aperture, we shall find it not much to exceed 1/120,000of an inch. If we restrict the circle of chromatic dispersion to 1/250 of the aperture, which is hardly the fifth part of the whole dispersion in it, it is θ^\*\*\* of an inch, and is about 1900 times greater than the other.

The circle of spherical aberration of a plano-convex lens, with the plane side next the distant object, is equal to the circle of chromatic dispersion when the semi-aperture is about 15° ; for we saw formerly that EH is 1/4 of FG, and 7,2 AP3 AP3

that FG is = 2ÄC\*’ and lherefore EG = *p '* ~~⅞ γ(J~~~ ~~τhis~~ v∙ j AP . .p /HÏÏÂC-

being made = gives us Ar = √ which is

AC nearly AC/4, and corresponds to an aperture of 30o diameter,

if *r* be to *i* as 3 to 2.

Sir Isaac Newton was therefore well entitled to say, that it was quite needless to attempt figures which should have less aberration than spherical ones, while the confusion pro- duccd by the chromatic dispersion remained uncorrected. Since the indistinctness is as the squares of the diameters of the circles of aberration, the disproportion is quite beyond our imagination, even when Newton has made such a liberal allowance to the chromatic dispersion. But it must be ac­knowledged, that he has not attended to the distribution of the light in the circle of spherical aberration, and has has­tily supposed it to be like the distribution of the coloured light, indefinitely rare in the margin, and denser in the centre.

Boscovich has shown that the light in the margin of the circle of spherical aberration, instead of being incompara­bly rarer than in the spaces between it and the centre, is incomparably denser. The indistinctness therefore pro­duced by the intersection of these luminous circumferences is vastly great, and increases the whole indistinctness ex­ceedingly. By a gross calculation which we made, it ap­pears to be increased at least 500 times. The proportional indistinctness, therefore, instead of being 19002 to 1, is only 1900,

-- -, or nearly 7220 to 1; a proportion still sufficiently 500

great to warrant Newton’s preference of the reflecting tele­scope of his invention. And we may now observe, that the reflecting telescope has even a great advantage over a re­fracting one of the same focal distance, with respect to its spherical aberration: For we have seen (Cor. 2) that the rs AV’

lateral aberration is — gQyg ∙ This for a plano-convex glass

9 AV3

is nearly j at,d the diameter of the circle of aber-

9 AV3

ration is one fourth of this, or jg\*\*\*. In like manner,

AV’

the lateral aberration of a concave mirror is ■ ; and the

\*L V

A Vs

diameter of the circle of dispersion is ~~~Jgy~~~~a~~> and therefore, if the surfaces were portions of the same sphere, the diame­ter of the circle of aberration of refracted rays would be to that of the circle of aberration of reflected rays as 9/16 to 1/4, or as 9 to 4. But when the refracting and reflecting sur­faces, in the position here considered, have the same focal distance, the radius of the refracting surface is four times that of the reflecting surface. The proportion of the dia­meters of the circles of spherical aberration is that of 9 × 42 to 4, or of 144 to 4, or 36 to I. The distinctness therefore

of the reflector is 36 × 36, or 1296 times greater than that of a plano-convex lens (placed with the plane side next the distant object) of the same breadth and focal distance, and will therefore admit of a much greater magnifying power. This comparison is indeed made in circumstances most favourable to the reflector, because this is the very worst position of a plano-convex lens. But we have not as yet learned the aberration in any other position. In another position the refraction and consequent aberration of both surfaces are complicated.

Before we proceed to the consideration of this very dif­ficult subject, we may deduce, from what has been already demonstrated, several general rules and maxims in the con­struction of telescopes, which will explain (to such readers as do not wish to enter more deeply into the subject) and justify the proportion which long practice of the best artists has sanctioned.

Indistinctness proceeds from the commixture of the cir­cles of aberration on the retina of the eye : for any one *sensible* point of the retina, being the centre of a circle of aberration, will at once be affected by the admixture of the rays of as many different pencils of light as there are sen­sible points in the area of that circle, and will convey to the mind a mixed sensation of as many visible points of the object. This number will be as the area of the circle of aberrations, whatever be the size of a sensible point of the retina. Now in vision with telescopes the diameter of the circle of aberration on the retina is as the *apparent* magni­tude of the diameter of the corresponding circle in the focus of the eye-glass ; that is, as the angle subtended by this diameter at the centre of the eye-glass ; that is, as the dia­meter itself directly, and as the focal distance of the eye-glass inversely. And the area of that circle on the retina is as the area of the circle on the focus of the eye-glass directly, and as the square of the focal distance of the eye-glass inversely. And this is the measure of the apparent indistinctness.

*cor.* In all sorts of telescopes, and also in compound microscopes, an object is seen equally distinct when the focal distances of the eye-glasses are proportional to the diameters of the circles of aberration in the focus of the object-glass.

Here we do not consider the trifling alteration which well-constructed eye-glasses may add to the indistinctness of the first image.

In refracting telescopes, the apparent indistinctness is as the area of the object-glass directly, and as the square of the focal distance of the eye-glass inversely. For it has been shown, that the area of the circle of dispersion is as the area of the object-glass, and that the spherical aberra­tion is insignificant when compared with this.

Therefore, to make reflecting telescopes equally distinct, the diameter of the object-glass must be proportional to the focal distance of the eye-glass.

But in reflecting telescopes, the indistinctness is as the sixth power of the aperture of the object-glass directly, and as the fourth power of the focal distance of the object-glass and square of the focal distance of the eye-glass inversely. This is evident from the dimensions of the circle of aberra- A V3 tion, which was found proportional to ^ξyγ5∙

Therefore, to have them equally distinct, the cubes of the apertures must be proportional to the squares of the focal distance multiplied by the focal distance of the eye-glass.

By these rules, and a standard telescope of approved goodness, an artist can always proportion the parts of any instrument he wishes to construct. Huyghens made one, of which the object-glass had 30 feet focal distance, and three inches diameter ; the eye-glass had 3∙3 inches focal distance ; and its performance was found superior to any which he had seen. Nor did this appear owing to any