telescope would be improved, and made more distinct at the edges of the field, by employing another glass of great focal distance between C and D.

There is an image formed at H of the object-glasses, and the whole light passes through a small circle in this place. It is usual to put a plate here pierced with a hole which has the diameter of this image. A second image of the object-glass is formed at I, and indeed wherever the pencils cross the axis. A lens placed at H makes no change in any of the angles, nor in the magnifying power, and affects only the place where the images are formed. And, on the other hand, a lens placed at *f* or F", where a real image is formed, makes no change in the places of the images, but affects the mutual inclination of the pencils. This affords a resource to the artist, by which he may combine proper­ties which seem incompatible. The aperture of A dcter- mincs the visible field and all the other apertures.

We must avoid forming a real image, such as *fg,* or F''G", on or very near any glass ; for we cannot see this image without seeing along with it every particle of dust and every scratch on the glass. We see them as making part of the object when the image is exactly on the glass, and we see them confusedly, and so as to confuse the object, when the image is near it. For when the image is on or very near any glass, the pencil of light occupies a very small part of its surface, and a particle of dust intercepts a great proportion of it.

It is plain that this construction will not do for the tele­scope of graduated instruments, because the micrometer cannot be applied to the second image *fg,* on account of its being a little distorted, as has been observed of the Huy- ghenian eye-piece. Also the interposition of the glass C makes it difficult to correct the dispersion.

By proper reasoning from the correction in the Huyghe- nian eye-piece, we are led to the best construction of one with three glasses, which we shall now’ consider, taking it in a particular form, which shall make the discussion easy, and make us fully masters of the principles which lead to a better form. Therefore let PA (fig. 25) be the glass which

first receives the light proceeding from the image formed by the object-glass, and let OP be the axis of the extreme pencil. This is refracted into PR, which is again refracted into R*r* by the next lens Br. Let *b* be the focus of parallel rays of the second lens. Draw PBr. We know that A*b* : *b*B — PB : Br, and that rays of one kind diverging from P will be collected at *r.* But if PR, P V be a red and a violet ray, the violet ray will be more refracted at V, and will cross the red ray in some intermediate point *g* of the line R*r*. If therefore the first image had been formed precisely on the lens PA, we should have a second image at *fg* free from all coloured fringes.

If the refractions at P and R are equal (as in the com­mon day-telescope), the dispersion at V must be equal to that at P, or the angle *v*Vr = VPR. But we have ulti­mately RPV : R*r*V = BC: AB (= B*b* : *Ab* by the focal theorem). Therefore *g*V*r : gr*V (or *gr : g* V, or *Cf* : *f*B) = B*b* : A*b,* and AB : A*b —* R*r* : R*g*.

This shows, by the way, the advantage of the common day-telescope. In this AB = 2 Aft, and therefore *f* is the place of the last image which is free from coloured fringes\* But this image will not be seen free from coloured fringes

through the eye-glass C*r* if *f* be its focus : for had *gr, gv* been both red rays, they would have been parallel after re­fraction ; but *gv* being a violet ray, will be more refracted. It will not indeed be so much deflected from parallelism as the violet ray, which naturally accompanies the red ray to *r,* because it falls nearer the centre. By computation its dispersion is diminished about 1/7 th.

In order that *gv* may be made parallel to *gr* after refrac­tion, the refraction at *r* must be such that the dispersion corresponding to it may be of a proper magnitude. How to determine this is the question. Let the dispersion at *g* be to the dispersion produced by the refraction at *r* (which is required for producing the intended magnifying power) as 1 to 9. Make 9: 1 = *ff' : f'C =,fC :* CD, and draw the perpendicular D*r'* meeting the refracted ray *rr'* in *r'.* Then we know by the common focal theorem, that if *f'* be the focus of the lens C*r*, red rays diverging from *g* will be united in *r'*. But the violet ray *gν* will be refracted into *vv'* parallel to *rr'.* For the angle *vr'r : vgr =* (ultimately) *fC* : CD =9:1. Therefore the angle *vdr* is equal to the dispersion produced at *r,* and therefore equal to *r'νυ',* and *vνl* is parallel to *rd.*

But by this we have destroyed the distinct vision of the image formed at *fg,* because it is no longer at the focus of the eye-glass. But distinct vision will be restored by push­ing the glasses nearer to the object-glass. This makes the rays of each particular pencil more divergent after refrac­tion through A, but scarcely makes any change in the di­rections of the pencils themselves. Thus the image comes to the focus *f',* and makes no sensible change in the dis­persions.

In the common day-telescope, the first image is formed in the anterior focus of the first eye-glass, and the second image is at the anterior focus of the last eye-glass. If we change this last for one of half the focal distance, and push in the eye-piece till the image formed by the object-glass is half way between the first eye-glass and its focus, the last image will be formed at the focus of the new eye-glass, and the eye-piece will be achromatic. This is easily seen by making the usual computations by the focal theorem. But the visible field is diminished, because we cannot give the same aperture as before to the new eye-glass ; but we can substitute for it two eye-glasses like the former, placed close together. This will have the same focal distance with the new one, and will allow the same aperture that we had before.

On these principles may be demonstrated the correction of colour in eye-pieces with three glasses of the following construction.

Let the glasses A and B be placed so that the posterior focus of the first nearly coincides with the anterior focus of the second, or rather so that the anterior focus of B may be at the place where the image of the object-glass is form­ed, by which situation the aperture necessary for transmit­ting the whole light will be the smallest possible. Place the third, C, at a distance from the second, which exceeds the sum of their focal distances by a space which is a third proportional to the distance of the first and second, and the focal distance of the second. The distance of the first eye-glass from the object-glass must be equal to the product of the focal distance of the first and second divided by their sum.

Let Oo, *Aa,* B*b*, Cc, the focal distances of the glasses, be O, *a,* *b*, *c*. Then make AB = *a* + *b* nearly ; BC = *b* + *c* + \*\*\*\*\*; OA = *bc*/*b+c*. The amplification or magni­fying power will be = ob/ac, the equivalent eye-glass = ac/b, and the field of vision = 3438 × aperture of A/foc.dist.ob.gl..