SERIAL #522

MAINTENANCE AND OPERATION MANUAL

MODEL #1

Moore Jig Borer

MOORE TOOLS BPT. CT.

MOORE SPECIAL TOOL CO., INC. • Bridgeport 7, Conn.

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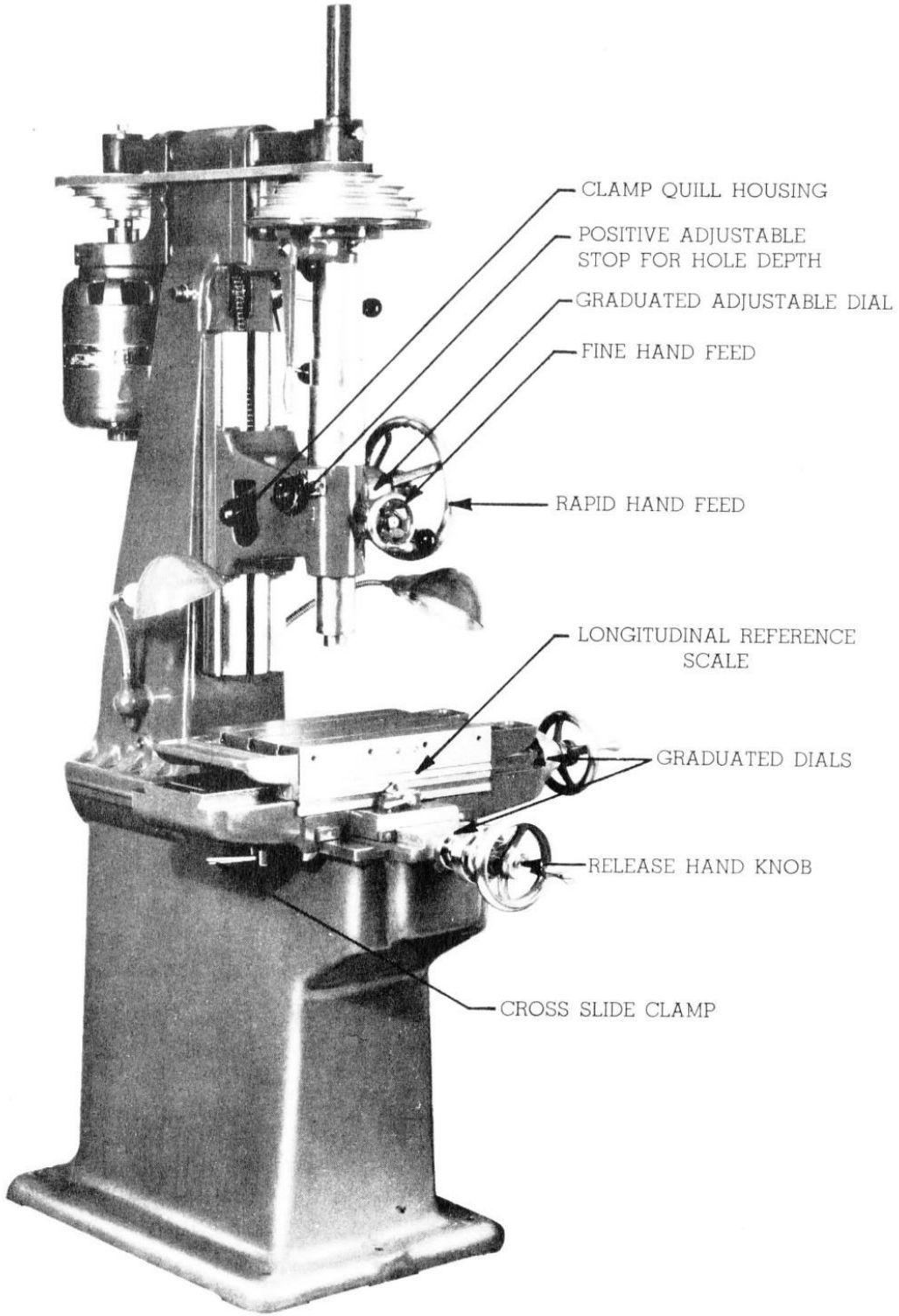


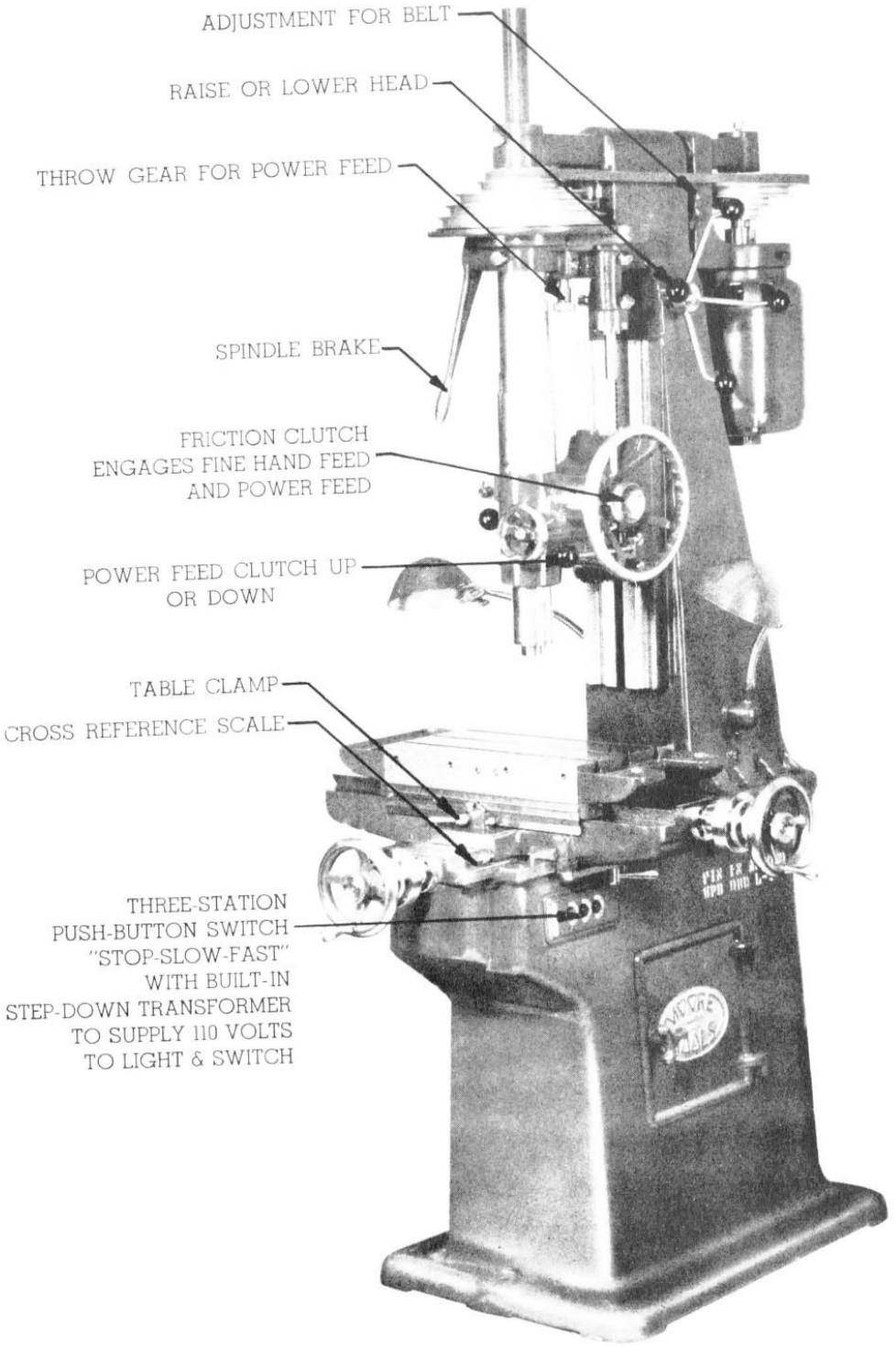
MEET YOUR MACHINE

• The term "Jig Borer" has evolved until it is today associated with definite standards of accuracy. It is synonymous with *precision* boring and *precision* spacing. We have built an accurate jig borer, small enough to have every control easily accessible from the operator's sitting position and yet with ample capacity to meet normal toolroom requirements. It is extremely sen-

sitive for holes of 1/32" or less and still sufficiently rugged to be accurate under heavy cuts.

- Our straight-line production methods and our rigid inspection of all parts assure you a uniform high initial accuracy, a long life and steady performance. The care which the operator takes with his machine, however, can influence this initial efficiency.

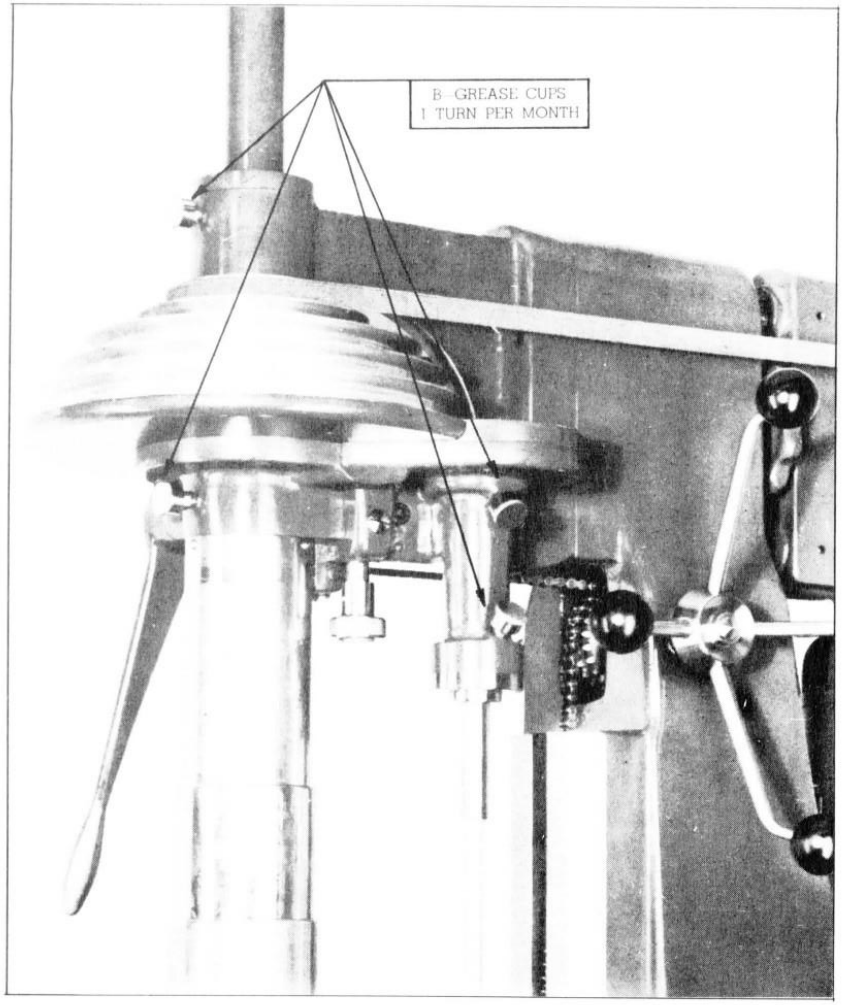
- The operator who knows his machine thoroughly, who understands the improvements embodied in it and who maintains it properly with a reasonable amount of attention can turn out better work over a longer period of time than the operator who takes these things for granted.



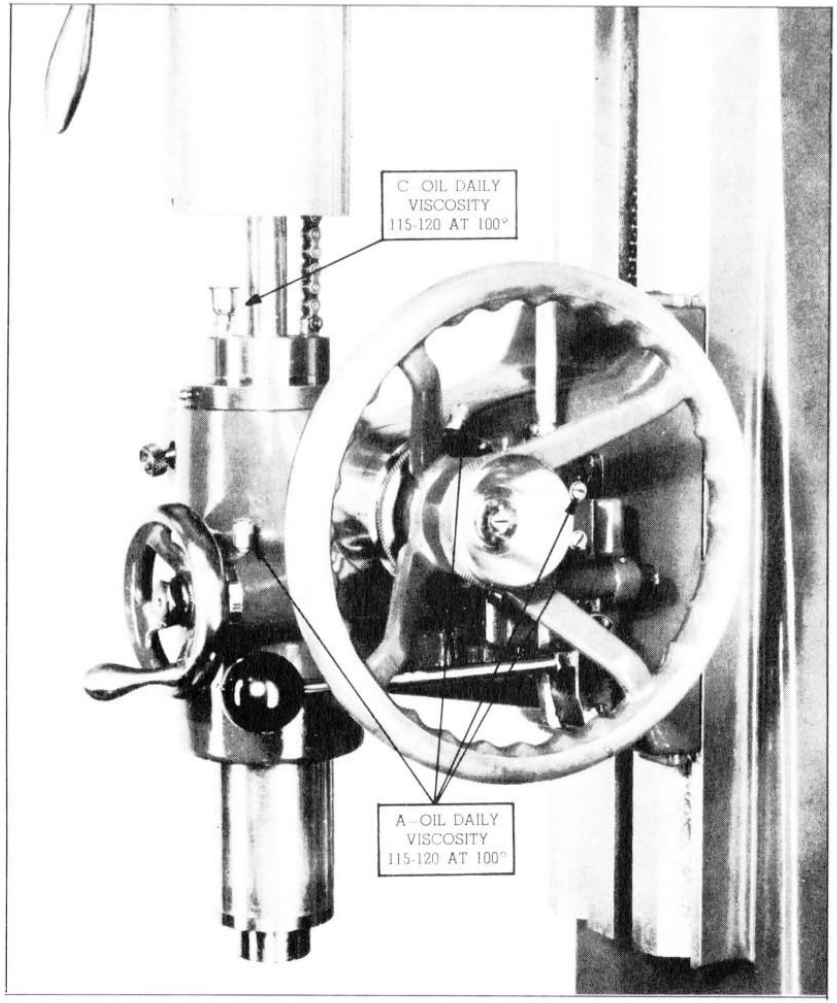
Wipe clean the column ways under the quill housing and re-oil with clean, oily waste after each job.

Push the cross-slide guards back as far as they will go after each job. Wipe them clean and re-oil. Normally during the operation of the machine, these guards are left in position in order to keep the lead screws covered.

Quill Housing Section



Gear Bracket Assembly



method of cleaning lead screws is to rotate them in a lathe and wipe them with waste. This action causes the waste to work down into the threads, follow the threads along, and clean them.

Release the cross-slide clamps and *carefully* push the table back toward the column. Do not push it to the end of its travel, since this may bump and damage the lead screw nut. Do not go any farther than the seven or eight inch mark on the scale.

The short screw should now be flushed with high-grade, light, clean oil, and inserted. Use extreme care when picking up the first thread in the nut. Screw in until the collar on the zero dial comes up against the base of the machine. Screw tight with the four ¼ x ¾ cap screws furnished.

Release the table clamp and *carefully* push the table to the left. Do not push it to the end of its travel, as explained above. Do not go any farther than the twelve or thirteen inch mark on the scale. The long screw should now be flushed with oil and inserted, following the same procedure as the short screw.

WIRING

Only one power cable is needed to connect the machine to the existing power line, inasmuch as a transformer is provided to step down the current for the light circuit.

The Junction Box is mounted on the rear of the column for easy access. An extra receptacle is provided in the cover of the Junction Box for general use, or for the operator's convenience.

The system of electrical controls includes push-button station, magnetic relay with thermal overload and under-voltage protection.

A complete wiring diagram will be found inside the door in the base of the machine.

LUBRICATION

By lifting the bottom section of the telescoping spindle guard tubes, a wick-feed oil reservoir is exposed in the top of the quill. Fill this reservoir daily with a good grade of light spindle oil.

Keep grease cups filled with a good grade of automobile grease and screwed in one turn per month.

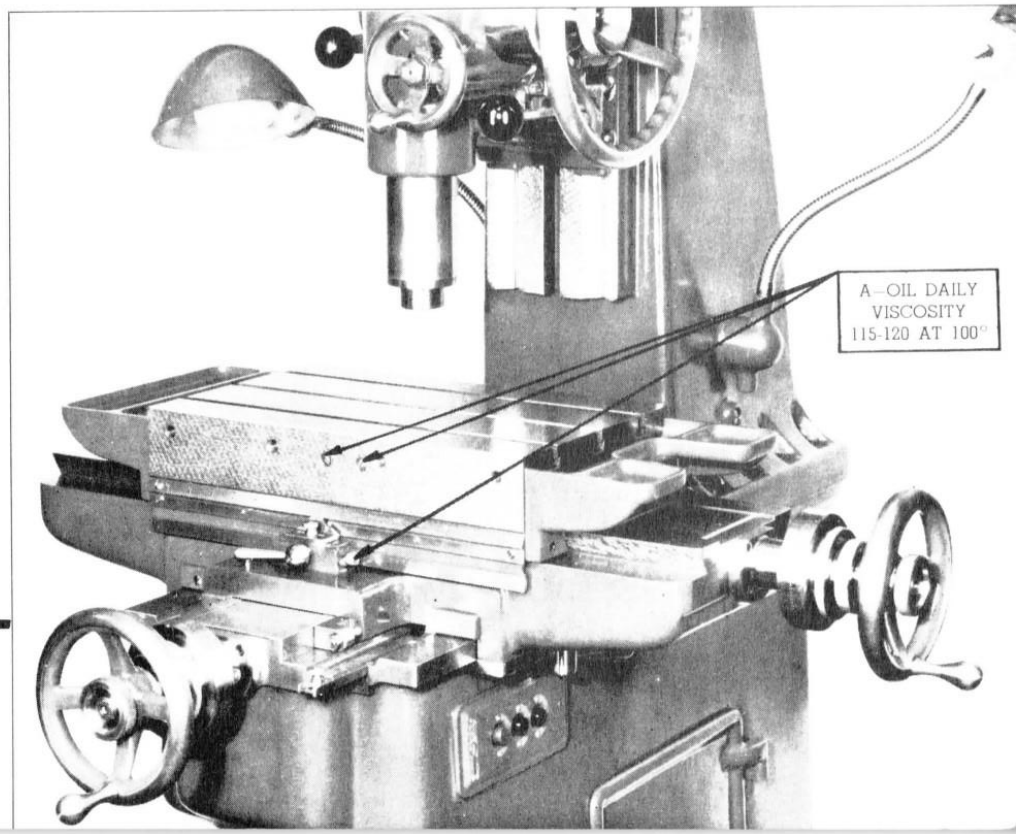
Oil all flush-type oilers at least once each week with non-oxidizing, non-gumming and non-staining light spindle oil. (Viscosity: 115-120 at 100°)

The table ways can be oiled by removing screw-caps in the front and back of the table and squirting oil into the holes. Additional oiling can be provided by wiping the ways with clean waste and squirting oil directly on them. The cross-slide ways can also be oiled in this same manner.

A screw cap in the front of the table and an oiler on the front of the cross-slide provide means for oiling the lead screw nuts.

Wipe the bottom of the quill clean after every job. Re-oil with a squirt can or with clean, oily waste.

Table Section



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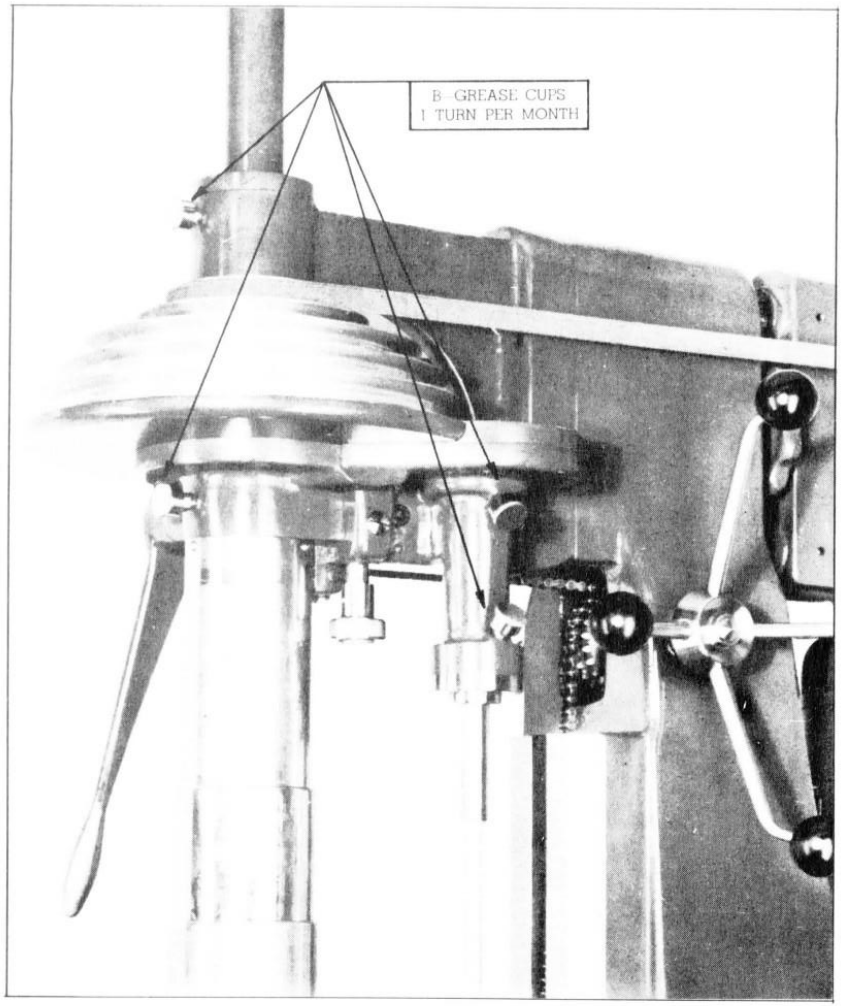

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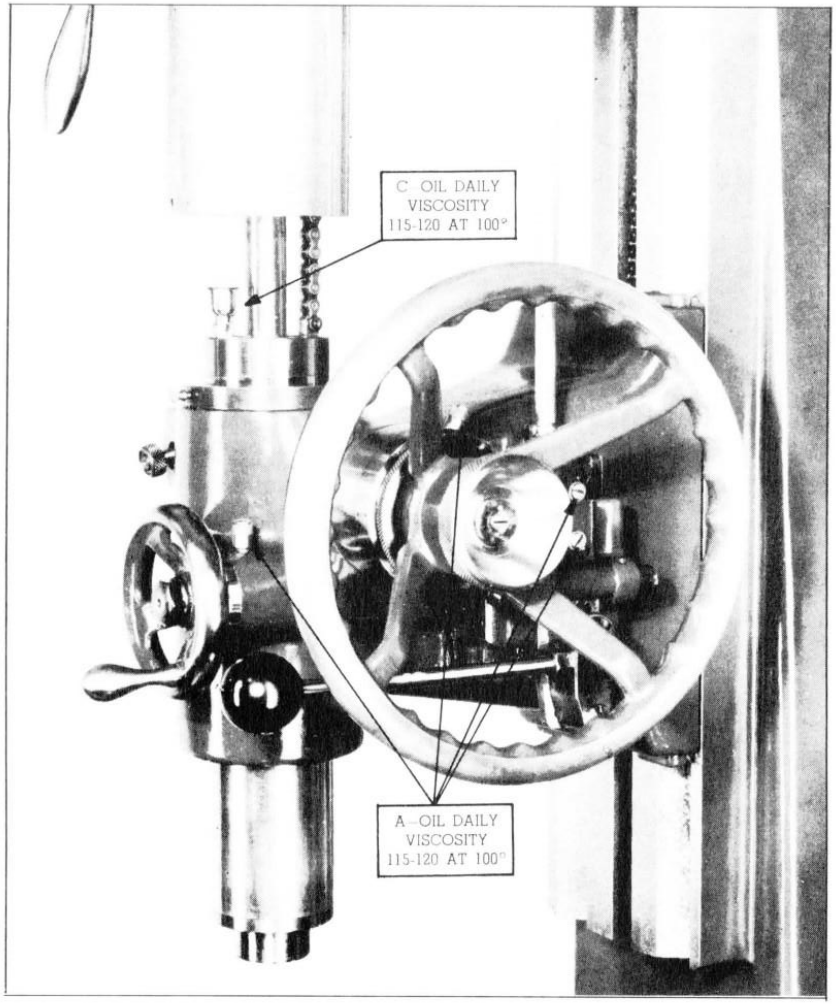


II. Operation

POWER FEED

Refer to pp. 2 and 3. Underneath the gear bracket, slightly behind and to the right of the spindle guard tube is a knob indicated "Throw Gear for Power Feed." Pulling this knob downward engages the power feed gears . . . . pushing it upward disengages them. Always stop the machine before engaging these gears.

When the gears are engaged and the machine is started the power feed drive shaft rotates. This delivers power to the reversible clutches controlled by the black-knobbed horizontal "Power Feed Clutch." These clutches, in turn, transmit the movement to the shaft carrying the small "Fine Hand Feed," and then to a friction clutch controlled by a knurled knob, "Friction Clutch," in the center of the large handwheel.

The large handwheel, "Rapid Hand Feed," is permanently connected to the spindle. When the power feed is engaged and the power feed lever is in the proper position, this handwheel turns while the spindle is fed by power. Even under these conditions, however, the spindle can, if desired, be fed by means of the "Rapid Hand Feed," in which case the friction clutch slips.

The "Power Feed Clutch" has three positions—up, down and neutral (no feed). From the foregoing description it follows that with the "Power Feed Clutch" in neutral and with the "Friction Clutch" tightened, the spindle can be fed up or down by means of the small handwheel at a very fine rate of speed.

INSERTING SHANKS IN THE SPINDLE OF THE MACHINE

Take extreme care to be sure that the taper shanks on all tools inserted into the spindle are perfectly clean. Do not insert the shanks too tightly, especially when the spindle is warm. If the spindle is warmer than the inserted shank, the latter will subsequently expand and jam in the spindle, so that it will be difficult to remove.

A very thin film of oil may be desirable on the shanks, but great care should be taken to protect them from finger perspiration, especially if the shanks are to remain in the spindle for any length of time. This might cause the shank and the spindle to rust slightly, making removal of the shank almost impossible.

When removing tools from the spindle, hold the brake firmly with the left hand and loosen the tool with the wrench in the right hand. Make sure, while loosening the tool, that the wrench does not slip out of the hand or off the hex on the shank. If the wrench slips off the tool, the latter, being free, will continue to turn and possibly fall out of the spindle, damaging the table of the machine or any work which might be clamped on it.

When extra accessories are purchased to fit the spindle, blue them lightly with Prussian blue and insert, making sure they fit with an even bearing at both ends of the tapered hole in the spindle, or slightly tighter on the large end of the taper.

SETTING UP THE WORK

By means of the furnished bolts and straps, clamp the work to the table of the machine firmly enough to prevent it from shifting its position while holes are being drilled or bored. Place the work to be bored on parallels, making sure there is sufficient space under the work to allow drills and boring tools to go through without hitting the table. In clamping, try to keep the bolts as close as possible to the work and to keep the ends of the straps directly over the points where the work rests on the parallels.

In the recesses in the heel-rests furnished, place the heads of the screws in the heel-ends of the straps. The adjusting screw has a 1″ (or 25.40 mm) adjustment and saves many minutes looking for packing of

the exact height required. These heel-rests can be stacked to provide for work of unusual height. In addition, a set of extension bolts is furnished for the same purpose.

Either of two methods can be used to set work parallel with the direction of table travel. The first is simply to indicate one side of the job. The other is to place one side of the job against the straight-edge on the front or back of the table. In order to keep the work somewhere near the center of the table, it may be necessary not to have the job directly against the straight-edge. In this case, feelers, size-blocks or parallels can be used to make sure that the sides of the work are parallel to the straight-edge.

MAKING SETTINGS

With the Moore Jig Borer, the lead screws are used to make all longitudinal and transverse settings of the table. When making settings, therefore, always turn the handwheel in the direction of the arrow, thereby eliminating any error from back-lash. If it is necessary to work backwards, go past the setting further than what corresponds to the back-lash, then when making the final setting, turn to the right again, in the direction of the arrow.

NOTE—*When approaching the limits of travel of the lead screws, use extreme caution not to bump the lead screw nuts against the ends of the pockets in which they travel. If these nuts are bumped too hard, they are difficult to loosen and may become damaged.*

LOCATING THE POSITION OF WORK ON THE TABLE WITH RESPECT TO THE SPINDLE

There are various methods which may be used for locating or "picking up" work with respect to the spindle. Most of them involve the use of the small tools in the indicator set, which consists of an indicator with its holder, an edge-finder and a line-finder.

The indicator is made so that it will work in both directions, and when it is used in conjunction with our holder, it will be found to have a large range of uses. The point is small enough to be used in holes about 3/16″ (5mm) in diameter. It can also be extended from the spindle far enough to pick up holes or bosses as large as 7½″ (approx. 190mm) in diameter.

If you desire to locate the spindle centrally with the work, the point of the indicator can be swung back and forth, moving the table with the screw until the indicator reads the same on both sides. Now loosen the dial clamp on the screw. Then set the dial to zero and clamp it firmly. Now set the scale on some even inch or centimeter. The position thus established should be checked by turning the screw to the left about .005″ to .010″ (.1 or .2mm) to be sure the back-lash is taken up. Then, returning to the original zero position, swing the indicator both sides as before.

The edge-finder may be used to set the center of the spindle over the edge of a piece of work. This tool is ground so that the working face is, with the English style edge-finder, exactly .200″ from each side of the slot on the top (or 5.00 mm with the metric system). Hold the working face against the edge of the work to be located and indicate the slot so that the indicator reads the same on both sides. This position may be checked in the following manner: Back away .200 in. (or 5.00 mm) and touch the indicator to the actual face of the work. In this position, the indicator should read exactly the same as it did originally on both sides of the slot of the edge-finder.

Occasionally, it will be found desirable to lay out lines on the work before setting it up in the machine. In order to pick up the location of these lines, use the wiggler or line-finder. This is not as accurate as the indicator, but you will find it more convenient in some cases. You can establish locations in this manner within about .001″ (Approx. .02 or .03 mm).

COORDINATES

The following practice has been found most advantageous with the

Moore Jig Borer:

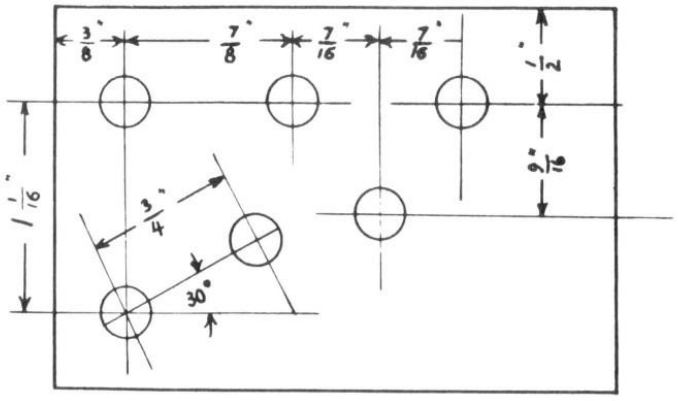
1. Spot all holes on a certain piece of work.
2. Drill and bore all holes to the roughing dimensions.
3. Go back and check the original setting of the work to make sure that it has not shifted during the roughing operation.
4. Make the final finish-boring cuts in each hole.

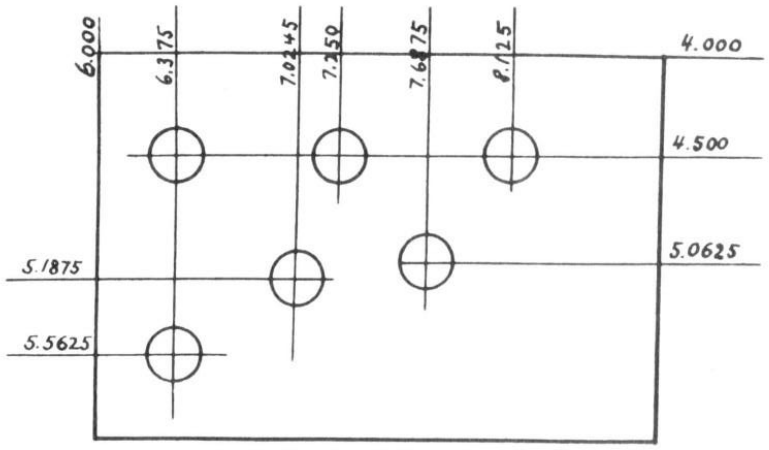
This is possible because of *The Coordinate Location System*, a fundamental method which finds its most efficient application in the direct-reading Moore Jig Borer. By means of two precision lead screws, working at right angles to each other, you can move the work-piece into any desired position in relation to the fixed spindle.

Any point on the work-piece may be used as a reference or starting point, such as a hole, dowel, the intersection of any two edges or lines, etc.

Having established this point in relation to the spindle by means of an indicator, edge-finder, line-finder or microscope, lock the table and the graduated dials are set and locked at zero. The scales may then be set to the nearest full-inch graduation and these figures noted, as they now become the actual starting point for all dimensions.

Assuming, for example, that the setting comes to 4.000 on the cross-scale and 6.000 on the longitudinal scale for the typical conventionally dimensioned piece (see below), it would only be necessary to make a simple sketch (see below), adding the dimensions to the previously established reference figures, i.e. 4.000 and 6.000, in order to determine





coordinates corresponding directly to readings shown by the scales and dials. The position of any hole may be set very quickly, enabling the operator to move from one hole to another between operations. Hence, it is not necessary to finish one hole before proceeding to the next.

DRILLING AND BORING

First spot the holes with a center drill, held in the collet or chuck. Then drill a small hole, which is gradually enlarged by successively larger drills, increasing the diameter about ¼" (approx. 6 mm) with each step. Carry this operation to within .005" or .010" (about .1 or .2mm) of final size. Then finish-bore with a single-point tool.

The eccentric boring chuck furnished for finish-boring is of the swivel-block type. Therefore, the graduations have a meaning only in connection with the length of tool used. When using the tool bits furnished, each graduation represents .001" with the English-style boring tool (or .02mm with the metric style).

Turning the adjusting screw to the right increases the size of the hole

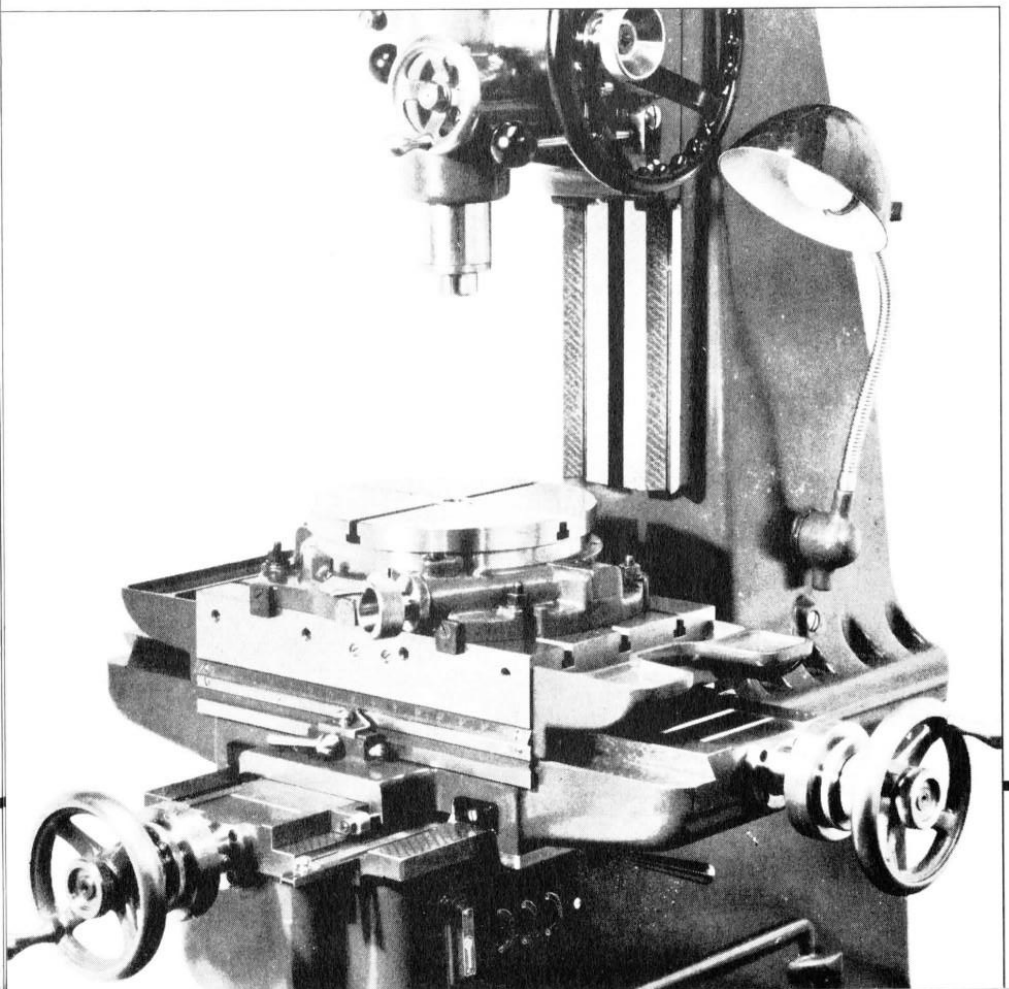
to be bored. Always loosen the swivel-block clamp screw before setting, and always clamp firmly with the wrench furnished before making cut.

In making the final finish-boring cut, set the tool first accurately for the undersized hole and then advance the tool slightly. After this make a test-cut and measure the hole size very carefully. This measurement, together with the graduations on the chuck, will then enable you to set the tool accurately for the final cut. Always remember to tighten the swivel screw firmly before making the final cut.

The solid-type boring bars and boring tool collets furnished are used chiefly for jobs of a repetitive nature, where it is advisable to leave a tool set continuously for one size of holes. The graduations on these boring bars represent a tool travel of .001″ with the English style (or .02mm with the metric style). The boring tool collets are not graduated and the boring bits are set according to the operator's estimate. Once set, however, a change is required only as tool bits are worn or require regrinding.

Sweeping tools of various sizes can be provided to face off bosses, eyes, etc., in conjunction with jig-boring operations.

The Rotary Table



END-REAMER METHOD

The End-Reamer method is the fastest way to locate holes on a jig borer, but the results obtained are not quite as accurate with respect to location as single-point boring. First spot the holes with a center drill held in the collet or chuck, then open successively as before, up to within about .005″ (or .1mm) of final size, and then ream with an end-reamer. Our end-reamer method includes drills which can be held in the same collets.

COLLETS FOR END REAMERS

Collets for straight-shank end reamers with ⅜″ or ½″ shanks are available, equipped with set screws to press against the flats on corresponding tool shanks. This permits easy exchange of these tools while the collet remains in the spindle nose.

NOTE: The collets are of extremely high precision but the end reamers are a commercial product in which some variation must be expected. It is well to polish or lap the shanks to a good gage fit in the collet, then to check the teeth for concentricity with an indicator and to check for size with micrometers. If found oversized or eccentric, stone, grind or straighten and then test before proceeding with the job.

USE OF THE ROTARY TABLE

In locating holes from polar coordinates, the rotary table will be found

very handy. The worm can be disengaged so that the table can be turned around by hand, making it convenient to centralize the work on the table, and to centralize the table itself by indicating the central hole in relation to the spindle. The table can be clamped firmly in position by means of hex. socket cap screws. Angular measurements may be taken from the graduations and vernier on the edge of the table and radial measurements from the lead screws of the machine. The vernier is graduated on a segment which is adjustable, so that zero angular settings can be made, although the work is not clamped exactly parallel to the T-slots in the table top.

Available also are an Angle Plate for mounting the rotary table vertically at 90°, so that holes may be drilled or bored radially, and an Extension Plate, making it possible to locate holes on a circle as large as 22″ (550mm) in diameter.

USE OF THE SINE TABLE

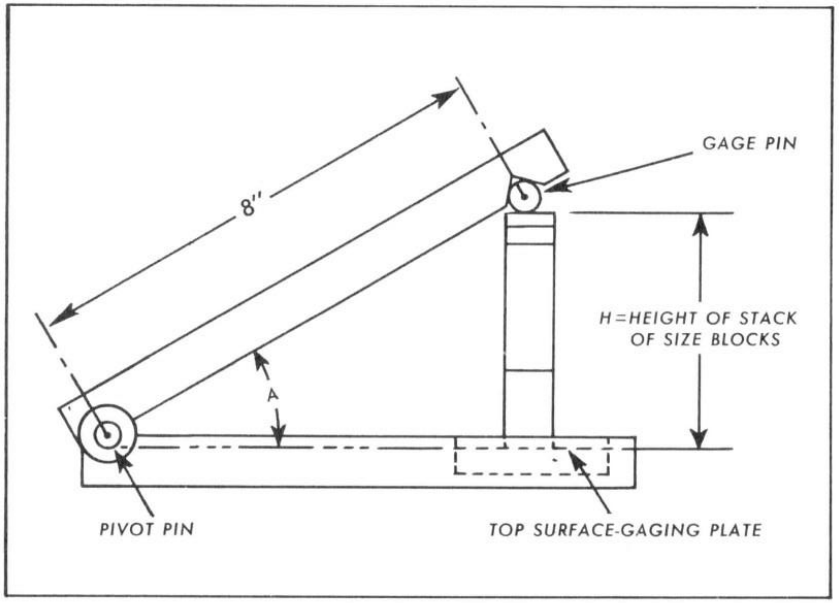
(See photo, Page 13)

The Micro Sine Table was designed for holding the Rotary Table at any desired angle, up to 90°. It can also be used to hold jobs where angular holes are to be bored, and for this reason a number of drilled and tapped holes are provided along the outside of the clamping area.

The angle is determined and set according to the Sine Bar principle, using gauge blocks, the sizes of which are calculated from any table of trignometric functions. However, an assortment of tie rods are provided to be used for clamping the top securely to the base, after the correct combination of gauge blocks are inserted.

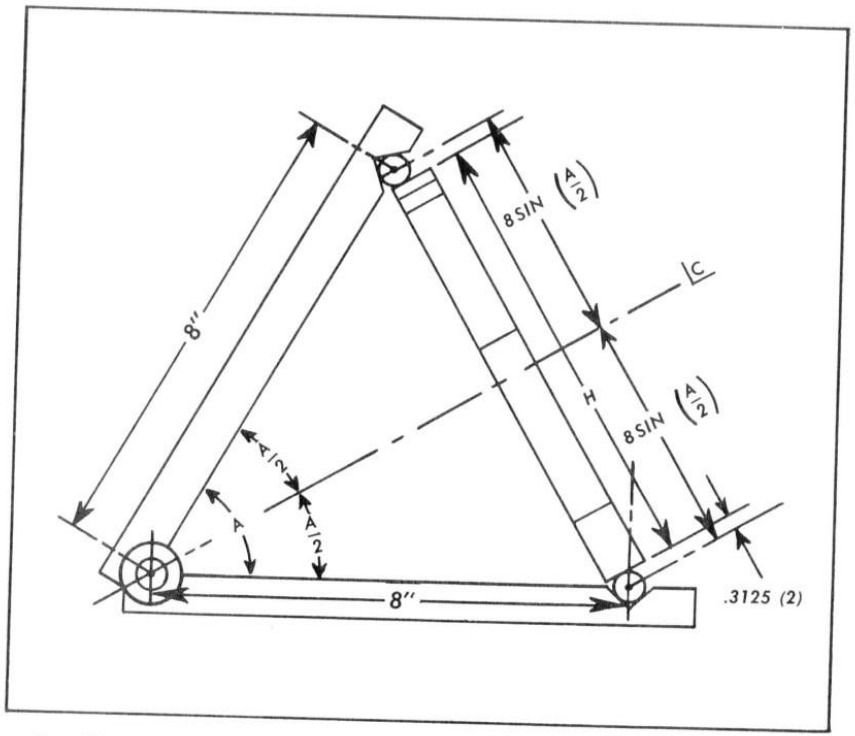
In order to secure the best accuracy at all angular positions of the micro-sine plate, two different setting methods are used, one for cases where the angle is relatively small (up to 45° or thereabouts) and one where the angle is relatively large (between 45° and 90°).

The first method we shall describe is the simplest, and is the method used for relatively small angles. In this case, the operation is similar to that of a regular sine-bar, as shown by this sketch, wherein A is the angle to which it is desired to set the sine plate:



Note that the top of the gaging plate is in line with the bottom of the pivot pin, and that the formula for the height of the pile of gage blocks H, is the same as for a regular sine-bar 8 inches long. H = 8 sine A.

The second method used is for relatively large angles, and is provided for and used only because the first method becomes less and less accurate as the angle increases. It is evident that, as A approaches 90°, the height of the pile of blocks becomes nearly the same length as the distance between the pivot pin and the gage pin, and the control over the angle is very poor. The sketch illustrating the second method is shown below. Note that provision is made for a second gage pin in the bottom plate, and that the gage blocks are placed on an angle between the two gage pins. Great care must be used in inserting the blocks, to make sure that they are exactly parallel to a line connecting the centers of the two gaging pins.



It will now be seen that the distance between the two gaging pins is 8 sine (A/2) + 8 sine (A/2) = 16 sine (A/2). To find the height of the stack of blocks, one-half the diameter of each pin must be subtracted. Therefore, H = 16 sine (A/2) — .625".

The advantage of having the Rotary Table and the Sine Table in two units is that either the Rotary Table or the Sine Table can be used alone, thereby getting the maximum of useful distance between table and spindle nose. The useful Sine Table surface is 10" x 12½".

DEPTH MEASURING FEATURES

On the Moore Jig Borer, there are three major depth controlling features, which are generally used in conjunction with each other: The Quill Travel Stop, the Quill Travel Dial, and the Micrometer Stop.

The Quill Travel Stop is used only for repeating a depth once established. The spiral slot in it swings the limiting screw up, and out of the way in case the stopping position is such that more than a complete turn of the handwheel is required; yet will return to its original position if turned back. A slight turn of the limiting screw controls very accurately the depth of the cut, in case a very small and sensitive adjustment is wanted.

If the quill is moved downward until the tool bit touches the top of the work, and the quill travel dial is set to zero, any depth may be read directly in thousandths of an inch, or in hundredths of a millimeter (depending on how the dial is graduated). This is accomplished by means of a vernier on the zero dial.

If the quill housing is brought down against the micrometer stop and the quill travel stop is set at a certain point, a positive depth setting is attained which can be repeated at will. The quill housing may now be moved up and out of the way while an accurate measurement of the depth of the hole is taken. The micrometer stop can then be adjusted by turning the knurled and graduated knob on top of the micrometer stop to the correct depth position.

This done, the quill housing is lowered again until it touches the stop and a final cut can now be taken until the quill travel stop indicates the depth desired has been reached.

GENERAL SUGGESTIONS

These operational instructions are, of course, very brief and intended to touch on fundamentals only. They have been drawn up as a general guide for the benefit of the operator. Principles of precision boring on a Jig Borer are not different from time-honored practice in other work. The operator, as he gains in experience with this machine, will develop his own common-sense methods best suited for each particular problem.

We stand ready at any time to help and assist with any special problem users may have and shall welcome such inquiries.

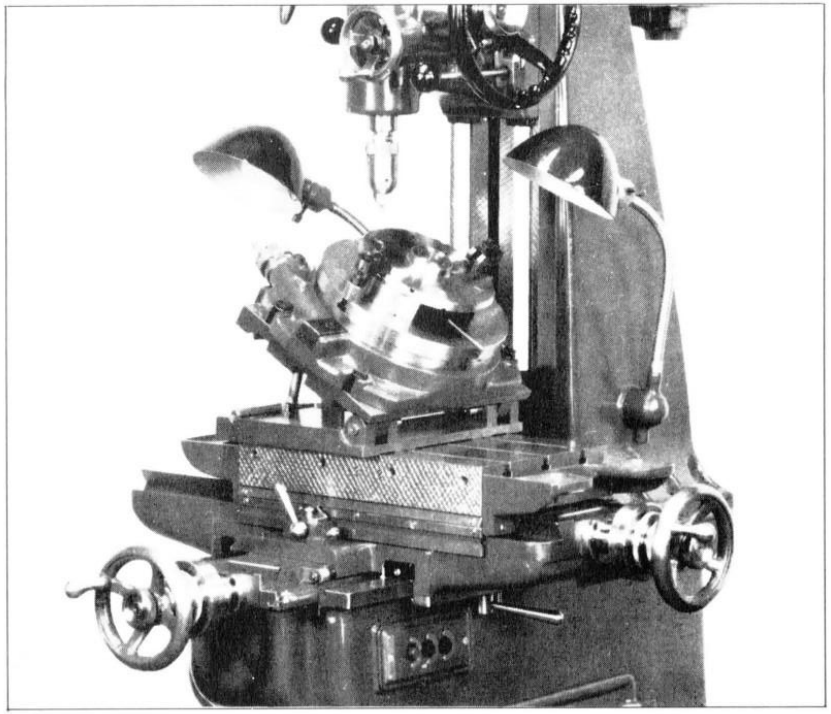
MOORE JIG BORER ACCESSORIES

This photograph illustrates the wide variety of jobs which may be performed on the Moore Jig Borer.

We feel that no machine tool is better than the small tools which accompany it. Actually, we have spent a great deal of time and effort to develop a line of accessories, matching the high-grade workmanship of the machine itself, to meet the requirements of practically any job that may come along. We believe that we have developed a more complete line of small tools and accessories than any other Jig Borer builder.

Consult our catalogue, representative, or service man regarding these.

Accessories



III. Adjustments

GIBS

Keep gibs for longitudinal and cross travel just tight enough to be sure there is no play in the ways.

QUILL HOUSING SPRING

Have the quill housing spring tight enough so that the quill housing does not fall of its own weight. Inside the quill housing, accessible from the left side, is a square-headed set screw, protruding from the quill housing clamp collar (large round nut). If the spring tension is too light, correct it by turning this set screw a little to the right to increase the tension.

BELT

Due to the high traction coefficient of a V-belt it is not necessary to have any appreciable tension on it. It can be operated satisfactorily when rather loose. At low operating speeds, however, especially with heavy cuts, it is desirable to increase the tension somewhat to prevent slippage. The V-belt pulleys on the Moore Jig Borer are arranged so that the belt is automatically tighter on the slow speeds. This is done so that once the belt adjustment is set, no further attention is required unless the belt wears or stretches.

BACK-LASH AND LEAD SCREW DIALS

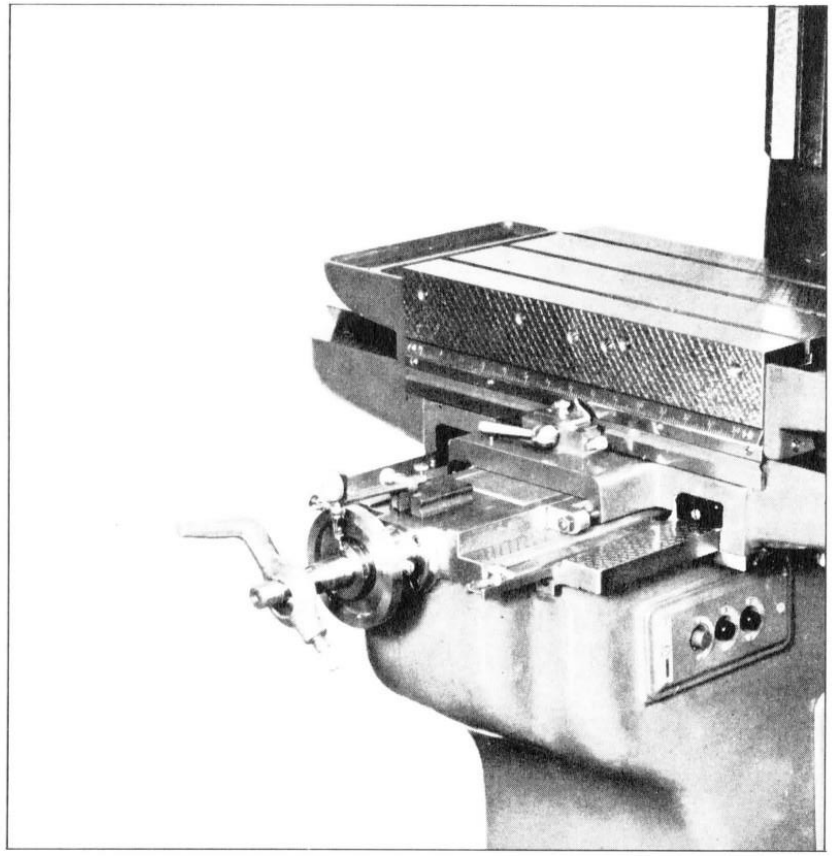
It is impossible to make a screw and nut so perfect that there is no back lash between them. In the Moore Jig Borer this back lash is kept at a minimum. The fit is so good that some operators attempt to make

settings by turning the handwheel in the wrong direction. This introduces an error in the work amounting to about .0005".

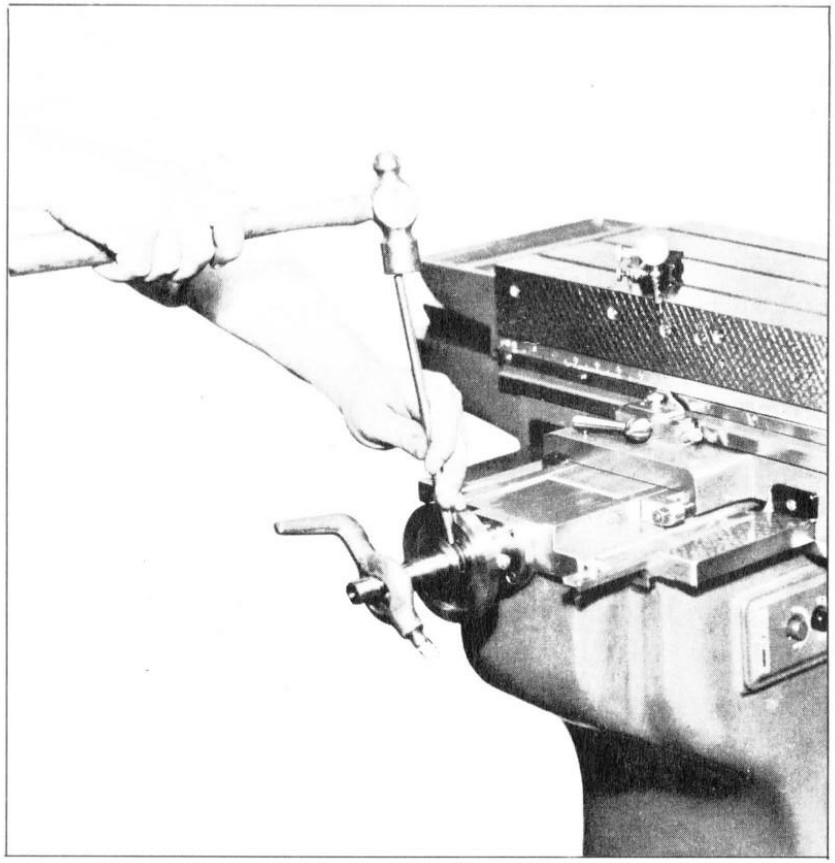
The factory makes a practice, therefore, of introducing sufficient additional back lash (.002" to .003") in the thrust bearing of the lead screw that the error would be large enough to eliminate any temptation the operator might have to do this.

The method of checking the back lash and the trueness of the

Checking the Back Lash



Locking the Collars



locking collars is shown by the left photograph.

The method of locking the collars is shown by the right photograph.

As shown by these two photos, the lock collars should run true and should be locked snugly enough to make sure they will never loosen up during the operation of the machine.

IV. Repairs

HOW TO REMOVE QUILL AND SPINDLE

A. Move table forward, toward front of machine, remove limit screw. Turn handwheel to left to bring table as far toward front part of machine as possible. Use extreme caution when approaching end of table travel to avoid bumping lead screw nut. Cover table to protect it from scratching by tools, etc.

Notice block of wood laid on table to prevent spindle from bumping it when it is withdrawn. Remove quill housing limiting screw T-slot in column with Allen wrench as shown.

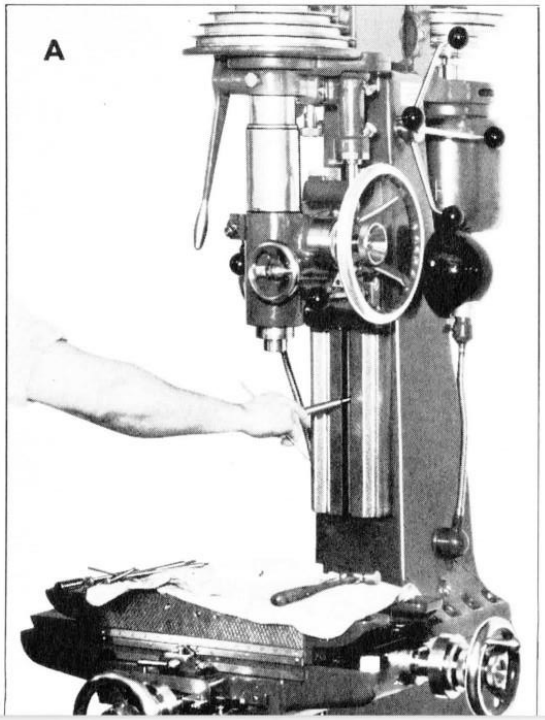
The purpose of this screw is to prevent the quill housing from dropping down too far in use so that keyways in spindle and power feed drive shaft will not be disengaged.

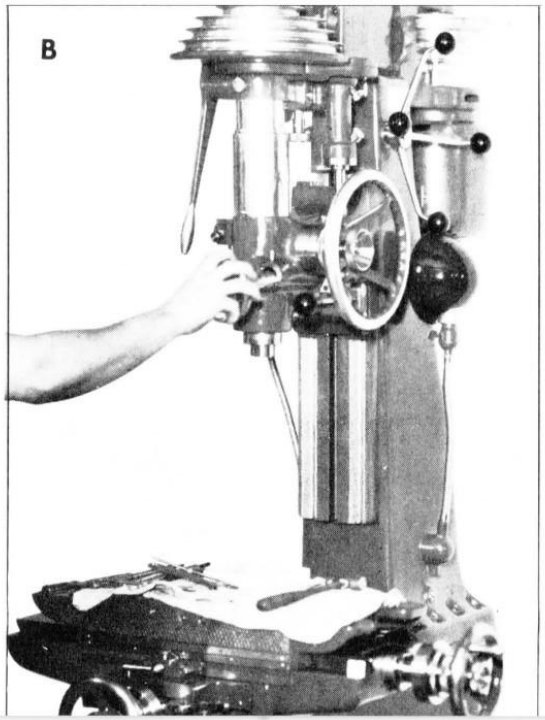
When machine is reassembled make sure this screw is inserted.

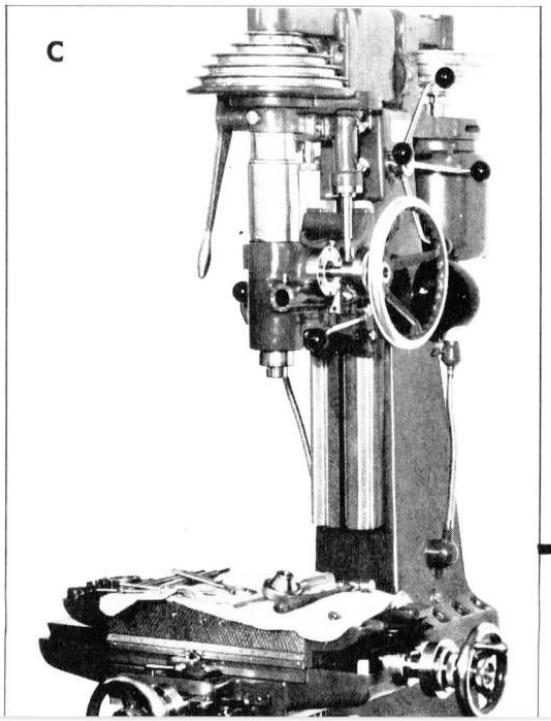
B. Withdrawing worm shaft assembly. Remove fine feed handwheel. In order to do this, first remove the nut holding the wheel on the shaft.

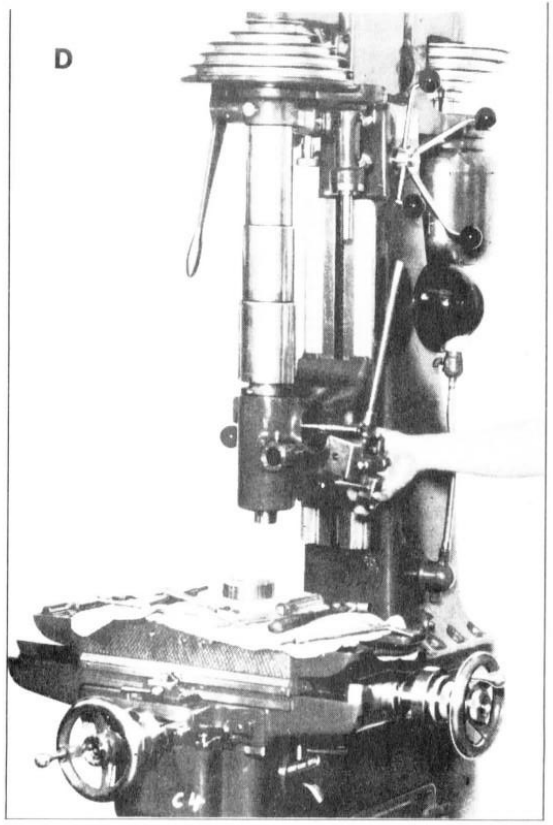
Slip the handwheel off the shaft and remove the four Allen head screws holding the bearing collar. Replace handwheel on shaft and withdraw the whole assembly as shown, at one time, including handwheel worm shaft and worm shaft bearing collar.

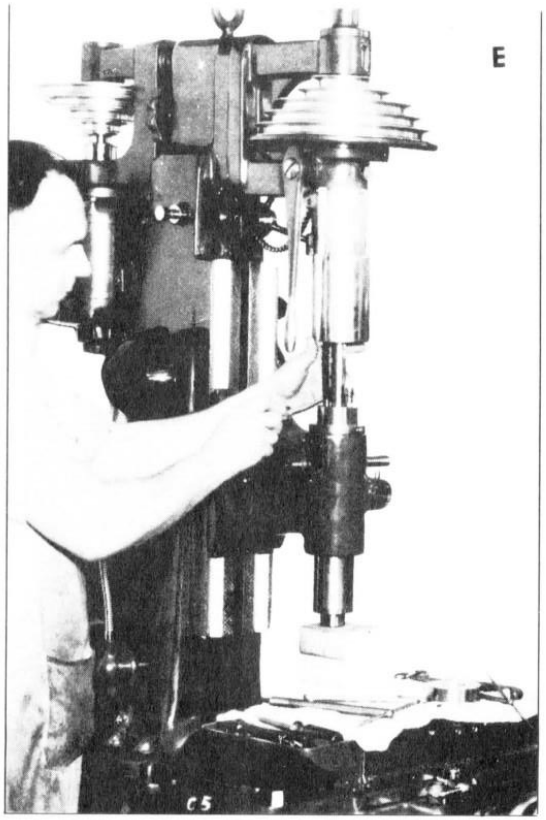
C. Remove stop assembly and dial assembly. Remove stop assembly on left-hand side of machine. To do this remove three Allen head screws holding the stop block, and remove round-headed screw and washer from end of pinion shaft.

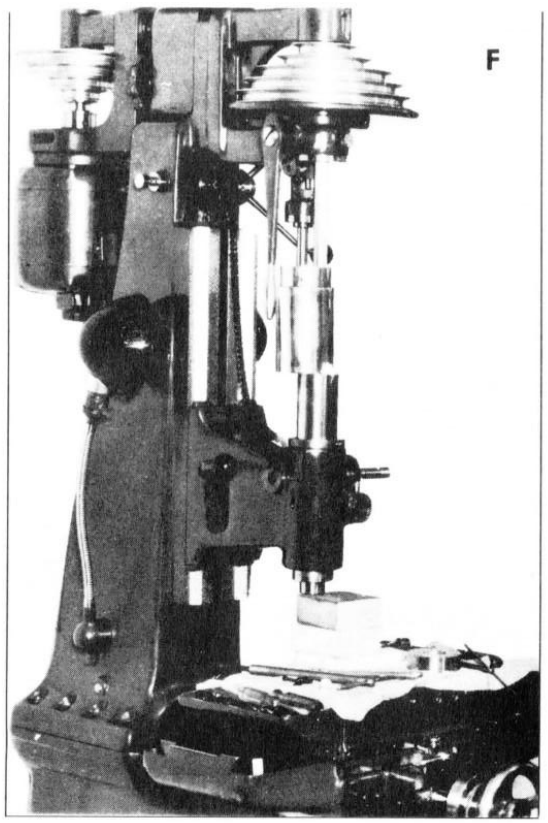












On the right-hand side of machine remove round-headed screw and washer from inside of power feed clamp knob. Unscrew power feed clamp knob, withdraw dial assembly as shown.

After dial assembly has been withdrawn, remove six screws from zero dial. Withdraw zero dial.

D. Remove clutch housing. Lower quill housing far enough to disengage power feed drive shaft. Remove four Allen head screws from clutch housing assembly; withdraw clutch housing assembly as shown.

E. Quill key removal, pin in chain, disconnect chain from quill. Remove quill key—unscrew two oval head screws. Note that the holes in the key are tapped to receive a 10-32 screw.

If the screw is inserted in the key as shown they may be used as handles to withdraw the key as shown. Pull the chain down from the front pulley bracket to allow plenty of slack.

Insert an offset pin about 5/32″ in diameter through the chain as shown and allow this pin to rest against the front base of the column. This will prevent the chain from pulling back through the column.

Disconnect chain from the terminal stud on the top of the quill with a screwdriver as shown.

F. Oil cup from top of quill, adjust heights, withdraw pinion shaft. Remove oil cup from top of quill. Plug this hole *immediately* with clean white waste. It is extremely important that no dirt be allowed to get into this hole.

Adjust the height of the quill housing and spindle rest so that quill cap extends about

11/16″ from the bottom of the quill housing. This aligns a scallop cut into the side of the quill with the pinion shaft so that it may be withdrawn without interference.

Withdraw pinion shaft gently; if it seems to stick, adjust the quill slightly up and down until the correct alignment is found.

G. Raise quill housing, rest spindle nose. Raise quill housing, rest spindle nose on block as shown.

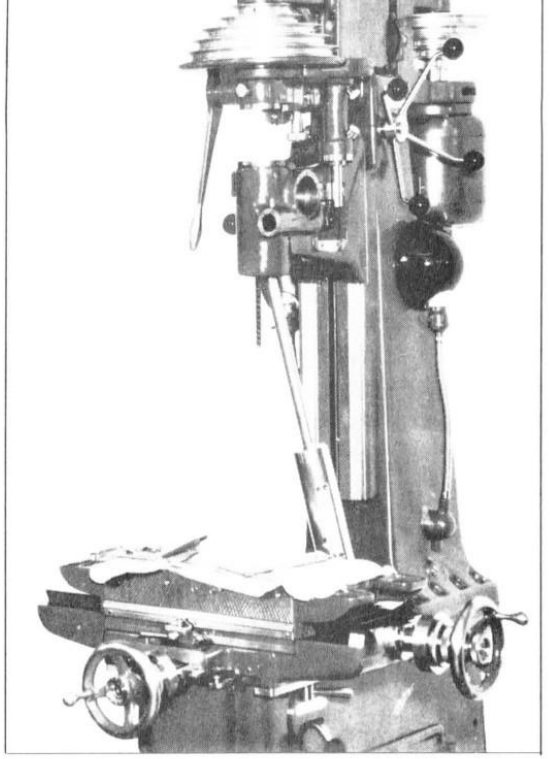
H. Remove guard cans. Slide spindle carefully backward off table, rest on rear extension of cross slide, remove guard cans as shown.

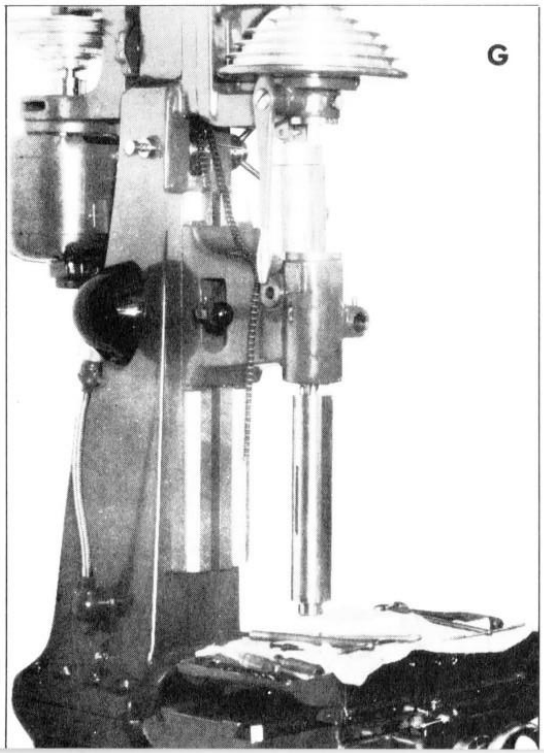
I. Reset spindle on block, raise quill housing to limit. Rest spindle nose on block, again raise quill housing as far as it will go as shown.

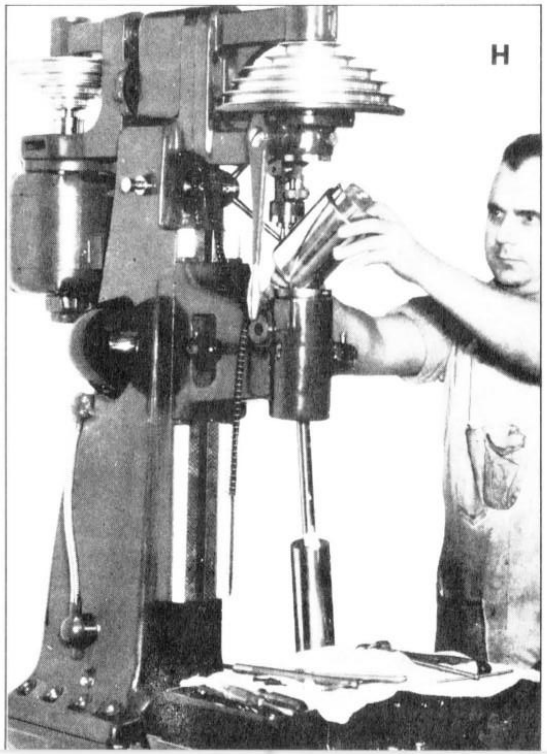
Note in this photo the scallop cut into the quill for clearance for withdrawing the pinion shaft from the rack.

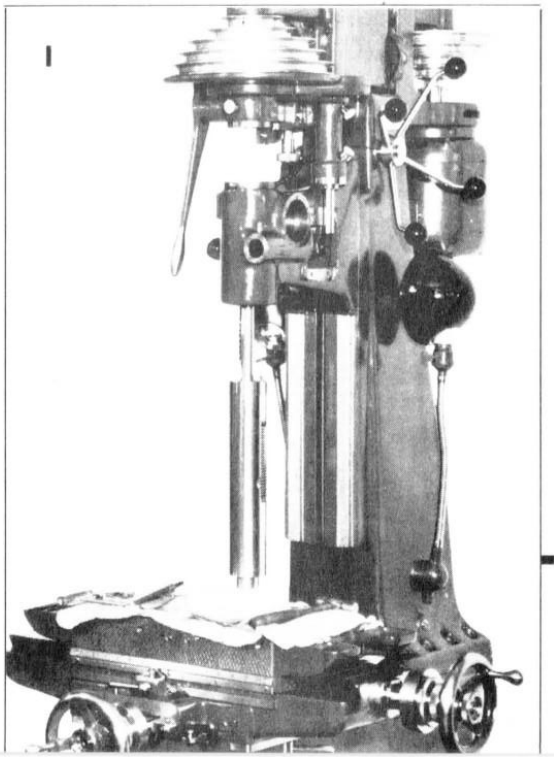
J. Remove quill and spindle. Withdraw spindle and quill completely down through quill housing.

Handle these parts very carefully at this point since they are heavy and slippery. When reassembling machine the order of operation in these instructions and photographs should be exactly reversed.









POWER FEED CLUTCH ADJUSTMENT

Tightening the Knurled Knob, Power Feed Clutch, in the center of the large handwheel, engages the Power Spindle Feed. This feed is not designed for pulling heavy loads. It is designed in this way to prevent operators from feeding too large drills or cutting tools into the work, thereby straining or distorting the spindle or other parts of the machine.

At times, however, grease or oil may impregnate the cast-iron clutch faces on the worm gear. If the operator feels that the clutch is losing its pull, he should remove the parts by following instructions B and C of "How to Remove the Quill and Spindle" on pages 15 and 16. Thorough cleaning and oiling with oil of low viscosity will usually correct this condition.

REPLACING OF LEAD SCREWS

Since building our first machine, our own practice in installing and aligning lead screws and nuts has constantly changed and improved.

Therefore, instructions cannot be written to cover all conditions which might be met in the course of the job of replacing the screws and nuts.

As a matter of fact, it will seldom be necessary, except in case of accident, to replace the screws in the machine. Our experience has shown that if the screws are damaged or worn sufficiently to be replaced or corrected, the entire machine is badly in need of overhauling. For this purpose the machine should be returned to the factory.

In case this is impracticable, or in case of accident to the screw, write the factory for specific instructions in each case.

FOR REPLACING BEARINGS

Inasmuch as the bearings used in the spindle are preloaded and manufactured to our own specifications, we recommend that the spindle and quill assembly be returned to us when bearings are to be replaced.

It is practically impossible for the user to replace these in the field, for we have developed a considerable quantity of equipment especially for the purpose of checking, aligning and preloading the bearings.

To attempt to do this without this equipment would be uneconomical in the first place, and the highest precision could not be achieved.