

OTMT®

SC4 Bench Lathe



User's Guide and Installation Manual

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Please Read This Manual Carefully Before Operating this Machine.
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IMPORTANT SAFETY INSTRUCTIONS

Common sense and caution are factors which cannot be built into any product. These factors must be supplied by the operator.

PLEASE REMEMBER:

1. When using electric tools, machines or equipment, basic safety precautions should always be followed to reduce the risk of fire, electric shock, and personal injury.
2. Keep work area clean. Cluttered areas invite injuries.
3. Consider work area conditions. Do not use machines or power tools in damp, wet or poorly lit locations. Do not expose equipment to rain, keep work areas well lit. do not use tools in the presence of flammable gases or liquid.
4. Keep children away; all children should be kept away from the work area.
5. Guard against electric shock. Prevent body contact with grounded surfaces such as pipes, radiators, ranges and refrigerator enclosures.
6. Stay alert. Never operate a power tool if you are tired.
7. Do not operate the product if under the influence of alcohol or drugs. Read warning labels on prescriptions to determine if your judgment or reflexes might be impaired.
8. Do not wear loose clothing or jewelry as they can be caught in moving parts.
9. Wear restrictive hair covering to contain long hair.
10. Use eye and ear protection. Always wear.
11. Keep proper footing and balance at all times.
12. Do not reach over or across running machines.

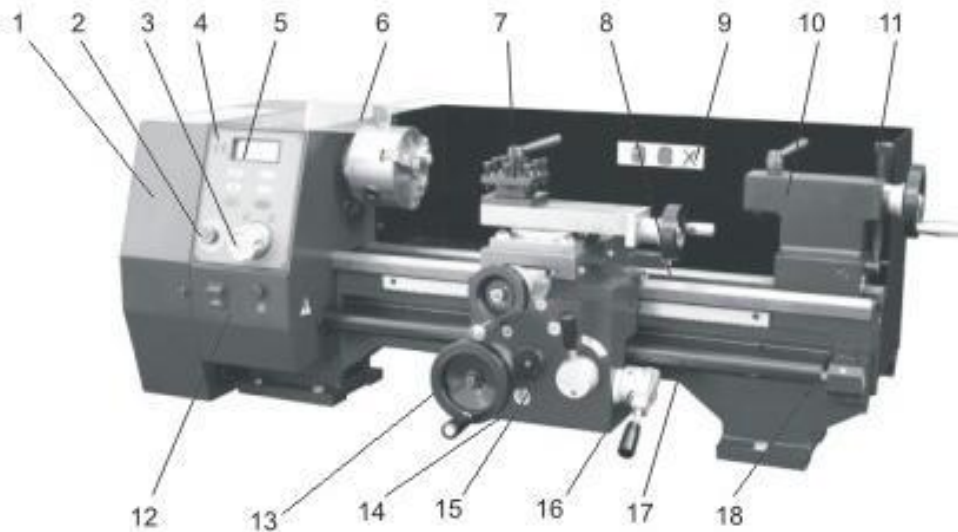
Before operations

1. Be sure the power switch is OFF when not in use and before plugging in.
2. Do not attempt to use inappropriate attachments in an attempt to exceed the tool's capacity.
3. Check for damaged parts before using the machine. Any part that appears damaged should be carefully checked to determine that it will operate properly and perform its intended function.
4. Check for alignment and binding of all moving parts, broken parts or mounting fixtures and any other condition that may affect proper operation. Any part that is damaged should be properly repaired or replaced by a qualified technician.
5. Do not use the machine if any switch does not turn off properly.

Operation

1. Never force the machine or attachment to do the work of a larger industrial machine. It is designed to do the job better and more safely at the rate for which it was intended.
2. Always unplug the cord by the plug. Never yank the cord out of the wall.
3. Always turn off the machine before unplugging.

Lathe Features



1. Change gear Cover	11. Quick locking handle
2. Emergency stop switch	12. Spindle box cover
3. Control handle	13. Apron handle
4. Touch panel	14. Apron
5. Spindle speed display	15. Handle
6. Chuck guard with power off	16. X or Y axis auto feeding change handle
7. Tool rest	17. Cover for leadscrew
8. Bed way	18. Leadscrew
9. Splash guard	
10. Tailstock	

Welcome

Congratulations on selecting the OTMT SC4 Bench Lathe (SC4). You have chosen a precision machine tool that can perform a wide range of complex and precise lathe operations. With proper maintenance and care, it will provide many years of service. Should you have any questions regarding the operation of your lathe, please contact **Travers Technical Support** for assistance.

Technical Support
(1-800-234-9985, press 4)
Fax: 718-661-5637
Email: tech@travers.com

User Manual

The purpose of this manual is to familiarize the lathe operator with the installation and controls of the machine and basic lathe procedures. To become proficient in using the lathe, the operator should seek in-depth training using reference books, resources available on the Internet, training courses at community technical schools or from an operator already skilled in the use of a similar lathe.

Capabilities of the Lathe

A precision metal-working lathe is one of the most useful and productive tools in the machine shop. The lathe provides the capability to produce cylindrical and tapered shapes with very accurate dimensions in a wide variety of materials such as steel, brass, aluminum and many plastics. With appropriate tooling it is even possible to create round, concave and cubical shapes on the lathe.

The SC4 lathe is equipped with a powerful 1000-watt brushless DC motor with electronic speed control, providing strong torque at all speeds, electronic braking and instant direction reversal for operations such as tapping. The

motor is completely sealed from dirt, dust, oil, metal chips and other shop contaminants and is permanently lubricated and maintenance-free.

While the ultimate precision of a finished workpiece depends on many factors, such as the material, shape of the cutting tool, proper adjustment of the lathe and skill of the lathe operator, dimensions of one-one-thousandth of an inch (0.001") or better are possible.

With the provided set of change gears, power feed rates may be adjusted and a wide range of both metric and SAE external and internal threads can accurately be cut. The optional milling head accessory ([Item # 87-116-027](#)) adds light vertical milling and precision drill press capabilities to the SC4.

Setting up the Lathe

The SC4 lathe should be located in a well-lighted and well-ventilated area free from excessive humidity or moisture that could cause rusting of the precision metal surfaces or tooling.

Electrical Requirements

The SC4 lathe configured for U.S. operation uses standard 120V AC 60-cycle single-phase power and has a peak current demand of 12 amps. While a 15-amp circuit may be sufficient for powering the lathe, a 20-amp circuit is recommended. The circuit must not be shared with other high-current devices, such as an air compressor, window air conditioner or coffee pot, that may be operating, or switch on, while the lathe is in use. Low current devices, such as a work lamp, may share the same circuit as the lathe.

A plug-in power failure emergency light that will automatically turn on in the event of a power failure or tripping of an overloaded circuit breaker is recommended for safety. In the event that power to the lathe, or workspace lighting, should be interrupted while the lathe is in use, the emergency light will enable the operator to safely turn off the power switch to the lathe and move away from the lathe until power is restored. Suitable lights are available at most hardware and home-supply stores.

Care should be taken to ensure a safe work area with electrical wiring and grounding approved by local electrical codes. The lathe uses a three-prong electrical plug to protect the operator from risk of shock or electrocution. The lathe must be plugged into a properly grounded outlet to ensure safe operation. Do not attempt to modify the plug to fit a 2-prong outlet or extension cord by removing the ground conductor or by using an adaptor. Doing so may result in shock or electrocution.

If it is necessary to plug the lathe into an extension cord, the extension cord must have

a properly functioning 3-prong electrical ground plug and outlet, plugged into a properly grounded 3-prong wall outlet. The extension cord must have at least 15 Amps of current-carrying capacity to avoid overheating the cord, which could cause a risk of fire. A cord rated for 20 Amps or more is recommended. In no case should the length of the extension cord exceed 20 feet.

Lifting the Lathe

The SC4 lathe weighs approximately 275 lbs. (125 kg.) and must be mounted on a strong table or bench capable of supporting 350 lbs. or more. A shop crane with a nylon lifting strap or other suitable lifting apparatus should be used to safely lift the machine onto the table or bench.



Shop crane (Item # [96-004-166](#))



Using a shop crane to lift the lathe

Proper lifting techniques (e.g. bend at the knees, not at the back) should be used to minimize any risk of personal injury. Consult the Internet for information on proper lifting techniques.

Bench Mounting

For stability and safe operation the lathe must be bolted to a sturdy machine stand or workbench capable of safely supporting at least 350 lbs. A carpenter's or machinist's level should be used to verify that the lathe bed is level. Large diameter metal fender washers or shims may be used under mounting feet to level the lathe. Sufficient clearance must be provided on the left side of the lathe to allow the access door to swing open and provide working room to adjust the gears.

Machine Cleanup

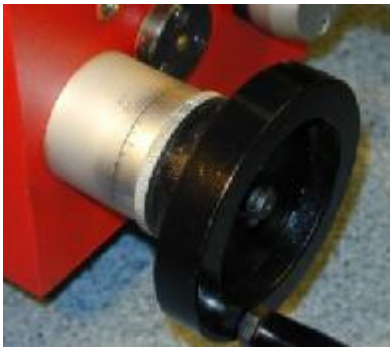
The lathe is protected from rust during shipping by a waxy red grease that must be removed before putting the machine to use. This is best done using disposable shop rags and paint brushes together with a solvent such as kerosene or WD-40™. Avoid solvents such as paint thinner that may damage the painted surfaces of the lathe, and highly volatile solvents such as acetone that present a fire and inhalation hazard.

Good ventilation must be provided when solvents are used and care must be taken to avoid open flames, smoking materials or electrical sparks that could ignite solvent fumes. Care should be taken to clean the shipping grease from all moving parts, including parts that may be hidden from view, such as leadscrews under the cross-slide and compound slide.

Operating Controls and Features

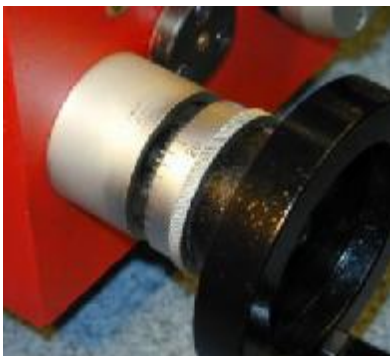
Carriage Handwheel

The carriage handwheel moves the carriage back and forth along the ways. Turning the handwheel clockwise moves the carriage towards the tailstock; turning it counter-clockwise moves the carriage towards the headstock.



Carriage Handwheel

When the carriage is moved by power feed, the carriage handwheel may be disengaged by pulling it towards the operator. This prevents the handwheel from rapidly rotating and causing a potential hazard. To re-engage the handwheel, press it inwards while slowly rotating it until the gears engage.



Carriage Handwheel Disengaged

Cross-Feed Handwheel

The cross-feed handwheel (also known as the cross-slide handwheel or cross-feed) advances

or retracts the carriage across the ways. This motion may control the depth of a cut for a turning or boring operation or may advance the cutting tool across the face of a workpiece in a facing operation.



Cross-Feed Handwheel

Compound Handwheel

The compound handwheel (also known as the compound feed) advances or retracts the toolpost along the angle at which the compound is set as indicated by the protractor. The compound handwheel typically is used for making short tapered cuts, limited by the range of motion of the compound slide, and for thread cutting operations.

Both the cross-slide and compound handwheels have graduated collars that can be used to measure the movement of the cutting tool towards or away from the workpiece. By grasping the graduated dial while holding the handwheel steady, the graduated dial can be set to a zero reading to facilitate making a cut to a specific depth.



Calibrated Handwheel Dial

Carriage Lock Screw

For certain operations such as facing, in which the tool is advanced across the face of the work by the cross-feed handwheel, it is good practice to lock the carriage to the ways to prevent the carriage from moving during the cut. If the carriage were to move during a facing cut, the result would be a slightly concave or convex cone-shape rather than a perfectly flat surface on the end of the workpiece.



Locking the carriage

The carriage is locked by turning the carriage lock screw clockwise using a 5mm hex wrench. When the locking screw is used for the first time it may be in the locked position as shipped from the factory to prevent the carriage from shifting position during shipment.

Always check to make sure that the locking screw is unlocked before attempting to move the carriage with the carriage handwheel or power feed.

Power Feed (Half-Nut) Lever

The Power Feed Lever, also known as the Half-Nut Lever, is located on the right side of the apron at the front of the lathe, next to the carriage handwheel. It is used to drive the carriage under power for turning and threading operations.



Power Feed (Half-Nut) Lever

When turned about 45 degrees to the right, it clamps a pair of “half-nuts” around the thread of the lead screw. If the lead screw is engaged and rotating, the carriage will be moved along the ways under power from the leadscrew. Before engaging the Power Feed Lever, ensure that the carriage is not locked to the ways by the Carriage Lock Screw.

When the spindle is rotating in the Forward direction, the carriage is moved towards the headstock. With the spindle rotating in the Reverse direction, the carriage moves away from the headstock. Moving the lever back to the vertical position disengages the half-nuts from the leadscrew and stops the motion of the carriage.

X-Y Auto Feed Lever

Located on the right side of the apron, next to the Power Feed Lever, the X-Y Auto Feed Lever controls the motion of the carriage when used with the optional milling head accessory, but can also be used for lathe operations. When using the X-Y Auto Feed Lever, the Power Feed lever must be disengaged.



X-Y Auto Feed Lever

In the lower position, the X-Y Auto Feed lever moves the carriage along the ways, much like the Power Feed lever, but at a slower speed. This feature is useful for making fine finishing cuts using power feed.

In the upper position it functions as a power cross-feed control and moves the cross slide away from the operator towards the back of the lathe. When the motor is reversed, the power cross feed moves the cross slide towards the operator. In the center, "0" or neutral position, the feed is disengaged.

Tailstock Handwheel

Rotating the tailstock handwheel moves the tailstock quill (also known as the tailstock ram) in and out of the tailstock. This feature is used during drilling operations and when a center is used in the tailstock to support long stock.

Tailstock Quill Lock

When the tailstock is used in stationary operations, as when supporting the end of long stock, the quill may be locked in place using the tailstock quill lock. A quarter turn of the handle is sufficient to lock or unlock the quill.

Tailstock Locking Handle

The tailstock locking handle on the rear of the tailstock locks the tailstock at any location along the ways. The tailstock is locked by pulling the lever towards the operator and released by pushing the lever away from the operator. If necessary, the clamping action

may be adjusted by removing the tailstock from the end of the lathe ways and adjusting the locking nut on the underside of the tailstock.

A stop screw located between the ways at the right end of the lathe prevents the tailstock from falling off the end of the lathe. This screw must be removed before sliding the tailstock off the end of the ways for adjustment.

Tailstock Offset Feature

To turn long tapers on a workpiece mounted between centers, the tailstock may be offset horizontally from the lathe centerline. To offset the tailstock, loosen the two small setscrews below the cam lever on the right side of the tailstock, then loosen the two setscrews on the front and back sides of the tailstock.



Tailstock Offset Indicator

The two screws on the front and back of the tailstock work in opposition to each other to offset the tailstock; as one screw is tightened the other must be loosened by a corresponding amount. The amount of offset may be gauged by observing the offset indicator guide on the right end of the tailstock.

After completing the taper operation, the tailstock is restored to its normal position at the horizontal centerline. Accurate alignment using a test bar and dial indicator is recommended.

Electronic Controls

The main power switch for the lathe is the red rocker switch located on the control panel. A green pilot lamp illuminates when the power is on. A fuse holder above the pilot lamp contains a replaceable 20 Amp fuse to protect the lathe from electrical overloads.

Control Panel



Control Panel

A soft-touch panel of buttons controls the lathe spindle speed and direction:

- ↕ - Increase spindle RPM speed
- ↔ - decrease spindle RPM speed
- Start** – start the spindle motor
- P** – set spindle to forward rotational direction
- Q** – set spindle to reverse rotational direction
- Stop** – stop the spindle motor

Setting the Spindle Speed

To start the spindle rotation, press the **Start** button. The current spindle rotational speed and direction (FOR or REV) are displayed on the digital display.



Spindle-speed tachometer

When the lathe is powered on or the **Emergency Stop** button is reset, the display will momentarily display 8888, then will display 0000.

To increase the speed of spindle rotation, depress and hold down the ↕ button. To decrease spindle speed, depress and hold down the ↔ button. Small incremental changes to the spindle speed may be made by momentarily pressing the buttons. To stop the spindle rotation, press the **Stop** button.

The first time that the **Start** button is pressed after turning on the power to the lathe, or after resetting the **Emergency Stop** button, the spindle will begin turning at its slowest speed, about 100 RPM.

When the operating speed is adjusted to a higher RPM, the new speed is saved when the **Stop** button is pressed. When **Start** is pressed again, the lathe will resume operating at the saved speed. The saved speed is cleared when the lathe is powered off or the **Emergency Stop** button is pressed.

Emergency Stop Button

Located below the **Start** button, the red **Emergency Stop** button is used to quickly stop the spindle in the event of an emergency,

such as a workpiece working loose from the chuck.



Emergency Stop button

Pressing the **Emergency Stop** button firmly with the heel of the hand will bring the spindle to a stop and keep the lathe from restarting until the **Emergency Stop** button is reset by rotating the knurled rim of the button in a clockwise direction.

Pressing the **Start** button, or any other control on the panel, will have no effect until the **Emergency Stop** button is reset. When the **Emergency Stop** button is reset, the spindle speed will also be reset to the minimum speed of about 100 RPM.

Spindle Disengagement Knob

The large silver knob to the right of the **Emergency Stop** button engages and disengages the spindle from the motor drive while still allowing the leadscrew to turn and move the carriage under power from the gear train.



Spindle Disengagement Knob

When performing milling operations using the milling head accessory ([Item # 87-116-027](#)) the

spindle should be disengaged for safety so that the rotating chuck does not pose a hazard.

With the lathe stopped, turn the knob to the right about $\frac{1}{4}$ turn to disengage the spindle. To re-engage it, rotate the knob to the left while also turning the chuck by hand to allow the gears inside the head to mesh. The knob should not be moved while the motor is running.

Tooling and Accessories

Operation of the lathe requires certain basic necessities such as cutting tools. Optional accessories such as a 4-jaw chuck and milling head extend the capabilities of the lathe to perform advanced types of work. Safety gear, such as safety glasses and eye shields help to protect the lathe operator.

This section describes some useful accessories and tooling for the SC4 lathe.

High Speed Steel Cutting Tools

For the home machinist and light industrial user of the lathe, High Speed Steel (HSS) cutting tools are used for most cutting operations. Along with finished versions, these tools can be purchased as blanks and ground to the desired cutting shape using a bench grinder.



Set of HSS cutting bits

Item # [22-501-102](#)

Aside from low cost, the main benefit of HSS tools is that specialized tool shapes can be ground as needed for operations such as chamfering, material cut-off and boring.

4-Jaw Independent Chuck

A 4-jaw chuck can hold stock with a square or rectangular cross-section in addition to round and octagonal stock. Unlike the standard 3-jaw chuck, in which all of the jaws move together, on the 4-jaw chuck the jaws adjust independently, enabling them to clamp irregularly-shaped stock.



4-Jaw Chuck

Item # [87-116-026](#)

Adjusting the jaws individually makes it possible to center a round workpiece, or a reference point on an irregular workpiece, with great precision. This feature is useful when a workpiece has features on opposite ends that must be machined on exactly the same axis. Offsetting the workpiece also makes it possible to drill off-center holes and to turn cam lobes.

Digital Caliper

Digital calipers are convenient measuring tools for many lathe operations. They measure outside and inside diameters as well as hole depths to a resolution of 0.0005". They switch instantly between metric and inch units, so you work in either format.



Digital Caliper

Item # [57-016-060](#)

Center Drills

Center drills, also known as a drill & countersink, are short and stiff and therefore do not flex.

Standard-length drills may flex and wander a small amount when they first start to penetrate the surface of the work. The flexing may cause the starting point to be off-center and therefore the drilled hole may be off-center and not perfectly parallel to the axis of the workpiece. Therefore, it is recommended always to use a center drill to start a drilled hole



Center Drill

Center drills are available in many sizes and made of various materials, much like drill bits. For work on the SC4, a set of 5 HSS center drills, #1 through #5 in size, will meet most of the needs the operator is likely to encounter.



Set of five Center Drills

Item # [01-095-000](#)

Tailstock Chuck and Arbor

For most drilling operations, the drill bit is held in a Jacobs-type chuck mounted in the tailstock by means of a #2 Morse Taper arbor.



Jacobs-style chuck

Item # [63-100-004](#)

Since the chuck and the arbor are purchased separately, care must be taken that the front taper of the arbor that mates with the chuck is the proper size for the chuck.

Chucks for use on a lathe usually have a female Jacobs Taper, so an arbor is needed with a #2 Morse Taper on one end and a Jacobs Taper matching the chuck taper on the other end.



Arbor for tailstock chuck

Item # [63-004-821](#)

Arbors, such as the one in the photograph, often have a flat tang at the end of the Morse Taper, used to drive the arbor in some types of machinery. For use in the SC4 tailstock, the tang needs to be cut off using a hacksaw, metal-cutting bandsaw or abrasive cutoff wheel. Part of the Morse Taper may also need to be cut off in order for the arbor to fit properly in the tailstock bore.

The chuck generally is permanently mounted to the arbor. To do this, first wipe the JT end of the arbor and the corresponding JT taper in the end of the chuck with a clean shop rag to remove any oil, grease, chips or grit. It is important that both mating surfaces be free from any contamination to ensure a tight, secure fit. Insert the JT taper end loosely into the chuck taper, then rap the opposite end of the arbor firmly on a board to drive the tapered

end sharply into the chuck. The arbor should now be tightly coupled to the chuck.

When mounting the arbor in the tailstock taper, again, both tapers should be free from any oil, grease or grit to ensure a tight coupling. Hold the chuck in one hand, then snap it rapidly into the tailstock taper to ensure that the tapers lock securely together.

The tailstock chuck arbor is removed from the tailstock by rotating the tailstock handwheel counterclockwise until the arbor is forced out. When cutting off the excess end of the arbor, care must be taken to ensure that it is not cut too short, or it will not be long enough to be forced out of the tailstock for removal.

Drill Sets

Drill sets in inch, metric and number and letter sizes will provide a great range of capabilities when using the lathe as a precision drill press.



Inch-size Drill Sets

End Mills

End mills are the most commonly used cutting tools for milling operations when using the optional milling head accessory ([Item # 87-116-027](#)).

End mills are available in a wide range of sizes, configurations and materials specialized for different types of work. For general use, a set of 2- and 4-flute, high-speed-steel (HSS) is convenient to start with, as it will handle many basic operations.



Set of 2- and 4-flute end mills
([Item # 09-335-905](#))

Eye Protection

Lathes produce hot and sharp metal chips that can fly out from the cutting area at high speed to a distance of 24 inches or more. Always wear appropriate industrial-quality safety glasses or face shields when operating the lathe. Safety shields attached to the machine or held by a magnetic base may also be used together with eye protection for additional safety.



Safety glasses
[Item # 96-085-300](#)



Face shield
[Item # 97-000-794](#)



Safety shield

Item # [99-003-525](#)

Cutting Fluid

For many lathe operations, cutting fluid is used to reduce friction and improve chip clearance. Proper use of cutting oil will extend tool life, reduce stress on the lathe and improve the quality of the cut surface. Modern cutting fluids are specially formulated for specific metals and operations. For most lathe work, a general-purpose cutting fluid such as Tap-Magic® or Tapmatic® is appropriate.



Tap Magic® Cutting Oil

Item # [81-002-914](#)



Tapmatic® Cutting Fluid

Item # [81-007-050](#)

When machining aluminum, a specially formulated cutting fluid such as Tap-Magic® Aluminum will give superior results. It helps prevent chips from welding to the cutting edges of the tool – a common problem when machining aluminum.



Tap Magic Aluminum

Item # [81-002-928](#)

Initial Safety Checks

Before the lathe is used for any machining operations, it should be checked for proper operation.

- Use the handwheels to move the carriage, cross-slide and compound through their full range of motion.
- Turn the chuck by hand through a few full turns. Ensure that the gears in the gear train on the left side of the lathe are turning smoothly. Verify that everything is moving freely without binding or excessive resistance.
- If the chuck is installed in the spindle, ensure that all of the retaining nuts are tight and that the chuck key has been removed.
- Turn on the red power switch. The digital tachometer should display 0000 and the sound of the cooling fan should be heard.
- Ensure that the cutting tool is clear of the chuck, then lower the chuck safety shield. The lathe will not start with the safety shield in the raised position.
- Press the green **START** button to start the spindle rotation.
- Use the \hat{e} and \hat{e} buttons to gradually increase the spindle speed from slow to high speed and back to slow speed again to verify that the speed controls are functioning properly and that the spindle turns freely.

If any unusual noises or other unexpected events occur, contact **Travers Technical Support** for assistance.

Technical Support
(1-800-234-9985, press 4)
Fax: 718-661-5637
Email: tech@travers.com

Regular Safety Checks – Each Time Machine is Used

Before beginning any cutting operation:

- Always wear industrial-quality safety glasses or use a safety face shield when operating the lathe.
- Make sure that the chuck key has been removed from the chuck.
- Clear away any strands of material that may be left from prior operations from the area of the chuck.
- Loose material could become entangled in the chuck or the workpiece and pose a hazard.
- Lower the chuck safety shield over the chuck. The motor will not start with the guard in the raised position.
- Be sure that the work is securely held in the chuck jaws and not mounted at a skewed angle. Grasp the end of the workpiece and attempt to move it – make sure that it is not loose.
- Verify that the cutting tool and any other objects are clear of the chuck and the workpiece before starting the lathe.
- Clear the work area of any objects that could cause you trip or slip; also any tools or other objects on or near the lathe that are not required for the current operation.
- Avoid loose sleeves or loosely fitting shirts that could become entangled in rotating parts. Remove or secure necklaces and other jewelry.
- Tie back long hair to avoid getting it entangled in the rotating chuck and workpiece.
- Use recommended cutting fluids to reduce the force required by the cutting tool. This will help keep the tool cooler and increase its life, and will make it less likely that chips will weld to the tool or workpiece causing rough surface finishes.

- Never reach over or across the area of the rotating chuck or cutting tool.
- Never attempt to remove strands of material while the chuck is rotating. Stop the lathe, then use pliers to remove any excess material that could pose a hazard or obstruct the view of the work.
- Before removing the workpiece from the chuck, move the cutting tool away from the workpiece. The sharp tip of the cutting tool could cut you.
- Be careful when removing work that has just been machined. Both the work and the tool used to cut it may be very hot from the frictional forces of cutting.

Using the 3-Jaw Chuck

A 5-inch 3-jaw chuck is included with the lathe. The chuck attaches to the spindle by three studs threaded into the back of the chuck which pass through corresponding holes in the spindle plate and are locked in place by nuts.

Always ensure studs are properly threaded into the back of the chuck before mounting the chuck on the spindle. Before starting the lathe, verify that the nuts holding the chuck on the spindle are securely tightened.



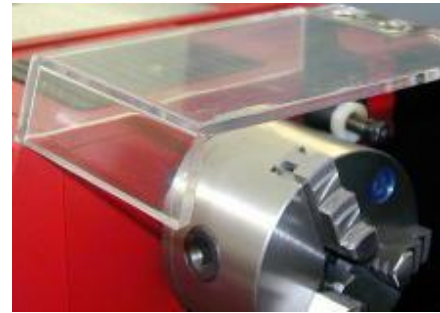
3-Jaw Chuck

The jaws of the chuck are opened or closed by inserting the square end of the chuck key into any one of the three key slots and rotating the key clockwise to tighten the jaws or counter-clockwise to loosen the jaws. A spring is fixed to the end of the key to prevent the key from being left in the chuck, which would pose a safety hazard.



Chuck key with safety spring

A safety shield is mounted above the chuck to ensure that the chuck key is removed from the chuck before starting the lathe. When the safety shield is in the raised position, an electrical interlock switch prevents the lathe from starting.



Chuck Safety Shield

The standard jaws mounted in the chuck when it is shipped from the factory can grip a cylindrical workpiece. The jaws can also grip short tubular stock by expanding them outward to grip the inside diameter of the tubing. Since the gripping surface is not very large, this procedure should be restricted to rigid-wall tubing no longer than 4" in length.

A second set of jaws shipped with the chuck can grip the outside diameter of larger diameter stock than can be gripped by the standard jaws. These are called external jaws.

Remove the standard jaws by rotating the chuck key counter-clockwise until the jaws drop out of their slots in the chuck. Place a shop rag on the ways below the chuck to prevent the jaws from dropping on and denting the ways.

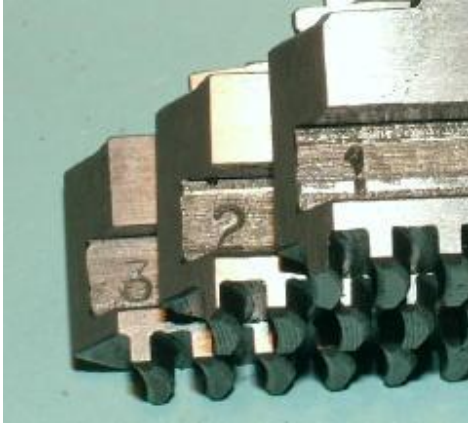


External chuck jaws

When installing the external jaws, or re-installing the standard jaws, the jaws are individually numbered 1, 2 and 3 and must be installed in that sequence. The numbers

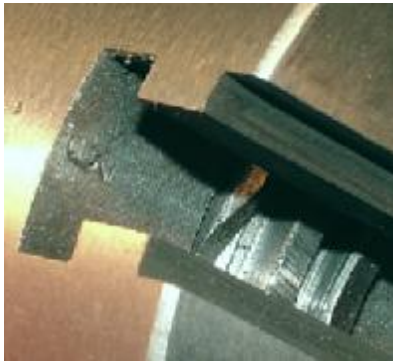
usually are stamped into the channel above the teeth. Some chucks have corresponding numbers stamped into each slot of the chuck. In that case, install the corresponding jaw in each slot, in sequence from #1 to #3.

#2 and jaw #3, then advance the jaws to make sure that they all meet evenly at the center of the chuck. If not, back them out and repeat this procedure.



Numbered chuck jaws

To install the jaws, look at the front of the chuck through one of the jaws slots. Slowly rotate the chuck key clockwise until the leading edge of the spiral scroll appears in view in the slot.



Start of spiral in slot #3

Rotate the scroll in the opposite direction until the leading edge moves back under the edge of the slot. Now press jaw #1 into the slot as far as it will go and hold it in position.

Rotate the chuck key clockwise again so that the leading edge of the scroll thread engages with the teeth of the jaw. Continue rotating the chuck key until the leading edge of the scroll thread is visible in the next jaw slot. Install jaw

Basic Lathe Operations

The following procedures describe typical sequences for setting up a workpiece for basic lathe operations. Before operating the lathe, please review the safety practices.

In the following sections we will explore these basic lathe operations:

- Facing
- Drilling
- Turning
- Short Taper Turning

These operations are the most commonly used on the lathe and account for perhaps 80% or more of all lathe work.

Stock Preparation

All of these operations will use a piece of aluminum round stock 1" in diameter x 2 1/2" long. The exact length and diameter are not critical, but the workpiece should be at least 3/4" diameter and between 2" and 3" long.

Select a suitable piece of material and mount it in the chuck jaws. As the jaws are tightened around the stock, twist the stock slowly back and forth to ensure that it seats evenly between the three chuck jaws.

Make sure that the stock is not skewed at an angle. Tighten the jaws firmly. It is good practice to use two, or all three, of the key slots to tighten the chuck to ensure that the workpiece is secure and properly aligned in the chuck jaws.

Cutting Tool Selection

Lathe cutting tools usually are made either from high speed steel (HSS) or carbide or a similar very hard material. Factory-made carbide cutting are convenient, since they are already configured in various shapes for standard cutting operations. They also have a

long life, particularly in high-volume industrial settings. They can be purchased in sets with a variety of commonly used shapes.

Cutting tools come in many sizes to accommodate different sizes of lathes.

The C4 uses tool bits with a 5/16" square cross-section.

On larger tool bits, the tip of the cutting surface may be above the centerline of the lathe. While HSS tools could be ground down until the tip is the right height, there is no easy way to accommodate carbide tools if the tip is too high.

HSS tools are an excellent choice for the home shop and other non-industrial settings. They are inexpensive, will last for a long time and when properly shaped and sharpened will provide an excellent surface finish on most materials. Plain HSS blanks can be purchased in a variety of cross-sectional sizes to accommodate the size of the lathe or special cutting requirements.



5/16" HSS Tool Blank

Item # 22-501-020

HSS tools usually are sharpened by the lathe operator on a bench grinder, but also may be purchased in pre-sharpened sets including a variety of shapes. The sharpening process requires some skill and experience and is beyond the scope of this manual, but many resources describing the process can be found on the internet and in technical text books. Searching with Google for "grind lathe tool" will locate several useful resources.

An advantage of HSS tools over carbide tools is that they may be ground to unique shapes for specialized cutting operations. For example, small blanks may be used to form a thread cutting tool for cutting very fine threads.

For the exercises in the following sections of this manual we will use a single HSS tool bit with an easily formed shape that be used both for facing and turning operations. The tool was ground on a bench grinder from a 5/16" square x 2 1/2" long tool blank.



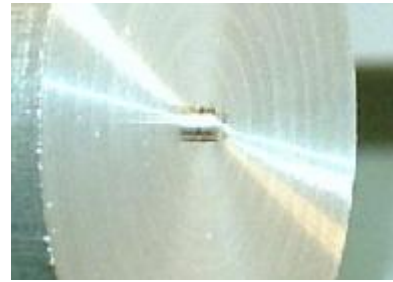
Cutting tool tip

Note that the sides of the tool bit near the cutting tip are undercut to provide clearance. Without sufficient clearance, or "relief", the edges of the tool will rub against the workpiece without proper cutting action.

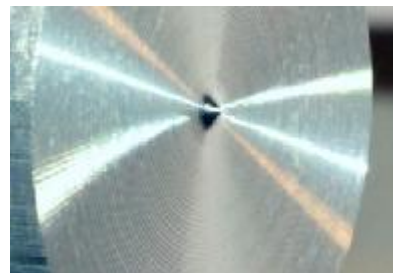
Setting the Tool Height

For proper cutting action the top edge of the cutting tool must be aligned with the centerline of the lathe. If the tip of the tool is higher or lower than the centerline, it will tend to rub against or dig into the workpiece rather than cutting smoothly.

On a facing operation, if the tip of the tool is too high or too low a small nub of material will be left at the center of the face: usually a tapered cone shape if the tool is too high and a narrow cylinder if the tool is too low. If the tool tip is too high, resistance usually will be felt in the cross-slide handle as the tip of the tool approaches the center of the workpiece. These effects make a facing operation a convenient way to check the height of the cutting tool.



Too Low



Too High

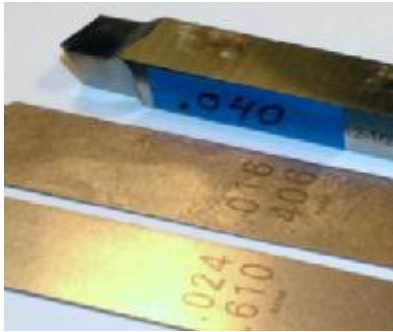


Correct Height

The height of the cutting tool is adjusted by inserting shims underneath the tool. A set of automotive feeler gages that can be removed from their holder makes a convenient set of shims for this purpose.

Another method for setting the tool height is to align the tip of the cutting tool with the point of a dead center mounted in the tailstock. Insert a dead center into the tailstock ram to act as a reference for the lathe centerline.

Adjust the toolholder so that the tip of the cutting tool is near the tip of the dead center, then select shims of various thickness and stack them underneath the base of the cutting tool until the tip of the cutting tool is at the same height as the tip of the dead center. Then firmly tighten the hold-down screws to lock the cutting tool in place.



Two spacers totaling 0.040"

A pair of two shims will do the job. After finding a combination that's just right, write the required thickness on a piece of masking tape stuck to the tool; then you'll know what shims to use next time you use that tool. Over time, as the tool is sharpened, metal is removed from the top surface of the cutting edge, thus lowering the height of the tool and reducing the thickness of shims required.

Quick Change Tool Posts

Due to the time-consuming nature of setting tool heights using shims, experienced lathe users generally invest in a Quick Change Tool Post (QCTP). A QCTP uses a separate holder, with an adjustable height feature, for each tool. The proper height for each tool can quickly be set using a thumbscrew and, once set, ensures that the tool is at the correct height any time it is used in the holder. Therefore, tools can be changed in a matter of a few seconds.

Positioning the Tool

Mount the tool bit in the tool holder so that the tip extends no more than about $\frac{1}{2}$ " from the edge of the tool holder. The objective is for the tool to be as rigid as possible and to avoid overhang that could cause flexing of the tool holder that can result in chatter. Chatter is a squealing or screeching sound from the tool that indicates that vibrations are occurring.

Chatter will cause uneven variations in the surface of the workpiece which often are visible upon inspection. For the same reason the compound slide should be extended no more than necessary. The farther back it sits over the center of the compound, the more rigid is the setup.



Tool positioned for a facing cut

The tool bit should be approximately centered under the clamping screws of the tool holder. For a 2- $\frac{1}{2}$ " long tool bit, only two clamping screws are used to hold the bit. The shims under the tool bit should not extend out much beyond the edge of the base of the tool holder.



Tool bit height adjusted by shims

For the following exercises, the compound should be set to an angle of 30° as indicated by the protractor scale at the reference mark on the left side of the compound base plate. This angle is not critical, and with experience each lathe operator tends to develop their own preferences regarding the setting of the angle.

A 30° angle is convenient because each division that the compound is advanced on its

dial moves the tip of the tool 0.0005 (one-half thousandth) towards the face of the workpiece.



Compound set to 30°

Depending on the type of operation being performed, the tool post usually is rotated to bring the cutting tip of the tool into the desired orientation with the workpiece. For example, for a facing cut, the tool post is angled so that the left side of the cutting tool is at a slight angle (say 10°) to the face of the workpiece.

For a turning cut, the tool may be at the same, or a similar, orientation; however the cutting would now be done by moving the tip of the tool to the left (towards the headstock) along the length of the workpiece.

Rotational Speed Selection

Different machining operations and materials require different cutting speeds for optimal results. In general, harder materials such as stainless steel are machined at lower speeds and softer materials such as aluminum at higher speeds.

The important factor is the speed at which the edge of the cutting tool passes over the surface of the workpiece. For larger diameter work, the tool moves over the work surface faster than for a smaller diameter workpiece rotating the same number of RPM. Cutting speed also depends on the speed at which the tool is advanced into the work, known as the feed rate.

Similarly, when drilling holes, larger diameter drills are used at lower RPM than smaller diameter drills. A full discussion of the details of cutting speeds is beyond the scope of this

manual. Detailed information can be found in technical manuals such as *Machinery's Handbook*® and on the Internet. For example see [Feeds and Speeds in Wikipedia](#).

While cutting speeds and feeds are critical in industrial settings where maximum production throughput is the goal, for the home shop and light industrial use they are not nearly as demanding. For most cutting operations on the SC4 lathe a speed of between 600 and 1200 RPM will work well, with lower speeds being used for harder materials and higher speeds for softer materials.

Rotational speeds above 1500 RPM are used mainly for polishing and for drilling with very small drills. Very low speeds are used for threading, tapping and reaming. In fact, these operations may be performed by manually turning the spindle using a hand crank engaged in the left end of the spindle.

Facing a Workpiece

Facing removes material from the end, or face, of the workpiece. When working with relatively small diameter stock, say less than 3" diameter, facing cuts generally are made by rotating the cross-feed handle by hand. To face a larger diameter workpiece the SC4 has a power cross feed capability.

When making a facing cut, it is important to use the carriage lock to lock the carriage to the ways. Otherwise, the cutting force on the face of the workpiece could cause the carriage to move away from the end of workpiece while the cut is being taken. If this happens, the face will have a slight conical shape rather than being exactly square to the centerline of the workpiece.



Tool positioned for a facing cut

Following is a step-by-step procedure for making a facing cut.

1. Insert a piece of round stock in the chuck as described in Stock Preparation above.
2. Select a cutting tool suitable for a facing operation and mount it in the toolholder using shims if necessary to bring the tip of the tool even with the lathe centerline.
3. Loosen the compound lock screws and adjust the angle of the compound so that it reads 30° on the protractor, lining up with the reference mark on the left side of the compound. The exact angle is not critical. Tighten the compound lock screws.
4. Verify that the workpiece is secure in the chuck and that there are no tools, shards of material or other hazards near the chuck.
5. Loosen the toolpost handle and adjust the angle of the toolholder relative to the workpiece. The left side of the cutting tool should be at about a 10° angle to the face of the workpiece.
6. Verify that the tool is securely held in the toolholder and that the tool holder is tightened down.
7. Use the carriage handwheel and cross-slide handwheel to move the tip of the cutting tool close to and at a glancing angle to the end of the workpiece.
8. Use a 4mm hex wrench to lock the carriage lock.
9. Verify that the Emergency Stop button is in the unlocked (outward) position and that the chuck safety shield is in the lowered position. The lathe will not start unless these conditions are met.
10. Turn on the power to the lathe if it is not already on, then press the green **Start** button on the control panel. Verify that the chuck is rotating counterclockwise (**Forward** on the digital display).
11. Advance the cross-slide until the tip of the cutting tool begins to make a shallow cut across the face of the workpiece. If necessary use the compound feed handwheel to move the tip slightly to the left to make contact with the end of the workpiece.
12. Once the tip of the cutting tool makes contact, continue turning the cross-slide handwheel to move the tip of the tool across the center of the workpiece. Turn at a slow, even pace – about one rotation per second. Once the center is crossed, rotate the cross-slide handwheel counterclockwise to withdraw the tool back beyond the edge of the workpiece.
13. Use the compound handwheel to advance the tool 10 divisions, then use the cross-slide handwheel to once again move the tool across the face of the workpiece, removing a thin layer of metal.
14. After crossing the center of the workpiece, withdraw the tool until it clears the front edge of the workpiece.
15. Press the **Stop** button on the control panel

Caution: *the edge of a facing cut can be very sharp. Avoid touching the sharp edge.*

At this point you should have a smooth even face on the workpiece. If there is a small nub at the center, the tip of the cutting tool is either too high or too low. Usually the nub will appear cylindrical if the tool is too low and cone-shaped if the tool is too high. To correct this condition, add or remove shims underneath the tool to bring the tip of the cutting tool in line with the center of the workpiece face.



Smooth finish after facing

If the surface is rough or grooved, the tool may be too sharply pointed. The area of the tool in contact with the workpiece should be smooth or rounded, not a sharp point. Also, advancing the tool too rapidly can leave a series of spiral grooves on the surface, rather than a smooth face. If necessary, adjust your tool and repeat the process until you achieve a satisfactory result.

Cleaning up a Facing Cut

Next a small file is used to clean up the sharp edge of the face. This is standard practice after making a facing cut, to remove the hazardous sharp edge before handling the workpiece. This step requires a small file, preferably about 4"-6" in length with a flat smooth face. For safety, the file must have a wooden or plastic handle over the tang.



Filing the edge after facing

Warning: *Never use a file without a handle designed for that purpose. The tang of the file could be driven into your palm or wrist causing serious injury.*

Caution: *In the following procedure the file will be used near the rotating chuck. This is a*

standard practice on metal lathes, but requires your full attention. Until you are experienced in this operation do not attempt it if there are visitors in your shop or anything else that could distract you.

1. Move the carriage towards the tailstock until the cutting tool is at least 6-8" away from the end of the workpiece.
2. Press the **Start** button
3. Grasp the handle of the file in your left hand and the tip of the file in your right hand. Both hands are used to ensure good control of both ends of the file. The left hand is used on the handle to avoid reaching over the spinning chuck.
4. Carefully bring the flat edge of the file into contact with the rotating sharp edge left by the facing operation. The flat surface of the file should be at about a 45° angle to the edge.
5. Apply mild pressure for just a few seconds. As the workpiece rotates, the file will clean up the edge all the way around. You may work the file forward as you would in a normal filing operation to enhance the cutting action.
6. Carefully withdraw the file from the area of the chuck and place it in a safe place on the workbench.
7. Press the **Stop** button

At this point, the workpiece can safely be handled. However, it will be used in the following operations so should be left in the chuck for now.

Facing with Power Feed

While the workpiece is still set up for a facing operation, we will next demonstrate the use of the power cross-feed feature of the SC4. When the power cross feed lever is engaged, the cross-slide is moved under power of the leadscrew towards the center of the workpiece.



X-Y Auto Feed Lever

Note: the following operation assumes that the gear train is set up to the factory default configuration. If the gear train has been changed from the default, do not attempt this exercise as the feed rate may be too fast for safe operation.

Verify that the factory default gears are in place and that the gears are engaged to turn the leadscrew. If necessary, loosen the locking bolt for the gear train assembly and swing the gears to mesh with the spindle drive gear, then lock the bolt.

Before making an actual facing cut, the following procedure will familiarize you with the power cross feed with the tool at a safe distance away from the workpiece.

1. Move the carriage towards the tailstock until the cutting tool is at least 6-8" away from the end of the workpiece.
2. Press the green **Start** button. Confirm that the leadscrew is rotating.
3. Set the rotational speed to about 600 RPM.
4. Move your hands clear of the cross-feed handle as it will rotate under power in the next step.

Caution: In the next step, be sure to move the X-Y Auto Feed lever upwards; moving it downwards will cause the carriage to move to the left. Move your hands clear of the cross-feed handle as it will rotate under power.

Note: When engaging the power feed, it may be necessary to apply light pressure to the X-Y

Auto Feed lever for several seconds until the leadscrew meshes with the power feed gear. The lever should then drop into the engaged position.

5. Push the handle of the X-Y Auto Feed lever to the left, then rotate it **upwards** to engage the power cross-feed. The cross-feed handwheel should be rotating clockwise and that the cross-slide should be moving slowly away from the operator.
6. After the tip of the cutting tool has moved across the center of the workpiece, push the handle of the X-Y Auto Feed Lever to the left, then rotate it **downwards** to the center ("0") position to disengage the power cross-feed.
7. Rotate the cross-slide handwheel manually counterclockwise to move the cross-slide back approximately to its starting position.
8. Repeat steps 5-7 a few times until you are completely comfortable with the procedure for using the power cross-feed.
9. Press the red **Stop** button.

Next we will repeat the power cross feed procedure but this time actually making a facing cut on the workpiece.

1. Use the carriage handwheel and cross-feed lever to manually move the cutting tool into proximity of the work, as you would to take a facing cut.
2. Use a 4mm hex key to lock the carriage lock.
3. Use the cross-slide handwheel and/or compound handwheel to move the tip of the tool until it is just touching the face of the workpiece.
4. Grasp the outer collar of the compound handwheel and while holding the handle steady, rotate the collar to set the dial to zero.
5. Rotate the cross-slide handwheel counterclockwise until the tip of the cutting tool is clear of the face of the workpiece.
6. Press the green **Start** button. Confirm that the leadscrew is rotating.

7. Set the rotational speed to about 600 RPM.

Move your hands clear of the cross-feed handwheel as it will rotate under power in the next step.

8. Use the compound feed to advance the tip of the cutting tool 10 divisions. This will set a cutting depth of 0.005" (5 thousandths) for the facing cut. The compound is used here to set the depth of cut because the carriage is locked to the ways.

9. Push the handle of the X-Y Auto Feed Lever to the left, then rotate it **upwards** to engage the power cross-feed. You should observe that the cross-feed handle is rotating clockwise and that the cross-slide is moving slowly away from the operator with the cutting tool making a facing cut on the end of the workpiece

10. After the tip of the cutting tool crosses the center of the workpiece face, push the handle of the X-Y Auto Feed Lever to the left, then rotate it **downwards** to the center ("0") position to disengage the power cross-feed.

11. Rotate the cross-slide handwheel manually counterclockwise to move the cross-slide back approximately to its starting position, clear of the workpiece.

12. Repeat steps 8-11 a few times until you are completely comfortable with the procedure for using the power cross-feed.

13. Move the carriage well away from the end of the workpiece and use a file to clean up the sharp edge of the face.

14. Press the red **Stop** button.

15. Use a hex key to unlock the carriage lock.

The cross-slide also can be withdrawn under power feed by reversing the rotational direction of the spindle by pressing the **Reverse** button (Q) on the control panel after completing the inward cut. That feature is convenient when facing a relatively large diameter workpiece of 4" or more.

Center Drilling a Workpiece

Drilling into the end of a workpiece is another very common lathe operation. It is good practice always to make a shallow conical starter hole using a center drill before drilling with a regular drill bit.

Drilling into the end (face) of a workpiece nearly always is preceded by a facing operation to prepare a flat surface, square to the length of the workpiece in which to drill. Complete the facing operation described in the previous section before beginning the following center-drilling operation on the same workpiece.



Center Drilling a workpiece

For maximum accuracy, it is good practice to extend the tailstock ram only as far as needed for the depth of the drilled hole.

1. If it is not already in place, mount the tailstock drill chuck into the tailstock.
2. Mount a center drill in the tailstock chuck. Twist the drill slowly while tightening the chuck jaws to ensure that the drill bit seats evenly between all three jaws, then tighten the jaws firmly.
3. Move the carriage as needed to make room to slide the tailstock up close to the workpiece.
4. Use the cross-slide handwheel to withdraw the cross-slide back away from the work area to make room for drilling.
5. Loosen the tailstock locking cam-lock lever and slide the tailstock towards the headstock until the tip of the center drill is

close to the end of the workpiece. Lock the tailstock in place.

6. Check to make sure that the tailstock ram lock lever (located near the front of the tailstock) is not in the locked (tightened) position. Unlock it if necessary by turning it counterclockwise about ½ turn.
7. Apply a few drops of cutting fluid to the tip of the drill bit
8. Check to make sure that the area around the chuck is free from any hazards, then press the green **Start** button.
9. Set the speed to about 800 RPM. Make sure that the chuck is rotating in the **Forward** (counterclockwise) direction.
10. Use the tailstock handwheel to advance the tip of the center drill into the workpiece.
11. Continue advancing the drill tip into the workpiece until the angled portion of the center drill is nearly covered. This completes the depth for the center drill hole.
12. Withdraw the center drill from the hole and then press the **Stop** button.
13. Disengage the tailstock cam lock lever, then slide the tailstock towards the right end of the lathe.
14. Remove the center drill from the drill chuck and return it to its storage location.



Completed center-drilled hole

The completed hole should have a smooth, even appearance.

Drilling a Workpiece

The procedure for drilling a hole into the workpiece is similar to the center-drilling operation except that the drilled hole usually is deeper. Sometimes the hole is drilled only part way into the workpiece; in other cases, for relatively short workpieces, the hole may be drilled all the way through until the drill bit emerges from the opposite end of the workpiece.



Drilling a workpiece

In either case, if the hole to be drilled is more than about three times the diameter of the drill bit, it is regarded as a “deep hole”. When drilling deep holes the drill bit should be withdrawn from the hole to allow chips to be cleared after every advance of about three drill bit diameters.

The drill bit can be withdrawn by reversing the rotation of the tailstock handwheel while the work is still rotating. If the hole is “very deep”, say ten times the diameter of the drill or more, it may save time to unlock the tailstock and slide the tailstock towards the back of the lathe to clear the chips. The tailstock can then be advanced until the drill bit reaches the point where it left off to continue drilling the hole.

Failure to clear chips from a deep hole can cause the chips to “weld” to the surface of the drill bit or the workpiece resulting in an oversized hole with rough, uneven walls. Cutting fluid will also help to prevent welding of the chips and is recommended for nearly all drilling operations on the lathe. A few drops applied to the tip of the drill bit each time it is

advanced into the workpiece is sufficient to do the job.

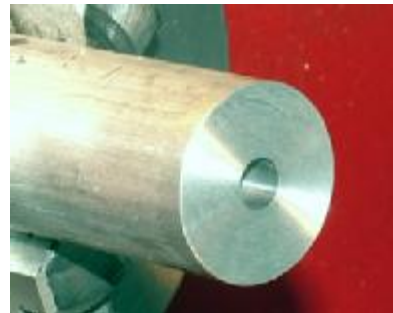
1. Mount a ¼" diameter drill bit in the tailstock chuck. Twist the drill slowly while tightening the chuck jaws to ensure that the drill bit seats evenly between all three jaws, then tighten the jaws firmly.
2. Loosen the tailstock cam lock and slide the tailstock towards the headstock until the tip of the drill bit is close to the end of the workpiece. Lock the tailstock in place.
3. Apply a few drops of cutting fluid to the tip of the drill bit.
4. Check to make sure that the tailstock ram lock lever (located near the front of the tailstock) is not in the locked (tightened) position. Unlock it if necessary by turning it counterclockwise about ½ turn.
5. Check to make sure that the area around the chuck is free from any hazards, then press the green **Start** button.
6. Set the speed to about 800 RPM. Make sure that the chuck is rotating in the **Forward** (counterclockwise) direction.
7. Use the tailstock handwheel to advance the tip of the drill bit into the workpiece. Turn the handle at a slow, steady pace, allowing metal shards to exit the hole.
8. Continue advancing the drill tip into the workpiece for a depth of about four rotations of the tailstock handwheel.
9. Rotate the tailstock handwheel counterclockwise (as viewed from the end of the lathe) to withdraw the drill bit completely from the hole.
10. Use a small (1") chip brush to clear the chips or strands of aluminum from the drill bit. If the strands adhere to the drill bit, posing a safety hazard, stop the lathe and use a pair of needle-nose pliers to remove the strands.

Warning: metal strands from drilling can be extremely hot and sharp and can cause deep cuts on fingers. Always turn off the lathe and

use leather gloves or pliers to remove sharp metal shards.

11. Apply a few drops of cutting fluid to the tip of the drill bit.
12. Advance the drill bit back into the workpiece until it begins drilling again. Continue advancing the drill bit for another four turns of the tailstock handle.
13. Press the **Stop** button
14. Disengage the tailstock cam lock lever, then slide the tailstock away towards the right end of the lathe.
15. Remove the drill bit from the chuck and return it to its storage location.

Depending on the required depth of the hole, and whether or not the hole will be drilled all the way through the workpiece, the above steps are repeated as necessary to complete the drilling operation.



Completed drilled hole

When drilling holes larger than about 5/16" diameter, or whenever maximum hole-size accuracy and alignment is required, it is good practice to drill the hole using a sequence of two or more drill bits of increasing diameter. This technique reduces the amount of metal that must be removed during a single drilling pass, thus creating a more accurately sized hole with a smoother internal bore.

For maximum accuracy of the hole diameter and concentricity, it is good practice to drill the hole about 1/64" undersize and then finish the hole using a chucking reamer of the required final hole size. Chucking reamers are available in sets, much like drill bits.

Turning a Workpiece

Turning is the process of removing material from the outside surface of a cylindrical workpiece to reduce its diameter. This might be done, for example, to form the end of a shaft to fit into a bearing.

During a turning operation the cutting tool is advanced a small distance into the side of the workpiece. Then the carriage is moved at a steady rate towards the headstock, either by turning the carriage handwheel by hand or by moving the carriage using power feed. As the carriage moves along, material is removed all along the length of the workpiece that the cutting tool contacts, thus reducing the diameter.

Typically, several passes are made, since the amount of material to be removed often is too large to be done in one pass. The goal of these initial passes, called roughing cuts, is to quickly remove material to approach the final required diameter.

If a fine surface finish is required, one or two finishing cuts are made, removing only a few thousandths of an inch of material on each pass with the carriage traveling relatively slowly along the workpiece.

The following exercise is a continuation of the previous operations and assumes that the workpiece is already set up as in the completion of the drilling operation.

1. Adjust the angle of the toolholder so that only the rounded tip of the tool bit will contact the side of the workpiece. The side of the tool bit should be at about a 95-100° angle to the side of the workpiece – similar to, but slightly less than the angle it was at for facing – with the tip slightly closer to the headstock than the end of the tool bit.



2. Verify that the carriage locking screw is in the unlocked position.
 3. Position the tip of the tool so that it is close to the side of the workpiece.
 4. Advance the cross-slide handwheel until the tip of the tool just touches the side of the workpiece.
 5. Holding the handwheel with one hand, rotate the calibrated sleeve with the other hand to set it to zero.
 6. Rotate the carriage handwheel to move the tool to the right until it is clear of the end of the workpiece.
 7. Press the **Start** button.
 8. Adjust the spindle speed to about 800 RPM
- Note:** When making a turning cut, the depth of the cut as indicated by the cross-feed dial is the depth removed from the radius of the workpiece; **the diameter will be reduced by twice that amount.** Thus, taking a cut of 5 divisions (five thousandths) will reduce the diameter by 0.010 (ten thousandths).
9. Rotate the cross-feed dial by 5 divisions to remove ten-thousandths (0.010") from the diameter of the workpiece.
 10. Slowly rotate the carriage handwheel counter-clockwise to move the carriage towards the headstock. As the carriage moves, the cutting tool removes material from the workpiece, reducing its diameter.



Turning Cut

11. After advancing the carriage by about 1", rotate the carriage handwheel in the opposite direction to move the cutting tool back past the right end of the workpiece. This movement may be done fairly quickly.
12. Note that as the tool moves to the right, it may leave a spiral groove in surface of the work. For this reason, the tool usually is withdrawn slightly before moving the carriage back to the starting point.
13. Repeat steps 9-12 until you are comfortable with the steps of the turning procedure.
14. Repeat steps 9-12 two more times, but with the following variation:
15. When the tool has reached the end of its travel towards the chuck, make a note of the current dial reading of the cross-feed.
16. Now rotate the cross-feed dial one full turn counterclockwise to move the tip of the cutting tool away from the surface of the workpiece.
17. Move the carriage back to the right end of the workpiece to begin the next pass.
18. Rotate the cross-feed dial about one full turn back to the setting that you took note of in step 15, then advance it by an additional 5 divisions.
19. Continue as before. In this variation of the procedure, the tool is withdrawn to avoid making a spiral groove on the workpiece when the carriage is moved back past the end of the workpiece.

20. When you are familiar with this process, move the carriage away from the end of the workpiece and press the **Stop** button.

This process has reduced the diameter of the workpiece and produced a smooth even finish of a specific diameter. In actual operating practice, a digital caliper or micrometer would be used to check the diameter of the workpiece as the desired diameter is approached, resulting in a final diameter exactly as needed for the specific project being done.

Turning with Power Feed

In the next exercise, we will repeat the turning process using the power feed feature. The steps are essentially the same except that the power feed is used to move the carriage towards the headstock.

Note: *the following operation assumes that the gear train is set up to the factory default configuration. If the gear train has been changed from the default, do not attempt this exercise as the feed rate may be too fast for safe operation. Verify that the factory default gears are in place and that the gears are engaged to turn the leadscrew. If necessary, loosen the locking bolt for the gear train assembly and swing the gears to mesh with the spindle drive gear, then lock the bolt.*

Caution: *when the carriage is moving under power feed, the carriage handwheel will rotate. Keep hands and tools clear of the rotating handwheel. The handwheel may be pulled towards the operator to disengage it so that it does not rotate when power feed is in use.*

Caution: *When the power feed lever is engaged, the carriage will move under power towards the headstock. Great care must be taken to ensure that the carriage and/or tool do not run into the rotating chuck.*

The workpiece should have at least 2" of stock extending from the chuck jaws to provide sufficient room to work. Running the carriage into the chuck can damage the chuck, the

carriage, and the leadscrew and may endanger the operator.

Avoid distractions in the shop during power feed operations: control of the lathe requires your undivided attention!

Keep your right hand on the power feed lever, ready to disengage it quickly. Use low spindle RPM settings (400 RPM) until you are familiar with making cuts using power feed.

1. Use the carriage handwheel and cross-slide handwheel to move the tip of the cutting tool close to the end of the workpiece.
2. Advance the cross-slide until the tip of the cutting tool begins to make a shallow cut into the side of the workpiece.
3. Once the tip of the cutting tool makes contact, rotate the power feed (Half-Nut) lever about 45 degrees clockwise until it locks into position.
4. The carriage should be moving towards the headstock and the carriage handwheel may be rotating.
5. As the tip of the tool moves along the side of the workpiece, it should remove a layer of material along the diameter, thus reducing the diameter.
6. After advancing the carriage about 1", rotate the power feed lever counterclockwise until it reaches the stop near the vertical position.
7. Make a note of the current reading of the calibrated cross-feed dial. Retract the tool by rotating the cross-feed handwheel counterclockwise about one revolution.
8. Rotate the carriage handwheel clockwise to manually move the tip of the cutting tool back past the right end of the workpiece.
9. Advance the cutting tool to the setting of the cross-feed dial noted earlier, then advance the cross-feed an additional ten

divisions. This will set the tool for the next cutting pass.

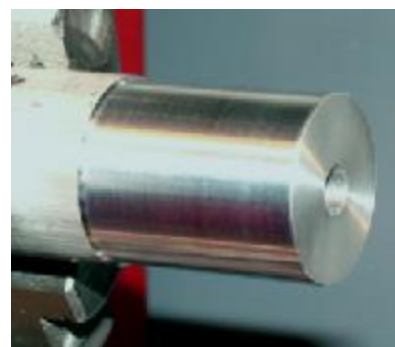
10. Repeat steps 3 through 8 to make two more passes along the workpiece.
11. Withdraw the cutting tool clear of the workpiece. Press the **Stop** button on the control panel to stop the lathe.



Workpiece after turning with power feed

Caution: As with a facing cut, a turning cut may also leave a sharp edge. Use a file to clean up the sharp edge before handling the workpiece.

The auto feed lever, in the downward position, drives the carriage along the ways much like the power feed, but at a slower speed. It is convenient for making a final finishing cut for a smooth finish.



Workpiece turned with fine-feed

Cutting Short Tapers

Short tapers, or bevels, are made by advancing the tool using the compound slide. The compound is rotated and locked into position such that the cutting tool moves outward (away from the bed) at a selected angle. For the following exercise, we will cut a 20° taper on the end of the workpiece used for the previous exercises.



Setup for bevel cutting

1. Move the tailstock all the way to the right end of the ways and remove the tailstock chuck to provide maximum working room for the following procedure.
2. Use a 4mm hex wrench to loosen the two cap head screws that secure the compound. (Note: if one of the gib screws is over the cap screw, move the compound-slide in or out until the cap screw is accessible.)
3. Rotate the compound slide counterclockwise until the 20° position on the scale is in line with the small index mark at the front of the protractor.
4. Lock the compound in this position by tightening the two 4mm cap head screws.
5. Loosen the toolpost locking handle and rotate the toolpost so that the tip of the tool is pointing towards the workpiece and the back edge of the toolpost is parallel with the edge of the compound slide. Lock the toolpost in this position.
6. Use the carriage handwheel and cross-slide handwheel to position the tip of the cutting tool near to the edge of the workpiece and drawn back about 1/2" towards the center of the workpiece face.
7. Lock the carriage in place.
8. Make sure that the work area around the chuck is clear of any tools or shards of material that might pose a hazard.
9. Press the **Start** button and adjust the spindle speed to about 800 RPM.
10. Turn the **compound** handwheel clockwise, advancing the tip of the cutting tool towards the edge of the workpiece.
11. If necessary, adjust the position of the tool using the cross-slide handwheel so that the tool is at a cutting depth of about 1/16".
12. Continue to advance the compound handwheel to make a cut diagonally across the edge of the workpiece. The tool should leave a beveled edge on the workpiece.
13. Rotate the compound handwheel counterclockwise to withdraw the tool back past the edge of the workpiece.
14. Advance the cross-slide handwheel by 10 divisions.
15. Repeat steps 10-14 until the beveled surface is about 1/4" wide.
16. Take 2 or 3 light finish cuts to leave a smooth even bevel on the workpiece.
17. Press the **Stop** button
18. Unlock the carriage and move the carriage clear of the workpiece



Completed bevel cut

At this point the next step would be to cut off and then face the unfinished end of the workpiece. The workpiece could be cut off using a cutoff tool or by removing it from the chuck and cutting it off using a hacksaw or metal-cutting band saw. These operations are beyond the scope of this manual.

Cutting Screw Threads

Screw threads often are most conveniently and quickly cut on the lathe using taps for internal threads and dies for external threads. For best control and safety, these operations should be done by engaging a shop-made handle into the left end of the spindle bore and turning the spindle manually using the handle. Detailed procedures for using taps and dies are beyond the scope of this manual.

Alternatively, both metric and inch threads may be cut using the threading feature of the lathe. This operation is known as single-point thread cutting because the tool used has a single point in the shape of one turn of the thread, rather than multiple cutting surfaces as in a tap or die. Threading is an advanced operation, so it is best to master the operations previously described in this manual before attempting thread cutting.

The shape, or form, of a thread cut by single-point threading is determined by the profile of the cutting tool. Both metric and inch threads use a very similar thread form, so the same type of tool may be used for cutting both types of threads. The type of thread, metric or inch, is determined by the pitch (the spacing between adjacent threads). Each system of units has standard pitches.

In general, larger diameter screws have fewer threads per inch (a larger pitch) than smaller diameter screws. However, each screw diameter is manufactured in several pitches for fine and coarse threading applications. For example, a 1/4" diameter bolt may have either 20 threads per inch (TPI) for coarse threads or 28 TPI for fine threads. These are designated as National Coarse (NC) and National Fine (NF) respectively.

A TPI designation that is NC for one screw size, for example 6-32, may be NF for a larger screw size, such as 8-32.

A thorough discussion of screw threads and threading is beyond the scope of this manual. Consult the Internet or technical reference manuals for detailed information on these subjects.

Setting Up a Gear Train

To cut a screw thread with a given number of threads per inch or per mm, a sequence of gears, called a gear train, is set up on the left end of the lathe. The train of gears is driven by a gear permanently attached to the spindle and drives the leadscrew in a fixed number of rotations for each rotation of the spindle.

For example, to cut 20 TPI, the lead screw must advance exactly one inch during 20 revolutions of the spindle. The specific gears required for each TPI setting are designated on charts attached to the lathe.

$1\frac{1}{8}$ "	8	9	10	11	12	14
A C	50 127	50 127	50 127	50 127	50 127	30 127
B D	100-40	100 45	100 50	100 55	100 60	120 35
$1\frac{1}{4}$ "	16	18	20	24	36	44
A C	30 127	30 127	30 127	30 127	30	30 100
B D	120 40	120 45	120 50	120 60	90 85	120 87
$1\frac{3}{8}$ "	56					
A C	30 85					
B D	120 94					

Gear chart for inch threads

Each box along the top of the chart shows the number of TPI: 8, 9, 10, etc. Below each TPI setting is a chart of four gear positions: A, B, C and D. The smaller numbers below each TPI setting designate the number of teeth on the gear at each position.

Thus for a 12 TPI thread, the gears would be

A:50, B:100, C:127, D:60.

The next exercise will cut a $\frac{1}{4}$ "-20 thread, or 20 threads per inch. The gear chart under the heading **20**, shows that the following gear train is required:

A:30, B:120, C:127, D:50.

The letters A, B, C and D correspond to four positions on the gear shafts to indicate which gear goes in each position. In the photo below, the gear shafts have been labeled to make it easier to visualize the position for each gear.



Note the spacer to the right of the D position. For some gear trains, the D gear may go where the spacer is shown, with the spacer moved to the outer position on the shaft.

The 30-tooth gear goes on the end of the shaft labeled A, the 120-tooth gear goes on the inner position of the shaft labeled C-B, the 127-tooth gear goes on the outer position of that shaft and the 50-tooth gear goes on the shaft marked D. The next photo shows the gears in their respective positions before they are locked in place with the lock washers and nuts.

Refer back to the gear chart above. Note that no gear is used in the C position for a 36 TPI thread. In that situation, the spacer ring on the D shaft is removed and the gear at D occupies the position where the spacer had been. Then the spacer is replaced where the D gear normally would go. In some cases, a small gear such as the 30-tooth may be used as a spacer without engaging any other gears.

The frame on which the B-C gears are mounted can be rotated to accommodate

various sizes of gears. In addition, the B-C shaft can be moved in or out along the arm of the frame.



In order to fit the gears onto the B-C shaft, it may be necessary to loosen the shaft by turning the square end counter-clockwise and then slide the B-C shaft further out along the support arm; then retighten the shaft. It may also be necessary to install the gears in a particular sequence so that one gear does not overlap and block the position of another gear.

When new, the gears may fit very tightly on the shafts. To remove the gears it may be necessary to use a pair of long screwdrivers to prise the gears gently off of the shaft. When removing the nuts that secure the gears to the shafts, use one hand to hold the spacing washers; they are slotted and will drop off of the shaft when the nut is loosened.

When all four gears have been secured by the washers, nuts and the bolt for the D shaft, loosen the square end of the B-C shaft and slide the B and C gears along the support arm until the C gear meshes with the D gear.

Tighten the square end of the shaft. Next, loosen the 14mm bolt on the cutout arc below the D shaft and rotate the entire gear train clockwise until the B gear meshes with the A

gear. After meshing the gears, tighten the 14mm bolt.

Rotate the lathe chuck by hand to make sure that gears are properly meshed and turn without interference. There should be a small amount of play, or free space, between the teeth of the meshed gears to keep the gear train from binding.

Gear trains for cutting metric threads are set up the same way but using a chart that shows the pitch of the thread in millimeters

mm	Λ	0.25	0.3	0.35	0.4	0.45	0.5
A	C	30 60	30 60	35 60	40 60	30 60	30
B	D	120 120	100 120	100 120	100 120	100 80	80-120
mm	Λ	0.6	0.7	0.75	0.8	1	1.25
A	C	30	50 70	45	50 80	50	50
B	D	100-100	100 100	80-120	100 100	80-100	100-80
mm	Λ	1.5	1.75	2	2.5	3	
A	C	45	49	50	50	45	
B	D	100-60	120-56	120-50	120-40	120-30	

Gear Trains for Metric Threads

Power feed gear trains also are set up the same way except that a lower gear ratio is used so that the rotational speed of the leadscrew is much lower than for threading.

mm	Λ	0.045 0.126	
A	C	30 60	50 70
B	D	120 120	100 100

Power Feed gear trains

Thread Cutting Exercise

For this exercise, select a piece of $\frac{1}{4}$ " diameter stock at least 3-4" long and mount it in the chuck with about 1-1/2" extending from the chuck. This is a greater extension than normally might be used for $\frac{1}{4}$ " stock, but it provides extra distance away from the face of the chuck for safety until you become familiar with the threading procedure.

If you don't have $\frac{1}{4}$ " diameter stock on hand, use the next larger diameter you have available.

Commercially manufactured bolts typically have a diameter a few thousandths of an inch less than the nominal bolt diameter. Thus a diameter of 0.245 will be used in this exercise.

1. Use a facing cut to form a smooth end on the workpiece.
2. Use a turning tool to turn down a length of about $\frac{3}{4}$ " to a diameter of $0.245" \pm 0.002"$. Check the diameter with a caliper or micrometer.

Next, perform the following steps to zero the calibrated dials:

1. Mount a thread-cutting tool in the toolholder.
2. Adjust the angle of the compound slide so that the 30° mark lines up with the reference mark at the left side of the compound base.
3. Bring the tip of the tool about $\frac{1}{8}$ " from the side, and close to the end of the workpiece.
4. Loosen the toolpost handle and rotate the toolpost until the tip of the tool is square to the side of the workpiece. This is best done using a "fishtail" gage.
5. Rotate the cross-slide handwheel a partial turn until the ball on the handle is pointing straight up. This position will serve as a convenient reference point later on.

6. Hold the cross-slide handwheel in place and rotate the calibrated ring until it is set to "0".
7. Rotate the compound handwheel until the tip of the tool just touches the side of the workpiece.
8. Hold the compound handwheel in place and rotate the calibrated ring until it is set to "0".

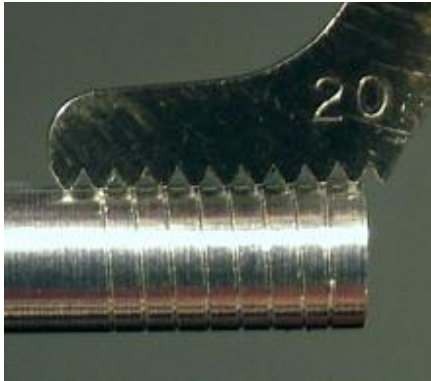
This procedure zeros the calibrated dials to the surface of the workpiece to facilitate measuring the depth of the threading cut.

Next, a test pass is made to verify the proper thread spacing.

1. If not already done, set up the gear train for a 20 TPI thread.
2. Apply light pressure to the half-nut (power feed) lever.
3. Rotate the chuck by hand counter-clockwise while maintaining pressure on the half-nut lever.
4. When the leadscrew threads mesh with the gear of the half-nut lever, the lever will drop into the engaged position.
5. Continue rotating the chuck about 5 or 6 turns.
6. The tip of the cutting tool should cut a shallow spiral groove into the side of the workpiece.



Use a ruler or a thread pitch gage to verify that the grooves are spaced 20 per inch. If they are not, recheck and correct the gear setup.



Checking TPI

Caution: Thread cutting should always be performed at the lowest speed setting (100 RPM). One way to ensure that the speed is at the lowest setting is to press the **Emergency Stop** button, then rotate it clockwise $\frac{1}{4}$ turn to reset it. The spindle speed will be reset to 100 RPM.

Warning: In the next steps the carriage will move rapidly towards the headstock. Keep a finger poised over the red **Stop** button and be prepared to stop the lathe quickly as the carriage approaches the rotating chuck.

The following steps cut the thread in multiple passes until the correct thread depth is reached. This exercise assumes that the tip of the cutting tool is zeroed to the side of the workpiece from the previous exercise.

1. Press the **Reverse** button (Q)
2. Press the **Start** button
3. The carriage should move to the right towards the tailstock
4. When the tip of the cutting tool is just past the end of the workpiece, press the **Stop** button.

The carriage is now positioned to begin cutting the thread.

Note: the following sequence of steps must be followed carefully to cut a good thread. The power-feed (half-nut) lever stays engaged through the whole procedure. If it is disengaged at any time, alignment of the thread may be lost on subsequent passes, creating a poor thread form.

Note: After two or three passes, as the thread becomes deeper, the depth of the cut must be reduced, advancing the compound only 3, 2 or 1 divisions rather than 5.

1. Advance the compound handwheel by 5 divisions to set the depth of the cut.
2. Press the **Forward** button (P). Verify that the digital display indicates **FOR**.
3. Press the Start button; keep your hand near the **Stop** button
4. Allow the cutting tool to cut about 1" down the length of the workpiece.
5. Press the **Stop** button
6. Rotate the **cross-slide** handle one full turn counter-clockwise so that the handle is at the bottom of its swing.
7. Press the **Reverse** button (Q). Press the **Start** button.
8. When the tip of the cutting tool clears the end of the workpiece, press the **Stop** button.
9. Rotate the **cross-slide** handle one full turn clockwise so that the handle is at the bottom of its swing and the dial is at "0".
10. Repeat steps 1-10 three more times. Each pass deepens the thread. As the thread becomes deeper, advance the compound by smaller amounts. Continue until the compound dial reaches a reading of 32. counterclockwise arrow



Thread gets deeper on each pass

11. Press the **Stop** button
12. Press the **Reverse** button (Q).
13. Press the **Start** button.
14. Allow the cutting tool to move past the right end of the workpiece.
15. Carefully use a file to slightly bevel the tip of the screw thread.
16. Press the **Stop** button.

Verify that a commercially-made ¼-20 nut fits smoothly over the thread.



This completes the thread cutting exercise.

Maintenance

To ensure a long lifetime of safe and accurate operation, lubrication and adjustments must be carried out on a regular basis.

Periodic Lubrication

The moving surfaces of the lathe, such as the dovetails and leadscrews, should regularly be lubricated. 20W non-detergent machine oil is recommended, but ordinary 10W-30 motor oil also works well for this purpose.

A light coating of oil should be maintained on the lathe ways at all times. This will help to prevent rust and will help the carriage and tailstock to move smoothly along the ways. All of the unpainted bright metal surfaces of the lathe, such as the tailstock ram, chuck, spindle, compound and cross-slide, leadscrew and carriage feed rack should be similarly protected to prevent rust.

Oil ports with spring-balls to seal out foreign material are provided at several locations on the lathe. An oiler with a fine tip that opens the ball while oil is dispensed should be used on these ports to inject a small quantity of oil. A few drops of oil should be injected into each port at least monthly, and more often if the lathe is used frequently.

If the lathe will not be used for an extended period of time of several months or more, all of the plain metal surfaces should be protected with a liberal coating of oil to help prevent rusting.

Bearing Race Lubrication

All of the sealed bearing races used in the lathe, such as those supporting the spindle, are permanently lubricated. No oil, grease or other lubricant or solvent should be applied to these bearings.

Bare Metal Surfaces

Bare metal surfaces such as the table, dovetails and quill should be protected by wiping them periodically with a light coating of oil to prevent rust. Light rust caused by damp conditions can be removed by wiping the affected area with WD-40 or a similar solvent.

Adjusting the Gibs

Gibs, or gib strips, are metal strips with a diamond-shaped cross section that are used as the bearing surface on one side of a dovetail slide. As the dovetails gradually wear with normal use, the gibs are adjusted to take up any clearance so that the dovetails operate smoothly and precisely.

On the cross-slide and compound slide, set screws with locking nuts are used to adjust the gibs. To adjust the gibs, loosen each locknut in turn, then gently tighten the set screw until resistance is felt.



gib adjustment screws

Back off the set screw 1/8 turn, then, while holding the set screw with a hex wrench so that it does not turn, tighten the lock nut. When the gibs are properly adjusted, the cross-slide and compound should be free from excess play, but move without resistance or excessive force needed to move the handwheels.

Appendices

Appendix A – Specifications

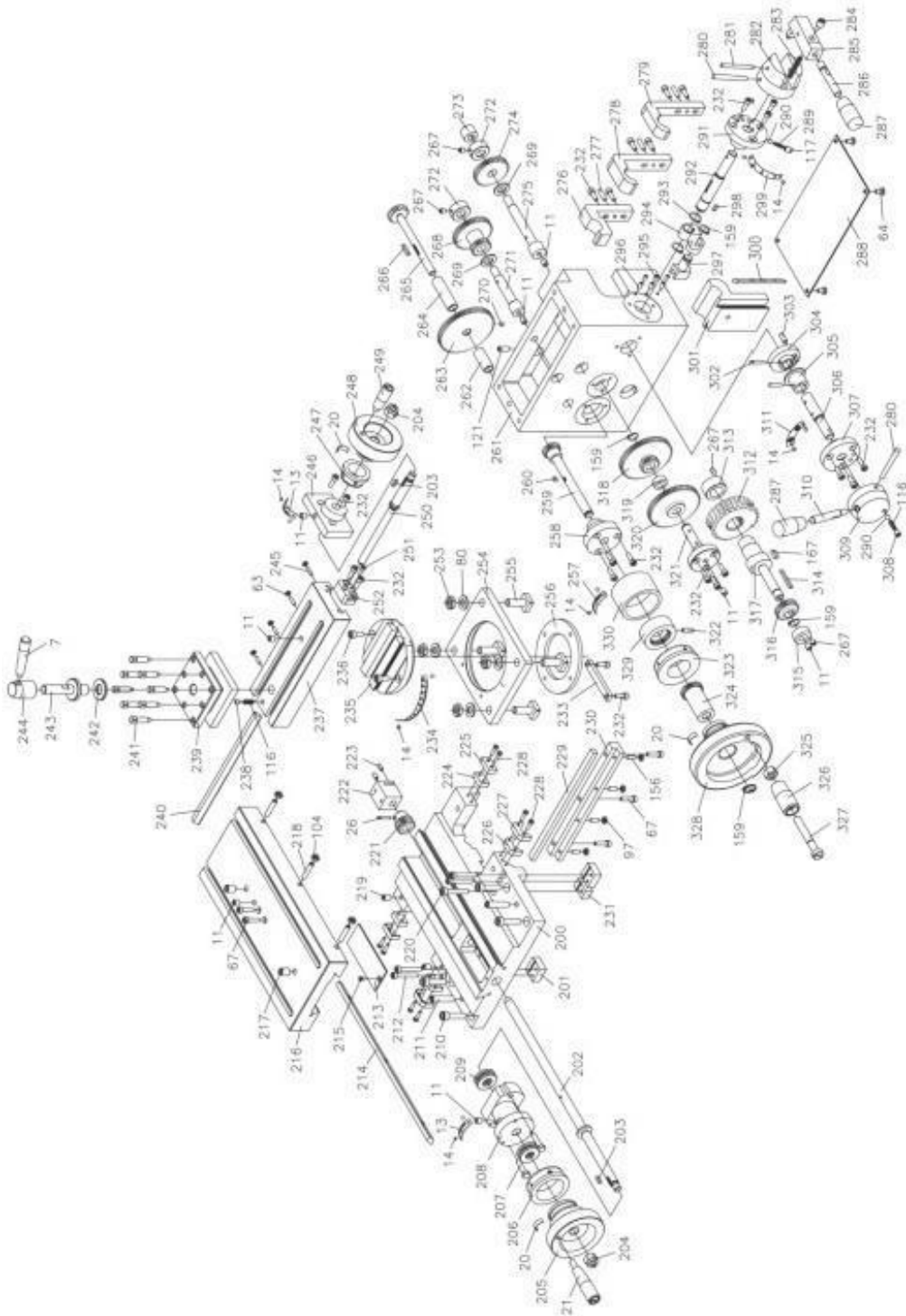
Lathe

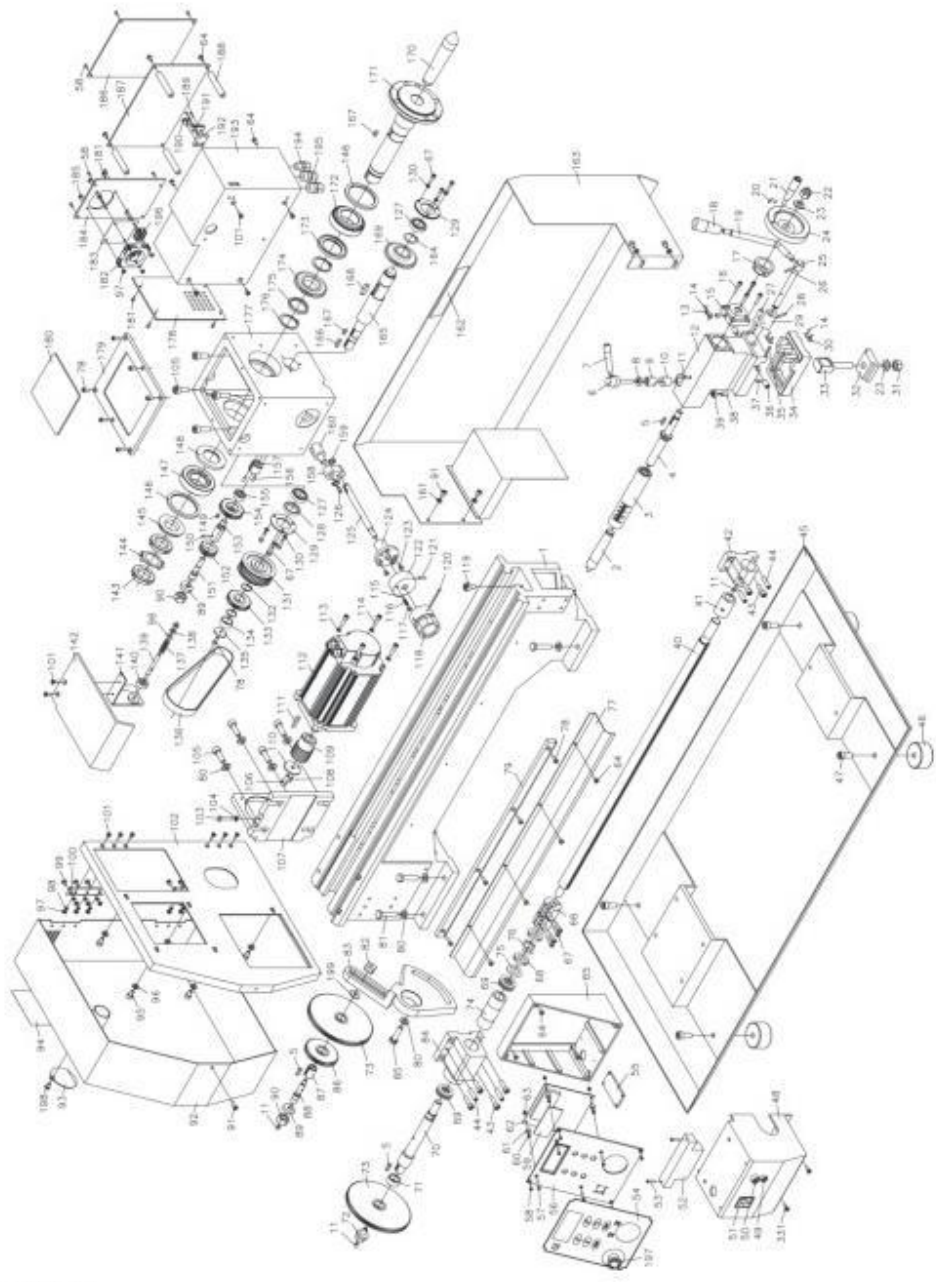
Swing over bed	8.27" (210 mm)
Distance between centers	16.14" (410 mm)
Spindle bore	0.79" (20 mm)
Spindle taper	MT #3
Tailstock taper	MT #2
Spindle speed	0-2000 RPM
Compound travel	3.50" (89 mm)
Cross slide travel	4.50" (114 mm)
Motor output power	1000 W
Thread range	8-56 TPI (13 thread pitches) 0.25-3.0 mm (17 thread pitches)

Milling Head Accessory

Drilling capacity	.39" (10 mm)
End milling capacity	.39" (10 mm)
Face milling capacity	.79" (20 mm)
Spindle taper	MT #2
Spindle speed	Low range: 100-1000 RPM \pm 10% High range: 100-2000 RPM \pm 10%
Spindle travel	1.18" (30 mm)
Headstock travel	5.51" (140 mm)
Spindle angle	30°L, 45°R
Motor	150 W

Appendix B – Parts Diagrams



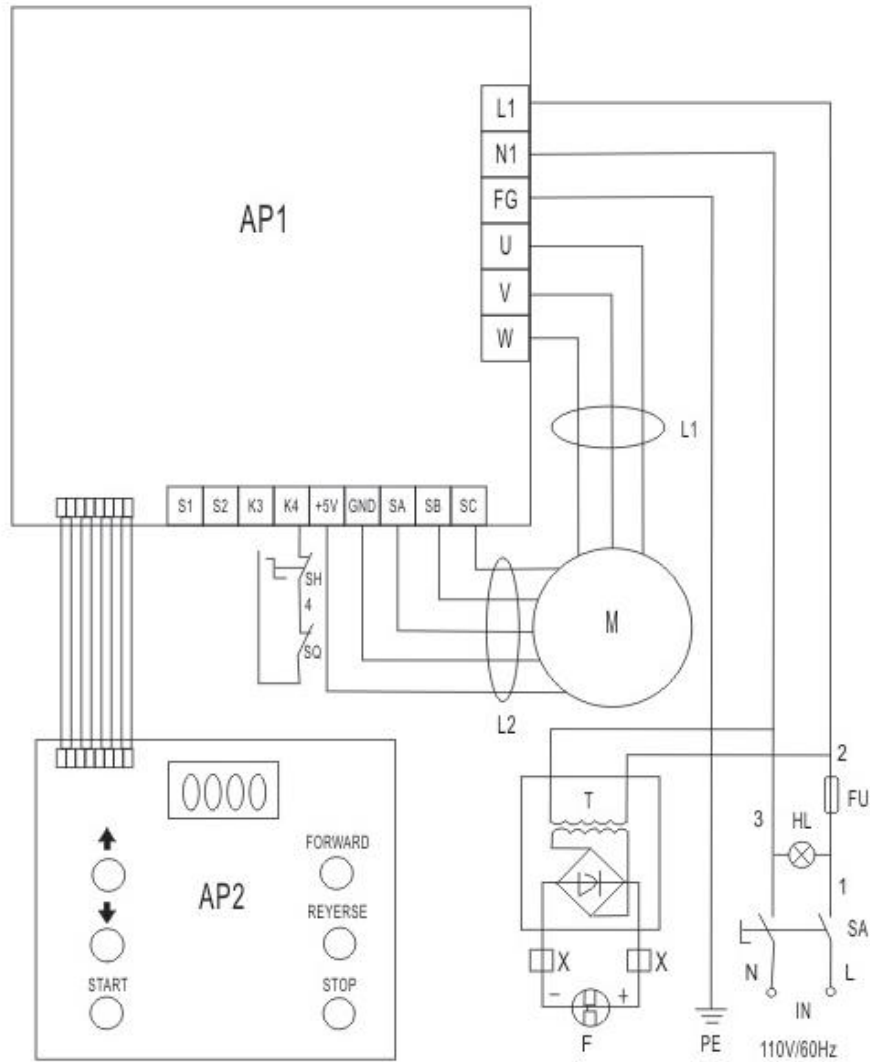


Appendix C – Parts List

No.	Description	Q'ty	No.	Description	Q'ty
169	H/L gear	1	211	pin 6*30	2
170	spindle center	1	212	screw M4*30	4
171	spidle	1	213	cover	1
172	bearing 32007	1	214	gib strip	1
173	oil ring	1	215	screw M3*6	1
174	spindle gear	1	216	cross slide	1
175	spacer	1	217	screw M8*12	2
176	check ring 30	2	218	screw M5*25	3
177	head stock body	1	219	screw M6*10	2
178	cover of electric box	1	220	screw M5*30	1
179	cover	1	221	gear	1
180	rubber	1	222	nut	1
181	screw ST2.9*9.5	6	223	screw M4*8	2
182	small fan	1	224	oil-stopping felt	2
183	protect mesh	1	225	protecting panel	2
184	small cover of electric box	1	226	oil-stopping felt	2
185	screw M4*16	4	227	protecting panel	2
186	big cover of electric box	1	228	screw M3*12	8
187	pc board	1	229	gib strip	1
188	stepping	4	230	rear clamp	1
189	screw M2*10	2	231	rear clamp	1
190	screw M4*12	2	232	screw M4*12	24
191	micro switch	1	233	finding block	1
192	bottom plate of micro switch	1	234	angle ruler	1
193	electric box	1	235	cutter rest revolving dial	1
194	lock connect M12	1	236	screw M5*12	2
195	lock connect M16	2	237	compound rest	1
196	connection pole	1	238	positing pin	1
197	emergency stop switch	1	239	tool rest	1
198	screw M5*8	1	240	gib strip	1
199	washer	1	241	screw M6*20	8
200	saddle	1	242	adjusting washer	1
201	front clamp	2	243	fuselage	1
202	lead screw	1	244	clamping lever	1
203	key 3*10	2	245	screw M3*12	4
204	lock nut M8	2	246	leadscrew support	1
205	handle wheel	1	247	dial	1
206	dial	1	248	handle wheel	1
207	bolt M5*20	2	249	knob M6*32	1
208	bearing seat	1	250	lead screw	1
209	bearing 8100	2	251	screw M3*8	1
210	screw M6*25	4	252	nut	1

No.	Description	Q'ty	No.	Description	Q'ty
253	nut M8	4	295	screw M4*6	3
254	stand	1	296	screw M4*8	3
255	T bolt	4	297	shifting block	1
256	rotating clamp	1	298	key 3*8	1
257	lable	1	299	cross feeding lable	1
258	shaft I sleeve	1	300	gib strip	1
259	shaft I gear shaft	1	301	half nut	1
260	key 3*6	1	302	pin 3*18	2
261	apron	1	303	pin 5*12	1
262	shaftII sleeve I	1	304	shifting dial	1
263	shaft II gear	1	305	lock wheel	1
264	shaft II sleeve II	1	306	shaft VII	1
265	shaft II gear shaft	1	307	finding flange sleeve	1
266	key 3*16	1	308	screw M6*6	1
267	screw M5*8	4	309	handle seat I	1
268	H/L gear of shaft V	1	310	bolt	1
269	washer	2	311	lable	1
270	screw M4*6	1	312	worm wheel	1
271	shaft V	1	313	shaft VI sleeve I	1
272	ring 10	2	314	key 3*28	1
273	shaft sleeve	1	315	shaft VI sleeve II	1
274	shaft IV gear	1	316	H/L gear	1
275	shaft IV	1	317	shaft VI	1
276	leadscrew support	1	318	shaft III H/L gear	1
277	pin B4*16	3	319	spacer	1
278	leadscrew supporting clasp II	1	320	shaft III gear	1
279	leadscrew supporting clasp I	1	321	shaft III	1
280	pin 4*45	2	322	screw M4*14	1
281	pin 4*40	1	323	dial	1
282	handle seat II	1	324	meshing gear of wheel	1
283	compression spring 0.8*5*30	1	325	nut M8	1
284	finding screw	1	326	handle	1
285	active handle block	1	327	screw M8*55	1
286	handle shank	1	328	handle wheel	1
287	long handle sleeve M8*40	2	329	inner gear sets	1
288	apron botton cover	1	330	protecting sleeve	1
289	Compression spring 0.6*3.5*12	1	331	screw M4*12	2
290	steel ball 5	2			
291	limit flange sleeve	1			
292	shifting knob	1			
293	check ring 12	2			
294	shifting arm	1			

Appendix D – Circuit Diagram



Appendix E – Packing List

No.	Descriptions	Q'ty
1	Bench lathe	1
2	Instruction Manual	1
3	L Hex. End Wrench S 2.5; 3; 4; 5; 6.	Each 1
4	Double end Wrench 8*10; 14*17; 17*19.	Each 1
5	Screw driver 125*9	1
6	Screw driver 2#	1
7	Key for 3-jaw chuck	1
8	Spindle dead center	1
9	Tailstock dead center	1
10	Change gear set	Set 1