single white ray ; it will be separated into coloured rays, following diderent courses. The red ray C*r* being less refracted will fall on a point *r* of the eye-glass more remote from its centre B than the violet ray *Cv,* and (the prismaticity of the lens increasing from the centre outwards) will in proportion by the second trans­mission be more bent aside than the violet, and thus a compensa­tion is effected, and the two rays finally emerge parallel, their exact parallelism being secured by the proportion of their focal lengths. The Huygenian eye-piece possesses also other important advantages. The total deflexion of the light, to produce the mag­nifying power, is equally divided between the two glasses,—the most favourable condition for diminishing that distortion which is always perceived in looking obliquely through a lens ; and the field of view is greatly enlarged in proportion to the size of the eye-lens, being such as would require, to produce the same magnifying power, a single lens of the much greater semi-diameter *bd,* found by draw­ing Q*b* parallel to *q*B and erecting *bd.* The inconvenience of this eye-piece (whence it is improperly termed a negative eye-piece) is that the image, being formed between its lenses, undergoes a cer­tain amount of distortion by the field-glass, owing to which equal linear portions of it do not correspond precisely to equal angular measures of the distant object. Equal parts of a micrometer applied at the place of the image, so as to be seen at the same time through the eye-lens, will not correspond to precisely equal angular inter­vals. The common astronomical or positive eye-piece, described by Ramsden (*Phil. Trans.,* 1783), consists of two plano-convex lenses of equal lengths, having their convexities turned towards each other and separated by two-thirds of the focal length of either, as in fig. 8. This combination is placed behind the image PQ

formed by the object-glass, at a distance AP equal to one-fourth of the focal length of A. The first or field-glass, therefore, forms an enlarged image *pq,* at a distance one-third of that focal length which places it in the focus of the eye-glass. This eye-piece is not properly achromatic, but its spherical aberration is much less than in any of the other constructions, and it has the advantage of giving a flat field of view, requiring no change of focus to see the

centre and borders of the field with equal distinctness. The erect­ing or terrestrial eye-piece was invented by Dollond. The principle of its construction will be understood from fig. 9. It is conveni­ent for telescopes of ordinary use, because it presents a non-in- verted image to the eye, although at some sacrifice of light and definition.

For an account of the theory of the chromatic and spherical aberration of eye-pieces by Sir George B. Airy, see *Trans. Phil. Soc. Camb.,* vol. ii. p. 243 and vol. iii. p. 61. The author’s con­clusions are the following. (1) To secure the greatest distinctness with an eye-piece of the Huygenian type, the field-lens should be a meniscus of focal length 3, the radii of its surfaces 11:4, and its convexity towards the object-glass ; the eye-lens should be a double convex of focal length 1, the radii of its surfaces 1 : 6, and its more convex side towards the field-lens. The distance of the lenses should be 2. There should be a perforated diaphragm at distance 1 from the eye-lens. If a bright object appears yellow or a dark one blue at the edge farthest from the centre of the field, the lenses must be brought a little nearer together. (2) For an eye­piece of Ramsden’s type the two lenses should be plano-convex, of focal length 3, placed at distance 2, their convex surfaces being turned towards each other. (3) For an erecting eye-piece of four lenses the first and fourth (reckoned from the object-glass towards the eye) should be crossed lenses of focal length 3, the radii of their surfaces 1 : 6, with their convex surfaces towards each other. The second lens should be a meniscus of focal length 4, the radii of its surfaces 25:11, and its convexity towards the eye. The third lens should be plano-convex, of focal length 4, its plane side towards the eye. The distance of the centre of the second lens from that of the first=4 ; that of the third from the second=6 ; and that of the fourth from the third = 5∙13. If a bright object appears yellow or a dark one blue at the edge farthest from the centre of the field, the third and fourth lenses must be together pushed inwards towards the second lens.

In many telescopes constructed specially for star observation only the object-glass is over-corrected for colour and under-corrected for spherical aberration ; both these errors may sometimes be nearly eliminated by a properly constructed Huygenian eye-piece (see Microscope, vol. xvi. pp. 266-267). But, when a telescope is to be used over a considerable range of field for micrometric measure­ments, it is obvious that the spherical aberration should be corrected by the object-glass alone. It is possible, however, to improve the appearance of objects somewhat in a telescope in which the chro­matic aberration is over-corrected by employing an eye-piece somewhat under-corrected for colour, and *vice versa* ; but the only satisfactory plan is to have both object-glass and eye-piece as free as possible from both chromatic and spherical aberration. In order to secure this, or a very large field of view, many forms of eye-piece have been devised. Achromatic combinations have been substi­tuted in some cases for the field-lens, in others for the eye-lens, in others for both simple lenses of the Ramsden eye-piece. The best of these combinations which the present writer has tested and which practically fulfil all requirements of the astronomer are due to Dr Hugo Schröder, to whom he is indebted for information as to their construction. Fig. 10 represents Schroder’s high power eye-piece, which is admirably suited for micrometer work, not only because there are only two reflecting surfaces in the triple lens of which it is composed, but also because there is a comparatively large distance between the lens and the micrometer web when the latter is in focus. This condition is essential when it is desired to get the best bright illumination of the wires in a dark field (see Micrometer, vol. xvi. p. 248). The triple lens is composed of a dense fluid plano-convex lens between two lenses of soft crown glass. The radii of curvature are—

*r*1= 80∙026 convex

surfaces ( r2 = 36'536 convex f soft crown glass> cemented ( r3 = 36∙536 concave ) - fl∙. „ surfaces J 4= oo plane j∙ ,⅛∏se flint glass, cemented 1 r« = ∞ plane ) ~ ,

4=80’026 convex f soft crown ≡lass∙

The corresponding foci for zones of different distance from the axis are—axis = 100∙00 ; zones 12∙5 from axis, 99∙81 ; 25 from axis, 99∙32 ; 40 from axis, 93∙35 ; 45 from axis, 100∙15 ; 50 from axis, 101∙85. Thus the aperture of the lens may be half its focal length without any sensible defect. Fig. 11 represents Dr O. Schröder’s aplanatic eye-piece. The glass employed is Dauget’s crown (C*b*1) and flint (F*b*1). The refractive power of crown is 1∙5126 for D, that of flint l∙6405 ; the dispersive power of both kinds of glass is 0 ∙588.

The radii of curvature for a lens of 1 inch (27∙07 mm.) focal length are—

mm. mm.

*r*1=20∙12 *r*5=13∙30

*r*2=*r*3=10∙94 cemented *r*6=*r*7= 7∙00 cemented

*r*4=∞ *r*8*=∞*

F1 = focal point of combination = - 9∙05 mm. from vertex of *r*1 ; F2 = position of observer’s eye= - 14∙49 mm. from vertex of *r*8*.*

The thicknesses and distances apart of the surfaces are—