commissariat department for the supply of "hot water at twopence a head."

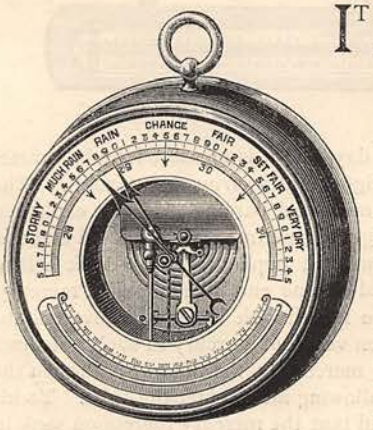
Kenilworth is famous for the cultivation of large strawberries. What cotton is to Manchester, pigs to Ireland, coals to Newcastle, and herrings to Yarmouth, strawberries are to Kenilworth, and large quantities of that delicious fruit find their way every year to Covent Garden Market.

The British Isles do not afford a prettier or more stately drive than that between Kenilworth and Coventry, but to thoroughly enjoy it the whole distance had better be walked. The scene is as lovely as the Vale of Avoca, and there is nothing to disturb the serene loveliness of the picture save now and then a carriage full of tourists armed with a guide-book in one hand and a field-glass in the other. For several miles the road runs through a magnificent avenue of trees, like those at Versailles, only this is much longer, and the trees are higher and more natural in their wild luxuriance. Standing at the farthermost end, the lofty trees seem to the visitor to touch the sky. The same delightful panorama continues till Coventry is reached, where the story of Lady Godiva's famous ride, and of Peeping Tom's prying curiosity, is still perpetuated. The country abounds in "beauty-spots," such as Stoneleigh Abbey, Coombe Abbey, Charlcote Park, the drive from Leamington to Stratford, and a host of others. But I have said enough if I can induce the fashionable tourist not to spend so much on German landlords—to forsake for once the fascination of the Italian language and the seductive allurements of foreign capitals, for the healthy invigorating breezes and charming scenery of his own native country. I am persuaded that there are many comparatively undiscovered sights and scenes at home quite as interesting, and that will compare favourably with anything abroad. Let, then, some of the vast multitude of holiday-seekers leave for awhile the well-beaten routes of Continental travel, and do a little home-touring.

J. W. C.

STUDYING THE WEATHER.

BY J. MUNRO, C.E.



IT is not so many years since the study of the weather was considered a very vain pursuit. The wandering gales were either believed to obey no laws, or laws which it was hopeless to try to find out. Far otherwise is the view of educated persons to-day, and those who make a special study of the subject assure us that only time, observation, and thought are necessary to enable us to comprehend the processes of the atmosphere, and to a certain extent predict the coming weather.

Meteorology, or modern weather-science, is only about twenty five-years old, and dates from the employment of the telegraph in transmitting reports from different places of the state of weather existing there at the same time. The word itself, however, is old, since it was used by Aristotle some 300 years B.C. to name a treatise on water and earthquakes. It does not come, as popularly supposed, from the "meteors," or falling stars sometimes seen in the sky, but from the Greek words *meteoros*, soaring, and *logos*, a discourse. As a science it is of endless practical utility, not only in commerce, engineering, and agriculture, but also in pleasure-seeking. At present, however, it is mainly in its relations to shipping and farming that it is valuable. By its aid Captain Maury has pointed out the least tempestuous routes across the Atlantic ; and General Myers daily informs Western American farmers what weather they may expect for their crops. These results have been attained by an intelligent scrutiny of ships' log-books, which are now all kept on a uniform system, and by weather observatories planted all over the vast extent of the United States. Great Britain is too limited in area and insular in position to encourage the hope that weather-study in these islands will ever give the same certainty of prediction as it gives in America or India or other continental regions ; but nevertheless much may be achieved, even in stormy England, by a proper system of observation carried on for a considerable number of years.

Most civilised nations have awakened to the great importance of the science, and systematic observations are daily made at our national observatories of Kew, Greenwich, Edinburgh, &c., as well as at the weather stations of the Meteorological Office. This office issues daily reports in the newspapers of the recent weather in all the districts of the United Kingdom, and forecasts of the probable weather, besides answering telegrams of inquiry as to the weather in different places. They depend for a good deal of their information on individual observers provided with correct instruments and obeying their instructions, so that valuable assistance may be rendered in this way by persons who have the opportunity at their disposal, and the study of the weather may be made a means, not only of private, but of public good.

The elements of weather-study are: observations of the intensity of solar radiation; the temperature of the air in the shade; the weight of the superincumbent air, or, in other words, the barometrical pressure; the velocity and direction of the wind; the dampness or humidity of the atmosphere; the amount of rain or snow-fall; the amount of electricity and ozone in the air; with notes on the forms and drifts of clouds, the colour of the sky, thunderstorms, aurora, sea-disturbance, or other signs. These elements are intimately associated, and it is by a concurrent study of all that weather-knowledge is obtained.

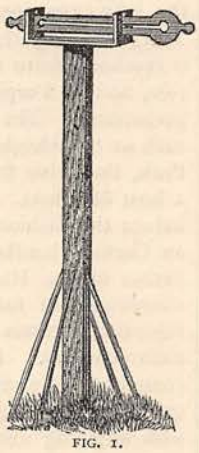


FIG. 1.

The intensity of the sunshine is best measured by the solar radiation thermometer of the Rev. F. W. Stow. This consists of a mercury *maximum* thermometer, having a black bulb and stem, and enclosed in an outer glass chamber, from which the air is exhausted. The bulb is exposed to the sun's rays, and the expanding mercury drives before it a small index along the tube, so that the *maximum* temperature in twenty-four hours is recorded by the index. Fig. 1 represents this thermometer exposed in a S.E. direction, on a stand about four feet above the ground, with the air circulating freely all round it. The maximum temperature of the air in the shade is also to be taken at that place, and the difference between the maximum in the sun and the maximum in the shade is a measure of the solar radiation.

In observing the temperature of the air in the shade it is necessary to guard the thermometer not only from the sun's direct rays, but likewise the radiation of walls, trees, &c.; hence the instrument should be enclosed in a shade which admits the air freely, but excludes lateral heat-rays. Glaisher's shade or stand is a little wooden penthouse or shed facing away from the sun; but a better is Stevenson's, now generally used, and consisting of a louvre-boarded hutch, something like a small meat-safe, as shown in Fig. 2. The legs should be about four feet high, and it should stand over grass on open ground, away from the shadow of trees, and above twenty feet from any wall. In default of any screen of this kind, the temperature of the air in a makeshift way can be got by swinging the thermometer round at the end of a cord some two feet six inches long, after the manner of a sling.

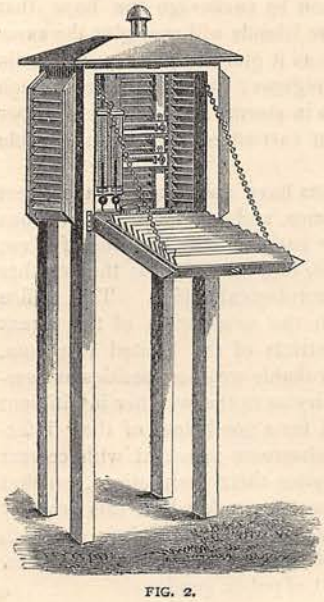


FIG. 2.

The maximum and minimum temperatures during the twenty-four hours are to be observed by means of maximum and minimum thermometers. The most favoured maximum thermometer in England is, perhaps, that of Professor Phillips, in which a bubble of air in the top of the mercury column is pushed up as the column rises, and left behind when the column sinks, to mark the highest temperature reached. The minimum temperature, on the other hand, can be very well obtained by Rutherford's minimum thermometer, in which a column of coloured alcohol, as it shrinks with the cold, drags a light index or float down the tube, and flows past the latter on expanding with the heat again. These instruments are represented in Figs. 3 and 4.

The atmosphere is a gaseous ocean resting on the earth with an average pressure of fifteen pounds on the square inch. From various causes, chiefly the rarefying power of the sun's heat and the amount of aqueous vapour it contains, this pressure varies from hour to

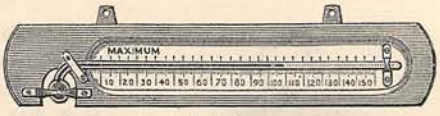


FIG. 3.

hour and day to day, and it is measured by barometer (from *baros*, weight, and *metron*, a measure). The principle of the mercurial barometer is best explained by citing the original experiment of Torricelli made in 1643. This renowned pupil of Galileo took a long glass tube closed at one end, filled it with mercury, and, stopping the mouth with his finger, inverted the tube over an open vessel of mercury in such a manner as to merge the mercury in the tube with that in the cistern without allowing air to enter the tube. To his surprise, he found that the mercury thereupon sank in the tube till it became about thirty inches long, when it remained stationary. Pascal, the celebrated French philosopher, divined the true explanation of this singular action. He saw that the weight of the column of mercury in the tube just balanced the weight of the column of air resting on the mercury in the open cistern, and applied the apparatus as a barometer in measuring the pressure of the atmosphere.

In Fortin's barometer, which is illustrated in Fig. 5, the cistern consists of a glass vessel with a flexible leather bottom, which, by means of an adjusting screw, can be pressed in or out, so as to raise or lower the level of the mercury in the cistern till it reaches a certain fixed mark made by a small ivory point projecting downwards like a spike from the roof of the cistern. The need of this adjustment will be seen when it is called to mind that the real height of the mercury column balancing the air is the height from the level of the

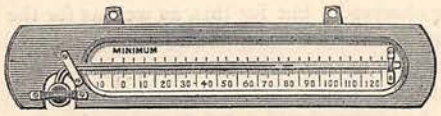


FIG. 4.

mercury in the cistern to the level of the mercury in the tube. Now, as the level in the tube rises or sinks, the level in the cistern must sink or rise, since there is only a certain amount of mercury common to both tube and cistern. Hence it is necessary either to bring the mercury to its datum level by a device like that of Fortin, or to correct the reading for "capacity error," as it is called, or to use a scale which can be moved till its zero coincides with the cistern level, or one with its degrees contracted to make up for the error.

Of the other barometers in use, the syphon barometer of Gay-Lussac is the best for travellers, and the marine barometer of Mr. Adie is well adapted for the sea. In the latter, as well as in household barometers, the scale is divided only to 10ths of an inch, and the Vernier reads only to 100ths. With them the reading should be taken as quickly as possible, so as to avoid heating the mercury by the warmth of the hand. Pediment household barometers and wheel barometers, with indicating hands, are too well known to need description here. The aneroid barometer, although it does not give the pressure of the atmosphere so exactly as a mercurial barometer, is nevertheless very sensitive to changes of pressure, and hence is serviceable as a weather-glass and a measurer of altitudes. From its extreme portability it has become the pet instrument of the explorer, and it is also a favourite with tourists and sportsmen. Its action depends, as is tolerably well known, on a small box of thin corrugated metal, from which the air is exhausted. The atmosphere, pressing on the outside of this sensitive chamber, elevates or depresses the corrugated surface with greater or less force according to the weight of air, and by means of levers this minute effect is communicated to the hand on the dial. The initial figure represents this little instrument with the corrugated chamber exposed.

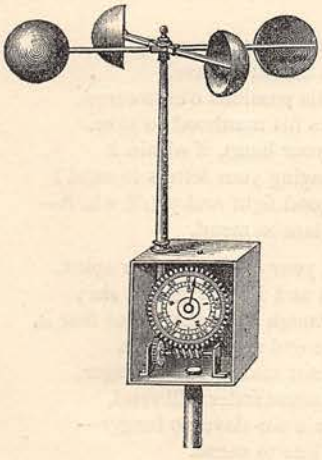


FIG. 6.

The usual warnings, "Fair," "Stormy," &c., on a barometer are not much to be relied on. A far more certain indication is the barometric "gradient" given by the difference of barometric pressure at the two extremities of a line 60 nautical miles long, for the force of the wind is usually in proportion to the steepness of the gradient. In the weather-charts of the Meteorological Office the gradient is expressed in 1-100th of an inch of mercury per degree of 60 nautical miles. On weather-maps the gradient is steepest, and the difference of pressure most, across the isobars which are closest together, and the force of the wind is greatest in that district.

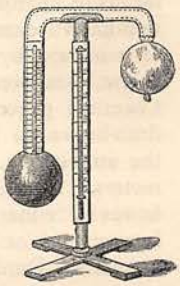


FIG. 7.

That every wind brings its weather is a true remark, and hence one of the first steps to weather-study is measuring the direction and force of the wind. The direction is measured by the wind-vane, and Prestel's vane also roughly indicates the pressure of the wind by a pendulous plate which hangs vertically when there is a calm, but swings to an angle with the gale, like a hanging signboard. The velocity of the wind is best given by Dr. Robinson's anemometer, or wind-measurer, which consists, as will be seen from Fig. 6, of four brass cups on the ends of cross-arms. These cups catch the wind, and the vertical stem is driven round mill-wise at one-third of the wind's velocity. By means of wheel-work and an indicating-dial, the number of miles travelled by the wind in a given time can be read off. The anemograph, or self-recording wind-gauge, is a form of this apparatus designed to mark down its own indications, and is very useful in observatories. The velocity of the wind per hour can, of course, be easily obtained from the number of miles traversed in a certain number of hours, and from the velocity the *pressure* in pounds on a square foot of surface can be readily calculated, or it may even be measured direct

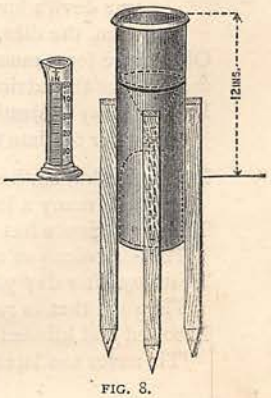


FIG. 8.

FIG. 5.

by means of pressure-plates such as are used by engineers.

The dampness or humidity of the air exercises a great influence on the temperature, and consequently on the weather. It is estimated by means of hygrometers, the simplest of which are the well-known damp-detectors based on the absorption of moisture by such materials as hair, oat-beard, catgut, sea-weed, grass, and chloride of lime. Chemical papers, which change their colour from drab-brown to blue, according to the humidity of the atmosphere, also belong to the class of hygrometers. The exact measurement of humidity is, however, either done by Daniell's or Regnault's hygrometer or by the wet and dry bulb thermometer. Daniell's instrument, as shown in Fig. 7, consists of a bent glass tube with two bulbs, the lower of which is blackened and the upper covered with muslin. The lower tube contains pure ether and a sensitive thermometer. In using the apparatus ether is dropped on the muslin, and its rapid evaporation cools the ether in the black bulb so much that the moisture of the outer air condenses on the latter as dew. The temperature of the *dew-point*—that is, the point at which the dew begins to form on the bulb—is to be noted in the thermometer.

The amount of rainfall is measured by means of the pluviometer, or rain-gauge. Circular gauges of copper of the same diameter as the mouth are the best for ordinary purposes. Mechanical gauges with registering trains are liable to error. Fig. 8 illustrates that adopted by the Meteorological Office. It consists of an outer protecting cylinder, having its rim 12 inches above the surface, and containing a glass bottle or reservoir, with a catch-funnel. The graduated glass beside it is to measure the amount of rain-water which it holds.

The amount of electricity in the atmosphere is also to be observed; but for this, as well as for the observation of terrestrial magnetism, expensive and delicate electrometers and magnetometers are necessary. The effects of lightning and of auroral displays may, however, be observed and noted, together with the amount of ozone in the air. Ozone is a condensed form of oxygen formed chiefly by evaporation of water and lightning discharges. It is an active agent in destroying corruption, and its presence is necessary to the healthiness of air. By the sea, or in the open country, especially after snow and thunder storms, it is most prevalent; in the crowded parts of cities it is rarely to be distinguished. Strips of paper saturated with a solution of iodide of potassium and starch, then dried and exposed to the air, but protected from rain and sunshine, turn blue, owing to the ozone decomposing the iodide of potassium and forming iodide of starch. By exposing the strips for twenty-four hours, and testing their tint by a scale of ten shades of blue, Dr. Moffat has provided a simple ozonometer.

The drift and shape of clouds is also an index of the weather, and some excellent hints on this subject are given by the Rev. W. Clement Leys, F.R.S. According to this observer, there is generally a great bank of frozen vapour (or cirro-stratus cloud) in the higher atmosphere in front of an advancing storm-centre. When clouds likewise begin to form in the lower atmosphere, the barometer falls, the wind rises, showers begin, and the storm is at hand. In the case of local storms, on the other hand, the heralding clouds are formed first in the lower atmosphere and afterwards spread to the upward. A red dawn or a yellow or grey evening marks the advent of wind or rain, as also does an unusual visibility in the atmosphere. It is perhaps needless to add that personal observation may be greatly assisted by a regular study of the daily weather-charts given in the newspapers.

"'TIS NEVER TOO LATE TO MEND."

A SONG FOR THE PEOPLE.

MAN! does some passion enslave you,
Degrading your body and soul?
Some devil's lure master and brave you,
The siren, the dice, or the bowl?
Oh! pause for a moment and hearken,
And take the advice of a friend,
Ere life's day in death's night shall darken—
'Tis never too late to mend.

It may be that sin has enthralled you
Through many a long misspent year,
That Conscience has pleadingly called you
Till her voice you no longer can hear:
That day after day you are going
The road that in ruin will end,
Besotted and blinded—not knowing
'Tis never too late to mend.

No brave man is he, but a coward,
No freeman is he, but a slave,
Who yields, by his passions o'erpowered,
No blow strikes his manhood to save.
Come, rouse up your heart, if within it
There's one longing your fetters to rend!
Man! fight the good fight and you'll win it—
'Tis never too late to mend.

With your body, your soul, and your spirit,
Fight constant and instant 'gainst sin;
Long and sore though the fight, never fear it,
Fight on to the end and you'll win.
Each lure you resist makes you stronger,
Each struggle some fetter will rend,
Till at last you're a sin-slave no longer—
'Tis never too late to mend.

JOHN FRANCIS WALLER.