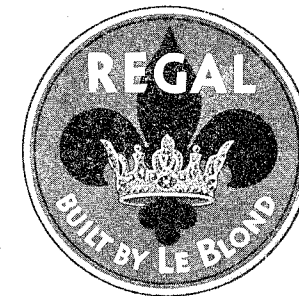


RUNNING A REGAL

A Manual of Lathe
Operations and Main-
tenance of a modern

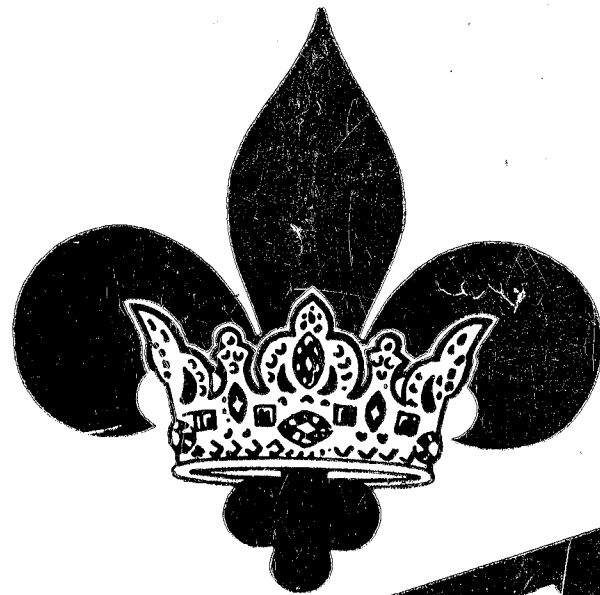
GEARED HEAD
ENGINE LATHE



Price 25 Cents Prepaid

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

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RUNNING A REGAL

THE R. K. LEBLOND MACHINE TOOL CO.
LARGEST MANUFACTURER OF A COMPLETE LINE OF LATHES
CINCINNATI 8, OHIO, U. S. A.

PREFACE

THIS manual is intended to present the basic principles of lathe operation to the student, the apprentice and others mechanically inclined.

The Engine Lathe is the basic, fundamental tool of industry. Henry Maudslay's crude lathe of the late Eighteenth Century was the beginning of the world's most prosperous era, and it is still the basic machine of industrial manufacturing. Without it the present industrial era would not exist. Our luxuries and conveniences would be only a dream. It has made possible our various modes of transportation—steamships, electric and steam railways, automobiles and airplanes. Without lathes the production machines used for manufacturing these conveniences would not be possible. Practically every modern mechanical invention and improvement is developed through the use of engine lathes which produce the majority of the component parts of the new machine.

In view of its importance to industry, and as a servant to mankind, it is remarkable that so few people know just what an engine lathe is, what it will do and how it is operated.

To make this booklet as practical as possible, we have assigned one of our men, who has not only operated, but designed and built engine lathes for many years, to give you in plain language the benefit of his knowledge and experience on the subject.

It is almost impossible to cover all phases of operation which might come up in connection with running a lathe; however, we are always glad to assist you in solving your individual problems if you will write us, giving complete details of what you are trying to accomplish.

Running a Regal will be a valuable guide to the beginner. This manual will familiarize him with the various parts of a modern engine lathe, with procedure and operation, and with the kinds of work that can be performed on it. If this book is helpful, we will be more than compensated for its publication.

The R. K. LeBlond Machine Tool Co.

CINCINNATI 8, OHIO, U. S. A.

August, 1946. 11th Edition.

IMPORTANT

Read Carefully

When you order a LeBlond Regal Lathe you will receive an acknowledgment of the order. Acknowledgment specifies a date of shipment, also the probable amount of freight charges for transporting the lathe from the factory to your nearest shipping point.

When the lathe is shipped from the factory, the railroad company or other transporting agency issues a bill of lading. This is a receipt that the machine has been accepted in good order by the railroad.

The railroad freight agent will advise you when the lathe reaches its destination. The lathe becomes your property upon payment of the freight charges and surrender of the bill of lading.

Before accepting the shipment, be sure that the lathe has not been damaged in transit. Regal Lathes are carefully crated to protect them against the usual handling. Sometimes, however, in switching or transferring from one car to another, they are subjected to rough handling, causing breakage for which the railroad company is responsible. Therefore, inspect the machine carefully. If damaged in any way, do not accept it, but write at once to our Traffic Department, giving complete information on the nature of the damage. We will immediately take up the matter with the railroad company and have it adjusted to your satisfaction.

When ordering repair parts always specify size of lathe and serial number. The serial number is stamped on the flat surface of the front way at the tailstock end of the bed. Prior to 1940 it was stamped on the cross girth of the bed, at the tailstock end.

B 10117
144 9
X 72" B20

How To Set Up The Lathe

The lathe should be placed in a well lighted area. If the space available is dark, artificial illumination should be provided. The shop should be comparatively dry to keep the machine free from rust.

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

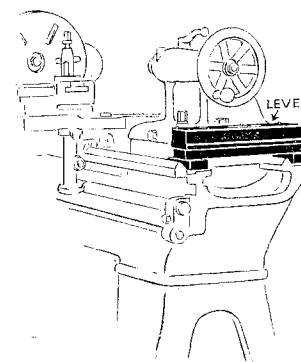
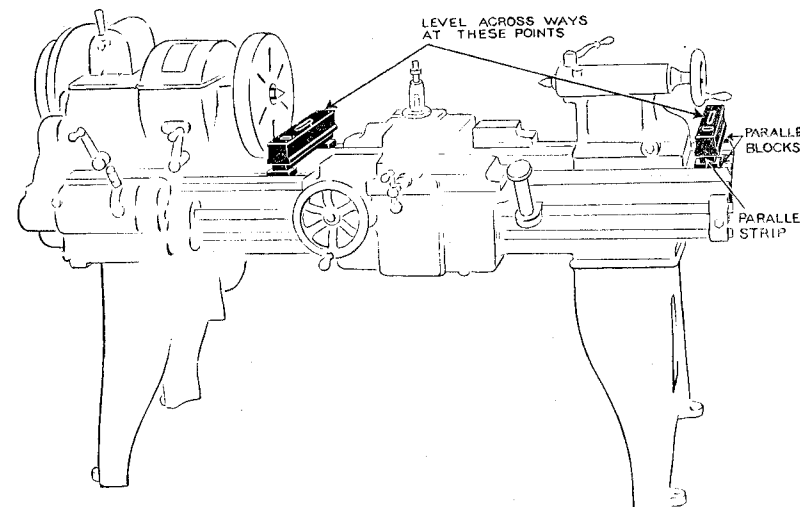
The floor on which the lathe sets should be absolutely firm. A lathe must set level and solid in order to perform accurately. It will be impossible to keep the machine level and in alignment if the floor is springy. Therefore, a solid foundation for the tool is of the utmost importance.

Next remove the lag screws which hold the legs to the skids and remove the skids from under the machine, taking care that the machine does not upset.

Remove all slush oil from the various parts of the machine. This can best 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.

The lathe is then ready to be leveled. Even some of the best mechanics do not realize how important it is to level the lathe properly. Although the bed is heavy it can easily be sprung if not properly leveled. All of our care and inspection is wasted if the machine is not set up properly.

First of all, secure a precision ground bulb level for this work, such as made by Pratt & Whitney, Starret, or Queen & Company. An ordinary carpenter's level or a combination square level is not sensitive enough for this important operation. Next drive hardwood wedges under each of the legs to compensate for any depressions in the floor. Special wedges are not necessary, a shingle will do very well. Place the level on two short parallel strips between the front and back ways just as near to the headstock as possible, and drive the wedges under the headstock legs until the bubble is in the center of the bulb. Then take the level and parallel strips to the tailstock end of the lathe and wedge up under the tailstock legs until the level registers the same as at the headstock end. By repeating this several times, both the head and tailstock ends of the bed



will be brought to a perfect level. The lathe, when properly leveled, should show the same degree of accuracy of alignment as noted on the test card which accompanies each machine.

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 will be necessary from time to time to check and correct the machine for level.

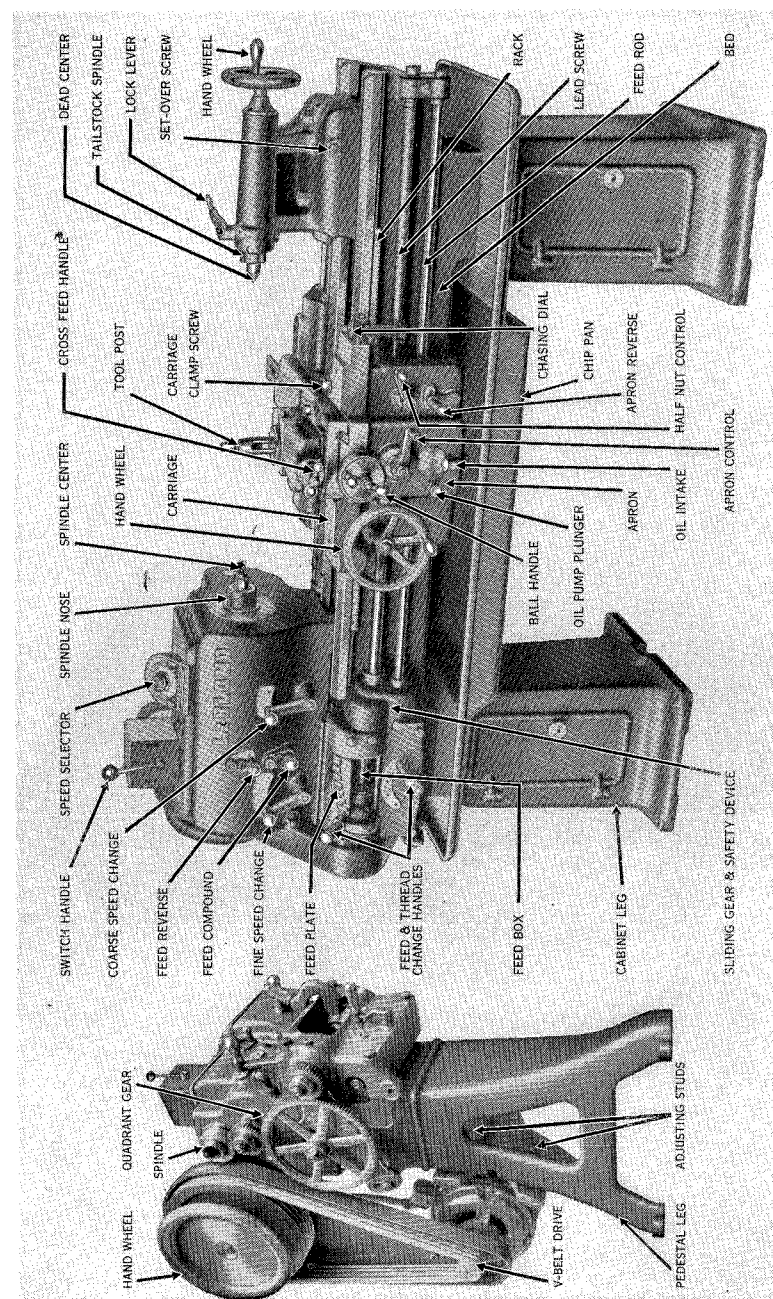
The next step is to connect the service lines to the motor. It is important that the voltage and the other specifications of the motor are the same as those of your service lines. The data plate on the motor specifies whether the current should be direct (D. C.) or alternating (A. C.). If direct current is specified, the voltage is shown. If alternating current is specified, the voltage, frequency (cycles) and number of phases are shown. If there is any doubt about the current and voltage, call your local power and light company and verify the supply. If there is a difference, advise us before connecting, and avoid burning out or otherwise damaging the motor.

Before you start the lathe consult the lubrication chart on the following pages, which shows the location of various oil inlets on the machine. Fill the headstock with a medium grade of machine or engine oil (SAE 20) to the oil level line indicated on the chart 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.

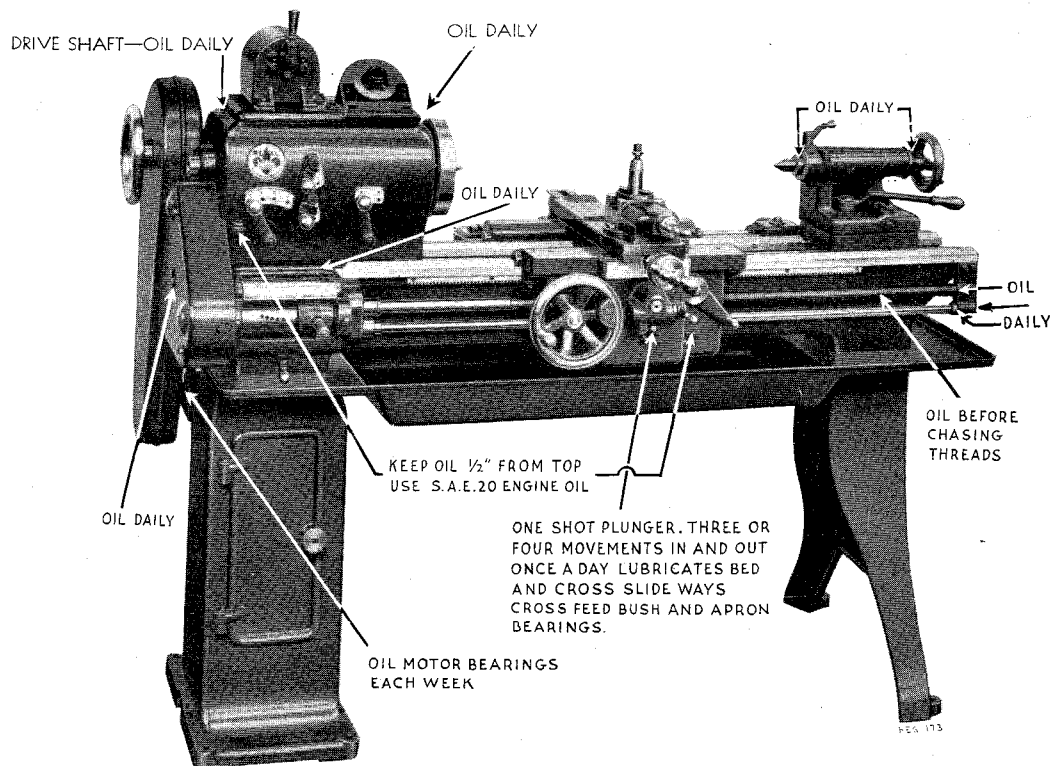
A lathe, like an automobile or any other piece of mechanical equipment, depends on the attention it receives during the first three or four days' use—"the breaking-in period". See that all bearings are carefully oiled and watch that none run hot.

Get Acquainted With Your Lathe

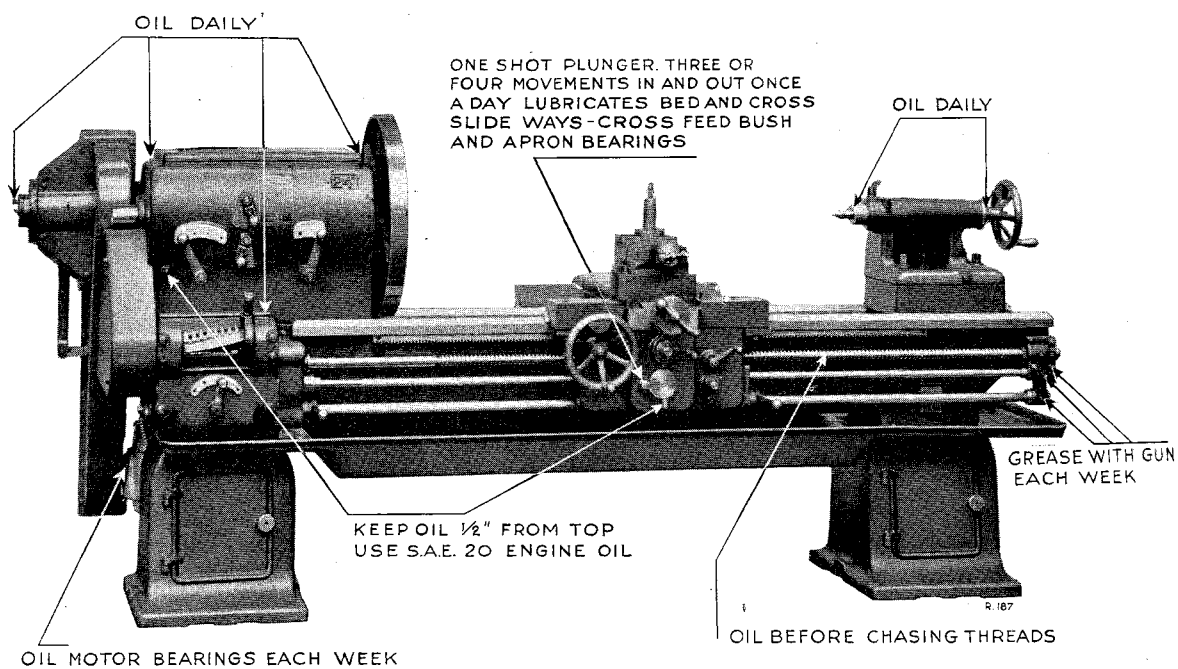
Before trying to do any work on the machine, the operator should familiarize himself with the names of the various working parts from the chart on page 7, as the parts are referred to throughout the book by these names. He should also know the functions of the various parts.



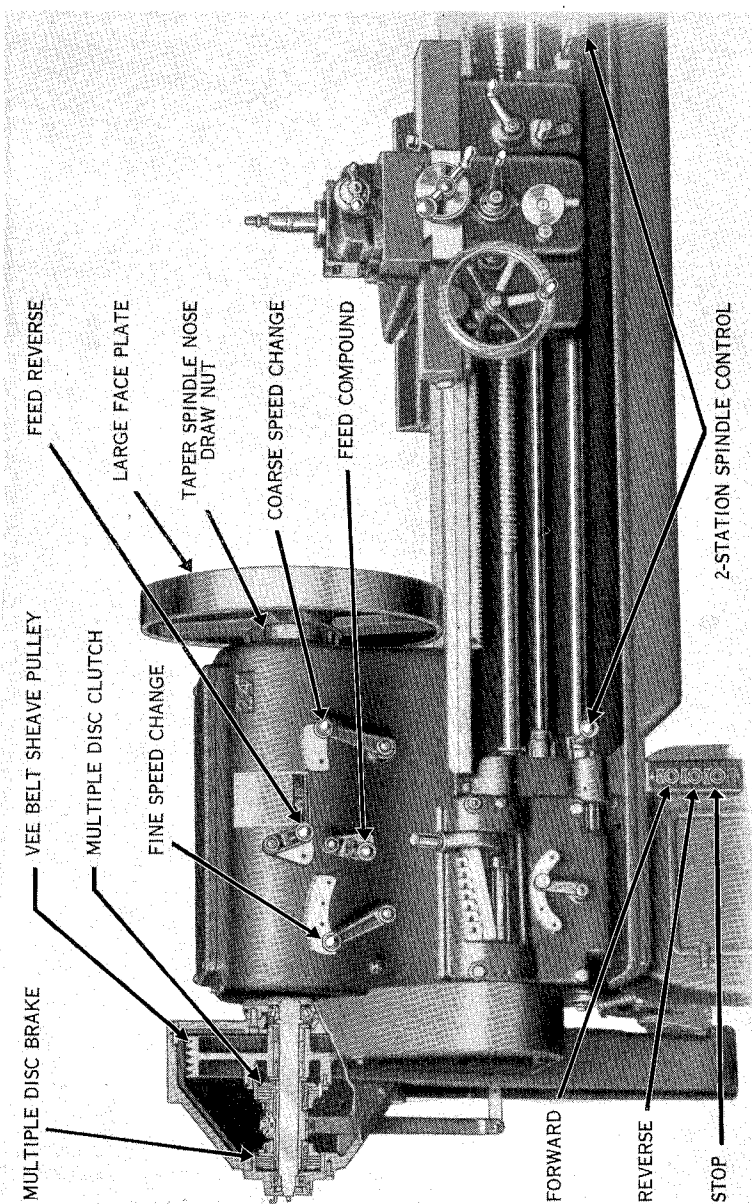
DESCRIPTION CHART—13" to 19" REGAL LATHES



LUBRICATION CHART 13" to 19" REGAL LATHES

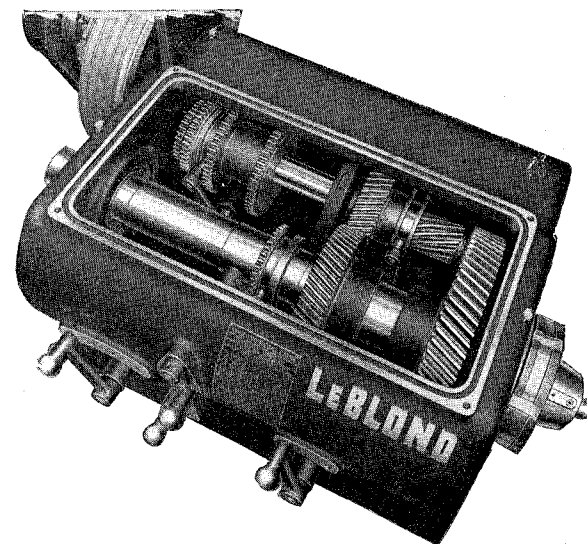
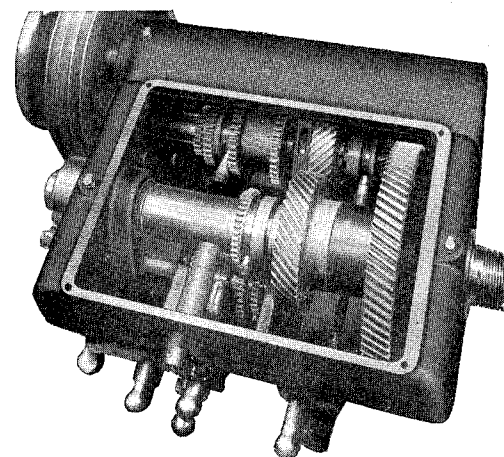


LUBRICATION CHART 21" and 24" REGAL LATHES



DESCRIPTION CHART—21"-24" and Lathes with Multiple Disc Clutch and Brake (Optional on 13", 15", 17" and 19")

13"-19" Regal Headstock

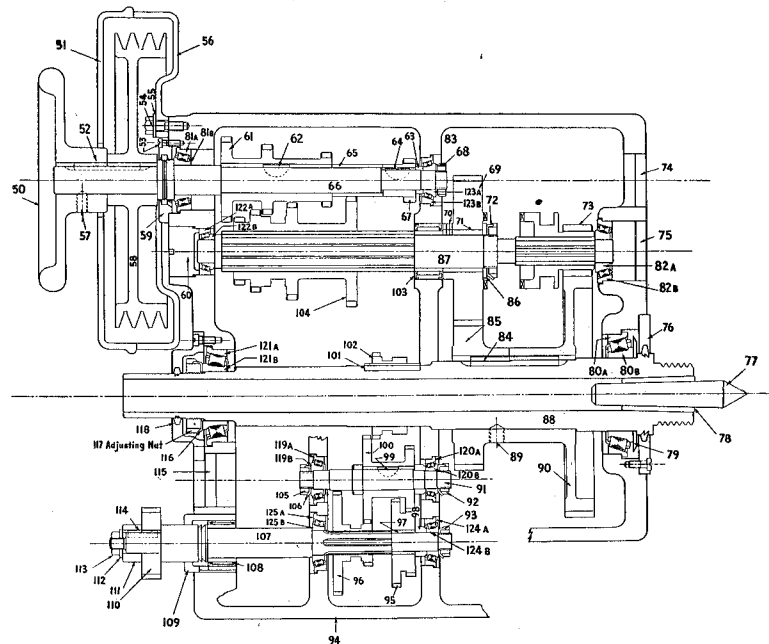


21"-24" Regal Headstock. Note the clutch and brake and tapered spindle nose furnished as standard equipment.

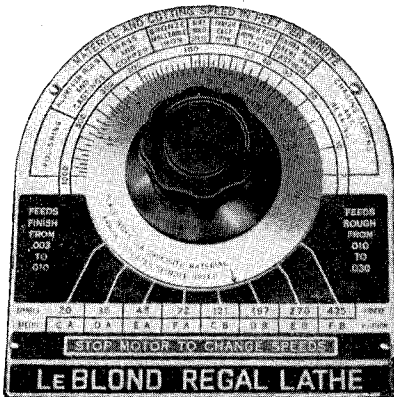
In both models, reverse to leadscrew, feed rod and compounding feed gears are all incorporated within the 8-speed selective geared headstock. Gears are steel throughout, and all gears and shafts run in oil.

Headstock 13 to 24-inch

The headstock spindle and shafts on the 13" to 24" lathes are all on anti-friction bearings, splash oiled, and require very little attention. The spindle bearings 80 A & B and 121 A & B can be adjusted by removing cover (118) and turning nut (117) to the



right as tight as it can be pulled by hand with a spanner wrench. However, with the normal use of a lathe, it is necessary only at long intervals. Headstocks on the Le Blond Regal Lathes have the reverse to the leadscrew and compounding feed gears built in the head and controlled by two levers on the headstock. The upper small lever in the center of the head reverses the feed and the lower small lever compounds the feed. No reverse plate, quadrant or slip gear is required. The drive is direct from the head through an idler gear to the feed box.

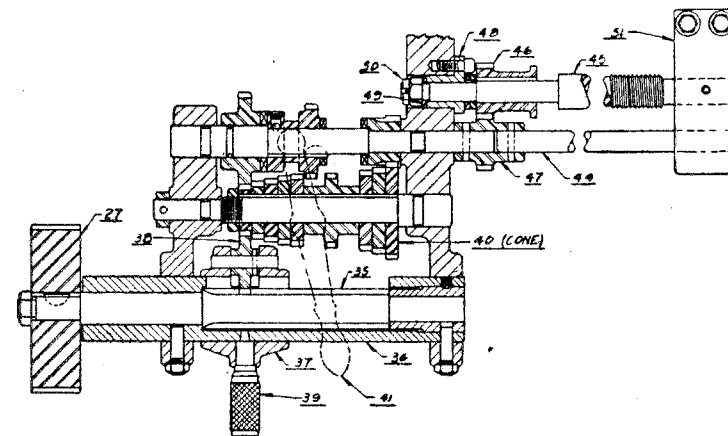


The 13" to 19" sizes also have the speed selector on head. (See opposite page.) A simple device that indicates the cut speed and the proper r.p.m. for all commonly machined materials. The lever positions are indicated on the dial below the r.p.m. Just set the work diameter dimension on the dial at the material being machined and the arrow will indicate the lever setting for most effective speed for the job.

See page 19 for direction operation of feed reverse lever.

Quick Change Mechanism 13-15-inch

The quick change box gear (27), below, is driven by an idler gear from the feed gears in the head. It (27) is mounted on the end of the sleeve gear (35). This sleeve gear runs inside of the quick change box sleeve (36). The quick change box tumbler (37) is mounted on the sleeve (36). The back of the sleeve is cut out to permit the tumbler gear (38) to engage the sleeve gear. By means of the tumbler gear handle (39) the tumbler gear can be rocked into engagement with any of the change gears (40) in cone formation. This is done by pulling out the handle plunger and bearing down on 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. The eight feed

changes obtained through the tumbler gear and the quick change gear are multiplied three times by means of the three positions of the compound lever (41), which operates a sliding gear and gives three different gear ratios to the feed shaft. In the feed

THE R. K. LeBLOND M. T. CO. CINCINNATI, OHIO, U.S.A.											
LEVER ON BOX	THREADS PER INCH & FEEDS										
LEFT	4	4 1/2	5	5 1/2	5 3/4	6	6 1/2	7	7 1/2	8	8 1/2
MIDDLE	8	9	10	11	11 1/2	12	13	14	15	16	17
RIGHT	16	18	20	22	23	24	26	28	30	32	34
LEFT	32	36	40	44	46	48	52	56	60	64	68
MIDDLE	64	72	80	88	92	96	104	112	120	128	136
RIGHT	128	144	160	176	184	192	208	224	240	256	272

train two ratios are obtained by compounding feed gears in the head. They are controlled by the lower small handle near the center of the head and are multiplied by the eight different

ratios through the tumbler and change gears, making sixteen changes. These sixteen changes are multiplied by the 3 additional ratios obtained by the use of the compound lever, giving a total of 48 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 cuts per inch that the lead-screw 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 compound lever (41).

Quick Change Mechanism

17-19-21-24-inch]

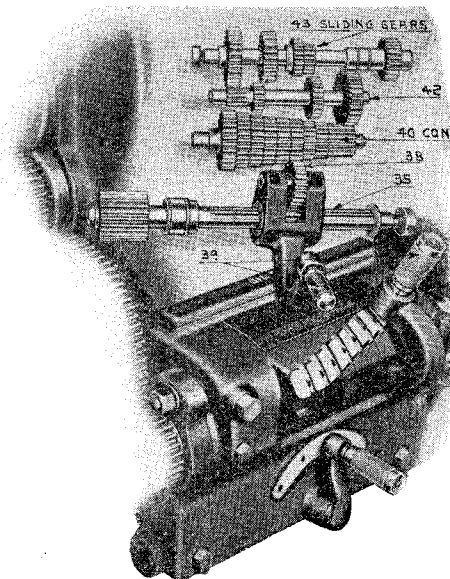
All of the shafts in the improved quick change feed box are on anti-friction needle bearings with only two levers to make all changes except compounding, which is accomplished by a single lever on the head. The mechanism is simple, consisting of a cone of gears (40, opposite page), an intermediate shaft with four gears (42) and a set of sliding gears (43). The shifter, operated by handle (39), slides easily on a splined shaft (35) and carries the tumbler gear (38) which can be dropped into engagement with any one of the gears of the cone (40), and positively held by means of a plunger in the shifter handle. A simple direct reading plate indicates the 56 feed and thread changes.

THE R. K. LeBLOND M. T. CO. CINCINNATI, OHIO, U.S.A.											
THREADS PER INCH											
A	2 1/8	0.04	2 3/4	0.06	2 1/2	0.07	2 1/4	0.08	2	0.09	1 3/4
B	5 3/8	0.32	5 1/2	0.34	5	0.37	4 1/2	0.41	4	0.47	3 1/2
C	11 1/2	0.16	11	0.17	10	0.18	9	0.20	8	0.23	7
D	23	0.08	22	0.09	20	0.09	18	0.10	16	0.10	14
E	46	0.04	44	0.04	40	0.04	36	0.04	32	0.04	28
F	92	0.02	88	0.02	80	0.02	72	0.02	64	0.02	56
G	184	0.01	176	0.01	160	0.01	144	0.01	128	0.01	112

The numbers on the plate refer to threads per inch in one column and feeds in thousandths of an inch in the adjoining column that can be cut with the gear combinations in conjunction with either the lead-screw or feed rod when the tumbler gear is engaged directly below the arrow. The letters A, B, C and D on the left side of the plate indicate the setting of the compound lever (41) on the feed box. The letters A and B on the right side of the plate indicate the position of the feed compound lever on the head. For example, if you want to cut 11 1/2 threads per inch, engage the tumbler (39) under the first arrow on the left side of the plate, set the lever (41) on the front of the feed box in the C position and set the lever on the head in the A position. The same setting engaging the feed rod instead of the lead-screw will give a feed of .016 inch per revolution.

Feed changes can be made while the machine is running, and although the changes can be made under cut, we recommend that the feed trip lever on the apron be disengaged and the feed thrown out. The gears are of alloy steel and will stand any load within the capacity of the lathe, but changing feeds under cut is bad practice because it damages the cutting edge of the tool.

Ample provision has been made for oiling all of the bearings of the quick change box from a large reservoir on the top of the box. Oil holes lead from the reservoir to the various bearings carrying the shafts in the box. The tumbler gear bearings are oiled from the reservoir by placing the tumbler in the central position of the mark "Oil Here". The quick change box reservoir should be filled each morning before starting the operation of the machine.



Apron 13-inch and 15-inch

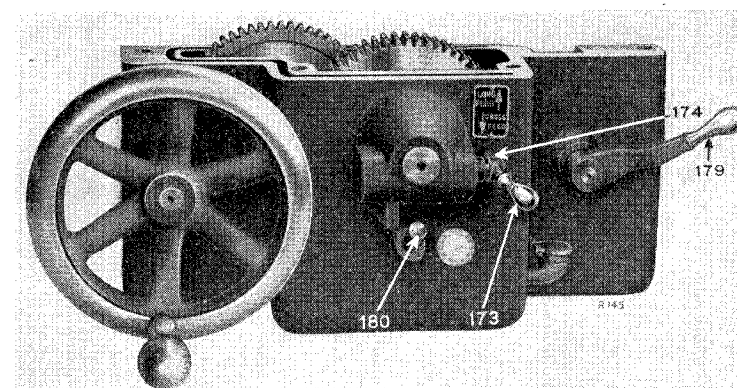
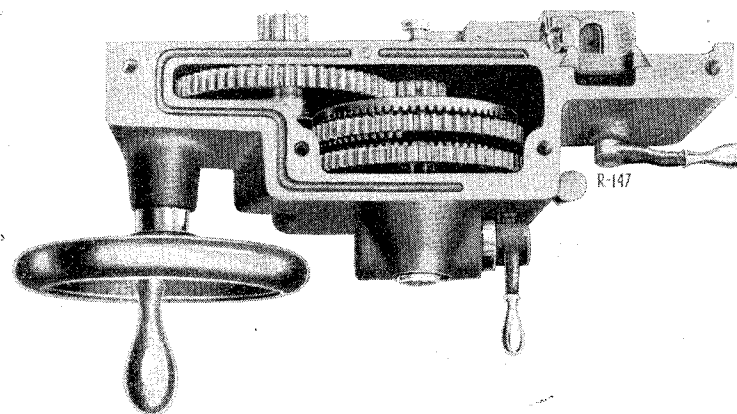
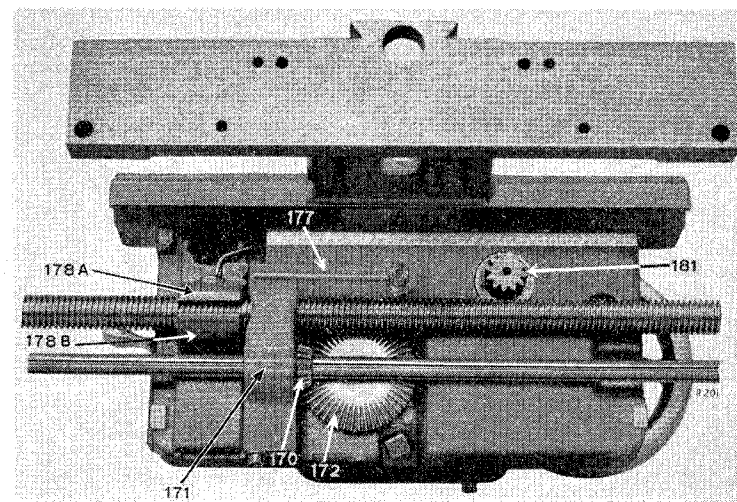
The apron on the 13-inch and 15-inch lathes (shown on opposite page) is a double walled one-piece casting in which all shafts and gears are supported on both ends. The splined feed rod passes through the feed bevel pinion (170). A key (171) in the bevel pinion engages the spline (keyway) on the feed rod. The bevel gear (172) is always in engagement with the bevel pinion (170), which slides on the feed rod. The feed trip (173) 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 (173) is moved to the right to clear the safety lug (174) and pressed down, it slides into engagement the lower two gears, center illustration, opposite page. The lower of these two gears is always in mesh with the cross feed pinion in the carriage and the cross slide moves forward or back depending on the direction of the leadscrew as explained on page 22. 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 head reverse lever to the left, the carriage moves toward the tailstock. The direction is toward the head if the head reverse lever is moved to the right, that is, toward the operator.

When the feed trip (173) is in the neutral position, the safety rod (177) is in the slot of the half-nut and allows the half-nuts (178 A & B) to be closed on the lead-screw by lever (179) to chase threads. When the feed trip (173) is moved up or down, the safety rod (177) moves to the right or left 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 (173). Manual movement of the carriage is by means of the hand wheel on the left side of the apron engaging the pinion (181) with the rack on the bed.

A one-shot lubricating system forces oil to all bearings by means of plunger (180).

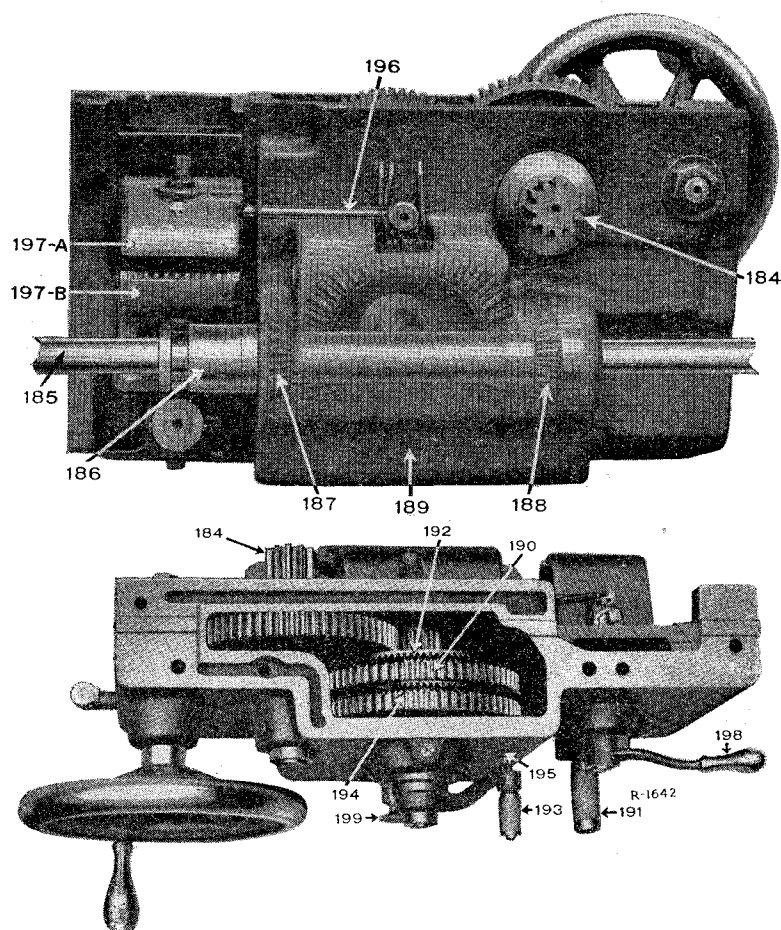
Apron 17-inch, 19-inch, 21-inch and 24-inch

The splined feed rod (185) (page 18) passes through the bevel pinion sleeve (186); the two bevel pinions (187) and (188) are mounted on this sleeve. When the sleeve is in the position so that the pinion



(187) is driving, the feed movement is in one direction, and when the pinion (188) is driving, it is in the opposite direction.

The drive is transmitted from these pinions to the bevel drive gear (189). This gear is pinned to the gear that engages clutch gear (190). When either bevel pinion (187) or (188) is engaged with bevel gear (189) by reverse shifter (191) the feed clutch gear (190) is in motion, and when gear (192) is engaged with it by feed control lever (193), motion is imparted to the carriage. When gear (194) is meshed with the clutch gear the cross slide moves.



Manual movement of the carriage is by means of the hand-wheel on the left side of the apron engaging the pinion (184) with the rack on the bed.

In outlining instructions for the operation of the apron, where the feed reverse mechanism is in the head, it is necessary to establish the position of both the head reverse lever and the apron reverse lever. Let us assume that both the feed reverse lever on the head and the apron reverse lever (191) are in right-hand positions, then when the apron feed control handle (193) is pulled up, the carriage moves toward the headstock; when pushed down past the neutral stop (195) the cross slide moves toward the operator. If the position of both the head and apron levers are reversed, the movements of the carriage and cross slide will be the same as outlined above. However, if the position of either lever is changed, then the direction of movement will be reversed for both carriage and cross slide, that is, the carriage will move toward the tailstock and the cross slide to the back of the lathe. The use of the lead-screw reverse is particularly valuable in chasing odd threads that cannot be picked up with the thread dial on short threading jobs.

When the handle (191) which actuates the bevel pinion sleeve is in the "mid" position, the bevel pinions (187 and 188) are both out of mesh, the interlock (196) is in a neutral position and the half-nut can be closed.

The half-nuts (197 A & B) are actuated by the handle (198).

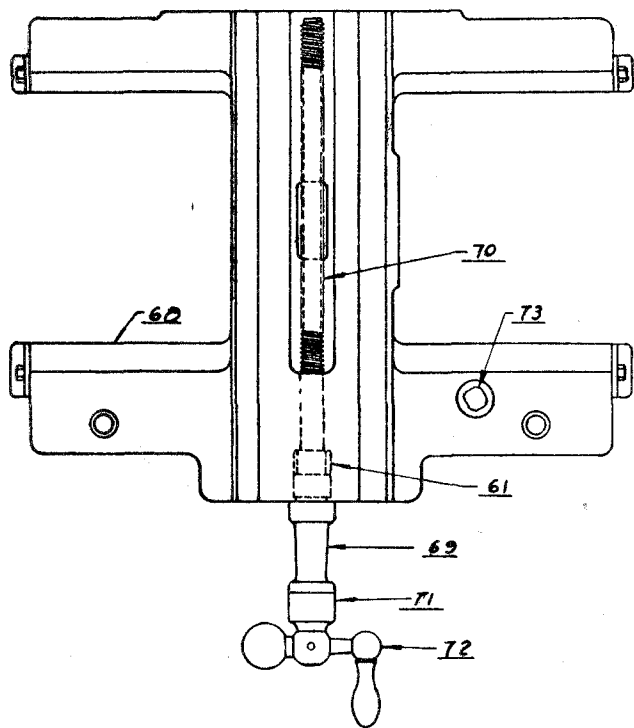
The carriage may be locked in position on the bed by the stud on the right-hand front wing, which tightens the clamps.

A plunger pump on the apron forces oil to all bearings in the apron. Work the plunger (199) slowly in and out three or four times. This should be done daily. Fill the reservoir through the intake on the left side of the apron. The reservoir is full when the oil can be seen in the bottom of the intake. A good grade of machine oil SAE 20 is recommended.

Note—When the handle (193) is not in the "mid" position, it is impossible to move handle (198) to close the half-nut. A camming action on pin (196) locks the half-nut.

Carriage

The carriage (68) 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 (69) forms the bearing for the cross feed screw (70), on the front end of which is a micrometer dial



(71) and cross feed handle (72). The carriage clamp screw (73) is used to clamp the carriage to the bed for facing and cutting off operations. 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.

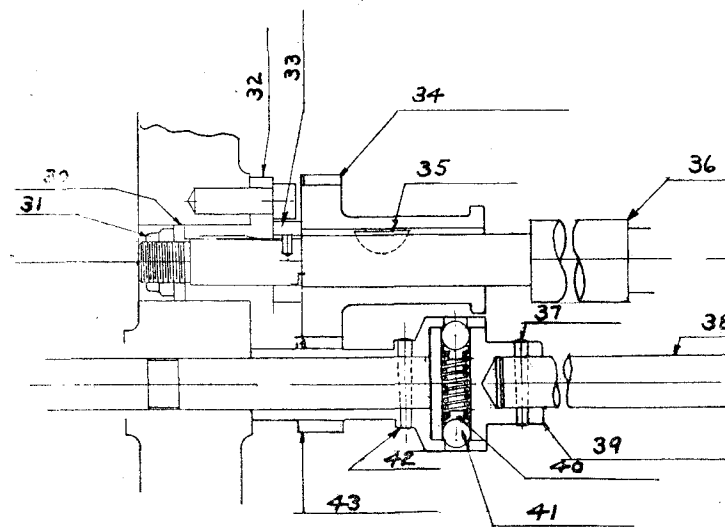
Remove the compound rest dirt guard (77) over the feed rod and oil the screw and the cross feed bush. Also see that the dovetailed cross slide is cleaned and oiled occasionally. Oil the felt in the wipers. When working with cast iron, remove the wipers occasionally and clean them in gasoline or kerosene.

Feed Rod

The feed rod (44), page 13 or (38) below, 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 lead-screw for both turning and chasing, thus the lead-screw is always in use. On Regal Lathes a separate feed rod is provided to transmit the power for turning and facing. The feed rod is connected to the final drive shaft 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 save the feed mechanism of the lathe.

Safety Device

All Regal Lathes, because of their extensive use in schools where they are operated by comparatively inexperienced persons,



Safety Release to Protect Feed Mechanism

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 point 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 (41) will compress the spring (40) and release the shaft (38) 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.

Leadscrew

The leadscrew (45), page 13, is used for thread-cutting, and it is driven by the leadscrew gear (46) and the feed rod gear (47). The leadscrew slip gear (46) 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 leadscrews are subjected to torsional strains at all times and soon become 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 (48), 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 (50), with hardened thrust washers on each side of the bush. End play is eliminated with the adjusting nut (50). 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. To adjust the nut, take out the screws holding the leadscrew bush (48) to quick change box; engage the half-nut to the screw by raising the half-nut lever (179), page 17; move the carriage toward the tailstock sufficiently to allow the withdrawal of the bush (48) and draw up the nut (50) until there is no end play in the screw.

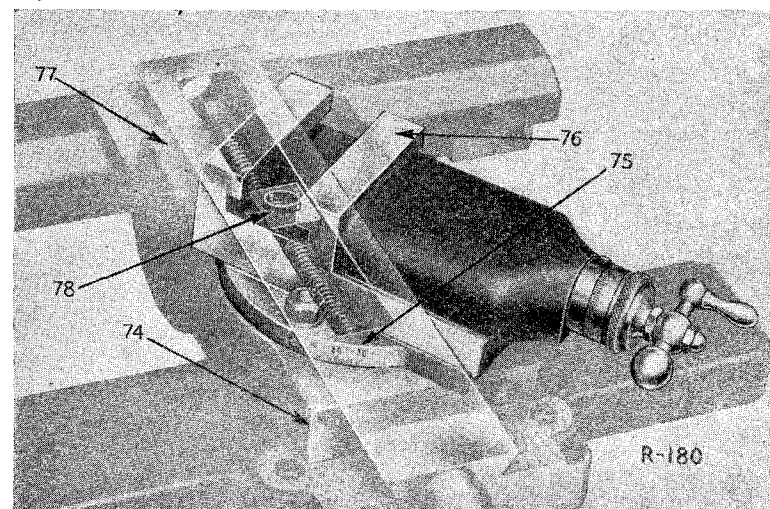
All right-hand threads, and the majority of turning cuts on a lathe, are cut toward the headstock. For this reason the Regal Lathes are equipped with left-hand threaded leadscrews. This also reduces the number of gears in mesh between the spindle and

the leadscrew. The thrust of the leadscrew is taken at the feed box end of the screw, and as most threads cut are right-hand, the leadscrew is in tension under this condition. The leadscrew takes a bearing in back box (51), page 13, 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. Also, put a few drops of oil on your hand and run your hand over the feed rod. This will not only lubricate the parts but keep them from rusting. Oil both bearings in the back box daily.

Compound Rest

The compound rest unit consists of compound rest bottom slide (74), compound rest swivel slide (75), compound rest top slide (76), cross feed dirt guard (77), and cross feed nut (78). The bottom slide (74) is fitted to the dovetailed cross slide of the



carriage and is equipped with a flat gib to provide means of adjustment for wear. The gib adjusting screws in the side of the bottom slide can be tightened or loosened to obtain the proper adjustment. The bottom slide should be adjusted so that it will

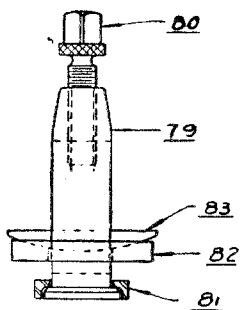
move freely on the dovetail and still be a snug fit. The cross feed nut (78) is attached to the bottom slide and runs on the cross feed screw (70), page 20. The compound rest gets the movement on the carriage through the cross feed screw and nut.

The compound rest swivel slide (75) is fitted on top of the bottom slide and swings around to the angles 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 (75) is graduated in degrees so that the compound rest can be accurately set 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 (76). The top slide is also fitted with a 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.

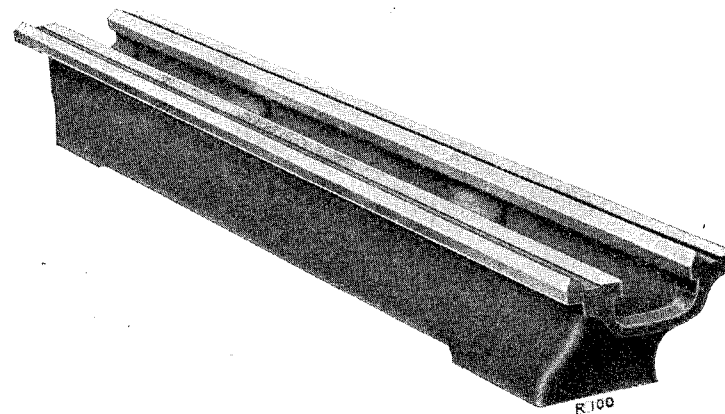
Tool Post

The tool post unit comprises the tool post (79) itself, with component parts as follows: Tool post screw (80), tool post washer (81), tool post collar (82) and tool post wedge (83). The washer (81) 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 top 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.



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 polished 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 little 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.



Tailstock

The tailstock unit comprises the tailstock top (84), tailstock bottom (85), tailstock clamp (86), tailstock spindle (87),

move freely on the dovetail and still be a snug fit. The cross feed nut (78) is attached to the bottom slide and runs on the cross feed screw (70), page 20. The compound rest gets the movement on the carriage through the cross feed screw and nut.

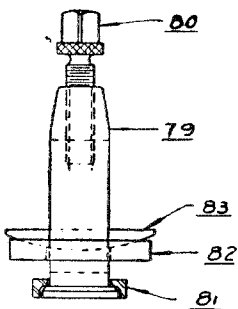
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Tool Post

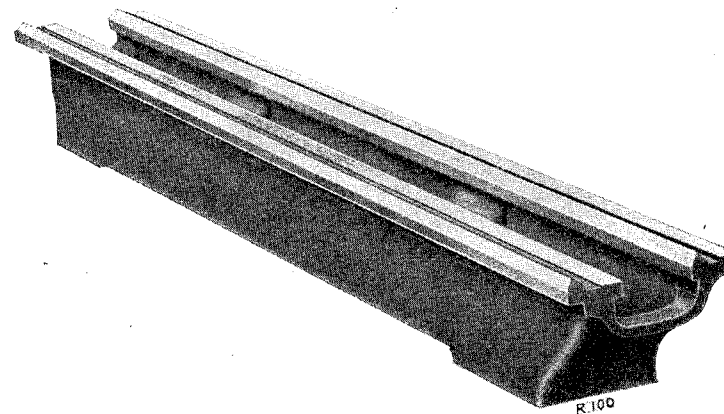
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Tailstock

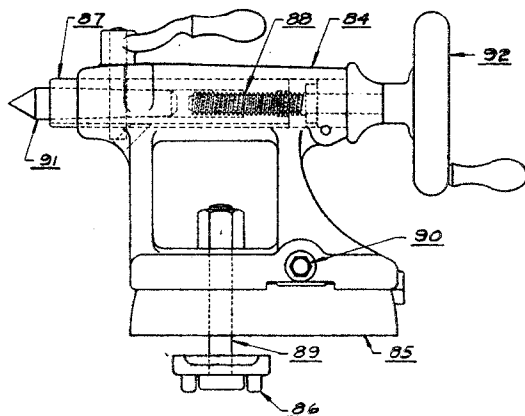
The tailstock unit comprises the tailstock top (84), tailstock bottom (85), tailstock clamp (86), tailstock spindle (87),

and tailstock screw (88). 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 (89). 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.

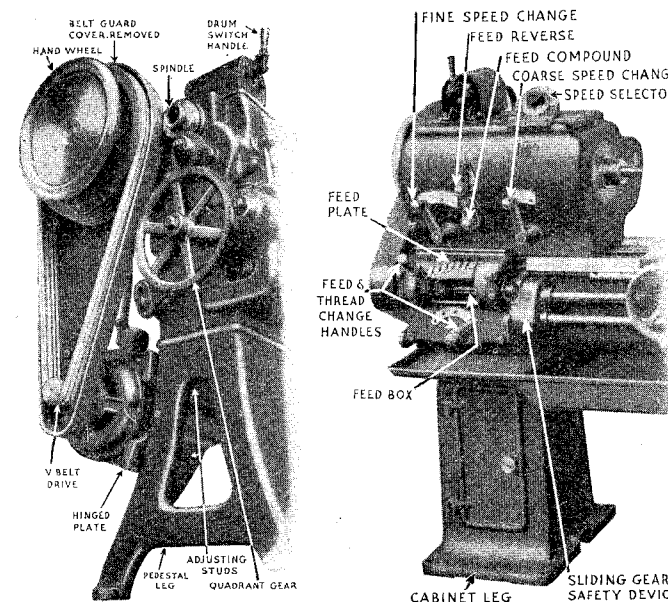
The tailstock top (84) sets on the bottom (85) and is held in alignment by a cross tongue. For turning tapers a setover is provided for the tailstock top. A setover adjusting screw (90) on each side of the tailstock top provides means for setting, and a raised boss in the rear is graduated to show the amount of setover. The tailstock spindle (87) is moved in and out of the tailstock barrel by means of the screw (88), 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 (91), 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 handwheel (92), 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 in the taper 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. The spindle (87) should be removed occasionally, in order to oil the spindle nut and the outside of the spindle barrel.



Motor

The motor is mounted on a hinged plate on the back of the leg below the headstock. The hinged plate is equipped with adjusting screws to regulate the tension on the multiple V belts which drive the lathe. For greater safety, the belts are enclosed in a driving belt guard, shown below with cover removed. Two screws hold the belt guard cover.

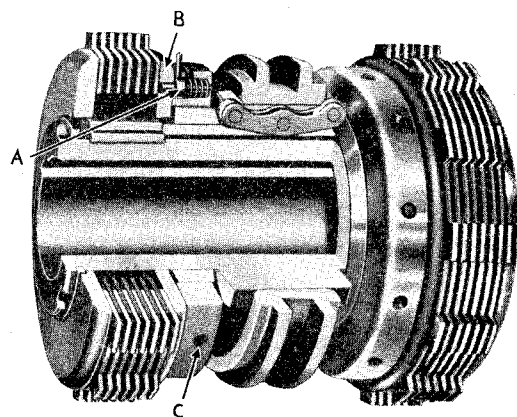


The multiple V belts should have just enough tension to take the cuts without slipping. Do not put belts under too much tension, for in so doing a strain is thrown on the motor and driving shaft bearings, causing excessive wear. Also see that no oil gets on the belts. They are made of a rubber composition and oil will rot them. Keep the bearings of the motor filled with high-grade lubricating oil.

Motor Control

The drum reversing switch, above, is mounted on the headstock cover and the wiring to the motor is protected by a flexible conduit. The switch starts, stops and reverses the lathe. When the handle of the switch is vertical, it is in the "off" position. Turning the handle to the right starts the lathe running forward—turning the handle to the left starts the lathe running backward or in reverse. The 21" and 24" lathes are built with a multiple disc clutch

and brake. This feature is optional on the 13" to 19" sizes. The clutch is compact in size with high torque capacity and suitable high wear-life to stand up under rapid cycle operation. It is operated by convenient handles (page 10), on the control rod, from either side of the carriage. The clutch is provided with single point adjustment that can be accomplished quickly without undue loss of operating time. To adjust clutch, place cone in the disengaged position, as shown, and pull adjusting lock pin (A) which may be locked in the out position by means of the small vertical pin. Turn adjusting ring (B) to right or clockwise, with spanner wrench in holes (C), until clutch requires distinct pressure to engage. Release vertical pin from slot and engage adjusting lock pin (A) into the nearest locking hole available. A plate with instructions for adjustment of the clutch is on the front of the headstock.



Changing Spindle Speeds. When you have selected the required speed (see article on selection of proper speeds, pages 97 and 107), consult the speed plate on 21", 24", or speed selector (page 12) on 13", 15", 17", 19", for the proper position of levers to obtain that speed. Stop the lathe. By turning the speed change hand-wheel, the gears are slowly turned so they will mesh with one another. The proper spindle speed will thus be obtained. We do not recommend changing speeds while the machine is running or under cut. The gears are heat-treated, and no damage would result if the operator accidentally shifted gears while the machine was running, but doing this flakes and burrs the edges of the teeth, and it becomes difficult to mesh the gears. Learn to shift the gears in the proper way and you can very quickly obtain any desired spindle speed. These instructions apply to all Regals.

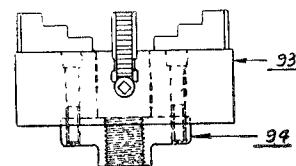
Know Your Lathe - Keep It Clean - Use Oil Liberally

ACCESSORIES REQUIRED FOR LATHE WORK

For the full and complete operation of a lathe certain tools and accessories are necessary, such as chucks and dogs for holding and driving the work; lathe tools for the actual turning or boring operations, and measuring tools such as calipers, micrometers, scales and gauges. These accessories are illustrated and described below.

Four-Jaw Independent Chuck

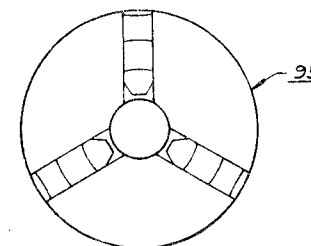
The four-jaw independent chuck (93), as the name implies, has four jaws, each jaw being independently adjusted with a chuck wrench. The jaws are reversible so that the chuck can be used for inside or outside chucking. It is attached to the spindle of the lathe by means of a chuck plate (94), which is threaded to fit the spindle nose. 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. See page 50.



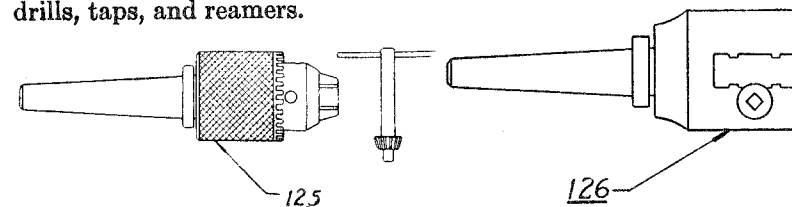
The four-jaw chuck is used to hold rough pieces that are not perfectly round, and other irregular shaped pieces; for example, a cast-iron gear blank.

Three-Jaw Universal Chuck

The three-jaw universal chuck (95) 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.

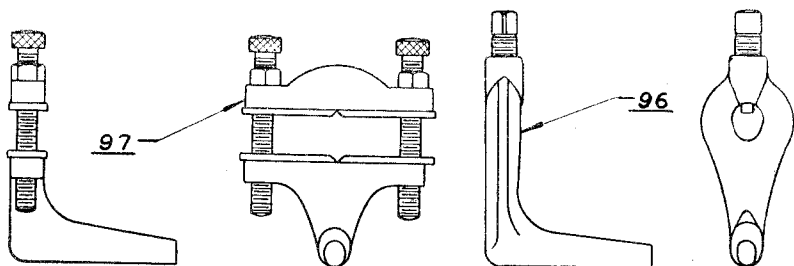


Drill Chuck and Shank. For holding center drills and straight shank drills, a drill chuck with a shank fitting the Morse taper hole in the tailstock spindle is almost a necessity. These chucks are made in the three-jaw self-centering type (125), and the two-jaw type (126) which is more desirable for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



Lathe Dogs

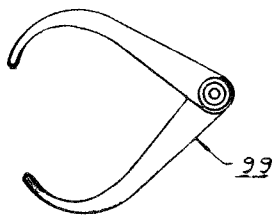
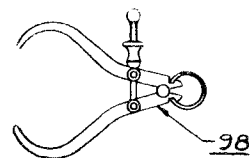
Lathe dogs (96) are used to grip and to drive pieces between centers. They are used with the small face or driving plate (page 41). Dogs of different sizes can be obtained for use with corresponding diameter of work. The usual form of lathe dog has a bent tail which engages a slot in the driving plate. Another form of a dog is known as the clamp dog (97) and it is used to drive square, hexagon or octagon shaped pieces between centers.



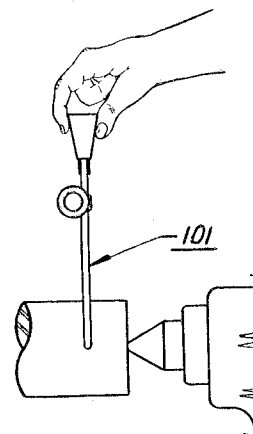
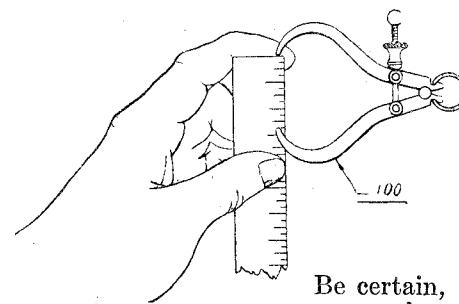
We have described the most essential tools used with lathes. Many other tools are used and some of their uses will be explained in connection with the different lathe operations described later.

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. 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 the one leg from slipping off the end of the scale and adjust the caliper (100) to the dimension



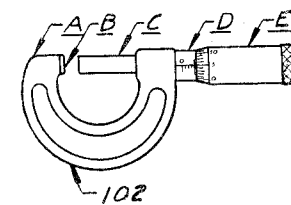
required. Some mechanics become quite expert at setting calipers, acquiring a "feel" that enables them to set calipers to .005 of an inch. In many cases your work will be to reproduce broken parts, and the calipers can be set from the broken part.

Be certain, however, that the part is not worn where you set the calipers. Try the calipers at different points to see if the piece is round 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.

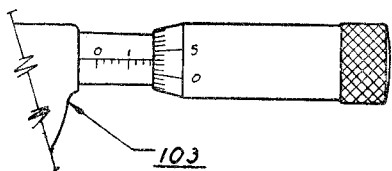
Never try to caliper a piece revolving in the lathe where accuracy is required. For obtaining the approximate diameter this is permissible, but for accurate dimensions, the lathe should be stopped.

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 "D" which is not exposed. The threads are cut 40 to the inch so that exactly one revolution of the thimble "E" advances the spindle "C" one-



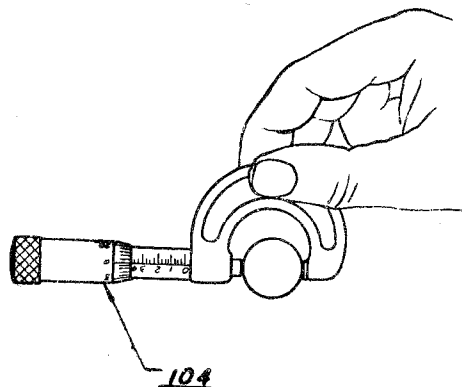
fortieth of an inch, or twenty-five thousandths (.025) which is the gap between the anvil "B" and the spindle "C", the measuring point. The sleeve "D" is graduated with 40 divisions to the inch and numbered 0-1-2, etc. to 10, a number at every fourth division, so that figure one, or four divisions, represent $4 \times .025$ 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 $7 \times .025$ or .175, and three graduations on the thimble beyond the zero (0) mark, each representing .001,

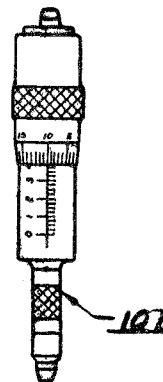
so that the caliper is set at .175" plus .003", equaling .178", or for greater convenience read the highest numeral showing on the sleeve, 1 or one-tenth (.1); beyond this read the number of graduations showing (3), which equals $3 \times .025$ " or .075", then add to this the graduations on the thimble, three making .178". For convenience in using micrometers, tables of fraction and decimal equivalents, also English and metric equivalents, will be found on page 103.

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 up the "mikes" occasionally with a reference disc (standard gauge) to see that they register correctly.



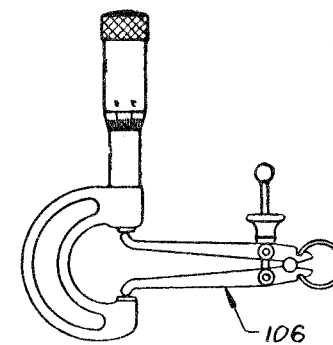
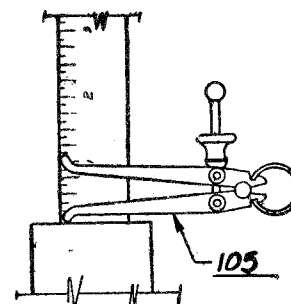
Inside Micrometer Caliper

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

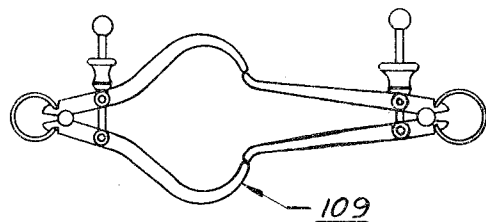


adjustment is obtained by rocking the caliper in a vertical plane between the axis of the anvil and spindle of the micrometer.

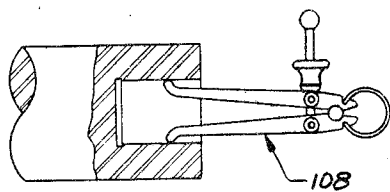
When calipering a hole (108) set one leg of the inside micrometer caliper in the hole, pivoting the caliper in a vertical plane and adjusting until the other leg enters the hole. By

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.

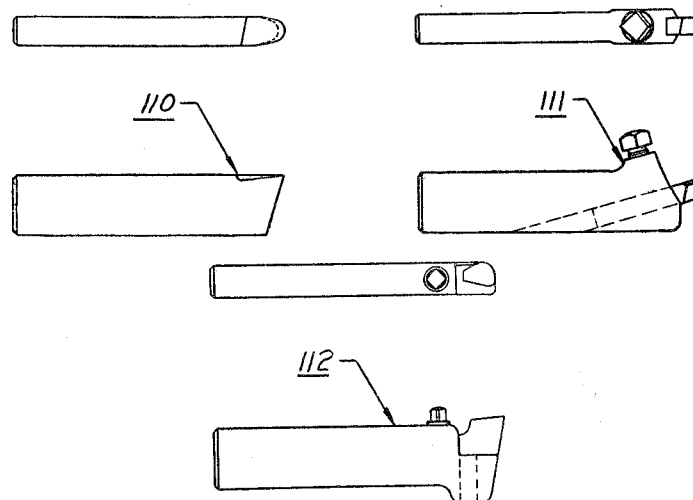
When boring a hole to fit a shaft or turning a shaft to fit a hole, it is necessary to transfer measurement from outside to inside calipers and vice versa. This can best be done by holding



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.



LATHE TOOLS

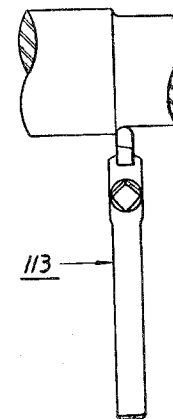
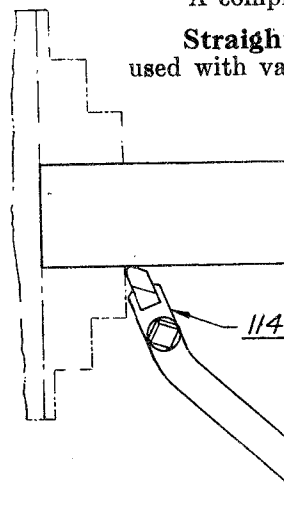


Each lathe should be equipped with a complete set of lathe tools for turning, facing, threading and boring. They can be either of the forged type (110), or of the tool holder type using high-speed steel bits, such as are made by Williams, Armstrong (111) or O. K. (112). The tool holder type is the most commonly used because it is more convenient. No forging or dressing is necessary with this type.

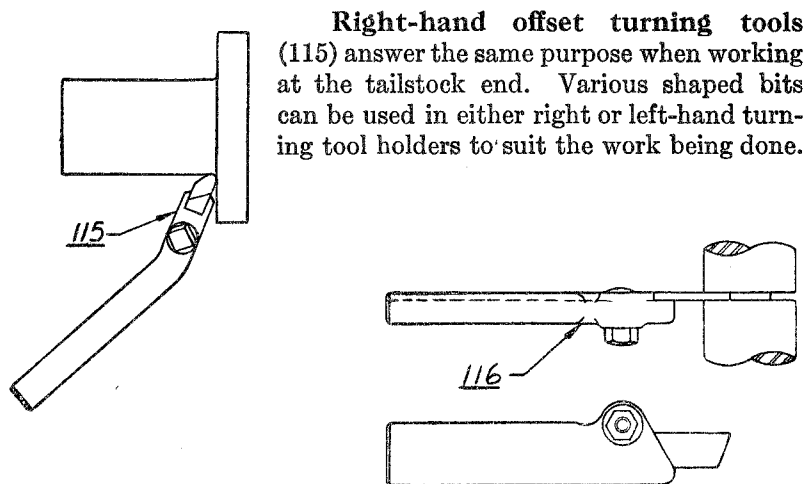
A complete set of tools consists of the following:

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, etc.

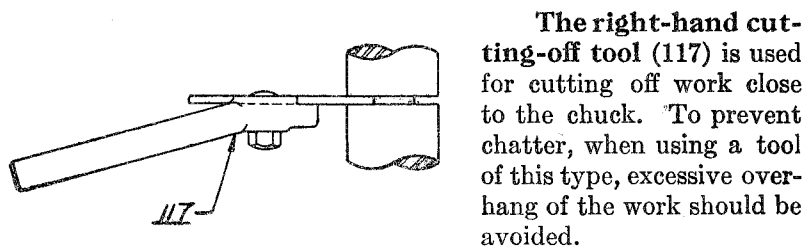
Left-hand offset turning tools (114) are desirable when the operator wishes to work close to the chuck or the driving dog. By using this type of tool it is possible to turn the



piece up to the chuck and at the same time have the chuck clear the side of the carriage and compound rest.

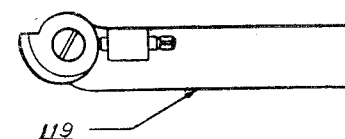
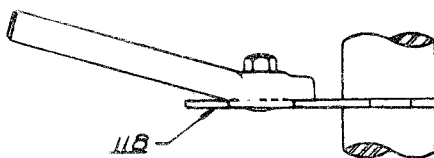


Straight cutting-off tools (116) are used for cutting off in the lathe. The blade used in this tool is ground with the proper side clearance. Then, when properly set in the holder, the tool does not drag.

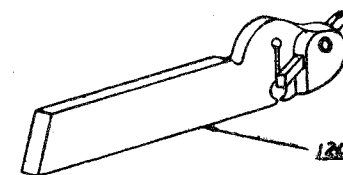


The right-hand cutting-off tool (117) is used for cutting off work close to the chuck. To prevent chatter, when using a tool of this type, excessive overhang of the work should be avoided.

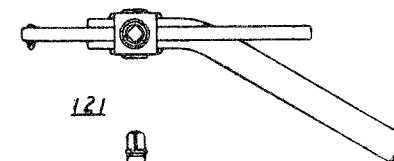
The left-hand cutting-off tool (118) is for use near the tailstock end of the lathe. This type of tool is rarely used and in most cases the right-hand cutting-off tool serves all purposes.



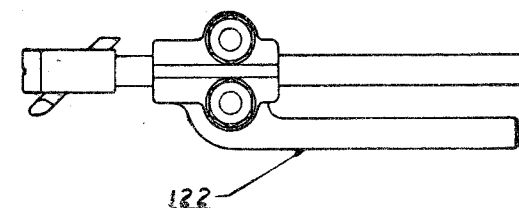
Threading or chasing tools (119). There are many patented types of threading tools. The tool shown is provided with a formed cutter, and is ground on the top to maintain the correct thread form. On some classes of material where it is not possible to cut a smooth thread with a rigid chasing tool, a spring threading tool (120) will produce better results.



The spring threading tool is built with a nut for the lockable spring head which provides 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. The bit is held in a turning tool holder.

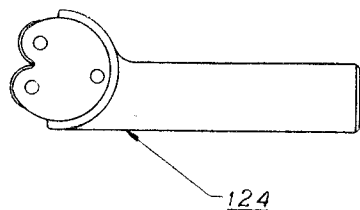
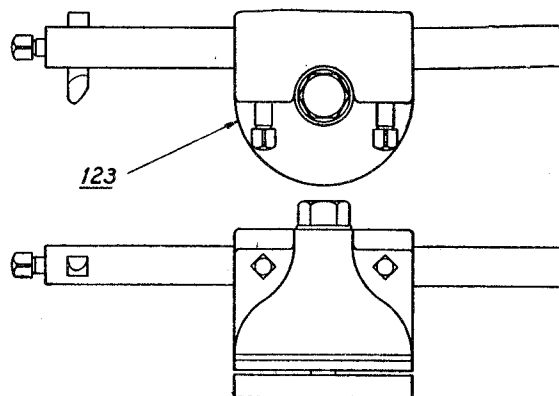


Boring bars and holders. Tools of the type shown are used for boring holes and chasing internal threads. Two basic types of boring bars are used, namely, the forged type and the bar and holder type. Three of the bar and holder types are shown in the accompanying illustrations.



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. 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.

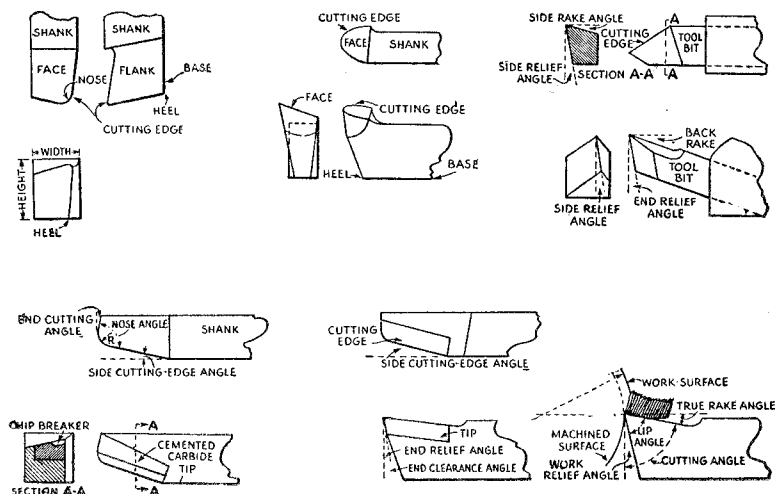
Figure (123) shows a boring bar for heavy work that is held in the compound rest T-slot. This makes the bar more rigid than when held in the tool post. Various shaped tool bits for boring, facing, counterboring and threading holes can be used in the different bars.



Knurling tool (124). On some classes of work such as thumb screws, 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. Wheels of different patterns can be obtained for the knurling tool holder.

Nomenclature of Lathe Tools



REGAL EQUIPMENT AND ATTACHMENTS

The compound rest was developed to give a rigid yet adjustable mounting to the tool.

In facing, for instance, where the carriage is locked and the cross feed is used to traverse the tool across the work, the compound rest may be set with the screw parallel to the axis of the lathe. In this position the micrometer dial on the screw can be read directly to determine the necessary movement of the compound rest to secure the proper depth of cut in the face.

The compound rest is made to swivel a full circle of 360° to allow convenience of set-up and also to enable facing or turning to be done at any angle with axis of work.

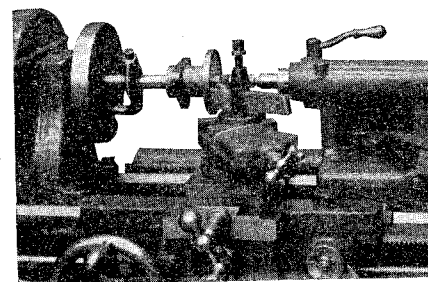
The compound rest is graduated thru 240° , and the bottom slide marked with zero line at the point where the compound rest would face at 90° to axis of lathe centers.

When turning or facing a taper, it is necessary to note the reference axis of the angle on drawing, or whether included angle of taper is given.

If for instance the angle is given as 60° from axis of work the compound rest should be set at 90° minus 60° or 30° from the zero position which is at right angles to line of center of lathe.

If a tapered piece is marked to be turned 32° included angle of taper, the taper from axis to side is one-half the included taper or 16° and compound rest should be set at 90° minus 16° or 74° from zero position.

When taking finish cuts to secure a given size in facing, the compound rest, as illustrated, may be set with the axis of the compound rest screw 60 degrees from the axis of the lathe (at 30 degrees) on the compound rest graduations. In this position one-thousandth of an inch motion of the compound rest along the screw will move the tool exactly one-half thousandth of an inch in the direction of the axis of the lathe. This rule may be relied upon im-

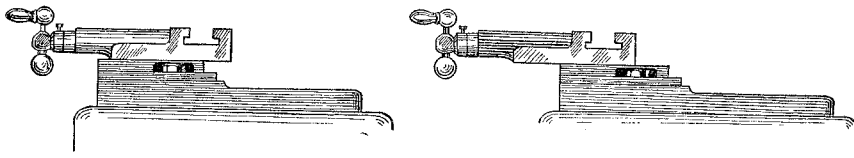


licitly as it is a trigonometric fact and not subject to variation.

To Duplicate a Tapered Surface Using the Compound Rest

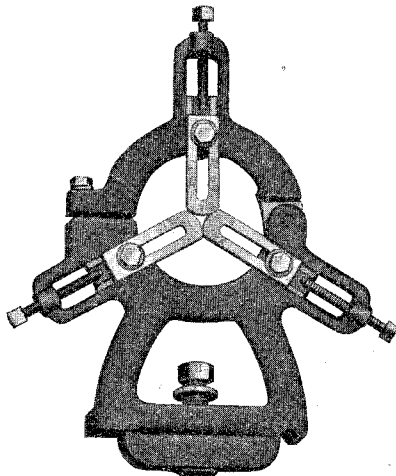
(a) Mount sample between centers. (b) Mount test indicator in tool post. (c) Swivel compound rest to approximate angle and set indicator to contact on center line of sample. (d) Run compound rest along work and note error. (e) Reset compound rest to correct error and repeat (d); continue until error is within limit of accuracy desired. (f) Remove sample and insert work piece. (g) Set cutting tool of proper shape so edge is exactly on center line of work. (h) Turn, using compound rest screw to obtain feed travel, until correct size plus finish allowance. (i) Finish by grinding or filing and polishing as in other work.

Various attachments may be bolted to the compound rest, thus widening the scope of operations possible with the lathe.

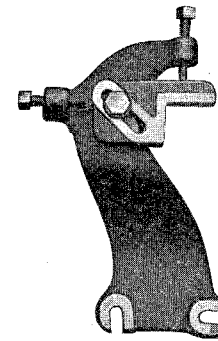


Caution. Note position of compound rest slide in the two extremes. In the forward position the slide overhangs the rest to which it is clamped. In this position it is not advisable in any lathe to take roughing cuts as top slide may break in the middle of the tee slot. When taking heavy cuts, always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

The steady rest is used to give support to long round pieces, or bars of small diameter, rotating between centers, and to provide a fixed support between the headstock and tailstock ends of the work while it is being turned. The steady rest makes it possible to support a piece of round work of small diameter (see page 61), so that it can be accurately turned with a faster feed. Otherwise it would spring away from the tool and chatter. Many jobs are impracticable without the use of a steady rest.

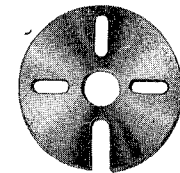


The steady rest is also used when it is necessary to drill or bore the end of a piece of work which is too long to be held entirely by a chuck on the headstock spindle. The steady rest is clamped on the bed and is aligned on the lathe by a bearing which fits the same inverted vee and aligns the tailstock with the headstock.

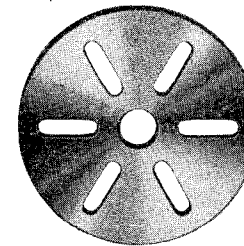


The follow rest is used to support the bar or round piece of work being turned between centers, against the forces of the cut being taken. It is bolted to the carriage and consequently moves with it. (See page 62). To set the follow rest, the cut is started and turned slightly longer than the width of the follow rest jaws. The jaws of the follow rest are then set to the turned diameter, after which the cut can be taken across the entire length of a piece of work of small diameter.

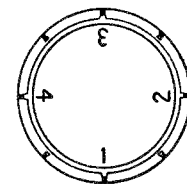
Face Plates. The Regal Lathe is furnished with one small and one large face plate. The small face plate is used to drive pieces of work such as shafts, mandrels, etc., by means of a lathe dog clamped to the work. The lathe dog is made with a bent tail which engages a slot cast in the face plate. The face plate also has other cored slots radial to the center, which makes it convenient to mount special drivers or fixtures to the face of the plate.



The large face plate performs the same functions as the small one, except that it provides more room to mount fixtures such as angle plates, vee blocks, etc. 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 page 60 for details.

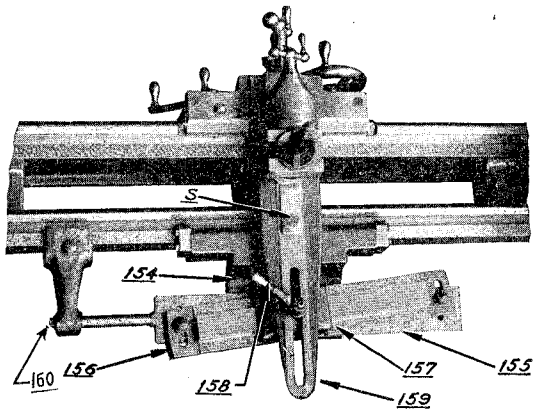


Thread Indicator. The chasing dial thread pick up is supplied as an extra to the lathe. This unit comprises a worm wheel which meshes with the lead-screw, and a shaft connecting the worm with the indicator dial. The dial is marked with numbered lines as illustrated. When chasing an even number of threads, the half-nut 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.

The plain taper attachment on the older model Regal Lathes is simple but exceptionally rugged and accurate. The principal

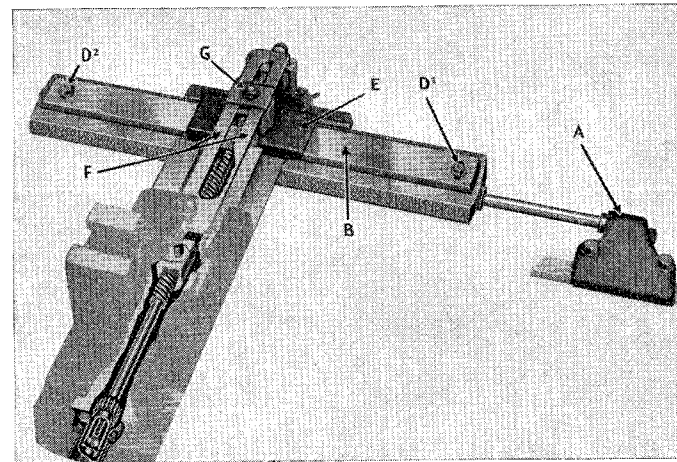


parts are the carriage bracket (154) (a substantial casting bolted to the rear of the carriage), in which is machined a dovetail slot to take the dovetail on the lower slide (155), the adjustable taper or swivel bar (156), graduated on one end in degrees and the other in inches, and the shoe (157), which slides over the bar and follows the taper at which the bar is set. The clamp handle (158) clamps the shoe to the extension on the cross slide bottom slide (159). The cross slide with the extension is a special casting comprising the bottom slide and extension in one piece, thus eliminating any inaccuracy due to loose joints, etc., that are inherent in a two-piece construction. This special casting is supplied with the taper attachment and is included in the published taper attachment price.

When preparing to use the taper attachment, first set the turning tool on line with the centers of the lathe, advancing the tool to the approximate position of the cut to be turned, then remove the screw "S", next set the swivel bar at the desired angle or taper and tighten the clamping screws. Bolt the bracket (160) to the bed and tighten handle (158). The final adjustment of the tool for size, after screw "S" is removed, must be made by the movement of the compound rest.

The telescopic taper attachment now furnished (page 43) is ruggedly constructed and simple to operate. When the carriage is brought into position for the taper operation, the bed bracket (A) is tightened on the flat bed way. The swivel guide bar (B) 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 (D¹-D²) and moving

Telescopic Taper Attachment



bar (B) to the desired taper. The swivel guide bar is held secure by the screws (D¹-D²). Now with the taper bar clamp screw (G) loosened and assuming that the shoe bracket gib and the carriage bracket gib are properly adjusted, we are ready to chase taper threads or to finish taper turning, or finish boring. 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 (E) along taper bar.

With light cuts 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.

On heavy cuts, none of the pull is on the cross feed screw, but on the flat draw bar (F) shown over the cross feed screw, which is connected to the bottom slide of the tool rest. On heavy cuts the clamping nut (G) over the sliding shoe is tightened and the action of the sliding shoe is the same as on light cuts, except that the pull is then on the draw bar. This relieves the cross feed screw of all strain and pull and wear, and insures longer life and also retains the original accuracy of the screw. Adjustment of the cut is made by loosening clamping nut (G) 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.

Grinding Attachment. The grinding attachment is a complete unit with its own motor, and it is ready for use when it is bolted on the compound rest and attached to a light socket.

GRINDING ATTACHMENT

There are many grinding jobs that can be done advantageously in a lathe with a suitable attachment. Hard centers can be repointed, cutters and reamers sharpened, and all kinds of straight and taper cylindrical and internal grinding can be done in a lathe. There should never be more than a few thousandths left on the work for grinding.



Grinding a Mandrel

The illustration shows a mandrel being ground in a lathe. The procedure for this job is to set the compound rest at "0" or with the axis of its screw perpendicular to the axis of the lathe, and clamp the grinding attachment with the axis of its spindle parallel to the surface to be ground. Since mandrels are ground with a slight taper, it is necessary to set the tailstock over or else use the taper attachment. When the taper is set and all is ready, start the grinder and take a very light cut across the work to make sure the taper is correct. Then run the wheel back and forth across the work by power, feeding it in toward the center about .0005" each

time until the mandrel is ground to size. When a diameter has been ground to size, run the wheel over the work a few times, without feeding in to allow it to "spark out." This produces a better finish.

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.

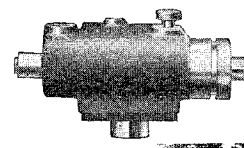
When grinding attachments are used on a lathe, utmost care must be exercised that no grinding grit is allowed to work into the slide bearing surfaces.

Safe Speeds

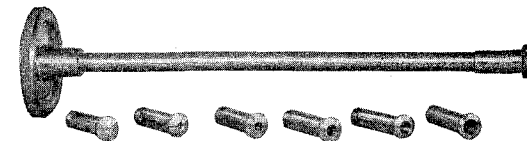
Size of Wheel	2"	3"	4"	5"	6"
Spindle R. P. M.....	9550	6380	4775	3825	3190

The micrometer 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, as cutting threads, etc.

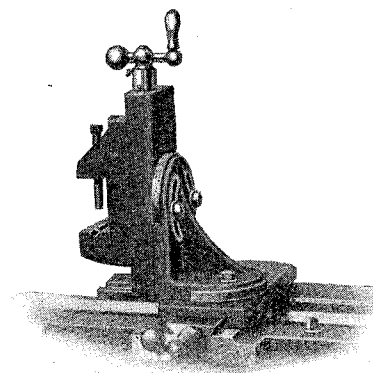
The micrometer stop is clamped to the front vee or way of the lathe bed. The design of the clamping surfaces is such that there is no danger of scoring the vee of the bed while using this attachment. A micrometer screw with hardened ends is turned by a large diameter collar. The collar is knurled to 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.



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. This attachment in the spindle allows stock bar to pass through the collet 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, short length racks cut, etc.



The attachment consists of a graduated (swinging 90 degrees) angle plate support mounted on the cross slide in place of the compound rest. A vise is mounted on a slide which is in turn bolted to the angle plate. Vertical motion is imparted to the vise slide by a screw mounted

in the vertical slide which engages a nut in the vise slide. The vertical slide screw is equipped with a graduated collar reading in thousandths of an inch travel.

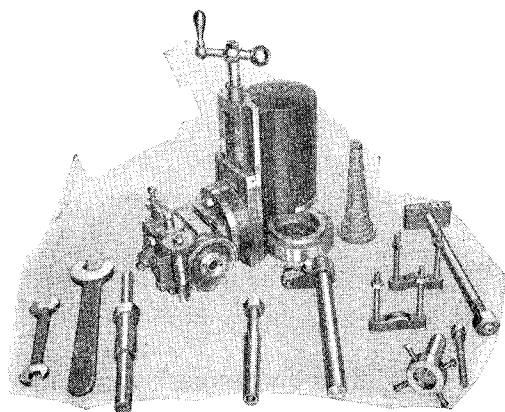
The vertical slide swivels 45 degrees each side of the vertical position, and the angle plate assembly swivels 360 degrees on the cross feed slide, giving universal setting possibilities.

Horizontal feed parallel to the axis of the lathe is imparted to the carriage and consequently to the milling attachment vise in the regular manner, while the motion in and out, with respect to the center line of the lathe, is derived from the cross feed screw.

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

The Millerette Converter is recommended where accurate indexing is required. The "Millerette" gives a lathe the wide range of a complete milling machine with a dividing head. It is a lathe attachment that takes the place of a milling machine for all ordinary purposes. The "Millerette" on a lathe makes it possible to cut gears of all kinds—spur, bevel and angular—to graduate diameters, to cut various types of keyways, to spline, to slot, in fact to do any milling machine and dividing head work.

The principle used in the dividing head construction is that regularly used on gear cutting machines, the interchange of gears.



For division from 2 to 360 the index plate shows the proper gears to use and the number of turns required of the index lever. It is easy to set up and does not require a skilled operator. The lever or handle makes one or more complete revolutions for each divisional space.

METHODS OF HOLDING WORK IN THE LATHE

For practical purposes 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.

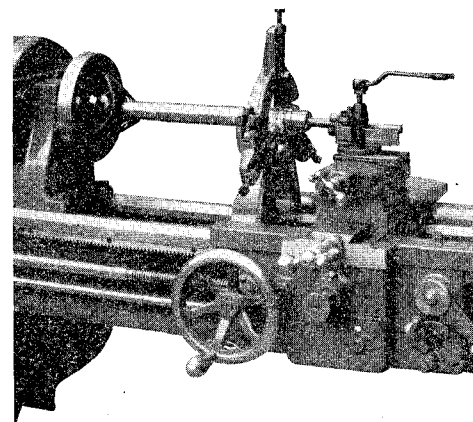
There are many combinations of the above methods such as chucking one end of a piece and using the steady rest to support the other end while facing, or boring the free end of the work. Another is to hold one end of the work in a chuck and the other end on the tailstock center, etc.

Work on Centers

By far the greatest percentage of work machined on a lathe is held between centers. With this method the work revolves on conical holes drilled in the ends to fit the lathe centers and is driven by a lathe dog (page 30) clamped on the work. The bent tail of the dog fits the cored slot of the driving plate, illustration (page 80). The tool is fed along the work by the movement of the carriage.

A variation of the above method of holding work is to use a chuck to clamp and drive one end of the work while the other end is supported by the tailstock center; the tool is fed by the carriage as before.

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 method 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 piece of work.



A Practical Set-Up with Steady Rest Boring Spindles

Work on Mandrel

Many parts such as bushings, gears, collars, etc., require all the finished external surfaces to run true with the hole which extends

through them. That is, the outside diameter must be true 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 $\frac{3}{4}$ " standard hole would ordinarily be held from .7495" to .7505" or a tolerance of $\frac{1}{2}$ thousandth of an inch above or below the true standard size of exactly .750".

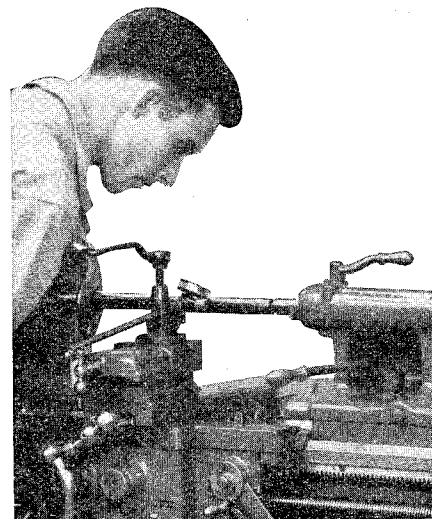
The usual practice in machining work of this kind is to drill or bore the hole to within a few thousandths of an inch of the finished size, then remove the remainder of the material with a machine reamer, following with a hand reamer if the limits are extremely close. The piece is then pressed on a mandrel. A dog is clamped on the mandrel and is mounted between centers. Since the mandrel surface runs true with respect to the lathe axis, 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 $\frac{5}{8}$ " and smaller, the whole length is usually tapered. The common practice is to make the small end $\frac{1}{4}$ to $\frac{1}{2}$ thousandth of an inch under the standard size of the mandrel, while the large end is about $\frac{1}{2}$ 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 is pressed into the hole. On mandrels over $\frac{5}{8}$ " diameter about two-thirds of the length is turned straight, about $\frac{1}{4}$ 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 $\frac{1}{2}$ 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.



Testing a Mandrel

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.

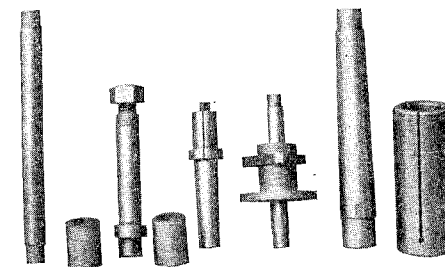
When taking roughing cuts on a piece of work mounted on a mandrel, it is necessary to have a tighter press fit than for finishing. Therefore, on

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 expansion mandrels of various types, and the straight mandrel 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.

Proper Fit of Fixtures Mounted on Spindle Nose

The small face plate is usually used only as a drive plate for work held on centers. As a general practice work is not mounted on the small face plate. For this reason the fit of the small face plate on the threads of the spindle nose is not important and may vary from "snug" to "loose" without harm.

With the use of the large face plate and chuck plates, however, the work is held and positioned by the plate, and any shake in the plate from a loose thread fit on the spindle nose would show up as an inaccuracy on the finished work.

Therefore, large face plates and chuck plates are finish tapped and fitted to the lathe spindle as tight as the plate can be screwed on the clean well lubricated spindle nose.

On a well fitted thread the bearing will be distributed evenly on the sides, and the position of the plate will be the same each time it is mounted.

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.

It is imperative that the chuck plate should have a good fit on the spindle nose threads. The chuck plate should be screwed on the spindle nose without undue force and yet not be loose enough to allow shake on the threads. The chuck plate on all Le Blond Lathes is held true to the lathe spindle axis by the fit of the spindle nose threads in the threaded bore of the chuck plate. The chuck plate is held square with the lathe spindle axis by the fit of the chuck plate shoulder against the square face of the spindle shoulder.

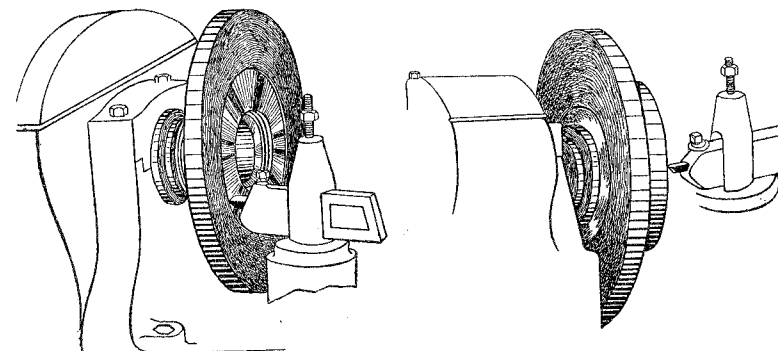
Chuck plates are supplied by Le Blond in both semi-fitted and full-fitted styles.

A semi-fitted chuck plate is machine bored, machine tapped and counterbored, and is then "finish hand" tapped, to a plug screw-gauge fit, before being shipped.

The full-fitted chuck plate, as its name implies, is completely machined and assembled to the chuck so that no further work is necessary.

So much of the accuracy depends on the thread fit (accurately obtained only by use of a precision ground finish tap such as we use in our plant) that we strongly recommend the use of genuine Le Blond semi-finished chuck plates in fitting up chucks to Le Blond Lathes.

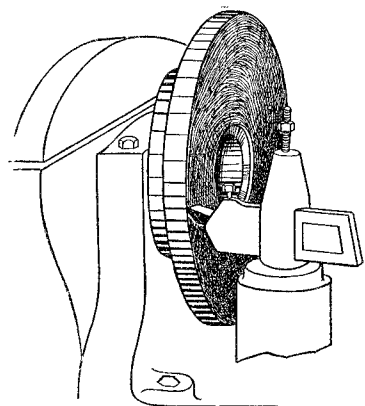
The procedure to fit plates is as follows:



First, screw chuck plate on spindle in regular position about two-thirds of way up to shoulder so that bearing of chuck plate is entirely on threads. Take rough and finish cuts on face of chuck plate so that this finished surface will be square with thread and large enough to clear diameter of collar used in Step No. 2, above.

Second, reverse chuck plate on spindle and insert a collar with true parallel faces between spindle shoulder and part of chuck plate just machined.

This collar should be wide enough to extend from spindle collar to the first full depth thread, since the face of chuck plate is not counterbored as is the back. Next take a skim cut off end of hub. Clean up counterbore of hub at 45 degrees and true up diameter of hub and take cut off back of chuck plate.



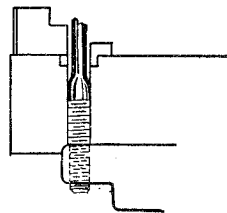
Next take chuck plate off; remove collar; clean spindle nose and chuck plate thread and screw chuck plate on spindle in proper position. Rough face front face and rough turn outside diameter $\frac{1}{32}$ -inch above diameter of counterbore in chuck. Also counterbore tapped hole at 45 degrees to $\frac{1}{8}$ -inch 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.

Next transfer the holes in the chuck to the chuck plate, using the chuck as a drill jig.

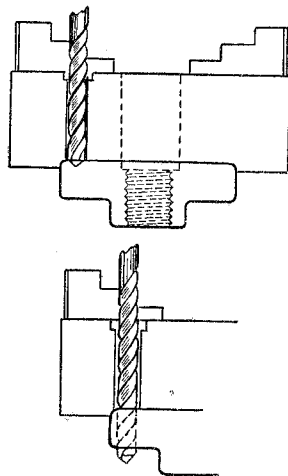
Lightly tap the chuck plate into the chuck counterbore and spot drill through the chuck body to the plate with body size drill. Without removing chuck plate, drill in spotted holes with the proper tap drill for the screws furnished with the chuck.

Start taps into tap holes, tapping from front of chuck to insure proper tap alignment.



Center punch plate and chuck for location; 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 on the face 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 width 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 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 properly done.

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 and three-jaw universal chucks.

When putting on chucks or face plates, care should be taken to see that the threaded hole in the chuck plate is clean and free from dirt. Also wipe off any dirt or grit from the spindle nose and put a few drops of oil on the threads.

Do not try to run the chuck on the spindle nose when the machine is running. This may damage the thread on the spindle, or even more disastrous, the operator's sleeve may be caught in the revolving jaws and cause him serious injury.

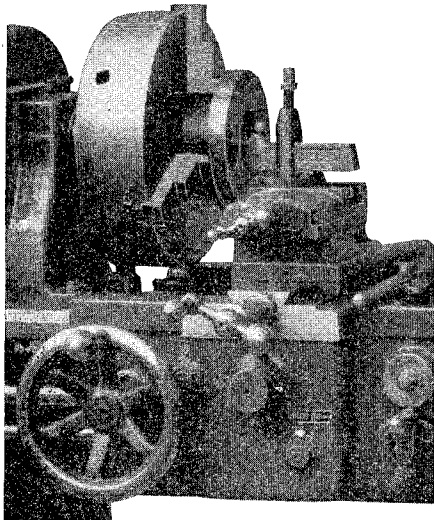
The safe and better procedure is to hold the chuck and revolve the spindle by hand until the internal thread in the chuck plate engages the first thread on the spindle nose, then run the chuck on by hand. For a heavy chuck, a board should be laid across the wings of the carriage to support it, moving the chuck toward the spindle by means of the carriage handwheel. Keep a board of the proper thickness for this purpose.

When removing the chuck, the foregoing operation should be reversed. When the chuck sticks, which occurs occasionally, run the lathe at the slowest spindle speed and jar the chuck loose with a piece of babbitt metal or wood block set endwise on the lathe bed in a position tending to stop the motion of the slowly revolving jaws.

This binding or sticking of the thread can be prevented by cutting a collar from blotting paper and putting it between the spindle shoulder and the chuck plate.

The three-jaw universal or scroll chuck is made so that all jaws move together or apart in unison. The combination scroll chuck allows each jaw to be moved independently in addition to the universal movement.

We do not recommend the use of the combination chuck.



Work held in a 3-Jaw Universal Chuck

Mounting and Adjusting Work in Chucks Three-Jaw Universal*

(a) Adjust jaws roughly to size required. Place wrench in any pinion socket and turn to right to advance jaws toward the center.

(b) Place work in chuck, seating face of work against vertical faces of jaws.

(c) Tighten jaws, as indicated above.

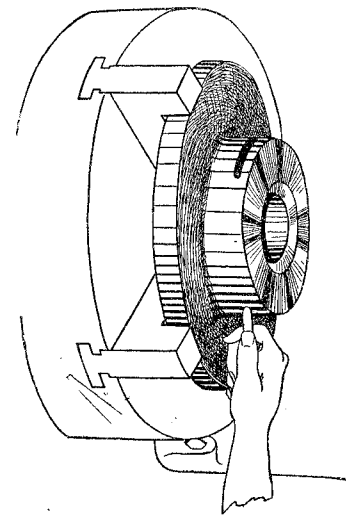
(d) Revolve lathe at speed set for the operation to be performed.

*A "Universal Chuck" is called universal because the jaws are all operated at once, universally, being moved toward or away from the common center together when the wrench is applied to any one of the pinions.

(e) 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.

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

(g) 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.



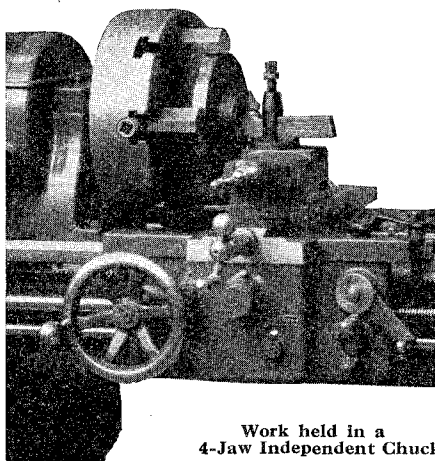
(h) Select shims one-half as thick as the observed run-out. Loosen jaws and insert shims between work and the jaw or two jaws nearest the chalk mark on the side.

(i) 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 position is no longer round.

The four-jaw chuck has, as its name implies, four jaws, each individually adjustable with an appropriate wrench. Where considerable adjusting is necessary, 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.



Work held in a
4-Jaw Independent Chuck

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 followed: 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.

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 2 to 10 thousandths of an inch in centering the work and consequently the run-out of the work must be corrected.

Sometimes this may be done by tightening the screw over the high spot, but at other times it is necessary to pack a piece of paper or thin shim stock between the jaw and the work on the high side.

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.

Care of Chucks and Face Plates When Not in Use

Face plates, chucks, etc., when not in use, should be hung on pegs so that the threads are kept free from dirt and chips.

Caution

Some operators, through a mistaken zeal in attempting to have all parts working very freely, will lap out the threads in the chuck or face plate, by placing grinding grit and oil on spindle nose and then screwing face plate back and forth till fit is loose enough to suit them.

This is not to be recommended.

In the first place, the spindle nose will be worn below standard size, thus ruining the fit over all other fixtures previously fitting on spindle correctly.

In the second place, large face plates and chuck plates should fit tight.

In the third place, with the ordinary grits employed, the cast iron becomes charged with grit and continues to cut even after a loose fit is obtained.

The recommended procedure is to write our factory stating how far plate will screw on spindle nose, both in regular and reversed positions, and send plate in to be tapped larger, or request loan of spindle tap which will be forwarded to you through agent from whom you bought the lathe. Your only charge will be parcel post both ways for the tap.