

“The History of the Kew Observatory.” By ROBERT HENRY SCOTT, M.A., F.R.S., Secretary to the Meteorological Council. Received and read June 18, 1885.*

THE building, known by a misnomer of at least half a century's date as the Kew Observatory, while it is really situated at Richmond, is erected on, or close to, a part of the foundations of a much earlier structure, the old Carthusian Priory of Jesus of Bethlehem.

We learn from Crisp's “Richmond” that “the ancient hamlet of West Sheen occupied that portion of land now known as the Richmond Gardens, or Old Deer Park, and for the site of which hamlet or village we may perhaps take with tolerable correctness the present Observatory as the centre.”

The Observatory is situated upon a low mound, which is apparently artificial. The central part of the building stands upon vaulting constructed of bricks, differing in character from modern “stock” bricks, being soft, red, thinner and narrower. Similar bricks are to be found in the walls of Richmond Palace (Crisp, p. 123), and such have been mainly used in the construction of the basement of the Observatory, up to the stone course.

The basement is surrounded by three successive square rings of vaulting, of which the innermost is 5 feet wide by 8 feet high, the second 8 feet by 6 feet high, and the third and last 6 feet 6 inches by 5 feet high. This vaulting is constructed of bricks similar to those used in the upper part of the building, which resemble the bricks of the present day.

Crisp's statement, given above, is not absolutely exact, for the topographical history of the plot of land bounded on the one side by the bend of the river, and on the other by the present high road from Richmond to Kew, the old “Kew Lane” (see Fig. 3, p. 46), is rather complicated. Three separate domains can, however, be recognised—

1. Kew Gardens.
2. Richmond Gardens.
3. The Old Deer Park.

Of the three domains Nos. 1 and 2 were separated by a bridle path called “Love Lane,” which started from West Sheen Lane near Richmond Green, and ran in a north and south direction to the Horse

* I am indebted to the kindness of several friends for much assistance in the preparation of this history, particularly to Dr. E. W. Bond, of the British Museum, Mr. W. Thiselton Dyer, F.R.S., and to the members of the staff of the Observatory.—R. H. S.

Ferry at Brentford. Nos. 2 and 3 were quite distinct, though contiguous to each other, whereas the above quotation from Crisp would convey the idea that the two names, Richmond Gardens and the Old Deer Park, were applied indiscriminately to the same area.

1. Kew Gardens lay to the east of Love Lane, they were the gardens of Kew House, of which Frederick Prince of Wales (son of George II) took a long lease from Mr. S. Molyneux, his secretary, to whom it had passed by his marriage with Lady Elizabeth, grand-niece of Lord Capel.

Mr. Samuel Molyneux, F.R.S., had erected an observatory in a wing of the house, in which he in the year 1725 made, with a telescope of his own construction, in conjunction with Bradley, the famous observations which, after his death, were continued by Bradley and proved the Aberration of Light. *This was the original and real Kew Observatory.*

Kew House was taken down in 1803, and the present sundial on its site erected by William IV, in 1832. The inscription on that dial* hardly gives sufficient credit to Molyneux, to whom, however, Bradley does full justice in Phil. Trans., Vol. XXXV, No. 406, p. 637.

2. Richmond Gardens were the gardens of Richmond Lodge, formerly Ormonde House; of this area 37 acres, including 12 taken from the Old Deer Park, are still in the occupation of the Royal Family.

As Dr. Evans, in his "Richmond and its Vicinity" (2nd Ed., 1825), says (p. 12), "Richmond Gardens existed and were in the zenith of their popularity before Kew Gardens emerged into distinction."

3. The Old Deer Park was the park of the same house, which stood between it and the gardens.

As to the origin of Richmond Lodge, we have to go further back. Richmond Palace (or the Palace of Sheen, as it was called before Henry VII gave the village the name of Richmond) was the Sheen Manor House. It was situated on the south-west side of Richmond Green, near the river, and of it little remains save an archway with the Tudor Arms and parts of the outer walls. Edward I made it a palace, and it continued so until the time of Charles I. Edward III, Henry VII, and Elizabeth all died there. Under the Commonwealth in 1650 it was sold, and after the Restoration was again in the hands of the Crown, and it had been mostly pulled down in the seventeenth

* The inscription upon the dial is as follows :—"On this spot, in 1725, the Rev. James Bradley made the first observations which led to his two great discoveries—the Aberration of Light and the Nutation of the Earth's Axis. The telescope which he used had been erected by Samuel Molyneux, Esq., in a house which afterwards became a Royal residence, and was taken down in 1803. To perpetuate the memory of so important a station, this dial was placed on it in 1832, by command of His Most Gracious Majesty King William the Fourth."

century. On a part of the site the Duke of Queensberry's house was built.

Richmond Lodge, which in its turn became the Palace of Richmond, was apparently originally the Lodge of the Palace Park, the Old Deer Park. It was situated near the present Observatory. The gardens were in front of it, the park at the back.

As regards the position of the Priory, I have learnt from Dr. Bond, of the British Museum, that all the recognised authorities agree in placing the Carthusian Monastery to the north or the north-west of the old Palace of Sheen. Crisp gives an engraving of the Monastery before its demolition, and in an engraving of a panoramic view of Richmond by Anthony van de Wyngaerde, dated 1562, a building resembling Crisp's view is shown in the site of the Priory indicated in the subjoined map.

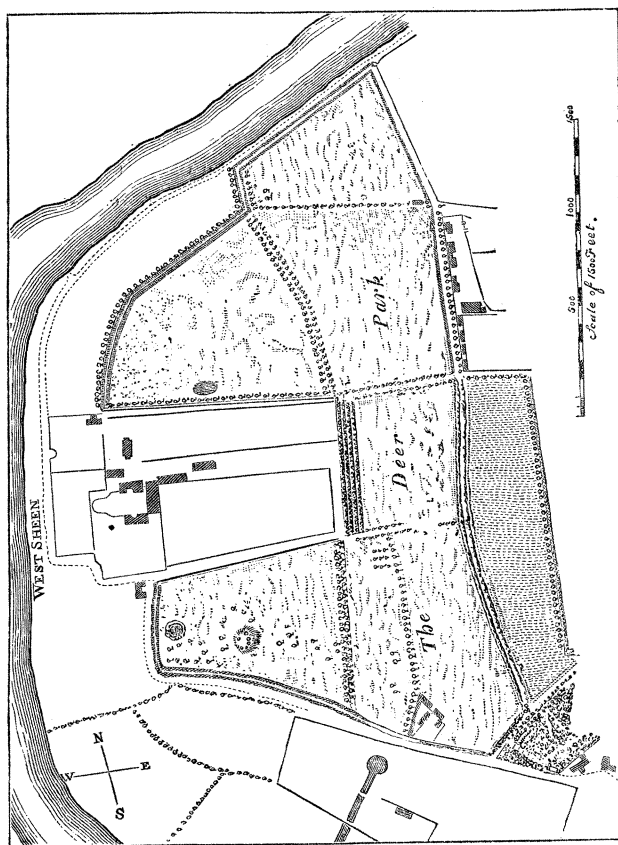


FIG. 1.—SITE OF THE CARTHUSIAN PRIORY, WEST SHEEN, CIRCA 1730.

From a Portfolio marked K, 46, 16 h, in the King's Library, British Museum.

We now come to the original buildings on the actual site of the Observatory, and we find in Crisp the following statement :—

“It was in the year 1414 that Henry V, to expiate, as it has been said, the crime by which his family had attained to the crown of England, namely, the dethronement and murder of the unfortunate Richard II, founded here a ‘famous’ religious house for forty monks of the Carthusian order, under the name of ‘The House of Jesus of Bethlehem at Sheen,’ by which name it was incorporated, and one John Wydrington constituted the first prior.

“At the same time that Henry founded this noble priory, he likewise built and endowed another one at ‘Syon’ on the opposite bank of the river, where the present Syon House now stands; this he dedicated to St. Bridget, for sixty nuns of that order.”

Crisp says, “There is in the British Museum an old work, in which mention is made of these two ‘religious houses,’ and that ‘it is there stated they were founded for the reason that a constant succession of holy exercises should be kept up night and day to the end of time, so that when the devotions at one convent had been concluded, at the other they should instantly begin.

“Shakespeare had learned from the works of old chroniclers and historians the reasons given for the institution of these two (houses), as in his ‘Henry V’ he makes the king, prior to the battle of Agincourt, utter the following words :—

“Not to-day, O Lord,
O, not to-day think thou upon the fault
My father made in compassing the crown!
I Richard’s body have interred anew,
And on it have bestowed more contrite tears
Than from it issued forced drops of blood.
Five hundred poor I have in yearly pay,
Who twice a day their withered hands hold up
Toward Heaven, to pardon blood; and I have built
Two chantries, where the sad and solemn priests
Still sing for Richard’s soul.”

“These buildings of Sheen and Syon were both of them stately edifices, and were as nobly endowed.”

In 1541 the monastery, along with others, was suppressed.*

* Extract from *Archæologia Soc. Antiq.*, Lond., vol. xx, App. pp. 575, 576 :—

“June 8, 1820. William Bray, Esq., Treasurer, exhibited to the Society an impression from the seal of the Carthusian Priory, which formerly existed at Shene, near Richmond, in Surrey; appended to an indenture between John Bokyngham, prior of that house, on the one hand, and John and Joan Rede, of Lewisham, in Kent, on the other, respecting a garden or toft in East Greenwich, dated in the 22nd year of Henry the Sixth.

“The impression of the seal is small, of an oval shape, and has a representation of the Adoration of the Shepherds in the area. At bottom are the arms of France and

Crisp says further: "It was in the year 1770* that the village or hamlet of West Sheen with the ancient gateway forming the entrance to, or rather part of, the priory, and eighteen houses with large pieces of ground attached, were pulled down, and the entire site converted into park or pasture land, as we now see it; but the antiquary to whom the records of such institutions as this 'House of Jesus of Bethlehem' are so dear, while pondering over the changes which have taken place in Richmond, and observing how little we now retain of so much which has once existed here as the work of our Norman, Plantagenet, and Tudor kings, can but cherish a feeling of the deepest regret at the total annihilation of the ancient priory buildings of Henry V at Sheen."

Richmond Lodge, or House (once occupied by Cardinal Wolsey), which stood at no great distance from the present Observatory, had been granted in 1707 by Queen Anne to the Duke of Ormonde, and partly rebuilt by him, in the year 1708-9, on the site of an old building which had likewise borne the name of the Lodge for a long period of years. On the impeachment of the duke in 1715, he hastily left the country, and resided at Paris. Ormonde House was apparently unfinished at the time. The Earl of Arran, his brother, who purchased the property, then leased for the term of about ninety years, sold the lease to the Prince of Wales, afterwards George II, of whom, both before and after his succession to the throne, it was a favourite place of residence, and even more particularly so of his queen (Caroline). From this cause a numerous circle gathered in and about the village and neighbourhood of Richmond, forming here the court of the reigning monarch.

Here, in the garden appertaining to this lodge, took place the interview between Queen Caroline and Jeannie Deans, after her journey on foot from Edinburgh to plead for the life of her sister Effie, which has been so graphically and so touchingly described by Sir Walter Scott in his "Heart of Midlothian."

There is one passage in the dialogue which has a connection with the site of the Observatory, and that is Jeannie's reply to the Queen when addressed in the following words:—

"Stand up, young woman, and tell me what sort of a barbarous people your countryfolk are, where child murder is become so common as to require the restraint of laws like yours."

"If your Leddyship pleases, there are many places besides Scotland where mithers are unkind to their ain flesh and blood."

For as Crisp says, "It cannot be denied that the behaviour of Caroline had been unnatural towards her son; she seems to have

England quarterly. The inscription round, when read at length, is—*Sigillum Domus Jhesu Christi de Bethlem Ordinis Cartusiensis de Shene.*"

* 1769, Evans.

hated him thoroughly and intensely—slighted his young and amiable wife—sided with his father, who upon all occasions behaved towards him with harshness and severity; and when on her deathbed the prince importuned to be allowed to see her, and sent her a most affectionate message, refused to have him admitted to her presence.” And therefore “of this famous Richmond Lodge, its magnificent gardens, the statuary and the numerous and singular buildings with which the Queen of George II had at such an extraordinary outlay enriched the place, the remains of the ancient monastery of Sheen, the large and embattled Gothic entrance, and the numerous houses still appertaining to the hamlet—we have now not a vestige left.” For “a few years after the accession of George III, the public, more especially of Richmond and Kew, were surprised to learn that it was His Majesty’s intention to pull down the whole of the buildings and convert the estate into a large pasturage for cattle, which intention was duly carried out.”

“It was at the time asserted, and in that assertion there is no doubt much truth, that the young King so detested the memory of his grandmother, Queen Caroline, so cherished a recollection of the unnatural behaviour which she had always shown towards his late father, Frederick, Prince of Wales, that he took an earnest pleasure in destroying all that she had erected, or on which her taste and resources had been expended.”

To return to the topographical description of the property. The Brentford Horse Ferry was superseded by the erection of the first Kew Bridge in 1759.

In 1765 George III obtained an Act (6 George III) for the shutting up of Love Lane, undertaking in return to maintain Kew Lane, the present high road from Richmond to Kew Bridge. This Act was apparently ineffective, for a further one was passed in 1784 (25 George III).

The Palace at Kew was the residence of Augusta Princess of Wales, mother of George III, and the Observatory attached to it fell into disuse. Accordingly, when the Transit of Venus occurred in 1769, facilities for observing it at the old Kew Observatory did not exist. This was pointed out to King George III (apparently by Dr. Demainbray), and he gave orders for the erection of an Observatory in the Old Deer Park, the architect being Sir William Chambers. This was known as the “King’s Observatory,” and in a paper* by the late Major-General Gibbes Rigaud, it is further styled “the King’s Observatory at Kew.” Dr. Evans, however, calls it “The Royal Observatory,” and speaks of it as being at Richmond.

* “Dr. Demainbray and the King’s Observatory at Kew.”—“The Observatory,” October 2nd, 1882.

The first Superintendent of the Observatory was Dr. Stephen Charles Triboudet Demainbray, descended from parents who had fled to London from France on the Revocation of the Edict of Nantes. This gentleman, after a varied career as a lecturer on science in various universities and institutions in these islands and in France, had settled in London as instructor in science to the King before his accession, and subsequently to Queen Charlotte. One point in his career shows the estimation in which he was held in France. I gather from General Rigaud's paper, "In France (although not of the religion of the country) he was received as an 'Associé Ordinaire' and member of the Royal Academy; the only instance of a declared Protestant not being placed on the list termed 'la Liste Etrangère.'"



FIG. 2.—THE KEW OBSERVATORY FROM THE SOUTH-WEST.

Latitude $51^{\circ} 28' 6''$ N.
Longitude $0^{\circ} 18' 47''$ W.

When the new Observatory was finished, Dr. Demainbray adjusted the instruments there in time to make the Transit observation, and was its Superintendent until his death in 1782.

George III frequently attended at the Observatory, and procured the best clocks and watches that could be made and placed them in the Observatory, so that by daily observations of the sun when passing the meridian, the time was regulated, and for many years the accurate time for the regulation of the clocks in both Houses of Parliament, at the Horse Guards, St. James's, and elsewhere, was taken from the King's Observatory, before the accommodation was so well and publicly afforded as it is at present from the Royal Observatory at Greenwich. The clock which was the principal timekeeper at the

Observatory is now at the Patent Museum, South Kensington (No. 1426), and is going well. It bears the following inscription:—

“This clock was made by Benjamin Vulliamy, Clock-Maker to the King, for his Majesty George III, by whom it was used in his private observatory at Kew. It was successively the property of their Majesties George IV and William IV, of H.R.H. The duke of Sussex, and of their Majesties Ernest, King of Hanover, and George, King of Hanover, by whom it was given to Frances Moulton, widow of Benjamin Lewis Vulliamy, eldest son of the maker, April 18th, 1854.”

His Majesty King George III, with the assistance of Dr. Demainbray, and his son the Rev. Stephen Demainbray (who held and superintended the Observatory, as the astronomer, for upwards of fifty-eight years after his father's death) procured a large collection of instruments, models, &c., besides a large apparatus for experiments in all branches of natural philosophy, as also a very valuable natural history collection. In addition to these, there was a collection of minerals from the Hartz mines; but these were afterwards given by King George IV to the British Museum.

The Observatory was for many years an object of great interest to King George III, and the Rev. S. Demainbray was for a length of time the teacher of the younger members of the King's family, who attended at the Observatory for his lectures on astronomy, electricity, &c. King William IV also took great interest in the Observatory, and frequently visited it.

At the time of the transfer of the Observatory to the British Association, Mr. S. Demainbray retired on a pension, and he died in July, 1854, at the age of ninety-five years.

During the latter part of the fifty-eight years in which he superintended the Observatory he was assisted by his nephew, Stephen Peter Rigaud, Esq., Savilian Professor of Astronomy at Oxford, and Radcliffe Observer. This gentleman took charge of the Observatory during the Oxford vacations, and thus enabled his uncle to reside during those periods on his living in Wiltshire. The King's Observatory lasted, therefore, for seventy-one years, *i.e.*, from 1769 to 1840.

The Observatory itself was at one time in charge of a curator named John Little, who was hanged in 1795 for the murder of two old people in Richmond to whom he owed money, and who was strongly suspected of having murdered a carpenter named Stroud, who was discovered in the principal or octagon room of the Observatory, the body lying under an iron vice. The St. James's Chronicle, in August, 1795, in giving an account of Little's execution, says, “from his civil department he was in general the only attendant on His Majesty when he walked in the gardens.” The inquest on Stroud at a previous date had resulted in a verdict of accidental death.

We find in a French book, Simond's “Voyage en Angleterre,” 8vo,

Paris, 1817, the account of an amusing episode in the astronomical studies of George III during the later years of his life.

EXTRACT FROM SIMOND'S "VOYAGE EN ANGLETERRE." PARIS, 8VO, 1817.

"Le roi aime l'astronomie, et a un Observatoire dans un petit parc à Richmond, appelé "The King's Paddock." Il y a un grand télescope de Herschel; un instrument des passages (transit) de huit pieds de long, à travers lequel nous observâmes passant le méridien; un instrument vertical de douze pieds, pour les observations au zénith; un mural de huit pieds de rayon; un télescope équatorial, et plusieurs autres instrumens moins considérables; quelques modèles de machines, entre autres, une pour déterminer la pression latérale des voûtes; une collection de minéraux, et un cabinet d'instrumens de physique.

"Sa Majesté étant venue à l'Observatoire, il y a quelques années, pour observer une occultation de planètes, un daim poursuivi de Windsor, traversa la rivière, franchit les palissades, suivi de toute la meute, et vint se laisser prendre au pied de l'Observatoire, précisément au moment de l'observation.

"Je demandai si l'attention de Sa Majesté s'était montrée supérieure à cette interruption. On me répondit qu'un nuage, malheureusement survenu précisément au même instant, avait rendu l'observation impossible, et qu'autrement rien n'aurait pu l'en distraire."

The following would appear to be a correct account of the incident somewhat romantically treated in the above, as it was narrated by the late Sir James South to Dr. Balfour Stewart:—

One day Sir James was at the Observatory with the King (George III) when they saw the stag hunt from Windsor approaching, and ascended to the roof to watch it. Concealed by the parapet His Majesty pointed out to Sir James the different gentlemen following the hounds, and at the royal dinner in the evening the King created considerable amusement by assigning to the guests the relative places they each occupied in the hunt, as they were unable to imagine what position of vantage His Majesty had occupied during the proceedings.

With this the record of the first period of the Observatory comes to a close, and the building passed into the management of the British Association for the Advancement of Science, for the space of thirty years, till August 1871. The negotiations, which were carried out in connection with the establishment by H.M.'s Commissioners of Woods and Forests, in the first instance with the Royal Society, and in the second with the British Association, cannot be better described than in the following Memorandum drawn up in 1871 by Sir Charles Wheatstone, who himself, with Sir Edward Sabine and Mr. J. P. Gassiot, was among the original subscribers to the undertaking in 1842. The same three gentlemen, as Members of the Committee,

continued their active superintendence of the Observatory during the whole period of its connection with the British Association.

It will be seen that throughout this memorandum it is termed the Kew Observatory in all official documents.

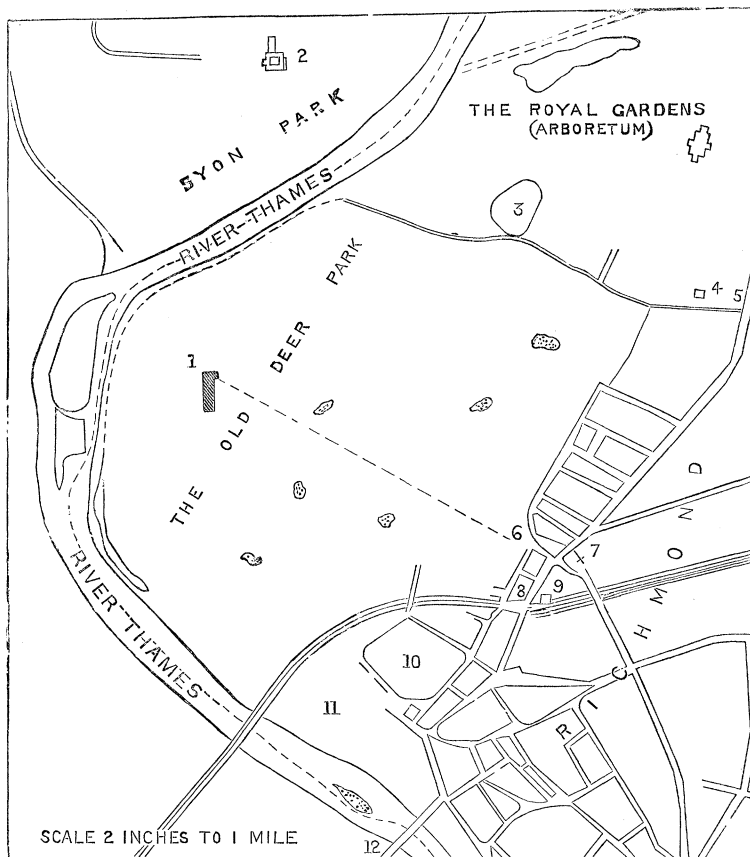


FIG. 3.—THE KEW OBSERVATORY AND VICINITY, 1885.

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| 1. The Observatory and Garden. | 7. St. John's Church. |
| 2. Syon House. | 8. Richmond Station (Old). |
| 3. The Queen's Cottage. | 9. " " (New). |
| 4. The Pagoda. | 10. Richmond Green. |
| 5. The Lion Gate. | 11. Richmond Palace (Site of). |
| 6. The Entrance to the Observatory (Fuller's Gate). | 12. Richmond Bridge. |

HISTORICAL REMARKS BY SIR CHARLES WHEATSTONE.

In 1841 the Government came to the determination of no longer keeping up the Observatory and Museum established by His Majesty George the Third in the Old Deer Park at Richmond. In consequence of this resolution, the Curator and the Reader in Natural Philosophy, who had for many years been attached to the building, were pensioned off, and the valuable contents were distributed to the Armagh Observatory, the British Museum, King's College, London, the College of Surgeons, and some members of the Royal Family. The building being thus dismantled and vacant, was applied for by the Council of the Royal Society, on the recommendation of the Committee of Physics and Meteorology, as appears from the following Minutes of June 24, 1841 :—

“Mr. Daniell reported, on the part of the Committee of Physics, that they had passed the following resolution, viz. :—

“The Committee, understanding that the building formerly occupied as the Observatory at Kew is disposable, and may be had if applied for, and having frequently experienced the want of such a building for various scientific purposes, recommend to the Council that an application be made to secure it for the Royal Society.’

“Resolved,—That this recommendation be adopted; and that the President be requested to make application to the proper quarter for the possession of the building in question.”

An application was accordingly made, and the possession granted to the Royal Society; consequent on which the following resolution was recorded on November the 11th of the same year :—

“Resolved,—That it be referred to the Committee of Physics to consider and report to the Council to what specific scientific purposes it would be desirable to appropriate the building formerly occupied by the Observatory at Kew, in case of a grant of that building being made to the Society by the Government; and what would be the probable annual expense of applying it to such purposes.”

On January the 10th, 1842, a communication was received by the Secretary from the Office of Woods and Forests, requesting to be informed when the Society would be prepared to take possession of the building, as it had long since been cleared and ready to be delivered up when required. The following resolution was thereon recorded :—

“That the Secretary inform Mr. Milne, in answer to his letter, that the Council having referred the matter in question to the consideration of a Committee, beg to defer their answer till they receive the report of that Committee, which they expect will soon be prepared.”

The report called for was read on February 10, 1842, and was as follows :—

“ The Sub-Committee report that, from the peculiar restrictions as to access and inhabitancy, and other circumstances affecting the proposed grant of the Kew Observatory to the Royal Society, they do not consider that any regular and systematic course of physical observations at present devisable could be therein advantageously made by the Society, or by any observer under their immediate appointment and direction ; but that nevertheless they consider that such a building so held might, if occupied for safe custody by a proper person, be highly available for many useful scientific purposes, which have long been desiderata as part of the establishment at Somerset House ; such as, among others, the following :—

“ 1. As a depository of instruments and other property of the Royal Society, either not in use, or for which, for general or special reasons, Somerset House may not be regarded by the Council as an advantageous place of deposit.

“ 2. As a station for occasional observation and comparison of pendulums, either returned from abroad, or about to proceed on voyages, as also for affording foreigners wishing to compare pendulums an opportunity of so doing.

“ 3. As a station for trial and comparison of magnetical apparatus, and affording to observers desirous of acquiring a knowledge of the nature and use of such apparatus, an opportunity for conveniently doing so, and of obtaining a practical knowledge of the system of magnetical observation recommended by the Society.

“ 4. As a station in which many occasional phenomena might be advantageously observed by Fellows of the Society, or others, on permission obtained from the President and Council, such as, for example, concerted observations of shooting-stars, &c., or in which the phenomena of what has been called ‘ magnetic storms,’ or unusual magnetic disturbances might be witnessed, and their particulars attended to by observers desirous of so doing, without interfering with observations regularly in progress at official stations, or with a view to other circumstances in their phenomena than what may be ordinarily observed at such stations ; it being considered that such ‘ storms ’ are sometimes of considerable duration, and may become known to exist by direct communication from Greenwich or other regular observing station.

“ 5. As a proper place, for the trial of physical apparatus and occasional physical experiments, for which no convenience exists at Somerset House ; such as may either be proposed by scientific committees, or be undertaken by individuals, on permission duly obtained from the President and Council.

“ 6. As a proper place for the comparison of standards of every

description in which general steadiness of temperature and structure, light, retirement, and security may be especially needed.

“As regards the probable cost of such an establishment to the Society, it appears to include essentially:—1st, the wages of a man who should reside in the house, and take care of it; 2nd, such repairs as may from time to time be required, should Government not take on itself the charge of maintenance of the structure; 3rd, the interest of money expended in fitting it for the purposes in view; and 4th, the taxes and rates which may be incident on its occupation.

“As to the first of these items, the Sub-Committee consider that an amount of 10s. 6d. per week, 27l. 6s. per annum, would suffice with fuel.

“The building has been represented to them as being in excellent repair, and not to have cost 5l. annually for some time in its maintenance in that state; nor are they without reason to hope that such an understanding might be had with the proper authorities as would strike out this item in future.

“It has also been stated to them, that among the fixtures of the buildings are included an ample provision of glass cases and other receptacles well adapted for the preservation of instruments and books, and which have heretofore served for the preservation of the very valuable collections lately presented by Her Majesty to King’s College, London, and which would materially alleviate the charges incidental on this head.

“J. F. W. HERSCHEL.

“C. WHEATSTONE.

“EDWARD SABINE.”

On the 10th of March, however, the Council of the Royal Society rejected the gift they had previously solicited, in the following resolution:—

“Resolved,—That, on full consideration of the report of the Committee of Physics, including Meteorology, presented at the last meeting of the Council, it does not appear to the Council to be expedient for the Society to occupy the Observatory at Kew; and that the Treasurer be requested to make known this decision to the Commissioners of the Woods and Forests, expressing at the same time their thanks for the courtesy and attention paid to the suggestion of the Council on the subject.”

The building having thus become again unappropriated, a number of Fellows of the Royal Society and Members of the British Association, desirous that it should be retained for the purposes of science, recommended that an application should be made for it in the name of the British Association, and entered into a subscription for the purpose of promoting the objects stated in the following prospectus.

The subscription was headed by donations of 15*l.* each from the Marquis of Northampton and Lord Francis Egerton as Presidents respectively of the Royal Society and the British Association; and the following gentlemen entered their names for sums varying from 5*l.* to 10*l.* each:—

Sir John Herschel, Sir John Lubbock, Sir Charles Lemon, Sir H. de la Beche, Sir John Rennie, Lieut.-Col. Sabine, Capt. Chapman, The Rev. Dr. Buckland, Dr. Arnott, Dr. Fitton, Prof. Daniell, Prof. Graham, Prof. M'Cullagh, T.C.D., Prof. Wheatstone, R. I. Murchison, Esq., J. Davies Gilbert, Esq., H. F. Talbot, Esq., J. Taylor, Esq., G. Rennie, Esq., J. Evans, Esq., J. P. Gassiot, Esq., and R. Napier, Esq.

The views of these gentlemen were expressed as follows:—

“It has frequently been the subject of regret that there does not exist in this country any of those facilities for the encouragement and advancement of physical science which have been so liberally afforded by the Governments of other nations.

“The Continental philosopher, when he for the first time visits our shores, finds to his great surprise that in the metropolis of this great empire there is not one collection of physical instruments which can afford the slightest idea of the present advanced state of scientific investigation. A few of our establishments for public instruction, indeed, are provided with apparatus for exhibiting the most usual results of experimental philosophy to classes of learners at public lectures, and there are two or three public exhibitions at which some of the most popular and practical results are shown, but the most valuable instruments of scientific researches, particularly those by means of which alone accurate quantitative results can be obtained, are nowhere to be found. It is to be hoped that ere many years have passed a National Physical Museum worthy of the name may be established in London, but as this is an object which we cannot expect to see realized by the private co-operation of individuals, it is proposed to carry into present effect a plan of a more limited nature, which will supply some of the most obvious and urgent existing wants otherwise unprovided for, and which does not seem beyond our means of accomplishing.

“It is proposed to establish, in connexion with the British Association, a Physical Observatory. The useful purposes to which it is intended to apply the Building at Kew, to be placed at the disposal of the British Association, are, among others, the following:—

“1. It will be a repository for, and place for occasional observation and comparison of the various instruments which the recent discoveries in physical science have suggested for improving our knowledge of meteorology, &c., in order that their relative advantages and defects may be ascertained.

“A great number of very ingenious instruments have been invented

on the Continent within the last twenty years, which are practically unknown in this country, but which, if properly understood, verified, and brought into use, would lead to valuable results.

“At the present moment a most important and widely extended series of simultaneous observations in different parts of the world is being carried out, and to this object the British Government and East India Company have munificently contributed. With the exception of the magnetical instruments, none are at present employed for these observations but those which have been long known and verified; this has arisen from want of proper knowledge of the means of constructing, using, and interpreting the results of the new instruments. Did we possess this knowledge, the harvest to be gained from the system of combined observations, now in operation, might be more than doubled, with scarcely any increase of expense.

“2. A repository and station for trial of new instruments, having the same objects as the above in view, which may be proposed in this country. Among instruments which have been proposed, and which will probably not be constructed and brought into use without the assistance which an Institution like this alone can afford, may be mentioned: a universal meteorograph, which will accurately record half-hourly indications of various meteorological instruments, dispensing entirely with the attendance of an observer; an apparatus for recording the direction and intensity of the wind simultaneously at various heights above the earth's surface; an apparatus for telegraphing the indications of meteorological instruments carried up in balloons or by kites, to an observer at the earth's surface.

“3. As a station to which persons, willing to become coadjutors in the system of consentaneous observations, may bring their instruments for the purpose of comparison with the standard instruments there deposited. Attention need not be called to the increased value of observations made with instruments thus properly compared.

“4. As the depository of a complete set of the magnetic instruments at present in use in the various magnetic observatories, in order that any person desirous of so doing may understand their construction and acquire their use. The only magnetic observatory in England is at Greenwich, and the instruments, being in constant use, cannot be employed for the purposes here mentioned.

“5. A complete series of apparatus for experiments on atmospheric electricity. For such investigation the locality is peculiarly adapted. Nothing of the kind at present exists in England, and yet there is no subject in meteorological science for which so much remains to be done.

“6. One of the rooms to be fitted up as an optical chamber with a Heliostat, Fraunhofer's prismatic telescope, photometers, &c., principally for the purposes of optical astronomy, a subject at present totally neglected.

"7. As complete a collection as can be gathered together of the measuring instruments employed in the various branches of physical science, for the purpose of obtaining accurate quantitative results.

"The facilities which such a collection would give to original investigation do not at present exist in this country.

"It is not at present recommended that any expenditure of the funds should be made for apparatus intended merely to exhibit the necessary consequences of established laws."

A successful application was then made by the authorities of the British Association for the possession of the building; and at the Meeting at Manchester in June, 1842, the President of the year, Lord Francis Egerton, thus alluded to this gift of the Government in his opening address:—

"I have been speaking of matters for some time past in progress and notorious to all who have taken an interest in your proceedings. They are gratifying as proofs that the impulse of this Society has been communicated and felt in high quarters. It is surely desirable that under any form of Government, the collective science of a country should be on the most amicable footing with the depositories of its power; free indeed from undue control and interference, not dangling in antechambers, nor wiping the dust from the palace staircases, uncontaminated by the passions and influences with which statesmen have to deal, but enjoying its good will and favour, receiving and requiting with usury its assistance on fitting occasions, and organized in such a manner as to afford reference and advice on topics with respect to which they may be required. * * * The most recent instance I cannot omit—I mean the important accession to the means of this Society of a fixed position, a place for deposit, regulation, and comparison of instruments, and for many more purposes than I could name, perhaps even more than are yet contemplated, in the Observatory at Kew. This building was standing useless. The Council of the Association approached the throne with a petition that they might occupy it, and I am happy to say that the sceptre was gracefully held towards them; and I think this transaction a fair instance of that species of connexion between science and government which I hope may always be cultivated in this country. I am informed that the purposes to which this building is readily and immediately applicable, are of an importance which none but men advanced in science can appreciate. You will hear further of them in the Committee Recommendations."

C. W.

KEW OBSERVATORY UNDER THE BRITISH ASSOCIATION.

This period naturally divides itself into two intervals, the first of ten years, 1842 to 1851, when Mr. (afterwards Sir Francis) Ronalds, F.R.S., acted as Honorary Superintendent. In 1852, the second period of twenty years commenced, and the Kew Committee first appeared as actually taking control of the establishment, with Mr. John Welsh, F.R.S., as Superintendent. The Committee had been formally constituted in 1849, as shown by the following extract:—

Extract from the First Minute Book of the Kew Committee of the British Association.

“At a Meeting of the Council of the British Association, held at 6, Queen Street Place, London, October 25, 1849—

“Present :

Sir Charles Malcolm, K.C.B., in the Chair, succeeded by Robert Hutton, Esq. ;

| | |
|-------------------------|-------------------------|
| W. J. Hamilton, Esq. ; | Dr. Forbes Royle ; |
| Robert Hutton, Esq. ; | Lient.-Colonel Sabine ; |
| Francis Ronalds, Esq. ; | John Taylor, Esq. ; |

It was resolved that the following gentlemen be named as a Committee for visiting and exercising a general superintendence over the experiments and observations to be made at Kew ; and that the Council are persuaded that the Members of the Committee will render a good service to science, and will entitle themselves to the cordial thanks of the British Association, if they will regard themselves as Members of a real working Committee :—

Sir J. W. Herschel, Bart. ;
 J. P. Gassiot, Esq. ;
 Colonel Reid, Royal Engineers ;
 Colonel Sykes ;
 Charles Wheatstone, Esq. ;

in addition to the President, Trustees, and Officers of the Association.”

The first Report of the Committee, signed by Mr. Gassiot as Chairman, was that for 1853. In 1859 Mr. Welsh died, and was succeeded by Mr. Balfour Stewart, F.R.S., who held office for twelve years, up to August, 1871, when the connection of the Observatory with the Association was terminated, as will be explained subsequently.

The first notice we find in the Reports of the Association as to

the administration of the Observatory was the following resolution adopted at the Manchester Meeting in June, 1842:—

“That Professor Wheatstone, Professor Daniell, and Mr. Snow Harris be a Committee for constructing a self-recording meteorological apparatus to be employed in the building at Kew, recently placed by Her Majesty the Queen at the disposal of the British Association, with the sum of 50*l.* at their disposal for the purpose.

“Also that the sum of 200*l.* be placed at the disposal of the Council for upholding the establishment in the Kew Observatory.”

In the volume for the next year, 1843, we have the Report of a Committee, consisting of Professor Wheatstone, Mr. Hutton, the General Secretary (Colonel Sabine), and Treasurer (Mr. John Taylor), appointed by the Council to superintend the establishment of meteorological observations at the Kew Observatory. And at the close of the first year the Council report the establishment of the following registries, viz. :—

- “1. An ordinary meteorological record with standard instruments made by Mr. Galloway under the superintendence of Professor Wheatstone.
- “2. A meteorological record with self-registering instruments on a new construction by Professor Wheatstone.
- “3. A record of the electrical state of the atmosphere.

“Mr. Ronalds’ name now appears in connexion with the electrical records, and for the next nine years he acted as Hon. Superintendent.

It is evident that the action of the Council in taking charge of the Observatory was criticised at an early date, for from the Report of the Meeting at Southampton, 1846, we learn that the expediency of discontinuing Kew had been referred to the Council at the previous Meeting, as will be seen by the following extract of a Report from the Council presented to the general Committee, September 9, 1846.

The General Committee at Cambridge having passed a resolution—

“That it be referred to the Council to take into consideration before the next Meeting of the Association the expediency of discontinuing the Kew Observatory,”

the Council appointed a Committee, consisting of the President (Sir John Herschel), the Dean of Ely, the Astronomer Royal, Professors Graham and Wheatstone, and Lieut.-Colonel Sabine, to collect information on the scientific purposes which the Kew Observatory has served, and on its general usefulness to science and to the Association, from whom they received the following Report:—

“Kew Observatory, May 7, 1846. Present, Sir J. F. W. Herschel,

Bart., the Astronomer Royal, Professors Graham and Wheatstone, and Lieut.-Col. Sabine.

“After an attentive examination of the present state of the establishment and of other matters connected therewith, the following resolutions were unanimously adopted, viz. :—

“That it be recommended to the General Committee that the establishment at Kew, the occupancy of which has been granted by Her Majesty to the British Association, be maintained in its present state of efficiency.

“1. Because it affords, at a very inconsiderable expense, a local habitation to the Association, and a convenient depository for its books, manuscripts, and apparatus.

“2. Because it has afforded to Members of the Association the means of prosecuting many physical inquiries which otherwise would not have been entered upon.

“3. Because the establishment has already become a point of interest to scientific foreigners, several of whom have visited it.

“4. Because the grant of the occupancy of the building by Her Majesty, at the earnest request of the British Association, is an instance of Her Majesty’s interest in and approval of the objects of the Association.

“5. Because if the Association at the present time relinquish the establishment it will probably never again be available for the purposes of science.

“6. Because it appears, both from the publications of the British Association and from the records in progress at the establishment, that a great amount of electrical and meteorological observation has been and continues to be made, and that a systematic inquiry into the intricate subject of atmospheric electricity has been carried out by Mr. Ronalds, which has been productive of very material improvements in that subject, and has in effect furnished the model of the processes conducted at the Royal Observatory; and because these inquiries are still in progress under local circumstances extremely favourable.

“7. Because other inquiries into the working of self-registering apparatus, both meteorological and magnetical, are in actual progress at the establishment, and there is a distinct prospect of the facilities it affords being speedily much more largely profited by.

“8. Because the access to the Observatory from London to Members of the Association will shortly be greatly improved by railroads, and because the local facilities and conveniences of the establishment have been very greatly enhanced by alterations in its relations to the Commissioners of Woods and Forests.

Signed. “J. F. W. Herschel, Chairman.”

In presenting this Report to the General Committee the Council

requests that it may be understood to convey also the opinion of the Council.

At this early period much of Mr. Ronalds' attention was directed to the subject of atmospheric electricity, and in this investigation he was assisted by Mr. W. Radcliff Birt. At the same time the Hon. Superintendent was far from neglectful of other branches of physical research, and he devoted much of his rare mechanical energy to the invention and perfecting of the photographic processes for the registration of meteorology and terrestrial magnetism, with which the name of the Kew Observatory has been permanently associated.

In the course of the year 1850 magnetic observations were commenced with instruments provided by Lieut.-Colonel Sabine, and Mr. John Welsh was appointed by the Committee as Assistant, Mr. Birt having left the Observatory; and in the following year we notice the first commencement of the Verification Department, which has subsequently become such an important feature of the Kew operations—the purchase of a standard thermometer by Regnault, with the intention of employing the latter instrument in the verification of thermometers made by artists in this country—and the procuring of M. Regnault's apparatus for calibrating and graduating thermometer tubes.

In 1852 the verification work had fairly started, as well as the making of standard thermometers. Mr. Welsh also had made two ascents in a balloon, for the determination of the temperature and hygrometric condition of the air at different elevations, before the date of the British Association Meeting.

In the course of this year Mr. Ronalds left the Observatory to reside on the Continent, and accordingly from this date Mr. Welsh is to be regarded as Superintendent of the Observatory, the first or preliminary stage of the Observatory having come to an end.

In 1853, as already stated, appeared the first Kew Report, signed by Mr. Gassiot as Chairman of the Kew Committee, and in the next year, 1854, we learn that the best form of barometers and thermometers for the use of the Mercantile Marine had been decided on by the Kew Committee at the request of the Board of Trade, and that Mr. Welsh had experimentally tested the marine barometers in a voyage to Leith and back, and in one to and from the Channel Islands.

Also that Sir J. Herschel had suggested the importance of obtaining daily photographic pictures of the sun's disk, and that Mr. Warren de la Rue having reported that the probable cost would not exceed 150*l.*, this sum had been procured from the Donation Fund of the Royal Society.

In the same year Robert Beckley was engaged as machinist, on the recommendation of Mr. de la Rue. Two acres of ground were also

secured, contiguous to the Observatory. Welsh's standard barometer dates from 1855, and the introduction of gas to the Observatory from the next year. In the same year Mr. Balfour Stewart was engaged as Assistant, but he only remained for a brief period in that capacity, for in 1857 he was succeeded by Mr. Charles Chambers.

In 1856 Mr. Beckley's modification of Robinson's anemometer was submitted to the Committee, and also a series of monthly determinations of dip and horizontal force was commenced with instruments provided by General Sabine from his Department at Woolwich.

The next important event to be chronicled is that the following Memorandum relative to the re-establishment of self-recording magnetic instruments at the Kew Observatory was submitted to the Committee by General Sabine on July 22, 1856:—

“1. The decennial period in the solar magnetic variations, and its coincidence with a similar period in the frequency and amount of the solar spots, appear to be highly deserving of attention in an Observatory established, as Kew is, for physical researches.

“2. There is reason to suppose that the permanency and regularity in the occurrence of the decennial period in the magnetic variations, and its coincidence with the periodic variation of the solar spots, might be effectually and satisfactorily tested by observations of both classes of phenomena at the alternate periods of maximum and minimum, say, for example, in 1857 and 1858 as the anticipated period of maximum, and in 1863 and 1864 as the anticipated period of minimum, and so forth.

“3. The apparatus constructing under the superintendence of Mr. de la Rue will, it is hoped, fully meet the requirements of the research in respect of the solar spots.

“4. Since the time when the magnetic self-recording instruments belonging to the Kew Observatory were constructed under the direction of Mr. Ronalds, very considerable improvements have been made in the art of photography, and the six months' trial which was made by Mr. Welsh of Mr. Ronalds's instruments has led in several other respects to suggestions for improvements which could not but be expected to be required in instruments of so novel a kind, while at the same time the six months' trial referred to has placed beyond doubt the sufficiency of a properly conducted research by means of self-recording instruments, for the examination of the solar magnetic variations.”

The Committee authorized Mr. Welsh to proceed with the construction of the instruments, which were completed at an expense not exceeding 250*l.*, derived from the Government Grant Fund, the instruments remaining at Kew at the disposition of the Council of the Royal Society.

In the same year the Kew Heliograph was completed, and it was arranged that Mr. Welsh should undertake the Magnetic Survey of Scotland, the results of which operation were published by Mr. Stewart in the Report of the British Association for 1859. In 1858 also Mr. G. M. Whipple was engaged as a boy.

In 1859 Mr. Welsh died, and was succeeded by Mr. Balfour Stewart. At this date an instrument had been devised at the Observatory for tabulating the values of the magnetic elements from the magnetograms, and as the staff of assistants at the Observatory was not sufficiently large to undertake these tabulations, General Sabine undertook to have the results tabulated at Woolwich for every hour.

In 1860 the Kew Photoheliograph was taken by Mr. de la Rue, mainly at his own expense, to Spain, for employment at the Solar Eclipse on July 18th. Its use was a complete success, and proved that the red prominences belonged to the sun.

In 1861 Sir W. Thomson's Electrograph was brought into regular operation at Kew, and an account of two years' work with it was prepared and submitted to the Royal Society by Professor J. D. Everett in 1868.

In 1862, at the suggestion of Admiral Fitz Roy, who agreed on the part of the Meteorological Department of the Board of Trade to bear the expense incurred, the Barograph designed by Mr. Ronalds was fitted up, and has been from that date kept in constant operation.

It was also reported that as on account of the inadequate strength of the staff of assistants it was not possible to work the Photo-Heliograph at Kew, it had been in operation at Mr. de la Rue's observatory, at Cranford, since February 7th. The instrument remained in Mr. de la Rue's hands for twelve months, when it was re-erected at Kew.

In 1862 Mr. Stewart communicated to the Royal Society an account of some experiments made at Kew in order to determine the increase between 32° Fahr. and 212° Fahr. of the elasticity of dry atmospheric air the volume of which remains constant; and also of others to determine the freezing-point of mercury.

In the next year Mr. Chambers left the Observatory to enter the India Telegraph Service, and eventually to take charge of the Colába Observatory, Bombay; his place, as Magnetic Assistant, being filled by Mr. Whipple.

In 1865 we hear that the Indian Government having decided that pendulum observations should be made in India, Col. Walker and Capt. Basevi received instruction at Kew. A convenient room for pendulum observations was likewise fitted up in the Observatory, the expense being defrayed from the Government-Grant Fund of the Royal Society; and in this room preliminary observations were made for determining the constants of the two pendulums about to be

used in India. The observations were made by Mr. Loewy, and the results communicated to the Royal Society.

In the same year it is reported that—(1) the solar spectrum was being mapped by the spectroscope belonging to the Chairman (Mr. Gassiot), and at his expense. All the measurements between D and E had been made and completely verified, and a map of this region in accordance with these constructed; the investigation was continued until 1866, at which time about three-fourths of the region between E and F had been mapped. And (2) that Hofrath Schwabe, of Dessau, had very generously placed his valuable and extensive series of sun-pictures at the disposal of the Royal Astronomical Society for the immediate use of the Kew Observatory. The enumeration of spots on the principle followed by Herr Schwabe was then commenced and has been continued up to the present time.

1865 also witnessed the commencement of an investigation, which was continued at intervals for several years, but which cannot be said to have led to definite results as yet. It is thus introduced:—

“At the joint suggestion of Professor Tait, of Edinburgh, and the Superintendent, an ingenious apparatus has been constructed by Mr. Beckley, by means of which a disk can be made to revolve *in vacuo* with great velocity; and a short description of some experiments performed by means of this instrument, with a view of ascertaining whether visible as well as molecular motion is dissipated by a medium pervading space, has been communicated to the Royal Society by the Superintendent in conjunction with Professor Tait.”

In 1866 the completion of the Kew Photographic thermograph by Mr. Beckley is announced, and in the same year the General Committee of the British Association adopted the following resolution:—

“That the Kew Committee be authorized to discuss and make the necessary arrangements with the Board of Trade, should any proposal be made respecting the superintendence, reduction, and publication of meteorological observations, in accordance with the recommendations of the Report of the Committee appointed to consider certain questions relating to the Meteorological Department of the Board of Trade.”

This resolution initiated the close relationship between the Kew Observatory and the Meteorological Office, of which the reorganization was then in contemplation: a relationship which has materially modified the course of operations at Kew Observatory in subsequent years.

In 1866 the first set of results obtained from the heliograph were published at the expense of Mr. de la Rue under the following title, “Researches on Solar Physics,” by Messrs. Warren de la Rue, B. Stewart, and B. Loewy; first series, “On the Nature of Sun-spots.”

This was successively followed in 1867 by the Second Series, entitled "Researches on Solar Physics, Second Series, Area-measurements of sun-spots observed by Mr. Carrington during the seven years 1854-60 inclusive, and deductions therefrom," and in 1868 by Appendix to the second series, "On the Distribution in Heliographic Latitudes of the Sun-spots observed by Carrington." These papers all appeared at Mr. de la Rue's expense, and all bore the names of the same authors.

Two papers were likewise communicated in 1868 to the Royal Society by these gentlemen. The first is entitled "Researches on Solar Physics, Heliographic Positions, and Areas of Sun-spots observed with the Kew Photoheliograph during the years 1862 and 1863." The second, "Account of some recent observations on Sun-spots made at the Kew Observatory."

1867. In the Report of the Kew Committee for this year we have a short account of what steps had been taken by Government with reference to Meteorology, ending with the names of the superintending Meteorological Committee, and stating that on the 3rd of January this Committee had appointed Mr. Balfour Stewart as its Secretary, on the understanding that he should, with the concurrence of the Kew Committee of the British Association, retain his present office of Superintendent of the Kew Observatory.

It was also proposed that Kew Observatory should become the Central Observatory, at which all instruments used by or prepared for the several observatories or stations connected with the Meteorological Department should be verified, the entire expense attendant thereon, or any future expense arising through the connexion of the Observatory with the Meteorological Department, being paid from the funds supplied by the latter, and not in any way from money subscribed by the British Association. These proposals having been submitted to the Kew Committee, they approved of the Kew Observatory being regarded as the Central Observatory of the Meteorological Office, and of Mr. Stewart's holding the office of Secretary to the Scientific Committee superintending that office.

In the same year we are informed that the magnetic curves produced at Kew previously to the month of January, 1865, had all been measured and reduced under the direction of General Sabine, by the staff of his office at Woolwich; and the results of this reduction communicated by General Sabine to the Royal Society in a series of memoirs.

In the course of this and the succeeding year the assistants at the six outlying automatic observatories, in connection with the Meteorological Office, Aberdeen, Armagh, Falmouth, Glasgow, Stonyhurst, and Valencia, received their training at Kew, while Mr. Stewart, with the assistance of Mr. Beckley, personally superintended the erection

of the instruments at the several stations. The Report for 1868 contains an account of the work done at Kew as the Central Observatory of the Meteorological Committee, in which it is stated that this work may be divided into four heads :—

- (1) The arrangement of the self-recording meteorological instruments, their verification at Kew, and erection at the various stations.
- (2) The arrangement of a system of tabulation from the automatic records of these instruments.
- (3) The arrangement of a system by means of which the accuracy of the instruments themselves, and of their tabulated records, may be secured.
- (4) Work done at Kew as being itself one of the Observatories of the Meteorological Committee.

In 1869 we learn *inter alia* that Mr. Beckley had devised his self-recording rain gauge, an account of which was submitted to the British Association at Exeter. At the close of the year, in October, Dr. Stewart resigned the Secretaryship of the Meteorological Committee, and the relations between the Kew Committee and the Meteorological Office were consequently modified.

KEW OBSERVATORY UNDER THE ROYAL SOCIETY.

The letter from the Secretary of the British Association, communicating the Resolution of the Council of that body, which has been given above, was taken into consideration by the Council of the Royal Society on the 19th of January, 1871. At the Meeting of the Council on the 16th of March of the same year, a letter was read from Mr. J. P. Gassiot, F.R.S., offering to the Royal Society an immediate gift of securities, the proceeds of which were to be devoted to the maintenance of a Central Magnetical and Physical Observatory at Kew. The negotiations for the acceptance of this munificent offer were carried to a successful issue during the ensuing months, and on the 15th of June the following memorandum was entered on the Council Minutes of the Royal Society:—

Memorandum of the general heads of the proposed Deed of Trust of the Fund offered by Mr. Gassiot for maintaining the Kew Observatory and carrying on the magnetic, meteorological, and physical observations there:—

“Securities representing 10,000*l.* are proposed to be given to the Royal Society by J. P. Gassiot, Esq., F.R.S., upon trust, for the purpose of assisting in carrying on and continuing magnetical and meteorological observations with self-recording instruments, and any other physical investigations as may from time to time be found practicable and desirable, in the Kew Observatory, in the Old Deer Park, at Richmond, Surrey, belonging to Her Majesty’s Government; or, in the event of that Government at any time declining to continue placing that building at the disposition of the Royal Society, then in any other suitable building as the Council of the Royal Society may determine.

“The Observatory and the income of the Trust Fund are to be under the entire control and management of a Committee to be from time to time appointed by the Council, for the time being, of the Royal Society.

“The services of such Committee (like those of the present Meteorological Committee nominated at the request of Her Majesty’s Government) are to be gratuitous.

“The income is to be paid to the Committee (to be by them applied generally towards continuing and maintaining the Observatory and providing the expenses of conducting the observations and investigations), also for any repairs to the Observatory building and premises, or for repair or improvement of the present instruments, or for providing new instruments, as the Committee may from time to time

deem expedient, and generally for carrying out the objects of the Trust as may be from time to time determined by the Committee.

“An annual statement of receipts and expenditure is to be prepared by the Committee with any report that the Committee may from time to time deem to be desirable, and the same are to be presented to the Royal Society, and the report is to be published in the Proceedings of the Royal Society, or in such other form as the Council may from time to time direct.

“If, by reason of the Kew Observatory, or any other such equivalent Observatory being at any time discontinued, the observations should cease to be recorded, and the investigations cease to be made for (say) twelve consecutive months, the Trust Funds, with all accumulations (if any), are to be paid over to the person who shall, for the time being, be, *de facto*, the Treasurer of the London Middle-Class School incorporated by Royal Charter, dated 12th of June, 1866, by the name of “the Corporation for Middle-Class Education in the Metropolis and suburbs thereof,” to the intent that the same may be applied for the use and benefit of that Corporation as it may think fit and as a part of its general funds, and the receipt of such officer is to be a sufficient discharge to the persons paying over the same.

“Power to the Royal Society to enlarge such period of twelve months for a further period of not exceeding (say) two years, in order to give time for obtaining a site and constructing a new Observatory, with power to apply the current income, and any accumulations thereof, in aid of those purposes.

“Also, give power to the Royal Society to direct some other charitable disposition of the Trust Fund, in case, at the time of the failure of the Trust as to the Observatory, the London Middle-Class School shall have ceased to exist as a corporation.’

The Deed of Trust was duly prepared and submitted, and was sealed with the corporate seal of the Society on the 29th of June, 1871.

The Kew Committee of the Royal Society was at once appointed, and consisted of the then existing Members of the Meteorological Committee of the Royal Society.

The Observatory was handed over to the Society by the British Association at its Edinburgh Meeting.

Mr. Samuel Jeffery, formerly in charge of the Magnetic Observatory at Hobarton, was then appointed Superintendent, while Mr. R. H. Scott undertook the duties of Honorary Secretary to the Committee, which he continued to discharge for six years until 1877, by which time the future success of the undertaking was fully secured.

Mr. Jeffery held the office of Superintendent until February, 1876, when he was succeeded by Mr. G. M. Whipple, B.Sc., who, as appears from the preceding pages, had been connected with the Observatory for eighteen years.

During the period of the connection of the Observatory with the British Association the expenses incurred in carrying out the various experiments and researches as detailed in the foregoing pages were considerable. These were met by grants from the Government Grant Fund or the Donation Fund of the Royal Society, or from private sources.

During the last fourteen years, however, since the establishment has been under the management of the Royal Society Committee, the necessity for greater economy has been recognised, and the operations have been carried on without assistance from the Funds above mentioned. The administration has, at the same time, been so satisfactorily conducted, and the receipts for the verification of instruments have so largely increased, that the Committee have been enabled, out of the surplus balances at their disposal annually, to provide important and costly additions to the instrumental equipment of the Observatory, such as the complete refitment of the magnetographs, and the purchase successively of a Galton's Thermometer testing apparatus—of a hydraulic press for deep sea thermometers—of a new cathetometer—and lastly of the entire apparatus for watch-rating.

The only extraneous source of income for the Observatory, over and above occasional small grants from the Meteorological Council for special researches, has been the money so liberally supplied by Mr. de la Rue for the completion of the measurement of the sun-pictures.

The Committee has, however, to regret the gradual disappearance of many familiar faces from the band of men who took prominent parts in the management of the Observatory in former years.

Of Superintendents, the death of Mr. Welsh has already been noticed, and his predecessor, Mr. Ronalds, after receiving the well-merited honour of knighthood for his inventions in Telegraphy, died in 1873 at the age of eighty-five years.

Of the members of the British Association Committee, Col. W. H. Sykes, almost its first Chairman, died in 1870; Sir C. Wheatstone, whose name appears in the very first resolution of the British Association relating to Kew, deceased in 1871; Mr. Gassiot, for eighteen years the chairman of the British Association Kew Committee, and the munificent patron of the Observatory in recent years, died in 1876; while Sir E. Sabine, who had been from first to last identified with the magnetic operations at the Observatory, and might almost be termed the guiding spirit of the undertaking, passed away in 1883, having almost attained the patriarchal age of ninety-five years.

The following are the most important facts which can be gathered from the successive Reports of the Royal Society Committee:—

1872. The Photoheliograph was regularly worked, as in former years,

up to the end of February, 1872, at which epoch the period expired which was originally fixed by Mr. de la Rue for the continuance of the observations at the expense of the Royal Society Government-Grant Fund. The observations were afterwards carried on up to the end of March, with the object of fully including ten years. Since that date eye observations of the sun, after the method of Hofrath Schwabe, have been made in order that the observations for connecting sun-spots with magnetic phenomena might not drop through until photographic records had been taken up on a permanent footing.

In order to furnish the final corrections to the reductions of the sun-pictures, a scale of equal parts, 15 feet in length, designed by Mr. de la Rue, and made at his expense, was, with the sanction of Her Majesty's Office of Works, erected temporarily on the Pagoda at the Royal Gardens, Kew. This was photographed by the Kew Photoheliograph, and so enabled the optical distortion of that instrument to be determined.

Observations were continued for several months, when the apparatus was taken down, and the Photoheliograph lent for two years to the Astronomer Royal for use at Greenwich.

1873. A series of experiments were commenced and carried on for a space of nearly two years at the expense of the Meteorological Committee, at the Pagoda in the Royal Gardens, to test the influence of height above the ground on the vertical distribution of temperature. The thermometers were placed at three different levels, viz., 22 feet 6 inches, 69 feet, and 128 feet 10 inches above the ground.

In the month of May a request was received from Col. J. T. Walker, F.R.S., Superintendent of the Great Trigonometrical Survey of India, for provision to be made at the Observatory for vibrating pendulums.

In the year 1865 two pendulums lent by the Royal Society for use in India had been vibrated at Kew by the late Capt. Basevi, as explained above; and it was necessary that these pendulums should be vibrated again on their return, and that at the same time two pendulums obtained from the Imperial Academy of Sciences at St. Petersburg should also be vibrated.

The Committee at once complied with the request; and at the expense of the Indian Government preparation was made for the experiments in the south hall on the basement story, by removing for a time the apparatus for testing sextants, and building up from the foundation-arches two solid isolated supports for the Russian clock and pendulum.

Capt. Heaviside, R.E., the officer charged with the duty of making the pendulum experiments, arrived in England in July, and, finding all the arrangements satisfactory, at once commenced his operations.

Endeavours were made, in connection with the arrangements just mentioned, to obtain an electrical time communication between Kew

and the Royal Observatory at Greenwich ; but the proposal failed of success.

The experiments were continued until the end of May, 1874, when the apparatus employed, with the exception of the Russian pendulums and their accessories, was, at the request of the Secretary of the Royal Society, received at Kew for storage.

1874. The Magnetograph instruments were dismantled in January, 1874, for the purpose of thorough examination and readjustment. The necessity for this measure is obvious, when it is remembered that the instruments had been in unintermitted action for the period of fifteen years.

The scale-values were accordingly redetermined, and the instruments handed over to Mr. Adie for examination and repair. They were returned and remounted in May, but were not at that time set in continuous action, inasmuch as it was intended that the automatic records should be suspended for the entire year, so as to commence a new series of observations with the year 1875.

In this year an improved automatic Electrograph, invented by Sir W. Thomson, was erected and set in operation.

In the year 1873 a grant had been obtained from the Government-Grant Committee for the purpose of carrying on a series of experiments on the constants of Robinson's Anemometers ; and a piece of ground in the Park was rented. Several anemometers, of various constructions, were erected therein.

The experience of a few months was sufficient to show that the exposure in the Park was not nearly sufficiently open to afford facilities for testing the instruments at any but very low velocities, and not satisfactorily even in such cases. Application was therefore made to the Secretary of the Crystal Palace Company for permission to employ a rotary machine driven by steam-power, so as to be able to vary the velocities at pleasure.

Consent having been most freely given, the experiments were commenced, and the instruments tested at various velocities up to about thirty miles an hour, the highest attainable by the apparatus.

A paper on the results of these experiments was laid before the Royal Society by Prof. Stokes in 1881 (Proceedings Royal Society, Vol. XXXII, p. 170).

1875. The year was marked by the recommencement of regular work with the Magnetographs. The instruments were set in action on the 1st of January, 1875, and therewith the second series of continuous photographic records of magnetic phenomena was inaugurated.

The principal constants employed in the computations for the Tables used in the reduction of the monthly absolute observations which had been determined by Mr. Welsh were also re-examined. A memorandum containing the results of the observations in question for the twelve

months ending September 30th, 1875, was prepared and appended to the Report for the year, and has formed a feature of every subsequent annual report.

The Registering Sunshine Recorder invented by the late Mr. J. F. Campbell, of Islay, F.G.S., which had been in operation for about twenty years at the Office of the Local Government Board, 8, Richmond Terrace, Whitehall, was transferred to Kew, and set in action at the Observatory. The instrument consists of a glass sphere and wooden bowl, and the effect is measured by the amount of wood charred by the sun's action in the course of six months. Experiments were set in progress at the Observatory to obtain a satisfactory daily record of the duration of the sun's heating action by a similar method.


1876. In the previous year Mr. C. S. Peirce, of the United States Coast Survey, had made through the Admiralty an application to the Royal Society to swing his pendulums at the Observatory. Permission was at once granted, and Mr. Peirce arrived at Kew in June, 1876, and as soon as some necessary fittings had been put up in the Pendulum Room he erected his apparatus, and made a complete series of vibrations.

In 1876, at the request of the Editor of the *Times*, and at the expense of that journal, the Staff commenced the preparation of a weekly diagram showing the traces of the self-recording meteorological instruments on a reduced scale, together with an epitome of the general features of the weather. This has appeared without intermission from that date.

The examination and checking of the work of the self-recording Observatories of the Meteorological Committee was discontinued in November. This change of arrangements involved a considerable reduction in the amount allowed by the Meteorological Office to Kew, as its central Observatory.

1877. Sir Edward Sabine having brought the discussion of the Magnetical Observations carried on under his superintendence in all parts of the globe for a period of nearly forty years, to a close in a final "Contribution," presented to the Royal Society (No. XV, Phil. Trans., Vol. 167), represented to the War Office that he was able to dispense with the further services of the two Sergeants of the Royal Artillery who had acted as his clerks, and had been in constant attendance at Kew since November, 1871. These men were in consequence withdrawn on the 31st of March.

The documents deposited in Sir E. Sabine's late office were presented by the War Office to the Royal Society, and, in conformity with instructions received from the Council, are retained in the custody of the Observatory. A detailed list of these documents and papers has been prepared, and a selection made of all those relating to marine observations, which, at the request of the Hydrographer, were transferred to the Hydrographic Department of the Admiralty.

A system was organized for etching a "Hall-mark," as in the annexed figure, upon all Thermometers which have been  verified.

The Astronomer Royal having courteously offered the Committee every facility for a suggested comparison between the Greenwich and Kew Standard Barometers during April and May, a number of carefully selected Portable Standard Barometers were conveyed to and fro between Greenwich and Kew on three separate occasions, and a large number of comparative readings were obtained by the Superintendent and Messrs. Baker and Foster.

A complete detailed account of the experiment was drawn up, and laid before the Royal Society, February 7th, 1878. (Proceedings, Vol. XXVII, p. 76.)

A Hydraulic Press especially constructed for the purpose of subjecting Deep Sea Thermometers to pressures similar to those they experience when sunk to great depths, was erected in the workshop. It is capable of exerting a strain equal to 4 tons on the square inch.

1879. Experiments were commenced at the Observatory, with the view of determining the relative merits of different patterns of thermometer screens, and continued for upwards of two years. For this purpose there were erected on the lawn a Stevenson's screen, of the ordinary pattern, and a large wooden cage, enclosing a Wild's screen, of the pattern employed in Russia. Each of these screens contained a dry and a wet bulb thermometer, and a maximum and minimum, all of which were read daily, at 9 A.M. and 9 P.M., their indications being compared with those of the thermograph at the same hours.

A discussion of the twenty-eight months' observations was subsequently made by Mr. Whipple, and the results published by the Meteorological Council.

1880. A Sub-Committee, which had been appointed in 1878 to consider the best means of utilising the records of the magnetographs, reported that it was inadvisable, in their opinion, to proceed with the regular tabulation of the curves, and suggested that attention should rather be directed to their comparison with synchronous curves, taken at other Magnetic Observatories in different parts of the globe, in order to ascertain whether similar disturbances occur at these several stations, and at what time intervals; with a view to the development of the theory of magnetic disturbance.

In order to carry out this scheme, a circular, inviting co-operation on the part of observers provided with magnetographs of the Kew pattern, was issued to the Directors of the following Observatories:—Batavia, Bombay, Brussels, Coimbra, Colába, Lisbon, Mauritius, Melbourne, Potsdam, St. Petersburg (Pawlowsk), San Fernando, Stonyhurst, Utrecht, Vienna, and Zi-Ka-Wei. Replies favourable to

the project were received from all those whose instruments were working under satisfactory circumstances.

An examination of the records for the year 1879 indicated the month of March as that most suitable for the purpose of the comparison. Accordingly, a further request for copies of the Declination curves for that month was issued, and, in response, they were received from Coimbra, Colába, Lisbon, Mauritius, Melbourne, St. Petersburg, Stonyhurst, Toronto, Utrecht, Vienna, and Zi-Ka-Wei.

The comparison of these magnetic curves was undertaken by Professor W. Grylls Adams, who communicated to the Swansea Meeting of the British Association a preliminary account of the principal facts which came to light. This was followed by a second paper printed in the Report of the York Meeting, 1881.

At the request of the Council of the Royal Astronomical Society, the valuable collection of MSS. containing the memorable series of sun-spot observations made by Hofrath Schwabe, of Dessau, during the years 1825 to 1867, which had been deposited in the Library of the Observatory, the first volumes since 1865, was transferred to the Society's Library at Burlington House, London. In order, however, to render the collection of sun-spot observations as complete as possible, and to prevent the total loss of the observations in case of fire, the Committee voted the sum of 90*l.* to defray the cost of making a complete copy of the solar drawings.

This was accordingly done, and accurate tracings made of every one of Schwabe's drawings. These were pasted into blank books, and any important notes were transcribed at the same time.

The Observatory, therefore, now possesses a complete record of the condition of the sun's surface, extending from November, 1825, to the present date.

In 1881, an application was received from Major Herschel, R.E., F.R.S., by authority of the India Office, for permission to make certain experiments with the invariable pendulums deposited at Kew, and for the loan of the instruments, with their accompanying appliances, with facilities for prosecuting the experiments at the Observatory.

These requests were granted, and in the autumn of the year operations were carried on, both in the Pendulum Room and in the Experimental House at Kew.

On completing his work Major Herschel conveyed the instruments he employed, first to the Royal Observatory, Greenwich, and subsequently to a house near Portland Place, London. Series of observations were made in both those places, with the object of reducing to a common standard the determinations of gravity made by Kater, Airy, Sabine, and others.

On the conclusion of these latter experiments, Major Herschel conveyed the pendulums, clock, &c., to America, where, after making a

series of observations at Washington, he handed them over to the officers of the United States Coast Department. Subsequently Professor C. S. Peirce, of the United States Coast Survey, who had made a series of pendulum observations at Kew and elsewhere in 1876, visited the Observatory in July, 1883, and made a subsidiary series of experiments with a view of determining the flexure of his stand when on the Kew piers.

1882. In April of this year the Chairman announced the completion of the long series of reductions of the Kew Photoheliograph measurements, extending over the period February 7th, 1862, to April 9th, 1872. He stated that the MSS. volumes containing the results had been deposited for reference with the Royal Society, and that the whole of the sun-pictures had been re-measured at the Observatory, and reduced by Mr. A. Marth, F.R.A.S., so as to give the heliocentric longitudes and latitudes of the spots, as well as their areas.

The entire expense attendant on these reductions, which has amounted to the considerable sum of 1,452*l.* 6*s.* 7*d.*, was defrayed by Mr. de la Rue. This amount was in addition to the sums that gentleman had previously disbursed in contributing to the maintenance of the Photoheliograph, and the prosecution of solar research. The total amount of his payments towards this branch of the Observatory work has reached the large sum of 2,071*l.* 15*s.* 4*d.*

In the same year the Committee received very gratifying testimony as to the accuracy of the Standard Thermometers constructed at the Observatory. In a paper contributed to the "American Journal of Science," Dr. Leonard Waldo, of the Winchester Observatory, Yale College, U.S.A., remarks that after a critical examination of three Kew Standard Thermometers, in which every degree was separately measured, entailing no less than 2,300 micrometer readings, he came to the conclusion that their errors are practically insensible, and too small to be detected with certainty.

Professors Thorpe and Rücker also tested very minutely three similar instruments made for them at Kew. In a paper read at York before the British Association, Professor Rücker stated, "In no case would the calibration error in the determination of a difference of temperature have amounted to 0.02° C. It may therefore be concluded that Welsh's method, as applied at Kew to selected tubes, and with a measuring instrument of great accuracy, is capable of giving first-rate results. The errors which remain when it has been applied are so small that they may be neglected in all cases but those where the thermometers are to be used under the most favourable conditions, *i.e.*, with the stem of the same temperature as the bulb, &c. This satisfactory conclusion is confirmed by the fact that Professor Rowland has recently stated that the calibration of the Kew thermometer used by him in his research on the mechanical equivalent of heat was practically perfect." (British Association Report, 1881, p. 541.)

1883. In this year the Committee decided to make a trial of a system of watch-rating for the public, and granted 100*l.* for the preliminary expenses. In accordance with a scheme prepared by the Superintendent, they fitted up in the Observatory a first-class burglar- and fire-proof safe for the safe custody of the watches. In the next year's Report we learn that the arrangements for rating watches mentioned in last year's Report had been completed and brought into operation successfully, at a cost of 193*l.*

1884. A second safe having been purchased by the Committee, an apparatus was fitted to it which enables the enclosed watches to be maintained continuously at either high or low temperatures, whichever may be required, and furthermore without being subjected to injury by fumes of gas in the former case.

The following was the constitution of the Kew Committee at the close of the year 1884:—

Mr. W. de la Rue, Chairman.
Captain W. de W. Abney, R.E.
Professor W. G. Adams.
Captain Sir F. Evans, K.C.B.
Professor G. C. Foster.
Mr. F. Galton.
Admiral Sir G. H. Richards, C.B.
The Earl of Rosse.
Mr. R. H. Scott.
Lieut.-General W. J. Smythe.
Lieut.-General R. Strachey, C.S.I.
Mr. E. Walker.

The staff employed at the same date was as follows:—

G. M. Whipple, B.Sc., Superintendent.
T. W. Baker, Chief Assistant and Magnetic Observer.
J. Foster.
H. McLaughlin.
E. G. Constable.
T. Gunter.
With five juniors.

The following may be considered as a summarised statement of the scientific work done at the Kew Observatory since its foundation as a Physical Observatory :—

1. Improvements in the construction and manufacture of instruments for meteorological observations, the production of new ones, and the modification of older forms.
2. The same with regard to magnetic and electrical instruments.
3. The distribution of such instruments over the globe.
4. The ensuring of accuracy of observations by means of the verification and distribution of standard instruments and the instruction of observers.
5. The continuous recording of magnetical and meteorological phenomena.
6. The practical adaptation of photography to scientific purposes, and especially to the continuous registration of phenomena occurring on the sun's surface.
7. The improvements of nautical, geographical, fiscal, physical, and medical instruments by verification, and of horological by watch-rating.
8. Assistance in the prosecution of research in the following sciences :—
 1. *Astronomy*.—De la Rue's, Stewart's, and Loewy's solar researches ; Gassiot's spectroscopy.
 2. *Geodesy*.—Pendulum observations—Basevi, Heaviside, Peirce, Herschel.
 3. *Magnetism*.—Sabine and others too numerous to mention.
 4. *Meteorology*.—Ditto, ditto.
 5. *Physics*.—Roscoe's Actinometry ; Stewart's ditto.
Sanitary Institution—Ventilation.
Greaves, Evaporation.
Stewart, Dilatation of Air and Theory of Exchange Experiments.
Stokes, Friction of Gases.
Loewy, Pressure on Thermometers.
Anemometrical Coefficients, &c.
 6. *Magnetic Surveys*—Scotch (Welsh) ; Arctic and Antarctic—Perry's, Thorpe's, &c. ; Fort Rae and other Expeditions.

The following Appendices supply particulars as to the operations at the Observatory in successive years :—

- A. Physical Constants for Kew Observatory.
- B. List of Observatories supplied with Magnetographs.
- C. " " " " Meteorographs.
- D. List of Verifications.
- E. Catalogue of Papers relating to Kew Observatory.
- F. Annual Statement of Money received by Kew Observatory.

APPENDIX A.

KEW OBSERVATORY, RICHMOND, SURREY.

Latitude 51° 28' 6" N. Longitude 0h. 1m. 15.1s. W.
 0° 18' 47" W.

Height of Barometer cistern above sea-level 34 feet.

Magnetic Constants { Mean declination for 1885 18° 25' West.
 " horizontal force for 1885 English Units: C. G. S.
 " vertical " " " " " " 5.92 0.18
 " total " " " " " " 9.53 0.44
 " " " " " " 10.30 0.47

Force of gravity... .. 32.190 feet.
 Length of seconds pendulum 39.138 inches.

METEOROLOGICAL CONSTANTS.

| | Jan. | Feb. | March. | April. | May. | June. | July. | August. | Sept. | Oct. | Nov. | Dec. | Mean. |
|--|--------|--------|--------|--------|--------|--------|--------|---------|--------|--------|--------|--------|---------|
| Mean height of barometer reduced to sea-level, 1871-80 | 29.961 | 29.909 | 29.922 | 29.940 | 29.955 | 29.920 | 29.914 | 29.903 | 29.917 | 29.866 | 29.853 | 29.909 | 29.906" |
| Mean temperature of air, 1871-80 | 39.2 | 40.8 | 42.9 | 47.3 | 51.5 | 58.8 | 62.4 | 62.1 | 56.7 | 49.4 | 42.5 | 39.1 | 49.4° |
| Mean temperature of evaporation, 1871-80 | 37.6 | 38.9 | 40.1 | 44.0 | 47.3 | 54.3 | 57.7 | 57.7 | 53.5 | 47.3 | 40.6 | 37.8 | 46.4° |
| Mean rainfall, 1871-80 | 2.14 | 1.68 | 1.26 | 2.13 | 1.79 | 2.45 | 2.83 | 2.29 | 2.43 | 2.77 | 2.20 | 2.01 | 2.16" |
| Mean percentages of bright sunshine, 1880-84 | 16 | 19 | 33 | 29 | 39 | 34 | 36 | 39 | 34 | 27 | 25 | 12 | 24% |

B. LIST OF OBSERVATORIES SUPPLIED WITH KEW PATTERN MAGNETOGRAPHS.

- Toronto }
 Madrid } Ronalds' pattern.
1. Batavia.
 2. Coimbra.
 3. Lisbon.
 4. United States (?).
 5. St. Petersburg (Pawlowsk).
 6. Florence.
 7. Stonyhurst.
 8. Utrecht.
 9. Melbourne.
 10. Bombay (Colába).
 11. Mauritius.
 12. Vienna (Hohe-Warte.)
 13. Zi-Ka-Wei.
 14. San Fernando.
 15. Potsdam.
 16. Brussels.
 17. Nice.
 18. United States (Naval Department.)

C. LIST OF OBSERVATORIES SUPPLIED WITH SELF-RECORDING METEOROLOGICAL INSTRUMENTS ON THE KEW MODEL.

| | Barograph. | Thermograph. | Anemograph. | Rain gauge. |
|----------------|------------|--------------|-------------|-------------|
| Valencia | 1 | 1 | 1 | 1 |
| Armagh | 1 | 1 | 1 | 1 |
| Aberdeen | 1 | 1 | 1 | 1 |
| Glasgow | 1 | 1 | 1 | 1 |
| Stonyhurst | 1 | 1 | 1 | 1 |
| Falmouth | 1 | 1 | 1 | 1 |
| Radcliffe | 1 | 1 | 1 | 1 |
| Toronto | 1 | 1 | — | — |
| Mauritius | 1 | 1 | — | — |
| Brussels | 1 | 1 | — | — |
| Zi-Ka-Wei | 1 | 1 | 1 | — |
| Adelaide | 1 | 1 | — | — |
| Japanese Govt. | 2 | 1 | — | — |
| Hong-Kong | 1 | 1 | — | 1 |
| Bombay | 1 | 1 | 1 | — |
| Sydney | 1 | — | — | — |
| Melbourne | 1 | 1 | — | — |
| Batavia | 1 | 1 | — | 1 |

D. LIST OF VERIFICATIONS COMPLETED AT THE OBSERVATORY.

| | Thermometers. | Barometers. | Hydrometers. | Standard Thermometers made. |
|---------|---------------|-------------|--------------|-----------------------------------|
| 1852-53 | — | — | — | 70 |
| 1853-54 | 181 | 23 | — | 24 |
| 1854-55 | 2520 | 257 | 1269 | — |
| 1855-56 | 530 | 137 | 100 | — |
| 1856-57 | 1524 | 278 | 751 | — |
| 1857-58 | 268 | 221 | 150 | — |
| 1858-59 | 911 | 187 | 92 | — |
| 1859-60 | 222 | 173 | — | — |
| 1860-61 | 660 | 150 | 8 | 7 |
| 1861-62 | 282 | 184 | — | — |
| 1862-63 | 296 | 130 | 22 | 1 |
| 1863-64 | 389 | 97 | — | 5 |
| 1864-65 | 420 | 88 | — | 6 |
| 1865-66 | 395 | 126 | — | 8 |
| 1866-67 | 608 | 89 | — | 2 |
| 1867-68 | 1138 | 78 | — | 14 |
| 1868-69 | 1153 | 157 | 38 | 12 |

NUMBER OF INSTRUMENTS VERIFIED, &c, SINCE 1869.

| Year | Thermometers. | | | | Barometers. | | | Magnetic Apparatus. | | | | Self-Registering Apparatus. | | | | | Anemometers, Scales, and Evaporating Dishes. | | | Surveying Instruments, &c. | | | | |
|---------|------------------------|-------------------|--------------------------|-----------|-------------|----------------------|-----------|---------------------|-----------|--------------|------------|-----------------------------|-----------------------------------|------------|---|------------------|--|---------------|--------------|----------------------------|-----------|--------------|--|-----|
| | Standards Constructed. | Standards Tested. | Ordinary Meteorological. | Mountain. | Clinical. | Solar Radiation, &c. | Standard. | Marine and Station. | Aneroids. | Hytrometers. | Unifilars. | Dip Circles and Fox's do. | Dipping and Magnetograph Needles. | Compasses. | Detection Bars, Declinometers, Magnets, &c. | Magnetotographs. | Barographs. | Thermographs. | Anemographs. | Hain Gauges. | Sextants. | Theodolites. | Chrometers, Telescopes, and Sextant Glasses. | |
| 1869-70 | 21 | 20 | 851 | 20 | 269 | — | 34 | 184 | 12 | 103 | 1 | 4 | 4 | — | 1 | — | — | — | — | — | — | — | — | — |
| 1870-71 | 14 | 20 | 876 | 7 | 417 | 6 | 22 | 76 | 17 | 215 | — | 2 | 4 | — | — | — | — | — | — | — | — | — | — | — |
| 1871-72 | 12 | 31 | 1,219 | 16 | 1,395 | 24 | 34 | 73 | 17 | 12 | 4 | 5 | 6 | — | 1 | — | — | — | — | 1 | 6 | 3 | 1 | — |
| 1872-73 | 9 | 29 | 782 | 52 | 1,233 | — | 49 | 110 | 20 | — | 3 | 5 | 2 | 1 | — | — | — | — | — | 1 | 1 | — | — | — |
| 1873-74 | 18 | 22 | 1,471 | 32 | 1,555 | 37 | 110 | 40 | 10 | 66 | 4 | 6 | 5 | 3 | 6 | 1 | 1 | 1 | — | 13 | 14 | 1 | 1 | — |
| 1874-75 | 13 | 64 | 1,238 | 20 | 1,439 | 272 | 67 | 126 | 21 | 150 | 3 | 7 | 1 | — | 5 | 1 | — | 1 | — | 3 | 6 | 1 | 1 | — |
| 1875-76 | 10 | 36 | 1,410 | 34 | 1,560 | 311 | 96 | 106 | 28 | 129 | 3 | 5 | 7 | — | 3 | — | — | — | — | 29 | 20 | 1 | — | — |
| 1876-77 | 12 | 57 | 1,428 | 22 | 2,281 | 177 | 71 | 113 | 25 | 249 | 1 | 3 | 2 | 2 | 2 | 2 | — | — | — | 11 | 5 | 3 | 1 | — |
| 1877-78 | 14 | 47 | 1,435 | 16 | 2,032 | 199 | 56 | 137 | 29 | 356 | 4 | 7 | 2 | 3 | — | 1 | 2 | 3 | — | — | 1 | 2 | — | — |
| 1878-79 | 12 | 67 | 1,286 | 43 | 3,405 | 88 | 68 | 77 | 51 | 120 | 5 | 6 | 4 | — | 2 | — | — | — | — | 6 | 2 | 4 | 5 | — |
| 1879-80 | 17 | 94 | 1,487 | 68 | 3,638 | 244 | 47 | 156 | 21 | 10 | 1 | 6 | 9 | 1 | — | — | — | — | — | 13 | 17 | 5 | 4 | — |
| 1880-81 | 10 | 60 | 1,704 | 40 | 4,217 | 118 | 59 | 109 | 34 | 47 | 3 | 7 | 5 | — | 1 | — | — | — | — | 6 | 13 | 25 | 3 | 237 |
| 1881-82 | 11 | 166 | 1,518 | 69 | 5,365 | 243 | 48 | 105 | 30 | 195 | 5 | 10 | 1 | — | 5 | — | 2 | — | 4 | 12 | 36 | 4 | 8 | — |
| 1882-83 | 7 | 116 | 1,165 | 39 | 7,255 | 164 | 45 | 114 | 52 | 59 | 8 | 5 | — | — | — | 1 | 2 | 1 | — | 9 | 12 | 55 | 1 | 393 |
| 1883-84 | 10 | 83 | 1,225 | 164 | 8,726 | 197 | 44 | 80 | 84 | 1,161 | 5 | 9 | 4 | — | 6 | 1 | 1 | 1 | — | 3 | 2 | 64 | — | 341 |

E. CATALOGUE OF PAPERS RELATING TO KEW
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On the Total Solar Eclipse of July 18th, 1860, observed at Rivabellosa, near Miranda de Ebro, in Spain. *Phil. Trans.*, 1862, pp. 333–416.

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- Note on the Distribution of Solar Spotted Areas in Heliographic Latitude. *Phil. Mag.*, XXXIII, 1867, pp. 79, 80; *Astron. Soc. Month. Not.*, XXVII, 1867, pp. 12-14.
- Account of some recent Observations on Sun-spots made at the Kew Observatory. *Roy. Soc. Proc.*, XVI, 1868, p. 447.
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- Researches on Solar Physics. No. 2. The Positions and Areas of the Spots observed at Kew during the years 1864, 1865, 1866; also the Spotted Area of the Sun's visible Disk from the commencement of 1832 up to May, 1868. *Phil. Trans.*, CLX, 1870, pp. 389-496; *Phil. Mag.*, XL, 1870, pp. 53, 54; *Roy. Soc. Proc.*, XVIII, 1870, pp. 263, 264.
- Further Investigations on Planetary Influence upon Solar Activity. *Roy. Soc. Proc.*, XX, 1872, pp. 210-218.
- On some recent Researches in Solar Physics, and a law regulating the time of duration of the Sun-spot period. (1871.) *Roy. Soc. Proc.*, XX, 1872, pp. 82-87, 290; *Phil. Mag.*, XLIII, 1872, pp. 385-390.
- On a Tendency observed in Sun-spots to change alternately from one Solar Hemisphere to the other. *Roy. Soc. Proc.*, XXI, 1873, pp. 399-402.

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- Description of a Train of Eleven Sulphide-of-Carbon Prisms arranged for Spectrum Analysis. *Roy. Soc. Proc.*, XIII, 1864, pp. 183-185; *Phil. Mag.*, XXVIII, 1864, pp. 69-71.

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F. ANNUAL STATEMENT OF MONEY received for the carrying on of the Kew Observatory from its commencement to November, 1884, first under the British Association, and subsequently under the Royal Society, classified under the different heads whence the various sums were obtained, as specified in the Reports to the two above-named Societies.

| | British Association. | | Meteorological Office. | | Donations. | Verification Fees. | Commissions, Sales and other Sources. | Annual Totals as per Reports. |
|-----------|----------------------|-------------------|-----------------------------|-----------------------------|------------|--------------------|---------------------------------------|-------------------------------|
| | Special Purpose. | | Special Work, Postages, &c. | | | | | |
| | Maintenance Fund. | Annual Allowance. | Annual Allowance. | Special Work, Postages, &c. | | | | |
| 1842-1843 | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| 1843-1844 | 133 4 7 | 56 7 3 | ... | ... | ... | ... | 133 4 7 | 174 4 6 |
| 1844-1845 | 117 17 3 | 43 17 8 | ... | ... | ... | ... | 193 12 8 | 146 16 7 |
| 1845-1846 | 149 15 0 | ... | ... | ... | ... | ... | 107 8 6 | 171 15 11 |
| 1846-1847 | 146 16 7 | ... | ... | ... | ... | ... | 76 2 5 | 255 18 0 |
| 1847-1848 | 107 8 6 | ... | ... | ... | ... | ... | 309 2 2 | 233 17 8 |
| 1848-1849 | 171 15 11 | ... | ... | ... | ... | ... | 165 0 0 | 165 0 0 |
| 1849-1850 | 76 2 5 | ... | ... | ... | ... | ... | 330 15 4 | 602 16 0 |
| 1850-1851 | 255 18 0 | ... | ... | ... | ... | ... | 736 2 8 | 491 5 0 |
| 1851-1852 | 309 2 2 | ... | ... | ... | ... | ... | 610 0 0 | 569 12 7 |
| 1852-1853 | 233 17 8 | ... | ... | ... | ... | ... | 949 10 2 | 708 0 8 |
| 1853-1854 | 165 0 0 | ... | ... | ... | ... | ... | 36 13 8 | 577 19 0 |
| 1854-1855 | 330 15 4 | ... | ... | ... | ... | ... | 14 0 0 | 698 6 9 |
| 1855-1856 | 500 0 0 | ... | ... | ... | ... | ... | 50 0 0 | 803 0 10 |
| 1856-1857 | 500 0 0 | ... | ... | ... | ... | ... | 102 0 0 | 728 1 11 |
| 1857-1858 | 350 0 0 | ... | ... | ... | ... | ... | 24 0 0 | 764 8 2 |
| 1858-1859 | 500 0 0 | ... | ... | ... | ... | ... | 97 10 0 | 905 10 0 |
| 1859-1860 | 500 0 0 | ... | ... | ... | ... | ... | 157 1 6 | 1,221 2 10 |
| 1860-1861 | 500 0 0 | ... | ... | ... | ... | ... | ... | ... |
| 1861-1862 | 500 0 0 | ... | ... | ... | ... | ... | ... | ... |
| 1862-1863 | 600 0 0 | ... | ... | ... | ... | ... | ... | ... |
| 1863-1864 | 600 0 0 | ... | ... | ... | ... | ... | ... | ... |
| 1864-1865 | 600 0 0 | ... | ... | ... | ... | ... | ... | ... |
| 1865-1866 | 600 0 0 | ... | ... | ... | ... | ... | ... | ... |
| 1866-1867 | 600 0 0 | ... | ... | ... | ... | ... | ... | ... |
| 1867-1868 | 600 0 0 | ... | ... | ... | ... | ... | ... | ... |
| 1868-1869 | 600 0 0 | 430 0 0 | ... | ... | ... | ... | ... | ... |

† Mr. Cassiot.

* The Royal Society.

ANNUAL STATEMENT OF MONEY received for the carrying on of the Kew Observatory—continued.

| | British Association. | | | Meteorological Office. | | Donations. | Verification Fees. | | Commissions, Sales and other Sources. | | Annual Totals as per Reports. | | |
|-----------|----------------------|------------------|-----|------------------------|-----------------------------|-----------------------------|--------------------|----|---------------------------------------|-----|-------------------------------|----|------------|
| | Maintenance Fund. | Special Purpose. | | Annual Allowance. | Special Work, Postages, &c. | | £ | s. | d. | £ | | s. | d. |
| | | £ | s. | | | | | | | | | | |
| 1869—1870 | 600 0 0 | ... | ... | 560 0 0 | 7 10 0 | †202 11 7 | 133 | 16 | 0 | 24 | 17 | 1 | 1,528 14 8 |
| 1870—1871 | 600 0 0 | ... | ... | 541 13 4 | 80 13 6 | *96 6 1 | 131 | 6 | 9 | 23 | 11 | 1 | 1,473 10 9 |
| 1871—1872 | 300 0 0 | ... | ... | | | | | | | | | | |
| | Royal Society. | | | | | Mr. de la Rue for Sun-work. | | | | | | | |
| | Gassiot Trust. | | | | | | | | | | | | |
| 1871—1872 | 600 0 0 | ... | ... | 767 18 5 | 3 2 6 | 20 13 1 | 125 | 6 | 0 | 267 | 12 | 9 | 2,084 12 9 |
| 1872—1873 | 608 0 7 | ... | ... | 649 7 6 | 23 16 11 | 49 9 6 | 302 | 15 | 11 | 260 | 14 | 8 | 1,894 5 1 |
| 1873—1874 | 498 18 4 | ... | ... | 650 0 0 | 40 0 6 | 34 17 1 | 253 | 10 | 9 | 402 | 3 | 10 | 1,879 10 6 |
| 1874—1875 | 499 19 4 | ... | ... | 650 0 0 | 38 7 10 | 100 0 0 | 368 | 7 | 6 | 436 | 13 | 5 | 2,093 8 1 |
| 1875—1876 | 498 18 4 | ... | ... | 650 0 0 | 26 7 1 | 109 13 0 | 380 | 8 | 7 | 550 | 11 | 6 | 2,215 18 6 |
| 1876—1877 | 497 17 4 | ... | ... | 420 16 8 | 7 11 11 | 106 4 6 | 395 | 4 | 1 | 508 | 4 | 11 | 1,935 19 5 |
| 1877—1878 | 495 15 3 | ... | ... | 400 0 0 | 15 5 8 | 125 7 10 | 486 | 2 | 11 | 976 | 0 | 0 | 2,498 11 8 |
| 1878—1879 | 495 14 0 | ... | ... | 410 8 4 | 14 15 8 | 104 1 3 | 405 | 7 | 7 | 606 | 3 | 7 | 2,036 10 0 |
| 1879—1880 | 496 13 8 | ... | ... | 400 0 0 | 35 12 9 | 100 0 0 | 447 | 3 | 0 | 372 | 15 | 4 | 1,852 4 9 |
| 1880—1881 | 496 13 8 | ... | ... | 400 0 0 | 44 17 2 | 8 6 8 | 523 | 8 | 5 | 364 | 18 | 5 | 1,838 4 4 |
| 1881—1882 | 496 14 6 | ... | ... | 400 0 0 | 35 11 7 | ... | 621 | 17 | 0 | 680 | 15 | 0 | 2,234 18 1 |
| 1882—1883 | 493 11 1 | ... | ... | 400 0 0 | 9 5 1 | 15 8 3 | 615 | 18 | 6 | 561 | 7 | 6 | 2,085 10 5 |
| 1883—1884 | 494 4 10 | 25 0 0 | 0 | 400 0 0 | 27 3 11 | ... | 759 | 4 | 11 | 822 | 7 | 6 | 2,528 1 2 |

† Mr. Gassiot.

* The Royal Society

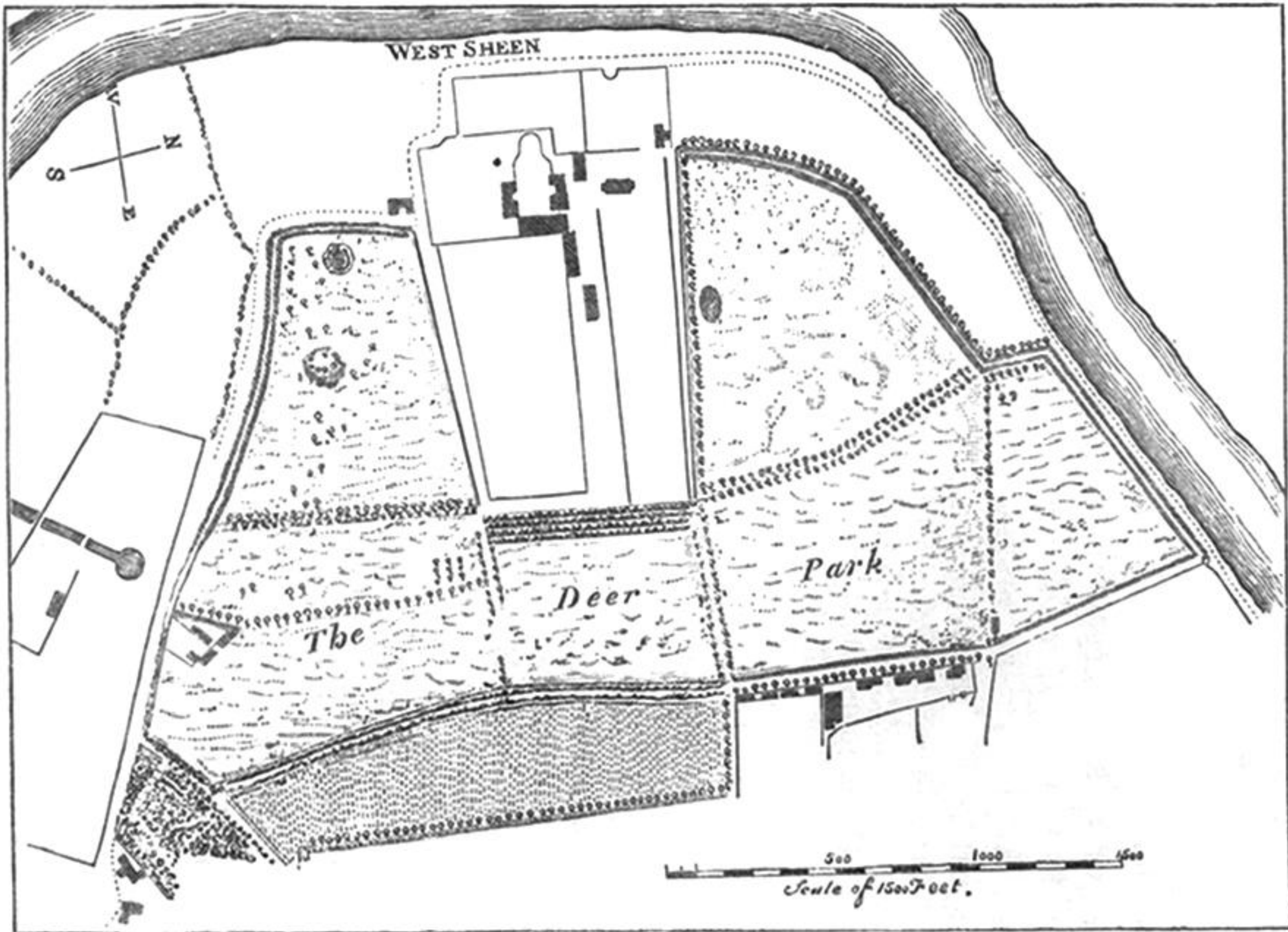


FIG. 1.—SITE OF THE CARTHUSIAN PRIORY, WEST SHEEN, CIRCA 1730.

From a Portfolio marked K, 46, 16 h, in the King's Library, British Museum.



FIG. 2.—THE KEW OBSERVATORY FROM THE SOUTH-WEST.

Latitude $51^{\circ} 28' 6''$ N.
Longitude $0^{\circ} 18' 47''$ W.