By GEOMETER

WORM and PINION DRIVES

THE worm and pinion pair, or worm and wheel combination, has wide applications for gearing shafts at right-angles where, within a relatively small compass, a considerable reduction in speed, or increase in force, is required. In design, features of the pair admit of varying proportions to suit available shaft centres; while the construction provides essays in workshop techniques that, by contrast, may he all the more interesting when they follow a surfeit of plain turning jobs.

Typical applications of a. worm and pinion are in the steering gear of a model traction engine; in the drive to the oil pump of a high speed reciprocating engine or turbine; and in special equipment for the lathe to give slow feed to a slide. At one extreme, a large single-start worm is self-locking on a winding drum; while at the other, a multiple-start worm and appropriate pinion make the two-to-one skew gear pair for the camshaft drive of a gas engine.

With the usual form of single-thread or single-start worm, the pair are as at ***A,*** and their ratio is given by the number of teeth on the pinion. If it has 20 teeth, the ratio is 20 : 1. Should the worm be two-start, the ratio with 20 teeth on the pinion is 10 : 1. It is 6.66 : 1 if there are three-starts, and 5 : 1 if there are four-starts. Thus, fundamental ratio requirements are met by varying the teeth on the pinion and the starts on the worm.

Freedom in design to choose shaft centres appropriate to the space follows from the way in which the worm can be varied in size without altering the ratio, as at ***B,*** though in a drive which transmits power up to its proportions there is a limit to what should be done-because a large worm occasions disproportionate sliding friction. If there is a hint of an excess of this, a coarser pitch of thread giving a larger pinion is advisable. A minor point in construction is a radius at the periphery of the pinion which conforms to the core diameter of the worm.

All proportions follow from the pitch, ***p*** (opposite of t.p.i.) which is employed. This is the distance from the centre of one tooth to another. A standard worm thread has flanks at 29 degrees. The total depth is 686 ***x p,*** the flat at the top 0.335 ***x p,*** and the flat at the bottom 0.310 x ***p***. The pitch line, as at C, Y-Yl, is 0.318 ***x p*** from the top of the thread. The straight pitch on this line; tooth to tooth, is the same as the circular pitch, tooth to tooth, on the pitch circle Z-Z1 of the pimon.

Thus! the pitch of the worm multiplied by the number of teeth on the pinion is the circumference of the pinion pitch circle. Diameter is circumference divided by 3.1416; adding 0.318 x ***p x*** 2 provides the diameter of the pinion blank at the bottom of the radius.

Subtracting the pinion pitch circle radius from the shaft centres gives the worm radius at the pitch line. Multiplying by two and adding 0.318 x ***p x*** 2, we get the diameter of the worm blank.

For the pinion to work properly with the worm, it must be hobbed to suit it. In small sires, hob and worm can be turned and screwcut together, leaving the hob a few thou larger to give clearance to the pinion.

The set-up can be as at ***D;*** then, with the worm parted off, the hob is slotted to form cutting teeth and is hardened and tempered, or case-hardened, depending on whether silver steel or mild steel is used. Screw-cutting is best done in stages with side and in-feeds, as at El and 2.

Gashing and hobbing the pinion blank can both be done on a simple fixture on the vertical slide, as at ***F.*** For gashing, a change gear provides spacing, the fixture is set at an angle, and a slotting cutter is used. For hobbing, the iixture is set vertically on the slide, and the spindle mounting the pinion blank is free to turn with it. The depth of the teeth is obtained from cross-slide feed. ❑