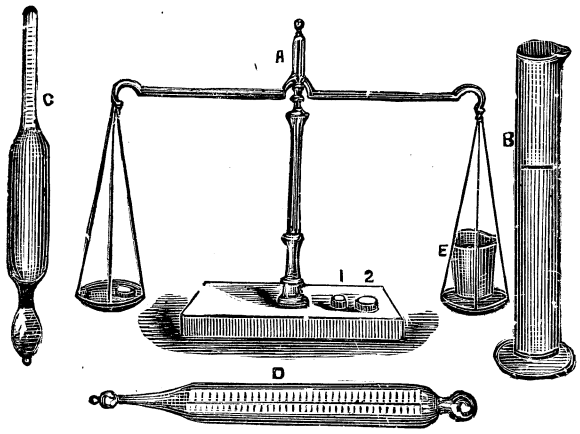
14694. CREAM TUBES, according to Gerber 75

14695. LACTOBUTYROMETER, according to Marchand 75

14696. LACTOBUTYROMETER, according to Marchand, with foot and glass stopper 1 50

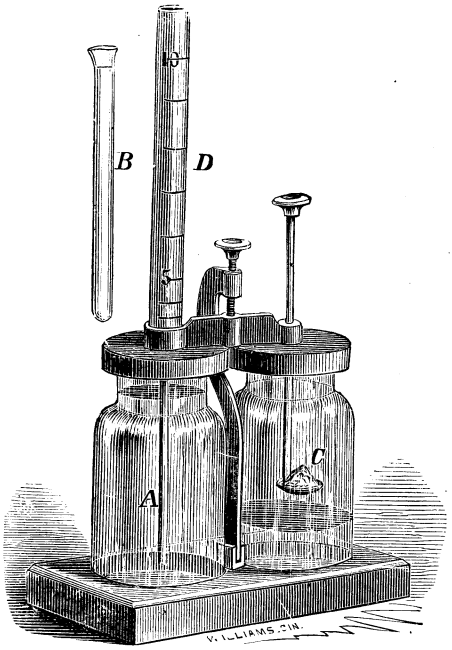
14697. LACTOBUTYROMETERS, MARCHAND'S, in sets of three with Pipettes, etc., packed inside of a brass cylinder complete . . 10 00

14698. LACTOSCOPE, according to Feser, show amount of fat in milk 3 50



14715.

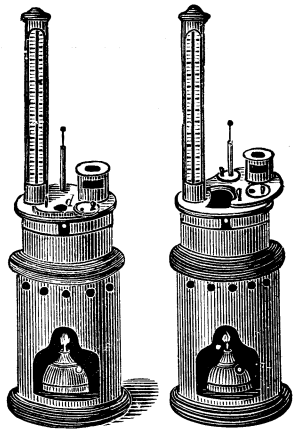
No.		Price.
14715.	GRAPE-SUGAR TESTER, giving percentage of saccharine in Grape-sugar,	$10 00



14716.

14716.	TWITCHELL'S ACIDOMETER, for determining the strength of Vinegar,	12 00

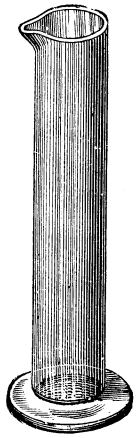
COAL OIL PYROMETERS.



14722.

No		Price
14720.	Copper Coal Oil Fire-Testers, with thermometer, complete,	$5 00
14721.	Copper Fire-Testers, High Grade for Heavy Oils,	10 00
14722.	Coal Oil Pyrometer,	12 00
14723.	Coal Oil Pyrometer, large size,	15 00

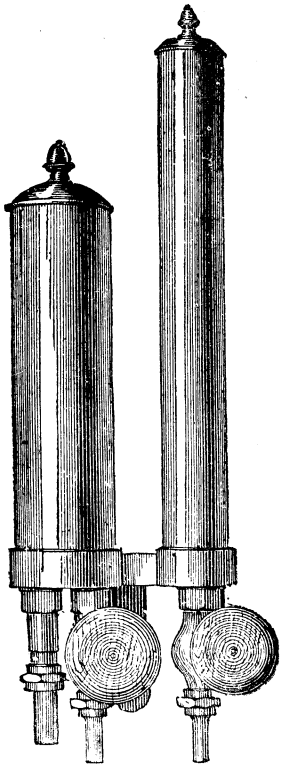
HYDROMETER JARS.



14725.

14725.	8 inches high,		25
14726.	10 do.		35
14727.	12 do.		50
14728.	14 do.		75
14729.	16 do.		1 00
14730.	18 do.		1 25

SALINOMETERS.



14714.

This instrument is a form of hydrometer, specially designed for the purpose of ascertaining the density of water in marine steam boilers. The scale is graduated 0 at the point to which the instrument sinks in pure water at a temperature of 200° Fahr., the graduation $\frac{1}{32}$ds, $\frac{2}{32}$ds, $\frac{3}{32}$ds and $\frac{4}{32}$ds, indicating that the liquids contain one, two, three or four parts of saline matter in 32 parts of water.

The word "Blow" is engraved midway between $\frac{2}{32}$ds and $\frac{3}{32}$ds, indicating that at that density the boiler water should be replaced by fresh water, to prevent incrustation.

No.		Price.
14710	SALINOMETER, of glass,	$1 50
14711.	SALINOMETER, of German silver, in mahogany case,	7 00
14712.	SALINOMETER, of German silver, with Thermometer, in mahogany case,	10 00
14713.	THERMOMETER for SALINOMETER,	1 50
14714.	LONG'S SALINOMETER POT, including Thermometer and Glass Hydrometer,	40 00

BOURDON PRESSURE OR VACUUM GAUGES.

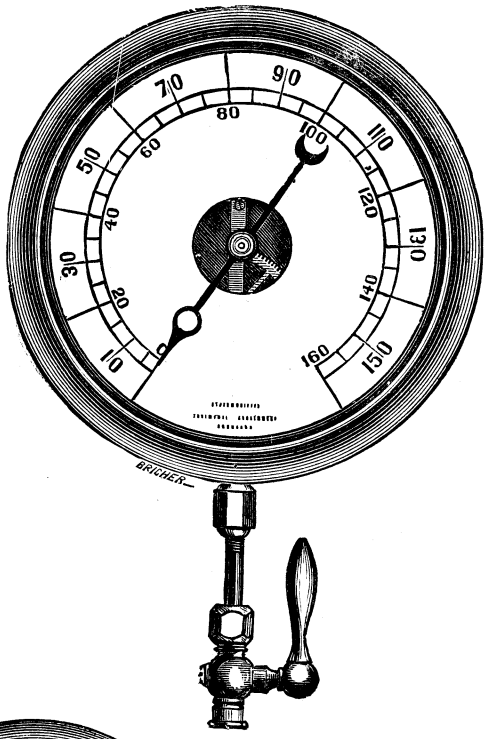


Fig. 1.

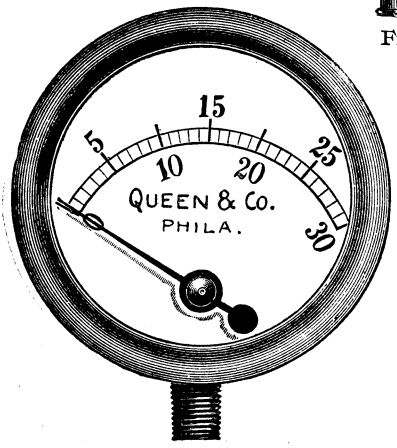


Fig. 3.

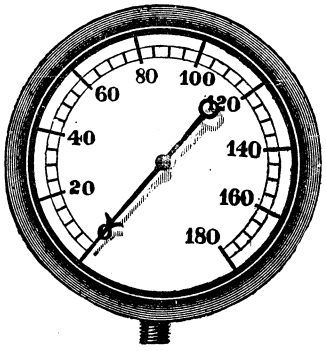


Fig. 2.

BOURDON, HIGH OR LOW PRESSURE OR VACUUM GAUGES.

Prices, including Cocks, for Vacuum or Pressure Gauges to Three Hundred Pounds or Less.

No. 14750.

Composition Cases with Ring.					Iron Cases Japanned, with Brass Rings.				
	No.	Diameter of Dial.	Diameter across Ring.	Price.		No.	Diameter of Dial.	Diameter across Ring.	Price.
		INCHES.	INCHES.				INCHES.	INCHES.	
Fig. 1	000	12	15½	$40 00	Fig. 1	000	12	14½	$25 00
	00	10	13	20 00		00	10	13	16 00
	1	8½	10	15 00		1	8½	10	11 00
	2	6¾	7⅞	10 00		2	6¾	7⅞	8 00
Fig. 2	4	6	7¼	8 00	Fig. 2	4	6	7¼	6 50
	6	5	5¾	5 50		6	5	6⅛	4 00
	7	4¼	5⅛	5 00		7	4¼	5	4 00
Fig. 3	8	4	6	5 00	Fig. 3	8	5	6	3 00
	9	3½	$4\frac{5}{16}$	4 50		9	3½	$4\frac{5}{16}$	3 00

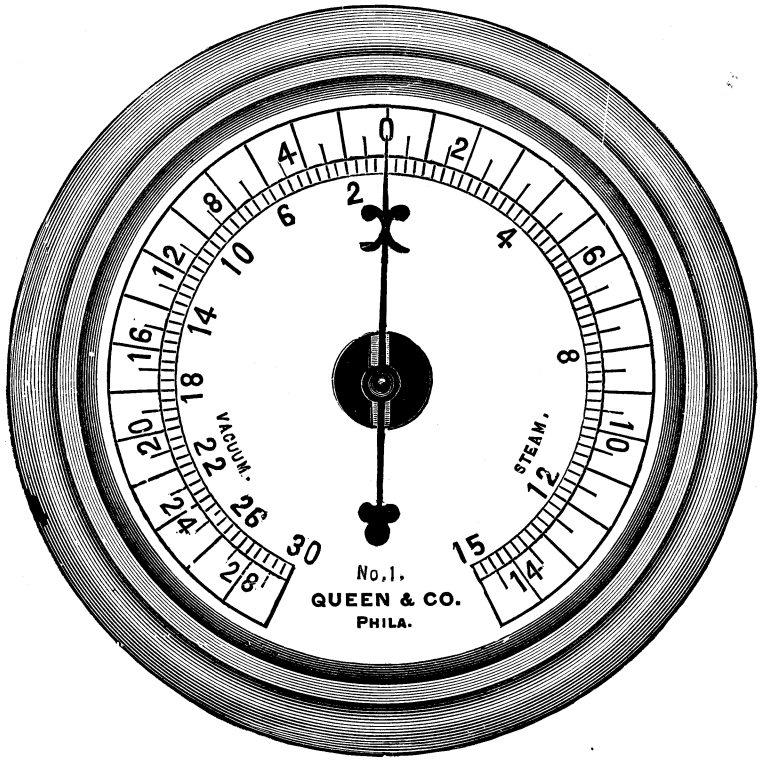
The Half Circle Gauge, Fig. 3, we recommend for low pressures. It is more sensitive and is not as easily deranged as the whole circle gauge.

We would especially recommend our half circle gauge to 10 lbs. for back pressure from engines

In ordering, state size wanted, whether brass or iron, and about the actual pressure carried.

Our dials are of brass, either silvered or black electro-plated, with silvered figures and graduations. This black dial greatly facilitates reading, and adds much to the appearance of gauge. For black dials we charge 50 cents to $1.00 extra according to size. Nickel-plating gauges at cost.

COMPOUND GAUGE.



14752.

Since the adoption of compound engines, there has been a great demand for gauges to show both pressure and vacuum. These gauges are graduated by two mercury columns, showing the pressure and vacuum and are warranted absolutely correct. Use a siphon always.

The pressure usually ranges from 15 to 60 pounds.

In ordering, state the pressure desired.

We make an additional charge of 50 cents each for Black Dials with white figures up to 6 inches, and 1.00 each additional for larger size.

Prices Including Cock.

Composition Case.			Iron Case, Brass Rim.		
12 inch dial		$40 00	12 inch dial		$30 00
10 " "		25 00	10 " "		20 00
8½ " "		20 00	8½ " "		15 00
7 " "		13 00	7 " "		10 00
6 " "		10 00	6 " "		8 00
5 " "		9 00	5 " "		7 00
4 " "		8 00	4 " "		6 00

THE HYDRAULIC GAUGE.

No. 14753.

The attention of the public is particularly called to these gauges, which are of the most durable and accurate character. The spring is the Bourdon style, made of heavy steel. When required we furnish these Gauges to graduated in pounds and tons at slight additional cost.

PRICES INCLUDING COCK.

Brass Case.		Iron Case Brass Rim.	
12 inch dial, 10,000 lbs.	$60 00	12 inch, to 10,000 lbs.	$55 00
10 " " " "	50 00	10 " " " "	45 00
8½ " " " "	40 00	8½ " " " "	35 00
7 " " " "	30 00	7 " " " "	25 00
6 " " " "	20 00	6 " " " "	17 50

Each additional ton, $5.00 extra. Black dial, $1.00 extra.

Maximum Registering hand, $5.00 extra.

N. B.—A check valve is almost indispensable in using an hydraulic gauge; as the pressure is often suddenly removed, and the momentum of the hand will throw the gauge out of gear, and otherwise damage it. A check valve prevents any trouble of this kind.

Price, - - - $2.50 Net.

14754.

AMMONIA GAUGE.

These gauges are made of a tempered steel spring, same as used in hydraulic gauges. To withstand ammonia or any acids or liquids which brass will not withstand.

Gauges are made almost entirely of iron.

PRICES.

IRON CASE NICKEL PLATED RIM.

Pressure only.		Pressure and Vacuum Combined.	
8½ inch dial, . . .	$22.50	8½ inch dial, . . .	$24.00
6¾ " " . . .	20.00	7 " " . . .	21.00
6 " " . . .	18.00	6 " " . . .	19.00

THERMOMETER GAUGE.

These gauges are intended to indicate pounds pressure per square inch, and the corresponding degrees of heat (Fahrenheit), on the same dial.

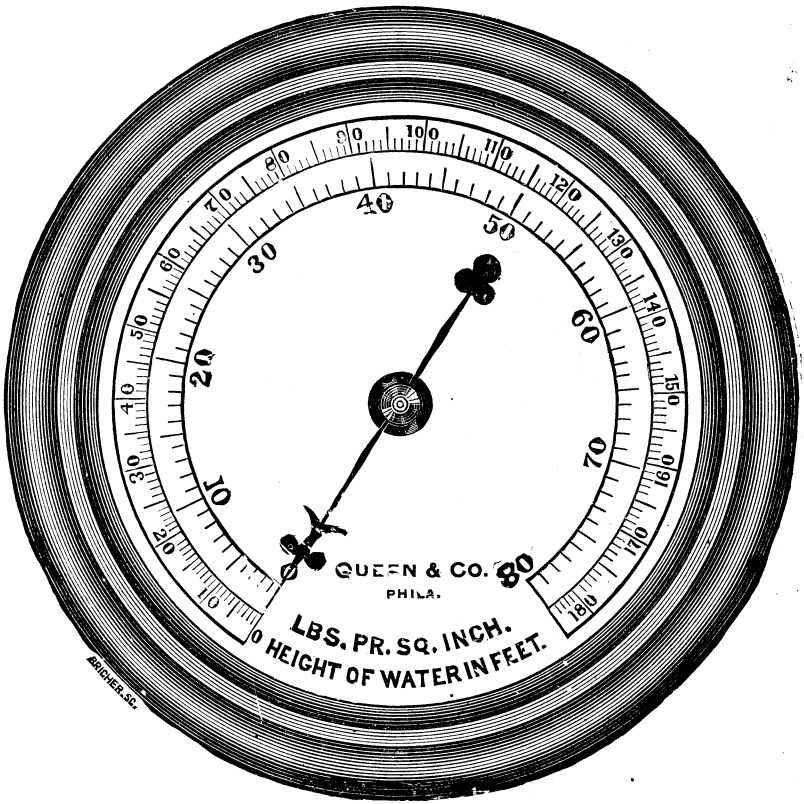
14755.

PRICES, INCLUDING COCK.

BRASS CASE, POLISHED.		IRON CASE, JAPANNED.	
No. 000. 12 inch dial,	$40 00	No. 000. 12 inch dial,	$30.00
" 00. 10 " "	25 00	" 00. 10 " "	20.00
" 1. 8½ " "	20 00	" 1. 8½ " "	15.00
" 2. 6¾ " "	12 50	" 2. 6¾ " "	10.00
" 4. 6 " "	10 00	" 4. 6 " "	8.00

Black dials, - - - $1.00 extra.

COMBINATION GAUGE.



14756

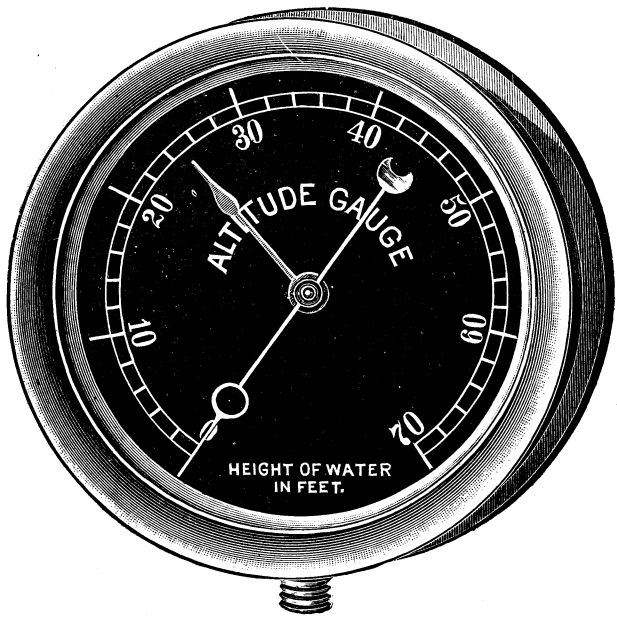
For indicating the height and pounds pressure per square inch of water in reservoir, stand pipe, or pumping station.

PRICES.

BRASS CASE, POLISHED.		IRON CASE, JAPANNED.	
12 inch dial,	$43 00	12 inch dial,	$39 00
10 "	28 00	10 "	25 00
9 "	23 00	9 "	20 00
8½ "	21 00	8½ "	18 00
6¾ "	13 00	6¾ "	11 00
6 "	10 00	6¼ "	9 00
5½ "	8 00	5½ "	7 00

To raise a column of mercury 2.04 inches, or to raise a column of water 27.67 inches, requires one pound pressure. We furnish them to any pressure desired; and, in ordering, always state the maximum height of water.

Altitude Gauges.



14757.

Altitude Gauges, showing the height of water in a tank in feet, are made of solid drawn tubes.

They are provided with a set hand to indicate the rise or fall of water.

10	inch dial,	iron case,	N. P. ring	$20 50
8½	"	"	"	15 00
6¾	"	"	"	10 00
6	"	"	"	8 25
5½	"	"	"	7 00
5	"	"	"	6 00
4	"	"	"	6 00
3½	"	"	"	5 00

These gauges do not require a siphon.

14758.

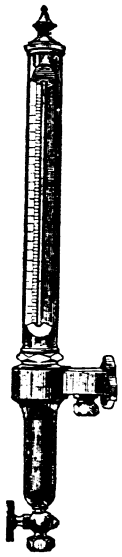
MERCURIAL PRESSURE GAUGES.

For measurements of Steam, Vacuum, Hydraulic or Blast Pressures.

These Gauges are constructed of a plain mercury column without the intervention of springs or other mechanical devices and as the measurements depend solely upon the actual weight of mercury alone, they must of necessity maintain their accuracy.

PRICE LIST.

Steam Gauges, 50 to 200 lbs., brass, tube face, . . . $16.00, flanged face, $18.00.
Vacum " - - - iron frame, ... 5.00, Brass frame, 18.00.
Blast " iron, ... 5 lbs., $ 2.75 ; 10 lbs., $ 3.75 ; 15 lbs., 5.50.
Blast " brass, ... 5 lbs., 10.00 ; 10 lbs., 12.00 ; 15 lbs., 18.00.
Any of the above nickeled at $2.75 each, extra.
Mercury Hydraulic Gauge Columns, 3 ft. 1000 to 3000 lbs., ... $65.00.



14760.

TANK INDICATORS.

For all heights and all sizes of Tanks.

14759.

For 50 ft. elevation, brass mounted, $24.00, iron mounted, $12.00
" 100 " " " 28.50, " " 14.50.
" 150 " " " 35.00, " " 17.50.

HOT WELL VACUUM GAUGE.

14760.

This form of Vacuum Gauge is used on all Government Vessels of the same appearance as the Hot Well Thermometers.

Price, $25.00.

Bristol's Recording Pressure Gauge.

Fig. 1.

Makes a Continuous Record, Day and Night, of Steam, Water, Gas or Air Pressure.

Users of Steam in Manufactories and Mills, Water and Gas Works, Electric Light and Power Stations, Public Buildings and Institutions, Hotels, Etc., will find the Instrument of great value, as it shows at a glance whether the boiler has received the attention upon which largely depends its

SAFETY AND ECONOMY.

While the Instrument is the pride of an Efficient Engineer, it will serve as a check upon a Careless one.

Fig. 1 represents the instrument ready for application. Fig. 2 shows the pressure tube with inking pointer attached, the front of case, dial and clock cover being removed. It illustrates the fundamental simplicity of the instrument, and shows that

NO MECHANISM OR MULTIPLYING DEVICES ARE REQUIRED.

LIST OF
BRISTOL'S RECORDING GAUGES AND THERMOMETERS.

14761.

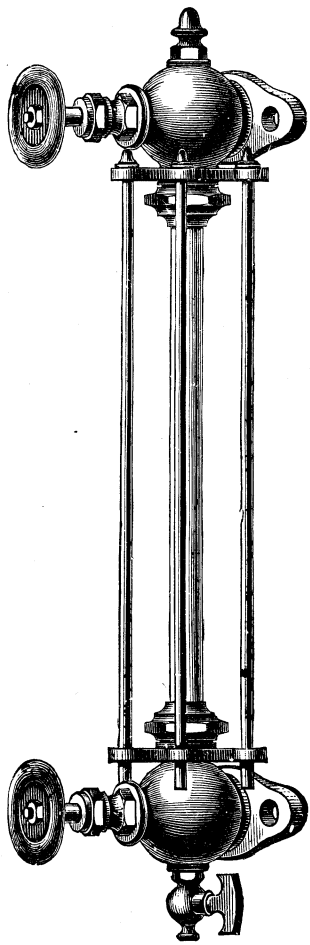
Gauge No. 20—For Gas or Air. Total range, **0 to 24 inches Vacuum.**
Gauge No. 18—For Gas or Air. Total range, **2 in.** Vacuum to **4 in.** pressure.
Gauge No. 14—For Gas or Air. Total range, **0 to 4 inches.**
Gauge No. 19—For Gas or Air. Total range, **0 to 8 inches.**
Gauge No. 16—For Gas or Air. Total range, **0 to 12 inches.**
Gauge No. 17—For Gas or Air. Total range, **0 to 20 ounces.**
Gauge No. 13—For working pressure to 5 lbs. Total range, **0 to 6 lbs.**
Gauge No. 10—For working pressure to 9 lbs. Total range, **0 to 12 lbs.**
Gauge No. 0—For working pressure to 18 lbs. Total range, **0 to 25 lbs.**
Gauge No. 5—For working pressure to 35 lbs. Total range, **0 to 45 lbs.**
Gauge No. 12—For 75 ft. head of water. Total range, **0 to 100 ft.**
Gauge No 3—For working pressure to 65 lbs. Total range, **0 to 90 lbs.**
Gauge No. 6—For 150 ft. head of water. Total range, **0 to 200 ft.**
Gauge No. 2—For working pressure to 140 lbs. Total range, **0 to 180 lbs.**
Gauge No. 7—For 300 ft. head of water. Total range, **0 to 400 ft.**
Gauge No. 4—For working pressure to 280 lbs. Total range, **0 to 350 lbs.**
Gauge No. 15—For working pressure to 600 lbs. Total range, **0 to 800 lbs.**
Gauge No. 11—For working pressure to 1100 lbs. Total range **0 to 1500 lbs.**
Thermometer No. 601—For working range to 210° Fahr. Total range, **32° to 220°.**
Thermometer No. 600—For working range to 260° Fahr. Total range, **32° to 270°.**
Thermometer, No. 605—For working range to 480° Fahr. Total range, **32° to 500.°**
Thermometer, No. 608—For working range to 650° Fahr. Total range, **300° to 670°.**
Thermometer, No. 613—For working range to 700° Fahr. Total range, **300° to 800°.**

PRICE LIST.

All prices include ink and 100 charts.

Recording Pressure and Vacuum Gauges, nickel plated	$50 00
Recording Thermometers, nickel plated	60 00
Aluminium Cases, reducing weight one half, extra	10 00
Additional Charts, per 100	75
Recording Ink, per bottle	25
Extra Large Recording Pressure Gauges, special charts for one week	60 00
Extra Large Recording Thermometer	65 00
Extra Large Additional Charts, per 100	1 50

WATER GAUGES.



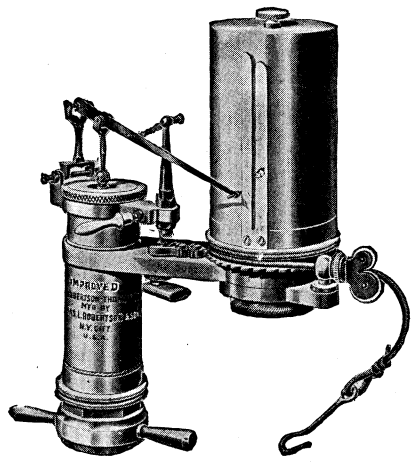
No.		Price
14775.	WATER GAUGE, iron wheels, four guards, for ½-inch pipe,	$4 50
14776.	WATER GAUGE, brass cocks, four guards, for ⅜-inch pipe,	5 50
14777	WATER GAUGE, do. do. for ½-inch pipe,	6 75
14778.	WATER GAUGE, wood wheels, four guards, for ¾-inch pipe,	11 50

PRICE LIST.

Genuine Scotch Glass Tubes.

LENGTH, INCHES,	EXTERNAL DIAMETER.				
	½ INCH.	⅝ INCH.	¾ INCH.	⅞ INCH.	1 INCH.
10	$ 3.00	$ 3.00	$ 3.60	$ 5.04	$ 6.12
11	3.25	3.25	3.96	5.64	6.72
12	3.60	3.60	4.32	6.12	7.32
13	3.84	3.84	4.80	6.60	7.92
14	4.20	4.20	5.16	7.08	8.52
15	4.44	4.44	5.52	7.56	9.12
16	4.80	4.80	5.88	8.16	9.72
17	5.04	5.04	6.24	8.64	10.32
18	5.40	5.40	6.60	9.12	10.92
19	5.64	5.64	7.08	9.60	11.52
20	6.00	6.00	7.44	10.20	12.12
22	6.60	6.60	8.16	11.16	13.44
24	7.20	7.20	8.88	12.12	14.64
26	7.80	7.80	9.60	13.06	15.86
28	8.40	8.40	10.32	14.10	17.08
30	9.00	9.00	11.16	15.24	18.24
36	10.80	10.80	13.44	18.24	21.96
48	14.52	14.52	18.00	24.36	29.16
60	18.12	18.12	22.56	30.48	36.48

THE IMPROVED
Robertson-Thompson Indicator.



The indicator has become such an important factor in engineering that its application has lead to the production of many inferior grades of instruments.

The Robertson-Thompson Indicator, while moderate in price, we can thoroughly recommend as equal to any of the highest priced indicators in accuracy and finish.

The indicator is made mostly of brass, nickeled, and packed in a handsome mahogany case.

The drum is the standard size, 1¾ inch diameter, and with the volute or clock springs.

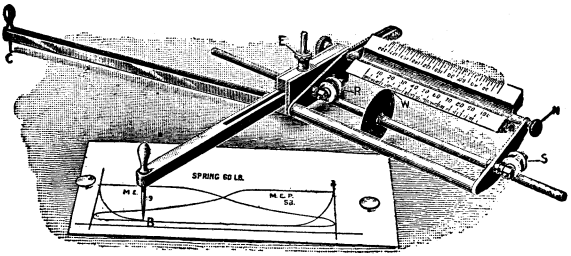
The piston is of ½ inch area and made of special composition to insure the requisite hardness and proper expansion rate.

The parallel motion is of the type which has been the standard for many years, and the only perfectly accurate one in use to-day.

The springs are made of the finest quality steel wire obtainable. Having but one wire with 4½ coils to the inch, gives at least ¾ inch more movement to the pencil point than in indicators using the double spring.

Robertson-Thompson Indicator, with two springs and two cocks, three springs and one cock or two springs and one 3-way cock. Boxwood scale for each spring, cord, cards, book, oil and screw driver, in mahogany case, complete	$60 00
Extra springs, 8, 10, 12, 16, 20, 30, 40, 50, 60, 70, 80, each	3 00
,, ,, 100, 125, 150, each	5 00
Boxwood scales, each	60
Cards, block of 100	30
Cards, Metallic, per 100	75

Planimeters for Indicator Diagrams.



14779.

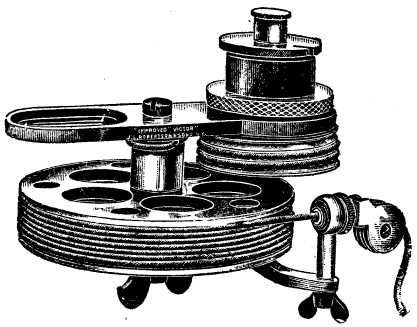
14779. Willis Improved Planimeter is the best planimeter for indicator work. It has six scales suitable for use with any spring. By using the scale corresponding to the spring the planimeter reads direct in mean effective pressure. Price, complete . . $18 00

14780. Standard Averaging Planimeter, complete with drawing board 15 00

When the points *A* and *B* are set 4 inches apart, the readings are in square inches. Set the points *A* and *B* the length of the card and the readings will be mean effective pressure.

14781. Amsler's Polar Planimeter, for indicator diagram 32 50

The Victor Improved Aluminum Reducing Wheel.



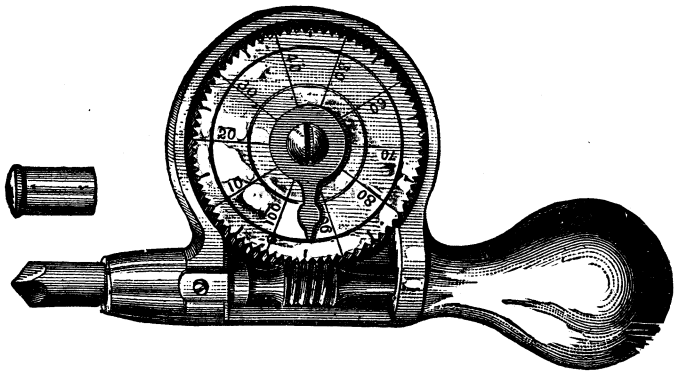
14782. Victor Aluminum Reducing Wheel 15 00

This reducing wheel can be attached to any indicator and adapted to all strokes from 8 inches to 6 feet, guaranteed to stand 500 revolutions per minute.

14783. Improved Three-way Cocks to fit any indicator 6 00

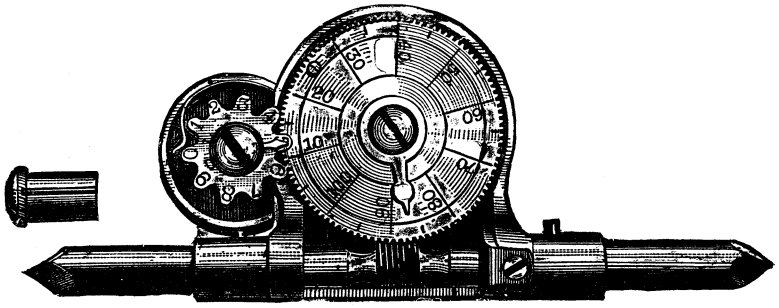
SPEED COUNTERS AND TACHOMETERS, &c.

For determining the speed of Engines, Dynamos, Motors, etc.



14786.

	Price.
Single Speed Indicator (can be carried in pocket).	$1 00



14787.

Double Speed Indicator (1or revolution in either direction). It is accurate, strong and compact, and can be carried in the pocket . .	1 50

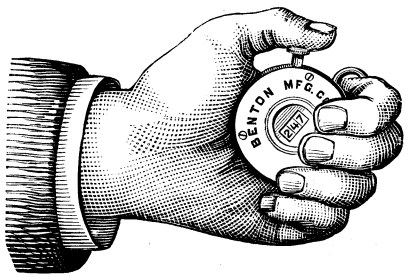
STROKE COUNTERS.

With zero set adjustment for counting strokes of machinery and engines, etc.

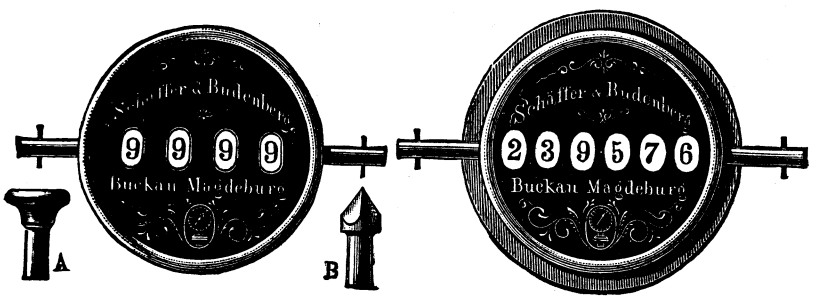
14791.	Counter, with 2 figs.	(100)	. . . . .	each	$ 6 00
14792.	" " 3 "	(1,000)	. . . . .	"	7 00
14793.	" " 4 "	(10,000)	. . . . .	"	8 00
14794.	" " 5 "	(100,000)	. . . . .	"	10 00
14795.	" " 6 "	(1,000,000)	. . . . .	"	12 00

Tally Counter.

The Tally counter may be used for counting any objects up to 1,000. It is 2 inches in diameter, in nickel-plated brass case.



14796. Tally counter . . . . . each $ 2 50

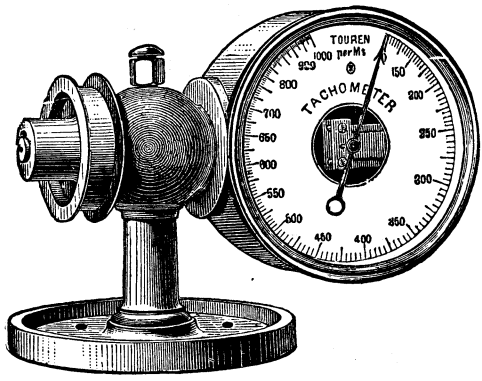


Direct Reading Speed Counter; four figures registering to 10,000 revolutions per minute, 1½-inch dial $12 00

Direct Reading Speed Counter; six figures, 4-inch dial 16 00

QUEEN'S

STANDARD STATIONARY TACHOMETER.



This instrument, like the portable type, indicates instantly the speed of rotating machinery, and also depends upon centrifugal force as the principle of action.

The pointer on the dial shows the exact number of revolutions made by the pulley per minute, and, the mechanism being very sensitive, will indicate the slightest variation in speed. To obtain accurate results, the driving belt must be smooth, and the joints made without lapping. All internal parts of the apparatus require no oiling, but the pulley shaft should be oiled in the usual manner, the journal set screws being provided with proper openings for that purpose. The motion may be in either direction and the apparatus can be fastened to the floor, wall or ceiling, with the dial set at any angle.

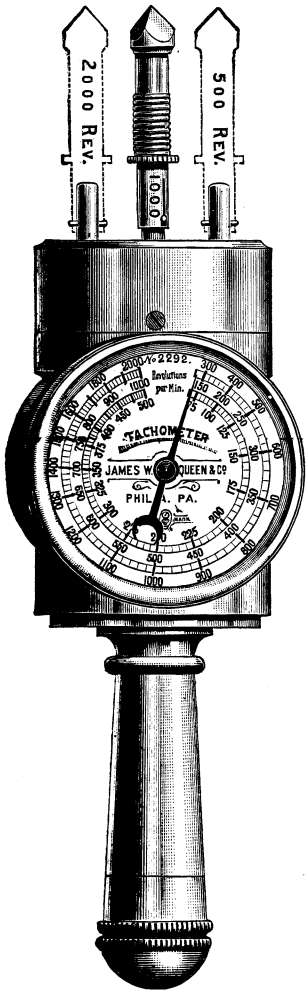
Different ranges are made, to meet varying requirements, and the following can be promptly supplied, *viz:* 300, 400, 500, 1000 and 2000 turns per minute. When ordering, it is necessary to state the approximate number of revolutions to be measured, so that we can send the proper range.

Two sizes are made, with dials $5\frac{1}{2}''$ and $7\frac{1}{2}''$ diameter, respectively.

The net prices are:—

14800.	Stationary Tachometer. Dial $7\frac{1}{2}''$ diameter	$60 00
14801.	" " " $5\frac{1}{2}''$ "	55 00
14802.	Recording Tachometer, for giving a continuous record of the speed of a shaft or wheel	120 00

Queen's Standard Portable Tachometer.



14803.

This tachometer, which we have recently placed on the market, is recommended as a thoroughly reliable instrument for instantly indicating the speed of rotating shafts. Special features in construction, will be noticed, which render it of much greater value than any portable apparatus of the kind ever before offered. Three shafts, as illustrated, are geared to the rotating parts inside of the case, each one of them having a separate scale on the dials, so that the indications are direct reading throughout. A detachable point, with slightly flexible end, to fit any of the spindles, is supplied, the flexibility of which acts as a safeguard; for, if made perfectly rigid, there is danger of breakage when not applied exactly at right angles to the shaft.

The scales on the dial are graduated as follows: 40 to 200, 120 to 600, and 600 to 3000, which gives a maximum range of 40 to 3000 turns per minute. Thus it is possible to measure directly both high and low speeds, with the same instrument.

This apparatus is of excellent workmanship, and handsome in appearance. The case is nickel-plated, and has a conveniently shaped handle, inside of which (exposed by removing the end), is a set screw, by means of which any lost motion can be taken up, when necessary. A substantial leather carrying case is supplied, which protects the instrument and makes it perfectly portable.

14803. Price, complete, with detachable spindle, in leather case, range 40 to 3000 turns $60 00

Books on Meteorology.

ATKINSON.—A Practical Treatise on the Gases met with in Coal Mines. By the late J. J. Atkinson, government inspector of coal mines for the County of Durham, England (Van Nostrand's Science Series) . . . $ 50

ATKINSON.—Friction of Air in Mines. By J. J. Atkinson (Van Nostrand's Science Series) 50

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BLODGET.—Climatology of the United States and of the Temperate Latitudes of the North American Continent, etc., etc., with isothermal charts. By Lorin Blodget. Royal 8vo 5 00

BUCHAN.—Introductory Text-book of Meteorology. By Alexander Buchan. 12mo., illustrated 2 25

DAVIS.—Elementary Meteorology. By Wm. Morris Davis, Professor of Physical Geography of Harvard University 2 50

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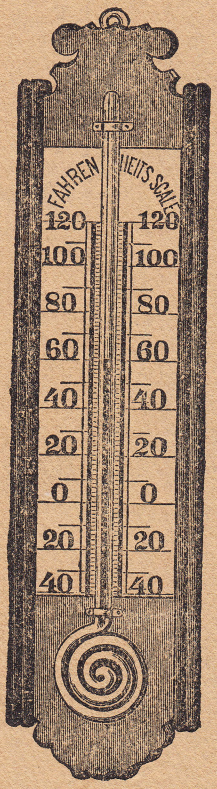

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PHILADELPHIA.