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Contributors

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EPITOME
OF THE
ELECTRO-METEOROLOGICAL
AND
MAGNETIC OBSERVATIONS,
EXPERIMENTS, &c.

MADE AT
THE KEW OBSERVATORY.

UNDER THE DIRECTION OF
FRANCIS RONALDS, Esq. F.R.S.

CHISWICK :
PRINTED BY CHARLES WHITTINGHAM.
1848.



*Epitome of The "Kew Electro-Meteorological and Magnetic
Observations and Experiments," &c.*

THE principal object of this enumeration of Proceedings at, and relative to, the Kew Observatory during the last five years of my honorary directorship, is to adduce, as briefly as possible, *some* evidence of a constant desire to promote the views of the British Association in general, and more particularly, First, as regards the well known chief purposes of my going there, viz. the establishment of an apparatus for the correct observation of Atmospheric Electricity; whereby the maintenance of an uninterrupted series of such observations might be insured: and Secondly, in regard to my invention of an efficient system of self-registration (by means of Photography) of all meteorological, and ter-restro-magnetical instruments.

The first chief purpose had long been deemed a desideratum, and I trust that it has been effected in a satisfactory manner, and that the intended reduction of the five years of uninterrupted electrical observations will not prove a useless addition to the stock of information which has been accumulated by the British Association.

The second principal purpose was also deemed an important desideratum, and although it has not yet been carried to its full application, by reason of insufficiency of funds; (It has hitherto been applied to the atmospheric Electrometer, the Thermometer, the Barometer, and the declination Magnet *only*;) yet strict investigation and comparison have shewn that the advances, already made, have been completely successful, and leave no doubt as to the extensive applicability of the system, not only to meteorology and magnetism, but to many other useful purposes.

It will be seen that in several other respects successful attempts have been made to improve the means of meteorological investigation.

And I hope that a *desire* to accomplish the ends of all my humble labours at Kew, with due regard to *financial* considerations, will be apparent in the little appended digest.

But a minor object, which I trust that the general tenor of this statement will greatly tend to accomplish, is the correction of an erroneous report or impression, still obtaining a certain degree of currency, to the effect that I have been employed at Kew under the direction of other persons, and not in carrying into effect plans, inventions, and suggestions of my own.

Having (when questioned by many distinguished visitors to Kew), invariably claimed the invention or the improvement, and the direction of all that part of the Apparatus and Proceedings referred to below, and which are not mentioned as the inventions, &c. of other persons (or well known old inventions, &c.) I cannot avoid taking the opportunity of challenging rigid enquiry into the validity of those claims, and this is done much rather for the sake of guarding against the slightest imputation of *vile* charlatanerie than for the purpose of defending my right to contrivances, &c. which, however useful they may be (or may become) are not such that any person of common experience in affairs of this sort and of common sense, would dream of greatly priding himself upon.

For the convenience of reference, the subject shall be divided into heads corresponding with the Five MSS. Volumes, entitled, "*Kew Electro-meteorological Observations and Experiments*," being the annual Journals produced at the yearly meetings of the British Association during the same period. But other documents in my possession have been consulted also.

1ST. VOL.

In October, 1842, some regular observations were commenced at the Kew Observatory, of a Barometer, an ordinary Thermometer, a pair of Six's maximum-and-minimum thermometers, a Daniel's hygrometer, and a Mason's wet-bulb hygrometer, which Instruments had been deposited, before my attendances there began, at the north window of the east (or quadrant) room, where they have from that time to the present, been constantly employed.

A chronometer of Mr. Dent, was also there, and has been always used to note *Greenwich mean time*.

In November, 1842, I described particularly my plan or project for erecting on, and in, the equatorial apartment of the Observatory an electrical Conductor on the principle of that which I had formerly invented, and described.* In this plan or project I also suggested the employment of some additional apparatus necessary, or subservient, to the prosecution of electro-meteorological observations and experiments, (and adverted to a scheme for exposing a very large extent of wire, or wire-gauze, to the action of dew, &c. &c. with a view to some other new electrical experiments, &c.).

In the earlier part of 1843 I made some drawings of the alterations and constructions required for converting the equatorial apartment of the observatory into an Electrical observatory; and other drawings of the required electrical apparatus, viz. the principal Conductor, with its glass support and heating apparatus, its voltaic collecting lantern, its glass Voltaic Electrometers (as first employed), a Henley's electrometer (*apud* Volta), my new Discharger (or spark-measurer), gold-leaf Distinguisher, and improved gold-leaf Electroscope, &c. &c.; and the execution of these alterations, constructions, and instruments was superintended by myself at Kew, and (at Mr. Newman's) at Somer's Town. They were completed and brought into use in June, 1843.

Before the 1st of August, 1843, I added to the above collection, a Lind's Anemometer, my improved Wind-vane, my Rain-and-vapour-guage, an eight-haired Saussure's Hygrometer, my improved resinous plate Electrograph, (the three last coming from Chiswick, on loan), and a Goujon's galvanometer was sent in by Professor Wheatstone.

In May, 1844, my balance Anemometer was constructed and brought into use, after finding the Lind's and Guyot's not sensible enough.

In June, 1844, the glass Voltaic electrometers above mentioned, were discarded, and the improved instruments now employed were substituted.

The journal of Electro-meteorological observations may be said to have properly commenced on the 1st of August, 1843, and all the instruments hitherto mentioned were more or less employed in the observations. It ends, in this Volume, on July 31, 1844. In arranging the form of it, I adhered as nearly as the new circumstances would admit to that of the

* In my "*Descriptions of an Electrical Telegraph, and of some other electrical apparatus*." 8vo. Lond. 1823.

Greenwich "Observations." In superintending the observations themselves, I took great pains to instruct the observer in the methods of using the electrical instruments, but did not so closely watch the other observations, for he had received orders and instructions, &c. before my attendance at Kew, respecting them, and I hoped that other gentlemen would have assisted in this kind of manner, and in making reductions, &c. Four daily periodical observations of electricity were set down, viz. at sunrise, at 9 a. m., at 3 p. m., and at sunset. The morning minimum and maximum, and the afternoon minimum and maximum were also noted, in so far as these could be ascertained by quasi hourly observations made between sunrise and 10 p. m.

In about September, 1843, the erection of the Greenwich electrical apparatus, on the Kew principle, began, and a few drawings, visits, suggestions, (and proved electrometrical pendulums), were most gladly furnished.

In October, 1843, I had a little correspondence with the late Professor Daniel, and made a modification of an experiment of Volta, intended to prove to him that, "in examining the electricity of serene weather, the use of a flame is free from that objection which is founded on a doubt as to whether our conductor may become electrified by induction, or by absorption, or both."

Experiments were made,

In February, 1844, on the comparison of the Voltaic electrometers, for the purpose of establishing authentic measures.

In February, March, August, and September, on the insulating powers of our glass pillars, under various conditions as to atmospheric humidity, &c. (for a similar purpose).

Between January and June, 1844, on the insulating power of uncoated glass, resins, &c. when immersed in an atmosphere dried by chloride of calcium (which experiments led to the invention of the Night-registering electrometers) hereafter mentioned.

In March, 1844, and subsequently, on the comparative effects of induced and absorbed atmospheric electricity: for which purpose, a pair of portable voltaic electrometers were constructed, and Professor Wheatstone brought a gold leaf electrometer, adapted to M. Peltier's (or rather Herr Erman's) experiment, which he then, and several times afterwards, repeated.

In April, 1844, I requested Mr. Collen, of Somerset-street, to employ his ordinary camera-obscura, in the manner usual for portraits, to procure impressions of figures which had been produced upon the resinous-plate-electrograph by atmospheric electricity, and to calotype them.

In May, 1844, some experiments were begun on the important subject of the *Frequency* of atmospheric electricity, but their further prosecution required more expense than could be afforded.

In the same month, an experiment was made to prove by analogy the efficiency of the collecting lantern, as now used; which experiment had also some relation with the inductive theory.

Before the end of September, other experiments were made preparatory to the construction of the Storm-clock, the Pluvio-electrometer, &c. and several minor contrivances and arrangements were executed.

At the end of this (Association) year, (*i. e.*) September 26th, 1844, this my first MS. volume of observations and experiments was compounded of a description and drawing of the Observatory itself; of full descriptions of all the above-mentioned apparatus (with diagrams, &c.); of accounts

of the principal experiments which had been made; and of the whole electro-meteorological journal. The chief contents of which compilation were printed in the volume of the Society reports for 1844, (p. 120, et seq.) with the exception of the voluminous tables of observations, of which specimens only were given.

2ND. VOL.

On the 1st of January, 1845, the three Registering electrometers were applied to the clock work of the electrograph, in lieu of the resinous-plate by which means the series of two-hourly electric observations for the whole 24 hours could be rendered complete.

In the beginning of 1845, a new modification of Coulomb's torsion electrometer was completed, whereby observations on atmospheric electricity (or other) can be made at all times, and under circumstances (of humidity, &c.) which render the use of former constructions troublesome and unsatisfactory; but in windy weather the tremor of the pedestal and high conductor in the electrical observatory was found to interfere too much with its regular employment.

In April, 1845, the Storm-clock, now in the electrical observatory, and which empowers an observer to set down multifarious events occurring in very rapid succession, was finished. A valuable suggestion concerning it, and the loan of a journey-man clock from the Greenwich Observatory, were obligingly furnished by the Astronomer Royal.

The Pluvio-electrometer, a large copper dish supported by an insulating glass-pillar, warmed by the usual lamp, &c. and placed upon a pedestal on our roof, was constructed in this year, and employed in June, 1845, in the observation of a singular fact, viz. that, without rain, this dish was, during about 26 minutes, in a positive state, whilst the high conductor was negatively charged, but rain was impending.

In the same month, 1845, Kreil's Barometrograph arrived, and after a slight addition had been made, was set to work experimentally.

On the 12th of June, 1845, the wooden Balance-anemometer gave place to a much more solid and complete apparatus (of brass).

The journal in this Volume begins August 1, 1844, and ends June 18, 1845. It went on as usual until the end of 1844. From the 1st January, 1845, fourteen electric observations are generally recorded daily, viz. one at every even hour, one at sun-rise, and one at sun-set. The recorded two daily minima and two daily maxima are derived from these 14 observations.

The new experiments were as follow, viz.

In February and March, 1845, on the different effects produced by two atmospheric conductors, whose insulators were situated at different heights above the earth, but whose upper extremities had the same height above the earth. This set of experiments was made to prove that a difference in construction of the Greenwich and Kew apparatus caused *some* of the difference in the values obtained from each.

On March 19th, 1845, the principal conductor was removed from its glass pillar, in order to test the permanence of the insulating power, which was found to remain entirely undiminished. A charge of 100 degrees of Volta decreased to 3 degrees in 12 hours.

In May, 1845, a striking example of atmospheric electrification without insulation, occurred. It was an instance of the St. Elmo fire, I believe, and my attention was first called to it by Mr. Galloway.

In June, 1845, I made a plan and elevation for erecting an electric

conductor on the pagoda, and it was presented at the Office of Woods, &c. by Sir William Hooker, but the subject was not further prosecuted.

This 2nd volume of observations, &c. with descriptions (and drawings,) of instruments and experiments, was completed and carried to the Cambridge meeting on June 19, 1845.

3RD. VOL.

The collection of instruments for ordinary observations recorded in this Volume, remained unaltered, excepting that the gold-leaf electroscope was now placed under a glass bell, with some chloride of calcium, in order to preserve it in a state perfectly dry, and fit for immediate use.

The journal begins on the 19th of June, 1845, and ends September 10, 1846; 14 observations per diem were made, as usual, of the electrometers.

In July, 1845, my experiments (in pursuance of my previous proposals in 1840, 1841, and 1844,) on the photographic registration of all meteorological and terrestro-magnetical instruments, began at this Observatory. The first attempts, which should be esteemed quite successful, were upon an artificially charged Voltaic electrometer, on August 2nd, 1845, (*vide* "Kew Photographs;") upon a thermometer, on the 5th of August, 1845; and upon a barometer on the 15th of August, 1845. Previously to these, I had made some rough experiments, and had received some assistance in the *chemicalities* from Mr. Collen.

On the 24th of September, 1845, I obtained the first *good* specimen of registered *atmospheric* electricity; and on the 25th, and frequently afterwards, the apparatus enabled me to observe the curious fact, that the electric tension increased with the light of the sun, under certain circumstances, but that such increased tension did not continue.

In the beginning of November, 1845, these experiments on either the thermometer, barometer, or electrometer, having been repeated almost daily since the 2nd of August, and the specimens having displayed sufficient exactitude, I ventured to recommend the use of the method as regarded the electrometer particularly, in preference to that of the resinous-plate electrograph at Greenwich: for the Astronomer Royal had said in his excellent "Report" of June, 1845, that "if an efficient self-registering apparatus could be arranged, preserving its records in a permanent form, he should propose to mount an electric apparatus, nearly similar to that at Kew, on the top of the octagon room."

On December (6th) 1845, I first applied a kind of Distinguishing electrometer to the photographic microscope (or camera), in pursuance of a hint from the Astronomer Royal in reference to the dry pile distinguishing apparatus (of Bohnenburger) of gold leaf.

In December, 1845, I began to work upon the application of the system to the Declination magnet, and made drawings, patterns, &c. in January, but had not actually tried it, when, on the 9th of February, 1846, Mr. Brooke came to Kew (meeting Colonel Sabine and other gentlemen there) and I shewed him many very good specimens of my process on the electrometer, &c. and fully explained to him all my proceedings in procuring them. He shewed but two or three specimens of his process on the magnet, wherein the line was confused and scarcely distinguishable. Colonel Sabine (and I believe every body else) gave to my method the preference greatly.

In February, 1846, the Astronomer Royal lent me a Greenwich magnet. In March, 1846, a little alteration was made in the (former) transit-room,

for its reception; and on the 11th of April it traced my first curve of daily variation (for a few hours only).

On the 2nd of April, 1846, the Royal Society kindly granted me £50 for the purchase of magnetical and meteorological instruments.

On the 3rd of April, 1846, an intention was expressed of sending a magnetic registering apparatus of my kind to the Toronto observatory.

On the 4th of April, 1846, I proposed schemes for registering very short magnets, and propounded the possibility of making a magnet sound an alarm on occasions of very great excursions (or magnetic storms).

In May, 1846, a Committee appointed by the Council of the Association met at Kew, to report on the expediency of continuing the Establishment, Sir J. Herschell, president, and attended by the Astronomer Royal, Sir R. I. Murchison, Col. Sabine, and Professors Graham and Wheatstone, when it was unanimously resolved to recommend its continuance on very satisfactory grounds, and this recommendation was unanimously adopted by the Council and the General Meeting.

In July, 1846, I adapted my scale of declination to 20 seconds of arc, occupying something more than $\frac{1}{30}$ of an inch, which seemed to be the approved graduation.

In the course of August (1846) many of the magnetic photographs were submitted to a rigid comparison with the corrected readings of the ordinary Greenwich magnet by Mr. Glaishier (the meteorological and magnetical superintendent) and the result was officially declared by him to be "highly satisfactory."*

In the same month, Dr. Banks brought a rough experimental specimen of his self-registering Anemometer, and applied it for trial at the north eastern angle of the electrical observatory.

In September, this third volume of Observations and Experiments was completed, and carried to the meeting at Southampton.

At this meeting I expressed a desire to have Dr. Robinson's improved anemometer at Kew, and the Marquis of Northampton most kindly agreed to defray the then supposed expense of its construction—viz. about £10; but it was afterwards found that the cost would be much greater; therefore no further steps were taken.

4TH. VOL.

The building, about this period, beginning to dilapidate for the want of a little external repair, I ordered some work to stop the mischief.

The instruments for ordinary observation remained unchanged.

And the observations themselves proceeded as usual, beginning Sep. 10, 1846, and ending June 22, 1847.

My new photographic self-registering barometer began to be constructed in December, 1846, at Chiswick, and several months were required for its completion. It is furnished with a compensating apparatus (on the principle of the gridiron pendulum) whereby the necessity of correction for temperature is attempted to be avoided: it has one of Newman's standard tubes, and the image of the surface of the mercury itself is employed (totally unincumbered by any ball, piston, plug, float or machinery interfering with the *free motion* of the mercury in the clean tube whose interior surface is not exposed (of course) to injury from at-

* A paper on my photographic registering apparatus was sent to the Royal Society in November, 1846; read January 21, 1847; and printed in the Philosophical Transactions, Part I. for 1847, p. 111.

mospheric humidity. It can be used without the compensating apparatus, if that should be hereafter found objectionable. It is set in motion by the same clock which moves the magnetic photographs.*

The photographic self-registering declination magnet was improved in May, 1847, by the substitution of a new lens of Ross's construction for the lens of Voightlander, which had been before used. This new lens enlarged the scale.

A complete electrical apparatus, exactly like mine for ordinary observations began to be made by Mr. Newman, in January, 1847, and was sent to the Bombay observatory, by order of the East India Company. Drawings were lent, instructions given, and the electrometers were made to correspond exactly with those of Kew.

An apparatus of the same kind had been *intended to be* sent to Toronto.

The drawings relative to Mr. Russell's experiment on vessels arrived at Kew in November, 1846, and I tried very much to get possession of the Models themselves, but to no purpose.

Mr. Hunt's Actinometer arrived in May, 1847, but his engagements never permitted him to come to the Observatory, and nothing was achieved relative to it.

This fourth volume of Observations and Experiments was completed and carried to the meeting at Oxford on the 23rd June, 1847.

At this meeting I had some conversation with Dr. Lee, Professor Langberg and other gentlemen, on a project for establishing an electro-meteorological and magnetic Observatory at Alten, in Finwark, and proposed to furnish some electrical apparatus from Kew, together with some from Chiswick. The subject was discussed in the committee of recommendations, I believe.

5TH. VOL.

The building still requiring repairs (now that the magnetic apparatus was erected more particularly), I addressed, in September, 1847, a third application to the Government through Mr. Phillips of the Woods and Forests, and a new estimate for complete repairs (both inside and out) was soon afterwards made, amounting to £271. The commissioners, Mr. Milne, Mr. Phillips, and Mr. Burton, then visited the Observatory, examined it and the apparatus, and I had the satisfaction of thinking on this, as on other occasions, that the Government fully approved of the present application of the building, and felt disposed to promote our objects. Very soon after this visit, all such repairs were executed as were fully sufficient to render the building wind and water tight at least, and I entertain a hope that *internal* repairs will be soon undertaken.

No material alteration occurred in the instruments for ordinary observation.

Our little library having been augmented by several valuable additions (presented) I made, in September, 1847, and in July, 1848, a catalogue of all the books which had been received at the Observatory, and sent it to Professor Phillips. The total number of volumes now amounts to 281.

The ordinary observations proceeded as usual, beginning June 23, 1847, and ending Aug. 8, 1848.

* All the experiments on the thermometer, barometer, and electrometer had been hitherto made *alternately*, by means of *one* camera or lucernal microscope.

In August I discovered that Sir John Herschell had forestalled me in the idea of applying pyrometrical means to elevate and depress the Barometer-tube for self-correction for temperature. Mr. De Luc first applied such a method to the scale.

In August 1847 an experiment was made by Mr. Birt and myself, with complete success, to maintain a kite at an almost invariable given altitude, by the employment of *three* cords attached to it, and to points forming a triangle on the earth. The object was to enable us to do that *sometimes*, at a very small (or no) cost, which would be always expensive in the case of a captive balloon being employed. A short account of this trial appeared in the Philosophical Magazine for September 1847.

The self-registering declination magnet apparatus was improved a little by the addition of a second condensing lens, placed very near to the index, and by an adjustment for the height of the lamp.

The barometrical apparatus was also improved by similar means: a *very sharp* boundary line has been therefore obtained in the photograph.

In February, 1848, a complete apparatus for registering, photographically, the electricity of the atmosphere in all but the violent changes (which cannot be, in fact, ever duly *measured* by any apparatus) was established at the south window of the south upper room. It was not applied to the principal conductor, because I did not think it expedient to interfere with the ordinary course of observations *at present*.

I devoted much time and pains at about this period in endeavours to arrange a system whereby photographic papers might be put into the camera daily, and sent to Mr. Henneman's establishment, to be there fixed and calotyped, and from thence distributed to any meteorologists to whom the British Association might choose to give them (or even to publish them periodically). These endeavours have been zealously promoted by Mr. Henneman, and by Mr. Malone, who has brought out a few good specimens, after intervals of even 30 hours from the time of preparation, and sometimes much longer. It may here be mentioned that this system of procuring photograph impressions *for all the instruments* is applicable to either day-light or lamp-light, and a considerable saving of cost thus effected.

We now arrive at a circumstance which I (of course) cannot but esteem of considerable importance. In Mr. Glaisher's Remarks on the Weather, during the quarter ending December 31, 1847, for the Registrar-General's Report (at p. 2) he says in reference to the Greenwich electrical apparatus, "It is a fact well worthy of notice, that from the beginning of this quarter till the 20th of December, the *electricity of the atmosphere* was almost always in a neutral state, so that no signs of electricity whatever were shewn for several days together by any of the electrical instruments, &c." Feeling great disappointment at this news, I sent to Greenwich an Abstract from our Journal of the maxima and minima of two-hourly charges of the principal conductor during the same period, by which it was seen that the electricity of the atmosphere at Kew was then *never* "in a neutral state," and I found that so low a charge was never observed during that time as has been observed in other periods. These circumstances were candidly stated by Mr. Glaisher in the next Report, and it was ascertained that the discrepancy did not arise from any accidental defect in the apparatus. It was justly supposed that the length of the conducting wire, extending from the top of the mast to the magnetic observatory, enfeebled the effect. Both theory and experience fully confirm me in believing that this is the principal cause of failure in the existence of *constant* signs,* and as no efficient series of observation can be carried on without constant signs, constant observation, and constant electrometers, I am still in hope that the Astronomer Royal, (to whom I shall ever feel

* During the arrangement of the apparatus at the above mentioned South Window, this bad effect of a long wire became abundantly evident.

much indebted for his kind and patient attention to my former importunities), will one day be enabled to carry out his original proposal of erecting on his octagon room a self-registering electrical apparatus, seeing that *now* such an apparatus would not need attendance more than twice, or even once in the 24 hours.

I am very happy to be able to conclude, by announcing the highly probable establishment of another electrical observatory at Stoneyhurst, Lancashire; having been very recently visited by Alfred Weld, Esq. the director of the Astronomical Observatory there, to confer on the subject. This will constitute the fifth instance of the original influence of the British Association in promoting this interesting branch of enquiry.

DIGEST OF EXPENDITURE AT THE KEW OBSERVATORY

During the period between July 26, 1843, and August 8, 1848 (inclusive).

	From 1843, July 26, to 1844, July 8.	From 1844, July 9, to 1845, June 18.	From 1845, June 19, to 1846, Sep. 10.	From 1846, Sep. 11, to 1847, June 23.	From 1847, June 24, to 1848, Aug. 8.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Furniture, Fixtures, Household Articles, &c.	7 15 4	26 19 3	13 18 6	5 1 6	4 8 3
Instruments, Materials for and repairs of Instruments	48 2 1	53 15 1	2 2 1	1 5 8	31 0 0
Lamps	2 3 2	0 11 6	0 15 8	0 1 10	2 1 2
Tools	4 11 10	3 13 3	0 11 5	0 7 1	0 2 10
Stationery, Book-binding, Printing, Drawing Materials	1 17 0	7 7 9	1 4 3	2 18 5	1 11 6
Carpentry and Joining	5 10 4	5 10 11	0 3 0	2 9 8	12 3 1
Bricklaying, Plastering, &c. ....	.....	0 3 0	1 2 4	9 1 3	.....
Plumbing, Painting Glazing, Papering	5 18 7	0 3 10	1 12 6	1 18 9	1 5 11
Coals, Charcoal, Firewood	20 17 0	26 4 0	22 9 0	18 0 0	23 13 0
Chandlery, (viz.) Candles, Soap, Mops, Brushes, &c.	7 6 4	7 17 1	11 7 6	8 9 5	9 15 9
Oil for Lamps	8 13 9	10 9 0	11 12 0	9 19 0	12 15 0
Æther for Hygrometer .....	.....	4 5 0	.....	.....	1 16 0
Alcohol	0 17 10	0 9 6	0 10 0	.....	0 2 6
Chemicals .....	.....	0 5 6	1 19 1	3 11 1	.....
Sundries paid to Jno. Galloway for Carriage, Coach-hire, Washing, Wicks, Cork, Letters, Gratuities, &c.	5 5 9	10 18 2	10 13 6	0 19 0	6 0 0
Wages paid to Jno. Galloway	55 12 0	53 12 0	67 4 0	43 6 0	63 16 0
Surgery, Chimney Sweeping, Carriage, &c. ....	.....	0 13 6	0 2 6	.....	1 5 0
Total Payments ...	174 11 0	202 15 9	147 7 4	107 8 8	171 16 0
Total Receipts	174 12 9	203 10 1	146 16 6	107 8 6	171 16 0

The sum of £174 11s. 0d. includes £56 7s. 3d., an extraordinary Grant made at the Meeting of the British Association in July, 1844, for the extra cost which had been incurred "for Instruments and Experiments."

The sum of £203 10s. 1d. includes £43 17s. 8d. which was drawn for on account of an extraordinary Grant of £50 made at the same Meeting (in July, 1844) for "Electrical Experiments," &c. contemplated by Mr. Ronalds.

The sums of £146 16s. 6d. and £107 8s. 6d. *exclude* £50 which was granted to Mr. Ronalds by the Royal Society in April, 1846, for the purchase "of Magnetical and Meteorological Instruments" (£48 3s. 3d. has been expended out of this £50 for Instruments and Materials.)

The *ordinary* annual expenditure for the support of the Kew Establishment has therefore been—

In 1843-4,	In 1844-5,	In 1845-6,	In 1846-7,	In 1847-8,
£118 5s. 6d.	£149 15s. 0d.	£146 16s. 6d.	£107 8s. 6d.	£171 16s.

The mean ordinary annual expenditure for the Five years (beginning July 26, 1843, and ending Aug. 8, 1848) has been £138 16s. 2d. (being about £10 less than the sum of £150 per annum usually placed at the disposal of the Kew Establishment.)

And the mean total annual expenditure for the Five years, including the two above-mentioned extraordinary Grants, has been £160 16s.

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11 0 1	0 01 1	0 01 1	01 0 0	7 12 0
0 01 02	0 0 01	0 0 02	0 0 02	0 01 07
.....
0 01 0	0 0 0	0 0 11	1 01 7	0 0 7
0 01 01	0 01 0	0 01 11	0 0 01	0 01 0
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0 01 1	0 0 0
0 0 0	0 0 0	0 0 0	01 01 0
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0 0 0	0 01 0	0 01 01	0 01 01	0 0 0
0 01 02	0 0 0	0 0 0	0 01 0	0 01 0
.....
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0 01 01	0 0 01	0 0 01	0 01 01	0 01 0
0 01 0	0 0 0	0 0 0	0 01 0	0 01 0

Printed by C. Whittingham, Chiswick.