as shown in the illustration, well protected from the weather, the whole being designed for outdoor use.

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

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

On account of the great interference offered by buildings and other obstructions to the free movement of the wind, its velocity is much less in the vicinity of these obstructions than beyond; therefore, in selecting the location for an anemometer, preference should be given to the more elevated points in the vicinity of the station, and some rigid support should be used to raise the instrument as far as practicable above the immediate influence of the office building itself. The support must be set up so that the anemometer on top or on the cross-arm is as nearly vertical as possible.

The illustration shows clearly the appearance of an approved Weather Bureau pattern combined support for wind instruments, similar to the one installed at our plant.

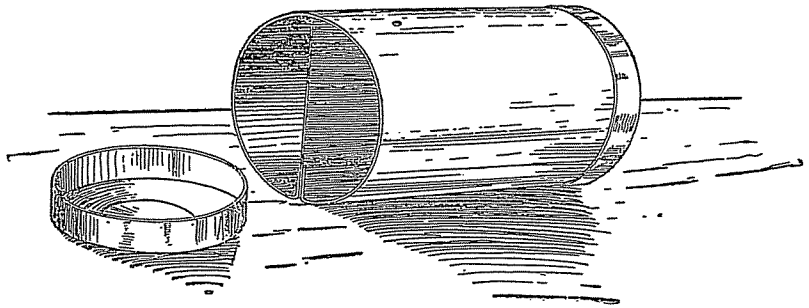
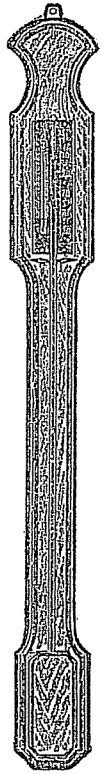


Fig. 40

Fig. 37. The Gilbert Anemometer.

The Gilbert Anemometer consists of a case containing a spindle passing through a worm gear, which turns a toothed gear. This gear in its rotary motion makes a contact with a brass brush, which is connected electrically with a flashlight. The cross arms, with cups attached, is placed on the spindle, and as the wind blows, it revolves the cups, causing the contact. The velocity of the wind is determined by counting the flashes for fifteen seconds, thus giving you the number of miles per hour. For instance, if light flashes eight times in fifteen seconds, this signifies that the wind is blowing eight miles an hour.



Courtesy Taylor Instrument Companies Rochester, N.Y.

Fig. 41

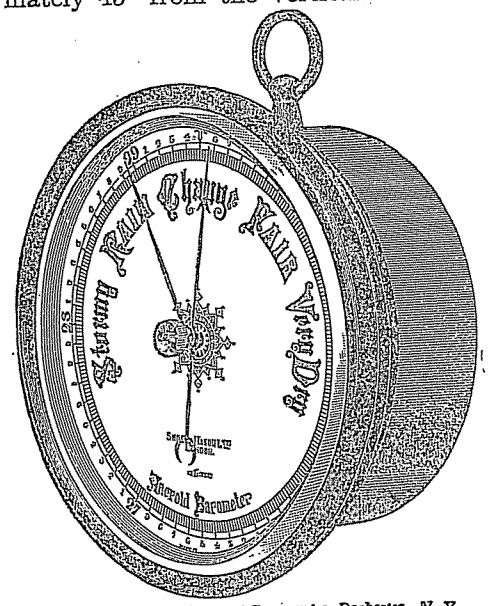
Fig. 38. How to Connect the Gilbert Anemometer.

By referring to the diagram, you will see that one wire which should be the annunciator wire, or even a small electric light wire, is connected from the wire at the anemometer case directly to one side of the lamp socket. Another piece of the same size wire connects the other side of the lamp socket to one terminal of your switch. The second terminal of the switch should be connected to an outer post of one dry battery. The inner post of this same dry battery should be connected to the outer post of the second dry battery. Complete the circuit by connecting the inner post of the second dry battery to any one of the screws at the bottom of the anemometer case. The lamp used should be a small flashlight battery lamp for use on two and a half to three volts. Be sure in making the connections that the ends of your wire are scraped free from insulation and dirt. This can be done by cutting off the insulation with a knife and then rubbing the copper wire bright by a piece of sandpaper or emery cloth, or even a file. The switch should be left open when you are not taking readings, in order to prolong the life of your batteries. By unloosening the little screw in the hub of the anemometer vanes, you can remove them and also take off the brass cap on the anemometer case. This should be taken apart once or twice a month, and some machine oil used around the bearings to keep them from wearing out too quickly.

THE STANDARD ELECTRICAL SUNSHINE RECORDER AND THE GILBERT SUNSHINE RECORDER

Fig. 39. The standard sunshine recorder is designed for recording the duration of sunshine electrically, continuously, and automatically, on a register. The instrument is essentially a differential air thermometer in the form of a straight glass tube with cylindrical bulbs at each end, enclosed in a protecting glass sheath, with suitable platinum wire electrodes fused in at the center, the whole mounted in a metal socket on an adjustable support.

The base is secured to the support on the roof so that the glass tube points north and south, with the blackened bulb toward the south and lowermost, then the tube is inclined at such an angle that the instrument will begin and cease to record sunshine with the proper degree of cloudiness. This inclination should be approximately 45° from the vertical. The machine should be adjusted at an hour when the sun is wholly obscured.

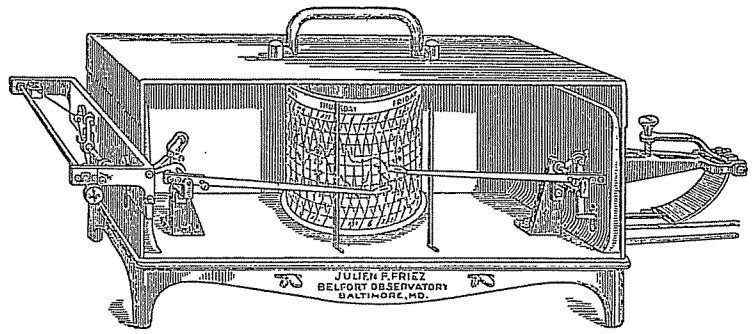


Courtesy Taylor Instrument Companies, Rochester, N. Y.

Fig. 42

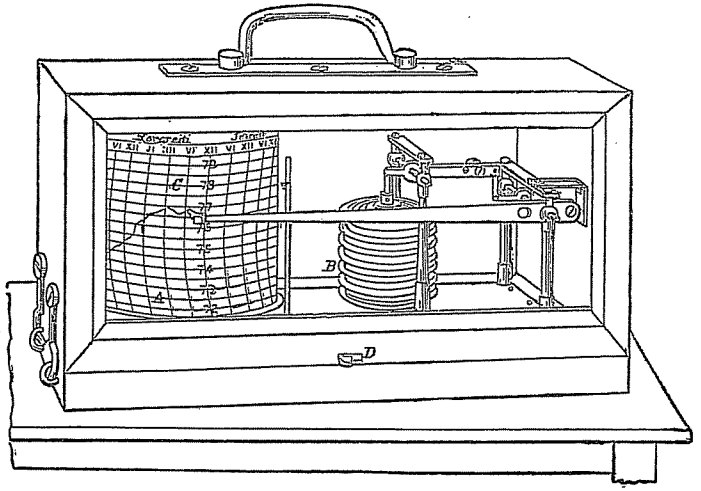
In temperate and cold climates, slightly different adjustments will be found necessary at different seasons of the year.

Fig. 40. The Gilbert Sunshine Recorder consists of a metal case, cylindrical in form, with a piece of metal turned up on the ends, dividing the cylinder in half. On each side of the case are small holes through which the sun casts its rays and records its movement and duration on a small piece of blue print paper inside the cylinder, one piece of paper being in each compartment. When the blue print paper is dipped in



Courtesy Julien Friez & Sons, Baltimore, Md.

Fig. 43



Courtesy Julien Friez & Sons, Baltimore, Md

Fig. 44

water, it becomes entirely bleached, with the exception of the path made by the sun, which shows up in a blue line.

The sunshine recorder should be set up so that the ends point directly north and south. The holes pierced in the sides of the case are nearer one end than the other. The end that the holes are nearest should be toward the south. It should be held firmly in place.

THE BAROMETER

The barometer is used for measuring the pressure of the atmosphere. The principle of this instrument was first discovered by Torricelli, a pupil of Galileo, the great Italian philosopher and scientist, in 1643. Many and various types of instruments have been made, but the two most generally used, especially where accurate indications are desired, are the mercurial and aneroid barometers. Either of these instruments are quite sensitive to changes in the weight or pressure of the earth's atmosphere, and from their variations we are able to draw conclusions relative to changes in the weather. Figs No. 41 and 42 illustrate the standard mercurial and aneroid barometers used most extensively today. A description of these barometers will serve to make the photographs clearer to the readers of this text.

THE MERCURIAL BAROMETER (Fig. 41)

The mercurial barometer in use today is practically the same as that invented by Torricelli. Of course, many changes have been made in the case containing the tube of mercury, adding to its attractiveness, but the principle remains the same.

The standard mercurial barometer consists of a straight glass tube about thirty-two or thirty-three inches in length, hermetically sealed at one end. The tube is of half-inch bore and is filled with chemically pure mercury, which has been boiled in the tube to insure the total exclusion of all air and moisture. After the tube has been filled, the open end is immersed in a cistern of mercury. Upon immersion the mercury drops in the tube to a height of 29.92 inches at sea level, or until counterbalanced by the weight of the surrounding atmosphere pressing upon the surface of the mercury in the cistern. The space in the top of the tube is a perfect vacuum and is called the Torricellian vacuum.

The glass mercury tube is enclosed in a brass case. About two

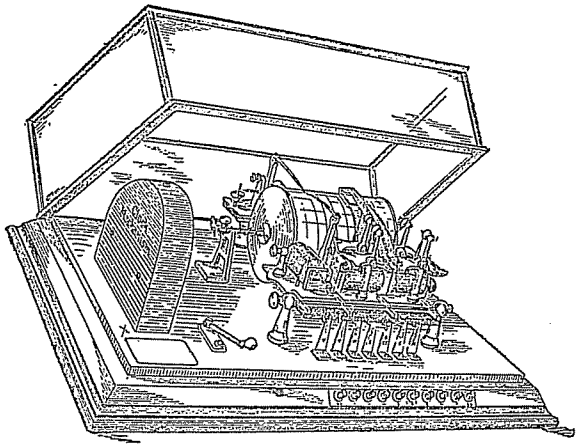
inches from the top of the case is an opening extending down the front and back for a distance of about eight inches. On each side of this opening is a graduated scale, one side being in inches and the other graduated in centimeters. The opening is fitted with a sliding vernier scale graduated in millimeters, thus permitting the reading of changes in the height of the mercury column most accurately, as the sliding vernier may be adjusted to the level of the mercury by means of a thumb screw fitted on the side of the case. The cistern containing the mercury is of glass, with a soft leather or chamois bottom and an adjusting screw, used to raise or lower the level of the mercury, so that it just comes in contact with a small ivory point, inserted in the top of the cistern, and which is used to mark the zero of the scale. Observations of the changes in the atmospheric pressure should be taken at regular intervals, and it is necessary to adjust the height of the mercury in the cistern before each observation. This is done by bringing the ivory point in contact with the level of the mercury and then bringing the vernier scale absolutely level with the top of the column of mercury in the tube, and then take the reading.

The mercurial barometer is a very delicate instrument and when once placed in the desired position should not be moved. Care should be taken that the room in which the barometer is placed is of nearly uniform temperature, for if the temperature at the top of the barometer is different than the temperature at the bottom, of course there will be an effect produced on the changes in the mercury column. All other barometers are set by the mercurial.

THE ANEROID BAROMETER (Fig. 42).

The aneroid barometer is so constructed that it contains no liquid whatever, and thus derives its name from the Greek compound word "aneroid," meaning "without fluid."

The essential parts of the instrument are a metallic case from which the air has been exhausted, and which contains a spring. The case of elastic metal is fastened to a base plate at the bottom and to the spring at the top. The pressure of the atmosphere causes the case to expand and contract, thus effecting the spring, which is connected to a needle or dial, causing the dial to move around on the scale on the face of the instrument and record the changes. The scale is marked off in inches from 28 to 31, and besides



Courtesy Julien Friez & Sons, Baltimore, Md.

Fig. 45

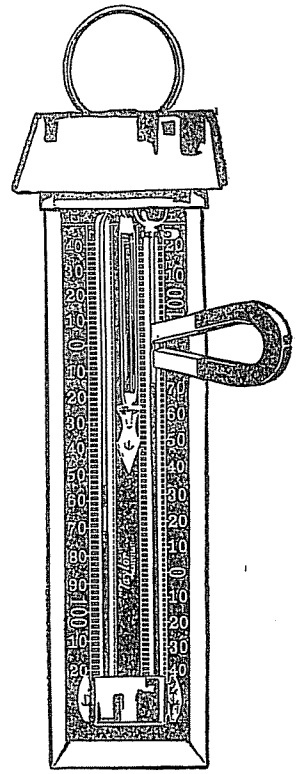
a brass hand or pointer, used to designate the changes in the atmospheric pressure, there is a small index hand to set over the needle so that the amount of change in a certain period is easily known on consulting the instrument.

The dial of the barometer is marked with the words "Fair," "Change," and "Rain," etc., but these words have no significance, and should be disregarded. For instance, 29½ is marked "Change"; 30, "Fair"; 31, "Very dry"; 28½, "Rain." If the barometer, which has been standing at 30.9, suddenly drops down to 29.9, this is positive indication that a storm is approaching, with strong winds, yet, according to the dial on the aneroid, the reading would be "Fair." If the barometer were standing at 28 and rose to 29, this would actually indicate approach of cold, dry weather, and yet on the dial it reads "Rain." This simply goes to show that the readings on the dial are of no significance whatsoever, and are not to be relied upon.

The aneroid is not as accurate an instrument as the mercurial, so should be checked up occasionally with the mercurial barometer.

The aneroid type of barometer is also used in altitude work, but must be compensated before using.

This type of barometer possesses several advantages over the mercurial in that it is portable and therefore used for altitude work; at sea it is used because there is no fluid to become unsettled by the motion of the vessel; it is used also in observatory work because the action is quicker than the mercurial barometer action, and sudden changes likely to occur are indicated.



Courtesy Taylor Instrument Companies Rochester, N. Y.

Fig. 46

INDICATIONS FROM THE BAROMETER

A single observation reading of the barometer is of no significance. Reading must be taken at different intervals or the results will be misleading. The important thing about the barometer is to watch the rise and fall, particularly, whether it is gradual or rapid. From no single reading can you make an observation or a forecast. A rapid rise indicates that a strong wind is apt to blow. A rapid fall indicates that the weather will be unsettled, and that strong winds are apt to blow. Both indicate a change in the weather, depending upon many things, particularly, however, the direction from which the wind blows. If an observer stands with the wind blowing on his back, the area of low barometric pressure will be at his left, and that of high barometric pressure at his right. With low pressure in the west and high pressure in the east, the wind will be from the south; but with low pressure in the east and high pressure in the west, the wind will be from the north. The barometer rises for northerly winds, from northwest by the north to eastward, for

RELATIVE HUMIDITY TABLES

Per Cent Fahrenheit Temperatures

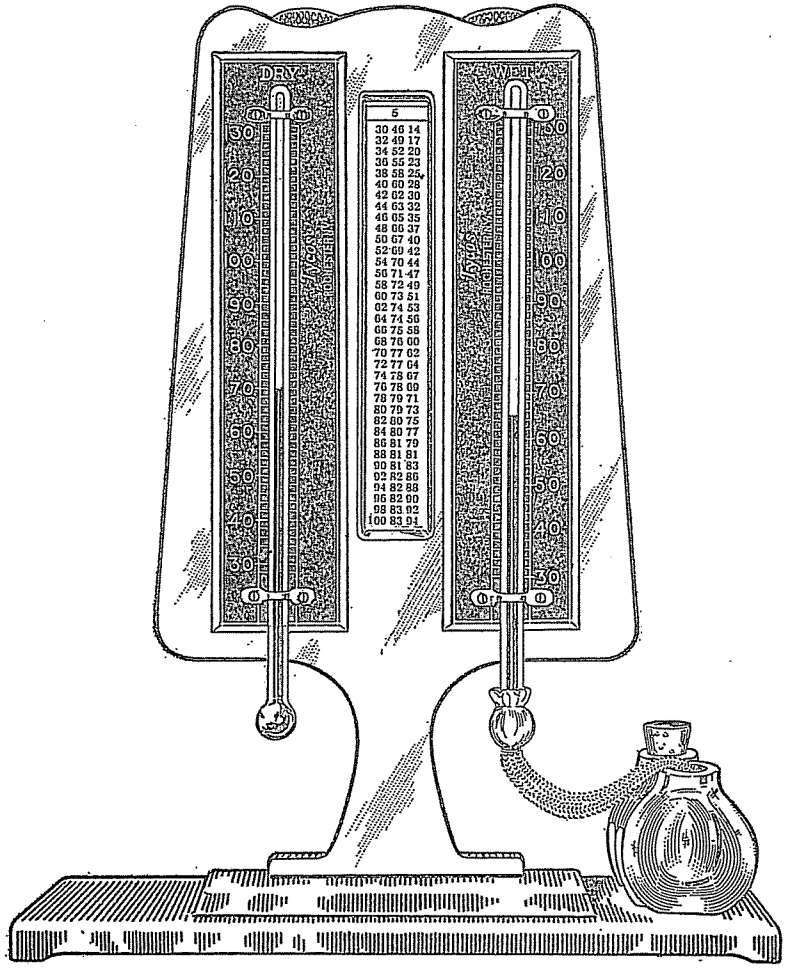
Difference in Degrees Between Wet and Dry Bulb Thermometers

Reading of Dry Bulb Thermometer	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
32	90	79	69	60	50	41	31	22	13	4							
33	90	80	71	61	52	42	33	24	16	7							
34	90	81	72	62	53	44	35	27	18	9	1						
35	91	82	73	64	55	46	37	29	20	12	4						
36	91	82	73	65	56	48	39	31	23	14	6						
37	91	83	74	66	58	49	41	33	25	17	9	1					
38	91	83	75	67	59	51	43	35	27	19	12	4					
39	92	84	76	68	60	52	44	37	29	21	14	7					
40	92	84	76	68	61	53	46	38	31	23	16	9	2				
41	92	84	77	69	62	54	47	40	33	26	18	11	5				
42	92	85	77	70	62	55	48	41	34	28	21	14	7				
43	92	85	78	70	63	56	49	43	36	29	23	16	9	3			
44	93	85	78	71	64	57	51	44	37	31	24	18	12	5			
45	93	86	79	71	65	58	52	45	39	33	26	20	14	8	2		
46	93	86	79	72	65	59	53	46	40	34	28	22	16	10	4		
47	93	86	79	73	66	60	54	47	41	35	29	23	17	12	6	1	
48	93	87	80	73	67	60	54	48	42	36	31	25	19	14	8	3	
49	93	87	80	74	67	61	55	49	43	37	32	26	21	15	10	5	
50	93	87	81	74	68	62	56	50	44	39	33	28	22	17	12	7	2
51	94	87	81	75	69	63	57	51	45	40	35	29	24	19	14	9	4
52	94	88	81	75	69	63	58	52	46	41	36	30	25	20	15	10	6
53	94	88	82	75	70	64	58	53	47	42	37	32	27	22	17	12	7
54	94	88	82	76	70	65	59	54	48	43	38	33	28	23	18	14	9
55	94	88	82	76	71	65	60	55	49	44	39	34	29	25	20	15	11
56	94	88	82	77	71	66	61	55	50	45	40	35	31	26	21	17	12
57	94	88	83	77	72	66	61	56	51	46	41	36	32	27	23	18	14
58	94	89	83	77	72	67	62	57	52	47	42	38	33	28	24	20	15
59	94	89	83	78	73	68	63	58	53	48	43	39	34	30	25	21	17

RELATIVE HUMIDITY TABLES

Continued

Reading of Dry Bulb Thermometer	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
60	94	89	84	78	73	68	63	58	53	49	44	40	35	31	27	22	18
61	94	89	84	79	74	68	64	59	54	50	45	40	36	32	28	24	20
62	94	89	84	79	74	69	64	60	55	50	46	41	37	33	29	25	21
63	95	90	84	79	74	70	65	60	56	51	47	42	38	34	30	26	22
64	95	90	85	79	75	70	66	61	56	52	48	43	39	35	31	27	23
65	95	90	85	80	75	70	66	62	57	53	48	44	40	36	32	28	25
66	95	90	85	80	76	71	66	62	58	53	49	45	41	37	33	29	26
67	95	90	85	80	76	71	67	62	58	54	50	46	42	38	34	30	27
68	95	90	85	81	76	72	67	63	59	55	51	47	43	39	35	31	28
69	95	90	86	81	77	72	68	64	59	55	51	47	44	40	36	32	29
70	95	90	86	81	77	72	68	64	60	56	52	48	44	40	37	33	30
71	95	90	86	82	77	73	69	64	60	56	53	49	45	41	38	34	31
72	95	91	86	82	78	73	69	65	61	57	53	49	46	42	39	35	32
73	95	91	86	82	78	73	69	65	61	58	54	50	46	43	40	36	33
74	95	91	86	82	78	74	70	66	62	58	54	51	47	44	40	37	34
75	96	91	87	82	78	74	70	66	63	59	55	51	48	44	41	38	34
76	96	91	87	83	78	74	70	67	63	59	55	52	48	45	42	38	35
77	96	91	87	83	79	75	71	67	63	60	56	52	49	46	42	39	36
78	96	91	87	83	79	75	71	67	64	60	57	53	50	46	43	40	37
79	96	91	87	83	79	75	71	68	64	60	57	54	50	47	44	41	37
80	96	91	87	83	79	76	72	68	64	61	57	54	51	47	44	41	38
82	96	92	88	84	80	76	72	69	65	62	58	55	52	49	46	43	40
84	96	92	88	84	80	77	73	70	66	63	59	56	53	50	47	44	41
86	96	92	88	85	81	77	74	70	67	63	60	57	54	51	48	45	42
88	96	92	88	85	81	78	74	71	67	64	61	58	55	52	49	46	43
90	96	92	89	85	81	78	75	71	68	65	62	59	56	53	50	47	44
92	96	92	89	85	82	78	75	72	69	65	62	59	57	54	51	48	45
94	96	93	89	86	82	79	75	72	69	66	63	60	57	54	52	49	46
96	96	93	89	86	82	79	76	73	70	67	64	61	58	55	53	50	47
98	96	93	89	86	83	79	76	73	70	67	64	61	59	56	53	51	48
100	96	93	90	86	83	80	77	74	71	68	65	62	59	57	54	52	49



Courtesy Taylor Instrument Companies, Rochester, N.Y.

Fig. 47

Like the hygrometer, this instrument measures the "relative humidity."

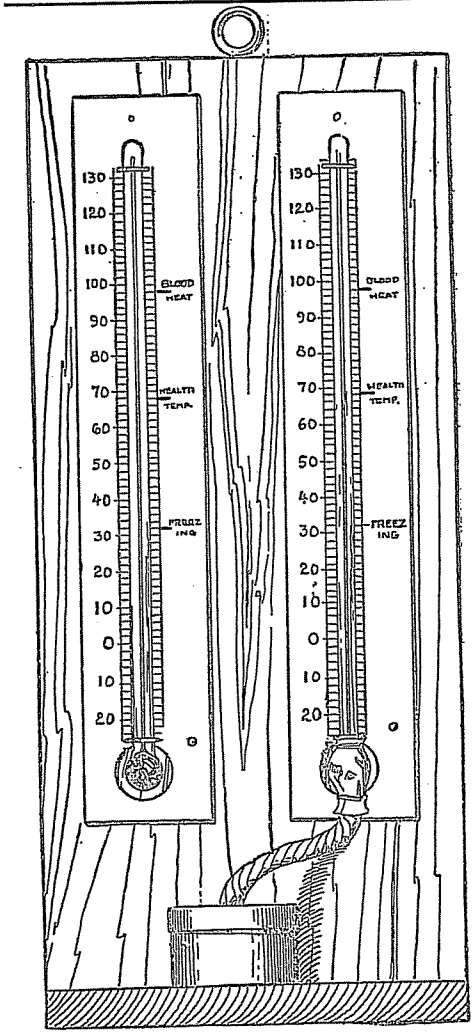


Fig. 48

GILBERT HYGROMETER

dry, or less wet weather, for less wind, or for more than one of these changes —except on a few occasions, when rain, hail, or snow comes from the northward with strong wind. The barometer falls for southerly wind, from southeast, by the south, to the westward, for wet weather, for stronger wind, or for more than one of these changes, except on a few occasions, when moderate wind with rain or snow comes from the northward.

GENERAL BAROMETER INDICATIONS

A gradual but steady rise indicates settled fair weather.

A gradual but steady fall indicates unsettled or wet weather.

A very slow rise from a low point is usually associated with high winds and dry weather.

A rapid rise indicates clear weather with high winds.

A very slow fall from a high point is usually connected with wet and unpleasant weather without much wind.

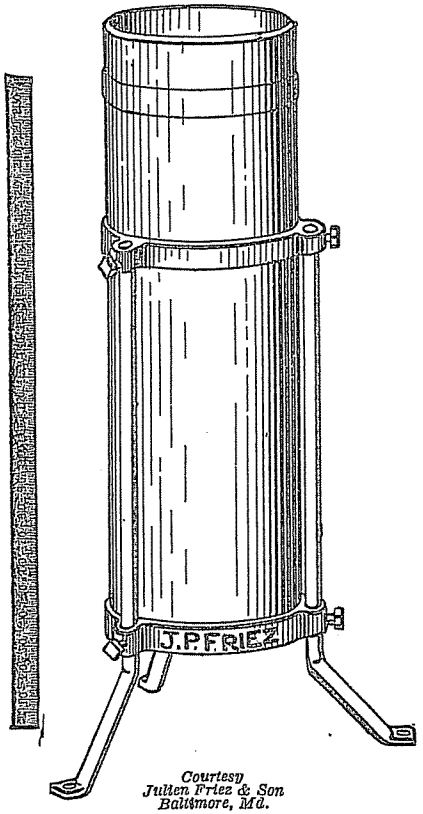
The following table of the United States Weather Bureau gives a summary of the wind and barometer indications:

Barometer Reduced to Sea Level	Wind Direction	Character of Weather Indicated
30.10 to 30.20 and steady	SW to NW	Fair with slight temperature changes for 1 to 2 days
30.10 to 30.20 and rising rapidly	SW to NW	Fair, followed within 2 days by warmer and rain
30.10 to 30.20 and falling slowly	SW to NW	Warmer, with rain in 24 to 36 hours
30.10 to 30.20 and falling rapidly	SW to NW	Warmer, with rain in 18 to 24 hours
30.20 and above and stationary	SW to NW	Continued fair, with no decided temperature change
30.20 and above and falling slowly	SW to NW	Slowly rising temperature and fair for two days
30.10 to 30.20 and falling slowly	S to SE	Rain within 24 hours
30.10 to 30.20 and falling rapidly	S to SE	Wind increasing in force, with rain within 12 to 24 hours
30.10 to 30.20 and falling slowly	SE to NE	Rain in 12 to 18 hours
30.10 to 30.20 and falling rapidly	SE to NE	Increasing wind, with rain within 12 hours
30.10 and above and falling slowly	E to NE	In summer, with light winds, rain may not fall for several days. In winter, rain within 24 hours
30.10 and above and falling rapidly	E to NE	In summer, rain probably within 12 to 24 hours. In winter, rain or snow, with increasing wind will often set in, when the barometer begins to fall and the wind sets in from the NE
30 or below and falling slowly	SE to NE	Rain will continue 1 or 2 days
30 or below and falling rapidly	SE to NE	Rain, with high wind, followed within 24 hours by clearing and cooler
30 or below and rising slowly	S to SW	Clearing within a few hours and continued fair for several days
29.80 or below and falling rapidly	S to E	Severe storm of wind and rain or snow imminent, followed within 24 hours by clearing and colder
29.80 or below and falling rapidly	E to N	Severe northeast gales and heavy rain or snow, followed in winter by a cold wave
29.80 or below and rising rapidly	Going to W	Clearing and colder

A sudden fall indicates a sudden shower or high winds, or both.

A stationary barometer indicates a continuance of existing weather conditions. (*Note*: Tap the barometer slightly on the face. If the hands move a trifle, it indicates that there is the tendency to rise or fall, depending upon the direction of movement of the hands.)

Northeasterly winds precede storms that approach from the southwest; that is, in New England and the Middle States and the Ohio Valley. Southeasterly winds precede storms that approach from the Lake region.



Courtesy Julien Friez & Son Baltimore, Md.

Fig. 49
U. S. STANDARD RAIN GAUGE

THERMOMETERS

For information regarding the manufacture of thermometers, we recommend P. R. Jameson's book, "Weather and Weather Instruments," published by the Taylor Instrument Companies of Rochester, N. Y.

Thermometers are of great importance to us in determining weather.

LOCATION OF THERMOMETERS

1. They must be properly exposed.
2. A good circulation of air around them is necessary.
3. They must be properly protected from the rays of the sun.

Note: If these instructions are not carefully followed out, errors are apt to occur, and you will be misled.

For a change of wind towards northerly directions, a thermometer falls. For a change of wind toward southerly directions a thermometer rises.

MAXIMUM AND MINIMUM THERMOMETERS

Maximum and minimum thermometers are used to record the daily maximum and minimum temperatures. Fig. 46 shows a typical maximum and minimum thermometer used for giving the extremes of temperature. One side of the thermometer has a scale reading, beginning at the top, from 60° below zero to 140° above zero. This is the scale used when determining the coldest temperature reached during a day. The other side of the thermometer has a scale marked from 70° below zero, beginning at the bottom and reading up, to 130° above zero. On this side the maximum heat reached during the day is recorded. There is a small metal piece in the tubes, one on each side, and as the mercury pushes ahead or recedes, the small index is left at the lowest point reached in one tube and at the highest point reached in the other. The small metal piece is drawn back to the level of the mercury by means of a small magnet.

WHEN MAXIMUM TEMPERATURE IS REACHED

You can generally look for maximum temperature between three and

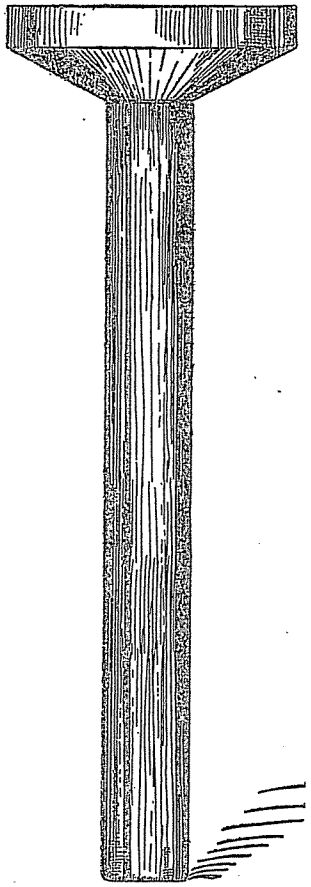
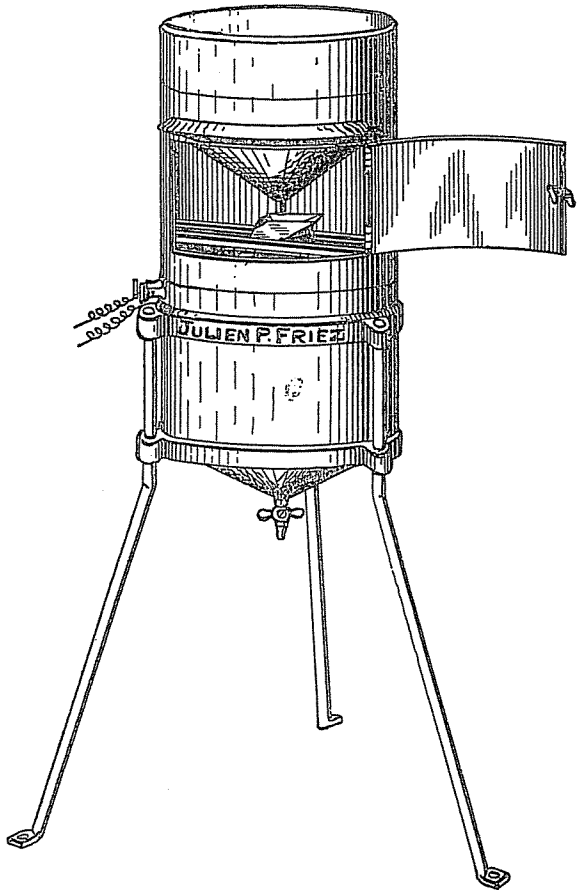


Fig. 50
GILBERT RAIN GAUGE



Courtesy Julien Friez & Sons, Baltimore, Md.

Fig. 51
TIPPING BUCKET RAIN GAUGE

four o'clock in the afternoon. At this time the sun has reached its highest altitude.

WHEN THE MINIMUM TEMPERATURE IS REACHED

This usually occurs a little while before sunrise. It is important in weather observing to make a record of the highest temperature of the day and the lowest temperature of the night. Continuous observation, as the reader will appreciate, is practically impossible for such a record.

THE THERMOMETER FOR HUMIDITY IN THE AIR

Moisture or dampness in the air, as shown by an instrument called the hygrometer, increases before rain, fog, or dew.

Before describing the hygrometer, a definition of a few of the terms used in conjunction with the instrument will be found useful.

ABSOLUTE HUMIDITY

The amount of vapor actually present in the atmosphere is termed the absolute humidity, expressed usually either in the expansive force that the vapor exerts or in its weight in grains per cubic foot of air.

RELATIVE HUMIDITY

The absolute humidity divided by the amount of vapor that might exist if the air were saturated gives a ratio that is called the relative humidity.

DEW POINT

The temperature at which moisture begins to be condensed on a cold vessel or other container and becomes visible is called the dew point.

HOW HYGROMETERS ARE MADE

The most generally used hygrometer consists of two ordinary thermometers, the bulb of one being covered with a piece of muslin and kept constantly moistened with water by means of a wick or cotton thread communicating with a container of water. The difference in the readings of the two thermometers, the wet and the dry, is observed, and knowing this, it is very easy to determine the

humidity by consulting a table (see table on pages 58-59), which has been prepared for this purpose. These instruments are, according to the increase in price, equipped with a table, and the container is held in a wire frame, as you will see from the Figs. 49-50 showing the standard Weather Bureau station instrument and the Gilbert hygrometer.

Fig. 49 shows the U. S. Standard Weather Bureau Station Rain Gauge, Fig. 50 the Gilbert Rain Gauge and Fig. 51 the U. S. Standard Weather Bureau Station Rain Gauge, Tipping Bucket Type.

The Gilbert Weather Station is equipped with the Tipping Bucket Type Rain Gauge. Fig. 51 shows the apparatus clearly, complete and mounted ready for use. The brass bucket seen in position through the open door is adjusted to tip for each hundredth inch of rainfall collected in the twelve-inch diameter receiver at the top, and this rainfall is electrically recorded at any convenient distance on a register. After any desired period the water may be drawn off and check measurements made by means of the brass measuring tube and graduated cedar stick shown in the figure.

THE GILBERT RAIN GAUGE (Fig. 50).

(*a*) Tube.
(*b*) Funnel.
(*c*) Measuring stick.

The essential parts of the Gilbert Rain Gauge consists of a metal tube twelve inches long, having a diameter of $1\frac{5}{16}$ inches (inside) and a funnel-shaped top, the neck of which fits snugly into the open end of the metal tube. The outside diameter of the neck of the funnel is a trifle less than $1\frac{5}{16}$ inches. The area of the circle formed at the top of the tube is one-tenth the area of the funnel circle. A measuring stick is provided to measure the rainfall collected in the tube.

To determine the amount of rainfall on the surface of the ground, the rain collected in the tube should be measured at regular intervals, usually twelve hours apart. For every inch of rain collected in the tube, as denoted by the measuring stick, it means that there is one one-hundredth of an inch of rain on the ground; if 10 inches of rain in the tube, it signifies one inch of rain on the ground. In