theory of refracting teleſcopes is the forms of the different lenſes. Hitherto we have had no occaſion to conſider any thing but their focal diſtances; but their aberrations depend greatly on the adjuſtment of their forms to their ſituations. When the conjugate focuſes of a lens are determined by the ſervice which it is to perform, there is a certain form or proportion between the curvatures of their anterior and po­ſterior ſurfaces, which will make their aberrations the smalleſt poſſible.

It is evident that this proportion is to be obtained by ma­king the fluxion of the quantity within the parentheſis in the formula of par. 2. col. 2. p. 348. equal to nothing. When this is done, we obtain this formula for *a,* the radius of curvature for the anterior ſurface of a lens. I/a = -Γ~r∙T7—TſſV’*a* 2ns-f-42(wτ4)r

where *m* is the ratio of the sine of incidence to the sine of re­fraction, and *r* is the diſtance of the focus of incident rays, poſitive or negative, according as they converge or diverge, all meaſured on a ſcale of which the unit is n, = half of th**e** radius of the equivalent iſoſceles lens.

It will be ſufficiently exact for our purpoſe to ſuppoſe

3. .31∙*lbtn =.* -, though it is more nearly —. In this caſe -=~~f-10 2lir+z□ ThOTforea=^. And‘*∙jr, —* 49r42rf-70 *0 a*

1 — *a*

As an example, let it be required to give the radii of cur­vature in inches for the eye-glass *be* of page 362. col. 1. par. 2. which we ſhall ſuppoſe of 11/2 inches focal diſtance, and that *ec* (= r) is 3 3/4th inches.

The radius of curvature for the equivalent iſoſceles lens is 1,5, and its half is 0,75. Therefore *r = ſſif* = 5 ;

and our formula is *a =* £2215— —— 0 874 ; and

42×5-j-70280’/J’i ~j~aιχd 3 \_\_ o>ij75, =*6 ~~ a '*0,875’3n O,125''

Theſe values are parts of a ſcale, of which the unit is C,75 inches. Therefore

*a,* in inches, = 0,875 × 0,75, = 0,65525

*b,* in inches, = 7 × 0,75, = 5,25.

And here we muſt obſerve that the poſterior ſurface is con­cave : for *b* is a poſitive quantity, becauſe 1 *— a* is a poſi­tive quantity as well as *a* ; therefore the centre of ſphericity of both ſurfaces lies beyond the lens.

And this determination is not very different from the uſual practice, which commonly makes this lens a plane con­vex with its flat side next the eye : and there will not be much difference in the performance of theſe two lenſes ; for in all caſes of maxima and minima, even a pretty conſider­able change of the beſt dimenſions does not make a ſenſible change in the reſult.

The ſame conſideration leads to a rule which is very ſimple, and ſufficiently exact for ordinary ſituations. This **is** to make the curvatures ſuch, that the incident and emer­gent pencils may be nearly equally inclined to the ſurfaces **of** the lens. Thus in the eye-piece with five glaſſes, A and B ſhould be moſt convex on their anterior ſides ; C ſhould be moſt convex on the poſterior side ; D ſhould be nearly isosceles; and E nearly plano-convex.

But this is not ſo eaſy a matter as appears at firſt sight. The lenſes of an eye-piece have net only to bend the ſeveral pencils of light to and from the axis of the teleſcope ; they have alſo to form images on the axes of theſe pencils. Theſe offices frequently require oppoſite forms, as mentioned in par.

3. col. 2. p. 360. Thus the glaſs A of fig. 20. n⁰ 2. ſhould be moſt convex on the side next the object, that it may produce little diſtortion of the pencils. But it ſhould be moſt convex next the eye, that it may produce diſtinct viſion of the image FG, which is very near it. This image ſhould have its con­cavity turned towards A, whereas it is towards the object- glaſs. We muſt therefore endeavour to make the vertical image *fg* flatter, or even convex. This requires a glass very flat before and convex behind. For ſimilar reasons the object-glaſs of a microſcope and the ſimple eye-glass of an aſtronomical teleſcope ſhould be formed the ſame way.

This is a ſubject of moſt difficult diſcuſſion, and requires a theory which few of our readers would reliſh ; nor does our limits afford room for it. The artiſts are obliged to grope their way. The proper method of experiment would be, to make eye-pieces of large dimenſions, with extrava­gant apertures to increaſe the aberrations, and to provide for each ſtation A, B, C, and D, a number of lenſes of the ſame focal diſtance, but of different forms : and we would adviſe making the trial in the way of a ſolar microſeope, and to have two eye pieces on trial at once. Their pictures can be formed on the ſame ſcreen, and accurately compared; whereas it is difficult to keep in remembrance the perfor­mance of one eye-piece, and compare it with another.

We have now treated the theory of refracting teleſcopes with conſiderable minuteneſs, and have perhaps exceeded the limits which ſome readers may think reaſonable. But we have long regretted that there is not any theory on this ſubject from which a curious perſon can learn the improve­ments which have been made ſince the time of Dr Smith, or an artiſt learn how to proceed with intelligence in his profeſſion. If we have accompliſhed either of theſe ends, we truſt that the public will receive our labours with ſatisfaction.

We cannot add any thing to what Dr Smith has deliver­ed on the theory of reflecting teleſcopes. There appears to be the ſame possibility of correcting the aberration of the great ſpeculum by the contrary aberration of a convex ſmall ſpeculum, that we have practiſed in the compound object- glaſs of an achromatic retracting teleſcope; But this can­not be, unleſs we make the radius of the convex ſpeculum exceedingly large, which deſtroys the magnifying power and the brightneſs. This therefore muſt be given up. In­deed their performance, when well executed, does already ſurpaſs all imagination. Dr Herſchel has found great ad­vantages in what he calls the *front view,* not uſing a plane mirror to throw the pencils to one side. But this cannot be practiſed in any but teleſcopes ſo large, that the loſs of light, occaſioned by the interpoſition of the obſerver’s head, may be disregarded.

Nothing remains but to deſcribe the mechaniſm of some of the moſt convenient forms.

To deſcribe all the varieties of ſhape and accommodation which may be given to a teleſcope, would be a taſk as tri­fling as prolix. The artiſts of London and of Paris have racked their inventions to pleaſe every fancy, and to suit every purpoſe. We ſhall content ourſelves with a few ge­neral maxims, deduced from the ſcientific consideration of a teleſcope, as an inſtrument by which the viſual angle ſubtended by a diſtinct object is greatly magnified.

The chief conſideration is to have a ſteady view of the diſtant object. This is unattainable, unless the axis of the inſtrument be kept conſtantly directed to the ſame point of it : for when the teleſcope is gently ſhiſted from its poſition, the object *ſeem to move* in the ſame or in the oppoſite direction, according, as the teleſcope inverts the object or