Controls with rolling gear tester

The gears are subjected to numerous inspections during the manufacturing process. Practically every stage of processing requires a specific control.
The controls on the teeth, however, are divided into two major categories: laboratory tests and functional checks.
For the first are used highly sophisticated CNC equipment, , with high precision and they check in particular the three basic parameters: the profile, the helix and the pitch.
Latest generation of electronic equipment with very sophisticated software allow a full automatic control of the gear.
For example, you can mount on the unit a gear, with unknown characteristics.
In the first phase of the control the equipment touches the diameter, measures the pitch, the number of teeth and measures the helix and with these information will calculates the basic characteristics of the gears.
It will make automatically the set up for the desired measure and then check the profile, helix and the pitch printing the diagrams.
If desired, can also do an examination of the topological surface of the tooth by providing on-screen or printing, a three-dimensional representation of the tooth with its errors.
It is evident that all this takes time and it is unthinkable to perform these detailed checks of all gear produced: also because they are not even very useful.
For mass production you can control 100% of production with rolling gear tester that allow a functional check so named because, to some extent, reproduces the conditions of use of the gears.
The rolling gear tester is an equipment that through the rotation of the gear matched with a master gear can detect certain types of errors present in the gear itself.
Because there are many types of gears that can be controlled and there are different reasons why you use the rolling gear tester and because there are many ways to use the rolling gear tester, it is clear that the type of equipment is quite extensive and the technical characteristics may also be completely different from one device to another.
In this short section we speak of a classic zero *backlash rolling gear tester (or single flank rolling gear tester*) , leaving the description of "*single flank rolling gear tester*" that are dedicated to the finest controls and most generally used in the laboratory, although there are some cases of use of these equipment, however, are much more complex and expensive than traditional rolling gear tester.
The single flank rolling gear tester are the most common system for controlling the matching of the gear because it offers a whole range of possibilities that make it a universal system. The single flank rolling gear tester mentioned here work with the principle shown in figure N°1.

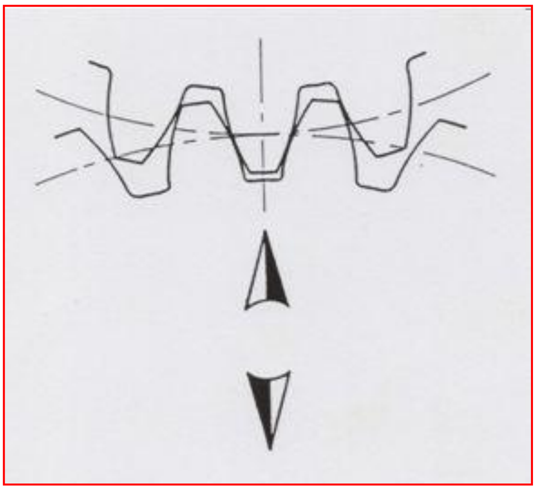

Figure N°1

The master is pressed against the gear so that the two sides of the teeth are in contact and then not letting backlash in matching .
The pressure is usually given by one or more springs applied to the slide on which is mounted the master.
By rotating the gear the master rotates also, and if the matching is free from errors, there is no radial movement of the master, but if there are an errors or an anomalies in the gear the master shows it by a radial movement in the direction of the arrows shown in figure N°1. This type of control can show the following errors:

- ***a)*** *Errors of the center distance*, that in practice errors of the tooth thickness. Because, knowing the characteristics of the teeth of the master, the center distance, ie the distance between the two axes of rotation is uniquely defined by the size of the gear tooth, in theory you could know the exact chordal thickness of gear tooth and judge whether it is or is not in tolerance.
  This would be an absolute measure of the center distance. practically it is preferable to control the center distance by comparison, that resets the equipment to a known center distance, such as by a master gear and measure the deviations from this value.
- ***b)*** *Errors of eccentricity*. They put in evidence the movement of the slide during a revolution of the gear. The maximum and minimum limit of these movements are precisely the eccentricity of the gear.
- ***c)*** *Detection of nicks*. "Nick" means a deformation of the tooth normally present or on its outside diameter or side edges, generated by an accidental collision. This deformation although minor causes intolerable noise during the coupling of the gear. A sudden change of center distance, ie a rapid shift of the master in a radial direction denotes precisely the presence of a nick.

These are the three classic responses to be obtained from a rolling gear tester but this control, which can be defined as standard, can be easily integrated with the control of the diameter and cylindricity of the bore, the position and perpendicularity of the supporting surfaces, the size of the cone of synchronizer if we talk about classic gear with the bore, or if we are in the presence of a shaft you can control simultaneously several gears and even some outside diameters seat of bearings and important shoulders.
Ultimately the rolling gear tester can turn into a device that makes also an examination of other parts of the gear and not just the teeth.
A further distinction is generally made according to the system of acquisition and management of signals generated from the mistakes.
You can start from a simple mechanical gauge that indicates grossly movements of the master but that in some cases may be sufficient. But you can use devices equipped with a sophisticated electronic units that not only indicate the value of various errors but can perform also a variety of statistical analysis and also provides graphic documentation of what happens on a lot of pieces by printing a list of errors or statistical graphs.
One of the problems facing the workshop and also the eventual recovery of rejected pieces found.
For example, if a gear has been rejected because in one or more teeth have been found nicks, it is perfectly recovered by removing the nick by a small rotary burrs.
The problem is to identify quickly the damaged tooth.
For this purpose it's applied in some cases the so-called markers, which are devices that mark the damaged tooth with a point of paint .
Figure N°2 shows a typical diagram obtained by a chart recorder applied in a rolling gear tester.

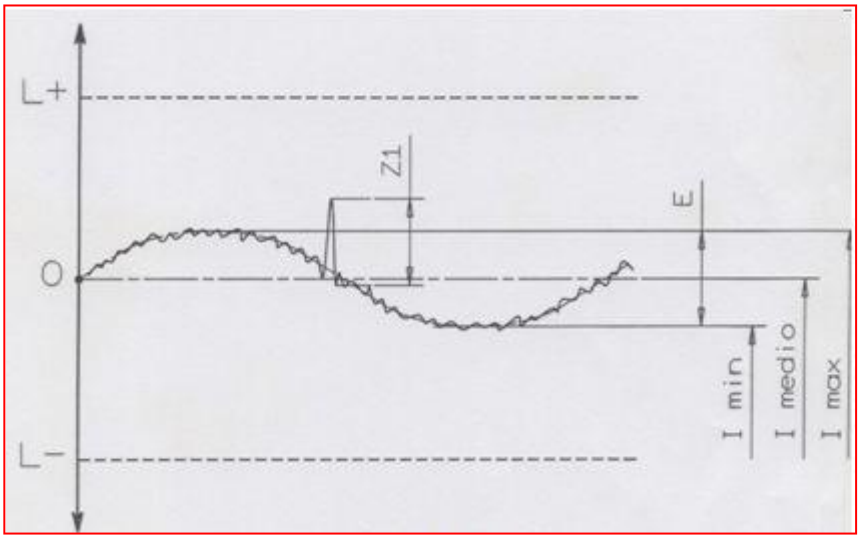

Figure N°2

The variation of center distance more or less, I_1 or I_2, compared to the theoretical center distance **O** , can also define the eccentricity **E** , ie the absolute variation of center distance in one revolution of the gear.
The instantaneous deviation Z_1 from the sinusoid indicates the presence of a nick.
The lines **L-** and **L+** are the lower and upper limits of the center distance, ie the entire tolerance.
The rolling gear tester in general can perform any other checks in addition to those of proper teeth.

Types of controls that can be performed.
As already mentioned, the controls which can be performed by this system are multiple and essentially include tooting control and dimensional control.
It however always deals with comparative type post-process controls, that is to say, not based on the absolute dimension value.
They are in substance, controls that detect the deviation with respect to the master or zero setting gauges.
To be more concise, in the case of a diameter control, the probe is set to zero on a sample of this diameter having the theoretic dimension (master) and the control consists of reading the deviation of the part under exam from the master used as zero reference.
Such procedure introduces the undisputed advantage to compensate within ample limits automatically, the wear-out of supports and probe tips, allowing a continuous use under grave conditions, even by personnel with limited experience.
The systems are able to assume compositions always more complex, eventually adding dimensions to check during the same cycle.
Figure N°3 is a schematized example of a shaft control with four gears controlled contemporarily, plus two diameters and two shims. Naturally, this is absolutely not an operative limit because we can add all transducers necessary in order to control each shaft part. The only limit is the encumbrance of the different probes, but now it’s possible to builds high reliability micro probes today that occupy a very limited space.
A key factor for reliability of multiple controls of this type, either those on shafts as depicted in the figure N°3 example or single gears, is the individualization of a reference axis which excludes positioning and rotation errors caused by shaft deformation or single gear bore tolerances.
For this purpose, through probes that reveal the diameters, we calculate the electrical axis for which all the measurements will reference to. In other words, we take into account the positioning errors of the real axis, as consequence modifying the other measurements. In

case of a gear with a central hole of great importance, besides the tooting control, hole analysis, its ovality and taper.

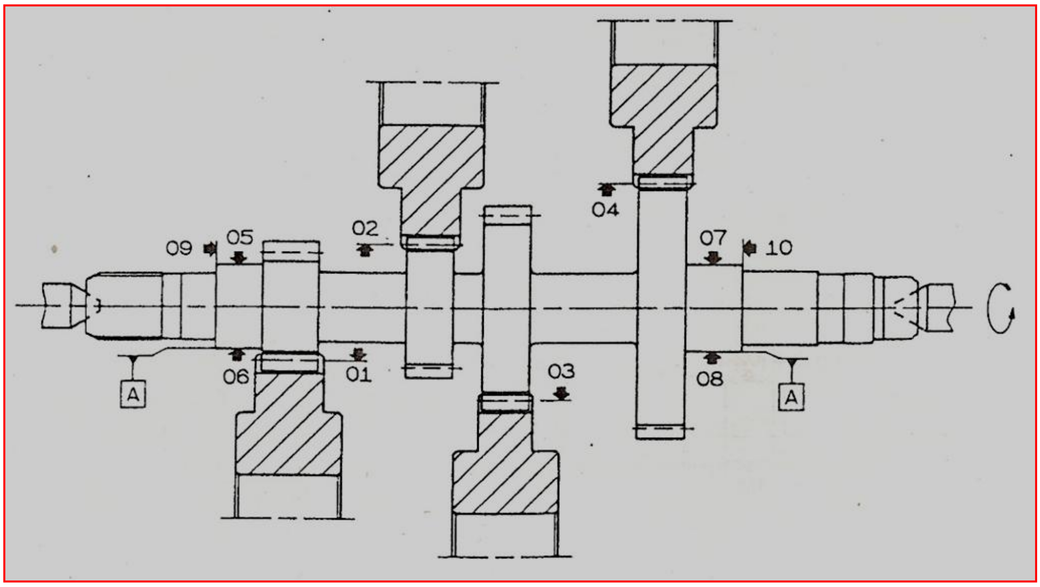

Figure N°3- *Measuring diagram of shaft with different gears*

This analysis is permitted through the adoption of four probes positioned two by two on different section as indicated in figure N°4.

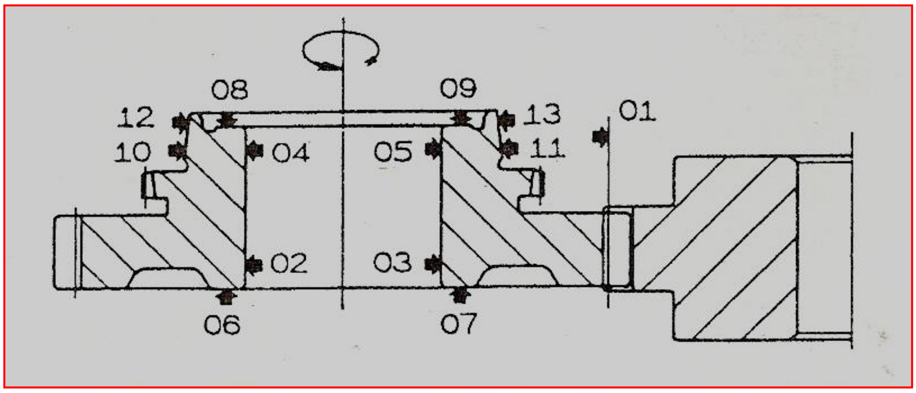

Figure N°4- *Complete control diagram of a gear with hole*

In the same figure, we can observe how to measure the diameter and taper of the synchronization cone. Naturally, all 13 probes of this example work simultaneously and the signals are collected and processed together from the electronic unit, for which after a few seconds, a complete picture of the gear dimension measurement is available.