TECHNICAL MANUAL

OPERATION, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL INCLUDING REPAIR PARTS LIST FOR ENGINE LATHE MODEL A-40H (3416-00-7094)

HEADQUARTERS, DEPARTMENT OF THE ARMY

MARCH 1983

SAFETY PRECAUTIONS

We offer the following partial list of safety points that should be observed, but which in no sense is offered as a substitute for the good judgement of a competent machinist.

1. Machine should be installed by a competent electrician and should be properly grounded.

2. Belt guard and gear guard should be kept on machine at all times except for servicing, at which time the drive motor should be stopped, Disconnect safety switch.

3. Proper eye shields and face guards, etc. should be used, depending on circumstances, to protect operator against hot chips.

4. Do not handle any of the metal cuttings with bare hands as they can produce serious lacerations.

5. When doing high speed machining with carbide tools, proper chip breakers should be used when cutting steel.

6. Do not let string chips wrap around rotating work.

7. Do not wear loose clothing that may became entangled in the rotating work piece.

8. Do not attempt to reach past rotating work member and particularly lathe dogs.

9. Large diameters and out-of-balance parts should not be run at excessive speeds.

10. Care should be used when machining parts that are supported by tailstock dead center as expansion of part can shear off tailstock center causing part to be thrown from machine.

11. All chucks, face plates, fixtures, etc. Should be carefully cleaned in the bore and threads and the retaining nut securely tight before starting machine. Failure to observe this procedure could result in the chuck of face plate being thrown.

12. This machine should be operated by competent and knowledgeable machinists. Apprentices or trainees should operate this machine only under close supervision.

TECHNICAL MANUAL
No. 9-416-241-14&P

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *22 March 1983*

OPERATOR, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL INCLUDING REPAIR PARTS LIST FOR ENGINE LATHE MODEL A-40H (NSN 3416-00-252-7094)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2, located in the back of this manual direct to: Commander, US Army Armament Materiel Readiness Command, ATTN: DRSAR-MAS, Rock Island, IL 61299. A reply will be furnished directly to you.

NOTE

This manual is published for the purpose of identifying an authorized commercial manual for the use of the personnel to whom this equipment is issued.

Manufactured by: McIlvanie Machine Works, Inc.
12 S. 6th Avenue
Yakima, Washington 98902
Procured under Contract No. DAAA09-79-C-4291

This technical manual is an authentication of the manufacturers' commercial literature and does not conform with the format and content specified in AR 310-3, Military Publications. This technical manual does, however, contain available information that is essential to the operation and maintenance of the equipment.

INSTRUCTIONS FOR REQUISITIONING PARTS

NOT IDENTIFIED BY NSN

When requisitioning parts not identified by National Stock Number, it is mandatory that the following information be furnished the supply officer.

1 - Manufacturer's Federal Supply Code Number. 82016

2 - Manufacturer's Part Number exactly as listed herein.

3 - Nomenclature exactly as listed herein, including dimensions, if necessary.

4 - Manufacturer's Model Number. A-40H

5 - Manufacturer's Serial Number (End Item).

6 - Any other information such as Type, Frame Number, and Electrical Characteristics, if applicable.

7 - If DD Form 1348 is used, fill in all blocks except 4, 5, 6, and Remarks field in accordance with AR 725-50.

Complete Form as Follows:

(a) In blocks 4, 5, 6, list manufacturer's Federal Supply Code Number - 82016 followed by a colon and manufacturer's Part Number for the repair part.

(b) Complete Remarks field as follows:

Noun: (nomenclature or repair part)
For: NSN: 3416-00-252-7094
Manufacturer: McIlvanie Machine Works, Inc.
12 S. 6th Avenue
Model: A-40H Yakima, Washington 98902
Serial: (of end item)

Any other pertinent information such as Frame Number, Type, Dimensions, etc.

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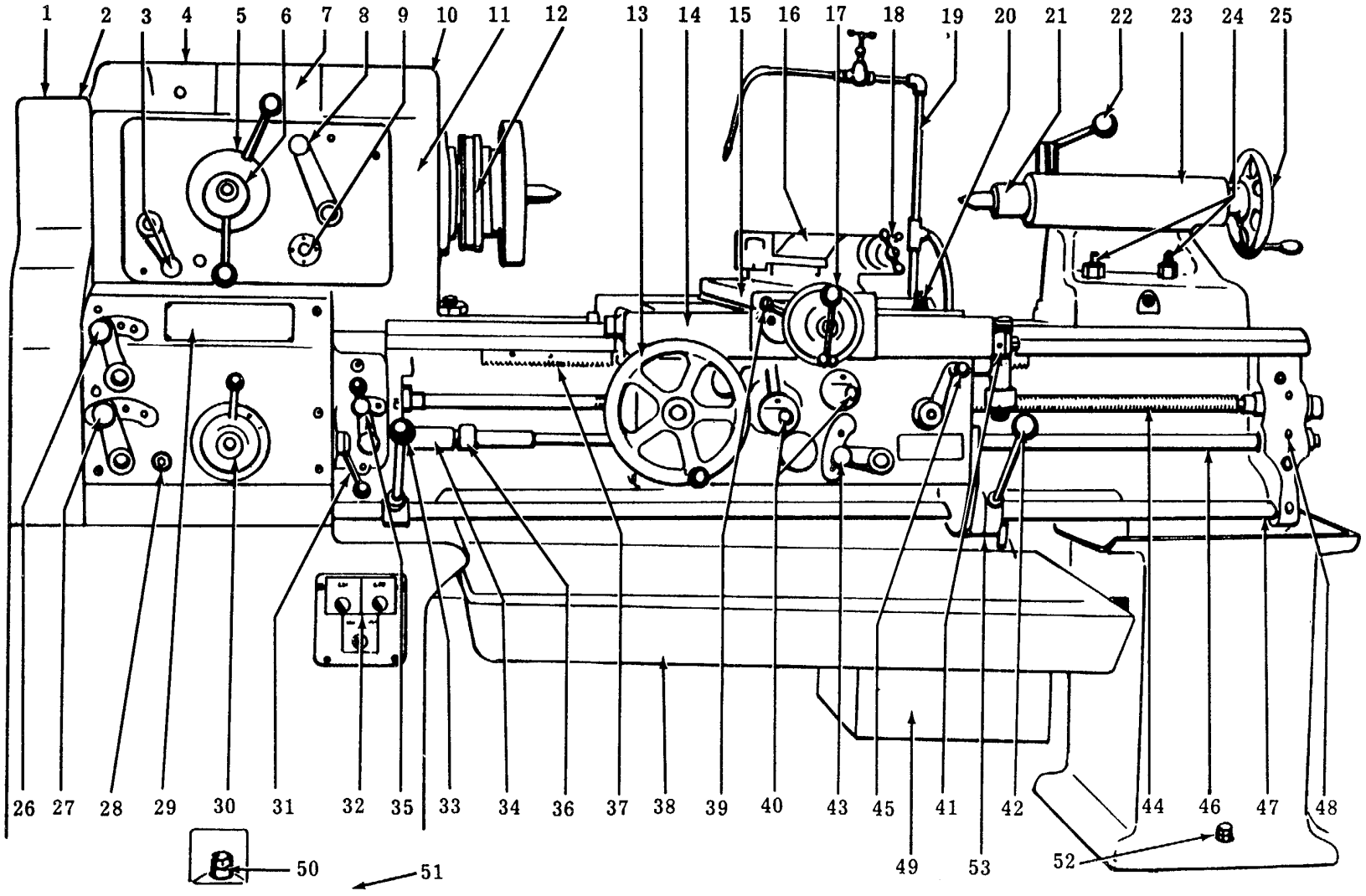
INSTRUCTIONS FOR MODEL A-40H LATHE

The instructions on the following pages cover the most important points for attention on the Model A-40H Lathe.

Trainees should operate this machine only under direct supervision.



MODEL "A" 40
FIGURE 1

LATHE CHART DESIGNATION

1. Belt guard
2. Drive pulley
3. Fine & coarse feed shift
4. Inspection plata
5. "B" shift dial
6. "A" shift dial
7. Speed chart
8. "C" shift lever
9. Headstock oil sight gauge
10. Headstock cover
11. Headstock case
12. Spindle nut
13. Apron handwheel
14. Carriage
15. Cross slide
16. Compound
17. Cross slide dial & handle
18. Compound dial & handle
19. Coolant pipes
20. Carriage clamp screw
21. Tailstock spindle
22. Tailstock spindle clamp
23. Tailstock housing
24. Tailstock clamp screws
25. Tailstock handwheel
26. Leadscrew-feed reverse lever
27. A.B.C. feed shift.
28. Quick change gear box oil sight gauge
29. Thread and feed chart
30. Feed change dial
31. Tumbler gear release
32. Electrical control station
33. Headstock machine control handle
34. Feed overload clutch & automatic stop
35. Rod control lever
36. Feed stop set collar
37. Longitudinal feed gear rack
38. Coolant & chip pan
39. Cross slide gib adjusting screw
40. Snap levers for carriage & cross feeds
41. Thread dial
42. Spindle start-stop-reverse lever
43. Feed reverse lever
44. Lead screw
45. Halfnut control lever
46. Feed rod
47. Control rod
48. End bearing bracket
49. Coolant reservoir
50. Motor pedestal leveling screws
51. Motor pedestal
52. Rear pedestal leveling screws
53. Spindle reverse lock out

INTRODUCTION

Your Lathe is a precision tool. Many years of practical experience and engineering skill are combined to make this lathe accurate, dependable and easy to operate. Its rigid construction, accurately fitted parts and bearing surfaces insure many years of trouble free service and maximum output.

Like all other precision tools, the most critical period in the **life of your Lathe is the first few weeks in your plant.** Proper installation, care and skillful operation are the factors which determine the period of its successful and accurate operation.

We suggest that you read carefully the instructions contained herein before starting to use your lathe. Strict observance of these instructions means years of trouble free service and maximum efficiency.

UNPACKING and CLEANING

After removing the crating and packing materials from your new Lathe, clean it thoroughly with kerosene, spec no. VV-K-211D. Make sure that all the grease or slushing compound, which was used to protect the finished parts and surfaces during shipment, is carefully and thoroughly removed. Particular attention should be given to the way surfaces on the bed and cross slide. Do not under any circumstances move the carriage, compound rest, or tailstock until these way surfaces are thoroughly cleaned and oiled with a good quality lubricating oil. Also thoroughly clean and oil the leadscrew, feed rod and control rods. It is quite obvious that this protective covering may collect considerable dirt and grit during shipment, and unless it is carefully removed, badly scratched or damaged surfaces will result.

Do not remove the skids until the lathe has been placed in the approximate operating location in your plant. When removing the skids do not drop or twist the lathe bed. Failure to observe this point may result in serious impairment of the accuracy of your lathe.

INSTALLATION

Place your lathe on a solid foundation, such as cement flooring, cement pillars through wood flooring, good wood floors, or other modern factory floors are satisfactory.

LEVELING

To properly level your lathe use only a precision level. The ordinary types of commercial levels, carpenter's levels, etc., are not sufficiently accurate. The correct leveling of your lathe is the most important step in its installation, in fact it is the very essence of its accuracy.

LEVELING - Cont.

First set your lathe in its operating position placing flat steel plates (about 4" x 4" x 1/8") under each of the two leveling screws of the front and rear pedestals. Place parallel or raising blocks of equal thickness on the two flat way surfaces of sufficient height to hold the level above the V's; place the level on these parallels and test alternately at the headstock and tailstock ends of bed and on long beds over center leg and make necessary adjustment with leveling screws.

It is not necessary that the lathe be dead level but it is important that the level readings be the same in both positions to .001 inch. The level of your lathe should be checked every week or so for the first six months after installation. After this period a checkup two or three times a year should be sufficient.

It is not recommended that the lathe be lagged tightly to the floor. In most cases it is not necessary.

ELECTRICAL CONNECTIONS

Connections to your power service should be made strictly in accordance with your local electrical code.

All lathes are wired in our factory according to the National Code. When local or state codes differ from this, advise our factory immediately. Be sure the lathe is properly grounded. After the electrical connection has been made, check the drive pulley to make sure the motor has the proper direction of rotation.

LUBRICATION

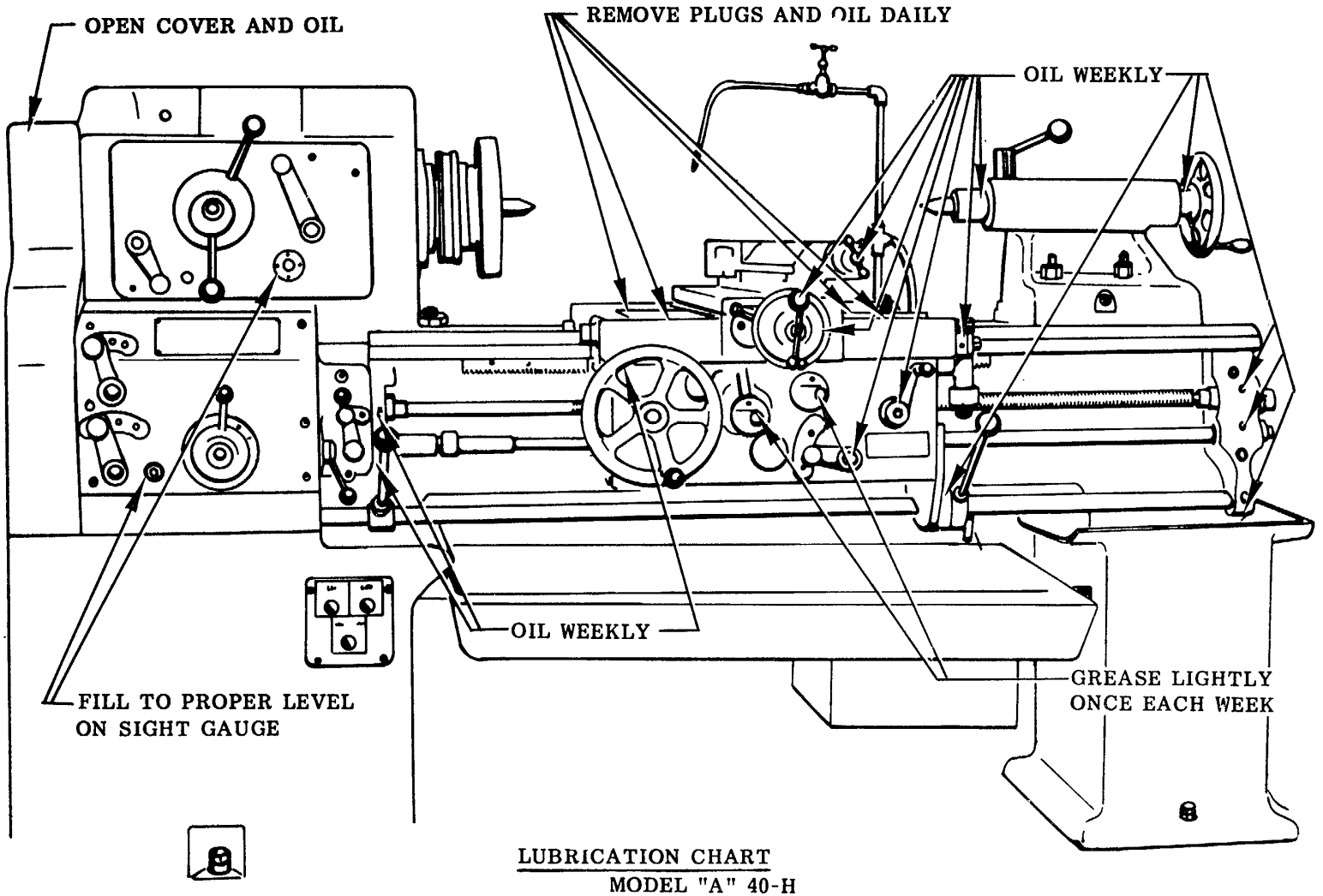
Do not run your lathe until it is thoroughly oiled and lubricated in accordance with the instructions on the oil chart. **{see Fig. 2, Pg. 6}**

A good quality oil having SAE 30 rating is recommended for all lubrication on your lathe. Do not use inferior grades of oil and be sure the oil is free from acid. The use of a high grade oil will be found the most economical in the long run.

HEADSTOCK

The headsock of the Model A-40H Lathe is oil tight and is lubricated by either splash or combined splash and pump. In the pump lubricated machine, a gear type oil pump delivers a continuous supply of oil to all bearings. The oil is pumped through an **oil filter located on the back of the headstock. The cartridge** (C-1110PB) should be replaced once each year. All gears in the headstock are generously flooded with oil by a splash system as soon as the lathe is started.

Sufficient oil should be placed in the headstock to bring the level to a height of 1/2" on the sight gauge located on the front of the headstock.



LUBRICATION CHART
MODEL "A" 40-H

USE A GOOD GRADE OF SAE 30 WT. OIL
IN ALL GEAR BOXES AND OILING POINTS

Figure 2

LUBRICATION - Headstock (cont.)

The headstock may be filled by removing the inspection plate in the cover and pouring the oil through this opening.

It is recommended that the oil be drained and the headstock flushed with flushing solvent, spec no. T-D-680, Type 1, after 4000 hours of operation. To make a thorough job of this, the cover should be removed and the oil and the flushing solvent drained out through the drain pipe located underneath the front end of the headstock. Be sure to see that any sediment which may have accumulated in the bottom of the headstock is carefully flushed out. On machines with oil pump, change filter cartridge and refill with fresh oil to the proper level.

QUICK CHANGE GEAR BOX

The gear box is oil tight and is lubricated by a cam operated pump. The reservoir is located in the bottom of the box and should be filled to the proper level as indicated by the sight gauge on the front of the box. A 1/2" pipe plug is located on the top of the box for filling purposes. The gear box should be drained and flushed after 4000 hours of operation. A 1/2" pipe plug drain is located on the end of the box. An oil hole is located in the idler gear bearing in the gear train at the end of the lathe, access to which may be had by opening the gear guard. This bearing should be lubricated twice weekly.

There are also two oil fittings at the right end of the gear box for the leadscrew and feed rod. A few drops of oil weekly at these points should be sufficient. One oil hole is located on the clutch rod bracket attached to the quick change gear box accessible by opening gear guard. A few drops of oil here weekly is sufficient.

CARRIAGE

The carriage cross slide, bed ways, gears and bearings for the main shaft are lubricated by the pump located in the apron.

On the front of the carriage almost directly underneath the crossfeed screw is a stud which carries the intermediate gear connecting to the crossfeed screw. There is an oil hole in the end of this stud, through which the intermediate gear is lubricated. Oil this bearing weekly.

Flush type oilers are provided for lubricating the bearings of the cross feed and compound rest screws. The crossfeed bracket at the back of the carriage has a flush type oil fitting to oil the thrust bearings. On machines equipped with telescopic taper attachment, this thrust bearing is located in the taper attachment and contains one flush type oiler. There is also a flush type oiler in the hexagon head of the screw which connects the cross slide to the crossfeed screw nut. This oiler lubricates the crossfeed screw and nut. A few drops of oil weekly at these points is sufficient.

LUBRICATION - Cont.

APRON

The apron is oil tight and all gears and the bearings for the main shafts are lubricated by a cam operated pump. The reservoir is located in the bottom of the apron and should be filled to the proper level as indicated by the sight gauge on the front of the apron. A 1/2" pipe plug is located on the front of the apron for fitting purposes.

The apron should be drained and flushed with flushing solvent, spec no. T-D-680, Type 1, after 4000 hrs. of operations. Do not move carriage hand wheel while flushing. A 3/4" pipe plug drain is located at the bottom of the apron. There are also two flush type oilers on the front of the apron which require a few drops of oil weekly. The feed clutches have zerk fittings and should be greased lightly with a good grade of grease weekly.

TAILSTOCK

The tailstock screw bearing is oiled through a flush type oiler in the cap on the back end of the tailstock. There is also a flush type oiler on top of the tailstock through which the spindle and screw are lubricated. A few drops of oil each week is sufficient at these points.

Every two or three weeks the tailstock spindle should be screwed forward exposing the greater part of its length. In this position it should be wiped clean, carefully oiled and then drawn back into its bearing. Before sliding the tailstock either forward or backward be sure to thoroughly clean and oil the way surfaces of the lathe bed. Failure of the operator to follow this procedure may result in damage to the lathe bed as well as to the bearing surfaces of the tailstock.

Three oil holes are located in the end bearing for leadscrew, feed rod and clutch rod. These should be oiled every fifteen or twenty hours on continuous operation. Also, the leadscrew should be occasionally cleaned and lubricated. It is advisable to apply oil to the leadscrew when threading.

DO'S AND DON'TS

HEADSTOCK

1. When putting chuck on lathe rotate spindle so driving key is at top and center. Be sure tapers are absolutely clean.

2. When tightening ring nut on spindle, use spanner wrench and see that wrench is in the center of nut. Do not drive nut up with hammer or punch.

3. Stop to shift, do not engage gears while running. If gears do not engage, rock spindle by hand to align gear teeth.

QUICK CHANGE GEAR BOX

4. hen using coarse feeds and threads, run lathe at slow speeds until lathe is well run in. Always run slowly when cutting coarser than 8 threads per inch.

5. Do not shift coarse-fine lever while lathe is running. Shift "A", "B", "C" levers only when operating at moderate feeds and speeds. Same applies to tumbler gear.

CARRIAGE

6. When taking large heavy cuts, take gibs of crosslide and compound rest up so noticeable friction can be felt when operating these two units. Be sure to loosen gib on cross slide when using taper attachment so attachment operates freely without causing cross slide to move irregularly.

7. Do not clamp chips under tool post ring as this deforms compound rest.

8. Wipe clean and KEEP ALL WAYS 'WELL OILED.

9. Make certain that enough travel is available for all machining operations before engaging power feeds or before cutting threads. Also check travel of taper attachment when machining tapers. These precautions may be accomplished by manually operating the slides before engaging the power feeds or threads if any doubt exists about adequate clearance.

TAILSTOCK

10. Keep spindle outside and inside clean at all times. Keep spindle well oiled as this is a honed fit.

11. Do not tighten excessively lateral adjusting screws on tailstock as this can cause lugs to break off from base and also deforms base so it does not fit properly to bed ways. Further, this does not increase rigidity of location as this is determined only by the diameter of the adjusting screws. KEEP TAILSTOCK WAYS CLEAN AND WELL OILED.

HEADSTOCK

The headstock is driven by a multi-vee belt from the motor located within the base. Control of the spindle is provided by the lever located at the right side of the carriage. On the electric drive machine this lever controls the motor; forward rotation being obtained when the lever is pushed downward and reverse when pulled upward. Stop position is located midway. On machines supplied with clutch, the motor runs continuously and rotation of spindle is obtained by pushing the control lever downward and engaging the clutch. Center position disengages the clutch while upward movement engages a brake which stops spindle rotation. The headstock provides 12 speeds in close geometric progression easily selected by three levers whose position is readily determined from the chart. The speed chart has incorporated a surface speed chart for 100, 200 and 300 feet per minute. Range of the chart may be increased by mentally doubling the diameters for the 200 and 300 foot range providing surface speeds of 400 and 600 feet respectively. Lever settings for any specific surface speed and diameter may be obtained directly without reference to RPM.

The increments of speed changes vary from fine to coarse from levers "A" to "B" to "C" in order, "A" being finest and "C" coarsest. The numbered positions of the lever are also in direct order to increasing speed. With this information, increasing or decreasing of speeds can be easily accomplished without reference to the chart. Thus, the largest speed change would be accomplished by shifting lever "C" position 1 - slow, 2 - fast; intermediate change, lever "B"; fine change, lever "A" 1 - 2 - 3 being the order of increasing speed. Always be certain the gear train is stopped before attempting to shift as failure to observe this procedure could result in damage to the gears. If levers will not slide into position, rotate the spindle very slightly either by hand or by jogging with the clutch lever. Avoid clashing of gears or clutches.

Starting & stopping of electric drive machine.

Before starting, push the "ON" (green) button of the control panel which will light the pilot light. The clutch lever on the carriage will now operate. When not operating the machine, push the "OFF" (red) button as this will prevent the accidental starting of the spindle. A low voltage relay is provided in the circuit so that in event of power failure, the starting procedure will have to be repeated.

QUICK CHANGE GEAR BOX

Forty-nine (49) changes of feeds and threads are provided in the conventional type Quick Change Gear Box.

The positions of the tumbler and ratio levers are clearly indicated on the index plate mounted on top of the box. When changing threads or feeds, the apron power feeds should be disengaged. This will make the gear box easier to operate. When changing to coarse feeds or threads, the motor should be stopped and the changes made while the lathe is coasting to a stop or the motor can be jogged by pushing the switch quickly to the "on" and "off" positions.

QUICK CHANGE GEAR BOX - Cont.

It is preferable to stop the gear train before shifting the levers for first several weeks of operation when machine is new and always when shifting gear box if it is running at high speeds or coarse feeds or threads. In selecting feeds and threads it will be noted that a fine and coarse range of feed and threads is provided by the small shift lever at the lower left panel of the headstock. It is referred to in the index chart on the quick change box. When running spindle speeds in excess of 400 RPM, always shift this lever to the fine range. When selecting the position of the tumbler, rotate the small lever on the lower right hand edge of the quick change gear box 180° clockwise which will disengage the tumbler gear from its position in the cone gear. The dial on the front of the machine may then be rotated to the desired setting after which the small lever is rotated back to re-engage the cone gear setting.

By means of a simple sliding gear and jaw clutch arrangement, the feed rod and leadscrew cannot be engaged or operated simultaneously. When the shift lever 35, Fig. 1, is in the left position the feed rod is in action and the leadscrew is idle. By shifting this lever to the right hand position the leadscrew is engaged and the feed rod will be idle. With the lathe running on one of the slow speeds this lever can be easily shifted by exerting a firm even pressure in the direction desired. Do not shift this lever when the lathe is running on the high or fast spindle speeds. It is also advisable to set the reverse lever 43 on the front of the apron to the neutral or central position, thus relieving the load on the feed rod before making the shift as outlined above.

APRON

The apron is provided with a positive interlocking device which prevents the simultaneous engagement of the feed rod and leadscrew. When the apron reverse lever 43, Fig. 1, is in either the extreme upper or lower position, the feed gears are engaged and the leadscrew half nuts are locked out. To engage the half nuts on the leadscrew, the reverse lever 43 must be placed in its central or neutral position, thus disengaging the feed gears and unlocking the half nuts which are opened and closed by shifting the control lever 45. When the leadscrew is in use be sure to release the feed clutches on both the longitudinal and cross feed. Feed clutches are engaged by pushing feed lever downward and raising to the horizontal position to disengage. A separate clutch is provided for both cross feed and longitudinal feed. Clutch is of the cone type and holds without slipping without excessive pressure on the clutch levers.

TAPER ATTACHMENT

Taper attachment furnished is of the precision telescopic type which is bolted to the back end of carriage. The end of taper attachment is graduated in degrees and inches per foot.

TAPER ATTACHMENT - Cont.

To use this attachment it is only necessary to adjust this taper attachment to the angle or inches per foot required. Then by locking clamp on bed, your machine is ready for turning your tapers. Use your cross slide for regulating your different amounts of cuts on your compound rest. It is always best, in taking an extra cut, to go by your work at least 1" to 1 1/2" to avoid any back lash that might be caused due to wear over a period of years.

A three-piece nut is provided on the crossfeed screw to remove all the back lash. All back lash should be removed when using the taper attachment. This is accomplished by loosening the screw nearest the operator slightly and rotating the center screw with a screw driver clockwise. This action wedges the two parts of the nut apart thus removing back lash after which the back screw should be clamped lightly. If the wedge is tightened too much it naturally will bind cross feed screw and you will not be able to revolve hand crank. Adjustment will have to be made to permit rotating screw without excessive force.

DISASSEMBLING AND ASSEMBLING LATHES

HEADSTOCK

Spindle removal is accomplished by first removing headstock cover. In order to do this you will have to remove inspection plate and remove connecting link from the cross shaft in the cover to the "A" dial shift lever so that cover may be removed. With visual examination through the inspection cover it will be apparent. The cover may then be removed by removing the eight screws that hold it to the main gear case. To remove the spindle, loosen the clamp screw on the split threaded adjusting nut on the center bearing. Rotate the nut **counterclockwise** to disengage it from the thread. Open the gear guard at the rear of the machine and remove the ball bearing clamp nut visible at the end of the spindle. Remove the oil seal plate with the oil seal and the oil seal sleeve attached to the spindle. Remove the four 5/16" socket head cap screws from the front oil seal plate behind the spindle. Remove dog point set screw from the high speed driving gear on the spindle. Spindle may then be driven out of the headstock with a large wooden block.

To remove third shaft, remove rear bearing cap at rear of lathe and cap screw and washer from end of shaft. Drive spline shaft toward spindle nose end of lathe until large clutch gear No. 1246 can be lifted out along with spline bushing and snap ring. Then remove smaller gear No. 1247 the same way. Then drive shaft in opposite direction to lift out pinion and high speed driving gear.

To remove the drive shaft, remove drive pulley from drive shaft. Remove the cover plate connecting cover seal. Drive shaft may then be driven out from the front or spindle nose end of machine. To remove the lower or second shaft in the gear train, loosen the ball bearing nut on the end of the shaft toward the spindle nose.

HEADSTOCK - Cont.

Take a shaft driver and lightly drive the shaft out to the rear of the machine. The parts on this shaft will fall in the bottom of the case and on to the driver and then can be removed one at a time from the gear case.

QUICK CHANGE GEAR BOX

To remove from machine.

1. Remove two 1/2" socket head screws from leadscrew-feed rod end bearing bracket at right end of lathe bed. Position carriage so as to balance the weight of leadscrew and feed rod and move end bearing, leadscrew and feed rod to the right in order to remove them from the quick change gear box. This operation may be facilitated somewhat by engaging the apron half nut to the leadscrew and cranking the apron to the right, thereby pulling the leadscrew and feed rod from the quick change box. Open the gear and belt guard and remove the bracket supporting the square operating rod from the underside of quick change box. Also remove the input gear and quadrant arm.

2. Remove cover from feed-thread selector box and remove snap ring from the left end of overload release shaft driving feed rod and remove shaft from the gear box. Remove feed gear from box and remove cap screw in back of box, attaching quick change box to lathe bed. Three more screws, one located in flange on box directly above feed-thread selector box and two at left end of box, being threaded into box through clear holes in flange of lathe bed, attach the gear box to the lathe bed. Support the box with a rope sling slipped over a stub shaft placed in leadscrew or feed rod bearing and over the input shaft. Carefully pry gear box from the key in lathe bed, being careful to keep the box balanced when it clears the key. Attention should be given to the limit switch at the rear of the box to avoid damage.

3. Disassembly - First drain oil by removing drain plug at left end of gear box. Remove front dial. Drive out taper pin holding the A-B-C shift lever and remove lever from shaft. Remove the 3/8" cap screws attaching cover to box and the cover itself by sliding the cover off the A-B-C shaft allowing the shaft to remain in the main case. The cover contains the entire tumbler shift mechanism.

Tumbler Shaft. **Remove screws from plug at right end of** upper or tumbler shaft and plate from left end. Remove retaining ring from dog point set screw in reverse gear hub at left end of shaft and remove set screw. Tap shaft to the right, which will drive retaining plug from case and pull ball bearing from right end of shaft; after which push shaft **to the left thru tumbler and** reverse gears and remove from box.

QUICK CHANGE GEAR BOX - Cont.

4. **Cone gear shaft**. **Remove set screws from plug at right** end of cone gear shaft. Tap shaft to the right which will drive the plug from the box. Remove ball bearing nut and washer and pull bearing from shaft. Remove entire assembly through front of box.

5. **Input shaft**. Remove the three cap screws from flange of input shaft bearing, drive shaft out of box to the left-through ball bearing and reverse cluster gear. Remove gears and bearing from the case.

6. **Rear shaft**. Remove bearing cap from left end of shaft. Drive shaft out left end of case through bearing and gears and remove from case. Be sure to depress oil pump plunger from cam groove in shaft before driving out shaft.

7. **Oil Pump**. Disconnect internal plumbing. Remove three 1/4" cap screws from flange of pump and pull pump from base of quick change box.

8. **A-B-C shift**. Remove connecting link from cross shaft lever to double shift fork. Loosen offset shift lever from cross shift shaft and push shaft out the front of box. Lift out offset lever. Remove set screws (2-1 locking screw) from casting and tap out shift rod. Lift out shift fork.

9. **Cover, shift mechanism**. Drive pins from eccentric (2) and slide eccentric shaft from cover. Remove two lower shoulder screws and one cap screw from lower jaw and remove jaw. Loosen 3/8" lock screws holding clevis studs and remove studs, clevis and link from upper jaw. Disconnect lift bar from upper jaw by removing three 1/4" screws. Remove upper jaw and then lift bar and brass slider. To remove chains drive pin from sprocket on dial shaft and pull shaft from the front of cover, being careful not to lose detent and spring which locate dial. Sprocket may now be lifted out of cover; chain is now free to be removed from idler sprockets along with slider. Idler sprockets are held on drive fit pins which may be removed by driving from front of case. When re-assembling be sure to synchronize dial with position of bronze shift fork on slide bar so that tumbler will engage proper gear in cone gear cluster. This can be accomplished by locating the marked tooth of the sprocket with the connecting link in the chain.

CARRIAGE

Carriage is removed by removing gibs on front and in back. To take up slack in drive from crossfeed handle to dial, turn screw driver slotted pin in front of carriage to the left of crossfeed handle slightly. Then, retighten set screw on top of carriage over pin. Do not loosen over 1/2 turn on set screw as this locates pin. When taking up slack on crossfeed screw, leave 1/2" cap screw tight and loosen other 1/2" screw, then tighten slightly, small cap screw in center. This will take up loss motion in thread.

APRON

All directions given are as viewed from operator's side.

To remove apron from the machine, first remove taper pin in left hand end of feed rod and leadscrew. Next remove two socket head cap screws in the leadscrew, feed rod and control rod bearing bracket at the right hand end of the lathe bed. The leadscrew and feed rod can now be removed by pulling through the apron.

Caution should be used to avoid bending leadscrew or feed rod. The apron halfnut will have to be opened at this time. The leadscrew and feed rod can now be laid aside still attached to the bearing bracket.

The micro switch operating cam, Part No. 1771, can now be removed from the left end of the control rod by loosening the set screw. Access to this cam is gained by opening belt guard. This part has a detent spring and ball and caution should be used when removing to avoid losing these parts. The control rod can now be pulled through bearing bracket under quick change gear box. This rod should be moved only far enough to clear the cover under the quick change gear box. By removing two socket head cap screws in the control rod bracket on right hand side of apron, the rod, bracket and control handles can now be laid aside. The apron itself can now be removed from machine. This is accomplished by removing two socket head cap screws, one on each side of the carriage. Support the apron as these cap screws are being removed. The two 3/8" keys that align the apron and carriage should be laid aside at this time.

The apron can now be disassembled. The half nut gibs, Part No. 229 and No. 1804 located at right rear should be removed first. They are attached by three hexagon head cap screws on each side. The bevel gear housing, Part No. 1777, also attached with hexagon head cap screws, should now be removed. This unit includes bevel pinion, Part No. 1778; cone clutch, No. 1788; shift fork, No. 1780 and shifting rod, No. 1781; and can be further disassembled by removing snap rings on the bevel pinions and tapered pin in the shift fork. The half nut, No. 1802, can now be lifted out. The half nut cam, Part No. 226 and shaft, No. 1803, can be removed by pressing out the tapered pin in the half nut handle, No. 228A and pushing shaft through rear of apron housing.

The rack pinion shaft, No. 184, can be removed by loosening the socket head set screw in the hub of the large gear, No. 205-1 and pressing out through rear of apron housing. The front rack pinion shaft bushing, No. 186, should be pressed flush with the inside front of housing before further disassembly. The oil pump No. C-2118, if so equipped, is attached with two hexagon head cap screws to the front of apron housing. Access for removal is through inspection plate at left rear of apron.

APRON - Cont.

The plunger on the pump should be on the low side of the cam, No. 1807, on the handwheel shaft. The handwheel shaft will now come out by removing tapered pin in the cam, No. 1807, and pulling out through front of apron housing. The cam and handwheel pinion, No. 1800, will lift out through top of housing.

The longitudinal feed clutch can now be removed. The clutch must be held compressed while nut, No. 189, is removed from end of feed shaft, No. 1791. The snap lever handle assembly, No. 188, 191 and 192 can now be pulled from end of feed shaft and shaft tapped through rear of apron housing. Clutch assembly, No. 1788, 1790 and 1789, can now be lifted through top of housing and decompressed. The bearing No. 1786 and ball thrust No. 195 will also lift out through top. The crossfeed clutch can now be removed in the same manner as longitudinal feed clutch. Bevel gear shaft

No. 1783, bearing No. 1127 and bevel gear No. 1782 can be pressed out through rear of apron housing by removing thrust button No. 1764, The gear is press fit on the shaft and can be pressed off if so desired.

Reassemble in reverse order. Caution should be used when assembling the apron to the carriage to see that feed gear train is in mesh correctly; also, that the 3/8" keys and keyways align. A short piece of shaft should be used to hold double Jaw clutch No. 1779 in the right position in the bevel gear housing to allow feed rod to be inserted.

PARTS LIST

When ordering repair parts, be sure to give the serial number of lathe. The serial number is stamped on the right front end or the bed. Give size of lathe viz., the swing and length of bed. Give detail number and plate number of each item required.

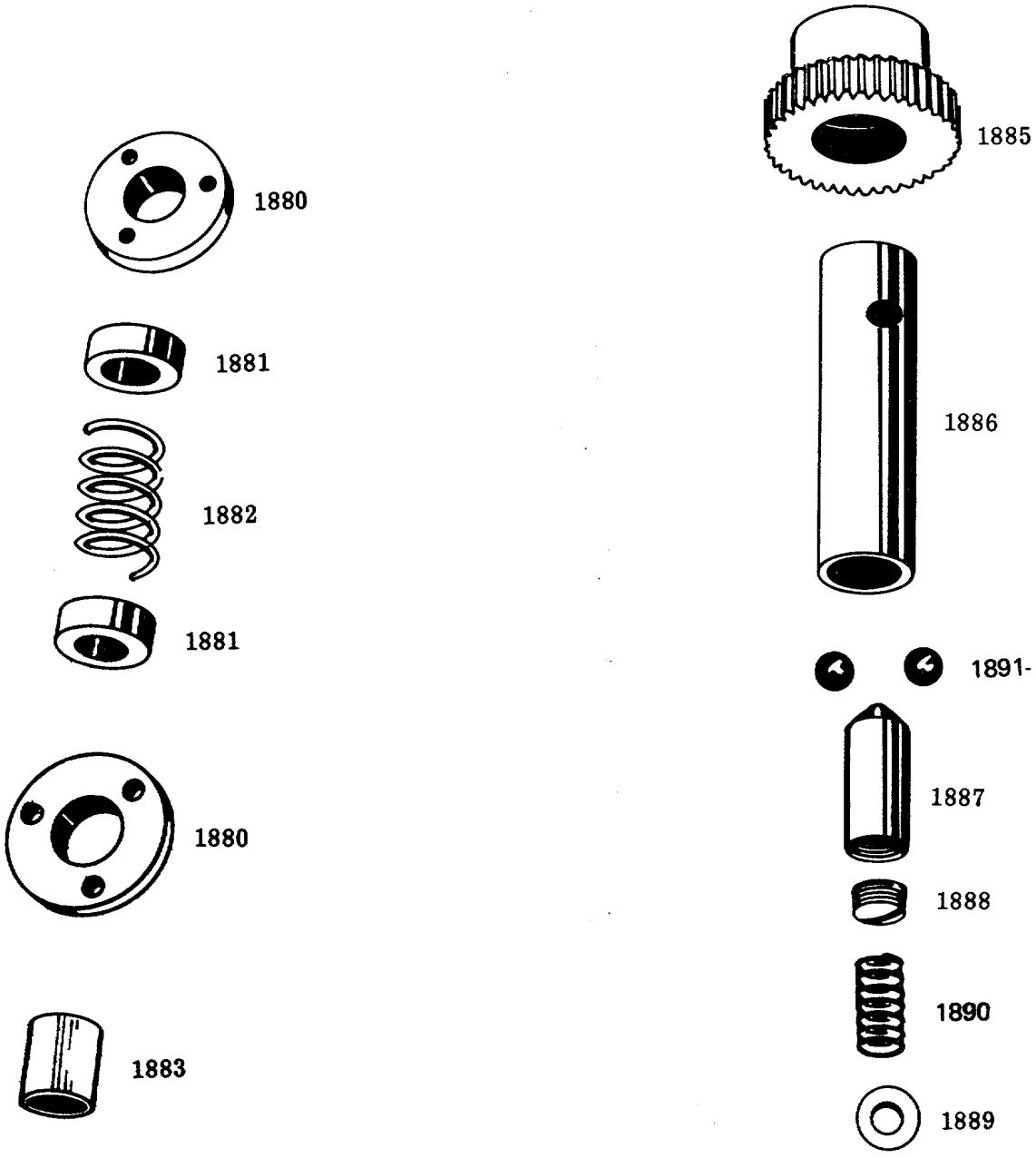


Figure 3

OVERLOAD CLUTCH & AUTOMATIC STOP

1880 End Collars
1181 Bronze Thrust Bushing
1882 Spring
1883 Sleeve
1885 39-T Feed Gear
1886 Stop Sleeve
1887 Plunger, Loading
1888 Spring Adj. Screw
1889 Spring Thrust Washer

1890 Spring-

1891 1/2" steel balls

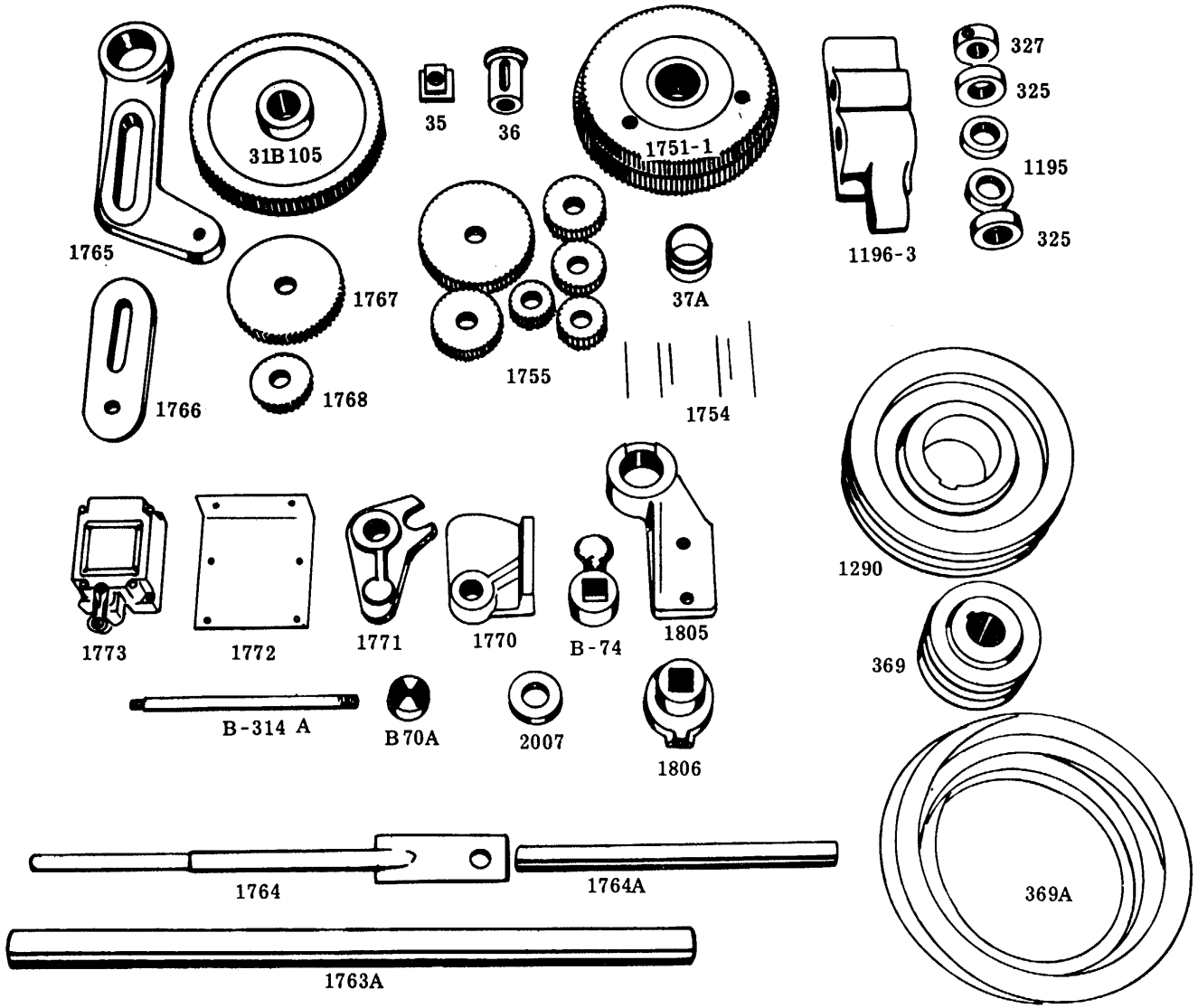


Figure 4
MISCELLANEOUS PARTS

MISCELLANEOUS PARTS

Figure 4

31-B-105	Gear
35	T-slot nut
36	Bearing for idler gear
37A	Bronze bushing
B-70A	Ball
B-74	Clutch control collar
B-314A	Lever, shaft
325	Front thrust collar
327	Leadscrew thrust, adj. nut
*346	Feed rod
*347	Clutch rod
369	Motor pulley
369A	Belts, 3 req.
*378	Rack
*650	Hardened "V" way
*1216	Hardened flat way
*1192	Leadscrew
1195	Ball thrust - 2 req.
1196-3	End bearing
1290	Drive pulley
*1750-1	127-T metric transposing gear
1751-1	120-T metric transposing gear
*371	Dog plate
*1202	Rear pedestal
*1214	Lathe bed
1754	Metric thread & pitch chart
1755	27-T, 30-T, 33-T, 36-T, 42-T, 72-T gears
*1760	Motor pedestal
*1761	Belt & gear guard
	Rear plate for gear guard
*1762	Louvre for motor pedestal
*1762A	Front cover plate for motor pedestal
*1763	Motor mount frame
1763A	Motor support shaft
1764	Hanger & belt tensioner
1764A	Hanger & belt tensioner pin
1765	Gear quadrant arm
1766	Link
1767	Gear on box - English threads
1768	Gear on head - English threads
1770	Clutch rod bracket
1771	Clutch rod cam
1772	Switch mounting plate
1773	Micro switch
1805	Clutch rod bracket on apron
1806	Square sleeve for clutch rod
2007	7/8" set collar

*Not Illustrated

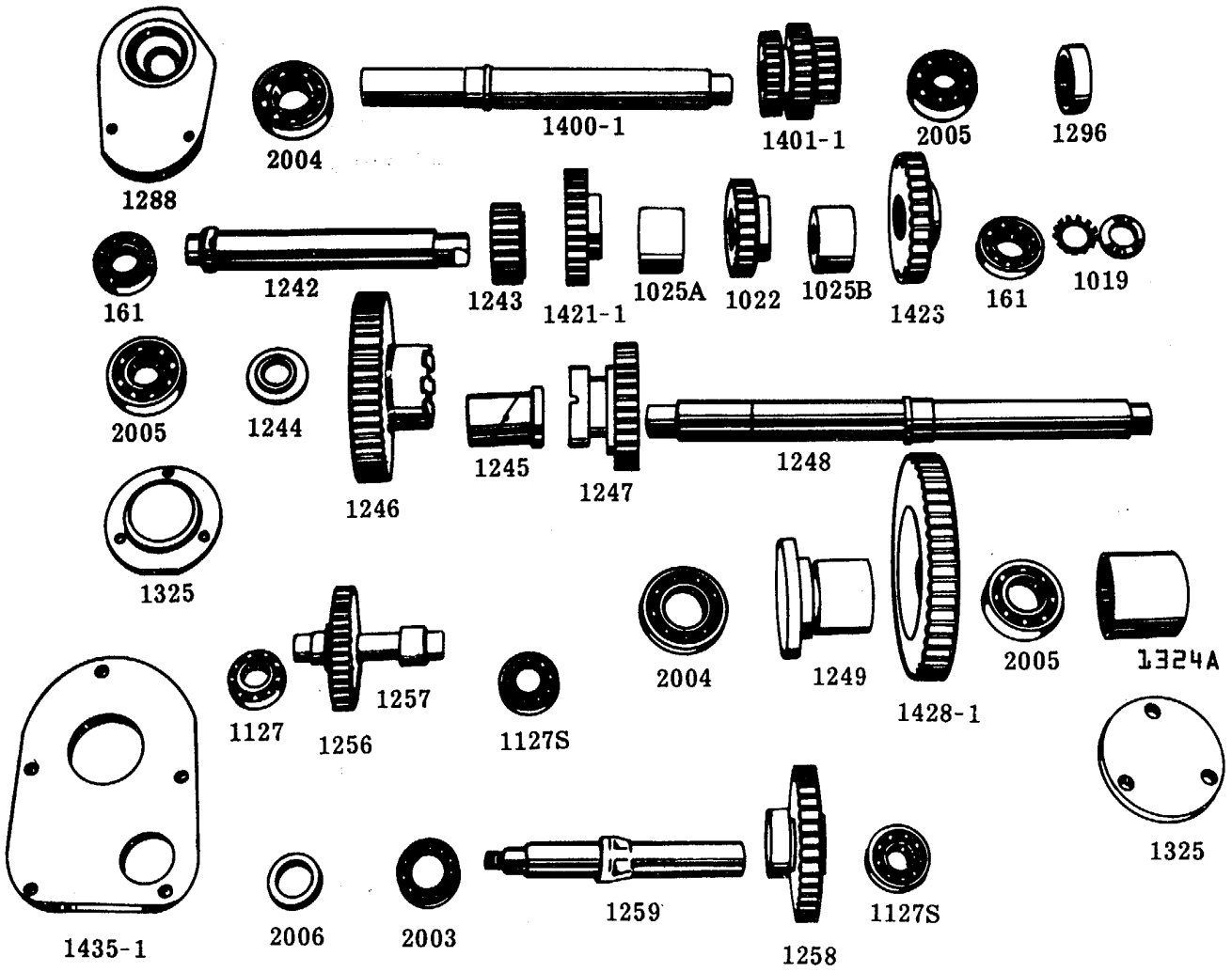


Figure 5
HEADSTOCK PARTS

HEADSTOCK {con't}
Figure 5

161	Ball bearing
1019	Nut for second shaft
1022	28-tooth gear
1025A	Spacer
1025B	Spacer
1127	Ball bearing for feed jack shaft
1127S	Ball bearing
1242	Second shaft
1243	20-tooth pinion
1244	Spacer
1245	Splined bushing
1246	Clutched gear - idler
1247	Sliding clutch gear
1248	Third shaft
1249	Back gear pinion
1256	40-tooth feed gear
*1257	12-tooth pinion feed shaft
1258	20-48 tooth feed cluster gear
1259	Output feed shaft
*B-61-A	Cover inspection plate
*69-A	Sleeve
*1287	Speed chart
1288	Cover plate, drive shaft
*1289	Oil seal for drive shaft
1296	Cover, plugs for 1st & 2nd shaft
1324A	Bearing spacer
1325	Bearing cap
*1346	Headstock cover
*1349	Headstock
1400-1	Drive shaft
14M0-1	Cluster gear on drive shaft
1421-1	33-tooth gear
1423	37-tooth gear
1428-1	47-tooth high speed drive gear
1435-1	Rear oil seal retainer plate
*2003	Ball bearing for feed output shaft
2004	Ball bearing for rear drive shaft
2005	Ball bearing for third shaft
*2005S	Ball bearing for front end of drive shaft
2006	Oil seal for feed shaft
*1290	Drive pulley

*Not Illustrated

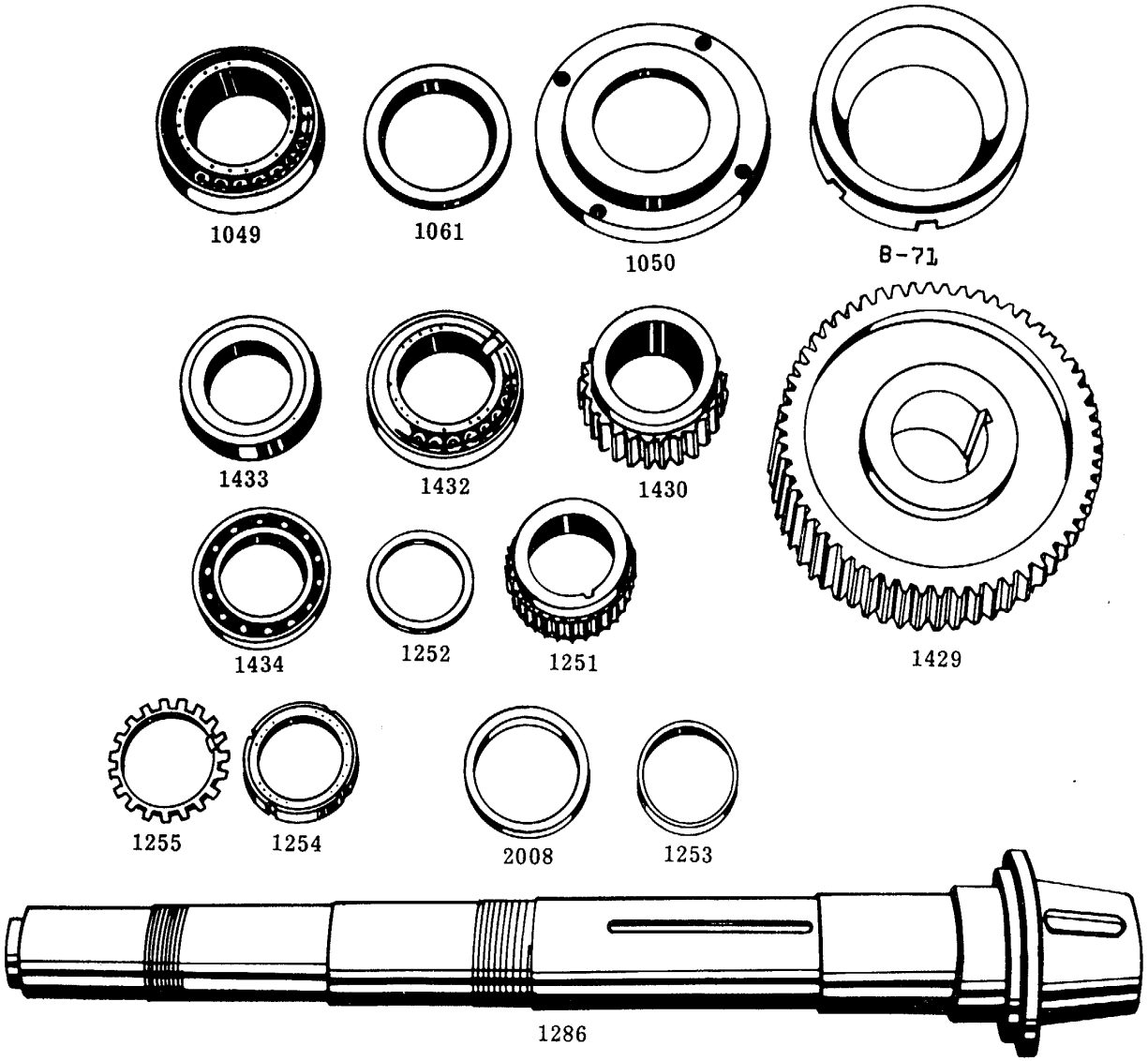


Figure 6
HEADSTOCK PARTS

HEADSTOCK PARTS {con't}
Figure 6

B-71	Spindle draw nut
1049	Front Timken bearing
1050	Oil seal retainer
1061	Oil seal
1251	Spindle feed gear
1252	Spacer
1253	Rear oil seal sleeve
1254	Rear bearing nut
1255	Rear lock washer
1286	Main spindle
1429	Back gear
1430	High speed spindle gear
1432	Center Timken bearing
1433	Spindle adjusting nut
*1434	Rear ball bearing
2008	Rear oil seal
*1286-A	Draw collar

*Not Illustrated

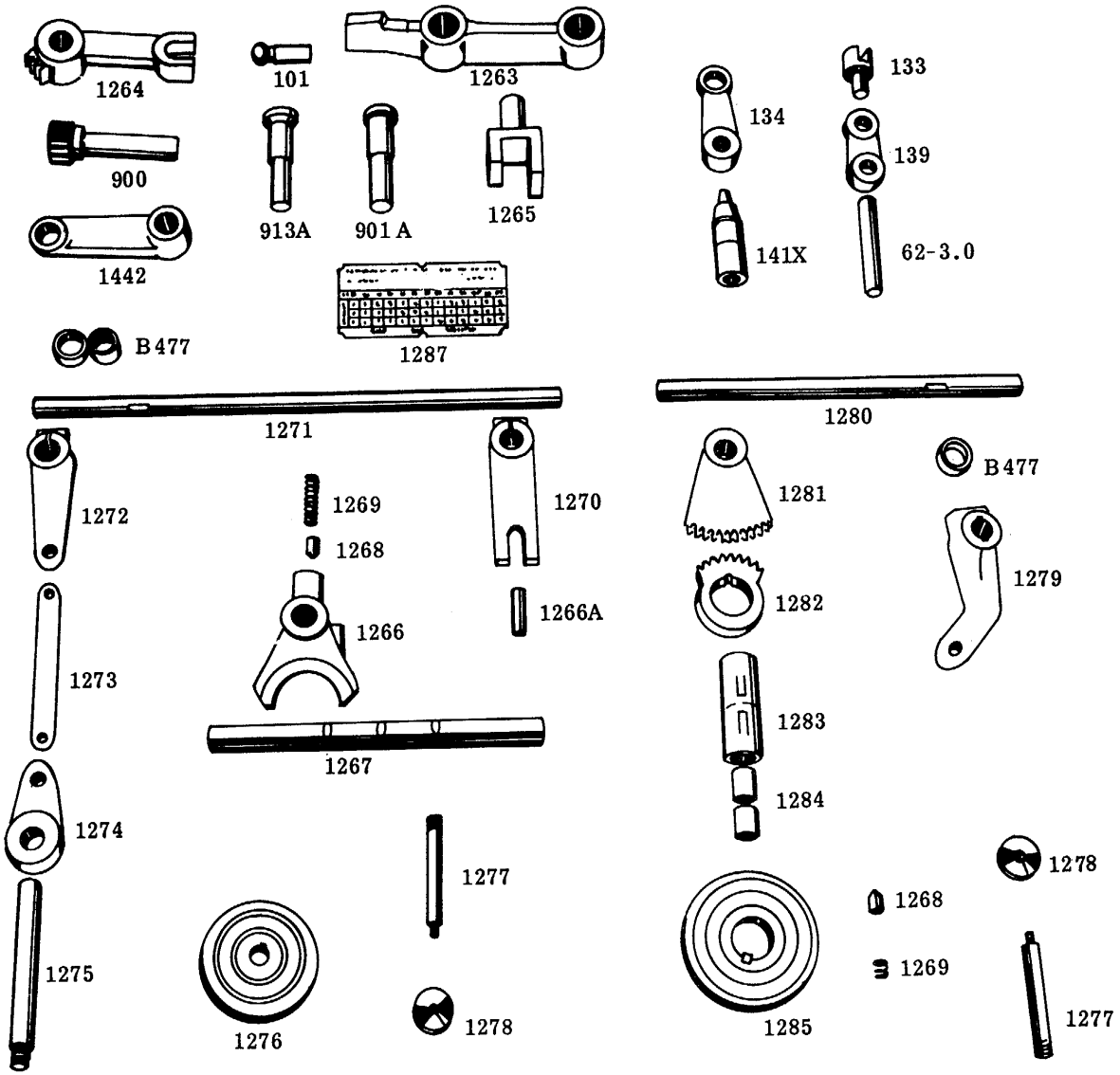


Figure 7
HEADSTOCK PARTS

HEADSTOCK {con't}
Figure 7

101	Ball for end of arm
133	Shift fork
134	External shift lever
139	Shift lever for feed gears
141X	Handle assembly
B477	3/4" set collar
900	Shift pinion shaft
901A	Support pin
913A	Support pin
1263	Overhead back gear shift lever
1264	Shift fork for 1263
1265	Back gear shift fork
1266	Shift fork for "A" shift
1266A	Shift pin for 1266
1267	Shift rail for "A" shift
1268	Detent
1269	Detent spring
1270	Shift fork for "A" shift
1272	Overhead shift shaft
*903	Outside shift lever
1272	Overhead "A" lever
1273	Link for "A" shift
1274	"A" lever on dial shaft
1275	"A" dial shaft
12-6	"A" dial
1277	Lever shaft
1278	Knob
1279	"B" shift lever - internal
1280	"B" shift shaft
1281	"B" sector gear on 1280
1282	"B" sector gear on dial shaft
1283	"B" dial shaft
1284	Bushing for 1283
1285	"B" dial
1287	Speed chart
*1322	"B" shift block
*1323	"B" shift pin
1442	Outside "C" shift lever
62-3.0	Shift shaft
*1275-A	Collar A shaft

*Not Illustrated

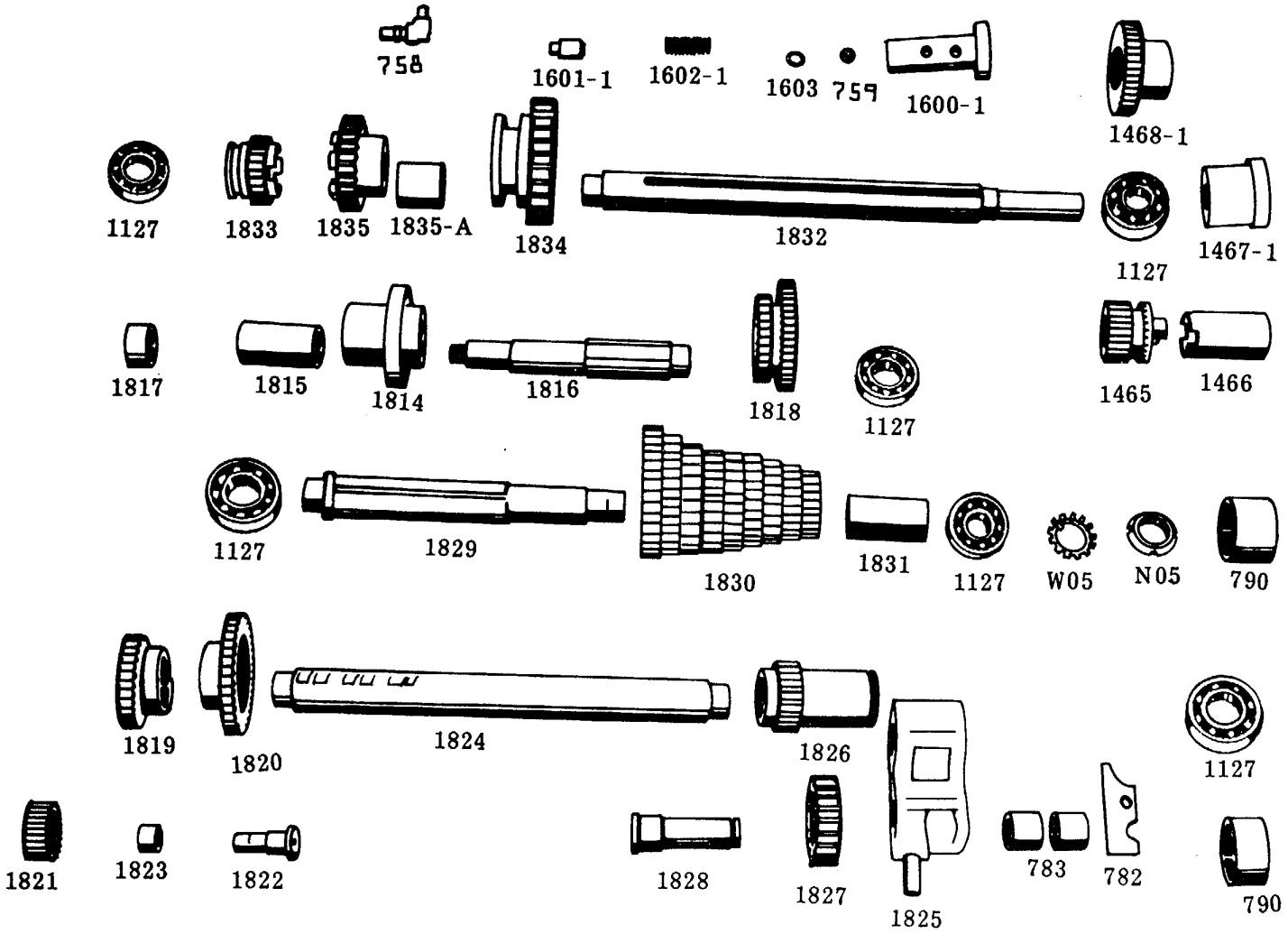


Figure 8
QUICK CHANGE GEAR BOX PARTS

QUICK CHANGE GEAR BOX PARTS

Figure 8

782	Keeper
783	Bushing for 1825
790	Bearing cap
1127	Ball bearing
1465	Clutch gear on leadscrew shaft
1466	Clutch coupling for leadscrew
1467-1	Shift bearing on leadscrew
1468-1	Clutch gear for feed rod
1600-1	Oil pump body
1601-1	Plunger
1602-1	Spring
1603-1	Washer
1814	Input bearing casting
1815	Bushing for 1814
1816	Input shaft
1817	Spacer on 1816
1818	Reverse cluster gear
1819	Reverse gear on tumbler shaft - small
1820	Reverse gear on tumbler shaft - large
1821	Reverse pinion
1822	Pinion stud
1823	Pinion bearing
1824	Tumbler shaft
1825	Tumbler housing
1826	Sliding gear on tumbler shaft
1827	Tumbler gear
1828	Tumbler gear pin
1829	Cluster shaft
1830	Cluster gears {9 sizes} 16-18-20-22-23-24-26-28-32
1831	Spacer on 1828
1832	Leadscrew shaft
1833	Sliding gear - 16-T
1834	Sliding gear - 32-T
1835	Idler clutch gear - 24-T
1835-A	Bushing
N05	Lock nut
W05	Lock washer
759	Ball
758	Check valve

*Not Illustrated

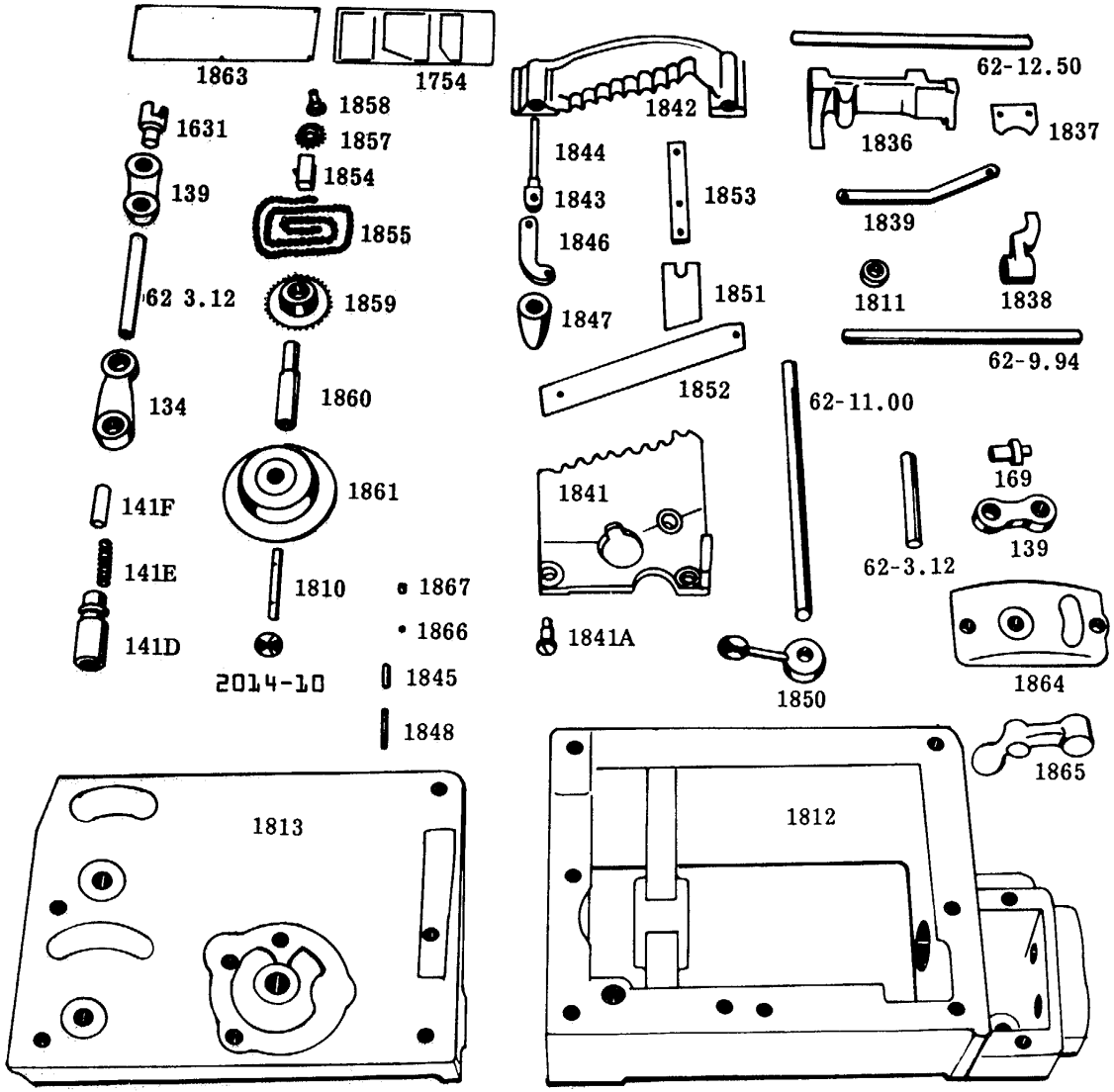


Figure 9
QUICK CHANGE GEAR BOX PARTS

QUICK CHANGE GEAR BOX PARTS {con't}

Figure 9

134	Outer shifting arm
139	Inner shifting arm
141-D	Gear shift handle
141-E	Gear shift handle spring
141-F	Gear shift handle plunger
169	Shifter key
1631	Shift fork
1754	Metric gear chart
1810	Dial handle
1811	5/8" thrust collar
1812	Quick change gear box
1813	Cover
1836	Double shift fork
1837	Retaining plate
1838	Shift lever - offset internal
1839	Connecting link
1841	Fixed jaw
1841-A	Shoulder bolt
1842	Movable jaw
1843	Clevis ends
1844	Stud
1845	Clevis pins
1846	Connecting link
1847	Eccentric
1848	Eccentric pin
1850	Release lever
1851	Shift fork
1852	Shift fork slide bar
1853	Slide bar link
1854	Slider
1855	Chain
1857	Idler sprocket
1858	Idler sprocket pin
1859	Drive sprocket
1860	Dial shaft
1861	Dial
1863	Thread & feed index plate
*1862	Bearing cover plate - input end
1864	Cover for leadscrew feed box
1865	Lever for screw feed box
1866	Spring pin
1867	Spring
62-3.12	Shaft
62-9.94	Shaft
62-11.00	Shaft
62-12.50	Shaft
2014-10	Ball

*Not Illustrated

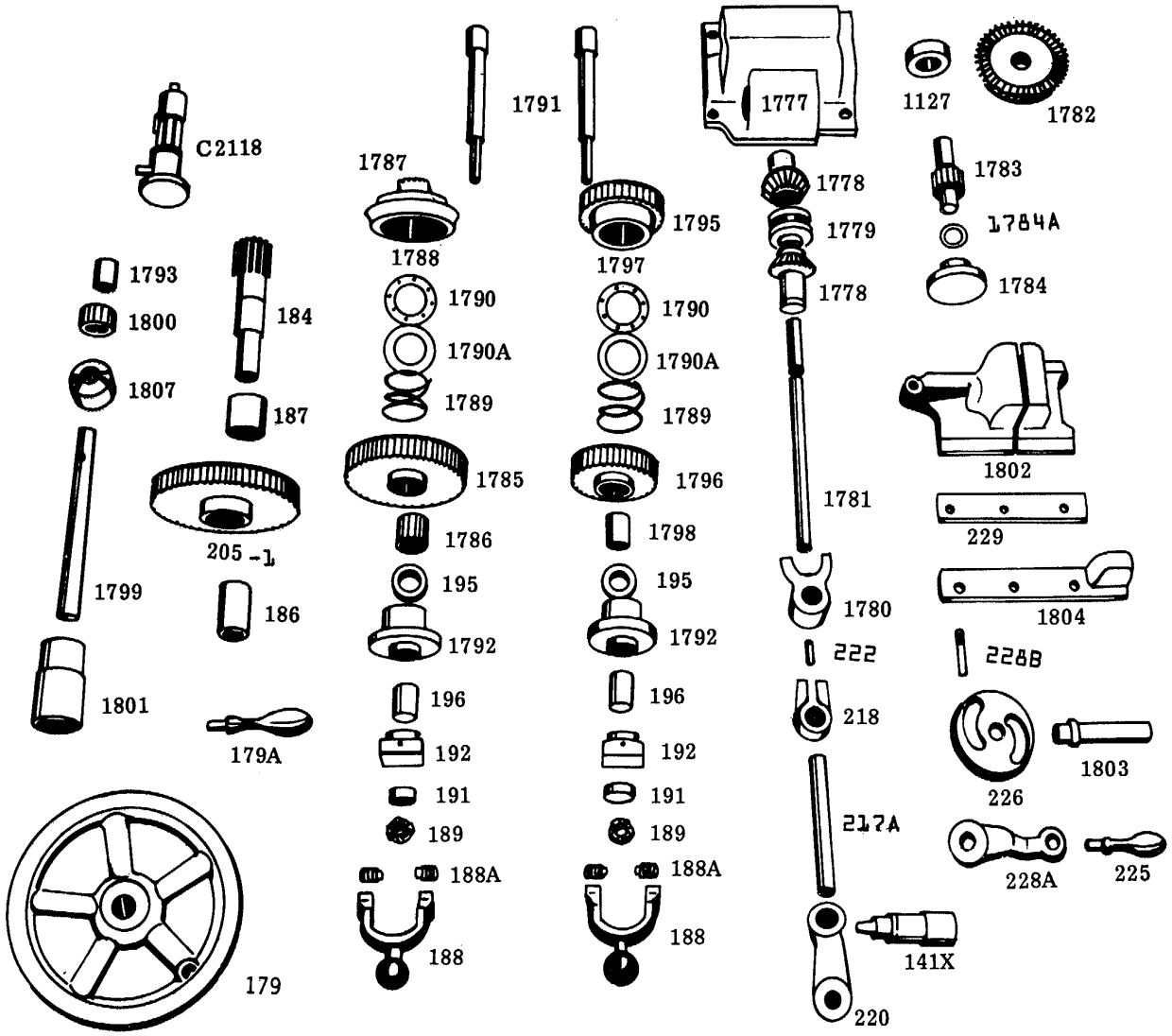


Figure 10
APRON PARTS

APRON PARTS {con't}

Figure 10

179	Hand wheel
184	Rack pinion shaft
186	Bronze bushing
187	Bronze bushing
188	Snap lever handles
188-A	Screw
189	Nut
191	Cone races for snap levers
192	Snap lever square thrust
195	Ball thrust for end of gear
196	Bronze bushing used in no. 1795
205-1	Large gear for rack pinion shaft
218	Inside shifting fork
222	Shifting pin for reverse gear
220	Outside shifting handle for reverse gear
228-B	Halfnut lock pin
225	Handle for 228-A
226	C.I. engaging cam
228-A	Half nut handle
229	Steel gib for half nut
*1776	Apron housing
1777	Bevel gear housing
1778	20-T bevel pinion
1777-A	Br. apron spacer
1779	Double jaw clutch
1780	Shift fork
1781	Shift rod
1782	41-T bevel gear
1783	Bevel gear shaft
1784-A	Thrust button
1784	Bearing - flanged for 1783
1785	56-T long. feed gear
1786	Hyatt bearing for 1785
1787	15-T cone feed pinion
1788	Cone clutch for 1787
1789	Release spring
1790	Ball thrust
1791	Feed shaft
1792	Bearing, flanged for feed shaft
1793	Bushing for 1795
*1794	Snap lever housing
1795	Cross feed cone gear
1796	Crossfeed - idler - friction gear
1797	Cone friction for 1736
1798	Bushing for 1796
1799	Handwheel shaft
1800	Handwheel pinion
1801	Bushing fo4 1799
1802	Half nut
1803	Half nut cam shaft
1804	Half nut gib with bearing
*1805	Clutch rod bracket
*1806	Square sleeve for clutch rod
1807	Oil pump cam
C-2118	Oil pump
217A	Shift shaft for reverse gears
1127	Ball bearing
1790-A	Race
179A	Handle for 179
141X	Plunger Handle Assembly

*Not Illustrated

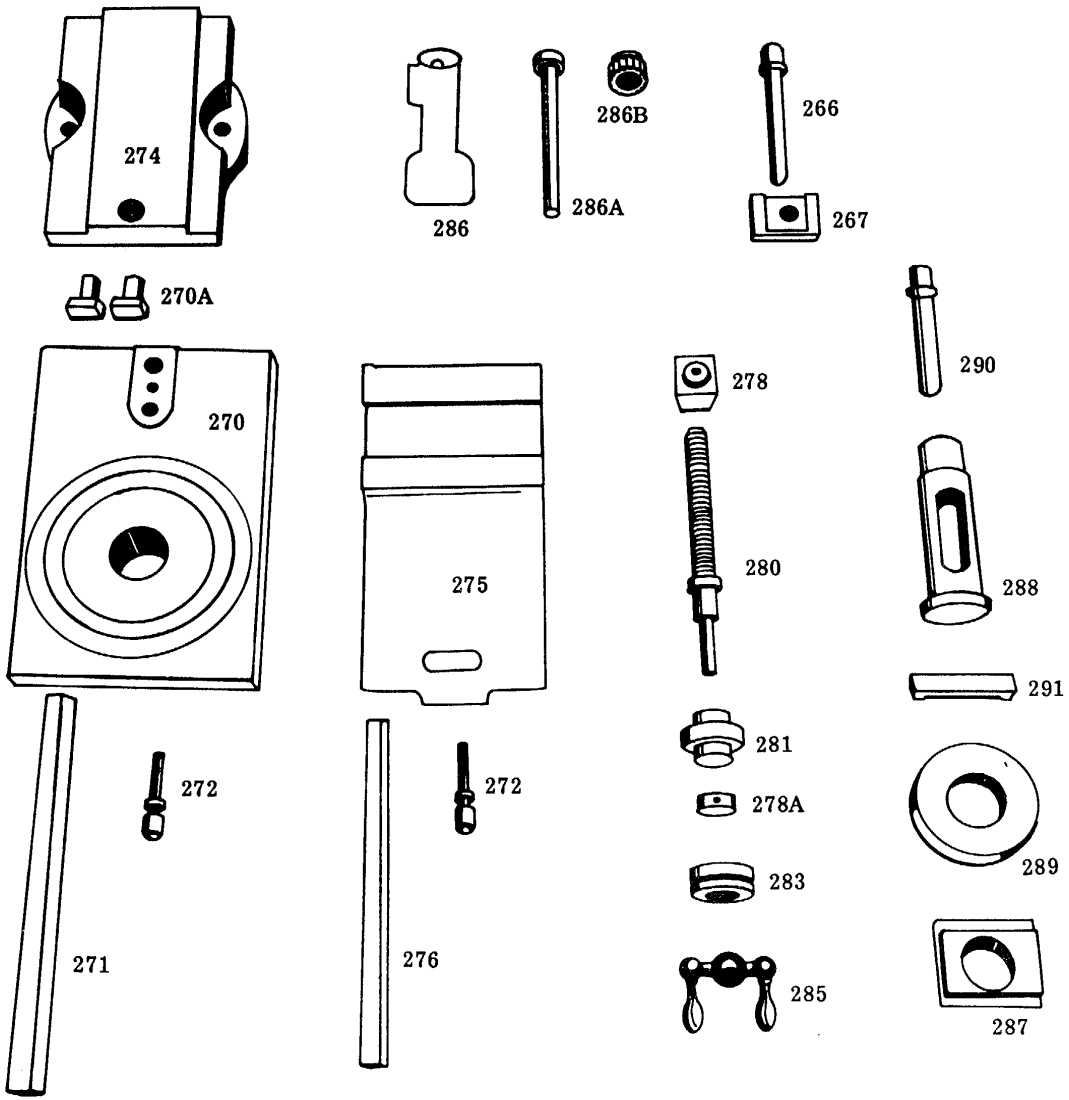


Figure 11
CARRIAGE PARTS

CARRIAGE PARTS
Figure 11

266	Clamp screw
267	Clamp plate
*268	Wiper felts
270	Crossfeed slide
270-A	Compound "T" slot bolts
271	Gib for cross slide
272	Gib screw
274	Compound rest base
275	Compound rest slide
276	Compound gib
278	Compound nut
278-A	Thrust nut
280	Compound screw
281	Threaded bushing
283	Dial
285	Handle
286	Thread dial housing
286-B	Thread dial gear
286-A	Thread dial shaft
287	Tool post block
288	Tool post
289	Tool post clamp surface
290	Tool post bolt
291	Tool post rocking shim

*Not Illustrated

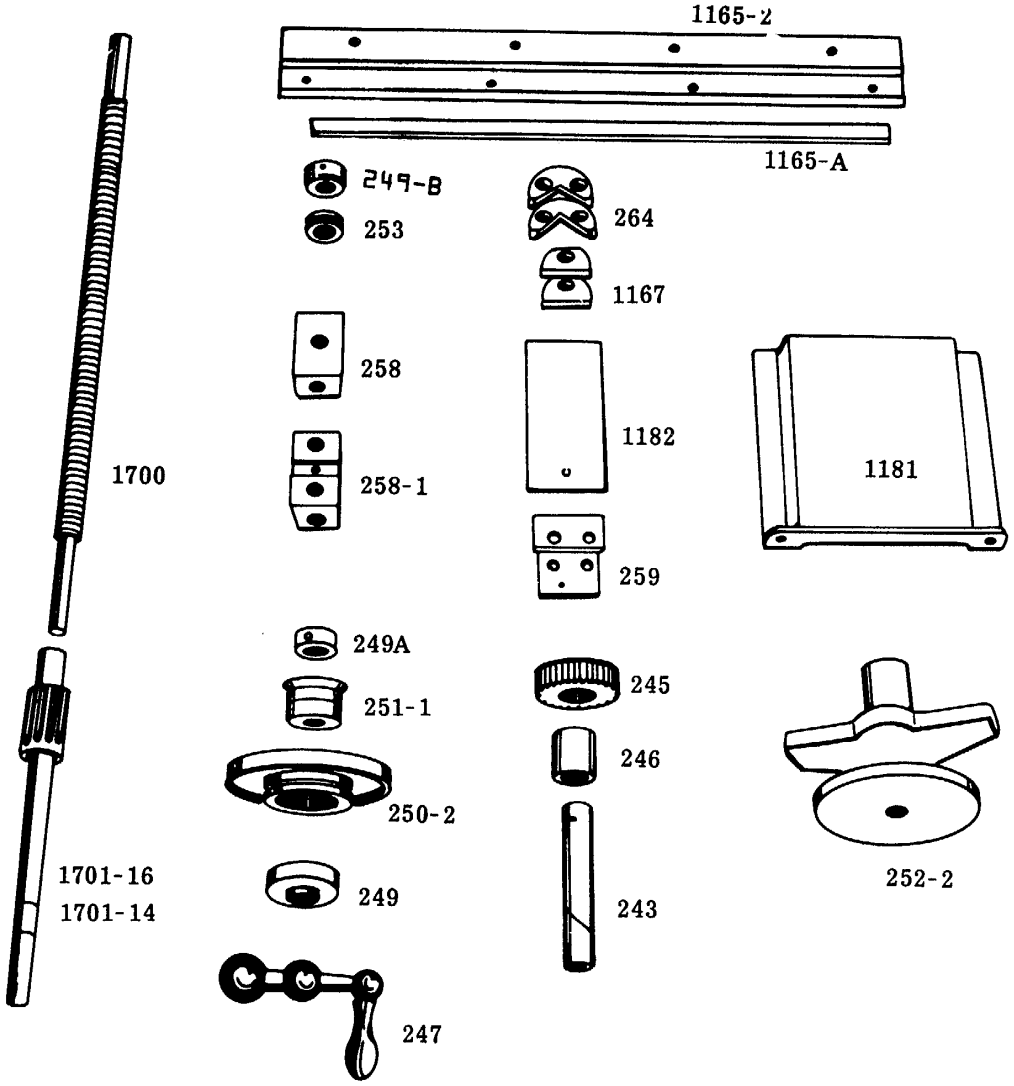


Figure 12
CARRIAGE PARTS

CARRIAGE
Figure 12

243	Idler gear pin
245	Idler gear
246	Bushing for 245
247	Crossfeed ball crank
249	Micrometer clamp nut
249-A	Adjusting nut
249-B	Taper attachment adj. collar
250-2	Crossfeed dial
251-1	Threaded dial bushing
252-2	Crossfeed bearing casting
253	Ball thrust
258-1	Crossfeed nut - one-piece
258-1	Crossfeed nut - 3-pc.
259	Front gib
264	"V" wiper
*1164-1	Carriage
1165-A	Wear strip
	1165-2 Rear gib
1167	Flat wiper
1181	Cross slide chip cover
1182	Telescoping dovetail slide cover
1700	Crossfeed screw
	1701-14 & 17M1-16 Telescopic crossfeed shaft with pinion
*Micrometer Stop	
653-1	Body
653-A	Bolt
653-2	Dial
653-3	Lock nut
653-4	Clamp
653-5	Screw
653-6	Stop key

*Not Illustrated

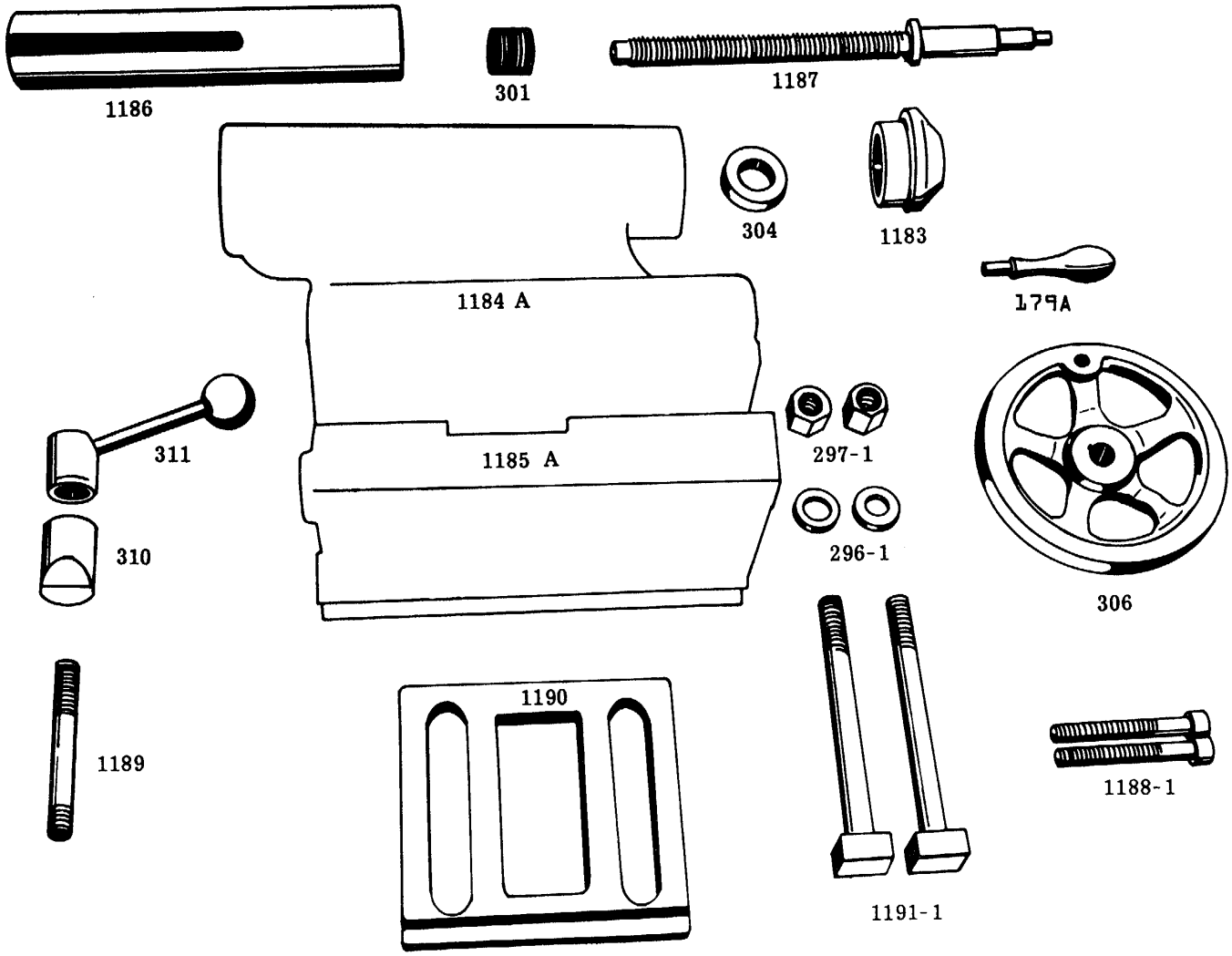


Figure 13
TAILSTOCK PARTS

TAILSTOCK PARTS

Figure 13

179-A	Handwheel handle
296-1	Washer
297-1	Nut
301	Spindle nut
304	Ball thrust
306	Handwheel
310	Clamp plug
311	Clamp handle
1183	Threaded bearing
1184-A	Tailstock
1185-A	Tailstock base
1186	Tailstock spindle
1187	Tailstock feed screw
1188-1	Tailstock set over screw
1189	Tailstock spindle clamp stud
1190	Tailstock bed clamp
1191-1	Clamp bolts
*1192-D	Tailstock dial
*1186-A	Key for spindle
*331-A	Clamp handle stud

*Not Illustrated

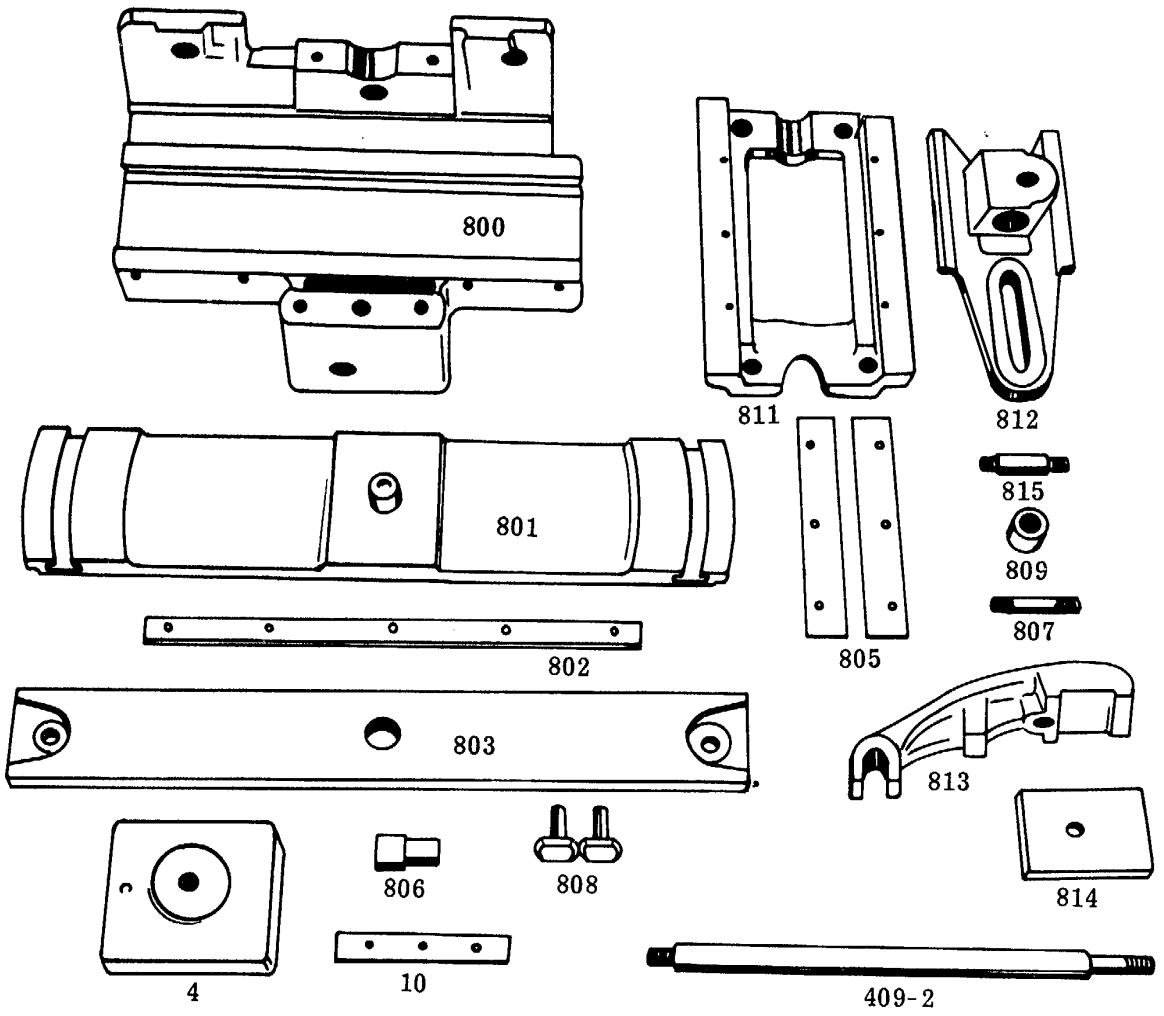


Figure 14
TAPER ATTACHMENT

TAPER ATTACHMENT

Figure 14

4	Fixed slide
10	Small flat gib
409-2	Connecting bar
800	Main frame
801	Dovetail slide
802	Gib for dovetail slide
803	Taper slide
805	Top plate for 811
806	Pivot pin
807	Clamp stud
808	"T" slot bolts
809	Spacer
810	Gib screw - cone point
811	Cross slide guide
812	Cross slide
813	Bed bracket
814	Clamp plate
815	Swivel stud
*	Gib screw for no. 4 - dog point

*Not Illustrated

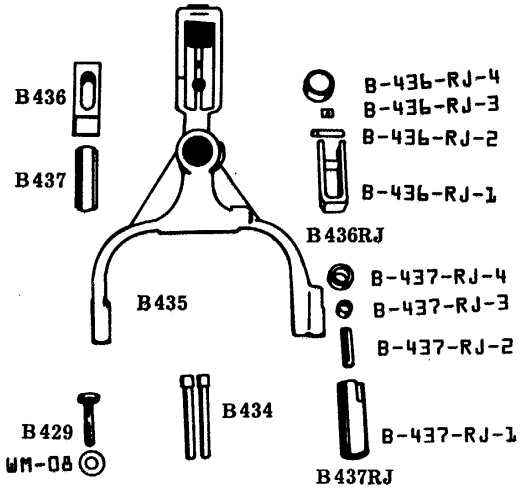


Figure 15
FOLLOW REST PARTS

Figure 15

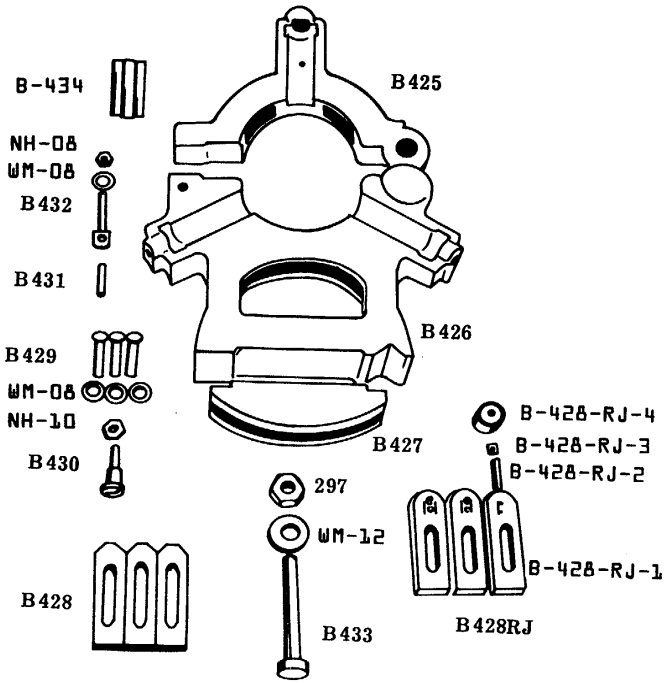


Figure 16
STEADY REST PARTS

Figure 16

FOLLOW REST
Figure 15

B-429	Adjusting screw
B-434	Adjusting screw
B-435	Follow rest frame
B-436	Follow rest vertical jaw
B-437	Follow rest horizontal jaw
B-436-RJ	Roller jaw
B-436-RJ-1	Jaw
B-436-RJ-2	Pin
B-436-RJ-3	Key
B-436-RJ-4	Bearing
B-437-RJ	Roller jaw
B-437-RJ-1	Jaw
B-437-RJ-2	Pin
B-437-RJ-3	Bearing
B-437-RJ-4	Roller
WM-08	Washer

STEADY REST
Figure 16

297	7/8" finished nut
B-425	Steady rest top
B-426	Steady rest base
B-427	Clamping block
B-428	Steady rest jaws
B-429	Adjusting screws
B-430	Swivel pin
B-431	Pin for locking nut
B-432	Locking bolt
B-433	Clamp bolt
B-434	Adjusting screw
B-428-RJ	Roller jaw
B-428-RJ-1	Jaw
B-428-RJ-2	Pin
B-428-RJ-3	Key
B-428-RJ-4	Roller
NH-08	Nut
WM-08	Washer
NH-10	Nut
WM-12	Washer

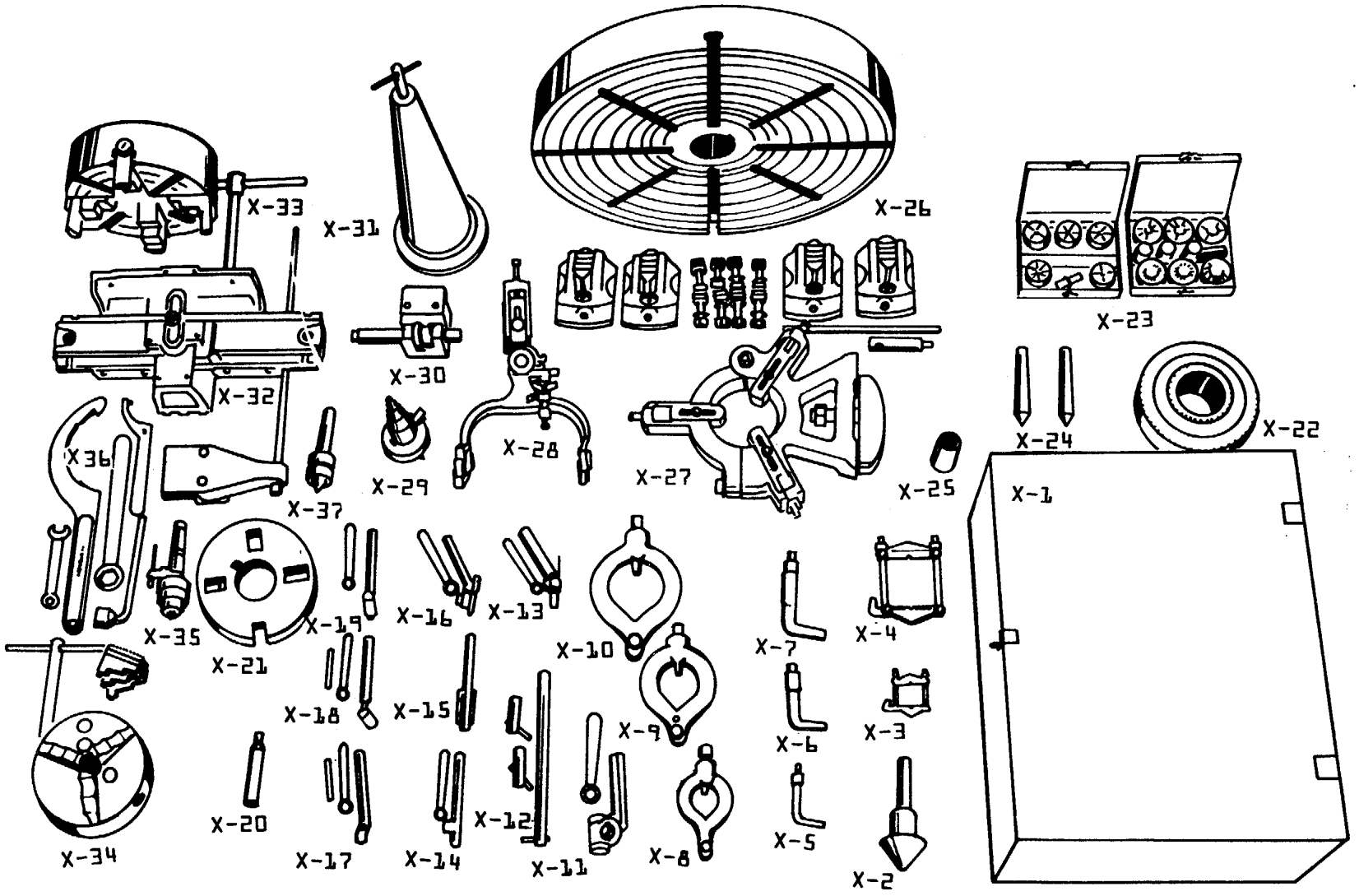


Figure 17
MISCELLANEOUS TOOLS AND EQUIPMENT

MISCELLANEOUS TOOLS AND EQUIPMENT

Figure 17

X-1	Box, Accessory
X-2	Center, lathe, pipe, ball bearing
X-3	Dog, lathe, clamp, 1-3/4" capacity
X-4	Dog, lathe, clamp, 3-1/2" capacity
X-5	Dog, lathe, 1/2" capacity
X-6	Dog, lathe, 1" capacity
X-7	Dog, lathe, 1-1/2" capacity
X-8	Dog, lathe, 2" capacity
X-9	Dog, lathe, 3" capacity
X-10	Dog, lathe, 4" capacity
X-11	Holder, boring bar
X-12	Bar, boring, 15/16" diam. cap type
X-13	Holder, cut-off R.H. Offset
X-14	Holder, cut-off, straight
X-15	Holder, knurling, revolving head
X-16	Holder, threading tool
X-17	Holder, turning, L.H. offset
X-18	Holder, turning, R.H. offset
X-19	Holder, turning straight
X-20	Socket, drill reducing
X-21	Face plate, lathe, dog driver
X-22	Spindle nose-collet chuck
X-23	Set of 11 collets
X-24	Lathe centers
X-25	Center sleeve
X-26	Face plate, large, with four adjustable jaws
X-27	Steady rest
X-28	Follow rest
X-29	Tool post
X-30	Micrometer carriage stop
X-31	Jack
X-32	Taper attachment
X-33	Chuck 4-jaw
X-34	Chuck 3-jaw
X-35	Drill chuck
X-36	Wrenches - #293 tool post wrench #414 spindle spanner #380 tailstock wrench #381 spindle adj. spanner #382 bed clamp wrench
X-37	Center ball bearing
*X-38	Metric transposing gears
*X-39	Coolant System
*X-40	Chip & oil pan
*X-41	Work light

*Not Illustrated

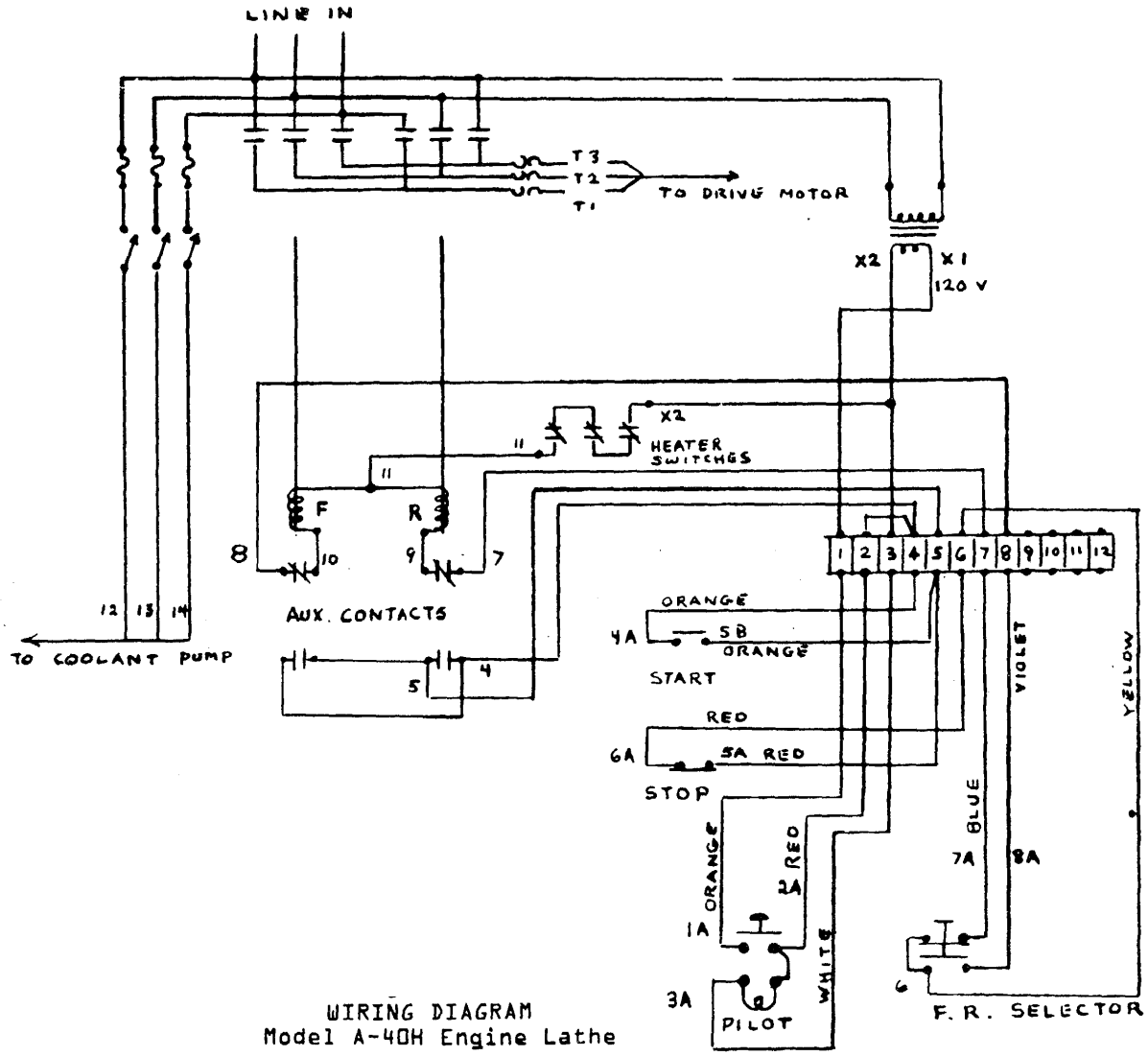


Figure 18
WIRING DIAGRAM
Model A-40H Engine Lathe

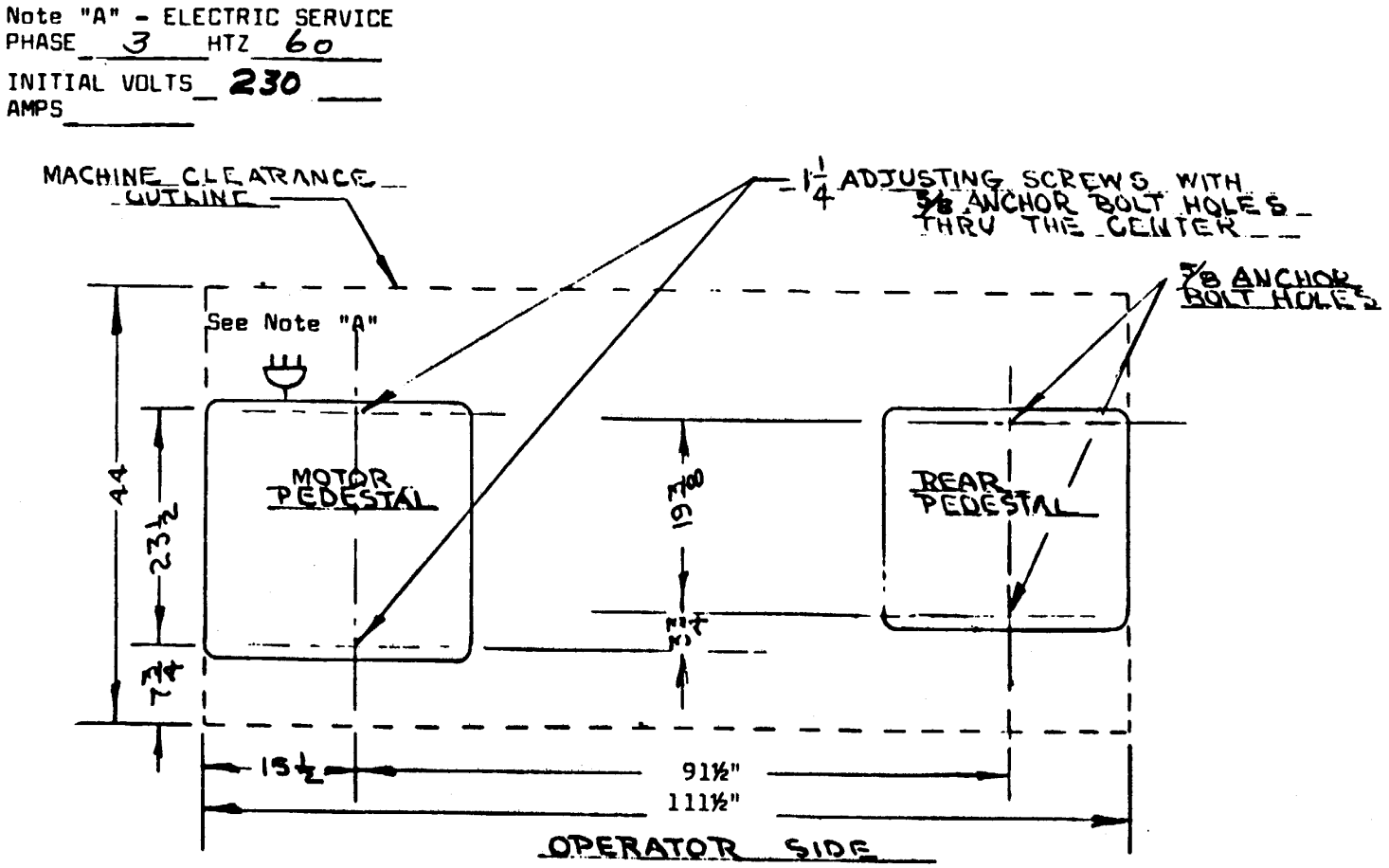


Figure 19
MODEL A-40H
MACHINE CLEARANCE AND ANCHOR BOLT LAYOUT

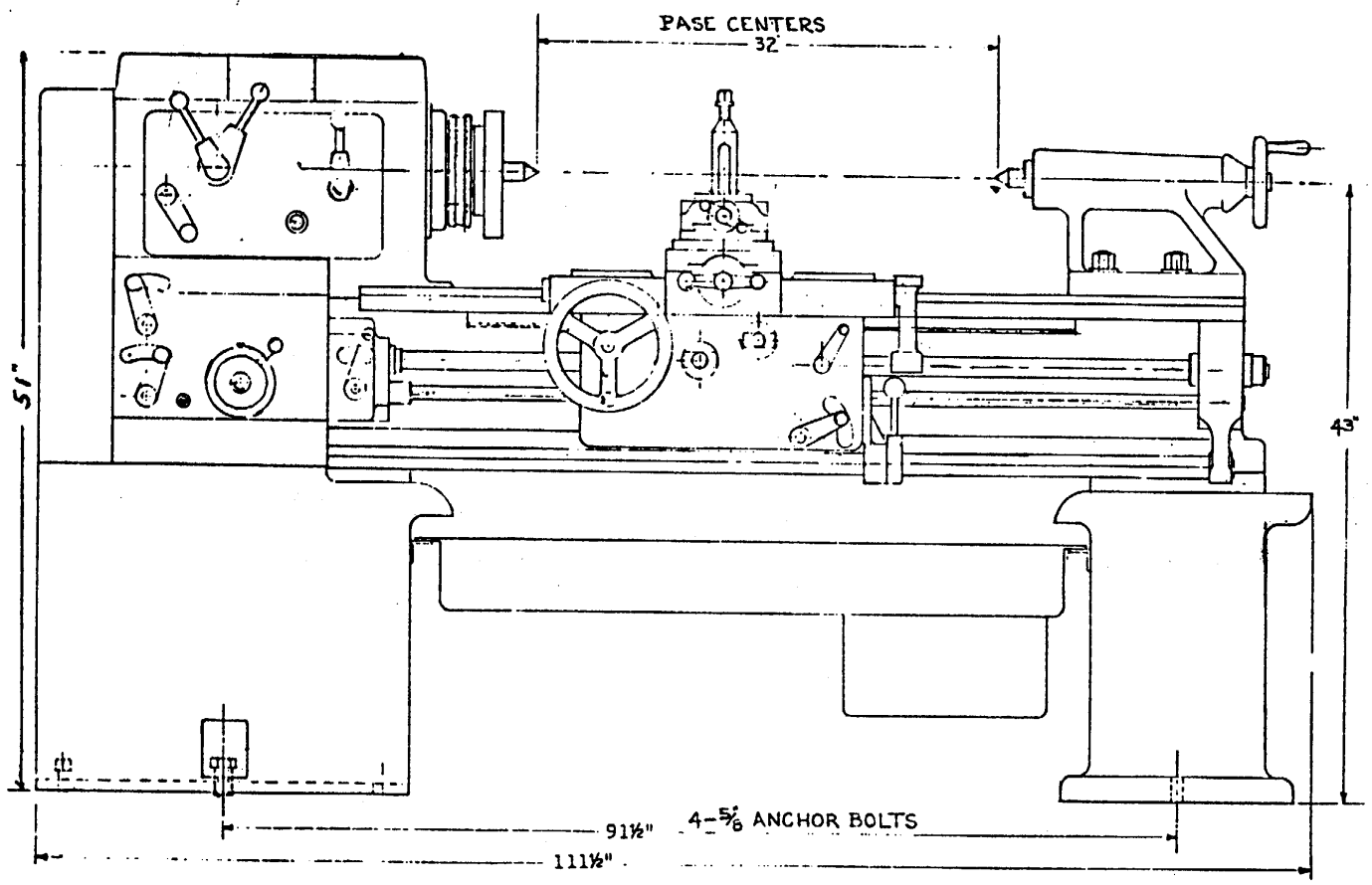
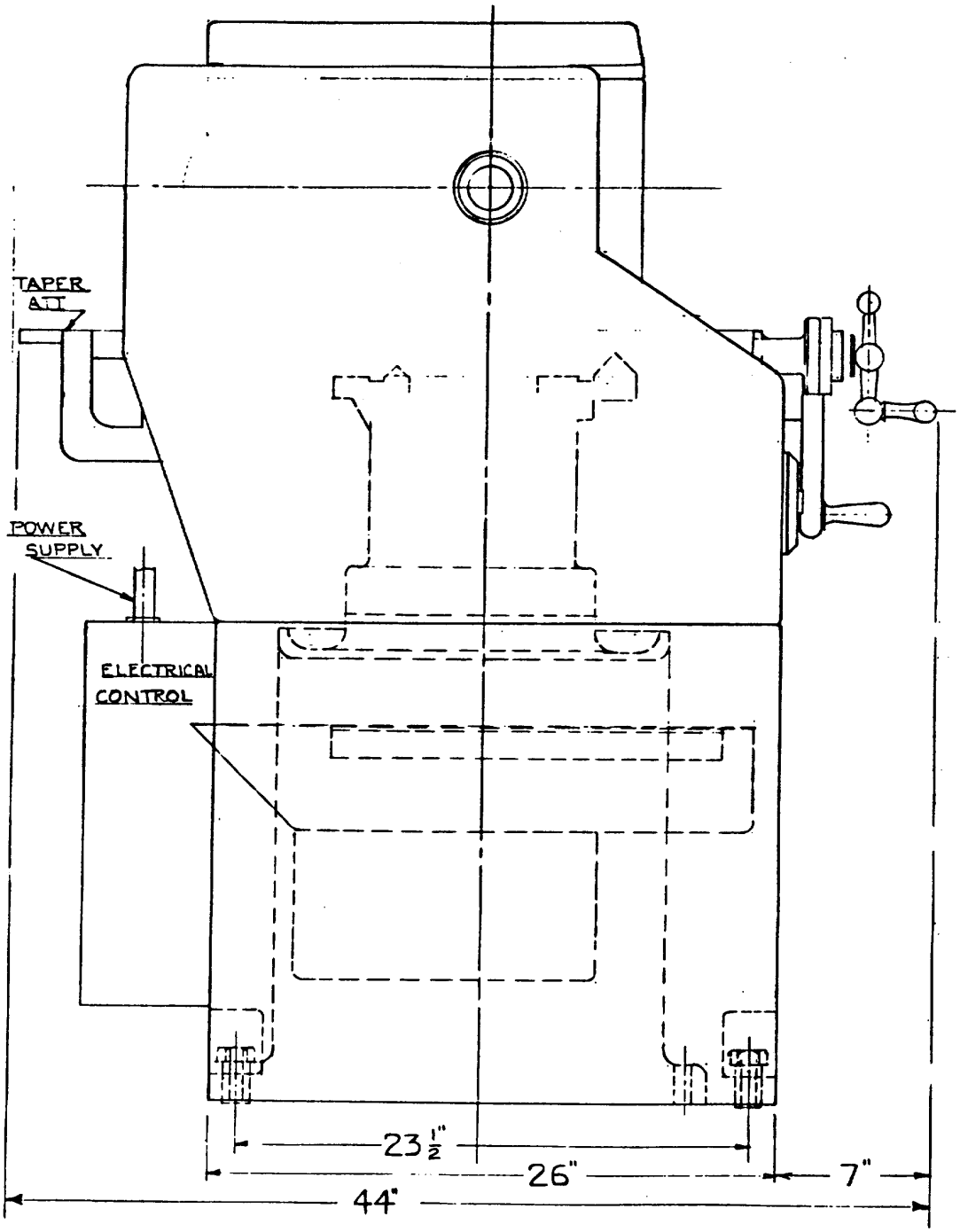


Figure 20. MODEL A-40H 18" Swing x 32" C.C.



MILITARY SPEC. MIL-L234008-18" SWING X 32" C.C.

Figure 21. Model A-40H

By Order of the Secretary of the Army:

E. C. MEYER
General, United States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Major General, United States Army
The Adjutant General

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THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 kilometer = 1000 Meters = 0.621 Miles

WEIGHTS

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 Lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

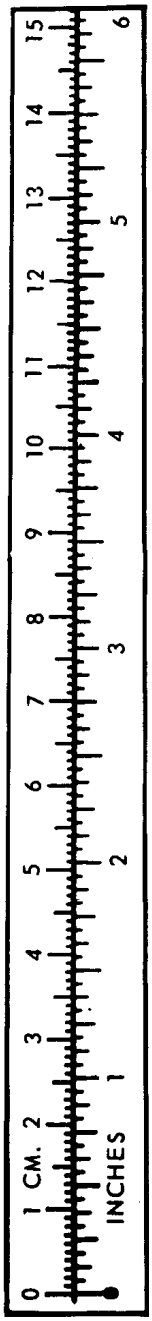
TEMPERATURE

5/9 (°F - 32) = °C
212° Fahrenheit is equivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5 (°C + 32) = °F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621



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