Making Gear Cutters

By H. Winton

THE making of gear cutters, particularly in the larger sizes, presents the following problems:-(1) How to produce an accurately contoured milling cutter. (2) How to back off the cutter.

With regard to the first problem, an excellent series of articles on the proportions of gear teeth by Ian Bradley appeared in THE MODEL ENGINEER for December, 1941. The information given in Fig. 4 is extracted from these articles and provides sufficient information to enable a cutter to be made, although anyone undertaking the manufacture of gear cutters is strongly recommended to read the articles in question.

Excellent as Mr. Bradley's article was, however, I do feel that his method of machining, and particularly his lack of directions for backing off, left something to be desired. In fact, for cutters of the order of 10 d.p. or so, it is quite impossible to contour a cutter with a form tool in a light lathe, and the present article sets out to describe a method of producing the contour accurately in the sort of lathe operated by the average amateur.

The gear tooth space is first drawn to as large a scale as possible, and for 10 d.p., certainly not less than four times full size. Continue the curves of the tooth flanks until they cut lines representing the thickness of the cutter which in my case is 7/16 in. Measure, as accurately as possible, the penetration of the curve of the flank into the side and diameter of the cutter blank; in the case of the example shown in Fig. 4, the dimensions are 0.160 and 0.304 respectively.

It will be seen that if the lathe is provided with micrometer indices on the cross-feed and leadscrew, it is a very simple matter by using the dimensions referred to above, to assess when the contouring tool has reached the correct position.

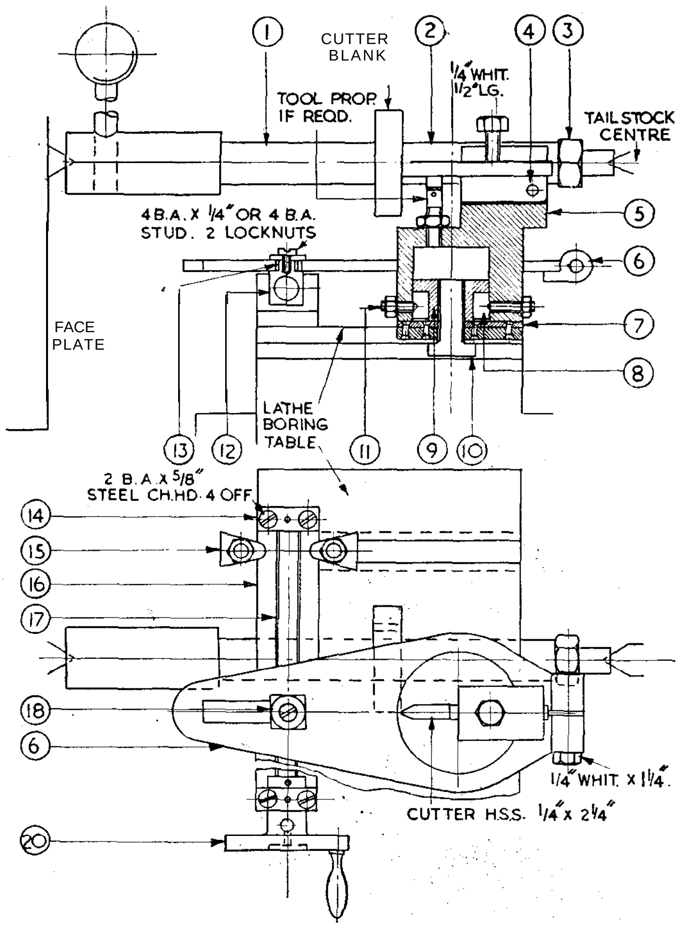
It was stated earlier that it is impossible to produce a 10 d.p. cutter by means of a form tool in a light lathe; this is of course due to lack of rigidity, causing excessive juddering and consequent marking of the work, and, therefore, the scheme to be described uses a single-point cutter for both forming the contour and subsequently backing it off.

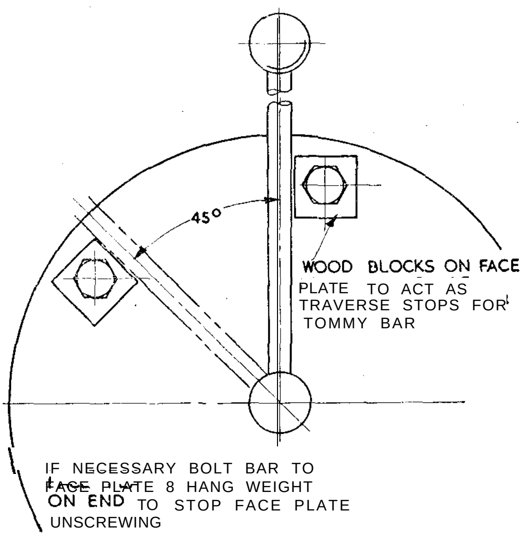
The drawing shows the rig which was used, and the detail drawings are relevant to a 3-1/2 in. Drummond model " M " lathe. It will be seen that the device consists essentially of a tool free to rotate about a vertical pivot (Item 9), and is really a crude form of turntable, as used on milling machines and the like.

The cutting tool is mounted in a clapper box (Items 4 and 5) since the work is subject to an oscillating motion during backing off. The turntable is caused to rotate by means of the arm 6 and the leadscrew 17.

A study of the detail drawings will show that the front face of the clapper-box is 1/8 in. from the centre of the axis of rotation, and it is a simple matter to set the cutter to the required radius by turning the turntable until the axis of the hole for the accommodation of the tool runs directly across the lathe bed; the cross-slide is then fed inwards until the front face of the tool holder just touches any mandrel placed between the lathe centres.

To the dimension of the required radius, 1/8 in. is added (1/8 in. + 0.3125 in. Fig. 4), and the cross-slide feedscrew is then fed outwards by this amount.





Rig for contouring and backing off milling cutters

The cutting tool is pushed in until the cutting point is touching the mandrel, and the tool clamping screw is tightened down.

For producing the cutter profile to a stage immediately prior to backing off, the cutter blank is mounted on the mandrel (Item 1). The six-inch tommy bar with the knob on the end is removed and a lathe carrier substituted; the mandrel is then mounted between the lathe centres by means of the concentric countersinks (it will be noted that there is an eccentric countersink at one end, and this will be used later when backing off).

To set correctly the position of the turntable, relative to the cutter blank, proceed as follows:

With the cutting tool axis running directly across the lathe bed, feed the cross-slide inwards until the point of the tool touches the periphery of the blank. Note the reading of the cross-slide micrometer index, and to this reading, add the amount by which the flank radius is to penetrate in the direction of the cutter blank diameter (0.304 in the example shown in Fig. 4). The reading so arrived at will be the final position of the cross-slide when contouring is complete.

Having made a note of the cross-slide index reading, turn the cutting tool and turntable through 90 deg. and traverse it by the leadscrew until the cutting point is touching the side of the cutter blank. Note the reading of the leadscrew index, and add to it the penetration. of the flank radius in an axial direction (0.160 in the example shown in Fig. 4).

By means of the cross-slide, withdraw the cutting tool clear of the blank, and set the leadscrew to the final position required. Set the cross-feed to the reading it showed when the cutting point just touched the periphery.

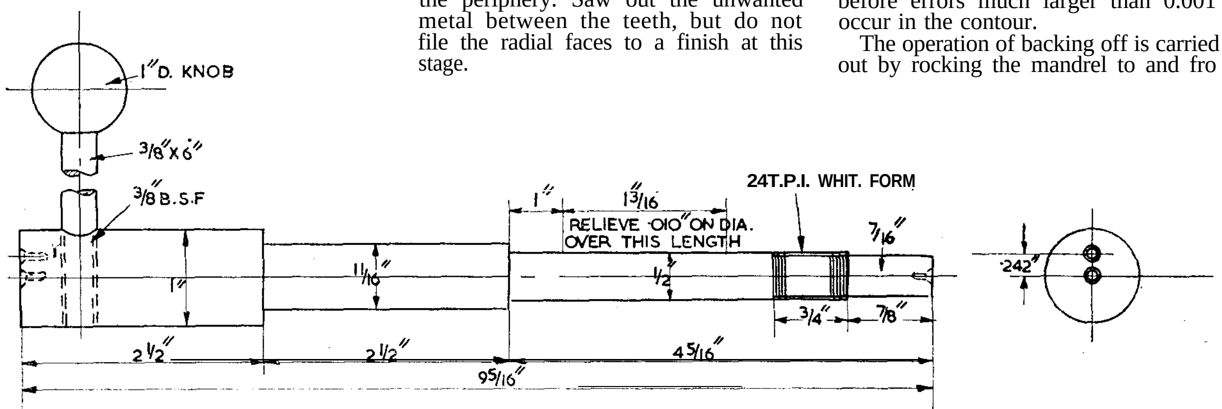
Rotate the cutting tool and turntable clear of the blank, if it is not already clear, and apply sufficient cross-feed to cause the tool to just start cutting the corner of the blank when the tool is rotated. After each rotary traverse, add successive amounts of cross-feed until the cross-feed index shows its final reading. Reverse the cutter blank, and repeat the operation.

Referring to Fig. 3, mark off and drill the 1/8 in. holes, and mark off the leading and trailing edges of each tooth on the periphery. Saw out the unwanted metal between the teeth, but do not file the radial faces to a finish at this stage.

To make the cutter cut efficiently. the backing off must be in two planes; side relief as indicated by the angle *A* in Fig. 1, and at the root and also the crests, the relief must be as shown by the angle *B* in Fig. 2. For practical reasons, a combination of backing off in both planes is applied over the whole of the tooth contour, and this is achieved by mounting the mandrel to which the cutter blank is attached,, eccentrically at one end as shown in Fig. 1.

It is appreciated that by backing off the cutter in this manner, the contour does not remain absolutely accurate after a lot of re-grinding, but it will permit something of the order of 0.015 to be ground off the radial face before errors much larger than 0.001 occur in the contour.

The operation of backing off is carried out by rocking the mandrel to and fro



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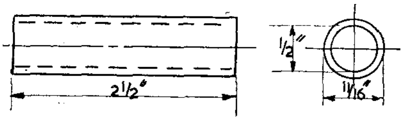

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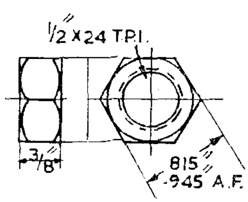

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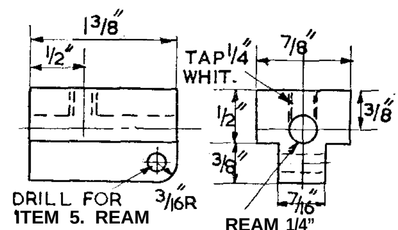

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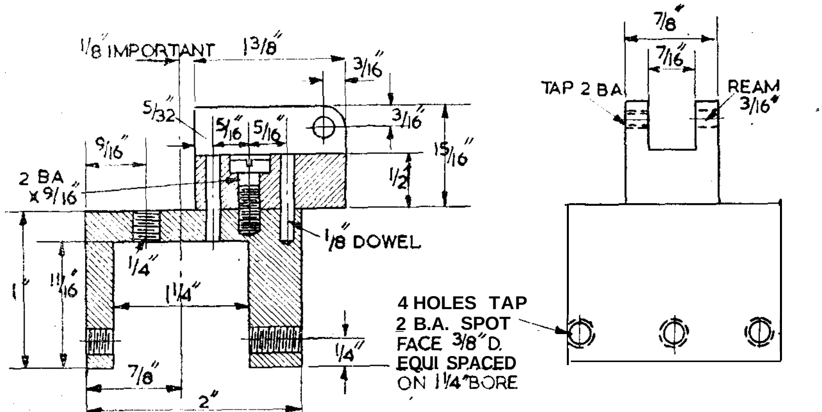

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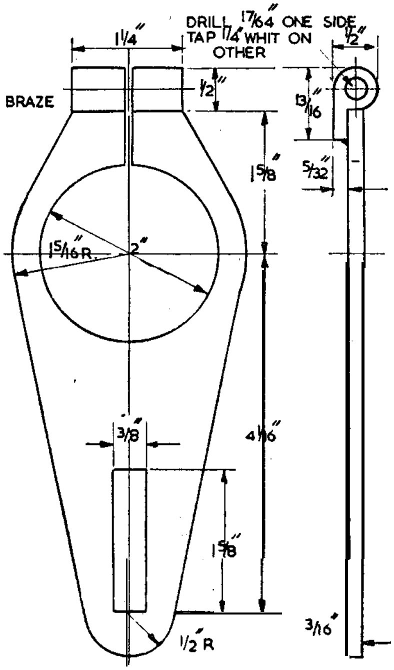

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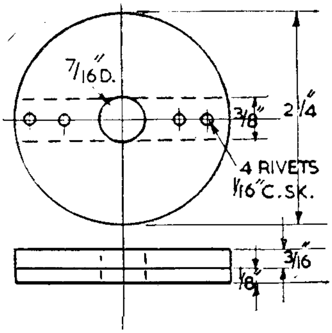

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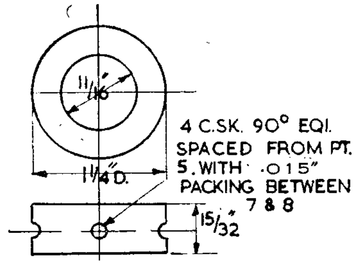

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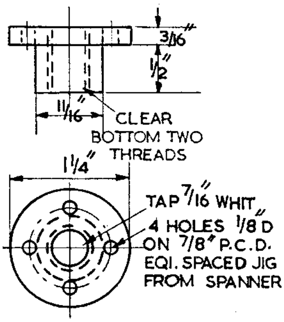

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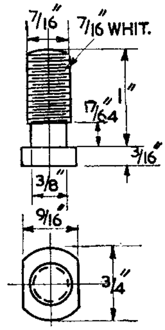

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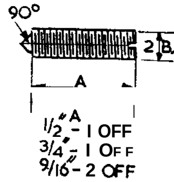

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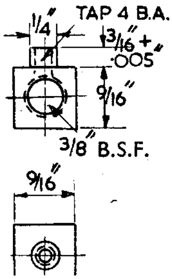

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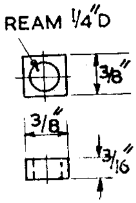

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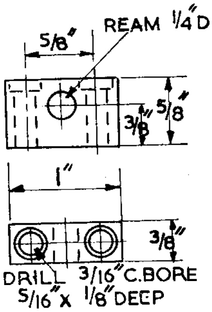

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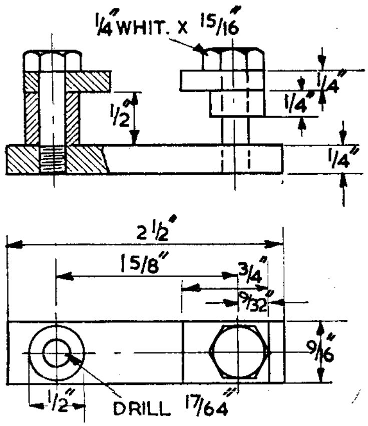

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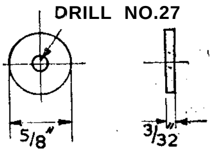

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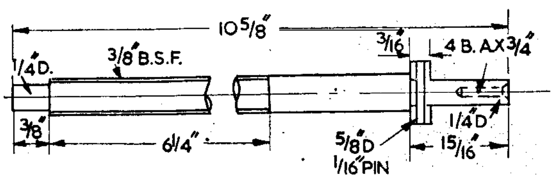

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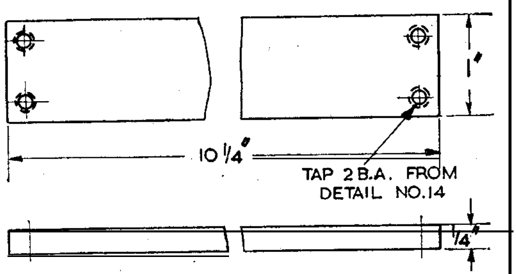

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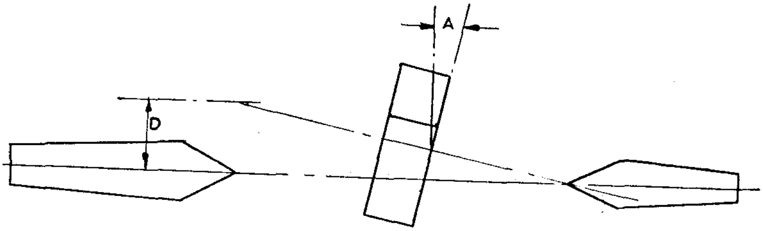


Fig. 1

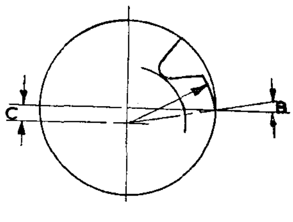


Fig. 2

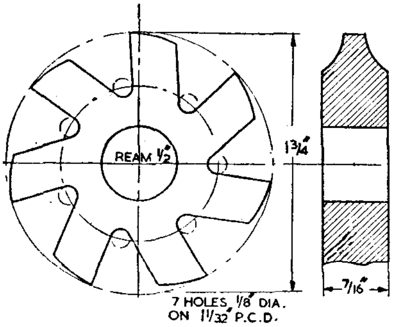


Fig. 3

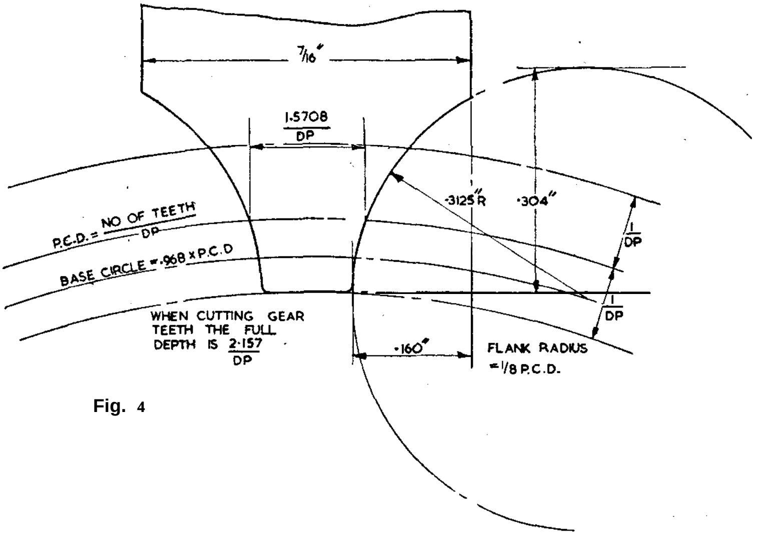
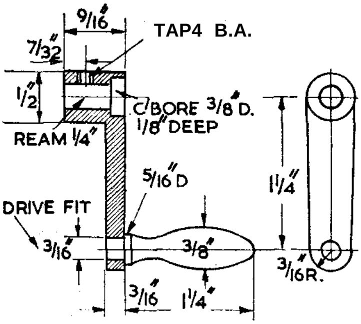


Fig. 4



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by means of the tommy bar, while simultaneously rotating the cutter and turntable; this sounds a little tedious, perhaps, but it can be done quite quickly after a little practice. It is essential that stops be provided to limit the oscillating movement, and in my case I used wooden blocks secured to the faceplate, the headstock being locked.

These limits are of course necessary to avoid damaging adjoining teeth. Having backed off one side of one tooth, the blank is indexed round one tooth and the operation repeated. It will be seen that no special provision is made for indexing. I achieved this by holding the tommy bar against the top stop, with the cutter mandrel at top -dead centre, so to speak, at the eccentric end. The cutter blank was then rotated until the leading edge of the tooth was'just above the point of the cutting tool. A crude height gauge made sure that all teeth were successively in the same position.

When all the teeth on one side are backed off, back off half the width of the tip of the tooth and then turn the mandrel end for end, so that the eccentric end is now at the tailstock.

Reverse the cutter blank on the mandrel, turn the turntable through 180 deg., and proceed to back off the other sides of the teeth and the other half of the tips of the teeth. Incidentally, since the tommy bar is now at the tailstock end, it will be necessary to fix a lathe carrier at what is now the headstock end, in order to provide something to butt against the wooden stops on the faceplate and thus retain the limit on the degree of oscillating motion.

The radial faces are now filed to the line, the cutter is hardened and tempered and on the side is etched, with nitric acid, information giving the d.p,, number of teeth of the gears which it will provide, and the full depth of cut.

I have successfully produced gear cutters in this way for 8, 9 and 10 d.p. gears.

MODEL POWER BOAT PROPULSION.

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fantastically fast speed. For example, if the meter reads 30 seconds on the top line, it means that the nomination time would be 30 seconds for an 80-yard course, 29 seconds for a 75-yard course, and 19 seconds for a 50-yard course.

It is only necessary for calibration purposes, of course? to make half a dozen timed runs in the first place, because it is obvious that the other scales are derived by a calculation of simple proportion relative to meter pointer angular displacement, and as current generated is proportional to the flux lines of force cut by each tooth of the wheel, the scale shape will be representative of the effects of engine speed variation for a particular hull design, though it will tail off towards infinity at the lower revolutions end.

Depending upon the type of construction employed and the sensitivity of the meter, the latter may or may not require shunting with a resistance to prevent overloading, or the distance between the magnet and toothed wheel may be varied to give the same effect.

In concluding these notes, it is to be hoped that some of the opinions here expressed may find favour amongst power boat men who, even if they disagree, at least are always willing to listen to and criticise the other man's views and perhaps try out his ideas.