Working with shaping process

Gear shaper cutter are used for cutting gears that cannot be done with hobbing, such as internal gears and shoulder gears.
When cutting a spline with removed tooth, combined tooth or unbalanced tooth thickness, normally shaper cutters are used.
The shaper cutters can be used also for sprocket wheels and for very special involute or not involute profiles.
The principle of the gears cutting with shaper cutter can be explained as follow.
The cutter reciprocates in the direction of the gear tooth line to produce a virtual gear.
In order to have the gear material correctly mesh with this, it also compulsory gives a relative movement between the two.
Then it shaves off the part which disturb the movement of teeth of a virtual gear from the gear material, and finally, the tooth profile is generated (see fig. N°1).

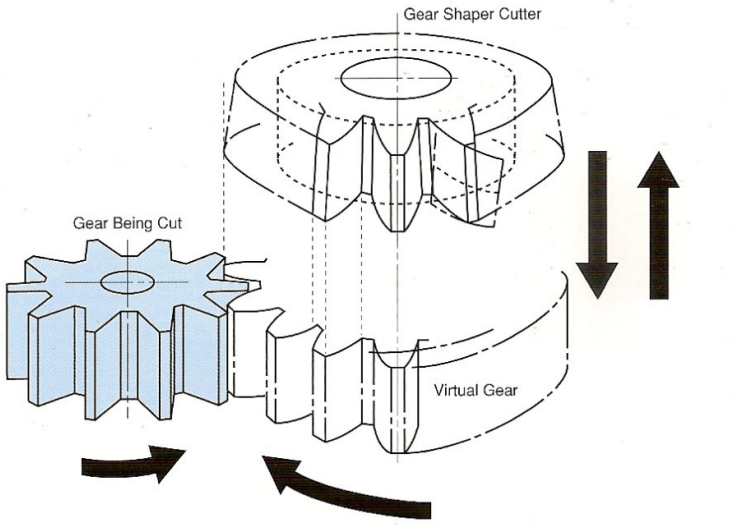

Fig. N°1

The fig. N°2 shows the nomenclature of the part of the disc shaper cutter.

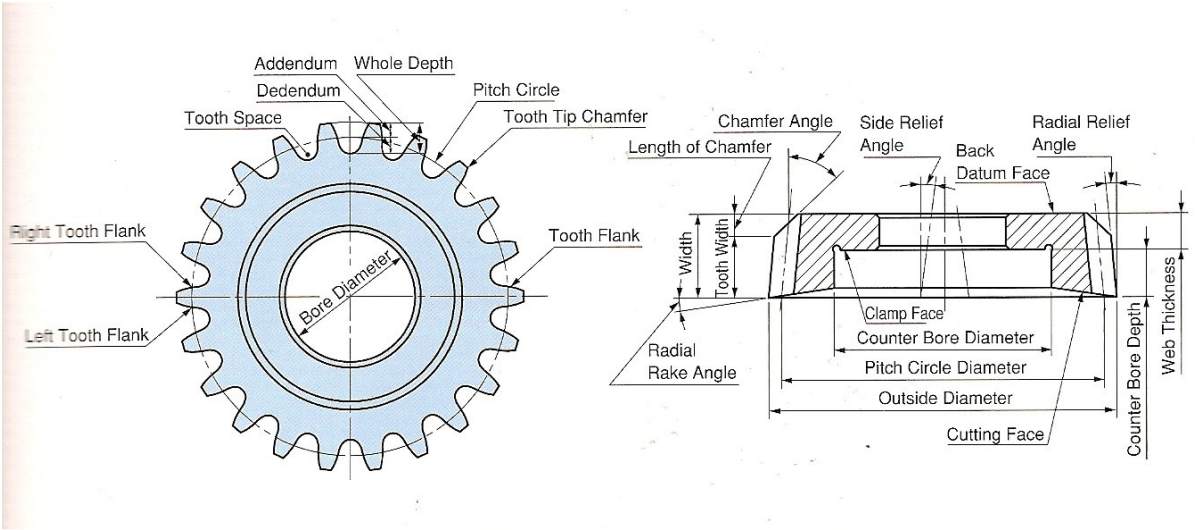

Fig. N°2

Normally the spur , helical and non involute shaper cutter are made in the followings types:

Disc type (DIN 1825)

This is the most common and the type incorporated in the stock cutter list of the most important makers..

Normally they are installed directly on the cutter spindle. This type is used for shoulder gear (see fig.N°3).

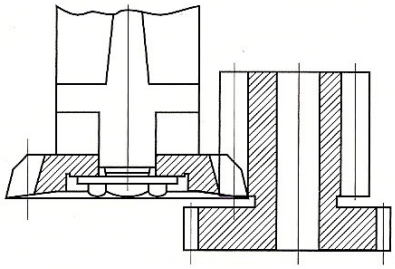

Fig. N°3

Deep counterbore type (DIN 1826)

Similar to disc type except the blank thickness is increased to position the cutter holding nut or screw above the cutter's lifeline.

Normally used for cutting internals and cluster or shoulder gears (see fig.N°4)

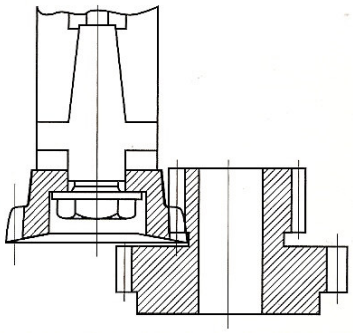

Fig.N°4

Taper shank type (DIN 1828)

Generally used in cutting small pitch diameter internal parts.

Cutter length below the taper must be adequate for the face width of the gear to be cut plus required over-travel at the bottom of machine stroke and available life in the cutter.

The work-holding fixture, hold-down straps, or recess of gear teeth in the blank ma require extra length. Pitch diameter of cutter should approximate diameter of taper. Flute can be added to long cutter of small pitch diameter to minimize deflection when cutting (see fig.N°5).

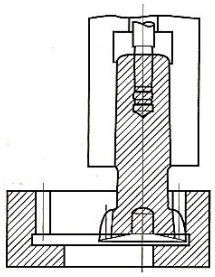

Fig.N°5

Hub type (DIN 1827)
This type of shaper cutter is used normally for large diameter of internal gear (see fig. N°6).

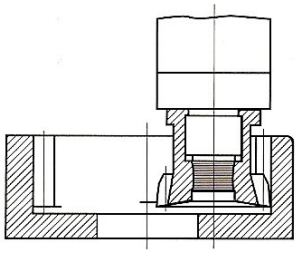

Fig. N°6

Factors affecting your shaper cutter selection

Size of external cutters
When selecting cutters for external application, the shaper cutter size is primaril dependent on the type of shaper machine on which it will be used.
A cutter should be able to clear is cutter spindle or cutter spindle adapter (depending on how the cutter is mounted) throughout its useful life.
Occasionally, size is dictated by a ratio that must be maintained with the workpiece.
Sometimes, larger cutters are required to avoid interferences created b workpiece design, work-holding fixture, center support, etc.
A shaper cutter should be only as large in diameter and thickness as the application requires. Over-hang of the cutter bon the cutter spindle should remain as small as possible.

Different tooth form
There are many application of cutters with profile in accordance with DIN standard, but in man other cases the cutter have a special profile. The most important kinds of profile are the followings.

- *Radius corner*: corners of cutter teeth are radiused to produce a controlled fillet in the root corners of the gear being generated-adds strength to gear and improves tool life (fig.N°7a)
- C*hamfering or semitopping*: Root of cutter is filled in to generated sharp corner break or chamfer on the tips of the gear, minimizes tip build-up during heat treatment due to shaving burrs and nicks incurred in handling (fig.N°7b).
- *Protuberance tip*: Cutter tooth profile is built up on the tip to provide an undercut near the root of the gear being generated ,provides relief for subsequent finishing operations (fig. N°7c).
- *Modifying flank for tip relief*: Root of cutter is filled in more gradually than chamfering cutter, removes a small amount of profile from tops of gear teeth; often desirable in high speed gears to minimize noise and heavy tip bearing resulting from tooth deflection under heavy load (fig.N°7d).
- *Pressure angle increment*: Cutter tooth profile is ground to a slightly lower pressure angle to provide for a constantly increasing amount of stock from root to tip of gear generated; another method of providing relief for subsequent finishing operations (fig.N°7e).
- *Topping*: Cutter tooth depth is ground equal to the whole depth of the gear tooth. The outside diameter of the gear is “topped” to size when the teeth are cut. More frequently used for fine pitch gearing (fig.N°7f).

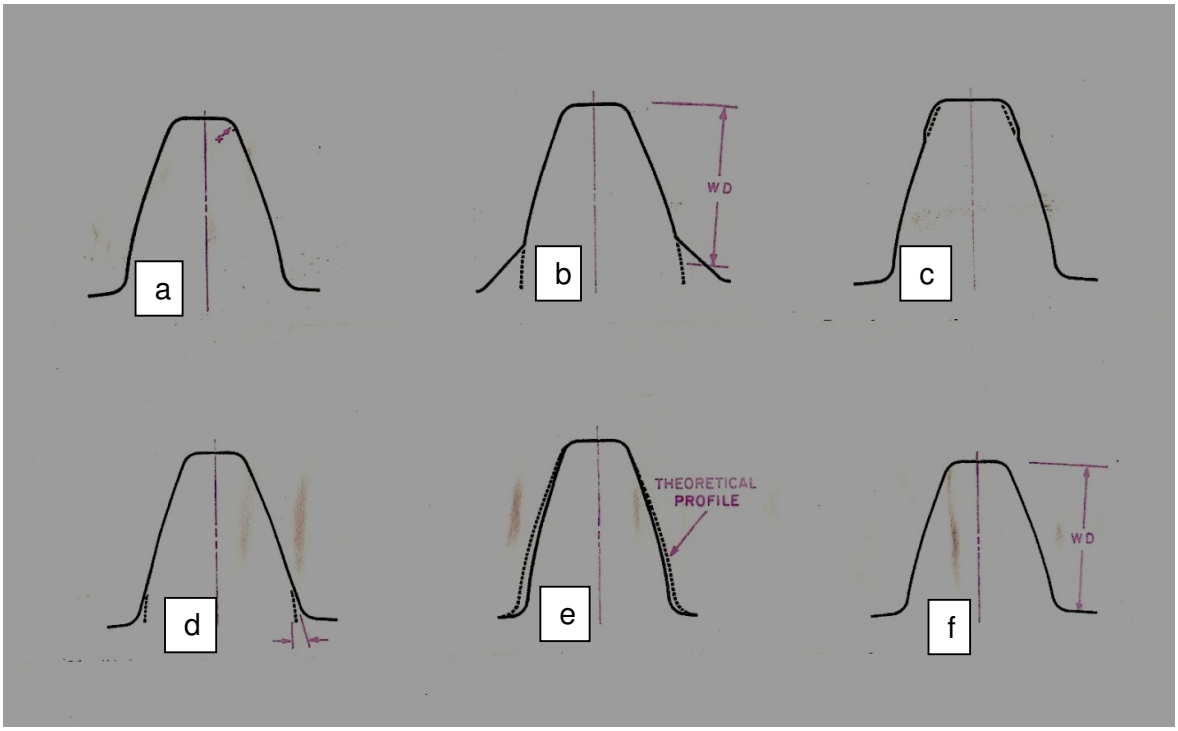

Fig. N°7

Problems and solutions in shaping internal gears

The internal shaper cutters often generate some problems due a interference between the teeth of cutter and the teeth of gear. This interference can reduce the life of cutter and can modify the profile of gear's teeth.

1)- *Infeed trim*: occurs when the number of teeth in the cutter is too large in relation to the number of teeth in the work. Trim shows up as a modification of the profile near the inside diameter of one or more finished teeth as shows in fig. N°8. This problem does not harm the cutting tool. The *solution* is to reduce the number of teeth in the cutter.

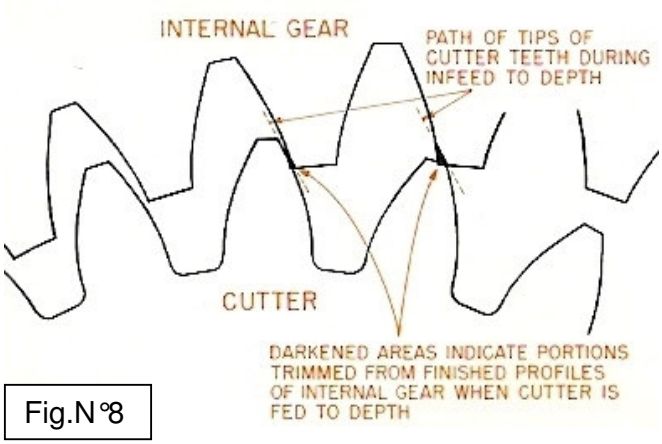

Fig.N°8

2)- *Finish side rub*: caused by having a cutter too large relative to working size. Show up as an excessive burr on the face and inside diameter of the work from the leading side of the cutter as show in fig. N° 9. This problem causes excessive wear and load on the leading side of the cutter resulting in a reducing in tool life. *Solution:* increase active

pressure angle b reducing cutter diameter, reduce number of teeth in cutter decrease angle of back-of providing rub is not transferred to other side.

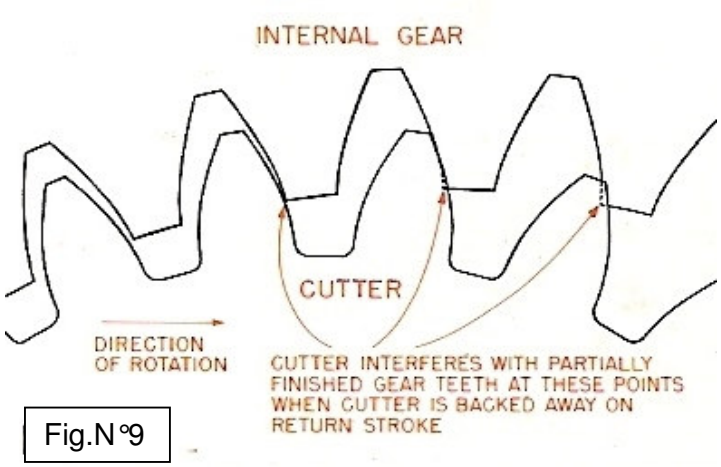

Fig.N°9

3)- Infeed rub: occurs when the cutter is too large in relation to the work or very similar to item 2, but only occurring when the cutter is infeeding. Burr produced on the inside diameter will be cut away by the time cutter reached full depth. Excessive infeed rub will result in abnormal wear on the leading side of the cutter. *Solution*: same as for item 2.

4)- *Rough side rub*: caused by the hooking action of the cutter teeth as they enter the undercut side of the work near the inside diameter. Show up as excessive burr on the face of the gear and the inside diameter from the trailing side of the cutter. This problem causes excessive wear and/or load on the trailing side of the cutter resulting in a deterioration of tool life. *Solution*: Increase the inside diameter, increase angle of back-off providing rub is not transferred to other side (item 2) or decrease the amount of back-off.

5)- *Involute form modification*. Occurs when the inside diameter of the work being cut is too close to the base circle and/or the cutter is too small. Result in trimming away of involute profile to the last point of involute contact as shown in fig. N° 10.
Solution: increase inside diameter of work and/or increase size of cutter.

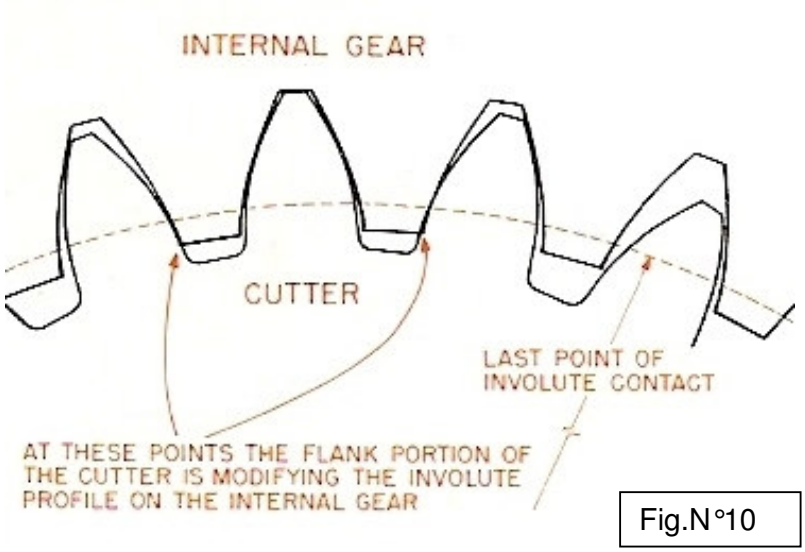

Fig.N°10

The table below may be used to determine the maximum number of teeth in a cutter for cutting a specified number of internal teeth.

N° of internal teeth	Maximun number of teeth in cutter		
	14°30' P.A. Full depth	20° P.A. Full depth	20° PA Stub 25° PA Full depth
24	--	--	10
28	--	--	11
32	--	10	12
36	--	13	14
40	14	17	18
44	16	21	23
48	18	25	27
52	21	29	32
56	24	34	36
60	27	38	40
64	30	42	45
68	33	46	49
72	36	50	53
80	44	58	62