

REPORT
OF THE
METEOROLOGICAL COMMITTEE OF THE
ROYAL SOCIETY,

For the Year ending 31st December 1869.

Presented to both Houses of Parliament by Command of Her Majesty.



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P R E F A C E .

THE Meteorological Committee consists of gentlemen who were nominated in 1866 by the Royal Society, at the request of the Board of Trade, for the purpose of superintending the Meteorological duties formerly undertaken by a Government Department, under the charge of Admiral FitzRoy.

The Committee are credited with a sum of £10,000, voted annually in the Estimates, for the administration of which they are wholly responsible, and over which they are given the entire control.

The Committee hold a meeting of some hours' duration at least once a fortnight, when every subject on which action has to be taken by their executive officers receives their careful consideration. The duties of the Committee are onerous, and *entirely gratuitous*; they were accepted, and are very willingly performed by the members, on account of the earnest desire they severally feel for the improvement of Meteorological Science.

The Committee consists of the following members :—
GENERAL SIR E. SABINE, K.C.B., President of the Royal Society,
Chairman.

Mr. FRANCIS GALTON.

Mr. GASSIOT.

The HYDROGRAPHER OF THE ADMIRALTY.

Dr. W. A. MILLER.

Mr. DE LA RUE.

Mr. W. SPOTTISWOODE.

Colonel W. J. SMYTHE, R.A.

REPORT

For the Year ending December 31, 1869.

IN this their third Annual Report the Committee have the simple task of chronicling the progress effected by the office in the several courses of inquiry, the commencement of which was fully described in the reports for 1867 and 1868. Introductory.

The most important feature presented by the work of the past year, as compared with its predecessors, has been the organization of systematic operations in the discussion and publication of the results furnished by the self-recording instruments at the observatories. Considerable increase in the computing staff has been requisite to the attainment of this end.

The distribution of duties has been the same as that noticed last year. The whole of the discussions are conducted at the office in London, under the direction of Mr. R. H. Scott; the marine branch being under the special charge of Captain H. Toynbee, the Marine Superintendent.

The general supervision of the self-recording observatories has been hitherto undertaken by Dr. Balfour Stewart, by permission of the Kew Committee of the British Association, in his capacity of Secretary to the Meteorological Committee, and director of the central (Kew) observatory. The Meteorological Committee have to report with sincere regret that Dr. Stewart has found himself unable to continue to devote so much of his time to their service as formerly, and has resigned his office. Such portions of his duties as are connected with the secretaryship, and the relations with the outlying observatories, will devolve upon Mr. Scott. The arrangements which have been made with the Kew Committee respecting the examination of the records from the observatories will be detailed subsequently.

The three heads into which the operations of the Committee are divided are as follows:—

I. *Ocean Meteorology*, comprising the investigation of the meteorological conditions of the entire ocean by means of observations made at sea with instruments lent by the office. Subdivision of objects of inquiry.

The supply of instruments to the Admiralty is also undertaken by this branch.

II. *Telegraphy and Weather Signals*, comprising the entire system of observation and of telegraphy required for the preparation of the daily weather reports, and for the issue to our own ports and to foreign countries of telegraphic information of ordinary weather and of storms.

III. *Land Meteorology of the British Islands*, comprising the method of inquiry carried on at the seven self-recording observatories established by the Committee. The object of this branch is, firstly, to afford for the entire area of the United Kingdom accurate meteorological information, similar to that published in most European countries under the auspices of their respective governments; and, secondly, to furnish better data for the study of our weather than had previously existed, so as to place the investigations conducted in connexion with Branch II. on a satisfactory scientific basis.

I.—OCEAN METEOROLOGY.

Collection of
information.

The office continues, as in former years, the practice of lending to captains in the mercantile marine instruments which have been tested at Kew, and are generally, except in short voyages, returned for re-comparison with standards as soon as the ship returns to port. The loan is granted on condition of observations being regularly taken and entered in a meteorological register, which is issued with the instruments, and is sent to the office when they are returned.

The instruments supplied to a ship consist of—

- 1 Marine barometer (Kew pattern).
- 6 Thermometers.
- 1 Thermometer screen.
- 4 Hydrometers.

And in exceptional cases an azimuth compass is added.

No observations made with instruments which have not been supplied, or authentically verified, by the office are employed in the investigations. Aneroid readings are never used.

Captains of merchant ships are allowed to purchase any of these instruments at cost price, on condition of their keeping a register of observations for the office.

The Committee undertake, in addition to their relations with the mercantile marine, the entire duty of supplying Her Majesty's navy with all the meteorological instruments used in the service. The observations made with these instruments are not necessarily sent to the Meteorological Office, as the keeping of a special meteorological register is entirely voluntary.

Examination of
registers.

The direct management of this branch of the office is entrusted to Capt. Toynbee, the Marine Superintendent. The minute examination of the registers as they come in, which is carried out under his directions, has given very satisfactory results. All particulars bearing on the quality of the observations and the mode of taking them, and any answers received from the observers in reply to questions arising out of their logs, are entered on a printed form, and bound up with the register for convenience of reference on future occasions.

The arrears of observations existing in the office are examined on similar principles. The absolute rejection of any registers which bear internal evidence of carelessness, inaccuracy, or "cooking," has been rigorously enforced. In some cases it has

been found that though the instrumental readings were from various causes untrustworthy, the wind and weather observations were of value, and these have accordingly been utilized. The slightest reflection will show the necessity of extreme care in order to avoid spoiling a mass of good observations by the introduction of others of inferior value, whether this be due to the quality of the instruments or to the observer.

The practical effect of the increased attention of the office to the particulars just described has been, as regards the new work, to improve very materially the quality of the registers received during the year.

The efforts of the calculators attached to this branch of the office have been consistently directed to the investigation of the meteorological conditions of the *equatorial* portion of the Atlantic Ocean, as already described in previous reports. The progress effected has been very good, as the Committee have fortunately been able in this, as well as in the other departments, to increase the number of their working staff, so that two additional computers have been engaged. In order to meet the possibility of the calculations being retarded by a deficiency of logs prepared for extraction, Capt. Toynbee has trained two of his most experienced assistants to examine the registers, subject to his control.

Discussion of observations.

As a general result it may be stated that about half of the materials at present in the office for the district under discussion has been by this time extracted on the plan described in the report for 1867. The very minute examination which the information necessarily undergoes in the process of sifting it into monthly sheets for single degree squares is sufficient to indicate very precise limits for the respective trade wind zones, with the gradual variations in the direction and force of the currents themselves according to latitude and longitude. Equally exact data are afforded for the position of the areas of hot and cold water, which have such an important bearing on the systems of ocean circulation.

Progress of work.

Very slight variations in the mean pressure or temperature of the atmosphere are also revealed. It may fairly be augured from the progress already made that the mode of investigation now pursued will be fruitful in results even beyond the expectations of its promoters.

The question of the future publication of the materials will soon have to be considered. It is obvious that if the mean results, say of the wind, be found to be uniform throughout the hundred sub-squares of a single ten-degree square, no advantage can be derived by proceeding to greater minuteness than a chart or a table for the entire district of 10 deg. of lat. and long. would require.

Publication of results.

As heretofore, the Committee have not been over-anxious to collect new information, if there was any risk of receiving inaccurate observations. The Marine Superintendent makes a point, if possible, of having a personal interview with the captains of all

Issue and return of instruments.

ships supplied in London, and he has made several journeys to Liverpool in order to meet the gentlemen, chiefly connected with the great ocean steamship companies who sail from that port. Appendix II. contains a list of the documents received during the year in this department.

When the office was under the management of Admiral FitzRoy, facilities were afforded for captains to receive and return instruments at certain of the ports, such as Liverpool, Bristol, &c. When the Committee took charge of the office, they found that almost all of the so-called "agents" at these ports had been desired by circular to desist from supplying ships. It has now, however, been thought desirable to recommence the practice of employing such agents, and accordingly verified instruments can now be obtained at Liverpool, Hull, Aberdeen, and Dundee.

It is hoped that as the three latter ports are the chief seats of the whaling and sealing trade, information will be obtained from high latitudes in the Atlantic Ocean.

The registers, when received, are divided into four classes: Excellent; Very Good; Good; Ordinary.

Presentations
to captains.

The Committee, wishing to present all gentlemen who have kept "excellent" registers with some slight mark of the value they set on the co-operation of careful observers, have determined to give in each case a presentation copy of the Atlantic Pilot Charts, recently published by the Admiralty. The names of the recipients of these charts during the 15 months ending with March 1870,* are—

Captain's Name.			Ship.
Banner, Frederick William	-	-	"Lady of the Lake."
Brooks, Samuel	-	-	"City of Brooklyn."
Brown, Robert	-	-	"Moravian."
Carruthers, Forrest Priest	-	-	"Minero."
Fry, Alfred	-	-	"Foam."
†Greenwood, William	-	-	"Scotia."
Hayes, James	-	-	"Ptolemy."
Henderson, Henry	-	-	"Hope."
‡Hodding, Samuel White	-	-	"Indus."
Hunter, David	-	-	"Alpha."
Jones, Arthur Arundel	-	-	"Victoria Nyanza."
Lecky, Squire Thornton Stratford	-	-	"Halley."
Martyn, John Artis	-	-	"Siberia."
Petrie, Peter Conrad	-	-	"Patagonia."
Potts, Thomas Crosby	-	-	"Tenasserim."
Rawle, Charles	-	-	"Star of the North."
Raymond, Charles Tenzer	-	-	"British India."
Smith, William Henry	-	-	"Hibernian."
§Stephen, John George	-	-	"Moravian."
Watson, William	-	-	"Palmyra."
Wherland, Frederick	-	-	"Galatea."
Wight, Henry Potts	-	-	"Gosforth."

* In addition the Committee have presented barometers to two gentlemen who have formerly kept registers for the office, but have now retired from the sea, viz., to Capt. A. D. Wood in 1867, and to Capt. Isaac Gales in 1870. A set of instruments was also presented to Capt. Alfred Fry in 1868.

† Chief Officer.

‡ Second Officer.

§ Chief Officer.

As in former years, the staff has been employed at extra hours in carrying on the unfinished work found by the Committee in the office when they took charge of it. The progress of these operations was noticed last year, and by the close of 1869 the examination of all the information collected by Admiral FitzRoy for the Pacific Ocean and the China Seas was completed. The results have been forwarded to the Hydrographic Office of the Admiralty for embodiment in their series of physical charts now in process of preparation.

Completion of former work of the office.

With reference to the wind data for the Atlantic, to which allusion was made in the report for 1868, the Committee have decided not to authorise any publication for the present, owing to a general deficiency of information respecting the less frequented parts of the ocean.

When these arrears of incomplete investigations relating to the strictly marine branch of the office, and enumerated in the Report of the Committee of Inquiry in 1865, had been cleared off, the subject which appeared in the next instance to demand attention was the reduction of anemometrical data, of which a large collection had been amassed.

Discussion of anemometrical data for Atlantic.

At the meeting of the British Association at Dublin in 1857, a committee was appointed "to express to the Board of Trade the wish of the British Association that self-recording anemometers should be established on some of the islands in the Atlantic Ocean, in aid of the meteorological observations now being carried on on shipboard under the direction of the Meteorological Department of the Board of Trade." The result was, that three anemometers on Dr. Robinson's pattern were erected early in 1859; two of them, those at Bermuda and Halifax, at the expense of the Meteorological Department, while the cost of the third, which was placed at Ascension, was mainly defrayed by the Government Grant Committee of the Royal Society.

The instrument at Bermuda has been in almost constant action since that date. That at Halifax was taken down in 1862, and removed to Sandwick Manse, near Stromness, where it remained at work under the superintendence of the Rev. C. Clouston, LL.D., up to June 1869, when it was replaced by a new instrument. The anemometer set up at Ascension was brought home when Lieut. Rokeby left that station in 1865.

The records furnished by these instruments have been only partially discussed. Reductions of the anemograms for 18 months from Bermuda, and for two years from Halifax, were effected in the office, and published respectively in the 8th and 13th numbers of Meteorological Papers. Some portion of the records from Sandwick Manse have been tabulated, and the observations at Ascension were discussed by Lieut. Rokeby.

No systematic treatment of the materials on the principles recommended by Dr. Robinson had ever been undertaken. It

was therefore determined by the Committee to commence the tabulation, reduction, and discussion of this accumulation of important matter. The work is now in progress, but will require a considerable time for its completion. It will be observed that all these special inquiries are totally distinct from the ordinary work of the office, with which no interference is permitted. The cost of the extra work is defrayed from time to time by special grants made by the Committee, who hope gradually in this way to be able to overtake the arrears of work in the office, and to give the results to the public.

Deep-sea
thermometers.

In the last report reference was made to the improvement of deep-sea thermometers: the construction of these instruments has been much improved in the course of the year. The Committee appointed by the Royal Society to superintend the dredging expedition conducted by Dr. Carpenter, Mr. J. Gwyn Jeffreys, and Dr. Wyville Thomson, in H.M.S. "Porcupine," have, at the suggestion of Dr. W. A. Miller, adopted a form of thermometer for deep soundings which resembles in principle that formerly employed under Admiral FitzRoy's direction, and described in *Meteorological Papers*, No. I., p. 55. Dr. Miller's instrument is fully described in the proceedings of the Royal Society, Vol. XVII., p. 482, from which the notice in Part II., p. 25, is extracted. The chief points in which it differs from its predecessors are its being of much smaller size, and therefore more convenient, and the fact that the liquid contained in the interval between the external glass casing and the actual thermometer bulb is spirit instead of mercury.

Great care is taken to prove every instrument thoroughly before it is issued, and they are all tested in a hydraulic press, the force exerted being gradually increased up to $2\frac{1}{2}$ or 3 tons per square inch so as to obviate any risk of the thermometers breaking from sheer pressure on service, and to ascertain the corrections to be applied to their readings for any given depth of water. These thermometers have given great satisfaction, one of them having been used throughout the entire cruise without its accuracy being in the slightest degree impaired.

These deep-sea thermometers are kept for the exclusive use of the Hydrographic Department of the Admiralty.

Instruments :
Admiralty
account.

In Appendix III. will be found a list of all the instruments supplied to ships in the Royal Navy during the year, with a statement of the entire stock of instruments standing on the books to the account of the Admiralty on the 31st December 1869. This latter statement is prepared from the latest returns furnished by the respective storekeepers at the dockyards, &c.

The work of tracing missing instruments has been systematically carried on during the year, and many questions relating to their disposal have been cleared up.

Instruments :
Board of Trade
account.

Appendix IV. gives similar information with regard to the Board of Trade instruments.

These tables, when compared with those for last year, show a considerable reduction in the number of instruments belonging to both accounts in use on shore. This amounts in—

—	Barometers.	Aneroids.	Thermometers.
Admiralty account -	10	20	36
Board of Trade account -	7	Compasses. 2	30

All these instruments have been recovered for use at sea.

The increase of heavy guns in the navy has brought with it an increasing demand for the so-called “gun” barometers which were made under Admiral FitzRoy’s direction, and specially adapted to resist concussion, by surrounding the tube with thick india-rubber tubing. These instruments were formerly only graduated to 0.01 inch, but as the tubes and the rest of the instruments were made with as much care as other barometers, the scales are now being graduated to thousandths of an inch, so as to render the instrument capable of as accurate reading as one of the well-known Kew pattern marine barometers.

Instruments have been supplied by the Committee for educational purposes to the following navigation schools :—

Supply of instruments to navigation schools.

- Aberdeen - - - Master, Mr. Jones.
- Leith - - - „ Mr. J. Bolam, jun.
- Plymouth - - - „ Mr. J. Merrifield.
- South Shields, the Winter-bottom Marine School - „ Rev. Dr. Hooppell.

In addition a set has been allowed, with the special sanction of the Board of Trade, to remain at the Church of Scotland Training School in Edinburgh.

Other instruments not used in the immediate service of the office have been recalled, with the exception of the supply presented to the Scottish Meteorological Society, as noticed in the last report.

II.—TELEGRAPHY AND WEATHER WARNINGS.

The only material change which has taken place in respect of the telegraphic system in the course of the year has been an increase in the number of reporting stations both at home and abroad. The list of these points of observation in our islands, with the respective observers’ names, will be found in App. V. Their number is now 20 (including London, where the reports are made by the clerks in the Meteorological Office), and they are situated, eight in England, two in Wales, six in Scotland, and four in Ireland. The substitution of St. Ann’s Head, at the entrance of Milford Haven, for Weymouth has been a most useful change. The development of telegraphic communication

Position of stations.

with the extreme north of Scotland has rendered it possible to receive daily reports from Wick and Thurso, and these stations have therefore been established, the former in the month of September, the latter at the beginning of February 1870. This extension of the system has proved to be of much practical benefit. Nairn was formerly the most northerly of the stations, and although it is on the coast, and has a very level country in its immediate neighbourhood, it is so enclosed on the S., W., and N.W. by a mountainous country that the most violent storms from the quarters indicated are rarely felt there. The reports from the two additional stations, which are situated at a considerable distance from any mountains, and possess a very good exposure to the winds, have enabled the office to form a much more correct conception of the conditions of weather prevailing daily on the north coast of Scotland than was previously possible. Some of the other stations, especially Liverpool and Greencastle, are at least as disadvantageously situated as Nairn. As regards Liverpool, the Committee are encouraged, by the readiness with which the authorities connected with the observatory belonging to the Mersey Dock Board have consented to co-operate with them, to cherish the hope that as soon as direct telegraphic communication with Birkenhead has been properly organized they will be able to receive daily reports from that observatory, which is situated in a well-exposed position on Bidston Hill near Birkenhead. The question of improving the reports from Greencastle presents serious difficulties. The N.W. coast of Ireland is so mountainous that it is almost impossible to find an unexceptionable place for wind observations. The same obstacle meets the proposal to obtain reports from the coast of the western highlands of Scotland.*

All the stations were visited by Mr. Scott in the course of the year, and were found to be almost uniformly in very good condition.

In order to test thoroughly the daily weather reports, comparisons have been instituted between the daily observations registered at the telegraphic stations, and the information for the same hours collected from the continuous curves at the observatories. This has only been possible in a few cases where the telegraphic station was reasonably near an observatory; thus Ardrossan was compared with Glasgow, London with Kew; and the results, as regards the correctness of the instrumental readings reported daily, have been very satisfactory.†

* The Committee have resolved, in compliance with a desire which has been very generally expressed, to replace Dover on their list of stations, so as to provide daily information from the S.E. coast of England. Dover with five other stations had been suppressed when the number of stations was reduced at the end of December 1864.

† The transference of the telegraphs over the United Kingdom to the Post Office which took place on the 5th of February will probably occasion some modification in the arrangements previously existing for the supply of the daily reports. However, from the great care which Mr. Scudamore, on behalf of the Post Office, has taken to ensure the speedy and accurate transmission of their telegrams, the Committee have every reason to expect that the change will be in every way beneficial to the cause of meteorological telegraphy.

A considerable change has taken place in respect of the interchange of weather reports with foreign countries, owing to the establishment of direct communication with Norway and Holland. The Meteorological Office now receives from the Observatoire Impérial in Paris reports from Paris (twice daily), as well as once a day from Strasbourg, Lyons, Brussels, and Corunna. The Ministère de la Marine forwards reports from Cape Grisnez, St. Mathieu (Brest), Grognon (L'Orient), Ile d'Aix (Rochefort) (twice daily), Biarritz, and Cape Sicié (Toulon).* In return, the Meteorological Office sends to the Observatoire reports from Nairn, Scarborough, Yarmouth, Penzance, Valencia, and Greencastle, (from the two last twice daily), and to the Ministère de la Marine a daily résumé of the weather as reported from the stations in these islands and in Norway.

Telegraphy
with the
continent.

The daily report from Helder, formerly received via Paris, now comes direct to London from Holland.

It is, however, with regard to Norway that the system has undergone the most extensive modifications. In the course of last summer a direct cable was laid from Peterhead to Egersund on the coast of Norway, and in the month of October Professor Mohn, director of the Royal Meteorological Institute of Norway at Christiania, submitted to the Committee a proposal for a daily interchange of observations, which was carried into effect in the first days of December. The arrangements are, that the Meteorological Office receives from Norway daily reports from Christiansund, Skudesnaes (twice a day), and from the island of Oxö near Christiansand, and sends in return information from Nairn (twice a day), Yarmouth, and Valencia.

It will be seen from the foregoing that the office receives 35 reports every morning and 9 every afternoon. The stations are situated along the entire coast of the continent from Christiansund in lat. 63° N. to Corunna, with the exception of the coast of North Germany, and of Denmark. It is, however, hoped that ere long intelligence may be regularly received from these districts also.

Extent of the
system.

Experience has shown that in most instances the office is able to transmit to neighbouring countries information of much greater value than any which it can receive from the continent, owing to the fact that most of our storms come to us from the Atlantic.

The service with Heart's Content has been maintained during the year owing to the continued liberality of the directors of the Anglo-American Telegraph Company. The messages are transmitted *free of cost* over the ocean wires to Valencia, so that the cost to the Committee of this distant station is precisely the same as if it were on the coast of Ireland.

Heart's
Content.

* These latter stations have all been placed (March 1870) in connexion with the observatory of Montsouris, established in the course of the year 1869, and managed by a meteorological commission of which M. C. Ste. Claire Deville is president.

Preparation of
daily weather
report.

The daily observations, with the exception of those at Heart's Content, are taken at 8 a.m., Greenwich time, and most of the telegrams arrive in London at about 10 o'clock. An hour is required for their reduction, discussion, and the preparation of the daily weather report, copies of which are at once supplied for the afternoon issue of several of the London papers. A brief telegraphic résumé of the weather is despatched to the Marine Ministry in Paris, and if necessary, telegraphic intelligence of storms or of atmospherical disturbance is sent to our own coasts and to foreign countries. Later in the day the foreign telegrams, and subsequently the afternoon reports, come in. Copies of the complete report are then sent by post to the newspapers for next day's morning issue, and to certain seaports which have applied for it on the terms named in the circular issued by the Committee in March 1867. (See Report, 1867, p. 17.) In addition, copies are supplied to a few meteorologists at a cost slightly exceeding the expense of postage. The list of recipients is contained in App. VI.

Telegraphic
weather in-
telligence.

The intelligence of storms which is sent out from the office is of different characters, according to the requirements of the place which receives it. In App. VII. will be found a list of the stations which are furnished with drums, in accordance with circular 278 of the Board of Trade, issued in December 1867 (App. VIII.). These stations are 106 in number, and are situated, 55 in England, 13 in Wales, 26 in Scotland, 10 in Ireland, and 2 in Jersey. Lamps for night use are supplied to a few of the stations. All the stations have been established and are carried on on the terms laid down in the circular, excepting the dockyards, which are of course under Admiralty management. The messages sent consist of an order to hoist the drum, accompanied by a brief explanation of the reasons why it is to be hoisted. The message is posted up as soon as it is received, for the information of the public. It continues in force for 36 hours, *and no longer*, from the time of its receipt, unless modified by a subsequent telegram, which is frequently sent, either when the danger is known to have passed over, or when there are signs of the approach of another storm.

The experimental semaphores which have been on trial at Blackwall, Liverpool, and Tynemouth, have been taken down, as it was found that the drum signal was sufficient for the requirements of the respective ports, as far as they could be ascertained.

Telegraphy to
Liverpool.

In addition to the foregoing, a special telegram is sent to the Underwriters' Association of Liverpool, whenever the difference between any two barometrical readings taken that morning in these islands or on the adjacent French coast, exceeds half an inch. The message consists of reports of the atmospherical pressure and the wind at three or four stations. By this means intelligence of the general conditions of weather that morning reaches the underwriters' rooms daily before 1 o'clock, as long as the atmosphere continues in a disturbed condition. Half the

expense of transmission of these telegrams is borne by the Association.

The intelligence of storms sent to foreign countries differs in each special case. To France* the same messages are sent as to our own south coast and to Jersey. A telegram is despatched to Utrecht and Hamburg, whenever the difference of readings between any two of our stations exceeds 0·8 in., and the authorities at Hamburg hoist drums at that port and at Cuxhaven whenever the intelligence received justifies the step in their opinion. The practical value of this information to the trade of Hamburg has been even more striking in the course of last year than it was before. In the Second Annual Report of the Nord-deutsche Seewarte, Herr von Freeden says,—

“ Let us now turn to the English storm warnings, for which we are indebted to the courtesy of the Meteorological Office in London.

“ We have received altogether 48 telegrams during the year 1869. Of these 18 were simply cautionary, as to the more or less threatening state of affairs, and out of these, four expressly stated, ‘ Do not hoist yet.’ ”

“ The 30 remaining telegrams may be considered as real storm warnings, but the direct order to hoist the ‘ drum ’ signal was only given in 22 cases.

“ Then the storm was experienced (a storm being taken as at least 30 miles per hour)—

“ Same evening, or next day	-	-	13 times
“ Previous day	-	-	4 „
“ (In three of these cases a Sunday had intervened and no telegram could be sent.)			
“ Squally weather	-	-	6 „
“ Fine	„	-	7 „
“ Total			<u>30</u> „

“ In two cases we received no telegram, but in one instance, as is clearly stated, it was owing to an interruption on the wires.”

The issue of warnings is conducted strictly according to the method indicated in the last report, and it is gradually assuming a more scientific character, according as principles which seem

Warnings to the continent.

Weather study and issue of warning.

* Since the commencement of the present year 1870 the Committee have been requested by the Ministère de la Marine to issue warnings for the *entire* north and west coast of France. They have declined to undertake so great a charge, but have consented, whenever it seems requisite, to send telegrams to Paris for transmission to the ports situated on the coast from Dunkerque to Nantes. At these stations the drum is hoisted, and it has precisely the same signification as in England.

The Norwegian government are also adopting the drum, and it is hoisted at Oxo near Christiansand.

to regulate the changes and sequence of our weather appear to be revealing themselves.

The Committee in the increase of their computing staff, to which allusion has already been made, have added two to the number engaged in this department, and the results have been very satisfactory. The daily weather chart is drawn regularly, and in addition an abstract of the conditions of weather for each day is entered in a book and carefully analysed. The books are in monthly volumes and each of them is copiously indexed, so as to afford facilities for the recognition of recurring types of weather.

Exchange of daily bulletins.

In order to supplement the telegraphic reports the office keeps itself in constant correspondence with the principal meteorological organizations of the continent, and exchanges the lithographed daily weather reports for their respective bulletins. The institutions with which such an interchange is maintained are given in the note.*

Increase of number of stations.

Each case of issue of a warning message is specially investigated with respect to the weather recorded at the self-recording observatories and the telegraph stations. As these points of observation are rather sparsely scattered around our coasts measures are being taken by the Committee to increase the number of their automatic instruments by erecting anemometers at Holyhead and Yarmouth (see p. 22), and to invite co-operation from private observers. In the last-named direction they have received great encouragement, as not only have several gentlemen of great zeal and acknowledged accuracy in observing agreed to help them by furnishing reports of wind and weather, but in some cases even daily anemographical records have been promised them.† This plan was only commenced at the close of the year, so that it would be premature to speak of it at more length.

* LIST of Daily Meteorological Bulletins received at the Meteorological Office.

Place.	Whence issued.
Christiania - - -	Norske Meteorologiske Institut.
Hamburg - - -	Nord-deutsche Seewarte.
Lisbon - - -	Observatorio do Infante D. Luiz.
Paris - - -	Observatoire Impérial.
Paris - - -	Observatoire Météorologique Central de Montsouris.
St. Petersburg - -	Observatoire Central Physique de Russie.
Utrecht - - -	Koninklijk Nederlandsch Meteorologisch Instituut.
Vienna - - -	K. K. Central-Anstalt für Meteorologie und Erdmagnetismus.

† Records of this nature have been received from His Grace the Duke of Northumberland, Alnwick Castle ; R. H. Barnes, Esq., Bayswater ; Rev. F. W. Stow, Whithy.

The principle that the direction and force of the wind on any day depend on the amount of difference in barometrical readings over a given area, or on the "gradient," as explained in the last report, has proved itself to be thoroughly trustworthy. The problem in weather study to which attention must now be directed is the discovery of the probable path of each storm taken as a whole, and of its rate of progress across the country. This is a question most difficult of solution, but great light is and will be thrown upon it by the study of the continuous records furnished by the observatories. At this point, therefore, the labours of the two branches of telegraphy and land meteorology coalesce. Under the latter head at p. 21 will be found an account of the proposed Quarterly Weather Report. This current chronicle taken with the facsimile representations of the graphical instrumental records, will afford materials for subsequent weather study incomparably more copious and accurate than anything which has been hitherto available either in this country or elsewhere.

In addition to the work which has just been described, Non-official inquiries of a more theoretical character have been carried out publications. during the year. The Committee, considering that speculative deductions of the nature indicated should rest on the authority of the respective investigators, have sanctioned the commencement of a series of non-official papers, consisting of reports addressed to them on the several questions which have been the subjects of the inquiries. The authors of these reports are alone responsible for their contents. The first paper of this class was Mr. Scott's "Report on the Connexion between Strong Winds and Barometrical Differences," noticed in the last report. It has been followed by two others from the pen of Capt. H. Toynbee, of which the first is "On the Meteorology of the North Atlantic between the parallels of 40° and 50° N.," the other "On the Use of Isobaric Curves." The former of these is an examination Meteorology of the observations taken on board the Atlantic mail steamers of the North Atlantic. on their outward and homeward voyages. Four passages each way, made by one observer, Capt. John A. Martyn, have been taken, and the diagrams of the observations exhibit this remarkable peculiarity, that when the ship is *outward* bound, the barometrical and thermometrical curves are marked by frequent oscillations, and the wind usually shifts from S. to W. and back again several times during the passage; while when she is *homeward* bound the instruments and the wind are much more steady. Capt. Toynbee offers as an explanation of these facts the idea that the atmosphere over the Atlantic is in a state of constant motion in a direction which is generally easterly, and at a rate of progress slightly less than that of a full-powered steamer, and that it is disposed in a series of successive eddies or waves. The ship, when outward bound, meets and passes through several of these systems, while on her homeward passage she may run with one for days together, and so experience little

change either in wind or weather. It is almost unnecessary to say that should these views be confirmed by more ample experience, the generalization is calculated to be a most useful one, as well to scientific meteorology as to practical navigation.

The use of
isobaric curves.

Captain Toynbee's Second Report is on the use of isobaric curves, in affording a clue to the present and probable conditions of weather. He has investigated the weather charts for several days at various seasons, drawing on every chart two lines, one indicating the line of greatest actual barometrical gradient as shown by the observations, the other showing the greatest change in the distribution of pressure, and joining the station where the barometer has risen most rapidly during the preceding 24 hours with that where the fall has been greatest. The normal to the first of these lines shows, on the principle of Buys Ballot's law, the wind which will prevail during the day, while the normal to the second indicates the probable change in direction and force which will supervene in that wind. It is evident that if these two lines run in the same direction the wind will increase, and *vice versa*, it will die down if their directions be opposed to each other.

These results are very useful, and they are employed by the office in the issue of cautionary telegraphic warnings.

Another practical principle which is brought under the notice of seamen in this report is, that the tack on which a ship is sailing influences the rate of rise or fall of the barometer on board.

Fishery
barometers.

The Committee have continued the practice of lending barometers to small ports and fishing stations, where the inhabitants are too poor to be able to provide such an instrument for themselves. The barometers usually supplied are the so-called "Fishery Barometers," which are of large size, so as to be easily consulted, and yet of considerable accuracy. This form of instrument was originally devised at Admiral FitzRoy's suggestion. 14 of these barometers were issued on loan during the year, and there are now 111 stations round our coasts supplied with barometers for public use.* The stations are situated, 48 in England, 2 in Wales, 39 in Scotland, and 22 in Ireland, see App. IX. The Board of Fisheries in Edinburgh has kindly undertaken the local supervision of these instruments in Scotland, and no fresh grants to Scotch stations are made without consultation with that office.

III.—LAND METEOROLOGY OF THE BRITISH ISLANDS.

Stations.

It is in respect of this branch of their system that the operations of the Committee have undergone the most active development since the date of the last report. The stations fitted with self-recording instruments are seven in number, and they were

* The Royal National Lifeboat Institution has also erected several of these instruments on the coast.

all inspected by Dr. Stewart in the course of the year. The following particulars about them may be of interest:—

Observatory.	Superintended by	Latitude N.	Longitude W.	Height of Barograph Cistern above Sea Level.
		° ' "	° ' "	Ft.
Aberdeen -	D. Thomson, M.A., Professor of Natural Philosophy.	57 8	2 5	88·5
Glasgow -	R. Grant, LL.D., F.R.S., Professor of Practical Astronomy.	55 51	4 16	184
Armagh -	Rev. T. Romney Robinson, D.D., F.R.S., Astronomer.	54 22	6 39	207·3
Valencia -	Rev. Thos. Kerr - - -	51 54	10 25	23·0
Stonyhurst -	Council of Stonyhurst College.	53 50	2 25	360·7
Kew - -	Kew Committee of British Association.	51 29	0 18	34
Falmouth -	Royal Cornwall Polytechnic Society.	50 9	5 4	210·8

The records from all the observatories are examined at Kew, in accordance with the regulations contained in Part II. of the report for 1868, prior to being sent to the office in London for discussion.

Dr. Balfour Stewart having resigned his appointment as secretary, the arrangement heretofore existing between the Meteorological Office and the Kew Committee has (with the concurrence of the Council of the British Association) been settled *pro tem.*, on the following conditions:—

New arrangements with Kew.

The records from the outlying observatories, together with those of the central (Kew), are, as heretofore, to be examined at Kew, in consideration of an annual sum (400*l.*) being allowed for the performance of that duty. This payment is irrespective of the annual grant (250*l.*) made to Kew as one of the seven self-recording observatories, and is an increase of 200*l.* on the amount originally paid to the Kew Committee for the same work, while the special salary to Dr. Stewart, as secretary, is no longer payable.

The direct supervision of the observatories is, from the commencement of the present financial year, to be transferred to the Meteorological Office.

It is understood that these arrangements shall continue in force as long as the present position of Kew Observatory with the British Association remains unchanged.

The Meteorological Committee regret that they have not been able to retain the benefit of Dr. Stewart's continued assistance to the same extent as in former years. They desire to record and acknowledge that they fully recognise the practical experience and the eminent scientific attainments of that gentleman, as evinced by him during their arduous task of arranging and

finally establishing a new and delicate system of meteorological observations.

Utilization of
results.

The Committee, finding that at the end of 1868 the difficulties of first starting the system had been overcome, and that the various observatories were sending in their records with great regularity and comparative freedom from defects, resolved that their systematic publication of results should commence with the year 1869. They have therefore during the year increased their computing staff, so as to keep pace with the progress of the instruments. The continuous records will be capable of being utilized for entirely distinct purposes. On the one hand, they will undoubtedly furnish mean numerical results of accuracy surpassing anything which could be yielded by eye observations; and on the other hand, they will exhibit the changes in atmospheric conditions which pass over our islands with absolute fidelity, and will thereby throw a totally new light on the study of weather.

The appendix to the last report contained specimens of tables of average results which were in process of calculation. These have been completed for the year 1869, and are in type: they are two in number.

Description of
Tables.

Table I. gives the monthly means for the barometer and dry thermometer, with the extreme readings, maximum and minimum, for each month, and in addition the monthly means of vapour pressure and of dry air.

Table II. gives the five-day means of the barometer and the dry and wet thermometers.

Periodic
corrections.

These tables will at the end of five years be supplemented by a third, exhibiting the hourly periodic corrections of temperature, so as to afford data for the determination of daily range in all parts of the country.

Anemometrical
reductions.

The calculation of numerical average results for the wind presents very serious difficulties, owing to the extremely changeable nature of our climate. It has finally been decided at the instance of Dr. Robinson, whose authority on the subject of anemometry is unquestioned, to conduct the discussion with a view to occasional publication at definite intervals, inasmuch as it appears that five years is the shortest period from which results of any practical value could be expected.

Publication of
curves.

Lastly must be noticed the method adopted by the Committee for presenting their continuous records to the public in a form available for weather study. In the last report the issue of lithographed curves, at full size, obtained by tracing from the originals and the subsequent use of the anastatic process, was mentioned. It became evident that any reproduction of the records at natural size would be far too cumbrous and costly. A little consideration showed that the time scale would bear much greater reduction than that of the ordinates for the actual instrumental readings. The problem which then presented itself was how to reproduce the curves by instrumental means with entire truthfulness, at the same time varying their scale in the manner

indicated. This difficulty has been met in the most satisfactory manner by one of the Committee, Mr. Francis Galton, who has invented a pantagraph which effects all that is required of it in this direction with the utmost accuracy, and is at the same time very easy of manipulation. A description of the instrument will be found in Part II. at p. 32.

The zinc templates obtained from it exhibit the curves on the same vertical scale as the original, but with the horizontal scale reduced to one third. These templates are then capable of any further reduction which may be desired in the ordinary pantagraph. The amount of reduction which has been adopted is one half, so that the final curves published are on one half the vertical and one sixth the horizontal scale of the original curves obtained from the instruments themselves.

It is found that when the records are reduced in this proportion the entire information from the barometers and thermometers at the seven observatories for five days can be brought within the space of a 4to. page. The data for wind and rain for the same interval form a corresponding plate.

It is obviously of paramount importance that the most extreme mechanical precision should be provided, so that the records shall be capable of exact measurement at any epoch of time.

The ordinary pantagraph is not sufficiently accurate for such very delicate work. The Committee have therefore ordered one of the pantagraphs invented by F. Wagner, junior, of Berlin. The construction of these instruments is admittedly superior to that of any others in use. This instrument will be ready about the month of June.

In order to avoid additional delay it has been determined to reproduce the records for the first three months of 1869 by lithography, and the work has been entrusted to Malby & Co. Specimens of the lithographed plates produced by the method above described are given (Plates I. and II.) representing the weather from Jan. 26-30, 1869.

The curves will, however, require some explanation, and with the view of affording this the Committee have directed that a continuous chronicle of the weather should be prepared. This has been commenced, and it is based on the data furnished by the observatories, combined with that provided by the telegraphic weather reports, ships' logs, and other sources of accurate information, such as observations made by independent British observers of known accuracy, and by the several bulletins, &c., published abroad (p. 16).

This chronicle will be illustrated by small sketch charts showing the conditions of barometrical pressure and of wind whenever such information seems requisite. This weather journal with the plates of curves will appear at intervals of three months, and will be entitled the Quarterly Weather Report of the Meteorological Office. With this publication the mean numerical results will be from time to time issued.

Quarterly
Weather
Report.

Additional
stations.

On commencing the systematic study of weather it at once became evident that additional information was required from British stations in order to afford an accurate insight into the changes of our weather. The most obvious particular in which an increase of points of observation was required was the wind. A cursory inspection of the simultaneous anemometrical records from the existing observatories was sufficient to show that their indications were much influenced by local conditions, the inland stations showing much less wind than those exposed to the sea. In order to obviate partially the inconvenience arising from this cause three new anemometers have been erected during the year at exposed points on our coasts. One was erected in June at Sandwick Manse, Orkney, in order to replace the instrument which has been in action there for the last seven years under the superintendence of Dr. Clouston. The second has been placed at Holyhead, and the third at Yarmouth. At the former station the anemometer is placed on the top of the old lighthouse by permission of the Board of Trade. The Committee have also to acknowledge the valuable assistance which they have received in the matter from Rear-Admiral Schomberg, the harbour master. At Yarmouth the instrument is set up on the Sailors' Home with the sanction of the committee of that institution.

The other measures which are being adopted with the view of inviting volunteer co-operation in observations have already been detailed (p. 16).

Self-recording
rain gauges.

An important development of the automatic system of observation introduced by the Committee will take place in the course of the year 1870, as they have determined to erect self-recording rain gauges at all the observatories. The form of instrument adopted is that invented by Mr. Beckley, a description of which will be found in Part II. (p. 36).

EXPENDITURE.

Change of
office.

On closing their accounts for the financial year 1868-9, the Committee fortunately found themselves with a balance to their credit, so that they were in a position to meet the serious outlay entailed on them by the necessity of fitting up and furnishing a new office. The total expenditure on this head has exceeded 750*l*.

It was at the end of February that notice was received from the Board of Works that they desired to resume possession of the rooms at No. 1, Parliament Street, which had been in the occupation of the Meteorological Office since its establishment. The Committee succeeded in finding suitable accommodation in the house No. 116, Victoria Street, and the office was removed to its present location on the 31st of May.

The addition to its annual expenditure entailed on the office by this change has been very considerable, exceeding 370*l*., for rent, &c., which is further increased by charges for firing, light, cleaning, and the wages of an office keeper.

Another source of augmented outlay has been the increase in the computing staff, in order to cope with the arrears of observations already existing in the office and the materials constantly coming in. The necessity of action in this direction was most emphatically urged by the Committee of Inquiry in their report, and the Meteorological Committee have kept constantly before them the desirability of carrying it out. Increase of staff.

No fewer than nine new computers have been engaged at weekly wages. Of these, two are attached to the branch of ocean meteorology, two to that of telegraphy, four to that of land meteorology of the British islands, while the ninth gives assistance in the clerical work of the accounts and correspondence. The payment of these gentlemen entails a yearly charge exceeding 500*l*.

The Committee are glad to be able to say that notwithstanding this great permanent increase of their expenditure they have been able to confine it within the limits of their annual grant. They find themselves at present with a balance of 1,486*l*. at their bankers, but of this sum almost the whole has been anticipated by various contracts, &c. The postal telegraph accounts for February and March will not fall much short of 300*l*.; 230*l*. is required to defray outstanding accounts for instruments for the mercantile marine; the pantagraphs will cost 280*l*.; and the rain gauges 210*l*. On the whole the Committee will commence the year 1869-70 with a small available balance in hand, and they hope, by careful management, to succeed in discharging the duties they have undertaken without requiring a present increase in the grant allotted to them by Parliament. In Appendix X. will be found a list of the present staff in the employment of the Committee, and of their several occupations. Present position.

App. XI. gives a list of the additions to the library made during the year. These books have, for the most part, been received in exchange for the publications of the office.

SUMMARY.

The progress made in the office during the year in the various directions of its inquiries may be thus summed up:—

I. *Ocean Meteorology*.—The investigation of the meteorology of the equatorial portion of the Atlantic Ocean has made satisfactory progress, as the number of assistants engaged on it has been increased.

The unfinished discussions relating to the Pacific Ocean, found in the office, have been completed, and the results sent to the Admiralty for embodiment in their series of physical charts.

The work now in hands at extra hours is the reduction of anemometrical data.

The issue of instruments on loan has been continued, and the character of the registers received shows a very sensible general improvement. The Committee have presented copies of the

Atlantic pilot charts to certain captains, who have kept "excellent" logs. Their names will be found at page 8.

The cost of this department has been 1,639*l.* 1*s.* 6*d.*

II. *Telegraphy and Weather Warnings.*—The home-reporting stations have been increased by two, Wick and Thurso. No material change has been made in the system of telegraphy with France, but a regular interchange of reports has been instituted with Norway, which has been productive of much mutual benefit.

The drum signal is hoisted, on orders from the Meteorological Office, at 106 British stations, as well as along the coast of France from Dunkerque to Nantes.

The study of weather is conducted on systematic principles; every warning message issued is carefully compared with the subsequent weather experienced as recorded at the self-recording observatories.

Fourteen new fishery barometers were supplied during the year, making the total number round our coasts 111.

The cost of these operations has been 2,639*l.* 0*s.* 1*d.*

III. *Land Meteorology of the British Islands.*—The regular discussion of the observatory records has been undertaken, and the mean results for the year 1869 are in type. Measures have been adopted to reproduce the curves yielded by the instruments in facsimile, so as to present to the public the entire information obtained by the system.

It has been determined to publish a quarterly weather report which shall contain the continuous plates, with a current chronicle of the weather explanatory of them. The facts on which this chronicle is compiled are obtained partly from Branch III. and partly from Branch II. Any information derivable from ships' registers is also utilized.

In order to increase the amount of information received at the office, anemometers have been erected at various points on our coasts, and invitations have been issued to independent observers of known accuracy to assist the office in its work. These proposals were only sent out at the close of the year, but the Committee have already received great encouragement to hope for good results from the plan.

The cost of the department of land meteorology has been 3,174*l.* 5*s.* 2*d.*

Office.—The expenses of management, in salaries and wages, have been 1,562*l.* 1*s.* 3*d.* This sum will be reduced during the ensuing year, owing to Dr. Stewart's resignation of the secretaryship. The other charges incident on the office for rent, furniture, &c. &c., have amounted to 1,404*l.* 3*s.* 7*d.*

Arrangements have been made with the Kew Committee of the British Association for the examination of the curves and tabulations at that observatory.

The general supervision of the observatories has been transferred to Mr. Scott.

PART II.

DESCRIPTION of NEW INSTRUMENTS, &c., adopted by the METEOROLOGICAL COMMITTEE.

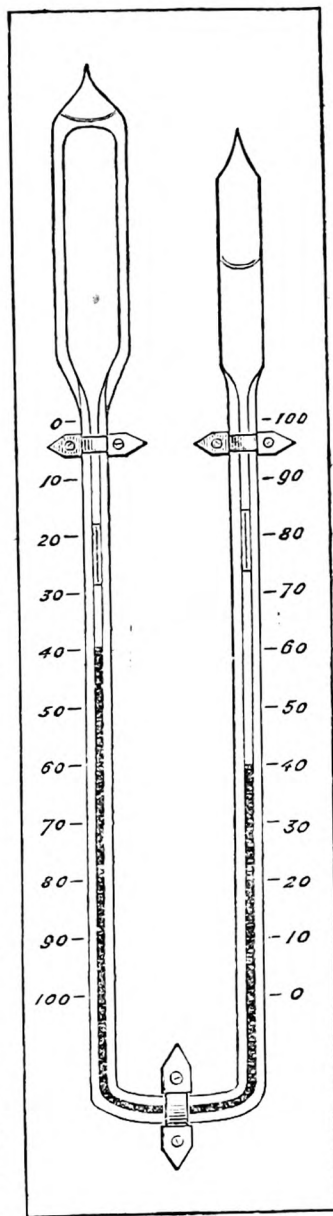
No. 1.—NOTE upon a SELF-REGISTERING THERMOMETER adapted to DEEP-SEA SOUNDINGS, by W. A. MILLER, M.D., Treasurer and V.P.R.S, extracted from Proceedings of Royal Society vol. xvii., p. 482.

It is well known that self-registering thermometers of the ordinary construction are liable to error when sunk to considerable depths in water, in consequence of the diminution produced for the time in the capacity of the bulb under the increased pressure to which it is subjected. The index, from this cause, is carried forward beyond the point due to the effect of mere temperature, and the records furnished by the instrument rise too high.*

A simple expedient occurred to me as being likely to remove the difficulty; and as upon trial it was found to be perfectly successful, I have thought that a notice of the plan pursued might not be unacceptable to future observers.

The form of self-registering thermometer which it was decided to employ is one constructed upon Six's plan. Much care is requisite in adjusting the strength of index-spring, and the size of the pin, so as to allow it to move with sufficient freedom when pressed by the mercury, without running any risk of displacement in the ordinary use of the instrument while raising or lowering it into the water. Several of these thermometers have been prepared for the purpose with unusual care by Mr. Casella, who has determined the conditions of strength in the spring and diameter of tube most favourable to accuracy. He has also himself had an hydraulic press constructed expressly with the view of testing these instruments. By means of this press the experiments hereafter to be described were made.

The expedient adopted for protecting the thermometers from the effects of pressure consisted simply in enclosing the bulb of such a Six's thermometer in a second or outer glass tube, which was fused upon the



* In sea water of sp. gr. 1.027, the pressure in descending increases at the rate of 280 lbs. upon the square inch for every 100 fathoms, or exactly one ton for every 800 fathoms.

stem of the instrument in the manner shown in the accompanying figure. This outer tube was nearly filled with alcohol, leaving a little space to allow of variation in bulk due to expansion. The spirit was heated to displace part of the air by means of its vapour, and the outer tube and its contents were sealed hermetically.*

In this way variations in external pressure are prevented from affecting the bulb of the thermometer within, whilst changes of temperature in the surrounding medium are speedily transmitted through the thin stratum of interposed alcohol. The thermometer is protected from external injury by enclosing it in a suitably constructed copper case, open at top and bottom, for the free passage of the water.

In order to test the efficacy of this plan, the instruments to be tried were enclosed in a strong wrought-iron cylinder filled with water, and submitted to hydraulic pressure, which could be raised gradually till it reached three tons upon the square inch, and the amount of pressure could be read as the experiment proceeded upon a gauge attached to the apparatus.

Some preliminary trials made upon the 5th of May showed that the press would work satisfactorily, and that the form of thermometer proposed would answer the purpose.

These preliminary trials showed that, even in the thermometers with protected bulbs, a forward movement of the index of from 0·5 to 1° F. occurred during each experiment. This, however, I believed was caused, not by any compression of the bulb, but by a real rise of temperature, due to the heat developed by the compression of the water in the cavity of the press.

This surmise was shown to be correct by some additional experiments made last week to determine the point. On this occasion the following thermometers were employed:—

No. 9645. A mercurial maximum thermometer, on Professor Phillips's plan, enclosed in a strong outer tube containing a little spirit of wine, and hermetically sealed.

No. 2. A Six's thermometer, with the bulb *protected*, as proposed by myself, with an outer tube.

No. 5. A Six's thermometer, with a long recurved cylindrical bulb, also *protected* in a similar manner.

No. 1. Six's thermometer, with cylindrical bulb of extra thickness, *not protected*.

No. 3. Six's thermometer, with spherical bulb, extra thick glass, *not protected*.

No. 6. Admiralty instrument, Six's thermometer, ebonite scale, bulb *not protected*.

No. 9651. An ordinary Phillips's maximum mercurial thermometer, spherical bulb, *not protected*.

The hydraulic press was exposed in an open yard, and had been filled with water several hours before. A maximum thermometer,

* See also p. 10.

introduced into a wrought-iron tube filled with water, open at one end to the outer air, closed at the other, where it passed into the water contained in the press, registered $46^{\circ}7$ at the commencement, and 47° at the end of the experiment. Temperature of the external air 49° F.

In commencing the experiment, the seven thermometers under trial were introduced into the water in the cavity of the press, and after a lapse of 10 minutes the indices of each were set, carefully read, and each instrument was immediately replaced in the press, which was then closed, and by working the pump the pressure was gradually raised to $2\frac{1}{2}$ tons upon the inch. It was maintained at this point for 40 minutes, in order to allow time for the slight elevation of temperature caused by the compression of the water to equalize itself with that of the body of the apparatus. At the end of the 40 minutes the pressure was rapidly relaxed. A corresponding depression of temperature was thus occasioned, the press was opened immediately, and the position of the indices of each thermometer was again read carefully; and the water was found to be at a temperature sensibly lower than before the experiment began, by about $0^{\circ}6$ F. By this means it was proved that the forward movement of the index in the protected thermometers, amounting to $0^{\circ}9$, was really due to temperature, and not to any temporary change in the capacity of the bulb produced by pressure.

This will be rendered evident by an examination of the subjoined table of observed temperatures :—

First Series : Pressure $2\frac{1}{2}$ tons per square inch.

Number of Thermometer.	Minimum Index.		Maximum Index.		Maximum Mercury. After.
	Before.	After.	Before.	After.	
Protected - 9645	—	—	47·0	47·7	46·5 46·0
„ - 2	47·0	46·5	46·7	47·6	
„ - 5	47·0	46·3	46·5	47·6	
Mean - -	—	—	—	47·6	
Unprotected - 1	46·7	46·4	46·5	54·0	46
„ - 3	47·0	46·5	46·5	56·5	46
„ - 56	47·0	46·0	47·0	55·5	46
„ - 9651	—	—	46·7	118·5	
Mean - -	46·9	46·3	46·7	—	46·1

Temperature of external air - - 49 49

Temperature of thermometer in press - 46·7 47

In the Phillips's maximum thermometer, with unprotected spherical bulb, No. 9651, the bulb had experienced so great a degree of compression as to drive the index almost to the top of the tube. In all the other unprotected instruments, which had been made with bulbs of unusual thickness, the index had been driven beyond its proper position from $6^{\circ}4$ to $8^{\circ}9$ F. ; and it is obvious that the amount of this error must vary in each instrument with the varying thickness of the bulb and its power of resisting compression.

Notwithstanding the great pressure to which these instruments had been subjected, all of them, without exception, recovered their original scale-readings as soon as the pressure was removed.

It will be seen that the mean rise of temperature indicated by the three protected instruments was $0^{\circ}9$ F., whilst the mean depression registered on removing the pressure amounted upon all the instruments which admitted of its measurement to $0^{\circ}6$, an agreement as close as was to be expected from the conditions of the experiment.

A second set of experiments was made upon the same set of instruments, with the exception of 9651 ; but the pressure was now raised to 3 tons upon the inch ; this was maintained for 10 minutes. When it had risen to $2\frac{3}{4}$ tons a slight report was heard in the press, indicating the fracture of one of the thermometers. On examining the contents of the press afterwards it was found that No. 2 was broken, the others were uninjured. The broken thermometer was the earliest constructed upon the plan now proposed, and it was consequently not quite so well finished as subsequent practice has secured for those of later construction. The results of the trial under the higher pressures showed an increase in the amount of compression experienced by the unprotected instruments, rising in one instance to as much as $11^{\circ}5$ F. With the protected instruments the rise did not exceed $1^{\circ}5$, due, as before, to the heat evolved from the water by its compression.

A pressure of 3 tons, it may be observed, would be equal to that of 448 atmospheres of 15 lb. upon the square inch ; and if it be assumed that the diminution in bulk of water under compression continues uniformly at the rate of 47 millionths of its bulk for each additional atmosphere, the reduction in bulk of water under a pressure of 3 tons upon the square inch will amount to about $\frac{1}{47}$ of its original volume. This probably is too high an estimate, as the rate of diminution would most likely decrease as the pressure increases.

APPENDIX.

Since the date of the foregoing paper some additional trials of deep-sea thermometers have been made, the results of which may be of interest.

The first set of experiments were made in Capt. Toynbee's presence,

and the instruments tested were 12 of Dr. Miller's thermometers. One unprotected deep-sea thermometer (Pastorelli, 73), and one protected with a jacket of mercury (see p. 10) on the plan approved of by Admiral FitzRoy (Negretti, 19); both the latter instruments belong to the office.

The instrument used as "standard" throughout the experiments was the same thermometer as that described in Dr. Miller's paper.

First trial ; pressure $2\frac{1}{2}$ tons per square inch.

28th September 1869.

Number of Thermometer.			Minimum Index.		Maximum Index.		Mercury. After.
			Before.	After.	Before.	After.	
Standard	-	-	-	-	60·5	61·1	Not recorded.
	1	-	60·5	60·5	60·5	62·0	
Protected by spirit jacket.	2	-	60·3	60·1	60·4	61·8	
	3	-	60·3	60·2	60·3	62·0	
	4	-	60·2	60·1	60·3	61·4	
	5	-	60·2	60·2	60·5	61·8	
	6	-	60·2	60·1	60·3	61·5	

Result :—The minimum indices in no case affected by pressure ; the standard rose $0^{\circ}6$, and the maximum indices rose on an average $1^{\circ}37$.

Second trial ; pressure $2\frac{1}{2}$ tons.

Standard	-	-	-	-	61·0	61·3	61·0
	7	-	60·8	60·5	60·8	62·0	60·9
Protected by spirit jacket.	8	-	60·7	60·5	60·8	62·0	60·8
	9	-	60·5	60·3	60·5	61·5	60·5
	10	-	60·4	60·5	60·8	62·0	60·6
	11	-	60·8	60·8	61·0	61·8	60·8
	12	-	60·7	60·5	60·8	62·0	60·6

Result :—Little or no effect upon minimum indices, standard rose $0^{\circ}3$, maximum indices rose $1^{\circ}10$.

Third trial ; pressure $2\frac{1}{2}$ tons.

Number of Thermometer.	Minimum Index.		Maximum Index.		Mercury. After.
	Before.	After.	Before.	After.	
Standard - - -	- - -	- - -	61·2	61·4	—
Pastorelli 73 - -	61·0	61·0	60·8	71·5	61·0

Result :—This thermometer was an ordinary Six's, without protection; the minimum was not moved ; the maximum rose $10^{\circ}\cdot7$; the standard rose $0^{\circ}\cdot2$.

Fourth trial ; pressure 1 ton.

Standard - - -	- - -	- - -	61·2	61·5	—
Negretti, 19 - -	61·0	61·0	61·0	61·5	61·3

Fifth trial ; pressure 2 tons.

Standard - - -	- - -	- - -	61·2	61·6	61·3
Negretti, 19 - -	61·0	61·3	61·0	62·6	61·3

Sixth trial ; pressure $2\frac{1}{2}$ tons.

Standard - - -	- - -	- - -	61·5	61·8	61·5
Negretti, 19 - -	61·2	61·0	61·2	63·0	9·19

One ton had no sensible effect on this instrument ; two tons raised the maximum index $1^{\circ}\cdot6$; and $2\frac{1}{2}$ tons raised it $1^{\circ}\cdot8$. The result of the experiments with this thermometer shows that as regards power of resisting compression it is fully comparable with the new instruments.

It is noticeable that the standard rose the same amount $0\cdot3$ under all pressures. This may be due to heat developed by friction or compression. Regarding it as such, the following resumé shows the effect of compression or pressure *per se*.

				Thermometer Rise due to			Tons per Inch.
				Heat and Pressure.	Heat.	Pressure.	
Standard	-	-	-	0·6	0·6	0·0	2½
1	-	-	-	1·5	„	0·9	„
2	-	-	-	1·4	„	0·8	„
3	-	-	-	1·7	„	1·1	„
4	-	-	-	1·1	„	0·5	„
5	-	-	-	1·3	„	0·7	„
6	-	-	-	1·2	„	0·6	„
Standard	-	-	-	0·3	0·3	0·0	„
7	-	-	-	1·2	„	0·9	„
8	-	-	-	1·2	„	0·9	„
9	-	-	-	1·0	„	0·7	„
10	-	-	-	1·2	„	0·9	„
11	-	-	-	0·8	„	0·5	„
12	-	-	-	1·2	„	0·9	„
Standard	-	-	-	0·2	0·2	0·0	„
73	-	-	-	10·7	„	10·5	„
Standard	-	-	-	0·3	0·3	0·0	1
19	-	-	-	0·5	„	0·2	„
Standard	-	-	-	0·3	0·3	0·0	2
19	-	-	-	1·6	„	1·3	„
Standard	-	-	-	0·3	0·3	0·0	2½
19	-	-	-	1·8	„	1·5	„

Two other thermometers were tested on the 8th of December, and the results present some features of interest.

Thermometers by Casella, Nos.		Minimum Index.		Maximum Index.		Mercury. After.	Pressure on the Square Inch.
		Before.	After.	Before.	After.		
1st Trial	Stand. 9,645	—	—	48·9	49·0	49·0	Tons. 1¾
	11,678	48·5	48·5	48·7	49·3	48·6	1¾
	11,679	48·5	48·5	48·8	49·1	48·6	1¾
2nd Trial	Stand. 9,645	—	—	48·4	48·5	47·6	2½
	11,679	48·3	47·6	48·3	49·0	47·6	2½
3rd Trial	Stand. 9,645	—	—	47·9	47·9	47·2	2½
	11,678	47·5	47·2	47·5	48·4	47·2	2½

—	Rise of Thermometer due to			Tons per Inch.
	Heat and Pressure.	Heat.	Pressure.	
9645	0·1	0·1	—	1 $\frac{3}{4}$
11678	0·6	0·1	0·5	1 $\frac{3}{4}$
11679	0·3	0·1	0·2	1 $\frac{3}{4}$
9645	0·1	0·1	—	2 $\frac{1}{2}$
11679	0·7	—	0·6	2 $\frac{1}{2}$
9645	— 0·7	— 0·7	—	2 $\frac{1}{2}$
11678	0·9	„	1·6	2 $\frac{1}{2}$

It will be noticed that the change of reading of the standard thermometer was not constant, as in some of the experiments a rise of 0°·1 was observed, while in one a fall of 0°·7 was recorded. This latter result is probably due to the fact that the hydraulic press was not in very good order, so that a large quantity of water at a lower temperature than the surrounding air had to be drawn through the apparatus before the pressure began to act on the gauge.

The foregoing experiments are sufficient to show that the new instruments perform satisfactorily, and also that the original thermometers described by Admiral FitzRoy were good and trustworthy instruments in so far as regards their capability of resisting pressure.

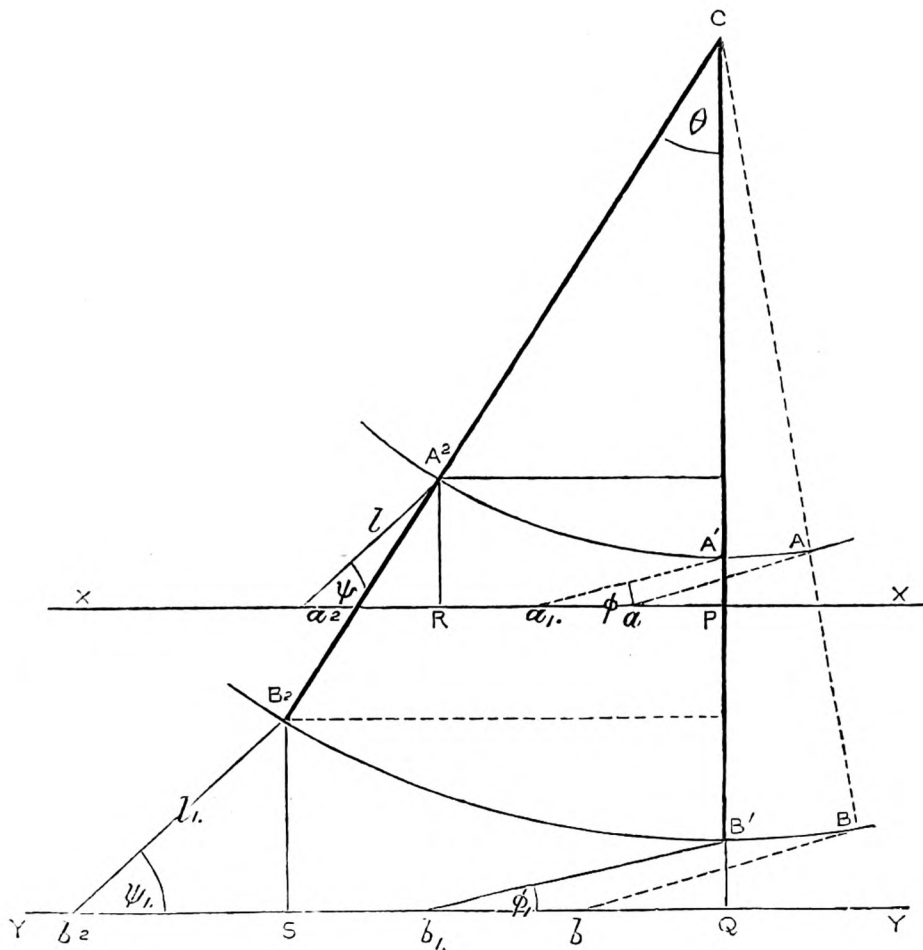
No. II.

On the PRINCIPLE of the PANTAGRAPH designed by F. GALTON.

In the pantagraph I have designed to reduce the tracings of the various self-recording meteorological instruments, the reduction is effected by two separate but similar actions, in length and in breadth. One hand of the operator controls the movements from side to side of the original tracing and of the plate that receives the reduced figure; the other hand controls the movements up and down of the style that passes over the original figure, and of the point that scratches the reduced copy. In both cases the reduction is effected by means of an arm connected through links with carriages compelled to run along parallel lines.

The following analysis shows the conditions of length and position that have to be observed in making and adjusting the instrument, and I shall now restrict my explanation to this, because although the existing instrument works very satisfactorily, yet the new one (which is not yet sufficiently finished to

make a drawing from) will be its superior in range of adjustment and in many other points of detail. It is therefore advisable to delay the description until the new instrument shall have been some time at work, and its appurtenances brought into perfect order.



$C A B$ is an arm which can be moved round C to any desired position as $C A_1 B_1$ or $C A_2 B_2$.

a is a point on a carriage that moves along a tramway, or is otherwise guided, so that it may be pushed to any desired position in the line $X X$, but nowhere else. It is connected with $C A B$ by a link $A a$, and therefore assumes the positions $a_1 a_2$, corresponding to the positions of the arm $C A_1 B_1$, $C A_2 B_2$.

Similar arrangements are made in respect to B , and the two tramways are made parallel to one another.

Required to find the conditions, if any, that will cause the movements of a and b to bear a uniform proportion to one another.

Take $C A_1 B_1$ perpendicular to the tramways, and let $C A_2 B_2$ be any other position of the arm. Let fall the perpendiculars $A_2 R$ and $B_2 S$.

Call the vertical angle θ ; call the angle $A_2 a_2 P$, ψ ; the angle $A_1 a_1 P$, ϕ ; and the link $A a$, l .

Let the corresponding values in the arrangement connected with B , be ψ_1 , ϕ_1 , and l_1 .

Now ψ is known in terms of the rest, because

$$(1) \quad l \sin \psi = C A \text{ versin } \theta + l \sin \phi, \text{ and so for } \psi_1,$$

therefore our problem is to find the relations (if they exist) between φ and φ_1 ; l and l_1 ; CA and CB ; that shall ensure the space of $a_1 a_2$ to bear a constant relation to $b_1 b_2$, = say $\frac{1}{c}$, for all values of θ .

$$\begin{aligned} a_1 a_2 &= Pa_2 - Pa_1 = Ra_2 + RP - Pa_1 \\ b_1 b_2 &= Qb_2 - Qb_1 = Sb_2 + SQ - Qb_1 \end{aligned}$$

$$\frac{a_1 a_2}{b_1 b_2} = \frac{l \cos \psi + CA \sin \theta - l \cos \varphi}{l_1 \cos \psi_1 + CB \sin \theta - l_1 \cos \varphi_1} = \frac{1}{c}$$

but from (1) $l \cos \psi = l \sqrt{1 - \sin^2 \psi} = \sqrt{l^2 - (l \sin \varphi + CA \text{ vers. } \theta)^2}$
and similarly for $l_1 \cos \psi_1$

therefore $\frac{\sqrt{l^2 - (l \sin \varphi + CA \text{ versin } \theta)^2} + CA \sin \theta - l \cos \varphi}{\sqrt{l_1^2 - (l_1 \sin \varphi_1 + CB \text{ versin } \theta)^2} + CB \sin \theta - l_1 \cos \varphi_1} = \frac{1}{c}$

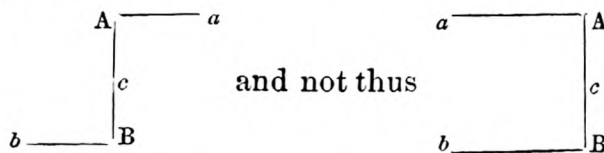
First, we see that these values can be real only so long as $l \sin \varphi + CA \text{ versin } \theta$ (or $A_2 R$) is less than l ; or the distance between A and the tramway is less than the length of the link, a fact which is evident enough on inspection of the figure.

Secondly, the equation holds for the combined values

$$\varphi = \varphi_1, \frac{l}{l_1} = \frac{1}{c}, \frac{CA}{CB} = \frac{1}{c}, \text{ and for no other ones.}$$

We may simplify the conditions yet further, by making $\varphi = \varphi_1 = 0$; that is to say, by so arranging the instrument that the link shall be parallel to the tramway when $CA B$ is perpendicular to it; in this case the adjustment of $\frac{CA}{CB} = 1$ must be made by varying the position of C , while those of A and of B remain intact. This is the arrangement adopted in the pantographs already made.

If it be desired that $\frac{1}{c}$ should be negative, or $\frac{l}{l_1} = -\frac{1}{c}$, and $\frac{CA}{CB} = -\frac{1}{c}$, i.e., that the movements of the arms should be in contrary directions, or that the reduction should be reversed, then $l = -\frac{l_1}{c}$ and $CA = -\frac{CB}{c}$ consequently both l_1 and CB having opposite signs to l and CA , the arms will lie thus:—



First adjustment:—To find the position of C so that $\frac{CA}{CB}$ shall = $\frac{1}{c}$

(1) When A lies between C and B

$$\frac{CA}{CB} = \frac{CA}{CA + AB} = \frac{1}{c}, \text{ or } CA(c-1) = AB, CA = \frac{AB}{c-1}$$

(2) When C lies between A and B (reverse action)

$$\frac{CA}{CB} = \frac{CA}{AB - AC} = \frac{1}{c}, \text{ or } CA = \frac{AB}{c+1}.$$

Hence AB ought to be divided into some convenient number of graduations, and one that is divisible in many ways, such as 60; and

the graduations should be numbered from A towards B. The same scale of divisions should be continued on the other side of A, and those graduations should be separately numbered, beginning also from A. It is then easy to find the position of c . For example, if it be required to reduce to $\frac{1}{4}$, $c = \frac{1}{4}$.

(1) Direct reduction : Set C among the upper graduations at $\frac{60}{4-1}$ or at 20; then $CA = 20$, $CB = CA + AB = 80$, and $\frac{CA}{CB} = \frac{20}{4 \times 20}$

(2) Reverse reduction : Set C among the lower graduations at $\frac{60}{4+1}$ or at 15; then $CA = 15$, $CB = 60$, and $\frac{CA}{CB} = \frac{15}{4 \times 15}$.

Second adjustment :—To find the position of a so that $\frac{Aa}{Bb}$ shall = $\frac{1}{c}$, it being, at the same time, required that CB and Bb shall remain intact. Since, in the two triangles CAa, CBb, the sides CA, Aa are proportional to CB, Bb, and since CAa, CBb are right angles, as also the vertical angles at C are identical in case (1) and equal in case (2), it follows that the triangles are similar, and that Cab is a straight line. Consequently, after making the adjustment described in the last paragraph, of $\frac{CA}{CB} = \frac{1}{c}$, we have simply to shift a into the line Cb, and the adjustment is complete.

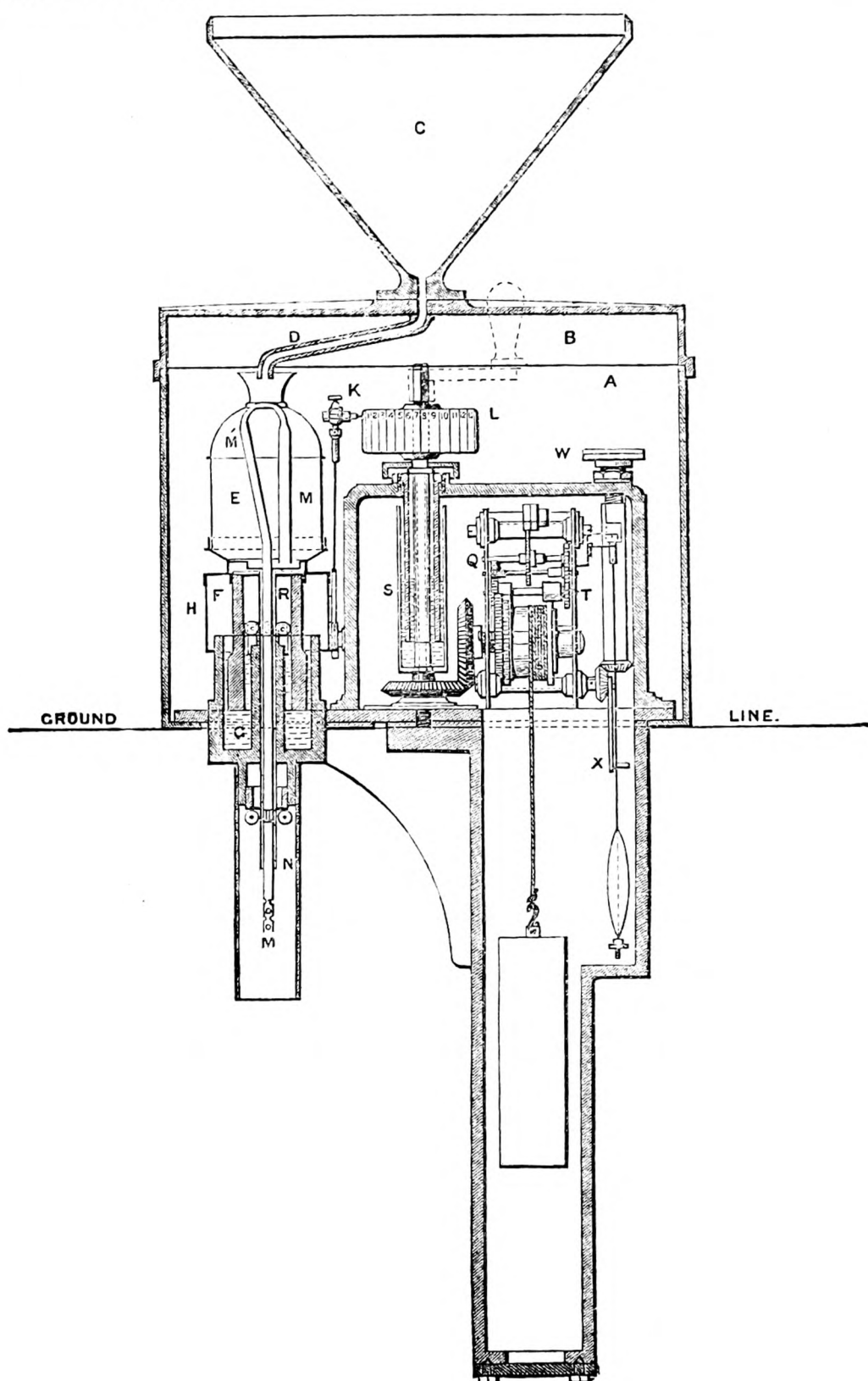
These adjustments of C and of a are mechanically effected on the same principle that is employed in shifting the centre of the well-known instrument, the proportional compasses.

FRANCIS GALTON.

No. III.

DESCRIPTION of a SELF-RECORDING RAIN-GAUGE, invented by ROBERT BECKLEY, of the Kew Observatory ; made by JAMES HICKS, London.

The instrument is shown in the annexed plate, a section being given of the whole :—



(A) is a cubical box of thin cast iron, 13 inches square and 11 deep, furnished with a loosely-fitted hinged cover (B). The top of the cover is stiffened by four ribs which meet at a boss in the centre, into which the funnel (C) is screwed. The funnel is also of cast iron, but its interior surface after having been turned is enamelled, in order to prevent rusting. It is provided with a lip to retain the splashes, which is $1\frac{1}{4}$ inches deep, and is turned accurately to a circle of $11\frac{1}{4}$ inches diameter, giving an area of exposure of 100 square inches. A small aperture in the bottom of the funnel opens into a pipe (D), which conducts the water, as it is collected, into the copper bottle or receiver (E); this is supported by a hollow ebonite cylinder (F) floating in mercury contained in the annular vessel or cistern (G). As water enters the receiver the float descends in the cistern, displacing more mercury the further it goes; the relation between the area of the cistern and float being so proportioned that the entrance of equal quantities of water into the vessel (E) shall cause its descent to take place through equal spaces. A cover (H) fixed to the top of the float supports on one side a spring, the upper extremity of which is adapted to hold a pencil (K) which presses against a cylinder (L) covered with waterproof paper, marking on it vertical lines as the float with the receiver rises and falls. When the level of the water in the receiver reaches the neck of the vessel (E), which has then descended to its lowest point, the syphon (M) comes into play, and rapidly discharging the water, enables the receiver to rise and resume its original position, while at the same time the pencil (K) marks a line from the bottom to the top of the cylinder. As the receiver (E) has a capacity of 20 cubic inches this occurs whenever two-tenths of an inch of rain has fallen. The syphon (M) acts on the principle of the intermittent syphon, modified and adapted so as to enable it to act accurately and with certainty in the present case. As the water enters the vessel (E) it rises in the short leg (M) of the syphon, driving the air before it through the long leg (M' M''). This continues until it reaches the bend at the top, when it flows down the long leg and brings the syphon into play, and then runs until the vessel (E) is quite emptied (a small depression in the bottom materially assisting it), and the air can enter at the lower extremity of the short leg. The flattened contracted bend of the syphon answers the double purpose of preventing the entrapment of an air-bubble in the bend, and also of ensuring that the vessel shall always be emptied immediately the water in it arrives at a constant fixed height, while at the same time sufficient area is left not to retard the flow of water through it. In order to prevent the retention of a few drops of water by capillary action in the lower extremity of the tube several small apertures are made at M''; these, by admitting air and also allowing the lateral escape of the fluid, effectually prevent all stoppage from this cause. The action of the syphon as thus constructed is so certain and constant that it is found on experiment that if the water running out of the

receiver, when it is discharging itself, be caught in some vessel and returned to the receiver, the syphon will not commence to act until the last drop is poured back. The long leg of the syphon, on issuing from the under side of the receiver (E), passes down a brass tube (N N), through the centre of the mercury cistern guided by rollers (R) fixed to the cistern, which serve to keep the float and receiver perfectly vertical and central. In the experimental forms of this instrument some difficulty was caused by the oxidation of the surface of the mercury in the cistern preventing the moving of the float with sufficient ease and freedom; but a suggestion of Mr. Hicks completely removed this source of annoyance. It consists in pouring a small quantity of glycerine over the surface of the mercury, which by acting in a measure as a lubricating fluid causes the movement of the float to be extremely delicate. The registering part of the apparatus consists of a clock (Q) turning a cylinder (L) at an uniform rate, the pencil (K) marking on the cylinder. The pencil is a piece of ordinary black-lead pencil fixed in a holder capable of being raised and lowered by an adjusting piece. This piece is fastened to the top of a flat metal spring which terminates below in a small brass bar screwed to the cistern cap, and running up and down between two friction rollers (R) to destroy any lateral movement. The cylinder (L) fits easily on the clock spindle, but is capable of being fixed in any position on it, and the paper with which it is surrounded is divided by engraved lines into 24 hour spaces. The clock (Q) is contained in a hermetically closed case, the two places where communication takes place between the interior and exterior being guarded by mercurial stuffing boxes (S and T). S is the vertical axis supporting and giving motion to the cylinder, being driven round by the clock once every day. By means of a peculiar adaptation of the wheel-work of the clock a reversal of this motion winds it up, a handle (shown by dotted lines in the figure) being temporarily fitted on to the end of it, which is made square for that purpose. The upper bearing of this axle is formed of a tube which surrounds it loosely for the greater part of its length. This tube is again contained in a larger tube closed at the lower extremity and fastened to the axis. Mercury is then poured into the tube, half filling it, and so preventing the passage of air either into or out of the clock case, but allowing it to expand under varying changes of temperature, whilst at the same time freedom from friction of the axle in its bearings is retained. A similar arrangement at T serves to put the pendulum in motion. On turning the milled head (W) on the exterior of the case, movement is imparted by bevelled wheels to a small arm (X), which pressing against the pendulum rod forces it out of its vertical position; immediately the pressure is removed from the head (W) the arm (X) falls back to its original place by its own weight, leaving the pendulum vibrating freely. The clock case is recessed at the bottom to a sufficient depth to allow the weight to fall for one day. The clock mechanism can readily be altered so as to go

any number of days, and the time scale can be made of any desired length ; but in the present instrument the time scale adopted is that chosen by the Meteorological Committee for their other self-recording instruments.

The rain-gauges supplied by the office to the telegraphic reporting stations are on Glaisher's pattern, but have been improved in construction. They are of copper, and are neither painted nor japanned. Their aperture is circular, 8 inches in diameter. The measuring glasses are of uniform pattern, and are carefully tested before issue. The receiver of the gauge is made deep enough to collect at least 8 inches of snow. It has a straight sharp edge without any flange or shoulder, so that there can be no possibility of the rain splashing in or out. The receiver fits *on* not *into* the vessel containing the collecting can, so that no water can be blown into this can at the joint.

APPENDIX.

APPENDIX I.

METEOROLOGICAL OFFICE REVENUE and EXPENDITURE ACCOUNT
for the year ending 31st March 1870.

Dr.	REVENUE.	EXPENDITURE.	Cr.
To Parliamentary Vote -	£10,000 0 0	OFFICE :	
„ Balance from year		By Salary of Director -	£800 0 0
1868-9 -	1,743 11 3	„ Secretary to	
„ Earl of Stair -	4 5 0	Committee -	400 0 0
„ Proprietors and		„ Two Clerks -	209 7 6
Fishermen of		„ Office-keeper and Mes-	
Downies -	4 5 0	senger -	152 13 9
„ H. Lee & Sons -	2 10 0		£1,562 1 3
„ W. W. Rundell -	12 12 6	„ Rent of Office -	376 17 0
„ G. Dornbusch -	10 0 0	„ Furniture and Fittings -	751 15 9
„ J. Balbirnie -	4 5 0	„ Postage -	90 19 7
„ Hill & Price -	5 10 0	„ Printing, &c. -	44 17 3
„ Rev. C. H. Griffith -	2 10 0	„ Travelling Expenses -	9 11 11
Telegraph Mainte-		„ Fuel and Gas -	19 19 11
nance, &c. Company	3 0 4	„ Attendance, Cleaning,	
„ Rev. J. T. Waller -	0 10 8	and other Contin-	
„ Cork Harbour Com-		gencies -	110 2 2
missioners -	4 11 0		1,404 3 7
„ Capt. J. Wessendorff	4 5 0	LAND METEOROLOGY :	
„ J. G. Gamble -	2 10 0	By Expenses at Observa-	
„ Sale of old instru-		tories -	2,277 3 9
ments -	29 6 9	„ New Instruments for do.	519 15 2
„ Sale of Signal Staff -	1 9 9	„ Computations -	377 6 3
„ Interest on deposit			3,174 5 2
account -	70 3 5	„ Telegrams -	2,193 16 7
		„ Inspections and other	
		Expenses -	87 9 11
		„ Computations -	357 13 7
			2,639 0 1
		OCEAN METEOROLOGY :	
		By Marine Superintendent	400 0 0
		„ Supply and Return of	
		Instruments :	
		Admiralty -	111 13 6
		Mercantile Marine -	262 8 5
		„ Computations and Care	
		of Instruments -	864 19 7
			1,639 1 6
			10,418 11 7
		„ Cash in hand -	35 12 7
		„ Advance to Valencia	
		Observatory -	50 0 0
		„ Bank of England	
		account -	285 5 1
		„ London and Westmin-	
		ster Bank -	1,115 16 5
			1,486 14 1
			£11,905 5 8
	£11,905 5 8		

Examined and compared with the vouchers and found correct.

(Signed) J. P. GASSIOT,
W. SPOTTISWOODE, } Auditors.

4 May 1870.

APPENDIX II.

The number of ships supplied during the year 1869 was 54, of which number 13 belonged to the various steam-ship companies now collecting observations for this office.

The above statement does not refer to ships in the Royal Navy, all of which are supplied with meteorological instruments from the office.

In addition to the registers returned from the ships referred to, documents amounting altogether to 36 in number have been registered during the year 1869, containing observations made at the following places:—

Place.	Observer.	Nature of Observations.
Australia (west coast) -	Lighthouse -	Lighthouse Registers (2 stations).
Bermuda -	Dockyard Authorities -	Anemometrical Records.
Brazil -	Rev. C. J. Nicolay -	Daily observations of barometer and thermometer, and remarks on winds and weather ; years 1858-9 and 1861-2.
Ceylon (Point de Galle) -	D. Blyth (Master Attendant)	Daily observations and monthly means.
Falkland Islands (Cape Pembroke)	Lighthouse -	Lighthouse register.
London (Charing Cross) -	W. Bone -	Daily observations (corrected and reduced) and diagrams ; year 1844.

APPENDIX II.—A LIST of DOCUMENTS received from SHIPS during the year 1869.

Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
Aird, A. D.*	S.S. Nestorian	1,528	Allan Brothers, Glasgow	Five voyages to and from Quebec	3
Angel, John	Twilight	630	E. Bates, Liverpool	To and from Bombay	8
Balderston, R. I.	Bowfell	1,001	T. & R. Brocklebank, Liverpool	To and from Calcutta	6
Ballantine, W.	S.S. Peruvian	1,432	Allan Brothers, Glasgow	Seven voyages to and from Montreal	7
Beal, T. S.†	S.S. Ruahine	1,018	P. N.Z. & A. R.M. Co.	Four voyages from Sydney to Wellington and Panama, and three returns.	8

* Meteorological Register was kept chiefly by G. Scott, 1st Officer.
+ " " by J. L. Stalker, 2nd Officer.

* +

LIST of DOCUMENTS, &c.—continued.

Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
Hayes, James	S.S. Cassini	687	Brazil and River Plate S.N. Co.	Two voyages to and from Monte Video, &c.	6
"	S.S. Ptolemy	758	Brazil and River Plate S.N. Co.	Two voyages to and from Rio Janeiro, &c.	4
"	"	758	Brazil and River Plate S.N. Co.	To and from Buenos Ayres, &c.	3
Henderson, Henry	Hope	454	J. Robinson	Shanghai to Newchwang, Swatow, Hong Kong, London.	8
Hicks, G. W.*	Indus	1,319	R. M. S. P. Co., London	To and from Bombay	7
Hillyar, F.†	Octavia	3,161	H.M.S.	Madeira to Sierra Leone, Cape of Good Hope, and Bombay.	4
Hunter, David	S.S. Alpha	514	W. Cunard, Halifax	Six voyages from Halifax to Bermuda, St. Thomas, and back.	4
"	S.S. Alpha	514	W. Cunard, Halifax	Eleven voyages, Halifax to Bermuda, St. Thomas, and back.	7
Irringer (Admiral)	Danish ships	—	-	Sea temperature between Greenland and Shetland.	—
Jones, A. A.	Victoria Nyanza	1,022	J. Prowse, Liverpool	To and from San Francisco	8
Judkins, C. H. E.‡	S.S. Scotia	2,125	Burns & MacIver, Liverpool	To and from New York	1
"	"	2,125	Burns & MacIver, Liverpool	Four voyages to and from New York	3
Le Messurier, F.	S.S. Tripoli	1,401	Burns & MacIver, Liverpool	Eight voyages to, and nine from New York	6
Lott, E. G.§	S.S. Samaria	1,695	J. Burns, Glasgow	To and from New York	1
Martyn, J. A.	S.S. Siberia	1,698	J. Burns, Glasgow	Four voyages to and from New York	4
Mayne, R. C.; C.B.¶	Nassau	695	H.M.S.	On coast of South America, thence to England.	16
Moodie, E. R.	S.S. Cuba	1,534	Burns & MacIver, Liverpool	Eight voyages to, and nine from New York	8
Moore, J. S. L.	Prince Albert	—	Hudson Bay Co.	To and from Hudson Bay	4
Morton, J. D'Arcy	Henry Bath	490	H. Bath & Son, Swansea	To and from Coquimbo	8
Mossop, Clement	Candahar	1,418	T. & R. Brocklebank, Liverpool	To and from Calcutta	7
Murphy, Michael	S.S. Siberia & Tarifa	—	Burns & MacIver	Nine voyages to and from New York, via Boston.	8
Nelson, J. E.	Philip Nelson	547	P. Nelson, Liverpool	To Bombay, and from Cochin	8

* Meteorological Register was kept chiefly by S. W. Hoddings, 2nd Officer.

by Thomas Pounds, Staff Commander.

by W. Greenwood.

by D. G. Tandy, Lieutenant.

APPENDIX III.

INSTRUMENTS supplied, &c. to the Royal Navy.

	Baro- meters.	Ane- roids.	Thermometers.			Hydro- meters.
			Ordinary.	Max.	Min.	
January 1st, 1869, afloat - - -	188	416	806	10	12	161
Issued in 1869 - - -	38	74	213	28	22	24
Returned in 1869 - - -	226 56	490 111	1,019 213	38 31	34 20	185 42
January 1st, 1870, afloat - - -	170	379	806	7	14	143

INSTRUMENTS supplied, &c. for use at Naval Stations, and by Admiralty Surveys by Shore Parties, &c.

January 1st, 1869, in use - - -	63	81	133	32	30	39
Issued in 1869 - - -	4	11	19	2	3	—
Returned in 1869 - - -	67 14	92 31	152 55	34 16	33 14	39 24
January 1st, 1870, in use - - -	53	61	97	18	19	15

DISPOSITION of ADMIRALTY INSTRUMENTS on January 1st 1870.

	Baro- meters.	Ane- roids.	Thermometers.			Hydro- meters.
			Ordinary.	Max.	Min.	
Afloat in Royal Navy - - -	170	379	725	7	14	143
At stations for use - - -	53	61	97	18	19	15
In store, at M.O. - - -	171	105	224	62	56	161
" Chatham - - -	2	5	18	2	2	17
" Sheerness - - -	14	14	33	14	13	9
" Portsmouth - - -	18	15	29	5	4	18
" Devonport - - -	7	11	23	3	4	42
" Queenstown - - -	1	4	6	2	2	8
" Gibraltar - - -	4	4	6	1	1	4
" Malta - - -	2	9	47	2	2	28
" Halifax - - -	5	5	20	—	—	4
" Bermuda - - -	6	7	9	1	1	16
" Jamaica - - -	6	4	7	2	1	8
" Ascension* - - -	2	4	7	—	—	—
" Cape of Good Hope - - -	3	9	—	—	—	16
" Hong Kong† - - -	10	24	45	—	—	24
" Vaiparaiso‡ - - -	4	1	23	2	2	16
Total, per account - - -	478	661	1,319	121	121	529
Lost, &c. during 1869 - - -	27	34	179	23	16	45

* No return has been made since 20th October 1868.

† No return has been made since 1st January 1868.

‡ No return has been made since 1st January 1869.

APPENDIX IV.

INSTRUMENTS supplied, &c. to the Mercantile Marine.

—	Baro- meters.	Com- passes.	Thermometers.			Hydro- meters.
			Ordinary.	Max.	Min.	
January 1st, 1869, afloat -	62	12	393	—	—	254
Issued in 1869 - -	52	4	305	—	—	197
	114	16	698	—	—	451
Returned in 1869 -	45	8	268	—	—	168
	69	8	430	—	—	283
January 1st, 1870, afloat -						

INSTRUMENTS in use at Stations, viz., Telegraph Offices, Lighthouses,
Observatories, Navigation Schools, &c.

January 1st, 1869, in use	101	7	254	40	39	55
Issued in 1869 - -	20	1	40	6	11	10
	121	8	294	46	50	65
Returned in 1869 -	27	3	70	11	14	7
	94	5	224	35	36	58
January 1st, 1870, in use						

DISPOSITION of Board of Trade INSTRUMENTS.

In merchant ships -	68	8	430	—	—	283
In naval ships -	—	—	81	—	—	—
In use at stations -	94	5	224	35	36	58
In store at M.O. -	69	36	158	7	6	72
„ Gibraltar -	—	—	12	—	—	—
At Southampton agency -	2	2	7	—	—	8
„ Liverpool „ -	10	9	33	—	—	50
„ Hull „ -	3	—	18	—	—	12
„ Aberdeen „ -	1	—	20	—	—	12
	247	60	983	42	42	495
Total, 1st Jan. 1870 -						
Lost, &c. during 1869	19	5	192	10	10	81

APPENDIX V.

LIST of STATIONS reporting Meteorological Observations by Telegraph to the Office, with the Observers.

Thurso*	-	-	J. Trotter	-	-	-	-	
Wick	-	-	J. Sandison	-	-	-	-	Postmaster.
Nairn	-	-	W. D. Penny	-	-	-	-	Schoolmaster.
Aberdeen	-	-	J. Gibson	-	-	-	-	Telegraph Superintendent.
Leith	-	-	T. Bolton	-	-	-	-	Telegraph Clerk.
Shields	-	-	T. Allaway	-	-	-	-	Do.
Scarborough	-	-	F. Shaw	-	-	-	-	Do.
Yarmouth	-	-	T. Robinson	-	-	-	-	Do.
Ardrossan	-	-	W. McNeil	-	-	-	-	Do.
Greencastle	-	-	J. Kelly	-	-	-	-	Do.
Holyhead	-	-	J. Andrews	-	-	-	-	Do.
Liverpool	-	-	S. Jones	-	-	-	-	Do.
Valencia	-	-	E. O'Sullivan	-	-	-	-	Do.
Cape Clear	-	-	G. Griffin	-	-	-	-	Do.
Roche's Point	-	-	W. Kennedy	-	-	-	-	Do.
Pembroke	-	-	J. C. Walker	-	-	-	-	Do.
Penzance	-	-	J. Senior	-	-	-	-	Do.
Plymouth	-	-	W. Pinchin	-	-	-	-	Do.
Portsmouth	-	-	T. Hardy	-	-	-	-	Do.
London†	-	-	Clerks in Meteorological Office					
Heart's Content	-	-	J. Weedon	-	-	-	-	Telegraph Superintendent.

* This station has been added since 31st December 1869.

† Reports not sent by telegraph.

APPENDIX VI.

LIST of Persons, Places, &c. to which the Daily Weather Report is supplied.

Newspapers :

Daily News.
Echo.
Express.
Globe.
*Lloyd's Shipping List.
Observer.
*Pall Mall Gazette.
Shipping and Mercantile Gazette.
Standard (Morning and Evening).
Times (1st and 2nd edition).

For Exhibition at following Seaports :

Banff.	Hayle.
Belfast.	Hull.
Blackpool.	*Newquay.
Buckie.	Port Dinorwic.
Carnarvon.	Porthcawl.
Cromer.	Silloth.
Cullen.	Teignmouth.
Exeter (2 copies).	Ventnor.
Great Grimsby.	

* Added since 31st December 1869.

Societies, &c. :

Association of Underwriters, Liverpool.
 Do. Lloyd's.
 Calcutta, Meteorological Committee.
 Patent Office, London.
 *Press Association.
 Royal Society.
 Scottish Meteorological Society.

Individual Observers, in co-operation, &c. :

Barnes, R. H., Kensington.
 Griffith, Rev. C., Strathfield Turgiss.
 Hoskins, Dr. S. E., Guernsey.
 Mansell, J. C., Longthorns.
 Moore, Dr. J. W., Dublin.
 Richards, W. H., Penzance.
 Tennent, R., Edinburgh.

Foreign Places :

Christiania, Meteorological Institute.
 Constantinople, Imperial Meteorological Observatory.
 Florence, Ministry of Agriculture.
 Hamburg, North German Ocean Observatory.
 Paris, Imperial Observatory.
 „ Meteorological Observatory, Montsouris.
 „ Meteorological Society.
 „ Ministry of Marine.
 St. Petersburg, Central Physical Observatory.
 Upsala, University Observatory.
 Utrecht, Royal Meteorological Institute.
 Vienna, Imperial Observatory.
 Washington, United States Naval Observatory.

* Added since 31st December, 1869.

APPENDIX VII.

TELEGRAPHIC WEATHER INTELLIGENCE.

The following stations, having been approved by the Board of Trade, are supplied with telegraphic information of storms free of expense, and "drum" signals have been furnished to most of them, all further expenses attendant on the maintenance and repair of the apparatus being borne locally. The stations are situated, 70 in England, 26 in Scotland, and 10 in Ireland.

NORTH.	WEST.	SOUTH.	EAST.
Inverness.	Douglas.	Plymouth.	Tynemouth.
Nairn.	Maryport.	Teignmouth.	Sunderland.
Burghead.	Workington.	Exeter.	Middlesborough.
Lossiemouth.	Whitehaven.	Exmouth.	Redcar.
Buckie.	Barrow.	St. Helier } Jersey.	Whitby.
Portsoy.	Morecambe.	Gorey }	Filey.
Banff.	Fleetwood.	Cowes.	Withernsea.
Fraserburgh.	Blackpool.	Ventnor.	Hull.
Peterhead.	Lytham.	Portsmouth.	Goole.
Aberdeen.	Runcorn.	Littlehampton.	Grimsby.
Stonehaven.	Southport.	Brighton.	Boston.
Montrose.	Liverpool.	Hastings.	Lynn.
Broughty Ferry.	Queensferry.	Rye.	Cromer.
Dundee.	Mostyn.		Yarmouth.
Anstruther.	Holyhead.		Ipswich.
Alloa.	Port Penrhyn.		Harwich.
Grangemouth.	Carnarvon.		Chatham.
Granton.	Aberystwith.		Sheerness.
Leith.	Milford.		Faversham.
Fisherrow.	Pembrey.		Dover.
Dunbar.	Llanelly.		
Eyemouth.	Briton Ferry.		
	Porthcawl.		
	Penarth.		
	Cardiff.		
	Newport.		
	Weston-super-Mare.		
	Burnham.		
	Ilfracombe.		
	Barnstaple.		
Glasgow.	Fremington.		
Greenock.	Instow.		
Campbelton.	*Newquay.		
Girvan.	Hayle.		
	Pendennis.		
	Penzance.		
	Falmouth.		
	Belfast.		
	Howth.		
	Kingstown.		
	Dungarvan.		
	Youghal.		
	Queenstown.		
	Cork.		
	Passage.		
	Tralee.		
	Galway.		

* This station added since 31st December 1869.

APPENDIX VIII.

CIRCULAR No. 278. M. 8542.

TELEGRAPHIC WEATHER INFORMATION.

SIR,

Board of Trade, 30 Nov. 1867.

I AM directed by the Board of Trade to acquaint you, that they have been informed by the Meteorological Committee appointed by the Royal Society, that that Committee are now prepared to issue, free of cost, to ports or fishing stations which are accessible by telegraph, notice of serious atmospheric disturbance on the coasts or in the vicinity of the British Islands.

The conditions on which these notices will be issued, are as follows, viz. :—

They will be forwarded in each case as soon as information of the atmospherical disturbance shall have been received at the Meteorological Office, and the ports or fishing stations to which they are to be sent will be determined by the Board of Trade.

When the list of places to which notices may be sent has been determined by the Board of Trade, it will rest with the Meteorological Committee, in each case of atmospheric disturbance, to send notices to all or any of those places, as the circumstances of the particular case may appear to the Meteorological Office to be advisable.

When a telegraphic notice of atmospherical disturbance is received at one of the places named on the Board of Trade list, its receipt is to be made public by hoisting one of the late Admiral FitzRoy's drums, and the drum is to remain hoisted for 36 hours after the receipt of the telegraph message containing the notice.

One telegraphic notice implies that the drum is to remain hoisted for 36 hours, and no longer.

Should the Meteorological Committee think it necessary that a drum should remain hoisted for more than 36 hours in any case, they will send messages to that effect, and continue them from day to day so long as it appears desirable, or until the storm shall have abated.

If the authorities at any port or fishing station wish to receive intelligence of atmospherical disturbances, and will undertake to hoist the drum, subject to the conditions named, and subject to such regulations or directions as may from time to time be issued by the Meteorological Office, an application should be addressed to the Secretary to the Meteorological Committee, 2, Parliament Street, Westminster, S.W.,* in order that the necessary steps may be taken to place the name of the station on the Board of Trade list, and to provide the flagstaff and drum.

It is to be understood that where the place or station can pay for a flagstaff and drum they will be expected to do so, if a staff and drum are not already provided; and that where it is made to appear to the Board of Trade that no staff and drum are provided, and that the place is too poor to bear the expense, then the cost will be defrayed by the Meteorological Office, with the sanction of the Board of Trade.

But in all cases, whether the first cost of the flagstaff and drum are or are not borne by the local authorities, the local authorities must undertake to bear all subsequent charges connected with the hoisting of the signal, and the maintenance of the signal apparatus.

The only subsequent expense that will be defrayed by the Meteorological Office will be the charge for transmission of the notices of atmospherical disturbances.

I am, &c,

T. H. FARRER.

* The present address of the office is 116, Victoria Street, Westminster, S.W.

APPENDIX IX.

LIST of PLACES supplied with FISHERY BAROMETERS.

Those supplied during the years 1867–9 are distinguished by an asterisk.

Shetland Isles.—Sandsair, Lerwick.

Orkney Isles.—Burray.

Scotland, east coast.—Stroma, Staxigoe and Elzie, Sarclet, Lybster, Portmahomack, Cromarty, Avoch, Nairn, Burghead, Portessie, Port Knockie, Portsoy,* Whitehills, Gardenstown, Roseheart, Pitullie, Findon, Portlethen, Arbroath, Broughty Ferry, St. Andrews, Crail, Cellardyke, St. Monance,* Burntisland, Newhaven.

England, east coast.—Berwick, Beadnell, North Shields, South Shields, West Hartlepool, Staithes, Scarborough, Filey, Flamborough, Bridlington Quay, Withernsea, Hull, Lynn, Wells, Gorleston, Harwich,* Brightlingsea,* Wivenhoe,* Margate, Deal, Kingsdown, Dover.

England, south coast.—Bognor,* Portsea, St. Helens and Ventnor* (Isle of Wight), Gorey (Jersey), Poole, Weymouth, Portland, Budleigh-Salterton, Cawsand, Mevagissey, Gorranhaven, Truro, Devoran, Penryn, Falmouth, Newlyn, Mousehole.

England, south-west coast.—St. Ives, Hayle, Port Isaac, Boscastle,* Fremington, Burnham, Highbridge.

Wales.—Swansea, Milford.

England, north-west coast.—Fleetwood, Morecambe, Maryport.

Isle of Man.—Port St. Mary,* Peel.

Scotland, south-west coast.—Port Patrick,* Stranraer.

Ireland, east coast.—Belfast, Bangor, Strangford, Ardglass, Dundalk, Howth, Kingstown.

Ireland, south coast.—Dungarvan, Kinsale.*

Ireland, west coast.—Valencia, Dingle, Tralee, Ballina,* Killybegs.*

Ireland, north coast.—Bunbeg, Burton Port, Dunfanaghy, Rathmullen.

Scotland, west coast.—Campbeltown,* Portree (Isle of Skye), Plockton.

Hebrides, Stornoway, Cromore, Babyle, Obb, Ness.

APPENDIX X.

LIST of PERSONS in the EMPLOYMENT of the METEOROLOGICAL COMMITTEE on December 31st, 1869, with their Occupations and Amount of Salary.

Name.	Duties.	Salary.						
		Yearly.			Weekly.			
		£	s.	d.	£	s.	d.	
<i>Office.</i>								
Robert H. Scott	- Director of the office	800	0	0	—			
J. S. Harding, jun.	- Correspondence and accounts	170	0	0	—			
J. S. Harding, sen.	} Copying, accounts of stores, registry of documents, &c.	—			1	18	6	
T. D. Bell		-	—			0	15	0
Commissionaire	- Messenger	—			1	1	0	
<i>Land Meteorology (Observatories).</i>								
S. Jeffery	} Discussion of returns from obser- vatories, and computations.	—			3	0	0	
C. F. Burton		-	—			1	15	0
E. Magrath		-	—			1	5	0
J. P. Cutts		-	—			0	15	0
<i>Land Meteorology (Telegraphy).</i>								
F. Gaster	} Preparation of weather reports, and computations.	130	0	0	—			
F. Steventon		-	90	0	0	—		
F. Brodie		-	—			0	15	0
G. G. Francis		-	—			0	15	0
<i>Ocean Meteorology.</i>								
Capt. H. Toynbee	- Marine Superintendent	400	0	0	—			
W. Salmon	- Examination of logs	220	0	0	—			
R. Strachan	- Care of instruments, and correspon- dence therewith connected	200	0	0	—			
C. Harding	} Examination of logs, and computa- tions.	110	0	0	—			
R. H. Curtis		-	90	0	0	—		
J. Curtis		-	—			1	5	0
W. G. James		-	—			1	5	0
Balfour Stewart	- Secretary to the Committee; Director of the Normal (Kew) Observatory	£	s.	d.	400	0	0	
Rev. Thos. Kerr	- Director of Valencia Observatory	250	0	0	—			

APPENDIX XI.

DONATIONS RECEIVED DURING THE YEAR 1869.

Presented by Societies, Institutions, &c.

Berlin	-	K. Statistische Bureau	-	Preussische Statistik, Nos. XIV. and XIX. (Monthly means of pressure, temperature, &c. for the years 1867-8. See also Dove.)
Bombay	-	Colaba Observatory	-	The normal winds of Bombay.
		"	-	Solar variations of magnetic declination at Bombay.
Calcutta	-	Meteorological Office	-	Reports of the Meteorological Reporter to the Government of Bengal, 1867-8 and 1868-9.
		"	-	On the origin of a cyclone.
		St. Xavier's College	-	Meteorological Register, January to June 1869.
Christiania	-	Norske Meteorologiske Institut.	-	Meteorologisk Aarbog for 1867 and 1868.
		"	-	Meteorologiske Jagttagelser paa Christiania Observatorium, 1867.
		"	-	Meteorologiske Jagttagelser i Norge, January to November 1869.
		"	-	Meteorologiske Middelelser.
		"	-	Nogle Bemærkninger om Tordenveirenes Dannelsse.
Cincinnati	-	Observatory	-	Inaugural Report, 30th June 1868, and Annual Report, 1st May 1869.
Constantinople	-	Observatoire Impérial Météorologique.	-	Résumé des Observations Météorologiques, December 1868 to October 1869.
Copenhagen	-	K. Danske Videnskabernes Selskab.	-	Forhandlinger, Nos. 6 and 7 for 1867; 1-4 for 1868; 1 for 1869.
Dorpat	-	Kaiserliche Universität	-	Meteorologische Beobachtungen; years 1867-8.
		"	-	Über die Correction der Thermometer.
Dublin	-	Trinity College	-	Observations made at the Magnetical and Meteorological Observatory, Vols. I. and II.
Edinburgh	-	Scottish Meteorological Society.	-	Journal, Vol. II., new series, Nos. 21-24. (See also Buchan.)
Florence	-	Ministero d' Agricoltura Industria e Commercio.	-	Meteorologia Italiana, September 1868 to September 1869.
		"	-	Supplement to ditto, p.p. 1-80 for year 1869, except p.p. 41-48.
Greenwich	-	Royal Observatory	-	Report of the Astronomer Royal to the Board of visitors, 1869.
		"	-	Magnetical and Meteorological Observations, 1867.
Hamburgh	-	Norddeutsche Seewarte	-	Jahres-Bericht, 1868.
		"	-	Mittheilungen, No. I., Über die wissenschaftlichen Ergebnisse der ersten deutschen Nordfahrt von 1868.
		"	-	Ditto, No. II., Nordwest-deutscher Wetterkalender.
		"	-	Die Seewarte und (1) das National Einkommen (2) der Suez Canal (3) ihr Verhältniss zu den Navigations-schulen.
Kew	-	Observatory	-	Report of the Kew Committee for the year 1868-9. (See also Stewart).

54 *Appendix to Report of the Meteorological Committee*

Lisbon	-	-	Observatorio do Infante D. Luiz.	Annaes, Vol. VI., July to November 1868, Vol. VII., December to February 1869.
London	-	-	Admiralty (Hydrographer)	South American Pilot, Parts I. and II.
			"	South Pacific Directory.
			"	Tide Tables for 1869 and 1870.
			"	Memoir of the Hydrographical Department.
			Board of Trade	Report of Wrecks, Casualties, &c. 1868.
			British Association	Report for 1868.
			British Horological Institute.	Journal, Vol. XI., Nos. 125-131, Vol. XII., Nos. 132-136.
			Meteorological Society	Proceedings, Vol. IV., Nos. 39-44.
			"	Meteorology of England, Reports for four quarters, ended June 1869.
			Royal Astronomical Society	Monthly Notices, Vol. XXV., No. 1.
			Royal Institution	Proceedings, Vols. I.-IV. Vol. V., Nos. 45-50.
			Royal National Lifeboat Institution.	Journal, Vol. VII., Nos. 71-75.
			Royal Society	Proceedings, Vol. XVII., Nos. 106-113. Vol. XVIII., Nos. 114-115.
			"	Catalogue of Scientific Papers, Vol. III.
			"	Address delivered at the Anniversary Meeting, 30th November 1869, by Sir E. Sabine, K.C.B., President.
			Royal United Service Institution.	Journal, Vol. XIII., Nos. 53-55.
			(War Office) Topographical Department.	Cape of Good Hope Observations, 1841-6.
Lyons	-	-	Commission Hydrométrique	Rapport, 1867.
Manchester	-	-	Literary and Philosophical Society.	Proceedings, Vols. III.-VII.
			"	Memoirs, Vols. I-III.
Madrid	-	-	R. Observatorio	Observaciones Meteorologicas, December 1867 to November 1868.
Milan	-	-	R. Osservatorio di Brera	Effemeridi Astronomiche, 1865-8.
			"	Sulle variazioni periodiche del barometro nel clima di Milano.
Moncalieri	-	-	Osservatorio del R. Collegio Carlo Alberto.	Bullettino Meteorologico, Vol. III., Nos. 11 and 12. Vol. IV., Nos. 1-9.
			"	Le Aurore Polari del 1869.
Munich	-	-	Königliche Sternwarte	Wochenbericht, Nos. 180-233.
New Zealand	-	-	(?)	Meteorological Report for New Zealand, by J. Hector, Esq., M.D., F.R.S.
Oxford	-	-	Radcliffe Observatory	Results of Meteorological Observations, 1864-6.
Palermo	-	-	R. Osservatorio	Bullettino Meteorologico, Vol. IV., Nos. 8-12; Vol. V., Nos. 4-8.
Paris	-	-	Association Scientifique de France.	Bulletin Hebdomadaire, Vols. V. and VI.
"			Ministère de la Marine	Annales hydrographiques, 4 Quarters of 1868. 3 " 1869.
"			"	Phares des Côtes, Nos. 216-219, 221-222.
"			Observatoire Impérial	Atlas des Mouvements généraux de l'Atmosphère, Jan.-Juin 1865, by M. Le Verrier, President of the Association Scientifique.
"			"	Atlas Météorologique de l'Observatoire Impérial, 1867-8, by M. Le Verrier, President of the Association Scientifique.
"			Observatoire Impérial	Bulletin International, 1858-9. Jan. to August 1860, and year 1869.

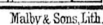
Toronto -	-	Magnetical Observatory -	Monthly Meteorological Register, January to June 1869.
"	"	"	General Meteorological Register, January to June 1868.
"	"	"	Meteorological Summary for 1869.
"	"	"	Monthly Absolute Values of the Magnetic Elements, 1865-8; with means from 1841-1868.
"	"	"	On the Changes of Barometric Pressure, &c., from Observations in the seven years 1860-6. (By Sir E. Sabine.)
Trieste -	-	R. Academia di Commercio e Nautica.	Osservazioni Meteorologiche, January to June 1869.
Upsala -	-	Observatoire - - -	Description d'un Météorographe enregistreur, construit pour l'Observatoire d'Upsal par Dr. A. G. Theorell.
"	"	"	Om organisationen af den meteorologiska oerskamhelten i Utlandet, &c., by H. H. Hildebrandsson.
Utrecht -	-	K. Nederlandsch Meteor. Instituut.	Jaarboek voor 1868. Part I.
		"	Over de Gelijktijdige Beweeging van Barometer en Thermometer.
Vienna -	-	K. K. Centralanstalt für Meteorologie und Erdmagnetismus.	Beobachtungen, November 1868 to September 1869.
		"	Telegraphische Witterungsberichte, November 1868 to September 1869.
		"	Normale fünftägige Wärmemittel für 88 Stationen, bezogen auf dem 20 jährigen Zeitraum, 1848-67.
		"	Die Temperatur-Verhältnisse der Jahre 1848-63.
		"	Jahrbuch, Vol. IV., new series.
		Oesterreichische Gesellschaft für Meteorologie.	Zeitschrift, Vol. III., No. 24; Vol. IV., Nos. 1-21.
Washington -	-	Smithsonian Institution -	Annual Report, 1867.
		"	Proceedings of the National Academy of Sciences, 1866-7.
		"	Reports of the U.S. Coast Survey, 1858 and 1862. (To complete series).
		U. S. Naval Observatory -	November Meteors of 1868.
		"	Meteorological Observations, 1864 and 1866.
Zurich -	-	Meteor. Centralanstalt der Schweizerischen Naturforschenden Gesellschaft.	Meteorologische Beobachtungen, December 1867 to November 1868.

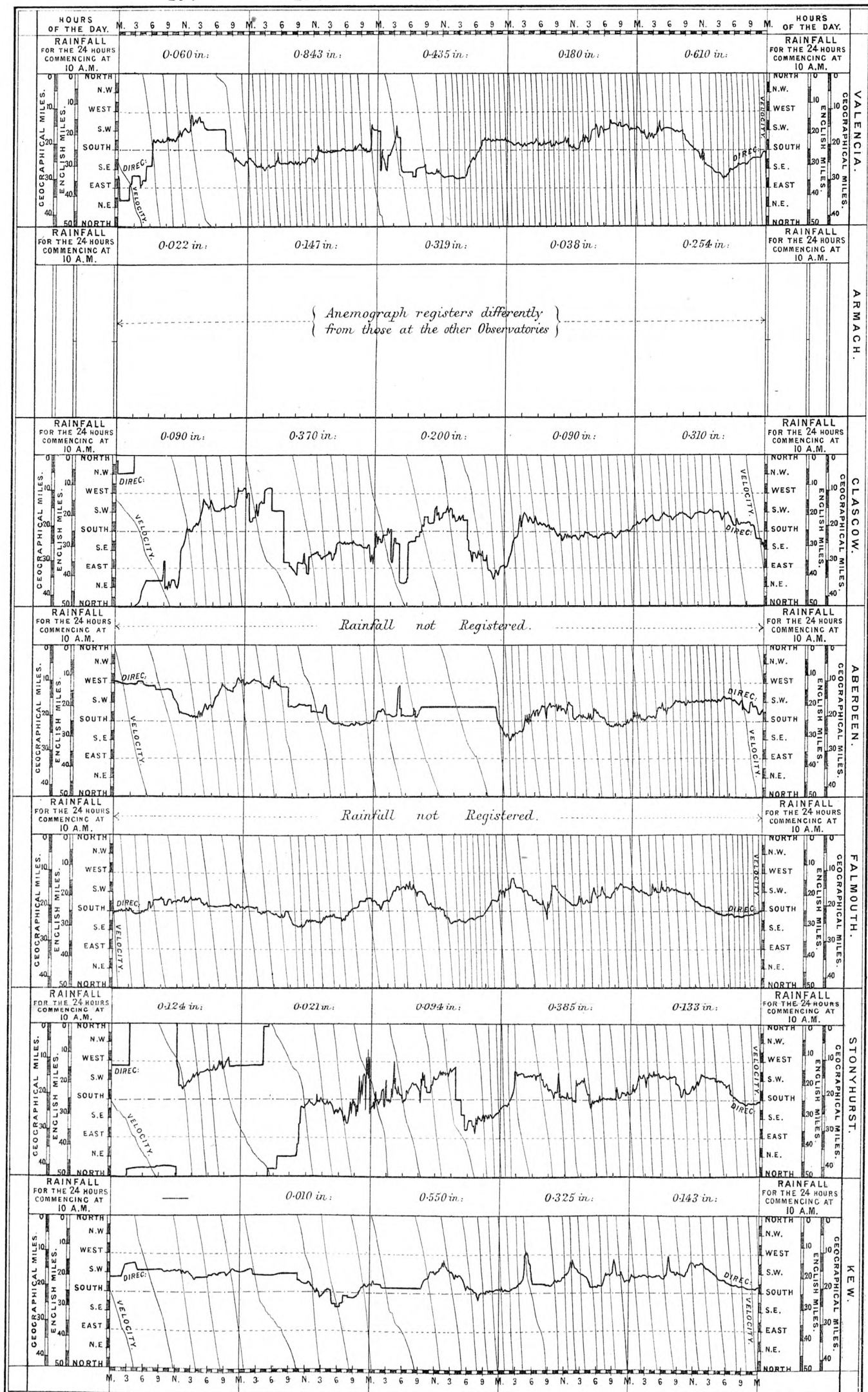
Presented by the Authors.

Abbadie, M. d'	-	See Paris. Société Météorologique.
Abbe, L.	-	„ Cincinnati.
Aguilar, Sr.	-	„ Madrid.
Airy, G. B.	-	„ Greenwich.
Ballot, Dr. B.	-	„ Utrecht.
Belavenetz, Captn.	-	Russian Nautical Magazine, No. 12 for 1868, Nos. 1-10 for 1869.
Belgrand, M.	-	See Paris. Service Hydrométrique.
Beverley, Rev. A.	-	Meteorological Observations taken at Aberdeen Grammar School, 1868.
Blanford, H. F.	-	See Calcutta. Meteorological Office.
Bruhns, Dr. C.	-	Übersicht der Resultate aus den Meteor. Beobachtungen angestellt auf den K. Sächsischen Stationen, August 1868 to May 1869.
Buchan, A.	-	Note on the Determination of Heights, chiefly in the Interior of Continents, from Observations of Atmospheric Pressure.
„	-	The mean Pressure of the Atmosphere, and the prevailing winds over the Globe, Parts I. and II.
Cacciatore, Sr.	-	See Palermo.
Chambers, C.	-	„ Bombay.
Chase, Pliny E.	-	Tidal Rainfall of Philadelphia.
Coumbary, A.	-	See Constantinople.
Davis, Staff Com. J. E.	-	Notes on Deep Sea Soundings.
Denza, Sr.	-	See Moncalieri.
Deville, M. Ste. Claire	-	Sur les rétors périodiques des Phénomènes Météorologiques.
„	-	Documents relatifs aux aurores boréales. (See also Paris, Observatoire de Montsouris.)
Dove, Prof. H. W.	-	Über das barometrische Maximum in Januar 1869.
„	-	Über die nicht-periodische Veränderungen der Verbreitung der Wärme auf der Erdoberfläche. (See also Berlin.)
Freedden, Herr W. von	-	See Hamburg.
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