Installing Crankshaft with Timing Tool (Kohler K241AS Engine)

**NOTE:** The special balance gear timing tool, Figure 35, makes precision installation of the crankshaft more accurate. See “Special Tools,” page 15-22.

Install special tool, as shown above, so two teeth on tool line up with primary timing marks on balance gears.

Install crankshaft so that counterweights are toward balance gear side of engine, Figure 35. Turn crankshaft so that standard timing mark on crankshaft is in line with lubrication passage in engine block, Figure 35.

Drive crankshaft 1/16 inch into the wide side of balance gears. Remove tool and turn crankshaft until standard timing mark on crankshaft aligns with timing mark on camshaft gear.

Engage crankshaft gear and camshaft gear. Tap crankshaft into place with plastic hammer.

Gears now should be in proper alignment. When properly timed, balance gears will form a straight line when counterweights are to either side, as in Figure 5, page 15-4.
Installing Crankshaft without Timing Tool (Kohler K241AS Engine)

Align crankshaft so the primary timing mark on top balance gear, Figure 36, lines up with standard timing mark on the crankshaft.

Slide the crankgear approximately 1/16 inch into the wide side of the upper balance gear. Rotate the crankshaft to align standard timing mark next to crankgear with dot (timing mark) on face of camshaft gear, Figure 37. Press crankshaft remainder of the way into block. Camshaft, crankshaft and upper balance gear are now correctly aligned.

Rotate crankshaft until it is approximately 15 degrees past bottom dead center. Slip one 0.010-inch spacer over lower stub shaft, and install lower balance gear.

Align secondary mark, Figure 36, on lower balance gear with the secondary timing mark on the crankshaft counterweight. Gears will turn slightly as they engage, causing the lower balance gear's secondary timing mark to line up with the standard timing mark of the crankshaft.

NOTE: Turn crankshaft until counterweight is in position indicated in Figure 5, page 15-4. A straight line should be formed by the half-moon sections of the balance gears, Figure 5, page 15-4. If this line is not straight, one of the balance gears was inserted into the wrong tooth of the crankshaft gear. Review timing procedure described above if the straight line is not formed and correct the timing.

When balance gears are properly timed to crankshaft, install spacers and snap ring on lower balance gear stub shaft. See page 15-13.
Installing Crankshaft (Kohler K181S Engine)

Cover keyway in PTO end of crankshaft with a strip of scotch tape to prevent cutting seal if seal has been left in block.

Slip power take-off end of crankshaft into bearing in cylinder block.

NOTE: Proper crankshaft and camshaft gear timing is important.

Timing marks are provided on crankshaft and camshaft gear for correct engine timing. When in place, mark between teeth on camshaft must be directly in line with lug on shoulder of crankshaft, Figure 38. Chalk timing mark positions for ease of viewing during assembly.

Assembling Bearing, Bearing Plate and Oil Seals (Kohler K181S Engine)

With bearing plate properly supported, press main bearing, shielded side up, Figure 39, into bearing plate until bearing bottoms in bearing bore. Be sure shielded side is up. Ball bearings must not be exposed to engine crankcase oil.

Assembling Bearing, Bearing Plate and Oil Seals (Kohler K241AS Engine)

With bearing plate properly supported and ball bearings facing direction shown, press main bearing, Figure 40, into bearing plate until bearing bottoms in bore.

NOTE: Press on outer race only, so as not to damage main bearing.
Installing Bearing, Bearing Plate and Oil Seals

Fig. 41-Installing Bearing Plate with Bearing on Cylinder Block

Install gasket and bearing plate over crankshaft. Using two 3/8 x 1-3/4-inch cap screws, draw bearing plate toward block. Insert two of the four 3/8 x 1-inch cap screws in other two holes in plate. Remove the two long cap screws and replace with shorter screws provided. Figure 41. Draw cap screws up evenly until correct torque is obtained. See "Torque Chart," Section 10.

Fig. 42-Checking Crankshaft End Play

Seat the bearings by first tapping the tapered end of crankshaft with a mallet. Then tap PTO end of crankshaft. Check distance between bearing ring and crankshaft shoulder with a feeler gauge, Figure 42. Refer to "Specifications," page 15-21, for crankshaft end play. Use gaskets as required to obtain correct crankshaft end play.

Install oil seals with lip facing inward. Use a seal tool to protect seal from being damaged during installation. Drive seal in seal bore until outer face of seal is flush or 1/32-inch beyond flush of engine exterior, Figure 43. (K181S Engine only.)

On the Kohler K241AS engine, place seal outside main bearing. Drive seal flush with housing.

Assembling Connecting Rod and Piston

Support connecting rod in a bench vise and slip piston down over connecting rod. Coat piston pin with a light film of oil. Insert piston pin through piston bore and connecting rod and on into opposite piston bore. A properly fitted piston pin can be pressed into position with hand pressure. Install retainer in both ends of piston pin bore, making sure that rings are securely seated in retainer grooves in piston.

Use a commercial rod aligner to check rod and piston alignment. Follow manufacturers recommendations for checking and correcting alignment.
Checking Piston Ring End Gap

Before installing rings on piston, insert each ring into the cylinder bore to check ring end gap, Figure 44.

Always check ring end gap whenever new rings are installed. Use an inverted piston without rings to push the ring squarely to a point in the bore which is approximately the center of piston ring travel.

Measure the ring end gap by inserting a feeler gauge between the ends of the ring, Figure 44. See "Specifications," page 15-21, for correct ring gap.

Minor increase in gap clearance can be made by filing the ends of the ring but this must be done accurately on equipment made for this purpose.

Too much end clearance indicates that wrong rings are being used or cylinder is bored too large.

Installing Rings and Piston

After checking ring side clearance and end gap, use a ring expander to position all rings exactly as shown, Figures 45 and 46. Regular set of rings do not have rails and expander on oil ring.

Note position of chamfer on top ring, under cut on center ring and expander of lower ring.

When installing heavy-duty rings, be sure to install chrome-edged ring in top piston groove.

Stagger the piston ring gaps by moving each ring until the gaps are out of alignment as much as possible. THIS IS IMPORTANT.

Coat piston and ring generously with light oil and insert complete assembly into cylinder bore using ring compressor, Figure 47.

NOTE: Be sure match marks on connecting rod and rod cap are aligned and face flywheel side of engine, Figure 48.
Attaching Rod to Crankshaft

Fig. 48-Rod and Crankshaft Assembly

After piston assembly is installed, place block on end and oil connecting rod and crankshaft journal. Be sure that match marks on connecting rod and cap, Figure 48, are aligned and face flywheel side of engine.

Attach connecting rod cap, lock plate (if used) and cap screws to the connecting rod. Torque to specifications listed on page 15-22.

IMPORTANT: Bend lips of lock plate to rod cap screw heads to prevent screws from loosening.

Installing Oil Pan On Block

Place a new gasket on oil pan. Position oil pan to match cylinder block, Figure 49. Install cap screws and torque to specification listed in "Torque Chart" in Section 10.

Installing Flywheel

Fig. 50-Flywheel Assembly

Place square key in crankshaft keyway.

Assemble flywheel, washer and nut on end of crankshaft and tighten nut.

Place bar between flywheel fins or use strap wrench, Figure 50, while torquing nut. See "Torques for Hardware," page 15-22, for proper flywheel nut torque.

Refer to Group 10 of this section and install valves, breather and cylinder head.

Litho in U.S.A.
Installing Shrouding

Install blower housing, cylinder baffle, head baffle and air intake screen. Tighten all cap screws firmly.

IMPORTANT: Be sure to install the 1/4 x 3/8-inch cap screw in the position shown in Figures 51 and 52. A longer cap screw will strike the flywheel.

Installing Exterior Components

Install coil and condensor. Attach leads to their respective terminals. See Section 40, Electrical System.

Be sure breaker point push rod is in place. Also inspect, clean and adjust breaker points if necessary. See Section 40, Electrical System.

Refer to page 20-6 of this Section for proper carburetor and governor arm assembly. See adjustments and adjust accordingly.
**SPECIFICATIONS**

**K181S and K241AS Kohler Engines**

<table>
<thead>
<tr>
<th>Component</th>
<th>K181S</th>
<th>K241AS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bore and stroke</td>
<td>2-15/16 x 2-3/4 inches</td>
<td>3-1/4 x 2-7/8 inches</td>
</tr>
<tr>
<td>Bore diameter, new</td>
<td>2.9375 inches</td>
<td>3.250 inches</td>
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<tr>
<td>Crankshaft end play</td>
<td>0.002 to 0.023 inches</td>
<td>0.003 to 0.020 inches</td>
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<td>Crankshaft journal-to-connecting rod side clearance</td>
<td>0.005 to 0.016 inches</td>
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<tr>
<td>Crankshaft journal length</td>
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<td>1.5000 to 1.4995 inches</td>
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<td>Connecting rod-to-crankshaft journal running clearance</td>
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<td>0.001 to 0.002 inch</td>
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<td>Connecting rod-to-piston pin clearance</td>
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<td>Piston pin-to-piston boss</td>
<td>0.0001 inch interference to 0.0003 inch</td>
<td>Select Fit</td>
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<td>Piston-to-cylinder bore (thrust face)</td>
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<td>Piston-to-cylinder bore (top of skirt)</td>
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<td>Ring side clearance, oil ring</td>
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<td>Ring width, inches, oil ring</td>
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<td>0.001 to 0.0035 inch</td>
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<td>Valve stem clearance in guide, exhaust</td>
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<td>0.0025 to 0.0040 inch</td>
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<td>0.0005 to 0.0020</td>
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<td>Valve clearance, exhaust (cold)</td>
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<td>0.037 to 0.045 inch</td>
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<td>0.0006 to 0.0022 inch</td>
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<td>Ball bearing-to-bearing plate (interference)</td>
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<td>Ball bearing-to-crankshaft (interference to loose)</td>
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### Torques for Hardware

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<th>Torque</th>
<th>Item</th>
<th>Specifications</th>
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<tbody>
<tr>
<td>Connecting rod cap screws</td>
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<td>Crankcase lubricant</td>
<td>Refer to Section 10 for proper crankcase lubricant</td>
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<tr>
<td></td>
<td>(K241AS) 300 in-lbs.</td>
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<tr>
<td>Flywheel nut</td>
<td>(K181S) 50-60 ft-lbs.</td>
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<td>Oil change</td>
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<tr>
<td></td>
<td>(K241AS) 60-70 ft-lbs.</td>
<td></td>
<td>Every 25 hours of operation or every 8 hours under extremely dusty conditions</td>
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<td>Misc. hardware</td>
<td>Refer to Torque Chart, Section 10</td>
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<td>Engine block</td>
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<td></td>
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<td>0.005 inch wear or 0.004 inch out of round. Install heavy-duty rings</td>
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### Tune-Up Data

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<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
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<td>Connecting rod cap screws</td>
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<tr>
<td>Crankcase lubricant</td>
<td>Refer to Section 10 for proper crankcase lubricant</td>
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### SPECIAL TOOLS

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<tr>
<td>Strap wrench</td>
<td>Rigid-5</td>
<td>To remove flywheel</td>
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<tr>
<td>Micrometer 1-inch</td>
<td>Starrett 230 RL</td>
<td>Check piston pin diameter</td>
</tr>
<tr>
<td>Micrometer 2-inch</td>
<td>Starrett 2 RL</td>
<td>Check crankshaft journal diameter</td>
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<tr>
<td>Micrometer 3-inch</td>
<td>Starrett 436 XRL</td>
<td>Check piston diameter</td>
</tr>
<tr>
<td>Micrometer 4-inch</td>
<td>Starrett 436 XRL</td>
<td>Check piston diameter</td>
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<tr>
<td>Inside telescoping gauge</td>
<td>Starrett S579H</td>
<td>Check cylinder bore</td>
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<tr>
<td>5/16-6-inch</td>
<td>OTC 860 A</td>
<td>Check end clearances</td>
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<tr>
<td>Feeler gauge</td>
<td>AMMCO 500</td>
<td>Deglazing and boring engine block</td>
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<tr>
<td>Cylinder hone</td>
<td>OTC 846</td>
<td>Clean piston grooves</td>
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<td>Ring groove cleaner</td>
<td>AMMCO 621</td>
<td>Finish cut</td>
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<tr>
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<td>AMMCO 3933</td>
<td>Finish and deglazing</td>
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<tr>
<td>cylinder hone</td>
<td>AMMCO 620</td>
<td>Semi-finish</td>
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<tr>
<td>Finishing-Stone for AMMCO 500</td>
<td>AMMCO 619</td>
<td>For roughing cylinder (primary cut)</td>
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<td>500 cylinder hone</td>
<td>KD 850</td>
<td>Tighten piston ring compressor</td>
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<tr>
<td>Medium-Stone for AMMCO 500</td>
<td>KD 850 B-1</td>
<td>To compress piston rings</td>
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<tr>
<td>cylinder hone</td>
<td>AMMCO Model 2100</td>
<td>To remove top ridge from cylinder bore</td>
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<tr>
<td>Coarse-Stone for AMMCO 500</td>
<td>Service Tools Inc.</td>
<td>Timing balance gears to crankshaft gear</td>
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<tr>
<td>cylinder hone</td>
<td>1901 Indiana Avenue</td>
<td></td>
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<tr>
<td></td>
<td>Chicago, Illinois 60616</td>
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<tr>
<td>Piston ring band handle</td>
<td>670156 Lauson Power Products, Parts Depot, Grafton, Wisconsin 53024</td>
<td>Measure engine rpm</td>
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<tr>
<td>Piston ring compressor</td>
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<tr>
<td>Ridge/Reamer</td>
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<td>Balance Tool</td>
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<td>Treysit Vibrator Engine</td>
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<td>Tachometer</td>
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The camshaft-driven governor maintains constant engine speed under varying loads and serves as a top speed limiting device.

The Kohler K181S and K241AS Engines feature an automatic compression release camshaft which is explained in detail on the following page.
Automatic Compression Release Camshaft

Automatic compression release provides a reduction in cranking effort by holding the exhaust valve open slightly during the first part of the compression stroke. This allows part of the fuel-air mixture to escape, lowering the compression pressure, Figure 3. This feature is especially valuable during cold weather starting.

By releasing compression, the pressure of the burning mixture is reduced sufficiently for the flywheel to carry the engine over top dead center. This prevents "kick-back" and eliminates the need for the spark retard mechanism.

When the engine speed reaches approximately 650 rpm, centrifugal force disengages the automatic compression release allowing the engine to operate in the usual manner at all higher speeds, with no loss of power.
Removing Camshaft and Tappets

Remove engine and all component parts covered in Group 15.

Use a blunt punch to drive camshaft pin out of block, Figure 5.

IMPORTANT: Drive pin out from power take-off side of cylinder block only. Pin will slide out easily after it is driven free from this side of block, Figure 5. Removing or installing pin incorrectly will damage engine block.

Lift out camshaft.

IMPORTANT: If the original camshaft is to be reinstalled, use the same number of camshaft shims as removed.
Removing Governor

Loosen nut on governor cross shaft and slide off all external parts.

NOTE: Do not attempt to remove governor cross shaft from outside of engine. It must be removed from the inside.

Turn block upside down and remove governor stop pin (1, Fig. 4) and copper washer. Governor assembly, brass washer, and cross shaft (4, Fig. 4) may now be removed.

Inspecting Camshaft

Wash governor and camshaft in a safe cleaning solvent and wipe parts dry.

Check camshaft for cracked, worn or broken gear teeth.

Check operation of ACR camshaft and weights, making sure all parts are intact and operate freely.

Inspecting Governor Gear

The governor gear assembly, Figure 6, will not normally show much wear. Be sure weights and governor center pin operate freely and that gears and teeth are in good condition.

The stub shaft is replaceable. Remove expansion plug from block and press replacement shaft into block until it protrudes 11/32 inch from the boss area.

Be sure cross shaft arm is not loose on shaft and is positioned perpendicular to shaft, Figure 7. This is important. If arm is loose, install new cross shaft.

INSTALLATION

Installing Governor

Place cylinder block on its side. Place brass or steel washer (see chart below) and governor gear on stub shaft. Install cross shaft from inside of block. Be sure snap ring, Figure 7, is in place on cross shaft.

Place washer on stop pin and turn in from outside of engine block.

Thread bushing nut into block. Tighten nut slightly.

<table>
<thead>
<tr>
<th>Engine</th>
<th>Gear Type</th>
<th>Washer</th>
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</thead>
<tbody>
<tr>
<td>K181S</td>
<td>Steel</td>
<td>Brass</td>
</tr>
<tr>
<td>K181S</td>
<td>Nylon</td>
<td>None required</td>
</tr>
<tr>
<td>K241AS</td>
<td>Steel</td>
<td>Brass</td>
</tr>
<tr>
<td>K241AS</td>
<td>Nylon</td>
<td>Two Steel</td>
</tr>
</tbody>
</table>
Grasp end of cross shaft and work cross shaft in and out to determine end clearance. Cross shaft should be free to move in and out approximately 1/64 to 1/32 inch. Adjust for more or less end clearance by tapping needle bearing either in or out of block, Figure 9.

NOTE: To prevent damage, tap needle bearing at depressed center area only.

Spin the governor gear assembly to be sure it rotates freely.

Install tappets in holes from which removed.

While holding camshaft assembly, Figure 10, insert camshaft pin. Be sure to install thin shim washer(s) on shaft next to bearing plate side of block. Drive pin into block until end of pin is flush with block exterior (flywheel side of block).

Use feeler gauge to check camshaft end clearance. See “Specifications,” page 20-7. Use 0.005 to 0.010-inch spacer washers as required to obtain correct clearance.

Spin camshaft to be sure governor and camshaft turn freely.
Connecting Governor Arm to Carburetor

Connect linkage between governor arm and carburetor in correct holes as indicated, Figure 11, for the K181S Engine.

On K241AS Engines, install the adjustable link as shown in Figure 12. Be sure that the link is 3-5/8-inch long before attempting to complete governor arm adjustment. To obtain this dimension, loosen lock nuts and turn ends on or off threaded rod until correct length is reached. Tighten lock nuts.

Whenever looseness is noticed in the throttle linkage, Figure 12, remove cotter pins and turn adjusting plugs inward until tight against ball joints. Be sure, however, there is no binding. Tighten plugs and insert cotter pins.

Installing Governor Arm

Turn block upright and slide governor arm and bolt assembly on end of cross shaft, Figure 13.

Before tightening bolt on cross shaft, turn governor shaft counterclockwise as far as possible. While holding governor arm to the left (away from block) tighten bolt, Figure 14. Move governor through its full arc of travel to be sure it operates loosely. Relieve pressure on bushing nut if too tight.

Governor arm adjustment is the same for both the K181S and K241AS Engines, Figure 14.
**ADJUSTMENT**

**Governor Speed Adjustment (Kohler K181S Engine)**

Governor speed is regulated by the position of the governor bracket. The bracket acts as a stop limiting the rotation of the speed control disk.

After engine is operable, start engine and check engine speed at full throttle. Move governor bracket up or down, Figure 15, as required until maximum engine speed is 3800 rpm on a tachometer with all drives disengaged. See “Special Tools,” page 15-22. Tighten bushing nut but AVOID EXCESSIVE PRESSURE. Governor arm must operate loosely.

**Governor Speed Adjustment (Kohler K241AS Engine)**

To adjust governor, Figure 16, stop engine and set throttle control in run (high speed) position. Position cable so that side of adjusting screw lever strikes breather stud.

Start engine. Turn governor adjusting screw clockwise to decrease maximum rpm. Turn screw counterclockwise to increase maximum rpm.


**IMPORTANT:** Engine speed should not exceed 3800 rpm at no load.

**SPECIFICATIONS**

'K181S and K241AS Kohler Engines

**Table of Clearances**

<table>
<thead>
<tr>
<th>Item</th>
<th>Clearances</th>
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<tbody>
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<td>Camshaft pin-to-camshaft clearance</td>
<td>0.001 to 0.0035 inch</td>
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<tr>
<td>Camshaft end clearance</td>
<td>0.005 to 0.010 inch</td>
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<tr>
<td>Tappet in block</td>
<td>0.0005 to 0.0020 inch</td>
</tr>
</tbody>
</table>

**SPECIAL TOOLS**

<table>
<thead>
<tr>
<th>Name</th>
<th>Part No.</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>15/16-inch tappet wrench</td>
<td></td>
<td>To loosen or tighten governor bushing nut.</td>
</tr>
</tbody>
</table>
Engine Camshaft, Tappets and Governor - Kohler

Tractors, 110 and 112 (Serial No. 100,001-)

SM-2088-(Nov-69)

Litho in U.S.A.
The Tecumseh HH100 Engine used in 112 Tractors is a four-cycle, internal combustion engine. It has a cast iron block, and is an L-head, single cylinder engine with large bore, short-stroke design.

The engine is air cooled with tapered roller crankshaft bearings, is oil bath lubricated and has an internal weight governor.

Detailed specifications for the HH100 engine are covered in Section 10 "General," and at the end of each group in this section.

Tecumseh HH100 engines in 112 Tractors beginning with Serial No. 161,772 vary from earlier models. Changes include battery-coil ignition, a new cylinder head, and a crankcase capacity of 3 U.S. pints.
ENGINE ANALYSIS

PRELIMINARY ENGINE CHECKS

A complete guide for diagnosing engine malfunctions appears on page 5-9 of this Section. However, the majority of engine trouble reports are of a minor non-chronic nature and are usually due to electrical or fuel system difficulties. First make the checks listed below to isolate the majority of engine problems.

Check spark, Figure 2, whenever engine will not start. If engine will not crank, follow diagnosing procedure on page 5-9.

Remove ignition cable from spark plug and install adaptor or ordinary paper clip. Hold approximately 1/4 inch away from grounded engine shrouding while cranking the engine.

If there is no spark at the adaptor or a weak spark, the trouble is in the electrical system. If the battery and spark plug are good and all electrical connections are tight, the trouble is either in the ignition charger coil or ignition trigger module.

If there is good spark between the adaptor and the grounded surface, the problem is in the fuel system or spark plug.

If gas tank is full, check fuel shut-off valve on gas tank and gas lines to carburetor to be certain gas is getting to carburetor. Connect high tension wire to spark plug and crank engine. Choke as necessary. If engine still does not start, refer to "Diagnosing Malfunctions" on page 5-9 to check for internal difficulties.

PRELIMINARY ENGINE TESTS

The following preliminary engine tests are recommended to detect and isolate possible malfunctions before proceeding with further diagnosis. These tests are especially important when engine is burning oil, losing power or running erratically and when carburetion and ignition adjustments do not correct the condition.

Compression Test

The HH100 Engine is equipped with an instamatic EZEE-start compression release camshaft. It will be referred to as "EZEE-start" in this manual. The EZEE-start feature releases compression pressure during lower cranking speeds. It is important to crank the engine at 1000 rpm, or more to obtain an accurate compression test. The EZEE-start mechanism is disengaged when the tachometer reads approximately 650 rpm.

When the engine is operable in the tractor check compression as follows.

Depress clutch-brake pedal and set parking brake. Be sure oil in crankcase is at proper level and battery is properly charged.

NOTE: Be sure tractor drives are all disengaged. Run engine until warm, then stop the engine.

Remove spark plug. Also remove air filter for most accurate test.

Fig. 2-Checking Spark at Plug

Fig. 3-Testing Engine Compression
Set throttle and choke valves in wide open position by raising throttle lever all the way and lowering choke lever.

Install compression gauge in cylinder, Figure 3. Follow manufacturer's recommendations for installing and reading compression tester.

Test Conclusions

An engine in top operating condition will read 80 to 110 psi when engine is cranked approximately 1000 rpm.

A compression test above 110 psi, indicates excessive deposits in the combustion chamber or on the piston.

A reading lower than 80 psi indicates leakage at the cylinder head gasket, piston rings or valves. Engine should be reconditioned if compression falls below 80 psi.

To determine whether the rings or the valves are at fault, pour about one tablespoonful of heavy oil into the spark plug hole. Crank the engine several revolutions to spread the oil and repeat the compression test.

The oil will temporarily seal leakage around the piston rings. If the same approximate compression reading is obtained, the rings are satisfactory, but the valves are leaking or the piston is damaged. If the compression has increased considerably over the original readings, there is leakage past the rings.

Crankcase Vacuum Test

The crankshaft breather maintains a partial vacuum in the crankcase when the engine is operating properly.

Connect a water U-tube manometer to oil filler hole in cylinder block, Figure 4. Tester must hang vertically as shown. Start and run engine at 1200 to 1700 rpm. Allow engine to warm up and observe reading on scale. Follow manufacturer's recommendations for installation, testing and compensation for the effect of altitude on the gauge reading.

Test Conclusions

Proper crankcase vacuum for the HH100 Engine is a 7 to 12 inch water column on the manometer gauge.

A crankcase vacuum reading lower than indicated above is most likely due to a leaking breather valve or improperly assembled breather. See Group 30 and carefully reassemble breather parts as shown. A low vacuum reading may also be caused by leaky valves, engine blow-by or worn oil seals.

If the crankcase is found to be pressurized rather than having a vacuum, the breather filter may be plugged.

Engines with zero vacuum or pressurized crankcase will likely be pumping oil into the combustion chamber or out the breather or oil seals. This can be detected by watching for excessive exhaust smoke, engine overheating or oil leakage outside the engine.

DIAGNOSING MALFUNCTIONS

Refer to Group 5 of this Section, pages 5-9 through 5-11 for details.
Group 30

CYLINDER HEAD, VALVES AND BREATHER
TECUMSEH ENGINE FOR 112 TRACTOR

GENERAL INFORMATION

It is not necessary to remove the engine from the tractor to grind valves and valve seats or to service the breather assembly.

The exhaust valve seat insert is press fitted into the block and can be replaced. The intake valve seat is machined into the block. The breather assembly is mounted in front of the valve spring chamber below the carburetor.

Valve guides can be reamed and new valves with oversize stems installed when guide wear tolerances are exceeded.
VALVE ANALYSIS

Corroded and pitted valves tend to collect deposits which in turn cause valve sticking. Always replace badly corroded or pitted valves with new valves.

Exhaust valves are designed to function in temperatures exceeding 5000°F. However, when operating at this temperature for long periods of time, valve burning occurs, Figure 4. Tell-tale signs of valves running too hot is the dark discoloration of the valve stem down into the area protected by the valve guide. Another indication is distortion of the valve margin and valve face. Valve inserts may also begin to burn away.

The most common cause of an overheated engine and valves is poor cooling due to dirt or obstructions inside the intake shrouding. Remove and clean shrouding and all cooling fins on the engine if this condition is noticed. NOTE: Never run engine with shrouding removed.

Also check for improper valve timing by checking and correcting valve clearance.

Worn valve guides or valve springs can also cause overheated valves.

Valves running hot also can be caused by an improper spark plug or overheated spark plug, which causes pre-ignition, or a lean fuel mixture.

Lead deposits on the intake valve, Figure 2 consist mostly of lead and some metal which comes from the lubricating oil. It is caused by a small amount of exhaust gas leakage into the intake port area. This indicates that the valve is not seating properly. Grind the valve and reface the seat to correct this condition. NOTE: Be sure to correct valve to tappet clearance after grinding valves. See page 30-8.

Valve stem corrosion, Figure 3, is caused by moisture finding its way into the engine. Moisture in the fuel-air mixture can condense inside the engine when the engine is stopped prior to warm up.

Valve corrosion can also occur during storage when the engine has been idle for some time. Fogging or pouring oil in the combustion chamber before storing will prevent valve corrosion.
Using gasoline which has been left in the tank a long time is a common cause of sticking valves.

Sometimes this gummy substance can be seen on the valve. When this condition is found, it is also likely that the carburetor also contains gum deposits and will require a complete cleaning.

Advise customer to use fresh gasoline and to drain gasoline from all fuel lines and carburetor before storing tractor.

Fig. 5 - Gummy Valve Causing Valve to Stick

**REPAIR**

1. Cylinder Head Cover
2. 5/16" Cap Screw
3. 5/16" Cap Screw
4. Washer, Hardened (9 used)
5. Hex. Nut (6 used)
6. 5/16" Cap Screw
7. Cylinder Head
8. Gasket
9. Stud (4 used)
10. Pin (2 used)
11. Intake Valve
12. Spring Cap (2 used)
13. Valve Spring (2 used)
14. Exhaust Valve
15. Breather Gasket
16. Breather Assembly
17. Breather Tube
18. Machine Screw (2 used)
19. Spring Washer (9 used)
20. Spacer, 5/8"

Fig. 6 - Exploded View of Cylinder Head, Valves and Breather
REPAIR—Continued

It is not necessary to remove the engine from the tractor when servicing the cylinder head, head gasket, muffler, breather assembly, valves and valve seats.

IMPORTANT: On tractors equipped with hydraulic lift, do not disconnect the hydraulic lines. Remove the pump, valve and reservoir unit from the top of the engine and lower it to the ground with the hydraulic lines still attached. This procedure avoids the possibility of dirt entering the system.

For accessibility, remove the grille. Also remove the cowl and hood assembly.

Remove heat shield. Disconnect throttle and choke conduits at carburetor and control arm. Remove carburetor, control arm, breather assembly, blower housing, cylinder head, and head gasket.

Removing Valves

Use a spring compressor to compress valve springs, Figure 7. Remove keeper pins from valve stem and lift valves from engine block.

Remove valve spring retainers and valve springs from valve chamber.

Inspecting Cylinder Head

Remove all deposits from combustion chamber and gasket surface of head with a scraper and a wire brush.

Be careful not to damage the cylinder head gasket surface. Use a safe cleaning solvent to remove dirt, grease and other deposits.

Check the cylinder head for cracks or broken cooling fins and inspect the gasket surface for burrs and nicks. Replace the head if any of these conditions are found.

When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head by placing it on a surface plate, Figure 9. Check to see that gasket surfaces make contact at all points. Replace the cylinder head if it is warped.

NOTE: Whenever the cylinder head is removed, discard the head gasket. Always use a new head gasket when installing the cylinder head.
Inspecting Breather

The breather is a sealed assembly. Do not immerse assembly in cleaning solvent. Carefully wipe outside of assembly with a clean cloth. After wiping, remove breather tube, Figure 10, and clean tube thoroughly in cleaning solvent. Discard assembly if inside of breather assembly is full of sludge or if assembly is distorted. Replace complete assembly when vacuum test indicates faulty breather.

Be sure drain holes in breather assembly are open and down.

Testing Valve Springs

Check valve spring for squareness, using a steel square and a surface plate, Figure 11. Stand the spring and square on end on the surface plate. Slide the spring up to the square. Revolve the spring slowly and observe the space between the top coil of the spring and the square. See "Specifications," page 30-11, for out of square limits.

Inspecting Valves

Remove carbon from valve head, face, and stem with a power-operated wire brush. Be sure carbon is removed and not merely burnished. Any carbon left on the stem will affect accurate alignment in the valve refacer collet.

Check valve faces, heads and stems, Figure 13, for defects. Also look for bent valve stems and excessive corrosion causing pits on valve face or stem. Replace...
Inspecting Valves—Continued

valves with a warped head. Recondition or replace valves with less than 1/64-inch margin. Valve stem ends should be ground square before checking valve tappet clearance.

Reconditioning or Replacing Valves

Valve Guides

Clean the valve guides first to assure valve alignment when cutting valve seats.

Use valve guide cleaner to clean inside of valve guide. Then measure I.D. of valve guide, Figure 14, and O.D. of valve stem, Figure 15. Refer to "Specifications," page 30-11, for tolerances. Ream guides as necessary.

Valve Seats

A broken or worn exhaust valve seat (insert) may be replaced. See page 30-8. They are either stellite or molychrome nickel. The intake valve seat is machined into the cylinder block.

Hold the valve seating, surface "A," Figure 16, as close to 3/64 inch as possible. Seats with more than 1/16-inch seating surface should be narrowed (cut back) with a 30° cutter, "E," Figure 16.

The valve seat angle "B" depends upon valve face angle "C." New valves have a 45° face. Recondition valve seats with 46° cutters and lap valves. See page 30-7.

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The valve seat angle "B" depends upon valve face angle "C." New valves have a 45° face. Recondition valve seats with 46° cutters and lap valves. See page 30-7.

Fig. 16-Valve Seat and Surface Dimensions

This valve seat cutter will cut a 46° valve seat and narrow the seat to 30°. See "Special Tools," page 30-12, for tool number and manufacturer.

When reconditioning valves, be sure there is no more than 1/16-inch and no less than 1/64-inch margin "D" on the valve.
Lift valve from seat every eight or ten strokes to keep compound equalized on surface of valve seat. Continue valve lapping operation until a uniform lapping ring appears around entire surface of valve face. When a good seal is attained, wash all parts with solvent to remove all traces of lapping compound. Dry parts thoroughly.

Note position of valve seat marked on valve face. The lapping mark made by the seat after lapping should appear on or near the center of the valve face.

**Reaming Valve Guides**

If valve guide clearance exceeds maximum tolerance, ream the guide.

Use an adjustable reamer, Figure 20, when enlarging valve guides for an oversize valve stem diameter. See “Specifications,” page 30-11 for valve guide oversize dimensions. See “Special Tools” page 30-12, for an adjustable reamer to enlarge valve guides.

**IMPORTANT:** Do not enlarge lifter guides, because lifters with oversize stems are not available.
Removing and Installing Exhaust Valve Seat Insert

To remove exhaust valve seat insert, use extractor, Figure 21, or a valve seat puller. Clean seat area thoroughly before installing new insert. If extractor is not available, break insert and drive out.

The exhaust valve insert is retained by a press fit only. Chill both the insert and driving tool in dry ice before pressing insert into block.

Checking Valve Clearance

Valve grinding changes the lifter and valve clearance. After grinding or installing new valves, check clearance as follows:

1. Rotate crankshaft until piston is top dead center (end of compression stroke) and crankshaft keyway is at exactly 12 o’clock (top) position. It is important that this procedure be followed to insure that the exhaust valve lifter is NOT riding on the EZEE-Start mechanism.

2. Insert valves in their guides and hold valves firmly on seats with either your fingers or a compressor as shown in Figure 22.

3. Check clearance between bottom of each valve stem and its lifter with a feeler gauge, Figure 22. Refer to “Specifications,” page 30-11, for proper valve clearance. Grind off tip of valve stem in a valve resurfacing machine set to grind a perfectly square face. Grind tip of stem until proper clearance is obtained.
INSTALLATION

Installing Valve Springs, Retainers and Keeper Pins

Place valve spring and retainer in valve spring chamber, Figure 23. Install valves in guides working them back and forth to make sure they slip through the guides easily. Using a valve spring compressor, compress the springs and install keeper pins in hole of stem, Figure 23.

Installing Breather

Install rubber breather tube on breather assembly, Figure 24. Install breather assembly on cylinder block with drain holes toward the base of the engine. Always use a new gasket. Tighten retaining screws firmly.

Installing Cylinder Head

Always install a new head gasket when the head has been removed for service. This will assure a gas-tight fit.

Position head gasket on block.

**IMPORTANT:** Install head gasket dry. Do not use Permatex, or other sealant on gasket.

Place milled head over gasket and install the 5/8-inch spacer over stud (9, Figure 25).

**NOTE:** Lubricate the threads of all studs and head bolts with paraffin or engine oil prior to installation.

Place hardened special flat washer (next to head) and special Belleville spring washer (crown up) on each head bolt and stud with the exception of the stud with spacer. See inset, Figure 25.

**IMPORTANT:** Head bolts 7 and 8 are 1-3/4 inches long, bolts 1 and 4 are 2 inches long and bolt 3 is 2-1/4 inches long.

Follow the sequence shown in Figure 25 and tighten the head bolts and stud nuts to 100 in-lbs of torque. Tighten bolts and nuts evenly in 50 in-lb steps until 200 in-lbs of torque is reached.

**NOTE:** Stud 9 with spacer cannot be torqued until blower housing is installed.

Install blower housing and grass screens.
Installing Carburetor

Fig. 26-Carburetor Assembly (Air Filter Base Removed for Clarity)

Connect throttle link in holes on governor arm and throttle shaft arm. Using a new gasket, mount carburetor on engine block and tighten nuts firmly. Install governor spring and control lever. Tighten control lever pivot screw firmly. Place governor spring in proper hole on governor plate, Figure 26. Install cables and secure conduits in clamps. Check controls for correct travel. Readjust if necessary. Connect fuel line.

Installing Muffler

Coat threads on muffler with an anti-seize compound to prevent carbon fusion.

Screw muffler in block hand tight. Exhaust outlet should be at bottom of muffler.

Checking Air Filter

Be sure air filter is clean. Remove filter and tap out dust or replace if necessary. See Section 30, Group 15.

Checking Spark Plug Gap

Refer to "Specifications," page 30-11, for proper spark plug gap. See Section 40, "Electrical System," for spark plug testing.

Setting Ignition Module Air Gap

Refer to Section 40, "Electrical System," for air gap setting procedure.

Installing Hydraulic System

Refer to Section 60, "Hydraulic System," for detailed service information.
### SPECIFICATIONS

**HH100 Tecumseh Engine**

<table>
<thead>
<tr>
<th>Item</th>
<th>Dimension</th>
<th>Wear Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve guides, STD dia.</td>
<td>0.312 to 0.313 inch</td>
<td>0.0015 to 0.0020</td>
</tr>
<tr>
<td>Valve guides, 0.030 inch oversize</td>
<td>0.343 to 0.344 inch</td>
<td>0.0015 to 0.0020</td>
</tr>
<tr>
<td>Valve seat width</td>
<td>0.042 to 0.052 inch</td>
<td>. . .</td>
</tr>
<tr>
<td>Valve face width</td>
<td>0.089 to 0.099 inch</td>
<td>. . .</td>
</tr>
<tr>
<td>Valve margin</td>
<td>1/16 inch</td>
<td>1/32 inch</td>
</tr>
<tr>
<td>Valve spring squareness</td>
<td>1/32 to 1/16 inch</td>
<td>3/32 inch</td>
</tr>
<tr>
<td>Valve spring compressed tension</td>
<td>19-21 lbs. at 1-21/32-inch length</td>
<td>. . .</td>
</tr>
<tr>
<td>Valve spring free length</td>
<td>2-1/8 inch</td>
<td>. . .</td>
</tr>
<tr>
<td>Valve stem diameter</td>
<td></td>
<td>. . .</td>
</tr>
<tr>
<td>Intake, standard</td>
<td>0.309 to 0.310 inch</td>
<td>. . .</td>
</tr>
<tr>
<td>Exhaust, standard</td>
<td>0.308 to 0.309 inch</td>
<td>. . .</td>
</tr>
<tr>
<td>Intake, oversize</td>
<td>0.340 to 0.341 inch</td>
<td>. . .</td>
</tr>
<tr>
<td>Exhaust, oversize</td>
<td>0.340 to 0.341 inch</td>
<td>. . .</td>
</tr>
<tr>
<td>Cylinder head flatness</td>
<td>Contact at all points</td>
<td>Replace warped head</td>
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### Table of Engine Clearances

<table>
<thead>
<tr>
<th>Item</th>
<th>Clearance</th>
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<tbody>
<tr>
<td>Intake valve clearance cold</td>
<td>0.010 inch</td>
</tr>
<tr>
<td>Exhaust valve clearance cold</td>
<td>0.020 inch</td>
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</tbody>
</table>

### Torque For Hardware

<table>
<thead>
<tr>
<th>Location</th>
<th>Torque</th>
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<tbody>
<tr>
<td>Cylinder head bolts</td>
<td>200 in-lbs</td>
</tr>
<tr>
<td>Spark plug (cold)</td>
<td>15 to 20 ft-lbs</td>
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### Tune-Up Data

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
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<tbody>
<tr>
<td>Engine compression</td>
<td>80 to 110 psi</td>
</tr>
<tr>
<td>Spark plug gap</td>
<td>0.030 inch</td>
</tr>
<tr>
<td>Valve face angle</td>
<td>45 degrees</td>
</tr>
<tr>
<td>Valve seat angle</td>
<td>46 degrees</td>
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<tr>
<td>Crankcase vacuum</td>
<td></td>
</tr>
<tr>
<td>U-tube manometer</td>
<td>7 to 12 inches water column</td>
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### SPECIAL TOOLS

<table>
<thead>
<tr>
<th>Name</th>
<th>Part No.</th>
<th>Use</th>
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<tr>
<td>Extractor</td>
<td>K.O. LEE R95</td>
<td>To remove exhaust valve seat insert.</td>
</tr>
<tr>
<td>Valve Spring Tester</td>
<td>STURTEDANT Model SPT</td>
<td>To check valve spring pressure.</td>
</tr>
<tr>
<td>Adjustable Reamers</td>
<td>QUICK SET 43</td>
<td>Ream valve guides after installation.</td>
</tr>
<tr>
<td>Valve Grinding Compound</td>
<td>B-K 1896</td>
<td>To lap valve seat and valve face.</td>
</tr>
<tr>
<td>Valve Keeper Replacer</td>
<td>KD 608</td>
<td>To install keepers on valve stem.</td>
</tr>
<tr>
<td>Valve Lifter</td>
<td>SNAP ON CF19</td>
<td>To compress valve springs.</td>
</tr>
<tr>
<td>U-Tube Manometer</td>
<td>DWYER Model 1211-24</td>
<td>Check crankcase vacuum.</td>
</tr>
<tr>
<td>Valve Seat Cutter Kit</td>
<td>NEWAY No. 102S Kit, NEWAY Sales Inc., Corunna, Michigan</td>
<td>Recondition valve seat.</td>
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</table>
OVERSIZE PISTONS AND RINGS ARE AVAILABLE FOR THE HH100 TECUMSEH ENGINE.

A SHORT BLOCK ASSEMBLY IS ALSO AVAILABLE. IT IS COMPLETE WITH CYLINDER BLOCK, CRANKSHAFT, BEARINGS AND SEALS, CONNECTING ROD WITH PISTON, INTERNAL GOVERNOR PARTS, VALVES AND SPRINGS, CAMSHAFT AND CYLINDER COVER AND CYLINDER HEAD.
Fig. 2-Exploded View Showing Piston, Connecting Rod, Crankshaft, Flywheel, Main Bearings and Oil Seals

Litho in U.S.A.
Removing Engine From Tractor

1. Drain crankcase oil.
2. Remove front grille.
3. Remove four cowl support bolts from tractor frame. Remove hood and cowl panels as an assembly.
5. Disconnect ignition wire harness at harness connector.
6. Disconnect choke and throttle control cables at the engine.
7. Remove muffler shield and hydraulic system if tractor is so equipped. NOTE: Do not disconnect hydraulic lines unless hydraulic system is to be repaired also.
8. Remove shielding from right-hand side of tractor and remove four engine base bolts. Lift out engine.

Disassembling Engine

Remove engine shrouding, ignition module, carburetor, starter, and oil filler tube.

Remove cylinder head, breather assembly and valves. See Group 30 of this section.

Removing Cylinder Ridge

Turn flywheel until piston is at lowest position, (B.D.C). Remove carbon and ridge from top of cylinder bore with ridge reamer, Figure 3. NOTE: Piston damage will occur if ridge is not removed before pushing piston out of cylinder bore.

Pulling Flywheel

Break flywheel nut loose with a long handle nut spinner and a flywheel wrench. Flywheel wrench is shown in Figure 4. The flywheel is mounted on a tapered shaft and should be removed with a puller, Figure 4. Remove key from crankshaft.

Removing Cylinder Cover

Place engine on two blocks high enough to allow the tapered end of crankshaft to extend freely. Using oil seal sleeve tool, remove cylinder cover, Figure 5.
Removing Cylinder Cover—Continued

See "Special Tools," page 35-19, for oil seal sleeve tool. Remove governor spool, camshaft and lifters. Identify exhaust lifter with an "x" marking to assure correct installation during assembly.

Remove and discard lock nuts from connecting rod bolts. NOTE: Use thin wall socket to remove lock nuts. Using the wrong socket will force pressure against rod cap and cause misalignment. Remove connecting rod cap and push piston and rod out top of block.

Removing Crankshaft

Insert seal sleeve tool in bearing retainer seal and remove crankshaft from cylinder block.

Remove bearing retainer, bearing cup and shims. Discard paper shims.

Remove retaining ring and governor gear assembly.

Removing Piston Rings

Clamp the connecting rod in a vise with soft jaws to prevent damaging rod. IMPORTANT: Tighten vise only tight enough to hold the assembly. Too much pressure will damage rod.

Use ring expander to remove rings, Figure 7. Discard old rings.

Remove retainers from each end of piston pin and push pin out of piston and connecting rod.

Analyzing Piston Ring Wear

Light scuffing or scoring of both rings and piston occurs when unusually high friction and combustion temperatures approach the melting point of the piston material, Figure 8.

When this condition is found, check and correct the following probable causes:
1. Dirty cooling shroud and cylinder head.
2. Lack of cylinder lubrication.
3. Improper combustion.
4. Wrong bearing or piston clearance.
5. Too much oil in crankcase causing fluid friction.
Rings of the wrong size or rings having improper end gap, Figure 9, cannot conform to the shape of the cylinder. This results in high oil consumption and excessive blow-by. This could also be caused by end gaps in alignment.

Ring end gaps should be staggered on the piston during installation.

Check wear of ring grooves carefully, Figure 10, especially the top groove. The top ring and groove are exposed to most combustion temperature and pressure as well as airborne abrasives which enter the combustion chamber.

Any condition which causes the engine to operate at abnormally high temperatures may cause varnish and lacquer gum deposits as well as carbon deposits to form in the piston grooves making the rings stick, Figure 11. When this happens, excessive oil consumption and blow-by will occur.

Engine heating and ring sticking are most often caused by:

1. Overloading
2. Incorrect ignition timing
3. Lean fuel mixture
4. Dirty cooling fins
5. Incorrect oil
6. Low oil supply
7. Stale fuel
Analyzing Piston Ring Wear—Continued

Vertical scratches across the faces of piston rings, Figure 12, are the result of an abrasive entering the engine. Abrasives may be airborne, may have been left in during overhaul or are loose lead and carbon deposits.

When this condition is found, always check and correct the source of abrasives to prevent premature ring failure.

1. Damaged, collapsed or improperly installed air filter.
2. Loose connection or damaged gasket between air filter and carburetor.
3. Air leak around carburetor to block gasket.
4. Air leakage around throttle shaft.
5. Failure to properly clean cylinder bore after reconditioning engine.

Rails of the oil ring are worn down to the oil drain holes and the oil ring surface is worn flat, Figure 13. This can only come from cylinder wall contact after much use and possible entry of abrasives. Compression rings will also be worn thin.

Badly worn oil rings will have:
1. Extra large gap.
2. Low tension.

Inspecting Piston

Remove deposits from piston surfaces. Clean gum and varnish from the piston skirt.

Do not use a caustic cleaning solution or a wire brush to clean pistons.
Be sure the oil ring holes are clean.

Clean carbon from piston ring grooves with a ring groove cleaner, Figure 14. If cleaning tool is not available, break an old ring and use it to clean grooves.

Check ring grooves for excessive wear by inserting a new ring in the proper groove at several points around the piston. Measure clearance between ring and groove with a feeler gauge, Figure 15. Refer to "Specifications," page 35-18, for ring groove side clearance. Replace piston having ring clearance beyond wear limits.

Inspect piston for fractures at the ring lands, skirts and ring bosses and for rough or scored skirts.

Analyze the condition of the piston by studying the illustrations beginning on page 35-8. Replace faulty pistons.

Check the piston-to-cylinder bore clearance by measuring the piston and bore diameters, Figures 17 and 24.

Measure the outside diameter of the piston with a micrometer at the centerline of the piston pin bore and at 90° to the pin bore axis.

If piston-to-cylinder bore clearance is more than 0.013 inch, rebore cylinder if piston is within tolerance. Install oversize piston and rings. See "Specifications," page 35-18.

Oversize pistons and rings are available in 0.010 inch and 0.020 inch sizes for service.

See page 35-11 for deglazing and reboring information.
Analyzing Piston Wear

Detonation is a form of abnormal combustion causing excessive temperature and pressure in the combustion chamber, Figure 18. Commonly called carbon knock, spark knock or timing knock, detonation occurs as compressed air-fuel mixture ignites spontaneously to interrupt the normal ignition flame front. When detonation is detected, check and correct the following possible causes:

1. Lean fuel mixtures.
2. Low octane fuels.
3. Over-advanced ignition timing.
4. Engine lugging.
5. Build-up of carbon deposits on piston and cylinder head causing excessive compression.
6. Wrong cylinder head or milling of head increasing compression ratio.

Pre-ignition is the igniting of the fuel-air mixture prior to the regular ignition spark. Pre-ignition causes severe internal shock resulting in pings, vibration, detonation and power loss. Severe damage to piston, rings and valves results from pre-ignition, Figure 19.

When pre-ignition is suspected and detected, check and correct the following possible causes:

1. Internal carbon deposits which remain incandescent.
2. Incorrect spark plug (high heat range).
3. Broken ceramic in spark plug.
4. Sharp edges on valves or elsewhere in the combustion chamber.
Check rod and piston alignment when a piston shows a diagonal wear pattern extending across the skirt of the piston, Figure 20. Contact with cylinder wall shows on bottom of skirt at left and ring lands on the right.

A cylinder bored at an angle to the crankshaft could also cause improper ring contact with the cylinder wall.

This condition can cause:
1. Rapid piston wear.
2. Uneven piston wear.
3. Excessive oil consumption.

In Figure 21 a piece of the retaining ring found its way into the oil ring.

Pin retaining rings loosen or break due to:
1. Rod misalignment.
2. Excessive crankshaft end play.
3. Crankshaft journal taper.
4. Weak pin retaining rings.
5. Pin retaining rings incorrectly installed.

Inertia can cause a retaining ring or loose object inside the piston pin to beat out the piston and cylinder in the pin boss area. Damage to both the piston and cylinder occurs.
Inspecting Crankshaft

Wipe crankshaft dry and check general condition. Clean up threads on end of shaft if necessary. If crankshaft journal indicates wear beyond specified limits or if journal is scored, replace crankshaft, Figure 22. Replacement crankshafts have crankshaft gear, journal, and bearings assembled to crankshaft. New bearing cups are also provided and should be used when installing a new crankshaft assembly.

Analyzing Connecting Rod And Cap Wear

Check rod and cap for signs of bending, cracking or unusual wear patterns.

Lack of lubrication or improper lubrication can cause the connecting rod and cap to seize to the crankshaft and may even cause rod particles to become embedded in the hardened steel crankshaft. When the rod and cap seize to the crankshaft, the connecting rod and piston may both break with shattering force causing other interior damage. When this happens, inspect block carefully for cracks and breakage before rebuilding engine.

Crankshaft and connecting rod damage can result from:
1. Engine run low on oil or without oil.
2. Oil slinger broken off bearing cap.
3. Oil hole in connecting rod plugged with sludge.
4. Oil not changed regularly.
5. Bearing cap installed incorrectly.

Note especially the condition of the rod and cap bearing area, Figure 23. Evidence of score marks on these areas indicates impurities in the oil or engine run without oil. Replace rod showing scratch marks or deep scores in the bearing area. Bent rods can be straightened with a rod aligner. Be sure slinger on rod cap is intact—not cracked, bent or chipped. This is important. NOTE: New rods and caps are available only as a matched set for service. If either is damaged, both must be replaced.

Measure fit of rod and cap to crankshaft journal. Also measure fit of piston pin in piston and rod. See "Specifications," page 35-18.
Inspecting and Repairing Block

After thoroughly cleaning the block, check it for cracks. Cracks not visible to the naked eye may be detected by coating the suspected area with a mixture of 25 per cent kerosene and 75 per cent light engine oil.

Wipe the part dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If a crack is present, the coating will become discolored at the defective area. Replace the block if cracked. NOTE: A short block is available for service.

![Image](M 5686)

Fig. 24-Measuring Cylinder Bore

Use a telescoping gauge and micrometer to measure bore in two places at top and bottom of ring travel area, Figure 24. Out-of-round dimension is the difference between dimensions A and B. Cylinder wall taper is the difference between dimension A at the top and dimension A at the bottom of cylinder bore. See "Specifications," page 35-18, for wear tolerance.

Deglazing Cylinder Bore

Deglazing is not intended to remove any appreciable amount of metal from the bore, but rather to clean up and provide the proper surface. A proper bore surface feels smooth, but has a cross-hatch pattern of micro-scratches which can be seen. This finish will allow the new rings to conform to the cylinder bore. This finish also retains a small film of oil to provide ring lubrication for the ring surface and prevents scoring.

![Image](M 5686)

Fig. 25-Deglazing Cylinder Bore

Use a deglazing tool to break glaze, Figure 25. Follow manufacturer’s recommendations.

A 200-280 grit tool is generally preferred for deglazing. A cross-hatch pattern of approximately 45 degrees should be obtained while operating the tool vertically during deglazing.

Boring Cylinder Block

If block is to be bored as determined on page 35-7, clean and dry block thoroughly. Boring can be done by machining at a reliable automotive repair shop or by using an electric drill and honing tool. See "Special Tools," page 35-19.

Honing to 0.010-inch oversize to accommodate oversize piston and rings can also be done with a coarse stone in the deglazing tool, Figure 25, and refinishing with finer grit stones. IMPORTANT: If block is jigged in a drill press for honing, be sure honing tool and block are in true alignment.

Inspecting Camshaft

Check camshaft for broken or cracked gear teeth. Check operation of EZEE-start assembly making sure all parts are intact and operate freely. Check condition of flywheel spring. If camshaft needs attention, see Group 40 for camshaft and governor service.
Inspecting Main Bearings

Main bearings turn in an oil mist and are normally durable. Check for unusual signs of wear such as race turning with bearing or bearing deflection caused by excessive engine lugging. Refer to "Bearing Analysis" below.

Analizing Bearing Wear

The cause of bearing failure must be identified and understood in order to apply the proper corrective measures.

Chipping of roller bearings, Figure 27, is caused by improper crankshaft end play adjustment.

Refer to pages 15-12 and 15-13 of this section for an analysis of other bearing failures.