HARDINGE

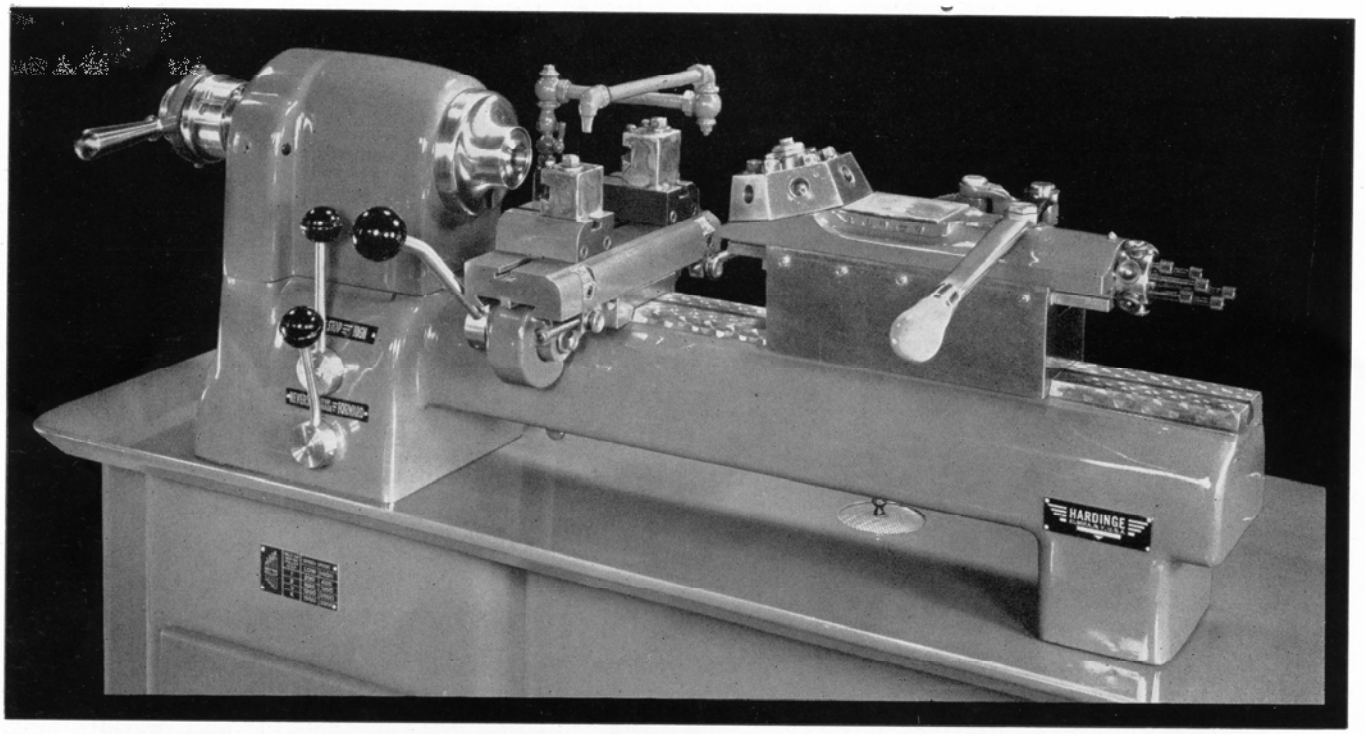
HIGH SPEED
PRECISION SECOND OPERATION MACHINE

FOR

ACCURACY - FINE FINISH - HIGH SPEEDS - LOW COST

HARDINGE BROTHERS, INC., ELMIRA, N. Y.

"Performance has established leadership for Hardinge"



USE A SECOND OPERATION MACHINE FOR SECOND OPERATION WORK

PRODUCTION departments will bring about lower costs when they realize that it is best to use a second operation machine for second operation work. The common fault is to buy a more complicated machine at a higher price because it may be rated as being able to do *many things* and then proceed to use the machine for *one thing* only. The machine presented in this bulletin is designed for second operation work and therefore should be considered first for that class of work.

A studied consideration of your requirements in conjunction with the possibilities presented in this bulletin will convince you that the Hardinge High Speed Second Operation Machine should be tried to determine the merits. One large manufacturing organization started a similar investigation and now has more than sixty of the units in operation.

The cross slide and turret take standard tools. Simple set-up is an important feature of the Hardinge Second Operation Machine. The various units are easily positioned as proper working clearances are provided. Built-in coolant facilities are included. The bed of the machine is amply proportioned and rests on three spheres for a perfect three point suspension to guard against any distortion which may come from an uneven floor.

SPECIFICATIONS:

Collet range 1/16″ to 1″ capacity, step chuck capacity for diameters above 1″ to 6″, jaw chuck capacity to 5″. Swing over bed 9″. Length of bed 36″. Maximum distance from spindle to face of turret 16-3/4″. Eight spindle speeds 230 to 3500 r. p. m.

See following descriptions for specifications of the various units.

THE essential requirements of a headstock are accuracy and speed. Super-precision duplex ball bearings with preloading, as described in this bulletin, provide extreme accuracy and high spindle speeds with *the bearings requiring no adjustment.* The desirable results are so surprising that actual use is the best medium to determine the advantages over your present machines.

HEADSTOCK: The headstock frame is of the finest grade, seasoned and heat-treated alloy iron and has a hand scraped bearing surface to fit the ways of the amply proportioned bed.

The outstanding feature is the *connected bearing, enclosed headstock.* The design has been successfully used with our precision machine tools over a number of years. Reflection will indicate that machine tool builders are offering enclosed headstock units: First, for greater accuracy; Second, to allow heavier cuts; Third, to permit higher spindle speeds; Fourth, to completely enclose driving belts. The enclosed headstock is the logical design for a ball bearing machine as it meets accuracy and speed requisites.

The spindle is hardened and ground, both internally and externally, and is made of the best grade ball bearing steel. With the ball bearing construction, the spindle is mounted in rotating members *to eliminate wear on the spindle.* The spindle pulley is provided with six notches for locking by means of a substantial pin at the rear of the headstock. The spindle has the Hardinge patent taper nose.

BALL BEARINGS: Work load on a sleeve bearing is supported by a film of oil, the functioning of which is dependent upon such variable factors as film thickness, temperature and difference in the grades of oil used. With a preloaded ball bearing, the pressure between balls and races is such as to prevent formation of an oil film and the contact of load carrying members is positively metal-to-metal. In other words, the load is carried on perfect spheres of hardened steel instead of globules of oil whose load-carrying ability varies with the operating temperature. Naturally, accuracy with speed and long life is attained.

The preloading is described separately and the resultant load-carrying capacity is not a matter of experiment, but is subject to as accurate a mathematical determination as is the strength of a steel bridge. The steel ball, because of its shape, presents a uniform and calculable resistance. The balls automatically adjust themselves to the proper angle for either purely end or radial thrust, or a combination of the two.

Proper steel, vast improvement in manufacturing methods and the use of optical gages have achieved a uniform standard of accuracy, considered commercially impossible a few years ago.

PRELOADING: The term "preloading" may be best understood by referring to the accompanying illustrations: Figure 1 shows the duplex double row bearing before clamping. The clearance between the inner rings at point "B" is calculated by the bearing manufacturer to produce a predetermined initial load for a second operation machine.

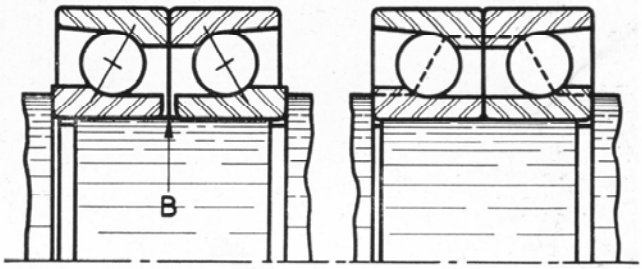


FIGURE 1 FIGURE 2

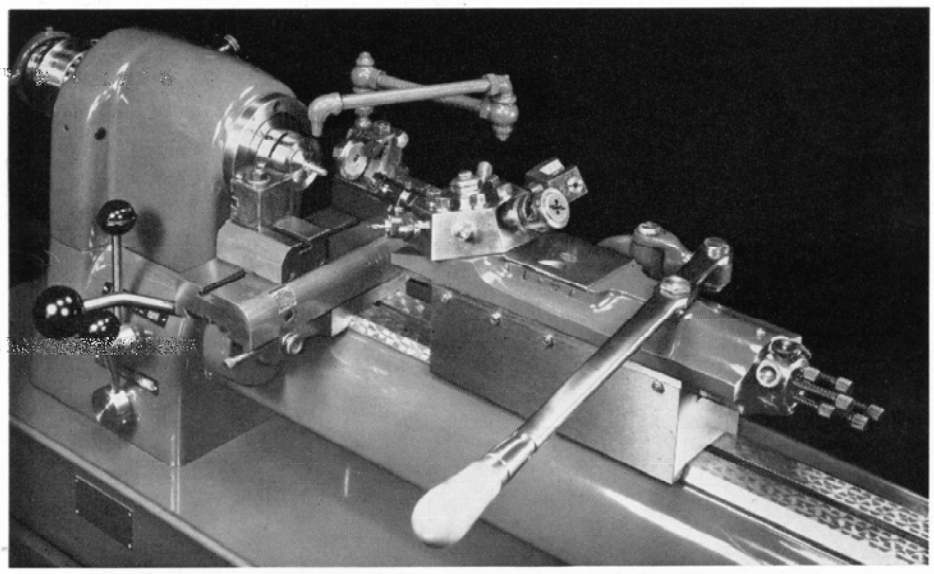
Our installation consists of turning the bearing clamp nut until the inner races of the ball bearings meet. This simple assembly procedure automatically secures the proper initial load for correct spindle rigidity and requires no further attention. The dotted line indicates how the preload pressure takes place through the bearing. With the angular races, the balls have an angular contact, so that they "rotate as they roll", thereby presenting ever-changing bearing points.

When external or work load is applied to the bearing, the preload is reduced according to the amount of the external load and the effect on bearing endurance is negligible. In operation, the work load is constantly distributed among one-half of the rolling balls. The preload on each ball gradually absorbs the work load and gradually returns to the normal preload, thus assuring quiet operation and forming the basis for smooth turning cuts.

All end thrust, as well as radial work load, is taken by the front bearings, while the single row rear bearing acts merely as a steadying support. The whole spindle assembly is in inherent balance to eliminate any undue vibration even at the highest speeds.

LUBRICATION: Each bearing section receives oil through cups located at the rear of the headstock. The oil hole is filled with felt to provide constant filtered lubrication. Both bearing sections are sealed with effective seals to exclude dirt and foreign matter. Because of the metal-to-metal contact described under the ball bearing section, the oil serves as a lubricant between the balls and the bakelite ball separator, and protects the surfaces from rust or corrosion.

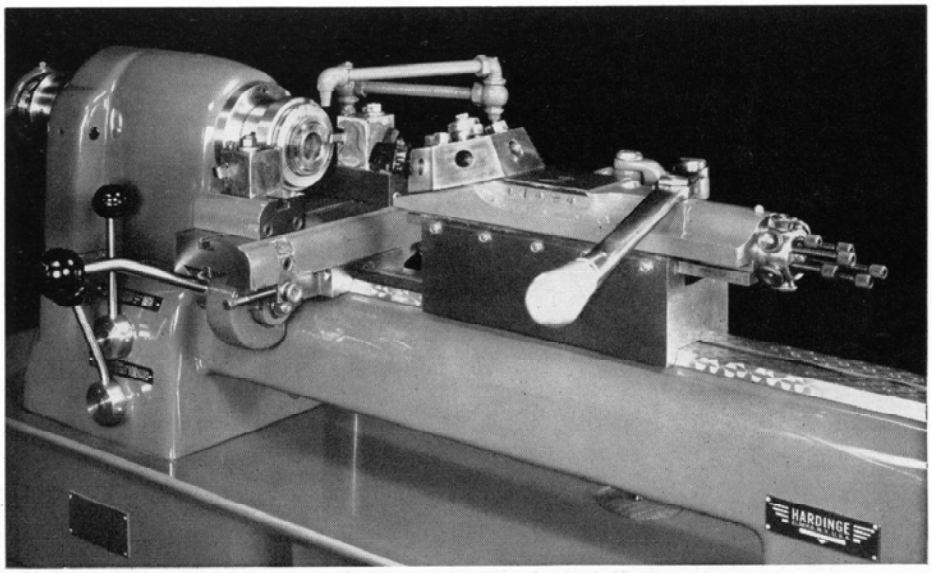
SECOND operation work is performed in almost every plant engaged in the manufacture of a modern precision product. Secondary operations, in many cases, are the final finishing or exact sizing operations performed on a partially completed part. The finishing or sizing operations must be performed on a precision machine designed to perform such operations. Many organizations today are attempting to produce precision second operation work on obsolete equipment or to use a machine out of proportion with the work, resulting in scrap in sizing, poor finish, short tool life, longer set-up time, inconvenient operation and less production.



TYPICAL SECOND OPERATION COLLET SET-UP

Work Held In a Collet: Work held in a precision collet can be accurately gripped with minimum loading time. Greater accuracy is obtainable on a Hardinge Second Operation Machine set-up using a collet because the ground collet seat is a part of the spindle itself.

The second operation set-up shown in the illustration is the use of a 3/8″ precision ground collet for holding a part made from S.A.E. 1120 steel. With the first operations performed on an automatic, the secondary operations were to turn the 3/8″ diameter to 1/4″ diameter; thread 1/4″ diameter; drill 1/16″ diameter hole 3/4″ deep; knurl 3/8″ diameter back of thread; form two angular surfaces back of knurled section and form a radius on the end of the 1/4″ diameter—all accomplished with standard tooling which, due to the adaptability of the machine, can be rapidly set up for short run jobs.



TYPICAL SECOND OPERATION STEP CHUCK SET-UP

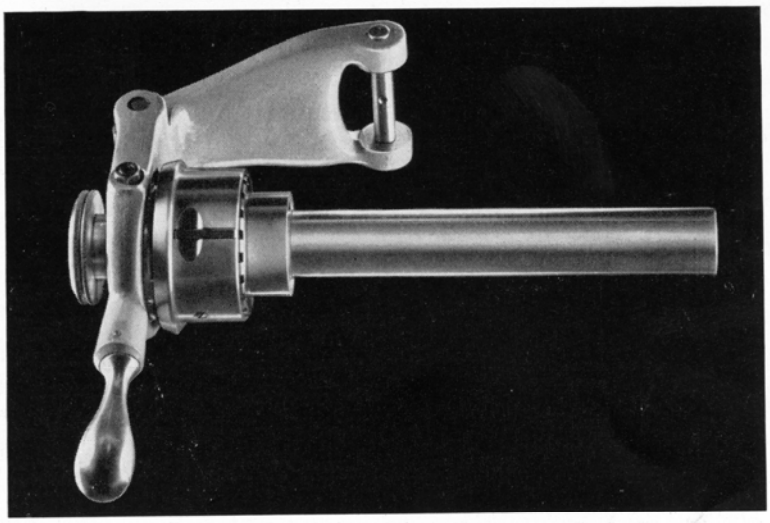
Work Held In a Step Chuck: Step chucks provide the capacity which is ordinarily found only in a jaw chuck, yet the speed of operation is the same as a standard collet. Inasmuch as step chucks are supplied soft, they may be recessed in place on the machine to take the part—this provides an extremely accurate chucking arrangement. The illustration shows a step chuck set-up for a 2-3/8″ diameter part. The first operations were performed on a large turret lathe. The finishing operations on the Hardinge Machine were to finish face the cut-off side, finish form the angular surface and chamfer the bore.

Other Holding Devices: Standard five-inch capacity three or four jaw chucks are available for heavier jobs which have a wide range of sizes. The chucks have integral mounts for direct application to the spindle nose. Many users manufacture special fixtures or holding devices to provide suitable arrangements for special purposes.

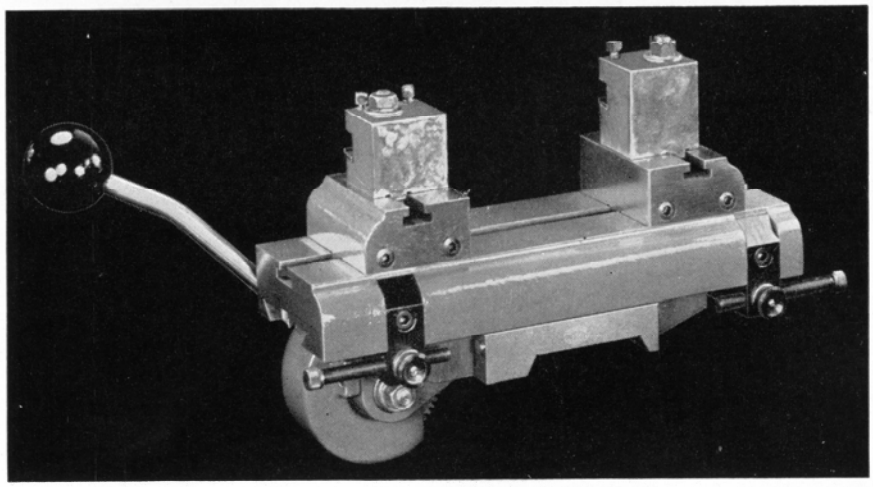
Automatic Collet Closer: The use of an automatic collet closer permits rapid opening and closing of the collet when the headstock spindle is at speed or stopped.

The automatic collet closer is adjustable so that any desired collet tension may be applied on the bar stock or parts to be machined. Moving the lever to the right or to the left instantly opens or closes the collet without interrupting constant machine operation.

An automatic collet closer saves time, reduces wear on draw spindle and collet threads, and assures positive and uniform collet or step chuck tension.



Double Tool Cross Slide: This tool was designed after years of practical manufacturing experience. It is amply heavy and rigid. The slide is 11-3/4″ long and has a movement of 3-3/4″, giving sufficient stroke to clear turret tools. The tool post blocks may be moved to any desired position on the slide and are held rigid with two bolts each. The tool posts are adjustable longitudinally along the T-slot of the blocks. The tool posts take standard 3/8″ square tool bits.



Adjustable stops are provided for control of slide movements in both directions. Operating lever is adjustable radially for the most convenient operating position.

We recommend the use of a double tool cross slide for forming, rounding, knurling, cutting-off, etc. of duplicate parts.

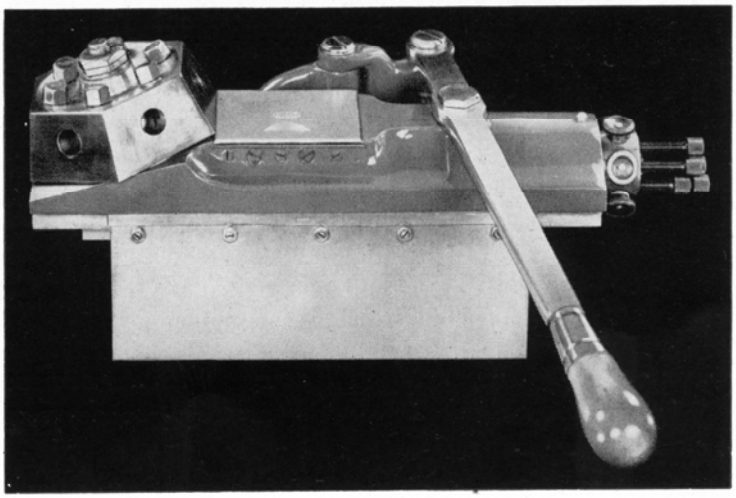
Tilted Turret: The illustration clearly shows the correctly designed turret for rapid and accurate machining of duplicate parts, turning, drilling, reaming, counterboring, threading, knurling, etc. Ease and simplicity of operation are the outstanding features. Like our other attachments, all important surfaces are hand scraped.

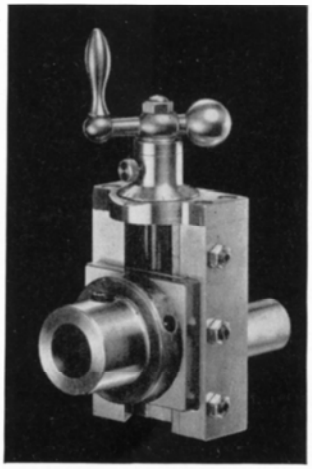
The hexagon head holds six tools. The tool holes are 5/8″ in diameter, 1-7/32″ deep, adapting standard Brown & Sharpe turret tools, as well as those having a 5/8″ diameter shank as manufactured by other tool organizations.

The tools are held securely in the head by specially designed clamp bolts. The tilting of the head provides clearance for the tools, eliminating difficulty encountered with other types of turrets.

The turret has six independent adjustable stops to regulate the desired travel of the slide for each tool. The hexagon head and independent stops are automatically indexed to the next tool position, locked and unlocked by operation of the lever. With the lever in a neutral position, the head may be swiveled to the next tool, passing the positions which do not have tools. This is an essential requirement when less than six operations are performed with a turret.

The base is 9-1/2″ long and the slide has a travel of 2-1/2″. The slide is dovetailed and has long adjustable gibs to compensate for wear.



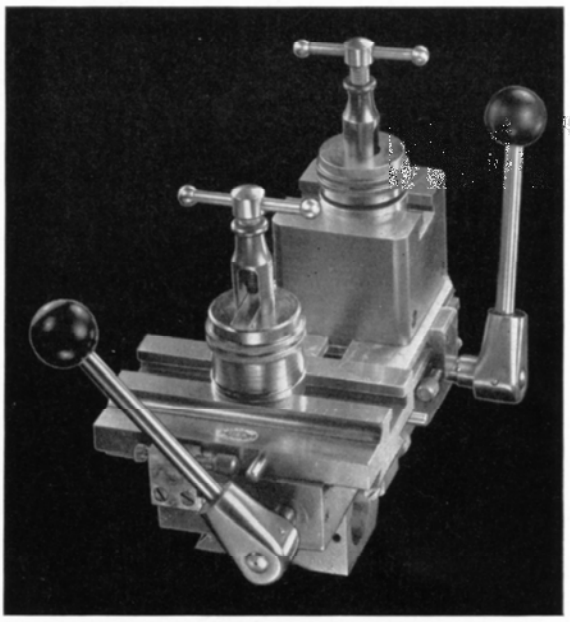


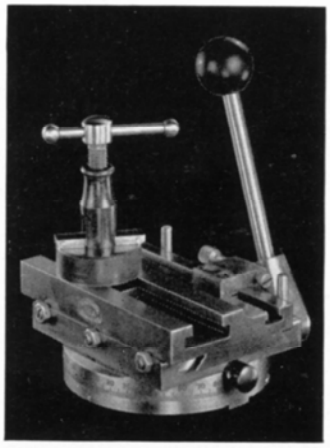
Slide Tool with Micrometer Handle: The slide tool is designed especially for use in the turret of the Hardinge Precision Second Operation Machine for boring, rough and finish turning operations. The bore in the slide head is arranged for 5/8″ shank tools or bushings which can be locked in position by a set screw. The slide has a travel of 7/8″. The dovetail slide is actuated by a fine pitch accurate feed screw with adjustable micrometer dial controlled by a ball crank handle graduated in thousandths. Adjustment of the slide gib is accomplished by means of gib screws and nuts. A locking ring with spanner wrench is provided to lock the slide in the desired position without changing the tool setting. Primarily intended for boring, rough and finish turning operations, the slide tool can also be used as a drill, reamer or counterbore holder when set on center. It is noteworthy that the slide can be locked on center, thus increasing its utility in operations such as drilling and reaming. It can also be locked in the off-center position for boring, etc.

Double Tool Cross Slide with Right Angle Slide: Besides being capable of operations regularly performed by a double tool cross slide, this attachment is also used for rapid and accurate straight turning operations.

The built-in rack and pinion right angle slide has a 1-1/4″ longitudinal travel which can be regulated by an adjustable stop. The cross slide travel of 1-1/2″ is controlled by a rack and pinion feed with adjustable stop. Further, the lever for rack and pinion feed to the cross slide has two housings so that it may be used at the front or rear of the attachment.

The tool posts are adjustable along the T-slots of the tool blocks and take standard 5/16″ square tool bits. This attachment is so designed that the right angle slide may be used at the front or rear of the machine.



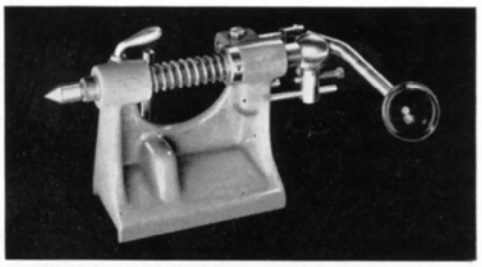


Double Tool Cross Slide Swivel Attachment: When used with our 1″ collet capacity, 9″ swing Precision Second Operation Machine, this attachment can be used instead of either the front or rear block of the double tool cross slide illustrated and described on page ESM-Five. It is for straight or taper turning as it can be swiveled to any angle. The angular setting is accurately maintained by an eccentric locking bolt.

The lever-controlled rack and pinion slide has a maximum travel of 2-1/2″ and is provided with an adjustable gib. An adjustable stop controls the movement of the slide in either direction. The tool post takes standard 5/16″ square tool bits. When ordering, specify whether for use on front or rear of the double tool cross slide.

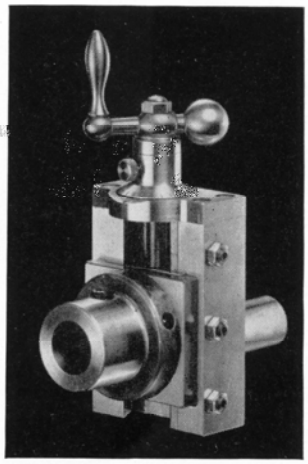
Spring Lever Tailstock: This attachment is designed for production drilling, reaming, counterboring, tapping, etc. It may also be used as a stock stop. The spring saves time by returning the spindle to its original position. Quite often it can be used to better advantage than the tilted turret.

The spindle is 9″ long, .787″ in diameter, and has a maximum travel of 1-1/4″. The travel may be regulated by the adjusting screw which stops against a hardened pin.



A lock is provided to hold the spindle in any position when it is desired to support work between centers.

NOTE: We can also supply a lever tailstock having a 5-1/2″ stroke but without spring action.



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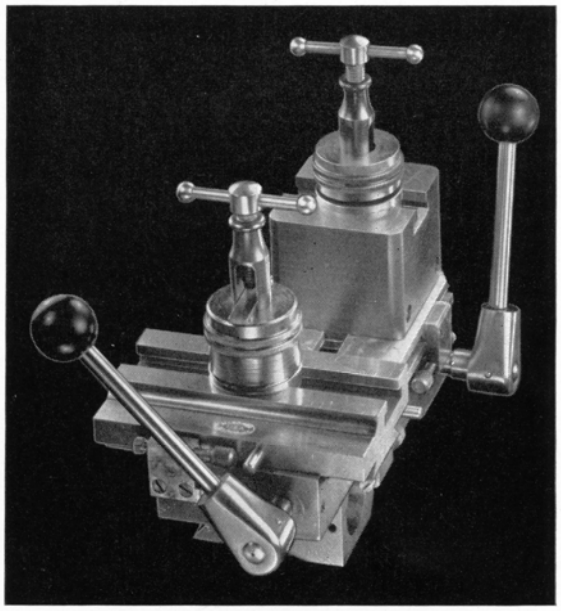

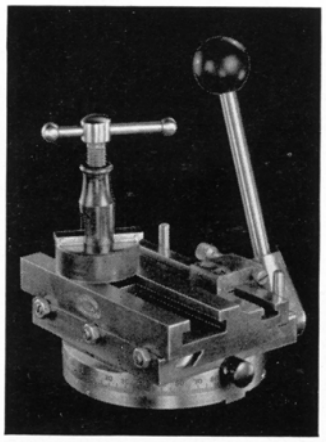

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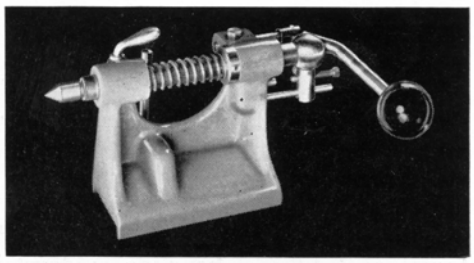

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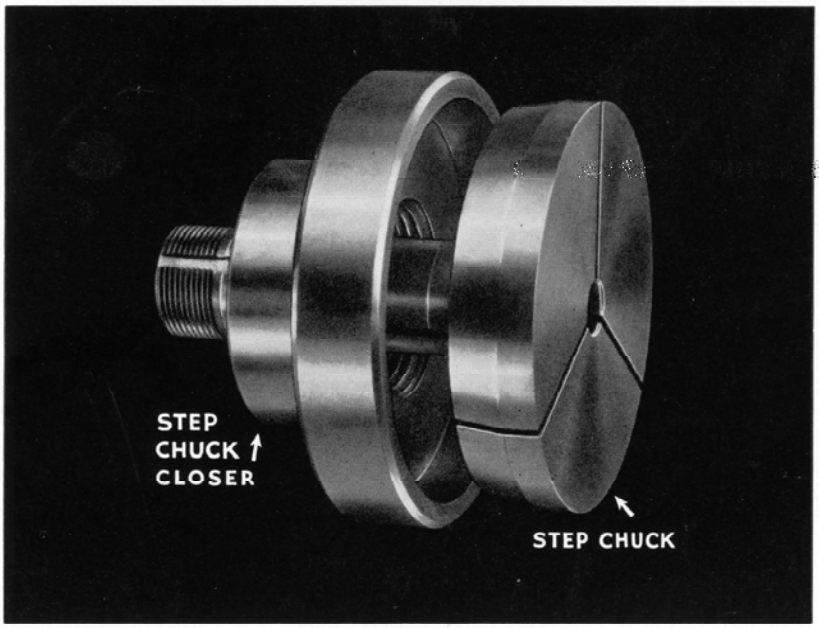
A lock is provided to hold the spindle in any position when it is desired to support work between centers.

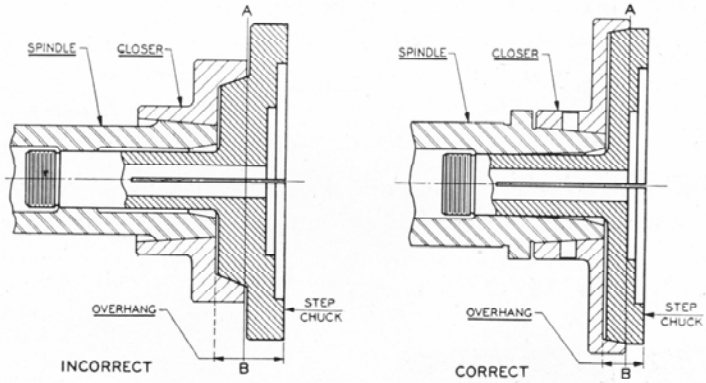
NOTE: We can also supply a lever tailstock having a 5-1/2″ stroke but without spring action.

Step Chucks and Closers: A step chuck is exceptionally useful for accurately holding large diameter work, tubing, etc. The closer is carried on the nose of the headstock live spindle. A standard draw spindle or automatic collet closer is used to draw the step chuck back into the closer. The step chuck is closed by the 10° taper on the outer periphery. With pins placed in the closer and holes drilled in the step chuck to correspond, pieces may be held to predetermined length.



We carry 2″, 3″, 4″, 5″ and 6″ step chucks and closers for all Hardinge headstocks. They are 3/8″ larger in diameter than the rated size, so the full capacity step may be readily applied. Step chucks may be purchased in a finished form, split only, or split and stepped to specifications. Many users purchase step chucks which are split only and then apply the desired steps while the step chuck is in place, assuring dead accuracy of the steps in relation to the headstock.

There are two reasons why we designed our step chucks to be used with a closer for each size, rather than having an angular dimension on the backs to reduce the number of closers required. (1) To have the steps in correct relation to the point of closing contact shown by line A-B on the diagram to the right. (2) To decrease the overhang, which means greater accuracy.



Circular Form Tools: Circular form tools of dependable accuracy are necessary for modern manufacture. Hardinge precision ground circular form tools are the result of many years' experience in the requirements of the screw machine industry. We manufacture circular form tools for all makes of automatic screw machines, chucking machines and turret lathes. The tools are made from selected steel and are heat-treated in keeping with our exclusive methods developed through years of careful investigation and research. Quotations on the particular tools you need will be sent promptly if you will forward us a drawing of the tool or finished part, sample of the part or sample of the tool desired.

You may also purchase standard Hardinge cut-off tools for use on your Hardinge Precision Second Operation Machines, as well as your automatic and hand screw machines.

PERFORMANCE FEATURES OF HARDINGE SECOND OPERATION MACHINE

SPEED

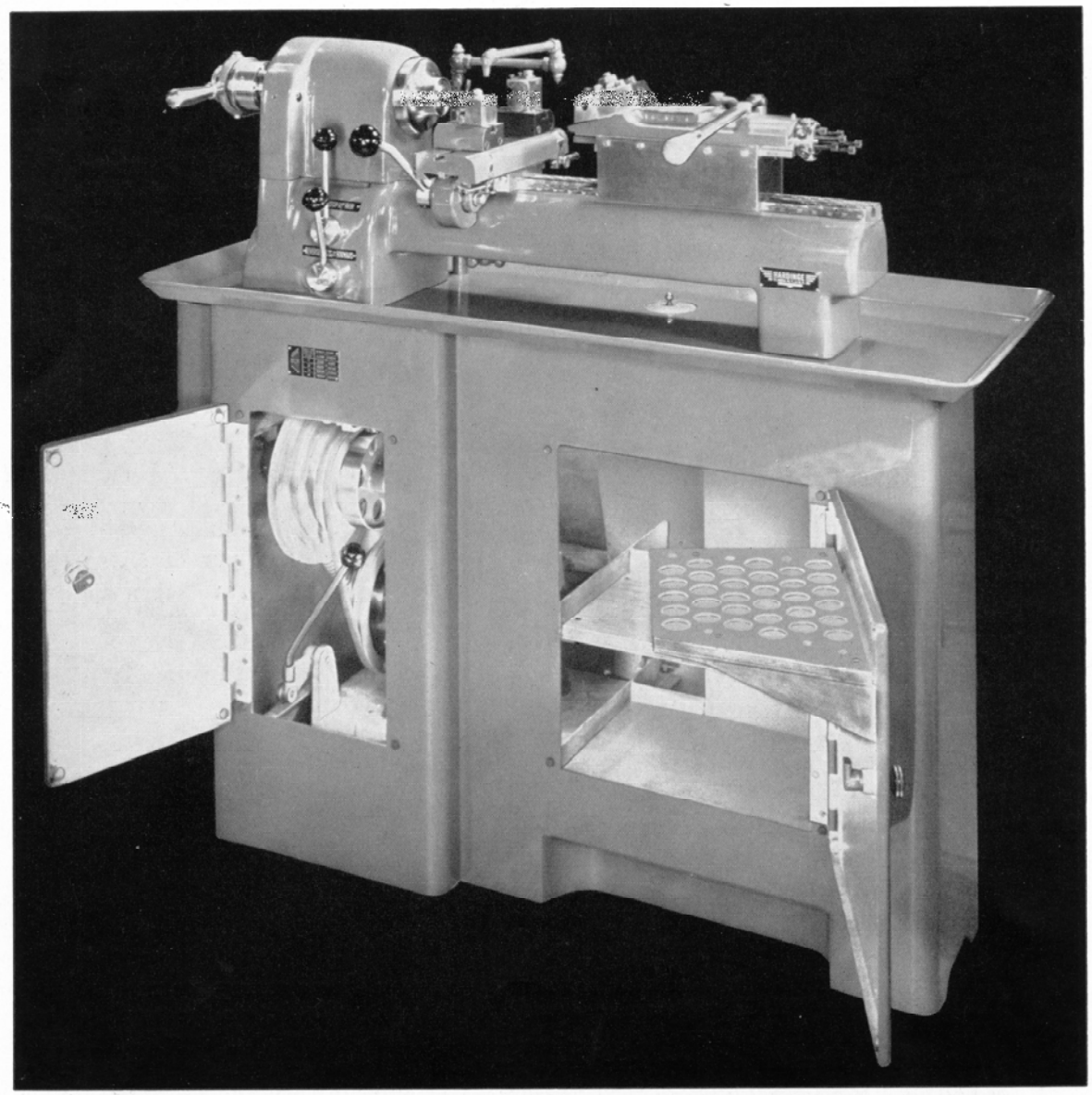
1. Proper cutting speeds for smallest size to capacity.
2. Perfect finish without polishing.
3. Allows use of tungsten carbide and diamond tools.
4. Absence of vibration.

ACCURACY

1. Positively no radial play.
2. Positively no end play.
3. Turns perfectly true pieces.

DESIGN

1. Super-precision preloaded ball bearings requiring no attention.
2. Ball bearings fully sealed to exclude foreign matter.
3. Well proportioned to insure rigidity, smooth performance and long life.



Pedestal Cabinet Driving Unit: The welded steel pedestal is a modern support for the modern Hardinge Second Operation Machine.

The pedestal fully encloses the motor, controls, driving unit and provides cabinet space for storage of tools, collets and other available attachments. The oil or chip pan is 24″ x 53″ and 1½″ deep. The pedestal is arranged to provide foot space for the operator and has openings at each end at the floor to facilitate moving. Provision for bolting the machine to the floor is made inside the pedestal base, eliminating brackets on the outside of the machine. The motor compartment is arranged for adequate ventilation.

The driving arrangement comes as a proven unit through years of use with our precision lathes and milling machines. There are no gears, clutches or loose pulleys to cause noise, chatter and vibration. Our application of vee belts and sound electrical principles brought about a silent, powerful driving unit with motor, driveshaft and headstock spindle having anti-friction bearings.

A standard two-speed ball bearing motor is vee belt connected to a four step speed change pulley for eight forward and eight reverse spindle speeds from 230 to 3500 r.p.m. in LOW-HIGH steps of 230-460, 790-1580, 1200-2400, and 1750-3500 r.p.m. The motor is cushioned and is mounted upon a hinged bracket. A lever arrangement is provided for raising the motor to permit quick positioning of the vee belt on the four step pulley. Vee belts connect the driveshaft with the headstock spindle. The driveshaft is supported by self-aligning ball bearings. Individual adjustment is provided to maintain proper tension for the vee belts at all times.

Brake and Lever Speed Control: A mechanical brake is mounted inside the pedestal on the driving unit. When adjustment of the brake is required, it may be readily made through the motor compartment door opening, without disturbing any part of the machine or driving unit.

The action of the brake is positive and rapid, but gradual. The long lever at the headstock operates an electrical motor control for LOW—STOP—HIGH speeds while the short lever operates a control for REVERSE—BRAKE STOP—FORWARD speeds. The levers are operated against a positive stop for each speed change. Two stop positions are provided so that the brake may be released to permit rotating the spindle by hand.