inner corona, which, however, will only show to the naked eye as a bright silver ring surrounding the narrow pink circle of the chromosphere, with long coronal streamers extending in all directions; if there are no spots and insignificant prominences on the sun, then the coronal wings will lie folded along the sun's equator. Prominences, of course, will be visible to the naked eye only if large enough; keen sight could detect a prominence of 40,000 miles height; one of 200,000 miles should be easily visible. The corona will be ivory or white in colour; the chromosphere will be rosy; prominences will probably be red, but they may be white.

We would wish for June 29, that the weather on the sun should be stormy with many eruptions; that—for naked-eye observers—there should be deep lunar valleys near the points of second and third contacts; and that great red prominences should show up where these lunar valleys are.

In the American eclipse of 1925, New York City had a very beautiful aspect of the eclipse, which there was of short totality. The eclipsed sun showed as a faint circle of light with an intensely brilliant place at one spot, the rays from which spread out and gave the impression of a ring with a big diamond inserted in the usual way. There was a depression in the moon's edge which grazed the edge of the sun for some time, as seen from New York, which lay on the edge of the shadow track, just as Liverpool lies (probably) on the edge of the shadow track on June 29 next. In one of the Russian chronicles there is a description of the eclipse of May 1, 1185: "In the evening there was an eclipse of the sun. It was getting very gloomy and stars were seen, and in the men's eyes was a green light. The sun became similar in appearance to the moon, and from its horns came out somewhat like live embers"; which seems to point to something like the 'diamond ring,' perhaps a prominence as well as sunlight.

I have myself only once seen the eclipsed sun with the naked eye, and then it seemed small, much smaller than the full sun and moon to which I have been accustomed. But this was in India, with the sun high in the heavens. Mr. H. B. Adames saw the beginning of the eclipse of 1905 as the sun rose over Lake Winnipeg, and to him the entire body of the moon, which suddenly appeared with a blood-red prominence on either side, was a "huge black ball immensely exaggerated."

The effect of the rapidly diminishing sunlight on land and sky is weird and uncanny; all life and warmth fade out of the landscape; the flowers look withered, the grass and trees lose all trace of their living green and become of a dull lead colour; even the very faces of the observers become livid. If the sky is blue, it changes to a deep funereal purple. If there are small clouds near the sun, the iridescent colours, which are always there but not always easily seen, stand out vividly as in a spectrum. Round the horizon—which is near or beyond the shadow's edge—there is a glow of an angry gold, a sulphur light, not untinged with red. These are sunset effects, perhaps, which become visible when the daylight is cut off, but they may owe something also, as Mr. C. T. Whitmell suggested, to the red chromospheric light. If clear, it will be well to glance at the shadows cast by the corona; in 1922, Miss Miriam Chisholm found that these, though present, were undefined.

In my opinion, all naked-eye observers who are artists should make the painting of the colour effects on land, sky, and sea their chief study at this eclipse. It is not, of course, possible to do this work actually in the short totality, but the outline should be drawn before the eclipse, the colours noted during the total phase, and the painting finished afterwards while the tints are still fresh in the memory. Like meteorologists, artists get their results, whether the eclipse is clear or cloudy.

Eclipse Photography.

By C. P. BUTLER.

ALTHOUGH the total solar eclipse on Wednesday, June 29, will be one of short duration—about 23 seconds total obscuration in England, and 30 to 40 seconds in Norway—the improvements in sensitivity of photographic materials and design of optical equipment warrant the attempt to obtain photographic records of various stages of the phenomenon. In order to give information wanted by observers having diversity of equipment, we may briefly summarise the various means with which observations may usefully be undertaken.

Ordinary Cameras.—These may range from the modest hand-camera to the largest field or studio apparatus, preferably fitted with some controllable exposing apparatus other than merely the lens cap. These may all give interesting pictures, but the scale of the result will be strictly proportional to the focal length of the lens employed. The diameters of the sun and moon are about half a degree of arc on the sky, so it is a simple matter to calculate what the actual linear diameter of the image of the eclipsed sun will be with any given

lens; an ordinary camera of, say, 7 inches focus, will give an image about $\frac{1}{16}$ inch diameter; one of 12 inches focus an image about $\frac{1}{10}$ inch diameter. In spite of the small scale, such lenses in previous years have given very beautifully defined pictures of the eclipsed sun and the surrounding corona. For the delicate outer streamers of the corona such apparatus is very efficient, and possibly more suitable than the larger scale instruments. This was illustrated by the success of Mrs. Maunder at the eclipse of 1898 in India, when the photographed coronal streamers extended about eight solar diameters from the edge of the moon. In this work of photographing an illuminated area, the power of the lens is regulated by the ordinary f value, i.e. the ratio of aperture to focal length, so that lenses with the largest a/f value available should be chosen for this occasion.

Telephoto Cameras.—By means of an auxiliary lens, generally concave, to reduce the bulk of the apparatus, increased focal lengths may be obtained with a given camera. Photographers having telephoto attachments to their lenses will be able to obtain large-scale pictures, but if the equivalent focal length is more than about 20 inches, some method of moving the camera with the sun will be necessary for exposures longer than a few seconds.

Long-focus Lenses or Telescopes.—These instruments are usually of larger aperture than a telephoto lens of similar focal length would be, so that, even when stationary, a useful picture may be possible with a snap-shot or short-time exposure. If furnished with clock-work drive, they provide perhaps the most important means of obtaining details of the structure of the eclipsed sun. Good results may be obtained by adjusting an ordinary camera, with lens set for infinity, immediately behind the eyepiece of a visual telescope which has also been adjusted on the distant object. If this arrangement is selected, it would be best mounted on a long, stiff board, and the whole fixed on a firm support pointing to the sun. The exposure should be made by rubber tube or antinous release, to avoid vibration.

Stationary or Clock-driven Apparatus.—With such a short eclipse it is doubtful if anything will be gained by installing temporary driving apparatus to follow the movement of the sun. Unless the utmost rigidity is secured, the small errors in fixing, driving, etc., may be greater than the actual movement of the object. The best advice appears to be that the camera should be firmly fixed on some rigid support, provided with a wedge adjusted to the elevation of the sun (about 11° in England).

With instruments of moderate focal length the movement during the possible exposures will be scarcely perceptible. The movement may begin to be effective when focal lengths of more than 20 inches are employed.

Alteration of Eclipse Track.—Notice should be taken of the recent alteration of the track of the eclipse and its time of occurrence. The latest calculations, kindly furnished by Dr. Comrie, of the "Nautical Almanac" Office (*Monthly Notices, Royal Astronomical Society*, vol. 87, April, p. 496), place the central line about *one mile farther north* than the previously published track, so that observers located near the southern limit as shown on the Ordnance Survey Map should move to some station at least two or three miles northwards, to be certain of complete obscuration. Observers near the northern limit of totality will be better situated in consequence of the alteration. The time of occurrence is only about 4 seconds later than the published time.

Perhaps a word here as to the actual method of observing the instants of totality will be welcome to those who have not previously seen a total eclipse of the sun. The moon commences to enter on the sun's north-western edge, about the position of 2-hours on a clock face as one faces the sun, and will gradually cross the disc in a slanting direction, roughly towards the 8-hour position. When near totality, about an hour after first contact, the sun will be 25° north of the east point of the horizon and at an elevation of about 11° above the horizon, these figures being slightly different at various localities. As the advancing edge of the moon gradually approaches the eastern edge of the sun, the intense white arc of sunlight will be broken into small beads, produced by the rough mountainous edge of the moon. The instant when the last of these bright spots disappears is the time of second contact, and denotes the beginning of totality. Unless the observer wishes to obtain a series of records, the exposure should not begin until this instant of second contact, otherwise the delicate features of chromosphere and corona will be lost in the bright glare.

It is advisable to protect the eyes with dark glasses, such as may be made from a densely fogged photographic plate, or ordinary deep-tinted neutral glass, until totality occurs. From second contact to third contact is the period of totality, which in England is expected to last for about 23 seconds. This is the time available for securing pictures of the corona, which can never be seen except in these special circumstances, and the exposures to

be given will depend on the number of pictures to be taken. In general it would be advisable to limit the number to three :

(i.) A snap-shot just after the last beads of sunlight are seen to disappear at the moon's eastern or advancing edge. This will give the prominences and perhaps the inner corona.

(ii.) A longer exposure of, say, 15 to 20 seconds, depending on the time occupied in changing plates.

(iii.) Another snap-shot just as the bright beads appear at the western edge of the black moon.

Cinema Record.—The eclipse, being of short duration, may be specially suitable for the taking of a cinematograph film of the various stages, in which case the exposures would be started some time before totality, to show the transition from partial to total phase.

Intending observers who are able to go farther afield will find the photographic conditions somewhat more promising in Norway, where the altitude of the sun during totality will be about 21° .

Photographic Plates.—In general it will be best for the photographer to use the plates to which he is accustomed. All the well-known brands of material, glass plates and films, are now so uniformly good with regard to clean working that any choice may be governed by whatever special features it is desired to obtain. If only one exposure is to be attempted, the most rapid emulsion is to be recommended. All the chief makers list plates from 350 to 650 H and D. For the corona much of the light is concentrated in a few special colours, violet, blue, green and red, the combination giving the silvery white sheen characteristic of the solar envelope. Ordinary plates, of whatever speed, will record only the violet and blue portions. To get the advantage of the visible colour action, panchromatic plates may be used. The outstanding plates of this variety are the Ilford Iso Zenith, Iso Wellington, and Imperial Eclipse Ortho, all being of the highest sensitivity and very clean working. Most makers also supply Spectrum Panchromatic Plates, which are of somewhat lower speed, but give a more equable representation of the spectrum colours. When the apparatus is fitted with lenses of large relative aperture, these plates may be used instead of those of greatest rapidity. The easiest way of treating these colour-sensitive plates is to develop in darkness for six minutes with the metol-hydroquinone solution recommended by the makers. For those, however, who cannot resist the temptation to enjoy seeing the image gradually built up, use may be made of one of the various desensitising

solutions which are now available. Before development, and in darkness, bathe the exposed plate in a weak solution of the desensitiser, such as phenosafranine, for about one minute. Then add the developer, and continue for a further six minutes, during which an ordinary safelight may be used to see the progress of development.

There is one possibility of difficulty, owing to the early hour (6 h. 23 m. A.M. British summer time) at which the eclipse will take place. If the sky is slightly hazy, the contrast of the silvery-white coronal structure may be lessened with respect to the sky background. With ordinary plates this cannot easily be remedied. But if panchromatic plates are employed, much of the sky glare may be eliminated by using a moderately tinted colour screen, of the type known as K_3 , which will cut out much of the blue glare, and yet pass sufficient of the green, yellow, and red to the panchromatic plate to give good density in the image.

Supersensitised Plates.—For observers with more experience, most varieties of plates may be hypersensitised by a preliminary ammonia bath. The plates are simply bathed in a weak solution of ammonium hydrate (about 1 per cent.) for one minute, at a temperature of about 50° F. (14.5° C.). Then dry the plate as quickly as possible, either by a centrifuge or a fan. All this should be done in darkness. If an alcoholic solution is preferred, the plate will dry much quicker, but the resulting sensitivity will be slightly lessened.

Films.—Observers desiring to use films may do so with every confidence; and as many film emulsions are now made colour-sensitive, the remarks already made as to using colour screens, if glare is present, also apply to films.

Colour Photography.—Many observers intimate their intention to try for colour records of the eclipse phenomena, for which several processes are available.

Backing.—It is advisable that all plates should be backed, as any traces of halation due to bright portions of corona, prominences, or slight cloud may otherwise diminish the delicacy of detail.

Shadow Bands.—In addition to the corona and prominences, there are several other features peculiar to a total solar eclipse which may be of interest to photographers wishful of a more extensive programme. Just before totality, and immediately after, a series of moving wavy shadows are usually seen on the ground or sides of buildings facing the eclipsed sun. The cause of these is not yet known with certainty, but they appear to have some relation to prevailing atmospheric conditions. If a white sheet or a whitewashed wall can be used,

photographs of these shadow-bands will be of value. Exact details of the position of the flat surface, whether horizontal or vertical, its direction with regard to north, south, etc., should be carefully noted. Also the actual width, rate of motion, and general direction of the bands on the white surface, and which way they move.

The Moon's Shadow.—This applies chiefly to observers who may be fortunate in occupying a hill station in Wales, Lancashire, or Yorkshire. The dense black shadow may be seen travelling over the landscape, and would form an interesting photographic study wherever possible. Only snap-shots may be made on this, owing to the great velocity of the moon's shadow over the earth's surface.

Landscape Colours.—Very varied descriptions of the remarkable changes of colour of landscape features have been noted during previous eclipses. Those provided with panchromatic plates or colour plates may do useful work in recording any of these changes. In such cases photographs of the same landscape under ordinary daylight conditions should be obtained to indicate changes due to the eclipse.

Spectroscopic Photographs.—So far we have only considered the photography of the eclipsed sun as a picture. There must be many observers who could photograph the spectrum of the phenomenon, and quite valuable records may be made with simple equipment. Either a prism or diffraction grating may be used, adjusted in front of the camera lens. In general this will involve some deviation of the pointing of the camera, which will have to be directed away from the line of the sun by an angle equal to the deviation produced by the prism, etc. Prisms and gratings can, however, be obtained which are arranged to give direct vision, and in such cases the procedure is exactly the same as with the camera lens alone. Very good results can be obtained with the replica gratings produced by the Thorp process, an additional feature being their relatively small cost compared with that of an original ruling on speculum metal. The photographic manipulation is identical with that for ordinary pictures, except that it is scarcely worth

using any except panchromatic plates, which will record the whole of the visible spectrum.

Time Records of Exposure.—The scientific value of any records obtained will be greatly enhanced if the instants of exposure are noted as accurately as possible. The track of the eclipse passes through such populated areas that few observers will be far away from some place where it should be possible to get facilities for listening to the standard time signals which will be broadcast from Greenwich and Paris. The well-known Greenwich six dots, the sixth indicating the time to be noted, will be broadcast at 6 h., 6 h. 15 m. and 6 h. 30 m. A.M. British summer time on June 29. (The latest arrangements for the broadcast time-signals will be found in "Our Astronomical Column.") Perhaps it would be a general convenience if the present 1.0 P.M. signals from Big Ben (12.0 G.M. noon) were given as Greenwich dots for the week preceding the eclipse. The Paris Observatory is also broadcasting from the Eiffel Tower (FL) rhythmic and other time signals specially for the eclipse on both spark and continuous wave.

Any records which can be made to the nearest second will be comparable in accuracy with the determinations of actual beginning and ending of the eclipse itself.

To summarise briefly :

- (1) Arrange for a steady support for the camera directed to the sun, special care being taken if there should be a high wind.
- (2) Provide the camera with a lens of as large a relative aperture as possible.
- (3) Use rapid plates, preferably panchromatic, with a light-yellow screen, and have the plates backed.
- (4) Exposures should be from snap-shot to about 10, 15, or 20 seconds for cameras up to 20 inches focal length. For longer cameras it is better to confine exposures to about 5 seconds, except in the case of clock-driven instruments.
- (5) For clock-driven apparatus take three exposures: snap for prominences at beginning, 15 to 20 seconds during totality for corona, and snap for prominences at end of total phase.

Radio Telegraphy and the Eclipse of the Sun.

SINCE 1912 observations have been made from time to time on the effect of solar eclipses on wireless signals. Up to 1925, however, the data obtained from the observations made was untrustworthy and contradictory, the reason for this being that the observations depended on estimates by the ear of the intensity of signal strength. Apart also from the absence of accurate and

suitable measuring apparatus, it is only in recent years that the mechanism of the propagation of waves round the earth has been understood to a sufficient extent to indicate the type of observation likely to yield positive results. The path of totality of the eclipse which took place on Jan. 24, 1925, crossed the United States, and the opportunity was then taken of arranging for a