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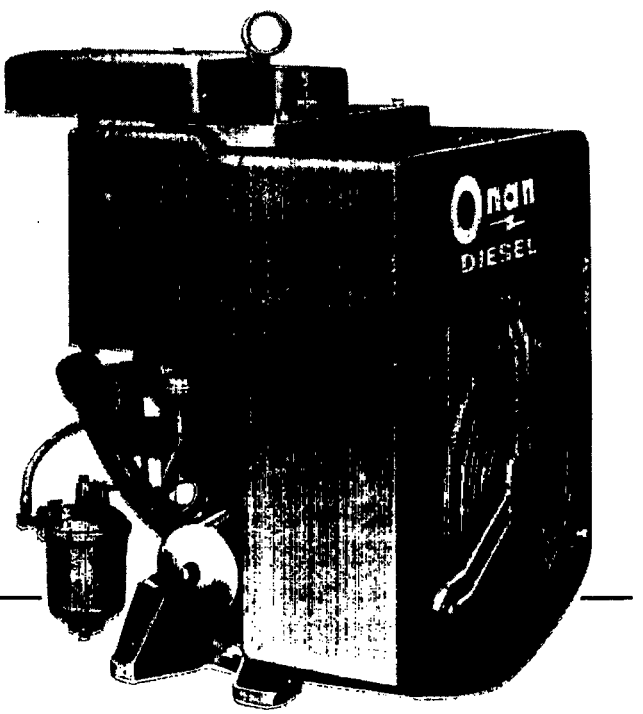
Onan

Operators and Service Manual

DJA
Diesel Engines



967-0755
(SPEC A-T)
5-79
Printed in U.S.A.

Safety Precautions

It is recommended that you read your engine manual and become thoroughly acquainted with your equipment before you start the engine.

WARNING ***This symbol is used throughout this manual to warn of possible serious personal injury.***

CAUTION ***This symbol refers to possible equipment damage.***

Fuels, electrical equipment, batteries, exhaust gases and moving parts present potential hazards that could result in serious, personal injury. Take care in following these recommended procedures.

Safety Codes

- All local, state and federal codes should be consulted and complied with.
- This engine is not designed or intended for use in aircraft. Any such use is at the owner's sole risk.

General

- Provide appropriate fire extinguishers and install them in convenient locations. Use an extinguisher rated ABC by NFPA.
- Make sure that all fasteners on the engine are secure and accurately torqued. Keep guards in position over fans, driving belts, etc.
- If it is necessary to make adjustments while the engine is running, use extreme caution when close to hot exhausts, moving parts, etc.

Protect Against Moving Parts

- Do not wear loose clothing in the vicinity of moving parts, such as PTO shafts, flywheels, blowers, couplings, fans, belts, etc.
- Keep your hands away from moving parts.

Batteries

- Before starting work on the engine, disconnect batteries to prevent inadvertent starting of the engine.
- DO NOT SMOKE while servicing batteries. Lead acid batteries give off a highly explosive hydrogen gas which can be ignited by flame, electrical arcing or by smoking.
- Verify battery polarity before connecting battery cables. Connect negative cable last.

Fuel System

- DO NOT fill fuel tanks while engine is running.
- DO NOT smoke or use an open flame in the vicinity of the engine or fuel tank. Internal combustion engine fuels are highly flammable.
- Fuel lines must be of steel piping, adequately secured, and free from leaks. Piping at the engine should be approved flexible line. Do not use copper piping for flexible lines as copper will work harden and become brittle enough to break.
- Be sure all fuel supplies have a positive shutoff valve.

Exhaust System

- Exhaust products of any internal combustion engine are toxic and can cause injury, or death if inhaled. All engine applications, especially those within a confined area, should be equipped with an exhaust system to discharge gases to the outside atmosphere.
- Do not use exhaust gases to heat a compartment.
- Make sure that your exhaust system is free of leaks. Ensure that exhaust manifolds are secure and are not warped by bolts unevenly torqued.

Exhaust Gas is Deadly!

Exhaust gases contain carbon monoxide, a poisonous gas that might cause unconsciousness and death. It is an odorless and colorless gas formed during combustion of hydrocarbon fuels. Symptoms of carbon monoxide poisoning are:

- Dizziness
- Headache
- Weakness and Sleepiness
- Vomiting
- Muscular Twitching
- Throbbing in Temples

If you experience any of these symptoms, get out into fresh air immediately, shut down the unit and do not use until it has been inspected.

The best protection against carbon monoxide inhalation is proper installation and regular, frequent inspections of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

Cooling System

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator pressure cap when coolant temperature is above 212°F (100°C) or while engine is running.

Keep the Unit and Surrounding Area Clean

- Make sure that oily rags are not left on or near the engine.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and present a potential fire hazard.

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GENERAL INFORMATION

DJA Series engines are four cycle, vertical, air-cooled diesel fueled engines with overhead valves. The crankcase and cylinder are integral. Engines are run in and adjusted at the factory. Any damage incurred in transit must be corrected before operating the engine. See Figure 1 for a typical model DJA Industrial Engine.

Normal engine speed range is up to 2400 rpm. An internal, constant speed, flyball-type mechanical governor, externally adjustable, is standard. Optional two-speed and variable-speed governors are available.

When instructions apply to a specific engine model, refer to the engine nameplate for the *Model* and *Spec No.* in question.

Throughout this manual the flywheel end will be called the *front* and the fuel pump side is designated the *left side.*

TYPICAL MODEL DJA

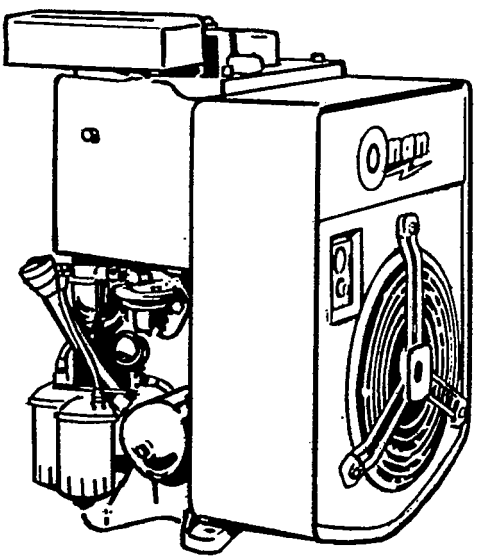


FIGURE 1. SERIES DJA INDUSTRIAL ENGINE

SPECIFICATIONS

Nominal dimensions of engine (inches)	
Height	24-1/2 (622 mm)
Width	19-1/8 (486 mm)
Length	28-3/16 (716 mm)
Approximate Weight (pounds)	230 (104 kg)
Number of Cylinders	1
Displacement (cubic inch)	30 (.49 litre)
Bore	3-1/4 (82.55 mm)
Stroke	3-5/8 (92.08 mm)
HP at 2400 rpm (nominal)	7.3 (5.4 kW)
Compression Ratio	19:1
Main Bearings are Steel-Backed Bronze, Precision Type for Replacement (quantity)	2
Connecting Rod Bearings Tri-Metal Replaceable	Yes
Piston Rings (chrome plated) - 3rd Compression Ring *NOT* Plated	
Oil Control	1
Compression	3
Hardened Chrome Alloy Faced Valves	Yes
Hardened Chrome Replaceable Valve Seats	Yes
Valve Rotator	Yes
Governor (internal flyball type - externally adjustable)	Yes
Nominal Battery Voltage	12
Battery Size	
SAE Group 1H	Two
Amp/Hr. SAE 20 Hr. (nominal)	105 (378 kC)
Solenoid Shift Starter	Yes
Engine cooling air CFM at 2400 rpm★	560 (15.86 m^3/min)
Total cubic feet per minute of air required	613.8 (17.38 m^3/min)
Combustion Air CFM at 2400 rpm	21 (.6 m^3/min)
Inlet Vent (sq. ft.)	7 (.7 m^2)
Outlet Vent (sq. in.)*	64 (.04 m^2)
Glow Plug and Air Heater to Aid Starting	Yes
Injection Pump	PLB
Primary and Secondary Fuel Filters	Yes
Fuel Pump Lift	6 ft. (1.8 m)
Oil Pump (Gear Type)	Yes
Oil Filter (Full Flow)	Yes
Oil Capacity (U.S. quarts)†	2-1/2 (2.4 litres)
Exhaust Connection (Pipe-Tapped)	1-1/4 (31.75)
Power Take-off (inches)	
Shaft Length	4 (101.16 mm)
Shaft Diameter	1-3/4 (44.45 mm)
Keyway Length	3 (76.2 mm)
Keyway Width	3/8 (9.5 mm)
Keyway Depth	3/16 (4.76 mm)

★ - Pressure-cooled type air flow.

* - Area when ventiduct is used; without duct, make vent as large as possible.

† - Add 1/2 quart (.5 litres) for oil filter.

DIMENSIONS AND CLEARANCES

All clearances given at room temperature of 70°F.
All dimensions in inches (metrics in parentheses) unless otherwise specified.

	Minimum	Maximum
CAMSHAFT		
Bearing Journal Diameter, Front	2.500 (63.5 mm)	2.505 (63.63 mm)
Bearing Journal Diameter, Rear	1.1875 (47.63 mm)	1.1880 (30.18 mm)
Bearing Clearance Limit	0.0012 (.031 mm)	0.0037 (.094 mm)
End Play, Camshaft	0.007 (.18 mm)	0.039 (.99 mm)
Cam Tappet Hole Diameter	0.7505 (19.06 mm)	0.7515 (19.09 mm)
Cam Tappet Diameter	0.7475 (18.99 mm)	0.7480 (19.00 mm)
CONNECTING RODS		
Large Bearing Bore Diameter	2.1871 (55.55 mm)	2.1876 (55.57 mm)
Small Bushing Bore Diameter	1.044 (26.52 mm)	1.045 (26.54 mm)
Distance Center Large Bearing Bore to Small Bushing Bore	5.998 (152.35 mm)	6.002 (152.45 mm)
Clearance, Large Bearing to Crankshaft	0.001 (.03 mm)	0.003 (.08 mm)
CYLINDER		
Cylinder Bore	3-1/4 (82.55 mm)	
Cylinder Diameter Limits	3.2495 (82.54 mm)	3.2505 (82.56 mm)
Maximum Allowable Taper		0.005 (0.127 mm)
Maximum Allowable Out of Round		0.001 (0.025 mm)
CRANKSHAFT		
Main Bearing Journal Diameter	2.2437 (56.99 mm)	2.2445 (57.01 mm)
Crankshaft Main Bearing Clearance	0.0014 (.036 mm)	0.0052 (.132 mm)
Connecting Rod Journal Diameter	2.0597 (52.32 mm)	2.0605 (52.34 mm)
End Play, Crankshaft	0.010 (.25 mm)	0.015 (.38 mm)
PISTON		
Piston Clearance to Cylinder Wall	0.0055 (.140 mm)	0.0075 (.191 mm)
Piston Pin Hole Diameter	0.9900 (25.146 mm)	0.9903 (25.153 mm)
Ring Groove Width, Top	0.097 (2.46 mm)	0.098 (2.49 mm)
2nd	0.0965 (2.45 mm)	0.0975 (2.48 mm)
3rd	0.0965 (2.45 mm)	0.0975 (2.48 mm)
4th	0.1880 (4.78 mm)	0.1895 (4.81 mm)
PISTON PIN		
Length	2.738 (69.55 mm)	2.753 (69.93 mm)
Diameter	0.9899 (25.14 mm)	0.9901 (25.15 mm)
Piston Clearance	Thumb Push Fit	
Connecting Rod Bushing Clearance	0.0002 (.005 mm)	0.0007 (.018 mm)
PISTON RINGS		
Ring Type		
Top		Compression
2nd		Compression
3rd		Compression
4th		Oil Control
Ring Width		
Top	0.0925 (2.35 mm)	0.0935 (2.37 mm)
2nd	0.0925 (2.35 mm)	0.0935 (2.37 mm)
3rd	0.0925 (2.35 mm)	0.0935 (2.37 mm)

VALVE INTAKE (Hardened Chrome Alloy Faced)		
Stem Diameter	0.3381 (8.59 mm)	0.3420 (8.69 mm)
Clearance in Guide	0.0005 (.013 mm)	0.0025 (.064 mm)
Seat Angle	42-degrees	
Valve Clearance	0.011 (.28 mm)	
VALVE, EXHAUST (Hardened Chrome Alloy)		
Stem Diameter	0.3405 (8.65 mm)	0.3415 (8.67 mm)
Clearance in Guide	0.0025 (.063 mm)	0.0045 (.114 mm)
Seat Angle	45-degrees	
Valve Clearance	0.008 (.20 mm)	
VALVE GUIDE		
Length	1-25/32 (45.24 mm)	
Outside Diameter	0.4690 (11.91 mm)	0.4695 (11.93 mm)
Cylinder Block Bore Diameter	0.467 (11.86 mm)	0.468 (11.89 mm)
Inside Diameter (after reaming)		
Exhaust	0.344 (8.74 mm)	0.345 (8.76 mm)
Intake	0.342 (8.69 mm)	0.343 (8.71 mm)
VALVE SEATS (Hardened Chrome Alloy Faced)		
Valve Seat Bore		
Diameter	1.361 (34.57 mm)	1.362 (34.59 mm)
Depth (from cylinder head face)	0.433 (11.00 mm)	0.439 (11.15 mm)
Seat Outside Diameter	1.364 (34.65 mm)	1.365 (34.67 mm)
Seat Width	3/64 (1.19 mm)	1/16 (1.59 mm)
Seat Angle	45-degrees	
Available Oversizes	0.002 (.05 mm); 0.005 (.13 mm); 0.010 (.25 mm); 0.025 (.64 mm)	
VALVE SPRINGS		
Free Length	1-7/8 (22.23 mm)	
Length, Valve Closed	1.528 (38.81 mm)	
Load, Valve Closed	45 lbs. (20.41 kg)	49 lbs. (22.23 kg)
Length, Valve Open	1.214 (30.84 mm)	
Load, Valve Open	83 lbs. (37.65 kg)	93 lbs. (42.18 kg)
STARTING MOTOR (Prestolite)		
Rotation	Counterclockwise	
Pinion Clearance to Pinion Stop (solenoid plunger bottomed)	0.070 (1.78 mm)	0.120 (3.05 mm)
Pinion Rest Position - Distance from pinion housing mounting face to outer edge of pinion	1-9/32 (32.54 mm)	1-15/32 (37.31 mm)
Armature End Play	.005 (.13 mm)	.030 (.76 mm)
Test Specifications		
No Load	10 volts - 80 amps (288 kC) 5000 rpm per Min.	
Stall Torque	4 volts - 420 amps (1512 kC) 7.8 ft. lbs. per Min. (8.8 N.m/min)	
Brush Spring Tension	32-40 oz. (.91 kg - 1.13 kg) with new brushes	

ASSEMBLY TORQUES AND SPECIAL TOOLS

The assembly torques given here will assure proper tightness without danger of stripping threads. Be careful not to strip threads. Use reasonable force only and a wrench of normal length.

Specially designed place bolts (Figure 2) do not require a lockwasher or gasket. Onan uses a hardened flatwasher under each bolt to prevent galling or yielding of bearing plate material. Do not attempt to use a lockwasher with these bolts; it will defeat their purpose. Check all studs, nuts, and screws often and tighten as needed to keep them from working loose.

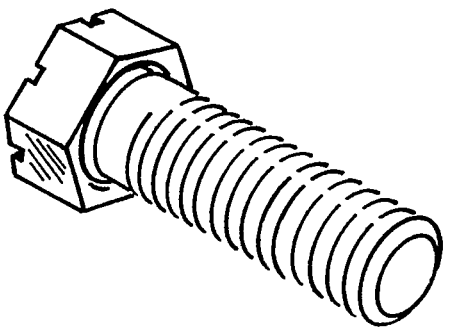


FIGURE 2. PLACE BOLT

TORQUE SPECIFICATIONS — FT. LBS.

Connecting Rod Bolt	27-29
Cover-Rocker Box	8-10
Cylinder Head Bolt	44-46
Exhaust Manifold Nuts	†13-15
Flywheel Mounting Screw	65-70
Fuel Pump Mounting Screws	15-20
Gear Case Cover	18-20
Glow Plug	10-15
Injection Nozzle Mounting Screws	20-21
Injection Pump Mounting Screws	18-21
Intake Manifold	13-15
Oil Base Mounting Screws	32-38
Oil Filter	Hand Tighten + 1/4 to 1/2 Turn
Oil Pump Mounting Screws	15-20
Rear Bearing Plate	40-45
Rocker Arm Nut	*4-10
Rocker Arm Stud	35-40

† - *Caution:* Tighten nuts evenly to avoid damage.

* - This torque is from friction between the threads only and locks the nut in place. The rocker arm nuts are for adjusting valve lash.

SPECIAL TOOLS

These tools are available from Onan to aid service and repair work.

Crankshaft Gear Pulling Ring	420-0275
Diesel Nozzle Tester	420-0184
Diesel Pintle Nozzle Cleaning Tool Set (Includes Injection Nozzle Centering Tool)	420-0208
Nozzle Centering Sleeve	420-0321
Delivery Valve Test Fixture	†420-0322
Combination Main and Cam Bearing Driver	420-0326
Driver, Valve Seat	420-0270
Oil Seal Guide and Driver - Bearing Plate	420-0456
Gear Cover	420-0281
Ridge Reamer	420-0260
Replacement Cutter Blade for 420-0260	420-0261
Diesel Compression Tester	420-0283
Valve Seat Remover	420-0311
Replacement Blades for 420-0311	420-0274
Valve Guide Driver	420-0300

† - Used with diesel nozzle tester.

DIESEL ENGINE TROUBLESHOOTING GUIDE LIQUID OR AIR COOLED

TROUBLE / CAUSE	COMPRESSION POOR	CONNECTING ROD, BUSHINGS, BEARINGS WORN	COOLANT TEMPERATURE TOO HIGH (FRESH WATER SYSTEM)	COOLANT TEMPERATURE TOO LOW (FRESH WATER SYSTEM)	COOLANT LOSS (FRESH WATER SYSTEM)	ENGINE MISFIRE	ENGINE POWER LOW	ENGINE OVERHEAT	ENGINE SPEED TOO LOW	ENGINE SPEED TOO HIGH	FUEL CONSUMPTION EXCESSIVE - BLACK SMOKEY EXHAUST	FUEL CONSUMPTION EXCESSIVE	FUEL KNOCKS	GOVERNOR CONTROL LOSS	HUNTING	INJECTION PUMP TIMING INCORRECT	MECHANICAL KNOCKS	OIL CONSUMPTION EXCESSIVE - LIGHT BLUE SMOKEY EXHAUST	OIL CONSUMPTION EXCESSIVE - NO SMOKE INCREASE	OIL DILUTED	OIL PRESSURE HIGH	OIL PRESSURE LOW	PISTON, CYLINDER AND RING WEAR	STARTER SPEED SLOW	STARTER MOTOR DOES NOT TURN	STARTING HARD, OR FAILURE TO START	SENSITIVITY POOR	VALVE BREAKAGE	VALVE BURNING	VALVE STICKING
STARTING SYSTEM																														
Discharged or Defective Battery																								●	●					
Defective Glow Plug or Lead						●							●		●										●					
Load Connected When Starting																									●					
Defective Solenoid																							●	●	●					
Defective Starter																							●	●	●					
Defective Control Circuit																									●					
FUEL SYSTEM																														
Defective Fuel System						●	●			●	●			●											●					
Air in Fuel System						●	●				●		●	●											●					
Incorrect Timing						●	●			●	●	●					●								●					
Restricted Air Intake - Dirty Air Filter						●	●			●	●												●		●					●
Poor Quality Fuel						●	●			●	●	●													●					
Dirty Fuel Filters						●	●				●														●					
Out of Fuel or Shut Off Closed																									●					
Worn or Damaged Transfer Pump, Leaking Diaphragm											●											●			●					
Faulty Injection Pump, Nozzles or Gaskets						●	●			●	●	●					●								●					
Fuel Line Leaks						●	●				●				●										●					
Wrong Timing Button in Injection Pump							●										●													
Wrong Thickness Pump Mounting Gaskets							●										●													
Run For Long Periods of Time at NO LOAD	●						●											●												
LUBRICATION SYSTEM																														
Low Oil Supply		●	●														●				●	●								
Defective Oil Gauge																					●									
Excess Oil in Crankcase																	●					●								
Oil Leaks From Engine Base or Connections																		●												
Light or Diluted Crankcase Oil		●															●	●			●	●								
Leaky Oil Seals																		●												
Improper Lubrication		●	●														●				●	●								●
Faulty Oil By-Pass																		●			●	●								
Worn Oil Pump		●																			●									
Heavy Oil or Clogged Passages		●																			●									
Dirty Oil Filter		●																												●
GOVERNOR SYSTEM																														
Loose or Disconnected Linkage							●		●	●			●	●												●				
Binding Linkage							●		●	●			●	●												●				
Excessive Wear in Linkage							●		●	●				●												●				
Incorrect Governor Adjustment							●		●	●			●	●												●				
High Spring Sensitivity									●	●			●	●																
Incorrectly Installed Governor Yoke or Cup							●			●			●																	
Overloaded Generator		●					●		●	●																				
COOLING SYSTEM																														
Insufficient Coolant		●				●																								
Faulty Thermostat		●	●		●	●																								
Worn Water Pump or Defective Seals		●		●		●																								
Water Passages Restricted		●				●																								
Blown Head Gasket	●	●		●	●	●													●											
Overheating																	●	●			●	●					●	●		
Restricted or Too Long Water Lines						●																								
Defective Expansion Tank Pressure Cap		●		●																										
Dirt on Cooling Fins (Air Cooled)						●																								
Inadequate Air Circulation (Air Cooled)						●																								
INTERNAL ENGINE																														
Poor Compression		●							●	●							●								●					
Loose Piston																	●					●								
Loose Connecting Rod or Crankshaft Bearing																	●				●									
Incorrect Valve Clearance	●					●	●			●							●								●		●	●	●	
Broken or Weak Valve Spring	●					●	●										●										●	●	●	
High Exhaust Back Pressure							●																				●	●		
Valves Not Seating Properly	●					●	●			●	●	●													●					
Worn Bearings																	●				●									
Worn Cylinder Walls, Pistons, Rings	●					●	●			●							●				●									
Sticking Valves	●					●	●			●							●													
Worn or Dirty Valve Guides																		●									●			●

INSTALLATION

GENERAL

Plan the installation carefully to ensure maximum operating efficiency. Use this manual as a general guide. Recommendations in this manual are based on extensive tests under favorable operating conditions. Abide by pertinent local codes regulating installation and operation of internal combustion engines.

LOCATION

Engine location is determined chiefly by the intended application. Provide adequate access for service and repair. Protect the engine from adverse weather. Consider the location of related systems, such as fuel, exhaust, and ventilation.

MOUNTING

Secure the engine to a rigid, level foundation. Foundations must be sturdy enough to withstand distortion and retain alignment with load equipment.

If necessary to exceed 23-degree tilt angle, consult the factory. Compensate for any tilt when checking crankcase oil.

VENTILATION

Ventilation is needed to cool the engine and support combustion. Avoid recirculation of ventilating air. See *SPECIFICATIONS* section for air flow requirements and vent sizes.

Locate vents so air flow from the inlet to the outlet will pass over the engine. The outlet should be slightly higher than the inlet.

An optional air shutter may be used in the outlet duct to control engine temperature by regulating air flow. Air shutters also prevent back flow of cold air during engine shutdown.

When shutters are used between the engine and outlet vent, use a canvas section to restrict vibration.

EXHAUST

WARNING **Pipe gas outside any enclosure. Exhaust gas is poisonous.**

Exhaust pipes must not terminate near inlet vents. Avoid sharp bends by installing sweeping, large radius elbows. Use flexible seamless section tubing between the engine and any rigid pipe to restrict vibration. Increase the exhaust pipe one size for each additional 10-foot length.

Protect walls and partitions through which exhaust pipes pass with a metal shield (Figure 3).

Install a suitable muffler preferably as close to the engine as practicable. Pitch exhaust pipes downward, or provide a condensation trap at point where a rise in the exhaust system begins.

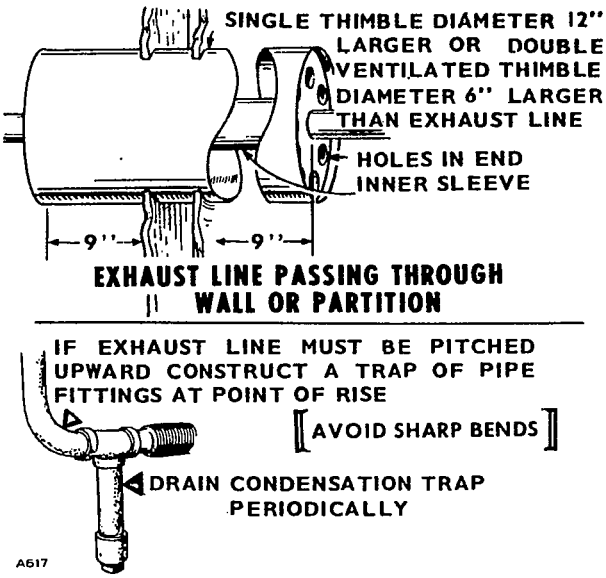


FIGURE 3. EXHAUST

FUEL TANK AND LINES

Install the fuel tank so that the vertical distance from bottom of the tank to the fuel pump does not exceed six feet. Auxiliary fuel pumps are available which provide an additional eight-foot fuel lift.

Avoid gravity feed of fuel to the engine. Provide a siphon break if tank is above pump. When sharing a fuel tank, do not connect to an existing line at a point above the fuel supply level.

These diesel engines require a fuel supply line and a separate return line. Install the fuel supply line from tank to the 1/8-inch pipe inlet in the fuel pump. Connect the fuel return line to the fitting (7/16-24 size) on the injection pump (Figure 4) to the top of the fuel supply tank. Use approved flexible fuel lines at the engine to absorb vibration. Be sure there are no air leaks in the suction line.

Do not use galvanized lines, fittings or fuel tanks. Carefully clean all fuel system components before putting the engine into operation. Any dirt or contamination may cause major damage to the fuel injection system.

Beginning with Spec S, a new fuel filtration system accommodates both primary and secondary fuel filters on a common mounting casting which is bolted to a newly designed oil fill tube. The engine cannot be run with either filter loose or missing, thus ensuring proper filtration at all times.

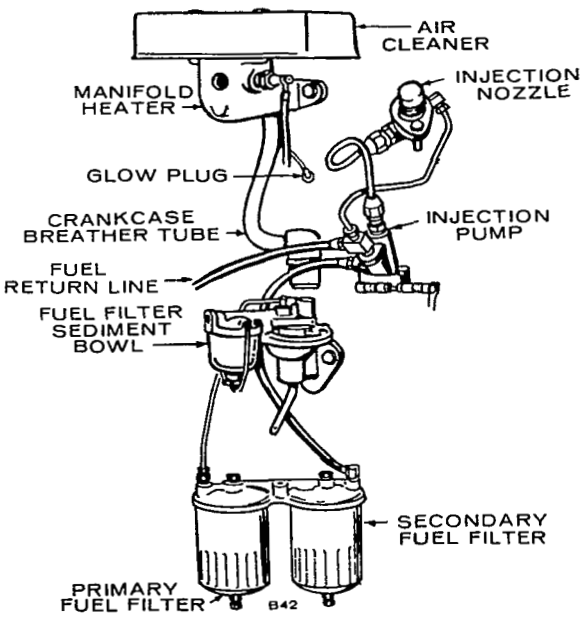


FIGURE 4. FUEL SYSTEM

BATTERY

Mount the batteries on a wood or metal rack near the engine. Air circulation around the battery is essential. Use number 2 battery cables of the proper length to limit voltage drop.

BATTERY CONNECTIONS

Batteries for engines equipped with optional flywheel alternators must be negatively grounded. A 30 amp fuse protects the rectifier should the battery be connected with reverse polarity (Figure 6). On early models without fuse, destruction of the rectifier will result.

Connect the remaining battery cable to the larger terminal on the starting motor solenoid (Figure 5)

OIL DRAIN EXTENSION

For service convenience, install an oil drain extension made from standard pipe and fittings, in the 1/2-inch pipe tapped oil base drain hole.

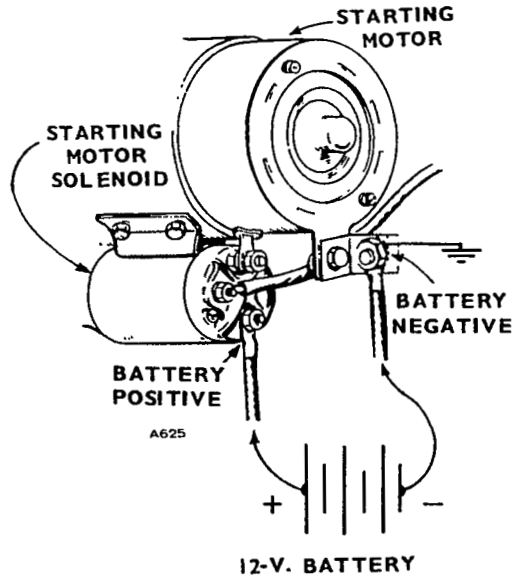


FIGURE 5. SOLENOID WIRING

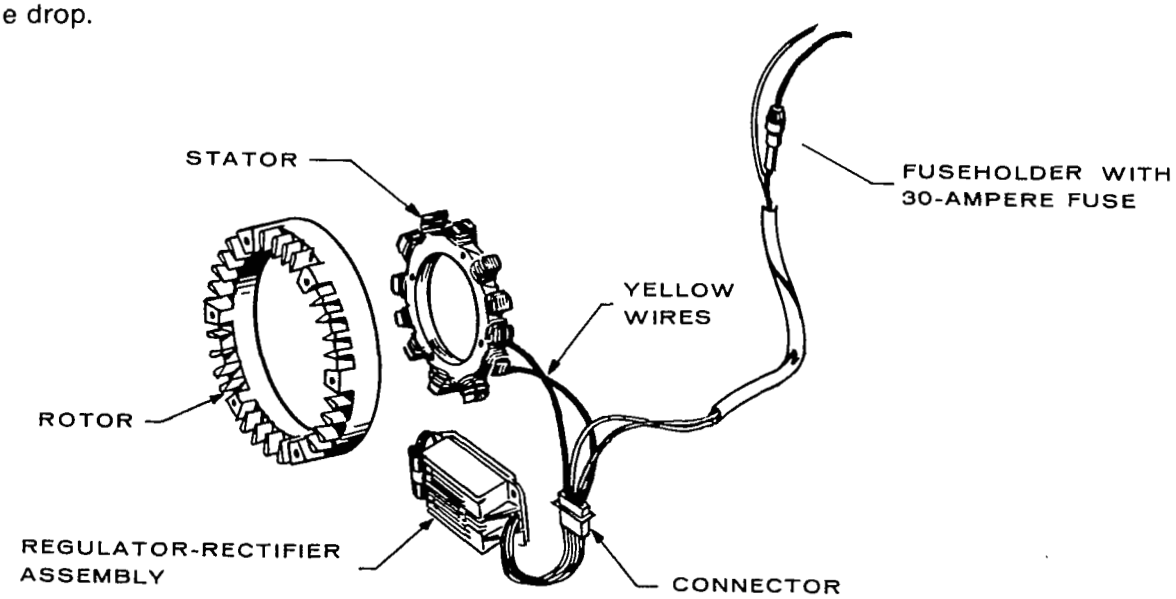


FIGURE 6. FLYWHEEL ALTERNATOR (BEGINNING WITH SPEC T)

OPERATION

CRANKCASE OIL

Use an oil with the API designation CD/SE or CD/SD. However, to reduce oil consumption to a normal level in the shortest time possible on a new or rebuilt engine, use CC oil for the first fill only (50 hours). Then use the recommended oil only. Select the correct SAE grade oil by referring to the following.

TEMPERATURE	GRADE
Above 30°F	SAE 30
0°F to 30°F	SAE 10W or 5W-30
Below 0°F	SAE 5W-30

Multigrade oils are recommended for temperatures of 30°F and below, but they are not recommended for temperatures above 30°F. When adding oil between oil changes, it is preferable to use the same brand as in the crankcase. Various brands of oil may not be compatible when mixed together.

If the oil supply in your local area still has the API designations ML, MM, MS, DC, DM and DS, use an oil with the DS designation which has passed the Series 3 Test and at least Sequence 1 of the Automotive Manufacturer's MS Sequence Tests. To reduce oil consumption to a normal level in the shortest time on a new or rebuilt engine, use DG or DM oil (passing the MS Sequence Tests) for the first fill only (50 hours). Then use the recommended oil. See *SERVICE AND MAINTENANCE* section for suggested oil changes.

OIL BATH AIR CLEANER (Optional)

Use the same grade of oil in the air cleaner as is used in the crankcase. The proper level is marked on the air cleaner.

RECOMMENDED FUEL

Use ASTM 2-D or 1-D fuel with a minimum Cetane number of 45*. Number 2 diesel fuel gives the best economy for most operating conditions; however, use ASTM 1-D fuel during the following conditions:

1. When ambient temperatures are below 32°F.
2. During long periods of light engine load; or no load.

***Fuels with Cetane numbers higher than 45 may be needed in higher altitudes or when extremely low ambient temperatures are encountered to prevent misfires.**

Use low sulfur content fuel having a pour point (ability to filter) of at least 10°F below the lowest expected temperature. Keep the fuel clean and protected from adverse weather. Leave some room for expansion when filling the fuel tank.

CAUTION **Due to the precise tolerances of diesel injection systems, it is extremely important the fuel be kept clean. Dirt in the system can cause severe damage to both the injection pump and the injection nozzles.**

INITIAL START

Check the engine to make sure it has been filled with oil and fuel. If necessary to prime a dry fuel system, return the priming lever to the disengaged position after priming. For more detailed starting information see Starting Guide, page 48.

This unit has been run and tested for approximately four hours at the factory. Additional break-in time is required and will vary depending upon load conditions, oil used, etc.

Run as follows:

1. No load ..... 15-20 minutes
2. One-third load ..... 30 minutes
3. Two-thirds load ..... 2 to 3 hours

Then regular operation can be resumed. Avoid light load operation during the following several hours for best ring seating to control oil.

STARTING

1. When starting a cold engine in ambients above 55°F, preheat for 20 seconds.
2. Continue to hold preheat switch:
   a. Push the fuel solenoid to its ON position.
   b. Press the START switch.
3. Release start switch after engine starts and reaches speed.
4. Oil pressure should read at least 20 psi. Pressure relief valve is not adjustable.

When starting at temperatures below 55°F, or under high humidity conditions, refer to suggested starting aids in *Low Temperatures* paragraph.

When restarting engine after short periods of shutdown, preheating is usually not necessary.

STOPPING

Disconnect as much load as practical from the engine before shutdown. Push the fuel solenoid switch to its OFF position (this de-energizes the solenoid, closing the throttle).

CAUTION **Carbon in the exhaust system will occur in diesel engines operated consistently at light loads. Occasionally operate engine at full load (or about five minutes before stopping) to clean out the exhaust system.**

APPLYING THE LOAD

Apply the load for new and reconditioned engines in four steps. Wait 30 minutes between each step. If practical, allow the engine to warm up before connecting a heavy load. Try to connect the load in steps instead of the full load at one time.

INSPECTION

Check for alignment of engine and load. Misalignment will cause excessive vibration and bearing wear. Make a visual inspection of the entire installation.

PROTECTION FOR EXTENDED OUT-OF-SERVICE PERIOD

1. Run engine until thoroughly warm.
2. Drain the oil base while still warm. Attach a warning tag to refill before operating.
3. Service the air cleaner.
4. Lubricate governor linkage. Protect from dirt by wrapping with a clean cloth.
5. Plug exhaust outlet to keep out moisture and dirt.
6. Clean entire unit. Coat parts likely to rust with light grease or oil.
7. Provide a suitable cover for the entire unit.
8. Disconnect battery and follow standard battery storage procedures.

HIGH TEMPERATURES

1. See that nothing obstructs air flow to and from the engine.
2. Be sure the room is properly ventilated.
3. Keep the cooling fins clean. See that air housings are properly installed and undamaged.

LOW TEMPERATURES

1. Use correct SAE No. oil for temperature conditions. Change oil only when engine is warm. If an unexpected temperature drop causes an emergency, move engine to a warm location or apply externally heated air until oil flows freely (do not use an open flame).
2. Preheat for one minute if the temperature is 55° F or lower. If engine fails to start after cranking for one minute, preheat for one minute more and reattempt the start. In extreme cold temperature it may be necessary to maintain preheating up to 2 minutes after the engine starts to sustain firing or to smooth out all cylinders, especially at no load or light loads.

CAUTION **Do not use preheat for more than one minute before cranking. This will help to prevent heater burn-out and conserve battery power.**

3. Protect fuel against condensation.
4. Keep batteries in a well-charged condition.
5. Reduce room ventilation, but use care to avoid overheating.

DUST AND DIRT

1. Keep engine clean.
2. Service air cleaner as often as necessary.
3. Change crankcase oil every 50 operating hours.
4. Keep oil and fuel supplies in dust-tight containers.
5. Keep governor linkage connections clean.

HIGH ALTITUDE

Maximum engine power will be reduced about 4 percent for each 1000 feet above sea level.

SERVICE AND MAINTENANCE

Before engine is put in operation, check all components for mechanical security. If an abnormal condition, defective part, or operating difficulty is detected, repair or service as required. See Figure 7 for service and maintenance instructions. The engine should be kept free of dust, dirt, and spilled oil or fuel. Be sure proper operating procedure is followed.

ENGINE ROUTINE CHECK CHART

WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS
Engine oil	Check level (should be at full mark on indicator).	Add oil as necessary to bring level to full mark. Do not overfill.
Engine fuel	Check level in tank.	See that fuel lines are properly connected.
Engine ventilation	Check ventilating openings.	Remove any obstructions.
Connecting cables	Check for proper connections. Check for physical damage.	Tighten connections. Replace damaged connectors.
Battery	Check electrolyte level.	Keep level above plates. Add only distilled water as necessary.

MAINTENANCE SCHEDULE

Use this factory recommended maintenance (based on favorable operating conditions) to serve as a guide to get long and efficient engine life. Neglecting routine maintenance can result in failure or permanent damage to the engine.

Maintenance is divided into two categories: (1) Operator Maintenance — performed by the operator, and (2) Critical Maintenance — performed by qualified service personnel.

OPERATOR MAINTENANCE SCHEDULE

MAINTENANCE ITEMS	OPERATIONAL HOURS					
	8	50	100	200	600	3000
Inspect Engine	x					
Check Fuel	x3					
Check Oil Level	x					
Check Exhaust System	x					
Check Air Cleaner		x1				
Clean Governor Linkage			x1			
Change Crankcase Oil			x1-2			
Drain Condensation Traps			x3			
Check Battery				x		
Replace Oil Filter				x1		
Clean Crankcase Breather				x		
Change Primary Fuel Filter					x3	
Change Sec. Fuel Filter						x

CRITICAL MAINTENANCE SCHEDULE

MAINTENANCE ITEMS	OPERATIONAL HOURS			
	500	1000	2000	5000
Check Valve Clearance	x4			
Replace Secondary Fuel Filter		x3		
Clean Engine		x		
Clean Rocker Box Oil Line Holes			x	
Inspect Valves; Grind if Necessary			x	
Remove and Clean Oil Base			x	
Check Injection Nozzles			x6	
General Overhaul				x5

x1 - More often under extremely dusty conditions.

x2 - CD/SD or CD/SE oil preferred. Use CC oil first 50 hours for break-in.

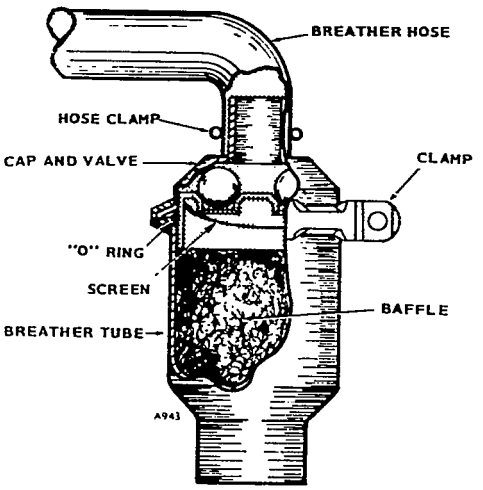
x3 - Water or foreign material in the fuel can ruin the injection system. If daily inspection shows water or excessive dirt in primary filter bowl, fuel handling and storing facilities should be checked and situation corrected. Primary fuel filter must be cleaned and secondary fuel filter replaced following correction of fuel contamination problem.

x4 - Tighten head bolts and adjust valve clearance after first 50 hours on a new or overhauled engine.

x5 - Or as required.

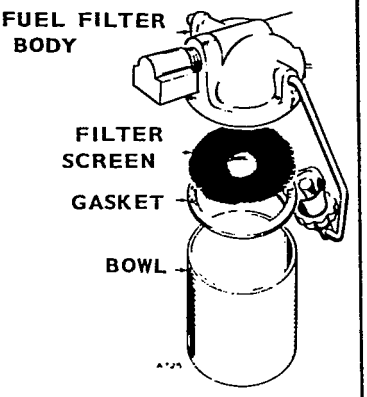
x6 - This service must be performed by trained diesel injection equipment personnel with suitable test facilities. Omit this service until these conditions can be met.

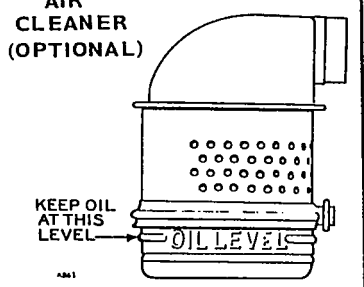
For any abnormalities in operation, unusual noises, loss of power, overheating, etc., contact your Onan dealer.

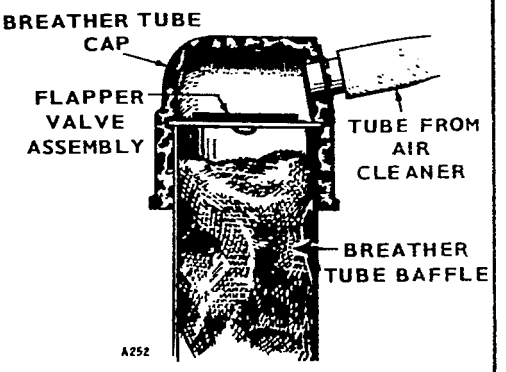


CRANKCASE BREATHER
Beginning Spec R

Remove hose clamp, breather hose, insulator clamp, insulator halves, and breather cap clamp. Wash cap, valve assembly, and baffle in suitable solvent and reinstall.





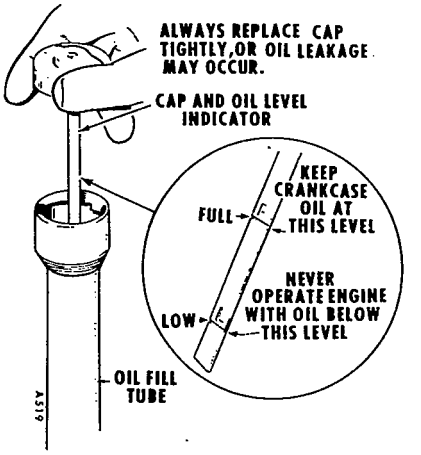


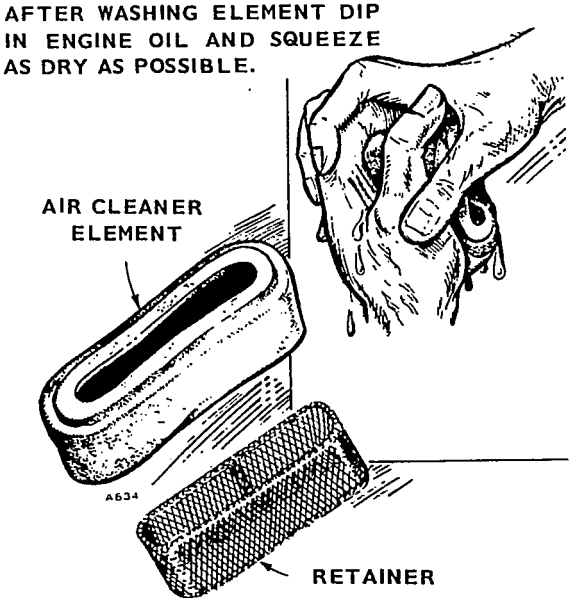
CRANKCASE BREATHER
Prior to Spec R

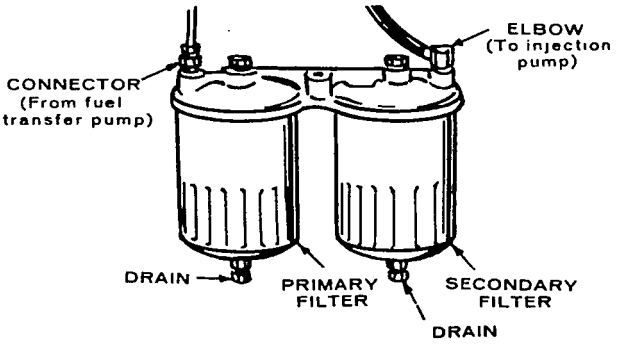
Remove breather cap. Remove valve from cap. Wash valve in a suitable solvent. Dry and install with perforated disc toward engine. If faulty, install new valve.

OIL FILTER CHANGE
(See Schedule)

Place pan under old filter and remove by turning counterclockwise. Clean filter mounting area. Install new filter; oil filter gasket and screw filter on clockwise until gasket touches mounting base, then tighten 1/2 turn.







MODELS BEGINNING WITH SPEC S

Drain water periodically as required from both filters and sediment bowl. Replace primary filter every 600 hours and secondary filter every 3000 hours. When replacing filter, tighten screw until gasket touches base, then tighten screw 1 to 1-1/2 turns.

FIGURE 7. MAINTENANCE PROCEDURES

COOLING SYSTEM

To remove heat produced during operation, engines use a pressure air-cooling system. Blades on the engine flywheel draw air in the front of the engine housing, force the air past the cylinder and out the right side of the engine. See Figure 8.

From the engine outlet, air can be ducted out of the area. To improve engine temperature control, an optional shutter assembly can be installed on the air outlet. See Figure 9.

MAINTENANCE

With a properly installed engine, maintenance should consist of cleaning the engine cooling area (fins on cylinder block and cylinder head) at regular intervals, normally every 1000 hours but more often under dirty operating conditions.

OVERHEATING

This is sometimes difficult to discover in an air-cooled engine. However, the first sign is usually engine losing speed momentarily or low engine power. This happens before the engine seizes and results in a scored piston.

The most probable causes of overheating are dirty cooling surfaces, operating without the engine air housing, poor air circulation, improper lubrication, wrong injection timing and engine overload.

CAUTION **The air housing including the door must be on when operating the engine. Overheating and permanent damage could result from as little as one minute of operation without it.**

Common installation problems leading to overheating are as follows:

1. Installation with duct size too small so air flow is insufficient.
2. Installation in small room with no ducts and insufficient air ventilation in the room.
3. Installation of air inlet and outlet ducts so air outlet feeds back to the inlet.

AIR SHUTTER (Optional)

The optional air shutter assembly is mounted at the engine air outlet, on the right side of the cylinder shroud. A thermostatic element (Figure 10) controls the shutters so they close and limit air flow when the air temperature reaches 120° F. The power element plunger begins to move outward, opening the shutters until they are completely open by 140° F.

Shutter opening temperature is not adjustable, but to assure complete opening, the power element plunger must contact the shutter roll pin at room temperature. To adjust this, loosen the power element mounting screws and slide the assembly until it touches the roll pin with the shutter closed.

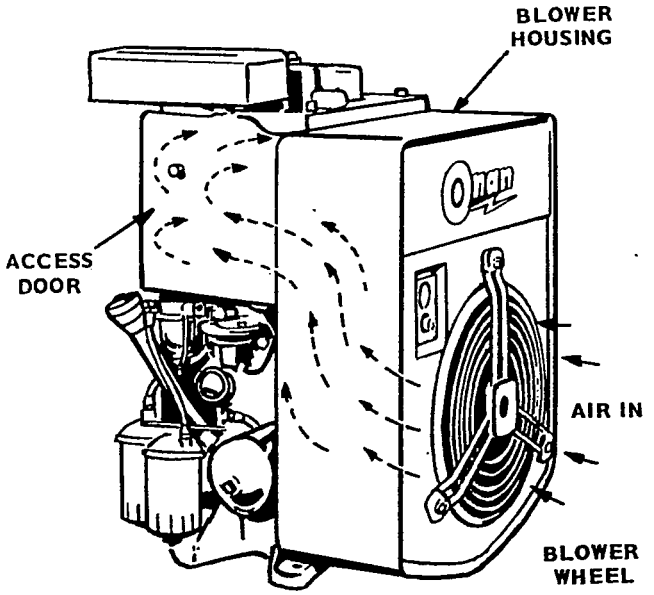


FIGURE 8. COOLING AIR FLOW

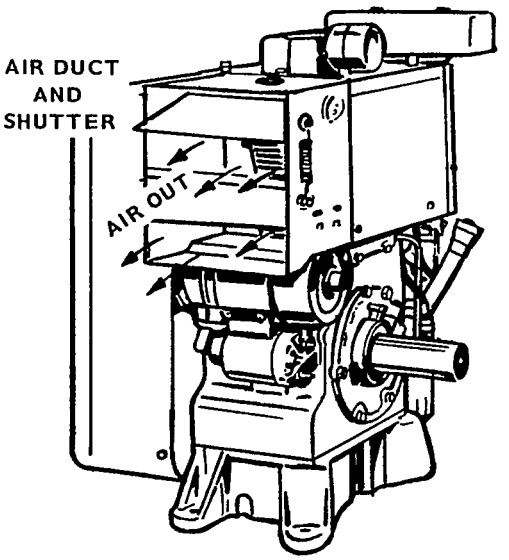


FIGURE 9. AIR DUCT AND SHUTTER

Repair

If the shutter will not open, check the power element for defects or binding of the plunger. Be sure the shutter does not bind against the housing in any position.

To test the power element, remove it from the assembly and heat it. When the unit reaches about 120°F, the plunger should start to move out. Total movement should be at least 1/5-inch. Do not overheat.

If the unit will not close, check for a weak return spring, binding in the nylon bearings or dirt in the power element plunger. If the nylon bearings are worn or bind, replace them. Remove the shutters and pull out the stub shaft. Push out the old and push in new bearings from the inside of the shutter housing. The large bearing surface serves as a spacer bushing so it must be on the inside of the housing. The shutters should be adjusted to obtain an end thrust clearance of not more than 1/32-inch.

HIGH TEMPERATURE CUT-OFF

When optional automatic air discharge shutter is used, it is recommended that the shutter include a high temperature cut-off switch. This switch protects the engine if shutter fails to open. The switch is in series with the governor solenoid. Switch is normally closed and opens at about 240°F. When it opens, the solenoid is de-energized, stopping the unit. The switch closes again at about 195°F.

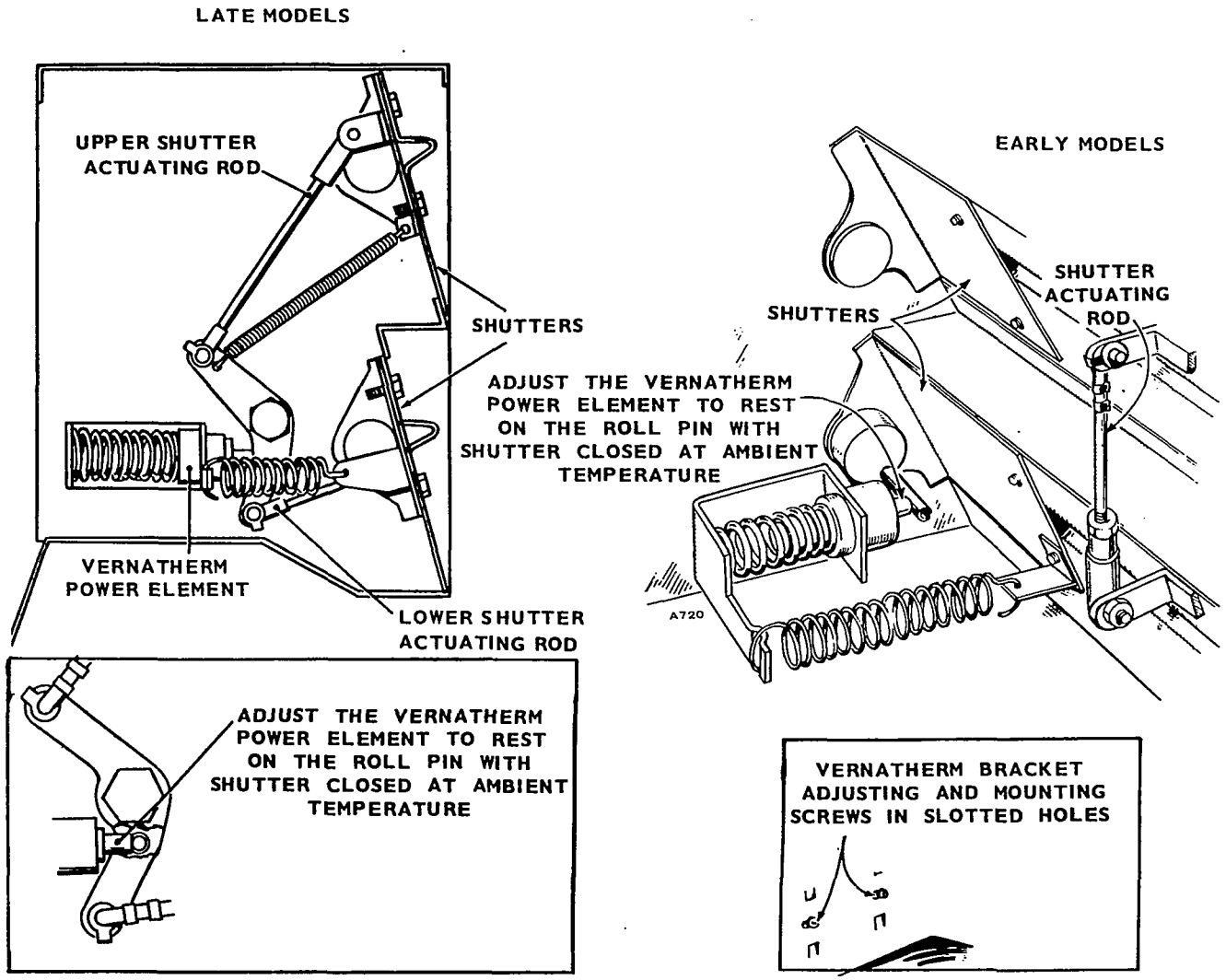


FIGURE 10. AIR SHUTTER

FUEL SYSTEM

The diesel fuel system provides a means of filtering, transporting and delivering fuel in a fine spray to the engine cylinder at the correct time for ignition. The system consists of a primary fuel filter, fuel transfer pump, secondary fuel filter, injection pump and an injection nozzle. See Figure 11.

The diaphragm fuel transfer pump which operates directly off the engine camshaft, draws fuel from a supply tank and delivers it through two filters to the injection pump. The injection pump meters fuel and delivers it, at high pressure to the injection nozzle at the correct time for ignition.

The injection nozzle opens at a set fuel pressure, delivering fuel in a fine spray, to the precombustion chamber for ignition. The nozzle remains open, delivering fuel as long as the fuel pressure remains above the critical point.

Extra fuel is bled off after each injection cycle by a fuel return line from the nozzle. An adapter combines the return fuel with the flow-through fuel from the injection pump. A return line connected at this point, returns the combined fuel back to the fuel supply tank.

CAUTION **Dirt in the fuel system is a diesel engine's worst enemy. It is one of the major causes of diesel engine failure. Even a tiny piece of dirt in the injection system may stop your unit. When opening any part of the fuel system beyond the secondary fuel filter, place all parts in a pan of clean diesel fuel as they are removed. Before installing new or used parts, flush them thoroughly and install while still wet.**

MAINTENANCE

In addition to regular service periods, change the secondary fuel filter cartridge if the engine shows signs of starving from lack of fuel. Remove the secondary filter by removing the large cap screw in the center of the filter cover. Use care when replacing the filter cartridge to avoid getting dirt into the injection pump passages.

When replacing or cleaning filters, bleed the fuel system. Do this by opening the air bleed screw located on top of the secondary filter removal cap screw. Operate the hand priming lever on the transfer pump until no air bubbles flow from the bleed screw hole, then tighten the bleed screw. Return the priming lever to its original position. See Figure 12.

If the transfer pump cam lobe is on the high side, the priming lever will not operate the pump. Turn the engine one revolution before operating the priming lever.

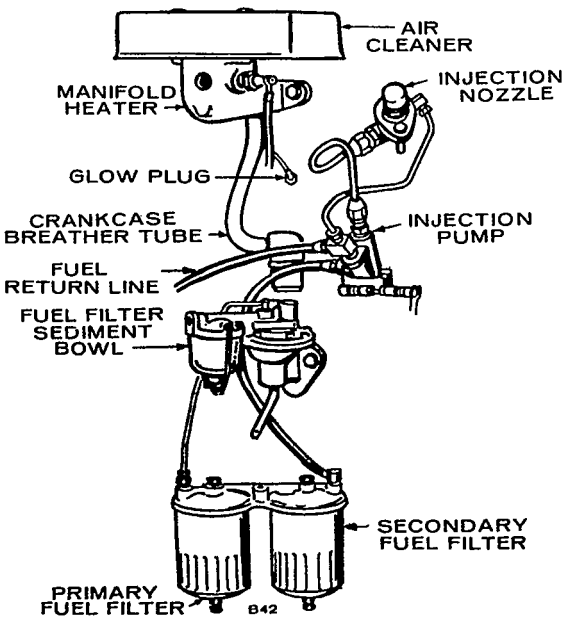


FIGURE 11. DIESEL FUEL SYSTEM (BEGINNING WITH SPEC S)

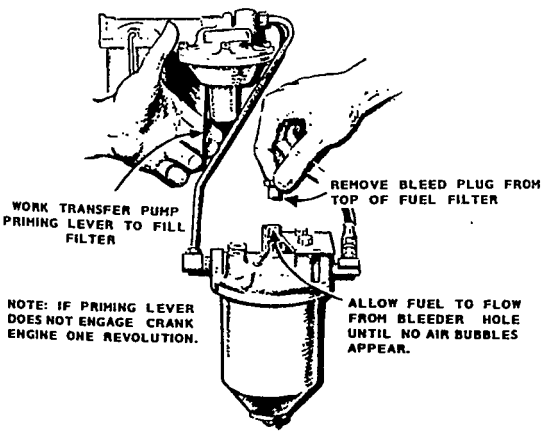


FIGURE 12. BLEEDING FUEL SYSTEM (PRIOR TO SPEC S)

FUEL TRANSFER PUMP

The transfer pump is located on the left side of the engine. If fuel does not reach the secondary filter, make the following checks before removing the pump.

1. Check the fuel tank and see that the shutoff valve is open.
2. Remove the fuel line from the transfer pump outlet and work the priming lever on the pump. Fuel should spurt out of the pump. If not, remove the pump for repair or replacement.

Testing

If the transfer pump delivers fuel, test it with a pressure gauge or manometer. Perform these tests before removing the pump from the engine. Remove the pump outlet and install the pressure gauge. See Figure 15.

Test the valves and diaphragm by operating the primer lever a few times and watching the pressure. It should not drop off rapidly after priming has stopped.

Next run the engine at governed speed on fuel provided by gravity feed and measure the fuel pump pressure developed. Pressure should be between 5 and 6 psi with the gauge 16 inches above the fuel pump.

A low pressure reading indicates extreme wear in one part or some wear in all parts, and the pump should be overhauled or replaced. If the reading is above maximum, the diaphragm is probably too tight or the diaphragm spring too strong. This can also be caused by fuel seeping under the diaphragm retainer nut and between the diaphragm layers, causing a bulge in the diaphragm. Overhaul the pump and replace the defective parts. See Figure 16.

Low pressure with little or no pressure leak after pumping stops indicates a weak or broken spring or worn linkage and in most cases the pump should be replaced.

Repair

Transfer pump failure is usually due to a leaking diaphragm, valve or valve gasket. A kit is available for replacement of various parts. Because the extent of wear cannot be detected by the eye, replace all parts in the kit. If the diaphragm is broken or leaks, check for diluted crankcase oil and replace.

Occasionally, failure is due to a broken or weak spring or wear in the linkage. In this case, replace the worn parts or install a new pump. Obtain replacement parts or install a new pump. Obtain replacement parts other than the repair kit from an original equipment parts distributor.

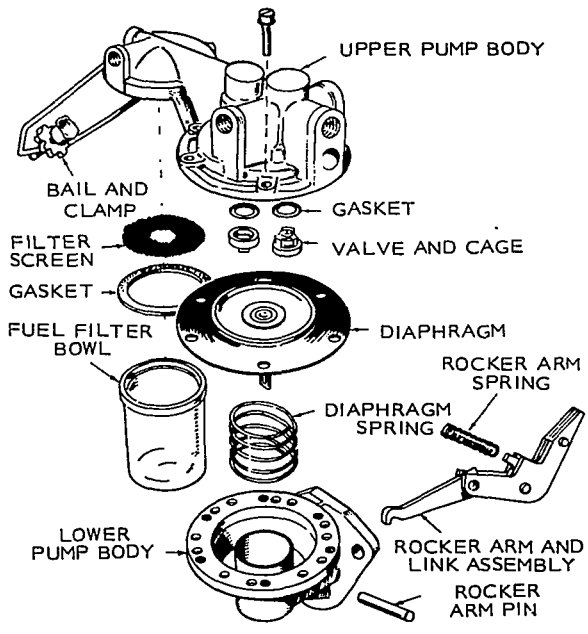


FIGURE 13. EXPLODED VIEW OF J-SERIES PUMP

Fuel Pump Removal
Disassembly

1. After the pump is removed from the engine, scribe a line on the flanges of the upper and lower pump bodies to assure correct positioning when reassembling.
2. Remove the securing screws and separate the upper and lower pump bodies (Figure 13).
3. To release the pump diaphragm, press down on the base of the diaphragm at the edge farthest from the pump mounting flange. Without releasing this edge, press down on the opposite edge. This action will unhook the diaphragm actuating rod from the rocker arm link (Figure 14).
4. With the aid of a pliers or screwdriver, push and tip the rocker arm return spring off the catch on the rocker arm and remove from pump.
5. Clean and inspect all pump components not included in the repair kit. If damage is apparent, replace the pump.

The valve and cage assemblies on the J series pump are permanently mounted in the upper body of the pump. If the assemblies are damaged or noticeably worn, the entire pump must be replaced.

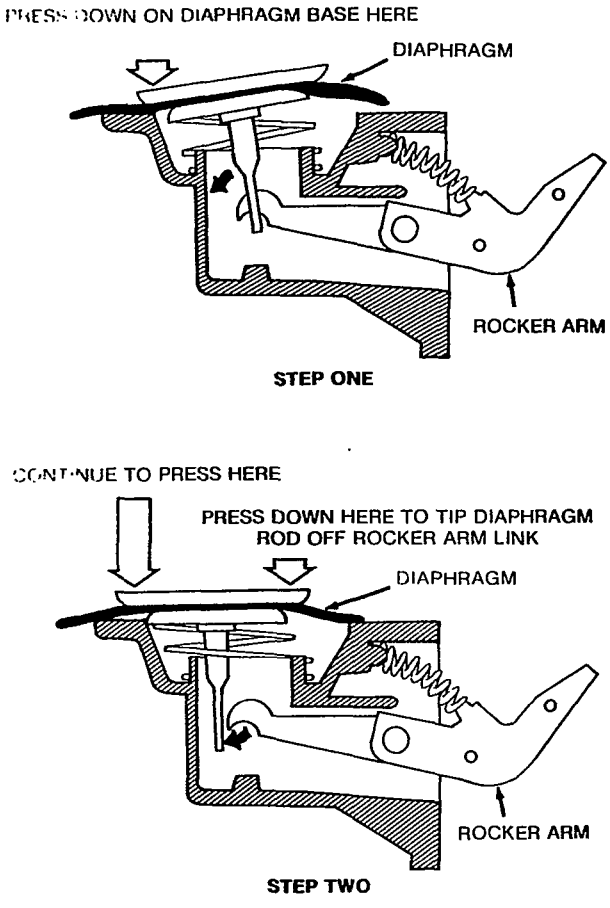


FIGURE 14. REMOVAL OF J-SERIES DIAPHRAGM ASSEMBLY

Assembly

1. Lubricate the diaphragm actuating rod and install the new diaphragm in the pump. Reverse the procedure used for removal, rolling back the diaphragm fabric to view the rocker arm link (Figure 14). Hold the pump body upside-down so that the weight of the link will keep it within reach of the diaphragm actuating rod.
2. Install the new rocker arm return spring.
3. Place the upper and lower bodies of the pump together with the scribe marks aligned. Start the six securing screws, making sure they do not chew into the diaphragm fabric. Leave the screws 2 or 3 turns loose.
4. Operate the rocker arm several times to fully flex the new diaphragm. While holding the rocker arm fully flexed, tighten the securing screws.

CAUTION **Failure to fully flex the rocker arm while tightening the pump bodies together will result in excessive pump pressure and possible engine flooding or pump diaphragm failure.**

NOZZLE

The injection nozzle is the conventional inward opening pintle type with adjustable opening pressure. It is factory adjusted to open at 1900 to 1950 psi. After several hundred hours of operation the nozzle pressure will decrease to approximately 1750 psi. Do not disassemble the nozzle or adjust nozzle pressure without proper test equipment. A nozzle pressure tester is essential to do this work.

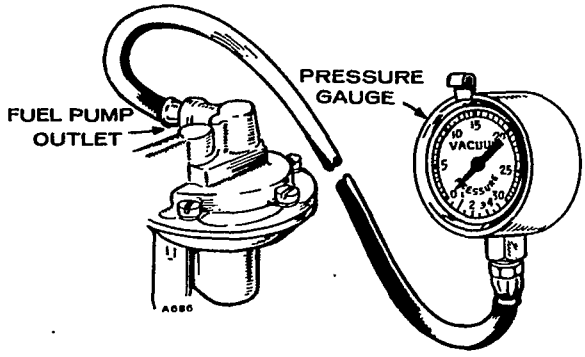


FIGURE 15. FUEL PRESSURE GAUGE

Inspection

To inspect the nozzle spray pattern, remove the nozzle from the cylinder head. Crank the engine, let the nozzle spray into the air and watch the pattern. The spray should be cone shaped with a solid appearing center surrounded by cloudlike fog in which the spray is evenly atomized. See Figure 17. An apparent chattering of the nozzle is normal.

If streamers are visible, the pattern is badly distorted or the nozzle drips before it reaches opening pressure, it is defective and must be cleaned or replaced.

WARNING **Do not let the nozzle spray against your skin. The fuel can penetrate flesh and cause a serious infection.**

Adjustment

To adjust the opening pressure, remove the nozzle from the engine. Remove the cap nut over the adjusting screw of the nozzle and install the nozzle on a static fuel nozzle testing fixture (may be purchased from Onan). Following the tester instructions, adjust the opening pressure to 1750 psi by turning the adjusting screw. See Figure 18. Clockwise increases the pressure and counterclockwise decreases it. *Do not* try to adjust the pressure without a testing fixture.

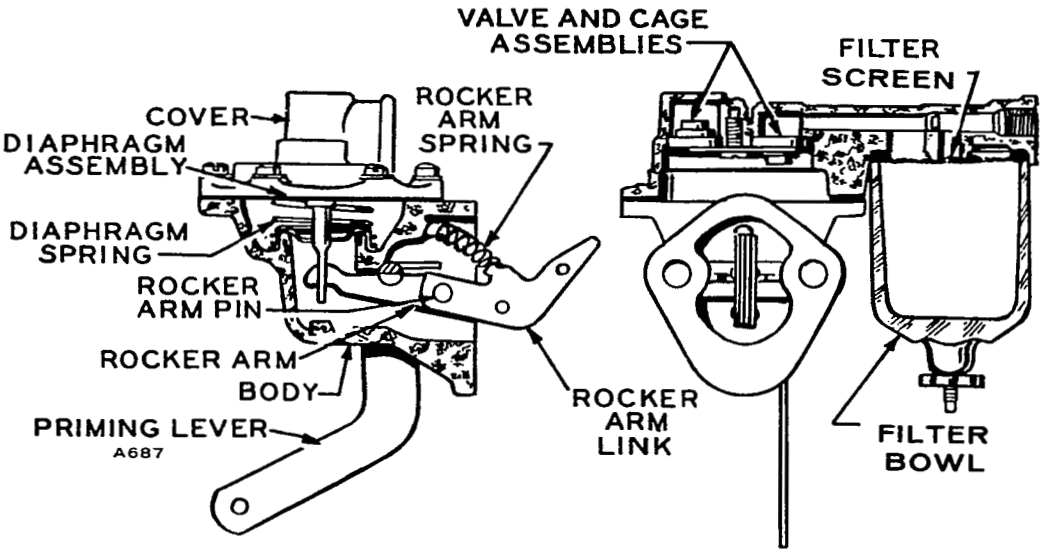


FIGURE 16. FUEL TRANSFER PUMP

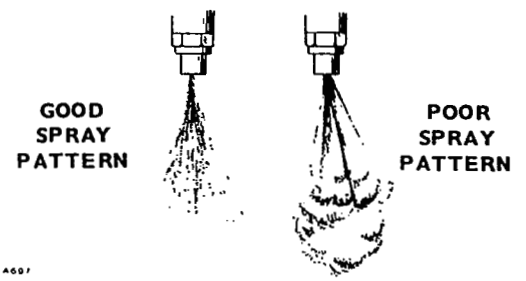


FIGURE 17. NOZZLE SPRAY PATTERN

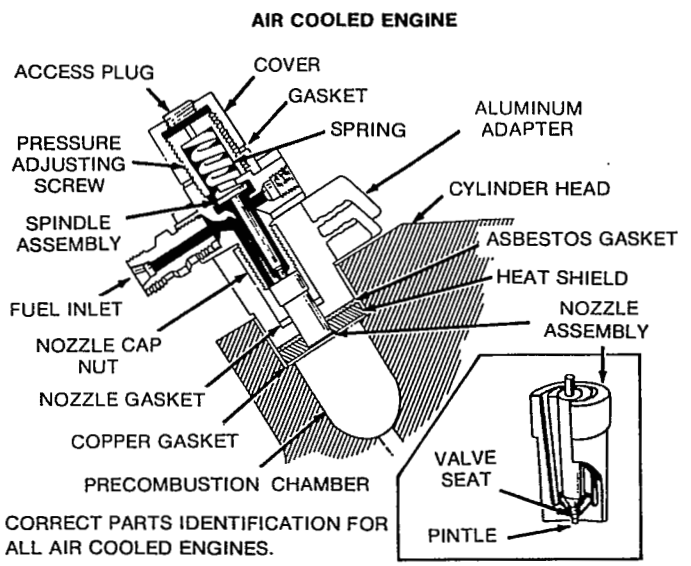


FIGURE 18. NOZZLE ASSEMBLY

Disassembly

When removing and disassembling nozzles, separate and label all nozzle components. Never interchange components between nozzles.

1. Remove nozzle assembly from the engine and remove the fuel inlet and return lines.
2. Clamp the nozzle holder body in a vise and remove the nozzle cap nut and nozzle.
3. Install the nozzle cap nut loosely to protect the lapped surface for the holder body.
4. If necessary to further disassemble the nozzle, reverse the pressure adjusting screw and lift out the spring and spindle assembly.

Cleaning

The most important part of nozzle cleaning is cleanliness.

Work only in a clean room, on a clean work bench. Keep a pan of diesel fuel handy and have a supply of clean, lint-free wiping rags.

Onan offers a kit to aid nozzle cleaning. See *SPECIAL TOOLS* section.

Never use hard or sharp tools, emery paper, grinding powder or abrasives of any kind.

Soak each nozzle in fuel to loosen dirt. Then clean the inside with a small strip of wood soaked in oil and the spray hole with a wood splinter. If necessary, clean the outer surfaces of the nozzle body with a brass brush but do not attempt to scrape carbon from the nozzle surfaces. This can severely damage the spray hole. Use a soft oil-soaked rag or mutton tallow and felt to clean the nozzle valve.

Repair

If cleaning will not eliminate a nozzle defect, replace the nozzle or take it to an authorized service station. Do not attempt to replace nozzle parts except for the nozzle and pintle assembly.

Assembly

Rinse both the valve and nozzle thoroughly before assembly and coat with oil. The valve must be free in the nozzle. Lift it about 1/3 way out of the body. It should slide back to its seat without aid when the assembly is held at a 45-degree angle. If necessary, work the valve into its body with clean mutton tallow.

1. Remove all pressure on the nozzle spring by adjusting the pressure adjusting screw.
2. Clamp the nozzle holder body in a vise.
3. Set the valve in the body and set the nozzle over it.
4. Install the nozzle cap nut loosely.
5. Place the centering sleeve over the nozzle (Figure 19) for initial tightening. Then remove the centering sleeve to prevent it from binding between nozzle and cap nut and torque nozzle cap nut to 50-55 foot-pounds.

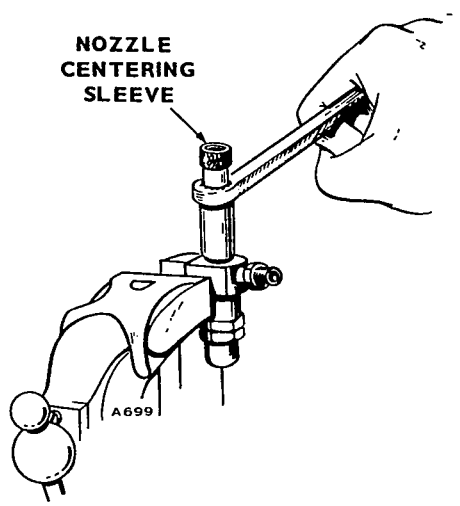


FIGURE 19. TIGHTENING NOZZLE CAP NUT

Installation

Before installing the injection nozzle in the engine, thoroughly clean the mounting recess.

A dirty mounting surface could permit blow-by, causing nozzle failure and a resulting power loss.

1. Install a new heat shield to head gasket in the cylinder head recess.
2. Install the heat shield, a new nozzle gasket and the nozzle adapter.
3. Insert the nozzle assembly into the recess. Do not strike the tip against any hard surface.
4. Install the nozzle flange and two cap screws. Tighten the cap screws alternately to avoid cocking the nozzle assembly. Tighten each cap screw to 20-21 foot-pounds.

PREHEATING CIRCUIT

This circuit consists of a manifold heater to heat the engine intake air in the intake manifold and a glow plug to heat the precombustion chamber. Used for engine starting, the manifold heater and glow plug are wired in parallel and controlled by a preheat switch.

Check the heater by removing its lead, operating the preheat switch, and touching the lead to its terminal. If it sparks, there is continuity and the heater is working. If any components of this circuit fail, replace them. Do not attempt repairs on individual components. If there is still a question, check the component for heating.

DECOMPRESSION MECHANISM

Before adjusting the decompression mechanism, valves must be set for correct clearance. After checking valve clearance, leave the flywheel at 10 to 45 degrees ATC with piston on power stroke so the exhaust valve will have its maximum clearance when adjusting the decompression mechanism. See Figure 20.

Set the arm in the decompression position (tension against release spring). Turn the setscrew so the end just touches the exhaust rocker arm. Be sure the decompression release arm is up right against the lock ring. Then turn the screw exactly one revolution clockwise.

If the screw is tightened more than one turn, the exhaust valve could hit the piston.

Hold the setscrew and tighten the lock nut 1/4 to 1/2 turn past finger tightness.

Release the mechanism to allow compression. Check the clearance between the screw and rocker arm. Take up valve clearance by inserting a feeler gauge between the valve and rocker arm. If the setscrew does not clear the rocker arm, loosen the lock nut and back off the screw until clearance is obtained.

When assembling the rocker box cover, remove the solenoid and remount it when the cover is on the engine.

INJECTION PUMP

The single outlet pump is mounted on the left side of the engine crankcase. The camshaft operates the pump plunger producing pressure to deliver fuel and open the injection nozzle. A helix in the pump meters fuel by controlling the length of time the plunger part is closed in each stroke.

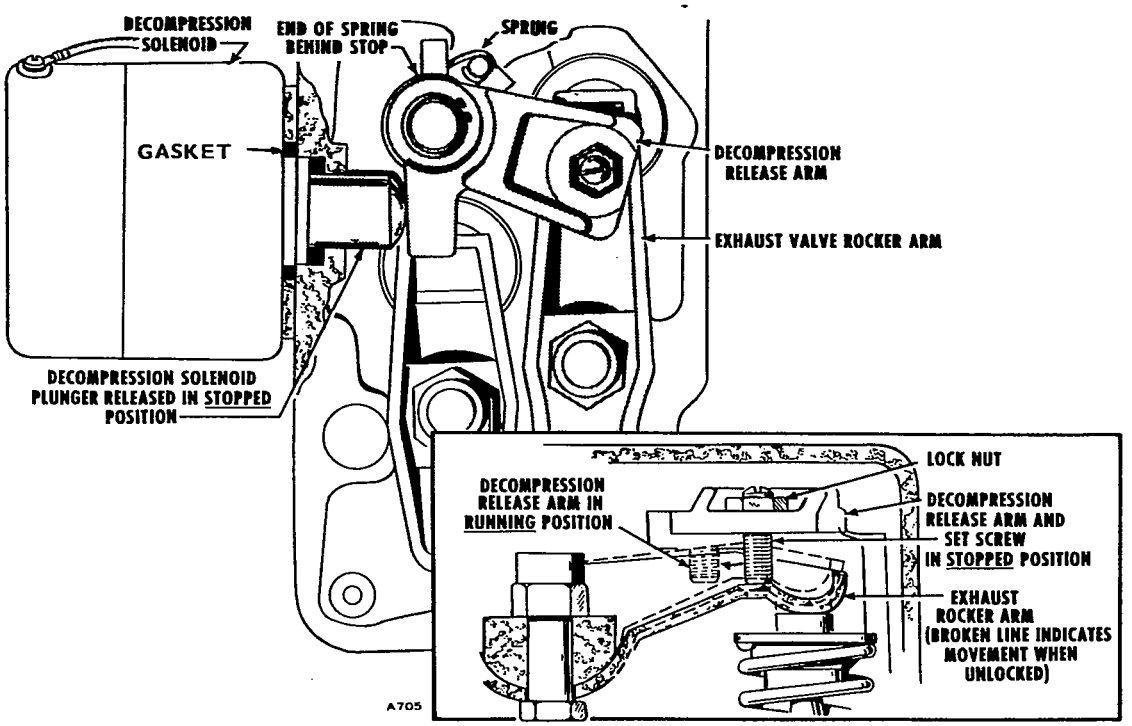


FIGURE 20. DECOMPRESSION MECHANISM

Timing the pump to the engine determines the port closing point (17 degrees BTC) PC mark on flywheel. See Figure 21. The helix position controls port opening and is, in turn, controlled by the throttle setting.

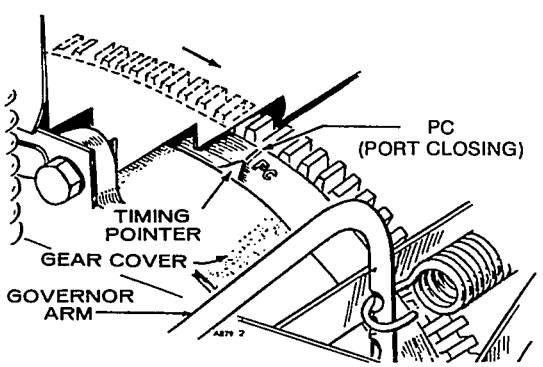


FIGURE 21. INJECTION PUMP TIMING

Repair

Most fuel system troubles are not due to a faulty injection pump. Test the rest of the fuel system before condemning the injection pump.

Onan discourages field repair of the injection pump because of the exceptionally close tolerances between parts and the specialized equipment necessary for repair. The injection pump is an expensive part of the unit and even a particle of dirt as fine as talcum powder could score its working surfaces. If the rest of the fuel system is in working order and fuel delivery is abnormal, remove the pump for replacement or repair.

Removal

Remove the pump inlet and outlet lines. Remove the two capscrews holding the pump to the engine and lift it off. Don't lose the shims. They time the injection pump to the engine. Cap all openings in the pump and fuel lines to keep dirt out of the fuel system.

Timing

Pump timing procedures determine the correct thickness of shims between pump and engine so port closing occurs at 17 degrees BTC.

The most accurate method of injection pump timing is with a depth micrometer (*Method 1*). However, if a depth micrometer isn't available, time it by *Flowing the Pump* (*Method 2*).

Injection pump must be timed on the compression stroke, not the exhaust stroke.

METHOD 1.
DEPTH MICROMETER METHOD

1. Install pump tappet in its recess and position flywheel on the port closing mark (PC) of the compression stroke.
2. Using a depth micrometer, measure the distance from the pump mounting pad on the crankcase to the tappet center. See Figure 22.
3. Subtract from the port closing dimension of the pump (1.670-inch) the depth obtained in step 2. The result is the thickness of shims necessary to correctly time the pump.

   Thickness of shims may vary from 0.006-inch to 0.052-inch. If it does not fall within these limits, check camshaft and tappet for excess wear or improper assembly.

4. Select the correct shims for the required thickness.
5. Install the pump.

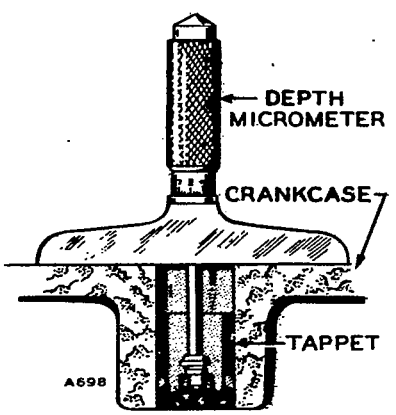


FIGURE 22. DEPTH MICROMETER

METHOD 2.
FLOWING THE PUMP

1. Install pump with 0.006-inch shims between pump and pad.
2. Loosen the delivery valve holder to relieve pressure on spring. See Figure 23.
3. Rotate the flywheel to about 15 degrees before the port closing (PC) point. Blow in the pump inlet and rotate the flywheel slowly clockwise until air stops coming out of the pump outlet. This is the port closing point.
4. Measure the distance from the point where port closing occurs to the PC mark on the flywheel. Find the thickness of shims to be added from the table that follows.
5. Install the pump.

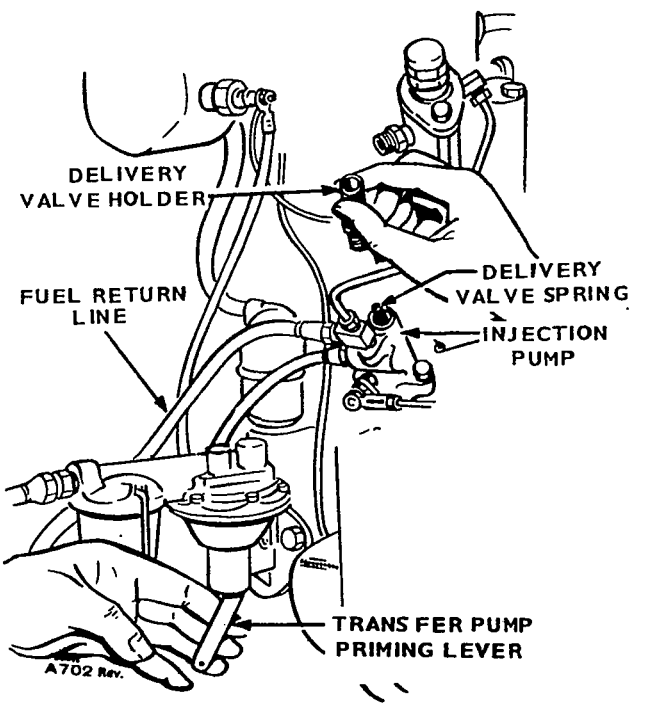


FIGURE 23. LOOSENING DELIVERY VALVE HOLDER

INSTALLATION: Prior to mounting the injection pump to the cylinder block follow steps 1 through 3.

1. Slide the shim or shims (using proper thickness of shims for correct timing) over the pilot until they are flat on the pump flange. See Figure 24.
2. Dip the seal ("O" ring) in engine lubricating oil.
3. Slide the seal over the pilot until tight against the shim or shims.

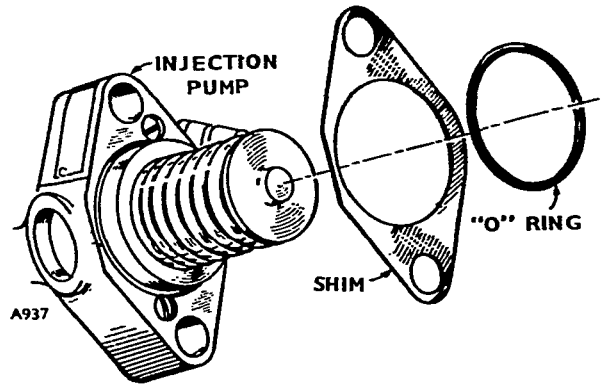


FIGURE 24. SHIMMING THE PILOT

With shims and seal in place insert the pump into cylinder block mounting pad, and insert mounting screws. Torque the mounting screws (tighten alternately) to 18-21 foot-pounds.

Install the fuel inlet line and governor linkage. Bleed the pump and then install the fuel outlet line (see *INSTALLATION* section).

SHIM SELECTION

USE THIS CHART WITH METHOD 2. (All dimensions are in inches)			
DISTANCE MEASURED STEP 4	ADD THESE SHIMS	DISTANCE MEASURED STEP 4	ADD THESE SHIMS
0.1	0.010	0.7	0.034
0.2	0.014	0.8	0.038
0.3	0.018	0.9	0.042
0.4	0.022	1.0	0.046
0.5	0.026	1.1	0.050
0.6	0.030		

GOVERNOR SYSTEM

The purpose of the governor is to maintain a constant engine speed during changes in power demands. A governor responds to changes by varying the throttle position. Three types of governors are used: The constant speed governor which is standard, the two-speed, and variable speed governors which are optional.

GOVERNORS

The constant speed governor (Figure 25) maintains engine speed up to 2400 rpm. The speed sensing device is a ball and cup mechanism on the camshaft gear. A yoke, resting on the cup, is connected to the governor arm, which in turn is connected to the throttle lever. Any change in engine speed is transmitted from the cup to the yoke, and onto the throttle.

Tension on the governor spring determines the speed at which the engine is governed. The position of the spring loop on the governor arm determines the amount of leverage the spring exerts on the arm to obtain the desired sensitivity. For engines prior to Spec R refer to Figures 25 and 26 for adjustment. For engines beginning with Spec R, refer to Figure 27.

Two-speed and variable-speed Onan governors are basically similar to the constant speed type. The difference is a second spring, riding in a sleeve, connected to the governor arm. It is completely relaxed during low speed operation, but combines with the constant (or low) speed spring when brought into play by either manual or solenoid control to exert a greater than normal force on the governor arm. If a ratchet lever is used to control high speed, the system is variable in nature. See Figure 26. The low speed adjustments are the same as the constant speed adjustments. High speeds of solenoid controlled two-speed systems can be adjusted by changing the length of the solenoid rod.

GOVERNOR SPRING DATA

GOVERNOR TYPE	SPRING NO.	SPRING RATE	COIL NO LOAD LENGTH	ACTIVE COILS
Constant	150-0821	—	1-3/8"	13-3/4
†Variable or 2 Speed	150-0919	25#/inch	1-1/4"	18
*2 Speed	150-0920	15#/inch	2-3/32"	30

* = 1800 rpm and † = 2400 rpm.

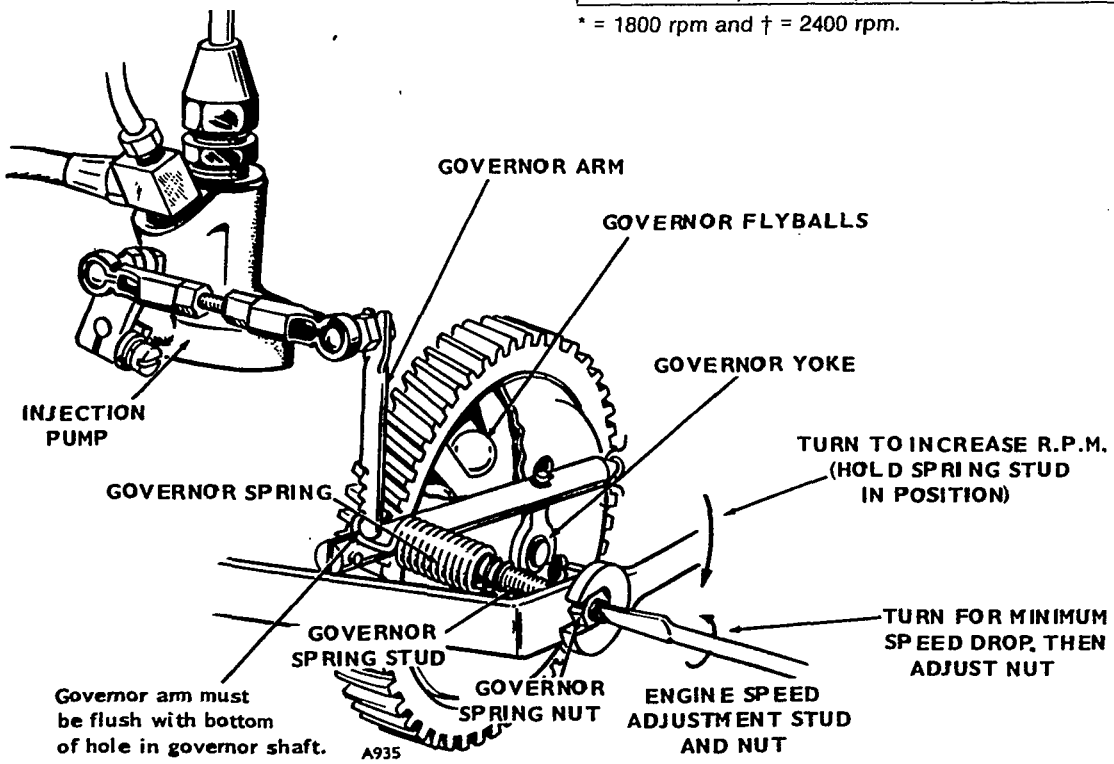


FIGURE 25. GOVERNOR ASSEMBLY (PRIOR TO SPEC R)

Maintenance

Linkage must be able to move freely through its entire travel. Periodically lubricate the ball joints with graphite or light non-gumming oil and inspect the linkage for binding, excessive slack, and wear. Plastic ball joints do not require lubrication.

Testing and Repair

Removing the gear cover for access to the governor cup and other internal governor parts is covered in *ENGINE DISASSEMBLY* section. External service and repair is limited to testing spring tension and checking ball joints.

To test spring rates, use a spring type scale. Compare the measured rates with those in the table.

Adjustments

Speed and sensitivity adjustments for both types of governors are made at the same place and in the same manner. Refer to the illustrations and the appropriate procedures.

Speed

Change spring tension with the speed adjusting nut while holding the sensitivity stud in place with a screwdriver. More tension gives more speed.

To adjust the high speed of solenoid controlled two-speed governors, change the tension on the high speed spring by adjusting the length of the solenoid rod. Shorten the rod to increase tension and speed.

Sensitivity

Models prior to Spec R (Figure 26). There are coarse and fine adjustments for sensitivity. The coarse adjustment is made by relocating the spring in the notches in the governor arm. Moving the spring up the governor arm will decrease sensitivity. Fine adjustment is made by changing the number of effective coils in the governor spring by turning the sensitivity stud farther in or out. Turn the stud counterclockwise to increase sensitivity. Adjust for maximum sensitivity without a hunting condition.

Governor High Speed Solenoid

This solenoid mounts on the blower housing. When energized the plunger is in the solenoid body. This exerts a greater than normal force on the governor arm auxiliary spring (Figure 26), holding the governor wide open for high speed operation. When de-energized the solenoid spring forces the plunger out relaxing the auxiliary spring. Adjustments can be made by changing length of solenoid linkage.

The solenoid contains two coils. Both are energized for pulling the plunger into the solenoid body. When the plunger hits bottom, it opens a set of contacts, de-energizing the pull-in coil. The other coil holds the plunger in.

To test the solenoid, check plunger operation and current draw with 12-volt input. Current draw with the plunger up should be about one amp. If it is much greater, the contacts did not open. If the plunger sticks, remove and clean the plunger and recess in the solenoid.

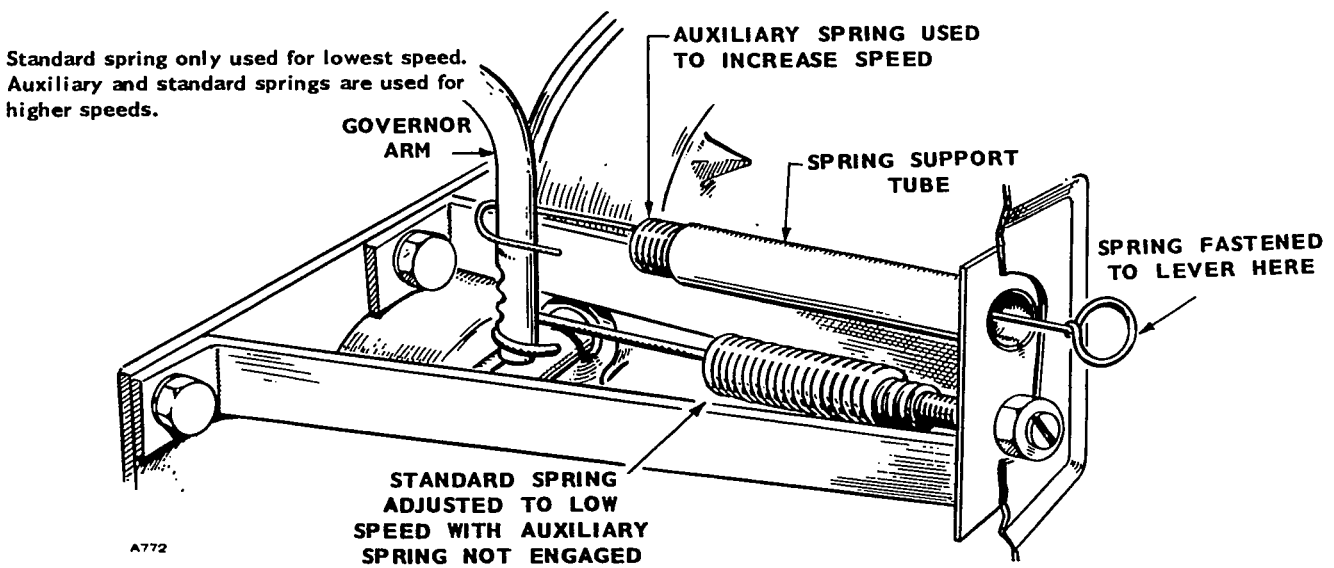


FIGURE 26. GOVERNOR ADJUSTMENTS (PRIOR TO SPEC R)

Sensitivity

Models starting with Spec R (Figure 27). Adjust by turning the sensitivity adjusting ratchet nut; accessible through a hole inside of blower housing. If speed drops too much when full load is applied, turn the ratchet nut counterclockwise to increase spring tension and compensate for reduced rpm. An oversensitive adjustment, approaching no speed drop when load is applied, may result in a hunting condition (alternate increase and decrease in speed).

After adjusting speed and sensitivity, secure speed-stud lock nut and replace dot button in blower housing.

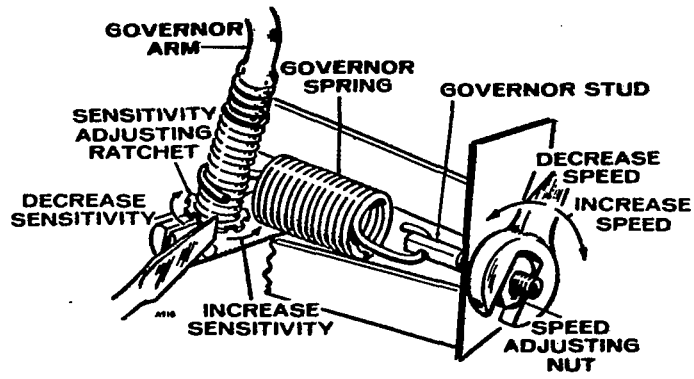


FIGURE 27. GOVERNOR ADJUSTMENTS (BEGINNING WITH SPEC R)

OIL SYSTEM

DJA engines have pressure lubrication to all working parts. The oil system includes oil intake cup, gear type oil pump, bypass valve, oil pressure gauge, full-flow oil filter, and block passages and drillings to deliver oil throughout the engine (Figure 28). Oil is held in the base, drawn by the pump, and delivered through the oil filter. Lines leading to the rocker housing, drillings through the block to crankshaft bearings and to front camshaft bearing crankshaft passages to connecting rod bearings and connection rod passages to piston pin bushings complete the oil system plumbing.

The crankcase breather is included in this system because it aids oil consumption control.

Oil pressure should be 25 psi or higher when the engine is at normal operating temperature. If pressure drops below 20 psi at governed speed, inspect the oil system for faulty components.

MAINTENANCE

Periodic oil system maintenance should include changing crankcase oil, cleaning the crankcase breather, cleaning rocker box oil lines, and replacing the oil filter. Consult the periodic service chart for service periods.

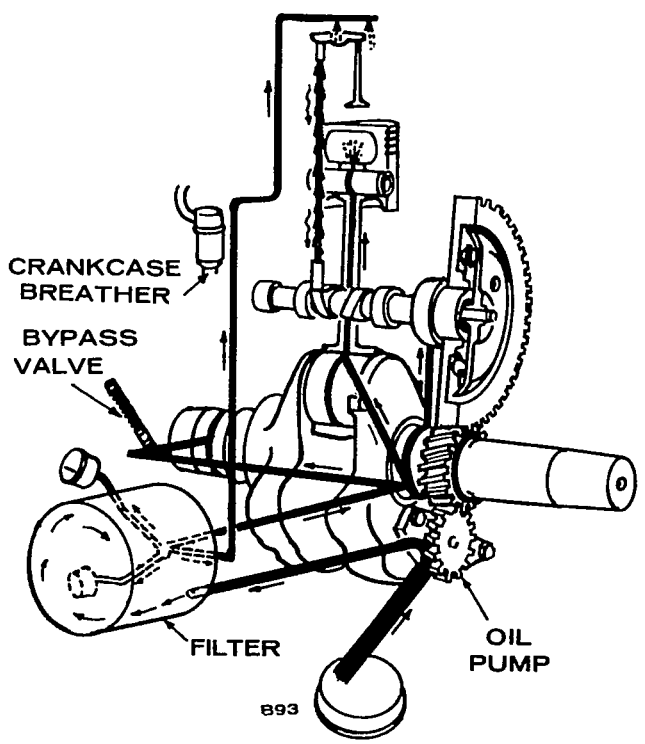


FIGURE 28. PRESSURE OIL SYSTEM

OIL PUMP

The oil pump is mounted on the front of the crankcase behind the gear cover and is driven by the crankshaft gear.

Removal

1. Remove the gear cover and oil base. (See *ENGINE DISASSEMBLY* section.)
2. Unscrew the intake cup from the pump.
3. Remove the crankshaft lock ring and gear retaining washer.
4. Loosen the two cap screws holding the pump and remove pump.

Repair

Except for the gaskets, component parts of the pump are not individually available. If the pump is defective or excessively worn, replace it. Disassemble the pump by removing the two cap screws holding the pump cover to the body. Inspect for excessive wear in gears and shafts. To improve pump performance, adjust the gear end clearance by changing the gasket thickness between the pump body and cover. Use the thinnest gasket that permits free movement of the pump shaft. Oil all parts when assembling the pump.

Installation

Before installing, fill the pump intake and outlet with oil to be sure it is primed. Mount the pump on the engine and adjust for 0.005-inch lash between the pump gear and crankshaft gear. Mount the intake cup on the pump so it is parallel to the bottom of the crankcase.

BYPASS VALVE

Located on the outside of the rear bearing plate, the bypass valve (Figure 29) controls oil pressure by allowing excess oil to flow directly back to the crankcase. Normally the valve begins to open about 25 psi. It is nonadjustable and normally requires no maintenance.

To determine if high oil pressure is caused by the plunger sticking closed or low oil pressure by the plunger sticking open, clean and inspect the valve.

To remove the valve, unscrew the recessed plug in the rear bearing plate and lift out the spring and plunger assembly. Determine proper valve operation by checking the spring and plunger against the values following.

Plunger diameter ..... 0.3365-inch to 0.3380-inch
Spring - free length ..... 2-1/4 - 2-3/8 inch
2.225 lb. 0.11 lb. at 1-3/16-inch (compressed)

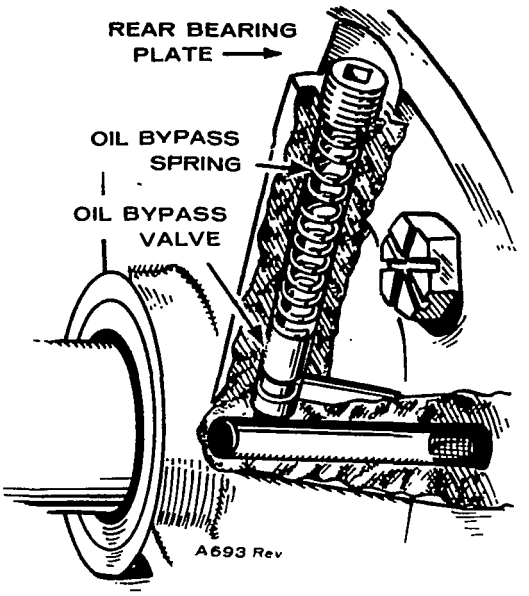


FIGURE 29. OIL BYPASS VALVE

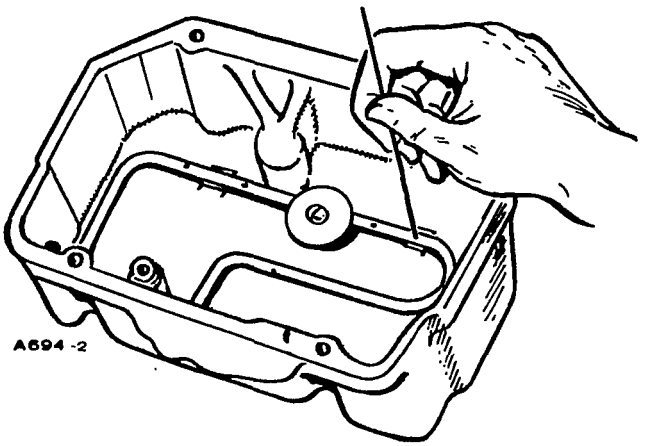
OIL LINES

The rocker box oil line should be flushed with fuel and small holes cleaned with fine wire at regular intervals. See Figure 30. Clean out all other oil lines and drillings with compressed air whenever the engine is disassembled or overhauled. Reach the oil gauge passage by removing the oil filter mounting plate.

External oil lines, the rocker box oil line and the internal oil line to the rear bearing are replaceable if damaged.

GAUGE

The oil pressure gauge is located on the lower front corner of the cylinder block. Remove it with a wrench and screw in a new gauge if it is faulty. Before replacing, check for clogged oil passage behind the gauge.



FLUSH ROCKER BOX OIL LINE WITH SUITABLE SOLVENT AND CLEAN HOLES WITH FINE WIRE.

FIGURE 30. CLEANING ROCKER BOX OIL LINE

OIL PRESSURE SWITCH

The nonadjustable oil pressure switch controls the decompression solenoid in the starting system, allowing it to energize only when the switch closes. This allows the engine to build up speed, during starting, before compression occurs. The switch closes at about five psi under increasing oil pressure.

This switch is not designed to be used as low oil pressure protection. It won't protect the engine against slowly decreasing oil pressure.

To check switch operation, if the decompression solenoid won't energize, short it to ground when the engine has built up speed during starting. The governor solenoid should energize immediately and the engine start.

CAUTION **When the engine starts, check immediately for oil pressure and shut the engine down if oil pressure doesn't build up within a few seconds. In this case it is lack of oil pressure that is causing faulty operation, not the switch.**

STARTING SYSTEM

Most engine installations use a starting motor, as shown in Figure 31. The starting motor mounts on the right side of the engine and drives the flywheel for starting. It is a standard automotive starting motor with solenoid shift and over-running clutch, controlled by a start solenoid in the control box. When the control box solenoid energizes, the solenoid on the motor operates, shifting the starter pinion to engage the flywheel ring gear and closing the circuit to the starting motor. The starting motor remains engaged until after the engine starts when the control circuit centrifugal switch closes, completing the starting cycle. The over-running clutch protects the starter armature from overspeeds.

ONAN does not stock all parts for the starting motor. See an authorized dealer.

MAINTENANCE

Check the battery water level and charge condition about every 100 hours. Every 500 hours inspect all starting system wiring for loose or dirty connections, especially connections to the battery terminals.

Separate Starting Motor: Every 500 hours check for loose or dirty connections. Check the battery water level and charge condition every 100 hours. Inspect the starter commutator and if it is dirty, clean with #00 sandpaper. Do not use emery paper or cloth! Check the brushes for excessive wear and poor seating on the armature.

TESTING

Poor cranking performance can be caused by a faulty starting motor, defective battery or high resistance in the starting circuit.

Battery: Check battery condition with a hydrometer. Specific gravity should be between 1.260 and 1.225. If not, recharge the battery. If the battery will not recharge, replace it.

Wiring: With the starting motor operating, check the voltage drops (1) from the battery ground terminal post (not the cable clamp) to the cylinder block (2) from the cylinder block to the starting motor frame and (3) from the battery positive post to the battery terminal stud on the solenoid. Each drop should be less than 0.2 volts. If extra long battery cables are used, slightly higher voltage drops may result. Thoroughly clean all connections in any part of the circuit showing excessively high voltage drops.

Starting Motor: If starting motor tests are required, remove the motor from the engine. Complete starting motor tests should include both tests of free-running voltage, speed and current and tests of stall torque, voltage and current.

To test the free-running characteristics, connect the starting motor in series with a battery and ammeter and install a tachometer on the motor. Read the free-running current and speed.

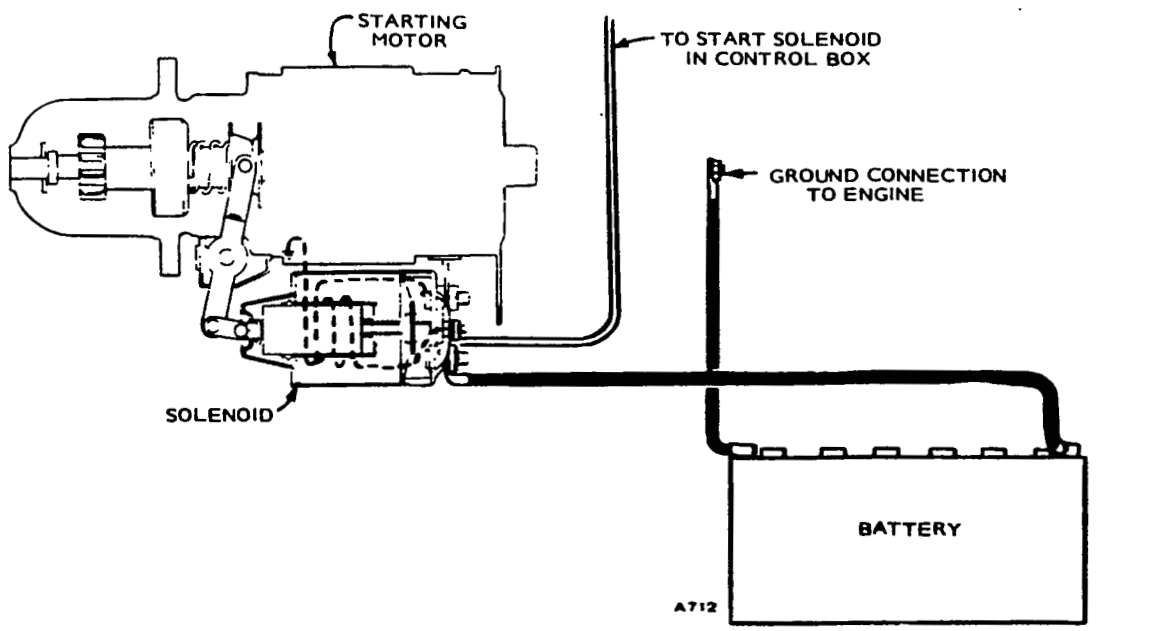


FIGURE 31. STARTING SYSTEM

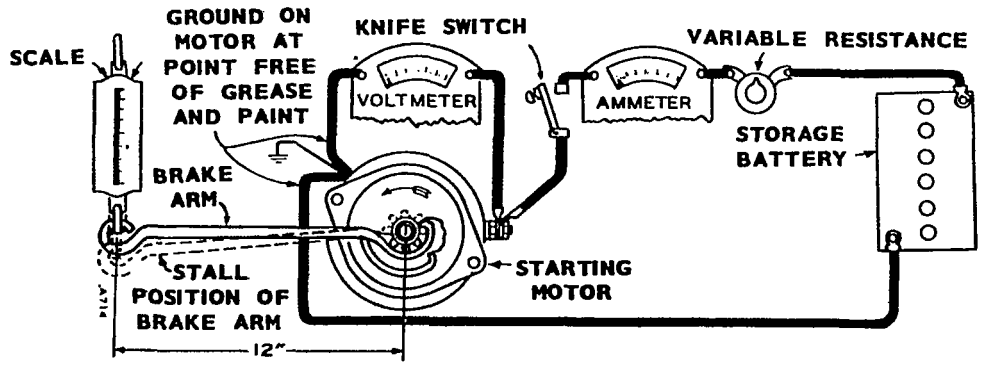


FIGURE 32. TESTING FOR TORQUE

The torque test (Figure 32) requires a spring scale and torque arm, voltmeter, ammeter and variable resistance to apply the voltage specified by the test characteristics. The voltage drop across the solenoid on the starting motor should be less than 1.50 volts. If not, remove it for repair.

BATTERY

Engines with a separate cranking motor normally use a single 12 volt battery of at least 62 amp.-hour capacity.

The battery charging system maintains the batteries at or near full charge at all times. Inspect the battery charging system and adjust the charge rate if batteries appear to be continually discharged.

Adding accessories that draw battery current requires an adjustment of the charge rate.

If discharge or failure to charge cannot be traced to the battery charging system, thoroughly inspect and test the battery, and replace it as necessary.

REPAIR

Armature: Inspect the armature for mechanical defects Before checking for grounds or shorted coils.

To test for grounds, use a 12 volt test lamp and check between each segment of the commutator and the shaft. Do not touch probes to the commutator brush surfaces, as this will burn the smooth surfaces.

A growler is necessary to test for shorted coils. With the armature in the growler, run a steel strip over the armature surfaces. If a coil is shorted, the steel strip will become magnetized and vibrate. Rotate the armature slightly and repeat the test. Do this for one complete revolution of the armature. If the armature has a short or ground, replace it.

If the commutator is only dirty or discolored, clean it with 00 or 000 sandpaper. Blow the sand out of the motor after cleaning. If, however, it is scored, rough or worn, turn it down in a lathe.

Field Coils: Using a test lamp and probes, check the field coils for grounding to the motor frame or open circuit. Inspect all connections to be sure they are properly clinched and soldered. Inspect the insulation for evidences of damage. The only way to check for field coil shorts is to use the starting motor test.

Bearings: If either the front or rear bearings show excessive wear, replace them. Drive the old bearings out, and using an arbor press and the proper arbor, press new bearings into place.

Brushes: Check the brushes for wear or improper seating. They should slide freely in their holders. Check the brush spring tension with a spring scale. To change spring tension, twist the spring at the holder with long nosed pliers.

Replace Prestolite brushes when excessively worn, or when worn to 5/8 inch in length. Replace Mitsubishi, brushes when excessively worn or when worn to 3/8 inch in length. Some brushes are soldered to the field coil. To remove these brushes, unsolder the lead and open the loop in the field coil lead. Insert the new brush pigtail completely into the loop and clinch before resoldering. A good soldering job is necessary to ensure good contact and low voltage drop across the connection.

Over-running Clutch: Clean the clutch thoroughly but do not dip in solvent. It cannot be repacked with grease.

It should slide easily on the armature shaft with no binding. Turn the pinion, it should rotate smoothly, but not necessarily freely. Reverse the direction a few times and it should instantly lock and unlock. Replace the clutch if operation is defective or pinion is worn or damaged.

Shifting Solenoid: See that the plunger moves freely in the coil. Check pull-in coil continuity between the solenoid control terminal and the solenoid connection to the motor. Check the hold-in coil continuity between the solenoid control terminal and ground on the motor.

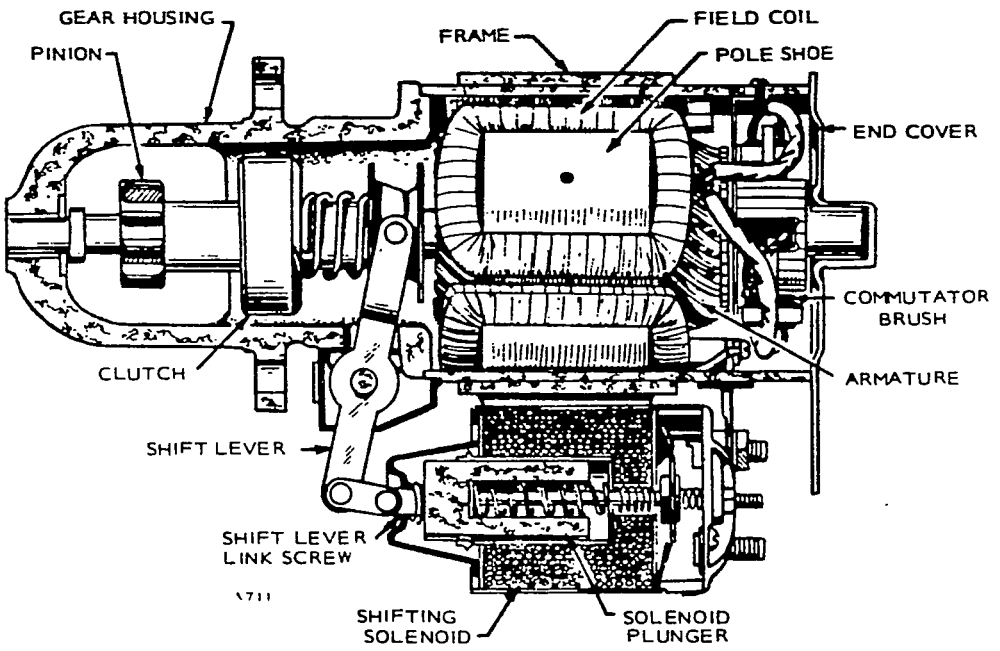


FIGURE 33. PRESTOLITE STARTER

PRESTOLITE STARTER REMOVAL AND DISASEMBLY

1. Remove connections to control and battery at the shifting solenoid.
2. Remove nut holding rear mounting bracket to the engine.
3. Remove the blower housing.
4. Remove flywheel (early models).
5. Remove the three cap screws holding the starting motor flange to the engine and pull out the motor.
6. Remove the link pin holding the shift lever to the solenoid plunger and remove the shift lever center pin.
7. Remove the through bolts from the commutator end of the motor. Pull off the end cover and lift the brushes off their seats.
8. Pull the cast housing from the front end of the motor and lift the armature and clutch out of the motor frame.
9. To remove the overrunning clutch from the armature, drive the retainer away from the lock ring near the front end of the shaft, remove the lock ring and pull the assembly off. Do not attempt to disassemble the clutch assembly.
10. If necessary to service the solenoid, remove the four cap screws and electrical connections holding it to the motor frame. Remove the two screws on the rear of the solenoid to reach the switch contacts.
11. If it is necessary to remove the starting motor flange (Figure 34), watch for shims between the flange and crankcase surface. Save any shims; they must be reinstalled to position the starter correctly.
12. Mount starter motor to engine by a direct reversal of the removal procedure. Connect battery cable and wires to starter.
13. Connect battery cables to battery. Connect ground cable last.

PRESTOLITE STARTER ASSEMBLY

Before assembling, soak the bronze bearings in oil. They are absorbent bearings, designed to hold up to 25 percent of their own weight in oil. Be sure the felt oil pad is in the outer end of the commutator end bearing.

When the motor is assembled, check the armature end play. It should be between 0.005-inch (0.127 mm) and 0.030-inch (0.762 mm). Adjust end play by adding or removing washers on the commutator end of the armature.

Before installing, check the pinion clearance. Proper clearance is important to ensure starter engagement.

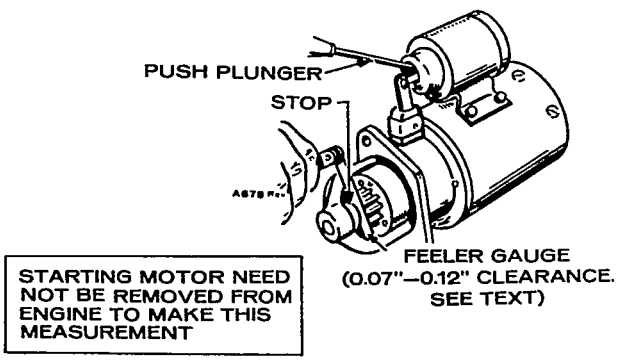
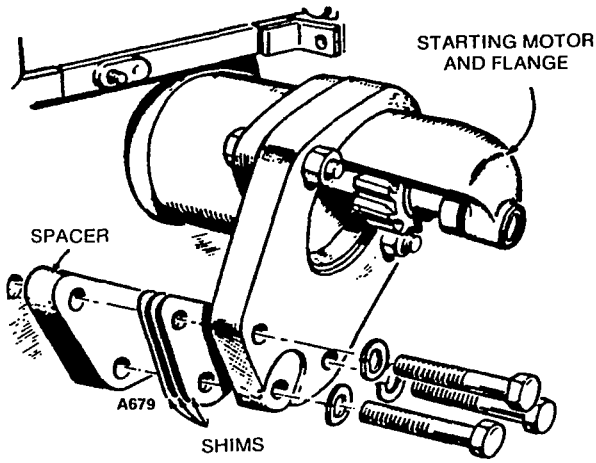


FIGURE 33a. CHECKING PINION CLEARANCE

Press on solenoid core to shift the pinion into full mesh and measure the clearance between pinion and pinion stop, Figure 33a. This should be between 0.07-inch and 0.12-inch (3.05 mm) (as near to 0.070-inch [1.78 mm] as possible.) Adjust the link screw on the end of the solenoid plunger for proper clearance.

On units built prior to serial No. 679677, it was necessary to maintain the gap between ring gear and starter pinion in the relaxed position at less than 1/8-inch to ensure starter engagement. When installing these motors, check this gap. If it is too great, a shim kit is available to reduce it. See Figure 34.



Required on some early models. Be sure to install same number of shims removed.

FIGURE 34. STARTING MOTOR MOUNTING SHIMS

MITSUBISHI STARTER REMOVAL AND INSTALLATION

1. Remove both battery cables from battery. Disconnect ground cable first.
2. Disconnect battery cable and electrical lead wires from starter.
3. Remove capscrews and flat washers that attach starter to mounting bracket.
4. Remove starter.
5. Mount starter motor to engine by a direct reversal of the removal procedure. Connect battery cable and wires to starter.
6. Connect battery cables to battery. Connect ground cable last.

MITSUBISHI STARTER DISASSEMBLY

1. Remove "M" terminal nut and wire lead from solenoid.
2. Remove the two solenoid mounting screws and remove solenoid.
3. Remove the two through bolts and brush holder retaining screws. Remove rear bracket (Figure 34a).

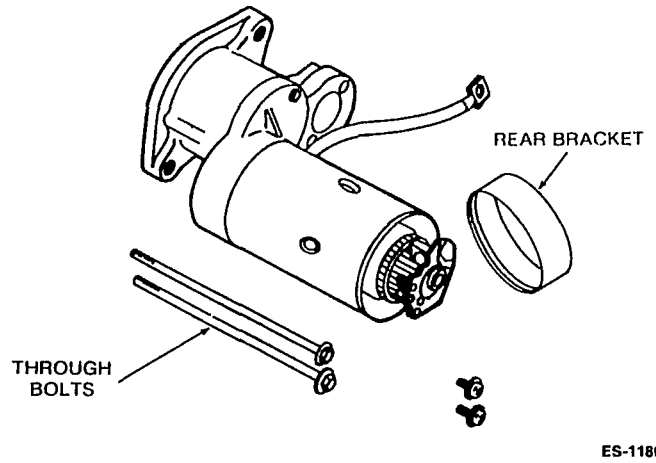


FIGURE 34a. REMOVING REAR BRACKET

4. Remove frame assembly, and brush holder assembly while pulling the brushes upward. Then remove armature assembly.
5. Remove cover assembly, (snap ring and washer) from the pinion shaft (Figure 34b).

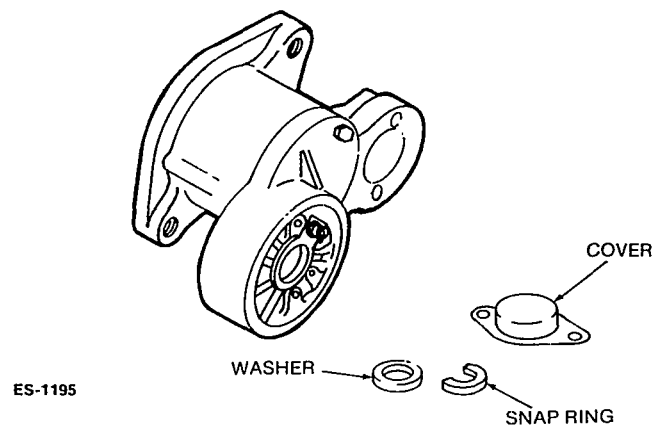


FIGURE 34b. REMOVING SNAP RING AND WASHER

6. Remove capscrew that secures center bracket to front bracket. Remove the center bracket; several washers used to adjust pinion shaft end play can now be removed (Figure 34c).

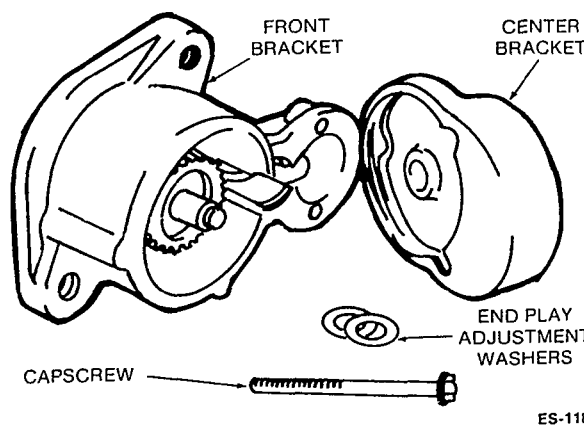


FIGURE 34c. REMOVING CENTER BRACKET

7. Remove gear, spring set and lever assembly from front bracket. Note direction in which the lever assembly is installed.
8. Push pinion gear and stopper down and remove retaining ring. Remove stopper, pinion gear, spring, and pinion shaft assembly.
9. Inspect ball bearings. If they are rough or noisy when rotated replace them. The front bearing is not replaceable and must be replaced with the bracket.

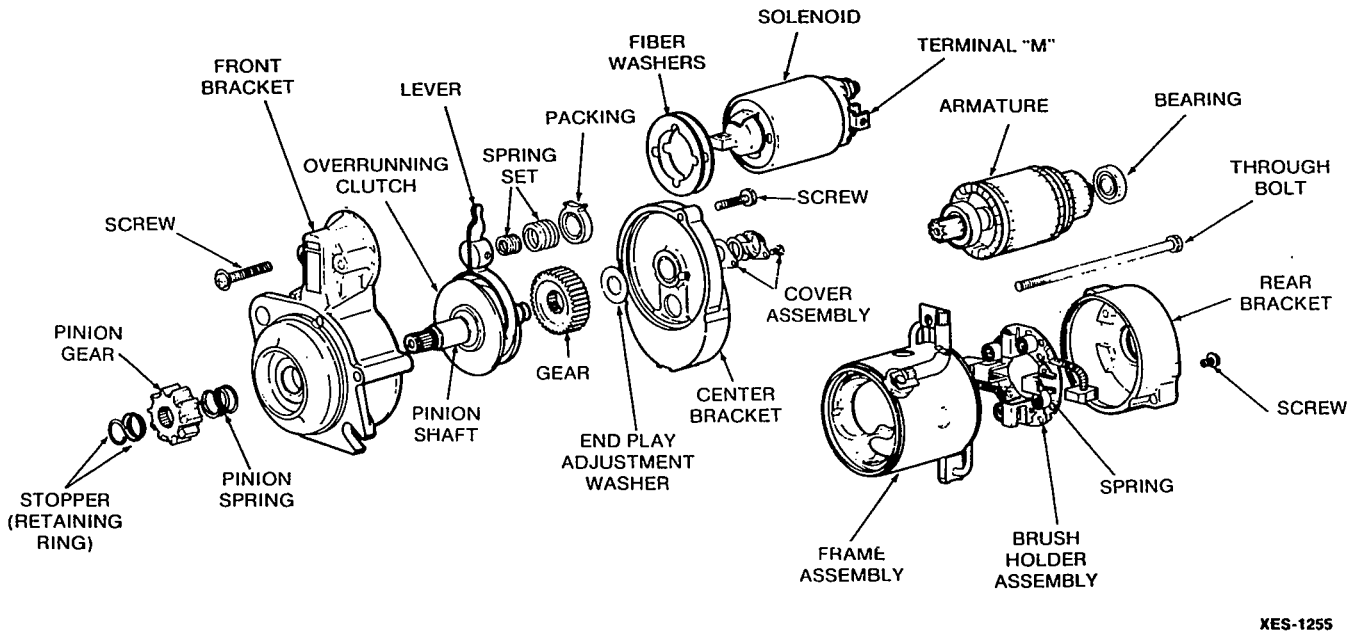


FIGURE 34d. MITSUBISHI STARTER

MITSUBISHI STARTER ASSEMBLY

For assembly reverse the disassembly procedure, but note the following items. See Figure 34d.

Whenever starter motor is disassembled apply grease to each of the following points. (Recommended grade; Multemp PS No. 2.)

- Armature shaft gear
- Reduction gear
- Ball bearing (Both ends of armature
- Stopper on pinion shaft
- Sleeve bearing
- Pinion gear
- Sliding portion of lever

Pinion Shaft End Play Adjustment

Adjust end play so that it is 0.1 to 0.8 mm (.0039 to .0315 inch) with the adjusting washers placed between center bracket and reduction gear (Figure 34e).

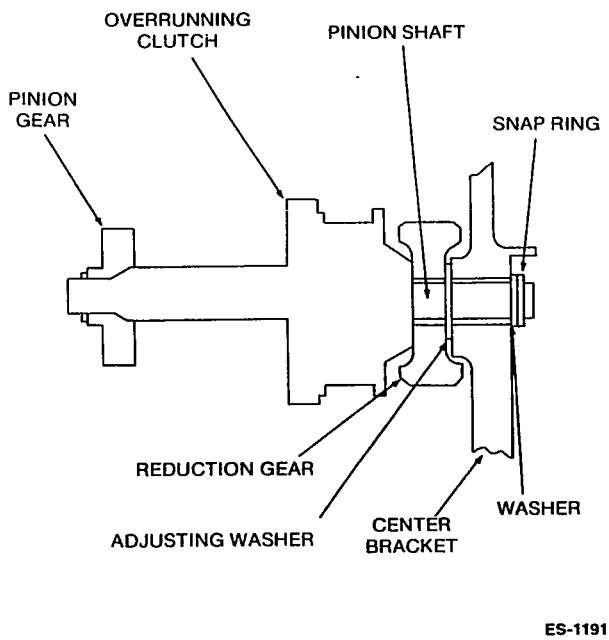


FIGURE 34e. ADJUSTING PINION SHAFT END PLAY

With pinion gear removed, install reduction gear onto pinion shaft. Place pinion shaft into center bracket and secure with washer and snap ring. Measure the end play with a feeler gauge between center bracket and gear. If necessary, adjust end play by adding or removing adjusting washers.

If pinion gear has not been removed, place pinion shaft and reduction gear between front bracket and center bracket. With lever spring removed and bolt tightened, push pinion shaft out and measure end play. Adjust end play if necessary by adding or removing shims.

Pinion Gear Installation

Place spring and pinion gear onto pinion shaft. Slide stop ring onto pinion shaft and install retaining ring in groove. Pull stop ring over retaining ring (Figure 34f).

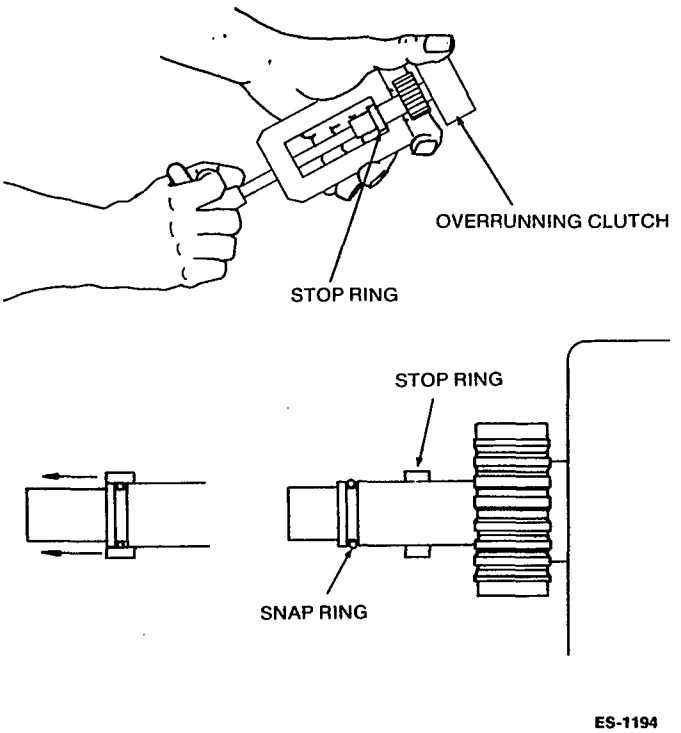


FIGURE 34f. PINION GEAR INSTALLATION

Lever Assembly Installation

Figure 34g shows the correct method of installing the lever assembly, spring, and packing. Pay close attention to direction of lever.

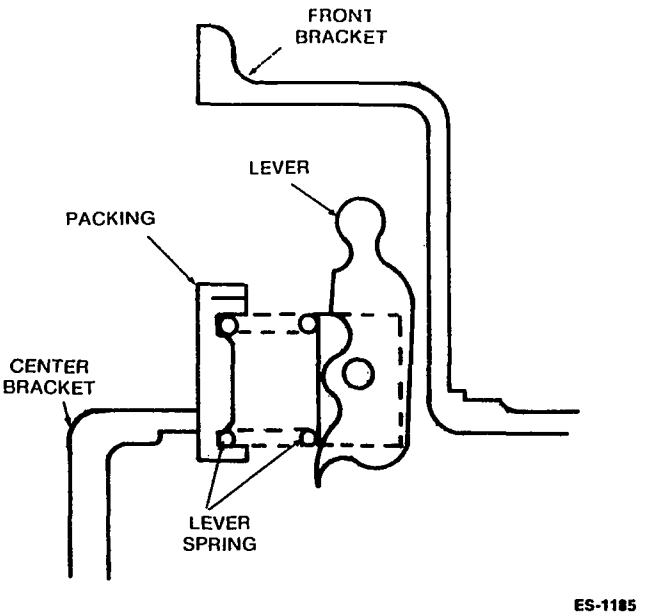


FIGURE 34g. LEVER INSTALLATION

Pinion Gap Adjustment

After assembling starter motor, adjust pinion gap.

1. Remove "M" terminal nut and wire from solenoid.
2. Connect positive terminal of battery to "S" terminal on solenoid and negative terminal to starter body. With battery connected pinion gear will shift into the cranking position.
3. **Gently push pinion shaft back towards front bracket and measure the amount of travel (Figure 34h).**

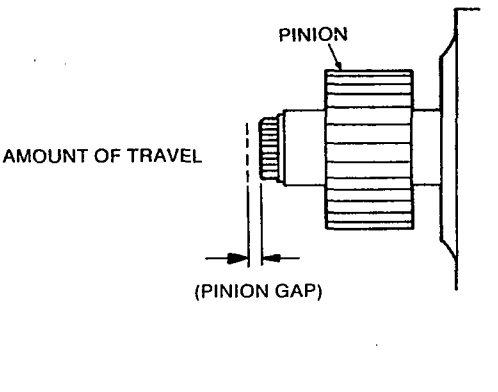


FIGURE 34h. PINION GAP ADJUSTMENT

4. The pinion gap should be 0.3 to 2.0 mm (0.118 to .0787 inch). Adjust by changing the number of fiber washers used on solenoid mounting surface. Increasing the number of fiber washers decreases clearance. Decreasing the number of washers increases clearance.

FLYWHEEL ALTERNATOR

MODELS BEGINNING WITH SPEC T

The flywheel alternator is a permanent magnet alternator and uses a solid-state voltage regulator-rectifier for controlling output (Figure 35).

A 30-ampere fuse is included in the battery charging system to protect the alternator in case the battery cables are accidentally reversed. The fuse is located behind the air housing door (above injection pump). Check the fuse before performing any tests.

Weak ignition spark or a discharged battery indicates trouble in the charging system, but always check the battery for serviceability first.

Keep these points in mind when testing or servicing the flywheel alternator:

1. Be sure the output control plug (connector) is inserted properly. The plug must bottom in receptacle to eliminate any resistance due to a poor connection. Keep clean and tight.
2. Be sure regulator-rectifier output control has a good ground connection. Mating surface for mounting must be clean and fasteners tightened properly.
3. Never reverse the battery leads. Reverse polarity will blow the fuse.

Regulator-Rectifier Tests

The following tests for the regulator-rectifier require a fully-charged battery.

1. Connect a voltmeter across the battery. Start the engine and operate at 2400 rpm.
2. Voltmeter should read 13.4 to 14.0 volts. If it does, no further testing of the charging system is necessary. If not, install a new regulator-rectifier and retest. Be sure it has a good ground connection and the connector is properly seated.

Stator Tests

For testing, use a Simpson 260 Multimeter or equivalent. Be sure test meter and battery, if battery powered, are in good condition. Check with engine NOT running.

1. Set voltage selector switch to DC+ and zero meter on RX1 scale.

   Zero the meter before each reading and each time scales are changed.

2. Unplug the connector and connect the meter leads to the two terminals of the female plug with the yellow wires. Meter should read less than 0.8 ohms if stator has continuity. If meter shows no reading, winding is open and stator should be replaced.

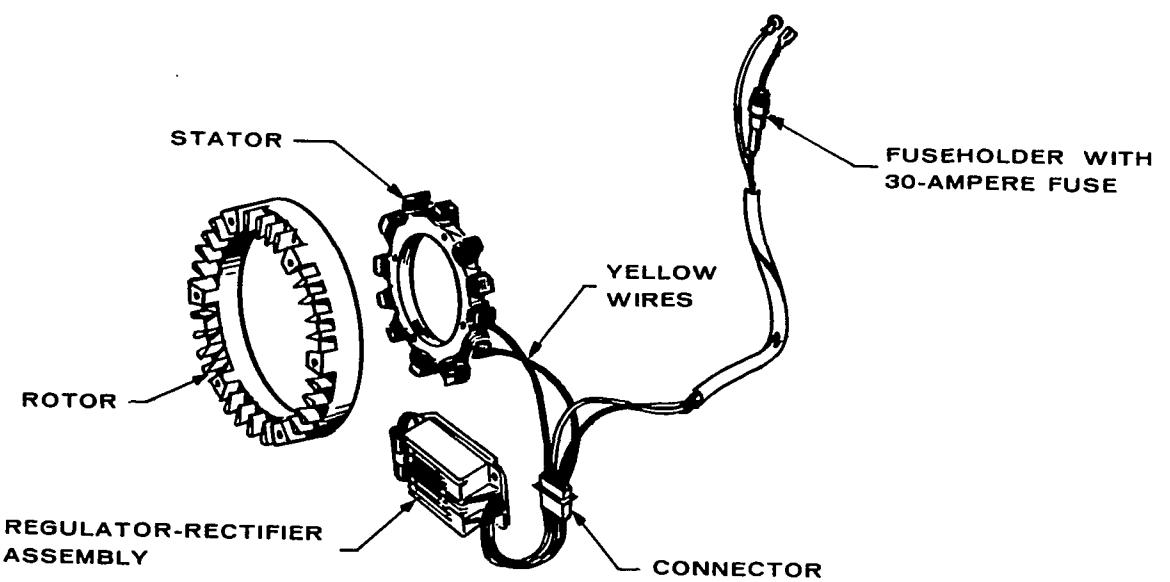


FIGURE 35. FLYWHEEL ALTERNATOR (BEGINNING WITH SPEC T)

3. Touch red meter lead to yellow wire plug terminal and other meter lead to metal core of stator. If meter doesn't read infinity, the stator winding is grounded. Replace the stator.

Flywheel Magnet Group or Rotor

To test the magnet group or rotor, lay a piece of ferrous (iron) material up against the magnets to be sure they are charged. If not, replace the rotor.

MODELS PRIOR TO SPEC T

There are four major components in the battery charging system: (1) a permanent magnet on the flywheel provides a rotating magnetic field; (2) a group of coils mounted behind the flywheel on the gear cover cuts the field to produce a voltage; (3) a two-step mechanical regulator controls the AC voltage to the rectifier, and (4) a full wave rectifier converts the regulated AC to DC for battery charging. See Figure 36.

The permanent magnet (rotor) is held to the flywheel by screws. It is fully supported by the flywheel and therefore has no bearings. The stator windings are encapsulated in an epoxy resin for protection from moisture. Cooling of the stator is from special fins on the rotor. The rectifier is located inside the blower housing and cooled by incoming engine air. A fuse between the rectifier and ground protects the rectifiers from destruction should the battery be connected in the circuit with reversed polarity. The mechanical regulator cannot tolerate normal vibration of the engine, so it must be mounted on a separate panel.

The alternator develops two different rates of current output. The smaller output is connected in the charge circuit for a continuous low rate charge. The larger output is controlled by the mechanical regulator, which has two relays, one of which is voltage sensitive. When battery voltage falls and the voltage sensitive relay is de-energized, contacts close to provide a circuit to the other relay, which makes a circuit for the high rate charge. See Figure 37. The voltage at which the sensitive relay is energized varies with the temperature.

The final result is a charge rate of 12 amperes into a 70-amp hour, 12-volt battery when the engine is running at 1800 rpm. The maximum continuous DC load is limited to 10 amperes at 1800 rpm. Reverse current through the rectifiers is 5 to 10 milliamperes, so no special reverse current protection is needed. The engine should not be run while the battery is disconnected, but if the battery is accidentally disconnected, the system will not be damaged.

MAINTENANCE

There are neither brushes nor bearings in this system so maintenance is limited to keeping the components in good condition. When the flywheel is off, clean the rotor and stator and check the wires. In general, see that all connections are secure and all components clean. If the alternator is operating satisfactorily, do not tamper with it.

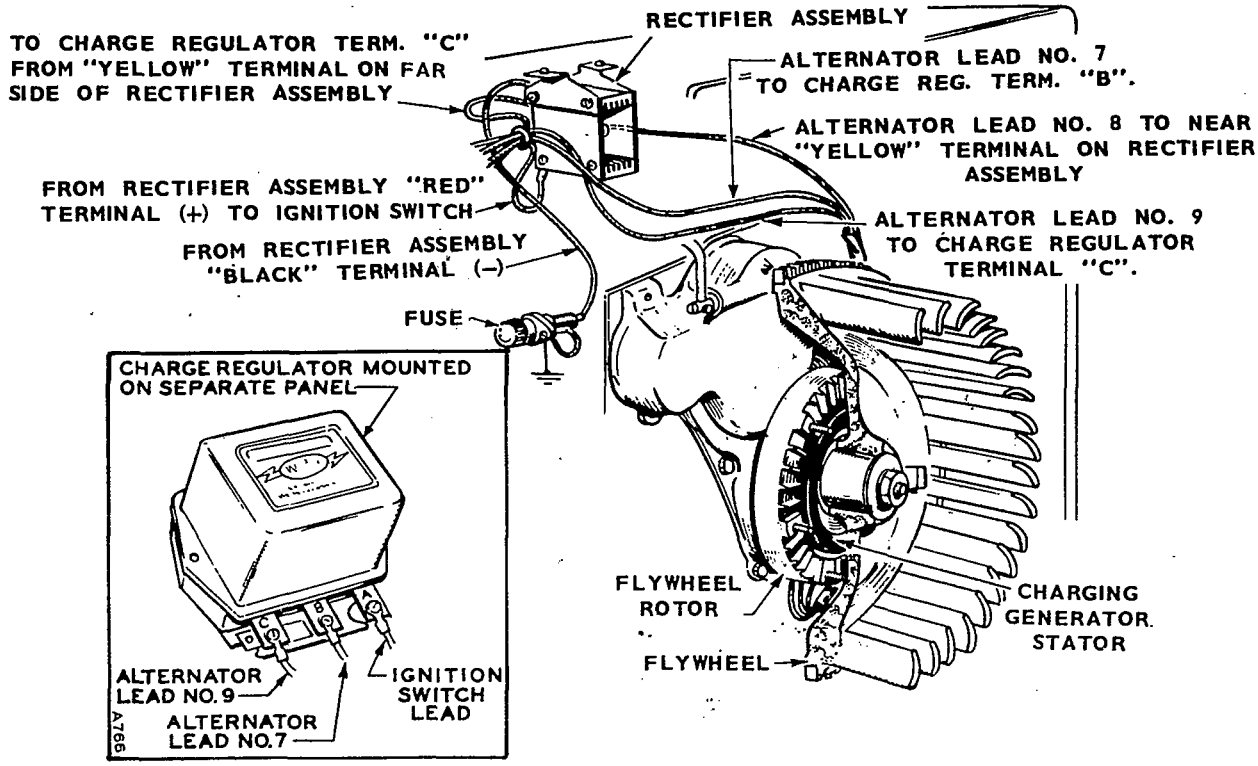


FIGURE 36. FLYWHEEL ALTERNATOR (PRIOR TO SPEC T)

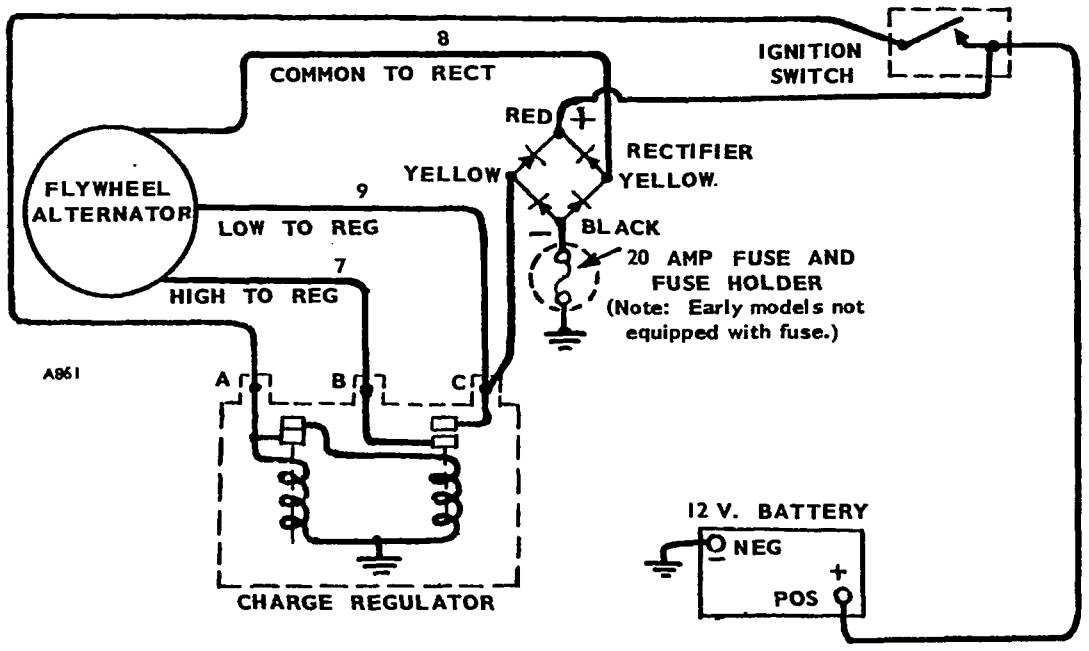


FIGURE 37. BATTERY CHARGING - SCHEMATIC DIAGRAM (PRIOR TO SPEC T)

TESTING

To check alternator output, connect an ammeter between the red terminal on the rectifier and the ignition switch. With the engine running at 1800 rpm, the ammeter should indicate about 8 amperes into a fully discharged battery, and progressively less as the battery becomes charged. The regulator switches from high to low charge at about 14-1/2 volts and low to high at about 13 volts. Current at low charge should be about 2 amperes. If output is unsatisfactory, do the following tests:

Rotor

To test for magnetism in the rotor, merely hold a piece of steel close to the magnet. If the steel is strongly attracted, the rotor is satisfactory. Strength of the magnet is a basic quality that will not change much over a period of time.

Stator

Disconnect the stator leads and test each one with a 12-volt lamp for grounding. Touch one probe to the lead and the other probe to a good ground on the engine. None of the leads should show a ground, which will be indicated if the lamp lights. If a ground is indicated, replace the stator.

To test for shorted coils or opened circuits, use an ohmmeter set to read the proper range of resistances. The resistance values are as follows:

Lead 7 to 8 — 0.25 ohms
Lead 8 to 9 — 0.95 ohms
Lead 9 to 7 — 1.10 ohms

If the resistance varies over 25 percent for the above values, install a new stator and check for improved performance.

Rectifier

Completely isolate the rectifier assembly from the charging circuit by disconnecting all four wires. Test each rectifier separately with an ohmmeter (Figure 38) or test lamp.

With an ohmmeter, connect one test lead to the rectifier lead and the other test lead to the rectifier base. Take reading and then reverse the test probes. If the rectifier is good, one reading will be much higher than the other.

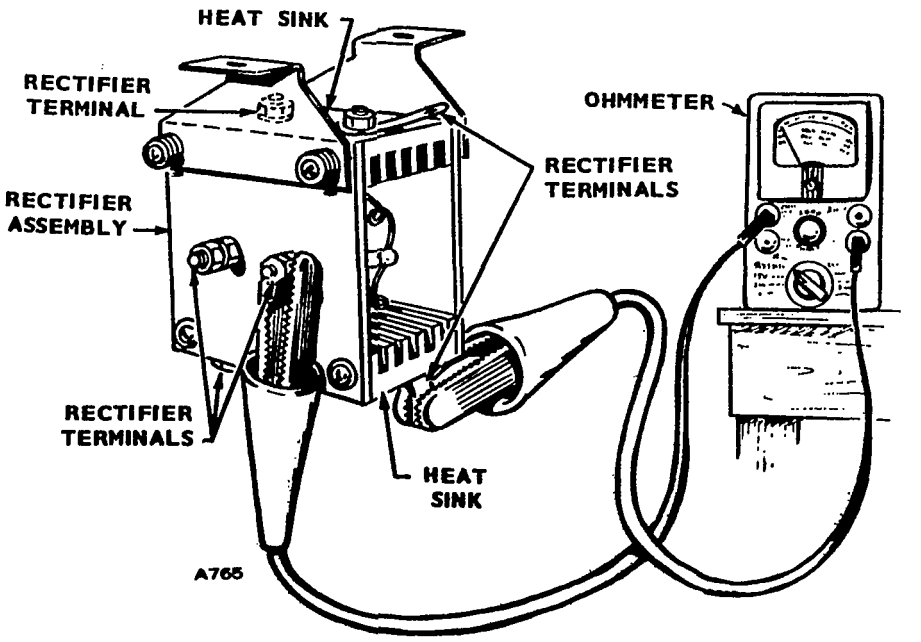


FIGURE 38. TESTING THE RECTIFIER (PRIOR TO SPEC T)

If a test lamp is used, touch the test probes together and observe the brightness of the bulb. Then touch the probes across the rectifier. If the rectifier is good, the bulb will light dimly. If the bulb lights brightly or not at all, the rectifier is defective and must be replaced.

Voltage Regulator

If the low rate charge is satisfactory, but high rate is not, connect a jumper between terminals B and C. Run the engine and check the charge rate at the battery; it should be about 8 amperes. If it is, either the regulator or its power circuit is defective. With a 12-volt test lamp, check input to the voltage sensitive coil at terminal A. If the lamp lights, input is okay and the regulator is defective.

If the charge rate with B and C jumpered is low, look to the alternator or its wiring for the cause.

Indicator Light

This light is used on engines with factory mounted controls. Light mounts on rear cylinder air housing and lights red when alternator is charging.

ENGINE DISASSEMBLY

CYLINDER HEAD, VALVES

The cylinder head assembly has alloy hardened faced valves, release type rotators, alloy hardened inserts, guides, rocker arms, injection nozzle and glow plug. The push rods run through shields.

Maintenance

Check the valve clearances at regular intervals. In addition, clean the combustion chamber and valve seats at regular intervals.

Valve Clearance

Check valve clearance when the engine is at room temperature (about 70°F).

1. Turn the flywheel until the cylinder is on its compression stroke. Use a socket wrench on the flywheel screw hex head.

   To determine if the cylinder is in its compression stroke, observe the action of the push rods as the engine is rotated in a clockwise direction. The exhaust valve push rod will be in its lowest position and the intake valve push rod will be moving downward. As the piston reaches top dead center, the flywheel timing mark should be aligned with the timing pointer and the valve push rods stationary.

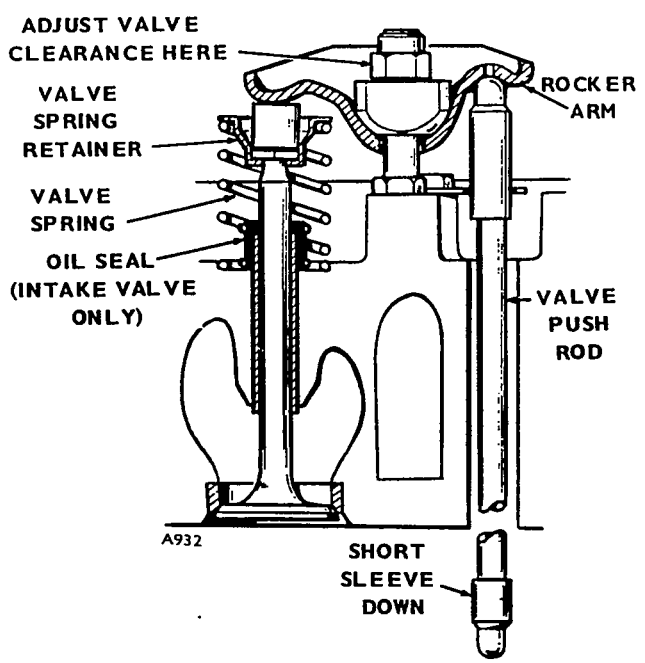


FIGURE 39. SETTING VALVE CLEARANCE

2. Now turn the flywheel clockwise for an additional 10 to 45 degrees. There is no timing mark for this position so it must be estimated. With the piston located in this position, it will be in its power stroke with both valves completely closed.
3. Cylinder head bolt torques should be 44 to 46 foot-pounds. To change the setting of valve clearance, adjust the locknut which secures the rocker arm to the cylinder head (see Figure 39). Loosen the locknut to increase clearance and tighten it to reduce clearance.
4. After allowing engine to cool, check the clearance with a feeler gauge between the rocker arm and the valve (see Figure 40). Increase or reduce the clearance until the proper gap is established. Correct valve clearance is 0.011-inch intake and 0.008-inch exhaust.

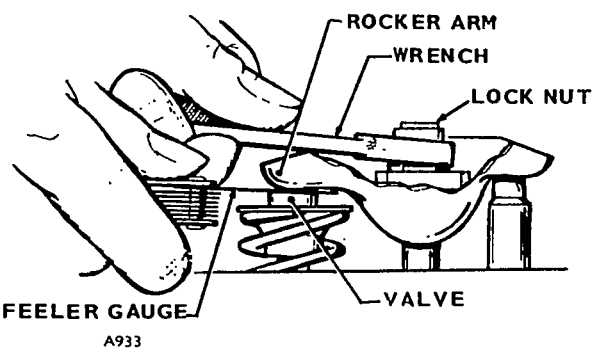


FIGURE 40. CHECKING VALVE CLEARANCE

J-SERIES VALVE ROTATOR CLEARANCE CHECK

Both the intake and the exhaust valves on all Onan J-Series engines are equipped with release-type valve rotators. The cap covering each valve tip releases keeper tension as the valve is pushed off its seat. This allows the valve to float in its guide. Engine vibration and cylinder air flow cause the valve to rotate while floating.

To assure proper operation of this system, valve stem tip-to-cap clearance should be checked every 5000 hours, or whenever the parts are exposed or removed. Clearance must be maintained at 0.001 to 0.005 inch (0.025 to 0.127 mm). Too little clearance will prevent valve rotation, increasing the possibility of valve leakage and engine power loss. Too much clearance can lead to valve breakage.

To check the clearance, refer to Figure 41 and proceed as follows:

1. Remove the cap from the valve tip and measure the depth of the cavity in the cap with a depth micrometer.
2. Measure the valve tip height from the valve keepers to the top of the valve. A vernier or dial caliper will probably be needed to make this measurement.
3. Subtract the valve tip height from the cavity depth to determine the clearance. It should be between 0.001 and 0.005 inch (0.025 and 0.127 mm).
4. If the clearance is not within specifications, replace the cap and keepers as a set. When replacing the keepers, check for wear on the valve spring retainer where it contacts the keepers. If wear is over 0.003 inches, replace the retainer. After replacement of parts, recheck the clearance. If it is still not within specifications, replace the valve.

Any time the valves are to be removed, these measurements should be carried out first. Keep each valve assembly together as a set. When reassembling, install the keepers with wear in original position. Keepers can be inverted to use the unworn side, but the clearance must then be rechecked. Place a drop of engine oil on the valve stem before replacing the cap.

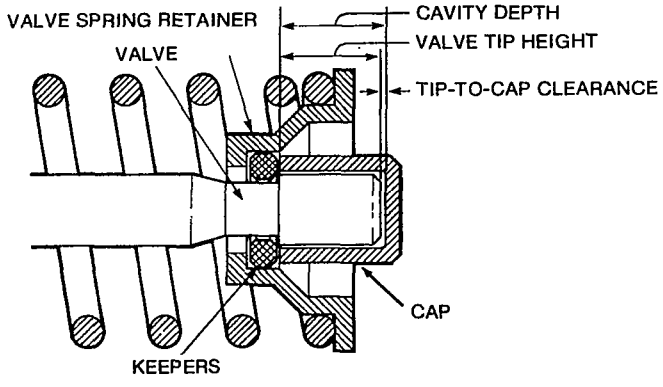


FIGURE 41. MEASURING VALVE TIP-TO-CAP CLEARANCE

Testing

The cylinder compression test can be used to determine the condition of valves, the piston, piston rings and cylinder.

To check compression, run the engine until thoroughly warm. Stop it, and remove the injection nozzle. Insert the compression gauge in the injection nozzle hole, crank the engine, and note the reading.

Compression of a standard new engine prior to Spec P at about 300 rpm is approximately 300-350 psi. Beginning Spec P, compression is about 350-400 psi.

Compression reading will deviate considerably from the above readings because of differences in cranking speed, altitude and ambient temperature conditions. Therefore, the specification is given only as a guide. The best indication of leakage is a compression increase when oil is added to the cylinder.

Disassembly

1. Remove the decompression solenoid.
2. Remove the rocker box cover, fuel nozzle and connecting oil lines to the cylinder head.
3. Remove the intake and exhaust manifold.
4. Remove the rocker arms and push rods.
5. Remove the cap screws holding the cylinder head to the cylinder block.
6. Remove the head. If it sticks, rap it sharply with a soft hammer. Do not use a pry bar.
7. Using a valve spring compressor, disassemble the valve assemblies.

Repair

Thoroughly clean all components of the cylinder head assembly. Remove all the carbon deposits from the intake and exhaust ports and clean all gasket surfaces.

Valves

Remove all carbon and check each valve for burning, pitting, or warped stem. Valves that are slightly pitted or burned, refinish on an accurate valve grinder. Refinish intake valves to a 42-degree angle and exhaust valves to a 45-degree angle. But, if they are badly pitted, or will have a thin edge when refacing, replace them.

Before removing intake valve from head, inspect for sharp edges on grooved section of valve tip. Remove any existing sharp edges with 240/320 grit emery cloth.

Check refinished valves for a tight seat to the valve seat with an air pressure type testing tool or by applying Prussian Blue on the valve face and rotating it against the seat.

Valve Guides

Check valve guide to valve clearance. See *DIMENSIONS AND CLEARANCES* section. If the proper clearances cannot be obtained by replacing

the valves, replace the valve guides. Drive the old valve guides into the valve chambers. Drive new guides in until they protrude 11/32-inch from the rocker box side of the head. Ream the new valve guide to obtain the proper clearance.

Valve Seats

If the valve seats are pitted, refinish them. Using conventional seat grinding equipment, reface each seat to a 45-degree angle and a seat width of 3/64- to 1/16-inch. You should be able to reface each seat several times before it becomes necessary to replace it.

If, however, the valve seats are loose or cannot be refaced, replace them. Use Onan tool No. 420-0272 in a drill press (Figure 42) to remove each valve seat. Adjust the tool to cut 1/64-inch from the edge of the seat. Oil the pilot to prevent it from seizing in the valve guide. Cut each seat down to a narrow rind on edges and bottom and break it out with a sharp tool. Be careful not to cut into the counterbore bottom.

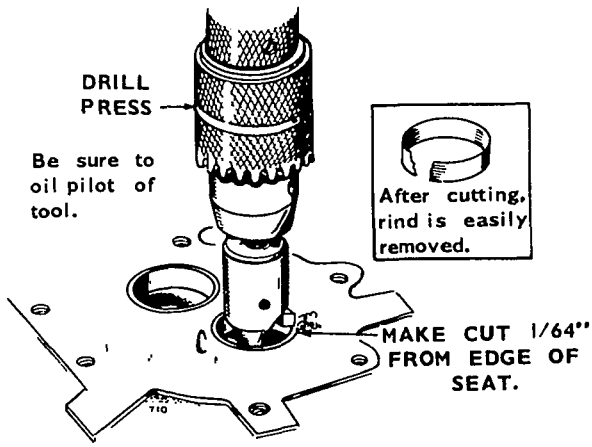


FIGURE 42. REMOVING VALVE SEATS

Thoroughly clean the valve seat counterbore and remove any burrs from the edges. If the counterbore is damaged, it will have to be remachined for an oversize seat. Oversize seats are available in 0.002-inch, 0.005-inch, 0.010-inch and 0.025-inch. Otherwise, install new standard size seat inserts.

Drive the new valve seat inserts into place. Be certain that each seat rests solidly on the bottom of the counterbore at all points. To make installation easier, heat the cylinder head in an oven at 325° F for about 1/2-hour and cool the valve seats in ice.

Face each new seat to a 45-degree angle and width of approximately 3/64-inch. The finished seat face should contact approximately center of the valve face. Use Prussian Blue on each valve face to check this. Make any corrections on the seat, not the valve face.

When the new seats are installed and faced, insert the valve into each and check the clearance from valve head to the face of the cylinder head. This must be at least 0.030-inch. If it is not, regrind the seat.

Valve Springs

Check the valve springs on an accurate compression scale. Valve spring data is given in the *DIMENSIONS AND CLEARANCES* section. Replace any spring that is weak, cracked or pitted or has ends out of square.

Installation

1. Push a valve stem oil seal onto the intake valve guide and clamp in place. Then oil the seal with SAE 50 engine oil. Support valve stem seal when installing valves.

   Units built before June 1962 had no valve seals.

2. Oil the stem of each valve lightly with SAE 50 engine oil and insert each valve in its own guide.
3. Check each valve for a tight seal with an air pressure type tester. If a tester is not available, make pencil marks at intervals on the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn in the seat. If the seat is not tight, regrind the valves.
4. Using a valve spring compressor, compress each valve spring and insert the valve spring retainer, and retainer locks. Spring retainer should never contact valve stem seal when compressing valve springs to install spring retainer locks.
5. Install the head assembly and gasket to the cylinder block. Tighten the head bolts in a "clockwise" manner starting with 12 o'clock and follow in the order shown around the "clockface" (Figure 43), finishing at the 10 o'clock position. Torque the bolts evenly to 44-46 foot-pounds.

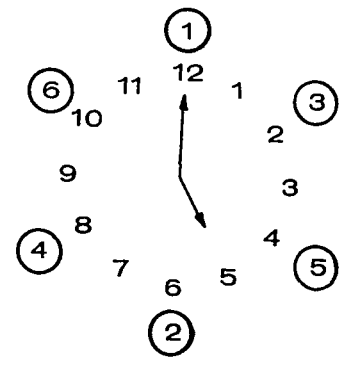


FIGURE 43. TIGHTENING HEAD BOLTS

6. Install the exhaust manifold, nozzles, glow plugs and oil lines.
7. Install the valve stem caps.

8. Install the push rods, rocker arms and rocker arm nuts.
9. Set the valve clearance. See Figure 39.
10. Install and adjust the decompression mechanism.
11. Install the rocker cover. Remove the solenoid, dip plunger "O" ring in oil and reinstall when cover is on engine.

After the first 50 hours of operation, retighten the cylinder head bolts and check valve clearance.

INTERNAL DISASSEMBLY

If engine disassembly is necessary, observe the following order (i.e., flywheel, gear cover . . .). As disassembly progresses, the order may be changed somewhat as will be self-evident. The engine assembly procedure is the reverse of disassembly. Any special assembly instructions for a particular group are included in the applicable section. When reassembling, check each section for these special assembly instructions or procedures.

FLYWHEEL

Remove the blower housing. The flywheel is a tapered fit on the crankshaft. Improvise a puller using at least a 7/16-inch bar and drilling two 7/16-inch holes 2-7/8-inches between centers. Loosen the flywheel mounting screw a few turns. Place bar against the flywheel screw, attach bar using two 3/8-16 thread screws in the holes provided in flywheel. Alternately tighten the screws until flywheel is free.

Replacement flywheels are supplied without the timing markings because each flywheel must be fitted to its engine. The only accurate method of determining the top dead center (TDC) and port closing points is to measure the piston travel. This is a critical measurement and should be attempted only with accurate, dependable equipment.

With the flywheel mounted, remove the head and install a depth gauge over the front piston. Rotate the flywheel to find the TDC position on the compression stroke and mark this point on the flywheel. Next, turn the flywheel counterclockwise until the piston drops exactly 0.102 inch from TDC. This is the port closing point, 17° BTDC. Mark it on the flywheel.

Ring Gear

To remove the ring gear (if damaged), saw part way through, then break it using a cold chisel and heavy hammer.

To install a new ring gear, place it in an oven heated to 380-400° F for 30 to 40 minutes.

CAUTION **Do not heat with a torch. Damage to ring gear will result.**

When heated properly, the ring will fall into place on the flywheel. If it does not go on all the way by itself, drive it into place with a hammer. Do it fast and do not damage the gear teeth. The ring will contract rapidly and may shrink to the flywheel before it is in place. If this occurs, a new ring gear may be required.

GEAR COVER

To remove the gear cover, detach the upper governor ball joint. Remove the governor speed adjustment nut and governor spring bracket.

Remove the screws holding the gear cover to the crankcase. To loosen the gear cover, tap it with a soft hammer.

Governor Shaft

The governor shaft is supported by two sets of needle bearings. To remove the shaft, remove the yoke and pull the shaft from the gear cover. If the shaft is binding, clean the bearings; if loose, replace the bearings. To remove the larger bearing, drive both bearing and oil seal out from the outside of the gear cover. Remove the smaller bearing with an Easy-Out or similar tool. Press new bearings and oil seal into place.

Gear Cover Oil Seal

Replace the oil seal if damaged or worn. Drive the oil seal out from inside the gear cover. See Figure 44. Lay the cover on a board so the seal boss is supported. Using an oil seal driver, insert the new seal from the inside with rubber lip toward outside of gear cover (open side of seal inward) and drive it flush with the outside surface. During gear cover installation, use the driver to protect the oil seal.

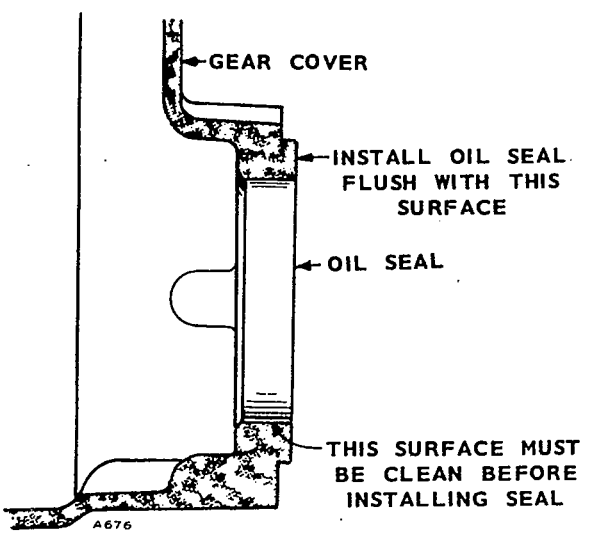


FIGURE 44. GEAR COVER OIL SEAL

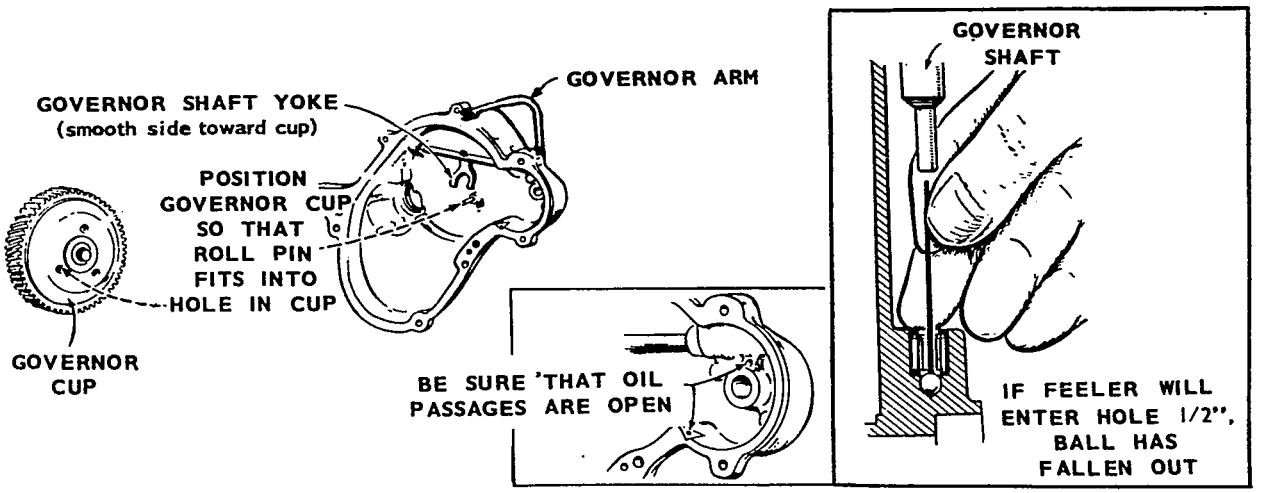


FIGURE 45. GEAR COVER ASSEMBLY

Assembly—Gear Cover

1. Work the governor shaft to check for binding and see that the governor shaft end thrust ball is in place (Figure 45). Later models have larger ball which will not fall out.
2. Turn governor yoke so the smooth side is toward governor cup.
3. Turn the governor cup so the stop pin in the gear cover will fit into one of the holes in the cup surface (Figure 45). Measure the distance from the end of the stop pin to the mounting face of the cover. It should be 25/32-inch. If it is not, replace the pin. Pin should be positioned with open end facing crankshaft seal.
4. Coat the oil seal lip with oil or grease. Set a piece of shim stock over the crankcase keyway to protect the seal and install the gear cover. Tighten the mounting screws to specified torque. Before tightening screws, be sure the stop pin is in the governor hole.

GOVERNOR CUP

To remove the governor cup, remove the snap ring from the camshaft center pin and slide the cup off. Be sure to catch the flyballs that will fall out when the cup is removed. See Figure 46.

Repair

Replace any flyballs that have flat spots or grooves. Replace the cup if the race surface is grooved or rough. The governor cup must be a free spinning fit on the camshaft center pin, but should be replaced if excessively loose or wobbly.

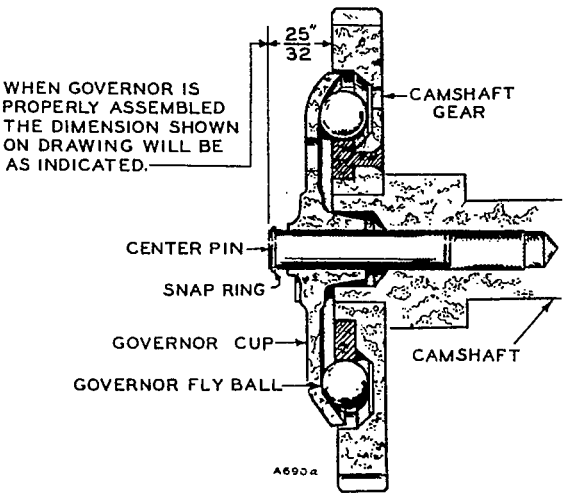


FIGURE 46. GOVERNOR CUP

Check the distance the center pin extends from the camshaft gear, this distance must be 25/32-inch to give the proper travel distance for the cup. If it is less, the engine may race; if more, the cup will not hold the balls properly. If the distance is too great, drive or press the center pin in. If it is too small, replace the pin; it cannot be removed without damaging the surface. In some cases, if the distance is too small, the head of the governor cup can be ground to give the necessary 7/32-inch travel distance.

Installation

To install the governor assembly, tip the front of the unit upward. Set the flyballs in their recesses and position the governor cup on its shaft. Finally, brush with heavy grease and install the snap ring on the center pin.

PISTONS, RINGS, RODS

This engine uses a cam ground aluminum piston tapered and fitted with three compression rings and an oil control ring. A full floating piston pin connects the piston to its connecting rod. The pin is held in place with a snap ring at each end. The lower end of the connecting rod contains half shell, precision bearings and the upper end, semi-finished bushings.

Some engines are fitted with a 0.005-inch oversize piston at the factory. These engines are marked with an *E* following the engine serial number.

Removal and Disassembly

1. Drain the crankcase oil and remove the oil base.
2. Remove the cylinder head.
3. Remove the cap from the connecting rod and push the assembly through the top of the cylinder bore. Replace the cap and bearing inserts in the assembly.
4. Using a ring expander, remove the rings from the piston.
5. Remove the two retaining rings and push the piston pin from the piston.

Cylinders

The cylinder wall should be free of scratches, pitting and scuffing. Check cylinder with an inside reading micrometer for out-of-round and wear. The bore should measure between 3.2495 inch and 3.2505 inches and be less than 0.001-inch out-of-round.

If necessary, rebore the cylinder to fit the next available oversize piston. Pistons and rings are available in 0.005-inch, 0.010-inch, 0.020-inch, 0.030-inch and 0.040-inch oversize. If the cylinder does not need refinishing, remove any existing ridges from the top of the wall with a fine stone.

Pistons

Clean thoroughly and inspect the piston. Clean the carbon from the ring grooves and be sure all oil holes are open. If the piston is badly scored or burred, loose in the cylinder, has badly worn ring grooves or otherwise is not in good condition, replace it.

Check the clearance 90 degrees from the axis of the piston pin and below the oil control ring. Clearance should be 0.0055- to 0.0075-inch. If not, replace the piston and check the cylinder for possible reconditioning.

Piston Pins

The piston pin should be a thumb push fit into the piston at room temperature. If the pin is excessively loose, install a new one. If the condition is not corrected, install the next oversize pin. If the condition is not corrected, install the next oversize pin. If the piston is worn enough that the oversize pin will not fit, replace it.

Rings

Inspect each ring carefully for fit in the piston grooves and seating on the cylinder wall. Fit each ring to the cylinder wall at the bottom of its travel, using the piston to square the ring in the bore. Check the gap with a feeler gauge. It should be 0.010-inch to 0.020-inch. If the gap is too small, file the butt ends of the rings. Do not use rings that need a lot of filing, they will not seat right on the cylinder wall. If an oversize piston is used, use the correct oversize rings. See Figure 47.

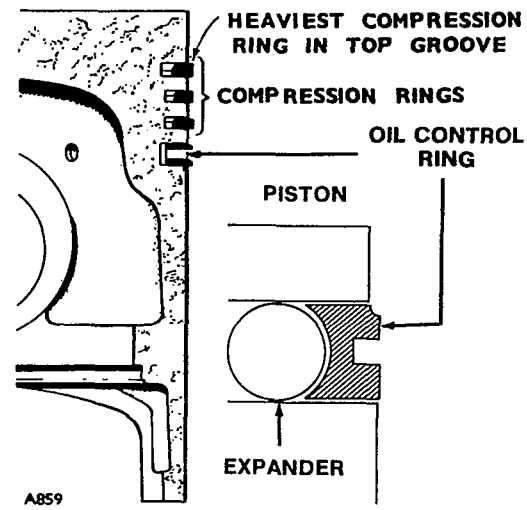


FIGURE 47. PISTON RINGS

Connecting Rods

Clean the connecting rod and check for defects. Check the connecting rod bushings for proper clearance with the piston pin. Clearance should be .0002-inch to .0007-inch.

If the bushings are excessively worn, press them out and install one new bushing from each side of the bushing bore. Press the new bushings only until flush with the side of the rod to leave 1/16-inch to 7/64-inch oil groove in the center. See Figure 48.

Connecting Rod Bearings

Inspect the connecting rod bearings for burrs, breaks, pits and wear. Measure the clearance between bearings and the crankshaft journal. The clearance should be 0.001-inch or 0.003-inch. If necessary, replace with new standard or oversize precision bearings.

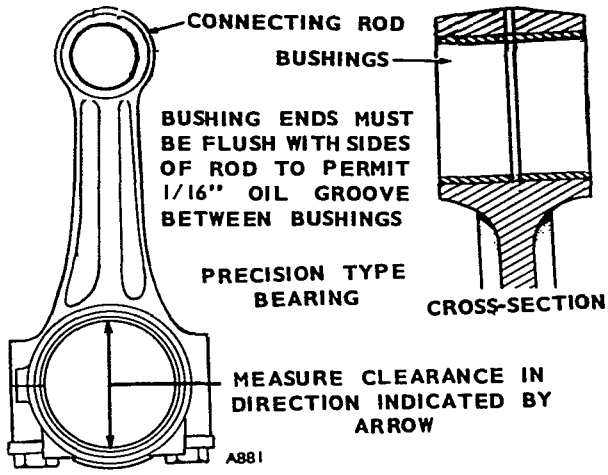


FIGURE 48. CONNECTING ROD BUSHINGS

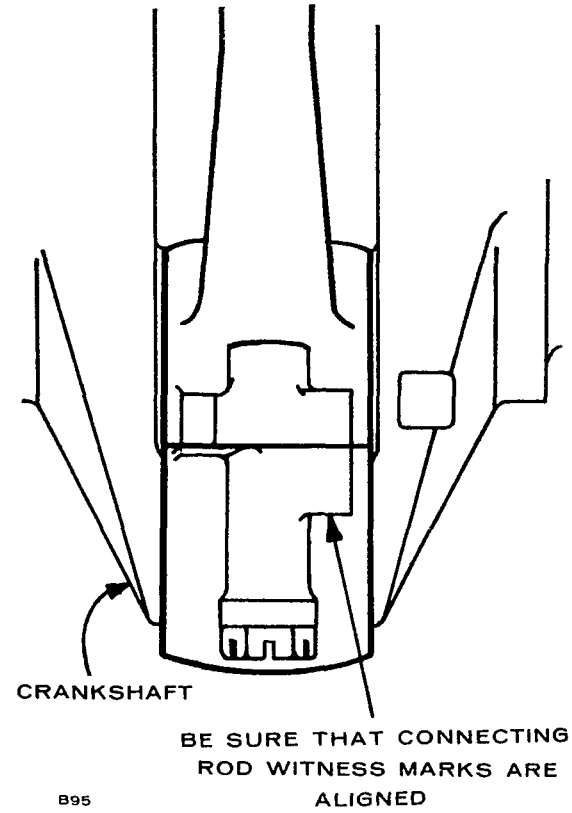


FIGURE 49. CONNECTING ROD CAP

Assembly and Installation

1. Install the connecting rod on the piston with the pin and retaining rings. If new bushings were installed, check to see that the ends are flush with the connecting rod to provide for the oil recess in the center.
2. Install the rings on the piston. Tapered rings will be marked *top* or identified in some other manner. Place this mark toward the closed end of the piston. Space the ring gaps 1/4 of the way around the piston from one another. No gap should be in line with the piston pin. Oil the rings and piston.
3. Position a bearing half in the connecting rod. Be sure there is no dirt under the bearing; this could cause high spots and early bearing failure.
4. Oil the cylinder wall. Install the piston in the cylinder using a suitable installer. The assembly should be installed with the stamp on the piston in the same direction as when removed.
5. Position the connecting rod on the camshaft, oil the journal and install its rod cap with bearing half. When installing the rod cap, position so the raised witness mark on the forging matches the mark on the connecting rod (Figure 49).
6. Tighten the cap screws to the specified torque.
7. Crank the engine over by hand to see that the bearings are free.
8. Install the oil base with a new gasket.
9. Install the cylinder head using an even bolt tightening sequence and specified torque.
10. Replace oil.

CAMSHAFT

The camshaft is a one-piece machine casting, driven through gears by the crankshaft. It rides on sleeve bearings pressed into the crankcase.

In addition to providing a means of opening and closing the valves, the camshaft operates the injection pump and fuel transfer pump.

Removal

1. Remove the rocker arms and push rods from the valve chambers.
2. Remove the injection pump and fuel transfer pump from the engine.
3. Remove the crankshaft gear retaining washer by removing the lock ring on the crankshaft.
4. Lay the engine on side to avoid dropping tappets and remove the camshaft assembly as a group. If necessary, pry it out with a screwdriver between the camshaft gear and crankcase.
5. Remove the valve tappets. These can be removed only from the camshaft end of the push rod holes.

Repair

If a lobe has become slightly scored, dress it smooth with a fine stone. If the camshaft is badly worn or scored, replace it. After installing a new camshaft, retime the injection pump to the engine.

Camshaft Gear

This gear is a pressed fit on the camshaft and drives it at 1/2 the crankshaft speed. To remove the gear, use a hollow tool or pipe that will fit inside the gear bore and over the center pin. Press the camshaft out of the gear bore. Be careful not to damage the center pin.

Camshaft Bearings

The camshaft bearings should be replaced if the clearance to the camshaft is greater than specified, the bearings show cracks, breaks, burrs, excessive wear. or other defects. The camshaft to bearing clearance should be 0.0012-inch to 0.0037-inch. To check the rear bearing, remove the expansion plug at the rear of the crankcase.

Press new bearings into place (Figure 50). Press rear bearing flush with the bottom of the expansion plug recess. Press the front bearing in flush with the crankcase front surface so the oil passages are aligned. Do not attempt to ream the bearings; they are a precision type. After the rear bearing is installed, insert a new expansion plug in the recess, using sealing compound, and expand it into place with sharp blows at its center.

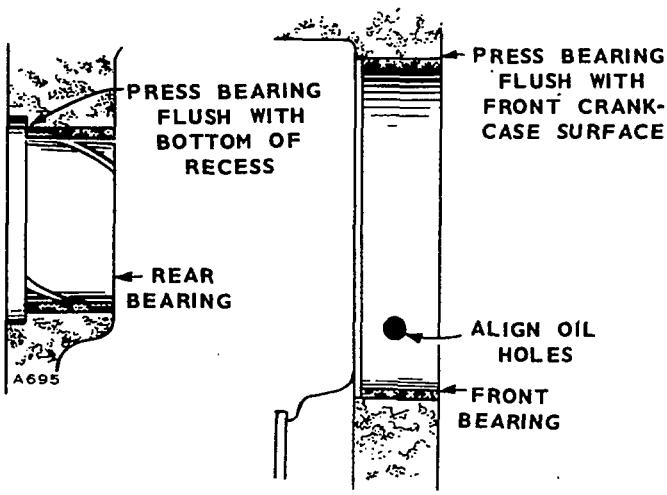


FIGURE 50. CAMSHAFT BEARINGS

Installation—Camshaft Assembly

1. Install the key and press the camshaft gear on its shaft.
2. Install the governor components.
3. Slide the thrust washer onto the shaft.
4. Lay the engine on side or end and insert the push rod tappets.
5. Install the camshaft assembly in the engine. Align the timing marks on the camshaft gear and crankshaft gear. See Figures 51 and 52.
6. Replace the push rods and fuel transfer pump.
7. When the engine is reassembled, install the injection pump following the steps for *Injection Pump Installation* in the *FUEL SYSTEM* section. This step is critical.

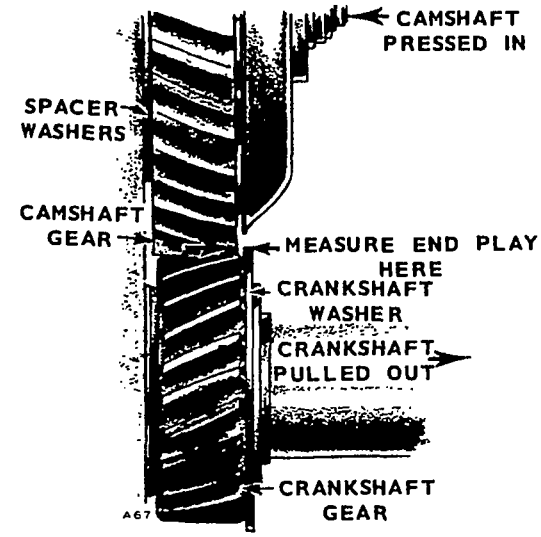


FIGURE 51. CAMSHAFT ENDPLAY

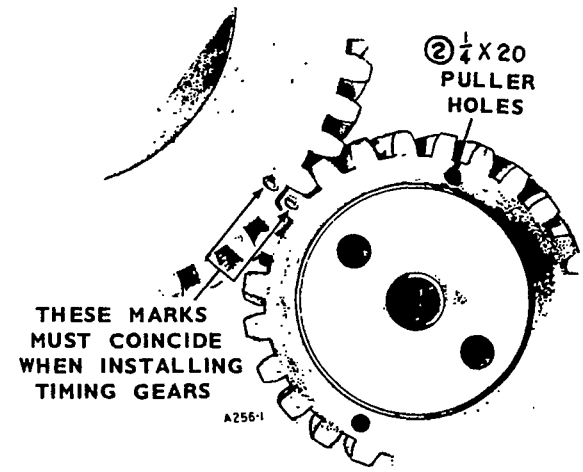


FIGURE 52. TIMING MARKS

CRANKSHAFT

These engines use a counter-balanced, ductile iron crankshaft. To increase the shaft's fatigue durability, all crankpin fillets are shot-peened during manufacturing. The crankshafts ride on two lead-bronze bearings, the front one housed in the crankcase and the rear one in the bearing plate.

Removal

1. Remove the lock ring and retaining washer in front of the crankshaft gear.
2. Pull off the crankshaft gear. See Figure 53. It has 2-1/4-20 UNC tapped holes for attaching a gear pulling ring. Use care not to damage teeth if the gear is to be reused.
3. Remove the oil pan, piston and connecting rod.
4. Remove the rear bearing plate from the crankcase.
5. Remove the crankshaft through the rear opening in the crankcase.

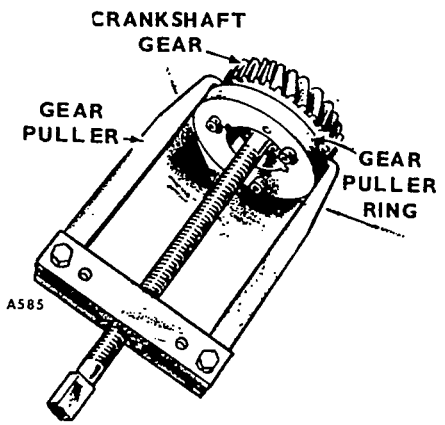


FIGURE 53. REMOVING CRANKSHAFT GEAR

Inspection

Clean the crankshaft and blow out all oil passages. Check journals for out-of-round, taper, grooving or ridges. Pay particular attention to ridges or grooves on either side of the oil hole area. Unusual conditions here often point to previous neglect of oil changes.

If journal dimensions are not within limits or the journals are scored, regrind the crankshaft.

Crankshaft Regrinding

Crankshaft grinding requires a trained, experienced operator, with precision equipment. Onan emphasizes that if facilities or trained personnel are not available, the crankshaft may be sent to the factory.

Special procedures must be observed when reworking diesel crankshafts. In addition to machining, the crankshaft must be *shot-peened* and super-finished. Failure to shot-peen the crankpin fillets is likely to cause early failure. When the shaft is machined, follow this data and Figure 54 to shot-peen each crank pin fillet.

1. Almen gauge reading, 0.012-A.
2. Mask off connecting rod bearing areas.
3. Peen for 15 seconds on each crankpin fillet.
4. Peen with 0.019-inch diameter cast steel shot.

Undersize bearings and connecting rods are available to rework the shaft to 0.010-inch, 0.020-inch and 0.030-inch undersize.

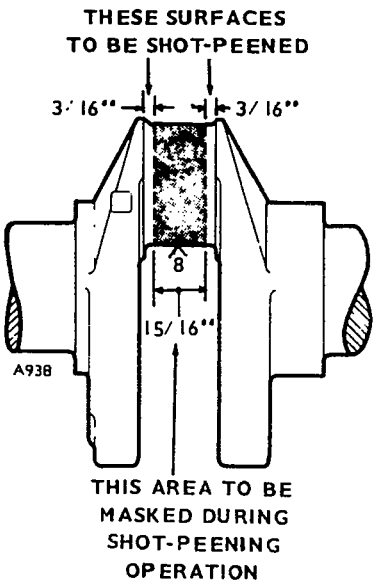


FIGURE 54. SHOT-PEENING THE CRANKSHAFT

MAIN BEARINGS

Replace main bearings if clearances are greater than limits, or the bearings are worn, grooved or broken. See Figure 55.

Precision replacement bearing inserts and thrust washers are available for all main bearings. Do not ream the bearings. Align the oil holes and press the new bearings into the front and rear housings.

REAR OIL SEALS

The rear oil seal is in the rear bearing plate. If damaged, drive it out from the inside of the plate. Using the oil seal installing tool, install a new seal with the rubber lip facing outward (open side of seal inward). See Figure 50. Drive the new seal flush with the rear surface of the bearing plate. Leave the seal installer on during bearing plate installation to protect the oil seal.

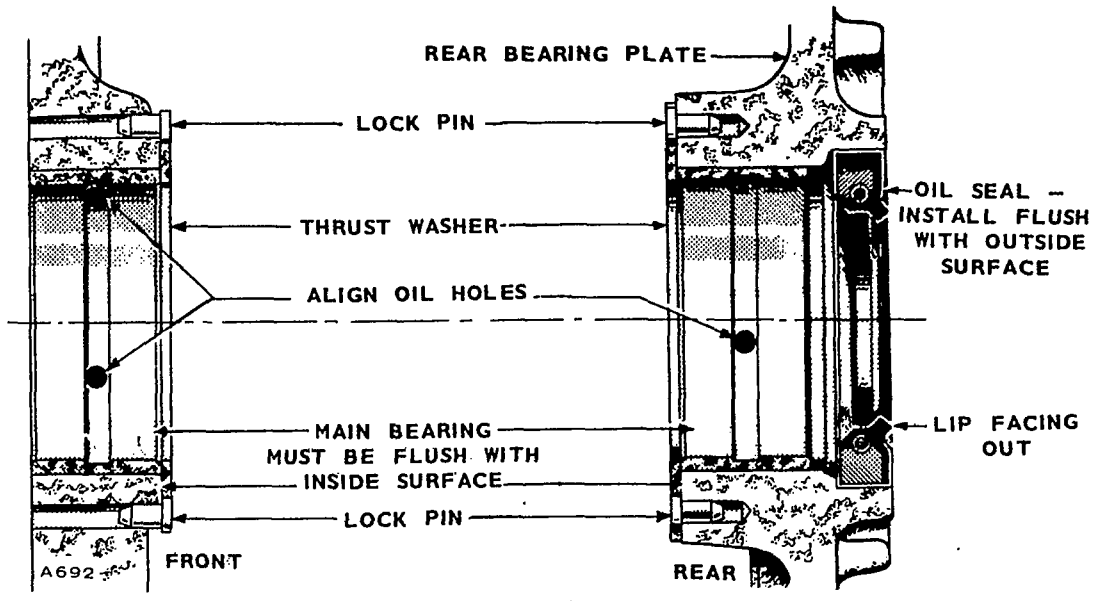


FIGURE 55. MAIN BEARING INSTALLATION

Installation

After each installation step, check the crankshaft to be sure it is not frozen into place.

1. Press the front and rear main bearings into place, aligning the bearing and bearing housing oil holes. Do not attempt to drive a bearing into a cold block or rear bearing plate.
2. Install the thrust washers and locking pins.
3. Oil the bearing surfaces and install the crankshaft from the rear of the crankcase, through the rear bearing plate hole.
4. Mount and secure the rear bearing plate.
5. Heat the timing gear on an electric burner or oven to about 350° F. Install the key on the crankshaft, then drive the gear into place. Install the retaining washer and lock ring.
6. Check the crankshaft end play. Use enough rear bearing plate gaskets or shim and gaskets to provide 0.010-inch to 0.015-inch end play. If gaskets of more than 0.015-inch total thickness are required, then use a steel shim of proper thickness and a thin gasket on each side of shim. This avoids excessive gasket compression and maintains bolt torque.
7. Install the piston assembly.

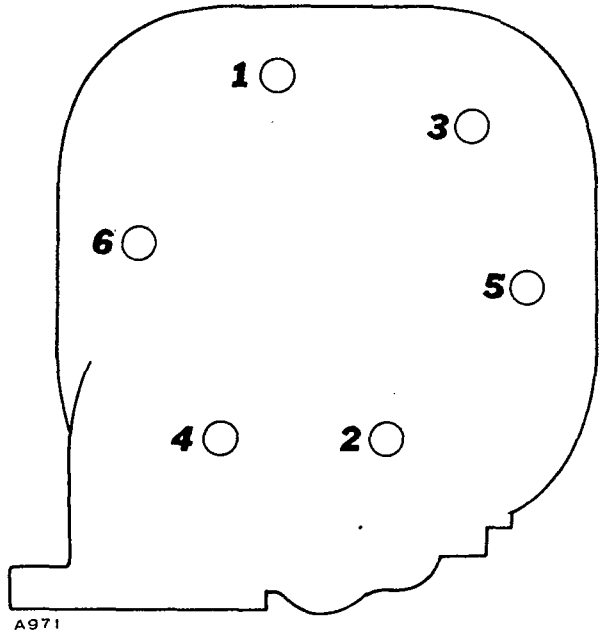


FIGURE 56. BOLT TIGHTENING SEQUENCE

CRANKCASE

If the crankcase requires replacement, a new set of injection pump shims will be furnished with the new crankcase. These must be used, and in addition, the injection pump must be retimed to the engine.

CYLINDER HEAD

After the first 50 hours of operation, retighten the cylinder head bolts and check valve clearance. See Figure 56.

BREAK-IN PERIOD

Whenever new rings or pistons are installed or the cylinder refinished, the engine must be run-in before regular operation can be resumed. Run the engine for 15-20 minutes at no load; about 1/2 hour at 1/3 load; and 2-3 hours at 2/3 load. Then regular operation can be resumed. Avoid light load operation during the following several hours for best ring seating to control oil.

CONTROL SYSTEM

Due to the wide variety of uses to which these engines are adapted, operating controls are not supplied with the majority of these engines. The engines in most cases are used for prime power to operate other manufacturer's equipment. Installation nearly always differs. Therefore, the manufacturer or fabricator generally provides a control, or control components for engine, incorporated in a control for the complete unit.

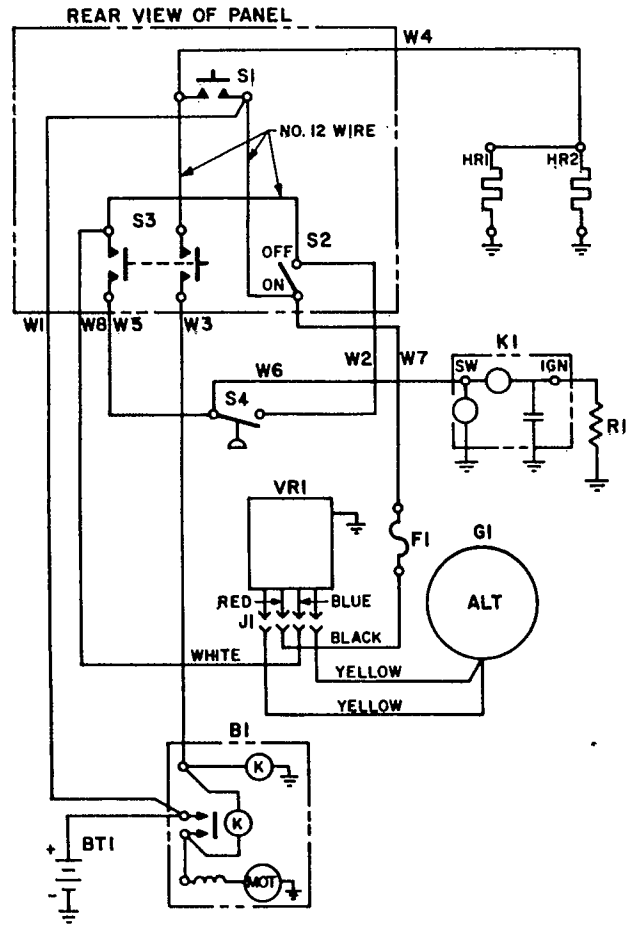
Operating controls are furnished on some models when the customer can use standard controls. They are mounted on the rear cylinder air housing. Refer to the appropriate wiring diagram.

For basic engine controls and optional equipment controls which are mounted on the engine, instructions are included in the related groups in the manual.

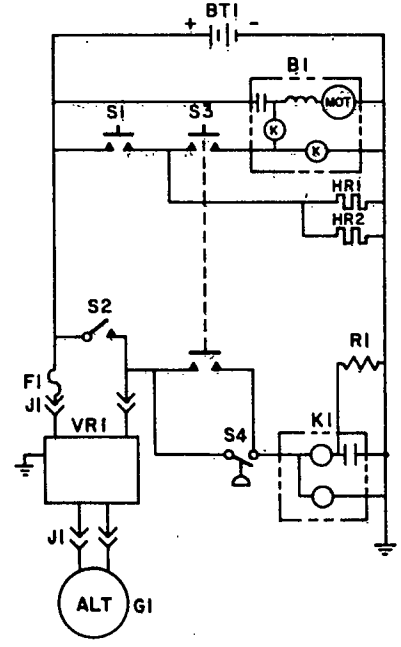
MAINTENANCE

Periodically check all connections and contacts in the control system to be sure they are tight and clean.

622B334 TYPICAL WIRING DIAGRAM



SCHEMATIC



PARTS LIST

REF DES	DESCRIPTION
B1	STARTER
BT1	BATTERY 12 V
F1	FUSE 30 A
G1	ALTERNATOR FLYWHEEL
HR1	PLUG-GLOW
HR2	HEATER MANIFOLD
J1	CONNECTOR
K1	SOLENOID-FUEL
R1	RESISTOR-5Ω, 25W
S1	SWITCH GLOW PLUG
S2	SWITCH FUEL SOLENOID
S3	SWITCH-STARTER
S4	SWITCH-LOW OIL PRESS
VR1	VOLTAGE REGULATOR
W1	LEAD ASSY
W2	LEAD ASSY
W3	LEAD ASSY
W4	LEAD ASSY
W5,6	LEAD ASSY
W7,8	LEAD ASSY
	PANEL ASSY-CYL SHROUD

LET	REVISION	CKD	DATE
A	SUPSDS SAME NO. DTD 12-30-71		7-18-72

Onan DIVISION OF STUDEBAKER CORPORATION

	MODEL NO	DATE	BY	CKD
-01	DJA-MF 2320T	7-18-72	DEB	G.F.T.
	12 VOLT STARTING	NAME: CONTROL-ENGINE (WIRING DIAGRAM)		
		DWG NO: 622 B 334		

ONAN DIESEL STARTING GUIDE

IMPORTANT!

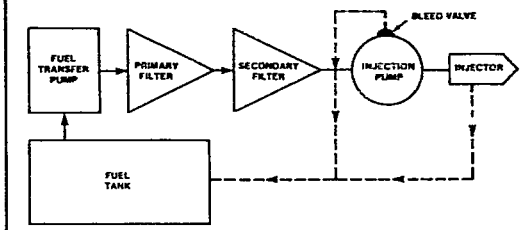
KEEP ENTIRE FUEL SYSTEM CLEAN AND FREE FROM WATER

- DIESEL INJECTION PUMPS WILL FAIL IF SYSTEM CLEANLINESS IS NEGLECTED

INJECTION PUMPS AND NOZZLES ARE NOT FIELD REPAIRABLE

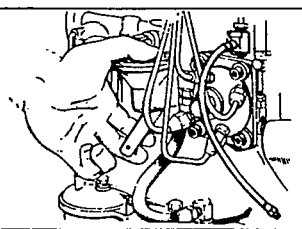
- WHEN TROUBLESHOOTING. CHECK ALL OTHER COMPONENTS FIRST

WARNING **DO NOT USE ETHER STARTING AIDS! ETHER IS EXTREMELY EXPLOSIVE AND MAY CAUSE SERIOUS PERSONAL INJURY. ENGINE DAMAGE IS ALSO LIKELY.**



BEFORE STARTING:

CHECK FUEL SUPPLY. BE SURE SHUTOFF VALVES ARE OPEN.



PRIME FUEL SYSTEM IF: FUEL FILTERS WERE DRAINED OR CHANGED, SYSTEM WAS JUST INSTALLED, FUEL TANK RAN DRY.

TO PRIME PUMP, MOVE PRIMING LEVER UP AND DOWN UNTIL FUEL FLOWS STEADILY FROM RETURN LINE (DISCONNECTED).

PREHEAT COLD ENGINE: PUSH PREHEAT SWITCH AND HOLD —

- **30 SECONDS IF ABOVE 55°F (13°C);**
- **60 SECONDS IF BELOW 55°F (13°C).**

TO START:

RELEASE PREHEAT

ENGAGE START SWITCH

LIMIT CRANKING TO 15 TO 20 SECONDS TO CONSERVE BATTERY. ALLOW 1 MINUTE BEFORE RE-CRANKING.

IF ENGINE DOES NOT START:

IF ENGINE FIRED, REPEAT ABOVE PROCEDURES, INCLUDING PRE-HEAT. IF IT STILL DOES NOT START, PROCEED AS FOLLOWS:

TEMPERATURES BELOW 32°F (0°C): USE NUMBER 1 DIESEL FUEL. USE CORRECT VISCOSITY OIL. KEEP BATTERIES FULLY CHARGED. DO NOT USE ETHER STARTING AID.

OBSERVE ENGINE EXHAUST "SIGNALS":

BLUE-WHITE EXHAUST SMOKE: ENGINE IS GETTING FUEL

- WAS PREHEAT OBSERVED?
- CHECK AIR HEATERS, GLOW PLUGS, WIRING HARNESS.
- CHECK PRE-HEATER CIRCUIT. SEE SERVICE MANUAL.
- CHECK ENGINE COMPRESSION. SEE SERVICE MANUAL.
- CHECK VALVE LASH. SEE SERVICE MANUAL.
- CHECK BATTERY - CRANKING.
- CHECK DECOMPRESSION SYSTEM ON 1 CYL. ENGINES.
- CHECK NOZZLE CONDITION. NOZZLE STUCK OPEN WILL RESULT IN POOR STARTS. OTHERWISE MARGINAL OR POOR NOZZLE CONDITION WILL NOT AFFECT STARTING.

IF ALL THE ABOVE CONDITIONS CHECK OK, CHECK INJECTION TIMING. SEE SERVICE MANUAL.

LITTLE OR NO EXHAUST SMOKE: ENGINE IS NOT GETTING FUEL. PRIME FUEL SYSTEM AS SHOWN ABOVE: OBSERVE FUEL FLOW FROM RETURN LINE

FUEL FLOWS STEADILY

CHECK GOV. LINKAGE, ADJUST IF NECESSARY.

CHECK AND TIGHTEN ALL HIGH PRESSURE FUEL LINES.

CHECK DELIVERY VALVE. PROBLEM MAY BE OVER-TORQUE OR STICKY DUE TO DIRT, ETC. USE CAUTION. DELIVERY VALVE MUST BE KEPT CLEAN. SEE MSM SECTION 20.

CHECK EXCESS FUEL DEVICE ON BRYCE-KIKI INJECTION SYSTEMS - DJE & MDJE - SPEC AB AND LATER.

LITTLE OR NO FUEL FLOW

CHECK FUEL SUPPLY SYSTEM:

- FUEL TANK EMPTY?
- SHUTOFF VALVES CLOSED?
- FUEL LINES KINKED?
- LOOSE CONNECTIONS?
- CLOGGED FUEL FILTERS?
- AIR IN SYSTEM FROM FILTER CHANGE
- FUEL SUPPLY LINE LEAK-SUCTION SIDE

CHECK FOR PLUGGED INJECTION PUMP BLEED LINE OR VALVE.

CHECK FOR WATER-ICE IN FUEL SYSTEM.

CHECK FUEL TRANSFER PUMP PRESSURE WHILE CRANKING. SHOULD BE 4-6 PSI (27.6-41.4 kPa) ON 1 CYL. ENG: 12-14 PSI (82.7-96.5 kPa) ON 2-4 CYL. ENG.

IF ENGINE IS STILL NOT GETTING FUEL, CHECK TRANSFER PUMP:

1. **CRANK ENGINE AND OBSERVE FUEL FLOW FROM RETURN LINE.**
2. **IF FUEL DOES NOT SPURT OUT, PUMP MAY BE DEFECTIVE.**

Onan

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