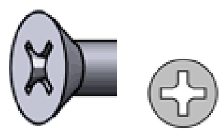
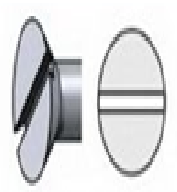
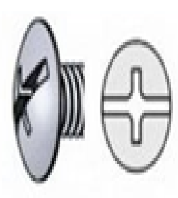
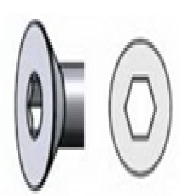
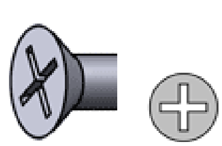
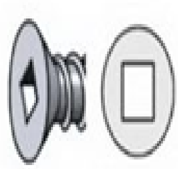
Working with Threaded Fasteners

Screwdrivers are available in a variety of fastener drive types, head styles, point styles, and shoulder styles.

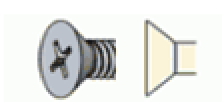
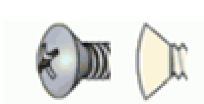
Drive Types

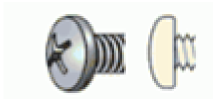
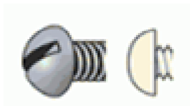
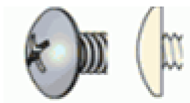
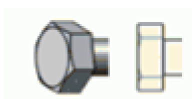
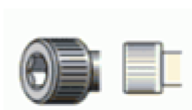
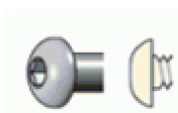
Drive type or drive recess refers to the kind of tool to use for installing or removing the screw. The table shows the various recesses for threaded screws.

Drive Types for Threaded Screws				
Drive Type	**Schematic**	**Description**	**Characteristics**	**Abbreviation**
Phillips		X-shaped drive	Common in screws, but prone to cam-out	PH
Slotted		A slot in the head		SL
Combination		Designed to accommodate more than one driver type; a common example is a combination of Phillips and slotted drives	• Can be used with either driver • Available for many fastener types	Combo
Hex Sockets or Allen		Hexagonal hole	• Compact and easy to drive, but prone to cam-out • Used with a hex wrench (also called Allen wrench)	
Frearson		X-shaped drive (Similar to Phillips)	• Requires a Frearson driver for installation	

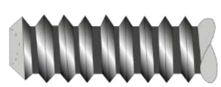
			• Less prone to cam-out than a Phillips drive	
Pozidrive		Similar to Phillips, but distinguishable by a set of radial indentations	Less prone to cam-out than a Phillips drive	PZ
Star (Torx)		Six-pointed star pattern	• Resistant to cam-out and stripped heads • Can be installed single-handed	
Square or Robertson		Square-shaped		SQ or SD

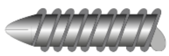
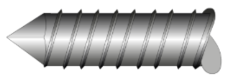
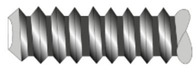
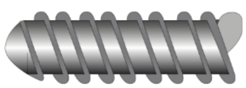
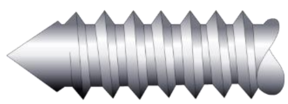
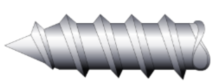
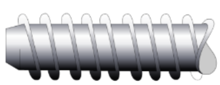
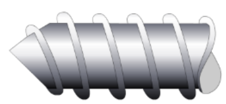
Head Styles
The table shows the different head styles for screw-type fasteners.

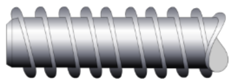
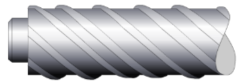
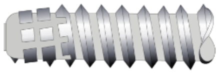
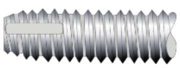
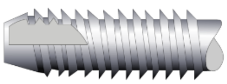
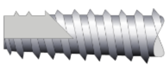
Head Styles for Threaded Screws			
Drive Type	**Schematic**	**Description**	**Abbreviation**
Flat		Installed in a countersunk hole for a flat surface	FH
Oval		Low domed and countersunk head, used primarily for decorative purposes.	OV

Pan		Gently rounded top surface, vertical sides, and a flat bearing surface	PN
Round		Domed head, used primarily for decorative purposes	RH
Truss		Slightly domed with a wide head for an extra-large surface area	
Hex		Hexagonal head, typically used with larger bolts and screws and tightened with a wrench	HH or HX
Socket cap		Cylindrical head using a socket drive, and knurled or smooth sides	
Button		Medium dome head, typically used with a hex socket drive.	

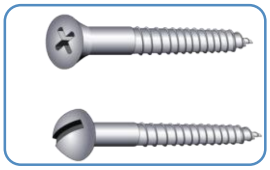
Point Styles
Next, let's learn about the point styles of threaded screws.

 **Die Point** Has a slight chamfer, aiding the insertion into predrilled holes	 **Dog Point** Has an extended, unthreaded chamfer to	 **Rolled Point** Has a thread roll-over on the first 540° of the helix	

	ensure that fine threaded products are not stripped		
 **Pinch Point** Is used in assembling several parts or aligning multiple sheets that require pilot action	 **Nail Point** Is employed for impinging or locking against wood and other soft material	 **Cupped Point** Increases its locking actuation under pressure.	
 **Round Point** Offers pressure without disfigurement; is used where end friction without cutting action is desirable	 **Cone Point** Offers a sharp point that provides an accurate pilot for threading	 **Self-Drilling** Is equipped with points that drill through varied applications (wood, metal and plastic); does not require predrilling	
 **Type-A Point** Is employed as a replacement screw, or used with predrilled holes in thin metals	 **Type-B Point** Is similar to Type A, but is used for heavier metals	 **Type-AB Point** Combines the precision point of Type-A with the pitch and thread size of Type-B	

 **Type-C Point** Requires higher driving torque and is used in heavy sheet metal and die castings	 **Type-U Point** Is best employed by hammering or driving.	 **Type-F Point** Has multi-cutting edges for tapping in large-gauge sheet metal, cast iron, zinc, and other such materials.	 **Type-F2 Point** Has multi-cutting edges for tapping in plastic and other soft materials
 **Type 1 Point** Has a groove in the chamfer and is a general machine screw thread fastener	 **Type 17 Point** Is ideal for use with wood; the large groove in the shank helps remove wood debris	 **Type 23 Point** Is similar to type 17, but has a finer thread, and provides maximum thread cutting area and excellent chip clearing	 **Type 25 Point** Is a hybrid between Type-17 and Type-23 and is equipped with a coarse thread

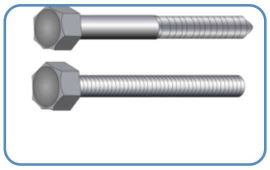
Types of Fasteners



Wood Screws (WS)

They have large threads, a smooth shank, and a tapered point for pulling two pieces of material together.

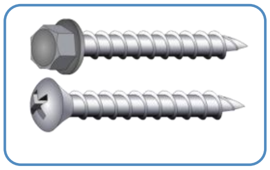
As the name suggests, they are ideally suited for wood and other soft materials.



Hex Bolts or Hex Cap Screws (HHMB or HXBT)

They are used in machinery and construction, with a nut or in a tapped hole.

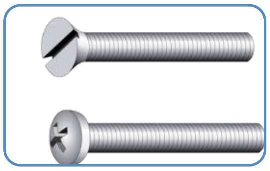
Fully treaded hex bolts are called tap bolts.



Sheet Metal Screws (SMS)

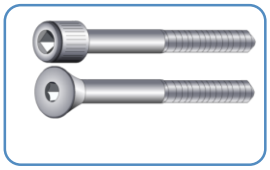
They have sharp points and threads.

They are designed to be driven directly into sheet metal and softer materials such as plastic.



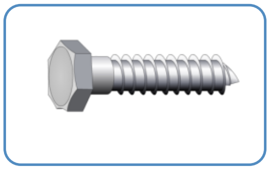
Machine Screws (MS)

These fully threaded screw are used with a nut or in a tapped hole.



Socket Screws

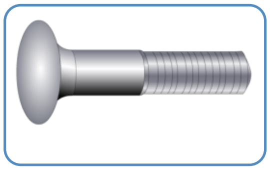
Socket screws, also known as Allen Head, are machine screws with an internal hex socket (Allen) drive.



Lag Bolts or Lag Screws (Lag)

They are large wood screws with hex heads.

Typically, they are used for wood construction and landscaping.



Carriage Bolts

They have smooth, domed heads with a square section underneath, which helps prevent spinning during installation.

Removing Damaged Fasteners

From time to time, you will have to deal with a problem of having a damaged or stuck/seized fastener. This problem could occur due to rusting, normal wear and tear, or when assembling the parts.

Here are some ways to remove damaged fasteners.

1) Penetrating oil

Using penetrating oil is the most basic method of removing a damaged fastener from its recess. The steps are listed here:

1. Take a wire brush and clean the bolt of loose rust and dirt.
2. Apply penetrating oil to the bolt and threads, covering it completely. Lightly tap the piece with a hammer a few times. This helps the oil penetrate the grooves of the thread.
3. Wait for some time.
4. Repeat Steps 2 and 3 a few times.
5. Select an appropriate tool, and apply steady, even pressure to loosen the piece.

Use a penetrating fluid **high in solids and low in solvents**. Such a fluid provides greater lubricity and can penetrate deeply into the tiny crevices, the rust, and the mating hole.

Typically, penetrating fluids with a high concentration of solvents evaporate before much penetration can occur.

2) Heat applications

The application of heat to a rusted or damaged fastener can help remove it from its recess. The added use of penetrants that can withstand high temperatures enhances the chances for success.

Heat is applied at the edge of broken fastener with the help of an electric torch. Make sure that the bolt does not melt.

Heat application causes the molecules in the metal to expand. This expansion occurs at different temperatures and rates for different metals.

An example is the heating of cast iron manifolds to remove stubborn steel studs. The cast iron expands at a rate greater than the steel fastener. This allows a space to form between the two metals and facilitates easier removal of the studs.

Avoid using heat around flammables or rubber gaskets/bushings.

3) Nut splitter

Another method of removing a fastener from its recess is by using a nut splitter, which is found at most auto-parts stores.

1. Slip a nut splitter over the seized nut and tighten the screw on the side of the splitter. This forces a wedge into the side of the nut.
2. Keep cranking the nut splitter screw until the nut makes an audible pop. You get through the nut.
3. Back off the nut splitter screw and clean the bolt of the split nut.
4. Add penetrating oil to the newly exposed bolt threads, or use heat application to remove the bolt.

The downside of this method is that it destroys the nut and sometimes even the bolt too.

4) Screw or bolt extractor

To remove a screw or bolt that has a stripped or broken off head, it is helpful to use a screw or bolt extractor.

1) Use a power drill to drill a pilot hole into the center of the damaged screw or bolt. Then use the appropriate size of bit.
2) Place the extractor bit into the pilot hole in the damaged screw or bolt. Keep turning it until the screw or bolt comes out.

3) Cold chisel

A cold chisel is useful in removing a nut out from the assembly, without damaging the bolt.

1) Drill a vertical hole down through the side of the nut using an electric drill and an appropriately sized drill bit.
2) Set the tip of a flat-edged chisel on the top of the nut. Ensure that the chisel blade is in line with the bolt shaft and is directly over the drilled hole.
3) Strike the head of the chisel repeatedly with a hammer until the nut splits and can be removed from the bolt. If there’s a problem in removing the nut, drill a hole on the other side of the nut and split the nut into two halves.

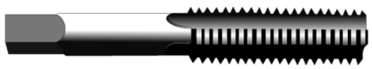
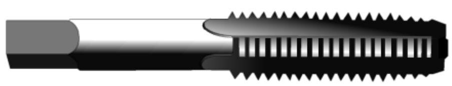
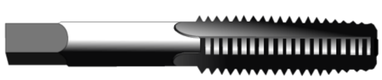
Cutting Threads with Taps and Dies

Taps

Taps are especially designed tools used for cutting internal screw threads. Let's learn about the types of taps.

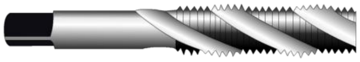
Hand Taps

Hand taps are designed to be manually operated. Hand taps come in three basic configurations: bottoming tap, second tap, and taper tap.

Hand Tap Type	**Description**
 **Bottoming Tap**	Chamfer (lead) of 1-2 threads Angle of the lead: 180 degrees per side Use: Produces threads close to bottom of blind holes.
 **Second Tap/Plug Tap**	Lead of 3-5 threads Angle of the lead: 8 degrees per side Use: Produces through holes, or blind holes, where the thread does not need to go right to the bottom
 **Taper Tap**	Lead of 7-10 threads Angle of the lead: 5 degrees per side Use: Helps the thread to start (prior to use of second or bottoming leads) or produces through holes as it distributes the cutting force over a large area

Machine Taps

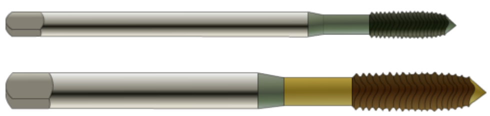
Machine taps are designed to run at higher speeds and need less cutting power than hand taps. Some of the common types of power driven taps are: spiral point, spiral flute, and forming or fluteless taps.

Machine Tap Type	**Description**
 **Spiral Point Tap** **(also known as gun nose or bull nose or chip driver)**	• Gives a better cutting action • Requires less power • Pushes the cut material forward, allowing free flow of coolant along the flutes to the cutting edge • Are ideal for machine tapping of through holes, or blind holes, that go all the way through the material, so that the chips can escape
 **Spiral Flute Tap**	• Has a short lead and is used to produce a thread close to the bottom of a blind hole • Are widely used in high speed, automatic tapping operations • Works better on materials that form long continuous stringy swarf, rather than chips
 **Fluteless or Forming Tap**	• Is used for the chipless production of threads in copper and other ductile materials • Does not have flutes; lobes contact the work piece to form the thread by extrusion • Are operated at high speeds and maintain size better

(also known as roll or polygon tap)	• Tends to have a longer life and less breakage than that of other types of machine taps

Long Shank Taps

These taps are longer in length than the regular types of taps. They have a long shank to facilitate reaching difficult holes that are blocked by other features on the part. They come in different sizes and types such as the Machine Nut (BS949). This type of long shank tap was designed to allow nuts to collect on the shank, but now it is generally used as a long reach tap.



Procedure for Tapping a Threaded Hole

Preparation

- Ensure that the proper tap hole has been drilled. (Drill a hole smaller than the measure needed for the tap.)
- Ensure that the tap has the correct specifications.
- Ensure that the tap hole is clean and free of all chips.
- Apply some rocol- cutting compound on the end of the tap.

Tapping Procedure

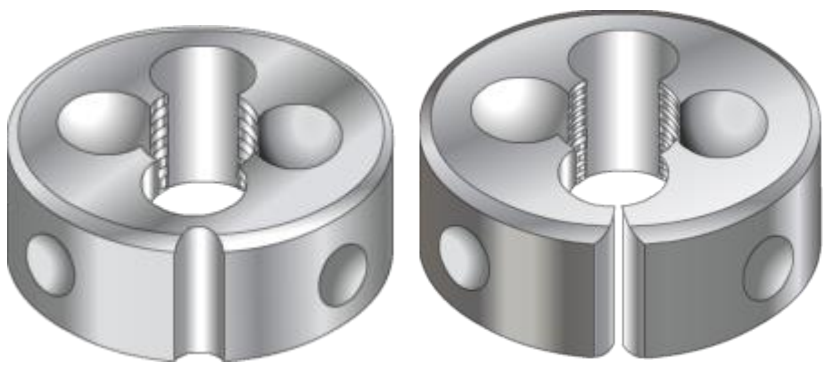
- Insert the end of the tap into the hole. Keeping the tap perpendicular to the face of the metal, turn the tap wrench until the first cut into the material has been made.
- Back off the tap about a half a turn for each complete thread formed. This ensures that the tap does not get clogged with the offcuts of the material.
- Keep turning the tap wrench until the cut has been made the full distance through the material and there is no resistance.

Check

- On completion, back the tap out of the hole.
- Clear all chips or metal shavings.
- Check the threading using the appropriate sized bolt or screw.

Dies

Dies are used for cutting external screw threads. Typically, hand operated dies are used for producing external threads. The dies are coaxially rotated around the premachined blank rod with the help of handle or die stock. They are made of hardened and tempered steel and fixed in a stock. Dies are generally made in two styles: solid and adjustable.



Solid Die **Adjustable Die**

Solid dies do not allow for adjustments of the screws over the stock. Generally, these dies are used for cutting smaller thread types, that is, threads of small pitch and diameter with a single operation. They are used for chasing or recutting damaged thread.

Adjustable dies are “split-ring” dies, that is, the die ring is provided with a slit. The split in the die can be opened or closed using a setscrew to increase or decreases the cutting diameter. They have an adjustment screw that permits an adjustment over or under the standard depth of the thread. Typically, these dies are used for creating longer threads.

Cutting of Materials Using Cutting Fluid

Thread cutting fluids may be used during tapping and threading. These cutting fluids help cool threads during operation, improve thread quality, reduce work piece thermal deformation, flush away chips from the cutting zone, and reduce threading torque. Let’s briefly look at the four categories of cutting fluids.

Straight Oils

- Composed of a base mineral or petroleum oil and often contain polar lubricants (fats and vegetable oils) as well as extreme pressure additives such as chlorine, sulphur, and phosphorus
- Non-emulsifiable and used in an undiluted form
- Best lubrication and the poorest cooling characteristics among cutting fluids

Soluble Oil

- Composed of a base mineral oil and emulsifiers to help produce a stable emulsion
- Used in a diluted form
- Good lubrication and heat transfer performance
- Least expensive among all cutting fluids and widely used in the industry

Synthetic Fluids

- Formulated from alkaline inorganic and organic compounds along with additives for corrosion inhibition; contains no petroleum or mineral oil base
- Generally used in a diluted form (usual concentration
- Best cooling performance among all cutting fluids

Semi-Synthetic Fluids

- Characteristics common to both synthetic and soluble oil fluids
- Cost and heat transfer performance lies between those of synthetic and soluble oil fluids

The uses of cutting fluids has certain disadvantages:

- Need for expensive and special machine tools
- Excessive tool wear
- Cost of buying, maintaining and disposing of cutting fluids
- Additional tasks of preparation and disposal of fluids
- Environmental concerns
- Health hazards from handling or working around coolants

Cutting of Materials Without Cutting Fluid

It is possible to eliminate cutting fluids in machining. To minimize the use of cutting fluid, one of the following techniques can be used:

Dry Machining

Dry machining or dry cutting refers to machining without using cutting fluids. It avoids problems of cutting fluid contamination, disposal, and filtration and is environmental friendly. However, it is not feasible under all machining applications. When machined dry, some materials tend to stick to the tools and thereby spoiling the tools. There are also problems of overheating of tools and absence of chip removal benefits.

Minimum Quantity Lubrication (MQL)

The problems with dry machining can be efficiently dealt with by another process known as minimum quantity lubrication (MQL) or near dry machining (NDM). MQL makes use of a lubricant, instead of a coolant. A tiny film of lubricant is applied to the tool tip with compressed air in mist form.

Most of the heat from friction is transmitted to the chip. This keeps the cutting tool cooler and reduces tool wear. As MQL lubricants are mostly consumed in the cutting process, no disposal is required and tools, equipment, and floors remain dry and clean. A large number of MQL lubricants are environmentally-friendly and safe for skin contact.

Steam, mist and oil smoke are considered undesirable sub-products of the MQL process because they increase air pollution. An efficient exhauster system that guarantees compulsory air pollution control needs to be used.

Despite this limitation, MQL could be more advantageous than dealing with the problems of using cutting fluids.