

Block B: Tools and Equipment



Plumbing Apprenticeship Program Level 1 Series

Block B: Tools and Equipment

BC Plumbing Apprenticeship, Level 1

SKILLEDTRADESBC

*AUDREY CURRAN; MARK OVERGAARD; BC PIPING ARTICULATION AND
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Block B: Tools and Equipment of the Plumbing Apprenticeship Program Level 1 Series features Skilled Trades BC industry-authority content that builds on the safety foundations introduced in Block A by focusing on the correct selection, use, and care of essential plumbing tools and equipment. Safe work practices remain central, but the emphasis in this block is on developing hands-on technical competence in the tools apprentices use every day on the job.

In Block B, apprentices learn how to safely and effectively use hand tools and measuring tools; operate portable power tools; access work areas using ladders, scaffolds, and other access equipment; and perform rigging, hoisting, lifting, and positioning tasks. This block also introduces the safe use of soldering, brazing, oxy-fuel cutting, and welding equipment. Mastery of these skills supports workplace efficiency, reduces the risk of injury or equipment damage, and lays the groundwork for more advanced plumbing tasks in later levels of the apprenticeship.

Plumbing Apprenticeship Program Level 1 Series

The *Plumbing Apprenticeship Program Level 1 Series* offers comprehensive training materials designed to build on foundational skills and knowledge. The series is divided into four main blocks, each focusing on critical areas of plumbing systems and installations.

Block A: Safety Related Functions

(<https://a-safetyfunctions-bcplumbingapprl1.pressbooks.tru.ca>)

A-1: Workplace Hazards

A-2: WorkSafeBC Regulations

A-3: Safe Handling of Hazardous Materials

A-4: Personal Safety Practices

A-5: Fire Safety

Block B: Tools and Equipment

(<https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca>)

B-1: Use Hand Tools and Measuring Tools

B-2: Use Portable Power Tools and Use

B-3: Use Access Equipment

B-4: Use Rigging, Hoisting, Lifting and Positioning Equipment, and Rigging

B-5: Use Soldering and Brazing Equipment and Oxy-Fuel Cutting Equipment

B-6: Use Welding Equipment

Block C: Routine Trade Activities and Electrical Concepts (<https://c-tradeactivities-electrical-bcplumbingapprl.pressbooks.tru.ca>)

- C-1: Mathematics and Science
- C-2: Electrical Concepts and Principles of Electricity
- C-3: Drawings and Specifications
- C-4: Codes, Regulations and Standards
- C-5: Manufacturer and Supplier Documentation

Block D: Piping and Components (<https://d-pipingcomponents-bcplumbingapprl.pressbooks.tru.ca>)

- D-1: Install Pipe and Tubing
- D-2: Install Valves
- D-3: Install Fittings
- D-4: Penetrate Structures

Plumbing Apprenticeship Program Overview and Upcoming Resources

- **Plumbing Apprenticeship Program Level 1 Series** (<https://openpress.trubox.ca/2024/12/13/plumbing-apprentice-level-1/>) can be found in the TRU Open Press Collection.
- **Plumbing Apprenticeship Program Level 2 Series** (<https://openpress.trubox.ca/2024/04/26/bc-plumbing-apprenticeship-level-2/>) can be found in the TRU Open Press Collection.
- **Plumbing Apprenticeship Program Level 3 Series** (<https://collection.bccampus.ca/search/?q=%22pl3%22>) can be found in the BCCampus Open Collection (<https://collection.bccampus.ca/>).
- **Plumbing Apprenticeship Program Level 4 Series** (<https://bccampus.ca/projects/archives/zed-cred-z-degrees/ztc-open-educational-resources-for-trades/>) can be found in the BCCampus Open Collection. (<https://collection.bccampus.ca/>) (Block F: Commission and Service will be available soon.)

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Safety Advisory

The current Standards and Regulation in BC can be obtained at the WorkSafeBC website: <http://www.worksafebc.com> (<http://www.worksafebc.com>)

Please note that it is always the responsibility of any person using these materials to inform themselves about the Occupational Health and Safety Regulation pertaining to their areas of work.

[From previous 2021 book – confirm this message with Skilled Trades]

Symbol Legend



Important Information



Potentially Toxic/ Poisonous Situation



Required or Optional Resources



Potentially Flammable Situation



Complete a Self-Test



Possibly Explosive Situation



Use Protective Equipment



Potential Electric Shock

Acknowledgements

The development of the *Plumbing Apprenticeship Level 1* learning resources was a collaborative effort driven by a commitment to excellence in trades education. These resources were created to support apprentices and journeypersons in mastering the skills and knowledge essential to the piping trades. This achievement would not have been possible without the dedication and expertise of *Skilled Trades BC* and the *Piping Trades Articulation Committee*, whose contributions, leadership, and guidance have been instrumental in shaping high-quality, industry-aligned training resources. We extend our sincere gratitude for their contributions and ongoing stewardship in advancing the piping trades.

The content for *Block B: Tools and Equipment* (<https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca/>) is adapted from the Piping Trades Apprenticeship Program from *SkilledTradesBC* (2019 Harmonized) and the Trades Access Common Core (TACC) (<https://collection.bccampus.ca/search/?q=%22Trades%20Access%20Common%20Core%22>) resources developed by Camosun College, originally created in 2015, revised in 2019, and made available through BCcampus:

- Line C: Tools and Equipment: Competency C-1: Describe Common Hand Tools and Their Uses (<https://collection.bccampus.ca/resource/BzEe9fcq>)
- Line C: Tools and Equipment: Competency C-2: Describe Common Power Tools and Their Uses (<https://collection.bccampus.ca/resource/zAYtfTec>)
- Line C: Tools and Equipment: Competency C-3: Describe Rigging and Hoisting Equipment (<https://collection.bccampus.ca/resource/hDUEqpfn>)
- Line C: Tools and Equipment: Competency C-4: Describe Ladders and Work Platforms (<https://collection.bccampus.ca/resource/7c8Ymhmk>)

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The Open Press

The Open Press combines TRU's open platforms and expertise in learning design and open resource development to support the creation and reuse of open educational resources, while encouraging open scholarship and research.

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- Camosun College
- Trades Training BC

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To order printed copies of Program Outlines or learning resources (where available) for BC Trades, contact:

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- Piping Trades Apprenticeship Program – Perform Safety Related Functions – Level 1 Harmonized (2019) (Binder) (ISBN: 978-0-7726-7362-6; product no. 7960000260) Crown Publications Online Catalogue – Piping Trades Apprenticeship Program – Perform Safety Related Functions – Level 1 Harmonized (2019) (Binder) (https://www.crownpub.bc.ca/Product/Details/7960000260_S)
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If you are using a printed copy, you can scan the QR code with your digital device to go directly to the video: Introducing SkilledTradesBC (<https://www.youtube.com/watch?v=OQgwdP0rNog>)



Starting December 1, 2022, Industry Training Authority was officially renamed to SkilledTradesBC. Hear more in this video from SkilledTradesBC CEO, Shelley Gray, on what this means for the trades industry and British Columbians. Closed captioning and transcripts are available with this video, Introducing Skilled Trades BC (<https://www.youtube.com/watch?v=OQgwdP0rNog>) (2022) on YouTube.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca/?p=2446> (<https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca/?p=2446>)

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References

- Camosun College. (n.d.). *Line C: Tools and Equipment*. BCcampus. <https://collection.bccampus.ca/resource/BzEe9fcq/>
- SkilledTradesBC. (2025). Plumber program outline (Implementation date: August 18, 2025; Last revised: December 16, 2025) [PDF]. Province of British Columbia. <https://skilledtradesbc.ca/media/2776/download>
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Other Formats Available

- In addition to the web version, this book is available in a number of file formats, including PDF. The Print PDF has passed our Accessibility Check.

PART II

B-2 USE PORTABLE POWER TOOLS

Plumber Apprenticeship Program – Level 1



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B-2 Use Portable Power Tools

Power tools are an important part of the pipe trade. They allow plumbers to cut, drill, thread, shape, and assemble materials safely and efficiently. However, improper use of power tools can lead to serious injuries and damage to equipment or materials. Safe work practices, proper tool selection, regular inspection, and the use of appropriate personal protective equipment (PPE) are essential. In this section, you will learn to describe portable and stationary power tools used in the pipe trade and demonstrate how to use them safely and correctly. Developing these skills will help you work confidently, efficiently, and responsibly on the job.

Learning Objectives

After completing this section, you should be able to:

- Describe portable power tools used in the pipe trades.
- Use portable power tools.
- Describe stationary power tools used in the pipe trades.
- Use stationary power tools



You will be required to reference publications and videos available online at WorkSafeBC.
(<https://www.worksafebc.com/en>)

Supplementary
Video Series:
Trades Access
Common Core
— Tools and
Equipment

To support your learning in this section, you may find the following video series helpful.

These short instructional videos were developed by Camosun College and shared through BCcampus as part of the Trades Access Common Core learning resources. Playlist Details – Trades Access Common Core Line C: Tools and Equipment Videos – BCcampus (https://media.bccampus.ca/playlist/details/0_3g8xp22x/categoryId/175673)

Terminology

The following terms will be used throughout this section. A complete list of terms for this section can be found in the **Glossary**.

- **abrasive cut-off wheel:** A circular cutting wheel made of abrasive material that grinds through metal or other hard materials instead of cutting with teeth. It is commonly used on power saws or grinders to cut metal. (Section B-2.1)
- **angle drill:** A power drill designed with the chuck set at a right angle to the motor so holes can be drilled in tight or hard-to-reach spaces. (Section B-2.1)
- **angle grinders:** Portable power tools that use a rotating grinding wheel or disk to grind, cut, smooth, or polish metal and other materials. (Section B-2.1)
- **auger bit:** A drill bit with a spiral shape and a pointed tip used for drilling deep, clean holes in wood. (Section B-2.1)
- **carbide-tipped drill bits:** Drill bits with tips made of carbide, a very hard material that helps the bit stay sharp and drill through tough materials like masonry or hardened metal. (Section B-2.1)
- **countersink bit:** A drill bit used to widen the top of a hole so the head of a screw can sit flush with or below the surface of the material. (Section B-2.1)
- **snake (drain auger):** A flexible tool used to clear blockages in pipes and drains. It is pushed into the pipe and rotated to break up or pull out the material causing the clog. (Section B-2.1)
- **grinding wheel (or disk):** A round wheel made of abrasive material used to grind, shape, smooth, or sharpen metal and other materials. (Section B-2.1)
- **hammer drill (roto-hammer):** A power drill that combines rotating motion with a hammering action to drill into hard materials like concrete or masonry. (Section B-2.1)
- **hot tapping:** A method used to cut into a pipe while it is still in service and under pressure, allowing a new connection to be added without shutting off the flow inside the pipe. (Section B-2.1)
- **mechanical bending:** A process that uses a machine or tool to permanently bend pipe or tubing into a desired shape without cutting it. (Section B-2.3)
- **nipple:** A short piece of pipe, usually threaded on both ends, used to connect two fittings or sections of pipe. (Section B-2.4)
- **portable:** A tool or piece of equipment that is easy to carry and move from one place to another and may be cordless or use a rechargeable battery. (Section B-2.1)
- **portable band saw:** A handheld power saw that uses a continuous loop blade to cut metal, pipe, or other materials. (Section B-2.1)
- **power cut-off saw:** A power tool that uses a rotating abrasive wheel or blade to cut metal, pipe, or other materials. (Section B-2.1)
- **reaming:** The process of smoothing and slightly enlarging the inside of a hole or pipe to remove rough edges and improve fit. (Section B-2.4)
- **reciprocating saw:** A power saw with a blade that moves back and forth quickly to cut through wood, metal, plastic, or pipe. (Section B-2.1)
- **sabre saw (jigsaw):** A handheld power saw with a narrow blade that moves up and down to cut curves or shapes in wood, metal, or plastic. (Section B-2.1)
- **spade bit:** A flat drill bit with a pointed tip used to drill larger holes in wood. (Section B-2.1)
- **three-jawed chuck:** A clamping device on a drill that uses three jaws to hold a drill bit or other tool securely in place while it spins. The jaws tighten or loosen together to keep the bit centered. (Section B-2.1)
- **twist drills (drill bits):** Common drill bits with spiral grooves that remove material as the bit drills into

wood, metal, or plastic. (Section B-2.1)

- **wavy set:** A band-saw tooth pattern where small groups of teeth are bent slightly in alternating directions to make smooth cuts in thin materials. (Section B-2.1)

B-2.1 Describe Portable Power Tools Used in the Pipe Trades

Portable power tools play a major role in virtually every trade. In the piping trades, you will be expected to be familiar with a wide range of portable power tools. You must be able to identify these tools, explain their uses, and select portable power tools appropriate for various processes. This section will explore tools that are powered by sources such as electricity, compressed air, and explosive charges.

Electric Portable Power Tools

Electric tools have seen much advancement in recent years, especially in the progress of battery technology. Lighter and more powerful than ever, almost any corded tool that is manufactured today is available in a cordless battery-powered design. Truly **portable**, cordless tools use a rechargeable battery cell that is composed of one of several different combinations of chemicals including nickel-cadmium, nickel-zinc, or lithium-ion.



Figure 1 Cordless drill with rechargeable battery (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Corded, electrically grounded tools usually have a three-prong plug, with one prong serving as the ground pin. Double-insulated tools may have only two prongs.

Electric Saws

Portable electric saws are valued for the speed and efficiency with which they can do certain jobs. The circular saw, for example, is well suited for cutting cleanly into thick lumber and for trimming assembled work.

Portable Circular Saws

Portable circular saws can make straight cuts in a variety of materials and can also start cuts in the middle of a workpiece.

The size of the saw is identified by the diameter of the blade. As a rule, the larger the blade diameter, the more powerful the motor must be and the greater the depth of cut.



Figure 2 Portable electric circular saw (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Portable circular saws can be used for both ripping and crosscutting. The depth of the cut is controlled by raising or lowering the base, and bevel cuts can be made by adjusting the tilt of the base.

The saw is usually guided freehand along a pencil or chalk line, so its accuracy depends on the operator's guiding skill.

Straight cuts can be made using the rip guide, a standard attachment on most circular saws. Even greater accuracy can be achieved by securing a straightedge to the work and guiding the base of the saw along it during the cut.

Circular saws can also start cuts in the middle of a workpiece. This makes them useful for cutting rectangular openings in materials such as plywood, a task that is difficult to do with a handsaw.

Saw Blades for Circular Saws

Circular saws use three types of blades:

- Crosscut
- Ripsaw
- Combination

Use crosscut blades for crosscutting (**perpendicular** or against the grain) and ripsaw blades for ripping (**parallel** or with the grain). Use a combination saw if the work requires you to constantly change from crosscutting to ripping.

Tooth Characteristics

This illustration shows two saw-blade teeth. The four characteristics that distinguish one type from another are **pitch**, **heel**, **hook**, and **gullet**.

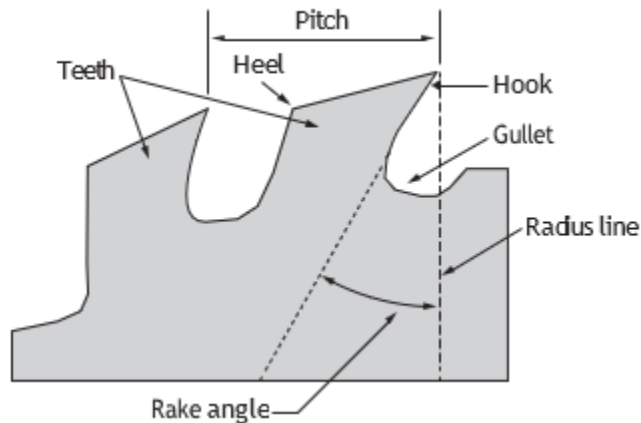


Figure 3 Parts of a saw's teeth (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

There are several designs of blades. Each blade design is intended for a specific cutting task and will last longer and perform better if used only for the intended task.

Rip blades are designed to cut solid lumber along the length of the stock. The teeth are square across their cutting edge and will cause chipping if used for cross cutting.

Crosscut blades have teeth sharpened to a knife-like point. They will produce a smooth, chip-free cut across the grain of solid lumber and they are ideal for cutting plywood regardless of the direction of the cut.

A **standard combination blade** provides an adequate cut with or across the grain of solid wood, as well as on various plywood's and panel products. However, it does none of these cuts as well as blades specifically designed for each task.

The **chisel combination blade** is a popular blade for cutting solid lumber and plywood. The teeth are sharpened square across the front and on a bevel across the back, forming a slight point on the cutting edge. The blade is easily sharpened and, when sharp, cuts fast and produces edges smooth enough for most construction.

Non-ferrous metals can be cut with **metal-cutting circular blades**. The blade resembles a fine-toothed crosscut blade, but the teeth are square across the cutting edge like those of the rip saw. These blades usually require lubrication on their sides to prevent the waste material from binding to the blade. The most common type of lubricant is a wax-stick which is rubbed on the sides of the blade.

Ferrous metals (metals that contain iron and form sparks when cut or ground) can be cut with an **abrasive disk blade**. This blade has no teeth and simply grinds a thin cut through the metal. The abrasive blade must be matched to the RPM of the saw and hardness of the steel being cut. Otherwise, the blade will either cut very slowly or wear out very quickly.

Masonry products are cut with an abrasive wheel similar to the type used for ferrous metals. Because **masonry blades**



Figure 4 Rip blade (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

and ferrous cutting blades are similar in appearance, check to make sure you have the correct type of blade. Masonry blades will not cut metal, and metal cutting blades will not cut masonry.

Carbide-tipped blades remain sharp much longer than conventional steel blades. They can be used to cut wood, plastic and composition board as well as non-ferrous metals. The carbide tips, which are extremely hard and brittle, are brazed onto a standard-sized metal disk. The carbide tips are then ground to a shape suitable for the blade's intended use. The shape of the tooth illustrated in Figure 12 is known as triple chip and can be used for plastic laminates, hardboard, plywood, aluminum, brass and for crosscutting lumber.

Carbide is so hard and brittle that it can be chipped and dulled through contact with other hard materials. As a result, all carbide-tipped blades require careful handling. You must not let the carbide come in contact with any hard surface, such as the metal parts of a saw, other saw blades, or concrete and masonry.

Sabre Saw (Jigsaw)

Sabre saws are used to make curved or irregular cuts in wood, plastics or metal.

The blade action is a high-speed up-and-down motion, with the cutting taking place during the up stroke.

The sabre saw is designed mainly for light cutting, but is also capable of making cuts through materials 40 mm to 50 mm ($1\frac{1}{2}$ in. to 2 in.) thick. The blade length should be such that when the blade is at the top end of its stroke, the lower end of the blade is below the bottom of the stock being cut.



Figure 5 Sabre saw (jigsaw) (BC Industry Training Authority, 2019).
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Although the sabre saw is capable of starting a cut in the middle of a piece of wood; it is much easier and safer to drill a starter hole through the workpiece and use the hole as the start of the cut. The rapid up-and-down action of the blade may cause the workpiece to chatter, so the workpiece must be secured and the sabre saw held firmly against the work.

The most common types of sabre saw blades are shown in Figure 6. Note that there are two different end types, straight and hooked end. They cannot be interchanged.

The blades for plywood, particle board and plastics have fine teeth. The blade for cutting thicker plywood and lumber has coarse teeth.

The blade for cutting thin hardboard and plywood in a scroll pattern has fine teeth and is very narrow.

The blade used for cutting ferrous metals has very fine teeth set in a wavy pattern.



Figure 6 Sabre saw blades (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Reciprocating Saw

The **reciprocating saw** makes cuts in any direction. It can do heavier work than the sabre saw. This type of saw can be used to cut metal, wood, fibreglass and virtually any other substance, using the correct blade.



Figure 7 Reciprocating saw (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

A reciprocating saw is a type of saw in which the cutting action is achieved through a push-and- pull (hence reciprocating) motion of the blade.

This type of saw, also known simply as a *recip saw* or *Sawzall* (a trademark of the Milwaukee Electric Tool Company) has a large blade resembling that of a jigsaw and a handle oriented to allow the saw to be used comfortably on both vertical and horizontal surfaces. The typical style of this saw has a shoe or foot plate at the base of the blade, similar to a sabre saw. The user rests this foot against the surface being cut to counter the tendency of the blade to push away from or pull towards the cut as the blade travels through its cycle.

Indispensable in construction, demolition and service work, most of these tools have a quick- release blade function that allow speedy blade replacement without the use of additional tools.



Figure 8 Reciprocating saw blades (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Power Cut-off Saw (Chop Saw)

A **power cut-off saw** is used to cut sections of lightweight material to length. Power cut-off saws use a thin, abrasive, circular disk as a saw blade. The disk is made from mineral or synthetic grains that are fibre-reinforced and resin-bonded. This disk comes in thickness from 2 mm to 3 mm ($\frac{1}{16}$ in. to $\frac{1}{8}$ in.) and in diameters from 150 mm to 500 mm (6 in. to 20 in.).

The saw in Figure 9 is called a chop or cut-off saw. The chop saw has the mandrel and motor mounted on a pivoting frame. You operate it by grasping the handle fastened to the pivoting frame and lowering the rotating cut-off wheel into the workpiece. The workpiece is secured on the bed of the tool by built-in vise or clamp. Power cut-off saws are also manufactured with special features for a variety of applications.



Figure 9 Cut-off (chop) saw.jpg (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

This saw cuts relatively quickly, but produces a considerable amount of heat at the site of the cut, which may damage the workpiece. It is used to cut steel that will not suffer too much from heat build-up.

Abrasive Cut-off Wheels

Abrasive cut-off wheels are designed for cutting masonry products or metal.

Metal-cutting wheels are available in two grades, fast-cut or long-life. Fast-cut wheels cut faster but wear out sooner than long-life wheels. Most metal-cutting abrasive wheels will cut steel, stainless steel, cast iron and aluminum.

Each abrasive cut-off wheel has a maximum speed listed in RPM (revolutions per minute). You must make sure that the rated speed of the cut-off wheel is greater than the speed of the motor, or the wheel will break apart and could possibly injure you or a workmate. Sparks and dust that are created can be a serious hazard to your eyes and lungs. Take extra precaution when operating this tool.

Portable Band Saw

Portable band saws are available in a variety of models and sizes.



Figure 10 Portable band saw (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The size of the metal-cutting band saw is designated by the thickness of stock you are able to cut with it. Standard sizes are 115 mm, 180 mm and 255 mm ($4 \frac{1}{2}$ in., 7 in. and 10 in.). Some larger models are capable of cutting through a pipe that is 50 cm (20 in.) in diameter. The material being cut is typically held in a portable vise.

Metal Cutting Blades

Metal-cutting band saw blades are defined by their grades of steel, tooth formation, tooth set and blade width.

Grades of steel include:

- Carbon steel
- Semi-high-speed steel
- High-speed steel



Figure 11 Band saw blades (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Carbon steel blades are used for general purpose cutting on a standard band saw. Blades made of carbon steel are the least expensive of the three types, but are less durable than the other grades.

Semi-high-speed steel blades cut 50% faster than carbon steel blades. They are harder than carbon steel, but are able to withstand mechanical shocks and vibrations that would break harder, more brittle blades.

High-speed steel blades cut better and last longer than other blades, but are more expensive and more delicate than the other two grades.

Tooth Formations

Tooth formations include:

- Regular
- Hook
- Skip

Band saw blades with **regular teeth** are used for straight and curved cuts in most ferrous and hard non-ferrous metals. Blades with regular teeth can be considered general-purpose blades.



Figure 12 Regular tooth (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The **hook-tooth blade** is best for fast cutting of non-ferrous metals. The large rounded gullets are capable of fast chip removal and the forward slope of the tooth requires less downward pressure to cut. Thin sections of metal should not be cut with this tooth style due to the wide spacing of the teeth.

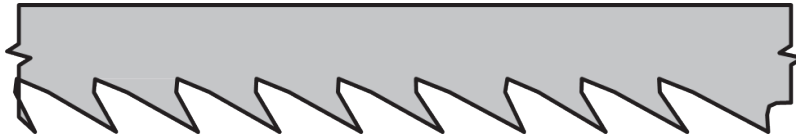


Figure 13 Hook tooth (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The **skip-tooth blade** is very similar to the hook tooth. Unlike the hook tooth, which can only cut softer metals, the skip tooth is capable of cutting ferrous metals. The wide spacing of the skip tooth makes the blade suitable for fast cutting of large sections of steel.



Figure 14 Skip tooth (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Hook and skip-tooth types are available in 3 to 6 teeth per inch. Regular-tooth styles range from 6 to 32 teeth per inch. The number of teeth per inch affects the cutting speed of a band saw, and the size of stock it is best suited to cut. Blades with large numbers of teeth per inch are able to cut small, thin pieces of metal but are slow for cutting large sections. Blades with few teeth per inch cut faster but are too coarse for cutting thin sections of metal. Too many teeth in the cut will result in destruction of the teeth.

Tooth Set

Set is defined as the left-and-right positioning of the teeth to provide a wider cut than the thickness of the blade (this creates the *kerf*). The wide cut provides clearance for the blade within the cut, preventing binding and overheating.

There are two types of tooth sets available on metal-cutting band saws, **Raker** and **Wavy set**.

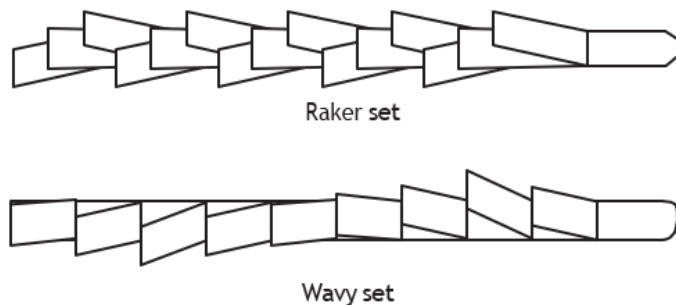


Figure 15 Tooth set (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Hook- and skip-tooth blades have raker set teeth. Regular-tooth blades with up to 24 teeth per inch come with either raker set or wavy set teeth. All regular-tooth blades with more than 24 teeth per inch have wavy set teeth.

Blade Width

Band saw blades are available in widths ranging from $\frac{1}{4}$ in. to $1\frac{1}{4}$ in. The narrower blades are able to cut curves of a smaller radius than are the wider blades. Wide blades used for straight cuts.

Portable Hand Drills

The portable electric hand drill can be used for a variety of tasks, including drilling holes, driving screws and mixing concrete. Cord-supplied drills may be double-insulated or of the three-prong type. Always make sure that you identify the type.

Most electric hand drills are manufactured with a pistol grip. A trigger switch is located on the pistol grip to allow for single-handed use during light-duty operations.

Heavy-duty portable hand drills incorporate removable side- and rear-mounted handles for extra control during two-handed operation.

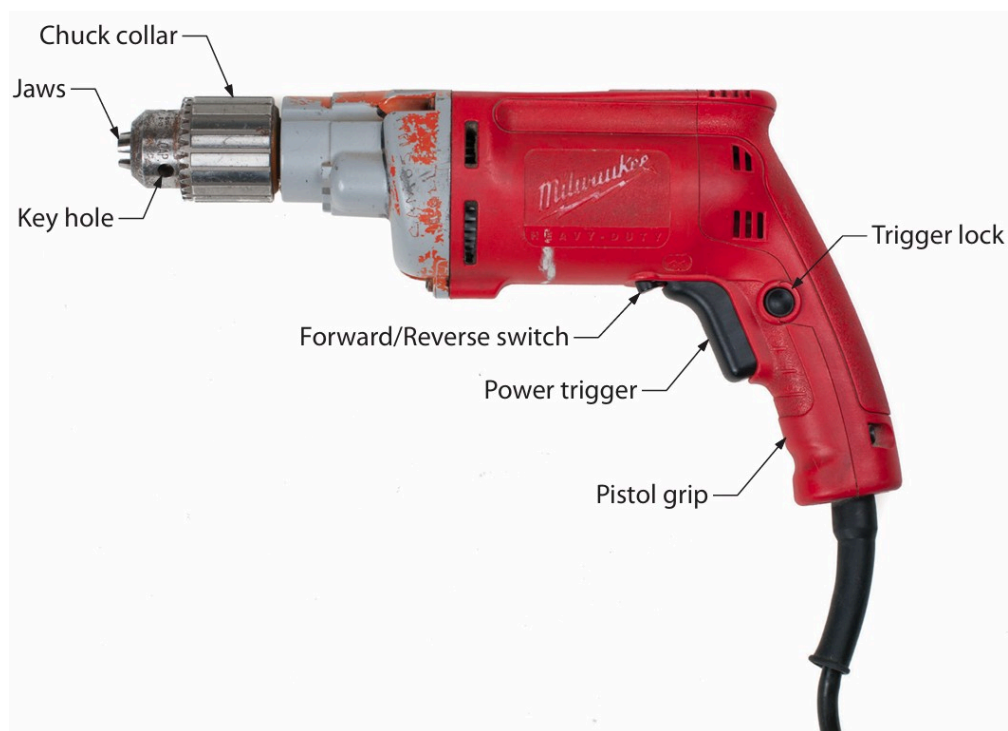


Figure 16 Electric drill components (Camosun College/BCcampus) CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 17 Cordless drill with rechargeable battery (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The drill bit is secured to the portable power drill by means of a chuck. The conventional style is a **three-jawed chuck**, that can be opened and closed by rotating the knurled outer sleeve, but final tightening is done with a special wrench known as a “chuck key” (Figure 17). The chuck key is inserted into a hole on the chuck so that the teeth on the key engage matching teeth on the chuck sleeve. Final tightening with the chuck key should be performed at two points on the three-jawed chuck to ensure a tight contact.



Figure 18 Chuck Key (Camosun College/BCcampus) CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 19 Keyless chuck (Camosun College/BCcampus) CC BY-NC-SA 4.0
(<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Another style of chuck is the quick-release hex chuck (Figure 19), originally designed to hold screwdriver bits but that also fits many drill bits that have hex shanks with a retaining channel.



Figure 20 Hex shank screwdriver bit (Camosun College/BCcampus) CC BY-NC-SA 4.0
(<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Control Switches

Some portable electric drills only have an on-off switch. This type of switch limits the use of the electric drill to those operations that require a clockwise rotation of the chuck at the fixed speed at which that particular drill turns.

Other drills are manufactured with a **variable speed** switch. These switches provide control over the chuck speed in relation to the travel of the control switch. This control allows the electric drill to be used for a variety of tasks.

Driving screws and drilling soft materials require a slow-turning drill, while other operations, such as drilling hard materials, require higher speeds.

An additional switch found on some drills allows the motor to turn counter-clockwise (“reverse”) as well as clockwise (“forward”). When both a variable speed switch and a reversible switch are present on an electric drill, the drill can be used to remove screws as well as to drive them.

$\frac{1}{4}$ Inch Drill Motors

Most $\frac{1}{4}$ in. drill motors are used for light-duty drilling operations. The $\frac{1}{4}$ in. means that the drill will accept a maximum $\frac{1}{4}$ in. shank size. The chuck on a $\frac{1}{4}$ in. drill motor turns about 1500 to 1800 RPM. Such high speeds are good for drilling small holes in soft metals but tend to burn drill bits if used for hard metals. The $\frac{1}{4}$ in. drill does not produce enough torque (turning power) at low speeds for driving screws.

$\frac{3}{8}$ Inch Drills

These drills can turn at a much slower speed than a $\frac{1}{4}$ in. drill. Average chuck speed is 750 to 900 RPM for $\frac{3}{8}$ in. drills. Considerably more torque is generated, making the $\frac{3}{8}$ in. drill more suitable for drilling larger holes in metal. A $\frac{3}{8}$ in. drill is often equipped with a forward-reverse switch and a variable speed switch.

$\frac{1}{2}$ Inch Drills

These drills generate substantial torque and are usually equipped with an additional handle to provide the operator with added leverage. Heavy-duty models have a pistol grip on one side, a removable T-handle opposite the pistol grip, and a D-handle at the back (Figure 20).



Figure 21 Drive drill – ½ in. (Camosun College/BCcampus) CC BY-NC-SA 4.0
(<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 22 Half-inch drill (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0
(<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Drill Bits (Twist Drills)

Twist drills are also commonly called *drill bits*. Twist drills may be made from carbon steel or high-speed steel. High-speed steel drills are harder and can drill harder metals. High-speed steel remains sharp longer than carbon steel and is able to withstand higher temperatures.

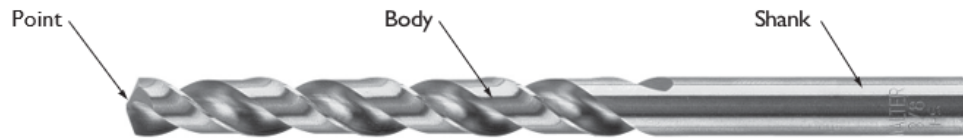


Figure 23 Twist drill (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Drill Sizes

Twist drills are available in sizes designated by one of four different systems:

- Metric
- Number
- Letter
- Fractional

Metric

Twist drills in metric sizes are usually supplied in 0.5 mm increments. However, they can be purchased in increments of 0.1 mm. Metric twist drills are commonly available in sizes from 0.5 mm to 15.5 mm in diameter.

Number

Twist drills in the number system range from 0.0135 in. to 0.228 in. in diameter. Size #80 is the smallest (just under $\frac{1}{64}$

in. in diameter) and size #1 the biggest (just less than $\frac{1}{4}$ in. in diameter). These sizes are commonly used in the gas fitter trade and are referred to as *orifice drills*.

Letter

Letter sizes range from A to Z, and are a continuation of sizes larger than number size #1. Size A is equal to 0.2344 in. in diameter and size Z is equal to 0.413 in. in diameter.

Fractional

Fractional bit sizing is very common in the construction and service trades. Fractional sizes start at $\frac{1}{64}$ in. in diameter

and increase in size by 64ths up to 1 in. Larger bits are available in fractional sizes at varying increments of $\frac{1}{32}$ in., $\frac{1}{16}$

in. and $\frac{1}{8}$ in.

By intermixing fractional, number and letter sizes you can get up to 138 different sizes less than $\frac{1}{2}$ in. in diameter.

Larger drills (over $\frac{1}{2}$ in.) are available with reduced shank sizes so that they can be used in standard chucks.

Spade Bits

The spade bit shown below is designed to drill into wood products only. Spade bit sizes range from 9 mm ($\frac{3}{8}$ in.) to 38

mm ($1\frac{1}{2}$ in.) diameter.



Figure 24 Spade bit (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The quality of the cut produced by the spade bit is not as good as most other bits. Therefore, its use is limited to rough work.

Self-Feeding Multi-Spur Bits

This **self-feeding multi-spur bit** uses the screw point to pull the bit through the wood while the sides of the bit guide it. Having a very short centre point, the multi-spur bit drills virtually flat-bottomed holes.



Figure 25 Multi-spur bit (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Multi-spur bits are available in sizes from 25 mm (1 in.) to 75 mm (3 in.). Their cutting action cuts clean, but shallow holes. Many have replaceable screw points.

Self-Feeding Auger Bits

Auger bits drill clean, accurate, straight and deep holes through wood. The bit is guided by both the screw point of the bit and the sides of the hole. Waste from the hole is carried to the surface by the spiral flutes.



Figure 26 Self-feeding auger bit (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Countersink Bits

When flathead screws are to be installed flush or below the surface of a wood workpiece, the **countersink bit** will drill a broad shallow hole to receive the head of the screw.



Figure 27 Countersink bit (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Countersink bits may be used before or after the pilot hole for the screw shank and threaded portion has been drilled.

Carbide-Tipped Bits

Carbide-tipped drill bits are used to drill holes in hard, abrasive materials such as concrete, stone, masonry, brick and ceramic tile.



Figure 28 Carbide-tipped bits (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Drilling into these materials requires a slow-turning drill (350–500 RPM) to prevent the bit from overheating. Special hammer/percussion drills can be used when multiple holes in masonry are to be formed.

Hole Saws

The **hole saw** is designed to cut large diameter holes in wood or sheet metal. The hole saw has an *arbour bit* (pilot bit) at its centre that enters the workpiece before the hole saw and serves to guide the hole saw as it enters the material.



Figure 29 Hole Saws (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Hole saws are available in sizes from 14 mm ($\frac{9}{16}$ in.) to 111 mm ($4\frac{3}{8}$ in.) in diameter. The depth of the hole drilled is

restricted by the length of the hole saw. Standard lengths are 12 mm ($\frac{1}{2}$ in.) or 28 mm ($1\frac{1}{8}$ in.).

Hammer Drill (Roto-Hammer)

A **hammer drill**, with heavy duty versions known as a *rotary hammer* or *roto-hammer*, is a rotary drill with a hammering action. The hammering action provides a short, rapid force to pulverize brittle material and provide quicker drilling with less effort. Many types allow the hammer and rotation functions to be used separately or in combination (hammer mode, drill mode, or both). When used in the hammer mode, the tool provides a function similar to a jackhammer for light chipping work.

Hammer drills are well suited for drilling holes in masonry or stone. They are also used to drill holes in concrete footings or slabs for supporting and installing piping. The hammering action helps to break up the masonry so that it can be removed by the drill bit's flutes.

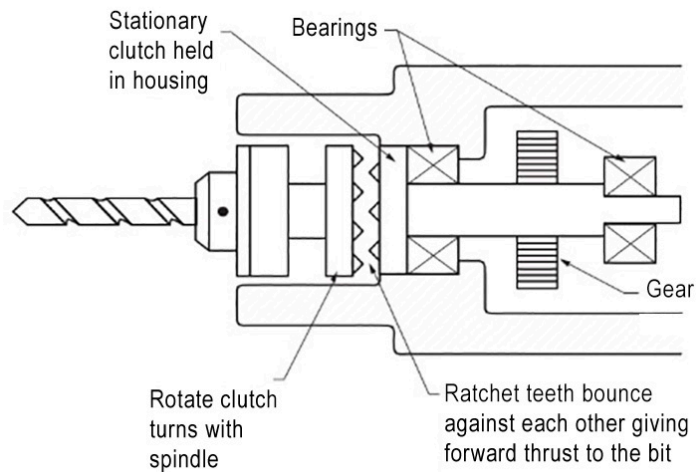


Figure 30 Hammer drill ratchet teeth provide the percussion action (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 31 Hammer drill (roto-hammer) and masonry bits (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Demolition Hammer (Chipping Gun)

Demolition Hammers are larger and more powerful than roto-hammers and operate in hammer mode only, often

earning them the name as a “chipping gun or jack hammer.” It is used for removing or demolishing concrete and masonry work.



Figure 32 Demolition hammer (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Angle Drill Motor

Drilling straight holes in tight spaces requires the use of a specialized type of drill motor. **Angle drills** have their chuck mounted at right angles to the drive motor, allowing for the motor to remain horizontal when drilling vertical holes (and vice-versa). Multi-positional handle attachments help maintain control in close quarters.



Figure 33 Angle drill (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Some manufacturers produce high-torque, high-powered angle drills that are specifically designed for cutting holes in wooden studs and joists for running pipe work. Known by names like *Hole-Hawg*, they offer impressive force that can handle self-feeding bits in excess of $4 \frac{1}{2}$ in. in diameter.



Figure 34 Milwaukee electric tool company's Hole-Hawg (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Always ensure that concealed objects such as nails and wiring have been located prior to drilling and maintain good balance during operation at all times.



Safety is paramount when using this tool because it generates substantial torque.

Pipe Saddle Drill

This specialized tool provides a slip-resistant platform to be used when drilling a pipe **saddle** (mechanical type of branch outlet). It allows for the drill motor to be centred on the convex pipe surface with adjustable straps and tensioning ratchets. Some varieties of pipe saddle drills allow for “**hot tapping**” into a live pipe so that the piping system need not be shut down and drained.



Figure 35 Pipe saddle drill (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Extracted-Tee Drill

Tees can be extracted in the walls of some types of copper tube using a tool specially designed for this purpose. The drill's head does the unique job of both drilling and forming the branch outlet. The extracted outlet must be brazed because it is very shallow compared to a standard branch tee fitting, but the resulting formation is quite strong.



Figure 36 Extracted-tee drill motor and branch outlets (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Coring Machine

Coring machines (also called *core drills*) are designed for producing horizontal or vertical round holes in masonry. Designed much like a drill press for concrete and brick, they have hollow steel cylindrical bits that create a long *core* (tubular sample) of the material. Commonly, the resulting penetration is used for the installation of pipe work in new construction, renovation or piping relocation work.

The bits used for coring machines are essentially diamond-tipped hole saws, minus the presence of an arbour bit. Water is fed to the bit through a direct hose connection, or by means of a portable tank to aid in the cooling of the bit and to remove *slurry* (mixture of concrete and water) from the kerf of the cut.

Coring machines must be securely fastened to the work surface by means of concrete anchors or the use of a brace to tension the stand of the machine firmly. Suction-type bases have been developed for quicker mounting without damage to the wall or floor finish.



Figure 37 Concrete coring machine (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Angle Grinders

Angle grinders may be used for removing excess material or for cutting material. There are many different kinds of disks that are used for various materials and tasks, such as cut-off disks, abrasive grinding disks, *honing* (abrasive) stones, sanding disks, wire brush wheels and polishing pads.

The angle grinder has large bearings to counter side forces generated during cutting. It is sometimes referred to as a **side grinder**.

The motor drives a geared head at a right angle on which is mounted an abrasive disk that can be replaced when worn. Angle grinders typically have an adjustable guard and a side-mounted handle for two-handed operation. Light and powerful, they are essential for pipe fabrication work.



Figure 38 Electric angle grinders with grinding disks (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Grinding Wheels and Disks

A **grinding wheel** or disk is a shaping or cutting tool made from natural or artificial abrasive particles. The wheels are made in numerous shapes and sizes. A small amount of stock is removed by each abrasive particle as it passes over the work. Grinding wheels are used for rough grinding, smooth finishing, and cutting or removing metal or other materials.



Figure 39 Grinding wheels and disks (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The most widely used abrasives in grinding wheel and disk construction are silicon carbide and aluminum oxide. Wheels containing particles of diamonds, either artificial or natural, are also made for limited special purpose application. The wheels and disks you encounter will usually be made of aluminum oxide.

The abrasive grain size determines the coarseness or fineness of the grinding wheel. The grain size is determined by the smallest screen mesh through which they can pass. For example, if the smallest screen through which the grains pass

has 100 openings per inch, the grain size is known as 100 grit, with each grain approximately $\frac{1}{100}$ in. Grinding wheel

abrasive grits from 6 to 24 are considered coarse, grits from 30 to 60 are medium, grits between 70 and 100 are fine and those over 100 are known as extra-fine.

One function of any bonding material is to hold each abrasive particle intact as long as it is sharp. When the particles become dull, they dislodge and expose other particles with sharp edges.

The hardness (**grade**) of a grinding wheel or disk refers to the strength with which the bond holds the abrasive particles together in the wheel, not the hardness of the abrasive particles.

The structure of a grinding wheel indicates how far apart the grains are spaced (**grain density**). If the spacing of the grains is close, the structure is dense. If the spacing is relatively wide, the structure is open. Grinding wheel structures are rated by numbers.

An **open-structure coarse-grain wheel** (which provides better chip clearance) is used on soft materials. **Dense-structure fine-grain wheels** are used where a smooth surface finish is required. Do not use wheels with a dense structure if the work material tends to clog the grinding wheel face.

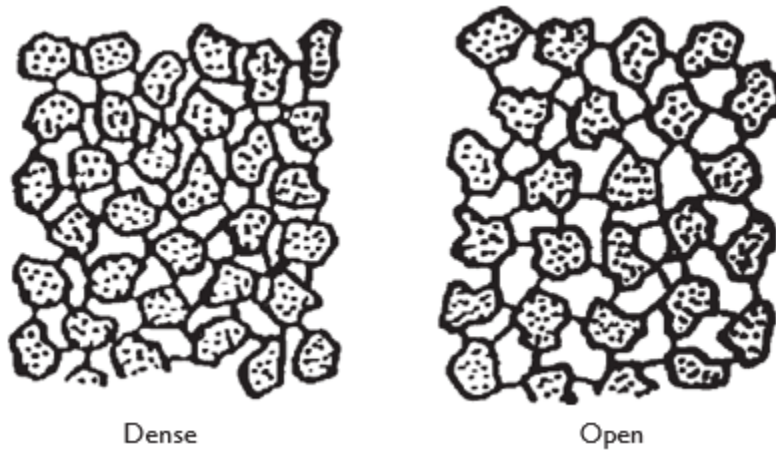


Figure 40 Relative grain spacing (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Choose a wheel or disk structure by compromising between the desired finish and the material removal rate. Always select a grinding wheel with a rated RPM at least as high as the grinder spindle no-load speed.

Allowing the wheel to operate at or slightly below the maximum safe speed automatically determines the cutting speed preferred for that wheel when used against material for which it was designed.

Markings

The standard marking system for most grinding wheels indicates:

- The maximum permitted operating speed (in RPM or m/sec)
- The wheel diameter
- The wheel thickness
- The hole diameter
- The grit size



Figure 41 Grinding disk with markings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Portable Electric Pipe Fabrication Tools

There are many portable electric tools designed for on-site pipe fabrication.

Portable Power Drives

The **portable power drive** is usually used with a tri-stand vise for pipe support. Weighing as much as 25 lbs., it is a powerful but compact drive for turning a drop head threader or a large-gear threader. When used with the geared threader, the drive is mounted on the threader by using an adapter.



Figure 42 Portable power drive (RIDGID TOOLS/Emerson Professional Tools)
Used with permission.

When a **drop head threader** is used, a support arm must be locked on the pipe if the pipe size is 1 in. or larger. In conjunction with the support arm, this drive can be used to turn drop head die threaders, with or without the use of a tri-stand supporting vise.

The maximum pipe capacity for most power drives is 2 in. pipe with a drop head threader and 6 in. pipe when using the geared threader.



Figure 43 Threading with a portable power drive using a support arm (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

In addition to threading uses, some portable power drives will also power hoists and winches and other accessories and operate large valves. It is activated by a switch button on the handle.

Power Pipe Cutter

The portable power drive can be used to operate a heavy duty displacement cutter that can provide square cuts on pipe up to 12 in. NPS with wall thickness up to schedule 40. A hydraulic foot pedal provides the required force to feed the wheel through the pipe wall while the cut is achieved without dust or sparks.



Figure 44 Power pipe cutter (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

A pipe roller is available for this tool that allows it to be used to rotate a pipe while a worker bevels one end for welding preparation.

Copper Cutting and Preparation Machine

The copper cutting and preparation tool is useful for cutting, reaming, de-burring and cleaning copper pipe and fittings up to 4 in. It is suitable when multiple cuts are to be made for numerous fit-ups.



Figure 45 Copper cutting and preparation machine (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

Plastic Pipe and Tubing Power Cutter

These types of powered cutters are designed to make precise cuts in multiple types of plastic materials. They are battery powered and suitable for use on polyethylene (PE), polypropylene (PP), PEX, rubber hose, PVC and CPVC, with a capacity typically up to 2 in.



Figure 46 Plastic pipe and tubing power cutter (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

Copper Tubing Power Cutter

This cordless tool can save time when making numerous cuts on copper tubing. Weighing typically less than 10 lbs., it can self-adjust for tubing sizes between $\frac{3}{8}$ in.–1 in. OD tube and has a compact head suitable when cutting in tight spaces.



Figure 47 Copper tubing power cutter (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Power PEX Expansion Tools

Due to the memory capability of certain types of PEX, one method of joining the tubing is by expansion of the tube and a special PEX ring. Power tubing expanders are most commonly of the cordless electric type and have the added advantage of one-handed operation with heads that often have an auto-rotate feature.

Power Press Tool

A fast one-time connection for copper, stainless steel and even PEX tubing is the use of press-fitting technology. This is popular due to its speed of installation and the fact that no flame or heat is required for copper connections. The barrel on the head can often swivel to obtain multiple installation positions.



Figure 48 Cordless pressing tool (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

Additionally, for tubing sizes over 2 in., press-rings are available that fit around larger fittings, typically up to 4 in. A special actuator-jaw attachment is used to press the ring while it remains around the fitting until the jointing process is complete. The jaws allow for a 180° swivel feature that permits the tool to connect to the ring at any angle relative to the tubing, allowing greater access in tight spaces. Note that the pressing action of the tool cannot be stopped once activated, so the operator must make sure that fingers are kept well away from pinch points.



Figure 49 Press ring set for larger pipe diameters and press fittings (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

Electric Soldering Tools

Professional electric soldering tools (guns) are intended for rapid, flameless soldering of copper tubing up to approximately 3 in. in diameter. Specially designed for renovation and repair work, they often utilize long cables to aid in accessing the work.



Figure 50 Electric soldering tool (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

Fusion

Fusion is a heat process that is used to join two pieces of **thermoplastic pipe** (pipe that is capable of being re-melted and

re-molded). Pipe fusion involves using a tool that will melt two ends of the pipe to be welded and some method that will apply force to their surfaces until set. The two pieces then cool together and form a permanent bond. Generally, **polyolefins** (such as polypropylene and polyethylene plastic) are used for this application. (Polyolefins do not join by solvent cementing because they have excellent chemical resistance.)

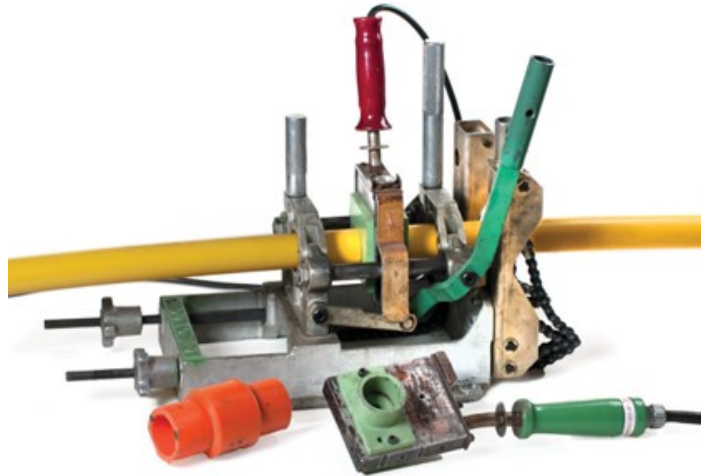


Figure 51 Socket fusion tool set (BC Industry Training Authority, 2019).
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Portable Power Tubing Bender

Most of these powered benders have radius abilities of 180° and offer a selection of bending formers for different diameters of copper tubes, aluminum and soft steel tubing, and pneumatic and hydraulic tubing. Most come with features that allow for bench mounting of the bender for multiple bending at the job site. Maximum capacity for these

models is usually $1 \frac{1}{8}$ in. OD.



Figure 52 Portable power tubing bender (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 53 Portable power tubing bender in use (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Portable Piping Maintenance Tools

There are many portable electric tools designed for on-site piping maintenance.

Power Drain Cleaning Tools

Drain cleaning tools are used to unblock clogged or obstructed drainage and venting pipes. Most types use some form of rotating auger that moves down the pipe to break up or retrieve the obstruction, while other varieties of machines may use jetted water to blast through material.

A drain auger is also known as a **snake** and consists of a coiled metal wire often wrapped around a wire core. Augers work to clear drains in one of several ways:

- The end of the auger's wire digs itself into the obstruction much like a corkscrew, allowing retrieval of the object (hair, cloth, etc.).
- The end of the auger breaks up the object, allowing it to pass through the drain (tree roots, paper, etc.).
- The snake scours around the inside surface of the pipe, scraping off accumulated matter (ranging from mineral deposits to bacon fat) that was reducing the effective inside diameter of the drain.



Figure 54 Handheld drain auger
 (<https://commons.wikimedia.org/wiki/File:Handheld-Drain-Auger.png>) (Pgdp123, Wikimedia) CC BY 3.0 (<https://creativecommons.org/licenses/by/3.0/deed.en>)

Sink Machines

Typically using an auger that is approximately $\frac{5}{16}$ in. in diameter, **sink machines** are light-duty drain cleaners that are for drains sized 2 in. or less, such as kitchen sink, lavatory and shower drains. They are often powered by pistol-grip-style drill motors or small motors that are meant to be positioned on the counter top, or near the point of use.



Figure 55 Sink machine drain cleaning tool with auto cable feed feature (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 56 Sink machine cleaning a fixture drain (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Drum Machines

These larger capacity **drum machines** have the ability to vary the speed of the cable feed and rotation. Using $\frac{3}{8}$ in. or $\frac{1}{2}$ in. cables, they are capable of cleaning drain lines in excess of 4 in. Larger machines can be equipped with 100 ft cables of either $\frac{3}{4}$ in. or $\frac{5}{8}$ in. diameter that can clean drains as large as 10 in. In drum-style drain cleaning machines, a pneumatic foot switch is commonly incorporated as a safety feature. The switch uses air pressure—rather than electricity—to control the motor. This design eliminates the risk of electrical shock, especially in wet or damp environments where water contact is likely.



Figure 57 Cable drum drain machine (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

Sectional Drain Cleaning Machines

Sectional drain cleaning machines allow the drain auger to be added in sections instead of being self-contained in a drum. Often, more than one size auger can be driven with the same motor. One characteristic of this style of drain machine is that it can offer the operator more control of the auger through the manipulation of the control handle.



Figure 58 Sectional drain machine (RIDGID TOOLS/Emerson Professional Tools). Used with permission.



Figure 59 Sections of drain auger (snake) and common head attachments (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Water Jetters

Water jetters propel flexible lines through sludge, soap and grease blockages. As it is pulled back, it power-scrubs the line, flushing away debris. Most operate with over 2000 psi water pressure to provide the required cleaning power to do the job.



Figure 60 Water jetter (RIDGID TOOLS/Emerson Professional Tools). Used with permission.

Pipe Inspection Cameras and Locators

Pipe inspection cameras can visually show the nature or severity of obstructions or failures of piping systems. Especially valuable when inspecting underground services, pipe inspection cameras can record filmed data with the on-board hard drive, and some models make instant digital copies as well. LCD displays record the distance to the camera head to aid

in locating the problem, while some cameras can transmit a signal to be detected with pinpoint accuracy with the aid of a locator device.



Figure 61 Pipe inspection camera system (RIDGID TOOLS/Emerson Professional Tools) Used with permission.



Figure 62 Digital pipe camera locator (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

Pipe Freeze Kits

Pipe freeze kits stop the flow of water while a system is inspected or repaired. Once the system maintenance is complete, the “**ice plugs**” are slowly melted and the system is put back in service.

There are electric versions of these systems (as shown), but many use bottles of refrigerant gases to perform the same task with a similar result.



Figure 63 Electric pipe freeze kit and a frozen pipe (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

Pneumatic Portable Power Tools

Air tools are often used to do work in explosive or flammable atmospheres, such as in grain elevators or other places where sparking from inside an electric tool could cause a fire or explosion.

Safety with Air Tools

Using tools powered by high-pressure air can be very hazardous. In addition to the hazards of flying materials, there are many other dangers.

- Air tools are very noisy. Hearing damage can result unless proper ear protection is worn. This protection must be worn at all times, not only by the operator but by other persons nearby.
- Continuous vibration can cause damage to nerves. Use heavy gloves if you do a lot of impact work.
- Fittings often come loose from their retainers and can fly a considerable distance at high speed. When using air tools, be cautious of where you point the tool.
- High-pressure air is a severe hazard. Never expose yourself or your fellow workers to any direct blast of air as they can drive particles under your skin or inject air bubbles onto your bloodstream. Never use compressed air to clean your clothing because particles can be blown into your skin.
- Blowing air at your clothing could also react with some petroleum products and cause combustion.



Never use air tools in an area where the exhaust from the tool could stir up clouds of toxic chemicals or hazardous materials such as asbestos dust.

Air Supply for Air-Operated Tools

Air or pneumatic tools are operated by compressed air supplied by an air compressor. This compressor is pre-set to maintain a constant supply of compressed air at pressures ranging between 350 kPa (50 psi) and 1050 kPa (152 psi). A reservoir tank attached to the compressor retains a supply of compressed air to assure sufficient volume.



Figure 64 Electric air compressor (Muhammad Abdullah, Freepik [AI generated]) Freepik Terms of Use (<https://www.freepik.com/legal/terms-of-use>)

Compressed air may also be found piped to quick-connectors placed conveniently around the shop. High- pressure flexible rubber air hoses are used to connect the air-operated tool to the wall outlet. These hoses must be kept in good condition, and their end connections must be tight. A broken or severed hose can be uncontrollably whipped around by the escaping air pressure and can cause serious injury to anyone in its path.

Components of a Compressed Air Supply System

Compressed air for a power tool is supplied through a hose or pipe to the tool. The system has a drain-off valve for releasing moisture from the compressed air, a filter and pressure regulator, and sometimes a lubricator. A quick connector is used to attach the hose that feeds the air-powered tool.



Figure 65 Typical compressed air system (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Filter and Regulator

A clean, dry air supply is of prime importance. Moisture in the air lines can damage tools or interfere with their performance. Water in the line tends to dilute and wash away the lubricant and can corrode internal parts. If water gets past the filter, it can enter the regulator mechanism and interfere with its operation. This can lead to erratic air pressure, which affects tool speed and may cause the **speed governor** (a built-in device that limits RPM) to malfunction. If the governor sticks or fails due to moisture or corrosion, the tool can over-speed, creating a dangerous condition for the operator.

Lubricator

In many tools, the compressed air must contain a lubricant to keep moving parts operating freely. A lubricator, attached between the regulator and the tool, supplies the lubricant in the form of a fine mist. The operator can control the amount of oil misted into the compressed air.

Quick Connectors

Connectors, which are also referred to as *quick couplers*, make it easier to connect and disconnect supply hoses and tools. The internal end of the connectors is designed to shut off the air flow when the external end is disconnected.

Air Hose

The air hose is made of rubber to make it flexible. The rubber is reinforced with braided thread or wire to make it strong, and coated inside to prevent air from leaking out past the layers. It is available in different lengths and diameters. Hoses can be joined together to reach longer distances. The most common lengths of single hose are 7.5 m and 15 m. The inside diameter must be no smaller than 8 mm. Hoses are available in a variety of pressure ratings and colours.

Air-Impact Wrenches

An **air-impact wrench** can be used to install or remove fasteners. In addition to rotary motion, there is a hammering effect much like the electric hammer drill to increase torque and make the tool more effective. There is a wide variety of sockets and attachments for this tool. Because impact wrenches are used for both assembly and disassembly, they are reversible.

Pneumatic impact wrenches are made in larger sizes than electrically-operated impact tools and are used more often in heavy-duty applications. Impact wrench sizes are designated by the size of the drive on the nose of the tool. The drive is usually square, with the most common sizes being $\frac{3}{8}$ in., $\frac{1}{2}$ in., $\frac{3}{4}$ in. and 1 in. It is used by inserting it into the drive end of a socket.

Although the sockets used with impact wrenches are similar to the ones that are used with hand tools, they are of a much stronger design in order to absorb the tremendous forces generated.



Figure 66 Pneumatic impact wrench (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Do not substitute a conventional socket for an impact socket. Conventional sockets can fracture, fly apart, and cause injury.

Air-Operated Grinders

Portable grinders are valuable tools for sharpening other tools, removing burrs, bevelling corners and grinding welding beads. Accessories for brushing, buffing, filing and sanding can be attached to certain models, increasing their versatility.

The grinder spindle speed varies proportionally to grinder size and ranges from 4000 RPM on larger models to over 40 000 RPM on smaller ones. Each grinder has a throttle lever to regulate speed. Certain models have a throttle lever stop-screw that limits throttle depression and may be adjusted to maintain a desired maximum RPM.



Figure 67 Typical heavy duty air-operated grinders (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

A heavy duty, air-operated grinder, which holds a depressed-centre (cup-shaped) grinder wheel may also be adapted for brushing or sanding. Two hand grips are featured for safe, controlled operation. One handle includes the air trigger or lever. This grinder is available with spindle speeds from 4500 to 7000 RPM.

Air-Operated Drills and Drivers

Pneumatic drills are operated by the force of air moving over the blades of a rotor. This turning force is transmitted to the chuck through a series of gears. The speed of the drill is controlled through its full RPM range by the amount the air-throttle lever or trigger is depressed. Many pneumatic drills are designed with mufflers to reduce the noise caused by the motor.

Chucks for pneumatic drills are made in different sizes corresponding to the drill capacity. Both keyless and key-type chucks are available. Both have three hardened steel jaws that are tightened and released by turning a threaded sleeve.



Figure 68 Chucks and key (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

A keyless chuck has a knurled sleeve to permit hand tightening. The key-type chucks are adjusted by inserting a key into a hole on the chuck so that the teeth on the key engage matching teeth on the chuck sleeve.

The portable pneumatic drill is often preferred to an electric drill because it is light and has infinite speed control. In addition, it cannot overheat or be damaged by overloading. Another feature of the pneumatic drill is that it will stop quickly.

Air screwdrivers and nut drivers look very much like air drills. The main difference is in the chuck or bit holder. The tool bit is held in place by a ball-and-spring detent, which facilitates quick changes of bits.

To further enhance the versatility of power screwdrivers, a clutch device or a friction drive can be incorporated, which runs the screw or nut to the required depth or tension.

Air drills can also be operated safely in wet areas, a condition that would make the operation of an electric drill hazardous.

Air Hammers and Chisels

Air hammers are used for riveting, metal cutting and chiselling. They use a reciprocating piston that strikes a tool bit accessory that, in turn, strikes the workpiece.



Figure 69 Air-operated hammer/chisel (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Air hammers and chisels can deliver between 1500 and 4000 blows per minute.

A typical tool bit (chisel) accessory is manufactured from high-quality alloy steel and heat-treated to withstand and deliver repeated blows from the striker piston. Many different bits are available to perform various tasks.

Powder-Actuated Tools

Powder-actuated tools are specially designed tools for driving fastening devices into steel or concrete. They are powered by an explosive powder charge similar to a rifle.

The explosive powder charge creates a rapid expansion of gas that either directly or indirectly, drives the fastener. The indirect system uses a captive piston whose velocity need not be nearly as great as that of a fastener alone to have enough energy to penetrate to the proper depth.

A number of manufacturers have designed different types and models of tools, each tool having specifically designed explosive charges and fasteners. These parts are not interchangeable.



Figure 70 Powder actuated fastener tool (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

History

Developed in Europe in 1908, the first powder-actuated tool was a high-velocity device that made possible the underwater repair of ships. With welders working inside the ships, divers on the outside used the new tool to nail plates onto the hulls. A captive piston was incorporated into the design to reduce the velocity of the expelled pin.

The tool manufactured by Hilti appeared on the market in 1979. Nearly 10 years later, Hilti introduced an improved design for the captive piston. The result was a safer tool, with the fastening pin travelling at a still lower velocity.

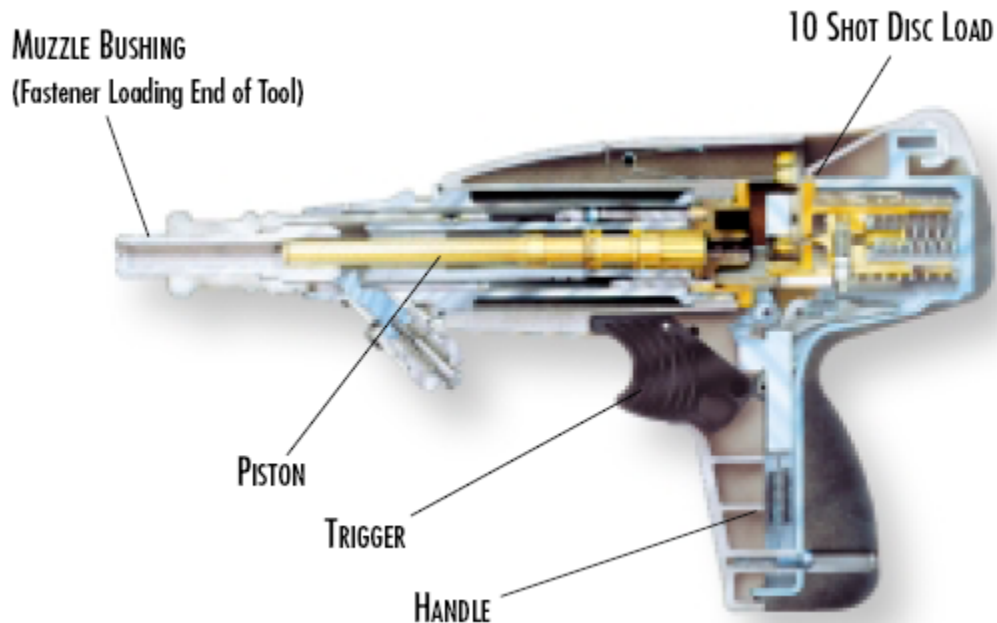


Figure 71 Powder-Actuated tool diagram (Dustinmck/Wikimedia Commons) CC BY-SA 4.0 (<https://creativecommons.org/licenses/by-sa/4.0/>)

Because of its safety features and efficiency, the low-velocity, powder-actuated tool manufactured by Hilti is the most widely used in the piping industry. Even so, you should know that other tools are available, and that the speed with which they discharge fasteners varies. The speeds below are measured two metres in front of the tool.

To better understand how powder-actuated tools are used in practice, watch the following demonstration from the BCcampus Trades Access Common Core video series, developed by Camosun College: Hilti DX 450 Powder-Actuated Tool (BCcampus Line C Series) [7:09] (https://media.bccampus.ca/media/Hilti%2BDX%2B450/0_qkdz82jw?utm_source=chatgpt.com)

This video shows the operation, handling, and typical applications of a powder-actuated fastening tool in construction settings.

As you watch the video, consider:

- What safety precautions are demonstrated?
- What materials is the tool used on?
- Why is training required before using this tool?

Low Velocity

Type: Hilti

This tool operates on the captive piston principle.

Both the fastening pin and the driving piston move at a speed less than 100 m (330 ft) per second.

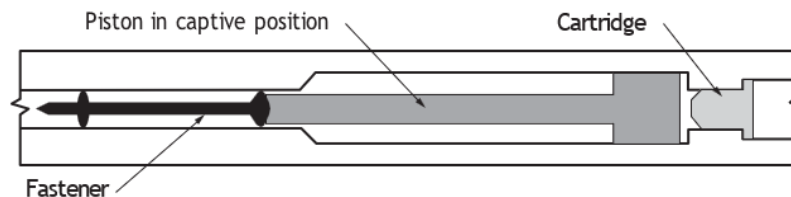


Figure 72 Low-velocity, captive piston mechanism (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Medium Velocity

Type: Ramset

When fired, the fastening pin travels at about 100 to 150 m (330 to 500 ft) per second.



Figure 73 Ramset gun (Bill Bradley [billbeee]/ Wikimedia Commons) CC BY-SA 3.0 (<https://creativecommons.org/licenses/by-sa/3.0/deed.en>)

High Velocity

Type: Omark Remington Phillips

These special tools have limited applications. They have no pistons, and the fastening pin is discharged at a velocity above 150 m (500 ft) per second. Speeds of 460 m/sec (1500 ft/sec) are not unusual.

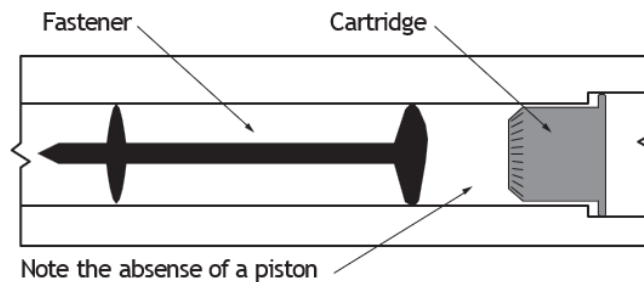


Figure 74 High velocity tool mechanism (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Safety Features

The Hilti powder-actuated tool has a number of built-in safety features:

- A captive piston, already described.
- A built-in device that prevents the tool from firing if it is held at an angle of more than 7° off the work surface. To fire, the tool must be held flat against the work area, at a right angle to the work surface.
- A built-in stop ring or stopping mechanism. Designed to absorb impact, it is the first part of the tool to break down from the force of the impact. When the stop ring becomes deformed, it must be replaced or the tool will not function properly.

Powder Loads and Firing Methods

Low- and high-velocity cartridges are rated according to a colour code; beginning with the weakest rating (grey) through to the strongest rating (purple). Both low- and high-velocity types share the same colour code; the difference is that low-velocity cartridges have a brass case, while the higher- velocity types are encased in nickel.

Table 1: Cartridge Colour Code by Power Level (Low and High Velocity)

Low Velocity (Brass Case)	High Velocity (Nickel Case)
Grey (Weakest)	Grey (Weakest)
Brown	Brown
Green	Green
Yellow	Yellow
Red	Red
Purple (Strongest)	Purple (Strongest)

Note: When selecting a cartridge, always start with the weakest load for that tool and increase the strength, one step at a time, until the proper fastening is obtained. Re-driving a fastener is not recommended, as it can damage the tool and weaken the grip of the fastener.

Cartridges

There are two designs used for cartridges: crimped and wadded. Both provide the same power. *Hilti* uses the crimped design and paints the cartridge tip to identify the strength of the powder load (grey to purple). The paint also acts as a waterproof barrier to keep the cartridge dry.

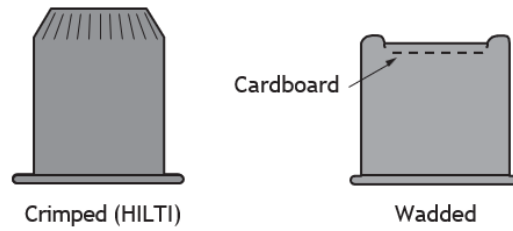


Figure 75 Types of cartridges (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Wadded cartridges are not used by low-velocity or captive piston tools because the wads could plug the vent ports needed with the captive piston system.

Firing Methods

The cartridges for powder-actuated loads are either:

- Rim fired (the Hilti method) or
- Centre fired

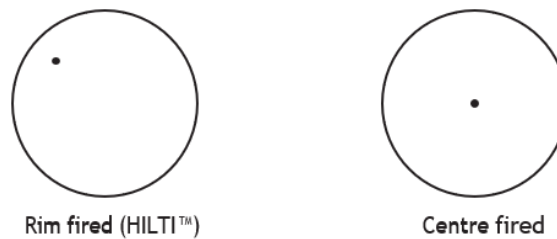


Figure 76 Cartridge firing methods (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Types of Fasteners

Fastening pins are made of specially hardened steel. For fastening into concrete, the shank (the end of the fastener being driven into the concrete) is smooth. For fastening into steel, the shank is knurled, meaning that the tip has a series of small ridges to aid fastening.

Each tool model will accept only the type of fastener specially designed for it. Therefore, it is very important that the right fastener is selected for the tool.

In designing fasteners for its tool models, Hilti has incorporated a double guidance system.

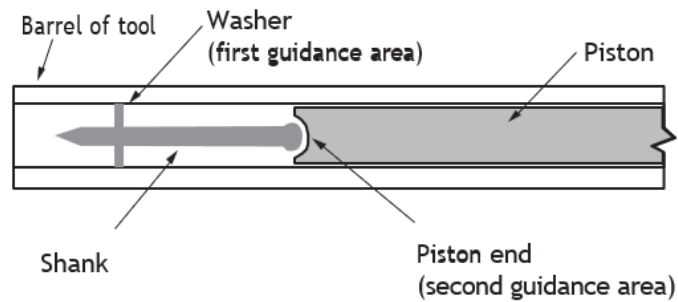


Figure 77 Double Guidance System (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Interpretation of Fastener Codes

The follow table describes the fastener by its corresponding code.

Table 2: Common Fastener Codes Used in Powder-Actuated Tools

Code	Meaning	Illustration
DN	Dome head nail (small)	
W	Threaded	
NK	Round head nail	
DS	Dome head nail (large)	
TB	Eyelet fastener	
E	E in front of any code indicates that the fastener has a knurled shank and is used for steel only.	

Example 1:

Code **W6-20**

W – designates threaded

6 – designates a thread diameter of 6 mm ($\frac{1}{4}$ in.)

20 – designates a thread length of 20 mm

Note: The piston must be changed for each threaded fastener so that the bore in the piston matches the fasteners. Thus, codes W6-11, W6-20, and W6-30 call for pistons with different bores, because each threaded fastener has a different length.

Example 2:

Code **W6-20-22-S-12**

W – a threaded fastener

6 – thread diameter – 6 mm

20 – thread length – 20 mm

22 – shank length – 22 mm

S – steel washer

12 – washer diameter – 12 mm

Note: Three types of material are used for washers.

S – steel

P – plastic

D – dual (a combination of plastic and steel)



Self-Test B-2.1: Describe Portable Power Tools Used in the Pipe Trades

Complete Self-Test 2.1 and check your answers.

If you are using a printed copy, please find Self-Test A-2.1 and Answer Key in the Appendix at the end. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca/?p=2776#h5p-3> (<https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca/?p=2776#h5p-3>)

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- Camosun College. (2022). Hilti DX 450 [Video]. BCcampus. https://media.bccampus.ca/media/Hilti%20DX%20450/0_qkdz82jw

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B-2.2 Use Portable Power Tools

Electric Portable Power Tools

Proper maintenance improves the service life and performance of the tool. Correct setup and operating procedures ensure good results and aid in the prevention of injury. If electrically powered tools are not handled cautiously and kept in good condition, they become dangerous sources of electric shock and serious wounds. Power tools may also be cordless. These tools are extremely versatile in that you do not need to have an electrical cord connecting the tool to the power source. These tools are safer than standard power tools in that the risk of electric shock is greatly reduced, and there is no cord that could contribute to a tripping or mobility hazard.

Using and Maintaining Electric Power Tools

The following are important considerations when using portable power tools:

- They should be stored in an appropriate storage area.
- They should be carefully inspected before being taken out of storage and used.
- They should be routinely cleaned and lubricated, if required.
- Cordless tools should have the batteries charged and ready for use.

The following are more specific rules for handling and maintaining electric power tools:

- To prevent damage to the tool, be sure that the voltage of the power source matches the requirements of the tool.
- Be sure that the batteries are the correct type for the tool and that they are properly charged.
- Keep a spare charged battery on hand.
- Be sure that the equipment is properly connected to the power supply and that the circuit is grounded or the tool double-insulated.
- Keep the plug and cord in good condition: there must be no loose prongs on the plug and the cord must not show any signs of deterioration.
- Be sure that the switches on the tool work properly.
- Make sure that the switch is in the off position before you connect a power tool to a power supply.
- Before you switch on equipment, check to see if all the guards are in place and in good working order.
- Never carry a power tool by the cord or yank the cord to disconnect it from the receptacle.
- Keep the cord away from heat, oil, and sharp cutting surfaces.
- Never operate a power tool near explosive or flammable liquids or materials.
- If you plan to cut into a wall, floor or ceiling, make sure that there is no live wiring behind it.
- If an extension cord must be used, make sure that it is approved for heavy-duty work.
- Keep the air cooling passages in the tool clean and free of obstructions.
- Compressed air may be used to clean the tool's air cooling passages, but the pressure must be limited to 69 kPa (10 psi) or less and eye protection must be worn, as dictated by workplace regulations.
- Make sure that the cutting edge of a tool is kept sharp and that the bit or blade is securely fastened in the tool.
- Stay focused on your work.

- Never operate power equipment until you are sure you know how to use it.
- Make sure that the work is secure and will not slip under the force of the tool.
- Make all required adjustments before you start up the tool.
- Know how you intend to use the tool before you activate it.
- Wear eye protection when you use power saws and other power equipment that kicks up dust and particles.
- Feed the work to the machine or the machine to the work carefully and at a pace suitable for both the machine and the operation.
- Turn off the power when you finish the work, then wait until moving parts come to a stop before you leave the machine.
- Never use a power tool with a deformed or cracked housing, or with a broken handle or part. Damaged or inoperative tools should be reported to a supervisor.
- Before storing a power tool, wipe dust, dirt and chips off it with a cloth.
- Clean plastic parts with a soft cloth lightly dampened with soapy water. Never clean them with solvents such as gasoline, thinner, benzene, carbon tetrachloride or alcohol as these substances damage and crack plastic.
- Never allow the motor portion to become wet with water or oil.
- Store tools properly. For example, drills, screw guns and routers should have the bits removed, a circular saw must have the guard in place, sabre and reciprocating saws must have the blades removed, or the blades must be adequately protected.

Grounding Tools and Equipment

All tools and equipment that are operated by electricity must be grounded or of the double-insulated type. Workplace regulations require that when used outdoors or in a damp location, portable electrical equipment, including temporary lighting, be protected by an approved *ground fault circuit interrupter* (GFI).

On tools that are not double-insulated, you must use a three-wire cord and the proper U-ground prong on the cord. By properly grounding the equipment, the operator should not receive an electrical shock if the tool or equipment develops a short circuit.

Portable Electric Circular Saws

When using portable saws:

- Make sure that there is enough set in the teeth to produce proper clearance for the blade
- Make sure that the work is well supported, as this will keep the **kerf** (the slot cut by the saw) open and prevent the saw blade from binding during the cut
- Support thin pieces near the cut and clamp small pieces to the workbench or sawhorse
- Never use a blade that is dull, has missing teeth, or requires setting



Figure 1 Electric portable circular saw (BC Industry Training Authority, 2019).
CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

- Adjust the depth of the cut to the thickness of the stock plus $\frac{1}{8}$ in. to $\frac{1}{4}$ in. (3 mm to 6 mm) more
- Check to make sure that the base of the saw, the guide and all other adjustments are tight
- Place the base of the saw on the stock, making sure that the blade is clear before you turn the saw on
- While making the cut, stand to one side of the cutting line
- Never reach under the material while it is being cut
- If the saw stalls during a cut, release the trigger, back out the saw until it is free of the material, then resume the cut
- If the saw continues to stall, unplug it and look at the condition of the blade and the set of the teeth
- When you come to the end of a cut, release the trigger and allow the blade to come to a standstill—lift the saw away from the stock but do not twist the saw as you lift, otherwise you may score the work
- Always make sure that all guards are in place and functioning properly before using the saw

Powered Cut-Off (Chop) Saws

You need to be especially safety-conscious while operating this tool. Consider the following before using a powered cut-off saw:

- Make sure the blade guard is in place before operating the machine
- Secure the workpiece in the vise or clamp. Never hold the piece with your hands
- If you are cutting long pieces, have the end supported or held by an assistant, as the piece could kick back and break the cut-off blade
- Use a face shield, not just eye protection
- Use leather gloves to handle the cut pieces as they will be hot and likely will have sharp edges
- Do not use excessive force when cutting, and be careful not to bump the blade onto the work, as this could break the blade
- During the cutting operation, do not stand in line with the cut-off blade. Stand off to one side so that if the blade breaks, you will not be in line with flying pieces
- Avoid the temptation to use the side of the abrasive cutting blade for grinding purposes as it will weaken the blade

Reciprocating Saws

Plunge-Cutting Wood with a Reciprocating Saw

To save time on the job site, a plunge cut can be made in plywood without having to pre-drill a starter hole.



Figure 2 Reciprocating saw (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

1. To make plunge cuts into wood or similar material, start by holding saw parallel to material, resting saw guide firmly against material but without having blade touch material.



Figure 3 Hold saw parallel to material (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

2. While holding saw firmly against material, press the OFF/LO/HI switch and pivot handle end of saw, slowly bringing blade in contact with material.



Figure 4 Pivot Handle Up (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

3. Raise saw slowly to upright position, keeping saw guide pressed firmly against material, and guide saw in this position along line of cut.



Figure 5 Plunge blade in material (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Portable Electric Drills

During heavier drilling operations, use both hands: one to apply force to the back end of the drill, and the other to hold the handle to counteract the **torque** generated by the drill. Always allow the motor on a reversible drill to come to a complete stop before switching the motor direction. Failure to do so will damage the motor.

Safety

If the bit jams, the forces used to turn the drill bit will be suddenly transferred to turning the electric drill. This sudden spinning of the tool in your hands can bruise, sprain muscles, or even break bones depending on the speed and torque of the tool. The risk of jamming increases with the diameter of the drill bit.

The more powerful the motor of the drill, the more force you will need to stop the drill from rotating. The faster the rotation of the drill bit, the more violent the reaction to jamming. If a risk of jamming exists, you should never lock the switch in the ON position. Keep your body clear of any path within the rotation of the drill. Be extremely cautious when drilling from elevated platforms or ladders.

Sharpening a Twist Drill

A correctly sharpened twist drill will cut mild steel with ease. Metal shavings should be produced equally by the two cutting lips of the drill. These shavings should eject from the hole in the shape of spiral coils. When the drill bit becomes dull, it must be sharpened.

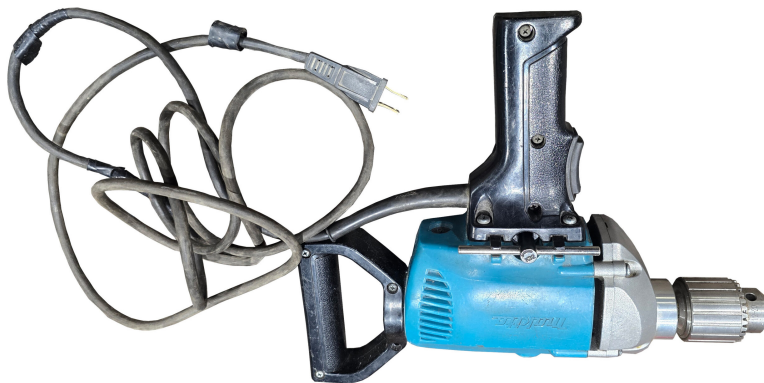


Figure 6 Electric hand drill (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

There are jigs made to hold twist drills at the proper angle to the grindstone for sharpening. These jigs are not always available, so it is valuable to learn how to sharpen a twist drill by the free-hand method.

Correct Drill Bit Angles

For normal use, a twist drill will have the cutting lips at 59° to the axis of the drill. Check the angle of the cutting lip with a drill grinding gauge. Both lips should be at the correct angle and equal in length.

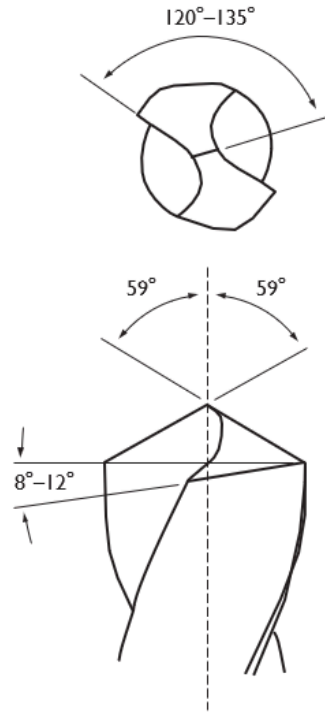


Figure 7 Cutting angle
(BC Industry Training Authority, 2019). CC BY-NC-SA 4.0
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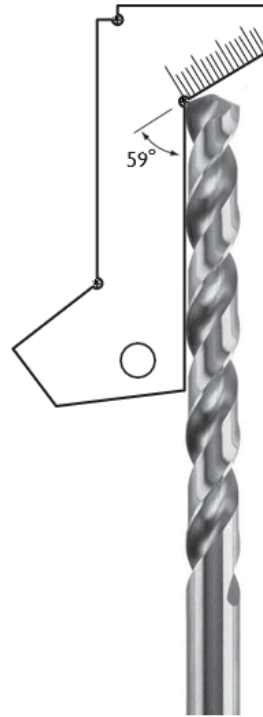


Figure 8 Checking the angle

Lip clearance on a drill bit can be compared to the heel clearance of a wood chisel. Not enough lip clearance will result in the cutting edge being held away from the workpiece surface. This chisel in the center image will cut when moved in the direction of the arrow because the heel clearance allows the cutting edge to make contact with the surface of the wood. Too much lip clearance, as shown at right, leads to rapid dulling of the cutting edge.

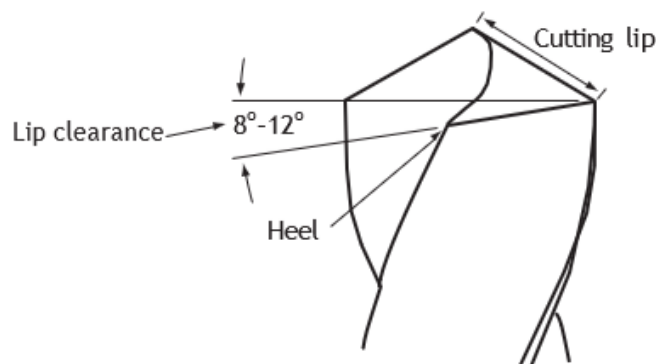


Figure 9 Chisel heel clearance (BC Industry Training Authority, 2019).
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Lip clearance on a twist drill is the angular difference between the heel and an imaginary horizontal line perpendicular to the lip. On a twist drill, a lip clearance of 12° is usually considered adequate. The heel of each cutting face rises 12° from the left end to the right end.

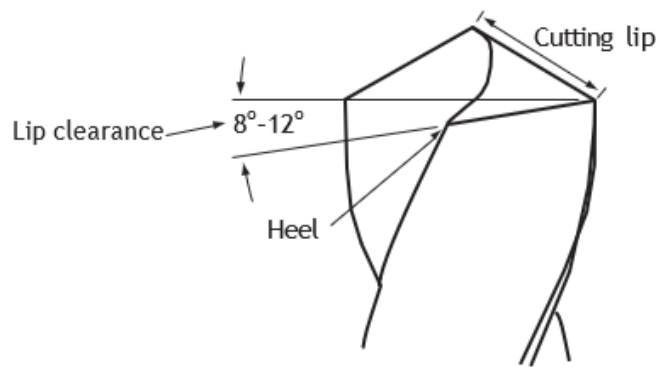


Figure 10 Lip clearance (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Another method of measuring the lip clearance angle is to use the 12° end cut on the drill grinding gauge. To use this gauge accurately, place it on its edge on a flat surface. Lay the twist drill behind the gauge with the point of the drill toward the 12° end of the gauge. The slope of the heel should be parallel to the 12° end of the gauge.

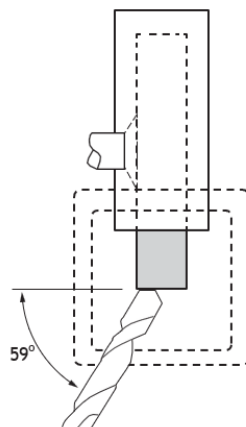


Figure 11 Placement of the twist drill (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The drill should be lying with its cutting lips parallel to the flat surface and should be sighted, as illustrated.

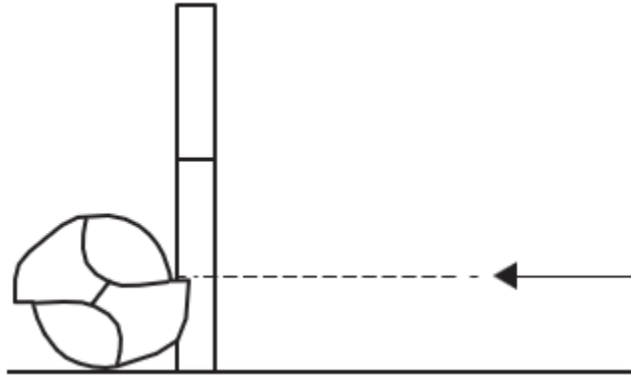


Figure 12 Checking the twist drill (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Hammer Drills

Drilling and setting concrete anchors is commonly done with a hammer drill or roto-hammer.



Figure 13 Using a hammer drill (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

There are many types of concrete anchors, but all serve the same purpose. They provide a secure mount for a bolt or a stud so that attachments can be made to a wall or foundation.

Consider the following points when setting anchors.

1. The strength of the concrete determines the holding power of the anchor. Drill only anchors into cured concrete and do not attempt to fasten to **spalled** (fractured) or cracked surfaces.
2. Follow the manufacturer's instructions for installing the anchor.
3. Most concrete anchors use a wedging action to hold the anchor in place. The wedging action will work only if the diameter of the hole is the correct size for the anchor being used. Refer to the anchor manufacturer's specifications for the appropriate diameter of hole.
4. The depth of the hole is also critical. Use the depth gauge to ensure the depth is exactly as specified by the manufacturer.



Figure 14 Using a depth gauge (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Always use steel bits with carbide tips when drilling into concrete with a hammer drill or a rotary hammer. Carbide-tipped bits are extremely hard and are designed to stand up to concrete. Helix-shaped bits are designed specifically for concrete. The helix shape removes the maximum amount of debris and helps to prevent the drill from binding in the hole.

Carbide tips are extremely hard, but also very brittle.

Never try to straighten a bent bit in a hole or to use the drill like a lever because the tip of the bit will chip and may break off.

Handle carbide-tipped bits with care. Do not allow them to drop onto hard surfaces. Store them in separate spaces to keep the tips from hitting together.

Carbide-tipped bits are usually very expensive to replace.

Demolition Hammers

Demolition hammers are used to chip or break up concrete foundations, walls or blocks.

- Use the shortest bit that is practical for the job. Long bits tend to bend and absorb some of the blow's energy.
- Make sure that the bit is sharp before you start work (careful to not remove the bit's *temper*).

- When you work with a demolition hammer, start the bit into the edge of the block or slab and turn it toward the edge. Take small “bites.”
- Always allow the weight of the hammer to assist in the breaking action. Use its weight to your advantage but always maintain your balance.

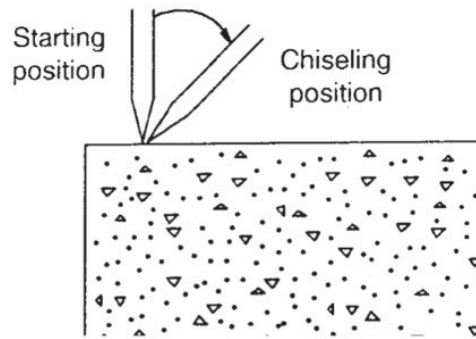


Figure 15—Working toward the edge when chipping concrete

Figure 15 Working toward the edge when chipping concrete (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 16 Demolition hammer or jack hammer (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Portable Grinders

Wheel (Disk) Selection

Selection of the correct grinding wheel or disk not only depends on the abrasive type, grain size, bonding material, grade, structure, size and shape, but also on the grinding machine, the material to be ground, and the nature of the operation. Medium-grain wheels (30 to 60 grit) are often chosen when only one metal-removing or sharpening operation is desired and the resulting surface finish is acceptable. Wheels having coarse grains (below 30 grit) work best with softer materials where material can be removed rapidly. Many bench grinders, for example, will have one wheel with a 30 grit and the other with a 60 grit.

When using **zip disks (cut-off disks)**, ensure that your entire face and body are out of the disk's path and that you wear a face shield and safety glasses. Cases have been well documented where cutting disks have shattered in operation and severely injured or even killed workers.



Never use a cutting disk or blade for grinding purposes. They are designed to cut on their edge only.

There are some rules that must be observed when using portable grinders:

- Always wear a face shield
- Use a portable shield to prevent sparks from hitting other workers
- Wear leather gloves and protective clothing
- Always use hearing protection
- Use both hands to control the grinder unless the grinder is so small that full control can be achieved with one hand
- Ensure that the RPM rating of the disk or wheel will not be exceeded by the RPM of the tool
- Secure the workpiece to prevent any movement during the grinding operation
- Ensure that the wheel or disk is suitable for the type of material on which you are working
- Ensure that the disk or wheel has not been damaged
- Remove flammable materials before grinding
- Never grind near disassembled components that could be contaminated or damaged by grit and sparks
- Keep sparks away from glass or finished surfaces
- Never remove the guard from a grinder and never use a grinder without a guard



Figure 17 Cordless electric angle grinder (BC Industry Training Authority, 2019).
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Portable Electric Pipe Fabrication Tools

Geared Threader with a Portable Power Drive

1. Insert the pipe in the threader and centre the end of the pipe in the throat of the dies.
2. Turn the work holder with a socket wrench to centre the pipe and hold it in position.
3. Tighten the clamp screw, securely locking the pipe in the work holder.
4. Place the oiler directly under the threader.

Notes:

- Long pieces of pipe must be supported by a pipe support, with the pipe free to rotate as it is threaded.
- If the pipe is installed in a tri-stand vise, the die head must be free to rotate. Both the tri- stand vise and the power vise, however, must be bolted to the floor.

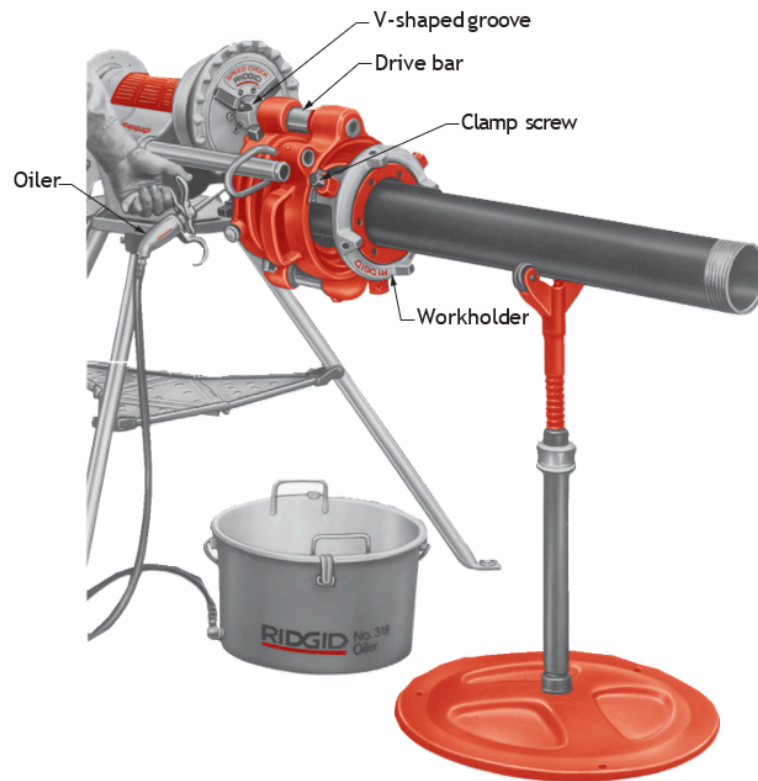


Figure 18 Oiler and geared threader (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 19 Using the portable power drive with the geared threader (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Pneumatic Portable Power Tools

All air tools require a large volume or flow of compressed air at a specified dynamic air pressure in order to operate efficiently. Dynamic air pressure is described as the pressure that is maintained while the air tool is in use. Static air pressure is the air pressure in the line when the air tool is not in use. The static pressure is always higher than the dynamic pressure. An air line and hose of the correct size are prime factors in maintaining adequate dynamic air pressure.

Filters and Regulators

When air is excessively wet, water shoots out of the exhaust port, which is unpleasant for the operator and can damage the work. In cold weather, moisture in the tool's air passages may freeze, rendering the tool inoperable.

Most of the moisture is removed at the compressor before it can enter the system. To remove any moisture still remaining, a filter and moisture separator is located at the beginning of the air-line hose. The trap on the water separator should be drained on a daily basis when the system is in regular use.

The regulator regulates the air pressure. A gauge at the front of the regulator shows the pressure reading. Air tools are rated for capacity and performance at an operating air pressure according to manufacturer's specifications. The pressure regulator should be preset to maintain this level of pressure at the tool.

Lubricator

The manufacturer's instructions for each type of tool should be followed, since lubrication requirements of air tools are different. Air tools require specially formulated air tool oil. Other oils, unless specifically recommended, should not be used because they can cause sticking and sluggish performance. In addition, some lubricants may contain toxic additives, which become a serious respiratory hazard when vapourized.

Some air tools have built-in oil reservoirs for continuous lubrication. The best way to ensure proper air tool lubrication is to connect air line lubricators at the end of each pipeline leading to an air tool hose. The air-line lubricator mixes a small amount of oil with the air, and all parts of the tool except those requiring a grease lubricant are then kept adequately lubricated. The lubricator reservoirs are usually made from clear plastic, allowing the oil level to be checked easily.

Air Hose

Air hoses must be protected from cuts and other damage and from oil or grease. Never drive over them or use them to pull attached air tools across the ground or floor.

Never leave air hoses lying on the floor where they can become damaged or weakened by being run over by vehicles or equipment. Store hoses so that the ends are connected.



Figure 20 Store hose with ends connected (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Air-Impact Wrench

Be careful when using large impact wrenches, as the torque can twist the tool out of your hands.

The pneumatic impact wrench shown has a square drive. Torque is controlled by regulating the airflow to the motor of the wrench. Even though there is little torque reaction, air-impact wrenches can produce very high torque values and you need to exercise caution. In-line air pressure regulators are sometimes required to control torque.

Air-Operated Grinder

A portable pneumatic grinder is more convenient to use if a 1 m (3 ft.) foot whip (leader) hose is attached directly to the tool and the air-line coupling is away from the tool. Although larger hoses are preferred for many pneumatic grinders,

all hoses must have inside diameters of at least $\frac{1}{4}$ in. Before using, adjust the throttle lever stop-screw. The grinder

speed is regulated by the distance the throttle lever is pulled or turned.

Air Hammers and Chisels

An air hammer or chisel may incorporate the use of a tool **retainer**. Its primary purpose is to keep the chisel or other attachment from flying off the end of the pneumatic hammer due to the intense vibration and **percussive force** generated during use. One type of tool retainer is the **beehive spring**, which threads on the barrel. The **quick-change spring** (a slight design variation of the beehive spring) has a retaining hook that can be pushed sideways for fast and easy tool bit installation or removal. To provide a more secure hold, a U-shaped **safety collar** can be used with either spring. Another retainer that reduces the possibility of a tool bit becoming loose is the **safety sleeve**. The safety sleeve is not used in conjunction with a spring but simply threads on the barrel.



Figure 21 Retainers (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The following safety rules apply to air hammers and chisels:

- Always use hearing and eye protection
- Always point the tool away from yourself and anyone else
- Always disconnect the air hose when changing the tool end

General Safety Precautions for Pneumatic Tools

The following safety rules apply to all pneumatic tools:

- When you use or work around a pneumatic tool, wear hearing protection, safety glasses with side shields, and steel-toed safety boots.
- Always inspect the air hose for fraying, kinks, loose or clogged fittings and air leaks.
- Keep the stapler or nailer pointed in a safe direction. Never assume that the stapler or nailer is empty. The tool you think is empty may fire and seriously hurt you or a fellow worker.
- Disconnect the tool from the air supply when you load the tool or change the depth of drive adjustment.
- Always disconnect the tool from the air supply to clear a jam, to change tool bits, or when you have completed the task.
- Carry the tool by the handle only. Never carry it by the air hose and do not touch the trigger while you carry it.
- Never operate a pneumatic tool if it is not working properly.
- Always use the recommended air pressure and check the gauge twice a day. Never use bottled air or gases to power the tool as they could cause the tool to explode.
- Clean the tool at least daily and lubricate it as needed. Never operate a dirty tool.
- Do not weaken the tool housing by abusing the tool: do not throw the tool, strike the tool housing, or use the tool as a hammer.

Powder-Actuated Tools

Powder-actuated tools, like any power tool, can be extremely dangerous if handled improperly. For that reason,

they must be used in accordance with local Workplace Safety Regulations. Strict attention must also be paid to the manufacturer's instruction manual.



Figure 22 Using a powder-actuated tool (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

To ensure proper operation of the double guidance system, these points should be considered:

- The washer must fit snugly into the chamber.
- The proper cartridge and fastener must be selected for the tool being used.
- The piston and the nail are each number coded. The numbers must match.

In selecting **fasteners**, the operator of the powder-actuated tool must also consider:

- The type of material to be penetrated: concrete or steel?
- The amount of **penetration** required.
 - For concrete, approximately 25 mm (1 in.) penetration is required. For steel, penetration should be a maximum of 12 mm ($\frac{1}{2}$ in.).
- The length of fastener required.
 - Type of material plus amount of penetration will determine the length of the nail. For example, to fasten a 50 mm × 100 mm (2 in. × 4 in.) onto concrete, a 75 mm ($2\frac{7}{8}$ in.) nail would be needed for 25 mm (1 in.) penetration into the

concrete.

Material Suitability for Powder-Actuated Fasteners



Fasteners can be set into two materials only: concrete and steel.

The holding ability of a **powder-actuated fastener** depends on the force of compression of the material into which the fastener is driven. On penetration, the fastener displaces and compresses the material. The material then tries to return to its original form and, in that effort, exerts a squeezing effect (Figure 24). This is called **holding action**.

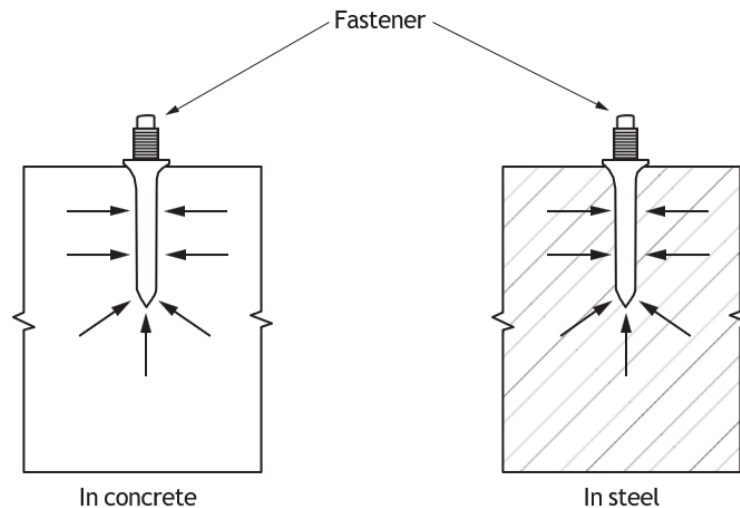


Figure 23 Holding action on fasteners (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Concrete

Notes about driving fasteners into concrete:

1. The fastening pin must be set only into the solid part of the concrete block. Also, because only the horizontal joint is under pressure, never fire a fastener into the vertical mortar joint.
2. The minimum thickness of concrete into which a fastener can be set must be three times the penetration of the

fastener; but at no time may the concrete be less than 75 mm (3 in.) thick. When fastening into concrete block, be sure the web is at least 75 mm (3 in.) thick.

3. Fastenings must always be at least 75 mm (3 in.) away from a concrete edge.

A good way to determine if a concrete block has a rating adequate for a powder-actuated fastener is to test its strength by using a fastener as a centre punch.



Figure 24 Standard concrete nail fastener (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Set the fastener against the concrete. Strike the fastener with a hammer and note the effect. If the concrete is not marked, it is too hard for fastening.

In addition to avoiding concrete that is too soft, too hard, or brittle, follow these additional “**do-not**” safety rules:

1. **Do not** set a fastener into an area where bits of concrete have exploded away as a result of an earlier attempt to insert a fastener. These chipped surfaces, known as spalled areas, are hazardous for powder-actuated fastenings.
2. **Do not** attempt a fastening into precast concrete beams containing pre-stressed cables. Pre-stressed cables struck by a fastener may cause the beam to weaken. In extreme cases, the beam could fail or the cable could rupture and cause injury.
3. **Do not** attempt to set powder-actuated fasteners close to the edge of a concrete block. The block will shatter.
4. **Do not** use a powder-actuated tool where atmospheric conditions are conducive to an explosion or fire. Flammable vapours can be ignited by the spark when the tool is fired.

Steel

Steel must be at least 5 mm ($\frac{3}{16}$ in.) thick for powder-actuated fastenings; but the operator should expect penetration

of up to 12 mm ($\frac{1}{2}$ in.). (The tip will protrude through $\frac{3}{16}$ in. steel.)

The fastening pin must be a minimum of 50 mm (2 in.) away from any weld or torch cut and at least 12 mm ($\frac{1}{2}$ in.) away from the edge of the steel.

To determine whether or not it is safe to set a fastener into steel, use the fastener as a centre punch. If, when struck with a hammer, the fastener marks the steel, it will penetrate.

Materials that may be fastened onto concrete or steel are:

- Wood
- Plywood
- Sheet metal
- Plastic

Note: Threaded or eyelet fasteners are used for holding light materials or loads, such as suspended ceilings.

Materials that cannot be fastened onto concrete or steel are:

- Brick
- Ceramic tiles
- vitrified tiles
- Glass
- Asbestos

Powder-Actuated Tool Regulations

Most jurisdictions require that operators of powder-actuated tools be trained or certified before using the equipment to ensure safe operation and handling. Guidance on the safe use of powder-actuated tools is provided by organizations such as CCOHS: Powered Hand Tools – Powder-Actuated Tools (https://www.ccohs.ca/oshanswers/safety_haz/power_tools/powder.html) webpage, and workplace requirements are set out in provincial health and safety regulations, including Powder Actuated Tools 12.51 Standards (<https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-12-tools-machinery-and-equipment#SectionNumber:12.51>) in the Occupational Health and Safety Regulation of British Columbia (WorkSafeBC) webpages. These sources outline requirements for operator training, safe handling, storage of power loads, and the proper use of fasteners and equipment.

The following *sample regulations* and safety practices illustrate common requirements for the safe use of powder-actuated tools and should be considered good practice. Always consult the applicable workplace health and safety regulations in your jurisdiction and follow the manufacturer's instructions for the specific tool being used.

- A low-velocity powder-actuated tool, with a fastener test speed rating of less than 100 m (330 ft.) per second, must be used unless no low-velocity tool is available on the market that is capable of doing the fastening task.
- When not in use, a powder-actuated tool must be unloaded and the tool and power loads must be securely stored and accessible only to qualified and authorized persons.
- Power loads of different power levels and types must be kept in different compartments or containers.
- Only a qualified person may handle or use a powder-actuated tool or power loads.
- The operator must have immediately available when using or servicing a powder-actuated tool:
 - ▶ a copy of the manufacturer's operating instructions for the tool
 - ▶ a copy of the power load and fastener charts for the tool, and
 - ▶ any accessories or tools needed for use or field servicing of the tool, including personal protective equipment
- A powder-actuated tool must not be used in an explosive or flammable atmosphere.
- A powder-actuated tool may only be loaded when it is being prepared for immediate use, and must be unloaded at once if work is interrupted after loading.
- A powder-actuated tool must not be pointed at any person.

- If a powder-actuated tool misfires, the operator must hold the tool firmly against the work surface for at least 5 seconds. Then follow the manufacturer's instructions for such occurrences and, until the cartridge has been ejected, keep the tool pointed in a direction that will not cause injury to any person. Place the misfired cartridge into water to prevent accidental discharge.
- A powder-actuated tool fastener must not be driven into very hard or brittle materials, such as cast iron, glazed tile, hardened steel, glass block, natural rock, hollow tile, and most brick.
- A powder-actuated tool fastener may only be driven into easily penetrated or thin materials or materials of unknown resistance if the receiving material is backed by a material that will prevent the fastener from passing completely through.
- A powder-actuated tool fastener must not be driven into steel within 13 mm ($\frac{1}{2}$ in.) of an edge, or within 50 mm (2 in.) of a weld except for special applications permitted by the tool manufacturer.
- Except for special applications recommended by the manufacturer, a powder-actuated tool fastener may not be driven into masonry materials:
 - ▶ Within 75 mm (3 in.) of an unsupported edge with a low velocity tool, or
 - ▶ Within 150 mm (6 in.) of an unsupported edge with a medium or high velocity tool
 - ▶ A powder-actuated tool fastener must not be driven:
 - ▶ Into concrete unless material thickness is at least 3 times the fastener shank penetration
 - ▶ Into any spalled area, or
 - ▶ Through existing holes unless a specific guide means, as recommended and supplied by the tool manufacturer, is used to assure positive alignment.
- Clean powder-actuated tools daily or after every 100 fastenings.
- Only have authorized service shops repair defective tools.



Figure 25 Medium powder-actuated fasteners (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Self-Test B-2.2: Use Portable Power Tools

Complete Self-Test 2.2 and check your answers.

If you are using a printed copy, please find Self-Test A-2.2 and Answer Key in the Appendix at the end. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca/?p=2786#h5p-4> (<https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca/?p=2786#h5p-4>)

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B-2.3 Describe Stationary Power Tools Used in the Pipe Trades

Stationary power tools are used in the piping trades for fabrication and production of material used for installation, alteration and repair of systems. Commonly, many of these tools will be found on larger construction projects and in fabrication shops.

Metal Cutting Band Saw

Metal cutting band saws are available in a variety of models and sizes.

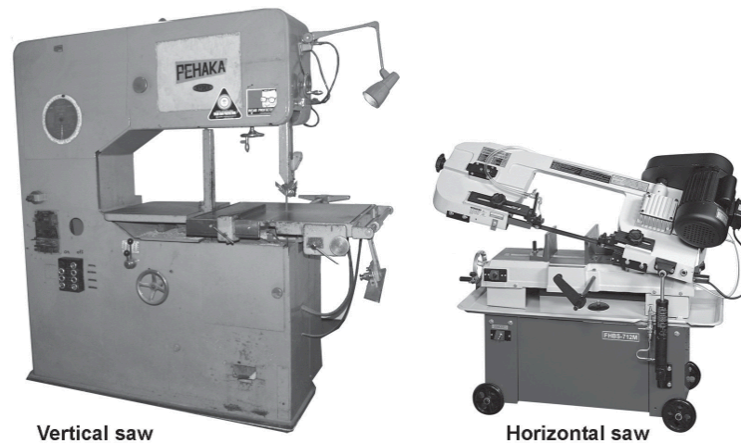


Figure 1 Metal cutting band saw (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The size of the metal-cutting band saw is designated by the thickness of stock it can cut. Standard sizes are 115 mm, 180 mm, and 255 mm ($4 \frac{1}{2}$ in., 7 in. and 10 in.). Some larger models are capable of cutting through a pipe that is 50 cm (20 in.) in diameter. A built-in vise holds the material being cut. The vise can be rotated to allow a range of cutting angles.

These saws produce an accurate cut without an excessive buildup of heat. Some saws are equipped with a mist spray cooling system that cools and lubricates the saw blade.

The smaller models regulate the amount of cutting pressure by use of an adjustable counterweight. Larger models use a hydraulic system to regulate the feed pressure. All models are designed to shut off once the workpiece is cut. These features allow the saws to be left unattended during long cutting operations. If several smaller pieces need to be cut, they can be cut simultaneously, providing they can all be secured in the vise.

The speed of the saw blade can be reduced to prevent heat buildup during a heavy cut. Speeds may range between 21 m/min (65'/min) to 90 m/min (300'/min).

Wear the appropriate safety equipment with all cutting machines including safety glasses and a face shield, which will protect your eyes from small particles of metal that can be sent flying during the operation.

Metal-Cutting Blades

Metal-cutting band saw blades are defined by their grades of steel, tooth formation, tooth set and blade width. Grades of steel include;

- Carbon
- Semi-high speed
- High-speed steel

Tooth formations include:

- Regular
- Hook
- Skip

Carbon Steel

Carbon steel blades are used for general purpose cutting on a standard band saw. Blades made of carbon steel are less expensive to buy but are less durable than the other grades.

Semi-High-Speed Steel

Semi-high-speed steel blades cut 50% faster than carbon steel blades. They are harder than carbon steel but are able to withstand mechanical shocks and vibrations that would break harder, more brittle blades.

High-Speed Steel

High-speed steel blades cut better and last longer than other blades but are more expensive and more delicate than the other two grades.

Regular Tooth

Band saw blades with **regular teeth** are used for straight and curved cuts in most ferrous and hard non-ferrous metals. Blades with regular teeth can be considered general-purpose blades.



Figure 2 Regular-tooth (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Hook Tooth

The **hook-tooth blade** is best for fast cutting of non-ferrous metals. The large rounded gullets are capable of fast chip removal and the forward slope of the tooth requires less downward pressure to cut. Thin sections of metal should not be cut with this tooth style due to the wide spacing of the teeth.

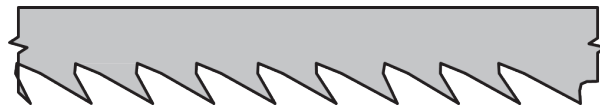


Figure 3 Hook-tooth (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Skip Tooth

The **skip tooth** is very similar to the hook tooth blade, except for the fact that the skip tooth can cut ferrous metals, whereas the hook tooth can cut only softer metals. The wide spacing of the skip tooth makes the blade suitable for fast cutting of large sections of steel.



Figure 4 Skip tooth (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Hook- and skip-tooth types are available in pitches from 3 to 6 teeth per inch. Regular-tooth styles range from 6 to 32 teeth per inch. The number of teeth per inch affects the cutting speed of a band saw, and the size of stock it is best suited to cut. Blades with large numbers of teeth per inch are able to cut small, thin pieces of metal but are slow for cutting large sections. Blades with few teeth per inch cut faster but are too coarse for cutting thin sections of metal.

Tooth Set

Set is defined as the left-and-right positioning of the teeth to provide a wider cut than the thickness of the blade. The wide cut provides clearance for the blade within the cut, preventing binding and overheating.

There are two types of tooth sets available on metal-cutting band saws: the raker set and the wavy set.

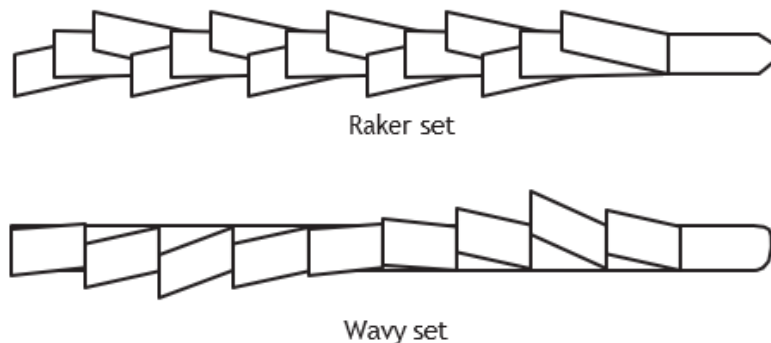


Figure 5 Tooth Set (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0
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Hook- and skip-tooth blades have raker set teeth. Regular-tooth blades with up to 24 teeth per inch come with either raker set or wavy set teeth. All regular-tooth blades with more than 24 teeth per inch have wavy set teeth.

Blade Width

Band saw blades are available in widths ranging from 6 mm to 32 mm ($\frac{1}{4}$ in. to $1\frac{1}{4}$ in.). The narrower blades are able to cut curves of a smaller radius than the wider blades. Wide blades are used for straight cuts.

Stationary Grinder

Stationary grinders may be mounted on a bench or a free-standing pedestal.

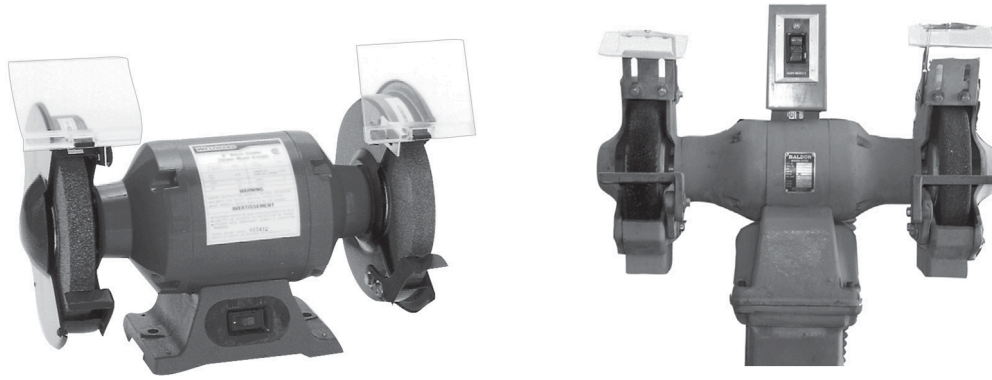


Figure 6 Bench Grinder (left) and Pedestal Grinder (right) (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Stationary grinders consist of an electric motor with grinding or wire wheels attached to both ends of the motor shaft. The wheels are enclosed in guards that support a tool rest at the front and a spark shield. The wheels rotate so that they travel toward the operator from the top of the wheel.

Tool Rest

The **tool rest** is adjustable and must be positioned no lower than the centre of the wheel. The distance between the front edge of the wheel and the tool rest must not be more than 3 mm (1/8 in.).

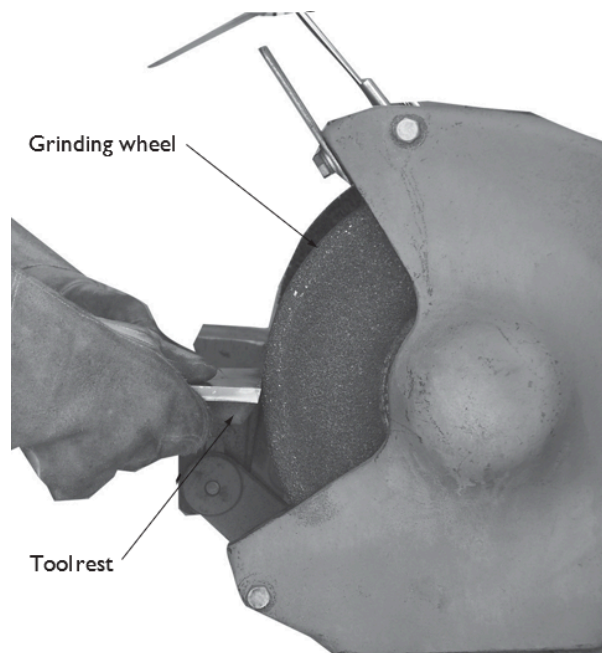


Figure 7 Bench grinder using a tool rest (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Spark Guard

Sparks are created during the grinding of ferrous metals or when using the wire wheel. To reduce the number of sparks that hit the operator, a **spark guard** is mounted at the upper end of the exposed portion of the wheel. The spark guard should be mounted as close as possible to the surface of the wheel. During wire wheel brushing, grit, dust and wires may be thrown off. The spark guard reduces operator risk from flying debris. A spark guard is not a substitute for a face shield. A face shield must also be worn when sparks are expected.

Grinder Ratings

Stationary grinders have motors with different horsepower ratings. As the horsepower increases, the grinding wheels become wider and larger in diameter. Motor speeds are reduced as the diameter of the grinding wheel becomes larger.

The wheels on stationary grinders are secured between two large clamping washers or flanges held tight by a nut on the end of the spindles. The nut on the left (as seen from the front) has a left-hand thread. Removing this nut requires a clockwise rotation. The nut on the other end of the grinder has a standard right-hand thread.

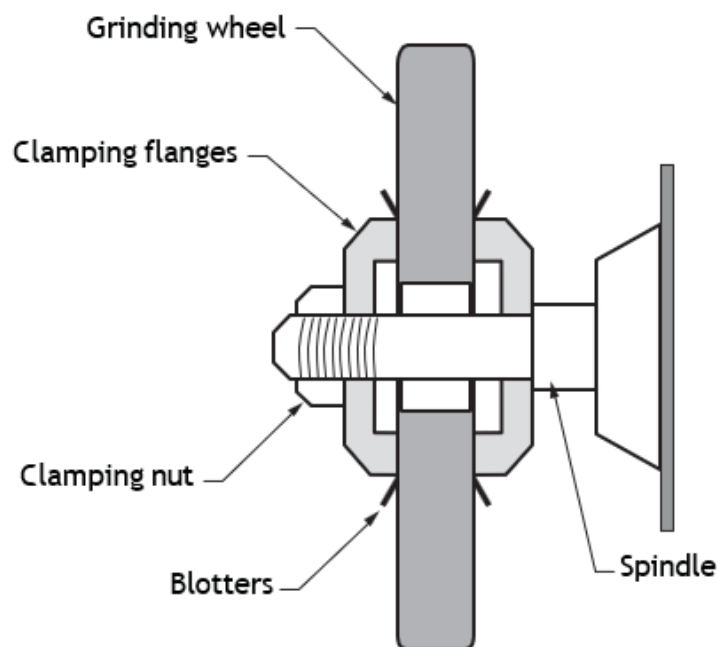


Figure 8 Grinding Wheel (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

When replacing a wheel, make sure the new wheel has an RPM rating that either matches or exceeds the no-load speed of the motor.

Grinding wheels are supplied with a blotter-type paper disk on each side. The disks serve to cushion the strain caused by the flanges when the clamping nut is tightened.

Grinding wheels with hair-line cracks are unsafe and must be discarded. To test for cracks, simply stand the wheel on

edge and tap the sides with a hard object, such as a screwdriver handle. Cracked grinding wheels will give off a dull sound, while a good wheel will give off a ringing sound.

Power Drives and Accessories

Power drives (also called power vises) rotate pipe so that hand tools can be used for cutting, reaming and threading operations. They are also used to drive tools that groove or thread pipe. The drive centres, holds, and rotates the workpiece as the various operations are performed.

A Forward-Off-Reverse switch selects the desired direction of rotation. To change the rotation of a vise in operation, turn the switch to the off position and wait for the machine to stop completely before flipping the switch to the opposite position.

Power vises may be mounted on a bench or on a three- or four-legged stand, depending on the type of vise and the work conditions.

Power vises, like the Ridgid Model 300 power drive, are widely used in the piping industry. This machine is designed to accept a carriage of power-driven accessories, as well as for use with hand tools.



Figure 9 Ridgid Model 300 Power Vise (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

Accessories for the Model 300 Power Drive

With mounted accessories, the Model 300 power drive can serve as a threading machine. The die head, cutter, and reamer are positioned on a carriage, which slides onto support bars.



- A. Die head and dies for threading
- B. Pipe cutter with wide rollers for straight cuts at power-drive speed.
Capacity: 3 mm to 50 mm (1/8 in. to 2 in.) pipe
- C. Reamer. Capacity: 3 mm to 50 mm (1/8 in. to 2 in.) pipe
- D. Carriage with lever
- E. Three-legged stand to hold the vise and pipe at the proper working height.
The stand folds up when not in use and is held together by a chain lock.
- F. Foot switch and power cord which allows for remote operation.
- G. Oiler
- H. Oil reservoir

Figure 10 Model 300 Ridgid (RIDGID TOOLS/Emerson Professional Tools)
Used with permission.

The **oiler** is used for applying thread-cutting oil to produce accurate, smooth threads and keep dies cooled and lubricated.

The oiler includes a hand-operated pump, a hose, and a reservoir containing a screen and chip pan. It is used only during the threading operation.

The clip-on tool tray is designed to hold hand tools while working with the power drive.



Figure 11 Clip-On Tool Tray (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The **nipple chuck** (Figure 12) holds nipples or studs for threading when the vise jaws may damage the threads or when they are too short to be held in the vise. The chuck releases them easily when threading is complete.

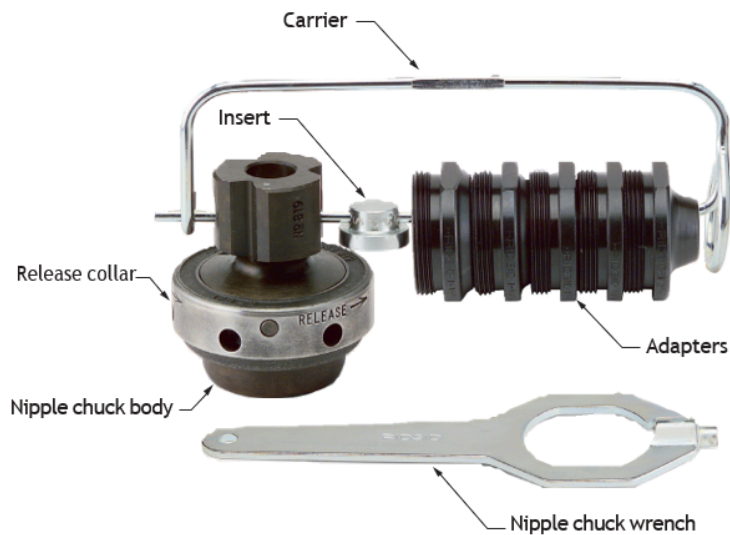


Figure 12 Nipple Chuck (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The telescoping universal jointed drive shaft, when used with a power vise, can drive a geared threader. The pipe must be secured in a separate stationary vise. The drive shaft length can be extended from 104 cm (41 in.) to 127 cm (50 in.).



Figure 13 Telescoping Universal Jointed Drive Shaft (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Figure 14 shows two types of adjustable pipe supports. Right-angle rollers in one style let pipe turn freely. The capacity is 10 in. pipe. Pipe supports can also be made on-site from scrap pipe, threaded rod and channel iron.



Figure 14 Adjustable Pipe Supports (RIDGID TOOLS/Emerson Professional Tools)
Used with permission.

Stationary Threading Machines

The threading machine differs from a portable power drive in that the cutter, the reamer, the carriage for the die head, and the pump to circulate thread cutting oil are built-in parts of the machine, not optional attachments. All machines are operated by a foot switch.

The threading machine is a portable machine that has the power and capacity to cut, ream, and thread large diameter pipe and conduit from 13 mm to 10 cm ($\frac{1}{2}$ in. to 4 in.). They can be bench mounted or fitted to a stand.

As an example, the Ridgid No. 535 pipe and bolt threading machine has a hand speed chuck or auto-chuck (to hold pipe without slipping), and the pipe can be inserted from the front or the back. Like other power threading machines, this model has tools that operate independently and swing up and out of the way when not in use. A variety of dies and die heads are available for the No. 535. A reversible pump re-circulates thread cutting oil making them a self-oiling threader. Some machines have die heads with oil passages built right into the head.

The machines can be bench mounted or fitted to an open leg or wheeled stand. Pipe capacity for the Model 535 is 13 mm to 50 mm ($\frac{1}{2}$ in. to 2 in.).



Figure 15 Pipe and Bolt Threading Machine No. 535 (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

The Ridgid Model 1224 threading machine threads 6 mm to 50 mm ($\frac{1}{4}$ in. to 2 in.) pipe at 36 RPM and 6 cm to 10 cm (2

$\frac{1}{2}$ in. to 4 in.) pipe at 12 RPM.

Due to their larger capacity, machines like these are ideal equipment for large construction sites and pipe fabrication shops.



Figure 16 Ridgid Model 1224 Stationary Threading Machine (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

Compact styles of threading machines have also been developed for the pipe trades industries that are well suited to light duty and service work, typically for pipe up to 25 mm (1 in.) in diameter. Most can be mounted on roll-away

folding stands or simply placed on a bench or tailgate for quick threading at the jobsite. Some threaders have even been developed to use an oil-free solvent to cool the dies when threading, providing for cleaner fabrication where required.



Figure 17 Ridgid Model 1210 Oil-Free Compact Threading Machine (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

Stationary Grooving Equipment

Through the use of special equipment, piping can be smoothly and uniformly grooved for mechanical couplings and fittings. As with power threading operations, an adjustable pipe support will often be required when using grooving attachments.

The Ridgid Model 975 combo roll **groover** uses rollers to form grooves in standard and thin-wall pipe. It can be combined with a power drive for machine grooving jobs, but it is also designed to manually groove pipe in-place. The 975 also comes with a permanently fixed depth setting gauge for quick setup.



Figure 18 Ridgid Model 975 Combo Groover (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

Designed for quick, multiple field work, groovers like the Ridgid Model 916 are designed to be driven only by some type of power drive. Groovers like these use a single-stroke feed mechanism that allows for quick operation and minimal effort. These units have capacities of 15 cm (6 in.) diameter for copper and light wall steel, and 8 cm (3 in.) for schedule 40 steel pipe.



Figure 19 Ridgid Model 916 Stationary Power Driven Groover (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

Also intended to be driven by a power vise, the Model 918 is an example of a heavy-duty hydraulic groover designed for light wall pipe up to 30 cm (12 in.) in diameter, and schedule 40 steel up to 20 cm (8 in.). The 15 tons of force exerted at the forming wheels allows for precision grooving.



Figure 20 Ridgid Model 918 Stationary Power Driven Hydraulic Groover (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

It has an extra set of support legs for additional stability and a built-in pressure gauge for accurate control of hydraulic pressure while grooving. With one of the largest capacities available, it can handle light wall pipe up to 60 cm (24 in.) and Schedule 40 pipe as large as 30 cm (12 in.).

The Ridgid 920 roll groover is a larger version of the 918 hydraulic machines, but like other groovers discussed in this section it still requires the use of a power drive to provide the muscle.



Figure 21 Ridgid Model 920 Large Capacity Stationary Power Driven Hydraulic Groover (RIDGID TOOLS/Emerson Professional Tools) Used with permission.

External mounting and drive action can provide quick, accurate cutting and grooving of ductile iron pipe and heavy-walled carbon steel pipe. Cut grooving removes less material from the wall of a pipe than threading does, and allows for some pipe separation and deflection.



Figure 22 Stationary Cut Groover (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Drill Press

The **drill press** is one of the most practical power tools because of its versatility and ease of operation. A drill press can be floor or bench mounted.



Figure 23 Drill press (Camosun College/BCcampus) CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Construction

The four basic parts of the drill press are the base, column, table and head. The head is the entire working mechanism attached to the upper end of the column. The table can be moved up and down on the column. On some models, the table can be swung to either side or tilted.

The chuck is moved downward by means of simple rack-and-pinion gearing worked by the feed lever. The feed lever is returned to its normal position by means of a coil spring. You can lock the feed and pre-set the depth to which it can travel.

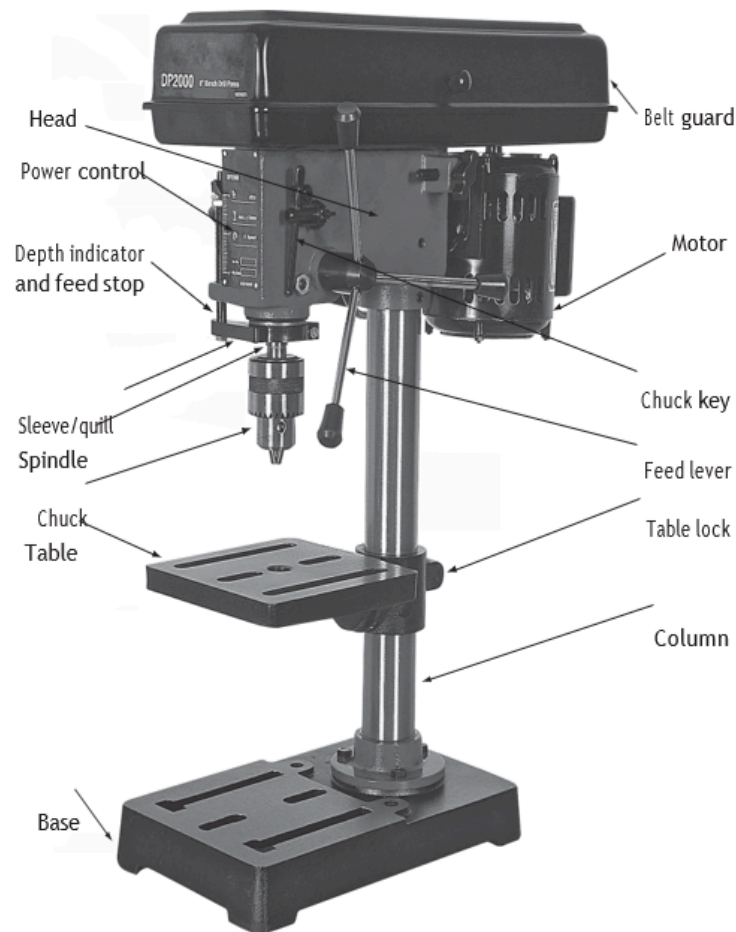


Figure 24 Drill Press (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Power and Speed

The drill press is fitted with pulleys or gears so that different speeds can be obtained. The average drill press can obtain speeds of 680, 1250, 2400 and 4600 RPM. When the machine is used exclusively for metal work, a larger cone pulley is used on the spindle to give lower speeds of about 470, 780, 1300 and 1950 RPM.

Stationary Pipe Benders

Mechanical bending is a metal forming process used to permanently change the shape of pipe or tube.

Procedures like “**ram bending**” or “**rotary draw bending**” are used to form the workpiece into the shape of a die. Straight tube stock can be formed using a bending machine to create a variety of single or multiple bends and to shape the pipe or tube into the desired form.

One side effect of bending the workpiece is that the wall thickness changes; the wall along the inner radius of the tube becomes thicker, and the outer wall becomes thinner. To overcome this, the tube may be supported internally or

externally to preserve the cross section. Depending on the bend angle, wall thickness and bending process, the inside wall of the bend may crease.



Figure 26 Portable Hydraulic Tube and Pipe Bender (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Self-Test B-2.3: Describe Stationary Power Tools Used in the Pipe Trades

Complete Self-Test 2.3 and check your answers.

If you are using a printed copy, please find Self-Test A-2.3 and Answer Key in the Appendix at the end. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca/?p=2788#h5p-5> (<https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca/?p=2788#h5p-5>)

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- Camosun College. (2015). Trades Access Common Core Competency C-2: Describe Common Power Tools and Their Uses. Victoria, B.C.: Crown Publications. Download for free from the B.C. Open Textbook Collection (<https://open.bccampus.ca/browse-ourcollection/find-open-textbooks/>).

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B-2.4 Use Stationary Power Tools

Stationary Grinding Tools

Before starting a grinder, check the condition of the grinding wheel. Place a fixed reference object on the tool rest so that it just touches the face of the wheel, then turn the wheel by hand. The wheel should just contact the object at all times as it makes a full turn. If not, the wheel is **out-of-round**. Out-of-round wheels cause the workpiece to vibrate during grinding.

Check the condition of the face of the grinding wheel. If it shows excess signs of metal particles, it will need to be cleaned. Grinding wheels with a surface embedded with metal (Figure 1) tend to generate heat rather than to grind. The left image of Figure 1 shows dulled grains and particles of metal embedded in the wheel, while the right image shows a sharp cutting and unclogged grain surface.

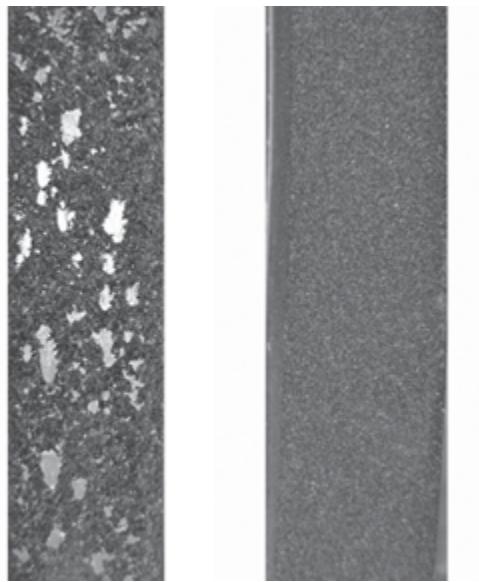


Figure 1 Metal in a grinding wheel (left), clean grinding wheel (right) (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

To remedy out-of-round or dirty wheels, use a wheel dresser on the face of the stone. Where the grinder design permits, the tool rest must be backed away from the grinding wheel enough to allow the dresser to hook over the front edge of the tool rest. While the grinder is running, the handle of the dresser is raised until the sectional washers touch the wheel's face and the dresser is moved across the width of the grinding wheel. Turn off the grinder. When the grinding wheels have stopped turning, check the entire face for metal particles or out-of-round. Repeat dressing as necessary.



Figure 2 Wheel dresser (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Remember to re-position the tool rest no further than 3 mm ($\frac{1}{8}$ in.) from the wheel after dressing.

When you are using a stationary grinder, you should rest the workpiece on the tool rest and apply enough pressure against the wheel so that grinding or brushing takes place. Avoid applying so much pressure that you cause a noticeable reduction in the motor's rotation speed.

Tools such as drill bits, screwdriver tips and cold chisels occasionally require grinding to improve their performance. You should grip such tools close to the area being ground so that you can feel any build-up of heat. If heated to the point of showing colour (yellow, purple or blue), the hardness of the tool will be affected. To prevent overheating, make sure the grinding wheel is clean, and dip the workpiece in water frequently to cool it.

The Right Wheel for the Job

Selection of the correct grinding wheel not only depends on the abrasive type, grain size, bonding material, grade, structure, size and shape but also on the grinding machine, the material to be ground and the nature of the operation. Medium-grain wheels (30 to 60 grit) are often chosen when only one metal-removing or sharpening operation is desired and the resulting surface finish is acceptable. Wheels having coarse grains (i.e. below 30 grit) work best with softer materials, where material can be removed rapidly. Many bench grinders will have one wheel with a 30 grit and another with a 60 grit.

Grinding Cold Chisels

The two areas on a cold chisel that may require grinding are the cutting edge and the end that is struck by the hammer.

Flat chisels should have a cutting edge ground to an included angle of approximately 60 and should have a slight curve to the width. The struck end should have all signs of mushrooming removed.

When using the grinding wheel, the chisel should be held at the desired angle and moved across the face of the wheel. Grind one side and then the other to form a sharp edge. The pressure applied to the chisel against the wheel should not be great enough to overheat the chisel end and draw (remove) the temper. If the temperature of the chisel end rises to a point where the metal turns blue, the temper has been lost and the end softened so that it will no longer stand up to normal use. Frequently dip the chisel end in water when grinding to keep the metal cool and to prevent overheating.

Sharpening a Twist Drill

Before you sharpen a twist drill, check the dull bit with your grinding gauge to ensure that the cutting lips are at 59° and that it has a 12° lip clearance. If it has the proper angles, these can act as a guide when you sharpen the drill tip. If the angles are not correct, you will know which areas require more grinding.

Place the twist drill so that the cutting lip to be ground is facing up and its cutting edge is level. Move the shank to your left until the axis of the drill is at 59° to the surface of the grindstone.

If the drill has a correct lip angle, the cutting edge will be exactly parallel to the surface of the stone.

Rotate the shank of the drill while sharpening so that the axis of the drill forms an angle of 12° to the horizontal.

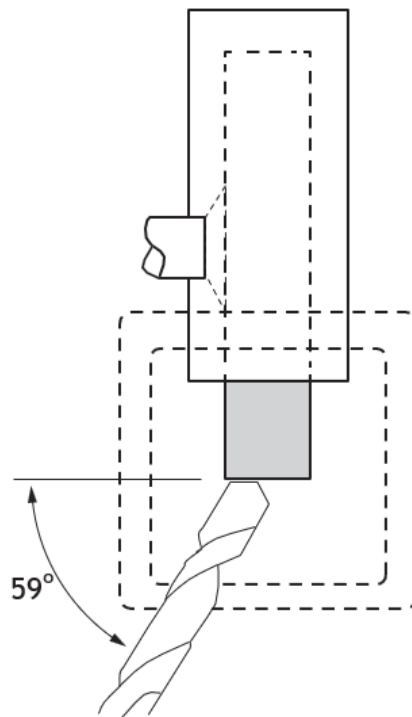


Figure 3 Placement of the twist drill (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

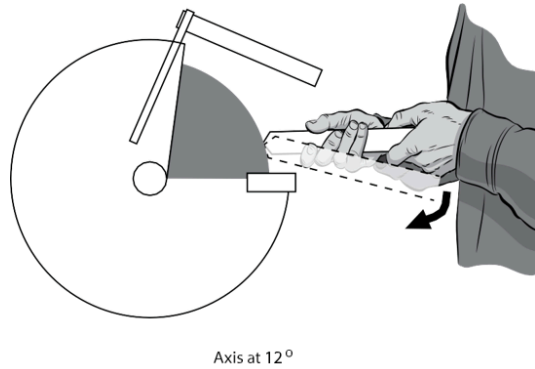


Figure 4 Axis at 12° (BC Industry Training Authority, 2019).
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Begin sharpening the cutting lip of the drill, continuing to lower the shank end of the drill bit as the grinding proceeds. You may wish to practise this motion several times with the grinder turned off. When this “dry run” (practice motion, with the grinder off) feels right to you, rotate the drill one half turn and see if you can repeat the required angle and motions.

When doing the actual sharpening, always start the grinding at the cutting edge, and tilt the bit so that you finish at the heel. Try not to remove any more metal than is required to achieve a sharp cutting lip. Check the length of each cutting lip often to maintain equal lengths.

If both cutting lips are at the same angle (59°) and the same length, the point of the bit will be centered. If the point is not centred properly, it is because one or both of these conditions has not been met.

You must be careful not to overheat the drill bit during the grinding operation. Dip the end of the twist drill in cold water frequently to prevent excessive heat buildup. Never allow the surface of the drill to get so hot that it turns blue from the heat—the temper (hardness) of the metal will be destroyed, and the drill will no longer remain sharp during use.

Safety with Stationary Grinders

There are some rules that must be observed when using stationary grinders:

- Always wear a face shield
- Wear leather gloves and protective clothing
- Always use hearing protection
- Use both hands to control the work
- Ensure that the RPM rating of the wheel will not be exceeded
- Ensure that the wheel is suitable for the type of material
- Never reverse a wire wheel, as the wires in the wheel will have taken a “set”
- When cleaning small parts, hold them with pliers, never with your hands
- Ensure that the wheel has not been damaged
- Ensure that all guards are in place
- Ensure that the tool rest is properly adjusted
- Always stand to one side when starting the grinder
- Remove flammable materials from the work area

- Have people not involved in the grinding operation leave the area
- Never grind on the side of a grinding wheel, as this can weaken the wheel and cause it to break apart.

Be sure all grinding wheel safety devices such as wheel guards, spark deflectors, eye shields and tool rests are installed and properly adjusted before operating a grinder.

Stationary Threading and Grooving Tools

In this section you will learn safe procedures for cutting, reaming, threading and grooving using various styles of power vises and cutting machines.

Safety Precautions for Operating a Power Vise

1. Know the machine. From the information in this guide and the operator's manual, find out what the vise will do and how to operate it to accomplish that work. Know, as well, the limitations of the machine.
2. Avoid accidental starting. Make sure that the machine's Reverse/Off/ Forward switch is in the Off position and that the foot switch will operate freely. These checks must be made before the machine is connected to a power source.
3. Ground the machine. The machine should be grounded while in use to protect the operator from electric shock. The machine is equipped with an approved three-conductor cord and three-prong grounding type plug to fit the proper grounding type receptacle. The green (or green and yellow) conductor in the cord is the grounding wire. Never connect this wire to a live terminal. If the unit is for use on less than 150 volts, it has a 115 V plug. If it is for use on 150 to 250 volts, it has a 230 V plug.

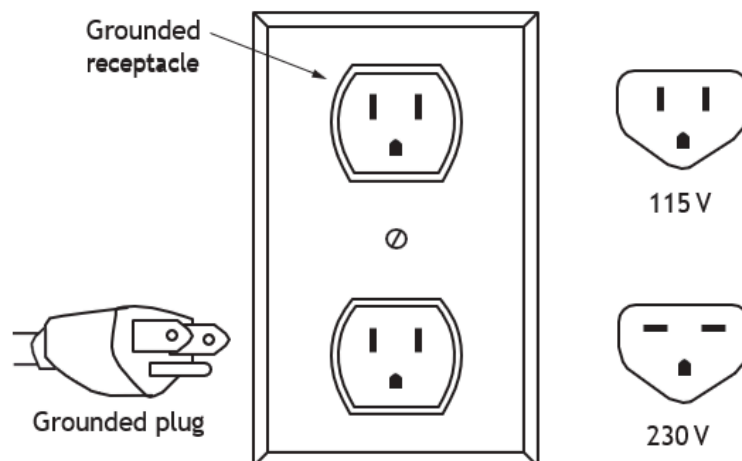


Figure 5 Equipment grounding (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

4. Use only three-wire extension cords that have three-prong, grounding-type plugs and three-hole receptacles that accept the machine's plug. Replace or repair damaged or worn cords immediately. When the machine is used

outdoors, use only those extension cords that are suitable for use outdoors and are so marked.

5. Remove tools from the machine. Form the habit of checking to see that the machine is clear of adjusting wrenches and other tools before starting.
6. Support the work. Support long, heavy work with a floor pipe support.
7. Secure the machine. Make sure that the machine is stable. A power drive must be bolted to the floor when used with a universal drive shaft.
8. Do not reach across the machine. Operate the machine from the switch side only. Keep proper footing and balance. Be sure your foot can be removed safely from the foot switch at all times. Do not reach across the machine, and keep clothing, hands and tools away from moving parts.
9. Maintain the machine in top condition. Use sharp cutting tools and keep the machine clean for best and safest performance. Follow lubricating instructions.
10. Work in a safe environment. Do not use the machine in damp or wet locations. Do not expose the machine to rain. Keep work area well illuminated. Allow sufficient space to operate machine and accessories properly and for others to pass safely. Keep the power cord away from heat, oil and sharp edges. Make sure that hand tools that are not being used are not, in any way, obstructing machine operation.
11. Disconnect the power cord. When adjusting, servicing or changing accessories, disconnect the power cord. The cord should be in top condition, and examined at regular intervals.

Safety Precautions for Operating a Model 700 Portable Power Drive

Follow the safety procedures for operating power vises modifications:

1. Check the off switch. Before plugging in the power cord, push down on the switch button a couple of times to make sure that the switch button spring returns the switch to the Off position. A safety feature of this machine is that the power drive automatically stops when the operator lets go of the switch button on the handle of the machine.
2. Use the proper accessories. The support arm assures safe operation when using this machine with drop head threaders in any position. The Model 700 power drive may also be used with a geared pipe threader. In that case, the power drive is not used with the support arm.

Cutting Pipe Using Power Tools

In this section, you will learn safe procedures for cutting pipe using different stationary power tools.

Inserting Pipe in a Power Vise or Threader

The following general procedure describes inserting pipe into power vises or threading machines:

1. Measure and mark the length of pipe being worked.
2. If pipe is long enough to be retained by the centring device, insert the pipe through the front or rear of the machine. If the pipe is short, insert it into the front of the machine.
3. Make certain that the pipe is centred in the centring device, if used, and tighten the device.

4. Tighten the chuck jaws with a repetitive counter-clockwise **snap-spin** of the hand wheel.

This hammering action tightens the jaws on the pipe. A clockwise rotation snap-spin releases the jaws.

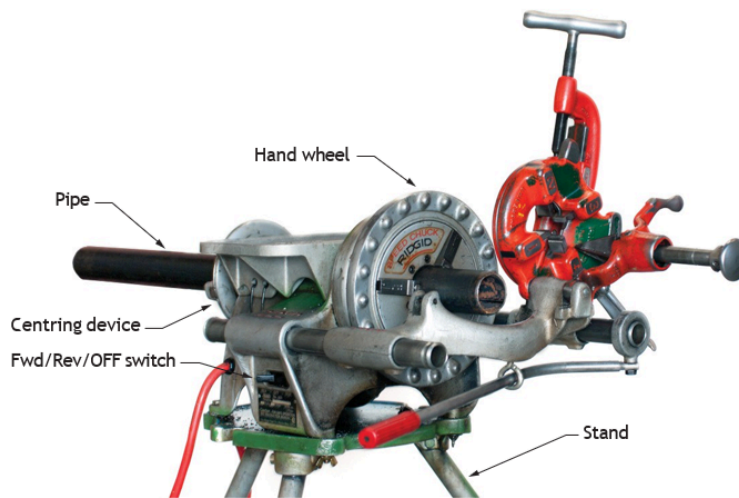


Figure 6 Power drive on stand with pipe installed (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Cutting Pipe with a Hand Cutter Using a Power Vise

The following general procedure describes cutting pipe using a hand cutter and power vise:

1. Measure, mark, and secure the pipe in the power drive.
2. Engage the pipe with the pipe cutter and align the cutter wheel with the mark on the pipe.
3. Rest the pipe cutter frame on the support bar, which is located on the switch side of the machine. Tighten the feed screw (sometimes called a feedscrew) handle.
4. With the power cord plugged in, turn the main switch to the forward position.
5. Place foot on the foot switch to operate the machine.
6. Continuously tighten the feed screw handle until the pipe cut is completed (Figure 7).

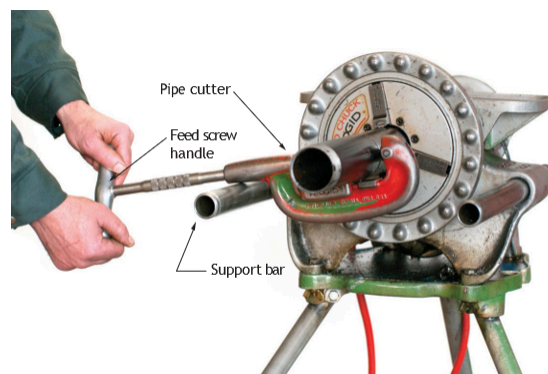


Figure 7 Cutting pipe with hand cutter (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

7. Release the foot switch.

Figure 8 shows hand cutters that can be used with power drives. The heavy-duty wide roll pipe cutter is especially suited for power drive use as the wide-rolls keep the cutter from wobbling.



Figure 8 Hand cutters (BC Industry Training Authority, 2019).
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Accessories for cutting, reaming, threading and oiling can be mounted on the power vise to convert it into a power threader. Below is a standard power vise with cutting, reaming and threading attachments installed. On this unit, oiling must be done manually.



Figure 14 Straight reamer (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0
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Cutting Pipe with a Power Vise Cutter

Assume the correct operating position for cutting, threading, and reaming. Stand on the switch side of the power vise, straddling the nearest tripod leg. The left foot operates the foot switch.



Figure 10 Operating a foot switch (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

1. Measure the pipe and mark the place where the cut is to be made.
2. Swing the reamer and threader out of the way.
3. Move the pipe cutter down onto the pipe.
4. Use the carriage lever to move the carriage to the point where the cutter wheel lines up with the mark you have made on the pipe.
5. Tighten the cutter feed screw handle until the cutter wheels are snug against the pipe.

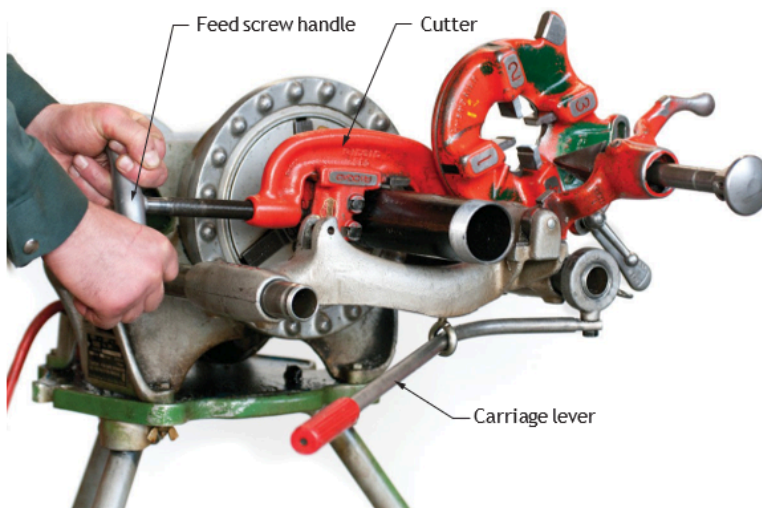


Figure 11 Tightening cutter screw wheel (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

6. With the main switch still in the forward position, step on the foot switch.
7. Using both hands, continuously turn the cutter feed screw handle until the pipe is cut off.
8. Release the foot switch.
9. Return the pipe cutter to its out-of-the-way position.

Cutting Procedure Using a Power Threader

1. Measure the pipe and mark the cut-off point.
2. Insert the pipe into the chuck.
3. With the reamer and the die head in an out-of-the-way position, bring the cutter down over the pipe, and position it on the mark you have made.
4. Turn the cutter handle to cut.

To use length gauge on machine carriage, place cutter wheel against end of stock and set pointer to “0”, raise to clear stock, and turn carriage hand wheel until pointer is at length desired.

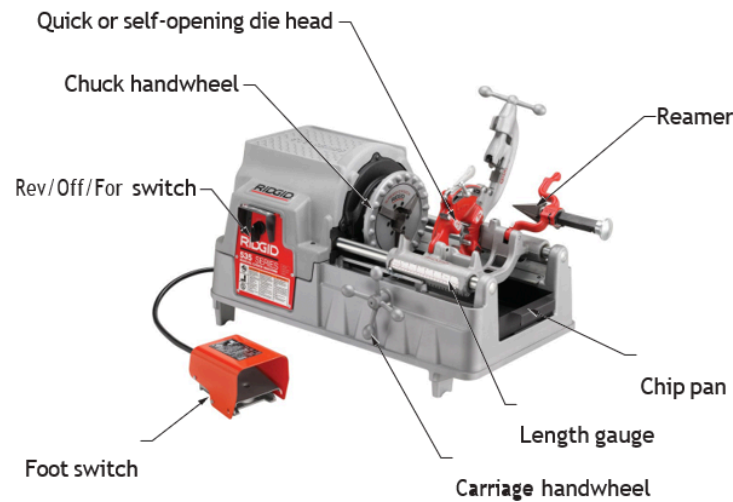


Figure 12 Power threader (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Reaming Pipe Using Power Vises or Threading Machines

In this section, you will learn safe procedures for **reaming** using various styles of power vises and reaming tools.

Reaming Pipe Using a Power Vise and Hand Threader

Follow the safety precautions for power vises, outlined in Safety Precautions for Operating a Power Vise.

1. Check to see that the main switch is in the forward position.
2. Insert the reamer into the end of the pipe and hold firmly onto handle and handgrip (Figure 13).

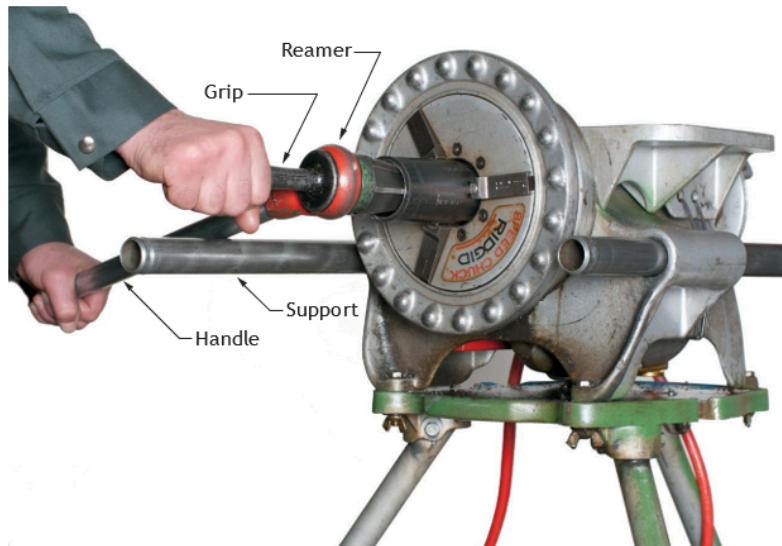


Figure 13 Reaming pipe with a hand reamer using a power vise (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

3. Step on the foot switch and slowly push on reamer handgrip (same Figure 13), with right hand to ream pipe.
4. Release foot switch and remove reamer.

The straight reamer is a safe hand tool for manual use with power vises. Spiral reamers are not safe.



Figure 14 Straight reamer (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Reaming Pipe with a Power Drive Reamer or Threading Machine

Assume the correct operating position by standing on the switch side of the power drive, straddling the tripod leg. Use left foot to operate the foot switch.

1. Move the reamer arm down into the reaming position.
2. Extend the reamer by pressing the latch and sliding the knob toward the pipe until the latch engages the bar.
3. With the main switch in the forward position, step on the foot switch.
4. Position reamer into pipe and complete reaming by pushing carriage lever. Exert pressure on the hand wheel for the same action on a power threader.
5. Retract the reamer bar and return the reamer to out-of-the-way position.
6. Release the foot switch.

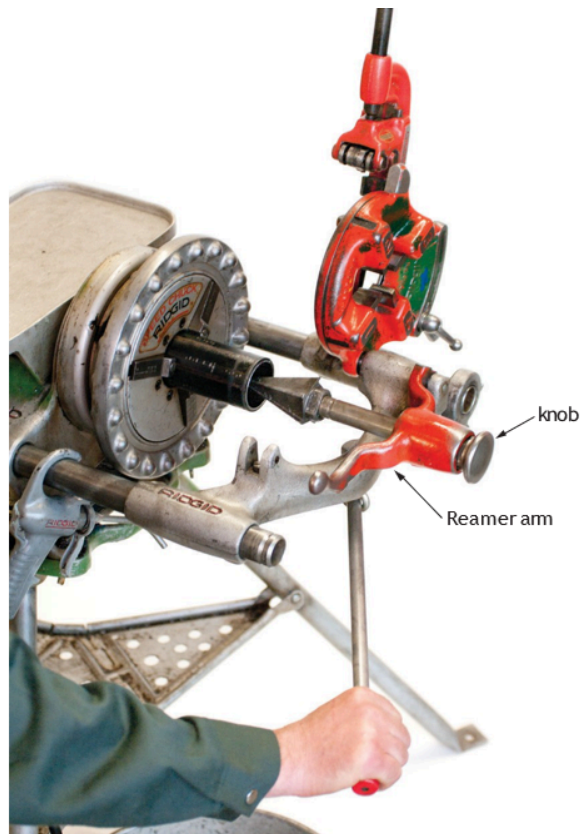


Figure 15 Reaming pipe with power drive reamer (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Threading Pipe Using Power Vises or Threading Machines

A quick-opening die head is the standard drive mounted threading accessory. Depending on the pipe size, different die sets are installed which determine the number of threads per inch.

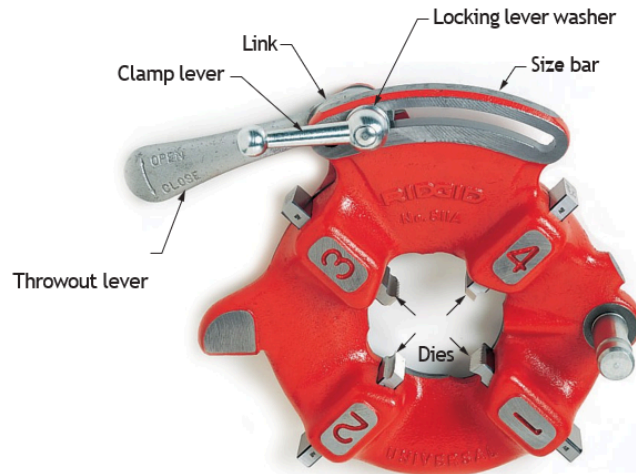


Figure 16 Quick-opening die head (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Install a Die Set

1. Select the correct set of dies for the pipe size. The size is marked on either the back end or the face of the dies.
2. Lay the die head on the workbench with the numbers on the head facing up.
3. Flip the throw-out lever to the open position.
4. Loosen the clamp lever approximately three turns.
5. Lift the tongue of the locking lever washer up out of the slot under the size bar. Then slide the sizing mark all the way to the end of the slot.
6. Insert the dies to the line marked on the side of the dies, numbered edge up. Note that the die numbers 1 through 4 must correspond with the numbers on the die head slots.

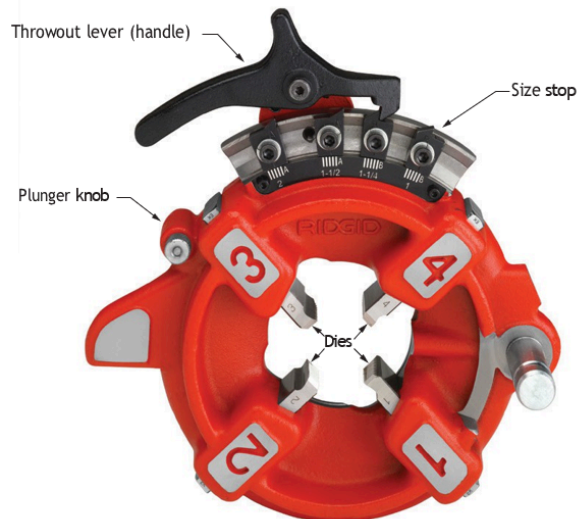


Figure 17 Semi-automatic die head (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

7. Slide the throw-out lever back so that the tongue of the clamp lever washer will drop into the slot under the size bar.

Adjust the Die Head to the Size Desired

1. For standard threads, adjust the size bar of the die head until the index line on the link lines up with the proper size mark on the size bar.
2. Tighten the clamp lever.

Thread Pipe with Quick-Opening Die Head

1. Install the die set.
2. Swing the cutter and reamer to an out-of-the-way position.
3. Lower the die head into the threading position.
4. Apply thread cutting oil to the end of the pipe.
5. Ensure that the main switch is in the forward position.
6. Step on the foot switch.
7. Engage the dies with the pipe, using the carriage lever.
8. Use plenty of thread cutting oil until the thread is completed.

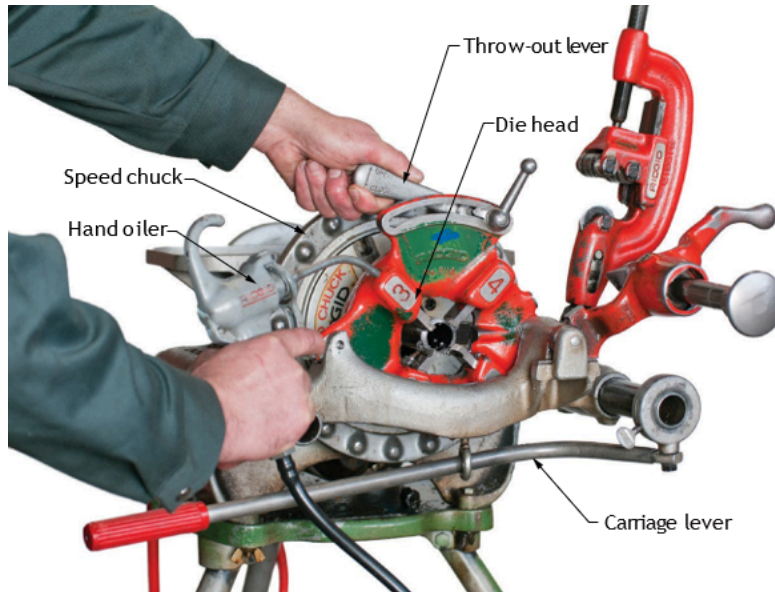


Figure 18 Thread pipe with a quick-opening die head (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The thread is completed when the end of the pipe is flush with the numbered end of the **dies**.

9. When the thread is completed, raise the throw-out lever to the open position.
10. Move the carriage lever away from the pipe end and return the die head to the up-and-out- of-the-way position.

Using a Geared Threader

In this section you will learn safe procedures for using a geared threader.

Install the Geared Threader on a Power Vise

1. Place the adjusted threader on the floor or on a workbench, with the drive shaft up.
2. Install the drive bar on the drive shaft of the threader and tighten the two set screws.

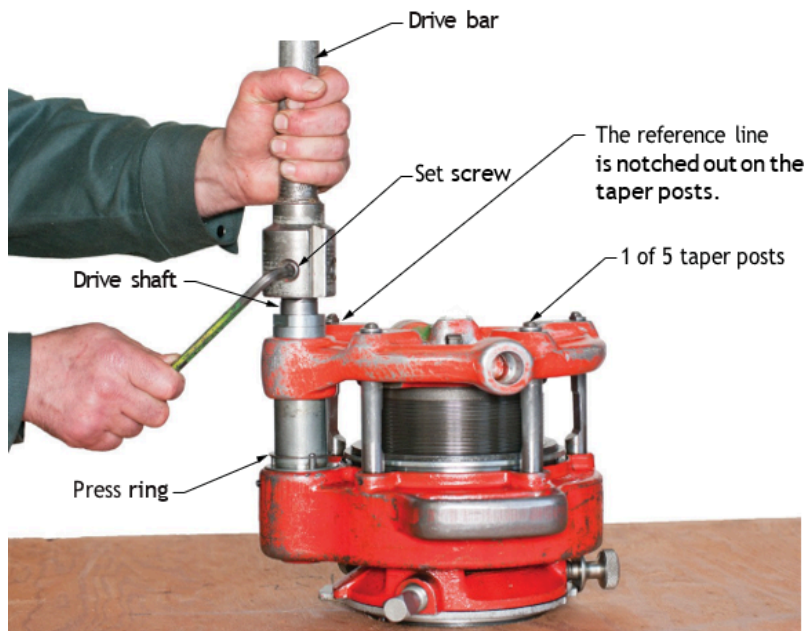


Figure 19 Install the drive bar on a geared threader (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

3. Insert the drive bar into the chuck of the power vise. (This will likely require the assistance of another person to pick up the threader and drive bar.)
4. Tighten the jaws of the power vise chuck into the three V-shaped notches in the head of the drive bar. Be sure to allow about 18 mm ($\frac{3}{4}$ in.) of the drive bar to be exposed in front of the chuck jaws. This will provide space for oiling.
5. Close the rear centring device on the shaft of the drive bar.
6. Pull out the support bar on the switch side of the vise and secure it in the extended position.
7. Slip the gear case loop over the support bar and secure it in the hole provided on the threader with the set screw.

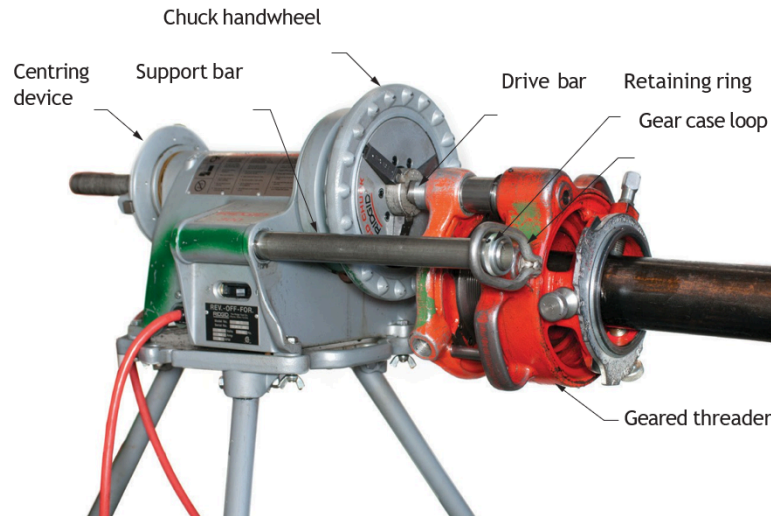


Figure 20 Geared threader close-coupled to power drive (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Position the Pipe in the Threader

1. Set the sizing screws using the gauge plate.
2. Insert the pipe in the threader and centre the end of the pipe in the throat of the dies.
3. Turn the work holder with a socket wrench to centre the pipe and hold it in position.
4. Tighten the clamp screw, securely locking the pipe in the work holder.
5. Place the oiler directly under the threader. Long pieces of pipe must be supported by a pipe support, with the pipe free to rotate as it is threaded.

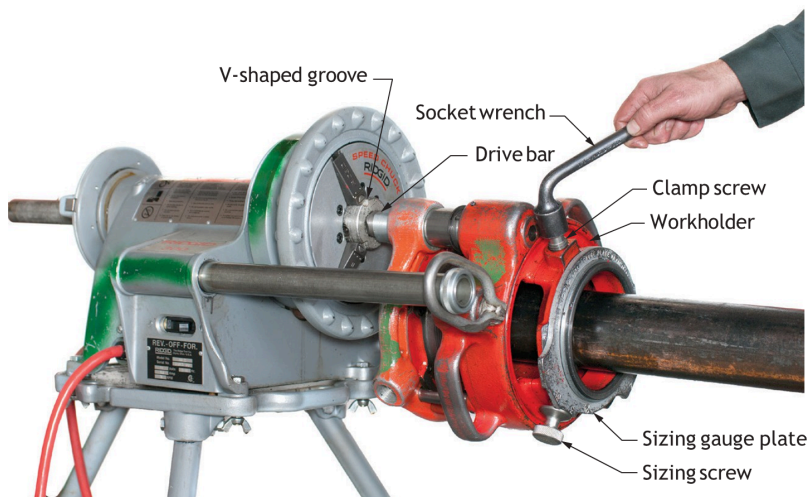


Figure 21 Tightening work holder on the geared threader (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Cut Threads with a Geared Threader

1. After the geared threader and pipe are installed, put in the power cord.
2. Turn the power drive switch to the forward position.
3. Step on the foot switch.
4. Flood die with thread cutting oil during the threading operation to ensure the die's long life.
5. Release the foot switch when the red STOP line appears on the pinion sleeve (Figure 22). (The die head starts to press on the ring at the base of the pinion sleeve.)
6. Turn the power drive switch to off. When motion stops, turn the switch to reverse and press the foot switch to unscrew the dies from the pipe. Loosen the set screw and the work holder from the pipe.

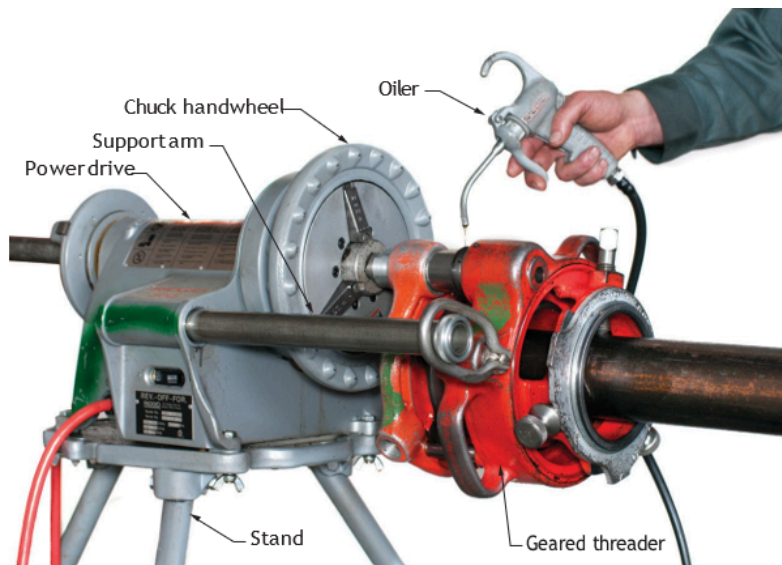


Figure 22 Cut threads with a geared threader (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Using Nipple Chucks

A **nipple** is a short piece of pipe, 300 mm (12 in.) or less in length, threaded on both ends.

The size of a nipple is designated by its diameter and length. For example, a 13 mm × 15 cm ($\frac{1}{2}$ in. × 6 in.) nipple is made

of 13 mm pipe, 15 cm long ($\frac{1}{2}$ in. pipe, 6 in. long.) A close nipple has threads along its entire length. The shoulder nipple has a short section of unthreaded pipe between the threads on each end.



Figure 23 Types of pipe nipples (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The **nipple chuck** is used to hold nipples (or **studs**) for threading when the nipple is so short that the jaws of the power vise would damage the threads. The nipple chuck is inserted into the jaws of a power vise or threader.

The nipple chuck accommodates pipe sizes up to 5 cm (2 in.). Adapters are used with 38 mm ($1 \frac{1}{2}$ in.) pipe and the smaller sizes, according to the size of the pipe.

The nipple chuck provides a means of holding a nipple with threads on one end, while cutting, reaming, and threading the other end. It also provides an easy release so that the nipple can be removed without overcoming the binding torque applied while threading.

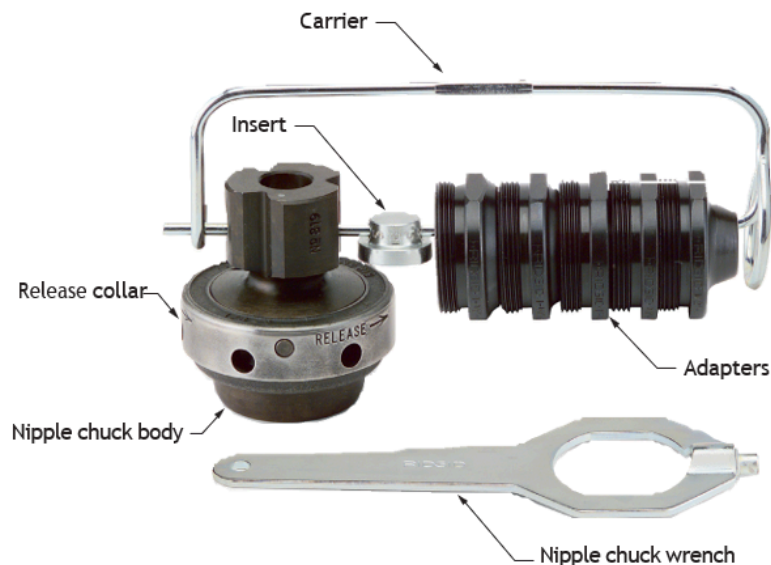


Figure 24 Nipple chuck kit (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Procedure for Short or Close Nipple Threading with Power Threading Machine

1. Ream and thread one end of the pipe in the usual manner. Cut off the end to the desired length of the nipple.
2. Install the nipple chuck in the power vise so that the jaws fit into the grooves of the nipple chuck.

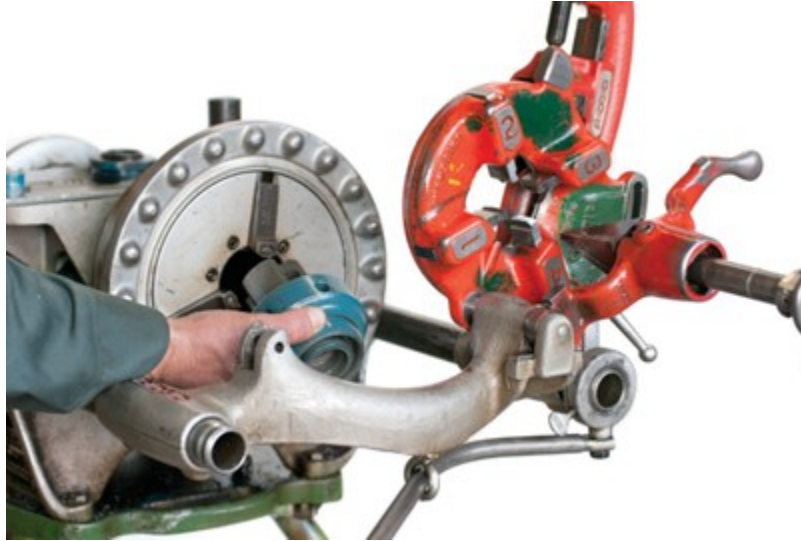


Figure 25 Installing the nipple chuck (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

3. Position the insert. For pipe sizes 3 mm to 19 mm ($\frac{1}{8}$ in. to $\frac{3}{4}$ in.), the small end of the insert should face the adapter. For 25 mm (1 in.) pipe size, the large end should face the adapter. No insert is required for pipe sizes of 32 mm ($1\frac{1}{4}$ in.) or larger.

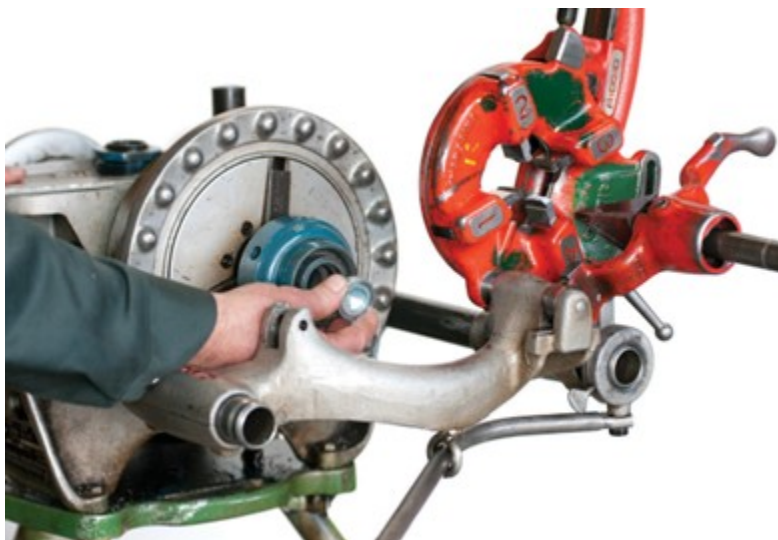


Figure 26 Positioning the insert (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

4. Select the proper adapter and screw it into the nipple chuck.

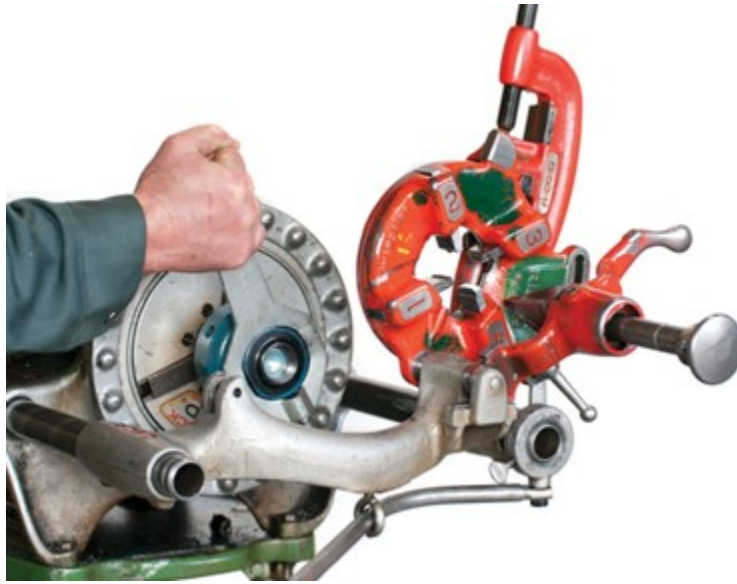


Figure 27 Install the adapter (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

5. Insert the nipple, threaded on one end, into the adapter by hand.

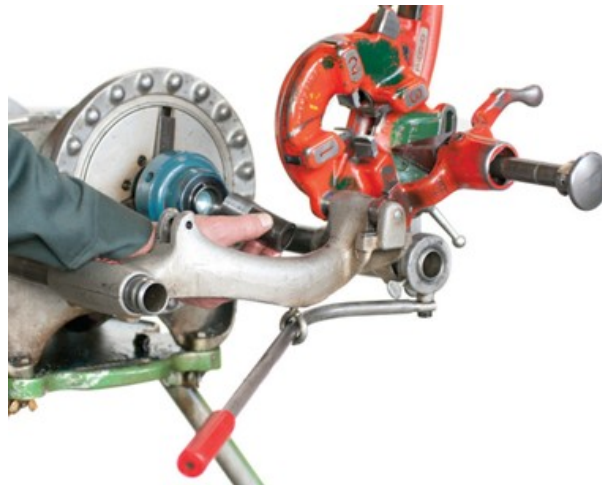


Figure 28 Install nipple into the adapter (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

6. Ream and thread the unthreaded end of the nipple.
7. To release the nipple, insert the pin on the end of the wrench into one of the holes on the release collar. Turn the wrench approximately a one-quarter turn in the direction indicated by the arrow to release. The nipple may be removed by hand.



Figure 29 Release the nipple (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Using Grooving Attachments

The **roll groover** forms grooves in standard pipe so that the pipe can be joined by mechanical couplings. Grooved pipe and fittings form a strong, leak-resistant conveyor for hot and cold fluids. They are easy to install and service and handle expansion and contraction without stress. They are ideal for use in heating and cooling systems, as well as in **fire standpipe**, sprinkler, and storm and roof drainage systems.

A grooving operation produces results similar to a threading operation. Like threading equipment, grooves can be cut with hand tools having ratchet handles, or with groove cutters or groove rollers driven by a power drive. With some grooving equipment, the pipe remains stationary during the cutting process; with other equipment, the pipe rotates between the rolls.

The Model 925 roll groover may be mounted on a stand designed for the machine, or it can be attached to a bench. A support stand is used to hold pipe longer than one metre (3 feet).

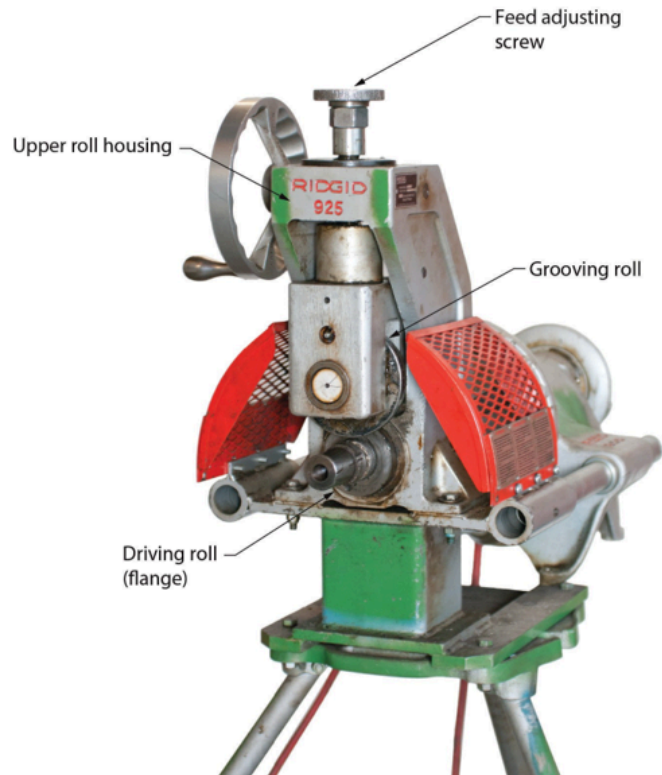


Figure 30 925 roll groover (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

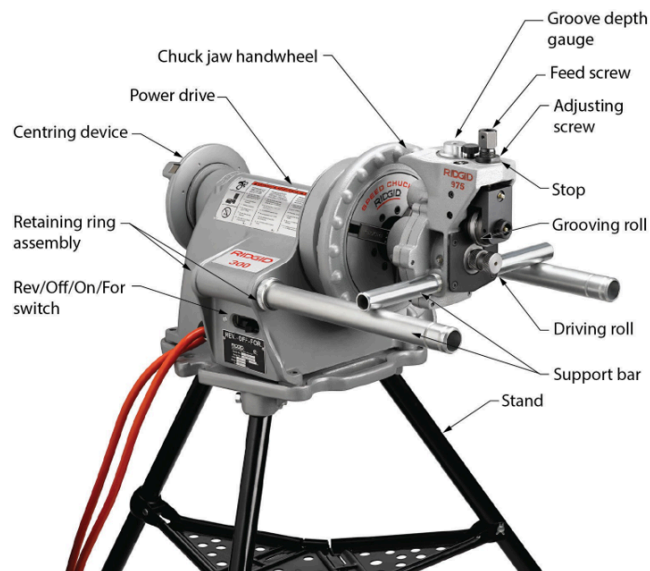


Figure 31 Components of a 975 roll groover with power drive (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

For safety reasons, the roll groover should not be operated at a speed faster than 36 rpm; and if it is mounted on a stand, the stand should be firmly anchored to the floor. The machine should be grounded and secured tightly to the power drive.

Preparing Pipe for Grooving

The following procedure is for grooving pipe with a maximum diameter of 15 cm (6 in.). It is assumed that the proper stop, grooving roll, and driving roll are already installed on the machine.

1. Ensure that the pipe is cut to the correct length and the ends are square cut.
2. Ensure that both the internal and external surfaces of the pipe are smooth and uniform from the end to at least 50 mm (2 in.) back. Any internal or external weld beads or seams in this section must be ground down until they are flush with the pipe wall.
3. Remove burrs, coarse scale, rust and any other irregularities on the surface of the pipe with a reamer, a file, a grinder, a sander, or a wire brush. Do not create flat areas or recesses on the gasket seating surface.

Operating the 925 Roll Groover

1. Ensure that a pipe length longer than 1 m. (3 ft) is supported with a pipe stand. The pipe stand, with rollers to hold the pipe level, allow it to rotate, and prevent lateral movement at a distance $\frac{3}{4}$ of the pipe length away from the driving roll flange. Pipe longer than 6.5 m. (21 ft) should be supported by two stands.
2. Place the pipe end on the driving roll against the flange.

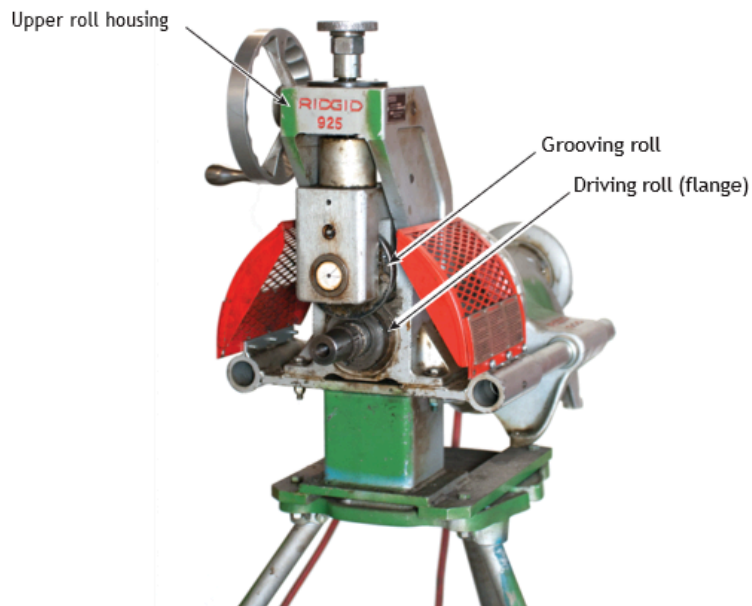


Figure 32 Operating the 925 roll groover (BC Industry Training Authority, 2019).
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3. Adjust the pipe (and pipe support stand) so that it comes in contact with the roll flange on one side only. To do this, face the groover and move the support stand holding the pipe to the right until the axis of the pipe is $\frac{1}{2}^\circ$ off the axis of the driving roll (Figure 33). For example, 10 ft from the groover, the pipe should be 25 mm (1 in.) to the right of centre.

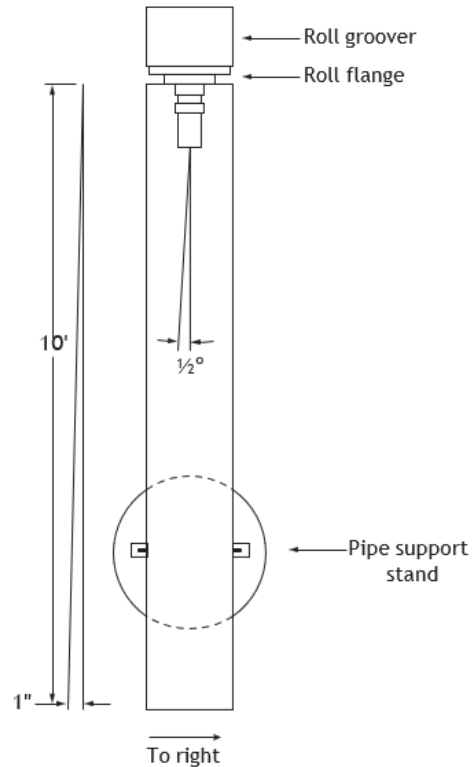


Figure 33 Plan view of pipe alignment with groover (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

4. Turn the hand wheel clockwise to bring the grooving roll in contact with the pipe.
5. Turn the feed screw for grooving depth down against the upper roll housing (Figure 34).
6. Back off the feed screw by the number of marks required to obtain the proper groove depth for the pipe size. For example, an 8 cm (3 in.) pipe groove should be 2 mm (0.078 in.) deep. (This is about eight hundredths of an inch back off the feed screw 8 marks.)



Figure 34 Adjusting the stop nut/feed screw on the Model 925 (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The manufacturer's manual for operators contains a chart specifying nominal groove depths for pipe sizes. Each mark on the 925's feed screw represents approximately 0.03 mm (0.01 inches).



Figure 35 Feeding grooving roll into pipe with hand wheel (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

7. Tighten the adjusting screw against the feed screw. Make sure the feed screw does not move.
8. Plug the power cord of the power vise into an electrical receptacle.
9. Turn the main switch of the power vise to the forward position.
10. Rotate the pipe slowly by jogging the foot switch (briefly pressing the foot switch). This will enable you to keep the pipe on the driving roll and against the flange. During the grooving operation, it is very important to keep the pipe against the flange of the driving roll. Serious injury could result if the pipe becomes disengaged from the drive shaft.
11. If the pipe moves away from the flange, turn the vise switch to the Off position, and back off the grooving roll using the hand wheel. Reposition the pipe, and again use the hand wheel to engage the grooving roll with the pipe. Then repeat Steps 9 and 10.
12. Continuously feed the grooving roll into the rotating pipe by turning the hand wheel clock wise.
13. When the stop nut bottoms against the bearing cap, allow the pipe to make two complete revolutions before releasing the foot switch.
14. Disengage the pipe and measure the diameter of the pipe groove, using an outside micrometer or a pie tape. Two readings, 90° apart, should equal the required groove diameter. (A mechanical coupling without the seal should just bottom when held completely closed in the groove.)
15. If the groove is not to specifications, adjust the stop nut accordingly and continue grooving until you obtain the correct groove diameter.

Using a Drill Press

A drill bit turning in a piece of metal exerts significant torque, which tends to cause the work to rotate. The twisting action increases when the drill bit breaks through the underside of the piece being drilled. A piece of work spinning on the end of a drill can cause serious bodily injury, break the drill bit, or spoil the work. Clamping the work or mounting it to prevent twisting avoids this hazard. A machine vise (Figures 36 and 37) can be used for holding smaller items. Large pieces should be secured with C-clamps.



Figure 36 Drill press machine vise – top view (Camosun College/Bccampus) CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

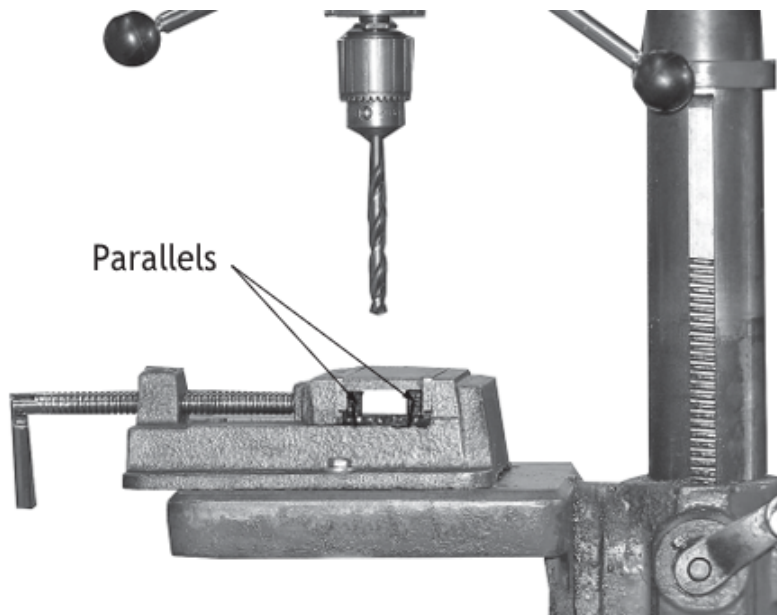


Figure 37 Drill press machine vise (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Speed and Feed

The **speed** in any drilling operation is determined by the kind of material and the size of the hole. The smaller the drill bit, the greater the required speed in RPM. The speed should also be higher for soft materials than for hard materials.

On most drill presses, it is difficult to obtain the exact recommended speed, but you can come close by adjusting the drive belt on the step-cone pulleys. You will find instructions on adjusting the pulleys in the manufacturer's manual, or else ask your instructor to demonstrate this procedure. There is usually a chart in the manual or on a tag fixed to the machine that gives the various speed ratios for your particular drill press.

Feed is the amount of pressure you apply to control penetration. Too much pressure will force the tool beyond its cutting capacity and can result in rough cuts and jammed or broken bits. Too light a feed, particularly with metals or other hard materials, will cause overheating of the bit, and burning of the cutting edge. The best results will be obtained by matching the correct speed with a steady feed pressure that lets the bits cut easily at an even rate.

Safe Use of the Drill Press

Before proceeding with any drill press operation, you should understand the following safety pre- cautions:

- Never attempt to hold the work by hand. Use a vise or clamp to prevent the work from spinning.
- Use a face shield to protect yourself from flying chips.
- Never set speeds or adjust the work unless the machine is stopped.
- Keep away from revolving parts of a drill press to prevent your clothing from being caught.
- As the drill begins to break through the work, ease up on the drilling pressure and allow the drill to break through gradually.
- Always remove burrs from a drilled hole with a file or scraper, not with your hands.
- Never leave a chuck key in the drill chuck.
- Never attempt to grab work while the drill is still in motion; stop the machine first.
- Always position the table or the vise so that the drill bit will not damage either of them as it penetrates through the work.
- Before you start to drill, check the speed settings.



Self-Test B-2.4: Use Stationary Power Tools

Complete Self-Test 2.4 and check your answers.

If you are using a printed copy, please find Self-Test A-2.4 and Answer Key in the Appendix at the end. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca/?p=2792#h5p-6> (<https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca/?p=2792#h5p-6>)

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Self-Test B-2.1: Describe Portable Power Tools Used in the Pipe Trades

Complete Self-Test B-2.1 and check your answers.

1. Which power drive requires a support arm when it is used with a drop head threader?

2. What power vise model can be mounted on a geared threader?

3. With a portable circular saw, what controls the depth of cut?

- a. Altering the speed of the motor
- b. Changing the size of blade
- c. Varying the cutting speed
- d. Raising or lowering the base

4. To make a bevel cut with a portable circular saw, you need to

- a. Tilt the lumber
- b. Use a special saw blade
- c. Tilt the base
- d. Raise the blade

5. The carbide metal used for carbide-tipped saws is hard and .

- a. Magnetic
- b. Very brittle
- c. Able to withstand rough treatment
- d. Virtually indestructible

6. Abrasive circular saw blades can be used to cut ferrous metals and what other material?

- a. Wood
- b. Plastic
- c. Non-ferrous metals
- d. Masonry products

7. What does a variable speed switch allow the drill operator to control?

- a. Direction of rotation
- b. Speed of rotation
- c. Danger or risk of jamming
- d. Size of the hole

8. The slowest speeds are normally found on what type of drills?

- a. ¼ in. drills
- b. 3/8 in. drills
- c. ½ in. drills
- d. Drills with forward-reverse switches

9. You must always wear eye protection when drilling.

- a. True
 - b. False
10. What is the smooth round portion of the twist drill that fits into the chuck known as?
- a. Body
 - b. Chuck-end
 - c. Shaft
 - d. Shank
11. Which twist drill is the largest?
- a. #1
 - b. #60
 - c. #80
 - d. #100
12. Which of the following bits would you use for drilling deep holes in wood?
- a. Auger bit
 - b. Spade bit
 - c. Spur bit
 - d. Carbide-tipped bit
13. What device supplies power to a pneumatic (air-powered) portable tool?

14. An air hose to a portable power tool must be free of water.
- a. True
 - b. False
15. Why should regular hand-tool sockets not be used with a pneumatic impact wrench?

16. How is the size of an impact wrench designated?

17. Name three uses for a portable grinder.

18. At what speed does the fastener move in a low-velocity, powder-actuated tool?

19. At what speed does the pin move when a high-velocity tool is used?

20. What device does a low-velocity tool have that is not found in a high-velocity tool?

21. Which kind of powder-actuated tool is most commonly used in the piping industry?

22. Besides the captive piston, what are two safety features of the low-velocity, powder-actuated tool?

23. What cartridge colour produces the second strongest impact?

24. Cartridges are available in two shapes. What are they?

25. Some cartridges for powder-actuated tools are centre fired. How are other cartridges fired?

26. Name the colour of the Hilti cartridges from strongest to weakest.

27. When selecting a cartridge for a fastening job, what cartridge do you start with?

28. For fastening into concrete, the tip of the pin must be knurled.

a. True

b. False

29. What must be remembered about the number code on the piston and the number code on the nail?.

Answer Key: Self-Test B-2.1 is on the next page.

Answer Key: Self-Test B-2.1

1. Portable Power Drive
2. Portable Power Drive
3. d. Raising or lowering the base
4. c. Tilting the base
5. b. Very brittle
6. d. Masonry products
7. b. Speed of rotation
8. c. ½ in. drills
9. a. True
10. d. Shank
11. a. #1
12. a. Auger bit
13. Air or pneumatic tools are operated by compressed air supplied by an air compressor.
14. a. True
15. They are not of a strong enough design to absorb the tremendous forces generated.
16. Impact wrench sizes are designated by the size of the drive on the nose of the tool.
17. Possible answers include: sharpening other tools, removing burrs, bevelling corners, and grinding welding beads.
18. Less than 100 m (330 ft.)
19. 460 m (1500 ft.) per second
20. Captive piston
21. Hilti low-velocity tool
22. (1) The tool is so designed that it will not fire if it is held at an angle of more than 7° off the work surface.
(2) A built-in stop ring to absorb impact of firing the tool.
23. Red
24. Crimped and wadded
25. Rim fired
26. purple (strongest)
red
yellow
green
brown
gray (weakest)
27. Start with the cartridge that has the weakest powder load.
28. b. False—the tip is smooth
29. The nail to be used with the tool must bear a number that matches the number code on the piston.

Self-Test B-2.2: Use Portable Power Tools

Complete Self-Test B-2.2 and check your answers.

1. When should you ease up on the feed pressure when drilling?
 - a. At multiple intervals
 - b. As the drill breaks through the work
 - c. As soon as the bit starts to cut
 - d. When the bit will self-feed
2. The drill speed should be increased if the material being drilled is_____.
 - a. Clamped to the drill press
 - b. Very hard
 - c. Soft
 - d. Ferrous
3. The preferred cutting speed of a grinding wheel is at or just below what rate?
 - a. 1725 feet per second
 - b. The speed that causes sparking
 - c. The maximum RPM rating
 - d. 3000 RPM
4. If the portable system feeding compressed air to a nailer or stapler does not contain a lubricator, what rule about lubrication should you follow when you use these tools?

5. List the problems you will look for when you inspect the air-supply hose to a portable power tool.

6. How should you store the hose for a portable air supply system?

7. Dynamic air-line pressure is greater than static pressure.
 - a. True
 - b. False
8. How should you store the hose for a portable air supply system?

9. Name three uses for a portable grinder.

10. List three important safety considerations when using an air chisel.

11. At what speed does the pin move when a high-velocity tool is used?

12. Any Hilti tool will accept any kind of fastener.

- a. True
- b. False

13. When using a powder-actuated tool, approximately how much penetration is required for fastening into concrete?

14. When using a powder-actuated tool, where must a fastening be made in a concrete block?

15. When using a powder-actuated tool, what is the minimum thickness of steel that a fastener may be used on?

16. What penetration should the tool-operator look for when setting a fastener into steel?

17. What is the minimum distance you may set a powder-actuated fastener from a torch cut or weld?

18. What type of concrete products should not accept a powder-actuated fastener?

19. What is the rule about spalled areas?

20. List five materials that cannot be fastened onto concrete or steel.

21. If you use an extension cord with a non-double-insulated power tool, ensure that it is a three- wire type.

- a. True
- b. False

22. If the incorrect voltage is applied to a power tool, it can be damaged.

- a. True
- b. False

23. When you connect a power tool to a power supply, the switch on the tool must be in the _____position.

- a. On
- b. Off

24. List three things that can damage a power cord.

25. Clean plastic parts of a portable power tool with a soft cloth lightly moistened with:

- a. Thinner
- b. Alcohol
- c. Gasoline
- d. Soapy water

26. Wear eye protection when you use saws and other power tools that kick up particles and dust.

- a. Thinner
- b. Alcohol

Use the *sample regulations* provided to answer the following:

27. You can only use a high-velocity tool if a low-velocity tool will not complete the fastening task.

- a. True
- b. False

28. If a powder-actuated tool misfires, the operator must hold the tool firmly against the work surface for at least _____seconds.

- a. 15

- b. 10
 - c. 5
 - d. 0
29. A powder-actuated tool fastener must not be driven into steel within _____ of an edge.
- a. 26 mm
 - b. 20 mm
 - c. 16 mm
 - d. 13 mm
30. A low-velocity, powder-actuated tool fastener may not be driven into masonry materials within _____ of an unsupported edge.
- a. 25 mm
 - b. 50 mm
 - c. 75 mm
 - d. 100 mm
31. A powder-actuated tool must not be used in an explosive or flammable atmosphere.
- a. True
 - b. False
32. A powder-actuated tool fastener must not be driven into steel within _____ of a weld.
- a. 25 mm
 - b. 50 mm
 - c. 75 mm
33. A powder-actuated tool must not be pointed at any person.
- a. True
 - b. False

Answer Key: Self-Test B-2.2 is on the next page.

Answer Key: Self-Test B-2.2

1. b. As the drill breaks through the work
2. b. Very hard
3. c. The maximum RPM rating
4. The manufacturer's instructions for each type of tool should be followed, since lubrication requirements of air tools are different.
5. Inspect air hoses for fraying, kinks, loose fittings and air leaks, and look for dust plugging the fittings.
6. When you store an air hose, coil it up and connect the connectors at the ends.
7. b. False
8. The water trap or separator should be drained on a daily basis when in regular use.
9. Air drills can be operated safely in wet areas, a condition that would make the operation of an electric drill hazardous.
10. Your answers should include the following: always remove the air hose before making a tool change, never allow anyone to stand in front of the hammer or chisel during operation, and always wear eye and hearing protection.
11. a. True
12. b. False—the tool uses only fasteners that are designed for it
13. About 25 mm (1 in.)
14. Into the solid part of the block and at least 75 mm (3 in.) away from the edge of the block
15. 5 mm (3/16 in.)
16. 12 mm (½ in.)
17. 50 mm (2 in.)
18. Precast concrete containing pre-stressed cables
19. Never use a powder-actuated tool on a spalled surface
20. Brick, ceramic tile, vitrified tile, glass, asbestos
21. a. True (to make sure that it is grounded)
22. a. True
23. b. Off
24. Heat, oil or solvents and sharp objects that can cut the cord
25. d. Soapy water
26. a. True
27. a. True
28. c. 5
29. d. 13 mm
30. c. 75 mm
31. a. True
32. b. 50 mm
33. a. True

Self-Test B-2.3: Describe Stationary Power Tools Used in the Pipe Trades

Complete Self-Test B-2.3 and check your answers.

1. Metal-cutting band saws may have downward pressure applied by means of hydraulics or what adjustable component?
 - a. Feed screw
 - b. Worm screw
 - c. Counterweight
 - d. Air-pressure regulator
2. To prevent overheating the work piece, what are some band saws equipped with?
 - a. A blower system
 - b. A mist spray
 - c. Abrasive blades
 - d. High-speed blades
3. When a metal-cutting band saw has cut through the workpiece it, will do which of the following?
 - a. Sound a beeper
 - b. Increase speed
 - c. Unclamp the stock
 - d. Automatically shut off
4. What is required to cut at an angle with a metal-cutting band saw?
 - a. Adding angled blocks to the vise
 - b. Rotating the vise
 - c. Tilting the band saw
 - d. Twisting the blade within its guides
5. When making a heavy cut with a band saw, how can you reduce heat build-up?
 - a. Applying greater downward pressure
 - b. Reducing the blade speed
 - c. Increasing the blade speed
 - d. Using a well-worn blade
6. Which of the band saw blades listed below is the least expensive to buy?
 - a. Rake set
 - b. Carbon steel
 - c. Hook-tooth
 - d. High-speed steel
7. Non-ferrous metals are easily and quickly cut with what type of blade?
 - a. Hook-tooth
 - b. Wavy set
 - c. Regular-tooth
 - d. Skip-tooth
8. What should thin or narrow sections of metal not be cut with?
 - a. Abrasive cut-off wheels

- b. Raker set teeth
 - c. Skip-tooth blades
 - d. Narrow blades
9. What is the best type of metal-cutting band saw blade for quickly cutting ferrous metals?
- a. Regular-tooth, carbon steel
 - b. Hook-tooth, high-speed steel
 - c. Skip-tooth, high-speed steel
 - d. Skip-tooth, carbon steel
10. Skip-tooth and hook-tooth blades are available with what teeth spacing?
- a. 1 to 3 per inch
 - b. 3 to 6 per inch
 - c. 6 to 24 per inch
 - d. 6 to 32 per inch
11. Which power vise can be used with hand tools or be converted for power drive tools

12. On what power vise model can you attach a roll groover?

13. How should you store the hose for a portable air supply system?

14. Identify the name and model number of this machine:



Figure 1 Image for question 14.

15. How does the power-threading machine differ from the power vise?

16. Name one safety feature common to all models of power vises.

17. What is the purpose of the grooving operation?

18. What model of Ridgid groover was designed to be used with a power drive for machine grooving, but it is also designed to manually groove pipe in place?

19. When groover is combined with the 300 power vise, what accessory may be required?

20. What is a side effect of mechanical bending

Answer Key: Self-Test B-2.3 is on the next page.

Answer Key: Self-Test B-2.3

1. c. Counterweight
2. b. Mist spray
3. d. Automatically shut off
4. b. Rotating the vise
5. b. Reducing the blade speed
6. b. Carbon steel
7. a. Hook-tooth blade
8. c. Skip-tooth blades
9. c. Skip-tooth, high-speed steel
10. b. 3 to 6 per inch
11. Model 300
12. Model 300
13. Power drive
14. No. 535 pipe and bolt threading machine
15. The cutter, reamer and threader are built into the power threading machine, while for the power vise, the tools are attached to the motor unit.
16. Foot switch
17. The purpose is to prepare pipe for grooved couplings and fittings.
18. Model 975 roll groover
19. Pipe support stand
20. Wall thickness changes: wall along the inner radius of the tube becomes thicker, and the outer wall becomes thinner.

Self-Test B-2.4: Use Stationary Power Tools

Complete Self-Test B-2.4 and check your answers.

1. The maximum distance from the face of a grinding wheel to the tool rest should be:
 - a. 1 mm (1/16 in.)
 - b. 3 mm (1/8 in.)
 - c. 6 mm (¼ in.)
 - d. 12 mm (1/2 in.)
2. To use a grinder safely you must wear:
 - a. Leather pants
 - b. A fireproof apron
 - c. Eye and hearing protection
 - d. A hard hat
3. To remove the nut on the left spindle of a stationary grinder, you must turn the nut:
 - a. In a clockwise direction
 - b. In a counter-clockwise direction
 - c. Opposite the rotation of the motor
 - d. Upward at the front
4. The purpose of the blotter paper disk on the sides of a grinding wheel is to:
 - a. Prevent grinding on the sides
 - b. Provide traction to the flanges
 - c. Absorb excess moisture
 - d. Reduce strain caused by the flanges
5. To correct out-of-roundness on a grinding wheel you must:
 - a. Return the wheel to supplier
 - b. Adjust the centre on the shaft
 - c. Dress the face of the wheel
 - d. Grind hard metals
6. To test a grinding wheel for cracks the wheel should be:
 - a. Properly mounted on the grinder
 - b. Standing or suspended on edge
 - c. Rotating slowly
 - d. Lying on a flat surface
7. State the safety precaution for checking the switches of a power vise before the machine is plugged in.

8. State the safety precaution for checking the switch of the Model 700 portable power vise before the machine is plugged in.

9. If you must use an extension cord with a power drive, what kind do you use?

10. It is never necessary to support a pipe when using a power vise.

- a. True
- b. False

11. Name the parts in the illustration below.



Figure 1 Image for Question 11.

a.

b.

c.

d.

e.

12. What must be done first before installing a length of pipe in a power vise?

13. How are the jaws of the chuck tightened on the pipe to be cut?.

14. After the pipe is installed, how is a hand cutter engaged with the pipe?

15. Which of the three ratchet reamers shown below is the safest hand tool to use with a power vise?

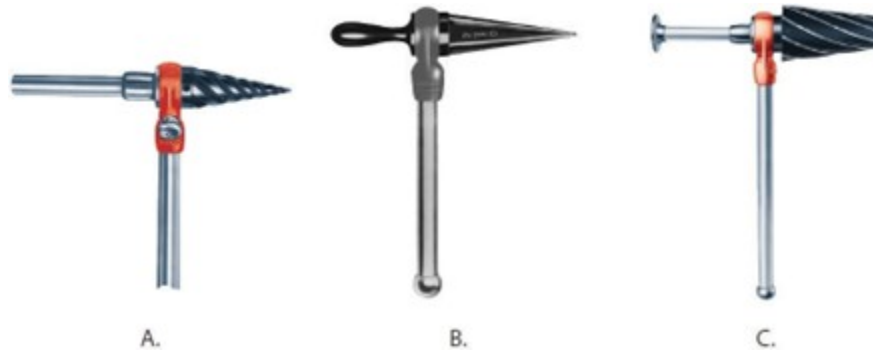


Figure 2 Image for question 15.

16. Name the steps for using a fluted hand reamer with a power drive.

a.

b.

c.

d.

e.

17. Name the steps for using a fluted hand reamer with a power drive.

a.

b.

c.

d.

e.

d.

e.

f.

g.

h.

18. A short nipple has threads along its full length.

- a. True
 - b. False
19. A 5 cm (2 in.) nipple requires an adaptor to thread into a nipple chuck
- a. True
 - b. False
20. A 25 mm (1 in.) nipple requires an insert and an adaptor in the nipple chuck.
- a. True
 - b. False
21. Describe the steps for preparing pipe for grooving.

22. If a pipe stand is used to support a length of pipe, how is the stand positioned?

23. What must you remember to do when placing a pipe end on the driving roll of the groover?

Answer Key: Self-Test B-2.4 is on the next page.

Answer Key: Self-Test B-2.4

1. b. 3 mm (1/8 in.)
2. c. Eye and hearing protection
3. a. In a clockwise direction
4. d. Reduce strain caused by the flanges
5. c. Dress the face of the wheel
6. b. Standing or suspended on edge
7. Check to make sure that the switch is in the Off position, and that the foot switch operates freely.
8. Before plugging in the machine, push down on the switch button a couple of times to make sure that the spring of the switch button returns to the Off position.
9. a. Three-wire extension cord, which has a three-prong grounding plug that fits into a three-pole receptacle
10. b. False—for long, heavy work, a floor pipe support must be used.
11. a. Cutter
b. Reamer
c. Quick or self-opening die head
d. Carriage w/lever
e. Lever arm
12. Measure and mark the length of the pipe being worked.
13. The jaws are tightened with a snap-spin of the hand wheel in a counter clockwise direction. The snap-spin is repeated until the operator is sure the pipe is held securely.
14. 1. Engage the pipe cutter with the pipe, and align the cutter wheel with the mark you have made when measuring the pipe.
2. Rest the frame of the pipe cutter on the support bar. Tighten the screw feed handle.
15. b. The straight reamer
16. a. Turn the switch to the Forward position.
b. Insert the reamer into the end of the pipe, holding the handle and handgrip firmly.
c. Step on the foot switch.
d. Slowly push on the reamer handgrip with one hand.
e. Release the foot switch, remove the reamer, and turn the switch to the Off position.
17. a. Move the reamer arm down to the reaming position.
b. Extend the reamer by pressing the latch and sliding the knob toward the pipe until the latch engages the bar.
c. Turn the switch to the Forward position and step on the foot switch.
d. Position the reamer into the pipe and complete the reaming operation by pushing the carriage lever with your hand.
e. Pull the reamer bar back and return it to its out-of-the-way position.
f. Release the foot switch and turn the switch to the Off position.
g. Release the speed chuck hand wheel and the centring head from the pipe.
h. Remove the pipe.
18. False
19. False
20. True
21. Check the pipe to make sure that:
 1. The ends are squarely cut
 2. The pipe fits smoothly on the driving roll

3. Steps have been taken to grind down any internal or external weld beads or seams that may interfere with the grooving operation
 4. Burrs, coarse scale, rust, and other irregularities have been removed.
22. The stand is positioned in line with the axis of the driving roll and three-quarters of the pipe length away from the driving roll flange.
23. First, fit the pipe on the driving roll so that the end of the pipe is against the flange of the driving roll. Next, after making adjustments to the support stand (if used), adjust the pipe so that it is in contact with the roll flange on one side only.

Version History

This page provides a record of changes made to this learning resource, Plumbing Apprenticeship Level 1, Block B (<https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca/>). Each update increases the version number by 0.1. The most recent version is reflected in the exported files for this resource.

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Version	Date	Change	Details
1.0	May 2026	Plumbing Apprenticeship Level 1 Block B learning resource from STBC content converted to open and freely accessible digital platform and published at TRU.	

Plumbing Apprenticeship & Trade Resources in BC

A successful career in plumbing requires a strong foundation of skills, knowledge, and workplace safety awareness. Below are key resources to support plumbing apprentices in BC, including educational pathways, trade certifications, workplace safety guidelines, and mental health and wellness support.

Plumbing Apprenticeship & Certification Resources

- **SkilledTradesBC – Plumbing Apprenticeship** (<https://skilledtradesbc.ca/plumber>) – Overview of plumbing training, certification requirements, and apprenticeship pathways in British Columbia.
- **Red Seal Program – Plumber** (<https://www.red-seal.ca/eng/trades/plumbers/overview.shtml>) – National certification program with exam prep guides and trade mobility information.
- **BC Building Codes & Standards** (<https://www.bccodes.ca/>) – Official building and plumbing codes for British Columbia.

Workplace Safety & Regulations

- **WorkSafeBC** (<https://www.worksafebc.com/en>) – Essential safety resources for plumbers, including:
 - Health & Safety – WorkSafeBC (<https://www.worksafebc.com/en/health-safety>)
 - Report Unsafe Working Conditions (<https://www.worksafebc.com/en/contact-us/departments-and-services/health-safety-prevention>)
 - Report a Workplace Injury or Disease (<https://www.worksafebc.com/en/claims/report-workplace-injury-illness>)
 - Submit a Notice of Project Form (<https://www.worksafebc.com/en/for-employers/just-for-you/submit-notice-project>)
 - Get Health and Safety Resources (Videos, Posters, Publications, and More) (<https://www.worksafebc.com/en/resources-health-safety>)
 - Search the OHS Regulations (and Related Materials) (<https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation>)
 - Conduct an Incident Investigation (<https://www.worksafebc.com/en/health-safety/create-manage/incident-investigations/conducting-employer-investigation>)
- **CCOHS: OHS Answers Fact Sheets – Plumber** (https://www.ccohs.ca/oshanswers/occup_workplace/plumber.html) – Safety guidelines and best practices for plumbers in various work environments.

Financial Supports

- **Financial Support (SkilledTradesBC)** (<https://skilledtradesbc.ca/financial-support>) – Information about grants, tax credits, Canada apprentice loans, employment insurance, and the Indigenous Skills and Employment Training

(ISET) program.

- **StudentAidBC** (<https://studentaidbc.ca/>) – Complete post-secondary education through student loans, grants, and scholarships. There is also programs that help with loan repayment.
- **WorkBC (Government of BC)** (<https://www.workbc.ca/find-loans-and-grants/students-and-adult-learners/services-apprentices-and-employers>) – Services for apprentices and employers.

Mental Health & Wellness Support

- **HealthLink BC – Mental Health and Substance Use** (<https://www.healthlinkbc.ca/mental-health-and-substance-use>) – HealthLink BC resources for mental health and wellness support.
- **Here2Talk** (<https://here2talk.ca/>) – Free and confidential counseling services available to all post-secondary students registered at a BC school.
- **Help Starts Here** (<https://helpstartshere.gov.bc.ca/>) – A database with over 2,500 listings of services related to mental health and substance use supports.
- **Hope for Wellness Helpline** (<https://www.hopeforwellness.ca/>) – 24/7 online chat and phone line with experienced and culturally competent counselors available to all Indigenous people in Canada.
 - First Nations Health Authority Mental Health Supports Info Sheet [PDF] (<https://www.fnha.ca/Documents/FNHA-mental-health-and-wellness-supports-for-indigenous-people.pdf>) by First Nations health Authority – List of culturally safe services for Indigenous people.
- **HeretoHelp – BC** (<https://www.heretohelp.bc.ca/>) – Mental health resources, including videos, articles, and support services in BC.
- **BC Construction Industry Rehabilitation Plan** (<https://www.constructionrehabplan.com/>) – Mental health and substance use services for CLRA and BCBT members and their families.
- **Virtual Mental Health Supports (Government of BC)** (<https://www2.gov.bc.ca/gov/content/health/managing-your-health/mental-health-substance-use/virtual-mental-health-supports>) – Virtual services are available for British Columbians who are experiencing anxiety, depression, or other mental health challenges.

Crisis Support

- **Interior Crisis Line Network** – Call 1-888-353-2273 (tel:+1-888-353-2273) for 24/7 emotional support, crisis intervention, and community resource information.
- **Talk Suicide Chat Service** (<https://talksuicide.ca/>) – An alternative if calling is difficult; available for crisis intervention.
- **310Mental Health Support** – Call 250-310-6789 (tel:+1-250-310-6789) for emotional support, information, and resources specific to mental health.
- **1-800-SUICIDE** – Call 1-800-784-2433 (tel:+1-800-784-2433) if you are experiencing feelings of distress or despair, including thoughts of suicide.
- **Opioid Treatment Access Line** – Call 1-833-804-8111 (tel:+1-833-804-8111) between 9 am and 4 pm to connect with a doctor, nurse, or healthcare worker who can prescribe opioid treatment medication that same day.
- **KUU-US Crisis Response Service** – Call 1-800-588-8717 (tel:+1-800-588-8717) for culturally-aware crisis support for Indigenous peoples in BC.
- **Alcohol and Drug Information and Referral Service** – Call 1-800-663-1441 (tel:+1-800-663-1441) to find resources and support.



Emergency Services — For life-threatening situations, call 911 or visit your nearest emergency department.