THE

HISTORY AND USE

OF THE

BAROMETER,

WITH NEW AND

COMPLETE RULES

FOR

PREDICTING THE WEATHER

ACCORDING TO

THIS INSTRUMENT.

BY

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ANN ARBOR, MICH.

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THE BAROMETER IMPROVED.

The only reasons why this instrument has not come into general use, have been: first the great expense, and second its extreme liability to injury. One of my correspondents writes: "I want to get one of your barometers, *after purchasing two that will not operate.*" And this is a common case with Barometers constructed on the old plan. They are sure to get out of repair by even a slight handling.

After some time spent in perfecting the instrument, I have at length adopted a peculiar mode of construction, whereby the safety of the instrument is secured during its transportation And in this way I have sent many barometers by express to some of the most distant States, and always without damage. In respect to accuracy my instruments are superior to any of the kind now made. On another page, I have shown why those instruments made with cisterns blown on the end of the tube must always be very inaccurate. In my barometers large wooden cisterns are employed, and so large a surface of mercury obtained in the cistern that the error in the working of the instrument is not appreciable. I have no room for certificates nor do I deem them necessary. A good Barometer must reccommend itself to every intelligent farmer. This much I can say, however, that no purchaser has ever been found dissatisfied with his bargain, and many after a few years trial would not part with their Barometer for ten times its cost. A first class Silver Medal was awarded my barometer at the last Michigan State Fair.

DIRECTIONS FOR PUTTING UP THE BAROMETER.

The following directions are intended for those who receive their instruments by express, and they should be carefully observed

As soon as you take the barometer from the box, turn it bottom end upwards, and while it is in this position, jar and shake the end uppermost, continuing the operation for some minutes. It may now be carried (keeping it still inverted,) to the place where it is to be kept. A hall is the best place for it, or some room where the temperature varies as little as possible. It is not necessary that it should hang out-doors. Before hanging up the instrument, turn it right end up, and then draw out the screw on the right side of the box near the bottom, unscrewing it just half an inch. Then keep the barometer exactly perpendicular for from three to five minutes, after which, return the screw to just the place you found it, taking care to drive it no farther than it was at first. If now the mercury has not fallen in the tube, shake the barometer at the top, lightly at first, but continue the shaking until you loosen the mercury from the top of the tube. When this is done, hang up the instrument (taking care to disturb the mercury in the tube as little as possible) and it will be all right. It should be hung on a screw of suitable size. Before leaving the barometer, fasten it to the wall by passing a string over the box in front, each end of the string being fastened to the wall. This will protect the instrument against injury from handling and serve to keep it always perpendicular. The barometer should be moved little as possible. But when it is taken down, place it slowly in a horizontal position, the side on which is the screw in the box being uppermost. Next draw out the screw about one half an inch, and jarring the box a few times, return the screw, being careful to keep the instrument in the same position throughout The barometer may now be turned bottom end upwards, and so carried in the hand. When it is to be hung up, repeat the process described at first. Some of my instruments have a brass screw under the bottom of the box. In this case, the instrument must be managed according to directions on page twelve.

EXPLANATION OF THE SCALE.

The scale or face of the instrument is divided into inches and tenths of an inch. The large figures (27, 28, &c.) indicate the height in inches of the mercury in the tube above that in the cistern. The small figures near the tube assist the enumeration of the tenths. The brass index should be adjusted to the height of the mercury twice a day, morning and night being the best time, and the movements of the mercury during the day or night will then be manifest.

HISTORY AND USE

OF THE

BAROMETER.

The time has arrived, we trust, when it is no longer necessary to render an apology for claiming the attention of the husbandman to the consideration of a subject essentially scientific. The more especially as it is intended throughout the discussion to point out the connexion between purely abstract and scientific principles, and useful and practical results. Doubtless, many who will read this article, have never seen a barometer, though all, or nearly all, have had opportunities of gaining some idea of the nature of the instrument through the medium of books. Taking this into consideration, we shall make our description as plain and direct as possible, and avoid technical phraseology. For the benefit of those who think of purchasing a barometer, and who are not already familiar with the instrument, we shall endeavor to furnish some useful hints in regard to the best forms of construction, &c.

The word Barometer is derived from two Greek words,—*Baros*, weight, and *Metron*, measure. The use of the instrument being to measure and indicate the weight of a column of air the height of the atmosphere. The discovery of this instrument was the result of one of those beautiful experiments, prompted by pure logical method which distinguished the accomplished investigator of science. That air has weight, was a fact discovered by Galileo, yet this philosopher failed to account for phenomena which result directly from this property of the atmosphere. The common pump was used for some time before the principle of its working was demonstrated; the prevailing opinion being that water rose to fill the exhausted cylinder, because nature abhorred a vacuum. A new difficulty was to be explained, however, when it was discovered that water could not be made to rise in a vacuum above 32 feet. Galileo, when asked to explain this, replied, that water was raised to the height of 32 feet on account of the horror which nature had for a vacuum, but that the horror was limited in its effects, and ceased to operate above the height of 32 feet. This answer was doubtless given sarcastically, since it is scarcely probable that Galileo really believed in the horror of a vacuum, although it is evident that he failed to account for the phenomena. The complete explanation and discovery of the principle of atmospheric pressure was reserved for Torricelli, a pupil of Galileo, and the demonstration is one of the most beautiful in the history of physics.

Suspecting that the rise of water in the common pump was due to the weight of the atmosphere pressing on the exposed surface of the reservoir, and causing a column of water to ascend in a tube to a height just balancing the pressure of the air outside, he saw that if this was the true explanation, any other fluid being substituted for water, would stand either higher or lower in the vacuum, according as it was lighter or heavier than that fluid. In order to test this explanation, he selected mercury, a fluid about 13½ times as heavy as water, and which, according to theory, should therefore rise in a vacuum to less than one-thirteenth the height of water. As the readiest means of experimenting, Torricelli took a glass tube about three feet in length, and hermetically sealed at one end, and filled it to the brim with mercury. He then inverted the tube, shutting the open end with his finger, to prevent the escape of the mercury until he plunged it into a basin full of the same liquid. His delight must have been great when he saw the mercury immediately flow out, and descend from the top of the tube, until it stood at the height of about 30 inches above the surface of the exposed liquid, as he anticipated it would. This experiment was made A. D. 1644, or a little over two hundred years ago.

The report of Torricelli's experiment spread rapidly over the continent, but the explanation it afforded was by no means readily received. The principle of the horror of a vacuum was too firmly believed to yield at once to the simplicity of truth, and many attempts were accordingly made to reconcile the experiments of the pumps and the tube of Torricelli with that absurd opinion. It was maintained that a subtle fluid or ærial spirit was evaporated from the surface of the water, and the mercury, which filled the upper part of the tube and left only as much activity to the horror of a vacuum as was sufficient to sustain a column of those fluids. Meanwhile an account of those experiments reached Pascal, an eminent French mathematician and philosopher, who immediately suggested a very ingenious method of confirming the results already obtained. This was to carry the tube and mercury to a considerable height in the air, when, a portion of the atmosphere being left behind, the instrument should show diminished pressure and the liquid in the tube sink in proportion. The trial was made, and succeeded perfectly. When conveyed to the tops of high buildings and of mountains, the mercury in the tube always fell in proportion as it was removed above the surface of the earth, and received the pressure of a shorter column of air. The principle of the barometer being thus established, it was soon after discovered that the height of the mercury in the tube did not remain the same, though the instrument was left stationary, showing that the pressure of the atmosphere was not constant at any place, but subject to daily fluctuations. Observation soon discovered that these fluctuations corresponded to certain changes in the weather. The instrument thus came to be used as a weather glass, and assumed a new interest and importance which have led to various and improved forms of construction.

In Fig. 1 we give a representation of the barometer of Torricelli, as already described, *m* being the top of the mercurial column, and *c* the open basin of mercury. The empty space above *m* in the tube is called the Torricellian vacuum. The empty

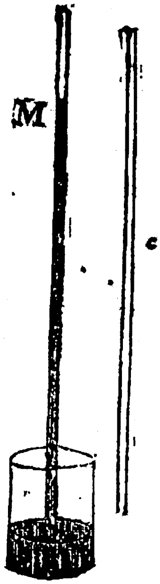
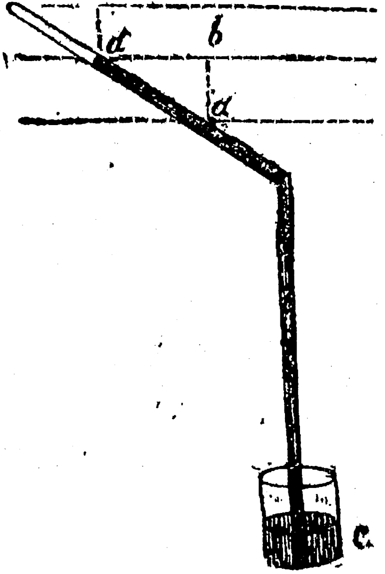


Fig. 1.

tube is shown, marked *c*, in the position in which it is filled. As the variations of the barometer are often very gradual and minute, various methods of rendering them more obvious and capable of exact measurement have been sought.—One of the earliest contrivances of this kind, is seen in Fig. 2, and is known as the rectangular barometer. This is nothing more than the tube seen in Fig. 1 bent to a horizontal angle of say 45 degrees, or less. In this tube the mercury will of course stand at the same height above the level of that in the basin, as in Fig. 1, but when a change of height takes place, as from *b* to *a*, the mercury will fall in the tube from *d* to *a*, a distance considerably exceeding the former. If we suppose the tube still less inclined above a horizontal plane, the difference in the length of the two lines *a d* and *a b*, will be still greater, and slight changes in the actual height of the mercurial column will occasion a much more extensive movement of the mercury in the tube, so that this movement may be very accurately measured by means of a scale fixed along the tube. Practically this form of barometer was found to present little, if any, advantage in point of convenience or accuracy. The position and length of the upper part of the tube caused a considerable increase of friction in the movement of the mercury, thus diminishing the sensitivesess and accuracy of the instrument.

Another form of the barometer less objectionable in its construction, besides being more elegant, is seen in Fig. 3; this is known as the wheel barometer, and is now in general use. The tube is of sufficient length, so that from *o* to *m* is about 30 inches, or the height at which the atmosphere will support a column of mercury. The tube is filled with mercury, as shown in the figure. The surface of the exposed mercury at *o* receives the pressure of the atmosphere, and as this is increased or diminished the mercury rises or falls at *m*, while at the same time a re-

Fig. 2.



verse movement of equal extent takes place at *o*. From the float resting on the surface of the mercury at *o*, a string passes over the small pulley *p*, supporting the weight *n*. An index or pointer is fixed in the axis of the pulley, as is seen in the drawing. It is plain that through this arrangement a very slight variation in the height of the mercury at *o* will give a considerable motion to the extremity of the pointer which traverses the graduated circle.

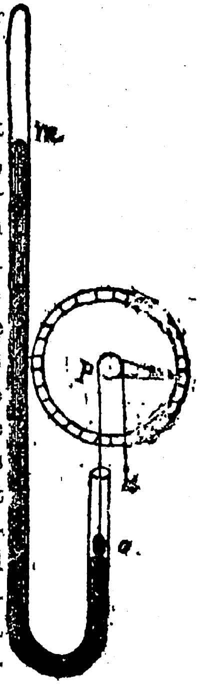


Fig. 3.

The syphon barometer is another form of the instrument in which the tube is similar in shape to that represented in Fig. 3, the only difference being that the lower leg is closed at top to a capillary opening, just admitting air, but excluding the passage of the mercury.—We will now imagine the tube to be filled with mercury, the same as in the last figure, and the float, dial plate, &c., to be absent. The movement of the mercury is the same as in the wheel barometer, and to measure its variations an accurately graduated scale is fixed by the side of the tube at the top, and also by the side of the short leg at *o*. When the barometer is observed, the extent of the movement, both at the top and bottom, is measured on the graduated scale attached, and the two results added together. The reason why the two measurements must be added, is this: Suppose a change occurs in the pressure of the atmosphere, causing the barometer to fall an inch, for example. Now in the syphon barometer the height of the mercury at *m*, must be estimated in all cases from a point exactly level with the surface at *o*. In the case we are supposing, the distance between these two points is to be shortened by an inch. As the mercury falls at *m* from diminished pressure, it also rises at *o*, at precisely the same rate; consequently, when the column at *m* has settled half an inch, that at *o* has risen the same amount, and the two points are nearer each other by just an inch, which was the result to be indicated. It is evident that precisely the same action would occur in a lesser movement, and if we suppose the pressure to be increased, the mercury will rise at *m* and fall at *o* at the same rate, so that in this case also, the sum of the two movements must be found in order to measure the true difference in the length of the mercurial column. The same thing takes place in the wheel barometer, the movement of the float at *o* being only half the actual change in the height of the mercury, but by means of the pointer and circular scale, a very slight change of the mercury is plainly shown. We have now to describe the cistern barometer, the most common as it is, (when properly constructed) the most useful and accurate form of the instrument.

It is with barometers as with every thing else, the very simplest form is found to be the best, and the most accurate and approved modern instruments are, with the exception of a single adjustment, copied directly from that first discovered by Torricelli. Before going further, it will be proper to describe the adjustment alluded to. In every cistern barometer the scale used for measuring the height of the column of mercury is permanently fixed in its position, and the beginning point of the scale is assumed to be the surface of the mercury in the reservoir or cistern. It is essential then to the accuracy of the measurement, that this surface should be kept at the same level. But the working of the instrument continually changes this level, for as the mercury falls in the tube it rises in the cistern, and *vice versa*. If the surface of the mercury exposed in the cistern is just ten times the surface of the top of the column, then when the mercury falls an inch in the tube, it will rise in the cistern one tenth of an inch and the fall as measured on the scale will be only nine-tenths of an inch. If the surface of the mercury in the cistern is fifty or one hundred times that in the tube, the error occasioned will be quite small; yet for the purpose of accurate observation this surface should always be brought to a fixed point. The contrivance employed by Fortin, a celebrated French artist, for correcting this error, consists in adjusting to the cistern a moveable bottom, which can be elevated or depressed, by means of a screw, until the surface of the mercury shall just touch a fixed ivory index, the point of which constitutes the zero or beginning point of the scale. The point and screw are represented in figure 5.

Figure 4 exhibits a very common form of the barometer, the tube being turned up at the bottom and expanded to the small bulb *c*, which is about half filled with mercury; there is a small opening in the top of the bulb admitting air. This bulb is often much less than an inch in diameter, so that the error occasioned in the working of the instrument must be considerable.

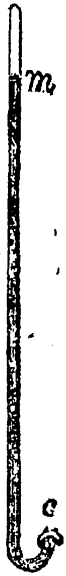
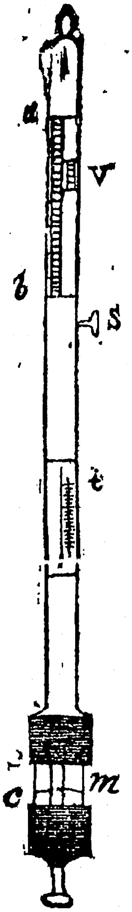


Fig. 4.

Figure 5 represents the barometer of the Detroit Observatory, at Ann Arbor. This instrument cost nearly a hundred dollars, and is probably one of the most perfect barometers ever constructed. The tube is enclosed in a cylindrical brass case about an inch in diameter.—*a b* show the scale at the top where there is an opening in the case for observing the height of the mercurial column. At the bottom the case is enlarged to about 2 inches diameter, so as to enclose the cistern. This is of glass, and the upper part of it above *m* is left exposed, showing plainly the surface of the mercury and ivory point. At *t* is placed the attached thermometer. Opposite *v*, at the top of the figure is seen a small scale fitting against the scale *a b*. This is the vernier, and when an observation is taken, the lower edge of this is adjusted by means of the screw *s* to exactly the height of the column of mercury, the cistern level being previously adjusted. The vernier is a very simple contrivance for measuring small fractions of an inch. The following explanation of its construction will enable any one to understand and use it with facility. It is a small slide of metal, either fitting against the edge

Fig. 5.

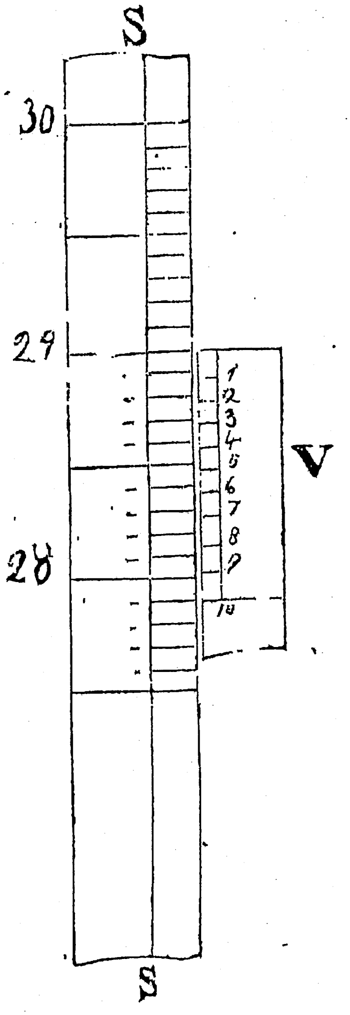


or face of the larger scale. Figure 6 shows the scale S with the vernier V attached. As is represented in the drawing, the scale is divided into inches and tenths of inches, and on the vernier a space is taken equal to nine or eleven-tenths (it is immaterial which,) on the fixed scale, and this space is divided into ten equal parts. It is plain that each of these parts is equal to a tenth and a tenth of a tenth, or one hundredth of an inch. (We have supposed eleven-tenths to be taken on the vernier.) The figure represents the vernier standing at just 29 inches, and the line marked 1 falls below the line on the scale by one-one-hundredths of an inch. The line marked 2 by two-one-hundredths, and so on.

If now we move the vernier from the position in which it is represented, up the scale, it is evident that the line marked 1 will first meet a line of the scale. The line 2 will next coincide, and so on to the 10th, when the upper edge of the vernier will again coincide with a line of the scale and the vernier will stand at 29 and one-tenth inches. It follows, therefore, that the figure standing against the line on the vernier which meets, or coincides with a line on the scale S, always shows the number of one-hundredths of an inch which are to be added to the inches and tenths of inches already found. In short, the following direction will enable any one to use the vernier. Adjust the vernier exactly to the height of the mercurial column, then find the inches, and tenths of inches below it on the scale; if there is a fraction, that is, if the upper end of the vernier does not exactly meet a line on the scale, find a line on the vernier which coincides, and the figure opposite this line will show the number of hundredths to be added to the inches already found. If no line exactly coincides, take the one which comes nearest a coincidence.

Changes in temperature affect the height of the mercury in the barometer to a considerable extent, hence when the instrument is intended to give very accurate results, a thermometer is attached, and the degree of temperature is noted at the time of each observation on the barometer. If during any period, the temperature (as shown by the attached thermometer,) rises 30 degrees, the barometer will stand about a tenth of an inch higher on this account, and correction must be made about in this proportion for all variations of the thermometer. In order to correct the errors continually arising from change of temperature, it has been agreed to reduce all observations on the height of the barometer to the temperature of 32 degrees Fahrenheit, the necessary correction being found from tables constructed for the purpose. We have thus briefly described the barometer with the adjustments and accompaniments indispensable for accurate observation. For observing a perfect or standard instrument, the following directions are important, viz: First note the temperature of the attached thermometer, next, by means of the screw at the bottom of the case, bring the surface of the mercury in the cistern to a constant level, and lastly, adjust and read the vernier. Before making this last adjustment, it is important to jar the barometer slightly, so as to remove the adhesion of the mercury to the tube, that the column may take its true equilibrium.

Fig. 6.



If the barometer is not handled too much, and the instrument is a good one, it will work accurately for an indefinite period of time. Having fixed the instrument on a suitable support, the bottom should also be secured so that it cannot move much out of a perpendicular position, or otherwise injured by meddlesome persons. If a barometer is to be moved, even for the shortest distance, as from one room to another, the cistern must be slowly screwed up so as to be filled with mercury, or if the mercury cannot be seen, until some resistance is felt; the instrument may then be taken from its support, *and very slowly* turned bottom upwards. While in this position and perpendicular, it may be carried safely in the hand. When it is to be hung up, bring it to its proper position very slowly, and afterwards unscrew the cistern. It ought to be well understood, that no barometer (except of very peculiar construction) can be moved when in the position for working, without great danger, either of breaking the tube, or of introducing air in the vacuum, which would of course spoil the instrument.

WHAT THE BAROMETER INDICATES.

According to Brocklesby the mean or average height of the barometer is nearly the same in all latitudes, when every essential correction is made, and the observations reduced to sea level.

The pressure of the atmosphere increases a little from the equator to about the 30th degree of latitude, where it is greatest; it then decreases to nearly the 64th degree, where it is least; after this it again increases, and between the 75th and 76th degrees, the pressure is equal to that of the eqatorial climes. The difference between the barometrical means of the 33rd and and 64th degrees of latitude amounts to a little over half an inch· The extremes of fluctuation, or range, of the barometer, depends to a much greater extent on the degree of latitude, its range with the tropics being but little over one-fourth of an inch, while at New York, (40 deg.42 min. N. lat.,) it is 2.262 inches, from the observations of five years; at St. Johns, Newfoundland, (47 deg. 34 min. N.,) 2.54 inches during the same period, while on the island of Great Britain the variations of the barometer amount to three inches. Here at Ann Arbor, the range of the barometer during the last twelve months has not exceeded 1.80 inches, though the entire range is no doubt considerably greater, as the general maximum and minimum do not usually occur oftener than once in ten of fifteen years. The extent of the movement of the barometer is also dependent on the time of year, the variations in atmospheric pressure being much greater during the colder seasons than in the summer months. During the spring, autumn and winter, the mercury frequently falls from half an inch to an inch, and even more, in a single storm, while variations of only half this amount are common in the summer. During the storm of December 12th; '55, the barometer fell 1½ inches in about 36 hours, the change in pressure amounting to about 3-4ths of a pound to every square inch of surface.

Before proceeding to discuss the indications of the barometer, it is proper to say a few words on the cause of the fluctuations of atmospheric pressure. The two most important elements which induce these variations are heat and moisture, and of these the former is in most cases predominant. The effect of changes in temperature on the pressure of the atmosphere is, obvious. If we suppose a portion of the air above any particular spot on the earth's surface to become heated above the temperature of the surrounding atmosphere, this body of air will expand according to a certain law, rising and passing out into the atmosphere around it—when this has taken place, the atmospheric pressure is diminished, and the barometer falls, for the column of mercury is sustained by a column of air of the same size and reaching the top of the atmosphere, and as heated air occupies more space, a given volume becomes lighter as its temperature increases.

The effect of moisture on the weight of the atmosphere depends on the manner in which it is contained in the air. According to the experiments of Dalton, a given space filled with air contains an equal amount of moisture with a vacuum, the temperature being the same, the two fluids arranging themselves the same as though one was a vacuum to the other. If this were always the case, the pressure of the air would always be increased by the weight of the moisture contained in it, and as the capacity of the air for moisture increases with the atmosphere, these two elements would partially counteract each other in their effect on atmospheric pressure. Some time, however, is required for the mixture of vapor and atmospheric air in the way we have described, and the probability is that a complete and mutual diffusion seldom or never takes place, owing to the frequent changes in temprature and the currents of vapor. On this account, and since it is impossible to estimate with any precision the moisture of the air much above the surface of the earth, it is not easy to separate and determine the effect of changes in the humidity of the atmosphere on the movements of the barometer.

From what has been said it may readily be imagined how the pressure of the atmosphere should be subject to almost constant variations, since at any place the air changes frequently and suddenly, both in temperature and the degree of moisture it contains. Now as to the effect of these changes on other atmospheric disturbances. If at any place the air becomes lighter than the surrounding atmosphere, as would be indicated by a low barometer, a partial vacuum is produced, and the air will immediately rush from the point of high pressure, or where the barometer stands high, to restore the equilibrium. In this way wind is produced, wind being nothing else than the movement of the atmosphere to restore its equilibrium. From the meeting of currents of air of different degrees of temperature, clouds and rain will in most cases result, though the condensation is not always powerful enough to produce the latter. For air at all temperatures may contain a certain amount of invisible vapor and no more, when it is said to be saturated, and if the temperature of a given volume of air which has been saturated is raised from 32 deg. to 90 deg., for example, it will be capable of receiving a large addition of moisture before reaching the point of saturation corresponding to the increase of temperature. If now, this volume of air be again cooled to 62 deg., it will be incapable of holding in suspension the additional moisture it has received, and this will be precipitated in the form of rain. This will be rendered more obvious by the following illustration from Brocklesby, viz: "4000 cubic inches of air at the temperature of 86 deg. Fah., can contain no more than 31½ grains of moisture, and an equal volume at 32 deg. Fah., only 7.7-8 grains. Now, if the two volumes are mingled together, their average temperature will be 59 deg., and the weight of the moisture they unitedly possess will be 39.3-8 grains. But at this temperature 31.1-12 grains is all the moisture that 8000 cubic inches of air can possibly retain, since the first portion by its union with the second diminished its capacity one half, while that of the latter was only doubled. The excess, therefore, of 7.7-8 grains will be condensed and descend in the form of water." If, when two volumes of air meet each other, the difference in their temperatures is not great, or they are not saturated with moisture, the condensation may not be sufficient to produce rain, in which case clouds or fog will only result.

We see clearly, therefore, how changes in the pressure of the atmosphere as indicated by the barometer, may be connected with changes of the weather, and the theory is confirmed by observation. Storms or rain usually occur when the barometer is falling or after it has fallen, for the fall of the barometer indicates the presence of warm currents in the atmosphere, which when containing moisture generally produce rain. In general there will be more or less wind while the barometer is falling, and if the wind is not felt, it will be in those cases, when the disturbance is confined to the region of the clouds, and the lower atmosphere remains quiet, though the equilibrium is rarely restored without some decided movement at the surface of the earth.

The following general rules for prognosticating are from the pen of Dr. Lardner. We introduce them here as the best to be found in the books, and that we may more concisely discuss particular cases, which may be regarded as exceptions to the generalizations, or as peculiarities of our climate:

Dr. Lardner says: "It is obvious that changes of weather are indicated not by the actual height of the mercury, but by its change of height. One of the most general, though not absolutely invariable rules is that when the mercury is very low, and therefore the atmosphore very light, high winds and storms may be expected.

The following rules may be relied on at least to a certain extent:

1. Generally the rising of the mercury indicates the approach of fair weather. The falling of it shows the approach of foul weather.

2. In sultry weather, the fall of mercury indicates coming thunder; in the winter, the rise of the mercury indicates frost, (i. e., cold, freezing weather,)—in frost it indicates thaw, and its rise indicates snow.

3. Whatever change of weather suddenly follows, a change of the barometer may be expected to last but a short time. Thus, if fair weather follows immediately the rise of the mercury, there will be very little of it; and in the same way, if foul weather follows the fall of the barometer, it will last but a short time.

4. If fair weather continue for several days, during which the mercury constantly falls, a long continuance of foul weather will probably ensue; and again, if foul weather lasts for several days, while the mercury continually rises, a long period of fair weather will probably succeed.

5. A fluctuating and unsettled state of the mercurial columns indicates changeable weather."

We shall comment on these rules separately.

1. Whenever the barometer remains quiet and steady, there will be no great or permanent change in the weather, previous to a decisive movement of the mercury. Small oscillations of the mercury not exceeding a tenth of an inch, generally exhibit only a *tendency* to rain or fair weather as the case may be. Still an inconsiderable fall of the barometer during a settled period of wet weather, is often followed by heavy storms, and this is frequently the case during the summer months. As a general rule, when the barometer falls very low, a reaction will speedily follow, accompanied by a change of wind to a westerly or northerly point; but the weather may remain unsettled for some time afterward. During a protracted spell of very wet weather, however, the barometer is not usually, most of the time, *very* low, often ranging but little below the mean. In such cases, a great fall of the mercury seems to indicate the near approach of a reaction, that is, a change of wind, and rise of the mecury, followed by fine weather. A great movement of the barometer is always accompanied or followed by a change of wind.

2. An ordinary thunderstorm of only a few minutes duration, and which is not preceded or followed by a marked change of wind and temperature is not likely to effect the barometer very perceptably, but in those cases where there is a sudden change of wind to a southerly quarter, accompanied by great rise of temperature before the storm, or when the storm terminates an extreme of heat, the fall of the mercury is commonly abrupt, and considerable in extent; and when the fall is due to the approaching thundergust, the mercury commonly rises with the first dash of rain, and is violently agitated during the passage of a severe shower. During the winter, as indeed at all other times, the observer should carefully attend to the direction of the wind, and the appearance of the sky, and compare these with the movements of the barometer. During the colder seasons, especially, a very marked and sudden rise of the mercury often immediately precedes a rapid fall, accompanied by a severe storm, and this result may be predicted when the barometer rises extremely high, the wind at the same time veering rapidly to an easterly quarter. Thaw and rain may be looked for in the winter, when, during the fall of the barometer, the wind sets in from S. E., or some point south of east, and the upper storm clouds move from south of west. 3. This rule results from the fact that gradual and protracted movements of the mercury are usually followed by settled changes in the weather, while rapid movements of the barometer, abruptly followed by atmospheric disturbances, seem to indicate variable and unsettled weather. 4 and 5. The same observations apply to these as to the preceding rule.

In order to calculate when the disturbance indicated by a movement of the barometer will probably occur, the condition of the atmosphere should be considered. If the weather has been quiet and settled for some time; and the movement of the barometer is gradual, the atmospheric change may not be visible short of 24 hours, sometimes not before two or three days have elapsed. Whenever, during fine, steady weather the barometer falls for two or three days, reaching a point below the mean, stormy weather is near at hand, though the sky may give no indication of it. In such cases, the movement, when the mercury begins to rise, indicates the arrival of the disturbance, and that it is passing. Although it is doubtless strictly true that no general storm can be developed without a fall of the barometer, during its passage, still observations show that at rare intervals rains occur before, and during which the mercury remains quiet, and also stands much above the mean. Several explanations of this apparent anomaly may be suggested. According to the investigations of Mr. Espy and others, the barometer falls more or less in the central region of a storm, while near the outer rim of the disturbance, the air pushed outwards from the center, causes the barometer to indicate a pressure in most cases considerably above the mean. It is this result which explains the extreme rise of the mercury which often occurs just before a severe storm. Now, if only the border of the storm should pass directly over the observer, rain might ensue and the barometer remain high and comparatively undisturbed. Again, several currents often exist in the atmosphere, underlaying each other and moving in different directions. Different conditions of temperature, moisture, &c., will of course pertain to these currents, but their effect on the barometer will be according to their united and predominant elements. Thus it sometimes happens that while a warm and moist upper current from the S. W. brings threatening clouds and rain, strong and cold northerly wind is blowing at the surface, more than compensating for the effect of the heated current above, and the barometer *rises*. It is very rare that a high wind occurs without a previous accompanying fall of the barometer. When this does happen, however, there will be a sudden and considerable *rise* of the mercury during the gale, the wind being the result of the approach of a wave of high pressure. Storms generally succeed a movement of this kind in a few days.