

Friez Julien P.

W. Skinner
6386

ILLUSTRATED CATALOGUE

OF

METEOROLOGICAL

 INSTRUMENTS

AND

APPARATUS

WITH

SPECIAL INSTRUCTIONS

ON THE EQUIPMENT OF METEOROLOGICAL
STATIONS; THE INSTALLATION AND CARE
OF INSTRUMENTS; AND THE COMPILA-
TION OF RECORDS.

JULIEN P. FRIEZ,

107 E. GERMAN ST., BALTIMORE, MD., U. S. A.

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THIS IS ALSO
A HANDBOOK OF METEOROLOGY
IN RESPECT TO
STANDARD METEOROLOGICAL INSTRUMENTS.

SPECIAL NOTICE.

ATTENTION IS RESPECTFULLY INVITED TO THE FACT THAT NO PAINS OR EXPENSE HAS BEEN SPARED TO MAKE THIS ILLUSTRATED AND DESCRIPTIVE CATALOGUE AS COMPLETE AS POSSIBLE, AND TO MAKE IT VALUABLE FOR REFERENCE, (IF NOTHING MORE), FOR THE AMATEUR METEOROLOGIST, AS WELL AS FOR THE PROFESSIONAL MAN, SKILLED IN SCIENTIFIC INVESTIGATION. IT WILL BE SENT FREE TO ALL UPON APPLICATION AND HAS BEEN MAILED TO THOSE BELIEVED TO BE INTERESTED IN THE SCIENCE OF METEOROLOGY. IF, HOWEVER, THE INDIVIDUAL WHO RECEIVES THIS BOOK HAS NO PERSONAL USE FOR THE INFORMATION CONTAINED HEREIN, HE WILL CONFER A FAVOR BY KINDLY HANDING IT TO SOME FRIEND WHO HAS.

*Entered according to Act of Congress, in the year One Thousand Eight Hundred and Ninety-three,
By JULIEN P. FRIEZ,
In the Office of the Librarian of Congress at Washington, D. C.*

*"My son, these mysteries are not concealed!
Go thou, study well the Book of Nature.
Her hidden secrets are only revealed
To him who strives to read the future."*

—ANON.

INTRODUCTORY.

To the Scientific Public:

In inviting your attention to the following pages, a few remarks on the subject of Meteorology, and Apparatus used in connection therewith, may be of interest.

The development in the past few years of great government weather bureaus, and the increasing interest taken by the people of *all* civilized countries in the science of Meteorology, have greatly stimulated the inventive genius of every enthusiastic observer to devise, if possible, more perfect instruments for indicating and recording atmospheric conditions.

There is scarcely a moment of the day when the weather is not constantly changing about us, and the progressive meteorologist or weather service of the present can no longer depend upon simple eye observations alone, and it is absolutely necessary, in fulfilling public requirements or private investigations, to call to their aid the latest improved mechanical and electrical appliances for making the desired record automatically and continuously.

During the past ten years especially we have seen greater advancement and improvement in meteorological apparatus than for centuries before, and under the fostering care of our own United States Weather Bureau has been developed a class of simple and comparatively inexpensive instruments, the records from which cannot be excelled in the world for accuracy.

The Government and State services of the United States are continually expanding; new and improved instruments are being constantly required, and it is to meet this growing demand (as well as to supply the colleges and the scientific public generally) with *standard* instruments such as used by the government, that has decided me to engage extensively in the manufacture of meteorological instruments and apparatus.

At the present time there is not a single manufacturer in the United States who makes any attempt to furnish private parties with meteorological instruments of a *uniform standard* finish and workmanship, such as purchased and used by the U. S. Weather Bureau.

I believe, therefore, that there is now an opening for an enterprising and responsible manufacturer, and, having secured large government contracts, I propose to devote *special attention* in the future to furnishing *first-class meteorological apparatus* to all interested in this new and useful science. I can assure prospective buyers that they may depend upon it they will receive instruments of *uniform excellence, perfect workmanship, and at prices that defy competition.*

I have been successfully engaged in the manufacture of meteorological apparatus, in connection with other similar work, for twenty years, my principal customer being the U. S. Weather Bureau, and my anemometers and registers are now in use at all the important stations of that service. As no word of complaint has ever been received by me, it is reasonable to suppose that they have been and *are* giving entire satisfaction.

Some new and important instruments have recently been perfected and constructed at my works (notably the new "Tipping Bucket Rain Gauge," and the "Recording Rain and Snow Gauge," and which are described on the following pages), and these are now for the first time offered to the public.

References: As to my financial standing and responsibility I refer to the U. S. Weather Bureau, or "The German Bank of Baltimore City."

Soliciting a trial order, I am,

Very truly yours,

JULIEN P. FRIEZ.

BALTIMORE, MD., June 1, 1893.

CORRESPONDENCE.

Correspondence on all subjects pertaining to the science of Meteorology is invited, and will receive careful attention.

Equipment of a Meteorological Observatory.

It is impossible to secure satisfactory results from any meteorological instrument unless it is given a good exposure to the atmospheric conditions it is desired to record, and is entirely free from the influence of surrounding objects, such as trees, buildings, towers, chimneys, etc. Correspondence on this subject is therefore especially invited with a view to giving our customers the benefit of our long experience in equipping and installing weather bureau stations, where every possible circumstance is taken into consideration. It is suggested, therefore, that those who desire to purchase, say an anemometer, give a rough plan as to how they desire to have it exposed, the height above ground, whether on a building or not, the shape of roof of the building, the proximity of towers, chimneys, trees, etc., and if possible furnish a photograph or sketch of the surroundings. All photographs, etc., will be promptly returned, and the observer will thus be enabled to secure results which will be comparable in every way with those made by our National Service.

Repairs to Meteorological Instruments.

Possessing the very best improved machinery, and having had great experience in the manufacture of all forms of meteorological apparatus, I am prepared to repair, in the most skilful and approved manner, barometers, anemometers, registers, etc., etc., on very short notice, and at prices that cannot be equaled when durability and finish are considered.

Mercurial barometers are repaired, refilled, etc., under my personal supervision, and as I have had many years experience with these delicate instruments, barometers turned out by me are *guaranteed* equal in accuracy to any used by the U. S. Weather Bureau.

Complicated or delicate instruments, or those of foreign construction, will receive *special* attention.

Meteorological Instruments and Apparatus may be Imported Free of Duty.

The Act of Congress, approved Oct. 1, 1890, permits schools, colleges, scientific and educational institutions, to import, free of duty, meteorological instruments and apparatus, *provided the same are to be used for scientific or educational purposes.*

Orders are respectfully solicited, therefore, for such instruments or apparatus of foreign manufacture, and estimates and instructions for securing free entry will be given upon application.

A considerable saving to purchasers may thus be made, as the duty on these articles is 45% *ad valorem*.

Correspondence solicited.

Shipment of Instruments and Apparatus.

Unless otherwise ordered, all instruments and apparatus (except wind-vane supports and instrument shelters) will be shipped by *Express*. The wind-vane supports and shelters are heavily constructed (in order to be as durable as possible), and having no delicate parts to break, are always shipped by *Freight*.

Every precaution is taken in packing all meteorological instruments and apparatus manufactured by me, and no allowance can be made if the same receive injury during transportation.

No charges made for boxing and packing, and all goods delivered f. o. b. in Baltimore.

Remittances can be made by bank-draft, payable to my order; by cash, sent through any of the Express Companies, or by P. O. money order. Cash sent by mail should always be by *registered letter*.

Parts of instruments and small articles are sent by mail in open packages, postpaid, but I cannot be responsible if any package is lost or contents injured during transmission

through the mails. Registering mail matter, however, will lessen the risk of loss, and this will always be done on receipt of the necessary amount, eight cents per package.

To State and Government Services, and also to parties furnishing suitable reference as to financial standing, I will ship any instrument or apparatus ordered, to be paid for if satisfactory, transportation charges both going and returning (if unsatisfactory) to be guaranteed by consignee. Orders from all others to be accompanied by *cash*.

"By their fruits ye shall know them."

Faithful and conscientious work brings its own reward, as the following *testimonial* plainly shows : *

U. S. DEPARTMENT OF AGRICULTURE.—WEATHER BUREAU.

WASHINGTON, D. C., *February 23, 1893.*

MR. JULIEN P. FRIEZ,

107 E. German St., Baltimore, Md.

Dear Sir :

In reply to your letter of February 18th, acknowledging receipt of order for triple registers, it gives me pleasure to say that the registers, anemometers, electrical contacts, and other meteorological apparatus made by you in the past for this Bureau, have always been satisfactory, the workmanship and finish being executed with care in all particulars.

Very respectfully,

MARK W. HARRINGTON,

Chief of Weather Bureau.

Every instrument turned out by me is a standing advertisement and SPEAKS FOR ITSELF.

* *Many other testimonials* from the U. S. Weather Bureau, State Weather Services, and professional and scientific men, are on file in my office, but limited space prevents their publication.

Prices.

Prices have been generally omitted from this Catalogue, as the cost of construction of special meteorological instruments and apparatus varies slightly from time to time, depending upon changes or improvements necessary to conform to Government standards. Prices will, however, *always be found reasonable and correct. Write.*

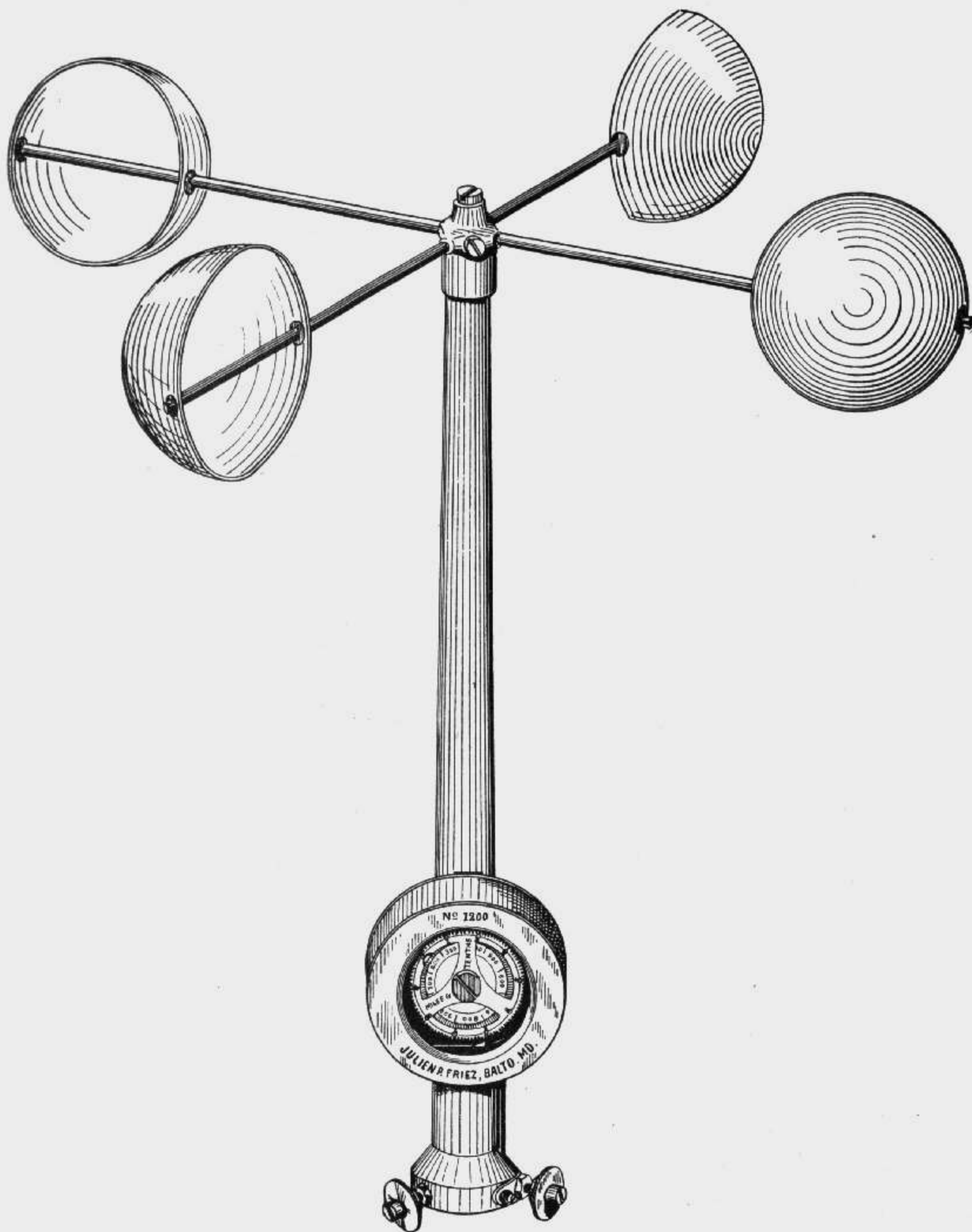
ANEMOMETERS.

Fig. 1.

U. S. Weather Bureau Pattern (latest improved).

(See next page.)

DESCRIPTION OF ANEMOMETER.

Four hollow hemispherical cups are mounted upon cross-arms at right angles to each other, with the open sections vertical and facing the same way around the circumference. The cross-arms are on a vertical axis which has at its lower end an endless screw. The axis is supported so as to turn with as little friction as possible. The endless screw is in gear with a wheel which moves two dials registering the number of revolutions of the cups. The mechanisms are mounted in a suitable metal case, as shown in foregoing illustration.

The center of the cups moves with a velocity about one-third that of the wind which puts them in motion. The cups are 4 inches in diameter. The distance from center of cup to center of rotation or axis is 6.72 inches. Assuming that the wind-travel is exactly three times that of the center of cup, the dials are marked to register miles of wind-travel, 503 revolutions of the cups corresponding to a mile.

The ratio of wind-travel to travel of cup is in reality variable, depending on the velocity of the wind. It is less for high than low velocities. It varies also with the dimensions of the instrument, being different for every different length of arm and diameter of cup. (See Table III, page 66 of this catalogue.)

Fig. 1 shows the standard Anemometer of the U. S. Weather Bureau. This instrument is what is known as the "Robinson" pattern, latest improved. It has been perfected until it is really the *best* instrument yet devised for determining wind-velocity.

I make but one kind, the BEST.

Standard Weather Bureau Anemometer, made of brass, highly polished and finished, aluminum cups, steel spindle with hard steel bearing, 10th mile indicator, electrical contacts, *perfect* workmanship (will last a lifetime if properly cared for), price.....\$

(Note.—All parts are *interchangeable*, and any part worn out or accidentally injured can be replaced at slight expense. Price of duplicate parts on application.)

Single (Anemometer) Register.

(IMPROVED.)

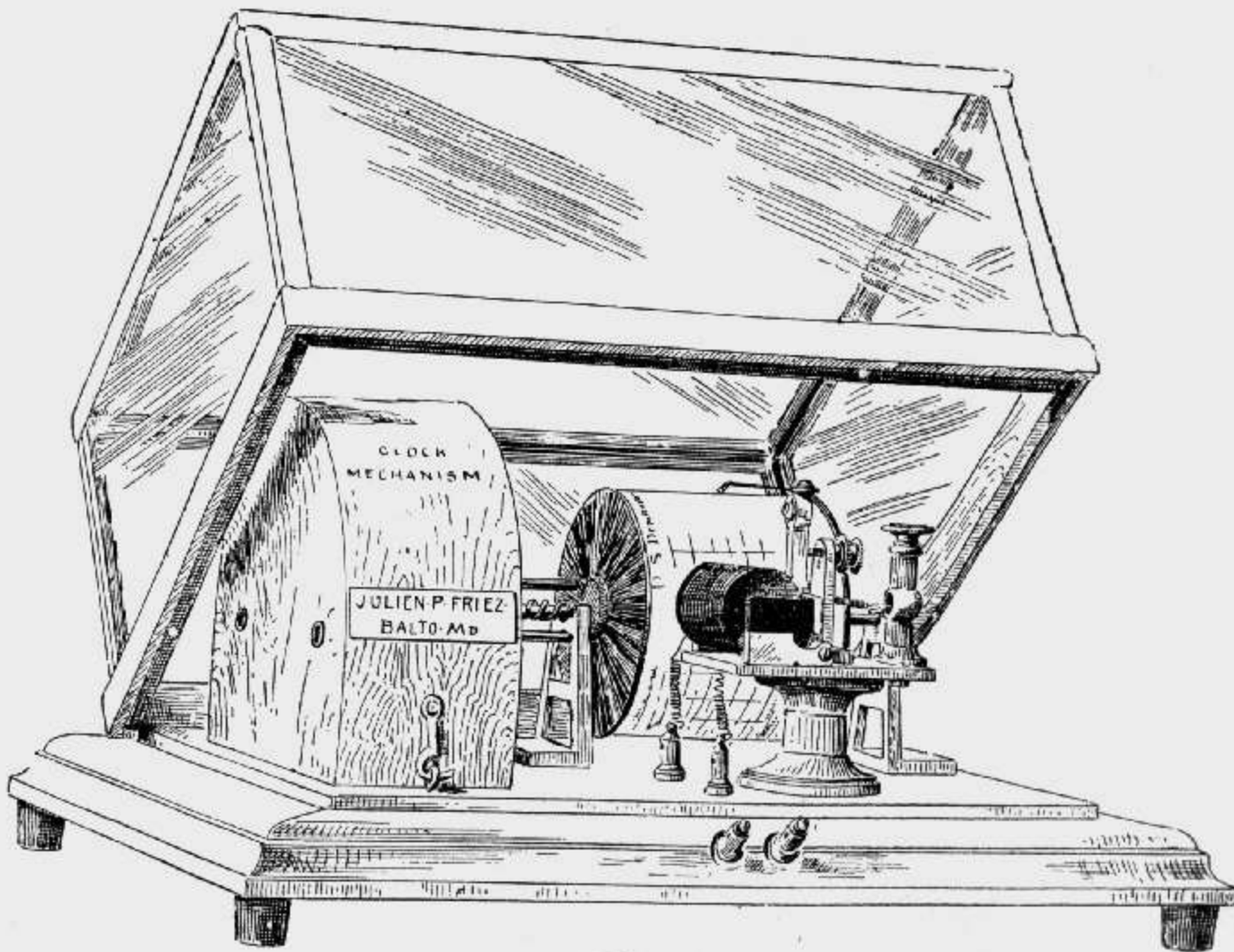


Fig. 2.

The above cut (Fig. 2) shows the Standard Improved Single (Anemometer) Register, with the lately invented pen and ink attachment and the magnet and recording cylinder, on the same principle as that of the Triple Register. The ordinary pencil-holder for using leads can be furnished if desired. This Register is of simple construction, not likely to get out of order, and with ordinary care will last for many years. The instrument has an extra heavy clock movement, of special design, which can easily be regulated to drive the recording cylinder on correct time. Registers of this kind have been successfully used by the U. S. Weather Bureau for over twenty years past, for all official records of wind velocity.

Single (Anemometer) Register, improved, first-class in every respect, nicely finished; iron base, German silver glass cover, &c., lead-pencil attachment, $\frac{1}{2}$ dozen special pencil leads, and 50 Forms 1015, price.....\$

Single (Anemometer) Register, as above, but provided with attachment and pen for ink records (shown in Fig. 2), complete, with 1 bottle special ink, price.....\$

(Note.—This Single (Anemometer) Register can also be fitted to record Sunshine or Rainfall, or *both* (instead of wind velocity). See remarks on Weekly Register, page 12.)

For Extras (battery, wire, &c.), needed in attaching this Register to Anemometer, see pages 54, 55 and 59.

Two-Magnet Register.

(NEW.)

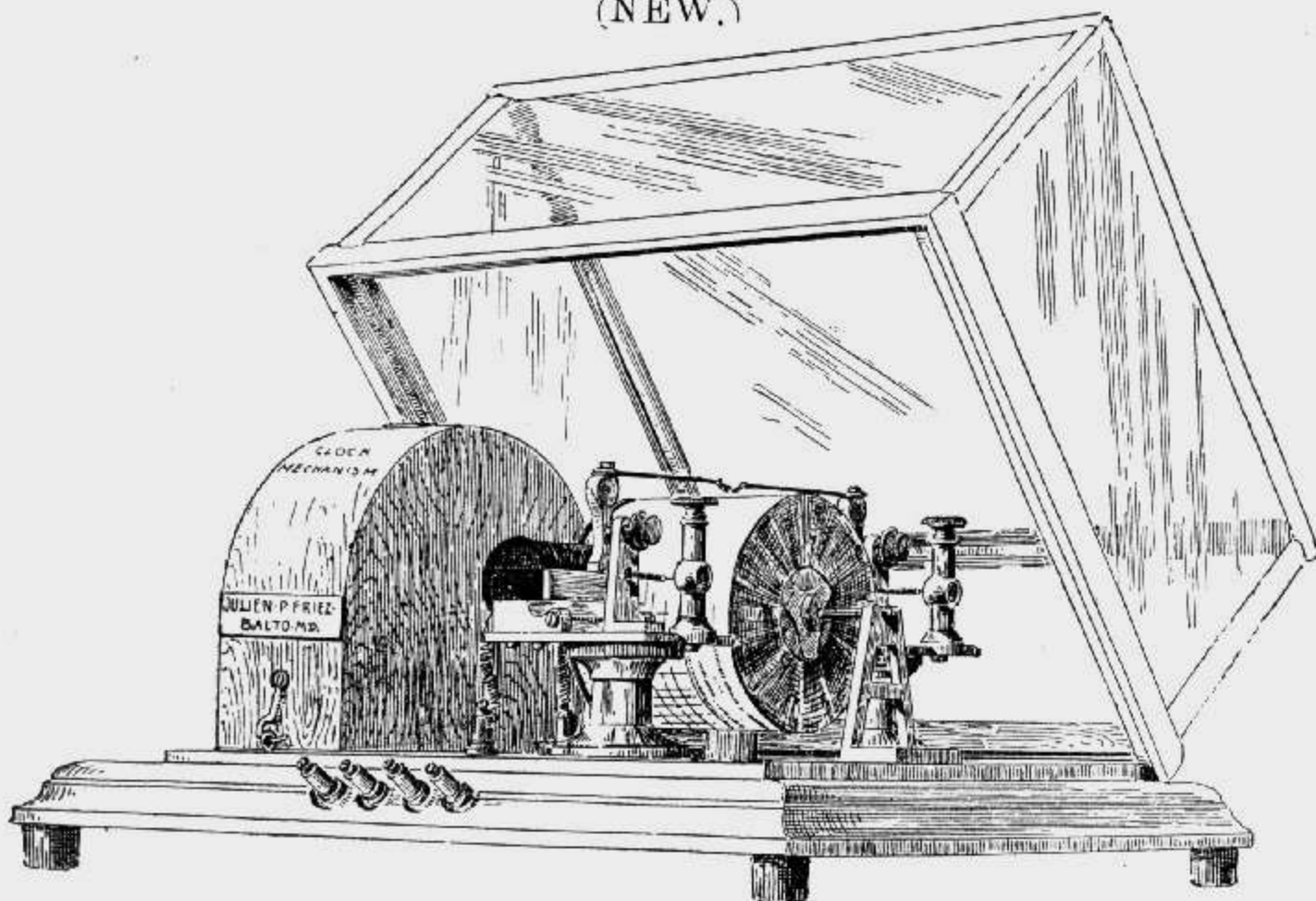


Fig. 2a.

This instrument has been designed to meet a long-felt want for a simple and inexpensive Register that would record something more than simply wind-velocity.

The general appearance, construction and finish of the instrument are the same as that shown in Fig. 2, but an additional magnet, with pen-arm attachment, is placed at back of cylinder.

The following are some of the uses to which this valuable instrument may be applied :

For simultaneously recording from two different Anemometers.

“ “ “ “ two different “Tipping-bucket” Rain Gauges.

For simultaneously recording from one Anemometer and one “Tipping-bucket” Rain Gauge.

For simultaneously recording from one Anemometer, one “Tipping-bucket” Rain Gauge and one Electrical Sunshine Recorder.

For simultaneously recording from two Electrical Sunshine Recorders.

“ “ “ “ two Electrical Sunshine Recorders and two “Tipping bucket” Rain Gauges.

The advantage of thus having records (especially those of *comparison*) made by *one* clock movement, which practically eliminates time errors, will be appreciated by scientists and those striving to obtain accuracy.

Two-magnet Register, as above, best finish throughout, German silver glass cover, &c., price.....\$

Attachments to armature (for “Tipping-bucket” Rain Gauge), per magnet, extra.....\$

Special 1-minute Clock Contact (for Electrical Sunshine Recorder), extra.....\$

(Note.—The regular Form 1015 is also used on this Register.)

Weekly (Anemometer) Register.

The following cut shows this handsome instrument, which represents the very latest improvement in Weekly (Anemometer) Registers. The idea of thus condensing the record was suggested some years ago by Mr. Chas. B. Tuch, but it has only been perfected within the past year by Mr. Geo. W. Scott and Prof. C. F. Marvin, all of the U. S. Weather Bureau. The size of the record sheet is identical with that of Form 1017 for Double and Triple Registers, and, by the ingenious mechanisms shown on the front of the instrument, the pen is made to travel very slowly across the cylinder from right to left, thus giving an entire week's record on *one* sheet of

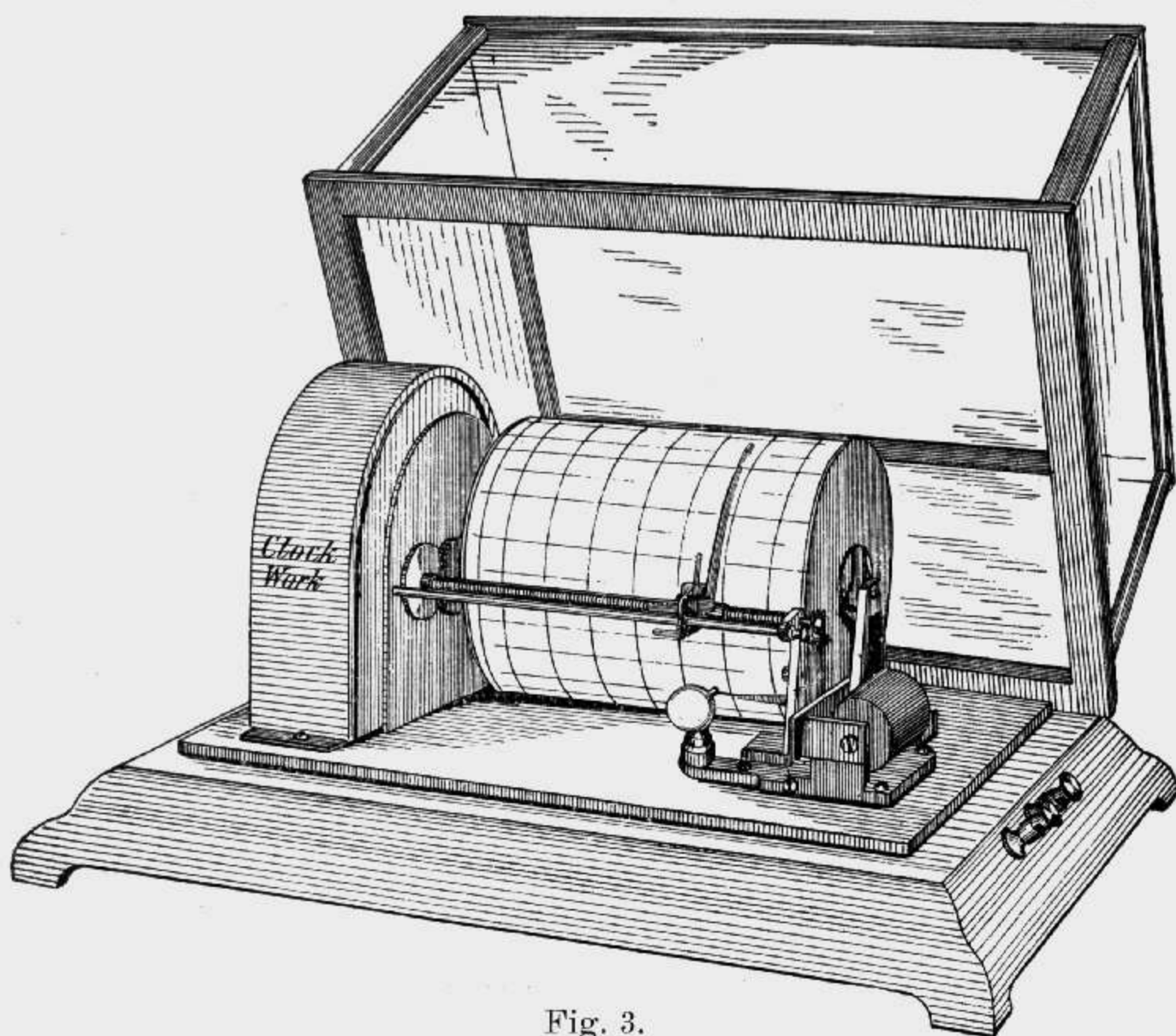


Fig. 3.

paper of convenient size. The instrument is therefore a very convenient one, as it requires only a few moments each week to change the sheets, wind the clock and readjust the pen. It is also very economical in the use of forms, requiring only about 52 sheets per year, to 365 for the Daily (Anemometer) Register.

This Register can also be fitted to record rainfall or sunshine, or *both* (instead of wind velocity), at slight additional expense, using the "Tipping-bucket" Rain Gauge and Electrical Sunshine Recorder, illustrated and described on pages 44 and 39.

Weekly (Anemometer) Register, as above, on handsomely decorated iron base, German silver and glass cover, special, heavy 8-day clock movement, pen attachment, complete, with 1 bottle Register Ink, 1 extra pen. 10 Forms 1016, best finish throughout, price.....\$

For special $\frac{1}{10}$ -inch Rainfall Indicator on magnet, for using "Tipping-bucket" Rain Gauge, *extra*.....\$

For special 1-minute clock contact, for using Electrical Sunshine Recorder, *extra*.....\$

Double, Triple and Quadruple Registers.

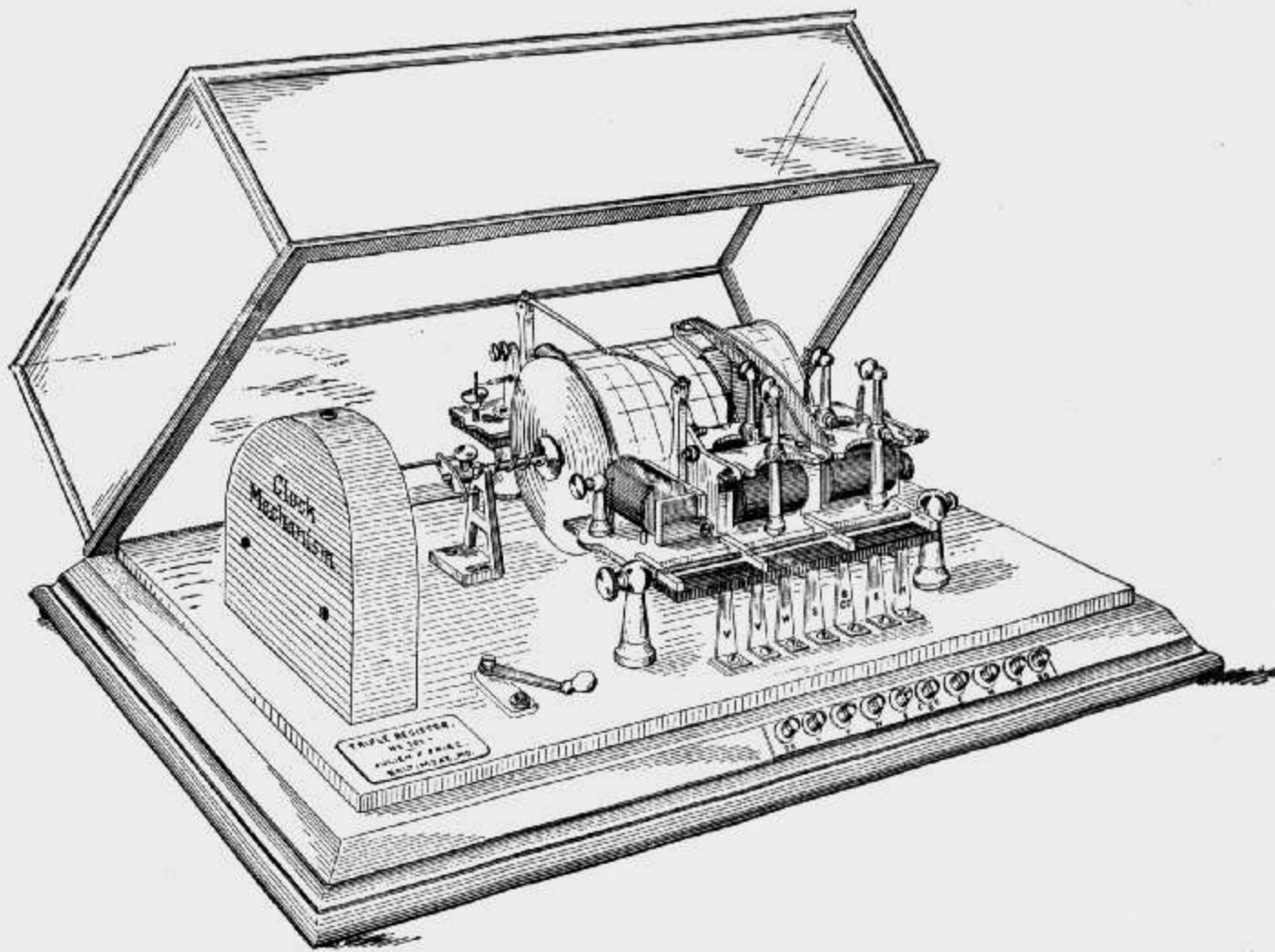


Fig. 4.

The Double, Triple and Quadruple Registers, of standard Weather Bureau Pattern, are mounted on decorated iron bases, provided with suitable German silver glass covers, and are uniform in general appearance, the words "double," "triple" and "quadruple" being used to indicate the number of meteorological elements the instrument will record. The above illustration gives an excellent view of the Triple Register, which contains all improvements devised during the past few years by Prof. C. F. Marvin of the Weather Bureau.

As now constructed these instruments are the result of many years' experiments by the officials of the Weather Bureau, and myself, every effort being made to devise a simple form of registering apparatus, having *one* clock movement, which would indicate, simultaneously, in a condensed manner on *one* sheet of paper, a continuous and automatic record of the more important meteorological phenomena. These instruments embody, therefore, the highest possible skill and ingenuity in their construction, and the elegance of their workmanship and finish makes them an ornament to any office. The above illustration shows the different parts of the instrument so clearly that a detailed description is not necessary. The principle upon which the records are obtained is very similar to that of the Single (or Daily) Register, and is fully described on pages 58 and 59.

I manufacture but one class of these Registers: THE BEST.

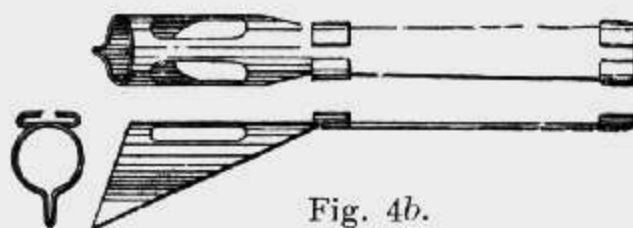


Fig. 4b.

- Quadruple Register, Standard Weather Bureau pattern, elegant finish, German-silver glass cover, complete, for recording wind velocity and direction, rainfall and sunshine, with two bottles special ink, 2 extra pens, and 25 Forms 1017 (blank record sheets), price.....\$
- Triple Register, in same finish, and with supplies as above, for recording wind velocity and direction, and rainfall, price.....\$
- Double Register, ditto, with supplies as above, for recording wind velocity and direction, price.....\$
- Register Pens, standard Weather Bureau pattern (Fig. 4b), for Single, Weekly, Double, Triple and Quadruple Registers, extra, each....\$
- (Note.—For batteries, additional supplies, &c., see pages 54 and 55.)

Improved Wind-Direction Contacts.

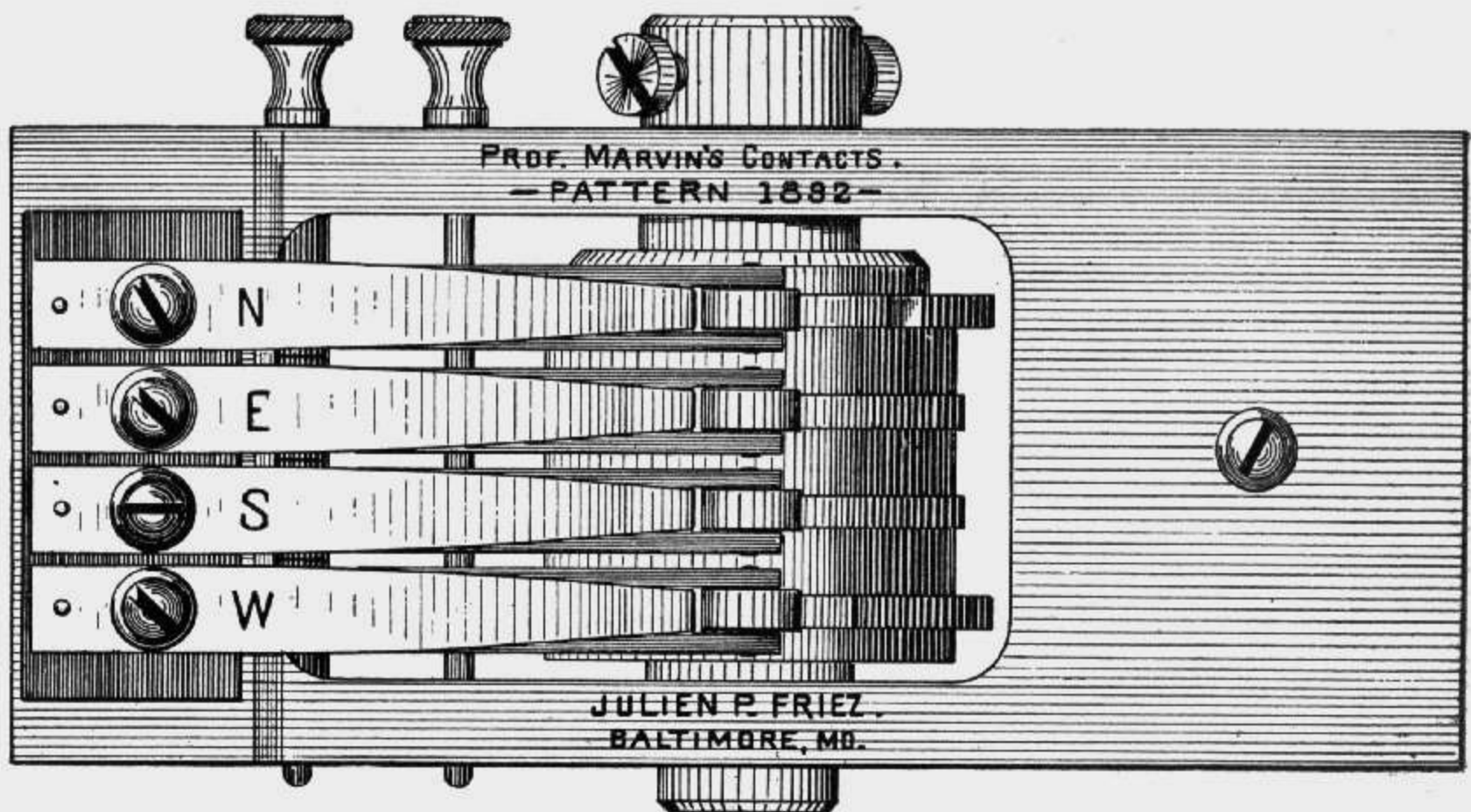


Fig. 5.

Fig. 5 is an illustration, front view, of the very latest Weather Bureau pattern electrical contacts for wind direction. This apparatus is now made complete in itself, that is, the parts are all rigidly mounted together on a suitable brass frame, which makes it unnecessary to obtain the rather difficult vertical adjustment of the cam collars on the vane rod, required with the old style contacts. These new contacts also contain the latest improvement for reducing friction to a minimum, and if a wind vane is properly erected on improved roller bearings, these contacts will not retard the movements of the vane even in the lightest winds. The contact plate is simply secured at each end by suitable set-screws through the sides of the iron contact box. After the vane and cams are properly and accurately adjusted to each other, and so that the electrical contacts are correctly made for each of the eight points of the compass, as determined by experiment, the cams are securely clamped to the rod leading from the vane. This inside rod is made of $\frac{1}{4}$ -inch iron pipe, and its proper position within the support is fully shown in Fig. 6, which also shows the iron contact box (with door removed) and the electrical contacts in place.

Improved Weather Bureau pattern, wind-direction contacts (electrical), made of *very best* materials and workmanship throughout, complete, per set.....\$

Wind-vane and Anemometer Supports.

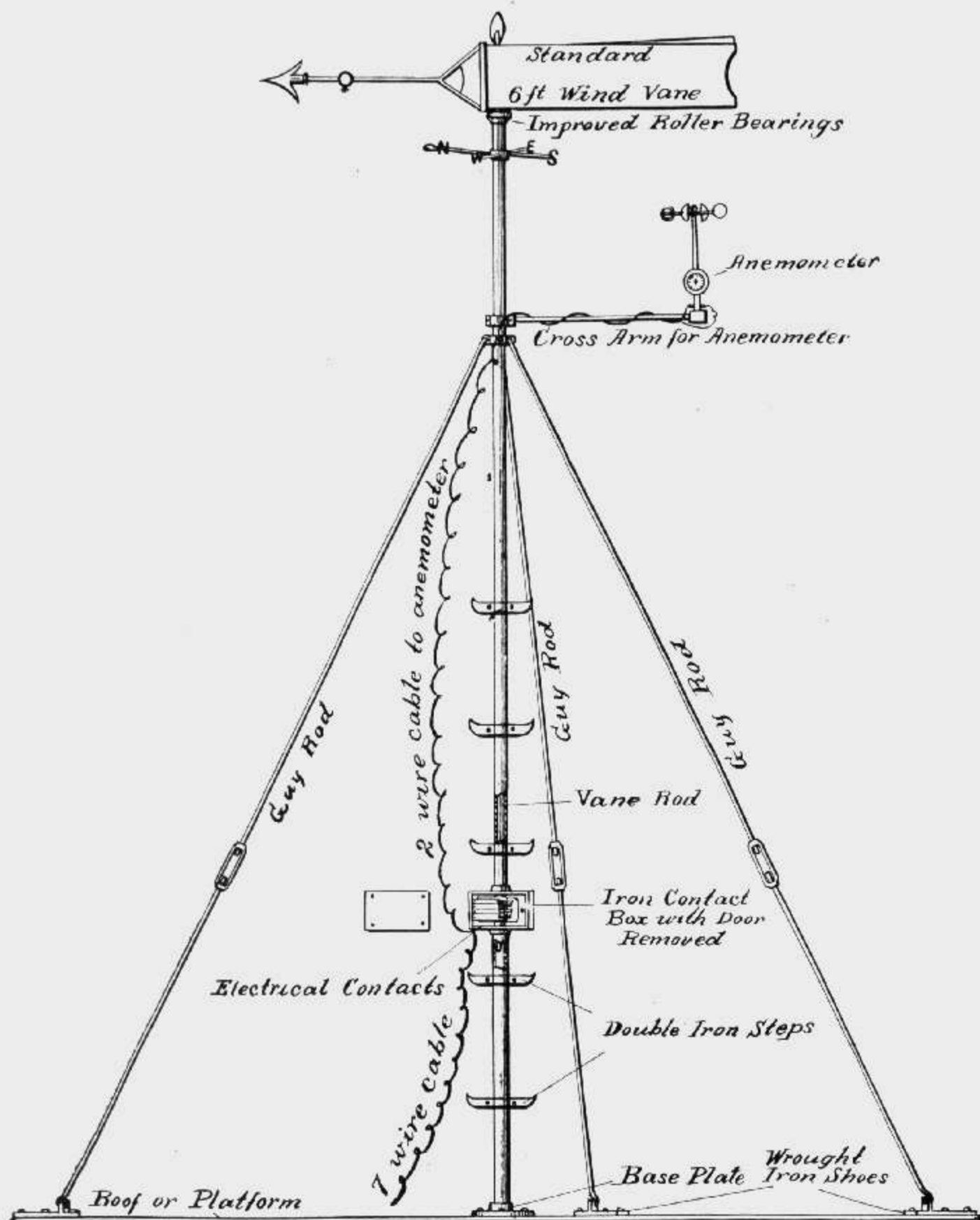


Fig. 6.

The above illustration shows clearly the appearance of the latest approved Weather Bureau pattern combined support for wind instruments, *complete*. It is made, in the

most durable manner, of iron and brass, to withstand severe exposure to the elements, and with ordinary care will last a lifetime. All parts are interchangeable, and any accidentally broken, by storm or otherwise, can be replaced at short notice and slight expense.

1. Combined Wind-vane and Anemometer Support, complete, as shown in Fig. 6, *except* Anemometer and wire cable; support 14 ft. high; standard 6-ft. wind-vane with improved roller bearings, contact box and electrical contacts, 6 iron steps, adjustable guy rods, cross-arm for Anemometer, wind-direction arms, &c., nicely painted and finished; arrow-heads, &c., gilded,* price...\$
2. Wind-vane Support, *alone*, as above, complete with vane, improved roller bearings, wind-direction arms and guy rods; standard finish,* price\$
3. Anemometer Support, *alone* (the Anemometer being mounted in place of vane, and support provided with 7 double iron steps), complete, with guy rods, &c., standard finish,* price.....\$
4. "Sunset" Wind-vane and Support, Weather Bureau pattern, general design and finish similar to above; vane 4 ft. long, support 6 ft. high, complete, with guy rods, &c., price.....\$

*Note.—For each foot increase in height (over 14 ft.), extra \$1.50.

Prices of separate parts, such as wind-vane alone, cross-arm for Anemometer, direction cross-arms, contact box, iron steps, etc., given upon application.

Diagrams of Electrical Circuits.

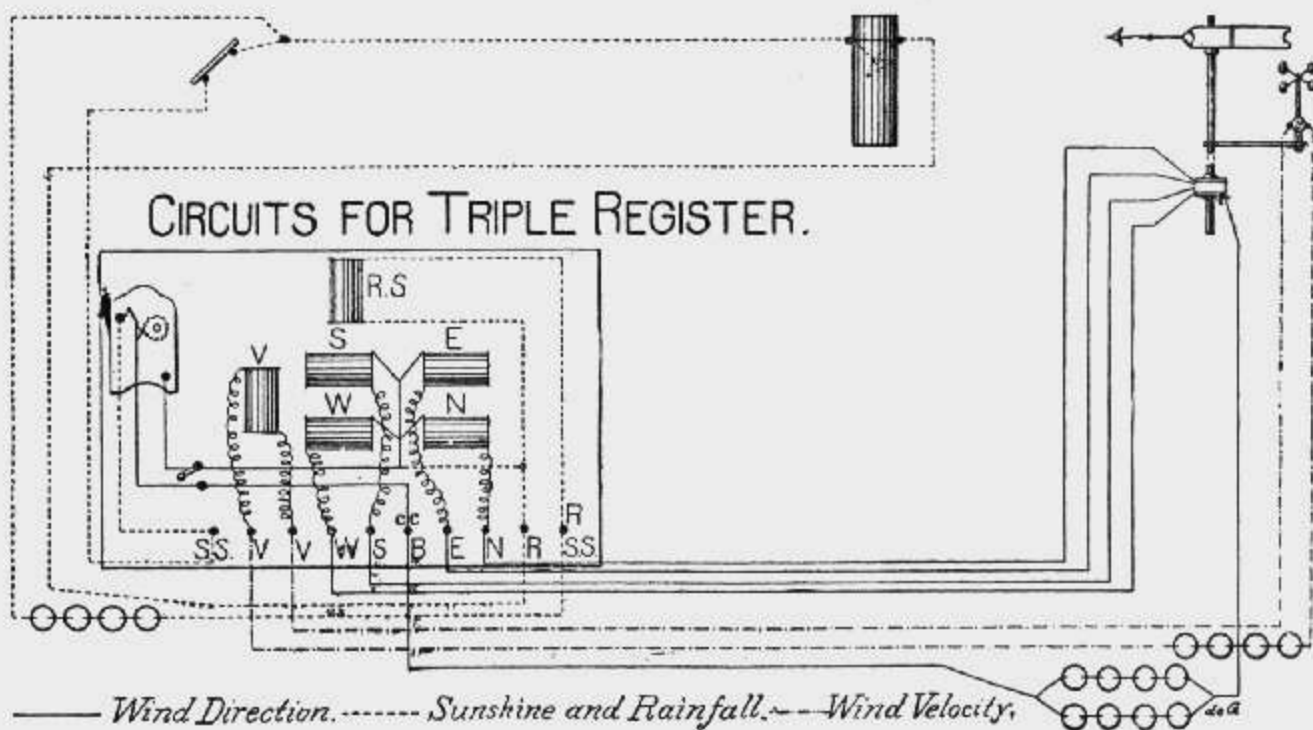


Fig. 7.

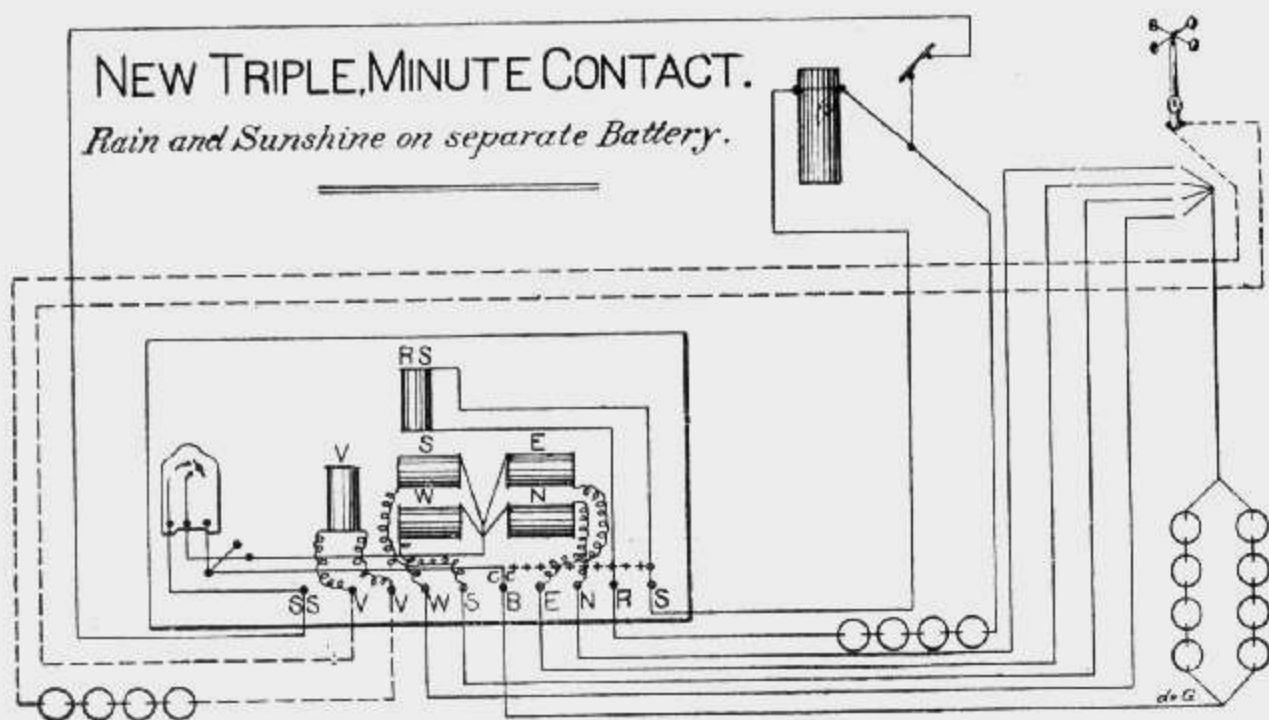


Fig. 7a.

CIRCUITS, NEW TRIPLE REGISTER, MINUTE CONTACT.
Sunshine and Wind on same Battery.

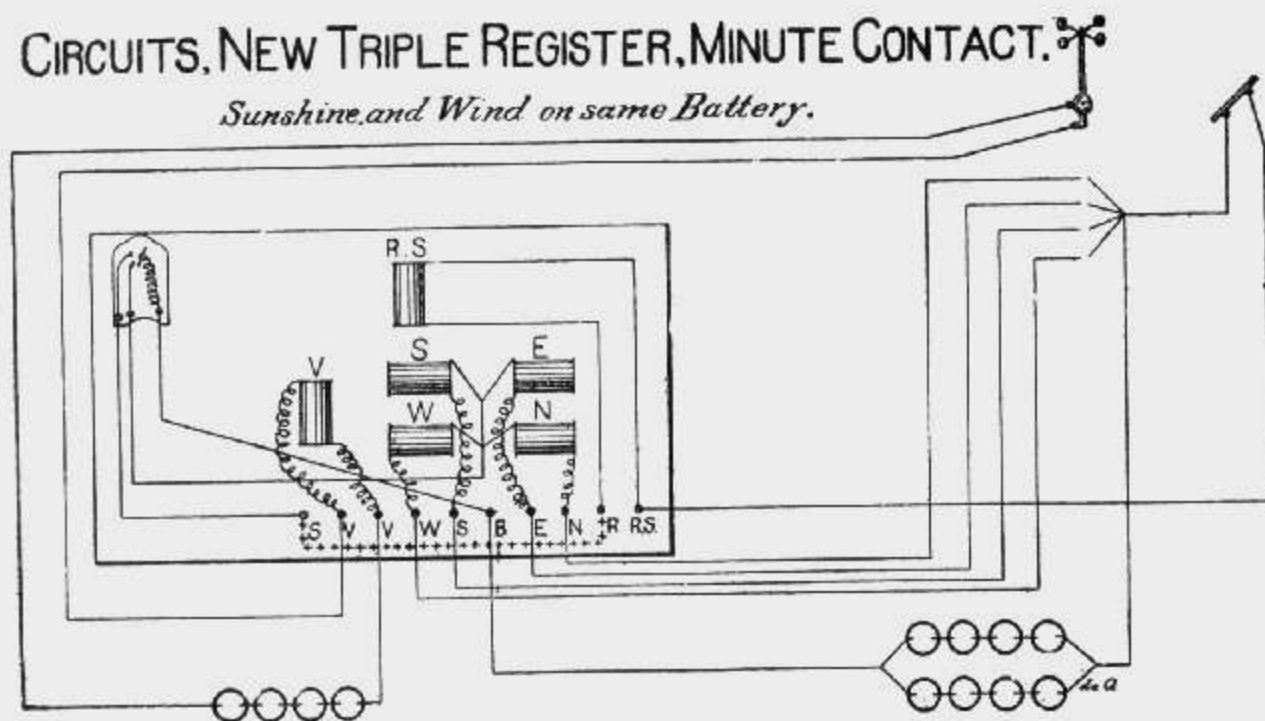


Fig. 7b.

(See paragraph 8d, &c., page 58.)

Barographs.

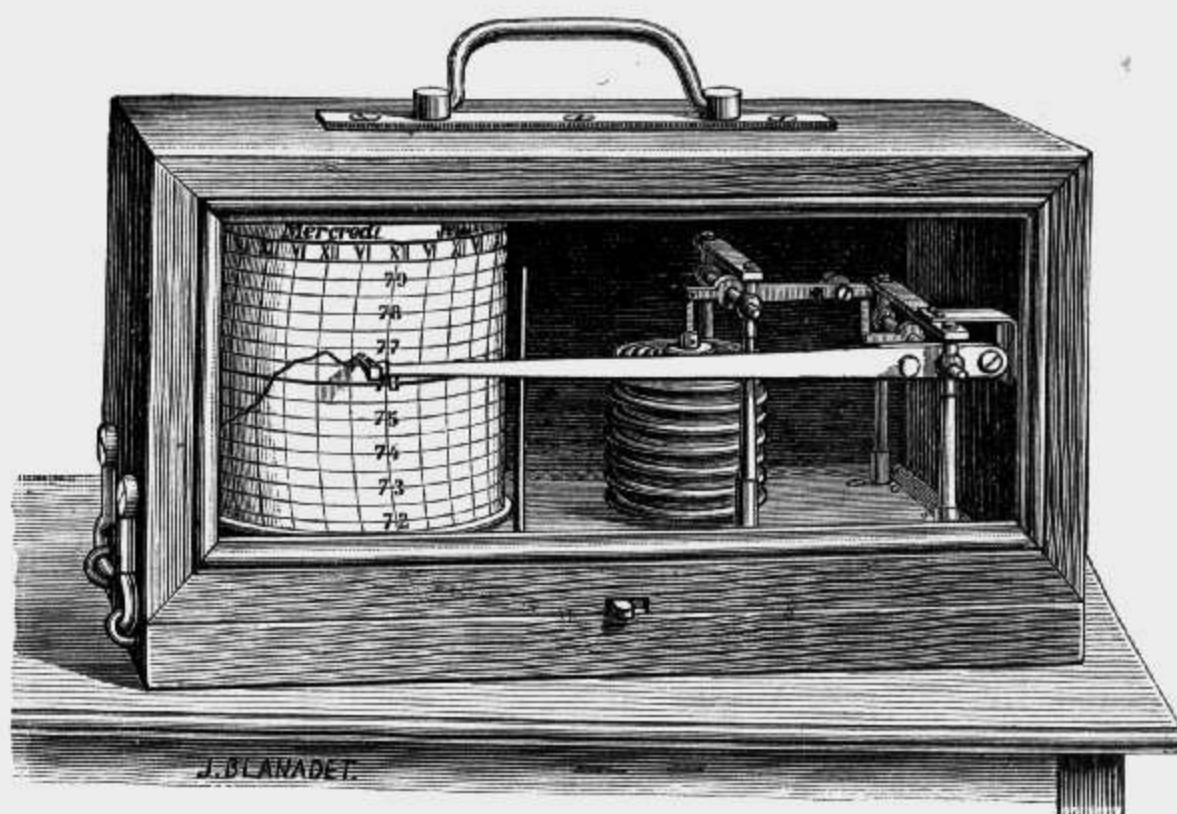


Fig. 8.

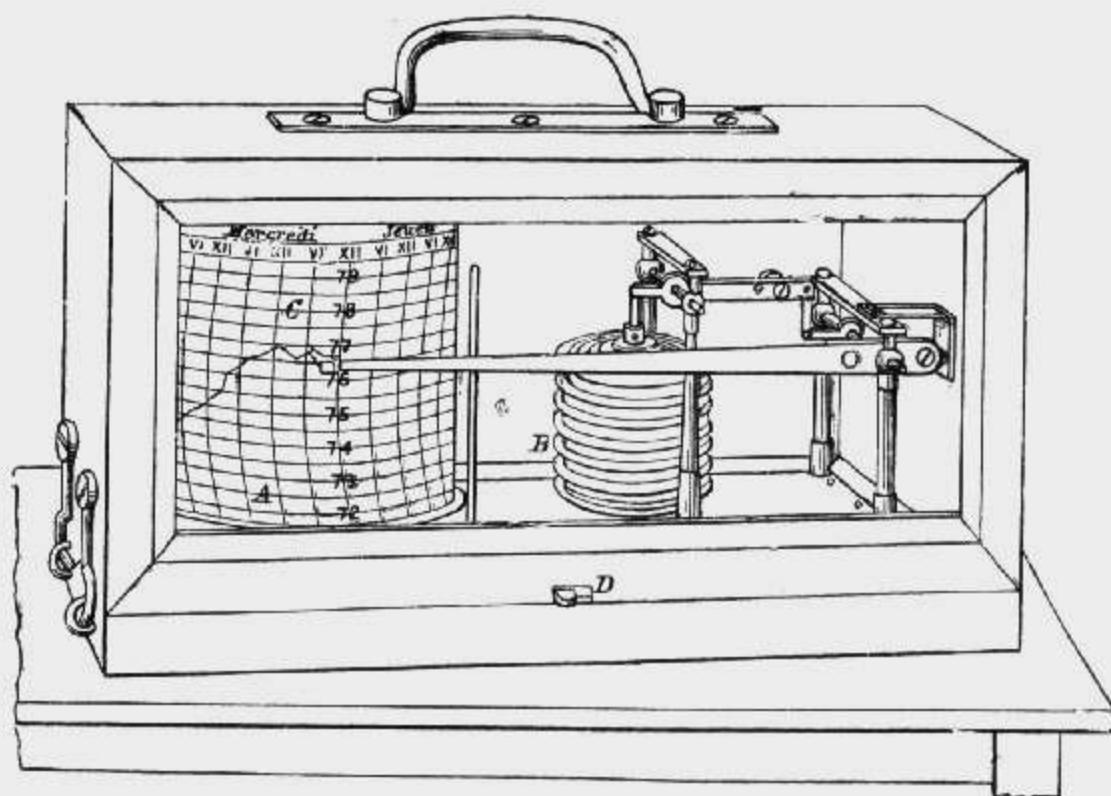


Fig. 9.

(See description, &c., next page.)

Barograph (or Recording Aneroid Barometer).

This instrument is made by Richard Bros., Paris, France, and has been adopted as one of the standard instruments of the U. S. Weather Bureau. It is clearly shown in the illustrations, Figs. 8 and 9. The expansion and contraction of the vacuum shells *B*, by changes in atmospheric pressure, is communicated to the recording pen (which contains a supply of ink), by means of suitable magnifying levers, the record being traced on the sheet of paper *A* at the left. This paper is attached to a cylinder *C*, made to revolve once a week by means of a clockwork within. The record sheets are accurately ruled, and the hours of the day and the days of the week are properly given at the top of each sheet. It is a reliable instrument, and exceedingly accurate records may be obtained by daily comparison with a good mercurial barometer, such as advertised and illustrated on page 21, and by following the instructions given on pages 60 and 61. The Barograph is placed in the office room, and should be at about the same elevation as the mercurial barometer.

Barograph, as described above, in handsome mahogany case with glass panel in front, nickel-plated handle and trimmings, 1 year's supply of record sheets, 1 bottle special ink, pen, &c. (complete), price.....\$

(Note.—For additional supplies, record sheets, &c., see page 55.)



Observatory Barometers.

U. S. WEATHER BUREAU PATTERN.

Observatory Barometer on Fortin's principle, No. 10B. Scale extending down to 26 in., divided to tenths and twentieths of an inch, and vernier reading, respectively, to 1-100th and 1-500th of an inch.

Bore of tube, .3 inch. In making the instrument the mercury is boiled in the tube to insure complete exclusion of air and moisture, while Fortin's principle of cistern insures a constant level from whence to take readings.

A highly sensitive Thermometer, with well-seasoned tube, stem-graduated and figured, is attached to the brass mount, which is perforated near the bulb, to insure its indicating the same temperature as the mercury contained in the barometer tube.

The instrument can be suspended by passing the top ring over a support or bracket. Better advantages are afforded, however, by having the barometer suspended in a glass case, as now adopted by the Weather Bureau, and which is illustrated and described on page 22.

Corrections for the attached thermometer, and corrections for instrumental error and capillary action, so as to agree with Weather Bureau standard, accompany each instrument.

No. 10B, as above, price\$

Fig. 10, No. 10A. Latest Weather Bureau Pattern Observatory Barometer, Fortin's principle, Tuch's improved cistern, with scale extending to 26 inches, and lower, if so ordered, and divided so as to admit vernier to read to 1-100th or 1-500th of an inch. In the cistern of this barometer the chamois-skin bag and objectionable wooden parts, which are a constant menace to the durability of the instrument, are avoided. The mercury is adjusted, raised or lowered, by means of a plunger or piston, moving in a malleable iron cylinder, ground and polished on the inside. This plunger or piston is actuated by a large milled-head screw, working on fine threads, through the bottom end of the iron cistern. *All* parts are interchangeable, and any part can be replaced at once.

The barometer tube is not tied on, as is usually done in ordinary barometers, but, having a projection on the lower end, is suitably clamped between washers in position. A new tube can be inserted at very short notice, and the instrument can be readily dismantled for the purpose of cleaning, and can again be conveniently put together without the aid of thread or wax.

This *greatly improved* mercurial barometer was invented and designed by Mr. Chas. B. Tuch, of the U. S. Weather Bureau.

No. 10A, with correction cards, &c., as above, complete, price\$



Fig. 10.

Improved Barometer Box.

In ^sFig. 11 is shown the standard pattern Weather Bureau Barometer Box. This box is made to offer the greatest possible protection to those delicate instruments (mercurial barometers), from dust, dirt, and sudden changes of temperature, and at the same time afford an easy and convenient means of adjusting and reading the instruments.

The box should be attached to the wall of the office-room or observatory, in such a position as to afford a good light and yet not subject the barometers to great or sudden changes of temperature. In some cases it may be necessary to first fasten to the wall hardwood strips, to which the top and bottom of the Barometer Box can be attached by screws. Place the large brass screw for holding the top of the box in the center of the top strip, at the place it is desired to hang the box, and place the box thereon. When the box hangs about vertical (as determined by a plumb-line), fasten it at the bottom to the lower wooden strip.

The hooks at the top of the box are adjustable, and the barometer, when freely suspended, should hang in the center of the ring-guide at the bottom without touching it.

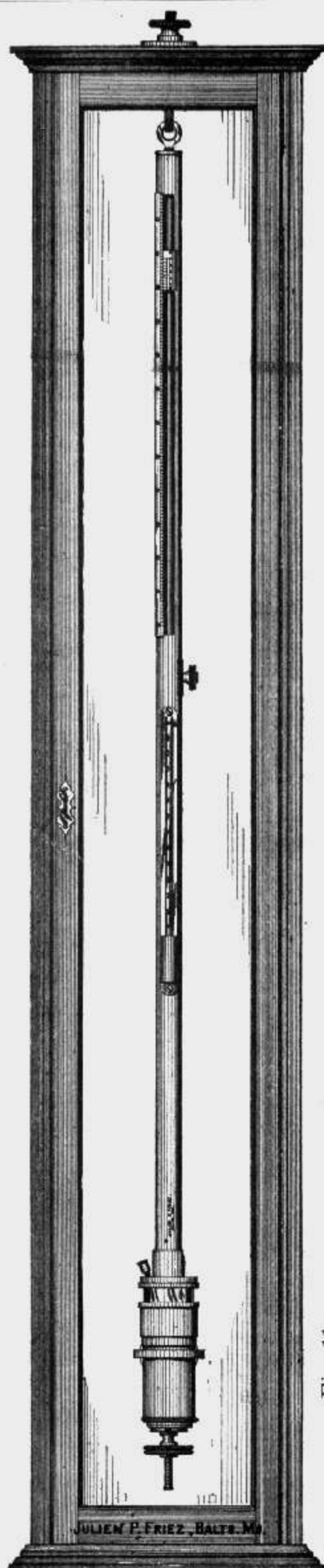


Fig. 11.

Care must be taken in adjusting the mercury in the cistern of a barometer suspended in this box, to see that the ivory point of the cistern just touches the mercury, when the barometer hangs free, as otherwise an erroneous adjustment may unconsciously be made. A little practice and observation will overcome this.

A piece of white paper (writing paper) should be placed behind the top and bottom of the barometer to facilitate setting and reading.

This Case is an ornament to any Office.

Improved Barometer Box, standard Weather Bureau [pattern, made of mahogany, with glass panels on front and sides, *fine* finish, complete, with lock and key, and brass rings and hooks for two barometers, price.....\$
Ditto, as above, for one barometer, and as shown in Fig. 11, price...\$

Aneroid Barometers.

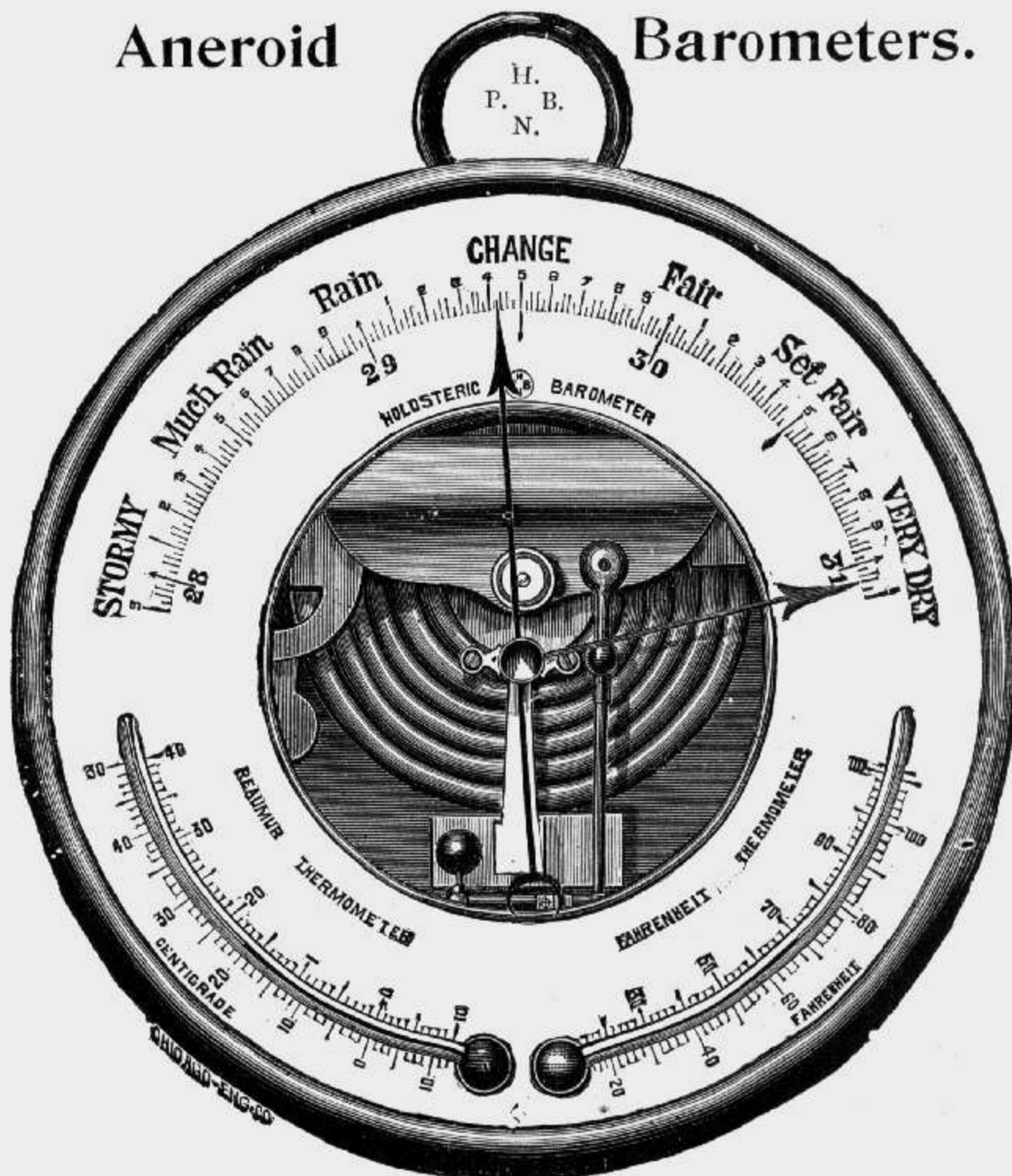


Fig. 12.

12.	Aneroid Barometer, 8-inch lacquered metal case, with suspensory ring, open silvered metal dial, two curved thermometers reading to scales of Fahrenheit, Reaumur, and Celsius, beveled glass front, in velvet-lined case.....	\$25 00
12a.	Aneroid Barometer, 6½ inch, as above.....	18 50
12b.	“ “ 5-inch, with but one thermometer, similar to preceding.....	15 00
12c.	Aneroid Barometer, 5-inch, as above, without thermometer.....	13 50
12d.	“ “ 5-inch lacquered metal case, with suspensory ring, open card dial and one thermometer.....	13 50
12e.	Aneroid Barometer, 5-inch, as above, without thermometer.....	12 50
12f.	“ “ similar to preceding, closed metal dial.....	10 00
12g.	“ “ similar to preceding, closed card dial.....	9 00
12h.	“ “ 2½-inch metal dial.....	12 00

These instruments are of superior workmanship, finish and reliability, and are recommended as trustworthy and efficient barometers. Each instrument bears the trade-mark shown within the ring at top.

The Aneroid Barometer.

This instrument possesses many advantages over the mercurial barometer on account of its portable form and the facility with which it may be shipped or carried without danger of injury or loss of adjustment.

It is sensitive and responds readily to changes in atmospheric pressure, and it is only necessary to secure great accuracy to have the instrument occasionally compared with, and adjusted to, a standard mercurial barometer.

The instrument has, therefore, on account of its simplicity and cheapness, come into very general use; it is practically the only *portable* form of barometer, and the smaller pocket sizes are as “handy” as a watch. It is especially adapted to the requirements of Civil Engineers, Tourists, Ship Captains, and similar occupations, for measuring altitudes or determining atmospheric pressures on shipboard where a mercurial barometer would be very quickly rendered unserviceable, if not injured beyond repair.

The better forms of aneroids for measuring altitudes are provided with adjustable scales, which denote at a glance the height of the instrument above sea-level.

The following table shows, approximately, the change in elevation, as indicated by barometric pressure:

Decrease in pressure:	Elevation above sea-level:
One inch.....	Equals..... 917 feet.
Two inches.....	“ 1860 “
Three “.....	“ 2830 “
Four “.....	“ 3830 “
Five “.....	“ 4861 “

In general, a decrease in barometric pressure indicates a rise in elevation of about 900 feet.

TO DETERMINE DIFFERENCES IN ELEVATION.

If practicable, and to insure greater accuracy, the observations should be made simultaneously, either by preconcerted arrangement or otherwise, using *two* aneroids which have previously been compared with each other and the discrepancy, if any, noted.

After the readings have been made to hundredths of inches and corrected, subtract the reading made at the higher point from that made at the lower and multiply the product by 9, this will give the *difference* in altitude in feet.

Example— 30.28
29.74

54
9

Difference in elevation— 486 feet.

This rule applies to atmospheric pressures near sea-level (that is, about 30 inches), and at temperatures about 50° Fahr. If the pressure or temperature is different, however, the following table should be consulted for factor to obtain more accurate results:

Mean Temperature—	Mean Atmospheric Pressure—			
	27 inches.	28 inches.	29 inches.	30 inches.
30° Fahr.	9.7	9.5	9.0	8.7
40° “	9.9	9.5	9.2	8.9
50° “	10.1	9.8	9.4	9.1
60° “	10.3	10.0	9.6	9.3
70° “	10.5	10.2	9.8	9.5
80° “	10.8	10.4	10.0	9.7

(For prices, &c., of Pocket Aneroids, see next page.)



Engineers' and Tourists' Altitude Barometers.

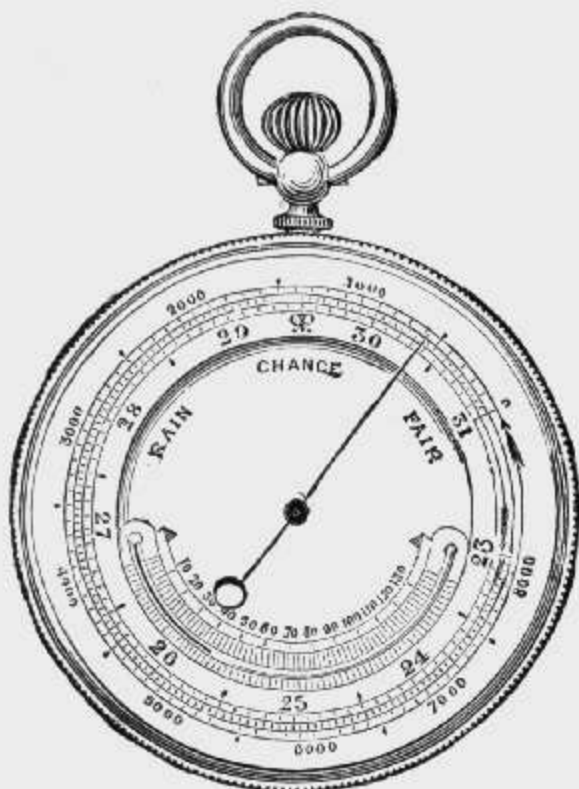


Fig. 13.



Fig. 14.

13. "Watch" Aneroid Barometer, compensated for temperature, gilt metal case, $1\frac{3}{4}$ -inch silvered metal dial, having thermometer attached, with detachable metal dial compass mounted at back, and stem-winding adjustment to revolving altitude scale, in morocco case, for altitudes of

10,000	15,000	20,000 feet.
\$35.00	38.00	40.00

- 13a. "Watch" Aneroid Barometer, compensated for temperature, open face sterling silver watch-case, $1\frac{3}{4}$ -inch silvered metal dial, with stem-winding adjustment for operating revolving altitude scale reading to

5,000	10,000	15,000 feet.
\$30.00	32.00	35.00

- 13b. "Watch" Aneroid Barometer, compensated for temperature, open face nickel hunting case, $1\frac{3}{4}$ -inch silvered metal dial, with stem-winding attachment operating revolving altitude scale reading to

5,000	10,000	15,000 feet.
\$20.00	22.50	25.00

- 13c. "Watch" Aneroid Barometer, compensated for temperature, gilt metal case, $1\frac{3}{4}$ -inch silvered metal dial, with attached thermometer, revolving altitude scale for

10,000	15,000	20,000 feet.
\$23.50	25.50	28.50

14. "Watch" Aneroid Barometer, similar to preceding, without thermometer :

3,000	5,000	8,000	10,000	15,000	20,000 feet.
\$22.00	20.00	20.00	21.00	24.00	27.00

- 14a. "Watch" Aneroid Barometer, non-compensated, gilt metal case, $1\frac{1}{2}$ -inch silvered metal dial, with raised revolving altitude scale reading to 15,000 feet, attached thermometer, in morocco case....\$13 50

- 14b. "Watch" Aneroid Barometer, similar to preceding, without thermometer, but stem-winding adjustment for operating revolving scale to 15,000 feet..... 15 00

- 14c. "Watch" Aneroid Barometer, non-compensated, gilt metal case,
 1 $\frac{1}{4}$ -inch silvered metal dial, with raised revolving altitude scale
 reading to 8,000 feet, in morocco case..... 12 50
 Sling Case, very superior, of buff English sole leather, for Pocket
 Aneroids, or any of above, *to order*..... 4 00

Thermographs.

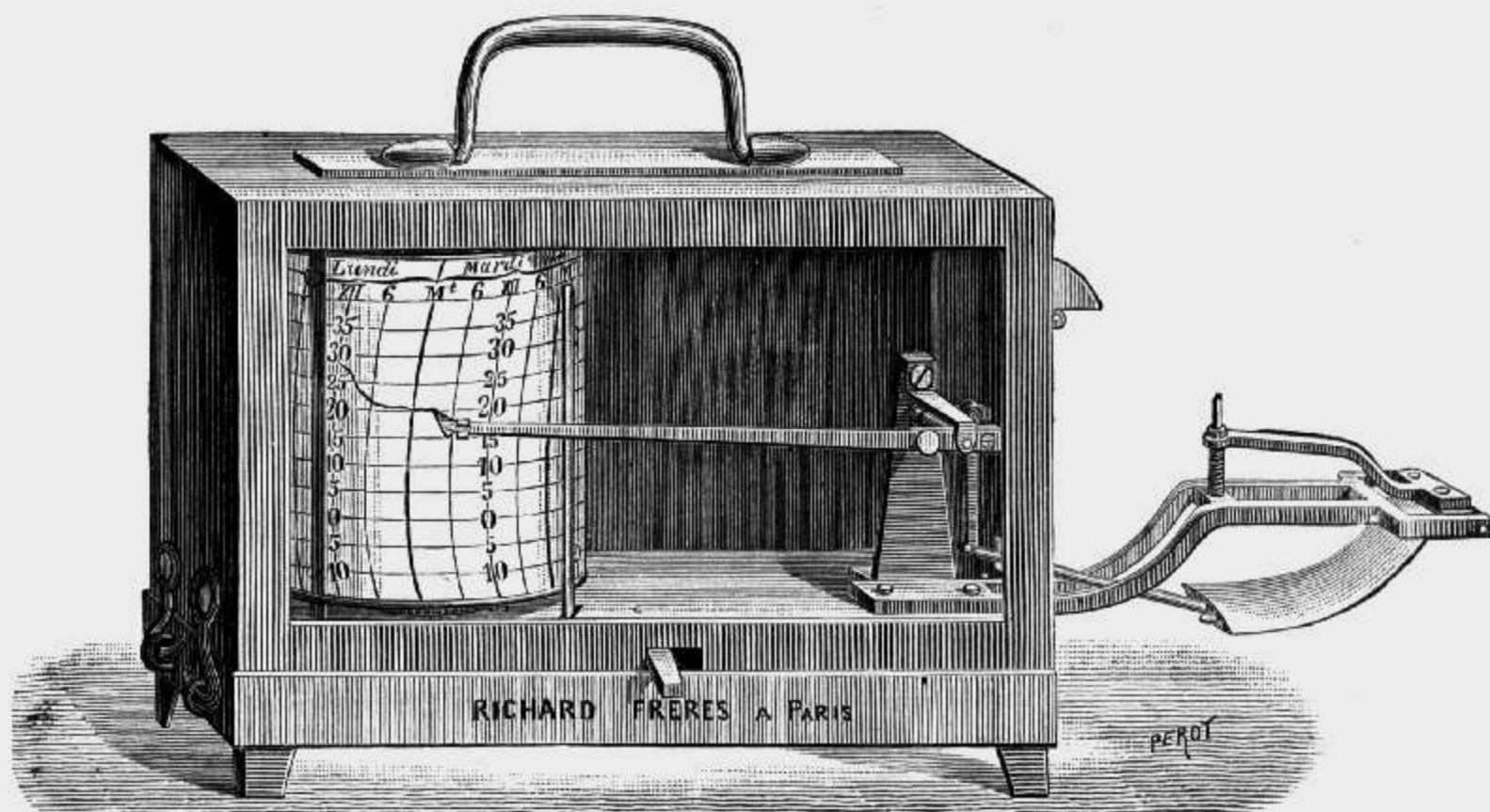


Fig. 15.

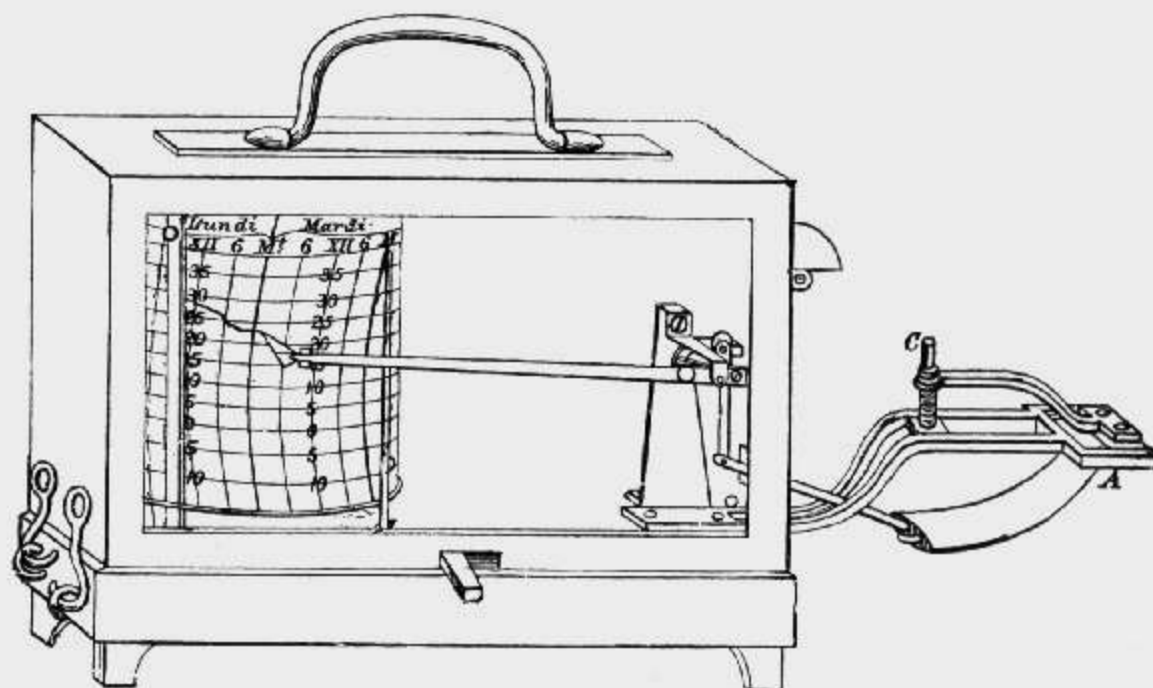


Fig. 16.

(See description, &c., next page.)

Thermograph (or Recording Thermometer).

This instrument is also of the manufacture of Richard Bros., Paris, and is part of the equipment of every 1st Order station of the U. S. Weather Bureau. The thermometric fluid is alcohol, which is enclosed in a¹¹ hermetically sealed and peculiarly shaped bulb,¹¹ shown at *A*, Fig. 16. The contraction and expansion of this bulb, caused by changes of temperature, is communicated by the levers to the recording pen, which holds enough ink to last for several days. The record cylinder revolves once a week, and the sheets are printed and ruled for record from Monday to Monday (a. m.). This Thermograph is considered as a reliable instrument by experts, but for accuracy it is necessary to carefully check the readings by daily comparison with an accurately graduated mercurial (dry-bulb) thermometer, such as described on page 30. The Thermograph is exposed in the instrument shelter as nearly as possible to the same conditions as the mercurial thermometer. See Notes on Records, page 60.

Thermograph, as above, in heavy sheet-iron case, glass front, nice finish, complete, with 1 year's supply of record sheets, 1 bottle special ink (warranted not to freeze at extreme low temperatures), pen, &c., complete, price.....\$

(Note:—For additional supplies, record sheets, &c., see page 55.)



Thermometers.

These instruments can really be considered as one of the most important inventions of modern times. Now-a-days, every one consults the thermometer, and the inquiry "What's the temperature?" is almost as common as the one "What time is it?" This little instrument has come into general use and application in nearly all the varied pursuits of life, and it is an indispensable necessity not only in the ordinary kitchen and household affairs, but also in certain lines of manufacture, such as artificial ice, cold storage, &c., &c., as well as in scientific investigations and the laboratory of chemical research.

Thermometers may truly be compared with watches as regards accuracy, reliability, &c. We can purchase a watch (or what has the appearance of being a timekeeper) for a few cents, and we can also procure what has the appearance of being a thermometer for a few cents, but while the cheap "tin-back" thermometer may seem to answer its purpose very well, yet its indications are far more unreliable than those of a cheap watch, for the sun acts as check upon the watch, while the poor or defective thermometer has absolutely *no* check upon its indications. Even if it has been compared with a standard, its corrections will change with age, and, not being stem-graduated, its indications really amount to but little more than simple guesswork on the part of the manufacturer.

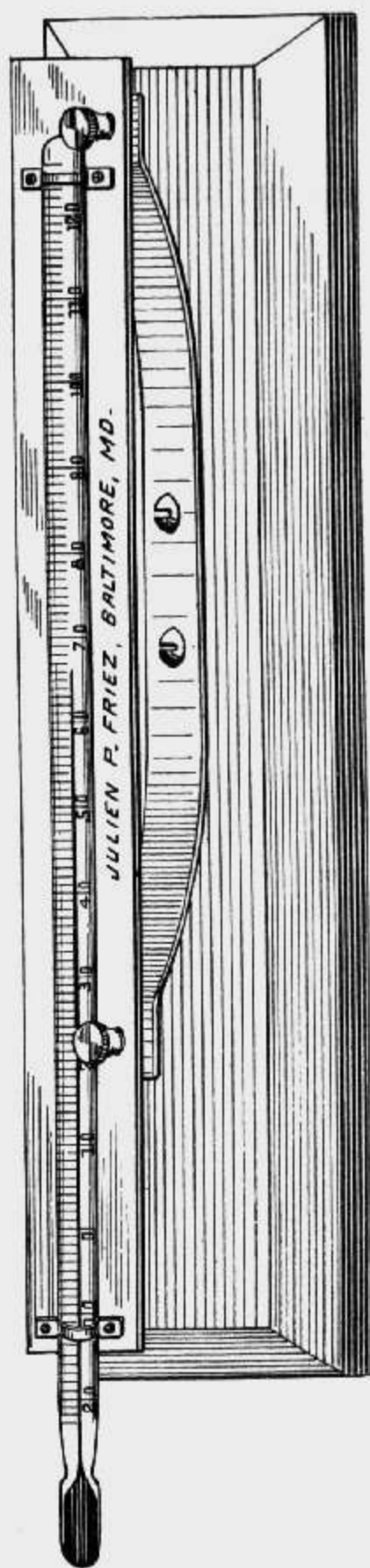


Fig. 17.

Therefore, those who have any regard for accuracy should procure only the *very best* thermometers, and these can now be obtained at prices within the reach of all. Experience, and improved machinery of special design, have made it possible to manufacture on correct scientific principles, reliable, stem-graduated thermometers that cannot be excelled.

The standard thermometers described below have been made with the utmost care and skill from thoroughly well-seasoned glass tubes, and, if purchasers so desire, they will be delivered free of cost at the Weather Bureau in Washington, where, upon special application, they will be compared and tested with government standards and appropriate correction cards furnished with each instrument. The Weather Bureau makes no charge for these comparisons, and the purchaser then really has an instrument that is comparable in accuracy with the Weather Bureau standards.

Exposed Mercurial Thermometer, Weather Bureau pattern, Fig. 17, 11 inches long, graduated and figured on glass stem, mounted on aluminum bronze metal back, with brass support for attaching to wall, instrument shelter, or whirling apparatus, price.....\$~~1.00~~



THERMOMETERS—Continued.

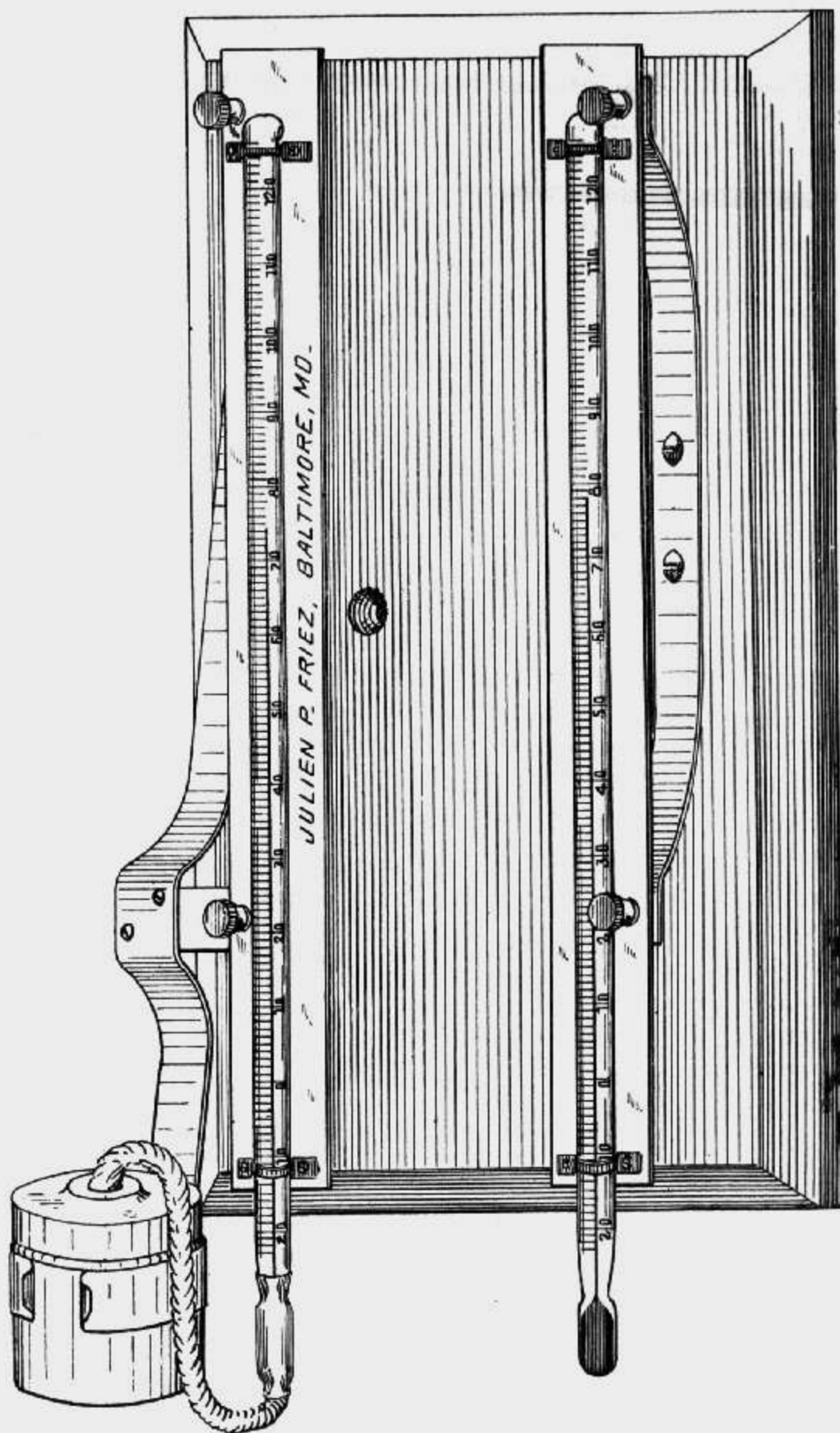


Fig. 18.

- Hygrometer, Weather Bureau Pattern, Fig. 18, consisting of two (2)
Exposed Thermometers as shown above (1 for wet and 1 for dry-
bulb). mounted on nicely finished board, complete, with wicking
and nickel-plated water cup, price.....\$**m**
- Hygrometer, Whirling Apparatus, Weather Bureau pattern, see page 55.
- Hygrometer, "Sling Psychrometer" (hand) " " see page 34.
- Hygrometer, Hair (Lambrecht's "Polymeter"), see page 35.

THERMOMETERS—Concluded.

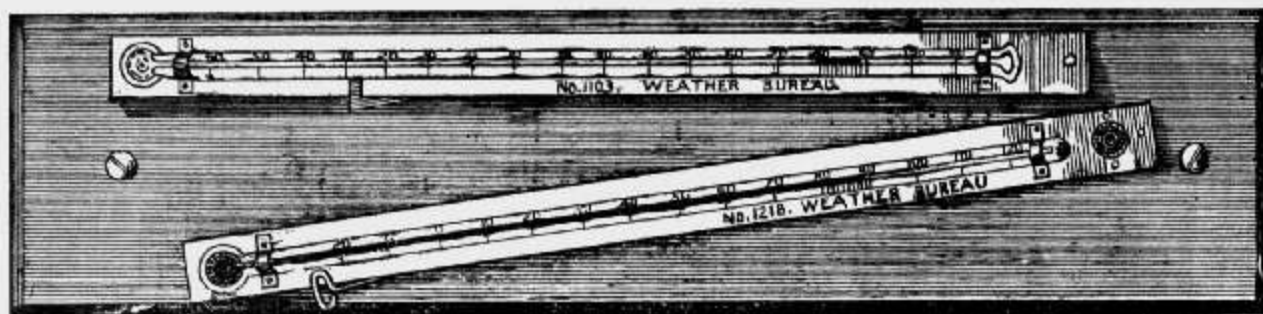


Fig. 19.

- Maximum Mercurial Thermometer (the *lower* instrument in the above cut), Fig. 19, Weather Bureau pattern, 12 inches long, stem-graduated and figured on glass, provided with heavy brass support and pin, price.....\$~~3.75~~ **3.75**
- Minimum Alcohol Thermometer (the *upper* instrument in the above cut), Fig. 19, Weather Bureau pattern, 12 inches long, stem-graduated and figured on glass, with brass support, price..... **1.75**
- Maximum and Minimum Thermometers, set complete, as shown in the above cut, mounted on nicely finished board, price..... **1.75**
- Set of Maximum and Minimum Thermometers, *portable*, mounted in oil-finished pine box..... **1.75**
- The above in neat and durable leather sling case for travel..... **1.75**
- (Note.—Special instructions on the care of Maximum and Minimum Thermometers are furnished with each set of these instruments.)
- Normal Standard Thermometers, from 15 to 20 inches long, graduated and figured on stem from 0° to 120°, or from 0° to 212°, Fahr. (or *Centigrade*, if desired), graduated to fifths or tenths of degrees and guaranteed within 1-20th degree, U. S. Weather Bureau standard, in brass metal cases, screw-top, made to order only, price..... **1.75**



STANDARD METALLIC THERMOMETERS.

FOR GENERAL USE.

The universal idea of a thermometer is a column of mercury, or spirits, contained in a glass tube, the tube being graduated in spaces on the outside, representing the degrees of temperature. The difficulty experienced in reading temperature in instruments of this nature, and the liability of error arising therefrom, has created a large demand from the public for a temperature measure constructed on different principles. This led to the production of the STANDARD METALLIC THERMOMETER.

In these instruments, thin plates of two metals, which have different powers of expansion and contraction, are soldered together, forming one solid plate. The action of heat on this bimetallic plate is multiplied by means of levers, which connect with the pinion carrying the hand, by which the temperature is accurately registered on the dial as plainly as time is indicated on a clock-face.

The figures upon the dial are so large and distinct they can be readily seen from all parts of the room. The value of such a thermometer cannot be overestimated. An uncertain temperature is detrimental to health; but with this plain dial in view, showing every fluctuation, an even and healthful temperature can be maintained.

Every instrument is carefully tested, accurately adjusted and warranted.

These thermometers are now in use in thousands of homes, many schools and other educational institutions, railroads, steamships, in many of the departments of the United States service, army, navy, and in all places where thermometers are usually to be seen.

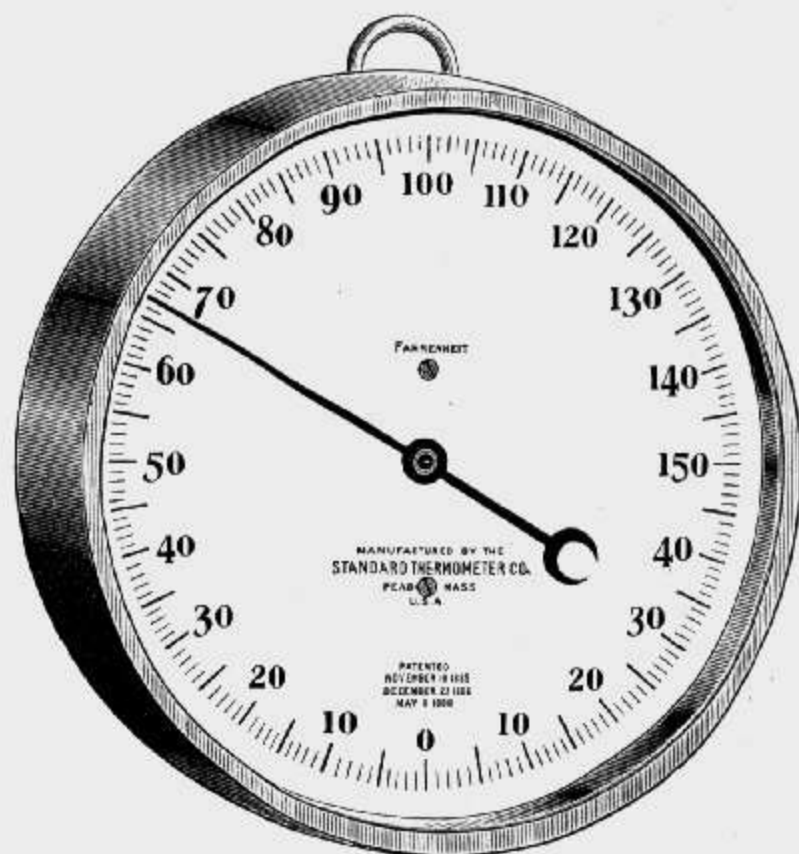


Fig. 20.

This cut is a representation of the nine-inch dial thermometers. They are mounted in handsomely finished cases, with plain dials graduated from 50 degrees below to 150 above zero Fahrenheit. Each instrument securely packed.

20. (See cut.) Has a nine-inch dial, black metallic case, with figures on dial particularly plain, and can be read at a great distance.
 Price, each.....\$2 50
 20a. Dial 9 inches diameter, brass case, each..... 2 50
 20b. " 9 " " polished brass case, each..... 2 50
 20c. " 9 " " nickel case, each..... 3 00

For other and more *elaborate* forms of this instrument, such as Thermostats, Telethermometers, Telehydrobarometers, Fire Alarm Indicators and Electrical Pressure Gauges, write for circulars and price list, to *Julien P. Friez, Baltimore, Md.*

Improved Sling Psychrometer.

(Designed by Prof. C. F. Marvin, U. S. Weather Bureau.)

NOTES ON HOW TO USE.

1. *This inexpensive and reliable instrument* affords at once the simplest and probably the most accurate means at general command for the determination not only of the true air temperature, but also of the amount of moisture contained therein. While the use of the instrument is attended with some risk as to its breakage, especially when in the hands of those not yet familiar with the "knack" of whirling it, yet many thousands of observations have been made with a single pair of thermometers without an accident.

2. *Exposure.* While the psychrometer will give quite accurate indications even in the bright sunshine, yet observations so made are not without some error, and where greater accuracy is desired the psychrometer should be whirled in the shade of a building or tree, or, as may sometimes be necessary, under an umbrella. In all cases there should be perfectly free circulation of the air, and the observer should face the wind, whirling the psychrometer in front of his body. It is a good plan while whirling to step back and forth a few steps to further prevent the presence of the observer's body from giving rise to erroneous observations.

3. *The Wet Bulb.* It is important that the muslin covering for wet bulb be kept in good condition. The evaporation of the water from the muslin leaves always in its meshes a small quantity of solid material, which sooner or later somewhat stiffens the muslin so that it does not readily take up water. This will be the case if the muslin does not readily become wet after being dipped in water. On this account it is desirable to use as pure water as possible, and also to renew the muslin from time to time. New muslin should always be washed to remove sizing, etc., before used. A small rectangular piece wide enough to go about one and one-third times around the bulb, and long enough to cover the bulb and that part of the stem below the metal back, is cut out, *thoroughly wetted* in clean water, and neatly fitted around the thermometer. It is tied first around the bulb at the top, using a moderately strong thread. A loop of thread to form a knot is next placed around the bottom of the bulb, just where it begins to round off. As this knot is drawn tighter and tighter the thread slips off the rounded end of the bulb and neatly stretches the muslin covering with it, at the same time securing the latter at the bottom.

4. *To make an Observation.* The so-called wet bulb is thoroughly saturated with water by dipping it into a small cup or wide-mouthed bottle. The thermometers are then whirled rapidly for 15 or 20 seconds; stopped and quickly



Fig. 21.

read, the *wet bulb* first. This reading is kept in mind, the psychrometer immediately whirled again and a second reading taken. This operation is repeated three or four times, or more, if necessary, until at least two successive readings of the wet bulb are found to agree very closely; thereby showing that it has reached its lowest temperature. A minute or more is generally required to secure the correct temperature. Reference to standard tables readily gives the percentage of Humidity and the Dew-point.

5. When the air temperature is near the freezing point it very often happens that the temperature of the wet bulb will fall several degrees below the freezing point but the water will still remain in the liquid state. No error results from this, provided the minimum temperature is reached. If, however, as frequently happens, the water suddenly freezes, a large amount of heat is liberated, and the temperature of the wet bulb immediately becomes 32° . In such a case it is necessary to continue the whirling until the ice-covered bulb has reached a minimum temperature.

Improved Sling Psychrometer, Weather Bureau pattern, as shown in Fig. 21, consisting of two (2) first-class, stem-graduated and figured, exposed, mercurial thermometers; mounted on an aluminum bronze back, and provided with polished, turned, hard-wood handle and brass trimmings, neatly finished, price.....\$1.10

The Polymeter.

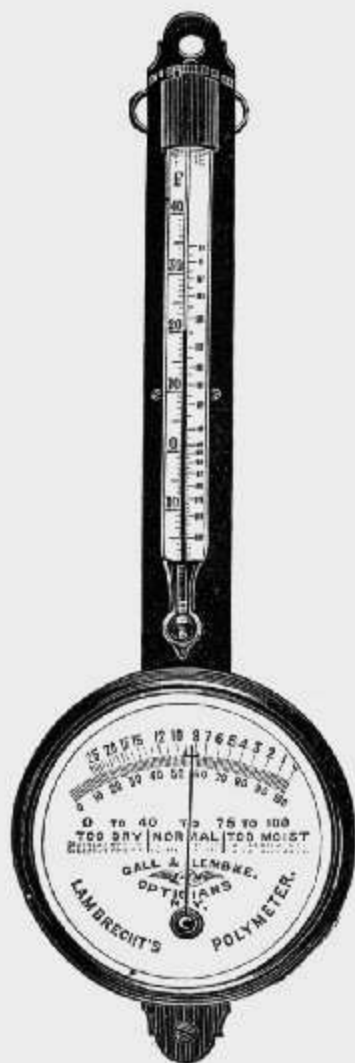


Fig. 22.



Fig. 23.

LAMBRECHT'S PATENT POLYMER gives the following meteorological conditions of the atmosphere:

1. *Temperature.* The thermometer on the stem of the Polymer gives the temperature of the air in Fahrenheit degrees, the same as any standard thermometer.

2. *Relative Humidity.* Relative Humidity is the percentage of moisture in the atmosphere at any degree of temperature. The Polymer gives it by the index hand on the dial, zero being extreme dryness and 100 extreme saturation, or the air filled with moisture.

3. *Dew-point, or Absolute Humidity.* To obtain the Dew-point or absolute humidity, it is necessary to read the number on upper scale of the dial above the index hand, and deduct it from the temperature given by the thermometer of the Polymer. The result is the dew-point of the temperature at which the air becomes completely saturated, or dew deposits.

4. *Vapor Pressure, in millimeters of mercury.* By maximum Vapor Pressure in millimeters is understood to be the pressure exerted by the invisible vapor of the air on the mercurial column of the barometer. Every degree of temperature has its own maximum vapor pressure, as will be seen on the scale to the right of the thermometer scale.

5. *Weight of Vapor, in grammes, in a cubic meter.* It is sometimes interesting to know the weight of vapor contained in a cubic meter, or the weight of moisture in a room. By the Polymer it may be easily ascertained.

Note.—Full instructions and examples for obtaining the above-mentioned meteorological data are given in the pamphlet entitled "Humidity and Weather Forecasts," copies of which are sent upon application and with each of these instruments purchased.

(See prices, &c., on next page.)

Weather Indications by the Polymer.

FOREKNOWLEDGE of the changes of the weather is of great importance to the generality of people, and is especially valuable to seamen leaving or entering port, to merchants in shipping goods, to gardeners and farmers on account of planting and reaping their crops, to builders in successfully attending to their work and ordering material; to physicians weather indications are of great importance as to the welfare of their patients. The inexpensive Polymer gives extremely reliable indications of the coming changes of the weather, and full instructions for making such indications are given in "Humidity and Weather Forecasts," a neat little booklet, which is sent upon application.

The Polymeters, Figs. 22 and 23, are constructed of brass or bronze, about 9 inches long, with a 3 inch dial, having engraved thereon a scale indicating relative humidity and dew-point figures.

The bronze instrument is more suitable for outdoor exposure, and makes a handsomer appearance than the brass instrument.

In regard to durability the instrument is well constructed.

The friction of the hand of the Polymer is almost nominal, as the axle-box is made of silicon bronze, and the axle of nickel copper. If spiders or insects should get inside of the instrument, they should, of course, be removed at once. Dirt, dust, etc., on the hair may influence the sensitiveness, but not the exactness of the hand indicating the humidity. The instrument should, however, be kept as clean as possible.

22.	Polymer mounted in Brass.....	\$8.00
22a.	“ “ Phosphor-Bronze	9.00
22b.	“ on Stand suitable for traveling, in Pocket Case.....	12.00
23b.	“ mounted in brass, attached to Window Bracket, in Black Japan.....	10.00
23c.	“ Same in Phosphor-Bronze.....	11.00
23.	Polymer mounted in Brass, attached to Window Bracket as shown in Fig. 23, highly Ornamented and Enameled..	13.00
23a.	“ Same in Phosphor-Bronze.....	14.00

The Clinical Hygrometer is especially constructed for hygienic purposes, and it is in use at the Hygienic Institute in Berlin, under the direction of Prof. Dr. Koch. Also used by many other medical authorities.

23d.	Clinical Hygrometer contained in Pocket Case.....	\$15.00
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For industrial purposes the Polymer or Hygrometer can be furnished with a dial of 5 inches diameter indicating percentage of humidity, and instead of the mercurial thermometer a metallic one is substituted. The figures are plain and can readily be distinguished from a considerable distance. The instrument has been especially designed to meet all requirements of *Cotton, Silk and Woolen Manufacturers, Paper, Starch and Powder Factories*, and other industries where a uniform degree of moisture in the atmosphere is required.

23f.	Industrial Hygrometer, with 5-inch dial and Metallic Thermometer attached.....	\$16.00
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Address all communications and orders to

JULIEN P. FRIEZ,
107 E. German St., Baltimore, Md.

Improved Photographic Sunshine Recorder.

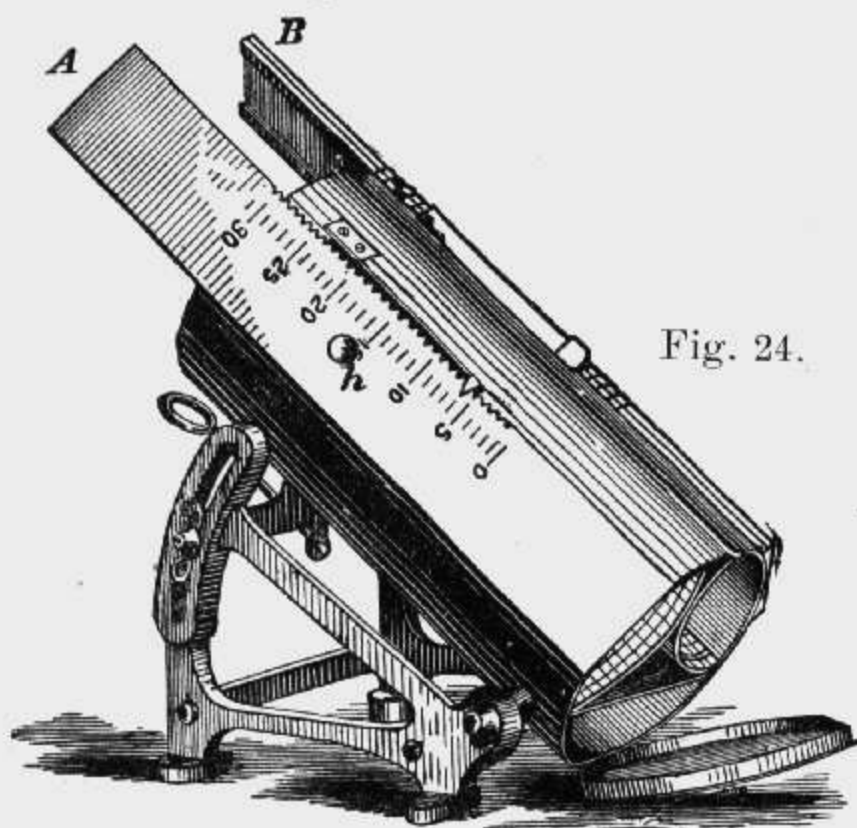


Fig. 24.

The above illustration shows this instrument about one-fourth actual size. This Sunshine Recorder consists of a metallic cylinder, supported on a frame, and it is set up so that the end marked *A, B*, is toward the north, the cylinder being exactly parallel with the *true* meridian for the place of exposure, and so that the direct rays of the sun for the entire day will shine squarely against the slides *A, B*. Each of these slides is provided with a tiny hole (the one in the slide *A* being shown at *h*), and the ray of sunshine passes through this hole and forms an image of the sun on the prepared "blue-print" paper charts within. This image of the sun passes across the chart, with the apparent motion of the sun, and causes a record to be made on the chemically prepared paper, which tracing is afterwards rendered permanent and indelible by washing the chart in water, in accordance with detailed instructions given in *Circular S*. The paper charts are clearly shown in the figure by the two ruled, curved portions; the door of the cylinder being open.

This instrument was designed by Prof. C. F. Marvin of the U. S. Weather Bureau, and is one of the instruments of

that service in use at 1st Order stations. It produces an excellent chemical record of the sunshine, with very little attention on the part of the observer; it is simple and complete in itself, and requires only a moment each night to adjust the slides *A* and *B* down one notch, so as to bring the next day's record on a different place on the prepared charts.

Improved Photographic Sunshine Recorder, nickel-plated, dull finish, complete, with detailed instructions for use (Circular S); 15 sets blank charts, and supply of Forms 1065, price.....\$

Electrical Sunshine Recorder.

A sectional view of the new Weather Bureau Electrical Sunshine Recorder, dismounted, is shown in Fig. 25. The principle upon which this instrument works is essentially that of a differential air thermometer; the air in each bulb being separated by a short column of mercury. The lower bulb, *d*, is covered with a heavy coating of lampblack, and, when the instrument is exposed to the direct rays of the sunlight, the air in this bulb expands more than that in the upper bulb, *c*, which has no coating of lampblack or any substance to attract the heat rays, and the column of mercury is forced upward and closes an electrical circuit through the fused-in wires, *f, f*. This circuit passes through the clock of the register (as shown by diagram on pp. 17, 18), and, when the sun is shining, short marks at regular intervals are made on the record sheet. During cloudy weather and at night time, the mercury retreats toward the blackened bulb and breaks the circuit, and the record on the sheet is then a straight line, unless rain should occur and there is a

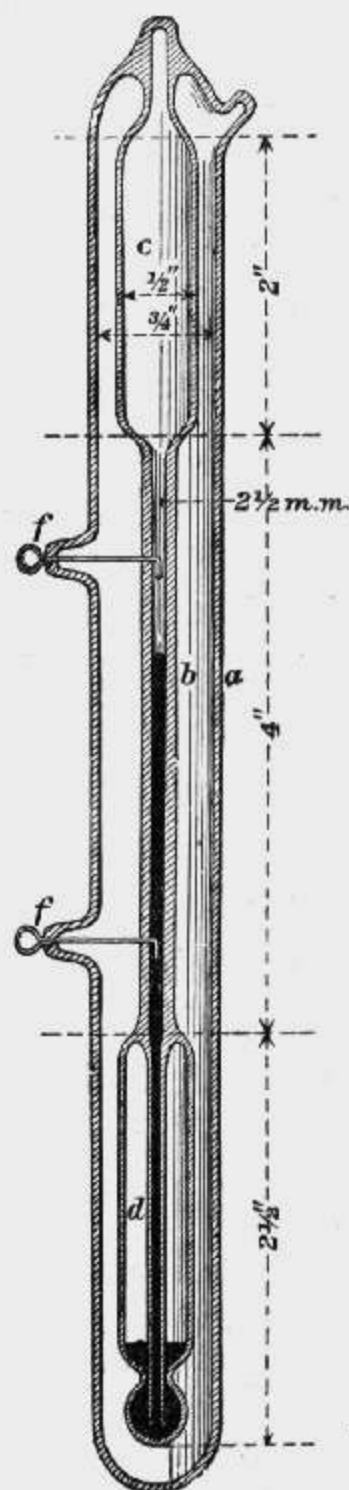


Fig. 25.

Tipping-bucket Rain-gauge in operation on the same register, when irregular marks will be made, as described on page 45.

The idea of thus recording sunshine electrically was first suggested by Mr. D. T. Maring of the Weather Bureau in 1891, and has since been developed by Prof. C. F. Marvin into the simple and ingenious instrument described above.

It is necessary to adjust each instrument very carefully, and, when once adjusted, it cannot be laid down on its side, or inclined much from the vertical, without materially injuring its accuracy. It can, however, be again readjusted by the skilful application of heat from a lamp or gas Bunsen burner. No bubbles of air should be allowed in the column of mercury, and the illustration shows about the proper adjustment for mercury with the instrument in the shade and the temperature of both bulbs the same.

While every precaution is taken to keep the box "right side up with care," when shipped by express, yet the instrument should only be transported to place of exposure by hand.

As the Weather Bureau observers frequently exchange stations—the Electrical Sunshine Recorders used by that service are carried from Washington, D. C., to their destinations by them, *by hand*. In order to facilitate the delivery of these Electrical Sunshine Recorders to *my* customers, I will, therefore, deliver to the Weather Bureau at Washington, *free of expense*; each instrument being carefully packed for hand transportation, and, upon special request being made by the purchaser to the Chief of the Weather Bureau, I am confident he will instruct his first observer going in that direction to carry the package to the nearest point to destination. Or, if not practicable, then other special arrangements can be made, or the instrument sent direct by express. Correspondence solicited.

Electrical Sunshine Recorder, glass (mounted on neat adjustable brass support having electrical binding posts and connections), carefully made and adjusted, packed for hand transportation (delivered in Washington, D. C., if desired), price.....\$

(*Note*.—Experiments are now in progress to overcome, if possible, this defect of transportation.)

Standard Weather Bureau Rain and Snow Gauges.

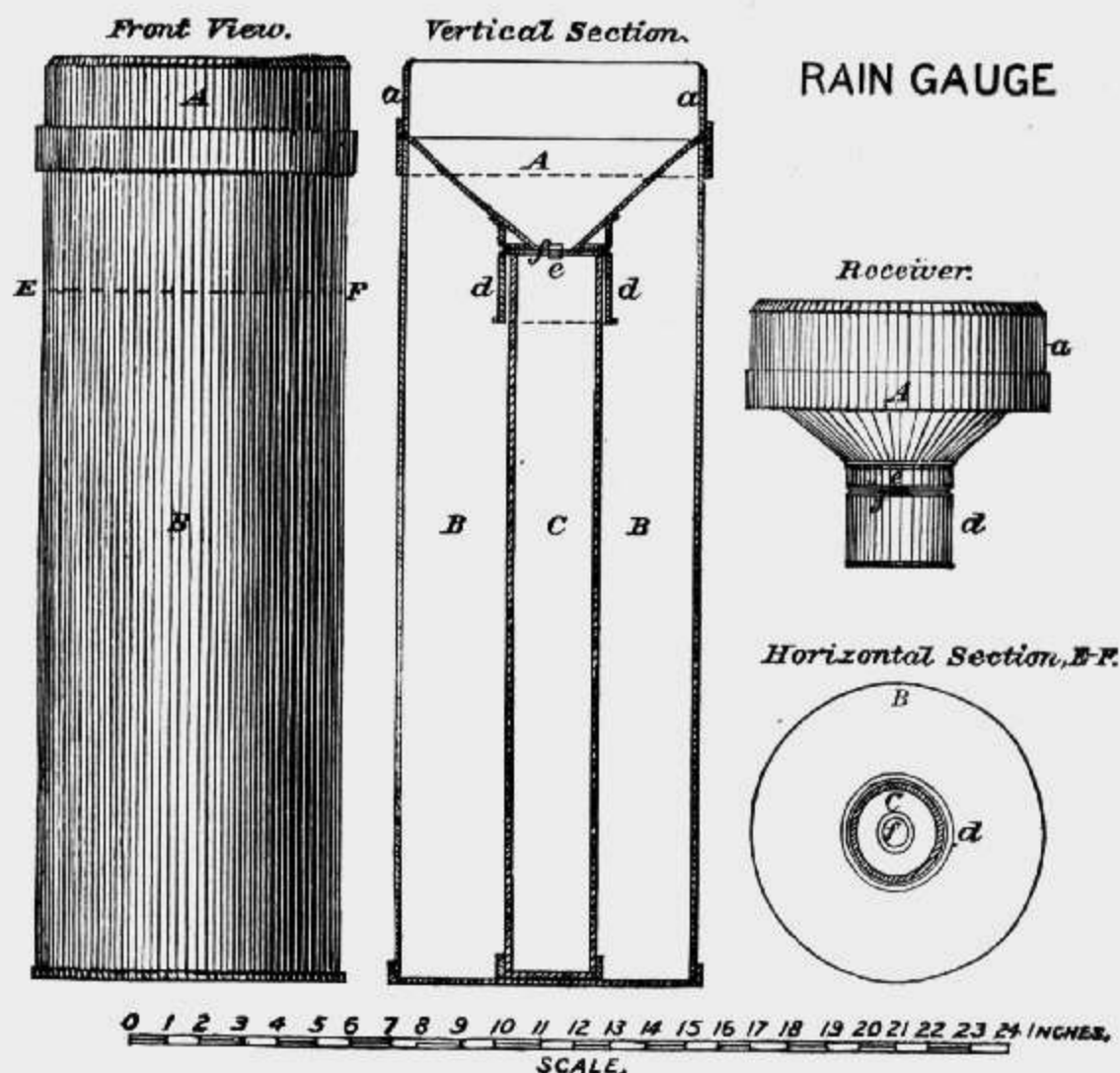


Fig. 26.

DESCRIPTION OF GAUGE.

This is really a combined rain and snow gauge and consists of the following parts:

The receiver, *A*; the overflow attachment, or snow gauge, *B*; the measuring tube, *C*.

The top cylindrical portion of the receiver, marked *a* in Fig. 26, is exactly 8 inches in diameter, inside, and is provided with a funnel-shaped bottom, which conducts any precipitation falling into the receiver into the tall cylindrical measuring tube, *C*, the total height of which, inside, is exactly 20 inches. The diameter of this tube is much smaller than the large receiving tube, *a*, being only 2.53 inches. In consequence of this a small amount of rain falling into the receiver and flowing into *C* fills the latter to a depth greater than the actual rainfall in proportion as the area of the receiver is greater than the area of the measuring tube. In the standard gauges of the Weather Bureau the depth of the rainfall, in accordance with this principle, is magnified just ten times. The receiver, *A*, has a sleeve, *d*, Fig. 26, which slips over the tube, *C*, and very effectually prevents any loss of rainfall. Again, when the rainfall is very heavy the tube, *C*, may be more than filled. In this case to still prevent loss a little opening, shown at *e*, is made in the sleeve, *d*, just on a level with the top of the tube, *C*. The excess of rainfall escapes through this opening, and is retained in the large overflow attachment, *B*, and can be measured afterwards, as will be described. The diameter of the overflow attachment in the latest style gauges is now made just 8 inches inside diameter. The object of this is to be able to use this portion of the instrument as a snow gauge, as is explained on page 62.

Standard Rain and Snow Gauge, well and accurately made; of specially drawn brass tubing and best quality galvanized iron, complete, with measuring stick, price.....\$
 Extra Measuring Sticks, cedar, best quality, each.....

(N. B.—For full instructions for measuring rain and snow see pages 61, 62 and 63.)

Improved Box Supports for Standard Gauges.

Rain Gauge and Support.

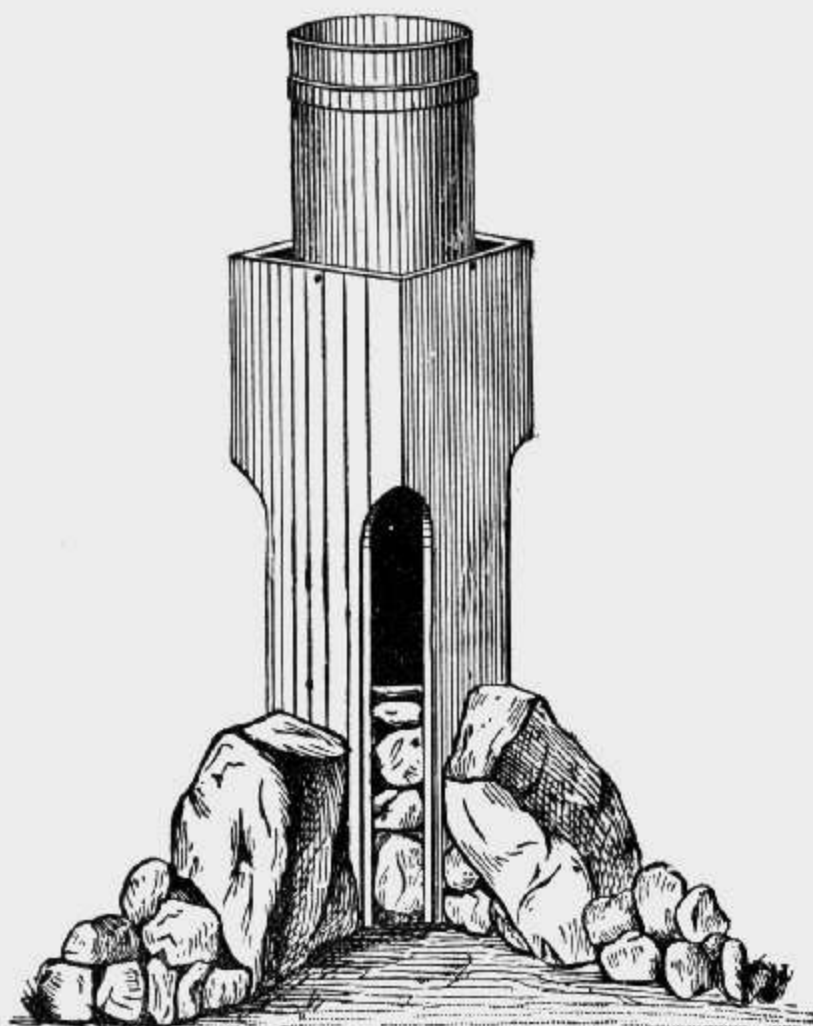


Fig. 27.

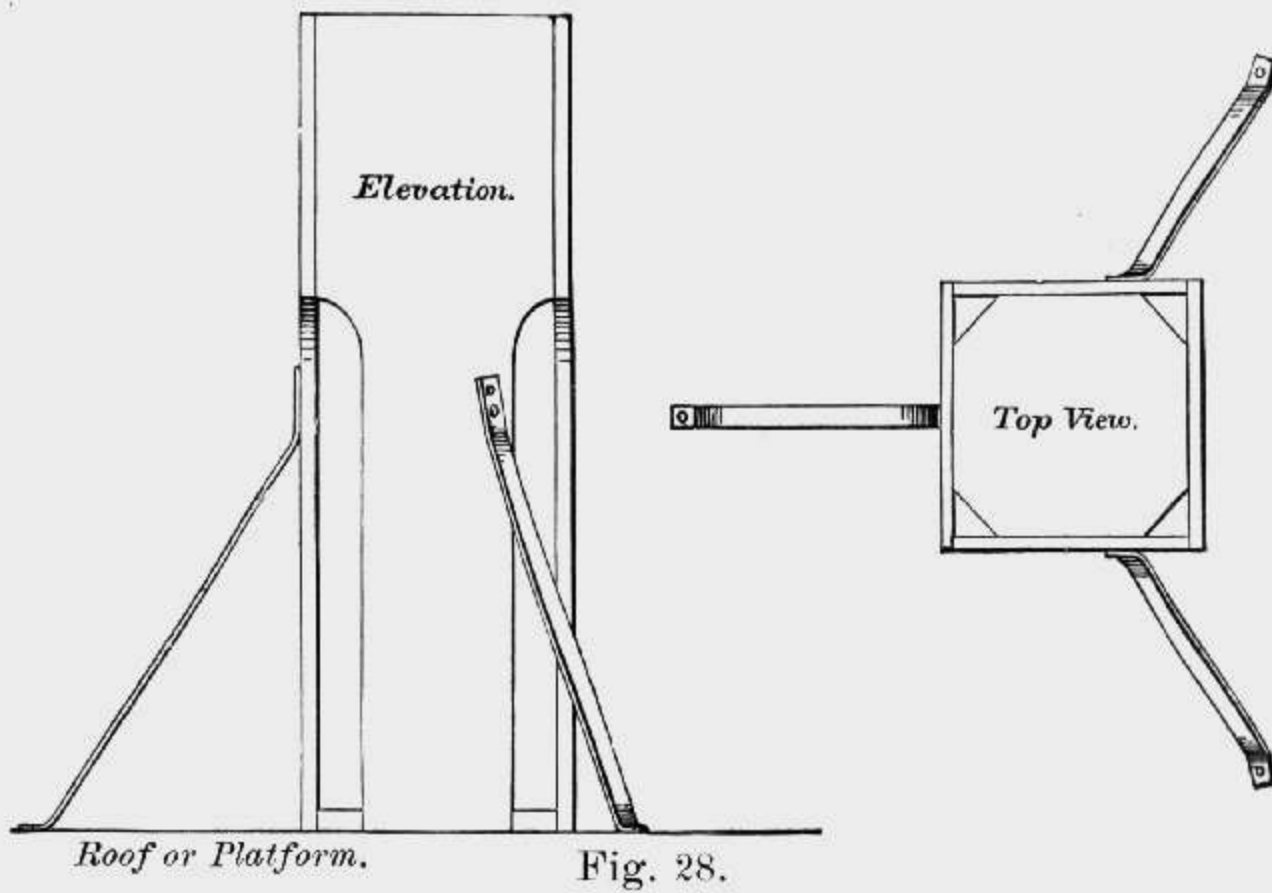
DESCRIPTION OF SUPPORT.

This Support is expressly designed as a stand for the instrument, and should be opened at the head, which is fastened by screws. Set the box up as nearly vertical as possible at the place selected for the exposure, and ballast by filling the lower portion with several inches of stone or broken brick. Slip in the head and lower to the level of the screw holes in the sides of the box about 10 inches from the bottom, where the head is securely fastened with the screws taken out in opening the box. The support is further secured and fixed in its position by piling up a few stones around the outside. The gauge can now be placed inside, and appears as shown in Fig. 27.

Box Support, made of best materials, given 3 coats (outside and in)	
best asphalt paint, price.....	\$
Box Support, as above, WHEN ORDERED WITH A STANDARD	
RAIN GAUGE, only.....	\$

(Note.—See next page for proper manner of attaching this Box Support to a ROOF.)

Roof Exposures for Box Supports.



When it is desired to erect the Box Support on the roof of a building, three suitable iron braces can be supplied. These should be attached as shown in Fig. 28, and the top of the box, which forms the false bottom, will be placed at a lower point, so that the top edge of the receiver of the gauge is just four (4) inches above the box support.

Iron Braces for Box Support, wrought-iron, nicely painted, complete
with necessary screws, only.....\$

Tipping-Bucket Attachment for Rain Gauge.

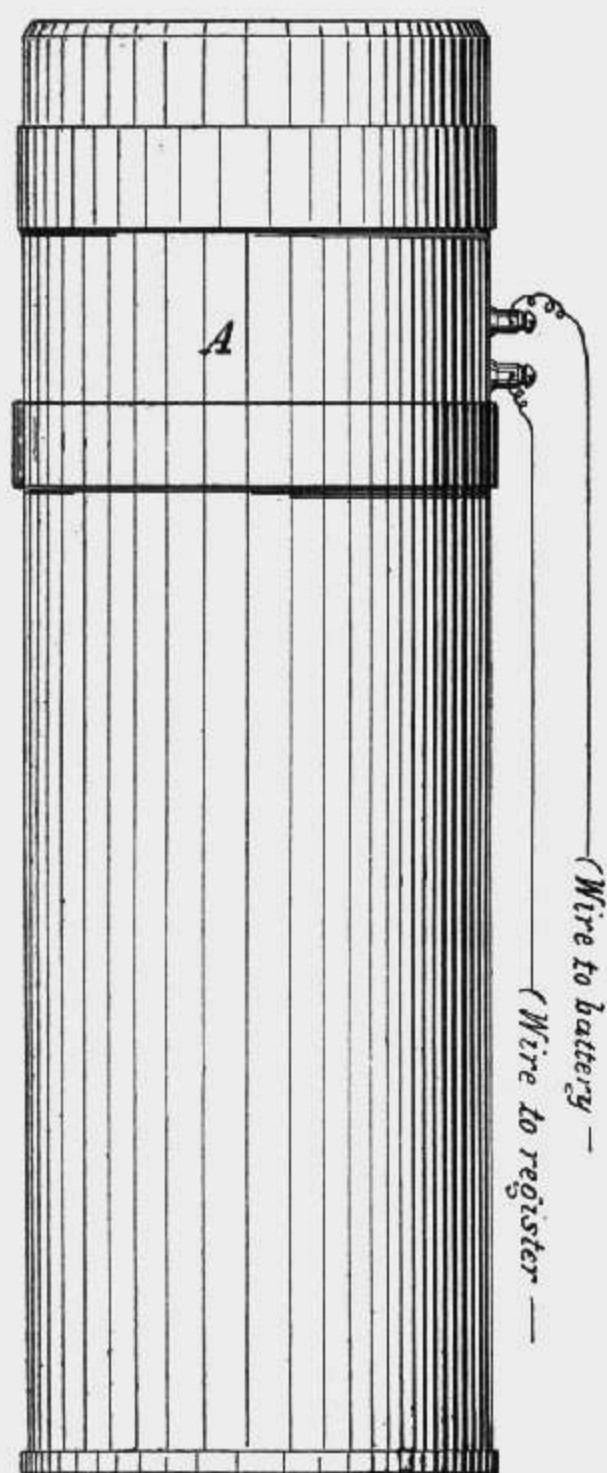
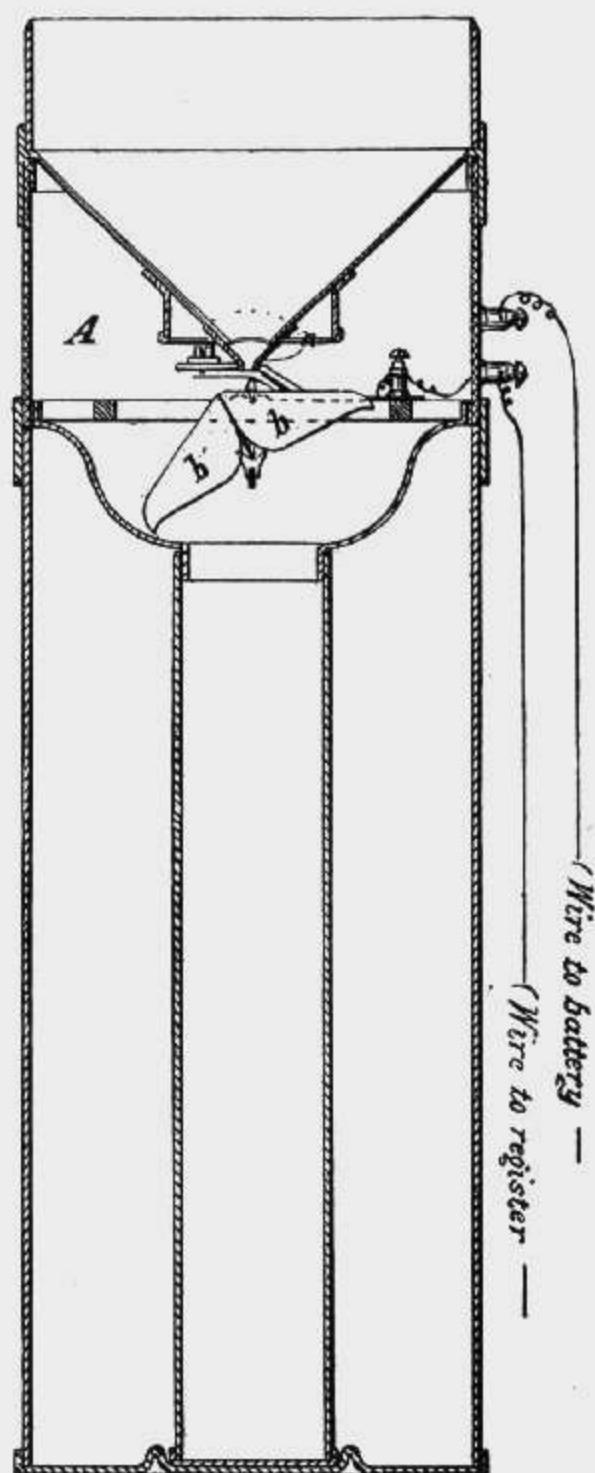
Front View.*Vertical Section.*

Fig. 29.

In the above illustration, at *A*, is shown one of the simplest automatic meteorological instruments. The idea of a tipping-bucket to measure rainfall is an old one, and the principle, as embodied by foreign inventors, was of using a comparatively large and crude form of bucket, or water wheel, this being expected to do a certain amount of "work" to en-

able a record to be produced. It proved a failure, however, in nearly every known instance, and instruments of this class were practically obsolete until 1891, when the subject was taken up by the experts of the U.S. Weather Bureau at Washington. The suggestions of Mr. Chas. B. Tuck were followed by careful experiments and improvements, and, through the great skill, perseverance and ingenuity of Prof. C. F. Marvin, the instrument has now reached a degree of mechanical perfection that can probably never be improved upon. Its readings are also practically reliable, and its construction so simple that it is a most desirable instrument to have.

The buckets, *b, b*, are formed in special dies and moulded in a smooth curved shape to hold, as nearly as possible, 1-100th of an inch of rain, as collected in the standard 8-inch rain gauge. These buckets are then attached together at the large end and mounted on suitable knife-edges, so that the point of support is considerably below the center of gravity, and the buckets, when filled with water, tip back and forth with these knife-edges as the pivot. The buckets thus alternately collect and empty the rain as it falls, through the special nozzle, *n*, the water being collected in the brass measuring tube of the gauge proper. Each movement of the buckets as they tip, closes, by an ingenious arrangement, an electric circuit, which circuit is connected with the rainfall magnet of the register, thus producing a permanent, continuous and automatic record of rainfall. The buckets and parts are held in place by gravity alone, and can readily be lifted out (for cleaning, &c.), without tools, by simply raising the small lever to which the electrical contact is fastened.

By a suitable attachment connected with the armature on the magnet of the register, each 10th mark of the recording pen is made longer than the others, thus insuring a distinct record, even during the most rapid rainfalls. If a record of rainfall *only* is desired, the daily or weekly registers, shown on pages 9 and 12, can be fitted for use with this attachment to rain gauge.

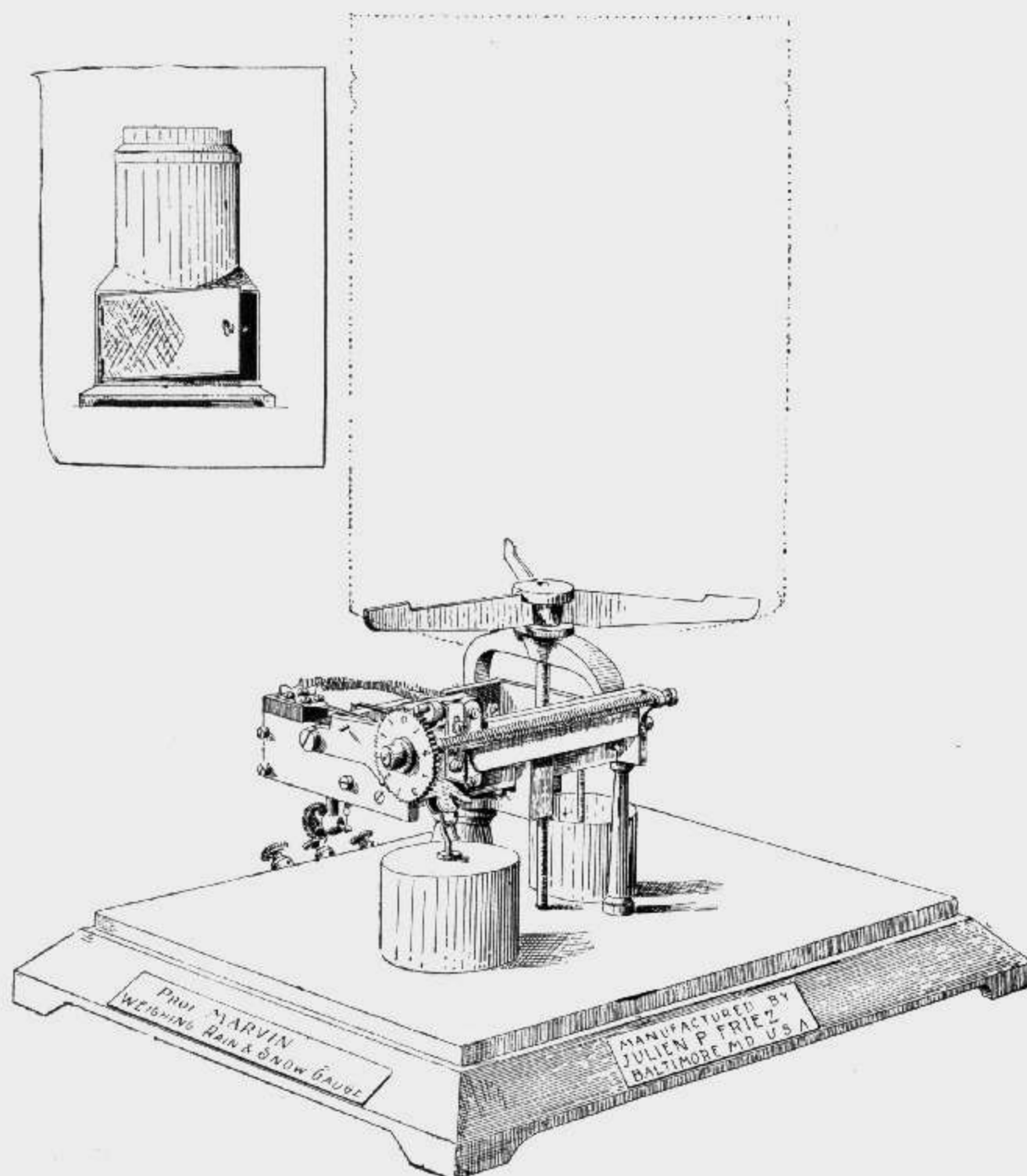
This attachment is made expressly for use on the stand-

ard Rain and Snow Gauges of the Weather Bureau, and when placed on those instruments practically makes them *recording* rain gauges with the least possible extra expense.

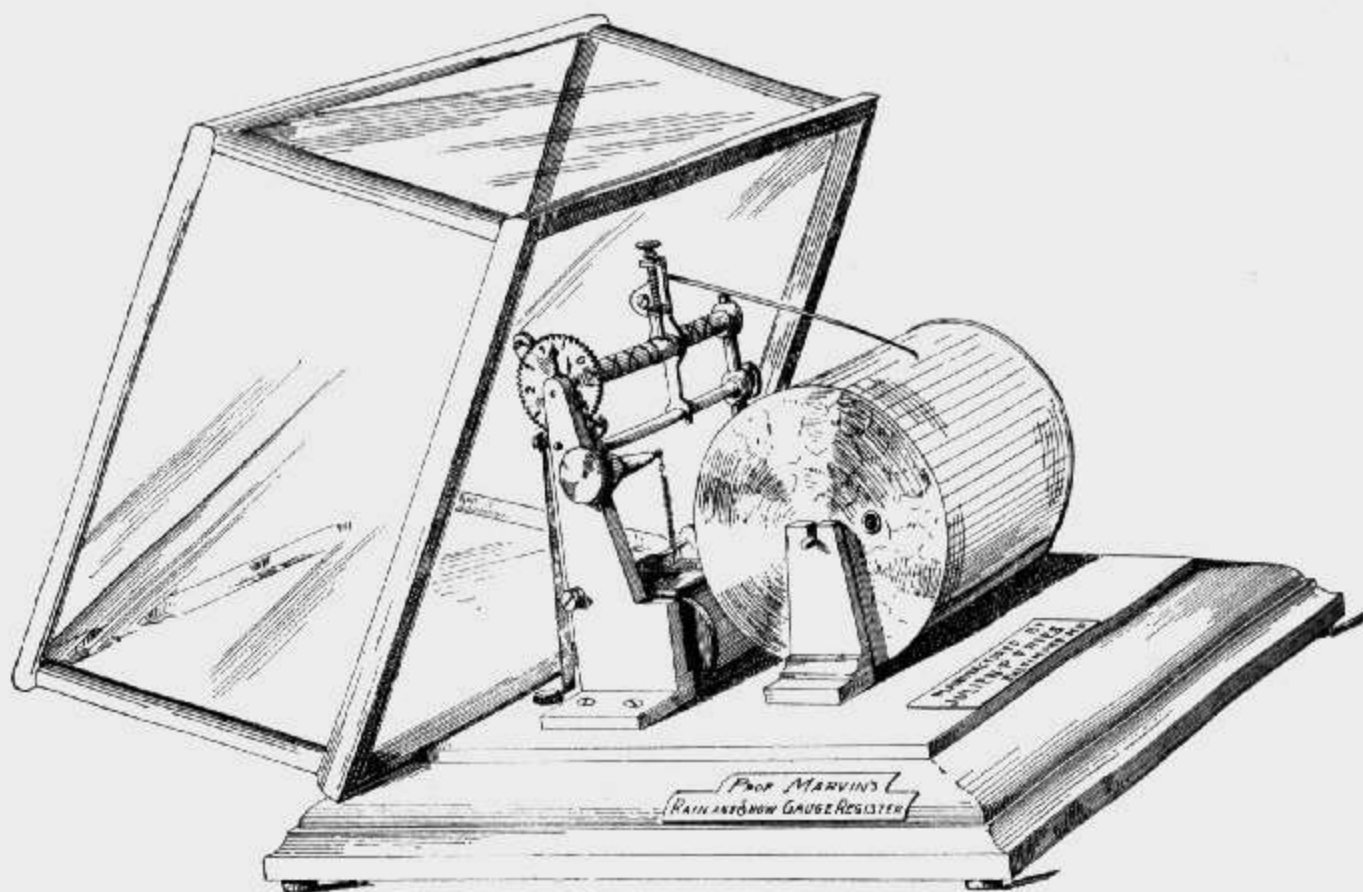
The record is carefully checked, after each rain, by *actual* measurements with a stick in the usual manner.

Tipping-bucket Attachment for Rain Gauge, as described above, made of best materials throughout, price\$

Improved Weighing Rain and Snow Gauge.



RECEIVER.—Fig. 30.



REGISTER. -Fig. 30a.

This instrument represents the latest and highest achievement of American ingenuity in the construction of meteorological instruments. It is the result of many months of study and experiment by Prof. Chas. F. Marvin of the Weather Bureau, and is really the *first* electrically recording *Snow Gauge* of which we have any knowledge. It also records, electrically, other forms of precipitation, such as hail and rain. The instrument is made in two parts; the receiver mechanisms (Fig. 30), which are placed out-of-doors and collect and transmit the small amounts of precipitation as they fall, and the recording part, or register (Fig. 30a), placed in the office room or indoors.

The *cover* of Receiver, with door ajar, is shown in reduced scale at left (Fig. 30).

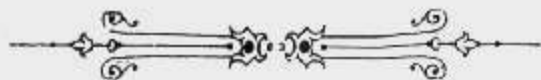
The principle upon which this instrument works is that of a balance beam, always kept in equilibrium, hence the name "Weighing Rain and Snow Gauge." One end of this beam holds the receptacle into which the precipitation falls, and the adjustment is so delicate that about 6 drops of water,

or the equivalent of that amount, in weight, of snow or hail, will depress the end of the beam sufficiently to close an electrical circuit and actuate the pen of the register. The movement of the armature controlling the recording pen closes another circuit, which sends a current of electricity through the mechanisms attached to the other end of the balance beam and restores the equilibrium. This operation is repeated for each thousandth of inch of rainfall. The record sheet has a very open scale, upon which the thousandths of inches of rainfall can easily be read, and, by an ingenious double-screw, the pen travels back and forth across the sheet. This makes the gauge only limited in the total amount it will record, to the capacity of the receiver itself, which is for about 10 inches of rain or snow fall. The register is provided with a good, reliable clock, which is located inside the recording cylinder. The instrument is complete in itself, is not complicated, and can be installed by anybody at all familiar with electrical circuits.

The *total* readings from this gauge are carefully checked, at the regular hours of observation, by actual *stick* measurements, or the precipitation may be weighed, see Table I, page 64.

(See note at top of page 59 for number of cells of battery needed with recording instruments of this character.)

Improved Weighing Rain and Snow Gauge, Weather Bureau pattern.
special clock movement, fine finish throughout, complete (but
without cable or battery). price.....\$
(*Note.*—For prices of cable (3-wire), battery, and Forms 1028 used on
register, see pages 54 and 55.)



Standard Weather Bureau Instrument Shelter.

(SMALL SIZE)

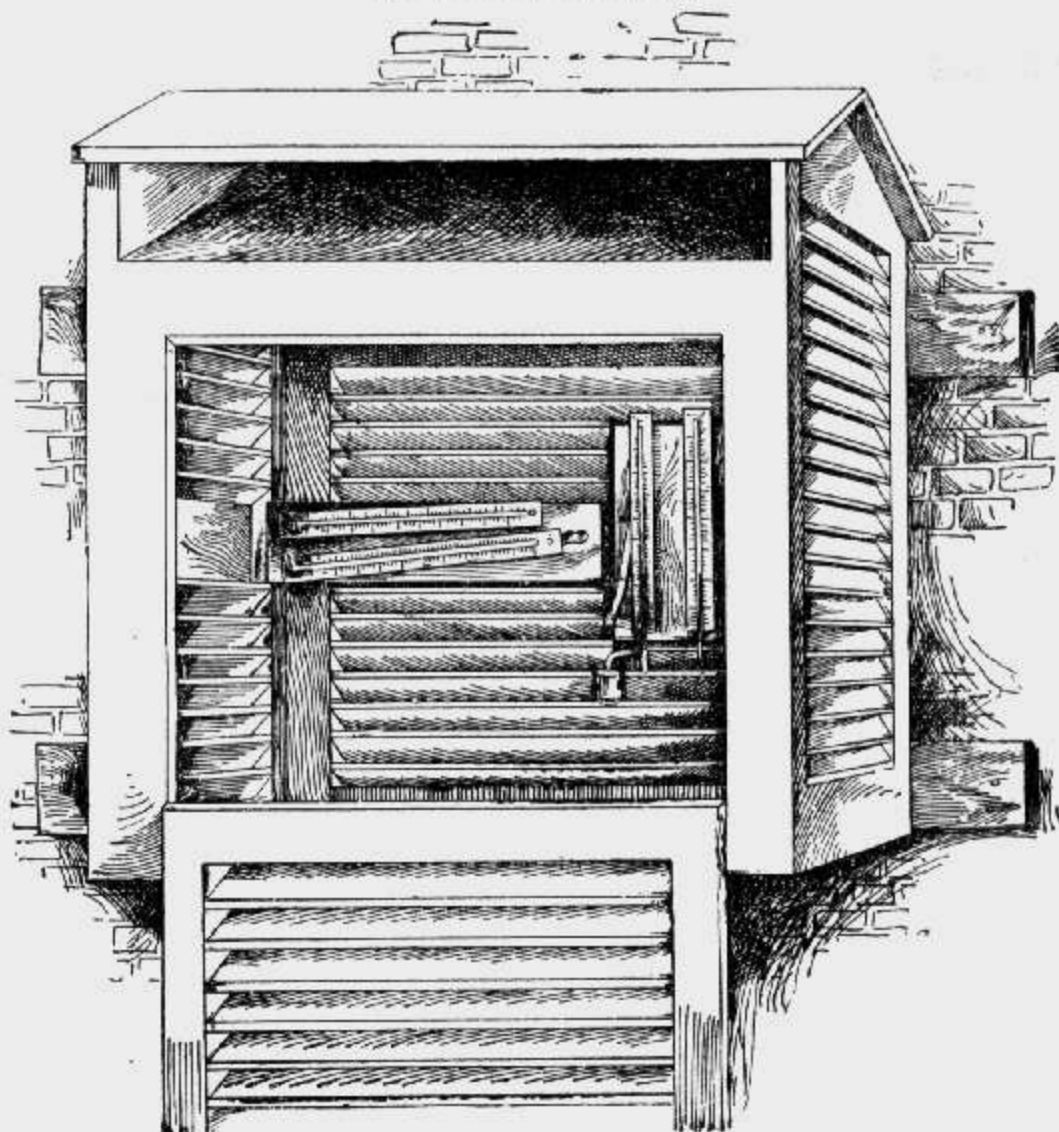


Fig. 31.

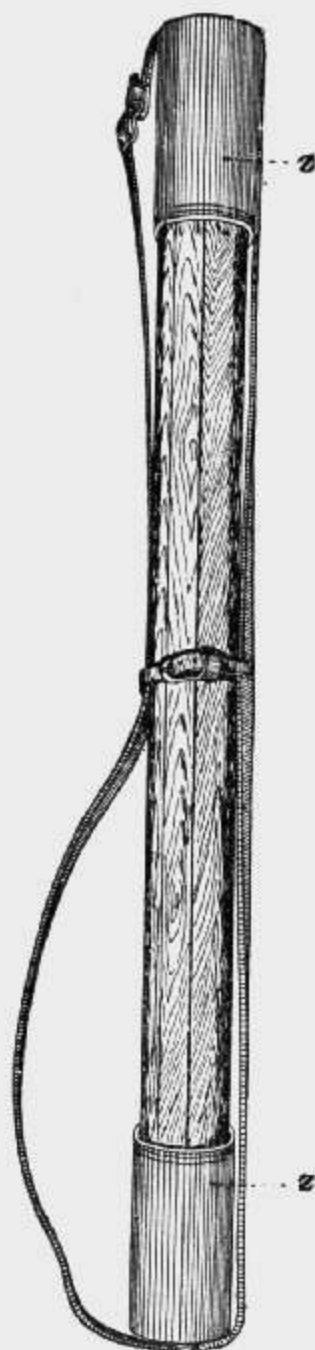
The latest pattern Weather Bureau Instrument Shelter (small size) is illustrated above, with door open and a complete set of thermometers in proper position. This shelter is sufficiently large to allow a good circulation of air, and will hold a thermograph (see page 25) in addition to the four thermometers shown. Wherever it is possible to do so this shelter should be placed on top of a suitable post, or posts, set in the ground very securely and sawed off square at the top for the shelter to rest upon, and so that the bottom of shelter will be *not less than 4 feet* from the ground, with *door on north side*. The shelter must be fastened rigidly to the top of the post, or posts, and for this purpose it may be necessary to attach boards or a rough frame, to which the shelter itself can be secured by suitable screws through bottom or ends. The best location for this shed, or ground, exposure for shelter, is near the center of the largest clear space available, and the location should, of course, be conveniently accessible for the observer. This manner of exposing the shelter gives much better results than that described below, as the instruments are not then so much affected by the close proximity of buildings, etc. When this exposure is not obtainable, however, the shelter will be attached to the side of a building, at such height that the thermometers, when in position, shall be on a level with the observer's eye, which will enable him to take accurate readings. Suitable wood screws are placed through frame at back, the wall or side of building being first prepared therefor by having two (2) pieces of 2 x 4 scantling securely nailed thereto, as indicated in the illustration (Fig. 31). It is necessary to have these pieces of scantling at least 2 inches thick, in order to allow a free air space all around the shelter.

The board support for maximum and minimum thermometers, shown in Fig. 19, is secured by screws, furnished for that purpose, to the center cross-piece of the shelter, a little toward the left-hand side, and so as to admit of swinging the maximum thermometer in a circle without danger of striking that instrument against the right-hand side of shelter; the hygrometer (Fig. 18) being attached at the right.

Standard Instrument Shelter, as above, made of best quality white pine, painted 3 coats white lead paint, swing door provided with lock and key, crated, ready for shipment, price.....\$

U. S. Army Signal Corps Heliograph.

MANUFACTURED BY JULIEN P. FRIEZ, 107 EAST GERMAN STREET, BALTIMORE, MD.



DESCRIPTION.

The field heliograph equipment consists of—

- x. A sole leather pouch, containing:
 - One sun mirror. } Enclosed in a
 - One station mirror. } wooden box.
 - One screen. One sighting rod. One screwdriver.
- y. A smaller pouch, sliding by two loops upon the strap of the larger, containing: One mirror bar.
- z. A skeleton leather case, containing: Two tripod stands.

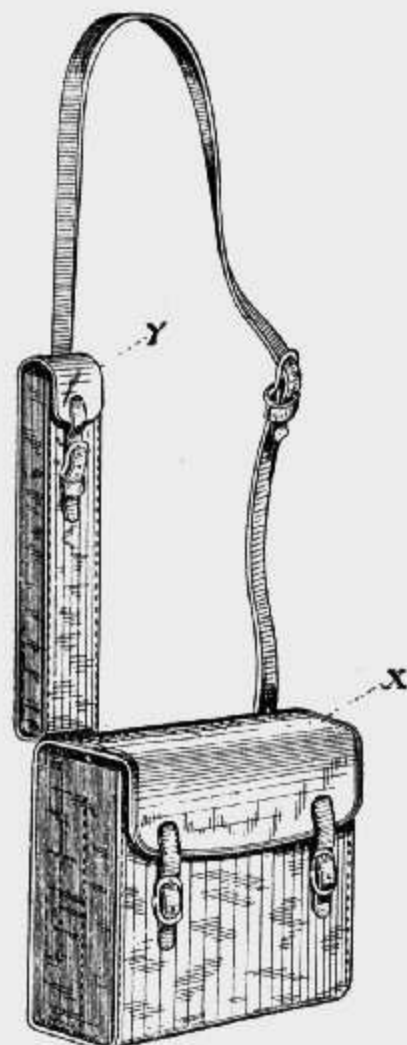


Fig. 32.

The above cut shows the Heliograph Signaling Apparatus packed, ready for transportation by hand. This Apparatus has been adopted as the *standard* by the U. S. Army for *military* purposes, but it is fast becoming a valuable adjunct to the telephone and telegraph in the dissemination of not only general information to isolated points and country villages, but also weather forecasts, frost warnings, storm signals, etc., for the benefit of commerce and agriculture. It is only necessary for those interested to become awakened to the fact that this instrument “knows neither time nor space” and its brilliant flashes can be read miles away, either by night or day, with an ease and reliability that leave but little to be desired.

U. S. Army Signal Corps Heliograph.

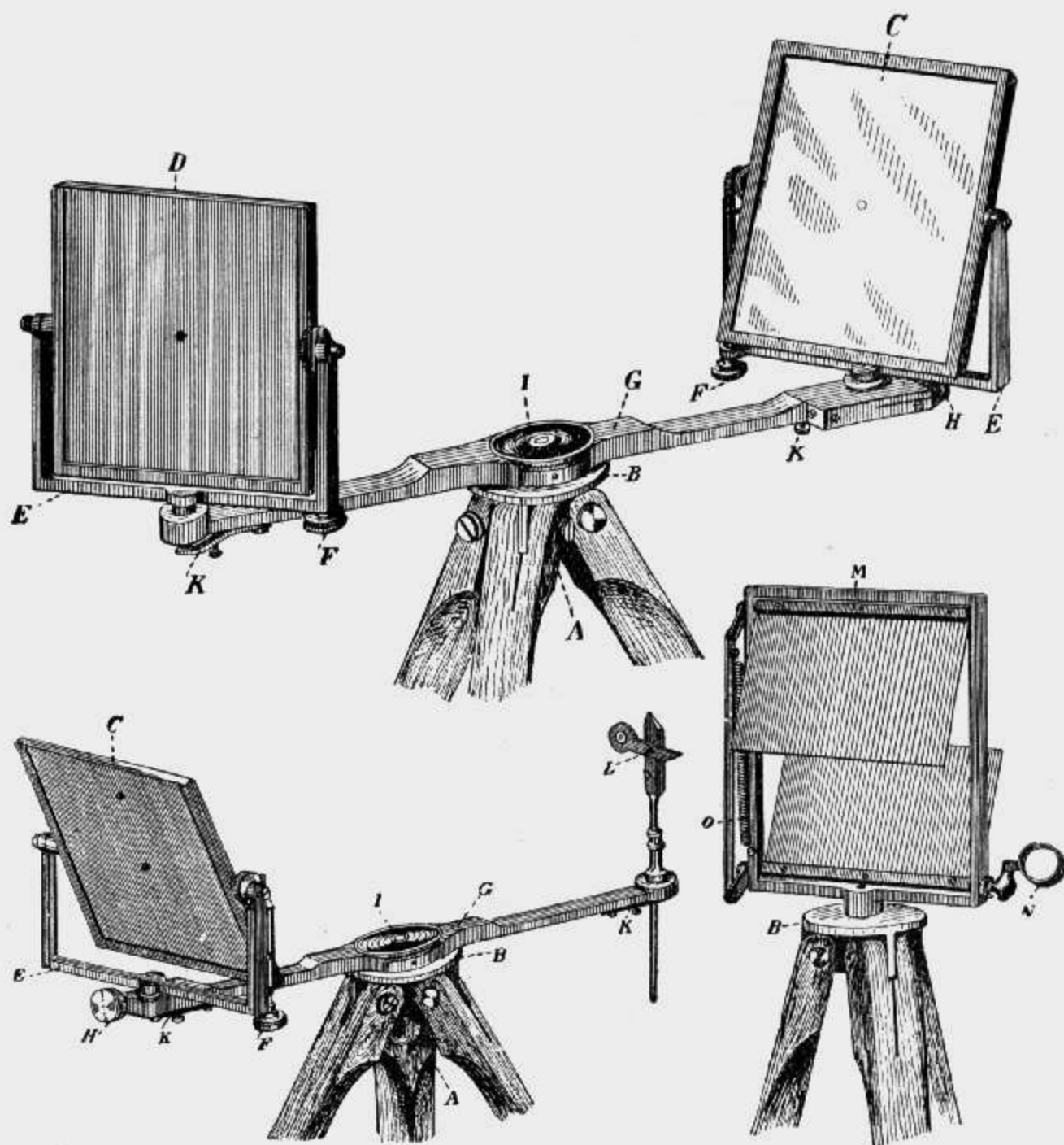


Fig. 33.

A Tripod.
B Tripod head.
C Sun mirror.
D Station mirror.
E Mirror supports.
F Tangent screw for revolving mirror about horizontal axis.
G Mirror bar.

H Tangent screw with ball bearings for revolving mirror about vertical axis.
I Clamp screw for attaching mirror bar to tripod.
K Spring for clamping mirrors and sighting rod.
L Sighting rod with movable disk.
M Screen.
N Key for screen. } Model 1892.
O Screen spring.

The above standard Army Heliograph Signaling Apparatus, complete, best finish throughout, price.....\$

Note.—For detailed instructions on “The Art of Signaling by Heliograph, &c.,” see *Circular H*, copies of which are sent with each equipment, and upon application.

Address all communications on this subject, and orders for Heliographs and Signaling Apparatus, to

JULIEN P. FRIEZ,
No. 107 E. German Street, Baltimore, Md.

Achromatic Field or Marine Glasses.

Long Model and High Tops.

MANUFACTURED BY BARDOU, PARIS.

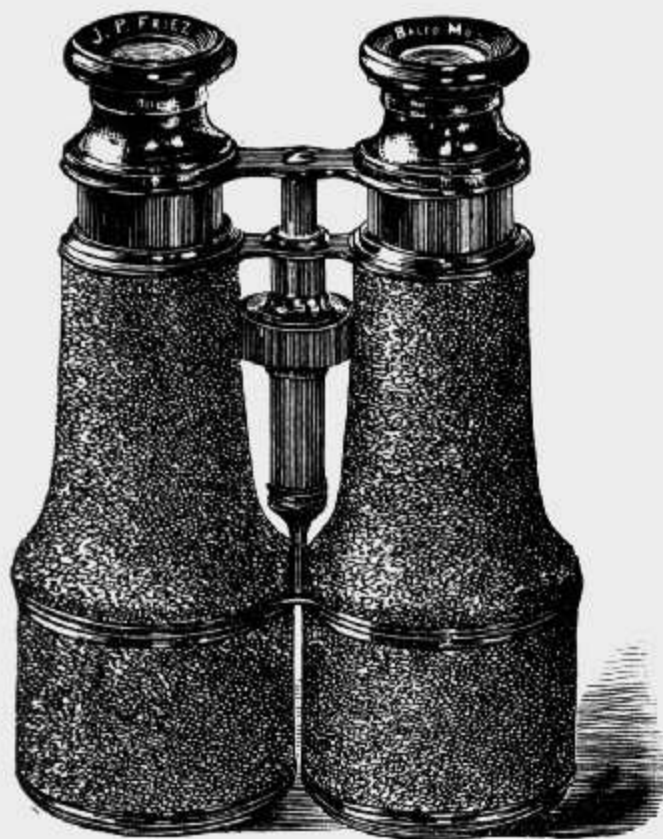


Fig. 34.

34. Field or Marine Glasses, black morocco body, with sun-shades, oxidized draw-tubes, cross-bars, tops and trimmings, in sole leather sling case :

21	24	26 lignes.
\$20 00	21 00	24 00

- 34a. Field or Marine Glasses, as above, with 12 lenses : 21 24 26 lignes.

\$22 50	25 00	28 00
---------	-------	-------

- 34b. Field or Marine Glasses, as in 34, with jointed cross-bars, affording adjustment for pupillary distance :

21	24	26 lignes.
\$22 50	25 00	28 00

MANUFACTURED BY LEMAIRE, PARIS.

- 34c. Field or Marine Glasses, superior, U. S. Signal Service, black morocco body, with sun-shades, finely black japanned or oxidized draw-tubes, cross-bars, tops and trimmings ; in sole leather sling case :

24	26 lignes.
\$18 00	20 00

- 34d. Field or Marine Glasses, black morocco body, with sun-shades, black japanned draw-tubes and cross-bars, long model and high tops, "Grand Power," 26 lignes. \$25 00

- 34e. Field or Marine Glasses, black morocco body, with sun-shades, black japanned or oxidized draw-tubes, cross-bars, tops and trimmings ; in morocco sling case :

15	17	19	21	24	26	28 lignes.
\$10 00	12 00	13 00	14 00	16 00	18 00	25 00

34f. Field or Marine Glasses, as above, with 12 lenses ; sole leather case :

21	24	26 lignes.
\$18 00	22 50	25 00

34g. Field or Marine Glasses, black morocco body, with sun-shades, black japanned or oxidized draw-tubes, tops and trimmings ; jointed cross-bars, affording adjustment for pupillary distance ; in sole leather sling case :

21	24	26 lignes.
\$20 00	22 50	25 00

Aluminum Field or Marine Glasses.

34h. Field or Marine Glasses, 12 superior lenses, black morocco body, with sun-shades, aluminum frame, with burnished draw-tubes and ring trimmings ; finely japanned cross-bars, adjusting bar and tops ; in sole leather sling case ; manufactured by Lemaire, Paris :

21	24	26 lignes.
\$40 00	50 00	60 00

Achromatic Field or Marine Glasses.



Fig. 35.



Fig. 36.

35. Field or Marine Glasses, black morocco body, with sun-shades, finely oxidized draw-tubes, cross-bars, tops and trimmings, in sole leather sling case. The Monarch :

21	24	26 lignes.
\$12 00	13 50	15 00

35a. Field or Marine Glasses, black morocco body, with sun-shades, oxidized draw-tubes, cross-bars and high tops. The Pilot :

19	21	24	26 lignes.
\$7 00	8 00	9 00	10 50

35b. Field or Marine Glasses, black morocco body, black japanned draw-tubes, cross bars, tops and trimmings, in morocco sling case. Chevalier, Paris :

15	17	19	21	24	26 lignes.
\$5 00	6 00	7 00	8 00	9 00	10 00

35c. Field or Marine Glasses, black morocco body, black oxidized draw-tubes, cross-bars, low tops and trimmings, in morocco sling case. Victor, Paris :

21	24	26 lignes.
\$9 00	10 50	12 00

35d. Field or Marine Glasses, with non-corrected objectives, black morocco body, black japanned draw-tubes, cross-bars, tops and trimmings, in morocco sling case :

21	24	26 lignes.
\$4 50	5 00	6 00

Sling Cases for Field or Marine Glasses.

36a. Morocco Case : 17 19 21 24 26 lignes.
\$2 00 2 00 2 50 2 50 2 50

36. Sole Leather Case : 3 00 3 50 4 00

36b. Strap, with buckle.....\$0 60 | 36d. Strap, without buckle....\$0 50

36c. Leather Cord, with swivel..... 50

Additional Supplies, Forms, etc.

Battery, electrical, "Gravity," with glass jar, supply of sulphate of copper, and copper and zinc plates, complete, price per cell..... \$1.10

Binding-posts, double, brass, nice finish, price each..... .25

" " " " nickel-plated, price each..... .30

" " single " " " " " " " "20

Black pigment, special, for restoring marks on thermometer scales, price per tube..... .25

Blank charts, for photographic sunshine recorder, price per set (15)... 

Blue-print paper, blank, any size, (prices on application).

Cable, 2-conductor, copper wire No. 18, extra heavy insulation for outdoor use, for connecting anemometer to daily or weekly register, and for use where only one circuit is needed, price per foot.

Cable, 3-conductor, ditto, for use on recording rain and snow gauges, &c., price per foot.....

Cable, 7-conductor, ditto, for use with double registers, &c., price per foot.....

Cable, 9-conductor, ditto, for use with triple registers, &c., price per foot.....

Cable, 10-conductor, ditto, for use with quadruple registers, &c., price per foot.....

(Samples and prices given on application.)

(See note at bottom of next page.)*

Clock-oil, "Ezra Kelly," best quality (the ONLY proper oil to use on anemometers, registers and other delicate instruments), price per bottle..... .35

(By mail, 10c. extra.)

Connectors, double, brass (very convenient for attaching ends of wire together), each.....	.15
Forms—No. 1015 (Daily Anemometer Record Sheet) per set (375).....	14
“ “ 1016 (weekly “ “ “ “ “ “ (55).....	14
“ “ 1017 (Double, Triple & Quad. “ “ “ “ “ “ (375).....	14
“ “ 1026 (Monthly Record sheet for Hourly Readings, Temperature and Pressure) per set (15).....	14
“ “ 1028 (Record Sheets for Weighing R. & S. Gauge) per set (100)	14
“ “ 1065 (Monthly Record Sheet for charts and data, Photo. Sunshine Recorder) per set (15).....	14
“ “ 1068 (Barograph Record Sheets), per set (55).....	14
“ “ 1072 (Thermograph “ “ “ “ “ “ (55).....	14
Ink, for registers, <i>special</i> (will not freeze at the lowest temperatures, can be sent by mail), per bottle.....	14
Instrument Shelters, large, Weather Bureau pattern, price.....	
“ “ “ “ “ “ “ “ “ “ (with supports, complete), price.....	
Instrument Stands (handsome article of furniture), for holding registers, &c., and contains cabinet for battery cells, drawers for forms, &c., complete.....	
(Prices on application.)	
Measuring sticks, cedar, best quality, each.....	.25
Pens, <i>special</i> , for Single, Weekly, Double, Triple and Quadruple Registers, &c., (Fig. 4b), each.....	14
Pens, ditto, for Thermographs and Barographs, each.....	
Whirling Apparatus, W. B. pattern, complete (without thermometers) each	7.50
Wire, office, copper No. 16, double-braided insulation, per foot.....	.02

N. B. Please write for prices, &c., on any supplies or articles not mentioned above.

* Note.—Use small awning hooks, or small staples, to fasten heavy insulated cable to sides of building, &c., and double-pointed carpet tacks for office wire. Hooks, &c., may be obtained at any hardware store. *Care must be exercised in using these staples, tacks, &c., not to injure insulation of wires.*



Notes on Wind Velocity and Records.

ANEMOMETER.

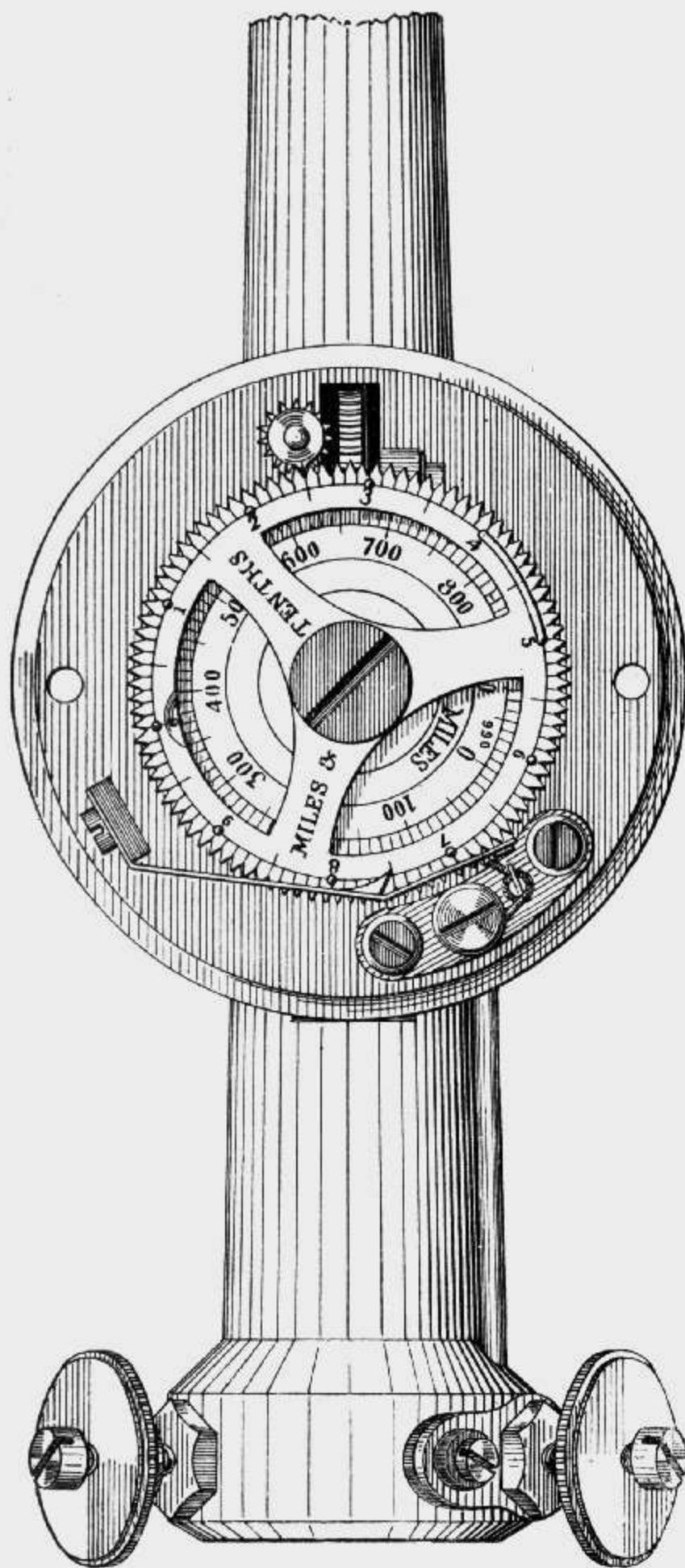


Fig. 37.
(Accurate dial reading, $372\frac{1}{2}$ miles)

1. *Dials, How read.* The standard pattern of anemometer used by the Weather Bureau has the registering dials mounted concentrically. The outer dial has 100 and the inner dial 10 divisions. As the dials are moved by the same wheel, they will move forward one hundred divisions in the same time (Fig. 37). The outer dial having one hundred divisions, the inner dial will complete one revolution and its zero be one division beyond or to the left of the zero of the outer dial when the outer dial has completed one revolution, the zeros of the scales coinciding at the time the instrument was set in motion. Thus the revolutions made by the outer dial are recorded on the inner one, the number of revolutions being shown by the number of divisions of the scale on the inner dial between the zero of that scale and the zero of the outer one. In taking the reading of the anemometer at any time, the hundreds and tens of miles are read from the inner scale and the miles and tenths of miles are read from the outer one. Take from the inner scale the hundreds and tens of miles contained between the zero of that scale and the zero of the outer one, and the miles and tenths of miles on the outer scale contained between the zero of that scale and the index of the instrument, and the sum of these readings will be the reading of the instrument at the time of making the observation.

2. *Index point.* The anemometer is furnished with an index point or mark on the small wheel at the top, which gives motion to the dials. This is taken as the reference point.

3. *Daily Wind Movement.* The total movement for the twenty-four hours will be obtained in the following manner: Subtract the reading of the anemometer at 12 noon of the preceding day from the reading taken at 12 noon of the current day, and the difference will be the total movement of the wind. When

the reading of the anemometer is less than the reading of the preceding day, 990 miles will be added to it, and the remainder, after subtracting the reading of the preceding day, will be the total movement.

Example: The dial reading of to-day is 372, (see Fig. 37), and that of yesterday was 983, hence we have $372 + 990 = 1362$; $1362 - 983 = 379$, the total observed movement of the wind in miles during the past twenty-four hours.

4. *Care of Anemometers.* Anemometers must be kept carefully and thoroughly oiled to prevent friction and injury to the several bearings; using *only* best quality, "Ezra Kelly," clock oil. Especial attention must be given to the large dial-screw, and when found loosened it must at once be tightened, but care must be taken not to screw it up tight enough to interfere with the free motion of the dials.

5. *Wind Pressure.* The pressure of the wind on a surface varies as the square of the velocity. The pressure in pounds per square foot of vertical exposure of a surface is equal to 0.004 multiplied by the square of the true wind velocity in miles per hour. (See also paragraph 2, Table III, page 66).

6. *Estimated Velocity.* When there is no anemometer for measuring the velocity, or if the instrument has become temporarily unserviceable, the force of wind may be estimated according to a scale of numbers from 1 to 12. The scale in most common use, especially at sea, is the Beaufort scale. Estimates on this scale at sea are made for the most part according to the commotion the wind causes in the water or the rigging of a ship. This arbitrary scale originated in the days of sailing vessels. The wind force was indicated by the various numbers according to the amount of sail that could be safely carried. The velocity in miles per hour corresponding to the different numbers has been ascertained by comparison of the estimated force on ships at sea with actual velocities observed by anemometers on shore in the vicinity at the same time.

The scale is as follows:

Wind force, Beaufort scale.	Character of Wind observed.	Velocity, miles per hour. (Approximately.)
0.....	Calm.....	0
1.....	Light air.....	3
2.....	Light breeze.....	13
3.....	Gentle breeze.....	18
4.....	Moderate breeze.....	23
5.....	Fresh breeze.....	28
6.....	Strong breeze.....	34
7.....	Moderate gale.....	40
8.....	Fresh gale.....	48
9.....	Strong gale.....	56
10.....	Whole gale.....	65
11.....	Storm.....	75
12.....	Hurricane.....	90

The above velocities are not corrected for the errors of anemometer. The velocities are those observed with the *English* pattern of anemometer at coast stations in Great Britain. This anemometer has larger cups and longer arms than the Weather Bureau pattern of instrument. (See Table III.)

7. *Exposure.* The exposure for an anemometer should receive very careful attention. The instrument, to indicate velocities at all accurate, should be *at least* 10 feet above surrounding objects, within a radius of not less than 100 feet, and away from the influence of chimneys, towers, gable roofs, trees, &c. If a rigid wooden support cannot be constructed and placed in position, or is not desired, a suitable and durable iron support, of required height, can be furnished; see price, &c., page 17.

8. *Electrical connections with Register.* The electrical connections for wind velocity are made by what is called a simple metallic circuit, which is fully shown by the broken lines (— — —) on pp. 17 and 18, where the anemometer register is represented by one of the single magnets of the Triple Register.

a. The "2-wire cable," (for Single and Weekly Registers) noted on page 54, is the easiest placed in position and is not so expensive as two single insulated wires. The ends of the 2-wire cable are divided for a short distance, and the two wires on one end are scraped clean and firmly attached to the two binding posts of the anemometer. The cable is then passed down the anemometer support, over the roof, etc., to the office window, taking care to secure it at several points, by means of small staples, to prevent its swaying in the wind. Pass the cable through a small hole in the window frame (where shutters and sash will not injure it), and down the inside. The lower ends of the cable will then be cleaned and one wire attached to one binding post of the Register and one to the Zinc pole of the battery. Then, with a short piece of office wire, and a "double connector," if necessary, connect the remaining binding post of the Register to the Copper pole of battery. This should complete the circuit and the armature of the Register should respond to every mile of wind made by the anemometer.

b. General Suggestions about running wires and cables for registers.—"When several registering instruments requiring a number of electric circuits are in use, or to be connected up, it is always best to use a cable containing a sufficient number of conductors, each insulated from the other, and much time is saved in the end if the several wires be each plainly marked or tagged at each end, so that any particular wire may be utilized at any time. This is sometimes done by the use of different colored threads in the insulation, but such marking is often obscure and of little value. The wires of a cable not already marked should be identified before placing the cable in position. The two ends are picked out of the coil and the outer wrapping laid back 8 or 10 inches, at the same time stripping the insulation from the ends of the wires themselves. A battery, or some other source of electricity, and a galvanometer or telegraphic sounder, must then be brought into requisition. A telephone call-bell answers admirably. A battery, however, is really the only thing required. One of the wires of the cable is joined to one pole and the other end of the cable and a wire from the other pole of the battery brought up in a position convenient to be touched to the tongue, which is very sensitive to electric currents. The single wire from the battery is held against the tongue, while one after the other of those in the cable are touched in turn until the one is found through which the current flows. This one is at once marked, say "1," either by a small but substantial tag, or, if the insulation is of rubber or similar material, by cutting out a single V-shaped gash near the end. When No. 2 is identified this may be marked by two gashes, etc."

c. "In case the cable is already in position the services of an assistant will be needed to shift connections and to mark the wires identified. One, at least, of the wires of almost every cable is marked by the manufacturer by some peculiarity of insulation. This wire should be permanently joined at one end with the battery, and at the other end of the cable first with one, then with each of the other wires of the cable in turn, until by testing in each case for currents each of the wires is identified and plainly marked. No difficulty from wrong connections will ever occur if this work is carefully and properly done. Failures in getting new instruments in operation are far more often due to insufficient care and attention in making all the connections correct throughout than to any other cause."

d. Explanation of circuits.—The diagrams, Figs. 7, 7a & 7b, pp. 17 and 18, show the electrical circuits for the latest pattern triple register, including sunshine circuit, but represent, in principle, the manner in which circuits of corresponding parts of the single and double registers are made.

e. Wind direction.—"The circuit for wind direction, starting from the battery, leads directly to a switch or control key on the register, thence through the clock mechanisms, and has joined to it one wire from each of the four direction magnets, N, E, S, and W. The remaining end of the wire of each of these magnets passes separately to corresponding binding posts, suitably marked, which are connected individually by wires with four corresponding insulated contact points located in the contact box of the wind vane. A single wire, generally called the "return wire," leads from a binding post on the metal contact plate to the remaining pole of the battery, and thus completes the wind-direction circuit. Either one or two of the contact points in the box are always closed, and one or two circuits are, therefore, completed through the corresponding magnets of the register at each closure of the circuit in the clock, which, as explained, takes place every minute or every five minutes, as the case may be. The small switch or key in the direction circuits is used only in testing the line, and simply enables one to close the circuit at any time without the delay of waiting for the closure in the clock."

f. Wind velocity.—"This circuit is very simple and direct. A wire leads from the battery to the magnet, thence to the anemometer, and returns directly to the battery."

g. Rain gauge.—"In case the rain gauge alone is used the circuit is made up in exactly the same manner as the one just described for the wind velocity, but is not shown in the diagram."

h. Rain and sunshine.—"In this case the same battery serves on both circuits and only three wires are required. Starting from the battery a wire connects directly to one end of the magnet coil at R_{SS} . The other end of the coil divides into two circuits, one passing to a binding post, *R*, thence direct to the rain gauge; the other circuit passes first through the clock contact, thence to the binding post, *S, S*, and finally to the sunshine recorder. This circuit and the one from the rain gauge unite again after leaving their respective instruments, and pass thence direct to the battery."

"On registers fitted with one-minute contacts the binding posts, *B, S*, are joined with a short piece of wire, marked + + + + on the diagram, Fig. 7a, in case the rain and sunshine are recorded by use of a separate battery."

i. Sunshine on wind-direction battery.—"This arrangement lessens the battery required and presents no difficulties with the minute contact, since the sunshine circuit

and the wind direction circuit are never closed at the same time. These circuits will be perfectly understood from the diagram, Fig. 7 b. The two posts *S, R*, on the register are joined by a short piece of wire. This is indicated by the line + + + + +."

* See page 18.

NOTE.—Special care must be taken to see that all the electrical connections are firmly made.

The number of cells of battery necessary is usually about as follows: If anemometer is 50 feet, or less, from register, use 2 cells; if 100 to 150 feet, use 3 cells; 200 to 400 feet, 4 cells, &c.

Register.

9. *For putting on the paper.* Remove the cylinder from the instrument and hold it with the advancing screw to the left hand; place the paper form on the cylinder, with the top of it from the screw. Let the line marked 12 m (noon) come on the line marked on the cylinder, and place a rubber band on each end. The lines at each end of the paper will then exactly coincide.

Replace the cylinder in its position, so that the end opposite the advancing screw will be near the post on which it rests. Slide the small sliding-bar on the horizontal bars until it fits on the ends of the screw-axle; then revolve the cylinder until the pencil or pen rests on the end of the upper line, marked 12 m., and tighten the thumb-screw.

10. *To regulate the length of the mark,* adjust the armature set-screw until the pencil mark is one-eighth of an inch long, when the armature is moved back and forward; then turn thumb-screw at the left of the coil until the pencil point rests on the line marked 12 m.; should the movement of thumb-screw at the left of the coil be insufficient to bring the pencil point to the line, the paper on the cylinder must have a piece cut from one side and shifted towards that side necessary to bring the pencil on the line. When the spring that holds the pencil to the cylinder is not sufficiently strong to produce a clear and distinct mark on the paper it must be strengthened by shortening the spring; but care must be taken that it is not stiffened so much as to prevent the free movement of the armature when the circuit closes. Should the pencil point not make a distinct mark on the record sheet the pencil must be soaked in oil, or a softer one used. The best kind of oil for this purpose is sperm. When the sheets are too long to fit the cylinder exactly, strips of paper must be wound around the cylinder until its circumference is increased sufficiently to make the lines of 12 m. and 6 p. m. coincide, care being taken to keep the surface smooth and even. Use Faber's Artists' Pencil Leads.

11. *The maximum hourly velocity* of the wind when the self-registering attachment is used is determined by multiplying the number of miles recorded in the fifteen minutes in which the maximum occurred by four, and, when the dial-readings are used, by multiplying the highest velocity in a period of five minutes by twelve.

In reckoning the number of miles recorded by the self-registering attachment, observers should count and record the number of *spaces* between the marks, and not the marks themselves.

12. Where *pens* are used on these registers (see Fig. 4 b) the following instructions should be carefully observed:

a. Only the *special ink* provided for registering instruments should be used, and the supply of ink in the pen should never become so low as to render a loss of record possible. The points of the pen can be cleaned and the flow of ink started by drawing between them a strip of smooth paper, but this should not be done in such a manner as to spread or deform the delicate points. It may be necessary to occasionally wash the pen in warm water.

b. In adjusting the pen to the paper the spring arm should be clamped so that the points of the pen rest with only gentle pressure against the sheet. Avoid excess of pressure, as the points of the pen will wear off and become clogged with particles of paper, thus yielding a poor and imperfect record. The lateral movement of the pen on the paper should be rather less than with pencils, as the violence of the action may, at times, cause the ink to be thrown from the pen. A movement of $\frac{1}{16}$ inch is amply sufficient.

c. Particular care must be taken not to deform the points of the pen, as the proper action can only be obtained when these are very close to each other, but yet not in contact, and *both* points touch the paper.

d. In removing the sheet from the cylinder the latter portion of the record will probably not be thoroughly dry, owing to the special properties of the ink, and it is therefore necessary to use care in slipping off the rubber bands, etc., in order to avoid blurring and smearing the record, which should be carefully blotted when removed from the cylinder.

Notes on records from Barographs and Thermographs.

13. SHEETS.—Barograph and thermograph sheets should be clearly marked on the face of the sheet with the name of station and date, each day's record being dated as near the noon line for that day as practicable. The sheets for the *weekly* instruments will be changed at about noon, Monday. New sheets will not be used on the beginning of a month, except, of course, it be Monday as well.

14. When an instrument is first put in operation the trace on the sheet should start at the proper date and hour, even if near the end of the sheet.

15. The lower edge of the sheet should rest closely against the flange at the bottom of the cylinder, and the pen be adjusted to the proper temperature, or pressure, as the case may be. The barograph should be made to agree as nearly as possible with the mercurial barometer when the latter is corrected for temperature and instrumental error.

16. When the pressure or temperature at any particular station is such as not to be included in the rulings on the record sheets, observers will change the numbering of the lines by some convenient whole number and adjust the pen of the instrument accordingly.

17. CLOCKS.—Every effort should be made to properly regulate the clocks to correctly keep standard meridian time, winding them once a week, or oftener, if necessary. The instruments should be inspected each day, by the observer, and properly adjusted when necessary. Whenever they are adjusted a marginal note, stating the fact, will be connected with the proper hour.

18. PENS.—Pens should be kept neat and clean. Only the standard Register ink should be used. Care must be observed in cleaning the pens not to bend or deform the points and render them unserviceable.

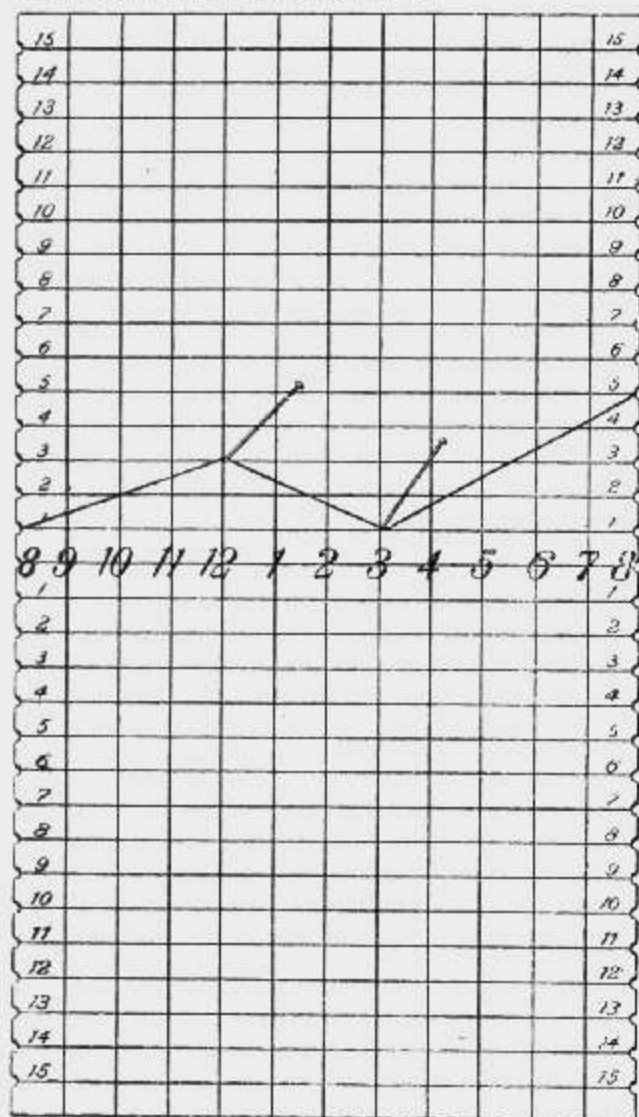


Fig. 38.

and numbering lines on a piece of white cardboard, and cutting notches on the sides, as shown in Fig. 38.

19. CORRECTIONS.—Owing to imperfections in barographs and thermographs, more or less frequent comparisons should be made with standard instruments. The difference between the indications of the two constitutes a correction by which the automatic records are reduced to standard values. Such corrections apply not only to the hours at which the comparisons are made, but also affect values for intermediate hours, and, as the correction may change from time to time, the determination of the most probable correction for any particular hour is greatly facilitated by the use of the device known as the "Thermograph correction card."

20. All eye readings of the thermometer and barometer at exact hours should be used to check and correct the corresponding recording instruments. The appropriate corrections derived from readings at other hours than 8 a. m. and 8 p. m. should be set off on the correction card by sticking a pin through the card at the point on the hour line corresponding to the proper correction, and deflecting the rubber band, after the manner illustrated in the accompanying sketch.

21. These "correction cards" are easily made by accurately ruling

22. **HOURLY READINGS.**—The hourly readings of the thermograph and barograph, after being corrected for instrumental error in accordance with the above instructions, will be entered in black ink on Form No. 1026-Met'l, in whole numbers for temperatures and two decimal places for pressures. At 8 a. m. and 8 p. m., and at all other hours at which eye readings are made, the black ink figures will be the readings of the standard instruments (corrected for temperature and instrumental error in case of barometric readings), and in the same hour column will be written, in red ink, with its appropriate sign, the correction for the self-registering instrument.

23. **DAILY RANGE.**—The data entered in the columns of Form No. 1026-Met'l (hourly thermograph readings) headed "Max.," "Min.," and "Range," respectively, will be taken from the observed readings of the station maximum and minimum thermometers.

24. Enter in column headed "Range of thermograph" the daily range of temperature as shown by the corrected thermograph readings.

25. **BASE NUMBER.**—With a view of reducing the labor of preparing Form No. 1026-Met'l (hourly barograph readings), observers should enter in the body of said form the fractional or decimal part of the readings *only*; the integer which is constant will be called the *base number*, and will be entered once for all on the upper left-hand margin of the form, thus, 29. + inches, or 26. + inches, as the case may be, according to the elevation of the station.

Thus, if the base number is 29 inches, 29.06 will be entered .06; 29.90, .90; 30.10, 1.10.

Readings *below the base number* will be entered as above, except that they will be preceded by the minus sign, thus, if the base number is 29., the reading 28.60 will be entered -.40. As a rule the base number will be low enough to preclude the probability of any considerable number of readings involving the entry of minus quantities.

26. **FOOTINGS.**—The sums and means will be determined from the data entered in accordance with the foregoing instructions. The thermograph means and averages being recorded to *tenths*, and barograph means and averages to *thousandths*.

Form 1026-Met'l, together with the corresponding trace sheets, should be carefully filed for study or reference.

Notes on How to measure Rainfall and Snowfall.

27. **EXPOSURE.**—Care should be taken to select a good place of observation, as the value of the records is sometimes greatly impaired by improper exposure. Every precaution should be taken to protect gauges from the interference of animals and unauthorized persons. Select, if possible, a position in some open lot as unobstructed as possible by trees, buildings or fences. Such a place in general affords the best exposure, though sometimes difficult to find. Gauges should be exposed upon roofs of buildings only when necessary, and then the roof should be flat, or nearly so, if possible. The middle portion of a flat unobstructed roof generally gives the best results.

28. **RAINFALL.**—The rain-gauge measuring stick is graduated into inches and tenths of inches. Remembering that the actual depth of the rainfall is magnified ten times, as described on page 41, it is plain that if we find the water 10 inches deep in the measuring tube, then the real rainfall must have been only *one* inch deep, or, if the water in the tube is only one-tenth inch (or written as a decimal .1 inch) deep, then the rainfall must have been only one one-hundredth inch (or written as a decimal .01 inch).

29. **MEASURING STICK.**—To save observers the trouble of always thinking about the magnification, and to avoid possible errors in observations, the numbers on the graduations of the measuring sticks are not actual inches, but in the latest pattern of measuring sticks have all been divided by 10, and thus represent the actual rainfall. Moreover, these numbers are expressed in hundredths of inches of rainfall, and are written as decimal fractions. Thus the ten-inch line is numbered 1.00 (read one and zero hundredths), which is the depth of rainfall in inches corresponding to 10 inches of water in the measuring tube; similarly the one-inch line is numbered .10 (read ten one-hundredths), which again is the depth of rainfall in inches corresponding to one inch of water in the tube.

30. **GRADUATION, HOW READ.**—The depth of the water is measured by inserting the measuring stick into the gauge through the small hole in the funnel. When the stick reaches the bottom of the measuring tube it should be held for one or two seconds and then quickly withdrawn and examined to see at what division of the graduation the top

of the wetted portion comes. The numbering of this division, as stamped on the stick, gives, as has just been explained, the actual depth of rainfall, and in making out records and reports observers should *always use the decimal expressions*. Of course, it will rarely happen that the top of the wetted portion will fall exactly upon one of the numbered lines—it will generally be on or near one of the shortest lines. Thus, for example, suppose the water-mark comes to the sixth short line beyond the line numbered .80, the proper record to make in this case would be .86 inch rainfall. The number of short lines, reckoned from the numbered line next lower, are always to be inserted in place of the 0 in the stamped numbers.

31. CAUTION.—Observers should always be careful to put the stick into the gauge so that the end at which the numbering begins goes to the bottom, and the stick passes through the middle of the tube; for if the stick is placed near the sides the water is sometimes drawn up by capillary action in the narrow space between the stick and the tube, so as to wet the former entirely too high and give very erroneous records.

32. RETURNING PARTS.—After measuring and recording in this way the precipitation found in the gauge the top should be removed, the measuring tube emptied and drained, and the gauge put in position again. Observers should be careful after emptying the gauge to replace the measuring tube so that the bottom stands within the ring in the middle of the bottom of the overflow, and in putting on the receiver that it passes over the measuring tube and rests squarely down upon the overflow.

33. WATER IN OVERFLOW.—When the amount of rain that has fallen more than fills the measuring tube, some care is required to determine the total rainfall. First carefully remove the receiver so as not to spill any of the water in the measuring tube, which should be exactly full. If some water has been slopped out and the measuring tube is not exactly full, the amount of water remaining must be accurately measured with the stick as already described. The tube is then lifted out slowly and carefully, if full, so as not to spill any of the water into the overflow, emptied and allowed to drain a moment or so. The water remaining in the overflow is now poured into the measuring tube, being careful not to lose any, and measured in the usual way. Suppose we find this to be .47 inch rainfall, then, remembering that the measuring tube is just 20 inches high, the total rainfall will be 2 inches plus .47 inch = 2.47 inches. Or, in case some water was spilled from the measuring tube, the .47 inch should be simply added to the first measured amount to give the total rainfall.

34. SNOWFALL.—During the winter season, especially in those climates where the precipitation is nearly all in the form of snow, it is necessary to expose only the overflow attachment in the support as a snow-gauge, removing the receiver and measuring tube to the house, as these parts cannot be used for measuring snow, and even if rain should occur it is very apt to be frozen while in the measuring tube, generally bursting it and rendering it worthless or highly inaccurate.

(a). *First method*.—The snowfall collected in the overthrow attachment is measured by first placing the vessel in a warm room until the snow is melted. The water is then carefully poured into the measuring tube and measured just as though it were rainfall.

(b). *Second method*.—The above method is objectionable because it often requires considerable time, and is liable to be inaccurate owing to the loss of the snow or water by evaporation. The following plan is much better unless clumsily conducted so as to spill and waste the water:

Take the overflow into the room and pour into it, carefully, *one measuring tube full to the brim* with water, preferably warm water. This in general will mostly melt, or at least reduce to a very fluid slush a considerable snowfall.

The measuring tube should be again carefully filled to the brim from the melted contents of the overflow and emptied, whereupon the remaining water in the overflow should be carefully measured in the measuring tube, thus giving quickly and easily the depth of melted snow.

(c). *Third Method*.—One of the simplest and best methods, where circumstances will permit, is to *weigh* the amount of snow collected in the 8-inch gauge, using for this purpose any ordinary pair of grocers' or household scales weighing to quarter ounces. Carefully determine the weight to the nearest $\frac{1}{4}$ oz., then, by reference to Table I on page 64 of this Catalogue, the amount of rainfall to the nearest hundredth of an inch is readily ascertained.

35. In addition to this measurement by the gauge a measurement should be made of the actual depth in inches of the snow on the ground. Select a level place of some extent where the drifting is least pronounced and measure the snow in at least three places. The mean of these measurements will give the snowfall approximately. Whenever it is impracticable to melt the snow as described in the preceding paragraphs, one-tenth of

this mean will give an approximate value, in water, for the snow which could not be melted. This value should be set down in the record in precisely the same manner as rainfall, or snow melted in the gauge, with an appropriate note indicating *snow*. After having once made a measurement of the snowfall it is not necessary that the same snow be measured at each succeeding observation until it shall finally disappear. Any fresh snow, however, should be measured and recorded as it falls. If there be any snow on the ground at the end of the month, that fact and the depth in inches should also be noted.

36. Observations of precipitation should be made every evening at some regular hour, also at the close of every storm, and the gauge should be emptied of all the water it may contain as soon as it has been measured.

37. In the interests of accuracy the observations should be recorded as soon as made, and the daily entries should be made day by day. Even if no rain has fallen the observer should bear in mind that his record of that fact is as important as though rain had occurred.



USEFUL TABLES FOR REFERENCE.

TABLE I.

Showing Depth of Precipitation Corresponding to Given Weights.

(Computed for 8-inch circular collector; water at maximum density: 39° Fahr.)

Weights. lbs. oz.	Rainfall (inches).				Weights. lbs. oz.	Rainfall (inches).				Weights. lbs. oz.	Rainfall (inches).			
	0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$		0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$		0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$
oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
0	.00	.01	.02	.03	1 13	1.00	1.01	1.01	1.02	3 10	2.00	2.00	2.01	2.02
1	.03	.04	.05	.06	1 14	1.03	1.04	1.05	1.06	3 11	2.03	2.04	2.05	2.06
2	.07	.08	.09	.09	1 15	1.07	1.08	1.08	1.09	3 12	2.06	2.07	2.08	2.09
3	.10	.11	.12	.13	2 0	1.10	1.11	1.12	1.13	3 13	2.10	2.11	2.12	2.12
4	.14	.15	.15	.16	2 1	1.14	1.14	1.15	1.16	3 14	2.13	2.14	2.15	2.16
5	.17	.18	.19	.20	2 2	1.17	1.18	1.19	1.20	3 15	2.17	2.18	2.18	2.19
6	.21	.22	.22	.23	2 3	1.20	1.21	1.22	1.23	4 0	2.20	2.21	2.22	2.23
7	.24	.25	.26	.27	2 4	1.24	1.25	1.26	1.26	4 1	2.24	2.24	2.25	2.26
8	.28	.28	.29	.30	2 5	1.27	1.28	1.29	1.30	4 2	2.27	2.28	2.29	2.30
9	.31	.32	.33	.34	2 6	1.31	1.32	1.32	1.33	4 3	2.30	2.31	2.32	2.33
10	.34	.35	.36	.37	2 7	1.34	1.35	1.36	1.37	4 4	2.34	2.35	2.36	2.37
11	.38	.39	.40	.41	2 8	1.38	1.38	1.39	1.40	4 5	2.37	2.38	2.39	2.40
12	.41	.42	.43	.44	2 9	1.41	1.42	1.43	1.44	4 6	2.41	2.42	2.43	2.43
13	.45	.46	.46	.47	2 10	1.44	1.45	1.46	1.47	4 7	2.44	2.45	2.46	2.47
14	.48	.49	.50	.51	2 11	1.48	1.49	1.50	1.51	4 8	2.48	2.49	2.49	2.50
15	.52	.52	.53	.54	2 12	1.51	1.52	1.53	1.54	4 9	2.51	2.52	2.53	2.54
1 0	.55	.56	.57	.58	2 13	1.55	1.56	1.57	1.57	4 10	2.55	2.56	2.56	2.57
1 1	.58	.59	.60	.61	2 14	1.58	1.59	1.60	1.61	4 11	2.58	2.59	2.60	2.61
1 2	.62	.63	.64	.65	2 15	1.62	1.63	1.63	1.64	4 12	2.61	2.62	2.63	2.64
1 3	.65	.66	.67	.68	3 0	1.65	1.66	1.67	1.68	4 13	2.65	2.66	2.67	2.67
1 4	.69	.70	.71	.71	3 1	1.69	1.69	1.70	1.71	4 14	2.68	2.69	2.70	2.71
1 5	.72	.73	.74	.75	3 2	1.72	1.73	1.74	1.75	4 15	2.72	2.73	2.73	2.74
1 6	.76	.77	.77	.78	3 3	1.75	1.76	1.77	1.78	5 0	2.75	2.76	2.77	2.78
1 7	.79	.80	.81	.82	3 4	1.79	1.80	1.81	1.81	5 1	2.79	2.80	2.80	2.81
1 8	.83	.83	.84	.85	3 5	1.82	1.83	1.84	1.85	5 2	2.82	2.83	2.84	2.85
1 9	.86	.87	.88	.89	3 6	1.86	1.87	1.87	1.88	5 3	2.86	2.86	2.87	2.88
1 10	.89	.90	.91	.92	3 7	1.89	1.90	1.91	1.92	5 4	2.89	2.90	2.91	2.92
1 11	.93	.94	.94	.95	3 8	1.93	1.94	1.94	1.95	5 5	2.92	2.93	2.94	2.95
1 12	.96	.97	.98	.99	3 9	1.96	1.97	1.98	1.99	5 6	2.96	2.97	2.98	2.98
										5 7	2.99	3.00	3.01	3.02

NOTE.—This table is designed especially for the measurement of *Snowfall*, and is compiled for use in connection with the standard U. S. Weather Bureau 8-inch Rain and Snow Gauges

MANUFACTURED BY

JULIEN P. FRIEZ,

No. 107 E. GERMAN ST.,

BALTIMORE, MD.

USEFUL TABLES FOR REFERENCE.

TABLE II.

Approximate Hours of Possible Sunshine.

FROM 25° TO 49° NORTH LATITUDE, INCLUSIVE.

(Use latitude nearest that of station, interpolating when necessary.)

Date.	25°	27°	29°	31°	33°	35°	37°	39°	41°	43°	45°	47°	49°
Jan. 1....	10.6	10.5	10.3	10.2	10.0	9.9	9.7	9.5	9.3	9.1	8.8	8.6	8.3
11....	10.7	10.6	10.4	10.3	10.2	10.0	9.8	9.7	9.5	9.3	9.1	8.8	8.6
21....	10.8	10.7	10.6	10.5	10.4	10.2	10.1	9.9	9.7	9.6	9.4	9.2	8.9
Feb. 1....	11.0	10.9	10.8	10.7	10.6	10.5	10.4	10.2	10.1	10.0	9.8	9.6	9.4
11....	11.2	11.2	11.1	11.0	10.9	10.8	10.7	10.6	10.5	10.4	10.3	10.1	10.0
21....	11.5	11.4	11.4	11.3	11.2	11.1	11.0	11.0	10.9	10.8	10.7	10.6	10.6
Mar. 1....	11.7	11.6	11.6	11.5	11.5	11.4	11.4	11.4	11.3	11.2	11.2	11.1	11.0
11....	11.9	11.9	11.9	11.8	11.8	11.8	11.8	11.8	11.8	11.7	11.7	11.7	11.6
21....	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2
Apr. 1....	12.4	12.4	12.5	12.5	12.6	12.6	12.6	12.6	12.7	12.7	12.8	12.8	12.9
11....	12.6	12.7	12.8	12.8	12.9	12.9	13.0	13.0	13.1	13.2	13.3	13.4	13.5
21....	12.9	13.0	13.0	13.1	13.2	13.3	13.4	13.5	13.6	13.7	13.8	13.9	14.1
May 1....	13.1	13.2	13.3	13.4	13.5	13.6	13.7	13.9	14.0	14.1	14.3	14.4	14.6
11....	13.3	13.4	13.5	13.6	13.8	13.9	14.0	14.2	14.4	14.5	14.7	14.9	15.1
21....	13.5	13.6	13.7	13.9	14.0	14.2	14.3	14.5	14.7	14.9	15.1	15.3	15.6
June 1....	13.6	13.7	13.9	14.0	14.2	14.4	14.6	14.7	14.9	15.2	15.4	15.7	15.9
11....	13.7	13.8	14.0	14.1	14.3	14.5	14.7	14.9	15.1	15.3	15.6	15.9	16.1
21....	13.7	13.9	14.0	14.1	14.3	14.5	14.7	14.9	15.1	15.4	15.6	15.9	16.2
July 1....	13.7	13.8	14.0	14.1	14.3	14.5	14.7	14.9	15.1	15.3	15.6	15.8	16.1
11....	13.6	13.7	13.9	14.0	14.2	14.4	14.6	14.8	14.9	15.2	15.4	15.7	15.9
21....	13.5	13.6	13.7	13.9	14.0	14.2	14.4	14.5	14.7	14.9	15.1	15.4	15.6
Aug. 1....	13.3	13.4	13.5	13.6	13.8	13.9	14.0	14.2	14.4	14.5	14.7	14.9	15.1
11....	13.1	13.2	13.3	13.4	13.5	13.6	13.8	13.8	14.0	14.2	14.3	14.5	14.6
21....	12.9	13.0	13.0	13.1	13.2	13.3	13.4	13.5	13.6	13.7	13.8	14.0	14.1
Sept. 1....	12.6	12.7	12.8	12.8	12.9	12.9	13.0	13.1	13.1	13.2	13.3	13.4	13.4
11....	12.4	12.4	12.5	12.5	12.5	12.6	12.6	12.6	12.7	12.7	12.8	12.8	12.8
21....	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.3	12.3
Oct. 1....	11.9	11.9	11.9	11.9	11.8	11.8	11.8	11.8	11.8	11.7	11.7	11.7	11.6
11....	11.7	11.6	11.6	11.6	11.5	11.5	11.4	11.4	11.3	11.3	11.2	11.1	11.1
21....	11.4	11.4	11.3	11.2	11.2	11.1	11.0	11.0	10.8	10.8	10.7	10.6	10.5
Nov. 1....	11.2	11.1	11.0	10.9	10.8	10.7	10.6	10.5	10.4	10.3	10.2	10.0	9.9
11....	11.0	10.9	10.8	10.7	10.6	10.4	10.3	10.2	10.0	9.9	9.7	9.5	9.3
21....	10.8	10.7	10.6	10.5	10.3	10.2	10.0	9.9	9.7	9.5	9.3	9.1	8.9
Dec. 1....	10.7	10.6	10.4	10.3	10.1	10.0	9.8	9.6	9.5	9.2	9.0	8.8	8.6
11....	10.6	10.5	10.3	10.2	10.0	9.8	9.6	9.5	9.3	9.1	8.8	8.6	8.3
21....	10.6	10.4	10.3	10.1	10.0	9.8	9.6	9.4	9.2	9.0	8.8	8.5	8.2

NOTE.—Compiled for use in connection with records obtained from the Improved Photographic Sunshine Recorder

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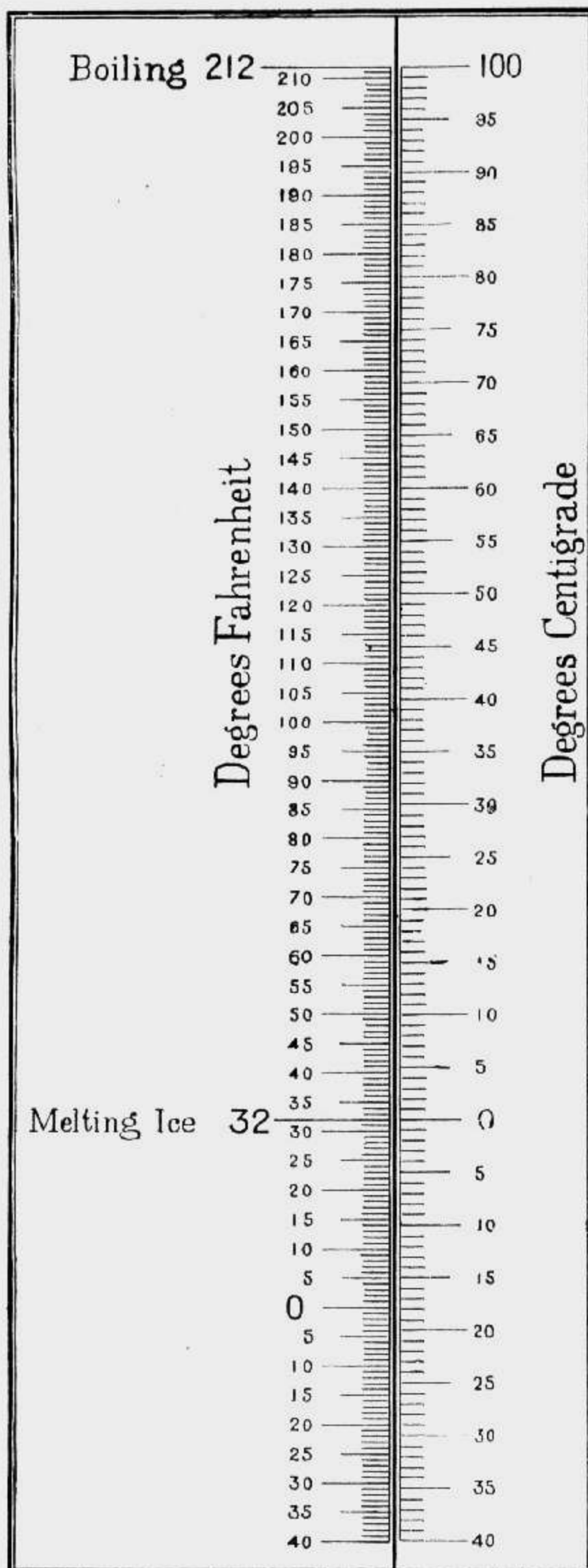
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TABLE IV.



COMPARISON OF THERMOMETER SCALES.

A little study of the accompanying information and diagram will enable any one to form a clear idea of the various thermometer scales and to convert temperatures from one scale to another.

Table of fixed points.

Scale.	Temperature of melting ice.	Temperature of boiling water.	No. of degrees between melting ice and boiling water.
Centigrade.	0	100	100
Celsius	100	0	100
Reaumur ..	0	80	80
Fahrenheit	32	212	180

From the above it will be seen that the Celsius scale is not identical with the Centigrade, as is very generally supposed, but resembles it only in that it has the same number of degrees between the freezing and boiling points of water.

Thermometers are now, however, never graduated according to the Celsius scale, and the use of the word as synonymous with Centigrade is quite erroneous.

Only Fahrenheit and Centigrade scales are in general use, and the accompanying plate is designed to enable observers to convert temperature readings from one scale to the other without resorting to a mathematical formula.

For accurate and precise reductions between the different scales the following rules should be used:

1. To convert Fahrenheit to Centigrade: Subtract 32 and multiply by five-ninths.

2. To convert Centigrade to Fahrenheit: Multiply by nine-fifths and add 32.

3. To convert Fahrenheit to Reaumur: Subtract 32 and multiply by four-ninths.

4. To convert Reaumur to Fahrenheit: Multiply by nine-fourths and add 32.

5. To convert Centigrade to Reaumur: Multiply by four-fifths.

6. To convert Reaumur to Centigrade: Multiply by five-fourths.

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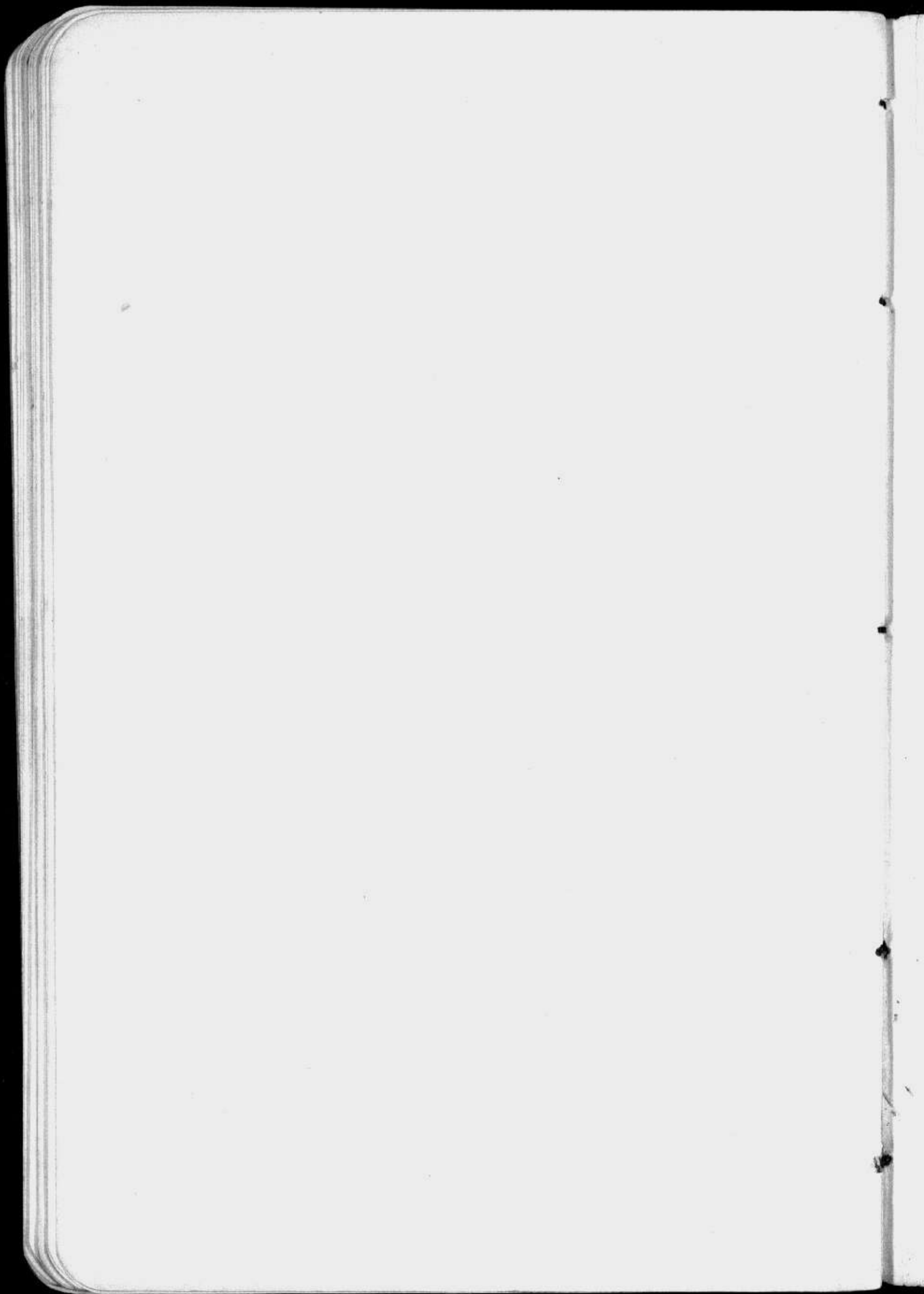
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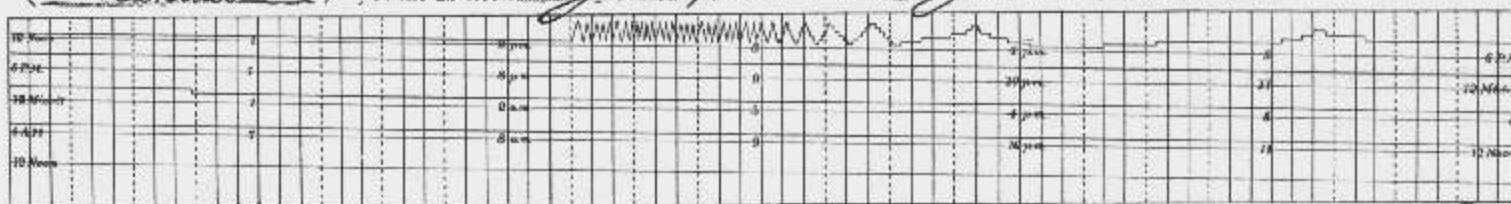
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