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RUNNING A REGAL . . .

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RUNNING A REGAL

An instruction manual describing the construction, operation and maintenance of the modern geared head engine lathe ... the LeBlond Regal ...

with exploded parts section for greater ease and speed in ordering repair parts.

15th Edition

R.K. LeBlond Co. 1951 Printed in U.S.A. Price 50c

THE R. K. LeBLOND MACHINE TOOL CO., CINCINNATI 8, OHIO, U.S.A.

Largest Manufacturer of a Complete Line of Shop-Tested Lathes

INTRODUCTION

Running a Regal and producing accurate work is not a difficult task if the fundamentals of good engine lathe operation are observed. It is important that the operator understand his Regal thoroughly, to see that it is well lubricated and maintained at a high standard of performance.

Running a Regal is intended to aid the operator in getting out of the Regal all the accuracy and dependability that has been built into it so carefully. In addition to specific instructions on how to operate, lubricate and maintain the Regal, this manual also contains information on the best methods of performing the most common lathe operations.

This edition contains for the first time an exploded parts section in which every part is illustrated in proportion and relation to connecting or adjacent parts. There is an exploded parts illustration for each of the units which make up the Regal, and each part is listed by name and number. This section was added to **Running a Regal** in order to make it easy for you to order necessary parts, and to assure you that your order will be processed quickly through our plant and the parts shipped to you without delay.

A great deal of thought, time, effort and money have been put into this new edition. However, nothing is ever perfect, and if at any time you think any part of **Running a Regal** could be improved, your comments or suggestions will be welcomed.

INDEX

PRELIMINARY INSTRUCTIONS

When you ordered your Regal, you received an acknowledgment of the order specifying a date of shipment. When the lathe left our factory, the transporting agency issued a bill of lading, a receipt indicating that the machine was accepted in good order for shipping.

The lathe becomes your property upon payment of the freight charges and surrender of your bill of lading. Before accepting the shipment, check the lathe to be sure that it has not been damaged in transit. If it has been damaged in any way, the shipment should be conditionally accepted from the transportation company with the provision that it be subject to thorough inspection.

When you have determined the extent of the damage and have placed your claim with the transportation company, we ask that you forward us complete details and our traffic department will help you expedite.

In uncrating and preparing your Regal for operation, follow the instructions contained in the section on "Setting up, Leveling and Running a Regal". Be sure to loosen the carriage clamp screw - it has been clamped to the bed to prevent movement during transit.

Also follow very carefully the leveling instructions given. Even some of the best mechanics do not realize how important this is. Although the bed is heavy, it can be sprung easily, and all the care taken in manufacturing and inspection is wasted if insufficient attention is paid to leveling.

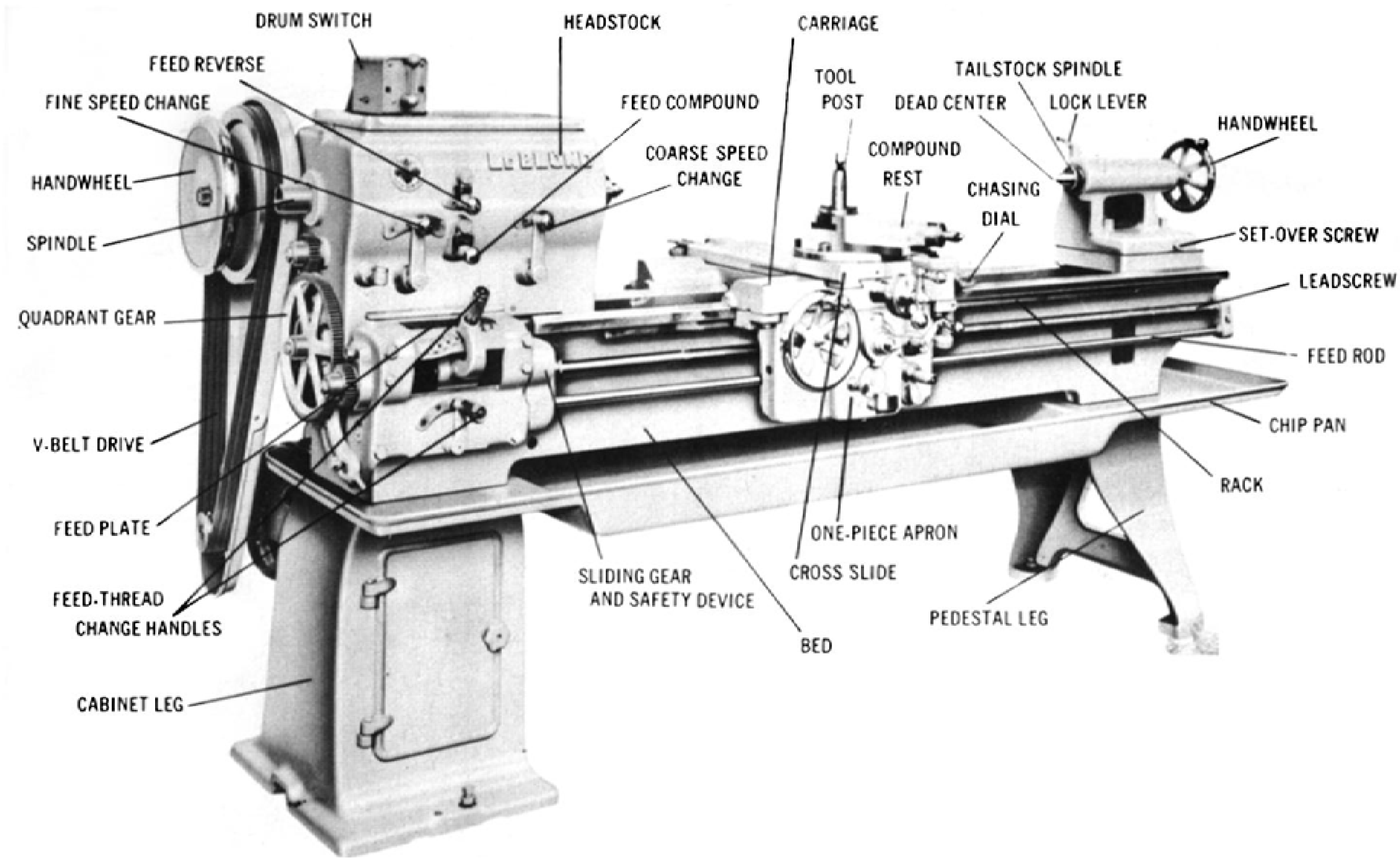


FIG.1--ENGINE LATHE NOMENCLATURE

DESCRIPTION

This handbook contains descriptive data and instructions for operation and service of the Regal Lathe, manufactured by The R. K. LeBlond Machine Tool Company, Cincinnati 8, Ohio.

HEADSTOCK

The feed reverse and compounding feed gears are incorporated within the eight-speed, selective geared headstock. Gears are steel throughout; all gears and shafts splash lubricated.

TAILSTOCK

The entire tailstock is movable on the ways along the length of the bed to accommodate pieces of varying lengths between centers within the capacity of the machine. The tailstock is kept in alignment with the headstock by a V on the rear way of the bed and can be clamped in position with the tailstock clamping bolt.

FEED ROD

The feed rod transmits the power from the quick change gear box to the apron. The feed rod is connected to the final drive through a safety device. Should the carriage meet with any obstruction on the bed or run into the chuck or face plate, the safety device will release and prevent damage to the feed mechanism of the lathe. As soon as the feed is disengaged at the apron, or obstruction is removed, the safety device engages again and resumes turning the feed rod.

LEADSCREW

The leadscrew is used for thread cutting, and it is driven by the leadscrew gear and feed rod gear located at the quick change gear box ahead of the safety clutch.

BED

The bed is the foundation of the lathe. On it are mounted such assemblies as the headstock, tailstock and carriage.

APRON

The apron is a double-walled, one-piece casting in which all shafts and gears are supported at both ends. The lathe apron contains the controls, gears and other mechanism for moving the carriage along the bed.

QUICK CHANGE GEAR BOX

The mechanism within the quick change gear box transmits motion from the main spindle in the headstock to the feed rod and leadscrew. The feed gears may be shifted while the machine is in motion. By use of the quick change levers, any thread or feed on the feed plate may be quickly obtained. Metric translating gears as well as special gears for odd threads may be obtained.

MOTOR DRIVE

The motor is mounted on a hinged plate on the back of the leg below the headstock. The motor mounting plate can be adjusted by screws in the leg to regulate the tension on the V-belts which drive the lathe. Belts are enclosed in a belt guard.

The drum reversing switch--on machines without apron spindle control--is mounted on the headstock cover. All wiring is protected by metal conduit. This switch starts, stops and reverses the spindle.

With the apron spindle control the drum switch is mounted on the rear of the bed under the head and is operated by either of the two spindle control levers: the one at the right of the apron, or the one at the quick change box.

CARRIAGE AND COMPOUND REST

The carriage travels along the lathe bed and is guided by an inverted V-way in front and a flat way in back. The movement of the carriage is by means of the gears in the apron to which it is attached. These gears transmit their power to a rack secured to the bed.

The compound rest supports the tool post in its various positions, and can be swiveled to any angle in the horizontal plane.

TOOL POST

The tool post, attached to the compound rest, supports the cutting tool and provides a means of raising or lowering the cutting edge.

To get the most out of your Regal you should be thoroughly acquainted with what it will do. To assist you in this respect, complete specifications for all six size Regals are contained in the Tables section at the back of this manual. Refer to these specifications frequently so you will know exactly what to expect when running a Regal.

SETTING UP, LEVELING AND RUNNING A REGAL

PREPARATION FOR USE

Remove the crating carefully and leave the skids under the lathe until you have skidded the machine to its approximate location.

The floor on which the lathe sets should be absolutely firm. A lathe must set level and solid in order to perform accurately. It will be impossible to keep the machine level and in alignment if the floor is springy. Therefore, a solid foundation for the lathe is of the utmost importance.

Next, remove the lag screws which hold the legs to the skids and remove the skids from under the machine.

Remove all slush oil from the various parts of the machine. This can be done with a rag or waste saturated with kerosene. Next, wipe off all the bright or bearing parts with a dry rag or waste, following with a rag saturated with clean machine oil to cover all these parts with a protecting film of oil.

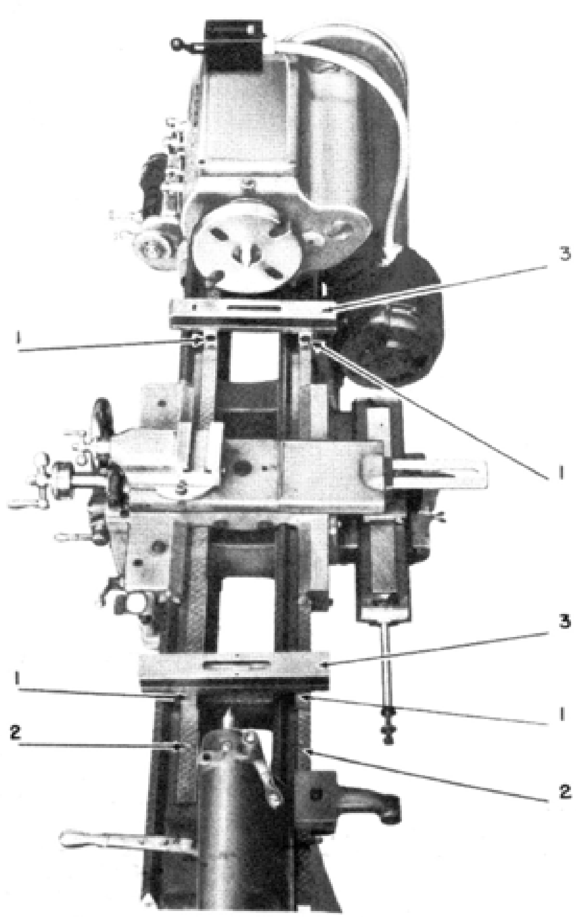


FIG. 2—LEVELING THE REGAL

LEVELING THE LATHE

Refer to figure 2. It is very important to level the lathe properly. Although the bed is heavy, it can easily be sprung if not properly leveled. A steel plate approximately 3/8 to 1/2" thick x 4" sq. may be placed under each leveling screw.

For best results in leveling, are a precision ground bulb level made by Pratt & Whitney, Starret, or Queen & Co. An ordinary carpenter's level, or a combine it square level is not sensitive enough. Proceed as follows:

1. Run the level screws down in the legs until they touch the floor.

2. Place two parallel strips (1, Figure 2) on the front and rear flat ways (2) as near the headstock as possible. Do not place level across vee ways.

3. Place level (3) across the two strips as indicated.

4. Raise the low side of the lathe by adjusting the leveling screws in the legs until the bubble is in the center of the glass bulb.

5. Move the two parallel strips to the tailstock end as shown in figure 2, and place the level across the parallel strips.

6. Proceed to level the tailstock end of the lathe in the same manner as the headstock end as set forth above.

7. Repeat the process of first leveling the headstock end, then the tailstock end until the lathe bed is brought into exact level.

8. After leveling the lathe, tighten the lock nut on each leveling screw, making sure each screw is touching the floor.

9. The lathe, when leveled, should show the same degree of accuracy of alignment as noted on the test card which accompanies each lathe..

10. On three legged beds level over the center leg and level length wise on the rear way in addition to above procedure.

If the lathe sets on a wood floor, the same lag screws taken from the skids can be used for lagging the machine to the floor. These, however, should not be pulled down so tight that they draw the bed out of level, but only tight enough to keep the lathe from "walking."

If set on a concrete floor, expansion bolts should be used for this purpose. Do not bed the legs in concrete because it may be necessary from time to tire to check and correct the machine for level.

Connect the service lines to the motor. It is important that the voltage and the other specifications of the motor be the same as those of your service lines. The data plate on the motor specifies whether the current should be direct (DC) or alternating (AC). If direct currrent is specified, the voltage is shown. If alternating current is specified, the voltage, frequency (cycles) and number of phases are shown.

BEFORE STARTING LATHE

Before you start the lathe, refer to the lubrication schedule (see page 14) which shows the location of various oil inlets on the machine. Fill the headstock with an industrial oil of 500 sec. at 100º F. This type oil is comparable to SAE-30. Fill to the oil level line indicated on the filler plug and squirt oil in all oil holes. It is important to use only the best grade of lubricating oil. All of the bearings fit closely and it is absolutely essential that the machine is properly lubricated before it is operated.

NOTE

> A lathe, like any other piece of mechanical equipment, depends on the attention it receives during the first three or four days use -- "the breaking-in period." See that all bearings are carefully oiled and watch that none run hot.

Before trying to do any work on your Regal, familiarize yourself with the names of the various working parts (see figure 1) as the parts are referred to throughout the manual by these names. Also, become familar with the functions of the various assemblies.

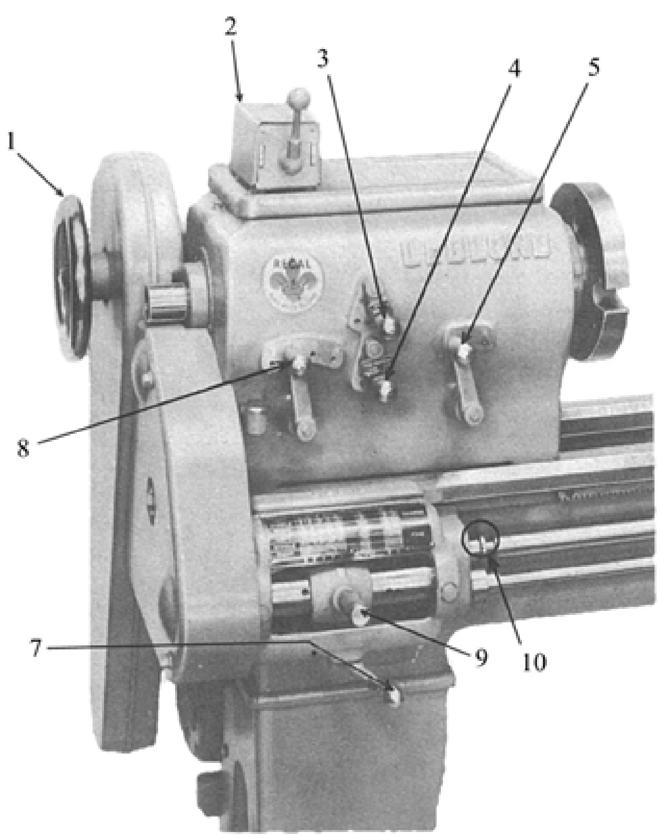


FIG. 3 – 13”-15” REGAL HEADSTOCK AND QUICK CHANGE BOX CONTROLS

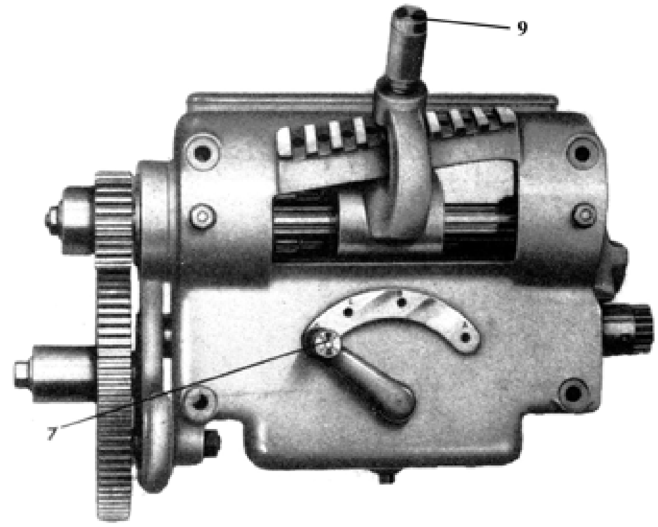


FIG. 4 – 17”-24” REGAL QUICK CHANGE BOX

HEADSTOCK

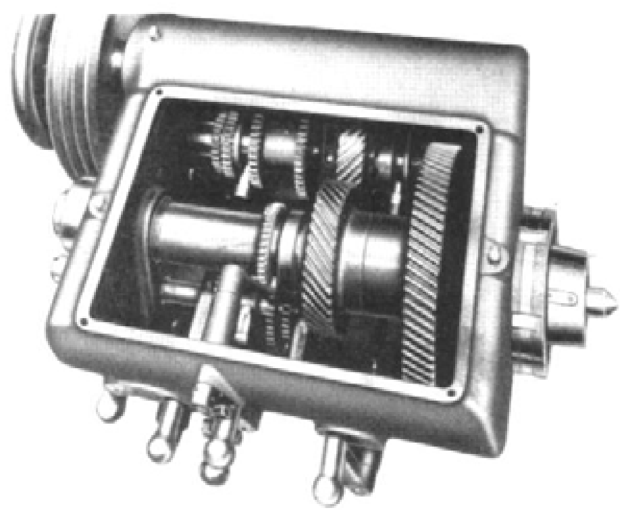


FIG. 5 – REGAL HEADSTOCK

All Regal headstocks have eight selective, geared speeds. Reverse to leadscrew, feed rod and compounding feed gears are contained within the headstock and are operated by convenient levers; the upper (3, figure 3) reverses the direction of feed, the lower (5, figure 3) controls the two feed gear ratios. Steel gears throughout the headstock. All shafts are supported on anti-friction bearings. Taper key drive spindle nose furnished as standard.

QUICK CHANGE GEAR BOX

By means of the tumbler gear handle (9, figures 3-4), the tumbler gear can be rocked into engagement with any of the change gears in the cone formation. This is done by pulling out the handle plunger and depressing the handle to disengage the tumbler gear, then sliding the tumbler along the sleeve to the proper location and lifting the handle up to bring the gears into engagement. When the gears are in engagement, the plunger in the handle locks the tumbler in place so that it cannot kick out when cutting left-hand threads. A series of slots milled in the quick change box sleeve and a pin engaging these slots prevent the tumbler from engaging two change gears at one time.

On the 13" and 15" lathes the eight feed changes obtained through the tumbler gear and quick change gear are multiplied three times by means of the three positions of the lower lever (see 7, figures 3-4), which operates a sliding gear and gives different gear ratios to the feed shaft. In the feed train two ratios are obtained by compounding feed gears in the head. They are controlled by the small handle near the center of the head (refer to 5, figure 3). The 13"-15" Regals provide 48 changes of feeds and threads. The 17"-19" Regals offer 56 feed and thread changes; the 21"-24", 63 changes.

The direct reading index plate is mounted on the quick change box directly over the tumbler sleeve. The numbers on the plate refer to the threads or feeds that the leadscrew and the gear combinations will cut when the tumbler is engaged directly under the number on the index plate. "Coarse" and "Fine" refer to the location of the compound feed handle on the head, and the location of the lever refers to position of the coarse change lever (7, figures 3-4).

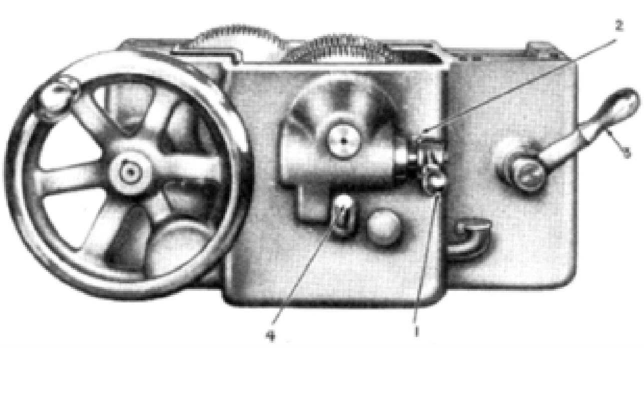


FIG. 7 – 13"-15" REGAL APRON

OPERATION OF APRON

The 13" and 15" Regal apron is a double-walled, one-piece casting in which all shafts and gears are supported on both ends. The splined feed rod passes through the feed bevel pinion. A key in the bevel pinion engages the spline (keyway) on the feed rod. The bevel gear is always in engagement with the bevel pinion, which slides on the feed rod. The feed trip (1) controls both the cross and longitudinal movements, but it is interlocked to prevent accidental shifting from cross to length feed or vice-versa. When the shifter handle (1) is moved to the right to clear the safety lug (2) and pressed down, it slides into engagement, the sliding gear with a gear that is always in mesh with the cross feed screw. Thus, the cross slide will move toward or away from the operator, depending upon the position of the feed reverse lever on the headstock. When the feed reverse lever on the head is in the left-hand position, that is, in the position farthest from the operator, the cross slide moves to the front, toward the operator.

When the shifter is moved to the left, past the safety lug, and pulled up, with the feed reverse lever to the left, the carriage moves toward the tailstock. The direction is toward the head if the feed reverse lever is moved to the right.

When the feed trip (1) is in the neutral position, the interference safety rod is out of the slot in the half-nut and allows the half-nuts to be closed on the leadscrew by lever (3) to chase threads. When the feed trip is moved up or down, the safety rod moves to the right and locks the upper half-nut so it cannot be moved. When the half-nut is closed, the safety rod is in the slot of the shifter shaft and prevents the movement of the feed trip. Manual movement of the carriage is by means of

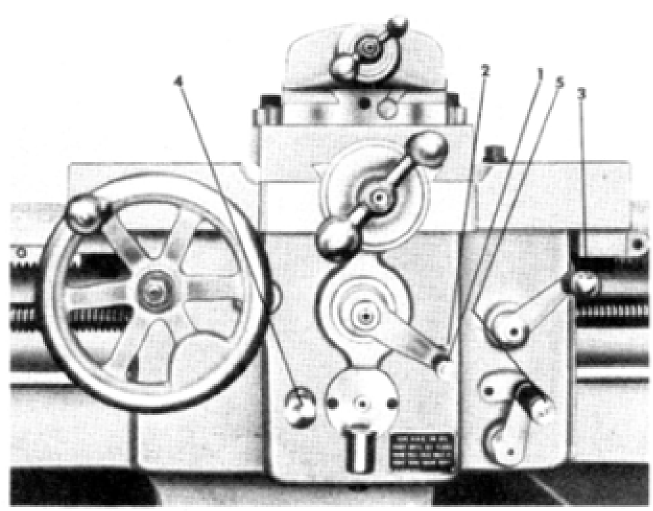


FIG. 8 – 17"-24" REGAL APRON

the hand wheel on-the left side of the apron engaging the pinion with the rack on the bed. By means of plunger (4), the one-shot lubricating system forces oil to all bearings in the apron, the bottom slide and carriage ways and the cross feed bush.

The construction of the 17"-24" Regal apron (figure 8) is similar to that of the 13"-15" but differs slightly in its operation. Lever (1) is moved down to engage the cross feed, and swings up past the stop (2) to engage the length feed. Lever (3) is the half-nut handle which can only be engaged when lever (1) is in neutral against the stop. Lever (5) is the apron feed reverse which reverses the direction of feed without shifting the headstock feed reverse. Of course, the direction of the leadscrew rotation must still be set at the headstock.

THE CARRIAGE

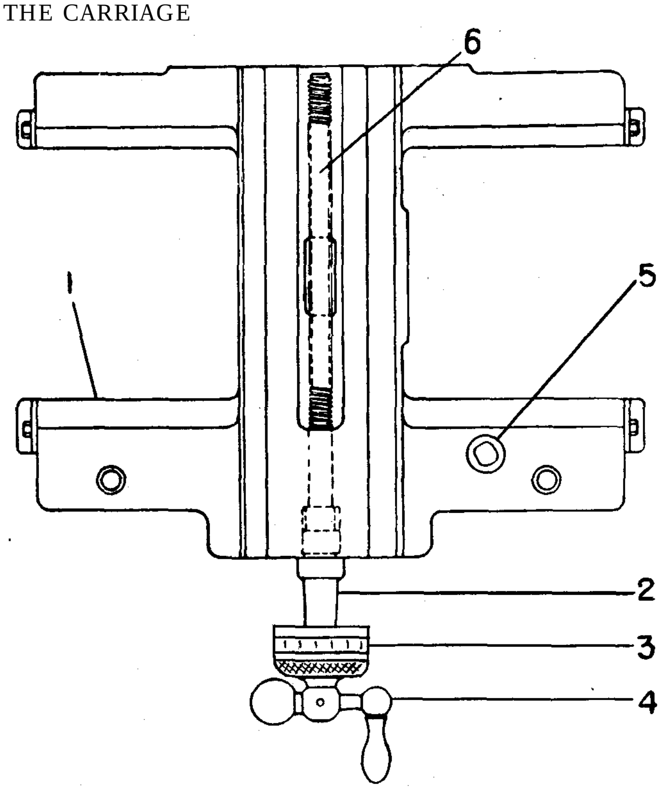


FIG. 9 – CARRIAGE ASSEMBLY

The carriage (1) travels along the bed and is guided by an inverted V-way or shear in front and a flat way in back. The movement of the carriage is by means of the gear train in the apron to which it is attached. The bearings (bed ways) are protected by shear wipers to prevent chips and dirt getting between the carriage and the bed. The carriage is gibbed to the bed both in front and back. The cross feed bush (2) forms the bearing for the cross feed screw, on the front end of which is a micrometer dial 3 and cross feed handle (4). The carriage clamp screw (5) is used to clamp the carriage to the bed for facing and cutting off operations.

NOTE: Before engaging the longitudinal feed, be certain that the clamp screw is loose and that the carriage can be moved by hand. The carriage is clamped to the bed when the lathe leaves the factory to prevent movement during transit.

Lift the compound rest dirt guard over the cross feed screw and oil the screw (6). Oil the felt in the wipers. When working with cast iron, remove the wipers occasionally and clean them in kerosene.

THE FEED ROD

The feed rod transmits the power from the quick change box to the apron. Most lathes of this type are not provided with separate feed rod, but use a splined leadscrew for both turning and chasing, thus the leadscrew is always in use. On Regal Lathes, a separate feed rod is provided to transmit the power for turning and facing.

FEED ROD SAFETY DEVICE

All Regal Lathes, because of their extensive use in schools where they are operated by comparatively in-experienced persons, are equipped with a safety device, which releases when the load on the feed rod becomes too great for the machine. At a predetermined factor of safety, the spring-ball clutch releases the feed rod and automatically engages it again when the strain is released. Thus, if the carriage runs into the headstock, the balls will compress the spring and release the shaft and save the feed mechanism from breakage, but as soon as the feed is disengaged at the apron, the safety device engages again and resumes turning the feed rod.

THE LEADSCREW

The leadscrew is used only for thread-cutting. The leadscrew slip gear (10, figure 3) has a sliding fit on the feed box end of the screw and can be engaged with, or disengaged from, the feed rod gear by a short sliding movement on the leadscrew. When not chasing threads., disengage the sliding gear so that the leadscrew does not revolve. On other lathes of this type, where splined leadscrews are used to drive the feed gears, the leadscrew is subjected to torsional strains at all times and soon becomes inaccurate. The key engaging the spline (keyway) in the leadscrew also burrs up the edges of the threads and the leadscrew acts as a tap, constantly wearing the half-nuts. The leadscrew on a Regal Lathe remains accurate for the life of the machine as it is not subject to these conditions.

The headstock end of the leadscrew runs in the leadscrew bush which is held in a bearing in the quick change .box by two screws. The leadscrew is held endwise between a shoulder and the adjusting nut with hardened thrust washers on each side of the bush. End play is eliminated with the adjusting nut. Care must be taken to keep the leadscrew free from end play or the threads will be spoiled when the lathe is reversed without backing the tool away from the work.

All right-hand threads, and the majority of turning cuts on a lathe, are cut toward the headstock. For this reason the Regal Lathes are equipped with left-hand threaded leadscrews. This also reduces the number of gears in mesh between the spindle and the leadscrew. The thrust of the leadscrew is taken at the feed box end of the screw, thus the leadscrew is in tension under this condition. The leadscrew takes a bearing in back box, but it takes no thrust at this point. The back box supports both the leadscrew and the feed rod on the tailstock end of the lathe.

When cutting threads, it is good practice to put a few drops of oil on the leadscrew even though this is oiled from the apron "one shot" system. Also, put a few drops of oil on your hand and run your hand over the feed rod. STOP LATHE before oiling feed rod! This will not only lubricate the parts but keep them from rusting. Oil both bearing in the back box daily.

THE COMPOUND REST

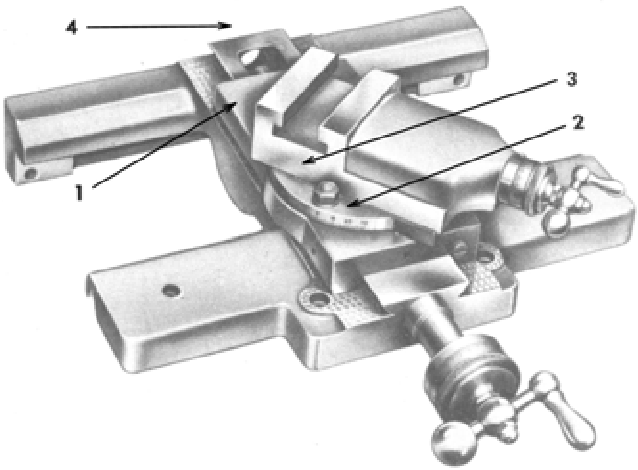


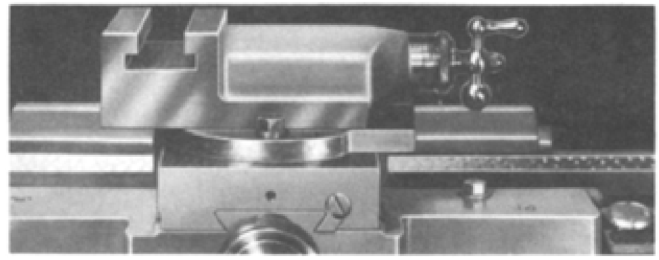
FIG. 10 – COMPOUND REST

The compound rest unit consists of compound rest bottom slide (1), compound rest swivel slide (2), compound rest top slide (3), cross feed dirt guard (4), and cross feed nut (not illustrated). The bottom slide is fitted to the dovetailed cross slide of the carriage and is equipped with a taper gib to provide means of adjustment for wear. The gib adjusting screws in the ends of the bottom slide can be tightened or loosened to obtain the proper adjustment. The bottom slide should be adjusted so that it will move freely on the dovetail and still be a snug fit. The cross feed nut is attached to the bottom slide and runs on the cross feed screw (6, figure 9). The compound rest gets Its movement on the carriage through the cross feed screw and nut.

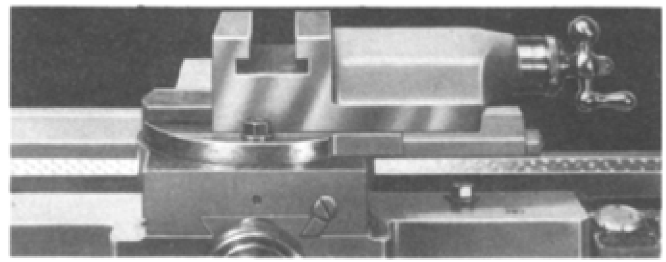
The compound rest swivel slide (see 2, figure 10) is fitted on top of the bottom slide and swings around to the angle selected. It is clamped in position by two T-slot bolts whose heads are in a circular T-slot in the bottom slide. The swivel slide is graduated in degrees so that the compound rest can be set accurately at the desired angle. This feature is used when turning angles on bevel gears, boring holes having short steep tapers, turning and grinding centers, etc., where the angle is too steep to use the taper attachment.

On the swivel slide a dovetail is planed, to which is fitted the compound rest top slide (see 3, figure 10). The top slide is also fitted with a taper gib for adjustment. A screw with a micrometer dial, which engages the nut mounted in the swivel slide, provides hand feed to the compound rest top slide.

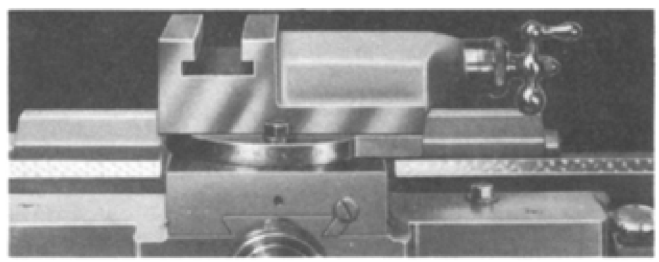
Caution: Note position of compound rest slide in the two extremes. In the forward position the slide overhangs the rest to which it is clamped. In this position it is not advisable in any lathe to take roughing cuts as top slide may break in the middle of the T-slot. When taking heavy cuts, always have top slide flush with bottom slide so the metal is all in compression.



THIS IS WRONG. SLIDE OVERHANGS TOO FAR FORWARD. PUTS UNNECESSARY STRAIN ON MIDDLE OF T-SLOT.



THIS IS WRONG TOO. SLIDE OVERHANGS TO RIGHT. REQUIRES EXCESSIVE TOOL OVERHANG



THIS IS BEST. TOP SLIDE SHOULD BE FLUSH WITH BOTTOM SLIDE TO GIVE GREATEST SUPPORT TO CUTTING TOOL

FIG. 11 – CORRECT SETTING OF TOP SLIDE IS SHOWN IN LOWER PHOTO.

THE TOOL POST

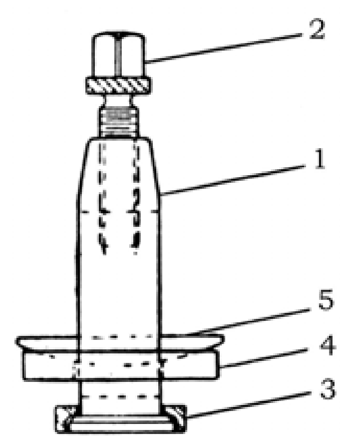


FIG. 12 – TOOL POST ASSEMBLY

The tool post unit comprises the tool post (1), tool post screw (2), tool post washer (3), tool post collar (4), and tool post wedge (5). The washer (3) fits the T-slot in the compound rest top slide. The collar and wedge elevate and lower the point of the tool, and the screw is used for clamping. When placing a tool in the tool post, be sure there are no chips or turnings between the collar and the compound rest, or between the wedge and the collar, to prevent the tool securing a firm foundation. Also see that the tool does not extend out of the tool post more than is necessary. The compound rest slide should not extend over the bottom slide when taking heavy cuts, and the tool post should be located as near the center of the top slide as possible. Failure to observe the above precautions will often cause chatter. Do not tighten the tool post screw with a long wrench, but use the wrench provided for that purpose. Clean and lubricate the compound rest slides occasionally. Also put a few drops of oil on the compound rest screw.

THE LATHE BED

FIG. 13 – REGAL BED

The bed is the foundation of the lathe. On it the different parts described in the foregoing paragraphs are mounted. The bed has been machined and accurately scraped at the factory, and the length of time that it stays in this condition depends entirely on the operator. Do not use the bed as an anvil for driving arbors in and out, or as a bench for hammers, wrenches and chucks. If you have no place to lay your tools, arrange a neat board at the tailstock end of your lathe, on which you can place them without damaging the bed. Do not lay chuck wrenches across the bed or wings of the carriage or leave tool post wrenches lying on the bed. Many lathes have been wrecked by allowing the carriage to feed against a chuck wrench or a tool post wrench lying on the ways of the bed, between the carriage and the headstock. Also see that the tops of the girths in the bed are free from heavy turnings or chips, as there is only a small clearance between the carriage bridge and the bed girths. Keep the shears clean. Wipe them off occasionally with a rag or waste, following up with a little oil on a piece of cloth. See that the bed rack is kept tight on the bed. Remember, the condition of the bed usually tells what kind of a mechanic has been running the lathe.

THE TAILSTOCK

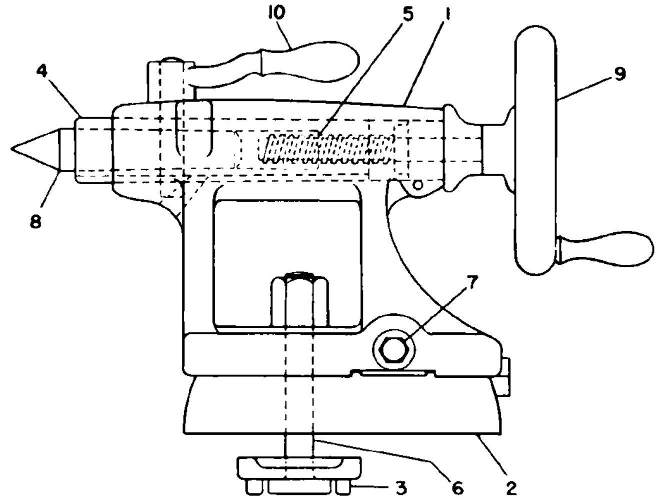
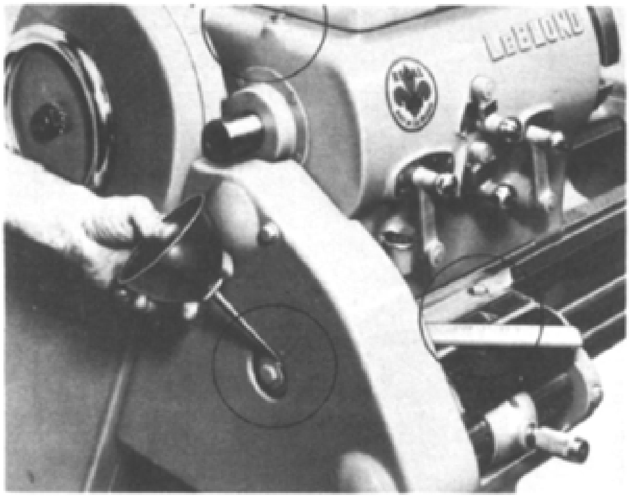


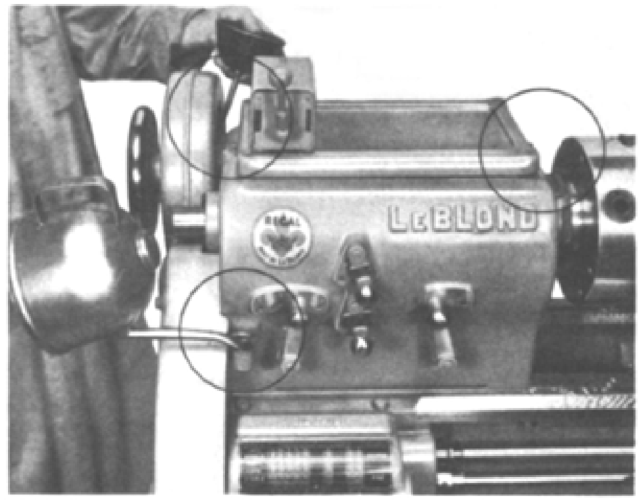
FIG. 14 – 13"-15" REGAL TAILSTOCK ASSEMBLY

The tailstock unit comprises the tailstock top (1), tailstock bottom (2), tailstock clamp (3), tailstock spindle (4), and tailstock screw (5). The entire unit is movable on the ways along the length of the bed to accommodate pieces of varying lengths between centers within the capacity of the machine. The tailstock is kept in alignment with the headstock by a V on the rear shear (way) of the bed and can be clamped in position with the tailstock clamping bolt (6). Before moving the tailstock along the bed, wipe the ways carefully to clean off any chips. Turnings on the ways will throw the tailstock out of alignment.

The tailstock top (1) sets on the bottom (2) and is held in alignment by a cross tongue. For turning tapers in the absence of a taper attachment, a setover is provided for the tailstock top. A setover adjusting screw (7) on each side of the tailstock top provides means for setting, and a raised boss on the rear is graduated to show the amount of setover. The tailstock spindle (4) is moved in and out of the tailstock barrel by means of the screw (5), which fits a tapped hole in the spindle. The front end of the spindle is bored and reamed to a Morse taper to hold the tailstock center (8), drills, drill chucks and reamers. To remove the tailstock center, run the spindle back as far as it will go until the center hits the end of the screw, which will force it out of the tapered hole in the spindle. Before replacing the center, carefully wipe out the hole; clean the tapered part of the center; move the spindle forward by a few turns of the hand wheel (9), and push center in. When using drills, drill chucks and reamers, be sure they are tight in the taper hole. If they are not tight they will revolve and cut the tapered hole, destroying its accuracy. Should the hole become scored, carefully ream out the burrs or score marks with a Morse taper reamer.

The design of the tailstock allows the spindle to be clamped in any position by means of a binder screw handle (10). The spindle (4) should be removed occasionally, in order to oil the spindle nut and the outside of the spindle barrel.





LUBRICATION

Certain common service practices should be adhered to on a periodic basis. Be sure to check spots as instructed below and as shown in the accompanying photos:

Daily

Maintain the oil level in headstock and apron. Clean bed ways by wiping with a cloth saturated with oil. Oil all points indicated in photos.

30-60 Days

Thoroughly clean the bed ways, feed rod and leadscrew by wiping with an oiled rag.

100-180 Days

Check motor drive belt tension. Check level of the lathe.

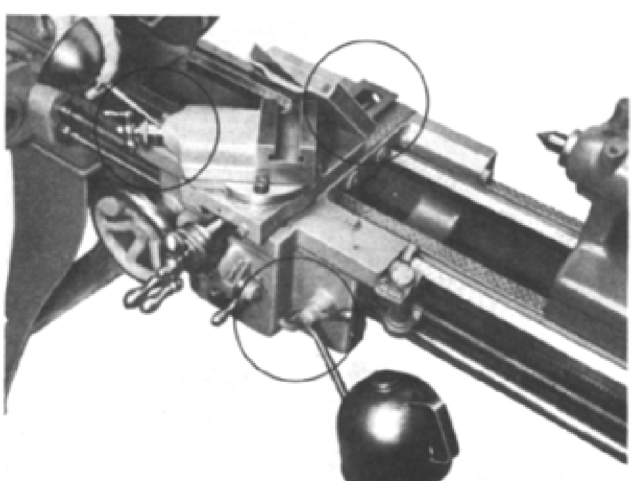
350-400 Days

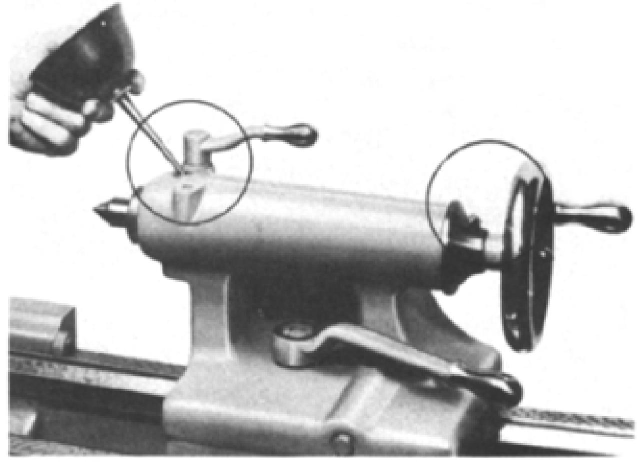
Check headstock spindle bearing adjustment. Check alignment of carriage gibs, bottom slide and top slide.

Maintain a constant oil level in both the headstock and apron assemblies. All other points indicated in photos are to be lubricated daily with an industrial grade oil, equal to SAE 30, 500 sec. 100°F. Apply lubricant with a pressure oil can.

HEADSTOCK OIL CAPACITIES (in quarts)

13"	15"	17"	19"	21"	24"
5	6	9	10	16	16





GENERAL

The operator can easily adjust headstock spindle bearing, drive belt tension, cross slide and top slide and front and rear carriage gibs, and take up any end play in the leadscrew.

HEADSTOCK SPINDLE BEARING ADJUSTMENT

1. Remove hex head nut and lock washer securing handwheel or spacer to drive shaft. Remove handwheel or spacer from drive shaft.

2. Take off two hex nuts and two Allen screws and remove front half of belt cover.

3. Remove three drive belts.

4. Remove drive pulley from headstock spindle.

5. Remove two hex head screws and washers to take off rear half of belt cover.

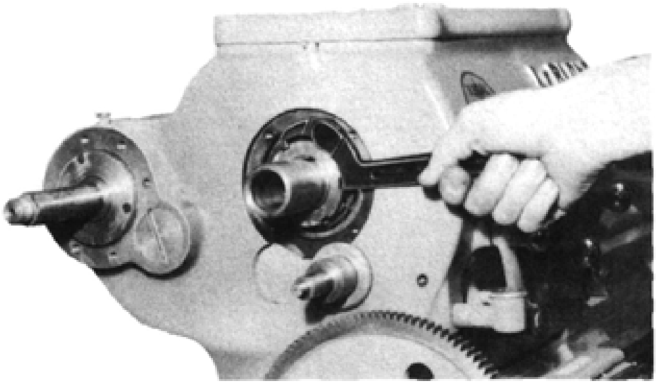


FIG. 15 – ADJUSTING HEADSTOCK SPINDLE

6. Remove three fillister head screws and take off rear spindle bearing flange.

7. Open ear of lock washer and, with spanner wrench applied to lock nut as indicated above, tighten lock nut until slight drag is felt on the spindle when it is turned over by hand, with all gears in a neutral position, i.e., disengaged.

8. After adjustment has been made, secure lock nut by bending over an ear on the lock washer, and replace all parts.

BELT TENSION ADJUSTMENT

The motor is mounted on a hinged plate on back of the headstock leg. The hinged plate is adjusted by means of screws in the leg to regulate the tension on the three V-belts which drive the lathe. The belts should have just enough tension to take the cuts without slipping.

NOTE
Do not put belts under too much tension, for in so doing, a strain is thrown on the motor and drive shaft bearings, causing excessive wear. Keep oil off belts.

LEADSCREW ADJUSTMENT - 13-19" REGALS

1. Remove fillister head screw securing slip gear cover to lathe bed, remove the cover.

2. Remove the back box.

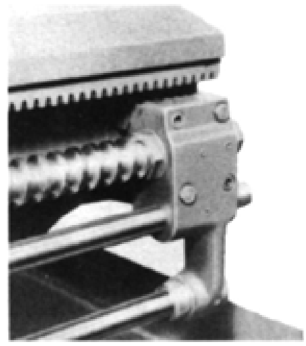
3. Take out two fillister head screws securing leadscrew bushing to side of quick change box. Engage the half-nuts on the leadscrew.

4. Move the carriage toward the tailstock end sufficiently to allow the withdrawal of the bushing.

5. Draw up the adjusting nut on the end of the leadscrew that extends through the bushing until there is no end play in the leadscrew.

6. Replace all parts.

LEADSCREW ADJUSTMENT - 21-24" REGALS



1. Tighten hex nut at end of leadscrew (A)

2. Tighten adjusting nut (B) to remove all end play.

ADJUSTING CROSS SLIDE AND TOP SLIDE GIBS

1. Loosen the gib screw at the small end of the gib, which is the end farthest from the operator.

2. Tighten screw at large end of the gib.

3. Repeat till a slight drag is felt when moving the slide. Be sure gib screws contact gib at both ends.

ADJUSTING CARRIAGE FRONT GIB

1. Remove front carriage gib by taking out hex head cap screw.

2. Scrape metal from the gib surface that contacts the underside of the carriage.

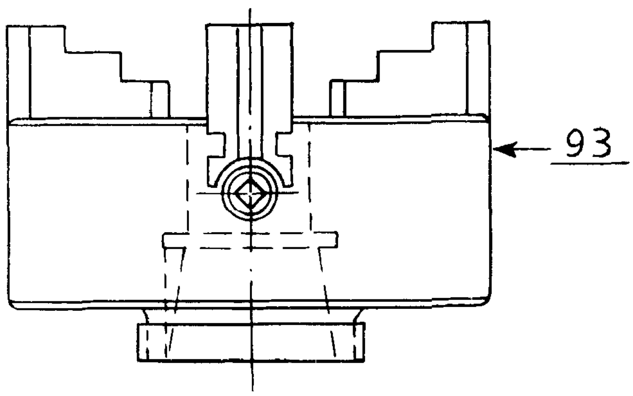
3. Replace front gib and secure with hex head cap screw.

4. Repeat til the gib takes a bearing on the bed.

ADJUSTING CARRIAGE REAR GIB

The carriage rear gib is adjusted by moving it vertically upward. To adjust gib, loosen two hex head screws holding gib against the rear wall of the carriage and then tighten the two screws that move the gib vertically upwards til a slight drag is felt when the carriage is moved up the bed. Tighten hex screws.

ACCESSORIES AND ATTACHMENTS

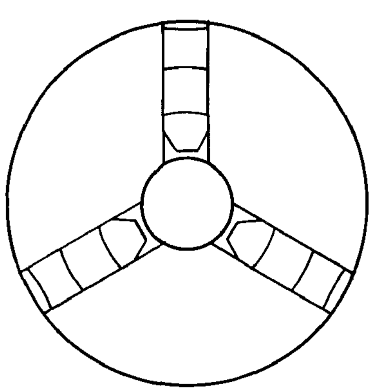


FOUR-JAW INDEPENDENT CHUCK

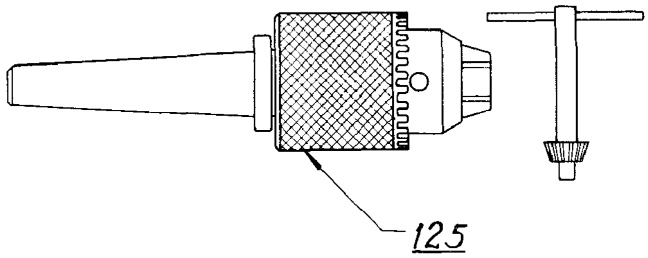
The four-jaw independent chuck (93), as the name indicates, has four jaws, each being independently adjusted with a chuck wrench. The jaws are reversible so that the chuck can be used for inside or outside chucking. It is attached to the spindle of the lathe by means of a chuck plate. The flange of the chuck plate is fitted to the recess in the back of the chuck and the chuck is bolted to the flange. This adapter plate is especially recommended for old style Regals which were built with the threaded spindle nose. For the newer Regals with taper key drive spindle nose, chucks are available for direct mounting on the spindle nose as shown above.

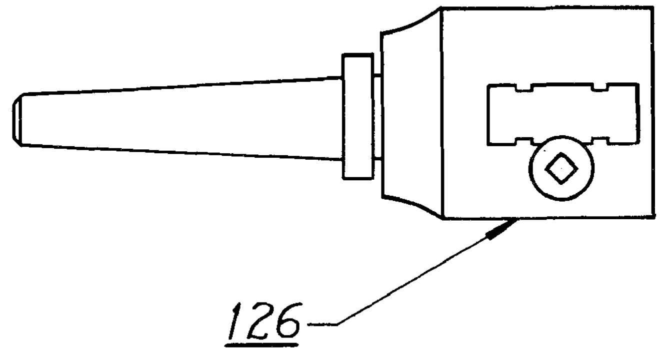
The four-jaw chuck is used to hold rough pieces that are not perfectly round, or pieces that must be centered on the chuck so that some section will be concentric with the lathe center line. This is accomplished by adjusting each jaw individually with an indicator against the work to determine the amount and direction of run-out.

THREE-JAW UNIVERSAL CHUCK



The three-jaw universal chuck is used to hold pieces that are semi-machined, and parts made of cold-rolled steel or drill rod which is ground to close limits. When the chuck wrench is used, all jaws move to or from the center in unison, gripping the pieces quickly. The chuck is attached to the spindle in the same manner as the independent chuck described above. Either two sets of jaws or jaws with reversable tops are supplied with this type of chuck.

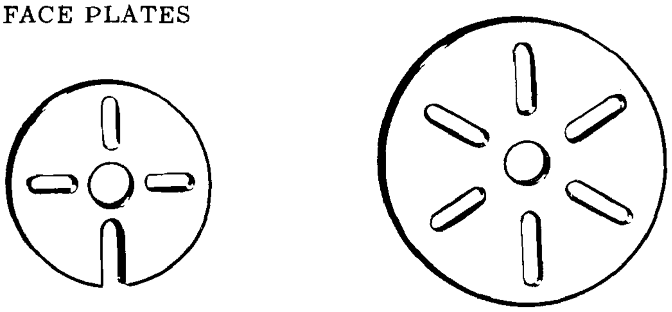




DRILL CHUCK AND SHANK

For holding center drills and straight shank drills, a drill chuck with a shank fitting the Morse taper hole in the tailstock spindle is almost a necessity. These chucks are made in the three-jaw self-centering type (125), and the two-jaw type (126) which is more desirable for large size drills, taps and reamers.

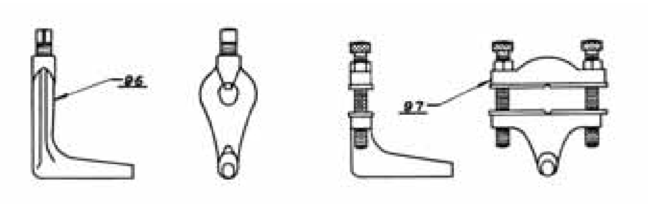
FACE PLATES



The small face plate is used to drive pieces of work such as shafts and mandrels by means of a lathe dog clamped to the work. The tail of the dog engages a slot cast in the face plate. Three cored slots radial to the center make it convenient to mount special drivers or fixtures to the face of the plate.

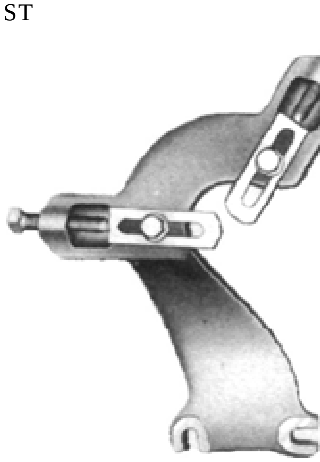
The large face plate performs the same function as the small, except that it provides more room to mount fixtures such as angle plates and vee blocks. The large face plate can also be drilled for the planer type hold-down stops to hold large, irregular pieces that cannot be accommodated in chucks of the conventional type. See pages 25-30 for details. (Methods of Holding Work in the Lathe.

LATHE DOGS



Lathe dogs (96) are used with the small face plate to grip and to drive pieces between centers. Dogs of different sizes can be obtained for use with corres-ponding diameter of work. The usual form of lathe dog has a bent tail which engages a slot in the face plate. Another form is known as the clamp dog (97) and is used to drive square, hexagon or octagon shaped pieces between centers.

FOLLOW REST



The follow rest is used to support between-centers work against the forces of the cut being taken. It is bolted to the carriage and consequently moves with it. To set the follow rest, the cut is started and turned slightly longer than the width of the follow rest jaws. The jaws are then set to the turned diameter after which the cut can be taken across the entire length of the piece of work.

STEADY REST

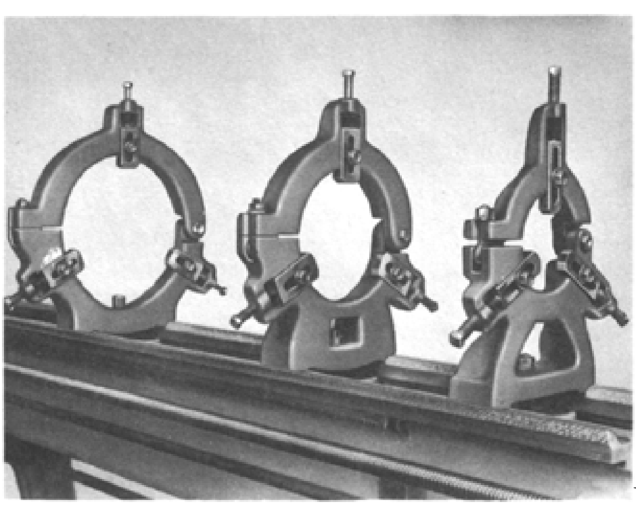
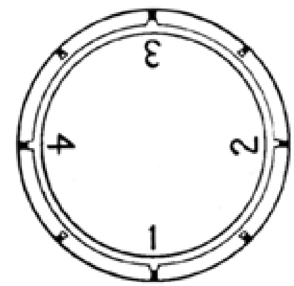


FIG. 23 – STANDARD AND OVERSIZE STEADY RESTS

The steady rest provides a fixed support between head and tailstock for long, round work while it is being turned. The support this rests gives a shaft of small diameter, for example, permits use of a coarser feed, and prevents chatter and any tendency for the work to spring away from the tool. Many jobs are impractical without the use of the steady rest.

CHASING DIAL



The chasing dial, or thread indicator, comprises a worm wheel which meshes with the leadscrew and a shaft connecting the worm with the numbered indicator dial. When chasing an even number of threads, the halfnut may be engaged .at any line on the dial; for odd threads, at any numbered line; and at any odd numbered line for half-threads.

Using the chasing dial in this manner, the operator can take a cut, back the tool out of cut and return the carriage to the starting position, set the tool for the next depth of cut, and re-engage the half-nut without stopping or reversing the lathe spindle.

TELESCOPIC TAPER ATTACHMENT

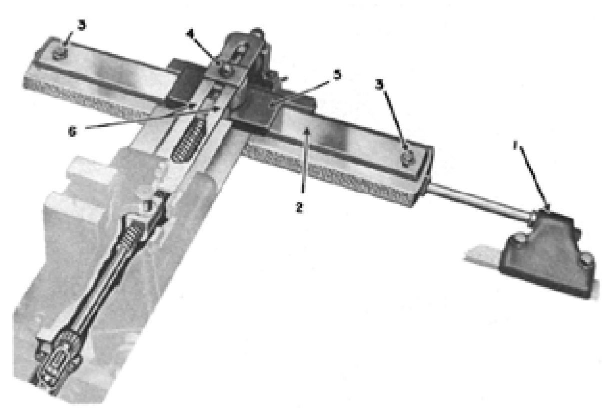


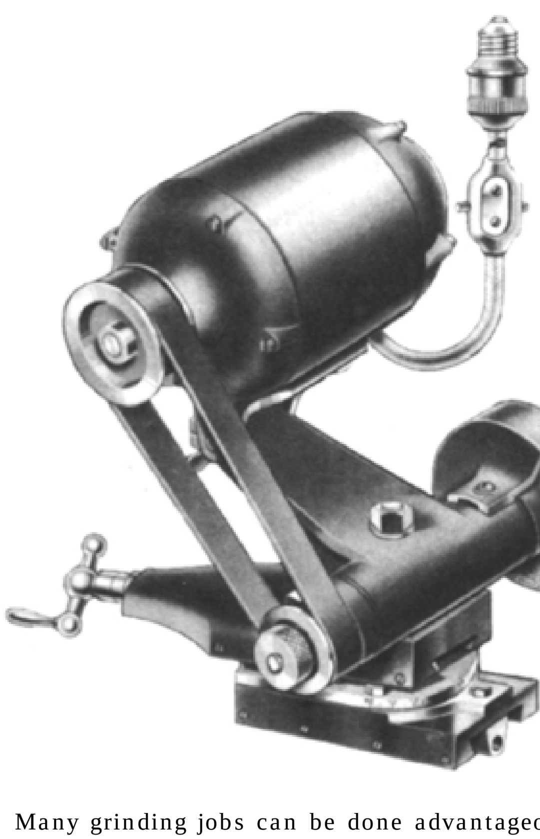
FIG. 25 – TELESCOPIC TAPER ATTACHMENT

The telescopic taper attachment is ruggedly con-structed and simple to operate. When the carriage is brought into position for the taper operation, the bed bracket (1) is tightened on the flat bed way. The swivel guide bar (2) is adjusted to the selected taper, which is marked in inches on one end of the lower bar and in degrees on the other end of the bar. Adjustment for selected taper is made by loosening nuts (3) and moving bar (2) to the desired taper. The swivel guide bar is held secure by the screws (3). With the taper bar clamp nut (4) loosened and assuming that the shoe bracket gib and the carriage bracket gib are properly adjusted, the tool is brought into position and the nut (4) is tightened. We are now ready to chase taper threads or to finish taper turn, or finish taper bore. When carriage feed is engaged, bed bracket and its connecting rod hold lower taper bar and adjustable swivel bar in a fixed position with relation to bed and work. Movement of carriage slides gibbed shoe (5) along taper bar.

With lights cuts, nut (4) need not be tightened, then the pull is on the cross feed screw and nut and the end of the screw telescopes in the cross feed telescopic bush, allowing the slide to move in or out.

With the nut (4) tightened, none of the pull is on the cross feed screw, but on the flat draw bar (6) shown over the cross feed screw, which is connected to the bottom slide. This relieves the cross feed screw of all strain and pull and wear, and insures longer life and retains the original accuracy of the screw. Adjustment of the cut is made by loosening clamping nut (4) and setting tool to proper diameter and, of course, tightening nut again after adjustment is made. Most adjustments of the tool are made by the compound rest. There is no necessity of adjusting clamping nut after taper is set, other than to adjust for depth of cut when using the cross feed screw. And this may be eliminated by using the compound rest screw.

GRINDING ATTACHMENT



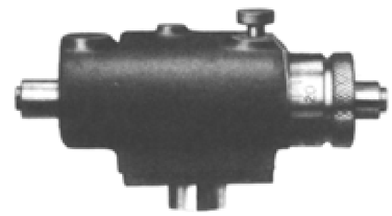
Many grinding jobs can be done advantageously in a lathe with this attachment: hard centers can be re-pointed, cutters and reamers sharpened, and all kinds of straight and taper cylindrical and internal grinding. A few thousandths should be left on the work before grinding.

For internal grinding, small wheels are used on special quills or extensions screwed on the regular spindle. For wheels less than 2" diameter the pulleys should be reversed to give the spindle greater speed. Cover the bed ways with clean cloth or paper to protect them from abrasive dust. Dispose of paper for safety.

SAFE GRINDING SPEEDS

Size of wheel	2"	3"	4"	5"	6"
Spindle rpm	9550	6380	4775	3825	3190

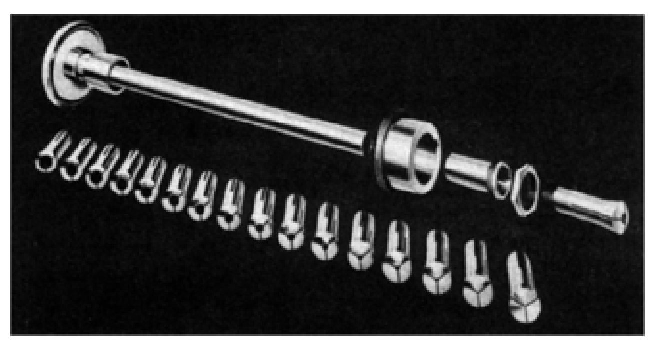
MICROMETER CARRIAGE STOP



The micrometer carriage stop is useful when the operator is obliged to bring the carriage to the same definite position a number of times, or where a series of cuts are desired at accurate decimal dimensions from one another, such as in cutting threads.

The stop is clamped to the front vee of the lathe bed. The design of the clamping surfaces is such that there is no danger of scoring the vee of the bed while using this attachment. A micrometer screw with hardened ends is turned by a large diameter collar. The collar is knurled to provide a finger grip for turning, and is graduated to show the travel of the screw in thousandths of an inch. The carriage is brought up against the end of the stop by hand in actual use. Never run carriage against stop with power feed.

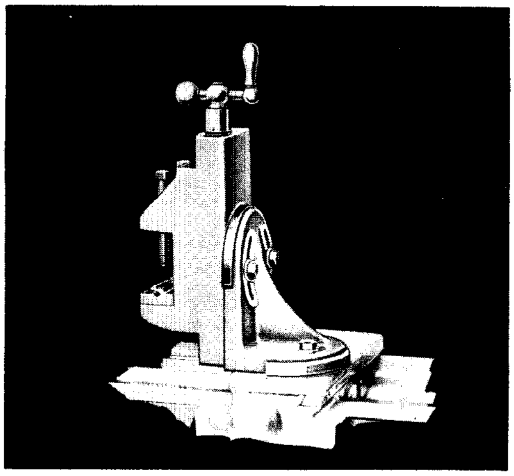
DRAW-IN ATTACHMENT



For turning small parts from round finished stock there is no more accurate, rapid and economical method than the use of a draw-in collet chuck, either the tube type as illustrated, or the spindle nose type such as the Sjogren chuck.

This attachment in the spindle allows bar stock to pass through the tube and to be gripped in the draw-in collet ready to be machined. When applying the draw-in attachment to the lathe, be sure that the ends of the spindle hole and the outside of the collet closer are clean. Any chips or particles of dirt on these surfaces will destroy the accuracy of the work.

MILLING ATTACHMENT



The milling attachment is used to cut slots, keyways, or flats on shafts or small pieces of work. Screw heads can be slotted and short length racks cut.

The attachment consists of a right angle plate which is mounted on the cross slide in place of the compound rest. To this plate is mounted a vise which uses two square-head bolts to hold the work. The entire assembly may be swiveled 360° on the cross slide, and the vise may be swiveled 45° on either side of the vertical. This makes possible setting the work at any angle.

A milling cutter is mounted in the lathe spindle nose and the work fed past it in any of the following three ways:

1. Regular lathe length feed.

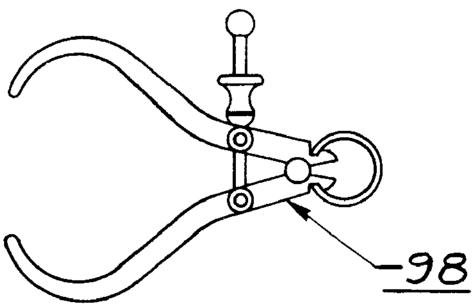
2. Regular lathe cross feed.

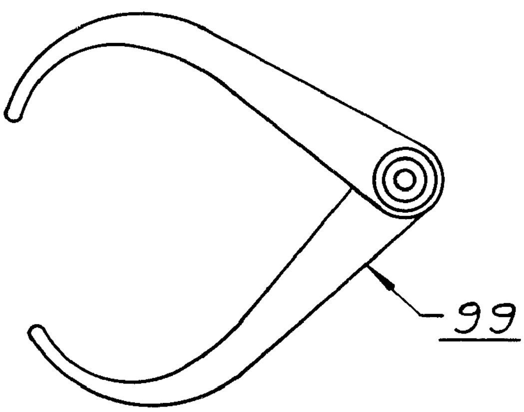
3. Vertical hand feed by means of the crank at the top of the vise.

With the use of this attachment, the field of work possible on the lathe is greatly extended, since many light milling operations can be accomplished in the lathe instead of on a heavier, more expensive milling machine.

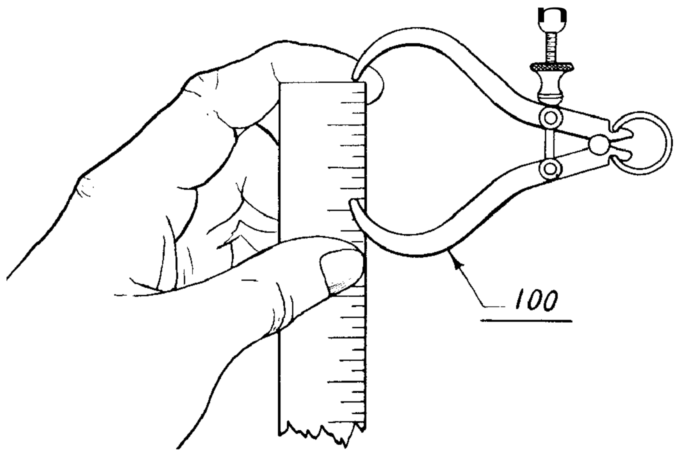
MEASURING INSTRUMENTS

OUTSIDE CALIPERS



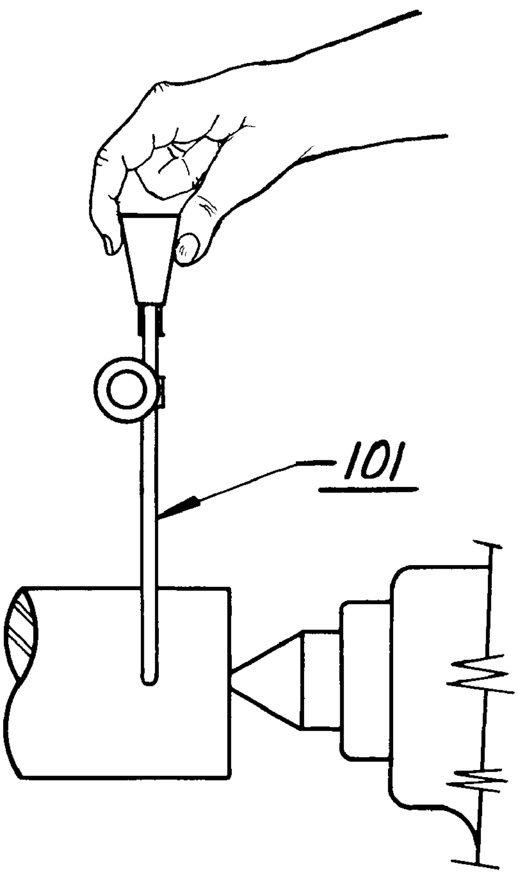


Outside calipers are used to measure the diameters of the work being turned There are three kinds: Spring calipers (98), firm joint calipers (99), and micrometer calipers or "mikes" (102). Spring calipers are provided with a screw and adjusting nut for quick setting to size, whereas the firm joint calipers are set by tapping one leg against a solid object. (Not on the lathe bed.) Both types have their advantages. The spring type is much preferred on small work, while on large diameter work, the solid joint type (because of stiffer legs) is better.



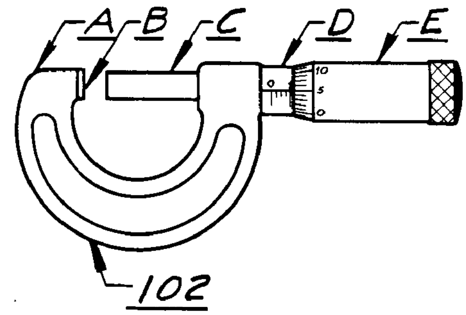
To set calipers to a diameter with the use of a scale, hold the scale in left hand and the caliper in the right hand, using the forefinger to keep one leg from slipping off the end of the scale and adjust the caliper (100) to the dimension required. Some mechanics become quite expert at setting calipers, acquiring a "feel" that enables them to set calipers to .005 of an inch. In many cases your work will be to reproduce broken parts, and the calipers can be set from the broken part. Be certain, however, that the part is not worn where you set tne calipers. Try the calipers at different points to see if the piece is round, not egg shaped, and that you are not calipering on the smallest diameter. When calipering a piece of work it is best to hold the caliper in a vertical position (101) with the legs at right angles to the axis of the piece, and adjust to a point where the weight of the calipers will just allow the points to pass over the diameter of the piece. This slight resistance is known as the "feel". Never force the calipers over the piece as the legs will spring and inaccuracy will result. If you get the same "feel" on the sample as you get on the piece being turned, the diameters will correspond within close limits.

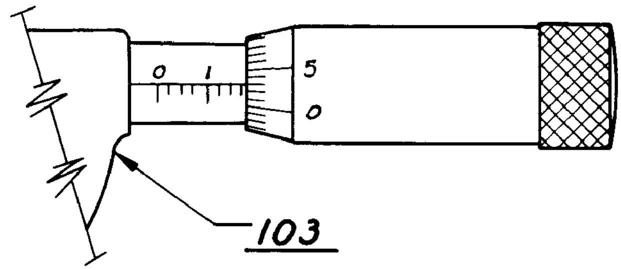
Never try to caliper a piece revolving in the lathe where accuracy is required. For obtaining the approximate diameter this is permissible, but for accurate dimensions, the lathe should be stopped.



OUTSIDE MICROMETER CALIPER

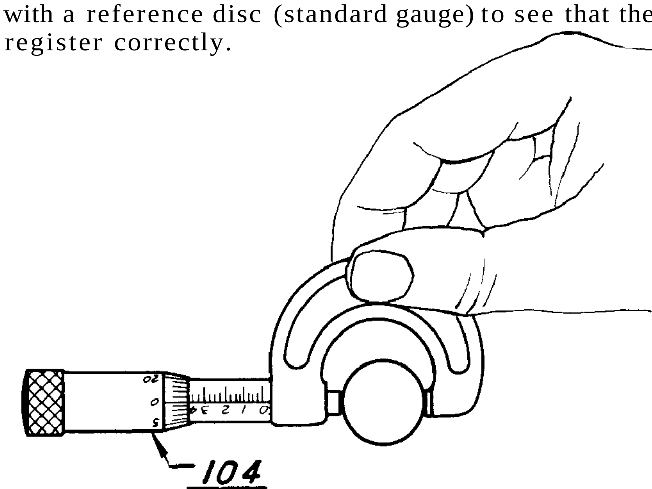
The micrometer caliper (102) is used for measuring to very close dimensions, its graduations reading to one thousandth of an inch. It consists of five principal parts, the frame "A", the anvil "B", the spindle "C", the sleeve "D" and the thimble "E". The spindle "C" has a thread cut on it which fits a tapped hole in the sleeve "Dl1which is not exposed. The threads are cut 40 to the inch so that exactly one revolution of the thimble "EMadvances the spindle "C" one-fortieth of an inch, or twenty-five thousandths (.025) which is the gap between the anvil "B" and the spindle "C", the measuring point. The sleeve "D" is graduated with 40 divisions to the inch and numbered 0-1-2, etc. to 10, a number at every fourth division, so that figure one, or four divisions, represent 4 x .025 of an inch (1/40) or one-tenth of an inch (.100). The number last showing on the sleeve



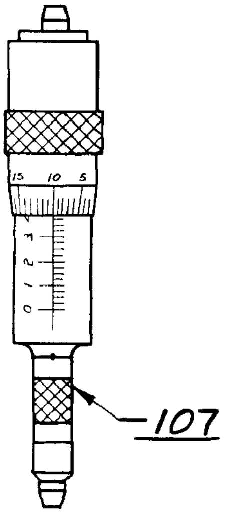


"D" when the "mike" is set on a diameter is the first numeral after the decimal point in your reading. On the bevel edge of the thimble "E" are twenty-five graduations, each of these representing one thousandth of an inch. In illustration (103) you have showing on the sleeve seven graduations representing .025 each, equaling 7 x .025 or .175, and three graduations on the thimble beyond the zero (0) mark, each representing .001, so that the caliper is set at .175" plus .003", equaling .178", or for greater convenience read the highest numera1 showing on the sleeve, 1 or one-tenth (.1); beyond this read the number of graduations showing (3), which equals 3 x .025" or .075", then add to this the graduations on the thimble, making .l78". For convenience in using micrometers, tables of fraction and decimal equivalents, also English and metric equivalents, will be found in Tables section.

When calipering with micrometers the same "feel" is necessary as with other calipers, and they should not be forced over the work. Hold the "mikes" between the forefinger and the thumb (104) and let the weight carry them over the diameter. Do not caliper with the piece revolving as this will damage the anvil and the end of the spindle. Check the "mikes" occasionally with a reference disc (standard gauge) to see that they register correctly.

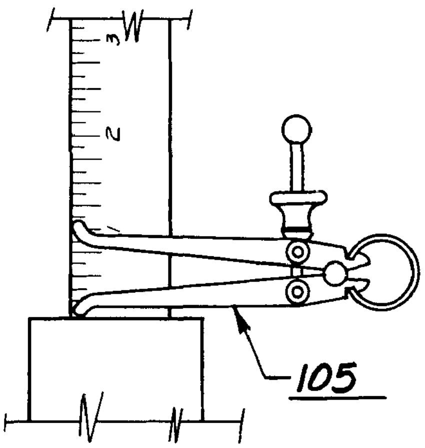


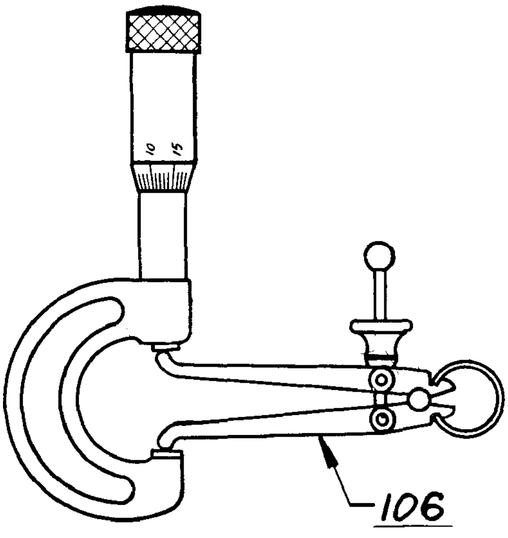
INSIDE MICROMETER CALIPER



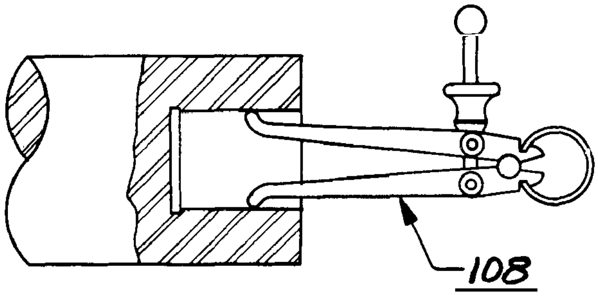
Inside micrometers (107) are manufactured for diameters of one-half inch and up. They are read the same as outside micrometers.

INSIDE CALIPERS



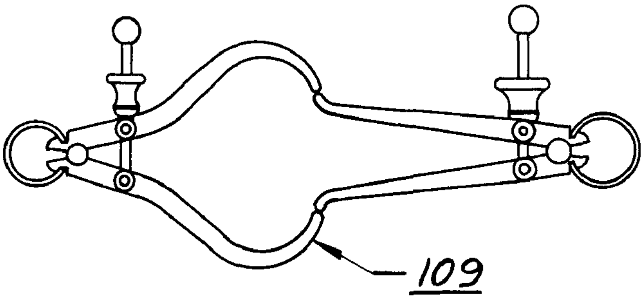


Inside calipers are used for internal work such as bored and reamed holes and are made both in the spring and firm joint type. In setting the calipers to a scale, hold the scale against a flat surface, placing one leg against the flat surface and adjusting the other leg to the required dimension (105). If you are boring to accurate dimensions, set a micrometer to the dimension



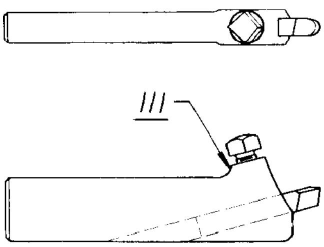
required and transfer this to your inside caliper. This can be done best by holding the micrometer in the left hand and the inside caliper in the right hand (106) and adjusting it until the proper "feel" is obtained, The adjustment is obtained by rocking the caliper in a vertical plane between the axis of the anvil and spindle of the micrometer.

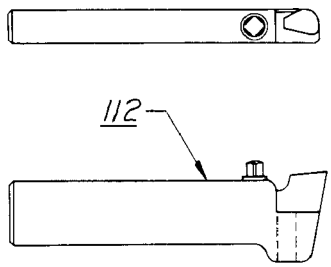
When calipering a hole (108) set one leg of the inside micrometer caliper in the hole, pivoting the caliper in a vertical plane and adjusting until the other leg enters the hole. By rocking and adjusting the caliper, the proper "feel" across the largest diameter can be obtained. If the calipers are forced into the hole, the legs will spring and an inaccurate measurement will be obtained.



When boring a hole to fit a shaft or turning a shaft to fit a hole, it is necessary to transfer measurement from outside to inside calipers and vice versa. This can best be done by holding the outside caliper in the left hand, supporting it between the thumb and forefinger (109) with the second finger of the left hand supporting the lower legs of the outside and inside calipers to be set. The inside calipers are held in the right hand with the adjusting nut between the thumb and forefinger. By rocking the inside caliper in a vertical plane and adjusting it until the proper "feel" is obtained, accurate transfer from one to the other can be made. Do not use for exact measuring.

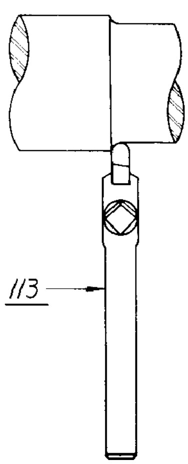
LATHE TOOLS

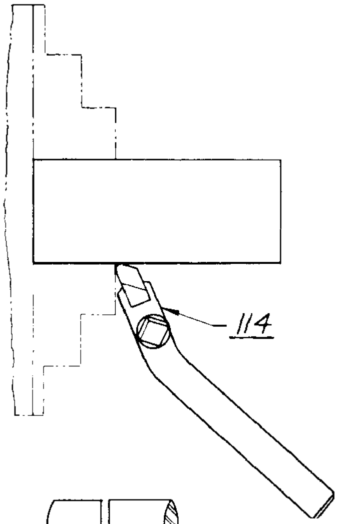


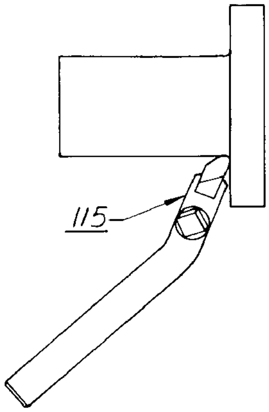


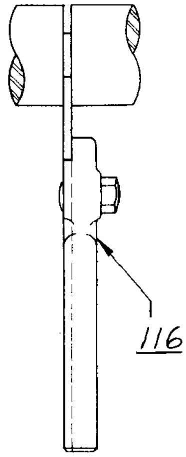
Every lathe should be equipped with a complete set of lathe tools for turning, facing, threading and boring. They can be of the tool holder type using high-speed steel bits, such as are made by Williams, Armstrong (111), or O.K. (112). These types are the most commonly used; however, forged tools are still used in many shops.

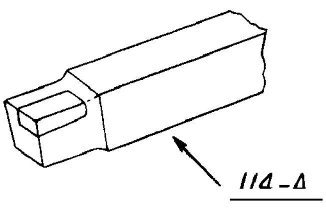
A complete set of tools consists of the following:

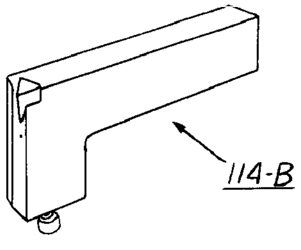












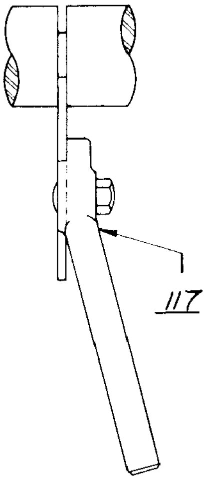
(1) Straight shank turning tool (113), which can be used with various types of tool bits for right- and left-hand turning, right- and left-hand facing and threading. Bits can also be ground to special shapes for fillets in corners and the like.

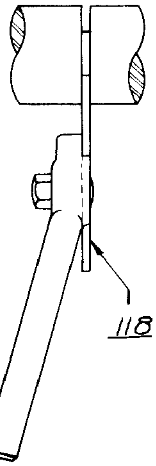
(2) Left-hand offset turning tools (114) are desirable when the operator wishes to work close to the chuck or the driving dog. By using this type of tool it is possible to turn the piece up to the chuck and at the same time have the chuck clear the side of the carriage and compound rest.

(3) Right-hand offset turning tools (115) answer the same purpose when working at the tailstock end. Various shaped bits can be used in either right- or left-hand turning tool holders to suit the work being done.

(3a) Two styles of carbide cutting tools are shown. 114a is the standard righthand turning tool with brazed-on carbide tip. 114b is the triangular insert turning tool. This is used in high-production operations. Its major advantage is that you have three cutting edges, simply obtained by indexing the triangular insert.

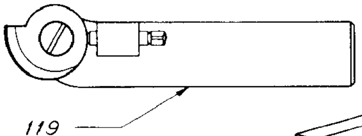
(4) Straight cutting-off tools (116) are used for cutting off in the lathe. The blade used in this tool is ground with the proper side clearance. Then, when properly set in the holder, the tool does not drag.

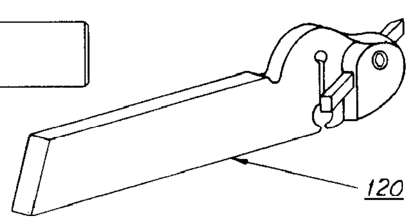




(5) Right-hand cutting-off tool (117) is used for cutting off work close to the chuck. To prevent chatter, when using a tool of this type, excessive overhang of the work should be avoided.

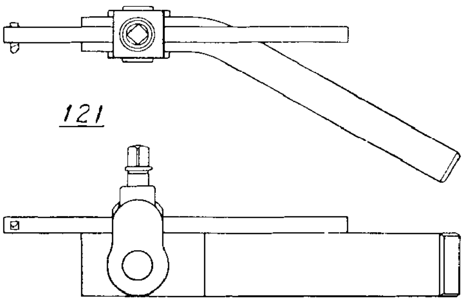
(6) Left-hand cutting-off tool (118) is for use near the tailstock end of the lathe. This type of tool is rarely used and in most cases the right-hand and straight cutting-off tools serve all purposes.





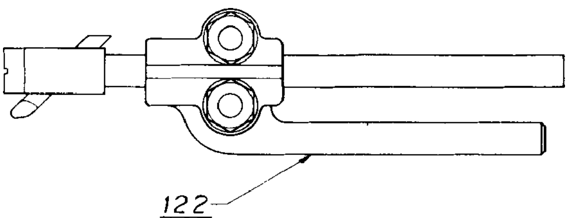
(7) Threading or chasing tools (119). There are many patented types of threading tools. The tool shown is provided with a formed cutter which is sharpened by grinding the top face only. On some classes of material where it is not possible to cut a smooth thread with a rigid chasing tool, a spring threading tool (120) will produce better results.

The spring threading tool is built with a nut for the lockable spring head which provides a rigid backing for coarse threads and heavy cuts, and when loosened, the holder becomes a spring tool for finishing work. Neither of these tools is absolutely essential as most threads can be cut by grinding a tool bit to the proper shape, with the use of a thread gauge.



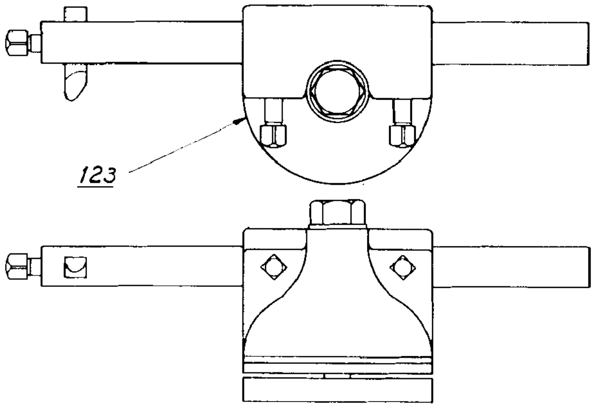
121

(8) Boring bars and holders. Tools of the type shown are used for boring holes and chasing internal threads. Two basic types of boring bars are used, namely, the forged type and the bar and holder type. Three of the bar and holder types are shown in the accompanying illustrations. No. 121 is used for small holes, which in addition to holding bars with bits as shown, can be used to hold boring tools made of drill rod for very small holes, and also for holding drills for drilling.



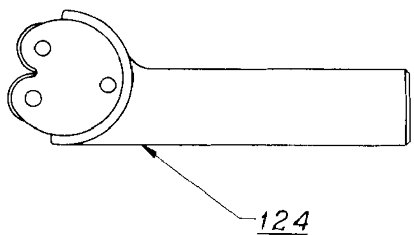
122

The boring bar shown in illustration (122) is used for medium size holes and is adjustable for different depths of holes. It is held in the regular tool post by a shank, the same as the turning tool.



123

Figure (123) shows a boring bar for heavy work that is held in the compound rest T-slot. This makes the bar more rigid than when held in the tool post. Various shaped tool bits for boring, facing, counterboring and threading holes can be used in the different bars.

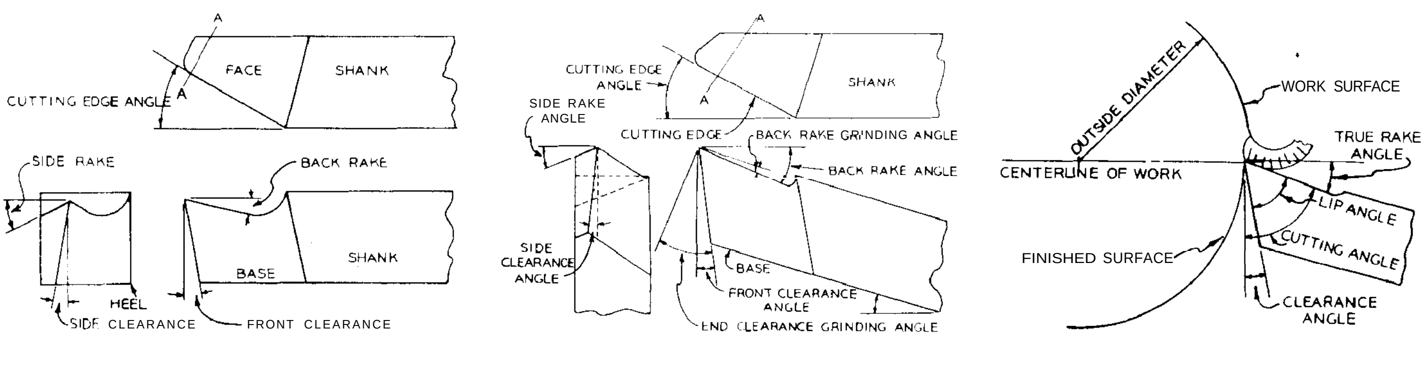


124

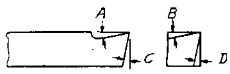
(9) Knurling tool (124). On some classes of work such as thumb screws, hand-reamers, plug gages, etc., it is necessary to roughen the diameter to give a better grip and prevent oily fingers from slipping. This is called knurling and is used extensively on optical, radio and other electrical work. A tool holder carrying two knurled wheels is fed into the work while it is revolving and impresses a pattern on the work. Extra wheels can be obtained for the knurling tool holder to cut various patterns.

Nomenclature of Lathe Tools

OFFICIAL A.S.M.E. DESIGNATIONS OF TOOL BIT ANGLES



GRINDING LATHE TOOLS



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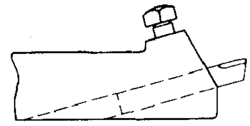

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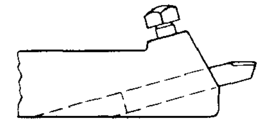

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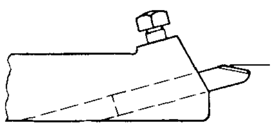

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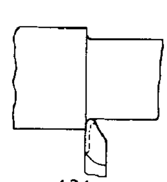

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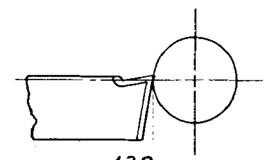

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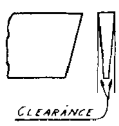

133

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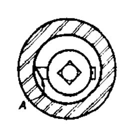


135

The successful operation of a lathe and the class of work turned out depend to a great extent on the skill of the operator in grinding his tools. Dull and improperly ground tools throw a heavy strain on the feed mechanism, eat up horsepower, and cause the work to spring and the lathe to chatter.

Lathe tools are made of carbon steel, high-speed steel and alloys such as stellite and cemented carbide. The cemented carbide tools are becoming more generally used as their cost is reduced. There are but a few carbon steel tools used, the general practice is to use high-speed steel tool bits in holders. Determine the kind of a tool you are grinding, as carbon and high-speed steel requires different treatment. Tools should be marked to show the kind of material from which they are made. A quick and simple way to tell whether a tool is carbon or high-speed steel is to grind the end and watch the sparks. If carbon steel, the wheel will throw a light colored spark and if high-speed steel, the sparks will be a dark red.

Carbon steel tools should be ground on a grindstone or wet emery wheel or dipped into water often to keep the tool cool while grinding to prevent the drawing of the temper. On the other hand, high-speed steel tools should not be dipped into water when hot as it will crack the tool and crumble the cutting edge.

Four angles are important in grinding tools and these vary with the material being machined. The back rake (see illustration 127 above) "A", the side "B", the front clearance "C" and the side clearance "D".

The back rake is usually provided for in the tool holder by the tool being set on an angle (128), which is correct for the machining of steel and cast-iron. On solid steel tools it is necessary to grind the top rake in the tool. By adjusting the tool in the tool post through wedge or rocker, this top rake can be varied somewhat to suit the material being turned. The softer the material the less the top rake should be as there is a tendency for the tool to dig in if the rake is too great.

The side rake "B" (127) also varies with the material being machined. If this angle is made great enough, the tool will drag the carriage along by feeding into the work of its own accord, especially if the material is soft. On the other hand, without side rake, the tool would not cut and the feed mechanism would be under excessive strain. The proper angle is from 6 degrees for soft material to 15 degrees for steel.

The tool is ground with the side clearance "D" (127) to take care of the feed advance and to prevent the dragging of the tool on the shoulder formed by the cut (131). This angle is usually about 6 degrees from the vertical and is constant.

The front clearance "C" (127) depends somewhat on the diameter work to be turned. To turn cast-iron or steel it is advisable to set the tool above center. If the tool was ground square without any front clearance, it would not cut, but would rub on the material to be turned below the cutting edge of the tool (132). The front clearance is necessary for this reason. This clearance should be less for small diameters than for large diameters. The clearance should range from 8 to 15 degrees. Do not grind more front clearance than is necessary as this takes away the support from the cutting edge of the tool.

Tool bits can be ground best in their own holders. To prevent grinding the holder, extend the tool beyond its regular cutting position.

After a tool has been ground on the emery wheel, it will produce better work and last longer if the cutting edge is stoned with an oil stone. This takes out the wheel marks and gives a smooth cutting edge. Care must be taken in grinding cut-off tools to see that both sides of the tool have the necessary side clearance (133). A tool of this kind also cuts better if a lip is ground back of the cutting edge to curl the chip as it comes off the piece (134).

In grinding boring tools, see that the front clearance is sufficient to prevent the tool from rubbing in the hole and dragging at the point "A" (135).

HOLDING WORK IN THE LATHE

There are five general methods of holding work in a lathe; between centers, on mandrels, in a chuck, clamped on the face plate, and clamped to the carriage.

Combinations of the above methods can be employed, such as, chucking one end of a piece and using the steady rest to support the other and while facing or boring the free end of the work. Another is to hold one end of the work in a chuck and the other end on the tailstock center.

WORK ON CENTERS

The greatest percentage of work machined on a lathe is held between centers, using the face plate as the driving plate. The face plate is mounted as indicated in figure 57.

The work revolves on conical holes drilled in the ends to fit the lathe centers and is driven by a lathe dog clamped on the work. The bent tail of the dog fits a cored slot of the driving plate as shown in figure 58. The tool is fed along the work by the movement of the carriage.

A variation of the above method is to use a chuck to clamp and drive one end of the work while the other end is supported by the tailstock center as indicated in figure 60.

Still another variation of center holding is to support the work on the headstock center and drive it by a lathe dog, using a steady rest to support the piece at the tailstock end. With this method, however, it is necessary to provide straps or some similar means to hold the work up tight on the headstock center, otherwise the piece will work off center and destroy the accuracy of the cut or spoil the work (see figure 68).

WORK ON MANDREL

Many parts such as bushings, gears and collars require all the finished external surfaces to run true with the hole which extends through them. That is, the outside diameter must be concentric with the inside diameter or bore.

General practice is to finish the hole to a standard size, that is, exactly right within the limit of the accuracy desired. Thus a 3/4" standard hole would ordinarily be held from .7495" to .7505" or a tolerance

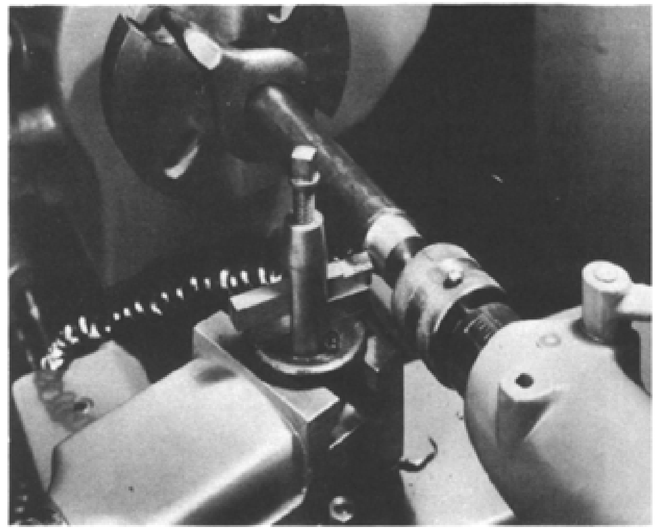


FIG. 58 – LATHE DOG TAIL. SECURED IN FACE PLATE SLOT DRIVES WORK.

of 1/2 thousandth of an inch above or below the true standard size of exactly .750".

The usual practice in machining work of this kind is to drill or bore the hole to within a few thousandths of an inch of the finished size, then remove the remainder of the material with a machine reamer, following with a hand reamer if the limits are extremely close. The piece is then pressed on a mandrel. A dog is clamped on the mandrel mounted between centers. Since the mandrel surface runs true with respect to the lathe axis (provided the centers are not scored or otherwise damaged), the turned surfaces of the work on the mandrel will be true with respect to the standard hole in the piece.

A mandrel is simply a round piece of steel of convenient length which has been centered and turned true with the centers. On mandrels of about 5/8" and smaller, the whole length is usually tapered. The common practice is to make the small end 1/4 to 1/2 thousandth of an inch under the standard size of the mandrel, while the large end is about 1/2 to 1 thousandth of an inch over standard size. This taper allows the standard hole in the work to vary according to the usual shop practice, and still provides a drive to the work when the mandrel

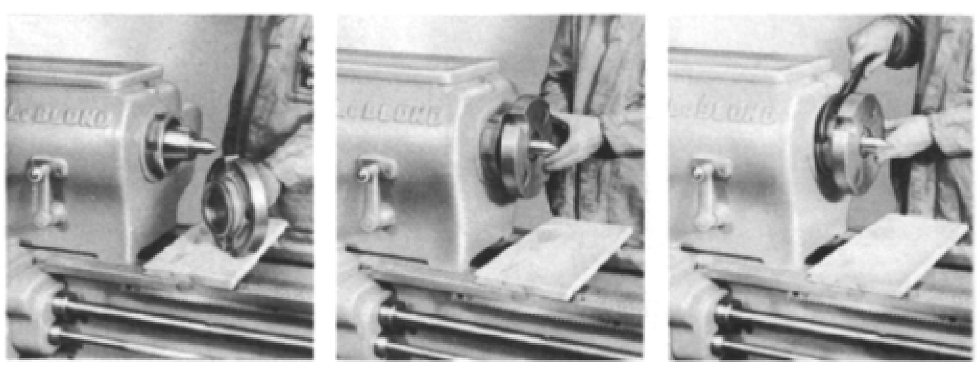


FIG. 57---MOUNTING FACE PLATES ON A REGAL IS QUICKLY ACCOMPLISHED THANKS TO THE TAPER KEY DRIVE SPINDLE NOSE WHICH HOLDS THEM SECURELY AT HIGH SPEEDS .

FIG. 59--MANDRELS

1.SPLIT BUSH	5. THREADED MANDREL
2.SPLIT BUSH MANDREL	6. MANDREL WITH 4 KEYWAYS
3.STANDARD MANDREL	7. STRAIGHT SHOULDER MANDREL
4.MULTI-SPLINED MANDREL	8. EXPANSION PLUG

is pressed into the hole. On mandrels over 5/8" diameter about two-thirds of the length is turned straight, about 1/4 thousandth of an inch undersize, and the other third tapered up to about two thousandths of an inch oversize for drive. Some are made with a very gradual taper on two-thirds the length from 1/2 thousandth of an inch undersize on the small end to standard at the end of the two-thirds length, with the remaining third tapered about two thousandths of an inch for drive.

Where the hole in the work piece is not of standard size or if no standard mandrel is available, a soft mandrel may be made to fit the particular piece.

When pressing a mandrel into work, it is well to remember that clean metallic surfaces when pressed together sometimes gall or stick. A few drops of oil on the mandrel before pressing it into the work will prevent sticking.

Commercial mandrels are made of tool steel, hardened, drawn, and the working surface ground, with the centers lapped for accuracy. Each end is turned smaller than the body of the mandrel and provided with a flat which gives a driving surface for the lathe dog. The size of the mandrel is always marked on the large end to avoid error, and for convenience when placing work on it.

It is necessary, of course, to have the centers true in both the head and tailstock spindles and to have the tailstock set to turn straight, otherwise the finish turned surface will not be true.

When finish turning accurate work it is well to test the mandrel between centers before placing any work on it. The best test for run-out is made with an indicator.

When taking roughing cuts on a piece of work mounted on a mandrel, it is necessary to have a tighter press fit than for finishing. Therefore, on pieces with a thin wall or section of metal, it is advisable to remove the work from the mandrel after the roughing cut and reload lightly on the mandrel before taking the finish cut.

Where close limits are to be held, it is also advisable to see that the work is not hot when the finish cut is taken, as the cooling of the piece will leave it undersized if it has been turned to the exact size.

TYPES OF MANDRELS

In addition to the solid mandrel just described, there are other types, as shown in the illustration.

In the expansion type shown a hardened taper mandrel spreads the split cast-iron sleeve, expanding it to fit the hole and to drive the piece under the cut. With the straight mandrel there is no friction drive on the mandrel itself, it being necessary to have a shoulder on one end with a nut and collar on the other end to clamp and drive the work.

The expansion plug is another type of mandrel. The part holding the work is similar to the expanding end of an expansion mandrel and it is supported on a taper plug which fits in the headstock spindle tapered hole. The work holding portion of the expansion plug is bored out and split and a taper headed screw expands the sections which grip the hole of the part to be machined:

WORK IN CHUCK

A chuck is usually employed to hold work which may be large in diameter in proportion to its length, irregular in contour, extremely long, which makes it necessary for the piece to be passed through the spindle, or for pieces to be drilled or bored on the axis of the lathe. Two types of chucks are commonly used. four-jaw independent chucks (figure 88, page 36), and three-jaw universal chucks (figure 60).

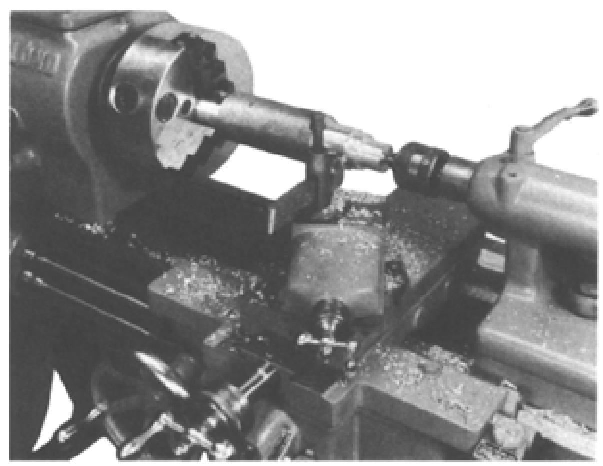


FIG. 60 – JAW CHUCK HOLDS WORK SECURELY AT HEADSTOCK END.

THREE-JAW UNIVERSAL CHUCK

This chuck is designed so that all jaws move together or apart in unison. When new, a universal chuck will center almost exactly at the first clamping, but after a period of use it is not uncommon to find inaccuracies of from two to 10 thousandths of an inch in centering the work and consequently the run-out of the work must be corrected. (See mounting and adjusting work in three jaw chucks, page 28).

After the positioning has been accomplished in a chuck, be sure to tighten all the screws evenly, so that each jaw is tight against the piece to prevent it slipping under cut.

When chucking thin sections be careful not to clamp the work too tightly, as then the diameter of the piece will be turned round when it is in a distorted position. When the pressure of the jaws is released after the cut, there will be as many high spots as there are jaws, and the turned surface will not be true.

When not in use, face plates and chucks should be stored where they will not become covered with chips and dirt.

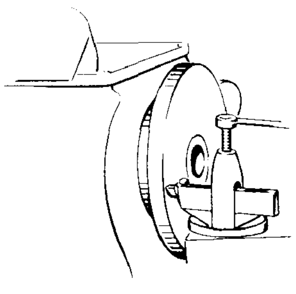
FITTING CHUCK PLATES TO CHUCKS

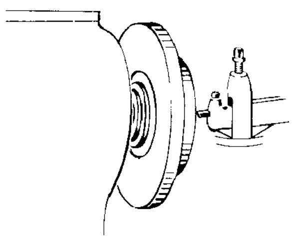
The accuracy of a three- or four-jaw chuck in holding work in the proper position is largely a question of the care used in fitting the chuck plate to the chuck (on those chucks that require plates), With chucks that have integral mountings (that is, with chucks having the mounting as an integral part of the chuck), the accuracy is built into the chuck during its manufacture.

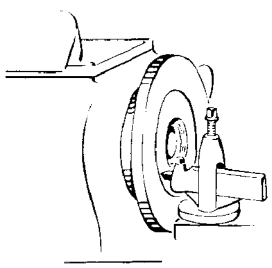
It is imperative that the chuck plate should have a good fit on the spindle nose threads or taper. The chuck plate on all Regal lathes is held true to the lathe spindle axis by the fit of the taper spindle nose in the tapered bore of the chuck plate. Current model Regals have the taper key drive spindle nose.

Chuck plates are supplied by LeBlond in both semi-fitted and full-fitted styles. A semi-fitted chuck plate is machined to fit the spindle nose only. The full-fitted chuck plate, as its name implies, is completely machined and assembled to the chuck so that no further work is necessary.

The procedure to fit plates is as follows:







Mount the chuck plate to the spindle in the same manner as mounting face plate to spindle (see figure 57). Rough face front face and rough turn outside diameter 1/32" above diameter of counterbore in chuck. Also counterbore the spindle hole in the plate at 45° to 1/8" across flat; next take finish cut off face of chuck plate.

Caliper counterbore of chuck and transfer size to outside mikes. Finish turn OD to fit counterbore allowing for a slight tap fit.

To transfer the holes in the chuck to the chuck plate, use the chuck as a drill jig. Lightly tap the chuck plate into the chuck counterbore and spot drill through the chuck body to the plate with body size drill. Without removing chuck plate, drill in spotted holes with the proper tap drill for the screws furnished with the chuck.

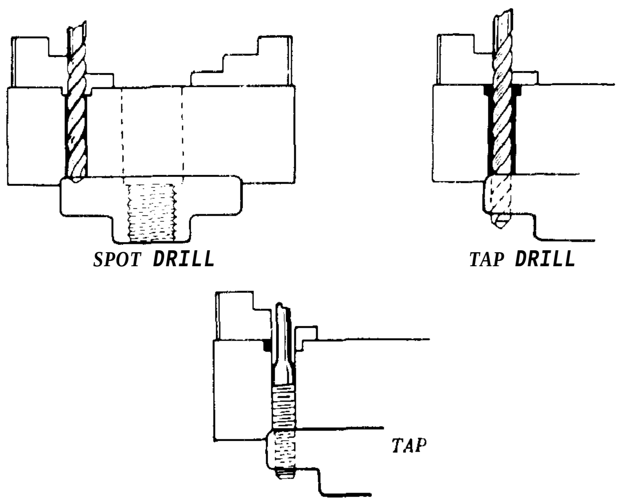


FIG. 62--DRILLING CHUCK PLATE USING CHUCK AS JIG.

Start taps into tap holes, tapping from front of chuck to insure proper tap alignment. Center punch plate and chuck so that they may be re-assembled in the position in which they are drilled; remove chuck plate, finish tap holes and file off burrs.

The plate can also be mounted with the chuck bolts going through both the chuck body and plate and held with nuts against the back of the chuck plate. The procedure would be the same as the foregoing, omitting the tapping operation. If the hub on the plate is shorter than the height of the nuts, the latter method cannot be used.

When body holes are not drilled through chuck, chalk chuck plate face thoroughly, wipe off mating face of chuck back, then tap chuck plate in position in chuck counterbore. Outline of bolt holes will show up on the chalked surface when chuck body is removed. Center punch plate and chuck for location and remove. Mark off holes, center punch circle and center for drilling. Drill with body size drill to allow clearance for chuck screws.

Clean chuck counterbore and chuck plate thoroughly. Reassemble in proper position and insert and draw screws up tight.

When chuck plate assembly is put on lathe spindle, the body of chuck should run true. A true piece of short shaft when clamped in a universal chuck should run true within .002" if work has been done properly.

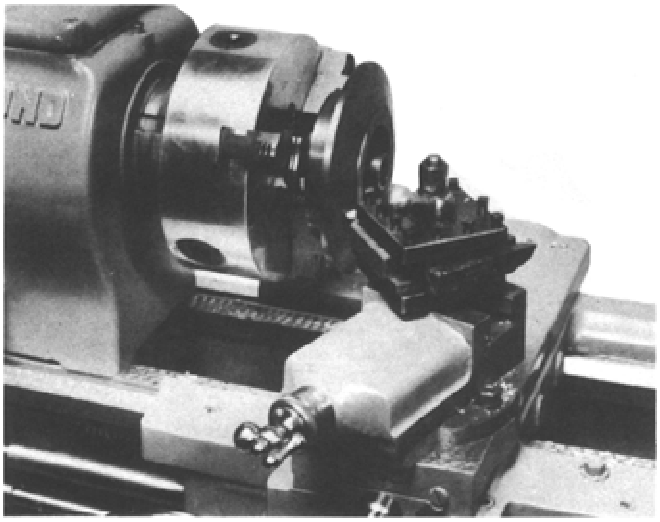


FIG. 63--3-JAW CHUCK USED FOR HOLDING FACING JOB.

MOUNTING AND ADJUSTING WORK IN THREE-JAW CHUCKS

1. Adjust jaws approximately to size required. Place wrench in any pinion socket and turn to right to advance jaws toward the center.

2. Place work in chuck, seating face of work against vertical faces of jaws.

3. Tighten jaws, as indicated above.

4. Revolve lathe at speed set for the operation to be performed.

5. Run carriage up to work, rest hand on carriage and hold chalk to just touch revolving work as indicated below. Chalk will touch high spot, indicating high side.

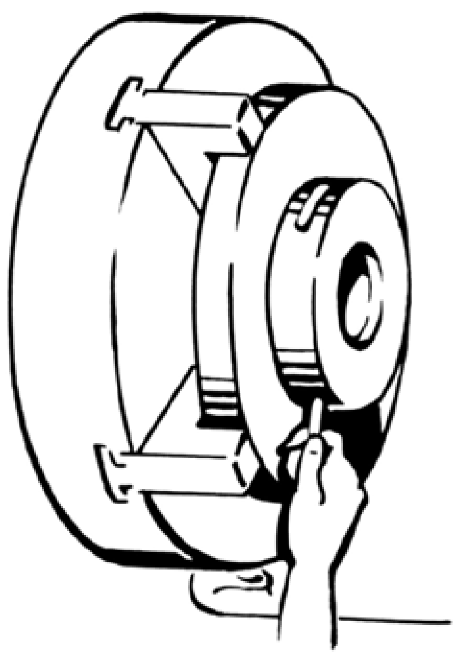


FIG. 64 – FINDING HIGH SPOT BY CHALKING

6. Loosen chuck jaws, revolve work one-third or one-quarter turn, tighten and retest. Repeat if necessary.

7. If work still runs out, mount a tool in the tool post, back-end to, and while revolving lathe very slowly by hand or power, adjust cross slide until butt of tool holder just clears high spot on work. Revolve work one-half revolution and note amount of error.

8. Select shims one-half as thick as the observed runout. Loosen jaws and insert shims between work and the jaw or two jaws nearest the chalk mark on the side.

9. If work must be chucked very accurately it is easier and much more accurate to use an indicator and secure an exact reading of the run-out in thousandths of an inch.

When work is finally centered, be sure that all jaws bear on work hard enough to drive work without slipping while under cut.

When work is to be roughed, and then finished while held in a chuck and the section of metal is not solid, it is usually advisable to release pressure on jaws and then reclamp lightly for finish turning. Otherwise the work may be turned "round" while in a sprung condition. When pressure is finally released, the work assumes its normal position and the turned or bored diameter is no longer round.

FOUR-JAW CHUCK

This chuck has four jaws, each individually adjustable with an appropriate wrench. Where considerable adjusting is necessary to center a piece, it is much simpler and quicker to use a four-jaw independent chuck. This type of chuck is the most adaptable of all for regular machine shop practice as the equalization of jaw position may be made so much more quickly, easily and accurately with the individual jaw adjustment.

Using the four adjustments, any shaped piece of work may be positioned to bring the desired point on the work over the axis or center of lathe.

When chucking an irregular piece in the four-jaw chuck so that a round boss will run true, the following procedure should be observed. The piece should be inserted in the chuck and the jaws brought down to an approximate clamping position. The piece should then be held flat against the back face of the jaw steps and clamped. Next, the lathe spindle should be rotated either by hand or slowly by power, and a piece of chalk held to touch the high spot as the piece revolves. The screw or two screws directly opposite the chalk mark should then be loosened slightly, and the opposite screw or screws tightened and the chalk test repeated. A few trials should be sufficient to locate the work in the desired position.

The same procedure is followed in clamping semi-or fully finished pieces in the chuck, except that the position is necessarily held to a closer limit before chucking is considered completed. An indicator of the dial type may be used to ascertain the run-out if the limit is extremely close.

COLLET OR DRAW-IN CHUCK

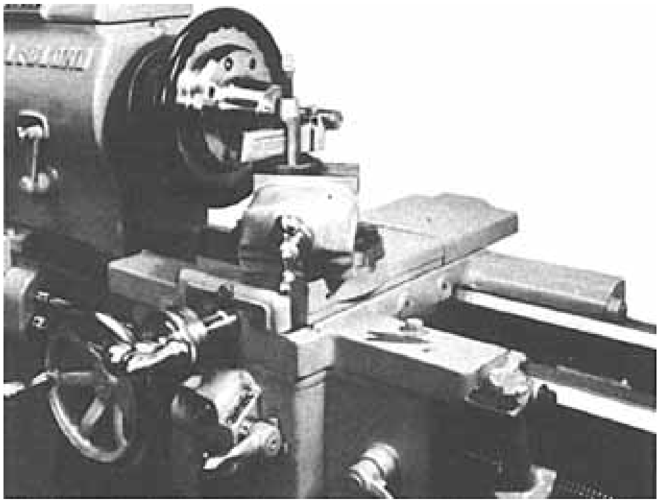


FIG. 65 – SJOGREN TYPE COLLET CHUCK

The Sjogren type collet chuck is shown in figure 65; the handwheel type on page 18. Both types are extremely accurate and are used to hold relatively small parts for additional machining operations.

The collet is a split cylinder with a male taper on the projecting end. The male taper is pulled into a female taper, thus closing the collet. The collet has a hole of standard size or slightly larger. To clamp or grip a piece of work, insert it in the collet and draw the collet back into the closer by means of the handwheel.

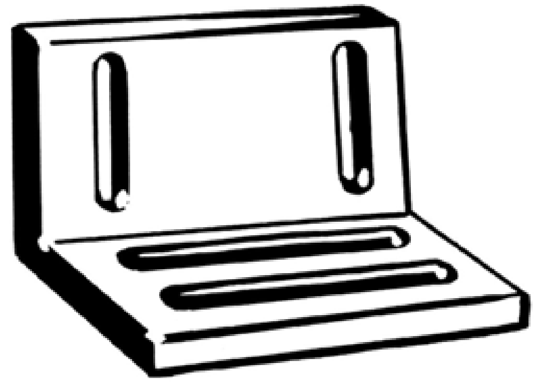
WORK ON FACE PLATE

Many jobs are of such a nature that due to physical dimensions they are most conveniently mounted on the face plate. They may be fastened to the face plate by T-bolts, clamp dogs, or planer type stops as best suited to the job.

Face plate boring is used in many cases where flat work is to be bored. Small jigs may be bored while mounted on the face plate and the holes located by means of the center punch marks for rough work, or by using tool-makers' buttons if the work must be performed accurately. Toolmakers' buttons are merely small hollow cylinders, generally .300", .400" or .500" in diameter by 7/16" long, ground round and straight on the outside diameter and having the ends square with the outside surface.

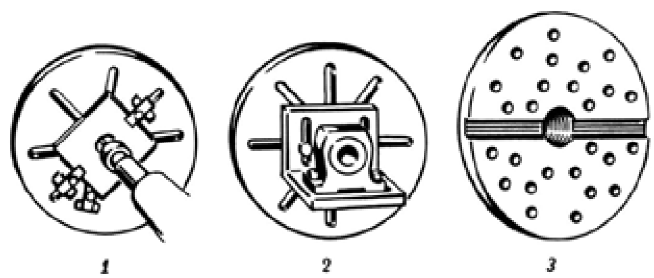
A small hole is tapped in the jig or part to be machined in the approximate location of the hole to be bored to receive the screw that holds the button. The hole through the cylindrical button is larger than the diameter of the screw allowing for movement of the button to locate it accurately. The outside diameter of the button is accurately located over the hole to be bored, by the use of straight edges and mikes, and then the button is positioned over the axis of the lathe, after which the hole is bored. The accuracy of the positions of the holes is thus limited only by the accuracy of the button positions and the accuracy with which the buttons are centered on the lathe preparatory to boring.

The small face plate is used mainly to provide a drive to a lathe dog clamped on work. However, a stud may be bolted to the face plate to engage a projection on the work which then acts as its own dog.



The large face plate is usually used in a different manner. Fundamentally, it is used to provide a plane surface at right angles to the axis of the spindle, on which the work is mounted for turning, boring, drilling. By means of a 90° angle plate, as illustrated above, many additional jobs may be mounted for lathe work. For the purpose of fastening work to the face plate, radial slots are provided to engage bolts used to clamp the work.

An outline of a few typical face plate jobs illustrates both the types of job and manner of fastening.



A motor base would be clamped to face plate, with the under side of base against face plate, to enable the surfacing of upper side of base by a facing cut in lathe.

A bracket, with axis of the hole perpendicular to face of bearing surface, could be bored very easily by means of an angle plate mounting as illustrated 2 above.

Trepanning may be easily accomplished by bolting material to face plate, as illustrated 1 above.

Trepanning is the term used to denote cutting out a washer or some such similar piece from a flat, relatively thin piece of stock which could not be bored and held on a mandrel as could a regular turning job such as a bushing.

A part, such as a round pipe, with a large hole and flanges, is readily faced on both ends by face plate mounting (1 above).

Boring jobs where several holes must be bored of specific dimensions, can be well handled with this mounting.

Face plates, as illustrated 3 above, may be specially prepared for certain classes of work. For instance, the face plate may be cast solid, that is without slots, and may be provided with a large number of tapped bolt holes arranged in circles so as to provide bolting surface for many kinds of odd-shaped pieces. Also a solid face plate may be provided with a groove similar to a keyway to facilitate mounting angle plates similarly provided with slots by means of a key and appropriate clamping.

An odd job plate such as described above is recommended for every lathe installation. Such a plate should be kept ready with various size clamps and clamping bolts to facilitate mounting of odd-sized pieces.

A small milling machine vise may be clamped to the plate and used to hold odd-sized parts for flat facing. This method is extremely useful in facing small odd-shaped pieces if a chuck is not available.

FACING WORK HELD IN A CHUCK OR FACE PLATE

Work that is large in diameter in proportion to length or that has no hole for mandrel mounting is usually held in the three- or four-jaw chuck for facing off end. Other pieces of odd shapes are sometimes held most advantageously on a face plate and machined in this position. Work should be chucked with as little overhang as possible to provide a rigid mounting and eliminate chatter.

If a cored or machined hole is present, it is advisable to start cut at inside and feed to outer edge when facing, as this direction of feed gives much better results than feeding from outside edge in, since it is easier to set the tool at center height at the center than at the OD of the work.

In facing, as above, a right-hand turning bit should be used in a right-hand or straight tool holder, as facing in this manner requires a tool similar to a tool used in turning toward the headstock.

The finish cuts are best taken with the right-hand side facing tool sharpened for the material being cut.

For finishing, use right-hand finishing tool as before, except that tool should be fed into work at the center so as to leave no point at exact center of work. The tool is then fed outward as before.

For roughing cuts, tool should be set a bit above center, as in turning large diameters. In finishing, tool should be exactly on center.

WORK CLAMPED TO CARRIAGE

Many variations of chucking work are possible. Work may also be bolted to the carriage or the carriage slide while the hole is machined with a fly cutter mounted in a boring bar held between centers and driven by a lathe dog. This method is used largely where the piece to be bored is too large to swing in the lathe, or is too bulky or awkward to handle properly.

STEADY REST

The steady rest should be placed where it will give the greatest support to the piece to be turned, which is generally about the middle of the piece. However, the best position is obviously determined by the design of the piece.

If the part to be supported has a diameter of short width to be turned, this can be finished with a fine feed and slow speed and used as the supporting position in the steady rest.

If the construction does not determine the position of the steady rest, turn a "spot" about the middle of the piece to be turned. Place the part between centers, with the steady rest in position at the turned "spot",

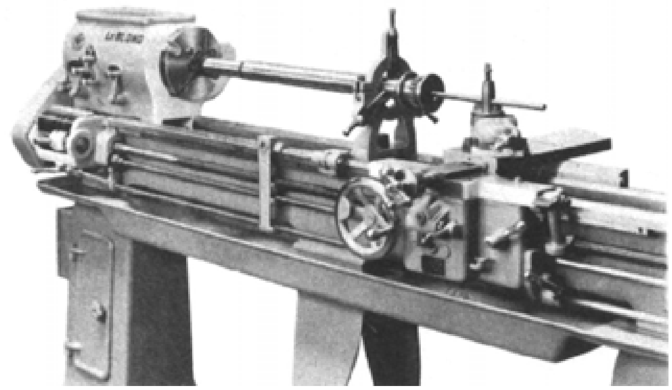


FIG. 68 – CORRECT USE OF STEADY REST

close and clamp the upper part of the steady rest, and bring the jaws to bear lightly on the finished "spot" with a running clearance. The clearance is set by means of the adjusting screws. To prevent scoring, oil the jaws each time a piece is clamped in the steady rest. To remove the piece, loosen the clamp bolt and swing the upper part of the steady rest back. Thus the pieces can be changed without changing the adjustment of the jaws.

The best way to align a steady rest to hold the unsupported end of a piece for boring is to place a bar of the same diameter, as the piece to be machined, between centers and adjust the jaws to it. Then remove the bar and place the piece in position. This method insures the proper centering of the steady rest (see figure 68).

FOLLOW REST

The follow rest differs from the steady rest in that it moves with the carriage and provides support against the forces of the cut only. The tool should be set to the diameter selected and a "spot" turned about 5/8" to 3/4" wide. Then the follow rest jaws should be adjusted to the finished diameter to follow the tool along the entire length to be turned.

The follow rest is indispensable when chasing threads on long screws, as it allows the cutting of a screw with a uniform pitch diameter. Without the follow rest the screw would be inaccurate, due to its springing away from the tool.

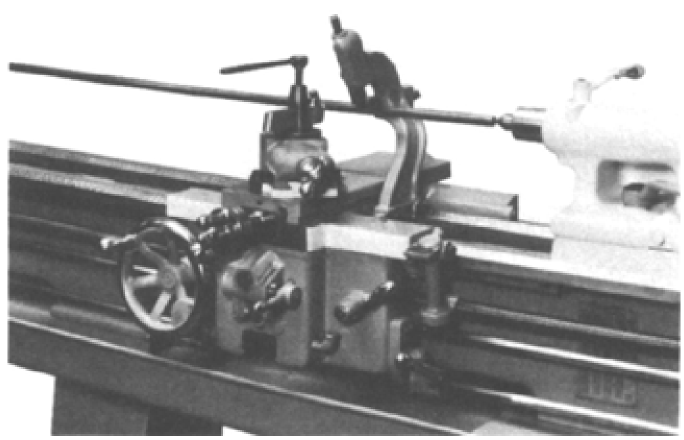


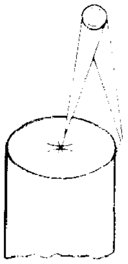
FIG. 69 – FOLLOW REST SUPPORTS WORK CLOSE TO CUTTING TOOL.

LATHE OPERATIONS

CENTERING WORK

Lathe work may be divided into two general classes, namely, work machined between centers and work machined in chucks. Bar or shaft work is done between the centers, the piece to be turned having been previously centered.

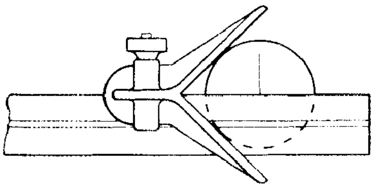
There are many ways of centering a piece of material. In large production shops this work is done in a centering machine. In small shops the lathe operator usually centers his own work. The first thing to do is to find the center on each end of the piece. This can be done by using hermaphrodite calipers. Set the caliper to about one-half the diameter of the piece, chalk the end of the piece so the scribe marks can be seen, and scribe four arcs, one from each quarter of the circumference (136). The center of the piece lies between the four arcs.



136

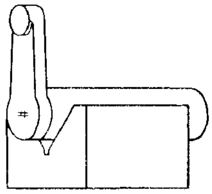
Mark the center thus located with a center punch. Perform the same operation on the other end of the piece and it is ready to have the centers drilled.

The center of a piece can also be located by the use of a center head on a combination square. Draw two lines at about right angles to each other. Where they bisect will be the center of the piece **(137).**



137

To center iregularly shaped pieces such as a drop forged brake lever, lay the piece in a V-block (138) on a plane surface and use a surface gauge for scribing the lines on each end. First set the gauge to the approximate height of the center and scribe a line. Turning the piece, scribe three more lines, each at about 90°. The center of the piece is in the center of the square formed by the scribed lines.

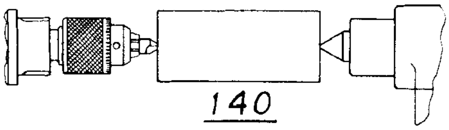


138

After the center has been found on each end of the piece and it has been centerpunched, the actual drilling of the center can be done under a drill press or in the lathe itself.

139

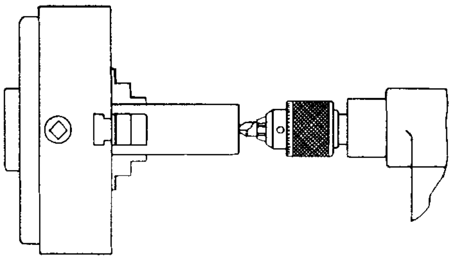
Center drills (139) are usually used for centering. The drill is held in a drill chuck (as shown on page 16), having a shank that fits the taper hold in the headstock spindle. The tailstock is set on the bed the proper distance from the headstock to permit holding the piece in the center punch marks between the center and the centering drill (140). To keep the piece from rotating,



140

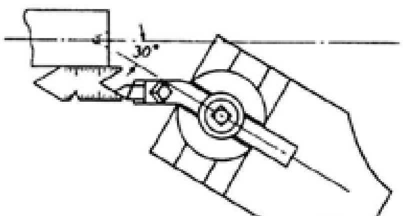
hold it with the left hand, and advance the tailstock spindle with the tailstock screw handle. The piece is fed into the drill and the one end center drilled. The piece is then reversed and the other end is drilled. This method is used for centering rough bar stock where the entire length is to be turned.

To center finish ground stock such as drill rod or cold-rolled steel, where the ends are to be turned and must be concentric with the unturned body, other methods must be used.



If the piece is small enough in diameter to pass through the spindle, it can be held in a universal chuck on the spindle nose (141), or a draw-in collet (page 18). Hold the center drill in a drill chuck in the tailstock spindle and center drill one end; reverse the piece, and proceed as before.

If a piece must be centered very accurately, the tapered center should be rebored after center drilling, to correct any run-out of the center drill. This is done by grinding a tool bit to a center gauge at a 60º angle. Then with the tool holder held in the tool post, set the compound rest at 30º with line of centers (142).



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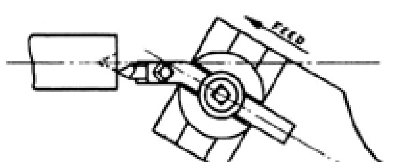
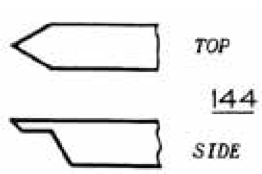
Set the tool exactly on the center for height and adjust to the proper angle with a center gauge. By feeding the tool in on this angle, any run-out of the center is corrected (143).



143

The tool bit should be relieved under the cutting edge to prevent the tool dragging or rubbing in the hole (144).



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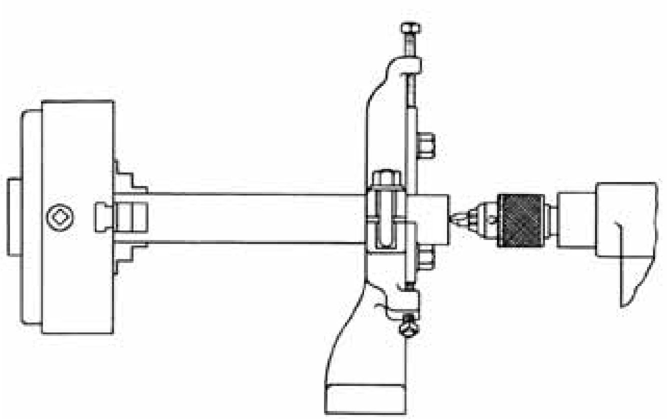

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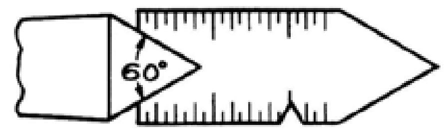
To center long pieces that will not pass through the spindle, a steady rest is used to support the outside end of the piece as near the end as possible (145). The drill and chuck are held in the tailstock spindle and the drill fed to depth by advancing the tailstock spindle. To correct any run-out of the center use the same methods as described before.

It is absolutely essential that the centers in the piece to be machined conform to the centers in the lathe so that the sides of the center in the piece have uniform bearing on the lathe center. Lathe centers are ground on a 60º included angle and can be tested with a center gauge (146). To do good work the lathe centers must



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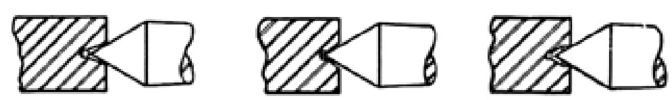
fit the drilled centers. If the center bearing is not uniform, the work will not be round but it is likely to be tapered due to the rapid wear of the center hole. Another result of improperly drilled centers is chatter marks due to the piece being loose between the centers.



147 148 149

Avoid conditions such as are shown in 147, 148, and 149. This is especially true of the tailstock end or dead center. To test for the kind of bearing the lathe center is taking in the work, rub a little red lead on the lathe center and spin the piece on the centers by hand, The bearing surface will be bright. If the bearing is incomplete, correct it as directed above.

TESTING LATHE CENTERS

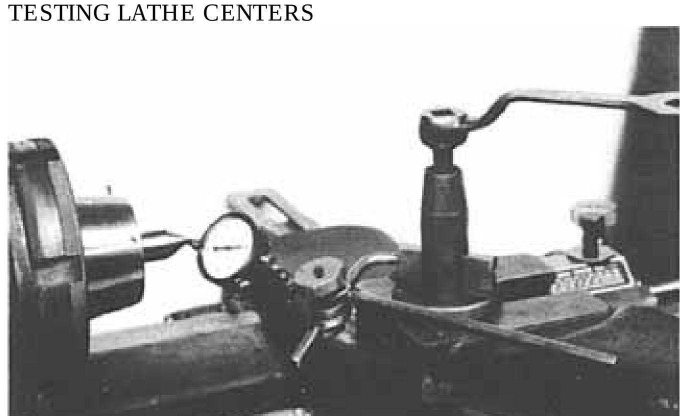


FIG. 82 – CHECKING FOR RUN-OUT

The center in the lathe should run true. To test this an indicator is necessary. The indicators are usually of the dial type and read in thousandths of an inch. When testing the headstock center try the indicator first on the point of the center to see that the spindle has no end movement. If the indicator is tried on the angle of the center when the headstock spindle has end play, the reading on the indicator dial will be inaccurate and misleading. However, if there is no end play in the spindle and the indicator shows run-out on the headstock center, then the three possible points of error should be checked and correction made.

The first and most probable source of trouble is the presence of dirt or chips in the taper hole between the spindle and the center bushing, or between the center bushing and the center itself. To correct this trouble, remove the center and the center bush, clean the taper holes in the spindle and the center bush and the outside of both the center bush and the center. Replace the bush and the center and again test with the indicator.

The second source of trouble may be the presence of a burr or scratch on the surface of the spindle tapered hole or on the surface of the center bush. Since the center bush is hardened (about file hard), it is very seldom that trouble from this source occurs. It happens at times, however, that there is a burr in the spindle hole, caused by a drill chuck shank turning under cut or some similar occurrence. Should this be the case, carefully remove the burr with a scraper, being careful to remove only the high spot, or use a Morse taper reamer of appropriate size.

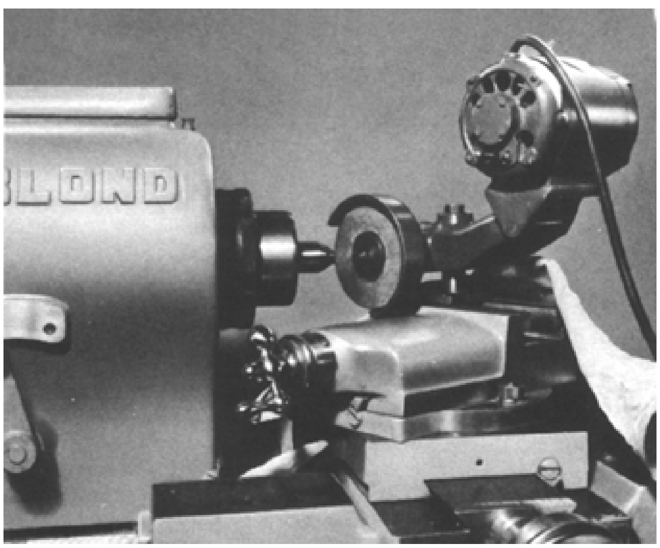


FIG. 83 – GRINDING LATHE CENTER

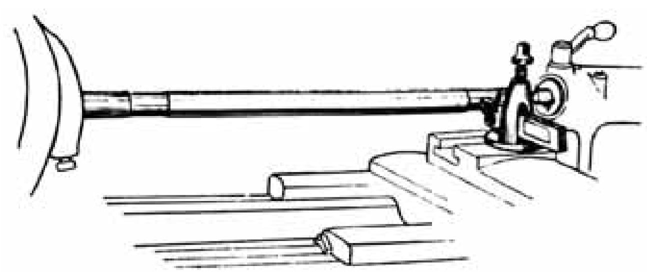
LeBlond Regal Lathes are tested before shipping, and the taper holes in both headstock and tailstock spindle have been reamed clean and true. Operators should make every effort to retain the original accuracy of the lathe, being careful to preserve smooth clean taper holes in the head and tailstock spindles, as the accuracy of the lathe is largely dependent on the bearing of the centers in the tapered center holes.

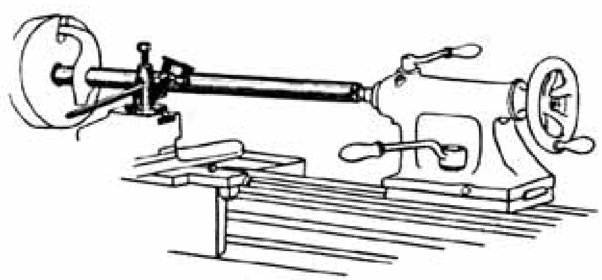
The third cause of center run-out is inaccuracy of the center point itself. Since both hard and soft centers may be used in the headstock spindle, two methods of correction are outlined.

For soft centers it is only necessary to set the compound rest at 30º with the axis of the lathe and take a a skim cut over the point with a lathe tool sharpened to cut smoothly. When repointing a hard center, it is necessary to grind it, as the center is harder than the turning tools. The procedure for grinding is a s follows:

As before, the first step is to set the compound rest over to 30 degrees with the axis of the lathe. Next, mount a tool post grinder in the tool post slide. Third, cover the exposed ways of the lathe with cloth or paper to prevent the grinding grit reaching the bearing surfaces of the bed and cross slides. Fourth, put the headstock in gear to give approximately 200 rpm. to the spindle, and take a light cut over the center point, feeding the wheel across the point by means of the compound rest handle. Continue to feed the wheel back and forth until it is cutting evenly all around and on the entire length of the center point, and then check the angle with a standard center gauge. Reset the compound rest if necessary and continue grinding until the center fits the center gauge accurately. The accuracy of the fit can be observed by placing a light beneath the center and looking for light between the center point surface and the edge of the center point gauge.

ALIGNMENT OF CENTERS





When turning straight work, try alignment of tailstock center with headstock to be sure work will not be tapered.

When zero marks are in line on tailstock, top and bottom, centers are approximately in line, but due to the impossibility of seeing an error of .001" misalignment, it is probable that the work will be tapered if a more sensitive test than this is not applied to the center alignment.

A test bar as shown is easy to make and use and gives positive results.

The tool is set to just miss one end and then the carriage is run to the other end to see if tool registers the same as the end first tried. If adjustment is as close as can be made by eye, a trial cut of about 2 thousandths depth is taken on one end and then a similar cut is taken on the other end. The two cuts are checked with micrometers and any error corrected by moving the tailstock one-half the error. If work is small at tailstock end, move tailstock away from tool edge. If tailstock end is large, move tailstock toward tool edge.

With this test the work can be held to any desirable limit of straightness.

Another method is to have perfectly straight test piece and try center alignment with this piece held between centers. A dial type indicator mounted on the compound rest will show up any error in alignment. Before testing with a straight piece, check live center in head to see that it runs true.

When shifting tailstock to line up centers: Unscrew handwheel, thus removing center from work; loosen hold-down clamp screws; loosen adjusting screw on side opposite to desired motion of tailstock top; tighten adjusting screw til indicator reads zero; reclamp tailstock hold-down clamp bolts; readjust tailstock center in work and re-check for alignment.

FACING TO LENGTH

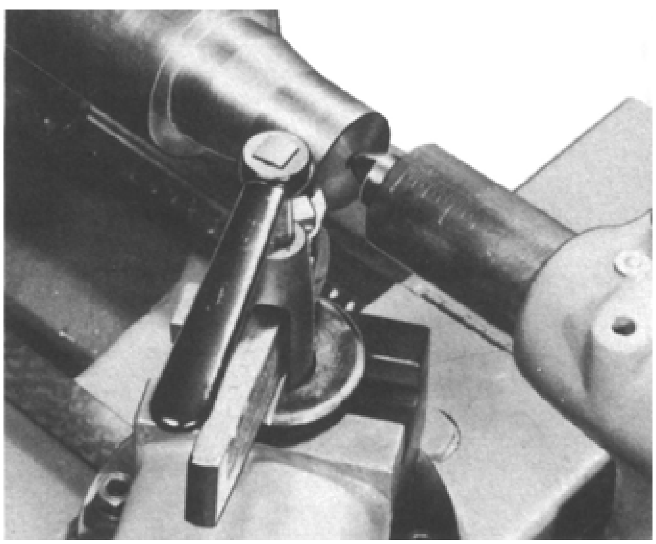
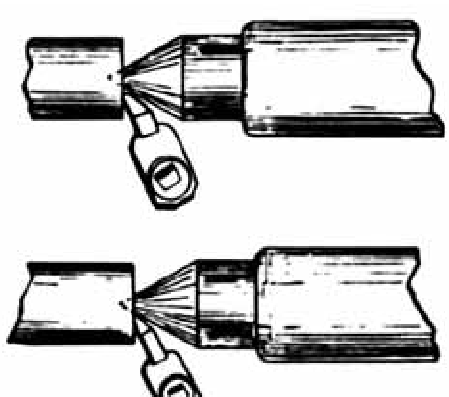


FIG. 85 – FLAT MILLED TAILSTOCK CENTER USED WHEN FACING TO LENGTH.



One of the operations done most frequently on a lathe is facing the ends of a piece to length. The procedure is as follows:

1. Measure piece to determine how much stock is to be taken off.
2. Be sure center holes are free of dirt, chips, etc., and have no burr on the edge of the center hole.
3. Put red or white lead or other center lubricant in center on tailstock end.
4. Tighten driving dog on work and place on live or headstock center and then run dead center into place. Hold work with left hand and adjust tailstock center with right hand until work can be turned easily on centers but has no end play. Clamp tailstock spindle.
5. Another method is to put work between centers, run up tail center until tight and back off until just free. Start lathe. Lathe dog tail will click as face plate and work revolve. Tighten tailstock until clicking just stops and clamp tailstock spindle. After a few trials the operator will learn to judge the proper setting of the tailstock center by feel.

Caution: if center is too tight it may burn off and work will "fly" out of lathe.

6. If stock to be turned off is slight, say 1/64" to 1/32", the right-hand side finishing tool may be used. If the stock is about 1/16" to 1/8" or more, however, the end should first be roughed off with the right-hand corner tool as far as possible toward center. Then the finish tool should be used to remove burr around center and a skim face cut taken for a smooth finish.

The corner tool, as stated above, is used for roughing off to length and cuts from outside toward center of work.

The finishing tool, however, is only used for skim cuts and cuts from the center hole out to the outside diameter.

For roughing cut, set edge of corner tool exactly on center of work and run the cross slide in until tool just misses the OD of work; measure work with scale and set tool edge to cut length so as to leave a skim cut for finishing. If excess length cannot be removed in one cut, split the excess amount into about equal parts and rough down to length.

7. Remove corner tool and put right side facing tool in holder. Clamp tool, set holder so tool edge is exactly on center line of work and tool edge is at slight angle with end of work, the point of the tool doing the cutting.
8. Feed tool into ridge around center hole until ridge is cut off flush with end of work. Use both longitudinal and cross motions for this operation, feeding them by hand.
9. Set point of tool toward headstock, adjacent to center, clamp carriage and start tool out by hand feed, after about 1/4 turn of cross feed handwheel, throw in feed clutch and take rest of cut out to edge of work under power.
10. The surface of the cut above taken should be very smooth and without tool marks.

If tool marks are evident, the following points should be checked:

The feed is too great; from 3 to 8 thousandths of an inch is the usual range.

The tool edge is at too great an angle to the line of the surface being faced.

There is a burr on the tool point such as would be caused by running point of tool into tailstock center when removing ridge around center hole.

To insure a smooth finish cut, sharpen tool with a small hand stone just before the finish skim cut.

Steel finishing side tools are ground with a 10º to 12º side clearance about 10º to 15º side rake, no back rake, and about 8° front clearance.

For cast iron and brass, the same clearance except no side rake is used on tool.

11. When facing to length it is possible to use the regular tailstock center. It is, however, much handier if a groove, or flat is milled or ground on the taper portion so as to provide clearance for the tool edge. This clearance space allows the use of standard shaped tools when facing to length instead of sharp pointed ones necessary to get into space between end of work and regular center.

The necessary flat may be ground by hand on a bench grinder. When grinding flat, be sure to grind less than half way through point as otherwise the center would become in effect a center reamer and would cut the center larger and allow the work to loosen between centers and wobble.

Chatter marks on finish cut are caused by one of the following:

1. Speed of work is too high -- slow work down.

2. Feed is too high -- slow feed down.

3. Tool edge is set too nearly parallel with edge of work being cut -- increase angle of tool slightly.

DRILLING, BORING AND REAMING

Holes may be drilled with the lathe by driving the drill in the headstock spindle, holding the work against a pad on the tailstock spindle and using the tailstock spindle motion for feed. Small pieces may be held on the face plate or in a chuck while the drill is held and fed by the tailstock spindle.

Holes and counterbores are easily machined in a lathe. The advantage of boring is that a perfectly round true hole is obtained. Two or more holes of the same or different diameters may be bored at one setting, thus insuring absolute alignment of the axis of the holes.

Work to be bored may be held in a chuck, bolted to the face plate, or bolted to the carriage slide. The tailstock end of long pieces may be supported in a steady rest (see figure 68, page 30).

Single point boring is the process of rotating the work either in a chuck or on a face plate while a tool is fed into a drilled or cored hole in the work.

Special boring bars of single and multiple tool types may also be used, provided the amount of work justifies the extra expense of the special tools, However, for the most part, single point boring is used on a single piece or small lot jobs.

Boring tools may be either of the solid forged type or of the inserted cutting bit type. The use of either depends upon the operator's choice or preference with reference to the respective costs. It is advisable, wherever possible to bore the hole within a few thousandths of the finished size and then to finish ream the hole to exact size.

The three above operations, while distinct items of individual operations, are often performed in sequence on a single piece of work at the same work setting, that they will be considered together.

We will assume piece to be drilled has been properly mounted on face plate or in chuck. (See articles on chucking and face plate mounting, in section on "Holding Work in the Lathe").

Spot center with center drill to provide true point of entry for small drill.

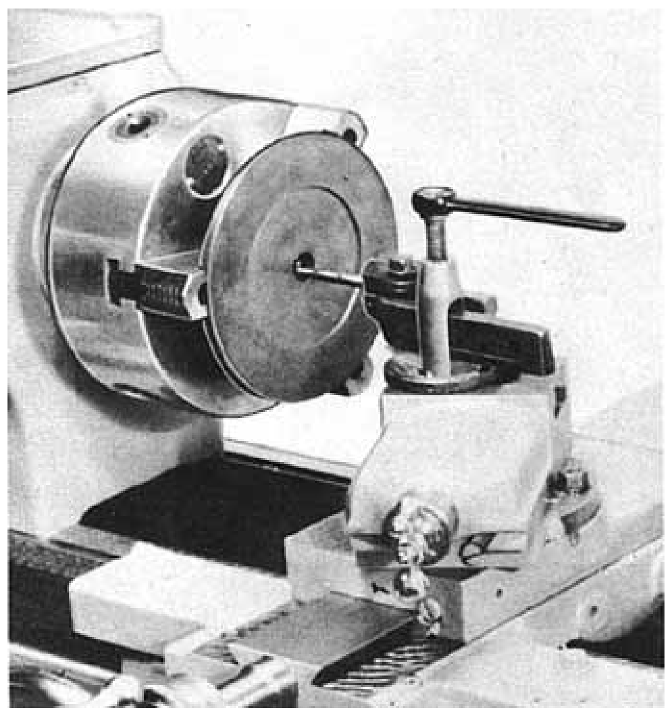


FIG. 87 – SINGLE POINT BORING

Drill through piece with 1/8" or 1/4" drill to clear flat tip of larger drill used to remove bulk of metal and to permit entry of boring tool if used.

If hole is to be just a rough job both as to size and straightness, use large drill 1/64" or 1/32" smaller than finish size, and run through piece. Drill is held in taper hole in tailstock spindle if taper shank drill is used, or in drill chuck mounted in tailstock spindle if straight shank drill is used.

A dog clamped to the drill as illustrated in figure 88 will prevent its rotation and the resultant scoring-of the tailstock center hole.

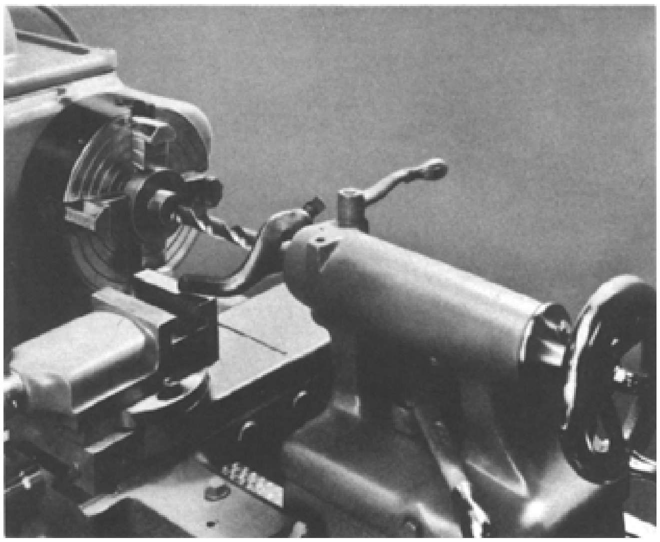
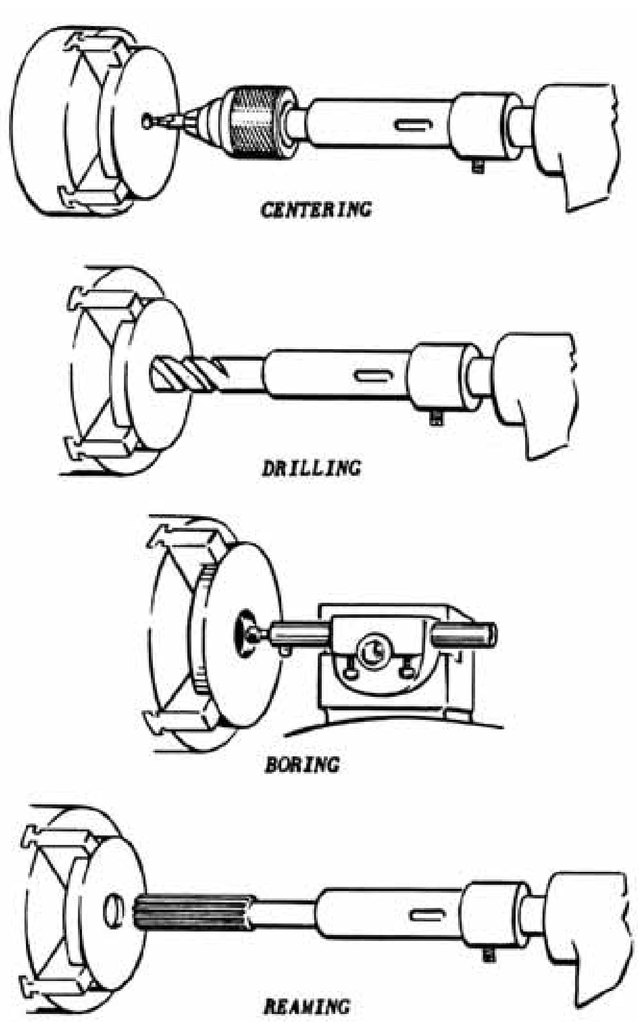


FIG. 88 – LATHE DOG HOLDS DRILL AND PREVENTS IT FROM ROTATING

A reamer can be held either on the taper shank in the tailstock bore, in a drill chuck mounted in the tailstock spindle, or held in line with the tailstock center of the lathe.



Hold center hole in reamer against tailstock center and guide the cutting or reamer end into hole, as right hand turns tailstock handwheel to bring reamer up to work. Run lathe spindle at about 40 rpm. Reamer should be prevented from rotating by clamping wrench on reamer and allowing handle to stop on carriage wing or bar held in tool post. Start lathe and feed reamer in by tailstock handwheel. On cast iron or brass no lubrication is necessary. On steel and wrought iron, it is advisable to lubricate with lard oil or some similar lubricant.

Above method produces a reamed hole, but hole may not be exactly straight or parallel with axis of lathe, due to fact that large drill previously used may have run slightly off the straight path. The reamer in this case follows the crooked hole.

To produce absolutely straight and true holes, drill used to rough-cut stock should leave hole about 3/64" to 1/16" small.

Use boring bar mounted in tool post (as illustrated), and bore hole until about eight to ten thousandths stock is left.

To act as true guide for reamer, bore hole at outer end -- or the end the reamer enters -- 1/8" deep about three thousandths small.

Proceed with rough and finish reamers if both are available.

If roughing reamer is not available, leave only 3 to 5 thousandths stock for finish reaming after boring.

Variations in the procedure outlined above are numerous, and will suggest themselves to the operator, but the general procedure is the same in all cases.

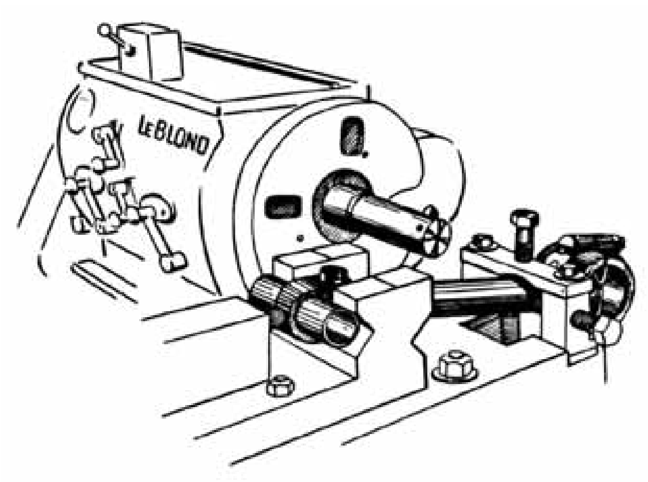
Points to be remembered when performing the above operation include the following:

Straighter holes are made with a drill held from rotating and fed into the revolving work, than with a revolving drill in a stationary piece. A small pilot hole to clear the flat tip of a larger drill to follow allows the drilling of the larger hole quicker and with less power. To insure a straight hole, singlepoint bore the hole after drilling and before reaming. Boring tools generally used are the single point type for rotating work, and bar type for fixed work where bar rotates between centers and work is fed past the cutter bit. Steel requires lubricant, it is advantageous on brass or cast iron, but not necessary. Boring tool tips should have clearance and rake similar to turning tools used on the respective materials. When boring to finished size, if no reamer is available, take last cut with feed entirely through piece, then reverse feed without changing boring tool setting and feed tool out again. The slight natural spring of the tool and the crossed feed line will assist in producing a smooth finished hole. In this connection it should be pointed out that the rounder nose the tool has the smoother the job if chatter does not occur. In case of chatter, slow work up. If this does not eliminate the trouble, try a more pointed nose on tool. Also try changing center height of tool.

Boring is very accurate with work mounted on a face plate and offers possibilities in boring a number of holes at accurate center dimensions by use of buttons, discs or some similar method of location (see page 29),

Boring is a simple and accurate method of machining a true straight hole, for both single hole jobs, which must be produced quickly and economically without jigs,and very accurate work where a hole must be bored true with relation to other holes or surfaces. After boring hole to within a few thousandths of finished size, a reamer is generally passed through holes to produce the exact size required.

DRILLING, BORING AND REAMING; WORK HELD ON CROSS SLIDE OR CARRIAGE



In this particular type of drilling and boring, the work remains stationary and the cutting tool rotates. The feed of work relative to tool is obtained by moving the carriage on which the work is mounted.

Boring two holes on the same axis may be done very accurately by this method. If the work is mounted on the compound rest, two sets of holes may be bored with axis parallel and to very close limits. By mounting the drill in the spindle and feeding the work onto the drill clearance holes can be opened to allow the boring bar to pass through, to finish bore the hole. If the holes are cored in the casting, the boring bar may clear the cored hole and the rough and finish bore operations may be proceeded with directly. Otherwise open up cored hole with drill or single point boring tool.

BORING WITH A BAR BETWEEN CENTERS

The boring described in previous sections has been devoted to the types where the tool was mounted in a bar either held in the tool post or in the spindle of the lathe.

A third variation is possible. The work may be mounted on the carriage or cross slide and the hole bored out by a tool bit mounted in a boring bar between centers of the lathe. This method is very useful when boring long holes or where the piece is mounted easier by bolting down flat than by holding in a rotary chuck.

The tool bit may be held in any practicable manner, such as clamping by set screws, by screws and nuts or by taper clamping plugs. Bars of this kind are easily made and present no difficulty, since all that is necessary is to make a bar as large as can be passed through the rough hole with 1/8" clearance -- long enough to suit width of work plus travel of work for cut. Center this bar on both ends and place between centers with work in position at start of cut. Mark location for cutting tool, remove bar, drill for bit and clamp screw and bar is ready for use. Drive boring bar with lathe dog.

TAPPING

Taps may be held on the tailstock center in the same manner as the drill shown in figure 88, to secure a tapped thread in line with the drilled hole.

A die holder may also be fitted to the tailstock spindle or to the compound rest to facilitate cutting threads on a turned pin or bolt held in a chuck. On work of this class a hand feed or floating connection is preferred so that the tap or die may travel along the cut thread at its own rate of travel without influence by the feed of the tailstock spindle which may not be fed correctly by hand. The proper unit to use for this work is a turret mounted on the bed of the lathe. However, this unit is special and unless there is a large quantity of work of the type mentioned, the cost will be excessive for the benefit derived.

Self-opening dies and self-closing taps are available which automatically release the cutting edges from the threads at the end of the cut. These units, also, are useful only when the lots of pieces to be machined are large.

STRAIGHT TURNING ON CENTERS

Be sure lathe centers are in alignment and that live center runs true. Put dog on work, clean all dirt, chips or burrs from center holes and adjust between centers, putting center lubrication in tailstock center hole. Use tool properly ground to shape for the operation and material being worked. Tighten tool in the holder so that it does not project more than 1½ times its thickness nor less than 3/4 of its thickness from the front of the holder.

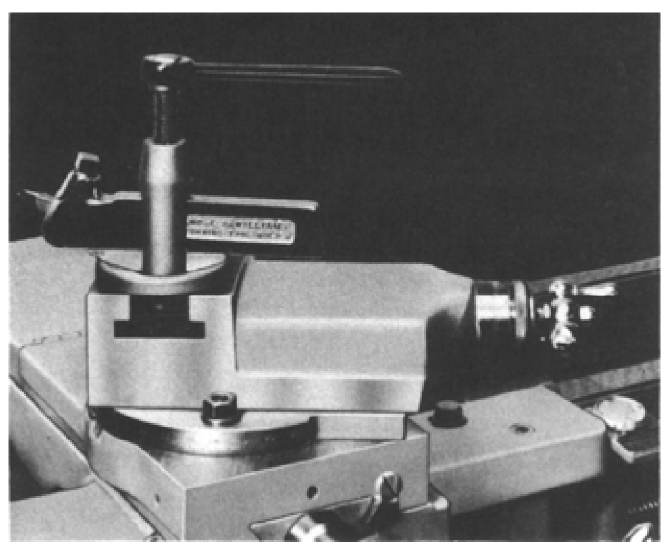


FIG. 91 – PROPER TOOL BIT PROJECTION

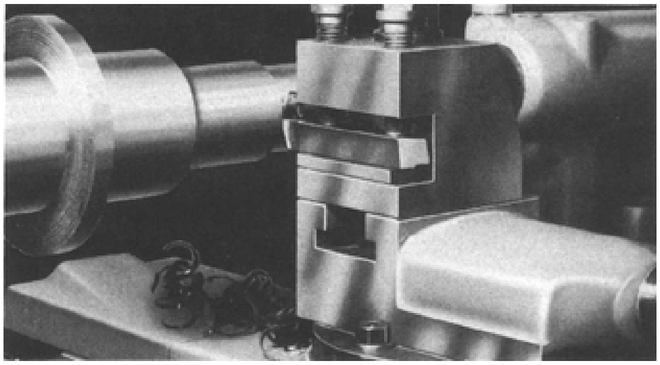
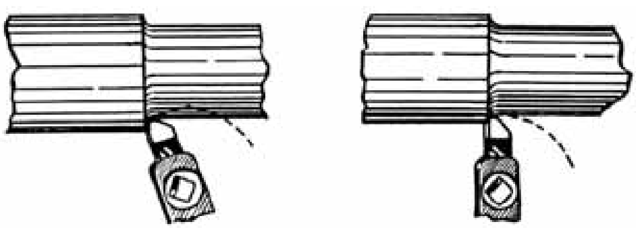


FIG. 92—TOOL SET SQUARE WITH AXIS FOR STRAIGHT TURNING

Set tool holder square with axis of work so that any movement of tool will lessen the depth of cut and not dig into the work, as illustrated below. Tool holder should be as close to tool post as possible for rigidity and still allow bit clamp screw to be turned by its wrench. Be sure the compound rest is as far back on bottom slide as is necessary to avoid overhang of the slide.

Adjust tool bit cutting edge by rocking tool holder on tilting wedge until cutting edge is at proper height, then clamp tight.

A tool properly ground should have the point set on the center line of the work. Some operators make a practice of setting the tool above the center line, about 1/64 of an inch for each 1" clearance in diameter. This, however, necessitates changing the clearance and rake angles of the tool and for this reason we do not recommend it for the student or beginner.



Move carriage left and right to be sure tool will traverse the length of cut without obstruction when lathe is running.

Be sure tool edge is free of work, then shift gears to give proper speed of work (see "Cutting Speeds", page 47 and 48) and start lathe.

Start cut at tailstock end, wherever possible, as the thrust of the cut is then taken by the thrust bearing in the headstock instead of by the small center hole in the work. If only one roughing cut is necessary, adjust tool to turn piece 1/64" over finished size of piece.

NOTE: When adjusting tool to depth of cut always move tool towards work so as to remove any backlash present between cross feed screw and nut.

Many times it is not possible to remove all the excess stock in one roughing cut. In this case take as many roughing cuts as are necessary to bring work down to finish turning size. Endeavor to split up roughing cuts into equal depths of cuts and take each cut at the maximum capacity of the tool and the machine.

When tool is set to proper depth of cut, throw in feed and cut to required dimension, or, if work is to be turned entire length, to a little over half the length.

Have gibs on cross-slide tight enough so a positive top raked tool will not draw the cross slide into work.

Throw out feed, stop lathe, and remove work from centers.

Return carriage to starting position and reverse work between centers, or put in another piece for same operation.

After all roughing work is completed, put round nose finishing tool in tool holder, set lathe for correct finishing speed (see Cutting Speeds, page 47) and set feed for finish cut.

Set tool for a light cut to true up all around; turn about 1/4" and "mike" diameter of part thus turned. Set tool in the amount work is oversize by means of the micrometer adjusting dial, and again turn 1/4". Turn only far enough from end to properly measure diameter, both to save time and avoid spoilage of piece.

FINISH ALLOWANCE

On work to be finish ground, make the finish turned diameter 15 thousandths over actual finish ground diameter.

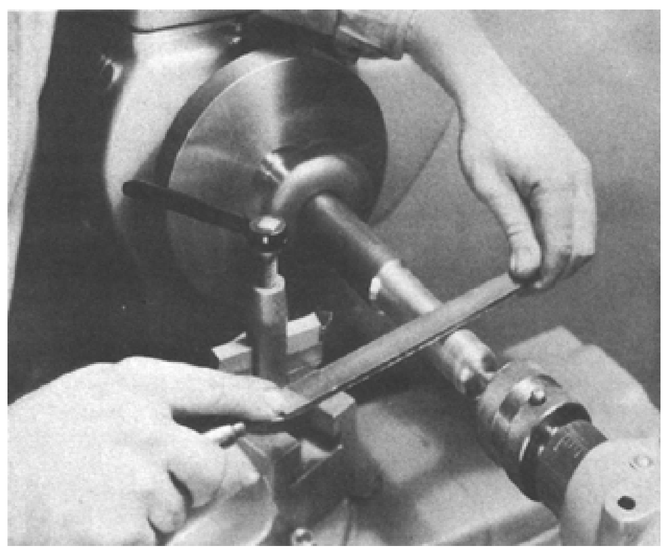


FIG. 94 – FILE FINISHING.

On work to be file finished and polished, leave 2 to 3 thousandths of an inch over finish size to provide stock to file and remove slight tool marks and give polish finish.

When finish turning several pieces to same diameter, do not change cross-feed setting after once correctly set. Turn diameter required length, stop feed, stop lathe, back off tail center, remove work, return carriage to starting position, insert new piece and turn as before. This insures duplication of size.

The finish turned surface of steel is usually considerably smoother if cutting oil or soapy water is dropped slowly over the work and tool point on this cut. If the machine is not equipped with a coolant system, the liquid may be dropped from an oil can, saturated sponge or waste squeezed in the hand, or by a regular drip spout connected to a can of solution and mounted on the carriage so as to follow the tool.

When clamping any driving device to a finished surface, be sure to protect the surface by placing a copper or brass sheet under the clamping screw.

TAPER TURNING AND BORING

There are three accepted methods of taper turning: (1) the "set-over tailstock" method, (2) by means of a taper attachment, and (3) the compound rest method. These methods may be described as follows:

SET-OVER TAILSTOCK METHOD

The oldest and probably the most common method of taper turning is the set-over tailstock method. The tailstock is made in two pieces, the lower fitted to the bed, while the upper part is fitted to a cross keyway machined on the lower section. To turn straight diameters, the tailstock spindle is set exactly in line with the headstock center, indicated by the zero mark on the graduated boss on the rear of the tailstock. To turn taper diameters the upper half of the tailstock is set over the amount necessary to produce the taper required.

To do this, loosen spindle clamp, unscrew handwheel to remove center from work, loosen tailstock clamp, adjust set-over screws to move tailstock top in proper direction, reclamp tailstock clamps, readjust center, reclamp spindle clamp and take cut and try taper.

When turning a number of tapered pieces by the above method, it is essential that all pieces be the same length within about 5 thousandths of an inch and should be centered to the same depth. When using the taper attachment, however, the length of the work has no effect on the taper cut if the taper attachment remains set at the same taper.

Tapers are usually given as the included angle in degrees or as a certain taper per foot. For instance, a taper of one-half inch per foot means that a bar one foot long, having such a taper, would be one-half inch smaller in diameter at the small end than at the large end. However, to turn such a taper, it is only necessary to offset the tailstock one-half the taper specified. In this case, for a piece one foot long, one-half inch taper per foot, set the tailstock over one-quarter of an inch.

If the piece were only six inches long, the tailstock top offset necessary to secure one-half inch taper per foot would be one-eighth of an inch.

From the foregoing examples it will be seen that the setover necessary would be:

$$S = \frac{T}{2} \times \frac{L}{2}$$

where S = setover in inches
T = taper per foot in inches
L = length of piece in inches

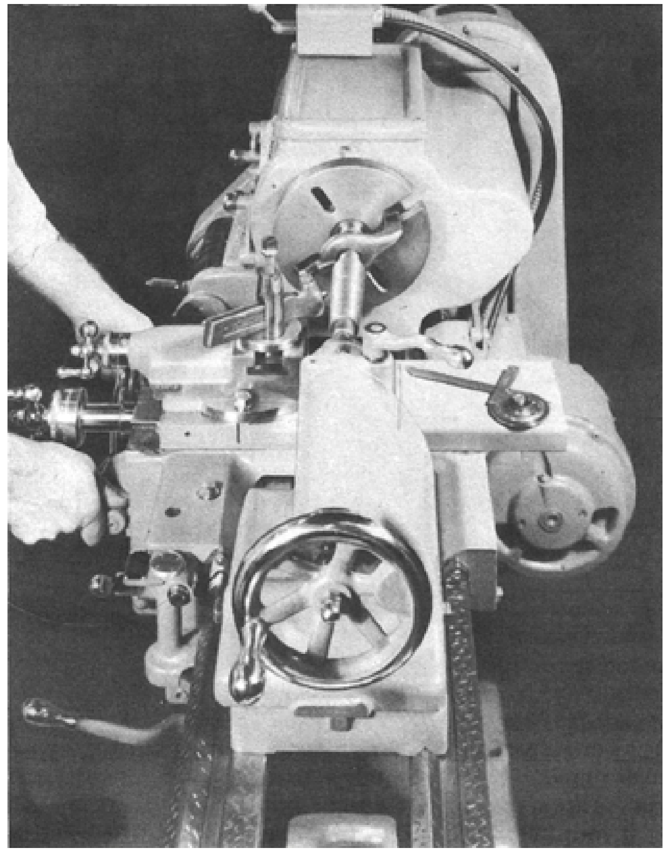


FIG. 95 – TAPER TURNING: SET-OVER TAILSTOCK METHOD

Be sure to observe these important points when taper turning with the set-over tailstock method:

Have tool edge set exactly on center of work.
Have ends of work faced off square with centers.
Do not adjust centers too tight as center point in tailstock burns easily in this set-up.

TAPER ATTACHMENT METHOD OF TAPER TURNING

The most economical way to produce a number of pieces of duplicate taper, especially where the length of pieces varies, is by the use of the taper attachment. It has been shown by the formula for the amount of tailstock setover, that the setover varies as the length of work, even when turning a taper of the same degree. It can be seen therefore, that a taper attachment is almost indispensable for taper work. The advantage of a taper attachment will readily be seen when it is necessary to change the taper attachment setup to machine the tapers. For instance, it is only necessary to turn the male taper, then change from the turning to the boring tool in the tool post, and put on the chuck or other accessory to hold the part in which the female taper is to be reproduced. The point is that the sensitive part of the setup, the setting of the taper attachment, has not been disturbed.

1. Clamp regular rough turning tool bit in tool holder and set cutting edge exactly on center of work. This is important, since if the tool was above or below center, the angle of the cut would not be the same as the setting of the taper attachment.

2. Mount work between centers in lathe as in straight turning.

3. Move carriage so taper attachment shoe is in center of swivel guide bar, as illustrated and described on page 17, and tool is in center of work.

4. Any depth adjustment of tool is made by means of compound rest top slide screw.

5. Run carriage toward tailstock until tool is about 1/2" to 1" past end of work. Next, run carriage back in direction of cut by hand until tool is just clearing end of work. Set tool for sufficient depth of cut to turn taper about 1/3 of finished taper length. Try in taper gauge. Turn down until taper centers about 1/3 of length into taper gauge.

6. Take light skim cut over surface just turned, about .005" depth to give smooth surface to test taper.

7. Test taper just turned in taper test sleeve or standard female taper gauge. Try to rock taper piece in taper gauge. If taper is too steep, the piece, will be tight at the big end of the gauge hole and will rock in the back. If the taper is too slight the work will be tight at the back of the hole and will rock at the big end of the hole.

8. Loosen clamp No. 4 (page 17), and adjust taper attachment to correct error in taper of work. Tighten clamp No. 4 and proceed to make another cut of just sufficient depth to turn surface for trial. Take a second skim cut to be sure surface tested is cut by taper attachment without spring.

Test as above until nearly correct and then put chalk lines on work length wise in four positions equally spaced. Twist gauge on work and see whether chalk marks are rubbed off evenly over entire length. If marks are rubbed off more on small end of taper, set taper attachment for more taper, and vice versa.

9. After work is proved to be of correct taper, rough work down until tapered piece goes into gauge 3/4" short of the finished length.

10. Put in finishing tool and take cut 8 thousandths deep to leave taper stick out from gauge 3/8" after cut. This 3/8" is left to provide grinding stock.

If turning and polishing to size take 8 thousandths deep cut as before, use fine feed and check taper by using Prussian Blue instead of chalk in rub test as described in 8. If taper is correct, take cut of about 6 thousandths for finishing cut and try gauge. Gauge should fit about 1/16" to 1/8" away from final position before turning is completed. The last 1/16" or 1/8" is left for filing and polishing which should be done slowly and carefully to insure a good fit in the gauge.

While filing and polishing try work in gauge and use rub test with Prussian Blue to insure proper taper and fit.

A cut of 8 thousandths will allow the gauge to go approximately 3/8" farther on the work with either Jarno or Morse taper and approximately 5/16" with a Brown & Sharpe taper.

The turning cut must be as straight and smooth as possible since the less filing and polishing necessary the more accurate the taper job will be.

It is important that these points be checked when taper turning with the taper attachment:

Have gibs in taper attachment adjusted to eliminate unnecessary play in taper attachment slides.

Always run carriage past end of work when returning tool and then come back in direction of cut by hand so as to remove any backlash in slide and connecting mechanism.

Have tool cutting edge exactly on center of work.

TAPER TURNING BY COMPOUND REST METHOD

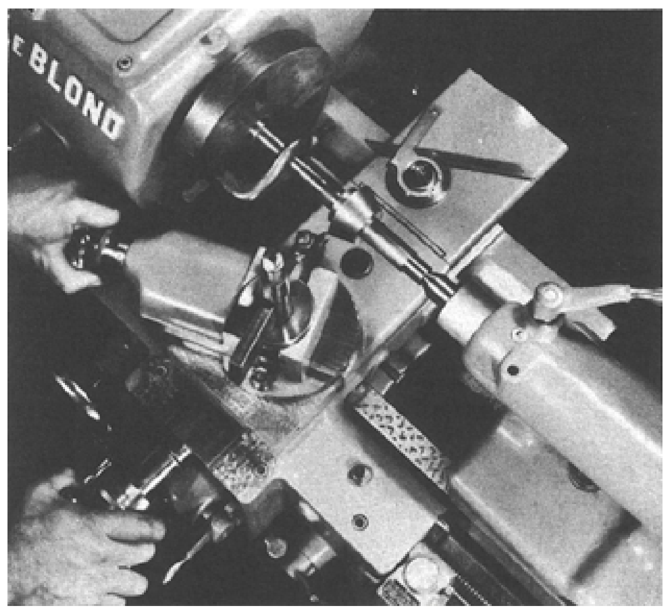


FIG. 96 – TAPER TURNING: COMPOUND REST METHOD

Set compound to desired taper by means of the swivel slide graduations. Mount piece in chuck or on centers and, with tool properly set, rough out piece and check for correct taper. Make final adjustments to correct taper while taking light finishing cuts.

SETTING LATHE TO DUPLICATE PIECE WITH COMPOUND REST

(1) Mount sample between centers. (2) Mount test indicator in tool post. (3) Swivel compound rest to

approximate angle and set indicator to contact on center line of sample. (4) Run compound rest along work and note error. (5) Reset compound rest to correct error and repeat (4); continue until error is within limit of accuracy desired. (6) Remove sample and insert work piece. (7) Set cutting tool of proper shape so edge is exactly on center line of work. (8) Turn, using compound rest screw to obtain feed travel, until correct size plus finish allowance. (9) Finish by grinding or filing and polishing as in other work.

SETTING LATHE TO DUPLICATE TAPER PIECE WITH TAPER ATTACHMENT

1. Clean centers of sample and mount in regular manner between centers.

2. Mount dial indicator in tool post so that actuating contact is on line with centers of the lathe.

3. Move carriage so indicator is at about the center of the sample and set taper attachment to bring shoe in center of slide.

4. Adjust taper slide to approximately the estimated or measured angle of sample, clamp the slide and the shoe and try indicator on taper surface by moving carriage about an inch or so ... when error is in range of full scale reading on indicator, move carriage until indicator is at one end ... set indicator at zero and run to the other end of taper, noting error.

5. Loosen clamp and taper slide and move taper slide until indicator moves back one-half previously noted error. Repeat test over full length and again correct taper attachment until error is small enough to be within limits of accuracy desired.

6. Mount tool in tool post and proceed to rough and finish work to same dimensions as sample.

SETTING LATHE TO DUPLICATE TAPER PIECE WITH SET-OVER TAILSTOCK METHOD

1. Measure large and small diameters of taper and measure length of taper between points measured along axis of work. Do not measure length along taper surface as this length is longer than the axial length.

Taper per foot = difference in diameter at large and small end in inches x 12, divided by length of taper in inches.

2. The next step is to prepare the work on which taper is to be turned. Center both ends and face ends square and to correct length. Measure length accurately for use in following formula to obtain setover.

Setover in inches=1/2 of required taper per ft. x length in inches divided by 12.

3. To measure the setover of the tailstock two methods may be used. Set indicator in tool post and while tailstock is still in line with headstock, bring contact point of indicator up to barrel of tailstock spindle which should be extended about 2" for convenience.

With indicator set at zero in this position, set index dial on cross feed screw at zero, and then move cross slide away from tailstock spindle amount of off-set as above computed.

Loosen tailstock clamp bolts and move tailstock top slide toward indicator by means of setover screws until indicator again reads zero. Re-clamp tailstock and proceed with turning work to same measurements as sample.

If no indicator is available, mount a tool holder in the tool post, wrong end to, and bring the blunt end up to the tailstock spindle with a piece of tissue paper between them. Make light contact until tissue paper can be pulled between tool holder and tailstock spindle with slight but perceptible tension.

Move cross slide away from tailstock spindle more than, amount of setover as before, then return to correct setting and bring tailstock spindle up to tool holder by means of setover screws until tissue paper has same feel as in last setting.

When setting cross slide to zero, be sure cross slide is going toward center of lathe so pressure of contact between tail stock spindle and tool holder backs up against cross feed screw without slack

When moving cross slide out for setting, move more than necessary and then return toward centerline for proper setting so as to again keep pressure of test solidly against cross feed screw.

When tailstock is properly offset, proceed as in regular taper turning, machining down to dimensions of samples.

BORING TAPER HOLES

The procedure used in boring taper holes follows closely the methods of straight hole boring. If a taper attachment is used, the only variation is in actually connecting the taper attachment to the cross slide and setting the attachment for the proper taper. In setting the taper attachment, the same precautions should be taken as outlined in section devoted to external taper turning.

Tools should be ground and set approximately the same for boring as for turning, as described in the section devoted to tools and tool setting, page 24.

The tool point should be set exactly on center, because if this setting is not made the taper hole produced will be incorrect.

If a taper attachment is not available, the taper may be secured by swiveling the compound rest around to the proper angle and feeding the tool by hand with the compound rest top slide screw.

With this method of taper boring it is of course, impossible to use the automatic feed to tool. However, by feeding slowly and uniformly by hand a creditable finish will be secured.

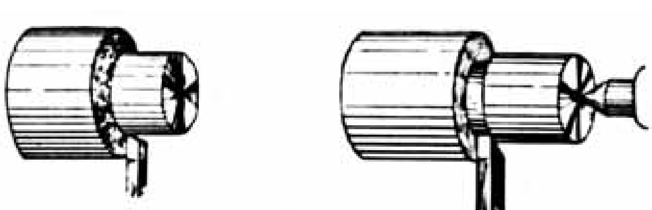
Tapers of any angle may be bored with the use of the compound rest and as long as the length of the cut is less than the length of travel of compound rest slide, there will be no difficulty. On surfaces larger than can be made in one cut, two cuts may be made if care is used in matching them up.

Taper parts like conical valve seats, dies with clearances, etc., are readily machined by means of this arrangement.

In respects other than noted in the foregoing, the regular boring procedure given in preceding section should be followed.

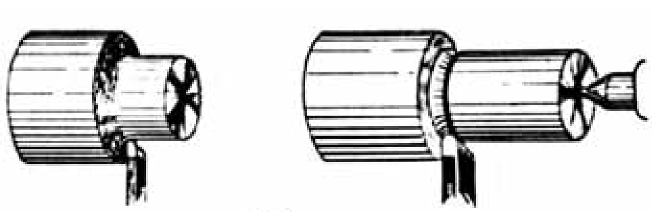
SHOULDER AND RADIUS FORMING

The corners in turned work are at various times finished square, necked, either square or round, or with a small radius. Or with square or radius tool at an angle of 45° to allow clearance for grinding both diameter and face.



A

The square corner is the simplest type and is used where the piece is not subject to excess stress at the corner section. The necked corner may be used where grinding allowance is left in turning. The undercut neck prevents undue wear on the corner of the grinding wheel. This design is weaker than the square corner due to the undercut.



B

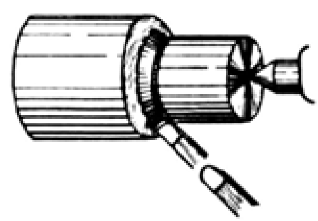
From the design standpoint, the rounded fillet corner is the best due to its strength. It is more costly in production, however, and so is used only in certain classes of work (where vibration is present) to prevent high stress concentration.

For square corner work, the tool is sharpened as shown (A) and the corner roughed out to within about 1/64" or less before the final finishing cut is taken on the straight diameter. The tool is then adjusted, as explained under straight turning, to secure the proper finished diameter of work, power feed engaged and cut taken to within about 1/64" of shoulder. At this point disengage power feed and read cross dial -- feed corner of tool into shoulder the approximate amount by hand -- lock carriage clamp -- feed tool out by hand with cross feed handle. Check length of shoulder, and if too long run tool in to micrometer dial reading noted above.

Loosen carriage clamp, advance tool to side into shoulder for next cut -- reclamp carriage and feed outward with hand cross feed. Repeat until dimensional length of shoulder is obtained. The tool used in the above is a side and front cutting corner tool.

A quick method of squaring the corner is to rough to within 1/64" as before. Finish turn to rough shoulder with round nose turning tool. Put in front turning corner tool as illustrated. Run in until just barely skimming finish turned diameter. Note cross feed dial reading. Back away from work and move carriage so point of tool is in proper position to cut shoulder the right length. Lock carriage in this position and feed tool in with slow hand feed until cross feed dial reading is again reached. Release carriage clamp and feed carriage to right by hand until cut of corner tool and turned surface merge.

The side cutting corner tool fed outward produces the smoothest finish, but is not as fast in removing stock and finishing length to size as the front cutting corner tool, which leaves a finish good enough for most jobs.



C

When roughing and finishing a diameter which ends against a round fillet corner, (B), it is advisable to sharpen the tool bit to approximately the radius of the fillet on the cutting edge. The final operation of forming the fillet is then easily accomplished by using a tool with radius ground to a fillet gauge corresponding to the fillet to be produced.

With a tool set at a 45° angle, the undercut allows clearance for the wheel in grinding the diameter and the face of the larger diameter (C).

The fillet forming tool is mounted in the tool post and the tool fed in until a very light skim is taken off the turned diameter. The tool is then fed by hand longitudinal feed till cutting a slight amount off face of shoulder. The tool is next fed by hand after clamping the carriage and the length of shoulder checked. If shoulder is large, repeat above facing operation until shoulder is reduced to correct length.

When forming a fillet in steel, it is advisable to lubricate the work with lard oil for a very smooth finish. Proper height of tool edge varies from exactly on center of work to as much as 1/8" above center on large work, depending on job and material. This height is best found by trial as no set rule governs every case.

When special forms or beads are required in turned work it is usually advisable, not to say necessary, to grind a tool to the proper shape and to form the work by advancing tool straight in to work.

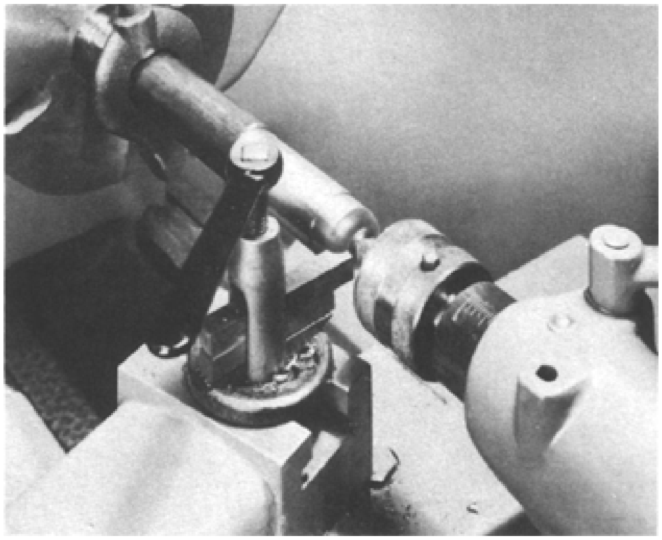


FIG. 100 – FORMING END OF SHAFT.

In such straight forming the tool edge is set exactly on center so as to produce the correct contour of the finish formed surface. The tool should be ground and stoned to a smooth finish as any marks in the tool will be reproduced in the work.

A form tool for brass or cast iron should have a flat top, while one for steel should have a slight lip around the contour of the cutting edge to enable cutting and prevent tearing the material. (fig. 100)

Form tools should be kept as narrow as possible, since a wide form tool is much more prone to chatter than a narrow one.

FILING AND POLISHING IN THE LATHE

No matter how much care is used in turning, it is usually impossible to secure a finish smooth and polished enough to be used directly in service.

It is unquestionably better to grind the finished surface whenever possible but many times a grinding machine is not available.

Under such circumstances work is usually filed to size and polished. Procedure is as follows:

1. Clean centers and see that there are no burrs around center holes.

2. Put center lubricant in tailstock center.

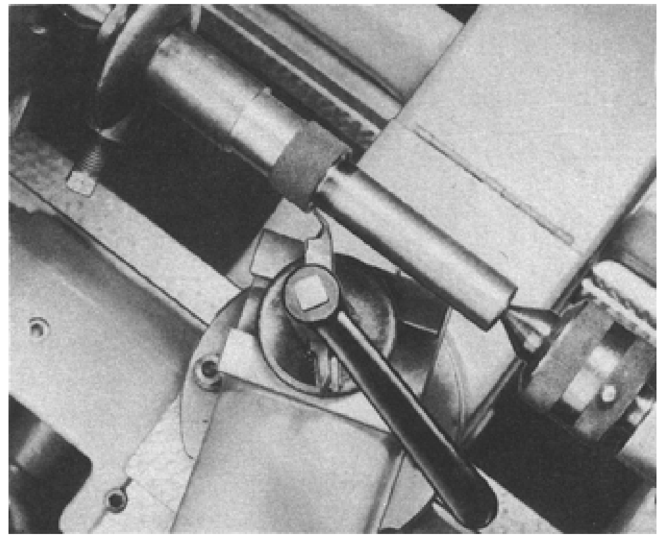


FIG. 101 – FACE UNDERCUTTING.

3. Put dog on work, protecting surface under clamp screw with small piece of copper or brass.

4. Place work on headstock center and run up tail center with right hand until tight. Loosen tail center slightly and start lathe, adjusting center to be just loose enough to allow dog to click in face plate but not loose enough to rattle or for work to have end shake.

5. Shift gears in headstock to give about 1-1/2 times the finish turning speed on surfaces to be filed for average work. For hard materials, or for those such as aluminum that will clog the file, reduce the speed to half turning speed.

6. Select twelve-inch mill file and be sure handle is properly driven on tang. If file is clean, it is ready for use on brass, cast iron, etc., but for use on steel it should be rubbed with chalk until evenly covered. (The chalk prevents the steel filings clogging the teeth.)

7. BE SURE YOUR SHIRT SLEEVE IS ROLLED UP ABOVE THE ELBOW OR JUMPER IS BUTTONED TIGHTLY AROUND WRIST SO THAT NO LOOSE EDGES FLY AROUND TO GET CAUGHT IN DOG OR WORK.

8. Start lathe and file work with slow even strokes, lapping the strokes from side to side.

When filing, use a long slow forward stroke and press firmly and evenly on the revolving piece being filed. Relieve pressure on return stroke.

9. Stop lathe and try diameter with micrometers frequently until whole surface is filed as straight and smooth as possible, and leave about 5 to 8 ten-thousandth (.0005 to .0008) of an inch for polishing.

Use file card to keep file teeth clean. NOTE: A file card is a short bristled wire brush which is brushed along the valleys of teeth to remove clogging material. A small metal pick is usually found in the handle. This pick is used to remove chips of metal which are stuck to teeth.

10. Polishing work.

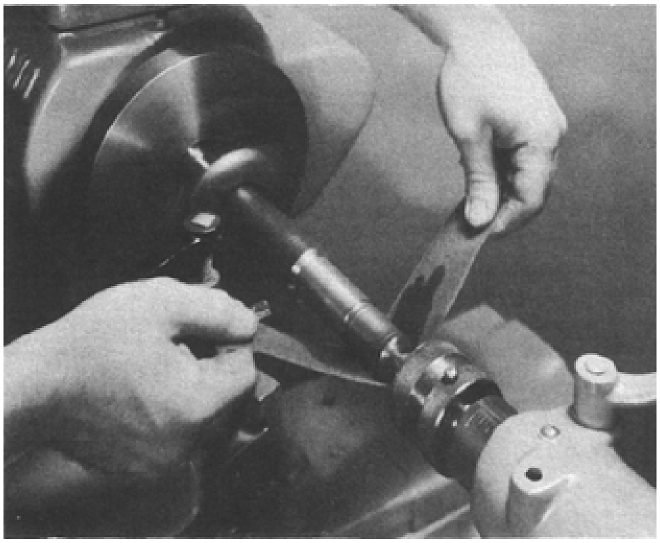


FIG. 102—FOR FINE POLISH MOISTEN EMERY CLOTH WITH OIL

After filing is completed the finished surface should be polished.

On work that is well balanced, set change levers to give highest speed. On unbalanced work run at highest possible speed without causing undue vibration.

On straight shafts, 1" or under in diameter, work should be polished in speed lathe if possible.

Use strip of emery or carborundum paper of fine grade and press against work, moving abrasive cloth from side to side to cross lines and bring work to a rough polish and to avoid cutting rings in work.

Use very fine abrasive cloth or a worn-out piece of fine grade and use oil on work to bring to final polish. Use crocus paper for very fine finish polishing.

If a piece of wood can be pivoted on the tool rest and used to press abrasive cloth on work a quicker and higher-lustred job is secured due to the higher pressure possible.

When polishing, check size and straightness frequently with mike to be sure dimensions are correct on finished piece.

The best polishing requirements are:

High speed of work;
Fine grade abrasive cloth;
Use of oil on abrasive cloth (preferably lard oil);
Greatest possible pressure on work (a polishing lever is recommended).

NOTE: Polishing and filing heat the work. When measuring diameter with micrometer, either cool work by immersing in water or make allowance of one or two ten-thousandths for cooling of work. It is recommended that less experienced operators cool work to room temperature before measuring.

CHASING THREADS

An important function of an engine lathe is to chase threads. To cut a thread requires first, that the work rotate; and, secondly, that the tool advance along the axis of the work at a predetermined constant rate in relation to the spindle rpm to cut the thread desired.

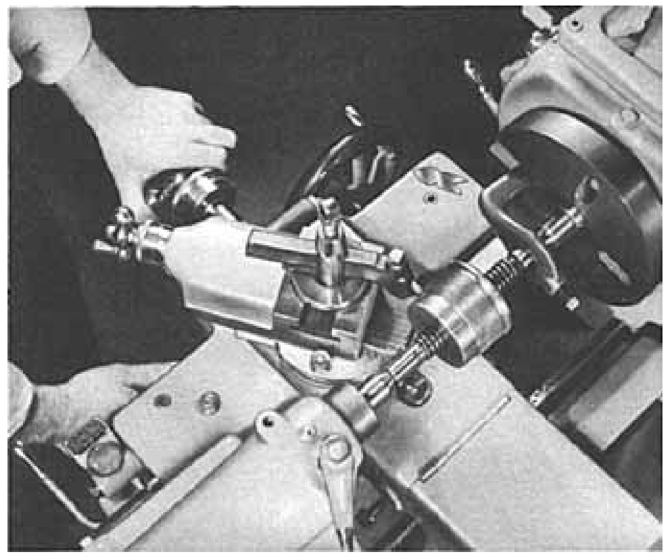


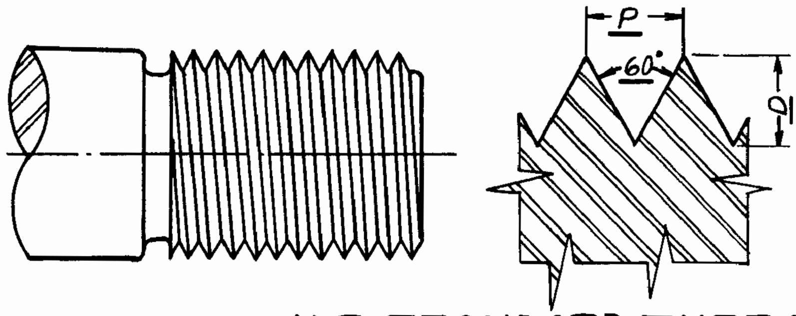
FIG. 103 – CHASING THREADS.

Threads are commonly designated in the English system by giving the number of complete revolutions of the thread per inch length of the screw. If, for instance, the chasing tool travels one inch along the screw while it rotates twice, there will be two revolutions of thread in one inch, commonly called two threads per inch.

The leadscrew on a lathe is rotated by means of a gear train connection between the leadscrew and the spindle. A nut mounted in the apron engages the leadscrew to move the carriage. If, for instance, the leadscrew is 6 threads per inch, then for each revolution of the leadscrew the carriage is moved 1/6" along the bed. If the spindle and the leadscrew are geared so that the spindle rotates once while the leadscrew rotates once, the carriage will move 1/6" per revolution of the spindle, and the thread cut will be 6 threads per inch. If the leadscrew rotates twice as fast as the spindle, three threads per inch will be cut. If, on the other hand, the leadscrew rotates one-half as fast as the spindle, the carriage will move 1/12" per revolution of the spindle; thus twelve threads per inch will be cut.

It is thus seen that threads of any desirable pitch can be cut, if an appropriate connection between the spindle and the leadscrew is provided.

SHARP V THREADS

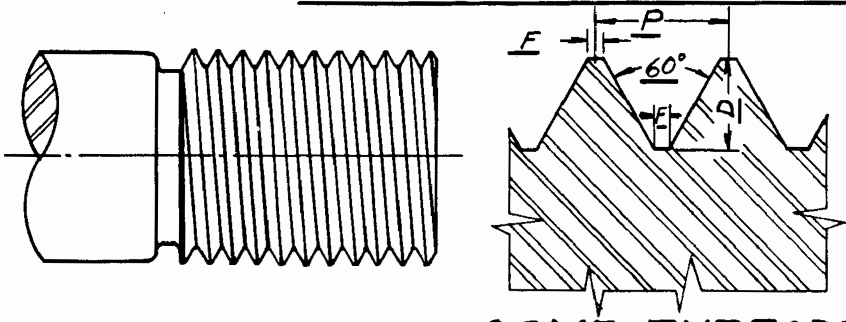


CALCULATIONS

PITCH = P = $\frac{1}{\text{NO. THD'S PER IN.}}$

DEPTH = D = $\frac{.866}{\text{NO. THD'S PER IN.}}$

U.S. STANDARD THREADS



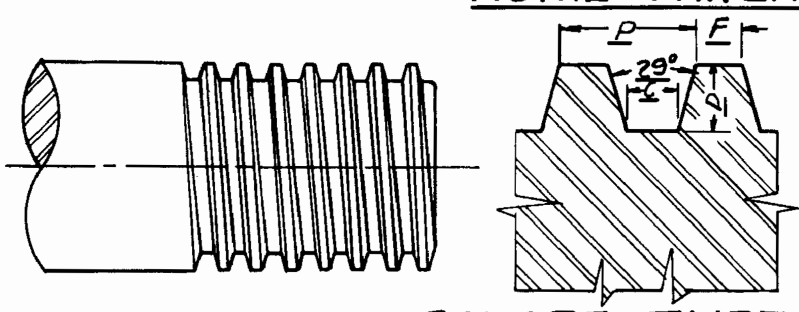
CALCULATIONS

PITCH = P = $\frac{1}{\text{NO. THD'S PER IN.}}$

DEPTH = D = $\frac{.6495}{\text{NO. THD'S PER IN.}}$

FLAT = F = $\frac{P}{8}$

ACME THREADS



CALCULATIONS

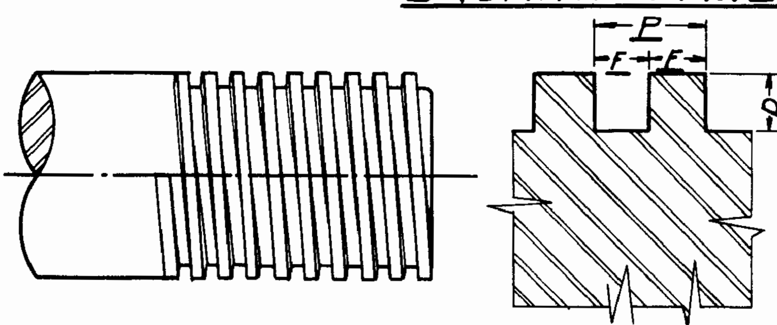
PITCH = P = $\frac{1}{\text{NO. THD'S PER IN.}}$

DEPTH = D = ½ X P + .010"

FLAT = F = .3707 X P

FLAT C .3707 X P − .0052"

SQUARE THREADS



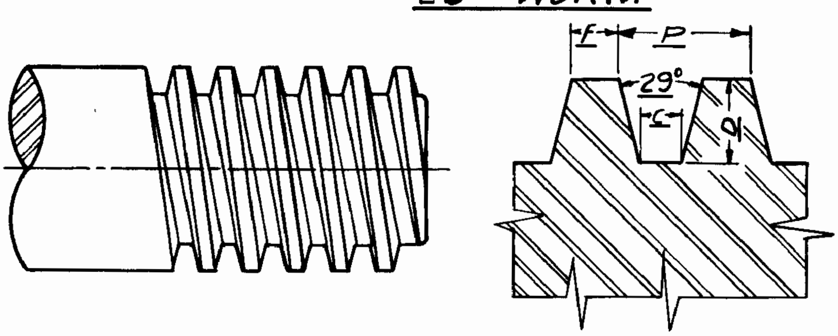
CALCULATIONS

PITCH = P = $\frac{1}{\text{NO. THD'S PER IN.}}$

DEPTH = D = ½ X P

FLAT = F = ½ X P

29° WORM



CALCULATIONS

PITCH = P = $\frac{1}{\text{NO. THD'S PER IN.}}$

DEPTH = D = .6866 X P

FLAT = F = .335 X P

FLAT = C = .31 X P

On standard change gear lathes, a quadrant and loose change gears are provided to cut various threads, and a chart placed on the gear cover indicates the proper gears and positions to mount them to cut each thread within the range of the gears.

On the quick feed change lathes, such as the Regal, the change gears are mounted in a gear box, with a gear train between the spindle and gear box, providing the various ratios needed to cut different threads. The changes are made merely by shifting levers on the box and the headstock. An index plate on the quick change box is plainly marked so that changes are quickly and accurately made.

Several different thread forms are used in practice and all may be cut in a lathe. Forms commonly used include sharp vee, U.S.S., Acme, and 29-degree worm thread, illustrated on preceding page.

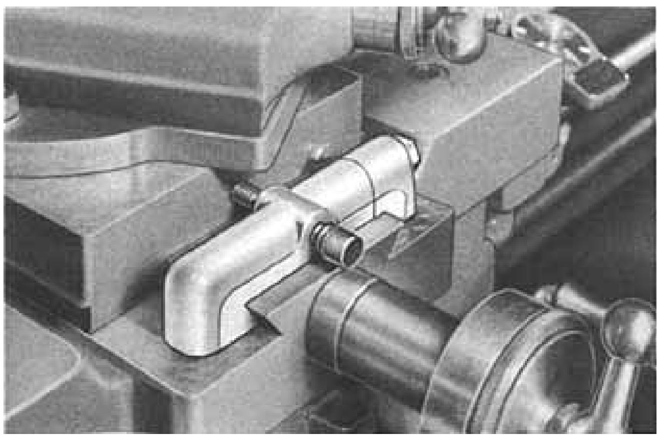


FIG. 105 – THREAD CHASING STOP

The setting of the change gears in the quick change box is the same, regardless of the form of thread to be cut. The only change is in the actual tool form used to cut the thread.

Tools used to cut threads are flat on top with no back rake. A slight lip may be ground in the side edges when cutting steel, but for other materials the top is usually absolutely flat. The front and side clearances on threadcutting tools are very important. The side clearances must be also adjusted for the helix angle of the thread being cut. On threads 26 and finer, this helix angle is negligible, but on coarse threads the amount of the helix angle is quite appreciable and must be taken in consideration when grinding clearance for the lead on the side of the tool.

To measure the number of threads per inch a thread gauge is generally used, and is merely a cluster of individual gauges, each one of which is cut with a thread tooth on a thin section of strip steel; so the teeth of only one gauge will properly mesh with the threads on the screw tested. Each gauge is labeled with the pitch of the teeth cut on it.

Another method is to lay a scale along the tops of the threads parallel to the axis of the screw with the end of the scale opposite the top point of a thread. Then, skipping the thread top directly below the end of the scale, count the number of tops until one falls directly below an inch mark on the scale. The number of thread tops thus counted, divided by the number of inches, gives the number of threads per inch. For example, suppose there were 27 thread tops under two inches of the scale (not counting the one under the end of the scale.) Then 27 divided by 2 = 13.5 threads per inch, or the thread is 1/13.5 or .074 of an inch pitch.

When cutting threads, it is necessary to set the tool at a right angle to the piece to be turned; that is, the axis of the thread tool should be exactly 90º from the axis of the work. This is easily done by use of a thread-setting gauge shown in figure 103, also 146 on page 32. Edges of the gauge are ground square with the male and female angles ground on the ends and in the sides.

Hold the gauge against the diameter of the work and adjust the tool until it fits in the notch in its side accurately, thus insuring the proper setting of the tool square with the work. Next, set the cutting edge of the tool exactly on the dead center. The depth of the thread and the thread angle will not be cut correctly if the tool is set in any other position. When cutting threads on cast-iron or brass, no cutting lubrication is necessary, but on steel it should be used. A good quality of cutting oil should be applied to the tool, especially on the finish cuts; a smoother surface is thus obtained.

On threads of fine lead, about 30 and finer, the tool may be fed straight into the work in successive cuts. However, on coarser leads it is better to set the compound rest at one-half the included angle of the thread, and feed in along the side of the thread, so that the tool cuts on one side only during roughing (see page 44). On the last two or three cuts the tool should be fed straight in to remove all lines caused by feeding along the side of the thread.

Since chasing requires a number of cuts and all must be in the same line of the cut of the thread, it is necessary either to keep the half-nut engaged on the leadscrew at all times and return the carriage by reversing the spindle rotation through the motor drive, or to use an indicator which meshes with the leadscrew and shows when the half-nut can be engaged so that the tool will cut along the same thread. The device used for this purpose is called a chasing dial or thread indicator, and consists of a worm wheel meshing with the leadscrew, and connected by a short shaft to the indicating dial. The dial is calibrated with four numbered lines and four others midway between them as shown on page 17.

For even threads the half-nut may be closed when the index mark is opposite any line of the dial; for odd threads at any numbered line and for half threads at any even numbered line. The advantage of the chasing dial is that the tool may be drawn back and the half-nut disengaged at the end of the cut, thereby permitting the quick hand return of the carriage to the starting point. When ready for the next cut, set the tool to the proper depth and engage the half-nut when the proper line on the chasing dial is opposite the index mark and take another cut across the thread.

The threading stop shown above may be used in several ways to aid the operator when cutting threads. When the tool is set for the first chasing cut, set the stop and clamp it to the carriage dovetail. Place the stop screw through the clearance in the clamping piece over dovetail slide and start the screw thread in the cross slide. Move the cross slide until the underside of the head of the screw is against the stop clamp and take the cut. At the end of the cut the tool must be backed off to clear the thread. This should be done with the cross feed screw. For the next cut, move the cross slide in to its previous position against the stop, then use the compound rest screw to move the tool in to the desired depth of cut. For the last few cuts, the stop screw should be run out (when the compound is set on an angle) and, reading the cross feed dial, the tool fed straight in to clean up both sides of the thread.

Another use of the chasing stop is to leave it set for the depth of the finished thread. Then on the succeeding pieces each successive cut can be fed in by the cross feed screw until the chasing stop prevents further motion. The screw will then be the same size as the previous screws turned with this setting.

The points just outlined are also true for taper and internal threading.

We would again point out that the top edge of the tool should always be set on the lathe center line and the proper side and front clearance must be allowed to clear the sides of the threads.

The following table conveys some idea of the number of cuts necessary to chase vee threads in common use:

THREAD CUTTING DATA

No. of Threads Per Inch	No. of Chasing Cuts
8	18
10	14
11	13
12	11
13	10
16	9
20	8

This table is based on. 005" per cut allowing an extra cut for finish which is the actual practice in our shop.

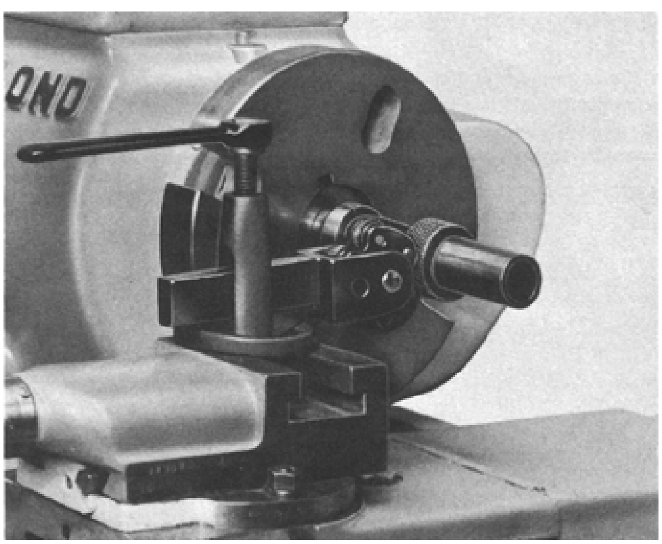


FIG. 106 – KNURLING

KNURLING

Many pieces used for handles or control knobs require a rough but finished appearing surface so that a good grip may be obtained without impairing the appearance of the part. This effect is obtained by raising the surface of the piece in symmetrical or cross lines and is called knurling. Knurling is a form of pressure indentation by a continuous process. The tool employed, as illustrated, consists of small rolls containing serrations in their periphery which squeeze the metal in the work piece to form a reproduction of the knurling tool. When using a knurling tool a slow speed is required. Adjust the tool to mark the work lightly. After it is seen that the tool is working properly, increase the pressure on the rolls by means of the cross feed screw, liberally oil the surface to be knurled, engage the power feed, allowing the tool to move across the work until the leading edge of the roll is just flush with the other end of the work. Reverse the feed, increase the pressure on the rolls slightly and feed back to the starting position. Repeat this procedure until the indentation is deep enough to suit the purpose for which the part is to be used. To produce the desired result a few trails on a sample piece will show the amount of pressure necessary.

CUTTING SPEEDS

For efficient operation of a lathe, the proper surface speed of work being machined must be maintained. If the speed is too slow, the job takes longer than necessary, and often the work produced is unsatisfactory. On the other hand, if the speed is too great, the tool edge will be worn down too rapidly, and frequent grinding will be necessary, which is also wasteful. For ordinary production work the speed should be as great as the tool will stand without requiring sharpening more often than every two to three hours when cutting continuously.

APPROXIMATE CUTTING SPEEDS
FOR HIGH SPEED STEEL
TURNING AND BORING

Material	Roughing Cutting Speed Feet per Minute	Finishing Cutting Speed Feet per Minute	Chasing Cutting Speed Feet per Minute
Cast iron	60	120	50
Mild Machine Steel	80	150	60
Alloy Steel*	50	90	40
Bronze	100	150	70
Brass	200	300	80
Aluminum	250	400	90

*Data for average alloy steel annealed.

When chasing threads on small diameters the limitation will be the ability of the operator to handle the lathe, rather than the cutting limit of the tool. We have found that 200 rpm is practically the limit at which threads can be chased. The table above gives the approximate speeds which can be maintained with various materials for rough and finish cuts. The surface speed is found by multiplying the length of the periphery in feet by the revolutions per minute of the work. Thus the cutting speed for a 4" diameter rotating at 60 rpm, will be 4 x 3.1416 x 60 divided by 12 or 62.83 feet per minute.

The cutting speeds possible are greatly affected by the use or absence of a suitable cutting fluid. Thus steel, which can be rough turned dry at 60' per minute, can be rough turned at about 80' or 90' per minute when flooded with good cutting lubricant.

When roughing parts down to size, use the greatest depth of cut and feed per revolution that the work, the machine, and the tool will stand at the highest practicable speed. On many pieces where tool failure is the limiting factor in the size of roughing cut, it is usually possible to reduce the speed slightly and increase the feed to a point where the metal removed is much greater with longer tool life. For example: Where the depth of cut is 1/4", the feed 10 thousandths of an inch per revolution and the speed 80 feet per minute. If the tool will not permit additional feed at this speed, it is usually pssible to drop the speed to 60' per minute and increase the feed to about 15 to 20 thousandths of an inch per revolution without having tool trouble.

In this case, the speed is reduced 25% but the feed increased 100%, so that the actual time required to complete the work is less.

On the finish turning operation, a very light cut is takeh since most of the stock has been removed on the roughing cut. Due to requirements of the finish a fine feed can usually be used and still make it possible to run at a high surface speed. A 50% increase in speed over the roughing speed is commonly used. In particular cases the finishing speed may be twice the roughing speed. In any event, to secure the maximum speed in this operation, the work should be run as fast as the tool will reasonably stand up without excessive regrinding. **A** sharp tool should be used when finish turning. The tool should be resharpened to a keen edge if the same tool is used for roughing and finishing.

CUTTING WITH CARBIDE TOOLS

Modern production turning has been speeded up many times by the use of sintered carbide cutting tools. This has been possible because of the extreme hardness and resistance to wear of carbides, even at high temperatures.

There are dozens of types of carbide cutting tools, mariufactured by several companies. Each company issues catalogs describing these tools and making recommendations as to cutting speeds and feeds to use and which carbide grade to use on different materials and types of cutting.

Because of the wide variety of carbide grades, of materials and of cutting conditions under which they may be used, it is difficult to make definite recommendations as to cutting speeds. However, generally speaking, cutting speeds of 200 surface feet per minute and up should be used. Some cut-and-try experiments will be necessary to see which carbide grade works best on the material to be cut. Highest possible cutting speeds should be used up to the point where tools break down too rapidly.

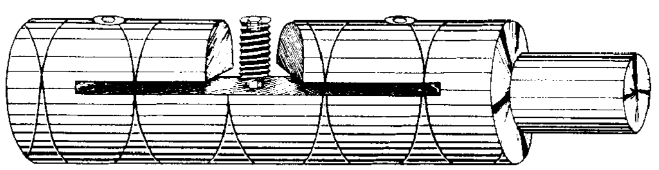
CHATTER

Briefly, chatter is vibration in either the tool or the work, producing a finished work surface that has a grooved or lined finish instead of the smooth surface that is to be expected. The vibration is set up by a weakness in the work, work support, tool or tool support, and is about the most elusive thing to find in the entire field of machine work. As a general rule, strengthening the various parts of the tool support train will help, also supporting the work by a steady or follow rest.

The fault may be also in the machine adjustments. Gibs may be too loose; bearings may, after a long period of heavy service be worn; or the tool may be sharpened improperly. If the machine is in perfect condition, the fault may be in the tool or tool setup. Grind the tool with a point or as near a point as the finish specified will permit; avoid a rounded leading edge on the tool. Reduce the overhang of the tool as much as possible and be sure that all the gib and bearing adjustments are properly made. See that the work receives proper support for the cut, and, above all, do not try to turn at a surface speed that is too high Excess speed is probably the greatest cause of chatter, and the first thing an operator should do when chatter occurs is to reduce speed.

On large thin sections such as cups or brake drums, a coiled spring stretched around the piece may dampen the vibration sufficiently to prevent chatter. Often, packing the inside with a wood disc cut to fit the cup will permit a smooth finish to be obtained on the outside surface.

LAPPING



Where holes are to be finished to an exact size or to a maximum straightness, it is advisable to leave the hole a few ten thousandths under size and remove this metal by lapping.

Lapping can be employed on both flat and cylindrical surfaces.

The procedure to be followed varies slightly, depending upon the reason for lapping; whether it is to finish a hole to an exact straight size, polish the surface for high finish, or merely to remove a bit of material from hardened metal.

When the requirement is to slightly enlarge a hole, a piece of carborundum cloth wrapped around a rotating rod held in the lathe chuck will provide the quickest but not the most accurate way.

Laps are made in both the solid and the expanding types. The expanding type is preferred to the solid type because it can be expanded, trued up, and recharged when the cutting surface of the lap is worn down. A lap may be charged with cutting grit so that it will cut in one spot only.

It is not advisable to crowd a lap, since the process is only used as a finishing operation and not to remove a large amount of stock.

The maximum stock allowance for lapping should not exceed one to two thousandths of an inch and is preferably about three to five ten-thousandths of an inch.

A good serviceable lap for general use is illustrated on this page. The construction of such a lap is simple. Turn the cast-iron piece all over to rough size -- turn handle end to size -- turn lap surface to standard size minus one thousandth of an inch or two thousandth if the holes you lap are apt to come that small. With work turning at a slow spindle speed, turn slight line in lap surface at very coarse lead about one inch per revolution. This feed can be done by hand as there is nothing particular about it. Make two such cuts, one right-hand lead, the other left hand. The purpose of these grooves is simply to act as grit and oil distributor troughs. They should be about 1/64" to 1/32" wide and 1/64" to 1/32" deep, depending on diameter of the lap. Cut with a sharp vee tool.

The lap surface is next split with a milling cutter within about 1/4" to 3/8" from the end of the lap as shown above. It is then drilled and tapped at right angles to the split for the expansion screws. This split through lap permits expansion by means of set screws in one half acting on other half through the slot as shown.

The best grits to employ are Arkansas Grit, of the correct grain for the work to be lapped, and Bon Ami cleaning powder. These grits are not as fast cutting as some but produce good accurate work with a high finish. The grit used is mixed with machine oil to a light paste consistency and applied to the lap evenly.

The lap is then pushed into the hole with a combination push and twist going in and pull and twist in opposite direction coming out. The lap is rotated slightly in the hole after every complete stroke to avoid lapping too much in a position which might keep the hole from being lapped cylindrically.

Sufficient take-up should always be given to the adjusting screw to insure lap fitting the hole snugly. If this is not done the hole may be lapped bell mouthed.

The above-mentioned grits and procedure may be used when lapping holes in steel, either hard or soft, cast iron and bronze, and are advantageous in that the work is not charged with the cutting grit as may occur when emery or carborundum is employed.

On some very hard materials the lap may be made of copper and diamond grit employed. In this case, however, the grit paste is rolled into the surface of the lap with a roller or by rotating the lap on a flat plate smeared with the grit paste as one handles a rolling pin. The excess loose grit is then washed off the lap with gasoline or turpentine and regular lapping procedure followed. The amount of cutting done and finish left are dependent on the size grit used and we would suggest looking up this subject in any good toolmaker's book which will give complete information on diamond lapping.

Lead laps are used for rough lapping where the main consideration is to remove material without extreme requirements as to hole accuracy or bell mouth.

A flat lapping disc is also useful on a lathe.

The rough finish type is merely a plate with a taper shank which fits in the headstock spindle on the face of which a disc of emery cloth is attached with beeswax.

A fine type of lap consists of the same type of plate provided with a lead or copper face which can be charged with suitable abrasive grit. Flat valve seats and other parts of this nature are thus easily provided with a proper flat surface of high finish.

It should be remembered that lapping is a sensitive and essentially slow operation. Lapping is not primarily a metal removing but a finishing or polishing operation.

All work should be finished as smooth as possible with the cutting tool or in the grinding operation so the lapping operation will have as little metal as possible to remove.

Use as little lapping compound as possible since a thin layer will cut according to the pressure or contact of lap while a thick layer may cut even over a low spot in the hole.

METRIC AND ODD THREADS

Metric threads can be cut through the quick change gear box by the addition of compound gears between the drive gear on the head and the gear on the feed box.

TABLES SECTION

TABLE OF DECIMAL EQUIVALENTS

1/64" to 1" in 64 ths

Fraction	Decimal Equivalent	Fraction	Decimal Equivalent	Fraction	Decimal Equivalent
1/64	0.015 625	11/32	0.343 75	43/64	0.671 875
1/32	0.031 25	23/64	0.359 375	11/16	0.687 5
3/64	0.046 875	3/8	0.375	45/64	0.703 125
1/16	0.062 5	25/64	0.390 625	23/32	0.718 75
5/64	0.078 125	13/32	0.406 25	47/64	0.734 375
3/32	0.093 75	27/64	0.421 875	3/4	0.750
7/64	0.109 375	7/16	0.437 5	49/64	0.765 625
1/8	0.125	29/64	0.453 125	25/32	0.781 25
9/64	0.140 625	15/32	0.468 75	51/64	0.796 875
5/32	0.156 25	31/64	0.484 375	13/16	0.812 5
11/64	0.171 875	1/2	0.500	53/64	0.828 125
3/16	0.187 5	33/64	0.515 625	27/32	0.843 75
13/64	0.203 125	17/32	0.531 25	55/64	0.859 375
7/32	0.218 75	35/64	0.546 875	7/8	0.875
15/64	0.234 375	9/16	0.562 5	57/64	0.890 625
1/4	0.250	37/64	0.578 125	29/32	0.906 25
17/64	0.265 625	19/32	0.593 75	59/64	0.921 875
9/32	0.281 25	39/64	0.609 375	15/16	0.937 5
19/64	0.296 875	5/8	0.625	61/64	0.953 125
5/16	0.312 5	41/64	0.640 625	31/32	0.968 75
	0.328 125	21/32	0.656 25	63/64	0.984 375

Millimeters Into Inches

Millimeters	Inches	Millimeters	Inches	Millimeters	Inches
1/10 mm	.00394	8 mm	.31496	17 mm	.66929
1/5 mm	.00787	9 mm	.35433	18 mm	.70866
1/2 mm	.01969	10 mm	.39370	19 mm	.74803
1 mm	.03937	11 mm	.43307	20 mm	.78740
2 mm	.07874	12 mm	.47244	21 mm	.82677
3 mm	.11811	13 mm	.51181	22 mm	.86614
4 mm	.15748	14 mm	.55118	23 mm	.90551
5 mm	.19685	15 mm	.59055	24 mm	.94488
6 mm	.23622	16 mm	.62992	25 mm	.98425

10 Millimeters = 1 Centimeter
10 Centimeters = 1 Decimeter
10 Decimeters = 1 Meter

1 Centimeter = .3937 inch
1 Decimeter = 3.937 inches
1 meter = 39.37 inches

1 Kilometer = .6214 mile
1 Meter = 39.37 inches; 3.2808 feet; 1.0936 yard
1 Centimeter = .3937 inch
1 Millimeter = .03937 inch

1 Mile = 1.609 kilometers
1 Yard = .9144 meter
1 Foot = .3048 meter
1 Foot = 304.8 millimeters
1 Inch = 2.54 centimeters
1 Inch = 25.4 millimeters

Limits for Turning and Grinding--The limits given in the table below are recommended for use in the manufacture of machine parts, to produce satisfactory commercial work. These limits should only be followed under ordinary conditions. For special cases, it may be necessary to increase or decrease the limits given in the table. The allowance to be used when rough turning parts to be ground varies from 0.010 to 0.030 inch; that is, a part to be ground to a diameter of 1 inch would be rough turned in the lathe to a diameter of from 1.010 to 1.015 inch, while a 3-inch shaft may have an allowance of from 0.015 to 0.025 inch. The allowance depends largely on the class of work.

Allowances for Fits

Grinding Limits for Cylindrical Parts

(+ Designates larger than nominal size; — Smaller than nominal size.)

Diameter, Inches	Limits, Inches	Diameter, Inches	Limits, Inches
Running Fits--Ordinary Speed		**Driving Fits--Ordinary**	
Up to 1/2	— 0.00025 to — 0.00075	Up to 1/2	+ 0.00075 to + 0.0015
1/2 to 1	— 0.00075 to — 0.0015	1/2 to 1	+ 0.001 to + 0.002
1 to 2	— 0.0015 to — 0.0025	1 to 2	+ 0.002 to + 0.003
2 to 3 1/2	— 0.0025 to — 0.0035	2 to 3 1/2	+ 0.003 to + 0.004
3 1/2 to 6	— 0.0035 to — 0.005	3 1/2 to 6	+ 0.004 to + 0.005
Running Fits--High-Speed, Heavy Pressure and Rocker Shafts		**Forced Fits**	
Up to 1/2	— 0.0005 to — 0.001	Up to 1/2	+ 0.00025 to + 0.0005
1/2 to 1	— 0.001 to — 0.002	1/2 to 1	+ 0.0015 to + 0.0025
1 to 2	— 0.002 to — 0.003	1 to 2	+ 0.0025 to + 0.004
2 to 3 1/2	— 0.003 to — 0.0045	2 to 3 1/2	+ 0.004 to + 0.006
3 1/2 to 6	— 0.0045 to — 0.0065	3 1/2 to 6	+ 0.006 to + 0.009
Sliding Fits		**Driving Fits--For such Pieces as are Required to be Readily Taken Apart**	
Up to 1/2	— 0.00025 to — 0.0005	Up to 1/2	+ 0 to + 0.00025
1/2 to 1	— 0.0005 to — 0.001	1/2 to 1	+ 0.00025 to + 0.0005
1 to 2	— 0.001 to — 0.002	1 1/2 to 2	+ 0.0005 to + 0.00075
2 to 3 1/2	— 0.002 to — 0.0035	2 to 3 1/2	+ 0.00075 to + 0.001
3 1/2 to 6	— 0.003 to — 0.005	3 1/2 to 6	+ 0.001 to + 0.0015

Rules for Figuring Tapers

Given	To Find	Rule
The taper per foot	The taper per inch	Divide the taper per foot by 12.
The taper per inch	The taper per foot	Multiply the taper per inch by 12.
End diameters and length of taper in inches	The taper per foot	Subtract small diameter from large; divide by length of taper, and multiply quotient by 12.
Large diameter and length of taper in inches and taper per foot	Diameter at small end in inches	Divide taper per foot by 12; multiply by length of taper, and subtract result from large diameter.
Small diameter and length of taper in inches, and taper per foot	Diameter at large end in inches	Divide taper per foot by 12; multiply by length of taper; and add small diameter.
The taper per foot and two diameters in inches	Distance between two given diameters in inches	Subtract small diameter from large; divide remainder by taper per foot, and multiply quotient by 12.
The taper per foot	Amount of taper in a certain length given in inches	Divide taper per foot by 12; multiply by given length of tapered part.

CUTTING SPEEDS AND FEEDS FOR CEMENTED-CARBIDE TOOLS

The following table is an approximation only. Should carbide tools be used extensively we recommend that an instruction manual such as is published by various carbide manufacturers be consulted, since their tables include all the factors: material to be cut, depth of cut, speed of cutting, type of cut, rate of feed and grade of carbide.

Material	Type of Cut	Surface Feet	Feed
Cast Iron	Roughing	150 - 300	.010 - .030
" "	Finishing	250 - 400	.002 - .012
Malleable Iron	Roughing	150 - 200	.010 - .030
" "	Finishing	175 - 250	.002 - .012
Semi-Steel	Roughing	100 - 250	.010 - .025
"	Finishing	150 - 300	.002 - .012
Chilled C.I.	Roughing	15 - 20	.010 - .020
"	Finishing	20 - 30	.002 - .010
Brass	Roughing	200 - 500	.010 - .030
	Finishing	400 - 700	.005 - .015
Aluminum	Roughing	250 - 500	.015 - .035
	Finishing	400 - 700	.005 - .015
Carbon Steel	Roughing	100 - 200	.010 - .025
" "	Finishing	150 - 300	.002 - .012
Manganese Steel	Roughing	50 - 150	.010 - .020
	Finishing	100 - 200	.002 - .012
High Speed Steel (annealed)	Roughing	120 - 200	.010 - .020
	Finishing	175 - 300	.002 - .012
Stainless Steel	Roughing	250 - 300	.010 - .030
	Finishing	350 - 450	.005 - .015
Plastics	Roughing	400 - Up	.010 - .040
"	Finishing	400 - Up	.005 - .020

SPECIFICATIONS FOR ALL LE-BLOND REGALS

SIZE	13" Floor and Bench Type	15"	17"	19"	21"	24"
Capacity						
Swing over ways	13-1/2"	15-1/4"	17-3/4"	19-1/4"	22-1/4"	25-1/4"
Swing over compound	8-1/4"	10"	10-1/2"	12"	13-1/2"	17"
Distance between centers	18"	18"	30"	30"	36"	36"
Center distance increases in increments of	12"	12"	12"	12"	12"	12"
Size of tool	1/2" x 3/4"	1/2" x 1"	5/8" x 1-1/8"	5/8" x 1-1/8"	5/8" x 1-1/4"	5/8" x 1-1/4"
Follow rest (extra equipment)	2-3/4"	2-3/4"	3-1/4"	3-3/4"	4"	4-1/2"
Face plate, small, diameter	7-1/2"	7-1/2"	9"	9"	10"	10"
Face plate, large, dia. (ex. equip.)	12"	14"	16"	18"	21"	24"
Headstock						
Spindle speed range, std. r.p.m.	25-500	25-500	20-425	20-425	15-350	15-350
Spindle speed range, high r.p.m.	37.5-750	37.5-750	30-638	30-638	24-525	24-525
Spindle nose, std. taper size and diameter	LOO-2-3/4"	LOO-2-3/4"	LO-3 1/4"	LO-3 1/4"	LI-4-1/8"	LI-4-1/8"
Front spindle anti-friction bearing o.d.	4-1/8"	4-1/8"	5-3/8"	5-3/8"	6-3/8"	6-3/8"
Radial load at 100 r.p.m., lbs.	3280	3280	5740	5740	8200	8200
Thrust load at 100 r.p.m., lbs.	2495	2495	4990	4990	7635	7635
Rear spindle anti-friction bearing o.d.	3-5/32"	3-5/32"	4-1/8"	4-1/8"	5-3/8"	5-3/8"
Radial load at 100 r.p.m., lbs.	2790	2790	3280	3280	5740	5740
Spindle size of hole	1-3/32"	1-3/32"	1-9/16"	1-9/16"	1-13/16"	1-13/16"
Spindle size of center, Morse number	3	3	4	4	4	4
Bed						
Length, standard	4'-3 1/2"	4'-3 1/2"	6'-1 1/4"	6' 1 1/4"	7' 3"	7' 3"
Length increases in increments of	12"	12"	12"	12"	12"	12"
Width	9-3/4"	9-3/4"	13-5/8"	13-5/8"	16-13/16"	16-13/16"
Depth	9-3/16"	9-3/16"	11-3/4"	11-3/4"	13-1/8"	13-1/8"
Carriage						
Length on ways	17-1/4"	17-1/4"	20-3/4"	20-3/4"	26-1/4"	26-1/4"
Bridge width	5-5/8"	5-5/8"	7-7/8"	7-7/8"	8-7/8"	8-7/8"
Cross slide travel	8-1/2"	8-1/2"	11"	11"	13-5/8"	13-5/8"
Compound rest travel	3-1/8"	3-3/8"	4"	4-1/4"	4-1/2"	4-1/2"
Feeds--Threads						
Feed and thread changes	48	48	56	56	63	63
Feeds, range	.0025-.143	.0025-.143	.001-.125	.001-.125	.0027-.333	.0027-.333
Threads per inch, range	4-224	4-224	1-1/2-184	1-1/2-184	1-120	1-120
Leadscrew diameter and threads per inch	1"-6	1"-6	1-3/16"-4	1-3/16"-4	1-7/16"-2	1-7/16"-2
Tailstock						
Spindle diameter	1-15/16"	1-15/16"	2-7/16"	2-7/16"	2-11/16"	2-11/16"
Center, Morse number	3	3	4	4	4	4
Spindle travel	4"	4"	6"	6"	6-1/2"	6-1/2"
Taper Attachment (Extra Equipment)						
Maximum taper per foot	3"	3"	3"	3"	3-1/2"	3-1/2"
Turns at one setting	10"	10"	13"	13"	18"	18"

REPAIR PARTS LIST

When ordering repair parts, the following information should be furnished us for best service:

1. The name of the part, the number of the part, and the number of the page on which it appears in this book.

2. Size of the lathe and its serial number.

For example, suppose you need an oil reservoir cover for your 19" Regal. To order this, you would write us for "one oil reservoir cover, part No. 71, pages 62-63 of Running a Regal Manual, 14th edition, for 19" Regal serial No. E-1001".

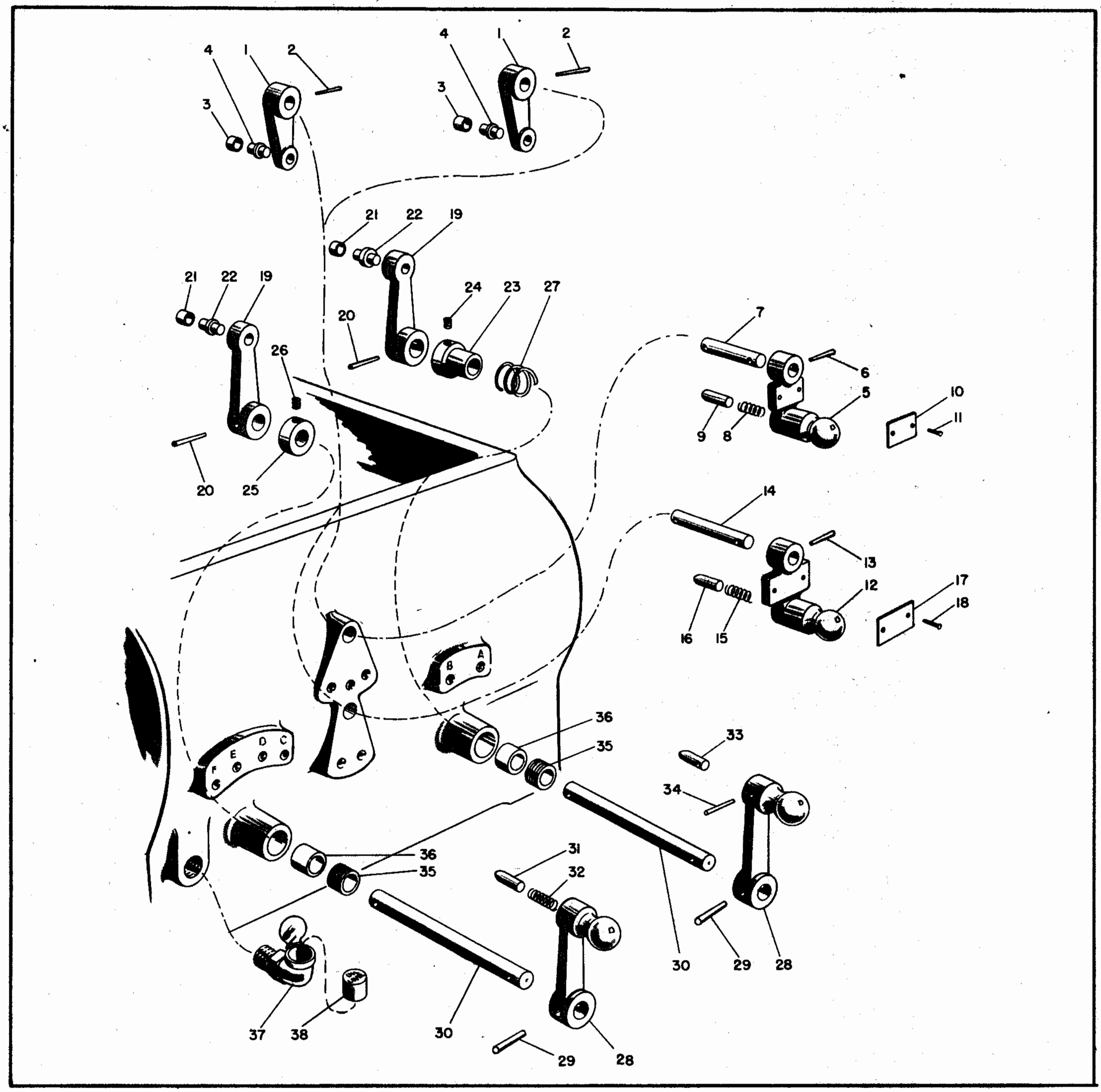
With this information we can send you the right oil reservoir cover immediately. Without it, there is needless delay while we write you for this information.

The serial number will be found stamped either on the front shear of the bed at the tailstock end, or on the cross girth at the same end of the machine.

In the Repair Parts Section the 13" Regal is taken as the basic machine in working up the lists. Therefore, some minor parts on Regals of other sizes will not be identical with the illustrations. For instance, the headstock cover, part No. 1 on page 58 has a different shape on the 21" and 24" Regals, and parts 3 to 10 are not included on these same two machines. Also, where two or more screws or washers are required, only one is illustrated.

However, if you will give us all the information requested in 1 and 2 above, we will know exactly what part you require and can ship it to you without delay.

Headstock Shifter Assembly
All REGALS

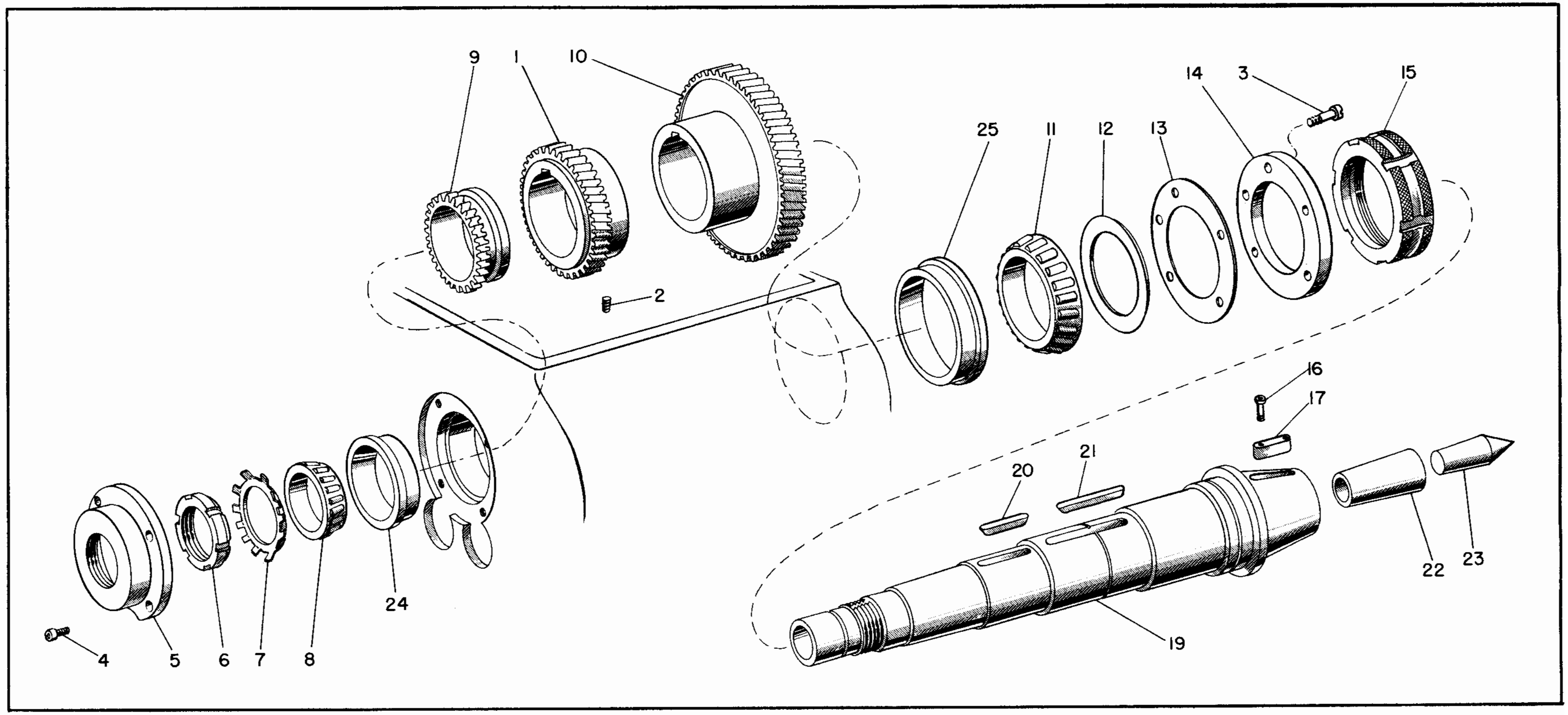


No.	Name
1.	Feed shifter arm
2.	Taper pin
3.	Feed shifter roller
4.	Feed shifter roller stud
5.	Feed reverse handle
6.	Taper pin
7.	Feed reverse shifter shaft
8.	Feed reverse shifter spring
9.	Feed reverse shifter plunger
10.	Feed reverse plate
11.	Drive pins
12.	Feed compound shifter handle
13.	Taper pin

No.	Name
14.	Feed compound shifter shaft
15.	Feed compound shifter spring
16.	Feed compound shifter plunger
17.	Feed compound plate
18.	Drive pins
19.	Speed shifter arm
20.	Taper pin
21.	Speed shifter roller
22.	Speed shifter roller stud
23.	A-B shifter spring collar
24.	Set screw
25.	C-D-E-F shifter shaft collar
26.	Set screw

No.	Name
27.	Shifter spring
28.	Shifter handle
29.	Taper pin
30.	Shifter shaft
31.	C-D-E-F shifter plunger
32.	C-D-E-F shifter spring
33.	A-B shifter plunger
34.	Pin
35.	Shifter shaft packing nut
36.	Shifter shaft packing
37.	Oil filler cup
38.	Oil level gauge

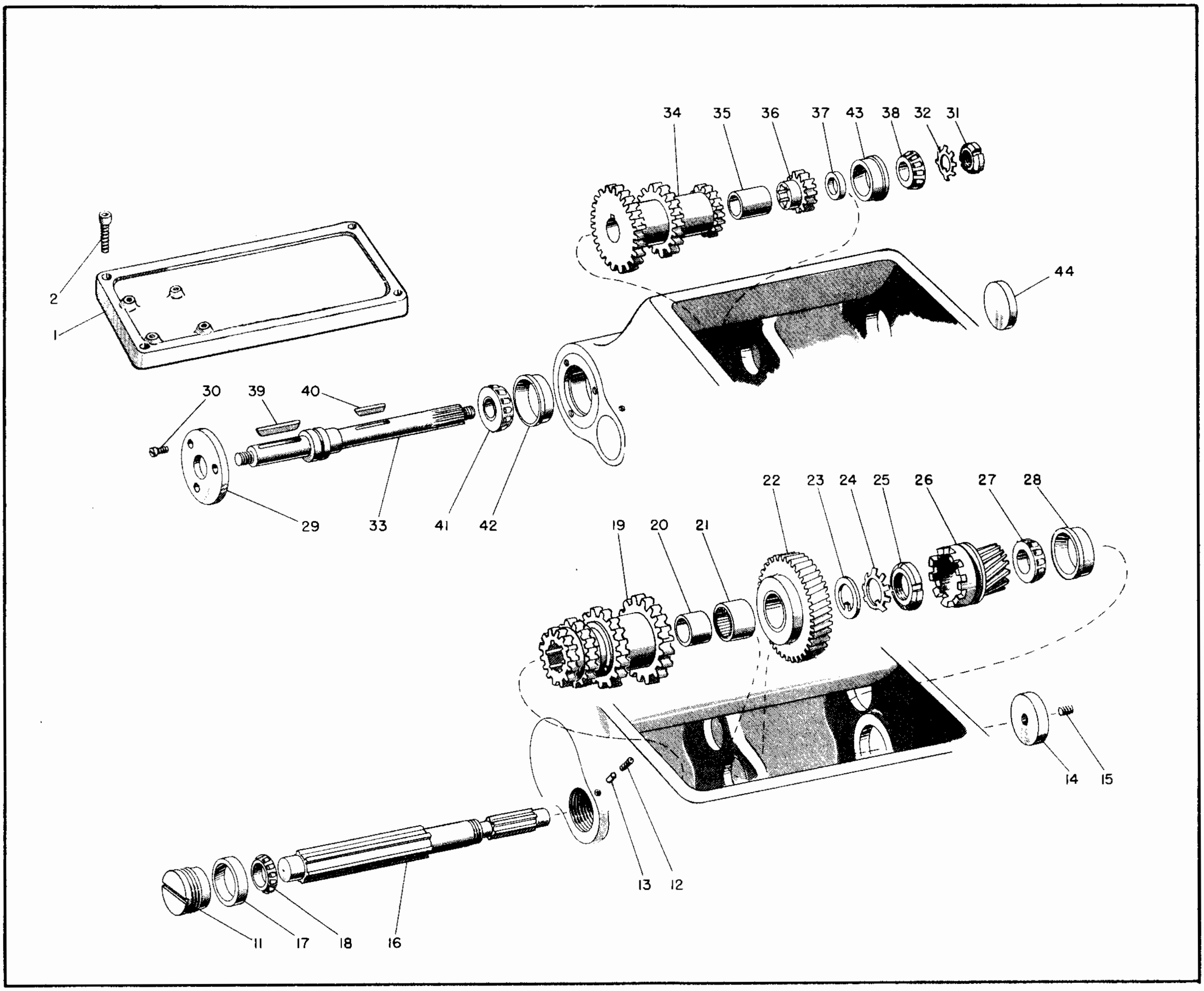
Headstock Spindle Assembly
All REGALS



No.	Name
1.	High speed gear
2.	High speed gear pin (see 18)
3.	Front flange filister screws
4.	Rear cover screws
5.	Rear cover flange
6.	Lock nut
7.	Lock washer
8.	Bearing cone
9.	Spindle feed gear
10.	Low speed spindle gear (see 18)
11.	Bearing cone
12.	Oil slinger
13.	Front flange gasket

No.	Name
14.	Front flange
15.	Spindle draw nut
16.	Allen cap screw
17.	Spindle nose key
18.	Low speed gear pin (on 21"-24" only; not shown)
19.	Spindle
20.	Feed gear key
21.	Speed gear key
22.	Spindle bush
23.	Spindle center
24.	Bearing cup
25.	Bearing cup

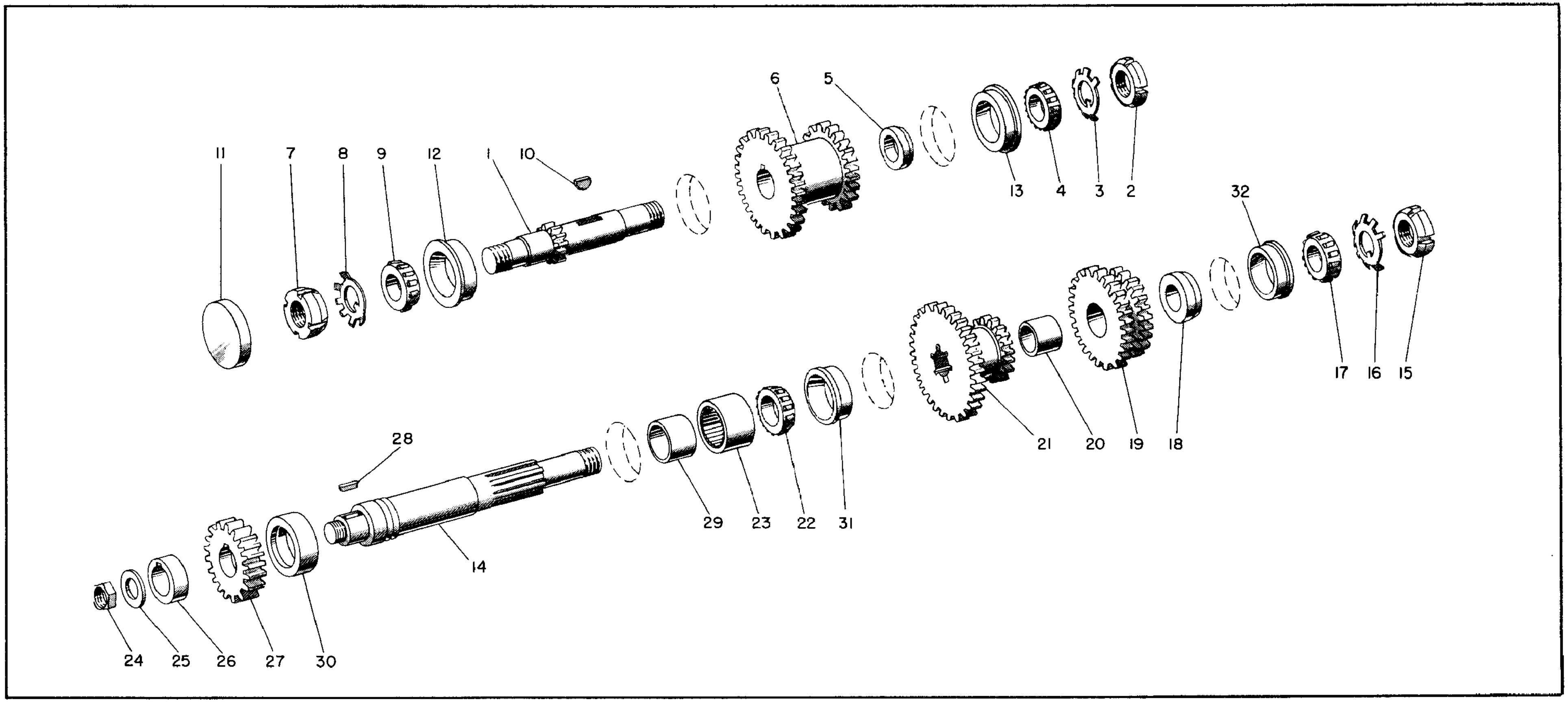
Headstock Drive Shaft and Intermediate Shaft Assembly
All REGALS



No.	Name
1.	Head cover
2.	Allen cap screw
11.	Bearing adjusting plug
12.	Set screw
13.	Brass plug
14.	Head plug
15.	Set screw
16.	Intermediate shaft
17.	Bearing cup
18.	Bearing cone
19.	Cluster gear
20.	Bearing inner race
21.	Bearing
22.	High speed gear
23.	Spacing collar
24.	Lock washer
25.	Lock nut
26.	Low speed clutch gear
27.	Bearing cone

No.	Name
28.	Bearing cup
29.	Bearing retainer
30.	Filister head screw
31.	Lock nut
32.	Lock washer
33.	Drive shaft (13"-15"-17"-19" only; see page 82 for 21" - 24" drive shaft) refers to electric brake machines only
34.	Drive shaft cluster gear
35.	Spacing sleeve
36.	Drive shaft pinion
37.	Spacing sleeve
38.	Bearing cone
39.	Drive pulley key
40.	Cluster gear key
41.	Bearing cone
42.	Bearing cup
43.	Bearing cup
44.	Head plug

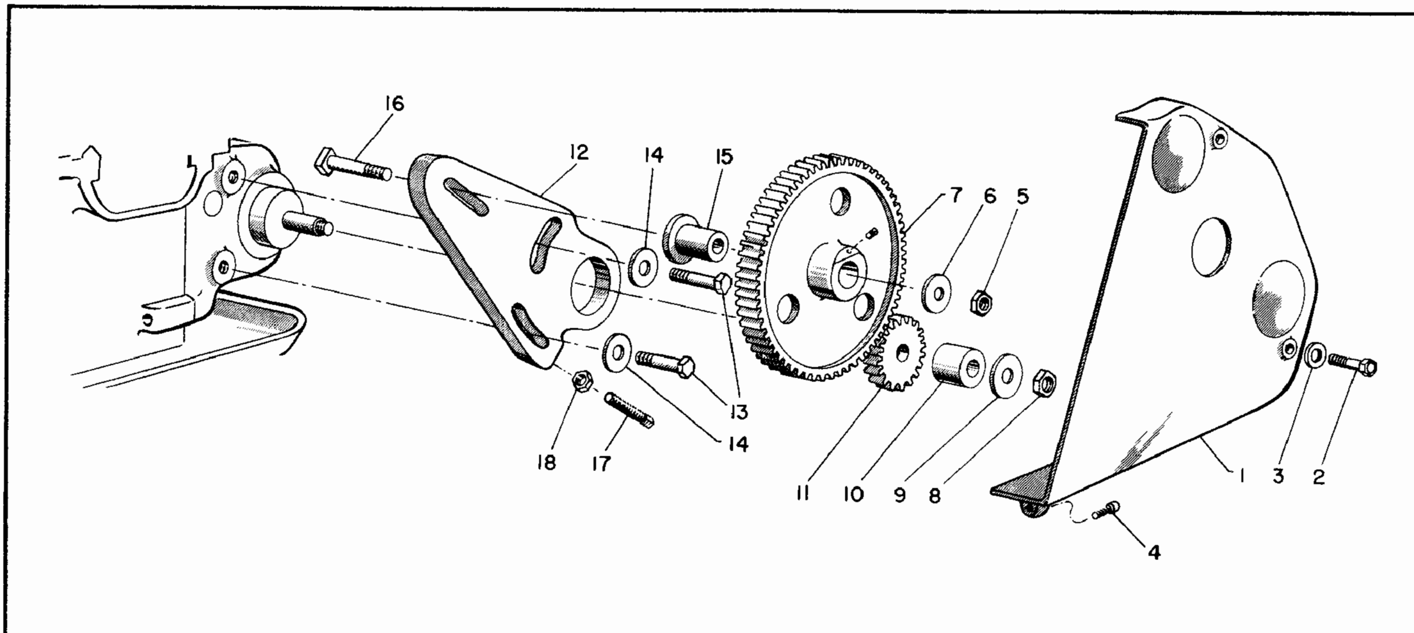
Headstock Feed and Feed Reverse Shaft Assembly
All REGALS



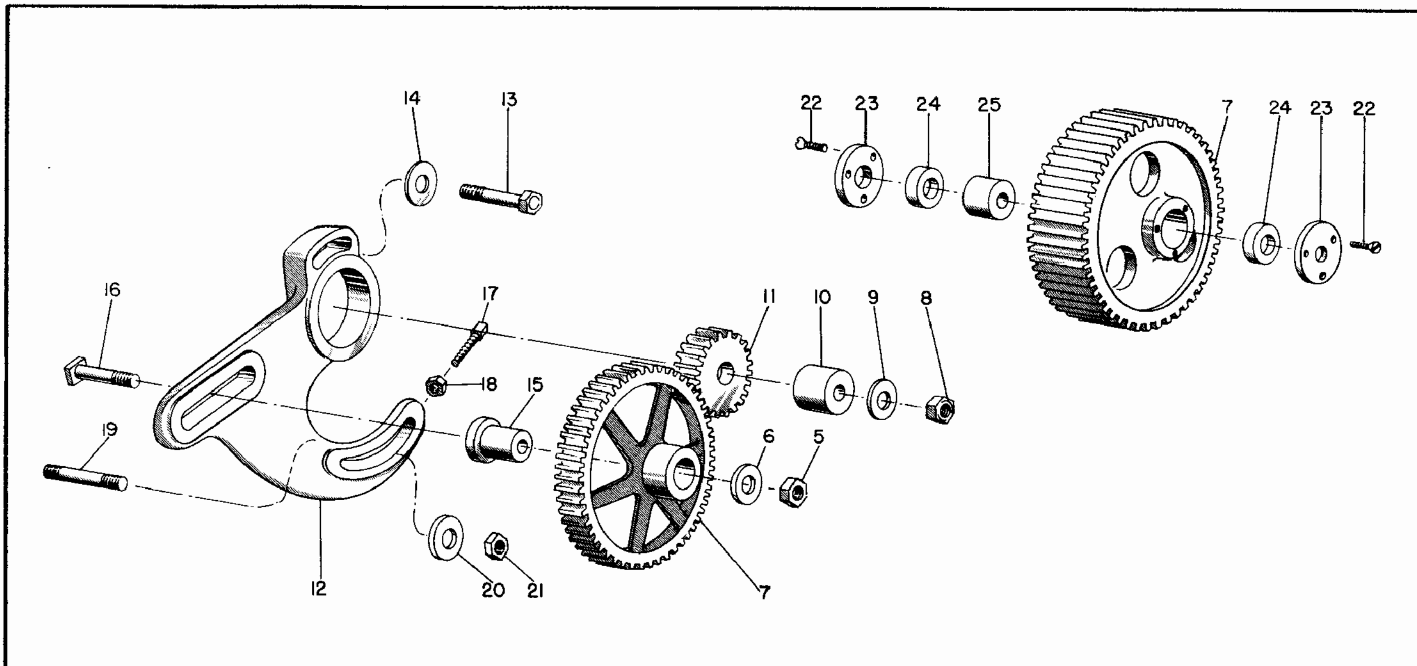
No.	Name
1.	Feed reverse shaft
2.	Lock nut
3.	Lock washer
4.	Bearing cone
5.	Spacing collar
6.	Reverse shaft double gear
7.	Lock nut
8.	Lock washer
9.	Bearing cone
10.	Key
11.	Head plug
12.	Bearing cup
13.	Bearing cup
14.	Feed shaft
15.	Lock nut
16.	Lock washer

No.	Name
17.	Bearing cone
18.	Bearing spacing collar
19.	Feed reverse gear
20.	Feed reverse gear bush
21.	Splined double gear
22.	Bearing cone
23.	Bearing
24.	Hex nut
25.	Washer
26.	Feed gear spacing collar
27.	Feed gear
28.	Feed gear key
29.	Bearing inner race
30.	Bearing cage
31.	Bearing cup
32.	Bearing cup

Quadrant Assembly
13"-15" REGALS



17"-19"-21"-24" REGALS



No.	Name
1.	Quadrant cover
2.	Quadrant cover hex screw
3.	Quadrant cover washer
4.	Quadrant cover Allen screw
5.	Quadrant gear hex nut
6.	Quadrant gear washer
7.	Quadrant gear
8.	Feed shaft hex nut
9.	Feed shaft washer
10.	Feed shaft gear spacer
11.	Feed gear
12.	Quadrant
13.	Quadrant screws
14.	Quadrant washers
15.	Quadrant gear bush
16.	Quadrant gear bush stud
17.	Square head adjusting screw
18.	Adjusting screw lock nut

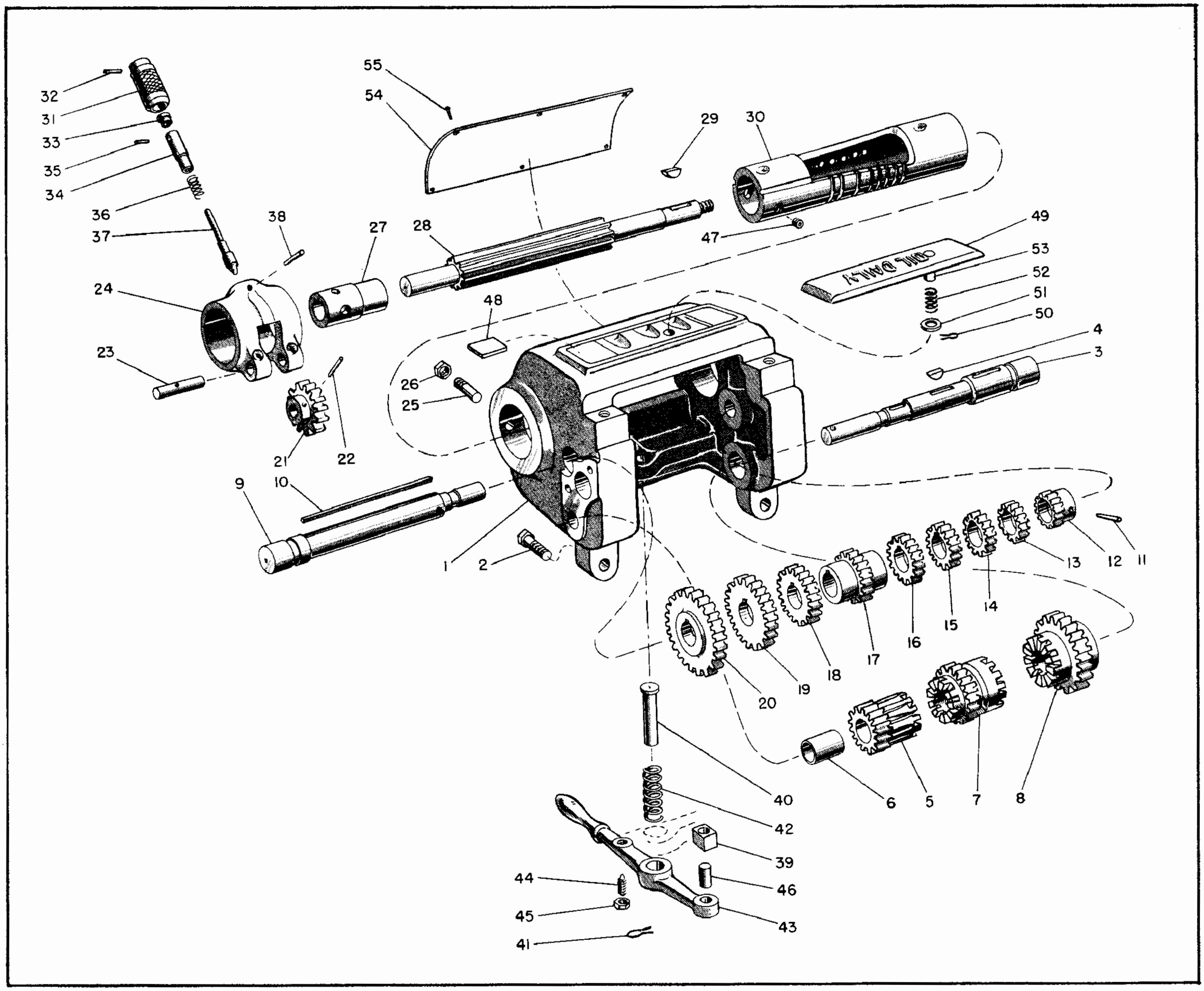
17"-19"-21"-24" REGALS ONLY:

No.	Name
19.	Quadrant stud
20.	Quadrant stud washer
21.	Quadrant stud nut

21"-24" REGALS ONLY:

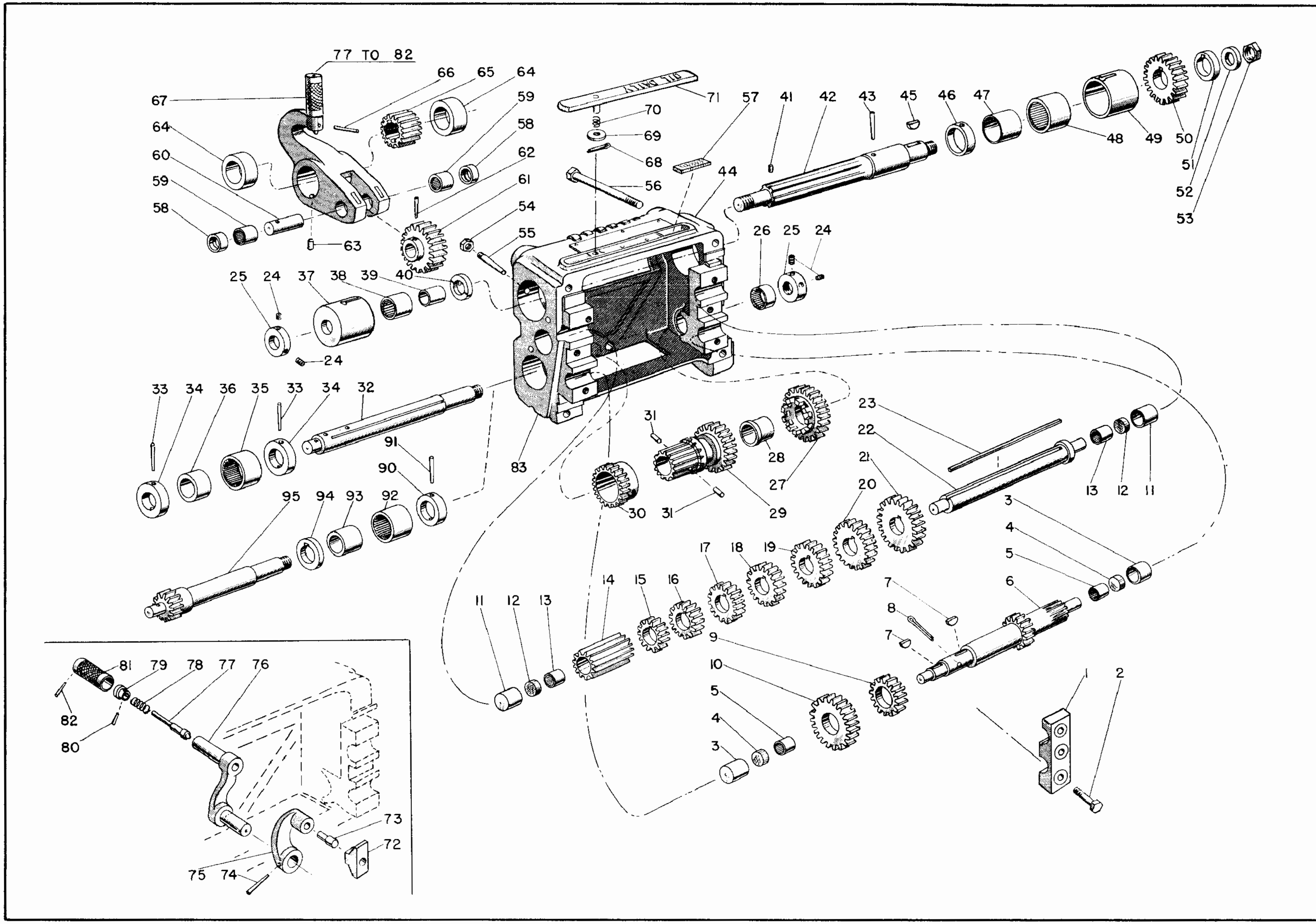
No.	Name
22.	Bearing retainer screws
23.	Bearing retainer
24.	Bearing
25.	Bearing spacer

Quick Change Box
13"-15" REGALS



No.	Name
1.	Quick change box
2.	Quick change box mounting screw
3.	Feed shaft
4.	Key
5.	Clutch gear
6.	Clutch gear bush
7.	Sliding gear
8.	32-tooth clutch gear
9.	Cone shaft
10.	Cone shaft key
11.	Taper pin
12.	16-tooth cone gear
13.	18-tooth cone gear
14.	20-tooth cone gear
15.	22-tooth cone gear
16.	23-tooth cone gear
17.	24-tooth cone gear
18.	26-tooth cone gear
19.	28-tooth cone gear
20.	Cone gear
21.	Tumbler gear
22.	Taper pin
23.	Tumbler gear shaft
24.	Yoke
25.	Draw pin
26.	Draw pin hex nut
27.	Cylinder head
28.	Cylinder gear
29.	Key
30.	Cylinder
31.	Index handle barrel
32.	Pin
33.	Index handle bush
34.	Index handle sleeve
35.	Straight pin
36.	Index handle spring
37.	Index handle plunger
38.	Straight pin
39.	Shifter shoe
40.	Shifter handle pin
41.	Cotter key
42.	Spring
43.	Shifter
44.	Detent screw
45.	Detent screw lock nut
46.	Yoke shoe pin
47.	Set screw
48.	Felt pad
49.	Oiler cover
50.	Cotter key
51.	Washer
52.	Oiler cover spring
53.	Cover hinge pin
54.	Index plate
55.	Drive pins

Quick Change Box
17"-19"-21"-24" REGALS



No.	Name	
1.	Cap (specify quadrant or feed rod end of box)	
2.	Cap hex screw (specify long or short)	
3.	Intermediate shaft plug	
4.	Intermediate shaft felt plug	
5.	Intermediate shaft bearing	
6.	Intermediate shaft	
7.	Intermediate shaft key	
8.	Intermediate shaft cotter key	
9.	Intermediate shaft second gear	
10.	Intermediate shaft large gear	
11.	Cone shaft plug	
12.	Cone shaft felt plug	
13.	Cone shaft bearing	
14.	Cone shaft 12-tooth gear	
15.	Cone shaft 13-tooth gear	
16.	Cone shaft 14-tooth gear	
17.	Cone shaft 16-tooth gear	
18.	Cone shaft 18-tooth gear	
19.	Cone shaft 20-tooth gear	
20.	Cone shaft 22-tooth gear	
21.	Cone shaft 23-tooth gear	
22.	Cone shaft	
23.	Cone shaft key	
24.	Set screw	
25.	Adjusting nut	
26.	Bearing	
27.	Clutch gear	
28.	Clutch gear bush	
29.	Double compound gear	
30.	Compound gear pinion	
31.	Straight pin	
32.	Feed shaft	
33.	Taper pin	
34.	Feed shaft collar	
35.	Bearing outer race	One unit (35–36)
36.	Bearing inner race	
37.	Small drive shaft bush	
38.	Bearing outer race	One unit (38–39)
39.	Bearing inner race	
40.	Hard collar	
41.	Straight pin	
42.	Yoke drive pinion shaft	
43.	Taper pin	
44.	Quick change box	
45.	Key	
46.	Collar	
47.	Bearing inner race	One unit (47–48)
48.	Bearing outer race	
49.	Drive shaft large bush	
50.	Feed gear	
51.	Feed gear collar	
52.	Feed gear washer	
53.	Hex nut	
54.	Draw pin nut	
55.	Draw pin	
56.	Box-to-bed screws (specify long or short)	
57.	Felt pad	
58.	Yoke stud plug	
59.	Bearing	
60.	Yoke gear shaft	
61.	Yoke gear	
62.	Yoke gear pin	
63.	Straight pin	
64.	Yoke pinion bush	
65.	Yoke drive pinion	
66.	Straight pin	
67.	Cylinder yoke	
68.	Oil reservoir cover cotter key	
69.	Oil reservoir cover washer	
70.	Oil reservoir cover spring	
71.	Oil reservoir cover	
72.	Shifter shoe	
73.	Shifter shoe pin	
74.	Shifter link pin	
75.	Shifter link	
76.	Shifter handle	
77.	Index handle plunger	
78.	Index handle spring	(specify whether for shifter handle 76 or for cylinder yoke 67) (78–82)
79.	Index handle plug	
80.	Index handle pin	
81.	Index handle	
82.	Index handle taper pin	

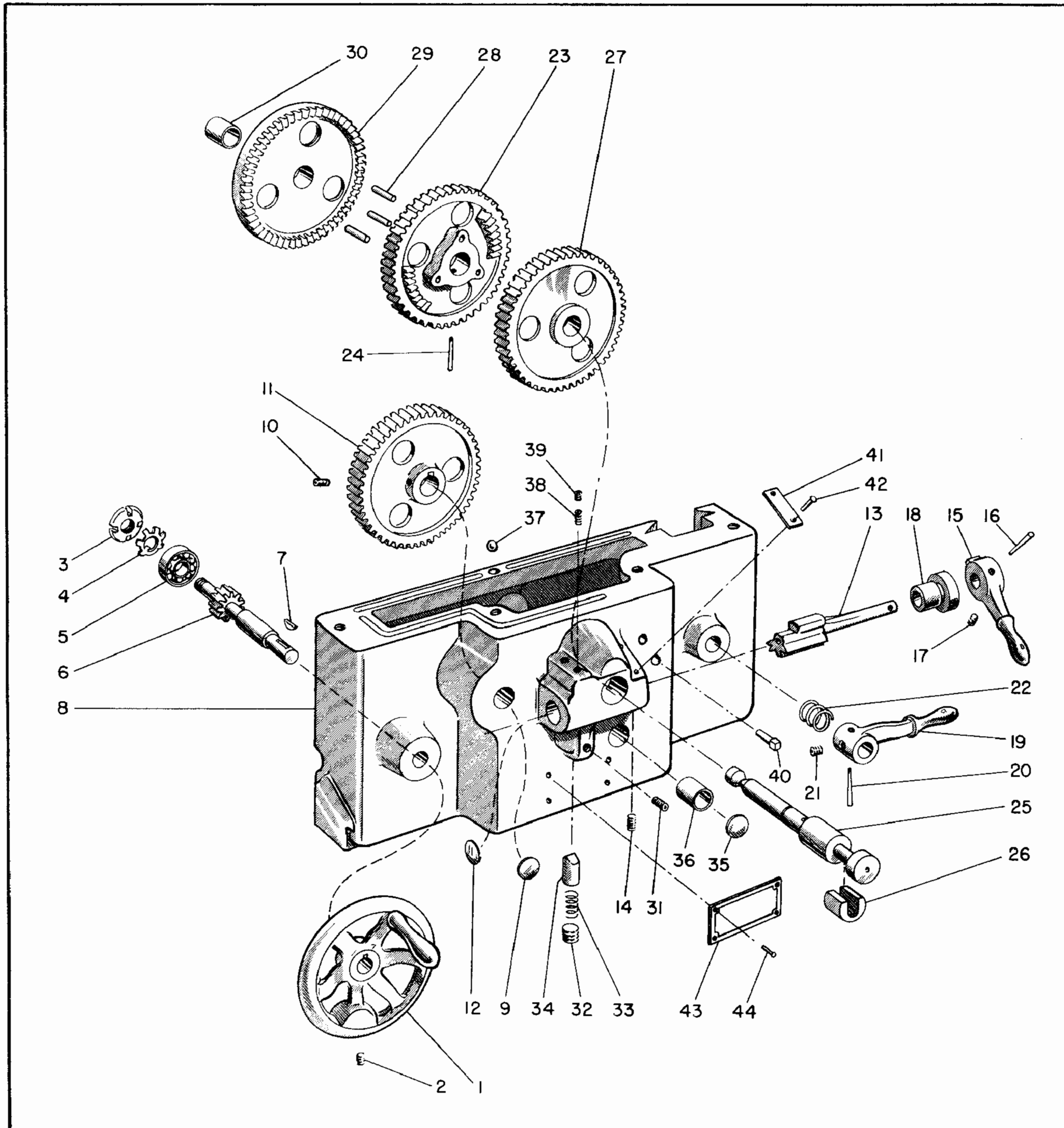
21"-24" REGALS ONLY:

All units above except parts 32-36 inclusive and plus the following:

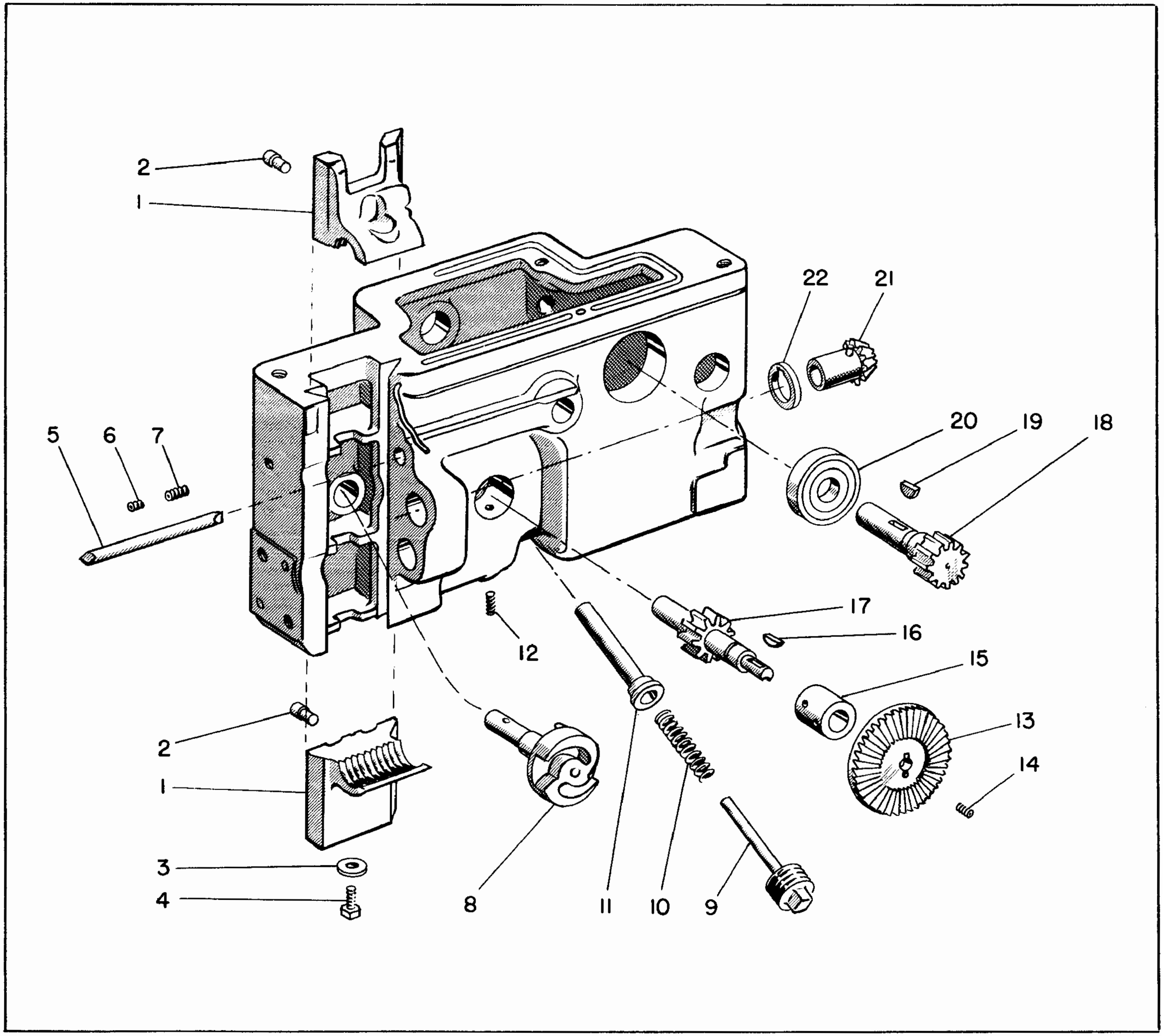
No.	Name	
90.	Feed shaft collar	
91.	Taper pin	
92.	Bearing outer race	One unit (92–93)
93.	Bearing inner race	
94.	Hard collar	
95.	Feed shaft	

Apron (Front View)
13"-15" REGALS

No.	Name
1.	Handwheel
2.	Handwheel set screw
3.	Lock nut
4.	Lock washer
5.	Bearing
6.	First stud shaft
7.	Key
8.	Apron
9.	Rack pinion shaft hole plug
10.	Rack wheel set screw
11.	Rack wheel
12.	Feed shifter hole plug
13.	Feed shifter
14.	Feed shifter bush lock screw
15.	Feed trip handle
16.	Feed trip handle pin
17.	Feed trip handle set screw
18.	Feed shifter bush
19.	Half-nut handle
20.	Half-nut handle pin
21.	Half-nut handle set screw
22.	Half-nut handle spring
23.	Sliding intermediate gear
24.	Sliding intermediate gear pin
25.	Rack wheel gear shaft
26.	Clutch shifter shoe
27.	Cross feed clutch gear
28.	Gear spacing pin
29.	Longitudinal feed gear
30.	Longitudinal feed gear bush
31.	Detent lock screw
32.	Detent screw
33.	Detent spring
34.	Detent plunger
35.	Bevel gear shaft hole plug
36.	Bevel gear shaft bush
37.	Oil flow control ball
38.	Feed trip adjusting screw
39.	Feed trip adjusting lock screw
40.	Feed trip stop
41.	Feed trip instruction plate
42.	Drive pins
43.	Oiling instruction plate
44.	Drive pins

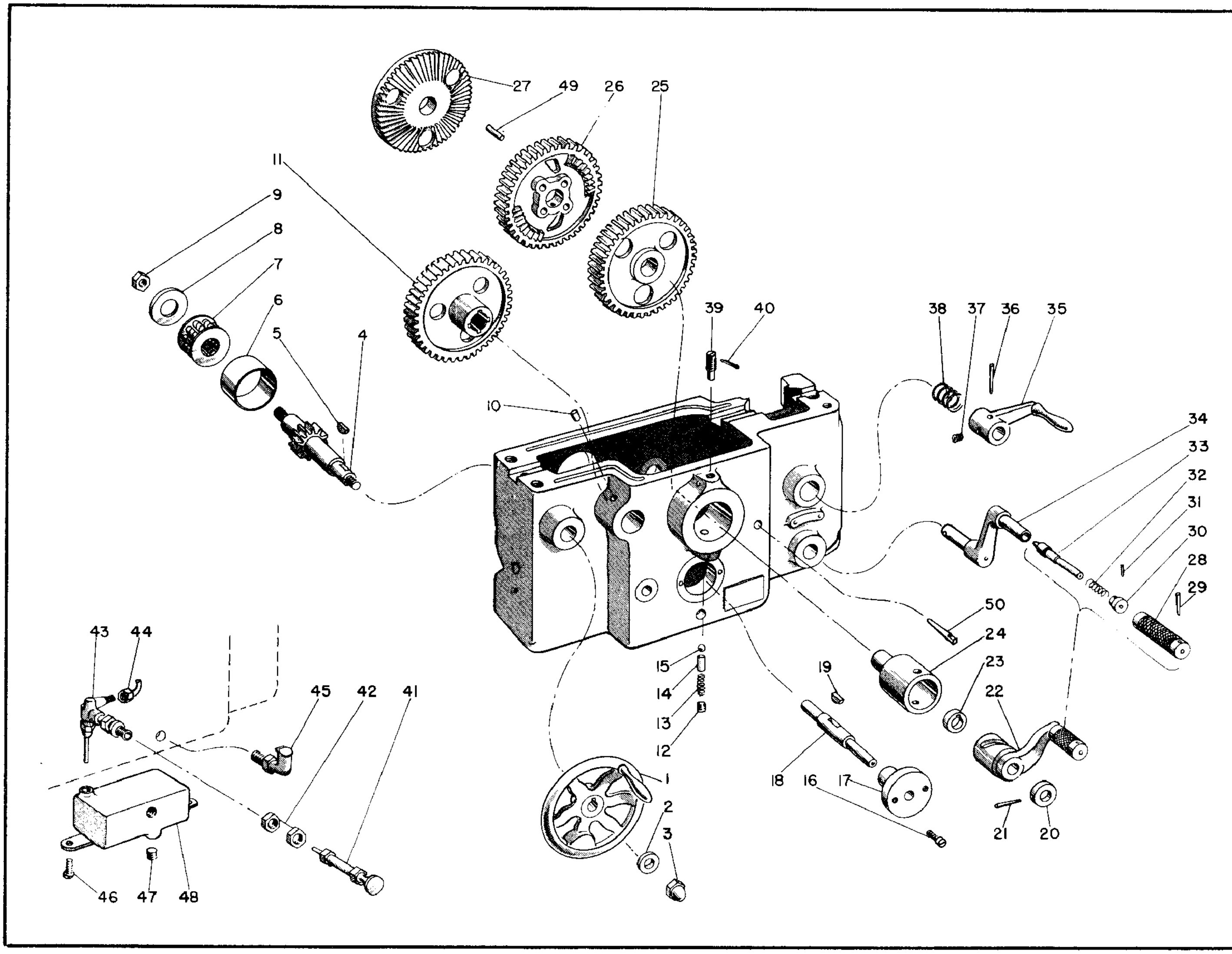


Apron (Rear View)
13"-15" REGALS



No.	Name
1.	Half-nut (2 halves)
2.	Half-nut cam pins
3.	Half-nut stop washer
4.	Half-nut stop screw
5.	Interference pin
6.	Half-nut adjusting screw lock
7.	Half-nut adjusting screw
8.	Half-nut cam
9.	Pump guide stem
10.	Pump spring
11.	Pump plunger
12.	Bevel gear bush set screw
13.	Bevel gear
14.	Bevel gear set screw
15.	Bevel gear shaft bush
16.	Key
17.	Bevel gear shaft
18.	Rack pinion
19.	Rack pinion key
20.	Bearing
21.	Bevel pinion
22.	Bevel pinion thrust collar

Apron (Front View)
17"-19"-21"-24" REGALS

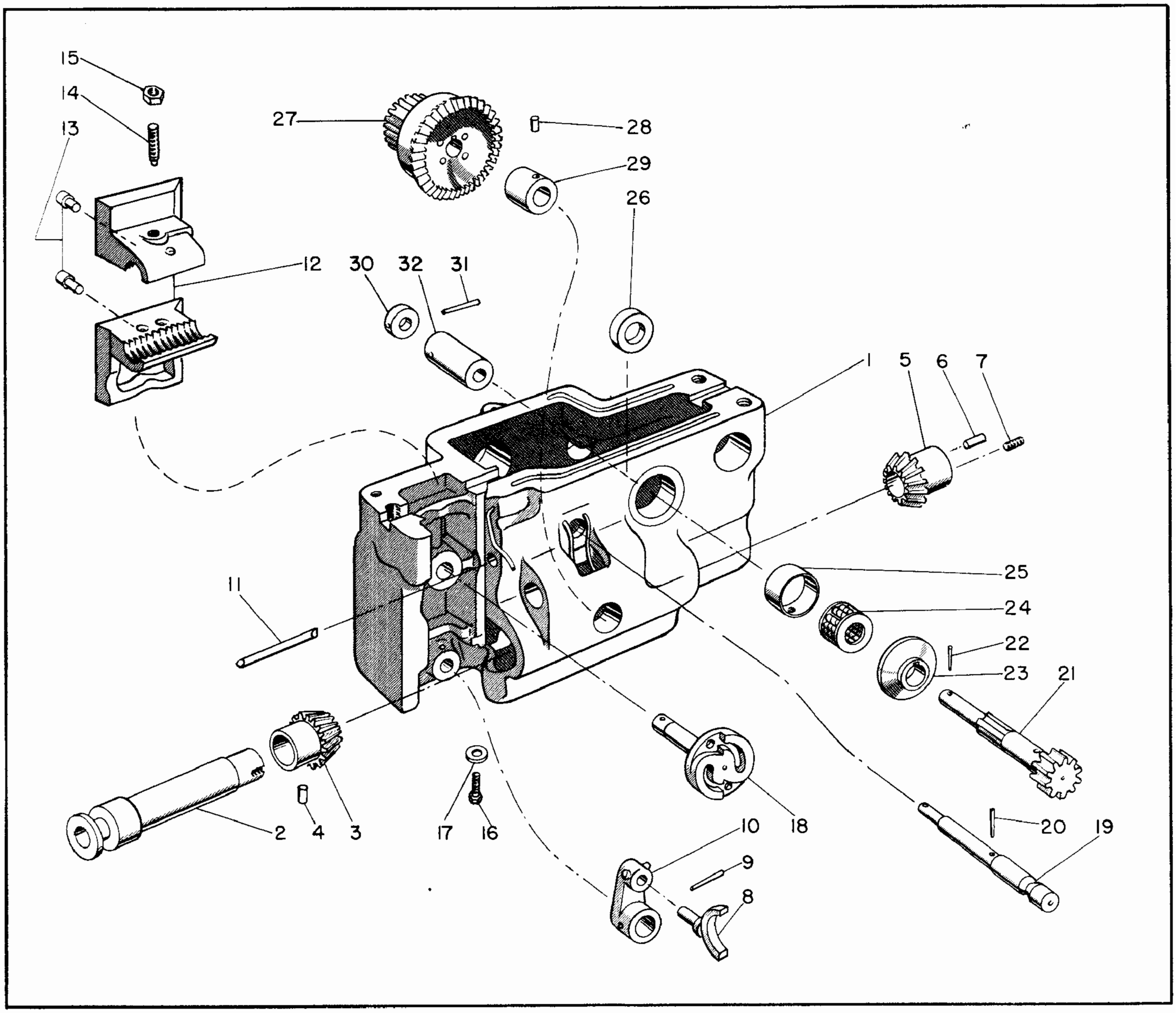


No.	Name
1.	Handwheel
2.	Handwheel washer
3.	Handwheel acorn nut
4.	First stud
5.	First stud key
6.	Bearing race } One unit
7.	Bearing } One unit
8.	First stud bearing washer
9.	Hex nut
10.	Rack wheel bush pin
11.	Rack wheel
12.	Detent screw
13.	Detent spring
14.	Detent
15.	Detent ball
16.	Bevel gear bush screw
17.	Bevel gear bush
18.	Bevel gear shaft
19.	Bevel gear shaft key
20.	Feed trip outer collar
21.	Feed trip outer collar pin
22.*	Feed trip handle
23.	Feed trip spacing collar
24.	Intermediate gear shifter bush
25.	Cross feed gear

No.	Name
26.	Sliding intermediate gear
27.	Sliding gear clutch
28.*	Bevel pinion index handle barrel
29.*	Bevel pinion index handle pin
30.*	Bevel pinion index handle bush
31.*	Bevel pinion index handle bush pin
32.*	Bevel pinion index handle spring
33.*	Bevel pinion index handle plunger
34.	Bevel pinion index handle
35.	Half-nut handle
36.	Half-nut handle pin
37.	Half-nut handle set screw
38.	Half-nut handle spring
39.	Feed trip stop screw
40.	Cotter key
41.	Pump plunger } One unit
42.	Pump locating nuts } One unit
43.	Pump body } One unit
44.	Tube connector } One unit
45.	Oil filler cup
46.	Tank mounting screw
47.	Drain plug
48.	Oil tank
49.	Sliding gear pin
50.	Feed stop pin

* Parts 28 through 32 inclusive are available in a smaller size for handle 22.

Apron (Rear View)
17"-19"-21"-24" REGALS

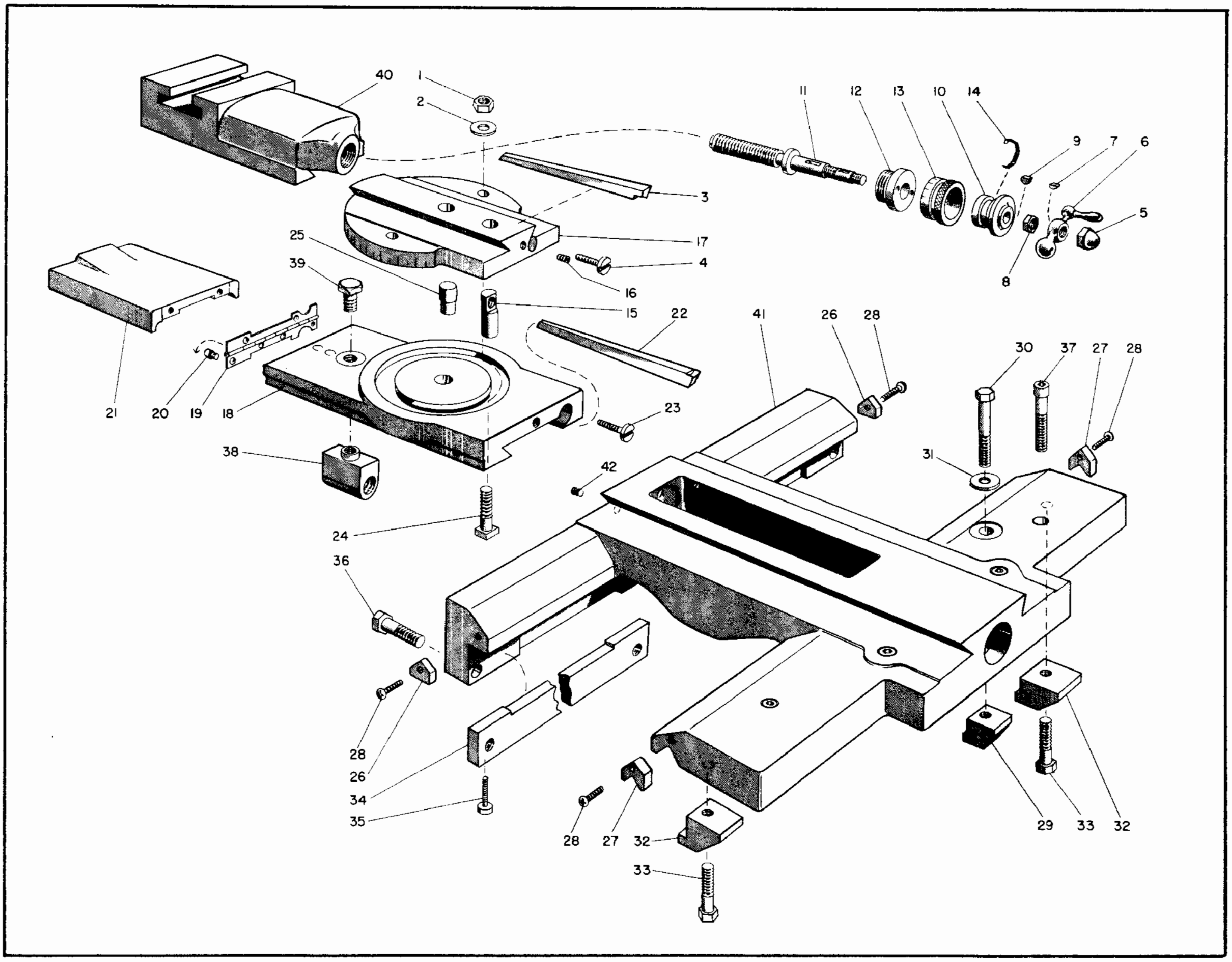


No.	Name
1.	Apron
2.	Bevel pinion sleeve
3.	Bevel pinion (large)
4.	Bevel pinion (large) pin
5.	Bevel pinion (small)
6.	Bevel pinion (small) pin
7.	Bevel pinion (small) set screw
8.	Bevel pinion shifter yoke
9.	Bevel pinion shifter pin
10.	Bevel pinion shifter arm
11.	Interference rod
12.	Half-nut (2 halves)
13.	Half-nut cam pins
14.	Half-nut adjusting screw
15.	Half-nut adjusting screw lock nut

No.	Name
16.	Half-nut stop screw
17.	Half-nut stop screw washer
18.	Half-nut cam
19.	Sliding gear shaft
20.	Sliding gear shaft pin
21.	Rack pinion
22.	Rack pinion pin
23.	Rack pinion bearing flange
24.	Bearing } One unit
25.	Bearing outer race } One unit
26.	Rack wheel spacer
27.	Bevel gear
28.	Bevel gear rear bush pin
29.	Bevel gear rear bush
30.	Rack wheel collar
31.	Rach wheel collar pin
32.	Rach wheel shaft bush

Carriage—13"-15" REGALS

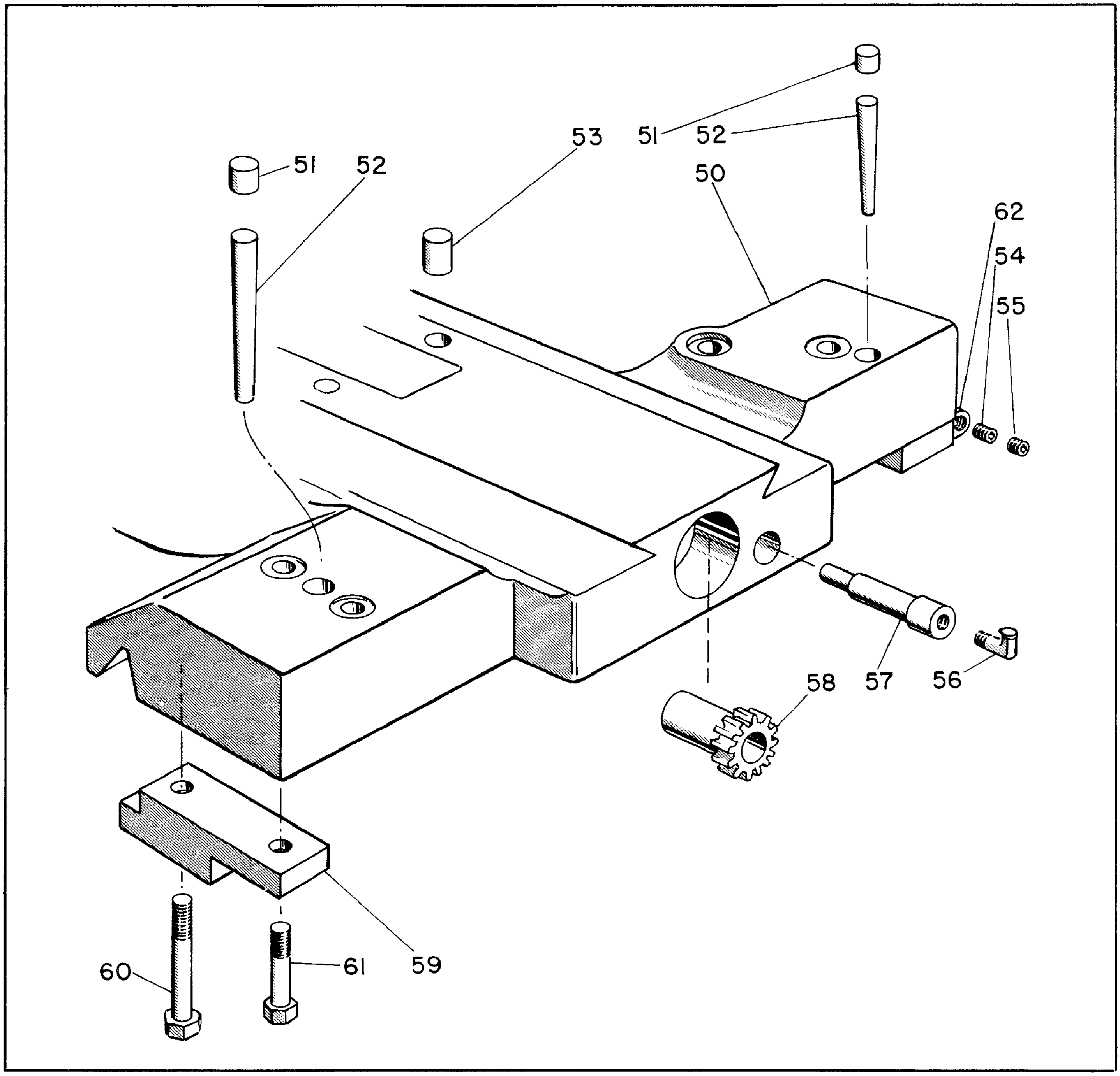
Compound Rest—All REGALS



(For cross feed screw -- all Regals,see page 71. For 17" - 19"-
21" - 24" carriage, see page 69; for gap carriage, see page 70)

No.	Name	No.	Name
1.	Compound rest hex nut	22.	Bottom slide gib
2.	Compound rest washer	23.	Bottom slide gib screw
3.	Compound rest gib	24.	T-slot bolt
4.	Gib screw	25.	Compound rest swivel pin
5.	Acorn nut	26.	Rear shear wiper
6.	Balcrank handle	27.	Front shear wiper
7.	Balcrank handle key	28.	Shear wiper screw
8.	Compound rest screw hex nut	29.	Carriage clamp
9.	Micrometer dial hub key	30.	Carriage clamp screw
10.	Micrometer dial hub	31.	Carriage clamp screw washer
11.	Compound rest screw	32.	Front gib
12.	Compound rest screw bush	33.	Front gib screw
13.	Micrometer dial	34.	Back gib
14.	Micrometer dial spring	35.	Back gib adjusting screw
15.	Compound rest screw nut	36.	Back gib screw
16.	Compound rest screw nut set screw	37.	Carriage-to-apron screw
17.	Swivel slide	38.	Cross feed nut (13"-19" Regals)
18.	Bottom slide	39.	Cross feed nut screw
19.	Dirt guard hinge	40.	Compound rest top
20.	Dirt guard hinge screw	41.	Carriage
21.	Dirt guard	42.	Oil hole plugging screw

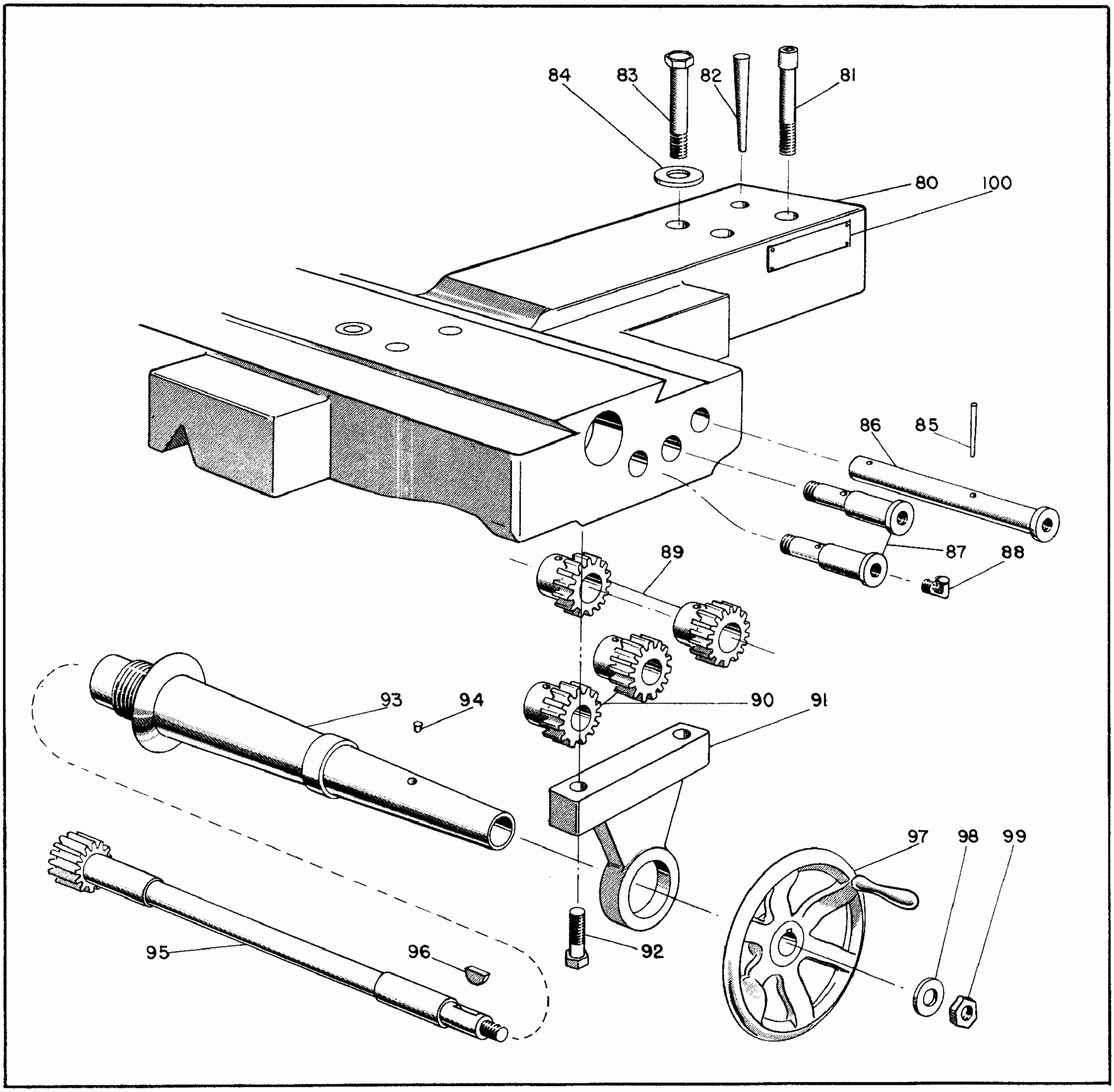
Carriage
17"-19"-21"-24" REGALS



No.	Name
50.	Carriage
51.	Pin hole plug
52.	Carriage pin
53.	Oil hole plug
54.	Chasing dial stop screw
55.	Chasing dial stop screw lock
56.	Oiler
57.	Tumbler pinion shaft
58.	Tumbler pinion
59.	Left-hand front gib
60.	Long gib screw
61.	Short gib screw
62.	Right-hand front gib

For other carriage parts, see Carriage -- 13" - 15" Regals, page 68

Gap Carriage and Apron Handwheel
17"-19"-21"-24" REGAL Gap Lathes

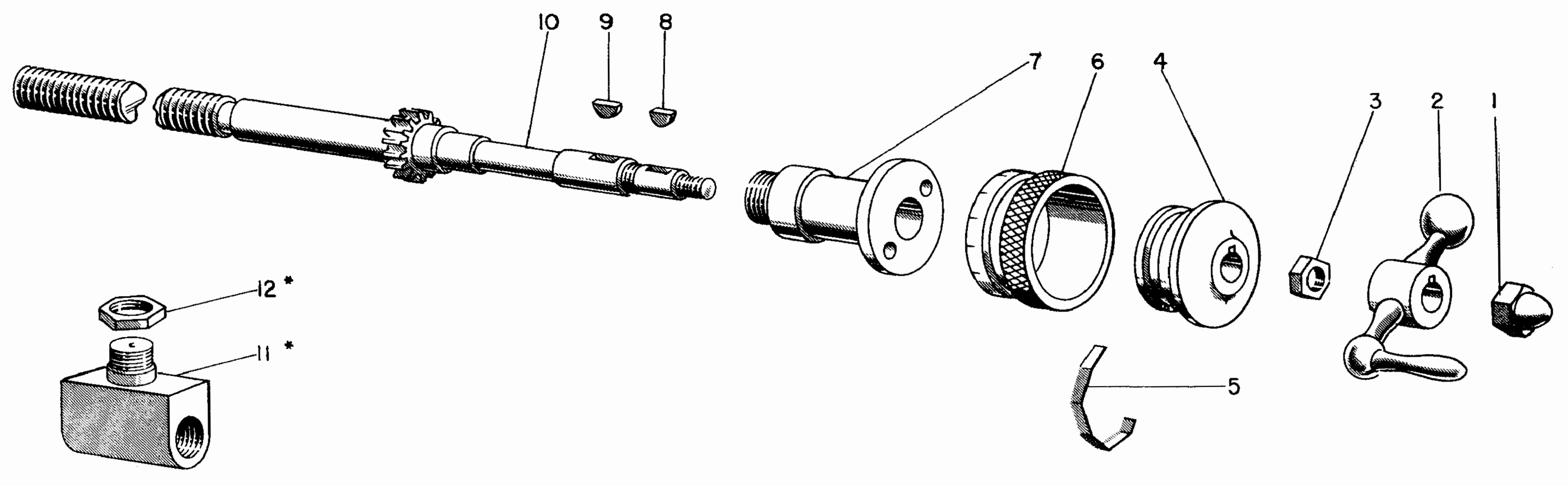


No.	Name
80.	Carriage
81.	Apron-to-carriage screw
82.	Apron pin
83.	Carriage clamp screw
84.	Carriage clamp washer
85.	Taper pin
86.	Cross feed shaft
87.	Cross feed stud
88.	Oiler
89.	Cross feed pinion
90.	Bushed cross feed pinion

No.	Name
91.	Handwheel support bracket
92.	Handwheel support bracket screw
93.	First stud sleeve
94.	First stud sleeve oiler
95.	First stud
96.	First stud key
97.	Handwheel
98.	Handwheel washer
99.	Handwheel nut
100.	Instruction plate

For other gap carriage and apron parts, see standard carriage (page 69) and apron (page 66-67).

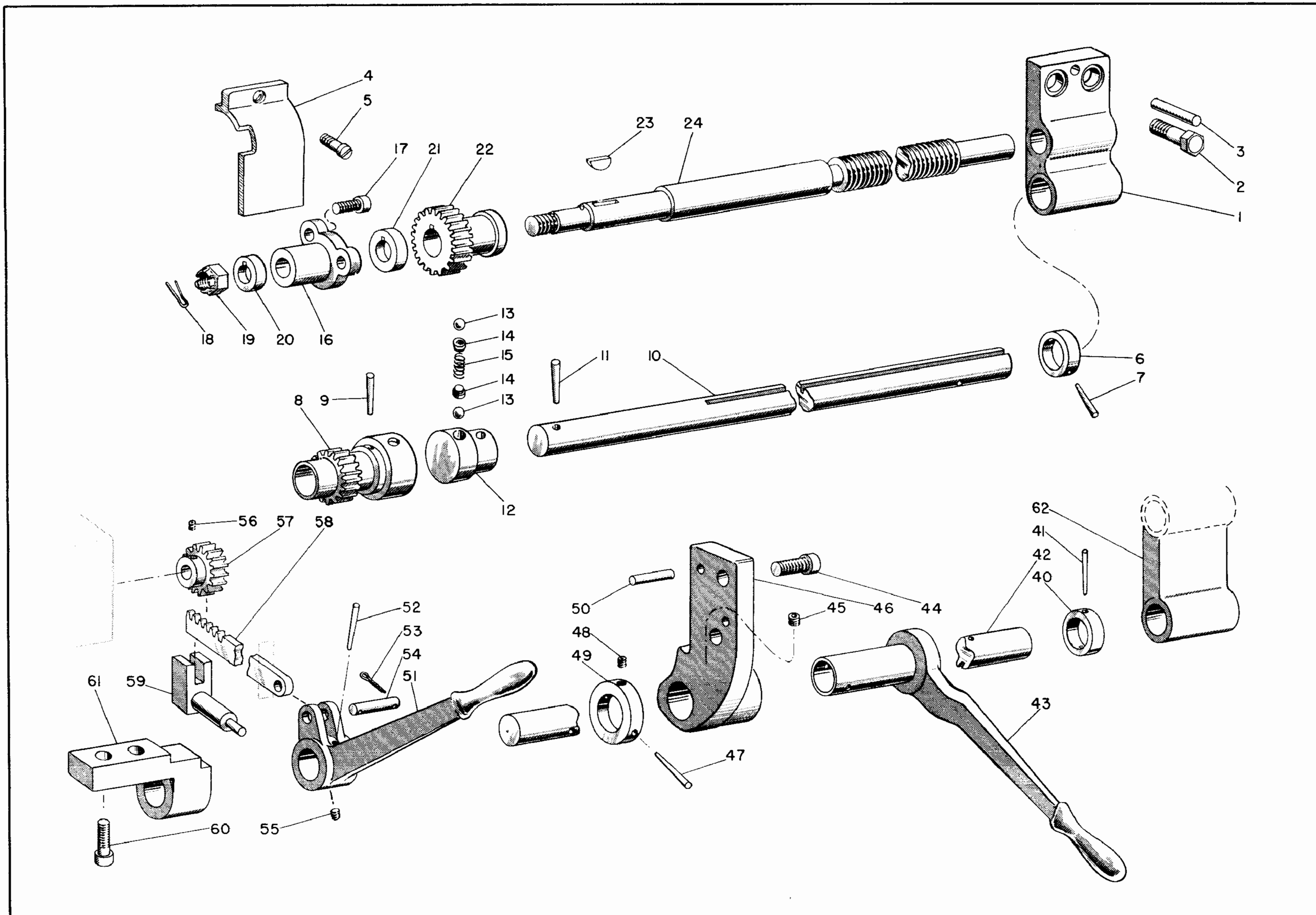
Standard Cross Feed Screw
All REGALS



No.	Name	No.	Name
1.	Acorn nut	7.	Cross feed bush
2.	Balcrank handle	8.	Handle key
3.	Hex nut	9.	Micrometer dial key
4.	Micrometer dial hub	10.	Cross feed screw
5.	Micrometer dial spring	11.	Cross feed nut (21"-24" only)
6.	Micrometer dial	12.	Cross feed hex nut (21"-24" only)

*For 13"-15"-17"-19" Regal cross feed nut, see page 68 (Compound Rest, All Regals)

Leadscrew, Feed Rod and Apron Spindle Control Rod
13"-15" REGALS



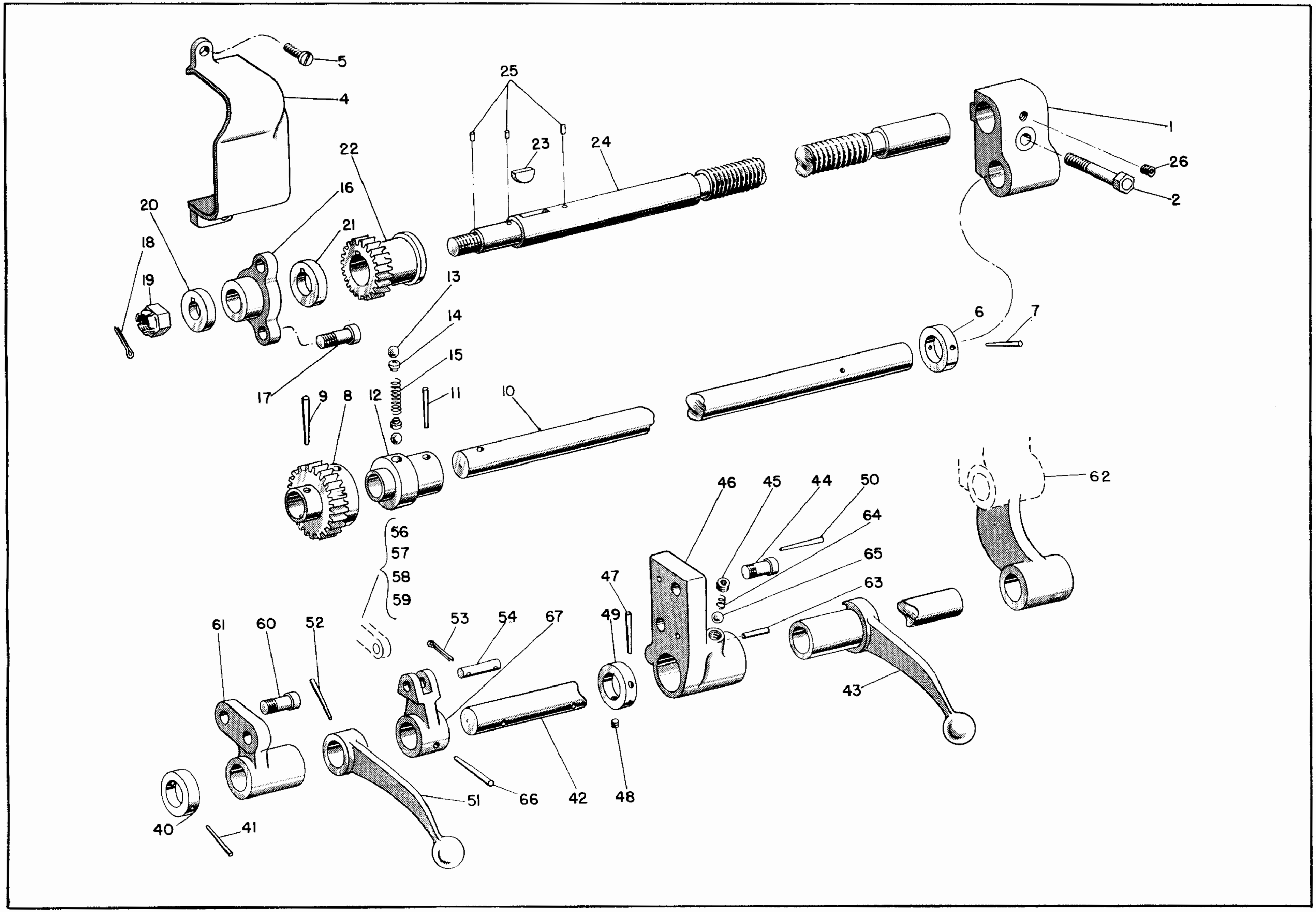
LEADSCREW AND FEED ROD

No.	Name	No.	Name
1.	Back box for standard machine	13.	Safety clutch ball
2.	Back box screw	14.	Safety clutch cup
3.	Back box pin	15.	Safety clutch spring
4.	Slip gear cover	16.	Leadscrew quick change box bush
5.	Slip gear screw	17.	Allen screw
6.	Feed rod collar	18.	Cotter key
7.	Taper pin	19.	Castle nut
8.	Safety clutch (feed box half)	20.	Small thrust collar
9.	Taper pin	21.	Large thrust collar
10.	Feed rod	22.	Slip gear
11.	Taper pin	23.	Slip gear key
12.	Safety clutch (feed rod half)	24.	Leadscrew

APRON SPINDLE CONTROL ROD

No.	Name	No.	Name
40.	Control rod collar	52.	Taper pin
41.	Taper pin	53.	Cotter key
42.	Control rod	54.	Clevis pin
43.	Apron control handle	55.	Set screw
44.	Apron bracket mounting screw	56.	Set screw
45.	Oil hole screw	57.	Drum switch pinion
46.	Apron bracket	58.	Rack
47.	Taper pin	59.	Rack guide
48.	Set screw	60.	Front bracket mounting screw
49.	Apron bracket collar	61.	Front bracket
50.	Apron bracket pin	62.	Back box for apron spindle control
51.	Head end control handle		

Leadscrew, Feed Rod and Apron Spindle Control Rod
17"-19" REGALS



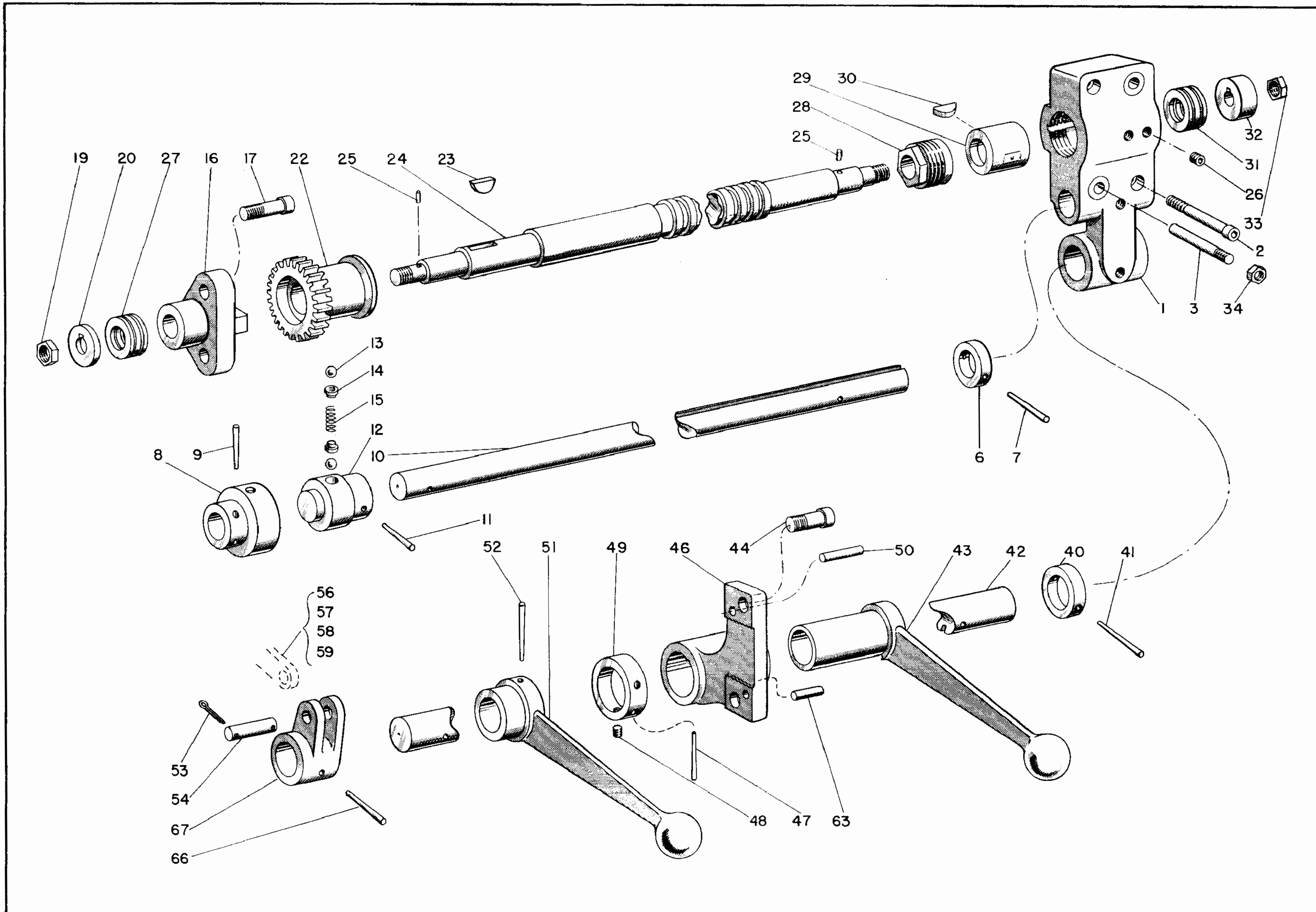
LEADSCREW AND FEED ROD

No	Name	No	Name
1	Back box for standard machine	14	Safety clutch cup
2	Back box screw	15	Safety clutch spring
4	Slip gear cover	16	Leadscrew quick change box bush
5	Slip gear screw	17	Allen screw
6	Feed rod collar	18	Cotter key
7	Taper pin	19	Castle nut
8	Safety ,clutch (feed box half)	20	Small thrust collar
9	Taper pin	21	Large thrust collar
10	Feed rod	22	Slip gear
11	Taper pin	23	Slip gear key
12	Safety clutch (feed rod half)	24	Leadscrew
13	Safety clutch ball	25	Straight pin
		26	Oiler screw

APRON SPINDLE CONTROL ROD

No	Name	No	Name	
40	Control rod collar	54	Clevis pin	see 13"-15" parts (54–58)
41	Taper pin	56	Set screw	
42	Control rod	57	Drum switch pinion	
43	Apron control handle	58	Rack	
44	Apron bracket mounting screw	59	Rack guide	
45	Oil hole screw	60	Front bracket mounting screw	
46	Apron bracket	61	Front bracket	
47	Taper pin	62	Back box for apron spindle control	
48	Set screw	63	Apron control handle stop pin	
49	Apron bracket collar	64	Detent spring	
50	Apron bracket pin	65	Detent ball	
51	Head end control handle	66	Taper pin	
52	Taper pin	67	Control rod arm	
53	Cotter key			

Leadscrew, Feed Rod and Apron Spindle Control Rod
21"-24" REGALS



LEADSCREW AND FEED ROD

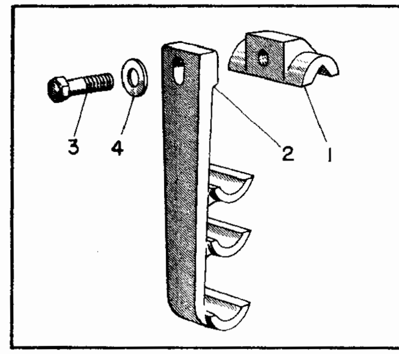
No.	Name	No.	Name
1.	Back box for standard machine	17.	Allen screw
2.	Back box screw	19.	Leadscrew nut
3.	Back box pin	20.	Thrust collar
4.	Slip gear cover } see 17"-19" parts	22.	Slip gear
5.	Slip gear screw } see 17"-19" parts	23.	Slip gear key
6.	Feed rod collar	24.	Leadscrew
7.	Taper pin	25.	Straight pin
8.	Safety clutch (feed box half)	26.	Oiler screw
9.	Taper pin	27.	Head end thrust bearing
10.	Feed rod	28.	Back box adjusting nut
11.	Taper pin	29.	Back box bush
12.	Safety clutch (feed rod half)	30.	Back box bush key
13.	Safety clutch ball	31.	Back box thrust bearing
14.	Safety clutch cup	32.	Back box thrust collar
15.	Safety clutch spring	33.	Leadscrew nut
16.	Leadscrew quick change box bush	34.	Draw pin nut

APRON SPINDLE CONTROL ROD

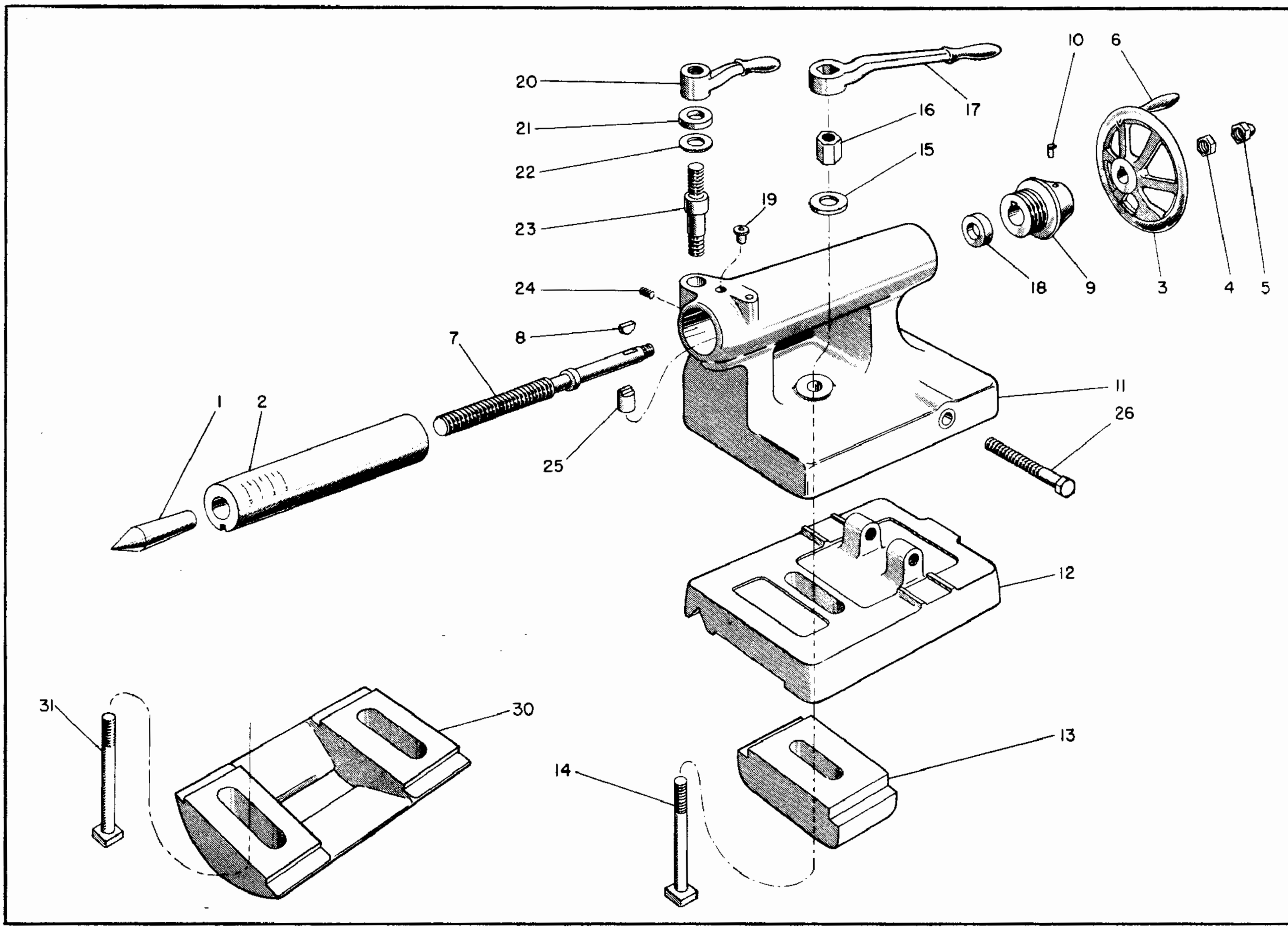
No.	Name	No.	Name
40.	Control rod collar	52.	Taper pin
41.	Taper pin	53.	Cotter key
42.	Control rod	54.	Clevis pin
43.	Apron control handle	56.	Set screw } see 13"-15" parts
44.	Apron bracket mounting screw	57.	Drum switch pinion } see 13"-15" parts
46.	Apron bracket	58.	Rack } see 13"-15" parts
47.	Taper pin	59.	Rack guide } see 13"-15" parts
48.	Set screw	63.	Apron control handle stop pin
49.	Apron bracket collar	66.	Taper pin
50.	Apron bracket pin	67.	Control rod arm
51.	Head end control handle		

Rod Supports All REGALS

No.	Name
1.	Support block
2.	Support
3.	Hex screw
4.	Washer



Tailstock
All REGALS

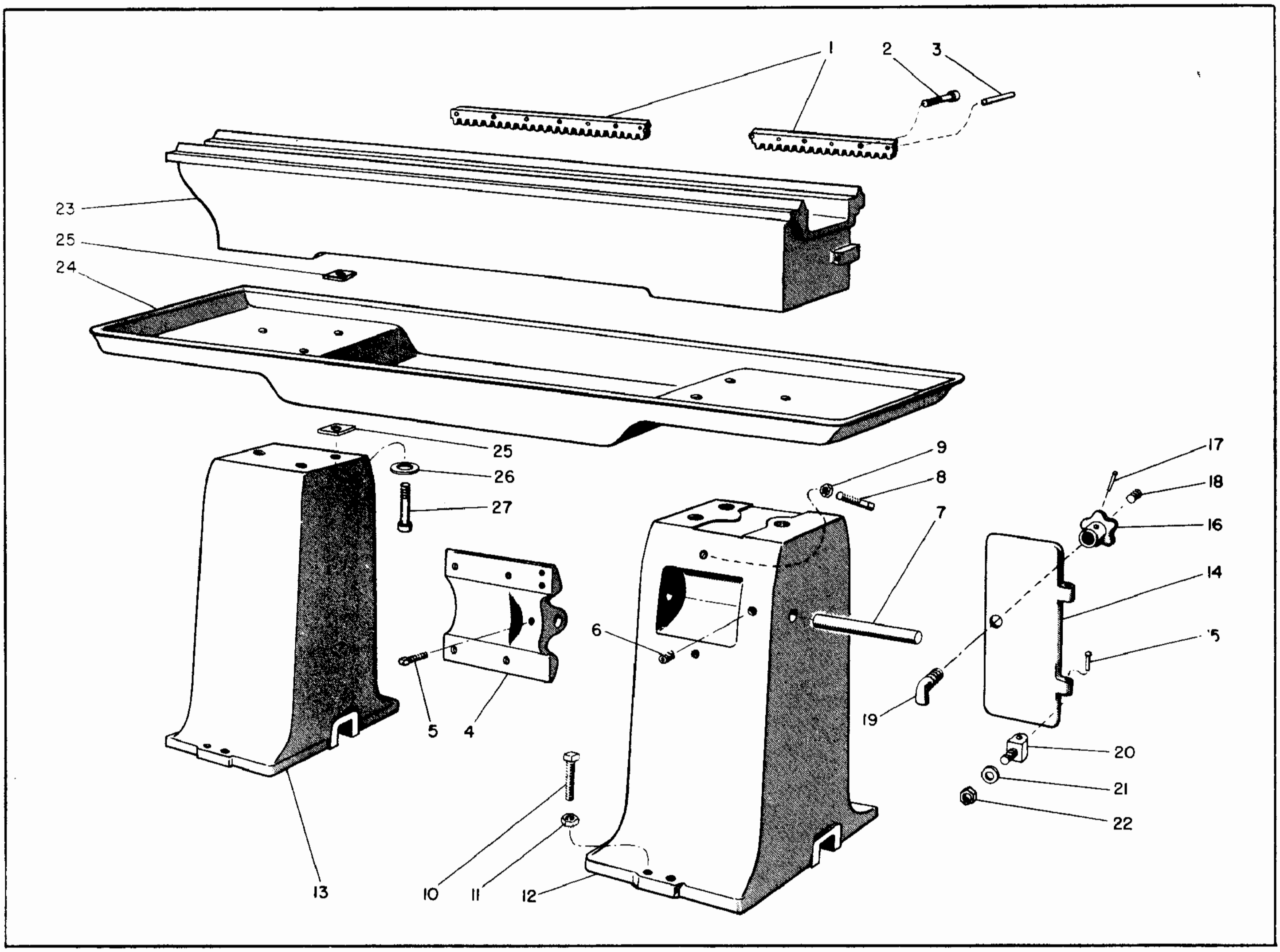


No.	Name
1.	Spindle center
2.	Spindle
3.	Handwheel
4.	Hex nut
5.	Acorn nut
6.	Handwheel handle
7.	Tailstock spindle screw
8.	Key
9.	End bell
10.	Oiler
11.	Tailstock top
12.	Tailstock bottom
13.	Tailstock clamp } 13"-15" Regals
14.	Tailstock clamp bolt } 13"-15" Regals
15.	Washer
16.	Hex nut
17.	Wrench
18.	Thrust bearing
19.	Oiler
20.	Clamp handle
21.	Washer
22.	Spacer
23.	Clamp stud
24.	Set screw
25.	Spindle key
26.	Set-over screw

17"-19"-21"-24" REGALS ONLY:

No.	Name
30.	Tailstock clamp
31.	Tailstock clamp bolt

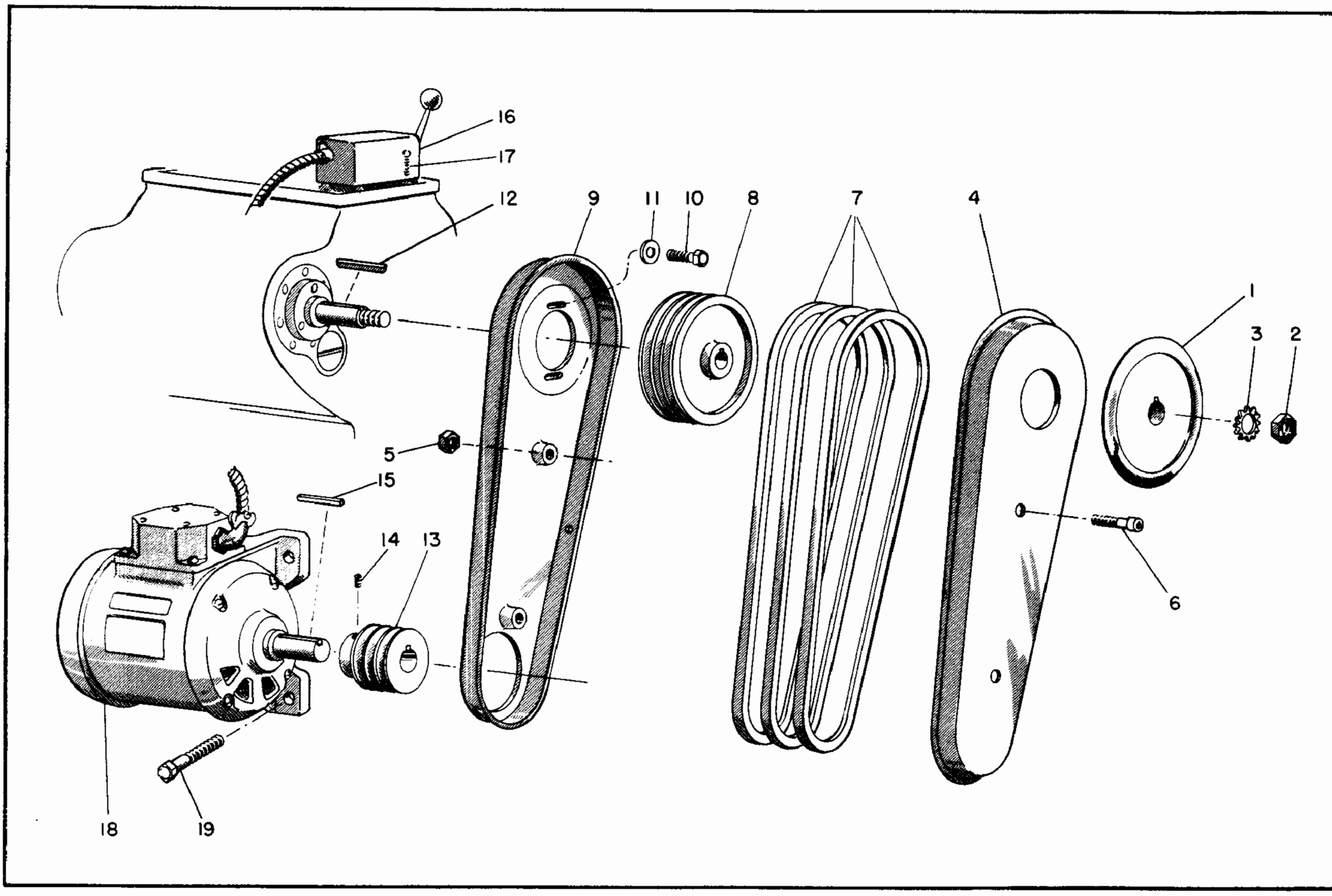
Bed and Cabinet Legs
All REGALS



No.	Name
1.	Rack
2.	Rack screw
3.	Rack pin
4.	Motor base
5.	Motor base lock screw
6.	Motor base shaft lock screw
7.	Motor base shaft
8.	Belt adjusting screw
9.	Belt adjusting screw lock nut
10.	Leveling screw
11.	Leveling screw nut
12.	Head end leg } different shapes on
13.	Tail end leg } each size Regal
14.	Leg door

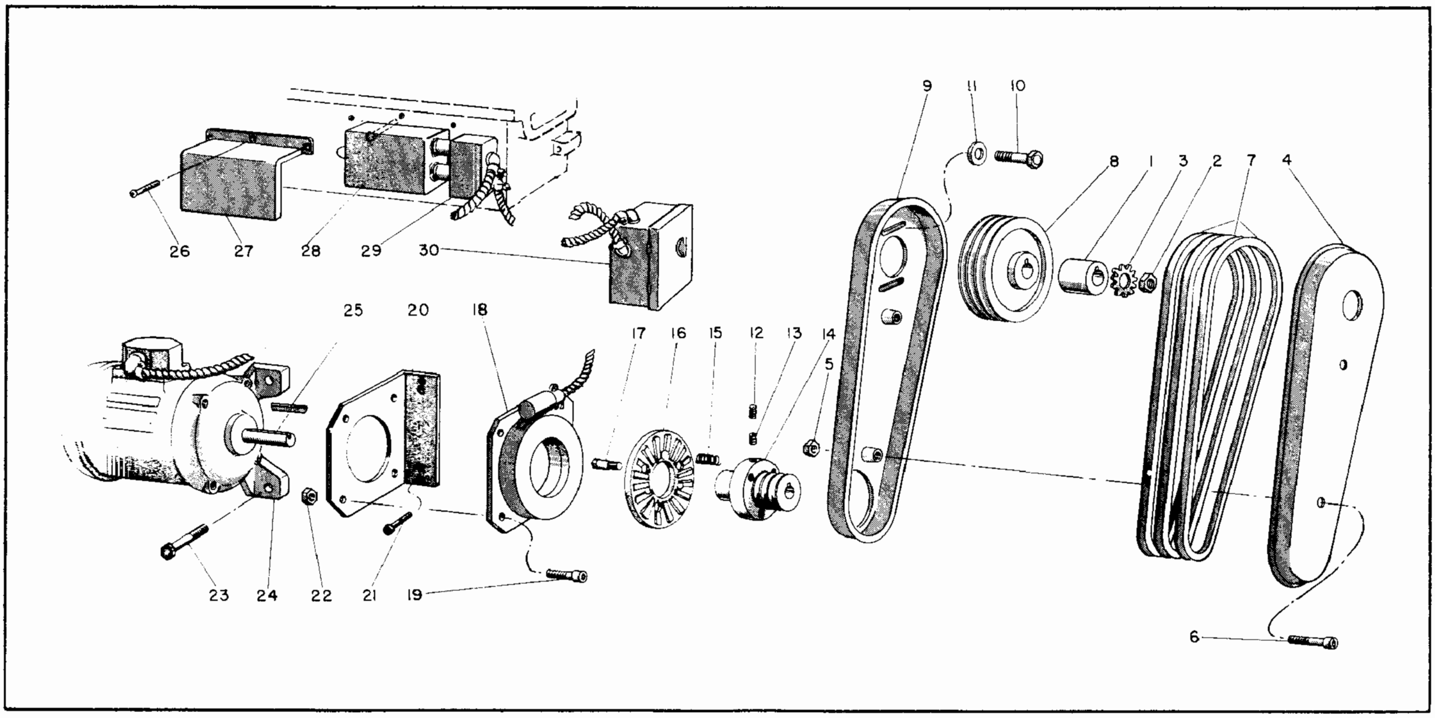
No.	Name
15.	Door hinge pin
16.	Door latch knob
17.	Door latch knob pin
18.	Door latch knob screw
19.	Door latch
20.	Hinge
21.	Hinge washer
22.	Hinge nut
23.	Bed
24.	Pan
25.	Bed-pan-leg gasket
26.	Leg-to-bed washer
27.	Leg-to-bed screw

Standard Motor Drive Details
13"-15"-17"-19" REGALS



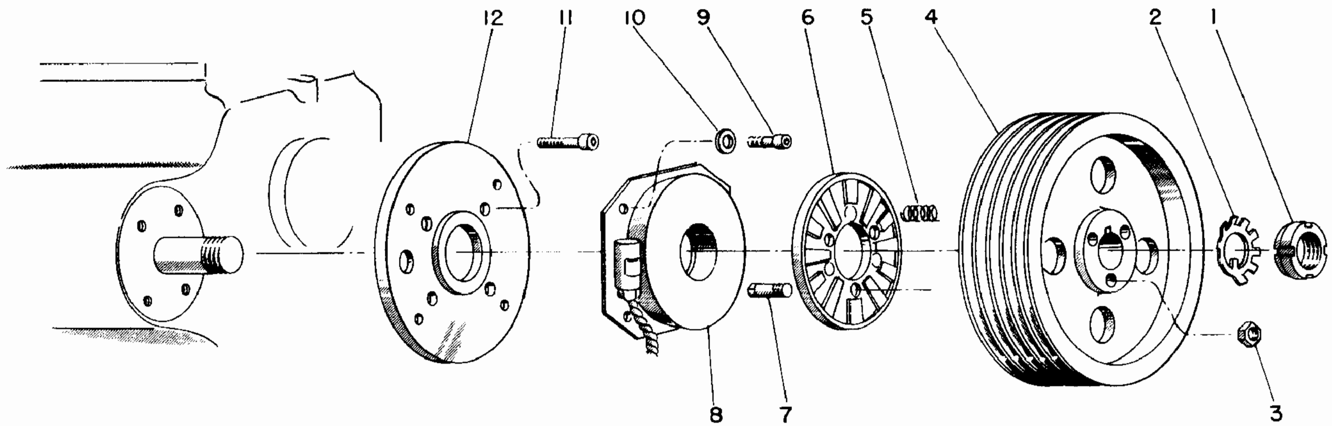
No.	Name	No.	Name
1.	Handwheel	11.	Belt cover washers
2.	Drive shaft hex nut	12.	Drive pulley key
3.	Drive shaft lock washer	13.	Motor sheeve
4.	Belt cover, outer half	14.	Motor sheeve set screw
5.	Belt cover hex nuts	15.	Motor sheeve key
6.	Belt cover screws	16.	Drum switch
7.	Vee-belts	17.	Drum switch screws
8.	Drive pulley	18.	Motor
9.	Belt cover, inner half	19.	Motor mounting screws
10.	Belt cover hex screws		

Motor Drive Details with Electric Brake
13"-15"-17"-19" REGALS



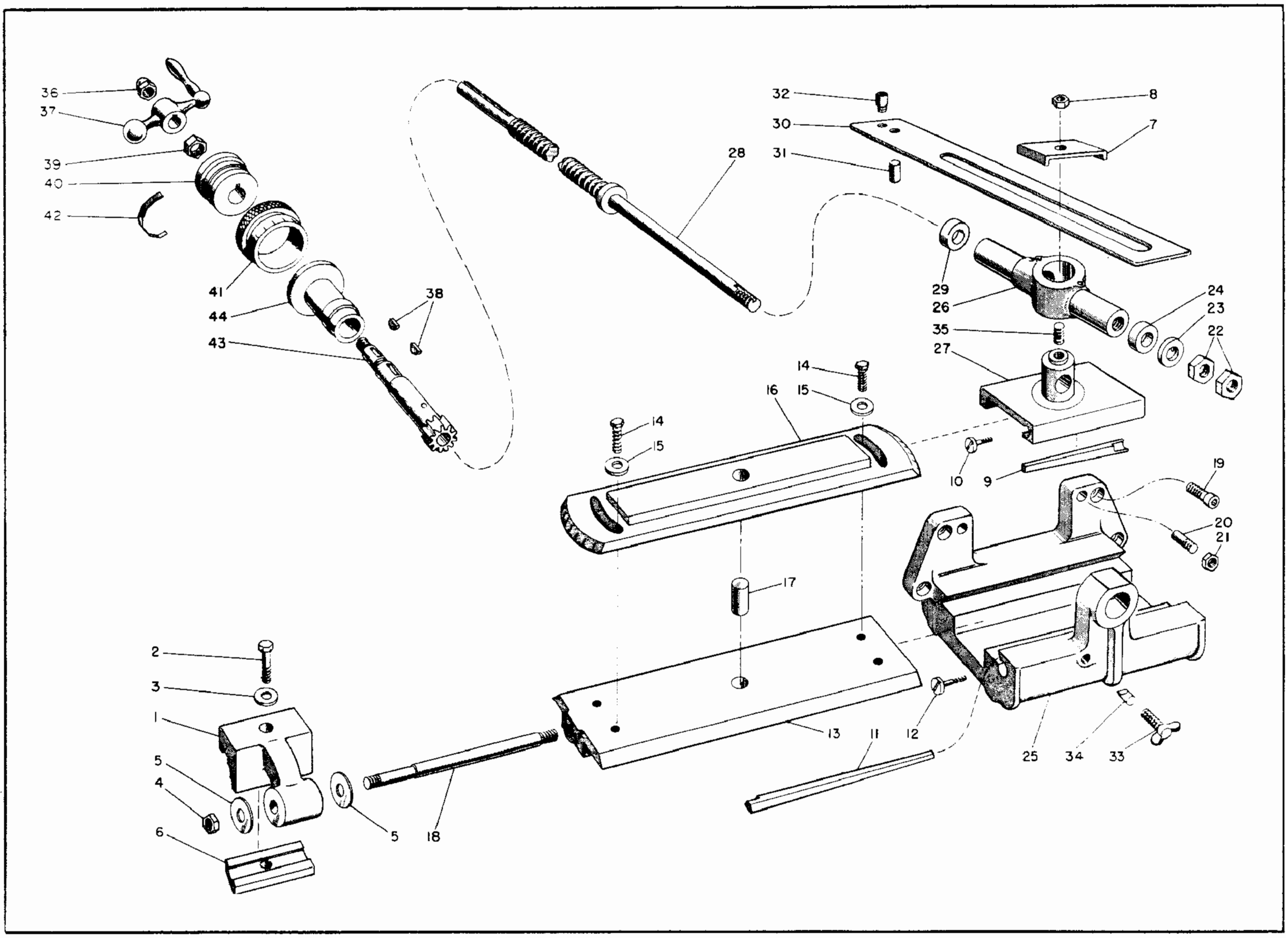
No.	Name	No.	Name	No.	Name
1.	Drive shaft sleeve	11.	Belt cover washers	21.	Brake mounting plate screws
2.	Drive shaft hex nut	12.	Lock set screw	22.	Brake mounting hex nuts
3.	Drive shaft lock washer	13.	Set screw	23.	Motor mounting screws
4.	Belt cover, outer half	14.	Motor sheeve	24.	Motor
5.	Belt cover hex nuts	15.	Brake spring (One unit)	25.	Motor sheeve key
6.	Belt cover screws	16.	Brake armature (One unit)	26.	Cover screws
7.	Vee-belts	17.	Armature pins (One unit)	27.	Switch cover
8.	Drive pulley	18.	Brake stator (One unit)	28.	Drum switch
9.	Belt cover, inner half	19.	Stator-to-plate screws	29.	Conduit box
10.	Belt cover hex screws	20.	Brake mounting plate	30.	Brake power pack

Motor Drive Details with Electric Brake
21"-24" REGALS



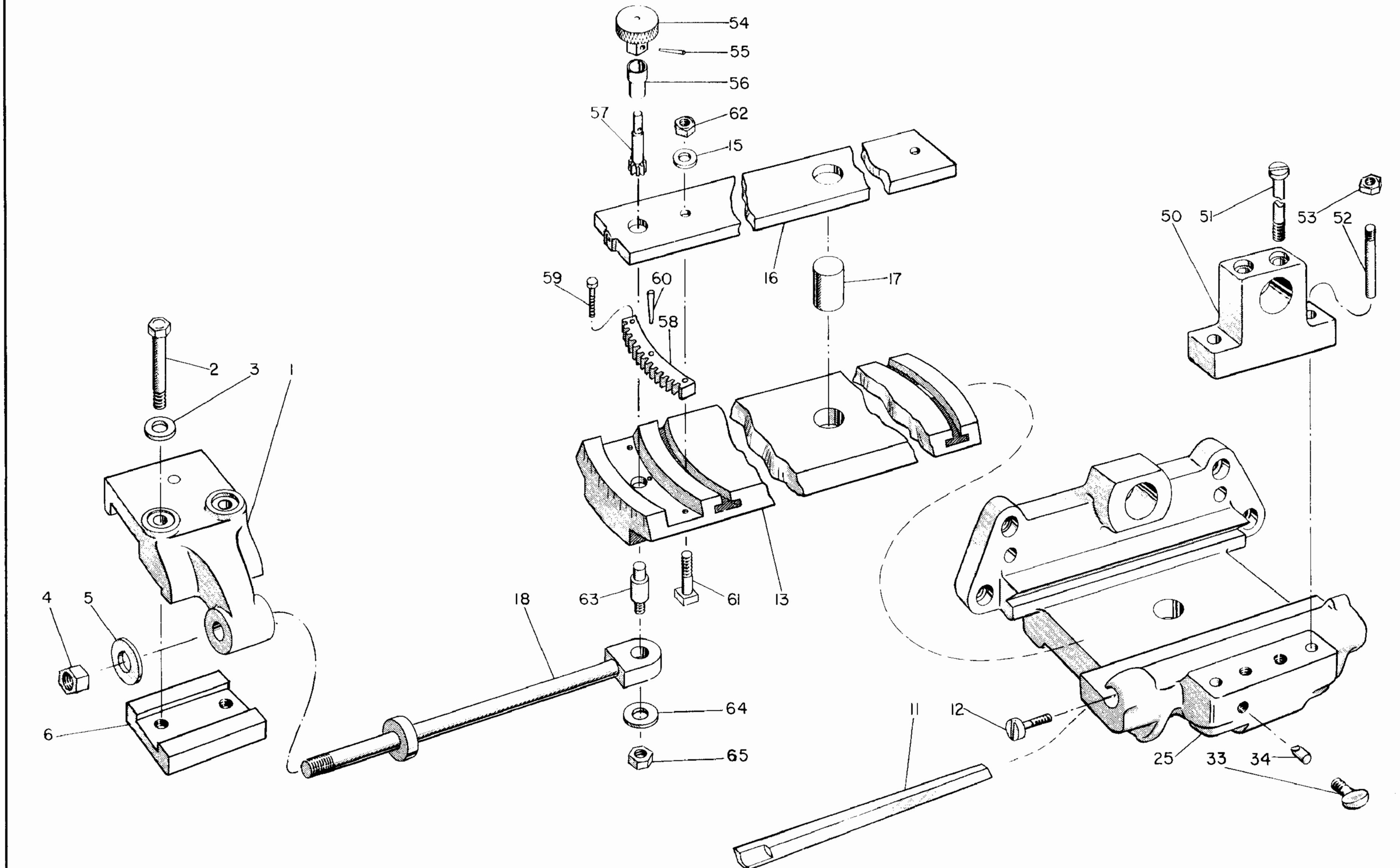
No.	Name	No.	Name		No.	Name
1.	Drive shaft lock nut	5.	Armature springs	One unit	9.	Stator mounting screw
2.	Drive shaft lock washer	6.	Armature	One unit	10.	Stator mounting washer
3.	Armature screw hex nut	7.	Armature screws	One unit	11.	Mounting plate screw
4.	Drive pulley	8.	Stator	One unit	12.	Mounting plate

Taper Attachment
13"-15"-17"-19" REGALS



No.	Name
1.	Bed bracket
2.	Bed bracket screw
3.	Bed bracket screw washer
4.	Draw rod nut
5.	Draw rod washer
6.	Bed bracket clamp
7.	Bottom slide draw bar clamp
8.	Bottom slide draw bar clamp nut
9.	Taper attachment shoe gib
10.	Taper attachment shoe gib screw
11.	Taper attachment slide gib
12.	Taper attachment slide gib screw
13.	Taper attachment slide
14.	Taper attachment slide screw
15.	Taper attachment slide screw washer
16.	Taper attachment swivel slide
17.	Taper attachment swivel pin
18.	Taper attachment slide draw rod
19.	Mounting screw
20.	Draw pin
21.	Draw pin nut
22.	Cross feed screw lock nuts
23.	Cross feed screw thrust collar
24.	Thrust bearing
25.	Taper attachment bracket
26.	Taper attachment carriage shoe
27.	Taper attachment shoe
28.	Cross feed screw
29.	Thrust bearing
30.	Bottom slide draw bar
31.	Bottom slide draw bar pin
32.	Bottom slide draw bar screw
33.	Safety screw
34.	Safety screw plug
35.	Taper attachment shoe stud
36.	Acorn nut
37.	Balcrank handle
38.	Cross feed pinion sleeve key
39.	Cross feed pinion sleeve hex nut
40.	Micrometer dial hub
41.	Micrometer dial
42.	Micrometer spring
43.	Cross feed pinion sleeve
44.	Cross feed bush

Taper Attachment
21"-24" REGALS



No.	Name
1.	Bed bracket
2.	Bed bracket screw
3.	Bed bracket screw washer
4.	Draw rod nut
5.	Draw rod washer
6.	Bed bracket clamp
7.	*Bottom slide draw bar clamp
8.	*Bottom slide draw bar clamp nut
9.	*Taper attachment shoe gib
10.	*Taper attachment shoe gib screw
11.	Taper attachment slide gib
12.	Taper attachment slide gib screw
13.	Taper attachment slide

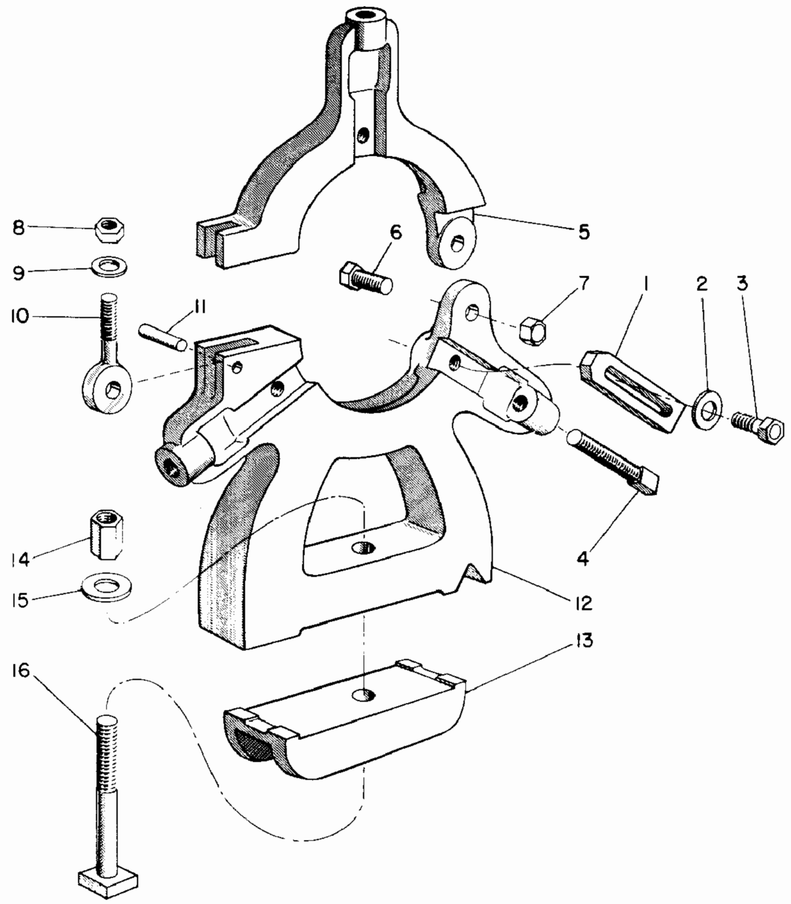
No.	Name
15.	Taper attachment slide screw washer
16.	Taper attachment swivel slide
17.	Taper attachment swivel pin
18.	Taper attachment slide draw rod
19.	*Mounting screw
20.	*Draw pin
21.	*Draw pin nut
22.	*Cross feed screw lock nuts
23.	*Cross feed screw thrust collar
24.	*Thrust bearing
25.	Taper attachment bracket
26.	*Taper attachment carriage shoe
27.	*Taper attachment shoe
28.	*Cross feed screw
29.	*Thrust bearing
30.	*Bottom slide draw bar

No.	Name
31.	*Bottom slide draw bar pin
32.	*Bottom slide draw bar screw
33.	Safety screw
34.	Safety screw plug
35.	*Taper attachment shoe stud
36.	*Acorn nut
37.	*Balcrank handle
38.	*Cross feed pinion sleeve key
39.	*Cross feed pinion sleeve hex nut
40.	*Micrometer dial hub
41.	*Micrometer dial
42.	*Micrometer spring
43.	*Cross feed pinion sleeve
44.	*Cross feed bush
50.	Carriage shoe bracket

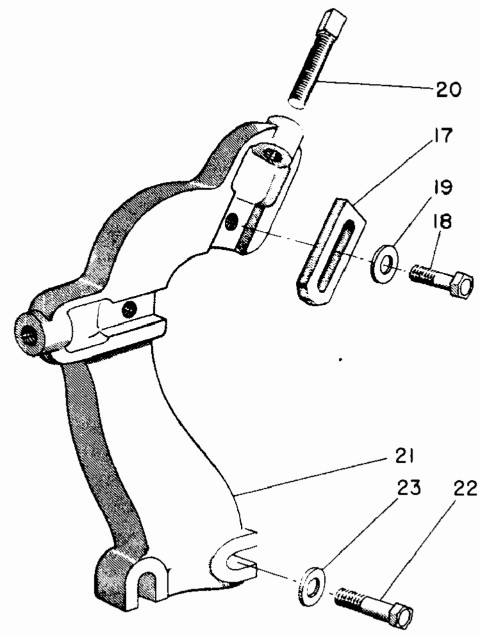
No.	Name
51.	Carriage shoe bracket screw
52.	Carriage shoe bracket draw pin
53.	Carriage shoe bracket draw pin nut
54.	Set-over knob
55.	Set-over knob pin
56.	Set-over bush
57.	Set-over pinion
58.	Set-over rack
59.	Set-over rack screw
60.	Set-over rack pin
61.	T-slot bolt
62.	T-slot bolt hex nut
63.	Draw rod stud
64.	Draw rod stud washer
65.	Draw rod stud hex nut

* See 13"-15"-17"-19" Regals page 83.

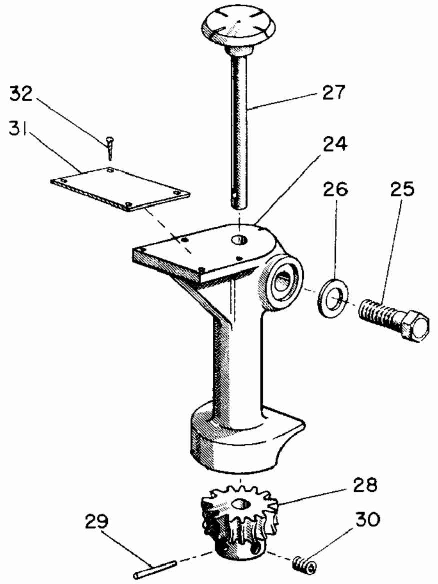
Steady Rest (standard capacity)
All REGALS



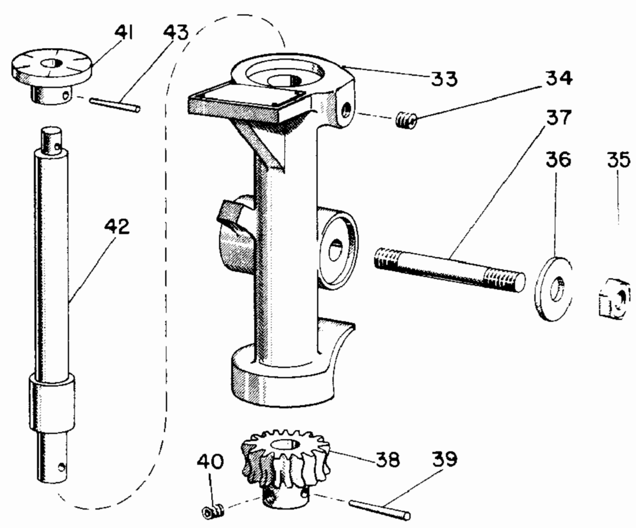
Follow Rest
All REGALS



Chasing Dial
13"-15" REGALS



Chasing Dial
17"-19"-21"-24" REGALS



STEADY REST

No.	Name
1.	Steady rest jaw
2.	Steady rest jaw washer
3.	Steady rest jaw screw
4.	Steady rest jaw adjusting screw
5.	Steady rest top
6.	Hinge screw
7.	Hinge screw nut
8.	Clamping nut
9.	Clamping nut washer
10.	Eyebolt
11.	Eyebolt pin
12.	Steady rest bottom
13.	Steady rest clamp
14.	Steady rest clamp nut
15.	Steady rest clamp washer
16.	Steady rest clamp bolt

FOLLOW REST

No.	Name
17.	Follow rest jaw
18.	Follow rest jaw screw
19.	Follow rest jaw washer
20.	Follow rest jaw adjusting screw
21.	Follow rest
22.	Mounting screw
23.	Mounting screw washer

CHASING DIAL 13"-15" REGALS

No.	Name
24.	Chasing dial body
25.	Mounting screw
26.	Mounting screw washer
27.	Chasing dial shaft
28.	Worm
29.	Worm pin
30.	Worm set screw
31.	Instruction plate
32.	Drive pin

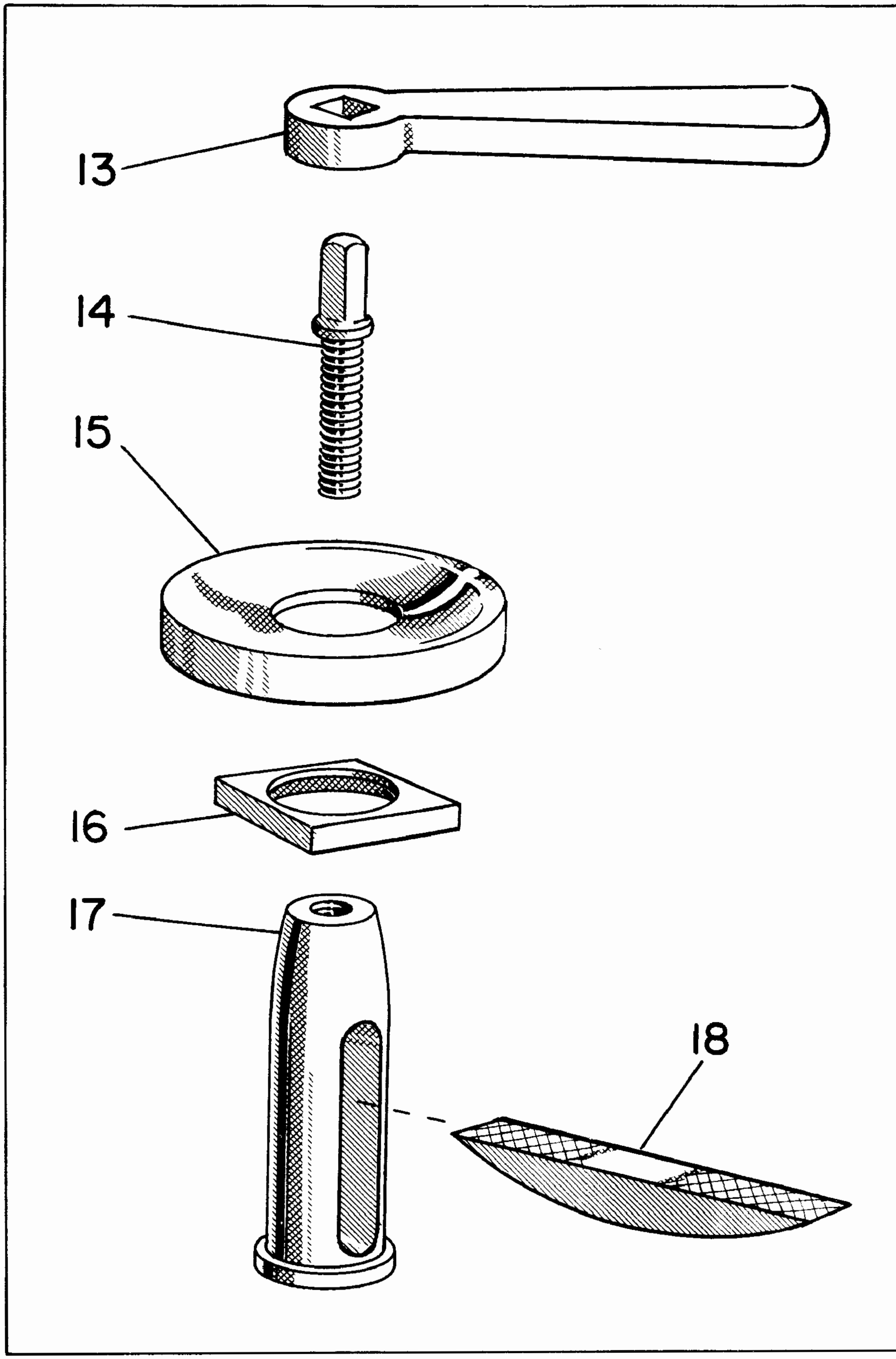
CHASING DIAL 17"-19"-21"-24" REGALS

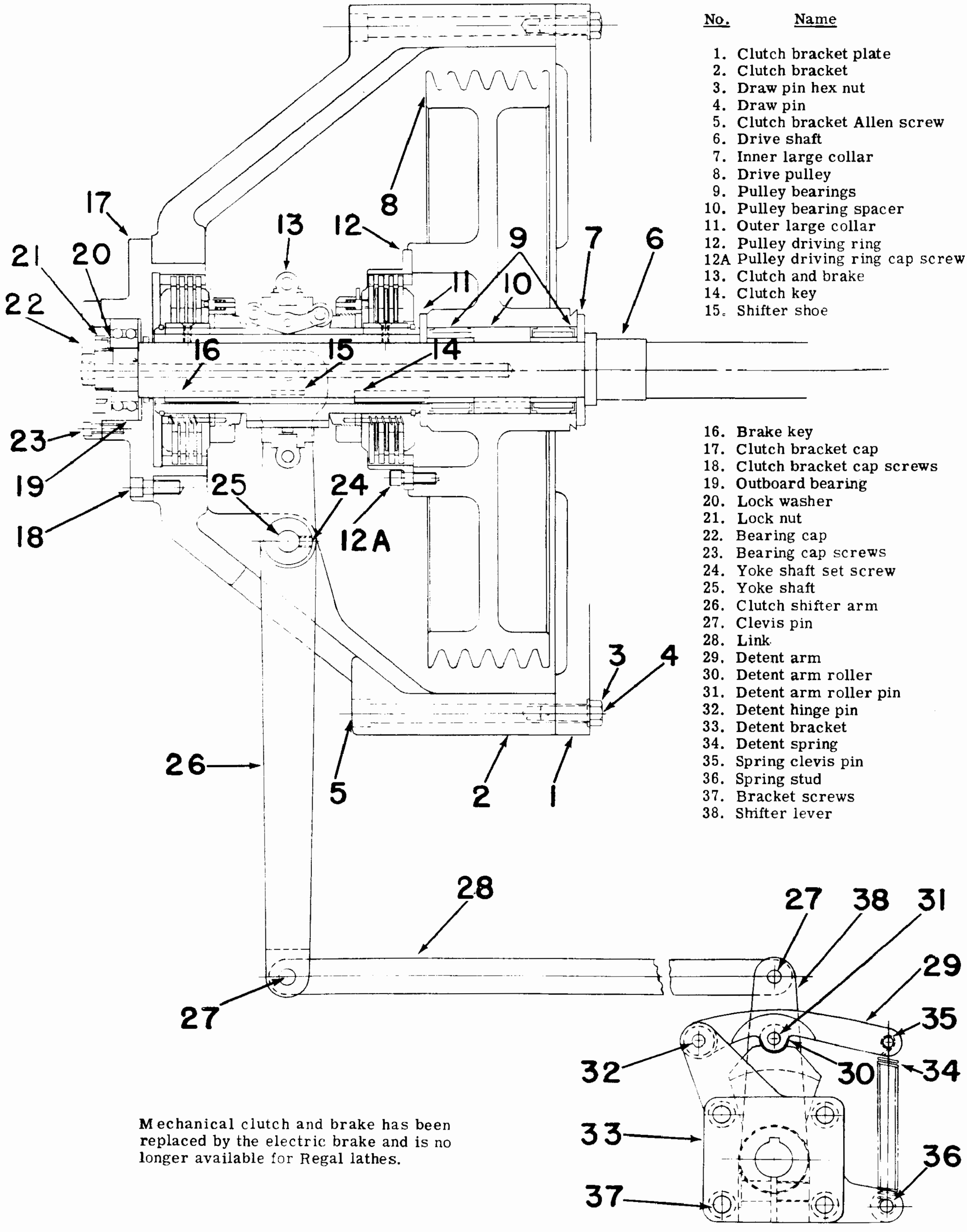
No.	Name
33.	Chasing dial body*
34.	Oiler screw
35.	Hex nut
36.	Washer
37.	Stud
38.	Worm
39.	Worm pin
40.	Worm set screw
41.	Dial
42.	Dial shaft
43.	Dial shaft pin

* Dial body is a slightly different shape on 21"-24" models.

Tool Post

No.	Name
13.	Tool post wrench
14.	Tool post screw
15.	Dished washer
16.	Square collar
17.	Tool post
18.	Tool post rocker





No.	Name
1.	Clutch bracket plate
2.	Clutch bracket
3.	Draw pin hex nut
4.	Draw pin
5.	Clutch bracket Allen screw
6.	Drive shaft
7.	Inner large collar
8.	Drive pulley
9.	Pulley bearings
10.	Pulley bearing spacer
11.	Outer large collar
12.	Pulley driving ring
12A	Pulley driving ring cap screw
13.	Clutch and brake
14.	Clutch key
15.	Shifter shoe
16.	Brake key
17.	Clutch bracket cap
18.	Clutch bracket cap screws
19.	Outboard bearing
20.	Lock washer
21.	Lock nut
22.	Bearing cap
23.	Bearing cap screws
24.	Yoke shaft set screw
25.	Yoke shaft
26.	Clutch shifter arm
27.	Clevis pin
28.	Link
29.	Detent arm
30.	Detent arm roller
31.	Detent arm roller pin
32.	Detent hinge pin
33.	Detent bracket
34.	Detent spring
35.	Spring clevis pin
36.	Spring stud
37.	Bracket screws
38.	Shifter lever

Mechanical clutch and brake has been replaced by the electric brake and is no longer available for Regal lathes.