The next observation—what happens at the bottom of the chimney? Here you will find the outside air is coming in, the same as it did in the window experiment. Particularly, notice however, that the smoke enters underneath the chimney from all directions, and the smoke paper should be moved away from the glass chimney to determine the distance at which the smoke flames will still be drawn into the chimney.

You now produced for yourself in miniature a storm and wind. The air that has been heated rises over a heated area, and cooler air from all directions around is passing into the space underneath the chimney and taking the place of the heated air that has gone up. This experiment illustrates what takes place, except on a smaller scale, out in the atmosphere when a portion of the earth becomes heated. If this is clear to you, it will help you to understand the main principles underlying storms and winds, which will be given later on.

EXPERIMENT NO. 9

Equally important is the last part of the experiment, which consists in lifting the lamp chimney off the table altogether and continuing with the smoke paper. Note results that you get now. The smoke will spread out over a large area.

WHAT IS THE WEATHER?

By the weather we mean the temperature, the amount of moisture in the air, the pressure of the air, the movement of the air, and all the conditions that have to do with the atmosphere, such as heat, cold, rain, snow, sleet, fog, frost, dew, etc. It has to do with everything, from calmness and clearness to cloudiness and blizzards.

THE EFFECT OF THE SUN

The sun has a great deal to do with the regulation of the weather. Its heat causes evaporation; it is the rays of the sun that raises the vapor from the water and brings it into the air; it is the cooling of this vapor that produces the rain, hail and sleet storms, and its brilliancy causes a difference in air pressure at times. It is this difference in air pressure that produces winds, as you will learn later.

HUMIDITY

The state of the air with respect to the vapor that it contains is called its humidity. The humidity is said to be high when the air is damp, and low when the air is dry. Humidity and moisture in the air are important factors about the weather. It is lack of humidity that has more to do with poor health, colds, and catarrh than anything else. The importance of proper humidity in houses and buildings cannot be emphasized too greatly. Proper humidity will save twelve and one-half per cent in the cost of heating. The great majority of people are under the impression that colds are caused by sudden change in temperature, but the most colds are actually caused by stuffy, hot rooms. The reason that some people complain that 70° is not hot enough is because the humidity is too low, but if the moisture is brought into the air at a proper degree, the humidity is maintained. You will find that 68° will be a proper temperature to maintain in a room. The reason for this is that the air in the room is dry and the heat actually goes through it. In other words, it does not warm it; moist air stops radiation. Consequently, the result is that it warms it. In other words, moisture is nothing more than clothing, and this accounts for the fact that in a hot room, where there is no moisture, we heat our rooms beyond the degree that is necessary in order to feel any reasonable amount of comfort. Dry air allows too much radiation from the body and too rapid evaporation, which makes us cold.

The following experiment illustrates the above statement. Place a few drops of water on a smooth surface, such as a table top or ordinary board, and over this a watch glass, containing a small quantity of ether. In order to hasten evaporation, blow a current of air across it, and it will be found that the glass will be frozen to the board. This is caused by the evaporation of the ether, which uses up heat.

You know a great many times when you go out into the wind how cold it feels, and yet if the wind would actually stop, you would think it warm. It is the wind that causes the rapid evaporation and makes the surface of the skin feel cold. As it is true that the moisture in the air acts as a blanket to us in our homes, it is likewise as true that the vapor in its natural form outside of the house acts as a blanket for the earth. Do you realize that without this blanket we would burn up in the summer and freeze to death in the winter?

FOGS

Water vapor in the air is transparent, but when this water vapor becomes cooled, a portion of it becomes precipitated, which is no more or less than drops of water that are extremely small, but yet large enough to become transparent, and the atmosphere in this state is called fog. In reality, fogs are nothing more than clouds near the surface of the earth. When the ground is at a higher temperature than the air, it produces fogs. They are also produced when a current of moist air and a current of hot air pass over a body of water at a lower temperature. Consequently, you can easily see that fog will never form when it is dry.

HAIL

After rain drops have been formed and they freeze in their passage through the air, they then become hail-stones.

SNOW

When condensation of vapor in the air takes place at a temperature below 32° F., a deposit is made in a solid condition, either in the form of snow or hail. Snow is made up of crystals, most of which have great beauty. Everyone should observe either by the naked eye or by a magnifying glass the little crystals caught before they are broken. When you see extremely large snowflakes in the sky, you can be sure the temperature is very near freezing, for at this point the flakes are more or less damp and the snow is heavy and wet. Now if there is a slight wind, the crystals become broken and separate flakes unite to form large masses of snow. Generally speaking, ten inches of snow makes one inch of rain.

DEW

If the temperature of the ground falls below the dew point of the air, the air deposits on the cooler surface moisture in the form of small drops of water, which we call dew drops. Where the temperature of the ground becomes cooler than the air above it, a rapid cooling by radiation on a clear night has taken place; and if the dew point or frost point has been reached by the ground, the air just above the point is several degrees warmer.

FROST

When the moisture in the air that is in contact with the earth is condensed above the freezing point, dew is formed. When below the freezing point, frost is formed or deposited on the earth. It is readily understood from this that the surface on which the frost is deposited is at a freezing temperature, while the air above it may not be freezing. Naturally, you can expect frost when the temperature falls to a point 8° or 10° above the freezing point. Clear, calm nights are favorable for frost, because the absence of clouds helps radiation, that is, it draws heat away from the earth. If there are clouds, it prevents this radiation.

THUNDER AND LIGHTNING

Free electricity is always in the air. During clear weather it is generally positive; during cloudy weather it is negative. This electricity is carried in the air by the moisture. As dry air is a non-conductor of electricity, in fair weather the electrified particles of air are insulated and therefore acquire very little intensity. The clouds having been formed and being filled with moisture, form an excellent conductor of electricity, which acquires considerable intensity. It is a well-known physical law that two bodies having opposite electricities attract each other, and those having like charges repel each other. From this, two clouds having opposite charges rush together and produce the phenomena, called lightning, which is accompanied by an explosion called thunder. Often we see several flashes of lightning and the hear several thunder crashes, which is caused by only one section of a cloud discharging its electricity at a time.

As a cloud attracts the opposite charge of electricity from the surface of the earth beneath it by inductive influence, often we see a discharge of electricity from the cloud to the earth, the charge usually being received by such objects as hills, trees, church spires, high buildings, etc. Bodies containing large quantities of moisture are susceptible to strokes of lightning, as the moisture causes them to become good conductors of electricity. Also trees on the outer edge of a forest are more liable to be struck than those farther in.

There are several forms of lightning, such as zigzag, ball, sheet, and heat lightning.

Zigzag lightning, as the name implies, follows an irrgeular course, producing a long zigzag line of light, sometimes ten miles in length, and is caused by the air producing a field of resistance to the path of electricity, causing it to seek a path of less resistance.

Ball lightning appears like a large ball of fire, usually accompanied by a terrific explosion. This is the result of the bodies being charged with electricity of great intensity, and travels in a straight path, as it has enough strength to oppose any resistance placed in its path.

Heat lightning is usually seen on warm evenings, especially during the summer, and very often unaccompanied by thunder, due to the great distance of the lightning clouds from where we are located, thus diminishing the intensity of the thunder. The electricity of the clouds escape in flashes so feeble as to produce no audible sound.

Sheet lightning is a diffused glare of light sometimes illuminating only the edges of a cloud, and again spreading over its entire surface.

Ordinary flashes of lightning last but the minutest part of a second.

Thunder is the re-entrance of air into an empty space. The vacuum is created by the lightning in its passage through the air. The violence of thunder varies according to the intensity of the electrical flashes.

Because of the fact that light is transmitted almost instantaneously, while sound travels at a speed of eleven hundred feet per second, the sound will not reach the ear for some few seconds after the flash of lightning. Average space of time between a flash and a report is about twelve seconds. The longest interval is seventy-two seconds and the shortest one second. Prolonged peals of thunder are, in some cases, due to the effect of echoes. These peals are especially noticeable in mountainous countries. The echoes are also produced by the reflection of sound from the clouds.

Thunder storms are distributed over certain sections of the globe, occurring most frequently in the equatorial regions and diminishing as we approach the polar regions. Within the tropics, where there are trade winds, thunder storms are rare. Thunder storms are common in warm climates because evaporation supplies electricity in great abundance, and thus precipitation of the air is brought about.

TORNADOES

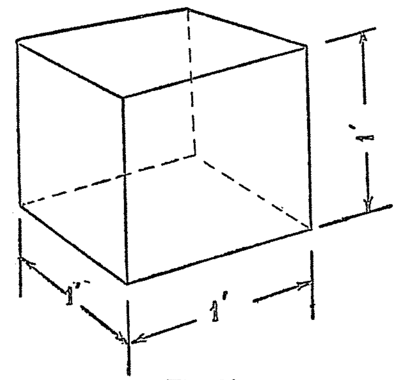

Fig. 11

Tornadoes are caused by the air becoming abnormally heated over certain areas. Likewise, caused by a difference in pressure. Tornadoes are local whirlwinds of great energy, generally formed within thunder storms. They are most easily distinguished by a funnel-shaped cloud that hangs from the bottom of the larger thunder cloud mass above it. The funnel is formed around a violent ascending mass of whirling winds; its diameter sometimes reaching several hundred feet, being larger above than below, the winds themselves covering a greater space.

The whirling funnel advances generally to the east or northeast at a rate of twenty to forty miles an hour, accompanied by a

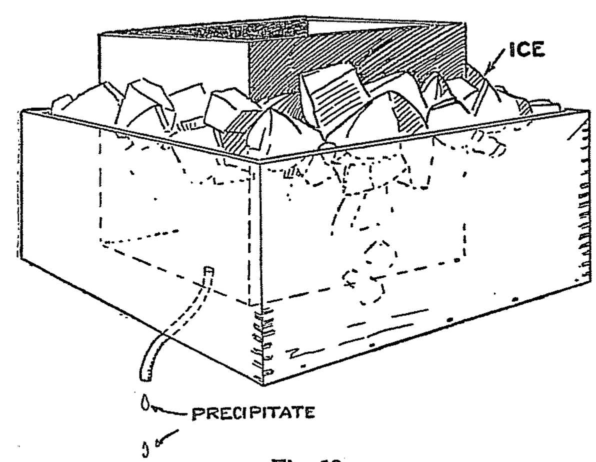

Fig. 12

deafening noise, destroying everything in its path. The path is usually less than a quarter of a mile in width.

The winds in the vortex (the apparent cavity or vacuum formed in the center of the whirling winds) of the tornado attain an incredible violence, and due to this fact houses are shattered, trees uprooted, and human lives lost, besides other devastation of property and animal life. It is, therefore, the vorticular whirl that causes the destruction produced by tornadoes.

Tornadoes are more frequent in the southern states than anywhere else in the country, and occur in the warmer months.

The velocity of the whirling winds in a tornado increase towards the center, and it is because of this that the point of danger is only a small distance from the funnel cloud. The direction of the whirling motion is from right to left. From the appearance of the funnel formed in a tornado, it looks as though the currents were descending from the cloud to the earth, when in reality the currents are ascending. The ascending current draws on the warm and moist air near the surface of the earth for its supply, and this inrush of air in a spiral form into the low pressure core made by the higher whirl constitutes the destructive blast of the tornado.

Tornadoes approach rapidly, and it is therefore almost impossible for those who happen to be in their path to escape their violence.

A tornado at sea is termed a water spout.

RAINFALL

You will recall a preceding statement that evaporated humidity turns into water when it becomes cool below a certain point. (See page 14, Effect of the Sun.) A given amount of air will hold a certain amount of moisture. For example, let us assume that a cubic foot of air (see Fig 11) is saturated, that is, it is holding all the water it will retain. Now if this cubic foot of air is cooled, it will contract, and as a result there will not be enough room to hold both the air and moisture, so the excess moisture will leak out. (See Fig. 12.) The result of this reduction in temperature causes precipitation, simply because the air cannot sustain the water that is in it. Therefor, at any time when moisture in the air has reached the point of saturation and a chilling takes place, due to the air becoming cold, rain follows. This may happen as a result of air rising into higher places or cooler levels, or through its contact with cooler surfaces.

WHY WE GET SUCH HEAVY RAINFALLS SOMETIMES AROUND MOUNTAINS

The air becomes thoroughly saturated. When air is comparatively warm, it will expand, and this air, which is heavily saturated is brought up by breezes onto the mountain range, which is cold, causing the air to lose its heat and contract and really force the water out of the air. The same principle applies to sea breezes bringing rain.

WINDS

Winds are caused as a result of differences in temperature between the various layers of the atmosphere. A certain amount of air becomes heated and rises, and as explained before, expands. As the air expands, it becomes lighter, and because it is light it goes upward toward higher regions. It also flows from hot to cold countries. A good illustration of this is the sea breezes. If you have lived around the seashore in the summer time, you will have observed that during the hot part of the day the winds generally blow from the sea toward the land. At night the direction of the wind is reversed, that is, it blows from the land to the sea. Why? Because the land during the day retains its heat, while the water diffuses it. What is the result? The air on the land expands, becomes light. The air over the water being cool, it does not expand, and the result is that it presses toward the land. At night the land loses its heat more rapidly than the water, so that it is not long before the land is cooler than the water, and when this happens, the air over the land, which has become cooler, presses seaward.

KINDS OF WINDS

Mountain Breezes: Caused by the heating and cooling of the hills and valleys.

Avalanche Winds: Winds that are in front of a landslide, caused by the movement of the snow forcing the air in front of it.

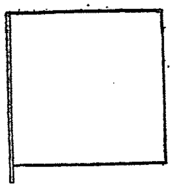

Fig. 13

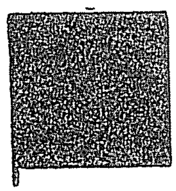

Fig. 14

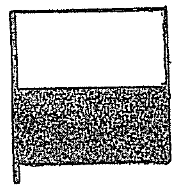

Fig. 15

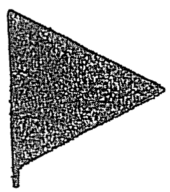

Fig. 16

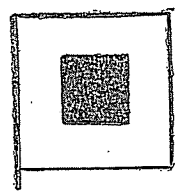

Fig. 17

Volcanic Winds: Due to volcanic eruption, which produces an outrush of air.

A Squall: Due to the sudden disturbance in temperature.

A Simoon: A desert wind.

VELOCITY OF WIND

The wind blows a great deal harder on water than on land, because on land it meets with various obstacles, whereas it has very little friction on the water.

THE FORCE OF THE WINDS

Wind blowing at 20 miles per hour has a force of 1¼ lbs.
Wind blowing at 35 miles per hour has a force of 6 lbs.
Wind blowing at 50 miles per hour has a force of 13 lbs.
Wind blowing at 75 miles per hour has a force of 28 lbs.
Wind blowing at 90 miles per hour has a force of 40 lbs.

DAY SIGNALS

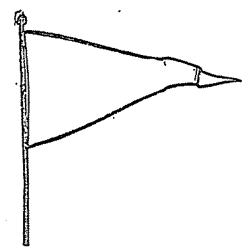

Fig. 18

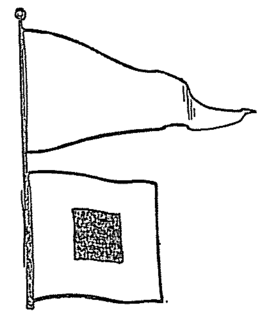

Fig. 19

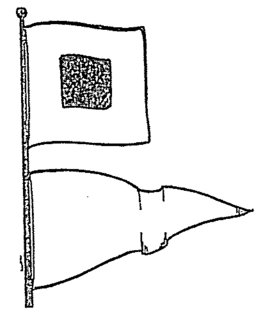

Fig. 20

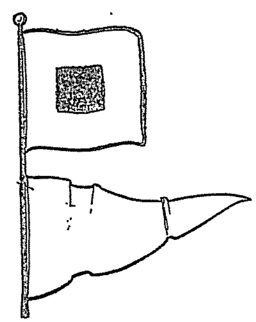

Fig. 21

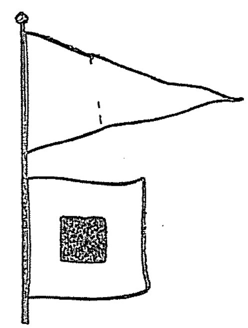

Fig. 22

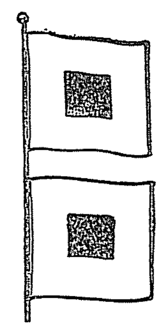

Fig. 23

NIGHT SIGNALS


Fig. 19A


Fig. 20A

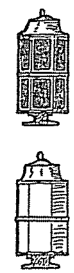
Fig. 21A

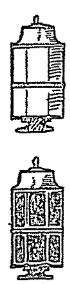
Fig. 22A

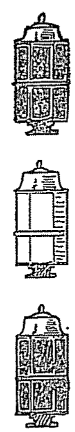
Fig. 23A

NAME OF WINDS

Beaufort's scale, used in preparation of all Weather Bureau wind forecasts and storm warnings.

FORCE	DESIGNATION	MILES PER HOUR
0	Calm	From 0 to 3
1	Light Air	Over 3 to 8
2	Light breeze (or wind)	" 8 " 13
3	Gentle breeze (or wind)	" 13 " 18
4	Moderate breeze (or wind)	" 18 " 23
5	Fresh breeze (or wind)	" 23 " 28
6	Strong breeze (or wind)	" 28 " 34
7	Moderate gale	" 34 " 40
8	Fresh gale	" 40 " 48
9	Strong gale	" 48 " 56
10	Whole gale	" 56 " 65
11	Storm	" 65 " 75
12	Hurricane	" 75

The following method of transmitting weather signals by means of flags was used for a number of years, but the newspapers now convey the same news to the interested public:

1. A square white flag indicates fair weather. (See Fig. 13.)
2. A square blue flag indicates rain or snow. (See Fig. 14.)
3. A white and blue flag, half white and half blue, indicates local rain or snow. (See Fig. 15.)
4. Black triangular flag indicates a change in temperature. (See Fig. 16.)
5. White flag with a square black center indicates cold wave. (See Fig. 17.)

When No. 4 is placed above No. 1, 2, or 3, it indicates warmer weather; when below, colder; when not displayed the temperature is expected to remain stationary.

The following flag warnings are used along the Atlantic and Gulf coasts to notify inhabitants of this section of the country of impending danger.

Fig. 18. The Small Craft Warning. A red pennant indicates that moderately strong winds that will interfere with the safe operation of small craft are expected. No night display of small craft warnings is made.

Fig. 19. The Northeast Storm Warning. A red pennant above

Fig. 24

a square red flag with black center displayed by day, or two red lanterns, one above the other, displayed by night (Fig. 19A), indicates the approach of a storm of marked violence, with winds beginning from the northeast.

Fig. 20. The Southeast Storm Warning. A red pennant below a square red flag with black center displayed by day, or one red lantern displayed by night (Fig. 20A), indicates the approach of a storm of marked violence with winds beginning from the southeast.

Fig. 21. The Southwest Storm Warning. A white pennant below a square red flag with black center displayed by day, or a white lantern below a red lantern displayed by night (Fig. 21A), indicates the approach of a storm of marked violence, with winds beginning from the southwest.

Fig. 22. The Northwest Storm Warning. A white pennant

above a square red flag with black center displayed by day, or a white lantern above a red lantern displayed by night (Fig. 22A), indicates the approach of a storm of marked violence, with winds beginning from the northwest.

Fig. 23. Hurricane, or Whole Gale Warning. Two square flags, red with black centers, one above the other, displayed by day, or two red lanterns, with a white lantern between, displayed by night (Fig. 23A), indicate the approach of a tropical hurricane, or of one of the extremely severe and dangerous storms which occasionally move across the Great Lakes and Atlantic Coast.

We have installed at our manufacturing plant a high-class weather station, with equipment of the latest United States Weather Bureau standard pattern, and are able to send out weather signals by wireless from our own wireless station twice daily, at 4 P. M. and 7 P. M., to all boys owning a wireless outfit. The indications are taken from our own instruments. A description of these instru-

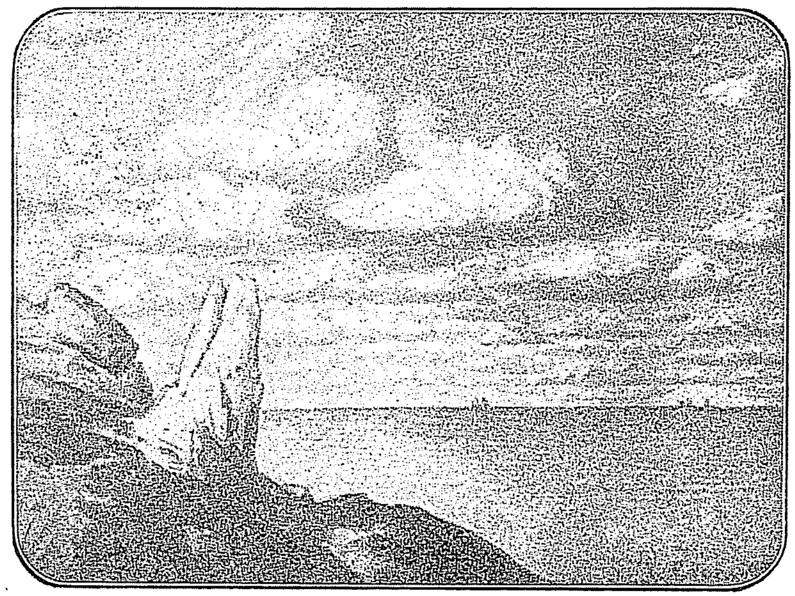

Fig. 25

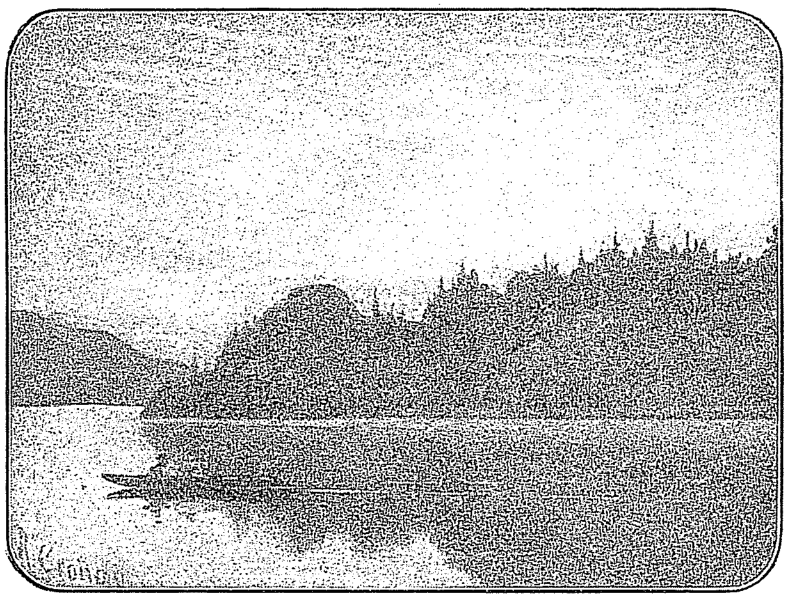

Fig. 26

ments and the method of recording the indications will give you an insight into how the various government weather stations arrive at their forecasts.

On the roof of the factory is a weather vane (Fig. 34) twenty feet high, which is connected electrically with a register in our weather office. The register is of the quadruple type (Fig. 45), and is capable of recording wind direction, wind velocity, rainfall, and sunshine on the same form or sheet. Thus, we know the wind direction and can deduce certain things relating to the weather. Mounted on the wind vane support is an anemometer (Fig. 36), an instrument for measuring the velocity of the wind. A rain gauge (Fig. 49) on the roof catches the precipitation, and for every one hundredth of an inch of rainfall, a small tipping bucket empties its contents into a receiver and a record is made on the form in the quadruple register.

The same pen that records the rainfall also records the number

of hours of sunshine during a day, for it is not a common thing to have rain and sunshine at the same time.

A hygrothermograph (Fig. 43) records on a form the temperature and amount of humidity in the atmosphere.

A barograph (Fig. 44) records the pressure of the atmosphere. For determining the pressure, we also have a mercurial and aneroid barometer, which will be described later on.

You can readily see that it is a simple matter to obtain the weather indications.

CLOUDS

The numberless kinds of clouds makes it quite difficult to describe and arrange them or illustrate them in any manner that makes it easy to recognize them. Although some may be recognized from description and with a fair amount of observation, you will be able to classify them in their proper place. For instance,

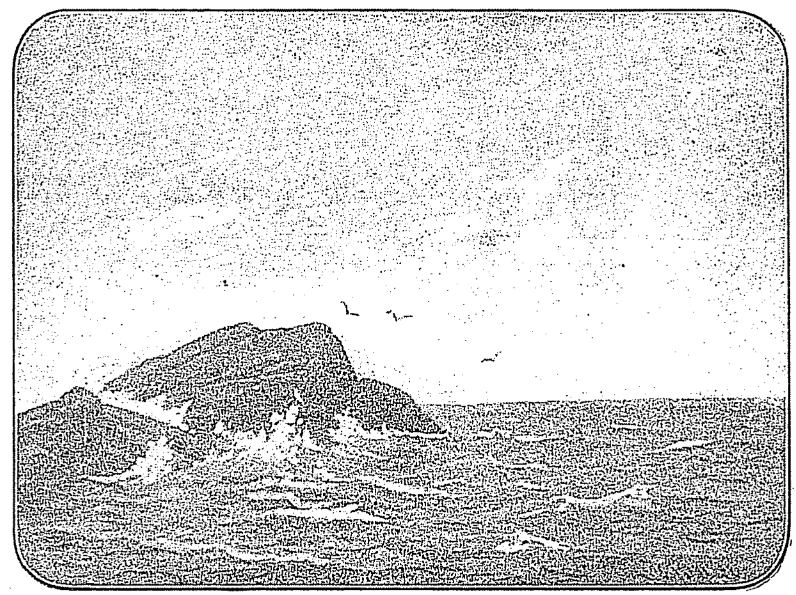

Fig. 27

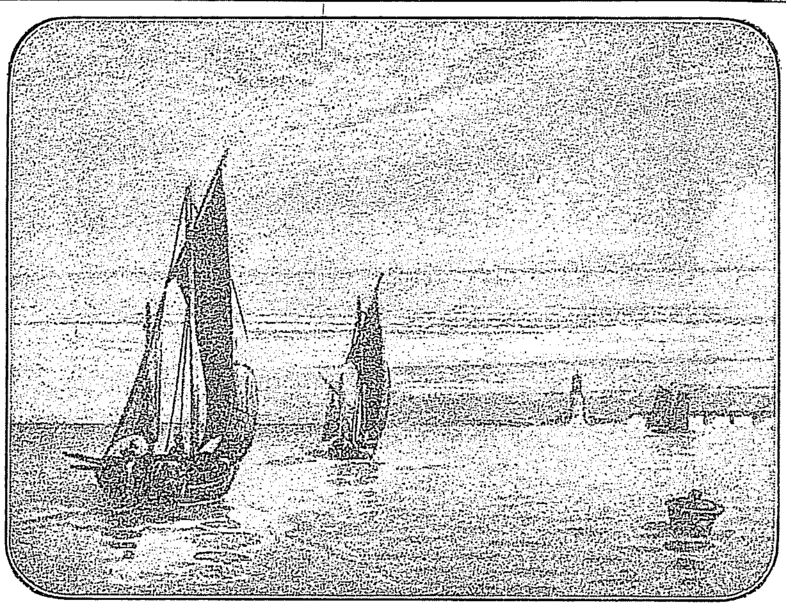

Fig. 28

the thunder clouds most anyone recognizes without any experience whatever.

There are really four simple cloud formations and three compound formations:

1. The Cirrus Cloud. (Fig. 24.)

The Cirrus cloud is always seen high in the sky and at a great elevation. Its formation is fibrous and it is particularly characterized for its many varieties of shapes. It also has a marked delicacy of substance and it is pure white.

2. The Cumulus Cloud. (Fig. 25.)

The Cumulus cloud is of moderately low elevation. It is a typical cloud of a summer day. It may be recognized by little heaps or bushes rising from a horizontal base. In summer-time we are all familiar with the cumulus clouds rising with the currents of air in huge masses. They form one of the most accurate indications of

fair weather when you see them gradually dissolving. Sometimes these clouds become very large, and, while the texture is generally of a woolly white, naturally, when they assume such large sizes, they gradually change in color to a darkish tint.

3. The Stratus Cloud. (Fig. 26.)

This is the opposite of the Cirrus cloud, because it hangs the lowest of all, in gray masses or sheets, with a poorly-defined outline.

4. The Nimbus Cloud. (Fig. 27.)

Any cloud can be classed as a nimbus cloud from which rain or snow is falling.

Of the Compound Clouds we have:

1. The Cirro-Cumulus Cloud (Fig. 28), which has all the characteristics of both the Cirrus and the Cumulus. The most characteristic form of this cloud, and the one most commonly known, is when these clouds form small round masses, which appear to be

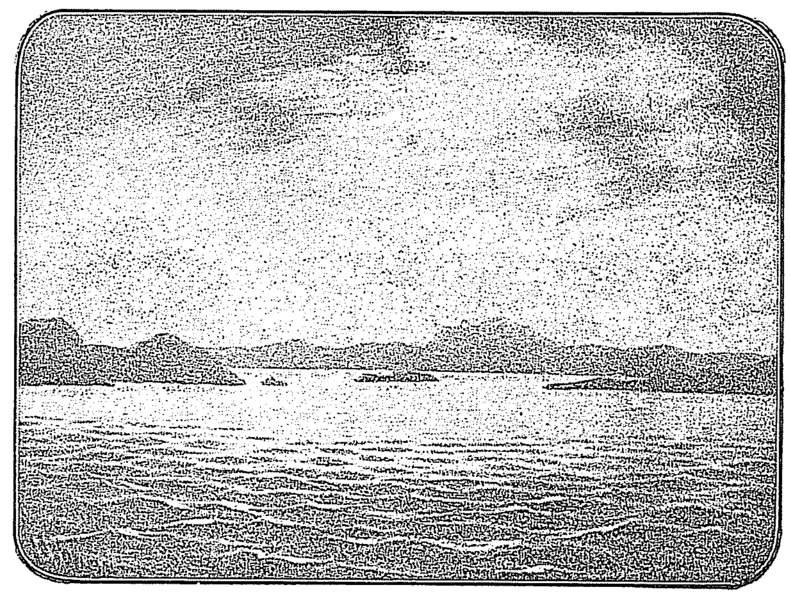

Fig. 29

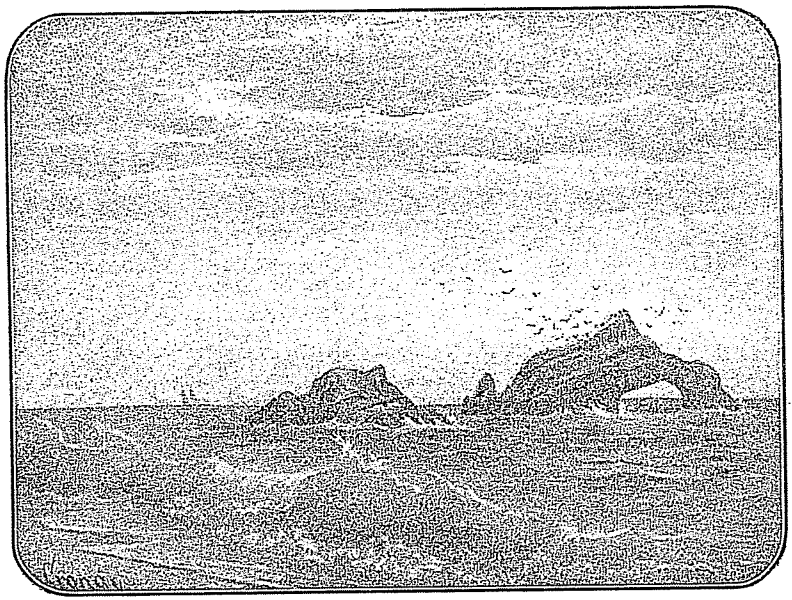

Fig. 30

cirrus bands broken up and curled up. This is what people call the "mackerel" sky.

2. The Cirro-Stratus Cloud (Fig. 29), which is known when the clouds arrange themselves in thin horizontal layers at a great elevation.

3. The Cumulo-Stratus (Fig. 30) is the cumulus and the stratus blended together. Their most remarkable form is in connection with approaching thunder storms, and are often called thunder heads. They rapidly change their outline and present a beautiful spectacle in the sky at times.

The Cirrus, Cirro-Cumulus and Cirro-Stratus are known as the upper clouds and the others are known as the lower.

ATMOSPHERIC DISTURBANCES

Disturbances of the atmosphere are classified as follows: Cyclonic, or low area storms, or anti-cyclonic, or high area storms.

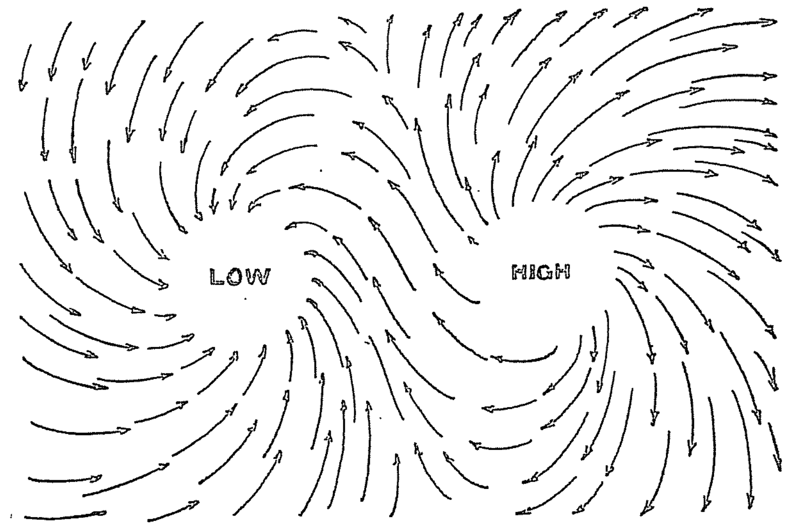

Fig. 31

The word "cyclone" to most people immediately means a terrific storm, whereas in weather observing the the cyclonic storm is not really a cyclone or hurricane at all. It is a storm with an atmospheric pressure below average. Particularly important is the wind that blows about this area, which is always spirally inward, due to the rotation of the earth on its axis. This is probably why it is given the name of cyclonic storm, for it bears one of the important characteristics of a real cyclone. As the wind is deflected and moves into the storm center, it turns to the right and in the form of a whirlwind, spirally, moves around the storm center. (See Fig 31.) It is this whirling process that has given it the name, cyclonic storm.

As the air rises over the point of low storm area, or, in other words, the area of low pressure, and travels into the atmosphere, it is not permitted to rise to any great height, because it is always acted upon by the force of gravity and is being pulled back to earth again. We assume that because of this fact, this rising air which has been pulled back to the earth again piles up in certain places,