A slight increase in the relative power of the first lens of 0∙543 would bring about a still closer correspondence in the rationality, but with the curves required to produce an object-glass of this type of 6 in. aperture and 108 in. focal length a discrepancy of 1 unit in the 3rd decimal place in the above proportional figures would cause a linear error in the focus for that colour of only about ·025 in., so that the largest deviation implied by the tables would be a focus for the extreme violet H ray about ∙037 longer than the normal. It will be seen, then, that the visual and photographic foci are now merged in one, and the image is practically as achromatic as that yielded by a reflector.

Other types of triple object-glasses with reduced secondary spectra have recently been introduced. The extension of the image away from the axis or size of field available for covering a photographic plate with fair definition is a function in the first place of the ratio between focal length and aperture, the longer focus having the greater relative or angular covering power, and in the second a function of the curvatures of the lenses, in the sense that the objective must be free from coma at the foci of oblique pencils or must fulfil the sine condition (see Aberration).

*Eye-pieces.—*The eye-pieces or oculars through which, in case of visual observations, the primary images formed by the ob­jective are viewed, are of quite secondary importance as re­gards definition in the central portion of the field of view. If an eye-piece blurs the definition . in any degree in the centre of the field it must be very badly figured indeed, but the defini­tion towards the edge of the field, say at 20º away from the centre of the apparent field of view, depends very in­timately upon the construction of the eye-piece. It must be so designed as to give as flat an image as is possible consistently with freedom from astigmatism of oblique pencils. The mere size of the apparent field of view depends upon obtaining the oblique pencils of light emerging from it to cross the axis at the great possible angle, and to this end the presence of a field-lens is indispensable, which is separated from the eye-lens by a con­siderable interval.

The earlier arrange­ment of two lenses of the Huygenian eye-piece (see Microscope) having foci with ratio of 3 to 1, gives a fairly large flat field of view approxim­ately free from distortion of tangential lines and from coma, while the Mittenzwey variety of it (fig. 4) in which the field-lens is changed into a meniscus having radii in about the ratio of +1 to -9 gives still better results, but still not quite so good as the results obtained by using the combination of two convexo-plane lenses of the focal ratio 2 to 1.

In the Ramsden eye­piece (see Microscope) the focal lengths of the two plano-convex lenses are equal, and their convexities are turned towards one another. The field-lens is thus in the principal focal plane of the eye-lens, if the separation be equal to ½(*f*1+*f*2). This is such a practical drawback that the separation is generally ¾ths or ⅞ths of the theoretical, and then the primary image viewed by the eye­piece may be rather outside the field-lens, which is a great practical advantage, especially when a reticule has to be mounted in the primary focal plane, although the edge of the field is not quite achromatic under these conditions.

*Kellner Eye-piece.—*In order to secure the advantage of the principal focal plane of the eye-piece being well outside of the field-lens and at the same time to obtain a large flat field of view with oblique achromatism and freedom from coma and distortion, there is no better construction than the modified Kellner eye-piece (fig. 5) such as is generally used for prismatic binoculars. It consists of a plano-convex field-lens of crown glass and an. approximately achromatic eye-lens, some distance behind it, consisting of an equi-convex crown lens cemented to a concavo- plane flint lens, the latter being next to the eye.

There are also other eye-pieces having the field-lens double or achromatic as well as the eye-lens.

In cases where it is important to get the maximum quantity of light into the eye, the field-lens is discarded and an achromatic eye-lens alone employed. This yields a very much smaller field of view, but it is very valuable for viewing feeble telescopic objects and very delicate planetary or lunar details. Zeiss and Steinheil’s monocentric eye-pieces and the Cooke single achromatic eye-piece (fig. 6) are examples of this class of oculars. (H. D. T.)

*Reflecting Telescope.*

The following are the various forms of reflecting telescopes:—

The Gregorian telescope is represented in fig. 7. A A and B B are concave mirrors having a common axis and their concavities facing each other. The focus of A for parallel rays is at F, that of B for parallel rays at *f*—between B and F. Parallel rays falling on A A converge at F, where an image is formed; the rays are then reflected from B and converge at P, where a second and more enlarged image is formed. Gregory himself showed that, if the large mirror were a segment of a paraboloid of revolution whose focus is F, and the small mirror an ellipsoid of revolution whose foci are F and P respectively, the resulting image will be plane and undistorted. The image formed at P is viewed through the eye-piece at E, which may be of the Huygenian or Ramsden type. The focal adjustment is accomplished by the screw S, which acts on a slide carrying an arm to which the mirror B is attached. The practical difficulty of constructing Gregorian telescopes of good defining quality is very considerable, because if spherical mirrors are employed their aberrations tend to increase each other, and it is extremely difficult to give a true elliptic figure to the necessarily deep concavity of the small speculum. Short appears to have systematically conquered this difficulty, and his Gregorian telescopes attained great celebrity. The use of the Gregorian form is, however, practically abandoned in the present day. The magnifying power of the telescope is = F*f*/ex, where F and *f* are respectively the focal lengths of the large and the small mirror, *e* the focal length of the eye-piece, and x the distance between the principal foci of the two mirrors ( = F*f* in the diagram) when the instrument is in adjustment for viewing distant objects. The images are erect.

The Cassegrain telescope differs from the Gregorian only in the substitution of a convex hyperboloidal mirror for a concave ellip­soidal mirror as the small speculum. This form has two distinct advantages: (1) if spherical mirrors are employed their aberrations have a tendency to correct each other;

(2) the instrument is shorter than the Gregorian, *caeteris paribus,* by twice the focal length of the small mirror. Fewer telescopes have been made of this than perhaps of any other form of reflector; but in comparatively recent years the Cassegrain has acquired importance from the fact of its adoption for the great Melbourne telescope, and from its employment in the 60-in. reflector of the Mount Wilson Solar Observatory (see below). For spectroscopic purposes the Cassegrain form has peculiar advantages, because in consequence of the less rapid convergence of the rays after reflection from the convex hyperboloidal mirror, the equivalent focus can be made very great in comparison with the length of the tube. This permits the employment of a spectroscope furnished with a collimator of long focus. The magnifying power is computed by the same formula as in the case of the Gregorian telescope.

The Newtonian telescope is represented in Fig. 8. A A is a con­cave mirror whose axis is *a a.* Parallel rays falling on A A converge on the plane mirror B B, and are thence reflected at right angles to the axis, forming an image in the focus of the eye-piece E. The surface of the large mirror should be a paraboloid of revolution, that of the small mirror a true optical plane. The magnifying power is = *F∣e.* This form is employed in the