

REPORT
OF THE
ASTRONOMER ROYAL
TO THE
BOARD OF VISITORS
OF THE
ROYAL OBSERVATORY, GREENWICH.

Read at the Annual Visitation of the Royal Observatory, 1930 June 7.

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REPORT OF THE ASTRONOMER ROYAL

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ROYAL OBSERVATORY, GREENWICH.

Read at the Annual Visitation of the Royal Observatory, 1930 June 7.

The Report here presented refers to the year from 1929 May 11 to 1930 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 Thompson Dome, Octagon Room and Flamsteed House was completed on August 31.

The redecoration of the Upper and Lower Computing Rooms was completed on June 24.

The interior of the 28-inch dome was painted between February 6 and March 23 and some small repairs made of the papier-mâché covering. The exterior painting of the dome was finished on May 12, 1930. The contract for the motor to turn the dome has been placed.

A portion of the zinc work covering the Photoheliograph Dome was torn off during the gale of January 12. The necessary repairs were completed by February 21.

As the dark room adjoining the Thompson Dome is much exposed, it has been found to be too cold in the winter months for silvering mirrors and photographic purposes. Attempts to warm it by stoves have not been very successful, and a shaft has been constructed to extend the hot air system into this room with satisfactory results.

The South Attic has been converted into an observing room for the Spectroheliograph. This room also contains a Spectrophotometer, a small Spectrograph and an enlarging Camera. The book shelves which were originally in the room were moved into the West Attic and North Library.

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On the return of the Eclipse instruments in July, an examination was made of the old instruments which had gradually accumulated at the Observatory. Amongst them were the following instruments of historical value: The Shuckburgh Equatorial, made by Ramsden, a fine early specimen of an English mounted equatorial; the Equatorial used by Admiral Smythe, the first clock-driven Telescope erected in England; Airy's Altazimuth. These instruments were presented by the Admiralty to the Science Museum, where they have been beautifully restored and are exhibited in the Astronomical Section. A mahogany tube of one of Herschel's reflectors, with the 6-inch speculum, was presented to a new astronomical museum at Chicago.

A considerable amount of material which was not worth preserving was handed over to the Naval Store Officer at West India Docks for disposal.

The electric generating plant at Abinger has given rise to some anxiety during the past twelve months. Detailed examination of the storage battery by inspectors from Chatham Dockyard revealed serious deterioration of the plates in a number of cells. The trouble has been met, temporarily, by measures taken to prevent further buckling of the plates in individual cells and the consequent liability to short circuits.

The generator engines were also found to be in need of a thorough overhaul. It was considered that the most practical way of dealing with this requirement was to replace them by duplicates. The substitution was carried out by engineers of the Chatham Dockyard staff during the first two weeks in February.

The following instruments which are in regular use have been lent to the Royal Observatory:—

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

A 13-foot Spectroheliometer, complete with coelostat, but without grating, from the Mount Wilson Observatory.

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.

Schuster-Smith Coil Magnetometer for measurement of Horizontal Intensity, from the National Physical Laboratory.

A Coil Magnetometer, designed by Dr. D. W. Dye, F.R.S., for measurement of Vertical Intensity, from the National Physical Laboratory.

Several other smaller instruments are also on loan to the Royal Observatory.

The following instruments have been lent by the Royal Observatory :—

To the Royal Observatory, Cape of Good Hope—

Transit A : Altazimuth B : Object glass of Photoheliograph No. 1 : Clocks.
Dent 1916 and Dent 2013.

To the University Observatory, Oxford—

Clock Arnold No. 2.

To the Solar Physics Observatory, Cambridge—

Photoheliograph object glass No. 5.

To the Radcliffe Observatory, Oxford—

6-inch Equatorial, Cooke No. 2.

To the Imperial College of Science and Technology—

6-inch Equatorial, Simms No. 2 : Altazimuth A.

To the Science Museum—

Harrison Time machine No. 2, and a number of other instruments of historical interest.

The annual examination of the Library has been made. Twelve books are reported missing and cannot be accounted for at present, including nine reported last year. Four of the books missing last year have been found. Four books which have been missing for a number of years are now assumed lost and have been written off.

II.—Astronomical Observations :—

Transit Circle.—The Sun, Moon, major planets and fundamental stars have been regularly observed.

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

Transits	9,136	Circle Observations ..	9,248
Collimation	294	Nadir point	675
Level	715		

The Sun was observed on 150 days and the Moon on 104 days.

Transits are reduced as far as apparent place to April 28 and Zenith Distances to April 14. Mean places for the Equinox 1925·0 have been determined as far as 1929 December 31 and have been collected on Catalogue forms up to 1928 October 19. The planetary ledgers are completed to 1929 December 31.

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Observations of stars by reflection and directly have been continued by Mr. Cullen and Mr. Acton. Corrections to the Nadir observations given in this way are:—

1928	..	..	..	..	+·07 from 168 observations on 18 nights.
1929	..	..	..	..	+·15 from 171 observations on 15 nights.

The corrections to the longitude of the Sun as given in the *Nautical Almanac* are:—

1922	..	..	..	+1·65	1926	..	..	..	+1·71
1923	..	..	..	+1·54	1927	..	..	..	+1·66
1924	..	..	..	+1·63	1928	..	..	..	+1·68
1925	..	..	..	+1·64	1929	..	..	..	+1·60

Observations of the Moon give the following corrections to the *Nautical Almanac*:—

Longitude.				Latitude.		No. of observations.	
	Limb.	Mösting A.		Limb.	Mösting A.	Limb.	Mösting A.
	"	"		"	"		
1923	..	+ 6·99	+ 7·47	— 0·56	— 0·63	101	60
1924	..	+ 7·21	+ 7·14	— 0·82	— 0·59	87	54
1925	..	+ 6·61	+ 6·71	— 0·87	— 0·75	90	52
1926	..	+ 6·40	+ 6·55	— 0·68	— 0·92	93	66
1927	..	+ 6·20	+ 6·24	— 0·70	— 0·91	80	43
1928	..	+ 5·51	+ 5·88	— 0·93	— 0·66	97	60
1929	..	+ 5·20	+ 5·89	— 0·78	— 0·80	108	67

Observations of the planet Vesta have been continued in view of the possible usefulness of observations of this planet for the determination of Equator point. An ephemeris, based on Leveau's tables, has been computed for 1916 and compared with the observations in that year, thus completing comparison with these tables since ephemerides were first published in the *Nautical Almanac*.

The observation of the zone 32° to 64° of declination will be terminated this year. The 10,460 stars in the catalogue are well observed except about 300 stars in right ascension 14^{h} to 16^{h} .

Beginning in 1931, it is proposed to observe about 6,000 stars between the Equator and declination $+24^{\circ}$. This will include all stars in the Draper catalogue of $7^{\text{m}}\cdot5$ and brighter and in some parts of the zone many fainter stars. Also the zone from 64°

to the North Pole, observed at Greenwich from 1897 to 1905, will be re-observed for all stars brighter than $8^m \cdot 0$.

Cookson Zenith Telescope.—The object glass was dismantled and the lenses cleaned without removing the central lens of the triplet. The telescope was re-focussed by short exposures on the pole star. During the year, 261 plates were taken for latitude variation and 11 for determination of scale. The results for 1929 are published in the *Monthly Notices* for 1930 March.

A new determination of the Constant of Nutation, from the observations with this instrument extending over 19 years, is being made by Dr. Jackson, and is nearly completed. It appears that the correction to the adopted value $9'' \cdot 210$ will be one or two units in the third decimal.

28-inch Equatorial.—The instrument was out of use from 1930 February 6 to March 25 for painting the dome and minor repairs to the shutters and dome.

During the year 505 observations of 300 double stars were made. These consist of :—

56	double stars,	with separation	$< 0'' \cdot 5$.
79	„	„	$0'' \cdot 5$ to $1'' \cdot 0$
109	„	„	$1'' \cdot 0$ to $2'' \cdot 0$
56	„	„	$> 2'' \cdot 0$

The Gerrish drive referred to in the last Report is working very satisfactorily.

Thompson Equatorial.—With the 26-inch refractor 1,508 plates have been taken for stellar parallax and 651 plates have been measured. The number of plates taken has been increased by various time-saving details at the telescope. The measures have been made of all stars, of which a sufficiently complete series of photographs have been obtained. In future there will be more photographs to measure but there will be no difficulty in keeping pace with the observing.

To improve the running of the occulting shutter an electric motor has been substituted for the spring-driven motor. This, with its higher speed, gives an increased number of exposures of the parallax star to be integrated during the normal exposures on the field.

A slight modification has been introduced into the electric clock control. To eliminate the storage batteries and the labour expended in their care and maintenance a metal Rectifier has been installed. The Rectifier converts the alternating current from the mains into a four-volt direct current for operating the magnets in the clock control.

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In 1929 November the parallaxes of 26 stars were published in the *Monthly Notices*.

With the 30-inch Reflector the work on colour temperatures of stars has been continued. As explained in the last Report, effort has been concentrated on the formation of a set of colour standards consisting of 24 early type stars fairly uniformly distributed over the northern sky. This work was completed in September and the results published in the *Monthly Notices*, 1929 November. These standards are now available for the determination of relative colour temperatures and also as a means of determining absolute temperatures by comparison with a terrestrial source.

The determination of the absolute temperature of the system has just been commenced and on a recent night four groups of stars each consisting of a high star, together with two low stars (for the elimination of the constant of atmospheric absorption), have been taken, and an arc lamp, mounted on the roof of the Octagon Room 600 feet away, has been photographed on the same plate. The carbons used will be compared with a gas-filled lamp, which has been calibrated in the laboratory at Utrecht through the kindness of Dr. Minnaert.

To avoid the loss of time at the telescope entailed in the use of the wire grating, a prismatic camera has been constructed in which, by means of slits of widths approximately 1 : 2 : 4, a density scale may be printed on each photograph at a convenient opportunity.

During the year, 95 comparisons of pairs of standard stars were obtained which, with the 295 comparisons secured previously, completes this stage of the work. In addition, 98 comparisons of 29 stars of types B 0 to G 0 with one or more of the standard stars have been obtained, which, with the observations obtained previously, makes 366 observations of 54 stars.

The measurement and reduction of the photographs is practically up to date.

In the *Monthly Notices*, 1929 November, a paper was published giving the Colour Temperatures of 24 standard stars and 19 other stars.

A self-recording micro-photometer, constructed by the Cambridge Instrument Co., has been purchased, but has not yet been brought into use.

Astrographic Equatorial.—The instrument was returned from the Eclipse in Siam and remounted late in July. During the year, 29 photographs of Astrographic fields have been taken and 83 measured for determination of proper motion by comparison with photographs taken 30 years previously. The zone Dec. 72° to 76° is complete except for one plate, and Dec. 76° to 78° from 12^h to 23^h of right ascension. Volume 5 of

the *Astrographic Catalogue* has been published, giving the proper motions of 14,500 stars out of 80,000, between declinations 64° and 72° , whose positions are given in Vol. I of the *Astrographic Catalogue*.

When attempting long-exposure photographs of the Pleiades an irregularity in the drive of the instrument was manifested, which was traced to the upper bearing of the polar axis. Examination showed that the friction roller and the bearing on the polar axis had become worn. The polar axis was despatched to Messrs. Grubb, Parsons & Co., and the following alterations were made, in addition to reconditioning the bearings. New friction roller for polar axis, running in self-aligning ball bearings; new pivot at lower end, turning in self-aligning ball bearings; oil cups were provided for both upper and lower bearings. The instrument was returned to the Observatory and remounted 1930 April 25-28. Preliminary observations show that the alterations made have proved effective.

Heliographic Observations.—Photographs of the Sun were obtained on 270 days with either the Dallmeyer 4-inch photoheliograph or the Thompson 9-inch. The number of photographs selected for preservation is 515, including 30 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.

Eight photographs were taken during the partial eclipse of the Sun on November 1.

H.M. Astronomer at the Cape has reported that the Sun was photographed there on 337 days in the year 1929, and on 88 days in the first three months of 1930. The Director of the Kodaikanal Observatory has reported that plates were taken there on 340 days in the year 1929, and on 87 days during the first three months of 1930.

Photographs have been received from the Royal Observatory, Cape of Good Hope, to 1930 February 27. Photographs have been received and others are in transit from the Kodaikanal Observatory to supplement the series for 1929. ^{These} ~~These~~ photographs are being kindly lent by the Yerkes Observatory to make the year complete.

The measurement of the combined series has been made from 1928 October 25 to 1929 October 10. The reduction of positions and areas of spot groups and their principal components have been completed from 1928 July 9 to 1929 July 10.

Solar activity has on the whole declined, but the period November to January was one of considerable sunspot activity. Large spots, of mean area greater than 1,000 millionths of the Sun's hemisphere, crossed the central meridian on November 30, December 16 and 27.

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Photographic prints of solar negatives for each day from 1928 April 1 to 1928 December 31 have been supplied to the Solar Physics Observatory, Cambridge.

Daily spot-numbers, both for the whole disc and for a central zone of the Sun, based on Wolf's method of counting have been supplied quarterly to Zürich for incorporation in the *Bulletin for Character Figures of Solar Phenomena* published under the auspices of the I.A.U.

An investigation into the recurrence of magnetic storms from Greenwich data, 1874–1927, has been made, and the results communicated to the Royal Astronomical Society.

A Spectroheliograph has been kindly lent by the Mount Wilson Observatory. The instrument was received on October 2 and set up in the South Attic of the new building; observations with it were commenced on November 21. In conformity with Dr. Hale's suggestion a survey of the sun's disc in H α light is made each day, whenever possible, for the purpose of detecting any special disturbances that might be related to the occurrence of magnetic storms. Special attention is given to the measurement of radial velocities of dark markings, and, in particular, those in the neighbourhood of sunspots.

Arrangements were made with the Director of the Science Museum and the Professor of Astrophysics at Cambridge that two complete series of solar photographs should be preserved, one at Greenwich and a second at the Science Museum. A complete series for the years 1914 to 1921 has been forwarded from Greenwich to the Science Museum, and those for later years will be forwarded at convenient opportunity.

III.—Magnetic Observations.

Regular magnetic observations have been made at Abinger throughout the year. The variations of declination, horizontal and vertical force have been recorded photographically. Absolute observations of declination, of horizontal force with the *Schuster-Smith* coil magnetometer, of vertical force with the *Dye* coil magnetometer and of dip with the Earth-Inductor are made every week-day, while observations of horizontal force with the unifilar magnetometer have been taken when possible, for purposes of comparison, on one of the piers in the testing hut. The coil magnetometer for the direct measurement of vertical force, designed by Dr. D. W. Dye, and temporarily lent by the Director of the National Physical Laboratory for use at Abinger, has been of great value. Since 1929 January 1 the records of vertical force have been based upon observations with this instrument, and the measurements both of the horizontal and vertical components of magnetic force are now dependent upon electrical standards.

The Observatory is also indebted to the National Physical Laboratory for periodical re-measurement of the electrical constants of the potentiometers which are essential accessories to the magnetometers. Only very small changes have been found (less than one part in ten thousand) and the effect of these has in general been carried back to the beginning of the year in which the change was measured.

A much smaller range in the base-line values of the magnetograms has resulted from the use of the two coil-magnetometers. The difference in base-line values obtained by the two methods for the horizontal force magnetograms, in the sense unifilar *minus* coil magnetometer, is shown in the table below. The difference changed sign in the middle of 1928, and again suddenly at the beginning of 1930, when a contributory cause may have been the dismounting and partial dismantling of the unifilar instrument.

TABLE OF THE MONTHLY MEAN DIFFERENCE OF HORIZONTAL FORCE BASE-LINE VALUES.

				Unifilar minus Coil-magnetometer.			
				1927.	1928.	1929.	1930.
January	...	...	...	—	+ 1.8γ	— 0.6γ	— 4.2γ
February	...	...	...	+ 1.2γ	+ 5.3	— 3.3	+ 10.0
March	...	...	...	+ 1.3	+ 1.9	0.0	+ 4.0
April	...	...	...	+ 2.7	+ 5.1	— 1.7	+ 5.0
May	...	...	...	+ 4.0	+ 5.5	— 4.3	—
June	...	...	...	+ 5.7	+ 4.7	— 4.8	—
July	...	...	...	+ 4.6	+ 1.3	— 4.1	—
August	...	...	...	+ 4.2	— 1.1	—	—
September	...	...	...	+ 4.7	—	—	—
October	...	...	...	+ 2.2	— 2.2	— 8.0	—
November	...	...	...	+ 1.7	— 5.2	— 8.7	—
December	...	...	...	+ 3.4	— 2.7	— 8.6	—

The differences for each month before 1928 June depend upon about 20 independent comparisons ; after that date upon a rather smaller number, which, however, was in only one case less than four. These differences are of a systematic character and must be attributed to the unifilar magnetometer, although the causes have not been located exactly. This is clearly shown when the base-line values are compared for the discordant period from 1929 November 23 to 1930 March 28 during which period the temperature in the recording room was unchanged. (See next page.)

BASE-LINE VALUES OF HORIZONTAL FORCE GIVEN BY UNIFILAR AND COIL MAGNETO-METER BETWEEN 1929 NOVEMBER 23 AND 1930 MARCH 28.

Unifilar.	Coil.	Diff.	Unifilar.	Coil.	Diff.	Unifilar.	Coil.	Diff.
18593	18604	- 11 γ	18596	18603	- 7 γ	18601	18601	0 γ
598	604	- 6	595	602	- 7	618	601	+ 17
600	604	- 4	600	601	- 1	609	601	+ 8
595	605	- 10	597	602	- 5	603	603	0
594	605	- 11	599	602	- 3	604	602	+ 2
590	603	- 13	601	601	0	607	602	+ 5
592	603	- 11	598	601	- 3	600	601	- 1
596	605	- 9	594	602	- 8	604	600	+ 4
590	600	- 10	612	601	+ 11	601	601	0
592	602	- 10	611	602	+ 9	606	600	+ 6
597	599	- 2	616	601	+ 15	604	602	+ 2
593	604	- 11	606	599	+ 7	615	602	+ 13
594	604	- 10	615	602	+ 13	609	601	+ 8
						607	602	+ 5

In the case of vertical force the systematic difference between results obtained by the old and new methods, mentioned in the last Report, has been traced to a defect inherent in the design of the Dip Inductor. It was found that the difference depended on the degree of freedom accorded to the spinning coil of the inductor in its bearings, and that correct adjustment was a matter both difficult to achieve and to maintain, inasmuch as there was no criterion except freedom to spin without observable looseness. A clearance of one-thousandth of an inch is theoretically capable of producing an error of $+ 0' \cdot 3$ in observed angles of dip (corresponding to 10γ in vertical force), and this error will not be eliminated by any reversal that can be made during observation. The systematic difference can thus be accounted for entirely by the existence of a very small amount of "end-play," either produced by wear or allowed in the original adjustment of the bearings, and it is difficult to see how the introduction of such an error could have been detected, except by an independent and more precise method of measurement such as that provided by the instrument lent by the National Physical Laboratory.

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The following table shows the monthly mean difference between base-line values for the vertical force magnetograms as determined by the two methods, in the sense Inductor *minus* Coil.

	1928.	1929.		1930.	
	(a)	(a)	(b)	(a)	(b)
January	—	+ 29 γ	—	— 6 γ	— 7 γ
February	—	+ 28	—	—	— 10
March	—	+ 31	—	— 2	+ 1
April	—	+ 32	—	+ 5	—
May	—	+ 30	—	+ 7	—
June	—	+ 34	—	—	—
July	—	+ 35	+ 31 γ	—	—
August	+ 33 γ	+ 33	+ 27	—	—
September	+ 36	+ 37	+ 35	—	—
		— 2*			
October	+ 32	0	—	—	—
November	+ 32	— 4	— 7*	—	—
December	+ 33	— 3	— 7	—	—

(a) Abinger Inductor.

(b) Former Greenwich Inductor.

* After adjustment of end-bearings of spinning coil.

As regards the reduction of observations, the mean hourly ordinates of all the traces have been read off to date. The reduction of absolute observations is complete to 1929 December 31, and with provisional constants to the present time.

The tabulation of results for 1929 and the preparation of copy for press are nearly complete.

The mean values of the magnetic elements at Abinger for the year 1929 are given below. The values for 1926 to 1928 are given for comparison.

	Decl. W.	Hor. Force.	Vert. Force.	Dip.
1926	13° 10'·4	0·18581	0·42947	66° 36'·3
1927	12° 58'·4	0·18575	0·42932	66° 36'·2
1928	12° 47'·0	0·18564	0·42941	66° 37'·3
1929	12° 35'·8	0·18555	0·42918†	66° 37'·2†

The weekly report of mean hourly values of declination has been regularly sent to several offices for publication or information—a service taken over from Kew Observatory at the beginning of 1925 and now maintained in conjunction with Eskdalemuir Observatory.

† These results are based upon observations with the Coil-magnetometer.

In connection with the Magnetic Survey of the British Isles by the Ordnance Survey Department, Mr. H. L. P. Jolly visited the Abinger station before the commencement and after the conclusion of his surveying programme in 1929, for the purpose of comparing his instruments with the Abinger standards.

A second portable Coil-magnetometer of the type designed by Dr. F. E. Smith has been tested and a certificate of the determination of its constants issued to the makers.

An inertia cylinder submitted by the Director of Lu-kia-pang Observatory, China, has been standardised by comparison with the Greenwich standard.

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 included in the meteorological observations made by eye at fixed hours.

Registration of the electric potential gradient of the atmosphere with a radium collector and a Kelvin-White quadrant electrometer is now satisfactorily maintained. Experiments toward improvements in standardising the records against absolute measures of potential gradient are in progress.

The following details of the weather refer to the period of twelve months ended 1930 April 30 :—

The mean temperature was $51^{\circ}\cdot 0$, or $1^{\circ}\cdot 5$ above the average of the 75 years 1841–1915. The highest temperature in the shade was $90^{\circ}\cdot 5$ on August 31, and the temperature exceeded 80° on twenty days, including two days on which it also exceeded 90° . The lowest temperature was $25^{\circ}\cdot 4$ on March 20. Temperatures of freezing point or below were recorded on thirty-four days. The mean daily horizontal movement of the air was 289 miles, which is 5 miles above the average for 50 years 1867–1916. The greatest daily movement was 847 miles, recorded on December 7, the least 83 miles, on September 4. The greatest motion in one hour, 62 miles, was recorded on January 12. The greatest pressure reached was 38·0 lbs. to the square foot, on January 12. The duration of bright sunshine recorded was 1,573 hours out of a possible 4,456 or 35·3 per cent. There were 56 entirely sunless days in the period. The total rainfall was 25·43 inches, that is, 1·19 inches greater than the average for 75 years, 1841–1915, and measurable rain fell on 158 days. The wettest month was December, with 4·80 inches, while November had a total of 4·73 inches. The driest month was September with 0·16 inch.

V.—Printing and distribution of Greenwich Publications :—

The volume for 1927 and its separate parts have been distributed and the printing of the volume for 1928 is complete. Vol. V of the Astrographic Catalogue has also been distributed.

VI.—Chronometers :—

The number of chronometers and watches belonging to the Admiralty now at the Observatory is 3,060. Of this total, 252 chronometers, 241 chronometer watches, 253 hack watches and 33 pocket watches are being rated. The remainder, consisting of 340 chronometers, 1,033 chronometer watches, 262 hack watches and 644 pocket watches are kept in storage.

In addition to Admiralty chronometers there are 44 chronometers and 12 watches deposited at the Observatory for various reasons.

During the year ended 1930 April 30, a total of 1,609 chronometers and watches have been received and 1,677 issued. The number sent for repair was 952, viz. : 916 for the Admiralty, 25 for the Indian, and 4 for the New Zealand Governments, 6 for the Royal Air Force, and 1 for Durham University.

During the year 27 chronometers, 37 chronometer watches, 7 hack watches and 5 Waltham chronometers have been sold out of surplus stock.

VII.—Time Service :—

The Time determinations have been made throughout the year by means of the reversible transit instrument "B" fitted with impersonal micrometer. When possible, observations are made at intervals of not more than 5 days. In the year 1929 May 11–1930 May 10, observations have been made on 72 nights.

The Clock Shortt No. 3 was used as Standard Sidereal Clock until July 31. No. 11 was used for the period 1929 August 1 to 1930 March 31, and No. 3 replaced as Standard on April 1. Shortt No. 3 was dismantled in October, overhauled and some refinements made to the mechanism. An invar bob was also fitted in place of the original type-metal bob. This alteration was made for the purpose of testing whether the increasing losing rate found in the clocks could be attributed to "settling" of the pendulum bob which contains a large percentage of lead. With the invar bob, which is considerably heavier than the type-metal bob, it is found that the clock still increases its losing rate, but by an amount which is half the increase shown in a corresponding time, when the type-metal

bob was in use. The progressive increase of losing rate of the Clock No. 11 shows no diminution.

The service of Rhythmic Time Signals at 10^h and 18^h transmitted through the Post Office Wireless station at Rugby, and also the daily time signals to the General Post Office and the British Broadcasting Corporation, have been transmitted regularly. The Free Pendulum Clock, Shortt No. 16, controls the mean time clocks used for the Post Office and Broadcast signals, in addition to the Rhythmic signal transmitter.

The corrections to the transmitted times of the rhythmic signals for adjustment to the final time determinations are published and distributed periodically by the Hydrographer of the Navy in "*Notices to Mariners*."

The Time Ball was not raised on account of high wind on five occasions, viz. : May 6, December 7, 9, 25 and 29.

The performance of the time balls at the Admiralty Signal stations and also the Westminster Clock is shown by the following table of the errors of the return signals.

Error of Return Signal.	Portsmouth.	Portland.	Devonport.	Westminster.
Not greater than 0 ^s .2	176	157	180	83
0 ^s .3 to 0 ^s .5	6	2	9	80
0 ^s .6 to 1 ^s .0	2	2	4	104
Greater than 1 ^s .0	0	0	10	21

The clocks at the Admiralty stations are corrected daily by the 10^h signal, but the Westminster Clock is not so corrected.

Wireless time signals are received regularly from the Eiffel Tower, Nauen, Bordeaux and Annapolis. These are registered automatically, and the corrections found for the Nauen, Bordeaux and Annapolis signals are published monthly for distribution in "*Notices to Mariners*," together with the corrections to the Rugby signals.

The monthly means of the differences from Greenwich shown by the various time signals, using the final clock errors derived from observations made with the small reversible transit instrument "B," are given in the following table. The Annapolis

signals have been corrected for lag of land line to Washington and $0^s.02$ for time of travel.

1929.	Paris $9\frac{1}{2}^h$ Rhythmic.	Nauen 12^h Rhythmic.	Annapolis 17^h .	Bordeaux 20^h Rhythmic.
	s.	s.	s.	s.
January	...	—·061	—·053	—·010
February	...	—·002	—·050	—·025
March	...	+·013	—·016	+·028
April	+·045	+·042	—·020	+·021
May	+·070	—·028	+·046	+·075
June	+·082	+·038	+·049	+·086
July	+·059	+·035	+·055	+·071
August	+·020	+·031	+·034	+·033
September	+·054	+·025	+·045	+·057
October	+·054	+·047	+·022	+·059
November	—·020	—·038	—·008	—·007
December	+·031	—·038	+·016	+·038
Mean	+·044	+·006	+·007	+·035
Number of comparisons ...	208	289	301	341

The sign + means late on Greenwich. The reference point for all comparisons is the commencement of the signals. The Nauen times have been referred to the Eichelberger system of star places.

VIII.—Personal Establishment :—

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

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

Assistants.—Mr. Bowyer, Mr. Davidson, Mr. Furner, Mr. Witchell.

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

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

Clerical Assistant.—Mr. Edney.

21 Computers, including 5 ladies, are employed at the Observatory.

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

Branch.	Established Staff.	Unestablished Staff.
<i>Transit Circle, Altazimuth and Zenith Telescope.</i>	Mr. Furner, Mr. Cullen, Mr. Acton, Mr. Symms.	Mr. Slator, Mr. Blackwell, Mr. Malyon, Mr. Diston, Mr. Larkin, Mr. Grimwood, Mr. Stockwell, Mr. Deeks.
<i>Time Signals and Chronometers</i> ...	Mr. Bowyer, Mr. Rickett ...	Mr. Harris, Mr. Shortland, Mr. Rudd.
<i>Thompson Equatorial</i> ...	Mr. Davidson, Mr. Martin ...	Miss Jeffries, Miss French.
<i>28-inch Equatorial</i> ...	Mr. Furner ...	
<i>Astrographic Equatorial</i> ...	Mr. Melotte, Mr. Jeffries ...	Miss Bonnett, Miss Cumberledge.
<i>Photoheliograph</i> ...	Mr. Newton, Mr. Barton ...	Mr. Whybrow, Mr. Howes.
<i>Small Transit</i> ...	Mr. Finch ...	
<i>Magnetic and Meteorological</i> ...	Mr. Witchell, Mr. Stevens, Mr. Wells, Mr. Rickerby.	Miss Clack, Mr. Reece, Mr. Harrild.
<i>Secretariat and Library</i> ...	Mr. Edney, Mr. Chamberlain ...	Mr. Dennis.

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 :—

In connection with the Gravity Survey of the Geodetic School of the University of Cambridge, half-seconds pendulums were swung at the Observatory by Mr. Jolly, of the Ordnance Survey, and Lieut. Willis, of the Geographical Section of the War Office, early in March.

During the year several gentlemen have been at Greenwich studying various details of astronomical work. These include Dr. Carl Schalen, of Upsala, in June and July, who was interested in parallax determinations ; Mr. Kasz, of the University of Manchester, in July and August ; and Mr. Smiley, of the Berkeley University, during the winter. Lieut.-Com. Milne-Henderson, of the Royal Indian Marine, had a short course in Magnetic observation at Abinger.

TO THE BOARD OF VISITORS, 1930 JUNE 7.

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The new programme for the transit circle, consisting of stars to magnitude $7^m.5$ from the equator to Dec. $+24^\circ$, will complete a fairly comprehensive series of observations for the northern hemisphere, made at Greenwich during the present century. Stars from 64° to the pole as far as $9^m.0$ are given in the catalogue for 1900: those from $+24^\circ$ to $+32^\circ$ to $9^m.0$ in that for 1910; those from $+32^\circ$ to $+64^\circ$ to $8^m.0$ in the series of observations nearly completed. A sufficient interval of time has passed to warrant the re-observation of the stars from $+64^\circ$ to the pole. The use of wide-angle lenses has made it unnecessary to observe faint stars except where required as reference stars, but it seems desirable to continue meridian observations of all stars brighter than $7^m.5$.

Through the kind offices of Mr. Hale, a Spectroheliometer has been lent to the Royal Observatory by the Mount Wilson Observatory. This will be of much value in the Solar work as it furnishes an opportunity for examining in detail the movements of spots, flocculi and prominences. It is proposed to make an inspection of the Sun's disc each fine morning. The observations are at present in a tentative stage, but we shall be glad to join in a co-operative programme of work.

Attention may be drawn to the Magnetic work at Abinger, where the zeal of the small resident staff has overcome difficulties in the use of the instruments and in the upkeep of the machinery. The coil magnetometers for the horizontal and vertical components of the Earth's magnetism, kindly lent by the National Physical Laboratory, give these elements with great precision. The comparison, given in the magnetic section of the report, between the results obtained by these and by the older methods is conclusive proof of their superiority.

F. W. DYSON.

ROYAL OBSERVATORY, GREENWICH.

1930 May 26.