dioptric instruments to the purposes of a lighthouse. This elegant apparatus consists of thirteen rings of glass of va­rious diameters arranged one above another, in an oval form. The five middle rings have an interior diameter of 11·81 inches (30cm∙) and refract equally over the horizon­tal plane of the focus the light which they receive from it, and thus operate precisely in the same manner as the dioptric part of the fixed light apparatus. The other rings or prisms, five of which are upper and three lower, are ground and set in such a manner, that they project all the light derived from the focus in a direction parallel to the other rays by *total reflection.* This effect is produced by arranging the prisms, so that the incident rays, after being refracted at the first surface, shall strike the reflecting side of the prism at such an angle, that instead of passing through the prism at that point, they shall be *totally reflected* from it, and after a se­cond refraction emerge from the third side in a direction parallel to those transmitted by the middle or simply re­fracting rings. When this apparatus is employed to light only a part of the horizon, the rings are discontinued on the side next to the land, and room is thus obtained for using a common fountain lamp ; but when the whole horizon is to be illuminated, the apparatus must inclose the flame on every side, so that it has in this case been found necessary to employ the hydrostatic lamp of Thilorier, in which the balance is sulphate of zinc in solution. Fresnel was pre­vented, by an early death, the consequence of severe appli­cation to scientific pursuits, from ever constructing this beautiful instrument ; and it was reserved for the present enlightened secretary of the *commission des Phares* to com­plete his brother’s invention.

The nature of this apparatus will be fully understood by a reference to fig. 1. Plate I. which shews its section and plan. F is the focal point in which the flame is placed, **r, r** cylindric refractors, forming by their union a cylinder with a lamp in its axis, and producing a zone of light of equal intensity all round the horizon, and r,, *r,* are cylindric refractors having their axes at right angles to those of the refractors r, **r,** and revolving around them. These exterior refractors in front of the inner refractors produce, by com­pound refraction, a beam similar to that resulting from an annιdar lens. x*, x* are catadioptric prismatic rings acting by *total reflection,* and giving out zoncs of light of equal intensity at every point of the horizon. The dotted lines shew the course traversed by the rays of light which pro­ceed from the lamp and are acted upon by the rings of glass. The catadioptric rings supply the places of the curv­ed mirrors M, M, shewn in Plate II. figs. 3 and 4 ; and as the reflection from the inner surface of a prism is, theo­retically speaking, *total,* and the whole loss of light is mere­ly that which is due to absorption in passing through the glass, and that which takes place at the two surfaces, there must of necessity be a much greater proportion of the in­cident light transmitted by the catadioptric action than can ever be obtained from the most perfect reflecting surface, the loss from reflection being held to be in no case less than one half of the incident light.

This consideration, together with some other views re­garding the greater convenience of the catadioptric ap­paratus, led Mr. Alan Stevenson to propose to the Com­missioners of the Northern Lighthouses, in a report, dated 8th October 1836, that an inquiry should be instituted re­garding the practicability of substituting in lights of the first order, a series of catadioptric prisms in the room of the curved mirrors which are at present used in France. Hav­ing received authority from the Lighthouse Board, he cor­responded with M. Fresnel at Paris, who, in the most liberal manner, furnished him with all the information regarding the steps which he bad pursued in reference to the smaller apparatus, and at the same time suggested many import­ant views regarding the larger one.

In the small apparatus of the fourth order, the nearness of the prisms to the flame makes the angle subtended by the first refracting side considerable ; and as the curvature of the reflecting side of the prisms depends upon this an­gle, the excess of the secant, above the radius of the arc, is a notable quantity, and the radius of curvature is propor­tionally small. But in the prisms of the first order, Mr. A. Stevenson found, that the radius of curvature of the re­flecting side is upwards of 24 feet, and that, even when the generating triangles are larger than those of the small ap­paratus, the excess of the secant over the radius is only about ∙0125 inch. Where a flame of great size, like that which illuminates the dioptric apparatus, is used, this cur­vature may be safely disregarded ; and is, indeed, such, that it could not be accurately ground, on account of the great length and unwieldiness of the radius. It is true, that an approximation to the true figure might be made, by giv­ing to the reflecting side the form which would be traced by two tangents to the curve, and thus forming a trapez­oidal prism ; but the difficulty of such an operation, where so little glass is to be removed, and the increased source of error from the necessity of an additional shifting of the glass on the chucks, seem to be sufficient reasons for rejecting this expedient. It ought also to be recollected, that in this case the tendency of the deviation from the theoretical form, is towards the side of safety, as the error in the path of any ray which it could cause, would throw the light at its emer­gence from the prism below, and not above the horizon. The prisms may therefore be considered as rings generated by the revolution of isosceles triangles round a vertical axis passing through the focus of the system.

Mr. Edward Sang, F.R.S.E. in an interesting communi­cation on the grinding of glass, which was lately read before the Society of Arts for Scotland, pointed out the advantage of adopting the highest point of the flame as the focus of the system of reflecting rings. By this arrangement, the light from the upper part of the flame, which would other­wise escape upwards, will be directed to the horizon, whilst the rays front the lower parts of the flame will be usefully directed to illuminate the space between the horizon and the lighthouse

All the lights on the dioptric principle, are illuminated by a flame placed in the centre of the apparatus or com­mon focus of the principal lenses and cylindric refrac­tors which are ranged round it. The burner of the lamp varies in its dimensions and its consumption of oil, accord­ing to the size of the instruments employed, which also de­termines what is called the *order* of the light, a name ex­pressive of its *power* and *range.* Above and below the strictly dioptric part of the apparatus of each order, there are also accessary parts, which are generally simply catop­tric, and consist of curved mirrors arranged in tiers, one above another, like the leaves of a Venetian blind and placed so as to reflect to the horizon the rays received from the lamp, which is in their common focus. At Corduan, however, and at Planier, near Marseilles, the apparatus above the principal lenses is dia-catoptric, being composed of an union of eight lenses of 19·68 inches (50cm.) of focal distance, inclined inwards to the flame, which is in their common focus, and thus forming a frustum of an octagonal pyramid of 50° of inclination. These upper lenses are sur­mounted by plane mirrors, placed so as to reflect horizon­tally the beams transmitted by the lenses. In placing these upper lenses, it has been thought advisable to give their axes a horizontal inclination of 7° from that of the great lenses. By this arrangement, the flash of the upper lenses always precedes that of the principal lenses, as already no­ticed in speaking of the appearance of Corduan light. The use of the accessary apparatus is to collect the rays, which would otherwise puss above and below the main lenses, with­out contributing to the brilliancy of the light. The nature