

Making Gear Cutters with four cutting edges

Ivan Law (in his book: Gears and Gear Cutting), Michael Cox and John Stevenson (www.metalwebnews.com) has published how to make gear cutters for making involute spur gears using the "two button" method. It is possible to use only one button (as described by Ivan Law). Both give tables of button diameters for the various cutters (see end of this doc.).

I have used discs cut from 30mm diam. silver steel when making gear cutters, first the silver steel rod is centred and a hole drilled in the centre and reamed to 13mm. A disc of correct width is then cut from the silver steel rod. The disc is placed in a jig (right photo) and four 2mm holes is drilled on one face (to a depth of 1.5mm), these holes are used to prevent the disc from turning on the mandrels used, and is also used for indexing the cutter blank on the eccentric mandrel.



Turning the gearcutter

The disc is first clamped on a 13mm mandrel running (concentric) between centres in the lathe. A suitable button is made and the profile of the gear cutter is turned, see right photo. To make sure the button is placed correctly it is first placed in middle of the cutter blank, then a suitable piece of steel (half the button distance) – *distance piece* – is placed between the carriage and a carriage stop. The carriage stop is then locked to the way. When the distance piece is removed and the carriage moved to the carriage stop the button is in correct position for the first cut.

Another distance piece (equal to the button distance) is used to position the button in the correct position on the other side of the cutter blank. The carriage is moved to the second position and the second side of the gear blank is turned to the right profile.

The result is a wheel with the correct profile, the right photo show the gear cutter profile compared to a gear wheel.



Backing off the gearcutter

The next operation is to back off the gear cutter, this is done either in an *eccentric mandrel* or you mount the concentric mandrel in the 4-jaw independent and offset the centre of the gear-cutter with respect to the lathe centreline (about 5mm). I blue the gear-cutter and use the same technique as described earlier using a single button to back off each cutting edge.

First I back off the front, then each side. You feed the button tool in until you have removed almost 25% of the blue on the outer diameter of the cutter blank.

The photo to the right show what the cutter looks like after the first turning with the single button tool. The button tool is used to cut both on the outer diameter of the cutter blank and on both sides.



The clamping bolt is then released and the cutter blank rotated 90 deg. Then the clamping bolt is tightened, and the next cut is taken both on the outer diameter and the sides as described before, the cutter blank will now look something like this:



After rotating the cutter blank four times it looks like this:
The two arrows point to the remains of the bluing, there should be four of them. These are the "high points" of the cutter blank.



The cutter is then mounted on an arbor in an indexer, and then the part in front of the "high spots" on the cutter blank is milled away the inner corner is filed round with a small round file. The cutter is marked with module number and for how many teeth it is intended, and heated to bright red and quenched in water, then tempered to straw.



Mandrels used

The first mandrel is turned from an old HT steel bolt. Each end was faced and centre drilled and mounted between centres.

One end turned down to 13mm for a good fit in the reamed holes of the cutter blanks. That end was screw cut M12 and a thick washer and a nut was made. A 2mm hole was drilled in the flange of the mandrel using the drilling jig mentioned earlier.

A hardened 2mm pin was inserted in the drilled hole. I put a small piece of rubber at the bottom of the 2mm hole. This means that when the cutter blank is clamped on the mandrel the pin is slightly pressed down into the hole.



I found it easier to turn the profile of the gear-cutter first, on a concentric mandrel, then making the backing off on another eccentric mandrel. I tried doing everything on the eccentric mandrel but got a lot of chatter.

The *eccentric mandrel* was turned from a mild steel rod. The 13mm dia. part that will hold the cutter blank was drilled 6.9mm and tapped 8. The 13mm part is eccentric to the rest by 5 to 6mm. A 2mm hole (with a piece of rubber at the bottom) was also drilled in the flange of this mandrel with a 2mm hardened pin in it. When the M8 screw and washer is released the cutter blank can be rotated 90 deg. before clamping again.

The eccentric mandrel looks a bit worn because some of the buttons had quite a large diameter and fouled part of the mandrel.



Table

Michael Cox has kindly allowed me to use parts of his tables of button diameters and distances, for an explanation of how to create the tables and the tables themselves visit his web-site:

<http://mikesworkshop.weebly.com/designing-gear-cutters.html>

The infeed is calculated from the outer edge of the button just touching the outer part of the cutter blank.

To use the table to make button tools for making module gear cutters, multiply the module with the figures in the table and the result will be in mm.

Module 1, Pressure Angle 20 deg.					
No of teeth on gear	Pitch circle dia. mm	Button dia. mm	Button spacing mm	Infeed mm	Cutter width mm
135 to rack	135	46.173	44.772	16.091	4
55 to 134	55	18.811	19.056	7.083	4
35 to 54	35	11.971	12.624	4.827	4
26 to 34	26	8.893	9.727	3.809	4
21 to 25	21	7.182	8.116	3.242	4
17 to 20	17	5.814	6.825	2.786	4
14 to 16	14	4.788	5.855	2.442	4
12 to 13	12	4.104	5.207	2.210	4