GENERAL INSTRUCTIONS

TO

OBSERVERS

OF

THE SIGNAL SERVICE.

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SIGNAL OFFICE, WAR DEPARTMENT,
Washington, D. C., December 1, 1887.

The following general instructions to the Observers of the Signal Service are hereby adopted, and will from the date of their receipt replace all previous instructions affecting any subject herein treated. Instructions which are of such a character as to render them liable to frequent changes have been omitted and will be issued in general orders.

Upon receipt of an order that may affect any paragraph contained in these instructions, as will be shown by foot-note on the order, it will be pasted in the blank leaves at the end of the book and its existence appropriately noted in red ink opposite the paragraph affected.

A. W. GREELY,
Chief Signal Officer.

Official:

Second Lieutenant, Signal Corps.

INSTRUCTIONS TO OBSERVERS OF THE SIGNAL SERVICE.

ESTABLISHING A STATION.

Selecting an office.—In selecting a building for occupancy as an office the observer will consider especially its accessibility and locality. In general the building occupied should be higher than those surrounding it, and should be so located that the conditions herein after stated as necessary for the proper exposure of each instrument will be possible. The building should be easily accessible to the public and not too far from the post-office, telegraph office, and the rooms of commercial bodies especially interested in the service.

Whenever possible secure two rooms, the second to be used as a storeroom. Permission, in writing, should be obtained from the owner or agent of the building to erect the instruments upon the roof, which must be convenient of access.

The observer will notify the Chief Signal Officer, postmaster, and managers of the telegraph offices of the location of the office, giving name of street, and, when possible, the number.

Diagram of office.—The observer will transmit promptly to the Chief Signal Officer diagrams of the office and roof newly occupied or to be occupied, which show the proposed location of the various instruments. The roof diagram will also show the relative position of chimneys, ventilators, or other structures which might affect the proper exposure of instruments.

As soon as the instruments are placed in position the elevation of each will be carefully determined and reported to the Chief Signal Officer upon the form provided for that purpose.

The office will be furnished in such manner as may be specially directed, and instructions governing expenditures and purchases at stations must be carefully followed.

Opening station.—The first pages of the daily journal must contain a complete history of opening the station. This history will show the date of the observer's arrival, rent of the office, its occupancy, the beginning of observations, elevation of the instruments, and all other information necessary for future reference.

The elevation of the ivory-point of the barometer above or below a fixed point of elevation designated by the Chief Signal Officer will be carefully determined, either by the observer or some other competent person whose employment has been authorized for that purpose. When *approximate* altitudes above sea-level are furnished the observer for preliminary use they will *not* be entered on the formal report of elevation of instruments.

Changes in position of instruments.—If changes in the position or elevation of any instrument are deemed necessary, authority will be

obtained from the Chief Signal Officer before action is taken in the matter. When changes are made the observer will enter in red ink on the retained copy of the last report of elevations of instruments any actual change which has been made in the elevations, with date of the authority therefor, and will promptly report the changes, by letter, to the office of the Chief Signal Officer.

After opening station the observer will call upon the principal officers of all commercial bodies and scientific or educational institutions and upon the editors of local newspapers. He will explain the nature and object of his duties and ascertain how his observations and reports can be made of use to them. He will ask their co-operation in making the work of his office of the greatest possible utility to the public.

Appointment of meteorological committee.—It is desired that a meteorological committee of not less than three members, selected from such commercial or other associations as are likely to use the weather reports, be appointed to confer with the observer from time to time as to the best means of conducting the local service. The early appointment of such a committee will be urged, and in the absence of commercial associations it should be formed from the most enterprising business and scientific men in the place. The chairman of the meteorological committee will be asked to communicate direct with the Chief Signal Officer, and the names and addresses of the entire committee will be reported by the observer.

CLASSIFICATION OF STATIONS.

The stations of the Signal Service, in charge of persons under pay from the United States, are classified as follows:

(1) Stations of the first order, making continuous records by means of self-registering instruments.

(2) Stations of the second order, taking three or more observations daily.

(3) Stations of the third order, taking one observation daily.

(4) Repair stations, on the United States military telegraph lines, at which no observations are taken.

(5) Special display stations, displaying wind signals.

(6) Special river stations, taking observations of the stage of water in the river.

(7) Special cotton-region stations, taking one observation daily.

(8) Special rainfall stations, taking observations of rainfall daily.

(9) State Weather Service, central stations, conducting the work of State Weather Services.

METEOROLOGICAL INSTRUMENTS.

Each station will be furnished with such meteorological instruments as are necessary to carry out instructions from the office of the Chief Signal Officer.

Correction cards.—A correction card showing the designation, number, and correction for instrumental error will be sent with each instrument requiring the same, and the corrections given thereon will be applied to all readings of the instrument.

No change in the correction for instrumental error will be made without first obtaining authority from the Chief Signal Officer.

Unserviceable instruments.—Whenever an observer has reason to believe an instrument is no longer accurate, he will report the fact to

the Chief Signal Officer. If there are duplicate instruments at the station comparative readings will be made and forwarded with this report. Only in extreme cases will an extra instrument be substituted for the regular one without first obtaining authority from the Chief Signal Officer.

Instruments broken by an observer.—If an observer break or otherwise render unserviceable only one instrument within a period of two years he will not be required to pay the money value thereof, provided he can furnish a certificate, satisfactory to this office, that the instrument was broken or rendered unserviceable through neither carelessness nor neglect on his part. Should more than one instrument be broken by the same person within the period of two years that fact will be considered as *prima facie* evidence of carelessness, and, unless money to replace the instrument is forwarded, action will be taken to charge the money value of the instrument or instruments against the pay of the observer, in accordance with paragraph 1743, Army Regulations, 1881, which reads as follows: "If any article of public property be lost or damaged by neglect or fault of any officer or soldier, he shall pay the value of such article, or amount of damage, or cost of repairs, at such rates as a board of survey, with the approval of the commanding officer, may assess according to the place and circumstances of the loss or damage. And he shall, moreover, be proceeded against as the articles of war provide, if he demand a trial by court martial, or the circumstances should require."

OBSERVATIONS AND REPORTS.

Instructions for preparing forms, where found.—Instructions for preparing the various meteorological forms and reports are printed in full on the blank forms furnished for the purpose.

Observers will give close attention to the observation and record of all local premonitory signs of storms, or changes of weather, and report them on the proper forms.

Signal Service Weather-Code.—Full instructions for enciphering meteorological observations for transmission by telegraph, with examples, will be found in the Signal Service Weather-Code.

Original Record, when forwarded.—The Original Record will be forwarded to this office not later than the 3d of the month succeeding that of which it is the record. From stations at some distance from railroads, especially in the Territories, whence mail matter is liable to be lost in transit, it will be *registered*, and stamps for the purpose will be sent to those stations.

A Monthly Meteorological Report of the observations recorded in the Original Record will be made out at each second-order station.

Monthly Meteorological Report, when forwarded.—This form will be mailed to the Chief Signal Officer on the second day of the month succeeding that for which it is the record.

Stations specially designated will issue for the benefit and information of the public, weather bulletins, special bulletins ("cold-wave coming"), and special wind signal bulletins.

Failure to render reports or forms.—The failure on the part of an observer to render any report or form within the time provided by instructions, or to forward any special report when so directed, will result, in the cases of sergeants and corporals, in reduction to the grade of first-class private, and in cases of first-class privates, to the grade

of second-class private, unless an entirely valid reason for the delay can be shown.

If reports are at any time delayed on account of sickness, the certificate of a properly qualified surgeon in good standing will be forwarded, with a letter of transmittal stating when the forms can be sent.

Official reports will not be forwarded until they have been carefully compared with the original records from which such reports have been made. Observers having assistants will have the latter read the original matter, and the observer will check and correct the copies to be forwarded, signing the reports only after he has thus assured himself of their *absolute correctness.*

Assistants on station are not authorized to sign the name of the observer in charge to official papers of any character.

Errors charged against person signing form.—All errors discovered in reports received from stations will be charged against the person signing them, as he is responsible for their accuracy. Such errors will be noted as a part of the observer's official record.

Annual report.—On the first day of July (or within ten days thereafter) of each year, every observer in charge of a second or third order station will make out and forward, on the printed form furnished for the purpose, a concise report of the operations of his station for the preceding twelve months. This report must show the changes, if any, that have been made in the location of the office or instruments, in the working force, and in the number of reports received during that period, with the authority for such changes. It will also show the public interest taken in the service, and the classes of citizens deriving the greatest benefit from the reports. If any marked advantages to commercial or other interests have been derived from the use of the reports or the display of signals, the facts in each instance will be briefly set forth. Observers will make notes from time to time, so that this report can be forwarded immediately after the close of the fiscal year.

SUNSET OBSERVATIONS.

The observer at each station will note daily, at the exact time of sunset, and for a period not to exceed thirty minutes thereafter, *the aspect of the sunset and the western sky.*

Sunsets will be divided into four classes: clear, yellow, green, and cloudy.

Clear will include all sunsets in which the western sky is free from clouds, or is of a reddish hue, or presents a combination of bright colors.

Yellow will include all in which the *predominant* color in the western sky is yellow.

Green will be used to designate those in which portions of the western sky plainly exhibit that color. Green is rarely the predominant color. Great care will be exercised in the observation of both yellow and green sunsets.

Cloudy will include those in which the sun sets behind a bank of stratus or nimbus clouds, or when it is obscured to such an extent as to exhibit none of the characteristics of the clear, yellow, or green sunsets.

Sunset observations will not in any sense be made with a view of making predictions of the weather.

For further information concerning the manner of reporting and recording sunset observations see instructions in Original Record,

Monthly Metecrological Report, Annual Meteorological Summary, and in Signal Service Weather-Code.

See pages .....

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See Signal Office General Orders .....

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NOTE.—These instructions will be kept complete to date by entering in the blank lines of the proper clause the numbers and series of all orders which in any manner modify them.

Forms and reports to be rendered by stations of the second order.—Observers in charge of stations of the second order will render to this office at the specified times the following meteorological forms or reports:

Original record of observations.
Wind-record sheets.
Morning weather map (Saturday) from stations issuing the same.
Morning weather bulletin (Saturday) from stations issuing the same.
Monthly meteorological report.
Monthly meteorological summary from stations issuing the same.
Monthly report of comparative barometer readings.
Annual meteorological summary.
Monthly report of instruments.
Quarterly report of tools, &c.
Abstract of Journal.
Monthly report of hourly wind movement.
Monthly report of thunder-storms.
River and Flood Bulletin (Saturday) from stations issuing the same.
Monthly record of cautionary, storm, and wind-direction signals from stations issuing the same.
Monthly record of cold-wave signals from stations issuing the same.
Monthly river report from stations issuing the same.
Monthly report of temperature of water from stations issuing the same.
Cotton-region bulletin (Saturday) from stations issuing the same.
Monthly record of observations at cotton-region stations.
Annual report of operations of station.

Duties of observers at stations of the third order.—The observer in charge of a station of the third order will enter daily on the proper form the readings of the maximum and minimum thermometers, amount of rainfall, direction of wind, and state of weather *at sunset*. The original will be forwarded to this office at the end of the month, and a copy will be kept on file for reference.

Observers in charge of third-order stations will keep a daily journal and forward an abstract of the same to this office monthly.

Forms and reports from stations of the third order.—Observers in charge of stations of the third order will render the following meteorological forms or reports at the specified times:

Monthly meteorological report.
Monthly report of instruments.
Monthly report of tools, &c.
Abstract of journal.

Reports from substations.—Observers in charge of centers (wind signal, cotton region, river, and rainfall) will transmit the reports from substations under their control promptly to the Chief Signal Officer as soon as the forms have been examined and existing instructions complied with. All derelictions of duty in this respect on the part of an employé in charge of a substation will be reported.

VOLUNTARY OBSERVERS.

The Chief Signal Officer will be pleased to receive observations taken by voluntary observers at places where there are no Signal Service stations.

The Signal Service is, however, unable to offer any pay for such services, but will furnish blanks upon which to make the monthly reports, a copy of instructions to voluntary observers, and send its publications to the observer.

BAROMETERS.

The mercurial barometer used at Signal Service stations is a modification of the Fortin pattern, and consists of a tube, a cistern, a scale, and a thermometer.

Zero point.—The point of the small ivory pin which extends downward from the ceiling of the cistern is the zero point of the barometer scale, and also the point from which the elevation of barometer above sea-level is measured.

The scale of the barometer, from which the readings are made, is divided into inches and tenths of an inch. The tenths can be further divided to hundredths by means of the vernier. As the fluctuations of the barometer column only extend over a few inches, the scale is never graduated down to the zero point. The scale of the barometer must never be moved except by special authority from the Chief Signal Officer.

The vernier.—The vernier is a short scale, which is moved by a screw and ratchet along the barometer scale. The divisions on the vernier are one more than the divisions on the part of the barometer scale which it covers. If the vernier has ten divisions, the barometer scale has nine divisions in the same length. To determine the value of a division on the vernier, divide the length of the smallest division on the barometer scale by the number of divisions on the vernier. Example: If the length of the smallest division on the barometer scale is 0.10 of an inch and the vernier has ten divisions, we have 0.01 of an inch as the smallest reading which can be made with the vernier.

Attached thermometer.—The attached thermometer is placed so that its bulb rests almost against the tube of the barometer near the point where the average temperature of the whole column of mercury prevails.

Moving barometer.—In moving a barometer always force the mercury to the top of the cistern by means of the adjustment screw; detach the barometer from its support, or bring it carefully to a horizontal po-

sition, invert it, then give the adjusting screw another turn, leaving, however, a small air space in the cistern, for if the mercury fills both that and the tube it may be forced through the joints of the cistern. While the cistern is uppermost the tube is full (one solid mass of metal and glass) and not easily injured. Never *swing* the barometer or endeavor to force the mercury against the top of the tube without first filling the cistern by means of the large adjusting screw.

Packing barometers for transportation by hand.—In packing for transportation by hand, place the barometer, cistern uppermost, in the wooden box or leathern case provided for the purpose; allow no play between the barometer and the case, but to prevent the instrument from shaking fill the spaces with yielding material, such as cotton or excelsior. On steamboats or railroads the barometer should be hung in a state-room or car, and, to prevent jarring, the lower end should be firmly strapped to the side of the room or car. In wheeled vehicles, the barometer should be carried by hand, supported by a strap over the shoulder or held upright between the legs; it should not be allowed to rest on the floor, as a sudden jolt might break the tube. On stage routes, when impracticable to carry it by hand, hang the barometer on a hook inside the stage and securely fasten the lower end so that it will not swing when being thus transported. If carried on horseback, it should be strapped over the shoulders of the rider, where it is not likely to be injured.

Packing for transportation by mail or express.—In packing for transportation by mail or express, the barometer should be placed in its wooden case and the latter in a box of sufficient size to admit packing on the sides and ends. Excelsior or other pliable material should be closely and evenly packed around the barometer case, to prevent its moving in any direction.

Mercury to be removed.—Before packing an unserviceable barometer for return to the office of the Chief Signal Officer, the mercury in the tube and cistern will be emptied and retained at the station.

Barometers, how returned.—All barometers issued from the office of the Chief Signal Officer, or returned in good order from stations by mail, should be accompanied by a printed letter, addressed to mail agents and signed by the General Superintendent of the Railway Mail Service, containing directions for the care of these instruments while in transit.

When received by mail or express, the party to whom the barometer is addressed should open the box in the presence of the postmaster or express agent, to determine if the instrument is in good condition.

To unpack barometer.—To unpack and suspend the barometer, take it, cistern uppermost, from its case, lower the milled-head screw at the bottom of the cistern one or two turns, invert the barometer slowly and gently, and then hang it in a vertical position.

Barometer-box.—At stations where the standard barometer-box is not furnished, the barometer will be suspended near a window, so that the 30-inch line on the barometer scale will be 5½ feet above the floor. The barometer should be well lighted, without exposure either to the direct rays of the sun or to currents of air, which are always found at window casings and doors. To protect the instrument from external injuries, from dust, and from the direct radiation of warm bodies or air currents, fasten the wooden case in which it is carried firmly against the wall in a vertical position. An opening large enough to admit the tube of the barometer must be cut in the upper end of the box, and

directly above this, at the distance of 1 inch, a strong hook will be inserted into the wall on which to hang the barometer. This hook must be small enough to allow the ring in the top of barometer to move freely upon it and allow the instrument to hang in a perfectly vertical position. The hook should extend 2 or 3 inches beyond the box. When an observation is to be taken, the door of the box will be opened and the instrument drawn out on the hook clear of the box. After the observation is made the barometer will be slipped back and the box closed.

Care will be taken not to remove from or return the barometer to its case with a sudden jar, as such handling will injure the instrument.

Erection of standard barometer box.—The standard barometer box will be erected as follows, Fig. 1:

Place the box horizontally upon a table and fit the barometer into it. Carefully lay the barometer upon the four grooved blocks in the box, moving the blocks so that the one marked A will be under the cistern just below (when the barometer is in position for observing) the projecting ring; one of those marked B, under the brass tube which incloses the glass tube, and just above the cistern; one just below the top of said brass tube, but not against the scale, and one at a point as nearly midway between the two latter blocks as possible, but below the scale. Leave sufficient space between the bottom of the cistern screw and bottom of the box so that the screw may have sufficient play for making adjustments.

Fasten the blocks A and B in place by means of the small screws through the sides and back of the box, first boring holes to prevent splitting.

The block marked C must then be fitted into the space between the top of the box and the block marked B, just below it, cutting off a portion of C, if necessary; then fasten it into place against the back of the box by two screws.

Fasten the curved brass plates over the barometer and against the blocks by the small screws, being sure they fit neatly over the barometer.

Place the *large* screw through the ring at the top of the barometer and screw it through block C and the back of the box, first boring a hole to prevent splitting. When in position the barometer will hang on that screw. Mark the box opposite the 30-inch line of the barometer scale.

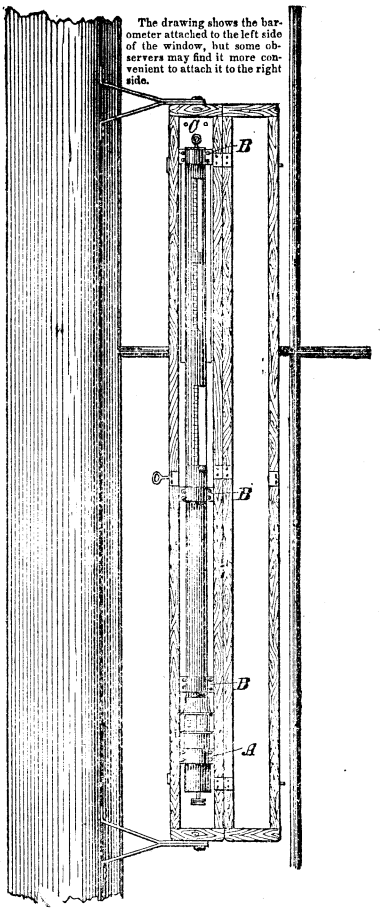
Remove the curved brass plates, large screw and barometer, and erect the box so that the 30-inch line will be 5½ feet above the floor. Screw the metal braces accompanying each box, one above the other, against the window casing at the side of a window where the sun will not shine upon the box, in such a manner as to allow placing the box directly between them; fix the box in position by screws passing through appropriate holes in the braces and into the ends of the box, using a plumb-line to secure the box in a vertical position. Before firmly fastening the latter screws, turn the box so that its back will be to the full light of the window, and in such a manner that at night a light may be held directly behind the windows of the box.

Paste a thin sheet of white paper over the outside of the glass windows of the box, if they have not already been reduced to translucency.

Carefully *invert the barometer*, place it in its box, replace the large screw, and secure the curved brass plates over the barometer and against the blocks sufficiently tight to hold the barometer in its place and yet permit the observer to turn the barometer around on its axis, vertically,

should he find it necessary, in order to secure a good light at the ivory point while taking an observation. Close the door of the box and keep it closed, except when taking an observation.

FIG. 1.



In placing barometers in the standard boxes it is very important that they should be vertical, for if one end of the barometer is one-fourth of an inch out of vertical it will cause the reading to be at least 0.004 of an inch in error. Use the plumb-line both from a front and a side position. To verify the verticality of the barometer adjust the mercury in the cistern to the zero point and slowly turn the instrument around. If the adjustment continues in all positions the barometer is vertical.

To read the barometer.—(1) Read the attached thermometer to the nearest half degree and record it.

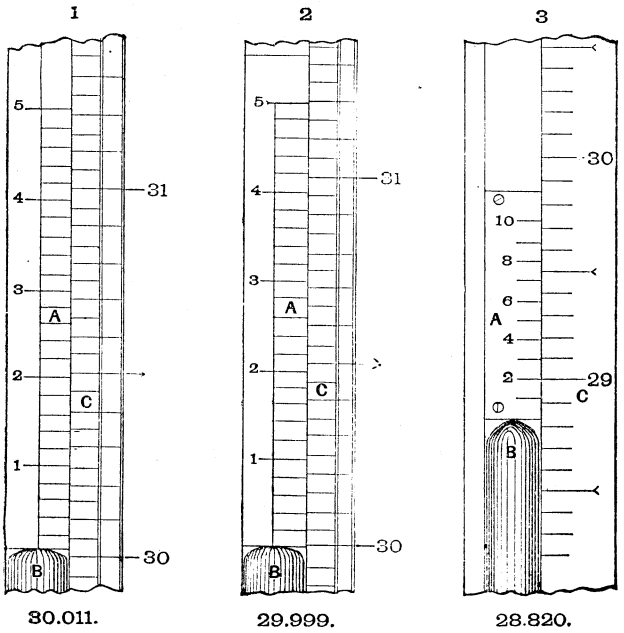
(2) Tap the barometer sharply with the finger to free the mercury from the sides of the tube at the top of the column.

(3) By means of the adjusting-screw lower the mercury in the cistern below, and then raise it until the surface exactly touches the ivory point.

When the mercury is perfectly pure the proper adjustment can be made by causing the ivory point to coincide exactly with its reflected image in the mercury below; but when the mercury is covered with a slight film of oxide it is necessary to determine the contact by immersing the point in the mercury until a slight dimple is formed, and then slowly lowering the screw until the dimple is about to disappear.

(4) Adjust the vernier, by means of the side milled-head screw, to the top of the column of mercury, until the zero line of the vernier and the bottom of the blind part of the vernier in the rear of the mercurial column exactly coincides with the top of the meniscus, that is, tangent to the convex surface of the mercury in the tube. This adjustment will not cut off the light at the sides of the meniscus. (See Fig. 2, in which A represents the vernier, B the column of mercury, and C the scale of the barometer.)

FIG. 2.



(5) Read the barometer scale up from the zero point to that line next below the zero line of the vernier. Find the number of the line on the vernier which coincides most nearly with a line on the barometer scale. This number will be the hundredths of an inch of the barometer reading. Add this to the inches and tenths and the result will be the barometer reading in inches, tenths, and hundredths, which will be recorded at once. When a line of the vernier does not exactly coincide with a line on the barometer scale, the observer will, after practice, be able to estimate the thousandths of an inch.

While making vernier adjustments of a barometer fixed only at one end, be careful not to move the barometer from a vertical position.

While adjusting the barometer at night the observer will carefully arrange his light in such way as to insure an accurate reading.

In the cut the vernier on the left has twenty-five divisions, equal to twenty-four divisions on the barometer scale, and the smallest reading accurately shown will be 0.002 of an inch.

Corrections applied to barometer readings.—The observer making the observation must correct the reading for instrumental error, temperature, elevation above mean sea-level, mean of high and low tides, and standard gravity.

If the correction for instrumental error of barometer No. 457, as given on the correction card, is —.003, it shows that the barometer reads .003 of an inch higher than the standard, and that .003 of an inch must be subtracted from each reading to correct for this error. If the correction for instrumental error of barometer No. 295, as given on the correction card, is +.004, it shows that the barometer reads .004 of an inch lower than the standard, and that .004 of an inch must be added to each reading to correct for this error.

The correction for temperature, which depends to a certain extent on the height of the barometer, will be obtained from the barometer correction cards furnished. (See Appendix No. I of these Instructions.) As will appear from the card, the corrections change from minus to plus at about 29° F.

In using the table find at the top of the page the observed height of the barometer, and in the column at the left the reading of the attached thermometer. The number at the intersection of these lines will be the correction to be applied. If the reading of the thermometer is less than 29°, the correction will be *added* to the original observation, but if 29° or more above zero it will be *subtracted.*

For barometer readings not given in the table, the temperature corrections will necessarily be determined by approximations with reference to the corrections for the next higher and lower readings given in the table. The same remark applies to cases where the temperature of the attached thermometer is required to half of a degree, when interpolation is also necessary.

Reduction of barometer readings to sea-level and standard gravity.—Barometer readings will be reduced to sea-level and standard gravity by means of special tables furnished by the Chief Signal Officer. In taking out the corrections from these special tables the "temperature argument" to be used will be obtained as follows:

Divide the sum of twice the *temperature* of the dry thermometer at the hour of observation, plus the sum of the temperatures at the two preceding tri-daily observations, by four; the result will be the "temperature argument" to be used in finding the correction for reduction to sea-level.

Example: For 7 a. m. observation of November 4, any station—

Temperature at 7 a. m. is 42°; then 42×2=	84
Temperature at 10 p. m. observation preceding	46
Temperature at 3 p. m. observation preceding	62
Sum	192

$\frac{192}{4}$ = 48.0=the "temperature argument."

Example: For 3 p. m. observation of November 4—

Temperature at 3 p. m. 67°; then 67×2=	134
Temperature at 7 a. m. observation preceding	42
Temperature at 10 p. m. observation preceding.	46
Sum	222

$\frac{222}{4}$ = 55.5="temperature argument."

Example: For 10 p. m. observation of November 4—

Temperature at 10 p. m. is 50°; then 50×2=.....	100
Temperature at 3 p. m. observation preceding.....	67
Temperature at 7 a. m. observation preceding	42
Sum.....	209

$\frac{209}{4}=52.2=$"temperature argument."

Reduction of barometer readings to latitude 45°.—The following will elucidate the nature of the gravity correction as applied to barometric observations, a matter that is not fully explained in the ordinary text-books of meteorology.

By the well-known principle of hydrostatics on which the action of the mercurial barometer is based, the pressure of the atmosphere is equal to the pressure of the column of mercury that it will support. But this latter pressure is only another name for the weight of the mercury, and for columns of equal section the weight varies both with the height of the column and with the force of gravity.

The force of gravity varies with latitude and altitude, therefore the height of the barometer (corrected for temperature and instrumental error) cannot be directly used as a true measure of the atmospheric pressure, but must be reduced to what the height would have been if the force of gravity and the weight of a given mass of mercury were constant all over the earth.

Force of gravity at latitude 45° and sea-level the standard.—The force of gravity at the latitude of 45° and sea-level is assumed as the standard value to which barometer readings shall be reduced, and is called "standard gravity." Our unit of mass becomes a standard unit of weight when weighed in vacuo at latitude 45° and sea-level.

According to the formula for the force of gravity adopted by the International Bureau of Weights and Measures, we have for the variations in gravity due to the latitude

$$G\varphi = g_{45^\circ}(1-0.00259\cos 2\varphi)$$

The variation in the force of gravity for different altitudes is small, and is given by the formula

$$G_h = g_0\,(1-11400000^{-1}h)$$

Neglecting this latter factor, the application of the gravity correction is equivalent to multiplying the height of the barometer by the factor

$$(1-0.00259\cos 2\varphi)$$

This is accomplished practically by computing a table of corrections with the latitude as an argument, the height of the barometer being assumed for low stations as 30 inches.

The diminution of gravity as we go from latitude 45° to the equator causes the mercury in the barometer to *weigh less*, and hence for a given pressure in the atmosphere the mercury in the barometer stands *higher* than it would if the force of gravity preserved the uniform standard value. Therefore, the farther a barometer is removed from latitude 45°, the *greater its correction becomes*, so that at the equator a pressure that appears to be 30.00 inches (at sea-level) is really about 29.92 inches.

It should be noticed that when the barometer is thus corrected for its peculiar error due to the influence on it of variations of gravity, the

pressure that it then gives is the actual pressure of the air at each latitude expressed in terms of an absolute and not a variable standard.

It is important to remember that the barometric pressure is due not only to the weight of the air, but also to the prevailing winds, the rapid heating or cooling and consequent expansion or contraction of low layers of air, and to other causes.

In the mercurial barometer we balance this elastic pressure by weight of quiescent mercury; a change of the force of gravity will change the weight of the column of mercury without necessarily changing the atmospheric pressure.

Table of gravity correction.

[Barometer, 30 inches.]

Latitude.	Inches.
30	−0.039
35	−0.027
40	−0.014
45	0.000
50	+0.014
55	+0.027
60	+0.039
65	+0.050
70	+0.060

Temperature of barometers.—When practicable, barometers must not be subjected to temperatures below 20° F. They will not be subjected to direct influence of heat or to sudden changes of temperature.

Cisterns of extra barometers to be kept full.—To prevent fouling the mercury of extra barometers, when not in use, the cisterns must be kept full. It is neither necessary nor desirable to force the mercury to the top of the tube, except when the barometer is to be moved.

When a barometer cistern is full of mercury, it must be lowered to the zero point at least twelve hours before readings are made.

Mercury.—Mercury will be furnished to stations only on special requisition, which will be made when the mercury is needed for immediate use in connection with cleaning and repairing barometers.

Changes in location of barometers.—Changes in the location of a station barometer will be made, as a rule, between the last observation of one day and the first observation of the succeeding day.

Comparative readings of barometers.—On the last two days of each month comparative readings of all barometers at the station will be made. Five readings will be taken each day, at hourly intervals from 9 a. m. to 1 p. m., inclusive. They will be corrected for temperature and instrumental error, and recorded upon the proper form.

The observer will also make a test at the end of each month of the verticality of each barometer, and record the result on the form containing the comparative readings. Any error found will be corrected at once. A *copy* of the form will be pasted in the daily journal for the last day of the month and the original forwarded to the Chief Signal Officer on the first of the succeeding month.

Whenever a barometer is received at a station the observer will place it in position and take five comparative readings, at hourly intervals, with it and all the other barometers, and send a record of these comparisons, with a letter of transmittal, to the Chief Signal Officer. A copy will be pasted in the Journal at the proper date.

Comparative barometer readings when an office is moved.—When an office is moved comparative barometric readings will be made, at fifteen-minute intervals, as follows:

(1) Five comparative readings of the station and extra barometers in the old office, the observer in charge reading the station barometer, the assistant reading the extra barometer.

(2) Five comparative readings with the station barometer in the old office, and the *extra* barometer in the *new* office, each observer reading the same instrument as in the first series.

(3) Five comparative readings with both barometers in the new office, each observer reading the same instrument as in the first series.

(4) Five comparative readings, both observers adjusting and reading the extra barometer. This series of readings should be made when both the temperaure and pressure are nearly constant.

(5) In the first three series the readings of the two barometers should be as nearly simultaneous as possible. The readings of the first, third, and fourth series should be made only when the attached thermometers read nearly the same. The four series will be recorded, a copy made, and the original mailed, at once, with a letter of transmittal, to the Chief Signal Officer. The copy will be retained at the station.

In making these comparative readings the services of a competent assistant are indispensable. When there is but one observer at the station he will apply, in advance, for authority to hire an assistant for the occasion, stating the cost.

The station barometer will be moved in the interval between the last observation of the day and the first observation of the following day. The extra barometer should be moved a day in advance.

Elevation of barometer changed; table for the reduction of readings.—If the elevation of the barometer is increased or decreased less than 65 feet the special table for reduction of barometric readings to sea-level and standard gravity will be changed as follows:

If *decreased*	6	to	15	feet	subtract	.01	inch	from	each	number	in	table.
"	"	16	25	"	"	.02	"	"	"	"	"	"
"	"	26	35	"	"	.03	"	"	"	"	"	"
"	"	36	45	"	"	.04	"	"	"	"	"	"
"	"	46	55	"	"	.05	"	"	"	"	"	"
"	"	56	65	"	"	.06	"	"	"	"	"	"

If the elevation of the barometer is *increased* then the same quantity should be *added* to the numbers in the special table.

When observations are commenced at new stations the barometer corrected for instrumental error and temperature only will be entered and copied on all forms until the receipt of the table for reduction of barometric readings to sea-level and standard gravity.

Comparisons of ships' or other barometers.—Upon application observers are authorized to compare barometers used by ship-masters, or others, with the station barometer. The comparison must be made at the observer's office, subject to the same rules hereinbefore prescribed for barometric comparisons.

A record will be made of the comparisons with the name and address of the owner and the name of the maker of the barometer.

If the barometer compared belongs to a marine or voluntary observer of the Signal Service, a copy of the comparative readings will be forwarded to the Chief Signal Officer.

Each barometer compared will be furnished with a comparison tag, properly filled up, signed, and attached to the barometer.

At the request of the owners, aneroid barometers will be set with the station barometer and a record made of the change.

Cleaning barometers.—Cisterns of barometers will not be cleaned or repaired at stations unless previously authorized by the Chief Signal Officer. Should such authority be obtained, a report will be rendered of the result, stating the number of the instrument and date of the work, accompanied by two sets of five, fifteen-minute interval, comparative readings of all barometers at the station, one set to be made before and the other after the repair or cleaning.

If authority is granted to clean or repair a barometer the following rules will be observed:

Fill the cistern with mercury by use of the adjusting screw (O) Fig. 3, at the bottom of the barometer; invert the instrument, unscrew and take off the brass casing (S) which incloses the wooden and leathern part of the cistern. This wooden part is made in two pieces, fastened together by four screws and four half-circle pieces. Remove the half-circle pieces by taking out two of the screws, and loosen the other two. Lift the upper wooden piece, to which the cistern bag (N) is attached, and the mercury will be exposed. Incline the instrument a little, and pour a small quantity of the mercury from the cistern into a clean and dry porcelain cup, just enough to uncover the end of the tube. Avoid the use of unclean, damp, or metal vessels. Bring the barometer into a vertical position, and close the end of the tube with the gloved finger; invert the instrument, and empty the cistern and bring the tube again to its vertical position. Care must be taken to prevent any mercury from passing out of the tube. Remove the long screws (P) which fasten the glass portion of the cistern to the other parts and clean the several parts by use of a chamois-skin or a clean, dry linen handkerchief. The glass tube (t) and the boxwood attachment (G), which contain the ivory zero point (h), need not be removed from the brass sheath. The scale must not be moved under any circumstances. Clean the mercury taken from the cistern by passing it several times through funnels which have very small holes in the ends, so as to permit the passage of but a small thread of the metal. The oxide and dust will adhere to the paper, and the filtered mercury, if sufficiently pure, will present a clean, bright appearance.

After running the mercury through paper funnels several times, if the refuse sticks to the paper in a web-like formation, the mercury may be considered serviceable; but if the refuse forms a thin uniform sheet on the paper, the mercury should not be used.

After the mercury and the several parts of the barometer have been cleaned replace the glass cistern and long screws (P). Fill the cistern as nearly as possible with clean mercury, put together and securely fasten the wooden parts of the cistern by the screws and clamps, screw on the casings and tighten the adjustment screw. Do not make the screws as tight as possible, or the glass cistern may be broken by the expansion and contraction caused by changes of temperature. The instrument can then be hung up and readjusted. If a little mercury has been lost during the operation (and there is none at hand to replace it) no serious harm has been done; but if much has been lost, fresh mercury must be added to prevent the open end of the tube from becoming exposed while inverting the instrument. Clean the tube about the scale by means of a knife-blade covered with chamois skin.

During the process of filling, transportation, or cleaning, air sometimes finds its way into the barometer tube and affects the vacuum above the mercurial column and causes the barometer to read too low.

FIG. 3.

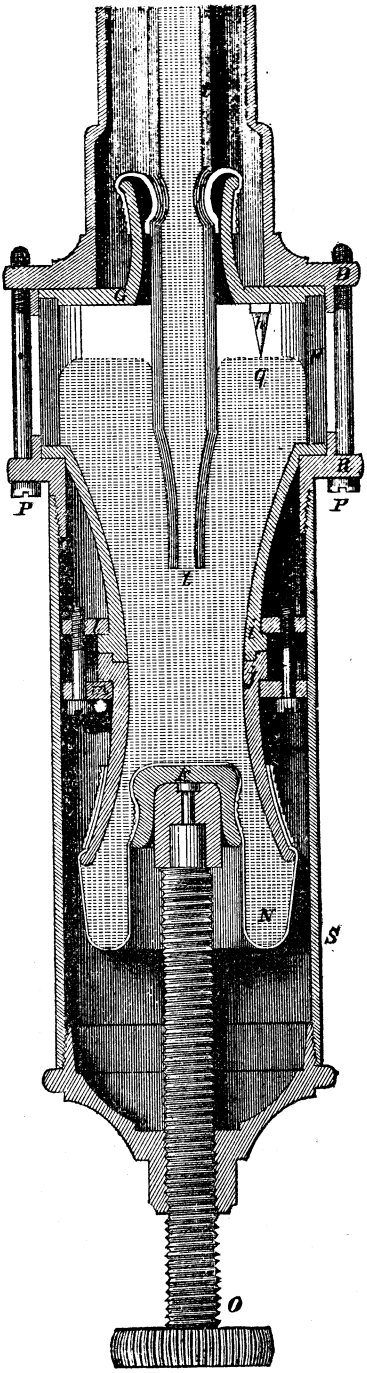
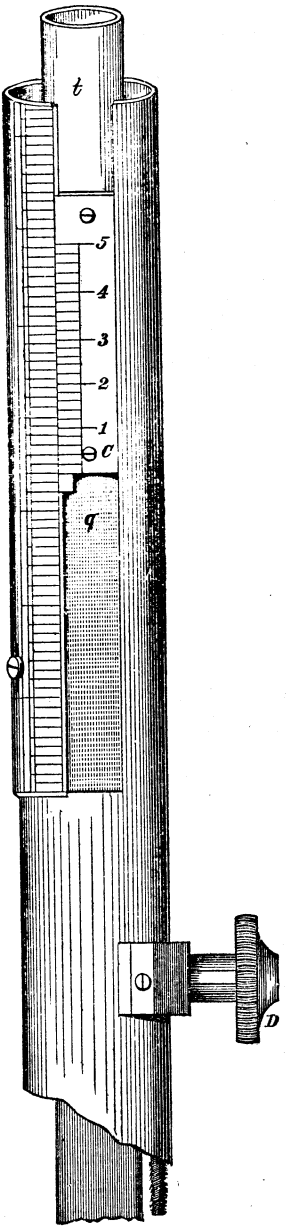


FIG. 4.



Air in barometer tube.—When it is thought that air has entered the tube its presence may be ascertained by filling the cistern with mercury and slowly inclining the barometer. If the mercury strikes the top of the tube with a clear metallic ring, it shows that it is free from air. But if the sound is a dull thud, the tube probably contains air. If air is present, proper effort will be made to expel it by pushing the mercury into the tube by means of the adjusting screw, then inverting the instrument, loosening the screw and tapping the top of the instrument against the observer's boot. If this fails to expel the air, the fact that the barometer is unserviceable must be promptly reported to the Chief Signal Officer.

In extraordinary cases, where it is necessary to expel the air, it may be done by removing the tube from the case, pouring about half an inch of the column of mercury out, placing the finger over the opening, partly inverting the tube, and allowing the air bubble to pass to the top of the tube. When it has reached the top, incline the tube gently and slowly, and watch the bubble of air as it returns. If it should separate and form two bubbles force them back to the top of the tube and make them recombine. Renew the effort to bring them to the mouth of the tube, and when successful completely fill the tube with mercury and put the parts of the barometer together. This process should only be resorted to in rare cases, as particles of air will separate from the bubble and, adhering to the glass, will eventually reach the vacuum and require a repetition of the above-mentioned process.

ANEROID BAROMETER.

The Chief Signal Officer has not yet adopted any particular aneroid barometer for the use of the service, as the aneroid is issued only when it is not advisable to furnish a mercurial barometer.

A good aneroid barometer indicates the slightest change in atmospheric pressure, but as these barometers deteriorate very rapidly, their readings are of inferior value as compared with those of the mercurial barometer where it is necessary to study synchronous barometric observations from a number of stations.

Aneroid barometers do not need gravity correction.—The readings of aneroid barometers are dependent on the elasticity of metal, which is not varied by gravity, although it may be by temperature; but they do need a correction to take account of the latitude in which they stood when compared with the standard mercurial barometer by which their scale was adjusted, unless the readings of that mercurial were already reduced to standard gravity.

Aneroids, how set with mercurial barometers.—An aneroid barometer should be compared with a good mercurial barometer monthly, when possible, and the index set to the reading of the latter instrument corrected for temperature and instrumental error by means of the screw on the back of the aneroid barometer. Any correction made to an aneroid barometer by this method must be noted upon the record of the readings made with that instrument, giving the exact change made and the number of the mercurial barometer used.

Aneroid barometer readings, how reduced to sea-level.—To reduce the readings of an aneroid barometer to sea-level the tables prepared for mercurial barometers may be used, except that the correction for standard gravity must be omitted, provided the aneroid barometer has been set with a mercurial barometer, the readings of which have been reduced to standard gravity.

To convert barometer readings in inches to millimeters and vice versa.—When it is necessary to convert barometer readings in inches to millimeters, or millimeters to inches, when special tables for conversion are wanting, it may be done by considering that 1 millimeter is equal to 0.03937 inch, and 1 inch is equal to 25.4 millimeters. For table, see Appendix No. 2.

For further information concerning the manner of reading, reporting, and time of recording the barometer see instructions in Original Record, Monthly Meteorological Report, Annual Meteological Summary, and Signal Service Weather Code.

See pages _____

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See Signal Office General Orders _____

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THERMOMETERS.

Temperature of the air.—To obtain a proper record of the temperature for general meteorological purposes thermometers should be exposed to a free circulation of air, and this exposure should be uniform at all stations. A good air circulation in the thermometer shelter for winds from any quarter is the first and principal requirement. It has been found that when there is little or no air circulation, the air of lowest temperature has a tendency to settle in the lowest places, hence it is important that to obtain a satisfactory record of the temperature of the general atmosphere, the thermometer exposure should be made on a slight elevation, or on the roof of a building. Correct results of the general air temperature are of the highest importance to this service.

The best exposure is found to be at a height above the ground free from the influences of neighboring buildings. The next best is a position on the roof of a building, uninfluenced by the harmful effects of artificial, radiated, or reflected heat. If the shelter is on the ground, it should not be within 25 feet of any building of the same height. If on the roof, it should not be *within* 10 *feet of a live chimney or less than* 10 *feet above any object within that distance of the shelter support.*

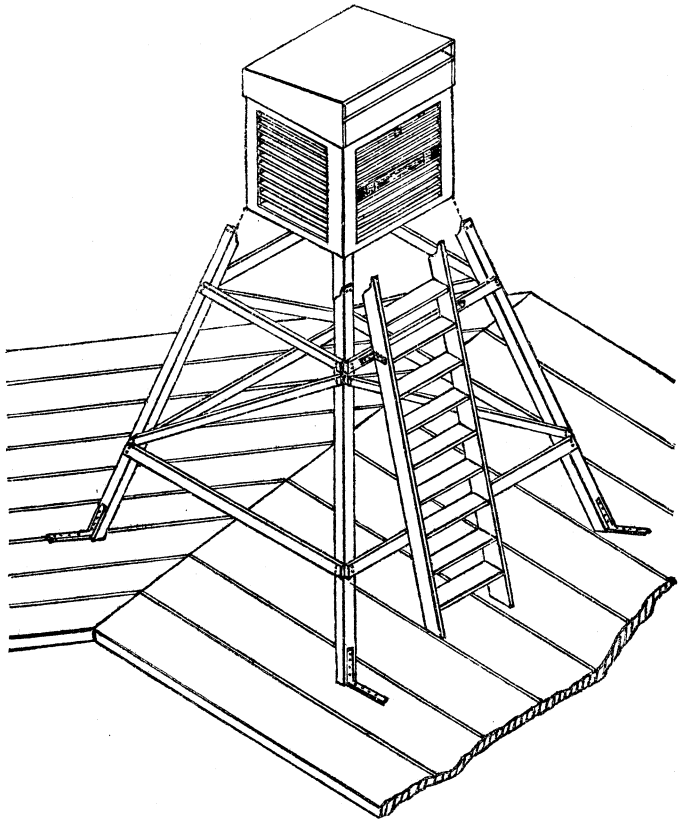
The thermometer shelter.—Figure No. 5 represents the thermometer shelter adopted by the Signal Service to be used when it can be located upon the ground or upon the roof of a building. The shelter is made in the shape of a 3-foot cube, the sides of open lattice work and the top and bottom of tightly matched boards. One board in the bottom is fitted with hinges and a button so that it may be lowered when it becomes necessary to clean the floor.

The shelter is sent from the office of the Chief Signal Officer and detailed plans and specifications for constructing the support and erecting the same will be furnished when a standard shelter is to be used.

The thermometers in general use at second-order stations are one dry thermometer, one wet thermometer, one maximum thermometer, and one minimum thermometer.

The minimum thermometers are alcohol thermometers. The maximum, dry, and wet thermometers are mercurial, except at stations where temperatures of 38 degrees below zero, Fahrenheit, are liable to occur, at which stations they are of spirits of wine.

FIG. 5.



Thermometers, how read.—In taking thermometric readings the eye should be on an exact level with the height of the mercurial or spirit column, and the reading should be taken as rapidly as accuracy will permit, to avoid affecting the thermometers by heat from the body or lantern.

All thermometers are carefully tested at the office of the Chief Signal Officer before being sent to stations, and each is accompanied by a correction card.

Correction of thermometers.—The corrections of thermometers given in the Signal Service correction-cards are for points ten degrees, Fahrenheit, apart, usually from — 28° F. to + 112° F. These corrections are to be applied algebraically to the scale-readings of the thermometers to give the true temperatures. For a scale-reading between those for which corrections are given, an interpolated value of the correction must be used.

The following are examples of the method of applying the corrections: For a reading of 62°.0 on, say, thermometer No. 1016, the correction is —0°.5. The true temperature is therefore 62°.0—0°.5=61°.5. For the reading —13°.5 the interpolated value of the correction is, say, —1°.3. The true temperature for this reading is therefore —13°.5—1°.3=—14°.8. For a reading of minimum thermometer, say, No. 904 of —28°.0, the correction being +7°.8, the true temperature would be —28°.0+7°.8 =—20°.2.

Corrections for thermometers only given from actual comparisons.—The corrections of thermometers are given on the cards only as low as actual comparisons have been made with substandards. If it should happen that a reading of a thermometer is obtained at a point lower than any for which its corrections are given, then the correction for that point must be derived by extrapolation. It will be found the better plan in most cases of this kind to use as a basis for this extrapolation the change in the correction for the last thirty degrees for which the corrections are given. On thermometer No. 1016, for instance, the change of correction between +2° and —28° is —1°.4. For seven degrees the change is about —0°.3. For the reading —35°.0, then, which is seven degrees below —28°, the correction is —2°.3, and the true temperature is —35°.0—2°.3=—37°.3. When the signs of the temperature and correction are the same they add; when different, they subtract.

For minimum thermometer No. 904 the change of correction from +2° to —28° is +4°.6. In twenty degrees the change would be +3°.1. For the reading —48°.0 the correction is +10°.9, and the true temperature —48°.0+10°.9=—37°.1. When carried very far, the corrections obtained in this way cannot be precise.

Alcohol thermometers, corrections for.—Corrections for alcohol thermometers are given to tenths of a degree, but two independent determinations of the corrections will often be found to differ by half a degree Fahrenheit at the same point. This is in part owing to the fact that the degree spaces are short. The different quantity of liquid, wetting the interior surface of the tube above the column of alcohol at different times, causes a variation in the reading. There is no special significance, therefore, when it is found that after applying the corrections of a dry and minimum thermometer read at the same time, they show temperatures differing by half a degree. The reading of the dry mercurial thermometer is always to be preferred to the alcohol thermometer at temperatures above —38° F.

A source of great annoyance in the use of alcohol thermometers is the continual condensation of the alcohol in the tube above the column. The tube ought to be frequently examined for such condensation. When the dry and minimum thermometers differ much more than half a degree it may be suspected that part of the alcohol column is detached.

As readings of most alcohol thermometers cannot be relied upon any nearer than 0°.5 F., any change of this kind in its freezing-point can only be certainly perceived after a great many years, if at all. Sometimes chemical changes in the alcohol cause alcohol thermometers to read lower than when they were first made. An alcohol thermometer, exposed a great deal to the sun, may have a film form along the bore which causes it to read 2°.0 F. too low.

Maximum thermometers, corrections for.—The corrections of maximum thermometers, with constriction in the tube, are not usually given lower than +12° F. Whenever the corrections are given for points below that reading they are not derived from comparisons with a standard, but by means of calibration.

The maximum thermometer, with constriction in the bore, is very apt to read two degrees or more too high at very low temperatures, unless the thermometer is very nearly vertical when read. The capilarity of the constriction pushes the detached column up, unless the column is long. The thermometer ought to be inclined enough when mounted to prevent this pushing. The distance in a vertical direction between the constriction and the top of the column ought not to be less than one inch.

Change of freezing-point.—There is a gradual rise in the freezing-points of mercurial thermometers with age. The rise is rapid at first. Within a week after a thermometer is filled it is sometimes as much as 2°.0 F., and in a year after that it may rise an additional 1°.0 F. After a number of years the rise may be only a few tenths of a degree. For this reason thermometers are usually filled about a year and a half before they are graduated. The amount of this change is very different for thermometers made of different kinds of glass.

The change of freezing-point is more rapid when the thermometer is frequently subjected to great changes of temperature. A thermometer subjected to a high temperature has its freezing-point lowered. If subjected to a low temperature the freezing-point is raised.

Changes take place in alcohol thermometers, but they are not so apparent as in the case of mercurial thermometers, for the reason that the expansion of alcohol is so much greater than that of mercury. Mercury expands between six and seven times as much as glass, while alcohol expands about forty times as much. A change of 0°.6 F. in the freezing-point of a mercurial thermometer caused by a contraction of the bulb would therefore, in the case of a similar contraction in the bulb of an alcohol thermometer, cause a rise in its reading at freezing-point of only 0°.1 F.

Freezing-point of thermometers.—The freezing-point of a thermometer to be used in connection with any temperature is that observed in melting ice immediately after exposure to the temperature for which the correction is required. The freezing-point varies so little from time to time, that for meteorological observations it is not necessary to observe it oftener than once a year. But if the highest accuracy is required at any particular observation of a temperature, the freezing-point of the thermometer should be determined immediately after the observation of the temperature.

In testing the freezing-point of a thermometer finely chipped ice or melting snow should be heaped up around the stem above the top of the mercurial column. In testing thermometers in snow in winter-time care must be taken that the snow is surely melting or they will read too low. Snow, even after being kept in a warm room for many hours, will often be found several tenths of a degree lower in temperature than 32°.0 F. To insure the correct temperature the snow should be moistened with distilled water.

The rise in the freezing-point of a thermometer comes from the constantly diminishing capacity of the bulb, due to some change in the nature of the glass.

When the freezing-point changes, all the corrections of a thermometer are changed by the same amount.

The observation of the freezing-point of a thermometer from time to time is necessary on account of other changes; such, for instance, as the shifting of the tube with respect to the scale when the graduation is not on the tube itself.

Air in tube of mercurial thermometers.—There is always some air above the column in the tube of a mercurial thermometer. The continual jarring and reversing of the instrument in transportation sometimes forces the air into the bulb or scatters the mercury along the bore. If there is air in the bulb it will be seen as a speck and must be removed, as it will cause erroneous readings of the thermometer. If the thermometer is inclined with the bulb uppermost, the mercury will run out in the tube readily as the speck grows larger.

How to remove air from thermometers.—To remove the air, it must first be brought to the junction of the tube and the bulb. To do this, take the thermometer in one hand and jar the bulb gently against the open palm of the other hand. When the bubble is brought to the junction, cool the thermometer to as low a temperature as can be done conveniently, by putting the bulb in ice or cold water. When the thermometer has cooled down, invert it and jar slightly. This will cause all the mercury above the bubble to run to the end of the tube. While the thermometer is still inverted or held horizontally, warm up the bulb in the hand. This will cause the mercury to rise in the tube and drive the air before it; then bring the thermometer vertical, and the detached mercury will run down and join the main column. The junction will not be complete; the air-bubble will be on one side. Put the bulb in ice or cold water again, and as the temperature falls the air-bubble will be stationary, the mercury passing by it. When the temperature is as low as it will go, then again inverting the thermometer and jarring, the mercury will run down as before. Then by heating with the hand, joining the column and cooling as before, the air-speck can be worked gradually to the top of the column.

In cooling off the thermometer for the last time, care should be taken that the top of the column falls below the last position of the air-speck. The latter part of the cooling must also be done slowly, or otherwise, when there are only a few degrees of mercury above the air-speck, the mercury will become detached. When the detached column is very short, it cannot be made to partially reunite with the main column again, as the elasticity of the intervening air is too great for the weight of the column.

When the short column cannot be partially reunited again, if the gap is only two or three hundredths of an inch, the column can be lengthened by jarring the thermometer, held vertically in the open palm of the hand. When the column has become long enough to reunite, the process described above can be repeated.

If after a few trials it is found impossible to get the air above the column in this way, it may be accomplished, in case the thermometer has but little scale below freezing-point, by putting the thermometer in a freezing mixture, as of salt and ice, and when the mercury has sunk into the bulb jarring the detached column down into it also.

It is important to observe that the bulb of a thermometer must never be presented to a flame.

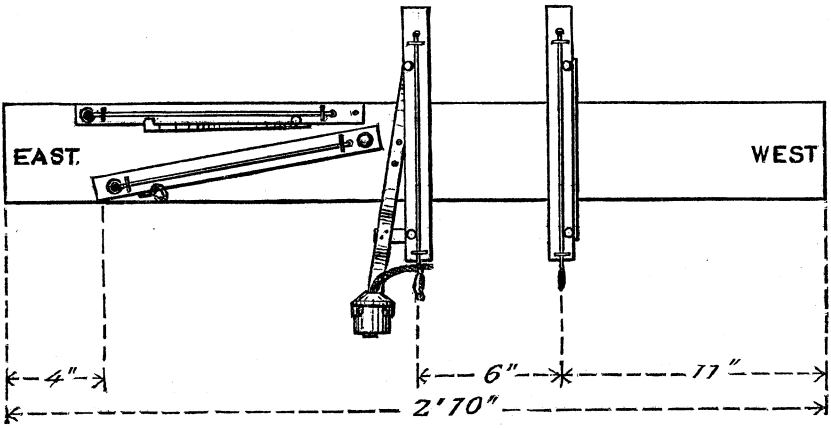
Mercurial thermometers, temperature at which they can be relied upon.—The mercurial thermometer can be relied upon down to temperatures on the verge of the freezing-point of mercury, even as low as —38° F., as long as the temperature to which it is exposed is falling. When the temperature has been lower than the freezing point of mercury and is rising, the readings will be very erroneous as long as there is any of the mercury in a solid state.

Atmospheric pressure affects readings of a thermometer.—The spherical bulb thermometers in use in the Signal Service read about 0°.4

F. lower in melting ice in a vacuum than when subjected to the pressure of the atmosphere. On Pike's Peak, where the barometer reads about 18 inches, the freezing-point of a dry thermometer will read about 0°.2 F. lower than when at the level of the sea. The amount of this change varies with different thermometers, depending on the thickness of the glass in the bulb. When the tip of a thermometer-tube is broken off, opening the bore to the air, its freezing-point will be lowered about 0°.5 F.

Thermometers, how placed in shelter.—When the whirled psychrometer is not used the thermometers will be located in the shelter as shown in Fig. No. 6.

FIG. 6.



Considering the three dimensions of the shelter, the bulb of the wet thermometer will be placed exactly in the center of the shelter, the bulb of the dry 6 inches to the right, the maximum thermometer bulb 13 inches to the left of the bulb of the wet and sufficiently to the front to permit it to be swung without striking the wet thermometer, and the minimum thermometer bulb 2½ inches above the maximum thermometer bulb and sufficiently to the rear to prevent contact when the latter is whirled.

The dry and wet thermometers will be erected in a true vertical position, and the minimum thermometer in a true horizontal position. The left end of the maximum thermometer scale will be one inch lower than the right end.

THE STATION STANDARD, OR DRY, THERMOMETER.

The thermometer used at Signal Service stations for the station standard, or dry, is the ordinary mecurial thermometer, of very small bore, with a cylindrical bulb. The tube is fastened to a brass plate and the degree marks (Fahrenheit) appear not only on the tube but also on the plate, or a porcelain scale attached thereto.

The temperature of the air will be obtained from this thermometer, the readings of which will also be used as those of a dry thermometer when psychrometric deductions are required.

The dry and wet thermometers are erected upon thin, narrow, curved strips of brass attached at each end to the ends of the thermometer plate and fastened at the middle to the cross bar of the shelter. This curved

support permits the thermometer to be placed about 3 inches away from the cross-bar in the shelter, thus preventing the temperature of the thermometer from being affected by contact with the cross-bar, and also facilitating free circulation of air about the thermometers.

For information as to the time of reading and manner of recording the station standard thermometer see instructions in Original Record, Monthly Meteorological Report, Annual Meteorological Summary, and the Signal Service Weather Code.

See pages.....

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See Signal Office General Orders.....

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NOTE.—These instructions will be kept complete to date by entering in the blank lines of the proper clause the numbers and series of all orders which in any manner modify them.

WET THERMOMETER.

The proper exposure and observation of the *wet* thermometer require more than ordinary attention. The position assigned to this instrument in the shelter, that farthest removed from the influence of external heat, the detailed instructions concerning the application of the bulb covering, the wetting of the bulb with selected water, and the subsequent tests for a proper reading, all indicate the care considered necessary to be exercised in using the instrument.

Muslin and wicking for thermometers, how applied.—The bulb of the wet thermometer and at least half an inch of the stem above it will be covered with thin muslin, fastened to the stem just above the bulb. A small tube composed of cotton wicking will extend from a cup of water to the stem of the thermometer just above the bulb. About 1 inch of the end of the wicking will be divided lengthwise and passed half on each side of the stem outside of the muslin, and fastened together. The wicking will then be in contact with the muslin, and water will freely pass through the wicking and wet the muslin. Under no circumstances will the wicking be allowed to cover the bulb, for there should be nothing touching the bulb but the muslin.

The muslin must be thoroughly washed in hot water before it is put on the bulb, to remove the starch usually found in it. The muslin is best applied to thermometers with spherical bulbs by placing the finger in the center of the circular piece of muslin, and by gentle traction on the ends of a thread on the margin, form a small bag; slip this bag over the bulb and tie securely, taking care that the muslin is firmly and smoothly applied.

For cylindrical bulbs, cut the muslin to a rectangular shape, in length about three-quarters of an inch greater than the length of the bulb, and in width a trifle greater than its circumference, so that, when wrapped about, it will cover the bulb completely; overlap the edges only

enough to insure perfect covering. After cutting, wet the cover and attach it smoothly and tightly to the bulb, making sure that it is covered completely with one thickness of cloth. While the cloth is wet tie it tightly, both above and below the bulb, with fine thread. Should it be found that the cover has become loose or does not completely cover the bulb, the thread may be wound around the bulb and tied securely.

Observers when making requests for hygrometer linens will state the kind of thermometer (round or cylindrical) for which the same are intended.

The muslin on the bulb must always be kept perfectly clean, and to this end must be replaced when necessary. A slight coating of any foreign substance on the muslin seriously retards free evaporation and conduction.

If the muslin becomes dry, then wet the wicking freely by direct application of a few drops of water.

Keep the cistern well supplied with pure distilled water, or rain water, when the temperature of the air is above the freezing-point.

Wet thermometers, how read when the temperature is below freezing.—When the temperature of the wet thermometer is below the freezing-point the following rules will be observed:

Remove the cup of water from its position in the shelter, and keep it full of cold water, as near the temperature of freezing as possible. The wicking need not be removed from the thermometer, but its free end should be passed over the brass support behind the thermometer, leaving the bulb with its muslin cover as before.

At least half an hour before the time for making an observation bring the cup of water underneath the thermometer, and wet the muslin by lifting the cup until the muslin cover is completely immersed, then quickly lower it; the drop which will gather on the bottom of the bulb should be removed by touching it with the edge of the cup. In order to secure a film of ice over the whole bulb, so thick that it will not be wholly evaporated before the time of observation, it may be necessary to repeat the wetting once or twice, especially if there is a high wind.

In case the bulb has *already a thin coating of ice* left from the preceding observation, the wetting should be wholly *omitted.* The aim is to have a thin ice film upon the bulb for a sufficient length of time before the observation, to insure that the thermometer has fallen to its lowest point, and is stationary at the time for making the observation.

It may sometimes happen, especially when the air is stagnant and the temperature is near the freezing-point, that the water takes more than an hour to freeze, and the mercury remains at the freezing-point of water instead of sinking to the temperature of evaporating ice. The freezing in this case may be accelerated by fanning the bulb, but if the thermometers are exposed in window shelters, great care should be taken to ward off the effects of the warm air of the room, and the reading should made after keeping the window shut at least ten minutes.

When a thaw occurs, care must be taken that the ice formerly on the bulb has been wholly melted and a water film substituted; at such times the covered bulb and its attached wicking should be immersed in warm water to melt the ice, at least an hour before an observation is to be made.

Wet thermometer reading higher than dry.—If the wet thermometer at any time is found to read higher than the dry, notwithstanding all precautions, examine the latter, wipe it, and make sure that its bulb is perfectly clean and dry, then observe whether the muslin cover of the wet bulb is clean and properly moistened on all

sides; if out of order, a new cover should be put on, and strict attention given to the preceding rules. If the wet thermometer still reads higher, place an extra wet thermometer beside it, make comparative readings, and forward them to the Chief Signal Officer without delay. During foggy weather it may sometimes happen that the wet thermometer will read higher than the dry. In all cases record the exact reading of the instrument, but if it reads higher than the dry, record the latter as the temperature of the dew-point, and the relative humidity as 100, with an explanatory note on the margin of the Original Record.

Observers will note carefully the above instructions, and if difficulty is experienced in making the readings in cold weather they will forward to the Chief Signal Officer a statement of the difficulty.

As the humidity of the air forms an important element in all calculations of atmospheric changes, especial care must be taken to keep the muslin covering clean and properly moistened, and to make the observations and deductions accurately.

In perfect saturation the dew-point and temperature agree, but as saturation may not be complete, and hence the dew-point may be lower, observations will be recorded as they are made.

Further information concerning the manner of obtaining the temperature of the dew-point and the relative humidity of the air when the dry and wet thermometers are stationary is to be obtained from the instructions in Original Record, Monthly Meteorological Report, and Annual Meteorological Summary.

See pages .....

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NOTE.—These instructions will be kept complete to date by entering in the blank lines of the proper clause the numbers and series of all orders which in any manner modify them.

WHIRLED PSYCHROMETER.

The temperature of the dew-point obtained by the use of the stationary dry and wet thermometers is not at all times satisfactory, especially when gentle movements of the atmosphere prevail.

When a carefully conducted series of observations is made with these instruments, with the surrounding air artificially disturbed, it is found that the temperature of the dew-point obtained more nearly coincides with the readings of Regnault's condensing hygrometer.

To secure a more perfect ventilation, the dry and wet thermometers are at times mounted upon whirling machines, by means of which the bulbs are made to describe a circle of two or more feet in diameter, and to come in contact with and be affected by a larger amount of the sur-

rounding air than if stationary. This machine with the instruments attached will be known as the *whirled psychrometer*.

Whirled psychrometer, how mounted.—When the whirled psychrometer is used, arrange the instruments in the shelter as shown in Fig. No. 7.

Place on the cross-strip S the maximum and minimum thermometers at such a point that the bulb of the maximum shall not be nearer than 4 inches from the left side of the shelter, with the other conditions the same as described for thermometers in a shelter without the whirled psychrometer.

Place the whirling machine in the space on the right, as shown in the figure, and pass the end of the crank rod out between the base and the lowest slat of the front of the shelter, being careful to select a point where the crank will not interfere with access to the shelter and will be convenient to operate. It may be necessary to cut a portion of the slat to accommodate the crank rod. In locating the machine, see that the thermometers, when in a vertical position with their bulbs down and the iron balls of the machine up, will be half way between the front and rear of the shelter, their scales face to the front; that the right bulb does not in any part of its path approach nearer than 2 inches to the right side of the shelter; and that the maximum thermometer can be set without coming in contact with any part of the machine as long as the thermometers are vertical.

When all adjustments are made fasten the machine to the floor of the shelter by screws, and secure the crank rod where it passes through the shelter by using the staple supplied with the machine.

To use the whirled psychrometer.—Cover the left thermometer bulb with thin muslin, and wet it by bringing up a small cup filled with water, so as to completely immerse the bulb. Turn the crank at the rate of about one hundred times per minute. After turning about thirty seconds read the wet and then the dry thermometer. Repeat these whirls and readings until the minimum reading is obtained. This minimum reading of the wet thermometer and the reading of the dry thermometer obtained at the same time will be the readings to be recorded.

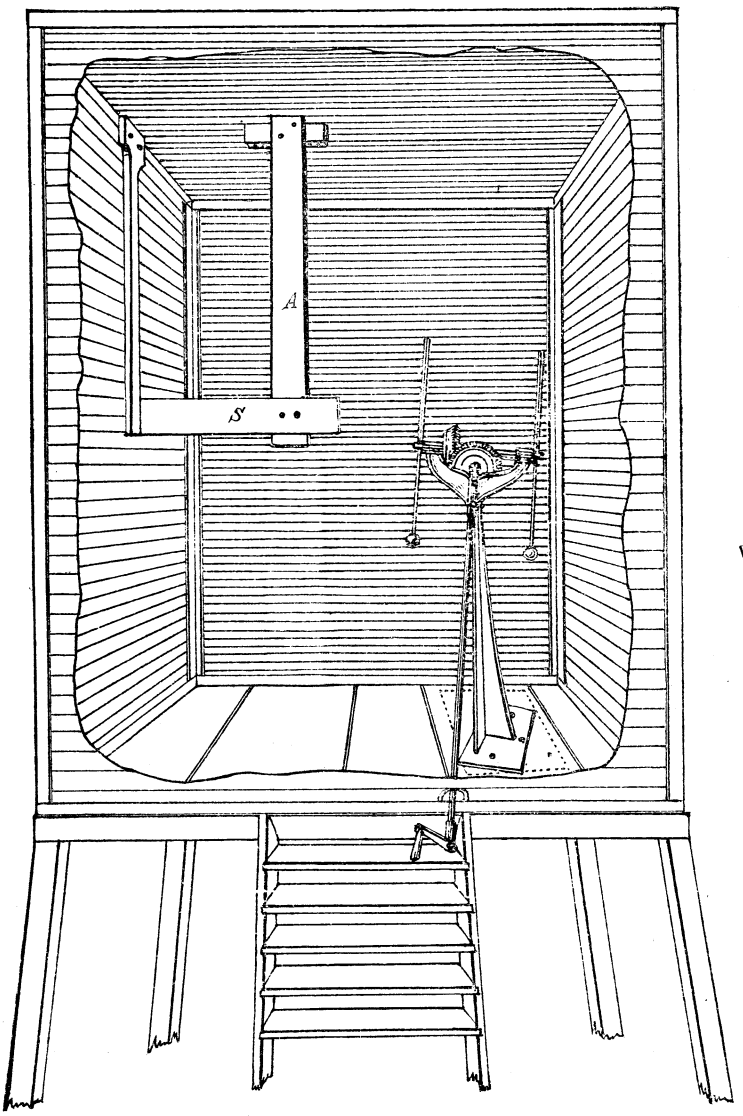
When the temperature is below freezing let the muslin remain on the bulb and wet it by repeated dippings, if necessary, until a thin, uniform coat of ice is obtained, then whirl as previously described.

Be especially careful to obtain the minimum reading when the temperatures are at, and just below, freezing.

The whirling machine will be oiled whenever the bearings appear to need it.

For further information concerning the manner of obtaining the temperature of the dew-point and the relative humidity of the air when the dry and wet thermometers are whirled, see the instructions in Original Record, Monthly Meteorological Report, and Annual Meteorological Summary.

FIG. 7



INSTRUMENT SHELTER WITH WHIRLED PSYCHOMETER IN POSITION.

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See Signal Office General Orders _____

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THE MAXIMUM THERMOMETER.

The maximum thermometer used by the Signal Service is the pattern devised by Negretti & Zambra, of London. It is a mercurial thermometer with its bore nearly closed by a stricture just beyond the bulb. A rise in the temperature of the air forces the mercury in the bulb through this contraction. When the temperature falls the mercury does not return to the bulb, but remains above the contraction, and the top of the column of mercury in the thermometer indicates only the highest temperature that has prevailed since the thermometer was last set.

Exposure of maximum and minimum thermometers.—Maximum and minimum thermometers are usually exposed together upon the same board. This board must be erected in a horizontal position to the cross-arm of the shelter, as shown in Fig. No. 6.

Maximum thermometer, how mounted.—For the support of the maximum thermometer, the long brass swing-pin, with a nut, must be screwed into the board, in the hole to the extreme right. The nut must be taken off and the pin slipped through the hole in the upper end of the instrument, and then secured by replacing the nut and screwing it tightly. The plain brass set pin must then be inserted in the hole on the left of the board, and the thermometer placed upon it so as to incline one inch in its length. The end of the swing-pin must be occasionally oiled to prevent friction.

Maximum thermometer, how read.—The maximum thermometer is read by observing the number of degrees on the *scale at the top of the column of mercury.*

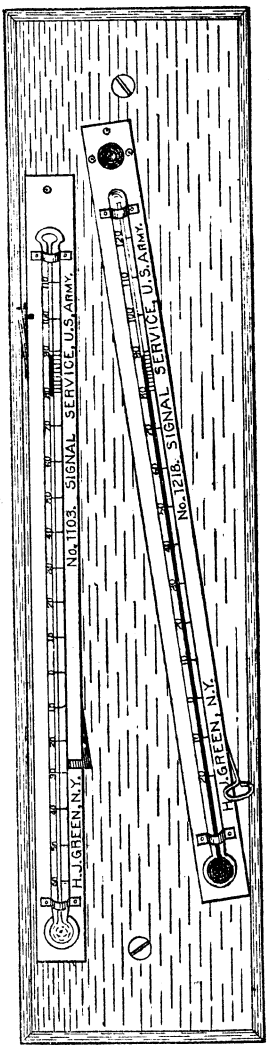
To reset maximum thermometer.—To reset the maximum thermometer remove the set-pin, take hold of the thermometer about 3 inches from the top, and spin it around several times until the top of the column of mercury indicates the same temperature as the dry thermometer.

The bulb of the thermometer should not be touched with the hand, as the increase of heat will prevent the mercury from coinciding with the current temperature. Before swinging the thermometer see that the nut on the support screw is tight, so as to prevent the instrument from deviating from its plane of revolution and striking some neighboring instrument. After swinging, slowly raise the instrument to its proper position and insert the set-pin.

After resetting the maximum and minimum thermometers, the top of the column of the maximum, the minimum, and the dry thermometer should all indicate the same temperature after their corrections are applied.

Figure No. 8 represents the maximum and minimum thermometers just after they have been set. It will be seen that the top of the mercurial column of the maximum indicates a reading of 89°. The top of the alcohol column, and the *top of the index* of the minimum show the same reading, 89°. This indicates that the two instruments have been properly set.

FIG. 8.



For further information concerning the manner of recording, reporting, and the time of reading the maximum thermometer, see instruc-

tions in the Original Record, Monthly Meteorological Report, Annual Meteorological Summary, and Signal Service Weather Code.

See pages .....

See Signal Office General Orders .....

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THE MINIMUM THERMOMETER.

The minimum thermometer devised by Rutherford is the pattern used by the Signal Service for registering the lowest temperature for any one period. It is a spirit thermometer with a small glass rod introduced into the tube. To set the instrument, the end of the rod or index farthest from the bulb is brought in contact with the top of the spirit column, and the thermometer placed in a horizontal position. When the temperature decreases and the top of the spirit column moves towards the bulb the index is drawn with it. After the top of the spirit column ceases to move towards the bulb, on account of the lowest temperature having been reached, and begins to ascend the tube again, the fluid does not disturb the index in the tube, but flows beyond and leaves it at the point of lowest temperature that has occurred since the index was set.

Minimum thermometer, how mounted.—The minimum thermometer is fastened to a long, thin, narrow piece of curved brass. This piece of brass is attached at its center by two screws to a board upon which the maximum thermometer is located. The brass support is placed upon the board so as to bring the notched end about 3 inches above the maximum thermometer and then fastened in the middle by one of the screws. The upper end of the thermometer scale is attached to the brass support by a milled-head screw, and the lower end of the scale is laid in the notch of the brass support. The thermometer is then carefully leveled to a position exactly horizontal and the second center screw is then inserted to firmly fasten the brass support to the board.

Minimum thermometer, how reset.—To set the minimum thermometer, raise it to a vertical position. This will cause the index to move towards the upper end of the spirit column until the end of the index exactly coincides with the top of the spirit column. Then lower the bulb until the thermometer rests in the notch in its proper horizontal position.

To read the minimum thermometer, ascertain by inspection the nearest tenth of a degree on the scale coinciding with the end of the index farthest from the bulb. This will be the lowest temperature which has occurred since the instrument was last set.

Sometimes the jarring of the shelter during high wind tends to displace the index.

Minimum thermometer to be compared with dry thermometer.—Before putting up a minimum thermometer compare it with the station standard, or dry thermometer, to determine whether the top of the alcohol column agrees with the readings of the standard thermometer. If any alcohol is found at the top of the tube, or the column is broken by air specks, the column may be united in the following manner:

To re-unite the alcohol column when detached.—To reunite the alcohol when the detached portion is only a few degrees in length, the most convenient way is to take the thermometer in one hand, hold it vertically, with the bulb down, and strike the brass edge sharply against a block of wood held in the other. A continued jarring in this way soon causes the alcohol to run down. The larger the bore of the thermometer the better this method succeeds, but it can be made to work even in the case of very small-bore thermometers.

Another and better method of uniting the detached column is to heat the bulb in warm water until the column is driven into the enlargement at the top of the tube and the main column joins it. The thermometer, placed in a vertical position, is then allowed to cool.

When a large portion of the column of alcohol is detached and the thermometer is heated, it sometimes occurs that before joining the alcohol in the enlargement a separation will take place in the main column of the alcohol, or that bubbles will form in the bulb. The best way to overcome this is to swing the thermometer. For this purpose a loop of several strands of copper wire should be made in the eye at the top of the brass scale, and to this a stout cord should be fastened. If the cord is fastened directly to the eye of the scale, without the loop, the process of whirling may cut it, and the thermometer is apt to fly off and break. The length of the cord from the loop to the hand should be about 18 inches. To make the column join in a thermometer with a narrow bore it must, in some cases, be whirled with great rapidity. The detached column works down gradually as the whirling is continued. In case of very refractory thermometers, instead of a continued uniform velocity of rotation it is sometimes found that the column runs down more readily to whirl by jerks, so that the thermometer has a very high velocity for only a part of a revolution.

Sometimes in joining a detached column, in order to save trouble in fitting on the cord or heating water, the thermometer is taken in the hand about the middle of the scale and swung in an arc of a circle. To swing a narrow-bore thermometer in this way with sufficient force to drive down the alcohol, it must not be grasped so firmly that there is danger of breaking the stem.

Where stations are supplied with whirling apparatus the reunion of the alcohol can be best accomplished by whirling the thermometers on it. For this purpose the dry and wet thermometers should be taken off.

For further information concerning the time of reading and the manner of recording the minimum thermometer, see instructions in Original Record, Monthly Meteorological Report, Annual Meteorological Summary, and Signal Service Weather Code.

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WATER TEMPERATURE THERMOMETERS.

The apparatus for ascertaining the temperature of the water consists of a small thermometer inclosed in a cylindrical case. A portion of the case is hinged so as to be opened when it is desired to read the thermometer. A valve at the bottom of the case admits the water as it sinks to the bottom of the river or lake, and, falling into place when the case is drawn up, prevents the water from escaping.

A dock or bridge over water that approximately represents the mean temperature of the surrounding water should be selected from which to take the observations; hence the mouths of sewers and other objectionable localities liable to affect the temperature should be avoided.

Observations with the water thermometer, how taken.—To take an observation with the water thermometer: (1) read the dry thermometer in the shelter; (2) immerse the case in the water until the top is just covered and keep it thus immersed long enough to allow the thermometer to attain the temperature of the water—usually about two minutes—when it will be quickly drawn up, the door opened, and the reading taken; this will be recorded as the surface temperature; (3) the case will be emptied by raising the lower valve with the finger, and then the thermometer will be lowered to the bottom of the water and allowed to remain there at least two minutes, quickly withdrawn, and the reading recorded as the temperature "at bottom." The water must not be emptied from the case until after the reading has been taken. If, on raising the case from the water, the lower valve allows the water to escape, repeat the observation, as the reading must be taken with the thermometer bulb surrounded by water in the case.

The thermometer will be thoroughly dried after each observation.

Deposits of dust on thermometers.—Deposits of dust or smoke upon the thermometers will be removed whenever observed, as any foreign substance reduces the sensitiveness of the instruments. These deposits may be removed without taking down the thermometers by use of clean water and a stiff brush. In such cases care must be exercised not to disturb the readings of the registering thermometers. The shelter must at all times be kept clear of snow.

Etchings on thermometers, how replaced.—When a thermometer is wetted repeatedly, or put in alcohol or ether, the marks in the etchings become very indistinct. To replace the marking, artists' black pigment is used, which will be furnished upon application. This substance must be rubbed on the thermometer when the tube is quite dry. The tube should then be wiped to remove all the pigment not in the marks.

To resilver tarnished thermometer scales.—Clean the scale with emery paper; moisten a small quantity of the silver with water, and

gently rub it over the scale with a piece of chamois skin until the scale assumes a silvery hue; wash the scale in cold water, and, after it is dry, polish with whiting and a piece of dry rag or chamois skin.

The silvering will be kept in a dark place, and not exposed to the light for a longer period than absolutely necessary.

Packing thermometers.—In packing thermometers for transportation, wrap them with sheet cotton and place them in a paper box; surround the whole with excelsior, or other soft substance, before depositing in the wooden box in which they are to be transported, and, to prevent shifting, fill all spaces with cotton. The lids of all boxes should be secured with screws, as the jarring resulting from driving nails into the wood is liable to break the thermometers.

Instruments received from postmasters to be examined.—Observers, or their assistants, receiving instruments from postmasters or employés of the Post-Office Department, must thoroughly examine each instrument before receipting for it, and state distinctly on the receipt, over their own signatures, whether it is received in good condition, or, if damaged, the nature of the damage.

To convert a temperature in Fahrenheit's scale to the corresponding Centigrade or Reaumur, and the Converse.—The following rules will be used to convert a thermometer reading of one system to that of another.

The Fahrenheit, the Centigrade, and the Reaumur are the thermometric systems in general use.

(1) Fahrenheit to Centigrade: Subtract 32 and multiply the remainder by $\frac{5}{9}$.

(2) Fahrenhit to Reaumur: Subtract 32 and multiply the remainder by $\frac{4}{9}$.

(3) Centigrade to Fahrenheit: Multiply by $\frac{9}{5}$ and add 32.

(4) Centigrade to Reaumur: Multiply by $\frac{4}{5}$.

(5) Reaumur to Fahrenheit: Multiply by $\frac{9}{4}$ and add 32.

(6) Reaumur to Centigrade: Multiply by $\frac{5}{4}$.

The table, Appendix No. 3, will give the figures by inspection.

WIND DIRECTION.

The movement of the atmosphere on the surface of the earth is subject to well-known general laws, but in many localities these laws are modified and often entirely reversed by local conditions. A thorough understanding of these laws and their modifications, used in connection with the current condition of air movements and kindred phenomena, enables the student to anticipate the probable direction of the surface winds a number of hours in advance.

The direction of movement of the air at 1,000 feet or more above the earth is affected less by the topography of the earth's surface than the winds on the surface, and are, therefore, much more valuable for study. It is only practicable to obtain the direction of movement of this upper air by observing the direction of cloud movements.

The direction of movement of the surface air is generally obtained, on land, by use of the wind-vane.

WIND-VANE AND SUPPORT.

Description of standard wind-vane.—The various parts of the standard vane of the Signal Service are represented in plates Nos. I and II.

Plate III shows the wind-vane and support in position.

The complete vane consists of the following parts:

Figs. 1 and 2 show the support;

PLATE I.

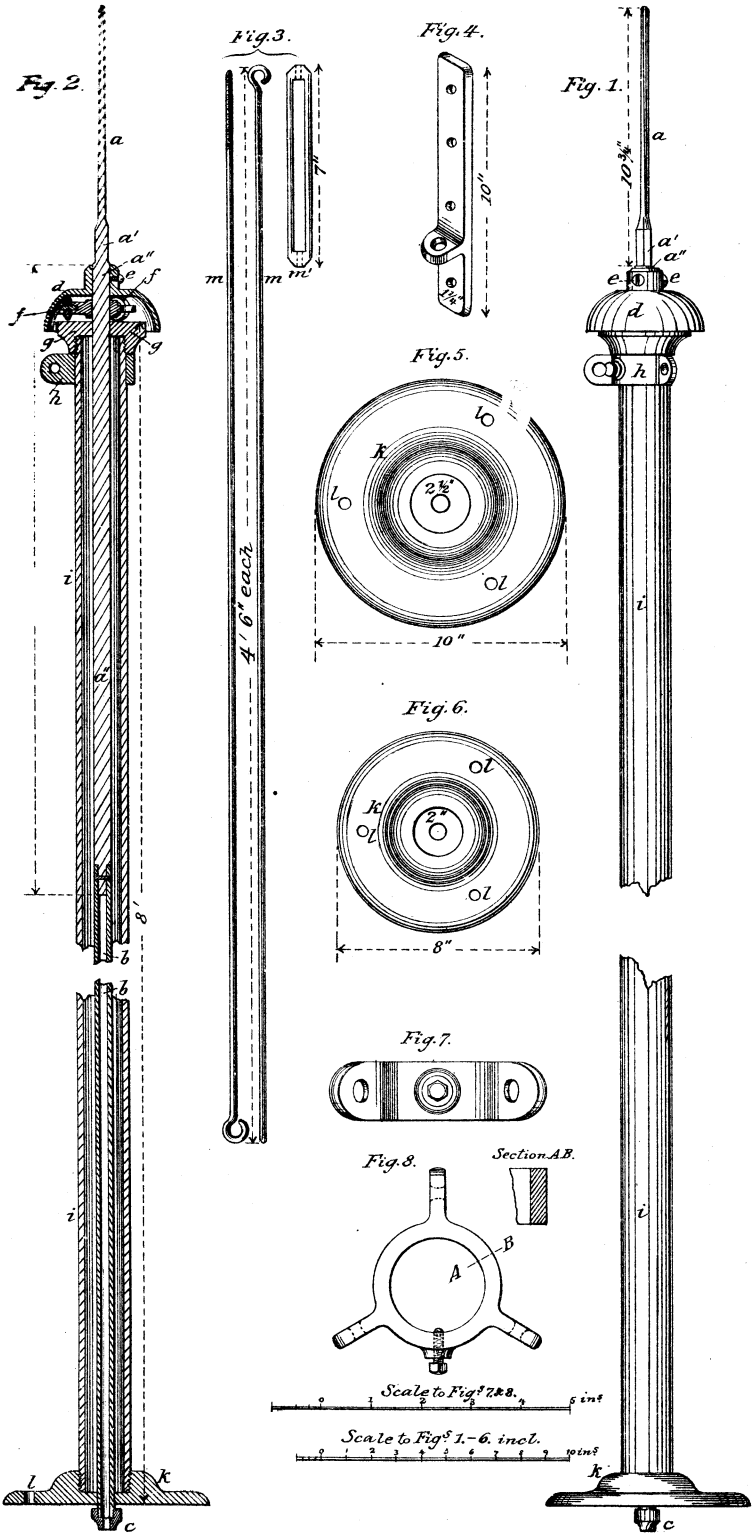


Fig. 2.
a
a'
a''
e
f
d
f
g
g
h
i
8'
b
b
i
l
k
c
Fig. 3.
m
m'
7"
4' 6" each
Fig. 4.
10"
1½"
Fig. 5.
l
k
2½"
l
l
10"
Fig. 6.
l
k
2"
l
l
8"
Fig. 7.
Fig. 8.
Section A.B.
B
A
Scale to Figs 7 & 8.
0 1 2 3 4 5 ins
Scale to Figs 1.-6. incl.
0 1 2 3 4 5 6 7 8 9 10 ins
Fig. 1.
10¾"
a
a'
a''
e
e
d
h
i
i
k
c

PLATE II.

Fig. 9.

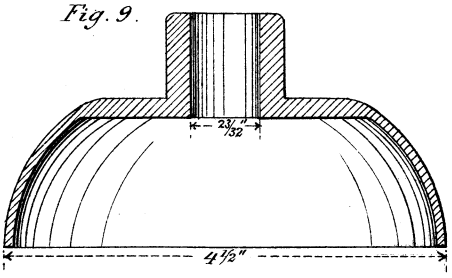
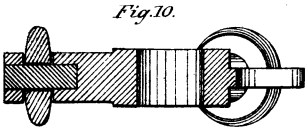
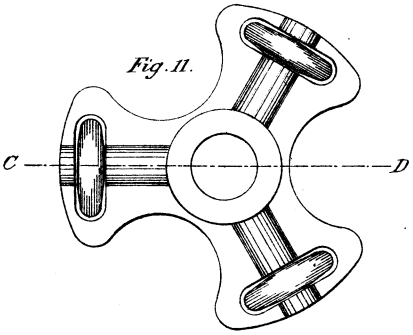


Fig. 10.



Section through C-D in Fig. 11.

Fig. 11.



Scale to Figs. 9 – 12.

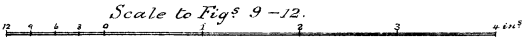


Fig. 12.

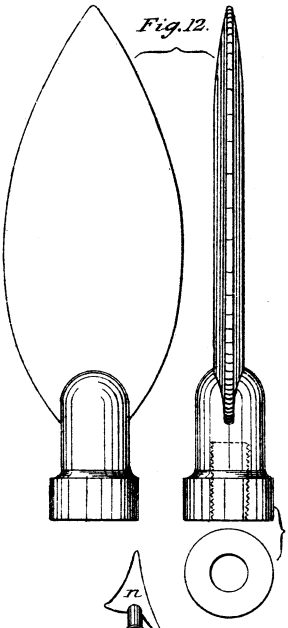


Fig. 13.

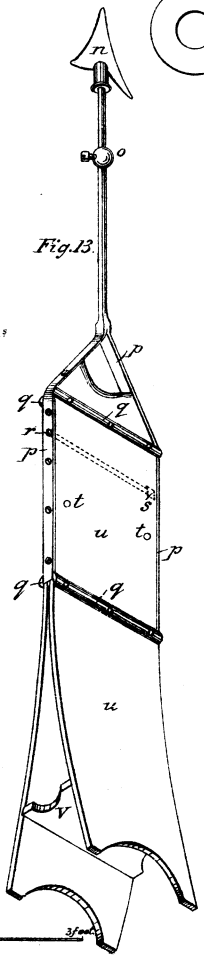
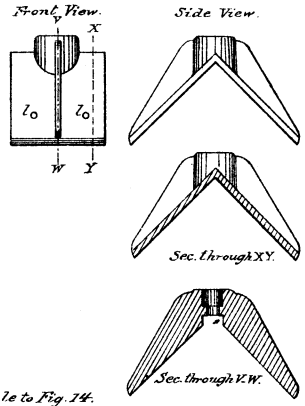
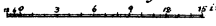


Fig. 14.



Scale to Fig. 14.



Scale to Fig. 13.

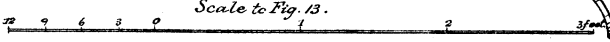
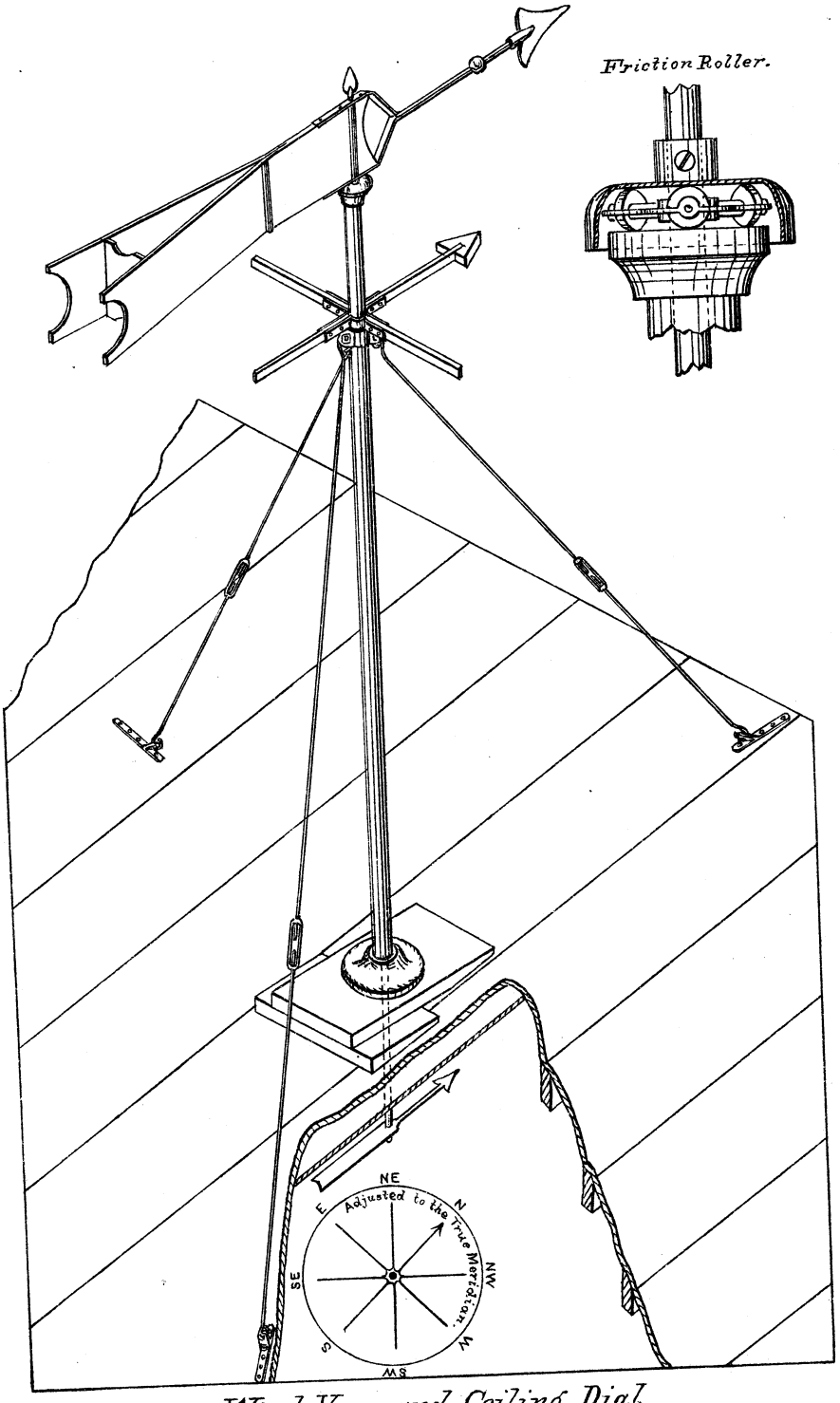


PLATE III.



Wind Vane and Ceiling Dial.

Fig. 3, stays, with swivels;
Fig. 13, vane; and Fig. 12, spear-head nut.

In Figs. 1 and 2, *k* represents a cast-iron base, secured to the 1½-inch pipe *i* by means of a screw-thread; the base has a hole in its center, $\frac{23}{32}$-inch in diameter, and three screw-holes, *l l l*, for ⅜-inch lag-screws, in its rim, as shown in Fig. 6.

In Fig. 2, *g* represents a cast-iron cap, with hole $\frac{23}{32}$-inch in its center, and which is secured to pipe *i* by means of a screw-thread. The upper face of the cap should be nicely turned and free of sand holes; below this cap the malleable-iron ring, *h*, Figs. 1 and 2, with its three ears for attaching stays, is secured to the pipe *i* by means of a set-screw. (Figs. 7 and 8 give size and details of this ring.)

The rod *a''*, which passes through cap *g*, pipe *i*, and base *k*, as shown in Figs. 1 and 2, is made up of two parts; the lower, of ⅜-inch gas pipe, is securely joined to the upper, of $\frac{11}{16}$-inch round iron. At *a'* the rod is made square, $\frac{7}{16}$ by $\frac{7}{16}$ inch, for a distance of 2 inches, to fit the square aperture of vane, shown at *s*, Fig. 13; from that point the rod is rounded to a diameter of ⅜-inch, and screw-threaded at the end to fit the spear-head nut. The lower end of rod has a reducer, ⅜ to ¼ inch, attached, as shown at *c* in Figs. 1 and 2.

Attached to the rod by means of two set-screws, *e e*, is a bell-shaped brass cap, *d*, shown in Figs. 1 and 2. The inside face of this bell is nicely turned to a distance of 3 inches. (Fig. 9 gives full size and section.) Between the cap *g* and bell-shaped cap *d*, the frame, shown in Fig. 11, carrying three anti-friction rollers, is placed, as shown at *f*, Fig. 2. The frame and rollers are of brass, and the hole in the center is of such dimensions that it will allow the frame to revolve freely around the rod *a''*; friction rollers nicely turned, of uniform diameter, and fitted, as shown in Figs. 10 and 11.

Each support is accompanied by three wrought-iron stays (Fig. 3), of ⅜-inch round iron, 9 feet 6 inches long, with eyes, bent at both ends for the purpose of attaching them to the malleable-iron ring *h*, and wrought-iron shoe (Fig. 4); three wrought-iron turn-buckles (Fig. 3), and three wrought-iron shoes, with four screw holes, for No. 16 flat-head wood-screws, and dimensions as shown in Fig. 4.

The vane, Fig. 13, is made of select spruce pine, well-seasoned, and free of knots, 10 inches wide and 1 inch thick, and of length shown. The tail to be spread for the distance of 2 feet, and held apart by the board, marked *v*, ½ inch thick and 5½ inches wide, securely glued and sprigged to the tail boards; thickness of tail boards to be ¼ inch; half-round iron strips are riveted to each side of the vane, as shown by *q q q q;* additional copper rivets and burs are placed at the points *t t* to prevent splitting.

The edges of vane are banded with flat iron, 1 by ¼ inch, welded to a round bar ½ inch in diameter, as shown at *p;* to this rod the arrow-head *n* and sliding ball *o* are attached; the ball *o* is supplied with a set-screw. The iron bands on edges of vane are let into the wood sufficiently to bring them flush with the tail of the vane, and securely fastened by wood-screws. A hole, ⅜ inch in diameter, is drilled through the iron bands *p* and wooden part *u*, squared at *s* to fit the part of vane marked *a'*, Figs. 1 and 2.

The length of the rod to which the arrow-head and counterpoise are attached depends upon the weight of wood used in making the vane, and can only be ascertained after the vane is nearly completed, since the vane, when finished, must balance when pivoted through the aper-

ture *r* and *s*, Fig. 13. When the vane balances, the counterpoise should be about 6 inches from arrow-head to allow for adjustment.

Extra base plates.—Fig. 5, Plate I, shows an extra base plate for extending support.

The plate has a hole $\frac{2}{3}\frac{3}{2}$-inch in diameter in the center, and screw-threaded socket for 2-inch pipe, constructed similar to the socket holding $1\frac{1}{2}$-inch pipe in base *k*, Fig. 2. Holes are drilled for $\frac{3}{8}$-inch lag-screws, as indicated by *l l l*.

Fig. 14, Plate II, is a cast-iron angular base plate, with a $\frac{2}{3}\frac{3}{2}$ inch hole in the center, and screw-threaded socket to hold 2-inch pipe, same as described in Fig. 5; two holes for $\frac{3}{8}$-inch lag-screws are drilled in each of the ridge plates, as indicated by *l l*.

The vane, when completed, is 6 feet in length, and is painted black. A vane 12 feet long is sometimes used where it can be exposed to advantage. In a number of instances the length of the vane has been changed to meet exceptional cases.

The vane will be placed in position under the supervision of the observer, who will see that the work is well executed and that the roof is properly repaired if damaged.

The vane-rod will not be extended to the office ceiling except when it will not be an additional expense.

For satisfactory results in moderately strong winds and for convenience of access the vane should be located upon the roof of office.

Observations of the wind in this service are confined entirely to the horizontal direction.

When the vane extends to the office ceiling the circle about the index will be 3 feet in diameter, and have letters not less than 3 inches in height representing the eight principal points of the compass. The index is set with the vane, and observations of the wind direction can be made by observing the position of the index. The following legend will be painted within the circle, viz: "Adjusted to the true meridian." (See Plate III.) This circle will be furnished from the office of the Chief Signal Officer.

To locate true meridian.—To locate the north and south points of the true meridian, suspend a plumb-line from the center of the lower end of the vane-rod to within 2 inches of the floor. Place the center of a compass under the plumb bob and adjust it to the magnetic declination of the station. If the magnetic declination is given as *east* a certain number of degrees, turn the compass until the north end of the needle reads that many degrees *east* of the N. point on the face of the compass. If it is *west*, turn the compass until the needle reads the given number of degrees *west* of the N. point. Draw a line through the north and south points of the compass a little longer than the diameter of the index circle. Suspend a plumb-bob from the index circle at two points exactly over the above described north and south line. Mark these points on the index circle as the true north and south points.

In an iron building the compass cannot be used, but the north and south line can be determined by reference to the north star.

Points of compass used in recording wind direction.—The eight principal points of the compass will be used in recording the direction of the wind, viz: N., NE., E., SE., S., SW., W., and NW. When there is not enough air in motion to move the anemometer cups the wind direction will be recorded by the figure (0) zero.

The wind direction to be recorded is that towards which the head of the vane points.

Wind-vane, observations of.—Before making an observation of the vane observers will be careful to note whether the air is in motion, which can be done by glancing at the anemometer cups.

The observations of the vane require more care than is usually given. In winds of considerable strength the vane is never at rest or fixed in the same direction; and its oscillations increase in extent with certain winds and with the violence of the wind. In such cases observers must *note the mean direction* between the extremes.

The bearings of the vane will be oiled once a week and the fact noted in the daily journal.

Veering and backing of wind explained.—In noting changes in the *direction* of the wind, the terms *veering* and *backing* will be used. In the northern hemisphere the term *veering* indicates the changing of the wind from N. to E. to S., and so on, or in the direction corresponding with the movements of the hands of a watch; while *backing*, being the reverse term, indicates that it changes from N. to W. and S., and so on.

To obtain a continuous wind direction record, additional mechanism for connection with the vane is necessary.

Directions for setting up the anemograph.—Fig. 9 shows the position of the contact when the vane-rod passes through the roof to the ceiling of the office.

Fig. 10 shows the position of the contact and of the friction rollers when inclosed in a cast-iron base on the roof of a building. It also shows the courses of the different circuits from the anemometer and anemoscope through the registering attachment to the battery.

To place the contact in position, as shown in Fig. 9, the vane-rod must be placed so as to extend from $3\frac{1}{2}$ to 4 inches below the ceiling, and the following directions be carefully observed:

1st. Fasten the circuit-closer *c*, *c*, *c*, *c* (Fig. 9) to the vane-rod, with the set screws close to the ceiling, and then pass the end of the rod through the aperture in the lower side of brass support, B, B (Fig. 9), which must be securely fastened to the ceiling.

2d. Screw the brass plate A, A, with which the four contact springs N, E, S, W are connected, to the support B, B (Fig. 9) in such a manner that the contact springs will be parallel with and opposite to their respective cams on the circuit closer *c*, *c*, *c*, *c*.

3d. Adjust the circuit closer *c*, *c*, *c*, *c* (Fig. 9) by having an assistant hold the wind-vane in a due north direction; loosen the set screws of the circuit-closer *c*, *c*, *c*, *c*, and turn it around until the point of the spring N corresponds with the notch filed in the uppermost cam on the circuit-closer opposite to the spring N. When this has been done, firmly refasten the circuit closer to the vane-rod by means of the set screws.

4th. Before connecting the five-wire cable test it, and mark the wires N, E, S, W, and R, respectively at *both* ends. Remove the covering from the cable, for at least 6 inches, at the end to be connected with the contact, clean the ends of the wires, connect them with the five binding posts at the ends of the springs N, E, S, W (Fig. 9), then fasten the cable to the ceiling and conduct it to the instrument by the most practicable route, where the four wires N, E, S, W will be connected with the binding screws N, E, S, W, shown in Fig. 9. The fifth wire, R, must be connected with one pole of the battery *c*, *c*, *z*, as shown in Fig. 10.

5th. Connect the other pole (*z*) of the battery with the binding screw R. (See Fig. 10.)

6th. When it is desired to work the anemometer circuit with only a part of the battery, the wire from the binding screw *a* on the anemometer is led to any one of the battery cells. (The number of cells to be used will depend upon the length of the anemometer circuit.) The current of all the cells in the battery will, however, be brought into action when the direction circuit is closed, at regular intervals, by means of the clock contact. The other wire, *d*, is led from the anemometer to the binding post V on the recording instrument. (See Fig. 10.)

7th. When all the wires have been properly placed, the arrow or indicator must be screwed to the vane-rod immediately under the lower portion of the brass support B, B (Fig. 9).

Where an office is so located that the vane-rod cannot be passed through the roof to the ceiling, a cast-iron base, B, B, Fig. 10, will be furnished. A suitable wooden block will be firmly fastened to the roof upon which the cast-iron base will be securely attached. The lower end of the pipe P, through which the vane-rod passes, will be placed in the socket in the top of the cast-iron base, and the vane-rod itself, D, passed through the two apertures in the top and bottom of the base B, B, and through the wooden block underneath the base. A hole should be bored in the wooden block of greater diameter than the vane-rod in order to prevent friction. In erecting the vane care must be taken to place it at such an elevation that the vane-rod will not extend too far below the iron base. After the large pipe, P, supporting the vane, is firmly braced to the roof, and before the vane is attached to the rod, the contact-friction rollers, G, must be placed in position. This will be done by raising the vane-rod sufficiently to enable the circuit-closer *c*, *c*, *c*, *c* and friction rollers, G, to be slipped on the lower end of the rod. Lower the rod to its former position so that the upper friction rollers (which are immediately below the vane) will rest upon the cap of the pipe. Then fasten the lower friction rollers, G, to the vane-rod D, so that the weight of the rod will be as equally distributed as possible between the upper and lower friction rollers. Place the circuit closer *c*, *c*, *c*, *c* and plate A, A in position. Pass the cable K (Fig. 10) through the small pipe *f*, and connect the wires in the manner heretofore described.

For further instructions in reference to the manner of recording and reporting wind directions see instructions in Original Record, Monthly Meteorological Report, Annual Meteorological Summary, and Signal Service Weather Code.

See pages _____

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See Signal Office General Orders _____

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Fig. 1.

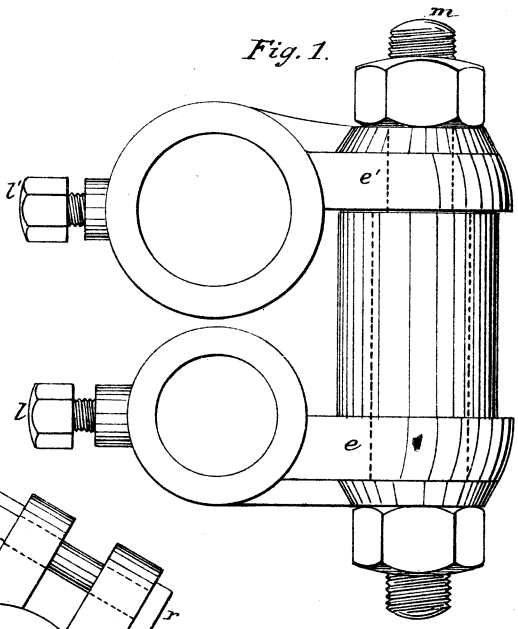


Fig. 2.

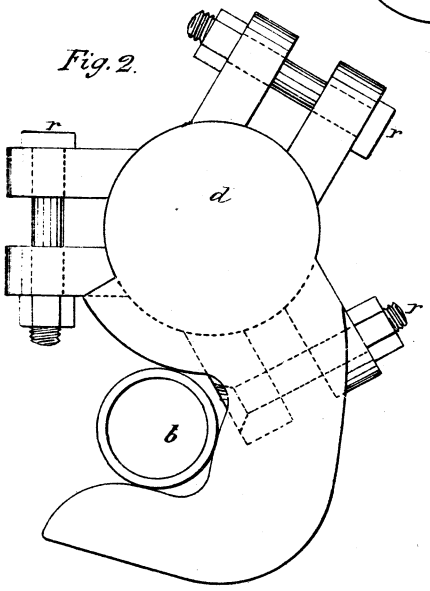


Fig. 3.

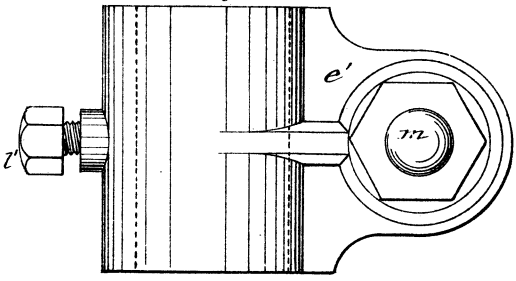


Fig. 5.

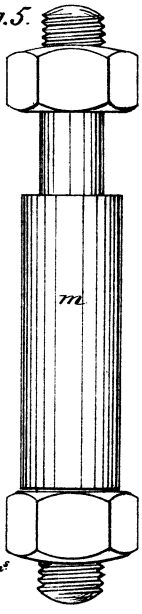
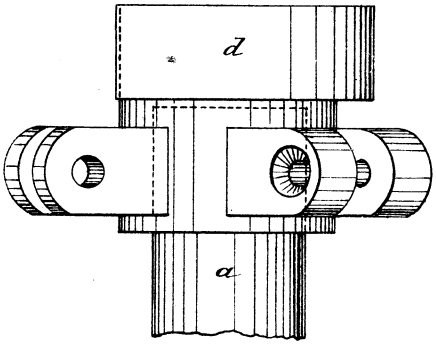


Fig. 4.



Scale.

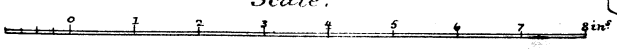


PLATE V.

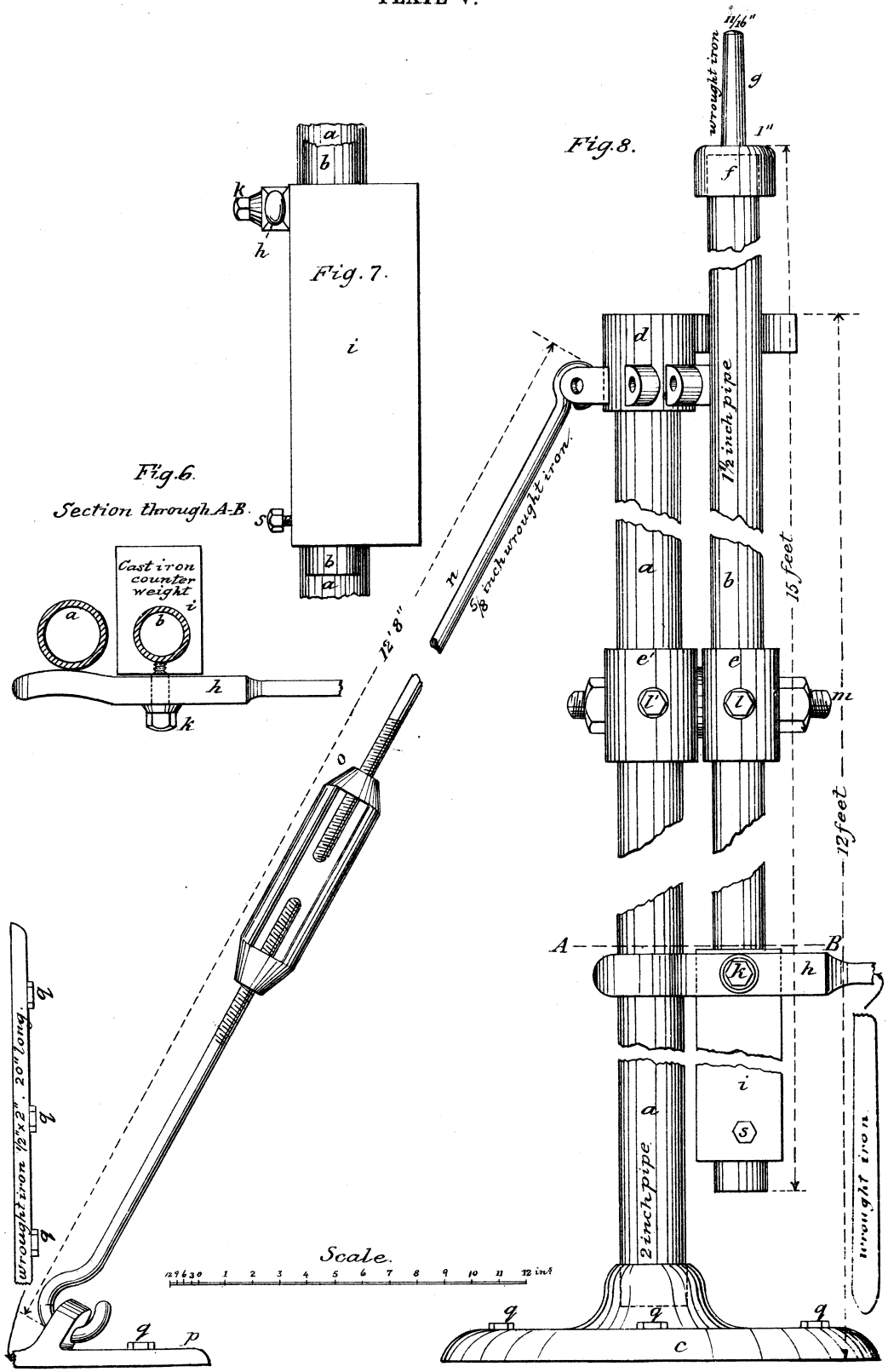


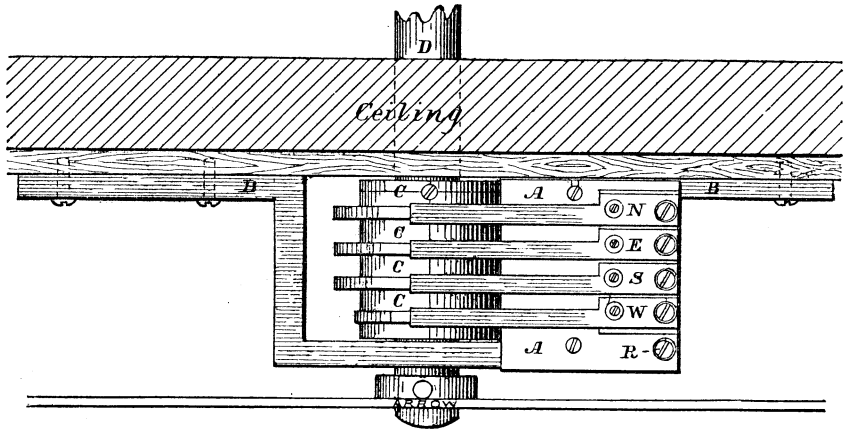
Fig. 8.
11/16"
wrought iron
g
1"
f
d
1½ inch pipe
15 feet
12 feet
a
b
e
e'
l
l'
m
n
⅝ inch wrought iron.
12'8"
A
B
h
i
s
2 inch pipe
wrought iron
c
q
Fig. 7.
k
Fig. 6.
Section through A-B.
Cast iron counter weight
p
o
Scale.
0 1 2 3 4 5 6 7 8 9 10 11 12 inch

The rapidity with which the air moves past any given point on the earth's surface is called the velocity of the air, or wind, at that point, and ranges from an almost imperceptible movement to that of one or more miles per minute.

On account of the friction resulting from the moving air in contact with the surface of the earth, or objects upon the earth, the movement of the air is retarded.

It is estimated that the effect of this friction decreases from 20 to 50 per cent. for the first hundred feet above the earth, and gradually diminishes until it is believed to have but little effect at an elevation of 10,000 feet. To reduce the effect of this friction instruments designed to measure the velocity of the wind should be placed as far above the earth and away from obstructions as practicable.

FIG. 9.



The rapidity with which the air moves upon the earth's surface at the several points of observation has an important bearing upon future meteorological conditions, and careful judgment should be exercised in selecting points of measurement where the influence of surrounding objects is reduced to a minimum and the instrument is supported upon a firm basis and kept in good running order.

Maring anemometer support.—Plates IV and V illustrate the different parts of the Maring anemometer support:

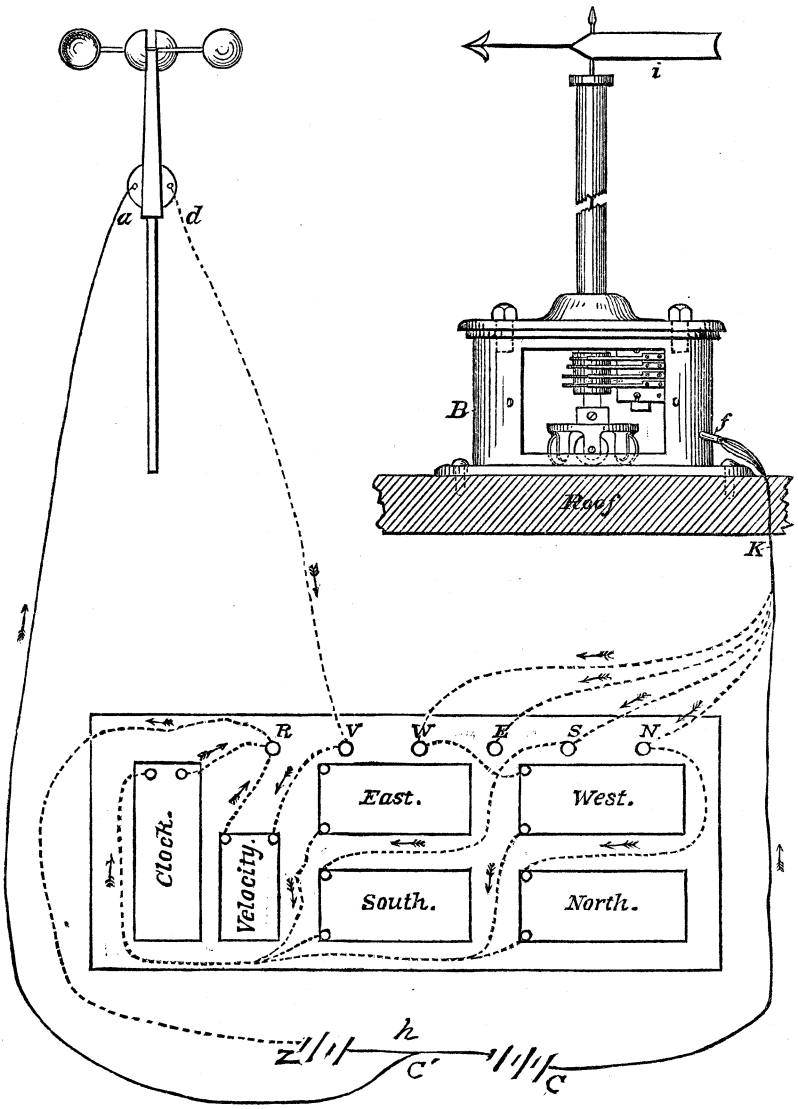
Figs. 1, 2, 3, 4, 5, 6, 7, Plates IV and V, show detail parts of support. Fig. 8 shows support when complete and in position, and consists of parts, as follows: *A*, Fig. 8, is a wrought-iron, 2-inch pipe, 12 feet long, screwed into a circular cast-iron base, C, and on top into a cast-iron cap, *D*, shown in Figs. 2, 4, and 8.

The cast-iron base *C* has four holes drilled into it for ½-inch lag-screws, marked *q*, in Fig. 8.

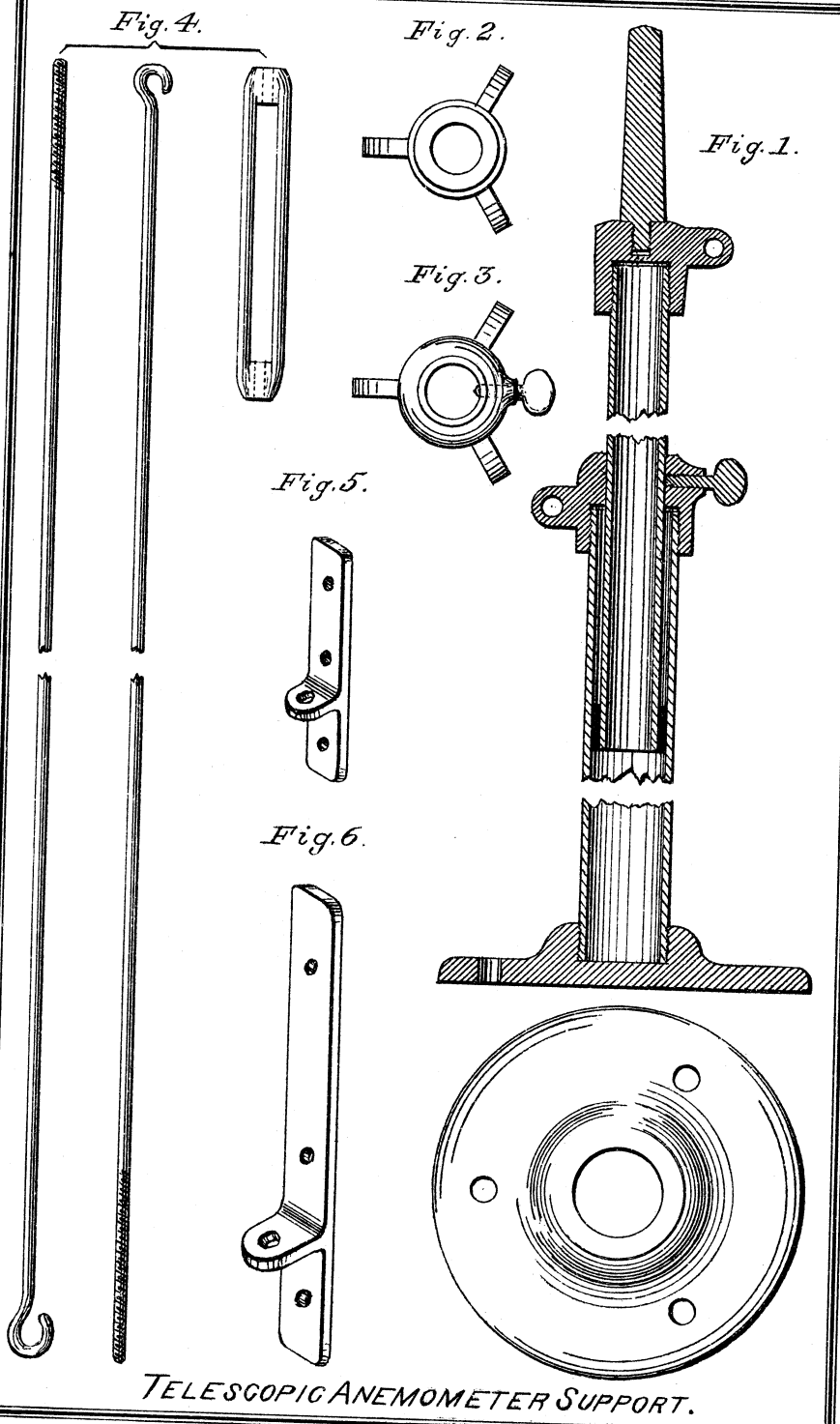
Three wrought-iron guy-rods, ⅝ of an inch round iron, 12 feet 8 inches long, marked *n*, Fig. 8, are attached to cap *d* by means of ½-inch bolts, marked *r*, Fig. 2. The guy-rods to have wrought-iron turn-buckles, *o*, Fig. 8, with right and left thread, for shortening or lengthening. The lower ends of guy-rods are hooked into the wrought-iron shoes *p*, shown

in Fig. 8; four holes are drilled into the shoe for $\frac{3}{8}$-inch lag-screws fo fastening same to roof. *e* and *e'*, shown in Figs. 1, 3, and 8, are cast iron swivel-sockets, the sleeves of same fitting to their respective pipe and held in position by means of set screws, *l l'*; the wrought-iro swivel-bolt *m*, shown in Fig. 5, is firmly attached to the socket *e'*, be tween its shoulder and screw nut; the projecting part of the bolt i accurately turned and fitted into socket *e'* in such a manner that th latter will freely revolve between nut and socket *e'*.

FIG. 10.—Anemometer and anemoscope circuits combined.

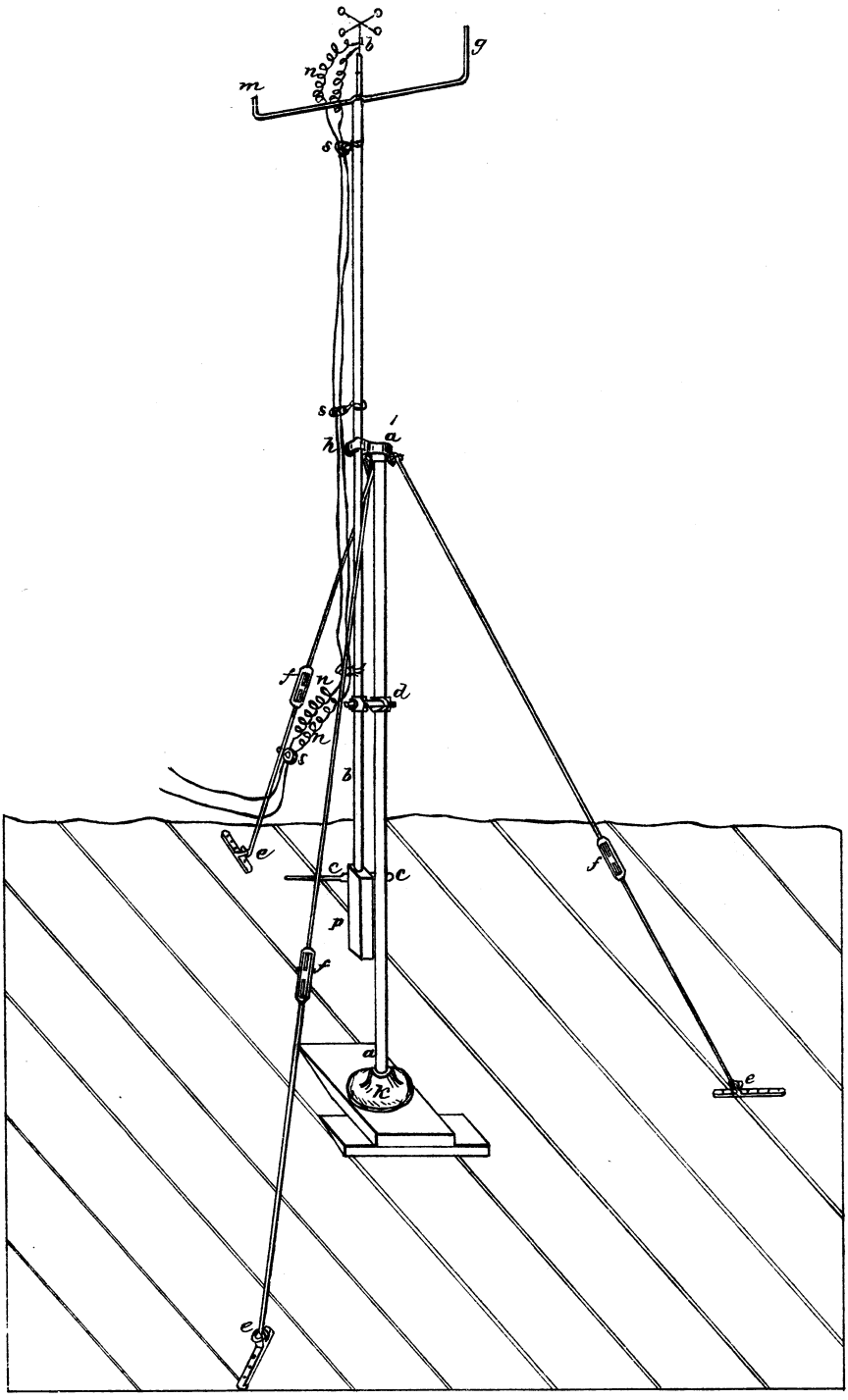


Fitted into sleeve of swivel-socket *e* is a 1½-inch wrought-iron pipe, 15 feet long, to the upper end of which is screwed a cast-iron cap, *f*, Fig.



TELESCOPIC ANEMOMETER SUPPORT.

FIG. 11.



Maring Anemometer Support.

8, to which is fastened a wrought-iron tapered pin, *g*, 4 inches long, 1 inch in diameter at bottom, and $\frac{1}{16}$ of an inch on top.

To the lower end of pipe *b* is attached a counter-weight, *i*, as shown in Figs. 6, 7, 8; the same is secured to pipe by means of set screws *S*; a wrought-iron lever, *h*, Figs. 6, 7, and 8, is fastened to the upper end of counter-weight by means of screw and washer *k*, Figs. 6, 7, and 8, in such a manner that when pipe *b* is brought in position the lever *h* will firmly press and hold the same into the recess of top cap *d* as shown in Fig. 8.

The weight of cast-iron of each support averages about 130 pounds.

Four lag-screws $\frac{1}{2}$ inch in diameter and 2 inches long, and twelve lag-screws $\frac{3}{8}$ of an inch in diameter and $2\frac{1}{2}$ inches long, to be furnished with each support.

Manner of erecting anemometer on Maring support.—Fig. 11 will illustrate the manner of erecting an anemometer upon the Maring support.

This support is so constructed that the anemometer may be lowered to the roof for the purpose of reading or cleaning by unlocking the lower end of the rod *b b* and raising the lever *c c* to a vertical position, thus permitting the rod to swing on the axis *d* and lower the anemometer to the roof. By means of the insulators *s s s* the electric circuit is carried to the anemometer and is not interrupted when the instrument is lowered. The points *m* and *g* are intended for extra anemometers when comparisons are desired.

The vibration of the anemometer support in heavy winds seriously interferes with the free movement of the anemometer; hence care must be taken to see that the socket *h* and the lever *c c* firmly bind the rod *b b* to the rest of the support. The twin screws *f f f* should be examined frequently in order that the guys may be tightened when necessary.

Telescopic anemometer support.—Plate VI shows the different parts of the telescopic anemometer support:

a, in Fig. 2, is a $1\frac{1}{2}$-inch pipe, secured at bottom to cast-iron foot-plate *b*, by means of a screw thread.

To the upper part of the pipe *a* is screwed a brass collar, *c*; the upper part of the latter is bored out to allow the pipe *e* to slide freely in same, the collar to be supplied with a case-hardened set-screw, shown at *d*, for holding pipe *e* in any desired position.

A brass collar *h* is secured to lower part of pipe *e*, the outside of collar to be turned to fit the inside diameter of lower pipe *a* so that it will slide freely.

To the upper part of the pipe *e* is secured the brass cap *f*, having three ears for attaching guy wires.

A tapered iron pipe, shown at *g*, Fig. 2, is screwed through the center of the brass cap *f*, the taper of iron pin to be accurately turned and of dimensions shown.

Three one-fourth inch guy rods, with turnbuckles, shown in Fig. 3, are to be attached to the ears of brass cap *c*, and each guy rod to be supplied with a wrought-iron shoe, shown in Fig. 4. In addition, three shoes shown in Fig. 5 are also to be supplied with each support for attaching guy wires to the ears of upper brass cap *f*.

The supports have two coats of paint—one coat of read lead and one coat of asphaltum.

Three lag-screws for foot-plate and 18 wood screws for wrought-iron shoes are to furnished with each support.

Location of anemometer.—In selecting the location for an anemometer preference should be given to the highest obtainable point in the vicinity of the station. A careful survey should be made by means of a level to determine whether any object in sight is as high as the proposed location, and, if there is, the observer should determine how large an angle the obstruction measures, taking the proposed location as the center of the circle. If the obstruction is 10°, or less, and not nearer than 500 feet, the location may be considered as satisfactory.

Robinson anemometer.—The instrument used by the Signal Service for measuring the velocity of the wind is a modification of the Robinson anemometer, so arranged that it can be easily erected. It offers little surface to obstruct the passage of the wind, and the velocity may be read either directly from the anemometer itself, or the instrument may be connected with an electric register and a continuous record obtained upon prepared forms.

The anemometer should be erected in a vertical position upon a support at least 8 feet above the nearest objects. The support should have a firm foundation and be secured by lateral guys extending from a point just under the anemometer in order to steady it and reduce the vibrations of the instrument.

Anemometer to be oiled each Saturday.—When in use the anemometer will be oiled each Saturday and the fact noted in the daily journal. Clock oil for the purpose will be furnished from the office of the Chief Signal Officer.

Anemometers to be compared.—At stations where two anemometers are supplied, the one not in use will be compared for twenty-four hours with the one in use at the end of every two months and then substituted for the one in use. This exchange will be noted on the monthly report of instruments and in the daily journal.

The instrument last in use will be thoroughly cleaned before being stored. Anemometers must not be taken apart unnecessarily.

Observers must familiarize themselves with the construction of the several parts of the anemometer, in order that they may be able to locate faults whenever the instrument is out of order.

Requisitions for parts of the anemometer, how made.—When any portion of the anemometer becomes unserviceable, immediate requisition must be made upon the Chief Signal Officer for duplicates of the injured parts, designating the parts by characters attached to them, as shown in Plate VII, always giving the official number of the anemometer.

Anemometers to be returned for repairs.—The anemometer which has been the longest in use at second-order stations displaying storm, cautionary, and wind-direction signals, will be returned at the end of every second fiscal year to the office of the Chief Signal Officer, for comparison and repair.

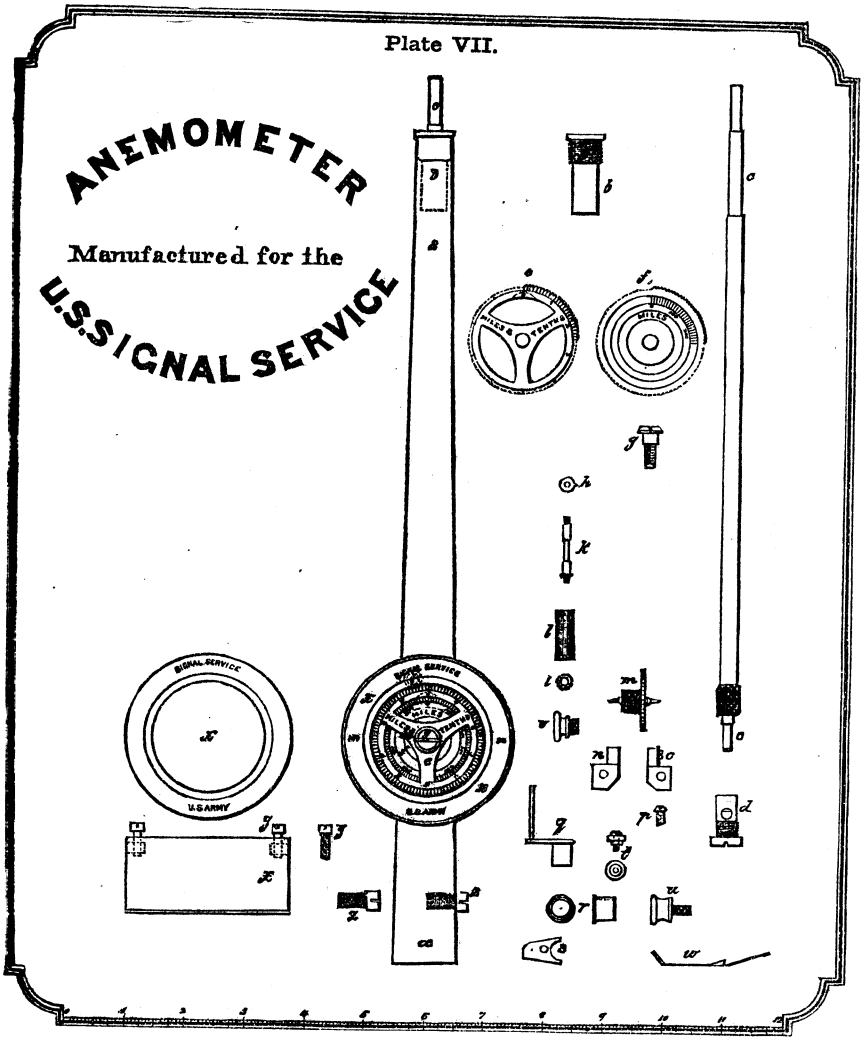
Explanation of anemometer dial.—The movement of the wind may be obtained directly from the anemometer dial for any period not containing more than 990 miles, provided the position of the dial relative to some fixed point is noted at the beginning and at the termination of the period in question.

The dial consists of two graduated wheels, called the outer dial and the inner dial (see Figs. *e* and *f*, Plate VII), and a fixed point or index fastened to the covering of the dial.

In case there is no index, the cog-wheel at the top of the dial (Fig. 12) *will be used as the index of the instrument.*

The outer dial has one hundred and the inner dial ninety-nine divisions. As the dials are moved by the same wheel, they will move forward one hundred divisions in the same time. The outer dial having one hundred divisions, the inner dial will complete one revolution and its zero be one division beyond 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.

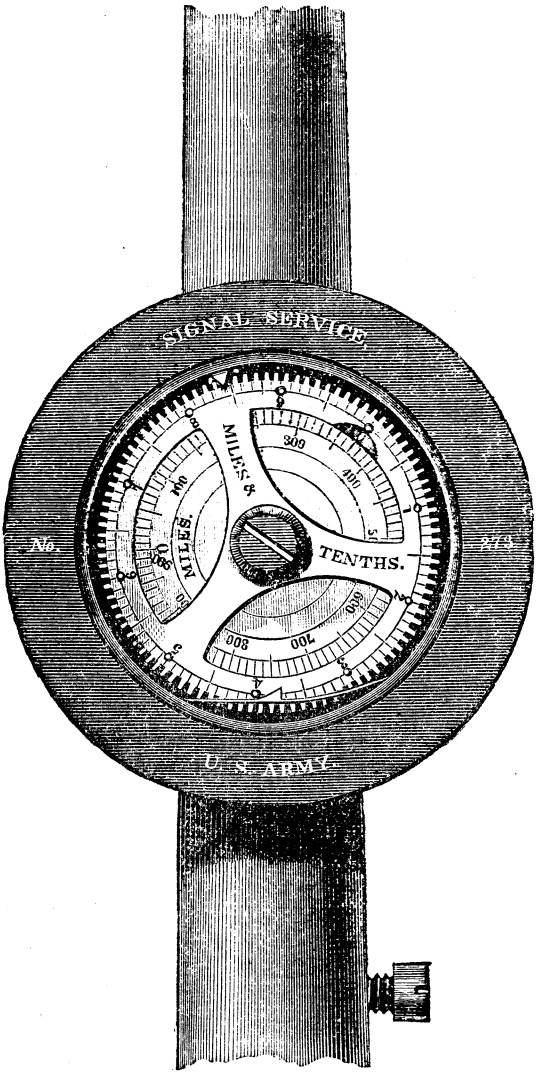
Plate VII.



The outer dial of the instrument (Fig. 12) is graduated in miles and tenths of miles, the figures 1, 2, 3, &c., indicating miles, and the subdivisions tenths. One complete revolution of this dial is equivalent to 10 miles of wind.

The inner dial is graduated to tens and hundreds of miles. One complete revolution of the inner dial upon the outer dial is equal to 990 miles.

FIG. 12.



ANEMOMETER DIAL.

Manner of reading anemometer dial.—In taking the reading of the anemometer at any time (see Fig. 12), 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 units 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.

To obtain the current wind velocity from dial.—To obtain the current velocity of the wind from the anemometer, make two readings of the outer dial with an interval of five minutes between them, and the *difference* between these readings will be the distance, in tenths of miles, traveled by the wind in that interval. This, multiplied by 12, will give the approximate velocity in miles per hour. Example: Suppose the index of the anemometer to be at 3 on the outer dial when the first reading is taken, and at 3.6, five minutes after, the difference (six-tenths) is the distance traveled in that time; and this, multiplied by 12, gives a velocity of $7\frac{2}{10}$ miles per hour. Whole numbers only will be used in expressing the velocity; when the decimal is five-tenths or more an odd unit's figure will be increased by one; when *five* or *less*, an even number will not be changed.

To obtain total wind movement by dial, for twenty-four hours.—To obtain the total movement of the wind for the twenty-four hours, subtract the reading of the anemometer dial at 12 noon of the preceding day, from the reading taken at 12 noon of the current day, the difference will be the total movement. 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 91, and that of yesterday was 950, hence we have 91+990=1081; 1081 —950=131, the total movement of the wind in miles during the past twenty-four hours.

Force of wind, how estimated.—Whenever a station is not supplied with an anemometer, or the one in use becomes unserviceable, or when there are no instruments at the station for determining the velocity of the wind, its force will be estimated according to the following scale:

Signal Service scale.

Name.	Miles per hour.	Apparent effect.
Calm	0	No visible horizontal motion to inanimate matter.
Light	1 to 2	Causes smoke to move from the vertical.
Gentle	3 to 5	Moves leaves of trees.
Fresh	6 to 14	Moves small branches of trees and blows up dust.
Brisk	15 to 24	Good sailing breeze and makes white caps.
High	25 to 39	Sways trees and breaks small branches.
Gale	40 to 59	Dangerous for sailing vessels.
Storm	60 to 79	Prostrates exposed trees and frail houses.
Hurricane	80 or more.	Prostrates everything.

SELF-RECORDING ATTACHMENT.

Manner of connecting self-register.—When a station is supplied with an electric self-recording attachment for making a continuous record of the wind velocity, it will be placed in the observer's office and connected with the anemometer by insulated wire in the following manner:

Fasten the wires separately near the top of the support on which the anemometer is fixed, leaving just sufficient of the upper end of each wire to reach to the outside ends of the contact-screws located in the rear of the anemometer dial. One of these contact-screws is insulated, and the wire attached to it will be run directly to the binding post H of the register (see Fig. 13) through the electro-magnet and binding post K to the battery. The other wire from the anemometer will be attached to the other pole of the battery, thus completing the circuit.

In running the wires from the anemometer to the register carefully insulate them by use of porcelain insulators and see that there is no slack wire for the wind to sway. In no case must the wire be twisted around nails for support. If the wire is brought into the room through the window, it can be done by bringing it over the upper sash, making two grooves in the top of the sash to permit it to close and not press on the wires. In making this electric circuit particular care must be taken to have all the connections well made.

Gibbon's self-register to the anemometer.—The Gibbon self-register is the anemometer register in general use in the Signal Service, and is shown in Fig. 13.

It consists of an electro-magnet, a clock-movement, and a drum. The drum is revolved by the clock through equal spaces in equal times, and is covered with spaced paper, upon which the point of a pencil is pressed. When the contact posts, located at the mile points on the outer dial of the anemometer, close the electric circuit by pressing upon the closing spring, which is done whenever a mile of wind has been completed, the circuit is closed, and causes the electro-magnet to move the pencil and record a mile.

The anemometer record sheet will be changed daily as explained in the special instructions printed on the form.

Manner of placing the sheet on self-register.—To put the paper on the cylinder:

Place the cylinder S on a table in front with the screw T to the left hand; place the paper on the cylinder with the top of it from the screw. Let the line marked 12 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.

Place the cylinder S in its position, so that the end opposite the screw T will be near the post on which it rests. Slide the small sliding bar on the horizontal bars O O until it fits on the ends of the screw-axle T; then revolve the cylinder until the pencil rests on the end of the upper line, marked 12 noon, and tighten the thumb-screw N.

Pencil mark, how regulated.—To regulate the length of the pencil mark, adjust the armature set-screw P until the pencil mark is one-eighth of an inch long, when the armature is moved back and forward; then turn the thumb-screw Q until the pencil point rests on the line marked 12 noon; should the movement of thumb-screw Q 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 so as 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 sperm oil, or a softer one used. 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 two outside time lines coincide. Keep the surface of the paper smooth and even.

In adjusting the armature-spring care must be taken not to make it too strong for the magnet, and yet strong enough to draw back the pencil in a straight line.

The pencils must be kept pointed enough to give a clear, distinct mark.

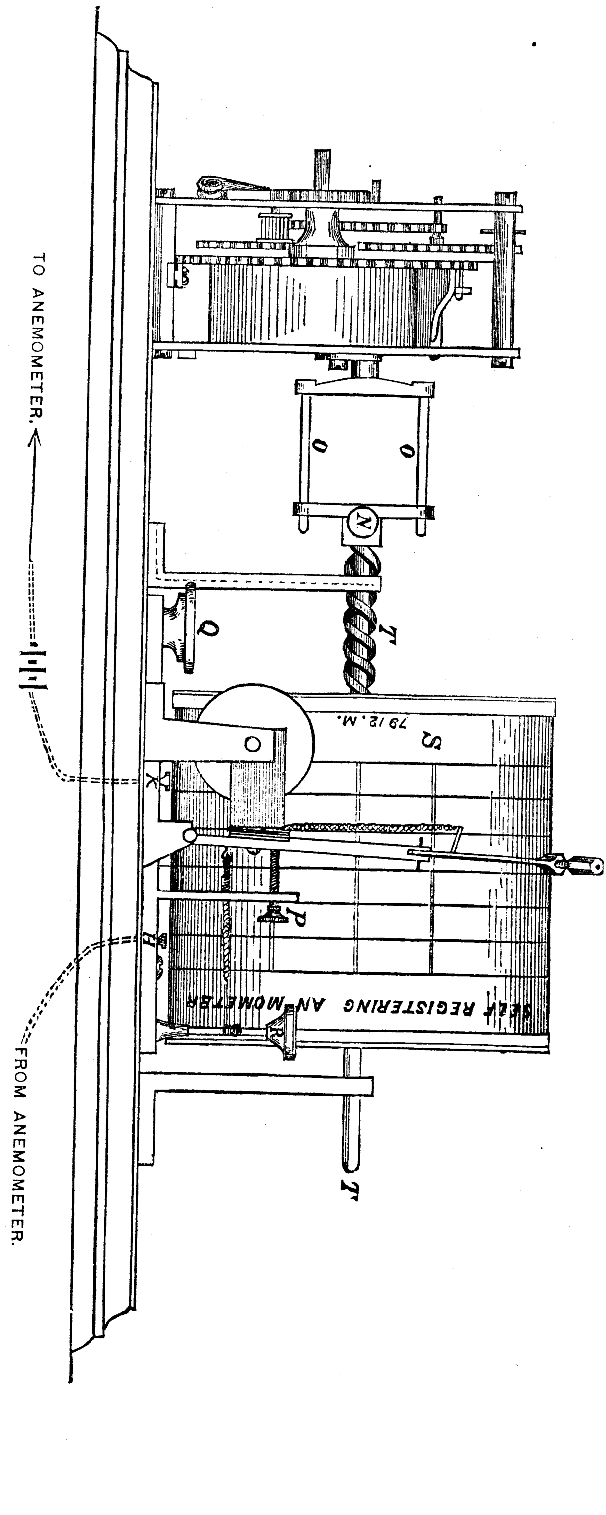

TO ANEMOMETER.
FROM ANEMOMETER.
SELF REGISTERING ANEMOMETER
O
O
N
T
Q
S
P
R
T

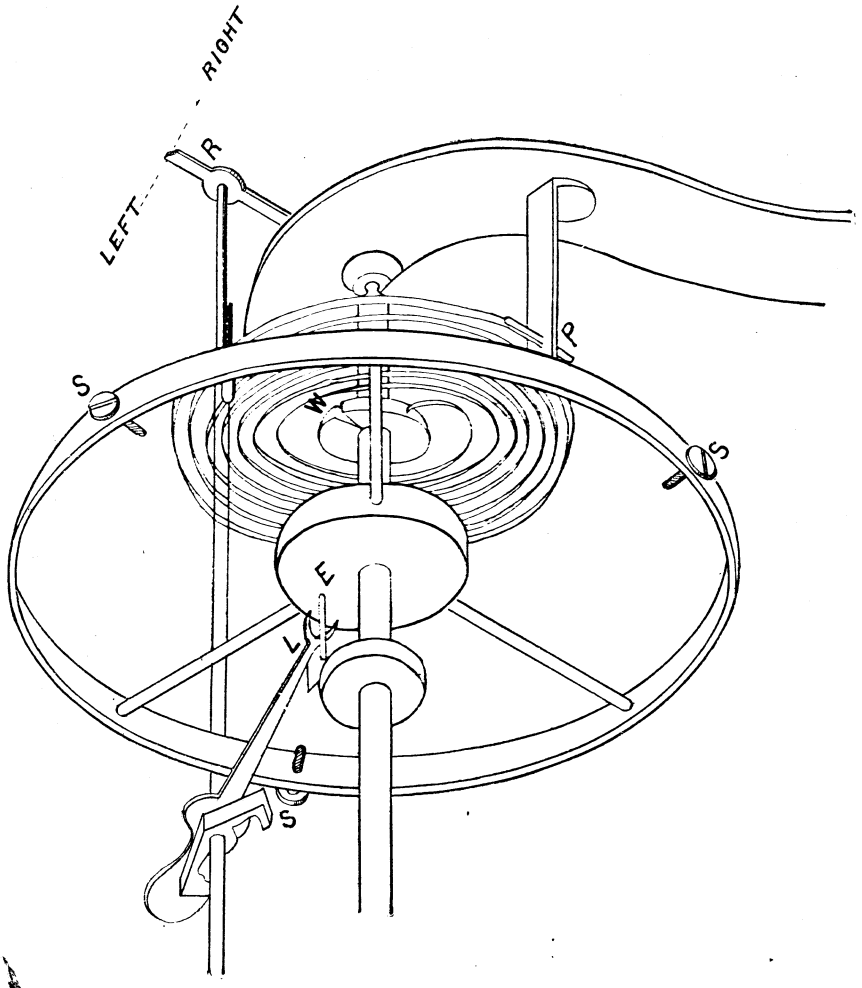
Fig. 13.

The clock must be wound every day when the anemometer sheet is changed.

Rules for regulating clock of self-register.—If the clock varies less than 10 or 15 minutes a day: if too slow, turn regulator R to the left; if too fast, turn regulator R to the right. (See Figure 14.)

When it varies 20 or 30 minutes a day: if too slow, take out pin P and set end of spring farther into the hole; if too fast, take the spring farther out of the hole.

FIG. 14.



When it varies over thirty minutes a day: set the regulator R in the center, and if too slow, tighten the three screws S S S of the balance-wheel equally; if too fast, loosen the three screws equally. In both cases allow about one turn for every thirty minutes' variation. If the escapement pin E vibrates more on one side of the forks of the lever L than on the other, the hair-spring must be brought either to right or to left on the axis, which can be done by inserting a small screw-driver into the

slot W to hold it in position and turning the balance-wheel in the desired direction.

When a self-register is used, a daily reading of the anemometer dial will be made and recorded immediately after changing the anemometer sheet.

Record of wind velocity as obtained from dial and self-register to be compared daily.—The record of the wind velocity, as obtained from the dial readings and the register, will be compared daily, and when a discrepancy is found to exist between the two records, the condition of the battery should first be examined, then the wires should be detached from the anemometer and connected together; the recording instrument can then be tested and the armature adjusted to respond to the strength of the battery; after this test, should the recording instrument still fail to correspond with the dial reading, the anemometer must be carefully examined as to the condition of the dial-pegs or contact-pins (which should always be perfectly straight) and the contact spring. The latter is liable to become corroded by the action of the electric spark or moisture, and must be kept clean and dry. When found, the defect should be remedied, and the cause of such discrepancy briefly explained by a marginal note on the sheet for the date or dates on which the discrepancy occurred. Should an anemometer be found to admit moisture, melted beeswax must be applied to the joints.

To obtain current velocity from self-register.—To obtain the current velocity from the self-register, take the number of spaces and parts of spaces between the mile marks recorded in the five minutes preceding the moment considered and multiply the result by twelve, *except* when the wind has blown *less* than twelve miles an hour, when the velocity for that hour will be determined as shown by the following examples:

First example. Suppose the number of spaces indicating mile marks between 2.55 p. m. and 3 p. m. were $1\frac{1}{4}$, then the velocity of the wind to be recorded at 3 p. m. is $1\frac{1}{4} \times 12 = 15$ miles per hour.

Second example. If the interval between the last two mile marks is 7 minutes, then the current hourly velocity would be obtained by dividing 60 by $7 = 8\frac{4}{7}$ miles, recorded as 9 miles.

If the anemometer cups are moving at the time of the observation, and the register has not recorded one mile in the fifteen minutes preceding, then base the velocity upon the length of time between the last two mile marks.

To obtain maximum velocity from self-register.—The maximum velocity of wind for any period will be obtained by considering the number of spaces and fractions thereof between the mile marks in any five minutes where the velocity is the greatest and multiply the result by twelve, and the product will be the maximum velocity for that period.

If the shortest space between two mile marks in the period covers more than five minutes of time, then the time expiring in said space will be the basis of the calculation. Example: If the shortest space between two mile marks is in thirteen minutes, then $60 \div 13 = 4.6$ miles per hour for the maximum velocity, which will be recorded as 5 miles.

The total velocity for any period will be obtained by counting the number of marks in the period.

Fractions of a mile, how disposed of.—The fractions of a mile obtained in computing the current or maximum velocity will be disposed of as provided in obtaining the current velocity from the dial. In no case will the fraction of a mile be recorded.

Tri-daily and total daily movements, how obtained when self-register is out of order.—When the self-register of the anemometer is out of order, the tri-daily and total daily movements will be obtained from the anemometer dial. This will be done by reading the dial at each telegraphic observation during the time the self-register is out of order.

Pressure of wind, how obtained.—Whenever it is necessary to use the pressure with or in the place of the wind velocity, in order to indicate its force upon each square foot of a surface exposed at right angles to the direction of the wind, it may be obtained by the following formula:

$P=.005\ SV^2$, in which P is the pressure in pounds sought, S the surface exposed to the wind in square feet, and V the velocity of the wind in miles per hour. The effect of atmospheric pressure and temperature upon the results of observations made at different times and elevations is found to be so slight, as compared with the unavoidable errors from defective exposures or defective instruments, that they have been omitted from the formula.

All stations of the second-order will be furnished with an anemometer and a self-registering attachment, and at these stations a continuous record of the wind velocity will be maintained.

Stations specially designated will be supplied with a self-recording anemograph (double register), and a continuous record both of the velocity and direction of the wind will be kept.

For further instructions in reference to the manner of recording, computing, and reporting the wind velocity see instructions in Original Record, Monthly Meteorological Report, Annual Meteorological Summary, Weather Code, and Anemometer Record Sheet.

See pages ----------

See Signal Office General Orders ----------

NOTE.—These instructions will be kept complete to date by entering in the proper space the number and series of all orders which in any manner affect or modify them.

ELECTRIC BATTERIES.

Two kinds of batteries are used in the Signal Service, in connection with operating the self-registering meteorological instruments, viz: the Eagle and the Callaud. These batteries are modifications of the Daniel; the copper and zinc solutions being kept apart by the difference of their specific gravities.

An element of the Eagle battery consists of a lead jar (the positive pole), a piece of zinc (the negative pole), sulphate of copper, sawdust or excelsior, and water.

To set up the Eagle cell, fill the jar half full of sulphate of copper, add sawdust to the depth of about two inches (or, better still, a piece of sponge or excelsior 2 inches thick), lay the zinc upon the sawdust, fill the jar with sufficient water to cover the zinc. Connect the zinc with the lead jar and let it remain connected for six hours.

See that the zinc is so located that it does not touch the lead jar.

Where it is practicable to suspend the zinc just below the surface of the water, the sawdust may be dispensed with.

As it is necessary to insulate the lead jar, a wooden shelf or box, dry and clean, will answer the purpose.

In making requisition for zincs for the Eagle battery, observers must state whether the jars are square or round.

The Callaud cell consists of a glass jar, a star of copper, a piece of zinc, sulphate of copper and water. To set up a cell, place the copper star in the bottom of the cup and bring the copper wire over the side; fill the jar one-third full of sulphate of copper, then suspend the zinc in position, and fill the jar with sufficient water to cover the zinc; connect the copper with the zinc by their wires and let them remain connected for six hours.

The number of cells necessary to operate a circuit depends upon its length. One cell for each hundred feet of circuit will be sufficient.

In using more than one cell be careful to connect the zinc of one cell with the copper (or lead) of the next cell. This arrangement will leave an unattached copper on one end of the battery and a zinc on the other end, one of which will be connected with the anemometer wires and the other with the self-register.

At the end of each week the cells in use will be carefully wiped off with a moist cloth or battery brush, and after about a pint of solution has been removed from the cell, add sufficient water to cover the zinc.

At the end of each month the zincs will be replaced by clean ones, and those last used will be well cleaned with water and the battery brush, and laid away for future use.

The fact that the two preceding paragraphs have been complied with will be noted in the journal.

Observers will see that the battery cells are always ready for inspection, and will not permit them to become crusted with salt, which will soil the battery box or stand and thus detract from the neatness of the office. The battery will always be located where it will not be subject to a freezing temperature.

CLOUD OBSERVATIONS.

Accurate observation of the kind of clouds, with the direction from which they are moving, forms a very important part of an observer's work. The direction should always be obtained by reference to some fixed point. In order to obtain absolute accuracy the observer should take the cloud observation with his head steadied by a fixed object.

The direction of the movement of clouds is more easily observed through slightly colored glass, and this should always be used in taking observations of dense clouds during the day. The colored glass not only protects the eyes from the glare of bright light, but also aids in bringing out in bold relief the finer portions of clouds, and assists in detecting the presence of very fine cirrus, not visible to the naked eye. It is important that cloud observations should be very carefully made.

Classification of clouds.—The following names of clouds, with their abbreviations, are to be used in Signal Service observations, viz: Cirrus,

C.; Cirro-cumulus, K. C.; Cirro-stratus, C. S.; Cumulus, K.; Cumulo-stratus, K. S.; Stratus, S.; Nimbus, nim.; Fog, fog; Smoke, smk.; and Haze, haze.

Upper clouds.—Cirrus, cirro-cumulus, and cirro-stratus are always upper clouds.

Lower clouds.—The nimbus, cumulo-stratus, and stratus are always lower clouds. The cumulus may be either upper or lower, depending upon their relative elevation above the surface of the earth.

Description of clouds.—Many cloud formations may gradually merge into each other, and the line of demarkation often cannot be well defined. The following general idea is given. The text in quotation marks are the definitions given by Howard:

Cirrus.—"Parallel, flexious, or diverging fibers extensible by increase in any or all directions." This is the highest cloud observed, and is of the least density. It is seldom less than 5 miles, and often 10 miles, in elevation. It is supposed to be composed of minute spiculæ of ice or snow crystals floating in the atmosphere, as it is only during their presence that the phenomena of parhelia and halos are observed. It is found in a great variety of shapes, and appears in a thin fibrous texture, or a feathery, hairy formation, often grouped in curled brushes or filaments, diverging at the ends as if electrified.

Cirro-cumulus.—"Small, well-defined, roundish masses, in close horizontal arrangement or contact." The cirro-cumulus cloud is a modification of the cirrus, consisting of high clouds having more or less rounded appearances, like masses of cotton. Their appearance is similar to small cumulus clouds, but not so dense. The mackerel sky, consisting of little, white, woolly clouds, arranged in parallel rows, is a common and pretty formation of the cirro-cumulus.

Cirro-stratus.—"Horizontal or slightly inclined masses, attenuated towards a part or whole of their circumferences, bent downwards or undulated, separate or in groups, consisting of small clouds having this character."

The cirro-stratus appear to be the result of the cirrus descending to a lower level, thickening by additional matter, and the gradual change from the frozen state to the vapor form. Their elevation varies from that of the low cirrus down to the position of the stratus clouds. Especially in the vicinity of bodies of water the cirro-stratus will gradually fall and thicken into stratus clouds. The fibrous state of the cirrus is often retained in the cirro-stratus, but is much more dense, and is spread out in strata either horizontal or inclined to the horizon. The strata are sometimes undulating and often broken.

The cirro-stratus seldom becomes thick enough to obscure the sun or moon, but often dim them sufficiently to kill or dull the shadows thrown. It is during the presence of the cirro-stratus that solar and lunar coronæ are observed.

Cumulus.—"Convex or conical heaps, increasing upwards from a horizontal base."

The cumulus are usually formed in the strata of lower base clouds. Their shapes are various, but may be observed most frequently as dense, roundish, hemispherical or convex masses, resting on horizontal bases. The outside and upper portions are generally white and the lower shaded portion or base of a dark color. They vary in size from a few rods to several miles in thickness. The cumulus clouds will often be observed crowded together in long horizontal rows, almost entirely shutting out the sun, with the exception of occasional rays at points between the

rows. These rays, passing through the rifts of the rows, illumine the dust and vapor, and produce the phenomenon described as "the sun drawing water." This arrangement of the cumulus is sometimes incorrectly reported as cumulo-stratus.

The position of the horizontal base of the cumulus approximately defines the point above the earth where the dew-point is equal to the temperature of the air.

Cumulo-stratus.—"The cirro-stratus blended with the cumulus, and either appearing intermixed with the heaps of the latter, or superadding a widespread structure to its base." The cumulo-stratus cloud is a form intermediate between the cumulus and the stratus. They are usually of a darker color than the cumulus. They will often be observed, when not too crowded, with the upper portion composed of forms like the cumulus and the lower portion of dark horizontal lines similar in shape to the cirro-stratus and stratus.

During the prevalence of the cumulo-stratus, previous to thunderstorms, grand and imposing clouds known as thunder-heads are observed.

Stratus.—"A widely-extended, continuous, horizontal sheet, increasing from below upwards."

The stratus is the lowest of clouds, and when it extends to the earth it is called fog. It consists of a thick veil of vapor of a dark color. When observed along the horizon it has the appearance of an irregular band of vapor.

Nimbus.—"The rain cloud. Any cloud or system of clouds from which rain or snow is falling." A nimbus cloud may be either a cumulus, a cumulo-stratus, a stratus, or fog, from which precipitation is occurring.

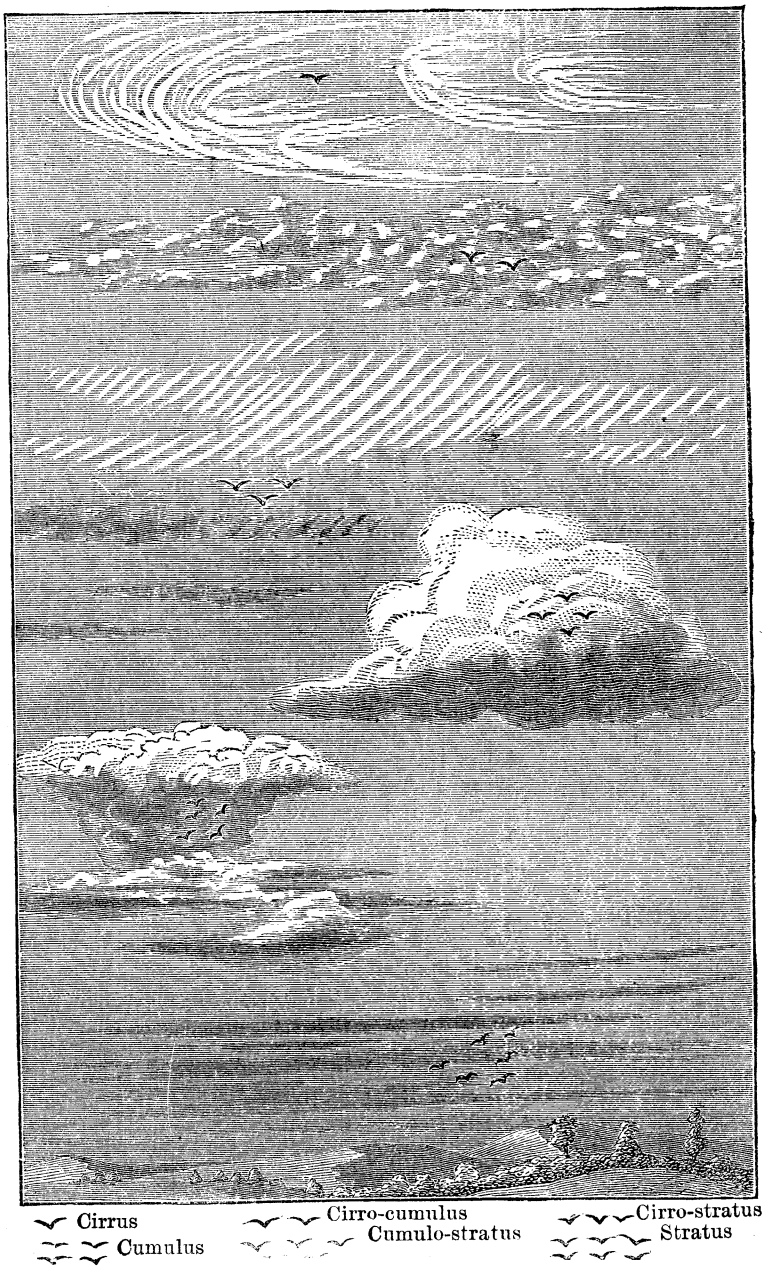
Scud is an individual cloud moving rapidly at a low elevation. It is usually composed of fragments of dark cumulus or stratus clouds, or detached portion of a fog-bank, broken off and driven away by increasing winds.

Fog is a visible vapor, or mist, resting on the surface of the earth. Fog and lower clouds, being of the same formation, vary in name according as they are observed at the earth's surface or above the earth. Fog may be either formed in the locality where observed or may be the lowering of clouds. Its vertical thickness varies from a few rods to a mile or more.

Haze.—This term designates the optical condition of the atmosphere when it is so charged with vapors that visible precipitation begins so as to perceptibly diminish the transparency of the air. This hazy condition of the atmosphere will sometimes prevail to such an extent as to dim the rays of the sun sufficiently to prevent shadows being thrown.

Smoke.—In many cases it is difficult for the observer to decide whether the condition of the atmosphere should be reported hazy or smoky, as the two are very similar to the unpracticed eye. The color of aqueous haze varies from a uniform dull light white to a delicate blue, but when the lack of transparency is due to smoke or other solid particles the tints are from ashy white to reddish and brown, with irregularities in the shade and density. There is rarely any perceptible movement of haze, but smoke will often oe noticed to have a slow drifting motion. To aid in discriminating between haze and smoke, the observer will consider whether the previous conditions have been favorable to the production of haze, and also will remember that a purely smoky condition must be caused by extensive combustion, such as forest or prairie fires, &c.

The following illustration, taken from Loomis' Treatise on Meteorology, shows the relative position of cirrus, cirro-cumulus, cirro-stratus, cumulus, cumulo-stratus, and stratus clouds:



PRECIPITATION.

The value accorded to the amount and rate of precipitation, in the preparation of the daily indications and the study of climatology, makes

the proper exposure of the collectors and the careful measurement of the precipitation of great importance.

The accepted manner of determining the depth of water deposited by precipitation over any area of territory is by locating a vessel or gauge of known size at some convenient point in the area under consideration, and making accurate measurements of the depth of the precipitation caught by this vessel.

Precipitation collected in gauges decreases with elevation.—The amount of precipitation collected in gauges has been found to decrease with elevation, often varying 5 or more per cent. per 100 feet. Carefully conducted observations indicate that elevated gauges are more or less subjected to the influences of eddies or currents of air, and as these influences have a minimum effect at the earth's surface, the gauges should, when practicable, be exposed on the ground.

Standard rain-gauge.—The standard rain-gauge of the Signal Service consists of three parts, viz, the collector *a a'*, the receiver *b b'*, and the overflow *c c'*. (See Fig. No. 17.)

The collector is funnel-shaped, and 8 inches in diameter at the top. The receiver is cylindrical, 2.53 inches in diameter and 20 inches deep. The overflow is 6 inches in diameter and 22 inches deep.

Standard snow-gauge.—The standard snow-gauge of the Signal Service consists of a cylinder 8 inches in diameter and 20 inches deep. (See Fig. No. 16.)

Position of the gauges.—When practicable the rain and snow-gauges will be firmly fixed upon reasonably level ground with the supports so arranged that the instruments will be vertical, the tops of their collectors in the same horizontal plane and 12 inches above the surface of the ground. (See Fig. No. 15.) The point selected should be at such a distance from surrounding objects that the tops of said objects will not have an angle of more than 45° elevation above the gauges. They must also be carefully protected from interference by unauthorized persons, or animals, by a barbed-wire fence of four wires, plans for which will be furnished from the office of the Chief Signal Officer.

Gauges located on roof.—When the gauges cannot be located on the ground they will be placed upon the roof of the office, the feet of the tripod being adjusted so that the gauge will stand in a perpendicular position, as shown in Figs. Nos. 16 and 17, and located as near the center of the roof as practicable.

The tripod rain or snow gauge support furnished stations is so constructed that it may be adjusted to slanting or uneven roofs by raising or lowering individual legs to make the top of the collector horizontal. As a rule the support should be fastened by screws.

Measuring rainfall.—The amount of rainfall is determined by inserting, vertically, a measuring rod into the receiver until it touches the bottom. Allow it to remain a moment, and then withdraw it and read the number of inches and tenths the water has wetted.

The sectional areas of the receiver and collector being only as one to ten, the depth of water measured is ten times as much as should be recorded. Ten inches of water in the receiver are equal to one inch of actual rainfall; one inch, to one tenth of an inch of rain; and one-tenth of an inch, to one-hundredth of an inch of rain.

Precipitation of less than 0.01 of an inch will be recorded by the use of the letter "T," indicating a *trace*.

After the receiver has been emptied, the water in the overflow, if any, will be poured into the receiver, measured, and added to that found in the receiver.

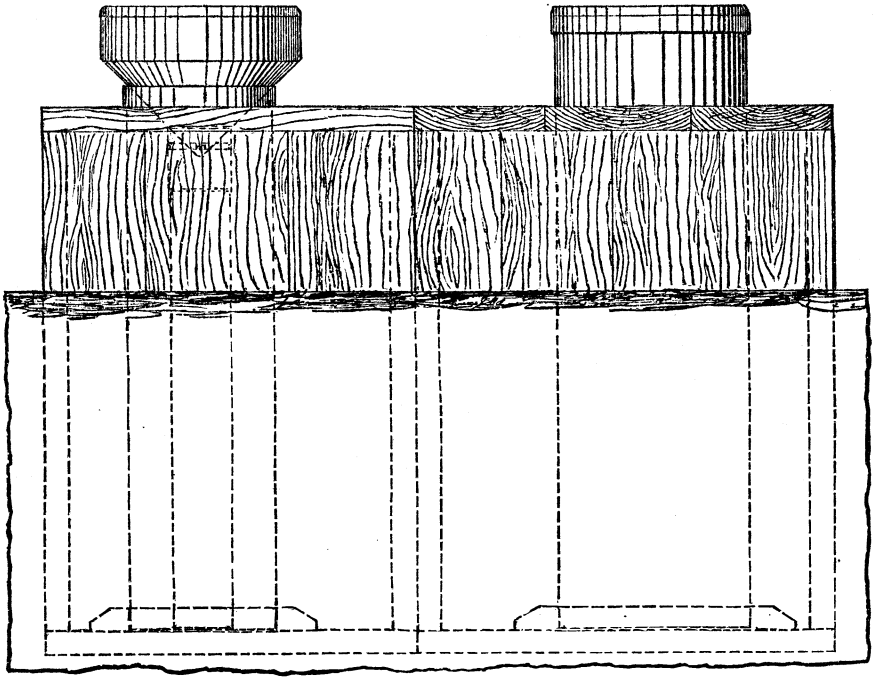
Deposits in the gauge from fog, frost, or dew, only, will be measured and recorded as precipitation, with a foot-note explaining its character, but it will not be included in the telegraphic report.

During snow-storms, should frost-work form on the gauge it cannot be considered separately; melt, measure, and record it, therefore, with the snow. If, in the opinion of the observer, the frost-work would, when melted, equal or exceed .01 of an inch, state the fact in a note with the estimated amount.

All precipitation, entirely or partially, in the form of sleet, snow, or hail, will be melted, poured into the rain-gauge receiver, measured, and recorded in the same manner as rainfall, and its character explained by a foot-note.

FIG. 15.

RAIN AND SNOW GAUGES IN GROUND BOXES.



Measuring snow.—Before melting the snow, measure its depth and then record it.

It will sometimes occur, especially when snow-gauges are located upon the roof of a building, that the whole amount of snow fails to enter, or is blown out of, the gauge on account of high winds, and a correct measurement cannot be made by considering the snow found in the gauge. In such cases the observer will reject the amount found in the gauge and will measure the depth at some point selected in the immediate vicinity of the office, where the snow on the ground fallen since last observation has been disturbed but little since its fall.

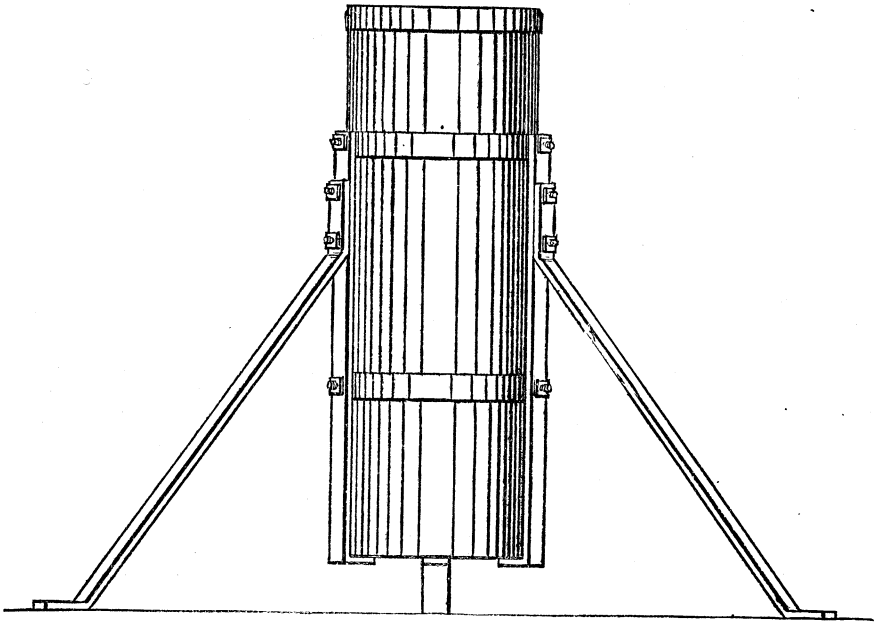
For the total measurement of snow made in this way, the observer will record only one-tenth of the amount as water. The fact of such measurement being made will be indicated by a foot-note, which will also give the amount found in the gauge.

As some receivers do not have a uniform capacity throughout their lengths, and as the depth of water in the receiver is increased by insert-

ing the measuring stick, it has been found necessary to give some rain-gauges a correction for instrumental error. This correction will be applied after the observation has been recorded.

FIG. 16.

SNOW GAUGE IN TRIPOD SUPPORT.



Beginning and ending of precipitation.—A careful record will be kept of the times of the beginning and ending of precipitation; intervals of fifteen minutes, or less, between the times of ending and recommencement not being considered except near observation time.

In the warm months of the year the rate of evaporation often exceeds that of precipitation. When this is the case, and when rainfall has occurred since the last observation and ceases before the next observation, it will be measured and recorded as soon as it ceases.

For further information concerning the manner of making, recording, and reporting precipitation observations, see instructions in the Original Record, Monthly Meteorological Report, Annual Summary, and on forms used in making the records.

See pages .....

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See Signal Office General Orders .....

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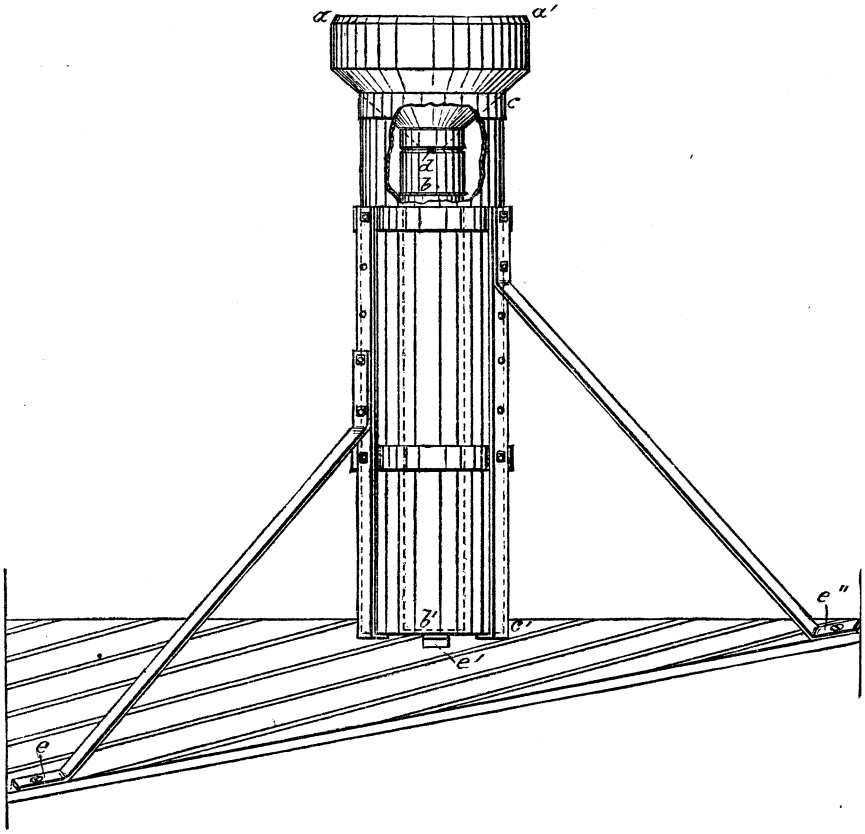
NOTE.—These instructions will be kept complete to date by entering in the blank lines of the proper clause the number and series of all orders which in any manner modify them.

FIG. 17.

SIGNAL SERVICE RAIN-GAUGE AND TRIPOD SUPPORT, UPON A SLANT ROOF.



RIVER-GAUGES, RIVER OBSERVATIONS, AND REPORTS.

The frequent floods and the consequent destruction of adjacent property resulting from sudden and unforeseen rises in the rivers of the United States have created a demand for accurate and reliable information that can be used to assist the public in anticipating the rise of rivers to the danger line.

In the absence of storms and floods the interests of river commerce demand a knowledge of the water supply in the larger tributaries, to permit a determination of the future supply of water for purposes of navigation at points where the depth is sometimes insufficient.

To meet these demands the Chief Signal Officer has been charged, by proper authority, with the duty of designating points of observation on the most important rivers, and having observations of the depth of water taken at stated times.

The rise or fall of the water at any point will of necessity cause a rise or fall farther down the river. To warn those interested who are

located below, the observations are telegraphed to the most important points.

Observers in charge of meteorological stations of the Signal Service located on the principal rivers are charged with taking daily river observations.

At other points where river observations are desired the observers are selected from the residents, who are appointed special river observers by the Chief Signal Officer.

RIVER-GAUGES.

The river-gauges in use by the Signal Service are of four kinds, and are shown in Figs. 18, 19, 20, and 21. The kind to be used at any station will be decided upon after an examination of the local conditions has been made.

If there is no river-gauge at the station, the following specifications will be carefully examined, and a selection made of the gauge best adapted to the location. All river-gauges built by the Signal Service are graduated in feet and tenths.

Specifications for the construction of river-gauges.—The specifications to be followed in procuring bids for the construction of these styles of gauges are as follows:

Specifications for the river-gauge shown in Fig. 18.—The river-gauge will be made of sound pine or oak timber, free from knots and shakes, 2 to 3 inches in thickness, 8 to 12 inches in width, and of such a length as to extend from 2 feet below the zero point up to 5 feet above the danger line. The side of the plank upon which the graduations are to be made will be planed smooth, and will receive two coats of the best white-lead paint. It will then be graduated as follows: Commencing at the point which will correspond to the zero, graduate the gauge both above and below zero, into feet and tenths of a foot. These graduations will be marked by copper-head tacks one-half inch long. The foot-lines will be marked by placing the head of each tack not more than one-eighth of an inch apart. The heads of these tacks should not be less than one-fourth of an inch across the top. Each foot-mark will be further designated by copper figures not less than 2 inches long by 1 inch in width. The figures will be securely fastened by copper nails over the central part of the division which they express. The five-tenth foot-marks will be designated by copper tacks extending one-half the way across the plank, while those for the tenths will be designated by tacks extending one-fourth the distance for the foot-marks.

Having graduated the gauge, select a pile or other stationary object in some portion of the levee or wharf where the gauge will be secure from injury, and where it will not be left dry by the low water. Lower the gauge into the water, taking care to keep it in a vertical position until it touches the bed of the river, or its zero is at the point of lowest water known to river-men; then firmly secure it to the pile, or other object selected, by spikes.

Specifications for river-gauge shown in Fig. 19.—Procure a piece of pine or oak timber, about 2 inches thick by 10 inches in width, and of a sufficient length to cover the full range of the river between extreme low-water and high-water marks. This timber will be placed in the river bank, the broad side vertical, firmly imbedded in the earth, leaving 1½ inches of its width exposed above the level of the ground. The upper edge will be planed smooth, and carefully graduated in feet and tenths of a foot, after being placed in position, taking the point of lowest

water previously referred to as the zero of the scale, and locating the feet and tenths both above and below that point. The graduations for this gauge will be the same as those authorized in the specifications for Fig. No. 18. Especial pains will be taken in graduating the gauge to see that the distances marked off upon it for each foot and its subdivisions will correspond exactly to a vertical foot and subdivisions of which they are the measure. This can be readily done by means of an ordinary spirit-level and a carpenter's square.

The specifications of the river gauge, represented in Fig. 20.—Where a stone pier or abutment of a bridge is available, a very durable gauge can be made by dressing a face 1 foot wide and perpendicular to the water line from extreme low water to the top of the pier or abutment, should there be any possible danger of the water ever reaching that point.

The dressed surface should be painted two coats of the best black paint after all holes and indentations in the pier or abutment have been filed with putty or cement. The dressed space both above and below the point at which the zero will be placed will be graduated in feet and tenths. The figures indicating the foot-marks should be not less than 2 inches in height, painted white, and placed as shown in Fig. 18. The half-foot marks will be indicated by lines painted in *red.* The lines representing the whole-foot marks and the tenths should be exactly one-fourth of an inch in width.

The specifications for constructing the gauge, represented in Fig. 21.—Where there is no pier, but a permanent sloping bank or levee is available, a gauge can be made of stone in the following manner: Blocks of stone, with one corner dressed to a right angle, should be placed in the bank or levee, like the steps of a stair. If the gauge is to be placed in a levee where there is traffic, each step should have a rise not exceeding five-tenths of a foot; where there is no traffic, a rise of 1 foot may be given to each block. The foot-marks should be cut in the top of the steps and the tenths of a foot on the perpendicular face of each block.

The specifications of the gauge selected will be furnished such mechanics as the observer considers competent to do the work, and the bids of at least two will be forwarded to the Chief Signal Officer for examination and approval. The construction of the gauge will not be commenced until this approval is obtained.

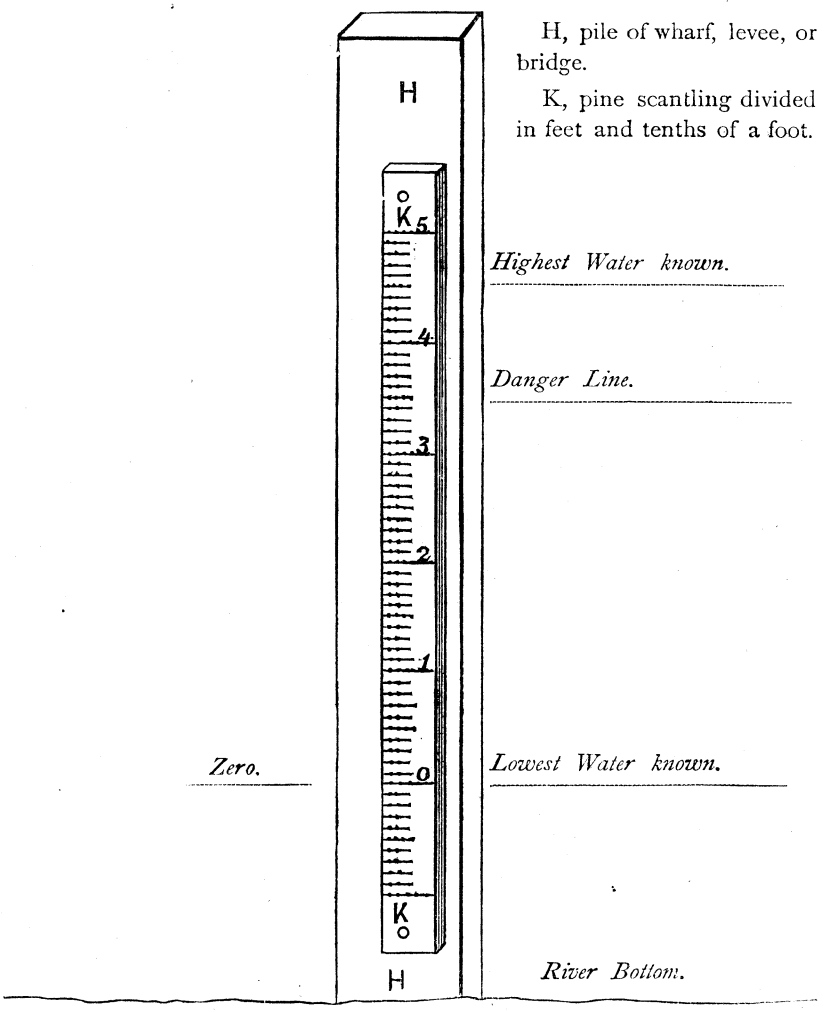
When the gauge is in an exposed place and liable to be injured by ice or floating débris, advantage should be taken of the first low water to secure it from being displaced or washed away. After securing the gauge fix some point of reference, so that in case it should be destroyed another could be put up at the same height. This may be done by marking on some given point in the vicinity any given height of the water. Thus, by driving a spike or drilling a hole and recording the height of the water as read at the time a "bench-mark," or point of reference, is obtained by which to set up another gauge. A sketch of the place will be made, giving the location of the gauge and the point of reference, noting the local names of the surrounding points, so that any other person could find the place from the description.

Zero of gauge.—Upon establishing a river-gauge it is necessary to determine the relation in elevation of the zero of the gauge and the danger line on the gauge to other gauges on the same river.

The most satisfactory manner of determining its relation to other gauges is to select some permanent point of reference at each station and ascertain the elevation of these points above sea-level. Such a

point of reference has already been determined in many localities and is usually known as the city bench-mark.

FIG. 18.



The zero of the gauge must be located at the lowest water known. The zero should be selected after a careful inquiry among the local records and of the authorities. The difference in elevation between the zero and the point of reference must then be determined, thus providing a relation between the several river gauges.

Danger line.—After determining the zero of the gauge the *danger line* will be located. The *danger line* will be the point reached by the

water when it is considered dangerous to neighboring property, shipping, &c., at or in the vicinity of the station.

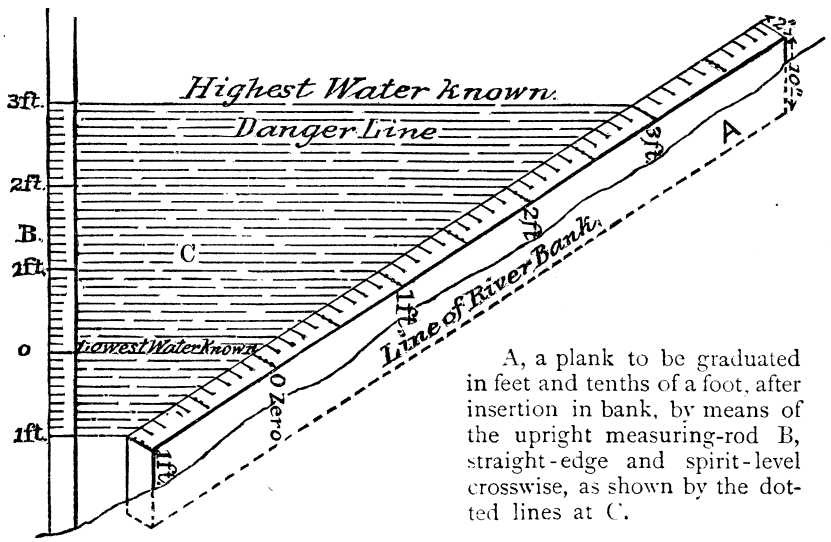
As soon as determined, the difference of elevation between sea-level and the point of reference, between the point of reference and the zero of the gauge, and between the zero of the gauge and the danger line will be reported by mail to the Chief Signal Officer.

When the differences of elevation between the gauges are known, the size or capacity of the river channel understood, and the amount of the rise in the river at the highest stations having been reported, it can be readily calculated when the dangerous excess of water will reach the successive points on the river below, and proper and timely warning given to protect property from destruction.

When reading the river gauge, if the surface of the water is at zero, or above zero, it will be recorded in figures representing the actual height in feet and tenths of a foot. Example: If the reading is two feet and eight-tenths of a foot above zero, it will be recorded simply 2.8 feet.

If the river falls below the zero of the gauge, the figures representing its height will be recorded with the minus (—) sign preceding them. Example: If the reading is, say, two feet and five-tenths of a foot below zero, it will be recorded —2.5 feet.

FIG 19.



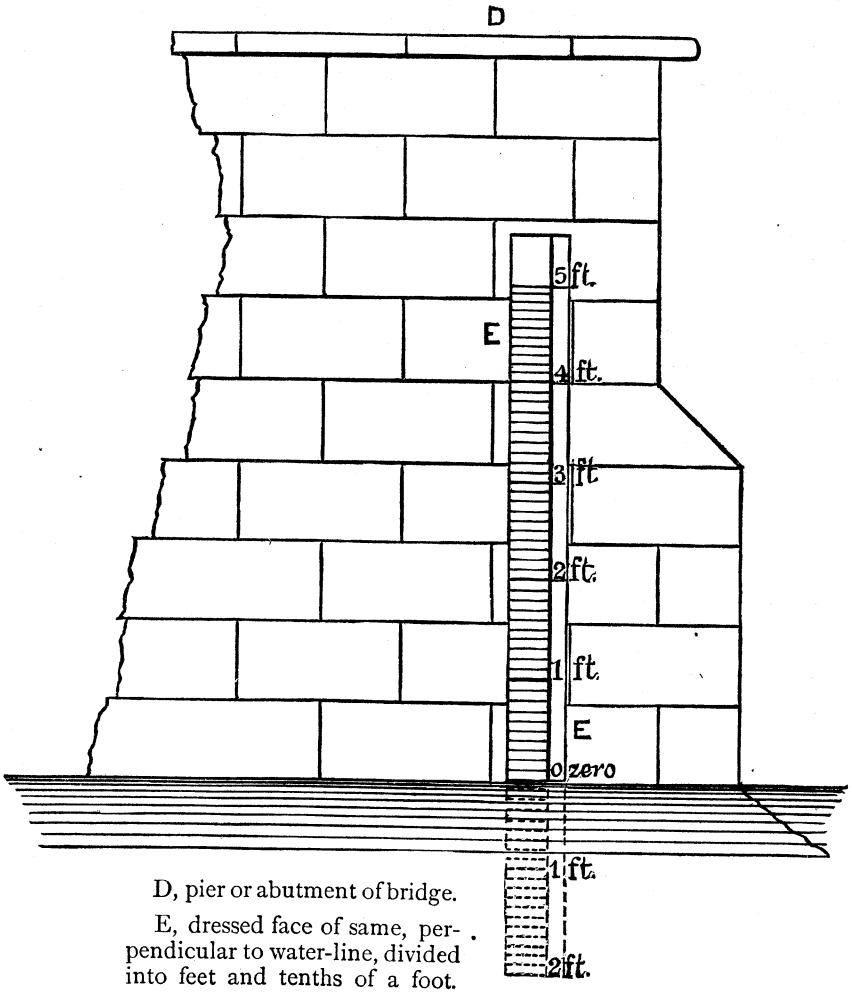
A, a plank to be graduated in feet and tenths of a foot, after insertion in bank, by means of the upright measuring-rod B, straight-edge and spirit-level crosswise, as shown by the dotted lines at C.

In making observations when the surface of the water is rough care must be taken to get the mean of the rise and fall of the waves.

At each river station a record of the observations will be kept in the Monthly River Record Book. These entries will be made daily in conformity with the several headings. There will also be entered in the same book, and copied into the Daily Journal, all unusual occurrences connected with the stage of the water at or near the station, such as the closing of the river by ice or from any other cause, the formation and breaking of ice gorges and their effect upon navigation, the presence of floating ice, timber, &c.; damages to the river banks and

to property, dates of highest and lowest water each month, the times of closing and opening of navigation on account of either ice or low water, &c.

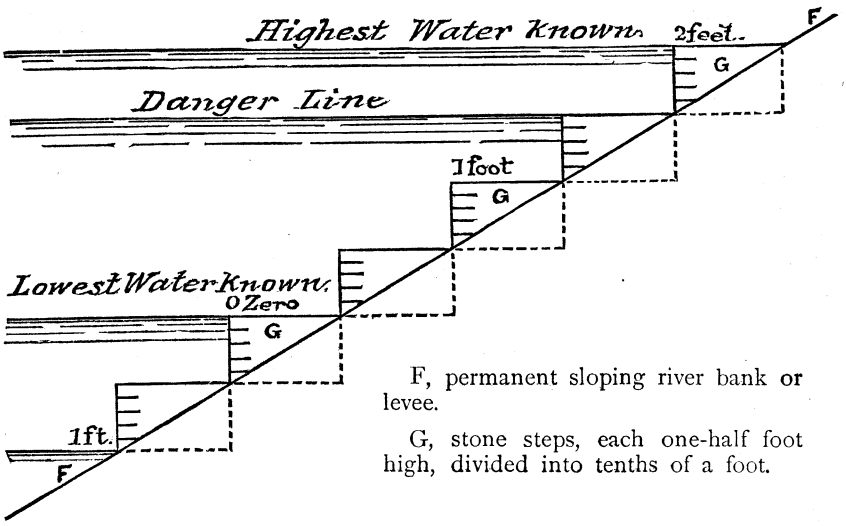
FIG. 20.



D, pier or abutment of bridge.

E, dressed face of same, perpendicular to water-line, divided into feet and tenths of a foot.

FIG. 21.



F, permanent sloping river bank or levee.

G, stone steps, each one-half foot high, divided into tenths of a foot.

For further information concerning the time of river observations, the manner of making, recording, reporting, and publishing them, see the forms used.

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See Signal Office General Orders _____

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NOTE.—These instructions will be kept complete to date by entering in the blank lines of the proper clause the numbers of all orders which in any manner affect or modify them.

SPECIAL RIVER SECTIONS.

Stations at which civilians are employed to take river observations are called special river stations.

Supplies for special river stations.—Each of these stations is furnished with a river-gauge, wind-vane, rain-gauge, and necessary stationery.

Special stations under charge of section center.—For the purpose of obtaining prompt communication by mail and telegraph, and to relieve this office of the detail duties in connection with the management of special river stations, they are grouped in sections and each section placed under the charge of the observer at a convenient second-order station, which latter is designated the section center.

With a few exceptions special river stations will receive all instructions from or through and render all reports to the observer in charge of the section center. (See instructions to special river observers.)

When the needs of the public demand, and the appropriations will admit, section centers will be authorized to send and receive, by telegraph, river reports to and from special river stations.

In communicating with special river observers, the observers at section centers will be careful to write in a distinct, complete, and formal manner, always exercising due official courtesy. Such correspondence will be made a part of the official records of the stations.

Further information concerning the time of observations at special river stations, the manner of making, recording, and publishing them, and the methods section centers are required to pursue in governing special river stations, will be found in the forms used and in Instructions to Special River Observers.

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DAILY JOURNAL.

In the Daily Journal will be entered all matters of interest not provided for in the various forms, such as meteoric and auroral displays, earthquakes, and unusual atmospheric appearances and disturbances, giving, when possible, the time of beginning and duration of each.

Entries must be complete.—All entries will be made complete for each day. Observers are particularly cautioned against keeping notes or trusting to memory with reference to data that should be entered in the journal.

Explanation of the terms "morning" and "evening."—Observers must pay particular attention to accuracy in the use of the terms "*morning*" and "*evening*," and will be governed by the following instructions in reference thereto:

Midnight is 12 h. 00 m. 00 s. and is the end of the day, and should receive the date of that day. Thus, whatever happened in the evening of June 10 at 11 h. 59 m. 59 s. happened at 11 h. 59 m. 59 s. *p. m.* June 10; whatever happened one second later was at midnight of June 10, and at one second later, at 12 h. 00 m. 01 s. *a. m.* of June 11. At midday of the latter date, whatever happened at 11 h. 59 m. 59 s. happened at 11 h. 59 m. 59 s. *a. m.* June 11; at one second later it was *noon* June 11; at one second later it was 12 h. 00 m. 01 s. *p. m.* June 11.

Especially will the observer enter a detailed account of the characteristic phenomena of every storm that passes over his station, and endeavor to give such information as will be of interest in making up the "Monthly Weather Review."

Thunder-storms, how recorded.—Record thunder-storms as follfollows:

Time of beginning and ending.
Direction from which the storm came and toward which it moved.
Temperature, and direction of wind, both before and after the storm.
Hail: time of beginning and ending, and size of hailstones.

Tornadoes.—Whenever a tornado occurs in the vicinity of the station, the observer will make diligent effort to obtain an accurate description of all meteorological elements accompanying the tornado; the hour and date of occurrence; direction of movement; appearance of the clouds; direction of the whirl; rainfall; accompanying noise; length of track; average width at different points; amount of destruction to property, loss of life, &c. So much of this information will be given as can be learned without leaving station for such time as to require special permission.

A full and detailed report of the tornado will be made on the form furnished for the purpose, and all the facts briefly noted in the Journal.

Frosts.—The dates of *all* frosts will be recorded in the journal and will be designated as "light" or "killing"; the term "light" signifies no destructive effects, and "killing" a frost that is destructive to vegetation.

If frost has not occurred at the station and there is positive proof that it has occurred in the vicinity, the observer will make inquiries regarding it and note the facts.

If a killing frost has not been observed previous to the first minimum temperature below 32°, that condition of the temperature will be sufficient evidence on which to report a *killing frost.*

Meteors.—Whenever a meteor is seen by the observer, the "cloud" left by the meteor will be carefully noticed, both as to its appearance and the direction in which it *floats*, and a record and full description of the meteor and cloud will be entered.

Aurora, description of, to be complete.—Observers will be particular to note every display of aurora, seeking by inquiry of others, if necessary, to make their record complete.

When observed, a full account of the phenomenon will be entered showing the exact minute of its beginning and ending, and the principal phases that it experiences. The following particulars should be especially noted: the azimuth and altitude of each extremity and of the crown of any arch of light, and the same data for any corona or glory that may be formed.

When the observer is familiar with the names of the principal fixed stars, he may locate the arch or crown by reference to them, but it is preferable that he should observe directly the altitude and azimuth.

Altitudes are expressed by degrees from the horizon to the zenith. If any circle be divided into three hundred and sixty parts, and the radial lines connect these parts with the center, each pair of lines subtend an angle of 1 degree; the fourth part of the circle will subtend an angle of 90 degrees or one right angle, and the corresponding radii are perpendicular to each other; thus the zenith (that point of the heavens

immediately above the observer) is 90 degrees from the horizon, or, in other words, its altitude is 90°. A point half way up from the horizon to the zenith has an altitude of 45°.

Azimuths are also expressed in degrees, but are measured on the horizontal plane, and will be recorded as is done in astronomy, from the south point to the westward, passing, successively, the west, north, and east points of the compass until 360° have been passed over, and the south point is again reached.

Observers must be particular as to the date of the aurora; and when it begins in the evening of one day and continues into the early morning of the next day, it will be entered as occurring on the *first* day, but its details will be given in the record as occurring between the hours of its actual beginning and ending. Thus, an aurora that began on the evening of the 12th of January, and continued until the early morning of the 13th, would be entered as the aurora of the 12th, but its details would be recorded as occurring, for instance, between the hours of 10 p. m. of January 12, and 2 a. m. of January 13.

Occurrences and observations reported must be entered separately for each day, thus: enter an auroral display occurring May 23, under that date, and not under the 24th as having occurred "last night."

The words "no aurora" and "obscured" will not be used.

Red sunsets.—To preserve a record of the special twilight phenomena known as "red sunsets," and in order to recognize the normal features of ordinary sunsets and twilight colors observers will make, *when specially ordered*, as often as practicable a record by descriptions and sketches of the character of sunsets and sunrises.

In these observations the special phenomena to be noted are:

(1) Time (hour and minute) of sunset or sunrise.

(2) The names of the tints, their combinations and shades (pale, light, dark, deep, &c.), as suggested by the following list: Black—brown, russet; white—gray, drab, slate; violet—purple, lavender; blue; green—olive; yellow—saffron, salmon, lemon; orange; red—rose, pink.

(3) The location (altitude and azimuth) of the colors and their time of appearance, of maximum intensity, and of final disappearance, noting especially any secondary increase of brightness.

(4) The visibility of the twilight arch, an ashy gray arch dividing the region of perfect darkness from that of twilight, and which begins to rise in the east after sunset; note specially the time when it passes westword over the zenith.

Observers will record the visibility, extent, and tints of the so-called "Bishop's Ring," which is an area of white or pink and purple haze surrounding the sun, with a rather definite boundary, at a distance from it of from 10 to 20 degrees. This is visible during the morning and especially the afternoon in clear and fair weather.

To insure uniformity of observations the following rules will govern in recording these observations:

(1) The character of the tints, their location and extent, and the hours and minutes at which they begin to make their appearance.

(2) The hours and minutes at which they attain their maximum intensity and extension.

(3) The time at which the tints disappear.

Observations of special twilight phenomena, twilight colors, and "Bishop's Ring" will not be made except when *specially ordered* by the Chief Signal Officer. When so ordered the data will be noted in the journal and will also form a part of the journal abstract.

Additional subjects to be noted in journal.—The following additional subjects will be noted: all changes in the working force of the station, together with the date and nature of such changes; the movements of office, or of instruments, and dates thereof; changes in elevation of instruments, and authority for making the same, and the fact that the battery cells have been cleaned each Saturday. These entries should be complete in every particular, as the journal must contain an accurate history of the station as well as meteorological phenomena not noted in other forms.

The time of hoisting and lowering signals will be noted, with remarks concerning benefits.

The character of the sunset will be the last entry for each day. If clear, yellow, or cloudy the words "clear sunset," "yellow sunset," or "cloudy sunset" will be given. If *green* the observer will give a brief description of the general appearance of the western sky, stating what other colors were seen, what proportion was green, and the length of time this color was perceptible.

At lake and sea coast stations the opening and closing of navigation, with the name of the first vessel to arrive and the last one to depart, with the nature of the cargo in each case, and the number of wind, cold-wave, and other signals displayed during the month will be reported, with results as far as known at each station; number of storms that passed over station for which signals were not ordered, dates, with velocity of wind, being stated in each instance.

Observers will note, each day, the number of inches and tenths of inches of snow (not melted) which fell during the preceding twenty-four hours, determined as accurately as possible by measurements made at points where the snow appears to be of average depth.

Should an instrument become unserviceable, the fact will be noted; also, the date of occurrence, and the date upon which application was made for authority to repair the instrument, or request made for a serviceable one to replace it. When an instrument is repaired, or replaced, the fact will be noted.

The result of the comparative barometer readings made in accordance with instructions will be noted under the proper dates.

The entry for the last day of the month will contain, in addition to other data, the time in current use at the station, the name of the instructed civilian, and the names of all civilians employed during the month, with compensation.

The number of times during the month the services of a physician were required for each man.

The number of days during the month each man was absent from duty on account of sickness.

The number of times during the month each man received medical attention from a physician, in which the illness did not necessitate absence from duty.

The cost of medical attendance and medicines for each man during the month.

All important subjects recorded in the journal will be indexed both on the side margin of each page and in the alphabetical index. Observers are enjoined to make this index very complete, as a badly indexed journal is useless, if data of any kind have to be looked up.

Abstract of Journal.—A monthly abstract of the entries in the journal, made out on the form furnished for the purpose, will be mailed to the office of the Chief Signal Officer not later than the third day of each month.

For further information concerning the daily journal,

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NOTE.—These instructions will be kept complete to date by entering in the blank lines of the proper clause the numbers of all orders which affect or modify them.

STANDARD OF TIME.

Seventy-fifth meridian time will be used by all observers and employés of the Signal Service in making and recording observations and preparing official papers of any kind.

At stations where the general public are using other than seventy-fifth meridian time, the weather bulletins, maps, and reports will contain both the seventy-fifth meridian time and the time in use.

Clock, to what time adjusted.—All first, second, and third order stations of the Signal Service will be furnished with a reliable clock. It will be hung upon the wall of the room used for an office, and kept carefully adjusted to seventy-fifth meridian time.

Seventy fifth meridian time is the mean solar time of the meridian 75° west of Greenwich, and is 5 hours slow of Greenwich time. *Central*, *mountain*, and *Pacific* times are the mean solar times of the meridians 90°, 105°, and 120° west of Greenwich, and are 6 hours, 7 hours, and 8 hours, respectively, slower than Greenwich time, or 1 hour, 2 hours, and 3 hours, respectively, slower than seventy-fifth meridian time.

Error of clock to be corrected twice each week.—Observers will endeavor to secure at least twice each week from the telegraph office, railway office, or local jeweler the error of his clock, on the standards in use by such offices, and will make the reduction to the 75th meridian time. Those who do not have access to railway or telegraph time signals will, in order to obtain the proper correction for keeping the clock on seventy-fifth meridian time, obtain the local meridian time from jewelers or by the use of sun-dials.

As the time in use by railways, telegraph offices, and the communities at all stations west of the limit of seventy-fifth meridian time differs from the seventy-fifth meridian time, the observer must be careful to note the amount of this difference, in order that his clock may be properly regulated to, and the observations made upon the designated moments of, seventy-fifth meridian time.

If none of the four standards (*eastern*, *central*, *mountain*, or *Pacific*) be in use at the station, then by reference to the table (Appendix No. 5), the difference between the true local meridian time and seventy-fifth meridian time will be found. If the station is east of the seventy-fifth meridian, the difference found in the table will be subtracted from the true local meridian time; and if the station is west of the seventy-fifth meridian, the difference found in the table will be added to the true local meridian time, the result in either case will be seventy-fifth meridian time.

The table given in Appendix No. 5 shows the difference between true local meridian time and the seventy-fifth meridian time and the time-belt for each of the stations designated:

PUBLICATION OF REPORTS.

Observer's duties at the telegraph office.—After delivering his report the observer will remain in the telegraph office until it has been sent to its proper destination, and the reports from other stations are received, or he is assured that their receipt has been prevented by some cause beyond the control of the operator.

When reports are delayed beyond the proper time for their receipt, the fact will be promptly reported to the Chief Signal Officer by mail, giving the cause of delay, when known.

When changes are made in reports sent over a circuit, or by special message, all stations affected will be notified. Any observer who sends extra words, or reports, or who receives and fails to report their receipt, will be held to a strict account. At transfer stations the observers will, by a personal supervision, see that the reports are properly transferred, and particularly so when changes have been made in reports sent.

Telegraph office to be supplied with forms.—The telegraph office at which the reports are received will be kept supplied by the observer with such forms as may be authorized. These forms must not be furnished to telegraph offices for the purpose of making copies of the reports for their own use. In all cases the receiving operator will be required to fill up the forms with the name of station, *date*, and time at which reports are received.

Immediately upon the receipt of reports the observer will translate and write them out clearly and plainly on the bulletin or cyclostyle map, filling in the data required to be entered thereon.

The bulletin, or map, issued in the morning will be furnished to the commercial exchanges and posted at such other conspicuous places as may be authorized.

The 3 p. m. bulletin will not be issued at stations except by special authority, the reports being received too late to make the data of benefit to the general public.

The 10 p. m. bulletin will only be issued at those stations where the newspapers publish the full report. At such stations the observers will furnish the newspapers the bulletin and report their action. At other stations the papers will be furnished by the observer with such reports or information, taken from the records, as will meet with the approval of the editor; the data being made up in the form of a press report.

Stations at which the 3 p. m. or 10 p. m. bulletins are not posted will continue to obtain the receiving sheets from the telegraph office.

Bulletins and maps not furnished private individuals.—Bulletins, or maps, will not be furnished to private individuals unless paid for and the parties desiring the reports are willing to send to the observers' office for them, but in no case will the issue be made without authority. All applications for publications made at a station will be forwarded to the Chief Signal Officer with appropriate recommendations.

Table for use of observer at telegraph office.—To avoid unnecessary delay in issuing the bulletins, observers will arrange, when practicable, to have the use of a desk or table in or near the operating room of the telegraph office, in order that the reports may be translated and written out as rapidly as received. Where permission to occupy the room for this purpose is granted by the manager, a small table will be furnished whenever necessary.

At many stations a bulletin on plain white paper is issued by the cyclostyle process, as this is found to be more economical and better adapted to the needs of this service.

The bulletin has the usual headings printed thereon. The reports are written on prepared paper which has been securely fastened in a frame, and then, by means of suitable ink and the use of a roller, transferred to the bulletin.

Explanation of the cyclostyle.—A cyclostyle outfit consists of a box, containing a bed-plate covered with zinc, inking-board, roller, pen, ink, and prepared paper.

The process is simply as follows: A sheet of the prepared cyclostyle paper is fixed in the printing frame, as shown in Fig. 22. The bulletin or map is then written on this sheet of paper with the cyclostyle pen, which consists of a wooden holder at the end of which is fixed on a pivot a minute iridium wheel which revolves in the direction of the writing and perforates the cyclostyle paper, making a perfect stencil composed of minute dots so close together as to appear a continuous line (Fig. 23).

Cyclostyle pens should be kept properly oiled when in use in order to prevent friction, which results in their soon becoming unserviceable. As a rule one of these pens should last for twelve months. Pens that have become gummy and seemingly unserviceable may often be put in good order by being thoroughly cleaned with benzine. In writing, write freely and naturally and the pen is as easy to write with as an ordinary pencil. The printing frame with stencil is now lifted, a bulletin, a map, or a sheet of paper placed on the zinc plate, the frame lowered, an inked roller passed over (Fig. 25) and a perfect copy is obtained (Fig. 24).

FIG. 22.

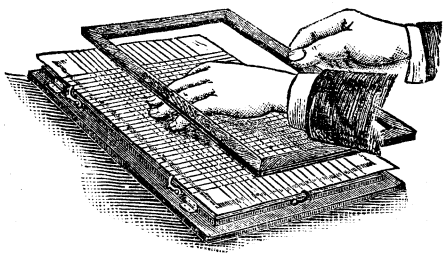


FIG. 23.

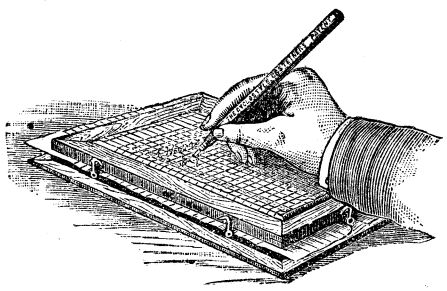


FIG. 24.

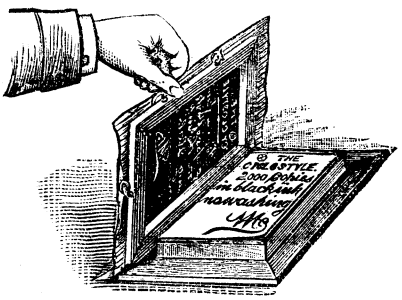
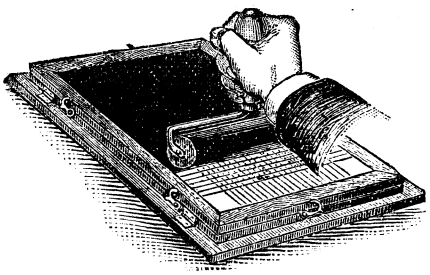


FIG. 25.



Cyclostyle weather map.—At the larger stations a weather map is issued in place of the morning bulletin by the cyclostyle process. These stations are supplied with a large cyclostyle on which an outline map of the United States has been drawn on the zinc; a punch, a dotting pen, and blank maps of a suitable size. Maps are made each day from the morning reports, having the isobaric and isothermal lines carefully drawn, and the data properly entered thereon.

The cyclostyle map is also intended to take the place of the large weather-symbol map, except in special cases.

Data on cyclostyle map.—The cyclostyle weather map shows the direction of the wind, state of weather, readings of barometer and thermometer, and the velocity of wind at each station. The arrow flies *with* the wind. In duplicating these maps by the cyclostyle process great care must be exercised to make all figures and signs correctly and legibly. Observers must never allow imperfect or illegible maps to leave their offices. To insure accuracy the data will be carefully compared with the original reports, and all errors corrected.

Observers will trace upon the maps *isobars*, or lines of equal barometric pressure, and *isotherms*, or lines of equal temperature, in accordance with the following directions:

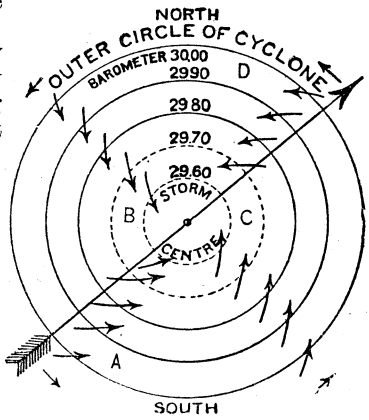
They will ascertain by a general examination of the reports after they have been entered on the map whether any of the lines of equal pressure and temperature will, when drawn, traverse a large portion of the map, and if this is found to be the case these long lines will be drawn first.

If decided differences in barometric readings are observed to exist between neighboring stations, enter upon the map little dots or dashes, intermediate between any two of them, to represent the points at which the barometric reading would be exactly 29.50, 29.60, &c., or 30.00, 30.10, &c., supposing the pressure to change uniformly in the space between

the two stations. The precise position of these intermediate points can usually be found with sufficient exactness by estimating with the eye.

The interpolated isobars—those which are drawn between stations, as explained—cannot be relied upon as perfectly accurate, but the amount of error need not exceed two-hundredths of an inch in the position of any line, if proper attention is paid to the following points:

When a sufficient number of dots or dashes have been made to enable the observer to trace the course of one or two of the principal isobars and isotherms, they will be joined together by a curved line passing through, or nearly through, all of them, without following any of the minor irregularities that would be possibly caused by slight errors in the interpolations.



Any perplexity that may arise in drawing these lines, as to their proper route, may generally be removed by considering the direction of the wind, as reported from each station. Thus, if from stations A, B, C, and D reports are received as shown in the figure, it would be seen at once that between B and C there was a central area of low pressure, around which the wind circulated in the direction indicated by the arrows, and the isobars would therefore be drawn as shown by the dotted lines.

When the lines are very much crowded together, as happens in a few severe storms, the isobars may be drawn for every two-tenths of an inch, instead of every one-tenth.

"High" and "Low" to be marked plainly.—Each isobar should be plainly marked at its extremities with the figures indicating the corresponding pressure, and the central areas of highest and lowest pressure should be marked "High" and "Low," respectively, unless by so doing the appearance of the map would be injured by the complication of the lines.

When the observer has any doubt as to the course of a given isobar, he should omit it entirely.

The isobaric lines will be continuous lines, while the isothermal will be broken lines, traced with the dotting pen.

Each isothermal line should be plainly marked at its extremities with the figures indicating the corresponding temperature, and be drawn for every ten degrees.

The position of the station on the prepared paper is formed by the *punch*, which makes a dotted circle, and in printing the circle is transferred to the map.

Indications and precipitation, how entered on map.—The indications for the State in which the map is issued will be written in the space in the lower left-hand corner, and in the space on the right-hand side will be entered the names of stations at which precipitation has fallen, and the amount.

Arrangements will be made, if possible, to have newspapers publishing weather reports send for them; otherwise the delivery will devolve upon the observer.

In furnishing weather reports and items for publication, observers must confine themselves strictly to the instructions, and will not, under any cir-

cumstances, publish, or cause to be published, forecasts or predictions of the weather, except such as are issued by authority of the Chief Signal Officer.

Requests for meteorological data must come from the parties desiring the same.

Indications to be posted with bulletins.—A copy of the latest indications and special bulletin received by the observer, or obtained from the Associated Press at stations where they are regularly received, will be posted with each copy of the bulletin that is publicly displayed.

Responsibility for reports.—Observers will be held directly responsible for the correct publication of all weather reports at their respective stations, and must take every precaution to guard against errors, especially in the newspaper copies, where, owing to the hasty composition, they are most frequently found. The accuracy of the published reports must be verified by daily personal inspection, and when errors are found they should be traced to their proper sources, and measures taken to prevent their repetition, as far as lies in the power of the observer.

The observer will request the editors of the newspapers publishing the bulletin to print the following heading:

The following observations were taken at the same moment of time at all the stations named.

The use of the regular official heading authorized for all reports must be insisted upon, and care taken that the correct time of issue is given to the bulletins, special bulletins, and indications.

Minus temperatures, how worded for newspaper publication.—In reporting minus temperatures in local press reports, or in other irregular reports furnished to newspapers for publication, the *minus signs* will not be used; but, instead, the words "below zero" will be written after the figures indicating the temperature, thus: "14 degrees below zero."

The publication of the Government weather reports by newspapers must be done without expense to the United States.

Newspaper clippings.—Newspapers will be forwarded to the Chief Signal Officer only in cases of special importance.

Observers will collect, as far as practicable, without expense to the United States, all the newspapers published at their stations and make clippings of items which *in any way* relate to the work of the Signal Service.

These items may be generally designated as follows: Storms, tornadoes, floods, navigation, signals, climatic conditions, optical phenomena, winds, temperature, precipitation, atmospheric electricity, frosts, ice, miscellaneous phenomena, State weather service, general remarks upon the Signal Service, &c.

Items published giving daily, weekly, or monthly Signal Service weather reports will not be sent unless they form part of some particular article or are the subject of remark, but extended meteorological tables will always be forwarded.

The name and date of paper and the place of publication will be invariably attached to clippings taken therefrom. Clippings will be mailed each Saturday and also on the first day of each month. They will not be inclosed with other matter, but placed in a separate envelope, in the lower left-hand corner of which will be written in bold letters the word "clippings."

Railway weather bulletins.—The Chief Signal Officer desires that the widest distribution be given to the daily weather indications. When the funds at his disposal will permit, the indications will be furnished

to such railroad, telegraph, or telephone companies as will transmit them to the offices along their lines, without expense to the United States, and post them for the benefit of the public. Suitable blank bulletins and frames will be furnished by this service.

Weather Symbol Map.—The "Weather Symbol Map" will be placed in the commercial exchanges only upon special request of those bodies.

Owing to the length of time consumed in making the necessary changes the display of this map will not be encouraged.

The map will be changed, daily, from the morning reports, in accordance with the following key:

The index consists of an arrow, disk, and tag, which show the direction of the wind and velocity in miles per hour, state of the weather, height of the thermometer, and relative condition of the temperature (as compared with corresponding report of previous day) at the place at which they are affixed.

The index will be changed once daily, as soon after the receipt of the morning reports as is practicable.

The arrow points in the direction in which the wind is blowing.

Absence of arrow indicates calm.

Red disk represents clear weather.

Half blue disk represents fair weather.

Blue disk represents cloudy weather.

Full black disk represents rain.

Full black and white disk, in alternate bars, represents snow.

White disk represents foggy weather.

A white disk with black border, containing the words "Cold-wave coming," represents the display of the cold-wave signal at that station.

Upon a silicate tag projecting below the disk, and held in position by the same hook that holds the arrow and disk, will be written the wind velocity in miles per hour, the height of the thermometer, and the relative condition of the temperature; a horizontal red band near the end of the tag indicating that the temperature is higher, and a blue band that it is lower, than twenty-four hours previous. The colored band will be omitted when the temperature is the same as that reported twenty-four hours before.

For further instructions concerning these bulletins, press reports, and maps,

See pages _____

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See Signal Office General Orders _____

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NOTE.—These instructions will be kept complete to date by entering in the blank lines of the proper clause the numbers and series of all orders which in any manner modify them.

Storm, Cautionary, and Wind-Direction Signals.—The Signal Service being charged by law with the announcement of the approach and force of storms on the northern lakes and sea-coast, it devolves upon every officer and member of the service to exercise the utmost caution and diligence in executing this very important charge.

A steady progress has attended this service in announcing the approach of wind storms, since it was first attempted in 1871, and it is believed that further improvement can be made by utilizing the many valuable recent discoveries in meteorology, assisted by the observers exercising the utmost care in making and forwarding their observations, and in promptly and correctly publishing, by signal or otherwise, the storm warnings received.

In view of the fact that the resolution of February 9, 1870, under which this service was organized, contemplated the announcement of the probable force as well as the advance of storms, the Chief Signal Officer has decided to display signals with a view to distinguish between light and severe storms, and with the intention of showing whether the storm-center has reached or passed the display station, as well as the probable direction from which severe winds are expected.

To adapt the signals to the varying interests of the maritime community, the system will take into consideration the fact that westerly winds of high velocity with clearing weather are less dangerous than those from easterly quarters with freezing weather.

Along the Atlantic, Pacific, and Gulf coasts and on the Great Lakes, there will be displayed, as storm conditions may demand, day signals of two kinds:

1. A cautionary signal, a yellow flag with a white center, will indicate that the winds expected are not so severe but well-found and seaworthy vessels can meet them without great danger.

2. A storm signal, a red flag with a black center, will indicate that the storm is expected to be of more marked violence.

In order to afford the public as exact information as possible regarding the relative position of the storm and the winds expected, two pennants will be displayed. A red pennant will indicate that the winds are to be easterly, that is, from northeast to *south*, inclusive, and that the storm-center is approaching. The white pennant will indicate westerly winds, that is, from *north* to southwest, inclusive, and that the storm-center has passed. While it is intended that the pennant shall indicate positively only whether the winds will be easterly or westerly, yet, in order to give still more definite information, the red or easterly pennant will be displayed above the cautionary or storm signal for winds from the northeast quadrant and below for winds from the southeast quadrant. In like manner, the white pennant, while indicating westerly winds alone, will show by its position above the cautionary or storm signal that northwesterly winds are probable, or by being below that they will be from the southwest quadrant.

In view of the difficulty of varying night signals, they will not distinctively show the force, but indicate the wind direction only; a red light for easterly winds, and red and white light for westerly winds. Night signals are not displayed on the Pacific coast.

Observers will receive with the order to hoist, and as often during the display as the indications officer considers necessary and practicable, a brief statement giving the location of the storm-center and the probable direction in which it will move; the probable direction of the wind

at the station in the next eight or sixteen hours, and the probable direction in which it will shift; the probable state of weather in the next eight or sixteen hours, whether rain, snow, or fog is expected, and whether higher or lower temperature, and the probable time the storm will cease.

To further add to the information concerning the area over which a storm is expected to prevail, telegrams will be sent to stations of the second order displaying wind signals, announcing the hoisting and lowering of wind signals at stations both in the vicinity and at those stations located in the direction from which the storm is approaching.

This information and that mentioned in the preceding paragraph will be given as wide a circulation by bulletins and newspaper reports as the means in the possession of the observer permit and the needs of the public demand.

To provide against keeping a wind signal displayed after the dangerous wind has passed, orders will often be received on station to lower the signal, even while the dangerous wind is prevailing, but is expected to cease before the next telegraphic observation. In no case will the signal be lowered until the wind falls below the verifying velocity.

As soon as practicable after a wind signal has been lowered, observers will collect from all available sources as much information as possible in reference to (1) the effect of the display upon the marine and other interests, as to whether said display was of any material *benefit* or *injury* in influencing the movements or protection of vessels or other property; (2) the apparent violence of the storm, as to whether any person or property was injured, and, if so, was it probable that such injury resulted from not heeding the display.

On account of there being a material difference at some stations between the wind velocity recorded by the station anemometer and that experienced by vessels in the vicinity of the point of display the verifying velocity will not be the same at all stations. The observer in charge of each wind-signal station will be informed as to what reading of his anemometer will be equal to the verifying velocity. Any change in the elevation or position of the anemometer will affect this verifying velocity.

When practicable wind signals will not be ordered by the proper authority for more than sixteen hours at lake stations and twenty-four hours elsewhere before the probable arrival of the verifying velocity.

On the approach of the season during which navigation may be closed, observers in charge of wind-signal stations on the lakes will confer with those most interested in lake navigation at their stations, and report the date upon which the display of wind signals can be discontinued for the winter. In the spring they will confer with similar above-mentioned persons and report the date at which the display of wind signals should be resumed.

The dates of suspension and resumption of the display of wind signals will be furnished each station on the lakes.

Equipments.—The stations at which these signals are displayed will be equipped with one flag-staff and two complete sets of wind-signal equipments. The staff will be located, if practicable, upon the roof of the building in which the observer's office is located, and equipped with two sets of halyards. If the staff is located where a signal cannot be seen from all points of the harbor, or navigable water within three miles of the observer's office, a second location will be selected, preferably at some point where the display will be visible over the area not visible from the main point of display. All wind-signal orders will be dupli-

cated at this second point. This second display should be made from some prominent flag-staff, the use of which will be obtained, if possible, without expense to the United States.

If, at any time, the staffs upon which the displays are made become disabled, the observer will take steps to secure the use of another staff for displays, pending the repair of the injured staff.

Inspection of equipments.—The equipments of a wind-signal station must be carefully inspected after each display and immediately put in perfect order, ready for the next display. If any portion of these equipments becomes unserviceable, requisition must be immediately made to have it replaced or authority asked to have it repaired.

Special display stations.—It being impracticable to establish second-order stations at all ports where it is desirable to display wind signals, arrangements have been made to display them at such points by employing some civilian at a nominal salary to attend to the signals and render reports.

Stations of this class are called display stations. No observations are taken at display stations.

Each display station will be furnished with two complete sets of wind-signal equipments.

For the purpose of obtaining prompt communication by mail and telegraph, and to relieve the Chief Signal Officer of the detail duties in connection with the management of these display stations, they are grouped and arranged in sections, and each section placed under charge of a neighboring second-order station, called a section center.

Orders to display wind signals at stations in a section are sent by the proper authority to the observer in charge of a section center, who distributes the orders to the several display stations in his section.

For further information concerning the manner of ordering, displaying, and reporting upon wind signals, see Monthly Record of Storm, Cautionary, and Wind-Direction Signals, Instructions to Displaymen, and Signal Service Weather Code.

See pages _____

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See Signal Office General Orders _____

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NOTE.—These instructions will be kept complete to date by entering in the blank lines of the proper clause the numbers and series of all orders which in any manner modify them.

Weather signals.—A system of signals has been adopted by the Chief Signal Officer, consisting of flags to be hoisted each morning to indicate the weather and temperature expected for the vicinity in which they are displayed during the succeeding twenty-four hours.

These flags are especially designed for the use of the general public for display upon railroad trains, river steamers, at railroad stations, and

other points having telegraphic communication, and where they will benefit agricultural and commercial interests.

The indications for the display of these signals are issued by the Chief Signal Officer, and cover the State, or portion thereof, in which the point of display is situated.

Applications of public carriers or corporations, town governments or individuals, who will agree to furnish the flags, display the signals for the benefit of the public, and render the prescribed monthly report provided daily indications are furnished them at Government expense, will receive favorable consideration by the Chief Signal Officer if the means at his disposal will permit and the information is not already furnished the locality of the applicant.

For further information concerning the weather and temperature signals see Signal Office circular of February 1, 1887.

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See Signal Office General Orders _____

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NOTE.—These instructions will be kept complete to date by entering in the blank lines of the proper clause the numbers and series of all circulars and orders which in any manner modify them.

Cold-wave signals.—By the term "cold wave" is understood a sudden and decided fall in temperature, as when the temperature falls from fifteen to thirty degrees, or more, within a very short time.

On many occasions the unexpected arrival of these sudden changes in temperature has proved very disastrous to the interests of persons engaged in agriculture and stock-farming, shippers of perishable goods, manufacturers, railroad and canal companies, merchants, cotton planters, and others, and the purpose of the Chief Signal Officer in sending out these warnings is that persons engaged in all industries liable to be affected by cold weather, or sudden changes in temperature, may be enabled to take the precautions necessary to protect their interests, by being informed in ample time of coming cold waves, which it is possible for the service to predict with accuracy.

When it is expected that the temperature will fall suddenly fifteen degrees, or more, in any section of the country, the cold-wave warning will be telegraphed to selected stations from twenty-four to forty-eight hours in advance, at which the cold-wave flags will be hoisted, in order that the public may be fully warned. The information is also sent by mail, telephone, or telegraph, whenever practicable, to all towns and railroad stations in the vicinity of the Signal Service stations displaying the signal.

For further information concerning the detailed manner of ordering, hoisting, and rendering reports of cold-wave signals, see instructions

on the forms for cold waves, Signal Office circulars February 15, 1886, and February 1, 1887.

See pages _____

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See Signal Office General Orders _____

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NOTE.—These instructions will be kept complete to date by entering in the blank lines of the proper clause the numbers and series of all circulars and orders which in any manner modify them.

FORMS AND BLANKS.

The necessary forms for recording and reporting observations, and for the transaction of other official duties, will be furnished each station by the Chief Signal Officer, and observers are enjoined to exercise the utmost economy in their use.

The instructions for filling up forms will, as a rule, be printed on the back of each, and said instructions will be strictly followed.

Forms to be complete in themselves.—Observers should bear in mind that every form made out must be complete in itself, and that no part of the data which it is intended to contain should be left out and the deficiency supplied by reference to another form or report. When any part of a report is omitted, or is not sufficiently clear to be understood by a person unfamiliar with it, a proper explanation must be made on such form or report.

For a full list of forms in use by this service and a brief description of each,

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See Signal Office General Orders _____

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NOTE.—These instructions will be kept complete to date by entering in the blank lines of the proper clause the numbers and series of all orders which in any manner modify them.

PRIVILEGES AND DISCIPLINE OF OBSERVERS.

Applications for leaves, &c., how made.—All applications for leave, furlough, or other privileges must be made directly to the Chief Signal Officer. Where the application is from an assistant, it must be forwarded by the observer in charge, who will note thereon his approval or disapproval of the same, and also state whether the station duties can be properly performed during the proposed absence without additional assistance, and without cost to the United States. When on *furlough* observers will receive pay proper, and 25 cents per day in lieu of all commutations.

Dates of returning from furlough or leave to be reported.—Whenever an observer returns to duty from furlough or other absence he will immediately report the dates between which he was absent from station, and give the authority for the same. In case of absence on account of sickness he will also state the nature of the same.

Observers will, upon receipt of orders take prompt steps to carry out their provisions, and when orders changing their stations or enjoining journeys are received, no applications for leave of absence, permission to delay *en route*, revocation of orders, or other indulgences, will be made, except in extreme cases, such as dangerous illness.

At stations having assistants a roster will be kept showing the name, rank, and address of each person on duty.

Neatness.—Observers will be especially neat and careful in their dress, and all rooms occupied as offices by the Signal Service must be kept scrupulously neat and clean.

Every observer will be held responsible for the thorough and complete police of his station. *Whenever a janitor is authorized* he will be required to do this work. In all other cases a contract will be made for this cleaning, preferably by women, at the least practicable cost.

Discharges.—The Secretary of War has power to grant discharges, which the Chief Signal Officer will recommend when applied for on proper grounds and at times when no special injury to the service would result therefrom; but as a rule, no application for discharge will be favorably entertained until after two years of faithful service.

Observers relieved from charge of station.—Whenever an observer is relieved from duty in charge of a station, he will, before leaving, inform his successor of the location of all map frames, bulletin boards, and other Government property for which he is responsible. He will also introduce the new observer personally to the members of the meteorological committee and members of the various commercial bodies, and give him such information as will enable him to intelligently discharge the duties of the station.

A written statement that the provisions of the foregoing paragraph have been complied with will be made by both observers.

Observers assuming charge of station, duties of.—When an observer is relieved from charge of a station his successor will, immediately upon assuming charge and before the departure of his predecessor, examine the station records, and if they are not found complete to date, he will report the fact by telegraph and direct his predecessor to await further orders. Should the failure to keep the records up to date be due to willful neglect of duty, the person responsible will be brought to trial, or such other action taken as the interests of the service may require.

When an observer arrives at a station he will examine all letters and instructions on file, that he may become acquainted with the instructions

which have been given to the station, and familiarize himself with its workings.

Contracting debts.—The contracting of debts by members of the Signal Corps is *strictly forbidden*, and those who violate this order will be summarily dealt with. As a rule, the Chief Signal Officer will consider the incurring of debts by any member of the Signal Corps beyond his means as evidence that such man's usefulness to the service is substantially destroyed.

During the absence of the observer in charge upon official business the observer next in rank will assume charge of the station until his return, unless otherwise ordered by the Chief Signal Officer.

Any information of interest to any department of the Government coming to the notice of the observer will be reported to the Chief Signal Officer, provided the department affected has not a representative in the vicinity to take cognizance of the information.

The following rules, relative to the number of errors detected in station meteorological forms, are published for the information and guidance of observers of the Signal Corps:

1. Observers who make more than 100 errors in six months will be reduced in rank.

2. Observers who make from 60 to 100 errors in six months will be censured in orders, and in the case of corporals and privates their names will be removed from the list for promotion.

3. An observer censured twice in any year will be reduced in rank.

Official data for courts of law and private use.—The United States Supreme Court has decided (case of Evanston *v.* Gunn, October, 1878), that the record kept by a person employed in the Signal Service of the United States, whose public duty it is to record truly the facts therein stated, is competent evidence of such facts. Observers of the Signal Service must bear in mind that the records which they keep are a part of the records of the War Department, and that by law they are in the custody of the Secretary of War; that they are not open to unauthorized inspection, nor are observers to produce them in the courts, upon subpœnas, without authority of the War Department.

Observers will inform applicants that duly certified copies are always furnished when necessary for legal purposes.

Section 882, Revised Statutes of the United States, 1878, provides that "copies of any books, records, papers, or documents in any of the Executive Departments, authenticated under the seals of such Departments, respectively, shall be admitted in evidence equally with the originals thereof."

Subpœnas, how to be obeyed.—The work of meteorological observations must be made at fixed hours, and the reports, to be of value, must make up a continuous series; therefore observers will make a respectful return to any subpœnas demanding the production of their station records, that such records belong to the War Department and cannot be produced without the authority of the Secretary of War, and a list of the data required by the subpœna will be obtained and forwarded, that authenticated copies of the records may be immediately supplied, as provided by the statute.

Observers, Signal Service, will obey a *subpœna duces tecum* for meteorological records under the following conditions, and no other:

First. That the production of such records in court shall not be made when by so doing any regular observation or other important official duty devolving upon the observer will thereby be prevented.

Second. That a regularly authorized attorney shall file a certificate setting forth that the delay necessary to obtain a certified transcript from the War Department will work injustice to his client in the case in question; said certificate (which the observer will transmit at once for file) to be in the following form:

CERTIFICATE OF ATTORNEY.

(Place) ——— ———,
(Date) ——— ———.

The undersigned, being an attorney in good standing, and having been duly authorized to act in the case of ——— ——— *vs.* ——— ———, does hereby certify that the delay necessary to obtain from the Secretary of War a certified transcript of the meteorological observations made at ——— ———, on the —— day of ——, 188–, would work an injustice to the client whom he represents; and further, that such injustice would be obviated by the production of the meteorological records under the *subpœna duces tecum* with which you have been served.

——— ———.

To ——— ——,
——— ———, *Signal Corps.*

The attention of observers is especially called to the fact that these supplemental instructions apply only to the conditions named above, and that such records will not be produced unless the *original* application by the attorney for the data in question shall be made at so late a date as to preclude the possibility of obtaining a certified transcript from the War Department.

Data, request for.—Whenever an observer is requested to furnish data from his station records for the use of any person or persons not connected with the Signal Service, he will prepare the data and forward the same to the office of the Chief Signal Officer for examination and approval, stating in his letter of transmittal to whom they are to be given and (if known to him) for what use they are required. After examination the data will be returned, and will then be forwarded by the observer to the person making the request.

The above instructions will not be followed in cases in which data are requested for publication in regular daily or weekly papers, or where persons desire the data for immediate use and the delay in transmitting would be detrimental to their interests.

Compiling of data not obligatory.—The Chief Signal Officer does not make it obligatory upon observers to compile official data for any one who may request them. If the data are to be used in the interests of the public, and can be prepared in a reasonable time, they should be furnished. In other cases the applicant should be asked to reduce his request to writing and forward it to the Chief Signal Officer, when the necessary action will be taken.

Purchase of Signal Service instruments or publications.—Persons desiring to purchase meteorological instruments or publications will be referred to the price-list published in the Monthly Weather Review. All communications in reference thereto, whether containing money or not, must be forwarded for action, and payment must in all cases be made in advance, and the money, check, or money order sent direct to the property and disbursing officer of the Signal Service, Washington, D. C.

BOOKS OF RECORD.

Original Record of Observations.
Daily Journal.

Monthly Meteorological Record.
Record of Letters Sent.
Record of Letters Received Index.
Record of Station Expenses.
Record of Wind Signals.
Record of Weather Signals.
Record of Cold-wave Signals.
Record of River Observations.

All books of record will have the *name* of the station to which they belong plainly written on the fly-leaf, and they will be carefully protected from injury or defacement. Those not in use will be carefully filed.

Each completed record book will be marked on its back in bold figures with the number it makes in the series to which it belongs. The books will be numbered in the order of their dates.

INSTRUCTIONS TO ASSISTANT OBSERVERS.

At all stations where there is an assistant on duty the observer in charge will give especial attention to his instruction in the theory as well as the practice of meteorology, signaling, and telegraphy.

Assistants who have not received instructions.—If the assistant has received no previous instruction in the duties of station work, or has not completed the prescribed course, he will be thoroughly instructed in the manner of taking, recording, and enciphering observations, but will not be allowed to take a regular observation until he is considered competent to do so.

He will be held at study, instruction, and practice (including one hour's recitation) not less than six hours each day (except Sundays and holidays).

Recitations from one of the following-named text-books will be made, using them in the order named: (1) General Instructions to Observers of the Signal Service, (2) Loomis's Treatise on Meteorology, (3) Pope's Telegraphy, (4) Manual of Military Signaling, (5) general orders and circulars of this service.

Besides the course of instruction in the text-books, the assistant will practice visual and sound signaling on alternate days, one hour each day, in the Army and Navy Signal Code, by use of a wand, and one hour each day in the Morse telegraph code, by use of an electric circuit with key and sounder.

Proficiency in signaling will be attained when the student is able to receive fifteen words per minute by sound and ten words per minute by sight.

A monthly written report will be made to the Chief Signal Officer of these daily recitations, giving (1) the name of text-book, (2) the number of pages completed each day, (3) the test at the end of each week in visual and sound signals, (4) other instructions given concerning routine duties, and (5) the character of the recitations. This report will continue to be made monthly until, in the opinion of the observer in charge, the assistant is qualified to perform all station duties.

At the end of two months a *special* report will be made to the Chief Signal Officer, stating whether or not, in the observer's opinion, the assistant has shown such a degree of proficiency as will warrant his retention in the service.

After an assistant has once passed through the course of instruction described above and has been promoted to the grade of first class private, the recitations and practice will be discontinued, but observers in

charge of stations will at all times be held responsible that their assistants are thoroughly conversant with station work, meteorological and kindred studies, wand and telegraph practice.

When but one observer is on duty at a station he will be expected to be thoroughly familiar with all the duties connected therewith.

The duty of instruction must be carefully and faithfully performed, and no application from assistant observers for promotion to the grade of first class private will be favorably considered until the course of study and practice has been completed in a satisfactory manner.

Communications from assistants.—All communications from assistants must be forwarded through the observer in charge, who will indorse his recommendation thereon. In cases of application for promotion he will give his opinion as to the character, habits, and ability of the applicant.

Civilian assistant, how selected and instructed.—As soon as practicable after arriving at a station at which there is no assistant on duty, the observer will make arrangements with some competent person to perform his duties in case of sickness, disability, or authorized absence. The person so selected will be carefully instructed in the use and care of the several instruments, in the manner of taking the observations, in making out and forwarding the weather reports sent from the station, and in the proper disposition of those received from other stations. His name and regular post-office address will be reported to the Chief Signal Officer as soon as the selection is made. It will be noted on the last day of each month in the journal abstract, and also in the annual report. The employment of this assistant will be temporary, that is, only during the sickness, disability, or authorized absence of the observer, and this office will be informed by telegraph in advance of the circumstances necessitating the employment and the probable cost. This civilian assistant will be paid at the rate of compensation fixed by this office upon the receipt of proper vouchers with certificate of observer in charge stating the number of days employed and dates thereof.

Course of study for observers.—Each observer should pursue a course of study or reading in such scientific works as may be related to or have a bearing upon his meteorological or other duties.

Books suggested for study.—For the information of members of the Signal Service who may wish to pursue a course of reading in meteorology, the following works are suggested as among the most valuable for this purpose. The publications of the Signal Service are not mentioned, but each class is to be understood as including the office publications appropriate to it. The general arrangement in each class is from the elementary to the more advanced. The best works in German and French are included for those who read these languages. Works preceded by a (*) are out of print, but can be purchased from dealers in second-hand books:

General treatises.

Deschanel, A. P. Elementary treatise on natural philosophy, translated and edited by J. D. Everett. 6 ed. New York, 1883. 8°. xxiv, 1155 p.

Loomis, E. Treatise on meteorology. New York, 1868. 8°. viii, 305 p., 3 pl. (Reprints to 1882.)

Scott, R. H. Elementary meteorology. 2 ed. London, 1883. 8°. xii, 403 p.

Modern meteorology. London, 1879. 8°. xii, 185 p., 2 pl.

Flammarion, C. The atmosphere. Translated from the French. Edited by James Glaisher. New York, 1873. 1. 8°. 453 p., illus. (Popular.)

Réclus, E. The ocean, atmosphere, and life. New York, 1873. 8°. 534 p., 27 col. maps., illus. (Popular. New edition now in press.)

Encyclopædia britannica. 9 ed. Articles on: Atlantic Ocean; atmosphere; barometer; climate; evaporation; meteorology.
* Blanford, H. Indian meteorologist's vade-mecum. Instructions. Meteorology of India. Tables. Calcutta, 1876–1877. 3 pts. 1. 8°. 95, 185, 81 p.
* Buchan, A. Handy book of meteorology. 2 ed. Edinburg and London, 1867. 8°. x, 371 p., 6 pl.
Mohn, H. Grundzüge der Meteorologie. 3 Auflage. Berlin, 1883. 8°. xii, 359 p., 15 pl.
———— Same. Les phénomènes de l'atmosphère, traduit par Decaudin-Labesse. Paris, 1884. 8°. lxiii, 487 p., 24 ch., illus.
Bebber, W. J. van. Handbuch der ausübende Witterungskunde. Stuttgart, 1885, 1886. 2 pts. 1. 8°. x, 392; x, 503 p., pls.
* Schmid, E. E. Lehrbuch der Meteorologie. Leipzig, 1860. 8°. Atlas 4° obl.

Instruments and methods.

Scott, R. H. Instructions in the use of meteorological instruments. London, 1875. 8°. 118 p.
Canada, meteorological service. Instructions to observers. Toronto, 1878. 8°. xvii, 190 p., 4 pl.
Blanford, H. Vade-mecum. Instructions. See under general treatises.

Dynamic meteorology.

Davis, W. M. Whirlwinds, cyclones, and tornadoes. Boston, 1884. 24°. 90 p.
Rosser, W. H. The law of storms, considered practically. London, 1876. 8°. 112 p.
* Espy, J. P. Philosophy of storms. Boston, 1841. 8°. xl, 552 p.
* ——— ———. Fourth meteorological report. 34 Cong., 3 sess. Senate ex. doc. No. 65. Washington, 1857. 4° obl. 240 p. 28 ch., 12 pl.
* Dove, H. W. Law of storms. Translated by R. H. Scott. London, 1862. 8°. xii, 324 p.
Loomis, E. Contributions to meteorology, Nos. 1–21. [New Haven, 1874–1885.] 21 papers, 8°. (From Amer. journ. sci., New Haven, viii, 1874–xxx, 1885.)
Ley, C. Laws of the winds prevailing in western Europe. London, 1872. 8°. 164 p., 27 pl.
* Coffin, J. H. Winds of the globe. Smithsonian contributions, No. 268. Washington, 1875. 4°. xxv, 756 p., 26 pl.
* Ferrel, W. Meteorological researches. Part 1. On the mechanics and general motions of the atmosphere. Part 2. On cyclones, tornadoes, and water-spouts. Washington, 1877, 1880. 2 pts. 4°. 43 p.; 95 p., 6 pl. (From U. S. Coast Survey Report, 1875, 1878.)
Guldberg, C. M., and Mohn, H. Études sur les mouvements de l'atmosphère. Christiania, 1876, 1880. 2 pts. 4°. 39 p., 4 pl.; 53 p.
Sprung, A. Lehrbuch der Meteorologie. Hamburg, 1885. 8°. xii, 407 p., 17 pl.

Climate and physical geography.

* Blodget, L. Climatology of the United States. Philadelphia, 1857. 1. 8°. xvi, 536 p., 13 ch.
Young, J. Physical geography. Putnam's advanced science series. New York [1873]. 12°. 368 p.
Réclus, E. The earth. New York, 1871. 8°. ix, 567 p., 23 col. maps. (Popular.)
Haughton, S. Six lectures on physical geography. Dublin, London, 1880. 8°. x, 386 p.
Hann, J. Handbuch der Klimatologie. Stuttgart, 1883. 8°. x, 764 p., chs.
Woeikof, A. I. Die Klimate der Erde. Theil i, ii. Jena, 1887. 2 v. 8°. xxiii, 396 p.; 422 p., 23 pl.
Supan, A. Grundzüge der physischen Erdkunde. Leipzig, 1884. 8°. xi, 492 p., 20 pl.

Weather predictions.

Ley C. Aids to the study and forecast of weather. London, 1880. 8°. 38 p., 2 pl.
Abercromby, R. Principles of forecasting by means of weather charts. London, 1885. 8°. viii, 123 p.
Scott, R. H. Weather charts and storm warnings. London, 1876. 8°. vi, 158 p., chs.
Radau, R. La météorologie nouvelle et la prévision du temps. Paris, 1883. 12°. 119 p.
Bebber, W. J. van. Handbuch. Theil ii. See under general treatises.

Periodicals.

American meteorological journal. i–iii. Detroit, 1884–1885. Ann Arbor, 1885–1887. 3 v. 8°. (Monthly. Subscription, $2 a year.)
Meteorologische Zeitschrift. i–iv. Berlin, 1884–1887. 4 v. 1. 8°. (Monthly. Subscription $4 a year.
In addition to the above, the Contributions and Annual reports of the Smithsonian Institution, American journal of science, Science, Kansas City review, Proceedings of the American association, and the Proceedings of the American philosophical society, contain papers of special value to the American student.

Books of reference.—The following books of reference are, as a rule, furnished for station use:

Guyot's Meteorological Tables; Buchan's Handy Book of Meteorology; Loomis's Treatise on Meteorology; Myer's Manual of Signals; Piddington's Horn Book; Manual of Military Telegraphy; Annual Reports of the Chief Signal Officer; Practical Use of Meteorological Reports and Weather Maps; General Instructions to Observers, Signal Service; Smithsonian Directions for Meteorological Observations; Daily Bulletin (Synopses, Indications, and Facts); Pope's Telegraphy; Holy Bible; Webster's Counting House and Family Dictionary; International Code of Signals; Professional Papers, issued by the Signal Service; Signal Service Notes, issued by the Signal Service; Monthly Weather Review, issued by the Signal Service.

When copies of reports or other books are sent to stations for distribution, preference must be given to the members of the meteorological committees, to public libraries, educational institutions, and scientists. *One copy of each report or book received must be kept permanently in the office for reference.*

All persons connected with the Signal Service are invited to furnish, for the benefit of the service, the results of investigations in meteorology. These contributions should treat of subjects germane to the work of the service, and when not published their return will be considered, on application.

INSTRUCTIONS FOR CONDUCTING CORRESPONDENCE AND KEEPING RECORDS THEREOF AT STATIONS OF THE SIGNAL SERVICE.

All correspondence at a station, or office, is comprehended within the terms "letters received" and "letters sent."

Letters received.—"Letters received" is the official designation of written or printed communications coming into any office or station relating to the business of the bureau, office, or station. They may be formal letters, memoranda, telegrams (except the regular cipher reports), unofficial or informal communications upon official subjects which need to be recorded to complete the written history of any business, memoranda made in the office of oral communications of which a record should be kept, and generally of all communications received to which reference may become necessary or desirable. All such communications received at a station will be carefully *folded*, *briefed*, *and numbered*, action taken thereon and noted, and the papers then filed, as hereinafter explained. Below the brief on each communication will be noted, *as concisely as possible*, in red ink, the action which has been taken on the paper; for example, "Answered May 3, '87, see L. S., page —," or, in case of indications and signal orders received, "Copy furnished May 3, '87, to ———, &c., see L. S., page —." When telegrams received are taken from their proper numbered places in the files to be sent to the office of the Chief Signal Officer, with "Report of messages sent and received," exact copies of the briefs will be made and put in their numbered places in the files. When a copy of such telegram is accessible in the "letters sent" book (in cases where it has been repeated

to substations, &c.), a full copy of brief need not be retained, but instead, on a slip headed with the file number, station, and year, reference will be made to the page of "letters sent" book where it can be found. When a communication is sent from the station by indorsement, *a copy of the brief and of the indorsement* will be made and retained in the proper place, according to number, in the file of "letters received." By these means the files of "letters received" will always be complete, containing either each communication of the numbered series or a copy of its brief, indorsement, &c. At stations where the number of letters received is large (fifty or more monthly) they will be put up in packages, monthly, neatly covered with envelope paper, which will be marked on four separate lines, thus: "Letters Received;" "Boston, Mass.;" "Month of April, 1887;" "Numbers 1 to 55;" they will be so treated *yearly* at stations where the number received is not large, and on the yearly or December package will be stated, "The last letter received in 188– was number ——."

Letters Received Index.—A book, to be called Letters Received Index, will be furnished each station, in which will be entered, under the proper letter of the alphabet, the name of each person occurring, and of the subject referred to, in briefs or indorsements of "letters received," followed by the file number of the paper in which occurring; the names of persons and subjects to be written in *black ink*, and the *numbers* in black ink when they refer to the *writer* of the letter being indexed; otherwise to be in red ink. Each name will be entered once only, thus: Smith, John, 1, 5, 8; Thermometers, 3, 6, 10. The book Letters Received Index will be kept at the top of the file of "letters received," and at the close of each year will be placed at the top of, and fastened to, the package, with name of station and period covered by index neatly written on the top cover of the book.

Folding communications.—In folding communications, those written on letter paper will be folded in three, and those on foolscap or legal-cap paper in four equal folds, parallel with the ruling or top of the sheet.

Briefing communications.—In briefing a communication, commencing about one inch from the top of the first or "brief" fold, the name of place where written, the date, the official designation or name of writer (the surname to be written first, as *Smith, John*), and a synopsis of the contents or subject will be written; the name of place, date, name of writer, and purport, each to commence, in the order named, on a separate line. On the space (one inch) reserved at top of brief fold will be written the number to be given the letter, the name of station and year—thus: 91, Milwaukee, 1887—in red ink; the brief to be in black ink, with number of inclosures thereto noted in red ink underneath. In briefing, everything of importance should appear with the utmost attainable brevity of expression, and the names of all persons occurring in the body of a letter must be given in full in the brief. A well-known city needs no State name affixed; a writer is sufficiently described by the official designation under which he writes; and dates, names, titles, offices, &c., not essential should be omitted. Where the location of a person, office, or institution is permanent or well known, or where location is of no importance whatever, the brief need only exhibit the date, the official designation of the writer (or his name), and the purport of the letter. Communications from officials on subjects relating to the business of their offices should not be briefed in their individual names, but either by their official titles or the names of the offices of which they are in charge or in which they are serving. Uniformity of plan is essential, because the

brief must be sufficient for all the different offices to which the paper may go, for the proper record and indexing of the communication in each of them.

Observers will in *all* cases brief letters addressed or forwarded to the Chief Signal Officer.

If a communication be received by telegraph, the word "Telegram" will be written in red ink immediately above the brief.

Communication, covering all sides of a sheet, treatment of.—If a communication cover all sides of a sheet, leaving no room for briefing or indorsing, or if the paper cannot be folded to the proper size, a half sheet of letter paper will be fastened to it, but in no case will any loose wrapper be placed around an official paper. Loose wrappers on which briefs, indorsements, or office marks have been placed by persons before the receipt of a communication at a station, will be securely fastened to the papers.

Numbering communications.—In numbering communications, a new series will begin each year with 1 on January 1st (or at date of receipt of the first letter when a station is opened during the year), and all letters, &c., received afterwards during the year will be numbered continuously. Each letter will be known by this number in all references made to it in the office records. Inclosures to letters will simply be marked in red ink, near top of first fold, with the number of letter to which they are inclosures, the name of station at which it has been received, and the year.

All indorsements, reports, remarks, or directions *attached* to a communication that has been briefed, sent from, and returned to the station, will be regarded as a part of the original paper and will not be separately briefed and numbered, but short notes will be made under the brief, of such papers as have been subsequently added, copies of which will be retained if the papers be sent from the station.

Separate communications relating to one particular case, though independently briefed and numbered, will be collected and filed together, both for the sake of convenience and to insure a full understanding of the case whenever taken up for action; notation to be made on the subsequent papers, that they are filed with the first communication upon the case, and on the first paper that the others are filed therewith.

In references, "letters received" will be referred to by number, name of station, and year, and "letters sent" by volume and page.

Letters transmitting checks, how disposed of.—Letters transmitting checks for pay, &c., of observers, assistants, and others, will be carefully briefed, and then delivered to the person to whom they are addressed, with note of the date of such delivery made on the *copy* of the brief, which will be retained on file. Observers personally receiving such letters will fill up and sign the receipt attached thereto and return them, retaining copy of brief on file, with note thereon of date of return of original.

Notations of the date or number of all letters, orders, circulars, memoranda, &c., will be placed on the papers based upon such communications.

Letters from the Chief Signal Officer will be replied to by letter, and not by indorsement, unless so ordered.

A strict conformity to these instructions is enjoined, and should an inspector find that letters received at a station have not been briefed, &c., as prescribed by these instructions, for more than two days previous to his arrival, the neglect will be considered sufficient cause for the reduction in rank of the observer in charge of such station.

Letters sent.—"Letters sent" is the official designation of all communications *sent from a station or office* similar in character to "letters received," as described. Such communications will be *recorded* in full in the order of their dates, in the book of "Letters Sent," with the exception of indorsements on "letters received," which will be recorded as already explained.

Marginal references.—In the margin of the "Letters Sent" book, other than press-copy-book, the entry marks of any letter received or sent, relating to the letter being recorded, will be noted in red ink; "letters received" being referred to by number, station, and year, and "letters sent," by volume and page. When a similar letter or telegram is sent to several addresses on the same date it will be recorded once only, and note will be made underneath, "Sent also to —— ——."

The word "telegram" will be written in red ink in the upper left-hand corner of the entry of telegram in "letters sent."

Letter-press books, rules for using.—Upon the receipt at a station of a copying-press, book, dampener, &c., the *written* record of letters sent will be discontinued, and a memorandum made in the current book of "letters sent" of the date of such discontinuance, and that copies of *all* subsequent letters will be found in letter-press copy-books. The latter will thenceforward be the only record kept of letters sent from the station, and will be indexed, &c., as hereinafter provided.

The books will be neatly marked on the back with the name of the station, number of volume, and the dates between which it is the record.

A perfect copy of every letter must be obtained, and to do this the following directions will be observed:

Use a good copying ink, such as Carter's.

The directions for filling the dampener are printed on each box containing it; they must be strictly followed, except that any piece of clean cloth may be used in place of a towel.

To make a copy: Open the book, place the oil-board on the left half of a book, turn a leaf over on it, and roll the dampened cylinder from the center of the book outward, toward the left until the sheet is thoroughly damp. Once or twice rolling will be sufficient. Then take a sheet of blotting paper and gently press it on the sheet so as to remove any surplus water, remove the blotting sheet and place the letter to be copied face down upon the wetted sheet; on it place a sheet of blotting paper, close the book, and apply the press. Too much force is unnecessary, and is liable to break the press.

When a letter fills two or more pages, one page should be copied at a time, and a sheet of oil-board, cut the size of a sheet of the book, should be placed between the second and third pages while the first and fourth pages are being copied, and between the first and fourth pages while the second and third pages are being copied; this is done to prevent "off setting" and blurred letters.

In copying a letter written upon a printed form the number of the form will be written on the upper left-hand corner of the first page, in copying ink, and a blank form should be pasted in front of each book. When the form has no number the blank should be pasted in front of the book, and a proper reference made on each press copy.

The leaves of the book must in no case be torn out, but if spoiled in copying, a memorandum to that effect should be written across the face of the leaf so spoiled.

Indexing.—A yearly alphabetical index will be kept up from day to day for each record book of letters sent. The index will contain the

names of all persons and things appearing in the record book and the subjects of the communications recorded therein, no name being entered more than once. Following each name, in black ink, in an index, will appear the numbers of all communications received from or relating to the person or thing concerned (space being provided for the purpose); the numbers of the communications in which the name appears in the body of the letter, and not as the writer, being distinguished by the use of red ink. In the indexes of letters sent, the numbers refer to the pages of the record book on which the communications are transcribed. Notations on letters received will be made in red. All names in briefs and indorsements, which require indexing, will be underlined in red. (See example of indexing, &c., page 100).

Handwriting and writing material.—Handwriting in record books and on official papers will be plain and of good size; flourishing and ornamental writing are especially to be avoided. Proper names should always be written with special care.

No other writing fluids than good black and red inks will be sanctioned, and copying-ink will be used only when letter-press copies are to be taken.

Record books not open to the inspection of unauthorized persons.—"Letters received," the books of "letters sent," and the books of "letters received" (now discontinued), kept at stations of the Signal Service, are official records, and will be open only to the inspection of the officers of the Signal Service and the observers on duty at the station to which the records belong.

No reports or letters containing information in reference to the Signal Service, or any of its duties, will be made or sent to any person or persons by members of the Signal Service until such reports or letters have been submitted to, and approved by, the Chief Signal Officer.

All written communications, such as reports on the verification of storm signals, &c., between the central office and any station of the service, are confidential, and will not be made public without authority from this office.

Letters on official subjects, how sent.—All letters upon official subjects from persons in this service should be forwarded only through official channels. Requests for changes of station, promotion, leave of absence, or indulgences are of this class, and if received through other channels they will be treated as if sent in violation of this order.

All communications should be made as brief as possible without impairing the sense of the subject treated.

All official communications (except those from the central office) received from any source, which in any manner affect the service or its official work, will be immediately forwarded for such action as may be considered necessary. Communications from substations (display, river, or cotton region, &c.) on routine matters are excepted.

Communications will be written on the official size of letter paper, and, when for the central office, inclosed in an official envelope, and directed to the "Chief Signal Officer of the Army, Washington, D. C.," and not to individual officers.

Observers will write, in bold letters, in the lower left-hand corner of the envelope, if there are no special envelopes on hand, the words "Property," "Stations," "Records," or "Review," as the case may be, whenever mail is forwarded pertaining to the work of the divisions so designated; but *no letters* will be inclosed in envelopes so marked for Records or Stations Division.

Matters relating to different subjects not to be embodied in the same letter.—Observers will not embody in the same communication matters relating to different subjects. Correspondence relating to meteorological observations and general details of duty will be separate from that relating to property, commutation or pay vouchers, bills, or any particulars involving money or property accountability. Each subject will be disposed of by a separate letter.

Letters of transmittal will not be forwarded with meteorological forms.

In acknowledging, state clearly contents of communication acknowledged.—In acknowledging the receipt of communications, and in all correspondence based upon letters received from the central office, observers will state clearly the nature of the contents of the communication to which they reply, and will quote the reference marks, as indicated upon the letter received, and usually in the following form:

In reply to your letter of the ———, [No. ———, P. D. (or Obs. or Sig., as the case may be), 188—], I have the honor, &c.

When more than one letter on the same subject is written, each succeeding letter must refer by date, &c., to the previous letter. All proper names will be given in full.

Manuscript reports.—Observers in preparing manuscript reports, that do not partake of the nature of a letter, and which may be of general interest, will write them on paper of letter size, leaving a margin of one and a half inches on left side of first page, right side of second, left side of third page, and so on, so that the paper may be stitched in book form if considered advisable.

Communications referred for report, how returned.—Communications referred by the Chief Signal Officer to a station for report, &c., will be returned by indorsement; copies of the briefs and report to be retained at the station.

Indorsements will be written, successively, crosswise upon the folds of the communication, beginning with the second fold (the first fold being always reserved for briefing, noting action, &c.)—additional sheets being pasted on if required—and will be commenced (after name of station and date), "Respectfully returned," or "Respectfully forwarded," &c., as the case may be. At close of indorsements such words as "Very respectfully," &c., required in subscribing to letters, will not be used, but the signature, rank, and corps only will be affixed.

Reports and remarks of any considerable length may be written on separate letter-sheets and inclosed with the communication, which will then be indorsed (after name of station and date), "Respectfully returned to the Chief Signal Officer, Washington, D. C., with report called for inclosed," &c., and marked below indorsement, in red ink, "One inclosure."

Indorsements, as well as letters, addressed to public officers on the business of their offices, will designate them by their official title and not by their individual names.

Letters forwarding bills.—In letters forwarding bills, great care will be taken to specify the amount of each bill, with date upon which each item was contracted, and also to note the date of all payments under the brief of the letter containing the remittance.

Communications from observers at military posts, how forwarded.—Observers on duty at military posts will forward *through the post commander* such communications as relate specially to the admin-

istration of the post, or to any of the officers or enlisted men on duty thereat.

Observers, in signing official communications, bulletins, &c., will give their full name and add their actual military rank and corps.

The words "Signal Corps" will be used when referring to the *personnel*, and "Signal Service" when referring to the service in general.

Observers in reporting errors made at their stations will always give the name of the observer making them.

The words "Official Business," when not printed, will be written on the upper left-hand corner of envelopes.

Copies of papers, as well as originals, will be written on both sides of the paper used, unless it is intended to take a press-copy, or it is probable that the matter contained therein is to be printed.

Half sheets of paper will be used in all cases in which letters are completed on the first page. When more than one page is required a whole sheet will be used, so that the last page may be free from writing for the purpose of briefing, indorsing, &c. When more than one sheet is used, each sheet will be numbered in the upper right-hand corner.

The stationery, &c., furnished stations will not be used for correspondence of a private or unofficial character.

General orders and circulars, how filed.—General orders and circulars will be pasted in Shipman's files, furnished for the purpose. In beginning a new year observers must be careful to ascertain that there are sufficient stubs remaining to contain all the orders and circulars for the year, which can be approximated. If it is thought that there are not sufficient stubs a new file will be used, as it is very objectionable to have the orders and circulars for one year in two books. General orders and circulars will be marked, in red ink, at the bottom of the first page, with the name of station and date of receipt. Special orders will be briefed and acted on as other "letters received."

General orders and circulars not to be acknowledged.—The receipt of *General Orders, Circulars, and Circular Letters* will not be acknowledged, but an entry will be made in the Abstract of Journal, on the last day of each month, giving the number of the latest General Order and Circular, and the date of all Circular Letters received during the month; in same entry request will be made for any numbers of the series of Orders and Circulars which may be missing, except those *not for general distribution.* An order or circular which is not intended for general distribution will be so announced at the foot of the next succeeding order or circular.

Explanation of the manner of briefing letters.—The following examples illustrate the manner of briefing letters received and treatment of inclosures:

EXAMPLE A.

SIGNAL OFFICE, WAR DEPARTMENT,
Washington City, April 12, 1887.

Sergeant JOHN SMITH,
Signal Corps, Milwaukee, Wis.:

SIR: Inclosed herewith is a copy of a letter from Mr. Louis Decker, requesting that the 7 a. m. map be furnished daily to Mr. James R. Stone, Racine, Wis., to be displayed for the benefit of the public. I am directed by the Chief Signal Officer to instruct you to place Mr. Stone's name upon your list and furnish him the map regularly. Report your action.

Very respectfully, your obedient servant,

JOHN JONES,
Second Lieutenant, Signal Corps.

The following shows the brief, marks, &c., which should be placed on first, or brief, fold of the foregoing letter:

*94. Milwaukee, 1887.
Washington, April 12, 1887. Chief Signal Officer, by Jones, Lieut. John.
Directs a. m. map be furnished daily to *Mr. J. R. Stone*, Racine, Wis., as requested by *Mr. Louis Decker*.
*(One inclosure.) *See L. S., Volume 1, page 59.
*Received, Milwaukee, April 19, 1887.

All office-marks (those marked with asterisk) in red ink; brief in black ink. "L. S., Vol. 1, page 59," refers to letter subsequently written in regard to this map.

INCLOSURE TO EXAMPLE A.

(Copy.)

MILWAUKEE, WIS., *April* 9, 1887.

To the CHIEF SIGNAL OFFICER, *Washington, D. C.:*

SIR: I have the honor to request that the observer in charge of the station in this city be directed to furnish the a. m. map daily to Mr. James R. Stone, Racine, Wis., to be displayed for the benefit of the public.

Respectfully, yours.

LOUIS DECKER.

This letter, as an inclosure to the example immediately preceding, should bear the following marks only:

*$\frac{1}{94}$. Milwaukee, 1887.

NOTE.—If there were other inclosures, they should be marked $\frac{2}{94}$. Milwaukee, 1887, $\frac{3}{94}$. Milwaukee, 1887, &c.

*Red ink.

EXAMPLE B.

SIGNAL OFFICE, WAR DEPARTMENT,
Washington City, April 12, 1887.

Sergeant JOHN SMITH,
Signal Corps, Milwaukee, Wis.:

SIR: I am directed by the Chief Signal Officer to inform you that one stylus dropped by you from your property return for first quarter, 1887, must be taken up until inspected and condemned by proper authority. You will make the necessary correction in the retained property return for that quarter.

Very respectfully, your obedient servant,

ROBT. CRAIG,
First Lieut., Fourth Artillery, P. & D. Officer.

This letter should be briefed, &c., as follows:

* 90. Milwaukee, 1887.
Washington, April 12, 1887. Chief Signal Officer, by Craig, Lieut. Robt. P. & D. Officer.
Directs that one stylus dropped from return for first quarter, 1887, be taken up until inspected, &c., and that retained copy be corrected.
* Received, Milwaukee, April 15, 1887.

The following illustration of the mode of entering "Letters sent" will show the manner in which the several notes are made:

SIGNAL SERVICE, OFFICE OF THE OBSERVER,
Milwaukee, Wis., May 3, 1887.

* 94 Milwaukee, 1887.	TO THE CHIEF SIGNAL OFFICER, *Washington, D. C.:* SIR: I have the honor to report that I am verbally informed by Mr. Louis Decker that Mr. J. R. Stone, of Racine, Wis., has removed to Oregon, and that in consequence, I have this day discontinued the weather map ordered by communication from your office under date of April 12, 1887. Very respectfully, your obedient servant, JOHN SMITH, *Serg't, Signal Corps.*

NOTE.—In case any other letters had passed in this connection the entry-mark should be entered in the margin.

* Red ink.

In indexing "Letters sent," the proper names will be followed by the number of the page on which the letter containing the name is to be found; if it is the name of the person to whom the letter is written, it will be entered in black ink; otherwise, in red. Each name will be entered but once, and the numbers will follow it successively, as follows:

Signal Officer, Chief, 1, 3, 4, 8, 10, &c.
Wind-vane, 3, 10, 29.
Wentworth, H. W., 18, 24, 26.

The following names and subjects should be indexed in the examples of letters received and sent, given in the preceding paragraphs, assuming that the letter sent is entered on page 25 of the letter-book:

"LETTERS RECEIVED."

Chief Signal Officer,	90. 94.	(under the letter S.)
Craig, Robt. (Lieut.)	90.	(under the letter C.)
Stylus, relating to	*90.	(under the letter S.)
Jones, Jno. (Lieut.)	94.	(under the letter J.)
Weather map, relating to	*94.	(under the letter M.)
Stone, James R.	*94.	(under the letter S.)

"LETTERS SENT."

Chief Signal Officer,	25.	(under the letter S.)
Decker, Louis	*25.	(under the letter D.)
Stone, J. R.	*25.	(under the letter S.)
Racine, Wisconsin,	*25.	(under the letter R.)
Weather map, discontinued	*25.	(under the letter M.)

All *names* and *words* will be written in *black* ink, and in these examples all *figures* except such as are asterisked, which latter will be written in *red* ink.

For further instructions relative to conducting correspondence and keeping records thereof,

See pages _____

_____

_____

_____

See Signal Office General Orders _____

_____

_____

_____

NOTE.—These instructions will be kept complete to date by entering in the blank lines of the proper clause the numbers and series of all orders which in any manner modify them.

PURCHASES AND EXPENDITURES ON STATIONS.

Any arrangement made with the person from whom the observer's office is rented should be in writing, a copy of which will be retained at the station, and the original forwarded to the office of the Chief Signal Officer for action.

In matters of business, it is not sufficient for the agents of this service to report over their signatures that a person said thus and so; but

* Red ink.

the statement of the person himself, properly signed by him, should be presented.

A lease of the office room for one year, with the privilege of renewal on the part of this service, will be made out on the regular form furnished by the Property and Disbursing Officer.

Requests for authority to make purchases; when made.—Requests for authority to make purchases will be made annually, and cover as nearly as possible the articles needed for actual consumption during the twelve months next ensuing.

Private funds not to be used for official purposes.—Private funds will not be expended by men of the Signal Corps for official purposes, nor for any object whatever connected with the transaction of official business, except as provided for in these instructions.

Expenses not to be incurred without authority.—Before incurring any debt at stations authority must be obtained from the office of the Chief Signal Officer. When, however, the emergency is too great to await authority by mail, and the amount involved justifies it, the Chief Signal Officer should be briefly informed by telegraph of the circumstances and probable expense; but bills for such expenses will be allowed only when the emergency is clearly shown to have existed, and in such cases observers must secure the service or make the purchase desired at the lowest possible prices, getting bids whenever possible.

All applications for authority to make purchases or expenditures must be made on a form furnished for the purpose.

Bills, how forwarded, and what must accompany them.—In forwarding bills for authorized purchases or expenditures, the letter of authority *must* accompany them, as without it the bills will not be considered; and they must also be accompanied by memorandum receipts, in accordance with the instructions printed on the back of the vouchers.

Except in cases of emergency, purchases which have been authorized will not be made during the last fifteen days of any quarter, and the bills for articles bought in March, June, September, and December, will accordingly be forwarded for settlement on the 15th day of those months, respectively, or as soon thereafter as practicable.

Purchases and expenditures to be noted in the expense book.—Every purchase and expenditure must be noted in the station expense book in detail, with reference to the authority upon which they were contracted.

As the sub-appropriation from which the bill must be paid is stamped on the letter of authority, the bill must correspond with the letter. In other words, one bill must not be rendered for purchases or expenditures authorized by two or more letters of authority, each having the stamp of a different sub-appropriation.

Requests for authority to make purchases or expenditures which can be anticipated, at stations, must be made quarterly on the proper form. Where the exigencies of the service require it, requests on the same form can be made at any time, but must be accompanied by a letter of transmittal fully explaining the necessity.

This form must state the price and give the name of the person or firm to whom the award has been made, or with whom a formal written contract exists. Notice of this name and contract is furnished the observer and the number at the top of said notice will be quoted.

Bids, how obtained.—As the law requires competition, bids for supplying articles or rendering services must be obtained from tradesmen

for all classes of articles or services (e xcept personal services, such as civilian assistants).

A supply of circulars will be furnished, upon application, to be used in advertising for bids. These circulars have printed on the back general instructions to bidders, and they should be thoroughly understood and must in all cases be carefully followed.

These circulars, properly filled up and addressed to the public, will be furnished, in duplicate, to each bidder, together with the special form of envelope in which the proposals are to be returned.

In filling up the circular fix a date and *hour* when the bids are to be in, which, unless otherwise ordered, must be at least ten days from the date of the circular, said date not to be counted, except where the bids are for articles needed for current use during a fiscal year. In such cases the circular must indicate that the prices are to hold good during the fiscal year (which extends from, and including, July 1st of one calendar year to June 30th, inclusive, of the succeeding calendar year), and a notice of at least thirty (30) days must be given, the date of the circular not to be counted.

In asking bids, each person must be given identically the same information, and if drawings or specifiations are submitted, such drawings or specifications must be securely attached with mucilage to each copy of the circular.

Bids for fuel, how prepared.—In inviting bids for coal, thirty days' notice will be given. The bidder will specify the number of pounds to the ton, the kind of coal, by its trade name, *i. e.*, the name of the mine or locality where the coal is mined, such as Lehigh, Wilkes-Barre, Schuylkill, &c., where and in what quantities it is to be delivered, whether anthracite or bituminous, and the size, whether stove, egg, or chestnut. The same applies to wood, whether oak, ash, pine, &c., and the length and size into which it is to be cut.

Bids must be obtained for all fuel (coal or wood) needed at a station as required by the above paragraph, except where such fuel can be obtained in the manner contemplated by paragraph 1760½, Army Regulations, 1881. The paragraph reads: "Quartermasters' property may be transferred by the officers of that department to the officers or agents of the Signal Service, on their requisition, approved by the Chief Signal Officer, for the use of signal officers or stations at or near military posts. The cost of the stores so transferred will be reimbursed from the appropriations for the Signal Service, upon the receipt by the Quartermaster-General of a report of their cost. The receipt of the officer or agent receiving the stores will be taken by the officer making the transfer, for file with his returns, and such receipt must show that request has been made for reimbursement of the cost of the stores so transferred."

Contracts for the fuel based upon the bids will be made in the form prescribed by law.

Requests for authority to purchase fuel must be made quarterly on the proper form, and, if approved, a letter of authority will be issued, but no purchase of fuel must be made until the receipt at the station of such letter of authority.

Bills for fuel must always specify the number of pounds to the ton of coal or feet to the cord of wood.

Certificate of inspection of fuel.—All fuel purchased for the use of the stations of the Signal Service must be inspected, and duplicate certificates of such inspection furnished with the bill and vouchers covering the purchase.

The certificate must be in the following form:

(Place) ——— ———,
(Date) ———, ———.

I certify that in accordance with paragraph 1902, Army Regulations, 1881, I have this day inspected the following fuel:
——— tons of coal (2240 pounds to the ton).
——— pounds of coal.
——— cords of wood (128 cubic feet to the cord).
——— of wood.
——— ——— as per bill herewith delivered by ——— ———, of ——— ———, on the ——— day of ———, 188–, under contract dated ——— ———, 188–, for the use of the Signal Service, and that the ———* ——— correct, and the fuel is of good merchantable quality.

(Signature) ——— ———,
(Rank) ——— ———.

*The words "weight" or "measurement," or both of them, to be inserted, according to the character of the fuel inspected.

(To be in duplicate).

The law (section 3711 of the United States Revised Statutes) requires that each ton of coal must consist of two thousand two hundred and forty (2,240) pounds, and each cord of wood must be of the standard measure of one hundred and twenty-eight (128) cubic feet, and inspectors must see that the fuel is up to this requirement.

By authority of the honorable the Secretary of War (2708, C. W. D., 1886), the officers, observers, or other employés of the Signal Corps, at the various stations, are designated to act as such inspectors, in analogy to the post quartermasters provided for in paragraph 1902, Army Regulations, 1881.

Inspection of fuel at the yard of contractor.—The inspection should take place at the yard of the contractor, and after the fuel is loaded ready for delivery, but if such is not practicable, other arrangements must be made, but in no case is the Signal Service to be put to any additional expense.

The inspection must be made and the certificates signed by the ranking officer or non-commissioned officer on duty at the station; but if only one man is on duty at the station, the inspection will be made and the certificates signed by that man.

If, before the contract can be completed, any fuel should be required, the observer must request authority for the purchase of a small quantity in open market, enough to last until a quantity can be purchased under the contract.

It is not sufficient that an observer report that bids could not be obtained unless every effort has been to secure them; each step necessary must be taken and, if at the time fixed for the bids to be in, none is received, then only can it be stated that bids could not be procured. All the papers are required and must be sent with a letter of transmittal, showing what steps were taken to procure the bids.

In asking for bids for illuminating oil, state the exact kind by its trade name, its flashing test, and how it is to be delivered.

Bids for stoves should specify kind, name, maker's name, and number.

Number of persons to be invited to bid.—Always invite at least three dealers or persons to bid (and as many more as possible), always being governed by the circumstances of the case. Thus, where thirty days' notice is given, the notice to bidders must be very generally distributed. If there are but one or two dealers in the town, bids must be

invited and the fact that *all* dealers in the place were invited to bid noted on the list of persons requested to bid.

One copy of the notice, properly filled up, must always be posted in a conspicuous place where the public will see it, and the fact that this has been done will be noted at the bottom of the list of persons asked to bid.

These requirements should be carefully studied and strictly followed in every respect, as much delay is caused in issuing letters of authority when any informalities appear on the papers submitted.

In preparing the special form of envelope which is to be sent out with the notices, mark each one "Proposals for ——— " (filling up the blank), also indicate thereon the hour and date until which the bids will be received.

As soon as each envelope containing a bid is received it must be indorsed plainly, in red ink, with the exact hour and date at which it was received.

Bids received after date for opening has expired.—Any envelope containing bids received after the time fixed for them to be in must not be inclosed with the other bids, but sent with a separate letter of transmittal, stating the circumstances of its receipt and the exact hour and date on which received. Although all persons asked to bid may have sent in their proposals before the time fixed, the bids must be held until the very date and hour specified in the notices before being forwarded to the Chief Signal Officer.

Bids, how forwarded.—When the limit of the time for the notice has expired, the bids should be forwarded, *unopened*, with a letter of transmittal, which must enumerate each and every paper inclosed. The papers to be inclosed in this letter are:

(1) Form requesting authority to make purchases or expenditures, with columns properly filled up, except, of course, as to cost of the articles, &c., applied for, which is to be left blank.

(2) List of persons invited to bid, in duplicate, which is to be counted as two inclosures.

(3) The bids sealed and properly indorsed.

(4) One copy, properly filled up, of the letter sent out asking for the bids. As a rule, the copy posted can be used for this purpose.

The letter of transmittal should show, in the lower left-hand corner, in red ink, the number of inclosures, as (—— inclosures).

Needs of the station must be anticipated in time to give the notice of ten days, or more, and the time to have the papers reach the central office and the authority to issue therefrom, which, of course, will vary as the distance of the station from Washington, D. C., but at least one month would seem to give ample time. Notices of thirty days must be given in each case where the prices are to remain good for the fiscal year. Notices of ten days cover only the purchase of the article and the quantity for which bids were asked, and cannot be used for purchasing additional quantities of the same article.

In the letter of transmittal the open market price of each article needed must be stated.

Items of expense for stabling public animals, hire of teams and boats in repairing telegraph lines and the like, can be anticipated and must be incurred only after inviting proposals.

In cases of ferriage, tariff rates, in duplicate, should be procured from every ferryman, or ferry company, whose ferry may be used, and forwarded for file for use in examining accounts of this nature. In case of tolls, obtain the printed schedule of rates from the toll-keepers.

Bids opened by an observer, how prepared.—Whenever the observer is directed to get bids and open them himself, he will be required to enter in black ink upon the "Abstracts of proposals," in accordance with the several headings, full information showing the bids as received, and under the column of "Remarks" any other information. He will certify that he opened the bids at the specified time, and recommend that the award be made to (naming the bidder).

As a rule the award should be recommended to be made to the lowest bidder. In case it is not so recommended, the reason why the award should be made to other than the lowest bidder should be set forth in detail in the form of a certificate, and signed by the observer. The papers should then be inclosed and addressed to the property and disbursing officer, with a letter of transmittal, fully setting forth all action taken, and inclosing the form requesting the purchases or expenditures, as required by these instructions.

Water and gas, rates for, when forwarded.—Where water or gas is used continuously at a station it is intended to make yearly contracts covering the items, and for this purpose observers and others in charge of stations must obtain and forward, in May of each year, the rates for the same, with the name of the corporation from which obtained, so that contracts can be made, if found necessary.

One copy of all formal written contracts is usually prepared and forwarded to the observer with instructions to make four copies. An extra blank is always sent for use in event of spoiling one in copying. This extra form should be prepared and preserved among the station records for the information and guidance of the observer during the time the same is in force.

Bills for services to be rendered quarterly.—When the persons interested are willing, bills for services should be rendered quarterly; in all other cases they must be rendered monthly. Bills contracted under special letters authorizing expenditures or purchases should be forwarded immediately upon incurring the debt, and accompanied by the letter of authority, in accordance with instructions printed thereon. Should, however, the letter of authority not be used, it must be returned at once for cancellation, by indorsement, stating the reasons why it was not used.

As the small clerical force at the central office is unable to properly and promptly perform the large and constantly increasing amount of work involved in the settlement of the many accounts for small sums forwarded monthly for payment; in the packing, shipping, and accounting for the supplies of stationery, &c., and in the preparation of letters of authority for purchases, observers will exercise proper judgment in carrying out the following special instructions, so that no unnecessary expense may be incurred:

Bills for services of cleauers will be rendered quarterly, and in every case the observer will procure such bills and forward them promptly at the expiration of each quarter, informing creditors of the reason for so doing. So far as practicable other bills, such as those for rent, gas, ice, and water, if the creditors are willing, should be rendered quarterly.

Bills forwarded for payment, or receipted vouchers returned, must be accompanied by letters of transmittal enumerating the inclosures.

Data to be noted on bills for rent of office.—The following data will be noted on all bills for rent of office:

Number of rooms occupied by observer, and the floor or floors on which located.

The numbers of the rooms in the building, if known, as "Room No. 4."

Name of building, if it has a special name.
Number on street.
Name of street on which the building is located.
City or town.
Whether the rent of office includes cleaner's service, heating, lights, water, &c.

Bills not to be made out in name of observer.—*As reimbursement cannot be made for money paid out* except as provided for on page 116, bills will not be rendered in the name of the observer or other person in charge of the station, but must be in the name of the party who performed the service or furnished the supplies.

Observers to certify to bills and reports.—Observers in charge of section centers will receive, examine, and certify to the correctness of all reports and bills from special stations, and then forward them to the central office.

If reports or bills are not received at the section centers within three days after the period at which they are due, they will be called for by mail. Any persistent neglect of a special observer in this direction will be reported to the Chief Signal Officer, with such recommendation as the observer may consider proper to make to improve the service. Defective reports or bills which cannot be remedied at section centers will be sent back to the special stations for correction. Section centers will report to the Chief Signal Officer on the fifteenth day of each month as to the reports or bills which are missing for the previous months, giving the probable reason therefor.

In certifying to bills, care will be exercised to see that the time for which charge is made is correct, the vouchers properly signed, &c. Bills will not be certified to until the reports which they cover are received and acted upon. Each bill will bear the following certificate on its face, signed by the observer in charge of the section center: "The account is correct and just and the services have been rendered as stated."

Bills will be rendered on the proper forms and filled out as follows:

For services rendered as ———, at ——— ———, for the month of ———, 188—, for ——— (give the number of days or observations), at ——— cents per day (or observation).

When an observation or report has been missed, the fact will be noted on the face of the bill; for example, "No observation taken Aug. 2d and 7th." If extra observations have been taken they will be entered. The bill will be altered to agree with the work done.

Bills for services of an observer in charge of a special station will not in any case be certified to by the observer in charge of the section center until the former has fully accounted for the property at his station.

Observers responsible for correctness of bills.—Observers in charge of sections will be held responsible for the correctness of all bills certified to by them, and they will assure themselves of their accuracy before forwarding them to the central office. In no case will reports or bills be held at section centers longer than is absolutely necessary to act upon them.

To avoid the return of bills for correction or omissions observers will note the following rules:

The name and address (number, street, city, and State) of the creditor must be plainly written at the top, and each bill must bear the certificate of the observer on its face, as follows:

Correct.

(Signature) ——— ———,
(Rank) ——— ———.

If for supplies, the date of purchase of each article, the quantity, the price per unit (as per pound, per gallon, &c.), the total price of each article, the total price of all the articles, and the authority upon which the purchase was made must be entered thereon.

If for services rendered, or in like cases (in addition to name, address, &c.), the inclusive dates of service must be given, together with the rate of pay per day or month, &c.

When fractions of a cent less than one-half occur in the total of a bill they should be disregarded, but if the fraction be one-half or greater it should be recorded a whole cent.

Payment will be made for any full calendar month's service at a stipulated monthly rate of compensation (or yearly rate if paid in regular monthly or bi-monthly installments), without regard to the number of days in that month.

Service rendered in fractional parts of a month, how computed.—When service *begins* on an intermediate day of the month thirty days will be assumed as the length of that month, whether the calendar length be twenty-eight, twenty-nine, thirty, or thirty-one days, and pay allowed accordingly.

When the service *terminates* on an intermediate day of the month the actual number of days during which service was rendered in that calendar month will be allowed in payments.

When the service embraces two or more months, or parts of months, but one fraction will be made, thus: From September 21 to November 25, inclusive, will be calculated September 21 to October 20, inclusive, one month; from October 21 to November 20, inclusive, one month; from November 21 to 25, inclusive, five days; making the time allowed two months and five days.

When two fractions of months occur, both together less than a whole month, as from August 21 to September 10, the time will be determined thus: August 21 to 30, inclusive (ignoring 31), ten days; from September 1 to 10, inclusive, ten days, making the time allowed twenty days. Service commencing in February will be calculated as though the month contained thirty days, thus: From February 21 to 28 (or 29), inclusive, ten days; but when the service commences on the last day of February only one day will be allowed in that month.

For services of persons employed at a per diem rate, payment will be made for the actual number of days.

When services are rendered from one given date to another, the account must state clearly whether both dates are included.

Vouchers to receive autograph signature of creditor.—All vouchers must receive the autograph signatures of the party or firm in whose name they are made, and must in no instance be signed by a clerk or others for them. Vouchers must always be signed with *black ink.*

The signature to the receipt and the name of the person or business firm as entered at the head of an account must be literally alike. When payment is made to an "attorney" he will be required to sign the receipt with the name of the principal, adding the words "by his (or her) attorney in fact," signing his own name thereafter.

But in all such cases the attorney will be required to produce a duly authenticated "power of attorney," executed before a clerk of a court of record and acknowledged before him.

Accounts rendered in name of a corporate body, how signed.—Where accounts are rendered in the name of a corporate body they must be signed by the treasurer (in his official capacity), unless it is made to appear by evidence filed with the voucher that the charter of the company has authorized some other person to sign, or that by official

action of the board of directors some person other than the treasurer has been duly authorized to sign receipts for the company.

If a company, but not a corporate body, the voucher should be made out in the firm-name and receipted by some member thereof duly authorized by the company to so receipt, which evidence must be filed with the voucher.

Vouchers signed by trustees, executors, or administrators.—Vouchers signed by trustees, executors, or administrators must be accompanied (the first account) with a certificate of the clerk of a court of record, under seal, attesting their appointment and qualification.

Voucher signed by mark.—Vouchers signed by mark must in all cases be witnessed by at least two persons, neither of whom should be the observer who certifies to the bill. Signatures by mark are usually written thus:

his
"JOHN X SMITH."
mark.

Vouchers in the name of national banks should show at the head the full corporate name, and should be receipted in like manner by the cashier.

PROPERTY.

Property Reports to be rendered.—The property reports named below are required to be rendered at the specified times from stations of this service:

Annual estimate of stationery, forms, &c. (meteorological stations).
Quarterly return of property.
Final return of property on relief of observer.
Quarterly report of cautionary signal equipments from stations reporting direct to the Chief Signal Office.
Memorandum receipt for property purchased.
Sub-vouchers, purchases.
Sub-vouchers to original bill for purchases.

Quarterly report of property, when rendered.—Each observer will render within ten days of the expiration of the quarters ending March 31, June 30, September 30, and December 31, of each year, a report of property on the form furnished for the purpose. Instructions for the preparation of this form are printed on the back and will be strictly followed.

The object of making these returns is to present, at stated times, in a condensed form, and according to a well-arranged system, an exact account, duly vouched for, of all property for which the observer is properly to be debited, and also for all property with which he is to be credited. The difference between the two gives an exact accountability.

Property received, how taken up.—All property received from the office of the Chief Signal Officer or purchased at the station on proper authority must be taken up on the returns as received during the respective months for which invoices were sent, and the aggregate of the property received during the quarter, together with that on hand to be accounted for from last return, must be brought down in the line opposite the word "Total"; this gives the debit side of the return.

Property expended, how noted.—All property expended by proper authority or returned to the office of the Chief Signal Officer during the quarter must be noted in the proper column and the aggregate brought down and deducted from the total above mentioned. The remainder will be the total remaining on hand to be accounted for, and must be

taken up on the succeeding return as "Total on hand as per last report."

Property received to be taken up whether invoiced or not.—All property received at the station during any quarter must be taken up on the returns, whether invoiced or not. Should any article of property be received, either by purchase or sent from the office of the Chief Signal Officer, and not included in the invoices, special attention should be called to said fact by the observer; but these articles should be taken up and a foot-note made showing that they were taken up without invoices. It may happen in some cases that invoices of articles sent are received in a quarter while the articles themselves did not reach the station during that quarter. In this case the articles should not be taken up until they are actually received at the station; otherwise, the observer will make himself responsible for such articles while they may never reach him.

Report of articles not received.—A special report by letter should be made of all articles not received within a reasonable time after the observer is notified of their shipment, but the quarterly return of property should be promptly made up at the expiration of the quarter, without holding it back to await the receipt of any particular articles.

Credit slips, on which are noted the articles of property returned or transferred to other stations, are sent to all stations quarterly. Upon receipt of the quarterly credit slip by an observer, it should be carefully compared with the records of the station and any discrepancies discovered therein, whether shortages or surpluses, should be immediately reported for adjustment.

In all cases, in making up returns, the headings printed at the top should never be altered or changed, but when articles other than those enumerated in the printed headings are at the station, they should be inserted in the blank lines for that purpose on the return.

The observer or others responsible must verify returns by an actual count of all the articles on hand at the time the return is made.

Whenever any discrepancy exists between the actual count of the property and that as shown by the returns, if a shortage, a special report of the case should be made; if an excess, the articles in excess should be taken up with proper foot notes on the returns and special report made by letter.

Public property and labor hired not to be perverted to private use.—Public property and labor hired for the public use shall not be perverted to any private use whatsoever, not authorized by the regulations of the service.

Property unserviceable, how disposed of.—When any article of public property, not of an expendable nature, for which an observer is responsible, becomes unfit for service from any cause whatever, he will report the facts in the case and submit the article for action to the inspector first visiting the station, but will not drop such article from his returns until authorized by the Chief Signal Officer so to do. Credit will be given for articles condemned and destroyed by an inspector, as soon as his (the inspector's) report of inspection shall have been received and examined. If any article of property shall have been destroyed at the station for which no credit is given, report of such fact must be made without delay.

When any public property for which an observer is responsible needs repair, a report will be made giving an estimate of the cost and the observer's recommendations in the case.

Annual requisitions for supplies, when rendered.—Two annual requisitions for supplies will be made, on or before the 15th day of September of each year; one for *forms alone*, the other for stationery, envelopes, desk furniture, and miscellaneous supplies which as a rule are furnished from the central office. Supplies which are usually purchased on station, such as oil, matches, lamp chimneys, wicks, brooms, &c., will not be estimated for on the latter-named requisition. Meteorological instruments will also be omitted from this form.

Requisitions for forms and stationery will be made annually on the prescribed form, and will embrace all the different varieties required for use at station. These estimates must be made out carefully and embrace all forms and articles of stationery, &c., required for twelve months' supply, making ample allowance for such increase of work as seems probable from past experience.

Requisitions not to be made at irregular times.—Requisitions must not be made at irregular times. In cases of absolute necessity, which must be fully explained, special requisitions may be made in writing, but if a previous request, either regular or special, has been made for the same article such previous request must be referred to by date, &c. Requisitions for forms and stationery must not be made in the same letter; one letter must be written for the forms and another for the stationery.

Expenses of substations.—The special display stations, special cotton-region stations, special river stations, and special rainfall stations of the Signal Service are arranged in sections. Each section will be under the observer in charge of a station of the Signal Service, which station is known as "the section center." When practicable the name of the section center will be used to designate the section.

The accounts of river, cotton, and rainfall observers, cotton-region operators, displaymen, and of all persons whose salary, or compensation, is less than ten dollars per month, will be paid quarterly; one bill, with duplicate signed vouchers, covering the services rendered during the quarter, will be forwarded at the expiration thereof, in the same manner as monthly accounts are rendered.

Property not to be exchanged.—Articles of Government property must not be transferred from one office to another without special direction from the Chief Signal Officer.

Property returned to be plainly marked.—All instruments and public property of every description ordered to be returned to the office of the Chief Signal Officer will be plainly marked with the name of the station whence it comes, the weight of the package, if known, and the nature of the contents. The packages will be addressed to the "Chief Signal Officer, care depot quartermaster, Washington, D. C.," when sent by quartermaster transportation; otherwise, they will be marked simply "Chief Signal Officer, Washington, D. C."

Observers in charge of display centers will call particular attention to this point, and, if considered necessary, send to each displayman who is ordered to return property a proper tag or label to put upon the package containing said property.

Officers and observers on duty in the Signal Service are directed to exercise the greatest possible care in the use and transportation of meteorological instruments. Before being packed in the wooden cases the cisterns and tubes of barometers will be emptied, unless otherwise ordered. In future no one will be relieved from responsibility for loss by breakage until it is clearly established that every proper precaution had been taken against such loss.

Receipts for shipment of property, how disposed of.—Upon the shipment, by express, of any article of property which may be ordered to be turned into this office, observers are directed to procure from the express agent at their stations original and duplicate (so marked) receipts for the package or box, and forward them by mail on the date of shipment.

Freight, how transported to observer's office.—Whenever freight is delivered by carriers at their depots or wharves only, observers will hire the necessary drayage from such places to their offices, for public property shipped to them, and procure and forward receipted bills and vouchers for such drayage, as in the case of other accounts, indorsing upon the bill the number and date of the bill of lading, and the name of the officer who issued it. The bills of lading will be returned to the officer who issued them. A careful record of all bills of lading, especially as to their number, date, place at which issued, and name of issuing officer, must be kept.

Station discontinued; property, how disposed of.—When a station is discontinued the disposition of the property will be ordered from the office of the Chief Signal Officer, and in any event the observer will be held responsible that each article is properly disposed of as ordered.

Property shipped through Quartermaster's Department.—Whenever property is ordered shipped through the Quartermaster's Department it should be properly packed, without expense, if possible; if not, then bids should be obtained as hereinbefore described, and when the observer is communicated with by an officer or agent of the Quartermaster's Department for the purpose of shipping the property, said observer should promptly and fully give all information desired to such officer or agent to accomplish the shipment.

Memorandum receipts of property at special stations, where filed.—Observers in charge of display, river, cotton-region, or rainfall sections must obtain and keep on file for their own information and protection a memorandum receipt on the proper form for each article of unexpendable Government property issued to the special observers or displaymen in their respective sections.

These receipts will be filed at the station; and whenever an observer in charge of a section is relieved, he will turn over these receipts to his successor.

Property issued to special stations.—When any article of Government property of an unexpendable nature is issued from a section center to a special station it will be accompanied by the proper form, with the name of the article, or articles, written thereon. This form will be sent with a letter of transmittal, directing the person to whom the property is sent to check the articles, sign the form, and return it to the section center.

Property unserviceable at special stations.—Whenever any article of public property at a special station becomes unserviceable by reason of ordinary wear and tear, or otherwise, such as breakage by accident, &c., the person in charge of the special station will immediately notify the observer in charge of the section center, and inform him of the name of the article and the nature and extent of the damage. The observer in charge of the section center will thereupon communicate the facts, as thus reported, for instructions in regard to the disposition to be made of the property. In no case will any article of public property be thrown away on account of its becoming, for the time being,

unserviceable, but it will be held until orders are received from the Chief Signal Officer concerning its disposal.

Employés at special stations to render return of property.—Wind-signal displaymen, special river, special rainfall, and cotton-region observers will be required to mail, quarterly, a return of Signal Service property, on the proper form, to the observer in charge of the section center, who will check and see that all articles actually at the special station have been taken up and reported thereon.

Property at special stations to be accounted for.—All property issued to special stations must be accounted for by the observer in charge of the center on his quarterly report of property. No article of an unexpendable character will be destroyed or disposed of, except by special orders received from the Chief Signal Officer.

Whenever an observer in charge of a special station fails to comply with the instructions of the observer in charge of the section center, the latter will immediately report the fact, with a full statement of the circumstances connected with the case, in order that the necessary action may be taken.

Attention of observers is called to the following paragraphs of the Army Regulations, 1881:

"1749. If any article of public property be embezzled, or by neglect lost or damaged, by any person hired in the public service, the value or damage, as ascertained, if necessary, by a board of survey, shall be charged to him and set against any pay or money due him.

"1750. Public property lost or destroyed in the military service must be accounted for by affidavit, or the certificate of a commissioned officer, or other satisfactory evidence."

Property lost or destroyed to be accounted for by affidavit.—Affidavits covering loss or damage to public property without fault of the person having charge of it should state the following: (1) The identity of the person making the affidavit, his duties, and the fact that he had charge of the lost or damaged property. (2) The articles lost or damaged to be enumerated. (3) The name and rank of the officer who is responsible to the United States for the lost or damaged property. (4) The circumstances of the loss or damage fully set forth. (5) The means taken to recover the property or repair the damage. (6) Care taken of the property and whether the loss or damage occurred with or without the fault of the person having charge of it.

Affidavits or depositions may be taken before any officer in the list following when recourse cannot be had to any of the before-named in the said list, which fact shall be certified to by the person offering the evidence, and be included in the body of the affidavit:

(1) A civil magistrate competent to administer oath. (It is preferable always to take the affidavit before a clerk of a court of record, to which his seal should be attached as such.)

(2) A judge-advocate.

(3) The recorder of a garrison or regimental court-martial.

(4) The adjutant of a regiment.

(5) A commissioned officer.

For further instructions relative to property, and to purchases and expenditures on stations, see instructions on the proper forms.

See pages _____

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See Signal Office General Orders _____

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NOTE.—These instructions will be kept complete to date by entering in the blank lines of the proper clause the numbers and series of all orders which in any manner modify them.

CHANGE OF STATION OF OBSERVERS.

Observer relieved from charge of station.—When an observer is relieved from the charge of a station he will turn over to his successor all property, stores, and money (line receipts) for which he is officially responsible, and will take duplicate receipts therefor on the forms furnished for the purpose, one copy of which he will forward to the officer responsible for the property and the other will be retained at the station. A third copy may be made for the observer relieved, if he so desires.

This form will be made out in precisely the same manner as the regular quarterly report.

Observers receipting for property to verify each article.—Observers in receipting for public property at stations of the Signal Service will verify each article receipted for *by actual count, or by the memorandum receipts of the persons having charge of the same.*

In no case will property be receipted for not actually turned over as prescribed above. An error especially to be avoided is that of giving a receipt for missing property under the impression, perhaps, that if a note is made on the margin of the form showing such and such articles to be missing, no responsibility attaches to the person giving the receipt. If an observer is responsible for five axes and can find but four, the transfer should be as follows:

On hand from last return of Sergeant A. B	
Total to be accounted for	5
Transferred to Sergeant C. D	5
	4
To be accounted for by Sergeant A. B	1

A report upon deficiencies, should there be any, *must accompany the final return of the observer relieved.*

Said report must be full and comprehensive, and should contain sufficient evidence to enable the Chief Signal Officer, or a board of survey, to place the responsibility where it justly belongs. (See instructions on the back of the forms for quarterly returns of property.)

When public property is receipted for by an observer, he must make a careful examination of it, and forward a written report of such examination, if in his opinion the circumstances of the case warrant such action. In case of damage to property or stores, excepting the ordinary wear and tear, the final report must state the condition of each article.

Responsibility of observers for property.—Observers of the Signal Service receipting for Government property, at a signal station or elsewhere, are responsible therefor to the property and disbursing officer, Signal Service, or should they be serving on a division of U. S. military telegraph lines, to the officer in charge of said division. They will be held personally responsible for such property, and will, in case of loss or damage thereto by their own neglect or carelessness, be proceeded against as contemplated by paragraph 1743, Army Regulations, 1881.

PAY AND ALLOWANCES.

Pay and allowances, how obtained.—The pay and allowances of enlisted men are obtained from three different sources—Pay, Quartermaster's, and Subsistence Departments—and are payable through the property and disbursing officer of the Signal Service, at the end of each month, on the receipt of the proper blanks, signed in duplicate.

The vouchers will be signed by observers and their assistants, one set by each man.

No part of the body or the receipt of either form will be filled up before transmission, and they must be forwarded at such time as will insure their receipt before the 20th of each month; otherwise no pay can be drawn on them until the end of the following month.

Observers of the Signal Service will not be allowed to sell or otherwise dispose of any of the above-mentioned accounts (vouchers for pay and commutation), nor will they be permitted to draw or give orders upon the central office, nor any of the officers connected therewith, without special authority.

No clothing allowance will be paid except on "final statements." When clothing is drawn, if the allowance is exceeded, it will be settled by the enlisted man on the 30th of June and the 31st of December of each year.

A deduction of 12½ cents per month is made from the pay of each enlisted man for the support of the Soldiers' Home.

In the third year the pay of enlisted men is increased $1 per month, in the fourth year $2 per month, and in the fifth year $3 per month, which amounts are retained and paid at the expiration of term of service, provided the enlisted man has served faithfully until discharged.

Requisitions for clothing and equipments will be sent to the Chief Signal Officer.

RULES FOR GUIDANCE OF OBSERVERS WHILE TRAVELING UNDER ORDERS.

Observers to report cost of ticket.—Observers traveling under orders will, immediately upon the completion of the journey, report the price of a first-class ticket over the route called for by the transportation requests. Sergeants, in addition to the above, will report the cost of sleeping-car accommodations when such were actually furnished.

Baggage allowed sergeants while traveling.—Sergeants of the Signal Corps, when changing station, are allowed 500 pounds of baggage in excess of weights transported free of charge. The following regulations will govern the transportation of such extra baggage, which is carried as freight by ordinary freight lines, at the public expense:

1. Sergeants ordered from Washington City to other stations must fill up, in duplicate, Form No. 5 (Q. M. D.), "Invoice of stores transferred," and forward both copies through the Chief Signal Officer, by

letter of transmittal, addressed to the depot quartermaster, U. S. A., Washington City, accompanied by two official copies of the special orders directing the journey.

2. Sergeants changing stations outside of Washington City must fill up, in duplicate, Form No. 5 (Q. M. D.), "Invoice of stores transferred," and forward both copies through the Chief Signal Officer, by letter of transmittal, addressed to the Quartermaster-General, U. S. A., Washington City, accompanied by two official copies of the special orders directing the journey.

3. The Quartermaster's Department will issue the necessary bills of lading, and the officer issuing the bills of lading will, upon receiving the baggage, give a receipt on Form No. 6 (Q. M. D.), "Receipt for stores," to the sergeant.

4. Baggage should be properly marked, for identification, with the owner's name in full and destination.

5. Trunks are required, by most of the roads, to be boxed when shipped by freight; the expense for boxing must be borne by the sergeant.

6. Hereafter, when forwarding special orders, two official copies and two blanks Form No. 5 (Q. M. D.) will be sent to each sergeant ordered to change station.

Report will also be made of the freight charges on the extra baggage carried by them for not exceeding the number of pounds authorized by regulations. This information can be readily obtained at either the place of departure or of destination, except where through tickets for the entire journey cannot be obtained, when the cost of each portion of the journey must be ascertained *en route* and reported as separate items.

In cases where a journey, for which transportation requests were issued, has been performed without expense to the United States, the fact will be stated and the unused requests returned to the Chief Signal Officer.

Transportation requests not used to be returned.—Whenever, from any cause, one or more of the transportation requests furnished to an observer with his orders are not used, such unused requests will at once be returned upon the completion of the journey or the revocation of the order on which they were issued. This will apply to all cases where journeys were performed without expense to the United States, or where, for any reason, the transportation was not required.

A brief letter of explanation will accompany the transportation requests thus returned.

Great care should be taken to make these reports absolutely correct, so that the expenses incurred by this service on account of transportation of men may be accurately debited against the appropriation therefor.

Extra commutations of rations while traveling.—To fix the number of days for which commutation of rations at $1.50 per day will be paid under the provisions of paragraph 2232, Army Regulations, as modified by General Orders No. 104, Headquarters of the Army, Adjutant-General's Office, Washington, D. C., August 28, 1882, enlisted men in making changes of stations or when traveling under orders will observe the following rules:

Before leaving a station report the day and hour of departure on the form furnished for the purpose.

Upon arrival at a station report upon the proper form the day and hour of arrival and the means of transportation, accompanying said report with a set of vouchers (Form No. 12, Subsistence Department)

properly signed. If by steamer state the number of meals, if any, furnished on Government transportation. If paid for from private funds receipted bills covering the amount must be forwarded. Reimbursement for sleeper on railroad or berth on steamer will not be allowed in the cases of corporals or privates; sergeants only are entitled to those privileges.

If delayed while traveling, state the cause and extent of delay in the report made on arrival; if granted leave to delay *en route*, state the duration of the leave, giving the inclusive dates.

As the commutation of rations at one dollar and fifty cents is authorized only while traveling, it will not cover any periods of delay. If unavoidably delayed at a station previous to beginning a journey, the soldier will be entitled, while so delayed, to the allowances for that station, and to the travel allowance only after he actually leaves it. There is no rate prescribed for commutation for periods of delay while traveling. In case of unavoidable delay *en route*, reimbursement may be made, after approval of account, for the necessary expenses for subsistence *actually paid*. In making claim for such reimbursement the account should be accompanied by another set of vouchers (Form No. 12, Subsistence Department) properly signed, and a full explanation of the cause of delay and the *number of hours delayed*, and should be supported by the *original receipted bills* for the expenditures, or, where these cannot be obtained, by an affidavit. Authorized delays *en route* will be considered as leaves of absence from the station to which the observer is ordered, and he will be entitled to the allowances of that station.

Observers traveling under instructions, how reimbursed for expenses.—Observers of the Signal Corps, acting as *marine agents, inspectors of railroad bulletins or cotton-belt stations, or on similar duty, and traveling under instructions from the Chief Signal Officer*, will, in the performance of such duty, be reimbursed for actual expenses necessarily incurred by them for street-car fare, ferriage, rowboat hire, and other costs of short transits.

A detailed account, *under oath*, showing the daily expenses under each of the above items, and including the cost of the affidavit in the account, should be made upon the completion of the duty, or at the end of each month, and forwarded for audit and settlement.

The account must be forwarded in duplicate, accompanied by a copy of the order or instructions under which the journey was performed, and by Form No. 13 (Q. M. D.), properly signed.

SICKNESS.

When there are two or more observers on duty at the same station, and one becomes ill, the observer in charge, if assistance is absolutely necessary, will telegraph the facts (asking authority to hire the same), and giving the probable duration of the illness of the observer and the cost per day of whatever assistance may be needed to do the necessary station work.

If an observer, when alone at the station, should, through illness, be prevented from performing his duties, the current station work will be kept up by the civilian assistant and the Chief Signal Officer will be notified by wire, as above described.

Medical attendance, manner of employing.—When medical attendance is required by an officer or enlisted man of the Signal Corps, on duty at a station where the attendance of a medical officer of the

Army cannot be had, a private physician may be employed under the provisions of paragraph 2340, Army Regulations, 1881. But in such cases accounts will not be approved for extra travel if a physician nearer could have been consulted.

The physician's account will be made out in duplicate, on proper blanks, which will be furnished upon application.

When medicines have been furnished by an apothecary for which a separate charge is made by the physician, the receipted bill of the apothecary for them (in the name of the physician) is required. This bill need not be in duplicate, nor sworn to, an ordinary receipt being sufficient.

When the account of the apothecary, for medicine furnished, is necessarily separate it may be made out in the name of the apothecary, the sworn certificate being made by him.

Medical accounts, how forwarded.—The vouchers and accounts, with the original prescriptions (when medicines have been furnished), will be forwarded, with a letter of transmittal to the Chief Signal Officer for transmission to the Surgeon-General of the Army. This letter will contain an express statement as to the correctness of the account and any explanation or criticism necessary to its full understanding.

In all cases the data entered on the vouchers must be as full as possible. Should the charge of the physician be greater than usual, on account of his having to make a long journey to an isolated station, the number of miles traveled each way will be stated on the vouchers.

The account must show the date of and charge for each visit.

But one medical account, covering the same period, will be allowed.

Medical accounts to be certified to by a court of record.—The oath and signature to medical accounts will, if possible, be made before a notary public, who should affix his official seal, or before an officer of a court of record having charge of its official seal. If the oath and signature be before a justice of the peace, or other magistrate having no official seal, the certificate of an officer of a court of record, with the seal of the court, that he was such justice, &c., is required. If the physician and enlisted man subscribe and swear to an account before different officials, the seal or certificate will be required in each case. The fee that a notary or magistrate may charge for administering the oath and certifying to the signature as required, cannot be made the subject of a specific claim for reimbursement, nor will it be included as an item of the account.

Observers in charge of stations will make local inquiry or write to the Chief Signal Officer for information as to whether there is a medical officer of the Army on duty at or near their stations.

An enlisted man obtaining medical attendance or medicines from other sources than a medical officer of the Army, when the latter can be called upon, will be held personally responsible for the charges therefor, unless it shall appear that the attendance of the medical officer could not be obtained in the special case. Should the medical officer be temporarily inaccessible upon the occurrence of a case so sudden and serious as to require immediate attention, he will, nevertheless, be called upon as soon as possible, and his certificate that the case required another practitioner to be employed under the circumstances will be necessary before the account of the latter can be paid.

Bills for dental services not allowed.—Bills for dental services are not allowed by the Medical Department, nor for medicines or medical services rendered while on furlough or leave of absence.

Bills for surgical operations not allowed.—Bills for expensive surgical operations will not be approved unless authority to contract them has first been obtained.

Services of a nurse.—When the services of a nurse are necessary a separate account for the nursing will be made and certified in the same manner and on a form similar to that for medical attendance, the word "nursing" being substituted for "medical" on the heading of the vouchers. This account may be rendered either in the name of the nurse or of the medical practitioner if he pays the nurse. In the latter case the receipt of the nurse, in duplicate, to the physician for the amount charged will be inclosed with the account.

Accounts covering two fiscal years, how prepared.—No account of a physician for attendance, or of a nurse for services, or of an apothecary for medicines furnished, will embrace charges to include time both before and after the 30th of June in any year. An account which runs through a period both prior and subsequent to June 30 must be separated into two distinct accounts, the one closing with June 30 and the other beginning with July 1, in any year. The law requires payments to be made out of different appropriations in such cases, and the accounts for any charges in any one fiscal year must be separate from those in any other year, otherwise they will be returned for separation of items into new accounts.

The observers in charge of stations will keep on hand a supply of medical vouchers, which they will procure by the usual mode of requisition.

Great care will be exercised in the preparation of medical accounts, and they must be forwarded at the earliest date practicable after the termination of the illness. Observers before sending accounts for medical services will carefully read the directions and compare the vouchers.

Action to be taken in case of the death of an enlisted man.—On the death of an enlisted man of the Signal Corps, the fact will be immediately telegraphed to this office, giving the time, place, and cause of death, if the latter be known. Under General Orders No. 105, A. G. O., October 5, 1885 (made applicable to Signal Service men by Circular No. 12, dated Adjutant-General's Office, December 31, 1885), the burial expenses of an enlisted man, if a non-commissioned officer, is limited to $15, and for a private soldier, to $10. The expenses of transporting the remains to the nearest fort, barracks, or national cemetery, and of those who must necessarily accompany them, will be confined to the lowest possible limit. If relatives or other friends are present and insist upon a more expensive funeral, they and the undertaker will be informed that no expenses incurred in excess of the above items and amounts will be settled by the Government. Funeral expenses should all be included in an itemized bill of the undertaker, which should be forwarded with a letter of transmittal.

Inventory of effects, how prepared.—An inventory of the effects of the deceased will be taken in duplicate, and forwarded in accordance with the following form:

Inventory of the effects of ——— ———, late a ———, Signal Corps, who died at (place), at (hour), on the —— day of ———, 18—, by reason of (disease).

(Here will be inserted a list of the articles, including any money (specie or notes) which may be found among the effects of the deceased,

and which will also be forwarded with the inventory.) (The following certificate will be given below the list of articles:)

I certify that the above inventory comprises all the effects of ——— ———, Signal Corps, deceased, and that the effects are stored in the signal office at ——— (or were turned over to ——— ———, the legal representative of the deceased, as the case may be).

(Signed) ——— ———,
——— *Signal Corps.*

Place: ———
Date: ———

In case the effects are turned over to the legal representative, the following certificate will be given under the inventory:

I certify that I am the legal representative of ——— ———, late ——— Signal Corps, and that I have this day received from ——— ———, Signal Corps, the above effects.

(Signed) ——— ———.

Sworn to and subscribed before me this —— day of ———, 18—.

——— ———,
——— ———.

(This certificate to be sworn to before a justice of the peace, a notary public, or a commissioned officer, at the expense of the party subscribing to the certificate.)

Immediately after the funeral a certificate of the attending surgeon will be forwarded, giving cause and date of death; also a certificate of the undertaker or superintendent of cemetery in which deceased may be interred, giving date of burial and location and number of the grave.

OFFICIAL TELEGRAMS.

Officers and observers on duty in this bureau are directed to employ the commercial telegraph lines of the country in the transmission of messages which require payment by the United States only in cases of urgent and imperative necessity, when the delay of the mail would be prejudicial to the public interest.

In framing telegrams all words not important to the sense of the communication and all words of mere respect will be omitted. Thus, the smaller parts of speech, personal pronouns, articles, and prepositions, are rarely necessary to the sense of a message.

Telegrams should be addressed to the office rather than to the person holding the office, after the following manner: "Adjutant-General, Division Pacific, San Francisco;" "Commanding Officer, Camp Halleck, Nevada."

Applications for discharge or leaves of absence, or messages not strictly for the benefit of the United States, must be prepaid as private messages at commercial rates.

Applications for special indications, authority to produce records, or attend as witnesses in court, &c., are for the benefit of private individuals, and must be prepaid by them at regular rates.

Observers are enjoined to use the utmost care in forwarding messages, and all violations of these injunctions will be carefully noted, and will form a charge against the sender.

Telegrams, how addressed to the Chief Signal Officer.—Telegrams sent to the Chief Signal Officer will be addressed "Signals, Washington," and marked "collect," unless paid for by the sender.

A copy of each telegram sent will be made, to accompany the observer's report of telegrams sent and received.

Refusal of telegraph companies to accept reports.—In case of actual or anticipated neglect or refusal on the part of the employés of any telegraph company by which an observer is directed to transmit telegraphic communications, at the time and in the manner stated in the orders of the Chief Signal Officer to the observer in charge of a station, then in force, he will notify the Chief Signal Officer.

Most of the telegraph companies by which the messages of the Signal Service have hitherto been sent, according to directions given to the observers, have accepted the provisions of the act of Congress approved July 24, 1866, a copy of which, and other acts bearing upon the subject, is hereto appended:

AN ACT to aid in the construction of telegraph lines, and to secure to the Government the use of the same for postal, military, and other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress asembled, That any telegraph company now organized, or which may hereafter be organized, under the laws of any State in this Union, shall have the right to construct, maintain, and operate lines of telegraph through and over any portion of the public domain of the United States, over and along any of the military or post roads of the United States, which have been or may hereafter be declared such by act of Congress, and over, under, or across the navigable streams or waters of the United States: *Provided,* That such lines of telegraph shall be so constructed and maintained as not to obstruct the navigation of such streams and waters, or interfere with the ordinary travel on such military or post roads. And any of said companies shall have the right to take and use from such public lands the necessary stone, timber, and other materials for its posts, piers, stations, and other needful uses in the construction, maintenance, and operation of said lines of telegraph, and may pre-empt and use such portion of the unoccupied public lands subject to pre-emption, through which its said lines of telegraph may be located, as may be necessary for its stations, not exceeding forty acres for each station; but such stations shall not be within fifteen miles of each other.

SEC. 2. *And be it further enacted,* That telegraphic communication between the several Departments of the Government of the United States and their officers and agents shall, in their transmission over the lines of said companies, have priority over all other business, and shall be sent at rates to be annually fixed by the Postmaster-General.

SEC. 3. *And be it further enacted,* That the rights and privileges hereby granted shall not be transferred by any company acting under this act to any other corporation, association, or person: *Provided, however,* That the United States may at any time after the expiration of five years from the date of the passage of this act, for postal military, or other purposes, purchase all the telegraph-lines, property, and effects of any or all of said companies, at an appraised value, to be ascertained by five competent, disinterested persons, two of whom shall be selected by the Postmaster-General of the United States, two by the company interested, and one by the four so previously selected.

SEC. 4. *And be it further enacted,* That before any telegraph company shall exercise any of the powers or privileges conferred by this act, such company shall file their written acceptance with the Postmaster-General of the restrictions and obligations required by this act.

Approved, July 24, 1866.

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION to authorize the Secretary of War to provide for taking meteorological observations at the military stations and at other points in the interior of the continent, and for giving notice on the northern lakes and seaboard of the approach and force of storms.

Be it resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and he hereby is, authorized and required to provide for taking meteorological observations at the military stations

in the interior of the continent, and at other points in the States and Territories of the United States, and for giving notice on the northern lakes and on the seacoast by magnetic telegraph and marine signals of the approach and force of storms.

Approved, February 9, 1870.

For further information concerning the manner of handling and accounting for official telegrams, see instructions to operators on the United States military telegraph lines, published in Signal Office General Orders No. 19, series of 1887:

WAR DEPARTMENT,
OFFICE OF THE CHIEF SIGNAL OFFICER,
Washington, D. C., July 3, 1872.

The following is the text of the order of the Secretary of War, received by the Chief Signal Officer of the Army, and is published for the information of all concerned:

"WAR DEPARTMENT,
"*Washington City, June* 27, 1872.

"The Chief Signal Officer of the Army is hereby directed and ordered to carry into effect the special duties imposed upon the Secretary of War by the act of Congress approved July 24, 1866, entitled 'An act to aid in the construction of telegraph lines, and to secure to the Government the use of the same for postal, military, and other purposes," and by the public resolution No. 9, approved February 9, 1870, and entitled 'Joint resolution to authorize the Secretary of War to provide for taking meteorological observations at the military stations and other points in the interior of the continent, and for giving notice on the northern lakes and seaboard of the approach and force of storms,' and by the act approved June 10, 1872, entitled 'An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1873, and for other purposes;' and the said Chief Signal Officer of the Army, and all such persons as have been or shall be designated and employed by him for the taking of meteorological observations, or for preparing or presenting telegraphic communications for transmission, or for transmitting the same, as hereby recognized and appointed as agents of the War Department for those purposes, and are hereby authorized and directed by and in behalf of said Department to offer to any telegraph company in the United States, for transmission, any and all such telegraph communications as they may be required by the Chief Signal Officer to make, and to request the transmission thereof by such company or companies, at such times, and in such places, as may be directed by said officer.

"WM. W. BELKNAP,
"*Secretary of War.*"

AN ACT making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and seventy-three, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated for the objects hereinafter expressed, for the fiscal year ending June thirtieth, eighteen hundred and seventy-three.

* * * * * * *

UNDER THE WAR DEPARTMENT.

* * * * * * *

SIGNAL OFFICE.

* * * * * * *

Provided, That the Secretary of War be, and he hereby is, authorized and required to provide, in the system of observations and reports in charge of the Chief Signal Officer of the Army, for such stations, reports, and signals as may be found necessary for the benefit of agriculture and commercial interests: *And provided,* That no part of this appropriation, nor of any appropriation for the several Departments of the Government, shall be paid to any telegraphic company which shall neglect or refuse

to transmit telegraphic communications between said Departments, their officers, agents, or employés, under the provisions of the second section of chapter two hundred and thirty of the Statutes of the United States for the year eighteen hundred and sixty-six, and at rates of compensation therefor to be established by the Postmaster-General: *Provided also*, That whenever any telegraph company shall have filed its written acceptance with the Postmaster-General, of the restrictions and obligations required by the act approved July twenty-fourth, eighteen hundred and sixty-six, entitled "An act to aid in the construction of telegraph-lines, and to secure to the Government the use of the same, for postal, military, and other purposes," if such company, its agents, or employés shall hereafter refuse or neglect to transmit any such telegraphic communications as are provided for by the aforesaid act or by the joint resolution approved the ninth day of February, eighteen hundred and seventy, "To authorize the Secretary of War to provide for taking meteorological observations at the military stations and other points of the interior of the continent, and for giving notice on the northern lakes and seaboard of the approach and force of storms," such telegraphic company shall forfeit and pay to the United States not less than one hundred and not exceeding one thousand dollars for each refusal or neglect aforesaid, to be recovered by an action or actions at law, in any district court of the United States.

Approved, June 10, 1872.

OBSERVATIONS AT SEA.

The Hydrographic Office, U. S. Navy Department, has charge of the collection of international simultaneous observations made at sea, and will give all necessary instructions relative to this work.

It is the desire of the Chief Signal Officer that all shipmasters sailing between the United States and foreign ports co-operate with the Hydrographic Office, as formerly with the Signal Service, in taking and recording simultaneous observations.

In this work the Chief Signal Officer of the Army and the Chief Hydrographer of the Navy are working in accord.

Observers at sea-coast stations, other than Boston, New York, Philadelphia, Baltimore, and New Orleans, will distribute for the Navy Department to shipmasters such forms and publications as may be sent them by the Hydrographic Office for the purpose. At the stations named, the Branch Hydrographic Offices will attend to this duty.

Observers of the Signal Service, when soliciting observations, will be careful to explain fully the importance of such observations, that it was impossible, before the new method of simultaneous observations was put in operation, and before a practical system for the co-operation of all nations was devised, to combine these investigations of the weather into a uniform scheme for observing the atmosphere. In order to comprehend the forces which unite to make a single cyclone, it is necessary to extend investigations far beyond the territorial limits of the United States; and there is no way by which this can be accomplished except through the co-operation of the merchant marine.

Shipmasters becoming co-operating observers of the Signal Service receive the publications of the Weather Bureau free of charge. They will be invited, when in port, to visit signal offices, and observers will impress upon them the necessity of, and the advantages to be derived by the shipping community from, tabulated meteorological observations taken at sea. The aims of the Hydrographic Office and of the U. S. Signal Service will be fully explained.

Barometric readings should be continued while the vessel is in port, as they furnish a very important connection between the land and marine observations.

Vessels arriving, frequently report having encountered derelicts, wrecks, gales, storms, and hurricanes; they also report interesting me-

teorological and nautical phenomena. Observers in such cases will take pains to secure particulars, and fill up and forward to the Chief Signal Officer (for the Chief Hydrographer) a form furnished, upon requisition, for the purpose.

Observers will inform shipmasters that, when in foreign ports, mail addressed to the Chief Signal Officer of the Army may be handed to the United States consular officers, who have been instructed by the State Department to forward the same to its place of destination without cost for postage to the observers.

APPENDIX No. I.

Table for the reduction of the barometric readings to a standard temperature—Add.

−30° to −0°

Attached thermometer.	Inch. 22	Inch. 22.5	Inch. 23	Inch. 23.5	Inch. 24	Inch. 24.5	Inch. 25	Inch. 25.5	Inch. 26	Inch. 26.5	Inch. 27	Inch. 27.5	Inch. 28	Inch. 28.5	Inch. 29	Inch. 29.5	Inch. 30	Inch. 30.5	Inch. 31
Degrees.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
−30	+.116	+.119	+.121	+.124	+.127	+.129	+.132	+.135	+.137	+.140	+.143	+.145	+.148	+.150	+.153	+.156	+.158	+.161	+.164
−29	.114	.117	.119	.122	.125	.127	.130	.132	.135	.137	.140	.143	.145	.148	.150	.153	.156	.158	.161
−28	.112	.115	.117	.120	.122	.125	.127	.130	.133	.135	.138	.140	.143	.145	.148	.150	.153	.155	.158
−27	.110	.113	.115	.118	.120	.123	.125	.128	.130	.133	.135	.138	.140	.143	.145	.148	.150	.153	.155
−26	.108	.111	.113	.116	.118	.120	.123	.125	.128	.130	.133	.135	.138	.140	.143	.145	.147	.150	.152
−25	.106	.109	.111	.113	.116	.118	.121	.123	.125	.128	.130	.133	.135	.138	.140	.142	.145	.147	.150
−24	.104	.107	.109	.111	.114	.116	.118	.121	.123	.125	.128	.130	.133	.135	.137	.140	.142	.144	.147
−23	.102	.104	.107	.109	.111	.114	.116	.118	.121	.123	.125	.128	.130	.132	.135	.137	.139	.142	.144
−22	.100	.102	.105	.107	.109	.112	.114	.116	.118	.121	.123	.125	.127	.130	.132	.134	.137	.139	.141
−21	.098	.100	.103	.105	.107	.109	.112	.114	.116	.118	.121	.123	.125	.127	.129	.132	.134	.136	.138
−20	.096	.098	.101	.103	.105	.107	.109	.111	.114	.116	.118	.120	.122	.125	.127	.129	.131	.133	.136
−19	.094	.096	.098	.101	.103	.105	.107	.109	.111	.113	.116	.118	.120	.122	.124	.126	.128	.131	.133
−18	.092	.094	.096	.098	.101	.103	.105	.107	.109	.111	.113	.115	.117	.119	.122	.124	.126	.128	.130
−17	.090	.092	.094	.096	.098	.100	.103	.105	.107	.109	.111	.113	.115	.117	.119	.121	.123	.125	.127
−16	.088	.090	.092	.094	.096	.098	.100	.102	.104	.106	.108	.110	.112	.114	.116	.118	.120	.122	.124
−15	.086	.088	.090	.092	.094	.096	.098	.100	.102	.104	.106	.108	.110	.112	.114	.116	.118	.120	.122
−14	.084	.086	.088	.090	.092	.094	.096	.098	.100	.101	.103	.105	.107	.109	.111	.113	.115	.117	.119
−13	.082	.084	.086	.088	.090	.092	.093	.095	.097	.099	.101	.103	.105	.107	.109	.110	.112	.114	.116
−12	.080	.082	.084	.086	.088	.089	.091	.093	.095	.097	.099	.100	.102	.104	.106	.108	.109	.111	.113
−11	.078	.080	.082	.084	.085	.087	.089	.091	.093	.094	.096	.098	.100	.101	.103	.105	.107	.109	.110
−10	.076	.078	.080	.081	.083	.085	.087	.088	.090	.092	.094	.095	.097	.099	.101	.102	.104	.106	.107
− 9	.074	.076	.078	.079	.081	.083	.084	.086	.088	.089	.091	.093	.095	.096	.098	.100	.101	.103	.105
− 8	.072	.074	.076	.077	.079	.081	.082	.084	.085	.087	.089	.090	.092	.094	.095	.097	.099	.100	.102
− 7	.070	.072	.074	.075	.077	.078	.080	.082	.083	.085	.086	.088	.089	.091	.093	.094	.096	.097	.099
− 6	.068	.070	.071	.073	.075	.076	.078	.079	.081	.082	.084	.085	.087	.089	.090	.092	.093	.095	.096
− 5	.066	.068	.069	.071	.072	.074	.075	.077	.078	.080	.081	.083	.084	.086	.087	.089	.090	.092	.093
− 4	.064	.066	.067	.067	.070	.072	.073	.075	.076	.078	.079	.080	.082	.083	.085	.086	.088	.089	.091
− 3	.062	.064	.065	.066	.068	.069	.071	.072	.074	.075	.077	.078	.079	.081	.082	.084	.085	.086	.088
− 2	.060	.062	.063	.065	.066	.067	.069	.070	.071	.073	.074	.075	.077	.078	.080	.081	.082	.084	.085
− 1	.058	.060	.061	.062	.064	.065	.066	.068	.069	.070	.072	.073	.074	.076	.077	.078	.080	.081	.082
− 0	+.056	+.058	+.059	+.060	+.062	+.063	+.064	+.065	+.067	+.068	+.069	+.071	+.072	+.073	+.074	+.076	+.077	+.078	+.079

Table for the reduction of the barometric readings to a standard temperature—Add.

+1° to +28°

Attached thermometer.	Inch. 22	Inch. 22.5	Inch. 23	Inch. 23.5	Inch. 24	Inch. 24.5	Inch. 25	Inch. 25.5	Inch. 26	Inch. 26.5	Inch. 27	Inch. 27.5	Inch. 28	Inch. 28.5	Inch. 29	Inch. 29.5	Inch. 30	Inch. 30.5	Inch. 31
Degrees.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
1	+.054	+.056	+.057	+.058	+.059	+.061	+.062	+.063	+.064	+.065	+.067	+.068	+.069	+.071	+.072	+.073	+.075	+.076	+.077
2	.052	.054	.055	.056	.057	.058	.060	.061	.062	.063	.064	.066	.067	.068	.069	.070	.072	.073	.074
3	.050	.052	.053	.054	.055	.056	.057	.059	.060	.061	.062	.063	.064	.065	.067	.068	.069	.070	.071
4	.048	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059	.061	.062	.063	.064	.065	.066	.067	.068
5	.046	.048	.049	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060	.061	.062	.063	.065	.066
6	.044	.046	.047	.048	.049	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060	.061	.062	.063
7	.042	.044	.044	.046	.046	.047	.048	.049	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060
8	.041	.041	.042	.043	.044	.045	.046	.047	.048	.049	.050	.051	.052	.053	.054	.054	.055	.056	.057
9	.039	.039	.040	.041	.042	.043	.044	.045	.046	.046	.047	.048	.049	.050	.051	.052	.053	.054	.054
10	.037	.037	.038	.039	.040	.041	.042	.042	.043	.044	.045	.046	.047	.047	.048	.049	.050	.051	.052
11	.035	.035	.036	.037	.038	.039	.039	.040	.041	.042	.042	.043	.044	.045	.046	.046	.047	.048	.049
12	.033	.033	.034	.035	.036	.036	.037	.038	.039	.039	.040	.041	.042	.042	.043	.044	.045	.045	.046
13	.031	.031	.032	.033	.033	.034	.035	.036	.036	.037	.038	.038	.039	.040	.040	.041	.042	.043	.043
14	.029	.029	.030	.031	.031	.032	.033	.033	.034	.035	.035	.036	.037	.037	.038	.038	.039	.040	.040
15	.027	.027	.028	.029	.029	.030	.030	.031	.032	.032	.033	.033	.034	.035	.035	.036	.036	.037	.038
16	.025	.025	.026	.026	.027	.028	.028	.029	.029	.030	.030	.031	.032	.032	.033	.033	.034	.034	.035
17	.023	.023	.024	.024	.025	.025	.026	.026	.027	.027	.028	.028	.029	.030	.030	.031	.031	.032	.032
18	.021	.021	.022	.022	.023	.023	.024	.024	.025	.025	.025	.026	.026	.027	.027	.028	.028	.029	.029
19	.019	.019	.020	.020	.021	.021	.021	.022	.022	.023	.023	.024	.024	.024	.025	.025	.026	.026	.027
20	.017	.017	.018	.018	.018	.019	.019	.020	.020	.020	.021	.021	.021	.022	.022	.023	.023	.023	.024
21	.015	.015	.015	.016	.016	.017	.017	.017	.018	.018	.018	.019	.019	.019	.020	.020	.020	.021	.021
22	.013	.013	.013	.014	.014	.014	.015	.015	.015	.016	.016	.016	.016	.017	.017	.017	.018	.018	.018
23	.011	.011	.011	.012	.012	.012	.012	.013	.013	.013	.013	.014	.014	.014	.014	.015	.015	.015	.015
24	.009	.009	.009	.010	.010	.010	.010	.010	.011	.011	.011	.011	.011	.012	.012	.012	.012	.012	.013
25	.007	.007	.007	.007	.008	.008	.008	.008	.008	.008	.009	.009	.009	.009	.009	.009	.009	.010	.010
26	.005	.005	.005	.005	.005	.006	.006	.006	.006	.006	.006	.006	.006	.006	.007	.007	.007	.007	.007
27	.003	.003	.003	.003	.003	.003	.003	.003	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004
28	+.001	+.001	+.001	+.001	+.001	+.001	+.001	+.001	+.001	+.001	+.001	+.001	+.001	+.001	+.001	+.001	+.001	+.001	+.001

Tables for the reduction of the barometric readings to a standard temperature—Subtract.

+29° to +100°

Attached thermometer.	Inch. 22	Inch. 22.5	Inch. 23	Inch. 23.5	Inch. 24	Inch. 24.5	Inch. 25	Inch. 25.5	Inch. 26	Inch. 26.5	Inch. 27	Inch. 27.5	Inch. 28	Inch. 28.5	Inch. 29	Inch. 29.5	Inch. 30	Inch. 30.5	Inch. 31
Degrees.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
29	—.001	—.001	—.001	—.001	—.001	—.001	—.001	—.001	—.001	—.001	—.001	—.001	—.001	—.001	—.001	—.001	—.001	—.001	—.001
30	.003	.003	.003	.003	.003	.003	.003	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004
31	.005	.005	.005	.005	.005	.006	.006	.006	.006	.006	.006	.006	.006	.006	.007	.007	.007	.007	.007
32	.007	.007	.007	.007	.008	.008	.008	.008	.008	.008	.008	.009	.009	.009	.009	.009	.009	.010	.010
33	.009	.009	.009	.010	.010	.010	.010	.010	.011	.011	.011	.011	.011	.012	.012	.012	.012	.012	.012
34	.011	.011	.011	.012	.012	.012	.012	.013	.013	.013	.013	.014	.014	.014	.014	.015	.015	.015	.015
35	.013	.013	.013	.014	.014	.014	.015	.015	.015	.015	.016	.016	.016	.017	.017	.017	.018	.018	.918
36	.015	.015	.016	.016	.016	.017	.017	.017	.017	.018	.018	.019	.019	.019	.020	.020	.020	.021	.021
37	.017	.017	.018	.018	.018	.019	.019	.019	.020	.020	.021	.021	.021	.022	.022	.022	.023	.023	.024
38	.019	.019	.020	.020	.020	.021	.021	.022	.022	.023	.023	.023	.024	.024	.025	.025	.026	.026	.026
39	.021	.021	.022	.022	.023	.023	.024	.024	.024	.025	.025	.026	.026	.027	.027	.028	.028	.029	.029
40	.023	.023	.024	.024	.025	.025	.026	.026	.027	.027	.028	.028	.029	.029	.030	.030	.031	.031	.032
41	.025	.025	.026	.026	.027	.027	.028	.029	.029	.030	.030	.031	.031	.032	.033	.033	.034	.034	.035
42	.027	.027	.028	.028	.029	.030	.030	.031	.031	.032	.033	.033	.034	.034	.035	.036	.036	.037	.037
43	.029	.029	.030	.031	.031	.632	.032	.033	.034	.034	.035	.036	.036	.037	.038	.038	.039	.040	.040
44	.031	.031	.032	.033	.033	.034	.035	.035	.036	.037	.037	.038	.039	.040	.040	.041	.042	.042	.043
45	.033	.033	.034	.035	.035	.036	.037	.038	.038	.039	.040	.041	.041	.042	.043	.044	.044	.045	.046
46	.035	.035	.036	.037	.038	.038	.039	.040	.041	.042	.042	.043	.044	.045	.045	.046	.047	.048	.049
47	.036	.037	.038	.039	.040	.041	.041	.042	.043	.044	.045	.046	.046	.047	.048	.049	.050	.051	.051
48	.038	.039	.040	.041	.042	.043	.044	.045	.045	.046	.047	.048	.049	.050	.051	.052	.052	.053	.054
49	.040	.041	.042	.043	.044	.045	.046	.047	.048	.049	.050	.050	.051	.052	.053	.054	.055	.056	.057
50	.042	.043	.044	.045	.046	.047	.048	.049	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060
51	.044	.045	.046	.047	.048	.049	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060	.061	.062
52	.046	.047	.048	.049	.050	.052	.053	.054	.055	.056	.057	.058	.059	.060	.061	.062	.063	.064	.065
53	.048	.049	.050	.052	.053	.054	.055	.056	.057	.058	.059	.060	.061	.063	.064	.065	.066	.067	.068
54	.050	.051	.052	.054	.055	.056	.057	.058	.058	.060	.062	.063	.064	.065	.066	.067	.068	.070	.071
55	.052	.053	.055	.056	.057	.058	.059	.060	.062	.063	.064	.065	.066	.068	.069	.070	.071	.072	.073
56	.054	.055	.057	.058	.059	.060	.061	.063	.064	.065	.066	.068	.069	.070	.071	.073	.074	.075	.076
57	.056	.057	.059	.060	.061	.062	.064	.065	.066	.068	.069	.070	.071	.073	.074	.075	.076	.078	.079
58	.058	.059	.061	.062	.063	.065	.066	.067	.069	.070	.071	.073	.074	.075	.077	.078	.079	.081	.082
59	.060	.061	.063	.064	.065	.067	.068	.070	.071	.072	.074	.075	.076	.078	.079	.080	.082	.083	.085
60	.062	.063	.065	.066	.068	.069	.070	.072	.073	.075	.076	.077	.079	.080	.082	.083	.085	.086	.087

61	.064	.065	.067	.068	.070	.071	.073	.074	.075	.077	.078	.080	.081	.083	.084	.086	.087	.089	.090
62	.066	.067	.069	.070	.072	.073	.075	.076	.078	.079	.081	.082	.084	.085	.087	.088	.090	.091	.093
63	.068	.069	.071	.072	.074	.076	.077	.079	.080	.082	.083	.085	.086	.088	.089	.091	.093	.094	.096
64	.070	.071	.073	.075	.076	.078	.079	.081	.082	.084	.086	.087	.089	.090	.092	.094	.095	.097	.098
65	—.072	—.073	—.075	—.077	—.078	—.080	—.082	—.083	—.085	—.086	—.088	—.090	—.091	—.093	—.095	—.096	—.098	—.100	—.101
66	—.074	—.075	—.077	—.079	—.080	—.082	—.084	—.085	—.087	—.089	—.090	—.092	—.094	—.096	—.097	—.099	—.101	—.102	—.104
67	.076	.077	.079	.081	.083	.084	.086	.088	.089	.091	.093	.095	.096	.098	.100	.102	.103	.105	.107
68	.078	.079	.081	.083	.085	.086	.088	.090	.092	.094	.095	.097	.099	.101	.102	.104	.106	.108	.109
69	.080	.081	.083	.085	.087	.089	.090	.092	.094	.096	.098	.100	.101	.103	.105	.107	.109	.110	.112
70	.082	.083	.085	.087	.089	.091	.093	.095	.096	.098	.100	.102	.104	.106	.108	.109	.111	.113	.115
71	.083	.085	.087	.089	.091	.093	.095	.097	.099	.101	.102	.104	.106	.108	.110	.112	.114	.116	.118
72	.085	.087	.089	.091	.093	.095	.097	.099	.101	.103	.105	.107	.109	.111	.113	.115	.117	.119	.120
73	.087	.089	.091	.093	.095	.097	.099	.101	.103	.105	.107	.109	.111	.113	.115	.117	.119	.121	.123
74	.089	.091	.093	.095	.097	.099	.102	.104	.106	.108	.110	.112	.114	.116	.118	.120	.122	.124	.126
75	.091	.093	.095	.098	.100	.102	.104	.106	.108	.110	.112	.114	.116	.118	.121	.122	.125	.127	.129
76	.093	.095	.097	.100	.102	.104	.106	.108	.110	.112	.114	.117	.119	.121	.123	.125	.127	.129	.131
77	.095	.097	.100	.102	.104	.106	.108	.110	.112	.115	.117	.119	.121	.123	.126	.128	.130	.132	.134
78	.097	.099	.102	.104	.106	.108	.110	.113	.115	.117	.119	.122	.124	.126	.128	.130	.133	.135	.137
79	.099	.101	.104	.106	.108	.110	.113	.115	.117	.119	.122	.124	.126	.128	.131	.133	.135	.137	.140
80	.101	.103	.106	.108	.110	.113	.115	.117	.119	.122	.124	.126	.129	.131	.133	.136	.138	.140	.143
81	.103	.105	.108	.110	.112	.115	.117	.119	.122	.124	.126	.129	.131	.134	.136	.138	.141	.143	.145
82	.105	.107	.110	.112	.114	.117	.119	.122	.124	.126	.129	.131	.134	.136	.138	.141	.143	.146	.148
83	.107	.109	.112	.114	.117	.119	.121	.124	.126	.129	.131	.134	.136	.139	.141	.133	.146	.148	.151
84	.109	.111	.114	.116	.119	.121	.124	.126	.129	.131	.134	.136	.139	.141	.144	.146	.149	.151	.154
85	.111	.113	.116	.118	.121	.123	.126	.128	.131	.133	.136	.139	.141	.144	.146	.149	.151	.154	.156
86	.113	.115	.118	.120	.123	.126	.128	.131	.133	.136	.138	.141	.144	.146	.149	.151	.154	.156	.159
87	.115	.117	.120	.123	.125	.128	.130	.133	.136	.138	.141	.143	.146	.149	.151	.154	.157	.159	.162
88	.117	.119	.122	.125	.127	.130	.133	.135	.138	.141	.143	.146	.149	.151	.154	.157	.159	.162	.165
89	.119	.121	.124	.127	.129	.132	.135	.137	.140	.143	.146	.148	.151	.154	.156	.159	.162	.165	.167
90	.121	.123	.126	.129	.131	.134	.137	.140	.142	.145	.148	.151	.153	.156	.159	.162	.164	.167	.170
91	.122	.125	.128	.131	.134	.136	.139	.142	.145	.148	.150	.153	.156	.159	.162	.165	.167	.170	.173
92	.124	.127	.130	.133	.136	.139	.141	.144	.147	.150	.153	.156	.158	.161	.164	.167	.170	.172	.175
93	.126	.129	.132	.135	.138	.141	.144	.147	.149	.152	.155	.158	.161	.164	.167	.170	.172	.175	.178
94	.128	.131	.134	.137	.140	.143	.146	.149	.152	.155	.157	.161	.163	.166	.169	.172	.175	.177	.180
95	.130	.133	.136	.139	.142	.145	.148	.151	.154	.157	.160	.163	.166	.169	.172	.175	.178	.180	.183
96	.132	.135	.138	.141	.144	.147	.150	.153	.156	.159	.162	.165	.168	.171	.174	.178	.181	.183	.186
97	.134	.137	.140	.143	.146	.149	.152	.156	.159	.162	.165	.168	.171	.174	.177	.180	.183	.186	.189
98	.136	.139	.142	.145	.148	.152	.155	.158	.161	.164	.167	.170	.173	.176	.179	.183	.186	.188	.191
99	.138	.141	.144	.147	.151	.154	.157	.160	.163	.166	.169	.173	.176	.179	.182	.185	.188	.191	.194
100	—.140	—.143	—.146	—.150	—.153	—.156	—.159	—.162	—.165	—.169	—.172	—.175	—.178	—.181	—.184	—.188	—.191	—.194	—.197

APPENDIX No. 2.

Comparative scales of old French, metrical, and English barometers.

Old French (or Parisien Zoll).		Metrical.	English.	Old French (or Parisien Zoll).		Metrical.	English.
Inches.	*Lines.*	*Millimeters.*	*Inches,*	*Inches.*	*Lines.*	*Millimeters.*	*Inches.*
26	3.3	711.2	28.00		8.2	749.3	29.50
	3.5	711.7	28.02	27	8.4	749.8	29.52
	3.7	712.2	28.04		8.6	750.3	29.54
	3.9	712.7	28.06		8.8	750.8	29.56
	4.2	713.2	28.08		9.1	751.3	29.58
	4.4	713.7	28.10		9.3	751.8	29.60
	4.6	714.2	28.12		9.5	752.3	29.62
	4.8	714.7	28.14		9.7	752.8	29.64
	5.1	715.3	28.16		10.0	753.4	29.66
	5.3	715.8	28.18		10.2	753.9	29.68
	5.5	716.3	28.20		10.4	754.4	29.70
	5.7	716.8	28.22		10.6	754.9	29.72
	6.0	717.3	28.24		10.9	755.4	29.74
	6.2	717.8	28.26		11.1	755.9	29.76
	6.4	718.3	28.28		11.3	756.4	29.78
	6.6	718.8	28.30		11.5	756.9	29.80
	6.9	719.3	28.32		11.8	757.4	29.82
	7.1	719.8	28.34	28	0.0	757.9	29.84
	7.3	720.3	28.36		0.2	758.4	29.86
	7.5	720.8	28.38		0.4	758.9	29.88
	7.8	721.3	28.40		0.7	759.4	29.90
	8.0	721.9	28.42		0.9	760.0	29.92
	8.2	722.4	28.44		1.1	760.5	29.94
	8.4	722.9	28.46		1.3	761.0	29.96
	8.7	723.4	28.48		1.6	761.5	29.98
	8.9	723.9	28.50		1.8	762.0	30.00
	9.1	724.4	28.52		2.0	762.5	30.02
	9.4	724.9	28.54		2.2	763.0	30.04
	9.6	725.4	28.56		2.5	763.5	30.06
	9.8	725.9	28.58		2.7	764.0	30.08
	10.0	726.4	28.60		2.9	764.5	30.10
	10.2	726.9	28.62		3.1	765.0	30.12
	10.5	727.4	28.64		3.4	765.5	30.14
	10.7	728.0	28.66		3.6	766.1	30.16
	10.9	728.5	28.68		3.8	766.6	30.18
	11.2	729.0	28.70		4.0	767.1	30.20
	11.4	729.5	28.72		4.3	767.6	30.22
	11.6	730.0	28.74		4.5	768.1	30.24
	11.8	730.5	28.76		4.7	768.6	30.26
27	0.0	731.0	28.78		4.9	769.1	30.28
	0.3	731.5	28.80		5.2	769.6	30.30
	0.5	732.0	28.82		5.4	770.1	30.32
	0.7	732.5	28.84		5.6	770.6	30.34
	1.0	733.0	28.86		5.8	771.1	30.36
	1.2	733.5	28.88		6.1	771.6	30.38
	1.4	734.0	28.90		6.3	772.1	30.40
	1.6	734.6	28.92		6.5	772.7	30.42
	1.8	735.1	28.94		6.7	773.2	30.44
	2.1	735.6	28.96		7.0	773.7	30.46
	2.3	736.1	28.98		7.2	774.2	30.48
	2.5	736.6	29.00		7.4	774.7	30.50
	2.8	737.1	29.02		7.6	775.2	30.52
	3.0	737.6	29.04		7.9	775.7	30.54
	3.2	738.1	29.06		8.1	776.2	30.56
	3.4	738.6	29.08		8.3	776.7	30.58
	3.6	739.1	29.10		8.5	777.2	30.60
	3.9	739.6	29.12		8.8	777.7	30.62
	4.1	740.1	29.14		9.0	778.2	30.64
	4.3	740.7	29.16		9.2	778.7	30.66
	4.6	741.2	29.18		9.4	779.3	30.68
	4.8	741.7	29.20		9.7	779.8	30.70
	5.0	742.2	29.22		9.9	780.3	30.72
	5.2	742.7	29.24		10.1	780.8	30.74
	5.4	743.2	29.26		10.3	781.3	30.76
	5.7	743.7	29.28		10.6	781.8	30.78
	5.9	744.2	29.30		10.8	782.3	30.80
	6.1	744.7	29.32		11.0	782.8	30.82
	6.4	745.2	29.34		11.2	783.3	30.84
	6.6	745.7	29.36		11.5	783.8	30.86
	6.8	746.2	29.38		11.7	784.3	30.88
	7.0	746.7	29.40		11.9	784.8	30.90
	7.2	747.3	29.42	29	0.1	785.4	30.92
	7.5	747.8	29.44		0.4	785.9	30.94
	7.7	748.3	29.46		0.6	786.4	30.96
	7.9	748.8	29.48		0.8	786.9	30.98

APPENDIX No. 3.

Fahrenheit.	Centigrade.	Reaumur.	Fahrenheit.	Centigrade.	Reaumur.	Fahrenheit.	Centigrade.	Reaumur.	Fahrenheit.	Centigrade.	Reaumur.
°	°	°	°	°	°	°	°	°	°	°	°
100	37.8	30.2	72	22.2	17.8	44	6.7	5.3	16	— 8.9	— 7.1
99	37.2	29.8	71	21.7	17.3	43	6.1	4.9	15	— 9.4	— 7.6
98	36.7	29.3	70	21.1	16.9	42	5.6	4.4	14	—10.0	— 8.0
97	36.1	28.9	69	20.6	16.4	41	5.0	4.0	13	—10.6	— 8.4
96	35.6	28.4	68	20.0	16.0	41	4.4	3.6	12	—11.1	— 8.9
95	35.0	28.0	67	19.4	15.6	39	3.9	3.1	11	—11.7	— 9.3
94	34.4	27.6	66	18.9	15.1	38	3.3	2.7	10	—12.2	— 9.8
93	33.9	27.1	65	18.3	14.7	37	2.8	2.2	9	—12.8	—10.2
92	33.3	26.7	64	17.8	14.2	36	2.2	1.8	8	—13.3	—10.7
91	32.8	26.2	63	17.2	13.8	35	1.7	1.3	7	—13.9	—11.1
90	32.2	25.8	62	16.7	13.3	34	1.1	0.9	6	—14.4	—11.6
89	31.7	25.3	61	16.1	12.9	33	0.6	0.4	5	—15.0	—12.0
88	31.1	24.9	60	15.6	12.4	32	0.0	0.0	4	—15.6	—12.4
87	30.6	24.4	59	15.0	12.0	31	— 0.6	— 0.4	3	—16.1	—12.9
86	30.0	24.0	58	14.4	11.6	30	— 1.1	— 0.9	2	—16.7	—13.3
85	29.4	23.6	57	13.9	11.1	29	— 1.7	— 1.3	1	—17.2	—13.8
84	28.9	23.1	56	13.3	10.7	28	— 2.2	— 1.8	0	—17.8	—14.2
83	28.3	22.7	55	12.8	10.2	27	— 2.8	— 2.2	— 1	—18.3	—14.7
82	27.8	22.2	54	12.2	9.8	26	— 3.3	— 2.7	— 2	—18.9	—15.1
81	27.2	21.8	53	11.7	9.3	25	— 3.9	— 3.1	— 3	—19.4	—15.6
80	26.7	21.3	52	11.1	8.9	24	— 4.4	— 3.6	— 4	—20.0	—16.0
79	26.1	20.9	51	10.6	8.4	23	— 5.0	— 4.0	— 5	—20.6	—16.4
78	25.6	20.4	50	10.0	8.0	22	— 5.6	— 4.4	— 6	—21.1	—16.9
77	25.0	20.0	49	9.4	7.6	21	— 6.1	— 4.9	— 7	—21.7	—17.3
76	24.4	19.6	48	8.9	7.1	20	— 6.7	— 5.3	— 8	—22.2	—17.8
75	23.9	19.1	47	8.3	6.7	19	— 7.2	— 5.8	— 9	—22.8	—18.2
74	23.3	18.7	46	7.8	6.2	18	— 7.8	— 6.2	—10	—23.3	—18.7
73	22.8	18.2	45	7.2	5.8	17	— 8.3	— 6.7	—11	—23.9	—19.1

APPENDIX No. 4.

Magnetic declinations at Signal Service stations, 1888 (*July*).

[Furnished by the U. S. Coast and Geodetic Survey.]

Abilene, Tex	10° 35′	E.	
Albany, N. Y	10 20	W.	
Alpena, Mich. (about)	1 00	W.	
Atlanta, Ga. (about)	4 00	E.	
Atlantic City, N. J	7 05	W.	
Augusta, Ga	2 05	E.	
Apache, Fort, Ariz	14 10	E.	
Assinaboine, Fort, Mont. (about)	20 45	E.	
Astoria, Oreg. (about)	22 00	E.	
Baltimore, Md	4 40	W.	
Block Island, R. I	10 55	W.	
Boston, Mass	11 55	W.	
Bridger, Fort, Wyo	16 35	E.	
Buffalo, N. Y	5 10	W.	
Boisé City, Idaho	18 35	E.	
Bismarck, Dak	15 35	E.	
Brownsville, Tex	7 35	E.	
Buford, Fort, Dak. (about)	18 15	E,	
Bidwell, Fort, Cal	18 00	E.	
Cairo, Ill	5 20	E.	
Canby, Fort, Wash	21 40	E.	
Carson City, Nev	16 55	E.	
Cedar Keys, Fla	3 15	E.	
Charleston, S. C	0 00		
Charlotte, N. C	0 15	E.	
Chattanooga, Tenn	2 20	E.	
Cheyenne, Wyo. (about)	15 15	E.	
Chicago, Ill	4 00	E.	
Cincinnati, Ohio	1 45	E.	
Cleveland, Ohio	1 35	W.	
Columbus, Ohio	0 25	E.	
Columbia, S. C	1 10	E.	
Colorado Springs, Colo	14 20	E.	
Concordia, Kans	12 10	E.	
Corpus Christi, Tex	8 05	E.	
Crete, Nebr. (about)	11 30	E.	
Custer, Fort, Mont. (about)	18 00	E.	
Davenport, Iowa	6° 15′	E.	
Denver, Colo	14 15	E.	
Des Moines, Iowa	8 50	E.	
Detroit, Mich	0 30	W.	
Dodge City, Kans	11 50	E.	
Dubuque, Iowa	6 40	E.	
Deadwood, Dak	15 45	E.	
Duluth, Minn. (about)	10 30	E.	
Davis, Fort, Tex	10 55	E.	
Eastport, Me	18 55	W.	
El Paso, Tex	12 00	E.	
Erie, Pa	3 30	W.	
Elliott, Fort, Tex	11 20	E.	
Escanaba, Mich. (about)	3 00	E.	
Eureka, Cal	18 10	E.	
Fort Du Chesne, Utah (about)	16 00	E.	
Fort Smith, Ark	8 15	E.	
Fresno City, Cal. (about)	15 30	E.	
Frisco, Utah, (about)	16 45	E.	
Galveston, Tex	7 40	E.	
Grand Haven, Mich. (about)	2 30	E.	
Green Bay, Wis	3 40	E.	
Grant, Fort, Ariz. (about)	13 20	E.	
Hatteras, N. C	3 45	W.	
Huron, Dak	12 15	E.	
Helena, Mont	19 55	E.	
Indianapolis, Ind	2 15	E.	
Jacksonville, Fla	2 00	E.	
Keokuk, Iowa	7 05	E.	
Key West, Fla	2 50	E.	
Knoxville, Tenn	1 30	E.	
Keeler, Cal. (about)	15 30	E.	
Las Animas, Colo	13 15	E.	
La Crosse, Wis	8 00	E.	
Lamar, Mo	8 40	E.	
Lansing, Mich	1 00	E.	
Leavenworth, Kans	9 35	E.	

Magnetic declinations at Signal Service stations, 1888 (*July*)—Continued.

Lexington, Ky	2° 0′	E.	
Little Rock, Ark. (about)	7 00	E.	
Los Angeles, Cal	14 30	E.	
Louisville, Ky	2 35	E.	
Lynchburg, Va	1 25	W.	
Mackinaw City, Mich	0 20	E.	
Manchester, N. H	11 15	W.	
McKinney, Fort, Wyo. (about)	16 25	E.	
Marquette, Mich	3 20	E.	
Memphis, Tenn	6 10	E.	
Milwaukee, Wis	4 30	E.	
Mobile, Ala	5 20	E.	
Montgomery, Ala	4 00	E.	
Moorhead, Minn	11 00	E.	
Mount Washington, N. H	14 30	W.	
Maginnis, Fort Mont. (about)	19 30	E.	
Montrose, Colo. (about)	14 45	E.	
Nantucket, Mass	11 20	W.	
Nashville, Tenn	4 40	E.	
New Brunswick, N. J	7 30	W.	
New London, Conn	10 00	W.	
New Orleans, La	6 00	E.	
New York City	8 20	W.	
Norfolk, Va	3 30	W.	
North Platte, Nebr	12 35	E.	
Northfield, Vt	12 50	W.	
New Haven, Conn	9 25	W.	
Olympia, Wash	21 40	E.	
Omaha, Nebr	10 10	E.	
Oswego, N. Y	7 25	W.	
Palestine, Tex	8 15	E.	
Pensacola, Fla	5 25	E.	
Pittsburg, Pa	3 00	W.	
Philadelphia, Pa	6 50	W.	
Prescott, Ariz. (about)	14 20	E.	
Pike's Peak, Colo	14 25	E.	
Poplar River, Mont	18 40	E.	
Port Angeles, Wash	22 30	E.	
Port Huron, Mich	1 30	W.	
Portland, Me	13 50	W.	
Portland, Oreg	22 00	E.	
Raleigh, N. C	1° 00′	W.	
Red Bluff, Cal. (about)	17 20	E.	
Rio Grande City, Tex	7 50	E.	
Rochester, N. Y	6 30	W.	
Roseburg, Oreg. (about)	18 30	E.	
Sacramento, Cal	17 15	E.	
Saint Louis, Mo	5 50	E.	
San Francisco, Cal	16 35	E.	
Saint Paul, Minn	9 35	E.	
Saint Vincent, Minn	12 15	E.	
Salt Lake City, Utah	16 20	E.	
San Diego, Cal	13 35	E.	
Sandusky, Ohio	0 20	E.	
Santa Fé, N. Mex	12 55	E.	
Savannah, Ga	1 40	E.	
Shreveport, La	7 20	E.	
Southport, N. C	1 10	W.	
Springfield, Ill	5 15	E.	
Springfield, Mo	8 0	E.	
San Antonio, Tex	9 00	E.	
Sill, Fort, Ind. T	9 45	E.	
Spokane Falls, Wash	21 40	E.	
Stanton, Fort, N. Mex	12 20	E.	
Sully, Fort, Dak	14 25	E.	
Tatoosh Island, Wash. (about)	23 00	E.	
Titusville, Fla. (about)	2 00	E.	
Toledo, Ohio	0 20	E.	
Topeka, Kans	10 00	E.	
Totten, Fort, Dak	14 40	E.	
University, Miss. (about)	5 45	E.	
Valentine, Nebr	12 45	E.	
Vicksburg, Miss	6 30	E.	
Washakie, Fort, Wyo. (about)	16 00	E.	
Washington City	4 10	W.	
Walla Walla, Wash	22 20	E.	
Wilmington, N. C	0 50	W.	
Winnemucca, Nev	17 40	E.	
Wood's Hoil, Mass	11 15	W.	
Yankton, Dak	11 45	E.	
Yuma, Ariz	13 35	E.	

Appendix No. 5.

Station.	Time-belt in which station is located.	Local meridian time faster than 75th meridian.	Local meridian time slower than 75th meridian.
	Meridian.	*h. m.*	*h. m.*
Abilene, Tex	105th		1 39
Albany, N. Y	75th	5	
Alpena, Mich	90th		34
Apache, Fort, Ariz	105th		2 20
Assinaboine, Fort, Mont	105th		2 19
Astoria, Oreg	120th		3 15
Atlanta, Ga	90th		37
Atlantic City, N. J	75th	3	
Augusta, Ga	75th		27
Baltimore, Md	75th		6
Bidwell, Fort, Cal	120th		3 1
Bismarck, Dak	105th		1 42
Block Island, R. I	75th	14	
Boisé City, Idaho	120th		2 44
Boston, Mass	75th	16	
Bridger, Fort, Wyo	105th		2 22
Brownsville, Tex	90th		1 30
Buffalo, N. Y	75th		15
Buford, Fort, Dak	105th		1 56
Cairo, Ill	90th		56
Canby, Fort, Wash	120th		3 16
Carson City, Nev	120th		2 59
Cedar Keys, Fla	90th		32
Charleston, S. C	75th		20
Charlotte, N. C	75th		23
Chattanooga, Tenn	90th		41
Cheyenne, Wyo	105th		1 59
Chicago, Ill	90th		50

APPENDIX No. 5—Continued.

Station.	Time-belt in which station is located.	Local meridian time faster than 75th meridian.	Local meridian time slower than 75th meridian.
	Meridian.	*h. m.*	*h. m.*
Cincinnati Ohio	90th		38
Cleveland, Ohio	75th		27
Colorado Springs, Colo	105th		1 59
Columbia, S. C	75th		24
Columbus, Ohio	90th		32
Concordia, Kans	105th		1 31
Corpus Christi, Tex	90th		1 30
Crete, Nebr	90th		1 28
Custer, Fort, Mont	105th		2 10
Davenport, Iowa	90th		1 2
Davis, Fort, Tex	105th		1 56
Deadwood, Dak	105th		1 55
Denver, Colo	105th		2 0
Des Moines, Iowa	90th		1 14
Detroit, Mich	90th		32
Dodge City, Kans	105th		1 40
Dubuque, Iowa	90th		1 3
Du Chesne, Fort, Utah	105th		2 19
Duluth, Minn	90th		1 8
Eastport, Me	60th	32	
Elliott, Fort, Tex	105th		1 41
El Paso, Tex	105th		2 6
Erie, Pa	75th		20
Escanaba, Mich	90th		48
Eureka, Cal	120th		3 17
Fort Smith, Ark	90th		1 17
Fresno City, Cal	120th		2 59
Frisco, Utah	120th		2 33
Galveston, Tex	90th		1 19
Grand Haven, Mich	90th		45
Grant, Fort, Ariz	105th		2 20
Green Bay, Wis	90th		52
Hatteras, N. C	75th		2
Helena, Mont	105th		2 28
Huron, Dak	105th		1 32
Indianapolis, Ind	90th		44
Jacksonville, Fla	75th		26
Keeler, Cal	120th		2 51
Keokuk, Iowa	90th		1 6
Key West, Fla	75th		27
Knoxville, Tenn	90th		36
La Crosse, Wis	90th		1 5
Lamar, Mo	90th		1 17
Lansing, Mich	90th		38
Las Animas, Colo	105th		1 53
Leavenworth, Kans	90th		1 20
Lexington, Ky	90th		38
Little Rock, Ark	90th		1 8
Los Angeles, Cal	120th		2 53
Louisville, Ky	90th		43
Lynchburg, Va	75th		16
Mackinaw City, Mich	90th		38
McKinney, Fort, Wyo	105th		2 5
Maginnis, Fort, Mont	105th		2 16
Manchester, N. H	75th	14	
Marquette, Mich	90th		49
Memphis, Tenn	90th		1 0
Milwaukee, Wis	90th		51
Mobile, Ala	90th		52
Montgomery, Ala	90th		45
Montrose, Colo	105th		2 12
Moorhead, Minn	90th		1 27
Mount Washington, N. H	75th	15	
Nantucket, Mass	75th	20	
Nashville, Tenn	90th		47
New Brunswick, N. J	75th	2	
New Haven, Conn	75th	8	
New London, Conn	75th	12	
New Orleans, La	90th		1 0
New York City	75th	4	
Norfolk, Va	75th		5
Northfield, Vt	75th	9	
North Platte, Nebr	105th		1 43
Olympia, Wash	120th		11
Omaha, Nebr	90th		43

APPENDIX No. 5—Continued.

Station.	Time-belt in which station is located.	Local meridian time faster than 75th meridian.		Local meridian time slower than 75th meridian.	
	Meridian.	*h.*	*m.*	*h.*	*m*
Oswego, N. Y	75th				6
Palestine, Tex	90th			1	22
Pensacola, Fla	90th				49
Philadelphia, Pa	75th				0
Pike's Peak, Colo	105th			2	0
Pittsburg, Pa	75th				20
Poplar River, Mont	105th			2	0
Port Angeles, Wash	120th			3	14
Port Huron, Mich	75th				30
Portland, Me	75th		19		
Portland, Oreg	120th			3	11
Prescott, Ariz	105th			2	30
Raleigh, N. C	75th				14
Red Bluff, Cal	120th			3	9
Rio Grande City, Tex	105th			1	35
Rochester, N. Y	75th				11
Roseburg, Oreg	120th			3	13
Sacramento, Cal	120th			3	6
Saint Louis, Mo	90th			1	1
Saint Paul, Minn	90th			1	12
Saint Vincent, Minn	90th			1	29
Salt Lake City, Utah	105th			2	27
San Antonio, Tex	105th			1	34
San Diego, Cal	120th			2	48
Sandusky, Ohio	90th				30
San Francisco, Cal	120th			3	10
Santa Fé, N. Mex	105th			2	4
Savannah, Ga	75th				24
Shreveport, La	90th			1	14
Sill, Fort, Ind. Ter	105th			1	33
Spokane Falls, Wash	120th			2	49
Springfield, Ill	90th				58
Springfield, Mo	90th			1	13
Stanton, Fort, N. Mex	105th			2	2
Sully, Fort, Dak	105th			1	42
Tatoosh Island, Wash	120th			3	19
Titusville, Fla	75th				23
Toledo, Ohio	90th				34
Topeka, Kans	90th			1	23
Totten, Fort, Dak	105th			1	36
University, Miss	90th				58
Valentine, Nebr	105th			1	42
Vicksburg, Miss	90th			1	3
Walla Walla, Wash	120th			2	53
Washakie, Fort, Wyo	105th			2	16
Washington City	75th				8
Wilmington, N. C	75th				12
Winnemucca, Nev	120th			2	51
Wood's Holl, Mass	75th		17		
Yankton, Dak	90th			1	30
Yuma, Ariz	120th			2	38

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