of that circle. This circle must, therefore, be chosen of a diameter equal to the required motion or threw of the steam valves attached to the cylinder.

This motion has been modified into a very excellent and durable arrangement in the following form.

Here the toothed wheels are as in the former figure, and the eccentric pin or crankpin is car ried round by the inner one. On the crankpin is a square brass nut or collar, made to fit exactly a space left between two parallel bars S1 S2 and S3 S4 that are kept *in situ* by means of nuts and screws at their extremities, and capable of adjustment. S3 and S4 are cοnnected with the straight bar S5 and S6, which works steadily through the collars S5 and S6, and from its end a connecting link S6 and S7 passes to work the crank and valve-rod S *c v*. This apparatus we have seen work well without repair for a long period. It was executed by the Messrs Carmichael of Dundee. Figs. 104, 105, 106, show the appara

tus in three other positions.

Another mode of prod icing the motion of the valves

is by a projection in the great axis of the engine itself. A rigid circular hoop **S** encloses the axle as in figs. 107, 108, 109, 110. lt is evident that if the projection E be just equal to the radius of the hoop the axle will revolve without producing motion in the hoop; but, if on the contrary, the axle and its projection be equal to the diameter of the hoop, as in the figs. 107, 108, 109, 110, it is apparent that the projection or cam, in passing round, must push the hoop in alternate directions.

But that modification of this principle, which is in by far the most general use, is in the form called “ the eccentric.” The eccentric is a circular disc, or ring of metal placed upon the shaft or axis, turned by the crank. O, fig. Ill, is the centre of the shaft or axis, to which revolution is given by the crank R of the steam-engine. On this axis the circular disc E E E is placed, but eccentric to it, so that its centre *d* moves round the axis. The distance of the centre *d* of the disc from the centre O of the axis, is called the eccentricity, and it is equal to half the throw or range of the motion of the valves to he moved by the eccentric. The rod, fig. 112, is called the eccentric rod, and is attached to a hoop or circle that exactly fits the eccentric disc. The various positions which the eccentric will take during the revolution of the engine, is shown in the succeeding figures.

We have used the common eccentric in a much simpler form than that generally adopted, by placing it immediately over the valve which it moves. In engines which require compactness and simplicity, this way is useful, and is valuable where the axis of rotation is immediately over the valves, thus:—

The valve-rod, figs. 117. 118., branches out into four portions ; a flat brass plate is inserted at their separation, an