We imagine that theſe caſes are ſufficient for ſhowing the management of the general equation; and the example of the numerical ſolution of the firſt case affords inſtances of the only niceties which occur in the proceſs, viz. the proper employment of the positive and negative quantities.

We have oftener than once obſerved, that the formula is not perfectly accurate, and that in very large apertures er­rors will remain. It is proper therefore, when we have ob­tained thc form of a compound object-glaſs, to calculate tri­gonometrically the progreſs of the light through it ; and if we find a considerable aberration, either chromatic or spherical, remaining, we muſt make ſuch changes in the curva­tures as will correct them. We have done this for the firſt example ; and we find, that if the focal diſtance of the com­pound object-glaſs be 100 inches, there remains of the ſpherical aberration nearly 1/60th of an inch, and the aberration of colour is over corrected above 1/9th of an inch. The firſt aberration has been diminiſhed about 6 times, and the other about 30 times. Both of the remaining errors will be di­miniſhed by increaſing the radius of the inner ſurfaces. This will diminiſh the aberration of the crown-glaſs, and will diminiſh the diſperſion of the flint more than that of the crown. But indeed the remaining error is hardly worth our notice.

It is evident to any perſon converſant with optical diſcuſſions, that we ſhall improve the correction of the spherical aberration by diminiſhing the refractions. If we employ two lenſes for producing the convergency of the rays to a real focus, we ſhall reduce the aberration to 1/4th. Therefore a better achromatic glaſs will be formed of three lenſes, two of which are convex and of crown-glaſs. The refrac­tion being thus divided between them, the aberrations are lessened. There is no occaſion to employ two concave lenſes of flint-glaſs ; there is even an advantage in uſing one. The aberration being conſiderable, leſs of it will ſerve for correc­ting the aberration of the crown-glaſs, and therefore ſuch **a** form may be ſelected as has little aberration. Some light is indeed loſt by theſe two additional ſurfaces ; but this is much more than compenſated by the greater apertures which we can venture to give when the curvature of the ſurface is ſo much diminiſhed. We proceed therefore to

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It is plain that there are more conditions to be assumed before we can render this a determinate problem, and that the inveſtigation muſt be more intricate. At the ſame time, it muſt give us a much greater variety of conſtructions, in conſequence of our having more conditions neceſ­ſary for giving the equation this determinate form. Our limits will not allow us to give a full account of all that may be done in this method. We ſhall therefore content ourſelves with giving one case, which will ſufficiently point out the method of proceeding. We ſhall then give the reſults in ſome other eligible caſes, as rules to artiſts by which they may conſtruct ſuch glasses.

Let the firſt and ſecond glasses be of equal curvatures on both ſides ; the firſt being a double convex of crown-glaſs, and the ſecond a double concave of flint-glaſs.

Still making *n* the unit of our calculus, we have in the firſt place a *= —b, = —a', = b'.* Therefore I/a' *—* I/b' = —(I/a — I/b), or I/n' = —I/n = —I. Therefore the equation dm/n + dm'/n' + dm''/n'' = 0 becomes *u —* I + u/n'' = 0, or I/n'' = I/u — I. Let us call this value *u'.*

We have I/p = m — I; I/p' = —(m' — I); I/p'' = u'(m — I); I/P = I/p + I/p' + I/p'', = m — m' + u'(m — I).

And if we make *m' — m =* C, we ſhall have I/P = — C , + **u'(m** — I). Alſo I/r' = m — I; I/r'' = m — I — (m' — I), = m — m', = —C'*.*

The equality of the two curvatures of each lens gives I/a = I/2n. Therefore I/a = —I/b, = — I/a', = I/b', = I/2; and I/b'' = I/a'' —I/n'', = I/a'' — u'. Subſtituting theſe values in the equation (p. 351. col. 2.par. 5.), we obtain the three formula,

*,x . c* fm∙4- 2) 1.- *cm—½c* (2 *m* -ſ- 1 ) -f- -—- -

v « ∕ I 4 m*rn* ^R 2 »

2. *— m'2-i-i* (2m'+ 1) (m~1>

2 (√+ 1) (ffl—1) \_\_ (3 ^÷2) (m— \*',, cu't (2 m -∣- 1)1 c υ! lm* -J- 2)

*2. cuιm1- -,* 4- *-t~—■ c c,* a’oo 0' \* *m a*, , s , 4cc'κ'(w+,) l *c c,2* (3 m÷ 2)

( 3 *m* -f- I ) -1-„■+■■—. 0.'o i V »*ma",m*

Now arrange theſe quantities according as they are coefficients of I/a''2 and of I/a''*,* or independent quantities. Let the coefficient of I/a''2 be A, that of be B, and the independent quantity be C, we have

*cu)(m + 2)* 4cc'√(m-{-I ).

A = ; B = r u 2 2mΨ i - — -,

*m* **∖ i z ffj**

and C = *c m 1 -↑- C- ⅛*-- -f- ⅛- (2 m'-∣∙ 1 ) -f- (3 *m'*-f- I) 4 m

∕ ∖ i '3 » i *cc' iu* (3 *m* -∣- 2) 1 z , ⅛

*(m —* 1) -+∙ *c ui m* 4- -- *‘—- — i c (2 m 4- 1)*

**v m XI«**

,t m'4-2\_\_2 *(m'-4-* 1 ) (ot— 1) (3w'-{-2) (m—1)\*

4 *m m' m'*

*— c c' u* 1 (3 *m* -f- i ).

**• ® z-,**

Qur equation now becomes A/a''2 — B/a'' + C = 0.

This reduced to numbers, by computing the values of the coefficients, is 1,312/a''2 — 1,207/a'' — 0,3257 = 0.

This, divided by 1,312, gives a = —0,92; and t = —0,2482 ; — 1/2s = 0,46 ; 1/4s2 = 0,2116 ; and *V∖ P — t* ~ — 0,6781.

And, finally, = 0,46 0,6781.

This has two roots, viz. 0,2181 and —1,1381. The laſt would give a very ſmall radius, and is therefore rejected.

Now, proceeding with this value of I/a'' and the we get the other radius *b",* and then, by means of u', we get the other radius which is common to the four ſurfaces. Then, by I/P = I/p'' — c'*,* we get the value of P.

The radii being all on the ſcale of which *n* is the unit,they muſt be divided by P to obtain their value on the ſcale which has P for its unit. This will give us