



Advanced Technology and Manufacturing Institute

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Lathe Operating Procedures

Grizzly G4002 gear head lathe



WARNING

The operation of machine tools carries the inherent risk of maiming, disfigurement, and death. Thoughtful attention to all posted warnings, safety instructions, the condition of equipment, and the precepts of this manual is required for operation of machine tools at ATAMI. Failure to comply with safety standards will result in revocation of machine tool privileges.

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Introduction

The purpose of this document is to provide guidance on the safe and responsible operation and maintenance of the Grizzly G4002 Gear Head Lathe at the Advanced Technology and Manufacturing Institute. This manual is meant to be used in conjunction with the ATAMI Client Training and Tool Use Guidance.

1. Safety Requirements

The most important safety feature of any machine tool is the operator. Prior to using the lathe, ATAMI tenants and OSU researchers must complete the ATAMI introductory shop safety course and lathe operator safety course, or OSU's ME 250 (Introduction to Manufacturing Processes) course. The following safety requirements must be observed when using any machine tools:

- a. Full mental alertness is required for safe operation of machinery. Never operate under the influence of drugs, when tired, while distracted, or while ignorant.
- b. The operator shall be correctly attired, including close-toed shoes, safety glasses, and a lab coat.
- c. The machine tool shall be operated in accordance with this publication and the manufacturer's manual.
- d. For ATAMI tenants and OSU researchers, the time and purpose of the use shall be logged in the ATAMI resource tracker.
- e. Turn off the machine immediately upon any indication of damage or abnormal operation, and immediately inform an ATAMI staff member.

Failure to adhere to these requirements will result in loss of machine tool privileges until the operator safety course can be re-taken.

2. Precautions

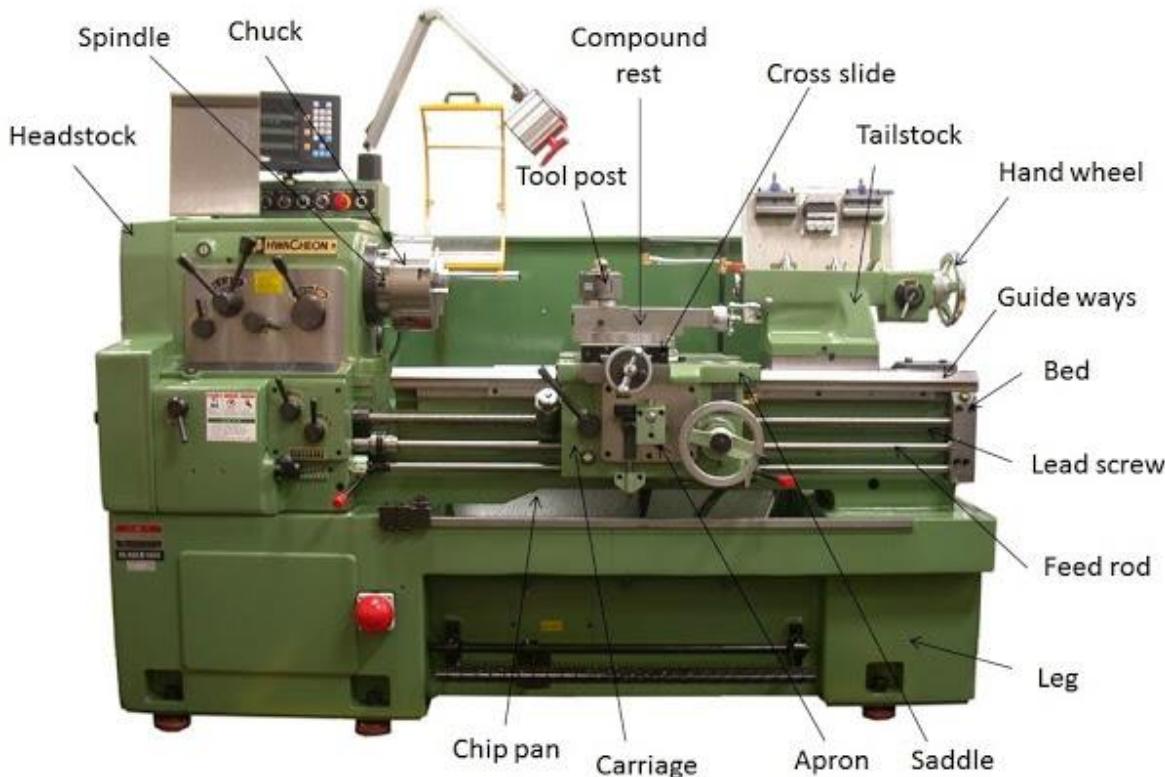
The following specific precautions apply to operating the lathe due to its design, construction, or condition:

- ROTATING PARTS. Always keep hands and body at a safe distance from rotating parts—especially those with projecting surfaces. Never hold anything against rotating workpiece that can pull you into lathe.
- ENTANGLEMENT. Entanglement with a rotating chuck can lead to death, amputation, broken bones, or other serious injury. Never attempt to slow or stop the lathe chuck by hand, and always roll up long sleeves, tie back long hair, and remove any jewelry or loose apparel BEFORE operating.
- AWKWARD POSITIONS. Keep proper footing and balance always when operating machine. Do not overreach! Avoid awkward hand positions that make workpiece control difficult or increase the risk of accidental injury.

- SECURE WORKPIECE. An improperly secured workpiece can fly off spindle with deadly force. Make sure workpiece is properly secured before starting the lathe.
- REMOVE ADJUSTING TOOLS. Tools left on machinery can become dangerous projectiles upon startup. Never leave chuck keys, wrenches, or any other tools on machine.
- USE THE CORRECT TOOL FOR THE JOB. Only use a tool for its intended purpose—do not force it or an attachment to do a job for which it was not designed. Never make unapproved modifications—modifying tool or using it differently than intended may result in malfunction or mechanical failure that can lead to personal injury or death!
- MACHINE INSPECTION. Inspect the machine tool prior to starting. Do not use the machine if any abnormal condition exists. Ensure all adjusting and measuring tools are removed or do not interfere.

3. Machine and Tooling Description

Lathes are machine tools for performing turning, boring, threading, and rotational work on a piece of raw material. On a lathe, the raw material to be worked is held in a chuck and rotated while the tool is held in position against the workpiece to remove material.

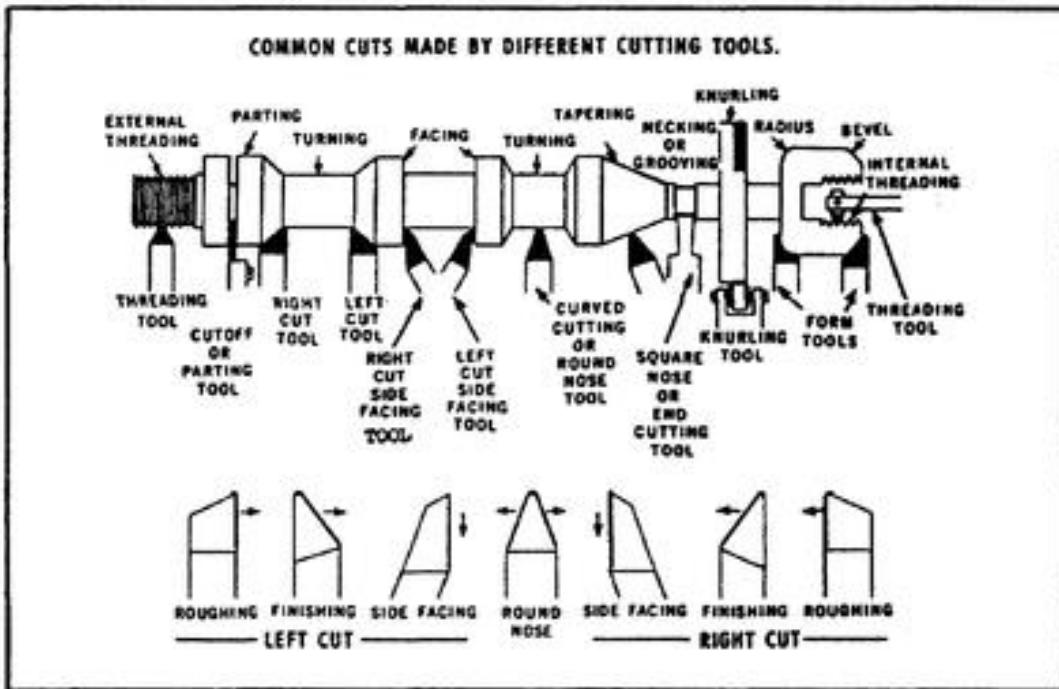


A gear head lathe similar to the Grizzly G4002, with parts labeled.

The gear head lathe is used for precisely machining rotational features in metal or plastic stock. The stock is mounted in the chuck and rotated, while the tool is held by the tool post, itself mounted on the movable carriage and cross slide. The operator precisely positions the cutting tool by rotating the

handwheels on the carriage and cross slide. The motion of the carriage and cross slide can be coupled to the rotation of the spindle for cutting threads and producing consistent surfaces.

The profile of the cut and surface finish after the cut are determined by the shape and material of the cutting tool. At ATAMI, most cutting tools are high speed steel blanks ground into the correct



shape. These kinds of tools are excellent for aluminum, plastic, and mild steel applications. Carbide tooling is available for cutting harder steels but will be used on a case by case basis due to cost.

An example of different lathe tool cutter shapes and their applications

Depending on the tool geometry and mounting, a variety of axially symmetric features can be cut into the stock.

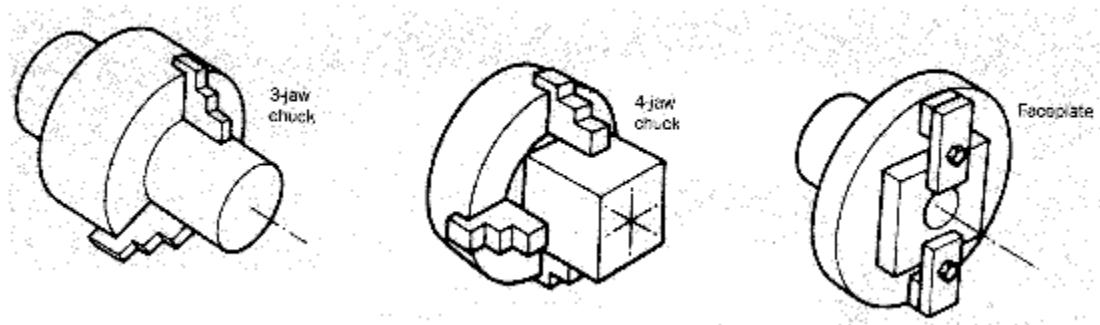
Face Turning	O.D. Turning	I.D. Turning (Boring)	Grooving and Profiling	Threading
Machining of a face on the part.	Machining of a profile on the outside diameter the part.	Machining of a profile on the inside diameter the part.	Machining between two edges on the part.	Machining of threads on the part.

Examples of lathe operations

Setup

1. Workholding

Workholding for the lathe is primarily accomplished with the three-jaw six-inch chuck. The chuck is operated with the chuck key. Clockwise rotation of the key tightens the chuck, and counterclockwise rotation loosens it. If your work piece does not fit in the three-jaw chuck, a larger four-jaw chuck and faceplate are available.



Three jaw chuck, four jaw chuck, and faceplate.

Securely fastening the workpiece to the chuck is vital for safe operation of the lathe. Improperly secured workpieces can be ejected from the lathe at deadly speeds.

To use the chuck:

- a. Insert the chuck key and rotate counterclockwise to loosen the chuck
- b. Place the workpiece between the jaws of the chuck. Three-jaw chucks automatically center round stock along the axis of the chuck as the chuck is tightened.
- c. Rotate the key clockwise to tighten the chuck. Once the key is hand tight, check to ensure the workpiece is securely mounted.
- d. Ensure the chuck key is removed prior to starting the machine.

2. Speed Selection

The lathe cutting speed and feed rate can be adjusted for various materials, depths of cut, and surface finishes. Cutting speed is defined as the rate at which the material being cut passed the cutting edge and is always expressed in inches per minute or feet per minute. Cutting speed is determined from a table based on depth of cut and the material of the workpiece. The cutting speed of a lathe is adjusted by changing the RPM of the spindle. Due to the nature of rotation, the cutting speed of a lathe changes not only with RPM of the spindle but the diameter of the workpiece as well. A standard equation for finding RPM from cutting speed and workpiece diameter is:

$$RPM = (4 * Cutting\ Speed) / (Part\ Diameter)$$

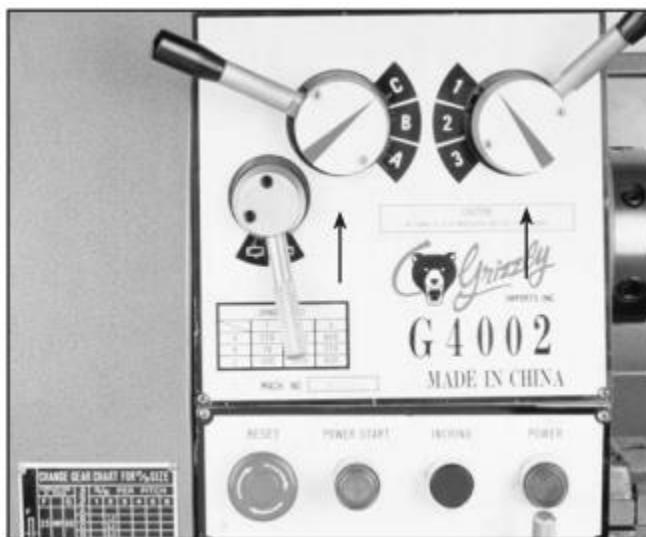
This equation will very rarely correlate to an actual RPM setting on the lathe and should be rounded down to the next lower RPM setting.

MATERIAL	STRAIGHT TURNING SPEED		THREADING SPEED	
	FEET PER MINUTE	METERS PER MINUTE	FEET PER MINUTE	METERS PER MINUTE
LOW-CARBON STEEL	80-100	24.4-30.5	35-40	10.7-12.2
MEDIUM-CARBON STEEL	60-80	18.3-24.4	25-30	7.6-9.1
HIGH-CARBON STEEL	35-40	10.7-12.2	15-20	4.6-6.1
STAINLESS STEEL	40-50	12.2-15.2	15-20	4.6-6.1
ALUMINUM AND ITS ALLOYS	200-300	61.0-91.4	50-60	15.2-18.3
ORDINARY BRASS AND BRONZE	100-200	30.5-61.0	40-50	12.2-15.2
HIGH-TENSILE BRONZE	40-60	12.2-18.3	20-25	6.1-7.6
CAST IRON	50-80	15.2-24.4	20-25	6.1-7.6
COPPER	60-80	18.3-24.4	20-25	6.1-7.6

NOTE: Speeds for carbide-tipped bits can be 2 to 3 times the speed recommended for high-speed steel

The speed of the lathe can be adjusted to setpoints between 70 and 1400 RPM by adjusting the selectors on the headstock. Speed is determined by the material of the workpiece and cutter, the diameter of the workpiece, and maximum intended depth of cut. The standard cutters at ATAMI are high-speed steel adequate for aluminum, plastic, and many mild steels. To adjust spindle RPM:

- With the lathe motor off, adjust the gear head speed shifting levers (pictured below) in accordance with the speed chart. DO NOT ADJUST SPINDLE SPEED WHILE THE MOTOR IS



Spindle Speed			
	1	2	3
A	270	1400	800
B	70	360	220
C	200	1000	600

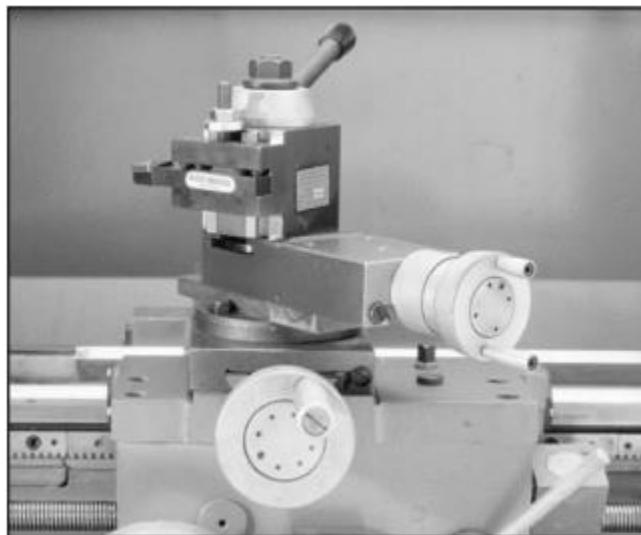
RUNNING. While repositioning the levers, rotate the spindle by hand to ensure proper gear meshing prior to running the motor.

Speed shifting levers (left) and speed chart (right)

Once a speed has been selected and the gears are correctly engaged, run the machine for several seconds and note any abnormal noises or vibration.

3. Tool Selection and Holding

Tool selection is based on the material of the workpiece and profile of cut desired. For most cuts, a single-point high speed steel cutter in a quick-change tool holder will be ideal. Select a cutter profile appropriate to the desired operation. For most common operations, there will be a cutter already mounted in a quick-change tool holder. Many different types of cutters and tool mounts are



available. If you believe you cannot complete your machining operation with the cutters available at the lathe, please get in touch with a technical assistant instead of attempting to select and mount the tools yourself, even if you have completed the lathe training.

Quick-change tool post with a high-speed steel tool mounted in a quick-change tool holder, itself mounted to the compound rest and cross slide.

4. Controls

NEVER REPOSITION GEARING CONTROLS WHILE THE LATHE IS OPERATING

The lathe is controlled variously with handwheels, levers, buttons, and pin selectors. Do not adjust any controls on the lathe without a clear idea of what the result of that adjustment will be. If you want to adjust any setting on the lathe and are unsure how to accomplish these changes, contact a technical assistant.

The next page shows the various control inputs for the lathe, along with their purposes.

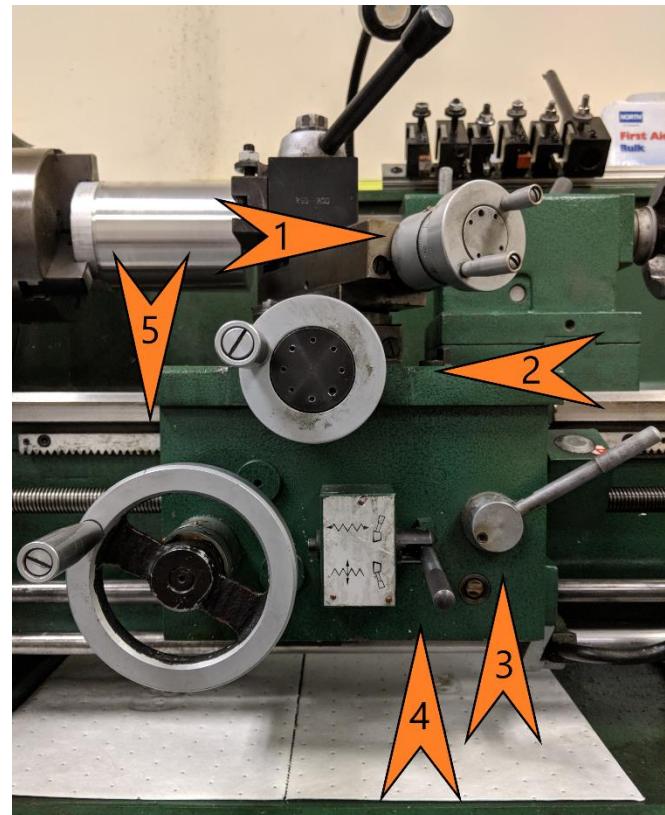


The figure to the left shows the gear head control panel of the G4002 lathe. This panel controls the spindle RPM, lead screw RPM, lead screw direction, and whether the feed rod is set for turning or threading operations. The controls are:

- (1) Spindle RPM letter selector (in position A)
- (2) Spindle RPM number selector (in position 1)
- (3) Spindle direction selector1 (Set to move the carriage TOWARDS the gear head, AWAY from the tailstock)
- (4) Feed rod/lead screw selector (show with feed rod selected)
- (5) Feed rod/lead screw speed pin selector (shown in position B3).

The figure to the right shows the carriage control panel. This panel controls the position of the tool and the feed rod/lead screw engagement. The controls are:

- (1) Compound rest handwheel (Movement along the axis of the compound rest)
- (2) Cross slide handwheel (Movement perpendicular to the lathe's axis)
- (3) Threading lever (Engages the carriage to the lead screw for threading operations)
- (4) Feed lever (Engaged the gearing of the carriage to begin cutting)
- (5) Apron handwheel (Movement parallel to the lathe's axis)



Standard Operations

1. Turning

Turning is the operation of reducing the diameter of a piece of raw material to a desired measurement. To accomplish this on the gear head lathe:

- a. Mount the correct tool and set the RPM and feed speed to settings appropriate to the material you wish to work. Ensure the spindle is powered by checking the green light on the front of the control panel.
- b. Securely mount the piece of raw material to the lathe with the three-jaw centering chuck, four-jaw chuck, or faceplate. Prior to starting the machine, ensure the work piece is secure and the chuck key has been removed.
- c. Push the clutch handle on the carriage DOWN to engage the spindle.
- d. Using the handwheels and automatic feed, cut material from the stock. The reduction in diameter of the stock will be twice the cut depth for each pass. Finishing passes should be made with a shallower cut depth and with a slower feed speed to improve surface finish.
- e. Once the desired diameter has been achieved, turn off the lathe.
- f. Move the tool away from the piece using the carriage handwheels to prevent damage to the workpiece or tool when removing the workpiece.
- g. Remove the finished part from the chuck or set up for another operation.

2. Boring

Boring is the operation of creating or enlarging a circular hole in raw material.

- a. Mount the correct tool and set the RPM and feed speed to settings appropriate to the material you wish to work.
- b. Securely mount the piece of raw material to the lathe with the three-jaw centering chuck, four-jaw chuck, or faceplate. Prior to starting the machine, ensure the work piece is secure and the chuck key has been removed.
- c. Install the boring bar or boring tool in the tail stock or tool holder, as appropriate. If you are unsure which tool is appropriate to the feature you wish to turn, consult the ATAMI student technical assistants.
- d. Using the handwheels, remove material from the inside of the bore hole. The increase in diameter of the bore will be twice the cut depth for each pass. Finishing passes should be made with a shallower cut depth and with a slower feed speed to improve surface finish.
- e. Once the desired diameter has been achieved, turn off the lathe..
- f. Move the tool away from the piece using the carriage handwheels to prevent damage to the workpiece or tool when removing the workpiece.
- g. Remove the finished part from the chuck or set up for another operation.

3. Threading

Threading is the operation of cutting threads on the inside or outside surface of a part. These instructions assume you have already turned the part to the required diameter for the threads about to be cut. This is the major diameter of the thread form as determined by the appropriate

standard (I.E, for $\frac{1}{2}$ -13 threads, the major diameter is $\frac{1}{2}$ inch.) Threads are defined by the nominal diameter and the pitch, or threads per inch. For example, $\frac{1}{4}$ -20 indicates a thread with a nominal diameter of $\frac{1}{4}$ inch and 20 threads per inch. In its normal configuration, the Grizzly gear head lathe does not cut metric threads.

- a. Mount the correct tool and set the RPM and feed speed to settings appropriate to the material you wish to work.
- b. Securely mount the piece of raw material to the lathe with the three-jaw centering chuck, four-jaw chuck, or faceplate. Prior to starting the machine, ensure the work piece is secure and the chuck key has been removed.
- c. Select the 'lead screw' position on the feed rod/lead screw selector lever. Using the lead screw speed selector pins, select the desired pitch.
- d. Using the handwheels, position the cutter where the threads should start. It is recommended to cut a small gap space on either side of the threads to prevent crashing the tool into the chuck or workpiece.
- e. Using the threading lever, engage the carriage to the lead screw at the appropriate point indicated on the thread dial.

4 N	8 ANY	16 ANY	32 ANY	64 ANY
$4\frac{1}{2}$ 1	9 1-3	18 N	36 ALL	72 ANY
$4\frac{3}{4}$ 1	$9\frac{1}{2}$ 1	19 1	38 N	76 ALL
5 1	10 N	20 ALL	40 ANY	80 ANY
$5\frac{1}{2}$ 1	11 1-3	22 N	44 ALL	88 ANY
6 1-3	12 ALL	24 ANY	48 ANY	96 ANY
$6\frac{1}{2}$ 1	13 1-3	26 N	52 ALL	104 ANY
7 1	14 N	28 ALL	56 ANY	112 ANY

ANY = Engage at any time

ALL = Engage on all lines

N = Engage on any Number

1-3 = Engage on 1 or 3

1 = Engage only on 1

- f. When the cutter has reached desired end of the threads, disengage the threading lever. Ensure the cutter has reached the gap at the end of the threaded segment prior to disengaging the carriage from the lead screw.
- g. Move the tool away from the piece using the carriage handwheels to prevent damage to the workpiece or tool when removing the workpiece.
- h. Once the desired section has been threaded, secure power by depressing the red 'reset' button until the switch clicks and the green 'POWER' light is extinguished.
- i. Remove the finished part from the chuck or set up for another operation.

4. Facing

Facing is the operating of removing material from the plane perpendicular to the axis of rotation of the work piece to create a flat, consistent feature in the same plane.

- a. Mount the correct tool and set the RPM and feed speed to settings appropriate to the material you wish to work.
- b. Securely mount the piece of raw material to the lathe with the three-jaw centering chuck, four-jaw chuck, or faceplate. Prior to starting the machine, ensure the work piece is secure and the chuck key has been removed.
- c. Using the handwheels, remove material from the face of the stock.
- d. Move the tool away from the piece using the carriage handwheels to prevent damage to the workpiece or tool when removing the workpiece.
- e. Once the desired length has been achieved, secure power by depressing the red 'reset' button until the switch clicks and the green 'POWER' light is extinguished.
- f. Remove the finished part from the chuck or set up for another operation.

5. Parting

Parting is the operation of separating one piece of the stock from the remainder with a parting cutter. Do not attempt to part stock thicker than three inches in diameter.

- a. Mount the correct tool and set the RPM and feed speed to settings appropriate to the material you wish to work.
- b. Securely mount the piece of raw material to the lathe with the three-jaw centering chuck, four-jaw chuck, or faceplate. Prior to starting the machine, ensure the work piece is secure and the chuck key has been removed.
- c. Using the handwheels, place the cutter at the point where you wish to separate the stock.
- d. Slowly move the cutter through the stock. Best practice is to use large amounts of an appropriate lubricant.
- e. Move the tool away from the piece using the carriage handwheels to prevent damage to the workpiece or tool when removing the workpiece.
- f. Once the desired length has been achieved, secure power by depressing the red 'reset' button until the switch clicks and the green 'POWER' light is extinguished.
- g. Remove the finished part from the chuck or set up for another operation.