

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

Read at the Annual Visitation of the Royal Greenwich Observatory, 1955 June 4.

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The Report here presented refers to the period from 1954 May 1 to 1955 March 31 and exhibits the state of the Observatory on the last named day.

I. GROUNDS AND BUILDINGS.

(a) Greenwich. The downpipes of the New Building, which were damaged in the war, have now been replaced, but there is still some roof damage that has been only provisionally repaired. The hot air furnaces have again been overhauled. Owing to the shortage of rough storage space which followed from the surrender of the Lower Store to the Ministry of Works, it has been found necessary to repair and use some of the old "stable" sheds. Some of the upper floor rooms, which are no longer required, have been temporarily lent to the Maritime Museum for storage of figure-heads and other "Cutty Sark" exhibits. In the old buildings, interior decorations have been carried out in the chart-room, landing, and astrographic dome and staircase.

A further quantity of library shelving was removed from Greenwich and erected in a temporary hut at Herstmonceux, for record storage.

(b) Abinger. The Admiralty Civilian Hostel at Feldemore, Holmbury St. Mary, which in the past nine years has provided accommodation for many of the staff employed at Abinger, was closed on February 13. Some of the rooms which have been set free are in temporary use as a flat: the remaining rooms will be used for stores and other official purposes.

The instruments and equipment of the Physics and Optics Laboratory are in course of transfer to Herstmonceux. The accommodation set free will be used jointly by the Electronics Laboratory and the Maintenance and Installation Section of the Time Department.

(c) Herstmonceux. In connexion with the maintenance of the external fabric of the Castle by the Ministry of Works, repairs have been in progress to the west tower of the south gateway and are now nearing completion. Portions of the stonework, which were badly weathered, have been rebuilt; the upper portion of the tower, which was in a not very safe condition, was dismantled and has been rebuilt.

In the Meridian Group of buildings, the painting of the Cooke Reversible Transit Circle building was completed and the entrance steps were provided. The small pavilion to house the Bamberg Small Transit and the pavilion for the Photo-graphic Zenith Tube have been erected. A few modifications to the latter building

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are required before final acceptance. It has been decided to erect a new pavilion for the Melbourne Reversible Transit Circle, generally similar in design and dimensions to the Cooke R.T.C. pavilion and with similar foundations, deeply piled for stability, for the instrument and collimators. The earlier proposal, to modify the existing Cooke R.T.C. pavilion at Greenwich and to transfer it to Herstmonceux, has been dropped.

Considerable progress has been made with the construction of the Equatorial Group. The steel frameworks of three of the six domes - those of the 30-inch reflector, the Schmidt reflector, and the 26-inch refractor - have been erected, but the cladding of these domes has been seriously delayed by the designs of the mechanisms for operating the dome shutters not having been completed. It is planned to commence the erection of the telescopes in this group as soon as the domes have been completed.

The base casting of the 26-inch refractor was lifted on to the concrete pier on November 26, when it was found that the pier was slightly too small. It will be possible for the casting to be rolled off on to a staging and the pier sufficiently modified before the erection of the telescope is commenced. The main north and south castings of the 28-inch refractor were placed in the dome on February 28, but will not be erected and grouted in until a later stage.

The foundations for the West Building, which will house the Nautical Almanac Office, the Time Department and the workshops and which will also provide miscellaneous storage accommodation, have been commenced and are in an advanced stage of construction. The erection of the steel framework of this building has been commenced.

(d) Hartland. The site at Hartland, N. Devon, selected as the future site for the Magnetic Observatory, which is to be transferred from Aginger because of the disturbing effects of the electrified railway system in its vicinity, has been purchased. Detailed drawings of the buildings to be erected there have been prepared by the Civil Engineer-in-Chief. The building is expected to be commenced shortly to ensure its completion in time for observations to be commenced before the beginning of the International Geophysical Year. Samples of the building materials to be used are being tested at Abinger to ensure that the materials are completely non-magnetic.

One of the buildings to be used for the testing of magnetic instruments will contain a system of large coils designed to provide artificial horizontal and vertical fields, comparable with those at any point upon the surface of the Earth. Details of this system have been discussed but it has been decided that, until the engineering problems have been settled, one end of the building designed to house these coils will be left temporarily open to ensure the necessary access for the castings.

II. INSTRUMENTS, APPARATUS, AND LIBRARY.

The following instruments are on loan to the Royal Observatory:-

A 13-foot spectrohelioscope, 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 16-inch coelostat, from the Royal Astronomical Society.

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A position micrometer for measuring solar photographs, from the Solar Physics Observatory, Cambridge.

A Schuster-Smith coil magnetometer for measurement of horizontal intensity, from the National Physical Laboratory.

A coil magnetometer designed by the late Dr. D. W. Dye, F.R.S., for measurement of vertical intensity, from the National Physical Laboratory.

Three potentiometers, with standard cells and resistances for measuring current supplied to the coil magnetometers, from the National Physical Laboratory.

A small transit instrument, of the broken type, with stand, by Bamberg, from the Royal Observatory, Edinburgh.

A 30° prism from the Royal Society.

Two 35-mm. cinema cameras, from the Admiralty Research 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:-

Clocks, Dent 1916 and Dent 2013.

To the Imperial College of Science and Technology:-

6-inch equatorial, Sinms No.2.

To the Cavendish Laboratory, Cambridge:-

Shortt clock No.16, with slave.

To the National Maritime Museum:-

Harrison's Time Machines, Nos.1,2,3 and 4 and the copy of No.4 by Larcum Kendall.

To the Science Museum:-

A number of astronomical instruments of historical interest.

To the Cambridge University Observatory:-

A comparison image micrometer.

To Messrs. Kelvin & Hughes Ltd.:-

An equatorial mounting with adjustable head.

The Cookson Floating Zenith Telescope, which has been on loan from the Cambridge Observatory since 1911, was dismantled preparatory to its return. This has been delayed, however, pending a decision as to its ultimate disposal, by Cambridge, who have now decided to present it to the Science Museum.

Airy Transit Circle.

The observations with the Airy Transit Circle having been discontinued, the instrument has been handed over to the care of the National Maritime Museum. It remains in its original position, defining the prime meridian of longitude, and is

available for the public to view, along with other historic instruments formerly in use at Greenwich, and also Flamsteed's original observatory in the Wren building of 1675.

The mechanism of sidereal clock Hardy, which had been the Airy T.C. pavilion clock for many years, was removed and taken to store. It was found that the case consisted of the front only; the clock will be overhauled and given a new case, at a suitable opportunity.

Cooke Transit Circle.

All of the more massive parts have been placed in position in the new pavilion. The collimator- and azimuth-mark lens brackets will not be grouted into position until stellar observations have defined the true meridian. The choice of the final positions for the azimuth marks will also await stellar observations and the delivery of the long-focus lenses.

The concentration of the available man-power of the Meridian Department on overtaking arrears of reductions has delayed completion of the installation of the instrument in its new housing.

A great deal of adaptation and modifications were required to the circle-reading cameras. The apparatus for simultaneously advancing the films in the two batteries of seven cameras from accessible central control points has been designed and constructed in the workshop. The cameras should be installed on the instrument piers in the near future, ready for adjustment and testing.

A machine is being designed for the rapid measurement of the films from the circle-reading cameras. Settings will be made relative to a fiducial wire by moving the film, and these small movements will be magnified mechanically by a lever. The magnified movements will be measured by photoelectric counting of Moiré fringes. The images of the circle divisions and of the fiducial wires will be viewed by a projection method. It is expected that the strain on the measurer involved in making accurate settings will be less by this method than with a more conventional type of screw machine and microscope. With a full observing programme approximately 200 frames per day will need to be measured. It is important, therefore, to use a method that is rapid in use and to print the readings automatically.

A small defect in the silver backing of the glass fixed circle partially obscured some six or seven consecutive divisions. Under magnification the blemish appeared as a central mottled patch surrounded by a cluster of satellite spots, which could be tolerated so long as the settings of the microscope micrometers were made visually, but which was considered intolerable with the larger coverage and possible photoelectric automatic measurement contemplated for the photographic technique. The circle was accordingly dismantled and sent to Greenwich, where the silver was successfully dissolved from a very small area around the defect, which was then resilvered. The join between the old and new silvering is noticeable but it is not considered likely to affect the measurements or alter the division error of the graduations.

Much work on the eye-end micrometer box was also carried out in the workshop. The automatic printing device for the registration of the zenith distance micrometer settings, obtained from Imperial College on indefinite loan, was adapted and fitted. The proposed registration of transits on a phonic motor chronograph necessitated two

new contact wheels in order to separate the electrical circuits for the contacts used for the transit records from those used merely as a warning device. The new contact wheels have been made in the workshop and fitted to the R.A. micrometer.

Melbourne Transit Circle.

The axis alidades, reversing carriage and weight-relieving apparatus were set up temporarily at Greenwich on mock piers, for measurement to be made necessary to the design of suitable piers, foundations and housing at Herstmonceux.

Photographic Zenith Tube.

In November representatives of the makers commenced the installation of this instrument and of the control console in the separate buildings. The installation has reached an advanced stage. The movement of the plate carriage is at present controlled from the frequency of a tuning fork vibrating at a nominal 1000 c/mean time second. The speed of the plate carriage has been found not to be precisely that appropriate to the diurnal motion of a zenith star, but can be corrected by changing the frequency of the fork to 1000 c/sidereal second. The tuning fork has therefore been returned to the makers for this change to be made. The installation will be completed on its return. It is intended, after the quartz clocks have been moved to Herstmonceux, to use the amplified output of 1000 c/sidereal second for driving the plate carriage during the stellar exposures.

Yapp 36-inch Reflector.

During the bad winter months the main mirror was removed and sent to Messrs. Cox, Hargreaves & Thomson for a test of its figure. It was suspected that there were "patchy" errors of figure, and perhaps some astigmatism; but nothing of this sort has been found. There is, however, a fairly wide turned edge and zonal error round the central hole; it is almost covered by the 11-inch hyperbolic Cassegrain at present in use, but will have been largely uncovered in the colour-temperature work, where the secondary was a 7-inch paraboloid. If such work were resumed, re-figuring would seem advantageous. The mirror was re-mounted on March 29 and observations will be continued for the present.

Lyot Monochromatic Filter.

The Lyot birefringent $H\alpha$ -filter was received from the makers, Optique et Précision de Levallois, in July. The filter was tested after completion at the Meudon Observatory; the co-operation of the Director of the Paris Observatory in providing the necessary facilities is gratefully acknowledged. A provisional optical system, using a small coelostat, showed the filter to be of high quality. Good contrast of small solar details was easily obtained, jets and spicules being seen in the chromosphere at the limb on any day of good atmospheric conditions. Experimental photographs have been taken using 35 mm. film specially coated by Kodak Ltd., with spectroscopic emulsion of Type E sensitivity and of two speed-ratings. The slower film (Type IV E) seems to be satisfactory, having extremely fine grain and good contrast.

The permanent mounting of the $H\alpha$ -filter on to the 6 $\frac{1}{4}$ -inch Newbegin telescope is very nearly complete. The use of a 35 mm. "Exacta" camera-body will enable sequences of photographs to be taken rapidly. A step-wedge is being provided for calibration of the photographic density to a limited degree of accuracy and a suitable photo-

metric procedure is being prepared. This will involve the construction of a special instrument serving the dual purpose of general inspection and measurement of the 21 mm. solar images and of registration of photographic density over small areas of the film.

The filter will be used for providing, when possible, a daily record of the features on the Sun visible in $H\alpha$ -light, providing a complement to the series of large photographs in integrated light taken with the photoheliograph. In addition, series of photographs will be taken during special observing periods throughout the International Geophysical Year and when the progress of solar flares is being followed.

Solar Spectrographs.

Reconstruction of the 16-inch coelostat of the Evershed solar spectrographs and the construction of the secondary mirror mounting have continued in the Greenwich workshop. Satisfactory castings for most of the major parts have been obtained, but the machining work has progressed rather slowly because of the pressure of other demands upon workshop time, particularly during preparation of equipment for the eclipse expeditions. The 10 $\frac{1}{2}$ -inch object-glass has been received from Messrs. Cox, Hargreaves and Thomson, having shown excellent definition in their testing rooms.

Further tests have been carried out with the train of three liquid prisms and good definition has been obtained with a single prism without stirring of the liquid. It is necessary, however, to maintain the prism at a constant temperature for which a substantial and suitably insulated prism-box is required. Successful tests of the three prisms together will not be possible until a sufficiently large prism-box is available. Difficulties have been encountered with the flexible seals, which do not seem to hold the prism-faces in an entirely unconstrained state, and with occasional small leaks. Since it seems difficult to eliminate the latter entirely, enquiries have been made as to whether any radically different type of seal and adhesive is likely to prove more satisfactory.

Library.

The removal of the Library from Greenwich was completed in July 1954.

The cataloguing of the Library is being proceeded with as quickly as circumstances permit. In addition to an author catalogue, a subject catalogue arranged by Universal Decimal Classification and a new shelf list are being prepared.

Plans for the re-arrangement of the books in classified order are complete and H.M. Stationery Office will send a binder to Herstmonceux to stamp the new class numbers in gold lettering on the spines of the books. It is expected that the binder will commence this work in early April.

In connexion with the work of cataloguing, a check of the contents of the Library is being made. When it is complete, a report on the number of books missing will be submitted.

III. ASTRONOMICAL AND RADIO OBSERVATIONS.

Airy Transit Circle.

As indicated in my last Report, in view of the staffing situation, the termination of the observational work has been used to overtake some of the serious arrears of reductions. The situation has been eased considerably as a result. Ledgers

of the planetary results for the Annual Volumes of Greenwich Observations are practically up-to-date, and copy for vari-typing, except for 1948 and 1949, is complete to the end of 1950.

Work on the First Greenwich Catalogue for 1950.0 is proceeding slowly, as it has been possible to allocate only the equivalent of one man's time to this work. For the G.C. stars in the list, it is intended to revise the G.C. proper motions by the incorporation of the data from recent observational catalogues not used in the G.C., in addition to the Greenwich observations. This entails, among other tasks, the reduction of some 12,000 star places to the common epoch, 1950.0. It is intended to do the whole of this revision by punched-card machines, and the formulae commonly used for this purpose have been adapted to punched-card work. The cards carrying the additional data from the observational catalogues are being punched. Other cards will carry the data from the G.C.

The G.C. system of proper motions itself needs systematic corrections. Any process of revision incorporating the uncorrected G.C. proper motions would merely perpetuate the errors. Allowance for the effects of the errors will be included in the revision.

The ledgering of the observations with the Airy Transit Circle of the stars to be observed with the P.Z.T. has been completed. A comparison of the observed places with the provisional places obtained by bringing up to 1950 the Yale photographic positions obtained around 1915 indicates that the latter are inadequate for use in the initiation of an observational programme with the P.Z.T. It is intended, therefore, to collect all modern observations of these stars, e.g. from AGK2, W250, Ottawa etc., in order to determine more reliable places and proper motions.

Additional unpublished information from the Greenwich observational programmes has been communicated to Professor Kopff for use in the revision of the FK3 fundamental catalogue, now in progress.

The observations of azimuth stars and the simultaneous readings of the azimuth of the Chingford Meridian Mark obtained during the summer and autumn of 1953 have been reduced and partially analysed. An accurate determination of the azimuth of the Greenwich-Chingford line will go some way to enabling Greenwich to be used as a Laplace station for Ordnance Survey purposes, and assist in the determination of the astronomical latitude and longitude of Herstmonceux by an independent method.

The observations show that the azimuth error of the Airy T.C. is dependent on the temperature, with a lag of some hours. The diurnal variation of azimuth is disconcertingly large (total range of 2 to 3 seconds of arc). These results stress the absolute necessity for azimuth marks to monitor the changes of azimuth error between observations of "double azimuths".

Astrographic Refractor.

The main programme with this instrument continues to be the observation of the brightest four minor planets for position. That Ceres, Pallas and Juno were observed on only 4, 4, and 3 occasions respectively is due to unfavourable apparitions in the period under review: Vesta was better placed for observation and 27 photographs were secured. Nemausa was observed on 15 nights in connexion with the Copenhagen programme which uses precision places of this minor planet for investigating systematic errors in fundamental catalogues. A few exploratory plates

were taken in anticipation of a proposed programme of measuring the proper motions of certain variable stars (types RR Lyrae, Mira Ceti, semi-regular and long-period) brighter than 12^m at maximum in the Greenwich astrographic zone. The proper motions are required for research on galactic structure: they are expected to be very small, but on the other hand more than 50 years have now elapsed since the first-epoch astrographic plates were taken, and by using a sufficient number of comparison stars it is believed that adequate accuracy can be attained.

The investigation of systematic errors of place produced by photographing away from the meridian continues. A small effect in declination has emerged, but this, like the R.A. effect already reported, is not appreciable except where a large range in hour angle is deliberately employed in positional work. A further 17 plates on the field at declination +27° have been taken during the year; and in an attempt to elucidate the dependence of the effect on declination, 31 plates on an equatorial field and 42 on a circumpolar field have been secured. There seems little doubt that in all three fields there is a real systematic effect, i.e. a dependence on hour angle, but the final analysis has not yet been made and data are still accumulating.

Yapp 33-inch Reflector.

Observations with this telescope were resumed in May, after the dismantling of the 21-ft. eclipse telescope had released the regular observers, and were continued until the main mirror was sent away for testing. The single-prism spectrograph has been used to secure 97 low-dispersion spectrograms of 77 stars, some of these being standard stars of the Yerkes Atlas.

Total Eclipse of 1954 June 30.

The 7-inch telescope of 21-ft. focus intended for studying the gravitational deflexion of light at this eclipse was erected on site in early June inside the tented framework hut described in the last Report. The party consisted of Mr. T. Gold, Dr. A. Hunter, and two volunteers, Dr. E. W. Bastin and Dr. D. W. Sciama. The site chosen, at the northern boundary of a small pine-wood on the island of Syd Koster, some 10 miles off the mainland near Strömstad, Sweden, was selected to minimize the hazards from wind and from convection currents rising from the rock of which the island is largely composed.

Preparations on the site on Syd Koster island extended over five weeks. The sky, though overcast at dawn on the day of the eclipse, gradually improved thereafter, and frequent views of the diminishing crescent were obtained during the early phases of the eclipse. At second contact, however, the sky was still covered with thin high cloud, and low fracto-cumulus crossed the field frequently during totality. Neither prevented a good view of the typical "minimum" corona, but there was clearly little hope of securing any usable star images in these conditions. A modified programme was, however, carried through, exposures on the eclipse field and on a nearby comparison field being made on one plate only instead of the two it had been intended to use if conditions were favourable. As was inevitable in the circumstances, the photograph proved to be severely fogged by coronal light scattered in the cloud, and only the bright stars near the edge of the field produced visible images on the plate. The object of the expedition was therefore not attained and the equipment was dismantled and brought back to England.

The photographic density on the eclipse plate varies from about 2 at the edge to nearly 5 in the inner corona. By contact printing through a rotation sector

suitably graded in aperture a representation of the corona that is pictorially satisfactory can be obtained. This shows remarkably symmetrical equatorial streamers, extending to more than four radii from the limb, sharply differentiated from the short polar plumes which border the limb at latitudes higher than 60° . The eclipse occurred at the exact epoch of minimum solar activity, as nearly as that can be determined, and at a time when the Sun was completely free from spots so that the corona was unusually free from the disturbances that occur at periods that are richer in sunspots. The axis of symmetry of the elongated streamers coincides, within the uncertainty of measurement, with the normal to the projection of the Sun's axis. If the exactness of this coincidence is more than a chance effect, this shows that those outer coronal regions are under the control of the Sun rotating deep within.

Two small expeditions were sent to Sweden to make observations of the position of the Moon for geodetic purposes. One, under Dr. Atkinson, was stationed on the island of Öland, off the east coast of Sweden, near the central line of totality, to make observations by the Banachiewicz method. The other, under Mr. Pope, was stationed on the mainland near the east coast, just south of the zone of totality, to make observations by the Atkinson method. Neither expedition was able to obtain observations during the eclipse because of clouds.

Through the courtesy of the Royal Air Force, the Astronomer Royal and Mr. Sadler obtained an excellent view of the eclipse from a Hastings aircraft. The aircraft reached the central line of totality to the south-west of Iceland and flew eastwards along the line, thereby adding 22^s to the duration of totality. An excellent view was obtained of the shadow of the Moon thrown on the uniform cloud layer beneath the aircraft, the shadow rapidly approaching the aircraft from behind before totality and receding ahead of it after totality. The symmetrical shape of the corona and the great length of the equatorial streamers were very noticeable. The remarkable colour effects in the sky and on the clouds were most impressive.

Mr. H. W. Newton saw the eclipse in similar conditions from a B.O.A.C. aircraft.

Several members of the staff joined the expedition, organized by the Royal Astronomical Society and the British Astronomical Association, to observe this eclipse. Dr. J. G. Porter gave a broadcast commentary for the B.B.C. during the eclipse.

Eclipses of 1948 November 1 and 1952 February 25.

The final paper on the 1948 eclipse has been completed and has gone to press. The analysis includes correction coefficients for possible changes in all three co-ordinates of the station, and in the basic time-system used; it also applies actual corrections for polar variation, annual variation in the Earth's rotation, light-time to the Earth's centre, the error of the FK3 equinox, and the Sun's perigee and eccentricity, as well as the Sun's longitude. The effects of errors in the Sun's and Moon's places are treated more rigorously than is usual. It is thought that the analysis now includes all such factors, so far as they are relevant to eclipse work, except corrections to the Moon's parallax and the Earth's ellipticity; these are interrelated and involve some complex questions which are still being studied. It has been decided that some re-design of the measuring-machine, and the incorporation of a reversing prism into its eyepiece, is desirable for future work; this cannot be undertaken in the workshop at the moment, and measurements of the 1952 films have been deferred.

Cosmic Ray Observations.

Recording of the general ionising flux with the Cintel apparatus was continued until 1955 February 9. One half of the sensitive area was then modified, in accordance with the recommendations of the Cosmic Ray Commission of the International Union of Pure and Applied Physics, to detect only the flux of mesons capable of penetrating 10 cm. of lead and entering from a smaller solid angle around the zenith than the previous arrangement would accept. The other half will be similarly modified shortly.

These substantial modifications are required to make the data comparable with those obtained by many other stations in different parts of the world, and thereby to facilitate the study of world-wide distribution and changes of this flux. The modified apparatus is also the one desired for the observations to be carried out during the International Geophysical Year.

Some consideration has been given to the project of neutron flux recording also. This is the subject of a recommendation of the Cosmic Ray Committee of the Special Committee for the International Geophysical Year and is also in accordance with the recommendations of the International Union of Pure and Applied Physics. New knowledge in this field has emphasized the connexion with solar events.

Photoheliograph.

During the eleven months covered by this Report, the Sun was photographed on 273 days, a second photograph being taken on all but 26 days.

Thirty-four plates with double images were taken for determining the zero of position angle, which was also regularly checked by a visual method. From reports received from H.M. Astronomer at the Cape and the Director of the Kodaikanal Observatory, India, all days are represented in the combined series for 1954.

Consignments of solar negatives have been received from the Cape in duplicate from 1954 January 1 to September 30. Those for the last quarter of the year are in transit from the Cape. Six photographs to fill gaps in the Greenwich-Cape series for 1954 have been kindly supplied by the Director of the Kodaikanal Observatory.

Measurement of the combined series has been completed from 1954 January 1 to September 30. Computations of sunspot positions and areas have been made from 1954 January 1 to September 14.

The MS. copy of the "Greenwich Photoheliographic Results" for 1951, 1952 and 1953 has been completed during the year. Vari-typer copy for the year 1947 has been sent for reproduction. Vari-typer copy for the years 1948 and 1949 has been started.

Daily sunspot numbers based on the Zürich system of counting have been sent to the Director of the Federal Observatory, Zürich, for inclusion in the Quarterly Bulletin on Solar Activity. Monthly mean values have been sent to several radio centres in this country. The mean daily sunspot number for the eleven months covered by this Report is 8, as compared with 10 for the preceding twelve months. There were 164 spotless days, May and June being nearly spotless months.

The period covered by this Report embraces the epoch of sunspot minimum, provisionally put as 1954.4, near the time of the total solar eclipse. The increase

in frequency of new cycle spots since then and the almost complete cessation of the old-cycle spots in low latitudes was quite apparent by the commencement of 1955. Up to the present, the largest of the new cycle spots, rising to a maximum area of 800 millionths of the Sun's hemisphere, crossed the central meridian on January 13.1 in latitude 36° north.

During the year small short-lived flecks of faculæ have continued to appear in the Sun's polar regions.

Summaries of the mean daily areas and mean heliographic latitudes for the years 1951 and 1952 are being published in the Monthly Notices of the Royal Astronomical Society.

The preparation of an appendix to the "Greenwich Photoheliographic Results" (referred to in the last Report), containing various tables of sunspot data and catalogues of geomagnetic storms 1874 to 1954, has been completed and set up by vari-typer. The printing of this as a special volume under the title "Greenwich Sunspot and Geomagnetic-Storm Data 1874 to 1954" has been commenced, and early publication requested of H.M. Stationery Office.

An investigation has been made into the relative spottedness of the Sun's northern and southern hemispheres using Greenwich spot areas from 1874 to 1954. There appears to be a progressive change of pattern which, it was thought, might be periodic. Examination of earlier records from 1832 embracing the observations of Schwabe, Carrington and Spörer does not, however, confirm this suggestion of periodicity. The progressive change of pattern and one or two other features of the record deserve further examination. A paper on the subject has been communicated to the Royal Astronomical Society.

The copying on bromide paper of the early negatives that was commenced in 1933 is being continued for the period 1903 to 1913. In this way the original photographic records, some of which were deteriorating through age, will be extended for many years.

Spectroheliscopes.

Observations of the Sun's disk in $H\alpha$ were made on 126 days, but on 44 days observations were restricted to a few minutes. Only one solar flare was observed, and this was of minor importance. On January 10, however, the occurrence of a moderately intense solar flare was indicated by the S.E.A. recorder working on 27 kc/s (11.1 metres). This flare, recorded from 12^h 04^m to about 13^h 30^m, was presumably related either to the sunspot that crossed the central meridian on January 13.1 or to a smaller one in latitude 20° N that was two days past the central meridian.

Thirty-four measures of line-of-sight motions of dark hydrogen flocculi on the disk were obtained. Thirty-one measures were also made on patches of normal bright flocculi around sunspots. Six photometer measures were made on the latter. A few prominences were examined at the Sun's limb.

The helpful co-operation has been continued by the Joint Radio Propagation Bureau (Admiralty) in the telephonic distribution of current solar data issued from Herstmonceux for use at a number of radio research centres.

Time Service.

At Abinger the Bamberg broken transit instrument was in use for the whole of the eleven-month period covered by this Report, 180 observations being obtained on 103 nights. The contact length and the level scale value received the usual routine check in October, and the values adopted were confirmed. At Greenwich during the same period Transit C was employed in the Courtyard Dome. Altogether, 234 observations were obtained: 103 of these were made on 79 mornings, and 131 on 127 evenings. The observations at Abinger and Greenwich, totalling 414, were combined for the purposes of time determination.

It was noticed in May that the effective length of the micrometer contact of Transit C differed from the value adopted from previous measurements. There was no independent evidence to indicate precisely when the change had occurred. As the instrument had been in operational service for less than a year, it was decided to recompute the observations on the assumption that the new value of the contact length had been applicable throughout. This micrometer was replaced on June 11 by the Cooke micrometer, which had previously been used on Transit B and which had been reconditioned and the drive altered so as to double the speed of manual turning. The contact length was redetermined in June and November and was found to have the same value as used throughout its 25 years of service. Since the introduction of this micrometer the mean error of the time determinations at Greenwich has been appreciably reduced.

The determinations of time have been corrected for the effects of polar motion, based on current latitude observations communicated regularly by the U.S. Naval Observatory. Various instrumental changes have occurred, but overlapping series of observations have preserved the continuity of the polar motion adopted. After this correction, the Greenwich and Abinger time observations have been compared with several selected quartz clocks and analysed to derive the apparent annual fluctuation in the rotation of the Earth. There has been no significant change in the amplitude and phase of the observed fluctuation.

Clocks.

The Time Service continues to be based on clocks at various stations: during the period under review, the clocks at Abinger have provided the majority of the long-term standards employed. The best performances at Abinger have been those of C6 and E5, and valuable supplementary information has been obtained from B5, B6, C5 and E6, but the last named still exhibits a large frequency drift and small but disappointing departures from uniformity. All of these oscillators are provided with ring crystals. The subsidiary standard clocks employing GT-cut plate crystals, which are used to control the time signal transmitting equipment, are proving inadequate for modern requirements, being insufficiently uniform in their performance. B4 is the only one of the three sub-standards which can be satisfactorily employed; fortunately, however, the frequency of one of the primary ring-crystal standards, B6, is fairly near nominal, and the rate of this clock has been sufficiently low for it to be employed not only as a primary standard but also to control time-signal transmitting equipment. Consideration is being given to various alternative ways of resolving the difficulties of the present unsatisfactory position.

The clocks at Greenwich, which are of the GT-cut plate type, although adequate for the purpose of transferring the Greenwich time observations to the primary ring-crystal clocks, have not themselves attained the high standard of uniformity

requisite in a primary standard clock. The clocks A2, F1 and F3 have run without interruption: H1 and H3 were stopped on November 21 by a fault on a common power supply. In order to reduce the large variations in the mains supply voltage at Greenwich, a Ferranti Voltage Stabiliser was supplied and installed on February 11 by the Electrical Engineering Manager, Chatham.

The Observatory has continued to receive information on the Post Office quartz clocks at Dollis Hill and Banbury. The information relating to the clocks at the National Physical Laboratory is now received by private telephone line via Dollis Hill.

Experimental Clocks.

Reference was made in the previous Report to the installation in D cellar at Abinger of three oscillators of the pattern developed in the Electronics Laboratory. These clocks are at present used as experimental clocks and not as operational standards. The quartz crystal resonator (of GT-cut plate type) which previously gave an excellent performance in the experimental oscillator G2 was transferred in the summer to oscillator D4 where, after an initial ageing period, it has given a performance comparable with that of primary standards incorporating ring crystals. D5 is operating temporarily with a GT-cut plate crystal, which has been supplied by the Post Office for special low-temperature tests which have been arranged in collaboration with the Clarendon Laboratory at Oxford. A similar crystal in oscillator D6 has been running for some time, but with disappointing results: it is planned in the near future to replace this crystal by the ring crystal now incorporated in oscillator E6.

As an alternative to the employment of a condenser in series with a crystal to bring the frequency of the oscillator conveniently near to its nominal value, the use of a continuous phase-shifting device has been considered. An experimental model incorporating a motor-driven phase-shift capacitor has been constructed and is now undergoing tests. Equipment for the precise measurement of the temperatures of the thermostatically controlled ovens has been received after considerable delay, and has been used to check the temperature variations in the new-type quartz crystal oven. Results obtained so far indicate that the variations do not exceed 0.001 degree in the course of one month. Investigations are being made into the possible advantages of employing transistors in quartz clock circuits. A departmental report on the design, construction, and installation of the laboratory pattern quartz clocks has been prepared and is in course of publication.

Control Room Equipment.

The prototype Dekatron divider has given a satisfactory performance for over twelve months, and six more dividers are approaching completion. Two are already working in conjunction with the new cold-cathode trigger-tube switching clock, a 60-61 frequency converter, and magflip phasing devices in an electronic installation capable of providing all the time signals transmitted by the Department. The switching clock, which is based on a Post Office idea, is designed to perform all the functions of the existing phonic motor transmitters. The rhythmic impulses are derived from a 1 kc/s source by means of an electronic 61/60 multiplication stage followed by a 1000-1 Dekatron converter. This has been operating reliably since December. The two solar-sidereal transformers, mentioned in last year's Report, have been delivered and tested, and one is now in operation with a 20-1 frequency divider supplying 50 cycles per sidereal second to drive a synchronous clock dial in the

Bamberg hut. This is an experimental installation for providing experience in the operation of the time distribution system that is being planned for Herstmonceux.

A new model of the Cintel decimal counter chronometer, which measures time intervals of up to one second with an accuracy of one microsecond, is being modified to suit Time Department requirements. It is the first of three new counters that are being prepared for installation at Herstmonceux.

In continuance of the tests on the private telephone line mentioned in last year's Report, two keyed 1 kc/s tone sending devices have been constructed and were brought into operation on December 1 for the control of the Rugby radio time signals. With the co-operation of the Post Office, a number of special test transmissions have been made with a view to ensuring that the time signal erratics are kept as small as possible.

The four rectifiers charging the quartz clock L.T. batteries have been replaced by Westat constant potential rectifiers to prevent large fluctuations in valve heater voltages, which are detrimental to the long-life valves with which some of the standards are equipped.

At Greenwich, the rewiring of the phonic motor circuits has been completed to work with the new signal forming unit. The full operation of the equipment awaits modification to phonic motor transmitter No. 3, which is now in hand at Abinger. The drive circuit for the Gate Clock has been replaced by one of an improved design.

Time Signals.

The international time signals, the six-pips time signals, and the hourly signals used by the Post Office for the control of the Speaking Clock, have been controlled by the phonic motor transmitters at Abinger. The reserve service of hourly and six-pips signals has been available from Greenwich. At the request of another department, a series of special time signals has been transmitted for four hours each week-day since February 14 from the Post Office radio station at Criggon.

At Greenwich, the Time Ball was dropped daily throughout the period under review, except on three days when high wind or snow on the mast prevented the ball from being raised.

The transmissions of the international time signals from Rugby on both long and short waves have been monitored at the Observatory. Routine measurements are made of the carrier frequencies of MSF (60 kc/s) and Droitwich (200 kc/s), together with the reception times of the seconds pulses superimposed on the MSF transmissions on 60 kc/s and $2\frac{1}{2}$ Mc/s. Radio time signals have been received throughout the year from Argentina, Australia, Canada, France, Germany, U.S.A., and U.S.S.R.

The Time Service Circular and the Monthly Frequency Estimate have been distributed at the middle of each month. The Time Service Bulletin, with its various supplements, has been published in quarterly instalments. Preparation of copy for press has proceeded: 1944 is ready for vari-type correction, and 1946 has been corrected. The tabular material for 1952 and 1953 has been completed.

Miscellaneous.

For the convenience of observers of the total solar eclipse of 1954 June 30, special time signals were transmitted between 0900 and 1500 by the Post Office long-wave transmitter at Rugby and by associated short-wave transmitters. In

order that the signals might serve also for a programme of radio observations, the seconds dots were lengthened from the normal duration of 0.1 second to become dashes 0.3 second in length. On the ten days preceding the eclipse, rehearsal time signals were transmitted between 0945 and 1030. In view of the difficulty experienced in obtaining reliable measurements at Abinger of the Rugby short-wave transmissions, the co-operation of the Fernmeldetechnisches Zentralamt at Darmstadt and of the Geodätisches Institut at Potsdam was invited. Results obtained at Abinger, Darmstadt and Potsdam have been described and tabulated in a departmental report. The assistance of the two German establishments is gratefully acknowledged.

A Bélin drum chronograph has been transferred from Abinger to Herstmonceux for the rating of chronometers and watches. A portable mains-driven quartz crystal frequency standard has been built to control the speed of the drum, and a five-way amplifier with one microphone input permits simultaneous recording of four contact chronometers and one chronometer or watch without contacts.

A prototype model of an improved receiver for the measurement of the seconds pulses of the 60 kc/s standard frequency transmission has been constructed and is undergoing tests. Electronic equipment is under construction for use in the proposed tests at the Clarendon Laboratory on the operation of a crystal resonator at low temperatures.

The problem of making precise frequency comparisons at widely separated points by means of very long wave radio transmissions has recently been under consideration by the United Kingdom Study Group VII of the C.C.I.R. Various methods have been proposed, one of which is being further developed in the Electronics Laboratory.

As a preliminary to the International Geophysical Year, a programme of international co-operation has been organized under the chairmanship of Professor Boella with a view to the better determination of the propagation times of radio time signals. On selected days the co-operating stations are asked to make precise measurements every three hours of the times of reception of the seconds pulses superimposed on local and distant standard frequency transmissions. The Royal Observatory has taken part in the programme on the days so far selected, three in December and two in March, using a visual cathode-ray tube technique specially developed for the purpose. Tests have been arranged to determine the suitability of the method for more general applications in the reception of conventional time signals.

During the past twelve months experience has been gained in the use of a new method, which avoids any personal bias, of extrapolation of clock performance for the purposes of "steering" the transmitted time signals. After some disappointments arising from adverse circumstances in the early part of the period, the method has more recently shown considerable promise, and the trial period has been extended. In anticipation of the delivery of an impersonal prismatic astrolabe, a pilot computation for the compilation of the observing list and factor table was undertaken.

An increasing proportion of the Time Department's work has been devoted to the formulation of detailed plans of the new installation in the West Building at Herstmonceux. Final decisions on these matters have been delayed as long as possible in order that the adopted designs should incorporate the most up-to-date techniques. The whole pattern of the Department's work is at present in a state of rapid change, which makes it extremely difficult to foresee and cater for the probable needs of a few years hence. The situation is further complicated by the special responsibilities which will fall upon the Time Department during the International Geophysical Year.

IV. MAGNETIC OBSERVATIONS.

A continuous check upon the base-lines of the magnetograms has been maintained and an unbroken photographic record of declination, horizontal intensity, and vertical intensity has been preserved throughout the eleven months under review.

During the seven months from May to November the Dye vertical intensity coil was out of service following the decision that the dimensions of the coil should be checked to ascertain whether any secular changes had taken place. The extensive recalibration, carried out at the National Physical Laboratory by Mr. L. O. C. Johnson, showed that since 1920 there had been a very slight overall increase in the dimensions of the coil. This has necessitated introducing a discontinuity of -1.2γ into the values of vertical intensity recorded at Abinger. The change was made on 1955 January 1. The check studs, mentioned in last year's Report, which it had been proposed to insert, were not inserted, as it was found that satisfactory recalibration was possible without them.

During the period in which the instrument was out of use the BMZ instrument No. 38 was used to bridge the gap in the coil observations of vertical intensity. This semi-absolute instrument provided a very reliable check upon the base-line of the vertical intensity variometer.

The dip inductor has been modified for ease of dismantling and assembling after repair, but the performance of the instrument has not proved entirely satisfactory because of wear of the lignum vitae bearings. The results of tests being made by the Cambridge Instrument Company on the use of Oilite (sintered metal) are now being awaited. Should these tests prove satisfactory, the fitting of Oilite bearings to the inductor will be considered.

The annual calibration of the potentiometers has been carried out and the three new standard resistances mentioned in the previous Report have been certified at the National Physical Laboratory. The two Broca galvanometers, subsequent to modification and repair, have been mounted on brick piers and surmounted with perspex covers (constructed in the workshop) which do not need to be removed during observations with the instruments. The supply circuits of the Schuster-Smith and Dye coils have been rewired and some modifications have been made to the illumination of the instruments. Two low frequency oscillators for use with the Dye coil have been constructed in the Electronics Laboratory and, after prolonged tests, have been brought into regular use.

The BMZ instruments Nos. 81 and 82 and QHM instruments Nos. 234, 235, 236 and 237, purchased by the Hydrographer for the use of survey ships, have been tested over extended periods. BMZ No. 81 and QHM Nos. 234 and 235 have now been issued for service, together with full instructions for their use.

The manuscript copies of the magnetic charts for epoch 1955.0 have been sent to the Hydrographic Department for reproduction. The three sectional charts of declination were published on September 24 and the world chart on February 4. The remaining six charts (of horizontal, vertical and total intensities, of the north and east components, and of the inclination) will be appearing shortly. Magnetic data for the correction of the charts remain very limited but determinations of declination made at a number of Royal Air Force stations in the Middle East are now being received regularly, together with results of ships' swings made by naval craft and weather ships.

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The following table contains the mean annual values of the magnetic elements determined at Abinger during the period 1951-54 with estimated values for 1955.

Year	Declination (West)	Horizontal Intensity	Vertical Intensity	Inclination
1951	9° 12'2	0.18648	0.43305	66° 42'1
1952	9 4.7	0.18671	0.43316	66 40.9
1953	8 57.5	0.18697	0.43321	66 39.3
1954	8 50.9	0.18722	0.43332	66 38.0
1955	8 44.1	0.18746	0.43342	66 36.7

There were 5 "storms" or disturbances having a range with a lower limit of 150y in H or Z or 30' in D. There were no "great storms" having double these ranges. The recurrent series of disturbances that was a feature of the previous year was not apparent during this period.

V. METEOROLOGICAL OBSERVATIONS.

Full scale meteorological observations have been maintained on a routine basis and detailed reports have been submitted monthly to the Meteorological Office.

In December the steel wet bulb of the thermograph was found to be pitted with rust due to deterioration of the Staybrite surface. To arrest the deterioration, the bulb was cleaned and the pitting treated with Loy plastic metal. The recorder continues to function satisfactorily.

The duration of bright sunshine recorded at Herstmonceux over the eleven months was 1453.4 hours or 36 per cent of the total possible duration. The highest monthly total during the period 1954 May to 1955 March was 192.0 hours, which occurred in May. There was a marked lack of sunshine during the summer months. During the four months from May to August there was a deficiency of about 200 hours as compared with the mean of the preceding four years. During the eleven months there were 55 entirely sunless days and 5 on which the record exceeded 90 per cent of the possible duration.

The total amount of clear sky at night, given by the night-sky recorder, during the period from May to August was also well below the totals for the preceding years, though the cloudiness was not so marked at night as during the day time. Unbroken trails of δ Ursæ Minoris were recorded on 20 nights, while no record at all was shown on 79 nights.

Temperatures rose above 70°F on 11 days, the maximum of 76°F occurring on August 4. On 59 days temperatures were below freezing point, the minimum of 22°F occurring on February 17 and 20.

The total rainfall for the period was 31.17 inches, the wettest month being November with a total of 5.48 inches. The driest month was March, with a fall of 1.29 inches.

Wind rose to gale force (34 knots) between 0^h and 3¹/₂^h on November 27, but the highest mean speed for the month was recorded in December, when the value was 9.3 knots. The lowest monthly mean occurred in May, with a value of 6.0 knots.

VI. CHRONOMETERS.

The number of Admiralty chronometers and watches on charge to the Royal Observatory, exclusive of those in the hands of outworkers for repair, is 14873. Of this total 77 chronometers (Pattern HS1), 368 chronometer watches (HS2), 1292 deck watches (HS3), 8 dashboard watches (HS4), 22 pocket watches (HS5), 1488 wrist chronographs (HS9), and 163 wrist watches (HS10 and HS11) are rating or ready for issue. There are 34 Pattern HS1, 41 HS2, 229 HS3, 7 HS7, 421 HS9, and 12 HS10/11 undergoing repair in the Chronometer Workshop. Chronometers and watches in use throughout the Observatory number eighteen. The remainder, consisting of 676 HS1, 2553 HS2, 4894 HS3, 772 HS4, 373 HS5, 414 HS6, 340 HS7, 108 HS8, 196 HS9, and 367 HS10/11, are held in store awaiting overhaul and rating. In addition to the foregoing, 190 chronometers and watches are deposited in the Chronometer Department for various reasons.

During the eleven months under review 7580 Admiralty chronometers and Watches were received and 7538 issued. These figures include the following non-routine items:

- 8 Chronometers sold to Atomic Energy Authority.
- 2 Chronometers formerly on the Royal Yacht transferred to National Maritime Museum
- 2 Chronometers sold to Falkland Islands Dependency.
- 11 Chronometer watches, 2 dashboard watches and 5 pocket watches and one deck watch sold to Pakistan Government.
- 1 Chronometer watch sold to Ceylon Government Survey.
- 13 Deck watches of non-standard type and one Waltham navigation watch sold.

The total number of chronometers and watches repaired and adjusted was 3772, including; one for the Canadian Government, three for the Ministry of Civil Aviation, eight for the Atomic Energy Authority and nineteen for the Pakistan Government. Of the total number repaired 47 chronometers, 57 chronometer watches, 314 deck watches, 25 dashboard watches, 242 sidereal stop watches, 1941 wrist chronographs and 18 other wrist watches were dealt with in the Chronometer Workshop.

The number of chronometers and watches passing through the Department compares closely with those handled during a similar period of the previous year, and the work of computing and notation of record cards has been maintained to a current date.

The sidereal Free Pendulum Shortt No. 40 has been in use continuously as the standard in the Department, being checked daily against the Rugby Rhythmic Signals. In November 1954 the Free Pendulum Shortt No. 49 rated to solar time was mounted in the clock cellar and brought into use as the solar standard, distributing seconds impulses to the dials in the chronometer rating rooms, the time signal reception room and the Cosmic Ray Laboratory. Hourly signals are sent to the Solar and Meteorological Departments for the calibration of recording apparatus.

Irregularities in the daily rates of the two standard clocks, at first attributed to instability of the Castle wall on which they are mounted, were eventually traced to fluctuations of the temperature in the clock cellar. Observations of the daily rates compared with the Rugby signals when the temperature of the cellar was changed by 5°C indicate a temperature coefficient in the rates of both clocks of

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approximately .03 secs. per 1°C, which appears to be much larger than the figures obtained from the earlier Shortt clocks. Attempts have been made to reduce the coefficient but little change has been effected to date.

In the Chronometer Workshop a second apprentice completed his term of indenture in August 1954 and shortly afterwards was called up for his National Service. At the moment, therefore, the complement of the Workshop is one short of the approved figure. At the request of the Pakistan Naval Headquarters in London, an instrument mechanic from the Pakistan Naval Yard at Karachi is undergoing a period of nine months training in the repair of chronometers and watches at Herstmonceux.

Apart from routine repairs and adjustments, the staff continue to deal with other items when required to do so. During the past eleven months clock repairs have included the overhaul of free pendulum and slave movements of Shortt No. 4 from the Royal Observatory, Edinburgh, and regulator clocks by Graham and Pennington from the Chart Depots at Sheerness and Malta respectively. The Molyneux regulator from Greenwich was reconditioned and returned for use in the Astrographic dome. Before being mounted at Herstmonceux the free pendulum and slave movements of Shortt No. 49 were overhauled, the slave being fitted with Ritchie contacts in lieu of the original synchronome switch.

Two chronometers supplied for use in the Falkland Islands Dependency were especially fitted into waterproof boxes, special winding and set hands mechanism being designed and incorporated. The experimental clockwork mechanism developed for D.R.E., Admiralty, was completed and submitted to tests which were considered satisfactory for the prototype.

The Department has carried out work of an advisory and experimental nature for the Ministry of Supply on matters concerning wrist watches used in the R.A.F. Other Observatory Departments have also made frequent use of the facilities available in the Chronometer Workshop for the repair, construction and maintenance of mechanical equipment.

The number of watches dealt with by the Chronometer Department on behalf of the Air Ministry is comparable with a similar period in the previous year, but the time spent on each watch is rather more than previously. This is due to the programme of examination of repairable watches being carried out with a view to discarding watches of sub-standard types brought into the Service during the war and not capable of economic maintenance to the specified standards. Considerable standardization of makes will result in a more efficient maintenance organization.

For over three years it has been the practice to insert a Vapour Phase Inhibitor in the cases of all wrist watches used in the R.A.F., to prevent rust and corrosion. Detailed examination of all such watches returned to Herstmonceux from service sources revealed crystalline formations on the movement plates in a large number of watches. Analysis of the crystals at R.A.E. Farnborough indicated that the crystals had been formed from the inhibitor, presumably as the result of climatic conditions encountered in service. Temperature changes, simulated in the various rating rooms and cold cabinets in the chronometer department failed to produce crystal formations but, subsequently, one of the watches under observation shewed signs of crystals after a few days wear in normal conditions at Herstmonceux. As a result of these observations the use of the inhibitor has been discontinued.

During the eleven months under consideration 18,641 Air Ministry watches were received and 17150 issued. The number sent for repair was 7247 viz., 49 6B/60,

495C 6B/159, 1489 6B/234, 250 6B/346, 250 6B/542 and 259 6B/551 of which the 49 6B/60 and 259 6B/551 were repaired and adjusted in the Chronometer Workshop.

Watches of various types belonging to the Air Ministry at present on charge to the Royal Observatory total 15749 and comprise 84 6B/60, 1945 6B/159, 2214 6B/234, 2427 6B/346, 2161 6B/542 and 53 6B/551 rating or ready for issue with 105 6B/60, 2154 6B/159, 1814 6B/346, 603 6B/542 and 48 6B/551 awaiting repair.

The departmental records and stocks were checked by a representative of the Air Ministry Audit Department in November 1954 and a subsequent report from the Air Ministry expressed satisfaction with the standard of accounting.

VII. H.M. NAUTICAL ALMANAC OFFICE.

The routine calculations and proof-reading involved in the preparation and printing of the publications for which the Office is responsible have been continued throughout the year.

As photolithographic reproduction is introduced instead of letterpress printing there will be a welcome reduction in the amount of proof-reading. The full extent of this cannot, however, be realised until experience has been gained of the accuracy of the photo-offset printing processes used.

The decision to unify the Nautical Almanac and the American Ephemeris will have much direct, and indirect, effect on the work of the Office. It opens the way to a revision of the distribution of astronomical calculations between the various ephemeris offices, with the probability of a significant increase in the overall efficiency in the preparation of the national ephemerides.

The Nautical Almanac.

The Almanac for 1956 should be published in April. The first part of the Nautical Almanac for 1958, containing the fundamental ephemerides of the Sun, Moon and planets, has been distributed to at least one observatory in each interested country. No change has been made in the content or presentation of the Almanac.

As reported last year, the first part of the Almanac for 1960 has been completely redesigned to meet the recommendations of the International Astronomical Union. It has now been agreed that, beginning with the 1960 editions, the American Ephemeris and the Nautical Almanac shall be, apart from a few introductory pages, identical publications. The first part of the Almanac will be the responsibility of H.M. Nautical Almanac Office, and the second part the responsibility of the U.S. Nautical Almanac Office. Both parts will be set in type and reproduction proofs interchanged between the Offices; the two Almanacs will then be printed by photolithography from identical material. They will be published separately in the United States of America and in the United Kingdom, and will maintain their separate identities. Reproduction proofs will be made available to other ephemeris offices who wish to make use of them. This "conformity" of the two publications will involve no substantial change of content or arrangement but should result in a considerable reduction in price. It should also prove a step towards still wider international co-operation in the field of astronomical ephemerides.

General Astronomical Work.

Further progress has been made in the calculation, from the appropriate tables, of the ephemerides of the Sun and planets for the years 1960-1980. The heliocentric

equatorial co-ordinates of Mercury, Venus and Mars have been completed and the geocentric equatorial co-ordinates completed for all planets. The quantities required for the ephemerides in the Nautical Almanac of the Sun and planets for 1960-1963 have all been calculated.

The conversion for the Moon from longitude and latitude to right ascension and declination has been completed for 1960-1971, and the hourly values have been formed for 1960.

The calculation of the day numbers, on the new basis, has been completed for 1960-1971. The values specially prepared for use in the calculation of the apparent places of P.Z.T. stars, for every half-hour of sidereal time, have been distributed for 1955-1956.

The calculation of all the tabular data for the third volume of Planetary Co-ordinates is virtually complete.

Predictions for 1955 of occultations of stars by planets have been published in the B.A.A. Handbook.

Occultations.

Of the 1276 conjunctions of stars with the Moon during 1957, for which preliminary times and position angles were recorded at the occultation machine for 71 stations, 178 conjunctions were rejected after computation. The apparent places of stars for the remaining 1098 conjunctions will be published in the Nautical Almanac for 1957. Copy has been prepared for 68 stations (the additional three stations having been used for checking purposes only), involving a total of 5729 computed predictions.

Of the 2206 conjunctions during 1958 examined by means of the occultation machine, 1054 were rejected, and preliminary times and position angles were recorded for 73 stations (three of these for checking purposes) for the remaining 1152 conjunctions.

1439 observations of occultations for 1953 were reduced by punched-card machines. 37 observations, which were received when the computation was almost finished, have been reduced by hand and are being included in the analysis. The discussion of the occultations observed in 1951 and 1952 has been accepted for publication in the Astronomical Journal.

The numbers of observations of occultations in 1953, 1954 and 1955 received since the last report are 483, 886 and 23 respectively.

A certain amount of investigatory work has been done into methods of selecting stars and calculating the elements of occultations. Work has also been continued on the reduction of additional observations for years since 1943, on repetition of doubtful calculations and the calculation of topocentric librations for the application of limb corrections when available.

The Star Almanac.

The Star Almanac for 1955 was published in June. No changes were made in the content or presentation. The edition for 1956 should be published in June.

Apparent Places of Fundamental Stars.

The volume for 1955 was published in May.

The volume for 1956 is being produced by photolithography of copy prepared on the card-controlled typewriter for the apparent place pages and of reproduction pulls for the remainder of the volume. Although all the copy and reproduction proofs were ready by the due date of December 1, there has been considerable delay in the photolithography and no machine sheets were received until late in March. It will thus be impossible for the volume to be published in the scheduled month of May, but it is hoped that publication will take place in June. As mentioned in the last report, only very minor changes of presentation have been made. No change has been made in the allocation of the computations.

Copies of punched-card lists of the mean places of the stars for 1958 and 1959 have been distributed to the several offices responsible for the computation of apparent places.

The whole of the apparent places for 1957 have been punched on cards in a form suitable for the typewriter. Grateful acknowledgment is again made to Statistical Branch, Admiralty, for punching the positions received in manuscript from contributing countries.

The Abridged Nautical Almanac.

The Abridged Nautical Almanac for 1956 was published in March. No change was made in the content or presentation.

It has been decided to produce the Almanac by photolithography of copy prepared on the card-controlled typewriter beginning with the edition for 1958. Various designs for the ephemeral pages have been prepared; these have generally proved acceptable to representatives of the users and have clearly shown that the medium is capable of meeting exacting requirements. The final decision between two possible forms - with two or three days to an opening - will shortly be made.

The Air Almanac.

Since the last report two parts of the Air Almanac for 1955 have been published. No change has been made in the content or presentation.

General Navigation Work.

Revised editions of Vol. 1 of A.P. 3270, "Sight Reduction Tables for Air Navigation", are required every five years. By agreement with the U.S. Nautical Almanac Office, the work on the second edition, with star positions for equinox 1960.0, is being shared; the Office is responsible for the calculations for southern latitudes. All preliminary planning has been completed and a start made on the routine calculations on the punched-card machines.

In response to requests from the Royal Navy, a special graph for low-altitude refraction (altitudes 0° - 5°) has been prepared. A start has also been made on the design and preparation of a set of nautical tables for use in the Royal Navy.

Many minor investigations have been undertaken for the Royal Navy and Royal Air Force.

Proof-reading.

Since the last report 1571 pages of first proofs and 1299 pages of stereo proofs or machine sheets have been read for the normal publications of the Office. The proofs of the photolithographic reproduction of the Air Almanac are treated as first proofs and read in duplicate. It is intended to read the machine sheets of the Apparent Places of Fundamental Stars, but the late receipt of these for the volume for 1956 means that they are not included in the above total.

It is hoped it may be possible in future to avoid a full reading of the printed sheets, but much depends on the printing process, and the care with which it is carried out. Little difficulty is anticipated in reaching an acceptable standard of accuracy on the copy.

Machines.

The Tabulator and 602A continue to give satisfactory service. They have been in operational use for over 80 per cent of the available time; they have been idle for only 5 per cent of the time. The largest job has been the formation of the geocentric equatorial co-ordinates of the planets for 1960-1980; this occupied about one third of the total time.

The card-controlled typewriter was used to prepare the 475 pages of copy for the apparent place pages of the volume of Apparent Places of Fundamental Stars for 1956. Many specimens of lay-out have also been prepared for the Abridged Nautical Almanac and other publications. It has also been used with great success for the preparation of printer's copy for the Nautical Almanac. The machine has not been fully used and is capable of much greater output; it has, unfortunately, given much mechanical trouble - the smallest fault is sufficient to put the machine out of action when preparing copy for reproduction. Many visitors have seen the machine in operation and it has aroused great interest in several quarters.

Miscellaneous.

The preparation of copy for the new and enlarged edition of "Interpolation and Allied Tables" has been delayed, owing to the difficulty of limiting its scope when incorporated into the N.P.L. series of Mathematical Tables; it has now been decided to publish it separately, but the preparation is still being shared with the Mathematics Division of the National Physical Laboratory.

Much work was done in the supply of special data in connection with the total solar eclipse of 1954 June 30; a leaflet, describing the eclipse as visible from the British Isles, was prepared for sale to the public.

Some statistical work on the punched-card machines has been done for the Solar and Magnetic Departments, and plans have been made to assist the Meridian Department in the calculation of proper motions. It is hoped that much more routine calculation of this kind can be centralized on the punched-card machines when all the Departments are established at Herstmonceux.

VIII. PUBLICATIONS.

Preparation of vari-typed copy for "Greenwich Observations" has continued at a satisfactory rate. Copy for an additional publication entitled "Sunspots and Geomagnetic-Storm Data, 1874-1954" was also vari-typed during the year.

REPORT OF THE ASTRONOMER ROYAL

The following eleven books were published during the year; this compares favourably with last year, when only four were published.

"Greenwich Observations" 1939, 1940, 1941 and 1945.

"Greenwich Astronomical Results" 1940, 1941 and 1945.

"Greenwich Photoheliographic Results" 1942, 1943 and 1944.

"Greenwich Magnetic & Meteoroldgical Observations" 1941.

These publications, together with "Cape Annuals, Vol. XVII", were distributed during the year.

Vari-typed copy for the following publications has been sent to H.M. Stationery Office for printing, and the completed books are awaited. That marked with an asterisk has been outstanding more than a year.

"Greenwich Observations" 1942, 1943 and 1946.

"Greenwich Astronomical Results" 1942, 1943 and 1946.

"Greenwich Photoheliographic Results" 1946* and 1947.

"Greenwich Magnetic & Meteorological Observations" 1942, 1943, 1944 and 1946.

"Sunspots & Geomagnetic-Storm Data, 1874-1954."

Preparation of copy for the following publications is in hand:-

"Greenwich Observations" 1944.

"Greenwich Astronomical Results" 1944.

"Greenwich Photoheliographic Results" 1948 and 1949.

"Greenwich Magnetic & Meteorological Observations" 1947.

The following other publications have appeared during the year:

Royal Greenwich Observatory. Mean Areas and Heliographic Latitudes of Sunspots in the year 1949. M.N. 113, 786.

Royal Greenwich Observatory. Mean Areas and Heliographic Latitudes of Sunspots in the year 1950. M.N. 114, 134.

Nautical Almanac Office. Total Solar Eclipse of 1954 June 30.

H. Spencer Jones. Dimensions and Rotation. Chapter I of "The Earth as a Planet".
(The Solar System: Volume II, edited by G. P. Kuiper.)

The Scale of the Universe. Proc. R.I. 36, pt.i.

Faut-il reviser le Calendrier? Ann. Françaises de Chronométrie.

D. H. Sadler. Ephemeris Time. O.N. of R.A.S. 3, No.17.

D. H. Sadler (with J. B. Parker). The Barcoo Observations. J. Inst. Nav. VII, 4.

T. Gold. Relation between modern cosmologies and nuclear astrophysical processes.
Société Royale des Sciences de Liège. 4 serie XIII, III.

The "Horizon" of the Steady State Universe. Nature 175, 382.

The Instability of the Earth's Axis of Rotation. Nature 175, 526.

Suggestions for Rocket Astronomy. Publication of symposium on Rocket Exploration of the Upper Atmosphere. Pergamon Press.

Turbulence in the Interstellar Gas. Chapter 43 of "Gas Dynamics of Cosmic Clouds" (North-Holland Publishing Company).

T. Gold (with H. Bondi and D. W. Sciama). On the reported colour index effect of distant galaxies. Ap.J. 120, 597, 1955.

H. W. Newton. Solar Activity (Council Note). M.N. 114, 358, 1954.

H. W. Newton and H. F. Finch. Solar Activity and Geomagnetic Storms. Observatory February No., 1955.

H. W. Newton and A. S. Milsom. The Distribution of great and small Geomagnetic Storms in the Sunspot Cycle. Journal of Geophysical Research 59, 203, 1954.

H. W. Newton and W. R. Piggott. Observational Aspects of Solar Corpuscular Radiation. Huitième Rapport de la Commission pour l'étude des Relations entre les Phénomènes Solaires et Terrestres, p.101.

A. E. Carter, J. G. Porter, D. H. Sadler. The Card-Controlled Typewriter in H.M. Nautical Almanac Office. J.R.N.S.S. 9, 6.

G. E. Taylor. The Prediction of Occultations of Stars by Minor Planets. J.B.A.A. 65, 2.

IX. PERSONAL ESTABLISHMENT.

The total non-industrial complement of the Royal Observatory and the Nautical Almanac Office remains at 113.

The following officers have joined during the year:- Mr. W. Nicholson, Scientific Officer; Mr. J. W. Gietzen, Experimental Officer; Miss P. P. Scott and Mr. J. E. Simes, Assistants (Scientific).

Dr. D. S. Perfect, Principal Scientific Officer, was invalided on May 1. Miss F. E. A. Jeffries, Senior Assistant (Scientific), retired on July 31.

Mr. J. L. Rudd, Experimental Officer, died suddenly on March 11.

Miss O. Marshall ceased duty as Hostel Warden on the closing down of the Admiralty Hostel at "Feldemore", Holmbury St. Mary, on February 12.

The following promotions have been made during the year:- Mr. G. B. Wellgate, Senior Scientific Officer to Principal Scientific Officer, Mr. N. P. O'Hara and Mr. E. Shepherd, Assistants (Scientific) to Assistant Experimental Officers, and Miss B. E. Carey, Clerical Assistant to Clerical Officer.

Mr. D. R. A. Christie, Miss A. M. Crisford, Mrs. J. H. Lamb and Mr. R. G. Lorton have been established in the grade of Assistant (Scientific).

Mrs. F. M. Sadler (née McBain) was married and re-engaged in her grade of Principal Scientific Officer in a temporary capacity. The following officers were also married during the year and retained in their existing capacities:-

Mrs. M. McI. S. Wayman (née Gibson), Assistant Experimental Officer; Mrs. A. J. Candy (née Nevell) and Mrs. J. N. Lamb (née Phillips), Assistants (Scientific); Mrs. W. Boorman (née Barton) and Mrs. B. S. Hayhurst (née Crowley), Temporary Assistants (Scientific); and Mrs. R. Christie (née Weakley), Established Typist, Grade I.

REPORT OF THE ASTRONOMER ROYAL

The staff of the Royal Observatory and Nautical Almanac Office is now constituted as follows:-

(a) Royal Observatory.

Chief Assistants (Senior Principal Scientific Officers)	- R. d'E. Atkinson, M.A., Ph.D., T. Gold, M.A.
Principal Scientific Officers	- H. F. Finch, B.Sc., A. Hunter, Ph.D., B.Sc., A.R.C.S., H. W. Newton, H. M. Smith, B.Sc., M.I.E.E., F.Inst.P., L. S. T. Symms, G. B. Wellgate.
Scientific Officer	- P. A. Wayman, M.A., Ph.D.
Temporary Scientific Officer	- P. J. D. Gething, Ph.D., M.Sc.
Senior Experimental Officers	- H. H. J. Barton, E. A. Chamberlain, E. G. Martin, P. L. Rickerby, G. W. Rickett, G. F. Wells.
Experimental Officers	- L. J. Bates, K. C. Blackwell, A. E. Cordwell, H. G. Gill, J. W. Gietzen, W. G. Grimwood, C. C. Harris, P. S. Laurie, B. R. Leaton, B.Sc., D. R. Palmer, Miss C. J. A. Penny, B. Sc., J. D. Pope, B.Sc., A.M.I.E.E., A. Shortland, R. H. Tucker.
Head of Royal Observatory Workshop	- A. C. S. Wescott, B.E.M.
Head of Chronometer Repair Shop	- D. W. Evans, F.B.H.I.
Assistant Experimental Officers	- A. M. Allen, P. M. Corben, B. J. Harris, B.Sc., A. P. Lamb, C. A. Murray, M.A., A. S. Milsom, N. P. O'Hora, E. Shepherd, D. C. Smith, E. A. Whitaker.
Assistants (Scientific)	- D. R. A. Christie, Miss H. Howe, Mrs. J. H. Lamb, R. G. Lorton, C. M. Lowne, Miss P. M. Morris, Miss M. Newman, Miss D. E. Pankhurst, N. S. C. Rhodes, Miss C. M. Ryall, Miss S. W. Slater, R. W. Teague, Miss V. E. Terry.
Temporary Assistants (Scientific)	- B. T. Archer, Mrs. W. Boorman, Mrs. B. A. Hayhurst, Miss M. A. Jeffery, Miss V. L. Papworth, Miss R. E. Sare, G. E. Satterthwaite, Miss P. P. Scott, P. Sykes, J. E. Simes, R. F. Wallis, P. J. Willmoth.

(b) Nautical Almanac Office.

Superintendent (Senior Principal Scientific Officer)	- D. H. Sadler, M.A.
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Principal Scientific Officer	- J. G. Porter, B.Sc., Ph.D.
Temporary Principal Scientific Officer	- Mrs. F. M. Sadler, M.A.
Scientific Officers	- W. Nicholson, B.Sc., G. A. Wilkins, B.Sc., Ph.D.
Senior Experimental Officers	- A. E. Carter, H. W. P. Richards, B.Sc., W. A. Scott, B.Sc.
Experimental Officers	- G. A. Harding, Miss M. R. Rodgers, E. Smith.
Assistant Experimental Officers	- M. P. Candy, D. A. Harragan, Mrs. A. M. Jarrett, B.Sc., Miss P. V. Knight, Mrs. M. McI. S. Wayman, B.Sc.
Senior Assistant (Scientific)	- G. E. Taylor.
Temporary Senior Assistant (Scientific)	- J. H. Barry.
Assistants (Scientific)	- Mrs. A. J. Candy, Miss A. M. Crisford, Miss A. B. Grogan, Miss E. J. M. Grove.
Temporary Assistants (Scientific)	- Miss V. Pessell, Mrs. I. M. Rhodes.

(c) Secretariat.

Secretary and Cashier (Higher Executive Officer)	- H. G. Barker.
Higher Clerical Officers	- H. P. C. Cook, J. H. Whale.
Clerical Officers	- Miss S. M. Billenness, Miss B. E. Carey, F. A. Everest, Miss J. E. Perry.
Librarian (Temporary Assistant)	- W. P. Preston.
Clerical Assistant	- Miss J. A. Morris.
Established Shorthand Typists, Grade I	- Miss A. R. Hewerdine, Miss C. V. Hewerdine.
Vari-typer Operators, (Established Typists, Grade I)	- Mrs. R. Christie, Miss S. K. Page.
Established Typist, Grade I	- Miss J. A. Pumfrey.
Temporary Shorthand Typist, Grade I	- Mrs. V. Hyde.
Temporary Shorthand Typist, Grade II	- Miss E. M. Swanborough.
Vari-typer Operator, (Temporary Typist, Grade I)	- Miss V. Kemp.
Temporary Clerk Grade III	- Mrs. H. L. Halloran.
Hostel Warden	- Mrs. E. M. Marples.

The industrial staff employed at Greenwich, Herstmonceux, and Abinger total 82 including Hostel staff, who, although not borne on the Observatory Vote, are attached to the Establishment for administration and pay.

REPORT OF THE ASTRONOMER ROYAL

The various grades are as follows:- fourteen watchmakers, one watchmaker apprentice, six laboratory mechanics, one mechanic, one fitter, two storehouse assistants, one head gardener, one forester, five messengers, two packers, three boiler attendants, three drivers, five skilled labourers, four night-watchmen, one caretaker, five gardeners, six labourers, two switchboard attendants, ten part-time cleaners and nine Hostel domestic staff.

X. ISAAC NEWTON OBSERVATORY.

Professor P. M. S. Blackett was nominated by the Council of the Royal Society as a member of the Board of Management to succeed Sir Thomas Merton on December 31, and Mr. G. T. Smith-Clarke was nominated by the Council of the Royal Astronomical Society to succeed Sir John Carroll on the same date. Sir John Carroll, however, at the express request of the Board, accepted an invitation to place his expert knowledge at their disposal for a further year, and was accordingly co-opted.

Expenditure amounting to £11,850 has been approved for the financial year beginning 1955 April 1.

Further tests of the figure of the 98-inch disk were made by Professor Redman at the works of Sir Howard Grubb, Parsons & Company, during the works holiday period in August, when there were no disturbing effects of vibration from heavy machinery. The mirror was placed horizontally and supported on an air bag, so as to be free from strain, and the tests were made from a staging over the mirror. The figure was found to be appreciably free from astigmatism, but the tests showed some differences from the earlier tests with the mirror in a vertical position. It was suggested by the firm that a change of figure might have taken place as a result of gradual release of strain in the glass through its optical working. Though this is inherently improbable, the mirror has been put aside for further tests at a future date, as it will be a few years before the telescope has been constructed.

A study design contract for the telescope has been placed with Sir Howard Grubb, Parsons & Company. The Board of Management has appointed a small Executive Committee, consisting of Professor R. O. Redman, Professor H. H. Plaskett, and Dr. R. d'E. Atkinson, to discuss details of the mechanical and optical design with the firm and to report to the Board of Management as and when necessary.

The method of artificial stiffening of structures proposed by Mr. B. N. Wallis has undergone some tests by means of the model constructed under contract by the Engineering Laboratory of the University of Cambridge. A number of variants are still to be tried, to discover the most stable and sensitive arrangement, but the apparatus has already demonstrated that the changes of length of a steel tube under stress can be reduced to less than one-eighth by this method.

XI. GENERAL.

Mr. M. F. M. Fahim of the Egyptian Meteorological Office spent a period of eight days at the Magnetic Observatory, Abinger, receiving instruction in the work of the establishment.

Dr. R. V. Hesketh visited the Abinger Magnetic Observatory in connexion with the building and installation of a magnetic station in the Falkland Islands.

Dr. N. S. Alexander of University College, Ibadan, visited the Abinger Magnetic Observatory in connexion with a similar project in Nigeria.

During the year a number of astronomers and geophysicists visited the various establishments of the Royal Greenwich Observatory, among them the following:-

Mr. S. Lahear Ahsan, University of Karachi, Pakistan.
 Prof. V. A. Ambartsumian, President of the Academy of Sciences of Armenian S.S.R., Erevan, Armenia.
 Sir Edward Bullard, Director of the National Physical Laboratory.
 Lieut. S. Chansuvan, Bangkok Hydrographic Service.
 Mr. A. E. Covington, Radio & Electrical Engineering Laboratory, National Research Council, Canada.
 Mr. W. Hannafor, Dominion Observatory, Ottawa.
 Mr. J. Hers, Union Observatory, Johannesburg.
 Prof. K. Hujer, University of Chattanooga, Tennessee.
 Mr. R. G. Madill, Dominion Observatory, Ottawa.
 Mr. W. S. McClenahan, Dominion Observatory, Ottawa.
 Dr. W. Markowitz, U.S. Naval Observatory, Washington.
 Mr. J. H. Nelson, U.S. Coast and Geodetic Survey, Washington.
 Rev. D. J. O'Connell, S.J., Director, Vatican State Observatory, Castel Gandolfo.
 Mr. Prem Pakash, Indian National Physical Laboratory, Delhi.
 Prof. Megh Nad Saha, Director, Indian Association for Cultivation of Science, Jadavput, Calcutta.
 Dr. L. E. Salanave, California Academy of Sciences.
 Dr. P. H. Sarson, Dominion Observatory, Ottawa.
 Prof. L. Slichter, University of California, Los Angeles.
 Dr. C. H. Smiley, Ladd Observatory, Brown University, Rhode Island.
 Mr. D. W. N. Stibbs, Commonwealth Observatory, Mount Stromlo, Canberra.
 Mr. Oliver Strauss, National Company, Malden, Massachusetts.
 Mr. J. Todd and Dr. Olga Todd, U.S. National Bureau of Standards, Washington.

Other visitors included members of the Court of Assistants of the Worshipful Company of Clockmakers, the Rt. Hon. Lord Pethick Lawrence, Admiral Sir Cecil Harcourt, Sir George Cuffe, Sir Harry Trusted, Q.C., Professor M. de Souza of the Brazilian Ministry of Labour.

Four parties of officers from special courses at H.M.S. DRYAD and the Royal Naval College, Greenwich, have visited Herstmonceux during the year.

The Astronomer Royal has been elected a Foreign Associate of the Académie des Sciences of the Institut de France, and a Foreign Member of the Société Royale des Sciences de Liège.

The Astronomer Royal has been awarded the Rittenhouse Medal by the Rittenhouse Astronomical Society of Philadelphia.

REPORT OF THE ASTRONOMER ROYAL

The Astronomer Royal attended the meeting of the Executive Committee of the International Astronomical Union at Liège in July. This meeting was followed by an international symposium on "Solid Particles in Astronomy", which was attended also by Mr. T. Gold.

The Astronomer Royal attended, as a delegate from the Royal Society, a small conference of representatives of Western European countries, held in Paris in November, for discussions about a proposal for the joint establishment of a southern observatory in South Africa.

The Astronomer Royal, Mr. T. Gold, and Mr. H. F. Finch attended the General Assembly of the Union of Geodesy and Geophysics, held in Rome in September. The subsequent meeting of the Special Committee for the International Geophysical Year was attended by the Astronomer Royal and Mr. Gold. The meeting of the Executive Board of the International Council of Scientific Unions, which was held in Naples immediately afterwards, was attended by the Astronomer Royal.

The Astronomer Royal and Mr. Gold attended the meeting of the British Association in Oxford in September. At a Convocation of the University, preceding the Presidential Address, the Honorary Degree of Doctor of Science was conferred on the Astronomer Royal.

The Astronomer Royal and Mr. I. S. T. Symms attended a conference on astrometry, held in Brussels in March, at which future programmes of meridian observations were discussed.

Mr. D. H. Sadler visited the U.S.S.R. in May at the invitation of the Soviet Academy of Sciences. He was one of the two British representatives at the ceremonies and conferences associated with the re-opening of Pulkovo Observatory at which he represented the Royal Greenwich Observatory, as the Astronomer Royal had been unable to accept the invitation. During his stay he was able to visit the Institute for Theoretical Astronomy in Leningrad, with which the Nautical Almanac Office exchanged astronomical calculations under international agreements. He also visited the Sternberg Astronomical Institute in Moscow, and other scientific and cultural institutions.

Mr. D. H. Sadler paid a short visit to Washington in October to discuss with Dr. G. M. Clemence, Director of the U.S. Nautical Almanac Office, the proposed unification of the "American Ephemeris" and the "Nautical Almanac". He was flown in both directions by the air transport service of the U.S. Navy. The conformity of the two publications, to be introduced as from 1960, is the direct outcome of this visit; it could hardly have been attained without such close personal contact.

Mr. H. M. Smith attended the International Congress of Chronometry in Paris in October, and presented two papers, one by himself and Mr. J. D. Pope on "L'appareil actuel du service horaire de Greenwich", and the other by himself and Mr. R. H. Tucker on "Calibrage des etalons de frequence, quartz et atomiques". These papers will be published in the transactions of the Congress. Mr. Smith afterwards visited the Paris Observatory to study the impersonal prismatic astrolabe.

In September, Dr. G. A. Wilkins attended the Summer School on Programme Design for Automatic Digital Computing Machines at the University Mathematical Laboratory, Cambridge.

TO THE BOARD OF VISITORS, 1955 JUNE 4.

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Consideration has been given to the participation of the Observatory in the general programmes of observation to be undertaken during the International Geophysical Year, 1957 July to 1958 December inclusive. Since many geophysical phenomena are closely related to the various aspects of solar activity, it is essential that the Sun should be kept as nearly as possible under continuous observation during this period. The normal hours of observation of the Sun will therefore be extended, as at other solar observatories, and additional observations will be made during the alert periods, when special activity is to be expected. In connexion with the world programme of longitude and latitude determinations, the photographic zenith tube will be used for the observations at Herstmonceux, and it is planned to obtain an impersonal prismatic astrolabe for the observations at Greenwich. With each of these instruments time and the variation of latitude can be determined free from personal equations, so that Greenwich and Herstmonceux will be tied into the world network with high accuracy. The receptions of radio time signals will be considerably increased. The seasonal changes in the rate of rotation of the Earth and the movements of the pole depend upon the general circulation of the atmosphere. The information on these subjects that will be derived from observations at many stations and at various altitudes during the International Geophysical Year should enable a closer evaluation to be made of the relationships between these phenomena. The times of reception of radio time signals will provide information about the velocities of travel of radio waves of long and short wavelengths and of the dependence of these velocities upon ionospheric conditions. It is hoped to extend the cosmic ray observations to include the recording of the neutron flux. Approval has been given for the building of the magnetic observatory at Hartland, and the buildings are expected to be completed in time for equipment to be installed and observations to be commenced before the beginning of the International Geophysical Year. The necessary overlap in observations between Abinger and Hartland will therefore be made during that period, so adding to the available magnetic data. The Abinger magnetic observatory will be closed after the completion of these observations.

The enlarged programmes of observations to be undertaken by the Observatory during the International Geophysical Year will require additional staff. The removal from Greenwich to Herstmonceux has reached a stage at which full observing programmes can shortly be commenced. The present staff of the Observatory is seriously inadequate for these programmes. Considered proposals for the adequate staffing of the Observatory will be submitted to the Board of Visitors in a separate memorandum. If the required increase in staff is approved by the Board of Admiralty, the additional staff required for the special programmes during the International Geophysical Year can be provided from this increase and absorbed afterwards into other programmes of observation.

H. SPENCER JONES
Astronomer Royal

ROYAL GREENWICH OBSERVATORY,
HERSTMONCEUX.
1955 April 1.