XXIV. *Description of a new Barometer, recently fixed up in the Apartments of the Royal Society; with Remarks on the mode hitherto pursued at various periods, and an account of that which is now adopted, for correcting the observed height of the mercury in the Society's Barometers.* By Francis Baily, *Esq. Vice-President and Treasurer R.S.*

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THE Barometer here alluded to may in some measure be considered as two separate and independent barometers, inasmuch as it is formed of two distinct tubes dipping into one and the same cistern of mercury. One of these tubes is made of *flint* glass, and the other of *crown* glass, with a view to ascertain whether, at the end of any given period, the one may have had any greater chemical effect on the mercury than the other, and thus affected the results. A brass rod, to which the scale is attached, passes through the framework, between the two tubes, and is thus common to both: one end of which is furnished with a fine agate point, which, by means of a rack and pinion moving the whole rod, may be brought just to touch the surface of the mercury in the cistern, the slightest contact with which is immediately discernible*; and the other end of which bears the scale of inches, on which I have set off with great accuracy, from the standard scale of the Royal Astronomical Society, the distance of 30 inches from the above-mentioned agate point. Above and below this mark of 30 inches, the usual scale of inches, tenths, &c. is engraved; and there is a separate vernier for each tube. A piece of thin brass projects from the zero point of each vernier, across its contiguous tube, which, when the height of the mercury is read off, is brought down so that the lower edge of it forms a tangent to the column of mercury, in the usual manner. A small thermometer, the bulb of which dips into the mercury in the cistern, is inserted at the bottom: and an eye-piece is also there fixed, so that the agate point can be viewed with more distinctness and accuracy. The whole instrument is made to turn round in azimuth, in order to verify the perpendicularity of the tubes and the scale.

It is evident that there are many advantages attending this mode of construction, which are not to be found in the barometers as usually formed for general use in this country. The absolute heights are more correctly and more satisfactorily determined; and the permanency of true action is more effectually noticed and secured. For, every part is under the inspection and control of the observer; and any derangement or

* The motion of this rack-work is much too slow, and might be greatly improved if made more rapid.

imperfection in either of the tubes is immediately detected on comparison with the other. And, considering the care that has been taken in filling the tubes, it may justly be considered as a *Standard Barometer*. The specific gravity of the mercury was determined by Dr. PROUT to be 13·581; the thermometer being at 62°, and the barometer at 30 inches*.

The second part of the present volume of the *Philosophical Transactions* will contain the first register of the observations that have been made with this instrument. The *daily* observations are recorded just as they are read off from the scale, without the application of any correction whatever. This will be found, on due consideration, and after the details which I shall presently state, to be the most simple, and by far the safest plan of registering them; whatever mode may be afterwards adopted of reducing and *discussing* them. At the end of each month the uncorrected *mean* is deduced; which mean, however, will also be given *corrected* agreeably to the usual formulæ, to which I shall now proceed to advert.

The *observed* height of the mercury in a barometer requires several corrections (differing according to the construction of such barometer) in order to determine its *absolute* height, or that point when it may be considered strictly comparable with another barometer, either of the same or of a different construction: and, for effecting this end, certain conditions are previously understood, and universally assented to. Thus, the temperature of the mercury is always supposed to be at the freezing point of water, or 32° FAHRENHEIT: the scale, by which the height is measured, if liable to expansion by heat, is always reduced to the standard temperature, which in this country is 62° FAHRENHEIT: the tube must be corrected for its capillary attraction: and lastly, proper allowance should be made, in certain cases, for the elevation of the place of observation above the mean level of the sea. I shall speak of each of these in their order†. With these corrections duly made, the absolute heights of two barometers might be considered comparable with each other, although separated by the whole diameter of the globe: and with barometers, formed of tubes of a considerable diameter, and having a well adjusted scale, this is probably the case. Yet as, even in the best barometers, there are still certain sources of discordance, some of which, although slight, cannot be altogether avoided notwithstanding our utmost care, such as differences in the specific gravity of the mercury, or in setting off the measure of the scale, or an uncertainty in the height of the station above the mean level of the sea, and, in the more usual ones, others of a more formidable and *variable* nature, depending on circumstances not yet sufficiently accounted for, it is always the most

* Dr. PROUT has been good enough to inform me that, in taking the specific gravity of mercury in the common mode, it is necessary, in order to expel the whole of the adhering air, to heat repeatedly the mercury in the vessel to nearly the boiling point, and in this state to expose it under the exhausted receiver of an air-pump. This precaution was taken in the present instance.

† In those barometers where the tube dips into a *measured* cistern (similar to that which was constructed for this Society by Mr. DANIEL, to which I shall presently allude) there is another correction requisite, which depends on the relative capacity of the tube and the cistern: but this does not apply to the present barometer.

satisfactory method to compare them together, if possible, on the same spot, more especially where great accuracy is required*.

The correction for the temperature of the mercury is by far the most important, since it is in most cases more than ten times the amount of the correction for the expansion of the scale. The correction, for both these sources of discordance and error, may be reduced to one general expression by the following well-known formula: viz.

$$-h \times \frac{m(t-32) - s(t-62)}{1 + m(t-32)}$$

where h denotes the observed height, as read off from the scale, which represents English standard inches when at the temperature of 62° FAHR., m the expansion of mercury in volume, and s the expansion of the scale in length, for 1° FAHR.: t denoting the temperature of the mercury and the scale, which are supposed to be the same, and to be ascertained by the thermometer that dips into the cistern of mercury; the slight difference which may exist in the temperature of the scale making no perceptible difference in the results.

According to the accurate experiments of MM. DULONG and PETIT, it appears that mercury expands in volume $\frac{1}{9990}$ (= ·000100100) for each degree of FAHRENHEIT's thermometer: and, with respect to the linear expansion of brass (of which the present scale is made) we may assume it to be ·000010434 for each degree of FAHRENHEIT. Consequently the above formula becomes

$$-h \times \frac{\cdot 0001001\,(t-32) - \cdot 000010434\,(t-62)}{1 + \cdot 0001001\,(t-32)}$$

which, by proper reduction, becomes

$$-h \times \frac{\cdot 000089566\,t - \cdot 002553092}{\cdot 0001001\,t + \cdot 9967968}$$

This expression may be easily formed into a table of double entry, which would be very convenient for correcting the observed heights of the barometer. And it is agreeably to this formula that Professor SCHUMACHER has constructed the tables which are printed in the first volume of his *Astronomische Hülfstafeln*, showing the correction for every difference of half an inch in the height of the mercury, from 27½ to 31 inches; and for every degree of FAHRENHEIT from 6° to 88°, to four places of decimals. These tables, having been afterwards slightly corrected, were (together with some others) printed on a separate sheet, and distributed with No. 114 of his *Astronomische Nachrichten*. They have been recently much enlarged by the distinguished author; and

* In one of my barometers, the tube of which is about a quarter of an inch in diameter, the mercury has generally stood about a quarter of an inch lower than that of a standard barometer placed by its side, after every correction made for capillarity and temperature, and after a careful examination of the scale. I satisfied myself that there was no *air* in the tube; having had it re-filled with mercury for the express purpose of determining that point, and having also placed it by the side of other excellent standards, and always with the same results. This anomaly, I have since been informed, is by no means rare, and shows the necessity of direct comparison of such barometers with standard ones. Mr. NEWMAN however conceiving that the imperfection arose from *vapour*, has remedied it by drying and wiping out the tube and filling it again with *heated* mercury.

having been extended to every tenth of an inch in the height of the mercury, and to every fifth part of a degree of its temperature, are now printed in his *Jahrbuch* for 1837. It is by these latter tables that the *monthly means*, in the Meteorological Register, are now corrected for temperature.

As I am not aware that any tables of this kind have been printed in England, I shall (with the approbation and consent of the author) give, on this page, some of the values here mentioned: namely, for every half inch in the height of the mercury from 28·0 to 30·5 inches, and for every degree of its temperature from 30° to 90°, which will be found very useful and convenient for the correction of such barometers as are furnished with a continuous brass scale*.

Corrections for a Mercurial Barometer with a continuous Brass scale: all *subtractive*.

Ther.	Barometer. in. 28·0	in. 28·5	in. 29·0	in. 29·5	in. 30·0	in. 30·5	Ther.	Barometer. in. 28·0	in. 28·5	in. 29·0	in. 29·5	in. 30·0	in. 30·5
30°	·004	·004	·004	·004	·004	·004	60°	·079	·080	·082	·083	·084	·086
31	·006	·006	·006	·007	·007	·007	61	·081	·083	·084	·086	·087	·089
32	·009	·009	·009	·009	·009	·009	62	·084	·085	·087	·088	·090	·091
33	·011	·011	·012	·012	·012	·012	63	·086	·088	·089	·091	·092	·094
34	·014	·014	·014	·014	·015	·015	64	·089	·090	·092	·094	·095	·097
35	·016	·017	·017	·017	·017	·018	65	·091	·093	·095	·096	·098	·100
36	·019	·019	·019	·020	·020	·020	66	·094	·095	·097	·099	·100	·102
37	·021	.022	·022	·022	·023	·023	67	·096	·098	·100	·101	·103	·105
38	·024	·024	·025	·025	·025	·026	68	·099	·101	·102	·104	·106	·108
39	·026	·027	·027	·028	·028	·029	69	·101	·103	·105	·107	·108	·110
40	·029	·029	·030	·030	·031	·031	70	·104	·106	·107	·109	·111	·113
41	·031	·032	·032	·033	·034	·034	71	·106	·108	·110	·112	·114	·116
42	·034	·034	·035	·036	·036	·037	72	·109	·111	·113	·115	·116	·118
43	·036	·037	·038	·038	·039	·040	73	·111	·113	·115	·117	·119	·121
44	·039	·039	·040	·041	·042	·042	74	·114	·116	·118	·120	·122	·124
45	·041	·042	·043	·044	·044	·045	75	·116	·118	·120	·122	·124	·127
46	·044	·045	·045	·046	·047	·048	76	·119	·121	·123	·125	·127	·129
47	·046	·047	·048	·049	·050	·050	77	·121	·123	·125	·128	·130	·132
48	·049	·050	·051	·051	·052	·053	78	·124	·126	·128	·130	·132	·135
49	·051	·052	·053	·054	·055	·056	79	·126	·128	·131	·133	·135	·137
50	·054	·055	·056	·057	·058	·059	80	·129	·131	·133	·135	·138	·140
51	·056	·057	·058	·059	·060	·061	81	·131	·133	·136	·138	·140	·142
52	·059	·060	·061	·062	·063	·064	82	·134	·136	·138	·141	·143	·146
53	·061	·062	·064	·065	·066	·067	83	·136	·138	·141	·143	·146	·148
54	·064	·065	·066	·067	·068	·070	84	·139	·141	·143	·146	·148	·151
55	·066	·067	·069	·070	·071	·072	85	·141	·144	·146	·149	·151	·154
56	·069	·070	·071	·073	·074	·075	86	·144	·146	·149	·151	·154	·156
57	·071	·073	·074	·075	·076	·078	87	·146	·149	·151	·154	·156	·159
58	·074	·075	·076	·078	·079	·080	88	·148	·151	·154	·156	·159	·162
59	·076	·078	·079	·080	·082	·083	89	·151	·154	·156	·159	·162	·164
60	·079	·080	·082	·083	·084	·086	90	·153	·156	·159	·162	·164	·166

* By a continuous brass scale, I mean one that extends the *whole length* of the tube: and it should be specially borne in mind that the tables, here alluded to, apply *only* to barometers of that construction. For barometers of the ordinary construction, other tables, computed also by Professor SCHUMACHER, will be mentioned in the sequel. See the note in page 437.

The correction for the capillarity of the tube is very slight, and might indeed be safely neglected: but it has been considered proper that every source of anomaly, however small, should be pointed out and scrupulously allowed for. The diameter of the tube of flint glass is ·594 inch, and of the tube of crown glass ·658 inch. The correction for these, agreeably to the formula of LAPLACE, would be respectively + ·0048 and + ·0033: but, in cases where the mercury has been well boiled in the tubes, the correction, as found by the formula, should be somewhat diminished. If we strike off the last figure in each case, we probably shall not be far from the truth: and I have therefore proposed that the correction to be applied should be + ·004 to the flint glass, and + ·003 to the crown glass.

These are all the corrections that, in the case of the present barometer, require to be applied in order to ascertain the absolute height at the place where it is now fixed. The correction for the height of a barometer above the mean level of the sea, is never applied except on especial occasions, and for some definite and express object. The formula for such correction, whenever it may be wanted, is as follows*:

$$d = + \frac{f.h}{24337{\cdot}55 + 58{\cdot}20\,t}$$

where d denotes the addition (in parts of an inch) to the height of the mercury in the barometer, when elevated f feet above the mean level of the sea, in order to show the height at which the mercury would stand, provided the barometer were placed at that level. So that, assuming the height of the station of the present barometer to be 97 feet above the mean level of the sea (and on this subject I shall have some further remarks to make in the sequel), the above expression would become

$$d = + \frac{h}{250{\cdot}90 + {\cdot}60\,t}$$

Whence, if the reading of the barometer, at the place where it is now fixed, were exactly 30 inches, and the temperature 60°, we should have

$$d = + \frac{30}{286{\cdot}9} = + {\cdot}1045$$

* This formula is easily deduced from that which I have given in my *Astronomical Tables and Formulæ*, page 111, for "computing the difference in the height of two places by means of the barometer." For, there we have

$$f = a\,.\,b\,.\,c\,.\log\frac{h'}{h}$$

all known quantities except h'. But $\log\frac{h'}{h}$ is equal to $\log h' - \log h$: and if we make $h' = h + d$ (where d is the required difference in the height of the mercury) we have $\log h' = \log h + \mathrm{M}\,.\,\frac{d}{h}$. The formula therefore becomes

$$f = a\,.\,b\,.\,c\,.\,\mathrm{M}\frac{d}{h}$$

whence we obtain

$$d = \frac{f.h}{a\,.\,b\,.\,c\,.\,\mathrm{M}}$$

which is the formula in the text.

Or, in other words, the height of the mercury in the barometer would in such case be 30·1045 inches, if placed at the mean level of the sea, instead of being in the apartments of the Society: and so in the proportion of ·0011 inch for every foot below its present position. But, as I have before remarked, this correction is wholly omitted in the Meteorological Journal.

I have been particular in giving these explanations as to the precise mode in which the corrections should (and are now directed to) be made, since it appears that great irregularity, as well as some inattention, error, or confusion has hitherto occurred on this subject, which ought not to have existed; and the Meteorological Journal of this Society has lost much of its utility, confidence, and importance in consequence thereof.

Prior to the year 1823, the registers of the barometer do not indicate whether the observations are corrected or not: nor can I obtain any satisfactory information on this point. So that a person now referring to them can consider them only as approximate values. The barometer then in use is still in existence.

In January 1823 the registers commence (as I presume*) with the new barometer which had been constructed in the preceding year under the able direction of Mr. DANIEL, now Professor of Chemistry at King's College. A description of this barometer is given by him in his *Meteorological Essays and Observations*, page 353. The daily observations are, in the register, said to be *corrected*; but no formula or rule is given, of the mode in which the corrections have been made: and if the observations have been corrected by the small table engraved on the face of the barometer (which is the same as that given by Mr. DANIEL in page 372 of his *Essays*), the result will in most cases, for the reasons which I shall presently mention, be slightly erroneous; but more so as the temperature varies from the freezing point. So that although, during the winter months, the results will not be far from the truth, yet in the summer they will not exhibit the correct values†. For, that table has been calculated "from the expansion of mercury and mean dilatation of glass:" it having been originally intended (as I have understood) that the divisions of the scale should have been cut on the glass tube. But this plan having been abandoned, and recourse had to the ordinary mode of construction, it is evident that the expansion of the glass tube does not affect the observed height of the column of mercury sustained by the atmosphere. The only effect which the expansion of the glass can have on the reading of the vernier, will be caused by an alteration in the relative capacity of the tube and the cistern; but this would be so extremely small, on all ordinary occasions, as to be

* There is nothing stated in the register by which we can judge whether the *old* barometer, or Mr. DANIEL'S, was at that time used for the daily observations; except that the height of the cistern of the barometer is then stated to be 19 feet higher than before: which was the position in which I find that Mr. DANIEL'S barometer was placed, as I shall presently explain more fully.

† Taking the thermometer at 70°, and the barometer at 30 inches, the true correction would be ·114; but, according to the table attached to the barometer, it is only ·098: being a difference of ·016 inch.

wholly imperceptible; or at all events now inappreciable, since we are not informed at what temperature the relative measures were ascertained. The true formula for the correction of the expansion of the mercury alone is

$$-h \times \frac{m\,(t-32)}{1+m\,(t-32)}$$

where m denotes, as in page 433, the *absolute* expansion of mercury for 1° FAHR. (= ·0001001), and not the *apparent* expansion (= ·0000857339) as assumed in the table above mentioned*.

Besides this correction, there is another, which is peculiar to Mr. DANIEL's mode of constructing this barometer, and which is called the correction for the *capacity* of the cistern. As the height of the mercury in the cistern is constantly varying with the variation in the height of the mercury in the tube, it is necessary that the relative capacity, or contents, of the volume of the cistern and the tube should be determined; as also some fixed point on the scale, as the zero of comparison. This has been done with great care by Mr. DANIEL; and the capacity of the cistern has been determined to be exactly $\frac{1}{100}$th part of the capacity of the tube, and the neutral point fixed at 30·576 inches†. So that the correction for capacity is

$$+\frac{30{\cdot}576-h}{100}$$

The diameter of the tube is ·530 inch: the correction for capillary attraction is therefore, by LAPLACE's formula, + ·006; and this is the value that is engraved on the front of the barometer case.

The whole of the corrections therefore for Mr. DANIEL's barometer will be as follows‡:

$$-h \times \frac{\cdot0001001\,(t-32)}{1+\cdot0001001\,(t-32)} + \frac{30{\cdot}576-h}{100} + \cdot006$$

There is a short brass scale, of about 4 or 5 inches, on which the divisions are cut: but the expansion of this would, in no possible case, cause an error of more than an unit in the third place of decimals: and as it is screwed to the wooden frame, which is

* The *absolute* expansion of a liquid is that which is independent of the form, or expansion, of the vessel that contains it: the *apparent* expansion is obtained by deducting 3 times the linear expansion of the containing vessel. Thus, the *absolute* expansion of mercury being ·0001001, and the linear expansion of glass being ·0000047887, we have ·0001001 − ·0000143661 = ·0000857339 for the *apparent* expansion of the mercury. See my Paper on this subject in the *Memoirs of the Astron. Soc.* vol. i. page 383.

† Fifty inches, measured in the upper part of the tube before it was sealed, raised the float in the cistern exactly half an inch.

‡ Amongst the tables, separately printed and distributed with No. 114 of the *Astron. Nach.* by Professor SCHUMACHER (as already mentioned in page 433), there is one showing the value of that part of the expression in the text which is denoted by $-h \times \frac{\cdot0001001\,(t-32)}{1+\cdot0001001\,(t-32)}$, for every $\frac{1}{2}$ inch from $27\frac{1}{2}$ to 31 inches; and for every degree of FAHRENHEIT from 6° to 88°. And this is the table that should be used for barometers of the ordinary construction, not furnished with a brass scale extending the *whole length* of the tube. But I am not aware that any such table has been published in this country.

liable to expand and contract with different degrees of moisture, independent of the temperature, no correction for this purpose can be depended upon. This is a great imperfection in the mode of constructing and fixing the scale of a barometer intended for very accurate purposes. The specific gravity of the mercury was ascertained by Mr. FARADAY to be 13·624: the thermometer being at 40°, but the height of the barometer not given.

I have already stated that prior to the year 1823, the registers do not indicate whether the observations have been corrected, or not; but that, commencing with January 1823, they profess to give the *corrected* heights of the readings of the barometer, unexplained however as to the mode of correction. This continued till March 20, 1826, when a temporary suspension of the observations took place. From April 6, 1826, down to the end of the year 1836, we are again left in doubt whether the *daily* observations are corrected, or not. But the inference is that they were not corrected; since we find a correction applied to the *monthly* means, for temperature and capillarity. I have ascertained, however, on inquiry, that the daily observations have in all cases been *partially* corrected: that is, the correction for the capacity of the cistern has been applied daily. Why this correction alone, on each day, should have been considered requisite, I have not been able to ascertain; and as it is nowhere mentioned in the meteorological journal, it may perhaps have sometimes led to error. But leaving this part of the subject, I shall now proceed to notice the loose manner in which the remaining correction (for temperature) has been from time to time applied to the monthly means.

From April 6, 1826, to the end of that year, the temperature has been taken from the *external* thermometer, instead of the thermometer which dips into the cistern of mercury. Consequently all the reduced values of the readings are too great. By the *external* thermometer, I mean the thermometer which is placed *outside of the building*, and consequently gives the temperature of the open air.

In the year 1827 this error appears to have been discovered and discontinued; but another of a different nature was at the same time introduced. For, from that epoch to the end of the year 1836, all the corrections are made under the assumption that the height of the mercury in the barometer was exactly 30 inches: when it is well known that the correction will vary according to the variation in the height. In fact there does not appear, at any time, to have been any regular and uniform system of reduction adopted.

Now this state of confusion and uncertainty ought not to exist in a meteorological journal emanating from this Society, more especially as the true values are as easily attainable as the approximate ones. And although, in a general point of view, the minute differences caused by such errors may be unimportant, yet as appeals are frequently made to the barometer of this Society, as a standard, by persons engaged in important researches, the most scrupulous accuracy ought to be adopted and pursued, and the fullest explanation placed on record. And notwithstanding the details which

I have here given may create some doubt respecting the accuracy of the past, yet I am persuaded that the system now pursued will inspire more confidence for the future. It is on this account that I have entered thus at large on the subject: trusting that what I have here stated will not only tend to preserve for the future a more correct and uniform system, but also justify the Council in directing that the register should henceforth contain the daily observations *uncorrected*, and thus prevent the possibility of any similar confusion and mistakes hereafter.

I shall now say a few words respecting the height of the barometer above the mean level of the sea; a subject of much interest to many persons engaged in various pursuits, but which appears, from the notes attached, at different periods, to the meteorological journal of this Society, to be involved in some confusion and uncertainty. Thus, prior to the year 1823, the cistern of the barometer is said to be 81 feet above the level of low-water spring tides at Somerset House; but without any information how this was connected with the sea. From 1823 to 1825, both inclusive, it is said to be 100 feet above the same level. And from 1826 to 1836, both inclusive, the above indication is omitted, and the height is said to be 83 feet $2\frac{1}{2}$ inches above a *fixed mark* on Waterloo Bridge; or "above the mean level of the sea (presumed about) 95 feet." The discordance between the 81 feet and the 100 feet is easily accounted for by the fact that the old barometer, prior to 1823, was fixed up in the Council-room of the Society, or the contiguous ante-room: but when Mr. DANIEL'S barometer was finished, at the end of the year 1822, it was fixed up in the closet adjoining the library, on the floor which is immediately *over* the Council-room: the assumed difference in the elevation of the two floors (namely, 19 feet) having since been ascertained to be correct.

With respect to the new reference of altitude, namely, the fixed *mark* at Waterloo Bridge, much doubt has frequently been expressed about its existence, since no person had been able to discover it. The fact is that there is no *mark*, in the common acceptation of the term; but the intended reference is nevertheless more conspicuous, more durable, and more convenient than any mark that could have been inscribed by hands. This standard mark, or level, was fixed on by Mr. BEVAN in the year 1827, at the request of the Council of this Society: and the same gentleman also ascertained the difference of level between that mark and the floor of the council room. As his Report on the occasion has never yet been made public, and will throw the best light on the subject, as well as be interesting to many persons, I shall here subjoin his letter to the Council, detailing the whole circumstances of the case.

"GENTLEMEN,—Pursuant to the order I had the honour to receive at the close of "your last session, I have selected a permanent and definite point of reference, or *bench-* "*mark*, for heights at Waterloo Bridge; and have determined the difference of level "between this point and the floor of the Council room, in the Apartments of the "Society at Somerset House.

"The bench-mark, I have adopted, is the *surface* of the granite pedestal at the

"base of the columns, at the north abutment of the bridge, and on the eastern side; "which is about five feet above the lowest platform, or landing, at the stairs.

"I have ascertained, by levelling from this spot, or bench-mark, to the floor of the "Council room, in which the barometer was kept in June 1826, that the floor in the "centre of the doorway between the two rooms is 62·41 feet above the said bench-"mark. The mercury, in the basin of the barometer, I found above the floor 2·84 "feet; making the rise from the bench-mark to the mercury 65·25 feet.

"I am, Gentlemen, your obedient humble Servant,

"B. Bevan."

Upon what authority it was presumed that the present position of the cistern of the barometer is ninety-five feet above the mean level of the sea, (or, in other words, that the above-mentioned station at Waterloo Bridge is 11 feet $9\frac{1}{2}$ inches above that level) I have not been able to ascertain; since Captain Lloyd's levelling of the river Thames, from Sheerness upwards, as detailed in the *Philosophical Transactions* for 1831, terminated at London Bridge. He says, page 190, "I *concluded* my levellings at a "standard mark sunk in the large plinth of the landing place (near the wall) of the "stairs on the north-east side of the New London Bridge. This standard was 2·3967 "[feet] below the north standard mark at Sheerness." Now, as the north standard mark at Sheerness was ascertained by Captain Lloyd to be 13·1511 feet above the mean level of the sea, we consequently have the surface of the above-mentioned plinth at London Bridge equal to 10·7544 (or $10\frac{3}{4}$) feet above the mean level of the sea. It therefore only remained to ascertain the difference of level between the surface of this plinth, and the surface of the plinth at Waterloo Bridge.

But a doubt for a long time remained as to the position of the mark at London Bridge, since (as in the case of that at Waterloo Bridge) it had escaped the search of all those who attempted to discover it. It was at length found by Dr. Fitton, who in a note to his paper "On the Strata below the Chalk," inserted in vol. iv. (second series) of the *Transactions of the Geological Society*, page 370, gives the following accurate and circumstantial description of its position. "The mark here referred to is "a flat piece of brass, let into a cavity in one of the two large flags, or slabs of gra-"nite, which form the landing place at the bottom of the second flight of steps, de-"scending from the footway on the north-east side of the bridge. The upper flight "consists of 29 steps; the second (at the foot of which is the mark) of 26. The "lowest flight is more or less commonly covered by the water. The cavity, in which "the mark is lodged, is about 3 inches square, with rounded angles; and is two feet "from the eastern wall, or side of the bridge, and two feet eight inches from the "southern side of the stone. The surface of the brass is about half an inch beneath "that of the stone, which is itself a few inches below the level of the water at high "spring tides."

The propriety of such a position for a *standard* mark may be much questioned, since we know, from what has recently taken place at Blackfriars Bridge, that the

steps of a common landing place, abutting on the river, are liable to *settle*; and in course of time to be altogether removed, for the purpose of repairs. It therefore became desirable, on more accounts than one, to connect together the two marks at London and Waterloo Bridges by direct levelling. This has recently been effected, at the request of the Council of this Society, by the direction and under the superintendence of Sir JOHN RENNIE, who readily undertook the determination of this point. In his letter on this subject, dated October 18, 1837, he says, "After repeated trials "(the greatest variation of which did not exceed $\frac{8}{10}$ of an inch) I find that the difference "is 3 feet 1·65 of an inch: that is, the mark on Waterloo Bridge is 3 feet 1·65 of an "inch *above* that on the New London Bridge fixed by Captain LLOYD."

The height of the cistern of the present barometer above the floor is 1·75 foot: therefore adding all these several quantities together, namely,

19·000
62·410
10·754
3·138
1·750

97·052

we have, in round numbers, 97 feet for the height of the mercury in the cistern of this barometer above the mean level of the sea.

One word more before I close this paper, as to the propriety of the position of the several meteorological instruments of this Society; on which, comments have occasionally been made. With respect to the *barometer*, I am not aware that any objection can be offered; and as to the *hygrometer*, the observations have been found, by recent trials, not to differ materially from some expressly made in another position, at King's College, which was considered to be more favourable for such experiments. It therefore only remains to speak of the external *thermometer* and of the *rain-gauge*; of which all that can be said on the subject would be merely a repetition of what was justly said sixty years ago by Mr. CAVENDISH on a similar occasion (Philosophical Transactions, 1776), namely, "that, on the whole, the situation is not alto-"gether such as could be wished, but is the *best* the house affords."