

MF 50 TRACTOR/BACKHOE/ LOADER

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GENERAL INFORMATION AND SPECIFICATIONS

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TRACTOR GENERAL

Front Wheel Toe-In	0-1/4 inch
Steering:	
Type	Hydrostatic
Hand Wheel Turns — Stop to Stop	3.25 turns
Steering Hand Pump Displacement Per Revolution	6.5 cu. inches
Pump (engine driven):	
Type	Positive displacement/gear
Capacity	5 gpm @ 2000 engine rpm
Integral Relief Valve Setting	1500 psi
Steering Cylinders (2 used):	
Type	Double-acting
Size	1.60" bore x 7.38" stroke
Single Clutch	12" dia. w/1520 lbs. pressure plate loading
Torque Converter	
Size	11-3/4" dia.
Normal Operating Temperature (recommended)	200°F. and below
Maximum Continuous Operating Temperature Under Extreme Ambient Air Conditions	250°F.
Torque Multiplication — Maximum @ Stall Point of Converter	2.12 times input torque
Maximum Stall Speed of Converter:	
Gasoline Engine	1400 rpm (1300-1450 rpm acceptable)
Diesel Engine	1390 rpm (1300-1450 rpm acceptable)

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Transmission:

Type	Manual Shuttle	Instant Reverse
Number of Sliding Spur Gears (Change Speed)	3	2
Planetary Reduction at Output End of Main Shaft	Yes	Yes
Number of Speed Selections Available	6 forward & 6 reverse	4 forward & 4 reverse

Rear Axle:

Spiral Bevel Gear Reduction	3.46:1
3-Pinion Planetary Final Reduction	3.14:1
Total Rear Axle Reduction	10.87:1

Brakes:

Type and Size	Double disc hydraulic, 7" dia.
Lining Thickness	3/16" approx.
Master Cylinder Bore	1 inch
Wheel Cylinder Bore	3/4 inch
Mechanical Advantage (approximate, between pedal & brake pull rod)	30 to 1

CAPACITIES (U.S. MEASURE) (All Measures Approximate)

Engine Crankcase:

Gasoline Engine <i>Without</i> Oil Filter Change	5 quarts
Gasoline Engine <i>With</i> Oil Filter Change	6 quarts
Diesel Engine <i>Without</i> Oil Filter Change	7-1/2 quarts
Diesel Engine <i>With</i> Oil Filter Change	8-1/2 quarts

Cooling System:

Gasoline Engine	10 quarts
Diesel Engine	10-1/2 quarts

Fuel Tank (Both Engines) 17 gallons

Transmission and Differential 36 quarts

Transmission and Torque Converter 11 quarts

Drive Axle Planetaries (each) 1/2 quart

Power Steering Pump Reservoir (engine driven) 2-1/3 pints

Brake Master Cylinder Reservoir 4 ounces

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LUBRICATION

Gasoline Engine Crankcase Oil:

Use A.P.I. Service Class "MS" Oils. (A.P.I. Service Class should be on container.)

EXPECTED AIR TEMPERATURE	RECOMMENDED OIL VISCOSITY
90°F. and above	SAE 30
32°F. to 90°F.	SAE 30
10°F. to 32°F.	SAE 20W
-10°F. to +10°F.	SAE 10W or 5W/20

Diesel Engine Crankcase Oil:

Use A.P.I. Service Class "DG" Oils. (A.P.I. Service Class should be on the container.)

EXPECTED AIR TEMPERATURE	RECOMMENDED OIL VISCOSITY
90°F. and above	SAE 30
32°F. to 90°F.	SAE 20 or SAE 20/20W
10°F. to 32°F.	SAE 10W
-10°F. to +10°F.	SAE 5W or SAE 5W/20

Transmission and Differential:

Use Extreme Pressure Transmission Oil conforming to Massey-Ferguson Specification M-1129 or M-1129A. (The MF Spec. No. is on the container.)

Transmission and Torque Converter:

Use Type "A" Automatic Transmission Fluid conforming to Massey-Ferguson Specification M-1110. (The MF Spec. No. is on the container.)

Drive Axle Planetaries:

Use Extreme Pressure Transmission Oil conforming to Massey-Ferguson Specification M-1129 or M-1129A. (The MF Spec. No. is on the container.)

Hydrostatic Steering System:

Use Type "A" Automatic Transmission Fluid conforming to Massey-Ferguson Specification M-1110. (The MF Spec. No. is on the container.)

Brake Master Cylinder:

Use heavy-duty type, hydraulic brake fluid conforming to Massey-Ferguson Specification M-1123. (SAE 70 R3 requirements.)

Pressure-Type Grease Fittings — Except Clutch Release Bearing:

Use a good grade of general purpose Lithium Soap Grease suitable for use as a chassis lubricant.

NOTE: Do not mix sodium soap greases (or other non-lithium base greases) with lithium soap grease.

CONSISTENT AIR TEMPERATURE	RECOMMENDED CONSISTENCY
80°F. and above	N. L. G. I. No. 2 (Firm)
45°F. to 80°F.	N. L. G. I. No. 1 (Soft)
below 45°F.	N. L. G. I. No. 0 (Soft)

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Clutch Release Bearing:

Use a good grade of Extreme High Temperature Bearing Grease. (Suitable for operating temperatures higher than intended for conventional metallic soap thickened petroleum greases. Shell-"Darina Grease AX" (or its equivalent) may be used.)

GASOLINE ENGINE

GENERAL INFORMATION:

Engine Model and Type	GF-193, four cylinder, four cycle, valve-in-head
Bore	3-3/4 inches
Stroke	4-3/8 inches
Piston Displacement	193.3 cubic inches
Compression Ratio	7.0 to 1
Firing Order	1-3-4-2
Low Idle Speed	450-500 rpm
Rated Engine Speed — Full Load	2200 rpm
High Idle Speed — No Load	2400-2450 rpm

Tappet Setting:

Intake Valves	0.016 inch "Hot"
Exhaust Valves	0.018 inch "Hot"

ENGINE LUBRICATING SYSTEM:

Type of System	Forced circulation
Oil Filter	By-pass type, replaceable element
Normal Oil Pressure	20-30 psi @ regular operating speeds
Minimum Oil Pressure	7 psi @ low idle speed

FUEL SYSTEM:

Float Level	1/4 inch from top of float to gasket surface
Idle Adjusting Needle	Approx. 1-2 turns open
Main Adjusting Needle	Approx. 1-5/8 — 1-7/8 turns open

COOLING SYSTEM:

Thermostat Opening Temperature	160°F.
Radiator Pressure Cap	10 psi

ELECTRICAL SYSTEM:

Type of System	12-volt, negative ground
Spark Plug Gap	0.025 inch
Distributor Point Gap	0.022 inch
Static Engine Timing	10° BTDC
Maximum Spark Advance	30° BTDC @ 2200 rpm

DIESEL ENGINE

GENERAL INFORMATION:

Engine Model and Type AD4.203 — four cylinder, four cycle, valve-in-head
 Bore 3.6 inches
 Stroke 5 inches
 Piston Displacement 203.5 cubic inches
 Compression Ratio 18.5 to 1
 Firing Order 1-3-4-2

Low Idle Speed:

Manual Shuttle Models 575-625 rpm
 Instant Reverse Models 575-625 rpm

Rated Engine Speed (Full Load) 2200 rpm

High Idle Speed (No Load) 2335-2385

Tappet Setting (Intake and Exhaust) 0.010 inch "Hot"
 0.012 inch "Cold"

ENGINE LUBRICATING SYSTEM:

Type of System Forced circulation
 Oil Filter Full flow — replaceable element
 Normal Oil Pressure 25-60 psi at normal operating speeds

FUEL SYSTEM:

Recommended Type Fuel No. 1 Diesel Fuel for winter and
 No. 2 Diesel Fuel for summer operation

Fuel Lift Operating Pressure 5-8 psi

Injection Pump Timing 26° BTDC

Timing Letter on Rotor for Start of Injection to No. 1 Cylinder Letter "B"

Nozzle Opening Pressure:

Used Injectors (more than 25 hrs. operation) 2500 psi
 New Injectors or Old Injectors with New Springs 2720 psi

COOLING SYSTEM:

Thermostat Opening Temperature 168°-176°F.
 Radiator Pressure Cap 10 psi

ELECTRICAL SYSTEM:

Type of System 12-volt, negative ground

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TORQUES (Bolt and Capscrew Tightening)

The torque charts under this heading may be used as a general guide when tightening fasteners that do not have specific tightening torque recommendations established.

Identification of the SAE Grade 5 and Grade 8 fasteners is as follows:

Grade 5



Bolt heads are marked with 3 radial dashes
120° apart to denote SAE Grade 5 fasteners. See below.

Grade 8

Bolt heads are marked with 6 radial dashes
60° apart to denote SAE Grade 8 fasteners. See below.

NOTE: Specific tightening torque recommendations are usually given where SAE Grade 8 fasteners are used.

The diameter of the bolt body (*not the head width*) determines the nominal size of the bolt.

FOOT-POUNDS					
Torque Values for SAE Grade 5 and SAE Grade 8 Bolts Coarse and Fine Thread					
SAE Grade 5* 			SAE Grade 8 		
NOMINAL SIZE	NON-RIGID JOINT**	RIGID JOINT***	NOMINAL SIZE	NON-RIGID JOINT**	RIGID JOINT***
1/4"	5-6	8-10	1/4"	8-10	12-14
5/16"	10-12	15-18	5/16"	16-20	24-28
3/8"	19-22	30-35	3/8"	29-35	43-49
7/16"	33-38	50-55	7/16"	47-56	70-79
1/2"	47-53	76-85	1/2"	70-85	105-129
9/16"	65-73	115-125	9/16"	100-125	150-175
5/8"	100-125	155-170	5/8"	140-175	210-240
3/4"	175-200	270-300	3/4"	250-300	375-425
7/8"	260-310	400-450	7/8"	400-475	600-675
1"	400-475	600-675	1"	600-725	900-1025
1-1/8"	525-625	800-900	1-1/8"	850-1025	1275-1450
1-1/4"	750-900	1125-1275	1-1/4"	1225-1450	1825-2050
1-3/8"	1000-1200	1450-1650	1-3/8"	1600-1900	2400-2700
1-1/2"	1300-1550	1950-2200	1-1/2"	2100-2500	3150-3550

***NOTE:** These torque values do not apply for SAE Grade 5 bolts used with weld nuts (or other low strength nuts). See chart for mild steel fasteners below SAE Grade 5.

****NOTE:** Tightening torques for non-rigid joints may be used when damage to the jointed members of the assembly may occur (and specific torque recommendation has not been made). Use of thick

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and highly compressable gaskets, nonflat unmachined seating surfaces for the bolt head or nut, non-flat or nonparallel joint faces are examples of conditions under which these torques may be used.

*****NOTE:** Tightening torques for rigid joints may be used when all of the following conditions exist (and specific torque recommendation has not been made):

1. Damage will not occur to the joined members of the assembly.
2. It is desirable to use this higher clamping force to ensure tightness.
3. Fastener thread is not lubricated prior to assembly.

TORQUE VALUES FOR MILD STEEL FASTENERS (BELOW SAE GRADE 5*)

Coarse and Fine Thread

NOMINAL SIZE	FOOT-POUNDS TORQUE
1/4"	5-6
5/16"	10-12
3/8"	18-21
7/16"	30-34
1/2"	45-52
9/16"	65-75
5/8"	90-105
3/4"	160-185

***NOTE:** These values may also be used when low strength nuts (such as weld nuts, jam nuts and slotted nuts) are used with SAE Grade 5 fasteners.

ENGINES (Gas and Diesel)

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REMOVING ENGINE FROM TRACTOR

Engine removal procedures recommended for tractors with a loader installed are slightly different than the procedures recommended when a loader is not installed. Engine removal (disconnect) from the transmission will depend upon whether the engine is a gasoline or diesel model. It will also depend whether the transmission is a Manual Shuttle or Instant Reverse.

If the tractor *has* a loader installed, removing the engine will involve disconnecting the loader from the rear axle housing. Then lowering the rear portion of the side frames to the ground, *while* allowing the front of the side frames to pivot on the tractor. The engine is then disconnected from the front axle support and rolled rearward (with transmission and center housing as a unit) from the loader. See Fig. 1. The engine is then disconnected from the transmission case.

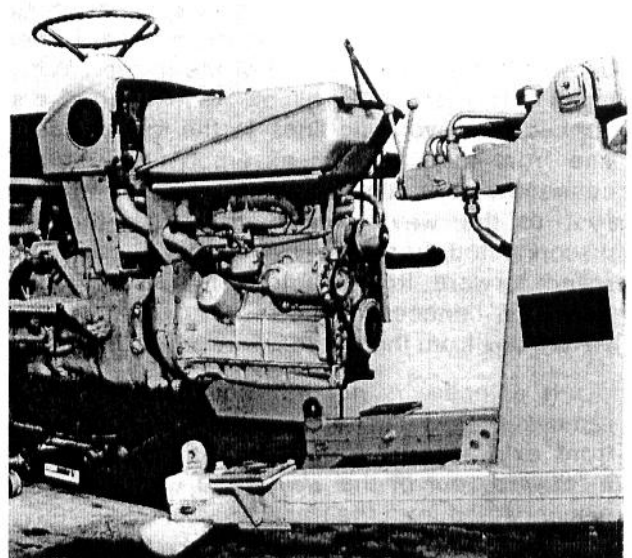


Fig. 1 — ENGINE, TRANSMISSION AND CENTER HOUSING ROLLED AWAY AS A UNIT FROM LOADER — GASOLINE ENGINE SHOWN

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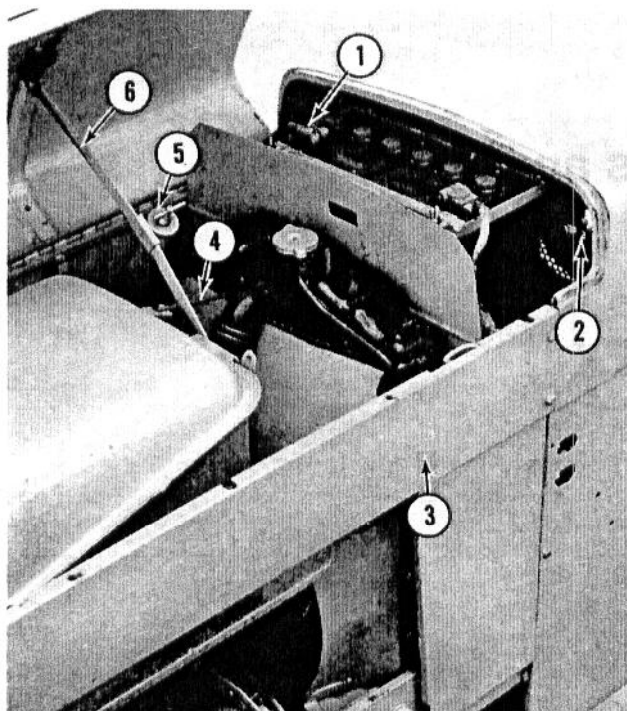


Fig. 2 — VIEW OF BATTERY AND RIGHT FRONT HEADLAMP (Gas Engine)

- | | |
|-------------------------------|---------------------------|
| 1. Battery "—" Pole | 4. Tension Rod (Radiator) |
| 2. Headlamp Wire | 5. Engine Oil Filler Tube |
| 3. Right-Hand Hood Side Panel | 6. Hood Brace |

If desired, and suitable equipment is available, the loader may be hoisted above the tractor and secured in this position. Blocks are then used under the loader side frames to maintain their position and the side frames are then unbolted from the front end of the tractor. When using this method it will be necessary to disconnect the hydraulic lines to the loader pump. The front axle support assembly is then disconnected from the engine and rolled forward (out of the way). The engine may then be disconnected from the transmission case and rolled forward from tractor. If this method is used it is unnecessary to remove a backhoe or weight box from the tractor.

If a loader *is not* installed on the tractor, removing the engine involves "splitting" the front axle support from the engine and rolling it forward (out of the way). The engine is then disconnected from the transmission case.

Read All Procedures Carefully

1. If tractor has a backhoe, weight box (or other equipment) attached, remove it. If a loader is installed, place a sufficient amount of

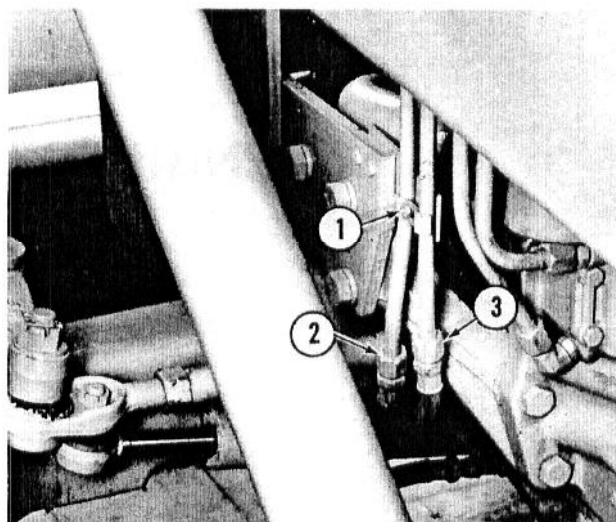


Fig. 3 — STEERING LINES TO STEERING CYLINDERS

- | | |
|------------------------------------|-----------------------------------|
| 1. Tube Clamp | 2. Tube — Valve to Left Turn Port |
| 3. Tube — Valve to Right Turn Port | |

blocks under the bucket attaching points to block the lift arms approximately 8 inches off the floor and relieve system pressure.

2. Open tractor hood and disconnect battery. Also disconnect headlight wire (along right-hand side panel) from right headlamp. See Fig. 2.

3. Remove right-hand hood side panel from tractor.

4. Loosen the clamps securing the hydrostatic steering lines to the hood's left side panel. Make sure lines are free of clamps.

5. Disconnect the hood brace (from the hood), and remove the hood and its left side panel (as a unit) from the tractor.

6. Disconnect battery "hot" lead from starter and place this lead wire out of the way.

7. Disconnect and remove tension rod between the front of the fuel tank and the radiator.

8. Disconnect the steering lines from the hoses to the cylinders. See Fig. 3. (Tag the lines so they may be identified with their connecting hoses when reassembling the tractor.) Loosen the clamp securing the tubes and make sure these tubes will be free to move with the engine (when it is separated from the front end).

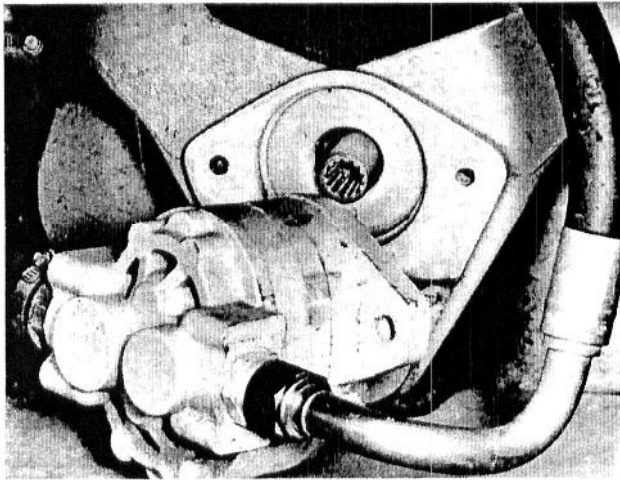


Fig. 4 — LOADER HYDRAULIC PUMP DISCONNECTED FROM THE FRONT AXLE

9. Drain coolant from radiator.

10. Disconnect and remove the front section of the exhaust pipe and the muffler (as a unit) from the engine manifold.

11. Disconnect radiator hose from top of radiator.

12. Remove oil filler tube and hose from tractor.

13. Disconnect water pump hose from radiator.

14. Remove the bolts securing fan blades to engine and position fan behind radiator (out of the way).

If tractor has a loader installed:

15. "Split" engine from the front axle support as follows:

- a. Remove the loader hydraulic pump mounting bolts (leave the hydraulic lines connected to the pump) and pull the pump forward, away from front axle. See Fig. 4.
- b. Unscrew the pump drive shaft from the pulley adapter (left-hand threads). If a suitable tool is not available to unscrew drive shaft, remove the bolts securing

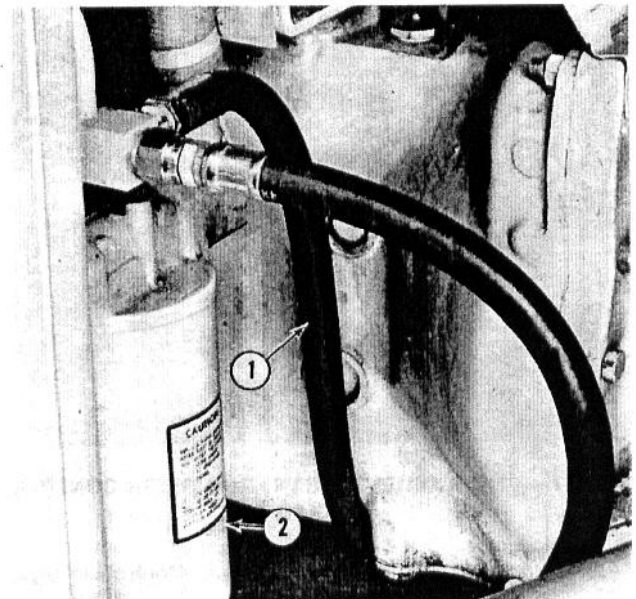


Fig. 5 — LIFT CYLINDER HEAD-END HOSE RE-ROUTED BENEATH TRANSMISSION CASE

1. Cross-Over Hose (to Left-Hand Lift Cylinder)
2. Loader Hydraulic Filter

the drive adapter to the crankshaft pulley and push the drive adapter toward the front axle (out of the way).

c. Remove the clamp securing the lift cylinder, head-end crossover hose and re-route this hose beneath the transmission case. See Fig. 5.

d. If a loader/backhoe oil cooler is in-

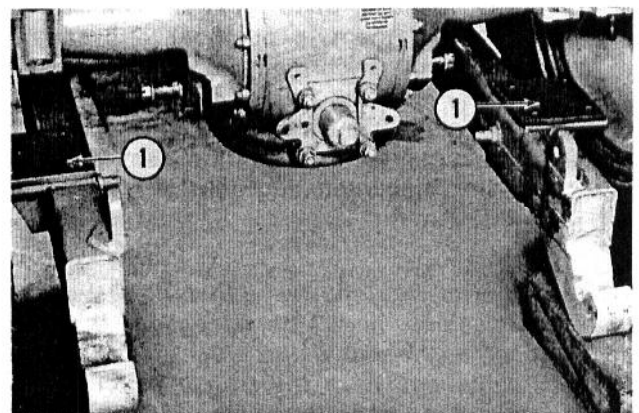


Fig. 6 — REAR VIEW OF LOADER DETACHED FROM REAR AXLE HOUSINGS

1. Spacers

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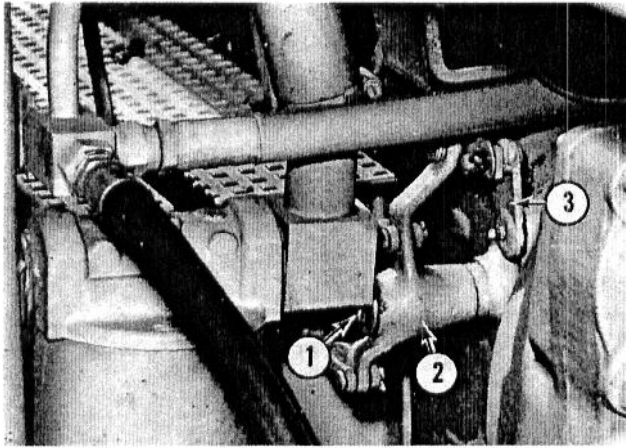


Fig. 7 — INSTANT REVERSE TRANSMISSION CONTROL LINKAGE

1. Capscrew
2. Bellcrank (Throttle and Transmission Control Linkage)
3. Transmission Control Arm

stalled on the tractor, it will be necessary to disconnect the hydraulic lines from the oil cooler.

- e. If an Instant Reverse Transmission is installed, disconnect the hydraulic lines from the cooler.
- f. Remove the upper side frame mounting bolts (one at each side) which secure the side frames to the front casting. Loosen the lower bolts (one at each side).
- g. Place jacks under loader side frames (to hold them in position) and remove the bolts securing the side frames to the rear axle housings. Slowly lower the side frames to the floor. (The fenders may be left on the rear axles by using their mounting bolts to hold them.) See Fig. 6.

NOTE: On tractors with Instant Reverse Transmissions, it will be necessary to disconnect and remove the throttle and shift control linkage from the transmission case to prevent damage when the side frames are lowered to the floor. See Fig. 7.

- h. Block the front wheels to keep them

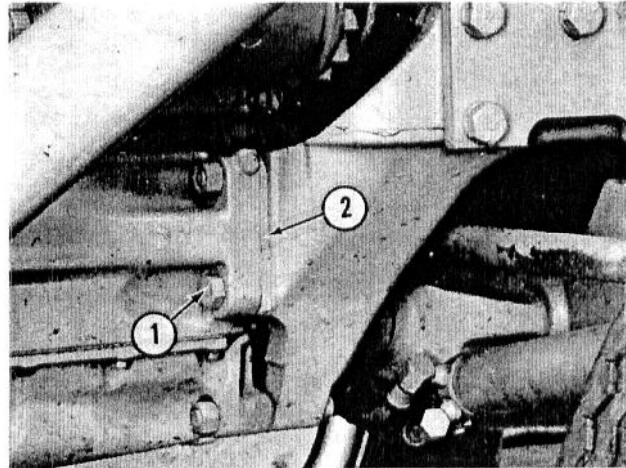


Fig. 8 — ENGINE AND FRONT AXLE SUPPORT ATTACHING POINT (Gasoline Models)

1. Bolt (3 used on each side of engine)
2. Spacer Plate (one used on each side)

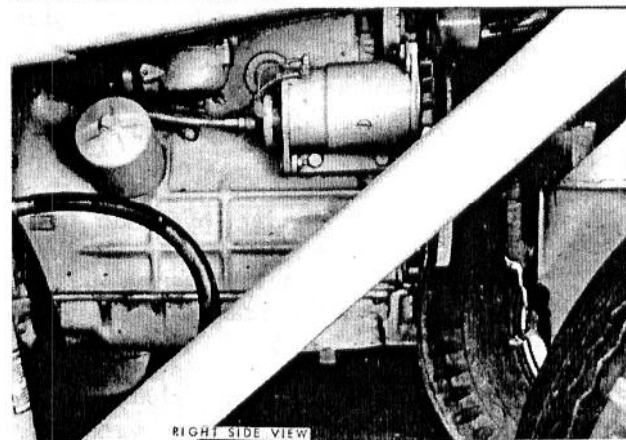
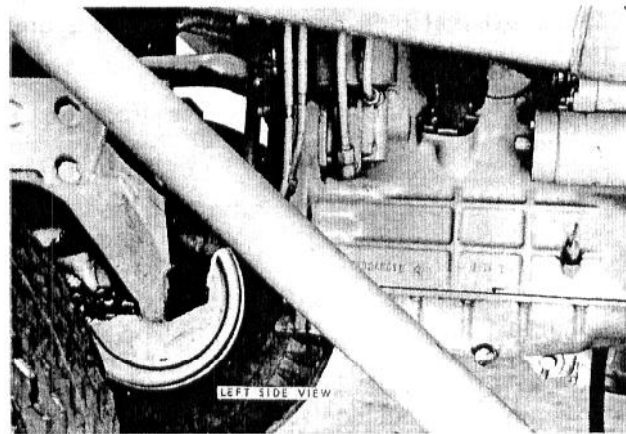


Fig. 9 — VIEW OF ENGINE ROLLED REARWARD FROM FRONT AXLE

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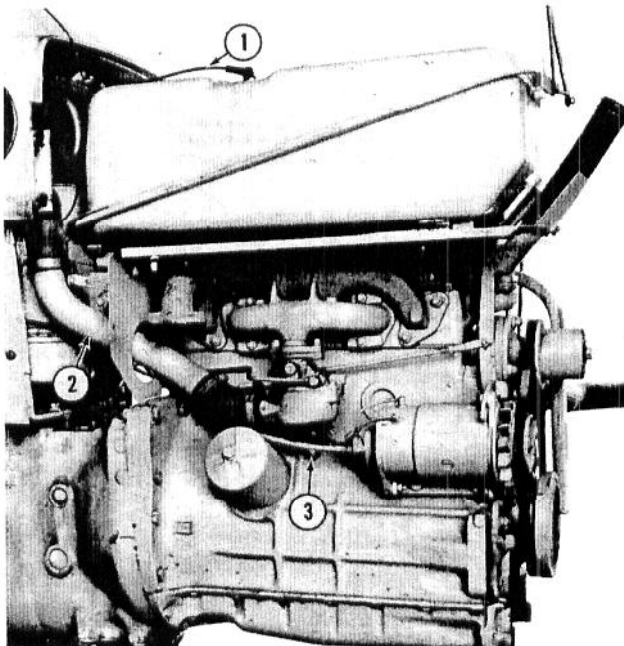


Fig. 10 — RIGHT-HAND VIEW OF GAS ENGINE SEPARATED FROM FRONT AXLE SUPPORT

1. Wire to Fuel Tank Sending Unit
2. Air Inlet Tube
3. Oil Pressure Connection (Engine)

from slipping (forward or rearward).

- i. Position a floor jack (of adequate capacity) under transmission case, just behind engine. Use this jack to maintain alignment of engine to the front axle support during the "split".
- j. Remove the bolts that secure the engine and front axle support to each other. See Fig. 8.
- k. Check both sides of engine to make sure it is free to roll rearward.
- l. Roll engine (with transmission and center housing as a unit) rearward *slightly* and remove spacer plates (see Fig. 9). Continue to roll engine rearward making sure that transmission case and engine clears the fitting on the loader hydraulic filter. It will be necessary to maneuver engine with the floor jack to pilot it completely free of loader. (See Fig. 1.) If tractor wheel tread is at a narrow setting, it may be neces-

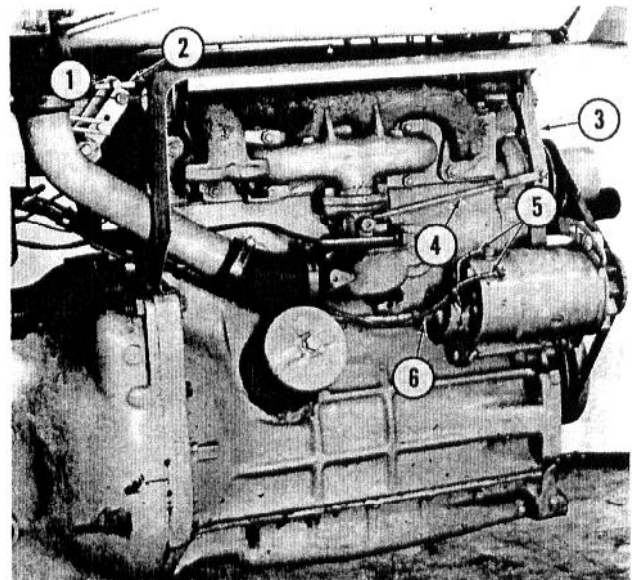


Fig. 11 — RIGHT-HAND VIEW OF GAS ENGINE SEPARATED FROM FRONT AXLE SUPPORT

1. Bellcrank (throttle control rod)
2. Throttle Control Rod
3. Governor Arm Assembly
4. Rod (governor to carburetor)
5. Electrical Wiring to Generator
6. Tachometer Cable

sary to pry in slightly on the loader side frames to provide clearance between the wheels and the frame mounting pads when the unit is rolled apart.

NOTE: Use care when performing this method of "splitting" the engine from the front axle support to prevent damage to the tractor or the loader.

If loader is not installed on tractor:

16. "Split" the front axle from the engine as follows:

- a. Place wedge blocks between the front axle and its support to prevent the front end from "tipping".
- b. Support front axle assembly with a suitable stand (or jacks) to secure it in an upright position when it is unbolted from the engine.

NOTE: Front axle assembly must be sup-

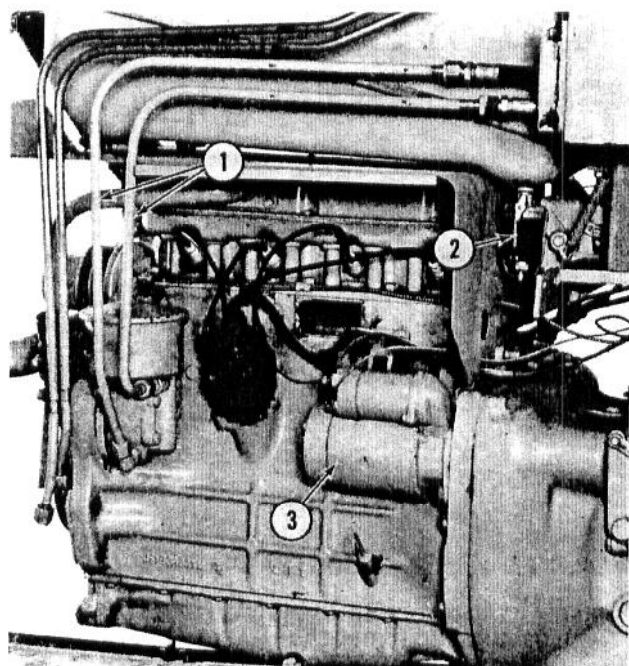


Fig. 12 — LEFT-HAND VIEW OF GAS ENGINE SEPARATED FROM FRONT AXLE SUPPORT

1. Pressure Lines Between Power Steering Pump and "Shuttle" Valve
2. Sediment Bowl
3. Starter Motor

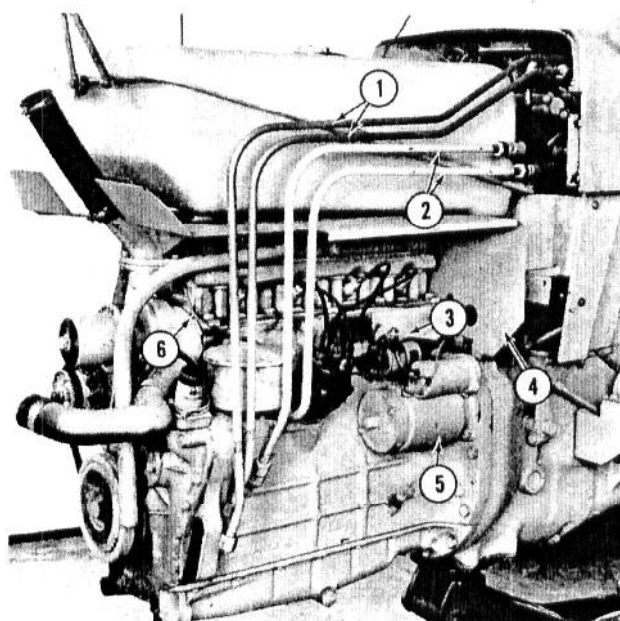


Fig. 13 — LEFT-HAND VIEW OF GAS ENGINE SEPARATED FROM FRONT AXLE SUPPORT

1. Pressure Lines to Power Steering Cylinders
2. Pressure Lines from Power Steering Pump
3. Wire to Starter Switch (from coil)
4. Heat Shield
5. Starter Motor
6. Temperature Indicator Sending Unit

ported in a manner that will not allow it to "tip" (fall) forward when it is separated from the engine.

- c. Position a floor jack (of adequate capacity) under transmission case, just behind engine. Use this jack to maintain alignment of engine to front axle support during the "split".
- d. Tractors with Instant Reverse Transmission, disconnect the hydraulic lines from the transmission oil cooler.
- e. Remove the bolts securing both sides of the engine to the front axle support.
- f. Carefully separate front axle support from engine (move it out of the way). Remove spacers between engine and front axle supports.

If gasoline engine is installed in tractor:

17. Separate the gasoline engine from the transmission as follows: Refer to Figs. 10, 11, 12 and 13.

- a. Disconnect electrical wire from fuel tank sending unit.
- b. Shut off fuel and disconnect fuel line at sediment bowl.
- c. Remove fuel tank.
- d. Disconnect electrical wiring from starter and remove starter motor.
- e. Remove temperature indicator sending unit from engine and pull it rearward, free of heat shield. Also disconnect the oil pressure line from right side of engine.
- f. Remove air inlet tube and disconnect the rear of the throttle control rod from its bellcrank.

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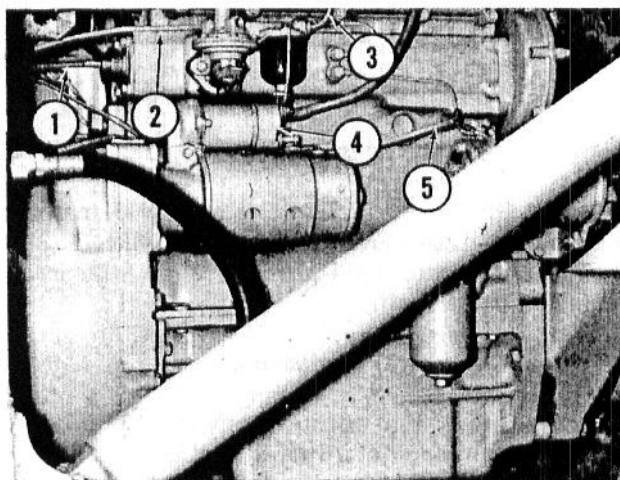


Fig. 14 — RIGHT-HAND VIEW OF DIESEL ENGINE

1. Tachometer Cable
2. Fuel Line (to primary filter)
3. Fuel Line (tank to fuel pump)
4. Starter Solenoid
5. Wiring Harness (to generator)

- g. Remove heat shield.
- h. Disconnect the tachometer cable, the electrical wiring to the generator (or alternator) and the choke cable (to the carburetor).
- i. Disconnect the hydraulic lines between the power steering pump and the "shuttle" valve. If desired, all four lines (at left side of engine) may be removed.
- j. Disconnect the electrical wire (between coil and starter switch) from the ignition coil.
- k. Remove the rocker arm cover and attach a suitable hoist to the engine. Allow the hoist to support the weight of the engine and *carefully* remove bolts and cap-screws attaching engine to transmission case.

NOTE: If engine is being removed from the Instant Reverse Transmission, insert guide studs, approximately 5-1/2 inches long, into transmission case at both sides of engine. These guide studs should be installed before all of the capscrews (securing engine and transmission) are removed. Damage to

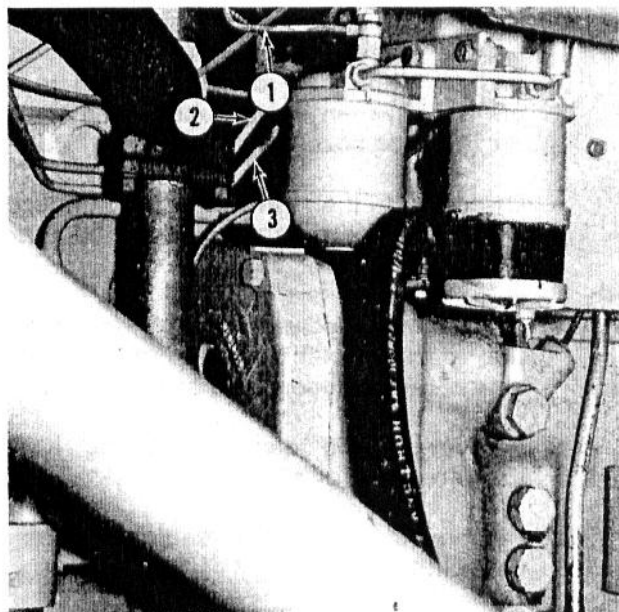


Fig. 15 — LEFT-HAND VIEW OF DIESEL ENGINE

1. Fuel Line (leak-off, from injection nozzle line)
2. Fuel Line (secondary filter to injection pump)
3. Fuel Line (injection pump to secondary filter)

the pump drive lugs on the torque converter may occur, if guide studs are not used. Also disconnect hydraulic lines between transmission oil filter and transmission case.

- l. *Carefully* separate engine from transmission case. Remove clutch or torque converter from engine flywheel.

If diesel engine is installed in tractor:

18. Separate the diesel engine from the transmission case as follows: Refer to Figs. 14 and 15.

- a. Disconnect electrical wire from fuel tank sending unit. Remove temperature indicator sending unit from left side of engine block and the oil pressure line from the right side of engine block. (Pull both free of heat shield.)
- b. Shut off fuel, disconnect fuel lines from fuel tank and remove fuel tank from tractor.
- c. Disconnect the fuel lines between the

fuel pump and the primary filter and between the injection pump and the secondary filter. Also disconnect the leak off line between the secondary filter and the injection nozzle line.

- d. Disconnect the throttle rod (injection pump control rod) from its actuating lever at left side of engine.
- e. Disconnect the electrical wiring from the starter solenoid and remove the starter (and solenoid as a unit).
- f. Disconnect the electrical wiring from the generator (or alternator).
- g. Disconnect tachometer cable from rear of engine.
- h. Remove air inlet tube from engine manifold.
- i. Pull all wires, cable and throttle linkage free of heat shield and remove heat shield from engine.
- j. Disconnect the hydraulic lines between the power steering pump and the "shuttle valve". (If desired, all four lines may be removed.)
- k. Attach a suitable hoist to the engine. Allow hoist to support the weight of the engine and carefully remove bolts and capscrews attaching engine to transmission case.

NOTE: If engine is being removed from the Instant Reverse Transmission insert guide studs approximately 5-1/2 inches long into transmission case at both sides of engine. These guide studs should be installed before all of the capscrews (securing engine to transmission) are removed. Damage to the pump drive lugs on the torque converter may occur if guide studs are not used. Also disconnect hydraulic lines between transmission oil filter and transmission case.

- l. Carefully separate engine from transmission case. Remove clutch or torque converter from engine flywheel.

INSTALLING ENGINE INTO TRACTOR

(Manual Shuttle Transmission)

A. Check that clutch is properly installed on engine. Use clutch aligning tool MFN 753, to insure that clutch will properly align with transmission input shaft.

(Instant Reverse Transmission)

A. Check that torque converter is properly installed on engine. Always use guide studs to make certain that engine and transmission are in perfect alignment.

NOTE: Guide studs approximately 5-1/2 inches long are to be inserted into transmission case. Engine must then be piloted carefully over studs or damage to the torque converter pump drive lugs may occur.

B. Place the impeller hub drive lugs on the torque converter in a horizontal position and the drive lugs on the transmission pump in a vertical position.

C. Mark one fin on the converter assembly with grease or paint. This mark will be used when aligning the splines on the input shaft. As the engine is piloted over the guide studs, rotate the converter back and forth (a maximum of 3" in either direction) using the mark as a reference point. This will align the splines during reassembly.

1. After the appropriate preliminary steps have been taken (procedures preceding this step), carefully position the engine to the transmission case. Secure the engine to the transmission with its retaining capscrews.

NOTE: The engine must freely mate with the transmission. Do not force the two units together or damage may result.

2. Complete installation of the engine by reinstalling the starter motor, heat shield, air inlet tube, fuel tank, fuel lines and hydraulic lines. Reconnect the tachometer cable, electrical wiring and throttle linkage. Reinstall tem-

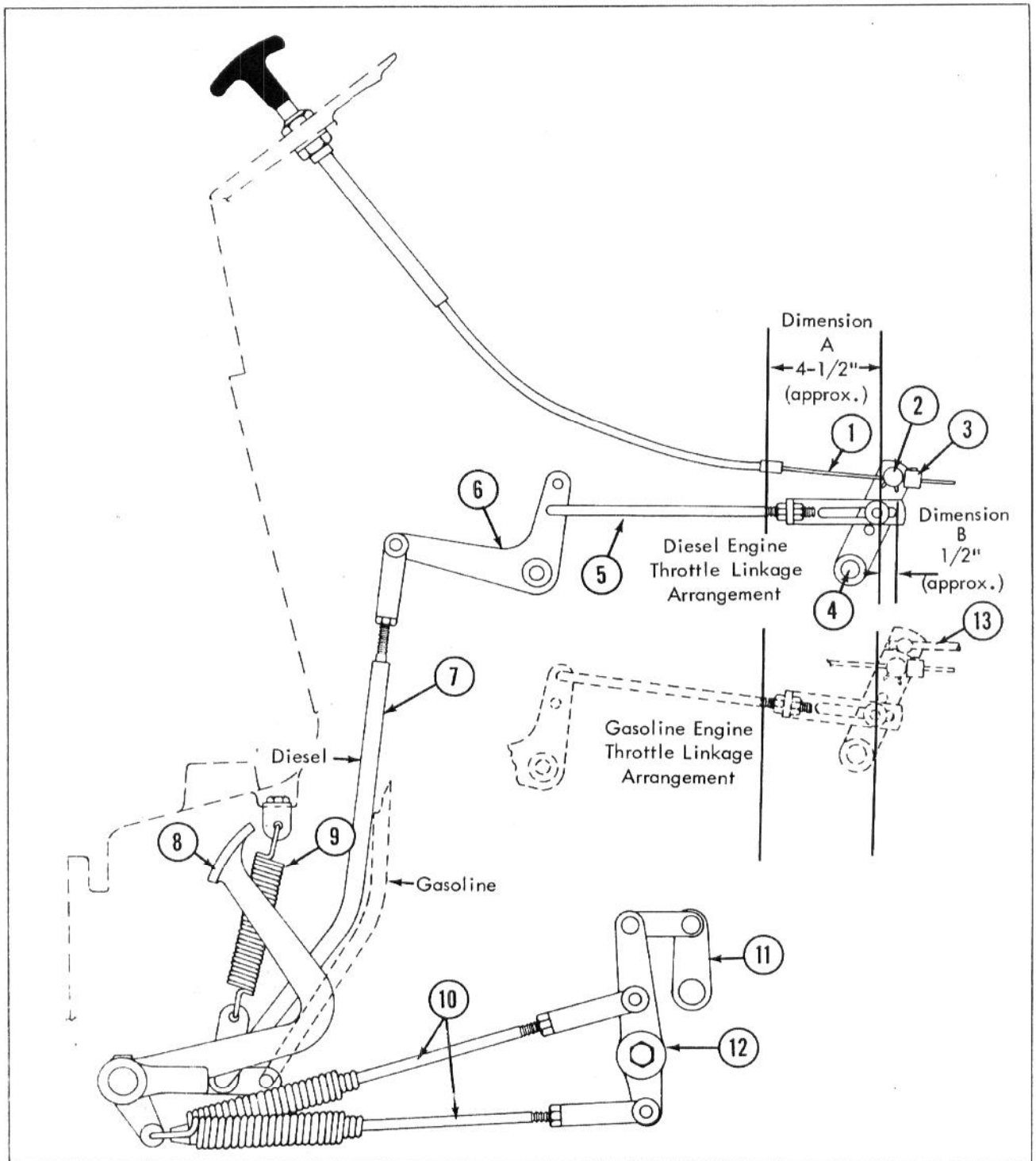


Fig. 16 — THROTTLE LINKAGE ADJUSTMENT — I. R. TRANS.

- | | | |
|---------------------------------------|---|-----------------------------------|
| 1. Hand Throttle Control Cable | 5. Rod — Throttle Linkage | 10. Control Rod (foot pedal) |
| 2. Swivel | 6. Throttle Bellcrank | 11. Transmission Control Arm |
| 3. Collar (cable lock) | 7. Accelerator Rod | 12. Selector Lever (transmission) |
| 4. Throttle Lever Shaft (cross shaft) | 8. Foot Pedals (directional control and throttle) | 13. Throttle Control Rod |
| | 9. Return Spring (pedal) | |

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perature indicator sending unit and engine oil pressure line.

3. Assemble the engine and the front axle support assembly, installing appropriate spacers, and reconnect the battery cables. Reinstall sheet metal. If a loader was installed on the tractor, complete attachment of loader.

NOTE: Check power steering pump reservoir before attempting to start the engine. Maintain correct oil level while running engine to "bleed" the hydrostatic power steering of entrapped air. Be sure that engine is shut off when checking oil level. Operate steering wheel in both directions to its maximum travel and re-check pump reservoir oil level often.

(Instant Reverse Transmission)

Be sure to recheck the transmission oil level after engine has been operated for a short time. Also, check the hydraulic lines between the transmission oil cooler, oil filter and transmission case.

If diesel engine is installed:

It will be necessary to "air bleed" the fuel system before attempting to start the engine.

ADJUSTING THROTTLE LINKAGE

Refer to the appropriate sub-headings for recommended throttle adjustment (and transmission control adjustment for Instant Reverse Transmissions) procedures.

Gasoline Engine Linkage Adjustments

1. Length adjustment of governor to carburetor control rod is as follows:

- a. Adjust engine low idle to 450-500 rpm.
- b. Shut off engine and disconnect the control rod, No. 4, Fig. 11, from governor control lever.



CAUTION: Never start engine while the throttle rod is disconnected from the governor control lever.

- c. Open governor control lever fully to create tension on lever spring.
- d. Adjust the control rod length (throttle fly in carburetor fully open) until it is necessary to move the rod back slightly (approximately 1/32") in order to connect the control rod and governor control lever with its clevis. Connect these two together and secure with cotter pin.
- e. Lock control rod clevis with "jam" nut. Make sure that clevis pin fits freely in its clevis and that the clevis end of rod does not bind against control lever.

Instant Reverse transmission only — see Fig. 16.

2. Adjust the foot throttle as follows:
 - a. Loosen the throttle stop bracket located on the throttle lever shaft, No. 4.
 - b. Hold pedals, No. 8, in the fully "up" position (bottoming against slots in step plate) and place transmission selector lever, No. 12, in "Neutral".
 - c. Adjust the length of control rods, No. 10, until it is necessary to move the rods back approximately 3/32" to insert clevis pin. Insert clevis pins and secure with cotter pins.
 - d. Position the cross shaft levers to dimension A and secure into this position with throttle control rod, No. 13. Adjust the length of rod, No. 5, to dimension B.
 - e. With cross shaft levers in forward position, push hand throttle control cable, No. 1, completely in and slide collar, No. 3, against swivel, No. 2. Secure collar in place with setscrew.
 - f. Secure linkage in place and start tractor. (Securely block wheels to prevent tractor movement.) Depress each foot pedal down, one at a time, until transmission

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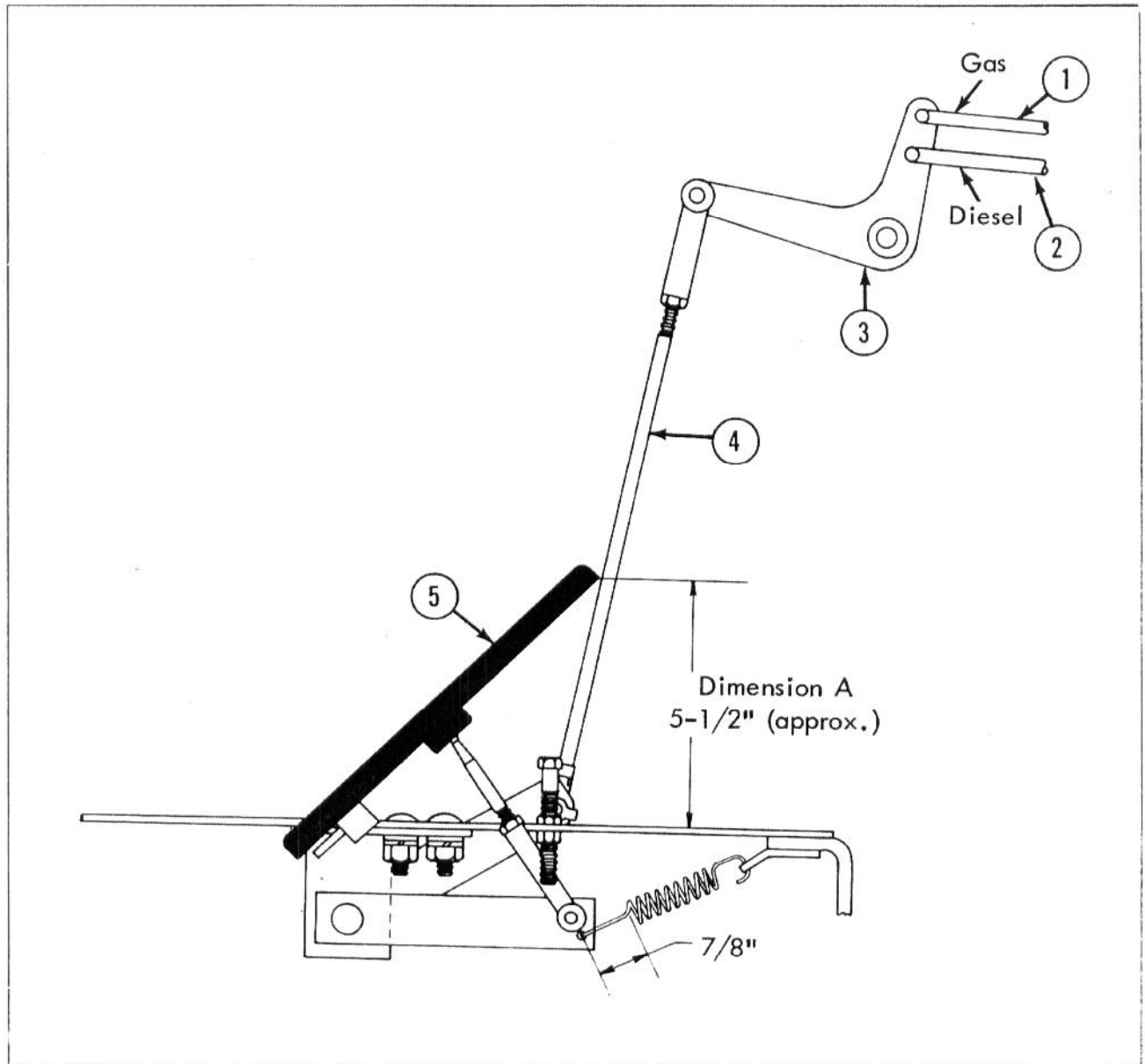


Fig. 17 — THROTTLE LINKAGE ADJUSTMENT — M. S. TRANS.

- | | | |
|--|-----------------------|-------------------------------|
| 1. Throttle Rod (linkage) — Gas Engine Connecting Point | 3. Throttle Bellcrank | 4. Throttle Rod (accelerator) |
| 2. Throttle Rod (linkage) — Diesel Engine Connecting Point | | 5. Accelerator Pedal |

engages. Check that transmission engagement speed is between 575-675 rpm. If engagement is abrupt (sudden), readjust rod, No. 5, until smooth engagement and proper engagement speed is obtained.

g. Pull out on hand throttle until engine is

operating at 2300-2400 rpm and secure throttle stop bracket. After adjustments have been made, check that 2300-2400 rpm can be obtained with foot pedals fully depressed.

Manual Shuttle transmissions only — see Fig. 17.

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3. Adjust the foot throttle as follows:

- a. Disconnect throttle rod, No. 4, and rod, No. 1, from bellcrank, No. 3, and loosen throttle stop bracket located on throttle cross shaft.
- b. Hold foot pedal in full "up" position and adjust to dimension A. (Cross shaft levers are to be in their forward position and adjusted to dimension A in Fig. 16.)
- c. Adjust rods, Nos. 4 and 1, so that the front of slot in "L"-shaped bracket of rod, No. 1, is in contact with clevis pin on cross shaft lever. Connect rods, Nos. 4 and 1, to bellcrank, No. 3.
- d. Hold cross shaft levers in forward position and push hand throttle control cable, No. 1, Fig. 16, completely inward. Slide collar, No. 3, Fig. 16, against swivel, No. 2, Fig. 16, and secure collar with setscrew.
- e. Start engine and pull out on hand throttle to run engine at 2300-2400 rpm then secure throttle stop bracket in position. After adjustments have been made, check that 2300-2400 rpm can be obtained with foot pedal fully depressed.

- d. Position the cross shaft levers to dimension A, and secure into this position with throttle rod connected to injector pump. Adjust the length of rod, No. 5, to dimension B.
- e. With cross shaft levers in forward position, push hand throttle control cable, No. 1, completely in and slide collar, No. 3, against swivel, No. 2. Secure collar in place with setscrew.
- f. Secure linkage in place and start tractor. (Securely block wheels to prevent tractor movement.) Depress each foot pedal, one at a time, until transmission engages. Check that transmission engagement speed is between 575-675 rpm. If engagement is abrupt (sudden), readjust rod, No. 5, until a smooth engagement and proper engagement speed is obtained.
- g. Pull out on hand throttle until maximum governed speed is obtained:

2335-2385 rpm
- h. Secure throttle stop bracket. After adjustments have been made, check that maximum governed rpm can also be obtained with foot pedals fully depressed.

Diesel Engine Linkage Adjustments

1. Adjust engine low idle to 575-625 rpm.

Instant Reverse Transmissions only — See Fig. 16.

2. Adjust the foot throttle (pedals) as follows:

- a. Loosen throttle stop bracket located on cross shaft No. 4.
- b. Hold pedals, No. 8, in the fully "up" position (bottoming against slots in step plate) and place transmission selector lever, No. 12, in "Neutral".
- c. Adjust the length of control rods, No. 10, until it is necessary to move the rods back approximately 3/32" to insert clevis pin. Insert clevis pin and secure with cotter pin.

Manual Shuttle transmissions only — see Fig. 17.

3. Adjust the foot throttle as follows:

- a. Disconnect throttle rod, No. 4, and rod, No. 2, from bellcrank, No. 3, and loosen throttle stop bracket located on throttle cross shaft.
- b. Hold foot pedal in full "up" position and adjust to dimension A. (Cross shaft levers are to be placed in their forward position and adjusted to dimension A in Fig. 16.)
- c. Adjust rods, Nos. 4 and 2, so that the front of slot in "L"-shaped bracket of rod, No. 2, is in contact with clevis pin on the cross shaft lever. Connect rods, Nos. 4 and 2, to bellcrank, No. 3.
- d. Hold cross shaft levers in forward position

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and push hand throttle cable, No. 1, Fig. 16, completely inward. Slide collar, No. 3, Fig. 16, against swivel, No. 2. Secure collar with setscrew.

- e. Start engine and pull out on hand throttle until the following maximum governed

speed is obtained:

2335-2385 rpm

- f. Secure throttle stop bracket. After adjustments have been made, check that maximum governed rpm can also be obtained with foot throttle fully depressed.

GF-193 ENGINE SPECIFICATIONS

GENERAL DATA

Bore	3-3/4 inches
Stroke	4-3/8 inches
Number of Cylinders	4
Total Piston Displacement	193 cu. inches
Compression Ratio	7 to 1
Firing Order	1-3-4-2
Maximum Engine Horsepower — with All Std. Accessories	63 @ 2200 rpm
Maximum Engine Torque	176 ft.-lbs. @ 1200 rpm
Low Idle Speed	450-500 rpm
Rated Engine Speed	2200 rpm
Maximum Engine Speed (no load):	2400-2450 rpm
Compression Pressure with Engine Warm, Spark Plugs Removed, Wide Open Throttle	(Approx.) 145-160 psi @ 150 rpm cranking speed
Tappet Clearance (Hot):	
Intake	0.016 inch
Exhaust	0.018 inch
Approximate Weight — Less Accessories	493 lbs.

ENGINE OVERHAUL SPECIFICATIONS

Torque Tensions

Cylinder Head	70-75 ft.-lbs.
Connecting Rods	40-45 ft.-lbs.
Main Bearings	85-95 ft.-lbs.
Flywheel:	
All Except Torque Converter Applications	70-75 ft.-lbs.
Torque Converter Applications	50-55 ft.-lbs.
Rocker Arm Supports	35-40 ft.-lbs.
Manifolds	25-30 ft.-lbs.
Camshaft Nut	125-130 ft.-lbs.
Oil Pan	12-16 ft.-lbs.
Crankshaft Pulley	140-150 ft.-lbs.

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Other Miscellaneous Torques (By Bolt Size — Diameter)

Diameter	1/4 Inch	5/16 Inch	3/8 Inch	7/16 Inch	1/2 Inch	9/16 Inch
Gear Cover, water pump and misc. ac- cessories and brackets	8-10	15-20	25-30	50-55	80-90	115-125
Die-castings	6-8	10-15	20-25	35-40	50-55	

Pistons

Piston Diameter (measured at right angles from piston pin hole)

Top of Skirt:

Early Coded Type Pistons See Chart

Late Uncoded Type Pistons 3.746-3.747 inches

Bottom of Skirt:

Early Coded Type Pistons See Chart

Late Uncoded Type Pistons 3.7475-3.7485 inches

Piston Pin Bore Diameter 1.1254-1.1256 inches

Cylinder Sleeve

Type Dry

Inside Diameter of Sleeve:

Early Coded Type Sleeves See Chart

Late Uncoded Type Sleeves 3.750-3.751 inches

Cylinder Block Bore 3.8745-3.8755 inches

Outside Diameter of Sleeve 3.873-3.874 inches

Sleeve Fit in Block 0.0005-0.0025 inch clearance

Location of Sleeve Relative to

Top Face of Cylinder Block From 0.0015 inch below to 0.0025 inch above

Piston and Sleeve Dimensions — Early Coded Type Pistons

IDENTIFICATION LETTER	PISTON SKIRT DIAMETER		SLEEVE BORE DIAMETER
	Bottom of Skirt	Top of Skirt	
A-1	3.7470 to 3.7475"	3.7455 to 3.7460"	3.7495 to 3.7500"
A	3.7475 to 3.7480"	3.7460 to 3.7465"	3.7500 to 3.7505"
B	3.7480 to 3.7485"	3.7465 to 3.7470"	3.7505 to 3.7510"
C	3.7485 to 3.7490"	3.7470 to 3.7475"	3.7510 to 3.7515"
D	3.7490 to 3.7495"	3.7475 to 3.7480"	3.7515 to 3.7520"
E	3.7495 to 3.7500"	3.7480 to 3.7485"	3.7520 to 3.7525"

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Piston Rings — Production Set

Ring Side Clearance:	
Top Compression Ring	0.002-0.0035 inch
Nos. 2 and 3 Compression Rings	0.002-0.0035 inch
Bottom Oil Control Ring	Does not apply
Ring End Gap (all one-piece rings)	0.010-0.020 inch

Piston Pins

Pin Diameter (standard size)	1.1250-1.1252 inches
Clearance in Connecting Rod Bushing	0.0001-0.0005 inch
Clearance in Piston Pin Bore	0.0002-0.0006 inch

Connecting Rods

Inside Bushing Diameter (finished)	1.1253-1.1255 inch
Connecting Rod Bore Diameter	2.1865-2.187 inch
Rod Bearing Inside Diameter (standard size)	2.0632-2.0642 inches
Crankpin Journal Diameter	2.0615-2.0625 inches
Bearing Clearance — New	0.0007-0.0027 inch
Desired Bearing Clearance	0.0015 inch
Maximum Bearing Clearance	0.0037 inch
Rod Side-Play	0.006-0.010 inch

Crankshaft and Main Bearings

Cylinder Block Bore	2.5615-2.5622 inches
Main Bearing Inside Diameter	2.3755-2.3765 inches
Main Bearing Journal Diameter	2.374-2.375 inches
Main Bearing Clearance — New	0.0005-0.0027 inch
Desired Main Bearing Clearance	0.0015 inch
Maximum Main Bearing Clearance	0.0037 inch
Crankshaft End-Play and How Controlled	0.004-0.008 inch by center main bearing
Crankpin Journal Diameter	2.0615-2.0625 inches
Radii on Crankpins and Mains .....	.3/32 inch

MASSEY-FERGUSON

Valves

Valve Tappet Clearance (Hot):

Intake	0.016 inch
Exhaust	0.018 inch

Valve Head Diameter:

Intake	1.323-1.333 inches
Exhaust	1.198-1.208 inches

Valve Stem Diameter:

Intake Valves:

Diameter — New	0.3406-0.3414 inch
Desired Stem Clearance	0.0015 inch
Wear Limits — Maximum Clearance	0.0049 inch

Exhaust Valves:

Diameter — New	0.3382-0.339 inch
Desired Stem Clearance	0.004 inch
Wear Limits — Maximum Clearance	0.0073 inch

Valve Face Angle:

Intake	30°
Exhaust	44°

Valve Lift:

Intake	0.383 inch
Exhaust	0.376 inch

Valve Seats

Valve Seat Angles:

Intake	30°
Exhaust	45°

Seat Contact Width 1/16 to 3/32 inch

Maximum Seat Run-Out 0.002 inch

Production Exhaust Seat Inserts:*

Outside Diameter of Insert	1.3475-1.3485 inches
Inside Diameter of Counterbore	1.3435-1.3445 inches
Press Fit	0.003-0.005 inch

**When the 0.010 inch oversize service replacement insert is used, the dimensions of the insert and counterbore increase proportionately.*

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Valve Guides

Location in Cylinder Head	1/16 inch below rocker cover gasket surface
Inside Diameter	0.3420-0.3435 inch
Clearance Limits — Production:	
Intake	0.0006-0.0029 inch
Exhaust	0.003-0.0053 inch

Valve Springs

Free Length	Approx. 2-5/64 inch
Spring Length Valve Closed	1-21/32 inch
Spring Pressure @ 1-21/32 Length	41-47 lbs.
Spring Length Valve Open	1-7/32 inch
Spring Pressure @ 1-7/32 Length	103-110 lbs.

Valve Lifters

Stem Diameter	0.5615-0.5620 inch
Valve Lifter Bore in Head or Block	0.5625-0.5635 inch
Clearance Limits — New Production	0.0005-0.002 inch
Maximum Clearance	0.003 inch

Rocker Arm Shaft Assembly

Direction of Oil Holes in Shaft	Toward push rods
Rocker Arm Shaft Diameter	0.9671-0.9677 inch
Inside Bushing Diameter	0.9687-0.9692 inch
Bushing Clearance	0.001-0.0021 inch

Valve Timing (Crankshaft Degrees)

Intake Valve Opens	0° T.D.C.
Intake Valve Closed	35° A.B.D.C.
Exhaust Valve Opens	40° B.B.D.C.
Exhaust Valve Closes	0° T.D.C.

Timing Gears

Timing Gear Backlash	0.001-0.002 inch
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Camshaft

End-Play	0.003-0.007 inch
Cam Lift (intake and exhaust)	0.2768 inch

Bearing Diameters:

Front Camshaft Support:

Journal Diameter	0.9965-0.997 inch
Bushing Inside Diameter	0.9995-1.000 inch
Clearance Limits	0.0025-0.0035 inch

No. 1 Camshaft Bearing (front):

Journal Diameter	1.808-1.809 inches
Bushing Inside Diameter	1.812-1.8125 inches
Clearance Limits	0.003-0.0045 inch
Block Bore Diameter	1.9365-1.9375 inches

No. 2 Camshaft Bearing:

Journal Diameter	1.7455-1.7465 inch
Block Bore Diameter	1.749-1.750 inches
Clearance Limits	0.0025-0.0045 inches

No. 3 Camshaft Bearing:

Journal Diameter	1.683-1.684 inches
Block Bore Diameter	1.6865-1.6875 inches
Clearance Limits	0.0025-0.0045 inch

Maximum Wear of Camshaft Journal Diameters	0.001 inch under minimum diameter
Maximum Bearing Clearance	0.006 inch

FUEL SYSTEM SPECIFICATIONS

Fuel

Minimum Octane Rating	82
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Carburetor

Make and Model No. Used	Marvel-Schebler TSX-856
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Adjustment Screws:

Idle Mixture Needle	Approx. 1 to 2 turns open
Main Adjusting Needle	Approx. 1-5/8 to 1-7/8 turns open

Float Level	1/4 inch from top of float to gasket surface
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Engine Speeds:

Low Idle Speed	450-500 rpm
Maximum Engine Speed (no load)	2400-2450 rpm

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LUBRICATION SYSTEM SPECIFICATIONS

Type of Oil	API Service Class "MS" (heavy-duty, high detergent)
Viscosity:	
Above 90° F.	SAE 30
From 32° F. to 90° F.	SAE 30
From 10° F. to 32° F.	SAE 20W
From -10° F. to +10° F.	SAE 5 w/20 or SAE 10W
Crankcase Capacity:	
Without Filter Change	5 U.S. quarts
With Filter Change	6 U.S. quarts
Recommended Oil Change Interval	100 hrs.
Type of Filter and Change Interval	By-pass type — change element every other oil change (200 hrs.)
Normal Operating Pressure	20-30 psi at 1800 rpm
Minimum Oil Pressure	7 psi at 450 rpm
Relief Valve Setting	30 psi
Backlash in Oil Pump Gear	0.004-0.008 inch

COOLING SYSTEM SPECIFICATIONS

Radiator Pressure Cap	10 psi
Fan Belt Deflection	1/2-3/4 inch
Thermostat Opening Temperature	160° F.
Water Pump Impeller Location	1-3/16 inches from rear face of impeller to machined face of water pump support
Water Pump Pulley Location	1/4 inch from front end of pulley to front end of water pump shaft

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ELECTRICAL SYSTEM SPECIFICATIONS

Battery

Make and Part No. Used	Massey-Ferguson 832 709 M2
Volts	12
Amp. Hrs. @20-Hr. Rate	95
Number of Plates Per Cell	17
Battery Ground	Negative

Spark Plugs

Size	18 mm
Normal Heat Range:	
MF Part No.	1027896 M91
Champion	D-16
Auto-Lite	BT-8
AC	C-85
Gap	0.025 inch
Torque	32-38 ft.-lbs.

Distributor

Make and Model No. Used:	
Engines Prior to Serial No. 1326	Delco-Remy 1112583
Engines Serial No. 1326 and Up (aluminum body)	Delco-Remy 1112644
Type of Advance	Centrifugal
Direction of Rotation (viewing drive end)	Clockwise
Point Gap	0.018-0.024 inch; set at 0.022 inch
Dwell Angle	31°-34°
Point Spring Tension (behind contact)	19-23 ozs.
Drive Shaft End-play	0.002-0.010 inch
Ignition Timing (crankshaft degrees and rpm):	
Initial Setting	10° BTDC
Desired Setting	Adjust to provide 30° BTDC @ 2200 engine rpm
Distributor Advance Data (distributor degrees and rpm):	
Start of Advance:	
250 RPM	0-1°
Intermediate Advance:	
400 RPM	1°-3°
700 RPM	5°-7°
Maximum Advance:	
1000 RPM	9°-11°

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Coil

Make and Model No. Used	Delco-Remy 1115071
Volts	12
Primary Resistance @ 75° F.	3.2-4 ohms
Secondary Resistance @ 75° F.	6500-9500 ohms

Starter Motor

Make and Model No. Used	Delco-Remy 1107329 or 1108324
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DR-1107226 Starter Motor:

Rotation (viewing drive end)	Clockwise
Minimum Brush Tension (oz.)	35
No. Load Test:	
Volts	10.3
Max. Amps	75
Min. RPM	6900
Lock Test:	
Amps	435
Min. Torque (ft.-lbs.)	10.5
Approx. Volts	5.8

DR-1107329 Starter Motor:

Rotation (viewing drive end)	Clockwise
Min. Brush Tension (oz.)	35
Pinion Clearance	0.010-0.140 inch
No. Load Test:	
Volts	10.6
Min. amps.	49 (includes solenoid)
Max. amps.	76 (includes solenoid)
Min. RPM	6200
Max. RPM	9400
Resistance Test:	
Volts	4.3
Min. Amps.	270
Max. Amps.	310

DR-1108324 Starter Motor:

Rotation (viewing drive end)	Clockwise
Minimum Brush Tension (oz.)	35
Pinion Clearance	0.010-0.140 inch
No. Load Test:	
Volts	10.6
Min. Amps.	49 (includes solenoid)
Max. Amps.	87 (includes solenoid)
Min. RPM	6200
Max. RPM	10700
Resistance Test:	
Volts	4.3
Min. Amps.	290
Max. Amps.	425

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Regulator

Make and Model No. Used Delco-Remy 1100735

DR-1100735 (Alternator):

Circuit B

Field Current (80° F.):

Amps. 2.2-2.6

Volts 12

Cold Output at Specified Voltage:

Specified Volts 14

Amps. 21

Approx. RPM 2000

Amps. 30

Approx. RPM 5000

Rated Hot Output 32 amps.

Make and Model No. Used Delco-Remy 1119513

DR-1119513 Regulator:

Circuit B

Polarity Negative

Field Relay:

Air Gap 0.015 inch

Point Opening 0.030 inch

Closing Voltage Range 3.8-7.2

Voltage Regulator:

Air Gap *

Point Opening 0.014 inch

Voltage See Temperature-Voltage Chart**

Temperature — Voltage Chart

Regulator Ambient Temperature (Degrees Fahrenheit)	65	85	105	125	145	165	185
Voltage Setting	13.9 to 15	13.8 to 14.8	13.7 to 14.6	13.5 to 14.4	13.4 to 14.2	13.2 to 14	13.1 to 13.9

* Adjust Air Gap only when necessary to obtain specified difference between voltage settings of upper and lower contacts. *After Bench Repair Only*; set air gap to approximately 0.067 inch; then, make final air gap adjustment.

** Operation on lower contacts must be 0.05-0.4 volt lower than on upper contacts.

GASOLINE ENGINE TROUBLE CHART

PROBLEM	SEE POSSIBLE CAUSE
A. Engine does not develop full power	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
B. Engine runs rough	4, 5, 6, 8, 11, 12, 13, 14
C. Engine misfires under load	8, 13, 15, 16, 17, 18
D. Engine starts but fails to keep running	16, 18, 19, 20
E. Engine cranks but will not start	3, 18, 19, 21, 22, 23
F. Engine misfires on acceleration	3, 4, 6, 8, 11

POSSIBLE CAUSES OF GASOLINE ENGINE MALFUNCTIONS

1. Clogged air cleaner. Clean.
2. Governor linkage improperly adjusted. Adjust.
3. Loose or faulty ignition wiring. Check connections or replace wiring.
4. Ignition improperly timed. Time ignition.
5. High compression pressure. Clean carbon from combustion chamber.
6. Low compression pressure. Replace rings, rebore cylinders or grind valves.
7. Incorrect valve clearance. Adjust.
8. Dirty or improperly adjusted carburetor. Clean and adjust.
9. Blown cylinder head gasket. Replace.
10. Restriction in exhaust system. Service
11. Spark plugs fouled. Clean.
12. Faulty breaker points. Replace.
13. Valves sticking. Service.
14. Improper valve timing. Adjust.
15. Faulty distributor. Service.
16. Faulty coil. Replace.
17. Dirty fuel sediment bowl. Clean.

POSSIBLE CAUSES OF GASOLINE ENGINE MALFUNCTIONS (Continued)

18. Water in fuel. Drain and refill.
19. Obstructed fuel line. Clean.
20. Faulty condenser. Replace.
21. Flooded engine. Push choke in and open hand throttle. Crank engine.
22. Vapor lock. Hold hand throttle open and crank engine.
23. Motor oil too heavy. Drain and refill with recommended grade and weight.

AD4.203 ENGINE - SPECIFICATIONS

GENERAL

Bore	3.6"
Stroke	5"
Number of Cylinders	4
Piston Displacement	203.5 cu. inches
Compression Ratio	18.5 to 1
Firing Order	1-3-4-2
Idle Speed	725-775
Rated Engine Speed	2000 rpm
High Idle (no load)	2225-2275
Tappet Setting	.010" hot; .012" cold

TORQUE TENSIONS (In Ft.-Lbs.)

Cylinder Head	55-60
Connecting Rods	40-45
Main Bearings	110-115
Flywheel:	
All Except Torque Converter Type	74-80
Torque Converter Type	76-85
Idler Gear Hub	50
Injector Hold-Down Nuts	10-12
Injector Nozzle Cap Nut	50
Oil Pump Cover Capscrews	18
Rocker Shaft Support	21-24
Intake Manifold	6-9
Exhaust Manifold	21-24
Injection Pump Gear	12-15
Crankshaft Pulley	140-150
Oil Pan	19-21

PISTONS

Top Skirt Diameter	3.5919-3.5929"
Bottom Skirt Diameter	3.5955-3.5965"
Piston Pin Bore Diameter	1.24975-1.250"

CYLINDER LINERS

Inside Diameter of Liner	3.6005-3.603"
Cylinder Block Bore	3.6875-3.6885"
Outside Diameter of Liner:	
Service Liner	3.6875-3.6885"
Production Liner	3.6895-3.6905"
Location of Liner Flange	Flush to .004" below top face of block

PISTON PINS

Pin Diameter	1.24975-1.250"
Clearance in Connecting Rod Bushing	.0005-.00175"
Clearance in Piston Pin Bore	Minus .00025 to plus .00025"

MASSEY-FERGUSON

PISTON RINGS

Ring Side Clearance (one-piece rings):	
Compression Rings	.0019-.0039"
Oil Rings	.002-.004"
Ring End Gap (one-piece rings)	.011-.016"

CONNECTING RODS

Inside Bushing Diameter (finished)	1.2505-1.2515"
Connecting Rod Bore Diameter (bearing end)	2.3950-2.3955"
Rod Bearing Inside Diameter (standard)	2.2515-2.2525"
Bearing Clearance	.0025-.004"
Rod Side Play	.0095-.0148"

CRANKSHAFT AND MAIN BEARINGS

Crankpin Journal Diameter	2.2485-2.249"
Main Bearing Journal Diameter	2.7485-2.749"
Bearing Clearance	.003-.005"
Crankshaft End Play	.002-.014"

VALVES

Valve Head Diameter:	
Intake	1.532-1.536"
Exhaust	1.313-1.317"
Stem Diameter	.311-.312"
Stem Clearance Limits	.002-.0045"
Face Angle	45°
Minimum Margin	1/32"
Tappet Setting	.010" hot; .012" cold
Valve Head Clearance Below Cylinder Head Face:	
Production	.073" maximum
Service	.084" maximum

VALVE SEAT

Seat Angle:	
Production	46°
Service	45°
Seat Contact Width	1/16-3/32"
Maximum Seat Run-Out	.002"

VALVE GUIDES

Location Above Top Face of Cylinder Head	.580-.594"
Inside Diameter	.3145-.3155"
Clearance Limits (stem-to-guide)	.0025-.0045"

VALVE SPRINGS

Free Length	1-25/32"
Spring Pressure @ 1.50" Length	21-25 lbs.
Spring Pressure @ 1-5/32" Length	48-52 lbs.

MASSEY-FERGUSON

TAPPETS

Stem Diameter .....	.62225-.62375"
Tappet Bore in Head .....	.6245-.62575"
Clearance Limits .....	.00075-.0035"

ROCKER ARM SHAFT ASSEMBLY

Shaft Diameter .....	.62225-.62375"
Inside Bushing Diameter .....	.6245-.62575"
Shaft-to-Bushing Clearance .....	.00075-.0035"

VALVE TIMING (Crankshaft Degrees)

Intake Valve Opens	13° B.T.D.C.
Intake Valve Closed	45° A.T.D.C.
Exhaust Valve Opens	46° B.T.D.C.
Exhaust Valve Closed	10° A.T.D.C.

TIMING GEARS

Timing Gear Backlash .....	.003-.006"
Idler Gears and Hubs:	
Hub Diameter (upper and lower)	1.996-1.997"
Upper Gear Bore Diameter	1.9998-2.0007"
Clearance (gear to hub) .....	.0028-.0047"
Gear End Play .....	.003-.007"
Inside Bushing Diameter (lower gear)	1.9998-2.0007"

CAMSHAFT

Cam Lobe Lift .....	.308-.322"
Camshaft End Play	Controlled by thrust plate
Front Bearing:	
Journal Diameter	1.869-1.870"
Bore Diameter	1.874-1.877"
Clearance .....	.004-.008"
Center Bearing:	
Journal Diameter	1.859-1.860"
Bore Diameter	1.864-1.867"
Clearance .....	.004-.008"
Rear Bearing:	
Journal Diameter	1.839-1.840"
Bore Diameter	1.844-1.847"
Clearance .....	.004-.008"

INJECTION PUMP

Injection Timing (static)	26° B.T.D.C.
Timing Letter on Rotor	B
Low Idle Speed Setting	725-775 RPM
High Idle Speed Setting (no load)	2225-2275 RPM

FUEL INJECTORS

Nozzle Opening Pressure:	
Injectors W/More Than 25 Hrs. Operation	2500 psi
New Injectors or Old Injectors W/New Springs	2720 psi
Spray Hole Diameter .....	.0098-.0106"

MASSEY-FERGUSON

OIL PRESSURE RELIEF VALVE

Setting	50-65 psi
Valve Spring:	
Free Length	1½"
Pressure @ 1.250"	5¼-7¼ lbs.
Pressure @ 1.0"	11½-13½ lbs.

OIL PUMP

Capacity @ 2000 Engine RPM	7.4 gal.
Idler Gear Bushing (I.D.) .....	.6562-.6572"
Idler Shaft Diameter .....	.65475-.65535"
Bushing Clearance .....	.00085-.00245"
Idler Gear End Play on Hub .....	.001-.015"
Pump Gears Backlash .....	.006-.009"
Inner-to-Outer Rotor Clearance .....	.006" maximum
Outer Rotor-to-Pump Body Clearance .....	.010" maximum
Top of Rotors to Face of Pump Body Clearance003" maximum

AD4.203 ENGINE - OVERHAUL

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Thoroughly clean the engine before removing any components. Be sure to cover all fuel openings as soon as they are exposed. Dirt must not be allowed to enter the fuel system. Cleanliness is very important and cannot be over-emphasized.

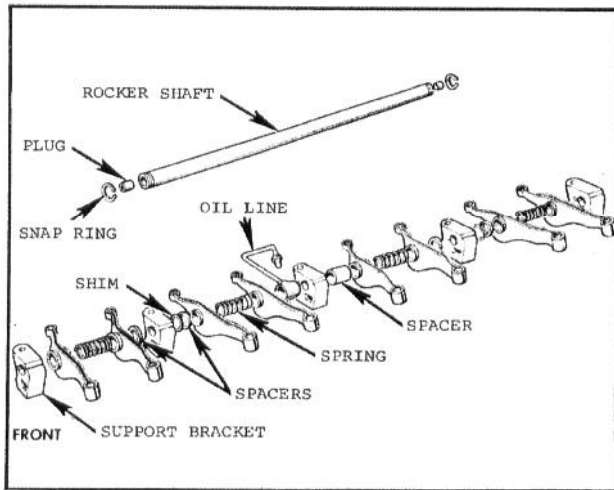


Fig. 1 — Rocker Arm Shaft Assembly Disassembled

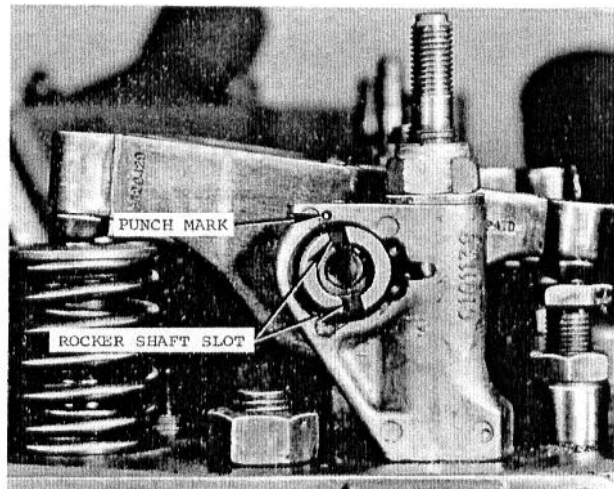


Fig. 2 — Rocker Arm Shaft Oil Slot Correctly Positioned

ROCKER ARM SHAFT ASSEMBLY

REMOVAL

1. Disconnect breather pipe hose, remove nuts securing cover and remove rocker arm cover.
2. Disconnect oil line to rocker arm shaft at cylinder head end.
3. Working from the center to both ends, loosen the nuts securing the rocker shaft supports.
4. After nuts are loosened, remove them and lift rocker arm shaft assembly from cylinder head.

DISASSEMBLY

1. Remove snap ring from each end of rocker shaft.
2. Remove the support brackets, rocker arms, spacer springs, spacers and rocker shaft oil line. Lay all parts in order so they may be installed in the same sequence.

NOTE: Rocker arms are right and left hand assemblies and cannot be interchanged.

3. Clean all components thoroughly.

INSPECTION

1. Inspect bearing surfaces of shaft for scoring. If shaft is scored, replace.
2. Inspect rocker arms for seized and loose bushings. If either condition exists, replace rocker arm assembly. Also replace arms having worn or pitted contact surfaces.
3. Measure diameter of bearing surfaces on rocker shaft and diameter of rocker arm bushings. Replace shaft and/or rocker arms if clearance exceeds .0035".

REASSEMBLY

1. Install all parts in their correct sequence as shown in Fig. 1. (Rocker arms are right and left-handed.)
2. Observe Fig. 2, and align the slot in the rear end of the rocker shaft with the punch mark on the rear support bracket. (The amount of oil circulating to the rocker assembly can be adjusted by positioning this slot.)

NOTE: Only in the event of inadequate or excessive rocker arm lubrication should the slot be repositioned. (Minimum oil flow occurs with the slot in a vertical position.)

3. Complete reassembly procedures by installing new snap ring at each end of rocker shaft.

CYLINDER HEAD

REMOVAL

1. Remove oil line connecting block and head.
2. Loosen the two clamps securing the by-pass hose. Remove the two bolts securing the by-pass connection to the thermostat housing and loosen the joint.
3. Remove the exhaust manifold.
4. Remove the injector leak-off line and the high pressure fuel lines. Cap fuel openings to prevent the entry of dirt.
5. Remove rocker arm shaft assembly.
6. Loosen cylinder head nuts in the order shown in Fig. 3. Remove nuts and carefully remove head.

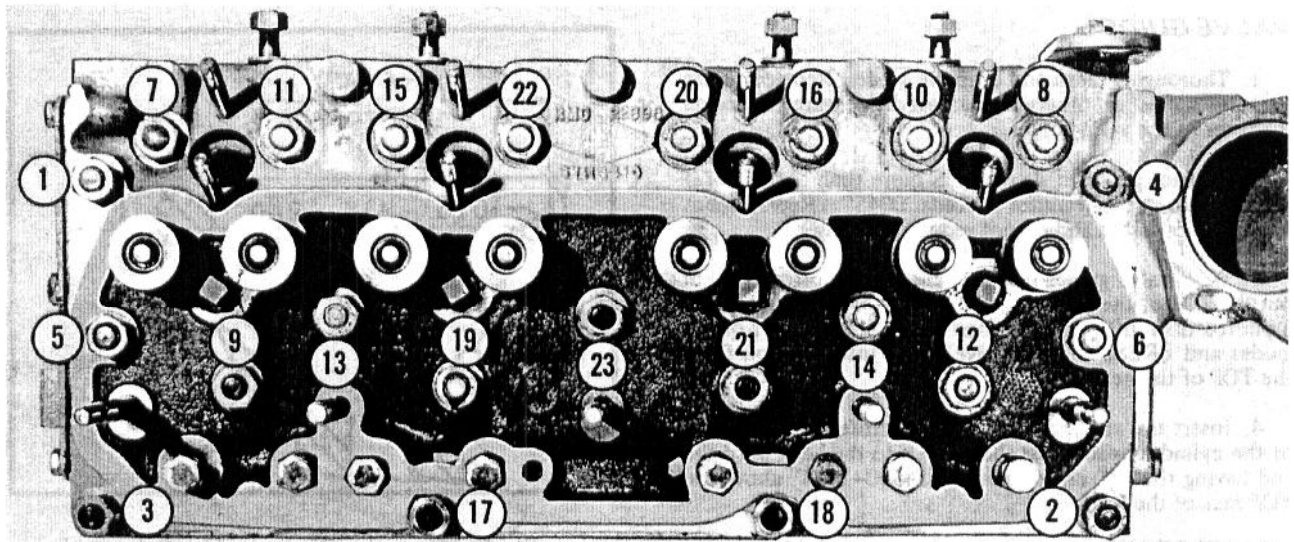


Fig. 3 - Correct Sequence for Loosening Head Nuts

DISASSEMBLY AND INSPECTION

1. Remove fuel injectors, intake manifold, water outlet connection, thermostat and thermostat housing.
2. Using a "C"-Type valve spring compressor, remove valve retainer locks, caps and springs.
3. Intake and exhaust valves are not interchangeable, therefore, place valves in a numbered rack so they will not be mixed in handling.
4. Discard the old cylinder head gasket and carefully clean the gasket surfaces. Be careful not to damage head and block.
5. Clean all rust and dirt from the water passages in the head. Inspect the head for cracks and damaged sealing surfaces.
6. Check head for warpage. If necessary, the head may be resurfaced up to .012 inch, providing the injector nozzle protrusion does not exceed .181 inch.
7. Do not use additional washers to reduce the protrusion. These may inadvertently be removed at a later date, resulting in a loss of power.
8. Remove any old injector sealing washers which may have remained in the head. Carefully clean nozzle recesses, using a soft tool that will not damage the sealing face.
9. Examine water jacket plugs for rust due to leakage. Check cylinder block studs for looseness and damaged threads.

VALVES

1. New valves are numbered consecutively from the front of the engine. Number replacement valves prior to installation.

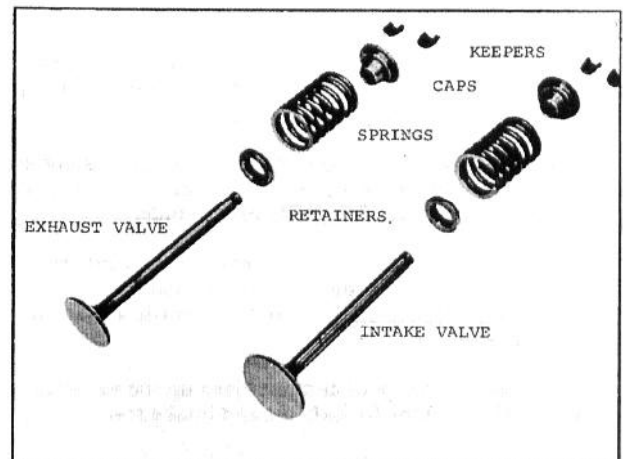


Fig. 4 - Intake and Exhaust Valve Assemblies

2. Thoroughly clean and inspect all valves. If valves appear in good condition, measure the following:
 - a. Thickness of valve margin - $1/32$ " minimum.
 - b. Stem diameter - .310" minimum.
3. New valve specifications are as follows:

Face Angle	.....	45°
Stem Diameter	.....	.311-.312"
Head Diameter - Intake	.....	1.532-1.536"
Head Diameter - Exhaust	.....	1.313-1.317"

4. Reface new and old valves with a 45° face angle. Discard any valves that are bent or have a marginal thickness of less than $1/32$ " after refacing. Clean finished valves and valve seats of grinding particles. Then check valve for proper contact with seats as outlined in "Valve Seats".

VALVE GUIDES

1. Thoroughly clean and examine guides. Replace guides that are scored or otherwise damaged. Measure the inside diameter of the valve guides.

2. Replace guides if diameter is more than .3155" or if the guide-to-stem clearance exceeds .0045". (Replacement guides are pre-sized and do not require reaming.)

3. Worn valve guides may be removed by pressing them out the TOP of the cylinder head. To install new guides, use a piloted drift .002" smaller than the inside diameter of the guides and PRESS (do not drive) them into position from the TOP of the head.

4. Insert the end having the 20° chamfer into the TOP of the cylinder head. Press the guide into the head until the end having the 45° chamfer extends .580—.594" above the TOP face of the head.

VALVE SEATS

1. Thoroughly inspect each valve seat for pitting, burning or other evidence of leakage. If any of these conditions exist, or if new guides have been installed, the valve seats must be refaced.

2. Several different types of equipment are available for refacing valve seats. The manufacturer's recommendations should be used to obtain proper results.

Regardless of what type equipment is used, it is essential that the valve guide bore be free from carbon or dirt to ensure proper centering of the pilot in the guide.

3. To reface the seats, install the pilot in the guide bore. (It is preferable to use a pilot having a solid stem with a long taper, as all seats must be ground concentric and square with the guides.)

4. Place stone over pilot and just clean up the valve seat. Use a dressed 45° stone for exhaust and intake seats.

5. Use a very fine grade of valve grinding compound and lightly hand lap each valve to its valve seat (to determine valve and seat contact). Do not lap excessively. If more than a few strokes are required, repeat the refacing operation.

6. Carefully observe the location where the seat contacts the face and the width of the valve seat. The seat should be located so it contacts the middle portion of the face and has a width of 1/16" to 3/32".

7. Carefully clean the valves and cylinder head to remove all particles and grinding compound.

8. The heads of the valves, when installed in the cylinder head, must be within the limits of .060—.084" below the cylinder head face. Do not reface valve seats or valves to the extent that the valve depth exceeds the amount specified.

EXHAUST VALVE SEAT INSERTS

Valve seat inserts are not installed in production engines. However, exhaust valve seat inserts can be installed if the existing seat is damaged or worn to the point where further

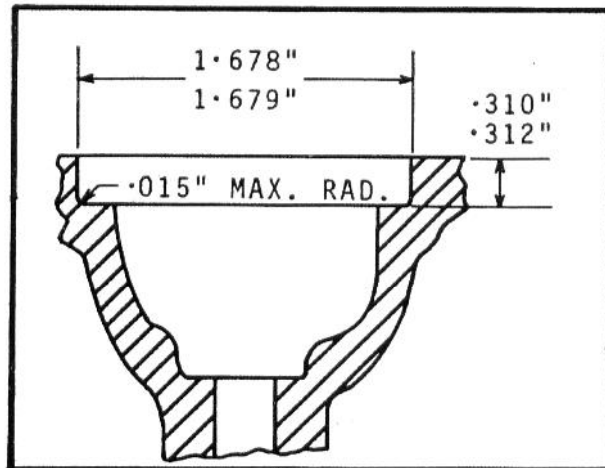


Fig. 5 — Machining Dimensions for Exhaust Valve Seat Inserts

refacing would locate the head of a new valve more than .084" below the face of the cylinder head.

1. To install a new exhaust valve seat insert, remove old valve guide and thoroughly clean bore in cylinder head.

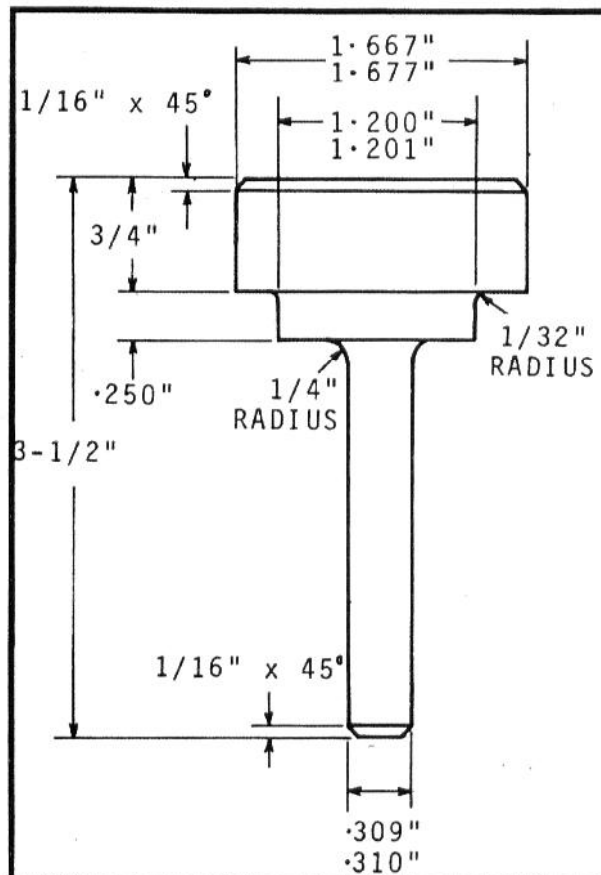


Fig. 6 — Tool for Installing Inserts

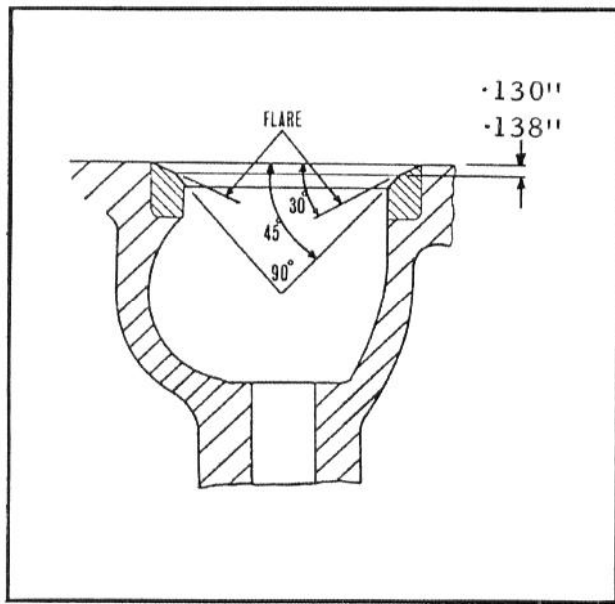


Fig. 7 - Machining Dimensions for Flare

2. Press new guide into position. Install a pilot into the new guide and machine the recess in the cylinder head face to the dimensions shown in Fig. 5.

3. Remove all cuttings and thoroughly clean insert recess. Make sure that all burrs are removed.

4. Shrink the insert by packing it in dry ice. Select the correct sized driver extensions (slightly smaller than the diameter of the recess), and using a pilot and driver, press the insert into position. Do not hammer the insert or use a lubricant.

5. Make sure that insert has been pressed in squarely and that it completely contacts the bottom of the recess.

6. Using the valve guide bore as a pilot, machine the "flare" to the dimensions shown in Fig. 7.

7. Remove all of the cuttings and any burrs that may be present.

8. Reface the valve seat as in the normal procedure. Install the valve and measure the valve head depth. It should be .060"-.084" below the cylinder head.

VALVE SPRINGS

The valve springs, caps and retainers are interchangeable for the intake and exhaust valves.

Discard any springs that do not have squared ends. Also, those that are discolored, damaged or otherwise defective. If springs appear to be in good condition, check in a spring tester and compare readings with the following specifications:

Approximate Free Length	1-25/32"
Spring Pressure @ 1-1/2" Length	21-25 lbs.
Spring Pressure @ 1-5/32" Length	48-52 lbs.

TAPPETS

1. Remove cylinder head.

2. Remove tappet adjusting screw and locknut.

3. Remove tappets and number them so they may be installed into their original bores.

4. Thoroughly clean the tappets. Make sure they are free to rotate and that they will slide into their bores under their own weight.

5. If the tappets are worn or damaged, replace them.

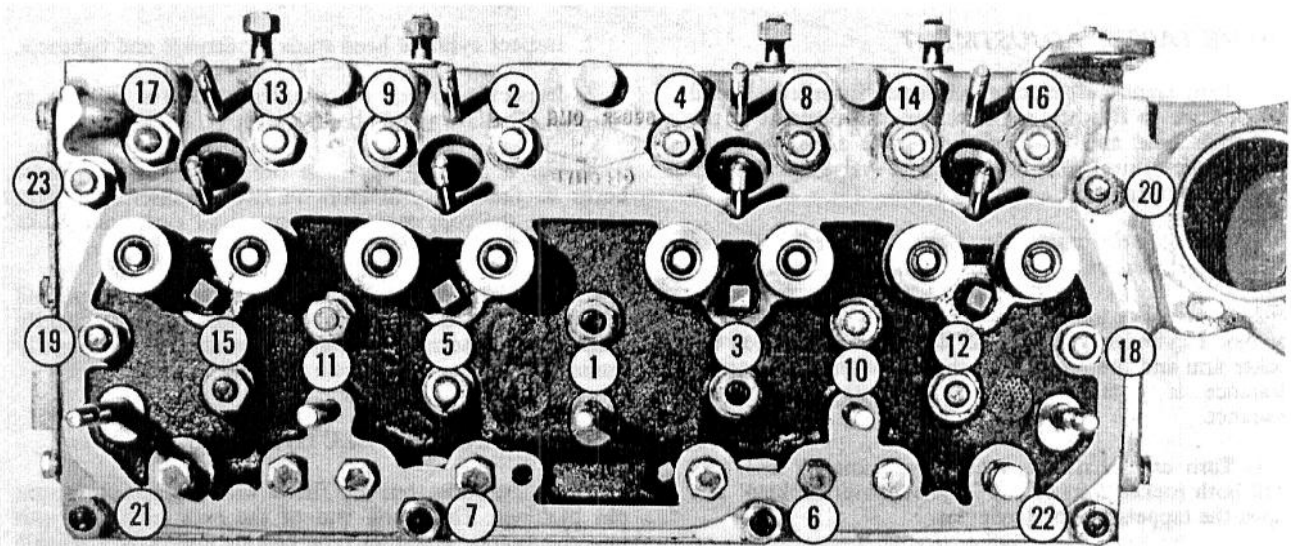


Fig. 8 - Correct Sequence for Tightening Head Nuts

REASSEMBLY

1. Lubricate valve stems and guides with engine oil. Using a valve spring compressor, install the valves into their proper guides. (Refer to Fig. 4.)

2. Reinstall thermostat body, thermostat and outlet connection (if removed). Use new gaskets and sealing compound. Install the intake manifold, using a new gasket.

INSTALLATION

1. Make sure mating surfaces of cylinder block and head are clean.

2. Note that head gasket is marked "Top Front" and install it onto the block in this position. Use a non-hardening sealing compound.

3. Install cylinder head and tighten nuts in the order shown in Fig. 8. Gradually tighten to 55-60 ft.-lbs. torque. (Go over nuts several times before pulling them down to their final torque. Then repeat the last stage of tightening to make sure there is no loss of torque on any nuts.)

4. Install rocker arm assembly and connect oil line between rocker shaft and cylinder head. Make sure slot in rocker shaft is to the rear of the engine and in line with the punch mark on the rear support.

5. Set tappet clearance to .012" cold. Connect oil line between cylinder head and block.

6. Install injectors, using new copper washers, and tighten nuts evenly to 10-12 ft.-lbs. torque. Make sure to install only one washer with each injector.

7. Install fuel lines and injector leak-off line. Install intake and exhaust manifolds.

8. Bleed the fuel system. After engine has been started and has reached normal operating temperature, re-torque the cylinder head nuts and adjust the valve tappet clearance to .010" hot. Install rocker cover, using new gasket.

VALVE TAPPET ADJUSTMENT

1. Turn crankshaft clockwise (viewed from front) until T.D.C. mark on flywheel is positioned in the middle of the inspection hole and both of the rocker arms of No. 4 cylinder (rear) are "rocking" (exhaust valve closing and intake valve opening).

NOTE: At this point, No. 1 cylinder is at T.D.C. on compression stroke, with both valves closed.

2. Loosen the locknuts on the tappet adjusting screws for No. 1 cylinder. With a .012" feeler gauge between the rocker arm and the screw, turn the screw until the correct clearance is obtained. Tighten locknuts and recheck clearance.

3. Turn crankshaft clockwise approximately 1/2 turn until both rocker arms of No. 2 cylinder are "rocking" and adjust the tappets of No. 3 cylinder.

4. Turn crankshaft another 1/2 turn clockwise until both rocker arms of No. 1 cylinder are "rocking" and adjust the tappets of No. 4 cylinder.

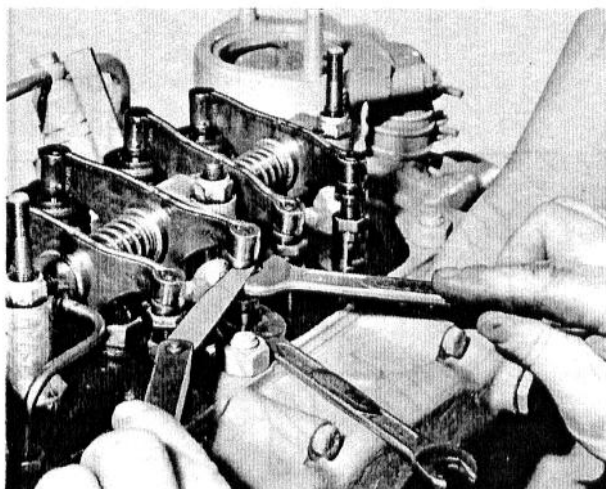


Fig. 9 — Adjusting Valve Tappet Clearance

5. Turn crankshaft another 1/2 turn until No. 3 cylinder rocker arms are "rocking" and adjust the tappets for No. 2 cylinder.

CYLINDER BLOCK

The main bearing caps are not replaceable and cannot be interchanged between cylinder blocks or located in different positions.

For identification purposes, the caps are numbered from the front of the engine as shown in Fig. 10. The caps and the cylinder block are also marked with an identification number. The caps must always be installed in their original location with their identification number on the block.

After the block has been stripped of all removable parts, the entire casting should be cleaned and inspected.

1. Inspect expansion plugs, replacing if any evidence of leakage is apparent.

2. Inspect cylinder head studs for damage and tightness.

3. Inspect top face of cylinder block for damage or warpage. The face should be true within .003".

4. Use a dial indicator and check the parent cylinder bores in the block. Measure in two directions (at right angles) at the top, center and bottom of each bore. Make sure bores are clean before checking.

The bores must not have burrs, or other damage, and should not be out-of-round. If a bore is only slightly damaged or distorted, it should be trued up by very lightly honing it to an inside diameter of 3.6875-3.6885".

PISTONS AND CONNECTING RODS

The connecting rods are fitted with replaceable piston pin bushings. The crank end of the rods are fitted with interchangeable, precision type bearing inserts. Replaceable connecting rod bearing inserts are available in standard size and .010, .020 and .030" undersize. The connecting rods and bearing caps are numbered from the front of the

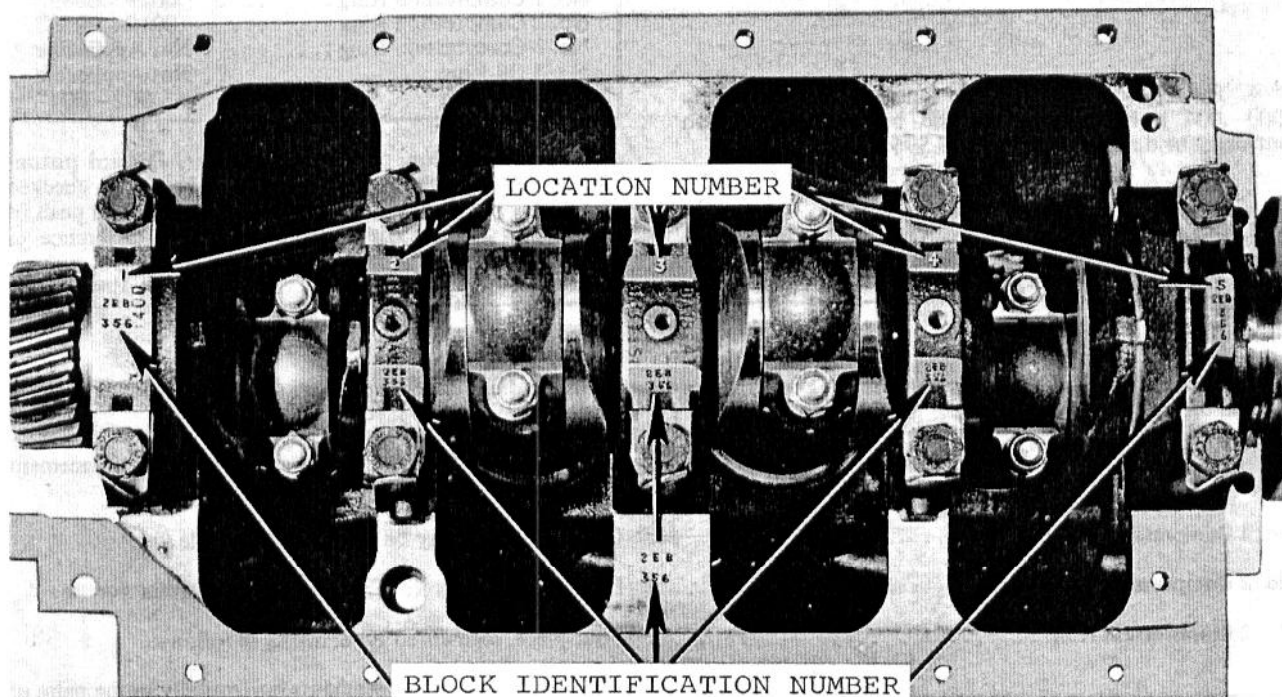


Fig. 10 - Block and Main Bearing Caps Identification

engine, as shown in Fig. 11, with the numbers opposite the camshaft side of the engine.

The full-floating type piston pins are retained by snap rings and are available in standard size only.

REMOVAL

1. Remove rocker arm assembly and cylinder head. Remove oil pan.

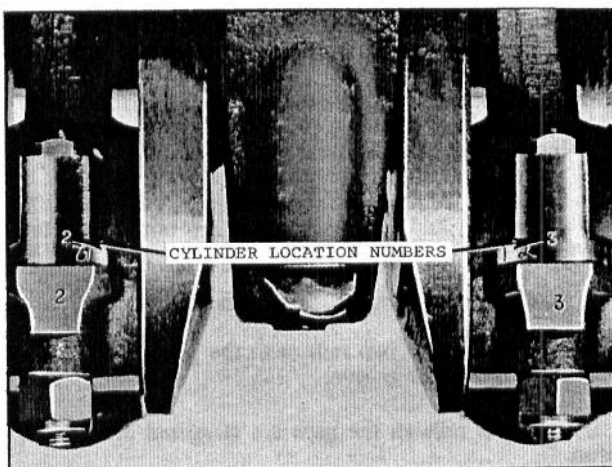


Fig. 11 - Cylinder Location Numbers

2. Turn crankshaft until the piston to be removed is at the bottom of its stroke.

3. Remove the oil pump suction and delivery pipes. Carefully remove any carbon that may have formed at the top of the cylinder liner bore.

4. Very carefully feel the upper piston ring travel area to determine if there is any cylinder ridge present inside the cylinder liner. If a ridge is present, determine if the liner is to be reused and remove the ridge.

5. Remove the nuts from the connecting rod bolts and remove the bearing cap and connecting rod bolts.

6. Remove piston and connecting rod assembly from top of block. Do not mix parts as they should be reinstalled in their original cylinder.

7. Discard old piston rings and clean the piston and rod assembly.

PISTONS

1. To separate the piston from the connecting rod, remove the snap ring from each end of the piston pin.

2. Heat piston in oil or water to 100–200° F. and slip pin out of piston.

3. Thoroughly inspect pistons. Discard pistons that are scored or otherwise damaged. If pistons appear serviceable,

measure the bottom piston skirt diameter at a right angle to the pin.

4. The piston is slightly tapered (approximately .003-.004"), being larger at the bottom. New piston bottom skirt diameter is 3.5955-3.5965".

5. Inspect for worn ring grooves. Piston ring groove clearance specifications are as follows:

No. 1 Compression Ring .....	.0019-.0039"
No. 2 Compression Ring .....	.0019-.0039"
No. 3 Compression Ring	Not Applicable
No. 4 Oil Ring	Not Applicable
No. 5 Oil Ring .....	.002-.004"

6. Inspect piston pin bores for wear. Discard pistons with bores larger than 1.250" or those that, when checked with a new piston pin, require less than a light hand push fit (using oil). Correct fit is from .00025" interference to .00025" clearance.

RINGS

Never install used rings onto a new or used piston. Before installing the rings, check the ring end gaps in the lower unworn portion of the cylinder liner. Proper gap in a new liner is .011-.016" for all of the one-piece rings.

When installing the rings, use a ring tool for all of the one-piece rings. Description of the rings and their correct placement is as follows:

No. 1 Compression Ring	Chrome-plated; may be installed either side up.
No. 2 Compression Ring	Parallel-faced, cast iron; may be installed either side up.
No. 3 Compression Ring	Four-piece, segmented type, install as follows:

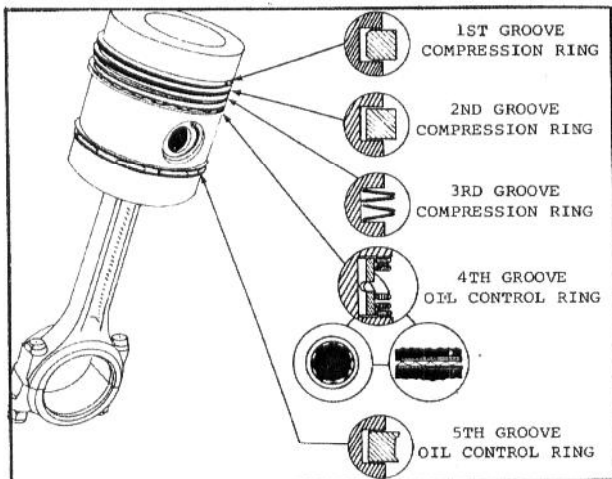


Fig. 12 — Piston Ring Arrangement

No. 4 Oil Ring	Chrome-plated, dualflex laminated ring; install as follows:
----------------------	---

1. Install internal expander in ring groove.
2. Spiral two of the chrome-plated rails onto the piston (one at a time) and locate them at the bottom of the groove.
3. Install center spring on top of rails.
4. Spiral the other two rails onto the piston and locate them in the top of the groove.
5. Turn the rails so the gaps are staggered around the piston.

No. 5 Oil Control Ring	Cast iron scraper; installed either side up.
------------------------------	--

PISTON PINS

Piston pins are 1.24975–1.250" in diameter and are available only in standard size. New pins fit from .00025" interference to .00025" clearance in the piston.

Fit new pins in connecting rod bushings to .0005–.00175" clearance.

To install the pins, heat pistons in hot oil to 100–120° F. and slide the pins in place by hand. Install new snap ring at each end of pin.

CONNECTING RODS

Check connecting rods for proper alignment. Discard or straighten any rods that are misaligned. Replace all unserviceable rods with new ones.

Connecting rod bearing inserts are available in standard size or in .010, .020 and .030" undersize. New specifications are:

Crankpin Diameter	2.2485–2.249"
Bearing Clearance	.0025–.004"
Rod Side Play	.0095–.0148"

When replacing piston pin bushings, whose inner diameter exceeds 1.2515", support the connecting rod in a press and press out old bushings. Position new bushing on the rod, aligning oil hole in bushing with oil hole in connecting rod, and press into place.

Ream excess material from bushing. Hone the bushing to an inside diameter of 1.2505–1.2515". Proper clearance between piston pin and bushing is .0005–.00175".

INSTALLATION

1. Make sure the word "Front" (on top of the piston) is toward the front of the engine and the connecting rod location numbers are opposite the camshaft.

NOTE: If old cylinder liners are to be used, they should be deglazed.

2. Make sure all parts are clean. Remove bearing cap and apply a liberal coating of oil to the cylinder liner bores and the pistons.

3. Stagger the ring gaps. Using a ring compressor, start the assembly into the cylinder bore. (Make sure piston is positioned as instructed in Step No. 1.)

4. Rotate the crankshaft until the appropriate crankpin journal is at the bottom of its stroke, then push piston into cylinder bore.

5. Carefully clean the bearing bore in the connecting rod and the bearing insert. Install upper insert in place.

6. Lubricate bearing insert and crankpin journal. Pull rod assembly into position on the crankpin, making sure that bearing insert is still correctly located.

7. Clean the connecting rod cap and the bottom bearing insert. Assemble it into the cap.

8. Lubricate the crankpin journal and the bottom insert.

9. With the cap location number opposite the camshaft side of the engine, position cap in place and install bolts. (Use new self-locking nuts.) Tighten nuts to 40–45 ft.-lbs. torque.

CYLINDER LINERS

INSPECTION

1. Thoroughly clean cylinder liners and inspect for scoring or other damage.

2. If piston seizure has occurred, remove liner and inspect cylinder block bore for distortion.

3. Measure the inside diameter of the liner at the upper portion of the piston ring travel area. If the cylinder taper exceeds .006", the liners must be replaced.

4. If the taper is within specifications, carefully remove any cylinder ridge present and deglaze the liners before installing the piston and connecting rod assemblies.

5. Be sure to thoroughly clean the cylinder bores and the bearing journals after deglazing liners.

REPLACEMENT

1. Remove piston and connecting rod assemblies. If necessary, remove studs from face of block.

2. Using special tool MFN 8308, remove the liner from the top of the block as shown in Fig. 13.

NOTE: Because of an interference fit, the production liner may require heavy-duty puller equipment.

3. After removing the liner, thoroughly clean the bore, giving particular attention to the top recess. After cleaning check for burrs.

4. Carefully clean the new liner. This is very important.

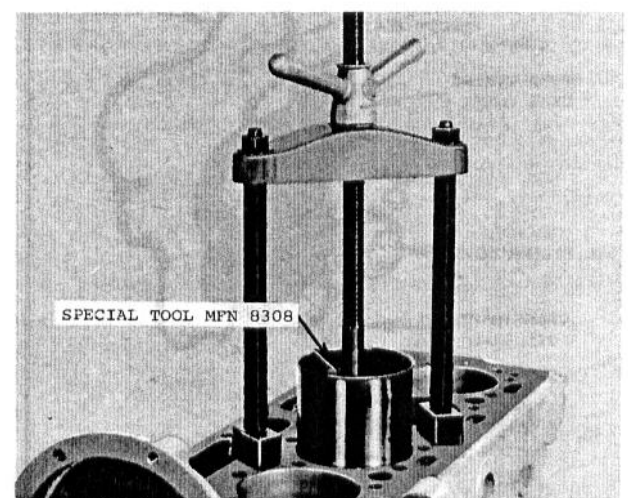


Fig. 13 — Removing Cylinder Liner

5. Make sure cylinder block bores and cylinder liners are thoroughly cleaned as outlined, then either; (1) chill the new liner and push it fully in place by hand or, (2) lubricate the outside of the liner and press it into place using special tool MFN 8308.

6. When correctly installed, the cylinder liner flange must be located flush to .004" below the block face.

7. Make sure the liners are fully seated and allow a period of time for the liners to settle in. Then measure the inside diameter of the liner to make sure there is no distortion.

8. Measure in two directions (at right angles) at the top, center and bottom of the bore. Pre-finished cast type liners should have a fitted diameter of 3.6005–3.603".

9. Maximum distortion (total indicator reading) should not exceed .0025". (Excess distortion is generally caused by improper cleaning.)

TIMING GEAR COVER AND FRONT CRANKSHAFT OIL SEAL

1. Loosen the clamps on the hoses from the water pump. Remove the two capscrews securing the by-pass adapter to the thermostat housing.

2. Disconnect the hose from the water pump to the cylinder block (at block end).

3. Remove crankshaft pulley. Disconnect and remove engine breather pipe and top hose.

4. Remove water pump.

5. Remove capscrews securing the two timing gear cover halves together. Remove upper and lower halves of the cover from the engine, being careful not to damage oil seal.

6. If oil seal requires replacement, remove the old seal by pressing it out of the cover.

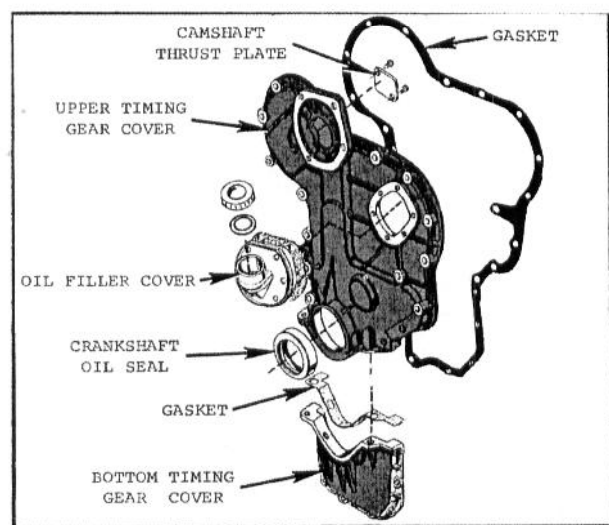


Fig. 14 – Timing Gear Cover

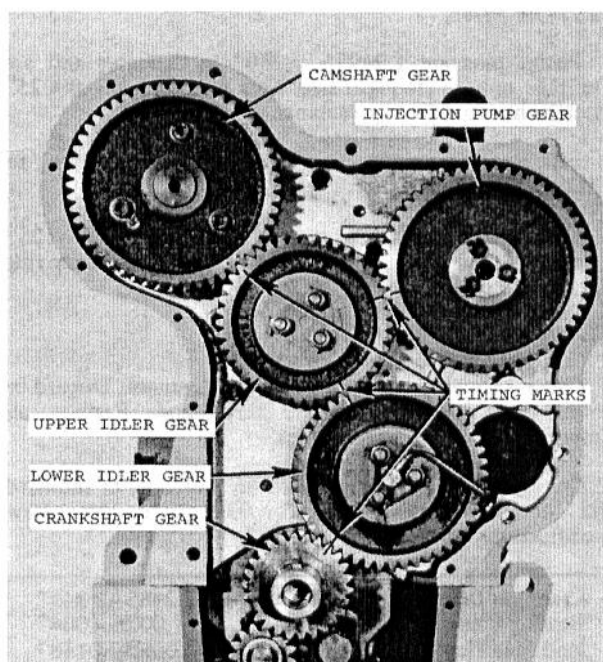


Fig. 15 – Timing Marks Aligned on Timing Gears

7. Carefully clean all of the gasket sealing surfaces and install new gaskets, using non-hardening sealing compound. Clean oil seal bore.

8. Install upper timing gear cover in place and install 4 or 5 capscrews to hold it in position. Do not fully tighten capscrews at this time.

9. Install special tool MFN 747AA onto the crankshaft, and slide single step side of tool in the bore of the cover. This will correctly position cover in relation to crankshaft.

10. Tighten capscrews at this time. Remove the special tool and lightly coat the bore in the cover with sealing compound. Install new "O"-ring in groove of oil seal housing.

11. Lubricate the lip of the seal with oil. Place seal onto the double stepped side of MFN 747AA so the lip will be toward the engine.

12. Slide the tool and the seal onto the crankshaft. If timing gear cover is properly located, it should not require any force to align the oil seal and the housing. If force is necessary, timing gear cover is improperly positioned. Use the pulley bolt and washer to push the tool and oil seal into the bore of the cover.

13. Remove bolt, washer and special tool.

14. Position bottom half of cover in place (ensure that new gasket is installed). Install the capscrews but do not fully tighten at this time.

15. Install the capscrews securing the bottom half of the cover to the top half.

16. Fully tighten the capscrews securing the bottom cover to the oil pan.

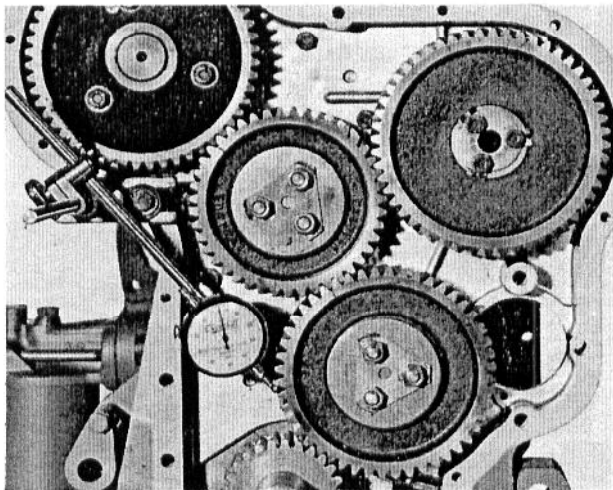


Fig. 16 - Measuring Timing Gear Backlash

17. Install water pump, crankshaft pulley, breather pipe and top hose.
18. Connect hose from water pump to cylinder block.
19. Tighten capscrews securing by-pass adapter to thermostat housing and tighten water hose clamps.

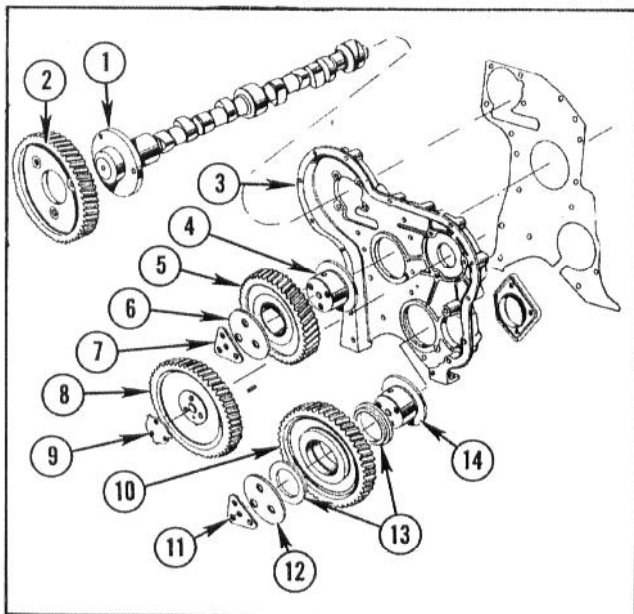


Fig. 17 - Timing Gears - Parts Identification

- | | |
|-------------------------------|-----------------------------------|
| 1. Camshaft | 8. Injection Pump Drive Gear |
| 2. Camshaft Gear | 9. Injection Pump Drive Gear Lock |
| 3. Timing Gear Housing | 10. Lower Idler Gear |
| 4. Idler Gear Hub | 11. Idler Gear Lock Plate |
| 5. Upper Idler Gear | 12. Idler Gear Retaining Plate |
| 6. Idler Gear Retaining Plate | 13. Lower Idler Gear Bushing |
| 7. Idler Gear Lock Plate | 14. Idler Gear Hub |

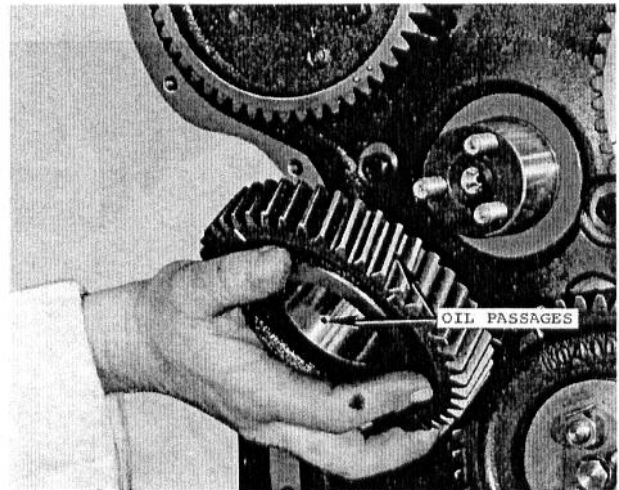


Fig. 18 - Removing or Installing Upper Idler Gear

TIMING GEARS

All of the timing gears are marked as shown in Fig. 15. These marks must align when No. 1 piston is at T.D.C. on the compression stroke. (Due to the odd number of teeth on the idler gear, the complete set of timing marks will not align every time No. 1 cylinder is at T.D.C. on compression stroke.)

CHECKING BACKLASH

1. Remove timing gear cover.
2. Check backlash between gears, using a feeler gauge or dial indicator, as shown in Fig. 16. Backlash between any two gears should be between .003-.006".
3. If excessive backlash is encountered, the gears should be replaced.
4. Also, check the backlash between the crankshaft gear and the oil pump idler gear as shown in Fig. 16. Correct clearance is .012"-.018".

IDLER GEARS AND HUBS

1. Remove oil spray pipe. Remove the three nuts securing the retaining plate.

NOTE: Before removing any of the gears, release the rocker arm shaft assembly to avoid the possibility of damage to the pistons or valve train.

2. Remove lock plate, No. 11, and retaining plate, No. 12. Remove lower idler gear, No. 10.
3. Remove upper idler gear in a similar manner as shown in Fig. 18. Remove idler gear hubs as shown in Fig. 19.
4. Inspect the components for wear and damage. Check oil holes to make sure they are not plugged. Replace components that exceed the following specifications:

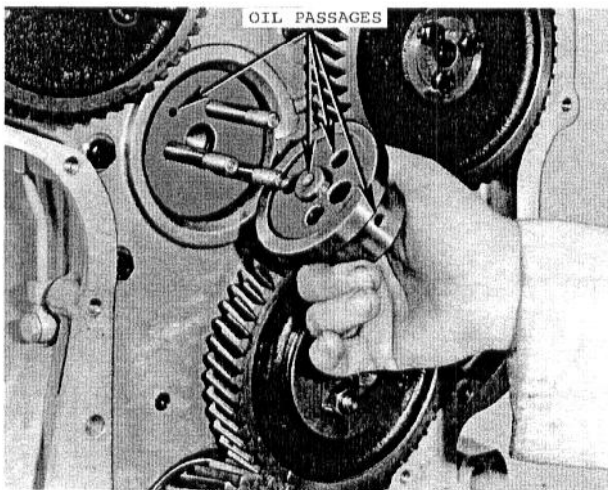


Fig. 19 — Removing or Installing Upper Idler Gear Hub

Hub Diameter	1.996"—1.997"
Gear-to-Hub Clearance .....	.0028"—.0047"
Gear Bore Diameter	1.9998"—2.0007"
Gear End-Play — Upper .....	.003"—.007"
Gear End-Play — Lower .....	.003"—.004"

5. Install the upper and lower idler gear hubs so the boss at the rear of the hubs locate in the machined face of the cylinder block.

6. Turn crankshaft until mark on crankshaft timing gear aligns with center line of lower idler gear hub. (No. 1 and No. 4 pistons will be on T.D.C. Also, T.D.C. mark on flywheel will align with mark on inspection hole.)

7. Install lower idler gear so one timing mark aligns with mark on crankshaft gear and the other mark aligns with the center line of the upper idler gear hub. Install lower idler gear retaining plate and nuts.

8. If lower idler gear is equipped with an oil spray pipe, install the pipe. (Use wire to lock the bolt in place.)

9. Turn camshaft gear and injection pump drive gear so their timing marks are approximately aligned with the center of the upper idler gear hub.

10. Install upper idler gear, aligning the three timing marks on the camshaft gear, injection pump gear and lower idler gear.

11. Ensure that all timing marks are aligned, as shown in Fig. 15, and install the retaining plate and nuts.

12. Secure the rocker assembly in position, adjust the valves and complete reassembly.

CAMSHAFT GEAR

1. Release rocker arm shaft assembly and remove upper idler gear.

2. Remove capscrews and washers and remove the camshaft gear as shown in Fig. 20.

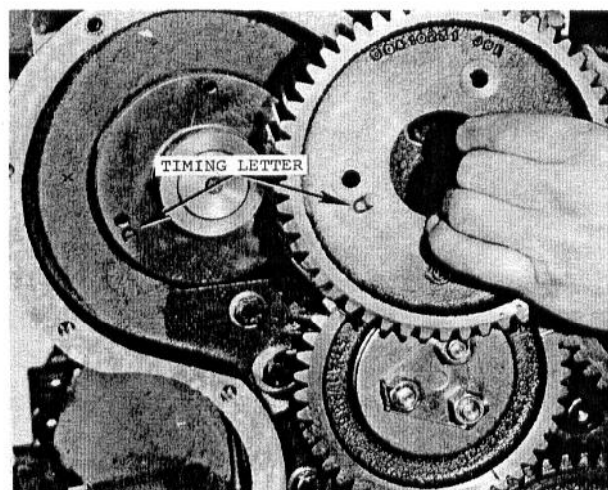


Fig. 20 — Removing or Installing Camshaft Gear

3. Inspect for wear and damage.

4. Install camshaft gear onto camshaft, aligning the timing letter ("D") as shown in Fig. 20.

5. Install upper idler gear, aligning all timing marks. Secure rocker arm shaft assembly in place and complete reassembly.

INJECTION PUMP DRIVE GEAR

1. Release rocker arm shaft assembly and remove upper idler gear.

2. Remove capscrews and washers and remove the injection pump drive gear as shown in Fig. 21.

3. Inspect for wear and damage.

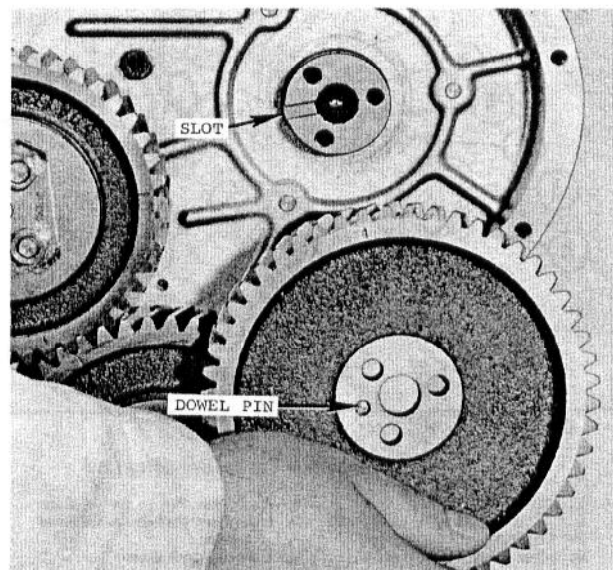


Fig. 21 — Removing or Installing Injection Pump Gear

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4. Install injection pump gear, aligning dowel pin in gear with slot in injection pump as shown in Fig. 21.

5. Install upper idler gear, aligning all timing marks. Secure rocker arm shaft assembly in place and complete reassembly.

VALVE TIMING

1. Turn crankshaft clockwise (viewed from front) until both rocker arms of No. 4 cylinder are "rocking" (exhaust valve closing and intake valve starting to open).

2. With No. 1 cylinder at T.D.C. on the compression stroke, adjust tappet of No. 1 cylinder intake valve so there is .043" clearance between the valve and rocker arm.

3. Turn crankshaft clockwise until the .043" clearance is taken up. Stop turning the crankshaft the instant the rocker arm contacts the valve.

4. With the crankshaft positioned as outlined, observe the timing marks in the inspection hole (plug must be removed). If the valves are properly timed and the procedure properly followed, the T.D.C. mark on the flywheel should be aligned with the mark on the side of the inspection hole.

NOTE: Timing is satisfactory if the mark on the flywheel is less than 1/3 inch away from the mark on the inspection hole.

5. Be sure to reset tappet to normal clearance after checking timing.

CAMSHAFT

1. With timing gear cover removed, turn the engine until No. 1 piston is at T.D.C. on the compression stroke.

2. Remove rocker shaft assembly, fuel lift pump and idler gears.

3. Lift the tappets and remove the camshaft as shown in Fig. 22. Use care not to damage journals, cams and tappets.

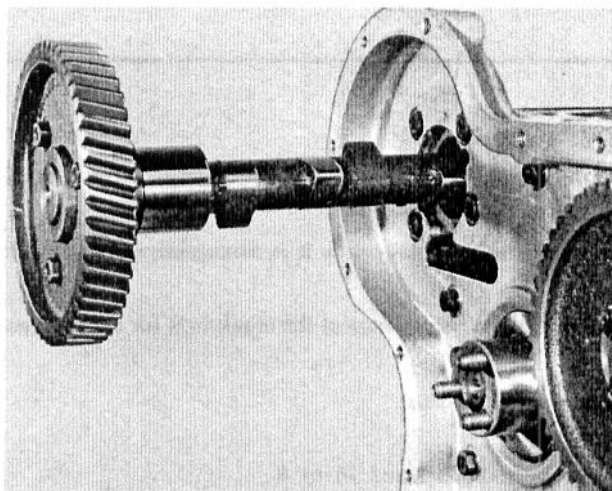


Fig. 22 — Removing or Installing the Camshaft

4. Inspect camshaft journals and lobes for wear, damage and out-of-round. If any of these conditions exist, replace the camshaft.

New camshaft specifications are:

Front Journal	1.869—1.870"
Center Journal	1.859—1.860"
Rear Journal	1.839—1.840"
Cam Lobe Lift	.308—.322"

5. Measure the camshaft bearing bores in the block. Compare each bore diameter to its mating journal diameter. Correct clearance is .004—.008".

6. If camshaft gear has been removed from camshaft, reinstall. (Be sure timing letters are aligned.)

7. With tappets supported in their raised position, carefully install the camshaft while slowly turning it.

8. Install idler gear, aligning all timing marks. Install rocker arm shaft assembly and adjust the tappets.

9. Install fuel lift pump, rocker arm cover and timing gear cover. Complete reassembly.

CRANKSHAFT AND MAIN BEARINGS

CRANKSHAFT END PLAY

1. Using care not to damage the crankshaft, force the crankshaft forward as far as it will go.

2. Measure the gap between the machined shoulder on the crankshaft web and the crankshaft thrust washer as shown in Fig. 23.

3. End play should be .002—.014". Install new thrust

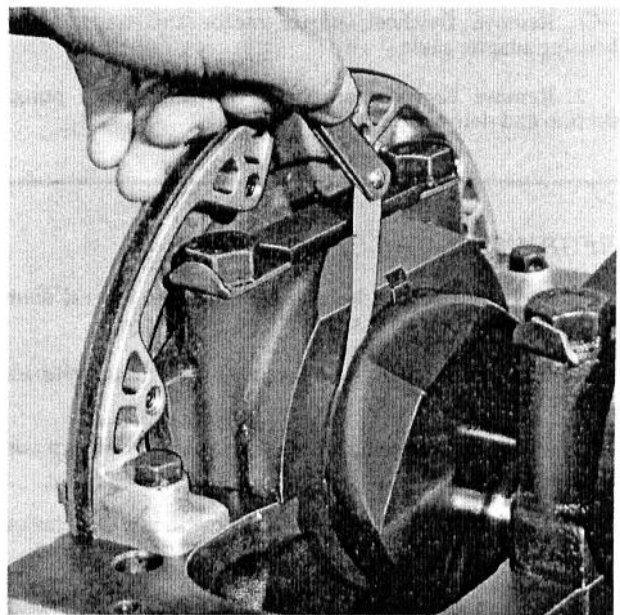


Fig. 23 — Measuring Crankshaft End Play

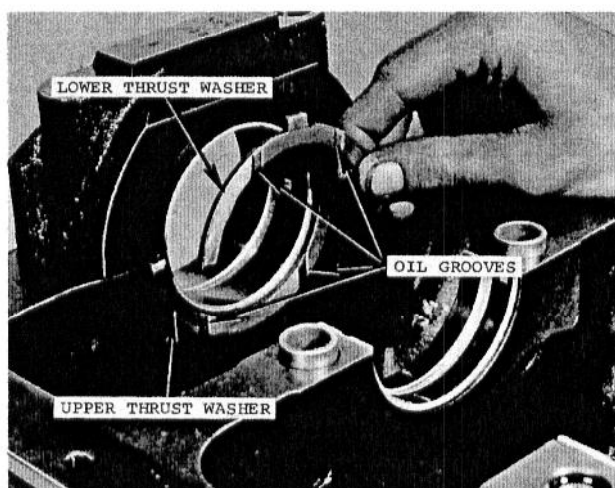


Fig. 24 - Crankshaft Thrust Washers

washers if end play exceeds .014". Replacement washers are available in standard size or in .007" oversize.

4. To replace the thrust washers, remove the rear main bearing cap. Rotate the old upper halves of the thrust washers out of the recesses in the block.

5. Lubricate new upper halves of thrust washers (those without locating lugs) and rotate them into place with the vertical grooves facing the crankshaft as shown in Fig. 24.

6. Remove old lower halves of thrust washers and install new ones, with grooves facing crankshaft.

7. Install rear main bearing cap. Tighten capscrews to 110-115 ft.-lbs. torque. Recheck crankshaft end play.

REMOVAL

1. Remove flywheel, starter motor and transmission housing adapter plate.

2. Remove timing gear cover, oil pan and oil pump suction and delivery pipes.

3. Remove rear oil seal retainers. Remove oil pan seal housing from rear of cylinder block and remove old gasket from its groove in housing.

4. Remove connecting rod caps and bearing inserts. Check crankshaft end-play to determine if thrust washers must be replaced when assembling engine.

5. Remove main bearing caps, using care not to drop bearing inserts and thrust washers. Bearing caps are numbered from front to rear and cannot be interchanged or replaced.

If caps are damaged, it will be necessary to replace the block, complete with main bearing caps.

6. Main bearing inserts are available in standard size or in .010, .020 and .030" undersize. Upper and lower main bearing inserts are interchangeable for each bearing, except the front.

7. Carefully lift crankshaft from block. Remove crankshaft timing gear and spacer. Make sure all main bearing inserts and caps are identified and installed in their original location upon reassembly.

8. Thoroughly clean and inspect all parts. Make sure all oil passages have been carefully cleaned. New crankshaft and main bearing specifications are:

CRANKSHAFT	
Main Bearing Journal Diameter	.... 2.7485-2.749"
Crankshaft End Play	..... .002-.014"
Crankpin Journal Diameter	..... 2.2485-2.249"
MAIN BEARINGS	
Diameter of Bearing	
Bore in Block	..... 2.9165-2.9175"
Bearing Clearance	..... .0025-.004"

If any of the main or crankpin journals are more than .0015" out-of-round, or tapered more than .001", the crankshaft should either be replaced or ground and fitted with undersize bearings.

REGRINDING THE CRANKSHAFT

1. Measure the main bearing and crankpin journal diameters to determine the next size they can be ground to and fitted with undersize bearing inserts.

2. Inspect the crankshaft for cracks. If the crankshaft has been magnetized, make sure it is demagnetized before it is reground.

3. After regrounding the crankshaft, remove the sharp corners on the oil holes. Again inspect the crankshaft for cracks, then demagnetize it.

4. The necessary specifications for regrounding the crankshaft journals are as follows:

NOTE: The surface finish on all bearings must not exceed 16 to 8 micro-inches (as measured by a profilometer) and no coarser. Also, it is very important to maintain the radii quoted on the main bearing and crankshaft journals.

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Main bearing journal diameters:

Standard size	2.7485–2.7490"
Undersize:	
.010"	2.7385–2.7390"
.020"	2.7285–2.7290"
.030"	2.7185–2.7190"
No. 1 front main bearing journal width	1.420–1.424"
No. 2 and No. 4 main bearing journal width	1.2147–1.2227"
No. 3 main bearing journal width	1.8397–1.8477"
No. 5 main bearing journal width	1.874–1.876"
Radii on No. 3 and No. 5 main bearing journals	1.562–1.662"

NOTE: These radii must be burnish-rolled with a load of 400 lbs. on the shoe for 45 seconds at 150 rpm, after polishing.

Crankpin journal diameters:

Standard size	2.2485–2.2490"
Undersize:	
.010"	2.2385–2.2390"
.020"	2.2285–2.2290"
.030"	2.2185–2.2190"
Crankpin journal width:	
Standard size	1.562–1.5635"
Maximum width after regrinding	1.5785"
Radii on all crankpin journals	.1875–.2031"

INSTALLATION

1. Install upper halves of the main bearing inserts in their proper positions and lubricate them. (New inserts are not completely interchangeable. Refer to following table to determine which ones are interchangeable.)

Bearing Inserts	No. of Inserts
No. 1 – Upper half only	1
No. 1 – Lower half only	1
Nos. 2 and 4 – Upper & lower halves	4
Nos. 3 and 5 – Upper & lower halves	4

2. Install upper halves of crankshaft thrust washers (those without locating tabs) on each side of the rear wall of the block housing, so the grooved side is toward the crankshaft. (See Fig. 24.)

NOTE: A light coating of grease will assist in holding the thrust washers in place.

3. Make sure that main bearing inserts are correctly installed and carefully lower crankshaft into position.

4. Install lower main bearing inserts into their respective bearing caps and lightly coat them with oil.

5. Lightly coat lower main bearing thrust washers with grease. Position them in the recess on each side of the rear bearing cap, so the grooved face is toward the crankshaft.

6. Install the numbered main bearing caps in their correct locations. Tighten capscrews to 110–115 ft.-lbs. torque.

7. Using care not to damage crankshaft, force the crankshaft forward as far as it will go. Measure the end play. End play should be .002–.014". If it exceeds .014", install new thrust washers.

8. Install oil pan seal housing, aligning it flush with the rear face of the block as shown in Fig. 25.

9. Install rear crankshaft oil seal retainers and new oil seals. Complete reassembly of engine, using new gaskets and seals.

REAR CRANKSHAFT OIL SEAL

1. Remove the flywheel. Remove the adapter plate from the block and oil pan.

2. Remove the oil seal retainers as shown in Fig. 26 and remove oil seal halves from retainers.

3. Thoroughly clean and inspect oil seal retainers. True up any faces that are distorted.

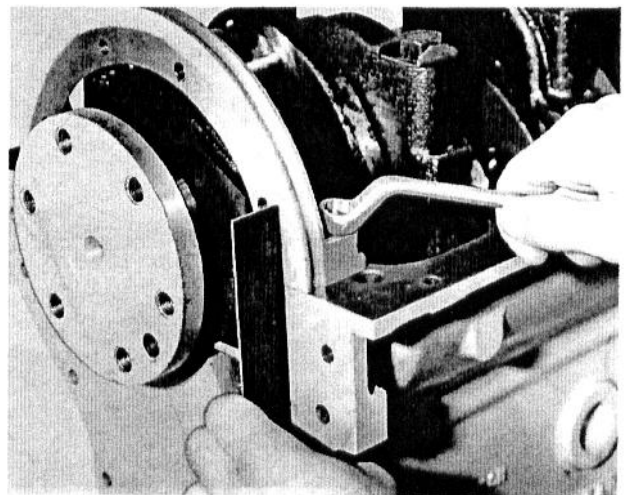


Fig. 25 – Installing the Oil Pan Seal Housing

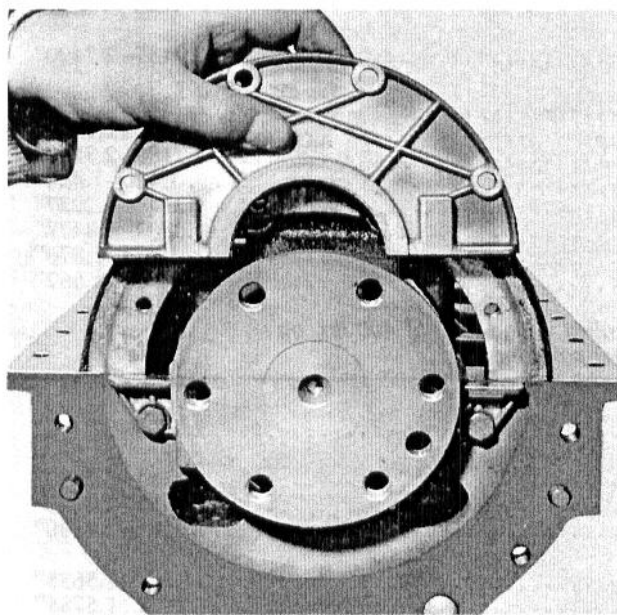


Fig. 26 — Removing or Installing Oil Seal Retainers

4. To install new oil seal half in each retainer, place the retainer in a vise. Press approximately one inch of the new seal into each end of the groove in the retainer, allowing the seal to project .010—.020" beyond both ends of the joint face.

5. A projection exceeding .020" may hold the retainers slightly apart and cause an oil leak. Each seal is of the correct length and must not be trimmed.

6. The middle of the seal will bulge out of the groove and must be pushed in with the fingers (work from the center) until well bedded in the groove. Use a round bar to further imbed the strip by rolling and pressing as shown in Fig. 27.

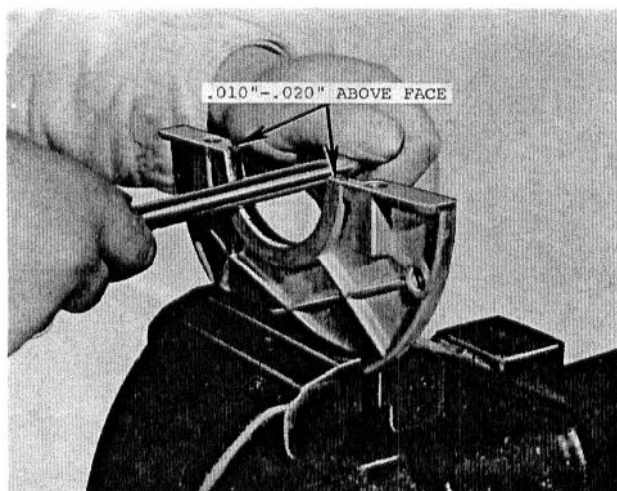


Fig. 27 — Oil Seal Correctly Installed

7. Make sure that seal extends .010—.020" beyond both ends of the joint face.

8. Repeat steps 4 through 7 for the other half of the seal retainer.

9. Remove all old gasket material from block and oil pan seal housing. Install new gaskets, using a sealing compound.

10. Lightly coat the joint faces between the two retainers with a sealing compound and coat the inside surface diameter of the oil seal with *graphite* grease.

11. Assemble oil seal retainers around the crankshaft and loosely bolt them together.

12. Position seal retainer assembly so holes align and loosely bolt it to the block and the oil pan seal housing, using shake proof washers on the upper retainer and aluminum washers on the lower retainer.

13. Fully tighten all capscrews. Install transmission adapter plate.

14. Install the flywheel and check the run-out.

FLYWHEEL

REMOVAL

1. Release the locking tabs, remove the capscrews securing the flywheel in place and carefully lift the flywheel from the crankshaft flange.

2. Remove clutch pilot bearing (if equipped) by tapping it from the back of the flywheel.

RING GEAR REPLACEMENT

1. The ring gear is shrunk onto the flywheel and must be cut to remove it. (An alternate method is to heat a localized portion of the ring gear to expand it and then carefully tap it off the flywheel.)

2. Carefully clean the outside diameter of the flywheel. Heat the new ring gear to approximately 475° F.

3. With the lead-in side of the teeth toward the front of the flywheel, lay the ring gear in position on the flywheel and allow it to cool. Make sure ring gear is fully installed against the flywheel shoulder.

INSTALLATION

1. Carefully clean the mating faces on the crankshaft flange and flywheel. (Failure to do this may result in a broken crankshaft.)

2. Position flywheel against crankshaft flange so the unevenly spaced holes align. This insures that flywheel timing marks are in a correct position in relation to the crankshaft. (See Fig. 29.) Do not fully tighten capscrews.

3. If servicing a unit equipped with a Standard 6-Speed or a Manual Shuttle Transmission, proceed to step 4. If unit is equipped with an Instant Reverse Transmission, proceed as follows:

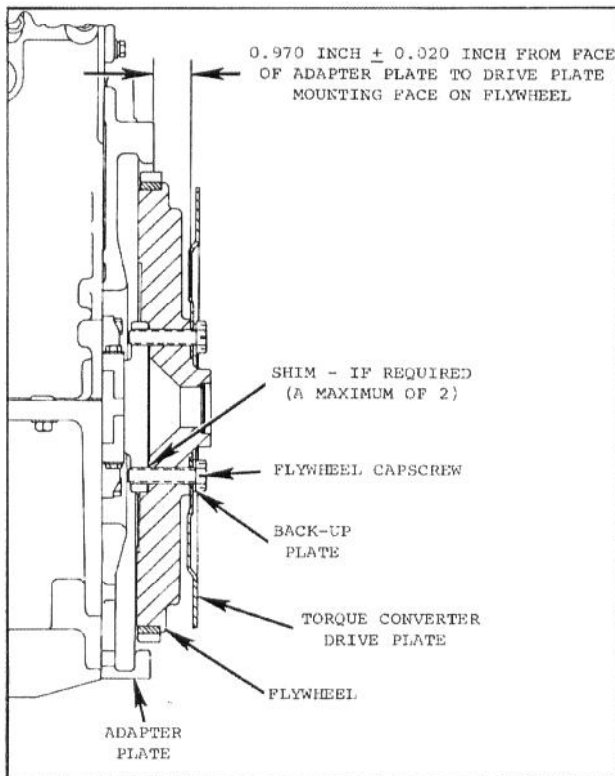


Fig. 28 - Converter Drive Plate and Back-Up Plate Installed

- a. Measure the distance between the rear face of the adapter plate and the converter drive plate mounting surface on the flywheel.
- b. A maximum of two shims may be added between the flywheel and crankshaft to maintain a distance

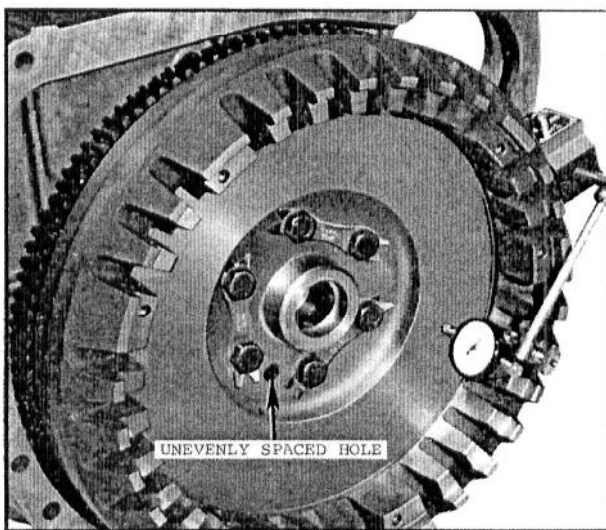


Fig. 29 - Measuring Flywheel Face Run-Out

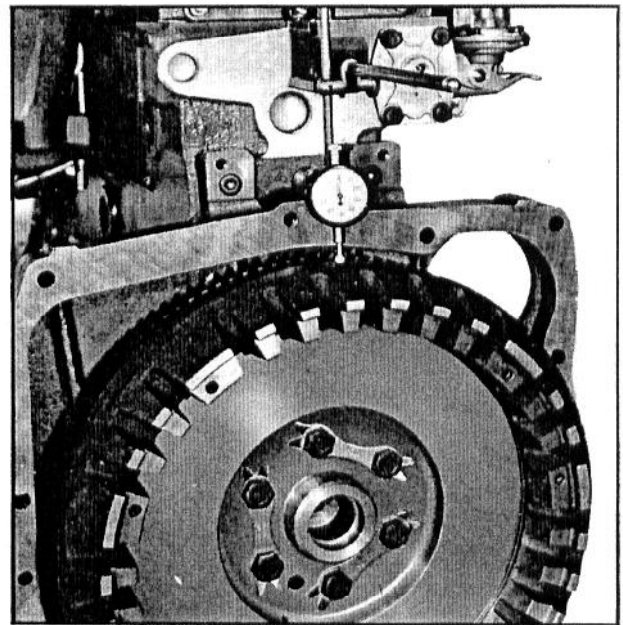


Fig. 30 - Measuring Run-Out on Outer Diameter of Flywheel

of .950-.990" between these two mounting surfaces. (See Fig. 28.)

4. Check the flywheel face run-out as shown in Fig. 29. The total indicator reading should not exceed .001" per radius from the flywheel center to the point of measurement.

5. Check the run-out of the outer diameter as shown in Fig. 30. The total indicator reading should not exceed .012".

NOTE: When making these checks, apply pressure against the center of the flywheel to eliminate any crankshaft end play.

6. If either run-out measurement exceeds specifications, remove the flywheel. Reclean the mating surfaces and inspect for burrs. Reinstall the flywheel and again check the run-out.

7. If servicing a unit equipped with a Standard 6-Speed or a Manual Shuttle Transmission, tighten the flywheel capscrews to 74-80 ft.-lbs. torque and bend over the locking tabs. Install new clutch pilot bearing, making sure that it contacts the shoulder inside the flywheel.

8. If unit is equipped with an Instant Reverse Transmission, remove the flywheel capscrews and install the converter drive plate and back-up plate. Reinstall capscrews and tighten to 76-85 ft.-lbs. torque. (See Fig. 28 for proper positioning of drive plate.)

DIESEL ENGINE TROUBLE CHART

PROBLEM	SEE POSSIBLE CAUSE
A. Engine will not turn over	1, 2, 3, 4, 5, 6
B. Engine turns over, but will not start	1, 2, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16
C. Engine starts, runs for a few moments, then stops	9, 10, 11, 17, 18
D. Engine misfiring or running erratically	9, 13, 14, 15, 16, 19, 20, 21, 22, 23
E. Engine lacks power	11, 13, 14, 15, 16, 17, 21, 24,
F. Excessive exhaust smoke (WHITE)	13, 14, 15, 16, 17, 20
G. Excessive exhaust smoke (BLACK or GREY)	14, 15, 16, 17, 22, 23, 24
H. Engine Noise - Combustion knocks	14, 15, 16, 24, 25
I. Engine Noise - Mechanical knocks	21, 26, 27, 28, 29, 30, 31, 32, 33
J. Engine overheating	16, 17, 24, 34, 35, 36, 37, 38, 39, 40
K. Excessive fuel consumption	14, 15, 16, 17, 20, 21, 22, 23, 24, 41
L. Excessive oil consumption	42, 43, 44, 45, 47, 48, 49
M. Low oil pressure	26, 44, 46, 50, 51, 52, 53
N. High oil pressure	44, 46, 54
O. Low compression pressure	16, 21, 48, 55, 56, 57, 58

POSSIBLE CAUSES OF DIESEL ENGINE MALFUNCTIONS

1. Dead or weak battery. Recharge or replace battery.
2. Poor battery cable or ground connections. Inspect, clean and tighten cables and connections.
3. Loose or faulty wiring connections. Clean and tighten connections.
4. Faulty starting switch. Check and replace.
5. Starter motor malfunctioning. Repair or replace.
6. Internal engine seizure. Check for foreign object in gears or cylinders and for piston seizure.

POSSIBLE CAUSES OF DIESEL ENGINE MALFUNCTIONS (Continued)

7. Fuel tank empty. Fill tank and bleed fuel system.
8. Fuel shut-off control in "Off" position and/or fuel tank shut-off valve closed. Open control and/or valve.
9. Air in fuel system. Bleed fuel system.
10. Fuel lift pump inoperative. Repair or replace pump.
11. Fuel filter, strainer or fuel lines clogged or damaged. Clean or replace.
12. Motor oil too heavy. Drain and refill with recommended grade and weight.
13. Low compression pressure. Pressures should not exceed 10% variation between cylinders. If compression is uniformly low, a complete engine overhaul is usually required to restore the engine.
14. Water in fuel or improper type fuel. Drain and refill with the recommended type fuel.
15. Dirty or faulty fuel injectors. Clean or replace.
16. Fuel injection pump or valves incorrectly timed. Reset timing.
17. Restriction in intake or exhaust system. Check and service.
18. Fuel tank cap vent hole blocked. Replace or clean.
19. Insufficient fuel or restricted fuel flow. Check for plugged fuel filter, strainer, loose connections, bent or cracked fuel lines or a defective fuel lift pump.
20. Low operating temperature. Check thermostat. Replace if defective.
21. Incorrect valve clearance. Adjust.
22. Mis-matching of fuel injection equipment. Recheck fuel system components for proper parts.
23. Faulty fuel injection pump. Have serviced by authorized C.A.V. service station.
24. Engine overloaded. Reduce load or shift to lower gear.
25. Low engine rpm and/or improper operating temperature. Adjust engine rpm to recommended speed. Check that thermostat is installed and operating properly.
26. Excessively low oil level. Repair all oil leaks and refill to "FULL" mark on dipstick.
27. Piston striking a valve. Check for valve sticking or improper valve timing. Also check piston height and valve depth relative to top face of cylinder head if recently overhauled.
28. Main bearing. Replace.
29. Connecting rod bearings. Replace.

POSSIBLE CAUSES OF DIESEL ENGINE MALFUNCTIONS (Continued)

30. Loose piston pin and/or piston slap. Service as required.
31. Broken piston ring. Replace.
32. Timing gears. Check backlash and condition of teeth. Replace gears if necessary.
33. Excessive camshaft end play. Adjust.
34. Low coolant level. Refill to proper level.
35. Fan belt slipping. Adjust.
36. Radiator fins partially clogged. Clean fins.
37. Ice formation in radiator during cold weather. Add anti-freeze solution.
38. Thermostat stuck closed. Replace.
39. Radiator or engine coolant passages blocked. Flush system.
40. Improper water pump operation. Repair or replace pump.
41. Leaks in fuel system. Repair.
42. Oil leaks. Repair.
43. New or rebuilt engine not yet fully "broken-in". Allow sufficient time for new piston rings to become seated.
44. Incorrect weight, diluted or inferior oil being used. Drain and refill with recommended grade and viscosity of motor oil.
45. Oil level too high. Fill to "FULL" mark.
46. Defective or improper oil pressure gauge. Replace.
47. Clogged crankcase breather pipe. Clean.
48. Worn, broken or stuck piston rings. Also worn pistons and liners. Replace.
49. Worn valve guide bores. Service as required.
50. Plugged oil intake screen. Clean.
51. Relief valve sticking open or broken relief valve spring. Clean or replace.
52. Air leaks in suction side of oil pump or badly worn pump. Repair.
53. Excessive bearing clearances within engine. Replace worn bearing.
54. Oil pressure relief valve sticking closed or improper spring installed. Replace damaged or improper parts.

POSSIBLE CAUSES OF DIESEL ENGINE MALFUNCTIONS (Continued)

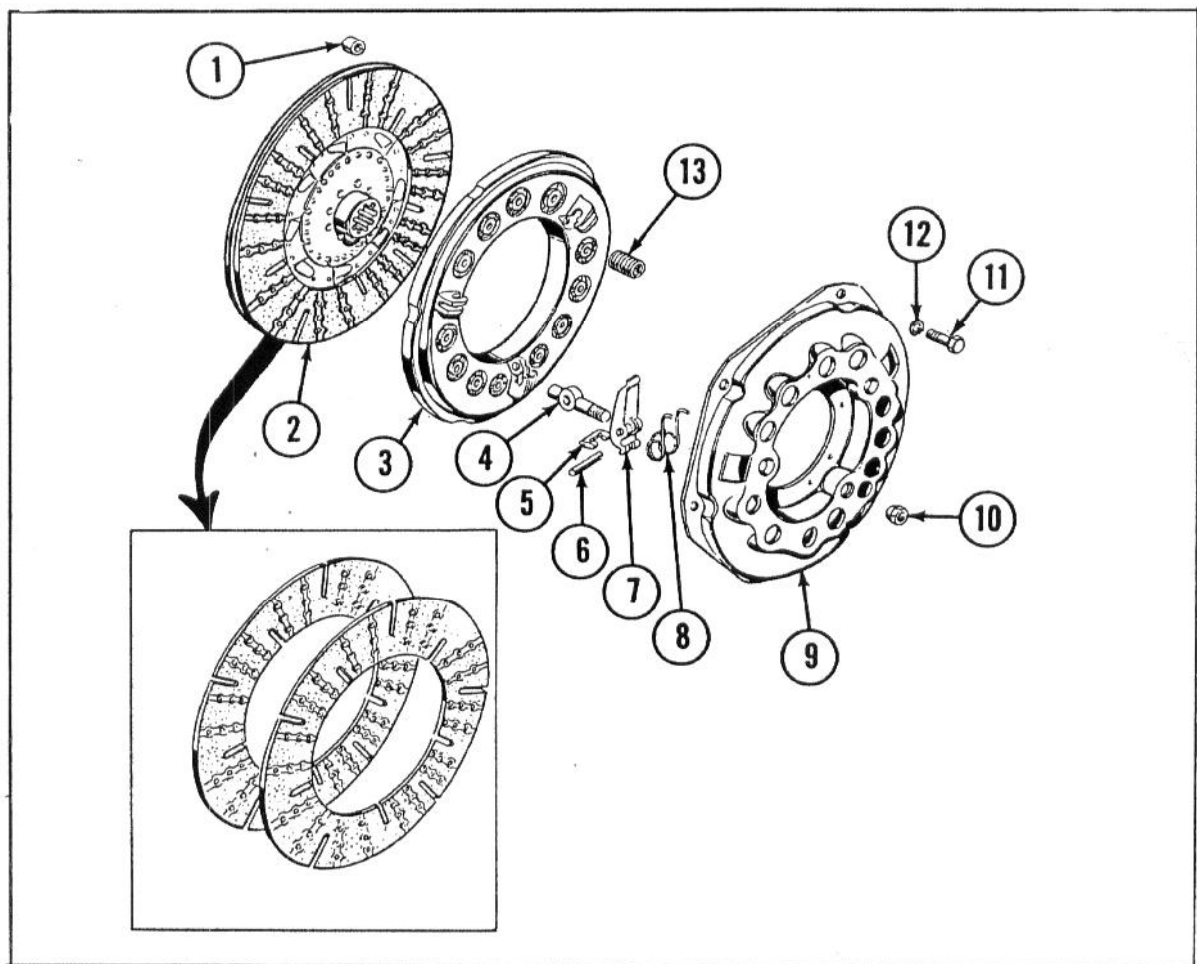
- 55. Burned or sticking valves. Service as required.
- 56. Blown cylinder head gasket. Replace.
- 57. Broken or weak valve springs. Replace.
- 58. Cylinder(s) "washed" with fuel by faulty injector operation. Repair or replace injectors.

CLUTCH

The twelve-inch single clutch has a pressure plate loading of 1520 lbs. (nominal). The pressure springs are chrome silicon spring steel and are aluminum colored. The dry-type clutch discs have sintered iron facings.

DISASSEMBLY (12" Single Clutch)

1. Place clutch assembly in a suitable press and with a bar positioned across clutch cover (so that it will not be across the release lever nuts), compress the clutch.



12-Inch Single Clutch — Identification and Sequence of Parts

- | | | | | |
|-------------------------|--------------------------|----------------------------------|-------------------------------|---------------------|
| 1. Clutch Spacer | 4. Eyebolt (Lever Pivot) | 7. Release Lever | 9. Clutch Cover | 12. Lockwasher |
| 2. Clutch Disc Assembly | 5. Lever Strut | 8. Return Spring (Release Lever) | 10. Nut | 13. Pressure Spring |
| 3. Pressure Plate | 6. Pin (Release Lever) | | 11. Bolt (Clutch to Flywheel) | |

MASSEY-FERGUSON

2. Remove the three staked nuts, No. 10, and slowly release pressure against clutch cover.

3. Remove the clutch assembly from the press and lift off clutch cover, No. 9, with release lever return springs, No. 8, attached. (Return springs may then be unhooked from the cover.)

4. Remove the twelve aluminum colored pressure springs, No. 13, from the pressure plate, No. 3.

5. To remove the release levers, lift up on eyebolt, No. 4, while maneuvering strut, No. 5, rearward of lever, No. 7. Rock the lever sideways while lifting on eyebolt and the release lever, No. 7, pin, No. 6, and eyebolt, No. 4, will lift free of the pressure plate. Strut, No. 5, may then be removed.

INSPECTION (12" Single Clutch)

1. Place pressure springs under 132 (± 5) lbs. load and measure the coil length. Replace springs that measure less than 1-1/2 inches in length.

2. Check the finished surface of the pressure plate for scoring and burned areas. If either condition exists, replace pressure plate.

3. Inspect the facing of the clutch disc for glaze, damage or excessive wear. If any of these conditions exist, either "reline" the clutch or replace the clutch disc assembly.

REASSEMBLY (12" Single Clutch)

1. Insert strut, No. 5, into its groove in pres-

sure plate.

2. Place pin, No. 6, through eyebolt, No. 4, and slide the release lever, No. 7, over the threaded end of the eyebolt. Hold the release lever in this position with one hand and use the other hand to hold strut, No. 5, upward and to the rear of its groove. Rock the release lever sideways and "work" eyebolt into pressure plate with the release lever beneath the strut.

3. Hook return springs, No. 8, into clutch cover, No. 9.

4. Place the twelve aluminum colored coil springs, No. 13, on their bosses in pressure plate, No. 3.

5. Position clutch cover, No. 9, over the coil springs, making sure that return springs, No. 8, in cover are over the release levers.

6. Place clutch assembly in a suitable press and with a bar positioned across clutch cover (so that it will not interfere with the release lever eyebolts), compress the clutch.

7. Install new release lever nuts, No. 10, on the eyebolts until the nut is flush with the top of the eyebolt. (This is a preliminary setting for the clutch release levers.) Do not stake the release lever nuts in position at this time. These nuts should be staked after the clutch assembly has been installed against the flywheel and the "Clutch Release Lever Adjustment" has been made. (See the appropriate Section of this Manual that pertains to the tractor using this particular clutch.)

8. Carefully release the pressure against clutch cover and remove the clutch assembly from the press.