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REPORT

OF THE

ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS

OF THE

ROYAL OBSERVATORY, GREENWICH.

Read at the Annual Visitation of the Royal Observatory, 1918 *June* 1.

GREENWICH OBSERVATIONS, 1917.

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THE BOARD OF VISITORS.

The President of the Royal Society - -	Sir J. J. Thomson.
The President of the Royal Astronomical Society	Major P. A. MacMahon.
Nominated as Fellows of the Royal Society -	Prof. A. Fowler. Mr. J. H. Jeans. Prof. Sir J. Larmor. Sir Napier Shaw. Lord Rayleigh. Prof. A. Schuster.
Nominated as Fellows of the Royal Astronomical Society.	Capt. Sir W. de W. Abney. Sir W. H. M. Christie. Dr. J. W. L. Glaisher. Col. E. H. Hills. Mr. E. B. Knobel. Prof. H. F. Newall.
Savilian Professor of Astronomy at Oxford -	Prof. H. H. Turner.
Plumian Professor of Astronomy at Cambridge -	Prof. A. S. Eddington.
Hydrographer of the Navy - - - -	Rear-Admiral John F. Parry.
Secretary - - - - - - - - -	Mr. W. D. Barber.

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ROYAL OBSERVATORY, GREENWICH.

Read at the Annual Visitation of the Royal Observatory, 1918 *June* 1.

The Report here presented refers to the year from 1917 May 11 to 1918 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 domes of the 28-inch and Thompson Equatorials was carried out in the summer of 1917. At my request the Civil Engineer kindly made a thorough survey of the state of repair of these domes. He reported that, broadly speaking, they were both found to be in an excellent state of preservation, which is undoubtedly attributable to their frequent painting. Several small repairs have been made to these domes, the Astrographic dome, and that of the longitude pavilion.

A commencement has been made towards the demolition of the Magnet-House, a wooden building erected in 1838 and now superseded by the buildings in the Magnetic Enclosure. The fittings have been made use of elsewhere in the Observatory, and parts of the building are being used in the construction of a small wooden hut now being erected in the Magnetic Enclosure. This hut will house the Electrometer, the only instrument which had not been already transferred from the Magnet House.

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The principal movable instruments are thus distributed:—

At Greenwich—

Transits B, C, D, and E. (Object glasses of D and E on loan—*see* below.)

Altazimuths D and E.

Equatorials (6-inch).—Cooke No. 2, Simms No. 1, Lee, Hodgson, and Corbett. (The telescopes of the two last-named are mounted respectively on the Thompson and 28-inch Equatorials.)

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

Detached Telescopes (on tripod stands).—Two 4-inch (Simms Nos. 1 and 2), two 4-inch (R.O. Nos. 1, mounted as finder on Thompson Equatorial, and 2), one $3\frac{1}{2}$-inch (R.O. No. 3).

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.

Object glasses of Sheepshanks' Equatorial, of Transits D and E, and a Dallmeyer 4-inch Rapid Rectilinear lens on loan to the Inspection Department, Woolwich Arsenal.

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. At the Cape Observatory with the exception of the parts mentioned above.

No. 4. Complete at Kodaikanal Observatory.

No. 5. Object glass on loan to Professor Newall, Cambridge.

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Clocks.—Dent No. 1916 and Dent No. 2013, at the Cape Observatory; Dent No. 2011, at the Kew Observatory; Arnold 2, at the University Observatory, Oxford.

Anemometer.—Whewell's Anemometer, formerly mounted above the roof of the Octagon Room of the Royal Observatory, lent for exhibition at the Victoria and Albert Museum, South Kensington.

On loan to the Royal Observatory—

The Cookson Floating Zenith Telescope from the Cambridge Observatory for a period of seven years from July 1911.

Two 16-inch cœlostats and a 12-inch cœlostat from the Royal Astronomical Society for use at the total eclipse of the Sun, 1914 August. (At present in Russia, at Pulkovo Observatory.)

A Quartz spectroscope from Prof. H. F. Newall, Cambridge, for the same eclipse. (At present in Russia, at Pulkovo Observatory.)

A Watson Quartz Fibre Vertical Force Magnetograph from the Meteorological Office.

An Adie-type Vertical Force Magnetograph from Professor Watson, Imperial College of Science and Technology.

The annual examination of the Library has been made as usual, the books on the shelves being compared with the catalogue. Twenty-six books are reported missing from the shelves and cannot be accounted for at present, including fourteen books reported missing last year. Eleven of the books reported missing last year have been returned.

II.—Astronomical Observations :—

Transit Circle.—The Sun, Moon, planets, and fundamental stars have been regularly observed on the meridian as in previous years. Other stars observed are taken from the list prepared by Dr. Backlund and Mr. Hough, but owing to the depletion of the staff this work has only been carried on to a very limited extent.

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

Transits	3,980	Circle observations	3,326
Collimation	231	Nadir point	484
Level	530	Reflection observations	98

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The Sun was observed on 165 days and the Moon on 108 days.

The observations are completely reduced to the end of 1917.

No discussion has been made of the reflection observations, the correction to the colatitude, or the position of the Ecliptic.

The planetary ledgers for 1915 and 1916 have been completed.

Advantage is being taken of the delay in the printing of the Greenwich catalogue of 12,000 stars for 1910 to insert the type of Spectrum as well as the magnitude of the star on the Harvard scale. This has been made possible by the kindness of Prof. Pickering, who is supplying, partly in manuscript and partly in early proofs, the results of Miss Cannon's Survey at Harvard College.

Discussions of some points connected with the proper motions of the stars in this catalogue have been communicated to the Royal Astronomical Society, and others are in progress.

Altazimuth.—This instrument has been used to supplement the observations of the Moon made with the transit circle. Meridian observations have been made on 20 nights and extra-meridian observations on 26 nights.

In the year ended 1917 Dec. 31, the Moon was observed with one or other of the two instruments on 125 nights. The mean correction in right ascension required by the *Nautical Almanac* is $+0^{s}\cdot94$, and by the *Connaissance des Temps* (depending on Delaunay's tables as revised by Radau and Andoyer) is $+0^{s}\cdot28$. The following table gives the mean tabular error of the Moon's longitude for each year since 1883, when Newcomb's Empirical Correction to Hansen's tables was introduced into the *Nautical Almanac*:—

1883	-	$-0''\cdot03$	1892	-	$+0''\cdot79$	1901	-	$-2''\cdot77$	1910	-	$-7''\cdot85$
84	-	$-0\cdot16$	93	-	$-0\cdot06$	2	-	$-3\cdot15$	11	-	$-8\cdot34$
85	-	$-0\cdot09$	94	-	$-1\cdot20$	3	-	$-3\cdot08$	12	-	$-9\cdot79$
86	-	$-0\cdot11$	95	-	$-1\cdot47$	4	-	$-3\cdot16$			
87	-	$+0\cdot21$	96	-	$-1\cdot68$	5	-	$-5\cdot29$	13	-	$-11\cdot93$
88	-	$+0\cdot76$	97	-	$-2\cdot77$	6	-	$-5\cdot91$	14	-	$-12\cdot86$
89	-	$-0\cdot38$	98	-	$-3\cdot03$	7	-	$-5\cdot96$	15	-	$-12\cdot58$
90	-	$-0\cdot27$	99	-	$-2\cdot18$	8	-	$-5\cdot97$	16	-	$-14\cdot05$
91	-	$+0\cdot72$	1900	-	$-2\cdot69$	9	-	$-6\cdot41$	17	-	$-14\cdot0$

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Cookson Floating Zenith-Telescope.—During the year 202 photographs have been taken, 201 for latitude groups and 1 for scale determination. The measurement of the photographs to the end of 1917 is completed, and the results for the variation of latitude at Greenwich for 1917 were communicated to the Royal Astronomical Society and published in the *Monthly Notices* for March 1918.

The Syndicate of the Cambridge University Observatory have kindly renewed the loan of this instrument for a further period of seven years. The possible advantage of moving the instrument to another site in the Observatory grounds has been carefully considered, but it is thought better to continue the observations on the present site in order to avoid a discontinuity in the series.

Equatorial Observations.—During the year ended 1918 May 10, 8 disappearances and 3 reappearances of stars occulted by the Moon have been observed. Encke's comet was observed on 3 nights.

The 28-inch Refractor.—The instrument has been throughout the year at the disposition of M. Jonckheere. His programme of work has consisted of the remeasurement of stars in Burnham's General Catalogue which he had previously observed at Lille and the remeasurement of some double stars in his own catalogue in Vol. LXI. of the *Memoirs of the Royal Astronomical Society.* From the first of these catalogues 155 stars have been observed and 151 from the second. Of these 306 stars 164 have a separation of less than 2″. Sirius was measured on 13 nights and 18 measures were obtained of Neptune's Satellite. Encke's Comet was followed to within 12 days of perihelion passage. Search was made for the Comets of Tempel and Wolf.

Thompson Equatorial.—Work with this instrument has been largely discontinued. Second exposures were given on 10 plates for parallax determination. Five photographs of Jupiter's Satellites were taken in September for Dr. de Sitter. The 30-inch mirror was re-silvered in October and 13 plates exposed for the faint Satellites of Jupiter. The eighth Satellite was successfully photographed on five nights, and on one of these nights the sixth Satellite was also obtained. In addition 7 photographs were taken of the Pleiades, the Great Nebula in Orion and on Wolf's planet 1918 D.B.

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Astrographic Equatorial.—During the year 34 plates have been taken on 13 nights for the determination of proper motion by comparison with earlier plates. Seventy-eight fields have been compared in the duplex micrometer; 29 fields still require measurement to complete the Zone 65°·0 to 81°·0. The results of these comparisons have been discussed together with all available meridian observations to give the proper motions of the stars in Vol. III. of the Astrographic Catalogue. In addition, 12 pairs of plates have been sent to Mr. Innes for examination with a Blink Microscope.

Heliographic Observations.—In the year ended 1918 May 10, photographs of the Sun were obtained on 209 days. Of these 409 have been selected for preservation, including 13 with double images of the Sun for the determination of the Zero of position angle.

The transmission to England of the solar photographs taken at the Royal Observatory, Cape of Good Hope, has been suspended for the present; the last originals received here being those for 1917 February, and the last duplicates those for the month previous. Similarly, no application has been yet made for photographs taken at the Indian observatories of Kodaikanal and Dehra Dûn to fill up gaps in the combined Greenwich-Cape record. The days in 1917 left without representation in the combined record are only 9 in number, and for 8 of these days photographs taken at Kodaikanal are available; the only date in 1917 still without a photograph being 1917 March 12.

H.M. Astronomer at the Cape has reported that the Sun was successfully photographed there on 333 days in the year 1917, and on every day in 1918 January. The Director of the Kodaikanal Observatory has reported that the regular series of photographs of the Sun was recommenced there 1917 April 1, and that plates were taken on 248 days out of the 275 of the nine remaining months of the year.

The measurement of the photographs for 1916 is now complete, and the reductions of the areas of the spot-groups, and of the heliographic positions of the estimated centres of the spot-groups—the measures of the individual spots of the groups being reserved for future treatment if desired,—have been carried out to 1916 November 14. The groups have been numbered, and the notes upon them written, and the copy for press of the Spot-Ledger has been prepared to the same point.

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The publication, or preparation for publication, of the results for the four years 1914 to 1917 stands now as follows:—

1914:—The complete Photo-Heliographic Results have been printed during the past year.

1915:—As mentioned in last year's Report, the copy for press of the Daily Photo-Heliographic Results was then ready for the printer. It is proposed, however, to hold back this section from publication, at any rate for the present. But, as mentioned above, the Spot-Ledger has now been computed, and the copy for press prepared. It is proposed to print this at the first opportunity, and with it the small Sections, which have usually followed it in the complete Results, as soon as these can be computed.

1916:—The same plan of publication is proposed for this year also. The Spot-Ledger, now nearly complete, will be published when ready, and followed by the usual small subordinate Sections; but the Daily Results will be held in reserve until an opportunity is afforded of reducing the measures,—which have been completely made,—of the individual components of the spot-groups.

1917:—The measures for this year are only complete to January 8, and the complete daily series of photographs is, at present, only available for measurement up to 1917 February 28. It is proposed, therefore, so long as only the Greenwich photographs are at hand, to select certain of these for measurement and reduction, in order to secure a rough indication of the amount of the solar activity and its distribution over the surface.

During the whole of the period covered by this report, the spot-activity has been considerable, but it reached a remarkable development during 1917 August, the mean daily spotted area during the second week of that month being the highest as yet registered in the Greenwich photographic record. No disturbance comparable with this has occurred since, but considerable secondary maxima, with total spotted areas of over 1,000 millionths of the Sun's visible Hemisphere, were observed in 1917 September and December, and in 1918 February and March.

III.—Magnetic Observations:—

The variations of magnetic declination, north force and vertical force have been registered photographically. Absolute observations of declination are made five or six times a week, of horizontal force twice a week, and of dip three times a week. The absolute observations and the photographic records are made in the two buildings in the Magnetic Enclosure.

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The thermostat in the Magnetograph room has not worked so well as last year. It has kept the diurnal change of temperature satisfactorily small, but the control temperature has fallen 4° Centigrade during the year.

The mean hourly ordinates of the declination, north force and vertical force registers are read off to the end of April 1918, and partly reduced.

The absolute observations are all reduced. The mean values of the magnetic elements for 1917 and three previous years are as follows:—

	Dec. W.	Hor. Force.	Vert. Force.	Dip.
	° ′			° ′
1914 - -	15 6·3	0·18518	0·43317	66 51·2
1915 - -	14 56·5	·18508	·43315	51·8
1916 - -	46·9	·18494	·43313	52·7
1917 - -	37·0	·18477	·43305	53·6

The annual diminution of declination increased considerably about 1910, its average value from 1900 to 1910 being 4′·9. The horizontal force, which had been increasing since measurements were begun at Greenwich in 1846, reached a maximum about 1910 and is now diminishing. The dip, which has been diminishing since measurements were begun in 1843, reached a minimum about 1913, and is now increasing.

There were no days of great magnetic disturbance in 1917, but four were classified as of lesser disturbance. Traces of the photographic curves for these days will be published in the annual volume.

IV.—Meteorological Observations:—

The registration of atmospheric pressure, temperature of the air and of evaporation, pressure and velocity of the wind, rainfall, sunshine, and atmospheric electricity has been continuously maintained.

Arrangements have been made for the transfer from the Magnet House of the Electrometer, the only instrument not already removed. Dr. G. A. Carse has rendered valuable assistance with regard to this instrument. To facilitate the installation in the Magnetic Enclosure it has been decided to substitute a radium collector for the water-dropping apparatus. Satisfactory results were obtained in some preliminary experiments with a radium collector kindly lent by Mr. F. H. Glew.

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The observations of barometer, thermometers, anemometers, rain-gauges, and sunshine recorder are entered and reduced to date. On the photographic sheets the hourly ordinates are read off and reduced to the end of April 1918.

The diurnal barometric variations at Greenwich during the period 1874–1917 have been subjected to harmonic analysis. This is a continuation of the analysis for 1854–1873 published by direction of the Meteorological Council in 1891. A new investigation of the lunar diurnal barometric variation at Greenwich is nearing completion.

The following details of the weather refer to the year ended 1918 April 30. The mean temperature was 50°·0 or 0°·4 above the average of the 75 years 1841–1915. The highest temperature in the shade was 93°·2 on June 17, and the temperature exceeded 80° on 15 days. The lowest temperature was 17°·2 on December 19, and on 53 days fell as low as 32°·0.

The mean daily horizontal movement of the air was 298 miles, which is 14 miles above the average of the previous 50 years. The greatest daily movement, 767 miles, was recorded on November 24, and the least, 47 miles, on December 20. The greatest recorded pressure on the square foot was 18·8 lbs. on October 25; the greatest velocity in one hour, 46 miles, was registered on the same day.

The duration of bright sunshine registered by the Campbell-Stokes instrument was 1,668 hours out of a possible 4,456 hours, or 36·1 per cent. January provided more and April less than any corresponding month since the present instrument was set up in 1897.

The rainfall was 28·06 inches, or 3·82 inches above the average for the period 1841–1915. The number of rainy days (0·005 inch or over) was 156. March with 0·97 inch was the driest, and August with 4·56 inches the wettest month.

V.—Printing and Distribution of Greenwich Publications:—

The Greenwich Observations for 1914 were in the press in 1916, but the type and printed sheets were all destroyed in a fire at the printers. The reprinting was commenced in June, 1917, and has just been completed. The Clock Star List and Report to the Board of Visitors were also printed as usual.

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VI.—Chronometers :—

The number of chronometers and watches belonging to the Admiralty now at the Observatory is 558, viz., 206 box chronometers, 83 chronometer watches, 144 hack watches, and 125 pocket watches. One box chronometer is also being tested for the Indian Government. In addition there are 40 chronometers and watches being rated or under examination, of which 10 are on loan to the Admiralty.

There are also 12 chronometers, 17 chronometer watches, and 15 hack watches belonging to various makers, now at the Observatory on trial for purchase by the Admiralty, and 2 chronometers for the Indian Government.

During the year ended 1918, May 10, 6,856 chronometers and watches have been received and 6,580 issued. The number sent for repair was 2,913, including 9 box chronometers and 1 watch belonging to the Indian Government.

Purchases of chronometers and watches have been made after severe trial in temperature and position. Altogether 152 chronometers have been tested, and of these 110 were purchased for the Navy. 375 chronometer watches have been tested, and 265 have been purchased. Further, 101 large-size lever watches mounted in gymbals have been tested, of which 78 have been purchased and the remainder are still under trial. 504 hack watches have been tested during the year, of which 323 have been purchased. 280 watches of a cheaper make, known as pocket watches, have also been purchased.

VII.—Time Service :—

Daily time signals have been sent to the General Post Office without failures. The signals from the Eiffel Tower have been received regularly, and a comparison with the Greenwich Clock sent daily to Paris.

The Sidereal Standard Clock was overhauled between July 23 and November 6, the Clock Dent II. being used as standard for this period.

On 7 occasions—August 28, September 29, October 7, October 25, February 9, February 28 and March 1—the Greenwich Time-Ball was not raised on account of the violence of the wind. The renewal of the Time-Ball previously referred to is again necessarily deferred.

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The Time-ball at Deal, which is released by the 13^h signal from Greenwich, failed to drop accurately on eight occasions, and could not be raised on one day owing to wind.

The performance of the Time-balls at the Admiralty Signal Stations and of the Westminster Clock is shown by the following table of the errors of the return-signals received at Greenwich:—

Error of Return Signal.	Portsmouth.	Portland.	Devonport.	Westminster.
Not greater than $0^s \cdot 2$ - - - - - -	286	256	299	53
Between $0^s \cdot 2$ and $0^s \cdot 5$ - - - - -	8	31	11	68
„ $0^s \cdot 5$ „ $1^s \cdot 0$ - - - - -	4	5	2	109
Greater than $1^s \cdot 0$ - - - - - -	1	0	0	49

On the 279 days of observation the error of the Westminster Clock never exceeded $3^s \cdot 0$. The clocks at Portsmouth, Portland and Devonport are corrected daily by the 10^h signal; the Westminster Clock is not corrected daily.

VIII.—Personal Establishment:—

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

Chief Assistants.—Mr. Jackson, Mr. Jones.

Assistants.—Mr. Bryant, Mr. Crommelin, Mr. Hollis, Mr. Maunder, Mr. Thackeray, Mr. Bowyer (acting).

Clerical Assistant.—Mr. Outhwaite.

Junior Assistants (Higher Grade).—Mr. Davidson, Mr. Edney.

Junior Assistants.—Mr. Acton, Mr. Burkett, Mr. Cullen, Mr. Furner, Mr. Jeffries, Mr. Melotte, Mr. Newton, Mr. Stevens, Mr. Witchell.

Dr. S. Chapman has continued to act as honorary Chief Assistant.

Mr. Jones has been lent from 1916 January 3 to the Optical Branch of the Inspection Department of the Woolwich Arsenal.

Mr. Jackson left on 1917 December 29 to take a commission in the Sound Ranging Section of the Royal Engineers.

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Mr. Lewis retired on 1917 September 30. Since 1882 he had had charge of the Time and Chronometer Department, and carried out his responsible duties with great efficiency. He also had charge of the 28-inch equatorial since its erection, and made important contributions to the study of double stars.

Mr. Bowyer was appointed Acting Assistant in charge of the Time and Chronometer Department on Mr. Lewis' retirement.

Mr. Edney was promoted to the Higher Grade of the Junior Assistants on October 1 on his return from the Hydrographic Office of the Admiralty, to which he had been lent from 1915 June 2.

Mr. Acton was lent to the Hydrographic Office for a short period from 1917 September 25 to 1918 January 10.

Mrs. Maunder has continued throughout the year to give voluntary assistance in the Solar Department.

M. Jonckheere, Director of the Lille Observatory, has continued throughout the year engaged in double-star work.

There are at the present time one lady Computer assisting Mr. Outhwaite and Mr. Bryant, and five boys employed in the Chronometer and Meteorological departments.

Of the 26 Computers who were employed at the Observatory at the outbreak of the war, Mr. Kilby died in hospital at Salonica; 19 are on Military Service, their places being kept open, and are receiving their salaries less military pay and allowances. The remaining six have resigned.

The staff of workmen now employed at the Observatory consists of a foreman of works with a joiner and a labourer, a foreman mechanic with a boy assistant, a gate-porter, a messenger, a night-watchman, a gardener, a labourer, and two charwomen.

Mr. Niblett, foreman mechanic, retired on account of age and failing health on 1917 November 10, after 34 years' valuable service at the Observatory. His place was taken by Mr. Woodman, who returned from the Woolwich Arsenal, where he had been temporarily employed in the Inspection Department. One joiner and one labourer are absent on naval service. Their places are being kept open and they are receiving their wages, less military pay and allowances. The gate-porter,

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night-watchman and one messenger are naval reservists. The places of the gate-porter and night-watchman have been temporarily filled.

The following list gives the members of the Observatory Staff who are serving in the Army or Navy with, as far as is known, the unit to which they are attached :—

Chief Assistant.

Mr. Jackson	Second Lieutenant, Sound Ranging Section, R.E.

Junior Assistants.

Mr. Burkett	Staff Captain, 74th Division.
Mr. Cullen	Ordnance Survey Section, R.E.
Mr. Melotte	„ „
Mr. Jeffries	Meteorological Section, R.E.
Mr. Newton	„ „

Computers.

Mr. Baldwin	Royal Field Artillery.
Mr. Barton	„ „ , 238th Brigade.
Mr. Berry	London Rifle Brigade.
Mr. Chamberlain	Royal Field Artillery, 47th Brigade.
Mr. Cogswell	Lieutenant, Royal Air Force.
Mr. Davies	Royal Field Artillery.
Mr. Davis	„ „ , 238th Brigade.
Mr. Divers	Army Service Corps.
Mr. Howick	Boy mechanic, Wireless Telegraphy, R.A.F.
Mr. Lambert	Royal Field Artillery.
Mr. Martin	Meteorological Section, R.E.
Mr. Percival	Royal Field Artillery.
Mr. Perry	Army Service Corps.
Mr. Sharpe	Hon. Artillery Company.
Mr. Showell	Durham Light Infantry.
Mr. Sims	Royal Field Artillery, 62nd Brigade.
Mr. Symms	„ „ , 238th Brigade.
Mr. Vaizey	London Rifle Brigade.
Mr. Whitaker	Royal Field Artillery, 238th Brigade.
Mr. White	„ „ „ „

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Messenger Staff and Workmen.

Holbrook (Gate Porter) - - - -	Royal Navy.
Weston, D. R. (Night Watchman) - -	Royal Marines.
Weston, D. (Messenger) - - - -	Royal Navy.
Wescott (Joiner) - - - - -	Royal Naval Air Service.
Franklin (Labourer) - - - -	Royal Navy.

F. W. DYSON.

Royal Observatory, Greenwich,
1918 May 22.

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