CHAPTER X

Miscellaneous Carbide Grinding Operations

Although molded cemented carbide blanks are used primarily for tips on cutting tools, there are scores of other applications of special forms of cemented carbides such as plug gages, gage blocks, drawing and blanking dies, bushings, and cold mill rolls. All of these carbide parts must be finished by grinding, followed in some instances by lapping. The grinding operations fall under the general headings of cylindrical, surfacing and internal.

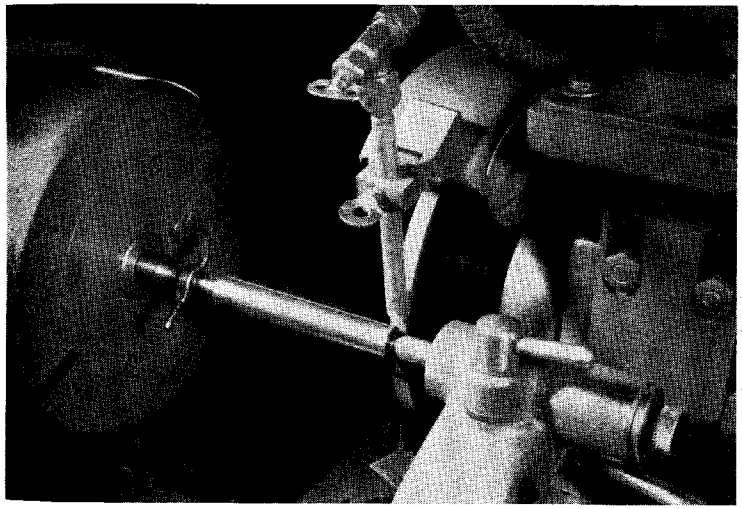
Cylindrical Grinding

Molded carbide blanks of cylindrical shape such as used for plug and ring gages, bushings and rolls, are readily ground with diamond wheels, either resinoid or vitrified bonded. While a relatively coarse grit diamond wheel, such as SD100-N100B$\frac{1}{16}$ (or $\frac{1}{8}$) will give best all-round results for rough grinding, a Crystolon wheel such as 39C60-J8VK may be used. For finish grinding, however, only a diamond wheel should be considered where dimensional accuracy and surface finish are important. The grit size may be either 220, 320, 400 or even as fine as 1500, depending upon the finish required.

The depth of cut should not exceed .001" per pass with the roughing wheel and should be reduced to only a few ten thousandths of an inch in finishing with any of the relatively fine grit diamond wheels.

The grinding should always be done wet, using a coolant of water with the addition of a small amount of soluble oil as a rust preventative. It is good practice to provide separate wheel mounts for the roughing and finishing wheels. Thus, when it becomes necessary to change wheels, the diamond wheel is left on its sleeve and the wheel and flange assembly removed as a unit so that the wheel will always be kept in running truth. All Norton peripheral type diamond wheels are finished with the arbor hole from standard to .001" oversize to fit snugly on the spindle or sleeve. To obtain a chatter-free finish, the diamond wheel must run true to within less than quarter of a thousandth on the periphery and must also be in perfect balance on its sleeve.

Dress (clean) resinoid bonded diamond wheels occasionally with either lump pumice or a 37C400-HV Crystolon stick;



Setup for O.D. grinding a carbide plug gage with a diamond wheel

vitrified bonded diamond wheels with a Crystolon stick of grain and grade like that of the sample supplied with the wheel.

See page 189 for the complete markings of the Crystolon and diamond wheels recommended for cylindrical grinding.

Surface Grinding

Cutter blades, gage blocks, dies, straight shank form tools, etc., require surface grinding operations. These are generally performed on small reciprocating table type surface grinders, mounting 6″, 7″ or 8″ diameter straight (type D1A1 [D1T]) diamond wheels, either resinoid or vitrified bonded.

For rough grinding, using a diamond wheel around 100 grit, the depth of cut per pass should not exceed .001″; for finish grinding with 220 grit wheels, .0005″. For extra fine finish with 320 or 400 grit wheels, the depth of cut per pass should be reduced to quarter of a thousandth. The table traverse should be relatively high.

Any steel should first be undercut with either a Crystolon wheel or an Alundum wheel. It is not economical to use diamond wheels for grinding both steel and carbide except for finish grinding.

Where it is desired to rough grind both steel and carbide simultaneously, use a Crystolon wheel such as 39C60-H8VK. For finish grinding both carbide and steel, a diamond vitrified bonded wheel of a grit size to give the desired finish is recommended. Manufacturers of carbide tipped milling cutter blades, for example, have found that the vitrified bonded diamond wheel will grind both the steel shanks and carbide tips much more readily and with relatively little dressing action as compared with resinoid bonded diamond wheels.

Where the tool or part is of such a design that the steel shank can be ground separately without touching the carbide

Bore grinding a carbide die with a vitrified bonded diamond wheel

insert, an Alundum vitrified wheel such as 32A46-J8VG, may be used. The carbide tip or insert is then ground on a diamond wheel of a grit size depending upon the amount of stock to be removed and the finish desired. Carbide tools or other parts to be surface ground should be ground in multiple so far as possible, supporting the tools on a magnetic chuck.

General recommendations of wheels for surface grinding are listed on page 190.

Internal Grinding

For internal grinding carbide bushings, dies, etc., diamond wheels should be used exclusively. These may be either resinoid or vitrified bonded and, in the very small sizes, molded on steel spindles. The grit size to use would depend upon the amount of stock to be removed and the finish required and

accordingly, might range from as coarse as 100 for rough grinding to as fine as 400 where a very fine finish is desired.

The depth of cut per pass will vary with the grit size of the wheel but should be relatively light to avoid springing the quill or spindle. The grinding should be done wet, if at all possible, to keep both the diamond wheel and the work cool.

Cutting Off and Grooving

Carbide single-point tools that have been chipped or broken in service can often be salvaged and reconditioned by cutting off the damaged portion of the carbide tip with a diamond cut-off wheel and then rough and finish grinding the head of the tool as previously described for "milled and brazed" tools. The proper procedure is to first cut the steel shank up to the carbide tip with an Alundum resinoid or rubber bonded cut-off wheel and then complete the cut through the carbide with the diamond wheel.

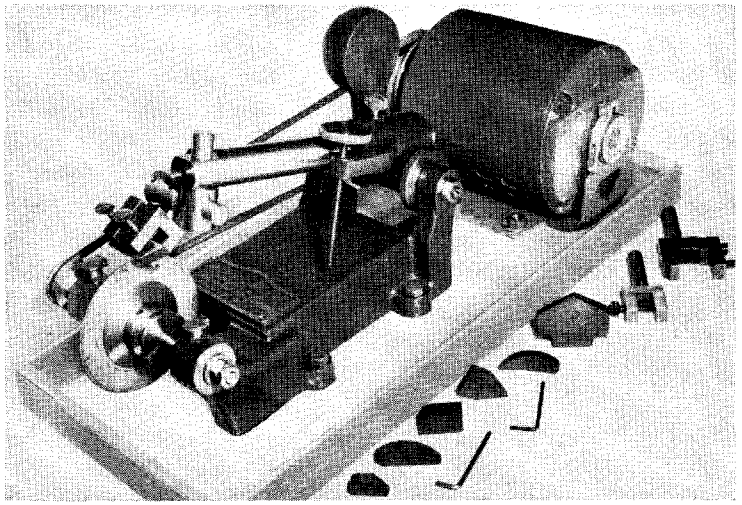
The diamond wheels most generally employed in cutting off cemented carbide blanks for tool tips are 3", 4", 5" and 6" in diameter and $\frac{1}{32}$" in thickness. For slotting or grooving purposes, wheels of any desired greater thickness may be had.

Diamond cut-off wheels are available with either $\frac{1}{8}$" or $\frac{1}{4}$" depth of diamond in the periphery. The grit sizes most generally used are 100S, 120 and 150. The coarser grit sizes will be found to wear at a somewhat slower rate. While the standard grade of hardness for straight (type D1A1 [D1T]) resinoid bonded diamond wheels is N, a harder grade, such as R, can readily be used for cut-off wheels, with the advantage of greater wear resistance and longer life. Complete wheel marking: D120-R100B$\frac{1}{8}$ (or $\frac{1}{4}$).

Metal bonded diamond wheels can also be used for cutting carbide blanks. While they have the advantage of long wheel

life, they are generally considered too slow cutting to be entirely satisfactory.

It is important that the cut-off wheel be mounted between flanges of as large diameter as the work will allow in order to insure maximum rigidity and straightness of cut. Furthermore, the wheels should preferably be used only on constant pressure types of cut-off machines, or, in other words, machines on which the pressure between the wheel and the work is supplied by means of a weight or spring. The amount of pressure should be only enough to allow the wheel to cut its way through the carbide freely. The cut should never be forced, as otherwise the wheel, which is relatively fragile, might break. If the fixed feed method of cutting is employed, the depth of cut should not exceed .001" per pass.



(Courtesy of Union Wire Die Corporation)

Bench machine for cutting carbide tool blanks (attachment for lubricating both sides of wheel while cutting is not shown but must be used)

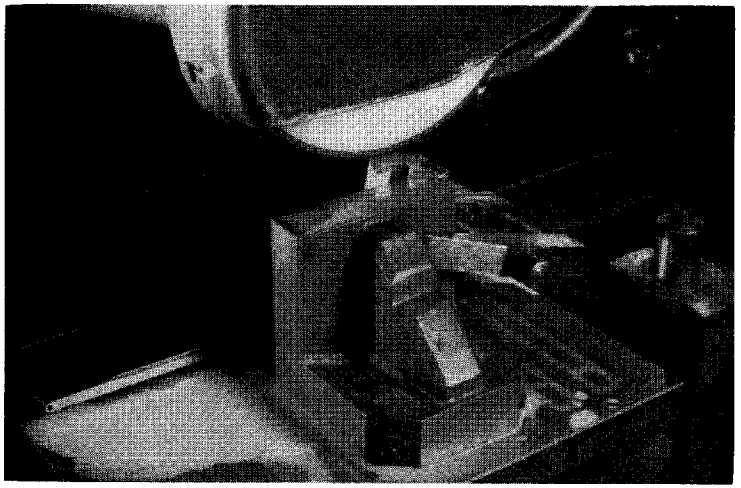
Diamond resinoid cut-off wheels should be operated in the vicinity of 6000 s.f.p.m. and metal bonded in the vicinity of 3600 s.f.p.m. with coolant for best cutting efficiency and wheel economy. This coolant should preferably be a thin solution of soluble oil directed to both sides of the wheel.

Flat Form Tools

Flat form tools can be made by the user from so-called standard carbide tools such as the style having a square carbide tip. First, the desired form is scribed on the blued surface. On a bench stand or carbide tool grinder mounting a Crystolon wheel, 39C60-I8VK, as used for offhand roughing single-point tools, rough out as much of the material as possible to within about $\frac{1}{64}$" of the scribed lines.

That portion of the material that may not be accessible to the Crystolon wheel is removed by plunge grinding a series of small steps, using the corner of a 100 grit straight diamond resinoid bonded wheel on a small surface grinder. With this same set-up, clean up any straight surfaces that were hogged out by the Crystolon wheel. Any radii or curved surfaces should be roughed out on the same surface grinder, using a Crystolon wheel of suitable width, 80 or 100 grit size and grade I. Complete wheel marking: 39C80-I8VK. The radius or special face can be trued on the wheel with a Crystolon dressing stick or radius truing device and checked with a template or optical comparator. Allow .005" for finish grinding or lapping.

The various straight and angular surfaces are finish ground with a 220 grit diamond resinoid bonded wheel, SD220-R100B $\frac{1}{16}$ (or $\frac{1}{8}$), of suitable thickness. If the form includes any angles, tilt the tool in the universal vise until the surface to be ground is horizontal and then grind with the same straight



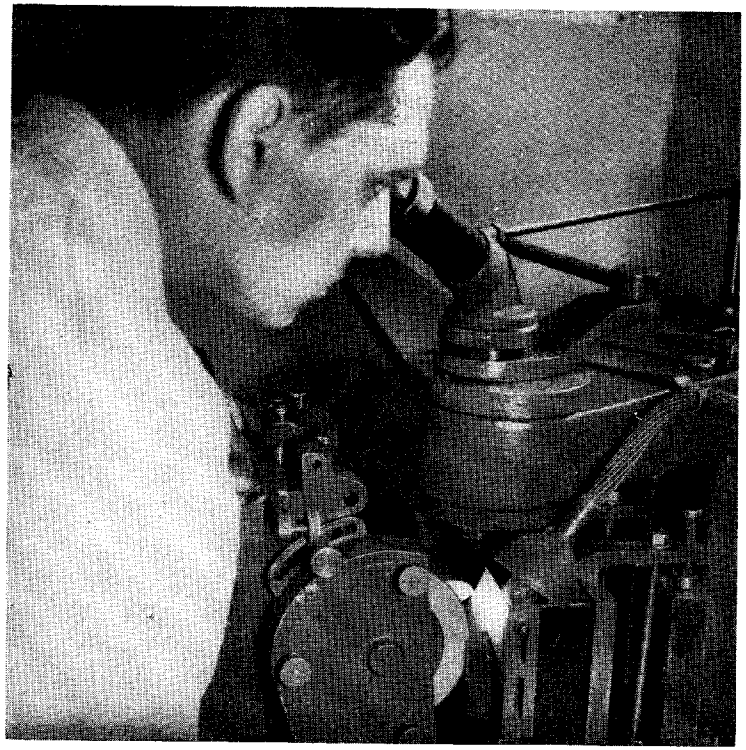
Sharpening a carbide-tipped flat form tool by surface grinding the top face with a 220 grit diamond wheel

diamond wheel. Any radius can be finish ground either with a 220 grit diamond wheel, one corner of which has been trued to the required radius, or by hand lapping on a cast iron lap with #4 diamond powder or #400 Norbide grain. In all of the above grinding operations on the carbide tip, the tool should be supported so as to grind the required relief on the front of the tip, generally 5° to 7°.

The steel shank below the tip is now backed off with the proper additional relief, using an Alundum wheel. Take care not to touch the carbide with this wheel.

Flat form tools are sharpened simply by surface grinding the top face of the tool using a straight (type D1A1 [D1T]) diamond wheel, either resinoid or vitrified bonded such as SD220-N100B$\frac{1}{16}$ (or $\frac{1}{8}$) or SD320-N100V$\frac{1}{8}$.

The Norton Bura-Way grinder is specially designed for



Grinding the contour of a flat form tool on an optical type precision form tool grinder equipped with a 220 grit diamond wheel

accurately producing and regrinding flat form tools of the convex type. This machine is completely described in a separate booklet which will be mailed to any reader upon request.

Circular Form Cutters

Carbide-tipped circular form cutters may be sharpened either on a tool and cutter grinder in the same manner as high-

speed steel form cutters or, clamped in a vise, on a small surface grinder.

The grinding is done only on the radial face of the carbide tip, using a diamond wheel, either type D11V9 (D11B) flaring cup or D15A2 (D15W) dish wheel. Complete wheel marking: SD150-R100B$\frac{1}{16}$.

Hand Scrapers

Properly ground carbide-tipped hand scrapers will last from two to three hours between resharpenings as against 20 to 30 minutes for steel scrapers. They require no hand stoning and the sharpening operation on a diamond wheel should take less than a minute. This regrinding operation, however, is important. In order to obtain maximum service from carbide scrapers, it is essential that the cutting edges be keen and ground to the proper radius and angle.

Typical carbide tips for scrapers measure $\frac{3}{32}$ x $\frac{1}{4}$ x 1″. These are butt brazed to high carbon steel shanks and then ground to the same width and thickness as the shank. This operation can be done offhand either on a 60 grit Crystolon wheel as used for rough grinding carbide single-point tools, or on a 100 grit diamond wheel.

The radius on the end of the scraper might vary from 10″ to 20″ depending upon the hardness of the material being scraped. For the harder materials, a smaller radius generally works better. Simultaneously with grinding the radius, the cutting edges are beveled 3° to 5° toward the middle of the tip. Both bevels should be of the same length.

To facilitate their resharpening, Norton Company designed for its own use a simple fixture, shown on page 165, which accurately controls the radius and cutting angles. The guides and bearing points are carbide-tipped for minimum wear.

The fixture is clamped to the tool rest table of a standard 6″ carbide tool grinder designed to use diamond wheels. The table is tilted upward the same number of degrees as desired on the beveled cutting edges.

In using the fixture, the operator simply holds the scraper firmly on the holder with one hand while swiveling it slowly back and forth across the diamond wheel with the other hand.

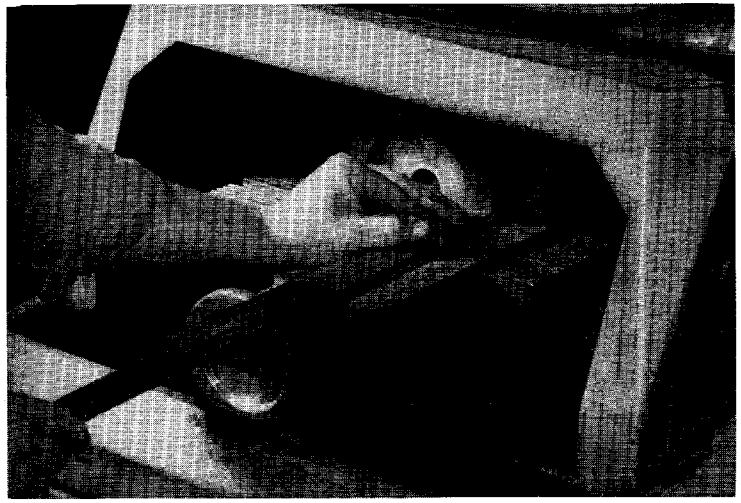
For best work, carbide-tipped scrapers must have keen cutting edges. Nothing coarser than a 220 or 320 grit diamond wheel should be used. A 320 grit vitrified bonded diamond wheel, as used for finish grinding carbide single-point tools, has been found entirely satisfactory for this exacting operation. Complete wheel marking: SD320-R50V$\frac{1}{16}$.

Masonry Drills

Carbide-tipped masonry drills have become popular with electricians, steam fitters, general contractors and maintenance crews in industrial plants for drilling holes in concrete, brick, marble, slate, tile, etc. Like any cutting tool, they should be touched up on a grinding wheel occasionally in order to cut with maximum efficiency. On an ordinary benchstand grinder mounting 5″ or 6″ diameter wheels and equipped with a suitable tool rest and properly selected abrasive wheels, this resharpening operation, as a rule, is a matter of only a few minutes.

While the steel shank below the carbide tip may also have to be ground back, the grinding wheel should be selected for the carbide and, as such, should be of Crystolon abrasive, about 80 grit and soft grade, such as J. Complete wheel marking: 39C80-J8VK. This wheel will also grind the shank steel.

Carbide masonry drills can also be reground on standard 6″ carbide tool grinders designed to mount a diamond cup



Resharpening a carbide-tipped scraper bit on a wet carbide tool grinder

wheel for finish grinding. Where this type of equipment is available, a superior cutting edge can be obtained on the carbide tip by finish grinding it on a 120 grit diamond wheel. The steel shank should be backed off first on a Crystolon wheel so that the finish grind with the diamond wheel will be on the carbide tip only.

Care should be taken to duplicate the original grind on the drill, keeping the point as nearly central as possible; otherwise it will cut an oversize hole and tend to lead off. The included angle at the tip should be approximately 118° and the cutting edges backed off at an angle of about 10°. When grinding, remember to keep the tool moving constantly back and forth across the face of the wheel, using relatively light pressure and dressing the Crystolon wheel with a star dresser at the first

signs of glazing or dulling. Never dip the point of the drill in water in order to cool it rapidly as this will crack the tip.

Larger type carbide-tipped drills, which may be used for drilling rock, can be resharpened on standard 10″ and 14″ carbide tool grinders. For rough grinding, as in the case of chipped or broken drills, a 60 grit Crystolon cup wheel, 39C60-I8VK or 39C60-H8VKP, is recommended. For finish grinding, and for touching up dull drills, a 100 grit Crystolon wheel, 39C100-H8VK, will be found satisfactory.

For touching up the drills on the job between regrinds, a 320 grit vitrified bonded diamond hand hone in the popular size, ¼ x $\frac{7}{16}$ x 4″, type DH1, is recommended. Complete marking: D320-V$\frac{1}{16}$.

Should it become necessary to cylindrically grind the steel shank of these larger rock drills, use an Alundum vitrified wheel, A54-L5VBE.

Lamination Dies

Carbide lamination dies have recently been developed for stamping out such parts as rotor laminations for small electric motors, transformer cores, etc. In a typical lamination (progressive) die, solid cemented carbide is used for all the operations, including cutting-off the stock, and all pilot pins are made of solid carbide for sustaining accuracy.

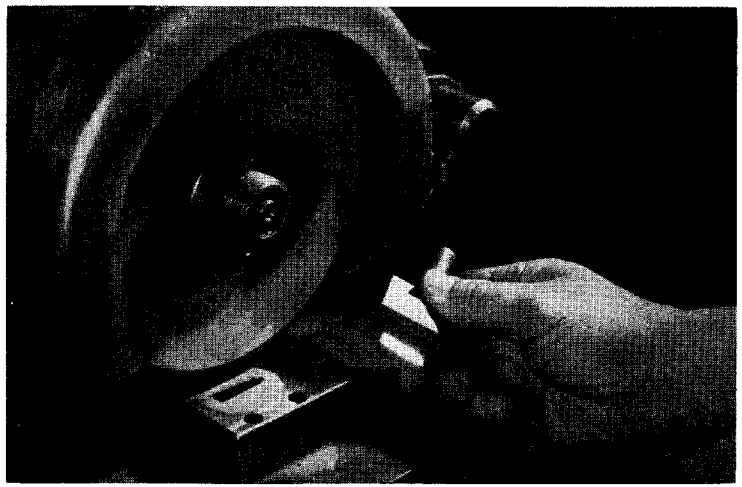
As might be expected, these carbide dies are capable of tremendous production between sharpenings, running, in some cases, beyond the half-million mark. Eventually, however, the cutting edges of the punch and die will have worn to the point where both must be resharpened. Only diamond wheels should be considered for this important surface grinding operation, and in order to insure both a fine surface finish and accuracy with respect to flatness, a relatively fine grit diamond wheel

such as #220 resinoid or #320 vitrified bonded, should be used. Complete wheel marking: SD220-N100B$\frac{1}{16}$ or SD320-L100V⅛.

The size of the die will, of course, govern the choice of the grinding machine. Such dies as are used for stamping small rotor and transformer laminations can be handled on a small reciprocating table type of surface grinder like the Norton 6 x 18″, mounting 7 x ¼″ or ½″ thick diamond wheels.

The machine should be equipped for wet grinding in order to obtain the best performance and economy from the diamond wheel. The depth of cut with a 220 or 320 grit diamond wheel should not exceed .0003″ per pass, combined with a moderately fast table speed and about $\frac{1}{16}$″ rate of cross feed.

In the event an appreciable amount of carbide must be ground, as in reconditioning a chipped or broken die, a coarser grit, faster cutting diamond wheel such as SD100-N100B$\frac{1}{16}$ or



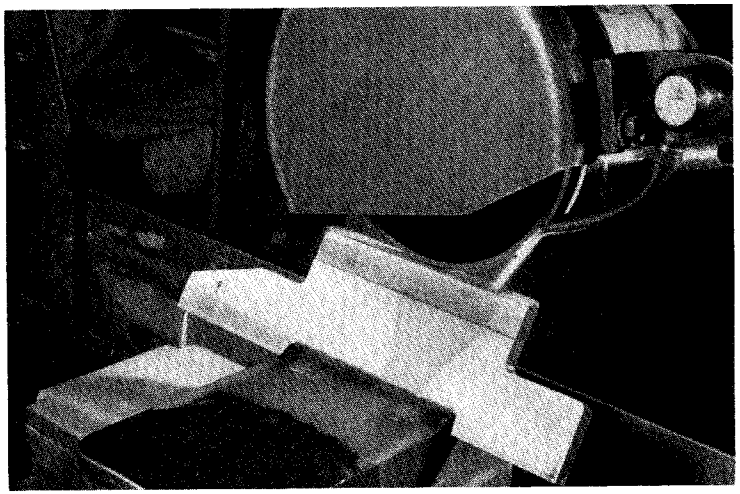
Setup for sharpening a carbide lamination die on a surface grinder, using a 220 grit diamond wheel

SD100-L100V1/8, should first be used for rapid rough grinding, followed by the finer grit finishing wheel.

Centerless Grinder Work Rest Blades

The wear resisting properties of cemented carbide are utilized in carbide-tipped work rest blades for centerless grinders. While they are capable of extremely long life between regrinds, the user is ultimately confronted with the problem of resurfacing them to restore the original smoothness and accuracy.

The blades can be reground on a small reciprocating table type of surface grinder equipped with a straight diamond wheel, 1/4" to 1/2" in thickness. It is desirable to have a fine surface finish on the carbide insert and, accordingly, a relatively fine grit diamond wheel such as 220 grit resinoid or 320 grit vitrified bonded should be used. Complete wheel marking: SD220-N100B$\frac{1}{16}$ or SD320-L100V1/8.



Resurfacing a carbide-tipped centerless grinder work rest blade, using a 220 grit diamond wheel

The depth of cut should not be more than a few ten thousandths of an inch per pass and on the finishing passes the cut should be allowed to sound out (spark out). If the grinding machine is not equipped for wet grinding, lubricate the diamond wheel face with a mixture of kerosene and spindle oil applied with a small brush or felt wick.

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