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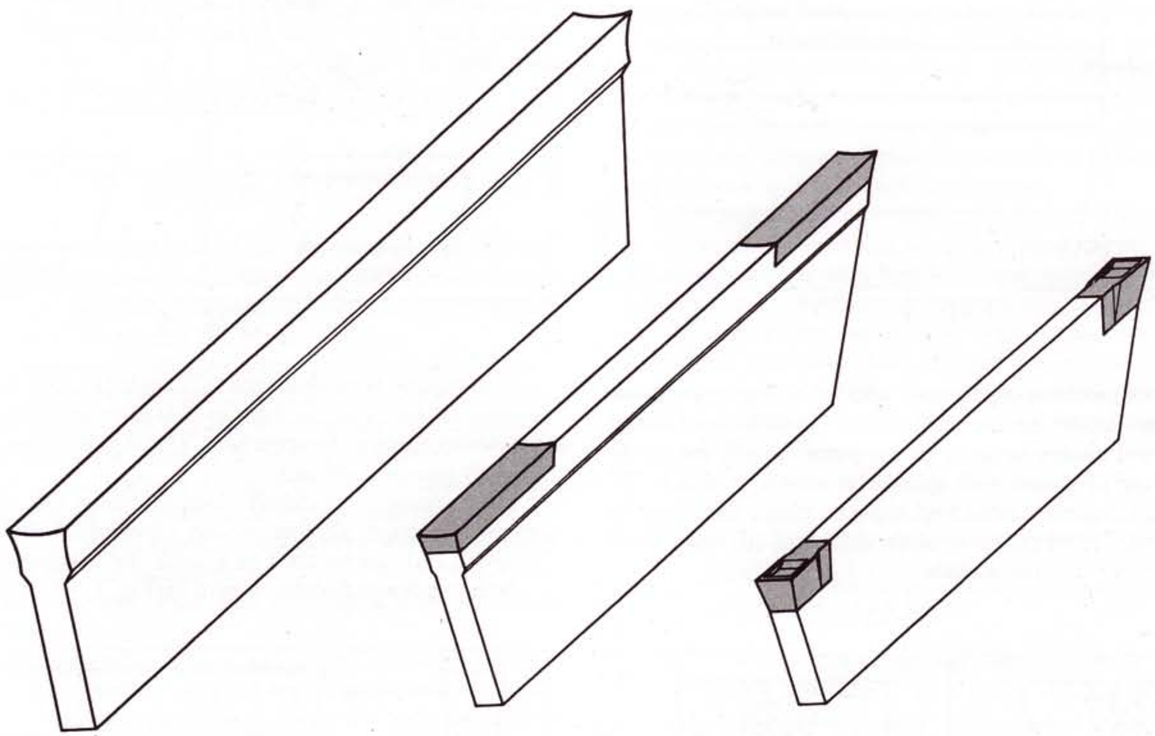
USE and MISUSE of CUT-OFF BLADES



The cut-off blade is one of the most misunderstood, misused and abused cutting tools in use today. The very nature of the work it must perform places many restrictions on its design and size.

The blade must be as narrow as possible to save stock and it must follow its own chip into the cut. The chip and the narrow slot the blade cuts both tend to keep the coolant away from the blade. These factors detract from tool life.

On many jobs the cut-off blade is the tool that determines the cycle time of the machine (automatic screw machine). Whether used on automatics or turning centers, the value of a cut-off blade can only be determined by investigating the original cost, the number of pieces per grind, and the cost of resharpening to get the cost per cut. Unless all of these factors are assessed carefully, a true comparison of different cut-off systems cannot be made accurately.

The most common terms used in cut-off work and those which should be considered as industry standards (Fig. 1) are: Blade extension, indicated by "E"; rake angle, "A"; front lead angle, "B"; front clearance angle, "C"; and cutting width, "W".

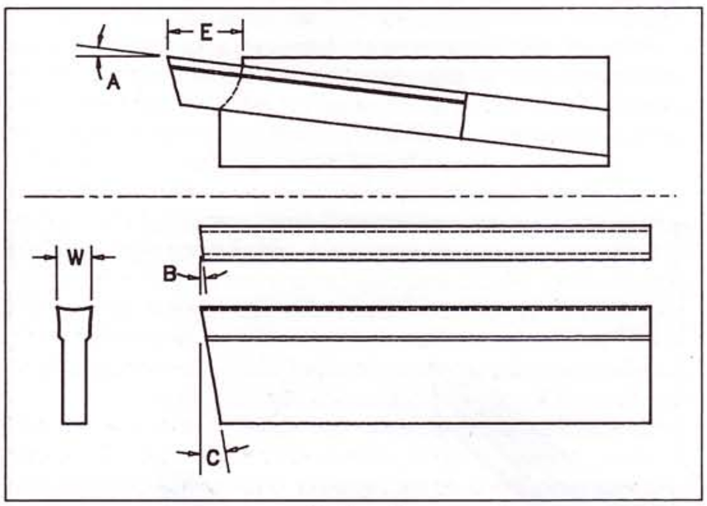


FIG. 1

Some common problems experienced with cut-off blades and those which are controlled by the mechanical setup itself are as follows:

1. Concave and convex surfaces on the piece cut off, caused by (a) holder set out of square with spindle, as shown by sketch "A" in (Fig. 2); (b) too great a front lead angle on blade, illustrated by sketch "B", (Fig. 2); (c) excessive blade extension; (d) end play in spindle, and (e) too narrow a blade.

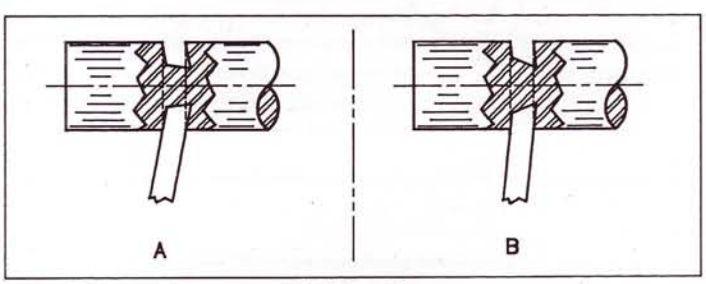


FIG. 2

2. Burning on front face of blade is caused by, (a) blade set above center, or "heeling", as shown by sketch "A", (Fig. 3); and (b) insufficient front clearance angle, sketch "B", (Fig. 3).

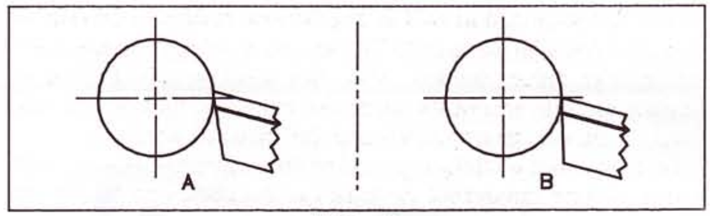


FIG. 3

3. Chatter is usually caused by: (a) excessive blade extension; (b) loose spindle; (c) too narrow of a blade for the job, or (d) too light a feed. (Sometimes chatter is caused by a loose spindle that can be eliminated by setting the blade about 0.020 above center to cause a slight "heeling" action, but this arrangement is only advisable if considered a temporary setup).

4. Blade breakage is caused by: (a) excessive blade extensions; (b) blade set below center; (c) too narrow a blade; (d) too heavy a feed; (e) dull blade, and (f) loose spindle.

5. Blade weaving is caused by: (a) too narrow a blade; (b) end play in spindle, and (c) excessive extension.

6. Blade slipping in the holder is caused by: (a) heeling action; (b) excessive feed; (c) dull blade; (d) improper holder; (e) jamming the blade into the bar stock, and (f) worn clamping mechanism.

7. Poor tool life is caused by: (a) lack of adequate side clearance; (b) lack of adequate back clearance; (c) excessive heat resulting from chip restriction; (d) grain paths made by grinding the blade in the wrong direction; (e) wrong rake angle (improper holder); (f) improper blade for the job; (g) blade too narrow; (h) excessive front clearance angle; and (i) front angle ground on radius instead of straight, as illustrated in (Fig. 4).

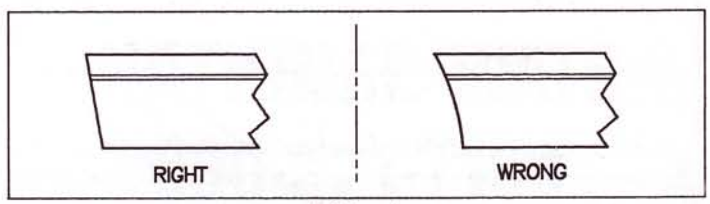


FIG. 4

The smallest front clearance "C" angle possible should always be ground on the blade so that the maximum material can be left at the cutting edges to dissipate heat. This is usually the rake angle "A" (Fig. 1) plus two degrees.

These examples of cut-off blade problems and solutions do not necessarily cover all that can be experienced, but are the most common and can be used as a guide for trouble shooting.

Pertinent design features--shown in (Fig. 5)--include the following:

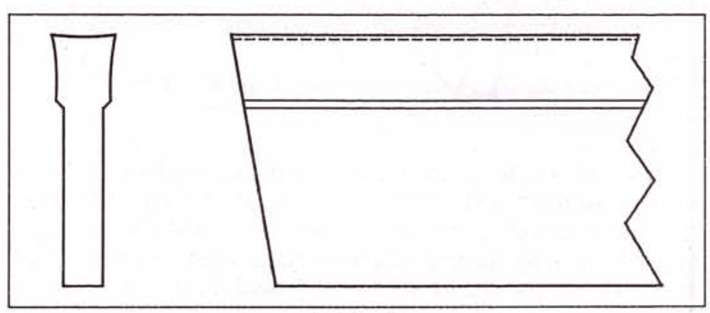


FIG. 5

Hollow ground top surface allows the chip to expand away from both side walls of the cut and the top of the blade, thereby reducing the heat generated and lengthening tool life. This hollow-ground tool also acts as a trough to enable the coolant to reach cuttng edges of the blades.

The hollow-ground as well as angular side clearances produce---in conjunction with the basic "T" cross section---a clean cutting action which helps reduce friction. Also, they eliminate side friction by limiting the side area of the blade that comes in contact with side walls of the cut, thereby restricting the frictional area.

Back clearance is machine ground on the longitudinal cutting width and is uniform throughout the length of the blade and exactly the same amount on both sides of the tool. On deep cuts this clearance is essential.

The cut-off blades is still the most cost effective cut-off tool!

Used properly, high speed and brazed carbide tipped cut-off blades are still the most cost effective cut-off tools available. Although there are throw-away type cut-off systems that make similar claims, careful study of these tools can prove otherwise. After over 50 years of selling cut-off blades there are still problems of misuse, which seriously distracts from the cost effectiveness of the "Empire" systems.

Resharpening has become a concept that is directly related to increased cost. This is not true with regrinding or resharpening cut-off blades; but because of the misconception, cut-off blades are "lumped" into this category.

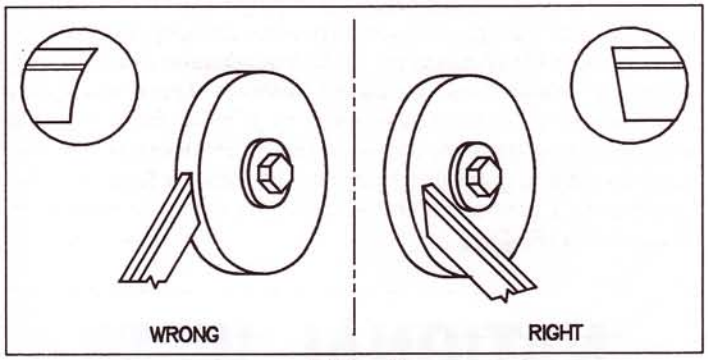


FIG. 6

Resharpening a cut-off blade should not take more than 15 seconds. operators grind clearance angles on high speed and carbide tipped blades in 15 seconds per blade. Resharpening with a lead angle should not take more than 30 seconds per blade.

Training an operator to resharpen a cut-off blade is not difficult. More time is required for complex chip breakers, lead and clearance angles, but the training cost is a one time expense. Most machine operators have no trouble learning to resharpen blades.

Resharpening can be costly if it is not organized. If operators can resharpen blades while the machine is running then there is not a cost involved. If this is not possible, an operator should resharpen several blades at once to reduce the per piece cost. Resharpening is usually done at the end of the shift to insure that the next shift has "good" blades.

Good grinding equipment, fixtures, and proper techniques can also reduce cost. Fixtures with 7° and 10° angles are desirable, as are CBN wheels for high speed blades and diamond wheels for carbide blades. Grinding techniques are very important and a prime factor in tool life.

Blades should be ground on the side of the wheel and not on the outside diameter. The "wrong" example actually reduces tool life because heat will not dissipate as well as it should in the "right" example. (Fig. 6). Blade should be quenched often during sharpening process to keep tool cool. Air cooling aneals blade. (A radius type clearance angle develops a point on the end of the blade.)

The process of regrinding should take from .010 to .025" in length as a "rule of thumb". No more than .250 should be taken even with severe lead angles. Regrind high speed blades with .005 and carbide Blades with .010 reduction in length.

The economics of regrinding must be evaluated and the following examples are just examples, as every cut-off job will usually be different. The examples can be used as a guide for costing purposes:

P3 H.S. (M2) Cut-off Blade.
Price: $9.75
15-20 regrinds available.
$9.75 ÷ 15 = $.65 per tip.
$9.75 ÷ 20 = $.48 per tip.

P3 C6 Carbide Tipped Cut-off Blade.
Price: $17.15
New Tip plus 3-5 regrinds available.
$17.15 ÷ 4 = $4.28 per tip.
$17.15 ÷ 6 = $2.85 per tip.

P3 C6 Double Ended Carbide Tipped Cut-off Blade.
Price: $20.60
New Tip plus 3-5 regrinds available.
$20.60 ÷ 8 = $2.57 per tip.
$20.60 ÷ 12 = $1.71 per tip.

Costs can be further reduced by purchasing larger quantities and retipping blades.

Cost per cut must be completed (÷ number of pieces by cost per tip) to determine the cost effectiveness of the cut-off blade.

Resetting blades after resharpening has always been a concern relative to cost. Again, operator training is a requirement; but done properly, the cost can be reasonable. Blade setting gages and notes on process sheets as to blade extensions are but two "helpful hints" to reduce resetting time. Realistically, the difference in time to reset a cut-off blade and change a throw away insert is not that great; especially those throw away systems with clamps and clamp screws.

It has always been our position that strength is the most important element in a cut-off tooling system. There is no stronger system than an "Empire" clamp lock holder with a high speed or carbide tipped blade. The "Empire" system is a multi-purpose system suited for the job shop that must cut various types of raw material or the dedicated machine set up for a single application.

Interchangeability of the different analysis of blades with one holder is all too often overlooked when evaluating cut-off tooling systems. We have customers using high speed and carbide blades in their shops, with operators resharpening and resetting both types.

Because the high speed and brazed tipped cut-off blades are considered "old fashioned", they are automatically placed in a cost ineffective classification. The "fashionable" throw away cut-off systems do have limitations that must be considered and evaluated.

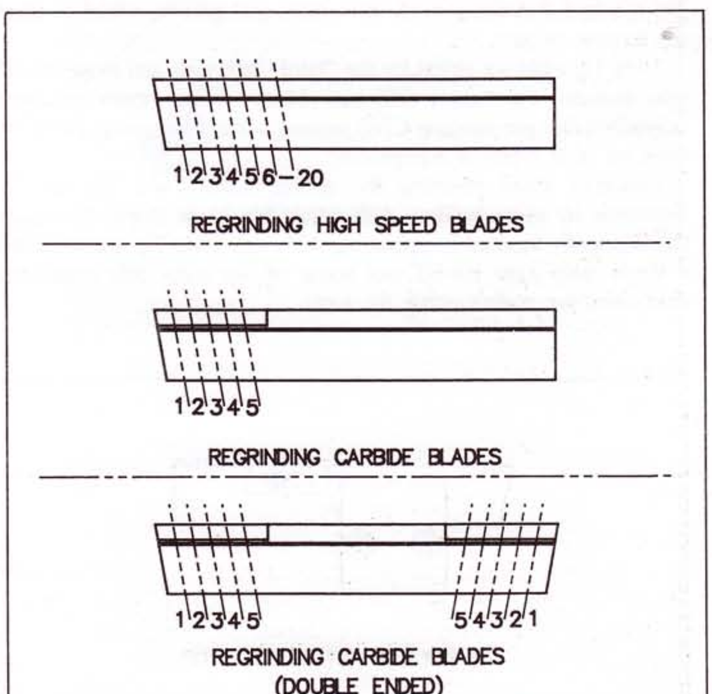


FIG. 7

Under certain conditions the carriers or blade supports can be subjected to "wrecks". This can happen when the tip heats the carrier and the pocket expands causing the tip to move or dislodge. It is sometimes difficult to know when a carbide tip begins to breakdown, as there can be inconsistency in the carbide and/or raw material. When a throw away tip "goes", the operator usually can't stop the machine in time and the carrier will be damaged. This is not the case with a blade.

Actual carrier costs must be a factor in cost per cut analysis. Carrier costs do not usually surface on one or two day testing. These "hidden" costs become evident after a period of time when the replacement carriers are put in stock.

Recent improvements in throw away systems have been in the addition of clamps to secure the insert tip. This evolution is due to tip movement or tip loss due to heat. Clamps and clamp screws increase resetting time and become inventory costs that must also be evaluated in cost per cut.

An "age old" problem that we encounter is the attempt to run carbide at high speed feeds and speeds or at the low end of the carbide range. In many applications, the high speed blade should be evaluated rather than completely dismissed. As an example, high speed blades would be recommended when cutting 1018 at 150 FPM. C6 is recommended at 500 FPM. In the ranges from 150-500 it is prudent to test M36 or M6 high speed blades at $.63 per tip (regrind) rather than the throw away insert at $6.50 per tip.

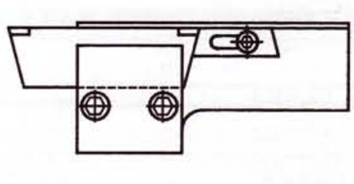
Micrograin carbide was developed to run at lower speeds than C6, but the lower speeds are "made" for the cost effective and yes, "old fashioned" high speed blades. If the other positions are set with high speed tools e.g. form tools, then high speed cut-off blades must be given serious consideration rather than forcing any grade of carbide.

Side load is also an important factor with cut-off tooling. Blades are prone to take more side load than inserts, which is an advantage in cutting the tougher aircraft and stainless steels. "There just isn't a stronger cut-off tool than a high speed blade or a carbide tipped blade with a high speed steel shank".

Our brazing and grinding expertise led us to the development of the Twin Tip cut-off tooling line for that portion of the market that **insists** on throw away tooling. Twin Tip tools were developed for the higher speeds/feeds that are available on CNC/NC turning centers. Again, the concept of strength was incorporated into the holder and blade combination with molded chip breakers and lead angles. Twin Tip is a tool that can cut-off, face, turn, and groove, which is ideal for turning centers.

Twin Tip tools are suited for the "hard" materials and those cut-off jobs that are the "most difficult". Many of our screw machine customers that are running CNC turning centers are using Twin Tip tools on both types of equipment.

Concerns about resetting the double-ended Twin Tip can be overcome by using holders with adjustable blade stops. The tools can be rapidly indexed by operators. Although Twin Tip is considered a throw away type cut-off tool some of our most cost conscious customers are resharpening the tools.



NC HOLDER WITH BLADE STOP

FIG. 8

Cut-off tool width has always received cost consideration, because of stock savings. High speed and brazed carbide tipped tools are stronger, thus the potential to run thinner widths as opposed to throw aways. In both the carbide blade and Twin Tip lines cutting widths are, as low as, .079 and .062. Throw away tools can be very difficult to run under .125, and in the lower speed ranges.

Conceptually, throw away insert type cut-off systems "sound good" with the sales "hype" directed at regrinding and resetting, but properly evaluate a system, the "overall picture" must be advanced to actual cost per cut. Evaluations must also be projected over a period of time to obtain parts costs, downtime due to "wrecks", inventory requirements, and managing several different types of systems.

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