# Section III. General Overhaul Instructions

## A. CLEANING SOLUTIONS.

Gasoline can be used as a cleaning solution but its use involves so many safety hazards that it is not recommended. Gasoline fumes are explosive, and the fuel is easily ignited. If engine parts are cleaned in gasoline, the ignition spark may be sufficient to explode the entire area. PLAY SAFE. DO NOT USE GASOLINE FOR CLEANING. Leaded gasolines can cause poisoning. Lead poisoning is the result of an accumulative effort. It is dangerous and is not easily diagnosed.

Kerosene will clean parts. Dip the parts in the solution and use a scraper or brush on stubborn areas However, kerosene leaves a film of oil on the part when dry. This film should be removed by wiping or by compressed air.

Commercial cleaning solutions do a good job of cleaning metal parts. All rubber, synthetic, neoprene, felt and fabric parts, and seals must be removed before the metal parts are cleaned. Be sure all parts are carefully rinsed with water and dried after cleaning.

Alkaline cleaners are effective and economical. The mixture is usually heated to a boil; the parts are then immersed until clean. Alkaline cleaners are highly caustic, and protective clothing as well as protective eye covering should be worn if caustic solutions are used. Be sure to label the tanks with CAUSTIC in large letters so the danger can be easily seen. Use goggles and a face mask. If the solution comes in contact with the skin, wash immediately with water, daub on boric acid, and cover the area with a soothing oil. Large areas of skin that cannot be treated properly in the shop should immediately be treated by a doctor. Parts cleaned in an alkaline cleaner must be thoroughly rinsed in water and dried. Take care when disposing of the rinse water; do not reuse it, since the alkaline solution builds up in the rinse.

Caution should be used if carbon tetrachloride is used as cleaning agent, as this is extremely toxic.

Cold, chemical commercial cleaners are also effective. Some are injurious to the skin, while others are not. Read the product label carefully and, in large letters, label any injurious compounds: DANGER.

Use a ventilating fan, or provide ventilation of some other means when cleaning. Some solutions give off toxic or noxious fumes; other fumes are highly combustible.

Clean the parts by placing them on screen trays with handles so that the tray can be lowered and raised in the solution without immersing the hands. Rinse the parts while they are on the same trays in order to avoid handling of the parts. Dry the parts with clean, compressed air at an air pressure of 25 pounds or less. If the compressed air is not clean, oil or foreign materials in the air stream can become imbedded in the carburetor passages or in other critical passageways.

It is recommended that the local fire marshals be contacted for legal opinions regarding cleaning solutions; regulations may vary from state to state or city to city.

## B. FITS AND TOLERANCES.

It is important to understand the variations of fits and tolerances between parts. Engine parts are built to critical tolerances and the fits vary, depending upon their respective motions and use.

A sliding fit is where one part slides easily over another with little to no drag.

In a push fit one part can be positioned in or on another by a slight push.

A thumb, palm, or heel push fit is where one part is inserted in or on another using the thumb, palm of the hand, or heel of the hand to apply pressure.

In a tap fit a soft hammer or another tool is used to tap the two parts together.

A press fit is where more pressure is required; the pressure is usually given in pounds-per-square inch. Items requiring a press fit are usually assembled in a press; fixtures may be used to apply the pressure on the correct surface. The two parts are sometimes said to have an interference fit. That is, the outer part is smaller in bore than the outside diameter of the part being inserted.

A shrink fit or heat fit is used for parts which must be assembled. But the part interference is too large to be assembled. The outer part is heated with a blow torch or in a hot solution, to expand the metal, and, then it is assembled to the inner part. In some cases, the inner part is contracted, using dry ice until it fits in the outer part. In extreme cases, the outer part is expanded and the inner part contracted simultaneously.

## C. GASKET REPLACEMENTS.

Engine gaskets are made of different materials, depending upon the requirements of heat, the solutions present, and the wear encountered. Some surfaces (particularly of two-piece crankcases) are sealed with liquid gasket compound. Since most gaskets partially adhere to the surfaces after use, it is impractical to reuse a gasket. The cost of replacing a gasket that has been removed is only the cost of the gasket, but if a gasket is reused and leaks, further engine troubles may develop and the overhaul time is then added to the gasket cost. Always clean the surfaces carefully to remove all gasket particles. Be sure that all surfaces are clean and flat, not warped, gouged or scratched. A gasket cannot compensate for wear, gouges, warping, misalignment, or dirt on the surface.

If gasket compound is being used, coat both surfaces lightly. Do not assume that a thick coating of the compound is better than a thin coating. A thick coat separates the parts causing more leaks than a thin coat.

## D. O-RING REPLACEMENT.

O-rings should be replaced whenever they are removed. Removal usually stretches or deforms the rings. Since the cost of O-rings is moderate, the lifetime in which the O-ring is effective must be considered. O-rings are made of pliable material which remains elastic and pliable for a lifetime. That is less than the life expectancy of the metal parts in the engine. A defective O-ring can cause leaking and may be the basis for other engine troubles.

When replacing O-rings, use the specific size O-ring supplied by the manufacturer for each required application. O-ring materials vary and the manufacturer has specified the material suited for this use. Insert O-rings carefully, taking care not to over-stretch or deform them. The O-ring can be inserted by using a tapered sleeve of the proper diameter to slide the O-ring into position and to stretch it evenly to the correct diameter for installation.

## E. BEARING CARE.

Several types of bearings are used in air-cooled engines.

The simplest type is a sleeve bearing, which is a cylinder of lubricating material which acts on both the outer and inner parts to allow them to move freely in relation to ach other. Nylon is an example of a material which acts as a metal lubricant. A commonly used sleeve bearing is made of a pressed, powdered metal (sintered) that is absorbent; bronze is used most frequently. This sleeve is soaked in lubricant which it absorbs. The lubricant is not on the surface of the sleeve but integral with the bearing, and, therefore, the bearing continues its lubricating function during use.

A sleeve bearing must be inspected for out of round. If the wear is uneven, the bore or outer diameter may be elliptical or the bore and outer axis may not be true. These defects are sufficient reason for replacing the bearing. Whenever an absorbent sleeve bearing is removed, it should be inspected. If it is in good condition, not worn or eccentric, soak it overnight in light oil before reuse.

A ball bearing consists of two races of retainers which hold a series of balls between them. These parts are carefully machined and polished so that little friction occurs between the surfaces. In addition, since the balls turn in the races, the sliding friction of the two parts is replaced by rolling friction which is much less. Ball bearings are usually installed between a stationary and rotating part. One race is stationary and the other rotates with the part. Races can be designed so that the bearing takes a certain amount of thrust or push along the axis. These bearing races are designed so the balls roll along the side of the race and so absorb the thrust in that direction. A thrust bearing must be installed correctly so the thrust is taken on the correct side of the bearing.

Some ball bearings are separable, consisting of two races and a center ball cage. Others are not separable and cannot be disassembled. Some bearings contain shields so that the lubricant in the case can lubricate the bearing but not go through it to the other side. These bearings must be installed with the shield on the "dry" side of the case. Some ball bearings are permanently lubricated and are shielded on both sides. These bearings cannot be cleaned or relubricated. If they do not operate smoothly and easily, they must be replaced.

Needle bearings have two races which enclose a row of needles or thin rollers around the circumference. Needle bearings are not made to absorb thrust and only act to provide a smooth, rolling surface between parts.

Roller bearings also have two races and a row of larger rollers around the circumference. Roller bearings can be made with flat or tapered races. When the races are tapered, the inner race holds the rollers at an angle. The outer race forms a cone on the inner diameter. Forcing the outer cone over the inner race and rollers increases the "load" on the bearing by closing the space between the rollers and the races. Increasing the "load" places a drag on the bearing when it turns.

Since a bearing is always designed to have a moving part rotating against a stationary part, lubrication is very important. Where a bearing is lubricated by the lubricant of the case, check to see if there are oil holes in the races which mate with the oil holes in the bearing journal. These must match up if the bearing is to be effective and not wear out rapidly.

Clean the bearings before inspection if they are not permanently lubricated. To clean them, disassemble the bearing, if it is so designed, and place them on clean trays or in baskets. Clean the bearings by moving the tray or basket rapidly up and down in a cleaning solution. Do not clean the bearings with other parts and always use clean solutions. After cleaning air dry the bearing, or dry with clean, dry, compressed air under low pressure. Be sure that the compressed air stream does not spin the bearing balls, needles, or rollers. When the parts are dry, assemble the bearings and dip them in clean light oil.

Check the bearings for smooth and easy rotation. Bearings should not catch or jerk. Inspect the races for roughness, score marks, or other damage. Be sure the bearing does not seem loose or sloppy in fit.

When installing bearings, be sure to press them straight in the bore. Do not cock the bearing when installing other parts. Be sure the correct side of the bearing is toward the outside. Check to be sure that the bearing seats firmly against the shoulder or retaining ring which positions it.

## F. SEAL INSTALLATION.

Seals are used to prevent the lubricant (four-stroke-cycle) or the fuel-air-oil (two-stroke-cycle) charge from leaking out of the crankcase. Whenever a rotating part moves through a stationary part, it is necessary to provide a seal. Seals are of several types. Basically, however, all seals consist of a sleeve, which is pressed or fit carefully into the stationary part, and a pliable wiper, which is sealed to the sleeve and held against the rotating part by spring pressure. Some seals have one pliable part or lip at one face. Other seals have two lips, one facing in each direction. If a seal with a single lip is being installed, it is important that it is installed in the same direction as the original seal.

When a seal is inserted into a bore, the lip must not be deformed or torn, and the seal must be inserted squarely. Many manufacturers recommend the use of a seal-insertion tool. This tool is shown in use in figure 187. The seal is worked over the tapered end of the inserter. Then the inserter is placed over the crankshaft and into the seal recess. Seals are usually damaged by removal and should be replaced at each overhaul.

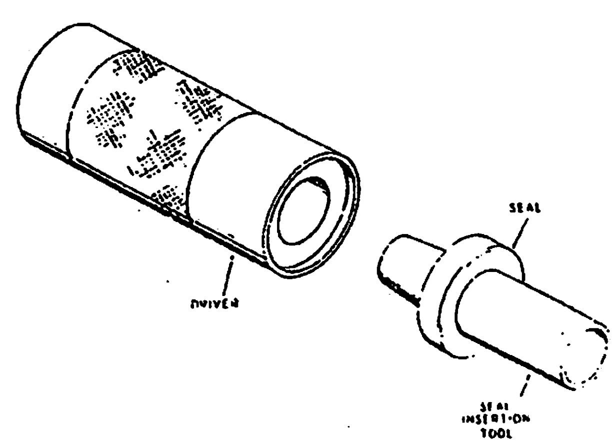


**Figure 187**
**Seal-Insertion Tool**

If a seal-installation tool is not available, place the seal carefully over the shaft, being sure that the lip is not damaged. Use a pipe of the same diameter as the outer part of the sleeve and place it against the seal, over the shaft. Strike the end of the pipe sharply with a soft hammer to drive the seal into position.

## G. LUBRICATION.

While the section on general shop practice stressed the necessity for cleaning parts as they are removed and keeping them in a clean place, it also mentioned keeping them oiled and being sure that they are lightly coated with lubricant as they are reassembled. Not only does this practice make reassembly easier, but it insures lubrication of the parts during initial operation of the engine, after reassembly. Use the same oil to lubricate the parts that is used in the engine crankcase (four-stroke-cycle) or fuel mixture (two-stroke-cycle).

## H. TORQUING.

There are industry standards for the torque to which bolts should be tightened, depending on their size. However, most parts are secured by tightening the bolts or screws as tightly as reasonable. Some parts must be held with a specific torque. These should be tightened with a torque wrench. Torques are not specified unless they are necessary. Wherever the manufacturer has listed a torque value to which a bolt or other part is tightened, it is important that the torque be observed. Parts that are usually torqued include connecting rod cap screws, cylinder head bolts or cap screws, and flywheel nuts.

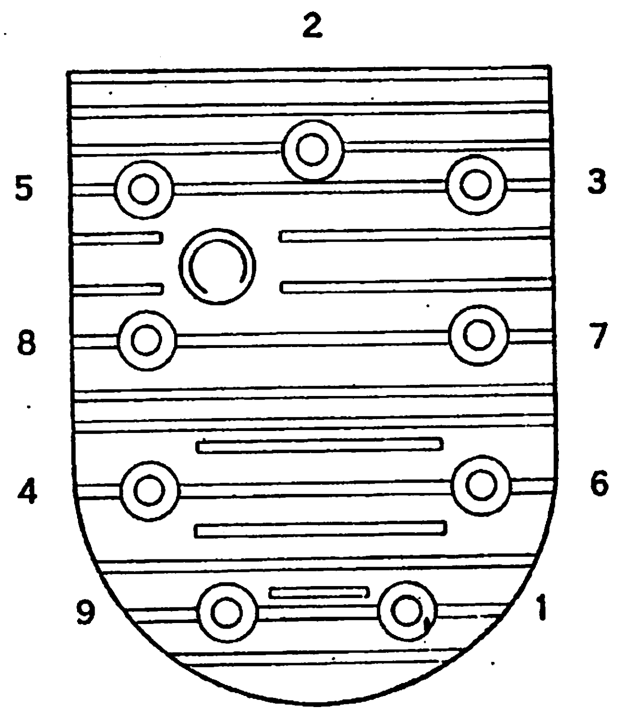


Figure 188
Typical Cylinder Head Bolt Tightening Sequence

In addition to the torque values, another important consideration is the sequence to be observed when tightening bolts or screws. In general, when a part has fastening bolts or screws around its circumference, they should be tightened from the center out, working on alternate sides. Always tighten the bolts or screws in stages, tightening each approximately the same amount each time. A typical cylinder head bolt tightening sequence is shown in figure 188.