GEAR CUTTING

With the Shaper

by "Base Circle"

FIRST, let it be said that the method here described is not claimed to be original. All that is claimed is that it does not appear to be generally known to readers of THE MODEL ENGINEER and that the writer has not come across any reference to such a method in print.

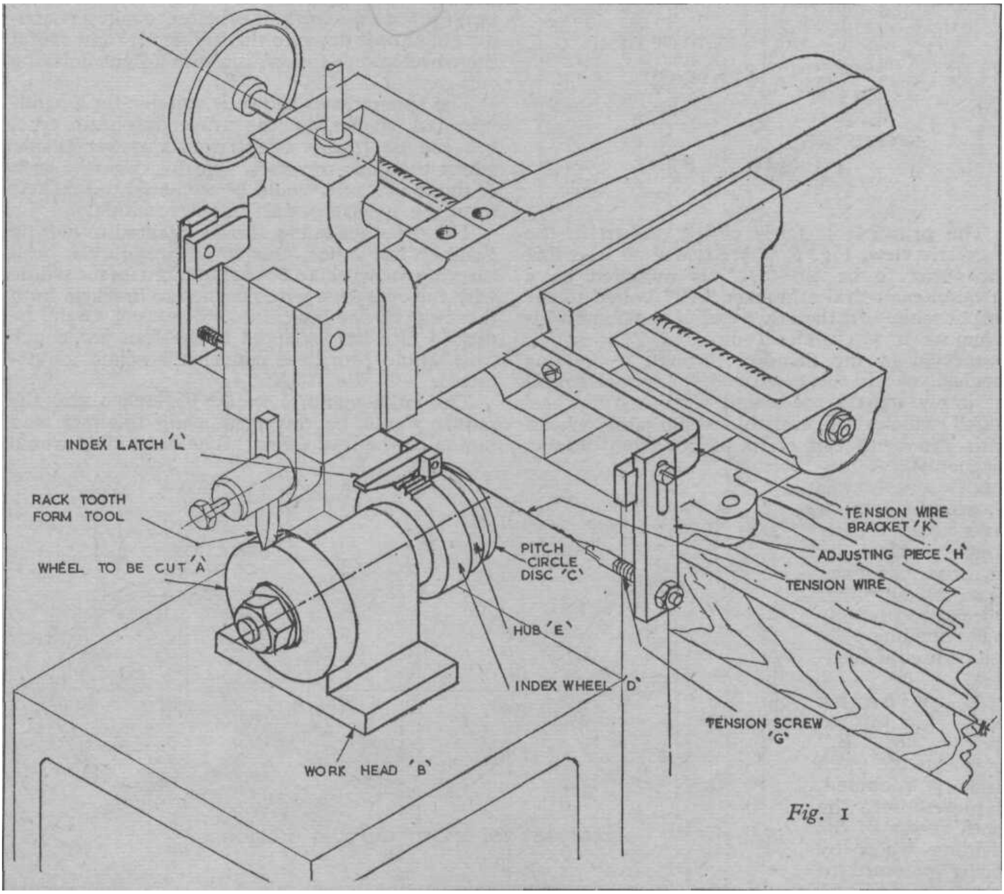

Fig. 1

The idea is to use a shaping machine (in the writer's case, a very old hand-operated machine) and to fit to it a mechanism on the lines of that used in some types of gear-grinding machines, such as the " Maag " or older " Lees-Bradners " to give a rolling motion to the gear blank while being cut. This method, being a true generating method—right back to first principles—results in a correctly formed involute tooth.

The curved sides of the tooth are made up of a series of small flats and the results can be made more and more accurate by reducing the feed of the machine and thus making the flats narrower. In other words, the finer the feed of the machine, the better the result. Even with only a moderately fine feed, however, the results will be very much better than those produced by the milling process with disc cutters. A disc cutter can, of course, only be correct for one diametral pitch and one number of teeth. As a compromise, such cutters are certainly sold to cover a range of teeth, but when so used, the resulting teeth are not correctly formed.

Using the suggested method, the cutter is a straightforward shaper tool, ground to the form of a rack tooth of the diametral pitch to be cut. The sides are straight and inclined to the centre-line at the same angle as the pressure angle of the tooth—*i.e.*, usually 141/2deg. (an included angle of 29 deg.). There is no difficulty in making such a tool, and if the same tool is used for the two wheels which are to mesh together, there is not even any need for meticulous accuracy in the tool. The cutting edges are backed off in the usual way.

A drawing of such a tool appears in Fig. 2.

This cutter will be suitable for all numbers of teeth of this particular diametral pitch.

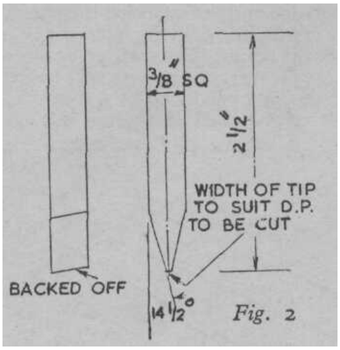

Fig. 2

The principle is fairly clearly shown in the isometric view, Fig. 1, where it will be seen that the wheel to be cut " A" is mounted on a mandrel carried in a bracket " B " bolted to the shaper table. At the other end of the mandrel is mounted a pitch circle disc " C" which is connected to the mandrel through a dividing mechanism. In this case the dividing mechanism is simply constructed round a 120-tooth wheel " D " which was available. (Suitable wheels with 120 teeth can often be got from derelict magnetos). A 120-tooth wheel was chosen because it gives a conveniently large number of divisions, but it can be replaced by other wheels or a properly made dividing plate can be used if available.

A swinging latch " L " pivoted on the hub " E," on which the pitch circle is mounted, is pushed into the tooth spaces of the dividing wheel by spring pressure to give the dividing effect. Of course, more elaborate and possibly more accurate methods could easily be designed and might be worth fitting, but the device shown has given every satisfaction.

The pitch disc " C," which is made to suit the diametral pitch and the number of teeth in the wheel to be cut, is located on the hub by a dowel and retained by two screws.

Now we come to the generating mechanism. Fastened to the pitch circle disc by a screw, is a length of 18 s.w.g. music wire which winds round the disc and is fastened by the ends through straining screws " G" to the adjustable ends " H " of the bracket " K " fastened to the sliding carriage of the machine.

It will be seen that as the head of the shaper is traversed over the wheel to be cut (see Fig. 3) the wheel will be caused to roll in such a way that the rack tooth-form cutter will produce a true involute tooth. When one tooth space has been cut, the head is brought back to the starting point and the work is set round one tooth by indexing the latch into the correct notch of the dividing wheel " D " (Incidentally, it is well worth while to number every second tooth space in the dividing wheel. It will save time and trouble).

The cutter can, if desired, be set to cut the full depth of the tooth at one traverse of the head, but, for accurate work, it is better to take a roughing cut almost down to the full depth right round the wheel and to follow this with a light finishing cut.

The apparatus as shown is suitable for a hand-operated shaper of the traversing-head type, but can be readily adapted to a power shaper where the table traverses. In this case, the ends of the music wire would be anchored to brackets from the stationary part of the machine.

The principle could also be adapted to cutting gears on the lathe. One could imagine the head carrying the wheel to be cut mounted on the saddle with the operating wire fastened to brackets from the bed of the machine. The tool could be carried in a bar mounted in the four-jaw chuck (this would provide a convenient height adjustment).

The lathe mandrel would be locked and the saddle would be traversed using the rack and pinion or the lead screw. The cross slide would provide the feed, which in this case would have to be put on by hand after every cutting stroke.

It should be noted that the quality of the machine used or its condition does not affect the accuracy of the finished jobs very much. The only machine error which is likely to cause trouble is wear in the traverse feed screw giving rise to excessive back lash. This can be overcome by weighting the slide, by attaching to it a cord which passes over a pulley fixed up in any convenient way, either to the machine or the bench, and carrying a weight of 30 to 40 lb. at the end.

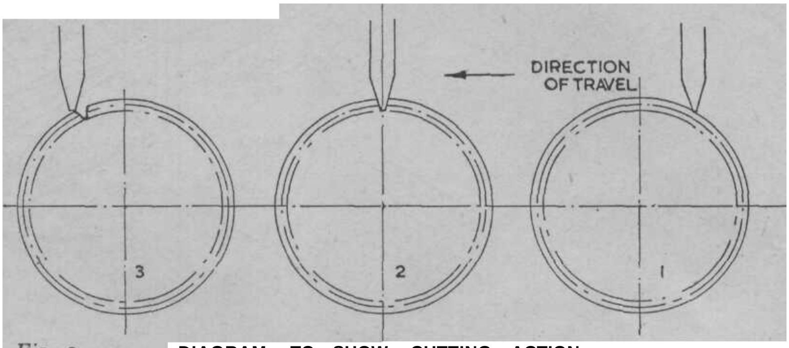

Fig. 3 **DIAGRAM TO SHOW CUTTING ACTION**

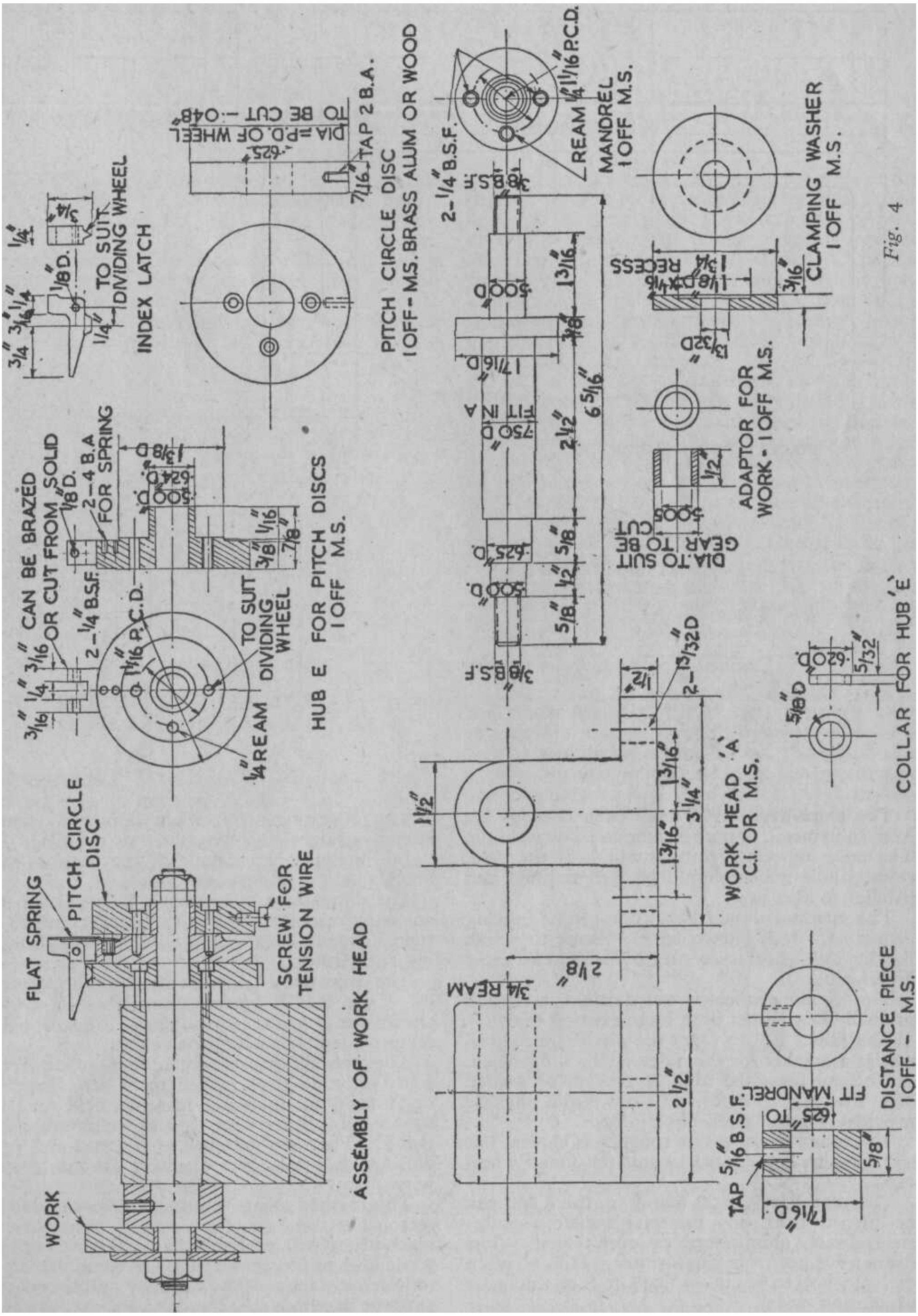

Fig. 4

This will ensure that all slackness is taken up in the same direction all the time.

A few details of the work-head assembly are given in Fig. 4 to show the suggested method of construction, but dimensions and even design would require to be modified to suit the machine to be used, the size of gears to be cut and the method of indexing to be adopted.

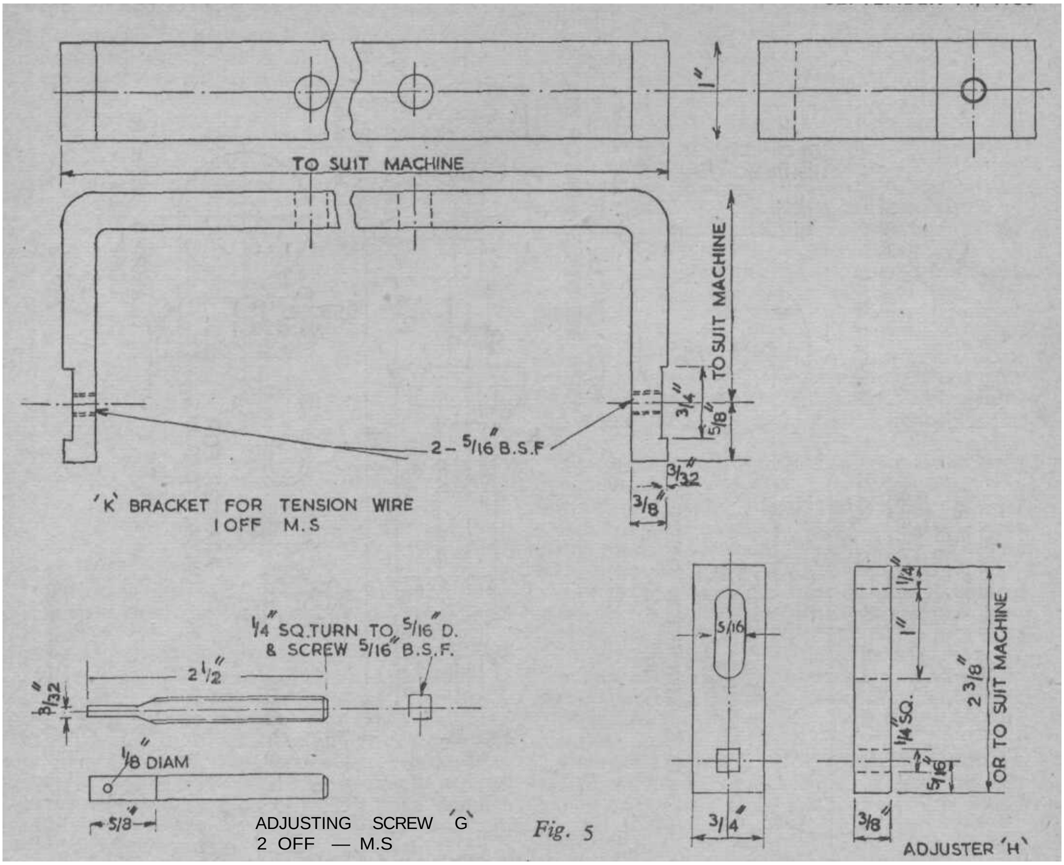

Fig. 5

The work-head " A " may be a casting, cut from solid metal, or may be fabricated by welding. The only important thing about it is the 3/4-in. reamed hole which should be well finished and parallel to the base.

The mandrel should be accurate in its bearing diameters. It is shown with a flange to which the dividing wheel is fastened by two screws and a dowel pin.

The dividing wheel is not detailed, as it will probably be adapted from some existing wheel.

The hub " E," to carry the pitch circle discs, carries a bracket for the index latch, which again can be cut from the solid or brazed, or welded on. Two tapped holes and a dowel-pin hole are provided for the pitch circle discs.

The index latch will be roughly as shown, but will have to be adapted to suit the index wheel used.

The pitch circle discs are 7/16 in. thick and can be turned from any material available—mild-steel, brass, aluminium, or even wood. The diameter is got from the formula. Dia. = pitch dia., of wheel to be cut — 0.048 in. (i.e., thickness of tension wire).

A 2-B.A. tapped hole is provided in the disc for fastening the tension wire.

The assembly of hub and pitch circle disc should be free to revolve on the mandrel, except when the index latch is engaged in the index wheel.

The operating wire, when adjusted, should form a straight line tangential to the disc.

In Fig. 5, rough details of the tension wire bracket and adjusters are shown.

The dimensions of bracket " K " will depend on the machine, but the bracket must be rigid enough to allow the wire to be tightened up sufficiently.

The adjusters " H " are held to the bracket by 5/16-in B.S.F. screws through a slot which allows for vertical adjustment. Square holes are provided for the tension screws.

The tension-screws are either made from 1/4-in. sq. mild-steel turned to 5/16-in. diameter, or from 5/16 in. diameter material filed to 1/4-in. square. In either case they are screwed 5/16-in. B.S.F. They are flattened at the end and provided with a hole 1/8 in. diameter for the tension wire.

This method of gear-cutting will be found to be reasonably fast ; in fact, with a power-driven machine, it will probably be as fast as milling, while the resulting wheels will be much more satisfactory than those usually produced by amateur methods.

It will be found, too, that the process is a very interesting one to watch, and the result in general, will well repay the comparatively slight amount of work involved in the manufacture of the apparatus.