This book has been reprinted from the original publication without revisions except the addition of Safety Precautions.
The Cincinnati Grinders Incorporated, by change of name, now is Cincinnati Milacron, Inc.

WARNING

In order to clearly show details of this machine, some covers, shields, doors, guards, or other protective devices have either been removed or shown in an "open" position. All such protective devices shall be installed in position before operating this machine. Failure to follow this instruction may result in damage to machine components and/or personal injury.

INSTRUCTION BOOK

12″ MODEL C LATHE

for Cincinnati Milacron®

Publication No. M1694-1

IMPORTANT

Carefully read the instructions and safety precautions given in this manual. Do not operate and/or service this machine/equipment until you have read this manual thoroughly.

At the time of writing, the book was completely up-to-date. However, due to continual improvements in design, it is possible that descriptions contained herein may vary to a slight extent from the machine delivered to you. This merely implies that the machine has been improved to better fulfill your requirements. If there are any questions, you are encouraged to contact the nearest Cincinnati Milacron representative for clarification.

CINCINNATI MILACRON

Cincinnati Milacron Marketing Company
Cincinnati, Ohio 45209

Reprinted in U.S.A. 5 6/92 CM

SAFETY PRECAUTIONS

IMPORTANT

These safety precautions for this CINCINNATI MILACRON machine have been prepared to assist the operator and maintenance personnel in practicing good shop safety procedures.

Operator and maintenance personnel must read and understand these precautions completely before operating, setting up, running, or performing maintenance on the machine.

These precautions are to be used as a guide to supplement safety precautions and warnings in the following:

a) All other manuals pertaining to the machine.

b) Local, plant, and shop safety rules and codes.

c) Federal and national safety laws and regulations.

> See the latest edition of the OCCUPATIONAL SAFETY AND HEALTH STANDARDS, available from the DEPARTMENT OF LABOR ,WASHINGTON, D.C.

WARNING

Read related safety precautions before operating this machine. Failure to follow safety instructions may result in personal injury.

WARNING: ILLUSTRATIONS

In order to clearly show details of this machine, some covers, shields, guards, barriers, devices or doors have either been removed or shown in an "open" position. All such protective components must be installed in position before operating this machine. Failure to follow this instruction may result in personal injury.

PERSONAL SAFETY

Machine owners, operators, setup men, maintenance, and service personnel must be aware of the fact that constant day-to-day safety procedures are a vital part of their job. Accident prevention must be one of the principal objectives of the job regardless of what activity is involved.

Know and respect your machinery. Read and practice the prescribed safety and checking procedures. Make sure that everyone who works for, with, or near you fully understands and - more importantly - complies with the following safety precautions and procedures when operating this machine.

WARNING

Failure to follow instructions on this page may result in personal injury.

Sudden movements, loud noises, horse-play, etc. must be avoided. These distractions may result in unsafe conditions for those working near the machinery.

Observe and follow safety instructions such as "NO SMOKING", "High Voltage", DANGER, etc., in your working area.

Accidents can occur that result in serious personal injury to yourself or others due to clothing and other articles becoming entangled in cutters, handwheels, levers, or moving machine elements. The following suggestions, if followed, will help you to avoid such accidents: Neckties, scarfs, gloves, loose hanging clothing, and jewelry such as watches, rings, or necklaces must not be worn around moving machinery. Restrain long hair with a cap or net. Wear gloves only when handling rough, sharp, or hot parts.

Use safety protective equipment. Wear clean approved eye or face protection. Safety-toe shoes with slip-proof soles can help you avoid injury. Keep your protective equipment in good condition.

WORK AREA SAFETY

Always keep your work area clean. Dirty work areas with such hazards as oil, debris, or water on the floor may cause someone to fall to the floor, into the machine, or onto other objects resulting in serious personal injury.

Make sure your work area is free of hazardous obstructions and be aware of protruding machine members.

Return tools and similar equipment to their proper storage place immediately after use. Keep work benches neat, orderly, and clean.

Report unsafe working conditions to your supervisor or safety department. Items such as: worn or broken flooring, ladders, and handrails, unstable or slippery platforms, or scaffolds must be reported and repaired before use. Do not use skids, workpieces, stock, machines, tote pans, and boxes as makeshift climbing aides.

TOOL SAFETY

Sharp edged cutting tools must be handled with gloves or a shop cloth. Inspect cutting tools before use and reject defective tools.

Remove hand tooling such as wrenches, measuring equipment, hammers, and other miscellaneous parts from the machine immediately after usage.

LIFTING AND CARRYING SAFETY

> **WARNING**
>
> Failure to follow instructions on this page may result in personal injury.

Contact supervision if you have any questions or are not sure about the proper procedures for lifting and carrying.

Before lifting or carrying an object, determine the weight and size by referring to such things as tags, shipping data, labels, marked information, or manuals.

Use power hoists or other mechanical lifting and carrying equipment for heavy, bulky, or hard to handle objects. Use hookup methods recommended by your safety department and know the signals for safely directing a crane operator.

Never place any part of your body under a suspended load or move a suspended load over any part of another person's body. Before lifting, be certain that you have a safe spot for depositing the load. Never work on a component while it is hanging from a crane or other lifting mechanism.

If in doubt as to the size or type of lifting equipment, method, and procedures for lifting, contact Cincinnati Milacron before proceeding to lift the machine or its components.

Always inspect slings, chains, hoists, and other lifting devices prior to use. Do not use lifting devices found to be defective or questionable.

Never exceed the safety rated capacity of cranes, hoists, slings, eyebolts, and other lifting equipment. Follow standards and instructions applicable to any lifting equipment you use. (For example, ANSI Standard B18.15, available from The American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, contains information concerning safe lifting loads for different size eyebolts, for various angles of lift and application instructions for safe use of eyebolts.)

Before inserting an eyebolt, be certain that both the eyebolt and the hold have the same size and type threads. To attain safe working loads, at least 90% of the threaded portion of a standard forged eyebolt must be engaged.

INSTALLATION AND RELOCATION SAFETY

Before lifting the machine, consult the machine manual or Cincinnati Milacron for proper methods and procedures.

An electrician must read and understand the electrical schematics prior to connecting the machine to the power source. After connecting the machine, test all aspects of the electrical system for proper functioning. Always make sure the machine is grounded properly. Be certain that all exposed electrical systems are covered properly. Place all selector switches in their OFF or neutral (disengaged) position. The doors of the main electrical cabinet must be closed and the main disconnect switch must be in the OFF position after the power source connection is complete.

WARNING

Failure to follow instructions on this page may result in personal injury.

Always lock the main disconnect device in the OFF position if the machine is left unattended. Never bypass or wire around safety devices.

When the machine is installed, be sure that the motors rotate in the proper indicated direction.

SETUP AND OPERATION SAFETY

Read and understand all the safety instructions before setting up, operating, or servicing this machine. Assign only qualified personnel, instructed in safety and all machine functions, to operate or service this machine.

Operators and maintenance personnel must carefully read, understand, and fully comply with all machine mounted warning and instruction plates. Do not paint over, alter, or deface these plates or remove them from the machine. Replace all plates which become illegible. Replacement plates can be purchased from Cincinnati Milacron.

Safety guards, shields, barriers, covers, and protective devices must be connected or in place before operating the machine.

Safety disengagements or interlocks provided on handwheels must be in place before operation.

When setting up or adjusting a workpiece or fixture, be certain it is a safe distance away from the cutting tool. Always retract the workpiece a safe distance from the cutting tool when loading and unloading.

The spindle must be stopped before adjusting the coolant discharge nozzle.

Never brake or slow down moving machinery with your hand or with some makeshift device. Never use machine power to remove a nut from any shaft. The spindle and slides must be stopped when measuring workpieces, changing tools, or removing chips and grit. Remove chips and grit with a chip rake or brush, not with your hands.

Keep all parts of your body off the machine table, table edge, out of the path of moving units, trip dogs, trip plungers, and out of the "machining area" during machining operations. Never lean on a machine or reach over or through a machine — you can become entangled in tooling and other moving elements or you may accidentally activate start buttons, feed controls, rapid traverse controls, power work holding control, or similar devices.

During operation, be attentive to the machining process. Excessive vibration, unusual sounds, etc., can indicate problems requiring your immediate attention. Watch for conditions such as packed chips or grit which can cause breakage of tooling or machine elements.

Shut off power to your machine when you leave the operating area or at the end of your work period; never leave a machine running unattended. Turn the master disconnect device to the OFF position before cleaning the machine at the end of the working day or when guards or covers are removed that expose hazardous areas.

MAINTENANCE SAFETY

WARNING

Failure to follow instructions on this page may result in personal injury.

Do not attempt to perform maintenance on this machine until you read and understand all the safety instructions.

Assign only qualified service or maintenance personnel to perform maintenance and repair work on this machine. Consult the service manual before attempting any service or repair work and when in doubt contact Cincinnati Milacron. Use only Cincinnati Milacron replacement parts; others may impair the safety of the machine. Before performing maintenance or service work, Warning or Danger signs must be placed conspicuously about the machine. Before detaching counterweights or driving mechanisms, vertical sliding members must be blocked properly. See the Service Manual for proper dismantling procedures.

DANGER: HIGH VOLTAGE

Before working on any electrical circuits, turn the machine Main Disconnect Device "OFF" and lock it.

Unless expressly stated in applicable Cincinnati Milacron documentation or by the appropriate Cincinnati Milacron Field Service Representative, do NOT work with electrical power "ON". If such express statement or advice exists, working with electrical power "ON" should be performed by a Cincinnati Milacron Field Service Representative. The customer and subsequent transferees must determine that any other person performing work with electrical power "ON" is trained and technically qualified.

FAILURE TO FOLLOW THIS INSTRUCTION MAY RESULT IN DEATH OR SERIOUS PERSONAL SHOCK INJURY.

O-GS-2 (3/83)

Before removing or opening any electrical enclosure, cover, plate, or door, be sure that the main disconnect switch is in the OFF position. If any tool is required to remove a guard, cover, bracket, or any basic part of this machine, place the main disconnect switch in the OFF position, lock it in the OFF position. If possible, post a sign at the disconnect switch indicating that maintenance is being performed.

Whenever maintenance is to be performed in an area away from the disconnect and the disconnect is not locked, tag all start button stations with a "DO NOT START" tag. Adequate precautions, such as locks on circuit breakers, warning notices, or other equally effective means must be taken to prevent electrical equipment from being electrically activated when maintenance work is being performed.

Before attempting to adjust, repair, or perform maintenance on electrical circuits connected with yellow wires, first find the source of power, turn it off; and lock it in the OFF position. Machine tool interlock control circuits connected with yellow wires are powered from a source away from the machine and carry voltage even when the machine's main disconnect device is turned to the OFF position.

When removing electrical equipment, place number or labelled tags on those wires not marked. If wiring is replaced, be sure it is of the same type, length, size, and has the same load carrying capacity.

Close and securely fasten all guards, shields, covers, plates, or doors before power is reconnected.

An electrical technician must analyze the electrical system to determine the possible use of power retaining devices such as capacitors. Such power retaining devices must be disconnected, discharged or made safe before maintenance is performed.

Working space around electrical equipment must be clear of obstructions. Provide adequate illumination to allow for proper operation and maintenance.

WARNING

Failure to follow instructions on this page may result in personal injury.

INDEX

INDEX TO ILLUSTRATIONS AND CHARTS

IMPORTANCE NOTICE

In order to use this book correctly, it should be noticed that all reference numbers throughout the text are related to a particular illustration. For instance the number B-3 refers to the number which appears on Figure B.

When sending to the factory for information on this machine, please refer to this book, giving the specific page numbers in full as they appear in the upper corners of the pages which refer to the question in hand.

All such requests should bear the serial number of the machine as it appears on the brass plate attached to the machine and stamped on the bed.

Requests for additional information on machines will be welcomed and will be given our full attention at any time.

The life, service and satisfaction derived from any machine tool depends in a large measure on the care and attention given it. The operator should be familiar with the contents of this instruction book before attempting to operate the lathe.

INSTALLATION

The lathe is shipped in one crate. When it is necessary to take the machine through a window, or under some similar conditions where an elevator is not available, do not uncrate it until it is on the floor on which it is to be located.

It should be placed in position, using the Floor Plan, Figure J, at the back of this book, to obtain the correct clearances. The foundation should be solid and free from vibration. Do not grout the feet in concrete. See Figure Ja showing the proper method of lifting the lathe.

Examine the lathe carefully and report to Pratt & Whitney at once any damage that may have occurred in transit.

Cleaning

The lathe as shipped is covered with a heavy grease to protect it against rust. This grease should be carefully cleaned off with kerosene and clean rags. Do not smear the grease into oil pockets or grooves. To clean the leadscrew, place the "Thread-Feed" lever B-7 in its neutral position and turn the leadscrew A-5 by hand, making sure the thread is thoroughly clean before engaging the leadscrew nut.

Do not get grease or oil on the motor drive V-belts as it will shorten their life.

Leveling

The lathe should be carefully leveled before it is bolted to the floor. The lathe is equipped with screws for leveling purposes, and checking the level and making adjustments from time to time is a simple matter. Steel plates measuring $\frac{1}{4}$" minimum thickness by 6" square should by used under all leveling screws.

The level of the bed in the lengthwise or longitudinal direction is not important.

In order to maintain the accuracy built into the machine the bed must not be twisted or strained. These conditions can readily be checked by leveling across the ways at both ends of the bed, and at the middle when the machine has a center leg.

An accurate level should be used for setting up and checking. The Pratt & Whitney Precision Level is an excellent instrument for this purpose.

1. Before leveling, make sure that the leveling screws are contacting the floor - not the cabinet legs.
2. Back off leveling screws 3 and 4 (Fig. J) so that they do not support the machine.
3. Place the level across the flats of the bed on a pair of size blocks or accurate parallels. Use a square with the precision level to be certain the instrument is at right-angle to length of bed.
4. Level the machine bed at both ends (and in the middle if machine has a center leg), using screws 1, 2, 5, and 6 (Fig. J.)
5. After the machine is accurately leveled, turn down leveling screws 3 and 4 (Fig. J) to equal finger tight only.

After the machine is leveled it should be bolted to the floor, but the machine must not be tightened down to such an extent that the initial leveling is upset. Check the level of the machine once more after it has been bolted to the floor. Never grout the machine legs or leveling screws to the floor.

In one or two weeks after the machine is set up the leveling should be carefully checked and also periodically thereafter. If you have difficulty boring a true hole or turning a cylindrical stud in a chuck without a tailstock support, recheck the leveling before writing us about it.

LUBRICATION

Before operating the machine lubricate it, as some of the oil may have been removed by the kerosene used in cleaning it.

The lubrication chart, Figure K, at the back of this book, gives complete information of the points to lubricate and the grade of oil to use.

The headstock, the speed control gear box for the leadscrew and the feed rod, and the tool carriage are all equipped with oil reservoirs and pumps for automatically distributing the oil to the moving parts when the lathe is running. Keep the reservoirs filled to the levels indicated on the oil gages A-9, A-11, and A-21.

An oil filter A-20 is located at the rear of the headstock. Give the projecting cross handle a few turns once a week to scrape off any foreign matter that may have accumulated.

Before pouring oil into oil cup A-13 on the leadscrew and feed rod gear box, move rocker lever A-1 to its extreme right-hand position.

To lubricate the rocker gear multiple spline shaft located in the leadscrew and feed rod gear box B-4, reach in with an oil can through the large opening in the front of this gear box.

The oiling of machine tools is often neglected when high production is being maintained, or at best is only attended to occasionally. Properly regulated shops usually require machines to be gone over each morning and noon when they are in continuous service, and time is allowed once a week for thorough cleaning and adjustment. Proper attention to these details will greatly increase the life of the lathe.

CLEANING

This lathe has been painted National Machine Tool Builders' gray, using "Peroxylin" paint. Soda water and cutting compounds will not hurt the finish.

It is well known that many machine tools are worn out sooner than necessary simply because dirt has been allowed to settle in the moving parts and has cut the wearing surfaces. A clean machine will last longer, look better and give better service. A high grade lathe of this sort deserves good treatment. Keep it clean.

TYPES OF DRIVES

Motor Drive (Fig.A)

A 3 hp 1800 rpm constant speed, ball bearing motor either a-c or d-c, is recommended for this lathe.

The motor is located in the left-hand pedestal A-10 and is mounted on a swinging platform with bolts for adjusting the tension of the V-belts.

Belts may be changed by removing the cover at rear, near top of guard, and the end cover from the left-hand pedestal. Belts are assembled thru the top opening and placed on the driven sheave and then over the motor sheave. Belt tension may be checked by removing cabinet leg cover only.

The motor starter is mounted within the belt guard closure at the left-hand end of the machine.

The electrical circuit is completely wired and placed in conduits. All the electrician has to do is connect the wires to the motor starter. The motor should drive the headstock pulley A-23 at the rate of 1000 rpm in the direction indicated by the arrow on the pulley guard.

The push button switch A-12 for the motor is conveniently located on the front of the gear box.

Do not run the V-belts too tight.

Tighten the check nut on the motor platform before operating the lathe.

HEADSTOCK

Main Driving Clutch (Fig. A)

A double end multiple disc clutch A-22 is mounted on the primary drive shaft. One end is used for driving the gear train to the spindle and the other end as a brake.

Either of the two levers, A-2 and A-8, operate the clutch and brake. Movement of lever A-2 to the right or an upward movement

Main Driving Clutch (Figure A) Continued

of A-8 will engage the clutch. A reverse of either movement releases the clutch and if the movement is continued applies the brake.

Sliding gears only, as shown in Figure B, are used for all combinations of the spindle speeds, so the spindle speed is positive at these points. Therefore, if there is any slippage the belts should be tightened or the clutch adjusted as indicated on the instruction plate located on the cover to the clutch A-22.

Spindle and Cam-Lock Spindle Nose (Fig. C)

The spindle is hardened, tempered and accurately ground, leaving the front end very hard to prevent the embedding of chips and to assure permanent accuracy. It is mounted on pre-loaded super-precision ball bearings, and will require no further adjustment.

In accordance with the newest and best lathe practice, this lathe is equipped with the Cam-Lock Spindle Nose, which holds face plates and chucks true and rigid.

To mount face plates or chucks on the Cam-Lock Spindle Nose, proceed as follows:

1. Wipe off all chips and dirt from the pilot and flange of the spindle nose and of the corresponding recess and shoulder on the face plate or chuck, so that no chips remain that would otherwise prevent their running true.

2. Place the registration lines C-2 on the heads of the six Cam-Locks so as to match the corresponding lines C-1 on the outer rim of the spindle nose. Detents will hold them in these positions.

3. Lift the face plate or chuck up in line with the spindle, either by hand (resting it on a wooden block) or by using the sling of a crane, and push it onto the spindle nose.

4. Tighten the cam-locks C-3 by a clockwise turn of the wrench, pulling them up tight by hand - it is not necessary to use a hammer on the wrench.

Spindle and Cam-Lock Spindle Nose (Fig. C) (Cont.)

When the cam-locks are tightened, the registration lines C-2 on their heads should be between the "three o'clock" and "six o'clock" positions. If any one of these does not register within this range, the mating stud C-4 in the face plate or chuck should be adjusted.

This is done by removing the hollow head retaining screw C-5, and by turning the stud C-4 one or more complete turns to the right to shorten and to the left to lengthen. Be sure to replace the hollow head retaining screw C-5.

It takes less than a minute to mount a chuck or face plate, the weight of which is within a man's ability to lift off the bench.

To remove the face plate or chuck reverse the operations. That is:

1. Unlock the cam-lock studs C-3 by turning the wrench counterclockwise until the registration lines C-2 on the heads of the six cam-locks match the corresponging lines C-1 on the flange of the spindle nose.

2. Gently tap the face plate or chuck with a lead hammer to loosen the pinch at the pilot, and then pull it away from the spindle nose. This operation also takes less than a minute under similar conditions.

The Cam-Lock Spindle Nose has been developed under the procedure of the American Standards Association (ASA-B-5-L) and sponsored by the Society of Automotive Engineers, the National Machine Tool Builders' Association, and the American Society of Mechanical Engineers, and is designated as "Lathe Spindle Nose, type D-1".

It is interchangeable with the American Standard Spindle Nose for turret and automatic lathes. Therefore, a com-lock chuck for a turret lathe may be used on this lathe or vice versa.

The taper hole in the front end of the spindle is hardened and accurately ground for true mounting of a center sleeve, collet closers, expansion bushing arbors, etc.

Headstock Gear Train (Fig. B)

The gears in the train from the pulley to the spindle are hardened and ground. Four levers B-8 are mounted on the front of the headstock for sliding the gears into the various combinations of spindle speeds as indicated on the instruction plate B-9.

There are 18 spindle speeds in either of two ranges - 14 to 1000 R.P.M. or 21 to 1500 R.P.M. This is a sufficient range to meet the latest developments in high speed steels and tungsten tantalum carbide cutting tools.

The spindle runs in only one direction by power. However, by sliding the gears into their neutral position the spindle can be turned by hand in either direction for balancing work on a face plate, etc.

The main driving clutch should always be released by lever A-2 or lever A-8, and the spindle stopped before attempting to change spindle speeds.

A speed and feed diagram, Figure L, will be found at the back of this book.

LEAD SCREW AND FEED ROD GEAR BOX

Ratio Gear Box (Fig. B)

The ratio gear box acts as the connecting link between the gear trains of the headstock and the speed control gear box B-4 of the leadscrew and feed rod. These three gear clusters when properly connected control the rate of travel of the tool carriage per revolution of the headstock spindle.

Operation of Lead Screw and Feed Rod Gear Box (Fig. B)

To change the feed of the tool carriage proceed as follows:

First: Select the proper spindle speed for the job to be done and set the spindle speed levers B-8 as indicated on instruction plate B-9.

Second: As a precautionary measure move lever D-13 to its horizontal or neutral position. This disengages the clutch between the gear trains of the spindle and the feed rod and leadscrew gear box.

Operation of Lead Screw and Feed Rod Gear Box (Fig. B) (Cont.)

Third: Find the figure on the instruction plate B-5 corresponding to the pitch of the thread to be cut, or the thickness of the chip desired when turning or boring. Place ratio lever B-2 in the corresponding notch. When lever B-2 is in the middle notch it is in neutral and the gear trains are disconnected.

Fourth: At the right of the instruction plate is a vertical row of letters. Find the letter at the end of the row of figures containing the figure selected. Place the plunger of lever B-6 in the hole marked with this letter.

Fifth: Engage the plunger of the rocker lever B-3 directly below the vertical column of figures containing the one selected.

Sixth: Engage the plunger of lever B-7 in the hole designated "Thread" if thread cutting or "Feed" if turning or boring. It may be necessary to turn the lead screw or feed rod part of a revolution by hand, so as to match the sliding gears.

Use the lead screw only when cutting threads. For all other operations, use the feed rod. This will prolong the accuracy of the lead screw.

TOOL CARRIAGE

Hand Operation (Figure D)

When the knob D-21 in the center of handwheel D-22 is pushed in, the handwheel will actuate the carriage through a gear engaging the rack D-12. If desired the handwheel D-22 can be disengaged by pulling out knob D-21 and thus eliminate the effects of its momentum when thread cutting.

To move the cross slide by hand, use handwheel D-20 which is equipped with a graduated micrometer dial reading to .001" on the diameter of the work, or in millimeters when so specified. This dial may be set by loosening binder nut D-2. Handwheel D-20 engages the cross feed screw.

Should the amount of backlash in the cross feed screw nut become excessive, it may be adjusted by the two socket head screws located at the rear end of the cross slide. To make an adjustment, proceed as follows:

First: Turn handwheel D-20 about three turns clockwise.

Second: Loosen right-hand screw two full turns.

Third: Tighten left-hand screw slowly and simultaneously turn handwheel D-20 clockwise until a very slight drag is felt.

Fourth: Tighten right-hand screw.

Fifth: Check for backlash and feel.

At the rear of the carriage the cross feed screw is enclosed in a sleeve which transmits motion from the taper bar to the cross slide.

Hand Operation (Cont.)

When the taper attachment is not used, the cross feed screw guide should be loced in placd with lock bolt A-17. The guide may be moved before locking by turning the handwheel D-20.

The carriage bronze way scrapers should be periodically removed and inspected and if found excessively worn, should be replaced.

The binder screw, on the right-hand side of the cross slide, locks the slide in any predetermined position.

Cross Slide Positive Stop (Fig. D)

The precision threading and diameter stop D-18 has been provided to control the positions of the cross slide.

It is applicable at any position of the cross slide. The positive stop is set by placing the cross slide in the position at which it is to be stopped. Then raise the lever D-17. By varying the amount of pressure on this lever the stop can be loced positively or permitted to slip under strain applied at handwheel D-20. Once the lever D-17 has been set, the cross slide can be withdrawn away from the stop for one-half inch at which time the stop for withdrawal becomes effective.

Compound Slide Rest (Fig. D)

The tool rest slide D-5 is mounted on top of the cross slide. It is provided with a swivel D-3, graduated to degrees of an acr. By loosening bolt D-4 and the corresponding bolt on the other side of the swivel, the slide can be swung around, located and clamped into any convenient position for the cutting tool or for turning bevels or boring taperholes.

The handwheel D-8 for operating the tool rest slide feed screw is equipped with a micrometer dial, adjustable by loosening binder nut D-7. This dial reads to .001" on diameter of work, or in millimeters if so specified. The micrometer dial will be found useful for quickly adjusting the tool a predetermined amount when turning, boring or thread cutting either crosswise or sidewise, depending on the setting of the graduated swivel.

It can also be used for cutting multiple start threads. Move the thread tool sidewise an amount corresponding to the pitch of the thread for each start.

The binder screw, on the right-hand side of the tool rest slide D-5, locks the compound tool rest slide in any predetermined position.

Adjustment of Carriage Gibs (Fig. D)

If, after long service, the slides of the compound rest require adjustment, withdraw the gib screw at the rear of the compound rest a fraction of a turn and follow it up with the small gib screw D-6 at the front of the compound rest, thereby advancing the taper gib in the seat. Repeat this adjustment in easy stages until the side play has been eliminated, but the slides should still move freely in their mating members.

A similar adjustment may be made of the cross slide by withdrawing the gib screw at the rear of the cross slide and following it up with the gib screw D-9 at the front.

Carriage Clamp (Fig. D)

When using the compound slide rest for turning or boring or the cross slide for facing, it is essential that the carriage remain in a fixed position. The carriage clamp bolt D-10, operated by the tool post wrench, locks it securely. Do not forget to unclamp the carriage before applying the longitudinal power feed.

Forward and Reverse Clutch (Fig. D)

A double end clutch transmits power from the ratio box to the feed gear box B-4 and thru the leadscrew or feed rod to the carriage. To make the carriage travel by power toward the headstock, lever D-13 must be in its lowest position. By swinging lever D-13 to its highest position the direction of the carriage is reversed. When lever D-13 is in its horizontal position the clutch is disengaged and the leadscrew and feed rod are both stationary.

In order to assure correct timing between the headstock spindle and the leadscrew after they have been disengaged for the reversal of the carriage, this clutch is of the single tooth type. A synchronizing device has been incorporated in the mechanism so that the clutch can be engaged without danger of breaking at any combination of spindle speeds and carriage feeds within the requirements of good shop practice. A little care must be taken by the operator in using lever D-13, however. Swing it into engagement, giving the synchronizing device time to function (in the same manner as the gear shift in an automobile should be operated). Be sure the clutch is fully engaged before the tool begins to cut.

Stop Collars (Fig. D)

Two collars E-8 are mounted on spline shaft D-11. By clamping these collars in suitable positions the carriage will, when traveling in either direction, push the single tooth clutch out of engagement, which stops the carriage in the predetermined position. The screw thimble D-23 with a lock nut may be used for fine adjustments.

Power Operating Using the Feed Rod (Fig. D)

To operate the carriage by power, pull lever D-19 upwards. This transmits power to the rack D-12 and moves the carriage toward or away from the headstock, depending upon the position of lever D-13 as explained in a preceding paragraph.

To operate the cross slide by power, pull lever D-16 upwards. This transmits power to the cross slide screw and causes the cross slide to move toward the work or away from it, depending upon the position of lever D-13. A 45° bevel may be cut by pulling up both levers D-19 and D-16 simultaneously.

To stop the power feeds push the lever D-16 or D-19, whichever is in use, downwards. This disengages the clutch.

Thread Cutting (Fig. D)

Lever D-15 is used for engaging the leadscrew nut. It is interlocked with lever D-19 and cannot be engaged unless the latter is in its lowest disengaged position. Also when lever D-15 is set for leadscrew, lever D-19 cannot be pulled upward engaging the feed rod clutch. This prevents the accidental simultaneous engagement of both the leadscrew and feed rod, and the resultant damage to the mechanism.

The leadscrew thread is of comparatively coarse pitch to insure durability. To engage the two halves of the nut, it is necessary to move the carriage back and forth a slight amount by hand, thereby easing the half nut into engagement without danger of raising any burs on the edges of the leadscrew thread and thereby impairing the accuracy.

When lever D-15 is in its 2 o'clock position the leadscrew is engaged and when it is in its 10 o'clock position, as shown in Figure D, the leadscrew is disengaged.

On Figure O (or Om), at the back of this book, is the formula for figuring change gears when cutting special threads. Figure Q gives the index for dimetrical pitches.

Thread Cutting Dial (Figures D, M and N)

Thread cutting dial D-14 is used in cutting multiple-start threads, It is in constant mesh with the leadscrew. It indicates the movement of the carriage at a ratio of one complete turn of the dial for a 4" movement of the carriage. Complete information on using this dial is given on the thread chasing dial diagram, Figure M and N (or Nm) at the back of this book.

METRIC EQUIPMENT

The metric lathe is equipped exactly as the English except that a 6 m/m leadscrew is supplied together with a set of 8 change gears.

With these 8 change gears, the lathe will cut all standard metric leads from .5 to 21 m/m.

It should be noted that the metric index plate does not read in order of magnitude, as does the English plate, but requires the same method of setting the three levers.

The metric index plate, although the same size as the English, is sub-divided differently. At the left of the plate the gears are listed for cutting the various leads in m/m, and the direct reading by the setting of the three levers is the same as the English lathe.

The leads are approximately 6.25 times the feeds in all cases.

The chart on Figures Nm, Om, Pm, Sm and Tm apply particularly to metric lathes.

TAILSTOCK
(Fig. E)

The tailstock spindle has a No. 3 New American Standard Taper hole at the front end for holding centers, drill chucks, etc., in the conventional manner. It also has a tang driving slot so that twist drills can be used to full advantage and with safety without turning in the taper hole.

There are graduations on top of the spindle for convenience in drilling holes to predetermined depths. On the front side of the spindle is a scribed line for setting the cutting tool to the correct center height.

Tailstock (Fig.E) (cont.)

An end ball bearing thrust relieves the end pressure of the spindle screw.

The spindle key is of generous proportions, designed to resist the twisting strain when drilling and also acts as an efficient spindle clamp. It is actuated by handle E-15.

The tailstock is mounted on its base. Sidewise adjustment of the tailstock can be made with bolt E-17, and the corresponding bolt on the other side. A zero line on the left-hand side of the base indicates true alignment with the head-stock spindle.

Two clamps hold the tailstock rigidly to the bedways. Clamping and unclamping are accomplished by a single lever, E-19, which actuates both clamps simultaneously for either light or heavy duty work. Spring loaded ball bearings under the tail-stock will support nearly all of its weight so that when the binder is released very little effort is required to reposition it on the bed.

Instructions for adjusting the tailstock clamps are shown on a plate attached to the tailstock base.

OPERATION OF THE LATHE
(Fig. E)

First: Release all driving clutches by depressing levers E-22, E-21 and E-20 to their lowest positions and place lever E-16 in its horizontal position.

Second: Swing lever E-13 counter-clockwise to its 10 o'clock position, thereby releasing the leadscrew nut.

Third: Place the four spindle speed levers E-6 in position to give the speed required. Do not make the spindle speed too high the first time the lathe is operated. It is safer to make the trial run with a moderate spindle speed. Do not change the spindle speed when the spindle is in motion.

Fourth: Place levers E-2, E-3, E-4 in position to give the required lead or feed. Then place lever E-5 in position for either leadscrew or feed rod, which-ever is to be used.

Fifth: Locate the stop collars E-8 to suit the job, or for the trial run allow about 6" on either side of the

Operation of the Lathe (Cont.)

tool carriage. Then move the carriage back and forth by hand until it almost touches the stop collars, making sure that the tailstock is out of the way.

Sixth: A — For thread cutting

Swing lever E-13 to the 2 o'clock position, moving the carriage gently back and forth a small amount by hand so the half nut will be eased into engagement with the leadscrew. Be sure lever E-13 has been swung beyond its detent, thereby locking it in place. Only use the leadscrew when cutting threads.

B — For turning or boring

Lift lever E-22. This engages the feed rod clutch.

C — To engage the cross slide traverse

Lift lever E-21.

Seventh: To start the headstock spindle revolving, swing lever E-7 to the right, or lift lever E-20, engaging the primary drive clutch.

Eighth: To start the tool carriage moving to the left and/or the cross slide moving outwards, swing lever E-16 gently downwards, giving the synchronizing device a chance to function while engaging the clutch. Be sure the clutch is fully engaged before the tool begins to cut.

Swinging lever E-16 into its highest position reverses the direction of travel of the carriage and/or cross-slide.

Ninth: When the job is finished place all levers on the carriage in their neutral positions and press the motor switch stop button at the close of the working period.

STORAGE

If you have occasion to store this lathe for any length of time, it should be cleaned and carefully slushed with a heavy grease on all exposed unpainted surfaces.

Storage (Cont.)

The storage place should be dry and the temperature reasonably uniform, as sudden changes of temperature in an unheated warehouse will cause condensation of the moisture in the air and induce rusting.

ADDITIONAL EQUIPMENT (Fig. G and H)

Expansion Arbors and Bushings (Fig. G-a)

The expansion arbor and bushing equipment includes one draw-in sleeve and sizes and quantities of arbors and bushings as ordered.

The taper shank of the arbor is mounted in the taper hole of the headstock spindle and secured with the draw-in sleeve.

Step Chucks (Fig. G-b)

Step chuck equipment includes one step chuck seat bushing and step chucks and closers in quantities ordered.

When received the faces of these chucks are blank and must be "stepped out" or recessed to suit the job on hand. By putting a piece of wire that fits in the center hole of the chuck, the chuck can be drawn back and held securely in its closer during the "stepping out" operation.

Follow Rest (Fig. G-c)

To mount the follow rest, loosen four screws in the sides of the carriage bridge and set slots in rest on to the screws. Tighten the four screws.

Collet Mechanism (Fig. G-d)

The collet mechanism equipment includes one collet closer, one collet draw-in sleeve and sizes and quantities of spring collets as ordered. Collet racks as shown on Figure G-d are also available.

Put a few drops of oil in the thread of the draw-in sleeve occasionally.

Micrometer Carriage Stop (Fig. G-e)

The micrometer stop can be clamped at either end of the tool carriage. When used for facing or similar operations the carriage is held against the micrometer stop by hand, or it can be looked in position with the carriage clamp bolt D-10.

When the micrometer stop is used as a stop in conjunction with the power longitudinal feed of the tool carriage, the stop collar E-8 should be set so that the clutch disengages, and the carriage stops just before it hits the micrometer stop. The carriage is then moved by hand up to the micrometer stop.

Ball Bearing Taper Attachment (Fig. G-f)

The taper attachment is mounted at the rear of the bed upon a finished pad having two T-slot and extending the full length of the bed. It can be located and securely clamped to the bed in any position within the range of travel of the tool carriage.

At both ends of the taper bar bracket G-9 are scales for setting the taper bar at the required angle. The scale G-3 at one end is graduated to a range of 20° included angle, and the one at the other end, G-1, to 4" taper per foot or in millimeters per decimeter if in metric measure. Thus it is possible to turn, bore or thread within these ranges and up to 15" in length.

As previously described, the cross feed screw guide is mounted at the rear of the tool carriage for the purpose of carrying the taper bar shoe G-8 and to transmit the motion from the taper bar G-7 to the cross slide.

Ball Bearing Taper Attachment (Fig. G-9)

Mount ball bearing taper attachment on plain machine as follows:

(1) Remove cap from cross feed screw bracket on rear of carriage and remove ball bearing nut. Remove cross feed screw bracket and ball bearing.
(2) On cross feed screw, assemble bearing retaining nut furnished with attachment. Assemble ball bearings (Mounted DF) and lock securely with retaining nut. Assemble over ball bearings the cross feed screw guide furnished with the attachment, locking securely with retaining nut previously mentioned.
(3) Assemble cross feed screw bracket to carriage, and bolt securely after the center of the cross feed screw and cross feed screw nut are in alignment, and the attachment is parallel with the taper bar. Then drill and ream for two dowel pins in cross feed screw bracket.
(4) Set taper bar to zero position and, place bar shoe into the center of taper bar. To engage the shoe to the taper attachment place the tool carriage in position so that the hole in the guide will align with the hole in the shoe. Lock swivel stud nut securely to shoe with T-wrench provided after the taper bar has been set to the desired angle.

Ball Bearing Taper Attachment (Cont.)

(5) Remove lock bolt bracket located in rear of taper attachment and measure the distance from the pad to the center of the tapered hole in the cross feed screw guide. Then remachine the back side of the lock bolt bracket to the same dimension obtained. Assemble lock bolt bracket. When taper turning lock bolt must be disengaged.

(6) On the rear edge of the taper bar, turn the two square headed eccentric binders G-6 a half turn counter-clockwise, unlocking the taper bar. Use knob G-5 to set the taper for the desired angle. Then reclamp the binders G-6.

(7) Before taking a chip run the carriage by hand all along the work, making sure that the taper bar shoe does not run out of the slot in the taper bar which the cut is being made.

(8) When turning straight work, disengage shoe and leave in taper bar. Also engage lock bolt located in rear of taper attachment.

Turning 45° Bevels

The compound slide rest is usually used for turning and boring tapers beyond the capacity of the taper attachment. By simultaneously engaging the longitudinal and cross power feeds of the tool carriage (done by lifting both lever E-22 and lever E-21) it is possible to turn or bore 45° bevels to the center line without use of the taper attachment.

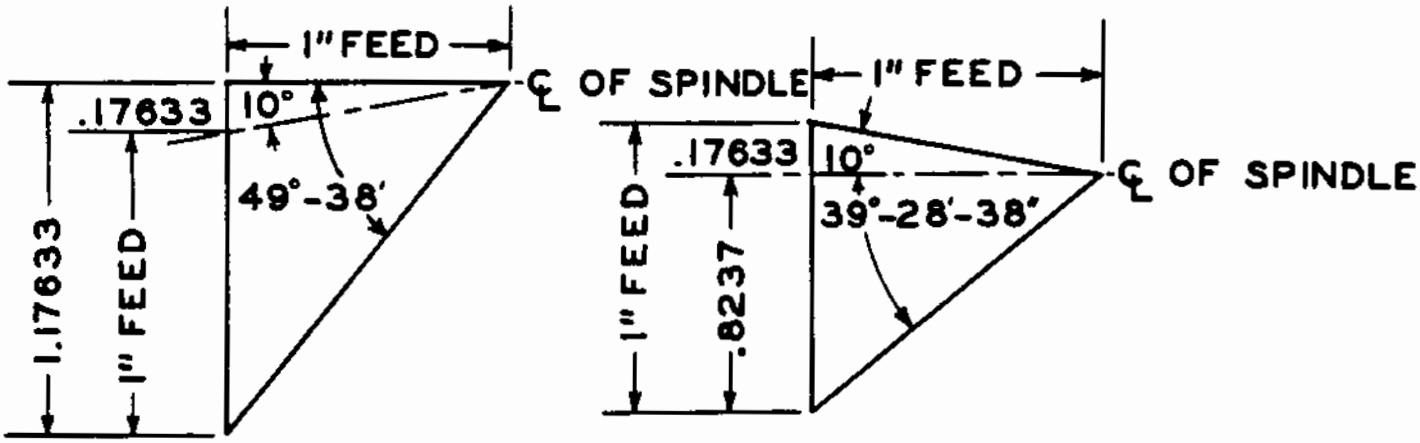
Turning Bevels Greater than 45°

By coupling the taper attachment and the combination described in the preceding paragraph, the 45° bevel, obtained by the two right angle slides, can be increased or decreased about 5° in increments to suit the requirements.

The readings on the taper attachment scales are graduated so as to express the included angles produced with a non-revolving carriage cross feed screw. Therefore the amounts indicated cannnot be added to or deducted from the 45°. To obtain the correct angular taper bar setting when the cross feed is in use, consult the chart on the next page.

This table gives the various angles obtainable at different settings of the taper attachment using the longitudinal and cross power travels of tool carriage.

Setting	Angle greater than 45°	Angle less than 45°
1°	45° - 30'	44° - 30'
2°	45° - 59'	43° - 59'
3°	46° - 28'	43° - 28'
4°	46° - 56'	42° - 56'
5°	47° - 24'	42° - 23'
6°	47° - 52'	41° - 49'
7°	48° - 19'	41° - 16'
8°	48° - 45'	40° - 41'
9°	49° - 12'	40° - 5'
10°	49° - 38'	39° - 28'



Multiple Indexing Face Plate (Fig. H-a)

The multiple indexing face plate is mounted on the Cam-Lock Spindle Nose in the same manner as a face plate.

It is used for cutting multiple start thread, etc. A 60-notch index plate is usually furnished, but special index plates with notches to suit requirements can be furnished.

Carriage Spacing Attachment (Fig. H-b)

Directions for mounting:

Clamp the outboard support H-9 to the "V" way of the lathe bed using the two bolts H-8. Insert the end measure trough H-4 and bushing H-6 in the outboard support, and place the dial indicator bracket H-1 on the right-hand horn of the

Carriage Spacing Attachment (Cont.)

tool carriage, lining the trough H-4 parallel with the ways of the bed. Then transfer the bolt holes of the bracket H-1 into the carriage horn, tap the holes and clamp bracket H-1 on the carriage horn.

Directions for use:

Set the micrometer H-3 and the dial indicator H-2 to zero, clamping the adjustable measuring contact H-5 in position with binder H-7, for the first shoulder or groove. Then extend the micrometer H-3 and add the necessary end measures for the required spacing, using the dial indicator as an anchor only, for subsequent shoulders or grooves.

This device is used for accurately facing shoulders and spacing grooves in shafts, etc.

Pump and Piping Equipment (Fig. H-c)

The pump for cutting oil and compounds is a self-contained motor driven unit H-10. It is mounted on the pad A-15 at the rear of the bed. The flexible hose H-11 with its nozzle H-12 are attached to the carriage.

The motor "on" and "off" switch is located at the headstock end of the machine.

Do not use solutions that will tend to clog the lubricating oil grooves in the tool carriage and its apron.

Speed Reducer (Fig. H-d)

For work where the coarseness of the lead of the thread to be cut is beyond the normal capacity of the leadscrew, a speed reducer should be used. It can also be successfully employed in conjunction with the cutter relieving attachment when the lowest spindle speed is too fast to obtain the correct surface speed of the work.

The speed reducer has a built-in planetary gear train which reduces the speed of its work dog driver six to one in relation to the headstock spindle and leadscrew. Thus it is possible to cut threads six times coarser in lead than indicated on the tabulated instruction plate B-5. The table, Figure R at the back of this book, gives the range of pitches and leads available when the speed reducer is used.

The speed reducer is particularly intended for coarse leads. If it becomes necessary to use it for cutting threads of less than .100" lead, the exact location of the carriage, at the time the single tooth clutch is engaged for forward travel, becomes very critical. It should not vary more than 1/20 of the lead even if it becomes necessary to use a dial indicator to control the stop position on the return travel of the carriage.

The single tooth clutch should not engage immediately as its lever is actuated. The distinct click heads when the clutch teeth engage should take place when the selected numeral (referred to on the next page) is passing out of the index zone. The clutch lever should be actuated when the two clutch teeth are about 180° apart. This relationship can be obtained by a slight change in the stopping position on the return travel of the carriage.

The speed reducer is shipped with the rotor H-19 and the stator H-20 locked together with the slotted square headed bolt and nut H-15 in the hole H-17, making the reduction gears inoperative. If it is mounted on the headstock spindle in this condition without the bed plate H-14, it can be used as a conventional work driver with a 60-notch index plate H-21 for cutting multiple threads when the required lead of the thread and surface speed of the work are within the normal capacity of the lathe. When so used, the small lever H-22 is used to lock the index plate in position.

The speed reducer is mounted on the Cam-lock Spindle Nose in the same manner as a face plate, which was described in a preceding section of this book.

After the speed reducer is mounted, place the bed plate H-14 on the bed directly below it. Then revolve the headstock spindle until the lug in the rim of the speed reducer matches the notch in the bed plate. Clamp the bed plate to the bed and transfer the square headed bolt and nut H-15 from hole H-17 to its position in the bed plate as shown in illustration H-d. The nut and bolt H-15 presses the disc H-13 against the lug in the rim of the speed reducer, clamping the stator H-20 to the bed plate. This makes the reduction gears operative.

When using the speed reducer for thread cutting, whether left or right hand, be sure the carriage stop E-8 is set so that on the return travel, the carriage will stop when the thread tool is a predetermined distance beyond the end of the thread. This will disengage the single tooth clutch so that the leadscrew is in the same position for the start of each cut and there will not be any danger of "crossing" the threads. The carriage may be stopped at any position after the cut is made, but each cut must be started at the proper point.

One, two, three or six "start" cuts may be made by using the 6 to 1 reduction on the face of the rotor for this purpose. By operating the carriage reverse lever E-16 when the proper numeral is within the index zone, indicated by the groove H-18, these starts can be obtained without using the index plate.

For single starts engage the reverse clutch by means of lever E-16 when any predetermined number passes the index zone. If, for example, number 3 is selected as the starting numeral, this number must always be used until the job is completed.

For double starts, operate the carriage reverse lever E-16 as every third numeral, such as 1-4, 2-5, or 3-6 passes the index zone.

Speed Reducer (Cont.)

For triple starts operate carriage reverse lever E-16 at every other number, such as 1-3-5 or 2-4-6.

For sextuple starts operate the carriage reverse lever E-16 at each successive numeral.

Special change gears and index plates can be furnished to cut threads which have not been tabulated but are within the range of the lathe.

To use the speed reducer as a conventional work driver, lock the rotor H-19 and the stator H-20 together. Turn the former until the registration line H-16 of the rotor corresponds with that of the stator. Then remove the square headed bolt and nut H-15 from the bed plate and place it in the hole H-17.

Relieving Attachments

Radial and Side Relieving Attachments are available as additional equipment, either separately or a combination of both. A complete description, charts and pictures of these attachments are included in all instruction books covering lathes so equipped.

To mount the Radial and Side Relieving Attachment Drive, proceed as follows:

(1) Set main drive clutch lever A-2 in the engaged position.

(2) Remove driving belts, disconnect leads to control panel and remove end guard from machine.

(3) Remove main drive sheave and clutch bracket.

(4) Remove four screws from retaining cap and disassemble clutch driving sleeve and ball bearings from clutch bracket.

(5) Reassemble driving sleeve and ball bearings in the new clutch bracket furnished with the relieving attachment. The retaining cap should hold bearings in place without end play - fit cap if necessary. Assemble new bracket to machine and replace driving sheave.

(6) Remove the spacing sleeve from the driving shaft in ratio box directly under lathe spindle and assemble gear G16-60-16 in its place.

(7) Assemble gear drive bracket to pulley clutch bracket. With gear G16-119-1 in place, adjust bracket position to obtain .004" to .008" backlash between gears, and dowel drive bracket in place.

(8) Assemble new end guard and replace belts and cabinet leg cover.

(9) Connect wiring to new control box.

Relieving Attachment

(1) Remove chip guard on rear of cross slide.

(2) If attachment is applied to a plain machine, assemble cross feed screw to cross feed screw guide in same manner as described under taper attachment.

(3) Assemble radial relieving attachment to carriage, and bolt securely in same manner as described under taper attachment.

Set taper bar to zero position and engage shoe to the relieving attachment in same manner as described under taper attachment.

(4) Remove lock bolt bracket located in rear of cam block and fit in same manner as described under taper attachment.

(5) When taper relieving or turning lock bolt must be disengaged.

(6) Assemble the special chip guards furnished on rear of cross slide.

(7) Attach the universal joints of the telescopic drive shaft one end to the projecting gear stud in the drive bracket and the other universal joint to the gear stud in the cam slide bracket.

(8) Make sure that the forks of the two halves of the universal joints that are attached to the apposite ends of the telescopic shaft are in alignment. This is very important as otherwise the camshaft in the relieving attachment will not revolve at uniform rate of speed - it will be gaining speed during one-half of a revolution, and losing speed on the other half.

(9) Turn the telescopic shaft by hand a few times to make sure that everything is in proper order.

(10) Unscrew the retaining nut and withdraw the camshaft. Insert the selected cam and reassemble the cam shaft.

(11) Attach the selected change gears and close the change gear cover.

(12) Lubricate throughly.

(13) When radial relieving attachment only is used, lock bolt must be engaged.

(14) When radial relieving and taper attachments are used in combination, the taper bar shoe and its stud should be securely locked in the hole provided in bottom side of cross feed screw guide in same manner as described under taper attachment.

(15) For straight turning without relieving disengage cam roll from cam by moving cam release lever, mounted on top of cam block to mid position.

(16) The taper shoe should be disengaged in same manner as described under taper attachment.

Relieving Attachment (Cont.)

To mount the side relieving attachment, proceed as follows:

(1) Bolt adapter plate to the side relieving attachment bracket.

(2) Clamp attachment to the rear of the bed.

(3) Align relief rod with hole in relief rod bracket that sets on the rear of the carriage.

(4) Tap 2 - 3/8" holes into the top of the carriage. Locate holes from relief rod bracket.

(5) Bolt bracket in place.

(6) Attach the universal joints and telescopic shaft.

(7) The attachments are now ready for operation, but it is well to oil all running bearings and slides and run the attachment idle for a few minutes, making final adjustments before putting them to work.

Oversize Steady Rest

This is of the same design as the standard steady rest illustrated on Figure F, except it has a 6" capacity instead of 4-1/2". It clamps solidly to the ways of the lathe bed, is very rigid and can be adjusted quickly.

Other Additional Equipment

In addition to the equipment described here, the following items can be supplied, to order only: Additional centers, Cushman collet chucks, drill chucks, plain and elevating tools, additional tool post and translating gears.

SPECIFICATIONS

RANGE:

*Center distance, maximum	30", 54"
Swing over bed	14-1/2"
Swing over carriage	8"
Steady rest capacity	4-1/2"
Follow rest capacity	2-1/4"
Tool post takes tool	1/2" x 1"
Spindle center to floor	43"
Spindle center to top of bed	7"
Center of bed V to center of flat	11"

*Longer center distances available by special arrangement.

SPECIFICATIONS (Cont.)

HEADSTOCK SPINDLE:

Special alloy steel, hardened and ground; bearings preloaded super-precision anti-friction; spindle supported in two heavy bearings at the nose end, and a third bearing at the outer end.

Hole through spindle	1-1/2"
Taper hole in spindle (New American Standard)	No. 5
Taper hole in center adapter (New American Standard)	No. 3
Cam-lock spindle nose (flanged)	Type D-1
Collet capacity (draw-back), maximum	1"

TAILSTOCK SPINDLE:

Diameter	2-1/4"
Maximum travel	5-1/2"
Taper hole (New American Standard)	No. 3

Spindle graduated for 5" by 16ths

SPINDLE SPEEDS:

18 spindle speeds in geometrical progression, either one or two ranges.

Low range, rpm	14 to 1000
Upper range, rpm	21 to 1500

Driving pulley supplied with correct diameter to produce one range or the other as desired.

Multiple V-belt drive	3 belts

FEEDS, with QUICK CHANGE MECHANISM (60 changes):

Carriage longitudinal, per revolution of spindle	.0025" to .152"
Carriage cross, per revolution of spindle	.0025" to .152"

Micrometer dials graduated in half thousandths

THREADING, with QUICK CHANGE MECHANISM (60 changes):

Threads per inch	1 to 60

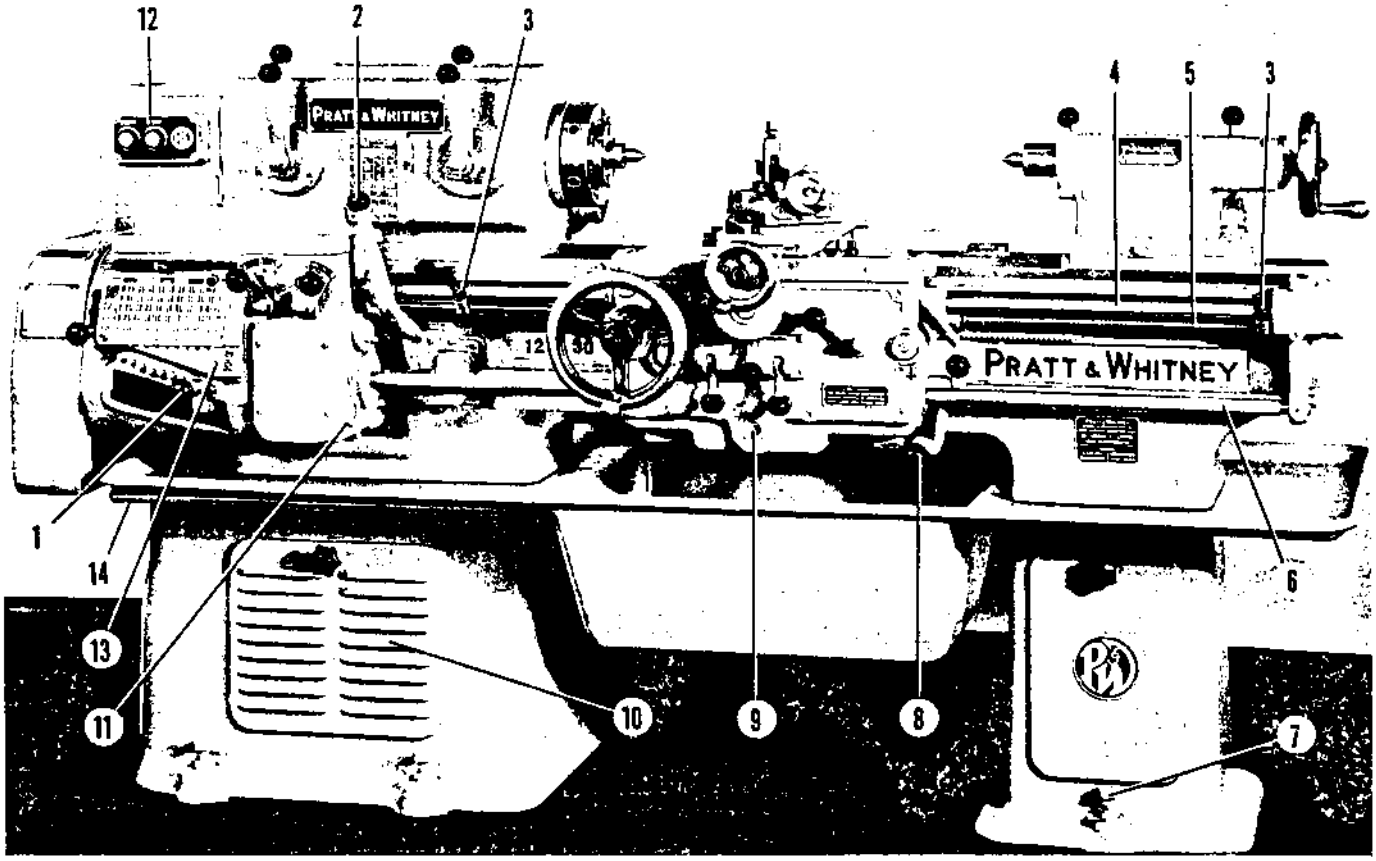
REGULAR EQUIPMENT:

Includes geared head; motor drive arrangement with motor base, motor pulley, 3 multiple V-belts, belt guard, conduit and wiring; built-in push button station; attaching and testing electrical equipment, but WITHOUT motor and starter; leadscrew reverse mechanism with automatic stop in both directions of carriage travel; automatic lubrication for all main units; all shafts including main spindles mounted on anti-friction bearings, main spindle on preloaded adjustable bearings; main clutch and spindle brake multiple disc type running in oil; Cam-lock spindle nose; compound rest with drop forged steel tool slide; cross slide positive stop; round tool post; steady rest; oil and chip pan; centers; large and small face plates; knock-out rod; set of wrenches.

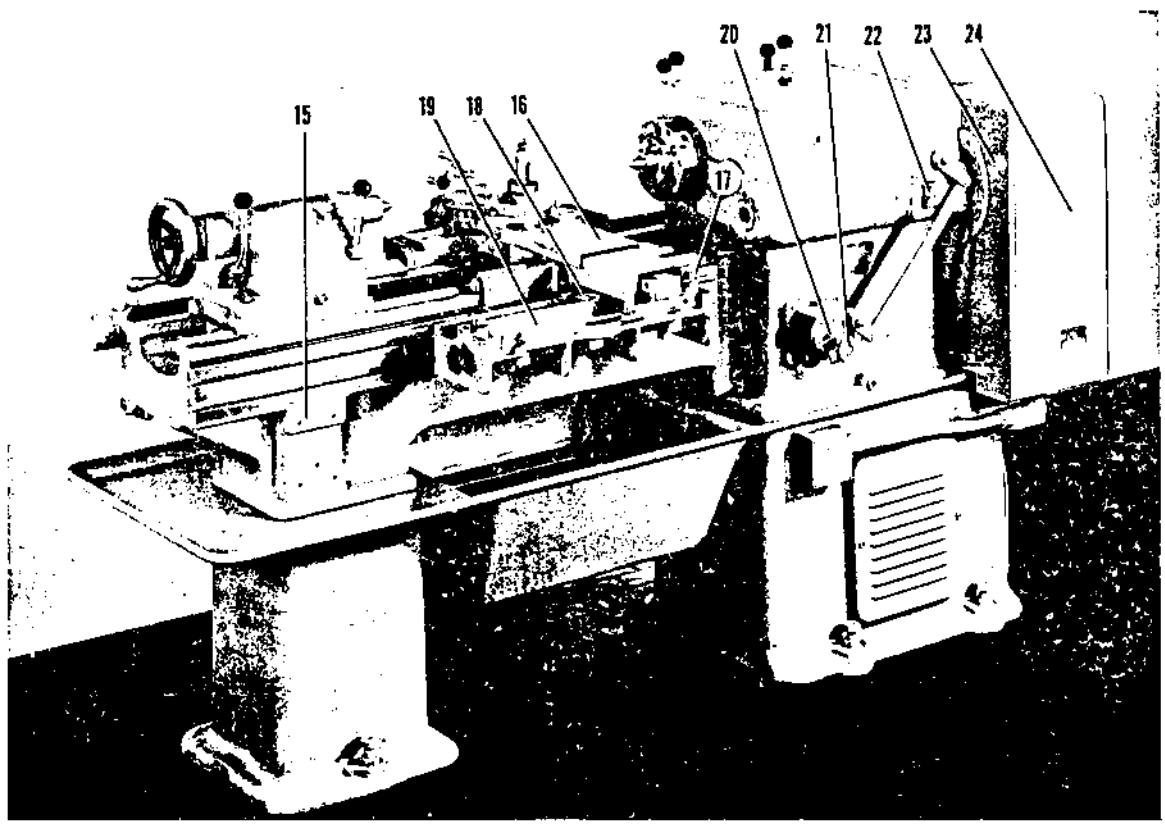
KEY TO FIGURE A

Front and Rear Views

1. Rocker lever
2. Main drive clutch lever
3. Carriage stop collars
4. Forward and reverse clutch shaft
5. Leadscrew
6. Feedrod
7. Leveling screw
8. Main drive clutch lever
9. Carriage and apron oil gage
10. Motor housing
11. Feed rod and leadscrew gear box oil gage
12. Motor pushbutton switch
13. Rocker oil cup
14. Knockout rod
15. Pump pad
16. Cross slide chip guard
17. Cross slide screw sleeve binder
18. Taper attachment shoe
19. Taper bar
20. Headstock oil filter
21. Headstock oil gage
22. Main drive clutch
23. Main drive pulley (Inside of guard)
24. Electrical equipment housing



FRONT VIEW



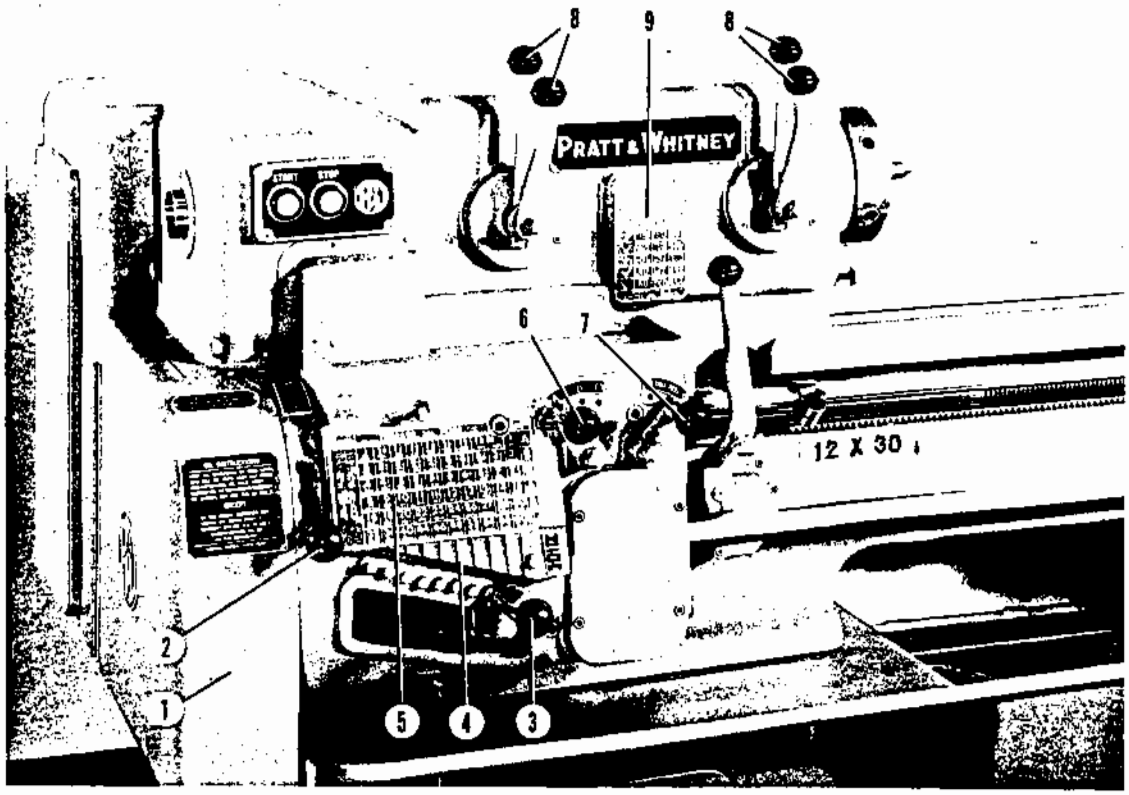
REAR VIEW

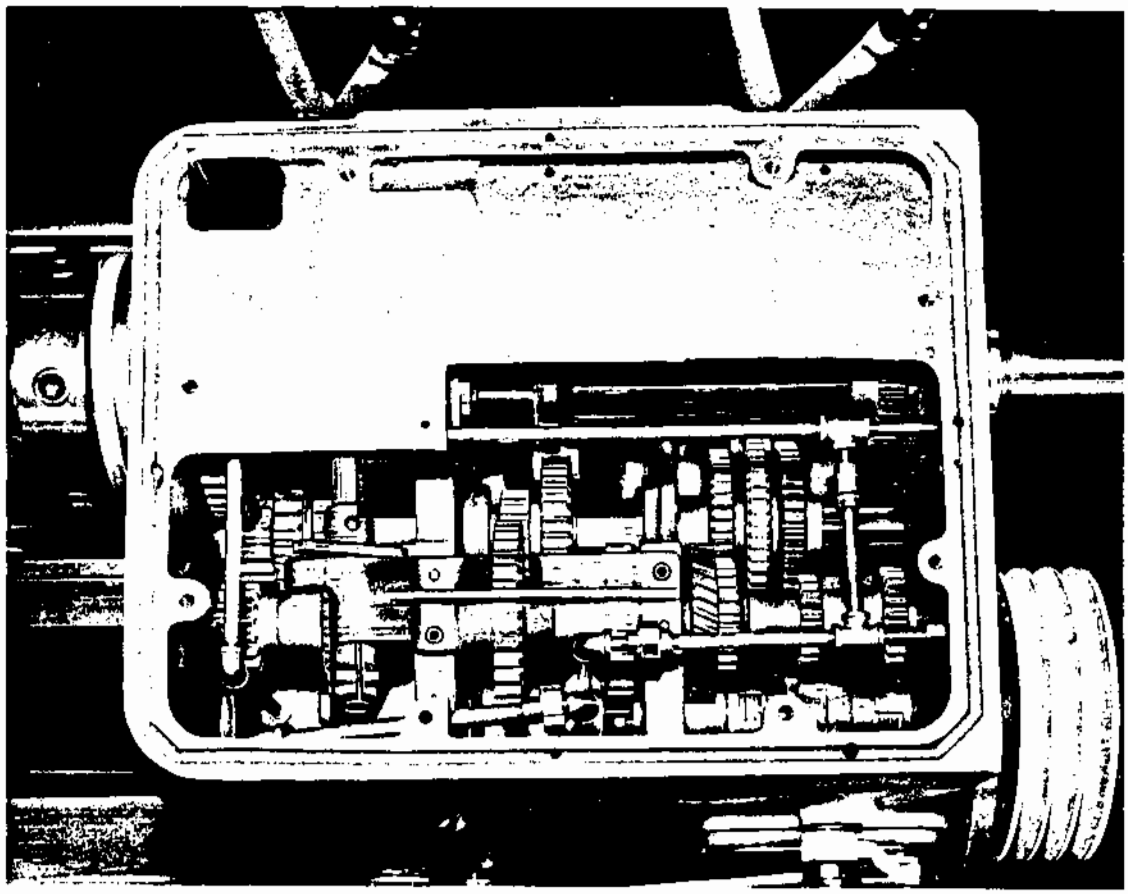
FIG. A

KEY TO FIGURE B

Headstock and Feed Rod and Leadscrew Gear Box

1. Change gear guard
2. Ratio lever
3. Rocker lever
4. Feed rod and leadscrew gear box
5. Feed and thread instruction plate
6. Selector lever
7. Thread and feed shift lever
8. Spindle speed levers
9. Spindle speed instruction plate





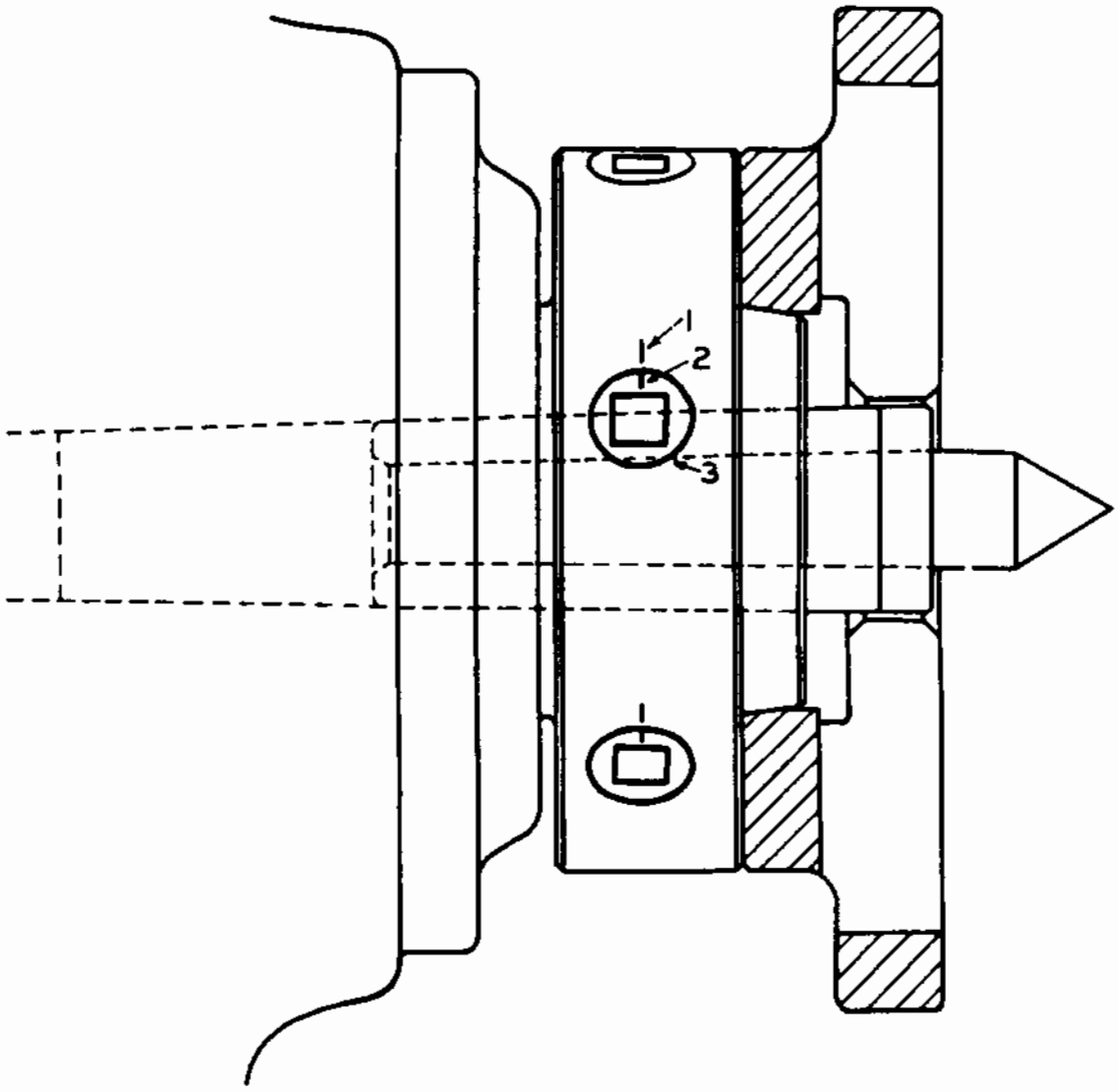
THE HEADSTOCK

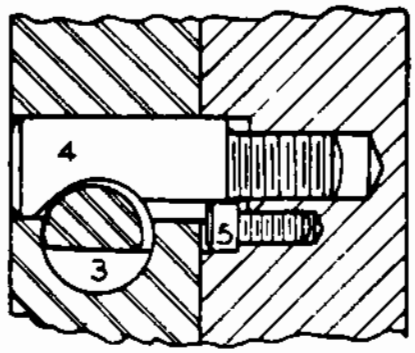
FIG. B

KEY TO FIGURE C

Cam-Lock Spindle Nose

1. Registration lines on spindle nose
2. Registration lines on Cam-Locks
3. Cam-Locks
4. Cam-Lock mating stud on chuck or face plate
5. Hollow head retaining screw





CAM-LOCK

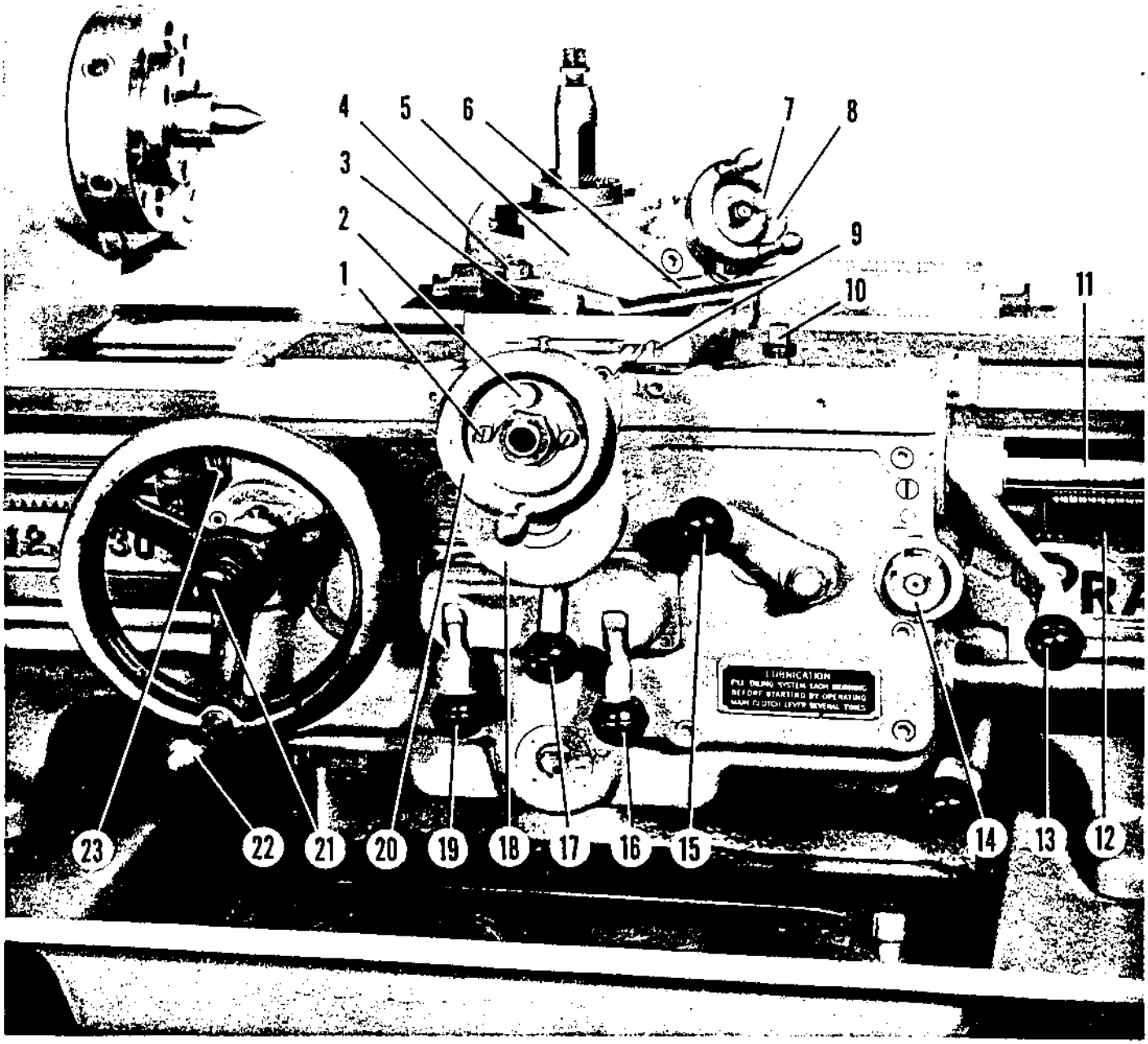
SPINDLE NOSE

FIG. C

KEY TO FIGURE D

Apron and Carriage

1. Friction binder screw
2. Cross slide micrometer dial binder
3. Tool rest swivel
4. Tool rest swivel binder
5. Tool rest slide
6. Tool rest slide gib screw
7. Tool rest slide micrometer dial binder
8. Tool rest slide handwheel
9. Cross slide gib screw
10. Carriage clamp
11. Forward and reverse clutch shaft
12. Rack
13. Forward and reverse clutch lever
14. Thread chasing dial
15. Leadscrew nut engaging lever
16. Cross slide feed rod clutch lever
17. Positive stop lever
18. Positive stop housing
19. Carriage feed rod clutch lever
20. Cross slide handwheel
21. Carriage handwheel disengaging knob
22. Carriage handwheel
23. Adjustable carriage stop with lock nut



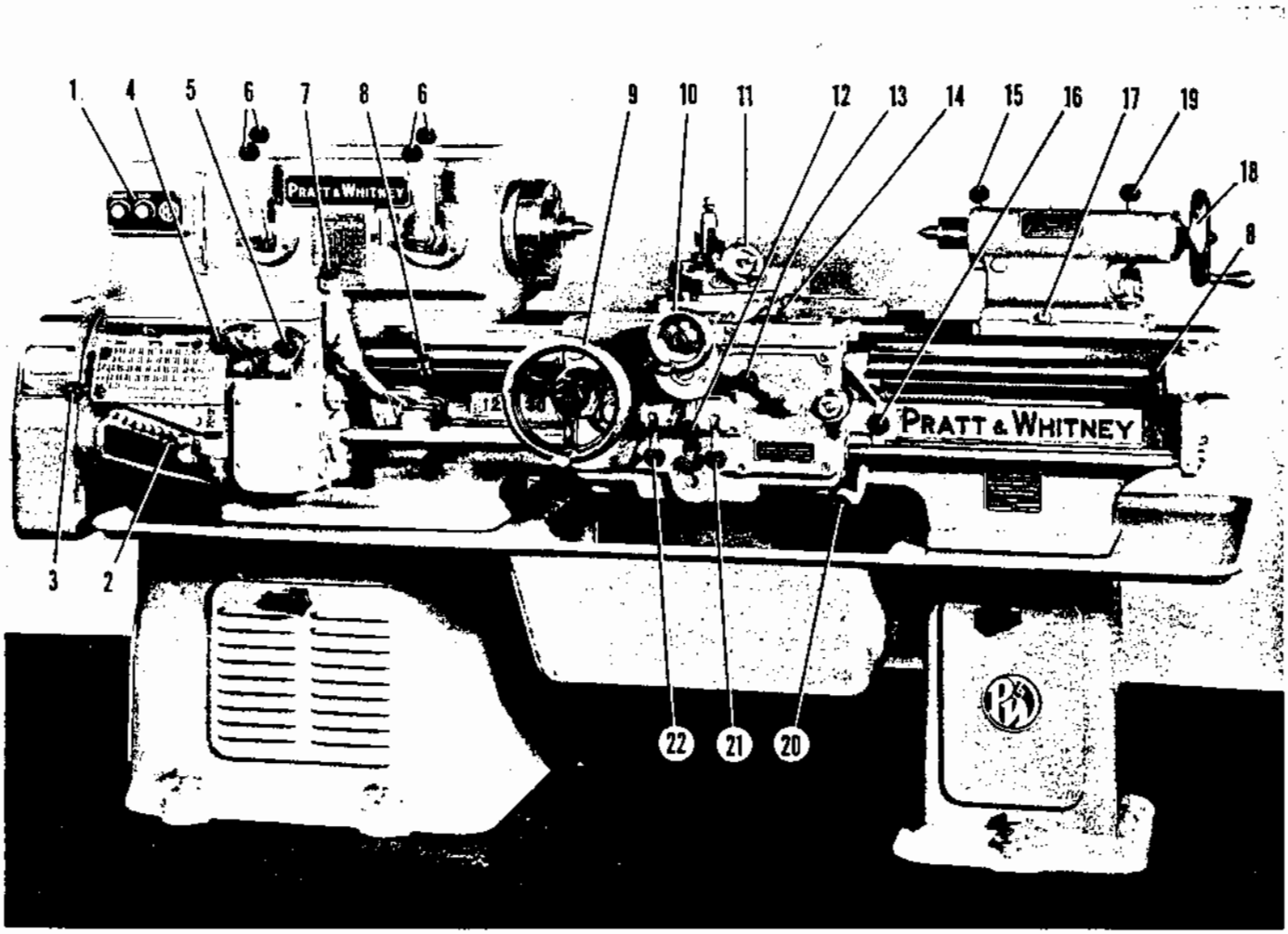
THE APRON AND CARRIAGE

FIG. D

KEY TO FIGURE E

Operating Levers

1. Motor push button switch
2. Rocker lever
3. Ratio gear lever
4. Selector lever
5. Thread and feed shift lever
6. Spindle speed levers
7. Main drive clutch lever
8. Carriage stop collars
9. Carriage handwheel
10. Cross slide handwheel
11. Tool rest slide handwheel
12. Positive stop lever
13. Leadscrew nut engaging lever
14. Carriage Binder
15. Tailstock spindle clamp lever
16. Forward and reverse clutch lever
17. Bolt for adjusting tailstock alignment
18. Tailstock spindle handwheel
19. Lever for clamping tailstock to bed ways
20. Main drive clutch lever
21. Cross slide feed rod clutch lever
22. Carriage feed rod clutch lever



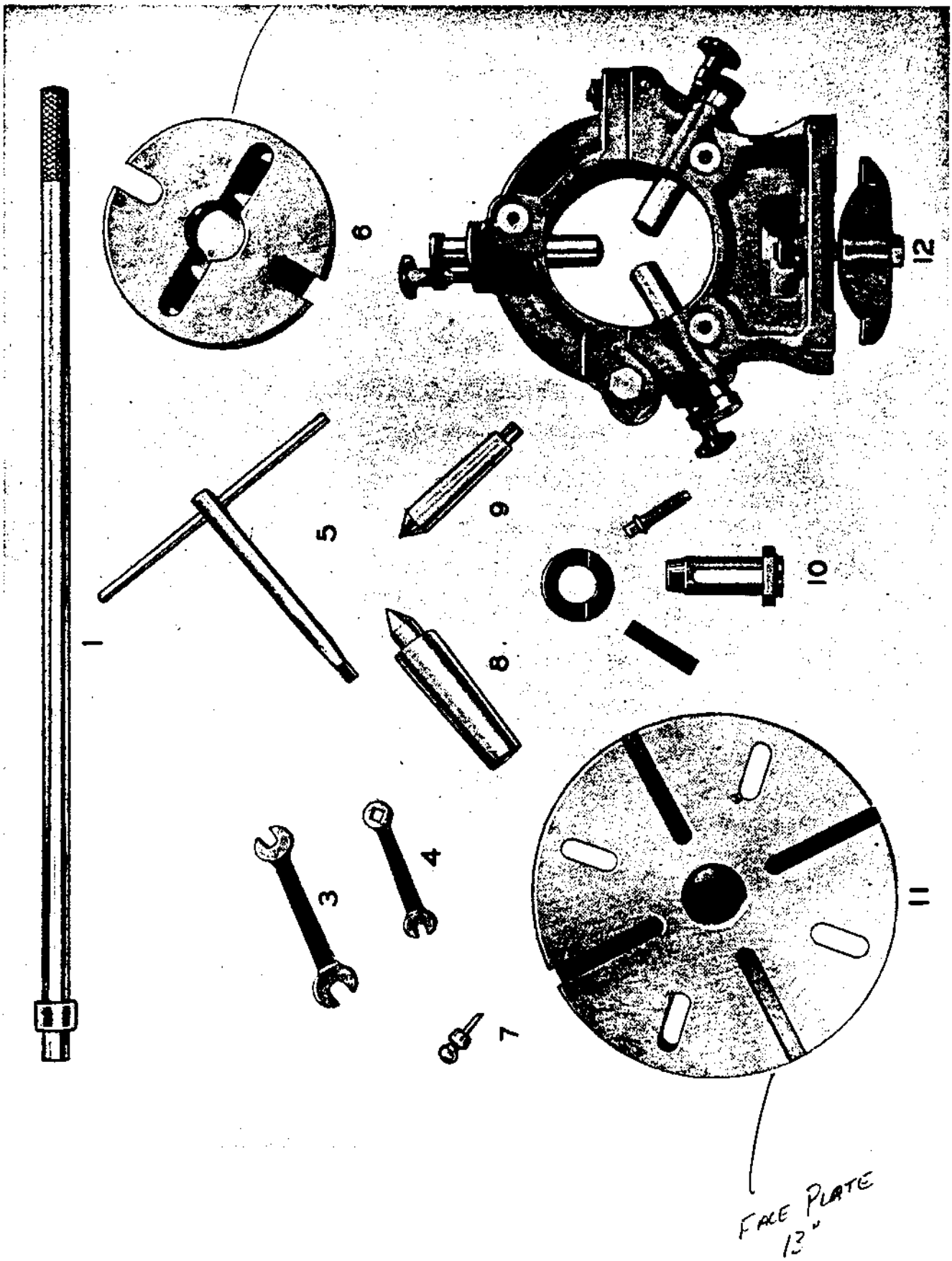
OPERATING CONTROLS

FIG. E

KEY TO FIGURE F

Miscellaneous Regular Equipment

1. Knockout rod
3. Wrench for compound rest swivel nuts and cross slide stop rod and latch
4. Wrench for tool post screw taper bar shoe and bracket bolts
5. T-wrench for spindle nose cam-locks
6. Dog driver plate
7. Oiler quill for tailstock center
8. Center for headstock spindle
9. Center for tailstock spindle
10. Tool post disassembled showing the washer, rocker and screw
11. Large face plate
12. Steady rest



MISCELLANEOUS REGULAR EQUIPMENT

FIG. F

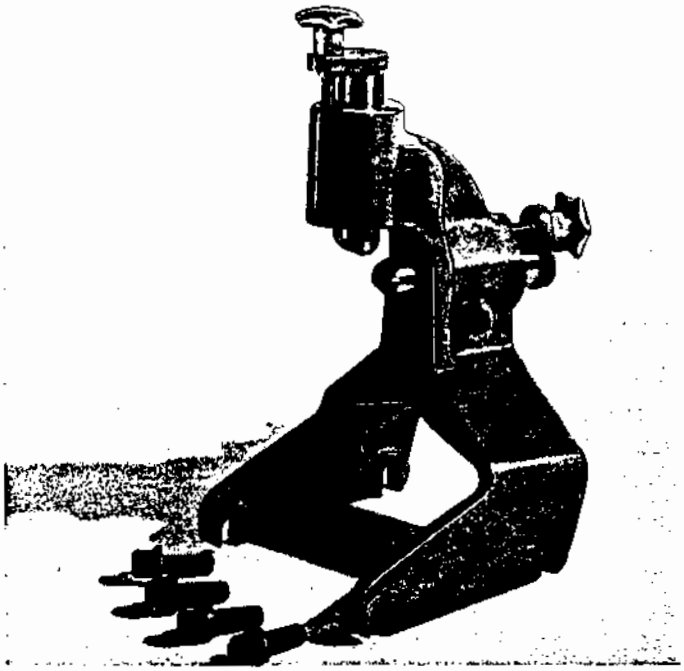
KEY TO FIGURE G

Additional Equipment (to order only)

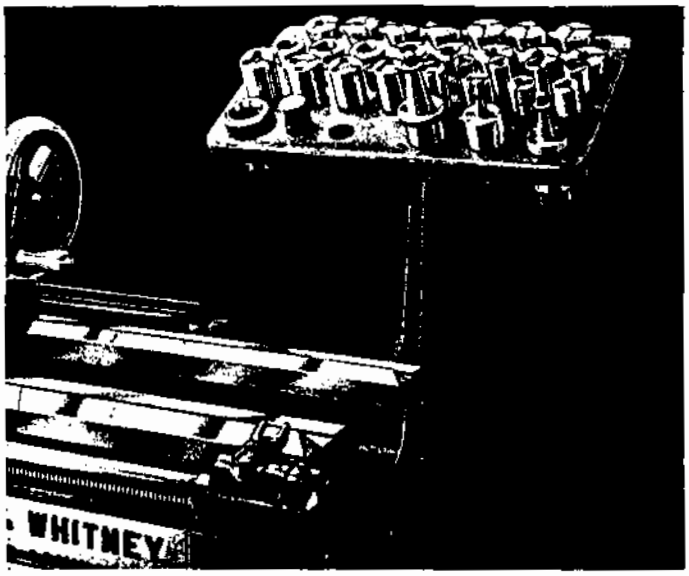
a. Expansion arbors and bushings
b. Step chucks
c. Follow rest
d. Collet rack
e. Micrometer carriage stop
f. Taper attachment
    1. Taper bar scale graduated in inches per foot
    2. Cross slide feed screw guide lock bolt
    3. Taper bar scale graduated in degrees
    4. Taper bar bracket clamp
    5. Knob for setting taper bar at desired angle
    6. Taper bar binder
    7. Taper bar
    8. Taper bar shoe
    9. Taper bar bracket

a. Expansion Arbors and Bushings

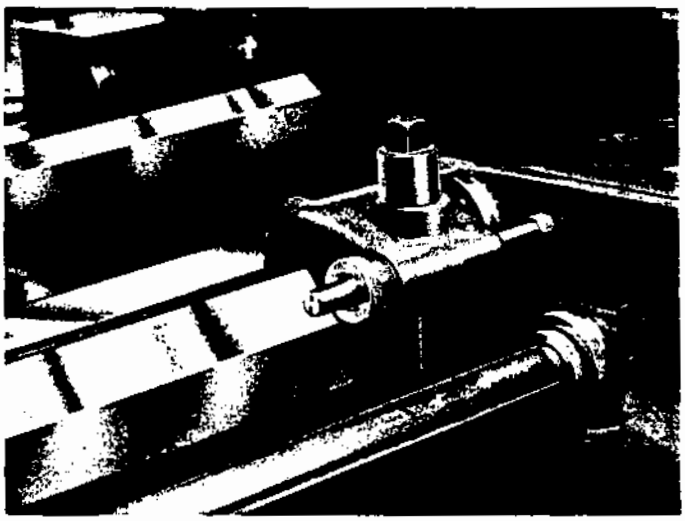
b. Step Chucks



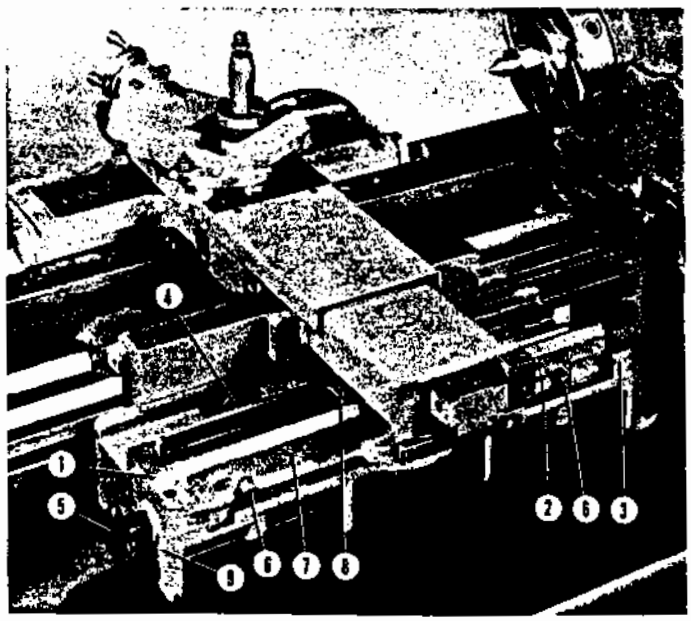
c. Follow Rest



d. Collet Holder



e. Micrometer Carriage Stop



f. Taper Attachment

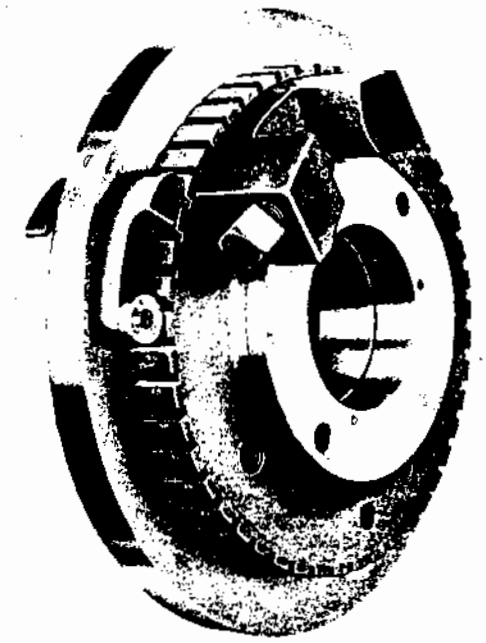
ADDITIONAL EQUIPMENT

FIG. G

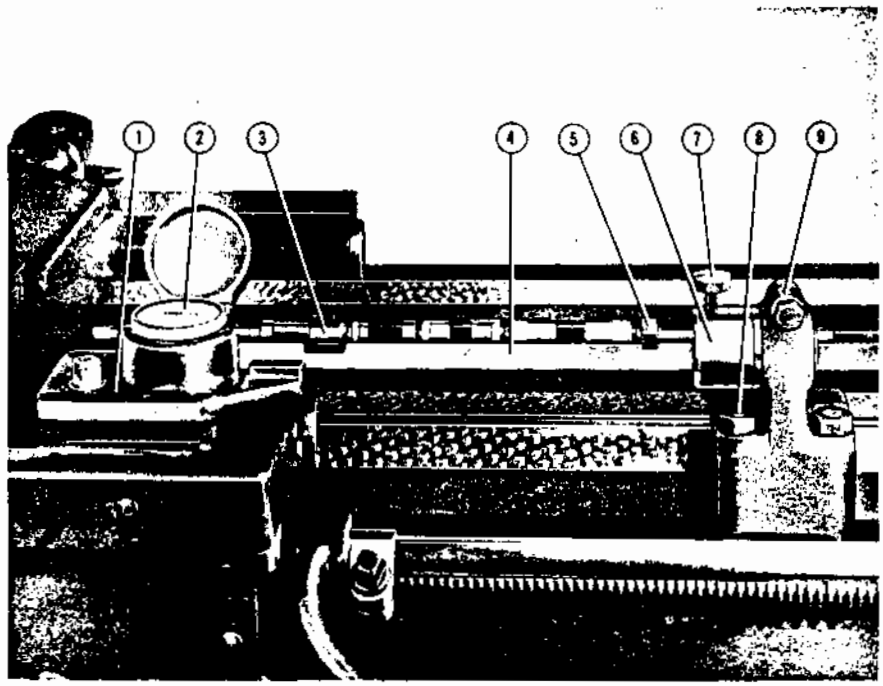
KEY TO FIGURE H

Additional Equipment

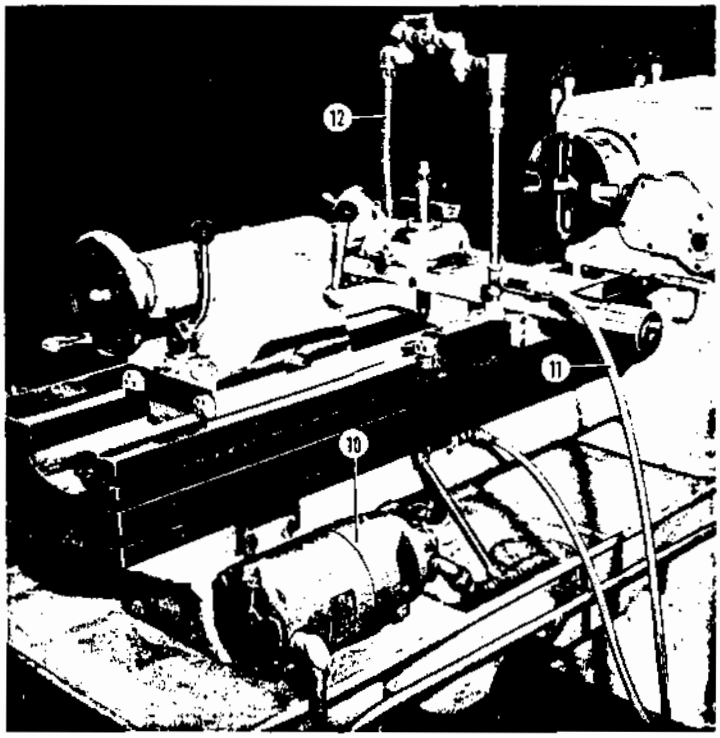
a. Multiple indexing face plate
b. Carriage spacing attachment
    1. Dial indicator bracket
    2. Dial indicator
    3. Inside micrometer
    4. End measure trough
    5. Adjustable measuring contact
    6. Outboard support bushing
    7. Measuring contact binder
    8. Outboard support clamp bolt
    9. Outboard support
c. Pump equipment
    10. Pump and motor
    11. Flexible hose
    12. Flexible nozzle
d. Speed reducer
    13. Disc for clamping stator to bed plate
    14. Bed plate
    15. Square headed bolt and nut
    16. Registration lines on rotor and stator
    17. Hole for square headed bolt and nut
    18. Index zone on stator
    19. Rotor
    20. Stator
    21. 60-notch index plate
    22. Lever for locking index plate



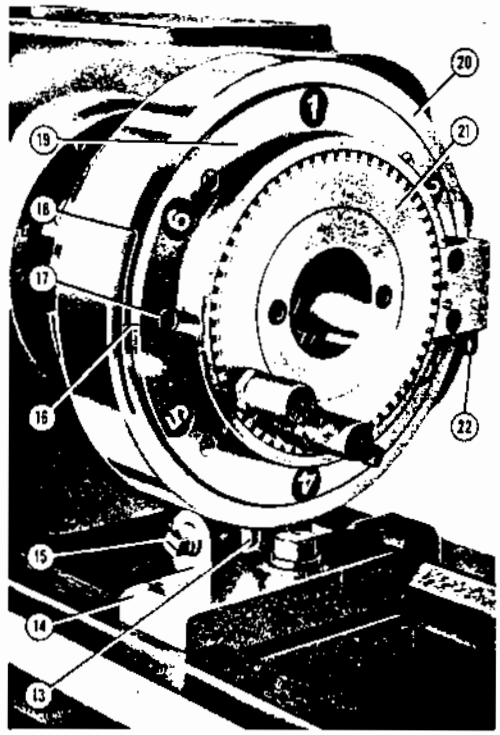
a. Multiple Indexing Face Plate



b. Carriage Spacing Attachment



c. Pump and Piping



d. Speed Reducer

ADDITIONAL EQUIPMENT

FIG. H

FIG. J

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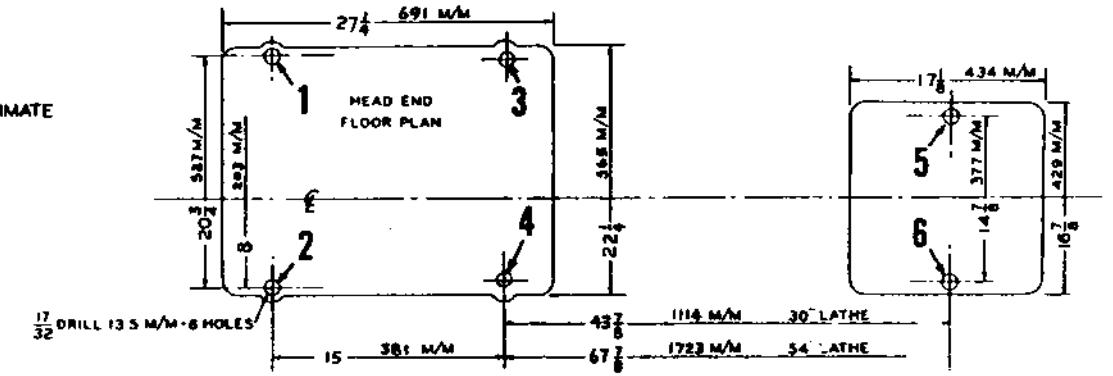
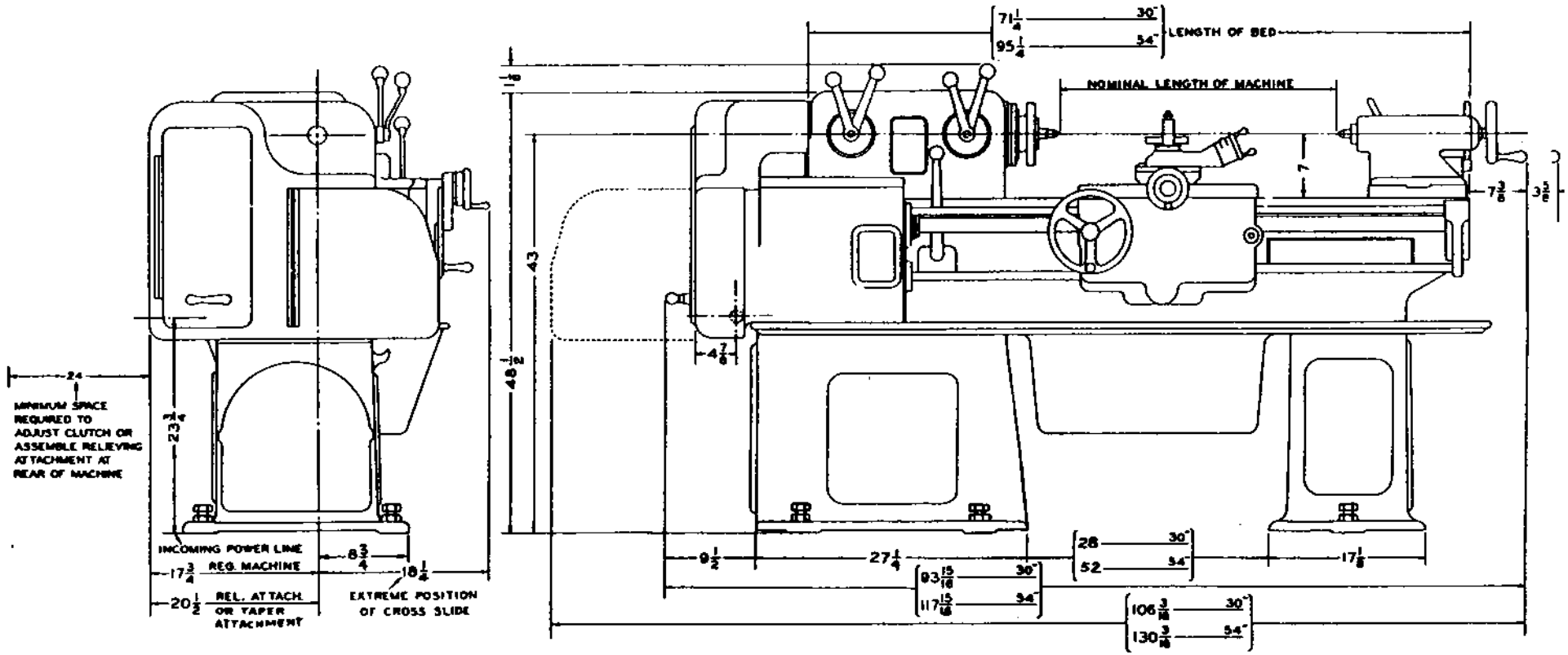
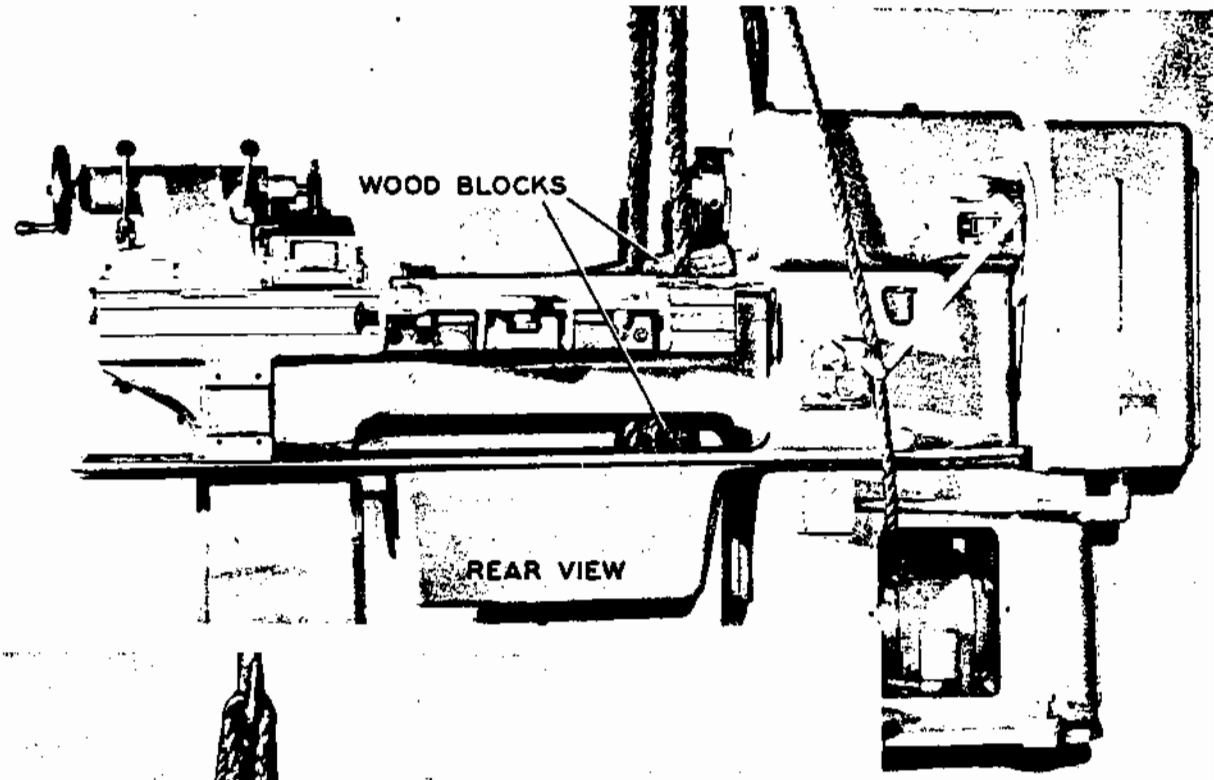
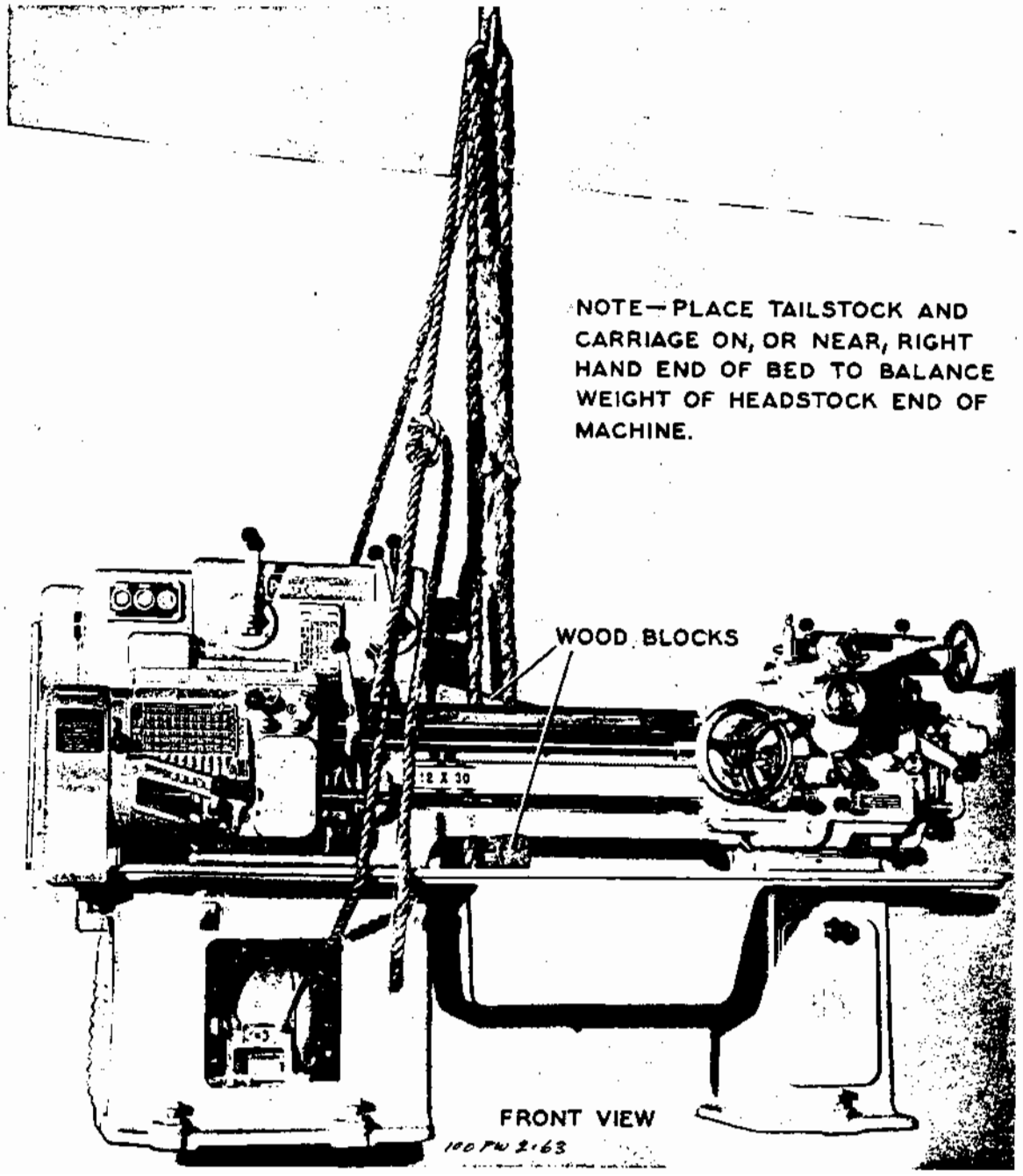
DIMENSIONS SHOWN ARE APPROXIMATE





FLOOR PLAN





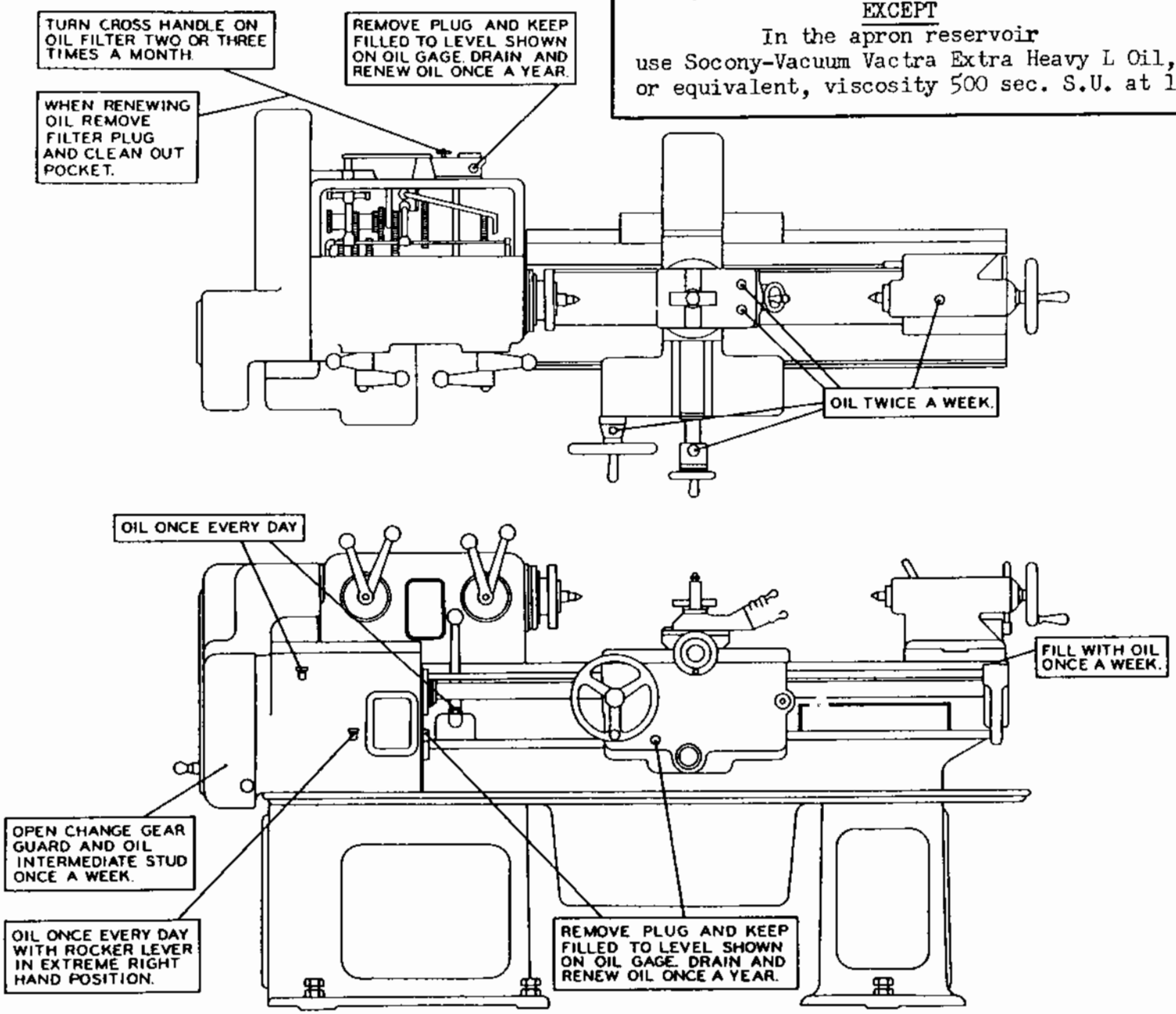
PROPER METHOD OF LIFTING THE LATHE

FIG. Ja

Use Socony-Vacuum D.T.E. Heavy Medium Oil,
or equivalent, viscosity 300 sec. S.U. at 100°F.

EXCEPT

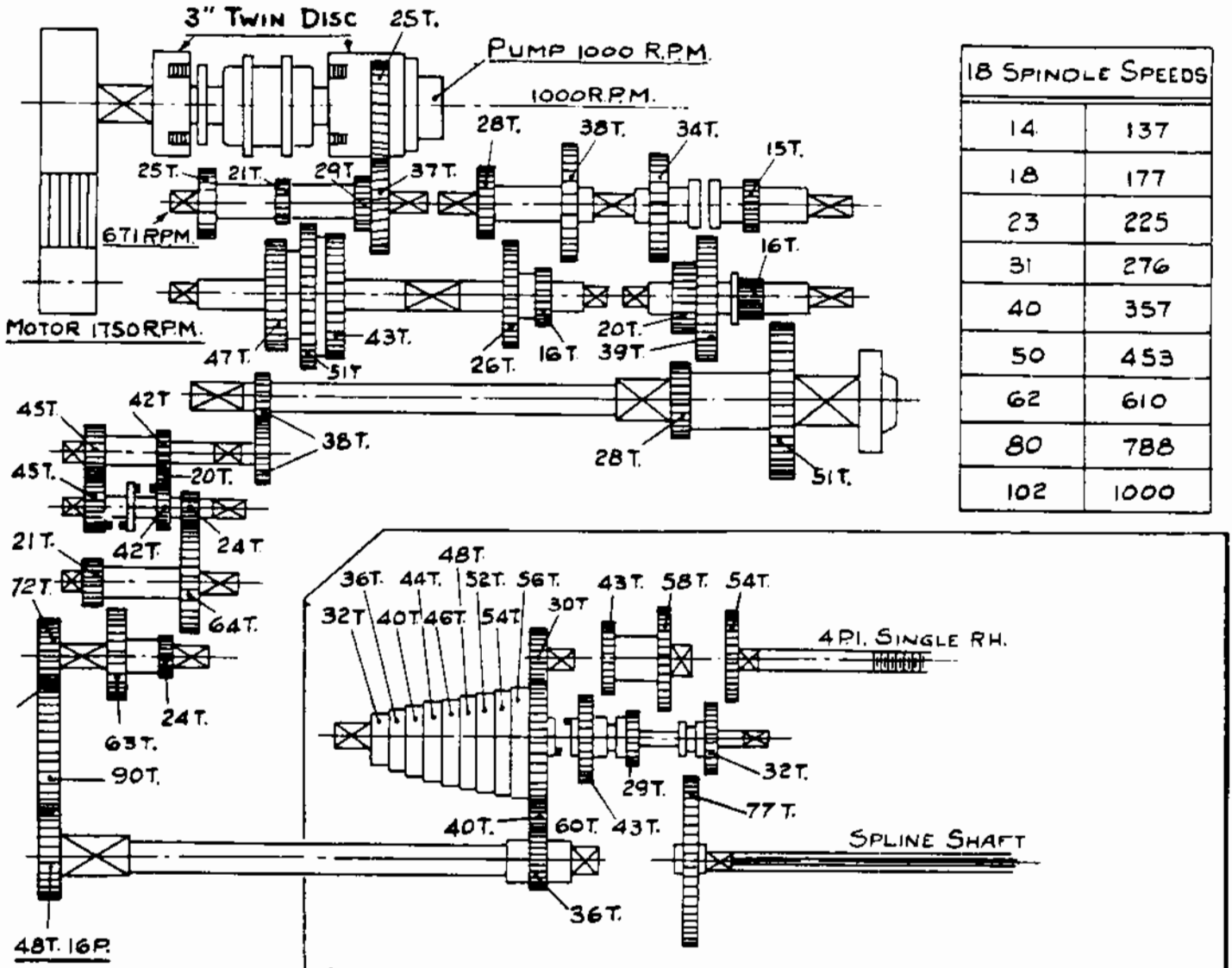
In the apron reservoir
use Socony-Vacuum Vactra Extra Heavy L Oil,
or equivalent, viscosity 500 sec. S.U. at 100°F.



LUBRICATION CHART

FIG. K

1694-R-45

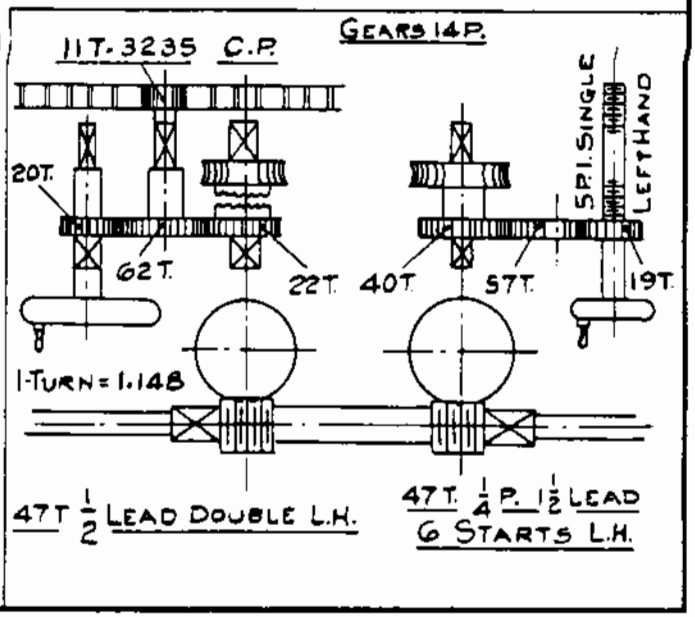


18 SPINDLE SPEEDS	
14	137
18	177
23	225
31	276
40	357
50	453
62	610
80	788
102	1000

CONE BANK GEARS 16P.

LEVER	STUD	SCR.	THREADS PER INCH											LEVER
1	72T.	48T.	1	1 1/8	1 1/4	1 3/8	1 7/16	1 1/2	1 5/8	1 11/16	1 3/4	1 7/8		A
			2	2 1/4	2 1/2	2 3/4	2 7/8	3	3 1/4	3 3/8	3 1/2	3 3/4		B
			4	4 1/2	5	5 1/2	5 3/4	6	6 1/2	6 3/4	7	7 1/2		C
2	72T	48T.	8	9	10	11	11 1/2	12	13	13 1/2	14	15		A
			16	18	20	22	23	24	26	27	28	30		B
			32	36	40	44	46	48	52	54	56	60		C

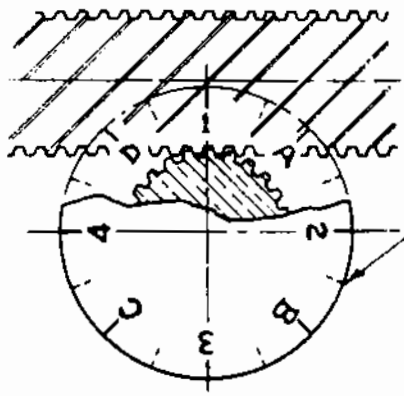
LEVER	STUD	SCR.	FEEDS PER REV.										LEVER
1	72T.	48T.	.152	.136	.124	.112	.104	.100	.092	.088	.084	.080	A
			.076	.068	.062	.056	.052	.050	.046	.044	.042	.040	B
			.038	.034	.031	.028	.026	.025	.023	.022	.021	.020	C
2	72T	48T.	.019	.017	.015	.014	.013	.012	.0116	.0110	.0105	.010	A
			.0094	.0084	.0076	.007	.0066	.006	.0058	.0056	.0054	.005	B
			.0047	.0042	.0038	.0035	.0033	.0030	.0029	.0028	.0027	.0025	C



SPEED AND FEED DIAGRAM

FIG. L

Chart For Multiple Thread Indexing With Thread Chasing Dial



* Half Nut Can Be Closed In Space Between Grad's

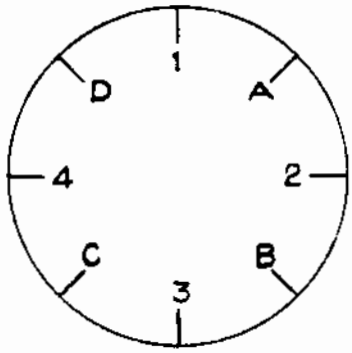
Lead Screw 4 P.I.-R.H. Acme
Indicator Pinion 16 T.
1 Turn Of Dial = 4" Travel Of Carriage

To Cut Multiple Start Threads :-
Close Half Nut At No. 1 Graduation And Take First Cut. Open Half Nut And Change To Positions Shown In The Table Below For Different Threads And Starts. Dial Can Be Made To Turn By Moving Carriage With Handwheel Or With Carriage Stationary By Allowing Lead Screw To Turn. The Half Nut Is Closed When The Proper Graduation Is In Line With Reference Mark On Apron And The Next Cut Taken.

Set Levers To Cut	Lead	Pitch		
		2 Start	4 Start	
$1\frac{3}{4}$	$\frac{4}{7}$	$3\frac{1}{2}$	7	For 2 Starts Use No's 1 & 3 For 4 Starts Use No's. 1, 2, 3 & 4
$2\frac{1}{4}$	$\frac{4}{9}$	$4\frac{1}{2}$	9	
$2\frac{3}{4}$	$\frac{4}{11}$	$5\frac{1}{2}$	11	
$3\frac{1}{4}$	$\frac{4}{13}$	$6\frac{1}{2}$	13	
$1\frac{1}{2}$	$\frac{2}{3}$	3	6	For 2 Starts Use No's. 1 & 2 For 4 Starts Use No's 1, A, 2 & B
$2\frac{1}{2}$	$\frac{2}{5}$	5	10	
$3\frac{1}{2}$	$\frac{2}{7}$	7	14	
$4\frac{1}{2}$	$\frac{2}{9}$	9	18	
3	$\frac{1}{3}$	6		For 2 Starts Use No's. 1 & A Or Start At Any No. And Change To Any Letter.
5	$\frac{1}{5}$	10		
7	$\frac{1}{7}$	14		
9	$\frac{1}{9}$	18		
11	$\frac{1}{11}$	22		
13	$\frac{1}{13}$	26		
2	$\frac{1}{2}$	4		For 2 Starts Use Any Grad. And Change To* Space Between
6	$\frac{1}{6}$	12		
10	$\frac{1}{10}$	20		
14	$\frac{1}{14}$	28		

MULTIPLE THREAD INDEXING

FIG. M



Lead Screw 4 PI R.H. Single

Indicator Pinion 16 T

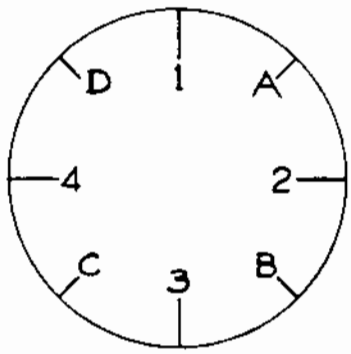
1 Turn of Dial indicates 4" advance on Lead Screw.

Method of Using Dial

For even threads that are multiples of 4
half nuts may be engaged at any point.
For even threads that are not multiples of 4
half nuts may be engaged at any graduation.
For odd threads
half nuts may be engaged at alternate graduations.
For fractional threads in halves
half nuts may be engaged at opposite graduations.
For fractional threads in quarters
use same graduation each time.
For other fractional threads use of dial is not recommended, readings being either fractionally less or more than one full turn of dial.

THREAD CHASING DIAL - ENGLISH

FIG. N



Lead Screw 1-1/4" dia., 6 M/M Lead, Single R.H.
Indicator Pinion, 16 Teeth.
1 Turn of Dial Indicates 96 M/M advance on Lead Screw.

For any Thread divisible into 12, Half Nut can be engaged at any graduation.

For any Thread divisible into 24, Half Nut can be engaged at any numbered graduation.

For any Thread divisible into 48, Half Nut can be engaged at any opposite graduation.

For any Thread divisible into 96, Half Nut must be engaged at same graduation each time.

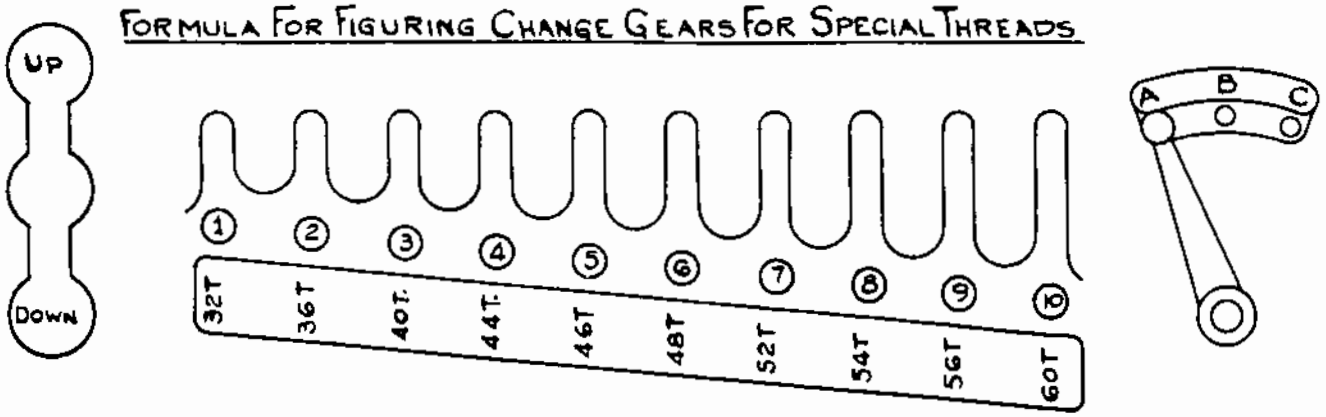
For any Thread not divisible into 12-24-48-96, Thread Chasing Dial can not be used. Half Nut must be left in engagement and Apron Reverse Lever used to return Carriage to starting point of cut.

THREAD CHASING DIAL - METRIC

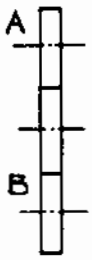
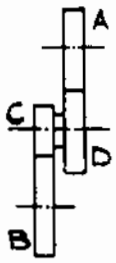
100 PW 3-63

FIG. NM

Formula For Figuring Change Gears For Special Threads



Rocker Gear 36T G = Gears In Cone Bank Lead Screw 4 P.I.

R = Ratio Of Gears In Gear Box	Ratio Obtained Thru Cone Bank
Up: A ..... 4 : 1; B ..... 2 : 1; C ..... 1 : 1 — Down: A ... 1 : 2; B ... 1 : 4; C .... 1 : 8	$\frac{36 \times 32 \times 1}{G \times 54 \times 4} = \frac{16}{3G}$
 For Simple Gearing: $\frac{A \times 16}{B \times 3G} \times R = \text{Lead}$; $\text{Lead} = \frac{1}{\text{Thds. Per In.}}$	 For Compound Gearing: $\frac{A \times C \times 16}{B \times D \times 3G} \times R = \text{Lead}$; $\text{Lead} = \frac{1}{\text{Thds. Per In.}}$

The Following Method Can Be Used In Most Cases.

Select Some Convenient Thread On Index Plate And Set Change Gear Levers As If Cutting This Thread. The Formula Would Then Be;

$$\frac{72 \times \text{Thread On Index Plate}}{48 \times \text{Thread To Be Cut}} = \frac{\text{Gear On Stud A}}{\text{Gear On Stud B}}$$

For Example To Cut 50 P.I., Set Levers To Cut 48 P.I. Then $\frac{72 \times 48}{48 \times 50} = \frac{A}{B} = \frac{72}{50}$

This May Be Checked By Formula $\frac{A \times 16}{B \times 3G} \times R = \frac{72 \times 16}{50 \times 3 \times 48} \times \frac{1}{8} = \frac{1}{50} = \text{Lead}$

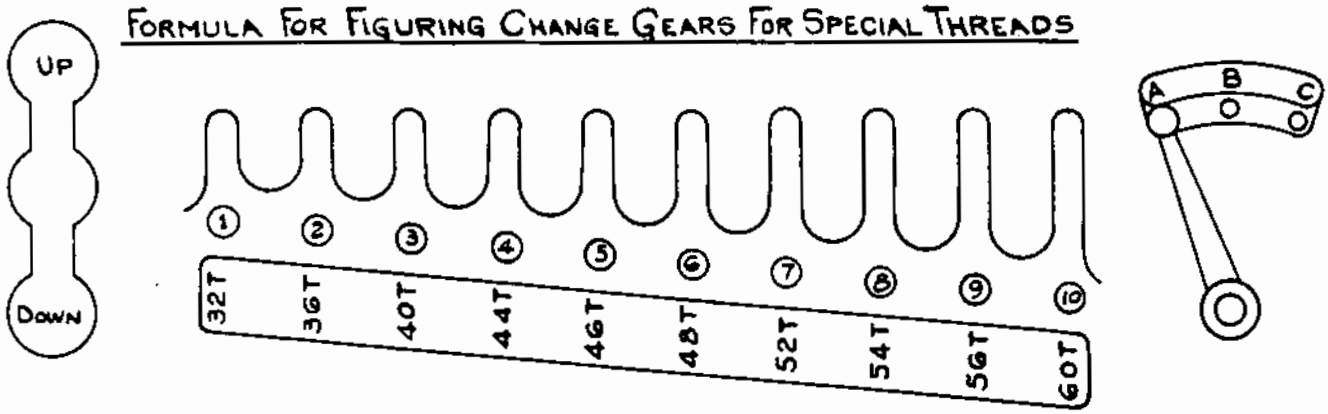
In Some Cases It Will Be Found Necessary To Use Compound Gearing, In Which Case The Formula Becomes, $\frac{72 \times \text{Thd On Index Plate}}{48 \times \text{Thd. To Be Cut}} = \frac{A \times C}{B \times D}$

CHANGE GEARS FOR SPECIAL THREADS - ENGLISH

FIG. O

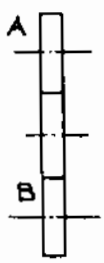
160 PW 2-63

FORMULA FOR FIGURING CHANGE GEARS FOR SPECIAL THREADS



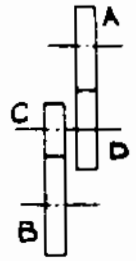
ROCKER GEAR 36T G = GEARS IN CONE BANK LEAD SCREW 6 M.M. PITCH

R = RATIO OF GEARS IN GEAR BOX	RATIO OBTAINED THRU CONE BANK
UP: A---4 : 1; B---2 : 1; C---1 : 1 — DOWN: A---1 : 2; B---1 : 4; C---1 : 8	$\frac{36 \times 32 \times 6}{G \times 54 \times 1} = \frac{128}{G}$



FOR SIMPLE GEARING

$$\frac{A \times 128}{B \times G} \times R = \text{LEAD IN M.M.}$$



FOR COMPOUND GEARING

$$\frac{A \times C \times 128}{B \times D \times G} \times R = \text{LEAD IN M.M.}$$

THE FOLLOWING METHOD CAN BE USED IN MOST CASES.

SELECT SOME CONVENIENT THREAD ON INDEX PLATE AND SET CHANGE GEAR LEVERS AS IF CUTTING THIS THREAD. THE FORMULA WOULD THEN BE:-

$$\frac{\text{STUD GEAR ON PLATE} \times \text{THREAD TO BE CUT}}{\text{SCREW GEAR ON PLATE} \times \text{THREAD ON INDEX PLATE}} = \frac{\text{GEAR ON STUD A}}{\text{GEAR ON STUD B}}$$

FOR EXAMPLE TO CUT 9 M.M. LEAD SET LEVERS TO CUT 12 MM LEAD THEN $\frac{45 \times 9}{48 \times 12} = \frac{A}{B} = \frac{45}{64}$

THIS MAY BE CHECKED BY FORMULA $\frac{A \times 128}{B \times G} \times R = \frac{45 \times 128}{64 \times 40} \times \frac{4}{1} = 9$

IN SOME CASES IT WILL BE FOUND NECESSARY TO USE COMPOUND GEARING, IN WHICH CASE THE FORMULA BECOMES; $\frac{\text{STUD GEAR ON PLATE} \times \text{THREAD TO BE CUT}}{\text{SCREW GEAR ON PLATE} \times \text{THREAD ON INDEX PLATE}} = \frac{A \times C}{B \times D}$

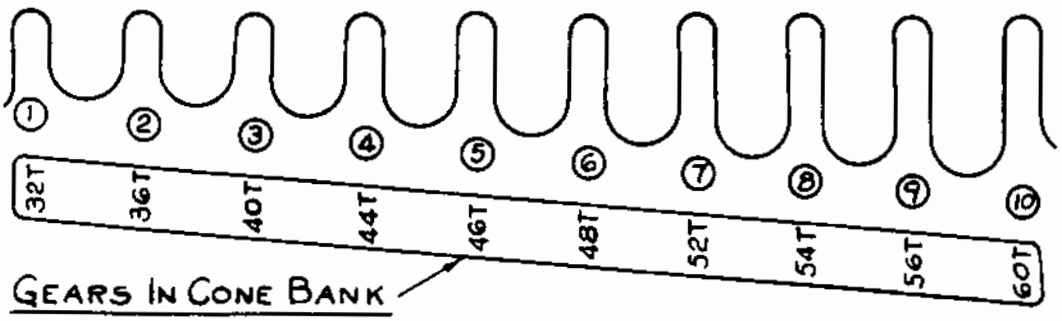
CHANGE GEARS FOR SPECIAL THREADS - METRIC

100 Fig 2.63

FIG. OM

THREADS PER CENTIMETER

LEAD SCREW 6 M/M



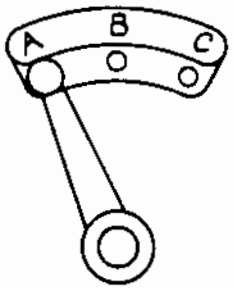
ROCKER GEAR = 36T

THREADS PER CENTIMETER	STUD	SCREW	RATIO LEVER	ROCKER LEV. ON PIN	CHANGE LEVER
2	60	48	UP	1	C
3	60	48	"	6	C
4	75	64	"	10	C
5	72	72	DOWN	1	A
6	60	72	"	1	A
7	50	70	"	1	A
8	45	72	"	1	A
9	60	72	"	6	A
10	72	72	"	1	B
11	50	55	"	1	B
12	60	72	"	1	B
13	60	78	"	1	B
14	50	70	"	1	B
15	48	72	"	1	B
16	45	72	"	1	B
17	40	68	"	1	B
18	60	72	"	6	B
19	45	57	"	6	B
20	72	72	"	1	C
21	60	63	"	1	C
22	60	66	"	1	C
23	60	69	"	1	C
24	60	72	"	1	C
25	48	60	"	1	C

RATIO LEVER

UP = $\frac{1}{1}$ RATIO

DOWN = $\frac{1}{8}$ RATIO



CHANGE LEVER

A = $\frac{4}{1}$ RATIO

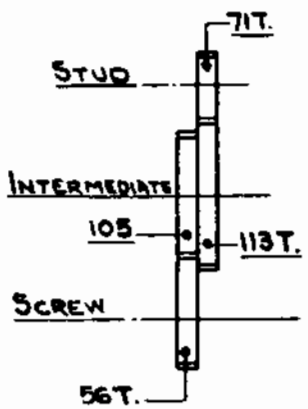
B = $\frac{2}{1}$ RATIO

C = $\frac{1}{1}$ RATIO

METRIC THREAD CHART

FIG. PM

Gears	Diametral Pitches										Lever
71 Stud	4	4½	5	5½	5¾	6	6½	6¾	7	7½	A
	8	9	10	11	11½	12	13	13½	14	15	B
	16	18	20	22	23	24	26	27	28	30	C
Screw 56	32	36	40	44	46	48	52	54	56	60	A
	64	72	80	88	92	96	104	108	112	120	B
	128	144	160	176	184	192	208	216	224	240	C



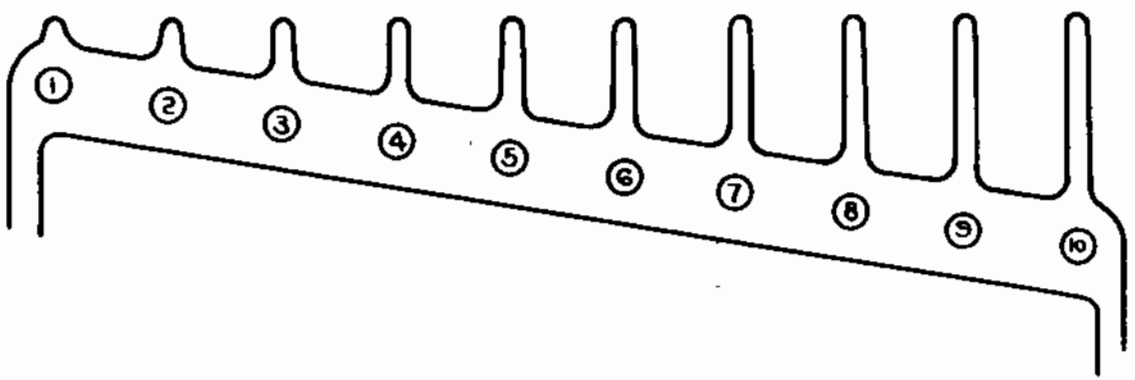


FIG. Q

INDEX TO DIAMETRICAL PITCHES

1694-R-53

FIG. R

1694-R-54

SPEED REDUCER THREAD INDEX

RATIO LEVER	STUD.	INTER.	SCREW	THREADS PER INCH										LEVER
UPPER HOLE	48	90	48	1	1 1/8	1 1/4	1 3/8	1 7/16	1 1/2	1 5/8	1 11/16	1 3/4	1 7/8	C
	"	"	"	2	2 1/4	2 1/2	2 3/4	2 7/8	3	3 1/4	3 3/8	3 1/2	3 3/4	A
LOWER HOLE	"	"	"	4	4 1/2	5	5 1/2	5 3/4	6	6 1/2	6 3/4	7	7 1/2	B
1:8	"	"	"	8	9	10	11	11 1/2	12	13	13 1/2	14	15	C
				LEADS IN INCHES										
UPPER HOLE 1:1	72	90	36	8	7.1111	6.40	5.8181	5.565	5.333	4.9230	4.7407	4.5714	4.2666	A
	54	"	"	6	5.333	4.80	4.363	4.173	4.00	3.692	3.555	3.428	3.2	A
	72	"	"	4	3.555	3.2	2.909	2.782	2.666	2.461	2.370	2.285	2.1333	B
	54	"	"	3	2.666	2.40	2.1817	2.086	2.00	1.846	1.7777	1.7142	1.6	B
	72	"	"	2	1.7777	1.600	1.4545	1.3913	1.3333	1.2305	1.1850	1.1428	1.0666	C
	54	"	"	1.5	1.3333	1.200	1.0908	1.043	1.000	.923	.8888	.8571	.8	C
LOWER HOLE 1:8	72	"	"	1	.8888	.800	.7272	.6956	.6666	.6153	.5925	.5714	.5333	A
	54	"	"	.75	.6666	.600	.5456	.5215	.50	.4615	.4444	.4285	.4	A
	72	"	"	.50	.4444	.400	.3636	.3478	.3333	.3076	.2962	.2857	.2666	B
	54	"	"	.375	.3333	.300	.273	.2607	.250	.2307	.2222	.2142	.2	B
	72	"	"	.250	.2222	.200	.1818	.1739	.1666	.1538	.1481	.1428	.1333	C
	54	"	"	.1875	.1666	.1500	.1363	.1304	.1250	.1153	.1111	.1071	.1000	C

R = RATIO OF GEARS IN GEAR BOX
A = GEAR ON STUD
B = GEAR ON SCREW
G = GEAR ON CONE BANK
L = LEAD TO BE CUT
RATIOS OBTAINED THRU GEAR BOX AND RATIO LEVERS ARE AS FOLLOWS

RATIO LEVER	GEAR BOX LEVER	RATIO-R
UP	A	4 : 1
	B	2 : 1
	C	1 : 1
DOWN	A	1 : 2
	B	1 : 4
	C	1 : 8

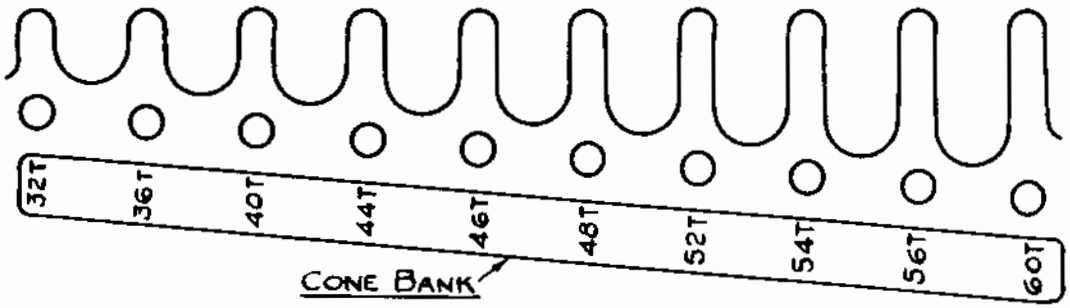
RATIO OBTAINED THRU CONE BANK

$$\frac{36}{G} \times \frac{32}{54} = \frac{64}{3G}$$

FORMULA

$$\frac{G}{T} \times R \times \frac{64}{3G} \times \frac{1}{4} \times \frac{A}{B} = L \quad \text{OR} \quad \frac{G}{R} \times \frac{L}{32} = \frac{A}{B}$$

NOTE: WHEN LEADS OTHER THAN THOSE LISTED ABOVE ARE WANTED, USE FORMULA BELOW FOR PROPER GEARS



LEAD SCREW - 4 P.I.

1 REV. OF FACE PLATE = 6 REV. OF SPINDLE

EXAMPLE
LEAD TO CUT 2.5

SELECT FIGURE IN LEAD TABLE NEAR 2.5
FIND RATIO "R" FROM RATIO POSITIONS INDICATED AND CONE BANK GEAR "G" BELOW. IF GEARS ARE NOT SUITABLE TRY OTHERS NEAR FIGURES.

SOLUTION

$$\frac{32}{2} \times \frac{25}{32} = \frac{A}{B} = \frac{5}{4} \text{ OR } \frac{45}{36} \text{ STUD SCREW}$$

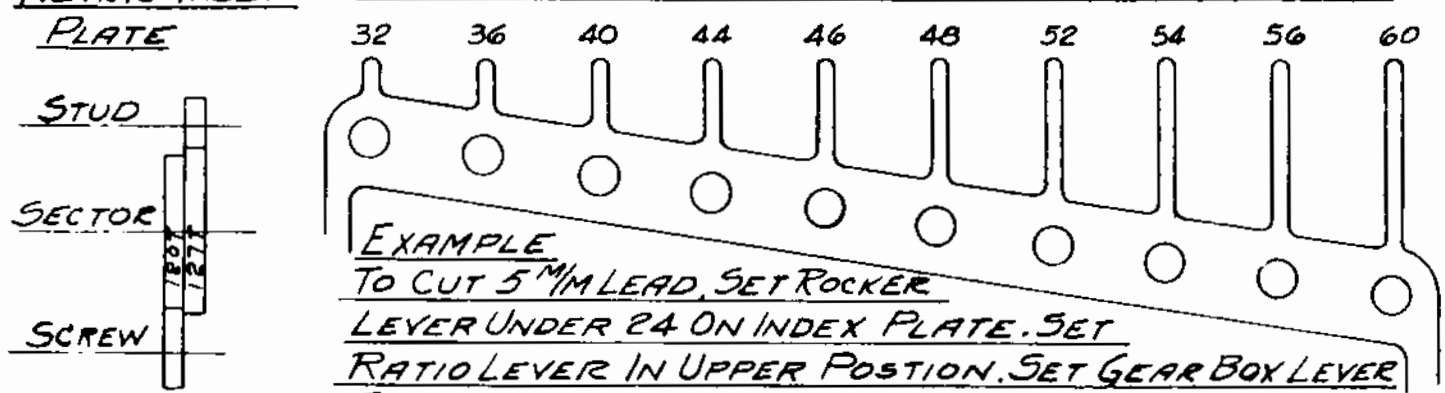
LEADS AND THREADS WITH SPEED REDUCER

ENGLISH TO METRIC TRANSPOSITION

STUD	SCREW	LEAD IN MILLIMETERS										LEVER
63	48	21.		16.8			14.			12.	11.2	A
45	"	15.		12.			10.				8.	
65	40	13.		10.4				8.				B
66	48	11.		8.8	8.							
63	"	10.5		8.4			7.			6.	5.6	
45	"	7.5		6.			5.				4.	
65	40	6.5		5.2				4.				C
66	48	5.5		4.4	4.							
63	"	5.25		4.2			3.5			3.	2.8	
45	"	3.75		3.			2.5				2.	
65	40	3.25		2.6				2.				A
66	48	2.75		2.2	2.							
63	"			2.1			1.75			1.5	1.4	
45	"			1.5			1.25				1.0	
66	48			1.1	1.							B
63	"			1.05						0.75	0.7	
51	"			0.85								
66	48			0.55	0.5							C

METRIC INDEX PLATE

FIGURES SHOWN CORRESPOND WITH THOSE ON C-157



4 P.I. ENGLISH SCREW

EXAMPLE
TO CUT 5 M/M LEAD, SET ROCKER LEVER UNDER 24 ON INDEX PLATE. SET RATIO LEVER IN UPPER POSTION. SET GEAR BOX LEVER AGAINST POSITION B. GEAR ON STUD 45, GEAR ON SCREW 48

FIG. SM

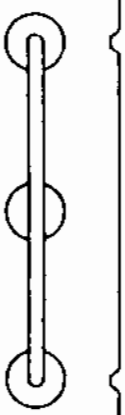
ENGLISH TO METRIC TRANSPOSITION

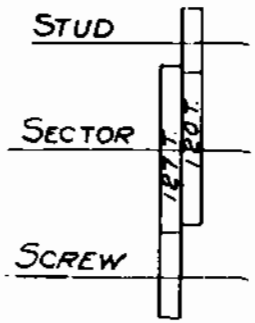
1694-R-55

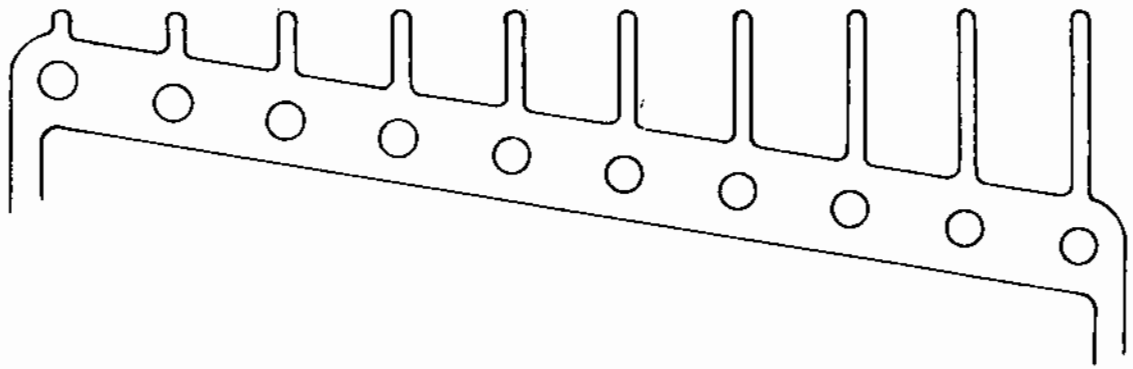
FIG. TM

METRIC TO ENGLISH TRANSPOSITION

GEARS	THREADS PER INCH										LEVER
72 STUD = SCREW 48	1	1 1/8	1 1/4	1 3/8	1 7/16	1 1/2	1 5/8	1 11/16	1 3/4	1 7/8	A
	2	2 1/4	2 1/2	2 3/4	2 7/8	3	3 1/4	3 3/8	3 1/2	3 3/4	B
	4	4 1/2	5	5 1/2	5 3/4	6	6 1/2	6 3/4	7	7 1/2	C
	8	9	10	11	11 1/2	12	13	13 1/2	14	15	A
	16	18	20	22	23	24	26	27	28	30	B
	32	36	40	44	46	48	52	54	56	60	C



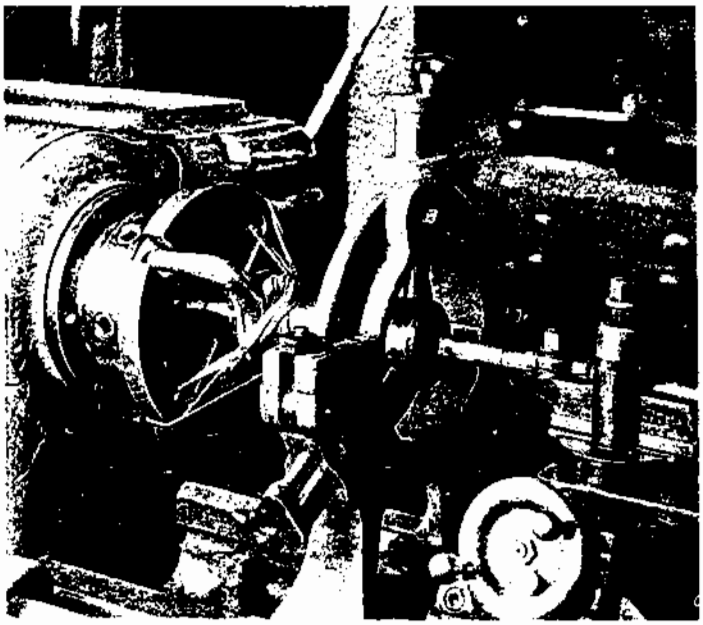




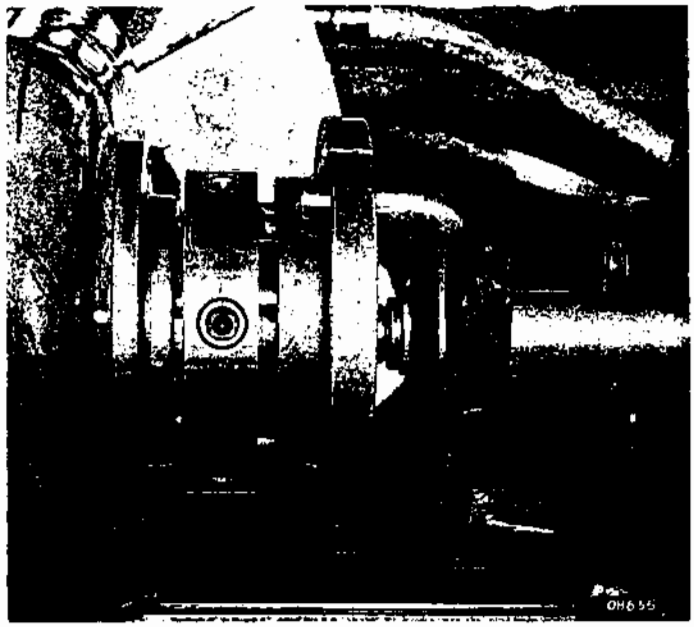
METRIC TO ENGLISH TRANSPOSITION

1694-R-56

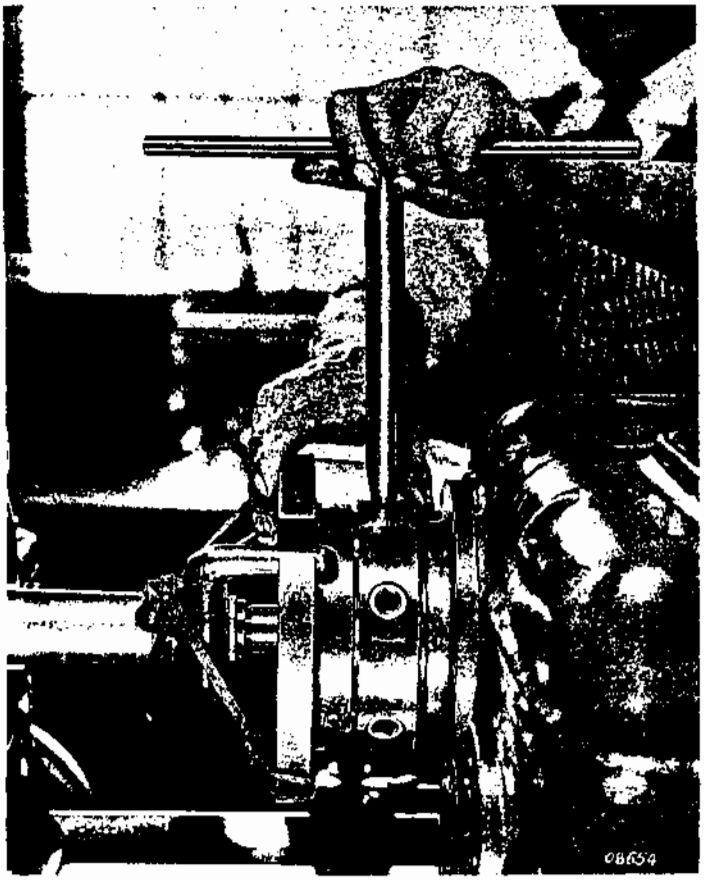
110 PM2-C3



A



B



C

D

STRAPPING WORK TO THE DOG DRIVER PLATE

A detailed description will be found on the next page.

FIG. U

STRAPPING WORK TO THE DOG DRIVER PLATE

When drilling or boring a hole in the center of a piece of work, and on other occasions, it is often necessary to hold one end of the work on the headstock center and the other end in a steady rest. As the tailstock cannot be used for supporting the work, there is a tendency for it to slide backward and slip off the headstock center. To prevent this, the work can be tied to the dog driver plate.

Although a steel strap and bolts are often used for this purpose, it has been found that a leather thong is very satisfactory for odd jobs of this kind. Illustration U-a shows the work in position for boring.

The dog driver plates furnished with Pratt & Whitney Model "C" Lathes have been provided with two opposite openings near the periphery for entering the thong. Tie the work to the dog driver plate leaving the face of the plate about 1/4" to 1/2" away from the spindle flange for draw as shown in U-b.

To bring the cam-locks into engagement, pull the dog driver plate up by hand, as shown in U-c, or by entering a rod between the tool post and the plate, using the carriage to push the plate up to about 1/8" from the flange of the spindle as shown in U-d. The final drawing up of the plate and tightening of the thong is done with the cam-lock wrench.

To remove the work, unlock the cam-locks of the dog driver plate before untying the thong.

RELIEVING ATTACHMENTS

FOR

Pratt & Whitney Model "C" Lathes

Including a general description of their use and complete gear ratio charts for spiral relieving

LIST OF EQUIPMENT

Straight Flute Relieving Attachment

THE straight flute equipment consists of the regular drive bracket, telescoping shaft and cam slide with the following cams:

.015″ single	.093″ double
.030″ "	.125″ quadruple
.060″ "	.187″ "

11 change gears:—one each 36, 40, 45, 48, 70, 80, 84, 90; three 60 tooth.

This equipment covers all ordinary straight flute relieving from 2 to 12 flutes when used without the speed reducer and from 2 to 32 flutes with the speed reducer. Extra gears may be had to order.

Spiral Flute Relieving Attachment

The spiral (or helical) flute equipment consists of the regular straight flute equipment and the following additional:

14 change gears:—33, 35, 37, 39, 46, 50, 54, 58, 62, 64, 68, 73, 74, 76 tooth, making a total of 25 gears and 6 cams.

This equipment gives a wide range of gear ratios (see Gear Charts) and usually one of the given combinations is close enough.

Note:—

When a lathe is already equipped with one style of relieving attachment and a second style is ordered, certain duplication of parts may occur. To avoid this always list equipment already on hand when ordering. Cams with special rises may be had to order, or standard cams may be purchased singly if desired.

Side Relieving Attachment

The complete equipment of the side relieving attachment includes a Drive Bracket carrying Change gears, the Side Relieving Attachment, one long drive shaft and 6 Cams:

.030″ double	.030″ quadruple
.060″ "	.060″ "
.125″ "	.093″ "

11 change gears:—36, 40, 45, 48, 70, 80, 84, 90 and three 60 tooth.

Combination Radial and Side Relieving Attachment

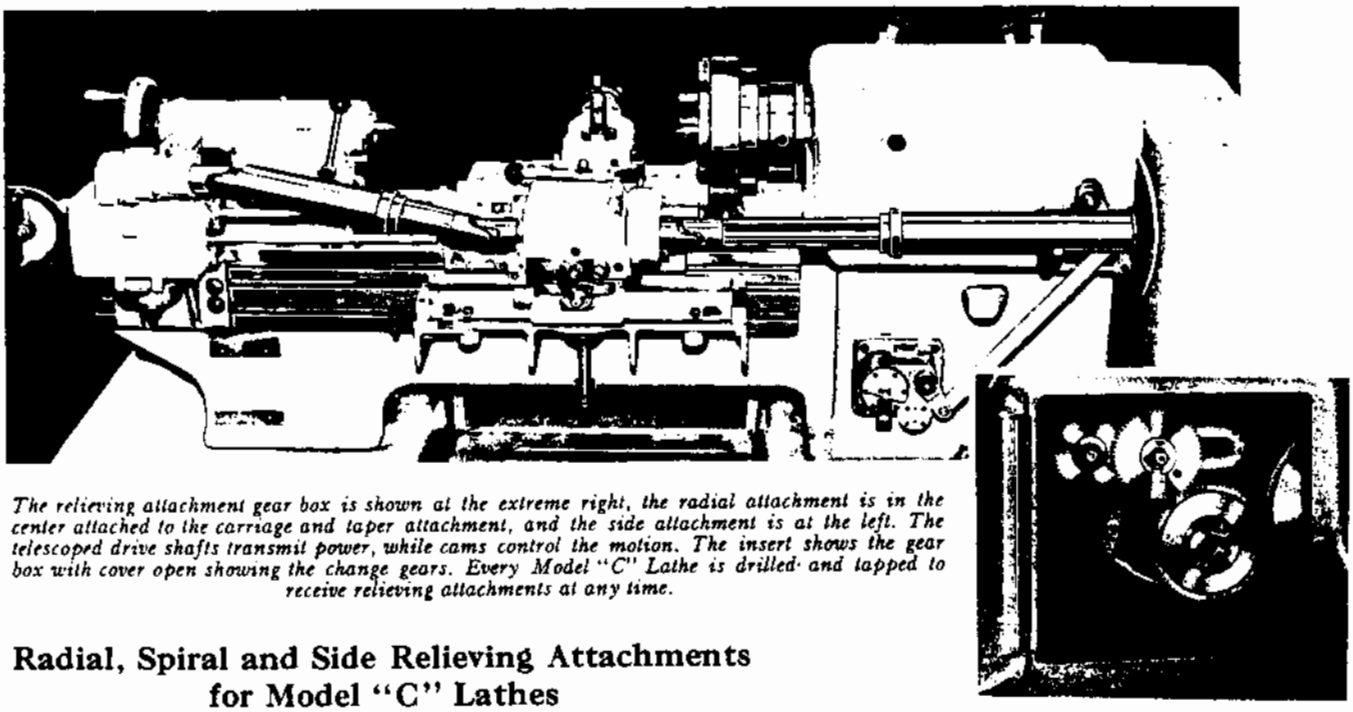
The complete equipment of the combination attachment which includes the regular equipment for radial relieving is as follows:

The Side Relieving Attachment; the Radial Relieving Attachment Cam Block; a Drive Bracket carrying Change Gears; a set of Auxiliary Drive Parts; two pair of Telescopic Drive Shafts and Sleeves; one Long Drive Shaft, and 12 Cams:

.015″ single	.030″ double	.030″ quadruple
.030″ "	.060″ "	.060″ "
.060″ "	.093″ "	.093″ "
	.125″ "	.125″ "
		.187″ "

11 change gears:—36, 40, 45, 48, 70, 80, 84, 90 and three 60 tooth.

All the cams supplied are interchangeable from one attachment to the other, so that the amount of side or radial relief can be produced in accordance with the requirements for any cutter within its range.



The relieving attachment gear box is shown at the extreme right, the radial attachment is in the center attached to the carriage and taper attachment, and the side attachment is at the left. The telescoped drive shafts transmit power, while cams control the motion. The insert shows the gear box with cover open showing the change gears. Every Model "C" Lathe is drilled and tapped to receive relieving attachments at any time.

Radial, Spiral and Side Relieving Attachments for Model "C" Lathes

THE relieving attachments designed and developed by Pratt & Whitney are the result of years of careful study. These attachments for radial, spiral and side relieving now provide a simple means of relieving all sorts of straight or spiral fluted work at a minimum cost. Mounted at the rear of the machine, these attachments do not interfere with any of the usual lathe functions. They can be disengaged easily and quickly when not required.

A gear box bolted to the end of the headstock brings the power to the telescoped drive shaft of the radial relieving attachment.

The relieving motion is obtained by means of a cam and roller, with a spring to return the cross slide. This mechanism is mounted on the rear of the carriage and is supported by the taper attachment. A friction device on the end of the drive shaft insures the smooth operation needed for relieving work. This attachment produces a simple movement of the cross slide at right angles to the bed.

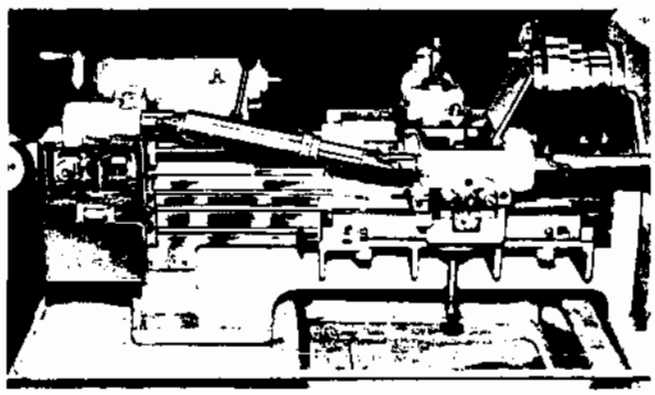
A brief understanding of the principles involved and formulae used will greatly assist the operator in using the attachment. It will readily be seen that when straight flutes are to be relieved the driving shaft and work should theoretically be traveling at the same speed, with the same number of rises on the cam as there are flutes in the work. This is possible for a very few cases, but it is too expensive to make a series of cams for multiple flutes. Therefore we use different gear ratios with the same cam to give various multiples. For instance if we have a hob with 8 flutes we simply use the quadruple cam and gear up the drive shaft to turn twice as fast as the work. See page 4 for formulae and examples.

Spiral Flute Relieving

For spiral relieving the equipment consists of the radial relieving equipment plus certain gears to give the complete range of spirals.

The difference between straight and spiral fluting is that in the former the flutes are parallel to the axis and in the latter they are in the form of the correct spiral to bring the cutting faces of the hob into their true shape. In other words the spiral flute is usually at right angles to the threads. When relieving spiral fluted work it is therefore necessary to have the tool movement speeded up enough to compensate for the changed spacing of the teeth due to the spiral.

The difference in the speeds of the work and the cam driving shaft will always be equal to 1 over the lead of the spiral. In other words if the spiral lead



Detail of the radial and side relieving attachments with covers raised to show the cams. Levers throw the cam followers in and out of engagement.

is 30 inches, the drive shaft will make 1-1/30 turns to one turn of the work provided the number of flutes corresponds to the number of rises on the cam, and the pitch of the thread being cut is 1.

It should always be remembered that for a right hand hob, relieving is from right to left, and just opposite for left hand. In either case however the work rotates at a decreased speed with relation to the relieving motion of the tool.

Given a hob with a known lead of thread, pitch diameter and number of spiral flutes, it is necessary to know the lead of this spiral. Usually this lead is also given, but if not it is generally safe to assume the flute to be at right angles to the thread, and its lead may be found as follows:—

L = Lead of thread
F = Lead of flutes
D = Fitch diam. of threads

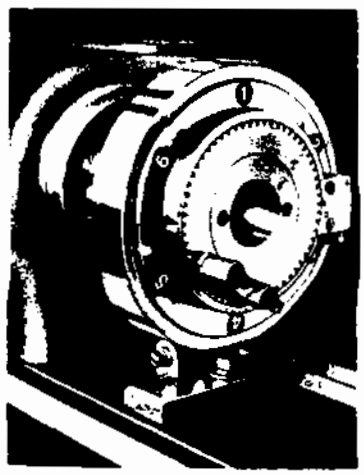
$$F = \frac{(3.14159D)^2}{L}$$

Note:—The best practice requires that L be measured on the pitch line of the hob.

Complete gear charts for spiral relieving are included in this book, and their use is explained on page 4.

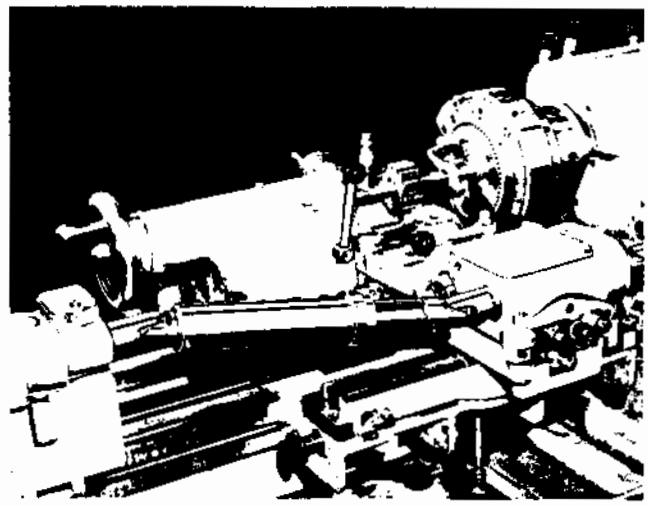
Side Relieving

The side relieving attachment may be used separately or in conjunction with the radial relieving attachment. This side relieving attachment was developed to give the cutting tool a longitudinal movement to produce side relief. The attachment is clamped to the rear of the bed as illustrated. It is connected to the lathe carriage by means of a rod with an adjusting thread which passes thru a bracket bolted to the rear of the carriage. This rod transfers the cam motion to the carriage, moving it back and forth along the ways. The adjustment on the rod permits setting the tool further into the work as needed.



This Speed Reducer makes possible speeds as low as two revolutions per minute. It is ideal for relieving work.

The sidewise motion is produced by a camshaft and cam, and the drive is thru a telescoped drive shaft. The side relieving attachment takes its power from the radial relieving attachment drive if the latter attachment is in use, or directly from the gear box thru a long shaft if the side relieving attachment is being used alone.



Relieving a hob using the Speed Reducer.

To the extreme left of the side relieving attachment is a swinging handle and sector. With the handle in the downward position, the attachment is set for relieving toward the headstock. If the handle is brought up 180 degrees it will relieve toward the tailstock and when moved to the horizontal position the attachment is thrown out of action. A lever is also provided for throwing the radial relieving attachment out of action. This allows the use of one attachment at a time as well as both in combination.

These attachments are available either singly or in combination as desired. *To obtain the best results it is very necessary that the speed reducer be used with the combination radial and side relieving attachment.*

When the radial relieving attachment is used in conjunction with the lead screw or feed rod of the lathe, *the bracket of the side relieving attachment, attached to the right wing of the carriage must be disconnected.*

General

Relieving operations should be carried on at much slower speeds than regular turning in order to obtain the best results, and to give the reciprocating parts time to function properly. For this reason, the relieving attachments for Pratt & Whitney Model "C" Lathes have been designed so they can be used in conjunction with the Speed Reducer. The Speed Reducer itself is an attachment placed like any chuck on the spindle nose, which produces a 6 to 1 reduction of whatever spindle speed is engaged. Common practice is to coat the work with copper sulphate so that the progress of the tool can easily be followed. This allows the operator to leave a sufficient land on each tooth to allow for grinding after hardening. Remilling after relieving will insure a sharper cutter and will lessen the necessity of grinding after hardening.

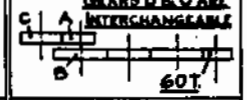
PRATT & WHITNEY
RELIEVING ATTACHMENT INDEX

WITHOUT SPEED REDUCER					WITH SPEED REDUCER				
A	B	C	E	N	A	B	C	E	N
80	60	40	1	2	40	60	90	1	2
90	40	45	1	3	40	60	80	1	3
60	60	40	2	4	60	90	60	1	4
60	48	40	2	5	40	60	48	1	5
90	40	45	2	6	60	60	60	1	6
84	40	36	2	7	70	60	60	1	7
80	60	40	4	8	60	45	60	1	8
90	60	40	4	9	60	40	60	1	9
80	48	40	4	10	40	60	48	2	10
90	40	45	4	12	90	60	60	2	12
FOR FLUTES ABOVE 12 - SPEED REDUCER IS RECOMMENDED					70	60	60	2	14
					60	60	48	2	15
					60	45	60	2	16
					60	40	60	2	18
					40	60	48	4	20
					60	60	60	4	24
					70	80	60	4	28
					60	45	60	4	32

FORMULA FOR HELICAL FLUTES

N = NO OF FLUTES
F = LEAD OF FLUTES
L = LEAD OF THREAD
E = NO. OF RISES ON CAM

GEARS B & C ARE INTERCHANGEABLE



WITHOUT SPEED REDUCER: $\frac{(1+\frac{L}{F})N}{E} \times 2 = \text{RATIO} = \frac{120A}{BxC}$

WITH SPEED REDUCER: $\frac{(1+\frac{L}{F})N}{E} \times \frac{1}{3} = \text{RATIO} = \frac{120A}{BxC}$

FOR MED. SIZE TAPS	FOR LARGE TAPS FOR MED. CUTTERS	FOR LARGE CUTTERS
RISE OF CAM	RISE OF CAM	RISE OF CAM
.015	.060	.125
.030	.093	.187
.060		

SEE INSTRUCTION BOOK FOR GEAR RATIO CHARTS

STRAIGHT FLUTE RELIEVING

RADIAL or straight flute relieving requires only the information given on the brass plate fastened to the relieving attachment gear box, and shown in the illustration here.

For straight flute relieving (flutes parallel to axis) it is only necessary to use the correct cam and change gears as shown by the chart, setting the lathe for the number of threads per inch in the usual manner.

The formula is:—

$$\frac{N}{E \times 60} = \frac{A}{B \times C}$$

where N = No. of flutes
E = No. of rises on cam
A, B, C = Change Gears

This formula should be used as a check on the setting of the attachment after the gears are in place, using the values stamped on the gears for A, B and C. This will insure the correct gear train being used. The Gear Charts given in this book are needed only for spiral relieving.

USE OF GEAR CHARTS

Spiral Relieving without Speed Reducer

Given:—

A hob which has 8 flutes having a 30-inch lead and whose thread has a 1-inch lead.

Formulae:—

$$\frac{(1+\frac{L}{F})N}{E} \times 2 = \text{Ratio} = \frac{120 \times A}{B \times C}$$

where
N = No. of flutes
F = Lead of flutes
L = Lead of thread
E = No. of rises on cam

Substituting in the left side of the formulae

$$\frac{(1+\frac{L}{F})N}{E} \times 2 = \frac{(1+\frac{1}{30})8}{E} \times 2 = \frac{16.5333}{E}$$

It is necessary to use a cam which has as few rises as possible, but which will give a value to the above which falls between 1.5 and 6 (see Gear Charts). Thus we let E = 4 and the gear ratio is $\frac{16.5333}{4}$ or 4.1333

Looking up the number 4.1333 on the Gear Chart gives the proper gear values, A-62, B-36, C-50. These gear values substituted in the second half of the equation form a check on the table as follows:—

$$\frac{120 \times A}{B \times C} = \frac{120 \times 62}{36 \times 50} = 4.1333$$

In case the gear ratio comes out a figure not given in the tables, the next nearest figure is usually close enough.

Spiral Relieving with Speed Reducer

Formulae:—

$$\frac{(1+\frac{L}{F})N}{E} \times \frac{1}{3} = \text{Ratio} = \frac{120 \times A}{B \times C}$$

We recommend for lead of thread longer than 1½ inch the use of the speed reducer and special drive. It should be noted also that we recommend the use of a speed reducer for hobs of more than 12 flutes.

PRATT & WHITNEY MODEL "C" LATHES

A — Driver
B & C — Driven

$$\text{Ratio} = \frac{120A}{BC}$$

Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C
1.50000	48	60	64	1.55761	73	74	76	1.62000	54	50	80	1.68950	37	36	73
1.50150	50	54	74	1.55954	37	39	73	1.62281	37	36	76	1.69080	36	35	73
1.50294	64	70	73	1.56000	39	50	60	1.62353	46	50	68	1.69118	46	48	68
1.50327	46	54	68	1.56164	76	73	80	1.62406	36	35	76	1.69213	48	74	46
1.50685	33	36	73	1.56250	50	60	64	1.62500	39	48	60	1.69231	33	39	60
1.50815	37	64	46	1.56303	62	68	70	1.62539	70	68	76	1.69355	70	62	80
1.50862	35	48	58	1.56429	73	70	80	1.62637	37	39	70	1.69412	48	50	68
1.50968	39	50	62	1.56522	36	60	46	1.62896	36	39	68	1.69505	73	68	76
1.50979	54	58	74	1.56757	58	60	74	1.62988	64	62	76	1.69565	39	60	46
1.51055	68	73	74	1.56863	48	54	68	1.63044	40	64	46	1.69591	58	54	76
1.51210	50	62	64	1.57103	33	36	70	1.63158	62	60	76	1.69686	64	62	73
1.51233	46	50	73	1.57258	39	48	62	1.63235	37	40	68	1.69863	62	60	73
1.51261	60	68	70	1.57393	33	37	68	1.63307	54	62	64	1.70052	60	58	73
1.51316	46	48	76	1.57421	35	46	58	1.63339	60	58	76	1.70370	46	54	60
1.51406	70	73	76	1.57529	68	70	74	1.63399	50	54	68	1.70526	54	50	76
1.51473	36	62	46	1.57534	46	48	73	1.63636	36	33	80	1.70588	58	60	68
1.51579	48	50	76	1.57658	35	36	74	1.63772	33	39	62	1.70690	33	40	58
1.51700	58	62	74	1.57714	46	50	70	1.64095	39	62	46	1.70778	60	62	68
1.51739	36	39	73	1.57779	36	37	74	1.64286	46	48	70	1.70928	39	37	74
1.52027	60	64	74	1.57808	48	50	73	1.64300	54	58	68	1.70956	62	64	68
1.52055	37	40	73	1.58108	39	40	74	1.64444	37	50	54	1.71053	39	36	76
1.52130	50	58	68	1.58242	36	39	70	1.64474	50	48	76	1.71233	50	48	73
1.52174	35	46	60	1.58371	35	39	68	1.64571	48	50	70	1.71296	37	48	54
1.52207	50	54	73	1.58571	37	40	70	1.64662	73	70	76	1.71428	37	35	74
1.52344	39	48	64	1.58621	46	58	60	1.64760	48	76	46	1.71531	48	73	46
1.52381	48	54	70	1.58654	33	39	64	1.64875	46	54	62	1.71625	50	76	46
1.52623	64	68	74	1.58730	50	54	70	1.65000	33	48	50	1.71701	36	37	68
1.52632	58	60	76	1.58824	54	60	68	1.65085	58	62	68	1.71827	74	68	76
1.52778	33	48	54	1.58904	58	60	73	1.65441	60	64	68	1.71875	33	36	64
1.52801	60	62	76	1.58967	39	64	46	1.65517	48	58	60	1.71990	35	33	74
1.52896	33	37	70	1.59081	60	62	73	1.65714	58	60	70	1.72043	48	54	62
1.52961	62	64	76	1.59247	62	64	73	1.65899	60	62	70	1.72059	39	40	68
1.53047	54	58	73	1.59375	68	64	80	1.66071	62	64	70	1.72249	36	33	76
1.53103	37	50	58	1.59420	33	54	46	1.66320	40	39	74	1.72297	68	64	74
1.53257	40	54	58	1.59483	37	48	58	1.66417	37	58	46	1.72414	50	58	60
1.53384	68	70	76	1.59606	54	58	70	1.66430	39	37	76	1.72500	46	50	64
1.53453	40	68	46	1.59677	33	40	62	1.66667	40	48	60	1.72624	33	37	62
1.53504	46	58	62	1.59687	68	70	73	1.66795	36	37	70	1.72697	70	64	76
1.53627	36	37	76	1.59722	46	54	64	1.66852	50	58	62	1.72973	64	60	74
1.53700	54	62	68	1.59817	35	36	73	1.66917	74	70	76	1.73077	36	39	64
1.53778	58	62	73	1.59927	58	64	68	1.66932	70	68	74	1.73175	68	62	76
1.53846	40	39	80	1.59941	36	37	73	1.67143	39	40	70	1.73269	39	37	73
1.53947	39	40	76	1.60000	40	50	60	1.67230	33	37	64	1.73333	39	50	54
1.54054	76	74	80	1.60058	74	73	76	1.67393	64	62	74	1.73346	62	58	74
1.54110	60	64	73	1.60178	48	58	62	1.67421	37	39	68	1.73438	37	40	64
1.54167	37	48	60	1.60274	39	40	73	1.67568	62	60	74	1.73611	50	54	64
1.54286	54	60	70	1.60369	58	62	70	1.67647	76	68	80	1.73697	35	39	62
1.54412	35	40	68	1.60714	60	64	70	1.67754	60	58	74	1.73777	74	70	73
1.54688	33	40	64	1.60870	37	60	46	1.67763	68	64	76	1.73913	40	60	46
1.54714	64	68	73	1.61029	73	68	80	1.68103	39	48	58	1.74000	58	50	80
1.54839	48	60	62	1.61111	58	54	80	1.68269	35	39	64	1.74086	73	68	74
1.55000	62	60	80	1.61290	40	48	62	1.68303	40	62	46	1.74174	58	54	74
1.55172	36	48	58	1.61345	64	68	70	1.68421	64	60	76	1.74194	54	60	62
1.55357	58	64	70	1.61379	39	50	58	1.68599	40	39	73	1.74229	64	58	76
1.55405	46	48	74	1.61638	50	58	64	1.68750	54	60	64	1.74346	35	33	73
1.55498	70	73	74	1.61765	33	36	68	1.68784	62	58	76	1.74569	54	58	64
1.55555	35	50	54	1.61919	36	58	46	1.68826	76	73	74	1.74658	68	64	73
1.55676	48	50	74	1.61943	40	39	76	1.68919	50	48	74	1.75000	70	60	80

RELIEVING ATTACHMENT GEAR RATIOS

A — Driver
B & C — Driven

$$\text{Ratio} = \frac{120A}{BC}$$

Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C
1.75066	33	39	58	1.80556	39	48	54	1.86335	50	70	46	1.92568	76	64	74
1.75135	54	50	74	1.80695	39	37	70	1.86487	46	40	74	1.92708	37	36	64
1.75310	40	37	74	1.80996	40	39	68	1.86555	74	68	70	1.92726	68	58	73
1.75343	64	60	73	1.81034	70	58	80	1.86603	39	33	76	1.92857	54	48	70
1.75403	58	62	64	1.81240	76	68	74	1.87013	36	33	70	1.92972	54	73	46
1.75412	39	58	46	1.81250	58	60	64	1.87097	58	60	62	1.93015	70	64	68
1.75439	60	54	76	1.81287	62	54	76	1.87135	64	54	76	1.93044	37	50	46
1.75676	39	36	74	1.81373	37	36	68	1.87500	50	40	80	1.93237	40	54	46
1.75720	62	58	73	1.81389	64	58	73	1.87867	40	35	73	1.93392	80	68	73
1.75824	40	39	70	1.81452	60	62	64	1.88018	68	62	70	1.93750	62	60	64
1.76028	76	70	74	1.81579	46	40	76	1.88034	33	39	54	1.93889	46	39	73
1.76191	37	36	70	1.81818	37	33	74	1.88108	58	50	74	1.93966	60	58	64
1.76245	46	54	58	1.82143	68	64	70	1.88235	64	60	68	1.94272	39	33	73
1.76263	50	74	46	1.82163	64	62	68	1.88317	36	37	62	1.94286	68	60	70
1.76326	36	35	70	1.82292	35	36	64	1.88406	39	54	46	1.94332	48	39	76
1.76560	58	54	73	1.82353	62	60	68	1.88455	74	62	76	1.94444	70	54	80
1.76613	73	62	80	1.82432	36	37	64	1.88571	33	35	60	1.94595	36	37	60
1.76786	33	35	64	1.82556	60	58	68	1.88641	62	58	68	1.94726	64	58	68
1.76904	36	33	74	1.82566	74	64	76	1.88710	39	40	62	1.94737	74	60	76
1.76959	64	62	70	1.82648	60	54	73	1.88737	62	54	73	1.94825	64	54	73
1.77034	37	33	76	1.82813	39	40	64	1.88889	68	54	80	1.95000	39	48	50
1.77143	62	60	70	1.82857	64	60	70	1.89041	46	40	73	1.95206	76	64	73
1.77273	39	33	80	1.83086	70	62	74	1.89163	64	58	70	1.95313	50	48	64
1.77340	60	58	70	1.83158	58	50	76	1.89189	70	60	74	1.95556	73	64	70
1.77365	70	64	74	1.83251	62	58	70	1.89474	60	50	76	1.95652	48	64	46
1.77419	33	36	62	1.83333	33	40	54	1.89543	58	54	68	1.95713	70	58	74
1.77534	54	50	73	1.83623	37	39	62	1.89655	33	36	58	1.95790	62	50	76
1.77632	54	48	76	1.83723	76	68	73	1.89744	37	39	60	1.95946	58	48	74
1.77712	40	37	73	1.83784	68	60	74	1.90000	76	60	80	1.96078	60	54	68
1.77778	40	50	54	1.83824	50	48	68	1.90069	74	64	73	1.96200	74	62	73
1.77855	68	62	74	1.83908	48	54	58	1.90121	68	58	74	1.96287	37	39	58
1.77885	37	39	64	1.84000	46	50	60	1.90217	35	46	48	1.96302	46	37	76
1.78065	46	50	62	1.84034	73	68	70	1.90345	46	50	58	1.96560	40	33	74
1.78082	39	36	73	1.84127	58	54	70	1.90364	54	74	46	1.96638	39	35	68
1.78125	76	64	80	1.84143	48	68	46	1.90476	60	54	70	1.96825	62	54	70
1.78268	70	62	76	1.84211	70	60	76	1.90563	70	58	76	1.97143	46	40	70
1.78378	33	37	60	1.84309	37	33	73	1.90588	54	50	68	1.97260	60	50	73
1.78474	76	70	73	1.84529	33	37	58	1.90685	58	50	73	1.97297	73	60	74
1.78571	50	48	70	1.84615	36	39	60	1.90790	58	48	76	1.97368	60	48	76
1.78660	36	39	62	1.84931	54	48	73	1.90933	73	62	74	1.97635	39	37	64
1.78678	50	73	46	1.84966	73	64	74	1.90981	36	39	58	1.97861	37	33	68
1.78744	37	54	46	1.85000	37	48	50	1.91020	39	35	70	1.98198	33	37	54
1.78881	48	70	46	1.85118	68	58	76	1.91177	39	36	68	1.98214	74	64	70
1.78938	64	58	74	1.85143	54	50	70	1.91268	46	39	74	1.98276	46	48	58
1.78947	68	60	76	1.85185	50	54	60	1.91379	37	40	58	1.98394	70	58	73
1.79032	37	40	62	1.85328	40	37	70	1.91388	40	33	76	1.98511	40	39	62
1.79212	50	54	62	1.85355	54	76	46	1.91571	50	54	58	1.98529	54	48	68
1.79328	36	33	73	1.85484	46	48	62	1.91597	76	68	70	1.98630	58	48	73
1.79487	35	39	60	1.85594	70	62	73	1.91646	39	33	74	1.98730	73	58	76
1.79688	46	48	64	1.85676	35	39	58	1.91667	46	48	60	1.98779	76	62	74
1.79795	70	64	73	1.85714	39	36	70	1.91781	70	60	73	1.98830	68	54	76
1.79910	40	58	46	1.85807	48	50	62	1.91816	50	68	46	1.98857	58	50	70
1.80000	48	50	64	1.85908	73	62	76	1.92000	48	50	60	1.98925	37	36	62
1.80099	73	64	76	1.86010	39	37	68	1.92105	73	60	76	1.99085	58	76	46
1.80180	60	54	74	1.86186	62	54	74	1.92192	64	54	74	1.99241	70	62	68
1.80200	54	58	62	1.86207	54	58	60	1.92208	37	33	70	1.99253	40	33	73
1.80292	68	62	73	1.86235	46	39	76	1.92308	40	39	64	1.99430	35	39	54
1.80451	40	35	76	1.86301	68	60	73	1.92513	36	33	68	1.99584	48	39	74

PRATT & WHITNEY MODEL "C" LATHES

A — Driver
B & C — Driven

$$\text{Ratio} = \frac{120A}{BC}$$

Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C
2.00000	40	48	50	2.07002	68	54	73	2.13904	40	33	68	2.21918	54	40	73
2.00223	60	58	62	2.07143	58	48	70	2.14286	50	40	70	2.22000	37	40	50
2.00431	62	58	64	2.07207	46	36	74	2.14413	60	73	46	2.22110	73	58	68
2.00985	68	58	70	2.07266	58	73	46	2.14706	73	60	68	2.22140	50	37	73
2.01081	62	50	74	2.07568	64	50	74	2.14737	68	50	76	2.22222	40	36	60
2.01149	35	36	58	2.07692	54	39	80	2.14815	58	54	60	2.22394	48	37	70
2.01242	54	70	46	2.07780	73	62	68	2.15054	60	54	62	2.22506	58	68	46
2.01287	73	64	68	2.07885	58	54	62	2.15278	62	54	64	2.22581	46	40	62
2.01305	36	37	58	2.07900	50	39	74	2.15399	76	58	73	2.22857	39	35	60
2.01389	58	54	64	2.08145	46	39	68	2.15517	50	48	58	2.23077	58	39	80
2.01452	74	58	76	2.08219	76	60	73	2.15625	46	40	64	2.23448	54	50	58
2.01502	76	62	73	2.08333	50	48	60	2.15764	73	58	70	2.23529	76	60	68
2.01607	46	37	74	2.08571	73	60	70	2.15873	68	54	70	2.23562	68	50	73
2.01613	50	48	62	2.08696	48	60	46	2.16000	54	50	60	2.23603	60	70	46
2.01724	39	40	58	2.08928	39	35	64	2.16149	58	70	46	2.23684	68	48	76
2.01754	46	36	76	2.09032	54	50	62	2.16216	40	37	60	2.23790	74	62	64
2.01843	73	62	70	2.09150	64	54	68	2.16319	76	62	68	2.24138	39	36	58
2.01964	48	62	46	2.09242	40	37	62	2.16374	74	54	76	2.24242	37	33	60
2.02105	64	50	76	2.09460	62	48	74	2.16541	48	35	76	2.24516	58	50	62
2.02198	46	39	70	2.09559	76	64	68	2.16667	39	40	54	2.24532	54	39	74
2.02318	48	39	73	2.09677	39	36	62	2.17009	37	33	62	2.24631	76	58	70
2.02429	50	39	76	2.09731	74	58	73	2.17143	76	60	70	2.24888	50	58	46
2.02500	54	50	64	2.10046	46	36	73	2.17195	48	39	68	2.25000	60	50	64
2.02597	39	33	70	2.10138	76	62	70	2.17391	40	48	46	2.25152	74	58	68
2.02614	62	54	68	2.10227	37	33	64	2.17500	58	50	64	2.25225	50	36	74
2.02703	40	37	64	2.10373	48	37	74	2.17647	74	60	68	2.25266	74	54	73
2.02740	74	60	73	2.10411	64	50	73	2.17742	54	48	62	2.25306	46	35	70
2.02941	46	40	68	2.10526	64	48	76	2.18080	39	37	58	2.25490	46	36	68
2.03125	39	36	64	2.10626	74	62	68	2.18182	36	33	60	2.25564	50	35	76
2.03175	64	54	70	2.10748	50	39	73	2.18566	62	74	46	2,25617	64	74	46
2.03478	39	50	46	2.10826	37	39	54	2.18624	54	39	76	2.25705	36	33	58
2.03571	76	64	70	2.10937	54	48	64	2.18719	74	58	70	2.25807	70	60	62
2.03704	33	36	54	2.10989	48	39	70	2.18750	70	60	64	2.25882	64	50	68
2.03804	50	64	46	2.11144	36	33	62	2.18824	62	50	68	2.26044	46	33	74
2.03947	62	48	76	2.11429	74	60	70	2.18919	54	40	74	2.26244	50	39	68
2.04011	39	37	62	2.11516	60	74	46	2.19048	46	36	70	2.26293	70	58	64
2.04044	74	64	68	2.11694	70	62	64	2.19138	50	37	74	2.26563	58	48	64
2.04101	73	58	74	2.11765	60	50	68	2.19178	48	36	73	2.26736	80	58	73
2.04204	68	54	74	2.11957	39	48	46	2.19219	73	54	74	2.26919	68	58	62
2.04369	46	37	73	2.12108	80	62	73	2.19298	50	36	76	2.27027	70	50	74
2.04444	46	50	54	2.12202	40	39	58	2.19355	68	60	62	2.27209	54	62	46
2.04465	58	74	46	2.12329	62	48	73	2.19396	46	37	68	2.27273	40	33	64
2.04545	36	33	64	2.12488	76	58	74	2.19429	64	50	70	2.27608	54	39	73
2.04608	74	62	70	2.12500	68	60	64	2.19680	64	76	46	2.27692	37	39	50
2.04678	70	54	76	2.12571	62	50	70	2.19780	50	39	70	2.27704	80	62	68
2.04706	58	50	68	2.12644	37	36	58	2.19828	68	58	64	2.27920	40	39	54
2.04836	48	37	76	2.12815	62	76	46	2.20109	54	64	46	2.27941	62	48	68
2.05128	40	39	60	2.12963	46	48	54	2.20541	68	50	74	2.28000	76	50	80
2.05278	35	33	62	2.13090	70	54	73	2.20588	60	48	68	2.28125	73	60	64
2.05405	76	60	74	2.13127	46	37	70	2.20690	64	58	60	2.28228	76	54	74
2.05480	60	48	73	2.13158	54	40	76	2.20766	73	62	64	2.28288	46	39	62
2.05556	37	40	54	2.13235	58	48	68	2.21053	70	50	76	2.28311	50	36	73
2.05645	68	62	64	2.13254	48	37	73	2.21154	46	39	64	2.28395	37	36	54
2.05714	60	50	70	2.13333	48	50	54	2.21198	80	62	70	2.28571	64	48	70
2.05882	70	60	68	2.13371	50	37	76	2.21429	62	48	70	2.28708	64	73	46
2.05950	60	76	46	2.13450	73	54	76	2.21561	62	73	46	2.28758	70	54	68
2.06250	33	40	48	2.13571	64	58	62	2.21591	39	33	64	2.28935	48	37	68
2.06452	64	60	62	2.13793	62	58	60	2.21739	68	46	80	2.28947	58	40	76

RELIEVING ATTACHMENT GEAR RATIOS

A — Driver
B & C — Driven

$$\text{Ratio} = \frac{120A}{BC}$$

Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C
2.29141	46	33	73	2.37037	64	54	60	2.45161	76	60	62	2.53968	40	35	54
2.29391	64	54	62	2.37363	54	39	70	2.45211	64	54	58	2.54005	74	76	46
2.29630	62	54	60	2.37500	76	60	64	2.45454	54	33	80	2.54200	58	37	74
2.29665	48	33	76	2.37548	62	54	58	2.45524	64	68	46	2.54386	58	36	76
2.29730	68	48	74	2.37852	62	68	46	2.45690	76	58	64	2.54642	48	39	58
2.29839	76	62	64	2.37931	46	40	58	2.45700	50	33	74	2.54795	62	40	73
2.29885	60	54	58	2.38095	50	36	70	2.45989	46	33	68	2.54945	58	39	70
2.30000	46	48	50	2.38235	54	40	68	2.46154	40	39	50	2.55000	68	50	64
2.30137	70	50	73	2.38356	58	40	73	2.46487	76	50	74	2.55172	74	58	60
2.30179	60	68	46	2.38474	50	37	68	2.46575	60	40	73	2.55556	46	40	54
2.30263	70	48	76	2.38509	64	70	46	2.46622	73	48	74	2.55882	58	40	68
2.30441	54	37	76	2.38562	73	54	68	2.46667	37	36	50	2.56000	64	50	60
2.30526	73	50	76	2.38710	74	60	62	2.46769	70	74	46	2.56046	60	37	76
2.30769	48	39	64	2.38961	46	33	70	2.46914	40	36	54	2.56410	50	39	60
2.31056	62	70	46	2.39103	48	33	73	2.46941	74	58	62	2.56552	62	50	58
2.31237	76	58	68	2.39224	74	58	64	2.47059	70	50	68	2.56685	48	33	68
2.31250	74	48	80	2.39583	46	36	64	2.47312	46	36	62	2.56757	76	48	74
2.31355	76	54	73	2.39718	68	74	46	2.47511	58	37	76	2.56944	74	54	64
2.31429	54	40	70	2.39726	70	48	73	2.47619	39	35	54	2.57143	60	40	70
2.31482	50	48	54	2.39911	54	37	73	2.47742	64	50	62	2.57223	46	37	58
2.31660	50	37	70	2.40000	48	40	60	2.47826	76	46	80	2.57344	73	74	46
2.31746	73	54	70	2.40132	73	48	76	2.48000	62	50	60	2.57353	70	48	68
2.31884	48	54	46	2.40240	40	37	54	2.48139	50	39	62	2.57552	54	37	68
2.31975	37	33	58	2.40275	70	76	46	2.48276	60	50	58	2.57647	73	50	68
2.32000	58	50	60	2.40385	50	39	64	2.48366	76	54	68	2.57682	58	37	73
2.32258	60	50	62	2.40628	46	37	62	2.48572	58	40	70	2.57778	58	50	54
2.32500	62	50	64	2.40741	39	36	54	2.48649	46	37	60	2.57796	62	39	74
2.32759	54	48	58	2.41164	58	39	74	2.49066	50	33	73	2.58065	64	48	62
2.32877	68	48	73	2.41270	76	54	70	2.49158	37	33	54	2.58333	62	48	60
2.33108	46	37	64	2.41304	74	46	80	2.49351	48	33	70	2.58373	54	33	76
2.33143	68	50	70	2.41379	70	58	60	2.49480	60	39	74	2.58621	50	40	58
2.33410	68	76	46	2.41546	50	54	46	2.49863	76	50	73	2.59109	64	39	76
2.33593	70	58	62	2.41667	58	48	60	2.50000	50	40	60	2.59259	70	54	60
2.33684	74	50	76	2.41830	74	54	68	2.50149	70	73	46	2.59460	48	37	60
2.33871	58	48	62	2.41936	60	48	62	2.50193	54	37	70	2.59615	54	39	64
2.33918	80	54	76	2.42017	48	35	68	2.50286	73	50	70	2.59740	50	33	70
2.34000	39	40	50	2.42188	62	48	64	2.50435	48	50	46	2.60000	39	36	50
2.34234	39	37	54	2.42424	40	33	60	2.50572	73	76	46	2.60274	76	48	73
2.34375	60	48	64	2.42857	68	48	70	2.50784	40	33	58	2.60417	50	36	64
2.34483	68	58	60	2.42879	54	58	46	2.50896	70	54	62	2.60536	68	54	58
2.34604	40	33	62	2.42915	60	39	76	2.51012	62	39	76	2.60571	76	50	70
2.34783	54	60	46	2.43002	68	73	46	2.51090	48	37	62	2.61177	74	50	68
2.34818	58	39	76	2.43056	70	54	64	2.51351	62	40	74	2.61261	58	36	74
2.34921	74	54	70	2.43243	48	37	64	2.51724	73	58	60	2.61290	54	40	62
2.35135	58	40	74	2.43288	74	50	73	2.51821	68	54	60	2.61328	62	39	73
2.35294	64	48	68	2.43421	74	48	76	2.52174	58	60	46	2.61364	46	33	64
2.35484	73	60	62	2.43531	80	54	73	2.52454	60	62	46	2.61438	80	54	68
2.35690	35	33	54	2.43604	73	58	62	2.52632	64	40	76	2.61552	50	37	62
2.35872	48	33	74	2.43728	68	54	62	2.52717	62	64	46	2.61649	73	54	62
2.35897	46	39	60	2.43750	39	40	48	2.52898	60	39	73	2.62069	76	58	60
2.35991	73	58	64	2.44039	58	62	46	2.52972	39	37	50	2.62108	46	39	54
2.36111	68	54	64	2.44344	54	39	68	2.53125	54	40	64	2.62443	58	39	68
2.36364	39	33	60	2.44468	58	39	73	2.53378	50	37	64	2.62500	70	50	64
2.36413	58	64	46	2.44514	39	33	58	2.53416	68	70	46	2.62626	39	33	54
2.36487	70	48	74	2.44565	60	64	46	2.53425	74	48	73	2.62857	46	35	60
2.36669	54	37	74	2.44737	62	40	76	2.53472	73	54	64	2.62966	60	37	74
2.36757	73	50	74	2.44898	50	35	70	2.53615	76	58	62	2.63014	64	40	73
2.36842	60	40	76	2.45098	50	36	68	2.53714	74	50	70	2.63158	60	36	76

PRATT & WHITNEY MODEL "C" LATHES

A — Driver
B & C — Driven

$$\text{Ratio} = \frac{120A}{BC}$$

Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C
2.63226	68	50	62	2.72059	74	48	68	2.82021	80	46	74	2.91188	76	54	58
2.63514	39	37	48	2.72269	54	35	68	2.82258	70	48	62	2.91429	68	40	70
2.63636	58	33	80	2.72401	76	54	62	2.82353	64	40	68	2.91560	76	68	46
2.63736	60	39	70	2.72528	62	39	70	2.82476	54	37	62	2.91667	70	48	60
2.63889	76	54	64	2.72727	60	33	80	2.82580	73	50	62	2.92000	73	50	60
2.64286	74	48	70	2.73115	64	37	76	2.82744	68	39	74	2.92105	74	40	76
2.64368	46	36	58	2.73438	70	48	64	2.83077	46	39	50	2.92237	64	36	73
2.64443	74	73	46	2.73504	48	39	54	2.83105	62	36	73	2.92308	76	39	80
2.64580	62	37	76	2.73529	62	40	68	2.83230	76	70	46	2.92437	58	35	68
2.64706	60	40	68	2.73649	54	37	64	2.83333	68	48	60	2.93103	68	48	58
2.64828	64	50	58	2.73750	73	50	64	2.83401	70	39	76	2.93255	50	33	62
2.64840	58	36	73	2.73973	60	36	73	2.83525	74	54	58	2.93478	54	48	46
2.65233	74	54	62	2.74194	68	48	62	2.83636	39	33	50	2.93877	60	35	70
2.65252	50	39	58	2.74286	64	40	70	2.83784	70	40	74	2.93919	58	37	64
2.65356	54	33	74	2.74599	80	46	76	2.83888	74	68	46	2.94118	60	36	68
2.65438	48	35	62	2.75304	68	39	76	2.83951	46	36	54	2.94194	76	50	62
2.65625	68	48	64	2.75454	62	37	73	2.84091	50	33	64	2.94355	73	48	62
2.65714	62	40	70	2.75555	62	50	54	2.84314	58	36	68	2.94530	70	62	46
2.66112	64	39	74	2.75676	68	40	74	2.84339	64	37	73	2.94840	60	33	74
2.66568	60	37	73	2.75776	74	70	46	2.84444	64	50	54	2.94872	46	39	48
2.66667	60	50	54	2.75862	64	48	58	2.84615	74	39	80	2.95047	70	39	73
2.66963	80	58	62	2.76000	46	40	50	2.84900	50	39	54	2.95238	62	36	70
2.67241	62	48	58	2.76191	58	36	70	2.85000	76	50	64	2.95385	48	39	50
2.67380	50	33	68	2.76276	46	37	54	2.85012	58	33	74	2.95455	39	33	48
2.67428	39	35	50	2.76316	70	40	76	2.85156	73	48	64	2.95546	73	39	76
2.67857	50	35	64	2.76498	50	35	62	2.85326	70	64	46	2.95652	68	60	46
2.67920	76	74	46	2.76630	58	37	68	2.85714	60	36	70	2.95708	62	37	68
2.67990	54	39	62	2.77174	68	64	46	2.86115	68	62	46	2.95946	73	40	74
2.68199	70	54	58	2.77500	74	50	64	2.86169	60	37	68	2.96000	74	50	60
2.68235	76	50	68	2.77512	58	33	76	2.86452	74	50	62	2.96296	64	48	54
2.68382	73	48	68	2.77778	60	48	54	2.86472	54	39	58	2.96525	64	37	70
2.68406	48	37	58	2.77992	60	37	70	2.86618	68	39	73	2.96651	62	33	76
2.68421	68	40	76	2.78261	64	60	46	2.86738	80	54	62	2.96875	76	48	64
2.68519	58	48	54	2.78571	39	35	48	2.87037	62	48	54	2.97436	58	39	60
2.68542	70	68	46	2.78788	46	33	60	2.87081	60	33	76	2.97554	73	64	46
2.68726	58	37	70	2.78846	58	39	64	2.87259	62	37	70	2.97767	60	39	62
2.68817	50	36	62	2.78861	62	58	46	2.87356	50	36	58	2.98028	68	37	74
2.68991	54	33	73	2.79279	62	36	74	2.87500	46	40	48	2.98077	62	39	64
2.69091	37	33	50	2.79310	54	40	58	2.87671	70	40	73	2.98137	80	46	70
2.69285	64	62	46	2.79412	76	48	68	2.87841	58	39	62	2.98246	68	36	76
2.69360	40	33	54	2.79452	68	40	73	2.87856	64	58	46	2.98378	46	37	50
2.69565	62	60	46	2.79590	50	37	58	2.88158	73	40	76	2.98617	54	35	62
2.69758	64	39	73	2.79694	73	54	58	2.88288	48	37	54	2.98720	70	37	76
2.69795	46	33	62	2.80000	70	50	60	2.88401	46	33	58	2.98879	60	33	73
2.69865	60	58	46	2.80051	73	68	46	2.88462	60	39	64	2.98901	68	39	70
2.70000	54	48	50	2.80193	58	54	46	2.88770	54	33	68	2.99517	52	54	46
2.70270	50	37	60	2.80497	64	37	74	2.88917	58	33	73	2.99595	74	39	76
2.70370	73	54	60	2.80520	54	33	70	2.89063	74	48	64	3.00000	54	36	60
2.70677	60	35	76	2.80543	62	39	68	2.89286	54	35	64	3.00300	50	37	54
2.70833	39	36	48	2.80645	58	40	62	2.89593	64	39	68	3.00587	64	35	73
2.70968	70	50	62	2.80702	64	36	76	2.89655	70	50	58	3.00940	48	33	58
2.71429	76	48	70	2.81250	60	40	64	2.89855	60	54	46	3.01299	58	33	70
2.71493	60	39	68	2.81319	64	39	70	2.90000	58	48	50	3.01630	74	64	46
2.71590	76	73	46	2.81379	68	50	58	2.90185	68	37	76	3.01724	70	48	58
2.71739	50	48	46	2.81482	76	54	60	2.90323	60	40	62	3.01957	54	37	58
2.71875	58	40	64	2.81525	48	33	62	2.90625	62	40	64	3.02069	73	50	58
2.71930	62	36	76	2.81739	54	50	46	2.90909	40	33	50	3.02083	58	36	64
2.72000	68	50	60	2.81800	60	35	73	2.91060	70	39	74	3.02110	68	37	73

RELIEVING ATTACHMENT GEAR RATIOS

A — Driver
B & C — Driven

$$\text{Ratio} = \frac{120A}{BC}$$

Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C
3.02222	68	50	54	3.13514	58	37	60	3.24561	74	36	76	3.37900	74	36	73
3.02521	60	35	68	3.13725	64	36	68	3.25275	74	39	70	3.37963	73	48	54
3.02609	58	50	46	3.13862	60	37	62	3.25359	68	33	76	3.38164	70	54	46
3.03030	40	33	48	3.14189	62	37	64	3.25714	76	40	70	3.38224	73	37	70
3.03400	58	37	62	3.14483	76	50	58	3.26087	60	48	46	3.38425	48	37	46
3.03534	73	39	74	3.14496	64	33	74	3.26471	74	40	68	3.38558	54	33	58
3.03673	62	35	70	3.14655	73	48	58	3.26923	68	39	64	3.38710	70	40	62
3.03922	62	36	68	3.14815	68	48	54	3.27273	54	33	60	3.38730	68	33	73
3.04000	76	50	60	3.14843	70	58	46	3.27586	76	48	58	3.39523	64	39	58
3.04054	60	37	64	3.15058	68	37	70	3.28125	70	40	64	3.40000	68	48	50
3.04110	74	40	73	3.15217	58	48	46	3.28205	64	39	60	3.40176	58	33	62
3.04167	73	48	60	3.15315	70	36	74	3.28336	73	58	46	3.40909	60	33	64
3.04348	70	60	46	3.15429	46	35	50	3.28502	68	54	46	3.41394	80	37	76
3.04668	62	33	74	3.15789	70	35	76	3.28767	70	35	73	3.41829	76	58	46
3.04762	64	36	70	3.16008	76	39	74	3.28829	73	36	74	3.41880	60	39	54
3.05246	64	37	68	3.16667	76	48	60	3.28889	74	50	54	3.42188	73	40	64
3.05847	68	58	46	3.16716	54	33	62	3.28913	62	39	58	3.42246	64	33	68
3.06207	74	50	58	3.16742	70	39	68	3.29032	68	40	62	3.42342	76	36	74
3.06220	64	33	76	3.17143	74	40	70	3.29143	48	35	50	3.42593	74	48	54
3.06306	68	36	74	3.17391	73	60	46	3.29323	73	35	76	3.42857	74	37	70
3.06452	76	48	62	3.17460	50	35	54	3.29545	58	33	64	3.43137	70	36	68
3.06513	80	54	58	3.17618	64	39	62	3.30317	73	39	68	3.43891	76	39	68
3.06667	46	36	50	3.17949	62	39	60	3.30435	76	60	46	3.43980	70	33	74
3.06793	70	37	74	3.18182	70	33	80	3.30484	58	39	54	3.44086	64	36	62
3.06818	54	33	64	3.18302	60	39	58	3.31035	64	40	58	3.44444	62	40	54
3.06905	80	46	68	3.18750	68	40	64	3.31429	58	35	60	3.44595	68	37	64
3.07018	70	36	76	3.18805	64	33	73	3.31551	62	33	68	3.44828	60	36	58
3.07153	73	62	46	3.18966	74	48	58	3.31797	60	35	62	3.45455	76	33	80
3.08108	76	40	74	3.19212	54	35	58	3.32143	62	35	64	3.45946	64	37	60
3.08333	74	36	80	3.19374	68	35	73	3.32308	54	39	50	3.46154	54	39	48
3.08571	54	35	60	3.19444	46	36	48	3.32468	64	33	70	3.46692	62	37	58
3.08642	50	36	54	3.19635	70	36	73	3.32640	80	39	74	3.46875	74	40	64
3.08824	70	40	68	3.19776	76	62	46	3.32834	74	58	46	3.47032	76	36	73
3.08842	62	33	73	3.19942	73	37	74	3.33090	76	37	74	3.47222	50	36	48
3.09091	68	33	80	3.20000	64	40	60	3.33333	80	48	60	3.47395	70	39	62
3.09179	64	54	46	3.20175	73	36	76	3.33863	70	37	68	3.47554	74	35	73
3.09677	64	40	62	3.20337	76	39	73	3.33913	64	50	46	3.47619	73	36	70
3.09764	46	33	54	3.20513	50	39	48	3.34066	76	39	70	3.47826	64	48	46
3.09783	76	64	46	3.20690	62	40	58	3.34152	68	33	74	3.48000	58	40	50
3.10000	62	48	50	3.20737	58	35	62	3.34448	50	39	46	3.48172	73	37	68
3.10160	58	33	68	3.20856	60	33	68	3.34545	46	33	50	3.48348	58	37	54
3.10345	60	40	58	3.20879	73	39	70	3.34786	64	37	62	3.48485	46	33	48
3.10502	68	36	73	3.21070	48	39	46	3.34842	74	39	68	3.48692	70	33	73
3.10714	58	35	64	3.21429	60	35	64	3.34928	70	33	76	3.48718	68	39	60
3.10811	46	37	48	3.21739	74	60	46	3.35135	62	37	60	3.49091	48	33	50
3.10996	70	37	73	3.22059	73	40	68	3.35294	76	40	68	3.49282	73	33	76
3.11111	70	50	54	3.22078	62	33	70	3.35508	60	37	58	3.50000	70	48	50
3.11360	74	62	46	3.22222	58	40	54	3.36364	74	33	80	3.50270	54	37	50
3.11522	73	37	76	3.22581	60	36	62	3.36539	70	39	64	3.50621	80	37	74
3.11688	60	33	70	3.22689	64	35	68	3.36606	80	46	62	3.50877	80	36	76
3.11828	58	36	62	3.22917	62	36	64	3.36703	50	33	54	3.50962	73	39	64
3.11907	74	39	73	3.23232	48	33	54	3.36957	62	48	46	3.51515	58	33	60
3.12329	76	40	73	3.23478	62	50	46	3.37197	80	39	73	3.51648	80	39	70
3.12500	50	40	48	3.23810	68	36	70	3.37469	68	39	62	3.51724	68	40	58
3.12605	62	35	68	3.24000	54	40	50	3.37500	54	40	48	3.51852	76	48	54
3.12857	73	40	70	3.24074	70	48	54	3.37653	76	37	73	3.51906	60	33	62
3.13044	48	40	46	3.24324	80	40	74	3.37778	76	50	54	3.52124	76	37	70
3.13480	50	33	58	3.24444	73	50	54	3.37838	50	37	48	3.52174	54	40	46

PRATT & WHITNEY MODEL "C" LATHES

A — Driver
B & C — Driven

$$\text{Ratio} = \frac{120A}{BC}$$

Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C
3.52273	62	33	64	3.67742	76	40	62	3.86088	74	50	46	4.03687	73	35	62
3.52381	74	36	70	3.67816	64	36	58	3.86364	68	33	64	4.04348	62	40	46
3.52526	50	37	46	3.68067	73	35	68	3.86473	80	46	54	4.05405	50	37	40
3.52657	73	54	46	3.68254	58	35	54	3.86667	58	36	50	4.05556	73	40	54
3.52941	70	35	68	3.68618	74	33	73	3.87097	70	35	62	4.06349	64	35	54
3.53226	73	40	62	3.69231	48	39	40	3.87268	73	39	58	4.06417	76	33	68
3.53247	68	33	70	3.69565	68	48	46	3.87464	68	39	54	4.07143	76	35	64
3.53276	62	39	54	3.69932	73	37	64	3.87500	62	40	48	4.08000	68	40	50
3.53917	64	35	62	3.70000	74	48	50	3.87879	64	33	60	4.08201	73	37	58
3.54067	74	33	76	3.70286	54	35	50	3.87960	58	39	46	4.08408	68	37	54
3.54167	68	36	64	3.70370	60	36	54	3.88571	68	35	60	4.08602	76	36	62
3.54680	60	35	58	3.70656	80	35	74	3.88715	62	33	58	4.08931	58	37	46
3.54730	70	37	64	3.71353	70	39	58	3.88889	70	40	54	4.09091	54	33	48
3.54783	68	50	46	3.71795	58	39	48	3.89189	48	37	40	4.09217	74	35	62
3.55424	80	37	73	3.72000	62	40	50	3.89744	76	39	60	4.10256	48	36	39
3.55556	64	40	54	3.72245	76	35	70	3.90374	73	33	68	4.10557	70	33	62
3.55711	68	37	62	3.72372	62	37	54	3.90572	58	33	54	4.10811	76	37	60
3.55769	74	39	64	3.72549	76	36	68	3.90805	68	36	58	4.11111	74	40	54
3.56250	76	40	64	3.72671	50	35	46	3.91071	73	35	64	4.11428	60	35	50
3.56322	62	36	58	3.73109	74	35	68	3.91304	60	40	46	4.12121	68	33	60
3.56923	58	39	50	3.73464	76	33	74	3.91426	70	37	58	4.13044	76	48	46
3.57143	50	35	48	3.74332	70	33	68	3.91892	58	37	48	4.13333	62	36	50
3.57488	74	54	46	3.74359	73	39	60	3.92157	80	36	68	4.13793	74	37	58
3.57551	73	35	70	3.75000	60	40	48	3.92473	73	36	62	4.14286	58	35	48
3.57764	48	35	46	3.75367	64	33	62	3.92573	74	39	58	4.14716	62	39	46
3.57843	73	36	68	3.75758	62	33	60	3.92727	54	33	50	4.14773	73	33	64
3.57875	64	37	58	3.76037	68	35	62	3.93103	76	40	58	4.15135	64	37	50
3.58025	58	36	54	3.76176	60	33	58	3.93120	80	33	74	4.15385	54	39	40
3.58065	74	40	62	3.76216	58	37	50	3.93651	62	35	54	4.15584	80	33	70
3.58722	73	33	74	3.76344	70	36	62	3.93846	64	39	50	4.15800	50	37	39
3.58974	70	39	60	3.77171	76	39	62	3.94595	73	37	60	4.15954	73	39	54
3.59820	80	46	58	3.77586	73	40	58	3.94805	76	33	70	4.16667	50	36	40
3.60000	60	40	50	3.77778	68	40	54	3.95062	64	36	54	4.17143	73	35	60
3.60360	60	37	54	3.78261	58	40	46	3.95257	50	33	46	4.17391	64	40	46
3.60743	68	39	58	3.78378	70	37	60	3.95722	74	33	68	4.17508	62	33	54
3.60902	80	35	76	3.78580	76	33	73	3.95833	76	36	64	4.18462	68	39	50
3.61204	54	39	46	3.78788	50	33	48	3.96428	74	35	64	4.18919	62	37	48
3.61905	76	36	70	3.79221	73	33	70	3.96522	76	50	46	4.19540	73	36	58
3.62069	70	40	58	3.79447	48	33	46	3.96739	73	48	46	4.19753	68	36	54
3.62283	73	39	62	3.80000	76	48	50	3.97022	80	39	62	4.20000	70	40	50
3.62319	50	36	46	3.80208	73	36	64	3.97436	62	39	48	4.20290	58	36	46
3.62480	76	37	68	3.80242	68	37	58	3.97559	76	37	62	4.20420	70	37	54
3.62500	58	40	48	3.80435	70	48	46	3.97727	70	33	64	4.20455	74	33	64
3.62745	74	36	68	3.80729	54	37	46	3.97850	74	36	62	4.21652	74	39	54
3.64286	68	35	64	3.80870	73	50	46	3.98506	80	33	73	4.21818	58	33	50
3.64583	70	36	64	3.80952	60	35	54	3.98827	68	33	62	4.21978	48	35	39
3.64672	64	39	54	3.81539	62	39	50	3.98860	70	39	54	4.22222	76	40	54
3.64865	54	37	48	3.81866	73	37	62	3.99168	48	37	39	4.22857	74	35	60
3.65000	73	48	50	3.82716	62	36	54	4.00000	48	36	40	4.23032	60	37	46
3.65217	70	50	46	3.82759	74	40	58	4.01254	64	33	58	4.24242	70	33	60
3.65385	76	39	64	3.83193	76	35	68	4.01338	60	39	46	4.24403	80	39	58
3.65714	64	35	60	3.84000	64	40	50	4.01970	68	35	58	4.24977	76	37	58
3.65591	68	36	62	3.84384	64	37	54	4.02162	62	37	50	4.25000	68	40	48
3.66173	70	37	62	3.84416	74	33	70	4.02299	70	36	58	4.25143	62	35	50
3.66502	62	35	58	3.84615	60	39	48	4.02484	54	35	46	4.25287	74	36	58
3.67150	76	54	46	3.85135	76	37	64	4.02778	58	36	48	4.26332	68	33	58
3.67246	74	39	62	3.85417	74	36	64	4.03183	76	39	58	4.26667	64	36	50
3.67568	68	37	60	3.85714	54	35	48	4.03361	80	35	68	4.26878	54	33	46

RELIEVING ATTACHMENT GEAR RATIOS

A — Driver
B & C — Driven

$$\text{Ratio} = \frac{120A}{BC}$$

Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C	Ratio	A	B	C
4.27350	50	36	39	4.56456	76	37	54	4.92973	76	37	50	5.37549	68	33	46
4.27807	80	33	68	4.56522	70	40	46	4.93243	73	37	48	5.38182	74	33	50
4.28094	64	39	46	4.56790	74	36	54	4.93333	74	36	50	5.38462	70	39	40
4.28153	73	33	62	4.57143	80	35	60	4.93537	70	37	46	5.38720	80	33	54
4.28571	80	35	64	4.57680	73	33	58	4.93827	80	36	54	5.40540	80	37	48
4.30107	80	36	62	4.57913	68	33	54	4.94545	68	33	50	5.40793	58	33	39
4.30556	62	36	48	4.58498	58	33	46	4.94983	74	39	46	5.42857	76	35	48
4.30769	70	39	50	4.59459	68	37	48	4.95652	76	40	46	5.44099	73	35	46
4.30976	64	33	54	4.59770	80	36	58	4.95727	58	36	39	5.45055	62	35	39
4.31527	73	35	58	4.60606	76	33	60	4.97143	58	35	40	5.45455	54	33	36
4.31818	76	33	64	4.61539	60	39	40	4.98317	74	33	54	5.47009	64	36	39
4.32099	70	36	54	4.62112	62	35	46	4.98961	60	37	39	5.48571	80	35	50
4.32298	58	35	46	4.62500	74	40	48	5.00000	60	36	40	5.50725	76	36	46
4.32432	80	37	60	4.62857	54	35	40	5.00571	73	35	50	5.51351	68	37	40
4.33048	76	39	54	4.63320	50	35	37	5.01567	80	33	58	5.51553	74	35	46
4.34018	74	33	62	4.63768	64	36	46	5.02703	62	37	40	5.52381	58	35	36
4.34286	76	35	60	4.63950	74	33	58	5.03497	54	33	39	5.52727	76	33	50
4.34783	60	36	46	4.65455	64	33	50	5.05929	64	33	46	5.53030	73	33	48
4.35897	68	39	48	4.66201	50	33	39	5.06667	76	36	50	5.53360	70	33	46
4.36364	48	33	40	4.66667	70	36	50	5.06832	68	35	46	5.55555	80	36	48
4.36782	76	36	58	4.67692	76	39	50	5.06944	73	36	48	5.55984	60	35	37
4.37133	62	37	46	4.67949	73	39	48	5.07246	70	36	46	5.58559	62	36	37
4.37438	74	35	58	4.68227	70	39	46	5.07428	74	35	50	5.59441	60	33	39
4.37500	70	40	48	4.69136	76	36	54	5.07936	80	35	54	5.60606	74	33	48
4.37838	54	37	40	4.69208	80	33	62	5.08361	76	39	46	5.61539	73	39	40
4.38000	73	40	50	4.69697	62	33	48	5.09091	70	33	50	5.62637	64	35	39
4.38438	73	37	54	4.69841	74	35	54	5.09890	58	35	39	5.63636	62	33	40
4.38872	70	33	58	4.70270	58	37	40	5.11785	76	33	54	5.64042	80	37	46
4.39394	58	33	48	4.71381	70	33	54	5.12821	60	36	39	5.65489	68	37	39
4.39560	50	35	39	4.72222	68	36	48	5.13514	76	37	48	5.66460	76	35	46
4.41081	68	37	50	4.72973	70	37	48	5.13889	74	36	48	5.66667	68	36	40
4.42396	80	35	62	4.73514	73	37	50	5.14286	60	35	40	5.67568	70	37	40
4.42424	73	33	60	4.74308	60	33	46	5.14689	73	37	46	5.69231	74	39	40
4.42857	62	35	48	4.74359	74	39	48	5.15152	68	33	48	5.70025	58	33	37
4.43478	68	40	46	4.74725	54	35	39	5.15593	62	37	39	5.71428	60	35	36
4.44000	74	40	50	4.75000	76	40	48	5.16667	62	36	40	5.74517	62	35	37
4.44444	64	36	48	4.76087	73	40	46	5.18919	64	37	40	5.75758	76	33	48
4.45748	76	33	62	4.76489	76	33	58	5.21143	76	35	50	5.76577	64	36	37
4.46154	58	39	40	4.76923	62	39	40	5.21429	73	35	48	5.77075	73	33	46
4.47205	60	35	46	4.77019	64	35	46	5.21739	74	37	46	5.78089	62	33	39
4.47552	48	33	39	4.79436	68	37	46	5.22523	58	36	37	5.79710	80	36	46
4.48718	70	39	48	4.80480	80	37	54	5.23077	68	39	40	5.81197	68	36	39
4.49064	54	37	39	4.82329	58	37	39	5.27273	58	33	40	5.81818	80	33	50
4.49231	73	39	50	4.82540	76	35	54	5.27472	60	35	39	5.82121	70	37	39
4.49275	62	36	46	4.82609	74	40	46	5.27778	76	36	48	5.82857	68	35	40
4.50000	54	36	40	4.83333	58	36	40	5.28571	74	35	48	5.83333	70	36	40
4.50450	50	36	37	4.85714	68	35	48	5.28986	73	36	46	5.84615	76	39	40
4.50617	73	36	54	4.86111	70	36	48	5.29915	62	36	39	5.84980	74	33	46
4.50909	62	33	50	4.86487	54	36	37	5.30303	70	33	48	5.85859	58	33	36
4.51234	64	37	46	4.86667	73	36	50	5.30713	54	33	37	5.89681	60	33	37
4.53333	68	36	50	4.87180	76	39	48	5.30909	73	33	50	5.90476	62	35	36
4.54054	50	33	40	4.88294	73	39	46	5.31428	62	35	40	5.91892	73	37	40
4.54545	60	33	48	4.90119	62	33	46	5.32225	64	37	39	5.93050	64	35	37
4.54850	68	39	46	4.90909	54	33	40	5.33333	64	36	40	5.96737	64	33	39
4.55385	74	39	50	4.91401	50	33	37	5.35117	80	39	46	5.96273	80	35	46
4.55840	80	39	54	4.91583	73	33	54	5.35840	76	37	46	5.97802	68	35	39
4.56000	76	40	50	4.92308	64	39	40	5.36232	74	36	46	5.98291	70	36	39
4.56250	73	40	48	4.92754	68	36	46	5.37452	58	35	37	6.00000	70	35	40

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