

Screws

Objectives: At the end of this lesson you shall be able to

- state the results of poor selection of fasteners
- state the various types of fasteners in industrial use
- state the types of thread fasteners and their uses - machine bolts, machine screws, cap screws and set screws.

In the industrial field much depends on the proper choice of fasteners to be used in each job.

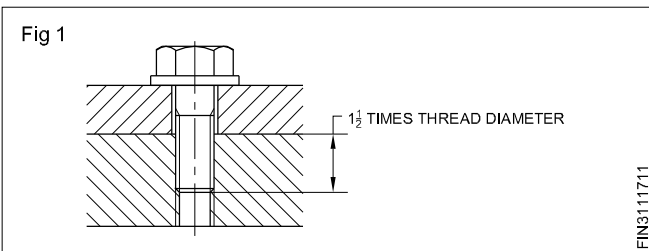
- A poorly selected fasteners might greatly lead to unsafe condition.
- Increase the assembly cost.
- Products are inferior quality.

Various types of fasteners

- Threaded fasteners
- Rivets
- Pins
- Retaining ring or circlips
- Keys
- Staples
- Adhesives.

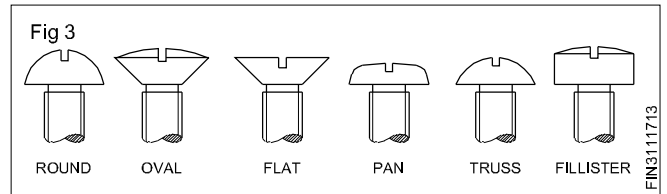
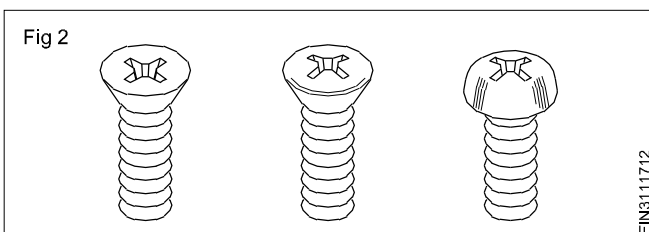
Threaded fasteners

Fasteners: Fasteners that fall into category utilise the wedging action of screw thread for clamping pressures. To achieve maximum strength, a threaded fasteners should screw into its mating part a distance equal to 1.5 times (minimum) the diameter of thread. (Fig 1)

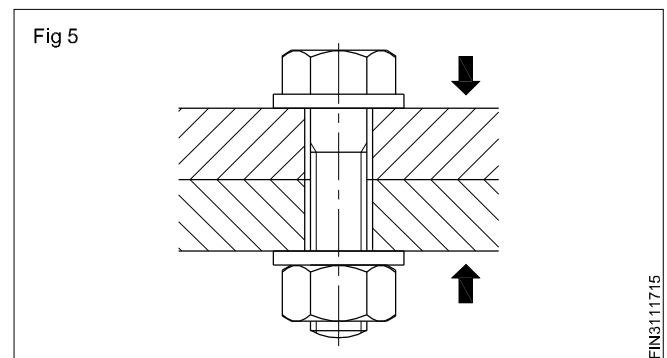
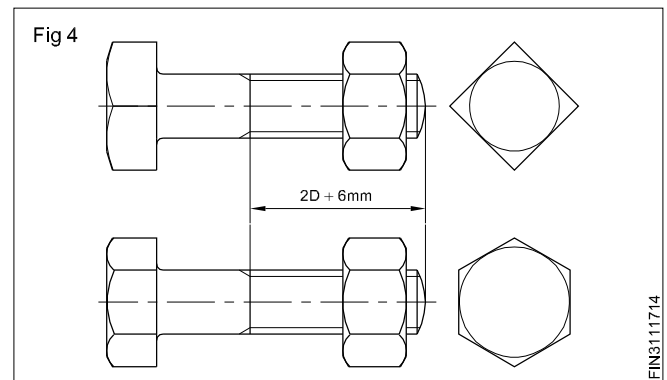


Machine screws: Machine screws are used for general assembly work. (Fig 2) It is manufactured in both COARSE and FINE series, fitted with either a slotted or recessed head. (Fig 3)

Sizes vary in diameter from 1.5 mm to 12 mm and in length 2 mm to 75 mm.



Machine bolts: Machine bolts (Fig 4) are manufactured with square and hexagonal heads. They are used where a close tolerance assembly is not required. Available in diameter 6 mm to 75 mm and in length 12 mm to 300 mm. Tightening the nut on machine bolt (Fig 5) produce clamping action.

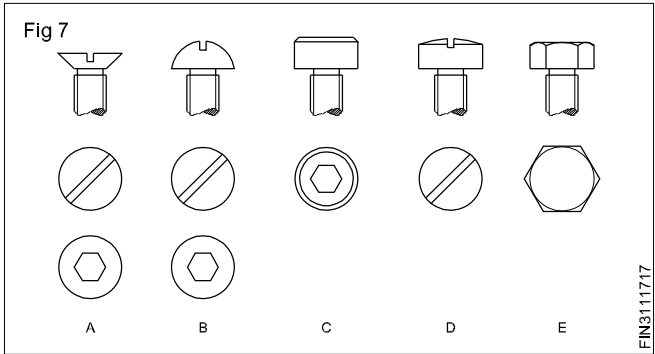
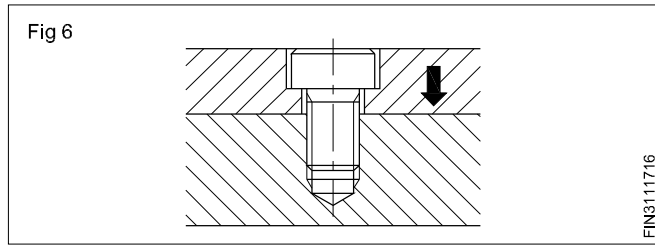


Cap screws: Cap screws are used when assembly requires a stronger, more precise and better appearing fastener. A cap screw is fitted through a clearance hole in one of the piece and screws into a threaded hole.

A clamping action is developed by tightening the cap screws. (Fig 6)

Cap screws are manufactured to closer tolerance than machine bolts and produced with semi-finished bearing surface. They stocked in aluminium, brass, bronze, mild

steel, alloy steel (Heat treated), stainless steel and titanium and in coarse in fine and special thread series (Fig 7).



Cap screws are available in diameter from 6 mm to 50 mm and in length from 10 mm to 200 mm. Nuts are not included with cap screws.

Set screws: Set screws are used to prevent pulleys from slipping on shafts, positioning and holding collars in place, on shafts and holding shafts in place in assemblies. (Fig 8)

Headless set screws have either a slotted or socket head and threaded entire length. Screw points are available in various styles and their recommended use. (Fig 9)

Types of screws

Objectives: At the end of this lesson you shall be able to

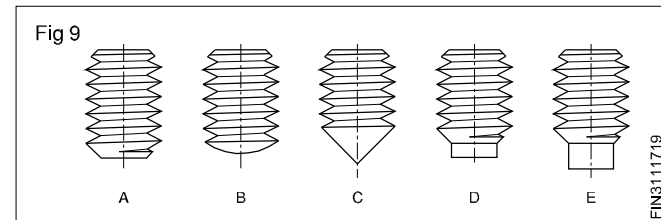
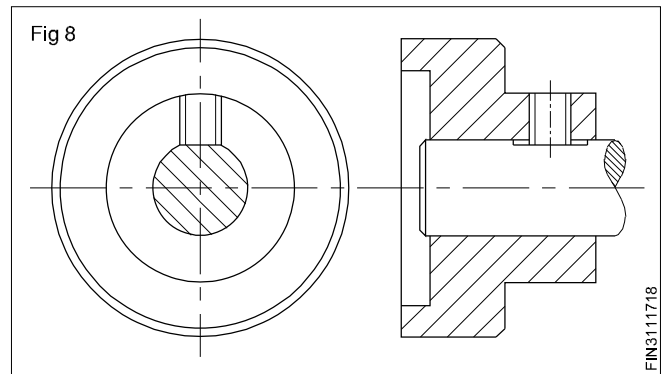
- state the various types of fastening screws and their uses
- state the various types of nuts and their uses
- state the various types of washers and their specific applications.

Self tapping screw: To eliminate the cost of tapping, a thread forming screw has been derived. These are designed to form a thread as they are driven. (Fig 1)

Thread cutting screws: Thread cutting screws which are hardened, actually cut rather than form threads.

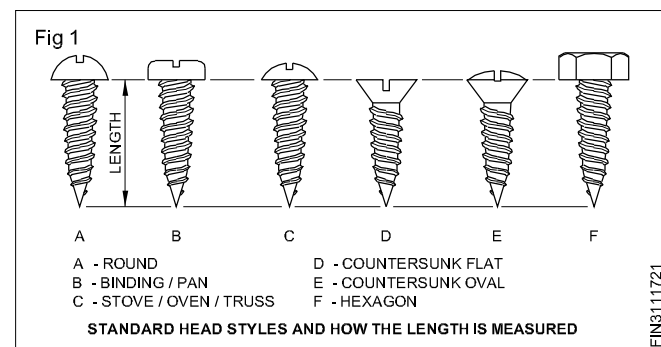
Type F: Cuts a standard machine thread used in castings and forgings. (Fig 2)

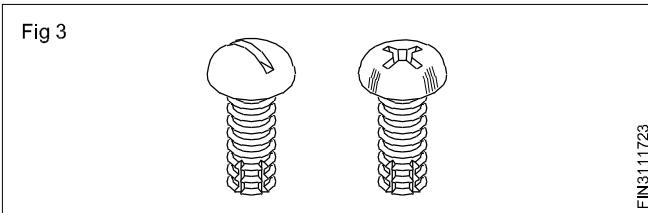
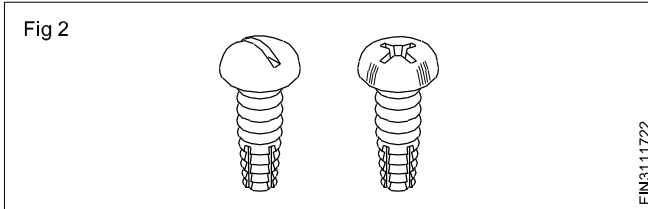
Type BF: This screw is recommended for die castings and plastics. (Fig 3)



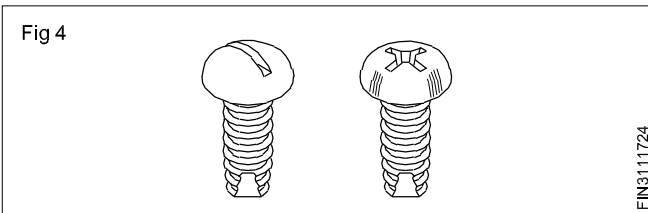
Uses

- A Flat point set screw is used on parts requiring frequent adjustment.
- B Oval point set screw is used against a shaft that has been spotted to receive it.
- C Cone point set screw is used for setting machine parts permanently on shaft and it is used as a pivot or hanger and for adjustment.
- D The half dog point set screws is probably one of the most useful and it can be used as a dowel. A hole is drilled to receive the point.
- E The full dog point set screw is suitable for use as a key that slides in a key way.

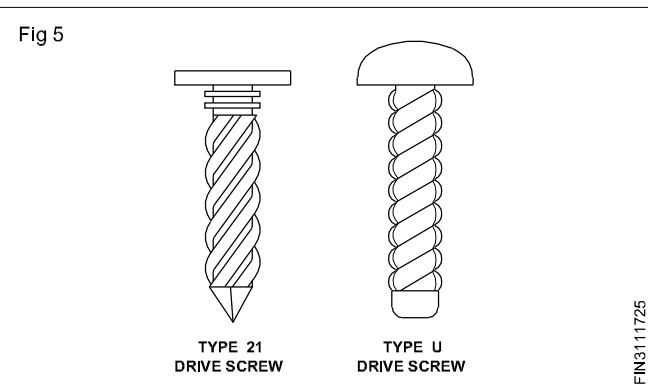




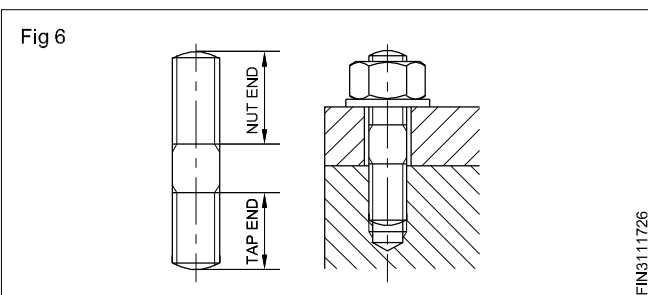
Type L: Widely used with plastics. (Fig 4)



Driver screws: Driver screws are simply hammered into a drilled hole or punched hole of the proper size. They make a permanent joints. (Fig 5)

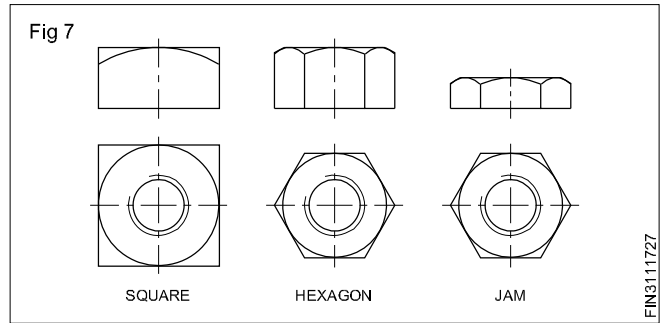


Stud bolts: Stud bolts are threaded on both ends. One threaded end is designated for semi-permanent installation in a tapped hole while the other end threaded for standard nut assembly to clamp the pieces together. (Fig.6)

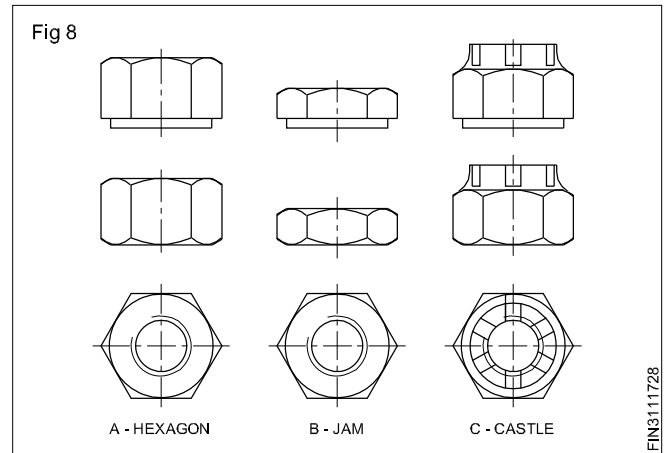


Nuts: Nut utilise a hexagonal or square head and are used with bolts with the some head shapes. They are available in various finish.

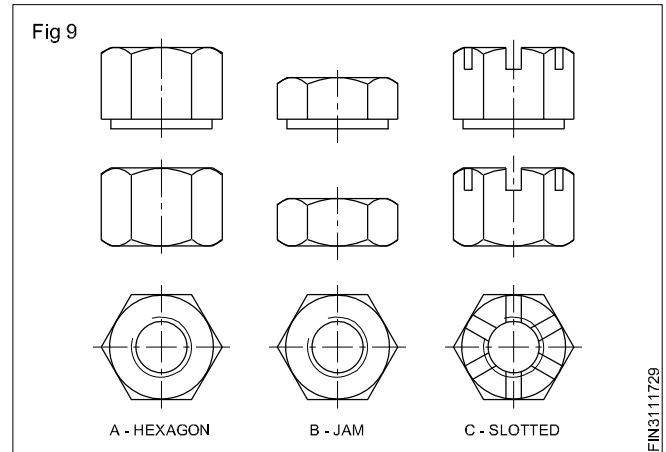
Regular is unfinished (not machined) except on the thread. (Fig 7)



Regular semifinished is machined on the bearing face to provide a truer surface for the washers. (Fig 8)



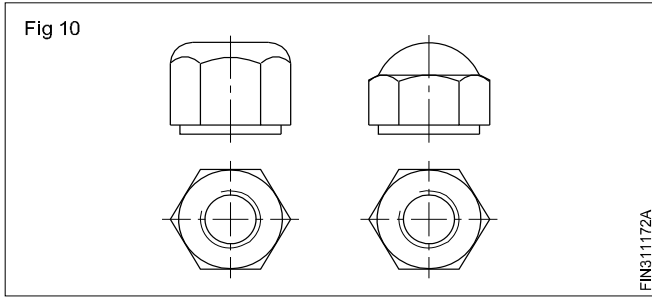
Heavy semifinished are identical in finish to the regular semi-finished nut, however, the body is thicker for additional strength. (Fig 9)



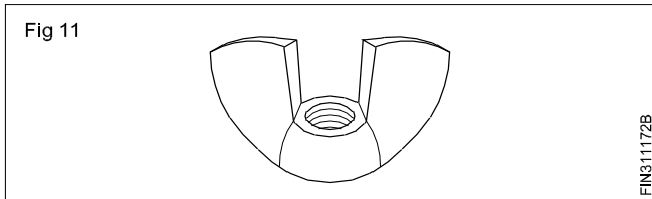
The jam nut/check nut is used where the strength of the full nut is not needed. They are frequently used in pairs or with standard nuts for locking action. (Fig 8B, 9B)

Castle and slotted nut have milled slots across the flats. So that can be locked with a cotter pin/split pin or safety wire that is inserted through the slot and a hole drilled in the bolt to prevent the nut from turning loose. (Fig 8C, 9C)

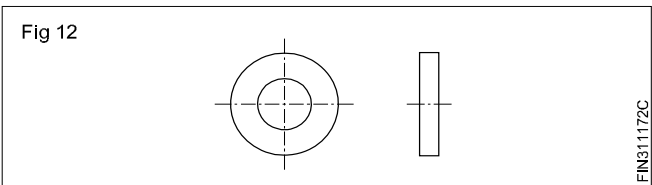
A corn nut/Cap nut are used when appearance is of primary importance or where projecting threads must be protected. They are available in low or high crown styles. (Fig 10)



The wing nut is used where frequent adjustment or removal is necessary. It can be loosened or tightened rapidly without the need of a wrench. Nut are manufactured in the same material as the bolts. (Fig 11)

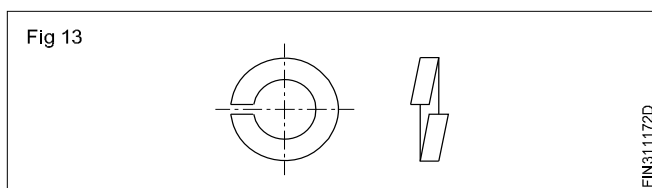


Washers: Washers are used to distribute the clamping pressure over a larger area, and prevent the surface damaged (marking). They also provide an increased bearing surface for bolt heads and nuts. Washers are manufactured in light, medium, heavy and extra heavy series. (Fig 12)



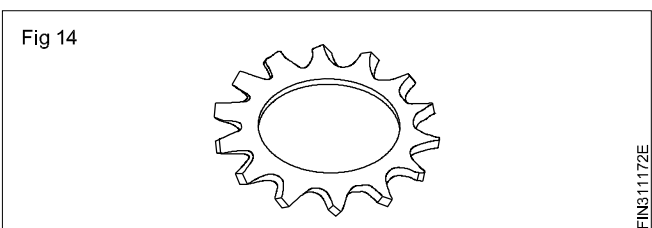
Lock washers: A lock washer is used to prevent a bolt or nut from loosening under vibration.

The split ring lock washer is being rapidly replaced by lock washers designed for specific applications. (Fig 13)

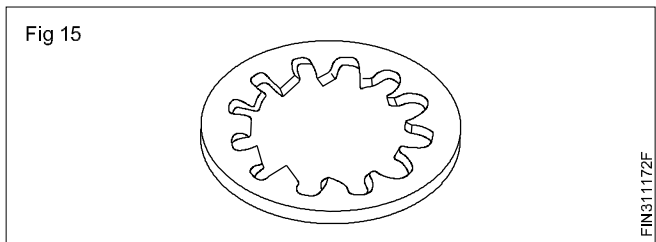


Tooth type lock washers: These washers have teeth that bite deep into both screw head and work surface. Their design is such that they actually lock tighter as vibrations increase.

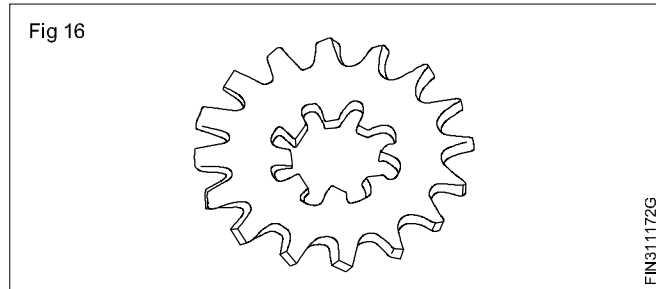
External type: Should be used where possible as it provides the greatest resistance. (Fig 14)



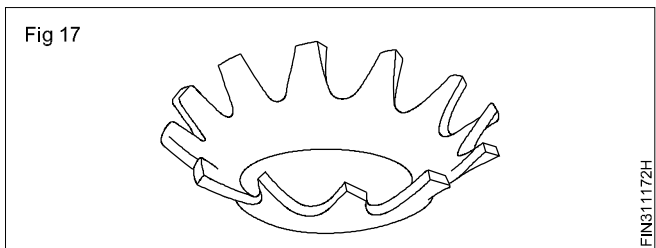
Internal type: Used with small head screws and where it is desirable to hide the teeth either for appearance or to prevent snagging. (Fig 15)



Internal and external type: Used when the mounting holes are over size. (Fig 16)



Countersunk type: For use with flat or oval type head screws (Fig 17).



Non threaded fastening devices

Dowel pins: Dowel pins are made of heat treated alloy steel and are used in assemblies where a parts must be accurately positioned and held in absolute relation to one another. They assure perfect alignment and facilitate quicker disassembly of parts and reassembly in exact relationship.

Property classes (as per IS/ISO) IS: 1367

The symbol for the property classes of bolts, screws and studs consists of two numbers separated by a point. The first number, when multiplied by one hundred, indicates the nominal tensile strength in newtons per square millimeter. The second figure, multiplied by ten, states the ratio between the lower yield stress and the nominal tensile strength (yield stress ratio) as a percentage. The multiplication of these two figures will give one tenth of the yield stress in newtons per square millimeter.

Example of a screw in property class 5.8

Nominal tensile strength

$$5 \ 100 = 500 \text{ N/mm}^2 \text{ (MPa)}$$

Yield stress ratio

$$8 \ 10 = 80\%$$

Yield stress

80% of 500 = 400 N/mm² (MPa)

The designation consists of two figures:

- The first figure indicates 1/100 of the nominal tensile strength in N/mm² and
- The second figure indicates 1/10 of the ratio, expressed as a percentage, between nominal yield stress and nominal tensile strength.

The multiplication of these two figures will give 1/10 of the nominal yield stress in N/mm².

Designation: Metric thread bolts, screws are identified by a letter M for the thread profile form. The letter M is followed by the value of nominal diameter expressed in millimeters and nominal length separated by the sign "x". (Example: M 8 x 35)

Materials: The table below specifies steel for the different property class of bolts, screws and studs. The minimum tempering temperature is mandatory for property classes 8.8 to 12.9 in all cases.

Chemical composition

Property Class	Material and Treatment	Chemical composition limits %				Tempering Temperature RE° C Min
		C		P	S	
		min.	max.	max.	max.	
4.6, 4.8, 5.8, 6.8*	Low or medium carbon steel	-	0.55	0.05	0.06	-
8.8	Medium carbon steel quenched, tempered	0.25	0.55	0.04	0.05	425
9.8	medium carbon steel quenched, tempered	0.25	0.55	0.04	0.05	425
10.9	Medium carbon steel additives e.g. boron, Mn, Cr or Alloy steel-quenched, tempered	0.20	0.55	0.04	0.05	425
12.9	Alloy steel-quenched, tempered	0.20	0.50	0.035	0.035	380

* Free cutting steel is allowed for these classes with the following maximum sulphur, phosphorus and lead content:

S-0.34% P- 0.11% Lead - 0.35%

** Alloy steel shall contain one or more of chromium, nickel, molybdenum or vanadium

* For size M20 and larger a temperature of 425° C may be used.

Note:

Property class 9.8 applies only to sizes up to 16 mm thread diameter and is included for information only and manufacture of products with this property class is to be discouraged.

The minimum tempering temperatures listed in above table are mandatory for property classes 8.8 to 12.9 in all cases.

Mating screws and nuts

Property classes bolts, screws, studs	3.6	4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9	14.9
Property classes nuts	5					6	8	9	10	12	14

Nuts of a higher property class can normally to be used in the place of nuts of a lower property classes.

* Property classes 14.9 are not ISO or ANSI standard = quenched and tempered

Screw drivers

Objectives : At the end of this lesson you shall be able to

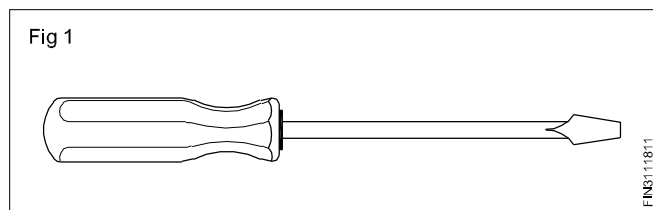
- state different types of screw drivers and their uses
- specify a screw driver
- list the precautions to be observed while using screw driver.

Screwdrivers are used to tighten or loosen screws and are available in various lengths.

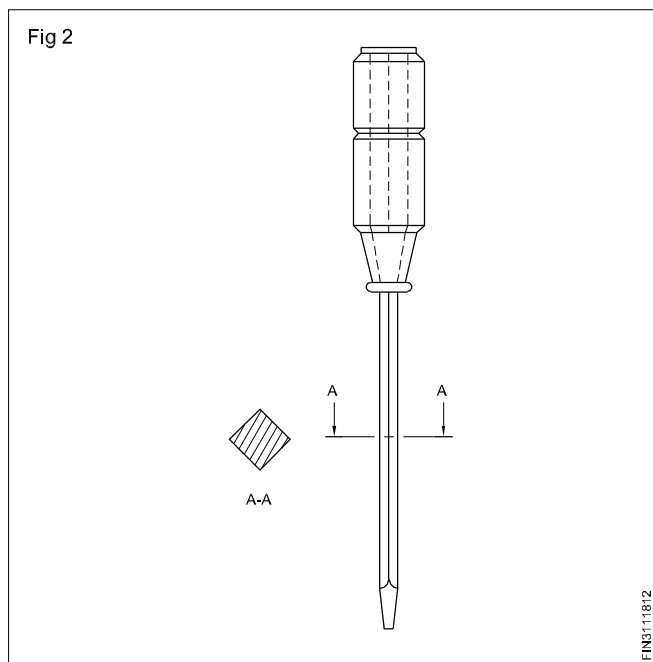
Hand-held screwdrivers are of the following types.

Standard screwdriver (Light duty) (Fig 1)

It is of round shank/blade with metal, wood or moulded, insulated material handle.



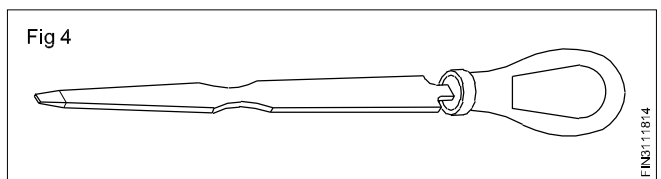
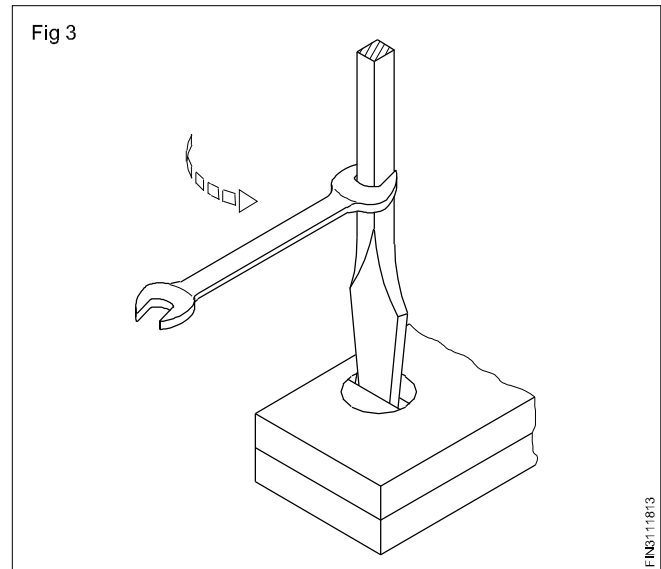
Standard screwdriver (Heavy duty) (Fig 2)



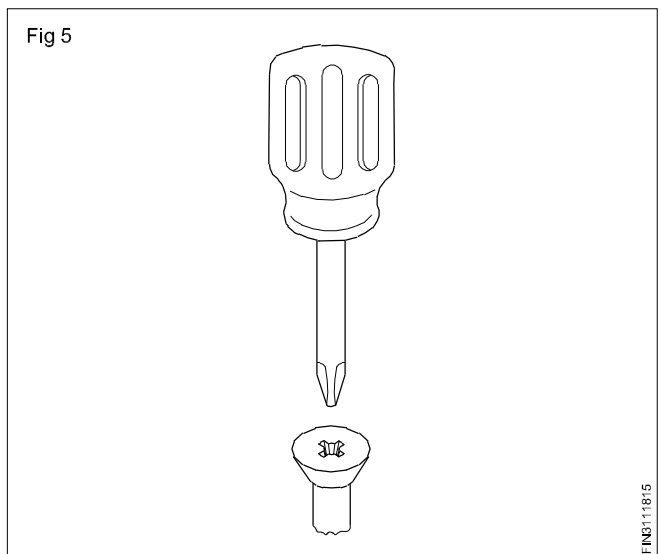
It has a square blade. The shank is also of square section for applying extra twisting force with the end of a spanner. (Fig 3)

Heavy duty screwdriver (London pattern) (Fig 4)

It has a flat blade and is mostly used by carpenters for fixing and removing wood screws.

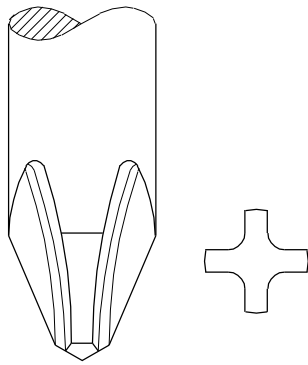


Philips screwdriver (Fig 5)



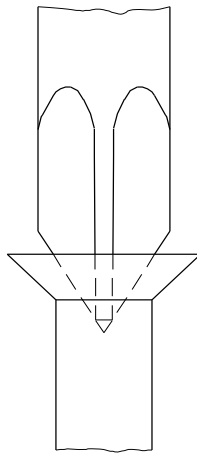
These are made with cruciform (Fig 6) tips that are unlikely to slip from the matching slots. (Fig 7) Philips recess head screws are shown in Fig 8.

Fig 6



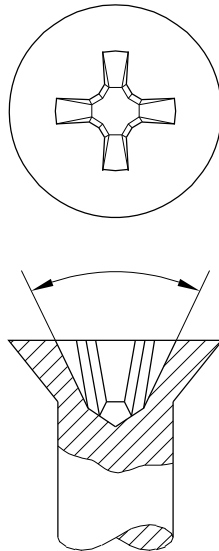
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Fig 7



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Fig 8



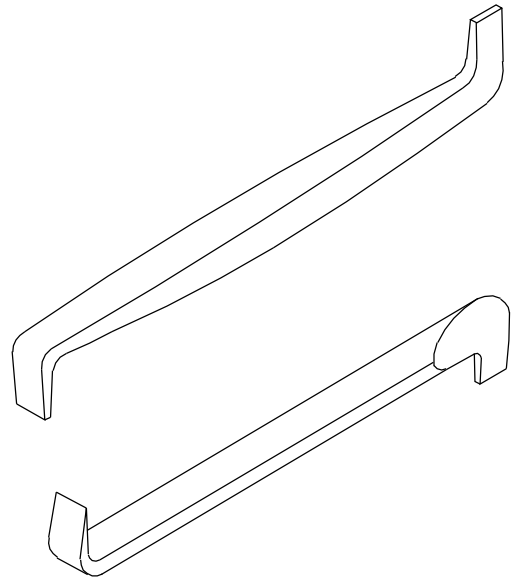
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The sizes of Philips screwdrivers are specified by point size 1, 2, 3 and 4.

Offset screwdrivers (Fig 9)

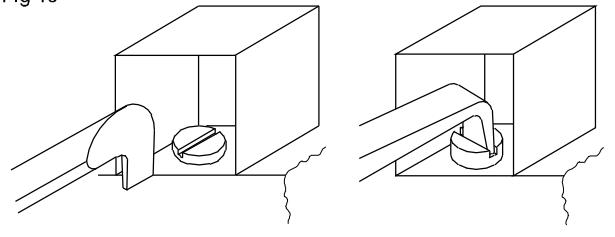
These are useful in some situations (Fig 10) where the normal screwdriver cannot be used because of the length of the handle. They are also useful for applying greater turning force.

Fig 9



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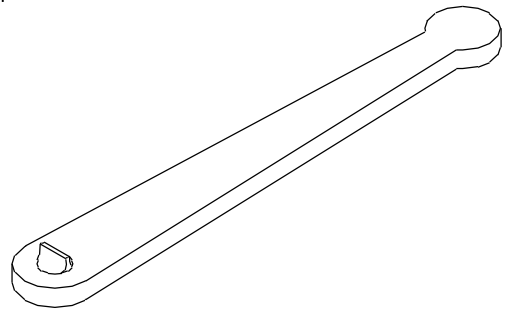
Fig 10



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For quicker application ratchet offset screwdrivers are also available with renewable tips. (Fig 11)

Fig 11



FIN31181B

Specification

Screwdrivers (Fig 12) are specified according to the

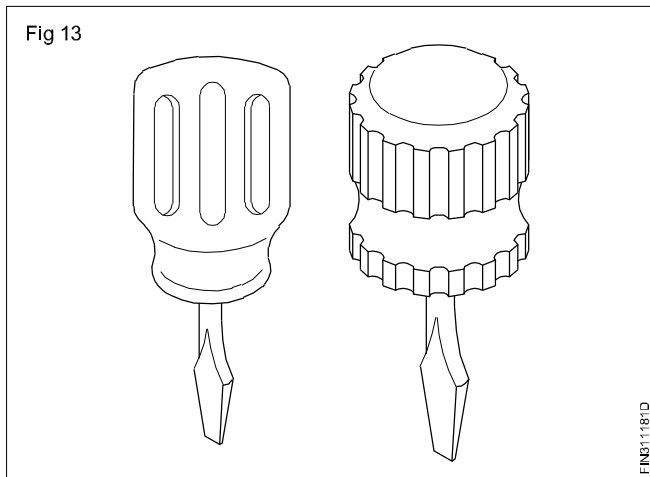
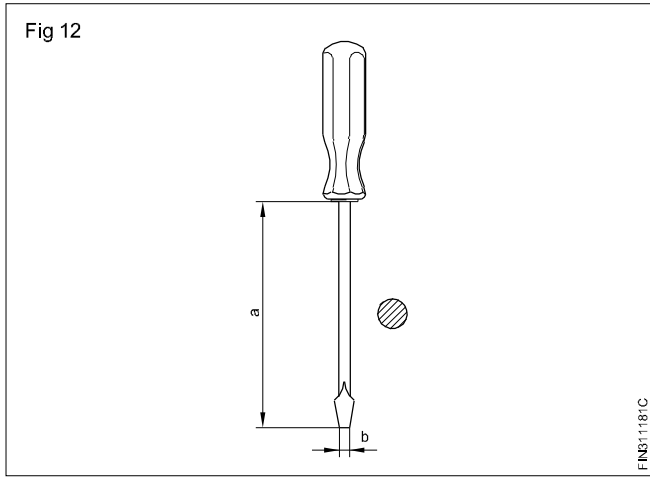
- length of the blade
- width of the tip.

Normal blade length: 45 to 300mm. Width of blade : 3 to 10mm.

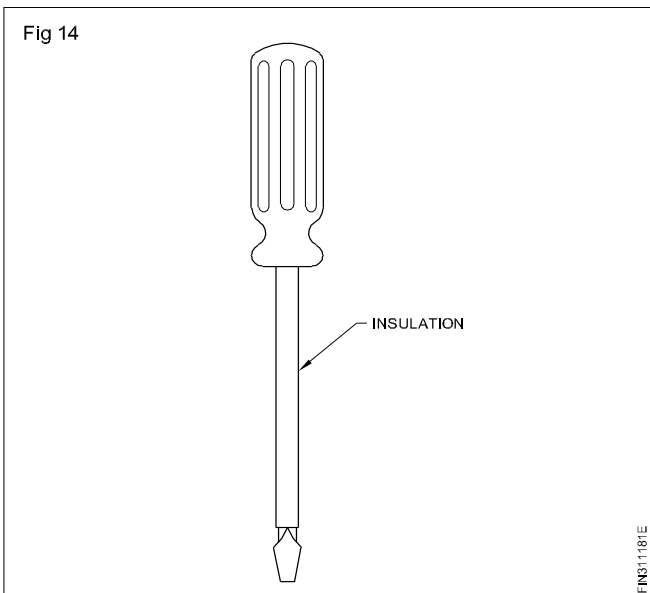
The blades of screwdrivers are made of carbon steel or alloy steel, hardened and tempered.

Screwdrivers for special uses

Small sturdy screwdrivers are available for use where there is limited space. (Fig 13)



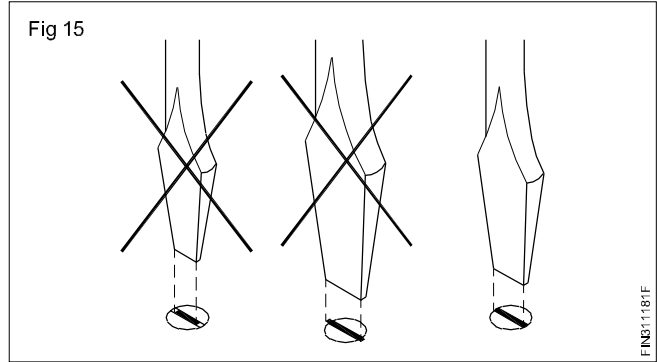
Screwdrivers with blades sheathed in insulation are available for the use of electricians. (Fig 14)



Precautions

Use screwdrivers with tips correctly fitting into the screw slot. (Fig 15)

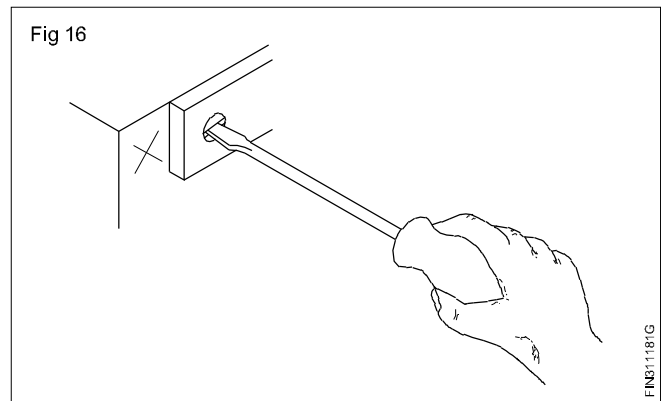
Make sure your hand and the handle are dry.



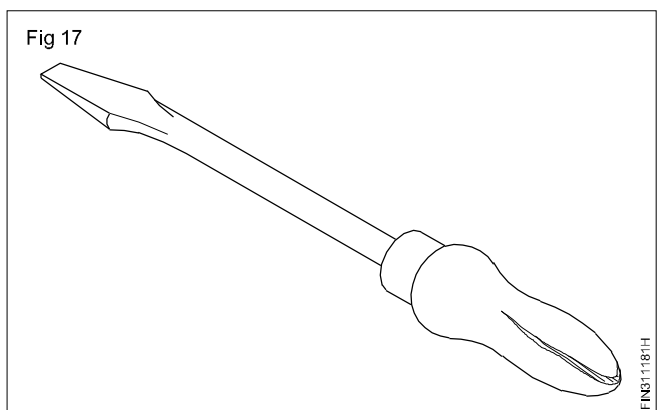
Hold the screwdriver with its axis in line with the axis of the screw.

While using a Philips screwdriver apply more downward pressure.

Keep your hand away to avoid injury due to slipping of screwdriver. (Fig 16)



Do not use screwdrivers with split or defective handles. (Fig 17)



In the case of damaged screwdrivers, the blades can be ground (the faces will be parallel with the sides of the screw slot) and used. While grinding ensure the end of the tip is as thick as the slot of the screw.

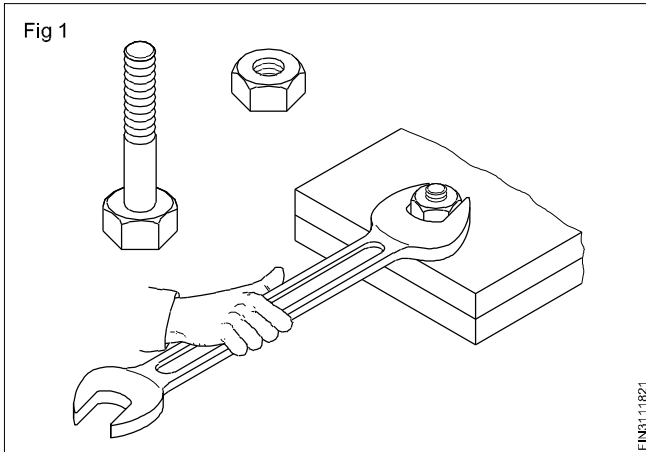
While using screwdrivers on small jobs, place the jobs on the bench or hold them in a vice.

Spanners

Objectives: At the end of this lesson you shall be able to

- state the uses of different sizes of spanners
- identify the size of a spanner.

A spanner is a hand tool with jaws or opening or a ring at one end or at both ends for tightening or slackening nuts and bolts and screw heads. (Fig 1) It is made of drop-forged, high tensile or alloy steel and heat treated for strength.



Types of spanners

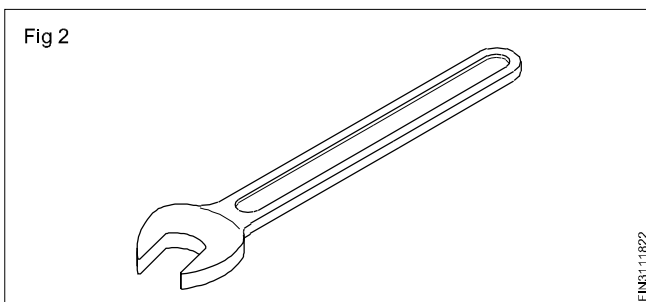
- Open end spanners
- Ring spanners

Open end spanners

They can be single ended or double ended.

Single-ended spanners

These are general purpose spanners. Single-ended spanners are mostly supplied with machine tools for a specific purpose. (Fig 2)



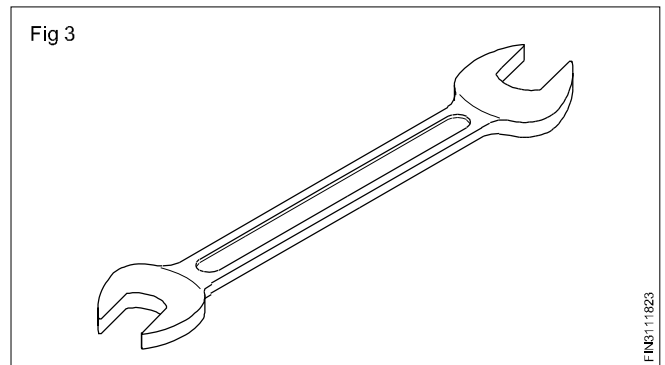
Double-ended spanners

Double-ended spanners are standard spanners having two different size openings. Some spanners are made of chrome vanadium steel.

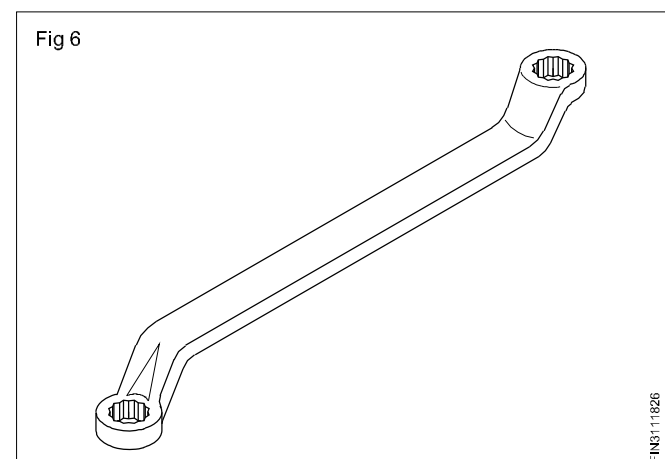
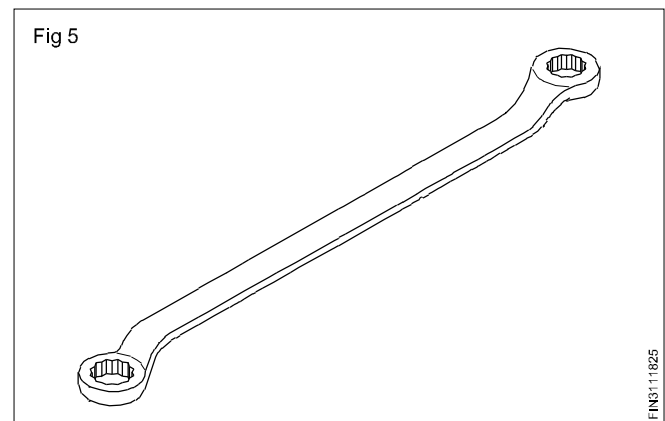
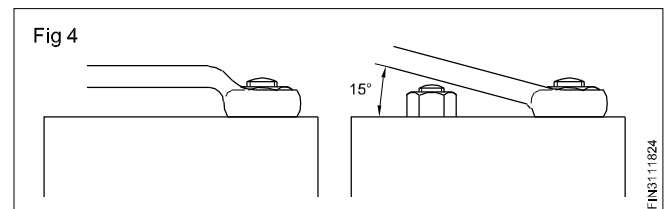
They are available in a set of 8, Nos 8 to 27 mm. (Fig 3)

8x10, 9x11, 12x13, 14x15, 16x17, 18x19, 20x22 and 24x27 mm.

Bigger than 27 mm size open end spanners are also available.



Ring spanners (Figs 4,5 & 6)



These types of spanners are used where obstruction close to the side of a nut prevails (Fig 4) and application of open-ended spanners is not possible.

These are available in a set of 8 Nos. (8 to 27 mm)

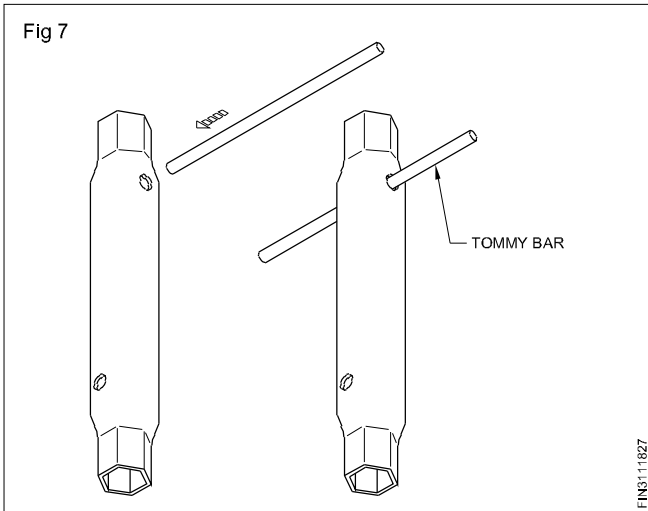
8x9, 10x11, 12x13, 14x15, 16x17, 18x19, 20x22 and 24x27 mm.

Sizes and identification of spanners

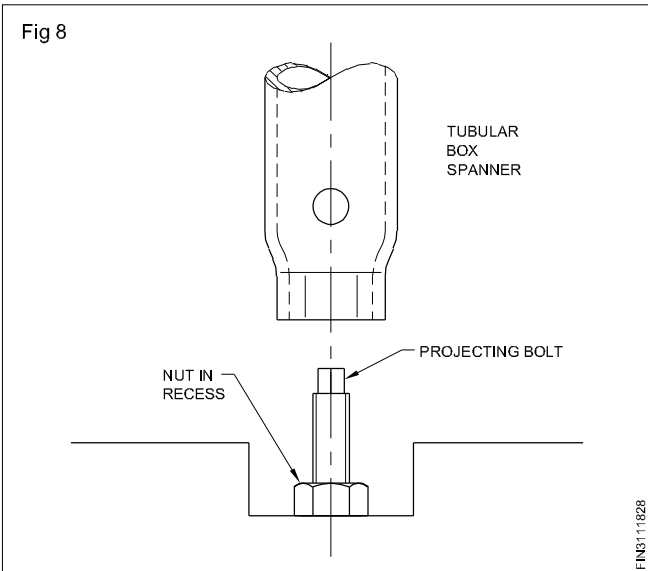
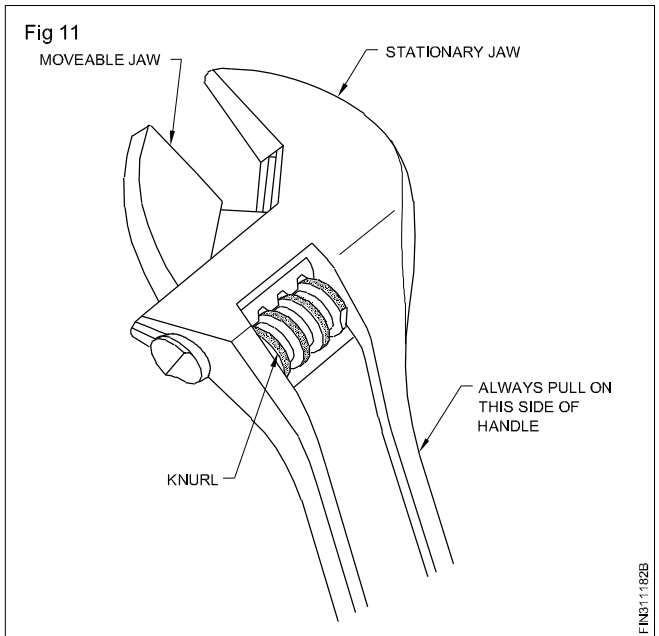
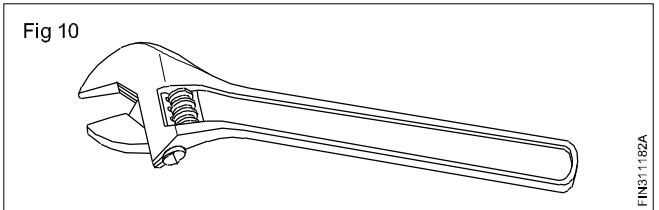
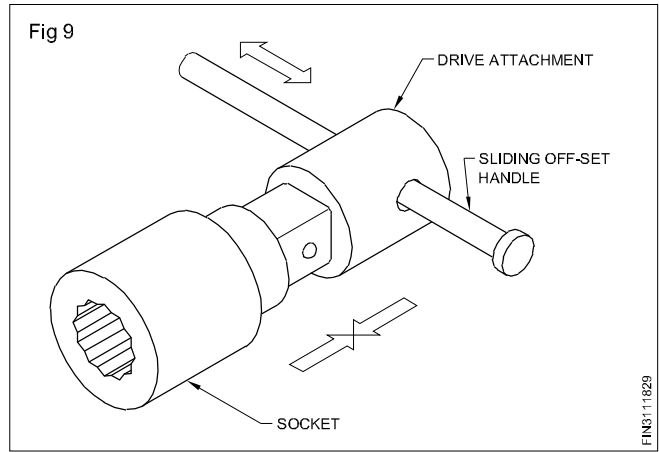
Spanners for metric bolts, nuts and screws are marked with the size across the jaw opening in mm.

Special purpose spanners

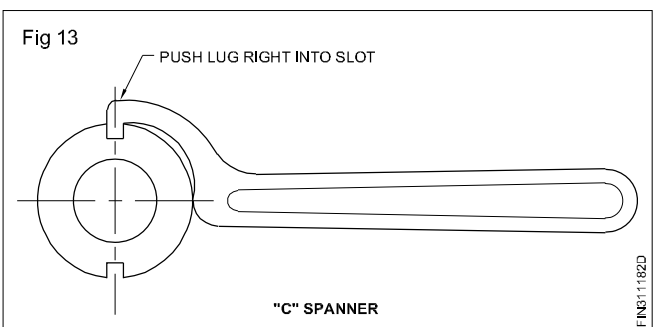
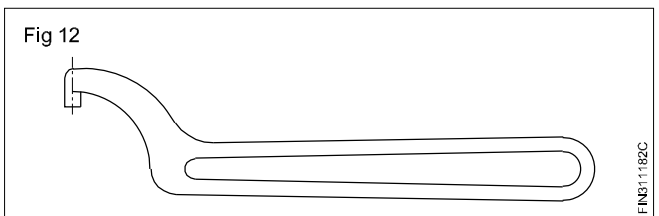
- Tube or tubular box spanners (Figs 7 & 8)



- Socket spanners (Fig 9)



- Adjustable spanners (Figs 10 & 11)
- Hook spanners (C-spanner) (Figs 12 & 13)



Power tools

Objectives: At the end of this lesson you shall be able to

- define power tool, torque and torque wrench
- state care and maintenance of power tools.

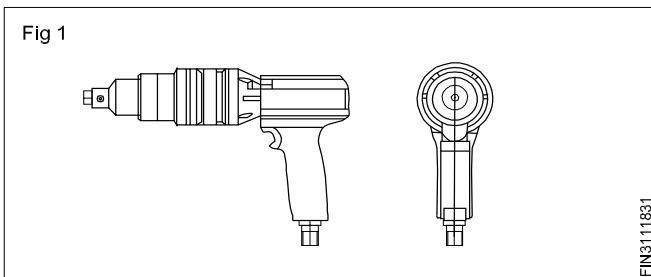
Definition

A power tool is a tool actuated by power source and mechanism other than manual labour used with hand tools for fastening bolts and nuts.

Power wrench

A power wrench is type of wrench that is powered by other means than human force. A typical power source is compressed air. There are two main types of power wrenches:

- 1 Impact wrenches and
- 2 Air ratchet or pneumatic ratchet wrenches

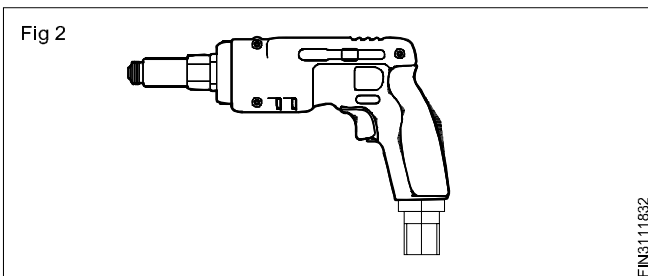


Air ratchet wrench

An air ratchet wrench is very similar to hand powered ratchet wrenches in that it has the same square drive, but an air motor is attached to turn the socket drive. Pulling the trigger activates the motor which turns the socket drive. A switch is provided to change the direction of socket drive.

This type of power wrench is designed more for speed and less for torque. If high levels of torque are desired an impact wrench should be used.

Pneumatic torque wrench



Pneumatic torque wrench setting torque on bolts.

A pneumatic torque wrench is a primary torque multiplier or a gear box that is mated to a pneumatic air motor. At the end of the gear box is a reaction device that is used to absorb the torque and allows the tool operator to use

it with very little effort. The torque output is adjusted by controlling the air pressure.

These planetary torque multiplier gearboxes have multiplication ratios up to 125:1 and are primarily used anywhere accurate torque is required on a nut and bolt, or where a stubborn nut needs to be removed.

The pneumatic torque wrench is sometimes confused with a standard impact wrench due to their similar appearance. A pneumatic torque wrench is driven by continuous gearing and not by the hammers of an impacting wrench. A pneumatic torque wrench has very little vibration and excellent repeatability and accuracy.

The pneumatic torque wrench was first invented in Germany in the early 1980's.

Torque capabilities of pneumatic torque wrenches range from 118Nm, up to a maximum of 47,600Nm.

Air requirements

A pneumatic motor using compressed air is the most common source of power for pneumatic torque wrenches. CFM requirements are usually 20-25 CFM of air consumption per tool.

CFM - Cubic feet/minute (or) PSI - Pounds/square inch.

Torque wrenches

Screwdrivers are available - manual, electric and pneumatic with a clutch that slips at a preset torque. This helps the user tighten screws to a specified torque without damage or over-tightening. Cordless drills designed to use as screwdrivers often have such a clutch.

Torque

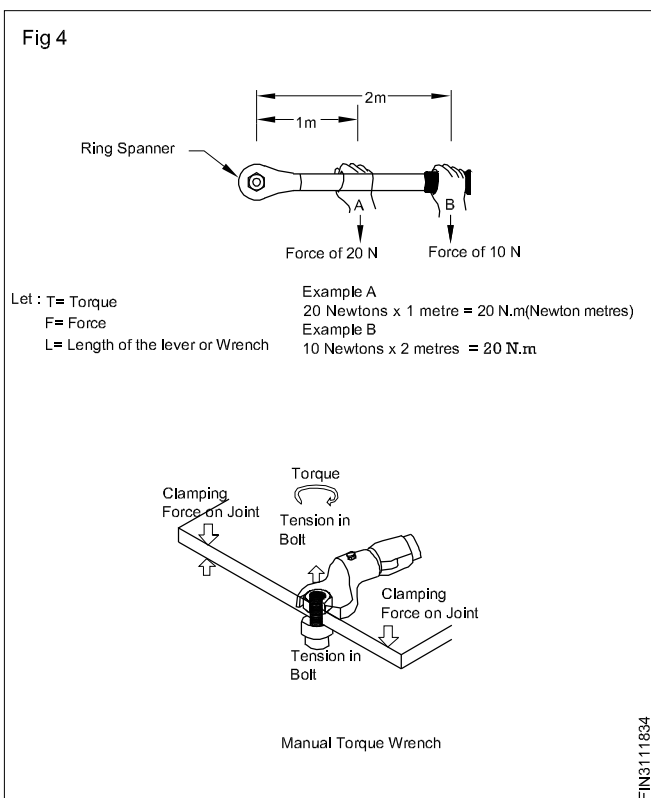
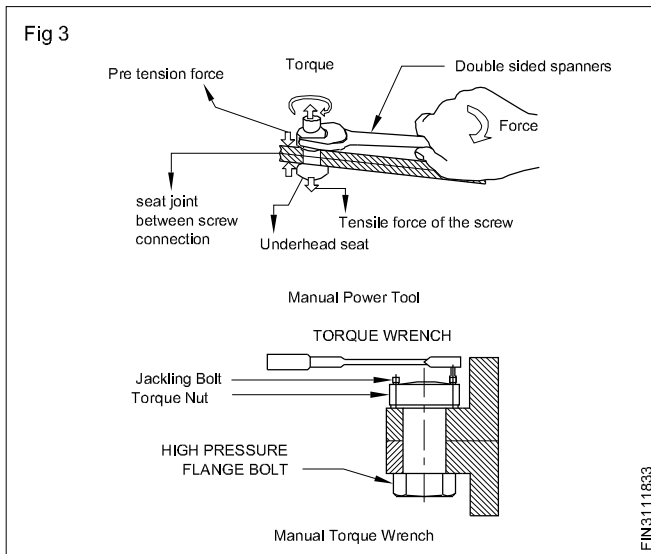
- Torque is the application of a force acting at a radial distance and tending to cause rotation
- Torque is used to create tension in thread fasteners
- When the nut and bolt are tightened the two plates are clamped together. The thread converts the applied torque into tension in the bolt shank. This turn is converted into clamping force. The amount of tension created in the bolt is critical.

Torque wrench

A tool for setting and adjusting the tightness of nuts and bolts to a desired value is called torque wrench.

Fastener tightening

- Always use a torque wrench to tighten fasteners, and use a slow, smooth, even pull on the wrench.



- When reading a bar type torque wrench, look straight down at the scale.
 - Viewing from an angle can give a false reading.
- Only pull on the handle of the torque wrench.
 - Do not allow the beam of the wrench to touch anything.
- Tighten bolts and nuts incrementally
 - Typically, this should be to one-half specified torque, to three-fourth torque, to full torque, and then to full torque a second time.

Maximum Tightening Torque

M4	270 Nm
M5	5.40 Nm
M6	9.50 Nm
M8	22.0 NM
M10	44.0 NM



Definition - What does power tools mean?

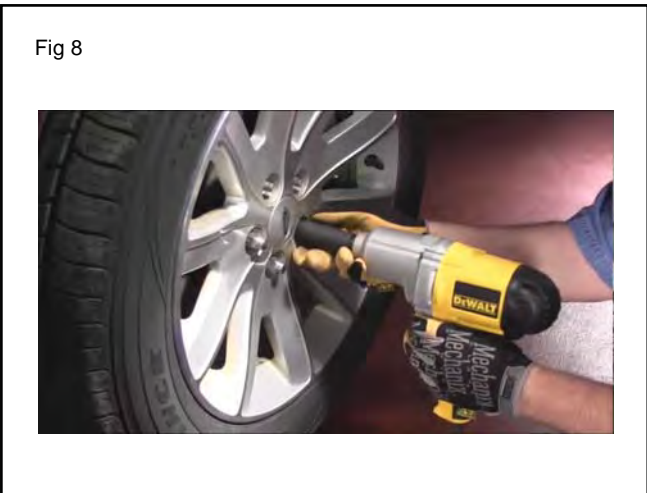
Power tool is a device that is activated by a power source apart from manual labor. There are various types of power tools, e.g., electric screwdriver, hammer drills, and fast screw guns. The tools are used construction and several do it your self jobs such as productions, assembly, packaging, and maintenance. They are available in multiple sizes and shapes and are simple to operate. Every reliable manufacturer makes sure that their power tools are marked under the rules and regulations of OSHA standards.

Occupational safety health administration

A power screwdriver will merely give us a screw driving capability at a quick and efficient manner. They are designed to work at a slower rate than typical power drills. They however have more torque drills, giving us the ability for more power, such as drilling screws into materials without having to do any predrilling. Solid models will give us torque limiters and allow you to set the maximum

torque to save the head of the screw or any mishaps of snapping.

Uses of power screwdrivers will really depend on the person and project out there, but are less versatile since the attachments are as of variety when compared to drills. We know many who have both a power screwdriver and drill for more versatility in their work flow. They can also help is in hard-to-reach spots and corners since they are usually smaller than drills and only take one hand to use.



Explanation on the creation of a clamping force

The tension in the bolt creates a clamping force (generally referred to as the preload) between the two parts

If the clamping force is too low, the fasteners can work loose due to vibrations or movement between the component parts

If a clamping force is too high, the fastener may permanently stretch and no longer apply the required clamping force

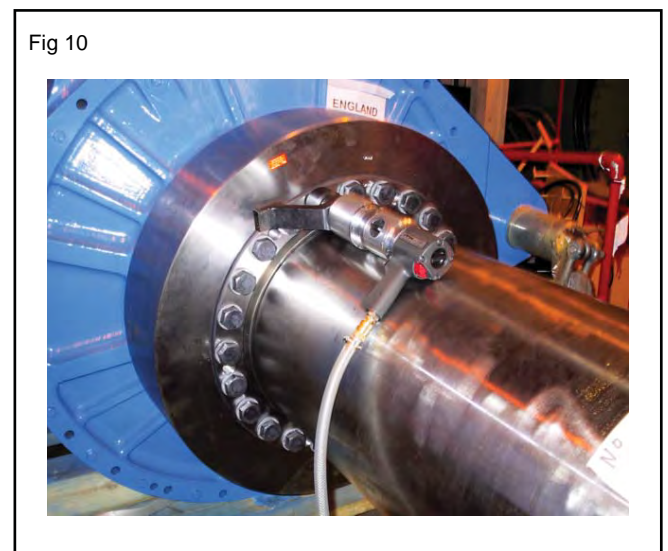
In severe cases the fastener may fail in assembly or during use when under loaded

How to calculate torque

Torque is the result of multiplying the value of force applied by the distance from the point of application

Comparing the two examples below (A and B) it will be noted that the same resultant torque can be achieved with a lower force if the distance from the nut/bolt is increased

It should also be realised that some torque wrenches are length dependent which means that the actual torque applied to the fastener varies if the hand position on the wrench is varied - even with the wrench preset. This occurs if the pivot point of the wrench mechanism is not coincidental with the point of application of torque



Maintenance of power tools

Power tools and other machines are designe for long life, but each requires some care and maintenance to meet its life expectancy. Properly storing power tools, performing maintenance as needed, and replacing machine parts will extend a tool's life to its full potential and deliver more value to its owner.

Proper storage

Our three guidelines for tool storage are:

1. Store tools in an area protected from the elements (like moisture).
2. Store tools in a clean and organized space.
3. Store tools in a well-ventilated area.

Keeping tools out of the elements protects them from damage and wear. A clean and organized storage space will promote safety, and keeping tools well-ventilated will help them run smoothly when it's time to pull them out of storage.

It might take a little extra time to put everything back in place at the end of the day or completion of a project, but storing tools the right way will always be worth the effort.

Care and maintenance

Before being stored, most power tools can use a little cleaning and a couple of quick checks for damage or other problems. Here's some maintenance tips for keeping those tools in good shape.

- Use a tooth brush and a soft cloth to wipe debris from power tool casings before storage.
- If available, use an air compressor to clean out power tool vents. A little air will go a long way. When a machine or tool can breathe more, it will run cooler and wear more slowly. For an "Air compressors 101" article -click here,

- Lubricate power tool parts that need to be lubricated. Following instructions in the tool's user manual will be help here.
- Check the parts that hold a tool together, screws and other fasteners. Tighten up anything that might have been shaken loose during operation.
- Electrical cords should be checked with each use of a power tool.
- A bad power cord can be dangerous and should be replaced before the tool is used again. For more information about power cords - click here.
- Keep blades and other cutting accessories sharp. Check bits and other accessories for wear and damage.
- Follow any other maintenance guidelines for a tool or machine explained in its user manual.

Replacing parts

Like cars and other machinery, many power tool parts are designed for wear and replacement. The expected service life of a power tool takes the replacement of certain parts into account.

Some examples of parts that commonly need to be replaced on power tools are : Carbon brushes, switch assemblies, power cords, accessories, bearings, and tires. Performing the checks and maintenance suggested in the section above is important for catching tool performance issues right when they start acting up.

Making tool repairs at the first sign of performance trouble can prevent damage to other parts of machine or tool.