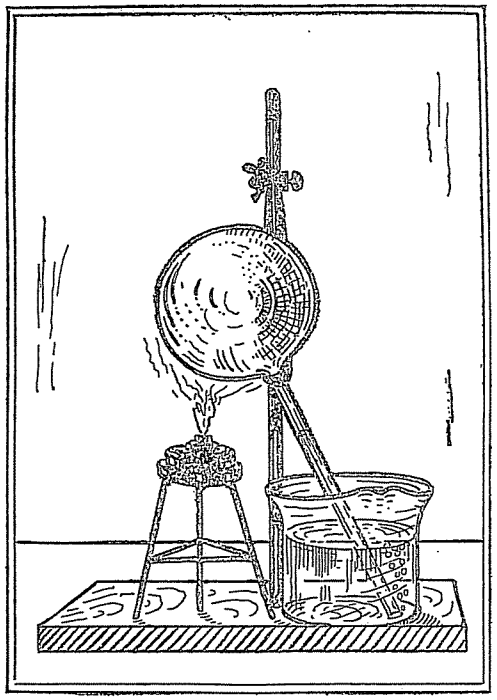


Fig. 32

causing the barometer to rise. Such a center as this is known as a high barometric center or the anti-cyclonic area. Here the circulation of the air is exactly opposite to that of the cyclonic area.

We are all more or less acquainted with these anti-cyclonic storms, because in winter these great masses of air rise up from the warm areas, pile up, and form high pressure areas over the mountains of Canada, and soon this high pressure works down upon us as blizzards and cold waves.

We have described quite minutely the movement of the wind about these points of high pressure and low pressure and have shown you the map and have illustrated the high pressure and low pressure areas, but there is still another feature that is of great importance to us, and that is the movement of the storms and the fact that storms have a progressive movement from west to east.

These storms move more rapidly in the United States than elsewhere, and are more rapid in their movement in winter than in summer. Their speed is almost one half again as great. The average velocity of the low area storm in the United States is about twenty-five miles an hour in June, July, August, and September, and from October on they continue to increase.

LOW PRESSURE

We can summarize low-pressure storms generally in the following manner: They have a wind circulation inward and upward and are elliptical in form. Their velocity varies from six hundred to nine hundred miles per day, moving in the same general direction. They are characterized in their eastern quadrants by cloudy weather, southerly and easterly winds, precipitation, temperature oppressive in summer and abnormally high in winter, falling barometer, increasing humidity and followed by clear weather, rising barometer, decreasing humidity and falling temperature in the western quadrants.

Buys Ballots' law of winds is, that in the Northern Hemisphere if one stands with his back to the wind, the low barometric pressure will be invariably to the left hand; in the Southern Hemisphere the lowest pressure is always to the right. This law explains one of the characteristics of low pressure storms.

AREAS OF HIGH PRESSURE

In speaking of low-pressure storms we called them storm centers, because nearly always they are of sufficient intensity to bear that name, but in high-pressure areas we do not speak of them as storm centers.

The Buys Ballots' law applies to anti-cyclonic as well as cyclonic storms, that is, when one's back is to the wind, the lowest barometric pressure is at the left and the highest at the right. This is probably understood by saying that in the cyclonic storms, the winds blow inward, contrary to the hands of a watch, and in the anti-cyclonic they blow outward, that is, in the same direction to the direction of the hands of the watch.

In the United States, the cyclonic storms are not as frequent as low-pressure storms, and it is safe to say that probably not more than one-third of the entire anti-cyclonic areas can be classed as storm areas.

WHY AIR RISES

Another very interesting experiment is to secure a long-stemmed glass bulb (see Fig. 32). Arrange this apparatus as illustrated, with the stem of the bulb immersed in the water. The glass bulb condenses the air. When you first put it into the water nothing

happens, but as soon as you apply heat the air bubbles come out of the end of the tube. This means that the air in the tube has expanded and part of it has come out through the stem of the tube and the remainder is lighter. It is well to remember, when air is heated it expands and becomes lighter. This fact is extremely important to remember, because it has a great deal to do with the important instrument, the barometer, which is used to measure the pressure of the atmosphere and is an important element in the question of humidity, as you will learn later. By this time you no doubt have learned that:

1. Air has weight.
2. Heated air expands, becomes lighter, and exerts less pressure.
3. Cold air comes from the side to take the place of hot air that rises.

When the rays of the sun heat an area of the earth, the air over such a place expands and becomes lighter, naturally rising, and the result of this is that the winds are produced by cool air moving in to take the place of the heated air. This cool air moves in from all directions. When such a thing happens at any point on the earth's surface, it is known as a storm center, an area of low pressure.

WHAT IS A CYCLONIC STORM?

Because of the rotation of the earth on its axis, a force arises which tends to deflect to the right all motions in the northern hemisphere, and to the left all motions in the southern hemisphere. The winds flowing toward the storm center are turned to the right or left and move in a spiral around the storm center. This system of whirling winds around a central region of low pressure produce what is termed a cyclonic storm. Storms have a tendency to move in an easterly or northeasterly direction, and at a rate of from five hundred to seven hundred miles a day. Cyclonic storms, although we look upon them as being very severe, are very often mild and not of an intensive character.

WHICH WAY DOES THE WIND BLOW AFTER A STORM?

From the descriptions and experiments preceding, which illustrate the development of storms, reference was made only to the winds blowing in toward the storm center. Naturally the question

comes to your mind: What happens to them after the cold air has taken the place of the warm air? They change to other directions when the storm has passed away. It is because of this fact that we look for a change in weather conditions when the wind changes—a very important sign that you will be interested in later on.

It is well to mention here a thing that is going to be very important to us when we study the barometer, that is, the pressure of the atmosphere. Should the pressure of the air, which is normally at sea-level 14.7 pounds to the square inch, change, that is, become lighter, it would not exert so much pressure on the column of mercury in the tube of the barometer and the mercury would drop in the tube. (See Fig. 7.) On the other hand, if the weight of the air was increased, that is, if it became heavier, it would force the mercury to rise in the tube. This should be quite clear to you, because it is the lightness and heaviness of the air that is going to interest us more particularly than any other part of the subject when we get into the study of the atmospheric changes, what causes them, and the indications that lead up to our conclusions. In order that this principle is absolutely clear to you, you should perform Experiment 4, or if you have not facilities for doing it, it is well to see it performed in any physics laboratory.

Immediately you ask yourself: If air has such a tremendous pressure as 14.7 pounds to the square inch, why is it that a weight of air amounting to thirty-five thousand pounds bearing down on the average individual does not cave the body in? Simply because air penetrates the body so easily that it exerts as much pressure on the inside as on the outside, and thereby equalizes itself. For instance, if you go down into a subway or a caisson (a water-tight box or chamber within which submarine construction is carried on under great air pressure to keep out the water), where the pressure is sometimes greater than it is outside, have you noticed the effect this pressure exerts on the ear drums? As it becomes greater, you may equalize it by swallowing, which allows the air to get back of the ear drums through the Eustachian tubes, which lead from the mouth to the inner ear.

MOISTURE

Water vapor is always present in the air.

EXPERIMENT NO. 10

Expose a piece of dry potash to the air. You will soon discover that the potash will dissolve. It has taken up water from the air.

EXPERIMENT NO. 11

Put a piece of ice in a pitcher of water and allow it to stand in a warm room. You will soon notice that little beads of perspiration collect on the outside of the pitcher. This moisture is air being condensed.

Water vapor is part of the atmosphere. Some of it is always present in the air. The amount of vapor that the air can hold depends upon the temperature. When the temperature is warm, the air will hold more water. For instance, at 100° F. a cubic foot of air will hold 19.79 grains of vapor; at 80° F., 10.95 grains; at 50° F., 4.09 grains, and 32° F., 2.17 grains. At 32° F. is the freezing point on the Fahrenheit scale.

Air containing as much water vapor as it can hold is saturated. If the air is suddenly cooled down, that is, if the temperature falls when the air is saturated, air molecules are contracted, and it must give up the water, which produces rain. The ocean and the Great Lakes are the source from which the air gets its water. It rises into the air in the form of vapor, that is, vapor rising from the surface of the water, and the wind distributes it over the land. Condensation turns it into clouds, and when it is over-saturated, or rather, when the temperature drops and the air is unable to retain any more water, then it forms into drops of water and falls as rain. When the clouds get into the air, below the freezing point of the water, the drops of water are changed into ice crystals or snow flakes.

When the ice crystals are just at the point of melting into water, due to the rise in temperature, the snowflakes lose their form and the result is sleet.

HOW CAN WE USE THESE FACTS?

So far we have described, in a general way, certain facts about the elements of the air, such as temperature, pressure, humidity, precipitation, evaporation, clouds, winds, etc., and these facts of the elements enter into a very interesting phase of weather obser-

Fig. 33

vation which we will designate as prophesying without instruments or forecasting by physical science. When we come to the more interesting and scientific part of weather observation, we will drop the word "prophecy," because the instruments that are used to measure these elements are going to indicate certain things to us that will lead you to more definite conclusions. Hence, the following observations are what have given an opportunity to the weather prophet or to those people who have been credited with some mysterious power to prophesy what the weather is going to be. They are not definite or conclusive, and they cannot always be depended upon, but they certainly are significant and interesting, and a description of weather would not be complete without a list in chronological order of a series of phenomena or physical signs of this character that have lead certain men to gain quite a reputation for prophesying what the weather is going to be.

APPEARANCES

Various appearances that come in the sky.

For instance, a good example is in the case of the thunder storm,

which can be determined at least a few hours in advance, by the movement of the clouds and the forms they take. In every locality there is a direction that clouds take that forecasts bad weather, and there is a direction that clouds take that forecasts fair weather.

When you see a halo about the top of a mountain, you know that bad weather is expected. The same is true when a halo appears about the moon. This indicates rain, or if the lower clouds break up and the upper clouds, or a second light covering of clouds, are seen above the lower ones, it speaks for continued bad weather. In some localities if rainy weather is continuing for some time, and a certain change in wind sets in, it will indicate that good weather is coming.

These observations will be readily understood as being adapted for certain localities and are not general. It is always necessary that the observer adapt himself to these localities and study them, so that he can make prophecies accordingly. It should be borne in mind that these prophecies are only possible from one day to another.

WHAT THE CLOUDS INDICATE

When high clouds are seen crossing the sun or the moon in a different direction from the lower clouds, this indicates change of wind toward the direction of the higher clouds. When you see hard-edged clouds, look for wind. When you see delicate soft clouds, look for fine weather and probably moderate breeze or high breeze. When you see gloomy dark clouds in a blue sky, look for slight winds. When you see a bright blue sky through fine clouds that are soft and delicate, this indicates fine weather. When you see soft-looking clouds, you can expect less wind, but probably rain. But when the clouds become hard and ragged, tufted and rolling in appearance, stronger winds are coming. When you see small clouds that are inky looking, look for rain. When you see light clouds traveling across heavy hard masses of clouds, this indicates both wind and rain, but if the light scud clouds are alone, you may expect wind only. Misty clouds forming or hanging over the peaks of hills indicate both wind and rain. If during a rainy spell they ascend or disperse the weather is pretty certain to clear up. If there has been fine weather and you begin to see light

streaks in the sky which are distant clouds, and they continue to increase and grow into cloudiness, this indicates rain.

SUNSET AS AN INDICATION

When the sun is setting and the sky in the west presents a color of whitish yellow or radiates out at a great height, rain can be looked for during the next night or day. Gaudy colors where clouds are definitely outlined indicate probably wind and rain.

Before setting, if the sun looks diffused and the color is a brilliant white, this forecasts storms. When the sun sets in a slightly purple sky and the color at the zenith is a bright blue, this indicates fine weather. A red sunset generally indicates good weather, whereas a ruddy or misty sunset indicates bad weather.

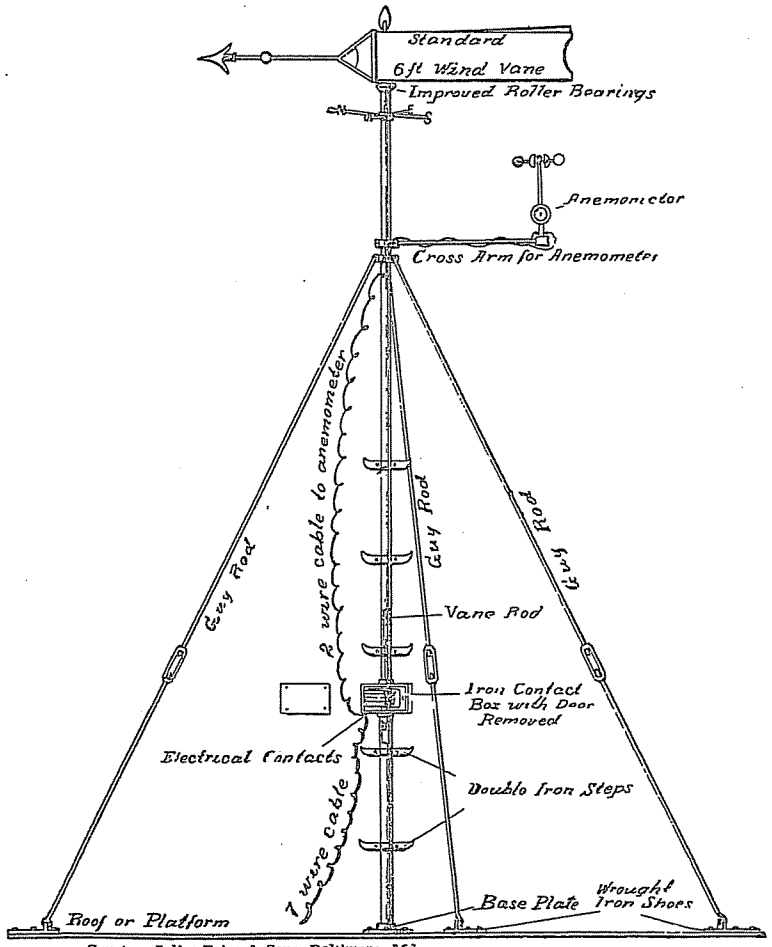
WHAT THE SKY INDICATES

When you see a dark, dismal sky, look for rain. A sky with a greenish hue, described as a sickly-looking sky, is an indication of both rain and wind. A sailor's sky, which is red in the morning, means either wind or rain, and it makes no difference if the sky is cloudy or clear, if at sunset it is rosy, it indicates fine weather. A gray sky in the morning indicates fine weather. When daylight is first seen above a bank of clouds, look for a good stiff wind. Wind is indicated if we have a bright yellow sky in the morning, and rain is indicated if the sky takes on a pale yellow hue. If the sky turns bright yellow late in the afternoon, it generally indicates that rain is near at hand. Unusual colorations, particularly of deep intense color, indicate wind or rain.

The following appearances indicate a change in the weather: When the atmosphere is clear and crystalline and the stars appear extremely bright; when the background of the horizon seems to be pinned up against the foreground; when the clouds form into delicate white film-like mist way up overhead. (Fig. 33.)

WHAT FOG AND DEW INDICATE

Locality has considerable to do with what the fog indicates. As a rule, where you have fog, there is not much wind, and as a result it does not indicate stormy weather, unless the fog becomes heavy with overhanging sky, then it is apt to turn into rain, but a



Courtesy Julien Friez & Sons, Baltimore. Md.

Fig. 34

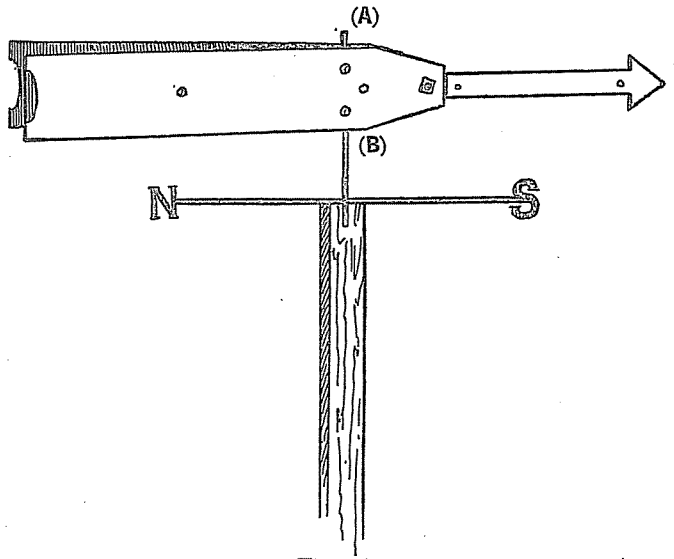


Fig. 35

heavy fog with a light sky indicates fine weather. A fog in the morning generally indicates a fair day. A rising fog is a good indication for fair weather.

Dew is a pretty good sign of fine weather. When you can see and hear with remarkable clearness, and everything is calm and still, it is a pretty infallible sign that cold weather is due.

Frost may be looked for on clear, calm, cloudless nights, when the ground is apt to be cooler than the air.

INDICATIONS FROM CIRRUS CLOUDS

When these clouds suddenly appear in the sky on a clear summer day, they indicate wet weather. Especially if the weather ends turn upward, which means that the clouds are coming down. When moisture in the form of little drops cling to vegetation, it is a pretty good indication that there is apt to be more rain.

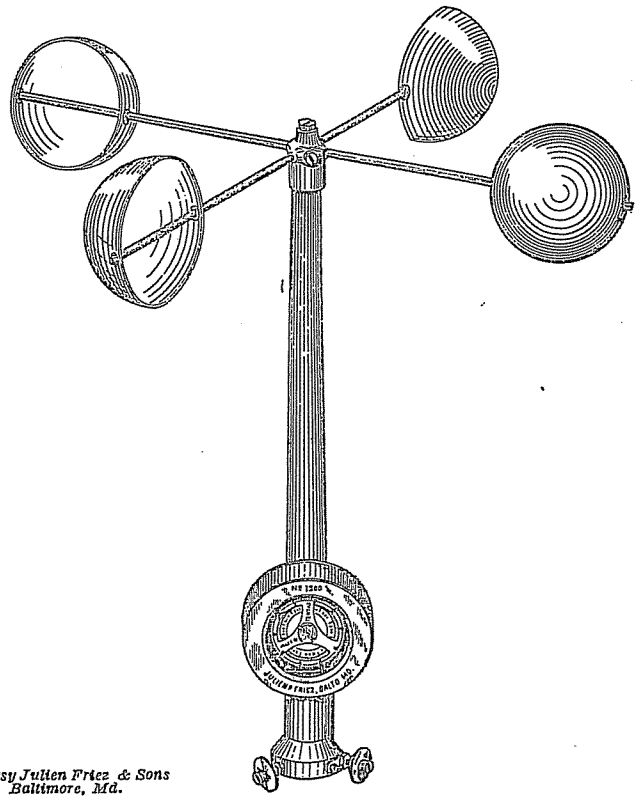
When the sky assumes the appearance of a gray mass and the sun is observed shining through, it is a pretty good indication that it will rain before night.

When overhead clouds are thick and grayish and the lower surface of them is lumpy, this is an indication of rain.

Whirlwinds of dust are also indications of rain.

THE MOON

The rings that we see formed about the moon are caused by the delicate white clouds through which the moon is shining.



Courtesy Julien Friez & Sons Baltimore, Md.

Fig. 36

THE RAINBOW

The morning rainbow indicates that a shower is in the west, but if the rainbow is in the east it indicates that the shower has passed over.

BIRDS AND STORMS

There are certain actions of birds that indicate many things pertaining to the weather that are interesting. It is probable that their ability to fly into the air gives them a view of the horizon, that by instinct they have been able to determine the atmospheric changes. For instance, it is well known that if birds of long flight remain at their base, it generally foretells a storm. The sudden silence of birds has been referred to a great many times preceding a storm.

Barnyard fowls do many peculiar things that foretell certain weather conditions. The crow flies low and in great circles, cawing loudly, before approaching rain.

Sometimes the house fly is a pretty good barometer. Generally before a storm they seem to light on everything, particularly persons, and we call them "sticky." Generally at these times they congregate in swarms. Most everyone is familiar with the gnat. They are one of the few insects that gives us indications and good signs, and when you see them forming in groups and moving along in front of you, you may expect fair weather.

There are many other interesting facts and fairy tales about indications by animals and insects, but there is nothing scientific about them. It has been demonstrated that there is nothing conclusive to be drawn from such signs, so we will not attempt to waste pages of this book reiterating these fables.

Certain actions of insects and animals give indications and enable the weather prophet to prophesy. The spider is a good example of an insect prophet, and if you will observe him carefully, you will find that when stormy weather is going to come on he shortens his webs, and if he anticipates a long, hard storm, he not only shortens the strings that hold up the web, but he strengthens them as well, and vice-versa, when he anticipates fine weather, he lengthens his strands of the web. When you see the spider cease his activities and he hangs pretty close to his home, which is the center of the web, you will know that rain is approaching. On the other

hand, if he continues to spread about during a storm, you can be pretty certain that it is not going to be of very long duration.

The frog is a good example of an animal prophet. There is a green frog which has been studied in Germany, which will come out of the water when rainy weather or cold is approaching. Some observers have placed these frogs in a glass jar with a landing provided so that he can come out of the water when he wants to, and he is always observed high and dry above the water several hours in advance of a storm.

DEFINITE CONCLUSIONS

Forecasting Weather by Means of Instruments

The first part of this book may not appeal to you, if you are of a scientific trend of mind, but it is quite essential that you possess a knowledge of the fundamentals treated in the earlier pages in order to thoroughly understand the weather instruments we will now describe. These instruments are the scientific means of forecasting what the weather is going to be. They definitely indicate certain things, and from these indications you are going to be able to draw conclusions and become a scientist or meteorologist. The success that you attain will depend upon the accuracy of the instruments and the care you use in reading them. You will be able to rig up a Weather Bureau of your own, and the use of these instruments will interest anyone in a study of the weather.

THE WEATHER VANE

To make a forecast, it is essential from what we have already written, to know the direction of the wind, and to determine the direction we must have a weather vane. It is real important that the vane should be sensitive to the slightest movement of the wind and give actual wind directions. At the same time it must possess the property of steadiness, so that when it is set up it will be rigid.

Fig. 34 shows the standard weather vane used at all United States Weather Bureau Stations and Fig. 35 shows the Gilbert Weather Vane.

Fig. 35. The Gilbert weather vane consists of a metal arrow pointer and a metal rod eight inches long and five thirty-seconds

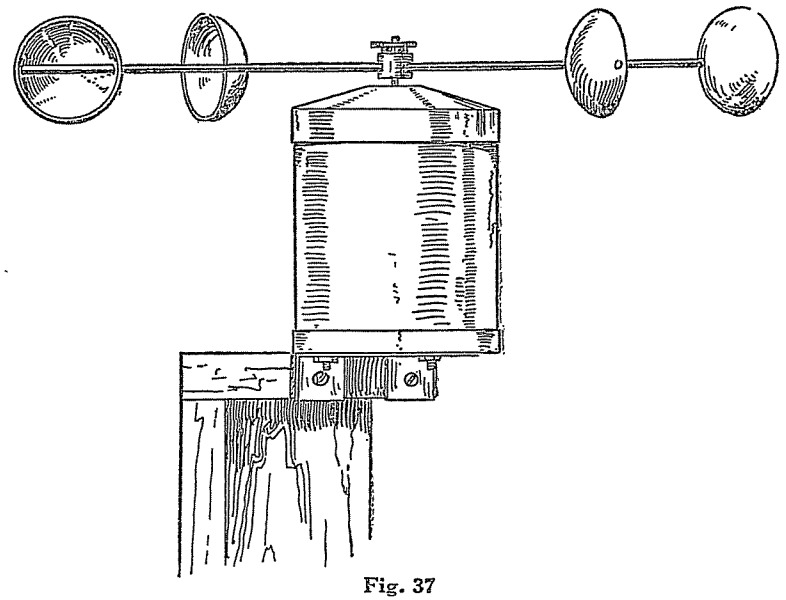


Fig. 37

of an inch in diameter. The rod is fastened by means of a few staples to the side of a pole, or whatever is to be used as a support for the vane. About three inches from the top of the rod is a collar with set screw, which is tightened, and the vane itself is then placed on the rod, the rod passing through the small angles A and B, between the sides of the vane. It will be found that the vane will swing freely on this support, and by constructing two crosspieces with letters N, S, E, and W at each end of the pieces, of course having N pointing directly north, the vane will swing around and show the direction of the wind.

The standard United States Weather Bureau type hardly needs explanation, as the illustration clearly shows all parts. It is the old, reliable, standard iron, combined wind vane and anemometer support complete, twenty feet high; iron contact box near base, improved roller bearings for six-foot vane; latter, with electrical contacts shown enlarged at the right. The vane is fastened securely to the roof of the building and held in a perfectly vertical position.

THE ANEMOMETER. Fig. 36

It is essential to know the velocity of the wind. This is determined by means of an instrument called the anemometer

Fig. 36. The Standard U. S. Weather Bureau Station Anemometer.

This is the well-known standard Robinson Anemometer, now in universal use throughout the world for the registration of wind velocity, but of the latest improved construction. It records electrically the miles or kilometers, etc., of wind movements on a register. The standard pattern as furnished to Weather Bureau stations is made of brass, highly polished and finished, aluminum (or copper reinforced) cups, steel spindle with hard steel bearings, a ten-mile or kilometer indicator, electrical contacts, etc.

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

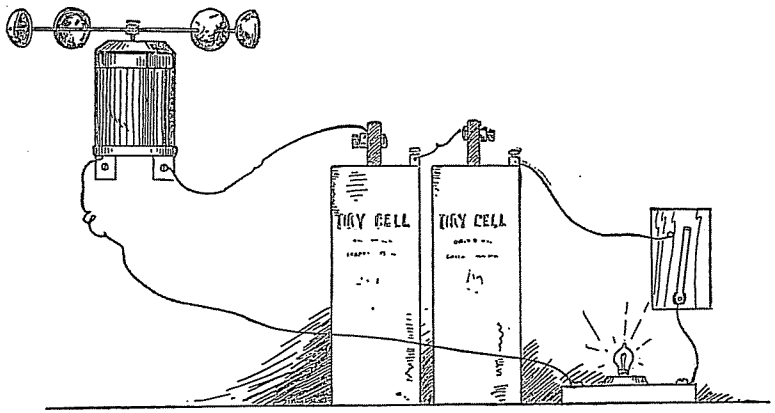
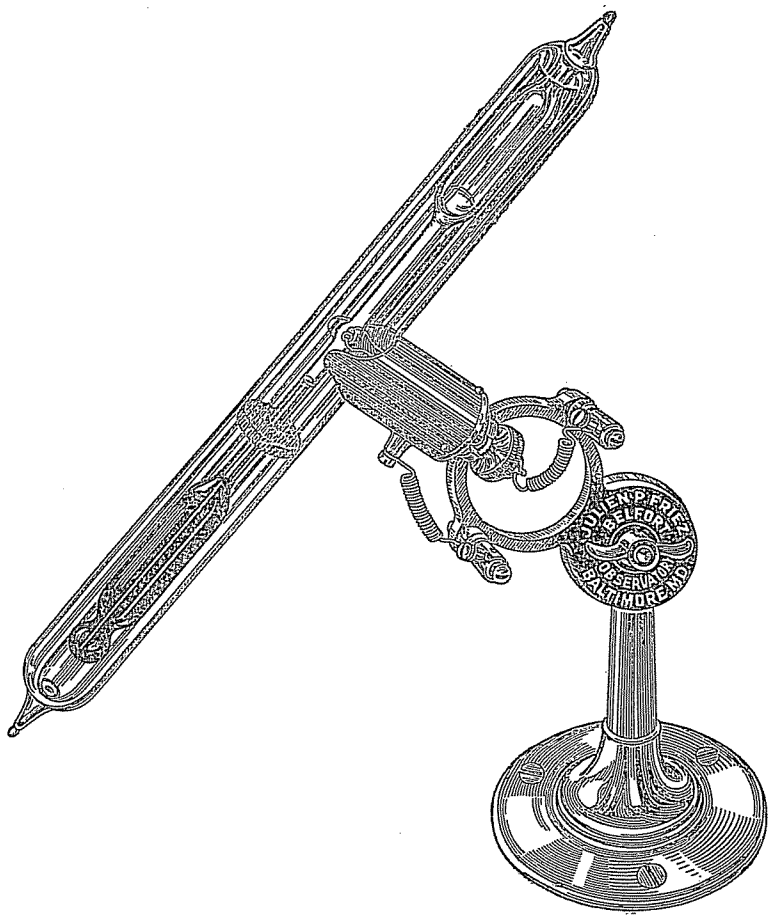


Fig. 38



Courtesy Julien Fries & Sons, Baltimore, Md.

Fig. 39