Basic of drill

In these technical descriptions for simplicity we use the term *drill* instead of the more complete name *twist drill bits*.
The drill is the tool universally used to make holes in any material.
Too often is neglected the importance of an accurate construction and maintenance, precisely because it is very common, is not considered a technological tool, and it's very cheap.
It 'must, however, note that the correct use of drills, and a deep knowledge and a scrupulous care in sharpening avoid, first, a unnecessary waste of tooling, few rejected machined parts , reduce the time lost for change the drill in the machine tool and the time to re-sharpening the drill worn.
In mass production, where the drills are mounted on transfer machines or complex multi-head or multi-spindle, the time factor for the replacement tool assumes a decisive role and is therefore logical to study in detail what is the most rational method to use the tool mentioned here.
Under certain circumstances, such as the simultaneous use on a single head of several drills with different diameters or used simultaneously the reamers, could be difficult to find the ideal operating conditions for every tool.
In these cases we will study the most economical conditions, the one that will have a short cycle time and a time for changing tools that are not too high and not too fragmented.
Also, if you must to choose between use with proper working conditions for a reamer and wrong for a drill, or vice versa, it is clear that the first alternative is better, both for the higher cost of reamer and the accuracy of work carried out.
In many cases, however, these choices can be avoided only by knowing well the drill , its characteristic angles and methods of sharpening.

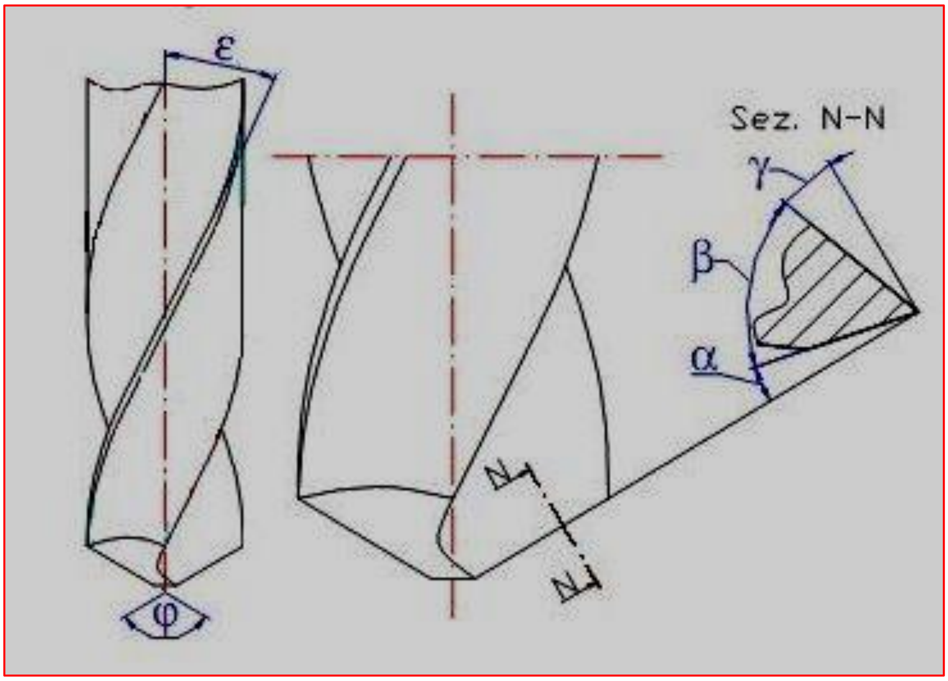

Figure N°1- *Characteristic angles of a drill*

<u>Description</u>

The drill is so named because it is a cylinder of HSS or Carbide on which are obtained deep helical grooves that have the purpose of facilitate the removal of chips and their

discharge towards the outside and therefore are always , except in very rare cases, with the direction corresponding to the direction of cut.
Queste scanalature possono essere eseguite in diversi modi:

- *directly with the grinding wheel, if the drill has small diameters;*
- *with cutter, if the diameters are greater;*
- *with a twist of the drill after performing straight flutes with milling cutter (of course this method does not apply to the solid carbide drill).*

The helix angle is measured on the outer diameter D and is found with:

$$\tan \varepsilon = \frac{\pi \cdot D}{P}$$

where P is the axial pitch of the helix.
From the inclination of helix depends the of nominal upper rake angle, which decreases if they are considered smaller diameters.
The upper rake angle determined by the helix suffers a slight variation due to the feed of the drill.
In fact the cutting edge moves along a trajectory inclined at an angle Δα, which is equal to Δγ, compared to the reference surface.

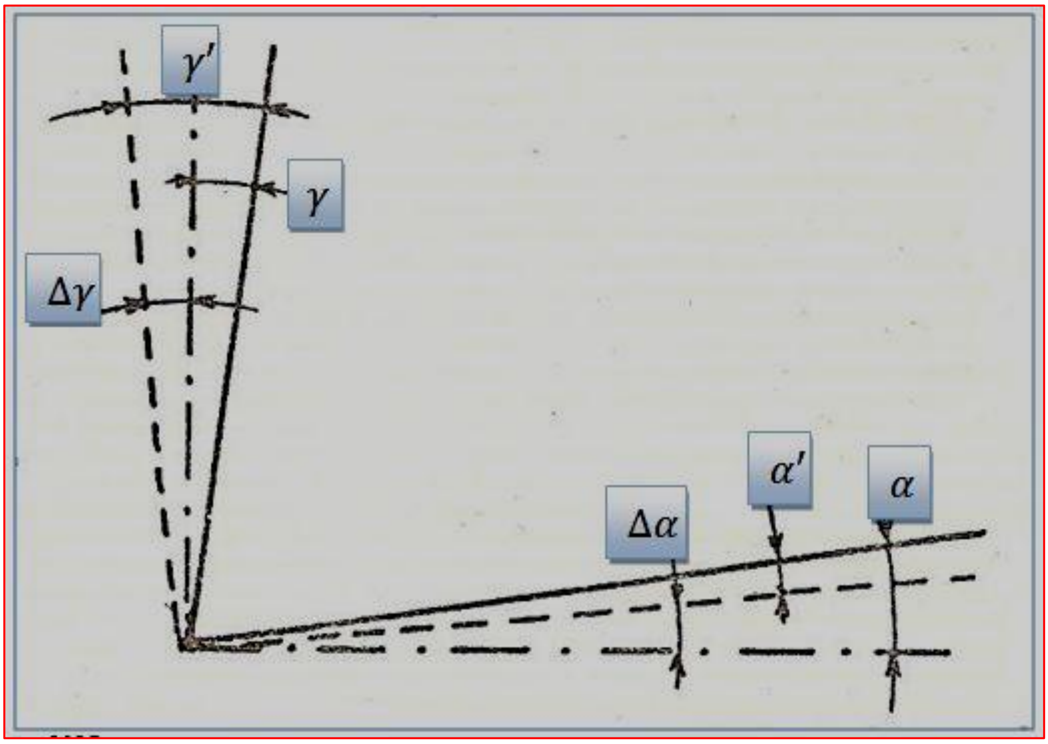

Figure N°2- *Variation of upper and lower rake angles due to the feed*

The value of Δγ depends from the diameter and from the feed per revolution according to:

$$\tan \Delta\gamma = \frac{a}{\pi \cdot D}$$ the effective upper rake angle will be: $$\gamma' = \gamma + \Delta\gamma$$

This angle increases if decrease D so that, as we proceed from the periphery to the center of the drill Δγ increases.
In practice it is as if the helix angle should grow, and this compensates the fact that the helix angle γ decreases if we consider lower diameters, as seen just above.

for the cutting action the inclination prop is very important and therefore should be dimensioned according to the material to be processed and the nominal diameter of the drill.
It's well known that for the processing of materials with low resistance the upper rake angle must be greater therefore the helix angle will be greater when machining soft material (aluminum) and lowest for hard materials.
The standards UNI divided the work into three possible areas of application in relation to the material, and for each field has defined the inclination of the helix according to the diameter of the drill.
The table UNI 3806 establishes :

- *N-type drills: Drilling of steels, cast iron, nonferrous metals of medium hardness.*
- *D-type drills: Drilling very hard and resistant materials.*
- *T–type drills: Drilling materials particularly soft and malleable.*

Table N°1 gives the values of the inclination of the helix as a function of diameter

Table N°1

Range of diameter in mm	*Type of drill*		
	N	*D*	*T*
Fino a 0,6	*13° - 19°*	*--*	*--*
Da 0,6 a 1,0	*15° - 21°*	*--*	*--*
Da 1,0 a 3,2	*17° - 23°*	*8° - 13°*	*30° - 38°*
Da 3,2 a 5,0	*19° - 25°*	*9° - 25°*	*30° - 40°*
Da 5,0 a 10,0	*22° - 28°*	*10° - 16°*	*35° - 45°*
Oltre 10,0	*25° - 30°*	*10° - 16°*	*35° - 45°*

Because the helix also has the purpose of extracting the chips from the hole, sometimes it may not be sufficient to set the angle of the helix shown in the above table and in particular there is a need to increase the standard angles when you have to drill deep holes .
During machining it is necessary that the contact between the drill surfaces and the surface of the hole is reduced to a minimum in order to have a low friction.
For this purpose we practice on the back of each helical edge a relief "**a**" keeping only a small cylindrical section "**q**" called "*phase*" that has the task of generating the desired diameter and to guide the drill.
The width of the phase varies if the diameter changes according to: the diagram with double-logarithmic axis shown in Figure N ° 4 in accordance with DIN 1414. This diagram shows three values of "**q**" for each diameter and therefore the choice must be made by introducing other considerations.

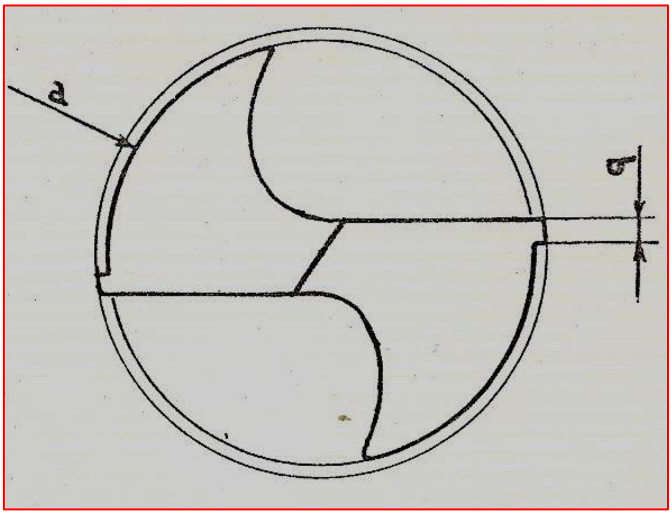

Figure N°3- *Milling of relief and phase*

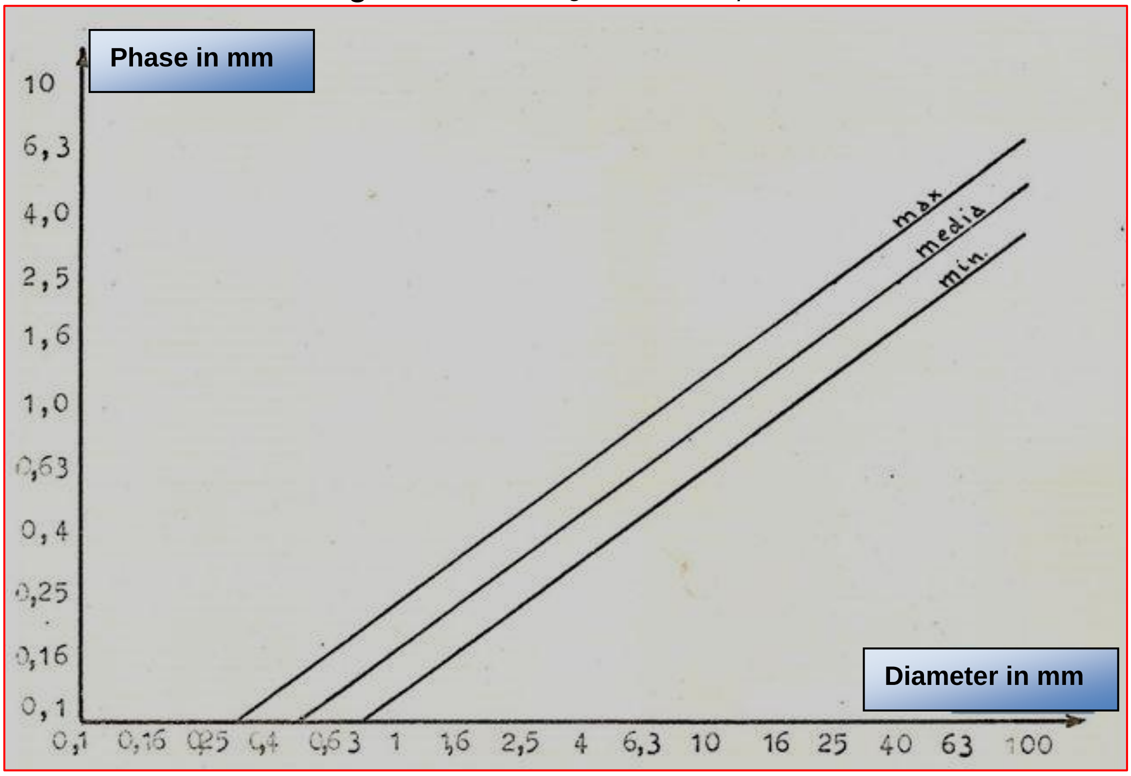

Figure N°4- *Link between the width of the phase and the diameter*

In principle, for the deep drilling the value of the phase must be reduced, for the drilling of abrasive materials such as cast iron and certain alloys of aluminum, the phase must be on maximum values, finally the phase should be the minimum values when drill material very ductile.

Also to avoid excessive friction on the drill, the diameter is ground with a slight negative tapering (approximately 0.05%) which makes the decreasing diameter when it proceeds from tip to the shank.

This slight relief in the axial direction aims to prevent the drill lockup when the initial diameter decreases due the wear.

In the following sharpening therefore the diameter decreases so it’s necessary to establish that the nominal diameter means the diameter measured at the beginning of the flutes with the drill new.

The standards UNI have established that the tolerance of the diameter is the **ISO h8,** therefore it possible a deviation from the nominal size only in minus of the values shown in table N°2.

Table N°2

Diameter in mm	*Tolerance of new drill (only minus)*
Da 1,0 a 3,0	-0,014
Da 3,0 a 6,0	-0,018
Da 6,00 a 10,0	-0,022
Da 10,0 a 18,0	-0,027
Da 18,0 a 30,0	-0,033
Da 30,0 a 50,0	-0,039
Da 50,0 a 80,0	-0,046
Da 80,0 a 100, 0	-0,054