These eye-pieces will admit the use of a micrometer at the place of the first image, because it has no distortion.

Mr Dollond was anxious to combine this achromatism of the eye-pieces with the advantages which he had found in the eye-pieces with five glasses. The eye-piece of three glasses necessarily has a very great refraction at the glass B, where the pencil which has come from the other side of the axis must be rendered again convergent, or at least parallel to it. This occasions considerable aberrations, which may be avoided by giving part of this refraction to a glass put between the first and second, in the same way as was done by the glass B put between A and C in his five-glass eye-piece. But this deranges the whole process. His ingenuity, however, surmounted the difficulty, and he made eye-pieces of four glasses, which seem as perfect as can be desired. He did not publish his ingenious inves­tigation ; we imagine therefore that it will be an acceptable thing to the artists to have precise instructions how to pro­ceed.

It is evident, that if we make the rays of different colours unite on the surface of the last eye-glass but one, commonly called the *field-glass,* the thing will be done, because the dispersion from this point of union will then unite with the dispersion produced by this glass alone ; and this increased dispersion may be corrected by the last eye-glass in the way already shown.

Therefore let A, B (fig. 26) be the stations which we have fixed on for the first and second eye-glasses, in order to give a proper portion of the whole refraction to the se­cond glass. Let *b* be the anterior focus of B. Draw PB*r* through the centre of B. Make A*b* : *b*B = AB : BK. Draw the perpendicular Kr, meeting the refracted ray in *r*. We know by the focal theorem, that red rays diverging from P will converge to *r ;* but the violet ray PV, being more refracted, will cross R*r* in some point *g.* Drawing the perpendicular *fg,* we get *f* for the proper place of the field-glass. Let the refracted ray R*r*, produced backward, meet the ray OP coming from the centre of the object-glass in O. Let the angle of dispersion RP V be called *p,* and the angle of dispersion at V, that is, *r*V*v*, be *v,* and the angle V*r*R be *r.*

It is evident that OR : OP = *p* : *v,* because the disper­sions are proportional to the sines of the refractions, which in this case are very nearly as the refractions themselves.

Let OP/OR (or op/*p*Bor *p*B*/b*B) be made = *m.* Then *ν = mp;* also *p : r =* BK : AB = *b*B : A*b,* and *r = p*A*b/b*B, or making A*b/b*B = *n*, *r* = *np ;* therefore *v : r = m : n =* *p*B*/b*B : A*b/b*B = *p*B *:* A*b.*

The angle R*g*V = *g*V*r + gr*V = *p(m+n);* and *RgV* : Rr*v* = R*r* : *Rg,* or *m* + *n* : n = R*r* : *Rg,* and R*g* =

Rrn/m+n. But Rr is ultimately = BK = ABA*b/b*B = AB/*n,* therefore R*g* = AB/*n.* n/m+n = n/m+n. and B*f =* AB/m+n. This value of B*f* is evidently *= bB ∙ AB/pB+Ab.* Now *bB* being a constant quantity while the glass B is the same, the place of union varies with *AB/pB+Ab.* If we remove B

a little farther from A, we increase AB, and pB, and *Ab,* each by the same quantity. This evidently diminishes *Bf.* On the other hand, bringing B nearer to A increases *Bf.* If we keep the distance between the glasses the same, but increase the focal distance *bB,* we augment B*f* because this change augments the numerator and diminishes the de­nominator of the fraction b*B · AB/pB + Ab.*

In this manner we can unite the colours at what distance we please, and consequently can unite them in the place of the intended field-glass, from which they will diverge with an increased dispersion, viz. with the dispersion competent to thc refraction produced there, and the dispersion *p(m + n)* conjoined.

It only remains to determine the proper focal distances of the field-glass and eye-glass, and the place of the eye-glass, so that this dispersion may be finally corrected.

This is an indeterminate problem, admitting of an infinity of solutions. We shall limit it by an equal division of the two remaining refractions, which are necessary in order to produce the intended magnifying power. This construc­tion has the advantage of diminishing the aberration. Thus we know the two refractions, and the dispersion competent to each ; it being nearly 1/27th of the refraction. Call this *q.* The whole dispersion at the field-glass consists of *q,* and of the angle K*g*V of fig. 19, which we also know to be *= p (m + n).* Call their sum *s.*

Let fig. 27 represent this addition to the eye-piece. *Cg* is the field-glass coming in the place of *fg* of fig. 26, and *Rgw* is the red ray coming from the glass BK. Draw *gs* parallel to the intended emergent pencil from the eye-glass ; that is, making the angle *Csg* with the axis correspond to the intended magnifying power. Bisect this angle by the line *g*K. Make *sg : gq = s : q,* and draw *q*K, cutting *Cg* in *t.* Draw *tδ*D, cutting *gk* in *δ*, and the axis in D. Draw *bl* and Dr perpendicular to the axis. Then a lens placed in D, having the focal distance D*d*, will destroy the dis­persion at the lens *gc,* which refracts the ray *gw* into *gr.*

Let *gv* be the violet ray, making the angle *vgr* = *s*. It is plain, by the common optical theorem, that *gr* will be re­fracted into *rr'* parallel to *δ*D. Draw *g* Dr' meeting *rr',* and join *vr'.* By the focal theorem, two red rays *gr, gv* will be united in *r'.* But the violet ray *gv* will be more refracted, and will take the path *vv',* making the angle of dispersion *r'vv — q* very nearly, because the. dispersion at *v* does not sensibly differ from that at *r*. Now, in the small angles of refraction which obtain in optical instruments, the angles rr't', *rgv* are very nearly as *gr* and *rr’,* or as *g*D and DP, or as CD and DT ; which, by the focal theorem, are as *Cd* and *dD* ; that is, *Cd : de = rgv : rr'v.* But D*d* : *d*C = D*δ* *: δt = sg : gq = s : q.* But *rgv = a ;* therefore *rr'v = q — r'υv',* and *vv'* is parallel to *rd,* and the whole dispersion at *g* is corrected by the lens Dr. The focal distance *Cc* of *Cg* is had by drawing Cx parallel to *Kg,* meeting *Rg* in x, and drawing *xc* perpendicular to the axis.