CHAPTER 3

FASTENERS AND THREAD REPAIR

OBJECTIVES

After studying Chapter 3, the reader will be able to:

1. Explain the terms used to identify bolts and other threaded fasteners.
2. Explain the strength ratings of threaded fasteners.
3. Describe the proper use of nonthreaded fasteners.
4. Discuss how snap rings are used.

KEY TERMS

Bolts (p. 29)
Cap Screws (p. 29)
Capillary Action (p. 37)
Christmas Tree Clips (p. 35)
Cotter Pins (p. 36)
Crest (p. 29)
Die (p. 32)
Grade (p. 30)
Helical Insert (p. 38)
Helicoil® (p. 38)
Jam Nut (p. 36)
Metric Bolts (p. 29)
Pal Nut (p. 36)
Penetrating Oil (p. 37)
Pitch (p. 29)
Pop Rivet (p. 36)
Prevailing Torque Nuts (p. 32)
Self-Tapping Screw (p. 34)
Snap Ring (p. 35)
Stud (p. 29)
Tap (p. 32)
Tensile Strength (p. 31)
Threaded Insert (p. 39)
UNC (Unified National Coarse) (p. 29)
UNF (Unified National Fine) (p. 29)
Washers (p. 34)

THREADED FASTENERS

Most of the threaded fasteners used on vehicles are cap screws. They are called **cap screws** when they are threaded into a casting. Automotive service technicians usually refer to these fasteners as **bolts,** regardless of how they are used. In this chapter, they are called bolts. Sometimes, studs are used for threaded fasteners. A **stud** is a short rod with threads on both ends. Often, a stud will have coarse threads on one end and fine threads on the other end. The end of the stud with coarse threads is screwed into the casting. A nut is used on the opposite end to hold the parts together.

The fastener threads *must* match the threads in the casting or nut. The threads may be measured either in fractions of an inch (called fractional) or in metric units. The size is measured across the outside of the threads, called the **crest** of the thread. See Figure 3-1.

Fractional threads are either coarse or fine. The coarse threads are called **Unified National Coarse (UNC),** and the fine threads are called **Unified National Fine (UNF).** Standard combinations of sizes and number of threads per inch (called **pitch**) are used. Pitch can be measured with a thread pitch gauge as shown in Figure 3-2.

Bolts are identified by their diameter and length as measured from below the head, and not by the size of the head or the size of the wrench used to remove or install the bolt. Bolts and screws have many different-shaped heads. See Figure 3-3.

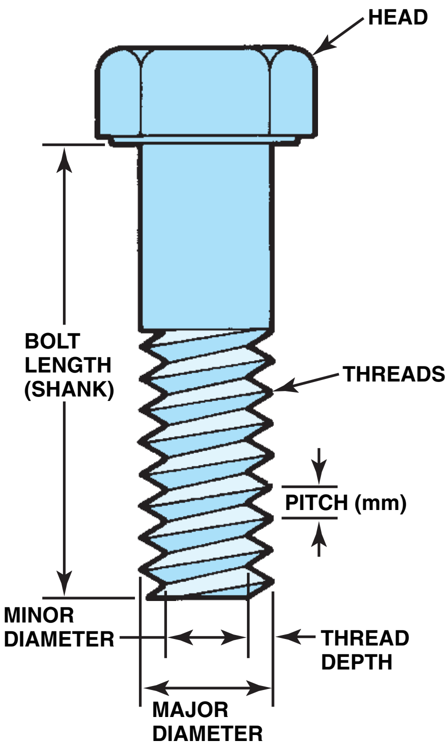


FIGURE 3-1 The dimensions of a typical bolt showing where sizes are measured.

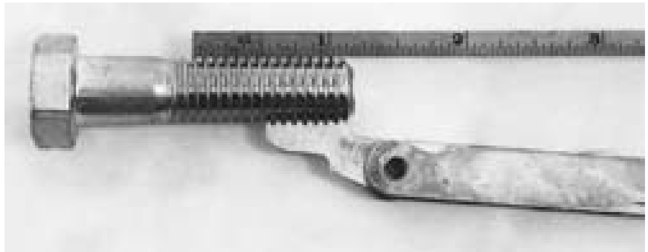


FIGURE 3-2 Thread pitch gauge used to measure the pitch of the thread. This bolt has 13 threads to the inch.

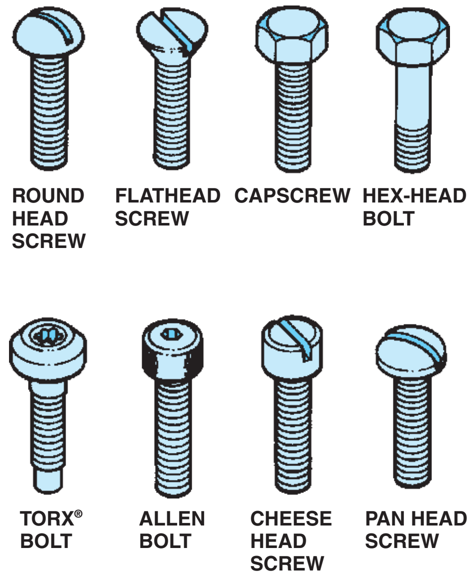


FIGURE 3-3 Bolts and screws have many different heads which determine what tool must be used.

Fractional thread sizes are specified by the diameter in fractions of an inch and the number of threads per inch. Typical UNC thread sizes would be 5/16–18 and 1/2–13. Similar UNF thread sizes would be 5/16–24 and 1/2–20. See Figure 3-4.

METRIC BOLTS

The size of a **metric bolt** is specified by the letter *M* followed by the diameter in millimeters (mm) across the outside (crest) of the threads. Typical metric sizes would be M8 and M12. Fine metric threads are specified by the thread diameter followed by *X* and the distance between the threads measured in millimeters (M8 × 1.5). See Figure 3-5.

Size	Threads per inch		Outside Diameter Inches
	NC UNC	NF UNF	
0	. .	80	0.0600
1	64	. .	0.0730
1	. .	72	0.0730
2	56	. .	0.0860
2	. .	64	0.0860
3	48	. .	0.0990
3	. .	56	0.0990
4	40	. .	0.1120
4	. .	48	0.1120
5	40	. .	0.1250
5	. .	44	0.1250
6	32	. .	0.1380
6	. .	40	0.1380
8	32	. .	0.1640
8	. .	36	0.1640
10	24	. .	0.1900
10	. .	32	0.1900
12	24	. .	0.2160
12	. .	28	0.2160
1/4	20	. .	0.2500
1/4	. .	28	0.2500
5/16	18	. .	0.3125
5/16	. .	24	0.3125
3/8	16	. .	0.3750
3/8	. .	24	0.3750
7/16	14	. .	0.4375
7/16	. .	20	0.4375
1/2	13	. .	0.5000
1/2	. .	20	0.5000
9/16	12	. .	0.5625
9/16	. .	18	0.5625
5/8	11	. .	0.6250
5/8	. .	18	0.6250
3/4	10	. .	0.7500
3/4	. .	16	0.7500
7/8	9	. .	0.8750
7/8	. .	14	0.8750
1	8	. .	1.0000
1	. .	12	1.0000
1 1/8	7	. .	1.1250
1 1/8	. .	12	1.1250
1 1/4	7	. .	1.2500
1 1/4	. .	12	1.2500
1 3/8	6	. .	1.3750
1 3/8	. .	12	1.3750
1 1/2	6	. .	1.5000
1 1/2	. .	12	1.5000
1 3/4	5	. .	1.7500
2	4 1/2	. .	2.0000
2 1/4	4 1/2	. .	2.2500
2 1/2	4	. .	2.5000
2 3/4	4	. .	2.7500
3	4	. .	3.0000
3 1/4	4	. .	3.2500
3 1/2	4	. .	3.5000
3 3/4	4	. .	3.7500
4	4	. .	4.0000

FIGURE 3-4 The American National System is one method of sizing fasteners.

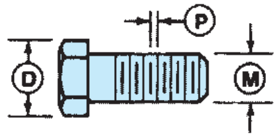
GRADES OF BOLTS

Bolts are made from many different types of steel, and for this reason some are stronger than others. The strength or classification of a bolt is called the **grade.** The bolt heads are marked to indicate their grade strength. Graded bolts are commonly used in the suspension parts of the vehicle but can be used almost anywhere in the vehicle.

The actual grade of bolts is two more than the number of lines on the bolt head. Metric bolts have a decimal number to indicate the grade. More lines or a higher grade number indicate a stronger bolt. Higher grade bolts usually have threads that are rolled rather than cut, which also makes them stronger. See Figure 3-6. In some cases, nuts and machine screws have similar grade markings.

METRIC HEXAGON HEAD CAP SCREWS

ALL MEASUREMENTS IN MILLIMETERS



M	P	D	M	P	D	M	P	D
1.6	0.35	3.2	10	1.00	17	20	1.50	30
1.7	0.35	3.5	10	1.25	17	20	2.50	30
2	0.40	4	10	1.50	17	22	1.50	32
2.3	0.40	4.5	12	1.25	19	22	2.50	32
2.5	0.45	5	12	1.50	19	24	2.00	36
3	0.50	5.5	12	1.75	19	24	3.00	36
3.5	0.60	6	14	1.50	22	27	3.00	41
4	0.70	7	14	2.00	22	30	3.50	46
5	0.80	8	16	1.50	24	33	3.50	50
6	1.00	10	16	2.00	24	36	4.00	55
7	1.00	11	18	1.50	27	39	4.00	60
8	1.00	13	18	2.50	27	42	4.50	65
8	1.25	13				45	4.50	70

FIGURE 3-5 The metric system specifies fasteners by diameter, length, and pitch.

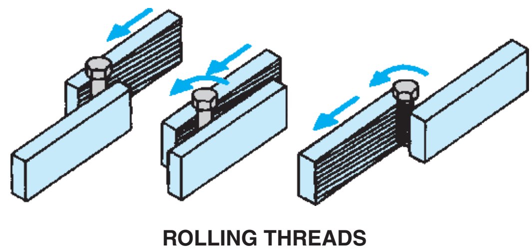


FIGURE 3-6 Stronger threads are created by cold-rolling a heat-treated bolt blank instead of cutting the threads using a die.

CAUTION: ***Never*** **use hardware store (nongraded) bolts, studs, or nuts on any vehicle steering, suspension, or brake component. Always use the exact size and grade of hardware that is specified and used by the vehicle manufacturer.**

TENSILE STRENGTH

Graded fasteners have a higher tensile strength than non-graded fasteners. **Tensile strength** is the maximum stress used under tension (lengthwise force) without causing failure of the fastener. Tensile strength is specified in pounds per square inch (PSI). See the following chart that shows the grade and specified tensile strength.

The strength and type of steel used in a bolt is supposed to be indicated by a raised mark on the head of the bolt. The type of mark depends on the standard to which the bolt was manufactured. Most often, bolts used in machinery are made to SAE Standard J429.

Metric bolt tensile strength property class is shown on the head of the bolt as a number, such as 4.6, 8.8, 9.8, and 10.9; the higher the number, the stronger the bolt. See Figure 3-7.

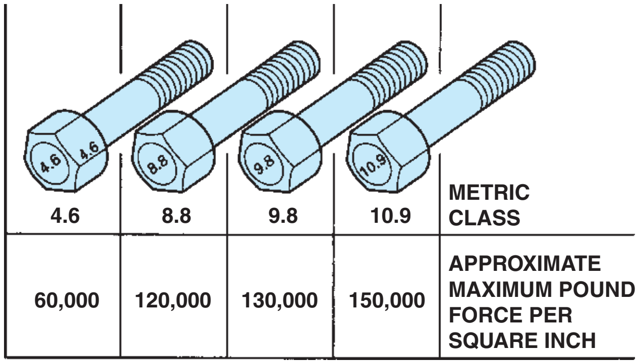
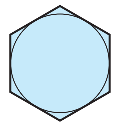
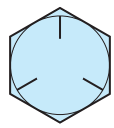
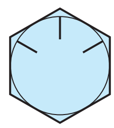
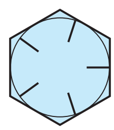
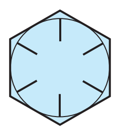
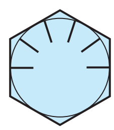


FIGURE 3-7 Metric bolt (cap screw) grade markings and approximate tensile strength.

NUTS

Most nuts used on cap screws have the same hex size as the cap screw head. Some inexpensive nuts use a hex size larger

SAE Bolt Designations

SAE Grade No.	*Size range*	*Tensile strength, PSI*	*Material*	*Head marking*
1	1/4 through 1-1/2	60,000	Low or medium carbon steel	
2	1/4 through 3/4 7/8 through 1-1/2	74,000 60,000		
5	1/4 through 1 1-1/8 through 1-1/2	120,000 105,000	Medium carbon steel, quenched & tempered	
5.2	1/4 through 1	120,000	Low carbon martensite steel*, quenched & tempered	
7	1/4 through 1-1/2	133,000	Medium carbon alloy steel, quenched & tempered	
8	1/4 through 1-1/2	150,000	Medium carbon alloy steel, quenched & tempered	
8.2	1/4 through 1	150,000	Low carbon martensite steel*, quenched & tempered	

*Martensite steel is steel that has been cooled rapidly, thereby increasing its hardness. It is named after a German metallurgist, Adolf Martens.

than the cap screw head. Metric nuts are often marked with dimples to show their strength. More dimples indicate stronger nuts. Some nuts and cap screws use interference fit threads to keep them from accidentally loosening. This means that the shape of the nut is slightly distorted or that a section of the threads is deformed. Nuts can also be kept from loosening with a nylon washer fastened in the nut or with a nylon patch or strip on the threads. See Figure 3-8.

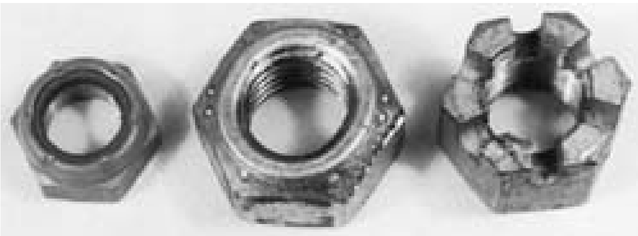


FIGURE 3-8 Types of lock nuts. On the left, a nylon ring; in the center, a distorted shape; and on the right, a castle for use with a cotter key.

TECH TIP

A 1/2-INCH WRENCH DOES NOT FIT A 1/2-INCH BOLT

A common mistake made by persons new to the automotive field is to think that the size of a bolt or nut is the size of the head. The size of the bolt or nut (outside diameter of the threads) is usually smaller than the size of the wrench or socket that fits the head of the bolt or nut. Examples are given in the following table:

Wrench Size	Thread Size
7/16 in.	1/4 in.
1/2 in.	5/16 in.
9/16 in.	3/8 in.
5/8 in.	7/16 in.
3/4 in.	1/2 in.
10 mm	6 mm
12 mm or 13 mm*	8 mm
14 mm or 17 mm*	10 mm

*European (Système International d'Unités-SI) metric.

Hint: An open-end wrench can be used to gauge bolt sizes. A 3/8-in. wrench will fit the threads of a 3/8-in. bolt.

NOTE: Most of these "locking nuts" are grouped together and are commonly referred to as **prevailing torque nuts.** This means that the nut will hold its tightness or torque and not loosen with movement or vibration. Most prevailing torque nuts should be replaced whenever removed to ensure that the nut will not loosen during service. Always follow the manufacturer's recommendations. Anaerobic sealers, such as Loctite®, are used on the threads where the nut or cap screw must be both locked and sealed.

TAPS AND DIES

Taps and dies are used to cut threads. **Taps** are used to cut threads in holes drilled to an exact size depending on the size of the tap. A **die** is used to cut threads on round rods or studs. Most taps and dies come as a complete set for the most commonly used fractional and metric threads.

Taps

There are two commonly used types of taps, including:

- **Tapered tap.** This is the most commonly used tap and is designed to cut threads by gradually enlarging the threaded hole.
- **Bottoming tap.** This tap has a flat bottom instead of a tapered tip to allow it to cut threads to the bottom of a drilled hole. See Figure 3-9.

All taps must be used in the proper size hole called a "tap drill size." This information is often stamped on the tap itself or in a chart that is included with a tap and die tool set. See Figure 3-10.

Dies

A die is a hardened steel round cutter with teeth on the inside of the center hole. See Figure 3-11. A die is rotated using a die handler over a rod to create threads.

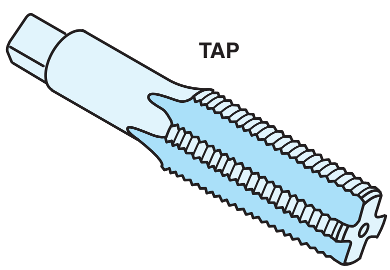


FIGURE 3-9 A typical bottoming tap used to create threads in holes that are not open, but stop in a casting, such as an engine block.

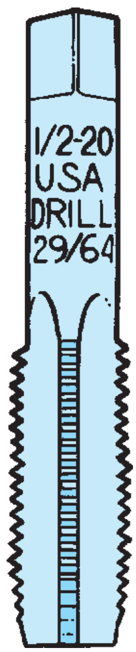


FIGURE 3-10 Many taps, especially larger ones, have the tap drill size printed on the top.

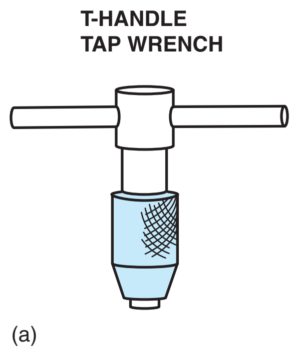


FIGURE 3-12a A T-handle is used to hold and rotate small taps.

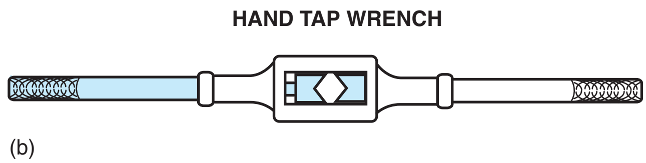


FIGURE 3-12b A tap wrench is used to hold and drive larger taps.

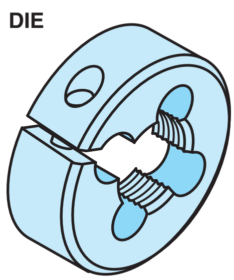


FIGURE 3-11 A die is used to cut threads on a metal rod.

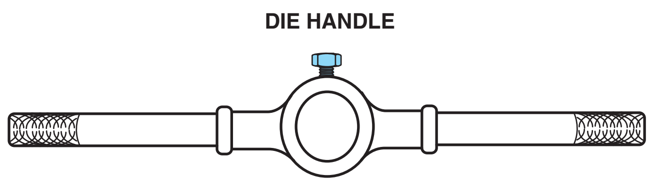


FIGURE 3-13 A die handle used to rotate a die while cutting threads on a metal rod.

Proper Use of Taps and Dies

Taps and dies are used to cut threads on roll stock in the case of a die or in a hole for a tap. A small tap can be held using a T-handle but for larger taps a tap handle is needed to apply the needed force to cut threads. See Figures 3-12a and 3-12b.

Tap Usage. Be sure that the hole is the correct size for the tap and start by inserting the tap straight into the hole. Lubricate the tap using tapping lubricant. Rotate the tap about one full turn clockwise, then reverse the direction of the tap one-half turn to break the chip that was created. Repeat the procedure until the hole is completely threaded.

Die Usage. A die should be used on the specified diameter rod for the size of the thread. Install the die securely into the die handle. See Figure 3-13.

Lubricate the die and the rod and place the die onto the end of the rod to be threaded. Rotate the die handle one full turn clockwise, then reverse the direction and rotate the die handle about a half turn counterclockwise to break the chip that was created. Repeat the process until the threaded portion has been completed.

THREAD PITCH GAUGE

A thread pitch gauge is a hand tool that has the outline of various thread sizes machined on stamped blades. To determine the thread pitch size of a fastener, the technician matches the thread of the thread pitch gauge to the threads of the fastener. See Figure 3-14.

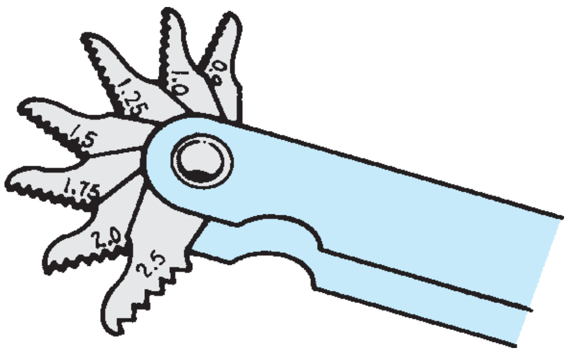


FIGURE 3-14 A typical thread pitch gauge.

FREQUENTLY ASKED QUESTION

WHAT IS THE DIFFERENCE BETWEEN A TAP AND A THREAD CHASER?

A tap is a cutting tool and is designed to cut new threads. A thread chaser has more rounded threads and is designed to clean dirty threads without removing metal. Therefore, when cleaning threads, it is best to use a thread chaser rather than a tap to prevent the possibility of removing metal, which would affect the fit of the bolt being installed. See Figure 3-15.

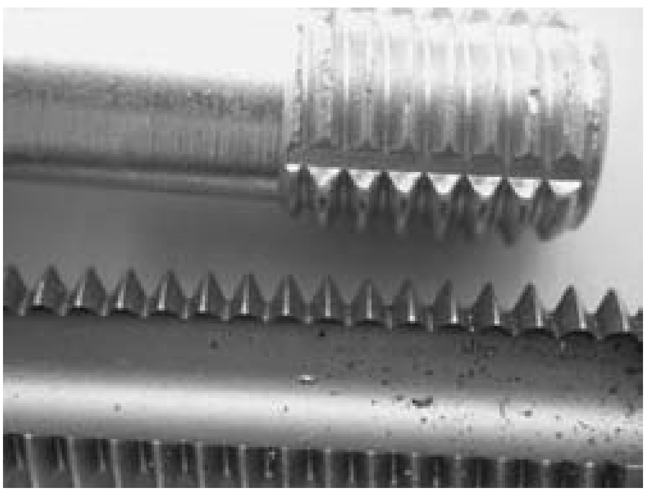


FIGURE 3-15 A thread chaser is shown at the top compared to a tap on the bottom. A thread chaser is used to clean threads without removing metal.

SHEET METAL SCREWS

Sheet metal screws are fully threaded screws with a point for use in sheet metal. Also called **self-tapping screws,** they are used in many places on the vehicle, including fenders, trim, and door panels. See Figure 3-16.

These screws are used in unthreaded holes and the sharp threads cut threads as they are installed. This makes for a quick and easy installation when installing new parts, but the sheet metal screw can easily strip out the threads when used on the same part over and over, so care is needed.

When reinstalling self-tapping screws, first turn the screw lightly backwards until you feel the thread drop into the existing thread in the screw hole. Then, turn the screw in; if it threads in easily, continue to tighten the screw. If the screw seems to turn hard, stop and turn it backwards about another half turn to locate the existing thread and try again. This technique can help prevent stripped holes in sheet metal and plastic parts.

Sheet metal screws are sized according to their major thread diameter.

Size	Diameter Decimal (inch)	Diameter Nearest Fraction (inch)
	0.11	7/64
	0.14	9/64
	0.17	11/64
0	0.19	3/16
2	0.22	7/32
4	0.25	1/4

WASHERS

Washers are often used under cap screw heads and under nuts. See Figure 3-17.

Plain flat washers are used to provide an even clamping load around the fastener. Lock washers are added to prevent accidental loosening. In some accessories, the washers are locked onto the nut to provide easy assembly.

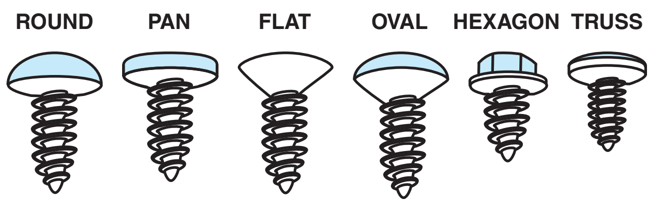


FIGURE 3-16 Sheet metal screws come with many head types.

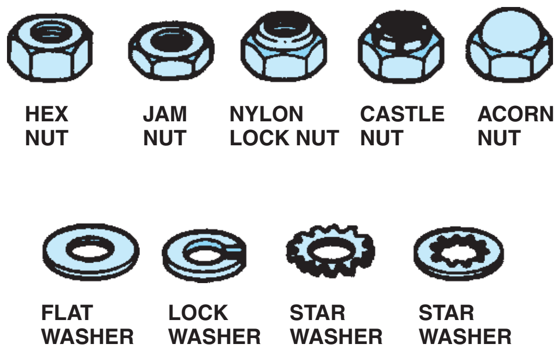


FIGURE 3-17 Various types of nuts (top) and washers (bottom) serve different purposes and all are used to secure bolts or cap screws.

SNAP RINGS AND CLIPS

Snap Rings

Snap rings are not threaded fasteners, but instead attach with a springlike action. Snap rings are constructed of spring steel and are used to attach parts without using a threaded fastener. There are several different types of snap rings and most require the use of a special pair of pliers, called snap-ring pliers, to release or install. The types of snap rings include:

- Expanding (internal)
- Contracting (external)
- E-clip
- C-clip
- Holeless snap rings in both expanding and contracting styles

See Figure 3-18.

Door Panel Clips

Interior door panels and other trim pieces are usually held in place with plastic clips. Due to the tapered and fluted shape, these clips are often called **Christmas tree clips.** See Figure 3-19.

A special tool is often used to remove interior door panels without causing any harm. See Figure 3-20.

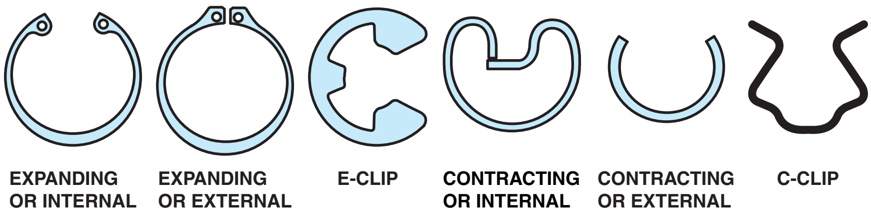


FIGURE 3-18 Some different types of snap rings. An internal snap ring fits inside of a housing or bore, into a groove. An external snap ring fits into a groove on the outside of a shaft or axle. An E-clip fits into a groove in the outside of a shaft. A C-clip shown is used to retain a window regulator handle on its shaft.

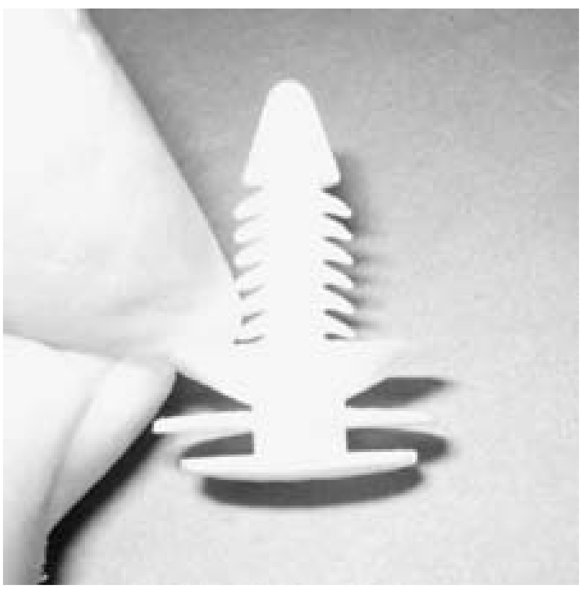


FIGURE 3-19 A typical door panel retaining clip.

FIGURE 3-20 Plastic or metal trim tools are available to help the technician remove interior door panels and other trim without causing harm.

CAUTION: Use extreme care when removing panels that use plastic or nylon clips. It is very easy to damage the door panel or clip during removal.

Pins

Cotter pins, also called a cotter key, are used to keep linkage or a threaded nut in place or to keep it retained. The word *cotter* is an Old English verb meaning "to close or fasten." There are many other types of pins used in vehicles, including clevis pins, roll pins, and hair pins. See Figure 3-21.

Pins are used to hold together shafts and linkages, such as shift linkages and cable linkages. The clevis pin is held in place with a cotter pin, while the taper and roll pins are driven in and held by friction. The hair pin snaps into a groove on a shaft.

Rivets

Rivets are used in many locations to retain components, such as window mechanisms, that do not require routine removal and/or do not have access to the back side for a nut. A drill is usually used to remove a rivet and a rivet gun is needed to properly install a rivet. Some rivets are plastic and are used to hold some body trim pieces. The most common type of rivet is called a **pop rivet** because as the rivet tool applies a force to the shaft of the pop rivet, it causes the rivet to expand and tighten the two pieces together. When the shaft of the rivet, which looks like a nail, is pulled to its maximum, the shaft breaks, causing a "pop" sound.

Rivets may be used in areas of the vehicle where a semi-permanent attachment is needed and in places where there is no access to the back side of the workpiece. They are installed using a rivet gun or by peening with a ball-peen hammer. See Figure 3-22.

Both types of blind rivets require the use of a rivet gun to install. The straight rivet is placed through the workpieces and then peened over with a ball-peen hammer or an air-operated tool. The plastic rivet is used with a rivet gun to install some body trim parts.

Locking Nuts

Some nuts, called jam nuts, are used to keep bolts and screws from loosening. **Jam nuts** screw on top of a regular nut and jam against the regular nut to prevent loosening. A jam nut is so called because of its intended use, rather than a special design. Some jam nuts are thinner than a standard nut. Jam nuts are also called **pal nuts.** See Figure 3-23.

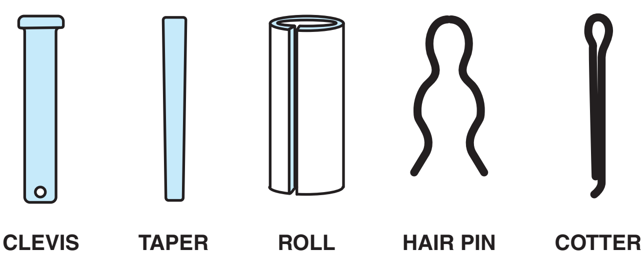


FIGURE 3-21 Pins come in various types.

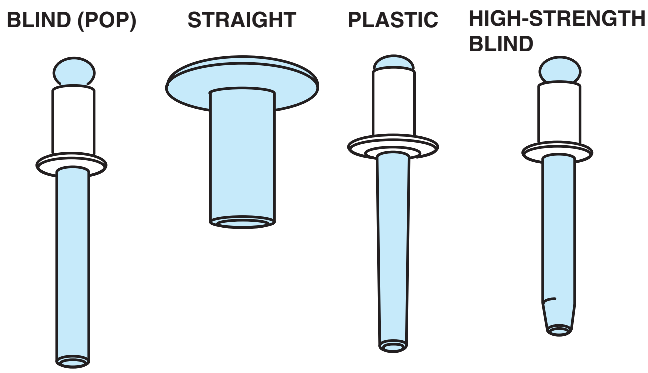


FIGURE 3-22 Various types of rivets.

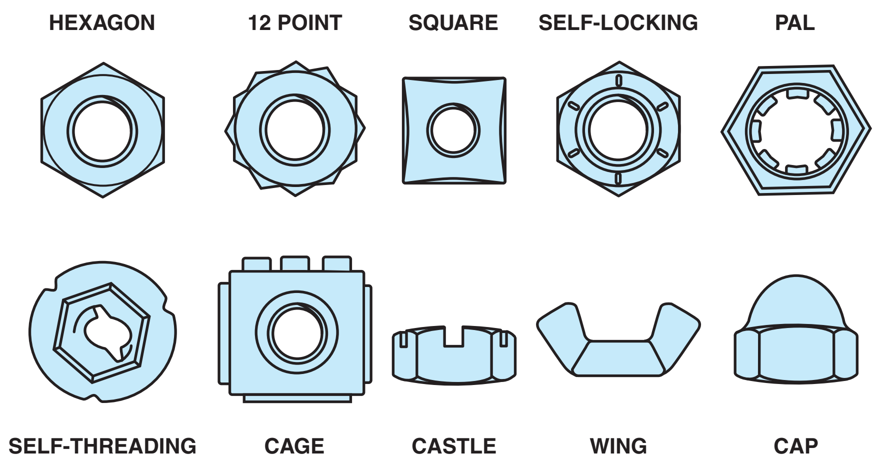


FIGURE 3-23 All of the nuts shown are used by themselves except for the pal nut, which is used to lock another nut to a threaded fastener so they will not be loosened by vibration.

There are also self-locking nuts of various types. Some have threads that are bent inward to grip the threads of the bolt. Some are oval-shaped at one end to fit tightly on a bolt. Fiber lock nuts have a fiber insert near the top of the nut or inside it; this type of nut is also made with a plastic or nylon insert. When the bolt turns through the nut, it cuts threads in the fiber or plastic. This puts a drag on the threads that prevents the bolt from loosening.

One of the oldest types of retaining nuts is the castle nut. It looks like a small castle, with slots for a cotter pin. A castellated nut is used on a bolt that has a hole for the cotter pin. See Figure 3-24.

Flat washers are placed underneath a nut to spread the load over a wide area and prevent gouging of the material. However, flat washers do not prevent a nut from loosening.

Lock washers are designed to prevent a nut from loosening. Spring-type lock washers resemble a loop out of a coil spring. As the nut or bolt is tightened, the washer is compressed. The tension of the compressed washer holds the fastener firmly against the threads to prevent it from loosening. Lock washers should not be used on soft metal such as aluminum. The sharp ends of the steel washers would gouge the aluminum badly, especially if they are removed and replaced often.

Another type of locking washer is the star washer. The teeth on a star washer can be external or internal, and they bite into the metal because they are twisted to expose their edges. Star washers are used often on sheet metal or body parts. They are seldom used on engines. The spring steel lock washer also uses the tension of the compressed washer to prevent the fastener from loosening. The waves in this washer make it look like a distorted flat washer.

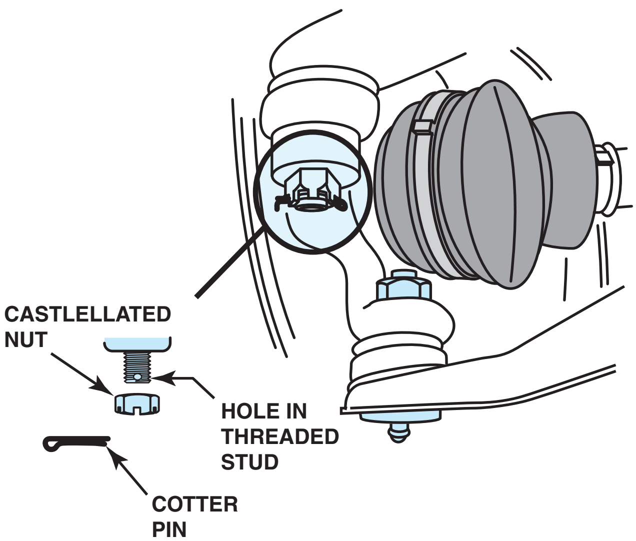


FIGURE 3-24 A castellated nut is locked in place with a cotter pin.

HOW TO AVOID BROKEN FASTENERS

Try not to break, strip, or round off fasteners in the first place. There are several ways that you can minimize the number of fasteners you damage. First, never force fasteners loose during disassembly. Taking a few precautionary steps will often prevent damage. If a bolt or nut will not come loose with normal force, try tightening it in slightly and then backing it out. Sometimes turning the fastener the other way will break corrosion loose, and the fastener will then come out easily. Another method that works well is to rest a punch on the head of a stubborn bolt and strike it a sharp blow with a hammer. Often this method will break the corrosion loose.

Left-Handed Threads

Although rare, left-handed fasteners are occasionally found on engine assemblies. These fasteners will loosen when you turn them clockwise, and tighten when you turn them counterclockwise. Left-handed fasteners are used to fasten parts to the ends of rotating assemblies that turn counterclockwise, such as crankshafts and camshafts. Most automobile engines do not use left-handed threads; however, they will be found on many older motorcycle engines. Some left-handed fasteners are marked for easy identification, others are not. Left-handed threads are also found inside some transaxles.

Penetrating Oil

Penetrating oil is a lightweight lubricant similar to kerosene, which soaks into small crevices in the threads, called **capillary action.** The chemical action of penetrating oils helps to break up and dissolve rust and corrosion. The oil forms a layer of boundary lubrication on the threads to reduce friction and make the fastener easier to turn.

For best results, allow the oil time to soak in before removing the nuts and bolts. To increase the effectiveness of penetrating oil, tap on the bolt head or nut with a hammer, or alternately work the fastener back and forth with a wrench. This movement weakens the bond of the corrosion and lets more of the lubricant work down into the threads.

Proper Tightening

Proper tightening of bolts and nuts is critical for proper clamping force, as well as to prevent breakage. All fasteners should be tightened using a torque wrench. A torque wrench allows the technician to exert a known amount of torque to the fasteners. However, rotating torque on a fastener does not mean clamping force because up to 80% of the torque used to rotate a bolt or nut is absorbed by friction by the threads. Therefore, for accurate tightening, two things must be performed:

- The threads must be clean and lubricated if service information specifies that they be lubricated.
- Always use a torque wrench to not only ensure proper clamping force, but also to ensure that all fasteners are tightened the same.

THREAD REPAIR INSERTS

Thread repair inserts are used to replace the original threaded hole when it has become damaged beyond use. The original threaded hole is enlarged and a threaded insert is installed to restore the threads to the original size.

Helical Inserts

A **helical insert** looks like a small, stainless-steel spring. See Figure 3-25.

To install a helical insert, a hole must be drilled to a specified oversize, and then it is tapped with a special tap designed for the thread inserts. The insert is then screwed into the hole. See Figure 3-26.

FIGURE 3-25 Helical inserts look like small, coiled springs. The outside is a thread to hold the coil in the hole, and the inside is threaded to fit the desired fastener.

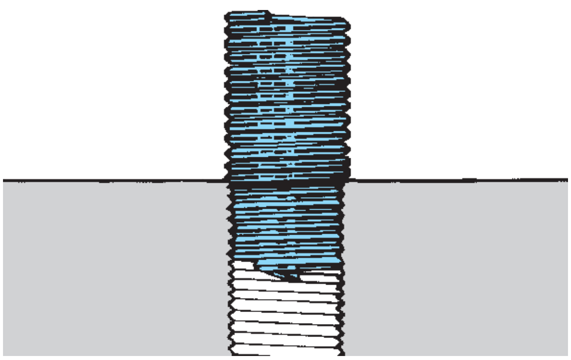


FIGURE 3-26 The insert provides new, stock-size threads inside an oversize hole so that the original fastener can be used.

The insert stays in the casting as a permanent repair and bolts can be removed and replaced without disturbing the insert. One advantage of a helical insert is that the original bolt can be used because the internal threads are the same size. When correctly installed, an insert is often stronger than the original threads, especially in aluminum castings. Some vehicle manufacturers such as BMW specify that the threads be renewed using an insert if the cylinder head has to be removed and reinstalled. Plus many high-performance engine rebuilders install inserts in blocks, manifolds, and cylinder heads as a precaution.

One of the best known of the helical fasteners is the **Helicoil®**, manufactured by Helicoil® Products. To install Helicoil® inserts, you will need to have a thread repair kit. The kit includes a drill bit, tap, installation mandrel, and inserts. Repair kits are available for a wide variety of diameters and pitch to fit both American Standard and metric threads. A simple kit contains the tooling for one specific thread size. Master kits that cover a range of sizes are also available. Installing an insert is similar to tapping new threads. A summary of the procedures includes:

1. Select the Helicoil® kit designed for the specific diameter and thread pitch of the hole to be repaired. See Figure 3-27.
2. Use the drill bit supplied with the kit. The drill size is also specified on the Helicoil® tap, to open up the hole to the necessary diameter and depth.
3. Tap the hole with the Helicoil® tap, being sure to lubricate the tap. Turn it in slowly and rotate counterclockwise occasionally to break the chip that is formed.
4. Thread an insert onto the installation mandrel until it seats firmly. Apply a light coating of the recommended thread locking compound to the external threads of the insert.
5. Use the mandrel to screw the insert into the tapped hole. Once started, spring tension prevents the insert from

FIGURE 3-27 Helicoil® kits, available in a wide variety of sizes, contain everything needed to repair a damaged hole back to its original size.

unscrewing. Stop when the top of the insert is 1/4 to 1/2 turn below the surface.

6. Remove the mandrel by unscrewing it from the insert, and then use a small punch or needle-nose pliers to break off the tang at the base of the insert. Never leave the tang in the bore. The finished thread is ready for use immediately.

Threaded Inserts

Threaded inserts are tubular, case-hardened, solid steel wall pieces that are threaded inside and outside. The inner thread of the insert is sized to fit the original fastener of the hole to be repaired. The outer thread design will vary. These may be self-tapping threads that are installed in a blank hole, or machine threads that require the hole to be tapped. Threaded inserts return a damaged hole to original size by replacing part of the surrounding casting so drilling is required. Most inserts fit into three categories:

- Self-tapping
- Solid-bushing
- Key-locking

Self-Tapping Inserts

The external threads of a self-tapping insert are designed to cut their own way into a casting. This eliminates the need of running a tap down the hole. To install a typical self-tapping insert, follow this procedure:

1. Drill out the damaged threads to open the hole to the proper size, using the specified size drill bit.
2. Select the proper insert and mandrel. As with Helicoils®, the drill bit, inserts, and mandrel are usually available as a kit.
3. Thread the insert onto the mandrel. Use a tap handle or wrench to drive the insert into the hole. Because the insert will cut its own path into the hole, it may require a considerable amount of force to drive the insert in.
4. Thread the insert in until the nut or flange at the bottom of the mandrel touches the surface of the workpiece. This is the depth stop to indicate the insert is seated.
5. Hold the nut or flange with a wrench, and turn the mandrel out of the insert. The threads are ready for immediate use.

Solid-Bushing Inserts

The external threads of solid-bushing inserts are ground to a specific thread pitch, so you will have to run a tap into the hole. See Figure 3-28.

Some inserts use a machine thread so a standard tap can be used; others have a unique thread and you have to use a special tap. The thread inserts come with a matching installation kit. See Figure 3-29.

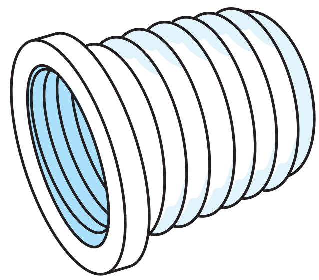


FIGURE 3-28 This solid-bushing insert is threaded on the outside, to grip the workpiece. The inner threads match the desired bolt size.

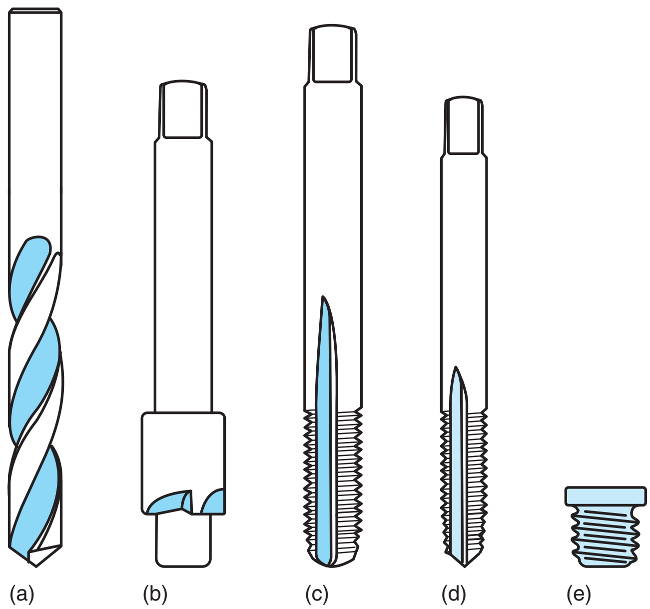


FIGURE 3-29 A Timesert® kit includes the drill (a), the recess cutter (b), a special tap (c), the installer (d), and the Timesert® threaded bushing (e).

To install threaded inserts, follow this procedure:

1. Drill out the damaged threads to open the hole to the proper size. The drill bit supplied with the kit must be the one used because it is properly sized to the tap. See Figure 3-30.
2. Cut the recess in the top of the hole with the special tool, then clean the hole with a brush or compressed air.
3. Use the previously detailed tapping procedures to thread the hole. See Figure 3-31. Be sure to tap deep enough; the top of the insert must be flush with the casting surface.
4. Thread the insert onto the installation driver, using the driver to screw the insert into the hole. Some inserts require that a thread-locking compound be applied; others go in dry.
5. Remove the installation driver, and the new threads are ready for service with the original fastener.

FIGURE 3-30 Drill out the damaged threads with the correct bit.

FIGURE 3-31 Use a special tap for the insert.

FIGURE 3-32 Put some thread-locking compound on the insert.

Key-Locking Inserts

Key-locking inserts are similar to solid-bushing inserts, but are held in place by small keys. After the insert has been installed, the keys are driven into place—perpendicular to the threads—to keep the insert from turning out. A typical installation procedure includes the following steps:

1. Drill out the damaged thread with the specified drill size.
2. Tap the drilled hole with the specified tap.
3. After putting thread-locking compound on the insert, use the mandrel to screw the insert into the tapped hole until it is slightly below the surface. See Figure 3-32. The keys act as a depth stop and prevent the insert from turning.
4. Drive the keys down using the driver supplied with the insert kit. Be sure the keys are flush with the top of the insert. See Figures 3-33 and 3-34.

FIGURE 3-33 Use the driver to drive the keys down flush with the surface of the workpiece.

FIGURE 3-34 The insert and insert locks should be below the surface of the workpiece.

SUMMARY

1. The most common type of fastener is a threaded one often referred to as a bolt. A nut or thread hole is used at the end of a bolt to fasten two parts together.
2. The size of threaded fasteners includes the diameter, length, and pitch of the threads, as well as the shape of the head of the bolt.
3. Metric bolts are labeled with an "M," and the diameter across the threads is in millimeters followed by the distance between the threads measured in millimeters, such as M8 × 1.5.
4. Graded bolts are hardened and are capable of providing more holding force than nongraded bolts.
5. Many nuts are capable of remaining attached to the bolt regardless of vibration. These types of nuts are often called prevailing torque nuts.
6. Other commonly used fasteners in the automotive service industry include sheet metal screws, snap rings and clips, door panel clips, cotter pins, and rivets.
7. Threads can be repaired using a Helicoil® or threaded insert.

REVIEW QUESTIONS

1. What is the difference between a bolt and a stud?
2. How is the size of a metric bolt expressed?
3. What is meant by the grade of a threaded fastener?
4. How do prevailing torque nuts work?
5. How are threaded inserts installed?

CHAPTER QUIZ

1. The thread pitch of a bolt is measured in what units?
   - **a.** Millimeters
   - **b.** Threads per inch
   - **c.** Fractions of an inch
   - **d.** Both a and b can be correct
2. Technician A says that the diameter of a bolt is the same as the wrench size used to remove or install the fastener. Technician B says that the length is measured from the top of the head of the bolt to the end of the bolt. Which technician is correct?
   - **a.** Technician A only
   - **b.** Technician B only
   - **c.** Both Technicians A and B
   - **d.** Neither Technician A nor B
3. The grade of a fastener, such as a bolt, is a measure of its _____.
   - **a.** Tensile strength
   - **b.** Hardness
   - **c.** Finish
   - **d.** Color
4. Which of the following is a metric bolt?
   - **a.** 5/16 – 18
   - **b.** 1/2 – 20
   - **c.** M12 × 1.5
   - **d.** 8 mm
5. A bolt that is threaded into a casting is often called a _____.
   - **a.** Stud
   - **b.** Cap screw
   - **c.** Block bolt
   - **d.** Crest bolt
6. The marks (lines) on the heads of bolts indicate _____.
   - **a.** Size
   - **b.** Grade
   - **c.** Tensile strength
   - **d.** Both b and c

7. A bolt that requires a 1/2-inch wrench to rotate is usually what size when measured across the threads?

a. 1/2 inch

b. 5/16 inch

c. 3/8 inch

d. 7/16 inch

8. A screw that can make its own threads when installed is called a _____ screw.

a. Sheet metal

b. Tapered

c. Self-tapping

d. Blunt-end

9. All of the following are types of clips *except* _____.

a. E-clip

b. Cotter

c. C-clip

d. Internal

10. What type of fastener is commonly used to retain interior door panels?

a. Christmas tree clips

b. E-clips

c. External clips

d. Internal clips