

REPORT

OF THE

TWENTY-FOURTH MEETING

OF THE



BRITISH ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE;

HELD AT LIVERPOOL IN SEPTEMBER 1854.

LONDON:

JOHN MURRAY, ALBEMARLE STREET.

1855.

CORRESPONDING MEMBERS.

Professor Agassiz, <i>Cambridge, Massachusetts.</i>	M. Kupffer, <i>St. Petersburg.</i>
M. Babinet, <i>Paris.</i>	Dr. Langberg, <i>Christiania.</i>
Dr. A. D. Bache, <i>Philadelphia.</i>	M. Le Verrier, <i>Paris.</i>
Professor H. von Boguslawski, <i>Breslau.</i>	Baron de Selys-Longchamps, <i>Liège.</i>
Mr. P. G. Bond, <i>Cambridge, U.S.</i>	Dr. Lamont, <i>Munich.</i>
M. Boutigny (d'Evreux).	Baron von Liebig, <i>Munich.</i>
Professor Braschmann, <i>Moscow.</i>	Professor Gustav Magnus, <i>Berlin.</i>
Chevalier Bunsen, <i>Heidelberg.</i>	Professor Matteucci, <i>Pisa.</i>
Prince Charles Bonaparte, <i>Paris.</i>	Professor von Middendorff, <i>St. Petersburg.</i>
M. De la Rive, <i>Geneva.</i>	M. l'Abbé Moigno, <i>Paris.</i>
Professor Dove, <i>Berlin.</i>	Professor Nilsson, <i>Sweden.</i>
M. Dufrenoy, <i>Paris.</i>	Dr. N. Nordengsciold, <i>Finland.</i>
Professor Dumas, <i>Paris.</i>	Chevalier Plana, <i>Turin.</i>
Dr. J. Milne-Edwards, <i>Paris.</i>	M. Quetelet, <i>Brussels.</i>
Professor Ehrenberg, <i>Berlin.</i>	Professor Plücker, <i>Bonn.</i>
Dr. Eisenlohr, <i>Carlsruhe.</i>	M. Constant Prévost, <i>Paris.</i>
Professor Encke, <i>Berlin.</i>	Professor C. Ritter, <i>Berlin.</i>
Dr. A. Erman, <i>Berlin.</i>	Professor H. D. Rogers, <i>Philadelphia.</i>
Professor Esmark, <i>Christiania.</i>	Professor W. B. Rogers, <i>Virginia.</i>
Professor G. Forchhammer, <i>Copenhagen.</i>	Professor H. Rose, <i>Berlin.</i>
M. Leon Foucault, <i>Paris.</i>	Baron Senftenberg, <i>Bohemia.</i>
M. Frisiani, <i>Milan.</i>	Dr. Siljeström, <i>Stockholm.</i>
Professor Asa Gray, <i>Cambridge, U.S.</i>	M. Struvé, <i>St. Petersburg.</i>
Professor Henry, <i>Washington, U.S.</i>	Dr. Svanberg, <i>Stockholm.</i>
Baron Alexander von Humboldt, <i>Berlin.</i>	Dr. Van der Hoeven, <i>Leyden.</i>
M. Jacobi, <i>St. Petersburg.</i>	Baron Sartorius von Waltershausen.
Professor Kreil, <i>Prague.</i>	M. Pierre Tchihatchef.
	Professor Wartmann, <i>Lausanne.</i>

REPORT OF THE PROCEEDINGS OF THE COUNCIL IN 1853-54, AS PRESENTED TO THE GENERAL COMMITTEE AT LIVERPOOL, WEDNESDAY, SEPTEMBER 20TH, 1854.

The Council has been informed that invitations to the Association will be presented to this Meeting on the part of the University and City of Glasgow; on the part of the Board of Trinity College, Dublin, for 1857, supported by the Royal Irish Academy and the Queen's University in Ireland; from Brighton; from the Mayor and City Council of Manchester; from Cheltenham; and from Ryde in the Isle of Wight.

In transmitting the accompanying reports from the Parliamentary Committee of the British Association, and from the Committee of the Kew Observatory, the Council believe that the General Committee will find in these two documents the most satisfactory evidence of the increasing public importance and general usefulness of the British Association.

In the case of the Parliamentary Committee, the Council consider themselves only as the organ through which the report of the last year's proceedings are presented to the General Committee. In the case of the Kew Committee, the members of which are also members of the Council, and act under the authorization of the Council, the report is addressed to the body from whence the authority is derived. In transmitting it to the General Committee, therefore, the Council desire to express at the same time their full concurrence in its closing recommendation. They are persuaded that if the financial position of the Association will admit of an increased grant being made to the Observatory for special purposes in the next year, no better application could possibly be made of the money, either for the benefit of science or for the credit of the Association.

The Report of the Kew Committee to the Council, signed by J. P. Gassiot, Esq., Chairman:—

In their Report for the last year your Committee stated that an application had been made to them by the Hydrographer of the Admiralty for advice as to the construction of Thermometers to be supplied to H.M. Navy, for the purpose of making meteorological observations at sea, and that your Committee had undertaken to provide a specimen of the form of instrument which they might consider most suitable.

When the necessary experiments were completed and a Model Thermometer constructed, your Committee directed that one should be sent to each of the Philosophical Instrument Makers who had been supplied with Standard Thermometers from the Observatory, requesting that they would acquaint the Committee at what price such instruments could be supplied.

The prices named by Messrs. Negretti and Zambra and by Messrs. Cassella and Co. having been ascertained to be the lowest, these firms were selected by your Committee as those to whom applications should be made to furnish such thermometers when required.

The diameter of the spherical bulb of the proposed thermometer is about $\frac{1}{10}$ ths of an inch; the graduation includes a range of from 10° to 130° Fahr.; the length of the thermometer is $10\frac{1}{2}$ inches; the brass scale on which the figures are stamped is raised to nearly the level of the front of the tube, which is fastened to the scale by two clips. The scale is cut away about one inch above the bulb, a stop being fixed on the copper case so as to prevent the bulb touching the bottom of the cup.

The thermometer is constructed of enameled tubing, and the divisions are etched on the stem with fluoric acid; the figures are stamped on the brass scale at every 10th degree, and each instrument is fitted to a japanned copper case with a cup surrounding the bulb, and has a distinguishing number. The cost, in consideration of the quantity ordered from the makers at one time, including the case, is *5s. 6d.*, and without the case *4s. 6d.*, for each thermometer.

On the 3rd of December 1853 your Committee requested Colonel Sabine to inform the Hydrographer of the Admiralty that thermometers according to the model described could be supplied in any quantities: a copy of the correspondence with the Hydrographer, as also with the Board of Trade, is annexed to this Report.

On the 28th January 1854 your Committee received an application from the Smithsonian Institution of the United States, through its agent, Mr. Stevens, for specimens of thermometers and barometers for marine use, as also for a standard thermometer. Mr. Stevens has since ordered one thousand thermometers for the use of the United States Navy, five hundred from each of the before-mentioned firms, and fifty marine barometers; the whole of these instruments, which will be similar to those described in this Report, will be verified by Mr. Welsh at the Observatory.

As each thermometer will undergo a rigorous examination at the Observatory, and as a table will in all cases be furnished of scale errors, which, on the terms of the agreement with the instrument-makers, are not to exceed $0^{\circ}\cdot6$ between 32° and 100° Fahr., nor to vary more than $0^{\circ}\cdot3$ within any 10° , your Committee consider that for all the purposes intended such thermometers will be found sufficiently correct, and being obtainable at a very moderate cost, they hope future observations made with such instruments will prove of essential practical and scientific value.

On the 27th March, 1854, the Board of Trade addressed a letter to the Chairman of your Committee requesting their aid in procuring barometers and thermometers for the use of the Mercantile Marine. On the 3rd of

April the Chairman replied, stating that the Committee were willing to superintend the execution of any contract which the Board of Trade might make for the supply of such instruments, in accordance with the following resolution of the Committee:—

27th March, 1854, at a Meeting of the Kew Committee of the British Association,

Resolved,—

“That in all cases in which the Committee is called upon to assist either Her Majesty’s or other governments, in the supply of meteorological instruments, it is to be understood as a principle that the contract for such supply is to be between the government requiring the instruments and the maker furnishing the same, the contract price in all cases to cover the cost of verification at Kew.”

A copy of the correspondence with the Board of Trade is attached to this Report.

Barometers.—Your Committee stated in their last year’s Report that in consequence of Lieut. Maury having requested their advice upon the best form of a marine barometer, the subject was under consideration; after having examined several forms of these instruments submitted for their consideration, your Committee selected one in which it is believed all the requisites for making correct observations at sea will be found to have been obtained at a very moderate cost, combining convenience and accuracy in observing, with simplicity and durability in its general construction.

The great importance as to certain conditions requisite in a good barometer induced your Committee to have the action of this instrument tested by such means as were at their command, and this was effected by Mr. Welsh (accompanied by Mr. Adie, the maker), in a voyage to Leith and back to London; subsequently the action of the instrument was further tested by Mr. Welsh in a voyage to and from the Channel Islands; the results of these trials will be seen in the following letters addressed by Mr. Welsh to the Chairman:—

“Kew Observatory, March 25, 1854.

“MY DEAR SIR,—In accordance with the request expressed by the Committee at their Meeting on the 15th instant, I sailed the same evening by the steamer ‘Clarence’ for Leith, in company with Mr. Adie, for the purpose of examining the action of three barometers made by him. These barometers were all of the same construction, but having the tubes contracted in different degrees, viz. in the proportions of five, ten, and fifteen minutes respectively for the time occupied by the mercury in descending to its proper level when first placed erect.

“We did not succeed in procuring a private cabin, but Mr. Turner, the commander of the vessel, kindly allowed us to suspend the instruments in his own cabin, to which we had access during the greater part of the voyage. As the weather in this passage was too calm to allow of a decided trial of the barometers, especially with regard to the *pumping* of the mercury in the tube, we returned on Wednesday the 21st by the steamer ‘Leith,’ in which we had engaged a private cabin. On the return voyage, the motion of the vessel was very considerable, and afforded a fair opportunity of examining the pumping. Unfortunately one of the barometers (the one contracted to 15^m) was broken in being carried on board, so that we had only the two least contracted in the tube remaining. From an examination of the observations made, I believe the following general conclusions are pretty near the truth.

"1st. Any one of the three barometers is capable of showing *at sea* the changes of pressure, with a probable error of about 0·005 inch, or at most 0·007 in.

"2nd. The tremor of a steam ship is rather beneficial than otherwise to the performance of the barometer, and (leaving the pumping out of consideration) the barometer performs rather better at sea than on land.

"3rd. For such a motion of the ship as must be very common, the amount of contraction of the tube should be greater than in any of the three barometers employed, say a contraction to 18 or 20 minutes. The *mean* amount of pumping from ten observations in the return voyage was, for the tube contracted to 5 minutes 0·064 in., and for the one contracted to 10 minutes 0·031 in.; the greatest observed being for the former 0·13 in., and for the latter 0·05 in. In order, therefore, to reduce the pumping so that the probable error of an observation from this cause may not exceed 0·01 in., the contraction should be to 20 minutes at least.

"4th. It appears to me very desirable that each ship should be furnished with *two* barometers—one for calmer weather and the other for rougher—the former having the tube contracted to 10 or 12 minutes, and the latter to about 25 minutes. This would render good observations obtainable in all states of the weather; and if occasional comparisons of the two were taken, would, besides obviating to some extent the inconvenience arising from an accident to one, afford the means of checking any changes which might occur in the zero-points of either instrument. If, however, two barometers cannot be supplied to each ship, I am disposed at present to think that a contraction to about 15 or 20 minutes would be generally the most convenient.

"The mode of suspension and the means of observation adopted in Mr. Adie's barometers seem very suitable, the spring of the suspending arm being quite sufficient. The arm should perhaps be a little longer, say 2 inches more.

"I should mention, that the two steamers were about 700 or 800 tons burden.

"J. P. Gassiot, Esq., F.R.S.,
Chairman of the Kew Committee."

"I am, yours faithfully,
"J. WELSH."

"Kew Observatory, May 25, 1854.

"MY DEAR SIR,—In compliance with a wish expressed by the Kew Committee at their Meeting on May 3rd, I proceeded to Southampton on the 8th instant, and made arrangements for a further trial of the marine barometers in one of the South Western Railway Company's mail steamers plying to the Island of Jersey. Having been furnished by you with a recommendation from Mr. Tite to the Secretary of the Company's steamers, I was most readily provided with the best accommodation which could be got in the ship, and received every attention and assistance from Mr. Babot, the captain.

"The principal object contemplated by me in this trial, was the determination of the amount of contraction required in the tube for the prevention, within convenient limits, of the pumping of the mercury. I took with me five barometers by Adie, all of the same general construction, but differing in the amount of contraction in the tubes. They were stopped in the following proportions—5, 10, 18, 21 and 35 minutes for the times required for the mercury to sink from the top of the tube to its true height after the barometer is placed erect.

"I found, as on the previous trial to Leith, that the first two were not nearly sufficiently contracted, the amount of pumping being indeed so great that good observations could not possibly be taken with either. The pump-

ing in the third and fourth was much more moderate, the greatest difference between the extreme readings in either having never been observed to be more than 0·02 and seldom above 0·015, thus giving 0·01 as the limit of error of an observation from this cause. The barometer No. 5 showed, of course, even less oscillation, the extreme readings not differing more than 0·01. The circumstances under which these numbers were obtained were, I believe, favourable to a just estimate of the amount of contraction necessary, as there was both in the passage to Jersey and back a considerable amount of swell, there having been on the previous day a heavy gale blowing.

“Considering that the existence of a small quantity of pumping must at all times be desirable, in order to secure a more free action of the mercury than if the barometer were suspended quite steadily, I am of opinion that barometers having their tubes stopped to about the same extent as in Nos. 3 and 4, would, on the whole, be the most generally convenient and accurate, whilst even a greater degree of contraction would do no great harm. I would, therefore, recommend that the contraction should be from about 18 to 25 minutes.

“I have both before this trial and since made a series of comparisons between the standard by Newman and these barometers. I have found that all the barometers follow the standard very consistently. There is, however, one circumstance which should be noticed, and which I have before to some extent mentioned to the Committee. The marine barometer does not act quite freely when suspended at rest. The standard barometer is always, to a certain extent, *in advance* of the marine barometer; that is, when the mercury is rising, the marine barometer is below the standard, and when falling it is above it. The amount of this retardation I find to be about 0·01 inch; and what is rather singular, it exists to about the same extent whatever the degree of contraction of the tube, although that has varied in the proportion of 1 to 7. This retardation, it should be remembered, has been observed when the marine barometer has been left quite *at rest*, a condition which will scarcely ever obtain at sea, where there will generally be, I conceive, a sufficient amount of motion to produce a certain small degree of oscillation in the column of mercury; and it is evident that so long as any oscillation at all exists, the equilibrium of the mercury will be maintained, and the reading of the instrument will show the true barometric pressure.

“J. P. Gassiot, Esq., F.R.S.,
Chairman of the Kew Committee.”

“I am, dear Sir, yours faithfully,
“J. WELSH.”

The barometer as now constructed is thus described by Mr. P. Adie, the maker:—

“The tube has a diameter of from 0·22 in. to 0·25 in. About 4 inches of the tube near the middle has a capillary bore in order to produce the contraction necessary to prevent inconvenient oscillation at sea from the motion of the vessel. The degree of contraction is such, that, when the barometer is first suspended, the mercury requires about twenty minutes to fall from the top of the tube to its proper level. A pipette, or Gay-Lussac's air-trap, about 2 inches long, is inserted a little below the contraction, which serves to prevent the entrance of air into the upper part of the tube, or into the capillary portion of it. The lower end of the tube, which is within the mercury in the cistern, is also contracted. With these precautions, it is believed, that when the tube has been well filled at first, it is very unlikely to become deteriorated. The mercury is necessarily boiled in the tube in the process of filling.

“The cistern of the barometer is a cylinder of cast iron, the tube being fitted into it mercury-tight by cement; a portion of the upper part of the cistern

being covered with strong sheep-skin leather firmly fixed by abutting flanges. This leather has been found to be sufficiently porous to permit the free action of the air through it, but not to allow the mercury to pass without considerable pressure, to which it can never from the construction of the instrument be subjected. The cistern is filled with mercury to such a height that it can never under any circumstances of temperature or pressure be full, but always sufficiently so to prevent the lower end of the tube being ever exposed either during carriage or when in use. This renders any adjustment of the instrument when being mounted for observation unnecessary. The diameter of the cistern is about 1·3 inch. The barometer tube is protected by a cylindrical case of brass, which is screwed firmly to the upper portion of the iron cistern. The graduation is made on this brass tube and the vernier moved by a rack and pinion, the index being adjusted to the top of the mercurial column by shutting off the light, as is commonly done in standard and other good barometers: the vernier reads to 0·002 inch. The correction for the relative capacities of the tube and cistern (which is usually applied as a numerical correction varying with the height) is in these instruments included in the graduation of the scale; the scale being shortened by the amount of the correction, but divided so as to *represent* the true measurements. The correction for capacity is obtained by computation from carefully measured diameters of the tube and cistern. The zero-point of the scale is determined by comparison with a standard barometer. A thermometer, whose scale is divided on its stem, and having its bulb within the encasing brass tube, gives the temperature of the mercury. In making an observation, it is only necessary to set and read off the vernier, and to note the height of the thermometer. The instrument presents much the appearance of a mountain barometer: it is suspended in gimbals from a point a little above the middle of the tube, the rack motion being close to the point of suspension, so that the hand may rest on the supporting arm. The supporting arm is flat, of hammered brass, thin enough to give the elasticity necessary to counteract sudden jars, and is equivalent to the spring gimbals usually employed, while much simpler in its construction."

The annexed copies of the correspondence with the Hydrographer of the Admiralty and with the Board of Trade, will explain the proceedings of your Committee as to the proposed supply of these instruments for the use of Her Majesty's Navy, as also for the Mercantile Marine of this country. Your Committee have also communicated with Lieut. Maury, by whose directions the fifty barometers were ordered from Mr. Adie by Mr. Stevens, for the use of the United States Navy, all of which are to be verified at the Observatory.

Standard Barometer.—Your Committee have devoted much attention to the completion of this instrument, but many casualties have occurred during the progress of its erection. On the 13th July last Mr. Negretti succeeded in boiling and erecting a tube of *one inch* internal diameter. Considerable changes were found necessary in the original mounting of the barometer and cathetometer. These have been satisfactorily executed at the Observatory, but the instrument still requires alteration to render its performance perfect. The scale of the cathetometer has been compared with the Kew standard scale, and found not to require any correction when laid horizontally. When the two scales are compared by observing their relative lengths vertically by the telescope of the cathetometer, a perceptible error is shown, involving a correction to the measurements of the cathetometer of + 0·003 inch in a space of 30 inches. This anomalous error is, it is conceived, due to faulty construction in the cathetometer, chiefly arising from the difficulty of making the instrument accurate on the design adopted. It is, therefore,

the intention of your Committee to direct that a new cathetometer should be constructed in the Observatory on more exact mechanical principles.

The number of instruments now in course of verification, under the directions of your Committee, is :—

For the U. S. Navy	1000 thermometers.	50 barometers.
„ Board of Trade	500 „	60 „

Definition of the Boiling-Point of Water.—Your Committee, at the last meeting of the Association, were requested to furnish a report on the definition of the boiling-point of water at present adopted in this country for the thermometric scale. This has already been considered by the Commissioners appointed by Government to construct Standard Weights and Measures, and in the Report they have presented to Government during the present year, they have defined 212° upon Fahrenheit's scale to represent "the temperature of steam under Laplace's standard atmospheric pressure, or the atmospheric pressure corresponding to the following number of inches in the barometric reading, reduced to 32° F.,— $29.9218 + 0.0766 \times \cosine$ (2. latitude) $+ (0.00000179 \times \text{height in feet above the sea})$." Your Committee recommend that this definition be adopted. In accordance with this definition, the standard pressure under which the boiling-point of thermometers will have to be determined will be,—

	At 32° F.	
In London	$29.905 + (0.00000179 \times \text{height above the sea})$.	
In Dublin	29.900	„
In Edinburgh	29.893	„

The small additional correction for the height above the sea level included in brackets, may be, however, neglected, being insensible at any part of the three towns mentioned.

The barometric heights here given are at 32° F., and this correction must not be overlooked.

Standard Thermometers.—The graduation of standard thermometers has been continued by Mr. Welsh, and 24 instruments have been issued since the last meeting of the Association, making a total of 94 standard thermometers supplied to institutions and individuals.

The requisite apparatus for determining the errors of barometers, as well as of thermometers, by comparison with the standards at Kew, has been constructed at the Observatory, and a detailed account of the processes employed will be given by Mr. Welsh in a separate communication to the British Association.

By means of this apparatus there have been examined during the past year—For the East India Company, 40 thermometers for 20 of Regnault's hygrometers, and 4 barometers; for the Trevandrum Observatory, 8 thermometers; for Hobarton Observatory, 3 thermometers; for E. A. Middleship, St. Kitts, 5 thermometers; for the Hydrographer of the Admiralty, 16 thermometers and 4 barometers; for Messrs. Schlagintweit, 93 thermometers, 6 mountain barometers, 9 aneroid barometers, 10 ground thermometers, and 6 boiling-point thermometers.

Standard Weights and Measures.—Your Committee have reported last year that the standard weights made by M. Certeing, under the direction of Dr. Miller, of King's College, were at that time in the hands of Prof. Miller, of Cambridge, for verification; and that the standard scale prepared by Messrs. Troughton and Simms, was with the Rev. Mr. Sheepshanks, for com-

parison with the standard bar in his possession. Your Committee beg to subjoin the following letter, received from Professor Miller:—

“Cambridge, 27th January, 1854.

“I beg leave to communicate to the Kew Committee the following results of the comparison of the Kew standard bar:—

“In air temp. $65^{\circ}66$ Fahr. ($18^{\circ}7C$), pressure $29^{\circ}75$ in. of mercury, reduced to the temperature of freezing water (755.64 M.M.) by a mean of 80 comparisons, the Kew standard appears to be 0.00035 gr. heavier than $\frac{7}{7700}$ (lost standard troy pound).

“The ratio of the density of the Kew standard at freezing to the maximum density of water is 8.20357 (log. 0.9140030), its vol. at freezing = volume of 853.2866 grs. of water at maximum density.

“The density of the Kew standard is different from that which appears to be the most probable value of the density of the lost standard, consequently its error, when reduced to vacuum, differs from the error given above. In vacuo the Kew standard is 0.00655 gr. lighter than the Parliamentary standard. (Signed) “W. H. MILLER.”

The Rev. Mr. Sheepshanks, in a communication with Dr. Miller, reports, as the result of 138 comparisons made at a mean temperature of $46^{\circ}78$ Fahr., that the Kew standard scale is at a temperature of 62° Fahr. 0.000091 inch longer than the standard yard. Mr. Sheepshanks proposes to repeat the comparison at a higher temperature, so as to avoid any uncertainty that may exist as regards the expansion of the Kew bar.

New Stand for Out-Door Observations with Thermometers.—At the first meeting of your Committee on 12th November, 1853, they authorized Mr. Welsh to prepare a new stand for out-door observations of thermometers. This stand has been erected outside the balustrade wall, at the top of the steps leading to the north entrance of the Observatory. The thermometers are placed at a distance of 8 feet from the wall of the house, 11 feet above the ground, and $2\frac{1}{2}$ feet from the nearest part of the balustrade. In this position there is a free circulation of air in all directions of the wind. The thermometers are protected from radiation by two cages with *venetian* blind sides and roofs; the sides of the cages descending to 6 inches below the bulbs. They are thus quite sheltered from rain, whilst very little interruption is offered to the free access of the air. The dimensions of the cages are as follows:—The outer is 6 feet broad, 5 feet deep, and 5 feet high; the inner cage is 3 feet broad, 2 feet deep, and $3\frac{1}{2}$ feet high, leaving a space of about 18 inches between the cages. The bulbs of the thermometers are about 16 inches above the lower portion of the framework, which is quite open. Doors on the side of the stand next the entrance of the Observatory are opened when the thermometers are to be observed. The whole of the stands are painted green inside and out.

The stand contains a pair of dry and wet thermometers, graduated at the Observatory; a maximum thermometer, also constructed at the Observatory, on the principle proposed many years since by Mr. J. Phillips, the Assistant General Secretary of the Association, and described by him in the first volume of its Reports; a maximum thermometer of the recent construction of Messrs. Negretti and Zambra; a minimum thermometer, on Rutherford's principle, made by Adie of London; and a Regnault's dew-point hygrometer, with a bellows aspirator, also made by Adie: the scales of these instruments, with the exception of Negretti's maximum thermometer and Regnault's hygrometer, are divided on the tubes.

It is believed, that by the arrangements above described, a very close ap-
1854.

proximation is made towards the conditions necessary to obtaining the true temperature of the air. Meteorological observations have been made since 1st January 1854, at 6 and 10 A.M., 2, 6 and 10 P.M.

In respect to the two forms of maximum thermometers now named, it may be stated that they have both been found to perform in a very satisfactory manner; the very ingenious instrument of Messrs. Negretti and Zambra has one quality, which, as regards durability, places it above every other form of maximum thermometer, for when once well constructed, it can never get out of order; it is somewhat difficult in construction, and consequently more costly, but the observer, having first satisfied himself as to its correctness, may ever afterwards use it with confidence, relying that his register will not be interrupted by any of those annoyances to which he may have been accustomed in other forms of this instrument. The plan of Mr. Phillips is most valuable for its extreme simplicity; it is capable of greater delicacy of indication than even Negretti's, and in the hands of an observer who treats his instruments with care, will continue to perform very accurately for probably an indefinite length of time. The only case in which this form of the instrument might be found to fail, would probably be in carriage or when otherwise exposed to violence: any thermometer, having an overflow chamber at the top of the tube, can be readily converted into a maximum with the aid of a spirit-lamp, and if the instrument should by any chance get out of order, it can as easily be remedied. Any careful observer, who is not afraid to handle a thermometer, will, it is believed, find this the most convenient form of all maximum thermometers. As an instrument for general use, and in the hands of persons unskilled or careless in the use of thermometers, its expediency may however be more doubtful.

Daily Photographic Register of the Spots on the Sun's Disc.—Colonel Sabine having reported to your Committee that Sir John Herschel had suggested to him the importance of arrangements being made for a daily photographic picture of the sun's disc, showing the spots, &c., it was resolved by your Committee that the Chairman should write to Sir John Herschel to request he would favour the Committee with his views as to the importance of the object, and the best mode of carrying it into effect. The following is a copy of the reply received from Sir John Herschel:—

“32 Harley Street, April 24, 1854.

“MY DEAR SIR,—I certainly do consider it an object of very considerable importance to secure at some observatory, and indeed at more than one, in different localities, daily photographic representations of the sun, with a view to keep up a consecutive and perfectly faithful record of the history of the spots. So far as regards the general delineation of the whole disc and the marking out on it, in reference to the parallel to the equinoctial passing through its centre, the places, sizes, and forms of the spots, there would need I should imagine no very powerful telescope; quite the contrary; but it should be equatorially mounted, and ought to have a clock motion in the parallel. The image to be impressed on the paper (or collodionized glass) should be formed, not in the focus of the object-lens, but in that of the eye-lens drawn out somewhat beyond the proper situation for distinct vision (and always to the same invariable distance to ensure an equally magnified image on each day). By this arrangement a considerably magnified image of the sun, and also of any system of wires in the focus of the object-glass, may be thrown upon the ‘focusing glass’ of a camera box adjusted to the eye-end of the telescope. By employing a system of spider lines parallel and perpendicular to the diurnal motion, and so disposed as to divide the field of view

into squares, say of 5' in the side, the central one crossing the sun's centre (or rather as liable to no uncertainty, one of them being a tangent to its lower or upper limb), the place of each spot on the surface is, *ipso facto*, mapped down in reference to the parallel and declination circle and its distance from the border, and its size, measurable on a fixed scale.

"If large spots are to be photographed specially with a view to the delineation of their forms and changes, a pretty large object-glass will be required, and the whole affair will become a matter of much greater nicety; but for reading the daily history of the sun, I should imagine a 3-inch object-glass would be ample.

"The representations should, if possible, be taken daily and the time carefully noted. As far as possible they should be taken at the same hour each day, but in this climate a clear interval, occurring when it may, had better be secured early in the day.

"Three or four observatories in tropical climates, distant several hours in longitude (suppose three, at 8^h distance in longitude), each reading at, or nearly at noon, would, when the results were assembled, keep up a continual history of the solar disc.

"With regard to proper preparations of paper, or the use of collodion, &c., the photographic art is now so much advanced that no difficulty can arise in fixing upon fitting preparations, or in the manipulations necessary for multiplying them. But it would be very requisite that many impressions of each day's work should be taken and distributed, and an interchange kept up among observers.

"Yours truly,

"J. P. Gassiot, Esq."

"J. F. W. HERSCHEL."

On the 3rd of May your Committee requested Mr. Warren De la Rue to ascertain the probable cost of an apparatus suitable to accomplish the recommendations contained in the preceding letter, and it having been subsequently ascertained by Mr. De la Rue that the probable cost would not exceed £150, your Committee, on the 29th May, resolved that the Chairman should apply to the Royal Society for that sum from the Donation Fund; the application was made on the 21st of June, and on the 29th of the same month the Council of the Royal Society acceded thereto; this amount has been since placed at the disposal of three Members of the Committee, in order that the apparatus may be purchased, and certain preliminary experiments having been made, the instrument is in course of completion by Mr. Ross, optician.

On the 14th November 1853, your Committee, on the recommendation of Mr. De la Rue, engaged the services of Robert Beckley, machinist. Mr. Welsh reports most favourably as to the efficiency of Mr. Beckley's services, not only in respect to his great ingenuity and accuracy as a workman, but also as to the interest and intelligence with which he has entered into and assisted him in the general work of the Observatory. He resides with his wife in the building, receiving weekly wages of 35s., which sum includes the payment to his wife as housekeeper.

Ground contiguous to the Observatory.—In accordance with the recommendation contained in their last Report, your Committee have had several interviews with the Chief Commissioner of Woods, Forests, and Land Revenue, with the view of obtaining the temporary use of about two acres of the land immediately adjoining the Observatory. Your Committee ascertained that the entire park round the Observatory was let at a yearly rental, and they were informed that it was necessary they should make arrange-

ments with the tenant previous to permission being granted to them to use the lands; the Honourable Mr. Gore, the Chief Commissioner, at the same time expressing his anxious desire to afford every facility to the Committee.

In reply to an application of the Committee, the tenant offered the use of the land at the rate of £20 per acre. Your Committee, feeling they could not make any reply to such a demand, requested their Chairman, in conjunction with Mr Hutton, to wait on Mr. Gore, who kindly appointed a day to meet the tenant and the Committee at the Observatory. It was subsequently arranged that for the present season, viz. until next October, the tenant should receive at the rate of £7 10s. per acre, and for the subsequent year £10 10s. per acre, at which period his present term with the Crown expires.

Two acres of the land have been enclosed with a strong wooden paling preparatory to the erection of a wooden tower, under the superintendence of Mr. De la Rue, for mounting the Huyghenian object-glass, as recommended by the British Association.

The cost of enclosing the land, the rent to October 1855, as well as the erection of the wooden tower, will be chiefly defrayed from funds supplied by the Royal Society for the erection of the Huyghenian telescope, from the annual Government Grant placed at its disposal: but your Committee earnestly recommend that an immediate application should be made by the Council of the British Association for the future gratuitous use of this small portion of the park, which will be found absolutely necessary for purposes now carried on and contemplated at the Observatory; while the very limited amount of funds which the Association can annually place at the disposal of your Committee, renders such an amount for rent, which they would be compelled to pay, of considerable importance.

The daily increasing work in the Observatory, arising from the verification of meteorological instruments, as well as the probable necessity for other experimental purposes, renders it advisable that further assistance should be obtained; a portion of the increased expense that will be thus incurred, your Committee anticipate will be obtained from the amount to be received for the verification of the instruments, viz. 10s. for each barometer, and 1s. for each thermometer.

Your Committee consider that the present yearly stipend received by Mr. Welsh ought to be increased. It is impossible for them to report in sufficiently strong terms the high opinion they entertain of this gentleman's services; but all who have visited the Observatory can bear witness, not only as to the efficient manner with which he has carried out the various duties your Committee have from time to time suggested, but the zeal and untiring energy he has always evinced in the promotion of science, and in the furtherance of those objects for which he was originally appointed by the British Association.

Considering the variety and importance of the objects which are now being carried out at the Observatory, the Committee submit for the consideration of the Council, that should the financial state of the Association at Liverpool justify an increase in the annual sum placed at the disposal of the Committee, they feel confident that a larger grant than has been allowed in the last few years for the maintenance of the Observatory, might be so appropriated in the next year with great advantage to the interests of science and to the credit of the Association.

By order of the Committee.

JOHN P. GASSIOT,
Chairman.

	£	s.	d.
Balance from Treasurer's Account, 1852.....	95	15	4
Grant of 1852, at Belfast.....	200	0	0
Grant of 1853, at Hull.....	200	0	0
	£495	15	4

	£	s.	d.
Payments from 1852 to 1853, details previously audited.....	160	10	2
Payments, detailed below, from Sept. 7, 1853, to Sept. 20, 1854.....	310	12	0½
Balance to be carried to next Account.....	24	13	1½
	£495	15	4

Detail of Payments from 7th September 1853, to 20th September 1854:—

Porterage.....	3	5	5
Charwoman.....	9	13	0
Petty Expenses.....	4	13	3½
Sundry Bills, materials purchased, &c.....	10	12	8
R. Beckley, Wages, Nov. 14, 1853, till Sept. 18, 1854, 44 weeks.....	77	0	0
Tools, Instruments and Apparatus.....	17	9	7
Postage Stamps.....	2	0	0
Stationery, Books, Printing.....	10	19	9
Carpenters' Bills.....	26	8	1½
Chandlery, &c.....	13	14	10
Coals.....	17	0	0
Ironmonger.....	5	15	4½
Plasterer.....	1	3	6
Plumber.....	0	16	6
Observer's Salary, One Year.....	100	0	0
Allowance for Petty Travelling Expenses, &c.....	10	0	0
	£310	12	0½

I have examined the above Accounts, have compared the items with the documents furnished, and find the balance to be Twenty-four pounds thirteen shillings and one penny halfpenny.

R. HUTTON.

Correspondence.

(Copy.)

“Office of Committee of Privy Council for Trade,
Marine Department, 27th March 1854.

“SIR,—I am directed by the Lords of the Committee of Privy Council for Trade, to address you as the Chairman of the Committee nominated by the British Association for the Advancement of Science to superintend the Kew Observatory ; and to state that for the purpose of aiding in carrying into effect the proposed plan of making an extensive record of meteorological observations, My Lords contemplate that they shall have occasion to provide fifty barometers and three hundred and eighty thermometers, with both Fahrenheit and Centigrade Scales, and also one hundred and twenty wet bulb thermometers similarly graduated.

“It is of the highest importance that the instruments to be provided should be correct, and should bear upon them a stamp indicating that they have undergone an inspection and have been compared with an approved standard.

“My Lords would therefore be greatly obliged if the Committee of the British Association could aid them with their valuable assistance in accomplishing the purpose they have in view, and they would also be glad to be informed whether hydrometers with the graduated scale, and other instruments referred to in the report of the conference held at Brussels last year, could be tested at the Observatory.

“Their Lordships desire me to express their hope that the Committee will consider the object they have in view a sufficient apology for the step they have taken in making this application.

“I have the honour to be, Sir,

“Your obedient Servant,

“J. P. Gassiot, Esq.”

(Signed)

“T. H. FARRER.”

(Copy.)

“Clapham Common, 3rd April 1854.

“SIR,—In reply to your letter of 27th March I have been directed to inform you, that for the purpose of forwarding a matter which is likely to prove of so much importance to the maritime interests of this country, the Kew Committee of the British Association are quite ready to superintend the execution of any contracts which the Board of Trade may make for the supply of thermometers and barometers.

“The Committee recommend that the same form of thermometers should be used for examining the temperature of the air, the sea, and aqueous vapour. The Committee have prepared a specimen of the thermometer approved by them for the purpose of taking observations at sea ; this thermometer is divided in Fahrenheit degrees, and the Committee are of opinion that very great inconvenience, and a considerable sacrifice in accuracy, would result from any attempt to combine both the Fahrenheit and Centigrade scales on the same instrument. They are also of opinion that no advantage whatever would be gained by such a combination.

“A barometer has been selected, and its action tested by Mr. Welsh in a trip to Leith and back to London in a steamer ; some slight alterations in its construction are being made, and in the mean time, application has been made to the Admiralty to have its action tested in a short cruise in the Channel, or North Sea, in order that its freedom from pumping, and convenience of reading may be judged of, and reported thereon by officers in H.M. Navy experienced in such observations.

"It is proposed by the Committee that the instruments shall be supplied at a fixed price, which for the barometer the Committee expect will be about £3 10s., and for the thermometer not exceeding 6s. each.

"In order to fulfil the conditions necessary to ensure the required accuracy, the Committee will prepare a memorandum of conditions to which each instrument-maker will be bound to accede in accepting the contract, and the price will include every expense of verification.

"On the return of any vessel which may be supplied with these instruments, the Committee will be ready to examine the errors, for which a small fee will be charged to cover the expense incurred.

"In respect to hydrometers recommended in the Brussels report, the Committee suggest for the consideration of the Board of Trade, whether any advantage could be obtained by their general use at sea.

"The Committee suggest that all contracts should be made by the Board of Trade with the instrument-maker, the prices being first fixed by the Committee, and which will include every expense of verification at Kew; and it is proposed that each instrument shall be stamped with a consecutive number.

"Should the above arrangements meet the approval of the Board of Trade, the Committee will be ready to forward a barometer and thermometer of the construction which they consider best adapted for the objects intended, and Mr. Welsh, whose especial duty it will be to compare each instrument before it is delivered to the Board of Trade, will be happy to wait on you at any time you may appoint.

"I have the honour to be, Sir,
 "Your obedient Servant,
 (Signed) "JOHN P. GASSIOT."

"To T. H. Farrer, Esq.,
 Secretary Marine Department, Board of Trade."

P.S. Should it be the wish of the Board, the Committee will readily take into consideration and recommend in a similar manner as they have the other instruments, a proper hydrometer suitable for ascertaining the specific gravity of sea water.

(Copy.)

"Office of Committee of Privy Council for Trade,
 Marine Department, 6th April, 1854.

"SIR,—I am directed by the Lords of the Committee of Privy Council for Trade to request you to convey to the Committee of the British Association for conducting experiments at Kew, their best thanks for the prompt and satisfactory manner in which the Committee have acceded to their Lordships' wishes as expressed in my letter of the 27th ultimo.

"I am to state that My Lords will avail themselves of the proposal of the Committee, and as it is desirable that no time should be lost in procuring the instruments in question, they will be obliged if the Committee will send a specimen of each of the instruments they approve (including an hydrometer) to the Board of Trade.

"My Lords coincide in the opinion expressed by the Committee that much inconvenience may in the onset arise from the attempt to combine in thermometers the Fahrenheit and Centigrade scales, and they would therefore wish that the present supply should have the Fahrenheit scale only.

"I am, Sir,
 "Your obedient Servant,
 (Signed) "T. H. FARRER."

"J. P. Gassiot, Esq."

(Copy.)

"Clapham Common, 10th April, 1854.

"SIR,—I beg to acknowledge the receipt of your letter of 6th inst.

"I have given instructions for a thermometer constructed under the superintendence of the Kew Committee, and recommended by them for adoption by the Board of Trade, to be forwarded to you for inspection.

"The instrument-makers selected by the Committee for the supply of thermometers are Messrs. L. P. Casella and Co., 23 Hatton Garden, and Messrs. Negretti and Zambra, 11 Hatton Garden, to whom the Committee have addressed letters, copies of which I annex, as also of the replies which the Committee received.

"The Committee are of opinion that the sum of one shilling per thermometer will cover the cost of verification at Kew, and this sum must therefore be added to whatever tender the Board of Trade may accept.

"No arrangement has been made by the Committee for the cost of packing, or the carriage of the instruments to and from the Observatory for verification.

"The barometer selected by the Committee has been constructed by Mr. Adie, of the Strand; its action has been tested by Mr. Welsh, but in consequence of suggested improvements, arrangements have been made for a further trial. In a few days the Committee will be enabled to forward the instrument for inspection, together with every information as to its probable cost.

"The Committee have given instructions for the construction of the hydrometer, suitable for the purpose of taking the specific gravity of sea water, and on receiving the instrument from the makers will forward it to you, with an estimate of the cost of its construction.

"T. H. Farrer, Esq."

(Signed) "JOHN P. GASSIOT."

(Copy.)

"Clapham Common, 10th April, 1854.

"DEAR SIR,—At a meeting of the Kew Committee held this day, it was resolved, that the offer of Mr. Clutton, for the temporary use of about two acres of the land immediately contiguous to the Observatory, and to be used for Meteorological and Astronomical purposes, should be accepted at the rate of £10 10s. per acre; such rent to commence from 25th of last March. It is also understood by the Committee, that the amount of any damage sustained by the cartage of materials for the erection of any buildings required by the Committee, is to be referred to Mr. Clutton, by whose decision the Committee will be bound. I am desired by the Committee to express to you their thanks for the kind and prompt manner in which you have always received their applications, and particularly for the personal trouble you took in visiting their Observatory, for the purpose of ascertaining the precise requirements of the Committee.

"I have the honour to be, dear Sir, yours truly,

"To the Hon. Charles Gore."

(Signed)

"JOHN P. GASSIOT."

(Copy.)

"Office of Committee of Privy Council for Trade: Marine Department,
20th April, 1854.

"2187.

"SIR,—I am directed by the Lords of the Committee of Privy Council for Trade to acknowledge the receipt of your letter of the 10th instant, with the inclosures from Messrs. Casella and Company, and Messrs. Negretti and Zambra, and I am to request that you will convey to the Kew Observatory Committee of the British Association their Lordships' thanks for the information therein contained.

"I am, Sir, your obedient Servant,

(Signed)

"T. H. FARRER."

"John P. Gassiot, Esq."

(Copy.)

"Clapham Common, 2nd June, 1854.

"SIR,—In reference to my letter of 3rd April, I have now to acquaint you, that the Committee have decided on the barometer which they consider most applicable for marine observations, one of which I forward for inspection.

"In selecting the form of marine barometer best adapted to the purpose of making observations at sea, the Committee have endeavoured to combine convenience and economy with accuracy, durability, and simplicity in construction and adjustments. A barometer which has been constructed by Mr. Adie appears to them to fulfil those conditions in a satisfactory manner. Its action at sea has been tested under their superintendence by Mr. Welsh on two occasions, one on a voyage to Leith and back, and subsequently to the island of Jersey. The general conclusion arrived at in those trials is, that in order to reduce the pumping of the mercury within convenient limits, it is necessary to have the tube contracted to such an extent that the mercury will take about twenty minutes to fall from the top of the tube to the height indicating the true pressure of the atmosphere at the time. From comparisons made at Kew with the standards there, it has been found that owing to this contraction in the tube the absolute freedom of the mercury is to a small extent interfered with; as the motion of the mercury in the standard barometer is always a little in advance of the marine barometer; that is, when the mercury is rising, from increasing pressure of the atmosphere, the marine barometer is a little lower than the standard, and, on the contrary, when the mercury is falling, the marine barometer is a little higher. The amount of this retardation is however very small, something less than $\frac{1}{100}$ th of an inch, and from its being in opposite directions in a rising and falling barometer, will produce no error in the *mean* height of the barometric column; it will, however, to some extent mark the smaller changes, such as the hourly variations. It should be remarked, however, that the motion of the ship will always tend to diminish the amount of the retardation, and it is believed will in general nearly destroy it.

"The instrument is constructed by Mr. Adie, of 395 Strand; the price, including cost of packing-case, 10s. for verification at the Observatory, carriage there, and subsequent delivery in London, will be 3*l.* 15*s.* 6*d.*, at which price Mr. Adie is prepared to supply any quantity that may be required.

"I have the honour to be, Sir, your obedient Servant,
"T. H. Farrer, Esq., Board of Trade." (Signed) "JOHN P. GASSIOT."

(Copy.)

"Clapham Common, 2nd June, 1854.

"SIR,—I am instructed by the Committee of the British Association to acquaint you, that after much consideration they have selected and decided on a barometer which they consider applicable for marine observations.

As to Mr. Farrer, 2nd June.

"The Committee suggest, that it might be advisable that the barometer should be also tested at sea by an officer of H.M. Navy, qualified to judge of the suitability of the instrument for the objects contemplated.

"The barometer is constructed by Mr. Adie, of 395 Strand: the price, including the cost of packing-case, 10s. for verification at the Observatory, carriage there, and subsequent delivery in London, will be 3*l.* 15*s.* 6*d.*

"I have the honour to be, my dear Sir, yours obediently,

(Signed) "JOHN P. GASSIOT,

"Sir F. Beaufort, F.R.S., Hydrographer,
&c. &c. &c. Admiralty."

"Chairman of Kew Committee,
British Association."

(Copy.)

" Hydrographic Office, Admiralty, 3rd June, 1854.

" DEAR SIR,—In acknowledging your favour of yesterday's date, I have to request that you will convey my thanks to the Kew Committee of the British Association for that satisfactory communication, and that I am glad to learn that a marine barometer has at length been constructed which is likely to fulfil so many useful conditions.

" In order to carry into immediate execution the suggestions of the Kew Committee, I would beg the favour of your directing Mr. Adie to supply this office, without delay, with one of those instruments.

" I have the honour to be, Sir,

" Your most obedient Servant,

(Signed)

" F. BEAUFORT,

" John P. Gassiot, Esq., Chairman of Kew Committee,
Clapham Common."

" Hydrographer."

(Copy.)

" Office of Committee of Privy Council for Trade:
Marine Department, 8th June, 1854.

" 3214.

" SIR,—I am directed by the Lords of the Committee of Privy Council for Trade, to acknowledge the receipt of your letter of the 2nd instant, and of the pattern barometer upon which the Kew Observatory Committee of the British Association have decided as most applicable for marine observations; and I am to acquaint you, that My Lords will avail themselves of the arrangements which the Committee have been so good as to make with the several instrument-makers, as soon as they are prepared to give the order for a supply.

" I am, Sir,

" Your obedient Servant,

" J. P. Gassiot, Esq."

" T. H. FARRER."

REPORT OF THE PARLIAMENTARY COMMITTEE OF THE BRITISH ASSOCIATION TO THE MEETING HELD AT LIVERPOOL IN SEPTEMBER 1854.

The Parliamentary Committee have the honour to report as follows:—

The subjects to which the attention of the Committee has been directed since their last report, are—

1st. Lieut. Maury's scheme for the improvement of Navigation.

2nd. The conditions on which pensions are now bestowed on men of science.

3rd. A correspondence which they have commenced with various eminent cultivators of science on the question,—Whether it might be possible to improve the position of science or its cultivators in this country by any measures to be adopted by Government or Parliament.

4th. The proposed juxtaposition of the scientific societies in some central locality of the metropolis.

As to the first,—

The Chairman and Mr. Heywood have had interviews with the President, the Vice-President and Officers of the Board of Trade on this subject, and Mr. Heywood has on two several occasions addressed some remarks to the House of Commons thereon; and the Committee have great pleasure in reporting, that Government have now established a department in the Board of Trade, with the view of carrying out in every particular the recommendations of the Royal Society and this Committee, in reference to this