until a standard wedge had been put upon it at Oxford ; for owing to a change in the selection of plates this had not been done. On development later this exposure showed some curious signs of drift, from which the 2-second exposure was free : as already stated, there had not been opportunity to test the short-period accuracy of the driving mechanism, but it is difficult to suggest a satisfactory explanation of the appearance observed.

Owing to the clouds it seems scarcely worth while to make elaborate measures of the photometric results, but the polariscopic pictures show even to casual inspection the difference between the two components, and it is inferred that the method is well worth a trial at future eclipses.

6. *Acknowledgments.*—It would be difficult to say too much in recognition of the kindly help received from the Mayor and Corporation of Southport ; from Mr. T. E. Wolstenholme (Publicity and Attractions Manager) ; from the Director of Works and those whom he sent to help us ; from Mr. G. A. Millward, Head Master of King George V. Boys' School, and his staff ; and from the police, who made arrangements for the safeguarding of our instruments during the night, and for our being quite undisturbed on the critical occasion.

A word may be added in appreciation of the wonderful way in which the stress arising from the sudden influx of immense crowds was met by everyone in Southport, though this is perhaps scarcely germane to the account of a scientific expedition.

The Total Solar Eclipse of 1927 *June* 29: *Report of the Norman Lockyer Observatory Expedition.* By William J. S. Lockyer, M.A., Ph.D., Major (late R.A.F.). (Plates 14, 15.)

The eclipse party from the Norman Lockyer Observatory consisted of Lt.-Col. Sir Francis K. McClean, Captain W. N. McClean, and myself. The site for the eclipse camp was selected early in March.

Its position (Lat. 54° 25′·8, Long. 1° 43′ W.) lay on the eastward and adjoining side of the main road connecting Richmond (Yorkshire) with Gilling village and distant one mile to the north-east from the market-place of the former town. It was situated on the Marquess of Zetland's estate and called the " Olliver Ducket Mound," and he very kindly gave permission for the Observatory's party to take up their position there. The site was situated on a 600-foot contour line, and looking away from it towards the north through the east and to the south-east the ground fell away sharply at first and gradually afterwards.

On the eastward side of the site was a massive historic " Ducket " or look-out tower. This tower was made considerable use of, not only for storing packing-cases under shelter on the ground floor, but for the erection of instruments on the eastern side of the upper storey in the open. One end of the wireless aerial was also attached to the top of the tower.

The low altitude of the sun, namely 12° 40′, combined with the brevity of totality, 24 seconds, at the Olliver Ducket Mound controlled to a great extent the choice of the instrumental equipment and the programme of work to be attempted. Had totality been of greater duration, more use would have been made of equatorial mountings and siderostats.

The actual programme decided upon was to secure large- and small-scale photographs of the corona, chromosphere, and prominences, and also a small-scale photograph of the spectrum of the corona. Time determinations of the contacts, using the broadcast time-signals, were also to be attempted. At Sidmouth the large partial phase was to be utilised to secure photographs of the spectrum of the chromosphere with a large dispersion instrument erected specially in the grounds.

During the whole of our stay the weather was most unsatisfactory, and there were only four fine days, namely, the 19th, 20th, 23rd, and 28th. On the 21st there was a strong gale, and the other days were chiefly wet.

On the early morning of eclipse day (29th) the sky was very cloudy, but the sun was visible at $3^h\ 35^m$ G.M.T. just above the horizon. At $4^h\ 10^m$ the clouds seemed to be breaking up, and blue sky was seen in the direction from which the clouds were drifting, namely, S.E. At $4^h\ 35^m$ the valley mists began to rise as if they were about to begin to dissipate, and they reached very nearly to our elevation of 600 feet. At $4^h\ 50^m$ the prospect of seeing totality improved, and the crescent sun was seen at $5^h\ 0^m$ for a few minutes in a perfectly clear gap. At $5^h\ 7^m$ clouds again completely obliterated the sun, and at $5^h\ 15^m$ the conditions looked entirely hopeless, and continued so until well after half of the second series of partial phases had elapsed, and even then for only a few minutes was the sun seen.

In accordance with the instrumental programme and the megaphone time-signals the whole routine work of the camp was gone through at the total phase, but, of course, with no successful results.

The instruments erected on the site formed themselves naturally into three groups, namely, those that were brought by each of the three members of the expedition.

Thus Sir Francis McClean's group of instruments consisted of the 6-inch Steward equatorial and a 3-inch coronagraph, both of which he operated himself, and a 6-inch aperture of 31·5-foot focal-length coronagraph, which he put in charge of Captain Leeston Smith (see Plate 14).

The second group consisted of a Ross-Williamson telephoto camera of 25-foot equivalent focal length, which Captain McClean operated with the assistance of Mr. Hunter, and two Beck instruments of focal lengths of 3·4 and 4 feet, worked by Mrs. W. N. and Miss McClean and Mr. J. McClean respectively.

While the above instruments were situated on the ground, my group was placed on the upper floor of the " Ducket " on the eastern side of the tower (see Plate 15). The Thorpe grating spectrograph, fitted with a Zeiss triplet aeroplane lens, and a Dallmeyer rectilinear coronagraph, both instruments being carried on a 12-inch siderostat mounting, were operated by me, and the Zeiss triplet and Aldis triplet

coronagraphs were in charge of Mrs. W. J. S. Lockyer and Mr. F. McClean respectively.

A special position was selected on the western portion of the ground for the exposure of a film during the whole time of totality to show the eastern aspect of the camp, including the "Ducket" and the eclipsed sun. Miss Lockyer was in charge of the instrument that was employed.

The composition of these groups is contained in the following table (Table I.), which sums up details concerning all the instruments, plates used, exposures, operators, etc.

TABLE I.

Instrument.	Aperture.	Focal Length.	Plates Exposed.	Brand of Plates.	Exposure.	Object.	Operator.
	In.	Ft.			Sec.		
Cooke (Moving Plate).	6	31·5	1	Ilford S.R. Pan.	20	Corona.	Capt. Leeston Smith.
Steward (Equatorial).	6	4	1	,,	20	,,	Sir Francis McClean.
..	3	4	1	,,	2	,,	,,
Ross-Williamson (Telephoto).	2·5	25	20	Excelsis Film (Imperial Dry Plate Co.).	$\frac{1}{10}$	Chromosphere Prominences.	Capt. W. N. McClear and Mr. Hunter.
Beck.	3	3·4	2	Imperial S.R.	1–2	Corona.	J. McClean.
Beck (Telephoto).	0·9	4	2	Ilford Ord.	$\frac{1}{100}$: 1	Baily's Beads Prominences.	Mrs. W. N. McClean and Miss McClean.
Zeiss Triplet	4	1·6	1	Ilford Iso Zenith.	20	Corona Spec.	Dr. W. J. S. Lockyer.
Thorpe Grating (Equatorial).	..	..	1	,, Empress.	20	Corona.	,,
Dallmeyer (Rectilinear).	3·4	1·2	1	,, Ordinary.	20	Corona.	,,
Zeiss Triplet.	4	1·6	2	,, Iso Zenith.	2 : 3	,,	Mrs. W. J. S. Lockyer.
Aldis Triplet.	4	1·7	2	,, ,, ,,	3 : 2	,,	F. McClean.
Kodak.	..	..	..	Kodak Film.	20	Landscape.	Miss Lockyer.

Not having obtained any photographic results, no useful purpose would be gained by describing the equipment in greater detail, but there are some points of interest concerning the chief instruments which may be found helpful on future eclipse expeditions. These are described in subsequent sections.

The eclipse party wish to express to the following their hearty thanks for valuable assistance rendered :—

The Marquess of Zetland, for the use of the "Olliver Ducket Mound"; Captain Nelson Rooke, agent to the Marquess, for giving every facility to ensure the success of the expedition; Messrs. J. H. Richard-

son and F. Stretch, the stationmasters at Richmond and Sidmouth respectively, for personally supervising the handling of the packing-cases on their arrival at and departure from Richmond and Sidmouth.

The 31·5-foot Coronagraph.

The chief points of interest of this instrument were the methods of construction and erection of the tube. The instrument consisted of a 6-inch Cooke photo-visual objective of 31·5 feet focal length. The tube (Plate 14) was mounted so as to point directly to the calculated position of the sun at mid-eclipse. It consisted of four strong wooden frames with graduated rectangular openings connected by hollow steel rods, these rods, threaded at each end, passing through the wood frames and being capable of being adjusted and locked to the frames by duplicate bolts and washers. The frames rested on wood supports constructed to give them the correct angle of elevation and inclination to the horizontal. Each of these wooden supports rested on main wooden trestles fixed in the ground at heights suitable to the contour of the ground. The tube was covered with a double thickness of light-tight material and waterproof fabric.

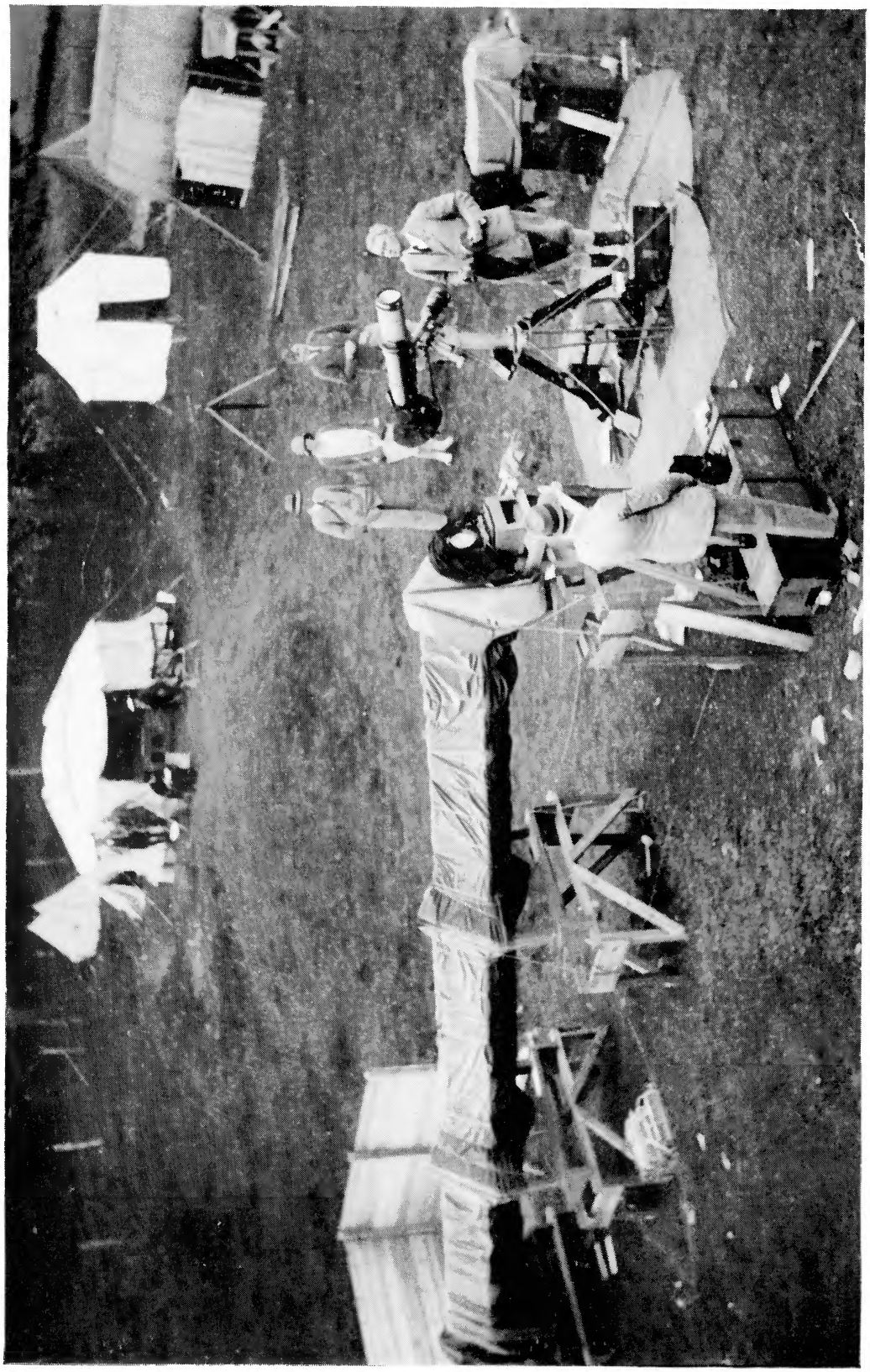
The object-glass was mounted in a heavy cast-iron frame, which in its turn was clamped to a wooden frame. This was fixed at the east end in front of the main tube on a separate foundation to avoid any vibration of the main tube. It was only attached to the tube by a flexible, double, light-tight fabric.

The main tube being in a fixed position it was necessary to have some arrangement by which the dark slide could be moved to correspond to the movement of the solar image.

The dark-slide holder was mounted on a wooden frame similar to the tube frames, and rested on a short trestle fixed in the ground at the west end of the main tube. It was quite independent of the tube, being connected only by a flexible, double, light-tight fabric. The dark-slide holder had an aperture of 12×24 inches; and carried a dark slide holding a plate 12 × 12 inches for obtaining one exposure on the corona of 20 seconds' duration. This dark slide was capable of moving smoothly inside the dark-slide carrier. It was so designed that it was pulled in the direction of the movement of the solar image by means of a weight, and the speed was controlled by a gramophone clock. The desired speed was approximately 1·5 inches per minute, which gave a run of 8 minutes, during which the sun could be followed.

The Ross-Williamson Telephoto Camera.

This instrument consisted of a German aeroplane camera in combination with a Ross lens of 2·5 inches aperture. In front of the aeroplane lens was fitted an aluminium extension tube 4 feet long, carrying at its upper end a 2·5-inch aperture lens with filter case and stops attached. The whole combination gave a virtual focal length of 25 feet and a solar image of about 3 inches. The overall length of the instrument was about 8 feet 6 inches.



The instrument was fitted with a film roll-holder for a $6\frac{3}{4} \times 4\frac{3}{4}$-inch picture geared to shutter and operated by turning a handle, one revolution of the handle changing the film and setting the shutter. The maximum capacity of the roll-holder was 100 exposures. There was also attached a Ross monocular finder (× 9) with fine adjustment for collimation and cross-hairs.

The camera was adapted to a cinematograph projector stand, and both vertical (inclination) and azimuth screw adjustments were available. As sufficient inclination could not be secured with the vertical adjustment, the front support was raised by wooden blocks, both supports resting on concrete foundations.

The whole instrument was housed in a corrugated iron shelter, as illustrated in the right-hand top corner of Plate 14.

The Thorpe Grating Zeiss Spectrograph.

The novelty of this instrument was not so much the instrument itself, for I have used similarly constructed instruments at previous eclipses, as the method of mounting it.

The spectrograph was composed of a Zeiss triplet aeroplane lens, in front of which was mounted in a wooden holder a Thorpe transparent grating of ruled surface 3 × 2 inches. These were fitted in a wooden tube of square section that slid into one side of an oblong box with scale attached for focussing purposes. The opposite end of this box was arranged to carry a plate-holder for a $12 \times 4\frac{3}{4}$ plate. Actually two plates were inserted, namely, one a slow plate of 5 × 4 inches for recording the direct image of the corona, and the other a very rapid plate of 7·9 × 4·8 inches for the coronal spectrum in the first order. Special diaphragms were inserted in the box to eliminate fogging by reflection from the other orders of the grating.

The base of this box was strongly hinged at the plate end to another wooden base of the same dimensions, and side supports with clamping screws were so fixed that these boards could be clamped at any inclination to one another.

As it was not considered desirable at this eclipse to make use of a 12-inch siderostat, the mounting of this instrument was stripped of the mirror fork and cell and other unnecessary parts, and the mounting utilised to carry the above spectrograph, as illustrated in Plate 15, figs. 1 and 2.

To the upper end of the polar axis a strong, circular, wooden disc was firmly fixed to the driving circle, and on this was screwed firmly the hinged wooden base of the spectrograph.

In this way one obtained a mounting adjustable for latitude and azimuth, and clock driven. It was only necessary to adjust the angle between the boards to the declination of the sun and the instrument was complete for the eclipse. To make further use of this mounting another box camera, carrying a Dallmeyer rectilinear lens of 3·4 inches aperture, was screwed to the top of the grating camera. The whole arrangement was brought into good balance by fixing the base board of the spectrograph unsymmetrically on the wooden disc.

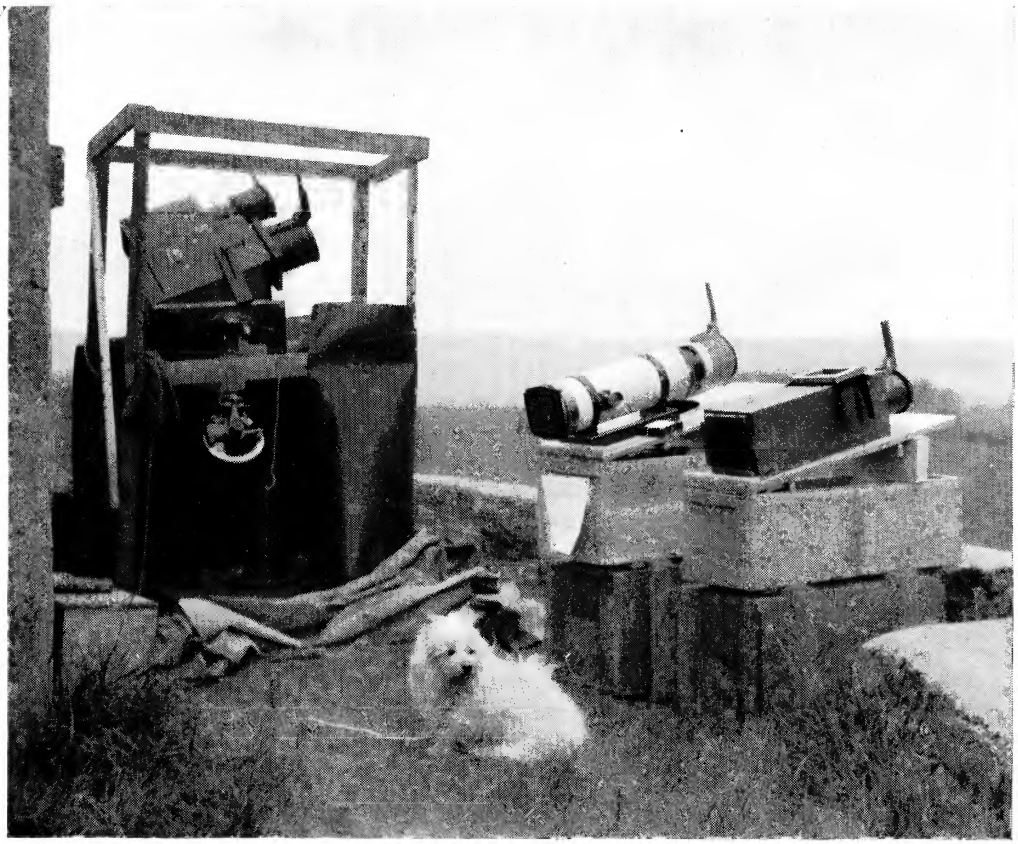


FIG. 1

FIG. 2

The instrument was erected on the upper platform of the " Ducket," and the clock driving-cord and weights were led to the outside wall by a system of pulleys, thus securing an available 12-foot fall (see Plate 15, fig. 1).

The whole arrangement worked exceedingly well, and suggested that probably quite a cheap form of mounting after this principle might be usefully adopted for instruments of moderate dimensions.

The Time-Signals.

From $5^h\ 0^m$ to $5^h\ 20^m$ G.M.T. the megaphone calls at five-minute intervals were taken from the wireless time-signals. The time and calls of the minutes after $5^h\ 20^m$ were taken from a stop-watch which was correct at that signal; thus it was only necessary to rely on the accuracy of the watch for five minutes only. Commencing at $5^h\ 24^m\ 10^s$ single seconds were called, the beats being timed from the bell of the eclipse pendulum clock, which pendulum was started four minutes before the calculated time of the commencement of totality and adjusted to beat seconds in time with the B.B.C. signals.

Time rehearsals were first commenced on the 27th, and several were held during the day. On the 28th full rehearsals took place at $5^h\ 0^m$ a.m., $9^h\ 30^m$ a.m., and $3^h\ 30^m$ p.m.

It is pleasing to record that all the time arrangements went absolutely according to plan on eclipse day, and this was due to the very efficient way in which Major Chapman and Mr. F. McKay, who assisted him, carried out the programme.

The Sidmouth Preparations and Results.

To take advantage of the large maximum phase of the eclipse (0·97) visible at the Norman Lockyer Observatory, preparations were made for photographing the spectra of the chromosphere and photosphere at the sun's limb with large dispersion, and also for securing a series of photographs of the partial phases themselves.

For the purpose of the former the laboratory Littrow spectroscope (Hilger) of 2·5 inches aperture and 8 feet focal length, giving a dispersion of 27 cm. between Hβ and Hδ, was erected in the grounds. A telescope with a $3\frac{3}{4}$-inch objective and of 4 feet 6 inches focal length was employed for throwing an enlarged image of the sun on the slit, and this was fed by a 12-inch siderostat.

Only a portion of the spectrum could be photographed at any one time, and only two plate-holders were available, each holding a plate 10 × 2 inches, on which four exposures could be made. The plate-holder could be moved vertically by rack and pinion to secure the four exposures.

The programme was to take twenty-four photographs in three series of eight exposures each, changing the plate in each holder after every eighth exposure. The necessary alteration in the adjustments of the prisms, focus and swing back, for the red and violet regions of the spectrum were made alternately after the fourth, twelfth, and twentieth exposures.

For the photography of the partial phases the 10-inch McClean telescope was used. The aperture of the object-glass was reduced to 1·1 inches by means of a wooden diaphragm placed in front of the lens, and on this a very fast-moving shutter with a slit width of 0·2 inch was mounted.

The weather previous to and on eclipse day seems to have been as unfavourable as it was in Yorkshire. No exposures at all could be made with the Littrow spectroscope, and only two, namely, at $4^h\ 30^m$ and $4^h\ 40^m$ a.m. with the McClean 10-inch refractor, and neither of these are free from cloud.

Mr. D. L. Edwards was responsible for the erection of the instruments, being assisted by Mr. H. W. P. Richards, a research student at the Observatory, and by Mr. Boot, the attendant of the Observatory.

Description of Plates.

Plate 14. The 31·5-foot coronagraph, together with the 6-inch Steward equatorial and the 3-inch coronagraphs. Reproduced by kind permission of the *North Mail and Newcastle Chronicle.*

Plate 15, fig. 1. The Thorpe grating Zeiss spectrograph and the Dallmeyer coronagraph on the mounting of the 12-inch siderostat, and the Zeiss and Aldis triplet coronagraphs on fixed bases, as erected on the "Ducket."

Plate 15, fig. 2. The above-named spectrograph to show the method of mounting.

Total Solar Eclipse, 1927 *June* 29: *Report of Dr. R. L. Waterfield's Expedition.* (Plate 16.)

Owing to the kindness of the Rev. C. D. P. Davies and the Headmaster of Giggleswick School, I was allowed to set up my instruments in the eclipse camp on a part of the school grounds.

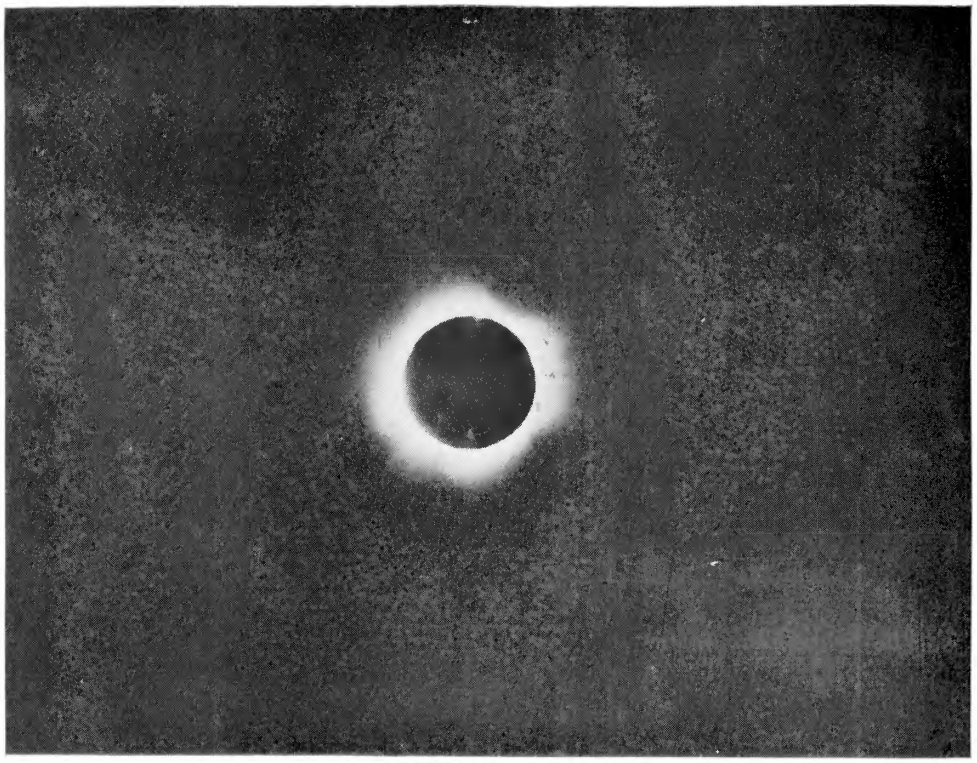
My own expedition consisted of Mr. W. E. B. Lloyd, the Very Rev. the Dean of Hereford, and myself. The instruments comprised three coronagraphs of varying focal lengths, a prismatic camera, a slitless visual spectroscope and a small telescope. Mr. Lloyd used the telescope and manipulated the two smaller coronagraphs. I myself observed the flash spectrum and worked the prismatic camera and large coronagraph. The Dean of Hereford assisted generally.

The programme arranged was (1) the photography of the first flash at second contact with a red sensitive plate—an Empress (Ilford) plate bathed the night before by Mr. Melotte with dicyanin—and of the second flash at third contact with a supersensitized panchromatic plate of speed 1250; and (2) three direct photographs of the corona to be taken one with each of the coronagraphs.

The prismatic camera consisted of a prism with replica grating on one surface (by Hilger) placed in front of an ordinary spectacle lens of 24-inch focal-length. By tilting a flat plate good focus was obtained on test plates from the middle of the green to well beyond the visible red. Owing unfortunately to a foolish mistake in the working of the

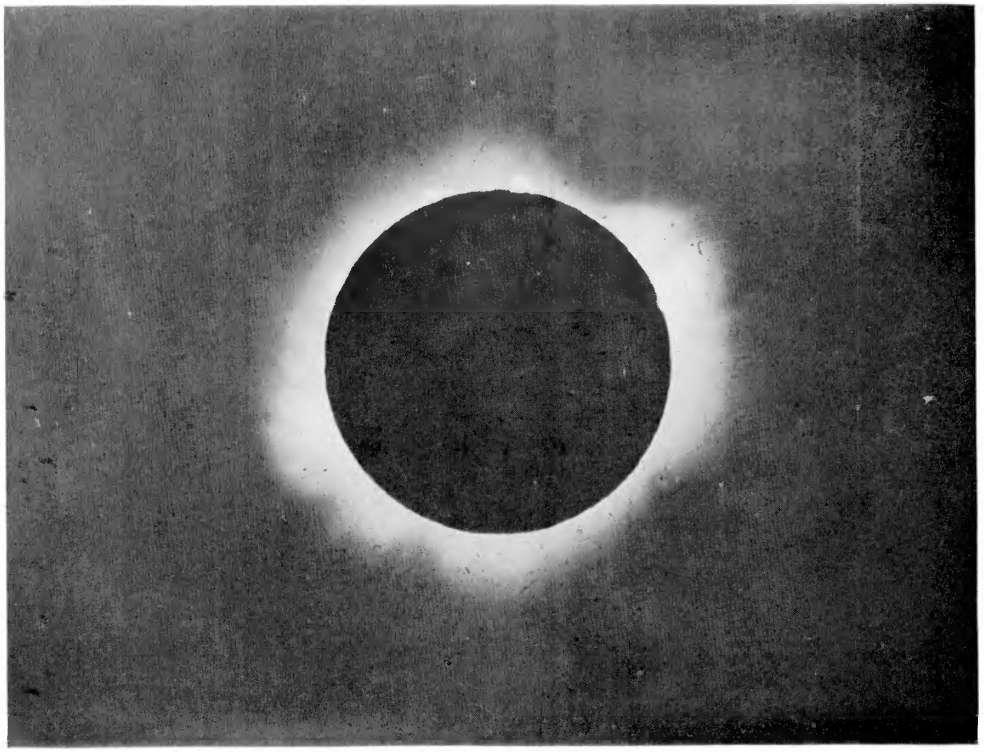
N

(A)



E W

(B)



S

Solar Corona, 1927 June 29. R. L. Waterfield.

(A) 3-in. doublet, f.l. 24 in. Exp. 1·5 sec.
(B) 4-in. refractor, f.l. 60 in. Exp. 0·75 sec.