

REPORT OF THE
ASTRONOMER ROYAL
*to the Board of Visitors
of the
Royal Greenwich Observatory*

Read at the Annual Visitation of the Royal Observatory, 1953 June 13.

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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, 1953 June 13.

The Report here presented refers to the period from 1952 May 1 to 1953 April 30 and exhibits the state of the Observatory on the last named day.

I. GROUNDS AND BUILDINGS

(a) Greenwich. Repairs to the structure of the Wren building have been completed, and the Octagon Room and staircase have been painted, by the Ministry of Works; the colour scheme is cream and saxe blue, which are thought to be the original shades; the windows have been fitted with leaded glass, artificially imperfect, to resemble those shown in drawings of Flamsteed's time. Linoleum to match that in the Maritime Museum has been laid, both there and in the Airy Transit Circle pavilion, and some cases of exhibits have been brought up from the Museum and put on display. The Bradley Zenith Sector has been removed from the Airy pavilion, where it had hung since its return from South Africa in 1851, and the brasswork and sector have been cleaned by the British Museum; the plumb-bob and various auxiliary items are missing, and duplicates may be made later. The tube itself has been cleaned by the Maritime Museum, and a wooden pier is being constructed for it there; this will be painted to resemble stone, but is a light-weight structure suitable for museum display. The Halley Transit is being provided with a similar pier by the Observatory, and both instruments will be set up in the Octagon Room for the present. Photographic copies of various old prints, generally of Flamsteed's time, are being prepared for hanging on the walls. A temporary loan is being made to the Maritime Museum of some of the important old manuscripts in the Observatory's possession, for showing in the Octagon Room, which is to be formally opened by H.R.H. the Duke of Edinburgh on May 8th. The Octagon Room will thereafter be accessible to the public at regular Museum hours, warders being provided by the Museum. The Airy Transit Circle may be shown to visitors in addition, subject to its not being in use for observation at the time. In preparation for the opening, the Ministry of Works have resurfaced the courtyard and repainted the Main Gates; they have also replaced the stone "meridian line", in the path outside the Observatory, with a more prominent line, sunk into larger stones.

The Time Ball was brought into operation again on October 26th and has been dropped at 1300 daily since then, with occasional exceptions due to dangerously high winds, or to the need for minor adjustments.

The Lower Store has been given up to the Ministry of Works and conversion work is now proceeding on it. The mirror-grinding machine housed in it has been disposed of and all the other contents have been removed to the Central Store.

The removal of books from the Library to Herstmonceux, which is being carried out by the Workshop staff, is now nearing completion; about 24000 volumes have been transported and placed in the new library there. Some of the shelving from Greenwich has been transferred to the huts at Herstmonceux, and will be used for storing some of the contents of the Greenwich Record Rooms.

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The main office of the Time Department was transferred to the old Wireless Room in October, at which time the Control Room, which had been serving both functions, was repainted. Internal painting has also been carried out in the Astrographic dome, and on the staircase and landing leading to the new Time Department office and to the Sheepshanks dome. In the New Building, the entrance, general office and adjacent rooms, and the Foreman's office, have also been painted. Exterior painting on the north side of the Old Building, the Control Room and Chart Room and on the Astrographic and Altazimuth domes has been completed.

(b) Abinger. The domestic water supply to Feldemore is drawn from the supply mains and fed to storage tanks in the roof by means of an electrically-driven booster pump. This system has given much trouble from repeated failures; various modifications to the pump and motor have not resulted in any permanent improvement. A new pump and motor have now been obtained, and will be fitted shortly.

Considerable inconvenience to the operational work of the Time Service has been caused by the large variations in the voltage of the mains electricity supply. As a result of discussions with the Electrical Engineering Manager, Chatham, and the Supply Authority, a static balancer has been installed as a temporary measure, pending modifications in the supply arrangements.

(c) Herstmonceux. The replacement of portions of the stonework of the south gateway and towers of the Castle has continued throughout the year. This work is being carried out by the Ministry of Works, who have accepted responsibility for the maintenance of the external fabric of the Castle.

The large wooden hut within the courtyard of the Castle has been dismantled and removed, thereby much improving the appearance of the courtyard. This is the first of the temporary buildings, erected during the war by the Hearts of Oak Friendly Society and acquired by the Admiralty with the Castle, to be removed.

The lighting of the Great Hall of the Castle, which has been adapted as a library, has been completed except for the reading lamps on the tables. Strip lights have been fitted in each bay between the book stacks under the gallery, and along both sides of each row of stacks in the gallery. Three specially designed fittings provide general illumination. The books brought from Greenwich have been arranged in the library, but not all are as yet in their final places.

The verges of the roadway to the east gate, which will give access to the Equatorial Group and to the Isaac Newton reflector, have been turfed. The area of the Meteorological Enclosure has been levelled and fenced; the housing for the anemograph recorder is nearing completion.

The foundations for the Control Building for the Photographic Zenith Tube were completed several months ago. The erection of the building itself, which is largely of wooden construction and of a prefabricated nature, was deferred until the spring and is now in progress.

In order to provide the maximum degree of stability for the large pier, which is to carry the Cooke Reversible Transit Circle and the two collimators, it was decided to support the pier on piles. Twelve piles have been driven to a depth of 34 feet 6 inches below the ground surface. The piles are of reinforced concrete; the steel reinforcing rods will be bent over at the top and will be incorporated in the pier, thus integrating the pier with the piles.

Contracts have been let for the manufacture and erection of the buildings to house the Cooke R.T.C., the Photographic Zenith Tube, and the Bamberg Small Transit. The foundations for each of these buildings, as well as the piers for the telescopes, will be done Departmentally. The expected completion dates for these buildings will be much delayed, but it is still hoped that the buildings will all be erected by the end of the present year.

In connexion with the retriangulation of the United Kingdom, the Ordnance Survey is to fix a datum point in a position that has been selected to the south of the site for the Isaac Newton telescope. When the base plate of the Cooke R.T.C. has been placed in position and before the walls of its housing have been erected, the position of the baseplate relative to the datum point will be determined. It will thus be possible to derive an accurate geodetic connexion between the Cooke R.T.C. at Herstmonceux and the Airy T.C. at Greenwich.

The working drawings for the Equatorial Group of instruments have been completed. Tenders for the steel work have been invited. It is expected that it will be possible to accept a tender for the buildings before the end of the summer.

Preliminary plans of the buildings to house the Time Department and Nautical Almanac Office, the Observatory Workshop, the Chronometer Repair Shop, and to provide miscellaneous storage accommodation and a works pound, have been considered. Some modifications to these plans were required and revised plans are in course of preparation. It is hoped that it will prove possible to accept a tender for construction by the spring of 1954.

Several further areas have been planted with trees, shrubs, or hedges in accordance with the scheme for landscaping.

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.
 - 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 4-inch astronomical telescope and stand, from the Oppenheimer Casing Co. (U.K.) Ltd.
 - Two 35-mm. cinema cameras, from the Admiralty Research Laboratory.
- Several other smaller instruments are also on loan to the Royal Observatory.

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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, Simms No.2.

To the Cavendish Laboratory, Cambridge:-

A synchronome slave clock.

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 gravity drive clock and five plate-holders for use at the 1952 eclipse.

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, has been dismantled preparatory to its return to Cambridge in the near future.

The Harrison's Time Machines, Nos.1,2 and 4, and the copy of No.4 by Larcum Kendall were loaned to the Science Museum for the special exhibition "The British Clockmaker's Heritage", which was organized by the Antiquarian Section of the British Horological Institute and open from the 23rd May to the 14th September, 1952.

A half-plate camera, with Cooke F 6.5 lens and accessories, has been presented by Mr. D. J. R. Edney.

An unprecedentedly large proportion of the apparatus sent out to the Sudan eclipse stations received damage. Castings have had to be welded, or entire fresh patterns and castings made, for two coelostats, both of which had been borrowed, and for the reversing gear of Small Transit C, which had been taken to the En Nahūd station to determine its longitude; there was a good deal of minor repair work to be done on this transit in other respects also. The old north library room at Greenwich has been turned temporarily into a store for eclipse equipment.

The errors of the spiral micrometers, of the glass scales, and of the plane guiding faces of the Zeiss plate measuring machine, whose purchase was mentioned in last year's report, are being investigated. An adapter has been made for the machine to take the small plates that will be used in the Photographic Zenith Tube; until a special machine is constructed for the measurement of these plates, the Zeiss machine will be used. An adapter supplied with the machine has been modified to take 16 cm. by 16 cm. plates.

Transit C has been erected in the old Small Transit pavilion, on the "Bradley" meridian. This instrument employs the micrometer originally made in the Observatory

Workshop for the "personal equation machine". It has also been fitted with weight-relieving gear; the bubble from the striding-level, which was in use with Small Transit B, has been mounted directly on the central cube of the instrument, and reverses with it, so that there is now no tendency to wear flats on the upper surfaces of the pivots by placing the striding-level on them. Levels can thus only be taken with the telescope pointing to the zenith; but since the pivot-form has been made very good nothing would be gained by using other positions, and on the old system the readings were subject to a progressive risk of falsification as wear developed. A spare bubble has been similarly fitted to the cube of Small Transit B; comparison revealed no actual discontinuity in the readings, due to the change, but the new arrangement is quicker and much safer.

In October, a tape-chronograph was installed for use with the Airy Transit Circle. For some time previously this instrument had been sharing a chronograph with the Small Transit, which was inconvenient. The old Airy barrel chronograph, with the original conical pendulum drive, is still kept in use; the tape record is ordinarily used for measuring, as it has the longer scale, but the sheets of the barrel chronograph provide a much more convenient form of file, in case any subsequent reference to the chronograph records is required.

Cooke Reversible Transit Circle

The new object-glass was tested in the laboratory of the Astrometry Department, and then on stars. The focal length is 0.6 inch greater than the old one, which necessitated the construction in the Workshop of a new counter-cell. The lens is a very great improvement on the original lens. The coma which made the old lens almost useless for off-axis observations is entirely absent out to the limits of the field that will be used, and extrafocal and intrafocal images confirm the general good quality.

It seemed desirable to repeat with the new lens the work on the collimation-error and its dependence on temperature. The small part of the total effect which could be ascribed to the lens and cell was in fact found to be different with the new assembly. Advantage was taken of the long delay in erecting the new pavilion at Herstmonceux to repeat and check the previous tests, and to extend them to similar tests on the nadir-point. The main previous result is fully confirmed: so long as the temperature of the instrument is changing, the collimation has a false value, and it returns nearly to the old one when the temperature becomes steady, with only a small difference that can be ascribed to an actual temperature-coefficient. It may prove necessary to take special precautions, in the insulated pavilion to be installed at Herstmonceux, to prevent the collimation during actual observations of the Sun being different from that determined before or after. Rotating the eye-end half of the telescope tube through 180° still reduces the effect very greatly and it seems clear that what is responsible is an unequal wall-thickness. It may well be found that a similar nadir-effect cannot be cured by the same means, at the same time.

The cameras for photographic recording of the circle-readings were received from the makers in November, but inspection revealed so many faults of design and workmanship that all 25 were returned for correction. One has now been received again, and is being examined in the Workshop.

Photographic Zenith Tube

The various finishing processes referred to in the previous report have now been completed. Some portions of the instrument have been delivered to Herstmonceux and all will be received before the pavilion to house the instrument has been erected.

Measuring Machine for P.Z.T. Stellar Plates

The photocells required for the microphotometric method of setting have recently been delivered and it is thus hoped that investigation of the method will shortly be resumed.

Further consideration of the design has suggested the desirability of certain modifications of the previous proposals. The mechanical lay-out is much simplified if a single carriage is used as it is in the Zeiss measuring machine; the elimination of the Y-traverse carriage, the guiding ways of which needed to be of very high accuracy, considerably facilitates the mechanical construction. In order to employ the microphotometric method of setting it is necessary to retain the system of measuring only in one co-ordinate and of transposing through 90° to obtain the other measurements. In the system now proposed, however, the angle of transposition is not critical since the optically polished square, which was previously intended for an autocollimation measurement of transposition, now becomes the co-ordinate frame of reference and errors of orientation are only of the second order. To facilitate the transposition it is proposed to retain the turn-table to carry the reference square and to mount it on the single carriage.

Since the pattern of star images to be measured is not random but is nominally rectangular, it is considered preferable to control the motion of the carriage by a pair of rectangular guide frames (the constraints of which are not critical) rather than by a mechanical linkage of the type used in the Zeiss machine. This system has the further advantage that the measuring scale can be carried by the X-guide frame. Consequently the scale suffers only minute displacements relative to its supports and a simple elastic mounting can therefore be provided. A further proposal which has been under consideration is to replace the divided glass scale, as the basis of measurement, by a Moiré fringe micrometer of the type at present in course of development by the National Physical Laboratory. This has the primary advantage of providing the highest precision required, while avoiding the necessity of calibrating the scale. Moreover, since the scale "divisions" would be very small (of the order of 1μ), the range of the optical micrometer, which it is proposed to retain for settings on the stellar plate so as to avoid the need of exact adjustment of the carriage, would be very considerably reduced.

Horizontal Transit Instrument

The telescopic system of this instrument has been erected on a concrete pier in the Optical Laboratory and used for preliminary investigation of the photoelectric method of determining transit times which it is proposed to adopt in connection with the Longitude Programme for the International Geophysical Year in 1957-58. In the course of this work, methods of making various auxiliary adjustments such as "squaring-on" and the autocollimation method of level determination have been tested. It had previously been proposed to employ a photographic method for the chronographic part of the instrument. This method, while sound in principle, is liable to be laborious in practice. As a result of the recent photoelectric work an alternative and more direct method of determining the times of parallelism of the "contact" mirrors by photoelectric recording has been proposed. Apparatus for testing this method is under construction.

Yapp 36-inch Reflector

Photoelectric guiding-apparatus, intended to fit this telescope and to be tried out on it as a pilot-experiment for the Isaac Newton reflector, has been under construction in the Engineering Department of the University of Birmingham. A wooden

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model, to verify clearances and other points, was constructed by the University, but it revealed that there had been some misunderstanding of the optical conditions. Though the instrument would fit into the telescope some redesigning was required before it could work with actual photographic plates. This is in progress, and arrangements for the necessary electrical connections have been surveyed.

Experiments have been made at the Outside Broadcast headquarters of the B.B.C. Television Service at Wembley on televising the disk of Jupiter, using a 14-inch reflecting telescope fed by a coelostat. Promising results were obtained with the very sensitive photocathodes used in modern television cameras, and it is proposed to attach such a camera to the Yapp reflector during the coming autumn, and to use it to show Jupiter in a short astronomical programme.

Field Equatorial Mounting

This equipment, constructed shortly before the war for use on eclipse expeditions, is being adapted to take the tube of the 21-foot eclipse camera, hitherto used only with a coelostat; at the same time, it is being slightly modified for use in high latitudes. It will then be erected in the old Thompson dome, and tested out with a view to using it at the eclipse of 1954 June 30.

Library

It is expected that the removal of the library from Greenwich to Herstmonceux will be completed by the end of July. The removal has provided an opportunity to discard many volumes of meteorological observations, for which the Observatory has no use.

It has not been practicable to take stock of the contents of the library this year, and the usual figures relating to missing books are therefore not available. A complete stocktaking will, however, take place in connection with the rearrangement and recataloguing of the library which will be begun as soon as the move is complete.

III. ASTRONOMICAL AND RADIO OBSERVATIONS

Airy Transit-Circle

Observations continue to be restricted to the Sun, Moon, and Planets, together with stars required for the determination of the clock and azimuth errors. The following observations were obtained during the year:-

Sun	153	Mars	13	Neptune	12
Moon	107	Jupiter	19	Ceres	9
Mercury	10	Saturn	12	Pallas	9
Venus	48	Uranus	5	Juno	7

Transits for the determination of clock and azimuth errors number 1926.

Work on the proper motions for the first Greenwich Catalogue for 1950.0 continues slowly.

Astrographic Telescope

The main work with this instrument continues to be systematic observation of the positions of the brightest four minor planets. Photographs of Ceres, Pallas, John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

Juno, and Vesta have been secured on 21, 24, 30, and 7 occasions respectively. All last year's plates have been measured and reduced, together with 78 of the total of 82 taken during the current year. Comparison with the ephemerides shows not unexpected secular drifts, amounting at times to a few seconds of arc in right ascension; in declination, qualitatively similar effects are overlaid by sharp discontinuities where the planet concerned enters successively areas covered by different zone catalogues. Existing catalogue intercomparisons are being examined to see if they can provide corrections of sufficient precision to remove these discontinuities; if not, the observations themselves must be used for this purpose. It will be recalled that the minor planet Nemausa is at present under intensive international observation with a similar object.

The series of special observations, designed to discover whether any serious systematic error is introduced by observing at large hour-angles, has been continued. Up to the present, 71 of these hour-angle plates have been taken, 50 in the year under review. They extend more than six hours on either side of the meridian. This is a considerably greater range than is in fact used, and within the range actually employed in the minor planet programme there is little indication of any systematic effect. There is some suggestion of a small effect in right ascension at extreme hour-angles, but further observations are needed to establish its reality beyond doubt. No effect appears in declination.

In addition to the main programme, the following observations have been secured:-

Minor Planets	30
Jupiter and Satellites	8
Comets	2
Miscellaneous Fields	13

Measurement and reduction of all these plates is proceeding, and the places found for the minor planets will be communicated to Cincinnati Observatory. A few exposures were also made on the eclipse field of 1954 June 30 and on neighbouring fields, to test their suitability for use in a possible redetermination of the Einstein gravitational shift.

Lunar occultations have again been observed with the ten-inch guiding telescope whenever they occurred during photographic duties; eight results have been communicated to the Nautical Almanac Office.

The 5 $\frac{1}{2}$ -inch Ross aircraft reconnaissance lens which had been tried out in an auxiliary camera attached to the astrographic mounting was recalled in January by the R.A.E., from whom it had been borrowed. It has been replaced by a 5-inch Zeiss lens of the same focal length, which was purchased from the R.A.E. The off-axis performance of the new lens is considerably better than that of the Ross: its usable field extends almost to the edge of the 10° plate. For moderately extended objects such as the central condensations of comets, the short focal ratio of this camera compensates for its small aperture, and its wide field makes it more suitable than the astrographic for search purposes.

Yapp 36-inch reflector

Poor observing conditions, in particular the frequent occurrence of veiled skies even when cloud was absent, have reduced the number of nights on which the fainter K0 stars on the programme could be efficiently observed. The telescope has,

however, been used on such nights, and also on good nights when gaps in the main programme permitted, on the much brighter standard stars of the Morgan, Keenan, and Kellman *Atlas of Stellar Spectra*, the object being to accumulate a library of standard spectra, with the dispersion of the single-prism spectrograph, for future application to the temperature-luminosity classification of fainter stars. The Atlas distinguishes about 150 classes in a network of 250 standard stars. Up to the present, 166 spectra of 83 stars have been obtained in this programme, and a start has been made in recording microphotometer tracings of these.

The 7-inch guiding telescope has been used for observing 2 lunar occultations which occurred during photographic duties, and these results have been communicated to the Nautical Almanac Office.

Cape Zone Photographs

The last of the reductions in the Cape Zone -56° to -60° were completed in November, the final process being the transformation by conventional methods of tangential to spherical co-ordinates for those stars for which rough places had had to be used in computing their standard co-ordinates, and for which, therefore, the residuals were too large for differential corrections to be satisfactory. Cards containing final equatorial co-ordinates, on the FK3 system, for the 7700 stars in the zone have now been dispatched to the Cape, together with the plates and computations, for use in preparing the final catalogues.

Comparisons from R.A. overlaps between adjacent plates within the zone were made for 6367 stars. The internal probable error deduced for a single place is $\pm 0''.089$ in R.A. and $\pm 0''.080$ in Dec.; the final catalogue entry will usually depend on two, and occasionally on four, such places. In order to compare with adjoining zones measured and reduced at the Cape, certain stars were measured along the north and south edges of the zone. The systematic differences from the Cape places for these stars were found to amount on the average to

Boundary	R.A.	Dec.	No. of Stars
-56°	$+0''.02$	$+0''.22$	309
-60°	$+0''.24$	$-0''.23$	377

These seem satisfactorily small. Removing them, the external scatter corresponds to probable errors, for a single place, of $\pm 0''.100$ in R.A. and $\pm 0''.119$ in Dec. As expected, these are larger than the internal uncertainties, doubtless because the stars concerned are at the edges of the plates, where the image quality is relatively poor, and where the corrections applied during reductions are more uncertain.

Solar Eclipse, 1948 November 1

The large number of photographs (3100) obtained by the expedition to Mombasa, and the high precision with which they can be measured (p.e. of one position angle $\pm 1'$, in most cases), has resulted in a very detailed record of the behaviour of the line of cusps, during the 172 seconds near mid-eclipse over which the observations extend. Comparison with the behaviour to be expected on the basis of limb-traces supplied by the U.S. Naval Observatory showed that most of this detail could be rather faithfully reproduced, but that there were certain systematic divergences, of relatively long period, superimposed on it. The I.A.U. meeting in Rome provided an opportunity for some very useful discussion with Mr. Watts, of the Naval Observatory, who is correlating a large number of different limb-traces and systematically John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

adjusting the mean levels inferred from individual traces, so as to reduce them all to the best "mean sphere". As a result, Mr. Watts very kindly gave special priority to the traces for librations corresponding closely to the librations at the time of the eclipse. In December he sent traces on which the revised baseline heights had been entered. The position-angle curve reconstructed from these showed an encouraging decrease in the systematic divergences from the Mombasa results, but certain difficulties remained which suggested that his position-angles might contain small zero-errors, differing from one trace to another. He has recently reported that he has found a possible source of such errors, and it is expected that the resulting corrections will be received from him very shortly. The Mombasa results involve the combined effect of the irregularities at both cusps, and are thus sensitive in this respect; a difference between the position-angle systems of the two Washington traces has almost exactly the same effect as a change in the adopted semi-diameter of the Moon, and the analysis has been held up until the revised values can be incorporated. Meanwhile, a detailed re-examination of a short stretch of the eclipse results, where the lunar features are exceptionally pronounced at both cusps at the same time, has been undertaken, as it seems that it may now be possible to infer a correction to the lunar semi-diameter, as well as to both co-ordinates of the place of observation. A paper giving the general principles of the work is in the press, and one describing the actual operations at Mombasa is nearly complete.

Solar Eclipse, 1952 February 25

The films obtained at the three stations which had clear weather have been inspected, but actual measurement of the position angles has been deferred until the 1948 film could be re-examined, as mentioned above. It was known from focus-tests made at the time that the definition in the Sudan was poor, compared with that at Mombasa, and in fact all four observers had difficulty in deciding on the best focus-setting. In addition, all the three cinema films and the two photoheliograph ones appear surprisingly over-exposed; it seems possible that the development, which was carried out by outside agencies, may have been pressed further than the observers in the field carried it in their tests. Some experiments on reducing the films have been made, and more are contemplated. The chronograph records have all been read off; in all cases the reception of the time signals was too poor to permit direct recording of the eclipse exposures against the signals, but the alternative of recording against contact-chronometers, and checking these against selected stretches of signal, immediately before and afterwards, proved quite satisfactory.

Cosmic Ray Observations

The Cosmic Ray recording apparatus made by Messrs. Cinema-Television Ltd., for the Royal Greenwich Observatory has been installed at Herstmonceux. Preliminary tests have shown it to be satisfactory, and continuous recording has commenced.

The apparatus does not select any particular range of the cosmic ray spectrum, but counts the general flux with a very high precision. For this purpose it contains 90 Geiger counters, arranged in such coincidence circuits as to exclude all effects of local radio-activity. A photographic record shows the flux counted every five minutes.

The general cosmic ray flux is known to be affected by solar phenomena and associated terrestrial magnetic disturbances. A constant comparison will therefore be made with the results of solar and magnetic observations.

In addition to the recording of the general flux, it is intended to commence the recording of rare high energy showers. Such events are not thought to be related to solar phenomena, but any variations in this flux would be of astronomical interest. These observations will be carried out with the apparatus designed and used by Mr. T. Gold at the Cavendish Laboratory, Cambridge, and now purchased by the Observatory.

Facilities have been granted at Herstmonceux to members of A.E.R.E., Harwell, for the investigation of the recently discovered light flashes in the sky. These short bursts of light are thought to be Cerenkov radiation from cosmic rays in the atmosphere. A photoelectric recording unit has been installed in the solar dome, and observations to test the directional effects of the phenomenon are being made, both by members of A.E.R.E. and of the Observatory. These tests will have to be discontinued, however, during the summer months when the period of total darkness each night is too short.

Photoheliograph

The Sun was photographed on 311 days, a second photograph being taken except on 17 days. The improved conditions for solar work at Herstmonceux are reflected in this large number of available days as well as in the quality of the definition which continues to be maintained.

Twenty-six 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, no day is unrepresented in the combined series for 1952.

Consignments of solar negatives have been received from the Cape in duplicate from 1951 July 1 to 1952 December 31.

Measurement of the combined series has been completed from 1951 January 1 to 1952 September 30. Computations of sunspot positions and areas have been made from 1950 January 1 to 1952 January 29.

The MS. copy of the Greenwich Photoheliograph Results for 1947 and 1948 has been completed during the year. Varsity copy for the three years 1946 to 1948 will be prepared as soon as possible.

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. Several radio centres in this country are also sent a monthly mean value. The mean daily sunspot number for the twelve months covered by this report is 27, showing a decline from the value of 57 for the preceding period.

No very large sunspot has appeared during the last twelve months, but ten spots with maximum area above 500 millionths of the Sun's hemisphere have been recorded, the last of these crossing the Sun's central meridian on April 28 in north latitude 10° . This spot rose in area to 1100 millionths of the Sun's hemisphere.

A period that with few exceptions was spotless lasted from February 12 until March 27. Although this increased frequency of spotless days indicates the approach towards the minimum of the present sunspot cycle, no high-latitude spots have yet appeared.

An interesting feature of the past year or two has been the frequent occurrence of small, short-lived flecks of faculae (10 to 20 seconds of arc across) in the Sun's polar regions. Such flecks have been recorded before on Greenwich photographs, but the present high frequency appears exceptional. The improved definition of the Herstmonceux photographs may partly account for this increase.

A paper dealing with the frequency distribution of great and small geomagnetic storms and the sunspot cycle has been nearly completed. The summary for the year 1948 of mean daily areas and mean heliographic latitudes is being published in 'Monthly Notices'.

Spectroheliscopes

Observations of the Sun's disk in $H\alpha$ were made on 168 days, but on 63 days observations were restricted to a few minutes. Only eight solar flares were observed, and none of these was of major importance. This continued decrease in the number of flares is another indication of the impending sunspot minimum.

The twelve-monthly period under review was again an active one for solar particle radiation, as shown by the frequency of geomagnetic disturbance that can be ascribed chiefly to solar M-regions.

Reports of solar flares, their times of occurrence, positions and highest intensity observed with a wedge photometer were sent quarterly to Meudon for subsequent inclusion in the Zürich Quarterly Bulletin. Copies of these lists are sent to the usual radio research centres and to the Director, Meteorological Office, Air Ministry, London.

The S.E.A. recorder, installed in November 1951 and working on a frequency of 27 kc/s, was in operation throughout the year. The traces indicate the occurrence of some 17 solar flares in Greenwich daylight hours. Of the 8 flares observed with the spectroheliroscope, 4 coincided with typical impulses on the S.E.A. traces. The 4 remaining flares were only of minor importance but fell within the accepted definition of a flare.

A few spectra of the $H\alpha$ region were obtained with the grating of the Newbegin spectroheliroscope. These spectrograms have been passed through the microphotometer at Greenwich, and instrumental corrections were obtained.

Besides following the progress of solar flares, 85 measures of line-of-sight motions of dark hydrogen flocculi on the disk were obtained. On one occasion the measured velocity exceeded 100 km./sec. Similar measures were also made on many patches of normal bright flocculi around sunspots, but these rarely show significant line-of-sight motions. Twenty-nine photometer measures were made on patches of normal bright flocculi, in addition to 7 sets on solar flares. Seventeen 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.

Lyot Monochromatic Filter

A bi-refrigrant monochromatic filter of the type developed by the late Dr. Lyot and manufactured, originally under his guidance, by the firm of Optique et Precision

de Levallois has been on order since October 1952. It is intended that this filter should be fitted on to the $6\frac{1}{4}$ -inch Newbegin telescope in the Solar Building. The suitability of this telescope has been investigated and it has been found that light from the whole of the Sun's disk can be passed unvignetted through the optical parts of the filter. The minimum band-pass of the filter, working at $H\alpha$, is specified as 0.65 A.U. and a "line-shifter" is provided for adjustment of the wavelength over a small range. The filter will be used for daily photographs of the Sun in the light of $H\alpha$ and for sequences of photographs during disturbed periods. Automatic operation is not contemplated at present.

Solar Spectrographs

Preliminary design-work on new solar instruments in the spectrograph cellar of the Solar Building has been carried out. A train of three large glass prisms, one of which is the property of the Royal Society, has been received from Mr. John Evershed, F.R.S. Their suitability for a large spectrograph, capable of being used on a spectroheliograph, has been investigated and the prisms have been sent to Messrs. Hilger and Watts for a detailed interferometer test of their optical quality. A $10\frac{1}{2}$ -inch object-glass and two 16-inch quartz mirrors have been ordered from Messrs. Cox, Hargreaves and Thomson. They will be used to provide the solar image for both the spectroheliograph and a high dispersion spectrograph in which the liquid prisms, which Mr. Evershed is presenting to the Observatory, will be used.

The glass prisms will be used in a spectrograph with a focal length of twenty-one feet and will yield a theoretical maximum resolving-power of approximately 56,000 at $H\alpha$ and 264,000 at the K line. At present it is intended that the spectroheliograph should be suitable for making rapid and detailed photographs of limited areas of the Sun's disk, with an effective line-width of about 0.25 A.U. at $H\alpha$. The optical design which has been provisionally adopted will make it possible to cover the 7-cm. solar image without losing much light by vignetting. The motion of the image across the first slit of the spectrograph will be obtained by rotating a mirror about a vertical axis through a small angle.

In preparation for the installation of this equipment, the floor of the spectrograph tunnel and the passage leading to it have been given a bitumastic coating and the piers will be painted with a silicate sealing compound, so as to minimize trouble from dust.

Time Service

Throughout the year the Time Service has been based upon astronomical observations made at Greenwich using Small Transit B and at Abinger using the Bamberg Broken Transit instrument.

At Greenwich 188 observations were secured on 149 nights and at Abinger 232 on 131 nights, making a total of 420 observations during the twelve months covered by this report. At Greenwich, the adjustable bubble, which had been used on Small Transit C, was mounted on the tube of Transit B on June 19. The bubble from the old striding level has been mounted on instrument C. Parallel tests between the two instruments are being made. It is intended to withdraw Transit B and to give it a thorough reconditioning, including fitting it with precision-worked chromium-plated pivots, as soon as it can safely be spared. At Abinger, observations are being made in the early morning as well as in the evening, as a control over periodic errors in the system of right ascensions.

The time determinations made at Greenwich and Abinger are reduced to the standard Greenwich meridian by the application of the appropriate adopted longitudes. It has been found that there are significant variations between the time systems defined by the two instruments. From an examination of the residuals of observations from the finally-adopted time, "observer corrections" are derived which take into account the "personal equation" of the observer concerned as well as the mean difference between his observing station and the adopted mean of the two stations, called the "station correction". The determined "observer corrections" are not strictly constant; for current use the adopted values are based on an examination of a series of quarterly means.

As in previous years, the astronomical observations have been corrected for the effects of polar motion, for which the current latitude variation data, communicated regularly by the U.S. Naval Observatory, are used. These provisional estimates are subsequently amended, when the polar motion data from the International Latitude Service become available. The observations, after correction for polar variation, are referred to the mean of five or six selected quartz clocks and analysed to derive values of the seasonal fluctuation in the Earth's rotation. The values have proved to be in substantial agreement with those obtained in 1950-51, which were smaller than those derived in earlier analyses, though a slight tendency for the amplitude to show a small and persistent increase has been noticed in the last few quarters.

An investigation has been made of the effects of systematic star-place errors on time determination, based on the Normal System N30 of Dr. H. R. Morgan, who kindly supplied data in advance of publication. When the Greenwich and Abinger time observations are referred to the N30 system, the deduced annual fluctuation for current epochs is reduced from about ± 30 ms. to about ± 20 ms., and is in close agreement with the annual fluctuation derived from the American P.Z.T. observations, for which the star places are tied to the FK3 places in the equatorial zone, which the N30 catalogue indicates are substantially free from periodic errors. The Canberra time observations, when corrected for the FK3-N30 periodic difference in R.A. at the Canberra zenith, are also in satisfactory agreement. The results have been reported in a paper read to the Royal Astronomical Society.

The Time Service Bulletin has hitherto been based on the G.M.T. (or U.T.) determined at the Royal Greenwich Observatory, and the time signals transmitted by the Observatory have been regulated in conformity with extrapolated G.M.T. A high precision in time intervals is required for the standardization of frequencies. In recent years, the Time Service Bulletins have given the corrections required to remove the inequalities from the adopted G.M.T. and so to provide an approximately uniform time system.

The effect on astronomically determined time of the polar motion depends on the position of the observatory; that of errors of a periodic nature in the adopted right ascension system depends on the declinations of the stars observed which, in turn, depends on the latitude. The astronomical determinations of time at two different observatories are consequently not directly comparable.

From 1953 July 1, the transmitted time signals and the Time Service Bulletin of the Royal Greenwich Observatory will no longer be based on G.M.T. but on a provisional uniform time system. The deviation of G.M.T. (as previously used) from the adopted time system will be included in the Bulletin for those users desiring to

maintain continuity with the old system. The adopted co-ordinates of the pole will be included in a supplement to the Bulletin for the convenience of astronomical users. Continuity in the adopted time systems and in the adopted co-ordinates of the pole will be preserved by a suitable smoothing process.

The transition in the regulation of the transmitted time signals from G.M.T. to uniform time will be effected during June 1953, by means of an adjustment in the trend or rate of the signals. As the deviation of G.M.T. from uniform time will be approximately zero at this time, there will be no need to make an adjustment in the time of the signals.

Experience throughout the year has further confirmed the superiority of the oscillators employing ring crystals, and standards of this type have been used exclusively for prediction and for the preparation of final corrections. At Abinger, oscillator E5, having a silk-supported ring crystal, was stopped on November 25 after running without interruption for $2\frac{1}{2}$ years. The crystal was transferred from a Post Office type 14 oven to a type 17 oven and connected to a modified maintaining amplifier. After careful re-alignment it was put back into service on December 9. Oscillators B5 and B6, having GT-cut crystals, have been taken out of service. The ring crystal oscillator E6 was removed from service on April 6 for temperature adjustment and re-alignment. Various minor modifications are also being made to it. The equipment has been cleared from D cellar in order to provide accommodation for new clocks of the pattern developed in the electronics laboratory.

Two oscillators, to be mounted on brick piers at Greenwich, are being built to the same specification as those at Abinger; each will contain a GT-plate crystal removed from the Greenwich A group. The buffer valve of the maintaining amplifier of clock F1 failed on September 26; as the oscillator had been running for more than five years, advantage was taken of this opportunity to change all the valves. Oscillators A1 and A2 have given a reasonable performance throughout the year, but A3 and F3 have suffered a number of changes of rate.

The Observatory has continued to enjoy close co-operation with the Post Office Radio Experimental and Development Laboratory and the National Physical Laboratory and information on the quartz clocks at these establishments has been communicated regularly and employed in the control of the time service. Information has also been received on the frequency standards at the B.B.C. Receiving Station at Tatsfield and the Research Division, Marconi's Wireless Telegraph Co. Ltd. A general account of the quartz clocks employed in the Greenwich time service is being published in 'Monthly Notices'.

The installation of the new regenerative frequency dividers has been completed. Five pulse dividers operating from 1000 pulses to one pulse per second were brought into use at Abinger on January 1. These pulse dividers have replaced phonic motors for clock inter-comparisons and for mean time radio time signal reception, but the motors are still used for time signal transmission, rhythmic signal reception and sidereal time. The dividers are phaseable in steps of 0.1 second to facilitate the reception of radio signals when a short interval between signal and clock is desirable; the mean deviation of the output pulses is of the order of one microsecond compared with 0.1 milliseconds for the phonic motors.

In view of the occasional slipping experienced with the rotary beat counters, the power to the driving motors has been increased, which has cured the trouble.

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At the same time the phase relationship was made uniform throughout the six groups of counters to avoid discontinuities in the last figure during the change over from one group to another. Two additional groups of beat counters are in course of construction in the workshop to deal with the requirements of the additional experimental clocks. An electrically-operated camera has been installed to photograph the rotary beat counter dials. The shutter is at present hand-controlled but provision is being made for automatic control from the time signal transmitting motors. Routine photographs are taken daily on roll film, which is developed weekly. A second magazine has been adapted to allow single exposures to be taken on bromide paper when required.

The gate circuits of the decimal counters at Abinger have been replaced by the new type which, as reported last year, had been fitted to a similar counter at Greenwich. The modification has led to higher accuracy and reliability and makes the ancillary trigger unit unnecessary.

A Bélin printing chronograph has been tried out and tested for accuracy and a report issued. At the request of the Hydrographer several methods of determining the error of a chronometer by using radio time signals have been investigated and a report is being prepared.

The receiver for the seconds pulses of MSF on a frequency of 60 kc/s, referred to in last year's report, was brought into regular use at Abinger on December 1. A significant increase in measurement accuracy has been achieved. It was originally intended as a prototype, but as changes in the MSF transmissions are pending, further construction has been postponed.

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 sent out from the phonic motor transmitters at Abinger. The reserve service of hourly and six-pips signals has been maintained from Greenwich, and has been called on a few times when faults occurred on the Abinger lines. The circuits of the send-relays, which were referred to in last year's report as under construction at Abinger for installation at Greenwich, have been modified and a new and improved type of valve incorporated. The relays are now complete, together with control and monitoring panels, but final wiring of the rack is held up pending delivery of a special multicore cable.

For an experimental period of four weeks from May 19, the GBR time signals from Abinger were sent from London to Rugby on one channel of a three-channel high-speed VF line. A reduced scatter resulted and a request was therefore made to the Post Office for the permanent allocation of this channel, which was brought into regular use on September 26; the physical line previously used is retained as a reserve. Transmissions of Greenwich time signals from Rugby on both long and short waves have been monitored at the Observatory although, owing to reception conditions, satisfactory short wave reception cannot always be achieved. Regular 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. Radio time signals from Australia, France, Germany, Russia, and the U.S.A. have been received throughout the year. Since November signals have also been received from Argentina. Occasional measurements have been made of Canadian and Japanese radio time signals.

Publication of the Time Service Bulletin, together with its supplements, has been continued. A number of requests have been received from abroad for the complete series of the Bulletin. The Time Service Circulars and Monthly Frequency Estimates have been published regularly on or about the 15th of each month. Copy for the volumes of Greenwich Observations has been completed up to 1949 and the material for 1950 and 1951 is approaching completion.

The second experimental oscillator, G2, which was mentioned in last year's report, has been in operation since July. It incorporates a soldered wire-supported GT-cut crystal, which had previously been used in a conventional circuit as oscillator E2. Its performance had never attained the standard of accuracy which had been expected either in long-term or short-term stability. In the new circuit a high standard of short-term stability has been achieved, the scatter of the daily measures of frequency being reduced from about ± 1 part in 10^8 to about ± 1 part in 10^{10} over periods which may extend over more than a month. The long-term performance cannot yet be assessed. A further experimental oscillator G3, which incorporates the clamped GT-cut crystal previously employed in the operational clock B5, has been constructed and is undergoing test. The first experimental oscillator G1 was stopped in December and is now being rebuilt in the light of experience gained with G2 and G3. A fourth standard is under construction so that experience may be gained in the use of a ring crystal in the new circuits; a slightly sub-standard ring crystal is being made available for the preliminary tests by courtesy of the Post Office Radio Experimental and Development Laboratory.

For the study of the short-term stability of the new experimental oscillators and of the operational ring crystal oscillators, frequency measuring equipment of high accuracy is essential. A direct-reading frequency comparator is therefore being constructed, with which it is hoped to achieve a comparison accuracy at 100 kc/s of ± 2 parts in 10^{11} . A new phase comparator has also been developed and constructed, which is capable of measuring phase changes of less than 0.001 radians at 100 kc/s.

Preliminary work has been carried out in the electronics and optics laboratories on methods of recording star transits by automatic photoelectric records. Ancillary equipment for the photomultiplier tubes has been constructed and tests have been made. The work is continuing.

IV. MAGNETIC OBSERVATIONS

Measurements of horizontal and vertical intensity, and of declination and inclination, have been maintained at Abinger throughout the year for the purpose of calibrating the base-lines of the magnetograms. The experimental electronic oscillator introduced on April 5, 1952, for use with the Dye Coil, has continued to prove very satisfactory, in consequence of which the construction of two permanent models is now under way in the electronics laboratory.

During the year several tubular compasses have been certified, on behalf of Lieutenant Commander Royds, R.N., of Hydrographic Department, J. A. Preiss of Boscombe Down Experimental Establishment, and Messrs. Cooke, Troughton and Simms. The testing of variometers has been continued at Abinger by Messrs. Hilger and Watts, and several Willmore seismographs have been installed there for test under vibrationless conditions.

Two theodolites, Troughton and Simms, Nos. 461 and 21137, have been acquired on permanent loan from Hydrographic Department.

The preparation of punched cards for the analysis of the Greenwich and Abinger magnetic data to determine the diurnal variation and lunar tidal effect upon the Earth's magnetic field is complete for the period 1916-1949. The cards, which contain the bi-hourly values of D, H and Z, were punched at Statistical Branch, Admiralty, and later supplemented with data from master cards loaned by the Mathematical Laboratory, Cambridge.

Preparation of the Admiralty world magnetic charts for epoch 1955 continues. Preliminary charts of D and H and of the corresponding secular variation have been drawn up and grid points obtained for X and Y at 10° intervals. An initial spherical harmonic analysis has been completed and the first synthesis of X and Y, which is being executed on the machines of the Nautical Almanac Office, is in progress. A special examination will be made of any regions in which this synthesis shows large systematic residuals.

Since the preparation of the initial charts, a long series of observations made with a vector airborne magnetometer has been supplied by the Department of Commerce, U.S. Coast and Geodetic Survey. These observations range over a large region of North America from the west to the east coasts, and extend half way across the Atlantic Ocean to about longitude 40° West. The list constitutes in all some 1500 sets of values of D, H, Z, I and total intensity, the accuracy of which is well within the limits required for the preparation of world charts.

To assist in the preparation of the charts, two plain 12-inch globes were obtained during the year and upon each of these has been ruled a $10^\circ \times 10^\circ$ grid; the ruling was carried out in the workshop at Greenwich.

Tests have been made upon the mirrors supplied for use with the La Cour recorders purchased for use at the proposed new site. A few of the mirrors were found to be of poor quality and have been replaced by the Institute of Meteorology, Charlottenlund.

The mean annual values of the magnetic elements at Abinger for the years 1949-52, with estimated value for 1953, are given below:-

Year	Dec. (West)	Horizontal Intensity	Vertical Intensity	Inclination
1949	$9^\circ 27.5$	0.18607	0.43273	$66^\circ 44.0$
1950	9 19.7	0.18628	0.43288	66 43.0
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	0.18691	0.43331	66 40.0

Classifying as "storms" and "great storms" disturbances having a lower limit of range of 150 γ and 300 γ respectively in H, or 30' and 60' in declination, 17 storms occurred during the twelve months covered by this report, and one "great storm". The latter occurred on June 29-30.

V. METEOROLOGICAL OBSERVATIONS

The programme of meteorological observations, which had been continued at Greenwich on a limited scale, was terminated on July 31, 1952. This concluded a series of observations which, beginning in 1840, had extended over a period of nearly 112 years.

The sunshine ball M.O.113, reported earlier as having been sent to the Meteorological Office on August 1, 1951, to undergo comparison tests, was returned in March 1953. The report upon this ball is summarized in the following statement by the Meteorological Office:-

"This sphere under-reads, over a long period, by $7\frac{1}{2}\%$. It should be emphasized, however, that the under-reading on any particular record may be different from this. With continuous bright sunshine all day there will be little under-reading. With very erratic, or very weak sunshine, the under-reading may well be as much as 20%." To this statement might be added that the determined percentage would also vary with the site at which the comparison was made in accordance with the average conditions of the sky.

The night-sky camera formerly in use at Greenwich has been transferred to Herstmonceux, where it was temporarily set up upon the roof of the solar building alongside the "Herstmonceux" recorder. Simultaneous exposures were obtained with both instruments over the period September 25-26, 1952, to mid-January 1953. An analysis of the results reveals certain differences in the records obtained with the two cameras which is most marked, as might be expected, in the δ Urs. Min. trails. The overall agreement in the Polaris trails, however, is good to about 1%. This, combined with the figures obtained earlier from the two instruments recording simultaneously at Greenwich and Herstmonceux, leads to the conclusion that the number of hours of "clear" night sky is about 10% higher at Herstmonceux than at Greenwich.

The cameras used in the above comparison differ greatly from the standard type employed by the Meteorological Office. To obtain a comparison of records given by the two types of instrument the loan of an M.O. recorder has been obtained by courtesy of the Director of the Meteorological Office. Comparison tests were commenced on the night of April 13-14, 1953.

The duration of bright sunshine recorded at Herstmonceux over the twelve months covered by this report was 1875.1 hours. There were 48 entirely sunless days and 10 days on which the record exceeded 90% of the possible duration. On 46 nights the night-sky camera recorder gave an unbroken trace of δ Ursae Minoris, and on 57 nights no trace of this star appeared on the record.

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 15353. Of this total 115 chronometers (Pattern HS1), 362 chronometer watches (HS2), 871 deck watches (HS3), 28 dashboard watches (HS4), 43 pocket watches (HS5), 1367 wrist chronographs (HS9) and 730 ATP wrist watches are rating or ready for issue. There are 19 Patt. HS1, 23 HS2, 154 HS3, 6 HS4, 1 HS5 and 249 HS9 undergoing repair in the Chronometer Workshop. The remainder, consisting of 597 HS1, 2680 HS2, 5037 HS3, 994 HS4, 339 HS5, 414 HS6, 99 HS7, 103 HS8, 814 HS9 and 289 ATP wrist watches, are held in store John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

awaiting overhaul and rating. Chronometers and watches in use throughout the Observatory number nineteen. In addition to the foregoing, 185 chronometers and watches are deposited in the Chronometer Department for various reasons.

During the year a total of 8556 chronometers and watches was received and 8437 issued. These figures include the following non-routine items:

- (a) 15 obsolete chronometers sold.
- (b) 6 chronometers transferred to Ministry of Supply.
- (c) 28 chronometers and watches returned to Australian Government.
- (d) 1 chronometer and 6 deck watches transferred to Indian Government,
- (e) 4 deck watches transferred to Pakistan Government.
- (f) 1 chronometer transferred to Belgian Government.
- (g) 1 chronometer watch transferred to Ceylon Government.
- (h) 4 chronometers and 3 deck watches sold to Crown Agents.
- (i) 1 chronometer sold to University of St. Andrews, Fife.

The total number of chronometers and watches repaired and adjusted was 4734, including three for the Canadian Government, one for the Colonial Office, and three for the Ministry of Civil Aviation. Of the total number repaired 35 chronometers, 204 chronometer watches, 337 deck watches, 12 dashboard watches, 38 watertight wrist watches and 1655 wrist chronographs were dealt with in the Chronometer Workshop.

Once again the number of transactions involving Admiralty timepieces shows an increase over the previous year. Despite this increase the rating, computing and notation of record cards has been completed to a current date. At the Annual Audit in April all chronometers and watches on charge to the Royal Observatory were accounted for.

The Shortt Free Pendulum No. 40 used as the time standard in the department has been running throughout the year and has been checked daily against the Rugby Rhythmic Signals. The daily rate of the clock is accurate to about ± 0.015 s from the mean rate, but the clock appears to have a large temperature co-efficient and to be subject to periodic changes of rate without apparent cause.

The water-test apparatus on loan from Messrs. Rotherham and Sons Ltd., London, for the testing of watertight watches was returned on 27th November 1952. Two improved models, of larger size, constructed in the Observatory workshop have been in use since that date. A small model of simpler design, presented by the Rolex Watch Company, is also in use.

Whilst increasing its output of chronometer and watch repairs, the Chronometer Workshop has also undertaken the overhaul of the following Chronometer Depot standard clocks: Dent 45081 (Portsmouth), Dent 2010 (Plymouth), Graham (Sheerness) and also the Graham and Shelton clocks used at Abinger. Some improvements were carried out on the occultation machine in the Nautical Almanac Office.

An appreciable amount of experimental work has been done towards the modification of a watch movement with a view to its being used as a portable current integrating meter measuring very minute currents. This project, which was undertaken for the Admiralty Medical Research Laboratory, has not been brought to a practical

conclusion at present. The design and construction of prototype models of specialized clockwork mechanisms was also undertaken for D.R.E., Admiralty, and has still to be completed.

During the year the renovation of the Harrison No. 3 timekeeper was completed in the Chronometer Workshop and it has since been returned for exhibition at the National Maritime Museum. All four Harrison machines and Larcum Kendall No. 1 are now in going order as they were in 1933 when their first restoration was completed by Lt. Commander R. T. Gould.

It is of interest to report that the first watchmaker apprentice to be trained in the department completed his term of apprenticeship during the year and was retained as a journeyman watchmaker. One journeyman watchmaker and another apprentice were also engaged. Although a number of applicants were interviewed it has not yet been found possible to recruit journeyman watchmakers to fill the two remaining vacancies. Lack of houses in the neighbourhood is a contributory factor.

The number of watches dealt with by the Chronometer Department on behalf of the Air Ministry shows an appreciable increase over previous years. This increase was augmented during April by the delivery of over two thousand of the new General Service wrist watch Patt. 6B/542, from Switzerland. Regular deliveries of repaired watches Mark 7A and Mark 11 have come to hand from repair contractors and new Mark 11 wrist watches and wrist chronographs Patt. 6B/551 have continued to arrive from Switzerland.

During the year 12393 Air Ministry watches were received and 8939 issued. The number sent for repair was 1242 made up of 53 Patt. 6B/60 and 1189 Patt. 6B/346 (Mk11).

Watches of various types belonging to the Air Ministry at present on charge to the Royal Observatory total 5581 and comprise 103 Patt. 6B/60, 7 6B/159 (Mk7A), 2220 6B/346 (Mk11), 2188 6B/542 and 2 6B/551 rating or ready for issue, with 85 6B/60 and 976 6B/346 awaiting repair.

Representatives of the Air Ministry Audit Department carried out half-yearly audits in July 1952 and January 1953. Subsequent reports expressed satisfaction with the standard of the accounting.

VII. H.M. NAUTICAL ALMANAC OFFICE

The routine calculation 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 foreshadowed in last year's report, a substantial reduction in staff has been possible through the concentration of routine computing on the punched-card machines. It has fortunately proved possible to achieve this reduction by leaving vacancies unfilled and by transfer to other Departments of the Observatory.

The Nautical Almanac

The Almanac for 1954 was published early in March. The first part of the Nautical Almanac for 1956, 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 contents or presentation of the Almanac. John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

General astronomical work

The calculation, from the appropriate tables, of the ephemerides of the Sun, Mercury, Venus and Mars for the years 1960-1980 is now well advanced. The periodic perturbations have been completed and a start has been made on the final calculations on the punched-card machines of the heliocentric spherical co-ordinates. In the near future, both heliocentric and geocentric equatorial rectangular co-ordinates will be computed for all planets for these twenty years; apparent positions, to be published in the Nautical Almanac, will then be obtained as required. For the five outer planets, equatorial rectangular co-ordinates for equinox 1950.0 are already available at intervals of 40 days in Astronomical Papers of the American Ephemeris, Vol. XII; small corrections for the perturbations of the inner planets will be necessary before these are used for the calculation of apparent places.

The planning of this work for the punched-card machines has involved a great deal of detailed investigation, since all possibilities have to be foreseen and allowed for; the final plan looks like a giant jig-saw puzzle, completely interlocked. One of the direct results will be copy for the next volume of "Planetary Co-ordinates for the Equinox 1950.0", covering the years 1960-1980; it is anticipated that this volume will be reproduced mainly from copy prepared on the card-controlled typewriter.

In connection with the volume of Planetary Co-ordinates, some work has been done on preparing illustrative examples of the use of various methods of calculating perturbations of comets and minor planets. A comet, N.A.O. I, has been "discovered" for this purpose and it possesses several desirable characteristics. It is hoped to follow it through a revolution by both rigorous and approximate methods, in order to enable a comparison to be made; Cowell's method has been finished, Encke's is nearly completed, and others are in hand.

Preparations have been made to carry through the resolutions passed at the Rome (1952) meeting of the International Astronomical Union, calling for many changes in the national ephemerides as from 1960. The increased accuracy required in all the ephemerides has necessitated much revision of computing programmes and techniques.

Although the Office will be relieved of the task of calculating the Moon's position from Brown's tables (which work is, however, almost complete to the year 2000), there will be a considerable increase of work in computing the hourly values of right ascension and declination to an extra decimal. Although this change will not be introduced into the Almanac until 1960, it was agreed that the revised ephemeris for 1952-1959 should be calculated and published in a joint supplement to the Nautical Almanac and the American Ephemeris. Plans for this supplement, which will also contain the new values of the nutation and aberration, are now being prepared.

The new series for nutation (A.J., Vol. 58, p.1, 1953) contains 69 terms in longitude and 40 terms in obliquity with coefficients not less than 0".0002. The major part of the calculations from this series, giving nutation in longitude and obliquity to 0".001 for every day, has now been completed on the punched-card machines for the whole of the twentieth century. These revised values of the nutation, together with the new values of the aberration, have been incorporated into the Day Numbers for 1954; these have recently been circulated to all users of Photographic Zenith Tubes.

During the year predictions of occultations of stars by planets have been published, and as a result two observations of an occultation by Jupiter on 1952 November 20 have been reported. One of these enabled Mt. Wilson observers to deduce a value for the mean molecular weight of the atmosphere of Jupiter (B.A.A. Journal, Vol. 63, p.132, 1953), and afforded the first direct evidence for the presence of considerable amounts of hydrogen and helium. Predictions for 1953 have been published in the B.A.A. Handbook and this work is being continued.

Occultations

Of the 2435 conjunctions during 1955 of stars with the Moon examined by means of the occultation machine, 1190 were discarded as the resulting occultations were not observable under suitable conditions. Preliminary times and position angles were recorded for 67 stations for the remaining 1245 conjunctions. After computation a further 112 conjunctions were rejected, and the apparent places of stars for the remaining 1133 conjunctions will be published in the Nautical Almanac for 1955. Copy is being prepared for the 67 stations, incorporating a total of 5589 predictions.

The predictions were calculated on the punched-card machines, using a modification of the method used for 1954. Although an unfortunate mechanical fault made some duplication necessary and involved some hand calculation, it is clear that the method is now satisfactory and the machines are reasonably efficient for this type of work, provided the preliminary data are correct.

The conjunctions during 1956 are being examined on the occultation machine, and about three-quarters of the year has been completed.

1582 observations of occultations for 1949 and 2607 observations for 1950 were reduced by the punched-card machines. The discussion of these observations is almost completed and will be sent for publication in the Astronomical Journal.

The numbers of observations of occultations in 1949, 1950, 1951, 1952 and 1953 received during the year were 8, 14, 251, 1055 and 25 respectively. Since the last report 35 occultations have been observed at Herstmonceux.

The combined list of all occultations included in the annual discussions for 1943 to 1947 has been published as an Appendix to Greenwich Observations for 1939; it has been distributed to all observers, among others.

The Star Almanac

The Star Almanac for 1953 was published in August. No change has been made in the contents or presentation. The edition for 1954 should be published in July.

Apparent Places of Fundamental Stars

The volume for 1953 was published in August. Most of the machine sheets of the volume for 1954 have been received and read; it is hoped that publication will take place at the end of May or the beginning of June. No changes have been made in the contents or in the allocation of the computations; the arrangements for the latter, which were made at the Zürich (1948) meeting of the International Astronomical Union, were confirmed at the Rome (1952) meeting.

Copies of the mean places of the stars for 1956 have been distributed to the several offices responsible for the computation of apparent places.

It is intended that this will be the first of the Office annual publications to be printed by photolithographic methods from copy prepared on the card-controlled typewriter. Some progress has already been made in the design and lay-out of the typical pages. If possible the new medium will be used for the apparent place pages for 1956.

The Abridged Nautical Almanac

The Abridged Nautical Almanac for 1953 was published in July and the edition for 1954 in April.

The binding of this Almanac has been criticized adversely on a number of occasions since 1952; an experimental quarter-bound edition of the 1954 Almanac is accordingly being put on sale, at a higher price. Otherwise only very minor alterations have been made to the redesigned form as introduced in 1952. A full year's experience of the G.H.A. method has brought no substantial criticism from users, and some unexpected appreciation from the older navigators, who were originally opposed to a change of method.

The Air Almanac

During the year the three parts of the Air Almanac for 1953 have been published.

1953 is the first year of the joint undertaking, with the Nautical Almanac Office of the U.S. Naval Observatory, for the production of this Almanac. A full account of the project and of the changes in the Almanac were given in last year's report.

The revised Air Almanac has been in use now for several months, but no adverse criticism of it has yet been received; reviews have been favourable.

General navigational work

The navigational work of the Office, additional to that involved in the compilation of the Almanacs, has been much less than in previous years owing to the completion of various projects.

The "Sight Reduction Tables for Air Navigation", mentioned in last year's report, have been published (in three volumes) by the U.S. Hydrographic Office as H.O. 249; one volume has so far been published in this country by H.M. Stationery Office as A.P. (Air Publication) 3270; the other two volumes are at the printers.

Volumes I, II and V of the British edition of H.O. 214, to be known as H.D. (Hydrographic Department publication) 486, have been issued during the year; Volume III is at present being bound and Volume VI is being printed. Volume IV was issued last year.

"Rising and Setting Diagrams for High Northern Latitudes", have been published by the Hydrographic Department as H.D. 489; these are diagrams to facilitate the determination of times of sunrise, sunset, twilight (civil, nautical and astronomical), moonrise and moonset for latitudes above those tabulated in the navigational almanacs.

The final copy of the computations for the South-Western Decca Chain was completed and circulated in June. The Office has now computed all the plotting data required for the English Chain, the North-Western British Chain, the South-Western British Chain and the western part of the Danish Chain; in all, about 2,500 double foolscap sheets of figures have been issued (usually six copies of each) to the various authorities.

During the year regular observations with a theodolite have been taken over Pevensey Bay, as part of an investigation into the dip of the sea horizon. The co-operation of Trinity House in arranging for observations of temperature to be made at the Royal Sovereign Light Vessel is gratefully acknowledged.

The Office is keenly interested in the Working Party of the Institute of Navigation on "The Accuracy of Astronomical Observations at Sea"; it will co-operate with the Institute in the reduction and analysis of the observations which are expected as a result of an appeal recently circulated by the Institute.

Proof-reading

During the year 2738 pages of first proofs and 1968 pages of stereo or machine sheets, depending on whether the publication is printed from stereo plates or movable type, have been read for the normal publications of the Office. The proofs for the photographic reproduction of the Air Almanac have been treated as first proofs, so that there is no longer equality between the numbers of the two readings.

No other proof-reading has been done during the year except for the introductions and auxiliary tables of the navigational publications H.D. 486 and A.P. 3270.

Machines

The punched-card installation has been in full use throughout the year; the machines have actually been in operational use for about 75 per cent of the available time. The remaining percentage has been taken up largely by "out of action" time, during which the machines are being serviced or are waiting for mechanical attention; this is slightly higher than in the previous year and is probably exceptional. The 602A Calculation Punch was out of action for nearly two weeks while the additional relays for division were being fitted; also the distance from London tends to expand the time needed to rectify a simple mechanical failure. A fault in one machine, putting it out of action for a couple of days, may easily disrupt the programmes on the other machines. The actual "idle" time on the machines, which was less than 8 per cent, represents a remarkable achievement.

Even with so much mechanical trouble, the machines have got through a very large amount of work, including: the ephemerides of the Sun, Moon, 12 major and minor planets for 1958 and 1959, completed in full detail and copy prepared for the printer; predictions (for 1955) and reductions (for 1949 and 1950) of occultations; apparent places of P.Z.T. stars (for 1953); completion of the calculations for the Decca South-Western British Chain; a new rigorous calculation of the times of sunrise, sunset and twilight for all the latitudes given in the Almanac, in a form suitable for preparation of copy for the next 20 or so years; the major part of the calculation of nutation from the new series for 1900-2009. This last job has proved peculiarly suitable for punched-card methods and the Tabulator has been used to full capacity and efficiency; it is difficult to see how this work, involving the formation, checking, and summation in groups, of some four million terms, could otherwise have been done, except on an electronic machine. The basic principle of the method used is the one adopted by E. W. Brown in the design of his lunar tables; each term is represented by a "cyclic pack" of cards which is used to reproduce the daily values on the working cards. Using the full 80-column capacity of the cards, many dates can be reproduced and summed simultaneously. A full description of the method is being written up for publication.

A certain amount of work was also done on the machines in co-operation with the Magnetic and Meteorological and the Time Departments.

There is no doubt that the machines can cope efficiently with the routine work of the Office, with some spare time for special jobs; there will, however, continue to be a heavy load on the machines until the special work arising from the recent I.A.U. resolutions has been completed. Some of this work could not have been undertaken without the punched-card machines.

The I.B.M. card-controlled typewriter, which had been on order for several years, was delivered at the end of February, but has so far been used only for experimental purposes. Considerable thought has been given to the many problems arising in the production on this machine of copy for the Office publications, to a standard which will satisfy the exacting requirements. Although extra work will be involved for the Office, the saving to H.M. Stationery Office in the cost of composition will be quite large.

VIII. PUBLICATIONS

At the end of the war there was a heavy accumulation of observations awaiting printing: "Greenwich Observations" for 1936 was the last volume printed before the war. When at length printing was resumed, progress was so slow that the arrears were still further increased. During the past year there has been a gratifying improvement and for the first time there has been some reduction in the arrears. The accumulated observations are being dealt with in two series: from 1937 to 1944 inclusive, and from 1945 onwards. It is planned to prepare varityper copy and to obtain publication of not less than one year's observations in both series each year.

The following were published during the year:-

"Greenwich Observations" (complete volume) 1937 and 1938.

"Greenwich Astronomical Results" 1938.

"Greenwich Photoheliographic Results" 1939, 1940, and 1945.

"Greenwich Magnetic and Meteorological Observations" 1938 and 1939.

"Reduced Observations of Lunar Occultations for the years 1943 to 1947". (An appendix to Greenwich Observations, 1939).

"Observations of Colour Temperatures of Stars" Vol. II.

The above mentioned publications, together with the "Annals of the Cape Observatory", Vol. XV, were distributed during the year.

Varityped copy for the following publications has been sent to H.M. Stationery Office for printing, and the completed books are awaited:-

"Greenwich Observations" 1939.

"Greenwich Astronomical Results" 1939.

"Greenwich Photoheliographic Results" 1941.

"Greenwich Magnetic and Meteorological Observations" 1940 and 1945.

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

"Greenwich Observations" 1940 and 1945.

"Greenwich Astronomical Results" 1940 and 1945.

"Greenwich Photoheliographic Results" 1942.

"Greenwich Magnetic and Meteorological Observations" 1941.

A third varityper operator, Miss V. Kemp, after a course of instruction at H.M. Stationery Office, started preparing the copy for Photoheliographic Results, 1942, in April. With three varityper operators a satisfactory rate of preparation of copy for photolithographic reproduction can be ensured.

The following other publications have appeared during the year or are in press:

- Royal Greenwich Observatory. Mean Areas and Heliographic Latitudes of Sunspots in the year 1947. M.N. 112. 570.
- Nautical Almanac Office. Occultation of Asteroids by the Moon, and Planetary Occultations and Appulses, 1953. Handbook of the B.A.A. 1953.
- H. Spencer Jones. The Earth: Dimensions and Rotation. Chap. 1 of Vol. II (The Earth as a Planet) of the 4 volume work "The Solar System" (edited by G. P. Kuiper, Univ. of Chicago Press).
Continuous Creation. Proc. R.I. XXXV. Pt. II.
- R. d'E. Atkinson. Cinematography of Partial Solar Eclipses. Pt. I. M.N. 113. No.1 (in press).
- D. H. Sadler. The Correction of Astro Fixes for Precession. J. Inst. Nav. 5. 375.
- D. H. Sadler (with E. G. R. Taylor). The Doctrine of Nautical Triangles Compendious. Pt. II. Correcting the Meridional Parts. J. Inst. Nav. 6. 141.
- H. W. Newton and H. Howe. Area Changes in Sunspots and Solar Flare Incidence. Observatory. 72. 113.
- H. W. Newton and H. F. Finch. Magnetic Storms and Solar Activity, 1952. Observatory. 73. 35.
- H. M. Smith. Quartz Clocks of the Greenwich Time Service. M.N. 113. No. 1 (in press).
- H. M. Smith and R. H. Tucker. The Annual Fluctuation in the Rate of Rotation of the Earth. M.N. 113. No. 2 (in press).
- P. A. Wayman. A Two-plate Catadioptric System for Astronomical Photography. M.N. 112. 18.
- G. E. Taylor. Occultations of Stars by Asteroids, 1953. Handbook of the B.A.A. 1953.

IX. PERSONAL ESTABLISHMENT

The ceiling which was fixed for the Royal Observatory complement last year is still in operation, but a temporary increase of two non-industrial and two industrial staff has been approved for special work undertaken in the Chronometer Department for the Air Ministry.

Vacancies in the scientific complement for two Senior Scientific Officers and one Experimental Officer remain unfilled, as no suitable applicants have yet been interviewed, but efforts are still being made to fill these vacancies.

Mr. T. Gold M.A., late Fellow of Trinity College, Cambridge, was appointed Chief Assistant, in the grade of Senior Principal Scientific Officer, on October 6.

The following Officers have also joined during the year:- Mr. H. P. C. Cook, Higher Clerical Officer; Mr. E. Shepherd, Assistant (Scientific), (rejoined from National Service); Mr. J. D. Winter and Mr. G. E. Satterthwaite, Temporary Assistants (Scientific) (the former from National Service); and Miss V. Kemp, Temporary Typist as Varityper Operator.

REPORT OF THE ASTRONOMER ROYAL

Mr. F. Jeffries, Senior Experimental Officer, retired on January 3 after 40 years' established service. The following Officers have also left during the year:- Mr. G. L. Fuller and Mr. J. S. A. Green, Assistant Experimental Officers; Miss I. S. Manning, Mr. J. E. W. Marten and Mr. R. W. L. Trundle, Temporary Assistants (Scientific).

Mr. G. F. Wells, Experimental Officer, has been promoted to Senior Experimental Officer.

Mr. G. E. Taylor, Assistant (Scientific), has been promoted to Senior Assistant (Scientific).

Mr. M. P. Candy, Assistant (Scientific), has been appointed to, and Miss P. V. Knight has been established in, the grade of Assistant Experimental Officer.

The following have been established in the grade of Assistant (Scientific):- Miss A. B. Grogan, Miss H. Howe, Mr. A. Jones, Mr. C. M. Lowne, Miss A. J. Nevell, Miss M. A. Newman, Mr. N. P. O'Hara, Miss D. Pankhurst, Mr. N. S. C. Rhodes, and Mr. R. W. Teague.

Miss S. K. Page has been established in the grade of Typist and Miss J. A. Pumfrey as Trainee Typist. Miss J. A. Morris has been established as Clerical Assistant, Grade 1.

Mrs. A. M. Jarrett, B.Sc., (née James), Assistant Experimental Officer, remains in her established grade after marriage, and Mrs. I. M. Rhodes (née Restorick) remains after marriage in her grade of Temporary Assistant (Scientific).

Dr. R. d'E. Atkinson, Chief Assistant, has received an award from the Royal Commission on Awards to Inventors for his contribution to degaussing.

The degree of Ph.D. (Cambridge) has been awarded to Dr. P. A. Wayman, Scientific Officer. His thesis was entitled "Applications of aspheric optics to Astronomy".

Mr. B. R. Leaton, Experimental Officer, has gained the B.Sc. degree.

The staff of the Royal Observatory is now constituted as follows.

(a) Royal Observatory.

Chief Assistants as
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.,
H. W. Newton, D. S. Perfect, M.A.,
D.Phil., H. M. Smith, B.Sc., M.I.E.E.,
F.Inst.P., L. S. T. Symms.

Senior Scientific Officer

- 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.

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Experimental Officers	- K. C. Blackwell, A. E. Cordwell, W. G. Grimwood, C. C. Harris, P. S. Laurie, B. R. Leaton, B.Sc., Miss C. J. A. Penny, B.Sc., J. D. Pope, B.Sc., A.M.I.E.E., J. L. Rudd, A. Shortland, R. H. Tucker.
Head of Royal Observatory Workshop	- A. C. S. Wescott.
Head of Chronometer Repair Shop	- D. W. Evans, F.B.H.I.
Assistant Experimental Officers	- A. M. Allen, L. J. Bates, P. M. Corben, B. J. Harris, A. P. Lamb, C. A. Murray, M.A., A. S. Milsom, A. E. Whitaker.
Temporary Assistant Experimental Officer	- D. C. Smith.
Senior Assistants (Scientific)	- H. G. Gill, Miss F. E. A. Jeffries.
Assistants (Scientific)	- Miss H. Howe, A. Jones, C. M. Lowne, Miss P. M. Morris, Miss M. Newman, N. P. O'Hora, Miss D. E. Pankhurst, N. S. C. Rhodes, Miss C. M. Ryall, R. W. Teague, Mrs. B. G. Tucker.
Assistants (Scientific) Temporary	- B. T. Archer, Miss W. Barton, D. R. A. Christie, Miss B. A. Crowley, R. G. Lorton, Miss M. A. Jeffery, Miss J. H. Phillips, G. E. Satter- thwaite, E. Shepherd, Miss S. W. Slater, Miss V. E. Terry, P. J. Willmoth, J. D. Winter.
(b) Nautical Almanac Office	
Superintendent as Senior Principal Scientific Officer	- D. H. Sadler, M.A.
Principal Scientific Officers	- Miss F. McBain, M.A., J. G. Porter, B.Sc., Ph.D.
Scientific Officer	- G. A. Wilkins, Ph.D.
Senior Experimental Officers	- H. W. P. Richards, B.Sc., W. A. Scott, B.Sc.
Experimental Officers	- A. E. Carter, G. A. Harding, Miss M. R. Rodgers, E. Smith.
Assistant Experimental Officers	- M. P. Candy, Miss M. McI. S. Gibson, B.Sc., D. Harragan, Mrs. A. M. Jarrett, B.Sc., Miss P. V. Knight.
Senior Assistant (Scientific)	- G. E. Taylor.
Temporary Senior Assistant (Scientific)	- J. H. Barry
Assistants (Scientific)	- Miss A. B. Grogan, Miss E. J. M. Grove, K. A. Miller, Miss A. J. Nevell.
Assistants (Scientific) Temporary	- Miss A. M. Crisford, Mrs. I. M. Rhodes.

(c) Secretariat

Secretary and Cashier as Higher Executive Officer	- H. G. Barker.
Higher Clerical Officers	- J. H. Whale, H. P. C. Cook.
Clerical Officers	- Miss S. M. Billenness, F. A. Everest, Miss J. E. Perry.
Librarian	- W. P. Preston.
Clerical Assistants	- Miss B. E. Carey, Miss J. A. Morris, Mrs. L. E. Nicholls.
Established Shorthand Typists	- Miss A. R. Hewerdine, Miss C. V. Hewerdine.
Established Vari-typer Operators	- Miss S. K. Page, Miss R. Weakley.
Established Trainee Typist	- Miss J. A. Pumfrey.
Temporary Shorthand Typists	- Mrs. V. Hyde, Miss E. M. Swanborough.
Temporary Vari-typer Operator	- Miss V. Kemp.
Hostel Wardens	- Miss O. Marshall, Mrs. E. M. P. Marples.

The industrial staff employed at Greenwich, Herstmonceux, and Abinger total 83 including Hostel staff, who, although not borne on the Observatory Vote, are attached to the Establishment for administration and pay.

The various grades are as follow:- twelve watchmakers, two watchmaker apprentices, five 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, nine part-time cleaners and thirteen Hostel domestic staff.

X. ISAAC NEWTON OBSERVATORY

Dr. C. R. Burch was renominated by the Council of the Royal Society as a member of the Board of Management of the Isaac Newton Observatory to serve for a further period to 31 December 1956.

Professor C. W. Allen was nominated by the Council of the Royal Astronomical Society as a member of the Board of Management, to succeed Dr. E. Finlay Freundlich, who retired on 31 December 1952.

Expenditure of preliminary expenses amounting to £8500 has been approved for the current financial year.

The work on the 98-inch disk has proceeded intermittently and the fine grinding is in progress. A watch has been kept on the small surface cracks, which form where some cords in the glass reach the surface. There appears to be no tendency for the cracks to increase in extent, though their existence necessitates special care in the work on the mirror and has slowed it down appreciably.

Models of alternative designs of the telescope and mounting, which have been under consideration by the Mechanical Design Committee, have been kindly made by Mr. G. T. Smith Clarke, M.I.Mech.E.

A method of artificial stiffening of structures, which may prove to be of value in the design of large telescopes, has been suggested by Mr. B. N. Wallis, F.R.S. The proposal is that the mechanical framework, which it is desired to keep inflexible, shall consist of tubes, each of which is filled with fluid. A hydraulic servo mechanism adjusts the fluid pressure in each tube, the pressure being controlled by the reading of an accurate distance gauge which is connected between its ends. The length of the tube is slightly altered by changes in that pressure. A stable servo system is formed in that way.

It is intended to test the principle by placing a study contract for the design and manufacture of a model mechanism, which can be subjected to various tests.

XI. GENERAL

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

Dr. M. K. Vainu Bappu, Nizamiah Observatory, Hyderabad.

Dr. D. Barbier, Institut d'Astrophysique, Paris.

Dr. C. S. Beals, Dominion Astronomer, Dominion Observatory, Ottawa.

Dr. Gertrude Blanche, Institute for Numerical Analysis, Los Angeles.

Dr. I. S. Bowen, Director, Mount Wilson and Mount Palomar Observatories, California.

Dr. G. M. Clemence, Director, Nautical Almanac, U.S. Naval Observatory, Washington.

Col. M. O. Collins, Ordnance Survey, Chessington.

Prof. J. F. Cox, Professor of Astronomy, Brussels University.

Dr. A. K. Das, Kodaikanal Observatory, S. India.

Dr. W. J. Eckert, International Business Machines Corporation, New York.

Dr. F. K. Edmondson, Director, Kirkwood Observatory, Indiana University.

Mr. J. Evershed, F.R.S., Ewhurst.

Dr. A. Fletcher, Department of Applied Mathematics, Liverpool University.

Dr. Jan. V. Garinck, Norwegian Defence Research Establishment.

Dr. E. T. Goodwin, Superintendent, Mathematics Division, National Physical Laboratory.

Dr. G. Haro, Director, Tonan. Zintla Observatory, Mexico.

Miss Margaret Harwood, Director, Maria Mitchell Observatory, Nantucket.

Major K. F. Kerr, U.S.A.F. Aero Chart and Information Centre, Washington.

Dr. H. Knox-Shaw, late Radcliffe Observer, Radcliffe Observatory, Pretoria.

Dr. W. Markowitz, U.S. Naval Observatory, Washington.

Mr. H. R. Mills, Director, Science and Engineering Dept., British Council.

Father D. J. O'Connell, Director, Specola Vaticana, Castel Gandolfo.
John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

Dr. R. M. Petrie, Dominion Astrophysicist, Dominion Astrophysical Observatory, Victoria, B.C.

Father Mayaud, Institut de Physique du Globe, Paris.

Mr. F. J. Sellers, Leighton Buzzard.

Dr. C. D. Shane, Director, Lick Observatory, California.

Dr. A. H. Shapley, Bureau of Standards, Washington.

Mr. W. H. Shortt, Exeter.

Mr. M. de Matos Silveira, Meteorological Service, Lisbon.

Dr. P. Sollenberger, U.S. Naval Observatory, Washington.

Dr. R. H. Stoy, H.M. Astronomer, Cape Observatory.

Dr. J. Veldkamp, Director, Netherlands Meteorological Institute, De Bilt.

Dr. C. B. Watts, U.S. Naval Observatory.

Dr. P. Wellman, Hamburg Observatory, Bergedorf.

Captain D. P. S. Wilson, Ordnance Survey, Chessington.

Other visitors included Admiral Sir Cecil H. J. Harcourt, Commander-in-Chief, Nore; Captain S. J. Hennessey, Assistant Hydrographer; Captain Boyle, Captain of H.M. Dockyard, Chatham; Commander G. S. Ritchie, Hydrographic Department; Wing Commander C. R. Alexander, Air Ministry; Flight Lieutenant H. K. Parker, Royal Australian Air Force, Overseas Headquarters, London; Wing Commander McBride and Squadron Leader Pickering, Royal Australian Air Force; Dr. H. S. Hatfield, Medical Research Council; Mr. Kernohoun, President, New Zealand Horological Institute; Dr. A. Fleck, Vice Chairman, I.C.I.; Mr. G. H. Shreeve, Deputy Chairman, British Council.

Visits have been paid by a number of organized parties from various Institutions, scientific societies, and from Congresses meeting at one or other of the nearby south coast resorts.

Dr. S. Herrick, Professor of Astronomy at the University of California, who has been awarded a Guggenheim Fellowship, is spending a year at Herstmonceux. His assistant, Mr. C. G. Hilton, is working in the Nautical Almanac Office.

The Astronomer Royal, Dr. Atkinson, Mr. Sadler, Mr. Newton, Miss McBain, and Dr. Wayman attended the General Assembly of the International Astronomical Union in Rome in September. Mr. Newton also attended the meeting of the Committee of the International Council of Scientific Unions on Solar and Terrestrial Relationships, which immediately preceded this General Assembly. The Astronomer Royal was re-appointed President of Commission 31 (Time) and Mr. Sadler was appointed President of Commission 4 (Ephemerides).

The Astronomer Royal attended the General Assembly of the International Council of Scientific Unions in Amsterdam in October as a delegate from the Royal Society.

The Nautical Almanac Office has made several contributions to the exhibition "Navigation Today" at the Science Museum. Mr. D. H. Sadler is a member of the organizing committee.

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The Nautical Almanac Office was asked to provide an exhibit to illustrate the present methods of computing planetary positions in connection with the Friday Evening Discussion at the Royal Institution by Dr. Derek J. Price in November. Mr. M. P. Candy produced an exhibit that was much admired.

Mr. D. H. Sadler attended the Symposium on Automatic Digital Computation at the National Physical Laboratory in March.

Mr. D. H. Sadler organized a discussion on "The Printing of Mathematical Tables" at the Royal Society, with special reference to the reproduction by photolithography of tables prepared by automatic computing machines.

It is gratifying to be able to record that a further stage in the removal of the Observatory to Herstmonceux has at last begun. The construction of the meridian group of instruments has been commenced, and the installation at Herstmonceux of the Cooke Reversible Transit Circle and of the Photographic Zenith Tube is to be expected during the present year. It is planned to proceed as rapidly as possible in obtaining tenders and in letting the contract for the equatorial group, and in commencing building. It seems reasonable now to hope that the removal will be substantially complete by the end of the year 1956.

H. SPENCER JONES

Astronomer Royal

ROYAL GREENWICH OBSERVATORY,
HERSTMONCEUX.

1953 June 13.