

ENGINE CONSTRUCTION STUDY

A student team will be assigned an engine to be partially disassembled and then reassembled. The team is expected to use the engine and its components, as well as the engine service manuals, to obtain the information required to complete the attached data sheets. At the completion of the reassembly, the group will have the opportunity to run the engine.

Unless a certain amount of organization is followed, it is quite likely that many parts may become lost or misplaced. To reduce the chance of lost parts, the following procedure should be followed:

1. Immediately after removing a part from the engine, loosely reassemble its component parts and place it on the table provided.
2. As soon as practical, replace cap screws and bolts in their original position after removing the part.

If these rules are followed, less confusion will result and the safety hazard of loose parts on the floor will be eliminated.

Start by draining engine crankcase oil into containers provided. Remove oil pan and cylinder head. Note that on some diesel engines it may be necessary to remove the exhaust manifold before removing cylinder head in order to avoid bending the injection lines. Do not remove diesel injection pumps. **Always remove head bolts and valve push-rods from their bores before attempting to remove cylinder head.** Furthermore, don't place the cylinder head flat on the bench top (especially with diesel heads unless the injectors are removed). The injector tips may be damaged since they stick out below the head. Set the heads on pieces of wood or place them on their sides in a safe area.

Remove and inspect one piston and connecting rod assembly from your engine. (Be careful not to loosen a main bearing.) Can you identify the thrust face of the piston? Place the piston ring (remove it from the piston first) in the cylinder bore and measure the clearance between the ends of the piston ring with a feeler gauge. Make this determination at the top and bottom of ring travel, and at two intermediate points. Record all readings at appropriate blanks on data sheets.

While the cylinder head is off the engine, use a valve spring compressor to remove one exhaust and one intake valve. Examine the valves and the associated assemblies, and complete the valve data section.

Also while the cylinder head is still off, turn the engine over until any one piston is in its uppermost position. Next, turn engine crankshaft clockwise 90° and with a ruler measure how far down the bore the piston has traveled. Finally, turn the crank another 90° (180° from original position) and measure piston travel from top. The arithmetic difference between the two measurements is the distance traveled in the second 90° . Record the values on your data sheet.

Inspect the lubrication system of your engine. Determine how oil is supplied for lubricating various engine parts such as main bearings, connecting rod bearings, piston pins, cylinder walls, valve levers, valve stems, timing gears, and governors.

Before reassembling, all parts should be cleaned and lightly oiled. When fitting bearings, the torque values should never exceed the values specified in the engine service manual. If range of torque is specified use the lower value. Cylinder head bolt torques should be obtained in three (3) steps. See manuals for tightening patterns (**Do not complete the last step i.e. additional rotation beyond the final torque**).

Stagger open ends of piston rings at 180° intervals around the piston. Pistons should be eased into the cylinder with a wood block never with steel hammer head. Tighten the connecting rod and head bolts in the approved sequence with the torque wrench.

Be absolute certain that bearing inserts are correctly installed. During the reassembly each bearing should be individually checked by hand-cranking the engine.

Following instructions in the service manual or FOS 30, use "Plastigage" to determine clearance between connecting rod "big-end" and its matching crankshaft journal. Record the values on your data sheet. Compare your readings with the manufacturer's specifications.

Connecting rod caps and bolts are often designed to fit only one way so they may be marked to match a similar mark on the proper connecting rod. The usual convention requires that the marks face the camshaft side of the engine, but check manual to be certain.

Also during reassembly apply a very thin film of grease to both sides of any gaskets. If a gasket has remained with one of its mating parts, it is only necessary to coat the exposed face.

Be especially careful when reassembling fuel and injector lines. Proper alignment of the fittings at this time should permit them to be threaded together with your fingers. Use a wrench only for a final "snugging" after loosening the fittings at the opposite end of the line or tube. This often makes hand reassembly of the first end considerably easier. Be sure to "snug" both ends after all fittings are seated.

Before placement of the rocker arm assembly on the head, loosen off all valve clearance adjustment screws.

After the engine has been completely reassembled, crank the engine by hand to be sure it turns freely (it may be necessary to loosen injectors to facilitate hand-cranking). Set the valve clearances to specifications and check ignition and diesel timing. (See manuals and/or notes at end of this outline.)

Fill engine crankcase with oil to at least the "add" mark on the dipstick. Be sure water jacket outlets are plugged and fill block with water. Check for leaks.

Using the battery provided, connect it to the engine starter in the proper polarity. Battery cables and starter switch are available for this purpose. All gasoline engines must have a voltage supply to the ignition system and some diesel engines will require a voltage supply to the injector pump. Place room exhaust vent tube over outlet of engine exhaust manifold. In addition, check to see that the exhaust fan is running.

Have a fire extinguisher handy and proceed to start your engine. Before diesel engines will run the fuel system must be bled to remove trapped air. Follow instructions given in the applicable manual. Running time is limited on most lab engines due to their limited cooling capacity. Do not run engine longer than three or four minutes. Do not "race" the engine.

If engine does not start after a reasonable number of attempts, do not continue trying to start it, but do try to determine and correct the difficulty. Also, if engine starts, but does not run smoothly, stop the engine and make the necessary corrections. Engine may then be restarted.

After your test run is completed, drain and dispose of the water in the cooling system. Do not drain the crankcase. Clean up your work area and clean and replace all tools and toolboxes.

Turn in your completed data set at the end of the period. Be sure your name(s) are on it, either as a team or individually. A "formal" report is not required.

GENERAL:

Engine (make and model) _____
 Number of cylinders _____
 Bore and stroke (in) _____
 Two- or four-stroke cycle _____
 Engine displacement (in³) _____
 Firing order _____
 Compression ratio _____
 Cylinder Clearance Volume (in³) (Show calcs) _____

CYLINDERS:

Piston Material _____
 No. of piston rings: Compression _____ Oil Control _____
 Ring end clearance (see p. 1) (Top of cyl.) _____
 (Pt. 2) _____
 (Pt. 3) _____
 (Bottom of cyl.) _____
 Is piston pin fixed, semi-floating or full-floating in pistons? _____
 Does engine have cylinder sleeves? _____
 If sleeve equipped, wet or dry type? _____

Piston movement check (see p. 1):

- a. Piston travel (in), T.D.C. to 90° A.T.D.C. (after top center) _____
- b. Piston travel (in), T.D.C. to 180° A.T.D.C. (Bottom dead centre) _____
- c. Piston travel (in), B.D.C. to 90° A.B.D.C. (After Bottom dead centre) _____
- c. Piston travel (in), 90° A.B.D.C. to T.D.C. _____
- d. Does piston travel further from 0°-90° or from 90°- 180°? _____
- e. Does piston travel further from 0°-90° or from 270°- 360°? _____

CRANKSHAFT:

Number of crankshaft main bearings _____
 Type of bearings (insert, poured, plain): Main _____

Connecting rod big end _____

Method of locking connecting rod cap screws _____

Connecting rod bearing clearance as measure with plastigage _____

Mfr's recommended connecting rod bearing clearance _____

Is provision made to counterbalance secondary internal vibration _____

If so briefly describe method used _____

VALVE SYSTEM AND TIMING:

Type of valve arrangement (OHV, L-Head, etc.) _____

Remove and examine 1 exhaust valve and 1 intake valve.

Are either equipped with rotators? _____

If yes, which valves are so equipped? Why? _____

What types of rotators are used? _____

Before reinstalling valves, examine the valve seats.

Do any seats have inserts? _____

Which ones? _____

What are the valve seat and valve face angles? (See service manuals.)

Intake: Face angle _____ °

Seat angle _____ °

Exhaust: Face angle _____ °

Seat angle _____ °

Do valves have an interference angle (see service manuals)? _____

If so, how many degrees? _____

Do exhaust and intake valves have the same head diameters? _____

If not, which is larger and why? _____

In the space below, diagram the location of individual exhaust and intake valves, labeling each one with symbols E or I respectively. Show also relative location of cylinder bores and the relative sizes of the valve openings.



Engine Front
Top View

LUBRICATION: (See also service manuals -- "Lubrication")

Type of pump _____
 Splash or pressure (or both) used to lubricate:
 Cylinder walls? _____ Piston Pin? _____
 Connecting rod and main bearings? _____
 Valve rocker arm assembly? _____
 Camshaft bearings? _____
 Is oil filter full-flow or by-pass type? _____

FUEL SYSTEM:

Type of fuel _____
 Pressure or gravity supply _____

Engine Reassembly

VALVE ADJUSTMENT:

1. Determine top dead center of No. 1 cylinder compression stroke. For the John Deere engine a Timing Hole in the bell housing is used to determine TDC (See Manual). A small screwdriver placed in the timing hole may be used instead of the special tool describe.

- a. Remove number injector.
- b. Place finger over the open hole.
- c. Manually rotate the engine and feel for pressure or suction. Pressure will indicate that the number one piston is on the upward compression stroke. (Engines rotate clockwise as you face the front of the engine.)

--OR--

- a. Manually crank engine clockwise and, with valve cover removed, observe action of valve rocker arms.
- b. If No. 1 cylinder is on compression stroke when timing mark indicates top dead center, both valve rockers will normally have some clearance, but the amount may be incorrect. The valves for the no. 4 cylinder will be rocking, that is the exhaust will be almost closed and the intake valve will start to open.
- c. If timing mark indicated TDC and the exhaust valve on No. 1 cylinder is still open (or just closing), crank engine one full revolution clockwise. No. 1 cylinder should then be on TDC compression when timing mark lines up.

2. Check tappet clearances.

With valve cover removed and No. 1 cylinder on TDC compression:

- a. Check tappet clearances on No. 1 cylinder and correct if necessary. "Feeler" gauges must be used parallel to the two surfaces. Otherwise, inaccurate settings will be made.
- b. Crank the engine 180° for a 4 cylinder, 120° for a 6 cylinder, or 240° for a 3 cylinder engine in

the normal direction of engine rotation. (The degrees given above are for 4-stroke-cycle engines.)

- c. Check both values on the next cylinder in the firing order.
- d. Repeat b and c for all valves.

Remarks: Please make any comments you feel are appropriate about this lab exercise.
