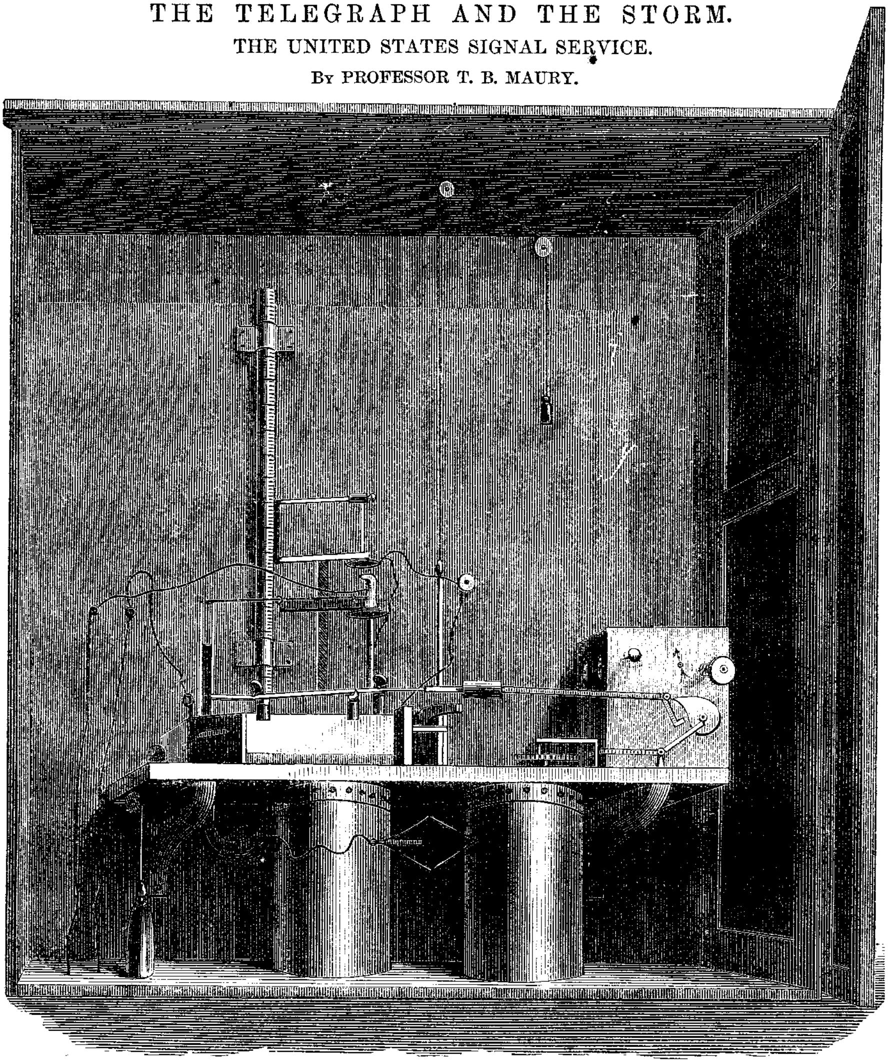
THE TELEGRAPH AND THE STORM.

THE UNITED STATES SIGNAL SERVICE.

By PROFESSOR T. B. MAURY.



PROFESSOR HOUGH'S NEW PRINTING BAROMETER.

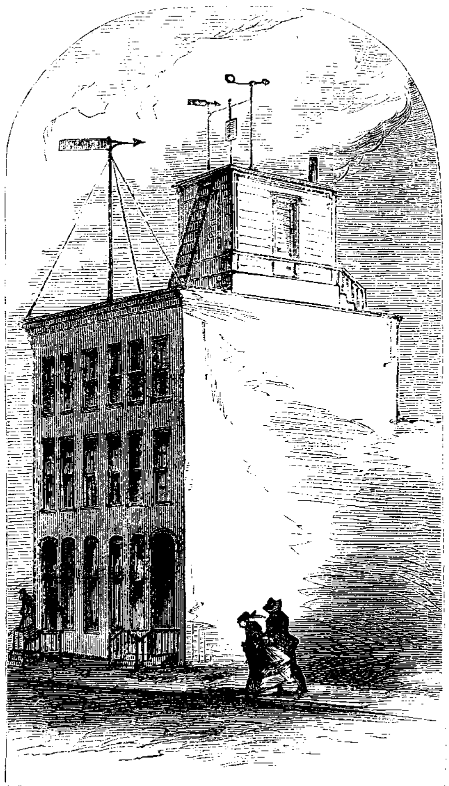
THE attempt to presage great weather phenomena is nothing new.

From time immemorial civilized society has sought after a plan for averting the violence of the storm and tempest as anxiously as it has sought to resist the deadly approach of the pestilence and the plague.

The Great Plague of London, historians tell us, carried off in a year about 90,000 persons. This was, however, in the rude and undeveloped condition of medical science, when the metropolis of England had but few hospitals, and every victim was left in his own house to spread and speed the march of the contagious foe. Appalling as such mortality seems for the *year* 1665, amidst the wretched and squalid dens of the London poor, it has been overshadowed in modern times by a greater calamity. On the 5th of October, 1864, the storm which swept over Calcutta destroyed, *in a single day*, over 45,000 lives! Yet this is but one of a large number of similar occurrences rivaling in magnitude the great Indian disaster.

To give forewarning of approaching tempests on the coasts of the Adriatic, the Italian and old Roman castles, as described by an antique writer, had on their bastions pointed rods, to which, as they passed, the guards on duty presented the iron points of their halberds, and whenever they perceived an electric spark to follow, they rang an alarm-bell, to warn the farmer and the fisherman of an approaching

THE WRECK OF THE "ROYAL CHARTER," ON THE COAST OF ANGLESEA, FIVE MILES FROM POINT LYNDS LIGHT-HOUSE.

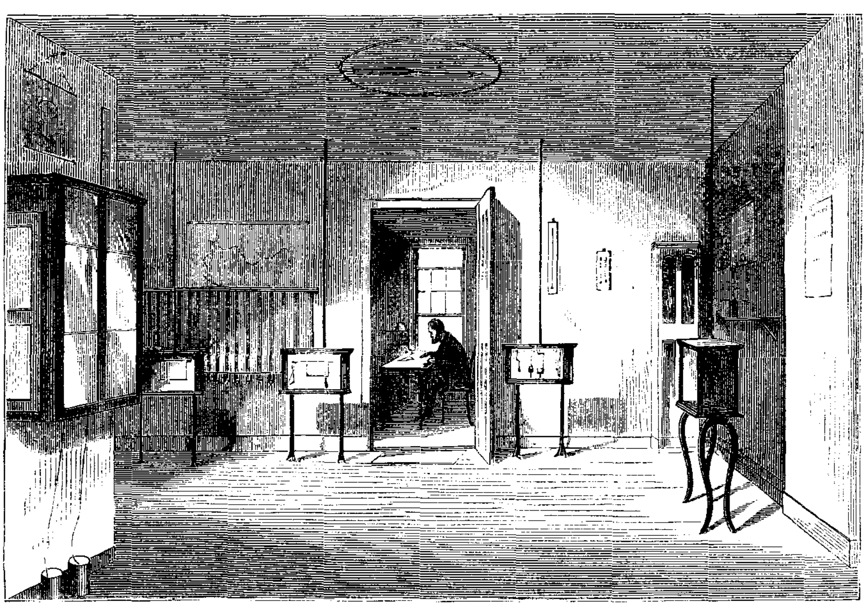


THE SIGNAL OFFICE AT WASHINGTON.

storm. It is interesting to note that this ancient Italian custom was widely spread over the earth in former ages. And it is not difficult to connect it with those olden towers (not only in Ireland, Scotland, and Spain, but in Africa and the East, Upper India and China) in which the use of a similar conductor may have been one among the many objects of those relics of the past.

But, as the title of our article shows, a new element of science has been introduced—the electric telegraph—an invention whose mission of usefulness is destined to unlimited enlargement.

In November, 1854, while the Anglo-French fleet was operating in the Black Sea against the stubborn walls of Sebastopol, the tidings flashed across the wires that a mighty tempest had arisen on the western coast of France, and, by the warnings of the barometer, was on its way eastward. The telegram was sent by the French Minister of War, Marshal Vaillant, from Paris, and reached the allied fleet in good time to enable them to put to sea before the cyclone could travel the five hundred leagues of its course, and disperse or destroy the most splendid navies that ever rode those waters. The storm came with a fatal punctuality to the predicted hour. The Crimea, shaken, ravaged, scourged by its fury, presented every where a scene of havoc and ruin in the allied camp more fearful than any the fire of all the Russian forts combined could have inflicted. It is perhaps not too much to say that, but for that telegram and its timely storm warning, the congregated navies, far from home and shattered to pieces, could not have sustained the besieging armies, and the event of the great Eastern war might have been different from what it finally was.



INTERIOR OF INSTRUMENT ROOM IN OFFICE OF CHIEF SIGNAL OFFICER.

So happily, in this instance, did theory (too often despised) blend with fact, that the French War Minister said, "It appears that, by the aid of the electric telegraph and barometric observations, we may be apprised several hours or several days of great atmospheric disturbances, happening at the distance of 1000 or 1500 leagues."

[EDITOR'S NOTE.—So far as we have been able to learn, the first idea of making use of the telegraph for conveying information in regard to the weather, with a view of anticipating changes at any point, occurred to Professor Henry, the eminent secretary of the Smithsonian Institution, in the year 1847, as in the report of the Institution for that year, page 190 (presented to Congress on the 6th of January, 1848), we find the following paragraph:

"The present time appears to be peculiarly auspicious for commencing an enterprise of the proposed kind. The citizens of the United States are now scattered over every part of the southern and western portion of North America, and the extended lines of telegraph will furnish a ready means of warning the more northern and eastern observers to be on the look-out for the first appearance of an advancing storm."

Additional references to this subject were made in the reports of 1848 and 1849, in the latter of which we are informed that "successful applications have been made to the presidents of a number of telegraph lines to allow, at a certain period of the day, the use of their wires for the transmission of meteorological intelligence." Although subsequent reports referred to the intention of the Institution to organize a telegraphic department for its meteorological observations, it was not until 1856, as far as we can ascertain, that observations were actually collected and posted. In the report for 1857 we find that "the Institution is indebted to the national telegraph lines for a series of observations from New Orleans to New York, and as far westward as Cincinnati, which were published in the *Evening Star*."

In the report of 1858 it is announced that "an object of much interest at the Smithsonian building is the daily exhibition, on a large map, of the condition of the weather over a considerable portion of the United States. The reports are received about ten o'clock in the morning, and the changes on the maps are made by temporarily attaching to the several stations pieces of card of different colors, to denote different conditions of the weather as to clearness, cloudiness, rain, or snow. This map is not only of interest to visitors in exhibiting the kind of weather which their friends at a distance are experiencing, but is also of importance in determining at a glance the probable changes which may soon be expected."

The report for 1859 contains a list of thirty-nine stations from which daily weather dispatches are received, and the report for 1860 refers to forty-five stations. In the report for 1861 Professor Henry announces that the system has been temporarily discontinued in consequence of the monopoly of the wires by the military department, and in 1862 it seems to have been again resumed.

It is very evident that to our own country belongs the credit of first initiating and carrying into successful operation the systematic use of the telegraph for the above-mentioned object.

In the year 1857 Lieutenant M. F. Maury, then Superintendent of the National Observatory at Washington, appealed to the public and Congress, through the press, urging the establishment of a storm and weather bureau, and at the same time made an extensive tour through the Northwest, addressing the people with a view of rousing public attention to the vast importance of this meteorological system.

In the Journal of the American Geographical and Statistical Society for 1860 we read that "As long ago as 1851 we find the Superintendent of the National Observatory at Washington urging the extension to the land—for the benefit of farmers, the shipping in our ports, and the industrial pursuits of the country generally—of that system of meteorological co-operation and research which had been so signally beneficial to commerce and navigation at sea. The Brussels Conference indorsed this recommendation. Much stress, in these appeals to Congress and the people, has been laid upon the value of the magnetic telegraph as a meteorological implement; for it was held that by a properly managed system of daily weather reports by telegraph warnings of many, if not most, of the destructive storms which visit our shores or sweep over the land might be given sufficiently in advance to prevent shipwreck, with many other losses, disasters, and inconveniences to both man and beast."—(Page 6.) The same journal states that the Meteorological Department of the London Board of Trade, under Admiral Fitzroy, was established to co-operate with the suggestion of Lieutenant Maury, which statement is confirmed by the report of the English Board for 1866 (page 17), and also by Admiral Fitzroy himself, in his Weather-Book, where he tells (page 49), "from personal knowledge, how coldly Maury's views and suggestions were received in this country [England] prior to 1853." The great meteorologist, Alexander Buchan, secretary of the Scottish Meteorological Society, in his recent work, strikingly states the indebtedness of Europe to the United States for this system: "The establishment of meteorological societies during the last twenty years must be commemorated as contributing in a high degree to the advancement of the science. In this respect the United States stand preeminent."]

Less than three years after the occurrence of the famous "Black Sea storm," just mentioned, there appeared for the first time, and in an American paper, a formal proposition for the establishment of a general system of daily weather reports by telegraph, and the utilization of that great invention for the collection of meteorologic changes at a central office, and the transmission thence of storm warnings to the sea-ports of the American lakes and our Atlantic sea-board.

"Since great storms," says Mr. Thomas B. Butler, in his work on the "Atmospheric System and Elements of Prognostication," "have been found to observe pretty well defined laws, both as respects the motions of the wind and the direction of their progress, we may often recognize such a storm in its progress, and anticipate changes which may succeed during the next few hours. When it is possible to obtain telegraphic reports of the weather from several places in the valley of the Mississippi and its tributaries, we may often predict the approach of a great storm twenty-four hours before its violence is felt at New York."

On the coasts of the kingdom of Italy mariners are forewarned that a storm threatens them by a red flag hoisted on all the towers and light-houses of the principal localities, ranging from Genoa to Palermo, and thence up along the Adriatic. On the most dangerous points of the coast of England, where the fishing-boats and small craft that perform the service of the coast are exposed to formidable gales even during the most promising season, barometers put up by the Meteorological Bureau are at hand to warn the seamen of bad weather. A striking illustration of the importance of storm weather signals was recently furnished (March 8), when a tornado swept over St.

Louis, destroying several lives and $1,000,000 worth of property.

In former publications the writer has demonstrated at length the fire-sprinkled paths and tracks of these storms, some of which are generated in the torrid zone, and sweep over the Gulf of Mexico, and thence up the valley of the Mississippi; or, shooting off from the bosom of the Gulf Stream, strike upon the Atlantic coast, and thence commence their march upon the sea-board and central States of the Union. In these published papers the view taken of these tropic-born cyclones is, with some modifications, that announced in 1831, and then substantially demonstrated by Mr. William C. Redfield, of New York, viz., that they rotate *around a calm centre of low barometer, in a direction contrary to the hands of a watch in the northern hemisphere, and with the hands of a watch in the southern hemisphere.*

It would, perhaps, be impossible to give a more vivid and exact account of a cyclone (or typhoon) than the following account of the typhoon of the United States war vessel *Idaho*.* After depicting the forlorn condition of the vessel after she had passed through the semicircle of the storm, the eye-witness writes: "At half past seven in the evening the barometer had fallen from 30.05 to 27.62. Suddenly the mercury rose to 27.90, and with one wild, unearthly, soul-thrilling shriek the wind as suddenly dropped to a calm, and those who had been in these seas before knew that we were in the terrible vortex of the typhoon, the dreaded centre of the whirlwind. The ship had been fast filling with water, and fruitless efforts had been made to work the pumps; but when the wind died away the men jumped joyfully to the brakes, exclaiming, 'The gale is broken! we are all safe!' For the officers there was no such feeling of exultation. They knew that, if they did not perish in the vortex, they had still to encounter the opposite semicircle of the typhoon, and that with a disabled ship. It was as though a regiment of freshly wounded soldiers had been ordered to meet a new enemy in battle, and that without delay, for the cessation of the wind was not to be a period of rest. Till then the sea had been beaten down by the wind, and only boarded the vessel when she became completely unmanageable; but now the waters, relieved from all restraint, rose in their own might. Ghastly gleams of lightning revealed them piled up on every side in rough pyramidal masses, mountain high, the revolving circle of wind which every where inclosed them causing them to boil and tumble as though they were being stirred in some mighty caldron.

"At twenty minutes before eight o'clock the vessel entered the vortex; at twenty minutes past nine o'clock it had passed, and the hurricane returned, blowing with renewed violence from the north, veering to the west.

"The once noble ship, the pride not only of our own navy, but of the whole craft of ship-builders over all the world, was now only an unmanageable wreck. There was little left for the wind to do but entangle the more the masses of broken spars, torn sails, and parted ropes, which were held together by the wire rigging. An hour or two later the tempest began sensibly to abate, and confidence increased in the ability of the ship to hold together. When daylight dawned the danger was over, and we first became aware of the astonishing amount of damage the ship had incurred in bearing us through the perils of that dreadful night. It was evident that she had sacrificed herself to save us."

The writer was aware, when this view was first publicly sustained by himself, that it was not accepted by all meteorologists.

The observations, of the most reliable and extended character, made within the last few years, go far to show that the storms which descend on low latitudes of the earth from high polar regions are, as the storms of the tropical regions, likewise of a rotary or cyclonical character.

One of the most beautiful illustrations of the law which governs these atmospheric disturbances may be found in the gale which is so celebrated as that in which, on the 25th of October, 1859, the noble steamship *Royal Charter* went down, and several hundred lives were lost, in sight of the island of Anglesea, on the coast of Wales. "The *Royal Charter* gale, so remarkable in its features, and so complete in its illustrations," as Admiral Fitzroy has well remarked, "we may say (from the fact of its having been noted at so many parts of the English coast, and because the storm passed over the middle of the country), is one of the very best to examine which has occurred for some length of time."

At the fatal time the barometer, for over at least a thousand square miles of sea and land, was generally low, and had become so, gradually, during many previous days—some tell us as much as a whole week. On the west coast of Ireland all was quiet in the atmosphere; the sky in the north of Scotland was serene. On the 21st of September a vessel passed the Scilly Islands and encountered no gale, and on the 23d securely left the Channel soundings. On the 24th a vessel bound for Africa sailed from Liverpool, and met no storm. The Channel squadron noticed the low barometer of 28.50 inches. In London rain was incessant and heavy, and the wind was from the south, while at Liverpool the winds were cold and northerly. On the dark and rainy afternoon and evening of the same day the *Royal Charter* was making way around Anglesea, close in shore, to her sadly chosen anchorage on the north side of that island, just in the place where she would feel the full force of the next day's tempest. The tempest broke upon her the next morning near seven o'clock, and in one short hour "that

* *Atlantic Monthly*, March, 1870: "A Night in a Typhoon."

doubly powered ship of iron," which had circumnavigated the globe, was destroyed, with nearly all on board. Another vessel, and a wooden sailing ship, *not a steamer*, the *Cumming*, and several smaller vessels, encountered the same gale but a few miles off, and by a few hours' sailing on the starboard tack (standing to the westward) ran out of the cyclone, and not one was wrecked, nor even materially injured. Had the *Royal Charter*, with her powerful engines and the use of her sails, followed their example on the morning of the 25th, all would, doubtless, have been right with her. The gale did not reach Liverpool until about twelve hours after the wreck of the noble vessel. Liverpool is about fifty or sixty miles from Anglesea.

The peculiarity of this gale which swept over the deck of the *Charter* was its *intense coldness*, being a *polar* current. Examining the accompanying diagram of "the *Royal Charter* storm," we see the tropical current advancing around the south and east of England with great force, to be, with greater force, speedily driven back by the polar current.

A letter from Dublin said, "In England you have had a tremendous gale (October 25–26). *Here* it was not felt." A dead calm and a *sharp frost* of unusual severity prevailed on the west coast of Ireland. A vessel returning from Iceland had heavy gales from the east-northeast between October 23 and 28.

"While at Anglesea," says Fitzroy, "the storm came from east-northeast, in the Irish Channel it was northerly; and on the east of Ireland it was from the northwest; in the Straits of Dover it was from the southwest; and on the east coast it was easterly—all at the *same minute*. Thus," he adds, "there was an apparent circulation of cyclonic commotion passing northward from the 25th to the 27th, being two complete days from its appearance in the Channel, while outside of this circuit the wind became less and less violent; and it is very remarkable that, even so near as on the west coast of Ireland, there was fine weather, with light breezes, while in the Bristol Channel it blew a northerly and westerly gale. At Galway and at Limerick, on that occasion, there were moderate breezes only, while over England the wind was passing in a tempest, blowing from all points of the compass in irregular succession, around a central, variable area."*

The phenomena of the *Royal Charter* gale have been given not as being peculiar or anomalous in the annals of cyclonology, but for the accuracy with which they were recorded, and because they furnish the reader with the type to which most American storms, and, indeed, all storms, more or less strictly conform, as geographical or orographical circumstances permit or prevent.

Storms similar in their conditions to that of the *Royal Charter* not infrequently occur in the United States, especially in the winter, when the conflict of the two currents, the polar and the equatorial, in high latitudes, is marked by sudden transitions in January from mild, moist, and balmy weather to a sudden and fearful cold, below zero. The furious battle of the elements rages, and reminds us of the famous Homeric description of Hector's attack on the Grecian walls:

> "As when two scales are charged with doubtful loads,
> From side to side the trembling balance nods,
> Till, poised aloft, the resting beam suspends
> Each equal weight, nor this nor that descends."

It may suffice to give one instance of this in the great northwestern snow-storm of January last. Speaking of this storm, the Chicago *Times* of the 16th of January said:

"The tremendous storm which has just passed is without a peer in the knowledge of the oldest inhabitant.

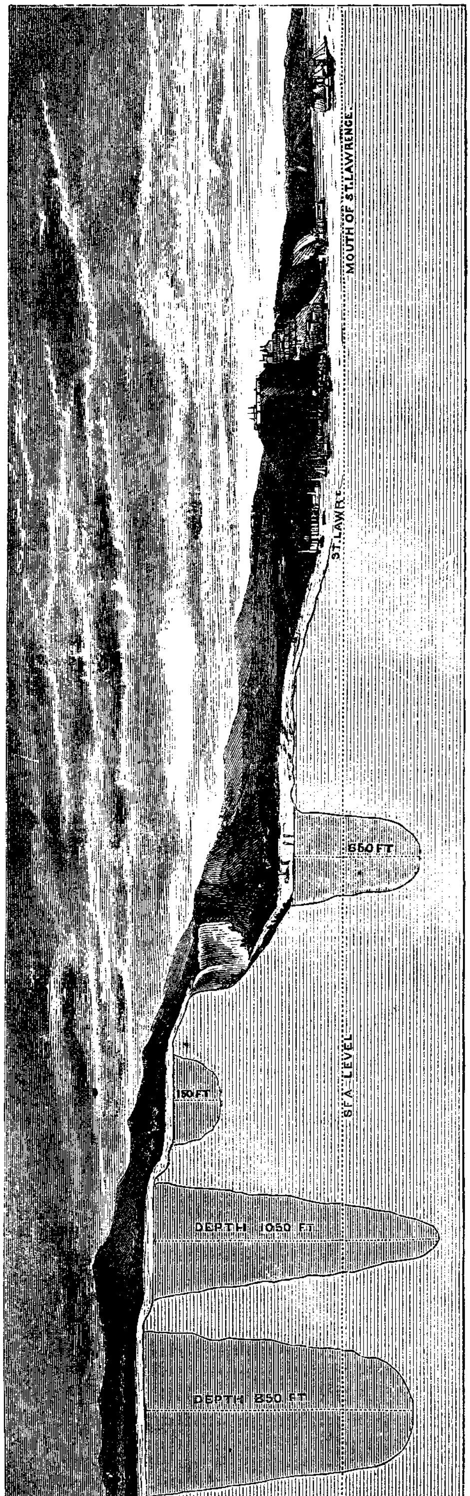
"The great snow-storm which visited Chicago on Friday (the 13th) first made its appearance on the 10th ultimo at Reno, among the Rocky Mountains, where it commenced its initiatory rage with such violence and with such a blinding fall of snow that the workmen repairing the Union Pacific track could not see ten feet before them. It made its appearance in Cheyenne on the 11th, and since then has been steadily advancing across the country. It has been one of those peculiar northwest storms whose coming was not indicated by the falling of the mercury in the barometer. On the other hand, the barometer rose, while the thermometer fell. *The immediate cause of the storm is indicated in the falling of the thermometer so suddenly after such mild weather.*

"The earliest direct news of the storm was received from Cheyenne, the most westward meteorological station, it having commenced to snow there about 4 P.M. on January 11. Reports were also received from Omaha, Duluth, and St. Paul on the same day, showing that the storm had also commenced in those cities. The storm continued, with no cessation of violence, till about midnight of the 12th, when the weather telegrams failed to give any further knowledge of it. It had suddenly disappeared; but only to strike Chicago with a premonitory drizzle of rain on the morning of the 13th, the same symptoms showing themselves in St. Louis and Milwaukee.

"The amount of snow that has fallen during the present storm is almost unparalleled; but, great as it is, it furnishes no gauge for the quantity of moisture that has reached the earth, as the amount of rain and sleet held in the snow makes it almost as heavy as salt. Another interesting feature of the storm has been its extreme duration, as compared with its violence. As bitter as the driving wind has been, the storm took thirty-nine hours to reach Chicago from Omaha, a progress which would give the very slow momentum of about ten miles an hour."

The Chicago storm was from the great polar current, and, as is the wont of westerly storms

* See Fitzroy's Weather Book, p. 300.



OROGRAPHIC SECTION OF THE AMERICAN LAKES.

(from the orographic peculiarity of the country), made its way to the Atlantic along the lakes and through the valley of the St. Lawrence.

"With daily telegrams from the Azores and Iceland," Buchan says, "two and often three days' intimation of almost every storm that visits Great Britain could be had." The Iceland telegram would give tidings from the polar air current, and that from the Azores would advertise the movement of the tropical current.

It is highly important that the United States should have telegrams from the Pacific, and from the valley of the Saskatchawan, or some point in British America on the eastern slope of the Rocky Mountains. The importance of reports from the southwest also was fearfully demonstrated in March, during the already mentioned interruption of the Signal Service, when the tornado in St. Louis destroyed many lives, and $1,000,000 worth of property.

It is due to the cyclone theory, or "law of storms," here and heretofore advanced by the writer, to say that many of the storms which seem to be deviations from the cyclonic law are modified by *interfering cyclones.* This view was formally adopted by the committee of the Meteorological Department of the London Board of Trade. Mr. Stevenson, of Berwickshire, England, as quoted by Fitzroy in the Board of Trade Report for 1862 (page 33), has some striking observations, founded on his own invaluable labors: "The storms which pass over the British Isles are found generally to act in strict accordance with the cyclonic theory. In many cases, however, this accordance is not so obvious, and the phenomena become highly complicated. This is a result which often happens when two or more cyclones interfere—an event of *very frequent occurrence.* When interferences of this description take place we have squalls, calms (often accompanied by heavy rains), thunder-storms, great variations in the direction and force of the wind, and much irregularity in the barometric oscillations. These complex results are, however, completely explicable by the cyclonic theory, as I have tested in several instances. A very beautiful and striking example of a compound cyclonic disturbance of the atmosphere at this place was investigated by me in September, 1840, and found to be due to the interference of three storms." Mr. Stevenson gives a number of instances of interfering cyclones which confirm this view. The points of *interference,* where two cyclones strike and revolve against each other, are best marked by a peculiarly and *treacherously* fine rain.

It may not inappropriately be added here that the cyclone theory, so strikingly illustrated by the hurricanes of the West Indies, has been demonstrated by Dove to apply to the typhoons of the Indian Ocean and China Seas. And Mr. Thorn has long since shown that the theory holds good for the storms of the Indian Ocean, south of the equator.

The following extract strikingly confirms what has been said. Mr. N. W. Goodwin, a resident of Superior, Wisconsin, writing me of the storms on Lake Superior, says:

"In my inquiries about these northeasters I have been informed by people living here, who have for years observed their peculiarities, that frequently steamers and vessels leave here and have pleasant weather down the lake, and that vessels leaving a short time after encounter these northeasters in all their violence; at the same time passengers from the southwest (Saint Paul) meet no storm until within a few miles of the lake.

"During these storms the upper strata of clouds, as seen through the rifts in the lower strata, move toward the southwest with seemingly as great velocity as the lower strata are moving toward the northeast.

"At times these storms will only reach a short way down the lake, and it seems as though the currents of air are moving in a circle, coming down from above and striking the surface of the lake, and then following it up until they encounter the influences of the land, hills, and woods at the head of the lake, and then turning and forming those currents that are seen through the lower strata of clouds moving toward the southwest.

"We have," Mr. Goodwin says, "a surer rule of forecasting these northeasters than by the barometer—that is, by the rise of the water in the lake. If the water first recedes, and then suddenly rises, look out for a heavy northeaster. But if it only rises, and *does not recede before* rising, the blow will be light."

We come now to examine the most important branch of our subject.

ORGANIZATION OF THE SIGNAL SERVICE.

It would be wanting in acknowledgment of great services which have been rendered to the whole country, and to science every where, not to mention the names of those who have been most directly engaged in establishing in the Signal Service Bureau a "Division of Telegrams and Reports for the Benefit of Commerce." Foremost in this work was the Hon. Halbert E. Paine, of Wisconsin, whose fine and cultivated intellect soon discovered the necessity for storm signals on the great lakes, and whose ability and commanding influence in Congress gave the proposition dignity and force. Warmly seconded by the Hon. Henry L. Dawes, of Massachusetts, the distinguished chairman of the Committee on Appropriations in the House of Representatives, in which he stands as one of the most able and conspicuous leaders, General Paine's advocacy secured an early adoption of the measure. The Hon. William W. Belknap, the Secretary of War, although from the first he intrusted the entire management of the service to the chief signal officer, has been the earnest and able supporter of the enterprise, which will always be an honor to his administration of the War Department.

It may be added that, without distinction of party, the whole people of the country, the press, both Houses of Congress, and the President have earnestly sustained and advanced this important branch of the public service.

The basis upon which all the operations of the Signal Service are conducted is that of *military precision and promptness*. This will be seen from the following circular:

WAR DEPARTMENT.

OFFICE OF THE CHIEF SIGNAL OFFICER.

Division of Telegrams and Reports for the Benefit of Commerce.

WASHINGTON, D. C., *August* 10, 1870.

[CIRCULAR.]

The following circular is published for the information of those desiring to enlist for appointment as non-commissioned officers in the army, for the duties of the "observation and report of storms, by telegraph and signal, for the benefit of commerce," under the late law of Congress and the authorization of the Secretary of War, and for such other duties as may be required in connection therewith.

Every candidate will be subjected to an examination, prior to enlistment, before a board appointed by the chief signal officer, which meets at this office, as may be convenient, and before which he must appear at his own expense. Testimonials as to good character and capacity, signed by persons known at this office, must be presented. The examination will be chiefly directed to accurate spelling, legible handwriting, proficiency in arithmetic (including decimal fractions), and the geography of the United States.

The United States is entitled to the whole time of the person enlisted; but the duties required are of such a nature that, with care and diligence, a good deal of time will be at the disposal of the persons employed, which may be devoted to reading or study, without detriment to the discharge of their duties. Thus time between the hours of reports can often be had for this purpose, and on frequent occasions when no active duty is pressing. A number of young men are already enlisted having such purposes in view. No employment of this nature can, however, be permitted to interfere, in any way, with that prompt and constant attention to duty which will be insisted upon.

Candidates, after successfully passing a physical and mental examination, will be enlisted in the general service of the United States, and will then receive the appointment of sergeant from the date of enlistment. If, however, after being under instruction, they fail to pass another examination, to be had before they will be put upon duty, they will be at once discharged.

Persons permanently relieved from duty for honorable reasons will be honorably discharged. The penalties for neglect of duty, bad conduct, etc., are dishonorable discharge, or such other punishment as a court-martial may direct.

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All the duties will be performed strictly under the discipline of martial law—all persons in the military service being subject to trial and punishment for improper conduct or neglect of duty under the rules and articles of war.

The duties will be chiefly those pertaining to the observation, record, and proper publication and report, at such times as may be required, of the state of the barometer, thermometer, hygrometer, and rain-gauge, or other instruments (instructions in the use of which instruments will be given by this office), and the report by telegraph or signal, at such times as indicated and to such places as may be designated by the chief signal officer, of the observations as made, or such other information as may be required—the telegraphic reports to be forwarded by the regular telegraphic operators, or in such manner as may be directed. The utmost precision will be required in observations and reports. The specification of these particular duties is not to exclude others connected therewith which may be necessary.

The object of this plan is to insure the correctness and regularity of reports by having them made under military control. It being desired to make this body of men especially select, rigid examinations will be insisted upon.

Married men are not enlisted, and only persons between the ages of twenty-one and forty years.

The *military system* is one of the most strikingly beautiful and valuable features in the constitution of this Signal Service for the benefit of commerce. The advantages of having the whole corps of weather observers *in the army* are manifest and manifold. Each observer feels the responsibility of a sentinel at his post, which begets in him a sentiment of devotion to duty the strongest of which men are capable, and which has often led the soldier to imitate the example of the Roman guard at Pompeii, who, after nearly eighteen centuries, was taken from its ruins in his martial position, showing that he had not fled before the molten flood from Vesuvius. Experience has proved, what the sense of the government originally suggested, that observations would be most punctually and scrupulously taken at the different stations by men accustomed to the discipline and obedience, even in minutest details, of army subalterns.

They are required to work out no difficult problems in meteorology, but simply to observe and record the indications of their instruments, and to transmit the same without delay or inaccuracy. In doing this work, they have become by tri-daily practice as expert and exact in reading the glasses as any of our veteran scientific men—indeed, as much so as a Fitzroy or a Leverrier could be.

Regarding the Signal Corps scattered through and over all parts of the country, we may compare it to a regiment on drill three times a day, the telegraph instantly revealing to the commanding officer, General Albert J. Myer, at Washington, the slightest failure in any observer.

By this now widely spread and magnificently organized system the United States army, engaged under the chief signal officer, is in time of *peace* undergoing a thorough training in the art of telegraphy and signaling, at the same time that it is passing through a most thorough discipline, is being educated to science, and also serving one of the most important ends ever devised for the benefit of commerce.

At Fort Whipple, Virginia, *every man is taught to use the telegraph, and to become a skillful operator*. He thus has a profession at all times lucrative to himself wherever he may be afterward thrown. The training, skill, and habits of exactness acquired by the Signal Corps in time of peace will be of the greatest value to the army in time of war. The telegraph is capable of indefinite utilization. General Von Moltke, it is well known, conducted the late operations of the German army on the battle-fields of France sitting in the rear with his map before him, and his telegraphic operator at his side, keeping him in communication with all parts of the field. It has been frequently said by distinguished military men that the telegraph will be one of the most effective weapons in any war that may now occur. How necessary for the government to keep up the efficiency of such a corps as that of which we have spoken!

Of its utility in time of war it is hardly necessary to say more than a word. These signals have been used in American military movements with great success, as in the famous movement of General Hood near Altoona, when by forced marches he found his way into General Sherman's rear, and seizing every road along which a courier could pass with the intelligence, was finally defeated by forces brought up by messages sent over the heads of his forces by the Signal Officer with General Sherman.

During the progress of war the force under General Myer would have a double office. They would communicate all the movements of the enemy and conduct the telegraphic business on the field and also in the rear; and that portion of the corps on duty at the signal station would keep up their weather reports, by which commanders would be informed of how their movements would be likely to be retarded by storms and rains, by heavy roads, by detentions of their supply-trains, by snow-drifts on their railroad communications, and by fatal floods in the rivers in their rear, and other weather phenomena affecting the very existence of their commands.

As the organization under General Myer now exists, the President and Secretary of War have a responsible military man at every important post in the country. If a warlike expedition appears on any part of our coast, causing a panic or stampede, there may be a thousand wild rumors of frightened message-senders. The government, however, is in the receipt every eight hours (and can be in the receipt every hour if it wishes) of a reliable message from its own agent, who reports on his responsibility what he saw and knows to be true; and this observer will not leave his post until ordered to do so. As a mere government police, therefore, the Signal Corps would be worth to the nation far more than it can ever cost, even if its operations should be more widely extended, as will speedily be done.

Each sergeant is sent to the Signal Service school of instruction at Fort Whipple, Virginia, where he is immediately supplied with Loomis's "Text-Book of Meteorology," Buchan's

"Hand-Book of Meteorology," Pope's "Practical Telegraphy," and the "Manual of Signals for the United States Army," together with all the instruments necessary for practical instruction. The books he must thoroughly master. He is required to recite once daily didactically, and to practice a certain time with the instruments. He is required to remain under tuition until considered by the instructor competent to take charge of a station and perform the necessary duties, when he is ordered before a board, consisting of three army officers, for examination, when, if considered incompetent, he is returned to Fort Whipple for further instruction and practice.

If, after a rigid examination, he is found capable, he is assigned to a station, and the necessary stationery and instruments furnished him (the latter consisting of the barometer, thermometer, hygrometer, anemoscope, anemometer, and rain-gauge), and instructions to make three observations daily, viz., at the time corresponding with 7.35 A.M., 4.35 P.M., and 11.35 P.M., *Washington time*, so that every observer at each station should be reading his instruments at the same moment, and in the following order, viz., 1st, barometer; 2d, thermometer; 3d, hygrometer; 4th, anemoscope; 5th, anemometer; and 6th, rain-gauge.

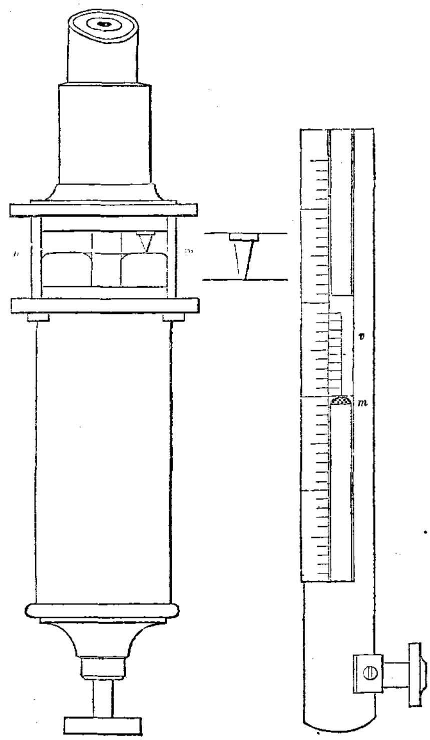
THE SIGNAL SERVICE STAFF.

General Myer is assisted by a staff of able and experienced officers, and by a corps of sixty-five observer-sergeants.

The Board of Preliminary Examination is composed of Brevet Lieutenant-Colonel Garrick Mallery, Captain First Infantry, U.S.A., and Brevet Captain H. W. Howgate, Second Lieutenant Twentieth Infantry. This board had examined previous to March 1 about one hundred and thirty applicants for appointment as observer-sergeants, of whom seventy-nine were recommended and assigned to instruction or other duty; most of those failing in examinations were deficient in the knowledge of decimal fractions and the geography of the United States.

The Board of Final Examination is composed of Brevet Lieutenant-Colonel Garrick Mallery, Captain First Infantry; Second Lieutenant Allyn Capron, First Artillery; Brevet Captain Henry W. Howgate, Second Lieutenant Twentieth Infantry. Of the seventy-nine observer-sergeants appointed before March 1 there were discharged for unfitness in final examination or for misconduct, four; reduced to the ranks for misconduct, two; discharged for unfitness after passing final examination, one; discharged for physical disability, two; discharged for failure to pass final examination, five—leaving sixty-five as the total number now composing the corps.

In addition to the duties discharged by the officers of the Examining Board, Colonel Mallery, A.S.O., has the general charge of the very large correspondence of the office; Captain Howgate has charge of the statistics and all observations of the service; and Lieutenant Capron has the difficult post of instructor of sergeants at Fort Whipple.



SECTIONS OF GREEN'S STANDARD BAROMETER.

Where a single person has been required to do the work of a station, receiving full reports from all stations, the labor occupied twenty hours out of the twenty-four. But the rule now adopted is to provide each station with two men—one a sergeant in charge and the other a private soldier as assistant. The observer stationed on Mount Washington has been alone on the mountain most of the time, and always responsible for the work.

Besides the officers already named as composing the Board of Examination, General Myer is also ably assisted by Major L. B. Norton, the property and disbursing officer of the Signal Service.

Professor Cleveland Abbé, long known as an officer of the Cincinnati Observatory, and as an eminent meteorologist, is employed chiefly in the work of making out the daily synopsis of the weather, and deducing therefrom the weather "probabilities," which are given to the public by telegram through all newspapers desirous of furnishing them to their readers.

To the conspicuous ability of all of these officers is attributable the success of the enterprise.

"THE GLASSES."

If the invention of the mariner's compass enabled navigators, as Columbus and Magellan, to leave the close seas and shores of the mainland, and strike their way across the great oceans in search of new continents, it is beyond dispute that (to use the words of a distinguished meteorologist) "the invention of the barometer has opened up a new world." Perhaps nothing has been so much in the way of meteorologic success as poor and unreliable instruments. To obviate this difficulty, numerous eminent laborers have made both common and self-registering instruments the study and experiment of a lifetime. The common barometer has undergone many and vast improvements within a few years, so that an old seaman like Lord Nelson would now hardly know a first-class Adie's or Green's barometer.

The ordinary barometer in use by Signal Office observers is that of Mr. James Green (the well-known scientific instrument maker of New York)—an instrument adopted by the Smithsonian Institution, and also by the American navy, as the most perfect to be obtained.

This barometer has its cistern furnished with a small glass index, which shows when the mercury is at the right height in the cistern. This is adjustable by a screw which works through the bottom of the instrument against the flexible bottom of the cistern. The instrument is ready for use when the mercury touches the little V-shaped index in the cistern. So simple and complete is this barometer that any one can use it, and it ought to be in the hands of all business gentlemen, and all who are interested in watching the mutations of weather.

In reading the barometer a *vernier* is used. The vernier (Figs. 1 and 2) consists of a piece similar to the scale of the barometer, and along which it slides. It will be seen from Fig. 1 that ten divisions of the vernier are exactly equal to eleven divisions of the scale; that is, to eleven-tenths of an inch. Each division of the vernier is, therefore, equal to a tenth of an inch, together with the tenth of a tenth, or a hundredth, *i. e.*, to ten hundredths and one hundredth, or 0.11 of an inch. Similarly, two divisions of the vernier are equal to 0.22 inch, three to 0.33 inch. If the vernier and scale occupy the relative positions as in Fig. 1, then the barometer reads 30.00 inches. But if they stand as in Fig. 2, we read thus: (1) The zero of the vernier being between 29 and 30, the reading exceeds 29 inches, but less than 30 inches. Hence the first figure is 29 inches. (2) Counting the tenths of an inch from 29 upward, we find the vernier indicates more than 7-10ths and less than 8-10ths, giving the second figure, 7-10ths. Casting the eye down the scale to see the point at which a division of the scale and one of the vernier meet in one and the same straight line, we find it at the figure 6—the last figure. And we read the barometer 29.76.

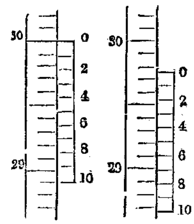


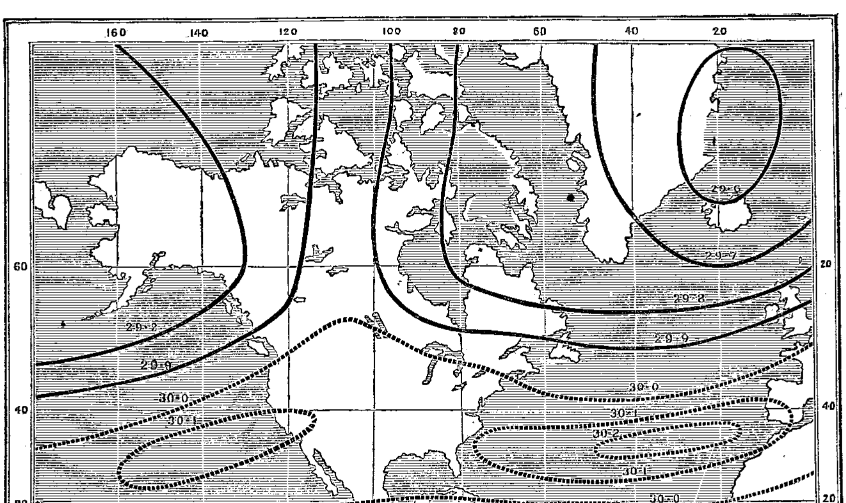
Fig. 1. Fig. 2.
FOR READING BY VERNIER.

By this simple mechanical contrivance the barometer is read to so fine a degree *that the variation of* 1-100*th of an inch in the mercurial column is detected!*

BAROMETRIC OSCILLATIONS.

Latitude and longitude on the earth's surface mark very conspicuous differences in the mean barometric pressure, as will be seen by a study of the Isobarometric Chart for the United States.

The barometer has a slight fluctuation also under several influences. It rises when the moon is on the meridian in some places. It has a diurnal oscillation, amounting on the



MEAN ANNUAL ISOBAROMETRIC LINES FOR THE UNITED STATES.

equator to more than one-tenth of an inch, but in the latitude of New York to only 0.05 inch, the greatest height being about 10 A.M., and the least about 4 P.M. The nocturnal variations are much less. In the latitude of Philadelphia and New York the northeast wind causes another variation of one-fourth of an inch, due to the meeting of two atmospheric waves giving a still higher wave, and hence a higher barometer. There is also the variation due to the height of the observer's station above the sea. This is, of course, of the first importance. The other fluctuations are comparatively unimportant, and do not blind an observer to those ominous fluctuations which precede the storm, the tornado, and the hurricane. The oscillations which indicate a storm are very marked. The tornado which recently ravaged St. Louis was preceded by a gradual fall of the mercury in the barometer, for thirty hours previous, of an entire inch. At Boston, within thirty-seven years, the barometer has ranged from 31.125 inches to 28.47 inches, the difference being 2.655 inches. At London it has ranged through more than 3.5 inches; but in the tropics not so much.

During the passage of a cyclone the mercury oscillates rapidly. The most noticeable fall occurs from four to six hours before the passage of the storm centre. This fall is often over an inch, and sometimes two inches.

Great changes are *usually* shown by falls of barometer exceeding half an inch, and by differences of temperature exceeding fifteen degrees. If the fall equals one-tenth of an inch an hour we may look out for a heavy storm. The more sudden the change the greater the danger. *But it is too often forgotten that the fall of the mercury is a forewarning of what will occur in a day or two*, rather than in a few hours.

A variation of an inch is certain to be followed by a tornado or violent cyclone. In the tropics "the glass" has been known to show a fall of more than an inch and a half in one hour!

The following guides in predicting weather changes are selected from the "Barometer Manual" of the London Board of Trade, and are suggestive:

I. If the mercury standing at thirty inches rise gradually while the thermometer falls, and dampness becomes less, N.W., N., or N.E. wind; less wind or less snow and rain may be expected.

II. If a fall take place with a rising thermometer and increasing dampness, wind and rain may be expected from S.E., S., or S.W.; a fall in winter with a low thermometer foretells snow.

III. An impending N. wind before which the barometer often rises may be accompanied with rain, hail, or snow, and so forms an apparent exception to the above rules, for the barometer always rises with a north wind.

IV. The barometer being at 29½ inches, a rise foretells less wind or a change of it northward, or less wet. But if at 29 inches a fast first rise precedes strong winds or squalls from N.W., N., or N.E., after which a gradual rise with falling thermometer, a S. or S.W. wind will follow, especially if the rise of the barometer has been sudden.

V. A rapid barometric rise indicates unsettled, and a rapid fall stormy weather with rain or snow; while a steady barometer, with dryness, indicates continued fine weather.

VI. The greatest barometric depressions indicate gales from S.E., S., or S.W.; the greatest elevations foretell wind from N.W., N., or N.E., or calm weather.

VII. A sudden fall of the barometer, with a westerly wind, is sometimes followed with a violent storm from the N.W., N., or N.E.

VIII. If the wind veer to the S. during a gale from the E. to S.E., the barometer will continue to fall until the wind is near a marked change, when a lull may occur. The gale may afterward be renewed, perhaps suddenly and violently; and if the wind then veer to the N.W., N., or N.E., the barometer will rise and the thermometer fall.

IX. The maximum height of the barometer occurs during a northeast wind, and the minimum during one from the southwest; hence these points may be considered the poles of the wind. The range between these two heights depends on the direction of the wind, which causes, on an average, a change of half an inch; on the moisture of the air, which produces in extreme cases a change of half an inch; and on the strength of the wind, which may influence the barometer to the extent of two inches. These causes, separately or conjointly with the temperature, produce either steady or rapid barometric variations, according to their force.

SELF-REGISTERING INSTRUMENTS.

But invaluable as is the ordinary barometer which has been described, the most valuable instruments are those which are automatic, or self-registering. Prominent among these are the celebrated self-recording barometer and the meteorograph invented by Professor G. W. Hough, Superintendent of the Dudley Observatory at Albany. Lord Rosse's telescope has not done more for astronomy than will the self-registering barometer do for meteorology.

Through the great kindness of Professor Hough, in sending me wood-cuts of his beautiful inventions, I am enabled to present these simple yet complete and consummate contrivances.

The diagram, Fig. 1, page 410, will illustrate the method of registering the height of the barometer and thermometer on a single sheet by the use of one set of mechanism:

Let D be a drum 6 inches in diameter and 7 inches in height, covered with a sheet of ruled paper. This drum is presumed to revolve at any convenient rate, say 1 inch per day. Let L be an iron or brass bar 24 inches in length, mounted on an axis passing through the point *c*. Let P be a steel pen attached to the end of the lever projecting over the centre of the drum. Let P′ and P″ be platinum wires attached to the lever at 3 inches on either side of the axis *c*. The wire P′ is over the shorter leg of a siphon barometer, and the wire P″ passes into the end of an open mercury thermometer.

Now if the lever L be elevated at the end over the drum, the wire P′ will touch the top of a float resting in the shorter leg of the siphon barometer. If then a battery, B, and electro-magnet, E, be arranged as in the diagram, when contact is made with the float a current of electricity will pass through the circuit, and the electro-magnet E is operated. If then, when the circuit is completed, a blow be struck on the pen P, by means of the electro-magnet, or a hammer unlocked by it, the dot on the drum sheet will indicate the height of the barometer at that time. It is obvious that as often as the lever is elevated a record will be made. For the barometer an hourly record will be found to be sufficient.

If the lever L is rigid and firmly mounted, the mere

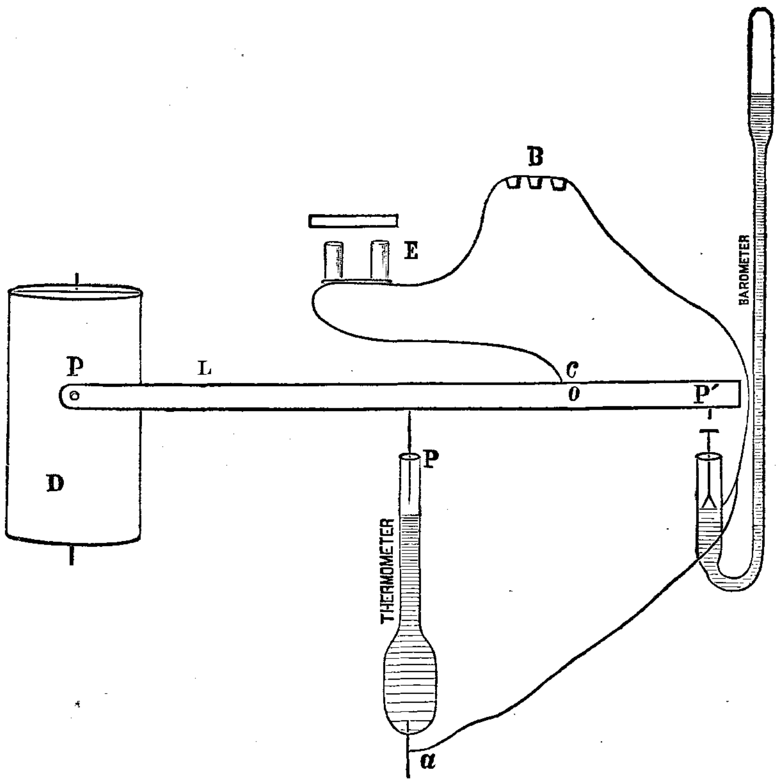


Fig. 1.—REGISTRATION OF THE HEIGHT OF BAROMETER AND THERMOMETER.

measurement of height by means of electrical contact can be carried to almost any degree of precision.

It was found from numerous experiments made some years since that the magnetic circuit is not completed for a distance of one-ten-thousandth of an inch. Therefore, whatever source of error there may be in the results recorded by this method is due to the barometer itself. In practice, from records extending over nearly one year, it is found that the results are inside the errors of reading from the drum sheet.

A long experience has led to the conclusion that this degree of precision is sufficient for the investigation of barometric changes, and is but little outside the limit of error from reading a standard barometer.

An examination of the diagram will also show at a glance how the height of the thermometer is recorded. It should, however, previously be stated that the thermometer is a little larger than those in ordinary use, and has a platinum wire, *a*, cemented in the bulb, communicating with the mercury in the inside.

DESCRIPTION OF A NEW METEOROGRAPH. (WEATHER RECORDER.)

The following is a general description of a machine constructed for the Signal Service at the request of the chief signal officer.

It registers hourly the barometer and wet and dry bulb thermometers, and thus shows the atmospheric pressure, the temperature of the atmosphere, and its hygrometric condition—*i. e.*, its condition of moisture or dryness.

The engraving, Fig. 2, page 411, is a perspective view of this instrument. The recording lever, A, is a bar of iron about two feet in length, nearly balanced on the axis, supported by the clock-frame, C. The clock is constructed with rather stronger gearing than an ordinary movement, its office being to elevate and depress the lever A hourly, regulate the drum, D, and raise the two striking hammers, H and H′. It is provided with a half-second pendulum, and requires winding once in two days, the weight dropping in that time about three feet.

The shorter leg of the siphon barometer is shown at B, and the wet and dry bulb thermometers at T′ and T. Directly over the leg of the siphon, as also over the two thermometers, the lever A supports a carriage, which is depressed or elevated whenever the lever A is in motion. The registering point, G, is connected with the lever, as shown in the diagram; and the curvilinear motion of the end of the lever is converted into rectilinear by allowing G to slide against a vertical steel rod.

To illustrate the action of the machine, we will suppose the lever A has reached its low-

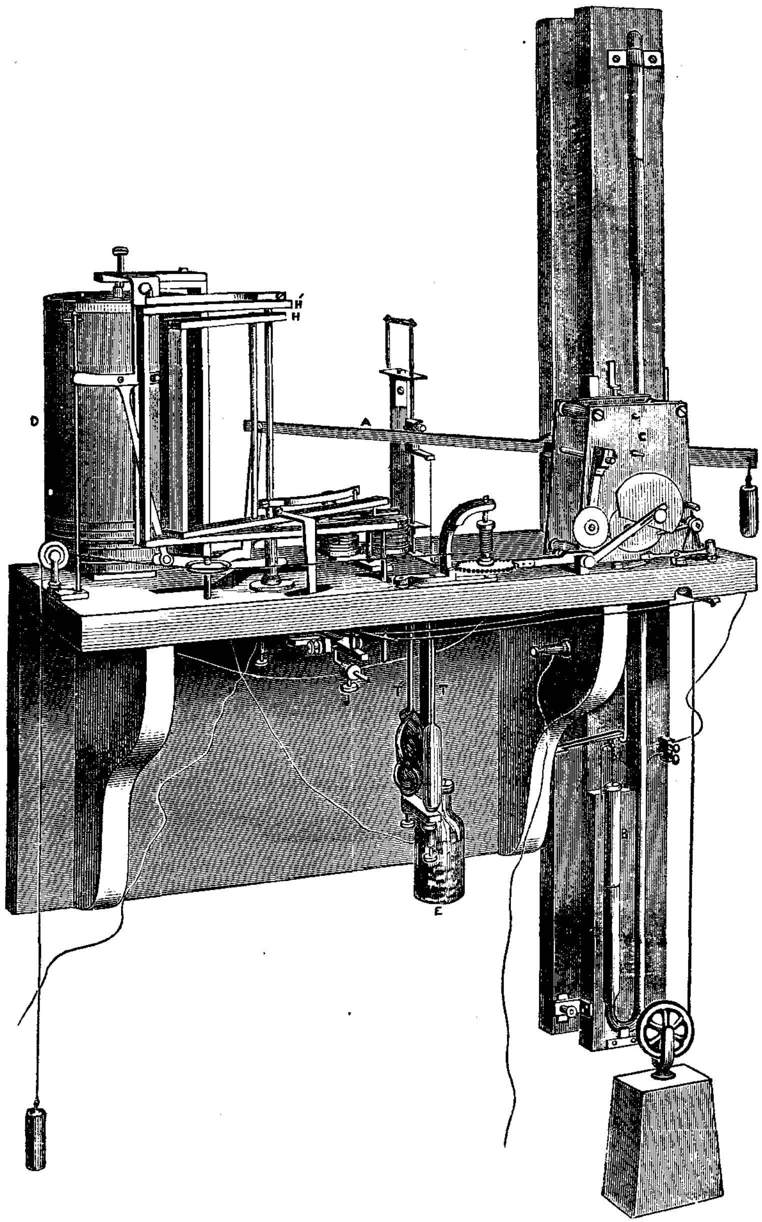
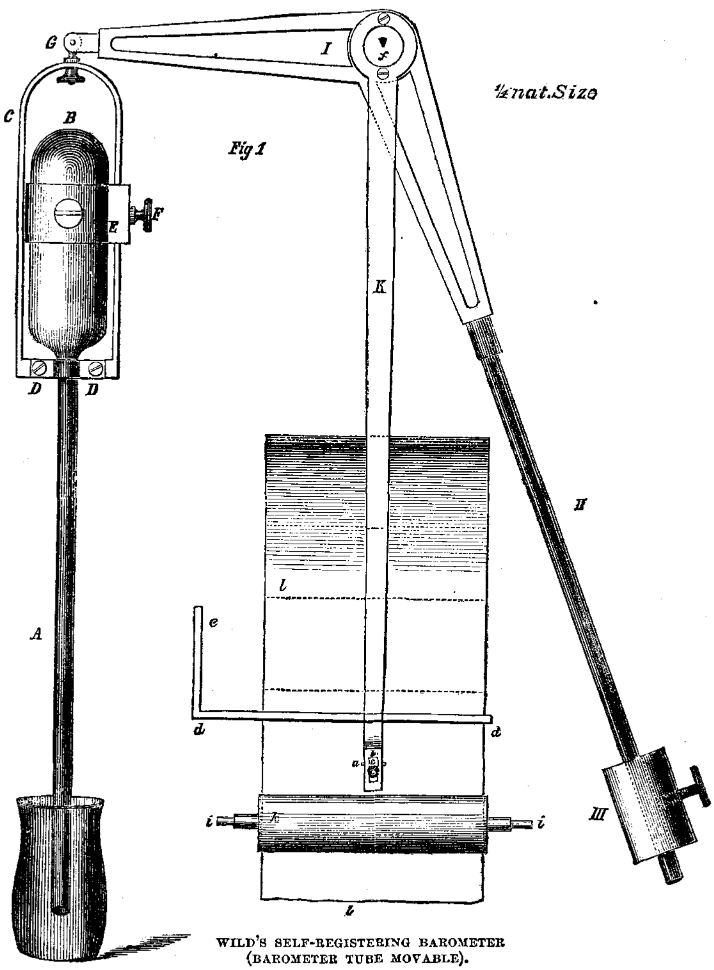


Fig. 2.—THE METEOROGRAPH.

est point, the registering pen G being at the bottom of the drum. Now, in order that we may be able to register the barometer on any part of the drum sheet, it is necessary that the striking hammer should be elevated and locked before the upward motion of the lever commences. As the hammers are raised by means of an arm carried by the hour shaft of the clock, at the point where the hammers begin to rise the snail for elevating the lever A is cut away, so that it remains at rest during a period of fifteen minutes, the time required for elevating the hammers H and H′. As soon as this is accomplished the lever begins to rise slowly, by means of the double snail on the hour shaft, the time required for traversing the drum being about fifteen minutes. When the position of the lever is such that the carriage in the rear of the clock touches the float in the shorter leg of the siphon, an electric current is



WILD'S SELF-REGISTERING BAROMETER (BAROMETER TUBE MOVABLE).

established through the magnet, F, which unlocks the hammer H, causing the pen G to make a record on the drum sheet. After the lever has reached the top of the drum it remains at rest fifteen minutes, while the hammers are being raised, when it is gradually depressed. So soon as the platinum wires—attached to the carriage over the thermometers—touch the surface of the mercury in the thermometer tubes, electric currents are established through the magnets F and J, simultaneously or successively unlocking the hammers, and, as the case may be, making records as before.

A complete double motion of the lever requires one hour. During this time the barometer and wet and dry bulb thermometers have each been recorded once. The records of the barometer and thermometers differ in time about half an hour. The wet and dry bulb thermometers are recorded within about one minute of each other, depending on the difference between them.

One of the most marked and wonderful features of the invention of Professor Hough is that *it prints its own records.* And this is done by a single screw, which rises or falls with the mercury in the barometer. This screw carries a pencil, which traces upon a revolving cylinder or roll of paper a line showing the minutest movements of the column of mercury for every minute in twenty-four hours. *This same screw also gives motion to a series of wheels which carry types, by which, at the end of every hour, the height of the column of mercury is printed on a slip of paper to the accuracy of* THE THOUSANDTH PART OF AN INCH!

One of the most beautiful and simple contrivances used is a *Wild's self-registering barometer,* of which we give a cut one-quarter the actual size. It scarcely needs explanation except to say that the tube, *A*, is suspended in a cistern of mercury, represented on the left of Fig. 1. As the atmospheric pressure changes, the level of the mercury changes in the cistern, and the tube *A* rises or falls as the atmospheric pressure increases or diminishes. The weight of this

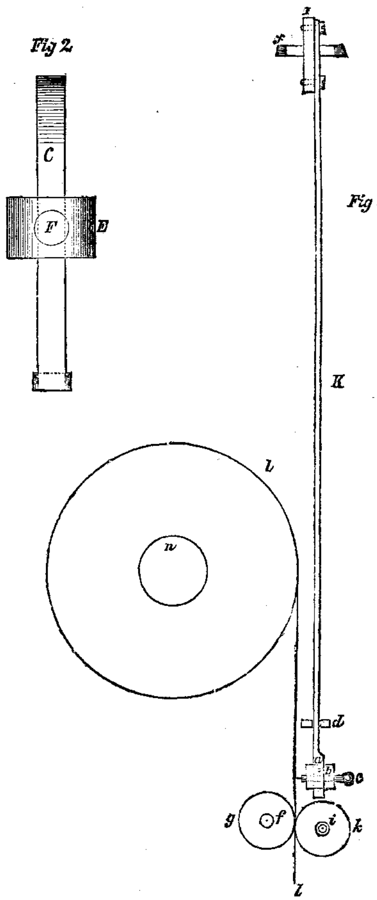


Fig 2

Fig 3

WILD'S SELF-REGISTERING BAROMETER (BAROMETER TUBE MOVABLE).

tube as it floats in the mercury, and also that of the arm, *I*, which supports it at *G*, is exactly balanced by the arm, *II*, to which is attached a sliding weight, *III*, adjustable by a small thumb-screw. *K* is a steel crayon-holder fixed to the balance *I II*, and to which is fixed a crayon, *c*, whose point is seen in Fig. 3 to impinge upon a sheet of paper, *l l*. This sheet is moved by clock-work. When the atmospheric pressure is increased, the tube *A* is forced to rise a little out of the mercury in which it floats, and as it rises at *G* the arm *I* is elevated. The crayon-holder, being fixed on the balance at the fulcrum, *f*, by two little screws, swings a little to the left, and the crayon which it carries with it makes a mark on the paper beneath it, which mark indicates the rise of the barometer, or the increase of atmospheric pressure. If the pressure decreases, the pencil, of course, moves in the opposite direction, and shows the barometric fall. The roll of paper on which the record is made by this automatic instrument is divided into rectangular parts, each one of which exhibits the atmospheric variations for twenty-four hours. At the end of every day this part of the roll is detached and put by to be bound up in book form in the records of the office in which the instrument is kept.

The roll of paper is on a reel, *n*, passing between two rollers, *g* and *k*, as seen in Fig. 3.

By these perfectly simple devices, instead of obtaining only three daily recorded observations, the observer at every station gets a *continuous* and perpetual record for every second in the day. That is to say, instead of getting, as by the common barometer (observed three times a day), observations for three seconds in twenty-four hours, he gets them for as many seconds as there are in twenty-four hours, or 86,400. Thus it follows that the value of the self-registering barometer, as compared with the ordinary one, is as 86,400 to 3!

The marvelous accuracy and exquisite nicety with which all the observations forwarded to General Myer by the observers are marked ought to assure the public that nothing is wanting to give reliability to the published results and the "probabilities" issued from his offices. A self-registering barometer, as well as other instruments of equal sensitiveness, will be used by all the observer-sergeants. It is scarcely possible for this invaluable instrument to suffer derangement or to get out of order.

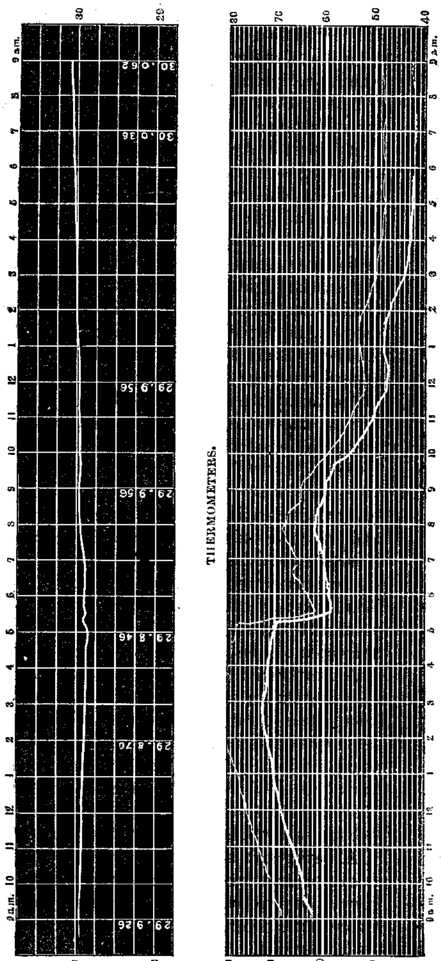
A third most beautiful and sensitive self-registering instrument is that of Mr. Peelor, of Johnstown, Pennsylvania, used with great success and satisfaction by the Signal Service. This needs no battery, no electricity, to work it. A simple clock-work is all that is required, and its operations are as exquisitely accurate and trustworthy as the best navy chronometer.

A barograph and thermograph made by Mr. Beck, of London, similar to those used in the Kew Observatory, are on trial in the Signal Office, and good results are hoped from them. Their beautiful machinery might also be mentioned and described, but our space fails. Indeed, our limits have allowed mention to be made only of the most novel instruments employed by the signal offices. A specimen record of one of these is presented on page 414, showing the synchronous readings, on a given day and at a given place, of the thermometers (wet and dry bulb), the hygrometer, and the barometer, all upon one sheet of paper.

We have already spoken of the beautiful adaptation of Professor Hough's meteorograph to the work of *printing* its own registrations. The mechanics of meteorology have been advanced one step higher than this, and the registrations of the automaton are instantly and perfectly *photographed*. The sheet of paper, suitably prepared for photographic impressions, is made to slide, by means of clock-work, before a gas flame. The mercury in the tubes protects a portion of the paper from the action of the light of the lamp, while above the mercury the rays of the lamp fall unobstructed upon the paper, and, making their impression, reveal the exact height of the mercury in the tubes.

SPECIMEN RECORD.

BAROMETER. THERMOMETERS.



DRAPER'S PHOTOGRAPHIC REGISTER OF BAROMETER AND THERMOMETERS AT NEW YORK, APRIL 28, 1870.

(The upper line of the Thermometers is the Dry Bulb, the lower line is the Wet Bulb.)

The "photograph of a storm," page 415, shows the movements of the mercury in the two thermometers and barometer for twelve hours.

This process, by which the *weather is photographed,* is employed by General Myer, and these necessarily exact records will prove most attractive pictorial representations of the great storms in the atmospheric ocean for the study of meteorologists all over the world.

PRESENT OPERATIONS OF THE SERVICE.

Although the Signal Service is yet in its infancy, and must be patiently nursed and cherished by the people for some years before it can expect to do and discharge its full mission. Under General Myer's indefatigable care and skillful management it has already achieved much good, and more than compensated the public for the expense of its establishment. Since it was instituted last summer "the chief signal officer has," to quote the words of the New York *World,* "thoroughly organized and equipped a system which now embraces in its scientific grasp every part of the land from Sandy Hook to the Golden Gate of California, and from Key West to the Dominion of Canada."

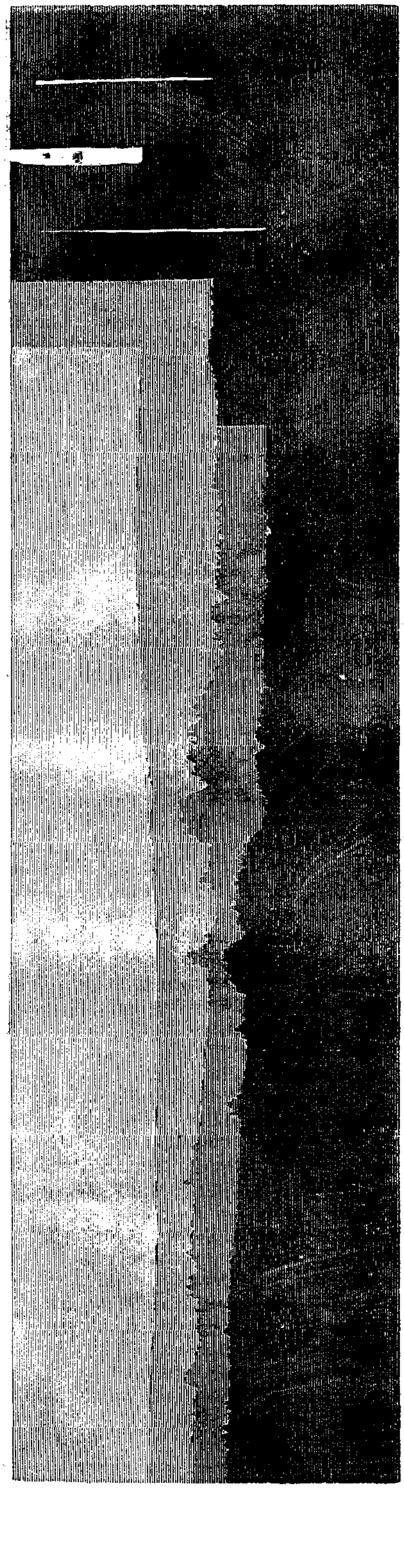
Three times every day synchronous observations are taken and reports made from the stations—one at 8 A.M., one at 4 P.M., and the third at midnight. These observations are made by instruments all of which are perfectly adjusted to a standard at Washington. They are also all taken at the same moment exactly, these observations and reports being also timed by the standard of Washington time. The reports from the stations are transmitted in full by telegraph. By a combination of telegraphic circuits, the reports of observations made at different points synchronously are rapidly transmitted to the different cities at which they are to be published. They are, however, all sent of course to the central office in Washington. These reports are limited to a fixed number of words, and the time of their transmission is also a fixed number of seconds. These reports are not telegraphed in figures, but *in words fully spelled out.* There are now about forty-five stations for which provision has been made, and which are in running order. These have been chosen or located at points from which reports of observations will be most useful as indicating the general barometric pressure, or the approach and force of storms, and from which storm warnings, as the atmospheric indications arise, may be forwarded with greatest dispatch to imperiled ports.

These stations are occupied by expert observers furnished with the best attainable instruments, which are every day becoming more perfect, and to which other instruments are being added.

The reports of observers are as yet limited to a simple statement of the readings of all their instruments, and of any meteorological facts existing at the station when their tri-daily report is telegraphed to the central office in Washington.

Each observer at the station writes his report on *manifold* paper.* One copy he preserves, another he gives to the telegraph operator, who telegraphs the contents to Washington. The preserved copy is a voucher for the report actually sent by the observer; and if the operator is careless and makes a mistake, he can not lay the blame on the observer, who has a copy of

* Thin paper with black carbon paper between the sheets. The pen is a dry *stylus,* and being pressed on the upper sheet, it makes a similar mark on the sheets beneath it.



PHOTOGRAPH OF A STORM.—(*Print from Photographic Register from Noon, December 13, 1870, ½ Inch per Hour.*)

his report, which must be a fac-simile of the one he has handed to the operator. The preserved copy is afterward forwarded by the observer-sergeant to the office in Washington, where it is filed, and finally bound up in a volume for future reference.

When all the reports from the various stations have been received they are tabulated and handed to the officer (Professor Abbé) whose duty it is to write out the synopses and deduce the "probabilities," which in a few minutes are to be telegraphed to the press all over the country.

This is a work of thirty minutes. The bulletin of "probabilities," which at present is all that is undertaken, is made out thrice daily, in the forenoon, afternoon, and after the midnight reports have been received, inspected, and studied out by the accomplished gentleman and able meteorologist who is at the head of this work.

The "probabilites" of the weather for the ensuing day, so soon as written out by the Professor, are immediately telegraphed to all newspapers in the country which are willing to publish them for the benefit of their readers.

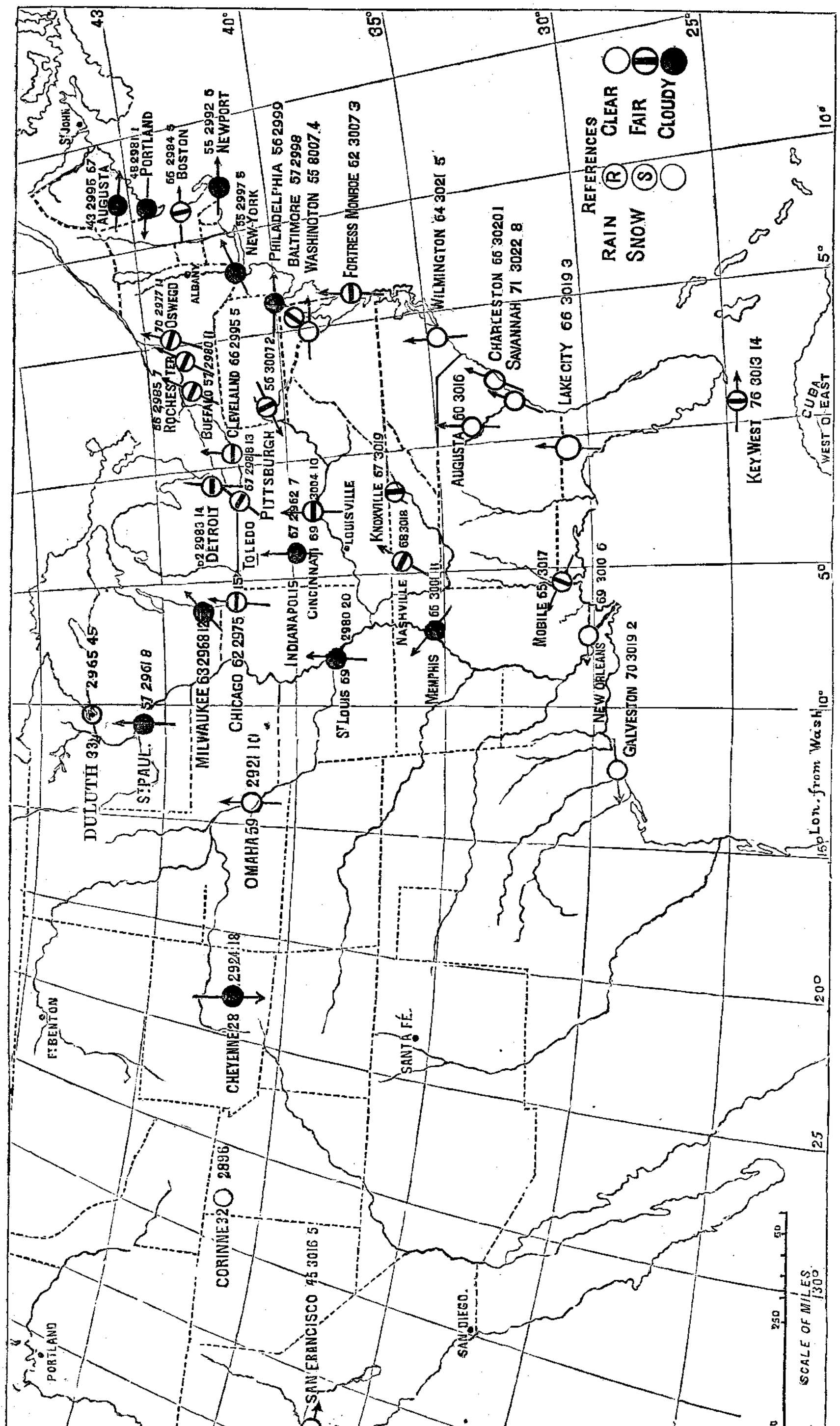
Copies of the telegrams of "probabilities" are also instantly sent to all boards of trade, chambers of commerce, merchants' exchanges, scientific societies, etc., and to conspicuous places, especially sea-ports, all over the country.

While the Professor is preparing his bulletins from the reports just furnished him by telegraph the sergeants are preparing maps which shall show by arrows and numbers exactly what was the meteorologic condition of the whole country when the last reports were sent in. These maps are printed in quantities, and give all the signal stations. A dozen copies are laid on the table with sheets of *carbon* paper between them, and arrow stamps strike in them (by the manifold process) the direction of the wind at each station. The other observations as to temperature, barometric pressure, etc., etc., are also in the same way put on them.

These maps are displayed at various conspicuous points in Washington—*e. g.*, at the War Department, Capitol, Observatory, Smithsonian Institution, and office of the chief signal officer. They serve also as perfect records of the weather for the day and hour indicated on them, and are bound up in a book for future use.

Every report and paper that reaches the Signal Office is carefully preserved on file, so that at the end of each year the office possesses a complete history of the meteorology of every day in the year, or nearly 50,000 observations, besides the countless and continuous records from all of its self-registering instruments.

When important storms are moving, observers send extra telegrams, which are dispatched, received, acted upon, filed, etc., precisely as are the tri-daily reports. One invaluable feature of the system as now organized by General Myer is that the phenomena of any particular storm are not studied some days or weeks after the occurrence, but while the subject is fresh



WAR DEPARTMENT WEATHER-MAP (SIGNAL SERVICE, U.S.A.), SATURDAY, APRIL 8, 1871, 7.35 A.M., WASHINGTON.
The Numerals denote: 1st, The State of the Thermometer; 2d, That of the Barometer; and 3d, The Force of the Wind.

in mind. To the study of every such storm, and of all the "probabilities" issued from the office, the chief signal officer gives his personal and unremitting attention. As the observations are made at so many stations, and forwarded every eight hours, or oftener, by special telegram from all quarters of the country, the movements and behavior of every decided storm can be precisely noted; and the terrible meteor can be tracked and "raced down" in a very few hours or minutes. A beautiful instance of this occurred on the 22d of February last, just after the great storm which had fallen upon San Francisco. While it was still revolving around that city, its probable arrival at Corinne, Utah, was telegraphed there, and also at Cheyenne. Thousands of miles from its roar, the officers at the Signal Office in Washington indicated its track, velocity, and force. In twenty-four hours, as they had forewarned Cheyenne and Omaha, it reached those cities. Chicago was warned twenty hours or more before it came. Its arrival there was with great violence, unroofing houses and causing much destruction. Its course was telegraphed to Cleveland and Buffalo, which, a day afterward, it duly visited. The president of the Pacific Railroad has not more perfectly under his eye and control the train that left San Francisco to-day than General Myer had the storm just described.

While the observers now in the field are perfecting themselves in their work, the chief signal officer is training other sergeants at the camp of instruction (Fort Whipple, Virginia), who will go forth hereafter as valued auxiliaries. It has been fully demonstrated by the signal officer that the army of the United States is the best medium through which to conduct most efficiently and economically the operations of the Storm Signal Service. Through the army organization the vast system of telegraphy for meteorological purposes can be, and is now being, most successfully handled. "Whatever else General Myer has not done," says the New York *World*, "he has demonstrated that there can be, and now is, a perfect net-work of telegraphic communication extending over the whole country, working in perfect order, by the signal-men, and capable of furnishing almost instantaneous messages from every point to the central office at Washington. Think of a single jump by wire from San Francisco 2700 miles eastward three times a day! When General Myer undertook to put this system in working order, the telegraph companies said it was impossible—no such thing had ever been heard of in telegraphing. It is now a grand *fait accompli*, as much as the passing of the Suez Canal by ships or the escaping from Paris by balloons."*

At present the signal officer aims only to give a synopsis of each day's weather, and a statement of what weather may be expected or *will probably occur*. The "probabilities" so far have been most beautifully verified and confirmed.

It is not thought wise to undertake more than can be securely accomplished. The synopses and "probabilities" are all that intelligent shippers and careful seamen require. Shippers will not send their vessels to sea if the weather synopsis indicates threatening or alarming weather.

Travelers can consult the "probabilities" before leaving home; and any severe storm that menaces any city or port is now specially telegraphed thither, and the announcement is made by bulletins posted in the most public places.

By the modest estimate of the signal officers, the following is a table showing percentage of "probabilities" that have been verified.

Fully verified	50 per cent.
Verified in part	25 " "
Failed	25 " "

It must, however, be borne in mind that the failures have often been due to lack of information from points where as yet no observer-sergeant is stationed.

FUTURE AIMS.

The Signal Service has, up to this time, acted upon the wise maxim of "making haste slowly," and undertaking to do nothing which was not in its power to do safely and securely, without risk of failure. It has acted upon the confidence it has in the people that they will patiently await the development of solid science, meantime leaving no stone unturned to hasten forward the observations which may lead to a more exact acquaintance with the habits, movements, and tracks of our American storms. Great progress has in a very short time been made in this knowledge, and every day new light is dawning upon the science of storms.

The instruments of the service have been bought on trial. They are undergoing the most varied experiments. In a short time, it is hoped, they will be greatly improved and perfected, and then the chief signal officer's results will be more satisfactory to himself, and his labors will be greatly facilitated. The celerity with which important results have already been attained by this officer has surprised and startled both himself and the friends of the great movement.

As soon as possible, therefore, the Signal Office will have its signal posts along the lakes and on our Atlantic sea-board, where cautionary signals will be displayed, warning vessels of approaching gales and storms, and also a signal for clear weather. These will be displayed by day and by night, by a very simple and suitable contrivance now being perfected by General Myer. In New York already arrangements have been made for displaying the signals to shipping in the harbor from a lofty structure on the roof of the Equitable Life Insurance Company's office, the best station that could be chosen. The display of these *storm*

* New York *World*, March 5, 1871.

signals proper will place the American Signal Bureau at once in a position to render inestimable service to shipping and all commercial interests.

These signals will at first be neglected by ruder and more unskillful seamen and shippers; but, as in the case of the famous Fitzroy signals on the English coast, every week will add new demonstrations of the value and utility of this system—one of the most splendid gifts bequeathed by modern science to the human race.

The signaling of storms and desolating cyclones to the unsuspecting seaman will, it is believed, mark a new era in our lake and coast navigation, and be the means of annually saving many lives and millions of dollars' worth of our floating property.

The comparison of these signals with the weather following the signals will be then a matter of special attention. Every discrepancy can then be carefully noted and probed, and every day the meteorologists in charge of the "probabilities" will find the means of rectifying any errors they may have fallen into, and daily increasing the accuracy and perfecting the plan of their forecasts.

The storm signals will be displayed at any hour of the day or night when the instrumental indications give notice of bad weather; and experience has already shown that generally at least twenty-four hours' forewarning can be given from the central office in Washington of all important weather phenomena. With the telegraph to premonish, forecasts for two or three days in advance are hazardous and unnecessary. For almost all practical purposes of life a day's notice of atmospheric disturbances is quite sufficient, and more reliable than longer premonitions. It will be a grand triumph for American science when the electric telegraph—an American invention—is so utilized that it will bring all citizens of the United States into electric communication with each other, and the most fearful storm, as well as the sunshine and shower, shall be every day a subject of forewarning or gratulation throughout the land, and even on the lakes and oceans that wash the American coasts.

MISS LANGTON'S PORTRAIT.

ST. ETIENNE is a little bathing establishment somewhere—not to be prosily exact—on the French coast. I say a bathing establishment, because it is this which really makes the place of any account; this, and not the small village with its château overlooking it, which constitutes St. Etienne proper. In the good old feudal days, when the lords of the soil took, as a matter of course, that unlimited license so sadly curtailed by the narrowing spirit of later times, there had been gay doings in that same château. The race of St. Etienne de Forsanz had always been used to grind the faces of their dependents with a charming indifference as to results. They had slept soft and lived well, however it might fare with those out of whom their ease was wrung, and who would as soon have thought of remonstrating with that invisible Power whose tempests sometimes swept down their harvests and swamped their boats as with the carelessly cruel line which from a height far removed from their common humanity—save in the accidents of birth and death—stretched out over their heads the rod of an absolute rule.

But all this was over now. The present representative of the family had neither the power nor the will to keep up the ancient state, and preferred getting rid of his much diminished revenues in Paris. So the walls that should have sheltered him stood lonely and moss-grown, and the people who should have been his serfs dwelt underneath, disgracefully free and contented, selling their cheese and eggs and fish to the best advantage, and luxuriating unhindered in dirt and disorder—a privilege, to be sure, with which, to do them justice, their former proud oppressors had never interfered.

But although the old château was deserted, or rather because it was deserted, it was one of the best features of a landscape rich in attractions. The scenery of St. Etienne is not so much striking as lovely. It has little of the bold, except just on the sea-shore, where the rocks are piled high and ragged, and where in a storm the great waves come climbing and clamoring in wildly enough. But turning to look inland, and keeping your back on the too-suggestive bath buildings, you see a soft green country rolling up and back in gentle swells, dotted with clusters of low thatched cottages scarcely rising over the abundant harvests about them, and behind, on the highest slope of all, looking down even on the leafy heads of its twisting chestnut avenue, with white glimpses of the road between, a gray irregular mass, with every seam and ivy stem outlined against the warm blue air that winks and trembles under the flood of the summer sunlight. Every where greenness, glow, and luxuriance, with that one sombre foil to give exactly the rest to the eye and shade to the thought needful for the perfect enjoyment of the picture.

Upon all this beauty there was but one blot—the bathing establishment mentioned in the beginning. Standing on the sea-shore you could, as I have said, turn your back upon it; but no such expedient availed when, seeking to reverse the view, you looked from the château's topmost turret down on the laughing land thrown out now against the dark rocks and the dim sea-distance. Here to turn your back on the building was to turn it at the same time on the finest points of view. You must bear with it as best you might, but with such a perpetual and growing irritation that you began to understand how the last St. Etienne de Forsanz had been willing to abandon his ancestral home rather than suffer from this constant eye-sore. Not that such a motive had in the least influ-