

## Points of first contact between cutting edge and workpiece

In face milling with blades milling cutters, included insert milling cutters, great importance is how has the first contact between the blade and the workpiece. In addition to this it is also important to pay attention to the axial and radial inclination of the cutting edge under the point of view of chip discharge.

As you can easily see from figure N°1, the chip discharge is facilitated if the axial angle is positive.

With this angle in fact the chip is removed from the machined surface, ie is ejected out of the work area.

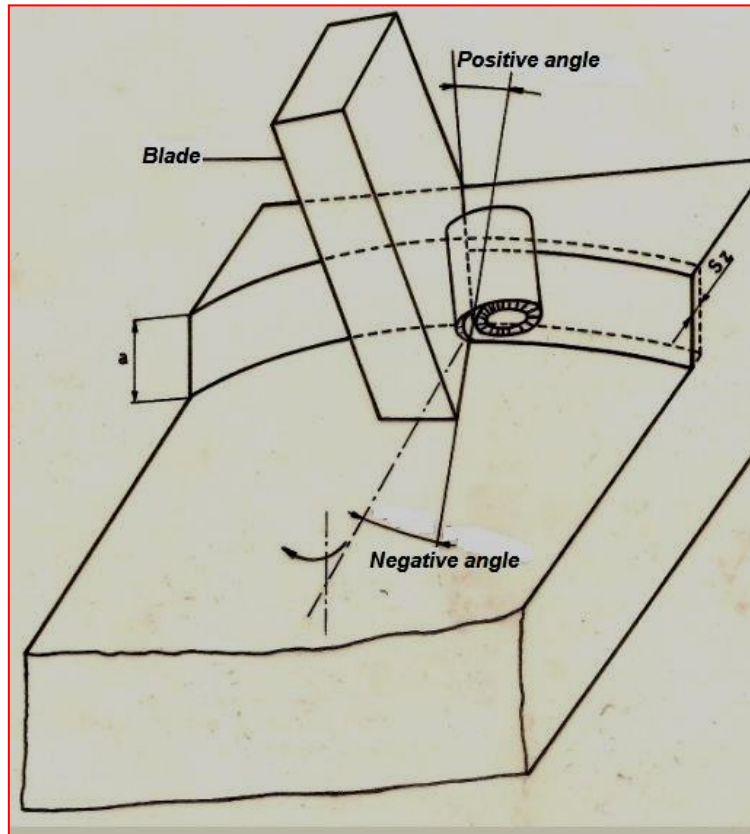


Fig. N ° 1 - Schematic representation of the action of the cutting edge on the chip

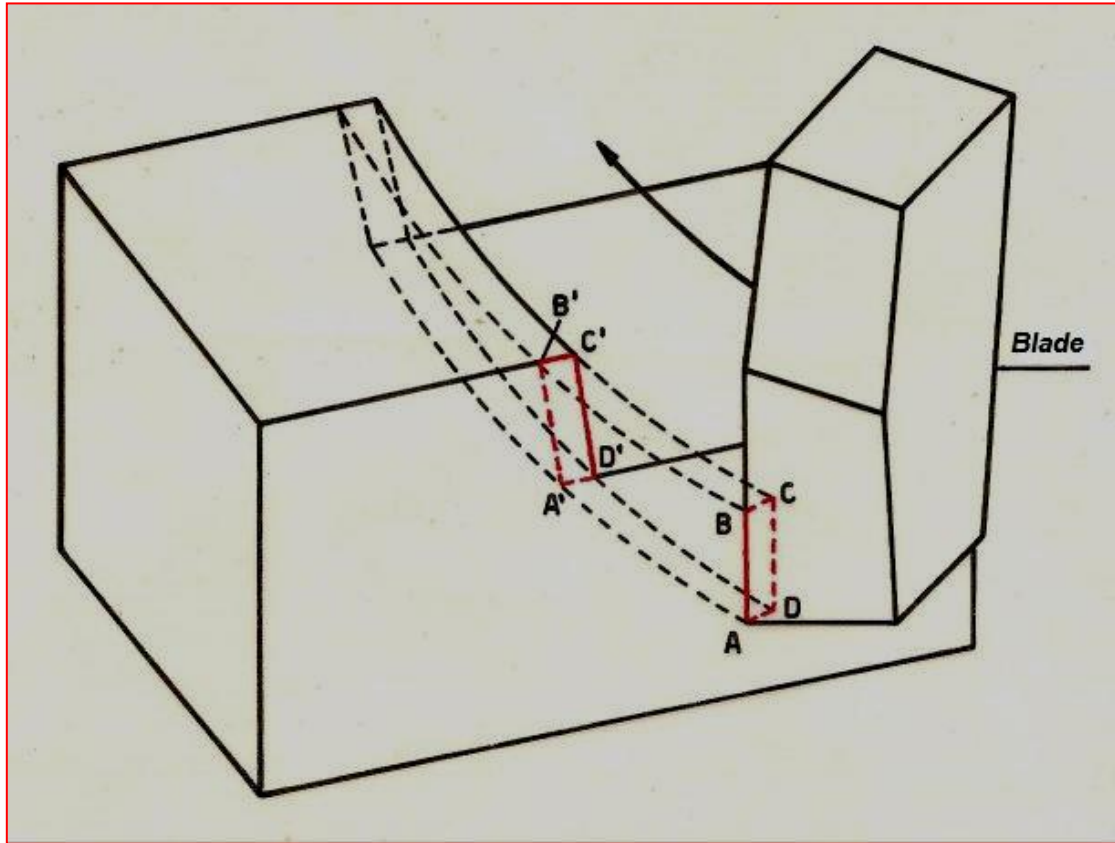
If you take the negative axial angle, the chip is pushed and pressed against the surface to be milled, causing blockages, increasing the probability of damage to the cutting edge and creating a poor surface finish.

The same argument is valid, although to a lesser extent, for the radial inclination of the blade; this factor also must be considered together with the position of the cutter over the workpiece.

We must now determine what are the possible points of first contact and what are the factors that may influence these points, and which of them are preferred for a good result of milling.

The possible points of the first contact are 9. Referring to figure N°2 you can have the initial contact at points **A**, **B**, **C**, **D**, or along the four straight lines connecting these points: **AB**, **BC**, **CD**, **AD**; finally you can have the initial contact of the entire section **ABCD**.

To say which of these initial contacts is the best in an absolute sense is impossible, because each has advantages and disadvantages in relation to various elements not always well defined.



**Fig. N°2-** Position of the blade with contact on the section ABCD

A parameter of crucial importance is undoubtedly the processed material because of its hardness, its machinability, its toughness mean that it is preferable to one or the other of possible contacts.

The question becomes necessarily general and the various comments that will be described below should be taken with a certain elasticity, precisely because each case of milling has a particular characteristic.

Even the analytical study of the influence of all possible variations of angles and positions of the cutter have on the points of initial contact, is very complex.

Most probably the designer of blades milling cutters can more easily locate the point of first contact by executing a graph rather than making use of mathematical formulas.

It is well known that greater damages on the edges of the blades milling cutters (or inserts), especially now that the edges are very often in carbide, are caused by repeated shocks against the section of the chip to be removed.

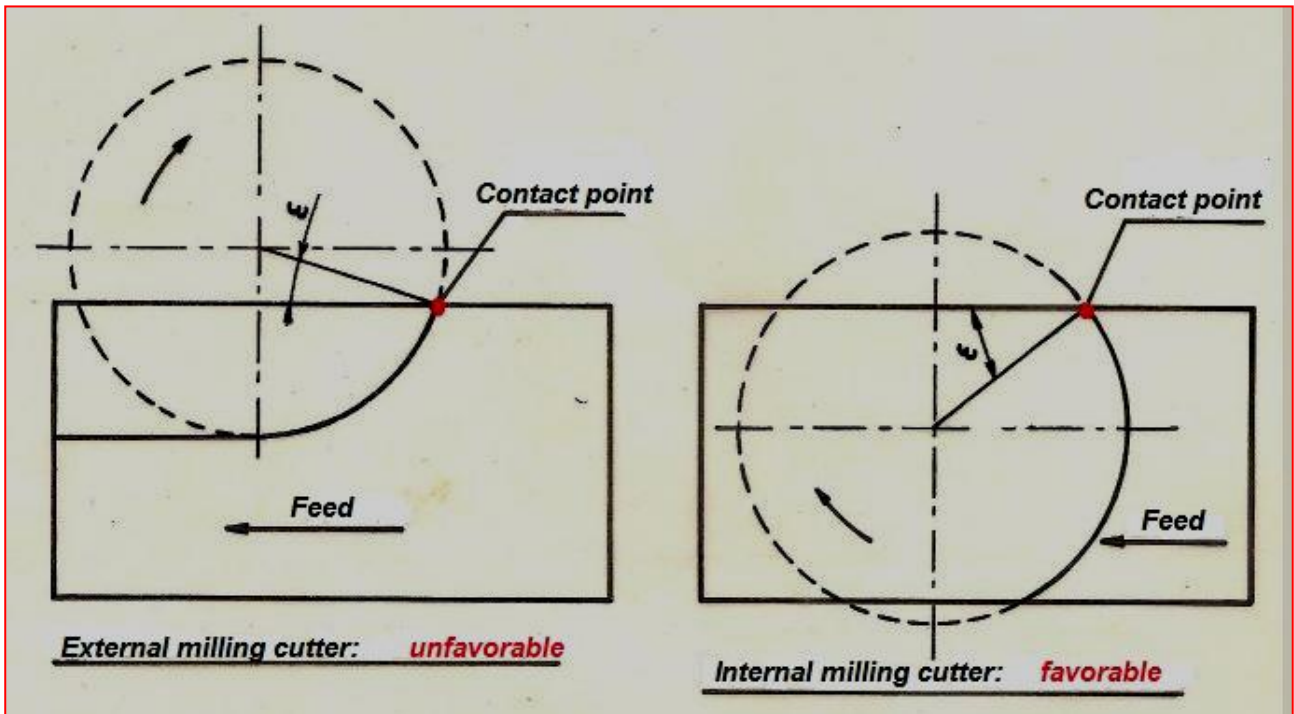
Generally speaking therefore it is always better to avoid that these shocks take place directly on the cutting edge or, worse, on the vertex formed by the intersection of peripheral edge with the secondary cutting edge (point a).

Under this point of view, the initial contacts are preferred in the points **C** and **D** which are inside of the blade and that can more easily absorb load peaks which are the shocks.

But it is not always a good idea to sacrifice other elements, such as proper formation and easy removal of chips, just to get the internal contact points.

As you can see in the following figures, the contact points **C** and **D**, or on the line  $\overline{CD}$ , you get almost always with negative radial angles, ie angles that do not facilitate the formation of chips.

These initial contact points are preferable only when working high strength steel with high cutting speed in roughing operations.



**Fig. N°3** – Position of the cutter to the workpiece

In this type of work, in fact, the impact against the hard and tough material is particularly violent and will damage the cutting edge almost immediately, moreover with negative radial angles, the cutting edge has a chance to be stronger and therefore more resistant to chipping.

The expulsion of the chips with high-speed often causes micro cracks that are avoidable only by varying the flow of chip.

If you are working cast iron, that is a material hard but not tough, is preferable the first contact, on B or **AB**, in order to allow the cutting edge to penetrate the material more gently.

The edge on the other hand there is not too much damaged by the chips even if you are working with positive radial angle.

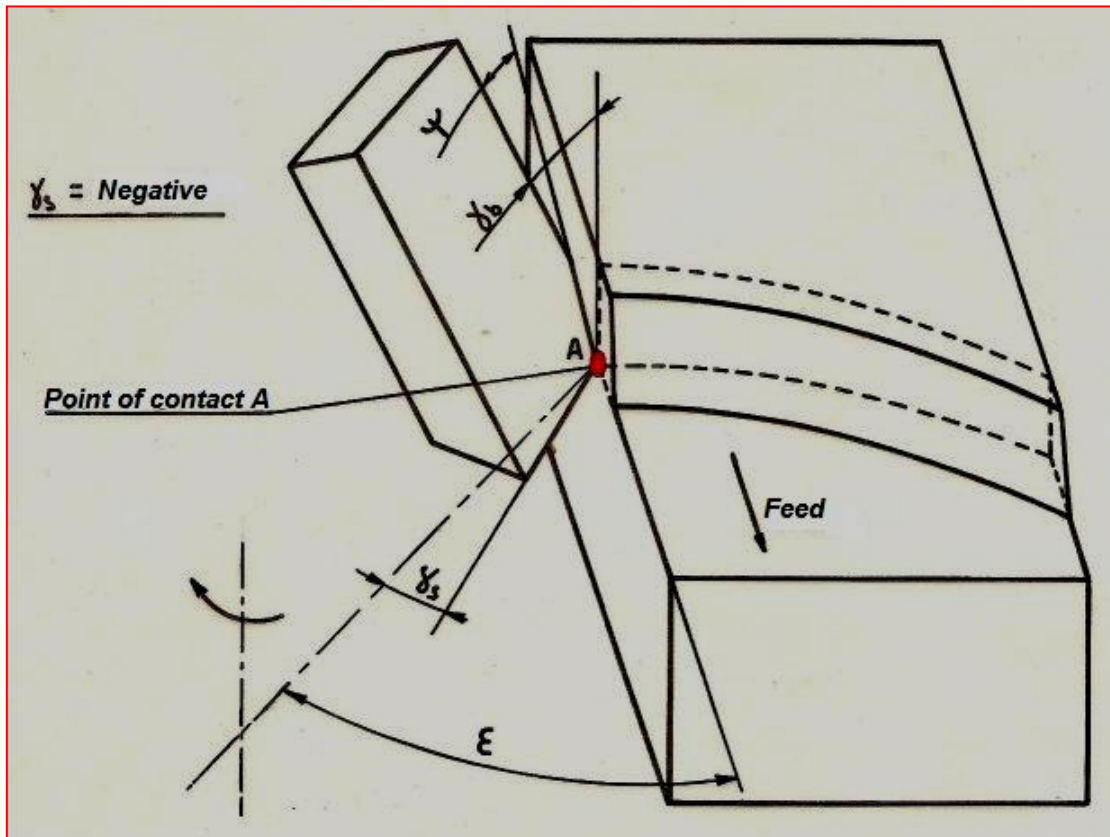
Working light alloys (aluminum alloys) there are no problems caused by shocks, then you can work very well with large positive radial and axial angles, in this way facilitates the formation and discharge of chips. The contact may take place in **A**.

The worst types of contact are those along the line **BC** or on whole section **ABCD** the first does not allow a rational formation and a proper discharge of the chips, in the second, there is the maximum intensity of impact because it is not an edge that penetrates and separates the material, but the whole section is attacked simultaneously.

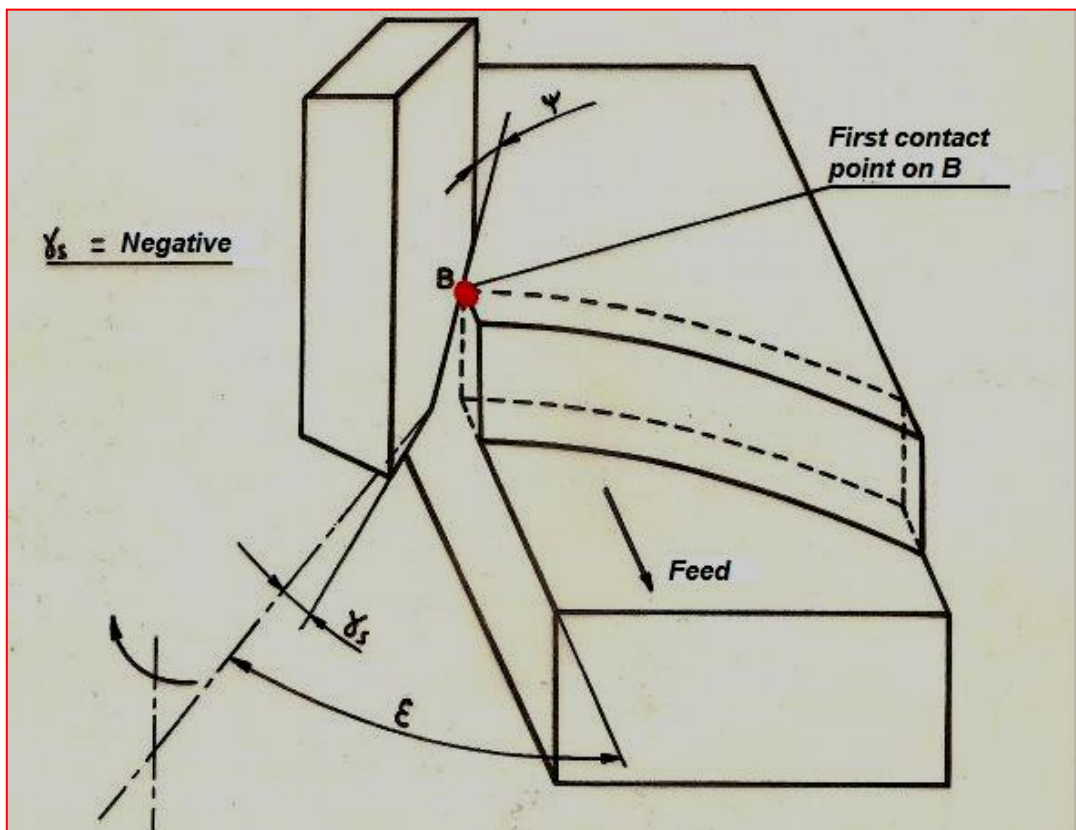
it is logical that the force required will be greater and that the chip will be formed with irregularity.

The following figures are represented the possible situations related to areas of first contact with the general guidelines for each situation.

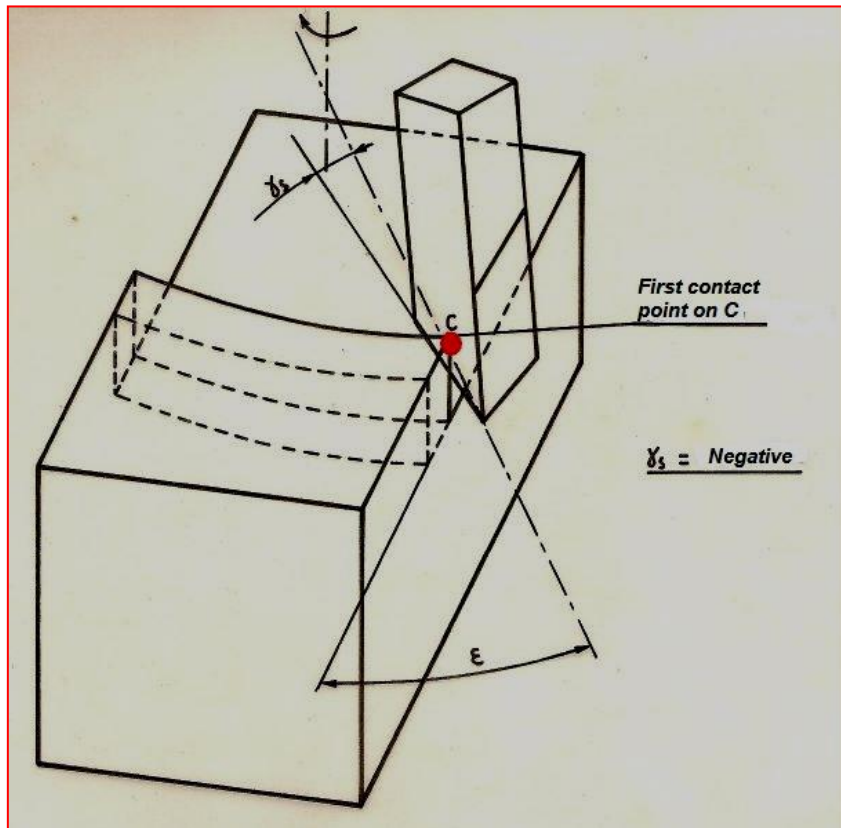




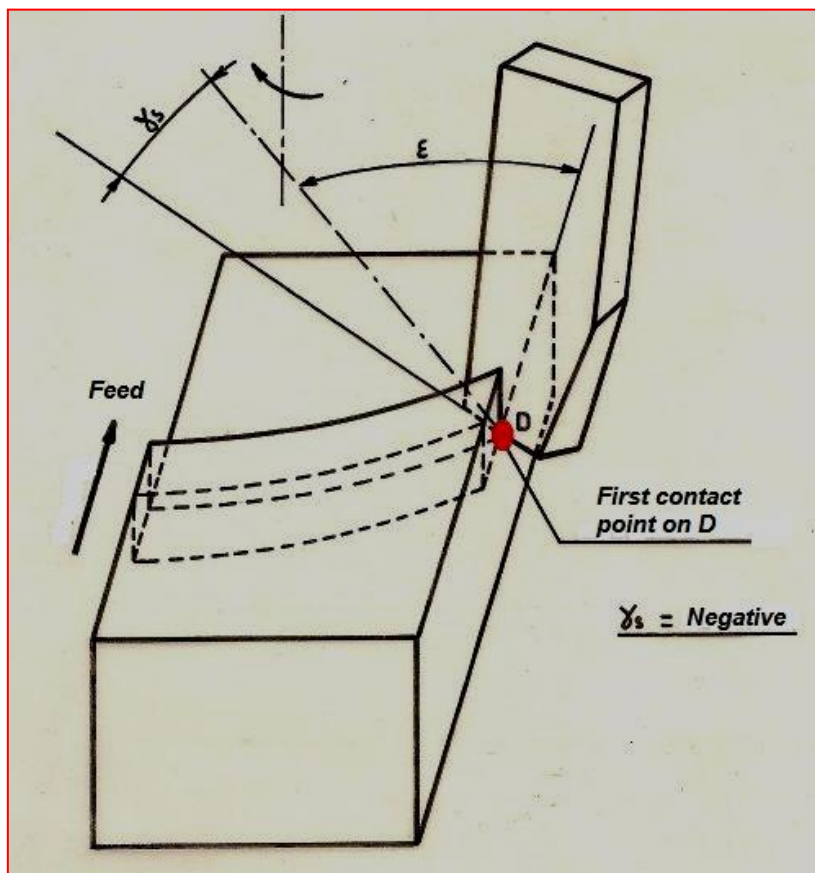
**Fig. N°4-** First contact point on A- Recommended for light alloys, aluminum, magnesium, etc.. Materials of low strength and low hardness and short chips. Machines with poor efficiency. To avoid if possible for cast iron and steel.



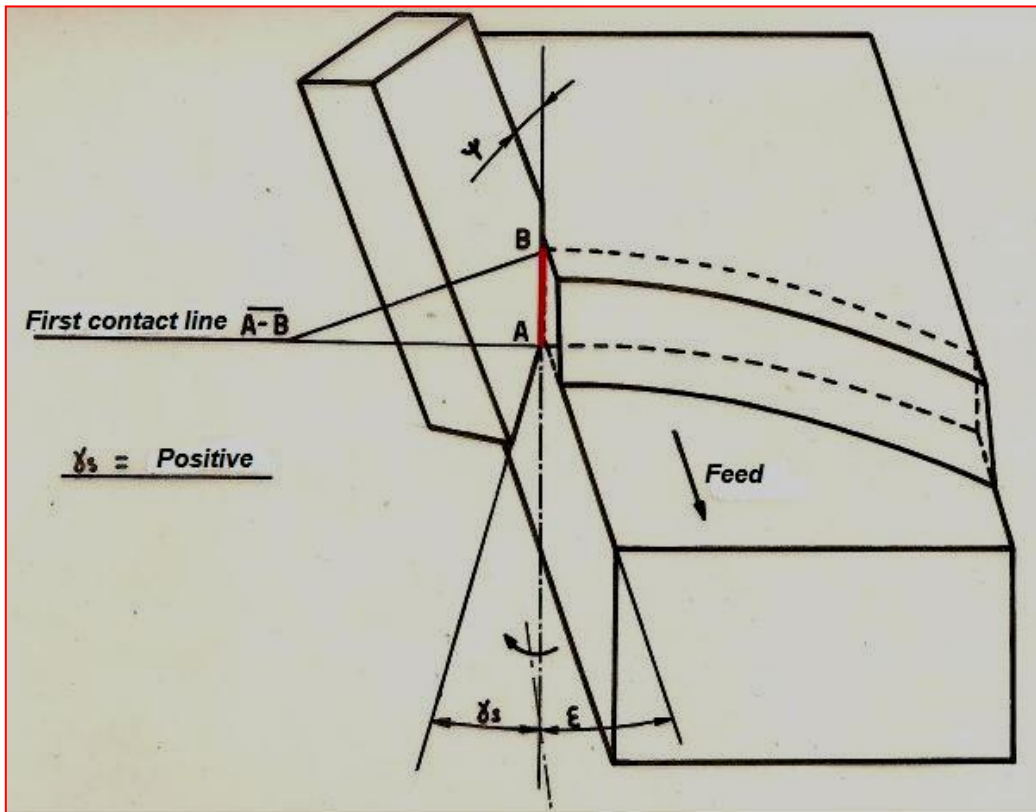
**Fig. N°5** – First contact point on B- More favorable situation because the cutting edge is more resistant, however, now the discharge of chips are more difficult and the cutting force is slightly higher. The cutting edge is more stressed with the possibility of chipping. To be used to milling cast iron.



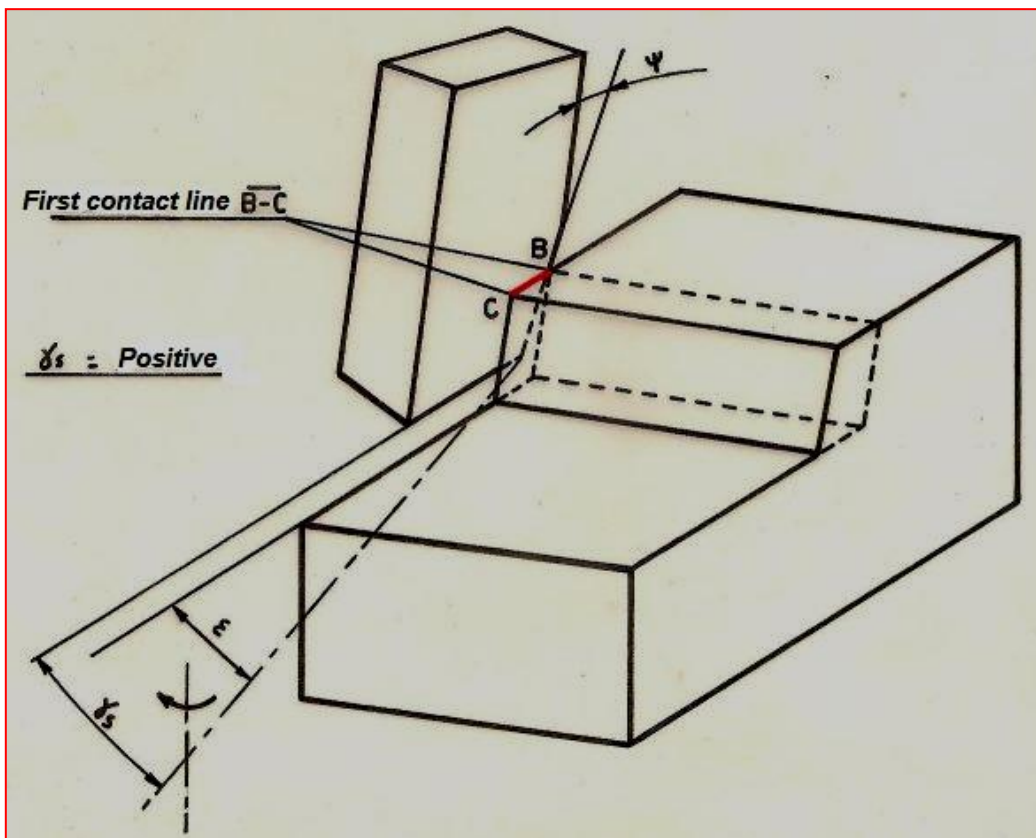
**Fig. N°6** – First contact point on C – Point that provides the maximum resistance to stress, but the conditions that create this contact is almost always unfavorable to the formation and discharge of chips. To be adopted in the milling of high-strength steel and generally hard and tough materials.



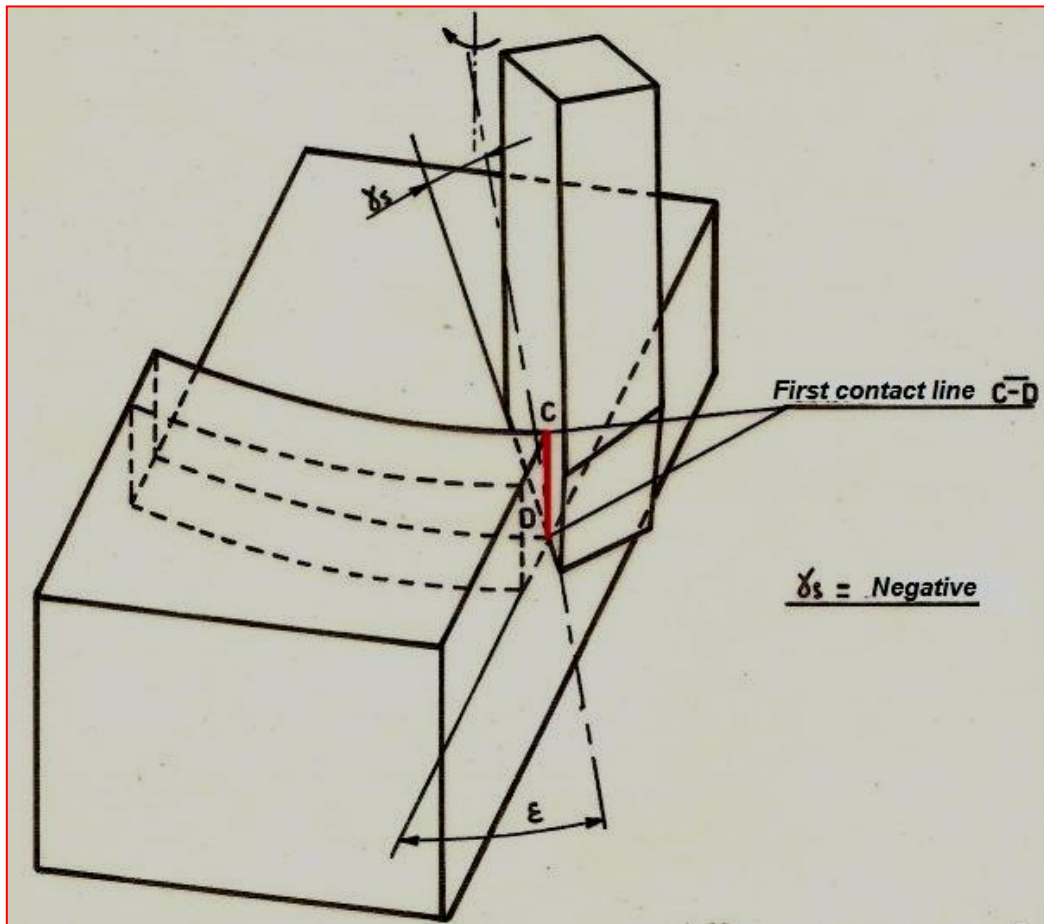
**Fig. N°7**- First contact point on D- Contact which under certain aspects is better than in C because the time of penetration of the edge to the entire chip section is higher and therefore there is a certain graduality in the effort. The discharge of the chip is more correctly. To be used for low strength steel.



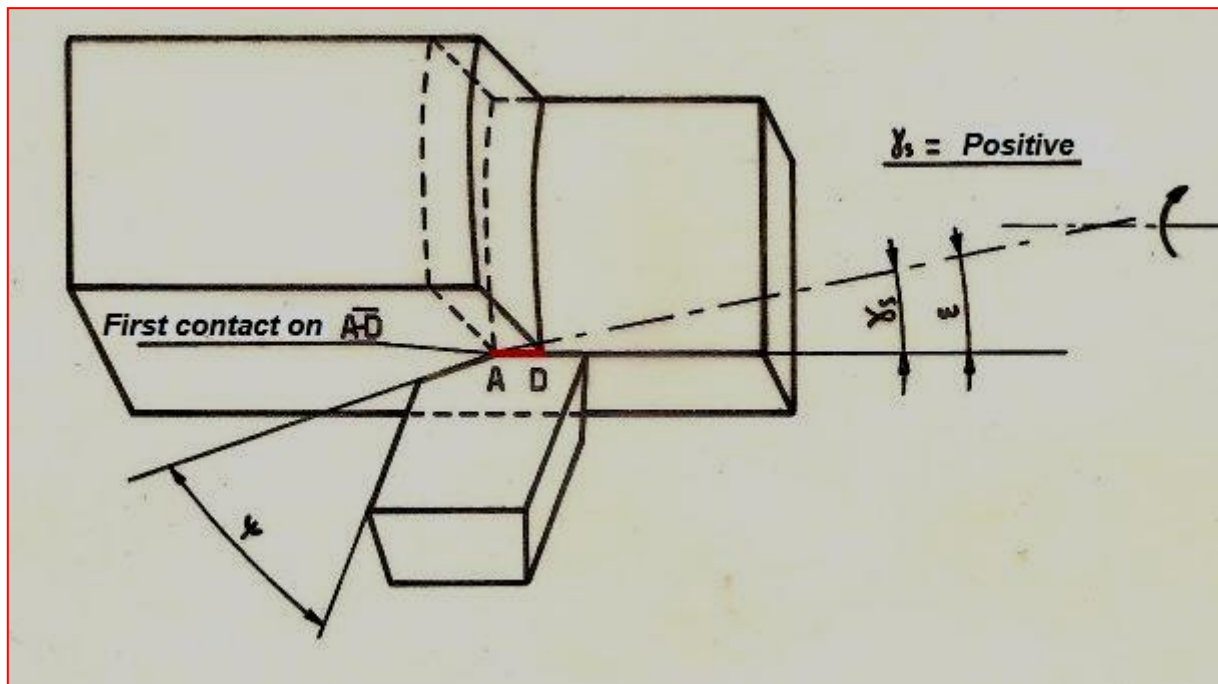
**Fig. N°8-** First contact line on  $\overline{AB}$  - Contact not so favorable; easy chipping of cutting edge. For use to low-resistance materials (light alloys). Also sometimes used to cast iron not too hard. The chip discharge is facilitated



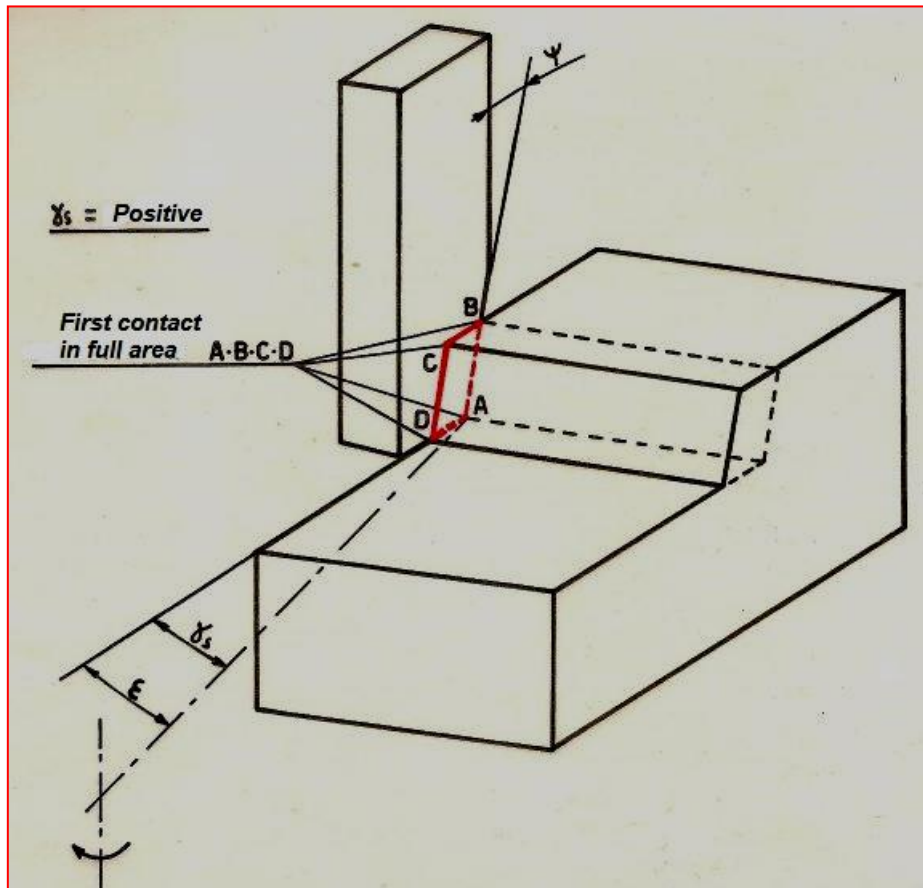
**Fig. N°9-** First contact line on  $\overline{BC}$  - Contact to avoid as much as possible. Formation and discharge of chips is not good. It is rarely used.



**Fig. N°10-** First contact line on  $\overline{CD}$ . Good impact resistance. For use with medium strength steel and malleable cast iron



**Fig. N°11-** First contact line on  $\overline{AD}$ . Contact good for low strength steel. The secondary edge is more stressed. The formation of chips is good.



**Fig. N°12-** *First contact in the full area **ABCD**- Contact should be avoided because the collision is too violent*