other in E, the violet ray muſt fall within the red ray at *i,* and be leſs refracted than if it had fallen on the ſame point with the red ray. Had it fallen there it would have ſepa­rated from it ; but by a proper diminution of its refraction, it is kept parallel to it, or nearly ſo. And this is one ex­cellence of this telescope : when conſtructed with three eye- glaſſes perfectly equal, the colour is ſenſibly diminiſhed, and by uſing an eye-glaſs ſomewhat ſmaller, it may be removed entirely. We ſay no more of it at preſent, becauſe we ſhall find its conſtruction included in another, which is ſtill more perfect.

It is evident at firſt fight that this teleſcope may be im­proved, by ſubſtituting for the eye-glaſs ik (fig. 13.) the Huyghenian double eye-glaſs, or field-glaſs and eye-glaſs re­preſented in fig. 14 A, and fig. 14. B ; and that the firſt of theſe may be improved and rendered achromatic. This will require the two glaſſes ef and *gh* to be increaſed from their preſent dimenſions to the size of a field-glaſs, ſuited to the magnifying power of the teleſcope, ſuppoſing it an aſtronomical teleſcope. Thus we ſhall have a teleſcope of four eye-glaſſes. The three firſt will be of a conſiderable focal diſtance, and two of them will have a common focus at *b.* But this is conſiderably different from the eye piece of four glaſſes which are now uſed, and are far better. We are indebted for them to Mr Dollond, who was a mathema­tician as well as an artiſt, and in the courſe of his reſearch diſcovered resources which had not been thought of. He had not then diſcovered the achromatic object-glaſs, and was buſy in improving the eye-glaſſes by diminiſhing their ſpherical aberration. His firſt thought was to make the Huyghenian addition at both the images of the day tele­ſcope. This ſuggeſted to him the following eye piece of five glaſſes.

Fig. 17. repreſents this eye-piece, but there is not room ſor the object-glaſs at its proper diſtance. A pencil of rays coming from the upper point oſ the object is made to converge (by the object-glaſs) to G, where it would form a picture of that part of the object. But it is inter­cepted by the lens A*a,* and its axis is bent towards the axis of the teleſcope in the direction *ab.* At the ſame time, the rays which converged to G converge to *g,* and there is formed an inverted picture of the object at *gf.* The axis of the pencil is again refracted at *b,* croſſes the axis of the teleſcope in H, is refracted again at c*,* at *d,* and at *e,* and at laſt croſſes the axis in I. The rays of this pencil, diverging from *g,* are made leſs diverging, and proceed as if they came from *g',* in the line Bgg'. The lens *c*C cauſes them to converge to *g',* in thc line G''Cg'. The lens *dD* makes them converge ſtill more to G", and there they form an erect picture G"F'' ; diverging from G", they are rendered parallel by the refraction at *e.*

At H the rays are nearly parallel. Had the glaſs B *b* been a little farther from A, they would have been accu­rately ſo, and the object-glaſs, with the glaſſes A and B, would have formed an aſtronomical teleſcope with the Huy­ghenian eye-piece. The glasses C, D, and E, are intended merely for bending the rays back again till they again croſs the axis in I. The glaſs C tends chiefly to diminiſh the great angle BH*b ;* and then the two glaſſes D and E are another Huyghenian eye-piece.

The art in this conſtruction lies in the proper adjuſtment of the glaſſes, ſo as to divide the whole bending of the pen­cil pretty equally among them, and to form the laſt image in the focus of the eye-glass, and at a proper diſtance from the other glaſs. Bringing B nearer to A would bend the pencil more to the axis. Placing C farther from B would do the ſame thing ; but this would be accompanied with more aberration, becauſe the rays would fall at a greater di­ſtance from the centres of the lenſes. The greateſt bend­ing is made at the field-glaſs D ; and we imagine that the 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 determines 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 f*g,* on account of its being a little diſtorted, as has been obſerved of the Huyghe­nian eye-piece.

Alſo the interpoſition oſ the glaſs C makes it difficult to correct the diſperſion.

By proper reaſoning from the correction in the Huyghe­nian 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. 18.) 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 retracted into PR, which is again retracted into Rr by the next lens Br. Let *b* be the focus of paral­lel rays of the ſecond lens. Draw PBr*.* We know that Ab : bB = PB : Br, and that rays of one kind diverging from P will be collected at r. But if PR, PV 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 f*g* 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* : A*b* by the focal theo­rem). Therefore *g*Vr *: gr*V (or *gr : g*V, or Cf : fB) = B*b* : A*b,* and AB : A*b =* R*r :* Rg.

This ſhows by the way the advantage of the common day teleſcope. In this AB = 2Ab, 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