distance generally adopted is four inches, so that the effec­tive divergence of the mirror in the horizontal plane may be estimated at about 14° 22'. In arranging reflectors on the frame of a fixed light, however, it would be advisable to cal­culate upon less effective divergence, for beyond 11° the light is feeble ; but the difficulty of placing many mirrors on one frame, and the great expense of oil required for so many lamps, have generally led to the adoption of the first valuation of the divergence.

The reflectors used in the best lighthouses, are made of sheet copper plated in the proportion of 6 oz. of silver to 16 oz. of copper. They are moulded to the paraboloidal form, by a delicate and laborious process of beating with mallets and hammers of various forms and materials, and are frequently tested during the operation by the application of a carefully-formed mould. After being brought to the curve, they are stiffened by means of a strong bizzle, and a strap of brass which is attached to it for the purpose of preventing any accidental alteration of its figure. Polishing powders are then applied, and the instrument receives its last finish.

Two guages of brass are applied to test the form of the reflector. One is for the back, and is used by the work­men during the process of hammering, and the other is ap­plied to the concave face as a test, while the mirror is re­ceiving its final polish. It is then tested, by trying a bur­ner in the focus, and measuring the intensity of the light at various points of the reflected conical beam. Another test may also be applied successively to various points in the surface, by masking the rest of the mirror. Having placed a screen in the line of the axis of the mirror at some given distance from it, it is easy to find whether the image of a very small object placed in the conjugate focus, which is due to the distance of the screen, be reflected at any dis­tance from that point on the centre of the screen through which the prolongation of the axis of the mirror would pass, and thus to obtain a measure of the error of the instru­ment. For this purpose, it is necessary to find the position of the conjugate focus, which corresponds to the distance of the screen. If *b* be the distance which the object should be removed outwards from the principal focus of the mirror, *d* the distance from the focus to the screen, and *r* the dis­tance from the focus to the point of the mirror which is to

be tested, we shall have *b=—* as the distance which the *d*

object must be removed outwards from the true focus on the line of the axis.

The flame generally used in reflectors, is from an Argand fountain-lamp, whose wick is an inch in diameter. Much care is bestowed upon the manufacture of these lamps for the Northern Lighthouses, which have their burners tip­ped with silver, to prevent wasting by the great heat which is evolved. These burners are also fitted with a slide appara­tus, accurately formed, by which the burner may be remov­ed from the interior of the mirror at the time of cleaning it, and returned exactly to the same place, and locked by means of a key. This arrangement, which is shewn in Plate II. figs. 7, 8, and 9, is very important, as it insures the burner always being in the focus, and does not require that the reflector be lifted out of its place every time it is clean­ed ; so that, when once carefully set and screwed down to the frame, it is never altered. In these figs, *a a a* represents one of the reflectors, *b* is the lamp, *c* is a cylindric fountain, which contains 24 oz. of oil. The oil-pipe, and fountain of the former, is connected with the rectangular frame *d,* and is moveable in a vertical direction upon the guide rods *e* and *f* by which it can be let down and taken out of the reflector, by simply turning the handle *g,* as will be more fully un­derstood by examining fig. 8. An aperture of an elliptical form, measuung about two inches by three, is cut in the upper and lower part of the reflector, the lower serving for

the free egress and ingress of the lamp, and the upper, to which the copper tube *h* is attached, serving for ventila­tion ; **t** shews a cross section of the main bar of the chan­delier or frame, on which the reflectors are ranged, each being made to rest on knobs of brass, one of which, as seen at *k h,* is soldered on the brass band *l*, that clasps the ex­terior of the reflector.

Plate II. fig. 8, is a section of the reflector *a a,* shewing the position of the burner *b*, with the glass chimney *b'*, and oil-cup *l*, which receives any oil that may drop from the lamp.

Plate II. tig. 7, shews the apparatus for moving the lamp up and down, so as to remove it from the reflector at the time of cleaning it. In the diagram, *c*, the fountain, is mov­ed partly down ; *d, d* shews the rectangular frame on which the burner is mounted, *e e* the elongated socket-guides, *f* the rectangular guide-rod, connected with the perforated sockets on which the *checking-handle g* slides.

The modes of arranging the reflectors in the frames, are shewn in Plate I. figs. 2, 4, and 5. It seems quite unne­cessary, after what is said on the subject of divergence, to do more than remark, that in revolving lights the reflectors are placed with their axes parallel to each other, so as to concentrate their power in one direction ; whilst in fixed lights, it is necessary, in order to effect as equal a distribu­tion of the light over the horizon as possible, to place the reflectors, with their axes inclined to each other, at an angle somewhat less than that of the divergence of the re­flected cone. For this purpose, a brass guage, composed of two long arms, somewhat in the form of a pair of com­mon dividers, connected by means of a graduated limb, is employed. The arms having been first placed at the angle, which is supplemental to that of the inclination of the axes of the two adjacent mirrors, are made to span the faces of the reflectors, one of which is moved about till its edges are in close contact with the flat surface of one of the arms of the guage. The different arrangements of the re­flectors will be more fully understood by referring to the Plates.

Plate I. figs. 2 and 5, shew an elevation and plan of a revolving apparatus on the catoptric principle. In these figures, *n n* shews the reflector frame or chandelier; *o o,* the reflectors with their oil-fountains *p p*). The whole is attached to the revolving axis or shaft *q.* The copper tubes *r r* convey the smoke from the lamps ; *s s are* cross bars which support the shaft at *t t ; u u* is a copper pan for re­ceiving any moisture which may accidentally enter at the central ventilator in the roof of the light-room ; *l* is a east- iron bracket, which supports the pivot on the shaft ; *m m* arc bevelled wheels, which convey motion from the machine to the shaft.

Plate I. fig. 4, shews a plan of one tier of reflectors ar- rangcd in the manner employed in a fixed catoptric light ; *n n* shews the chandelier, *q* the fixed shaft in the centre, which supports the whole, *o o* the reflectors, and *p p* the fountains of their lamps.

A variety of the parabolic reflectors has been invent­ed by M. Bordier Marcet, the pupil and successor of Ar­gand, who has laboured with much enthusiasm in per­fecting catoptric instruments, more especially with a vie w to their application in the illumination of lighthouses and the streets of towns. Amongst many other ingenious com­binations of parabolic mirrors, he has invented and con­structed an apparatus, which is much used in harbour-lights on the French coast. The object of this apparatus is to fulfil, as economically as possible, the conditions required in a fixed light, by illuminating, with perfect equality, every part of the horizon, by means of a single burner ; and M. Bordier Marcet has in his work-shop an instrument of this kind, eight feet in diameter, which he constructed on speculation. The apparatus used in harbour-lights, on the French coast, is of much smaller dimensions, and does