Shaving errors and their causes

Many defects that you can find on the shaved gears are characteristic and after having examined them you can easily trace back the causes that have generated them.
Unfortunately, things are not always so easy and in some particular cases it is necessary to proceed on a trail and error basis, modifying both the design and the working condition.
Anyway, the most common defects are the following.

Profile with sinusoidal trend
If the profile error of the gear before shaving is not too big and the sinusoidal trend after shaving remains even after having varied the cutter rotation speed and speed, the cause of this defect has to be searched in the wrong designing of the cutter. It is very likely that the even contacts condition is not fulfilled. See figure N°1.

Fig.N°1- *Profile error generated by the non fulfilment of the even contacts condition*

Unfortunately, anyway, in some instances even if the shaving cutter is correctly designed, this error remains. You can go and read again what we stated for the limits of the even contacts. In these cases the only way out is to modify the cutter profile in the opposite sense of the error generated on the profile; quite often you can get the profile right after a few trials.
This inconvenient is commonly found when you have to shave gears with a low number of teeth.
Sometime a similar error is caused by the fact that the cutter outside diameter touches the root fillet radius.
If you carefully look at the workpiece you can see a step close to the root, with a little burr.
In these cases, obviously, you have to alter cutter outside diameter.

Tooth with material at the tip
The cause is a too high cutting speed V_s (component in radial direction) or a too narrow cross of axes angle.
All this can cause stripping, too, close to tip area.
This defect can be better understood if you consider that the cutting edges cut well only if there is a high longitudinal component; only in this way you can have a *scraping* effect of the cutting edge. At the most, if there had been only the radial component, the cutting edge would not cut and would only leave grooves in a radial direction.
If the rotation speed is too high, the direction of vector V (total cutting speed) close to gear outside diameter will be oriented too vertically and the cutting would not be very effective.
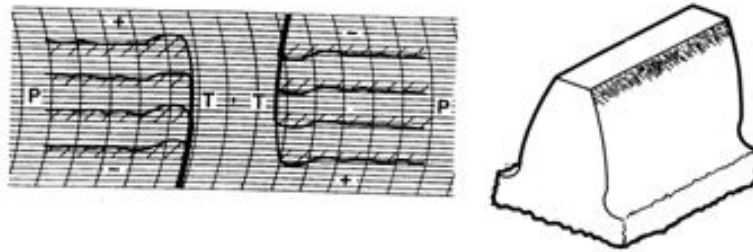See figure N°2.

Fig.N°2- *Excessive material at tooth tip with presence of stripping*

<u>Serrations traces are too evident on the gear</u>
The malfunction is due to the fact that for each revolution of the gear to be shaved you have a shifting of the contact between cutter and gear equal to the pitch of serrations.
It is sufficient to modify the shaving cutter leaving unchanged the feed speed: in this way you have a different orientation of the cutting direction and an improvement of the surface. You can also try to alter the feed, leaving rotation speed unchanged. See figure N°3.
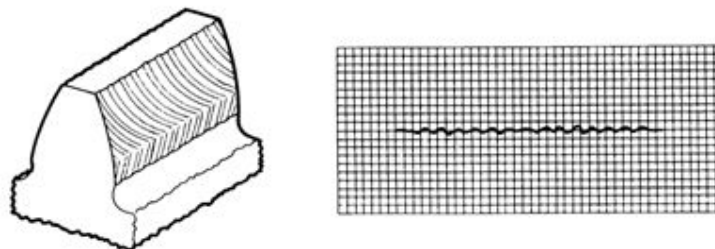

Fig.N°3- *Traces of serrations on tooth shaved surface*

<u>Gear has a lot of burrs and teeth surfaces have a slightly striped and glossy look all along the tooth length</u>
This defect is due to shaving cutter wear or to an insufficient cross of axes. For this last case it is necessary to increase as much as possible the longitudinal feed speed V_a.
If the cutting edges are toot rounded they can no longer "*bite*" the material and they do not produce a regular chipping.
You find sliding movements that, occasionally, produce a glossy appearance on the shaved surface, upsetting part of the material that has not been cut towards the outside diameter. See figure N°4.
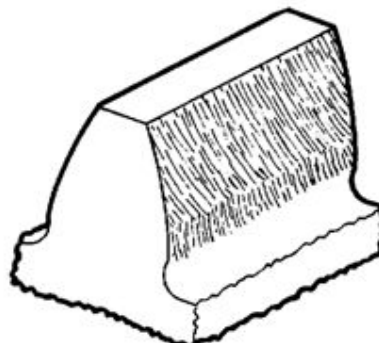

Fig.N°4- *Noticeable burrs on the teeth and partially glossy surface*

Helix is hollow
This error is due to insufficient table stroke length.
In plunge shaving, instead all this is caused by a wrong shaving cutter resharpening.
The point of contact in the parallel or diagonal shaving does not start and ends in a correct way. See figure N°5.
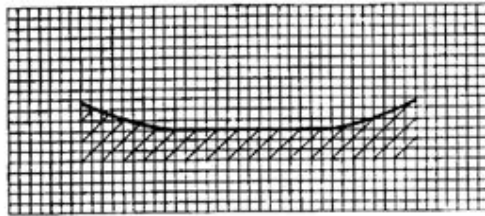

Fig.N°5- *Hollow helix*

Shaving stock close to a shoulder on a tooth flank has not been completely removed
This malfunction is nearly surely due to a too short table stroke on the side of the shoulder or to a wrong cutter setting.
You can get rid of such inconvenient by adjusting the stroke correctly . See figure N°6.
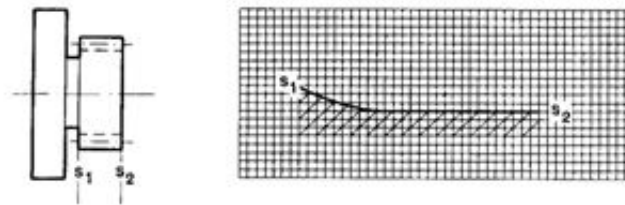

Fig.N°6- *Excessive material on helix close to a reference face*

Helix diagram shows that the gear is taper
The inconvenient is due to a wrong setting of workpiece and gear axes that are laying on non-parallel planes.
In this case, during the axial feed, the workpiece / cutter center distance either decrease or increase, thus varying the teeth thickness accordingly.
There are some special cases where such inconvenient is quite evident. It is the case when you have to shave gears with a very wide face width, e.g. 500 mm and further. These cases are normally concerning gears with big modules (5 to 8 mm) .
It is obvious that it is not easy to maintain aligned such a long piece. Then you can use a cutter having serrations only along one flank, while the other flank acts as a guide along the gear tooth flank. Once one flank is shaved, you turn the cutter and complete the finishing of the other flank , using the shaved flank as guide for the other one.

Other types of error
You can find many other types of error, such as, for instance, noticeable profile differences between one tooth and the other, or helix error, or traces of hobbing or shaping along the

shaved tooth profile, or even insufficient length of shaving (i.e. you do no reach the SAP - start of active profile).

All these error are mainly linked to a badly cut gear, with too big helix and profile errors, which cannot be completely cured by shaving.

Also too big hobbing scallops or stripping, maybe with a scarce stock removal can be a reason for a bad result.

An excessive spacing error on the shaved gear depends, mainly on a gear hobbed with noticeable errors.

We remind you that shaving can improve gear quality of 2, maximum 3 DIN classes, but not more.