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| Engine parts inspection | | | |
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# Engine parts inspection and torque procedures

## TASK OBJECTIVE

At the completion of this task the technician will be able to properly remove and reinstall the connecting rod from a crankshaft. He will be able to correctly torque bolts using the torque angle method.

In addition, the technician will be able to identify the serviceability of several internal engine parts, like plain bearings, connecting rods, crank shaft, pistons and cylinders.

**INTRODUCCTION**

Proper measuring and assembly of components is necessary when performing an engine rebuild. Detailed descriptions of the measuring and assembly procedures are included in the service manuals. The specifications can be found in both the shop manuals and the specifications booklet. Failure to perform the proper measuring and inspection can lead to early engine failure

**TORQUE TO YIELD**

Torque-to-yield tightening procedures which are commonly used for cylinder studs and cylinder head bolts, have been in use for many years. Torque-to-yield was originally developed to accommodate engines that use different metals in the cylinder or engine block and the cylinder head. Engines that employ a cast iron cylinder or block assembly with an aluminum head, are typically referred to as bi-metal engine, would be typical examples. This torque to yield procedure is preferred on modern internal combustion engines.

The fundamental problem associated with using standard torque procedures is the inconsistency of the clamping loads. There are three common torqueing procedures in use today. The first and most common is the use of a standard torque wrench. This just uses a twisting force to tighten the bolt. There are many problems associated with this method. First and foremost is mechanical resistance, as the bolt is being tightened, friction between the threads varies from bolt to bolt. For example, the difference in torque between a dry bolt and a lubricated can easily be 30 %.

The next type of tightening procedure is called the torque to yield method. In this method the bolt is tightened to a very light torque with a torque wrench. It is then tightened a certain number of degrees past that point. The clamping load of the bolt is determined by the amount of distance the bolt stretches when turned a certain number of degrees, calculated using tensile strength, thread pitch, material and other factors.

Torque–to-yield hardware is designed, to be tightened to a point that the bolt begins to stretch to its plastic point, no more and no less. Once it is tightened the torque-to-yield hardware will be stretched to a point where it will never return to its original length.  **As a result, the hardware cannot be reused unless stated in the service manual.**

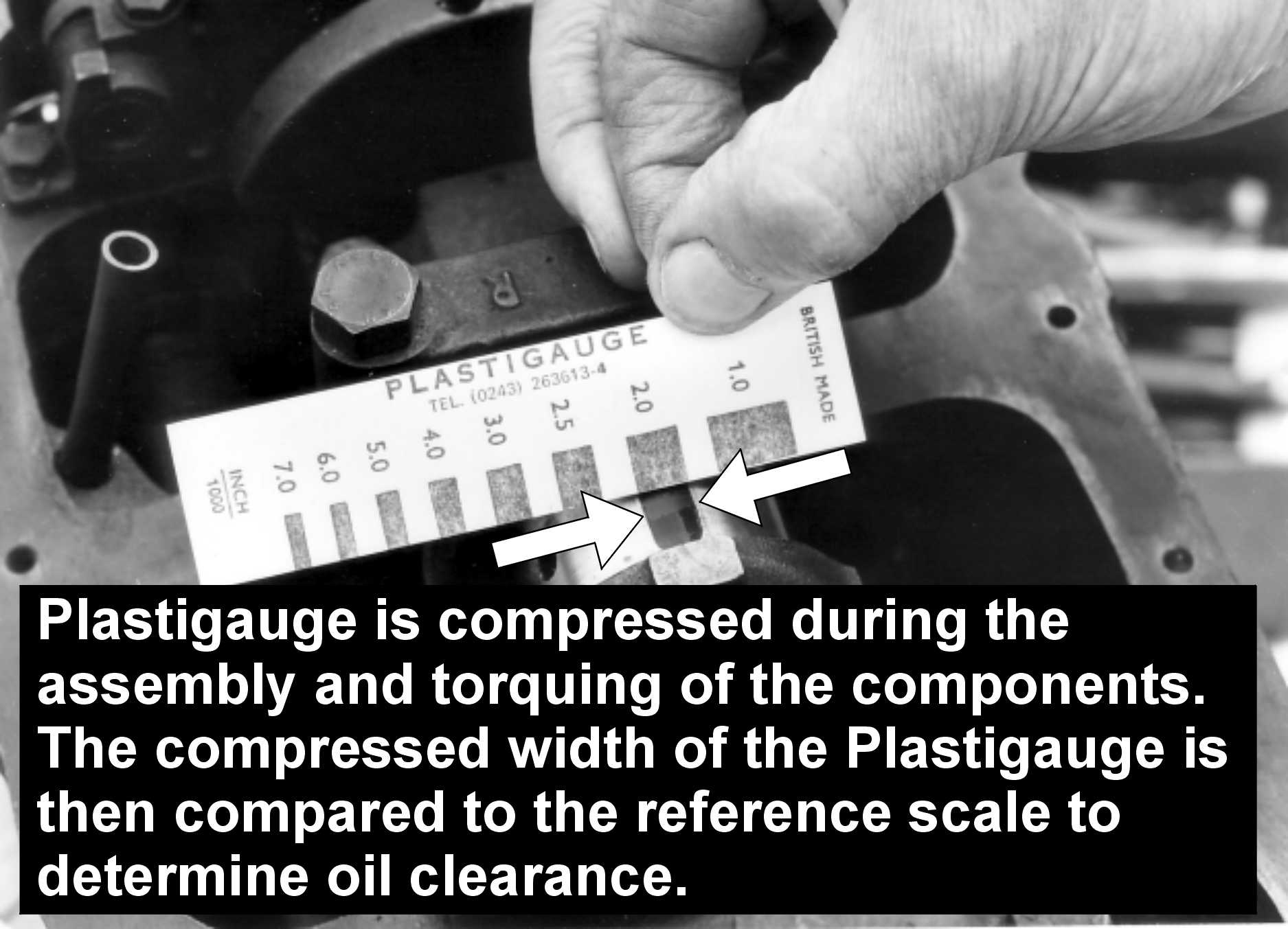
**PLASTIGAUGE**

Although Plastigauge is not recommended by all manufacturers, it does provide a simple but effective method for the measurement of clearance between fitted surfaces like those between crankshaft journals and connecting rod bearings. It is particularly useful for measuring clearance in plain split bearings or in situations where feeler gauges cannot be inserted.

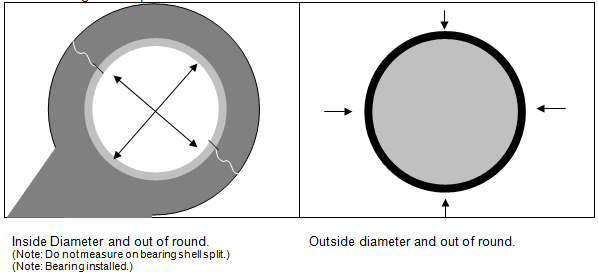
Plastigauge is precision - extruded plastic "wire" of a carefully calculated diameter. It comes in a long paper envelope, upon which may be found sample gauge marks corresponding to different widths to which the Plastigauge is squashed when compressed inside a bearing-journal space.

For example, Plastigauge can be used to measure the clearance (actually referred to as oil clearance) between a connecting rod bearing and the crankshaft journal. Simply clean up the bearing shells and the journal, apply a light coating of oil to each, break off a short piece of Plastigauge, apply it to the journal along its axis, and bolt up the rod. Then torque the rod cap bolts to specification.

The Plastigauge will be squished in the joint. The less clearance, the more it will be flattened. The scale printer on the Plastigauge envelope is then used to determine what the clearance is. Remove all traces of the Plastigauge before final assembly, or even before taking more measurements at other spots in the same bearing/journal interface.



Another method of measuring the connecting rod big end oil clearance is to measure the inside diameter of the connecting rod with the bearing in place and to measure the outside diameter of the crank big end rod pin.



The inside diameter of the rod big end with bearing minus the outside diameter of the crankshaft big end pin will equal to the oil clearance.

**PROCEDURES**

Refer to the attached extract of the Shop Manual for the correct procedures and service limit specifications.

Follow the steps and answer the questions below:

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| 1. Measure the connecting rod small end: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 1. Measure the piston pin diameter in the bushing area:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 1. Can they be reused? |
| 1. What is the radial play between them? |
| 1. Use old bolts to assemble the connecting rod and torque them to specification. |
| 1. Measure the connecting rod big end: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 1. Are the plain bearings reusable?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 1. Measure the 3 crankshaft pins |
| 1. Is there any out of limits?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 1. Which one?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 1. What will be the oil clearance if the conrod is installed on the #2 cylinder? \_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 1. What is the service limit of the big end radial play? |
| 1. Measure the piston:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 1. Measure the cylinder 2 at the 6 recommended positions.   A1:  A2:  A3:  B1:  B2:  B3: |
| 1. Is the cylinder out of round? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 1. What is the piston/cylinder wall clearance at location A1? |
| 1. What is the piston/cylinder wall clearance at location A3? |
| 1. Are they out of limits? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 1. Measure the ring/piston groove clearance of the 3 piston rings |
| 1. Is there any one out of limits?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 1. Remove the piston rings and measure the ring end gap of the oil scraper in the cylinder 2 |
| 1. Use the piston to place the ring on the right area |
| 1. Is the ring still reusable? |
| 1. Install the conrod on the crankshaft (cylinder #2) and torque it to specifications |
| 1. Measure the connecting end rod axial play:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

**QUESTIONS**

1. Can the conrod bolts be reused?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Which are the steps to properly torque the connecting rods?
   1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Is it allowed to mix standard size and oversize pistons?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. If Plastigauge is used to measure the big end rod clearance, it is **not** necessary to measure the rods or crankshaft.

TRUE FALSE

1. Where should point the arrow on the top of the pistons when installing them in the cylinders?

Intake Exhaust

**Instructor sign off-- Go \_\_\_\_\_\_\_\_\_\_**

**METRIC OUTSIDE MICROMETER INFORMATION**



 Each of the longer lines on the sleeve of the metric micrometer represents 1.0 mm (one millimeter).

**Note:** A comma is sometimes used in place of a decimal point to further indicate the use of metric readings.

 Each of the short lines on the sleeve of the metric micrometer represents 0.5 mm (five tenths of a millimeter) or 5/10 which equals 1/2 of a millimeter. When reading you would say, "Point five millimeter."

 The beveled edge of the thimble is divided into 50 equal graduations. Each space represents 0.010 mm (one one hundredth of a millimeter) or 1/100.

 Some metric micrometers may also have a vernier scale on the sleeve. If your micrometer has this scale, you can read to the third decimal after the point 0.001 (thousandths of a millimeter or 1/1000 of a millimeter). To read the vernier scale you find the line on the thimble that lines up with one on the vernier scale (only one will line up exactly). Read only the number next to that line on the ***sleeve***.

 The step-by-step process to read the micrometer involves adding all three scales together to come up with your total.

**Example:**

Read the last line on the sleeve that has been uncovered by the beveled edge of the thimble, in this example it is 1.50 mm.

Second, read the line on the thimble that lines up with the reading line on the sleeve of the thimble, in this example it is the 0.14 mm.

If your micrometer has the vernier scale read it last, in this example it is 0.002 mm.

1.500 mm First Reading

0.140 mm Second Reading

0.002 mm Third Reading

1.642 mm Total

**STANDARD DEPTH MICROMETER INFORMATION**

Depth micrometers are special micrometers used to measure the depth of holes, the depth of grooves and recesses the heights of shoulders or projections.

The depth micrometer consists of a stock on which a graduated sleeve is fitted. The other end of the sleeve is threaded with a `V' thread. A thimble which is internally threaded to the same pitch and form, mates with the threaded sleeve and slides over it. The other end of the thimble has an external step machined and threaded to accommodate a thimble cap.

A set of extension rods is generally supplied. On each of them the range of sizes that can be measured with that rod, is normally engraved on the rod. These extension rods can be inserted inside the thimble and the sleeve. The extension rods have a collar-head which helps the rod to be held firmly. The measuring faces of the stock and the rods are hardened, tempered and ground. The measuring face of the stock is perfectly machined flat. The extension rods may be removed and replaced according to the size of depth to be measured. Note: The rods are pre-calibrated, do not attempt to adjust the length.

The graduations are numbered in the reverse direction, to that marked on an outside micrometer.

The zero graduation of the sleeve is on the top and the 1"graduation near the stock. The bevel edge of the thimble is also graduated. The circumference is equally divided into equal parts. The numbering is in the reverse direction and increases from 0, .1, .2 , .3 , .4 , .5 , .6 ,.7, .8, .9 , 0 (1") The advancement of the extension rod for one full turn of the thimble is one pitch which is .025".

Therefore, the advancement of the extension rod for one division movement of the thimble will be equal to .001". This will be the smallest measurement that can be taken with this instrument, and so, this is the accuracy of this instrument.

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| depthmicpic | depthpic2 |

# CYLINDER BORE GAUGES

A cylinder bore gauge is actually an adaptation of the dial gauge and inside micrometer. It is used specifically to measure engine cylinder bores. Although you can use it to measure actual bore size, the cylinder gauge is usually used to measure the difference between two readings within the bore, so as to determine cylinder taper or out-of-round.

When using a bore gauge, the gauge must be perpendicular to the cylinder bore to obtain an accurate maximum bore size reading. Move the gauge from side to side, as illustrated below, and noting the minimum bore reading. When measuring a cylinder with a cylinder gauge, the difference between the largest and smallest diameters equals the bore taper or out-of-round measurement.

