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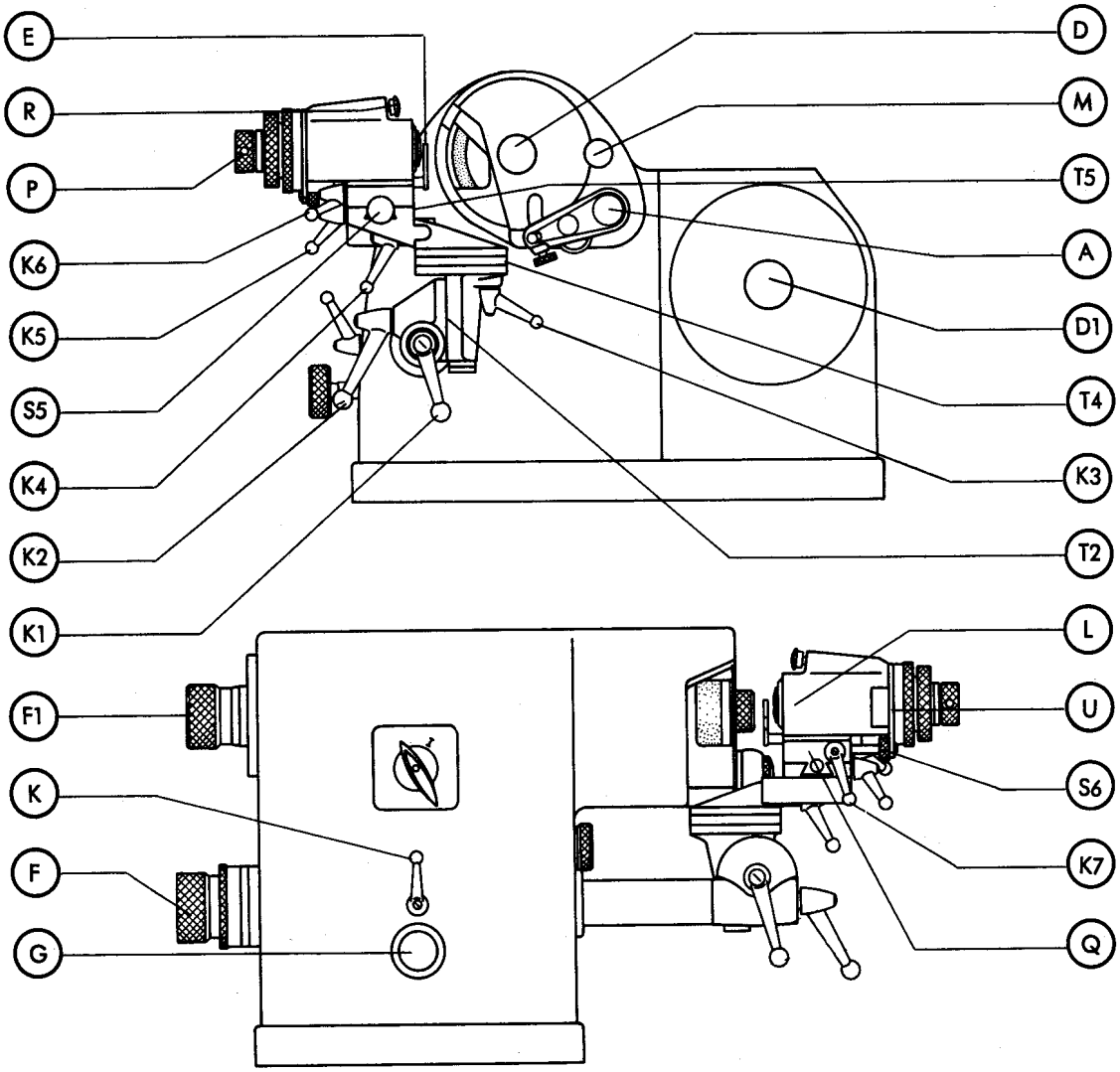
SOE

THIS OPERATOR'S MANUAL BELONGS TO MACHINE NO. .....

FEINMECHANIK GMBH

812 Weilheim · Germany

Nomenclature of Controls



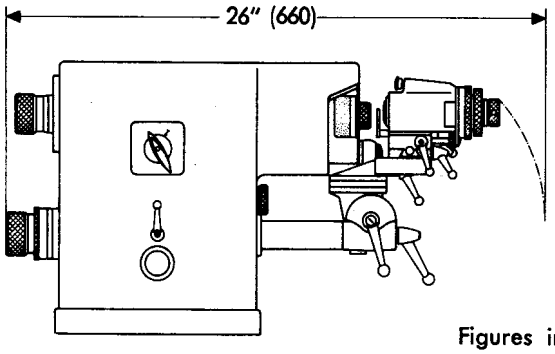
E Cutter lip aligning gauge
R Spring collet index pin
P Draw-in screw for spring collets
K6 Index head slide clamping lever
K5 Cross slide clamping lever
S5 Cross slide fine adjustment screw
K4 Scale drum T4 clamping lever
K2 Setting scale T2 clamping lever
K1 Clamp for index head bracket coarse adjustment
F1 Grinding wheel fine feed screw
K Tubular guide clamping lever
F Index head bracket fine adjustment screw
G Adjustable stop screw

D Knob for grinding wheel guard
M Nut for grinding wheel guard
T5 Cross slide vernier scale
A Wheel dressing attachment with eccentric stop
D1 Dust exhaust knob
T4 Horizontal swivel mount index drum
K3 Horizontal swivel arm clamping lever
T2 Relief grinding setting scale
L Index head slide
U Red dot window
S6 Index head slide fine adjustment screw
K7 Clamp for index head slide fine adjustment
Q Cross slide

For convenient reference, a fold-out copy of this sheet is provided at the end of this manual.

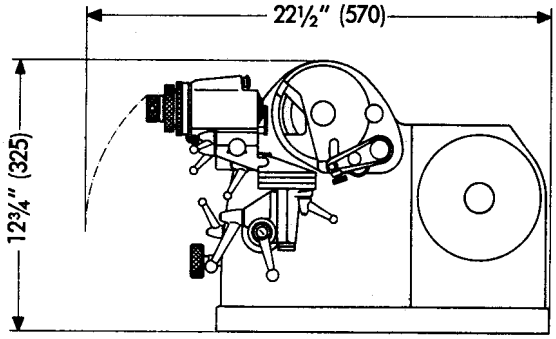
Dimensions – Specification

SOE

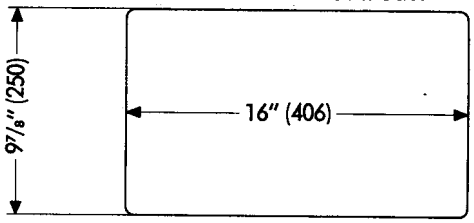


Operator's side

Figures in parantheses are mm-values.

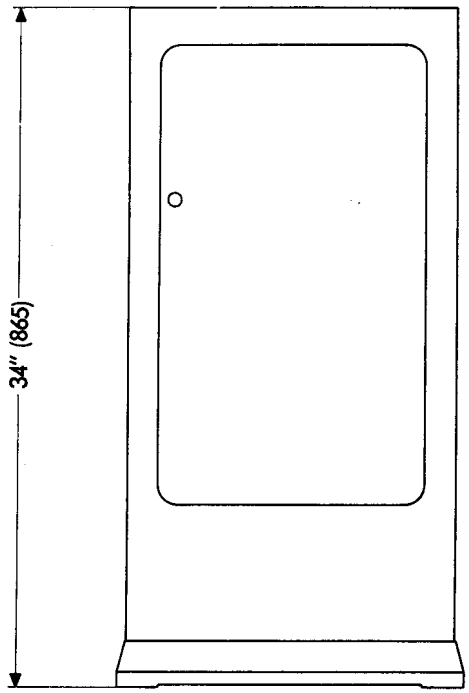


Base area of bench model

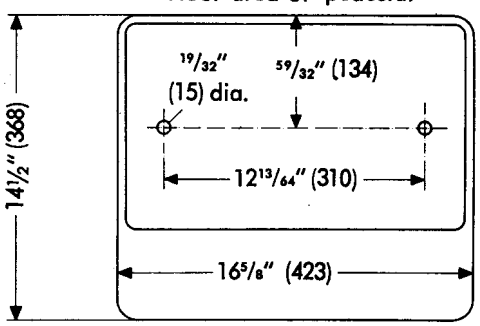


Motor capacity	.74 hp	.55 kw
Motor speed		2800 rpm
Spindle speed		4500 rpm
Max. collet capacity	⅝"	17.5 mm
Internal tapers of adapter sleeves	M.T. 1 — M.T. 2 — GA	
Max. radius ground	.4"	10 mm
Max. lateral traverse of index head, to both sides	.4"	10 mm
Max. longitudinal traverse of index head	1.57"	40 mm
Max. relief angle		45°
Coarse adjustment of index head bracket in tubular guide	4"	100 mm
Max. fine adjustment of index head bracket parallel to spindle axis	.6"	15 mm
Number of index plate registers		12
Length x width x height	26" x 22½" x 12¾"	
	660 x 570 x 325 mm	
Net weight of bench model	143 lb	65 kg
Net weight of pedestal model	276 lb	125 kg
Weight of bench model, boxed	198 lb	90 kg
Weight of pedestal model, boxed	370 lb	168 kg
Box dimensions, bench model	25½" x 21¾" x 20"	
	65 x 55 x 50 cm	
Box dimensions, pedestal model	55¼" x 21¾" x 21¾"	
	140 x 55 x 55 cm	

Pedestal



Floor area of pedestal



The weight of the SOE bench model permits grinding without securing the machine by bolts, provided that a level mounting surface is available. It is advisable to place the machine on a rubber pad of approx. .2" (5 mm) thickness.

Use suitable wedges for installing the pedestal model, in order to eliminate detrimental vibration. Bolting the pedestal to a poured base will provide added stability.

Electric Connection – Pedestal

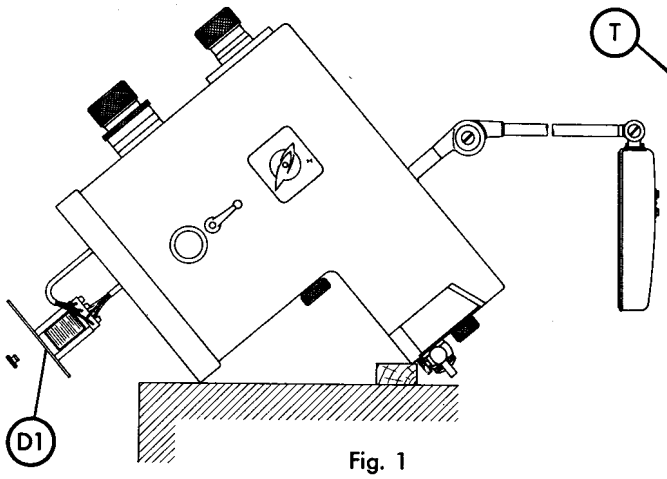


Fig. 1

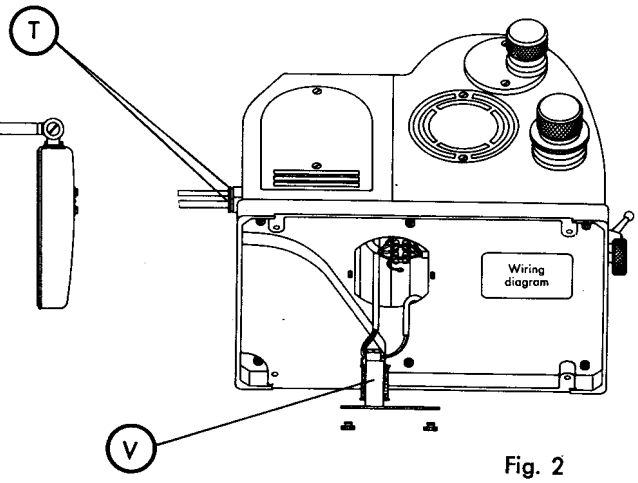


Fig. 2

Electric connection

Tilt the SOE table model near the edge of a table as shown in Figs. 1 & 2, supporting it by a wood block at the rear. Remove cover D1, introduce the cables for power and lighting current separately through cable conduits T and connect to terminals as indicated in the wiring diagram.

On the pedestal model (Fig. 3), indroduce the lead cable into the pedestal, remove lowermost wooden shelf and connect the cable to the terminal strip in the fuse box as indicated in the wiring diagram.

The fluorescent-tube lamp, if supplied with the machine, is wired ready for use including the necessary ballast V (Figs. 1 & 2).

Pedestal

The welded all-steel pedestal is mounted on an amply dimensioned base plate and permits installation of the machine independent of work benches or wall brackets. All controls are at a level most convenient for the operator.

The interior, accessible through a door with safety lock, is provided with wooden shelves for storing all the accessories and special attachments. The door is fitted with a bracket for convenient storage of spring collets. In addition, the pedestal will accommodate the measuring projector which is fitted with a cable for electric connection to the machine.

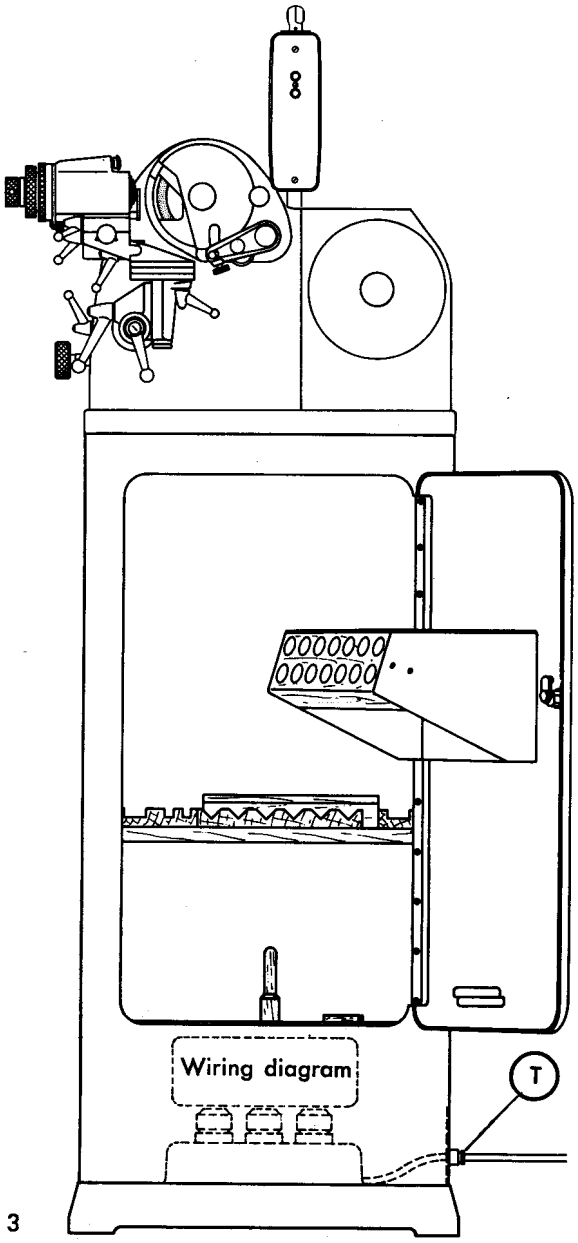
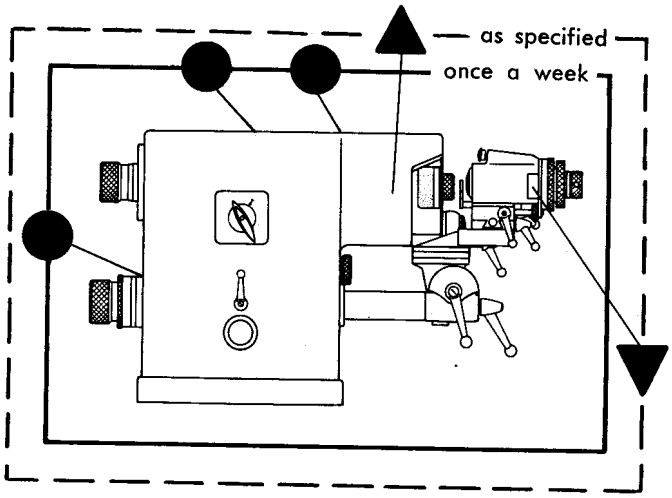


Fig. 3

Lubrication and Maintenance Schedule
Removing the Spindle – Changing the Wheel

SOE

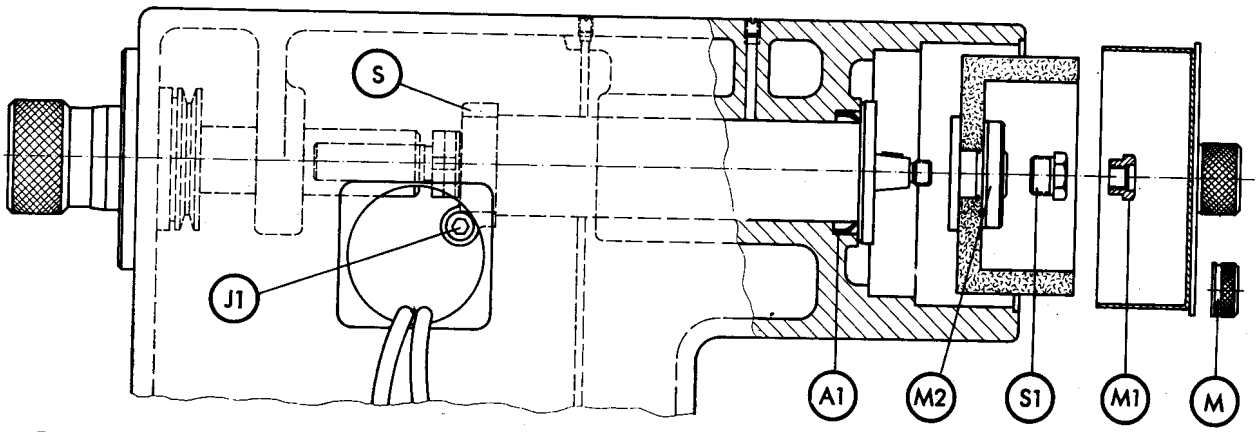


Recommended Lubricants		
Specification	Grade	Symbol
Bearing oil	4.5° Engler (35 cst) at 50° C (122° F)	●
Special spindle bearing grease	ISOFLEX SUPER TEL	▲
Spindle oil	1.2to 2° Engler (3 to 12 cst) at 50° C(122°F)	▼

The intervals specified apply to single-shift operation.

Lubricating point No. 5 is supplied with grease at the factory (see page 8).

Interval	No.	Machine Part	Quantity	Remarks	For details see
1 week	1	Bearing of index head bracket adjustment	approx. 1/3 cu. in. (5 cc)	Use oil can	
1 week	2				
1 week	3	Spindle seat	approx. 1/3 cu. in. (5 cc)	Use oil can	
See instructions	4	Index head spindle bearing			page 6
See instructions	5	Spindle			page 8



Removing the grinding spindle assembly

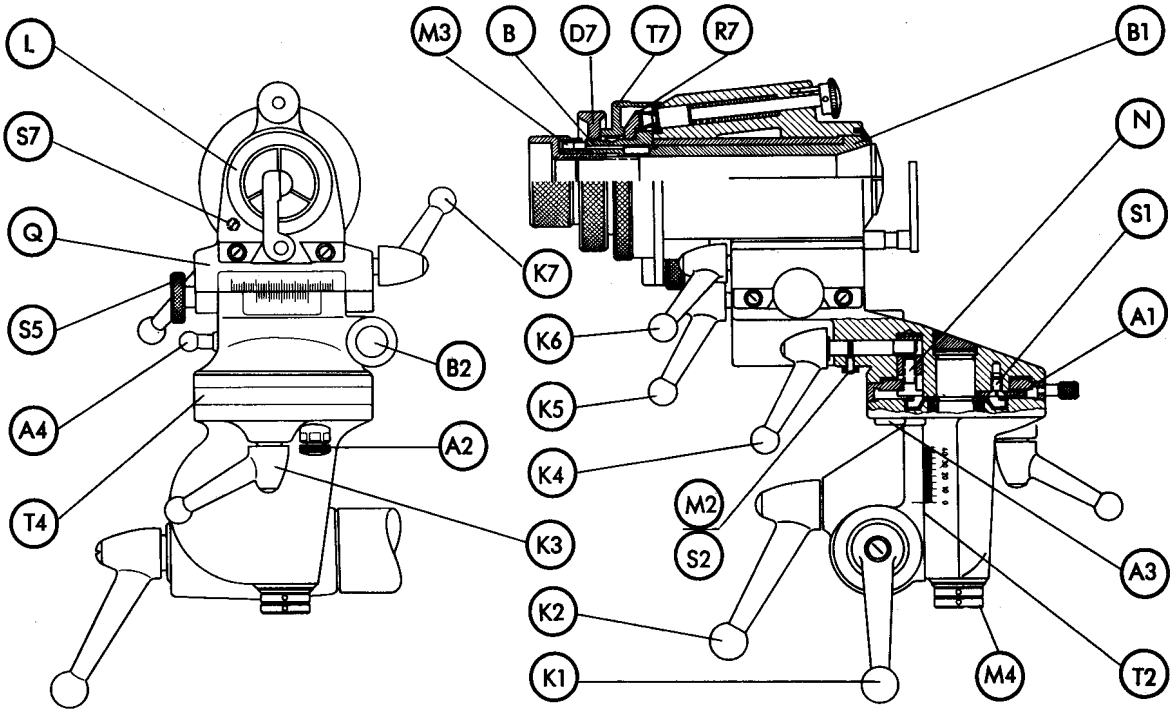
1. Move spindle assembly into its left-hand end position.
2. Screw off switch and remove from its seat without disconnecting the cable.
3. Through the opening thus provided, back off clamping screw J1 for spindle nut S.
4. Remove knurled nut M, take off wheel guard, and pull out spindle assembly. It is adsivable to leave the wheel on the spindle.

When re-installing the spindle, take care not to damage the lip of scraper ring A1 and to insert the rear end of the spindle smoothly into the coupling sleeve (see Fig. 1 on page 8). Do not retighten clamping screw J1 until the spindle has firmly engaged its seat in the spindle nut.

Changing the grinding wheel

The ginding wheel is attached to a wheel mount fitted to the tapered spindle nose and secured by means of nut M1. To remove the wheel mount, fit nut S1 and advance the nut until the mount is forced off the spindle nose. Watch for the position of the key when refitting the wheel mount. To ensure vibration-free operation of the machine, loosen nut M2 and adjust the grinding wheel until it rotates without unbalance.

Servicing the Index Head Bracket



To maintain the accuracy of the machine, all moving parts of the index head bracket should be dismantled, thoroughly cleaned and properly lubricated after a major period of use.

Lubricating the index head spindle
Remove thrust ring D7, scale drum T7 and index ring R7, screw off oiling screw S7 and lubricate through tapped hole, using the spindle oil specified on page 5. To re-assemble the parts, reverse the above procedure.

Dismantling the index head spindle
To remove index spindle B1, take off thrust ring D 7, scale drum T7 and index ring R7, remove the two nuts M3 and pull out index ring bearing sleeve B. Clean all parts thoroughly before re-assembly and use nut M3 for play-free adjustment of the spindle.

Servicing the slide ways
Release clamping lever K6 and screw off clamping lever K7 to remove the index head slide L. Clean the guide way surfaces, smear lightly with oil and wipe dry. Cross slide Q cannot be removed. Release clamp K5 and turn knurled screw S5 to move the cross slide to its extreme positions. Clean the bearing surfaces, smear lightly with oil and wipe dry.

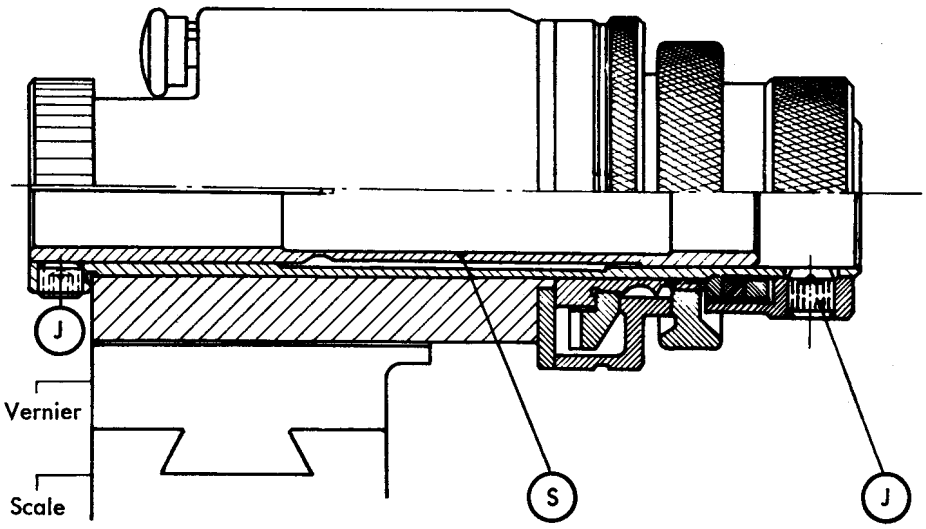
Dismantling and servicing the swivel arm
Remove the two nuts M4 and clamping lever K3 and pull the swivel arm out of its needle roller bearing seat. Clean bearing surfaces and apply a thin oil film. Clean all parts thoroughly before re-assembly and use nuts M4 for play-free adjustment of the bearings.

Adjusting the clamping mechanism of scale drum T4
If, after a major period of use, clamping lever K4 no longer locks the swivel arm scale drum T4, screw N will require adjustment. Proceed as follows: Remove the swivel arm as described above, remove screw S1 and stop plate A1, back off nut M2 and screw S2, and pull out clamping lever K4. Lift off scale drum T4 and pull out adjusting nut with screw N. Rotate the screw 180° relative to the nut to reduce the lengh, and then re-assemble the parts, reversing the above procedure.

Adjusting the stop for the 90° swivel motion
If, due to constant striking of stop plate A1 against stop pins A2 and A3, the swivel range should no longer be exactly 90°, re-adjust by turning the two eccentric stop pins A2 and A3. Adjustment of stop pin A2 will change the cylindrical setting of the index head spindle, while turning of stop pin 3 will adjust the 90° swivel motion..

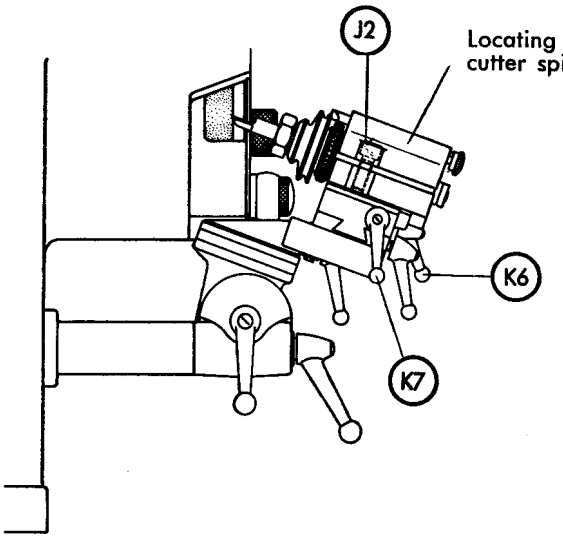
Special Index Head
Locating Fixture for Cutter Spindle Assembly

SOE



A special index head is available for receiving cylindrical-shank cutters of 3/4" or 1" diameter or M.T. 1, M.T. 2, or M.T. 3 taper shank cutters.

Except for cylindrical-shank cutters of 1" diameter, which are mounted direct in the index head, a clamping sleeve or taper sleeve (S), respectively, is interposed for locating the cutters. The head is provided with 2 hexagon socket screws at the front and 2 at the rear (J) for clamping the cutters as required.



The spindle assembly locating fixture permits sharpening of single-lip cutters while being held in the cutter spindle assembly of the milling machine. For this purpose, loosen clamping levers K6 and K7, remove the index head slide L from its bracket, and insert the locating fixture into the V-guide of the index head bracket.

For grinding operations insert the spindle assembly with the cutter into the slotted locating fixture and clamp by means of hexagon socket head screw J2. The index pin engages one of the notches provided on the cord pulley of the spindle assembly.

Exchanging the index heads may cause an eccentricity which should be determined as follows:
Set the scale of the cross slide at zero, mount an arbor "a" on the standard index head and bring the arbor into light contact with the grinding wheel.

Now exchange index heads and, depending on thetype of sleeve used, mount an arbor "A" on the special index head. (The same procedure applies if the locating fixture for the cutter spindle assembly is mounted instead of the standard index head.)

Again adjust the cross slide until arbor "A" is inlight contact with the grinding wheel.
The value which is read above or below dimension "X" (see formula below) on the scale of the cross slide is the desired amount of eccentricity. It must be taken into account in all settings made with the special index head or the locating fixture.

$$\text{Dimension "X"} = \frac{A - a}{2}$$

Grinding Spindle
Tensioning and Changing the V-belt

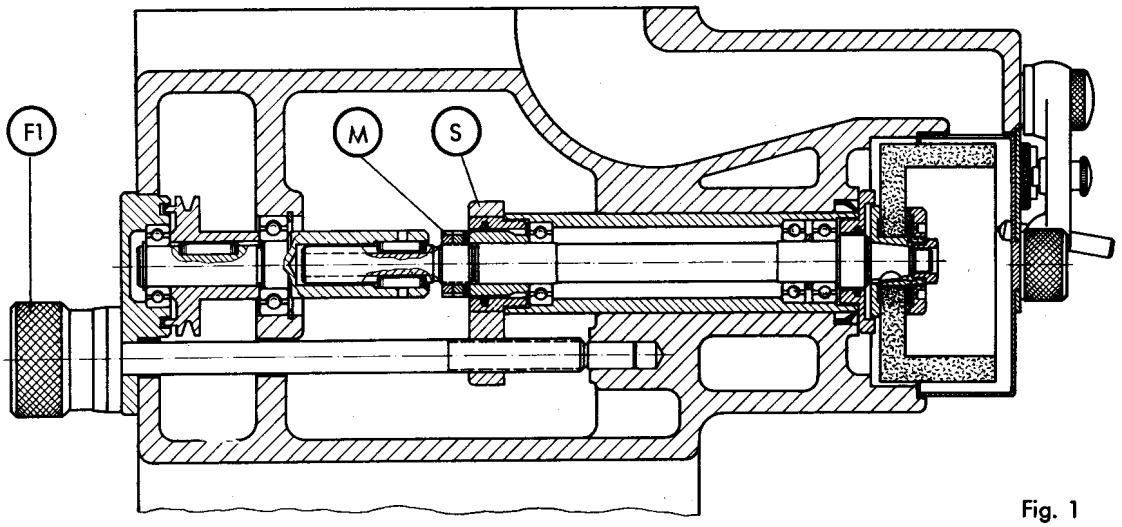


Fig. 1

The grinding spindle is factory-supplied with an ample quantity of grease for approx. 3000 hours of operation. After this period, remove and dismantle the spindle as described on page 5. Clean all parts with pure, filtered petrol (gasoline) or benzene, to which a small quantity of "ISOFLEX SUPER TEL" has been added, and lubricate by applying a thin coat of "ISOFLEX SUPER TEL" special bearing grease.

The spindle bearing has been factory-adjusted to exclude play while allowing for a free-running spindle. In the event some play develops in the course of time, remove the spindle assembly and adjust by advancing the two nuts M, making sure that the spindle runs freely. Excessive tightening of the nuts will result in bearing failure.

Tensioning the belt
The spindle drive V-belt can be easily tensioned by loosening and retightening the hexagon socket head screw provided on the left-hand side of the machine and accessible from the outside.

Changing the belt
CAUTION: Do not remove the spindle assembly when changing the V-belt, since otherwise the spindle nut S would fall into the housing and the machine would have to be dismantled.

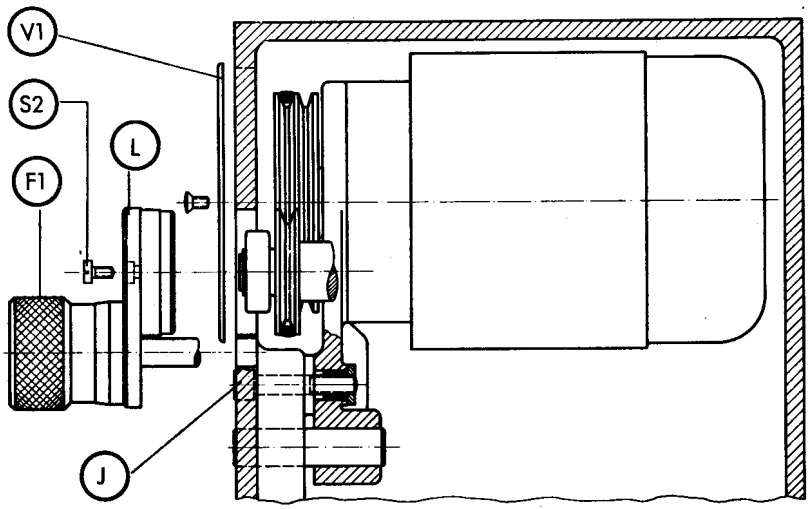


Fig. 2

To change the V-belt, proceed as follows:

1. Take off over V1 after removing screws.
2. Slide old V-belt off motor pulley.
3. Move grinding spindle into its right-hand end position and remove screws S2. Screw bearing flange L out of its seat by means of knurled knob F1 and remove flange assembly.
4. Through the opening now accessible, take out the old belt and fit new belt to spindle pulley.
5. Screw bearing flange L back into its seat and secure by screws S2.
6. Loosen screw J and lift the motor to fit the belt to the motor pulley, then tension belt by dead weight of motor and retighten screw J. Refit cover V1.

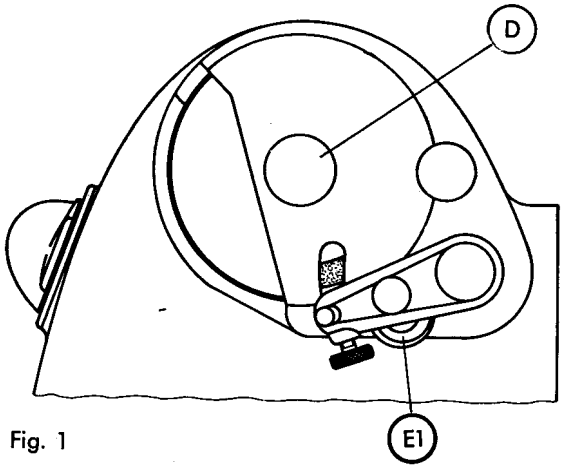


Fig. 1

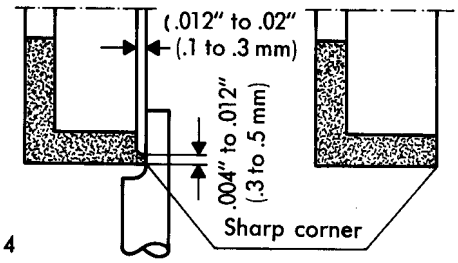
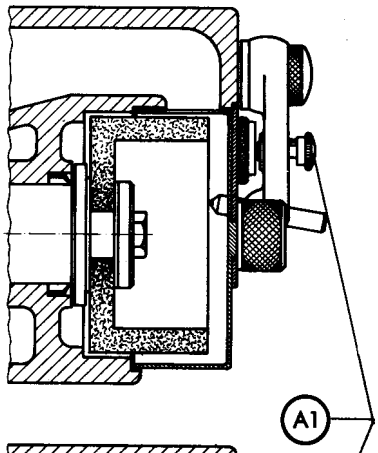


Fig. 4

Fig. 2



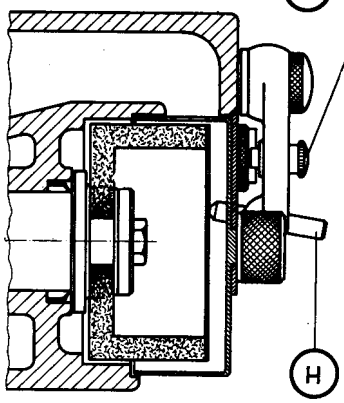


Fig. 3

Dressing the grinding wheel

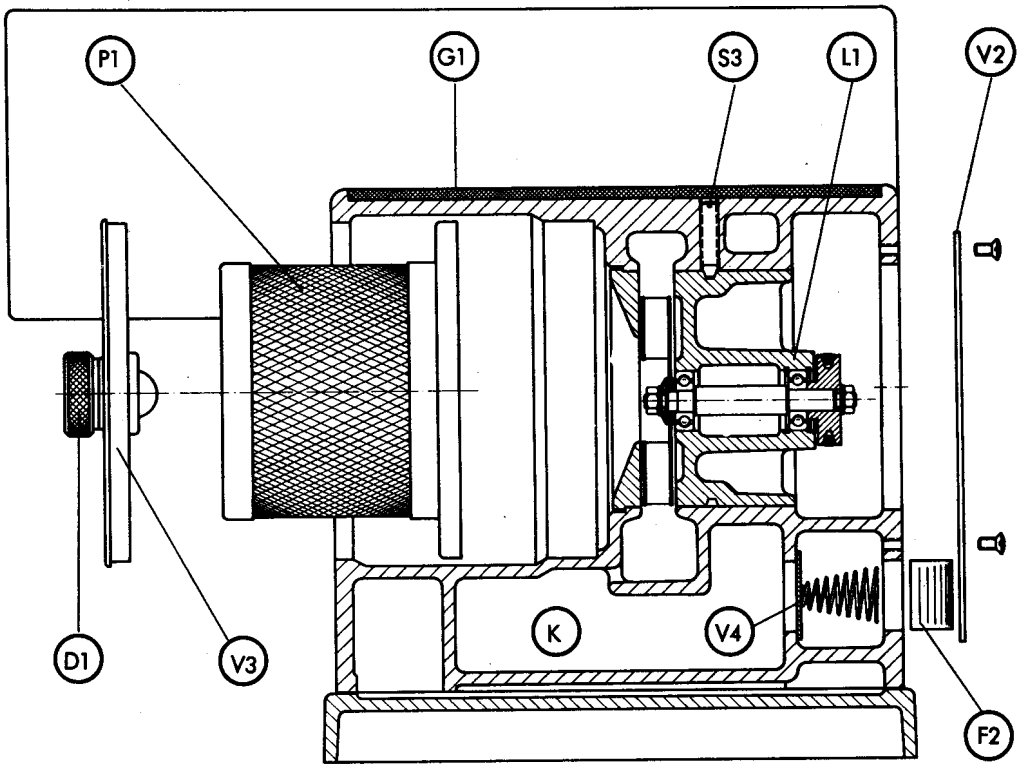
The grinding wheel should be dressed from time to time, especially when the wheel has become loaded with grinding dust or when the sharp corner has been worn off. Failure to dress the wheel in good time will result in poor surface finish and overheating of the cutters.

Rotate the wheel guard into closed position by means of knob "D" for dessing, otherwise the diamond cannot be brought into contact with the wheel. This arrangement prevents wheel dressing with the guard open.

The dressing diamond is mounted on an axially adjustable holder carried by a swivel arm which can be moved about a horizontal pivot pin on the face side of the machine. An knurled knob F1 (see drawings on pages 2 & 8) is provided to feed the wheel towardthe diamond by a graduated scale, the advantage being that the wheel will always remain in the same position relative to the cutter being ground. Initial setting when a new grinding wheel is used: move wheel into its left-hand end position and clamp the diamond holder with the point of the diamond contacting the wheel face. The holder is arranged at an angle relative to the wheel and should occasionally be turned about its axis to use sharp edges or points of the diamond for dressing. When centering the lip surface of a single-lip cutter it is necessary to relieve the wheel face except for a narrow rim portion (Fig. 4) to avoid detrimental overheating of the cutter. This can be accomplished with the aid of the rotatably mounted eccentric disc E1 which cooperates with push-out stop pin A1. Once selected, the width of the rim is maintained until the wheel is used up. The depth of the recessed portion can be adjusted by means of the scale associated with knob F1. After relieving the wheel face, retract the wheel and dress the rim portion once again in starting position to ensure that the active wheel face is in correct position relative to the cutter being ground.

Remove the rim portion prior to finish grinding of the cutter. To do so, retract stop pin A1 from engaged position: the diamond can now be guided across the entire face of the grinding wheel, down to its lower rest position.

Dust Exhaust Unit



Dust exhaust unit

The SOE has an integral dust exhaust unit with a blower connected to the drive motor of the machine by a V-belt. Through windows provided on the housing-like wheel guard, the dust-laden air is sucked from the grinding or dressing point into a short duct and from there into the filter compartment, then forced through a subsequently arranged, dry fine filter and discharged. Heavy dust particles will be deposited in the filter compartment ahead of the filter element, while the fine particles are held back by the filter element and the dry filter behind it. The capacity of the unit is such that up to three grinding wheels can be used up before the filters require cleaning. To dismantle and clean the filters, proceed as follows:

1. Remove cover V3 from its seat by turning knob D1.
2. Take off filter element P1.
3. Remove loose dust from out of the filter compartment and from the filter element. Then wasch element thoroughly in "PRURINOL" or hot soda water, allow to dry, and wet with DELBAG "VISCINOL A 30" air filter wetting agent. (Apply agent to outer surface of filter element and blast with compressed air towards inside). It is advisable to use two filter elements alternatingly, in order to reduce down time to a minimum.
4. Re-insert filter element, push into position by means of cover V3 and clamp by eccentric quick-clamping arrangement.
5. Screw off cover V2, remove the fine filter on the left-hand side of the machine, wash in trichloroethylene and re-install.

If, after a major period of use, chamber K is filled with grinding dust, remove covers V2 and V4 to clean the compartment.

To tension the V-belt driving the blower, remove cover V2 and turn eccentric bearing housing L1 as required. To do so, first back off clamping screw S3 located underneath the rubber cover G1. Do not forget to retighten the screw after making the adjustment. For changing the belt it will be necessary to remove covers V1 (see lower drawing on page 8) and V2.

To ensure maximum efficiency of the dust exhaust unit, remember the following two points:

1. **Before starting the machine,** close the wheel guard by means of knob D to prevent loose grains on the wheel surface from flying off when the wheel starts rotating.
2. **During operations,** move the wheel guard to a position immediately adjacent to the cutter being ground, so that the grinding dust is sucked off effectively.

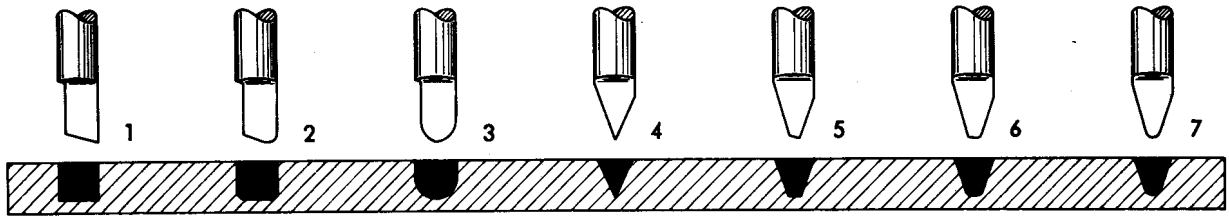
Instructions for Profile-Grinding of Single-lip Cutters without Measuring Projector

SOE

Single-lip Cutter Profiles
Tool Angles and Cutting Speeds

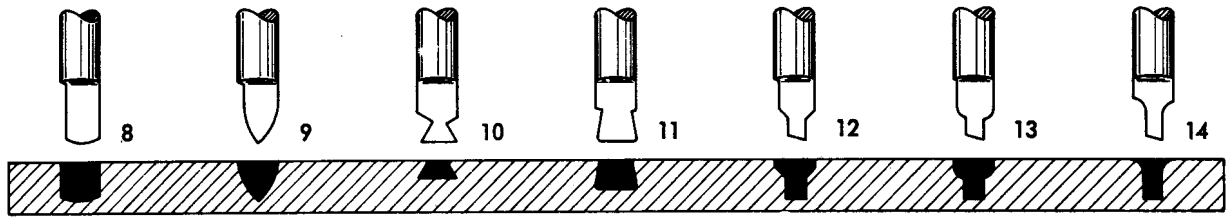
Cutter profiles

As a rule, single-lip cutters are given one of thefollowing seven basic profiles:

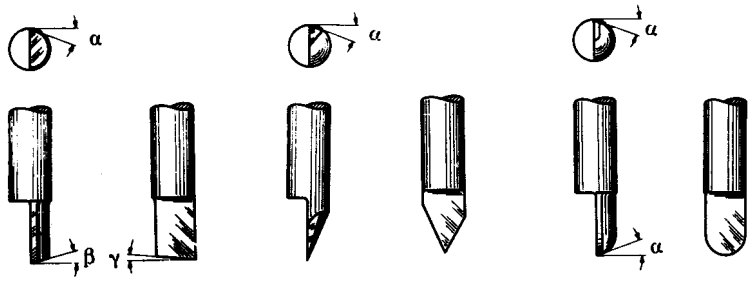


cylindrical, end-relieved | cylindrical, off-centre radius | cylindrical, rounded off | pointed | tapered, end-relieved | tapered, off-centre radius | tapered, rounded off

In addition, cutters may be ground to one of the following special forms:



crowned, rounded off | large radius, off-centre | dovetailed, sharp corners | dovetailed, rounded off | dog-point, tapered | dog point, off-centre radius | dog point, concave profile



End-relieved cutter | Pointed-end cutter | Rounded-off cutter

Tool angles and cutting speeds for single-lip cutters

Material to be cut		Tool Angles α	β	γ	Recomm'd cutting speeds for H.S.S. single-lip cutters roughing sfpm	m/min.	finishing sfpm	m/min.
Grey & mall. cast iron, cast steel		25°	15°	5°	195	60	260	80
Machinery steel, 57—85,000 psi (40 to 60 kg/mm²)					230	70	295	90
85—115,000 psi (60 to 80 kg/mm²)					195	60	230	70
over 115,000 psi (80 kg/mm²)					130	40	165	50
Tool steel	soft grade				195	60	260	80
	hard grade				165	50	230	70
Brass, 58/42	soft grade	30°	15°	5°	655	200	820	250
	hard grade				820	250	1150	350
Brass, 63/37	soft grade				395	120	490	150
	hard grade				490	150	590	180
Bronze	soft grade				525	160	655	200
	hard grade				655	200	755	230
Aluminium	soft grade	35°			655	200	985	300
	hart grade				820	250	1150	350
Wood					985	300	1150	350
Plastics: Trolon		25°	15°	5°	820	250	985	300
Pertinax, Fiber		35°			655	200	820	250
Pollopas, Resopal					655	200	985	300
Astralon, Celluloid, Plexi		45°	25°	20°	655	200	1150	350

Tool angles

Single-lip cutters, as all metal cutting tools, require an appropriate amount of cutting edge relief (back rake angle) for maximum stock removal and high surface finish. In principle, three angles (see left) must be taken into account, which apply to all cutter profiles.
Angle β is applicable to end-relieved cutters only. Cutters having an angle α of less than 20° should be relieved at between 25° and 30° (see special instructions).

Cutting speeds

The cutting speeds used for single-lip cutters should be three times higher than the speeds used for standard multi-point cutters. The data tabulated on the left should merely serve as a guide, since the values actually used will be dictated by the spindle speeds available on the machine. On end cutting edges, the cutting speed will decrease towards the cutter axis. Since this is of practical importance only on rounded-off cutters, care should be taken that stock is preferably removed by the outer portion of the cutting edge of such tools. Hence, when milling inclined surfaces, stock removal should take place in an upward rather than a downward direction.
When cutting soft aluminium, use kerosene as a coolant. When cutting celluloid, the cutter must always be in feed motion to avoid inflammation.

Centering the Cutter Lip by Grinding

SOE

Cylindrical single-lip milling cutters are supplied by the manufacturer with the lip preformed by rough milling (see Fig. 1). As a result, the cutter lip will first have to be accurately centered by grinding. Rough grinding of the lip is performed manually by holding the cutter against the circumference of the grinding wheel (see Fig. 2). This operation is followed by finish grinding in the machine. The off-center tolerance is ± .0004" (.01 mm), which should be checked with a micrometer caliper (see Fig. 3). To grind the cutter lip correctly, proceed as follows:

Setup Operations

1. Rotate swivel arm to set index drum T4 at zero, tighten clamping lever K3; set scale T2 at zero, tighten clamping lever K2 (Figs. 4 & 6).
2. Bring red dot into window U, insert index pin R into central hole (Fig. 5).
3. Align cutter by means of gauge E, clamp cutter in position, return aligning gauge E (Fig. 6).
4. Withdraw index pin R, rotate index head spindle 180°, allow index pin R to engage the central hole.
5. Release clamping lever K1; shift index head bracket in tubular guide to bring cutter lip into light contact with end face of grinding wheel; retighten clamp K1.

Centering the Cutter Lip

6. Fine adjustment screw F serves to set the index head accurately relative to the wheel and to provide the desired depth of cut. The travel of the cutter past the wheel can be limited by means of adjustable stop screw G. Thus it is possible, during grinding to advance the cutter as far as it will go. To bring the cutter lip within the prescribed off-center tolerance, reciprocate the index head bracket while advancing the cutter by rotating fine adjustment screw F.

   In order to prevent the cutter from being overheated, it is recommended to leave only a narrow cutting zone on the grinding wheel (see "Dressing the Grinding Wheel"). The length of the cutter lip should equal one and one-half times the diameter of the cutter.

   It is not advisable to increase the length of the cutter lip beyond a certain limit. In the case of deep engraving work where stepped cutters are used the shank of the cutter will be increased instead of the lip.

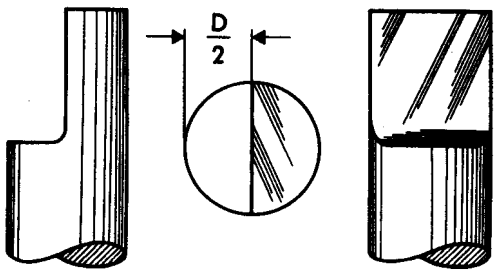


Fig. 1

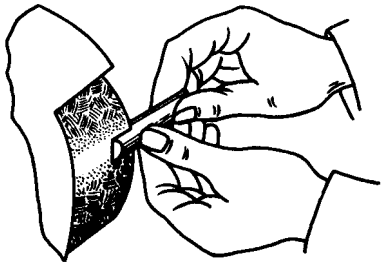


Fig. 2

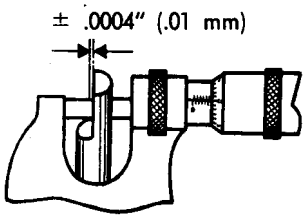


Fig. 3

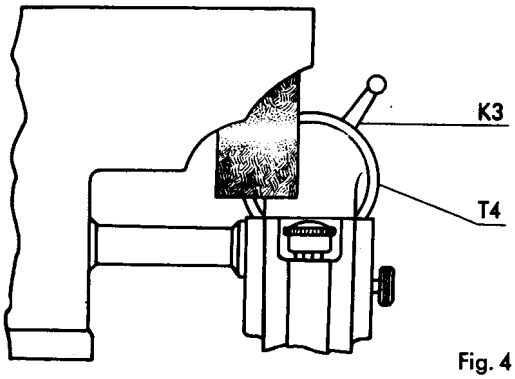


Fig. 4

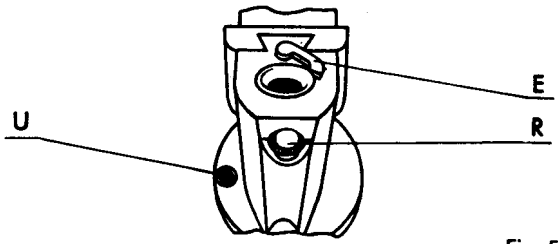


Fig. 5

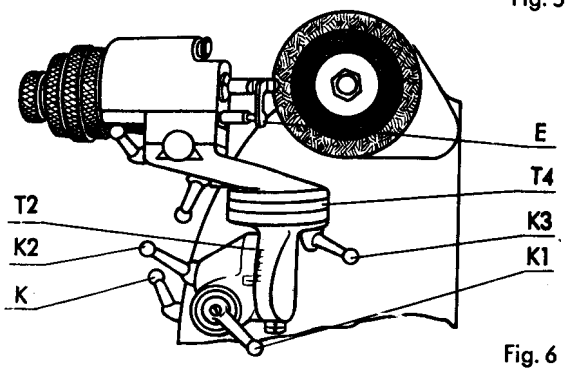


Fig. 6

Grinding Cylindrical-type Cutters

Circular Grinding and Relieving the Side Cutting Edges

After centering the cutter lip it will be necessary to grind the back rake angles of both the side cutting edge and the end cutting edge. The back rake angles of both cutting edges should be selected to suit the material to be cut (see table on page 12).
To grind the back rake angle of the side cutting edge of cylindrical cutters (Fig. 1), proceed as follows:

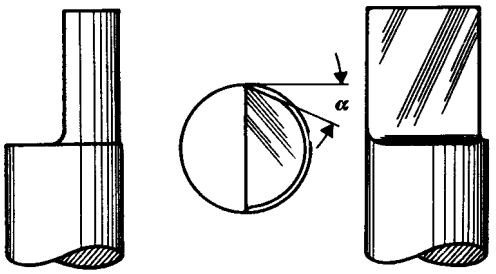


Fig. 1

Setup Operations

1. Rotate swivel arm to set index drum T4 at zero; tighten clamping lever K3.
2. Bring red dot into window U; insert index pin R into central hole.
3. Align cutter by means of gauge E; grip cutter in position; return gauge E (Fig. 2).
4. Release clamping lever K2; set swivel arm at desired back rake angle, using setting scale T2; tighten clamping lever K2 (Fig. 3).
5. Release clamping lever K1; shift index head bracket in tubular guide to bring cutter into light contact with end face of grinding wheel, retighten clamp K1.

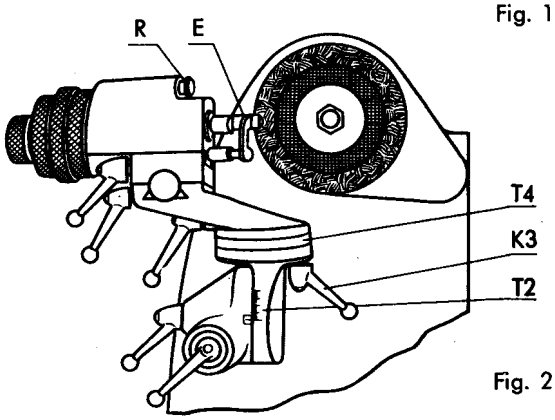


Fig. 2

Circular Grinding

6. Insert index pin R into right-hand hole; grind desired diameter by rotating index head spindle through 360°. During this operation slowly rotate adjustable stop screw G, while continuously rotating the index head spindle, to advance the index head bracket past the grinding wheel; this will produce uniform stock removal. Fine adjustment during circular grinding is by screw F. Stop screw G is used to establish the length of the cylindrical portion which should always be slightly longer than the cutting lip.

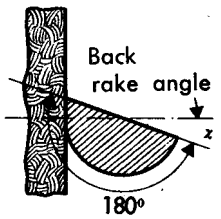


Fig. 3a

Setup Operations

7. Return red dot into window U; insert index pin R into left-hand hole to enable the index head spindle to be rotated 180° between the index plate stops.

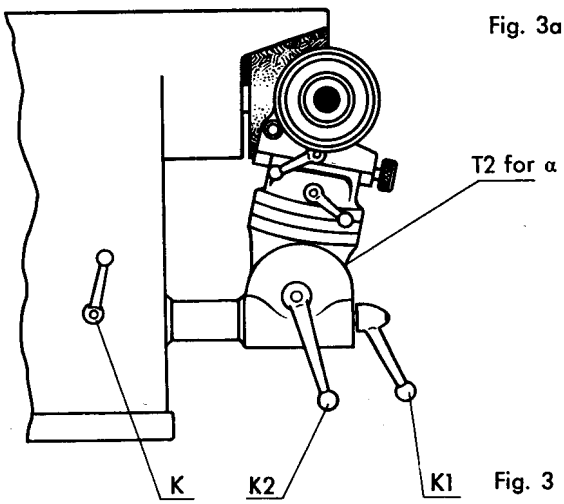


Fig. 3

Grinding the Back Rake Angle

8. When grinding the back rake angle, use the fine adjustment screw F over the entire range of rotation of the index head spindle (see Fig. 3a). Grinding of the back rake angle is positively controlled. The angle is required to extend over the entire length of the cutting lip.

   The vertical swivel bearing, which permits the index head bracket to be swung back, enables relief angles up to 40° to be produced. Relief angles over 40° can be obtained by additionally rotating the index head spindle in the index head. (Only for cylindrical or tapered cutters with straight end cutting edges or for pointed cutters.)

Upon completion of grinding operations a very narrow land must remain at the cutting edge (Fig. 4)

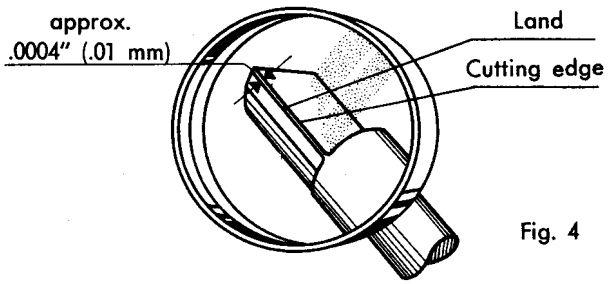


Fig. 4

Grinding Cylindrical-type Cutters

Relieving the End Cutting Edge (Straight)

SOE

The end cutting edge illustrated in Fig. 1 may be ground in an operation immediately following the grinding of the side cutting edge; or it may be ground independently. In the latter case the cutter will have to be aligned by means of gauge E and clamped in position. Whenever a single-lip cutter is to be ground, the aligning gauge will have to be used, as one leg of the cutting angle is formed by the cutting lip surface. The back rake angle should be selected to suit the material to be cut (see table on page 12).

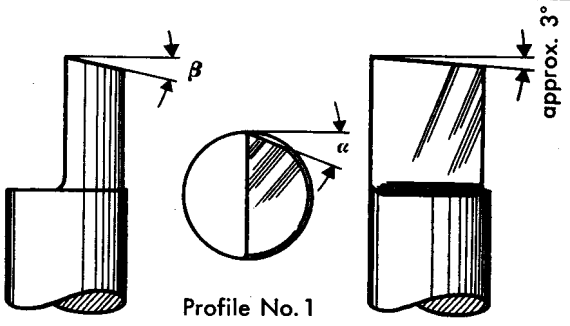


Fig. 1

Setup Operations

1. Insert index pin R into central hole; bring red dot into window U.
2. Release clamping lever K2; use setting scale T2 to set swivel arm at approx. 3°; tighten clamping lever K2.
3. Release clamping levers K3 and K4; hold index drum T4 against stop and, beginning at 90°-position, set swivel arm at desired angle; for example set arm at 75° for back rake angle of 15° (Figs. 2 and 3). Tighten clamping levers K3 and K4.
4. Release lever K1; shift index head bracket in tubular guide to bring cutter into light contact with end face of grinding wheel; retighten clamping lever K1.

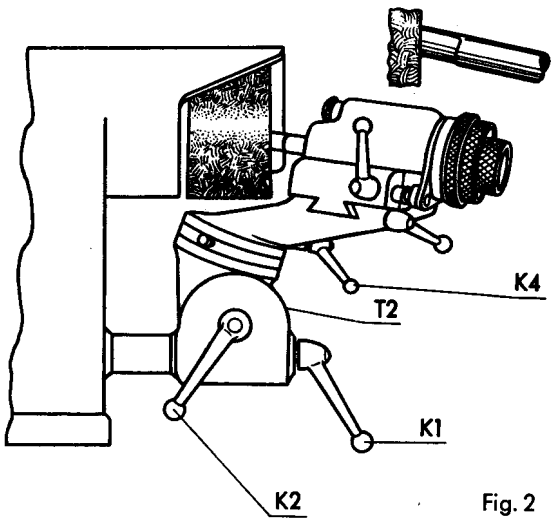


Fig. 2

Grinding the Back Rake Angle

5. Fine adjustment screw F serves to set the index head laterally relative to the wheel and to set the work for the desired depth of cut. — It is also possible to produce the desired back rake by holding the cutter against the circumference of the grinding wheel (Fig. 4), provided that the correct angle is obtained.

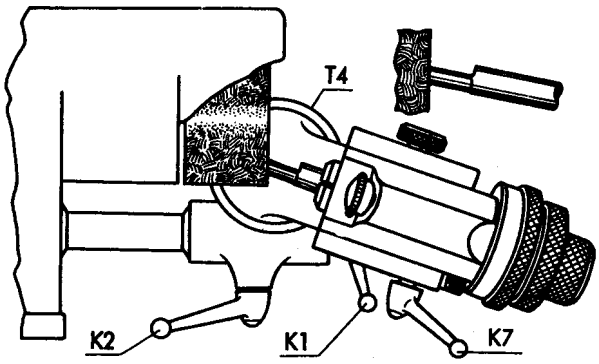


Fig. 3

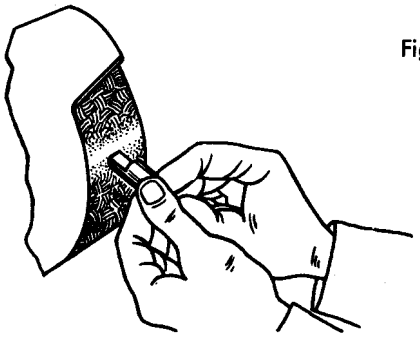


Fig. 4

Grinding Cylindrical-type Cutters

Relieving the End Cutting Edge (Round)

Cutter profiles having either on-center or off-center radii are derived from cylindrical single-lip cutters having a straight end cutting edge by rounding off the corners as shown in Fig. 1 (No. 2 and 3 profiles).
In rounded cutters of this type the back rake angle of the side cutting edge is the same as that of the end cutting edge. For this reason it is necessary, during grinding the end rake angle, that the index head bracket is set at the side rake angle by means of setting scale T2. If the end cutting edge is ground immediately after grinding the side cutting edge, it will not be necessary to re-set the index head bracket and to re-align the cutting lip by means of gauge E.

Setup Operations

1. Insert index pin R into left-hand hole; bring red dot into window U.

2.(a) Profile No. 2: Release clamping lever K5; rotate knurled knob S5 to set cross slide by means of vernier scale T5 for desired radius (to the right); tighten clamping lever K5 (Fig. 2). As the radiused corner is required to be tangent to the cutter diameter, the amount of offset "a" is: $\frac{D}{2} - r$.

Example:
Given r = .06" (1.5 mm); D = .30" (8 mm)
a = .15" (4 mm) — .06" (1.5 mm) = .09" (2.5 mm)

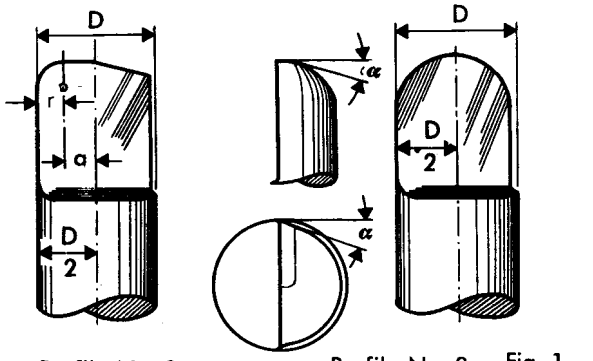
2.(b) Profile No. 3: The vernier scale T5 of the cross slide must be set at zero (Fig. 3).

3. Rotate fine adjustment screw F to bring the side cutting edge of the cutter into light contact with the face of the grinding wheel. Caution: Do not injure the land of the side cutting edge. Now screw F must no longer be rotated.

Grinding the Back Rake Angle

4. Swivel index head through 90° (Fig. 4). Depth of cut adjustment now is by index head slide L. Fine adjustment is by micrometer screw S6 of the index head slide with clamping lever K7 tightened. The end of the cutter is rounded by slowly swivelling the index head bracket back to its original position, while the index head spindle is continuously rotated back and forth between the stops, the rotation being through 180° (Figs. 5 and 6). Prior to grinding, be sure to withdraw the index head a slight amount by rotating screw S6, in order to prevent overheating of the cutter by excessive stock removal. After each pass of the grinding wheel the cutter is then fed towards the wheel by means of screw S6.

In order to obtain a satisfactory cutting edge it is advisable, as a final operation, to swivel the index head through 90° with the cutter lip pointing vertically upward. In cases where cutters given a No. 3 profile are intended for the machining of hard steel which requires a small back rake angle, it is good practice to flatten the curvature of the cutter by a manual grinding operation as shown in Fig. 7.



Profile No. 2 Profile No. 3 Fig. 1

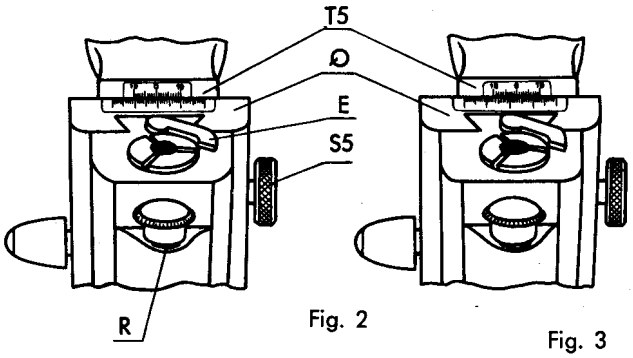


Fig. 2

Fig. 3

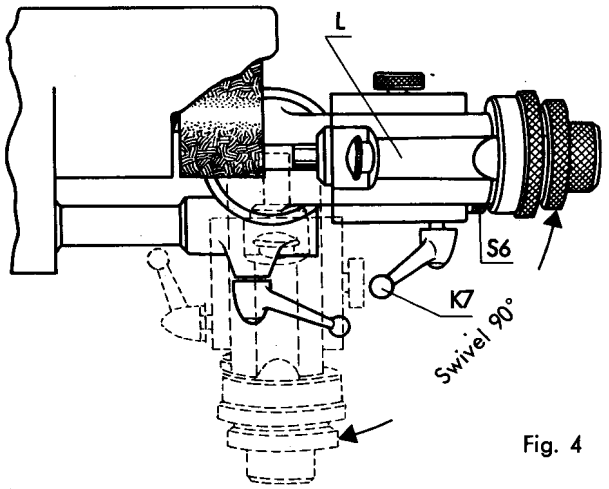


Fig. 4

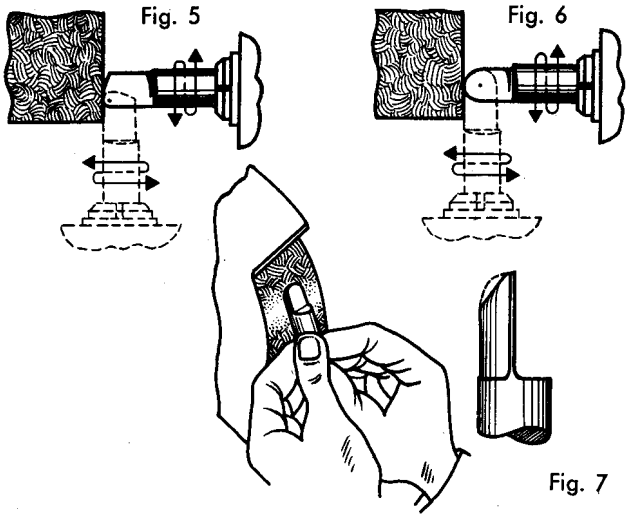


Fig. 5 Fig. 6

Fig. 7

Grinding Pointed Cutters

For pointed cutters, both the included angle of the point and the back rake angle are produced in one operation (Fig. 1). The back rake angle should be selected to suit the material to be cut (see table on page 12).

Setup Operations

1. Insert index pin R into central hole; bring red dot into window U.
2. Align cutter lip by means of gauge E; grip cutter in position; return gauge E.
3. Insert index pin R into left-hand hole to enable index head spindle to be rotated 180° between stops.
4. Release clamping levers K3 and K4; hold index drum T4 against stop and, beginning at zero position, set swivel arm at one-half the desired point angle (Fig. 2). Example: Given a point angle of 60°. Set swivel arm by index drum T4 at 30°. Retighten clamping levers K3 and K4.
5. Release clamping lever K2; set index head bracket for desired back rake angle by means of scale T2 (Fig. 3). Tighten clamping lever K2.
6. Release lever K1; shift index head bracket in tubular guide to bring cutter into light contact with end face of grinding wheel; tighten clamping lever K1.

Grinding the Back Rake Angle

7. During grinding slowly return stop screw G to advance the index head bracket past the wheel; at the same time continuously rotate the index head spindle back and forth between the stops, the rotation being through 180°. This ensures uniform stock removal (Figs. 4a, b, c) and will protect the cutter from overheating.

Whet the cutter point by means of an oil stone. It is advisable to whet the point as far as engraving conditions permit. This operation will give the point a small end cutting edge which will participate in removing stock (Fig. 5). However, where hairline engraving work is concerned (depth of cut not exceeding .0004" = .01 mm), the shape of the point should not be changed; only the cutting edge proper should be carefully whetted.

In addition it is recommended to whet also the cutting lip by means of an oil stone in order to remove burrs. However, care should be exercised not to remove noticeable amounts of stock from the cutting lip, as this would destroy the centering of the lip and might render a greater or lesser part of it useless (Grinding allowance .0004" = .01 mm).

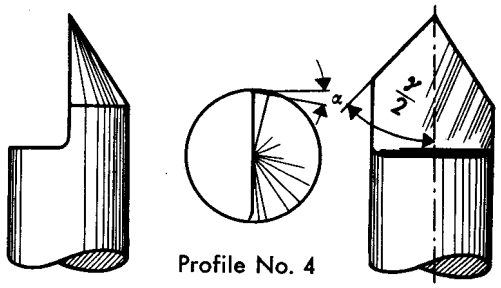


Fig. 1

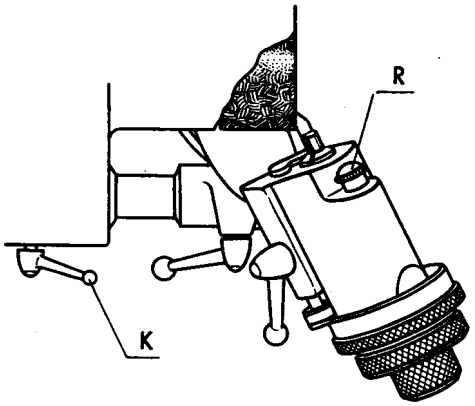


Fig. 2

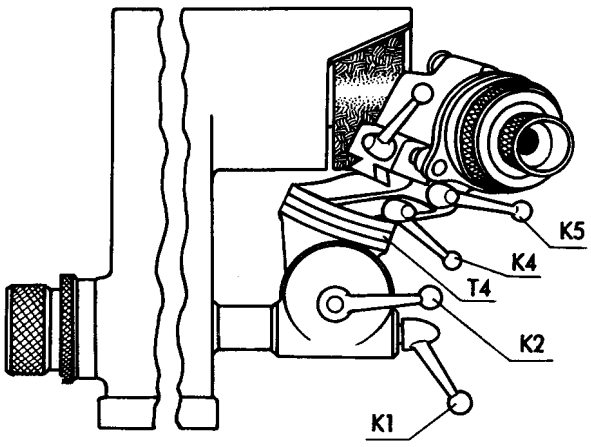


Fig. 3

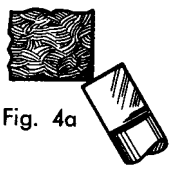


Fig. 4a

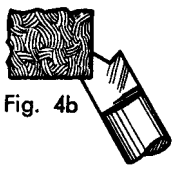


Fig. 4b

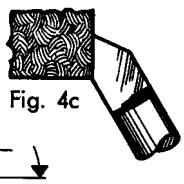


Fig. 4c

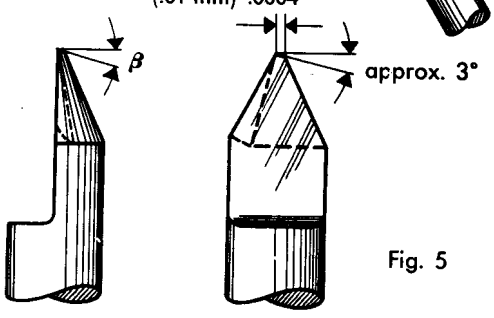


Fig. 5

Grinding Tapered Cutters

A. Circular Grinding of Side and End Cutting Edges

Tapered cutters can be ground to size in the machine without the use of any measuring instrument, exept for the scales provided on the machine. For circular grinding operations on tapered cutters, proceed as follows:

Setup Operations

1. Insert index pin R into central hole; bring red dot into window U.
2. Align cutter lip by means of gauge E; grip cutter in position; return gauge E.
3. Insert index pin R into right-hand hole to enable index head spindle to be rotated through 360°. Release clamping levers K2, K3, K4. Set scales T2 and T4 at zero. Tighten clamping levers K2, K3, K4 (Fig. 4).
4. Release clamping lever K1; bring cutter diameter into light contact with end face of grinding wheel; tighten clamping lever K1.

5.(a) Profile No. 5 (Figs. 1 and 2): Release clamping lever K5; rotate knurled knob S5 to shift cross slide to the right by one-half of the diameter of the taper ("a" in Fig. 1); for this purpose use cross slide vernier scale T5. Tighten clamping lever K5.

5.(b) Profile No. 6 (Figs. 1 and 2): Release clamping lever K5; rotate knurled knob S5 to shift cross slide to the right by the desired amount "a" (use cross slide vernier scale T5). Tighten clamping lever K5.

5.(c) Profile No. 7 (Figs. 1 and 3): Set cross slide vernier scale at zero.

6.(a) Profiles No. 5 and 7: Rotate fine adjustment screw F to bring cutter diameter into light contact with grinding wheel; again rotate screw F to shift cutter to the left by amount "x" $= \frac{D}{2} - a$. To facilitate this setting operation, set scale drum of screw F at zero without disturbing the setting of the screw (Fig. 4).

6.(b) Profile No. 6: Rotate screw F to bring cutter diameter into light contact with grinding wheel; again rotate screw F to shift cutter to the left by the amount "x" $= \frac{D}{2} - (a+r)$. Ta facilitate this setting operation, set scale drum of screw F at zero without disturbing the setting of the screw (Fig. 4).

7. Release clamping lever K3; rotate swivel arm through 90°; release clamping lever K6; rotate index head slide micrometer screw S6 to advance end face of cutter towards grinding wheel. Where tapered cutters are to be resharpened, the length of the cutting edge at the end of the cutter should be made larger than the desired small diameter of the tapered portion.
8. Release clamping lever K4; hold index drum T4 against its stop and, counting from the zero position, set swivel arm at the desired taper angle; tighten clamping levers K3 and K4 (Fig. 5).

Circular Grinding

9.(a) Profile No. 5: Slowly return stop screw G and continuously rotate the index head spindle through 360° to advance the cutter past the grinding wheel. Prior to the circular grinding operation rotate fine adjustment screw F to shift the cutter to the right; then advance the cutter towards the wheel by small increments until the desired size has been obtained (Fig. 6).

9.(b) Profiles No. 6 and 7: Release clamping lever K3; first slowly return stop screw G, then slowly swing the swivel arm while continuously rotating the index head spindle through 360° to move the cutter past the wheel and thus to circular-grind both the taper and the radius. Prior to the circular grinding operation rotate fine adjustment screw F to shift the cutter to the right; then advance the cutter towards the wheel by small increments until the desired size has been obtained (Figs. 7 and 8).

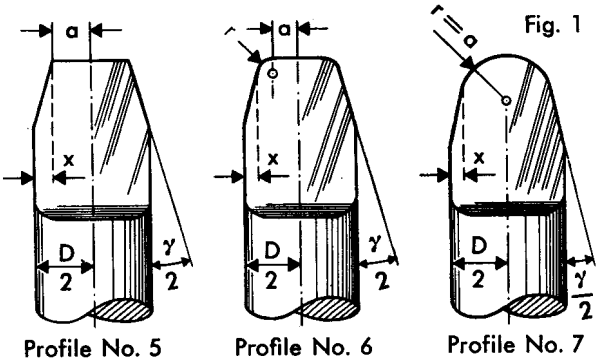


Fig. 1

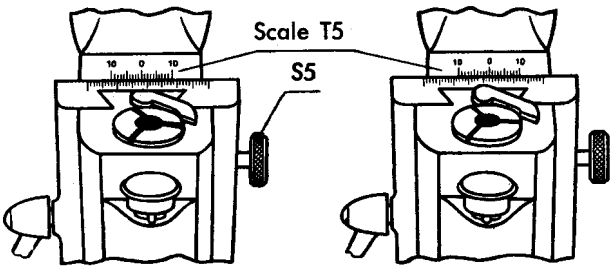


Fig. 2

Fig. 3

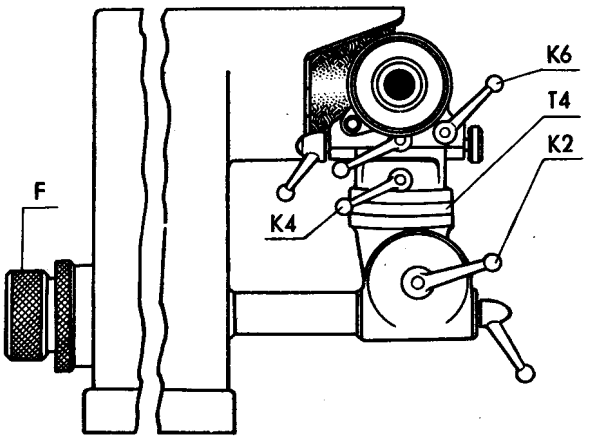


Fig. 4

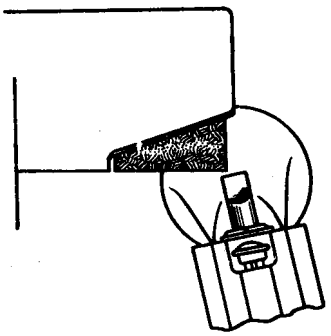


Fig. 5


Fig. 6

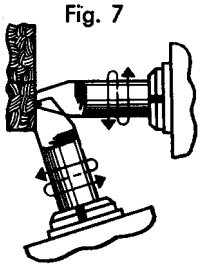


Fig. 7

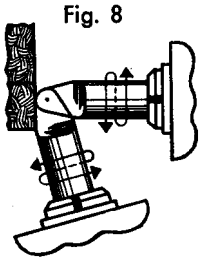


Fig. 8

Grinding Tapered Cutters

B. Relieving the Side and End Cutting Edges (Straight-end Cutters)

SOE

The back rake angles of the side and end cutting edges may be ground immediately after circular grinding the desired cutter profile; or in cases where only the taper angle (not, however, the small diameter of the tapered portion) is of importance, grinding may be performed in an independent operation. Where the small taper diameter must be held within close tolerances, only the end cutting face will be ground; in this case the cutter will have to be aligned by means of gauge E and clamped in position. The back rake angles of the side and end cutting edges should be selected to suit the material to be cut (see table on page 12). For tool angles refer to Fig. 1.

Grinding the Side Cutting Edge
Setup Operations

1. Insert index pin R into left-hand hole; bring red dot into window U.
2. Release clamping lever K2; use scale T2 to set cutter at desired back rake angle; tighten clamping lever K2 (Fig. 2).
3. Release lever K1; shift index head bracket in tubular guide to bring cutter into light contact with end face of grinding wheel; tighten clamping lever K1.

Grinding the Back Rake Angle

4. While continuously rotating the index head spindle through 180° (back and forth between the stops), advance the cutter towards the grinding wheel by means of fine adjustment screw F. This will produce the desired back rake angle in a positively controlled operation (Fig. 2).
   Upon completion of the grinding operations on the side cutting edge, a very narrow land must remain at the edge.

Grinding the End Cutting Edge
Setup Operations

1. Insert index pin R into central hole; bring red dot into window U.
2. Release clamping lever K2; use scale T2 to set swivel arm at an angle of approx. 3°; tighten clamping lever K2 (Fig. 3).
3. Release clamping levers K3 and K4; hold scale T4 against its stop and, beginning at the 90°-position, set swivel arm at the desired angle; for example, where an angle of 10° is desired, the swivel arm will have to be set at 80°. Tighten clamping levers K3 and K4 (Fig. 4).
4. Release lever K1; shift index head bracket in tubular guide to bring end face of cutter into light contact with end face of grinding wheel; tighten clamping lever K1.

Grinding the Back Rake Angle

5. Lateral fine adjustment of the index head bracket relative to the grinding wheel and adjustment for depth of cut is obtained by means of screw F. It is also possible to grind the back rake angle manually; however, care should be taken to produce the correct tool angles (Fig. 5).

In cases where close tolerances on the small taper diameter after grinding the end cutting edge are prescribed, the corner of the side cutting edge will have to be maintained; this will make it possible to check whether or not the small taper diameter was changed during grinding operations (Fig. 6).

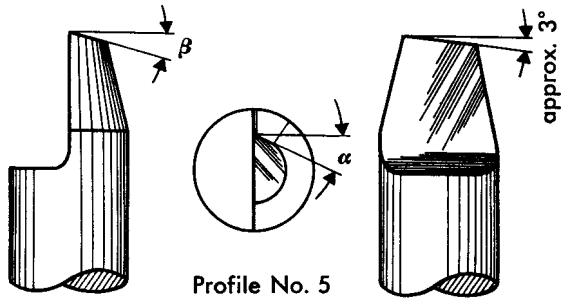


Fig. 1

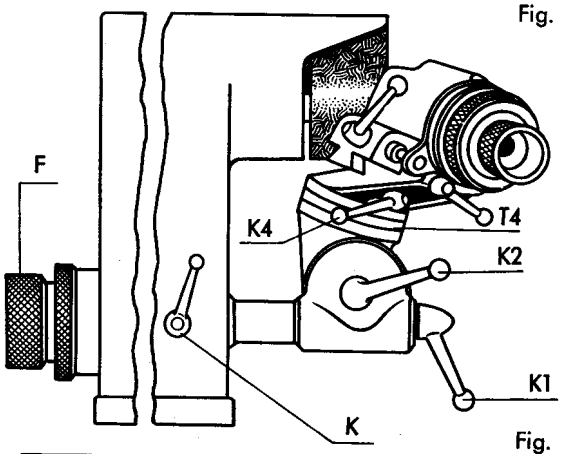


Fig. 2

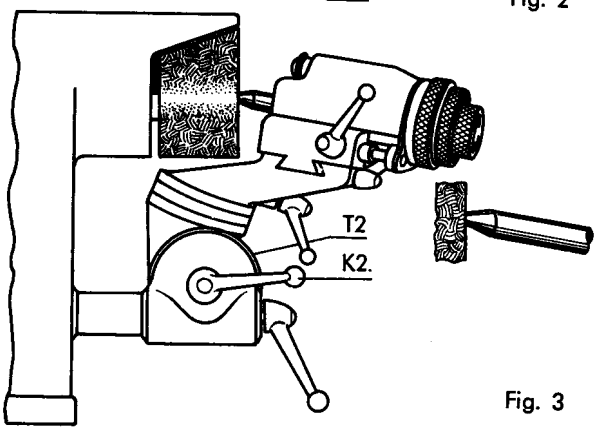


Fig. 3

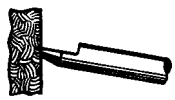


Fig. 4

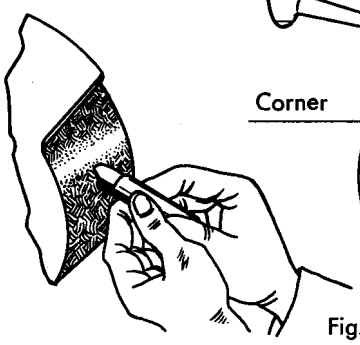


Fig. 5

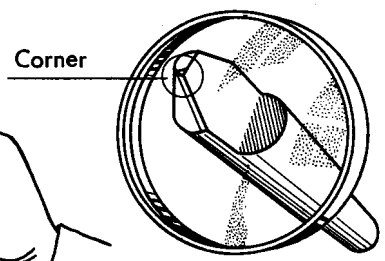


Fig. 6

Grinding Tapered Cutters

C. Relieving the Side and End Cutting Edges (Round-end Cutters)

Tapered cutters having either an off-center or an on-center radius (Fig. 1) can be given a back rake angle only in connection with the circular grinding operation. The back rake angle of the side cutting edge equals that of the straight or rounded end cutting edge: the proper angle to be used will be found in the table an page 12. After tapered cutters with rounded end cutting edges have become dull, first proceed with the circular grinding operation described on page 18; then follow the procedure indicated below.

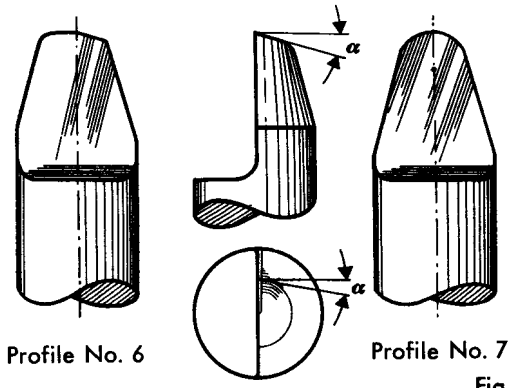
Setup Operations

1. Insert index pin R into left-hand hole; bring red dot into window U.
2. Release clamping lever K2; use scale T2 to set index head bracket at desired back rake angle; tighten clamping lever K2.
3. Release lever K1; shift index head bracket in tubular guide to bring cutter into light contact with end face of grinding wheel; tighten clamping lever K1.

Grinding the Back Rake Angle

4. While continuously rotating the index head spindle through 180° (back and forth between the stops), advance the cutter towards the grinding wheel by means of fine adjustment screw F. This will produce the desired back rake angle on both the side and the end cutting edges in a positively controlled operation (Figs. 3, 4, 5). Upon completion of grinding operations, a very narrow land must remain at the cutting edge.
5. In cases where the cutter is intended for the machining of hard steel which requires a small back rake angle, it is advisable to grind off part of the curvature in a manual operation (Fig. 6).

In addition it is recommended, with regard to all single-lip cutters, to whet the cutting lip by means of an oil stone in order to remove burrs. However, care should be exercised not to remove noticeable amounts of stock from the cutting lip, as this would destroy the centering of the lip and might render a greater or lesser part of it useless.



Profile No. 6 Profile No. 7

Fig. 1

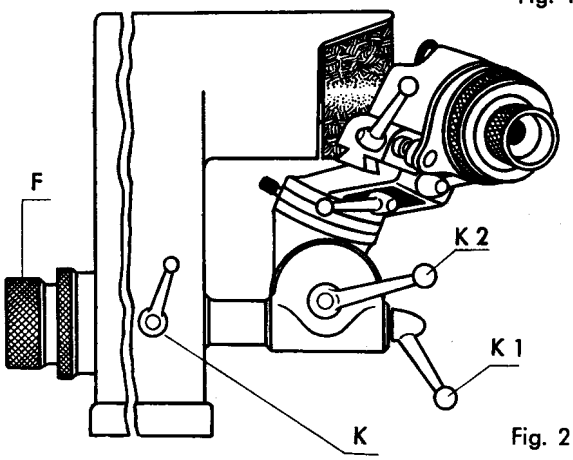


Fig. 2

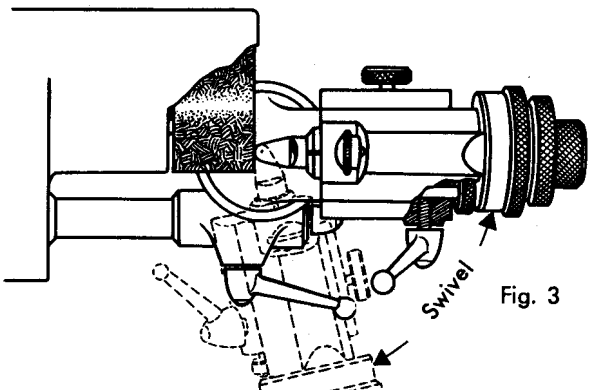


Fig. 3

Fig. 4

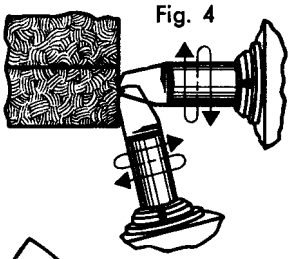
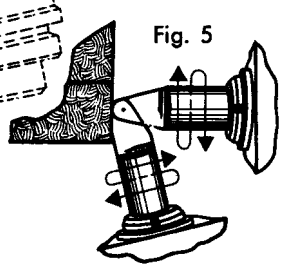


Fig. 5



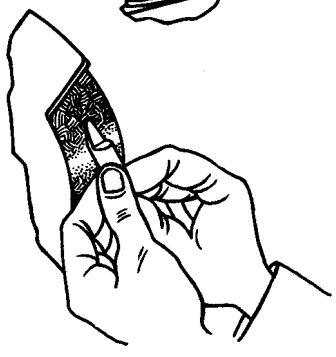
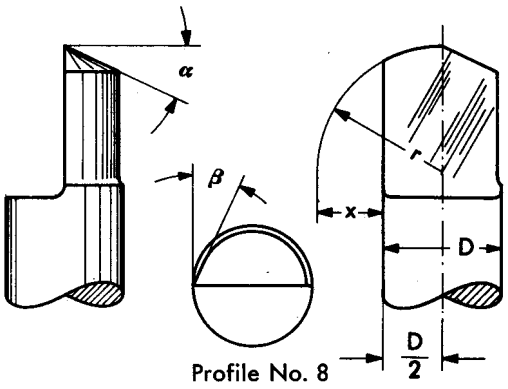


Fig. 6

To grind crowned, rounded-off cutters (profile No. 8), proceed as follows:

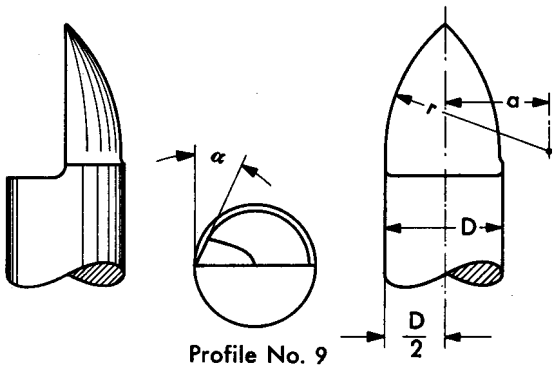
1. Set cross slide at zero, using the vernier scale.
2. Grind side cutting edge (circular and back rake angle (of diameter D) as described for profile No. 1 (page 14).
3. Move cutter diameter into contact with grinding wheel, then use fine adjustment screw F to advance cutter further to the right by dimension "x" $= r - \frac{D}{2}$
4. Turn swivel arm through 90° and move index head slide longitudinally until cutter end face contacts grinding wheel.
5. While continuously rotating the index head spindle through 180° (back and forth between stops), turn swivel arm horizontally to grind the back rake angle of the radius. Feed the cutter by moving the spindle head slide longitudinally, using fine adjustment screw S6.
6. Whet cutting edge by hand.



Profile No. 8

To grind cutters with large, off-centre radius profile (No. 9), proceed as follows:

1. Move cross slide to the left by dimension "a" $= r - \frac{D}{2}$.
2. Grind side cutting edge (circular and back rake angle) of diameter D as described for profile No. 1 (page 14).
3. Move index head slide to the rear and, while continuously rotating the index head spindle through 180° (back and forth between stops), turn swivel arm horizontally to grind the back rake angle of the radius. Feed the cutter by moving the spindle head slide longituinally, using fine adjustment screw S6. Continue until desired pointed form is obtained.
4. Whet cutting edge by hand.



Profile No. 9

To grind dovetailed cutters with sharp corners (profile No. 10) or rounded-off dovetail cutters (profile No. 11), proceed as follows:

1. Profile No. 10: Set scales T2 and T4 at zero. Grind end face of cutter to good finish.
2. Profile No. 11: Move cross slide to the right by dimension "a" $= \frac{D}{2} - r$.
3. Profile No. 11: Move cutter outside diameter into contact with grinding wheel. Turn swivel arm through 90° and move index head slide longitudinally until cutter end face contacts grinding wheel.
4. Profiles No. 10 & 11: Disengage stop pin A2 on index head bracket and move swivel arm from zero position to the right, to the desired profile angle γ (see page 17, par. 4).

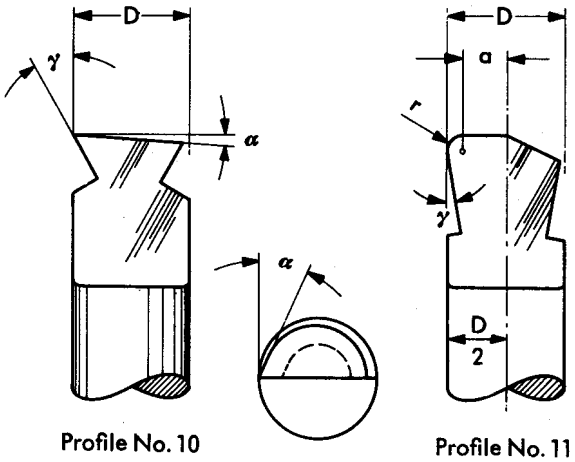
5.(a) Profile No. 10: Grind side cutting edge (circular and back rake angle) of diameter D as described for profile No. 1 (page 14).

5.(b) Profile No. 11: While continuously rotating the index head spindle, turn swivel arm horizontally to circular-grind the side cutting edge, radius and end face of the cutter to the desired diameter D.

6.(a) Profile No. 10: Grind the back rake angle of the end cutting edge as described for profile No. 5 (page 19, "Grinding the End Cutting Edge").

6.(b) Profile No. 11: Grind the back rake angle of the side cutting edge, radius and end cutting edge as described for profile No. 6 (page 20).

7. Whet the cutting edge by hand.

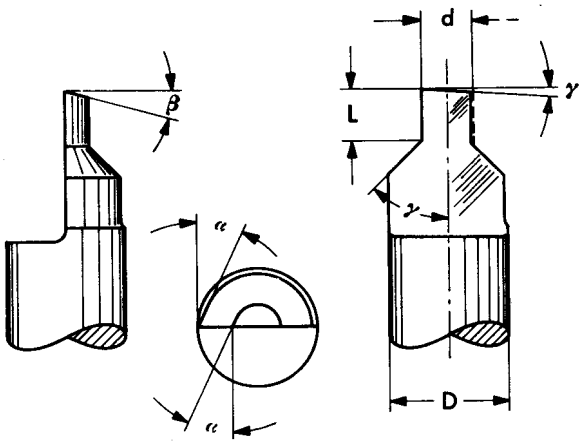


Profile No. 10 Profile No. 11

Grinding Special-profile Cutters II

To grind dog-point cutters with a tapered portion (profile No. 12), proceed as follows:

1. Grind end portion d to length L and relieve, following the instructions given for profile No. 1 (pages 14 & 15).
2. Grind side cutting edge (circular and back rake angle) of diameter D as described for profile No. 1 (page 14).
3. Move swivel arm from zero position to the left, to the taper angle γ of the desired profile (see page 17, par. 4).
4. Grind the back rake angle of the tapered portion, using the inner corner of the grinding wheel (Fig. 1). It is advisable to use a wheel having a **carefully trued** inner corner.
5. Whet the cutting edge by hand.



Profile No. 12

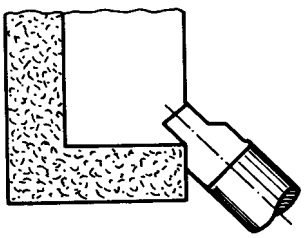
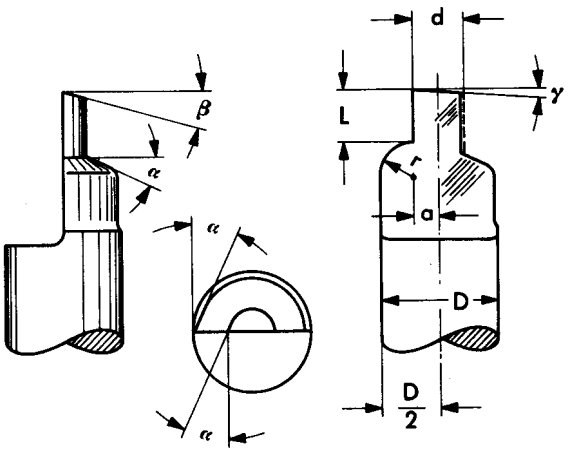


Fig. 1

To grind dog-point cutters with an off-centre rounded portion, proceed as follows:

1. Move cross slide to the right by dimension
$$\text{"a"} = \frac{D1}{2} - r.$$
2. Grind end portion d to length L and relieve, following the instructions given for profile No. 1 (pages 14 & 15).
3. Grind side cutting edge (circular and back rake angle) of diameter D as described for profile No. 1 (page 14).
4. Grind back rake angle of radius on inner corner of grinding wheel by turning swivel arm horizontally (Fig. 2). Move index head slide longitudinally in such a way that end of radiused portion coincides with length L on the inner corner. It is advisable to use a wheel having a **carefully trued** inner corner as shown in Fig. 2.
5. Whet cutting edge by hand.



Profile No. 13

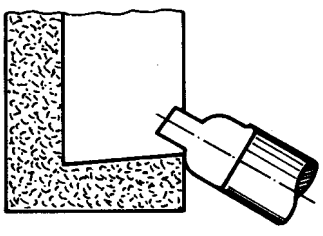


Fig. 2

Grinding Special-profile Cutters III

To grind a concave profile on dog-point cutters (profile No. 14), proceed as follows:

1. Grind end portion d to length (L—r) and relieve, following the instructions given for profile No. 1 (pages 14 & 15).
2. If required, grind the side cutting edge (circular and back rake angle) of diameter D as described for profile No. 1 (page 14).
3. Remove diamond holder and clamp holder in spring collet in such a way that, when viewed from above, the point of the diamond coincides with the axis of the holder (Fig. 1).
4. Set vernier scale of cross slide at zero. Move outside diameter D1 of diamond holder into light contact with grinding wheel and then move holder to the left by $\frac{D1}{2}$, using fine adjustment screw F. Turn swivel arm through 90° and move index head slide longitudinally until diamond point contacts grinding wheel. Use the scale of fine adjustment screw S6 to retract the index head slide by the radius to be dressed on the wheel.
5. Profile the grinding wheel to the desired radius, using fine adjustment to advance the diamond on the wheel circumference (at end of radius), and swivel the index head backet in the tubular guide to advance the diamond on the wheel end face (at end of radius).
6. Grind or relieve radius (as the case may be) to length L. Back rake angle α at the end of the radius will be produced by the inclined position of the cutter relative to the grinding wheel (Fig. 2).
   (Move index head slide longitudinally as required, or clamp the cutter in appropriate position).
7. Whet the cutting edge by hand.

To grind a concave profile on **other than dog-point** cutters (profiles No. 14a, b, c), use a profiled grinding wheel as shown in Fig. 3, proceeding as follows:

1. Move cross slide to the right by dimension "a".

2.(a) Profiles No. 14a, c: Bring cutter diameter D into contact with the grinding wheel.

2.(b) Profile No. 14b: Bring cutter diameter D into contact with the grinding wheel and move to the right by difference (r — x), using fine adjustment screw F.

3.(a) Profiles No. 14a, b: Turn swivel arm through 90° and move cutter end face into contact with the grinding wheel, using fine adjustment screw S6.

3.(b) Profile No. 14c: Move cutter to the left by dimension "x", using fine adjustment screw F.

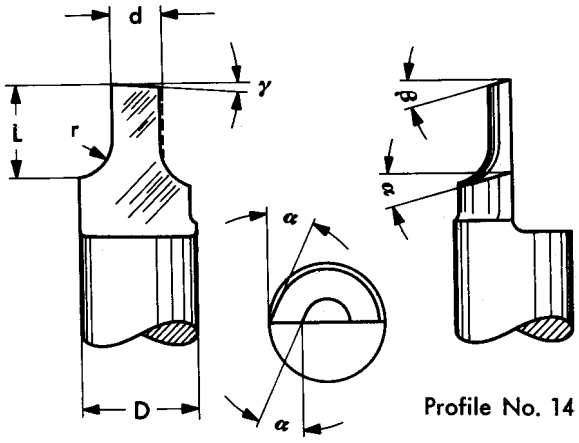
4.(a) Profiles No. 14a, b: Use adjustable stop screw G to feed the cutter until the cutter end face is in correct position relative to the wheel (Fig. 3).

4.(b) Profile No. 14c: Feed index head slide stepwise, using fine adjustment screw S6, until profile has been produced. Watch for position of grinding wheel during feeding. Correct by means of stop screw G if necessary.

5. Profiles No. 14a, b: Feed cutter in steps during grinding, using fine adjustment screw F, until dimension "x" or "d", respectively, is obtained.

6. Grind back rake angle, leaving a narrow land behind the cutting edge. Position relative to grinding wheel as before. Do not touch fine adjustment screw S6: all feed adjustments by adjusting screw F.

7. Whet cutting edge by hand.



Profile No. 14

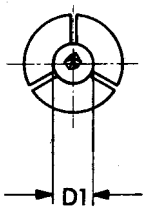


Fig. 1

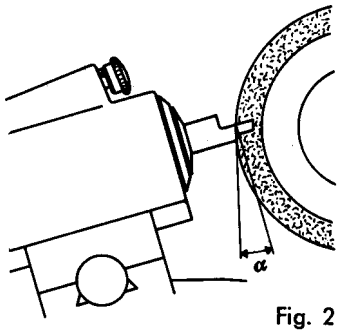
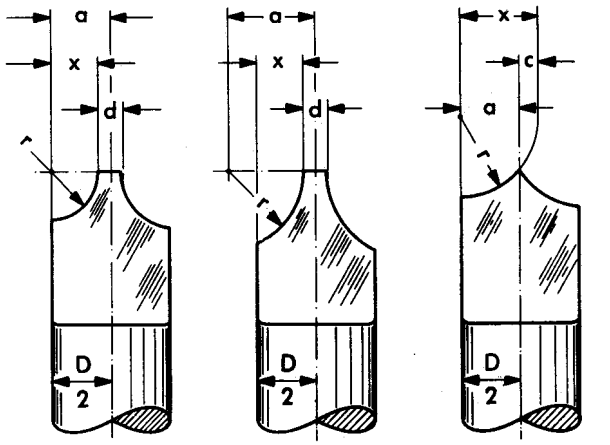


Fig. 2



Profile No. 14a | Profile No. 14b | Profile No. 14c

$a = \frac{d}{2} + r$ | $a = \frac{d}{2} + r$ | $a = r - c$

$x = \frac{D}{2} - \frac{d}{2}$ | $x = \frac{D}{2} - \frac{d}{2}$ | $x = \frac{D}{2} + c$

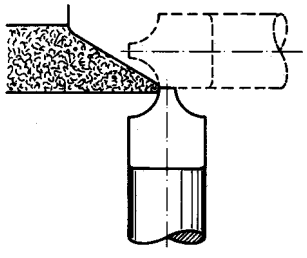
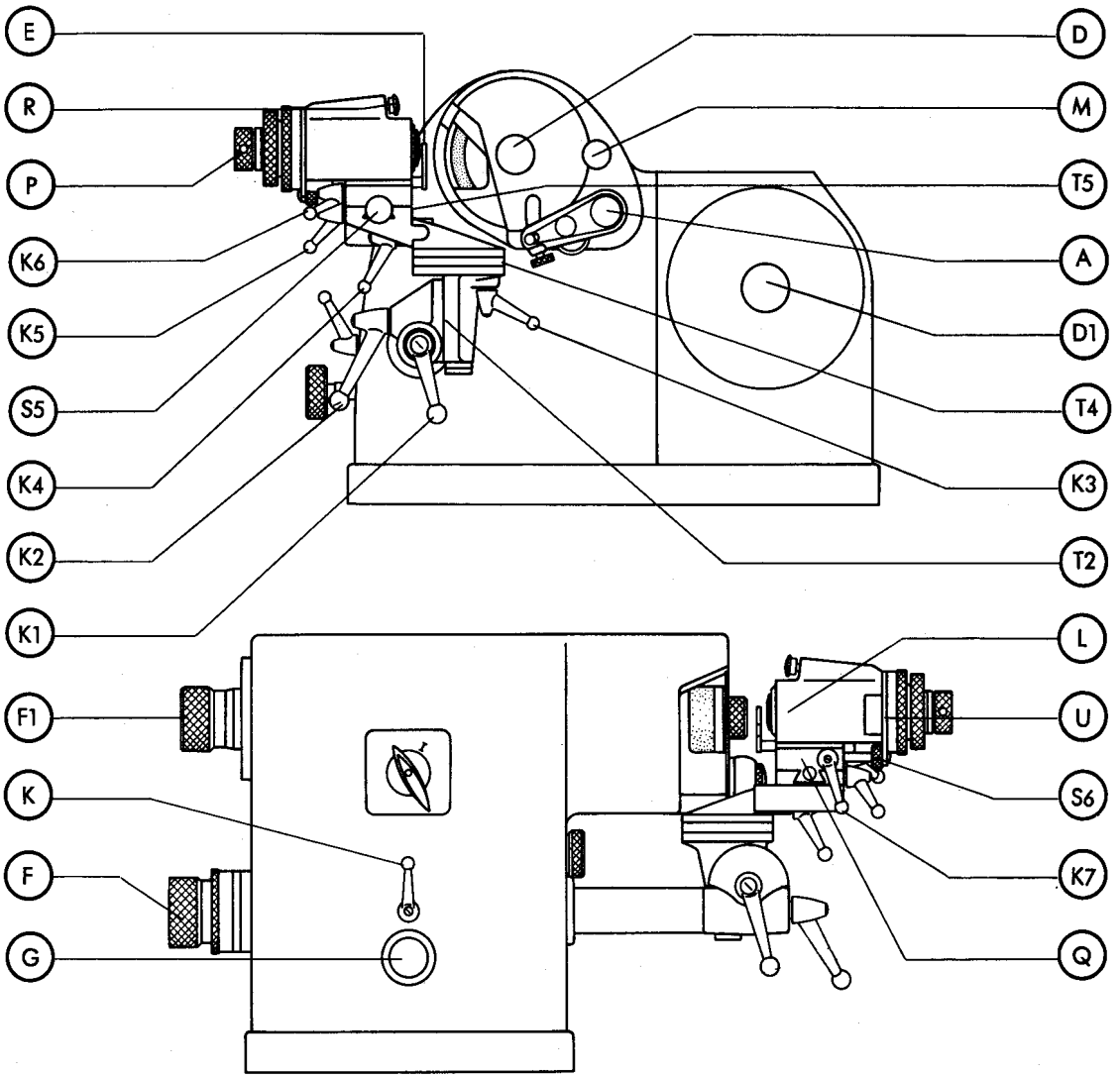


Fig. 3



E Cutter lip aligning gauge
R Spring collet index pin
P Draw-in screw for spring collets
K6 Index head slide clamping lever
K5 Cross slide clamping lever
S5 Cross slide fine adjustment screw
K4 Scale drum T4 clamping lever
K2 Setting scale T2 clamping lever
K1 Clamp for index head bracket coarse adjustment
F1 Grinding wheel fine feed screw
K Tubular guide clamping lever
F Index head bracket fine adjustment screw
G Adjustable stop screw

D Knob for grinding wheel guard
M Nut for grinding wheel guard
T5 Cross slide vernier scale
A Wheel dressing attachment with eccentric stop
D1 Dust exhaust knob
T4 Horizontal swivel mount index drum
K3 Horizontal swivel arm clamping lever
T2 Relief grinding setting scale
L Index head slide
U Red dot window
S6 Index head slide fine adjustment screw
K7 Clamp for index head slide fine adjustment
Q Cross slide

SOE

Twist Drill Grinding Attachment

The twist drill grinding attachment has been designed for grinding twist drills of 3 to 18 mm (1/8" to 11/16") diameter. The lip angle is always 116°, while the back rake angle is adjustable as required.

To mount the attachment (Fig. 2), attach a 12 mm (1/2") spring collet to locating pin 1 and insert the collet into the index head slide of the index head bracket, introducing retaining pin 2 into the bore of the off-side setting gauge. Adjustable stop 5 has a flat surface on one side for holding twist drills of 3 to 18 mm (1/8" to 11/16") diameter. The drill is held by hand against stop 5 and the swivel-mounted V-guide 4 during grinding (Fig. 1). After backing off clamping screw 7, stop 5 with ring 9 can be pulled off (depress catch 10) and mounted in reverse position. This permits clamping of small drills (3 to 6 mm or 1/8" to 1/4" dia.) by means of clamping screw 6, since experience has shown that such drills are difficult to hold by hand for grinding.

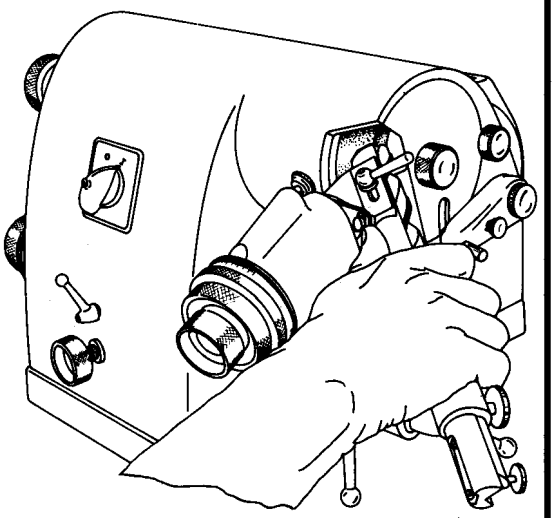


Fig. 1

Setup Operations

1. Release clamps K3 and K4. Hold index drum T4 against stop by means of the knob and set swivel arm at 13°. Retighten clamps K3 and K4.
2. Release clamp K2 and set swivel arm at zero on setting scale T 2 (resulting in a normally suitable rake angle). If larger or smaller rake angles are required, adjust swivel arm accordingly. Retighten clamp K2.
3. Release clamps K6 and K7. Move index head slide L until its front face stands out approx. .6" (15 mm) beyond the front face of cross slide Q. Retighten clamps K6 and K7.
4. Release clamp 3 (on attachment) and adjust swivel-mounted V-guide 4 until the scale shows the diameter of the twist drill to be ground. Retighten clamp 3.
5. Release clamp K1. Move index head bracket in tubular guide until gauge plate 8 is positioned approx. .04" (1 mm) laterally of the face of the grinding wheel. Retighten clamp K1.
6. Place twist drill on V-guide 4. Back off clamping screw 7 and advance stop 5 until the cutting face of the drill rests against gauge plate 8, projecting approx. .02" (.5 mm). Tighten clamping screw 7. When using the adjustable stop in reverse position (for small twist drills of 3 to 6 mm = 1/8" to 1/4" dia.), tighten clamping screw 6.
7. Insert index pin R into right-hand hole.

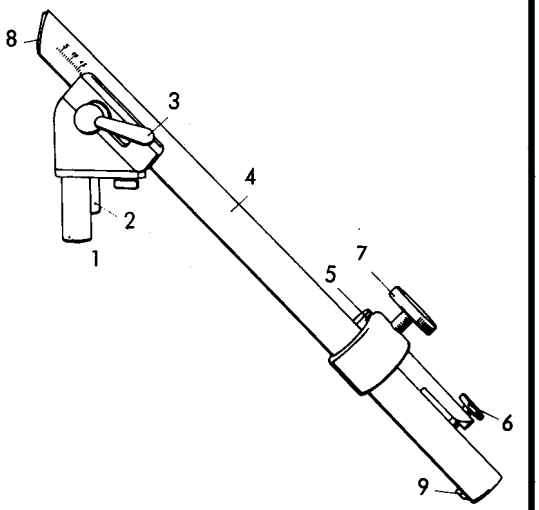


Fig. 2

Grinding

8. Swivel twist drill grinding attachment upwards. Use fine adjustment screw F to advance the drill until it contacts the grinding wheel. Grind first cutting edge by swivelling the attachment downwards (Fig. 3). Repeat feed and grinding operation if required.
9. Place twist drill into V-guide 4 in 180° inverted position and grind second cutting edge, leaving the attachment and the adjustable stop in the previously used positions (i. e., not advancing fine adjustment screw F).

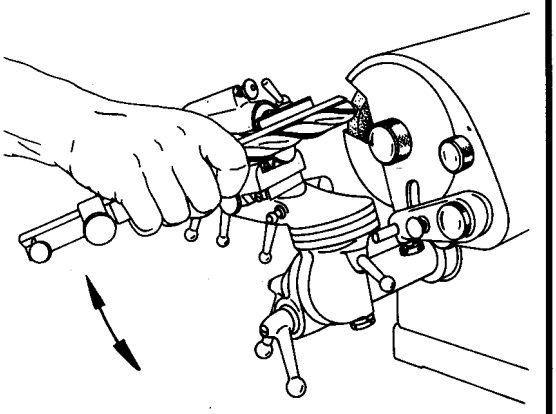


Fig. 3

Accessories

Standard Equipment

Q'ty	Name	Remarks
●	[redacted]	
1	V-belt for 50 c/s	DIN 2215 — 6x425 mm
	V-belt for 60 c/s	DIN 2215 — 6x400 mm
1	V-belt for 50 c/s	DIN 2215 — 6x500 mm
	V-belt for 60 c/s	DIN 2215 — 6x480 mm
1	Wheel mount for cup wheels	
1	Cup wheel for HSS cutters	100x50x20 mm
1	Filter element	Size 150/132 mm
1	Fine filter mat	
1	Nut for removing wheel mount	
2	Spring collets	1/8" — 1/4" dia.
1	Socket screw spanner	DIN 911 — 5 mm
1	Socket screw spanner	DIN 911 — 6 mm
2	Hook spanners	DIN 1810 — 30x22 mm
1	Socket spanner	17 mm
1	Ring nut spanner	
2	Pin spanners	16x20 mm
1	Operator's manual	

Special Equipment

Q'ty	Name	Remarks
1	Pedestal	
1	Measuring projector	
1	Fluorescent-tube lamp	
1	Locating fixture for cutter spindle assembly of DECKEL GL1 and GL2	
1	Special index head	
1	Spring collet	3/4" dia.
3	Taper sleeves	M.T. 1, 2, 3
1	Twist drill grinding attachment	
1	Wheel mount for cup wheels	
1	Spare filter element	Size 150/132 mm
1	Dressing diamond	8 mm dia. x 80 mm
12	Spring collets	3/32" to 9/16" dia.
7	Square collets	1/8" to 1/2" sq.
3	Taper collets	M.T. 1, 2, G.A.
1	Cup wheel for HSS cutters	100x50x20 mm
1	Special cup wheel for carbide cutters	Roughing
1	Diamond cup wheel for carbide cutters	Finishing
1	Diamond file for carbide cutters	
1	Fine filter mat	
1	V-belt for 50 c/s	DIN 2215 — 6x425 mm
1	V-belt for 60 c/s	DIN 2215 — 6x400 mm
1	V-belt for 50 c/s	DIN 2215 — 6x500 mm
1	V-belt for 60 c/s	DIN 2215 — 6x480 mm
1	Can of air filter wetting agent	VISCINOL-A 30
1	Tube of special bearing grease	Isoflex Super TEL