ways greater when a large arch (that is, an arch of many degrees) is employed. No radius ſhould be admitted which is much leſs than 1/3 of the focal diſtance.

All this proceſs will be made plain and eaſy by an example.

Very careful experiments have ſhown, that in common crown-glaſs the sine of incidence is to the sine of refraction as 1,526 is to I, and that in the generality of flint-glaſs it is as 1,604 to I. Alſo that dm/dm' = 0,6054 = *u.* Therefore *m —* I = 0,526 *; m' —* I = 0,604 ; *c = (m* — I)/(m' — I') =0,87086. By theſe numbers we can compute the coeffi­cients of our final equation. We ſhall find them as follows:

A = 2,012

B = 3,529

C = 1,360

D = —0,526

E = 1,8659

The general equation (p. 352.l.17.), when ſubjected to the aſſumed coincidence of the internal ſurfaces, is j— —

B 4- D — 2 C τ,

~ f-E+D — C = 0. A — C is = 0,652;

B÷D — 2 C is ≡ c,283 ; and Eſt-D — C is = —0,020; and the equation with numerical coefficients is 0,652/a2 — 0,283/a — 0,020 = 0, which correſponds to the equation px2 + qx + r = 0. We muſt now make s = q/p, = 0,283/0,625, = 0,434, and t = r/p, = 0,02/0,652, = 0,0307. This gives us the final quadratic equation I/a2 — 0,434/a — 0,0307 = 0. To ſolve this, we have — 1/2s = 0217, and 1/4s2 — 0,0471. From this take *t,* which is = — 0,0307 (that is, to 0,0471add 0,0307 ), and we obtain 0,0778, the ſquare root of which is = 0,2789. Therefore, finally, I/a = 0,2170 ± 0,2789, which is either 0,4959 or — 0,0619. It is plain that the firſt muſt be preferred, becauſe the ſe­cond gives a negative radius, or makes the firſt ſurface of the crown-glaſs concave. Now as the convergence of the rays is to be produced by the crown-glaſs, the other ſur­face muſt become very convex, and occaſion great errors in the computed aberration. We therefore retain 0,4959 forthe value of I/a, and a is = I/ 0,4959, = 2,0166. To obtain *b,* uſe the equation I/b = I/a — I, which gives I/b = — 0,5041, and therefore a convex ſurface. *b* is there­fore = I/0,5041, = 1,9837.

*a'* is the ſame with *b,* and I/a' = — 0,5041.

To obtain *b',* uſe the equation I/b' = I/a' + u*.* Now *u =* 0,6054, and I/a', = — 0,5041. The ſum of theſe is 0,1013;

and since it is poſitive, the ſurface is concave. b' = *I/,1013 = 9,872.*

Laſtly, I/P = *m — I — u (m' —* I) = 0,1603,and P = I/0,1603, = 6,2383.

Now to obtain all the meaſures in terms of the focal di­ſtance P, we have only to divide the meaſures already found by 6,2383, and the quotients are the meaſures wanted.

Therefore *a* = 2,0166/6,2383 = 0,32325

b = 1,9837/6,2383 = — 0,31798

a' = - - = — 0,31798

b' = 9,872/6,2383 = 1,5825

P = - I.

If it be intended that the focal diſtance of the object- glaſs ſhall be any number *n* of inches or feet, we have only to multiply each of the above radii by *n,* and we have their lengths in inches or feet.

Thus we have completed the inveſtigation of the con­ſtruction of a double object-glaſs. Although this was in­tricate, the final reſult is abundantly ſimple for practice, especially with the aſſiſtance of logarithms. The only troubleſeme thing is the preparation of the numerical coef­ficients A, B, C, D, E of the final equation. Strict at­tention muſt alſo be paid to the poſitive and negative ſigns of the quantities employed.

We might propoſe other conditions. Thus it is natural to prefer for the firſt or crown-glaſs lens ſuch a form as ſhall give it the ſmalleſt poſſible aberration. This will require a ſmall aberration of the flint-glaſs to correct it. But a little reflection will convince us that this form will not be good. The focal diſtance of the crown-glaſs muſt not ex­ceed one-third of that of the compound glaſs ; theſe two being nearly in the proportion of *dm' — dm* to *dm'.* Therefore if this form be adopted, and *a* be made about 1/6th of *b,* it will not exceed 1/5th of P. Therefore, although we may produce a moſt accurate union of the central and mar­ginal rays by oppoſite aberrations, there will be a conſiderable aberration of ſome rays which are between the centre and the margin.

It is abſolutely impoſſible to collect into one point the whole rays (though the very remoteſt rays are united with the central rays), except in a very particular caſe, which can­not obtain in an object-glaſs ; and the ſmall quantities which are neglected in the formula which we have given for the ſpherical aberration, produce errors which do not follow any proportion of the aperture which can be expreſſed by an equation of a manageable form. When the aperture is very large, it is better not to correct the aberration for the whole aperture, but for about 5/6ths of it. When the rays correſponding to this diſtance are made to coincide with the central rays by means of appoſite aberrations, the rays which are beyond this diſtance will be united with ſome of thoſe which are nearer to the centre, and the whole diffuſion will be conſiderably diminiſhed. Dr Smith has illuſtrated this in a very perſpicuous manner in his theory of his Catoptric Microſcope.

But although we cannot adopt this form of an object- glaſs, there may be other conſiderations which may lead us to prefer ſome particular form of the crown-glaſs, or of the flint-glaſs. We ſhall therefore adapt our general equation A/a2 — B/a — C/a'2 — D/a' + E = 0 to this condition.