REPORT

OF THE

ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS

OF THE

ROYAL OBSERVATORY, GREENWICH.

Read at the Annual Visitation of the Royal Observatory, 1927 *June* 3.

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The Report here presented refers to the year from 1926 May 11 to 1927 May 10, and exhibits the state of the Observatory on the last-named day.

I.—Buildings and Grounds, Movable Property, and Library :—

The external painting of the New Building was completed on 1926 June 4 and that of the Altazimuth Building on November 4. The domes of the Photo-heliograph, Transit Pavilion, Altazimuth, Sheepshanks and 28-inch Equatorials were painted during the summer of 1926. Some of the woodwork of the North-East Turret of the New Building was renewed in May 1927. Work was commenced on April 7 to make the room under the Shuckburgh Dome suitable for the installation of the Mean Solar Clock and Signalling apparatus which will be required for sending time-signals from the Rugby Wireless Station. The room is being protected as far as practicable from sudden changes of temperature. As the building is old, some structural defects were found which had to be remedied, making the preparation of the room longer than was anticipated.

The Admiralty have made arrangements with the Hurtwood Water Company to secure in perpetuity an adequate supply of water for the Abinger Magnetic Station.

An enlarging camera has been obtained with a large 14-inch condensing lens and a camera with bellows extension of 6 feet. This will enable enlargements to be made to the extent of 5 diameters. The photographic objective is a Cooke whole-plate lens of 2 inches diameter and 11·2 inches focus.

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During the months of March and April the mechanics and carpenters have been largely employed in preparations for the Eclipse. A considerable amount of work in wood and some in metal has been required to fit up two spectrographs and one long focus telescope.

The principal movable instruments are thus distributed:—

At Greenwich—

Transits B, C, D, and E.—Transit B is fitted with an impersonal Micrometer.

Altazimuths D and E.

Equatorials (6-inch).—Cooke No. 2, Simms No. 1.

Photoheliographs Nos. 2 and 3 complete and the mechanical parts of Nos. 1 and 5.

Detached Telescopes (on tripod stands).—Three 4-inch (Simms Nos. 1 and 2 and R.O. No. 2).

Cooke 6-inch triplet Photographic Objective.

Two Hilger Chronographs.

A single-prism Spectroscope.

On loan—

Transit A, at the Cape Observatory.

Transit, with axis view, at the Science Museum, South Kensington.

Altazimuths.—A, at the Imperial College of Science and Technology, South Kensington; B, at the Cape Observatory.

Equatorials.—Simms No. 2 (6-inch), at the Imperial College of Science and Technology.

Two Heliotropes at the Science Museum, South Kensington.

Photoheliographs:—

No. 1. Object-glass at the Cape Observatory.

No. 5. Object-glass to Professor Newall, Cambridge.

Harrison's Time Machine No. 2, Whewell's Anemometer, Airy's Dip Circle, and the large Bar Magnets in use from 1841 to 1915 at the Science Museum.

9-inch Speculum flat mirror to Prof. Newall, Cambridge.

Clocks.—Dent No. 1916 and Dent 2013 at the Cape Observatory; Arnold 2 at the University Observatory, Oxford.

4-inch R.R. lens 33-inch focus to J. L. Haughton, Esq., National Physical Laboratory.

On loan to the Royal Observatory—

The Cookson Floating Zenith Telescope from the Cambridge Observatory, for a third period of seven years from July, 1925.

A 7-inch Prism of 40° angle, from the Joint Permanent Eclipse Committee.

A Position Micrometer for measuring solar photographs, from the Solar Physics Observatory, Cambridge.

Astrographic Micrometer from Prof. Turner.

Schuster-Smith Coil Magnetometer from the National Physical Laboratory.

A Bendorff Electrometer, two Kelvin-White Multicellular Voltmeters, and a Flame Collector, from Dr. G. A. Carse, University of Edinburgh.

One seven-valve Amplifier and one C.W. Syntoniser, from the Royal Air Force.

A battery of 72 Leclanché cells, from the Director of Scientific Research of the Admiralty.

The following instruments have been loaned for the purposes of the Solar Eclipse Expedition in June, 1927 :—

16-inch Coelostat from the Royal Astronomical Society.

12-inch Coelostat from the Joint Permanent Eclipse Committee.

8-inch Coelostat from the Royal Irish Academy.

6-inch lens (45 feet focus) from J. H. Worthington, Esq.

6½-inch plane silver on glass mirror from the Joint Permanent Eclipse Committee.

6½-inch plane silver on glass mirror from Instructor-Capt. M. A. Ainslie, R.N.

6½-inch concave mirror from G. Merton, Esq.

2 spectroscope slits from Royal Astronomical Society.

4½-inch Littrow prism from Messrs. Grubb, Parsons & Co.

9-inch Herschel speculum concave mirror from Miss Herschel.

The annual examination of the Library has been made. Nine books are reported missing, and cannot be accounted for at present, including six reported last year. Six of the books missing last year have been found.

II.—Astronomical Observations :—

Transit Circle.—The Sun, Moon, major planets and fundamental stars have been regularly observed. Satisfactory progress is being made with the observation of stars brighter than $8{\cdot}0^{m}$ between $+32°$ and $+64°$, begun in 1922. The observation of comparison stars for the opposition of Eros in 1931 was interfered with a good deal by unfavourable weather in the winter months. Of these stars 26, 42, 82, 111, 133 and 95 have had respectively 5, 4, 3, 2, 1 and 0 observations. It will be difficult to get these stars well observed, as they are so near together in right ascension.

The total number of observations made during the year is as follows :—

Transits	11,266	Circle Observations	10,115
Collimation	335	Nadir point	628
Level	740		

The Sun was observed on 161 days and the Moon on 90 days.

Observations are all reduced as far as apparent place to April 30, and as far as mean place to 1926, Dec. 31. The mean places for the Equinox 1925·0 have been collected on catalogue forms as far as 1925, June 2.

The ledgers of Sun, Moon and planets are completed to 1926, Dec. 31.

A comparison of the observed positions of the Moon with those given in the *Nautical Almanac* gives the following results :—

Year.	No. of Obs.	Observed—Tabular. R.A. s	Dec. "	Long. "	Lat. "
1923	103	+ ·473	— ·73	+ 7·12	— ·55
1924	89	+ ·472	— ·59	+ 7·11	— ·76
1925	92	+ ·454	— ·78	+ 6·74	— ·84
1926	95	+ ·44	— ·7	+ 6·5	— ·8

The results for 1926 are provisional, as final values of variation of latitude are not yet available.

A preliminary investigation has been made of the declinations and proper motion in declination of some of the best observed stars from the observations with the Greenwich Transit Circle during the 75 years of its use. The annual results have all been reduced on a uniform system and observations by reflection omitted. From 55 bright stars between + 35° and — 10° the correction to Boss' declinations for 1925 is

$$+ ''\cdot 33 + ''\cdot 0068(t - 1925\cdot 0).$$

Altazimuth.—The instrument has been used up to the end of January to determine declinations of fundamental stars by observation of transits across the prime vertical. The number of transits observed in the year is 1495. The result of a preliminary discussion of the observations from 1923 to 1927 is shown in the following table.

Limits of Declination.	Altazimuth—Boss. R.A.	Altazimuth—Boss. Dec.	Raymond —Boss.	Eichelberger —Boss.
° °	s	″	″	″
$47\frac{1}{2}$ — 50	— ·024	+ ·32	+ ·27	
45 — $47\frac{1}{2}$	— ·011	+ ·21	+ ·29	+ ·43
40 — 45	+ ·006	+ ·35	+ ·31	
35 — 40	+ ·010	+ ·44	+ ·33	+ ·42
30 — 35	+ ·004	+ ·43	+ ·33	
25 — 30	— ·004	+ ·38	+ ·32	+ ·48
20 — 25	— ·005	+ ·51	+ ·30	
15 — 20	— ·004	+ ·51	+ ·28	+ ·59
$11\frac{1}{2}$ — 15	+ ·002	+ ·51	+ ·24	

The adopted value of the colatitude of the Altazimuth is 38° 31′ 23″·54, corresponding to 38° 31′ 21″·87 for the transit circle. The last columns of the above table give Raymond's and Eichelberger's corrections to Boss's Declinations reduced to 1925·0. The observations in Right Ascension are differential and do not include any constant equinox correction that Boss's R.A.'s may require.

Since January the instrument has been used in the meridian for the observation of Fundamental stars and the Eros comparison stars.

The Cookson Floating Zenith Telescope.—During the year 241 photographs were taken. The measurements are completed to the end of 1926, and a preliminary determination has been made of the variation of latitude and communicated to

the Royal Astronomical Society. A final reduction of the observations for the second period of seven years, including observations to the end of 1926, is nearly completed.

28-*inch Equatorial.*—During the year 556 observations of 309 double stars were obtained. They are distributed as follows :—

73	double stars,	separation	$< 0''\cdot5$
90	,,	,,	$0''\cdot5$ to $1''\cdot0$
75	,,	,,	$1''\cdot0$ to $2''\cdot0$
71	,,	,,	$> 2''\cdot0$

The results for stars observed three or more times between 1919 and 1925 have been published in the Volume for 1925.

Thompson Equatorial.—With the 26-inch Refractor 781 plates have been taken for stellar parallax and 788 plates have been measured. The number of completed determinations of parallax made during the year is 14, making the total to date 330. In addition, a number of stars have been partly measured but further plates are wanted before the determination is completed. It has been found desirable not to commence the measurement of a series until the series is complete and the arrears having been overtaken the measurement is not being pressed. In November, 1926, the parallaxes of 26 stars were published in the *Monthly Notices of the Royal Astronomical Society.*

With the 30-inch Reflector, in pursuance of the work on relative colour temperature of stars of early type, 103 pairs have been photographed and 110 pairs have been measured. The results have been published in the *Monthly Notices* in a paper on the " Relative Effective Temperatures of 22 stars of Early Type."

Also with the 30-inch Reflector 11 photographs of the comets, Comas Sola, Stearns, Pons-Winnecke and Grigg-Skjellerup, have been obtained by Mr. Merton.

Astrographic Equatorial.—The determination of proper motions by comparison with photographs taken 25 to 30 years ago has been continued. During the year 85 plates have been taken, the fields successfully photographed being 47 in Zone 71° and 10 in Zone 73°. Thirty plates have been measured in Zone 69° and 11 in Zone 71°. The reductions of the plates measured is complete to date (R.A. $4^h\ 12^m$ Dec. + 71°). Copy for press has been prepared for Zones 65°, 67° and 69°. It is

proposed to publish the results on the completion of Zone 71°, *i.e.*, of Vol. I. of the Greenwich Astrographic Catalogue.

Four plates were taken of the Nova in the Spiral Nebula M61 and two of the variable star in Ophiuchus.

Dr. H. Groot has kindly offered to pick out the double stars in the Greenwich Astrographic Catalogue. He has completed this work from Dec. 64° to Dec. 71° and from Dec. 80° to the North Pole. The following table, computed by him, gives n' the observed number of double stars between certain limits as compared with n the number to be expected in an accidental distribution of stars without physical connection.

Dec. 64° to 71°.

R.A.	0″—5″	5″—10″	10″—15″	15″—20″	20″—25″	25″—30″
0^h — 3^h	20	27	18	17	23	23
3^h — 6^h	19	27	23	21	12	22
6^h — 9^h	23	29	19	15	15	18
9^h — 12^h	11	14	8	13	11	8
12^h — 15^h	13	19	16	13	15	10
15^h — 18^h	22	28	21	20	21	20
18^h — 21^h	26	35	23	42	30	21
21^h — 0^h	53	44	33	40	58	37
n'	187	223	181	181	183	159
n	15	45·5	75·5	106·5	136	168·5
n'/n	13	4·9	2·1	1·7	1·4	0·96

The total number of stars is 68,913.

The double stars with separation less than 10″ have all been remeasured at Greenwich on the old plates in Zones 65°, 67° and 69°, and on the new plates. Also the proper motions of all the double stars with separation less than 30″ have been examined to give an indication of whether the stars are physically connected or merely optically double.

Short-focus Camera.—In July a camera with a Ross portrait lens of 17 inches focal length working at F/5½ was mounted on the Astrographic telescope. This was replaced in November by two cameras with aeroplane lenses lent by Mr. Merton. These lenses are both triple objectives of 20 inches focal length working at F/5·6. With these Mr. Merton obtained 14 successful photographs

of Comets, viz.: Comet Comas Sola 1926f (10), Comet Stearns 1927d (2), Comet Grigg-Skjellerup 1927e (2). Some plates were taken in an unsuccessful search for Finlay's Periodic Comet in July and Reid's Comet in March.

Miscellaneous Equatorial Observations.—Eight disappearances and one reappearance of stars occulted by the Moon were observed during the year. Comets Comas Sola, Stearns and Pons-Winnecke were observed with the Sheepshanks Equatorial on three nights, one night, and one night respectively. Orbits and ephemerides were computed by Dr. Crommelin and Mr. Merton.

Heliographic Observations.—In the year ended 1927, May 10, photographs of the Sun were obtained on 251 days with either the Dallmeyer 4-inch photoheliograph or the Thompson 9-inch. The number of photographs selected for preservation is 511, including 28 with double images of the Sun for the determination of the zeros of position angle. The zeros of position angle have also been determined regularly by visual observations.

H.M. Astronomer at the Cape has reported that the Sun was photographed there on 342 days in the year 1926, and on 87 days in the first three months of 1927. The Director of the Kodaikanal Observatory has reported that plates were taken there on 345 days in the year 1926, and on 56 days during the first two months of 1927.

Photographs have been received from the Royal Observatory, Cape of Good Hope, to 1927 February 25. Photographs have been received and others are in transit from the Kodaikanal Observatory to complete the series for 1926.

The measurement of the combined series has been made from 1926 January 8 to 1927 January 1.

The reductions of positions and areas of spot groups and their principal components have been completed from 1925 November 5 to 1926 September 6.

During the period covered by this Report, the solar activity has been very considerable, but with marked depressions at times. Ten naked-eye groups of spots, ranging in latitude from 7° to 25° were seen between 1926 May and 1927 January; since the latter month, however, no unusually large spots have appeared.

On October 20, Messrs. Ross Limited were consulted with a view to supplying a new enlarging lens for the Thomson photoheliograph which would give better definition at the Sun's limb. An enlarging lens No. 108292 working at F/2·8 was found to give an excellent field with only very slight radial distortion. On January 23 another enlarger of similar design, No. 110705, working at F/2·4, was supplied for the Dallmeyer photoheliograph. The radial distortion of the lens has been measured and found negligible. Both enlargers have a larger aperture than the ones previously in use, and considerable improvement in the definition at the Sun's limb has been obtained.

Photographic prints of the combined series of solar negatives are being supplied to Prof. Newall, at his request, to continue the series hitherto sent to him from Dehra Dûn.

Eclipses of the Sun.—On Sir William Christie's initiative drawings of the Solar Corona, from large scale photographs obtained at Greenwich expeditions, were made by Mr. W. H. Wesley. These and drawings of subsequent eclipses till 1919 May 29 were sent to the Royal Society and have been published with short explanatory text in the *Philosophical Transactions*.

Throughout the year Mr. Davidson has been largely engaged, in conjunction with Col. Stratton, in the measurement of the photographs obtained at the Eclipse of 1926 January 14, and discussion of the results. A valuable Memoir is in course of publication in the *Memoirs of the Royal Astronomical Society*.

Arrangements for the Eclipse of June 29 are well in hand. The proposed programme consists of (1) Comparison of the intensities of the Calcium Triplet λ8498, λ8542, λ8662 with H and K; (2) Spectrum of the Chromosphere from D to the extreme red; (3) Direct photography of the Corona. Suitable spectrographs for (1) and (2) have been constructed at the Observatory, mirrors being employed for forming the images on the slit. For the large scale photograph of the Corona, Mr. Worthington has lent a 6-inch lens of 45 feet focal length. A site for making the observations has been kindly placed at the disposal of the Eclipse party by Mr. Douglas, the Headmaster of Giggleswick School.

III. Magnetic Observations :—

After the opening on June 6, 1926, of the electrified sections of the Southern Railway, which pass near the Observatory, observations with the absolute instruments at Greenwich were discontinued.

At the Abinger magnetic station (near Dorking, Surrey) the variations of magnetic declination, horizontal force and vertical force have been recorded photographically throughout the period covered by this Report.

Absolute observations of declination have been made several times every week-day, and observations of horizontal force with the unifilar magnetometer and of inclination with the earth inductor have been made as a rule at least once every week-day.

As regards the reduction of observations, the mean hourly ordinates of all the traces are read off to the beginning of the current week. The reduction of absolute observations is complete to 1927 March 31, and with provisional constants, to the current week.

The tabulation of results for 1926 is well advanced. Copy for press is partly prepared.

The mean values of the magnetic elements at Abinger for the year 1926 are given below. The values for 1925 are given for comparison.

	Decl. W.	Hor. Force.	Vert. Force.	Dip.
1925 - -	13° 22′·8	0·18596	0·42949	66° 35′·3
1926 - -	13° 10′·4	0·18581	0·42947	66° 36′.2

The weekly report of mean two-hourly values of declination has been regularly sent to certain offices for publication or information, as mentioned in the last Report. This service was taken over from Kew Observatory at the beginning of 1925. In response to a representative expression of opinion from mining surveyors to the effect that hourly mean values would be more useful to them than two-hourly means, the table will be expanded to give hourly mean values of declination at Abinger, commencing on May 29, 1927.

In connection with the Magnetic Survey of the British Isles by the Ordnance Survey Department, Mr. H. L. P. Jolly has kept in touch with the Abinger station during the surveying season. Values of the magnetic elements at Abinger at the times of field observations made during 1926 have been supplied to the Director of the Ordnance Survey, Southampton.

One unifilar magnetometer and one dip circle have been examined for certification. In addition, five tubular compasses of novel design have been examined and their index errors determined for the Hydrographic Office.

The special hut sanctioned by the Admiralty for work of this character was completed in September, 1926.

Magnetic Charts.—The quinquennial revision of the Admiralty charts of magnetic declination was carried out in the autumn of 1926, and isogonals for the epoch 1927·5 were furnished to the Hydrographic Office. New charts have been recently published by that office.

Schuster-Smith Coil Magnetometer.—This instrument was delivered at Abinger on March 17, 1926, and was set up under the supervision of Mr. D. W. Dye of the National Physical Laboratory on the centre pier in the pavilion for absolute observations. Completion of the accessory apparatus occupied a further four or five weeks and the first observation of horizontal force was made on May 1. From that date several observations have been made every week-day, except in the interval from November 15 to December 8 when the current balance or apparatus for measuring the current employed in the observation was at the National Physical Laboratory for testing and slight repair.

The results from the coil magnetometer at first agreed closely, though not absolutely, with those obtained by the unifilar. The differences were not systematic and began to increase during the autumn months becoming at last so large as to preclude attributing them to the possibility of small variations in the constants of the unifilar. After rather tedious and protracted investigation it was concluded that the insulation of the circuits had become faulty through damp and other causes. Additional precautions were taken. Mica plates were inserted under the galvanometer and between the marble cylinder and its support. Thick ebonite discs were placed under the feet of the instrument and the whole current circuit was carried on porcelain insulating blocks, that part between the balance and the coil being replaced by high tension cable with $\frac{1}{4}$-inch solid rubber insulation, instead of best quality electric light cable as at first employed. On completion of these changes the results from the coil magnetometer came into exact agreement with those from the unifilar.

The changes were finally effected on February 2, 1927. From this date the coil magnetometer has been constituted the standard instrument for determination of the variometer base-line values. Range in values determined by the coil is considerably smaller than in values determined by the unifilar magnetometer, though results with the latter instrument have been very accordant from the beginning.

The following table is compiled from the weekly reports of the Abinger station.

Week ending.	Range of H.F. base-line values from Coil Magnetometer.	Number of Determinations.	Mean Diff. : Coil minus Unifilar.
1927. Feb. 12 -	6	34	0γ
„ 19 -	5	26	− 1
„ 26 -	7	27	+ 1
Mar. 5 -	7	24	− 1
„ 12 -	8	24	0
„ 19 -	9	26	+ 1
„ 26 -	8	28	− 1
Apr. 2 -	4	24	0
„ 9 -	7	26	0
„ 16 -	5	20	0
„ 23 -	4	34	0
„ 30 -	6	28	− 2

Standard Inertia Cylinder.—The proposal to adopt a standard inertia cylinder with which the cylinders of all magnetometers certified by the Observatory, as well as any others which it seemed desirable to standardise, could be compared, was mentioned in the last Report.

The apparatus designed by the late Dr. W. Watson for use in this connection having been transferred from Kew to Greenwich, the work of re-determining the value of the moment of inertia of the standard cylinder (that is, of the gilt cylinder with bevelled ends used by Dr. Watson in his investigations on the subject in 1903) was taken in hand at the beginning of 1927.

The determination of the several periods of vibration of the standard and the comparison cylinders was made chronographically, arrangements for recording the observations on the Altazimuth chronograph from the Greenwich magnetic pavilion having been effected for the purpose.

In all, 26 independent comparisons of the period of vibration of the Standard and of cylinders selected from among those used by Dr. Watson in 1903 were made, from which a mean value of the moment of inertia of the standard cylinder was deduced.

The following table gives the moments of inertia at 15° C. of the individual cylinders as calculated from the dimensions and masses furnished by the N.P.L. in 1922 and the deduced values of the moments of inertia of the Standard.

Comparison Cylinder.		Standard.
Watson's No. 1	544·929	547·355
7	576·739	·239
8	572·490	·211
9	573·269	·235

The mean adopted value (in deriving which, cylinder No. 1 was given half weight) is 547·246.

The value derived by Dr. Watson in 1903 was 547·24, showing a most satisfactory agreement.

A further series of ten comparisons between the Standard and the cylinder latterly used for the Gibson magnetometer was made with a view to constituting an auxiliary standard which should be the actual medium of comparison in standardising the cylinders of other magnetometers. It is considered that the result of the comparison between the standard and auxiliary standard is correct to the 5th significant figure.

Comparisons have also been made to standardise the cylinder of the Abinger magnetometer (Casella 181) and the old Gibson cylinder in use from 1912 to 1922. In the former case the resulting correction to observations of horizontal force to reduce to the standard is $-1{\cdot}0\gamma$ and in the latter case $-7{\cdot}0\gamma$; while the correction to determinations depending on the assumed moment of inertia of the new Gibson cylinder during 1923–26 is $-3{\cdot}9\gamma$.

Continuing the comparison between simultaneous records at Greenwich and Abinger, selected series of days both quiet and disturbed have been under review. The traces indicate that even on quiet days the movements at the two stations are not exactly parallel, but that departures from strict parallelism of the order of 1′ in declination and 3γ in horizontal force may occur. On disturbed days the departure from parallelism may be still greater. Analysis of short period movements (an hour or less in duration) in declination on disturbed days shows that on the average the movements at Abinger are about 3 per cent. less than corresponding movements at Greenwich.

A full account of the comparison with a discussion of the results will be given in the 1926 Volume.

Commander W. V. Rice, R.N., came to the Observatory for practice in magnetic observation from 1927 January 3 to 14, and Mr. R. v. d. R. Woolley of Caius College, Cambridge, from March 31 to April 12, 1927.

IV. Meteorological Observations :—

The registration of atmospheric pressure, temperature of the air and of evaporation, the direction, pressure and velocity of the wind, the amount of rainfall, sunshine and cloudiness at night has been continuously maintained.

Estimates of visibility are now included in the meteorological observations made by eye at fixed hours.

The registration of the electric potential gradient of the atmosphere with a radium collector and Kelvin–White quadrant electrometer has also been continued.

The sunshine recorder was taken to the Meteorological Office to be tested on 1926 September 13. The report was satisfactory, and a serial number (M.O. 113) was marked on the globe to indicate that it had passed the test.

The following details of the weather refer to the period of twelve months ended 1927 April 30.

The mean temperature was 50°·2, or 0°·6 above the average of the 75 years 1841–1915. The highest temperature in the shade was 88°·2 on September 19, and the temperature exceeded 80° on 13 days. The lowest temperature was 24°·0 on January 20. Temperatures of freezing point or below were recorded on 35 days, of which two were in April. The mean daily horizontal movement of the air was 284 miles, equal to the average for 50 years 1867–1916. The greatest daily movement was 692 miles recorded on January 29; the least, 39 miles on February 13. On two days—October 9 and January 29—the maximum velocity in one hour during the period was recorded, namely 43 miles. The greatest pressure reached was 16·1 lbs. to the square foot on January 29.

The duration of bright sunshine recorded was 1,320 hours out of a possible 4,447 or 29·7 per cent. There were 66 entirely sunless days in the period. The total rainfall was 28·20 inches, that is 3·96 inches more than the average for

75 years 1841–1915, and measurable rain fell on 177 days. The wettest month was November with 4·77 inches, and the driest month, December with 0·38 inches.

V. Printing and Distribution of Greenwich Publications :—

The volume for 1924 and its separate parts have been distributed and the printing of the volume for 1925 is complete. A small volume of Determination of Effective Wave-lengths is awaiting distribution. About 60 advance copies giving Time determinations and times of receipt of Wireless Signals during the Longitude observations of October and November have been distributed.

VI.—Chronometers :—

The number of chronometers and watches belonging to the Admiralty now at the Observatory is 3,098. Of this total 218 chronometers, 278 chronometer watches, 416 hack watches and 44 pocket watches are being rated. The remainder, consisting of 380 chronometers, 1,053 chronometer watches, 87 hack watches and 618 pocket watches, are kept in storage.

In addition to Admiralty chronometers there are 41 chronometers and 11 watches deposited at the Observatory for various reasons.

During the year ended 1927 April 30 a total of 1,971 chronometers and watches have been received and 1,961 issued. The number sent for repair was 1,143—namely, 1,088 for the Admiralty, 40 for the Indian, 1 for the Australian, 7 for the New Zealand and 2 for the Egyptian Governments. Eleven watches have also been sent for repair on behalf of the Royal Air Force.

VII. Time Service :—

The Clock Shortt No. 3 has been used as Standard Sidereal Clock throughout the year with the exception of the period June 11 to July 1. It has been regularly compared with Shortt No. 11 which was obtained last year and brought into use in July. Both clocks have gone with very great regularity; the air-leakage into the clock cases has been negligible. The rate of No. 3 in July was $0^{s}\cdot12$ gaining per day and it has gradually decreased to zero. Similarly No. 11 has decreased from $0^{s}\cdot16$ gaining in July to zero. During the last 50 days when the rates have been nearly coincident the clocks have never differed by more than $0^{s}\cdot05$.

The daily time signals to the General Post Office and the British Broadcasting Company have been transmitted regularly throughout the year.

The Time Ball at Greenwich has been operated regularly and also that at Deal until February 25 when the establishment was closed down.

The performance of the time balls at the Admiralty Signal stations is shown by the following table of the errors of the return signals :—

Error of Return Signal.	Portsmouth.	Portland.	Devonport.
Not greater than $0^s \cdot 2$ - - - -	242	230	234
$0^s \cdot 3$ to $0^s \cdot 5$ - - - - - -	1	7	4
$0^s \cdot 6$ to $1^s \cdot 0$ - - - - - -	2	0	0
Greater than $1^s \cdot 0$ - - - -	1	0	0

The Westminster Clock was purposely kept approximately 2^s fast as the chimes were used as a warning for the Greenwich Broadcast Time Signal. On 2 days it was less than 1^s fast, on 164 days between 1^s and 2^s fast, on 122 days between 2^s and 3^s fast, and exceeded 3^s on 9 days. Now that the Chimes are no longer used as a warning for the Greenwich signal it is no longer necessary to keep the clock fast.

Wireless time signals have been received regularly from the Eiffel Tower, Nauen, Bordeaux and Annapolis. They are registered automatically on a syphon recorder operated by an oscillating valve relay system. The signals from Annapolis were recorded on 279 days during 1926.

Longitude Observations.—At the Meeting of the International Astronomical Union at Cambridge in 1925 it was decided to carry out an extensive scheme of longitude determinations in October and November 1926. About 50 observatories throughout the world took part. At Greenwich special series of observations for time were made with the small reversible transit B which is fitted with a self-registering micrometer. Observations with this instrument were secured on 34 nights. On account of the great regularity of the clock a smooth clock error was deduced from a combination of the whole series of time determinations, giving a reliable clock error for each night whether observations of stars were obtained or not.

Eleven series of time signals from Eiffel Tower, Bordeaux, Nauen and Annapolis, were registered on most days during October and November. When rhythmic

signals were received, the Greenwich Sidereal times of the first and last signals were deduced, and when ordinary time signals were received the Greenwich Sidereal time of the reception of the standard signal was determined. The results have been printed and distributed to the observatories which took part in the operations. When the data from all the participating observatories are ready, valuable longitude determinations should result.

Preliminary comparisons from figures communicated from Paris and Washington point to corrections of less than $0^s \cdot 02$ to the adopted longitudes of these Observatories. The following figures for the apparent longitude of Greenwich–Washington are of interest as showing the difference of time of travel from Annapolis and Bordeaux to Greenwich and Washington.

	h	m	s		s	
October - -	5	8	15·737	(Bordeaux)	15·784	(Annapolis).
November - -			15·720	„	15·772	„

The differences for the two months are $^s \cdot 047$ and $^s \cdot 052$ respectively and are closely explained by the known velocity of propagation of wireless waves, and are approximately twice the travel time across the Atlantic.

The results of the observations made in the autumn of 1925 by MM. Beljajeff and Dnieprovsky for the determination of the longitude Poulkovo–Greenwich has been communicated by the Director, Poulkovo Observatory. The final difference of longitude is $2^h\ 1^m\ 18^s \cdot 572$.

VIII.—Personal Establishment :—

The permanent staff at the present time is constituted as follows :—

Chief Assistants.—Mr. Greaves, Dr. Jackson.

Assistants.—Mr. Bowyer, Dr. Crommelin, Mr. Davidson, Mr. Witchell.

Junior Assistants (Higher Grade).—Mr. Cullen, Mr. Furner, Mr. Melotte, Mr. Stevens.

Junior Assistants.—Mr. Acton, Mr. Barton, Mr. Chamberlain, Mr. Finch, Mr. Jeffries, Mr. Martin, Mr. Newton, Mr. Rickett, Mr. Symms, Mr. Wells.

Clerical Assistant.—Mr. Edney.

19 Computers, including 3 ladies, are employed at the Observatory.

Mr. Stevens, assisted by Mr. Finch, has charge of the Magnetic Station at Abinger. The station is visited periodically by Mr. Greaves and Mr. Witchell.

The Observatory will on the day following the date of this Report lose the valued services of Dr. Crommelin. He joined on 1891 May 11 and was for many years a regular observer with the Transit Circle and Altazimuth and was in charge of the Altazimuth observations. His wide knowledge of Astronomy was often called upon, especially for questions involving the calculation of the positions of the Moon, Planets, Comets, &c.

The present arrangement of the staff under the general superintendence of the Chief Assistants is as follows:—

Branch.	Established Staff.	Unestablished Staff.
Transit Circle, Altazimuth and Zenith Telescope.	Dr. Crommelin, Mr. Furner, Mr. Cullen, Mr. Acton, Mr. Symms.	Mr. Fellows, Mr. Davies, Mr. Rood, Mr. Ware, Mr. Bennett, Mr. Slator, Mr. Blackwell.
Time Signals and Chronometers	Mr. Bowyer, Mr. Rickett	Mr. Sizer, Mr. McKenzie, Mr. Brown.
Thompson Equatorial	Mr. Davidson, Mr. Martin	Miss Jeffries, Mr. Rickerby.
28-inch Equatorial	Mr. Furner	
Astrographic Equatorial	Mr. Melotte, Mr. Jeffries	Mr. Smith.
Photoheliograph	Mr. Newton, Mr. Barton	Miss Jackson, Mr. Judd.
Magnetic and Meteorological	Mr. Witchell, Mr. Stevens, Mr. Wells, Mr. Finch.	Miss Clack, Mr. Oliver, Mr. L. D. Melotte.
Secretariat and Library	Mr. Edney, Mr. Chamberlain	Mr. Cox.

The staff of workmen now employed consists of a foreman of works, two joiners, a mechanic, a boy assistant mechanic, a gate porter, two messengers, a night watchman, a gardener, three labourers and a charwoman. There is also a mechanic at Abinger who has charge of the engines and acts as caretaker.

IX.—General Remarks:—

The different branches of astronomical work have been carried on very satisfactorily throughout the year. A large number of observations have been made and the reductions and publication have been kept well up-to-date. The collection and re-discussion of the Transit Circle observations of the brighter stars and the prime-vertical observations of the Altazimuth will be useful contributions

to the more accurate determination of the system of fundamental declinations. The 28-inch Refractor, besides its regular use for double star observations, has been employed by Dr. Steavenson for the determination of the magnitudes of Novæ and faint variables which are beyond the reach of smaller telescopes. The determination of the relative temperatures of A and B stars with the 30-inch Reflector has given useful results. It is proposed to continue this work by comparing the A stars with stars of solar type. The determination of the proper motions of the Astrographic stars is resulting in a thorough examination of the Greenwich Zones.

Mr. Merton continued his researches during the year and has published a valuable memoir on comet Grigg-Skjellerup. Now that Dr. Crommelin has retired, Mr. Merton retains the Observatory in close touch with current cometary astronomy.

Now that initial difficulties at Abinger have been overcome, the new Observatory is working very satisfactorily and is fulfilling its function as the standard magnetic observatory of the southern part of Great Britain.

The observations for longitude during the months of October and November were carried out very successfully, thanks to the continuous astronomical observations of Dr. Jackson and the regular recording of a large number of wireless time signals daily by Mr. Bowyer.

The Admiralty, with the co-operation of the Board of Trade, has arranged with the Post Office for the distribution of Time Signals from the Wireless Station at Rugby. The signals will be sent at 10^h and 18^h. They will be of rhythmic type, the separate signals being at intervals of 60/61 seconds with prolonged signals marking the exact minutes of Greenwich Mean Solar Time. The apparatus will include a master pendulum of the Shortt type rated to Mean Time, the slave clock usual for this system, and in addition, a pendulum adjusted to transmit 61 signals in one minute. The latter pendulum will be controlled by the master by an action similar to that employed to keep the slave in phase. This apparatus has been ordered from the Synchronome Co., who have promised delivery by the end of July. The installation and adjustment of the apparatus at Greenwich will probably take at least two months before the service can be inaugurated.

Mr. Horrocks, Isaac Newton Student at Cambridge University, has been at Greenwich since January 14, taking part in the observations and acquiring

experience in the working of the Observatory. For shorter periods, Messrs. Madwar of Helwan, Commander W. Rice of the Royal Navy, Mr. Dobbie, a student in Astronomy at University College, and Mr. R. R. Woolley of Gonville and Caius College, Cambridge, have been at the Observatory studying particular branches of the work.

During the year the Observatory has been visited by the following Astronomers : Mr. Curry of Helwan, Mr. Dodwell of Adelaide, the late Prof. Hussey and Dr. Rossiter of Ann Arbor, Prof. de Sitter and Dr. Oort of Leiden, Prof. Schlesinger of Yale, Mr. Tsukuda of Kobe Marine Observatory, Mr. Wood of Johannesburg and Mr. Yeates of Perth, Western Australia.

F. W. DYSON.

Royal Observatory,
Greenwich.
1927 May 19.