neuritis, scotomata for red and green or for green only may be found. At times the green is seen the whole time but is stated to change colour, turning to yellow.

Occasionally a paracentral scotoma may be found. Rarely, in cases of pituitary tumour, a small central scotoma strictly limited by the mid line, usually bi-temporal, may be present.

But of course the purpose for which scotometry is of such importance is the determining of the increase of the blind spot in cases of suspected glaucoma.

A NEW PHOTOGRAPHIC AND A NEW DEMONSTRATION OPHTHALMOSCOPE*

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IN both these instruments, Gullstrand's principle of the "simplified indirect reflexionless ophthalmoscopy" has been applied (v. Tigerstedt, *Handbuch der physiologischen Methodik*, Vol. III, i; *Sinnesphysiologie*, Vol. III, p. 88, 1814). We shall first consider the photographic instrument.

Fig. 1 shows the general arrangement of the illuminating and the reproducing optical systems. The ophthalmoscope A lens forms a part of both systems. It is one of Zeiss's aspheric aplanatic lenses. The image of the retina formed by this lens in its back focus *a*, *b*, is in the photographic instrument reproduced on the same scale by means of a photographic lens B. The illuminating agent is a small arc lamp K running on some 6 amperes. A condenser C forms an enlarged image of the crater on a diaphragm D of 8 millimetres diameter. A rectangular prism E placed immediately below it deflects the illuminating rays in the direction of the ophthalmoscope lens, the surface of which is reproduced in the plane of the condenser by a lens, resting on the diaphragm, where also the photographic shutter has been placed. The already-mentioned reflecting prism partly covers the front surface of the photographic lens, so as to leave a free surface of a little more than half the diameter of the last one. If the pupil of the eye be placed at such a distance from the ophthalmoscope lens that this reproduces the aperture of the photographic lens, and, of course, also the illuminated diaphragm in the pupil of the eye, we have fulfilled the condition postulated by Gullstrand for the elimination

*Based upon a demonstration given before the Section of Ophthalmology, Roy. Soc. Med., on January 14, 1921.

of the reflexes on the cornea and the eye-lens; provided that in the eye pupil there be a free space of nearly 2 millimetres between the image of the diaphragm and of the uncovered part of the photographic lens.

We now have still to consider the presence of two images *r* and *s* of the illuminated diaphragm formed by reflection on the front and back surface of the ophthalmoscope lens. These images have a great instrinsic luminosity, and would spoil the photographic reproduction of the retina; therefore they must be rendered innocuous. In my instrument this is done by placing two very small blackened screens, of about 1·5 millimetre diameter, exactly in the places *r*, and *s*, when these reflexions are sharply reproduced by the photographic lens. As these screens cause the appearance of a limited quantity of diffracted rays behind them, I had also to

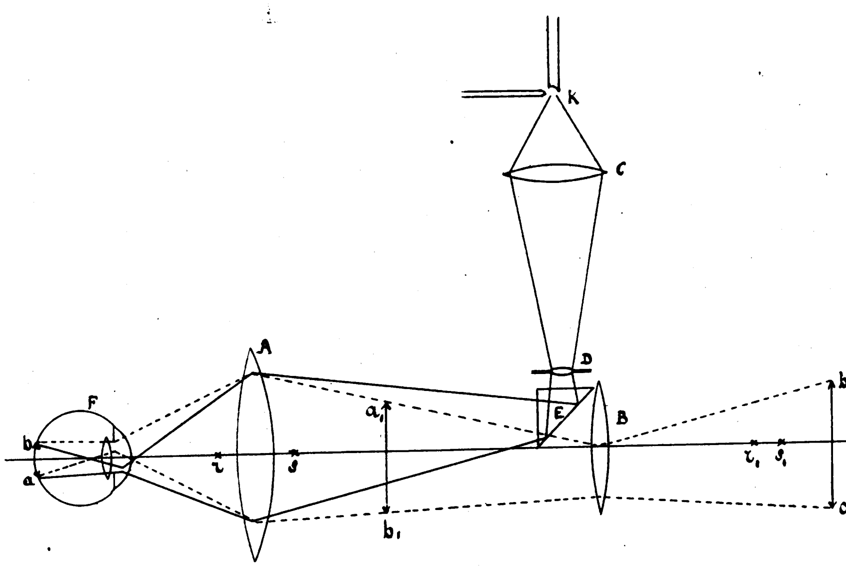

FIG. 1.

reduce the photographic action of the reflected rays by the interposition of a very small yellow transparent screen on the centre of the surface of the condenser. The illumination of the fundus is not appreciably lessened by this screen, whilst the reflexions on the ophthalmoscope lens are practically eliminated.

During the focussing of the retinal image the intensity of the arc light is reduced by a suitable absorbing medium, viz., a smoked and varnished mica-plate. Exposures of about 1/10th to 1/12th second are sufficient to give excellent negatives on panchromatic plates. They easily bear a direct enlargement of about two times. Having a diameter of 40 millimetres, they show the fundus over a solid angle of 30° covering a little more than five times the diameter of the papilla nervi optici. For taking photographs the pupil ought to be dilated to at least 7 millimetres.

The aspheric aplanatic ophthalmoscope lens has a focal distance of 70 millimetres, a diameter of 50 millimetres. The photographic lens is a tessar by *Zeiss* of 15 centimetres focal distance working at f. : 4.5. The distance of the instrument from the eye is about 80 millimetres.

In the demonstration instrument, which is much smaller than the photographic instrument, I use a small ½-watt lamp absorbing about 10 watts instead of the arc lamp. Instead of the photographic lens and camera a small short telescope is employed for viewing the image of the retina. In order to eliminate the reflexions on the ophthalmoscope lens, the light from the lamp passes through a small achromatic double-refracting prism ; a very narrow slit which serves as a diaphragm allows only the rays of one of the two images of the glowing filament to pass through it. These rays are polarized, and the reflected images of the diaphragm consist of polarized light. In the fundus the light is depolarized. As the telescope contains a small Nicol prism the reflexions can be extinguished, whereas the retinal image remains visible. The magnification of the telescope can be varied by using different eye pieces. The absolute magnification of the retina can in this way be varied from 6 times to about 50 times. Generally a magnification of 14 times is used, giving nearly the same magnification as with direct ophthalmoscopy, but with a field of vision as in indirect ophthalmoscopy. The field is a little less extensive than with the photographic instrument, and covers nearly 28°. Of course with the strongest eyepieces the field is much narrower, and with the strongest eyepiece we can just cover the papilla nervi optici. The light is quite sufficient even with this strong magnification ; it is about 10 times stronger than with the large Gullstrand ophthalmoscope, so as to render the use of strong eyepieces of practical advantage.

The greatest advantage of the instrument is that we are able to place it before the patient so as to render the image of the retina immediately visible to anyone looking into the instrument, even if he has not the slightest notion of ophthalmoscopy. The image needs only focussing, which is done by a slight movement of the eyepiece. I use the instrument regularly in my clinical lessons, and during my lectures, in order to show the retina to my students. Those who are not yet able to use the ordinary ophthalmoscopes can see the retina ; those who can use them see it much better with my instrument than with the ordinary ophthalmoscopes.