

NOTE: Refer to the Supplement at the back of this manual for information unique to 2004-2005 Eagle models, including Screamin'

CHAPTER ONE

GENERAL INFORMATION

This detailed and comprehensive manual covers the Harley-Davidson FLST and FXST Softail Series of motorcycles equipped with the Twin Cam 88B, 95B and 103B engines.

The text provides complete information on maintenance, tune-up, repair and overhaul. Hundreds of original photographs and illustrations created during the complete disassembly of the motorcycle guide the reader through every job. All procedures are in step-by-step form and designed for the reader who may be working on the motorcycle for the first time.

MANUAL ORGANIZATION

A shop manual is a tool and as in all service manuals, the chapters are thumb tabbed for easy reference. Main headings are listed in the table of contents and the index. Frequently used specifications and capacities from the tables at the end of each individual chapter are listed in the *Quick Reference Data* section at the front of the manual. Specifications and capacities are provided in U.S. standard and metric units of measure.

During some of the procedures there will be references to headings in other chapters or sections of the manual.

When a specific heading is called out in a step it will be *italicized* as it appears in the manual. If a sub-heading is indicated as being "in this section" it is located within the same main heading. For example, the sub-heading *Handling Gasoline Safely* is located within the main heading *SAFETY*.

This chapter provides general information on shop safety, tools and their usage, service fundamentals and shop supplies. **Tables 1-12**, at the end of the chapter, list the following:

- Table 1** lists model designation.
- Table 2** lists general dimensions.
- Table 3** lists motorcycle weight.
- Table 4** lists motorcycle weight ratings.
- Table 5** lists fuel tank capacity.
- Table 6** lists decimal and metric equivalents.
- Table 7** lists general torque specifications.
- Table 8** lists conversion formulas.
- Table 9** lists technical abbreviations.
- Table 10** lists American tap and drill sizes.
- Table 11** lists Metric tap and drill sizes.
- Table 12** lists special tools and their part numbers.

Chapter Two provides methods for quick and accurate diagnosis of problems. Troubleshooting procedures pres-

ent typical symptoms and logical methods to pinpoint and repair the problem.

Chapter Three explains all routine maintenance necessary to keep the motorcycle running well. Chapter Three also includes recommended tune-up procedures, eliminating the need to constantly consult other chapters on the various assemblies.

Subsequent chapters describe specific systems such as engine, transmission, clutch, drive system, fuel and exhaust systems, suspension and brakes. Each disassembly, repair and assembly procedure is given in step-by-step form.

WARNINGS, CAUTIONS AND NOTES

The terms, WARNING, CAUTION and NOTE have specific meanings in this manual.

A WARNING emphasizes areas where injury or even death could result from negligence. Mechanical damage may also occur. WARNINGS *are to be taken seriously*.

A CAUTION emphasizes areas where equipment damage could occur. Disregarding a CAUTION could cause permanent mechanical damage, though injury is unlikely.

A NOTE provides additional information to make a step or procedure easier or clearer. Disregarding a NOTE could cause inconvenience, but would not cause equipment damage or personal injury.

SAFETY

Professional mechanics can work for years and never sustain a serious injury or mishap. Follow these guidelines and practice common sense to safely service the motorcycle.

1. Do not operate the motorcycle in an enclosed area. The exhaust gasses contain carbon monoxide, an odorless, colorless and tasteless poisonous gas. Carbon monoxide levels build quickly in small enclosed areas and can cause unconsciousness and death in a short time. Make sure the work area is properly ventilated or operate the motorcycle outside.
2. *Never* use gasoline or extremely flammable liquid to clean parts. Refer to *Cleaning Parts* and *Handling Gasoline Safely* in this chapter.
3. *Never* smoke or use a torch in the vicinity of flammable liquids, such as gasoline or cleaning solvent.
4. Before welding or brazing on the motorcycle, remove the fuel tank, carburetor and shocks to a safe distance at least 50 ft. (15 m) away.
5. Use the correct type and size of tools to avoid damaging fasteners.

6. Keep tools clean and in good condition. Replace or repair worn or damaged equipment.
7. When loosening a tight fastener, be guided by what would happen if the tool slips.
8. When replacing fasteners, make sure the new fasteners are the same size and strength as the original ones.
9. Keep the work area clean and organized.
10. Wear eye protection *anytime* the safety of the eyes is in question. This includes procedures involving drilling, grinding, hammering, compressed air and chemicals.
11. Wear the correct clothing for the job. Tie up or cover long hair so it can not get caught in moving equipment.
12. Do not carry sharp tools in clothing pockets.
13. Always have an approved fire extinguisher available. Make sure it is rated for gasoline (Class B) and electrical (Class C) fires.
14. Do not use compressed air to clean clothes, the motorcycle or the work area. Debris may be blown into the eyes or skin. *Never* direct compressed air at anyone. Do not allow children to use or play with any compressed air equipment.
15. When using compressed air to dry rotating parts, hold the part so it cannot rotate. Do not allow the force of the air to spin the part. The air jet is capable of rotating parts at extreme speed. The part may be damaged or disintegrate and cause serious injury.
16. Do not inhale the dust created by brake pad and clutch wear. These particles may contain asbestos. In addition, some types of insulating materials and gaskets may contain asbestos. Inhaling asbestos particles is hazardous to health.
17. *Never* work on the motorcycle while someone is working under it.
18. When placing the motorcycle on a stand, make sure it is secure before walking away.

Handling Gasoline Safely

Gasoline is a volatile flammable liquid and is one of the most dangerous items in the shop. Because gasoline is used so often, many people forget that it is hazardous. Only use gasoline as fuel for gasoline internal combustion engines. When working on a motorcycle, keep in mind that gasoline is always present in the fuel tank, fuel line and carburetor. To avoid a disastrous accident when working around the fuel system, carefully observe the following precautions:

1. *Never* use gasoline to clean parts. See *Parts Cleaning* in this section.
2. When working on the fuel system, work outside or in a well-ventilated area.



3. Do not add fuel to the fuel tank or service the fuel system while the motorcycle is near open flames, sparks or where someone is smoking. Gasoline vapor is heavier than air, it collects in low areas and is more easily ignited than liquid gasoline.
4. Allow the engine to cool completely before working on any fuel system component.
5. When draining the carburetor, catch the fuel in a plastic container and pour it into an approved gasoline storage device.
6. Do not store gasoline in glass containers. If the glass breaks, a serious explosion or fire may occur.
7. Immediately wipe up spilled gasoline with rags. Store the rags in a metal container with a lid until they can be properly disposed of, or place them outside in a safe place for the fuel to evaporate.
8. Do not pour water onto a gasoline fire. Water spreads the fire and makes it more difficult to put out. Use a class B, BC or ABC fire extinguisher to extinguish the fire.
9. Always turn off the engine before refueling. Do not spill fuel onto the engine or exhaust system. Do not overfill the fuel tank. Leave an air space at the top of the tank to allow room for the fuel to expand due to temperature fluctuations.

Parts Cleaning

Cleaning parts is one of the more tedious and difficult service jobs performed in the home garage. There are many types of chemical cleaners and solvents available for shop use. Most are poisonous and extremely flammable. To prevent chemical exposure, vapor buildup, fire and serious injury, note the following:

1. Read and observe the entire product label before using any chemical. Always know what type of chemical is being used and whether it is poisonous and/or flammable.
2. Do not use more than one type of cleaning solvent at a time. When mixing chemicals, measure the proper amounts according to the manufacturer.
3. Work in a well-ventilated area.
4. Wear chemical-resistant gloves.
5. Wear safety glasses.
6. Wear a vapor respirator if the instructions call for it.
7. Wash hands and arms thoroughly after cleaning parts.
8. Keep chemical products away from children and pets.
9. Thoroughly clean all oil, grease and cleaner residue from any part that must be heated.
10. Use a nylon brush when cleaning parts. Metal brushes may cause a spark.
11. When using a parts washer, only use the solvent recommended by the manufacturer. Make sure the parts washer is equipped with a metal lid that will lower in case of fire.

Warning Labels

Most manufacturers attach information and warning labels to the motorcycle. These labels contain instructions that are important to personal safety when operating, servicing, transporting and storing the motorcycle. Refer to the owner's manual for the description and location of labels. Order replacement labels from the manufacturer if they are missing or damaged.

SERIAL NUMBERS

Serial numbers are stamped on various locations on the frame, engine, transmission and carburetor. Record these numbers in the *Quick Reference Data* section in the front of the manual. Have these numbers available when ordering parts.

The frame serial number (**Figure 1**) is stamped on the right side of the frame down tube.

The VIN number label (**Figure 2**) is located just below the frame number on the right side frame down tube.

The engine serial number is stamped on a pad on the left side of the crankcase (**Figure 3**) and the right side of the crankcase (**Figure 4**).

The transmission serial number (**Figure 5**) is stamped on a pad on the right side of the transmission case next to the side door.

The carburetor serial number (**Figure 6**) is located on the side of the carburetor body next to the accelerator pump linkage. There is no serial number for the fuel injection module.

Table 1 lists model designation.

FASTENERS

Proper fastener selection and installation is important to ensure the motorcycle operates as designed and can be serviced efficiently. The choice of original equipment fasteners is not arrived at by chance. Make sure that replacement fasteners meet all the same requirements as the originals.

Threaded Fasteners

Threaded fasteners secure most of the components on the motorcycle. Most are tightened by turning them clockwise (right-hand threads). If the normal rotation of the component being tightened would loosen the fastener, it may have left-hand threads. If a left-hand threaded fastener is used, it is noted in the text.

Two dimensions are required to match the threads of the fastener: the number of threads in a given distance and the outside diameter of the threads.

CAUTION

There are a variety of Metric and American fasteners used on the engine and chassis. Do not interchange fasteners of the incorrect type as the component along with the fastener may be damaged.

Two systems are currently used to specify threaded fastener dimensions: the U.S. Standard system and the metric system (**Figure 7**). Pay particular attention when working with unidentified fasteners; mismatching thread types can damage threads.

NOTE

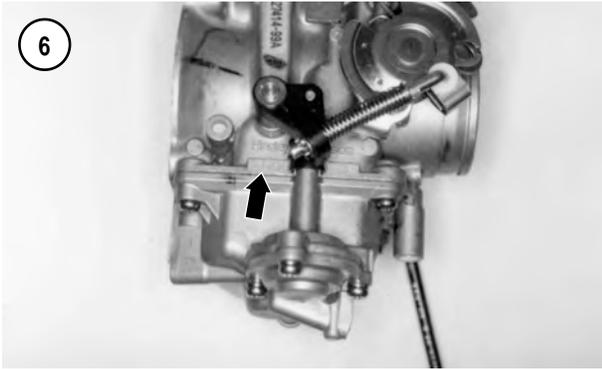
To ensure the fastener threads are not mismatched or cross-threaded, start all fasteners by hand. If a fastener is hard to start or turn, determine the cause before tightening with a wrench.

The length (L, **Figure 8**), diameter (D) and distance between thread crests (pitch) (T) classify metric screws and bolts. A typical bolt may be identified by the numbers, 8—1.25 × 130. This indicates the bolt has diameter of 8 mm, the distance between thread crests is 1.25 mm and the length is 130 mm. Always measure bolt length as shown in **Figure 8** to avoid purchasing replacements of the wrong length.

If a number is located on the top of the fastener, (**Figure 8**) this indicates the strength of the fastener. The higher the number, the stronger the fastener. Generally, unnumbered fasteners are the weakest.

Many screws, bolts and studs are combined with nuts to secure particular components. To indicate the size of a



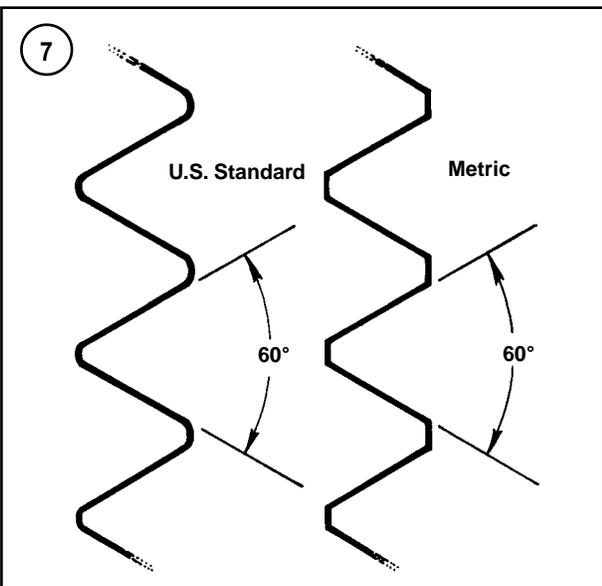


WARNING
 Do not install fasteners with a strength classification lower than what was originally installed by the manufacturer. Doing so may cause equipment failure and/or damage.

Torque Specifications

The materials used in the manufacture of the motorcycle may be subjected to uneven stresses if the fasteners of the various subassemblies are not installed and tightened correctly. Fasteners that are improperly installed or work loose can cause extensive damage. It is essential to use an accurate torque wrench, described in this chapter, with the torque specifications in this manual.

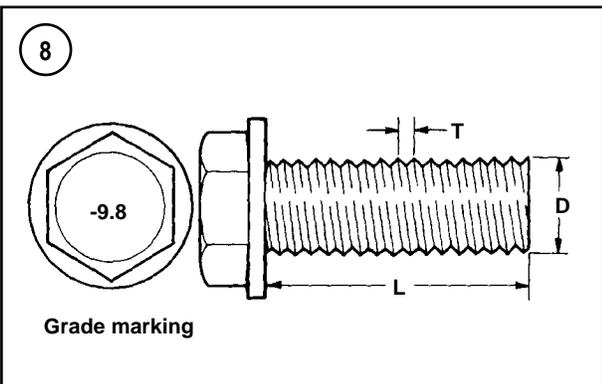
Specifications for torque are provided in Newton-meters (N•m), foot-pounds (ft.-lb.) and inch-pounds (in.-lb.). Refer to **Table 7** for general torque specifications. To use **Table 7**, first determine the size of the fastener as described in *Threaded Fasteners* in this section. Torque specifications for specific components are at the end of the appropriate chapters. Torque wrenches are covered in the *Basic Tools* section.



Self-Locking Fasteners

Several types of bolts, screws and nuts incorporate a system that creates interference between the two fasteners. Interference is achieved in various ways. The most common type is the nylon insert nut and a dry adhesive coating on the threads of a bolt.

Self-locking fasteners offer greater holding strength than standard fasteners, which improves their resistance to vibration. Most self-locking fasteners cannot be reused. The materials used to form the lock become distorted after the initial installation and removal. It is a good practice to discard and replace self-locking fasteners after their removal. Do not replace self-locking fasteners with standard fasteners.



Washers

There are two basic types of washers: flat washers and lockwashers. Flat washers are simple discs with a hole to fit a screw or bolt. Lockwashers are used to prevent a fastener from working loose. Washers can be used as spacers and seals, or to help distribute fastener load and to prevent the fastener from damaging the component.

As with fasteners, when replacing washers, make sure the replacement washers are of the same design and quality.

nut, manufacturers specify the internal diameter and the thread pitch.

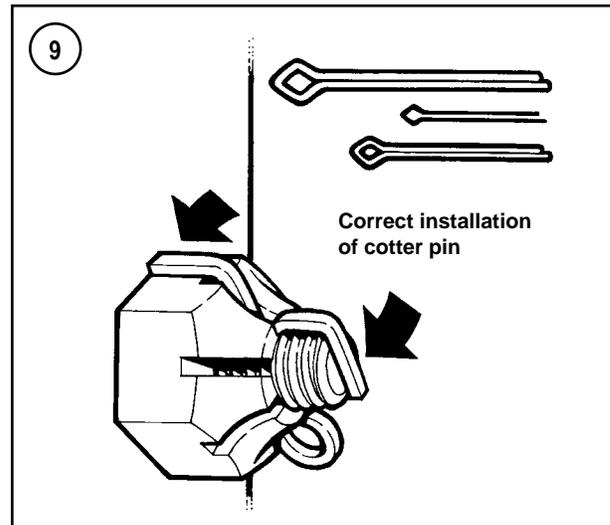
The measurement across two flats on a nut or bolt indicates the wrench size.

Cotter Pins

A cotter pin is a split metal pin inserted into a hole or slot to prevent a fastener from loosening. In certain applications, such as the rear axle on an ATV or motorcycle, the fastener must be secured in this way. For these applications, a cotter pin and castellated (slotted) nut is used.

To use a cotter pin, first make sure the diameter is correct for the hole in the fastener. After correctly tightening the fastener and aligning the holes, insert the cotter pin through the hole and bend the ends over the fastener (**Figure 9**). Unless instructed to do so, never loosen a torqued fastener to align the holes. If the holes do not align, tighten the fastener just enough to achieve alignment.

Cotter pins are available in various diameters and lengths. Measure length from the bottom of the head to the tip of the shortest pin.



Snap Rings and E-clips

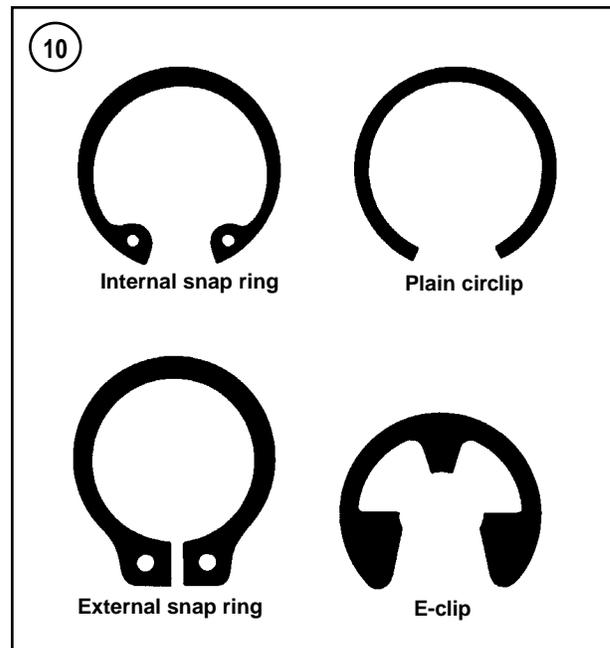
Snap rings (**Figure 10**) are circular-shaped metal retaining clips. They are required to secure parts and gears in place on parts such as shafts, pins or rods. External type snap rings are used to retain items on shafts. Internal type snap rings secure parts within housing bores. In some applications, in addition to securing the component(s), snap rings of varying thickness also determine endplay. These are usually called selective snap rings.

Two basic types of snap rings are used: machined and stamped snap rings. Machined snap rings (**Figure 11**) can be installed in either direction, since both faces have sharp edges. Stamped snap rings (**Figure 12**) are manufactured with a sharp edge and a round edge. When installing a stamped snap ring in a thrust application, install the sharp edge facing away from the part producing the thrust.

Remove E-clips with a flat blade screwdriver by prying between the shaft and E-clip. To install an E-clip, center it over the shaft groove and push or tap it into place.

Observe the following when installing snap rings:

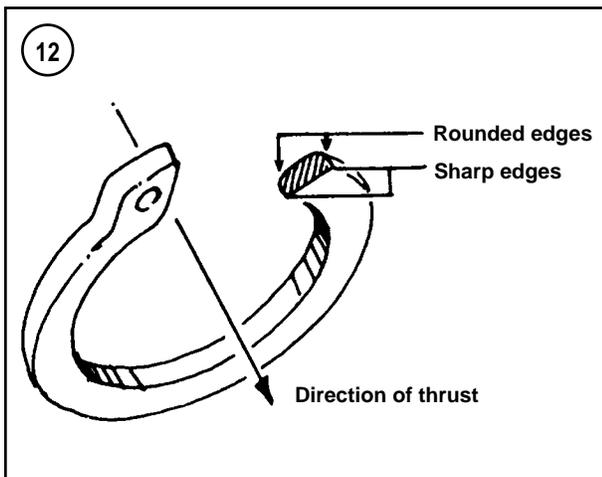
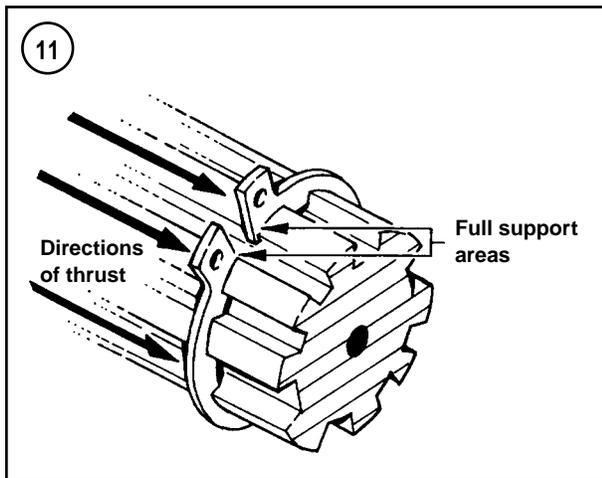
1. Remove and install snap rings with snap ring pliers. See *Snap Ring Pliers* in this chapter.
2. In some applications, it may be necessary to replace snap rings after removing them.
3. Compress or expand snap rings only enough to install them. If overly expanded, they lose their retaining ability.
4. After installing a snap ring, make sure it seats completely.
5. Wear eye protection when removing and installing snap rings.



SHOP SUPPLIES

Lubricants and Fluids

Periodic lubrication helps ensure a long service life for any type of equipment. Using the correct type of lubricant is as important as performing the lubrication service, although in an emergency the wrong type is better than none. The following section describes the types of lubricants most often required. Make sure to follow the manufacturer's recommendations for lubricant types.



Engine oils

Engine oil is classified by two standards: the American Petroleum Institute (API) service classification and the Society of Automotive Engineers (SAE) viscosity rating. This information is on the oil container label. Two letters indicate the API service classification. The number or sequence of numbers and letter (10W-40 for example) is the oil's viscosity rating. The API service classification and the SAE viscosity index are not indications of oil quality.

The service classification indicates that the oil meets specific lubrication standards. The first letter in the classification (*S*) indicates that the oil is for gasoline engines. The second letter indicates the standard the oil satisfies.

Always use an oil with a classification recommended by the manufacturer. Using an oil with a different classification can cause engine damage.

Viscosity is an indication of the oil's thickness. Thin oils have a lower number while thick oils have a higher number. Engine oils fall into the 5- to 50-weight range for single-grade oils.

Most manufacturers recommend multigrade oil. These oils perform efficiently across a wide range of operating conditions. Multigrade oils are identified by a (*W*) after the first number, which indicates the low-temperature viscosity.

Engine oils are most commonly mineral (petroleum) based; however, synthetic and semi-synthetic types are used more frequently. When selecting engine oil, follow the manufacturer's recommendation for type, classification and viscosity.

Greases

Grease is lubricating oil with thickening agents added to it. The National Lubricating Grease Institute (NLGI) grades grease. Grades range from No. 000 to No. 6, with No. 6 being the thickest. Typical multipurpose grease is NLGI No. 2. For specific applications, manufacturers may recommend water-resistant type grease or one with an additive such as molybdenum disulfide (MoS_2).

Brake fluid

Brake fluid is the hydraulic fluid used to transmit hydraulic pressure (force) to the wheel brakes. Brake fluid is classified by the Department of Transportation (DOT). Current designations for brake fluid are DOT 3, DOT 4 and DOT 5. This classification appears on the fluid container.

Each type of brake fluid has its own definite characteristics. The Harley-Davidson Softail uses the silicone based DOT 5 brake fluid. Do not intermix DOT 3 or DOT 4 with DOT 5 type brake fluid as this may cause brake system failure since the DOT 5 brake fluid is not compatible with other brake fluids. When adding brake fluid, *only* use the fluid recommended by the manufacturer.

Brake fluid will damage any plastic, painted or plated surface it contacts. Use extreme care when working with brake fluid and clean up spills immediately with soap and water.

Hydraulic brake systems require clean and moisture-free brake fluid. Never reuse brake fluid. Keep containers and reservoirs properly sealed.

WARNING

Never put a mineral-based (petroleum) oil into the brake system. Mineral oil will cause rubber parts in the system to swell and

break apart, resulting in complete brake failure.

Cleaners, Degreasers and Solvents

Many chemicals are available to remove oil, grease and other residue from the motorcycle. Before using cleaning solvents, consider how they will be used and disposed of, particularly if they are not water-soluble. Local ordinances may require special procedures for the disposal of many types of cleaning chemicals. Refer to *Safety* and *Parts Cleaning* in this chapter for more information on their use.

To clean brake system components, use brake parts cleaner. Petroleum-based products will damage brake system seals. Brake parts cleaner leaves no residue. Use electrical contact cleaner to clean electrical connections and components without leaving any residue. Carburetor cleaner is a powerful solvent used to remove fuel deposits and varnish from fuel system components. Use this cleaner carefully, as it may damage finishes.

Generally, degreasers are strong cleaners used to remove heavy accumulations of grease from engine and frame components.

Most solvents are designed to be used in a parts washing cabinet for individual component cleaning. For safety, use only nonflammable or high flash point solvents.

Gasket Sealant

Sealants are used with a gasket or seal and are occasionally used alone. Follow the manufacturer's recommendation when using sealants. Use extreme care when choosing a sealant different from the type originally recommended. Choose sealants based on their resistance to heat and various fluids, and their sealing capabilities.

One of the most common sealants is RTV, or room temperature vulcanizing sealant. This sealant cures at room temperature over a specific time period. This allows the repositioning of components without damaging gaskets.

Moisture in the air causes the RTV sealant to cure. Always install the tube cap as soon as possible after applying RTV sealant. RTV sealant has a limited shelf life and will not cure properly if the shelf life has expired. Keep partial tubes sealed and discard them if they have surpassed the expiration date.

Applying RTV sealant

Clean all old gasket residue from the mating surfaces. Remove all gasket material from blind threaded holes; it



can cause inaccurate bolt torque. Spray the mating surfaces with aerosol parts cleaner and wipe with a lint-free cloth. The area must be clean for the sealant to adhere.

Apply RTV sealant in a continuous bead 2-3 mm (0.08-0.12 in.) thick. Circle all the fastener holes unless otherwise specified. Do not allow any sealant to enter these holes. Assemble and tighten the fasteners to the specified torque within the time frame recommended by the RTV sealant manufacturer.

Gasket Remover

Aerosol gasket remover can help remove stubborn gaskets. This product can speed up the removal process and prevent damage to the mating surface that may be caused by using a scraping tool. Most of these types of products are very caustic. Follow the gasket remover manufacturer's instructions for use.

Threadlocking Compound

A threadlocking compound is a fluid applied to the threads of fasteners. After the fastener is tightened, the fluid dries and becomes a solid filler between the threads. This makes it difficult for the fastener to work loose from vibration, or heat expansion and contraction. Some threadlocking compounds also provide a seal against fluid leakage.

Before applying threadlocking compound, remove any old compound from both thread areas and clean them with aerosol parts cleaner. Use the compound sparingly. Excess fluid can run into adjoining parts.

Threadlocking compounds are available in different strengths. Follow the particular manufacturer's recommendations regarding compound selection. A number of manufacturers offer a wide range of threadlocking compounds for various strength, temperature and repair applications.

**BASIC TOOLS**

Most of the procedures in this manual can be carried out with simple hand tools and test equipment familiar to the home mechanic. Always use the correct tools for the job at hand. Keep tools organized and clean. Store them in a tool chest with related tools organized together.

Some of the procedures in this manual specify special tools. In most cases, the tool is illustrated in use. Well-equipped mechanics may be able to substitute similar tools or fabricate a suitable replacement. In some cases, specialized equipment or expertise may make it impractical for the home mechanic to attempt the procedure. Such operations are identified in the text with the recommendation to have a dealership or specialist perform the task. It may be less expensive to have a professional perform these jobs, especially when considering the cost of the equipment.

Quality tools are essential. The best are constructed of high-strength alloy steel. These tools are light, easy to use and resistant to wear. Their working surface is devoid of sharp edges and the tool is carefully polished. They have an easy-to-clean finish and are comfortable to use. Quality tools are a good investment.

When purchasing tools to perform the procedures covered in this manual, consider the tool's potential frequency of use. If starting a tool kit, consider purchasing a basic tool set (**Figure 13**) from a large tool supplier. These sets are available in many tool combinations and offer substantial savings when compared to individually purchased tools. As work experience grows and tasks become more complicated, specialized tools can be added.

The models covered in this manual use both U.S. Standard and metric fasteners. Make sure the correct type of tool is used.

Screwdrivers

Screwdrivers of various lengths and types are mandatory for the simplest tool kit. The two basic types are the slotted tip (flat blade) and the Phillips tip. These are available in sets that often include an assortment of tip sizes and shaft lengths.

As with all tools, use a screwdriver designed for the job. Make sure the size of the tip conforms to the size and shape of the fastener. Use them only for driving screws. Never use a screwdriver for prying or chiseling metal. Repair or replace worn or damaged screwdrivers. A worn tip may damage the fastener, making it difficult to remove.

Torx Drivers

Many of the components on the Harley-Davidson models covered in this manual are secured with internal Torx fasteners. These fasteners require specific Torx drivers for removal and installation. These fasteners reduce cam-out and fastener damage, and allow high torque transmission due to the complete enclosure of the driver within the fastener.

Torx screwdrivers in individual sizes, or screwdrivers that accept various bit sizes are available. However, the most practical application is a Torx bit set that accepts various drive types and sizes. A typical set contains T-10 through T40 bits that accept 1/4 and 3/8 in. drive attachments.

Wrenches

Open-end, box-end and combination wrenches (**Figure 14**) are available in a variety of types and sizes.

The number stamped on the wrench refers to the distance between the work areas. This size must match the size of the fastener head.

The box-end wrench is an excellent tool because it grips the fastener on all sides. This reduces the chance of the tool slipping. The box-end wrench is designed with either a 6- or 12-point opening. For stubborn or damaged fasteners, the 6-point provides superior holding ability by contacting the fastener across a wider area at all six edges. For general use, the 12-point works well. It allows the wrench to be removed and reinstalled without moving the handle over such a wide arc.

An open-end wrench is fast and works best in areas with limited overhead access. It contacts the fastener at only two points, and is subject to slipping under heavy force, or if the tool or fastener is worn. A box-end wrench is preferred in most instances, especially when breaking a fastener loose and applying the final tightness to a fastener.

The combination wrench has a box-end on one end and an open-end on the other. This combination makes it a very convenient tool.

Adjustable Wrenches

An adjustable wrench or Crescent wrench (**Figure 15**) can fit nearly any nut or bolt head that has clear access around its entire perimeter. Adjustable wrenches are best used as a backup wrench to keep a large nut or bolt from turning while the other end is being loosened or tightened with a box-end or socket wrench.

Adjustable wrenches contact the fastener at only two points, which makes them more subject to slipping off the fastener. The fact that one jaw is adjustable and may loosen only aggravates this shortcoming. Make certain the solid jaw is the one transmitting the force.

Socket Wrenches, Ratchets and Handles

Sockets that attach to a ratchet handle (**Figure 16**) are available with 6-point (A, **Figure 17**) or 12-point (B) openings and different drive sizes. The drive size indicates the size of the square hole that accepts the ratchet handle. The number stamped on the socket is the size of the work area and must match the fastener head.

As with wrenches, a 6-point socket provides superior holding ability, while a 12-point socket needs to be moved only half as far to reposition it on the fastener.

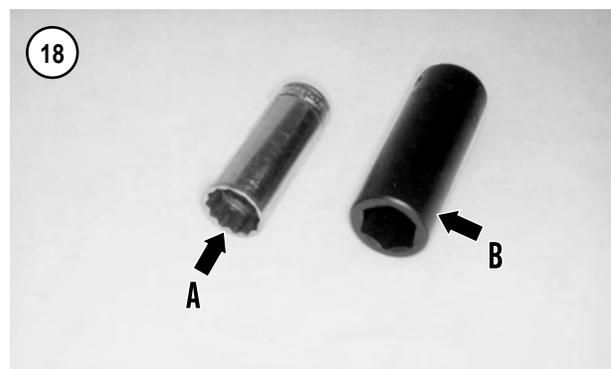
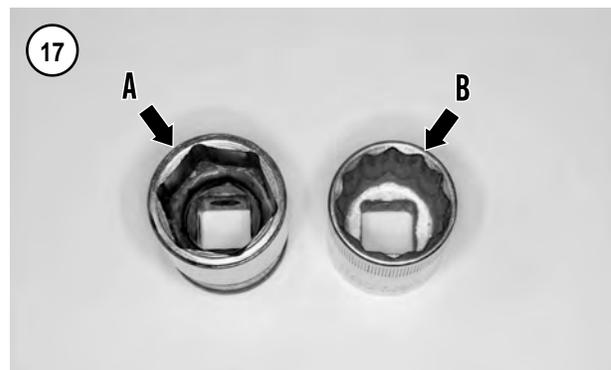
Sockets are designated for either hand or impact use. Impact sockets are made of thicker material for more durability. Compare the size and wall thickness of a 19-mm hand socket (A, **Figure 18**) and the 19-mm impact socket (B). Use impact sockets when using an impact driver or air tools. Use hand sockets with hand-driven attachments.

WARNING

Do not use hand sockets with air or impact tools as they may shatter and cause injury. Always wear eye protection when using impact or air tools.

Various handles are available for sockets. The speed handle is used for fast operation. Flexible ratchet heads in varying lengths allow the socket to be turned with varying force, and at odd angles. Extension bars allow the socket setup to reach difficult areas. The ratchet is the most versatile. It allows the user to install or remove the nut without removing the socket.

Sockets combined with any number of drivers make them undoubtedly the fastest, safest and most convenient tool for fastener removal and installation.





Impact Driver

An impact driver provides extra force for removing fasteners by converting the impact of a hammer into a turning motion. This makes it possible to remove stubborn fasteners without damaging them. Impact drivers and interchangeable bits (**Figure 19**) are available from most tool suppliers. When using a socket with an impact driver, make sure the socket is designed for impact use. Refer to *Socket Wrenches, Ratchets and Handles* in this section.

WARNING

Do not use hand sockets with air or impact tools as they may shatter and cause injury. Always wear eye protection when using impact or air tools.



Allen Wrenches

Allen or setscrew wrenches (**Figure 20**) are used on fasteners with hexagonal recesses in the fastener head. These wrenches are available in L-shaped bar, socket and T-handle types. Most motorcycles are equipped with metric fasteners. Allen bolts are sometimes called socket bolts.



Torque Wrenches

A torque wrench (**Figure 21**) is used with a socket, torque adapter or similar extension to tighten a fastener to a measured torque. Torque wrenches come in several drive sizes (1/4, 3/8, 1/2 and 3/4) and have various methods of reading the torque value. The drive size indicates the size of the square drive that accepts the socket, adapter or extension. Common methods of reading the torque value are the deflecting beam, the dial indicator and the audible click.

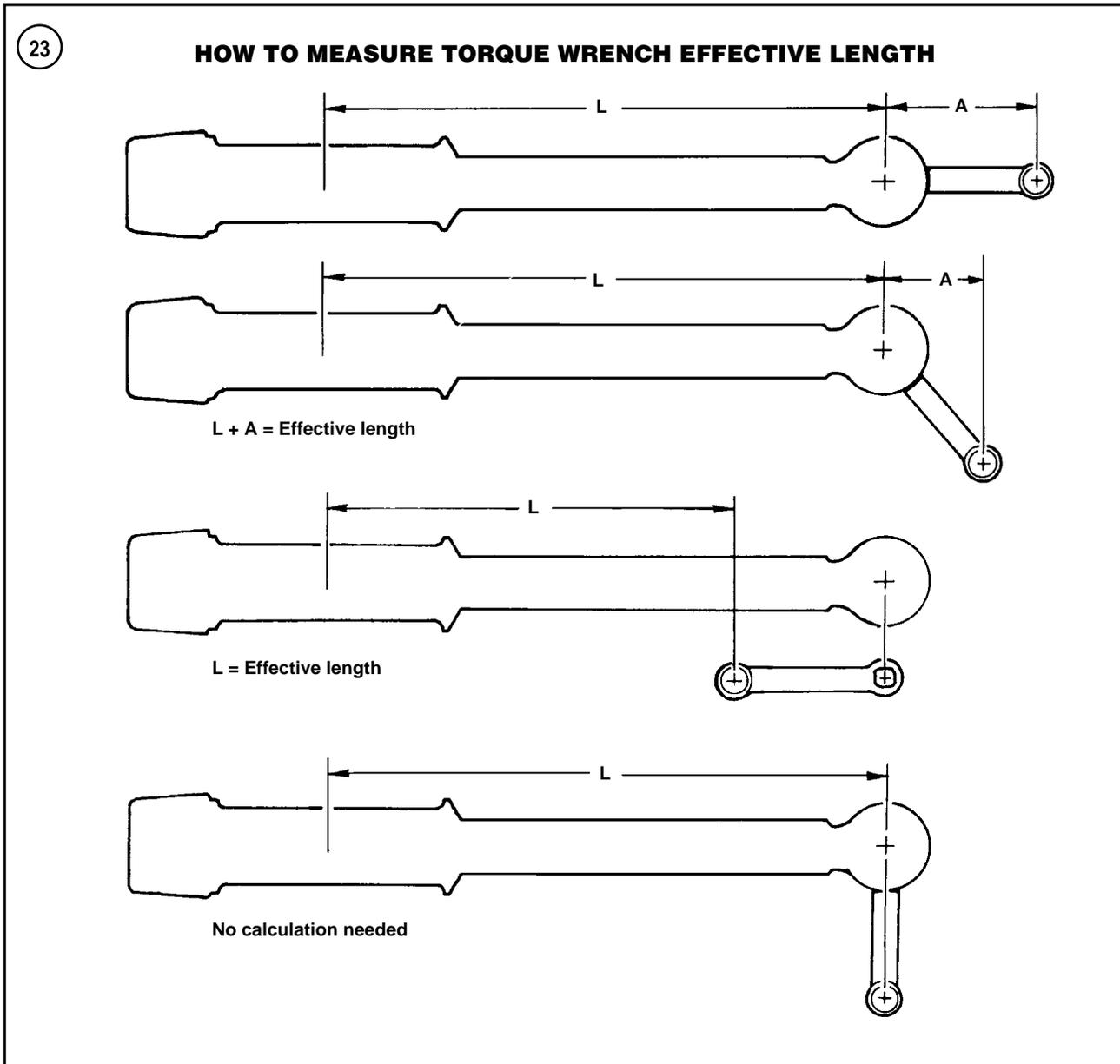
When choosing a torque wrench, consider the torque range, drive size and accuracy. The torque specifications in this manual indicate the range required.

A torque wrench is a precision tool that must be properly cared for to remain accurate. Store torque wrenches in cases or separate padded drawers within a toolbox. Follow the manufacturer's instructions for their care and calibration.



Torque Adapters

Torque adapters or extensions extend or reduce the reach of a torque wrench. The torque adapter shown in **Figure 22** is used to tighten a fastener that cannot be reached due to the size of the torque wrench head, drive and socket. If a torque adapter changes the effective lever length (**Figure 23**), the torque reading on the wrench will not equal the actual torque applied to the fastener. It is nec-



essary to recalibrate the torque setting on the wrench to compensate for the change of lever length. When a torque adapter is used at a right angle to the drive head, calibration is not required since the effective length has not changed.

To recalculate a torque reading when using a torque adapter, use the following formula and refer to **Figure 23**.

$$TW = \frac{TA \times L}{L + A}$$

$$L + A$$

TW is the torque setting or dial reading on the wrench.

TA is the torque specification and the actual amount of torque that will be applied to the fastener.

A is the amount that the adapter increases (or in some cases reduces) the effective lever length as measured along the centerline of the torque wrench.

L is the lever length of the wrench as measured from the center of the drive to the center of the grip.

The effective length is the sum of L and A.

Example:

TA = 20 ft.-lb.

A = 3 in.

L = 14 in.

$$TW = \frac{20 \times 14}{14 + 3} = \frac{280}{17} = 16.5 \text{ ft. lb.}$$



use them to turn fasteners. **Figure 24** show several types of useful pliers. Each design has a specialized function. Slip-joint pliers are general-purpose pliers used for gripping and bending. Diagonal cutting pliers are needed to cut wire and can be used to remove cotter pins. Needlenose pliers are used to hold or bend small objects. Locking pliers (**Figure 25**), sometimes called Vise-grips, are used to hold objects very tightly. They have many uses ranging from holding two parts together, to gripping the end of a broken stud. Use caution when using locking pliers, as the sharp jaws will damage the objects they hold.



Snap Ring Pliers

Snap ring pliers are specialized pliers with tips that fit into the ends of snap rings to remove and install them.

Snap ring pliers are available with a fixed action (either internal or external) or convertible (one tool works on both internal and external snap rings). They may have fixed tips or interchangeable ones of various sizes and angles. For general use, select a convertible type pliers with interchangeable tips.

WARNING

Snap rings can slip and fly off when they are being removed and installed. Also, the snap ring pliers tips may break. Always wear eye protection when using snap ring pliers.



In this example, the torque wrench would be set to the recalculated torque value (TW = 16.5 ft.-lb.). When using a beam-type wrench, tighten the fastener until the pointer aligns with 16.5 ft.-lb. In this example, although the torque wrench is pre-set to 16.5 ft.-lb., the actual torque is 20 ft.-lb.

Pliers

Pliers come in a wide range of types and sizes. Pliers are useful for holding, cutting, bending and crimping. Do not

Hammers

Various types of hammers (**Figure 26**) are available to fit a number of applications. A ball-peen hammer is used to strike another tool, such as a punch or chisel. Soft-faced hammers are required when a metal object must be struck without damaging it. *Never* use a metal-faced hammer on engine and suspension components, as damage will occur in most cases.

Always wear eye protection when using hammers. Make sure the hammer face is in good condition and the handle is not cracked. Select the correct hammer for the job and make sure to strike the object squarely. Do not use the handle or the side of the hammer to strike an object.

SPECIAL TOOLS

Many of the procedures in this manual require special tools. These are described in the appropriate chapter and are available from either the manufacturer or a tool supplier. See **Table 12**.

In many cases, an acceptable substitute may be found in an existing tool kit. Another alternative is to make the

tool. Many schools with a machine shop curriculum welcome outside work that can be used as practical shop applications for students.

PRECISION MEASURING TOOLS

The ability to accurately measure components is essential to successful service and repair. Equipment is manufactured to close tolerances, and obtaining consistently accurate measurements is essential to determining which components require replacement or further service.

Each type of measuring instrument is designed to measure a dimension with a certain degree of accuracy and within a certain range. When selecting the measuring tool, make sure it is applicable to the task.

As with all tools, measuring tools provide the best results if cared for properly. Improper use can damage the tool and result in inaccurate results. If any measurement is questionable, verify the measurement using another tool. A standard gauge is usually provided with measuring tools to check accuracy and calibrate the tool if necessary.

Precision measurements can vary according to the experience of the person performing the procedure. Accurate results are only possible if the mechanic possesses a feel for using the tool. Heavy-handed use of measuring tools will produce less accurate results. Hold the tool gently by the fingertips so the point at which the tool contacts the object is easily felt. This feel for the equipment will produce more accurate measurements and reduce the risk of damaging the tool or component. Refer to the following sections for specific measuring tools.

Feeler Gauge

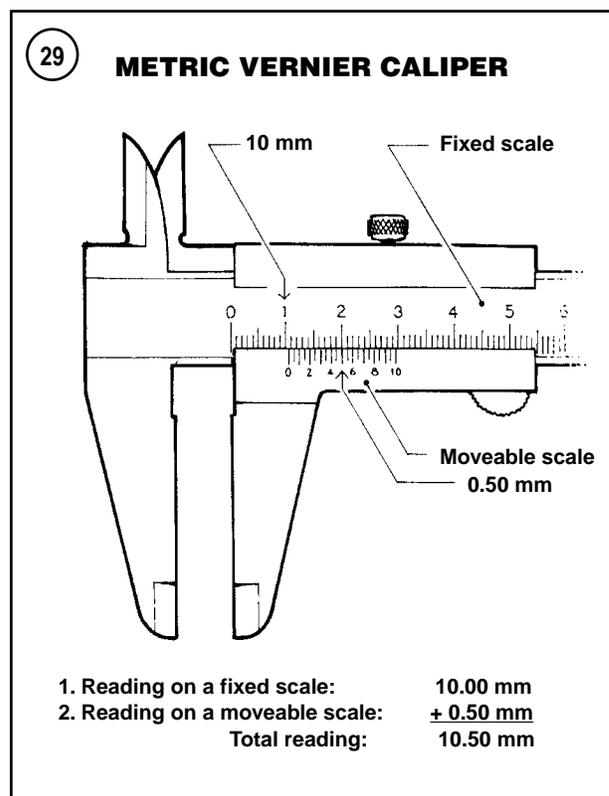
The feeler or thickness gauge (**Figure 27**) is used for measuring the distance between two surfaces.

A feeler gauge set consists of an assortment of steel strips of graduated thickness. Each blade is marked with its thickness. Blades can be of various lengths and angles for different procedures.

A common use for a feeler gauge is to measure valve clearance. Wire (round) type gauges are used to measure spark plug gap.

Calipers

Calipers (**Figure 28**) are excellent tools for obtaining inside, outside and depth measurements. Although not as precise as a micrometer, they allow reasonable precision, typically to within 0.05 mm (0.001 in.). Most calipers have a range up to 150 mm (6 in.).



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DECIMAL PLACE VALUES*

0.1	Indicates 1/10 (one tenth of an inch or millimeter)
0.010	Indicates 1/100 (one one-hundredth of an inch or millimeter)
0.001	Indicates 1/1,000 (one one-thousandth of an inch or millimeter)

*This chart represents the values of figures placed to the right of the decimal point. Use it when reading decimals from one-tenth to one one-thousandth of an inch or millimeter. It is not a conversion chart (for example: 0.001 in. is not equal to 0.001 mm).

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Calipers are available in dial, vernier or digital versions. Dial calipers have a dial readout that provides convenient reading. Vernier calipers have marked scales that must be compared to determine the measurement. The digital caliper uses an LCD to show the measurement.

Properly maintain the measuring surfaces of the caliper. There must not be any dirt or burrs between the tool and the object being measured. Never force the caliper closed around an object; close the caliper around the highest point so it can be removed with a slight drag. Some calipers require calibration. Always refer to the manufacturer's instructions when using a new or unfamiliar caliper.

To read a vernier caliper, refer to **Figure 29**. The fixed scale is marked in 1.0 mm increments. Ten individual lines on the fixed scale equal 1 cm. The moveable scale is marked in 0.05 mm (hundredth) increments. To obtain a reading, establish the first number by the location of the 0 line on the movable scale in relation to the first line to the left on the fixed scale. In this example, the number is 10 mm. To determine the next number, note which of the lines on the movable scale align with a mark on the fixed scale. A number of lines will seem close, but only one will

align exactly. In this case, 0.50 mm is the reading to add to the first number. The result of adding 10 mm and 0.50 mm is a measurement of 10.50 mm.

Micrometers

A micrometer is an instrument designed for linear measurement using the decimal divisions of the inch or meter (**Figure 30**). While there are many types and styles of micrometers, most of the procedures in this manual call for an outside micrometer. The outside micrometer is used to measure the outside diameter of cylindrical forms and the thickness of materials.

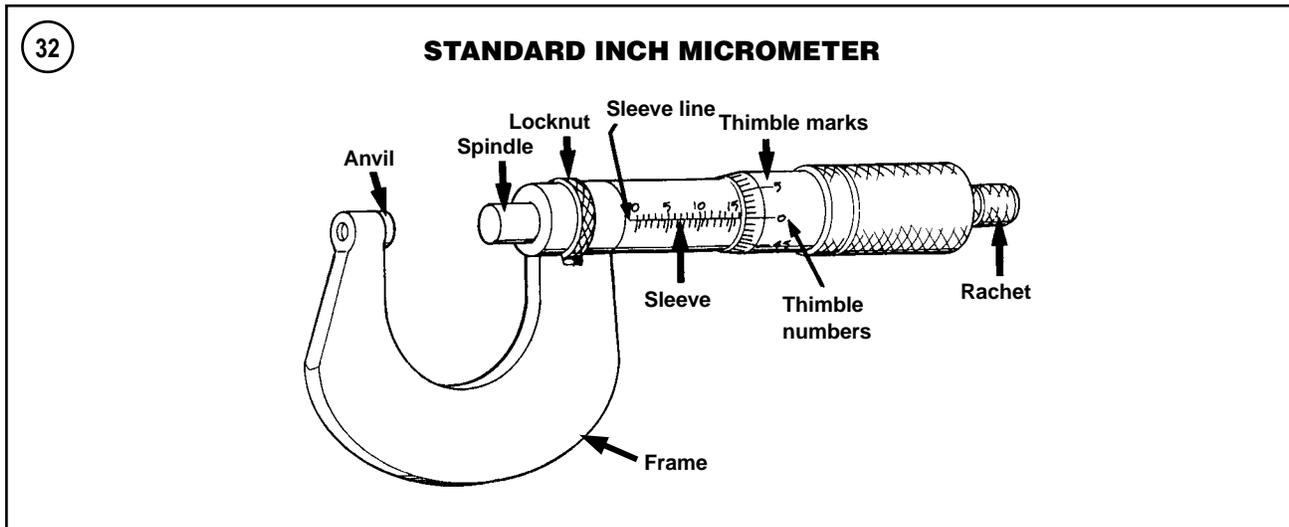
A micrometer's size indicates the minimum and maximum size of a part that it can measure. The usual sizes (**Figure 31**) are 0-1 in. (0-25 mm), 1-2 in. (25-50 mm), 2-3 in. (50-75 mm) and 3-4 in. (75-100 mm).

Micrometers that cover a wider range of measurements are available. These use a large frame with interchangeable anvils of various lengths. This type of micrometer offers a cost savings, however, its overall size may make it less convenient.

Reading a Micrometer

When reading a micrometer, numbers are taken from different scales and added together. The following sections describe how to read the measurements of various types of outside micrometers.

For accurate results, properly maintain the measuring surfaces of the micrometer. There cannot be any dirt or burrs between the tool and the measured object. Never force the micrometer closed around an object. Close the micrometer around the highest point so it can be removed with a slight drag. **Figure 32** shows the markings and parts



of a standard inch micrometer. Be familiar with these terms before using a micrometer in the follow sections.

Standard inch micrometer

The standard inch micrometer is accurate to one-thousandth of an inch or 0.001. The sleeve is marked in 0.025 in. increments. Every fourth sleeve mark is numbered 1, 2, 3, 4, 5, 6, 7, 8, 9. These numbers indicate 0.100, 0.200, 0.300, and so on.

The tapered end of the thimble has 25 lines marked around it. Each mark equals 0.001 in. One complete turn of the thimble will align its zero mark with the first mark on the sleeve or 0.025 in.

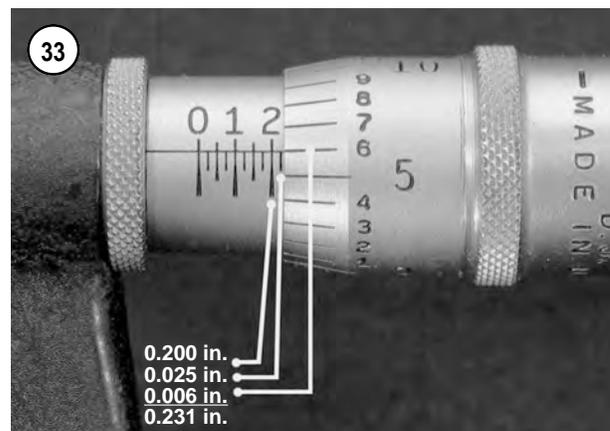
To read a standard inch micrometer, perform the following steps and refer to **Figure 33**.

1. Read the sleeve and find the largest number visible. Each sleeve number equals 0.100 in.
2. Count the number of lines between the numbered sleeve mark and the edge of the thimble. Each sleeve mark equals 0.025 in.
3. Read the thimble mark that aligns with the sleeve line. Each thimble mark equals 0.001 in.

NOTE

If a thimble mark does not align exactly with the sleeve line, estimate the amount between the lines. For accurate readings in ten-thousandths of an inch (0.0001 in.), use a vernier inch micrometer.

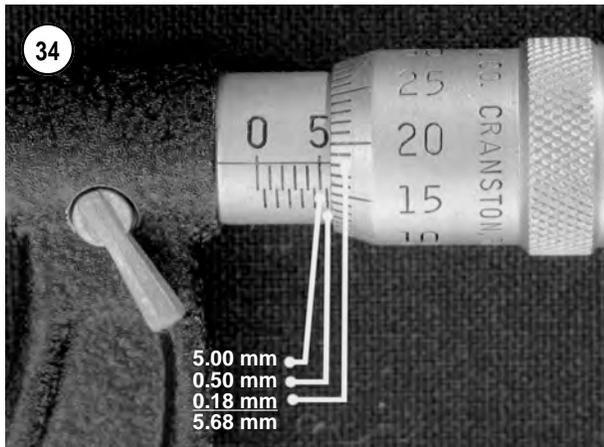
4. Add the readings from Steps 1-3.



Metric micrometer

The standard metric micrometer (**Figure 34**) is accurate to one one-hundredth of a millimeter (0.01-mm). The sleeve line is graduated in millimeter and half millimeter increments. The marks on the upper half of the sleeve line equal 1.00 mm. Every fifth mark above the sleeve line is identified with a number. The number sequence depends on the size of the micrometer. A 0-25 mm micrometer, for example, will have sleeve marks numbered 0 through 25 in 5 mm increments. This numbering sequence continues with larger micrometers. On all metric micrometers, each mark on the lower half of the sleeve equals 0.50 mm.

The tapered end of the thimble has 50 lines marked around it. Each mark equals 0.01 mm. One complete turn of the thimble aligns its 0 mark with the first line on the lower half of the sleeve line or 0.50 mm.



To read a metric micrometer, add the number of millimeters and half-millimeters on the sleeve line to the number of one one-hundredth millimeters on the thimble. Perform the following steps and refer to **Figure 34**.

1. Read the upper half of the sleeve line and count the number of lines visible. Each upper line equals 1 mm.
2. See if the half-millimeter line is visible on the lower sleeve line. If so, add 0.50 mm to the reading from Step 1.
3. Read the thimble mark that aligns with the sleeve line. Each thimble mark equals 0.01 mm.

NOTE

If a thimble mark does not align exactly with the sleeve line, estimate the amount between the lines. For accurate readings in two-thousandths of a millimeter (0.002 mm), use a metric vernier micrometer.

4. Add the readings from Steps 1-3.

Micrometer Adjustment

Before using a micrometer, check its adjustment as follows.

1. Clean the anvil and spindle faces.
- 2A. To check a 0-1 in. or 0-25 mm micrometer:
 - a. Turn the thimble until the spindle contacts the anvil. If the micrometer has a ratchet stop, use it to ensure the proper amount of pressure is applied.
 - b. If the adjustment is correct, the 0 mark on the thimble will align exactly with the 0 mark on the sleeve line. If the marks do not align, the micrometer is out of adjustment.
 - c. Follow the manufacturer's instructions to adjust the micrometer.
- 2B. To check a micrometer larger than 1 in. or 25 mm, use the standard gauge supplied by the manufacturer. A standard gauge is a steel block, disc or rod that is machined to an exact size.
 - a. Place the standard gauge between the spindle and anvil, and measure its outside diameter or length. If the micrometer has a ratchet stop, use it to ensure the proper amount of pressure is applied.
 - b. If the adjustment is correct, the 0 mark on the thimble will align exactly with the 0 mark on the sleeve line. If the marks do not align, the micrometer is out of adjustment.
 - c. Follow the manufacturer's instructions to adjust the micrometer.

Micrometer Care

Micrometers are precision instruments. They must be used and maintained with great care. Note the following:

1. Store micrometers in protective cases or separate padded drawers in a toolbox.
2. When in storage, make sure the spindle and anvil faces do not contact each other or an other object. If they do, temperature changes and corrosion may damage the contact faces.
3. Do not clean a micrometer with compressed air. Dirt forced into the tool will cause wear.
4. Lubricate micrometers with WD-40 to prevent corrosion.

Telescoping and Small Bore Gauges

Use telescoping gauges (**Figure 35**) and small hole gauges (**Figure 36**) to measure bores. Neither gauge has a scale for direct readings. An outside micrometer must be used to determine the reading.

To use a telescoping gauge, select the correct size gauge for the bore. Compress the movable post and carefully insert the gauge into the bore. Carefully move the gauge in the bore to make sure it is centered. Tighten the knurled end of the gauge to hold the movable post in position. Remove the gauge and measure the length of the posts. Telescoping gauges are typically used to measure cylinder bores.

To use a small-bore gauge, select the correct size gauge for the bore. Carefully insert the gauge into the bore. Tighten the knurled end of the gauge to carefully expand the gauge fingers to the limit within the bore. Do not overtighten the gauge, as there is no built-in release. Excessive tightening can damage the bore surface and damage the tool. Remove the gauge and measure the outside dimension (**Figure 37**). Small hole gauges are typically used to measure valve guides.

Dial Indicator

A dial indicator (**Figure 38**) is a gauge with a dial face and needle used to measure variations in dimensions and movements. Measuring brake rotor runout is a typical use for a dial indicator.

Dial indicators are available in various ranges and graduations, and with three basic types of mounting bases: magnetic, clamp, or screw-in stud. When purchasing a dial indicator, select the magnetic stand type with a continuous dial.

Cylinder Bore Gauge

A cylinder bore gauge is similar to a dial indicator. The gauge set shown in **Figure 39** consists of a dial indicator, handle and different length adapters (anvils) to fit the gauge to various bore sizes. The bore gauge is used to measure bore size, taper and out-of-round. When using a bore gauge, follow the manufacturer's instructions.

Compression Gauge

A compression gauge (**Figure 40**) measures combustion chamber (cylinder) pressure, usually in psi or kg/cm². The gauge adapter is either inserted or screwed into the spark plug hole to obtain the reading. Disable the engine so it will not start and hold the throttle in the wide-open position when performing a compression test. An engine that does not have adequate compression cannot be properly tuned. See Chapter Three.



Multimeter

A multimeter (**Figure 41**) is an essential tool for electrical system diagnosis. The voltage function indicates the voltage applied or available to various electrical components. The ohmmeter function tests circuits for continuity, or lack of continuity, and measures the resistance of a circuit.

Some manufacturers' specifications for electrical components are based on results using a specific test meter. Results may vary if using a meter not recommended by the



manufacturer is used. Such requirements are noted when applicable.

Ohmmeter (analog) calibration

Each time an analog ohmmeter is used or if the scale is changed, the ohmmeter must be calibrated. Digital ohmmeters do not require calibration.

1. Make sure the meter battery is in good condition.
2. Make sure the meter probes are in good condition.

3. Touch the two probes together and watch the needle location on the ohms scale. The needle must align with the 0 mark to obtain accurate measurements.

4. If necessary, rotate the meter ohms adjust knob until the needle and 0 mark align.

ELECTRICAL SYSTEM FUNDAMENTALS

A thorough study of the many types of electrical systems used in today's motorcycles is beyond the scope of this manual. However, an understanding of electrical basics is necessary to perform simple diagnostic tests.

Voltage

Voltage is the electrical potential or pressure in an electrical circuit and is expressed in volts. The more pressure (voltage) in a circuit, the more work can be performed.

Direct current (DC) voltage means the electricity flows in one direction. All circuits powered by a battery are DC circuits.

Alternating current (AC) means the electricity flows in one direction momentarily then switches to the opposite direction. Alternator output is an example of AC voltage. This voltage must be changed or rectified to direct current to operate in a battery powered system.

Measuring voltage

Unless otherwise specified, perform all voltage tests with the electrical connectors attached. When measuring voltage, select the meter range that is one scale higher than the expected voltage of the circuit to prevent damage to the meter. To determine the actual voltage in a circuit, use a voltmeter. To simply check if voltage is present, use a test light.

NOTE

When using a test light, either lead can be attached to ground.

1. Attach the negative meter test lead to a good ground (bare metal). Make sure the ground is not insulated with a rubber gasket or grommet.
2. Attach the positive meter test lead to the point being checked for voltage (**Figure 42**).
3. Turn on the ignition switch. The test light should light or the meter should display a reading. The reading should be within one volt of battery voltage. If the voltage is less, there is a problem in the circuit.

Voltage drop test

Resistance causes voltage to drop. This resistance can be measured in an active circuit by using a voltmeter to perform a voltage drop test. A voltage drop test compares the difference between the voltage available at the start of a circuit to the voltage at the end of the circuit while the circuit is operational. If the circuit has no resistance, there will be no voltage drop. The greater the resistance, the greater the voltage drop will be. A voltage drop of one volt or more indicates excessive resistance in the circuit.

1. Connect the positive meter test lead to the electrical source (where electricity is coming from).
2. Connect the negative meter test lead to the electrical load (where electricity is going). See **Figure 43**.
3. If necessary, activate the component(s) in the circuit.
4. A voltage reading of 1 volt or more indicates excessive resistance in the circuit. A reading equal to battery voltage indicates an open circuit.

Resistance

Resistance is the opposition to the flow of electricity within a circuit or component and is measured in ohms. Resistance causes a reduction in available current and voltage.

Resistance is measured in an *inactive* circuit with an ohmmeter. The ohmmeter sends a small amount of current into the circuit and measures how difficult it is to push the current through the circuit.

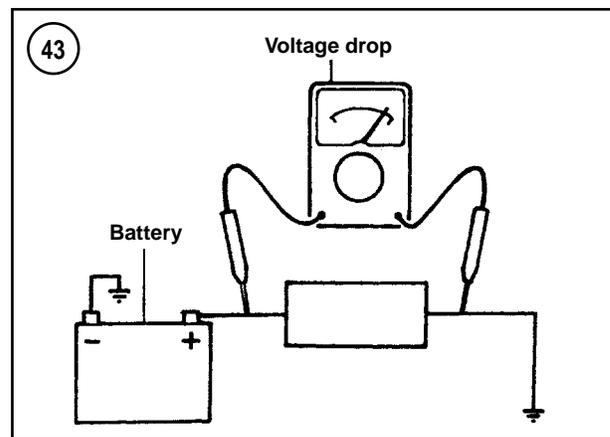
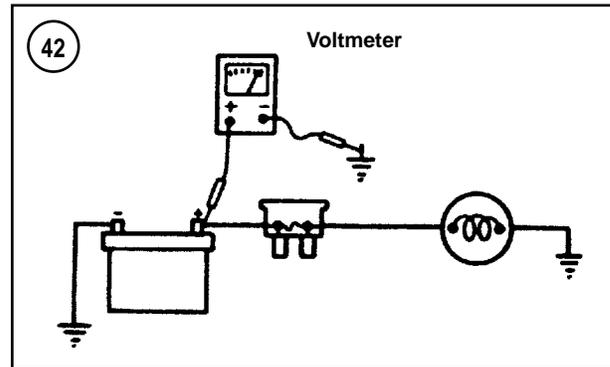
An ohmmeter, although useful, is not always a good indicator of a circuit's actual ability under *operating* conditions. This is due to the low voltage (6-9 volts) that the meter uses to test the circuit. The voltage in an ignition coil secondary winding can be several thousand volts. Such high voltage can cause the coil to malfunction, even though it tests acceptable during a resistance test.

Resistance generally increases with temperature. Perform all testing with the component or circuit at room temperature. Resistance tests performed at high temperatures may indicate high resistance readings and result in the unnecessary replacement of a component.

Measuring resistance and continuity testing

CAUTION

*Only use an ohmmeter on a circuit that has no voltage present. The meter will be damaged if it is connected to a live circuit. An analog meter must be calibrated each time it is used or the scale is changed. See **Multimeter** in this chapter.*

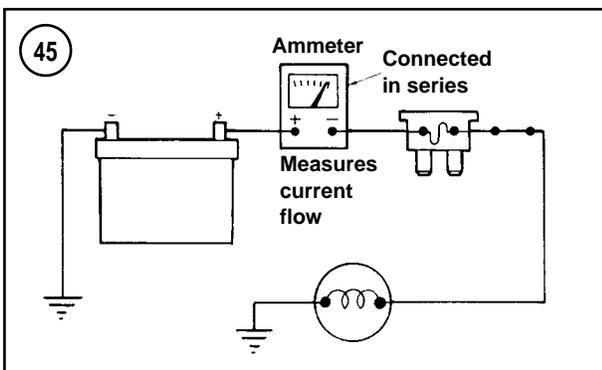
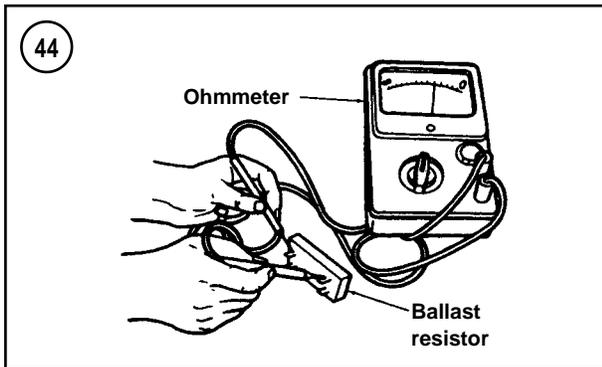


A continuity test can determine if the circuit is complete. This type of test is performed with an ohmmeter or a self-powered test lamp.

1. Disconnect the negative battery cable.
2. Attach one test lead (ohmmeter or test light) to one end of the component or circuit.
3. Attach the other test lead to the opposite end of the component or circuit (**Figure 44**).
4. A self-powered test light will come on if the circuit has continuity or is complete. An ohmmeter will indicate either low or no resistance if the circuit has continuity. An open circuit is indicated if the meter displays infinite resistance.

Amperage

Amperage is the unit of measurement for the amount of current within a circuit. Current is the actual flow of electricity. The higher the current, the more work that can be performed up to a given point. If the current flow exceeds the circuit or component capacity, the system will be damaged.



Measuring amps

An ammeter measures the current flow or amps of a circuit (**Figure 45**). Amperage measurement requires that the circuit be disconnected and the ammeter be connected in series to the circuit. Always use an ammeter that can read higher than the anticipated current flow to prevent damage to the meter. Connect the red test lead to the electrical source and the black test lead to the electrical load.

BASIC SERVICE METHODS

Most of the procedures in this manual are straightforward and can be performed by anyone reasonably competent with tools. However, consider personal capabilities carefully before attempting any operation involving major disassembly of the engine.

1. Front, in this manual, refers to the front of the motorcycle. The front of any component is the end closest to the front of the motorcycle. The left and right sides refer to the position of the parts as viewed by the rider sitting on the seat facing forward.
2. Whenever servicing an engine or suspension component, secure the motorcycle in a safe manner.

3. Tag all similar parts for location and mark all mating parts for position. Record the number and thickness of shims as they are removed. Identify parts by placing them in sealed and labeled plastic sandwich bags.
4. Tag disconnected wires and connectors with masking tape and a marking pen. Do not rely on memory alone.
5. Protect finished surfaces from physical damage or corrosion. Keep gasoline and other chemicals off painted surfaces.
6. Use penetrating oil on frozen or tight bolts. Avoid using heat where possible. Heat can warp, melt or affect the temper of parts. Heat also damages the finish of paint and plastics.
7. When a part is a press fit or requires a special tool for removal, the information or type of tool is identified in the text. Otherwise, if a part is difficult to remove or install, determine the cause before proceeding.
8. To prevent objects or debris from falling into the engine, cover all openings.
9. Read each procedure thoroughly and compare the illustrations to the actual components before starting the procedure. Perform the procedure in sequence.
10. Recommendations are occasionally made to refer service to a dealership or specialist. In these cases, the work can be performed more economically by the specialist than by a home mechanic.
11. The term *replace* means to discard a defective part and replace it with a new part. *Overhaul* means to remove, disassemble, inspect, measure, repair and/or replace parts as required to recondition an assembly.
12. Some operations require the use of a hydraulic press. If a press is not available, have these operations performed by a shop equipped with the necessary equipment. Do not use makeshift equipment that may damage the motorcycle.
13. Repairs are much faster and easier if the motorcycle is clean before starting work. Degrease the motorcycle with a commercial degreaser; follow the directions on the container for the best results. Clean all parts with cleaning solvent as they are removed.

CAUTION

Do not direct high-pressure water at steering bearings, carburetor hoses, wheel bearings, and suspension and electrical components. The water will force the grease out of the bearings and possibly damage the seals.

14. If special tools are required, have them available before starting the procedure. When special tools are required, they will be described at the beginning of the procedure.

15. Make diagrams of similar-appearing parts. For instance, crankcase bolts are often not the same lengths. Do not rely on memory alone. It is possible that carefully laid out parts will become disturbed, making it difficult to reassemble the components correctly without a diagram.

16. Make sure all shims and washers are reinstalled in the same location and position.

17. Whenever rotating parts contact a stationary part, look for a shim or washer.

18. Use new gaskets if there is any doubt about the condition of old ones.

19. If self-locking fasteners are used, replace them with new ones. Do not install standard fasteners in place of self-locking ones.

20. Use grease to hold small parts in place if they tend to fall out during assembly. Do not apply grease to electrical or brake components.

Removing Frozen Fasteners

If a fastener cannot be removed, several methods may be used to loosen it. First, apply penetrating oil such as Liquid Wrench or WD-40. Apply it liberally and let it penetrate for 10-15 minutes. Rap the fastener several times with a small hammer. Do not hit it hard enough to cause damage. Reapply the penetrating oil if necessary.

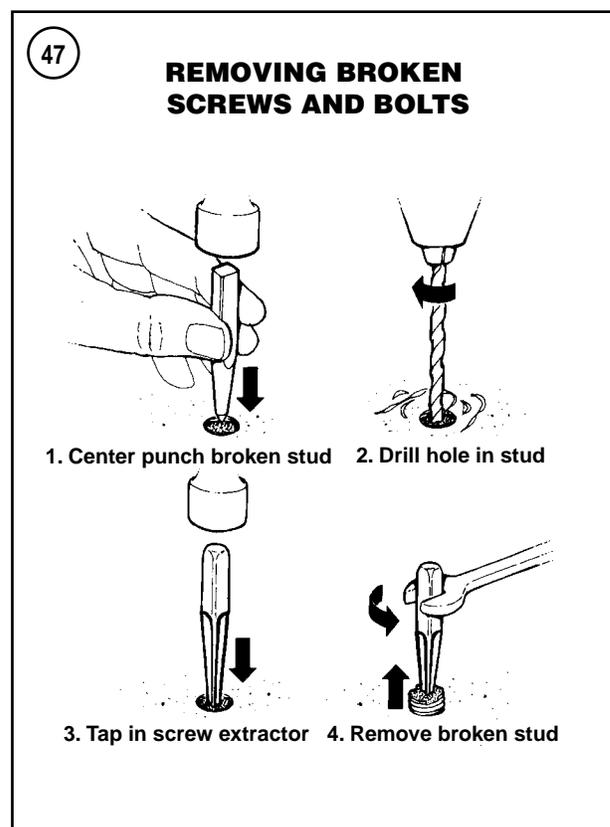
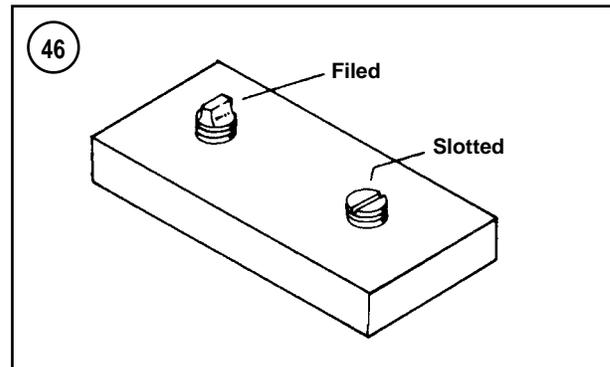
For frozen screws, apply penetrating oil as described, then insert a screwdriver in the slot and rap the top of the screwdriver with a hammer. This loosens the rust so the screw can be removed in the normal way. If the screw head is too damaged to use this method, grip the head with locking pliers and twist the screw out.

Avoid applying heat unless specifically instructed, as it may melt, warp or remove the temper from parts.

Removing Broken Fasteners

If the head breaks off a screw or bolt, several methods are available for removing the remaining portion. If a large portion of the remainder projects out, try gripping it with locking pliers. If the projecting portion is too small, file it to fit a wrench or cut a slot in it to fit a screwdriver (**Figure 46**).

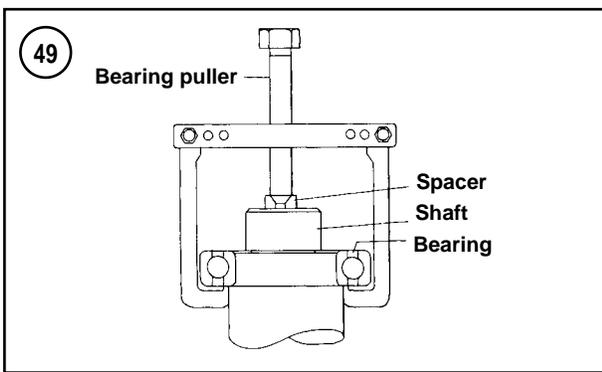
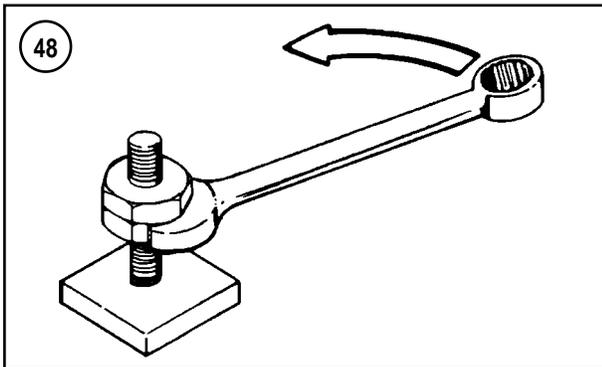
If the head breaks off flush, use a screw extractor. To do this, centerpunch the exact center of the remaining portion of the screw or bolt. Drill a small hole in the screw and tap the extractor into the hole. Back the screw out with a wrench on the extractor (**Figure 47**).



Repairing Damaged Threads

Occasionally, threads are stripped through carelessness or impact damage. Often the threads can be repaired by running a tap (for internal threads on nuts) or die (for external threads on bolts) through the threads. To clean or repair spark plug threads, use a spark plug tap.

If an internal thread is damaged, it may be necessary to install a Helicoil or some other type of thread insert. Follow the manufacturer's instructions when installing their insert.



If it is necessary to drill and tap a hole, refer to **Table 10** and **Table 11** for tap and drill sizes.

Stud Removal/Installation

A stud removal tool is available from most tool suppliers. This tool makes the removal and installation of studs easier. If one is not available, thread two nuts onto the stud and tighten them against each other. Remove the stud by turning the lower nut (**Figure 48**).

1. Measure the height of the stud above the surface.
2. Thread the stud removal tool onto the stud and tighten it, or thread two nuts onto the stud.
3. Remove the stud by turning the stud remover or the lower nut.
4. Remove any threadlocking compound from the threaded hole. Clean the threads with an aerosol parts cleaner.
5. Install the stud removal tool onto the new stud or thread two nuts onto the stud.
6. Apply threadlocking compound to the threads of the stud.
7. Install the stud and tighten with the stud removal tool or the top nut.

8. Install the stud to the height noted in Step 1 or its torque specification.
9. Remove the stud removal tool or the two nuts.

Removing Hoses

When removing stubborn hoses, do not exert excessive force on the hose or fitting. Remove the hose clamp and carefully insert a small screwdriver or pick tool between the fitting and hose. Apply a spray lubricant under the hose and carefully twist the hose off the fitting. Clean the fitting of any corrosion or rubber hose material with a wire brush. Clean the inside of the hose thoroughly. Do not use any lubricant when installing the hose (new or old). The lubricant may allow the hose to come off the fitting, even with the clamp secure.

Bearings

Bearings are used in the engine and transmission assembly to reduce power loss, heat and noise caused by friction. Because bearings are precision parts, they must be maintained by proper lubrication and maintenance. If a bearing is damaged, replace it immediately. When installing a new bearing, take care to prevent damaging it. Bearing replacement procedures are included in the individual chapters where applicable; however, use the following sections as a guideline.

NOTE

Unless otherwise specified, install bearings with the manufacturer's mark or number facing outward.

Removal

While bearings are normally removed only when damaged, there may be times when it is necessary to remove a bearing that is in good condition. Improper bearing removal will damage the bearing and maybe the shaft or case half. Note the following when removing bearings.

1. When using a puller to remove a bearing from a shaft, take care that the shaft is not damaged. Always place a piece of metal between the end of the shaft and the puller screw. In addition, place the puller arms next to the inner bearing race. See **Figure 49**.
2. When using a hammer to remove a bearing from a shaft, do not strike the hammer directly against the shaft. Instead, use a brass or aluminum spacer between the hammer and shaft (**Figure 50**) and make sure to support both bearing races with wooden blocks as shown.

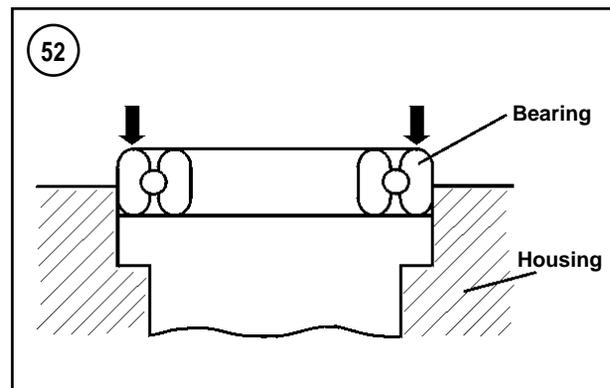
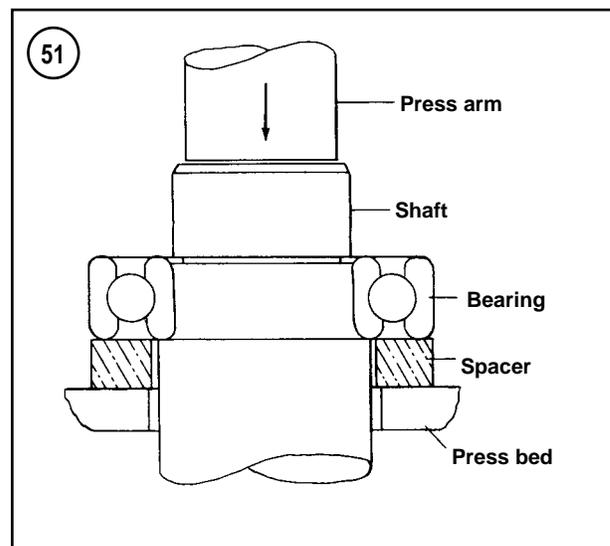
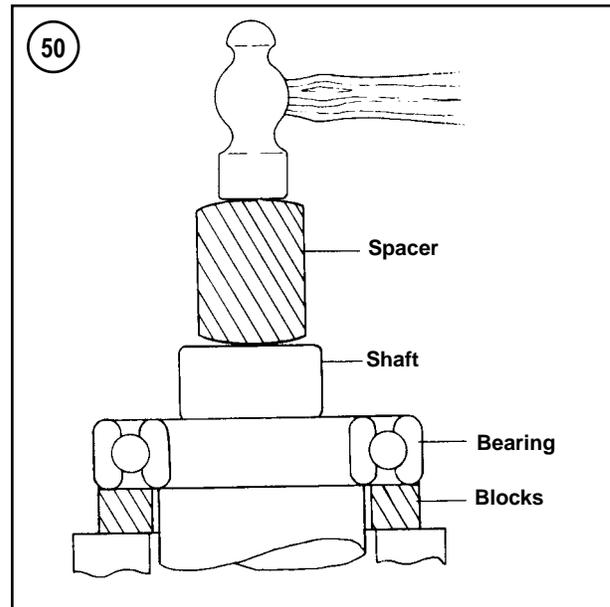
3. The ideal method of bearing removal is with a hydraulic press. Note the following when using a press:
 - a. Always support the inner and outer bearing races with a suitable size wooden or aluminum ring (**Figure 51**). If only the outer race is supported, pressure applied against the balls and/or the inner race will damage them.
 - b. Always make sure the press arm (**Figure 51**) aligns with the center of the shaft. If the arm is not centered, it may damage the bearing and/or shaft.
 - c. The moment the shaft is free of the bearing, it will drop to the floor. Secure or hold the shaft to prevent it from falling.

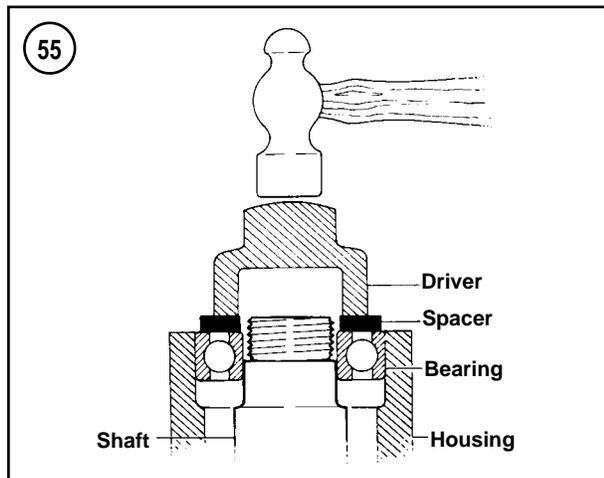
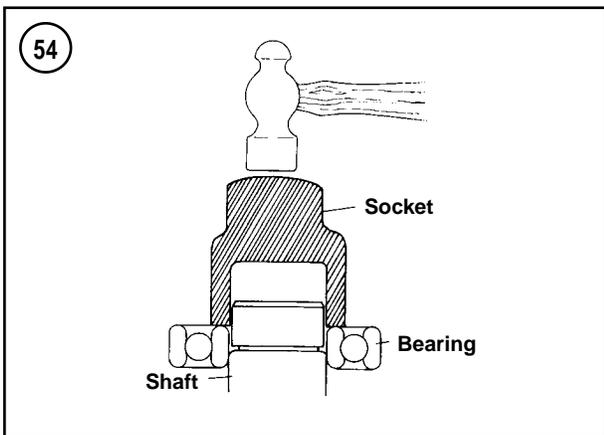
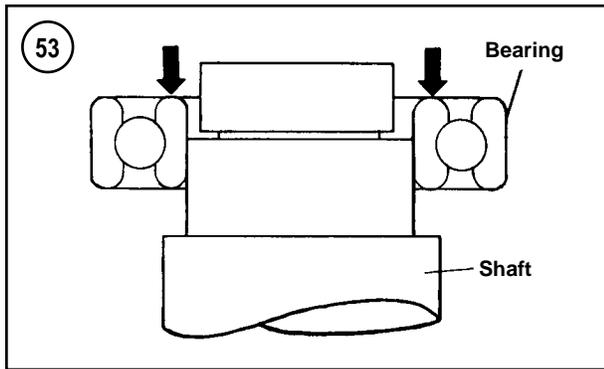
Installation

1. When installing a bearing in a housing, apply pressure to the *outer* bearing race (**Figure 52**). When installing a bearing on a shaft, apply pressure to the *inner* bearing race (**Figure 53**).
2. To install a bearing as described in Step 1, some type of driver is required. Never strike the bearing directly with a hammer or the bearing will be damaged. When installing a bearing, use a piece of pipe or a driver with a diameter that matches the bearing inner race. **Figure 54** shows the correct way to use a driver and hammer to install a bearing.
3. Step 1 describes how to install a bearing in a case half or over a shaft. However, to install a bearing over a shaft and into a housing at the same time, a tight fit will be required for both outer and inner bearing races. In this situation, install a spacer underneath the driver tool so that pressure is applied evenly across both races. See **Figure 55**. If the outer race is not supported as shown in **Figure 55**, the balls will push against the outer bearing race and damage it.

Interference fit

1. Follow this procedure to install a bearing over a shaft. When a tight fit is required, the bearing inside diameter will be smaller than the shaft. In this case, driving the bearing on the shaft using normal methods may cause bearing damage. Instead, heat the bearing before installation. Note the following:
 - a. Secure the shaft so it is ready for bearing installation.
 - b. Clean all residues from the bearing surface of the shaft. Remove burrs with a file or sandpaper.
 - c. Fill a suitable pot or beaker with clean mineral oil. Place a thermometer rated above 120° C (248° F) in the oil. Support the thermometer so that it does not rest on the bottom or side of the pot.





- d. Remove the bearing from its wrapper and secure it with a piece of heavy wire bent to hold it in the pot. Hang the bearing in the pot so it does not touch the bottom or sides of the pot.
- e. Turn the heat on and monitor the thermometer. When the oil temperature rises to approximately

120° C (248° F), remove the bearing from the pot and quickly install it. If necessary, place a socket on the inner bearing race and tap the bearing into place. As the bearing chills, it will tighten on the shaft, so installation must be done quickly. Make sure the bearing is installed completely.

2. Follow this step to install a bearing in a housing. Bearings are generally installed in a housing with a slight interference fit. Driving the bearing into the housing using normal methods may damage the housing or cause bearing damage. Instead, heat the housing before the bearing is installed. Note the following:

CAUTION

Before heating the housing in this procedure, wash the housing thoroughly with detergent and water. Rinse and rewash the cases as required to remove all traces of oil and other chemical deposits.

- a. Heat the housing to approximately 100° C (212° F) in an oven or on a hot plate. An easy way to check that it is the proper temperature is to place tiny drops of water on the housing; if they sizzle and evaporate immediately, the temperature is correct. Heat only one housing at a time.

CAUTION

Do not heat the housing with a propane or acetylene torch. Never bring a flame into contact with the bearing or housing. The direct heat will destroy the case hardening of the bearing and will likely warp the housing.

- b. Remove the housing from the oven or hot plate, and hold onto the housing with a kitchen potholder, heavy gloves or heavy shop cloth. It is hot!

NOTE

Remove and install the bearings with a suitable size socket and extension.

- c. Hold the housing with the bearing side down and tap the bearing out. Repeat for all bearings in the housing.
- d. Before heating the bearing housing, place the new bearing in a freezer if possible. Chilling a bearing slightly reduces its outside diameter while the heated bearing housing assembly is slightly larger due to heat expansion. This will make bearing installation easier.

NOTE

Always install bearings with the manufacturer's mark or number facing outward.

- e. While the housing is still hot, install the new bearing(s) into the housing. Install the bearings by hand, if possible. If necessary, lightly tap the bearing(s) into the housing with a socket placed on the outer bearing race (**Figure 53**). Do not install new bearings by driving on the inner-bearing race. Install the bearing(s) until it seats completely.

Seal Replacement

Seals (**Figure 56**) are used to contain oil, water, grease or combustion gasses in a housing or shaft. Improper removal of a seal can damage the housing or shaft. Improper installation of the seal can damage the seal. Note the following:

1. Prying is generally the easiest and most effective method of removing a seal from a housing. However, always place a rag underneath the pry tool (**Figure 57**) to prevent damage to the housing.
2. Pack waterproof grease in the seal lips before the seal is installed.
3. In most cases, install seals with the manufacturer's numbers or marks face out.
4. Install seals with a socket placed on the outside of the seal as shown in **Figure 58**. Drive the seal squarely into the housing. Never install a seal by hitting against the top of the seal with a hammer.

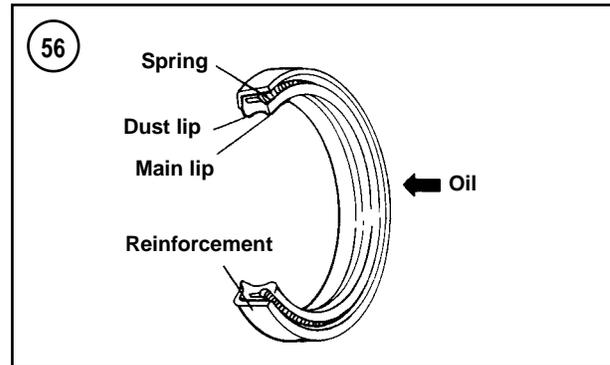
STORAGE

Several months of non-use can cause a general deterioration of the motorcycle. This is especially true in areas of extreme temperature variations. This deterioration can be minimized with careful preparation for storage. A properly stored motorcycle will be much easier to return to service.

Storage Area Selection

When selecting a storage area, consider the following:

1. The storage area must be dry. A heated area is best, but not necessary. It should be insulated to minimize extreme temperature variations.
2. If the building has large window areas, mask them to keep sunlight off the motorcycle.
3. Avoid buildings in industrial areas where corrosive emissions may be present. Avoid areas close to saltwater.
4. Consider the area's risk of fire, theft or vandalism. Check with an insurer regarding motorcycle coverage while in storage.



Preparing the Motorcycle for Storage

The amount of preparation a motorcycle should undergo before storage depends on the expected length of non-use, storage area conditions and personal preference. Consider the following list the minimum requirement:

1. Wash the motorcycle thoroughly. Make sure all dirt, mud and road debris are removed.
2. Start the engine and allow it to reach operating temperature. Drain the engine oil and transmission oil, regardless of the riding time since the last service. Fill the engine and transmission with the recommended type of oil.

3. Drain all fuel from the fuel tank, run the engine until all the fuel is consumed from the lines and carburetor or fuel injection module.
4. Remove the spark plugs and pour a teaspoon of engine oil into the cylinders. Place a rag over the openings and slowly turn the engine over to distribute the oil. Reinstall the spark plugs.
5. Remove the battery. Store the battery in a cool and dry location.
6. Cover the exhaust and intake openings.
7. Reduce the normal tire pressure by 20 percent.
8. Apply a protective substance to the plastic and rubber components, including the tires. Make sure to follow the manufacturer's instructions for each type of product being used.
9. Place the motorcycle on a stand or wooden blocks, so the wheels are off the ground. If this is not possible, place a piece of plywood between the tires and the ground. In-

flate the tires to the recommended pressure if the motorcycle can not be elevated.

10. Cover the motorcycle with old bed sheets or something similar. Do not cover it with plastic material that will trap moisture.

Returning the Motorcycle to Service

The amount of service required when returning a motorcycle to service after storage depends on the length of non-use and storage conditions. In addition to performing the reverse of the above procedure, make sure the brakes, clutch, throttle and engine stop switch work properly before operating the motorcycle. Refer to Chapter Three and evaluate the service intervals to determine which areas require service.

Table 1 MODEL DESIGNATION

FLSTC/FLSTCI* Heritage Classic FLSTF/FLSTFI* Fat Boy FLSTS/FLSTSI* Heritage Springer FXST/FXSTI* Softail Standard FXSTB/FXSTBI* Night Train FXSTS/FXSTSI* Springer Softail FXSTD/FXSTDI* Softail Deuce
*The I designation indicates models equipped with fuel injection from 2001-on.

Table 2 GENERAL DIMENSIONS

Item/model	in.	mm
Wheel base		
FLSTC/FLSTCI*	64.5	1638.3
FLSTF/FLSTFI*	64.5	1638.3
FLSTS/FLSTSI*	64.2	1630.7
FXST/FXSTI*	66.9	1699.3
FXSTB/FXSTBI*	66.9	1699.3
FXSTS/FXSTSI*	65.4	1661.2
FXSTD/FXSTDI*	66.6	1691.6
Overall length		
FLSTC/FLSTCI*	94.5	2400.3
FLSTF/FLSTFI*	94.5	2400.3
FLSTS/FLSTSI*	94.1	2390.1
FXST/FXSTI*	95.0	2413.0
FXSTB/FXSTBI*	95.0	2413.0
FXSTS/FXSTSI*	93.5	2374.9
FXSTD/FXSTDI*	95.4	2423.2

(continued)

Table 2 GENERAL DIMENSIONS (continued)

Item/model	in.	mm
Overall width		
FLSTC/FLSTCI*	37.5	952.5
FLSTF/FLSTFI*	40.2	1021.1
FLSTS/FLSTSI*	35.0	889.0
FXST/FXSTI*	37.9	962.66
FXSTB/FXSTBI*	30.9	784.9
FXSTS/FXSTSI*	32.6	828.0
FXSTD/FXSTDI*	35.9	911.9
Road clearance		
FLSTC/FLSTCI*	5.1	129.5
FLSTF/FLSTFI*	5.1	129.5
FLSTS/FLSTSI*	4.9	124.5
FXST/FXSTI*	5.6	142.2
FXSTB/FXSTBI*	5.6	142.2
FXSTS/FXSTSI*	5.4	137.2
FXSTD/FXSTDI*	5.6	142.2
Overall height		
FLSTC/FLSTCI*	57.8	1468.1
FLSTF/FLSTFI*	44.5	1130.3
FLSTS/FLSTSI*	46.0	1168.4
FXST/FXSTI*	46.4	1178.0
FXSTB/FXSTBI*	44.9	1140.0
FXSTS/FXSTSI*	47.3	1201.4
FXSTD/FXSTDI*	46.4	1178.0
Saddle height		
FLSTC/FLSTCI*	25.4	645.2
FLSTF/FLSTFI*	25.5	647.7
FLSTS/FLSTSI*	25.9	657.9
FXST/FXSTI*	26.1	662.9
FXSTB/FXSTBI*	25.2	640.1
FXSTS/FXSTSI*	25.9	657.9
FXSTD/FXSTDI*	26.0	660.4

*The I designation indicates models equipped with fuel injection from 2001-on.

Table 3 MOTORCYCLE WEIGHT (DRY)

Model	lbs.	kg
FLSTC/FLSTCI*	695.6	315.5
FLSTF/FLSTFI*	665	301.6
FLSTS/FLSTSI*	716.6	325
FXST/FXSTI*	628.6	285.1
FXSTB/FXSTBI*	629.6	285.6
FXSTS/FXSTSI*	652.6	296
FXSTD/FXSTDI*	644.6	292.4

*The I designation indicates models equipped with fuel injection from 2001-on.

Table 4 GROSS VEHICLE WEIGHT RATINGS

Model	lbs.	kg
Gross vehicle weight rating (GVWR)¹		
FLSTC/FLSTCI ²	1160	526.1
FLSTF/FLSTFI ²	1160	526.1
FLSTS/FLSTSI ²	1175	532.09
All FXST models	1125	510.3

(continued)

Table 4 GROSS VEHICLE WEIGHT RATINGS (continued)

Model	lbs.	kg
Gross axle weight rating (GAWR)		
Front axle		
All FLST models	430	195
All FXST models	415	188.2
Rear axle		
FLSTC/FLSTCI ²	730	331.1
FLSTF/FLSTFI ²	730	331.1
FLSTS/FLSTSI ²	745	337.9
All FXST models	710	322.1

1. GVWR is the maximum allowable vehicle weight. This includes combined vehicle, rider(s) and accessory weight.
 2. The I designation indicates models equipped with fuel injection from 2001-on.

Table 5 FUEL TANK CAPACITY

Model	U.S. gal	Liters
Total		
FXSTD/FXDT	4.9	18.55
All other models	5.0	18.9
Reserve	0.9	3.4

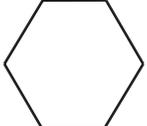
Table 6 DECIMAL AND METRIC EQUIVALENTS

Fractions	Decimal in.	Metric mm	Fractions	Decimal in.	Metric mm
1/64	0.015625	0.39688	33/64	0.515625	13.09687
1/32	0.03125	0.79375	17/32	0.53125	13.49375
3/64	0.046875	1.19062	35/64	0.546875	13.89062
1/16	0.0625	1.58750	9/16	0.5625	14.28750
5/64	0.078125	1.98437	37/64	0.578125	14.68437
3/32	0.09375	2.38125	19/32	0.59375	15.08125
7/64	0.109375	2.77812	39/64	0.609375	15.47812
1/8	0.125	3.1750	5/8	0.625	15.87500
9/64	0.140625	3.57187	41/64	0.640625	16.27187
5/32	0.15625	3.96875	21/32	0.65625	16.66875
11/64	0.171875	4.36562	43/64	0.671875	17.06562
3/16	0.1875	4.76250	11/16	0.6875	17.46250
13/64	0.203125	5.15937	45/64	0.703125	17.85937
7/32	0.21875	5.55625	23/32	0.71875	18.25625
15/64	0.234375	5.95312	47/64	0.734375	18.65312
1/4	0.250	6.35000	3/4	0.750	19.05000
17/64	0.265625	6.74687	49/64	0.765625	19.44687
9/32	0.28125	7.14375	25/32	0.78125	19.84375
19/64	0.296875	7.54062	51/64	0.796875	20.24062
5/16	0.3125	7.93750	13/16	0.8125	20.63750
21/64	0.328125	8.33437	53/64	0.828125	21.03437
11/32	0.34375	8.73125	27/32	0.84375	21.43125
23/64	0.359375	9.12812	55/64	0.859375	22.82812
3/8	0.375	9.52500	7/8	0.875	22.22500
25/64	0.390625	9.92187	57/64	0.890625	22.62187
13/32	0.40625	10.31875	29/32	0.90625	23.01875
27/64	0.421875	10.71562	59/64	0.921875	23.41562
7/16	0.4375	11.11250	15/16	0.9375	23.81250
29/64	0.453125	11.50937	61/64	0.953125	24.20937
15/32	0.46875	11.90625	31/32	0.96875	24.60625
31/64	0.484375	12.30312	63/64	0.984375	25.00312
1/2	0.500	12.70000	1	1.00	25.40000

Table 7 GENERAL TORQUE SPECIFICATIONS

Type ²	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1
SAE 2	6	12	20	32	47	69	96	155	206	310
SAE 5	10	19	33	54	78	114	154	257	382	587
SAE 7	13	25	44	71	110	154	215	360	570	840
SAE 8	14	29	47	78	119	169	230	380	600	700

1. Convert ft.-lb. specification to N•m by multiplying by 1.3558.
 2. Fastener strength of SAE bolts can be determined by the bolt head grade markings. Unmarked bolt heads and cap screws are usually mild steel. More grade markings indicate higher fastener quality.



SAE 2



SAE 5



SAE 7



SAE 8

Table 8 CONVERSION FORMULAS

Multiply:	By:	To get the equivalent of:
Length		
Inches	25.4	Millimeter
Inches	2.54	Centimeter
Miles	1.609	Kilometer
Feet	0.3048	Meter
Millimeter	0.03937	Inches
Centimeter	0.3937	Inches
Kilometer	0.6214	Mile
Meter	3.281	Feet
Fluid volume		
U.S. quarts	0.9463	Liters
U.S. gallons	3.785	Liters
U.S. ounces	29.573529	Milliliters
Imperial gallons	4.54609	Liters
Imperial quarts	1.1365	Liters
Liters	0.2641721	U.S. gallons
Liters	1.0566882	U.S. quarts
Liters	33.814023	U.S. ounces
Liters	0.22	Imperial gallons
Liters	0.8799	Imperial quarts
Milliliters	0.033814	U.S. ounces
Milliliters	1.0	Cubic centimeters
Milliliters	0.001	Liters
Torque		
Foot-pounds	1.3558	Newton-meters
Foot-pounds	0.138255	Meters-kilograms
Inch-pounds	0.11299	Newton-meters
Newton-meters	0.7375622	Foot-pounds
Newton-meters	8.8507	Inch-pounds
Meters-kilograms	7.2330139	Foot-pounds
Volume		
Cubic inches	16.387064	Cubic centimeters
Cubic centimeters	0.0610237	Cubic inches

(continued)