volving red and white lights revolving in equal periods. The utility of all these distinctions is chiefly to be imputed to their at once striking the eye of an observer and being instantaneously obvious to strangers.

Before entering upon the subject of the dioptric lights, the writer of this article embraces with pleasure the oppor­tunity afforded to him, of acknowledging the liberality of M. Léonor Fresnel, the present Secretary of the Lighthouse Commission of France. It was entirely owing to the readi ­ness with which M. Fresnel afforded him access to every avenue of information on the subject of lighthouses, that he was enabled to effect the object of a mission to France, on which he was sent in the year 1834, by the Commission­ers of Northern Lights.

The first proposal of applying lenses to lighthouses, is recorded by Smeaton in his account of the Eddystone Lighthouse, where he mentions that, in 1759, an optician in London proposed grinding the glass of the lantern to a radius of seven feet six inches ; but the description is too vague to admitof even a conjecture regarding the proposed arrange­ment of the apparatus. Above forty years ago, however, lenses were actually tried in several lighthouses in the south of England ; but their imperfect figure, and the quantity of light absorbed by the glass, which was of inferior quali­ty and of considcrable thickness, rendered their effect so much inferior to that of the parabolic reflectors then in use, that, after trying some strange combinations of lenses and reflectors, the former were finally abandoned.

The object to be attained by the use of lenses in a light­house, is, of course, identical with that which is answered by employing reflectors ; and both instruments effect the same end by different means, collecting the rays which di­verge from a point called the *focus,* and projecting them forward in a beam, whose axis coincides with the produced axis of the instrument. The actions by which these simi­lar results are effected, have been termed *reflection* and *refraction.* In the one case, the light, as has been already said, merely impinges on the reflecting surface, and is thrown back ; whilst in the other, the rays pass through the refracting medium, and are bent or refracted from their natural course.

The celebrated Buffon, to prevent the great absorption of light by the thickness of the material, which would ne­cessarily result from giving to a lens of great dimensions a figure continuously spherical, proposed to grind out of a solid piece of glass, a lens in steps or concentric zones. This suggestion of Buffon regarding the construction of large burning glasses, was first executed, with tolerable success, about the year 1780, by the Abbé Rochon; but such are the difficulties attending the process of working a solid piece of glass into the necessary form, that it is believed the only other instrument ever constructed in this manner, is that which was made by Messrs. Cookson of Newcastle-upon- Tyne, for the Commissioners of Northern Lighthouses.

The merit of having first suggested the building of these lenses in separate pieces, seems to be due to Condorcet, who in his *Eloge de Buffon,* published so far back as 1773, enumerates the advantages to be derived from this method.@@2 Sir David Brewster also described this mode of building len­ses in 1811, in the *Edinburgh Encyclopædia;* and in 1822, the late eminent Fresnel, alike unacquainted with the sug­gestions of Condorcet, or the description by Sir David Brewster, explained with many ingenious and interesting details, the same mode of constructing these instruments.

To Fresnel belongs the additional merit of having first fol­lowed up his invention, by the construction of a lens, and in conjunction with MM. Arago and Mathieu of placing a powerful lamp in its focus, and indeed of finally applying it to the practical purposes *of a* lighthouse. The fertile genius of the French Academician has produced many in­genious combi nations of dioptric instruments for lighthouses, which we shall have occasion to notice in the sequel.

The great advantages which attend the mode of con­struction proposed by Condorcet, are, the ease of execution, by which a more perfect figure may be given to each zone, and spherical aberration almost entirely corrected, and the power of forming a lens of larger dimensions than could easily be made from a solid piece. Both Buffon and Con­dorcet, however, chiefly speak of reducing the thickness of the material, and do not seem to have thought of determin­ing the radius and centre of the curvature of the generating arcs of each zone, having contented themselves with simply depressing the spherical surface in separate portions. Fres­nel, on the other hand, determined these centres, which constantly recede from the axis of the lens in proportion as the zones to which they refer are removed from its centre ; and the surfaces of the zones of the annular lens, consequently, are not parts of concentric spheres, as in Buffon’s lens. It deserves notice, that the first lenses constructed for Fresnel by M. Soleil had their zones polygonal, so that the surfaces were not annular, a form which Fresnel considered less accom­modated to the ordinary resources of the optician. He also, with his habitual penetration, preferred the plano-convex to the double-convex form, as more easily executed. After ma­ture consideration, he finally adopted crown glass, which, notwithstanding its greenish colour, he considered more suit­able than flint glass, as being less liable to *strife.* All his calculations were made in reference to an index of refrac­tion of l∙5l, which he had verified by repeated experiments, conducted with that patience and accuracy for which, amidst his higher qualities, he was so remarkably distinguished. These instruments have received the name *of annular* lenses, from the figure of the surface of the zones.

Fig. 6, Plate II, exhibits a plan and section of an annular lens of the largest size, whose focal distance is 92 centi­mètres, or about 36∙22 inches, and which subtends a lumi­nous pyramid of 46° of inclination, having its apex in the flame.

Having once contemplated the possibility of illuminating lighthouses by dioptric means, Fresnel quickly perceived the advantage of employing for fixed lights a lamp placed in the centre of a polygonal hoop, consisting of a series of cylindric refractors, *infinitely small* in their length, and having their axes in planes parallel to the horizon.

Such a continuation of vertical cylindric sections of va­rious curvatures, by refracting the rays proceeding from the focus only in a direction perpendicular to the vertical sec­tions of the cylindric parts, must distribute a zone of light *equally brilliant* in every point of the horizon. This effect will be easily understood, by considering the middle vertical section of one of the great annular lenses or burning glasses, already described, abstractly from its relation to the rest of the instrument. It will readily be perceived that this sec­tion possesses the property of simply refracting the rays at right angles to the line of the section, or in a direction parallel to the horizon, and cannot collect the rays from either side of the vertical line ; and if this section, by its revolution about a vertical axis, becomes the generating line

1 In all probability directly derived from the Greek *διόπτρα,* an optical instrument with holes for looking through, which is a compound of διὰ, *through,* and ὄ*πτoμαι, l see.*

@@@2 On pourrait même composer de plusieurs pièces ces loups à échelons ; on y gagnerait plus de facilité dans la construction, une grande diminution de dépense, l'avantage de pouvoir leur donner plus d'étendue, et celui d'employer suivant le besoin un nombre des cercles plus ou moins grand, et d'obtenir ainsi du même instrument differens dégrès de force· *Eloge de Βuffon,* p. 35. *Œuvres de Condorcet,* tom. iv. Pana, 1804