

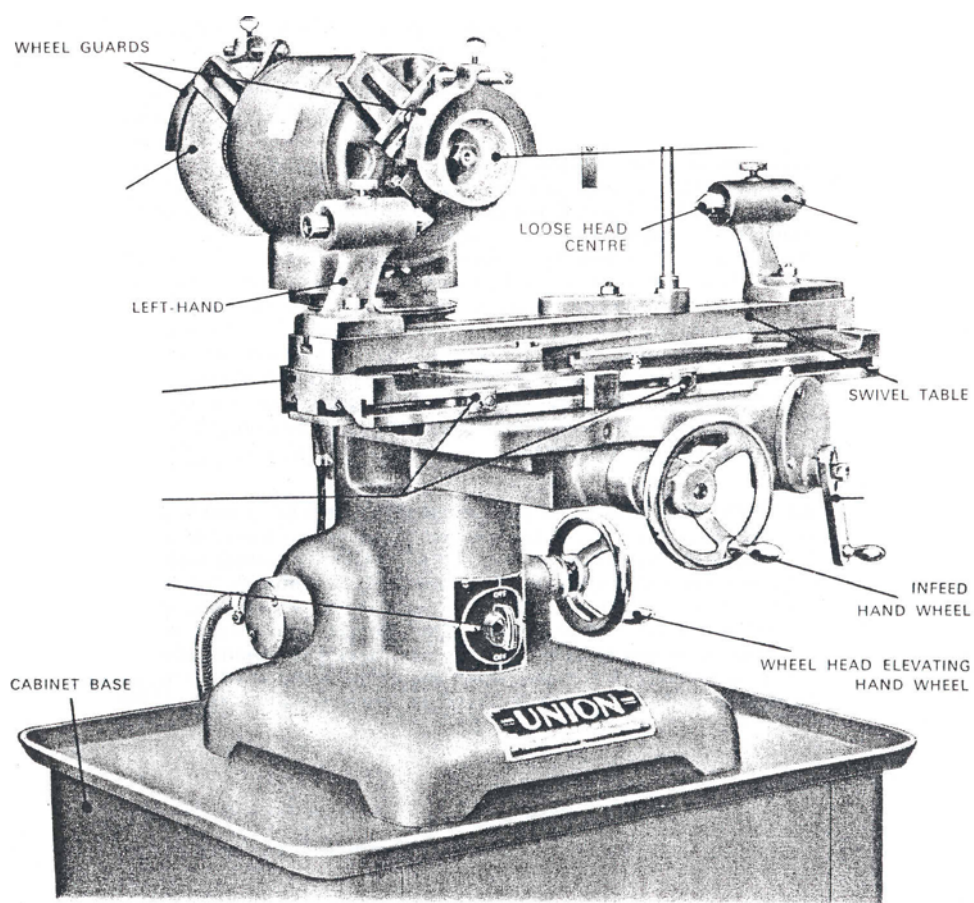
# **UNION Tool and Cutter Grinder**

## **Operators Handbook**

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## ***Principal Parts of Machine***



## Description

WORK (OR SWIVEL) TABLE is arranged to swivel on its slide through 180°, It is graduated 45° either side of the zero setting and is locked in position with two bolts on the swivel facing which being off-centre assists in the grinding of awkward shaped cutters, A central tee slot locates the loose centre heads and various other items of equipment as well as providing a means of clamping the tooth rest, etc. Provision is also made for taper settings in INCHES PER FOOT by means of an engraved plate on the end of the table slide.

TABLE (OR SWIVEL) SLIDE is located on accurately machined vee and flat ways. Longitudinal movement is through a rack and pinion by means of the handle situated to the right of the machine centre. The handle is arranged with a series of splined holes to provide different angular and stroke movements to suit the operator.

SADDLE OR CROSS SLIDE is located on dovetail ways on a knee bracket fastened to the body of the machine. Cross traverse is controlled by means of a handwheel situated in the front centre of the machine. The handwheel carries a friction mounted dial having 100 divisions each representing .001" movement. On machines fitted with metric screws and dials there are 80 divisions each representing .025 mm, movement.

WHEEL HEAD is a special totally enclosed 1/4 h.p. motor with double-ended spindle which runs at 2,800 r.p.m. - and is controlled by a rotary reversing switch built into the main body of the machine below the knee bracket. Wheel adaptors, one standard length and one extended length are supplied with the machine and can be mounted on either end of the spindle. They are interchangeable and will both receive the cup and dish wheels supplied. The wheel head is mounted on a base plate which can swivel through 360°. It is suitably engraved and can be clamped in any position by means of two studs accessible through the slot in the base plate. Vertical adjustment, through bevel gears, is obtained by the handwheel at the right hand base of the machine. The handwheel carries a friction mounted dial having 100 divisions each representing .001" movement (metric dial has 80 divisions of .025 mm.), A cranked locking handle, at the top right-hand side of the main casting, is provided for locking the column in any position. The portion of the column which otherwise would be exposed is protected by a telescopic bellows guard.

Note: Recent machines fitted with metric screws have dials with 100 divisions representing .020 mm movement.

CENTRE HEADS locate in the tee slot of the work table which allows the distance between them to be adjusted whilst still maintaining alignment, The heads are reversible and their "off set" design simplifies their use with long work pieces or mandrels. The centres are of a sufficient length to allow them to slide without the necessity of unclamping the casting, and can be locked in position with the thumb screw on top. The centres, usually the L.H. one, serve also as location for the Clearance Angle Setting Gauge used for accurate clearance angles when the

cutter is mounted on a mandrel between centres.

UNIVERSAL TOOTH REST consists of a cast iron base, universal knuckle joint and tooth rest post with trip finger. The base can be clamped either on to the table or on to the wheel head quadrant. As all the posts are the same diameter and therefore interchangeable, the combination of set ups is considerable. The unit also serves as a holder for the Diamond Dressing Tool which is available as extra equipment.

UNIVERSAL HEAD OR WORK SUPPORT is made up of three main parts, a base angle bracket and the spindle housing. It is arranged to swivel in both the horizontal and vertical planes and is provided with engraved scales. The spindle has a number 4 morse internal taper and can rotate and be locked in any position. For holding various cutters a draw in collet attachment (1/2" capacity) is available as extra equipment together with an arbor for mounting S & F cutters, slitting saws, etc. To facilitate the mounting of a tooth rest in certain applications, the spindle housing is provided with a tee- slot.

NOTE: The description above covers the basic UNION Tool and Cutter Grinder which is for bench mounting. It is, however, more usual to supply the machine mounted on a fabricated sheet steel cabinet base (available as additional equipment) which not only serves as a bench for the machine, but provides a 'lock-up' cupboard with shelves for storing standard equipment and most of the additional equipment available as listed inside the rear cover of this handbook.

The cabinet base can also be supplied fitted with Push Button starter to give full protection to the wheel head motor, a robust three arm low-voltage lighting unit, and a Fused Isolating Switch if required.

## **Lubrication**

Keep slides and machined surfaces clear of grinding dust and lightly oil daily. Oil weekly, all moving parts provided with oil nipples with the oil gun provided. Use any good quality light machine oil.

NOTE: Motor bearings are lubricated and sealed for life and require no attention.

# Introduction

To maintain high production and a quality finish careful attention must be paid to the grinding or sharpening of small tools and cutters. Ease of operation and simplicity in setting has been the keynote in the design of the UNION tool and cutter grinding machine but first class results can only be achieved by an operator who is fully conversant with the working parts of the machine together with a knowledge of basic tool grinding principles.

Certain basic principles must be adhered to, but due to the great variety of tools and cutters and the various methods by which these can be ground, there is no hard and fast method of sharpening a particular cutter. The following pages are intended to serve as a general guide to the operator in dealing with the majority of cutters which will be met in every day use but these may have to be varied depending on size, number of teeth and style of manufacture, etc.

It should be noted that the UNION Tool and Cutter Grinding machine has been designed primarily for the sharpening of cutters and tools made from HIGH SPEED STEEL, and the wheels supplied with the machine are suitable for most grades of High Speed Steel.

## Basic Principles

1. Select and mount the correct grade of wheel for the job. Most H.S.S. cutters and tools can be ground with the two wheels provided but special wheels with different grit, size, bond and made of other materials can be obtained from grinding wheel manufacturers for special work.
2. Choose a finger most suited for the job. There is no definite shape to use, but its length should be such that it gives adequate support to the cutter but is still free to flex to allow it to trip from one tooth to another.
3. Grind cutters with the correct clearance angles for the material being cut.
4. Where possible, always have the wheel rotation such that the grinding pressure is into the support finger.
5. Never apply too heavy a cut. It only gives rise to rapid wheel wear, and overheating of the tooth being ground, which results in an inaccurate cutter. Depth of cut should be in the region of .0005" to .001 " and allowed to "spark out" on each tooth. Avoid bumping work into wheel.
6. Always fit wheel guard securely in position closely over grinding wheel before starting machine, and rotate spindle by hand before running on power to ensure wheels are free to rotate and are not rubbing guards, fingers or fixtures.

## Wheel Mounting, Truing and Dressing

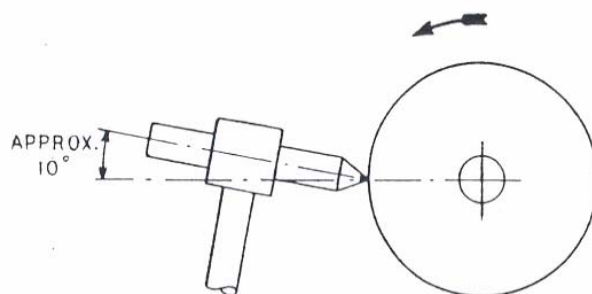
All grinding wheels should be mounted on the two adaptors provided. The adaptors are arranged to receive wheels having 5/8" dia. bore and up to 1/2" thickness. Before mounting, ensure that a wheel has cardboard clamping rings on both sides to prevent crushing of the wheel when tightening in position, and that the steel washer, which is keyed to the adaptor, is in position. This is to prevent the clamping nut unscrewing.

The clamping nut should be tightened only sufficiently to hold the wheel. Excessive clamping pressure will possibly crack the wheel and is unnecessary for driving purposes.

Whenever a new grinding wheel is mounted, before use, it should always be trued so that it will run without vibration. This is best done by using a diamond dressing tool which is correctly and rigidly mounted. Free hand truing is most inadvisable as there is a tendency to follow any irregularities in the wheel shape.

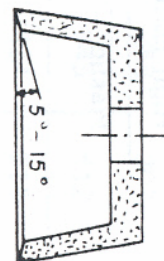
The diamond dressing tool should be clamped firmly, as close as possible to the diamond, in the universal tooth rest in place of the tooth rest post.

Insecurity or excessive overhang induces vibration and chatter which is detrimental to the work and the diamond. The diamond should touch on the wheel axis centre line with the diamond axis inclined at about 100 degrees to give "drag" effect or trailing cut.



Depth of cut should not be greater than '005", decreasing on subsequent passes according to the wheel finish required. Table traverse should not be too rapid and the approach of diamond to wheel should be made carefully to avoid shattering the diamond.

In tool and cutter grinding the most frequently used wheel is the Cup Wheel. It is advisable to dress this wheel with an angle on the face thus presenting a single edge of the wheel to do the work and avoiding an excessive amount of wheel in contact with the cutter which could result in excessive heat and distortion taking place.



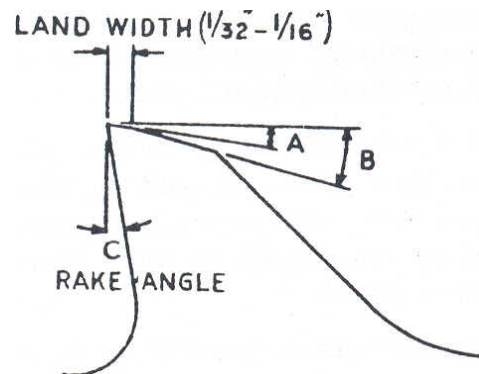
From time to time it will be necessary to dress a wheel in use, to open up the pores and remove any dull abrasive grain or clogging metal from the wheel face, thus presenting fresh sharp grains which will cut better and generate less heat.

Always ensure that the wheel guards are securely in place before attempting to dress or true a grinding wheel. Goggles or other suitable eye protection should always be worn when using the machine.

## Clearance Angles

Clearance angles are an important factor in the grinding of all types of cutters. In determining the correct angle, the material to be worked, the diameter of cutter and the degree of finish must be taken into account. There are no hard and fast rules for determining the amount of clearance, but the table below gives a general guide and is quite satisfactory for most applications.

Most cutters have two clearance angles, a primary (A) and a secondary (B).



The main function of the secondary clearance is to relieve the primary clearance after repeated grindings have increased the width of the land.

The land width should be kept quite small (about 1/32" – 1/16") otherwise with a wide land, depending on the diameter of cutter, there will only be a small clearance for the chips. With too little clearance the chips will score the work and affect the finish produced.

### Approximate clearance angles for H.S.S. milling cutters

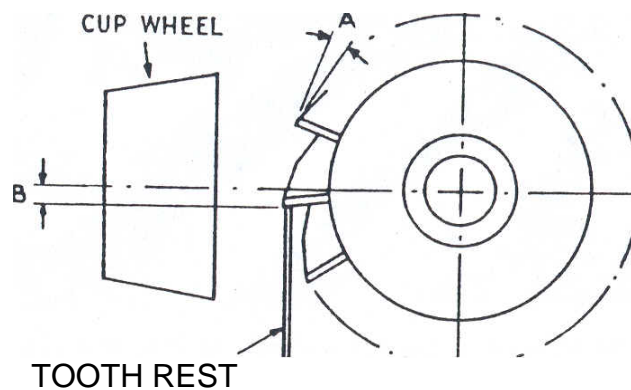
Material to be Cut	Primary Angle A	Secondary Angle B	Rake Angle C
Aluminum	8 ° to 12 °	11	15 ° to 20°
Brass	8 ° to 12 °	15°	0° to 5°
Cast iron	3° to 7°	15 °	0° to 5°
Mild steel	3° to 5°	15 °	10° to 15 °
Mild steel	3° to 5°	15 °	10° to 15 °
Plastic	8° to 12°	15 °	15° to 25°



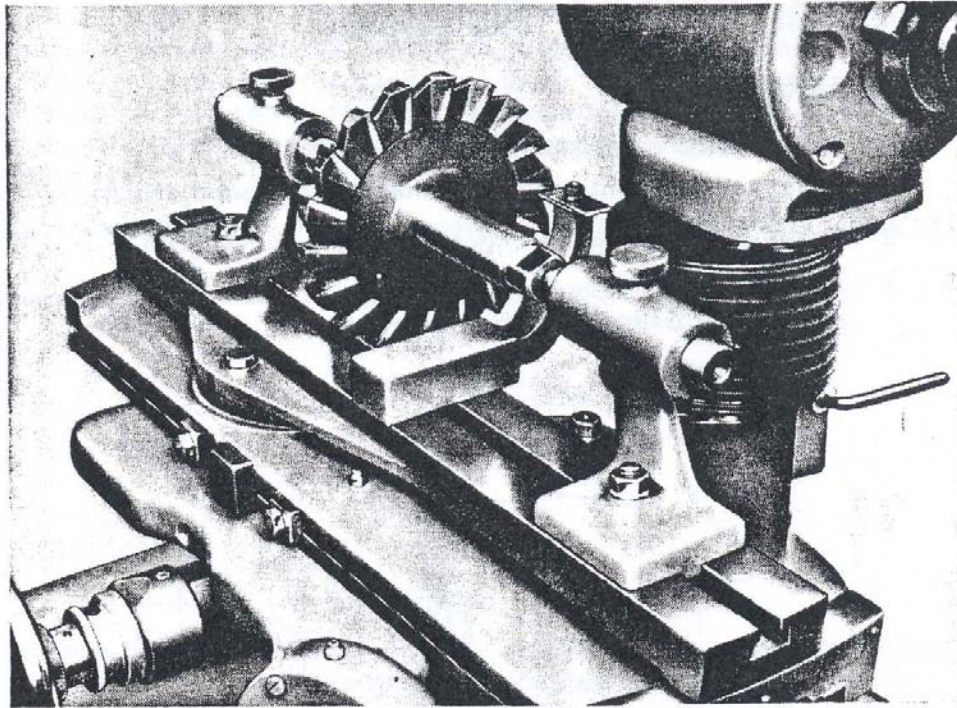
# Methods of Setting Clearance Angles

## LINEAR METHOD

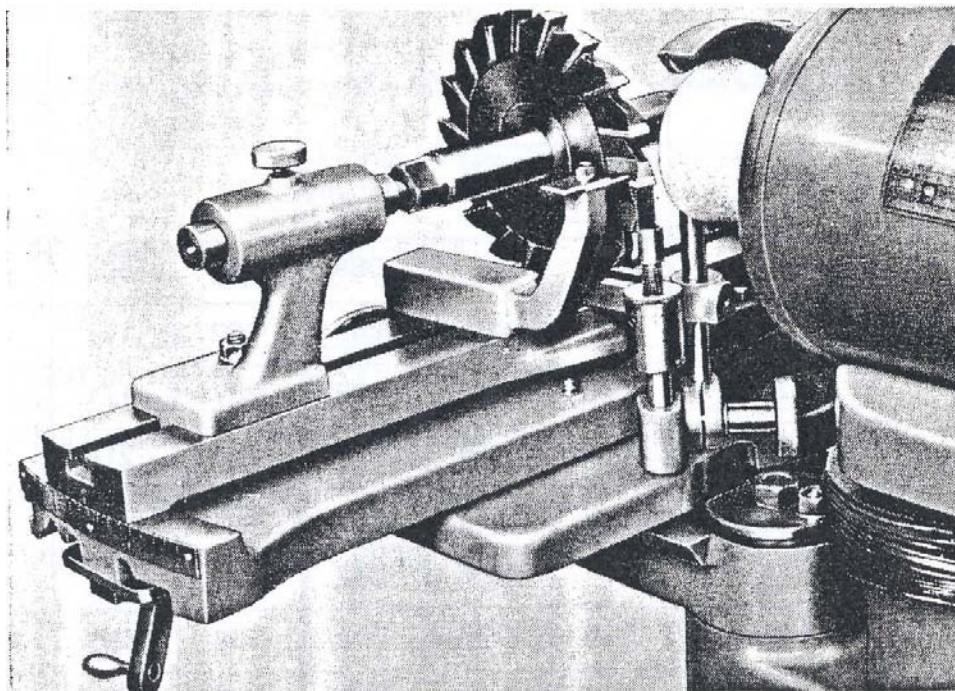
- 1 Mount cutter on suitable mandrel or stub arbor.
- 2 Using centre height gauge, set tooth to be ground on centre.
- 3 Using micro-adjustable finger, set finger under tooth.
- 4 Adjust finger an amount corresponding to clearance angle required and diameter of cutter (see chart below).



Clearance Angle 'A'	3°	5°	7°	8°	10°	12°
Dia. of Cutter (ins.)	Dimension 'B'					
1	.025	.042	.059	.067	.084	.100
1½	.038	.064	.089	.102	.127	.153
2	.052	.086	.120	.137	.171	.204
2½	.065	.108	.150	.172	.214	.257
3	.078	.129	.181	.207	.258	.309
4	.104	.173	.242	.276	.345	.412
5	.130	.216	.303	.346	.431	.516
6	.156	.260	.364	.415	.518	.620
7	.182	.304	.425	.485	.605	.724
8	.209	.347	.486	.554	.692	.828



Setting cutter to centre line with height gauge

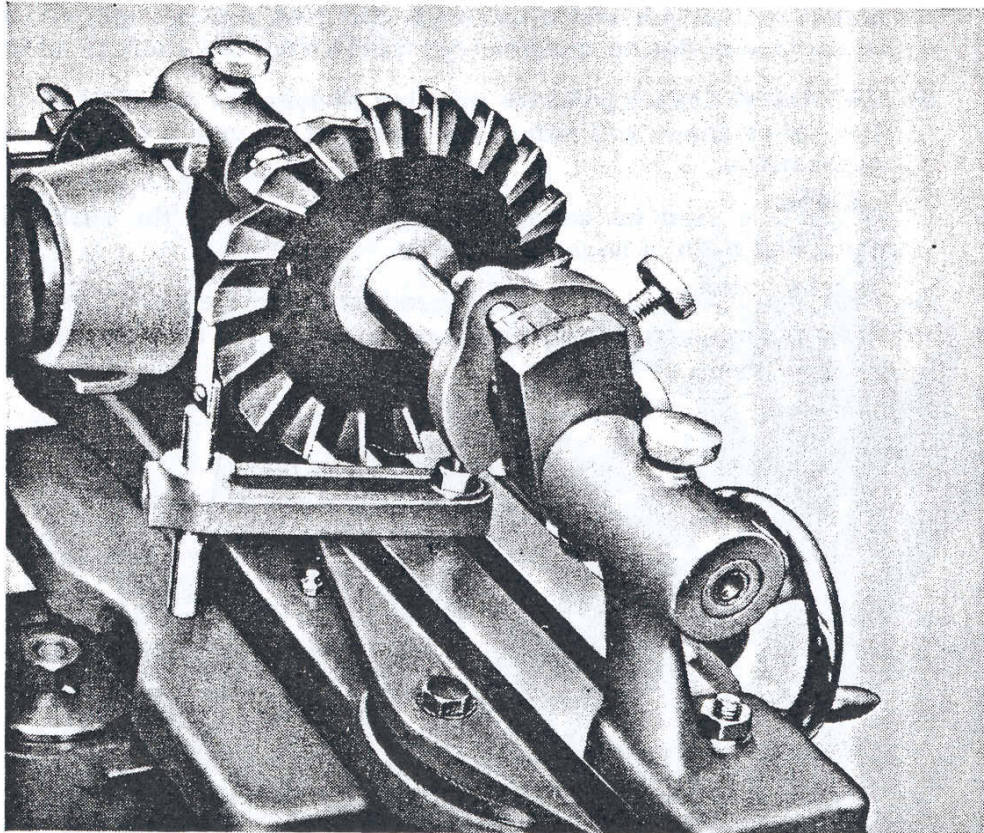


Micro-adjustable finger shown in position



## Setting Gauge Method

1. Attach clearance angle setting gauge to centre of L.H. bracket.
2. Mount cutter on mandrel between centres.
3. Set gauge to zero and attach carrier but do not secure to mandrel.
4. Using centre height gauge, set tooth to be ground on centre.
5. Tighten clamping screw of carrier on to mandrel, thus locking cutter with tooth on centre.
6. Slacken the clamping screw on the zero scale, rotate to required clearance angle and lock in position. As the mandrel is attached to the zero scale, by means of the carrier, it too will rotate.
7. Set a trip finger underneath the tooth, which is now in the correct position for the clearance required.
8. Slacken off the screw securing the carrier to the mandrel and remove carrier.



## Tooth Rest and Fingers

For the majority of operations, the tooth blade or finger should be located as near as possible to the holder to ensure maximum rigidity and support to the cutter tooth during grinding. The finger should also be as near as possible to the grinding wheel without touching but never more than 1/32" away.

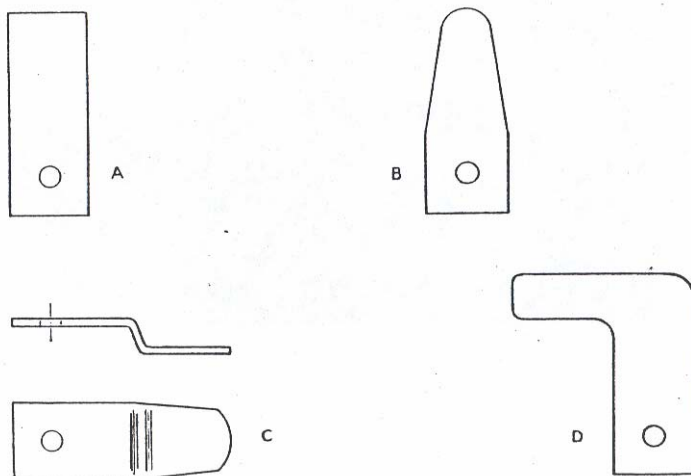
When grinding plain or straight toothed cutters that are mounted on arbors or between centres, and require the table to pass them along the wheel, the tooth rest should be mounted on the machine table, thus allowing the tooth being ground to remain stationary.

However, when grinding helical or spiral toothed cutters or reamers, the tooth rest must be mounted on the wheel head to remain in line with the wheel.

The type and shape of the finger will contribute to the ease and quality of the ground cutter. There are no definite shapes to use, but with experience the operator can easily make special shapes to suit any special cutter grinding operation. Worn and broken hacksaw blades can be easily shaped into fingers which will suit most applications.

The following shapes will serve as a guide.

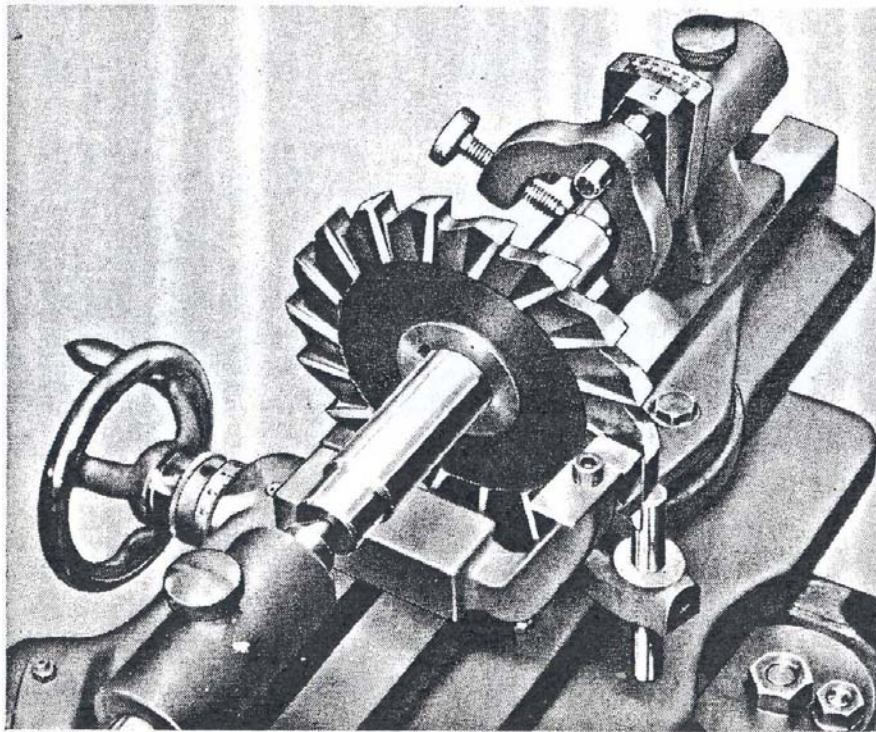
- A. STRAIGHT BLADE is used for grinding all types of straight fluted cutters such as side and face cutters, end mills, reamers, etc., and should be capable of flexing to allow for tripping from one tooth to another.
- B. RADIUS END is used for grinding all types of spiral-fluted cutters. The exact shape and radius will however be varied to suit particular applications.
- C. OFFSET is used for certain spiral cutters and for the sharpening of peripheral teeth of large cutters, etc.
- D. RIGHT ANGLE or L SHAPED is used for thin cutters and ones with too finely spaced teeth that will not accommodate the straight blade (A).



## Grinding Periphery of Side and Face Cutter

1. Use cup-shaped wheel, clearance angle setting gauge, centre height gauge and mandrel.
2. Mount clearance angle setting gauge on loose head centre and set gauge at zero.
3. Secure cutter to mandrel and mount between centres.
4. Using the centre height gauge set tooth of cutter on centre line and lock the mandrel to the clearance angle setting gauge with the thumb screw in the carrier.
5. Slacken the clamping screw in the zero scale of setting gauge, and rotate to the required clearance angle.
6. Set tooth rest, with trip finger, to cutter tooth and release or remove the carrier clamping the mandrel.
7. Set wheel head and table at zero.
8. Position the wheel head centre to approximately the centre height of the loose head.
9. Position and secure wheel guard.

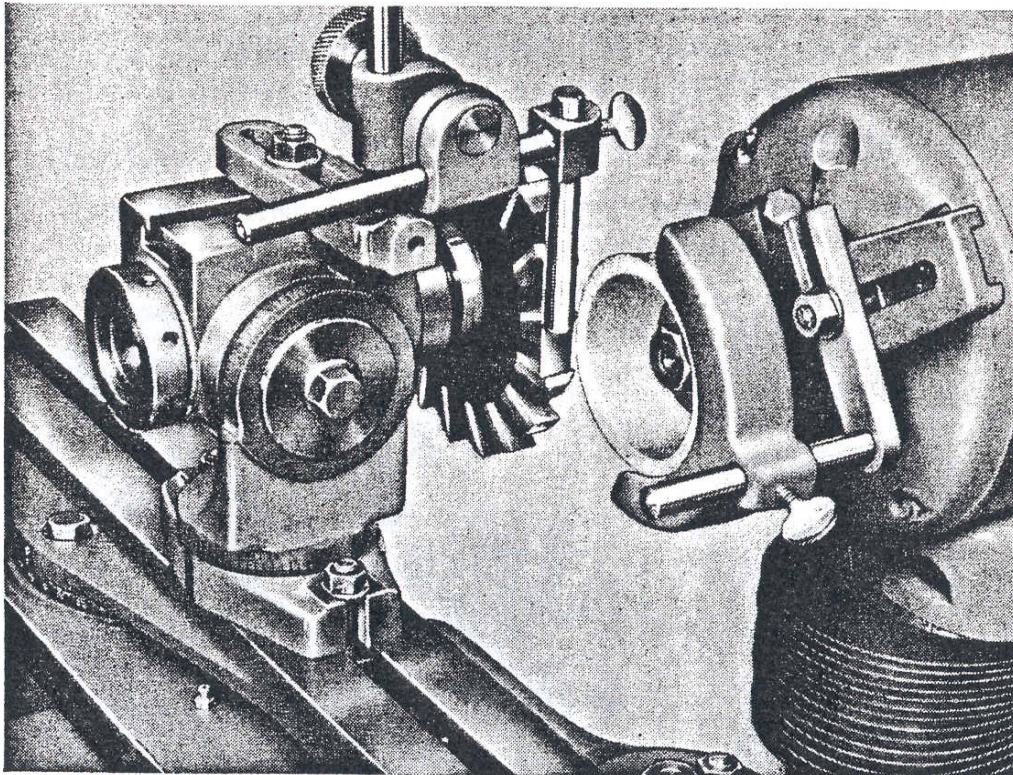
See table at Linear Method for alternative method of setting clearance angles.





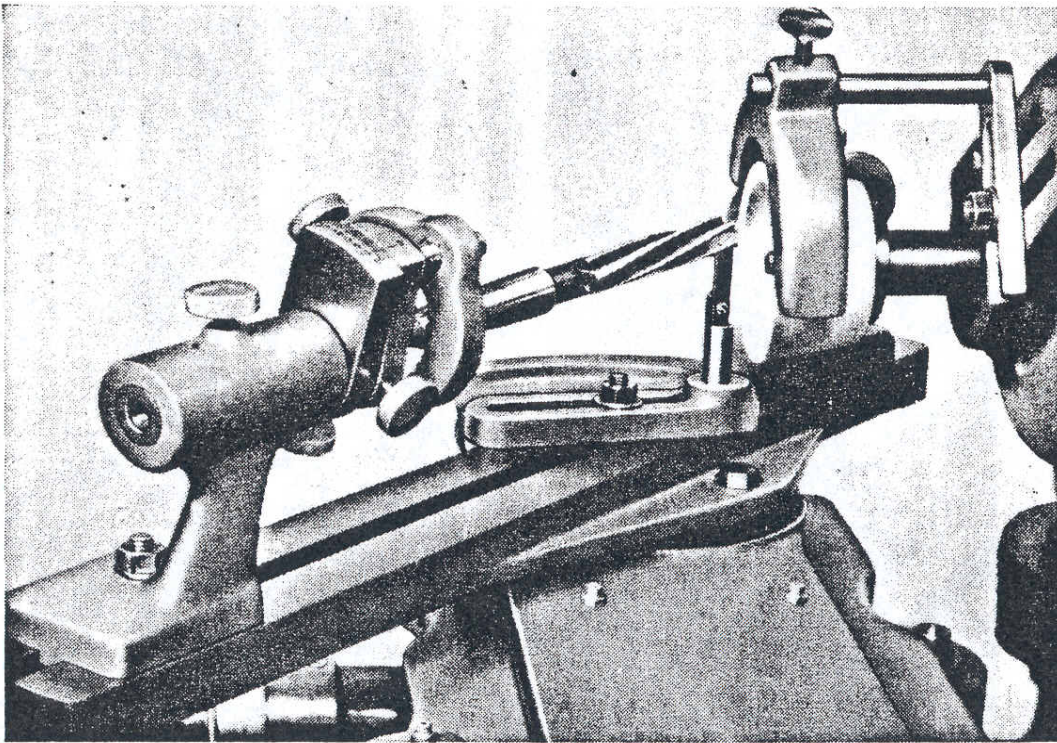
## Grinding Side Face of Side and Face Cutter

1. Use cup-shaped wheel, universal head and cutter arbor.
2. Set wheel head and table at zero.
3. Clamp universal head on table, insert cutter arbor and secure cutter. Set universal head to give  $3^\circ$  approx. side clearance and from outer diameter to centre of cutter.
4. *With* face of tooth to be ground horizontal, clamp toothrest on top of universal head and position on tooth.
5. Set wheel head centre above height of face of tooth to be ground, so wheel clears tooth below.
6. Position and secure wheel guard.



## Grinding Lead of Reamer

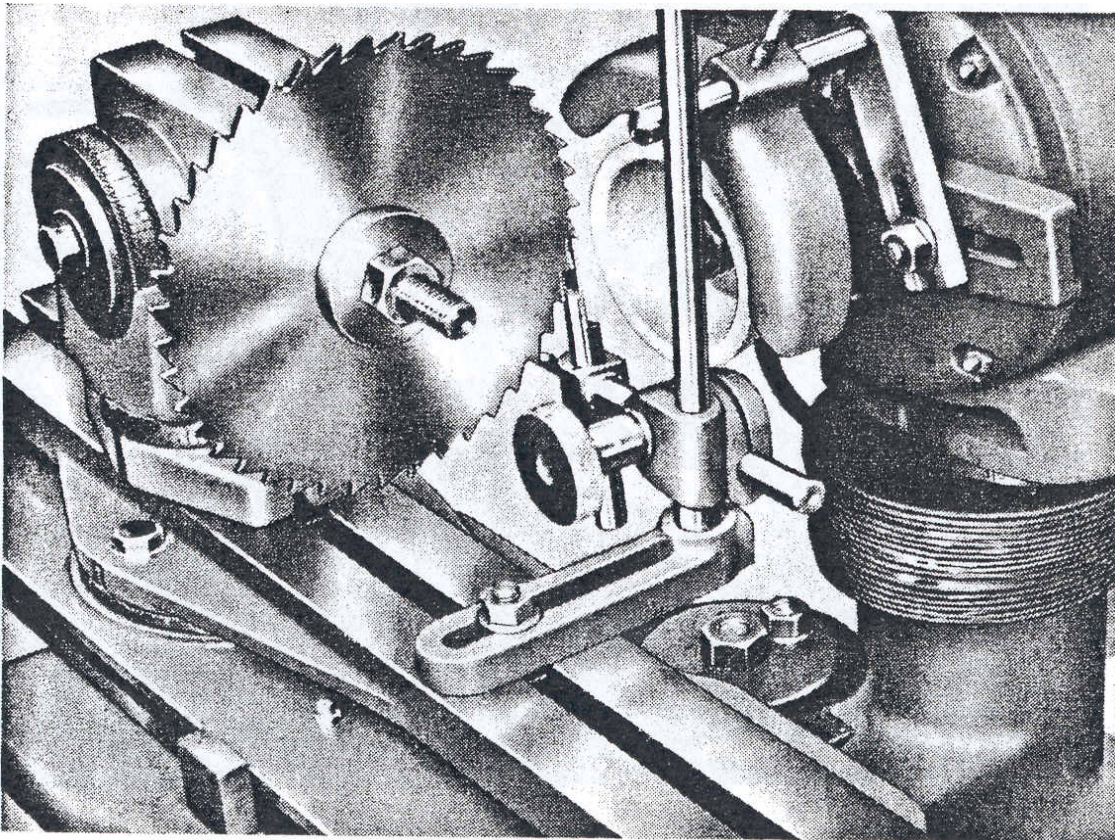
1. Use cup-shaped wheel, wheel extension, clearance angle setting gauge, centre height gauge and short tooth rest finger shaft.
2. Mount clearance angle setting gauge on loose head centre, and set gauge to zero.
3. Place reamer between centres.
4. Set wheel head at zero and the table to the required angle of lead.
5. Using the centre height gauge, set tooth of reamer on centre line and lock reamer to the clearance angle setting gauge with the thumb screw in the carrier.
6. Slacken the clamping screw in the zero scale of setting gauge, and rotate  $10^\circ$  to give required clearance angle.
7. Set tooth rest in spiral of lead to be ground and release or remove the carrier of the angle gauge.
8. Position table stop to avoid grinding centre.
9. Set wheel head centre to approximately the centre height of the loose head. Position and secure wheel guard.





## Sharpening Slitting Saw (Periphery)

1. Use cup-shaped wheel, universal head, cutter arbor and scribing block.
2. Set wheel head and table at zero.
3. Clamp universal head on table, insert cutter arbor and secure slitting saw.
4. Set universal head at zero in both planes.
5. Using scribing block, set tooth to be ground below centre of universal head an amount corresponding to the clearance angle required (see chart at Linear Method) and lock in position.
6. Set tooth rest, with trip finger under tooth to be ground.
7. Position and secure wheel guard, and adjust wheel head centre to approximately the centre height of the cutter.

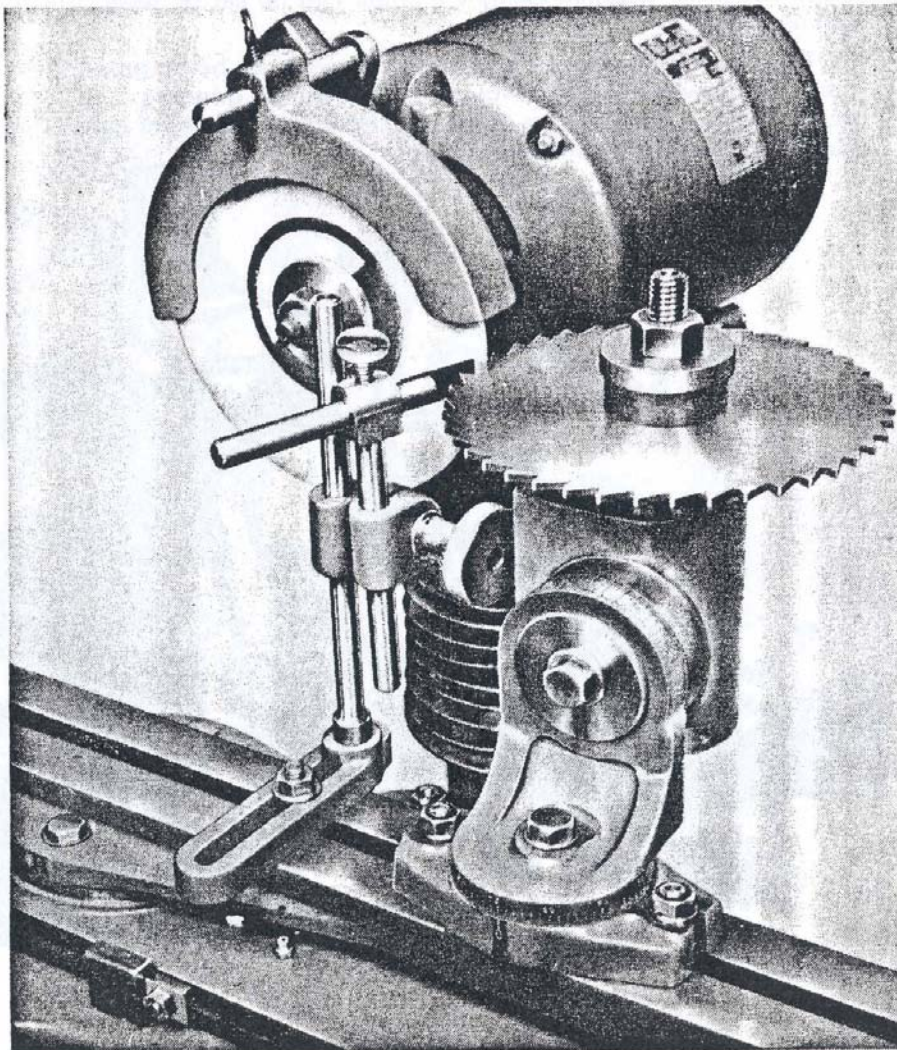




## Regashing Slitting Saw

1. Use dish shaped wheel, wheel extension, universal head and cutter arbor.
2. Set wheel head and table at zero.
3. Clamp universal head on table, insert cutter arbor.
4. Set universal head at zero and in vertical position.
5. Position wheel head so that cutting face of grinding wheel is in line with centre of cutter arbor.
6. Mount slitting saw and clamp so that face is parallel to table movement.
7. Position tooth rest with trip finger behind tooth to be gashed.
8. Set table stop to give required gashing depth.
9. Set wheel head centre central about the saw, position and secure wheel guard.

NOTE: Depending on size and shape of cutter the micro adjustable finger can be used to set the required clearance angle.

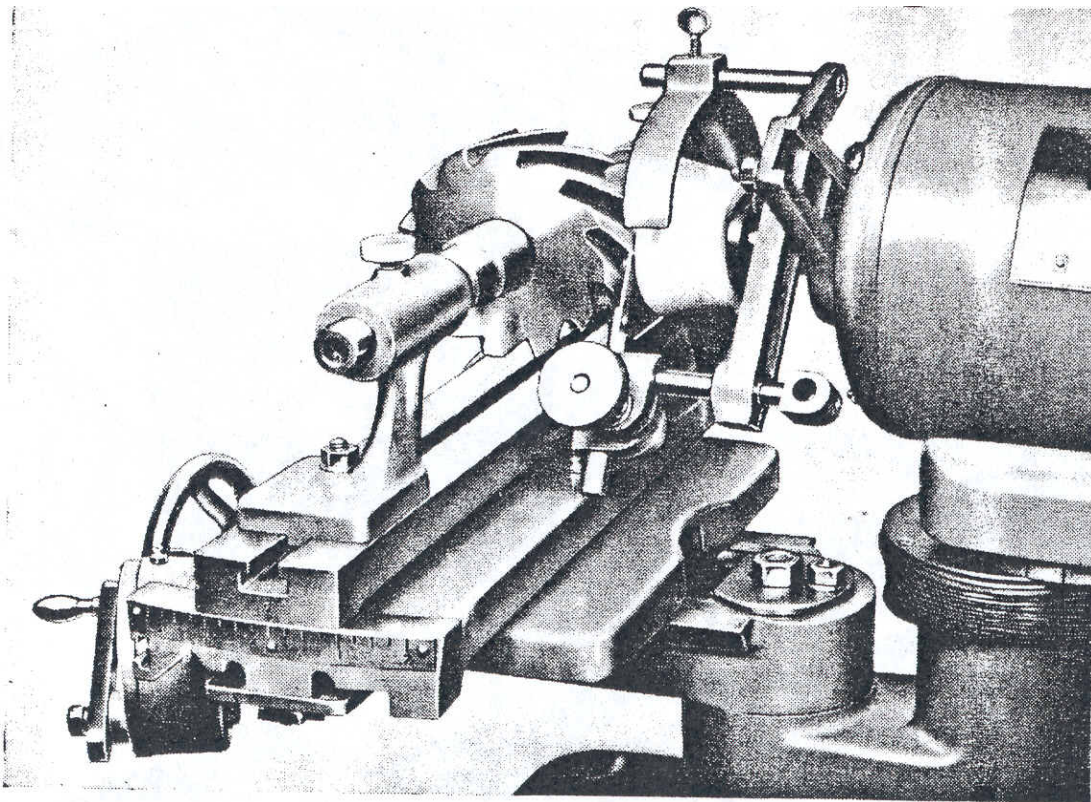


## Grinding Periphery of Helical Slab Cutter

1. Use cup-shaped wheel and centre height gauge.
2. Set table at zero and wheel head at 30° approx. to ensure grinding takes place on one side of wheel only.
3. Mount tooth rest on wheel head Banjo arm.
4. Set tooth rest to centre height of loose heads, inclined at approximately the cutter helix angle and approximately on centre line of wheel head.
5. 5. Secure cutter to mandrel and mount between centres.
6. Lower wheel head the amount corresponding to clearance angle required (see table at Linear Method).
7. Position and secure wheel guard.
8. Keep cutter in contact with the finger during grinding.

If preferred, the required clearance angle can be set by using the angular setting gauge.

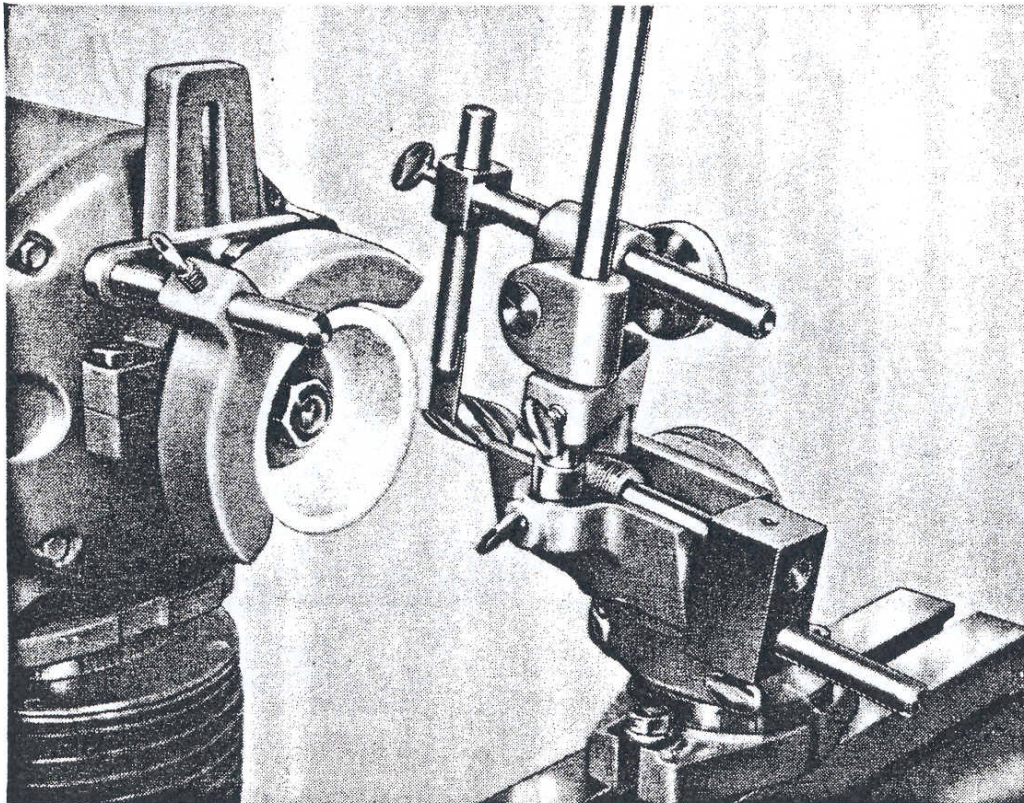
NOTE: Care must be taken to ensure that teeth not being ground will clear the grinding wheel when the cutter rotates during grinding.  
Set up may be made easier depending on size and style of cutter if raising blocks are used under the loose heads.





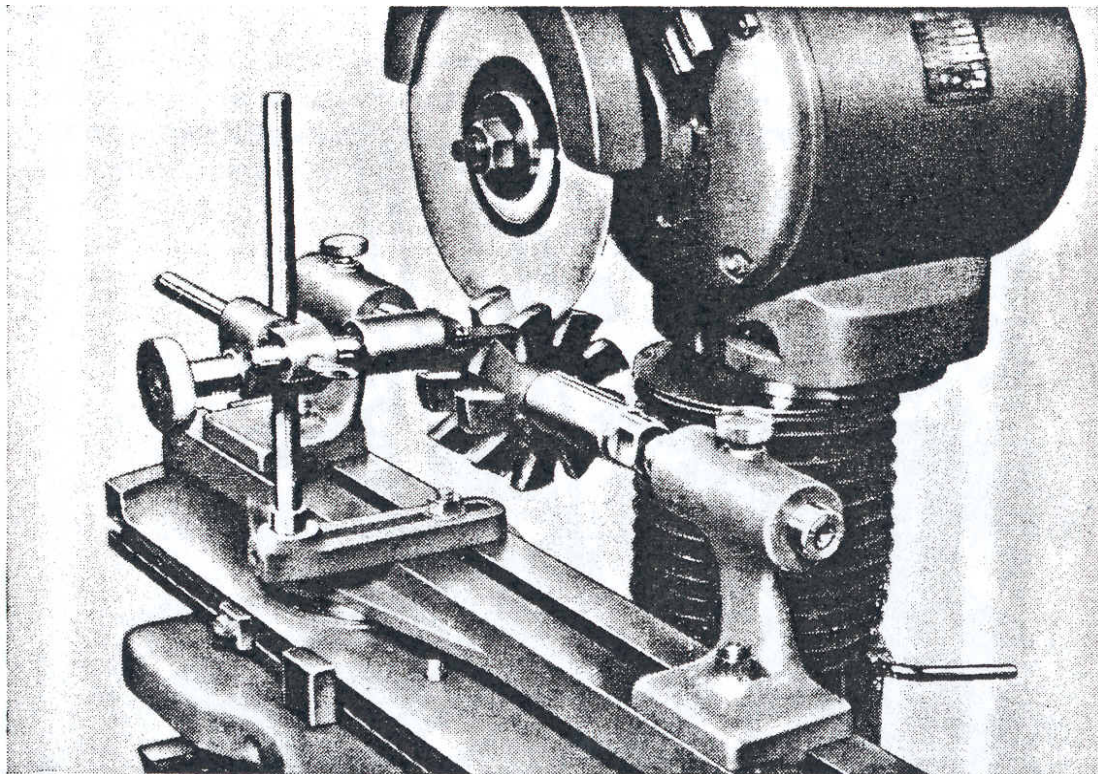
## Grinding End Face of End Mill

1. Use cup-shaped wheel, end mill grinding attachment and angle bracket of universal head.
2. Set wheel head and table at zero.
3. Clamp angle bracket to table and fix vee attachment.
4. Mount end mill in vee attachment and hold with spring-loaded clamp.
5. Set length stop and rotate end mill until cutting edge is parallel to table.
6. Set vee attachment at 5° approximate and swivel angle bracket 1° approximate to give clearances.
7. Mount tooth rest on attachment and set trip finger on tooth to be ground.
8. Set wheel head centre to approximate centre height of end mill, position and secure wheel guard.



## Sharpening Formed Milling Cutter

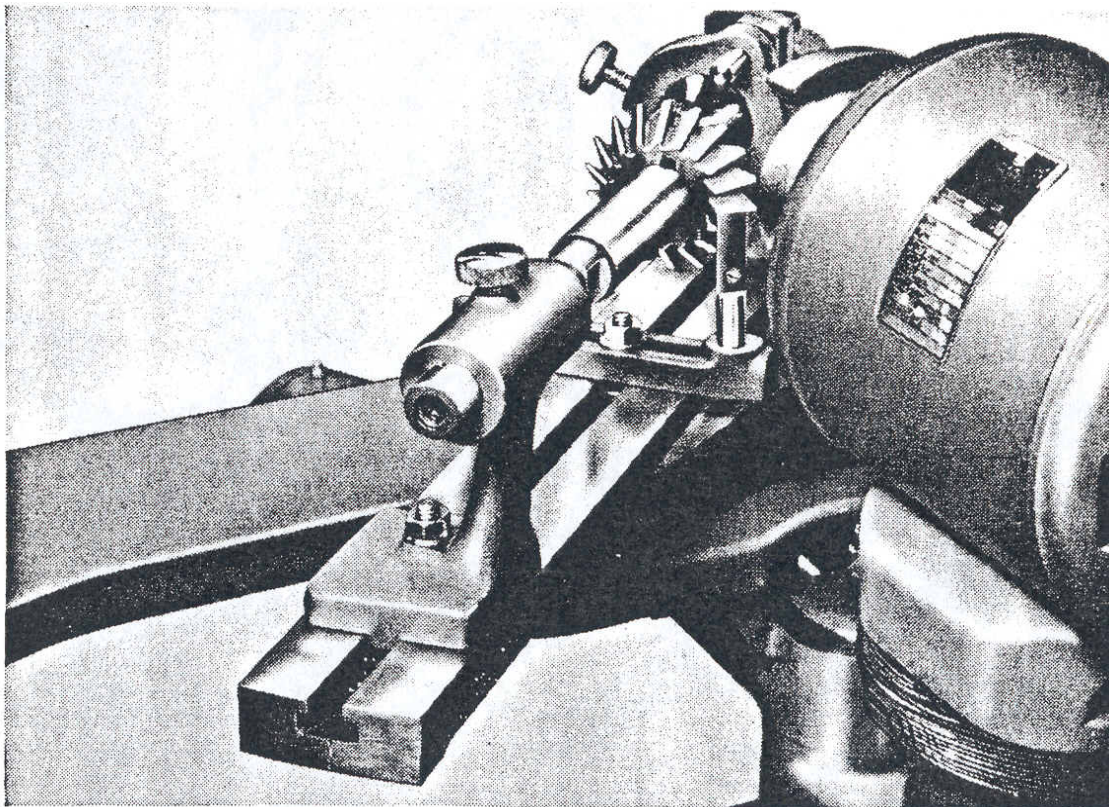
1. Use dish-shaped wheel, micro-adjustable finger and wheel extension.
2. Set wheel head and table at zero.
3. Position cutting edge of grinding wheel on axis of centres.
4. Secure cutter to mandrel and mount between centres.
5. With cutting face of cutter in vertical plane, position tooth rest with micro-adjustable finger behind tooth to be cut.
6. Adjust height of wheel head to grind full face of cutter.
7. Position and secure wheel guard.
8. Apply feed (or cut) by rotating cutter with micro-adjustable finger, then index from tooth to tooth in normal manner.





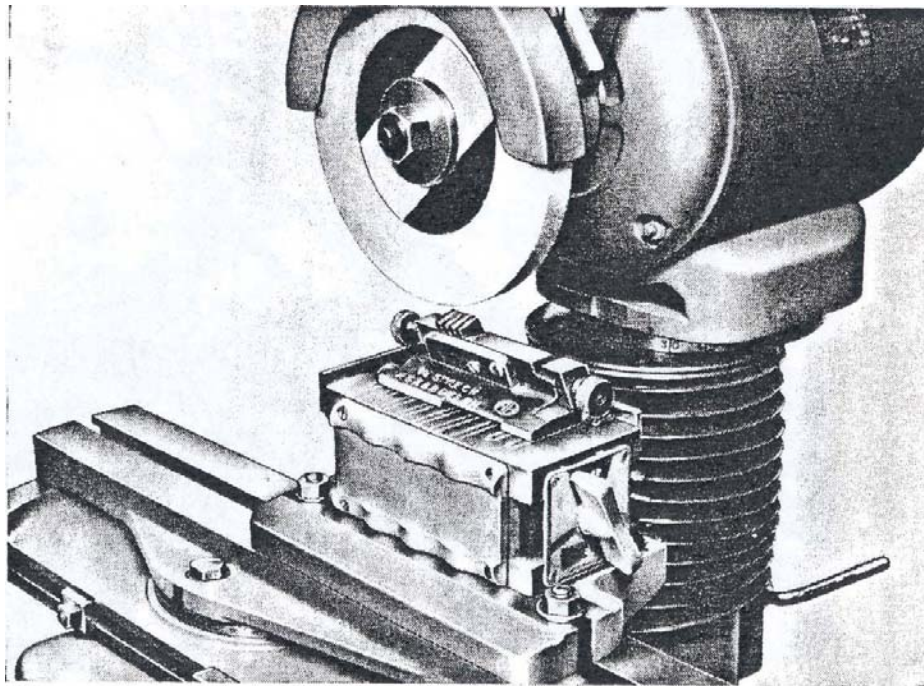
## Sharpening Angle Cutter

1. Use cup-shaped wheel, centre height gauge, clearance angle setting gauge, and short tooth rest finger shaft depending on diameter of cutter.
2. Set wheel head at zero and table to angle of cutter.
3. Mount clearance angle setting gauge on loose head centre and set at zero.
4. Secure cutter to mandrel and mount between centres.
5. Using centre height gauge, set tooth of cutter on centre line and lock mandrel to clearance angle gauge with thumb screw in the carrier.
6. Slacken the clamping screw in the zero scale of setting gauge, and rotate to the required clearance angle.
7. Set tooth rest, with trip finger, to cutter tooth and release or remove the carrier clamping the mandrel.
8. Position the wheel head centre to approximately the centre height of the loose head.
9. Position and secure wheel guard.



## Grinding Throat Angle of Coventry Dies Using Surface Grinding Attachment

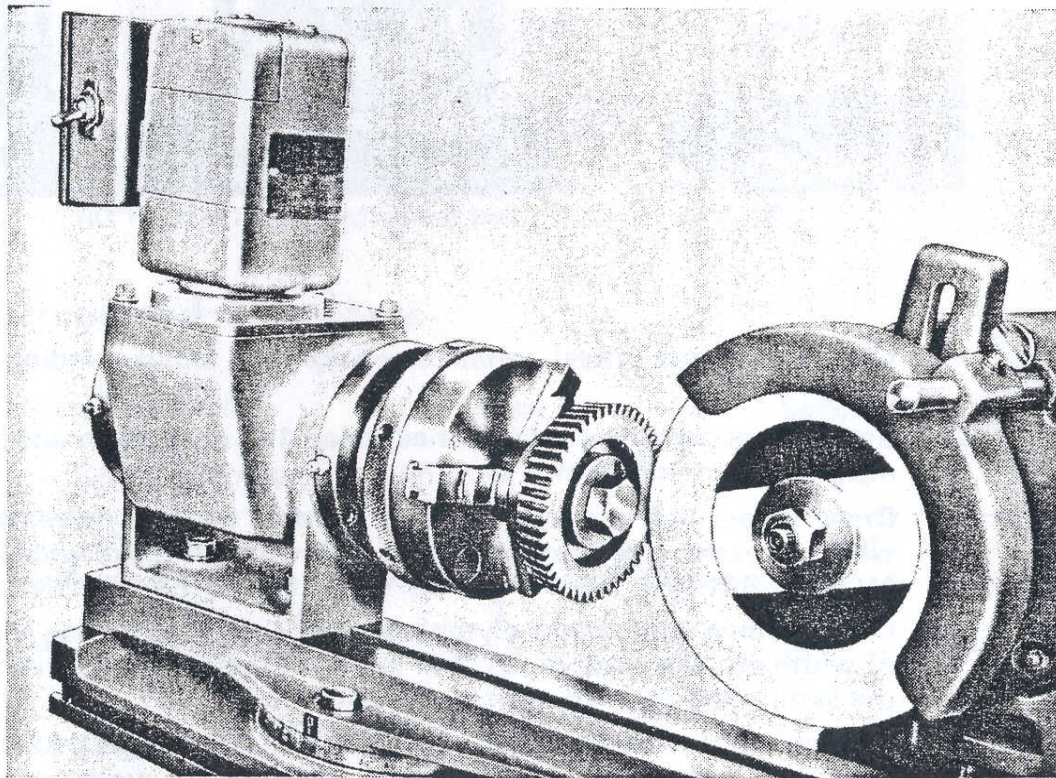
1. Use plain wheel, surface grinding attachment. die grinding fixture and wheel extension.
2. Set wheel head and table at zero.
3. Clamp mounting platform to table and attach magnetic chuck.
4. Secure die grinding fixture to magnetic chuck and lock in the dies.
5. Position and secure wheel guard.
6. Apply cut .002" maximum by lowering wheel head.
7. Pass dies longitudinally below wheel and move across transversely after each pass.



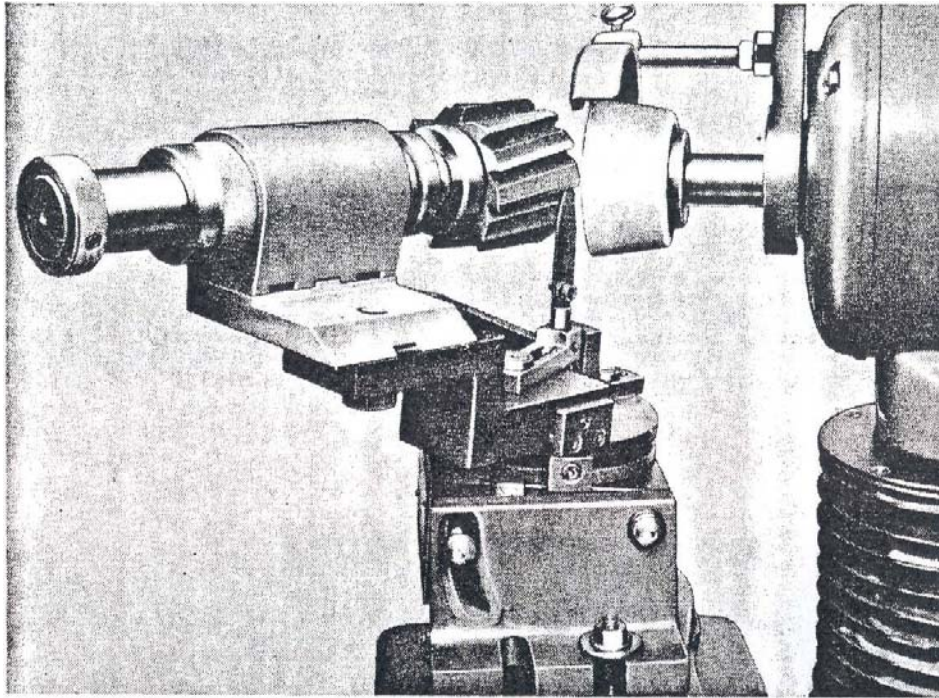


## Sharpening Gear Shaper Cutter with Motor- Driven Workhead

1. Use plain wheel, wheel extension, motor-driven workhead with or without chuck depending on the cutter arbor style and suitable cutter arbor.
2. Set wheel head at zero and table at 5° to give cutter relief.
3. Clamp motor-driven workhead to table and secure cutter arbor.
4. Secure cutter to the arbor and set table stops so that the grinding wheel just touches the cutter face to be ground.
5. Position and secure wheel guard.
6. Apply cut by moving table longitudinally and clamping with table stops
7. With cutter and wheel revolving traverse cutter across grinding wheel.



## Grinding Radius on End Mill



1. Use cup-shaped wheel, wheel extension and radius grinding attachment.
2. Set table at zero and rotate wheel head  $15^\circ$  or more to ensure teeth not being ground do not foul the grinding wheel.
3. Dress wheel flat and true on face to table traverse movement with wheel dresser (diamond) at centre line of grinding wheel. STOP MOTOR BEFORE PROCEEDING WITH FURTHER SETTING.
4. Clamp radius attachment on table and set setting bar, using slip gauge of width equal to radius required between the setting bar bracket and the setting diameter of the central pivot pin.
5. Clamp holder on swan neck end, set rotation limit dog so that the centre line of the holder is at right angles to table traverse movement.
6. Place setting centre in holder and set cutter finger on centre line.
7. Tilt bearing housing to clearance angle required (see table opposite).
8. Place cutter in holder and slide forward until cutter contacts the setting bar. Lightly lock sleeve with grub screw and the holder locating rings to remove any end float.
9. Position finger under lip of cutter. If flutes are spiral as on end mills, etc. a constant rake cannot be acquired. As the tooth spirals downwards so the rake increases, therefore to produce a rake which will blend into the side teeth and also connect on the end, the front tooth should be set on centre line at the point where the radius blends into the side tooth. If tooth spirals upwards, the end of the tooth should be set on centre line at the point where the radius blends into the end tooth.
10. Remove or swing setting bar out of way of grinding wheel.
11. Wind infeed handle of machine, thus moving table, until cutter just touches the wheel. Set dial to zero.



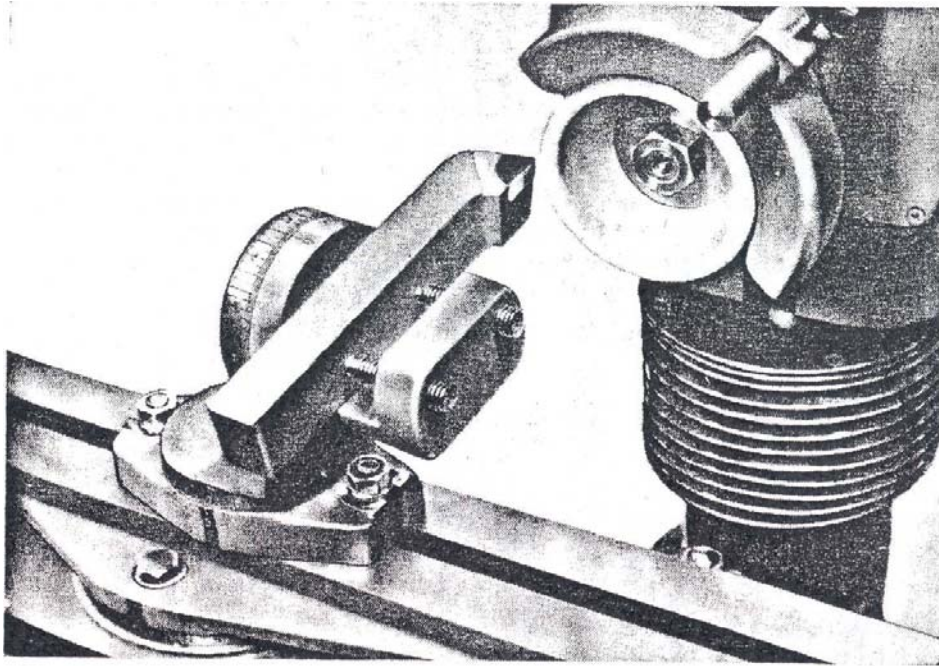
12. Traverse table (longitudinally) so that cutter moves clear of grinding wheel.
13. Swing fixture head 90° so side of cutter is parallel with face of wheel and set other limit dog.
14. Wind swan neck on fixture until cutter just contacts the wheel and lightly lock in position.
15. Traverse table longitudinally until fixture head can swing 90° without fouling the wheel.
16. Start wheel, and swinging head through 90° slowly traverse table (longitudinally) towards the wheel. This will produce a radius on the cutter.
17. Index to next tooth and repeat paragraphs 15 and 16.

### Recommend Clearances

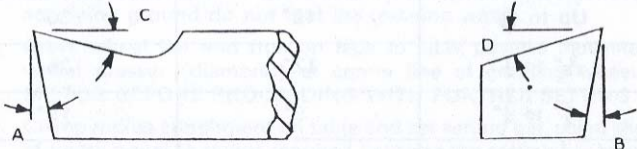
Cutter Diameter	Primary	Secondary
Up to $\frac{3}{16}$ "	15°	30°
$\frac{3}{16}$ " to $\frac{1}{2}$ "	12°	25°
$\frac{1}{2}$ " to $\frac{3}{4}$ "	9°	18°
$\frac{3}{4}$ " to 2"	7°	18°
Over 2"	6°	18°

NOTE: When grinding radii larger than 1/8" this should be carried out in two operations, i.e. rough and finish to ensure accuracy and minimise wheel wear.

## Sharpening Lathe Tool



1. Use cup-shaped wheel, angle bracket of universal work support and vice.
2. Set wheel head and table at zero.
3. Clamp angle bracket to table, the vice to bracket and secure the tool to be ground.
4. Swivel the angle bracket and vice to the required clearance angles (see table below).
5. Set wheel head centre to the approximate height of tool cutting edge; position and secure wheel guard.



**HIGH SPEED STEEL TOOL ANGLES**

Material	Front Clearance A	Side Clearance B	Top Rake C	Side Rake D
Aluminium	9°	9°	30°	15°
Brass	7°	6°	0°	5°
Cast iron	5°	4°	10°	9°
Mild steel	8°	6°	20°	15°
Plastic	10°	8°	25°	25°
Wood	15°	15°	25°	25°

## Specification

Swing over table	6" dia.
Swing over table with raising blocks	8" dia.
Maximum distance between centres	6"
Table longitudinal traverse	11"
Table cross traverse	4"
Table dimensions	20" x 2 3/8"
Tee slot width..	7/16 "
Centre of wheel above table (max.)	9 3/8"
Centre of wheel above table (min.)	2 3/4"
Table swivel	180°
Head swivel	360°
Speed of spindle (r.p.m.)	2800
H.p. of motor..	1/4
Spindle thread	7/16" Whit.
Overall working area of machine.	36" x 30"
Height of bench machine (max.).	28 1/8"
Height of cabinet mounted machine (max.)	58 1/2"
Nett weight of bench machine..	190 lb.
Nett weight of cabinet mounted machine	310 lb

### Standard Equipment

Set of loose centre heads complete with centres.  
 Compound universal work support  
 Universal tooth rest  
 One 3 1/2" x 1 1/2" bore cup grinding wheel  
 One 6" x 1/2" x 5/8" bore dish grinding wheel  
 Wheel guards  
 Set of spanners  
 Oil gun  
 Instruction booklet

### Additional Equipment

Cabinet base  
 Surface grinding attachment  
 End mill grinding attachment  
 Motor-driven workhead  
 Vice  
 Centre height gauge  
 Clearance angle setting gauge  
 Micro-adjustable finger  
 Diamond dressing tool  
 Raising blocks  
 Radius grinding attachment  
 Collet attachment (for universal work support)  
 Side and face cutter arbor (for universal work support)  
 Dust extractor unit