Racks and worms

By GEOMETER

ALTHOUGH seemingly dissimilar in their functions, racks and worms resemble one another ; and in many instances, their profiles are identical. Ordinarily, a straight worm and wheel provide but one variety of mechanical movement. The worm rotates and turns the wheel, at a much lower speed. The principle does not differ should the wheel be fixed on a base, and engaged by a worm on a platform capable of rotating as the worm is turned, though this would be a somewhat special application.

A rack and pinion, on the other hand, can be used in three different ways. The rack can be fixed and the pinion roll along it, mounted on a carriage and powered, as in the case of a lathe saddle, or a mountain railway. Alternatively, the pinion can turn in fixed bearings, and move the rack in a straight line in guides, as in a small mandrel press, or in rack and pinion steering in cars. Again, by a reversal of this latter, the pinion in fixed bearings can be made to turn through a certain arc or number of revolutions, for a given endwise movement of a rack in guides, as may be required on occasion in jig or machine tool applications.

Here the tooth action of the rack and pinion, within the restricted range, resembles that of a worm and wheel, where the teeth of the rotating worm move slowly endwise and turn the wheel. Hence, for a rack and a straight worm, the tooth profiles can be similar; and in all cases, the pitch circle of the pinion or worm wheel rolls in relation to the straight pitch line of the rack or worm, as at A.

The form of an involute rack and of a standard worm thread is as at B. The angle of a tooth flank is 14-1/2 deg.,making the included angle 29 deg. ; and all proportions derive from the pitch *P*, which is normally stated to be the distance from the centre of one tooth to the centre of the next. At the pitch line, tooth thickness and space width are each equal to half *P*. *The* total depth of teeth is 0.686 x *P*. *The* width of the tooth at the top is 0.335 x ***P;*** and the width of the space at the bottom is 0.310 x *P*. *Thus,* given *P,* proportions are obtained by simple multiplication.

For a rack to work with a normal spur gear, of diametral pitch, *P* derives from the circular pitch of the gear; but for a worm to be cut in a lathe, *P* can derive from t.p.i. to facilitate the work-since *P* to diametral pitch would not necessarily be a round number of t.p.i. The cutting of a straight rack, however, requires only simple steps, each equal to *P* and not difficult to arrange, whatever the friction.

A rack may be used to generate teeth on gears; and for this the British Standard rack form is as at C. Flank angle is 20 deg., total depth of tooth 0.716 x P, and height of tooth above pitch line 0.3183 x *P*. At its root,. a tooth has a radius 0.035 x *P;* and its tip is rounded to 0.004 x *P*.

A rack can be produced in the lathe with a flycutter, or a type as at *D*, the rack blank being mounted on an angleplate on the vertical slide. Using a long mandrel for a cutter of sufficient diameter, removing the tailstock handwheel, and employing a jig as at *E* and *F*, on the angleplate, a rack of considerable length can be cut.

To locate the blank, the jig should have a guide *W* and a backstop X. A clamped stop Y, and prepared distance pieces provide for spacing the first few teeth; then the stop can be removed and a jaw fitted, so that for each tooth the blank is moved up one.