



9 Fasteners, Gaskets, Seals, and Sealants

After studying this chapter, you will be able to:

- Identify commonly used automotive fasteners.
- Select and use fasteners properly.
- Remove, select, and install gaskets, seals, and sealants correctly.
- Summarize safety rules relating to fasteners, gaskets, seals, and sealants.
- Correctly answer ASE certification test questions that require a knowledge of fasteners, gaskets, seals, and sealants.

Many different fasteners, gaskets, seals, and sealants are used by the automotive technician. It is almost impossible to connect any two parts of a vehicle without them.

The information presented in this chapter is important and will prepare you for many repair operations and other text chapters.

Fasteners

Fasteners are devices that hold the parts of a car together. Thousands of fasteners are used in vehicles. **Figure 9-1** shows some of the most common types.

Bolts and Nuts

A *bolt* is a metal rod with external threads on one end and a head on the other. When a high-quality bolt is threaded into a part other than a nut, it can also be called a *cap screw*. A *nut* has internal threads and usually a

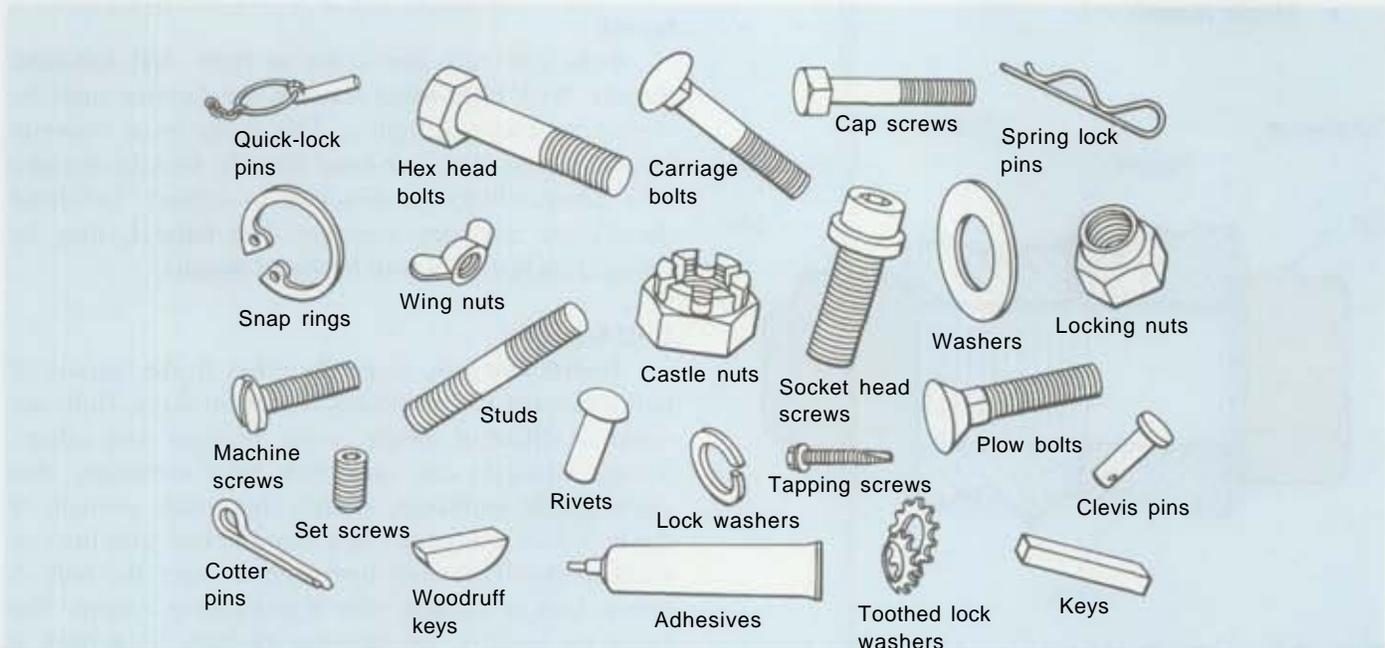


Figure 9-1. A fastener is any device or adhesive used to hold parts together. Study these basic automotive fasteners. (Deere & Co.)

six-sided outer shape. When a nut is screwed onto a bolt, a powerful clamping force is produced, **Figure 9-2**.

In automotive technology, bolts and nuts are named after the parts they hold. For instance, the bolts holding the cylinder head on the block are called cylinder head bolts. The bolts on an engine connecting rod are called connecting rod bolts.

Bolt and Nut Terminology

Bolts and nuts come in various sizes, grades (strengths), and thread types. It is important to be familiar with these differences. The most important bolt dimensions are:

- **Bolt size**—the measurement of the outside diameter of the bolt threads. See **Figure 9-3**.
- **Bolt head size**—the distance across the flats or outer sides of the bolt head. It is the same as the wrench size.
- **Bolt length**—measured from the bottom of the bolt head to the threaded end of the bolt.
- **Thread pitch**—the same as thread coarseness. With U.S. conventional system fasteners, thread pitch is the number of threads per inch. With metric fasteners, it is the distance between each thread in millimeters. Refer again to **Figure 9-3**.

Thread Types

There are three basic types of threads used on fasteners:

- **Coarse threads** (UNC-Unified National Coarse).
- **Fine threads** (UNF-Unified National Fine).
- **Metric threads** (SI).

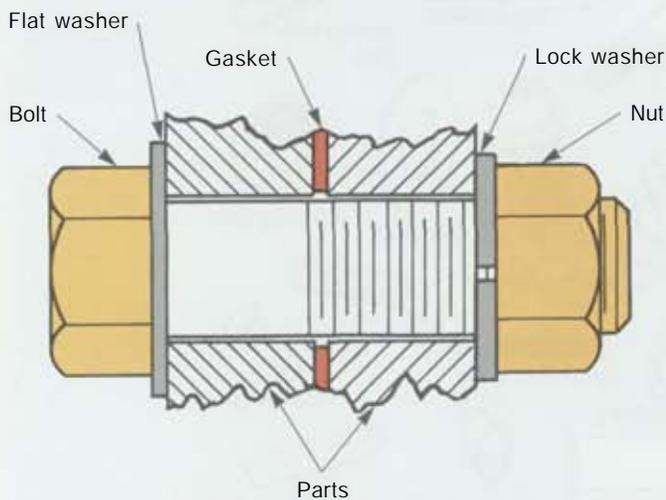
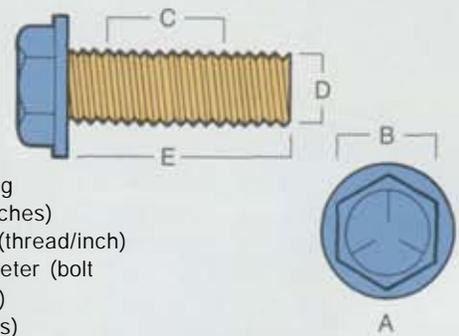


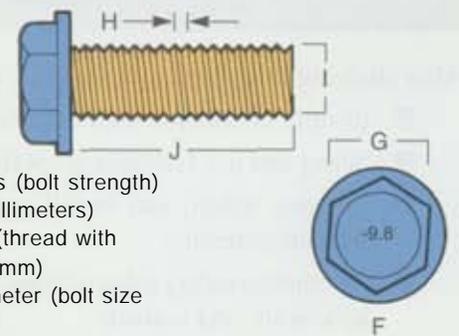
Figure 9-2. A bolt and nut exert a powerful clamping force on parts. Notice the washers and gasket used.

Customary System (1/2-13 x 1 bolt)



- A — Grade marking
- B — Head size (inches)
- C — Thread pitch (thread/inch)
- D — Nominal diameter (bolt size in inches)
- E — Length (inches)

Metric System (M12-1.75 x 25 bolt)



- F — Property class (bolt strength)
- G — Head size (millimeters)
- H — Thread pitch (thread with crest to crest/mm)
- I — Nominal diameter (bolt size in millimeters)
- J — Length (millimeters)

Figure 9-3. The naming systems for both customary and metric bolts. (Ford)

Never interchange thread types or thread damage will result. As shown in **Figure 9-4**, metric threads *look* like customary threads. If a metric bolt is forced into a hole with fine threads, either the bolt or part threads will be ruined.

Bolts and nuts also come in right- and left-hand threads. With **right-hand threads**, the fastener must be turned clockwise to tighten. This is the most common style of thread. With **left-hand threads**, turn the fastener in a counterclockwise direction to tighten. Left-hand threads are not very common. The letter L may be stamped on fasteners with left-hand threads.

Bolt Grade

Tensile strength, or **grade**, refers to the amount of pull a fastener can withstand before breaking. Bolts are made of different metals, some stronger than others. Tensile strengths can vary. **Bolt head markings**, also called **grade markings**, specify the tensile strength of the bolt. U.S. customary bolts are marked with lines or slash marks. The more lines, the stronger the bolt. A metric bolt is marked with a numbering system. The larger the number, the stronger the bolt. Look back at **Figure 9-3**.

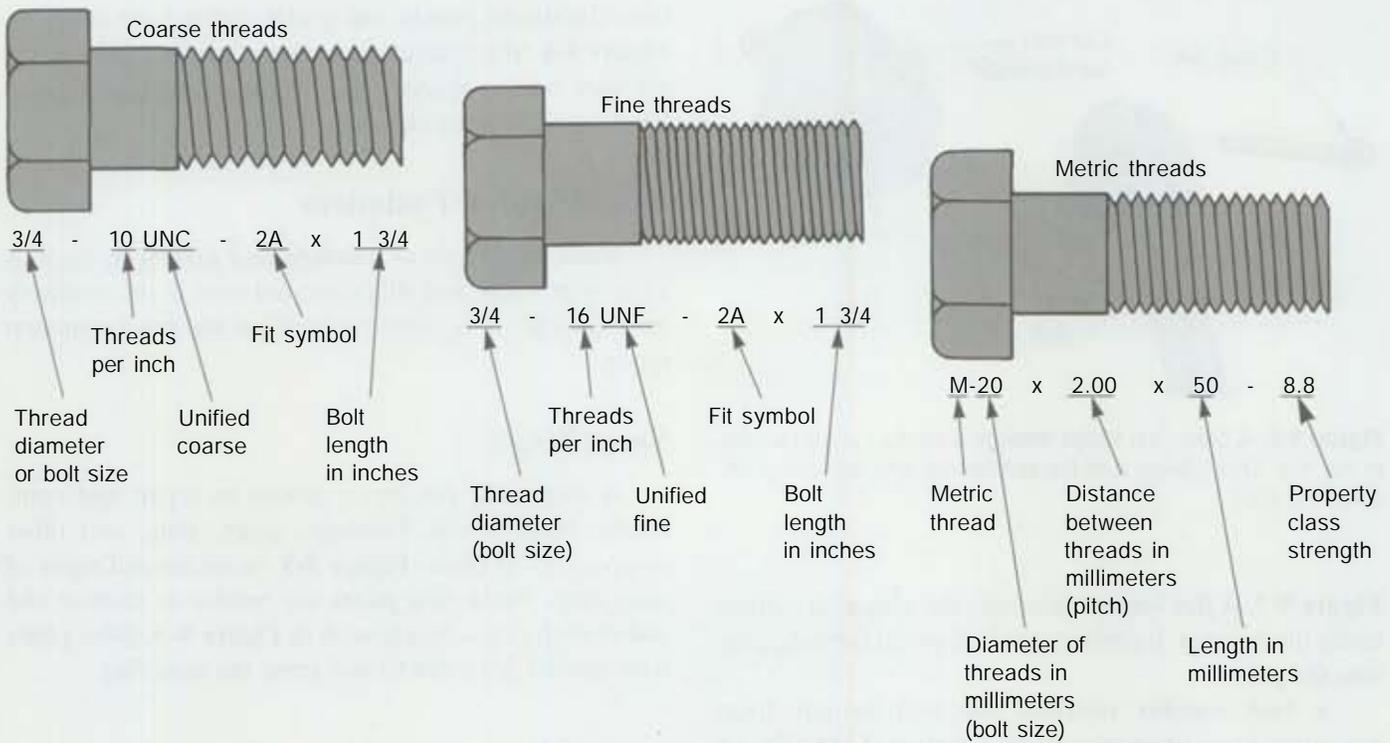


Figure 9-4. The bolt designation number gives information about the bolt. This number is commonly used when purchasing new bolts.



Warning!

Never replace a high-grade bolt with a lower grade bolt. The weaker bolt could easily snap, possibly causing part failure and a dangerous situation.

Bolt Description

A *bolt description* is a series of numbers and letters that describe the bolt, as shown in **Figure 9-4**. When purchasing new bolts, the bolt description information is needed.

Nut Types

Many types of nuts are used in a vehicle. The most common ones are pictured in **Figure 9-5**. Study their names closely. A slotted nut, or castle nut, uses a safety device called a *cotter pin*. The cotter pin fits through a hole in the bolt or part. This keeps the nut from turning and possibly coming off. Look at **Figure 9-6**.

Washers

Washers are used under bolt heads and nuts. The two basic types are flat washers and lock washers. Look at

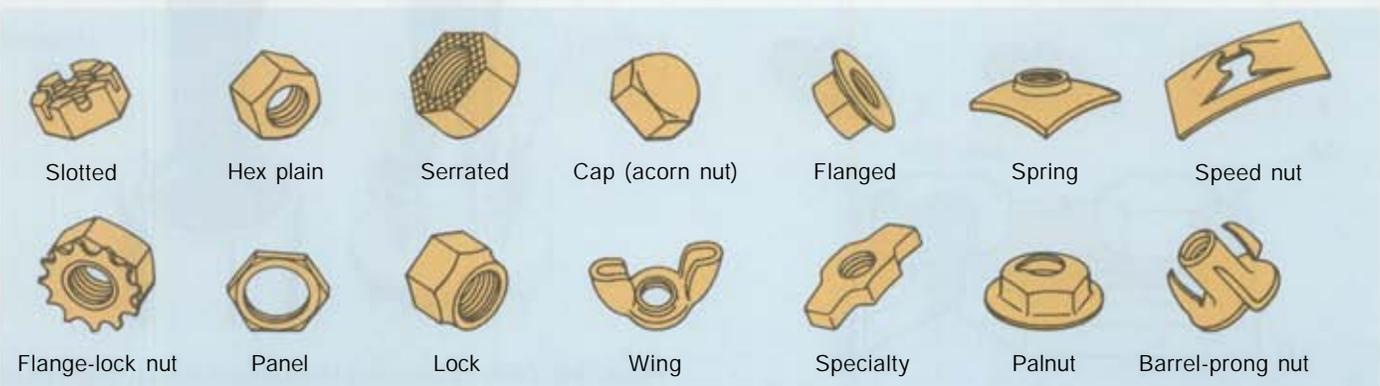


Figure 9-5. Common types of nuts used in vehicles. (Deere & Co.)

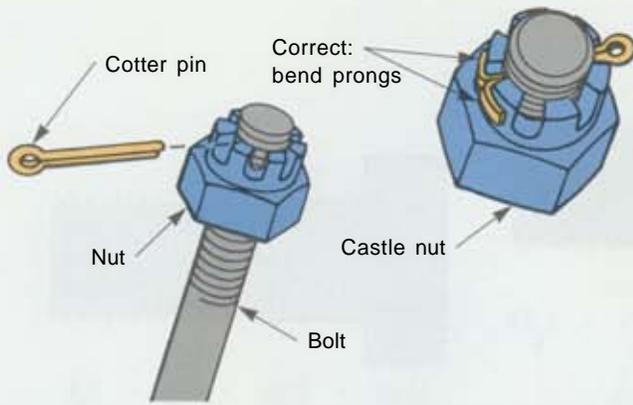


Figure 9-6. A cotter pin slides through a castle nut and a hole in the bolt. This makes sure the nut cannot turn and come off. (Deere & Co.)

Figure 9-7. A *flat washer* increases the clamping surface under the fastener. It prevents the bolt or nut from digging into the part.

A *lock washer* prevents the bolt or nut from becoming loose under stress and vibration. *Lock tabs*, or *lock plates*, perform the functions of both flat washers and lock washers. They increase clamping surface area and secure the fastener.

Machine Screws

Machine screws are similar to bolts, but they normally have screw-type heads. They are threaded along their full length and are relatively small. Refer back to **Figure 9-1**. Machine screws are used to secure parts when clamping loads are light. They come in various head shapes.

Sheet Metal Screws

Sheet metal screws, or *tapping screws*, are commonly used on plastic and sheet metal parts, such as body

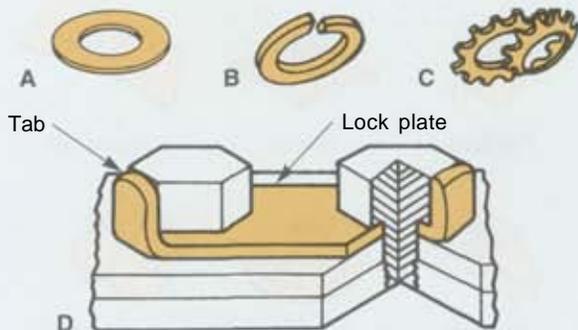


Figure 9-7. Basic washer types. A—Plain flat washer. B—Split lock washer. C—Toothed lock washer. D—Lock plate.

trim, dashboard panels, and grilles. Several are shown in **Figure 9-8**. Sheet metal screws have tapering threads that are very widely spaced. They come in a wide range of head configurations and sizes.

Nonthreaded Fasteners

Numerous types of *nonthreaded fasteners*, such as snap rings, clips, and adhesives, are used in the assembly of a vehicle. It is essential to learn the most common types.

Snap Rings

A *snap ring* fits into a groove in a part and commonly holds shafts, bearings, gears, pins, and other components in place. **Figure 9-9** shows several types of snap rings. *Snap ring pliers* are needed to remove and install snap rings. As pictured in **Figure 9-9**, these pliers have special jaws that fit and grasp the snap ring.

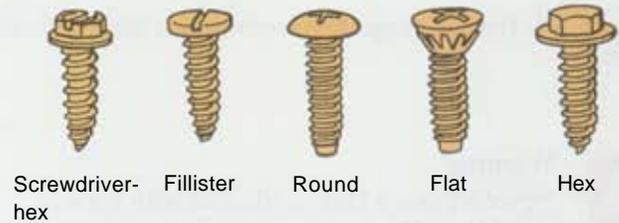


Figure 9-8. Basic types of tapping screws. (Deere & Co.)

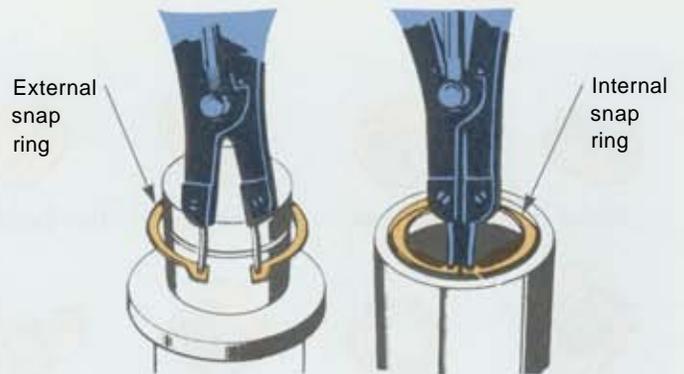
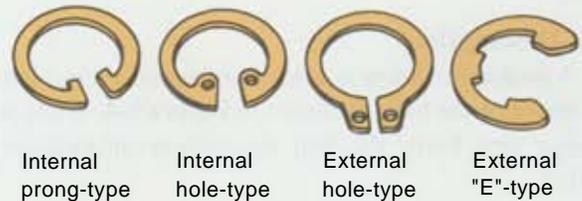


Figure 9-9. Different snap ring types. External snap rings fit into a groove on a shaft. Internal snap rings fit into a groove inside a hole.

**Warning!**

Wear eye protection when working with a snap ring. When flexed, the ring can shoot into your face with considerable force.

Keys and Set Screws

A metal **key** fits into a **keyseat**, or slot, cut into a shaft and a **keyway** cut into the mating part, such as a gear, pulley, or collar. The key prevents the part from turning on its shaft. Refer to **Figure 9-10A**. **Set screws** are normally used to lock a part onto a shaft. See **Figure 9-10B**. They can be used with or without a key and keyway. A set screw is a headless fastener normally designed to accept a hex (Allen) wrench or screwdriver.

Splines

Splines are a series of slots cut into a shaft and a mating part. See **Figure 9-11**. Splines have an advantage over keys in that they allow the gear or collar to slide on

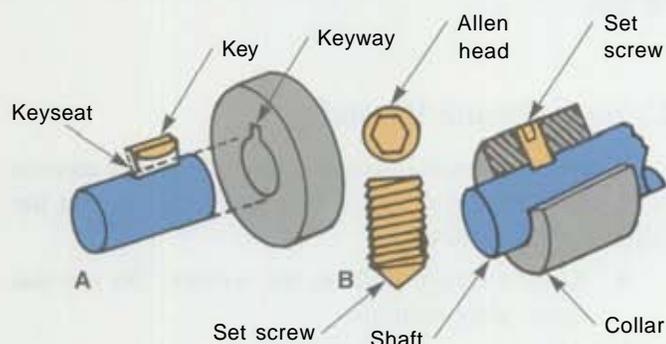


Figure 9-10. A—A key fits into the keyseat, or slot, in a shaft and keyway in the mating part. This keeps the part from turning on the shaft. B—A set screw also locks a part to a shaft, but with less strength. (Florida Dept. of Voc. Ed.)

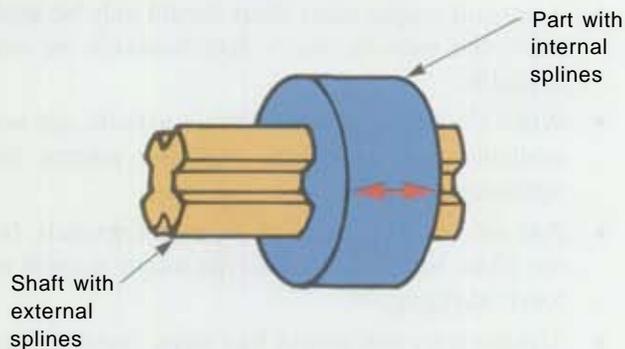


Figure 9-11. Splines allow a part to slide on a shaft, but not turn on the shaft.

the shaft but still *not* rotate. This sliding locking action is commonly used in manual transmissions, clutches, and drive shaft yokes.

Adhesives

Adhesives are special glues widely used in vehicles. They hold body moldings, rubber weather stripping, and body emblems. Some adhesives are designed to stay soft and pliable; others dry hard. Some take hours to dry, while others dry in seconds. Observe all directions and safety precautions when using adhesives.

Torquing Bolts and Nuts

It is very important that bolts and nuts be tightened properly. This is called **torquing**. If overtightened, a bolt will stretch and possibly break. The threads could also fail. If undertightened, a bolt may loosen and fall out. Part movement could also shear the fastener or break a gasket, causing leakage.

Torque specifications are tightening values given by the auto manufacturer. Torque specifications are normally given for all precision assemblies, such as engines, transmissions, and differentials. **Figure 9-12** shows a general torque specification chart that gives average bolt tightening values. It can be used when factory specifications are not available. Notice how bolt torque increases with bolt size and grade.

Service manuals sometimes recommend *new* bolts because of a torque-to-yield process. Discard the old bolts in such cases. **Torque-to-yield** is a bolt tightening method that requires the bolt to be tightened to a specific torque and *then* turned an additional number of degrees. After the fastener is torqued to specification, a degree wheel adapter is placed between the torque wrench and socket. The fastener is then turned until the degree wheel reads as specified by the manufacturer. This stretches the bolt to its correct yield point and preloads the fastener for better clamping under varying conditions.

Torque stretch is determined by measuring bolt length change while torquing the bolt. For example, when building a racing engine, you can "mike" connecting rod bolts to measure the length before and after tightening. Too much stretch indicates bolt weakness. Not enough stretch may indicate thread problems affecting torque.

Bolt Tightening Sequence

A **bolt tightening sequence**, or pattern, is used to make sure that parts are fastened evenly. An incorrect sequence or uneven tightening can cause breaks,

Caution

The torque specifications listed below are approximate guidelines only and may vary depending on conditions when used such as amount and type of lubricant, type of plating on bolt, etc.

SAE Standard / Foot-pounds

Grade of bolt	SAE 1 & 2	SAE 5	SAE 6	SAE 8		
Min. tensile strength	64,000 P.S.I.	105,000 P.S.I.	133,000 P.S.I.	150,000 P.S.I.		
Markings on head					Size of socket or wrench opening	
U.S. standard					U.S. regular	
Bolt diameter	Foot-pounds				Bolt head	Nut
1/4	5	7	10	10.5	3/8	7/16
5/16	9	14	19	22	1/2	9/16
3/8	15	25	34	37	9/16	5/8
7/16	24	40	55	60	5/8	3/4
1/2	37	60	85	92	3/4	13/16
9/16	53	88	120	132	7/8	7/8
5/8	74	120	167	180	15/16	1.
3/4	120	200	280	296	1-1/8	1-1/8

Metric Standard

Grade of bolt	5D	8G	10K	12K		
Min. tensile strength	71,160 P.S.I.	113,800 P.S.I.	142,200 P.S.I.	170,679 P.S.I.		
Grade markings on head					Size of socket or wrench opening	
Metric					Metric	
Bolt dia.	U.S. dec equiv.	Foot-pounds			Bolt head	
6mm	.2362	5	6	8	10	10mm
8mm	.3150	10	16	22	27	14mm
10mm	.3937	19	31	40	49	17mm
12mm	.4720	34	54	70	86	19mm
14mm	.5512	55	89	117	137	22mm
16mm	.6299	83	132	175	208	24mm
18mm	.709	111	182	236	283	27mm
22mm	.8661	182	284	394	464	32mm

Figure 9-12. A general bolt torque chart. Note how torque values increase as the bolt size and grade increase.

warping, gasket leaks, and other problems. Generally, a group of fasteners on a part are tightened in a **crisscross pattern**. This creates an even, gradual clamping force along the entire mating surface of the parts. A service manual will illustrate the proper sequence when a torque pattern is critical. Refer to **Figure 9-13**.

Tech Tip!

When tightening engine covers and covers on other large assemblies, remember that "less is usually better." The most common mistake is to overtighten covers and damage or split the gasket or seal. It usually takes much less torque than you may think to make a new gasket seal properly.

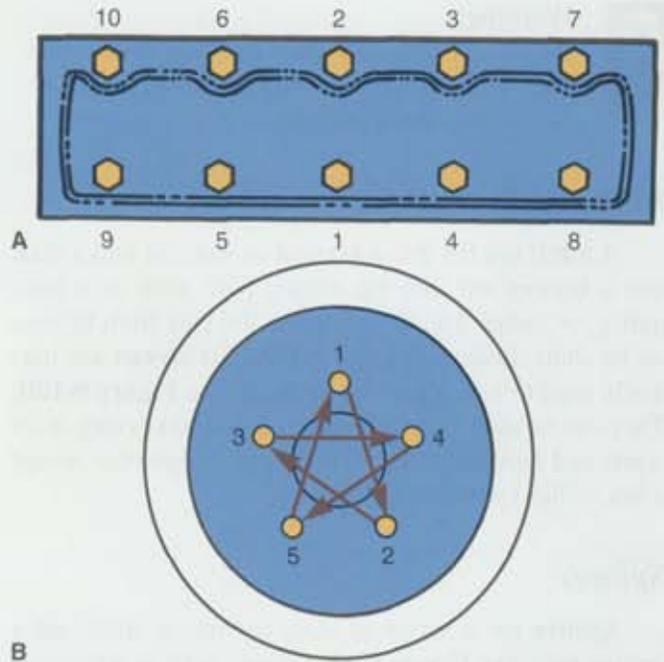


Figure 9-13. A crisscross pattern is recommended when multiple fasteners hold a part. A—A service manual pattern for engine cylinder head. B—A service manual pattern for wheel lug nuts.

Using a Torque Wrench

A **torque wrench** is used to apply the proper amount of torque when tightening a threaded fastener. Use the following basic rules.

- Keep a steady pull on the wrench. Do *not* use short, jerky motions.
- Clean fastener threads.
- When possible, avoid using swivel joints. They can affect torque wrench accuracy.
- When reading a torque wrench, look straight down at the scale. Viewing the scale from an angle can give a false reading.
- A general torque value chart should only be used when the manufacturer's specifications are *not* available.
- When the manufacturer's torque patterns are not available, use a general crisscross pattern for tightening fasteners.
- Pull only on the handle of the torque wrench. Do *not* allow beam of a beam-type torque wrench to touch anything.
- Tighten bolts and nuts in four steps: one-half recommended torque, three-fourths torque, full torque, and full torque a second time.

- Retorque when required. On some assemblies, such as cylinder heads, intake manifolds, and exhaust manifolds, bolts may have to be retightened after operation and heating. This is because expansion and contraction due to temperature changes can cause the fasteners to loosen.



Caution!

Many late-model parts are made of plastic or composite materials. These parts are more delicate than metal parts and are easily damaged from overtorquing.

Thread Repairs

Threaded holes in parts can become damaged, requiring repairs. A technician must be capable of repairing damaged threads quickly and properly.

Minor Thread Repairs

Minor thread damage includes nicks, partial flattening, and other less serious problems with the fastener or part. Minor thread damage can usually be repaired with a thread chaser, **Figure 9-14**. A **thread chaser** "cleans up" slightly damaged internal and external threads. The chaser is run through or over the threads to restore them.

Major Thread Repairs

Major thread damage generally includes badly smashed or stripped threads. Sometimes, major thread damage is repaired with either a tap or die. **Figure 9-15**. A **tap** is a threaded tool for cutting internal threads in holes. Various tap shapes are available. Some are for starting the threads. Others are for cutting the threads all the way to the bottom of a hole. A **die** cuts external



Figure 9-14. Thread chasers can be used to clean up slightly damaged internal or external threads. (Snap-on Tools)

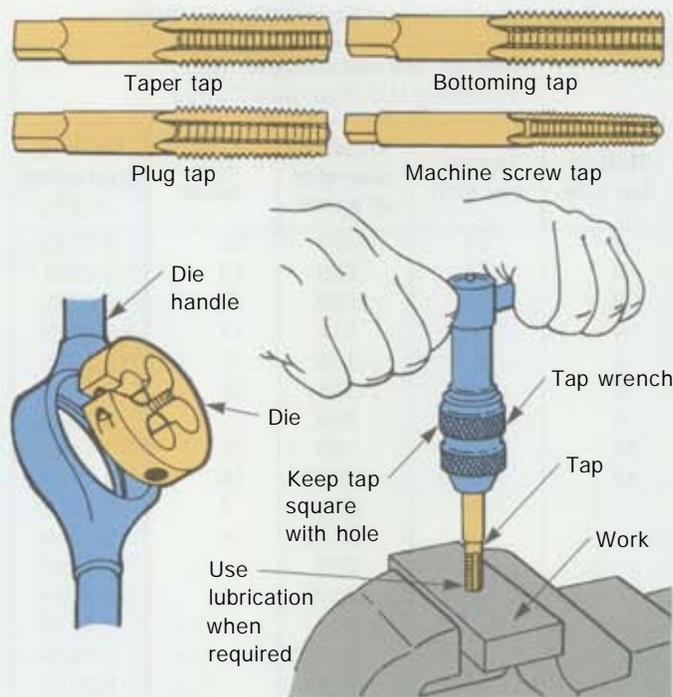


Figure 9-15. A tap or die fits into a special handle. The handle is held square as the bit is turned into the work. Back the handle off to clean metal out of the threads. A taper tap is used to start threads in a hole. Then, a plug tap and a bottoming tap are used to cut the threads to the bottom of the hole.

threads. It can be used to cut threads on metal rods, bolts, shafts, and pins.

Taps and dies are mounted in special handles called **tap handles** or **die handles**. See **Figure 9-15**. The tool must be held squarely while being rotated into the work. As soon as the tap or die begins to bind, back the tool off about a quarter turn. This clears away the metal cuttings. Then, the cut can be made another half turn deeper. Keep rotating a half turn in and a quarter turn out until the cut is complete.

Tap and Die Rules

- Never force a tap handle or the tool may break. Back off the handle to clean out metal shavings.
- Keep the tap and die well oiled to ease cutting.
- Always use the right size tap in the correct size hole.
- Use coarse threads when threading or tapping into soft metal, like aluminum. Coarse threads hold better than fine threads.

Tapping Oversize

When a thread chaser or tap cannot be used to clean up damaged threads, the hole can be drilled and tapped

American National Screw Thread Pitches

Coarse Standard Thread (N.C.) Formerly U.S. Standard Thread				
Bolt or tap size	Threads per inch	Outside diameter at screw	Drill sizes	Decimal equivalent of drill
1	64	.073	53	0.0595
2	56	.086	50	0.0700
3	48	.099	47	0.0785
4	40	.112	43	0.0890
5	40	.125	38	0.1015
6	32	.138	36	0.1065
8	32	.164	29	0.1360
10	24	.190	25	0.1495
12	24	.216	16	0.1770
1/4	20	.250	7	0.2010
5/16	18	.3125	F	0.2570
	16	.375	5/16	0.3125
7/16	14	.4375	U	0.3680
1/2	13	.500	27/64	0.4219
9/16	12	.5625	31/64	0.4843
5/8	11	.625	17/32	0.5312
	10	.750	21/32	0.6562
	9	.875	49/64	0.7656
1	8	1.000		0.875
1 1/8	7	1.125	63/64	0.9843
1 1/4	7	1.250	1 7/64	1.1093
Fine Standard Thread (N.F.) Formerly S.A.E. Thread				
Bolt or tap size	Threads per inch	Outside diameter at screw	Drill sizes	Decimal equivalent of drill
0	80	.060		0.0469
1	72	.073	53	0.0595
2	64	.086	50	0.0700
3	56	.099	45	0.0820
4	48	.112	42	0.0935
5	44	.125	37	0.1040
6	40	.138	33	0.1130
8	36	.164	29	0.1360
10	32	.190	21	0.1590
12	28	.216	14	0.1820
	28	.250	3	0.2130
5/16	24	.3125	I	0.2720
	24	.375	Q	0.3320
7/16	20	.4375	25/64	0.3906
1/2	20	.500	29/64	0.4531
9/16	18	.5625	0.5062	0.5062
	18	.625	0.5687	0.5687
	16	.750	11/16	0.6875
	14	.875	0.8020	0.8020
1	14	1.000	0.9274	0.9274
1 1/8	12	1.125	1 3/64	1.0468
1 1/4	12	1.250	1 11/64	1.1718

Figure 9-16. A tap drill chart tells you what size hole should be drilled for different taps. The drill bit size is in two right columns. The tap or bolt size is in left column.

oversize. A *drill and tap size chart* is used to determine right size drill bit and tap, **Figure 9-16**. For example, a 27/64" drilled hole should have a 1/2" coarse tap used in it. First, drill the hole one diameter or size larger than the original hole. Then, cut new threads in the drilled hole with the correct size tap. A larger bolt can then be installed in the threaded hole.

Thread Repair Insert

A *thread repair insert* should be used when the use of an oversize hole and fastener is not acceptable. An insert takes the place of damaged internal threads and allows the use of the original-size bolt.

To use a thread repair insert, drill the hole oversize as described in the insert manufacturer's instructions. Then, tap the hole. Finally, screw the insert into the threaded hole. The inside of the insert contains threads that are the same size as those in the original hole. See **Figure 9-17**.

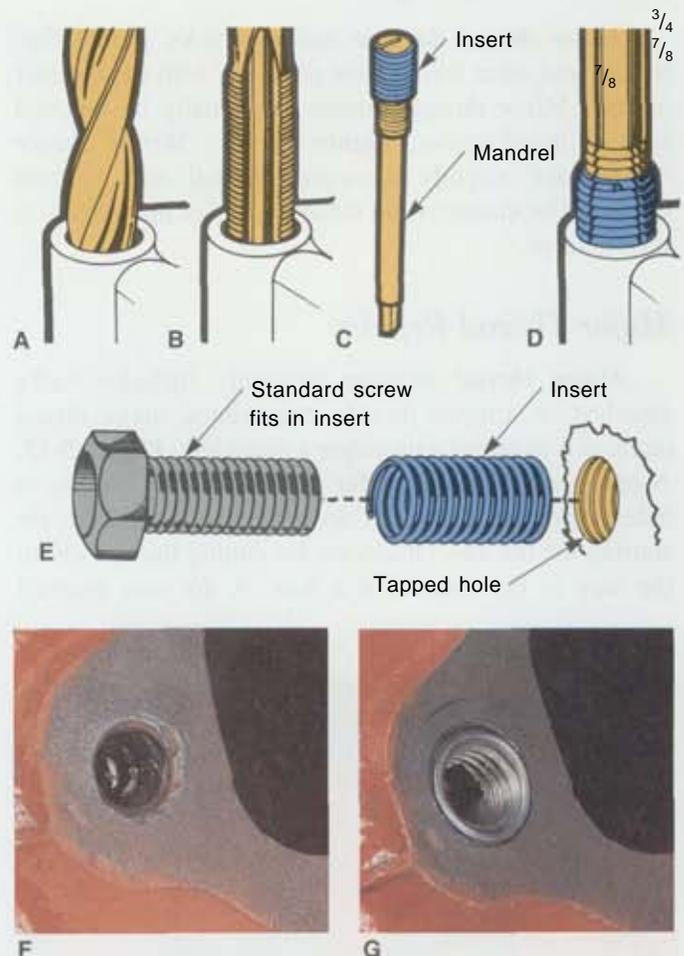


Figure 9-17. Using an insert to repair stripped threads. A—First, drill the hole oversize. B—Next, tap the hole oversize. C—Mount the insert on a mandrel. D—Thread the insert into the hole. E—The insert allows the use of the original-size bolt. F—Damaged threads before a repair. G—An installed insert. (Buick, Chrysler, and The Eastwood Company)

Removing Damaged Fasteners

An automotive technician must be able to remove broken bolts, screws, and studs, as well as fasteners with rusted or rounded-off heads. Certain tools and methods are needed for removing problem fasteners. Refer to **Figure 9-18**.

- **Locking pliers** can sometimes be used to remove fasteners with heads that are badly rusted and rounded off. Lock the pliers tightly on the bolt or nut for removal.
- A **stud puller**, or **stud wrench**, can remove studs and bolts broken off above the surface of the part. This tool is also used to install studs. Position the stud puller so that it will not clamp onto and damage the threads.
- In some cases, broken fasteners are too short to grasp with any tool. Either cut a slot in the fastener with a hacksaw or weld on another bolt

head. Then use a screwdriver or wrench to unscrew the broken bolt.

- When the fastener is broken *flush* with the part surface, a **hammer** and **punch** can sometimes be used to remove it. Angle the punch so that blows from the hammer can drive out the broken fastener.
- A **screw extractor**, or "easy-out," can also be used to remove bolts that are broken flush or below the part surface. See **Figure 9-19**. To use a screw extractor, drill a hole in the center of the broken fastener. Then, lightly tap the extractor into the hole using a hammer. Finally, unscrew the broken bolt by turning the extractor with a wrench.
- On some broken bolts, you may have to drill a hole almost as large as the inside diameter of the threads. Then, use a tap or punch to remove the thread shell. The thread shell is the thin layer of threads remaining in the hole.

Caution!

Be extremely careful not to break a tap or a screw extractor. They are hardened steel and cannot be easily drilled out of a hole. You will compound your problems if you over twist and break one of these tools.

Tech Tip!

If you accidentally break a tap off in a part, screw the broken piece back into the hole until the flutes, or grooves, in the two pieces of the tap align. Next, insert nails or pieces of cotter pin into the grooves and down through both pieces of the tap. You should then be able to unscrew both pieces of the broken tap from the hole. See **Figure 9-20**.

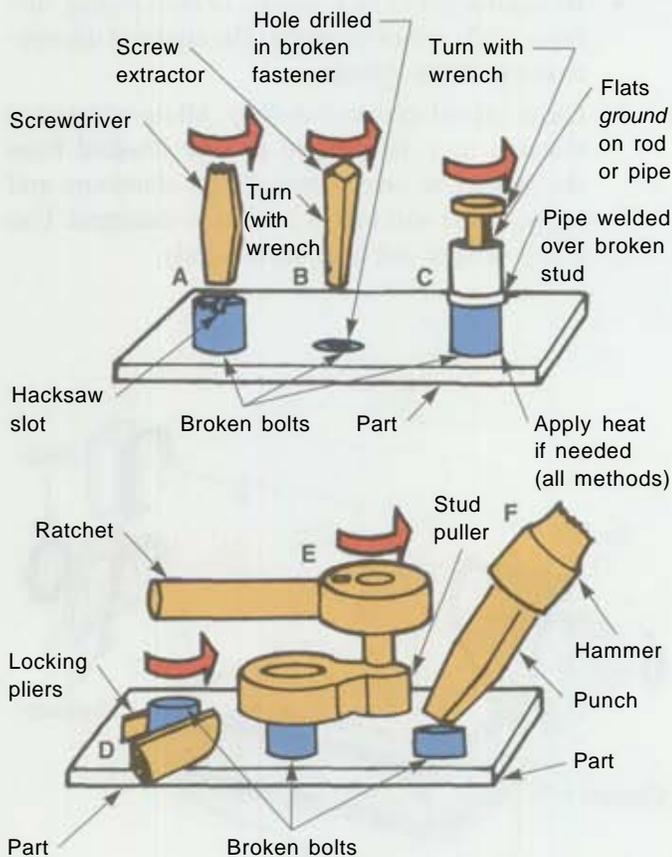


Figure 9-18. Various ways to remove broken bolts. A—Hacksaw a slot and use a screwdriver. B—Drill a hole and use a screw extractor. C—Weld a pipe or shaft onto the bolt and use a wrench. D—Use locking pliers. E—Use a stud extractor and ratchet. F—Use a hammer and punch.

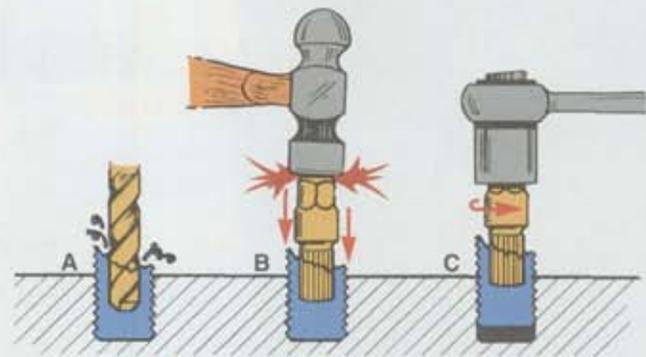


Figure 9-19. Using a screw extractor. A—First, drill a hole in the center of the broken bolt. B—Next, tap the extractor into the hole. C—Finally, unscrew the extractor and the broken bolt with a wrench. (Lisle Tools)

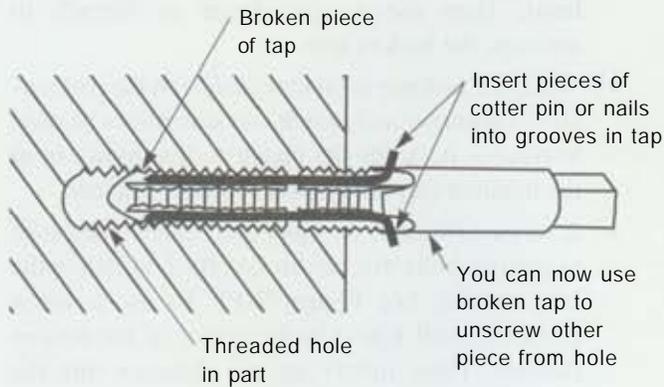


Figure 9-20. If you accidentally break a tap, try unscrewing it using nails or cotter pins to hold both pieces of the broken tap together.

Rust Penetrant

Rust penetrant is a chemical that dissolves rust or corrosion. It is often applied to rusted fasteners to aid in their removal. The penetrant is sprayed or squirted on the rusty fastener and allowed to soak for a few minutes. This often helps the fastener free up without breakage. See **Figure 9-21**.

Gaskets and Seals

Gaskets and seals are used between parts to prevent leakage of engine oil, coolant, transmission oil, and other



Figure 9-21. On rusted threads, such as those on this brake bleed screw, use rust penetrant to help ease turning and prevent breakage of the screw. (Fel-Pro Gaskets)

fluids. It is important to understand a few principles about gaskets and seals. If gaskets or seals are serviced improperly, customer complaints and serious mechanical failures can result.

Gaskets

A **gasket** is a soft, flexible material placed between parts to prevent leakage. See **Figure 9-22**. It can be made of fiber materials, rubber, neoprene (synthetic rubber), cork, treated paper, or thin steel.

When the parts are fastened tightly together, the gasket is compressed and deformed. This forces the gasket material to fill small gaps, scratches, dents, or other imperfections in the mating surfaces. A leakproof seal is produced.

Gasket Rules

When working with gaskets, remember the following:

- Inspect for leaks before disassembly. If the two parts are leaking, the part surfaces should be inspected closely for problems.
- Be careful not to nick, gouge, or dent mating surfaces while removing parts. The slightest unevenness can cause leakage.
- Clean off old gaskets carefully. All the old gasket material must be scraped or wire brushed from the parts. Use care, especially on aluminum and brass. These soft metals are easily damaged. Use a dull scraper and wire brush lightly.

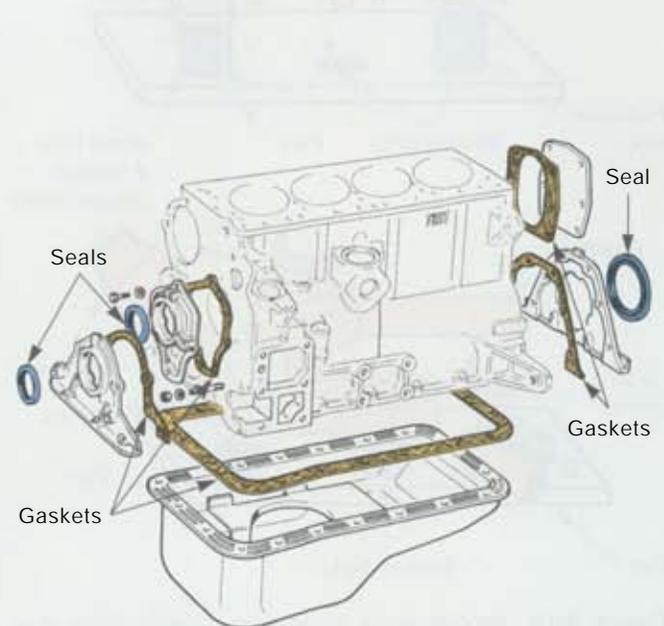


Figure 9-22. Gaskets prevent leakage between stationary parts. Seals prevent leakage between a moving part and a stationary part. (Fiat)

- Wash and dry parts thoroughly using solvent. Blow them dry with compressed air. Then, wipe mating surfaces with a clean shop towel.
- Compare the new gasket to the shape of the mating surface. All holes and sealing surfaces must match perfectly.
- Use sealer if needed! Some gaskets require sealer. Sealer is normally used where two different gaskets come together. It will prevent leakage where gaskets overlap. Check a service manual for details. However, use sealer sparingly. Too much sealer could clog internal passages in the assembly.
- After fitting the gasket and parts in place, screw all bolts in by hand. This will ensure proper part alignment and threading of fasteners. It also lets you check bolt lengths.
- Tighten fasteners in steps! When more than one bolt is used to hold a part, tighten each bolt a little at a time. First, tighten all the bolts to about half of their torque specification. Next, tighten them to three-fourths torque. Then, tighten the fasteners to full torque. As a final precaution, *retorque* each fastener.
- Use a crisscross tightening pattern. Either a basic crisscross or factory-recommended torque pattern should be used when tightening parts. This will ensure even gasket compression and proper sealing.
- Do not overtighten fasteners. It is very easy to tighten the bolts enough to dent sheet metal parts and smash or break the gaskets. Apply only the specified torque.

Tech Tip!

The trend in gasket design is to use large, synthetic-rubber O-ring-type seals instead of fiber or treated paper gaskets. These new seals can be round, D-shaped, or odd-shaped to help seal with the cover design. Follow the manufacturer's instructions when installing these types of gaskets or seals.

Sealers

A gasket is commonly coated with a *sealer* to help prevent leakage and to hold the gasket in place during assembly, **Figure 9-23**. There are numerous kinds of sealers. They have different properties and are designed for different uses, **Figure 9-24**. Always read the manufacturer's label and the service manual before selecting a sealer.

Hardening sealers are used on permanent assemblies, such as fittings and threads, and for filling uneven surfaces. They are usually resistant to heat and most chemicals.

Nonhardening sealers are for semipermanent assemblies, such as cover plates, flanges, threads, and hose connections. They are also resistant to most chemicals and moderate heat. *Shellac* is a nonhardening sealer. It is a sticky substance that remains pliable. It is frequently used on fiber gaskets as a sealer and to hold the gasket in place during assembly.

Form-in-Place Gaskets

Form-in-place gaskets are special sealers used instead of conventional fiber or rubber gaskets. Two common types of form-in-place gaskets are *room temperature vulcanizing (RTV) sealer* and *anaerobic sealer*.

When selecting a form-in-place gasket, refer to a manufacturer's service manual. Scrape or wire brush all gasket surfaces to remove all loose material. Check that all gasket rails are flat. Using a shop towel and solvent, wipe off oil and grease. The sealing surfaces must be *clean* and *dry* before using a form-in-place gasket.

RTV sealer, also called *silicone sealer*, dries in contact with air. It is used to form a rubber-like gasket on thin, flexible flanges. RTV sealer normally comes in a tube, as shown in **Figure 9-25**. Depending on the brand, it can have a shelf life from one year to two years. Always inspect the package for the expiration date before using it. If too old, RTV sealer will *not* cure and seal properly.

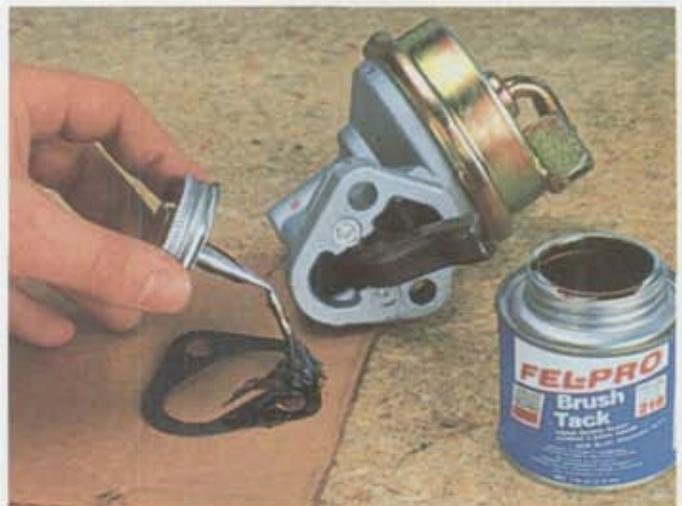


Figure 9-23. Always use the recommended type of sealer or adhesive on gaskets. Some adhesives are oil and fuel soluble and can cause leakage. Both spray adhesive and brush-on sealer are available. They will hold the gasket in place during the assembly of parts. (Fel-Pro Gaskets)

Type	Temperature range	Use	Resistant to	Characteristics
shellac	-65° to 350° F (-54° to 177° C)	general assembly: gaskets of paper, felt, cardboard, rubber, and metal	gasoline, kerosene, grease, water, oil, and antifreeze mixtures	dries slowly sets pliable alcohol soluble
hardening gasket sealant	-65° to 400° F (-54° to 205° C)	permanent assemblies: fittings, threaded connections, and for filling uneven surfaces	water, kerosene, steam, oil, grease, gasoline, alkali, salt solutions, mild acids, and antifreeze mixture	dries quickly sets hard alcohol soluble
nonhardening gasket sealant	-65° to 400° F (-54° to 205° C)	semipermanent assemblies: cover plates, flanges, threaded assemblies, hose connections, and metal-to-metal assemblies	water, kerosene, steam, oil, grease, gasoline, alkali, salt solutions, mild acids, and antifreeze solutions	dries slowly nonhardening alcohol soluble

Figure 9-24. Different uses and characteristics of various types of sealers. (Fel-Pro Gaskets)

RTV sealer should be applied in a continuous bead that is approximately 1/8" (3 mm) wide. All mounting holes must be circled. Locating dowels are often used to prevent the sealing bead from being smeared. If the continuous bead is broken, a leak may result. Uncured RTV can be removed with a rag. Components should be torqued in place while the RTV is still wet to the touch, usually within about 10 minutes of application.

Anaerobic sealer cures to a plastic-like substance in the absence of air and is designed for tightly fitting, thick parts. It is used between two smooth, true surfaces, *not* on thin, flexible flanges. **Figure 9-26** shows the use of both

anaerobic sealer and RTV sealer on an engine's front cover. The RTV-sealed section contacts the flexible engine oil pan. The anaerobic-sealed section touches the strong, machined engine block.



Figure 9-25. RTV sealer is commonly recommended where two different gaskets join. This sealer prevents leakage between the two gaskets.

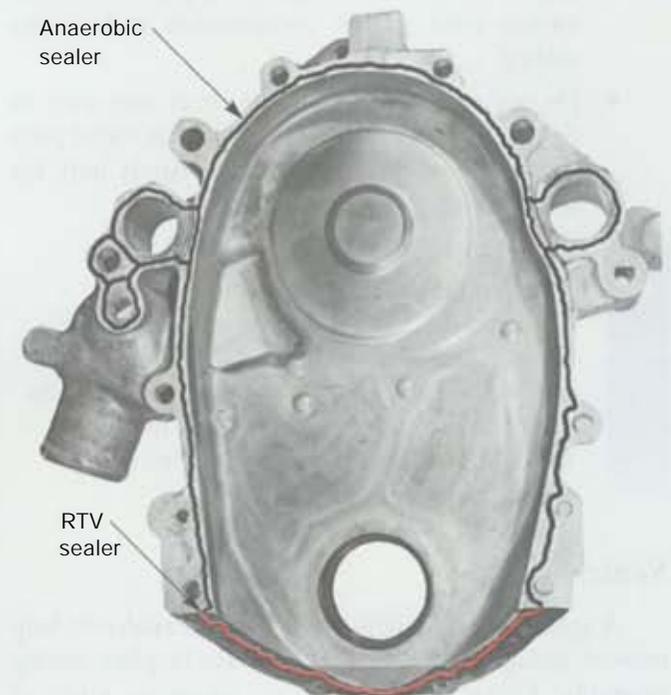


Figure 9-26. Notice the use of both RTV and anaerobic sealers. RTV is for flexible flanges. Anaerobic sealer is for solid, tight-fitting castings. Use the recommended bead size and form a continuous bead to avoid leakage. (Pontiac)

Anaerobic sealer should be applied sparingly. Use a 1/16"—3/32" (1.5 mm–2 mm) wide bead on one gasket surface. Be certain that the sealer surrounds each mounting hole. Typically, bolts should be torqued within 15 minutes of sealer application.

Tech Tip!

A few gasket manufacturers sell precut gaskets designed to replace form-in-place gaskets. When working on an engine installed in a vehicle, it can be difficult to properly clean the sealing surfaces. It may also be impossible to fit a part on the engine without hitting and breaking the bead of sealant. When this is the case, a precut gasket might work better than a form-in-place gasket.

Seals

Seals prevent leakage between a stationary part and a moving part. They can be found in engines, transmissions, power steering units, and almost any part containing fluid and moving parts. A seal allows a shaft to spin or slide inside a nonmoving part without fluid leakage. Seals are normally made of synthetic rubber molded onto a metal body, **Figure 9-27**.

Seal Rules

There are several important procedures to remember when working with seals.

- Inspect the seal for leakage before disassembly. If a seal is leaking, there may be other problems besides a defective seal. Look for a bent shaft, misaligned seal housing, or damaged parts. Leakage requires close inspection after disassembly.

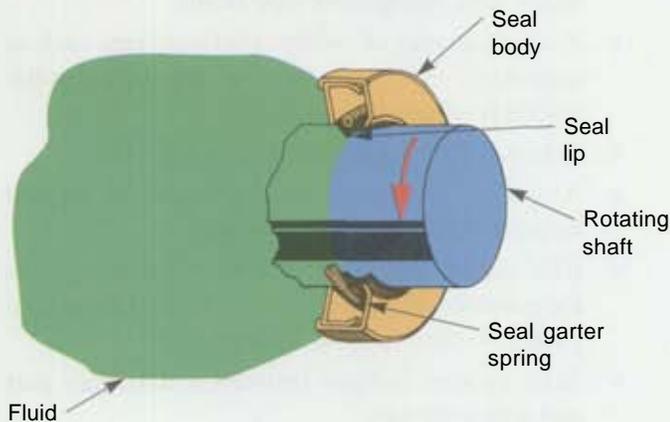


Figure 9-27. A seal mounted in a stationary part. The shaft spins inside the seal. The seal lip faces the fluid and keeps it inside the part. (Caterpillar Tractor)

- Remove the old seal carefully, without scratching the seal housing. Sometimes, a special puller is required for seal removal. This is discussed in later chapters.
- Inspect shafts for wear and burrs, **Figure 9-28**. Look at the shaft closely where it contacts the seal. It should be smooth and flat. File off any burrs that may cut the new seal. A badly worn shaft will require polishing, a shaft sleeve repair kit, or replacement.
- Compare the old seal to the new seal. Hold them next to each other. Both the inside diameter (ID) and the outside diameter (OD) must be the same. To double-check the ID, slip the seal over the shaft. It should fit snugly to prevent leakage.
- Install the new seal correctly. Coat the outside of the seal housing with approved sealer. Coat the inner lip of the seal with system fluid. Install the seal with the sealing lip facing the *inside* of the part. If installed backwards, a tremendous leak will result. Also, check that the seal is squarely and fully seated in its bore.

O-Ring Seals

An **O-ring seal** is a stationary seal that fits into a groove between two parts, **Figure 9-29**. When the parts are assembled, the synthetic rubber seal is partially compressed to form a leakproof joint. Normally, O-ring seals should be coated with system fluid, such as engine oil, diesel fuel, or transmission fluid before installation. This helps the parts slide together without scuffing or cutting the seal. Usually, sealants are *not* used on O-ring type seals. When in doubt about any seal installation, refer to a shop manual.

Figure 9-30 shows a special engine seal that fits into an odd-shaped groove in an engine part. When installing

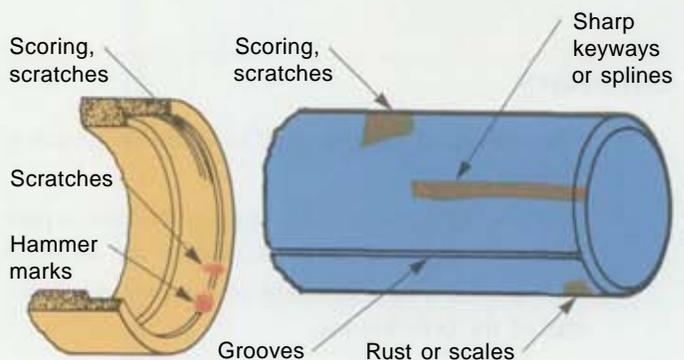


Figure 9-28. Always inspect seals and shafts for damage. Slight nicks or scratches could cause leakage. (Federal Mogul)

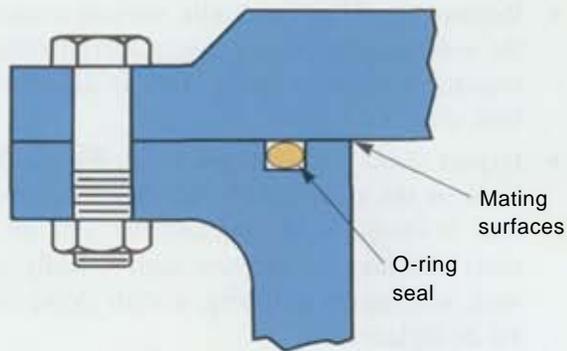


Figure 9-29. O-ring seals prevent leakage by applying pressure to multiple surfaces, as shown. When the parts are bolted together, they partially compress the O-ring. (Deere & Co.)

this type seal, make sure the part groove is perfectly clean. During assembly, make sure the seal does not fall out of its groove, or leakage will result.

Other Information

Special gaskets and seals sometimes require other installation techniques. These special situations are discussed in later chapters.

Workplace Skills

One of the most serious and common mistakes in automotive service is not torquing wheel lug nuts properly. Improper wheel lug nut torque can warp the brake rotor or wheel, or allow the wheel nuts to loosen, which can lead to a very dangerous situation. To torque wheel lug nuts correctly, run the lug nuts down lightly with an air impact wrench and then tighten them to factory specifications with a torque wrench. If tightening the lug nuts in this way prevents even one problem, it was worth the extra time to do the job right.

Summary

- Fasteners are devices that hold the parts of a vehicle together.
- When a high-quality bolt is threaded into a part without a nut, it can also be called a cap screw.
- Bolt size is a measurement of the outside diameter of the bolt threads.



Figure 9-30. Many modern engines use synthetic seals instead of gaskets. This specially shaped seal fits down into a groove formed in the part.

- Tensile strength, or grade, refers to the amount of pull or stretch a fastener can withstand before breaking.
- A flat washer increases the clamping surface under the fastener.
- A lock washer prevents the bolt or nut from becoming loose under stress and vibration.
- It is very important that bolts and nuts are torqued properly.
- Torque specifications are tightening values given by the vehicle manufacturer.
- Generally, tightening a group of fasteners on a part follows a crisscross pattern.
- A torque wrench measures the twisting force applied when tightening a threaded fastener.
- A tap is a threaded tool for cutting internal threads in holes. A die cuts external threads.
- Machine screws are similar to bolts, but they normally have screwdriver-type heads.
- Numerous types of nonthreaded fasteners, such as snap rings, clips, and adhesives, are utilized in the assembly of a vehicle.
- Adhesives are widely used on most vehicles.
- A gasket is a soft, flexible material placed between parts to prevent leakage.
- RTV sealer, also called silicone sealer, cures in the presence of air. It is used to form a rubber-like gasket on thin, flexible flanges.
- Seals prevent leakage between a stationary part and a moving part.

Important Terms

Fasteners	Torquing
Bolt	Torque specifications
Cap screw	Torque-to-yield
Nut	Bolt tightening sequence
Tensile strength	Crisscross pattern
Bolt head markings	Torque wrench
Cotter pin	Minor thread damage
Washers	Major thread damage
Machine screws	Tap
Sheet metal screws	Die
Tapping screws	Thread repair insert
Nonthreaded fasteners	Locking pliers
Snap ring	Stud puller
Key	Screw extractor
Keyseat	Rust penetrant
Keyway	Gasket
Set screws	Sealer
Adhesives	Seals

Review Questions—Chapter 9

Please do not write in this text. Place your answers on a separate sheet of paper.

1. Define the terms *bolt* and *nut*.
2. How are bolts and nuts usually named in automotive terminology?
3. List and explain the four basic dimensions of a bolt.
4. Customary bolt heads are marked with _____ or _____ marks to indicate bolt strength. Metric bolts use a _____ system to indicate bolt strength.
5. A(n) _____ is a safety device commonly used with a slotted nut.
6. Describe the difference between a flat washer and a lock washer.
7. What are torque specifications?
8. What is a bolt or nut tightening sequence?
9. Which of the following is *not* used for thread repair?
 - (A) Tap.
 - (B) Die.
 - (C) Chaser.
 - (D) Chisel.
10. A _____ and _____ is needed to select the right size drill and tap.
11. How do you use a thread repair insert?

12. Describe six ways to remove broken fasteners.
13. Which of the following group of sealers is used on permanent assemblies?
 - (A) Hardening.
 - (B) Nonhardening.
 - (C) Form-in-place.
 - (D) All the above.
14. Explain when RTV and anaerobic sealers are recommended.
15. Describe five rules for working with seals.

ASE-Type Questions

1. When rebuilding a steering system, a can of bolts and nuts was somehow lost. Technician A says to simply go to the hardware store and buy the same size fasteners. Technician B says to order the fasteners from the manufacturer. Who is correct?
 - (A) *A only.*
 - (B) *B only.*
 - (C) *Both A and B.*
 - (D) *Neither A nor B.*
2. Which of the following is a safety device that keeps a slotted nut from turning or coming off?
 - (A) *Lock tab.*
 - (B) *Snap ring.*
 - (C) *Cotter pin.*
 - (D) *Thread pitch.*
3. Which of the following is determined by measuring bolt length change while torquing a bolt?
 - (A) *Torque stretch.*
 - (B) *Torque-to-yield.*
 - (C) *Torquing sequence.*
 - (D) *Torque specification.*
4. Fastener tightening generally follows a:
 - (A) *clockwise pattern.*
 - (B) *crisscross pattern.*
 - (C) *left-to-right pattern.*
 - (D) *counterclockwise pattern.*
5. Which of the following is *not* a basic rule to follow when using a torque wrench?
 - (A) *Avoid using swivel joints.*
 - (B) *Pull only on the wrench handle.*
 - (C) *Clean fastener threads.*
 - (D) *Use short, jerky pull motions for accuracy.*

6. Which threaded tool is used for cutting internal threads in holes?
 - (A) *Tap.*
 - (B) *Helicoil.*
 - (C) *Thread chaser.*
 - (D) *Thread repair insert.*
7. Each of the following is a tool that can be used to help remove problem fasteners *except*:
 - (A) *hacksaw.*
 - (B) *stud puller.*
 - (C) *die.*
 - (D) *screwdriver.*
8. Snap rings hold and fit into grooves in:
 - (A) *pins.*
 - (B) *gears.*
 - (C) *shafts.*
 - (D) *All of the above.*
9. Set screws are headless fasteners designed to accept a(n):
 - (A) *hex wrench.*
 - (B) *screwdriver.*
 - (C) *Allen wrench.*
 - (D) *All of the above.*

10. While installing gaskets, Technician A believes gaskets alone will produce leakproof seals. Technician B believes that some gaskets require sealer to further prevent leakage where gaskets overlap. Who is right?
 - (A) *A only.*
 - (B) *B only.*
 - (C) *Both A and B.*
 - (D) *Neither A nor B.*

Activities for Chapter 9

1. Prepare a large chart for the shop showing how to read information given on a bolt.
2. Demonstrate the proper methods for repairing thread damage.