Boxford

G 200 tool and cutter grinder

Operator's Handbook

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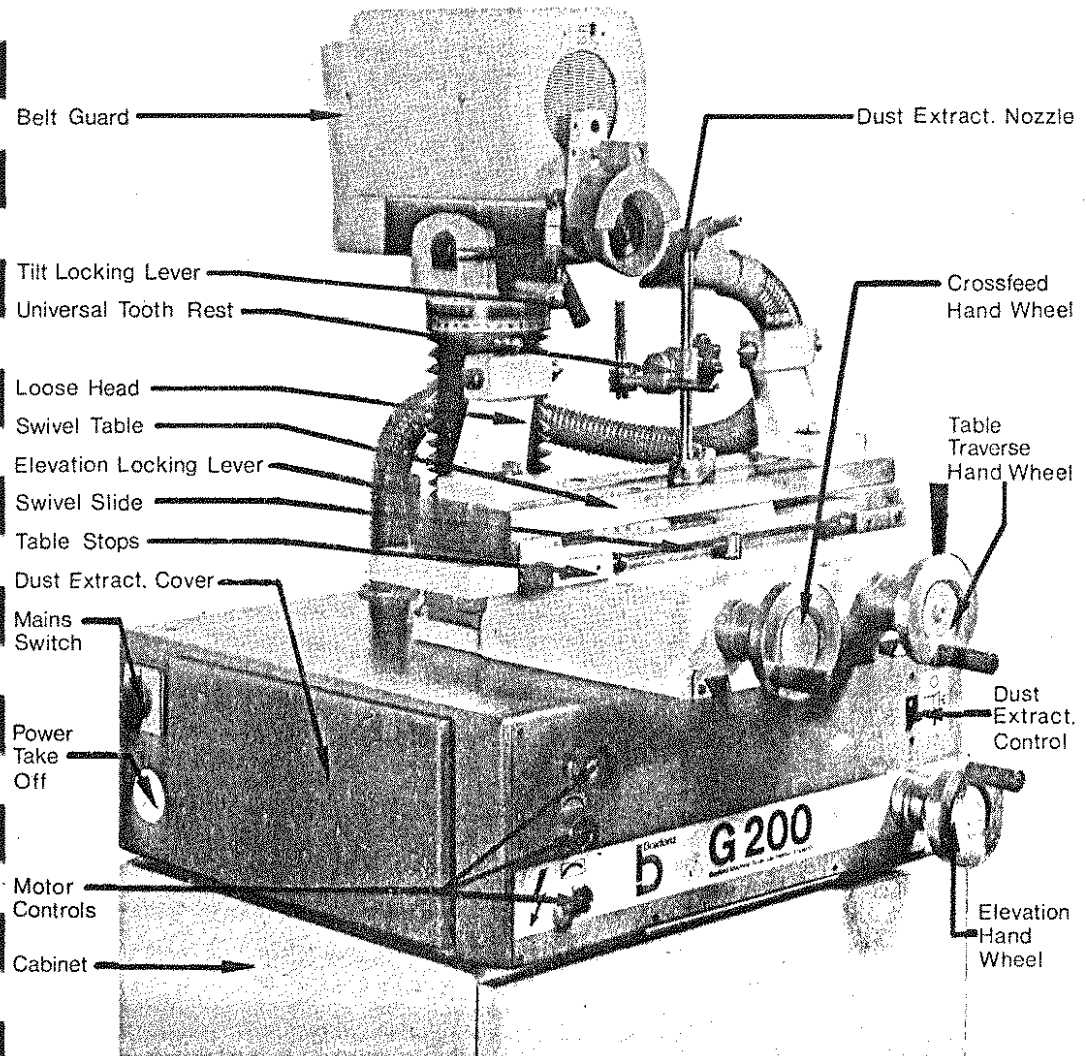
Principle Parts of Machine



Description

WHEELHEAD provides two spindle speeds (3,500 and 5,500 r.p.m.) which are obtained from 3/4 H.P. (.56 kW) totally enclosed fan cooled motor via a flat belt drive at the rear. Speed changes are made by varying the position on two-step pulleys situated behind a safety guard secured with a thumbscrew. The spindle, which is reversible by means of three conventional push buttons located on the front panel of the machine, is mounted on pre-loaded angular contact bearings and has a tapered location for the grinding wheel adaptors. Vertical adjustment of the head is by means of a handwheel, at the lower right hand of the front panel, fitted with a friction micrometer dial having 100 divisions each representing 0.02 mm on METRIC machines and 0.001" on IMPERIAL (ENGLISH) machines. It can be locked in the vertical plane by a lever situated on the left of the support column.

The wheelhead fits inside a swivel bracket so that it can be inclined 20° above and below the horizontal and is securely locked by the friction lever at the right hand of this bracket. It can be swivelled through 360° in the horizontal plane, being locked in the desired position by two socket head clamping screws at the rear of the column.

WORK (OR SWIVEL) TABLE is arranged to swivel through 180°. It is graduated 45° either side of zero and is locked in position by the two socket head screws in the top surface. The swivel point 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 by means of an engraved plate on the end of the table slide which indicates percentages, i.e. mm/cm etc.

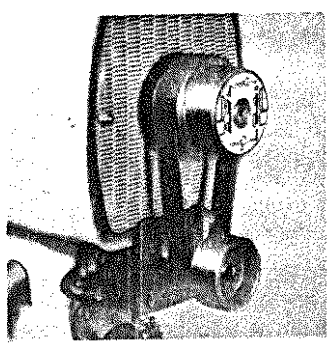
TABLE (OR SWIVEL) SLIDE runs on anti-friction needle bearings arranged on the vee and flat formation. A tee-slot along the front edge of the slide serves as location for the spring loaded stops which can be locked in any position and reversed should it be desired to have a more positive dead stop. Longitudinal movement is through a rack and pinion by means of a handwheel situated on the right of the Carriage (or saddle). This handwheel is friction mounted so that the grip can be used in the most suitable position by means of a central socket head clamping screw. A tapped hole is provided in the periphery of the handwheel for securing the loose handle should it be desired to convert it to a lever action for certain applications.

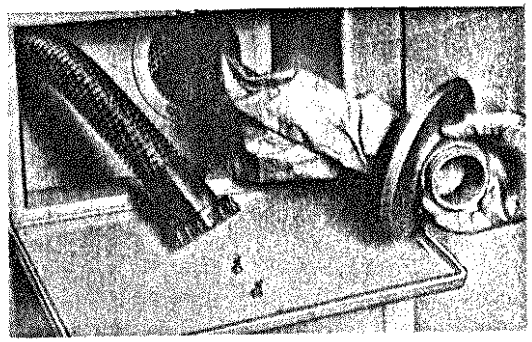
CARRIAGE (OR SADDLE) is located on dovetail ways on the main body of the machine and is fitted with an adjustable gib strip which engages one side of the dovetail. Adjustment to the gib is made by tightening or slackening the grub screws along the side of the carriage, except the one in the centre which serves as a location. The handwheel on the left of the carriage is for controlling the cross traverse, and carries a friction micrometer dial having 100 divisions each representing 0.02 mm on METRIC machines and 0.001" on IMPERIAL (ENGLISH) machines.

CENTRE HEADS locate in the tee slot of the work table which allows the distance between them to be adjusted whilst still maintaining alignment. Their "off-set" design allows full reversibility to accommodate long work pieces and/or different diameters of cutters. 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 serve also as a 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 toothrest post with finger. The base can be clamped either on the table or Universal Workheads. As the posts are the same diameter and therefore interchangeable the combination of "set ups" is considerable, also when the need arises, part of the unit

can be mounted on the wheelhead support posts. The unit also serves as a holder for the Diamond Dressing Tool which is available as extra equipment.





DUST EXTRACTION UNIT is housed in the machine body. It incorporates a fan motor, disposable bag and has externally a flexible hose terminating in a conical nozzle which can be mounted on the wheelhead support posts, or Universal Tooth Rest posts so that it can be positioned as near as possible to the grinding wheel and cutter. It is controlled by a special starter switch situated on the right of the front panel of the machine, electrically wired so that it operates the fan motor only when the wheelhead spindle is rotating. The switch has an overload protection device which having automatic reset requires no adjustment. Should the "heater coil" require replacing it will be necessary to unscrew the front panel from the machine (after first disconnecting the mains supply) so that the complete switch can be removed to reveal the "heater" adjacent to the switch "toggle". The replacement must have the same rating as the one originally fitted. Access to the disposable collecting bag (which is made of a special paper allowing air to pass through but not grit) is by a hinged panel on the left of the machine. When full the bag is simply taken out of the machine, and depending on its condition, discarded or emptied and used again.

Additional Equipment

TWO WORKHEADS, one with a No. 50 international taper plain bearing spindle and one with a No. 4. morse taper ball bearing spindle are available for use on a common universal support bracket, the base and bracket both being off-set to give maximum versatility and allow the heads to swivel in both the horizontal and vertical planes. Should the need arise, the workheads can be aligned with one of the loose centre heads. Each head has at the front (or internal taper end) an adjustable dial engraved 360° in increments of 1° and at the other end has an external register and tapped holes for securing the Indexing Attachment or a 100 mm (4") — 4 jaw independent chuck.

As the No. 50 int. taper is a "non-stick" taper three drawbolts, 1" whit, 1" U.N.C. and M. 24 are available for holding in the cutters.

The Ball bearing Workhead which has the No. 4. Morse internal taper also has at the rear an internal location for adaptor bushes which can be used to hold cutters with parallel shanks. It can also be motorized to drive either its spindle or in conjunction with a special Dead Centre be arranged for cylindrical grinding.

INDEXING ATTACHMENT consists of a drum with three rows of holes, 28, 36 and 40 per row, and a universal plunger bracket for clamping to the tee-slots in both workheads. The plunger can be kept raised to clear the drum by lifting and twisting clockwise, and a choice of two clamping holes is provided to allow the bracket to be fitted to either tee-slot.

After fixing a cutter either directly to the workhead spindle or in conjunction with other ancillary equipment, lock the spindle with first tooth to be ground set on centre line, then zero the engraved dial on the spindle. Unlock the spindle and rotate to give the desired angle of clearance or backing-off, then relock the spindle.

Fix the index drum to the rear of the spindle and lightly clamp with the two cap head screws near the centre of the two slots in the drum face. Secure the plunger bracket to the tee-slot of the workhead using the location pin and one clamping screw with plunger roughly in line with the row which gives the indexing required. Now slowly rotate the drum until the plunger drops into the hole. Finally fully clamp both the drum and plunger bracket, check that the plunger will lift in and out of the hole. The unit is now ready for grinding the cutter and indexing as required.

MOTOR DRIVING ATTACHMENT incorporates a 1/15 H.P. reversing worm drive motor which when coupled to the spindle pulley, via a flat belt, gives approx. 150 r.p.m. on full load. The motor and reversing switch are secured to a special mounting plate which is clamped to the tee-slot of the Ball Bearing Workhead by means of a double tee-nut and cap head screws. The unit is complete with a belt guard and rectangular pin fused plug, fused at 3 amp, which is suitable for plugging into the socket on the L.H. side of the machine. The motor mounting plate has two sets of clamping screws along both sides of the switch box to enable the unit to be fixed to either tee-slot thus allowing full use of the universal support bracket for maximum versatility.

A special dead centre, having a No. 4. M.T. shank complete with revolving pulley and driving pin is available to enable the unit to be used for cylindrical grinding etc. This centre also serves as a coupling device; by removing the driving pin and replacing this with the special dog pointed grub screw and locknut which is screwed in until the dog point enters the specially drilled hole in the front face of the spindle, it is then possible to power drive anything fixed to the rear of the spindle e.g. 4-jaw independent chuck etc.

SURFACE GRINDING attachment is complete with a high quality magnetic table 150 x 100 mm (6" x 4") capacity, a general purpose 150 x 13 mm wide (6" x ½") grinding wheel, special wheel extension with locknut and a special wheel guard having nozzle for attaching dust extraction hose.

The magnetic table should be clamped to the table tee-slot central about its length. It will then be necessary to remove the standard wheel adaptor from the wheelhead spindle and the guard and guard pin from the banjo plate. Clamp the new extended guard pin in the top hole of the banjo plate ready to receive the special guard. Mount the extended wheel adaptor onto the end of the spindle securing it with the special locknut. Now nest the grinding wheel inside the guard then slide them together, the wheel onto the adaptor and guard onto its pin. Secure the grinding wheel to the adaptor using the safety washer and clamping nut. Clamp the guard in position sideways centrally about the grinding wheel. Push the dust extraction flexible hose on to the nozzle attached to the guard. Using the magnetic table top as a guide rotate the banjo plate together with the guard about the spindle axis until the lower end of the guard is about 0.75 mm (1/32") above the bottom of the wheel periphery. As the wheel wears down (due to repeated dressing and truing) the banjo plate can be rotated to maintain the above dimension.

To facilitate dressing the wheel, an Adaptor Block is available for mounting the Diamond Dressing Tool on the magnetic table face.

NOTE: The use of the special attachments does not make the machine into a precision Cylindrical or Surface Grinder and its scope in this respect is therefore limited.

See leaflet and price list for other equipment not mentioned above.

Installation

Correct installation and maintenance of the machine is essential if the maximum performance is to be obtained.

Usually, if delivery of the machine entails only a short/medium road journey, it will (with the exception of the odd handle etc.) be received fully assembled and mounted on the cabinet base (if ordered) and will only require removal of protective greases etc. before levelling and connecting to the mains supply.

Certain cabinet mounted export machines are despatched with the specially designed cabinet base bolted to the top of the machine. See separate instructions for dismantling and assembling.

Protective greases can be removed using paraffin and a stiff brush; wiping over afterwards with a clean cloth.

Four eye bolts having M.10 threads are supplied for fixing to the corners of the machine to facilitate lifting. Care must be taken not to damage the slides with lifting slings or ropes. Once the machine is in position these eye bolts should be replaced with the four socket head grub screws supplied.

Preferably, the machine should be bolted down to a concrete floor (cabinet mounted models) or a substantial bench. It should firstly be accurately levelled using a level along and across the top of the table, placing steel wedges or shims between the floor and the base or the bench and the machine body.

Wiring

The machine is supplied ready wired internally and only requires the correct mains supply to be connected to the terminal strip fixed to the body inside the rear louvred cover.

Size of cable for connecting mains supply should be suitable for 15 amps approx. to allow for an additional load on the built-in plug socket. It is recommended that a wall mounted fused isolator, of at least 15 amps rating be mounted adjacent to the machine.

If preferred, 1 phase machines may be run from either 15 amp or 13 amp socket.

POWER PLUG SOCKET is provided for ancillary equipment such as motor drive attachment etc., but when machine is in use the following loads should not be exceeded:—

3 phase Machine — 10 amps.
1 phase Machine — 5 amps.

It is essential that the correct mains supply be connected to the machine. The following will cover most locations but if in any doubt consult a qualified electrician or contact us direct at the works.

3 phase — HIGH VOLTAGE —	380/440 must be 4 wire supply i.e. 3 LINES & NEUTRAL plus EARTH.
3 phase — LOW VOLTAGE —	220/254 must be 3 wire supply i.e. 3 LINES plus EARTH.
1 phase — up to 250 VOLTS	must be 2 wire supply i.e. LINE & NEUTRAL plus EARTH.

NOTE: The reversing starter, which incorporates no-volt and overload release is of the manual resetting type. Should an overload occur the RED reset button on the thermal overload unit must be depressed before the machine will operate

To gain access to the starter remove the rear louvred cover after first isolating the machine from the mains supply. Should the overload continue to "trip-out" consult a qualified electrician.

Lubrication

Keep slides and machined surfaces clear of grinding dust.

Oil weekly all moving parts fitted with oilers using the oil can supplied filled with any good quality light machine oil.

Oiling of the cross-traverse nut should be done when the carriage face is flush with the machine front panel thus aligning the oiler with the nut.

The saddle dovetail ways should be inspected every three months, the ways cleaned and smeared with a "moly-slip" lubricant or lightly oiled if oil is preferred.

It is advisable every month to remove the table slide to inspect and wash if necessary any dust from the table bearing strips.

Motor bearings are grease packed and sealed for life.

Wheelhead spindle bearings are fitted with greaser cups and require only one turn every three to six months. DO NOT OVER GREASE.

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 BOXFORD 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.

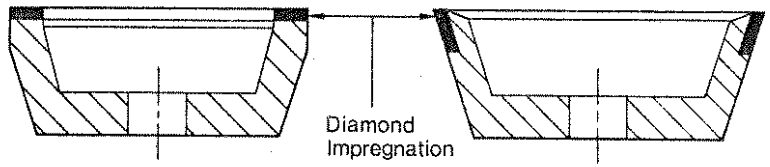
Basic Principles

1. Select and mount the correct grade of grinding wheel for the job, taking care to run it at a speed below the maximum safe speed marked on the wheel paper disc. Most H.S.S. cutters and tools can be ground with the two wheels provided but special wheels with different grits, bonds, materials and sizes can be obtained from grinding wheel manufacturers for special work. Carbide tipped cutters and tools are best ground with Diamond impregnated wheels. Available as additional equipment are two types of impregnated cup wheels which are capable of producing a good finish for most applications.
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 type of cutter and material being cut.
4. Where possible, always have the wheel rotation such that the grinding pressure is into the support finger.

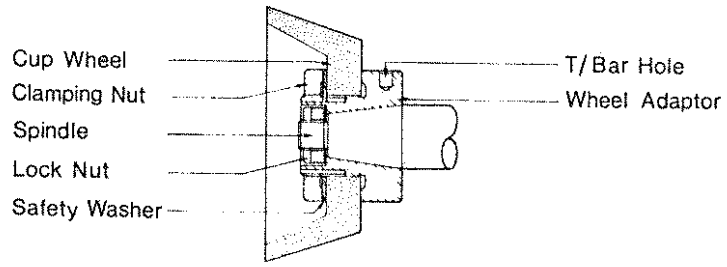
5. Never apply too heavy a cut especially when using diamond wheels. It only gives rise to rapid wheel wear, and overheating of the tooth being ground, which results in an inaccurate cutter. Depth of cut should be in the region of 0.01 to 0.03 mm (.0004" to .001") and allowed to "spark out" on each tooth. Avoid bumping work into the wheel.
6. Always fit wheel guard securely in position closely over grinding wheel and check that the spindle is on the correct safe speed before starting the machine. To ensure that the wheel is free to rotate and not rubbing guards, fingers or fixtures, rotate spindle by hand before running on power.
7. For your health's sake always use the dust extraction unit which will remove most of the fine grinding dust. It is also advisable to wear a pair of safety eye shields or glasses in case the larger particles of grit do not fall harmlessly to the base of the machine.

Types of Wheels, Mounting, Truing and Dressing

The standard grit Cup and Dish shaped grinding wheels supplied with the machine are suitable for most H.S.S. cutters and tools, but for the grinding of carbide cutters and tools it is recommended that Diamond Impregnated wheels are used. As with grit wheels, the shape, size, concentration and bonding etc. may have to be varied depending on the finish required or special nature of the work. A good commercial finish on most conventional carbide cutters and tools can be obtained with the two Diamond Impregnated Cup shaped wheels available as additional equipment. One, a Flaring Cup with the diamond in the periphery is suitable as a general purpose wheel, where both carbide and mild steel stock may be removed simultaneously. The other, a Taper Cup with the diamond in the 9.5 mm (3/8") wide rim is more suitable where a greater degree of "lapping" is required.



All grinding wheels should be mounted on a wheel adaptor which is secured to the tapered location on the front end of the spindle. The adaptor is arranged to receive wheels having 31.75 mm (1¼") dia. bore and up to 13 mm (½") thickness. Before mounting grit wheels, 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 safety washer, which is keyed to the adaptor, is in position. This is to prevent the clamping nut unscrewing.

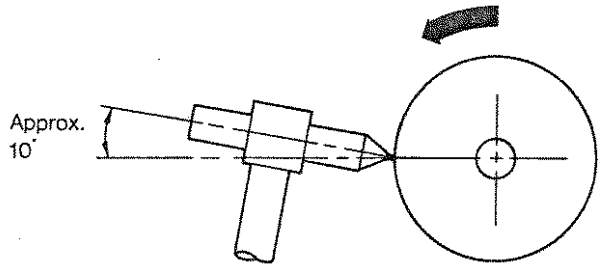


The clamping nut should be tightened only sufficiently to securely hold the wheel. Excessive clamping pressure will possibly crack a grit wheel and is unnecessary for driving purposes.

Whenever a wheel is mounted, before use, it should be checked to see that it is sound, the maximum safe speed noted so that the correct spindle speed can be selected and it should always be trued so that it will run without vibration. For grit wheels, this is best done by using a diamond dressing tool correctly mounted and rigidly clamped. Free hand truing is most inadvisable as there is a tendency to follow any irregularities in the wheel shape.

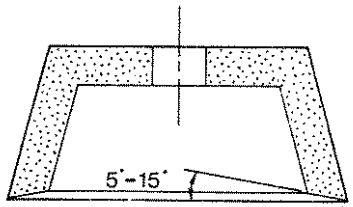
The diamond dressing tool should be clamped firmly, as close as possible to the diamond, in the universal tooth rest in place of the tooth rest post.

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 10° to give "drag" effect or trailing cut.



Depth of the cut should not exceed 0.12 mm (.005") decreasing on subsequent passes according to the wheel finish required. Table traverse should not be too rapid and 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 grit 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 generating 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.

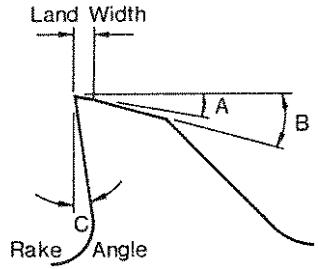
Diamond impregnated wheels must not be dressed as above but should be checked with a dial indicator for face and peripheral 'runout'. Such runout should not exceed 0.008 mm (.0003") on any particular wheel. Cup wheels may be scraped on the backs to correct any error in face runout, and any peripheral error in these and other shaped wheels can be corrected by moving round on the wheel adaptor. Bores are usually made slightly oversize to allow for this.

Always ensure that the wheel guard is securely in place, the wheel clamping nut is tight and the spindle is on the correct speed before attempting to dress or true a grinding wheel. Goggles or other suitable eye protection should always be worn and the dust extraction unit used.

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 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. Generally, land widths on carbide tipped cutters are smaller than those for H.S.S. milling cutters.

Recommended Land Widths

H.S.S. Cutters 0.8 – 1.5 mm (1/32" – 1/16")
Carbide Cutters 0.4 – 0.8 mm (1/64" – 1/32")

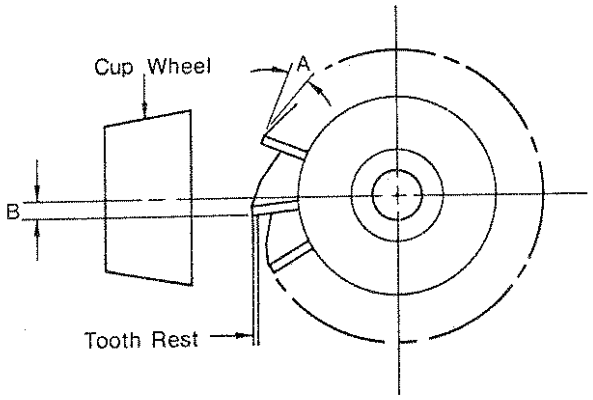
Material to be cut	Primary Angle "A"		Secondary Angle "B"		Rake Angle "C"	
	H.S.S. Cutters	Carbide Cutters	H.S.S. Cutters	Carbide Cutters	H.S.S. Cutters	Carbide Cutters
Aluminium	8°-12°	8°	15°	11°	10°-15°	10°-20°
Brass	8°-12°	8°	15°	11°	0 - 5°	5°- 8°
Cast Iron	3°- 7°	3°	15°	6°	0 - 5°	0 - 5°
Mild Steel	3°- 5°	3°	15°	6°	10°-15°	6°-10°
High Carbon Steel	3°- 5°	3°	15°	6°	3°- 5°	3°- 5°
Plastic	8°-12°	8°	15°	11°	15°-25°	15°-25°

When cutting Cast Iron with Carbide Cutters, if there is the horse-power available and great stock removal is required, sometimes the Rake Angle (C) is made Negative as opposed to the Positive Angles quoted and illustrated above. In such cases, it is usual to have angles up to 8° which will make the included wedge angle of the cutter greater than 90° for increased strength, compared with the more conventional cutter which always has an included wedge angle less than 90°.

Methods of Setting Clearance Angles

LINEAR METHOD "A"

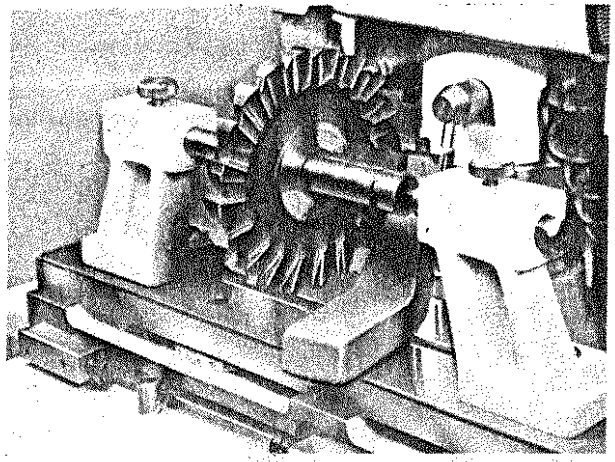
1. Mount cutter on suitable mandrel or stub arbor.
2. Using Centre height gauge, set tooth to be ground on centre.
3. Using Micro-adjustable finger, set finger under tooth.
4. Adjust finger an amount corresponding to clearance angle required and diameter of cutter (see chart below).



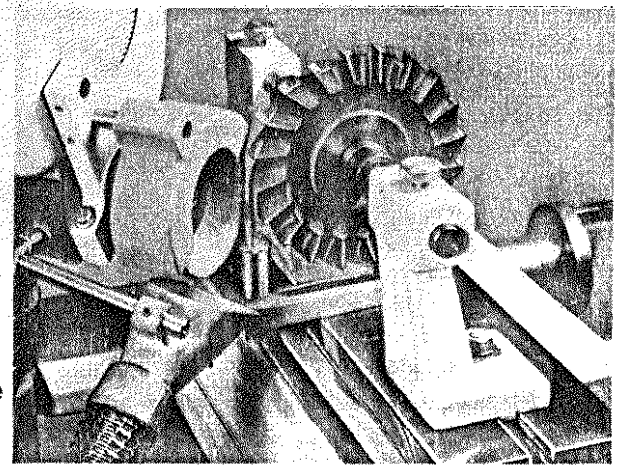
Clearance Angle 'A'		3°		5°		7°		8°		10°		12°	
Cutter Dia.		Dimension 'B'											
ins.	mm	ins.	mm	ins.	mm	ins.	mm	ins.	mm	ins.	mm	ins.	mm
1	25	·025	·63	·042	1·06	·059	1·49	·067	1·70	·084	2·13	·100	2·50
1½	38	·038	·96	·064	1·62	·089	2·25	·102	2·55	·127	3·20	·153	3·85
2	50	·052	1·32	·086	2·16	·120	3·00	·137	3·45	·171	4·30	·204	5·15
2½	64	·065	1·65	·108	2·75	·150	3·80	·172	4·35	·214	5·40	·257	6·50
3	75	·078	1·98	·129	3·25	·181	4·58	·207	5·20	·258	6·50	·309	7·80
4	100	·104	2·64	·173	4·35	·242	6·10	·276	7·00	·345	8·70	·412	10·40
5	125	·130	3·30	·216	5·45	·303	7·65	·346	8·75	·431	10·90	·516	13·00
6	150	·156	3·95	·260	6·55	·364	9·15	·415	10·50	·518	13·10	·620	15·60
7	175	·182	4·60	·304	7·70	·425	10·75	·485	12·20	·605	15·25	·724	18·25
8	200	·209	5·25	·347	8·75	·486	12·25	·554	14·00	·692	17·50	·828	20·90

LINEAR METHOD "B"

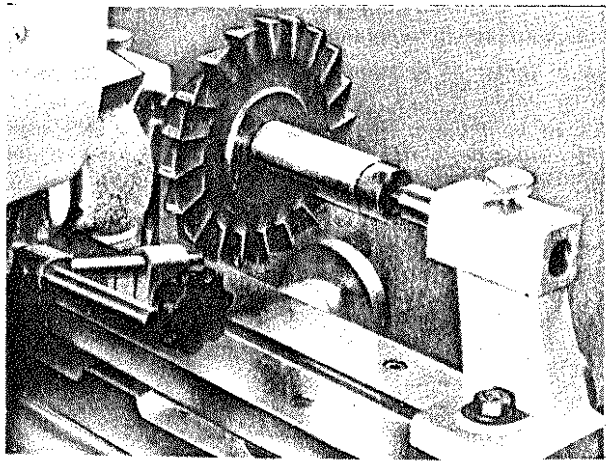
1. Mount Toothrest on wheelhead approximately on centre line of wheel.
2. Using Centre height gauge, raise or lower wheel head until finger is on centre.
3. Mount cutter on suitable mandrel or stub arbor.
4. Lower wheel head an amount corresponding to clearance angle required and diameter of cutter (see chart above), using dial on elevating handwheel.



Setting Tooth to Centre Line with Height Gauge

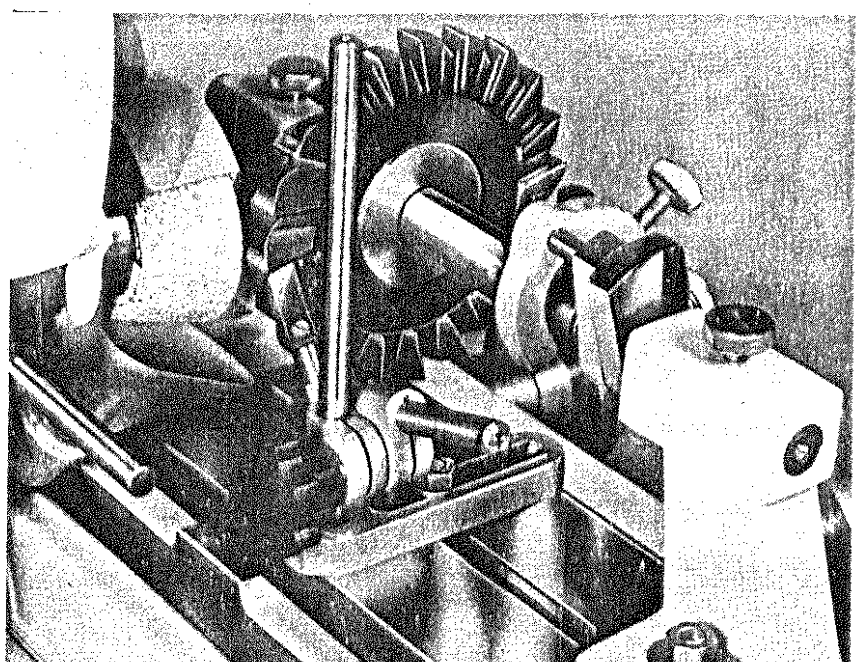


Micro-adjustable Finger used to Give Clearance



Finger mounted on Wheelhead

Methods of Setting Clearance Angles



SETTING GAUGE METHOD

1. Attach Clearance angle setting gauge to centre of L.H. loose centre head.
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, both it and the cutter will move to the required angle.
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 0.8 mm (1/32") away.

When grinding plain or straight 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 grinder operation. Worn and broken hacksaw blades can be easily shaped into fingers which will suit most applications.

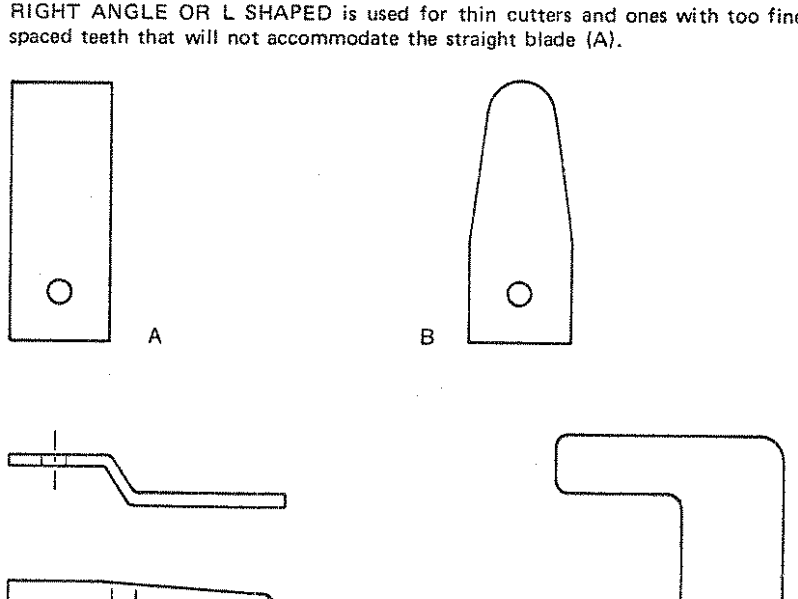
The following shapes will serve as a guide.

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. RADIUSED 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

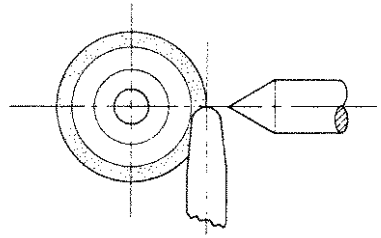
See Page 12 for Illustration of Set up.

STANDARD TOOTH

1. Use cup-shaped wheel, Clearance angle setting gauge, Centre height gauge and mandrel.
2. Set wheelhead and table at zero.
3. Mount clearance angle setting gauge on loose head centre and set gauge to zero.
4. Secure cutter to mandrel and place between centres.
5. Using centre height gauge set tooth of cutter on centre line and tighten clamping screw of carrier on to mandrel.
6. Slacken clamping screw on zero scale of setting gauge, rotate to required clearance angle and lock.
7. Set toothrest finger underneath tooth to be ground, then release or remove the carrier clamping the mandrel.
8. Set wheelhead to approximately centre height of loose heads. Secure wheel guard, select correct spindle speed and position dust extraction nozzle.

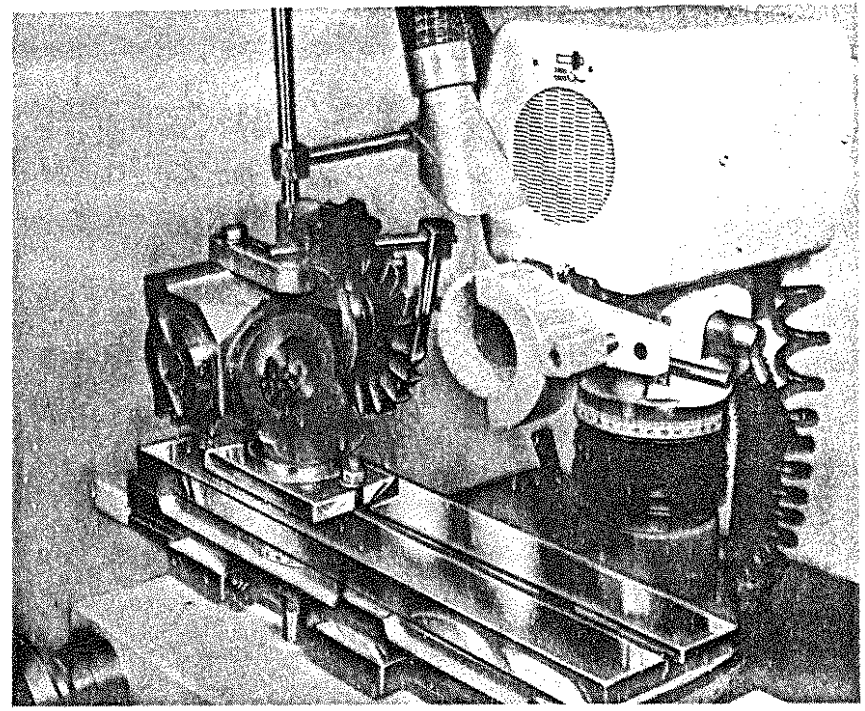
STAGGERED TOOTH

1. Use cup-shaped wheel, centre height gauge, radiused end finger (see P.13) and mandrel.
2. Set table and wheelhead at zero. Depending on size and style of cutter, wheelhead may have to be set at approx. 10° clearance to avoid grinding on both sides of wheel which will then require its nearest edge dressing parallel to table movement to give approx. 1.5 mm (1/16") land.
3. Mount toothrest on wheelhead support post (see P.11) and set finger on peripheral edge of wheel, vertical and on centre height as shown in sketch.
4. Secure cutter to mandrel and mount between centres with tooth to be ground on finger.



5. Lower wheelhead the amount corresponding to clearance angle required (see table on page 10).
6. Secure wheel guard, select correct spindle speed and position dust extraction nozzle.
7. Keep cutter in contact with toothrest finger during grinding.
8. Commence grinding left to right, index to next tooth, then grind right to left.

Grinding Side Face of Side and Face Cutter



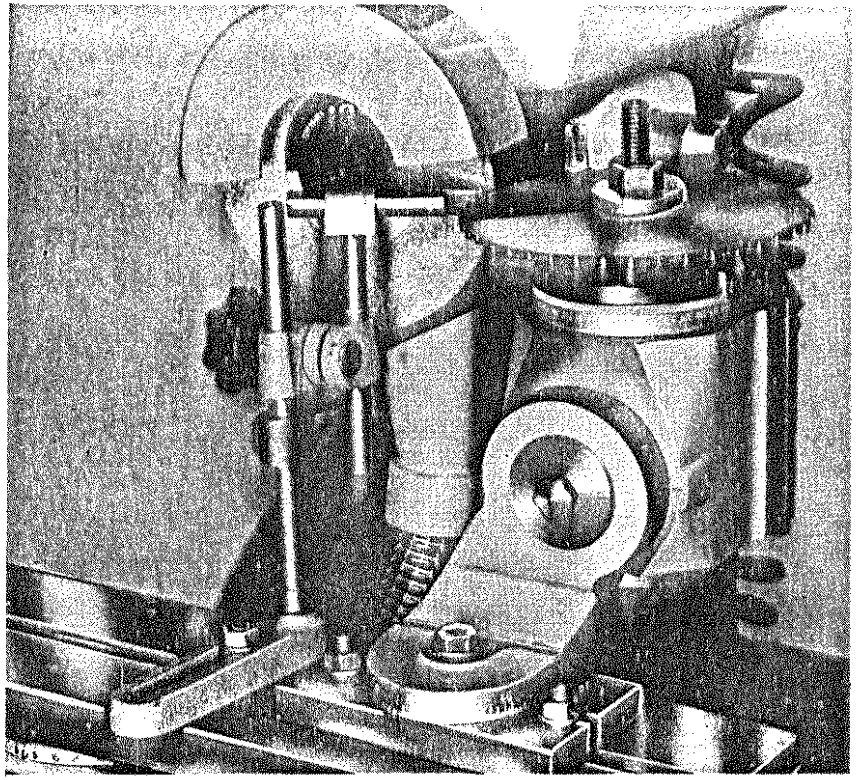
STANDARD TOOTH

1. Use cup-shaped wheel, No. 4 M.T. ball bearing Workhead and cutter arbor.
2. Set table and wheelhead at zero. Depending on size and style and style of cutter, wheelhead may be rotated to give up to 10° clearance to avoid grinding with both sides of wheel.
3. Clamp universal workhead on table and set to give 3° approx. side clearance and 1° from outer diameter to centre of cutter. Insert cutter arbor and secure cutter.
4. With face of tooth to be ground horizontal, clamp toothrest on top of universal workhead and position finger on tooth.
5. Set wheelhead centre above face of tooth to be ground so that wheel clears tooth below.
6. Secure wheel guard, select correct spindle speed and position dust extractor nozzle.

STAGGERED TOOTH

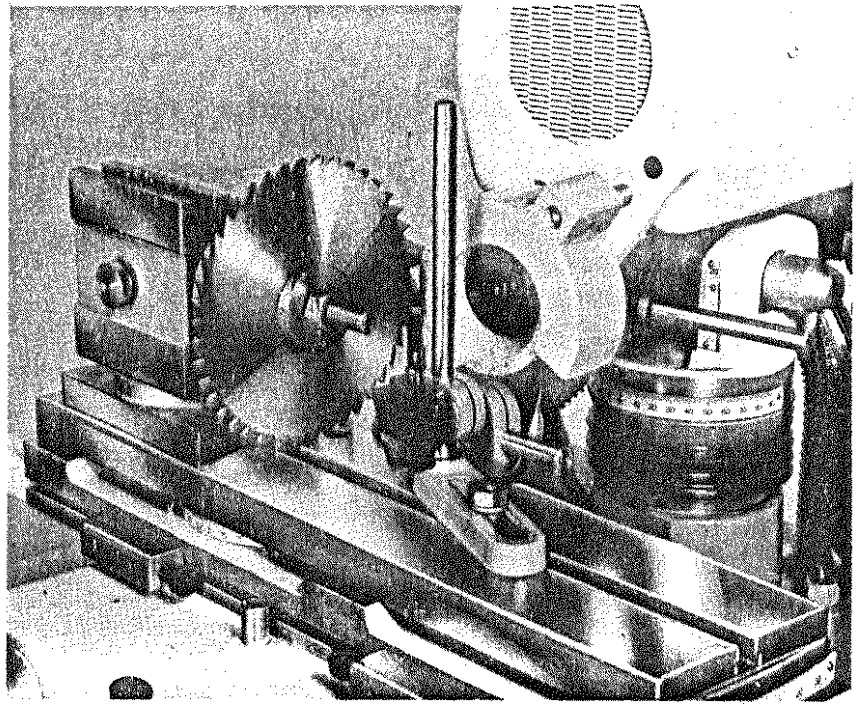
Equipment, set up and method of grinding is identical to above, but grind teeth with identical helix first, then re-set for others with opposite helix.

Regashing Slitting Saw



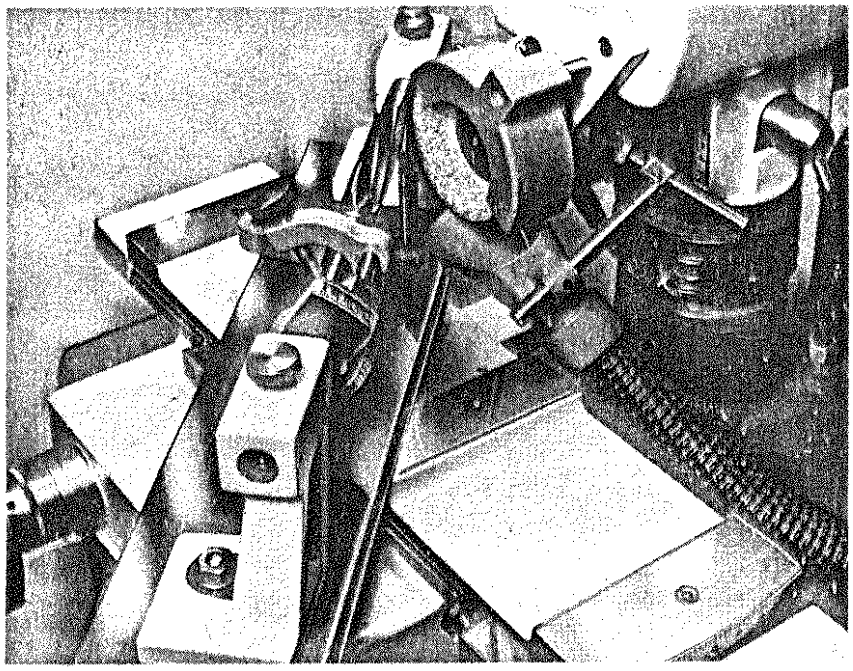
1. Use dish shaped wheel, No. 4 M.T. ball bearing workhead and cutter arbor.
2. Set wheelhead and table at zero.
3. Clamp universal workhead on table, set to zero in vertical position and insert cutter arbor.
4. Position wheelhead so that cutting face of grinding wheel is in line with centre of cutter arbor.
5. Mount slitting saw and clamp so that tooth face is parallel to table movement.
6. Position tooth rest with trip finger behind tooth to be gashed.
7. Set table stop to give required gashing depth.
8. Set wheelhead centre on axis of saw, secure wheel guard, select correct spindle speed and position dust extraction nozzle.

Sharpening Slitting Saw (Periphery)



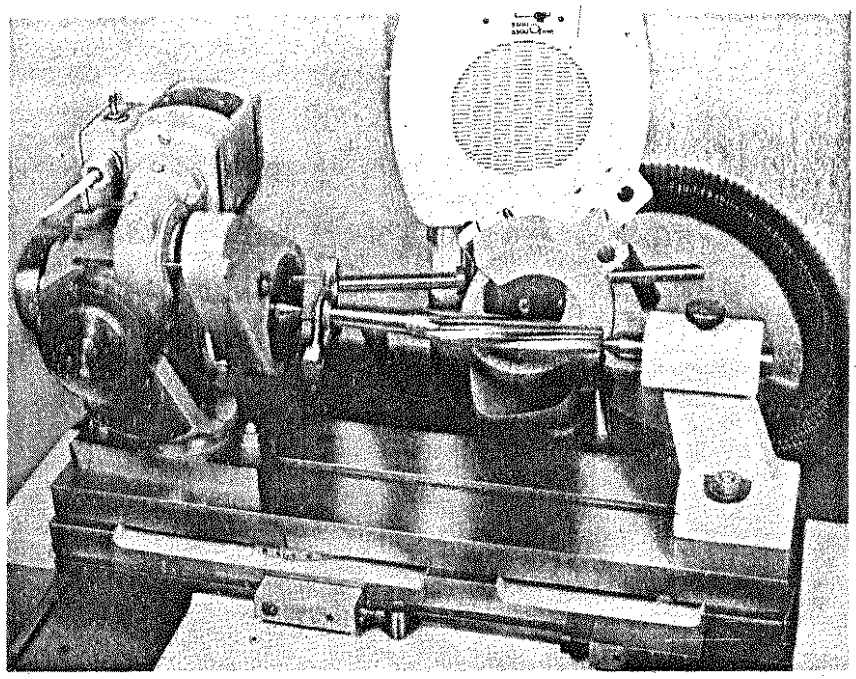
1. Use cup-shaped wheel, No. 4 M.T. ball bearing Workhead Centre height gauge and cutter arbor.
2. Set wheelhead and table at zero.
3. Clamp universal workhead on table, set to zero in both planes, insert cutter arbor and secure slitting saw.
4. Using centre height gauge, set tooth to be ground on centre, lock workhead spindle and set dial on front of spindle to zero.
5. Unlock workhead spindle and rotate to give angular clearance required. Then re-lock spindle.
6. Set tooth rest finger under tooth to be ground.
7. Secure wheel guard, adjust wheelhead centre to approximately the centre height of cutter and position dust extraction nozzle.

Grinding Lead of Reamer



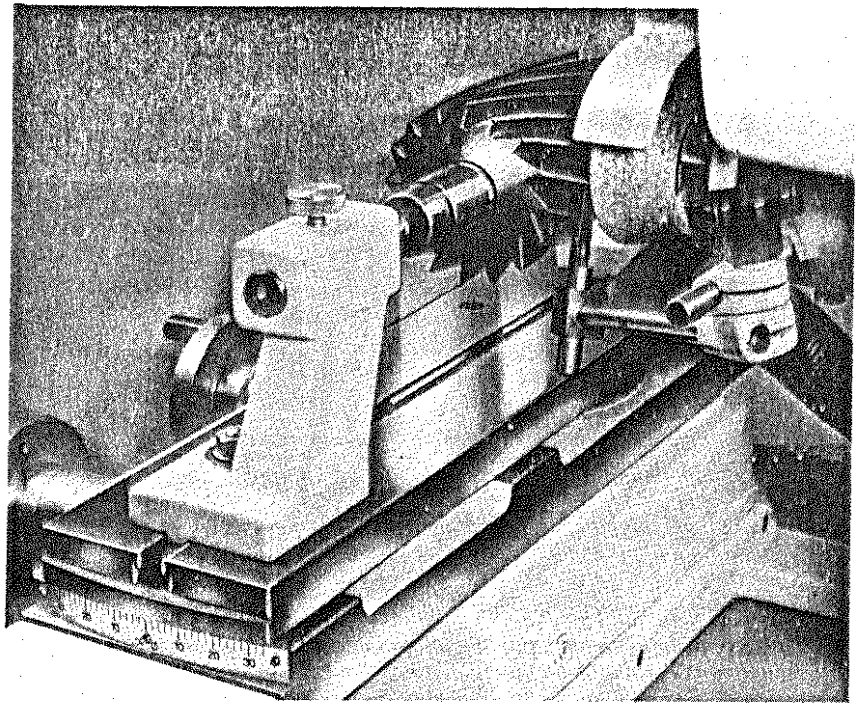
1. Use cup-shaped wheel, Clearance angle setting gauge and Centre height gauge.
2. Mount clearance angle setting gauge on loosehead centre, and set gauge to zero.
3. Place reamer between centres.
4. Set wheelhead at zero and swivel table to the required angle of lead.
5. Using the centre height gauge, 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 the setting gauge and rotate 10° to give required clearance angle.
7. Set tooth rest finger 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 wheelhead centre to approximately the centre height of the loose head. Secure wheel guard and position extraction nozzle.

Spinning Diameter of Reamer



1. Use cup-shaped wheel, No. 4 M.T. ball bearing Workhead, Motor drive unit, Dead centre with driving pin and Centre height gauge.
2. Set table at zero and wheelhead at 15° to give clearance between guard and loose head.
3. Using centre height gauge, set wheelhead and diamond dressing tool fitted in universal tooth rest to centre height.
4. Dress leading edge of grinding wheel to give a flat approx. 8 mm (5/16") wide true to table movement.
5. Mount workhead on table, insert dead centre in nose and set to zero in all planes to align with loose centre. Use of a Mandrel between centres and a dial gauge would be an advantage.
6. Attach motor drive unit to the workhead and belt between drive pulley and dead centre pulley. Secure belt guard.
7. With a carrier attached to plain end place reamer between centres so that driving pin locates on carrier.
8. Position dust extraction nozzle.
9. Check wheel guard and select correct spindle speed and direction of rotation which should be downwards.
10. Run motorised workhead so that at the grinding wheel the reamer is rotating in a direction opposite to the wheel.
11. Set table traverse stops.
12. Apply cut, 0.03 mm (.001") maximum and traverse table longitudinally until cut sparks out.

Grinding Periphery of Helical Slab Cutter

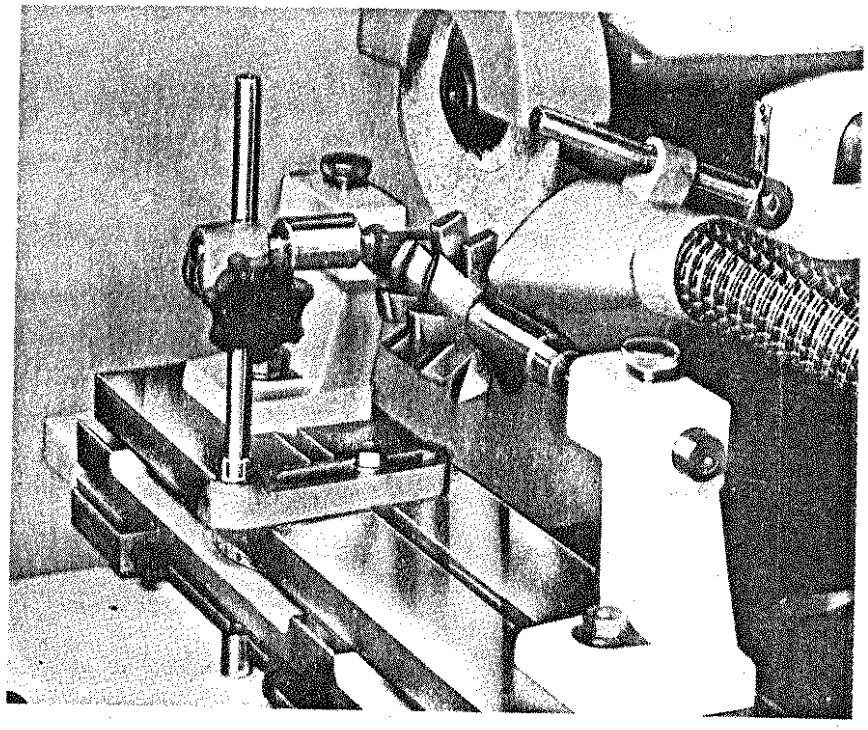


1. Use cup-shaped wheel and Centre height gauge.
2. Set table at zero and wheelhead at 5° approx. to ensure grinding takes place on one side of wheel only.
3. Mount tooth rest on wheelhead support post and set finger to centre height of loose heads, inclined at approximately the cutter helix angle and approximately on centre line of wheelhead.
4. Secure cutter to mandrel and mount between centres.
5. Lower wheelhead the amount corresponding to clearance angle required (see table on page 10).
6. Secure wheel guard and position dust extraction nozzle.
7. Keep cutter in contact with tooth rest finger during grinding.

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

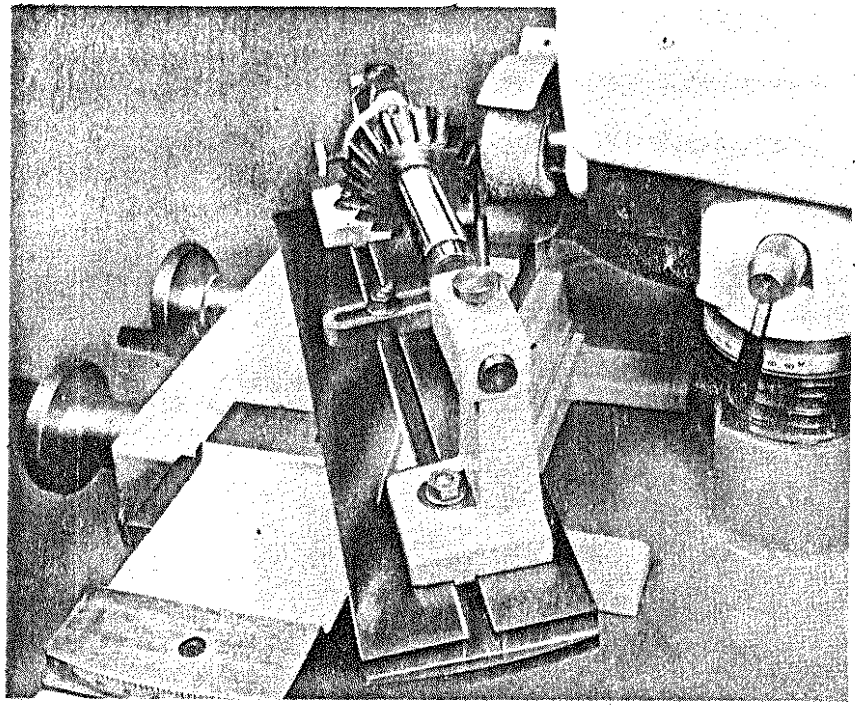
NOTE: Care must be taken to ensure that teeth not being ground will clear the grinding wheel when the cutter rotates during grinding.

Sharpening Formed Milling Cutter



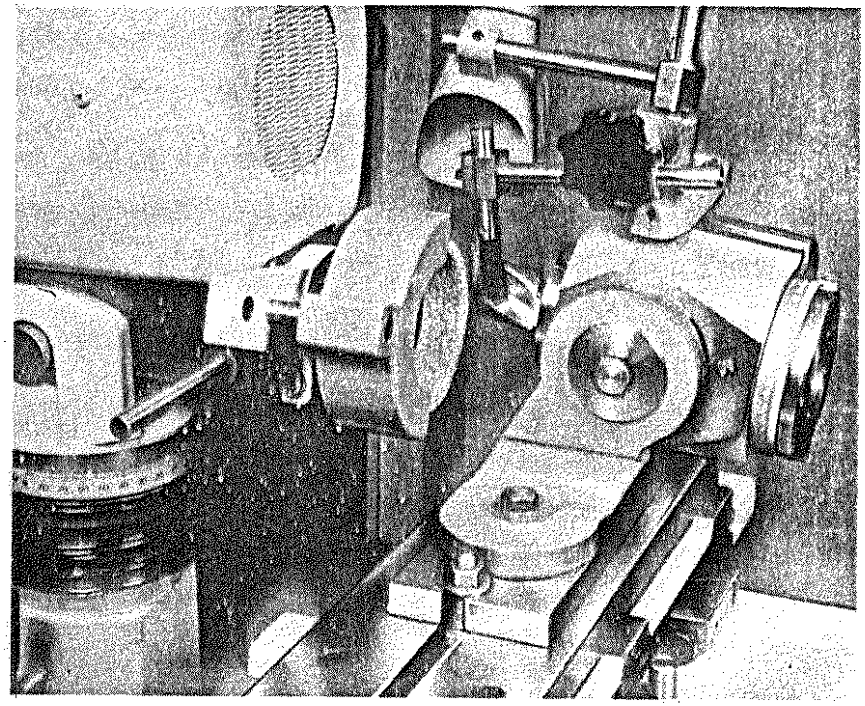
1. Use dish-shaped wheel and Micro-adjustable finger.
2. Set wheelhead and table to zero.
3. Position cutting edge of grinding wheel on axis of centres.
4. Secure cutter to mandrel and mount between centres.
5. With cutting face of cutter in vertical plane, position tooth rest with micro-adjustable finger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

Sharpening Angle Cutter



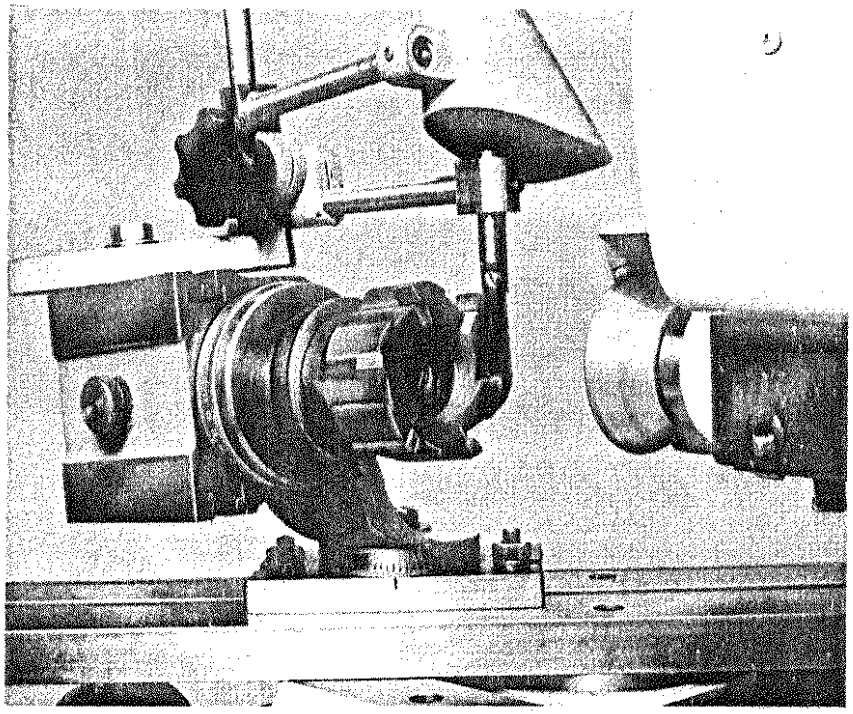
1. Use cup-shaped wheel, Centre height gauge and Clearance angle setting gauge.
2. Set table to angle of cutter and wheelhead at zero. Depending on size and style of cutter, wheelhead may have to be set at a clearance angle to avoid grinding on both sides of wheel which will then require its nearest edge dressing parallel to table movement to give approx. 1.5 mm (1/16") land.
3. Mount clearance angle setting gauge on loose head centre and set to zero.
4. Secure cutter to mandrel and place between centres.
5. Using height gauge, set tooth of cutter on centre line and tighten clamping screw of carrier on to mandrel.
6. Slacken clamping screw on zero scale, rotate to required clearance angle and lock.
7. Set tooth rest finger underneath tooth to be ground, then release or remove the carrier clamping the mandrel.
8. Position wheelhead to approximately centre height of loose heads. Secure wheel guard, select correct spindle speed and position dust extraction nozzle.

Grinding End Face of End Mill



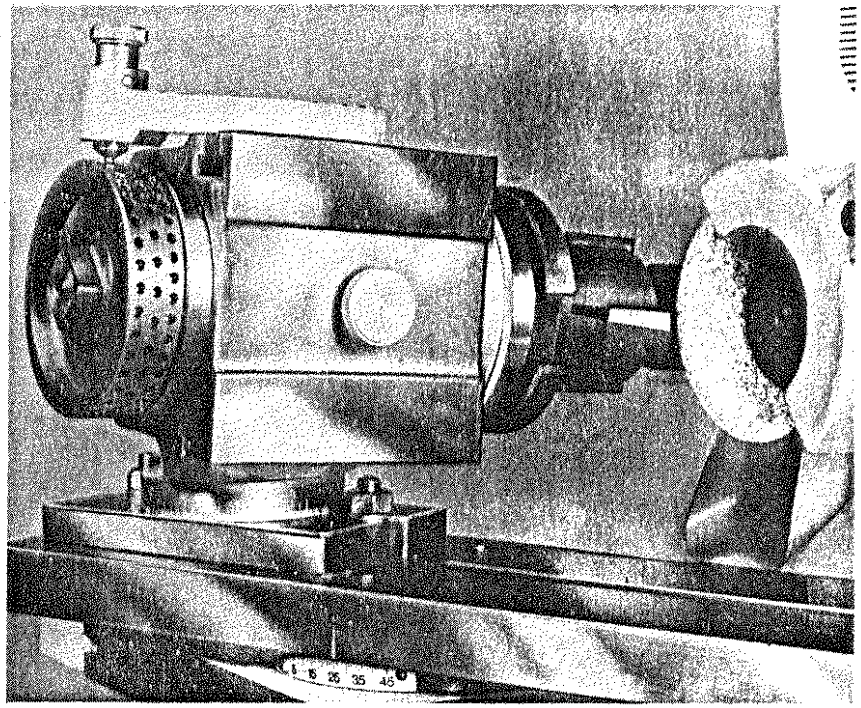
1. Use cup-shaped wheel, No. 4. M.T. ball bearing Workhead and adaptor bush.
2. Set wheelhead and table at zero.
3. Clamp universal workhead on table and set to give approx. 5° clearance vertically for end face and approx. 1° clearance horizontally from outer dia. to centre of cutter (concave).
4. Slide adaptor bush in rear of spindle with the cross drilled hole in line with the radial clamping screw. Wind in clamping screw to rough locate.
5. Place end mill in adaptor bush and firmly lock with clamping screw.
6. Rotate spindle until cutting edge of end mill is parallel to table, then lock.
7. Mount universal tooth rest or workhead and set finger on tooth to be ground.
8. Set wheelhead to approximate centre height of end mill. Secure wheel guard, select correct spindle speed and position dust extraction nozzle.

Sharpening Carbide "Dedlock" Cutter in Ball Bearing Workhead



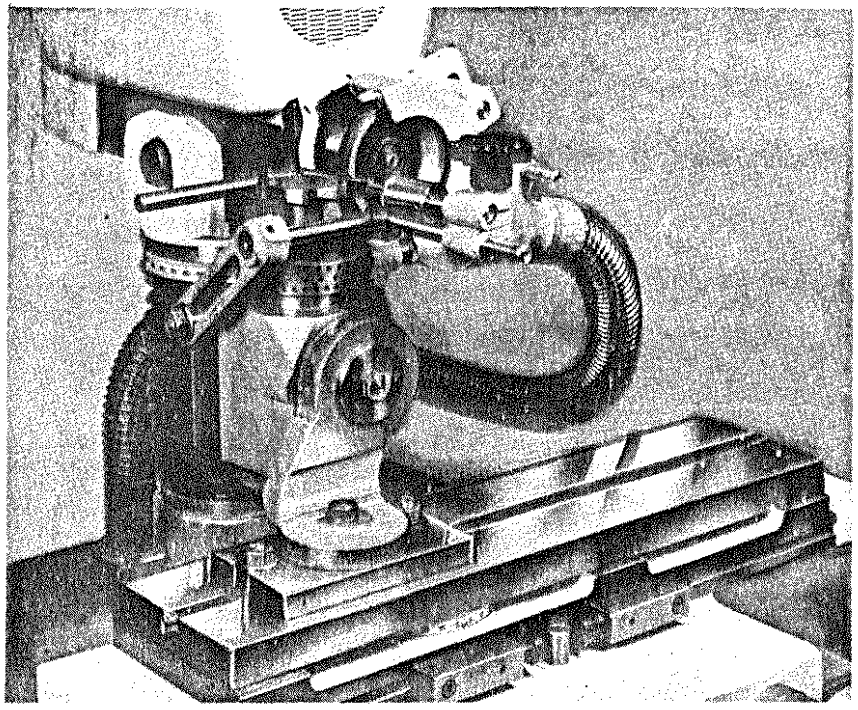
1. Use flaring cup-shaped diamond wheel, No. 4 M.T. ball bearing Workhead and "dedlock" regrind arbor.
2. Set wheelhead at zero. Table may also be set at zero, but depending on style and shape of cutter etc. it may be necessary to swivel both table and workhead bracket (corresponding angles) to give additional capacity.
3. Mount workhead on table, insert adaptor and screw on cutter.
4. Set workhead to give approx. 5° clearance vertically for end face and approx. 1° clearance horizontally from outer dia. to centre of cutter (concave).
5. Rotate workhead spindle until cutting edge of cutter is parallel to table, then lock.
6. Mount universal tooth rest on workhead and set finger on tooth to be ground.
7. Set wheelhead to approximate centre height of cutter. Secure wheel guard, select correct spindle speed and position dust extraction nozzle.

Grinding End Face of Boring Cutter with No. 50 Int. Taper Shank



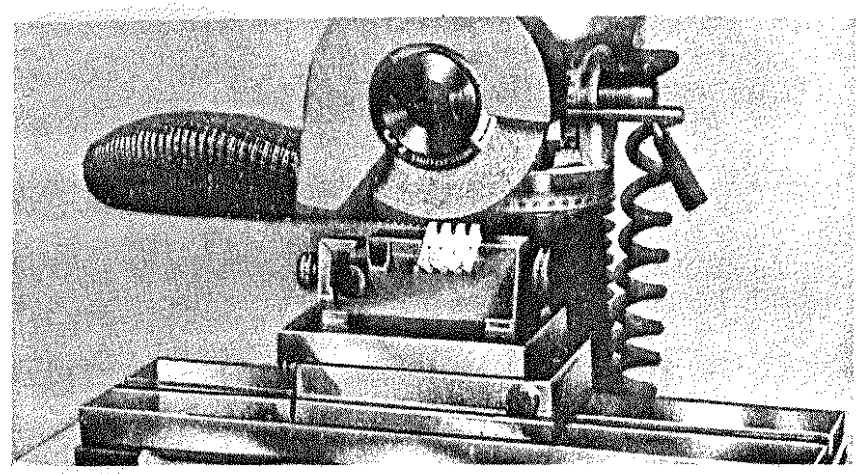
1. Use cup-shaped wheel, No. 5 INT, plain bearing Workhead, Indexing attachment and drawbolt to suit cutter.
2. Set wheelhead at zero. Table may also be set at zero, but depending on style and shape of cutter etc. it may be necessary to swivel both table and workhead bracket to give increased capacity.
3. Mount workhead on table, fix indexing attachment (see P.3), insert cutter and secure with drawbolt.
4. Set workhead to give approx. 5° clearance vertically for end face and approx. 1° clearance horizontally from outer edge to centre of cutter (concave).
5. Rotate workhead spindle until cutting edge of cutter is parallel to table, set up indexing attachment as described on page 3. Set stops to avoid grinding into stock.
6. Set wheelhead to approximate centre height of cutter. Secure wheel guard, select correct spindle speed and position dust extraction nozzle.

Grinding Rake Angle on Carbide Tee-Slot Cutter

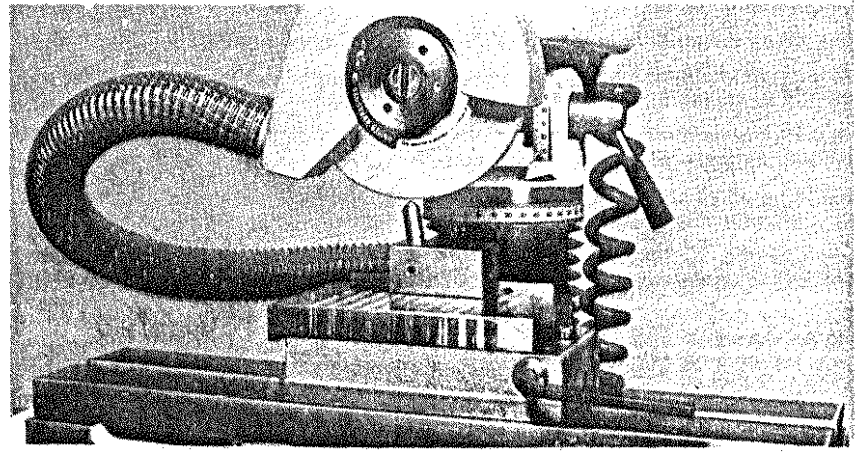


1. Use flaring cup-shaped diamond wheel, No. 4 M.T., ball bearing Workhead, Indexing attachment, adaptor bush and Micro-adjustable finger.
2. Set table and wheelhead at zero.
3. Mount workhead with rear of spindle in vertical position and insert adaptor bush to suit cutter.
4. Fix indexing attachment (see P.3), insert cutter and secure with face to be ground parallel to table movement.
5. Position table so that wheel just touches face to be ground and set table stops to avoid grinding into stock.
6. Lock index attachment (see P.3) and attach toothrest base to workhead. Position micro-adjustable finger set at zero behind tooth to be ground.
7. Set wheelhead centre to approximately centre line of cutter tooth. Secure wheel guard, select correct spindle speed and position dust extraction nozzle.
8. With wheel rotating downwards and leaving table cross traverse set to zero, wind table longitudinally several times to allow cut to 'spark out' then index to next tooth and repeat.
9. After indexing back to original tooth, apply feed (or cut) by rotating cutter with micro-adjustable finger (about 0.02 mm or 0.001") after first slackening index drum. Re-lock index drum and grind index in normal manner.

Grinding Throat Angle of Coventry Dies using Surface Grinding Attachment

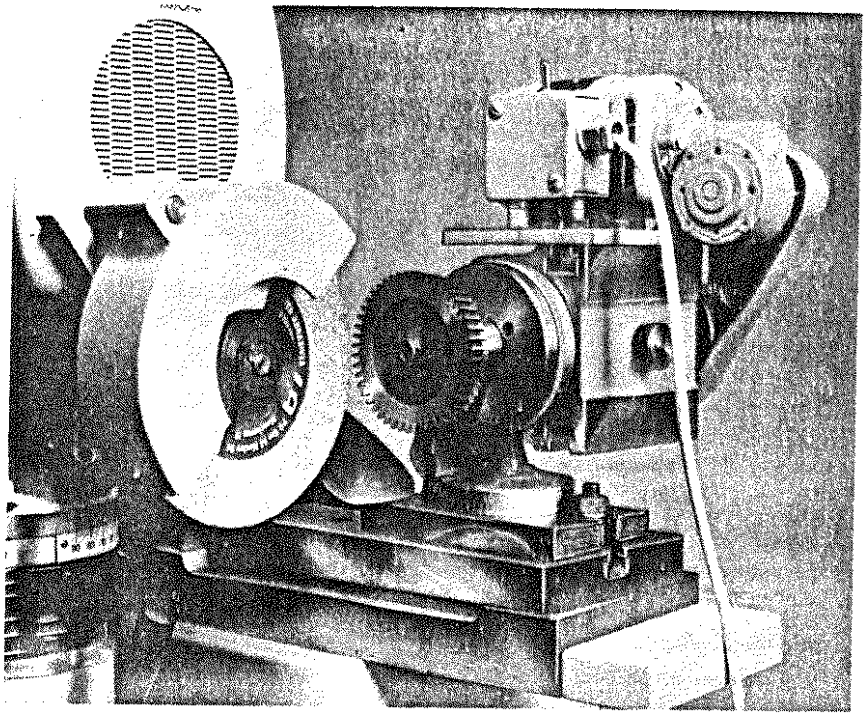


1. Use Surface grinding attachment (with plain wheel and extension) and die grinding fixture.
2. Set wheelhead and table at zero.
3. Mount magnetic table and dress grinding wheel.
4. Secure die grinding fixture to magnetic chuck and lock in the dies.
5. Attach dust extraction hose and select correct spindle speed (3,500 r.p.m.).
6. Apply cut, 0.05 mm (.002") maximum by lowering wheelhead.
7. Pass dies longitudinally below wheel and feed across transversely after each pass.



Set Up for Wheel Dressing (Clockwise Rotation)

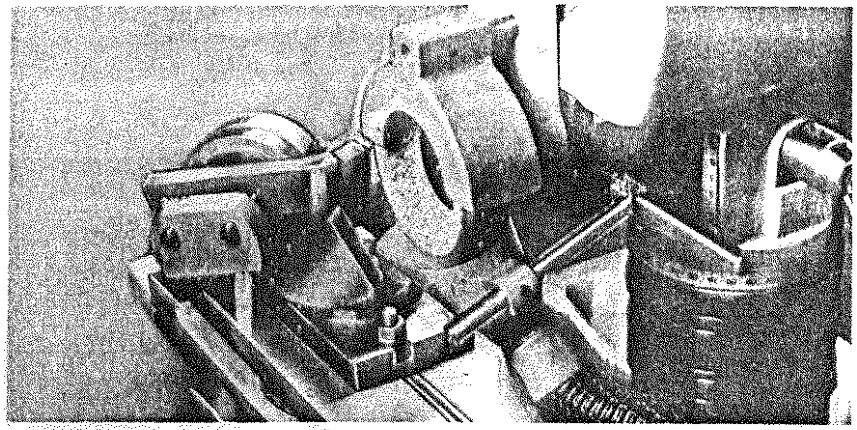
Sharpening Gear Shaper Cutter with Motor Drive Unit on Ball Bearing Workhead



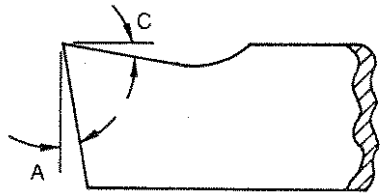
1. Use plain wheel, No. 4 M.T. ball bearing Workhead, Motor drive attachment and suitable cutter arbor (No. 4 M.T. shank).
2. Set wheelhead at 90° and table at 5° to give cutter concave relief.
3. Mount workhead on table, attach pulley of drive unit to rear of spindle and set to zero in all planes. Fit belt and secure guard.
4. Insert cutter arbor in spindle, secure cutter to arbor and set table stops so wheel will not foul part of cutter or arbor.
5. Secure wheel guard, select correct spindle speed (usually 3,500 r.p.m.) and position dust extraction nozzle. Set wheelhead centre to approximately that of the workhead.
6. With grinding wheel rotating in downward direction run workhead so that cutter is rotating upwards in opposite direction to the grinding wheel.
7. Apply cut, 0.02 mm (.001") maximum and traverse table longitudinally until cut 'sparks out'.

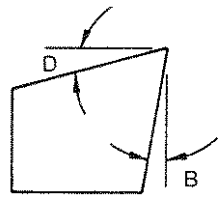
NOTE: Depending on style, shape of cutter and arbor used, it may be necessary to swivel both table and workhead bracket corresponding angles to give additional capacity, but the 5° difference must still be maintained to give cutter relief.

Sharpening Lathe Tool



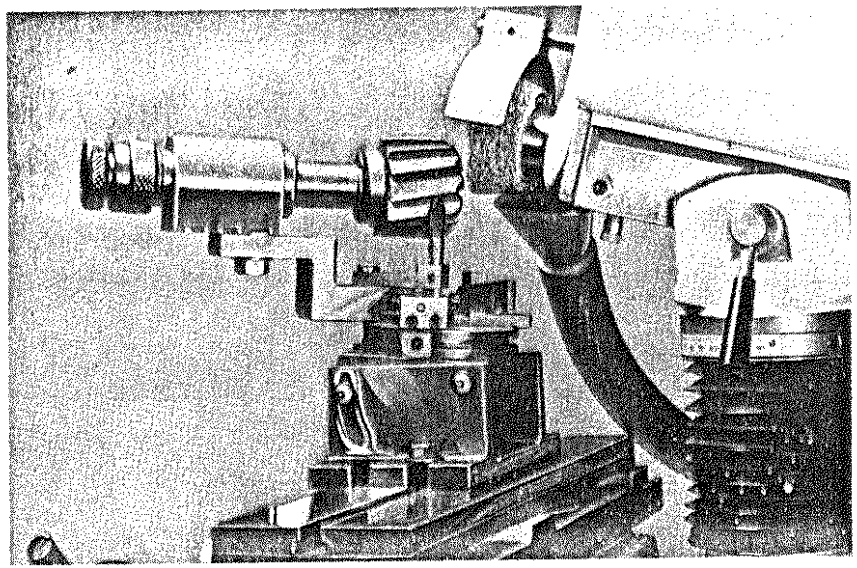
1. Use cup-shaped grit wheel for H.S.S. or diamond impregnated wheel for Carbide tools, angle bracket of universal workhead and Vice.
2. Set wheelhead and table to zero.
3. Clamp angle bracket to table, the vice to bracket and secure tool to be ground.
4. Swivel the angle bracket and vice to required clearance angles (see table).
5. Set wheelhead centre to the approximate height of tool cutting edge.
6. Select correct spindle speed for grinding wheel; position wheel guard and dust extraction nozzle.





Material to be cut	Front Clearance "A"		Side Clearance "B"		Top Rake "C"		Side Rake "D"	
	H.S.S. Tools	Carbide Tools	H.S.S. Tools	Carbide Tools	H.S.S. Tools	Carbide Tools	H.S.S. Tools	Carbide Tools
Aluminium	9°	5°- 8°	9°	5°-8°	30°	10°-20°	15°	15°-20°
Brass	7°	5°- 8°	6°	5°-8°	0°	3°- 8°	5°	6°-10°
Cast Iron	5°	5°- 8°	4°	5°-8°	10°	3°- 8°	9°	6°-10°
Mild Steel	8°	5°- 8°	6°	5°-8°	20°	3°- 8°	15°	6°-10°
Plastic	10°	10°-15°	8°	5°-8°	25°	5°-10°	25°	6°-10°
Wood	15°	4°- 6°	15°	5°-8°	25°	15°-40°	25°	6°-10°

Grinding Radius on End Mill



1. Use cup-shaped wheel and Radius grinding attachment.
2. Set table at zero, Wheelhead to zero in horizontal plane and inclined vertically 10°-15° (or more) to ensure teeth not being ground do not foul the grinding wheel.
3. With diamond dressing tool fitted in universal tooth rest, clamped to table and table locked with the stops so that the diamond is vertically central with wheelhead, dress the wheel to give a true flat face by raising and lowering the wheelhead. STOP MOTOR BEFORE PROCEEDING WITH FURTHER SETTING then remove universal tooth rest.
4. Clamp radius attachment on table and set setting bar, using slip gauges of width equal to radius required between the setting bar bracket and setting diameter of the central pivot pin.
5. Clamp holder on swan neck end and set rotation limit dog so that the centre line of the holder is at right angles to table longitudinal movement. Depending on style and diameter of cutter it may be necessary to interpose the swan neck extension between the holder and swan neck.
6. Place setting centre in holder and set cutter finger on centre line.
7. Tilt bearing housing to clearance angle required (see table).
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 correct 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 cross traverse or 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. Select correct spindle speed, secure wheel guard and position dust extraction nozzle.
16. Traverse table longitudinally until fixture head can swing 90° without fouling the wheel.
17. Start wheel, and swinging head through 90° slowly traverse table (longitudinally) towards the wheel. This will produce a radius on the cutter.
18. Index to next tooth and repeat paragraphs 16 and 17.

NOTE: Grinding radius larger than 3 mm (1/8") should be carried out in two operations i.e. rough and finish to ensure accuracy and minimise wheel wear.

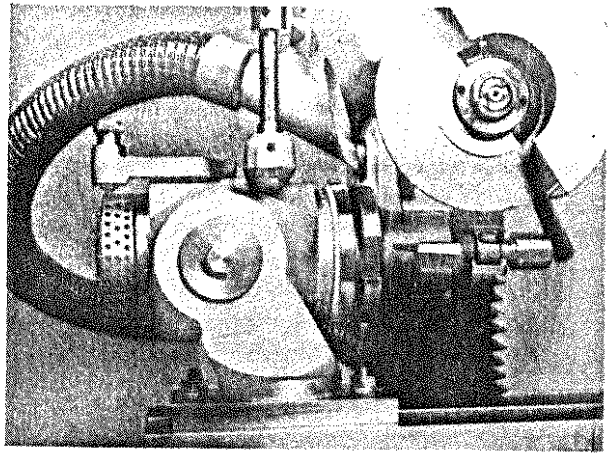
Recommended Clearances

Cutter Diameter	Primary	Secondary
Up to 5 mm (3/16")	15°	30°
5 to 13 mm (3/16" to 1/2")	12°	25°
13 to 20 mm (1/2" to 3/4")	9°	18°
20 to 50 mm (3/4" to 2")	7°	18°
Over 50 mm (2")	6°	18°

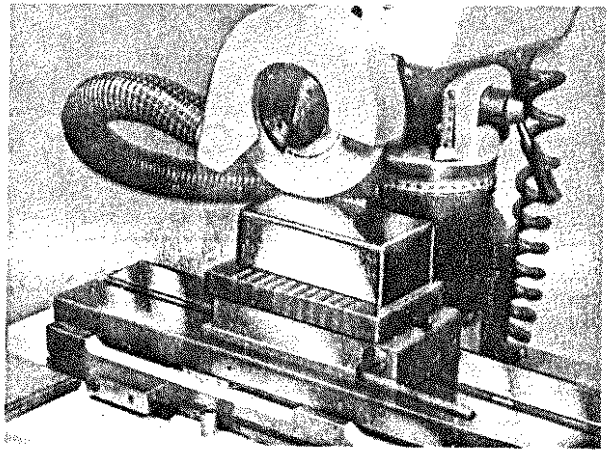
NOTE: FOR CARBIDE CUTTERS it will be necessary to vary the set up as follows, also depending on size and style of cutter the fixture may have certain physical limitations.

a. Use Taper Cup shaped diamond wheel not greater than 90 mm (3½") dia.
b. Set wheelhead at zero in both planes.
c. Tilt fixture to give required clearance (not less than 5°).
d. Set table stop to avoid grinding into fixture.
e. It may be necessary to make a special cranked finger. Also the setting bar etc. may have to be removed to allow grinding wheel clearance.
f. Procedure for grinding closely follows instructions 4 to 18 for above H.S.S. cutter.

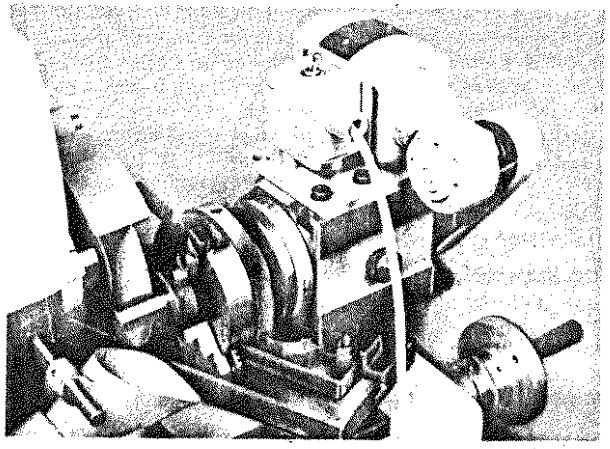
Example Set Ups



Grinding Special Boring Cutter



Surface Grinding



Grinding Location Peg

Specification

	METRIC MACHINE	ENGLISH MACHINE
Swing over table (dia.)	200 mm	8"
Distance between centres	400 mm	15 3/4"
Table longitudinal travel	300 mm	11 3/4"
Table cross traverse	130 mm	5 1/8"
Table dimensions	500 x 120 mm	19 3/4" x 4 3/4"
Tee slot width	12 mm (suit 10 mm Bolts)	
Centre of wheel above table (max.) ..	240 mm	9 1/2"
Centre of wheel above table (min.) ..	75 mm	3"
Table swivel	180°	180°
Head swivel	360°	360°
Head inclination	±20°	±20°
Spindle speeds	3,500 and 5,500 r.p.m.	
Motor	.56 kW.	3/4 H.P.
Overall working area	960 x 900 mm	38" x 35 1/2"
Height of bench machine (max.)	840 mm	33"
Height of cabinet mounted machine (max.)	1540 mm	60 1/2"
Nett weight of bench machine	175 kg.	390 lb.
Nett weight of cabinet machine	250 kg.	560 lb.

Standard Equipment

Set of loose centre heads with centres
Universal tooth rest and one finger
One 89/70 x 38 x 31.75 mm bore (3 1/2"/2 3/4" x 1 1/2" x 1 1/4" bore) cup grinding wheel
One 150 x 13 x 31.75 mm bore (6" x 1/2" x 1 1/4" bore) dish grinding wheel
Wheel adaptor
Wheel guards
Spanners, wrenches and oil can
Instruction booklet
Dust extraction unit, with three disposable collecting bags
Power take off socket

Additional Equipment

Cabinet base
Universal ball bearing workhead (No. 4 M.T. spindle)
Universal plain bearing workhead (No. 50 INT. spindle)
Indexing attachment for use with workheads
Surface grinding attachment
End mill adaptor bushes
Centre height gauge
Vice
Clearance angle setting gauge
Micro-adjustable finger
Diamond dressing tool
Diamond dressing tool adaptor block for surface grinding
Motor drive unit for ball bearing workhead
Dead centre
Radius grinding attachment
Chucks
Mandrels
Diamond impregnated grinding wheels
Side & face cutter arbor (No. 4 M.T.)
Dedlock re-grind arbor (No. 4 M.T.)
Low voltage lighting