onan®

OPERATORS/SERVICE MANUAL AND PARTS CATALOG

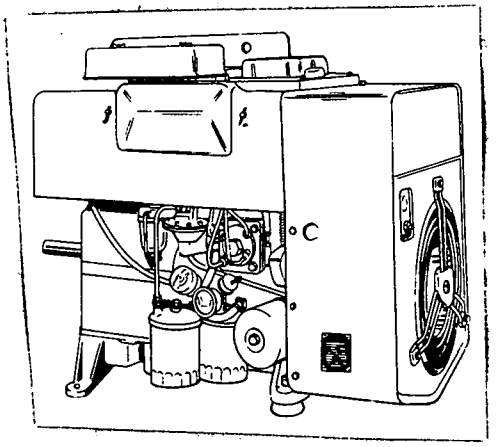
SERIES

DJB-DJC

INDUSTRIAL ENGINES

DJB FORMERLY CALLED DJ60

DJC FORMERLY CALLED DJ120



ONAN 1400 73RD AVENUE N.E. • MINNEAPOLIS, MINNESOTA 55432

A DIVISION OF ONAN CORPORATION

967-463

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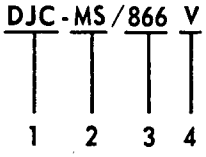
GENERAL INFORMATION

All DJ-Series engines discussed in this manual are 4 cycle, vertical, in-line, air-cooled diesel engines with overhead valves. The crankcase and cylinders are integral. The engines are run in and adjusted at the factory. Any damage incurred in transit must be corrected before operating engine.

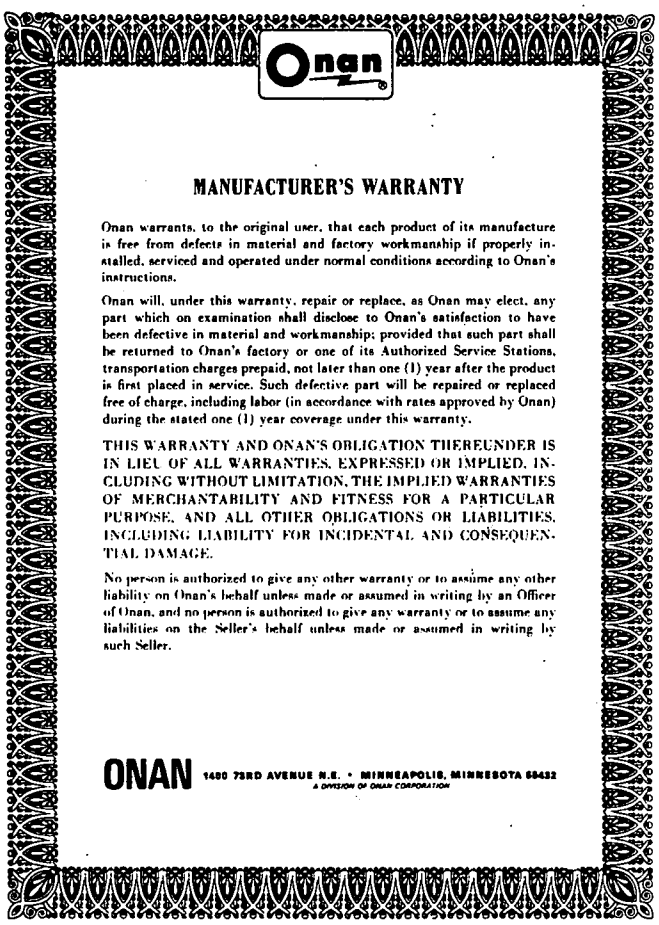
Normal engine speed range is up to 2400 rpm. An internal, constant speed, flyball type mechanical governor, externally adjustable, is standard. Optional two-speed and variable-speed governors are available. Two- and four-cylinder units are included in this manual because of their similarity. Unless otherwise specified, all instructions and procedures apply to all DJ engines. When instructions apply to a specific engine model, refer to the engine nameplate for the *Model and Spec. No.* in question. See Figure 1 for a representative view of the DJB-DJC Industrial Engine.

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

How to interpret MODEL and SPEC NO.



1. Factory code for general identification purposes.
2. Specific Type:
   S-MANUAL starting with stub shaft power take off.
   MS-ELECTRIC starting with stub shaft, starter and generator.
3. Factory code for optional equipment supplied.
4. Specification (Spec Letter) advances with factory production modification.


Onan

MANUFACTURER'S WARRANTY

Onan warrants, to the original user, that each product of its manufacture is free from defects in material and factory workmanship if properly installed, serviced and operated under normal conditions according to Onan's instructions.

Onan will, under this warranty, repair or replace, as Onan may elect, any part which on examination shall disclose to Onan's satisfaction to have been defective in material and workmanship; provided that such part shall be returned to Onan's factory or one of its Authorized Service Stations, transportation charges prepaid, not later than one (1) year after the product is first placed in service. Such defective part will be repaired or replaced free of charge, including labor (in accordance with rates approved by Onan) during the stated one (1) year coverage under this warranty.

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No person is authorized to give any other warranty or to assume any other liability on Onan's behalf unless made or assumed in writing by an Officer of Onan, and no person is authorized to give any warranty or to assume any liabilities on the Seller's behalf unless made or assumed in writing by such Seller.

ONAN 1400 73RD AVENUE N.E. • MINNEAPOLIS, MINNESOTA 55432
A DIVISION OF ONAN CORPORATION

SPECIFICATIONS

	DJB	DJC
Dimensions (inches)		
Height	28-1/2	26
Width	18-3/8	19-1/2
Length	24-9/16	34-1/2
Weight	270	440
Number of Cylinders	2	4
Displacement (cu in.)	60	120
Bore	3-1/4	3-1/4
Stroke	3-5/8	3-5/8
H P at 2400 rpm (continuous)	14.6	27.5
Compression Ratio	19.1	19.1
Main Bearings are Leaded Bronze, Precision Type for Replacement (qty)	2	3
Connecting Rod Bearings Tri-metal Replaceable	yes	yes
Piston Rings (chrome plated)		
Oil Control	1	1
Compression	3	3
Stellite Faced Valves	yes	yes
Stellite Replaceable Valve Seats	yes	yes
Valve Rotator	yes	yes
Governor (internal flyball type - externally adjustable)	yes	yes
Governor Regulation (percent)	5	5
Nominal Battery Voltage	12	12
Battery Size		
SAE Group 1H, 6 volt	two	two
Amp/Hr SAE 20 hr (minimum)	105	120
Solenoid Shift Starter	yes	yes
Engine cooling air CFM at 1890 rpm *	590	900
Total cu ft per min of air required	613.8	947
Combustion Air (cfm) **	32	64
Cooling Air (cfm) **	790	1135
Inlet Vent (sq ft)	7	12
Outlet Vent (sq in) ***	80	160
Air Cleaner	dry	dry
Glow Plugs and Air Heater to Aid Starting	yes	yes
Injection Pump (American Bosch type)	PSU	PSU
Injection Order		1-2-4-3
Primary and Secondary Fuel Filters	yes	yes
Fuel Pump Lift (feet)	6	6
Oil Pump (gear type)	yes	yes
Oil Filter (full flow)	yes	yes
Oil Capacity (U.S. quarts) ****	3	6
Exhaust Connections (pipe tapped)	1-1/4	1-1/2
Power Take-off (inches)		
Shaft Length	4	4
Shaft Diameter	1-3/4	1-3/4
Keyway Length	3	3
Keyway Width	3/8	3/8
Keyway Depth	3/16	3/16

* Pressure-cooled type air flow.

** Air requirements at 2400 rpm.

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

**** Add 1/2 quart for oil filter.

P. 3

MISSING

(PROBABLY WAS NONE!)

DIMENSIONS AND CLEARANCES

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

	Minimum	Maximum
CAMSHAFT		
Bearing Journal Diameter, front	2.500	2.505
Bearing Journal Diameter, rear	1.1875	1.1880
Bearing Clearance Limit	0.0012	0.0037
End Play, Camshaft	0.007	0.039
Cam Tappet Hole Diameter	0.7505	0.7515
Cam Tappet Diameter	0.7475	0.7480
CONNECTING RODS		
Large Bearing Bore Diameter	2.1871	2.1876
Small Bushing Bore Diameter	1.044	1.045
Distance Center Large Bearing Bore to Small Bushing Bore	5.998	6.002
Clearance, Large Bearing to Crankshaft	0.001	0.003
CYLINDER		
Cylinder Bore	3-1/4	
Cylinder Diameter Limits	3.2495	3.2505
CRANKSHAFT		
Main Bearing Journal Diameter (DJB)	2.2440	2.2445
Crankshaft Main Bearing Clearance (DJB)	0.0014	0.0049
Main Bearing Journal Diameter (DJC)	2.2430	2.2435
Crankshaft Main Bearing Clearance (DJC)	0.0024	0.0049
Connecting Rod Journal Diameter	2.0600	2.0605
End Play, Crankshaft	0.010	0.015
PISTON		
Piston Clearance to Cylinder Wall	0.0050	0.0070
Piston Pin Hole Diameter	0.9900	0.9903
Ring Groove Width, top	0.097	0.098
Ring Groove Width, 2nd	0.0965	0.0975
Ring Groove Width, 3rd	0.0965	0.0975
Ring Groove Width, 4th	0.1880	0.1895
PISTON PIN		
Length	2.753	2.758
Diameter	0.9899	0.9901
Piston Clearance	Thumb Push Fit	
Connecting Rod Bushing Clearance	0.0002	0.0007
PISTON RINGS		
Ring Type		
Top	Compression	
2nd	Compression	
3rd	Compression	
4th	Oil Control	
Ring Width		
Top	0.0925	0.0935
2nd	0.0925	0.0935
3rd	0.0925	0.0935
STARTING MOTOR		
Rotation	Counterclockwise	
Pinion Clearance to Pinion Stop (Solenoid Plunger Bottomed)	0.070	0.120
Pinion Rest Position - Distance from Pinion Housing Mounting Face to Outer Edge of Pinion	1-9/32	1-15/32

Armature End Play	0.005	0.030
Test Specifications		
No Load	10 V - 80 amps 5000 rpm min.	
Stall Torque	4 V - 420 amps 7.8 ft - lbs min.	
Brush Spring Tension	32-40 oz with new brushes	
VALVE INTAKE (Stellite faced)		
Stem Diameter	0.3405	0.3415
Clearance in Guide	0.0005	0.0025
Seat Angle	42 degrees	
Valve Clearance	See Table 4	
VALVE, EXHAUST (Stellite faced)		
Stem Diameter	0.3405	0.3415
Clearance in Guide	0.0025	0.0045
Seat Angle	45 degrees	
Valve Clearance	See Table 4	
VALVE GUIDE		
Length	1-25/32	
Outside Diameter	0.4690	0.4695
Cylinder Block Bore Diameter	0.467	0.468
Inside Diameter (after reaming)		
Exhaust	0.344	0.345
Intake	0.342	0.343
VALVE SEATS (Stellite)		
Valve Seat Bore		
Diameter	1.361	1.362
Depth (from cylinder head face)	0.433	0.439
Seat Outside Diameter	1.364	1.365
Seat Width	3/64 - 1/16	
Seat Angle	45 degrees	
Available Oversizes	0.002, 0.005, 0.010, 0.025	
VALVE SPRINGS		
Free Length	1-7/8	
Length, Valve Closed	1.528	
Load, Valve Closed	45 - 49 lbs.	
Length, Valve Open	1.214	
Load, Valve Open	83 - 93 lbs.	

ASSEMBLY TORQUES AND SPECIAL TOOLS

The assembly torques given here will assure proper tightness without danger of stripping threads. If a torque wrench is not available, estimate the degree of tightness necessary for the stud, nut, or screw. 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. 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.

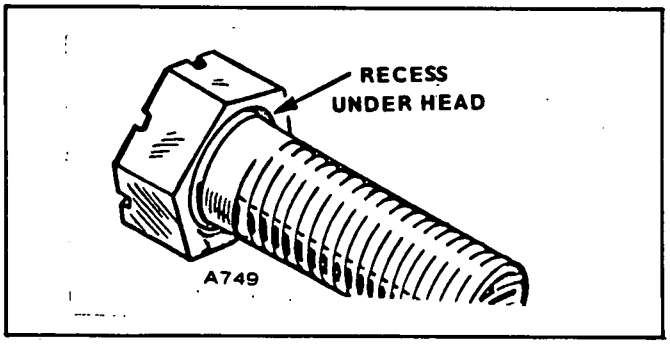


FIGURE 2. PLACE BOLT

TORQUE SPECIFICATIONS	FT.-LB.
Center main bolt (four cylinder)	97-102
Connecting rod bolt	27-29
Rocker-Box cover	8-10
Cylinder head bolt	44-46
Exhaust manifold nuts	13-15*
Flywheel mounting screw	65-70
Hub to flywheel screws (four cylinder)	17-21
Fuel pump mounting screws	15-20
Gear case cover	15-20
Glow plug	10-15
Injection nozzle mounting screws	20-21
Injection pump mounting screws	15-16
Intake manifold	13-15
Oil base mounting screws	45-50
Oil Filter	Hand tight plus 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

* - Exhaust nuts must be tightened evenly.

** - This torque is due to friction between the threads only and locks the nuts in place. Use the rocker arm nut to adjust valve lash.

SPECIAL TOOLS

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

Crankshaft gear pulling ring	420A248
Diesel nozzle tester	420P184
Diesel pintle nozzle cleaning tool set (includes injection nozzle centering tool)	420P208
Driver, Front camshaft bearing	420A252
Driver, Rear camshaft bearing	420B251
Driver, Center camshaft bearing (DJC only)	420B254
Driver, Main bearing front and rear	420B269
Driver, Valve seat	420B270
Oil seal guide and driver	420B250
Valve seat remover	420B272
Replacement blades for 420B272	420B274
Wrench; Oil filter (for Purolator full flow filter)	420P268

ENGINE TROUBLESHOOTING

OPERATOR'S TROUBLE-SHOOTING GUIDE for ONAN DIESEL ENGINES (Air Cooled)

	CAUSE / TROUBLE	Hard Starting or Failure to Start	Starter Motor Doesn't Turn	Engine Misfires	Speed Too High	Speed Too Low	Hunting Condition	No Governor Control	Poor Sensitivity	Excessive Oil Consumption	Excessive Fuel Consumption	Low Oil Pressure	High Oil Pressure	Diluted Oil	Engine Overheats	Mechanical Knocks
COOLING SYSTEM	Blown Head Gasket			●												
	Overheating									●		●		●		●
	Dirt on Cooling Fins														●	
	Inadequate Air Circulation (Ventilation)														●	
FUEL SYSTEM	Out of Fuel or Shut-off Valve Closed	●														
	Poor Quality Fuel	●		●							●					●
	Dirty Fuel Filters	●		●							●					
	Fuel Line Leaks	●		●			●				●					
	Air in Fuel System	●		●			●									
	Fuel Transfer Pump Diaphragm Leaks										●			●		
	Incorrect Timing	●		●							●				●	●
	Run for Long Periods of Time at No Load									●						
	Restricted Air Intake, Dirty Air Filter	●		●							●					
GOVERNOR SYSTEM	Linkage Loose or Disconnected				●	●	●	●	●							
	Linkage Binding				●	●	●	●	●							
	Excessive Wear in Linkage						●		●							
	Incorrect Governor Adjustment				●	●	●	●	●							
	Spring Sensitivity Too Great						●	●								
LUBRICATION SYSTEM	Low Oil Supply											●			●	●
	Defective Gauge												●			
	Excess Oil in Crankcase									●						
	Oil Leaks From Engine Base or Connections									●						
	Crankcase Oil Too Light or Diluted									●		●			●	●
	Crankcase Oil Too Heavy	●											●			
STARTING SYSTEM	Battery Discharged or Defective	●	●													
	Defective Glow Plug or Lead	●		●												
	Load Connected When Starting	●														
	Open Solenoid	●	●													
	Defective Starter	●	●													

INSTALLATION

GENERAL

The initial installation is very important. Plan it carefully to insure 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 the 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 to retain alignment with complementary equipment.

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

VENTILATION

Good ventilation is needed to cool the engine and to support combustion. Avoid recirculation of ventilating air. See *Specifications* for air flow requirements and vent sizes.

Locate vents so flow of air from the inlet to the outlet will pass over 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 backflow of cold air during engine shutdown.

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

EXHAUST

Pipe exhaust gas outside any enclosure - exhaust gas is poisonous. Exhaust pipes must not terminate near inlet vents. Avoid sharp bends. Use sweeping, large-radius elbows. Use a section of seamless, flexible tubing between the engine and any rigid pipe to restrict vibration. Increase exhaust pipe one size for each additional 10 feet in length.

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

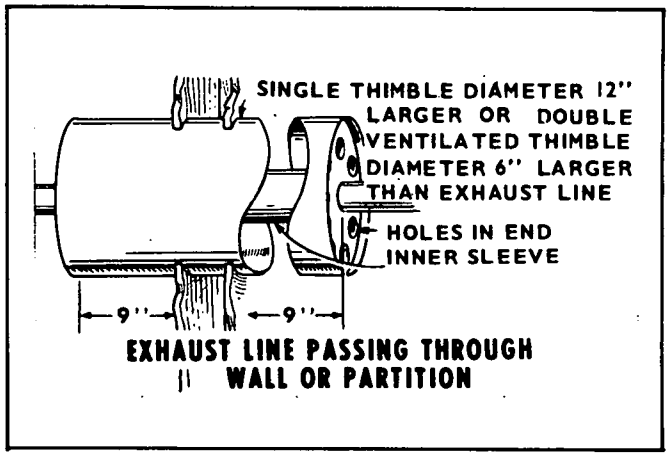


FIGURE 3. EXHAUST THIMBLE

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.

FUEL TANK AND LINES

Where a separate fuel tank is used, install so the vertical distance from bottom of the tank to the fuel pump does not exceed six feet. Auxiliary fuel pumps are available to provide an additional eight-foot 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 fuel return line to fitting at injection pump. See Figure 4. Use approved flexible fuel lines at the engine to absorb vibration. Be sure there are no air leaks in the suction line.

Install a shut-off valve in the tank for service convenience.

BATTERIES

Mount the batteries on a wood or metal rack near the engine. Air circulation around the batteries is essential. Use Number 2 battery cables of the proper length to limit voltage drop. Coat connections on the battery with vaseline or grease to prevent corrosion.

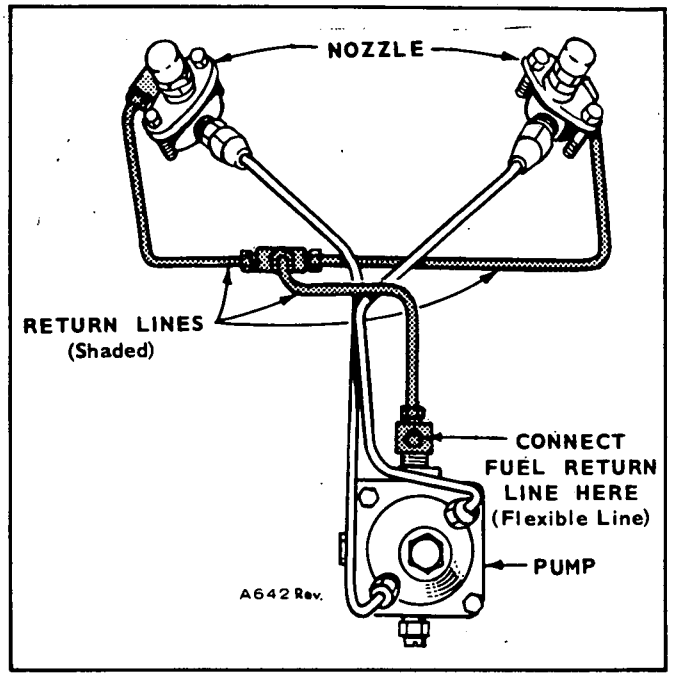


FIGURE 4. FUEL RETURN LINE CONNECTIONS

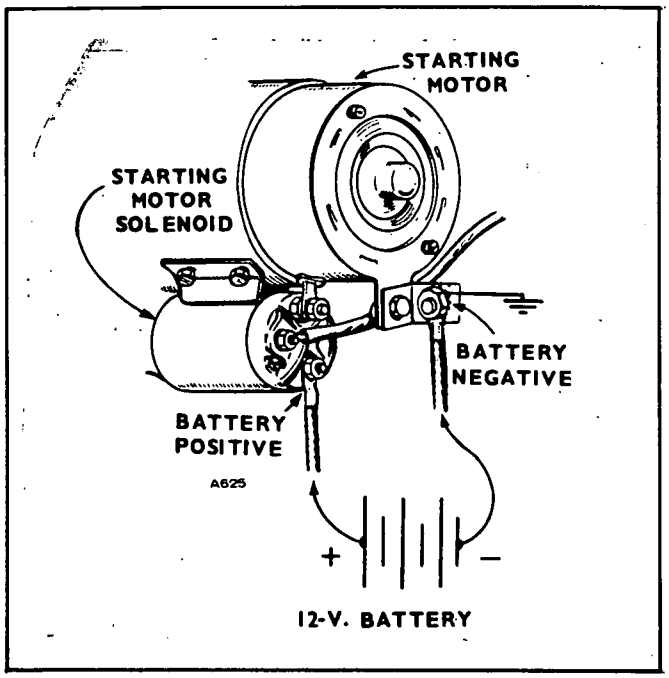


FIGURE 6. SOLENOID WIRING

BATTERY CONNECTIONS

Batteries for engines with flywheel alternators must be negatively grounded. A fuse protects the rectifier should the battery be connected with reverse polarity. See Figure 5. On early models without fuse, destruction of the rectifier will result.

Connect the remaining lead from a suitable source of DC to the larger terminal on the starting motor solenoid. See Figure 6.

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 drain hole in the oil base.

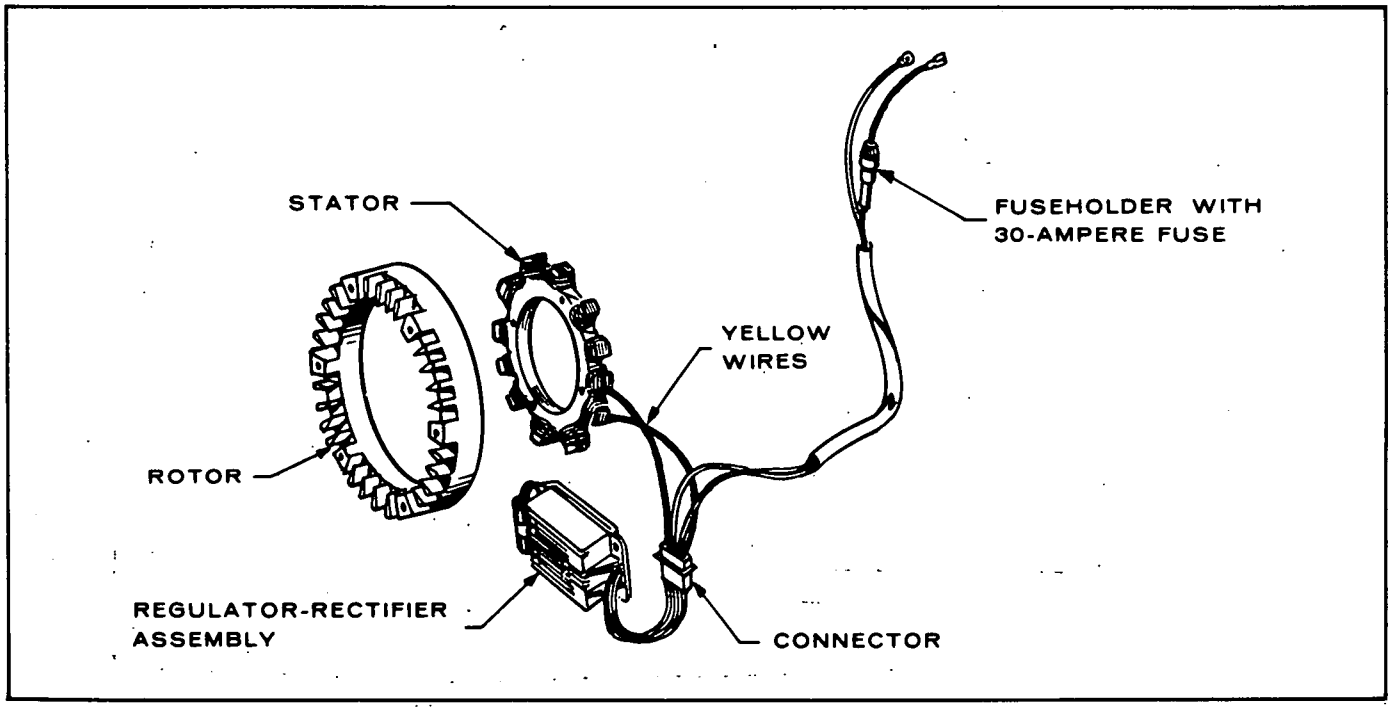


FIGURE 5. DJC FLYWHEEL ALTERNATOR (BEGINNING WITH SPEC V)

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.

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 temperature 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.

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

The type of fuel depends on operating conditions. Use Number 2 diesel fuel for best economy. Use Number 1 diesel fuel:

1. When ambient temperature is below 32°F.
2. During long periods of light engine load.
3. If preferred by user.

Use low sulfur content fuel having a pour point (ability to filter) of at least 10°F below the lowest expected temperature. Keep fuel clean and protected from adverse weather. Leave some room for expansion when filling the tank. Keep the fuel system clean. The long life built into the injection system can be destroyed by one moment of carelessness.

BLEED FUEL SYSTEM

Loosen the air bleed screw on top of the secondary filter (early models) or remove the fuel return line (late models). See Figure 7. Operate the priming lever on the fuel transfer pump until bubbles stop appearing in the fuel flowing from the bleed hole. Retighten the bleed screw.

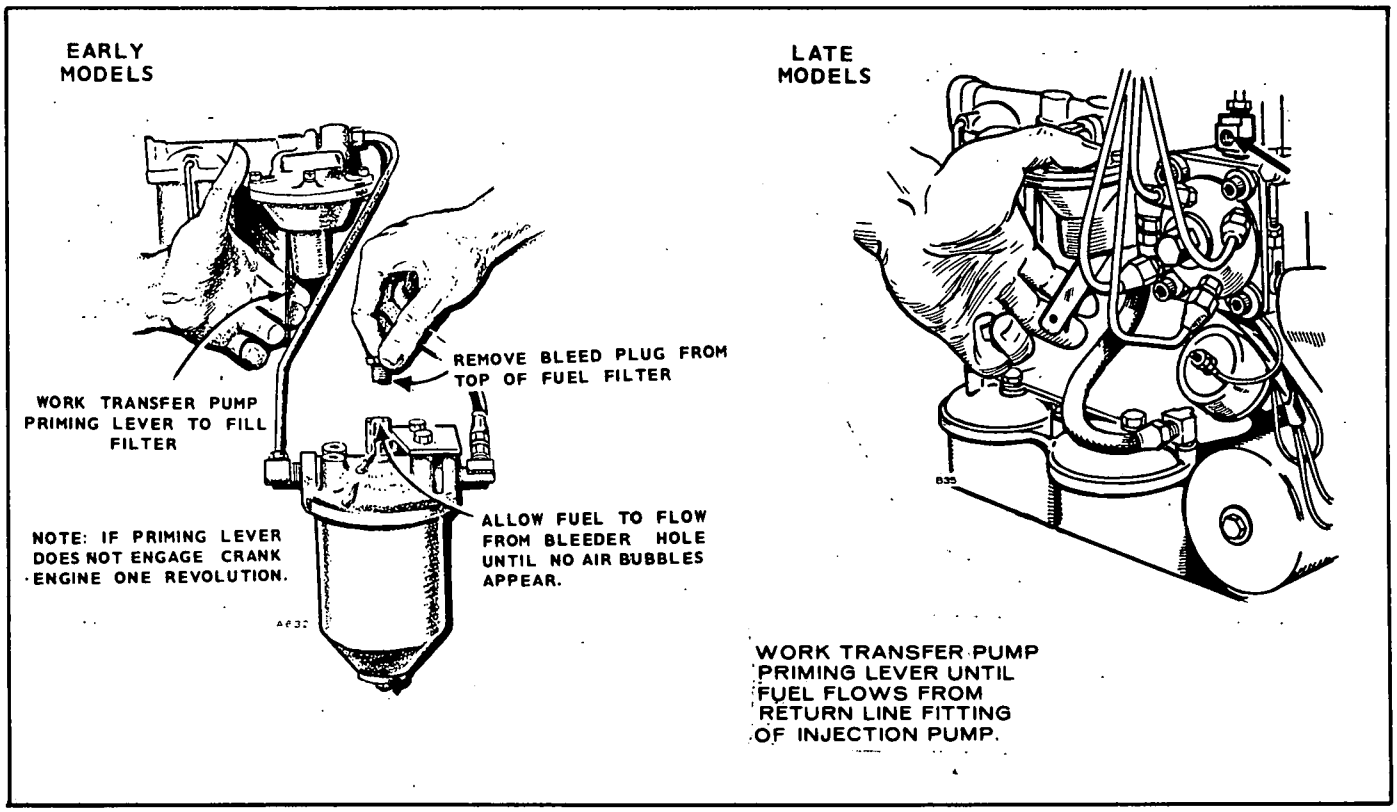


FIGURE 7. BLEEDING FUEL SYSTEM

IMPORTANT: *If the pump lobe on the camshaft is up, crank the engine one revolution to permit hand priming. When finished, return the priming lever to the disengaged position for normal operation.*

GOVERNOR LINKAGE

Lubricate with powdered graphite (preferably) or a non-gumming lubricating oil (Figure 8). Separate the ball and socket by shifting the spring-loaded sleeve away from the end of the link. Do not lubricate type with plastic socket.

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 (Figure 15) to the disengaged position after priming.

IMPORTANT: *This unit has been run and tested for 3 to 4 hours at the factory. Additional break-in time is required and will vary, depending upon load conditions, oil used, etc. Load during break-in should be between 1/2 load and rated load, preferably near rated load for best results. This procedure results in faster break-in and lower oil consumption.*

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 switch to 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 engine is to be restarted after short periods of shutdown, preheat is usually not necessary and saves on battery.

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. Operate the engine at full load occasionally (or for about five minutes just before stopping) to clean out the exhaust system.*

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 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

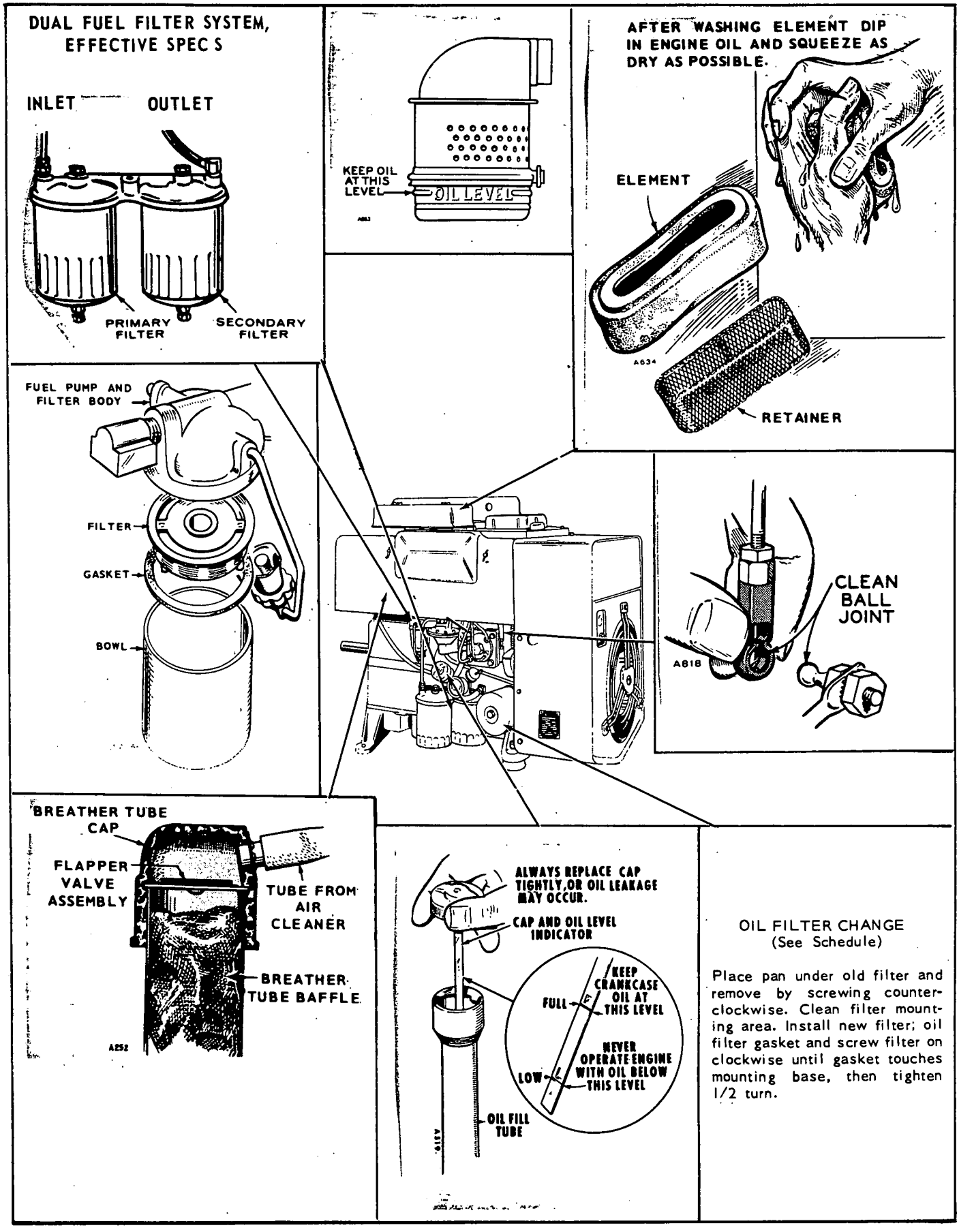
1. See that nothing obstructs air flow to and from the engine.
2. Be sure the room is properly ventilated.
3. Keep the cooling fins clean. See that air housings are properly installed and undamaged.

LOW TEMPERATURES

1. Use the proper SAE oil for existing temperature conditions. Change oil only when warm from running. If an unexpected temperature drop causes an emergency, move the engine to a warm location or apply flameless heat directly to the oil base until oil flows freely.
2. Preheat for one minute if the temperature is 30 to 50°F. Preheat for two minutes in ambients below 30°F. If engine fails to start after cranking for one minute, preheat for one minute more and reattempt the start.
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.



OIL FILTER CHANGE
(See Schedule)

Place pan under old filter and remove by screwing counter-clockwise. 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.

FIGURE 8. MAINTENANCE PROCEDURES

The following maintenance is recommended to keep the engine in good operating condition. Neglect of routine servicing may result in failure of the engine at a time when it is urgently needed. The following schedules are based upon favorable operating conditions. If the engine is operated under severe conditions in a dusty or dirty area, perform maintenance more often.

OPERATOR MAINTENANCE SCHEDULE

MAINTENANCE ITEMS	OPERATIONAL HOURS				
	8	50	100	200	500
Inspect Engine	x				
Check Fuel	x3				
Check Oil Level	x				
Check Air Cleaner		x1			
Clean Governor Linkage		x1			
Change Crankcase Oil			x2		
Clean Primary & Secondary Fuel Filter					x
Check Battery Electrolyte Level				x	
Replace Oil Filter				x1	
Empty Fuel Sediment Bowl				x	

x1 - More often under extremely dusty conditions.

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

CRITICAL MAINTENANCE SCHEDULE

MAINTENANCE ITEMS	OPERATIONAL HOURS					
	200	500	600	1000	3000	5000
Check Valve Clearance	*	x				
Replace Primary Fuel Filter			x			
Replace Secondary Fuel Filter					x	
Clean Rocker Box Oil Line Holes				x		
Inspect Valves and Grind if Necessary				x		
Remove & Clean Oil Base						x
Clean Fuel System		x				
Clean Engine				x		
Complete Reconditioning						x
Clean Crankcase Breather		x				
Check Injection Nozzles				x		

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

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

COOLING SYSTEM

To remove the heat produced during operation, engines use a pressure air-cooled system. Blades on the engine flywheel draw air in the front of the engine housing, force the air past all the cylinders and out the right side of the engine. Figure 9 shows this airflow path through the engine.

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.

MAINTENANCE

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

OVERHEATING

The first sign is usually a dark exhaust smoke and loss of engine power, which results in a speed loss. This happens before the engine seizes, and results in a seized piston, or worse. At the first sign of speed or power loss the engine should be stopped, if possible, and the cause found.

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 overloaded.

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

The most 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)

When used, the air shutter assembly is mounted at the engine air outlet, on the right side of the cylinder shroud. The air shutter is shown in Figure 10. A thermostatic element (Figure 11) controls the shutters so they close and limit air flow when the engine is cold. When the air temperature reaches 120°F, the power element plunger begins to move outward, opening the shutters. The shutters are completely open by 140°F.

The shutter opening temperature is not adjustable, and 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.

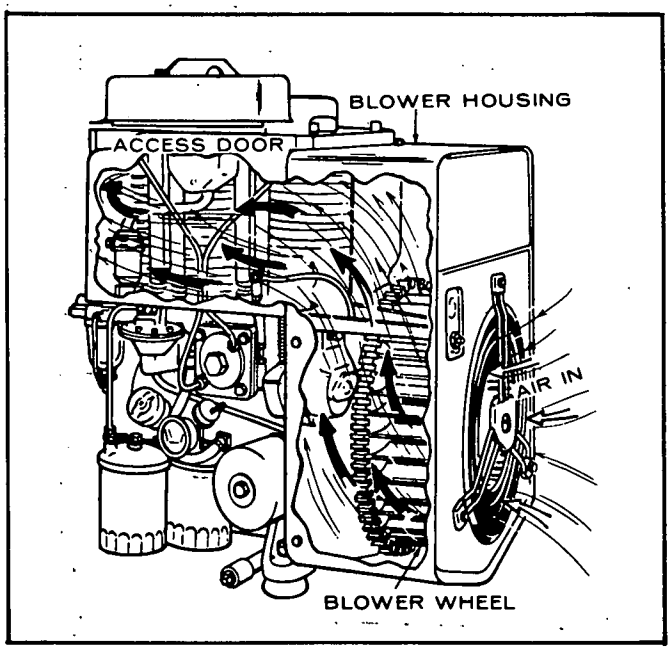


FIGURE 9. COOLING AIR FLOW

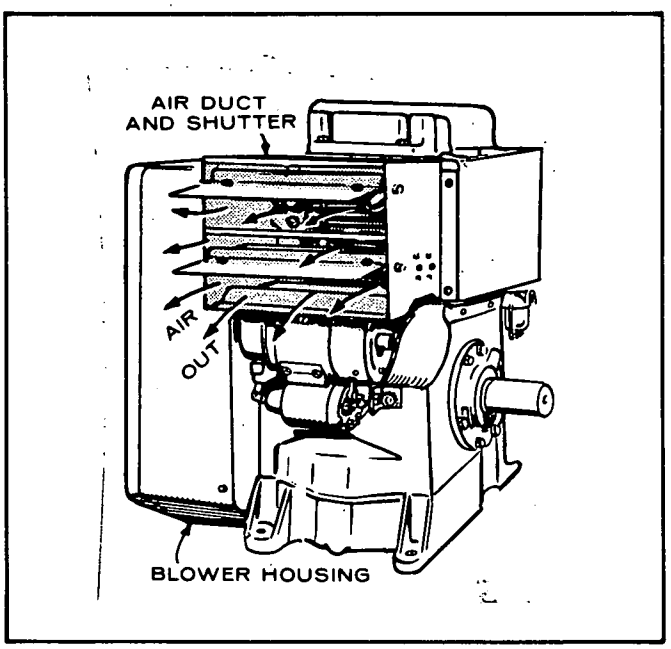


FIGURE 10. OPTIONAL AIR SHUTTER

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 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 CUTOFF

When the optional automatic air discharge shutter is used, an optional high temperature cutoff switch may be used. This switch protects the engine if shutter fails to open. The switch is in series with the governor solenoid. The 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.

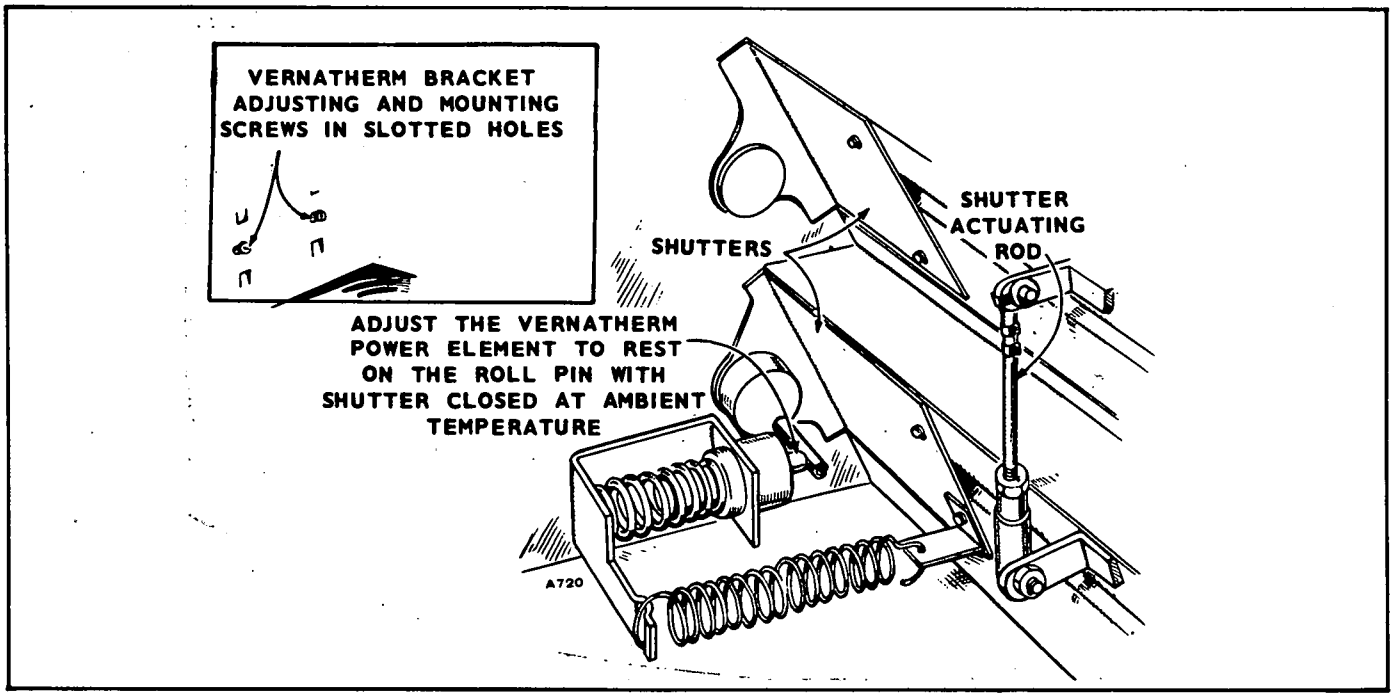


FIGURE 11. AIR SHUTTER THERMOSTAT ADJUSTMENTS

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. Figure 12 shows the fuel system.

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 pressure, delivering fuel in a fine spray to the precombustion chamber for ignition.

Excess fuel is returned to the tank after each injection cycle by a fuel return line from the nozzle. An adapter combines the lead-off 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 *A diesel engine cannot tolerate dirt in the fuel system. It is one of the major causes of diesel engine failure. 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.*

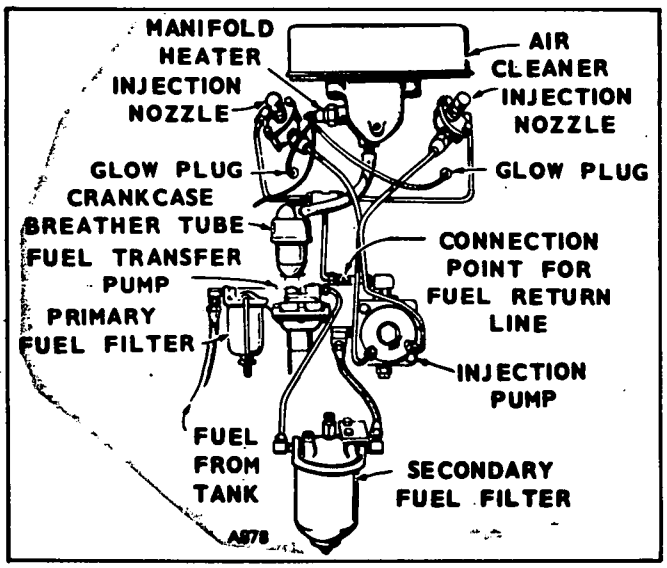


FIGURE 12. FUEL SYSTEM (PRIOR TO SPEC S)

MAINTENANCE

In addition to the regular service periods, change the secondary fuel filter cartridge whenever the engine shows sign 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 the 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 13.

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

Starting 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 assuring proper filtration at all times.

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

A new breather system involves a breather pulsation damper which serves two major functions. It dampens pulsations which originate in the intake manifold and contribute to oil carryover. It also acts as an oil separator to condense oil vapor and small oil droplets to prevent them from getting into the intake manifold and combustion chamber, causing excessive coke deposits in the valve ports.

FUEL TRANSFER PUMP

The transfer pump is located on the left side of the engine near the rear. 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.

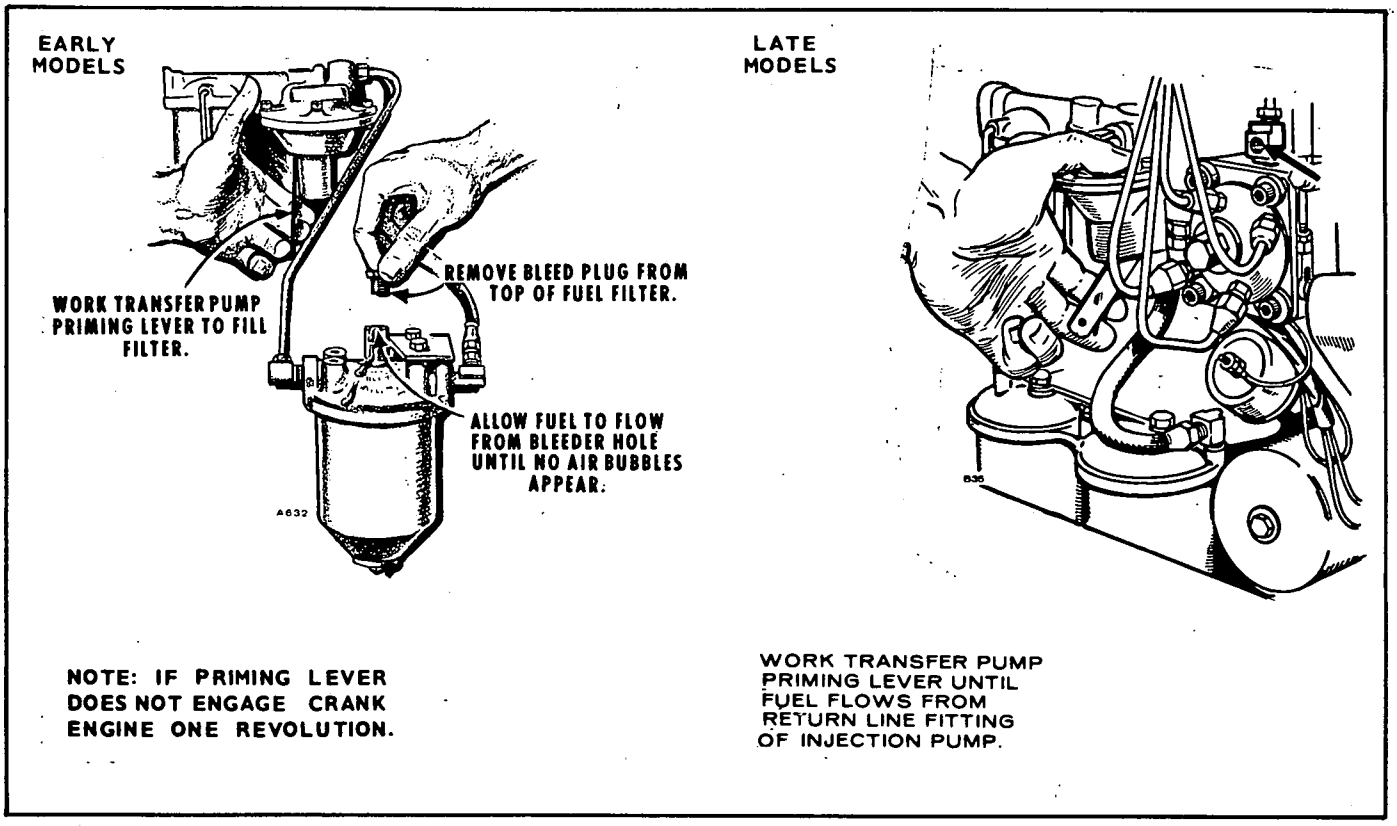


FIGURE 13. BLEEDING FUEL SYSTEM

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 (Figure 14).

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.

Run the engine at governed speed on fuel provided by gravity feed and measure the fuel pump pressure developed. Pressure should be between 12 and 14 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.

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. Figure 15 shows the fuel transfer pump.

Fuel Pump Removal Disassembly:

1. Remove the pump inlet and outlet lines. Remove the two cap screws holding the pump to the engine and lift it off.
2. Notch the pump cover and body with a file so they can be reassembled in the same relative positions and remove the six screws holding them together.
3. Tap the body with a screwdriver to separate the two parts. Do not pry them apart; this would damage the diaphragm.
4. Remove the screws holding the valve plate to the cover and lift out the valve and cage assemblies.
5. Drive out the rocker arm hinge pin.
6. Remove the rocker arm, spring and link.
7. Lift out the diaphragm assembly and diaphragm spring.

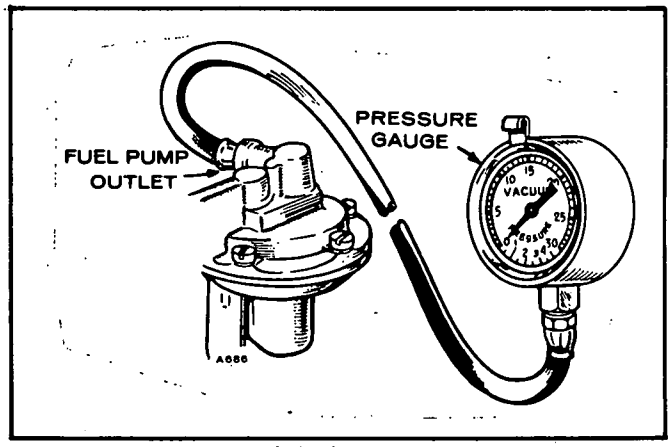


FIGURE 14. FUEL PRESSURE GAUGE

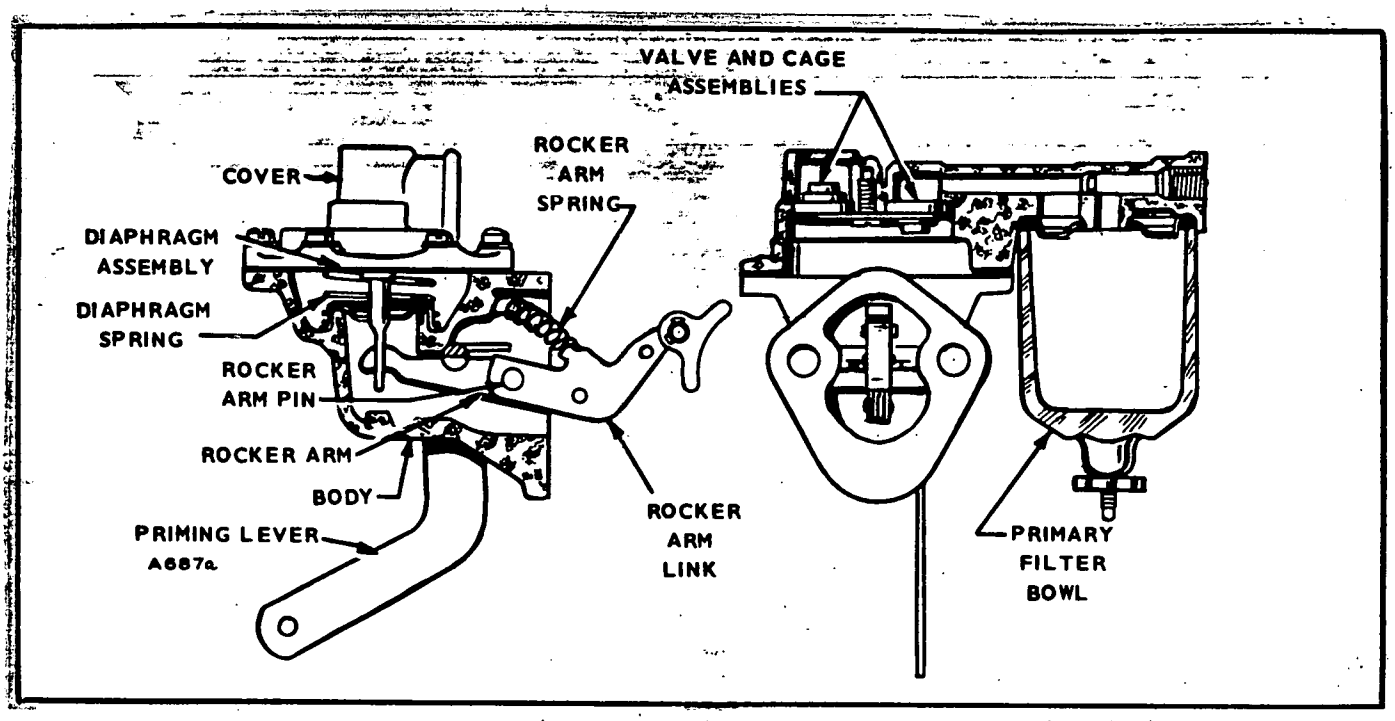


FIGURE 15. FUEL TRANSFER PUMP

Repair: Transfer pump failure is usually due to a leaking diaphragm, valve or valve gasket. See Figure 15. A kit is available for replacement of these 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 other than the repair kit from an original equipment parts distributor.

Assembly:

1. When installing a new diaphragm, soak it in fuel before assembling. Insert the diaphragm spring and soaked diaphragm into the pump body.
2. Insert the link and rocker arm into the body and hook it over the diaphragm pull rod. Align the rocker arm with the rocker arm pin hole and drive in the pin. The priming lever must be in the position shown in Figure 13 when installing the rocker arm.
3. Compress the rocker spring and install between the body and rocker arm.
4. Insert the valve cages, gaskets and valve cover plate. Position the inlet valve with spring showing and the outlet valve with spring in the cover recess.
5. Assemble the cover to the body with notch marks lined up. Install the screws, but do not tighten.
6. Push the rocker arm in full stroke and hold in this position to flex the diaphragm.

   IMPORTANT: *The diaphragm must be flexed, or it will deliver too much fuel pressure.*
7. Tighten the cover screws alternately and securely, then release the rocker arm.
8. Install the pump on the engine and repeat the pressure test.

INJECTION PUMP

The American Bosch PSU injection pump is located near the center of the left side of the engine crankcase. A cam and gear on the camshaft drive the pump. The gear drives the pump face gear, providing fuel distribution to each cylinder in the proper order. The cam operates the pump plunger, producing pressure to deliver the fuel and open the nozzles. A control sleeve meters the fuel by controlling the length of time the plunger port is closed, maintaining pressure and the amount of fuel delivered in each stroke. Timing the pump to the engine determines the point of port closing. The correct port closing point is 21 degrees BTC (before top center). The closing point is 19 degrees BTC on units built prior to Spec P. The position of the metering sleeve on the plunger controls the port opening and this depends on the throttle setting.

Adjustments: One adjustment screw, located on the injection pump control assembly, sets the maximum and minimum injection points. Set the maximum stop screw while gradually increasing the load to stop the throttle at the smoke point. Set the minimum stop screw to just fully close the throttle (no fuel injection).

Repair: Since 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 abnormal, remove the pump for replacement or repair. American Bosch maintains a world-wide repair service for these pumps.

Removal: Remove the pump inlet, outlet, and return lines. Remove the four cap screws holding the pump to the crankcase and lift it off. Be careful to retain the shims between the crankcase and pump. The correct thickness of shims, as stamped on the crankcase, is important to proper pump operation; it provides the proper gear lash.

When removing the pump for replacement, record the button thickness and port closing dimensions stamped on the side of the pump mounting flange (Figure 17). These values are important in timing the new pump to the engine.

Injection Pump Timing: Time the injection pump to the engine by using the proper thickness timing button between the pump plunger and tappet. It was timed to the engine when installed at the factory so the port closing for injection occurs at 21°BTC. See Figure 16.

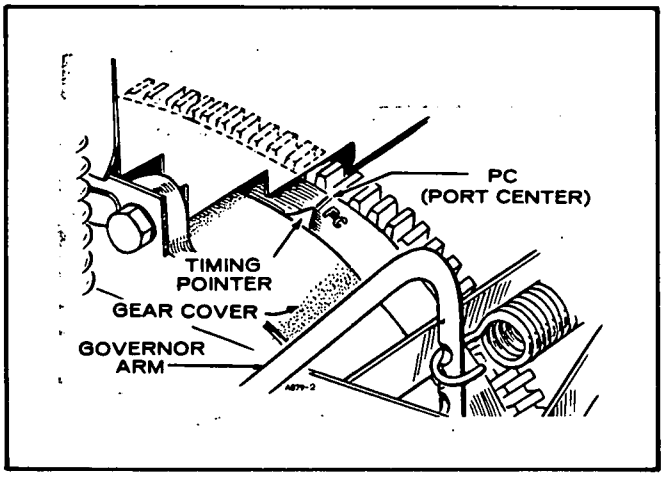


FIGURE 16. INJECTION PUMP TIMING

Use *Method 1* when replacing an old pump, if the port closing dimensions and button number of the old pump were recorded. Use *Method 2* if the dimensions are lost, and old pump is being retimed, or when replacing either the camshaft or crankshaft.

Remember, pump timing is critical.

Method 1: This is a means for calculating the correct button thickness before the pump is installed. It requires the port closing dimensions and button thickness from the pump being replaced. Put the dimensions in the formula below and calculate the new button thickness. Determine the button code letter from Table 1.

Example Formula:

Port closing dimension of old pump	1.109
Button thickness of old pump	0.107
	1.216
Port closing dimension of new pump	1.103
Button thickness of new pump	0.113
	Use button C

Install the correct button in the pump (Figure 17) and install the pump following the instructions under Injection Pump Installation.

Method 2, Flowing the Pump:

1. Install a standard timing button (not marked) in the pump and install the pump on the engine steps 1 through 5 under Injection Pump Installation.
2. Remove the delivery valve cap screw (Figure 18) and lift out the delivery valve spring and delivery valve.
3. Rotate the flywheel counterclockwise to about 15 degrees before the port closing mark (PC). The pointer to indicate timing marks is located on the gear cover near the governor arm. Use a socket wrench on the flywheel cap screw to rotate the flywheel.

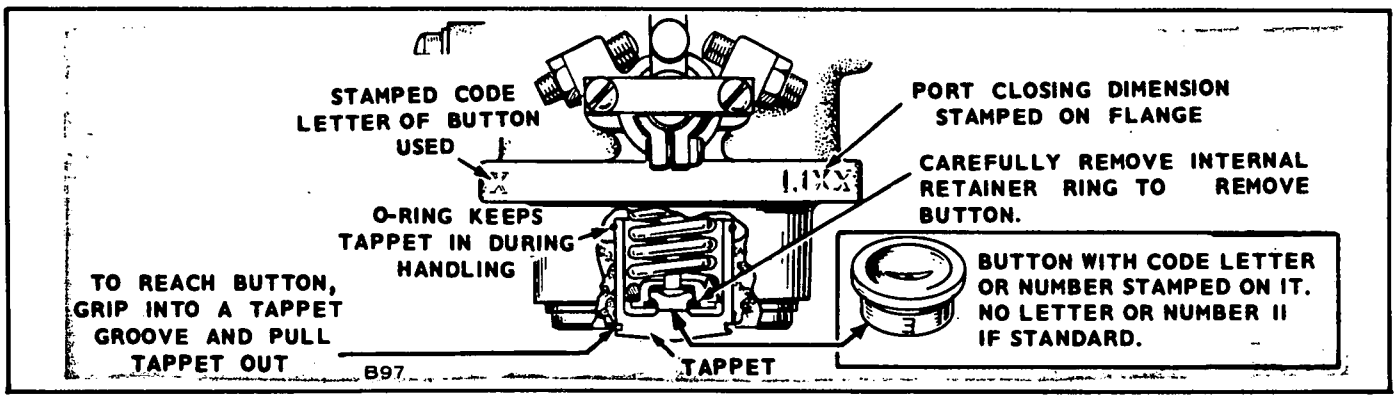


FIGURE 17. INJECTION PUMP BUTTON INSTALLATION

TABLE 1. INJECTION PUMP BUTTONS

OVERSIZE			OVERSIZE			UNDERSIZE		
CODE	PART NO.	SIZE	CODE	PART NO.	SIZE	CODE	PART NO.	SIZE
16 or S	147A186	0.134	1 or A	147A147	0.119	6 or F	147A152	0.101
15 or R	147A187	0.131	2 or B	147A148	0.116	7 or H	147A153	0.098
14 or P	147A188	0.128	3 or C	147A149	0.113	8 or J	147A154	0.095
13 or N	147A189	0.125	4 or D	147A150	0.110	9 or K	147A155	0.092
12 or M	147A190	0.122	5 or E	147A151	0.107	10 or L	147A156	0.089
			11 or STD.	147A161	0.104			

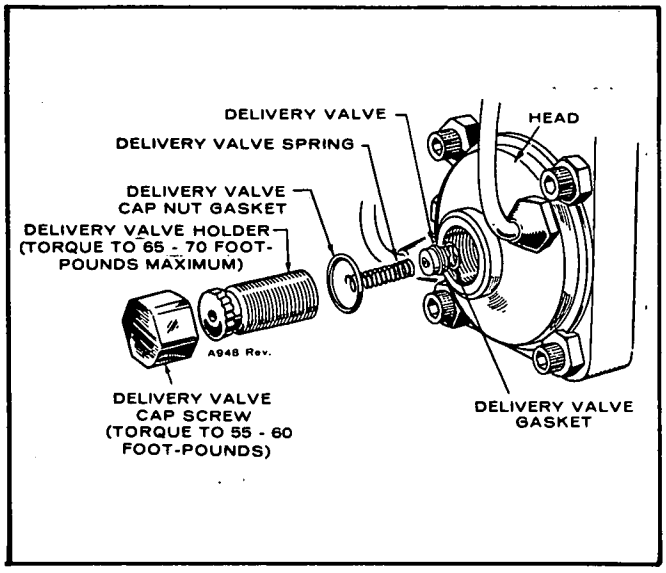


FIGURE 18. DELIVERY CAP VALVE SCREW

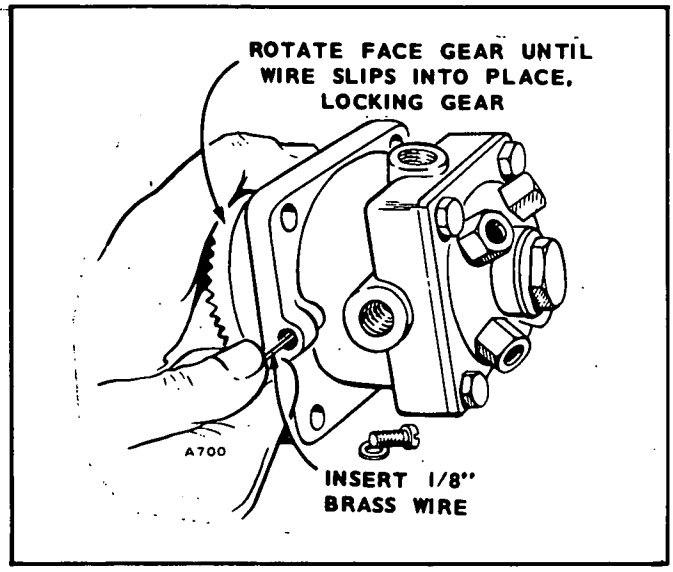


FIGURE 19. INJECTION PUMP

4. Set throttle lever on pump to wide open position (compress stop solenoid plunger spring or remove stop solenoid assembly). Connect fuel line from pump to number 1 cylinder so that outlet is above the level of the injection pump (otherwise fuel will run out by gravity and give an inaccurate port closing). Connect lines from fuel supply to transfer pump, transfer pump to filter, filter to injection pump. Operate fuel transfer pump primer lever to obtain fuel pressure and very slowly rotate flywheel clockwise (from front of engine). Fuel will stop flowing from the end of the injection line on number 1 cylinder at the port closing point. Be sure you still have fuel pressure at the PC point (check pressure by working primer lever at port closing; *no* fuel should flow from injection line).
5. Check the timing pointer. It will be within 0.5-inch on either side of the port closing mark on the flywheel. If the timing pointer and port closing mark coincide, the button thickness is correct. If not, measure the distance from the mark to the point on the flywheel below the pointer and determine the proper button from Table 2.
6. Remove the pump and insert the proper timing button (Figure 17).
7. Repeat the pump installation, steps 1 through 5 under Injection Pump Installation.
8. Check the port closing by repeating steps 1 through 3. The pointer should indicate the port closing mark.
9. Replace the delivery valve disassembly. Torque the valve to 75-80 foot-pounds.
10. Finish the installation procedure.

Injection Pump Installation:

1. Put No. 1 cylinder on compression.
2. Turn the flywheel to the port closing mark (PC) on the front cylinder compression stroke.
3. Remove the timing hole screw located on the pump mounting flange. Insert a 1/8-inch diameter brass wire into the hole (Figure 19).
4. Rotate the pump face gear until the wire slips into place, locking the gear in position.
5. Mount the pump on the crankcase (be sure the shims are in place) and secure with screws. If the "O" ring between pump and crankcase is worn, cracked or otherwise defective, replace it.
6. *Remove* the brass wire.
7. If the pump was not timed by *Method 1*, do it now, using *Method 2*.
8. Connect the flexible fuel inlet line to the pump inlet. Connect the fuel return line.
9. Connect each fuel outlet line to the proper pump outlet.

10. Connect the throttle linkage to the governor.
11. Run the engine and adjust the throttle maximum and minimum stops.

TABLE 2. TIMING BUTTONS

TIMING EARLY *	USE BUTTON	TIMING LATE *	USE BUTTON
0.1	6 or F	0.1	5 or E
0.2	7 or H	0.2	4 or D
0.3	8 or J	0.3	3 or C
0.4	9 or K	0.4	2 or B
0.5	10 or L	0.5	1 or A
		0.6	12 or M
		0.7	13 or N
		0.8	14 or P
		0.9	15 or R
		1.0	16 or S

* All measurements are in inches.

NOZZLES

The American Bosch injection nozzles are the conventional inward-opening pintle type with adjustable opening pressure (Figure 20). They are factory adjusted to open at 1900 to 1950 psi. However, after several hundred hours of operation the nozzle pressure will decrease to approximately 1750 psi. Do not attempt to disassemble the nozzles or adjust nozzle pressure without the proper test equipment. A nozzle pressure tester is essential to do this work.

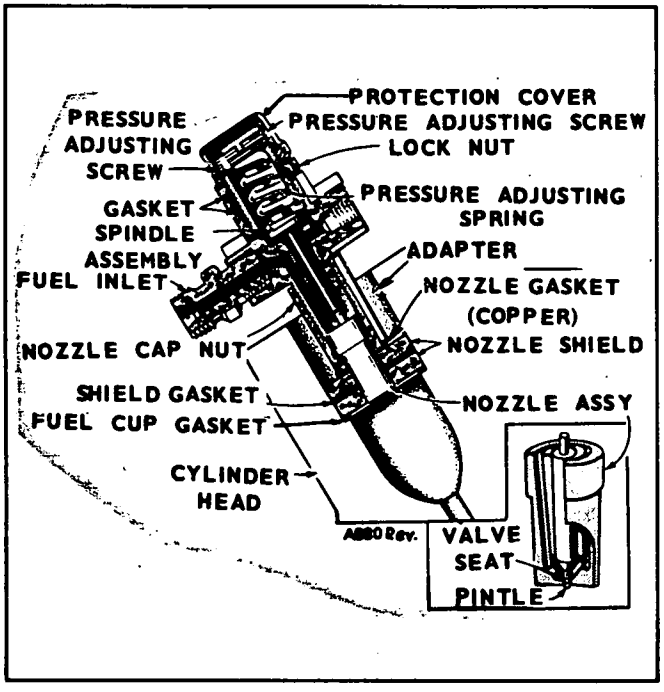


FIGURE 20. NOZZLE ASSEMBLY

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. An apparent chattering of the nozzle is normal. See Figure 21.

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.*

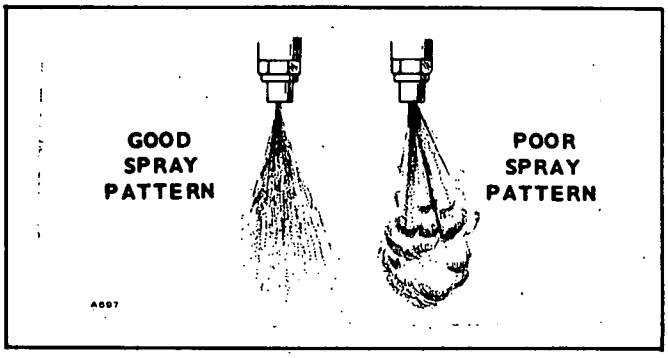


FIGURE 21. NOZZLE SPRAY PATTERN

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

Disassembly: When removing and disassembling nozzles, separate and label all components of each nozzle. Never interchange components between nozzles.

1. Remove each 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.

IMPORTANT: *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 American Bosch service station. Do not attempt to replace parts of the nozzle except for nozzle and pintle assembly.

Assembly: Rinse both valve and nozzle thoroughly before assembly and coat with oil. The valve must be free in the nozzle. Lift it about 1/3 of the 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 22) for initial tightening. Then remove the centering sleeve to prevent it from binding between nozzle and cap nut and tighten the nozzle cap nut to specified torque.

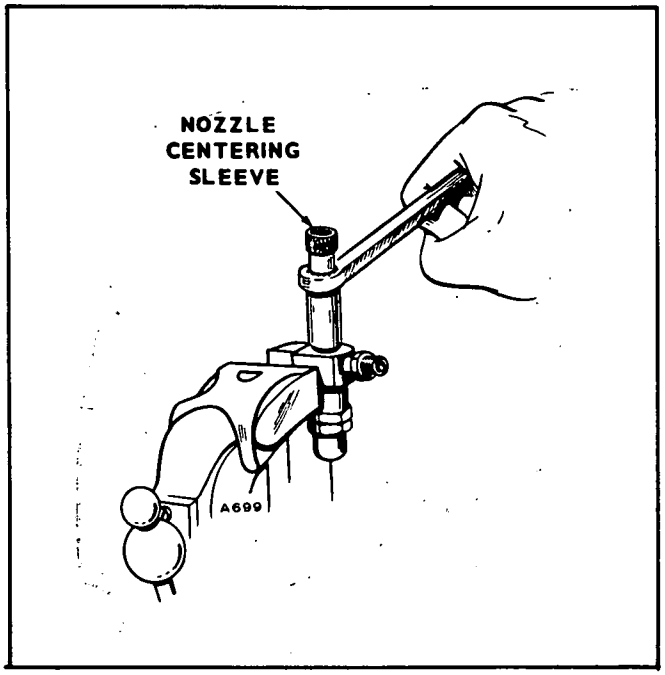


FIGURE 22. TIGHTENING NOZZLE CAP NUT

Installation: Before installing the injection nozzles in the engine, thoroughly clean each 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 to 20-21 foot-pounds.

PREHEATING CIRCUIT

This circuit consists of a manifold heater (two used on DJC) to heat the engine intake air in the intake manifold and glow plugs in each cylinder to heat the pre-combustion chamber. Used for engine starting, the manifold heater and glow plugs are wired in parallel and controlled by a preheat switch.

Check each 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.

FUEL SOLENOID

This solenoid is also referred to as a governor solenoid as it over-rides the governor. See Figure 23. The solenoid is mounted on the cylinder air housing bottom pan and controls the injection pump throttle lever. When energized, the plunger is in the solenoid body. When de-energized, the solenoid spring forces the plunger against the throttle arm, holding the throttle shut. The solenoid has two coils. Both are energized for pulling the plunger up. When the plunger reaches top, it opens a set of contacts, de-energizing the pull-in coil. The other coil holds the plunger up.

To test the solenoid, check plunger operation and current draw with 12-volt input. Current draw with the plunger up should be about 1 amp. If it is much greater, the contacts did not open.

The solenoid plunger should be adjusted so it fully stops injection when in the de-energized position. To adjust the plunger length, screw the hex head cap screw and jam nut on the plunger bottom in or out. If the plunger sticks, remove the solenoid from its mounting plate and clean the plunger and recess in the solenoid.

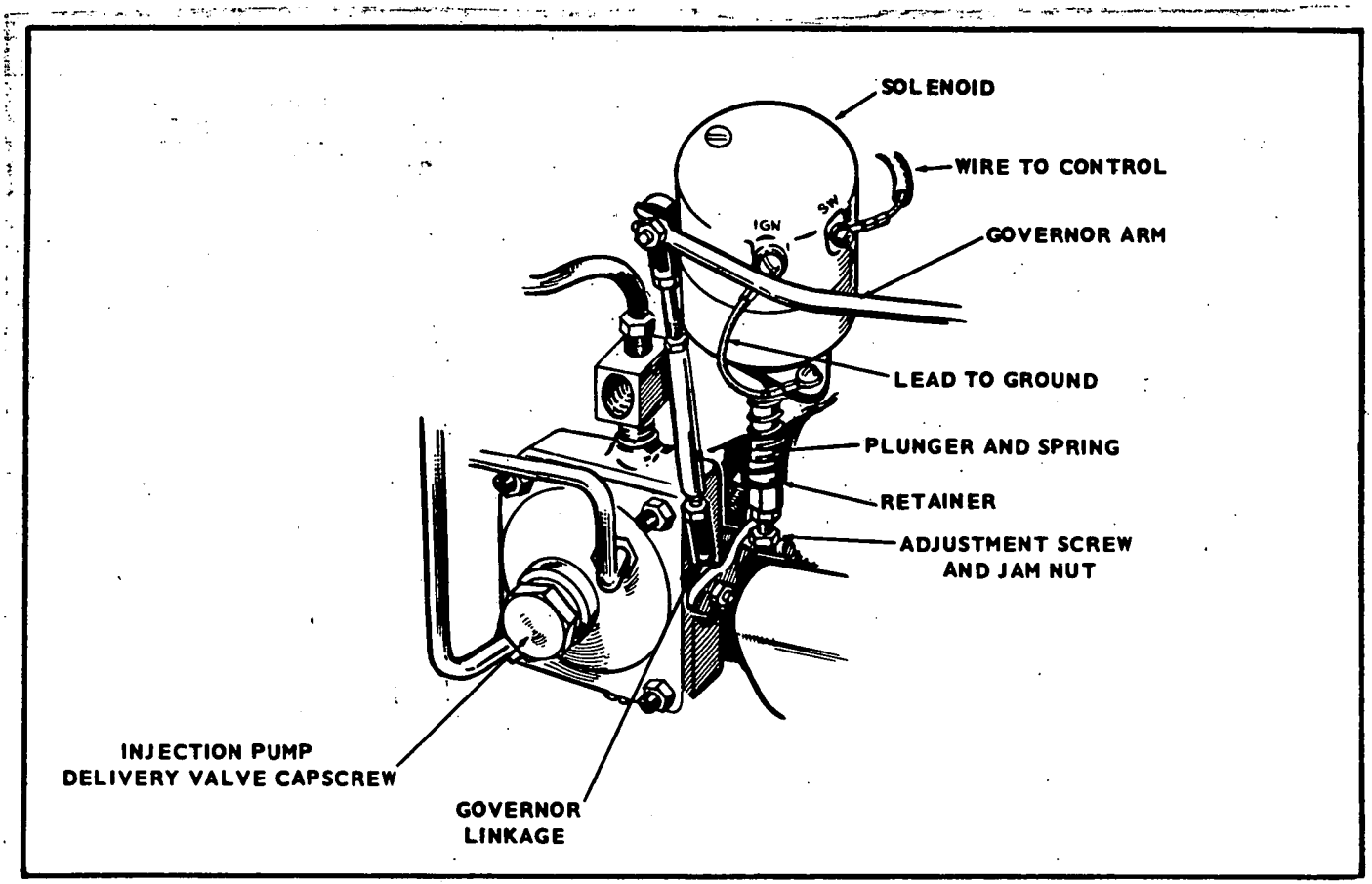


FIGURE 23. FUEL (GOVERNOR) SOLENOID

GOVERNOR SYSTEM

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

GOVERNORS

The constant-speed governor (Figure 24) 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 on to the throttle.

Tension on the governor spring determines the speed at which the engine is governed. A stud screwed into the spring is used to vary the number of effective coils for getting the desired sensitivity – the speed drop from no load to full load.

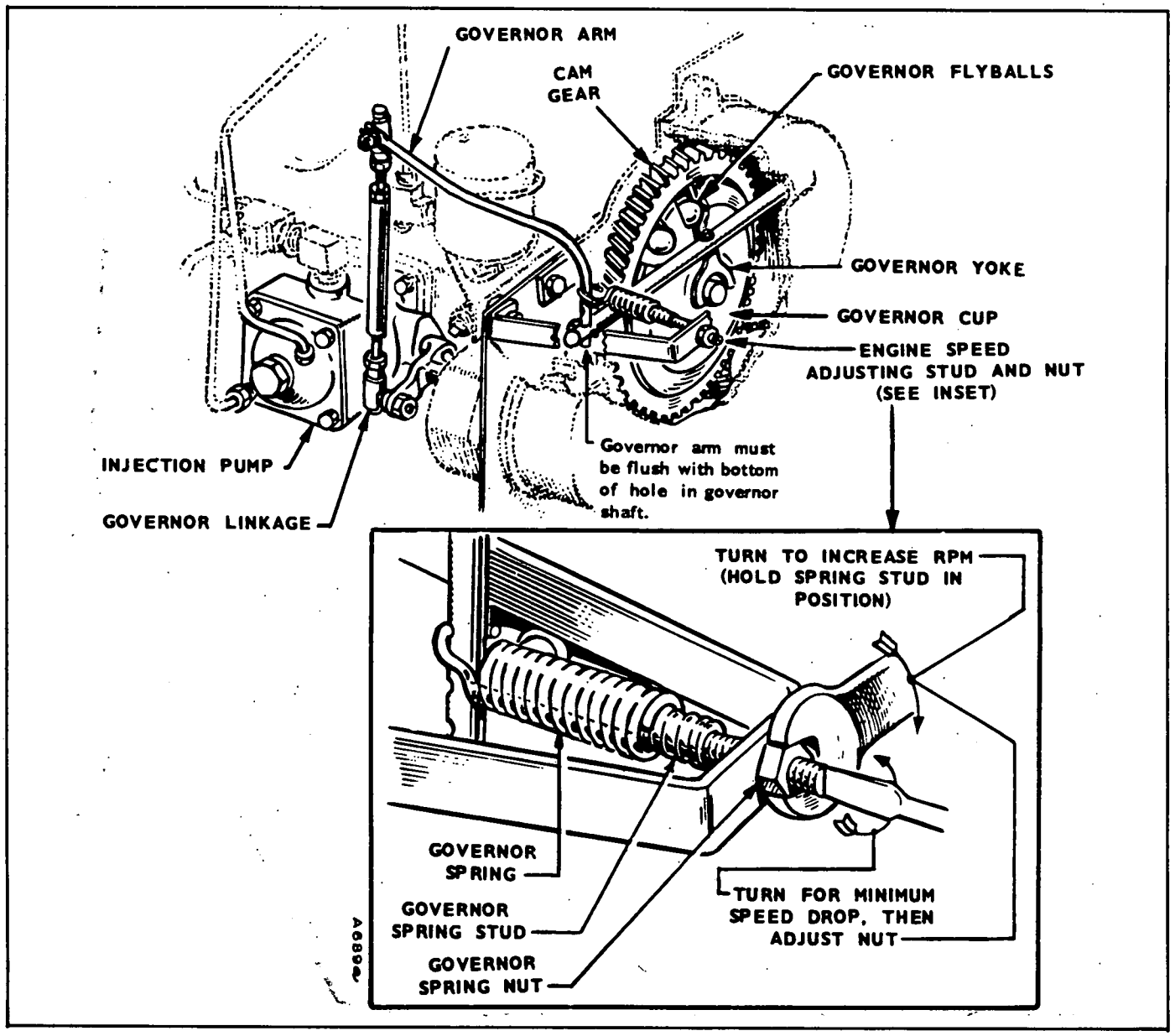


FIGURE 24. GOVERNOR ASSEMBLY AND ADJUSTMENTS

The 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 25. The low-speed adjustments are the same as the constant-speed adjustments. High speed in solenoid-controlled, two-speed systems can be adjusted by changing the length of the solenoid rod.

Maintenance: The linkage must be able to move freely through its entire travel. Periodically lubricate the ball joints with graphite or light non-gumming oil. Also inspect the linkage for binding, excessive slack, and wear.

Testing and Repair: Removing the gear cover for access to the governor cup and other internal governor parts is covered in the *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 Table 3.

TABLE 3. GOVERNOR SPRING DATA

Engine Model	Governor Type	Spring Number	Spring Rate	Coil No Load Length	Active Coils
DJB, DJC	Constant	150A846		1-3/8	13-3/4
DJB, DJC	** Variable or 2 Speed	150A921	21 ***	1-13/32	21
DJB, DJC	*2 Speed	150A922	16 ***	1-15/16	28

* 1800 rpm ** 2400 rpm *** inch-pounds

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

Speed: Change the 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.

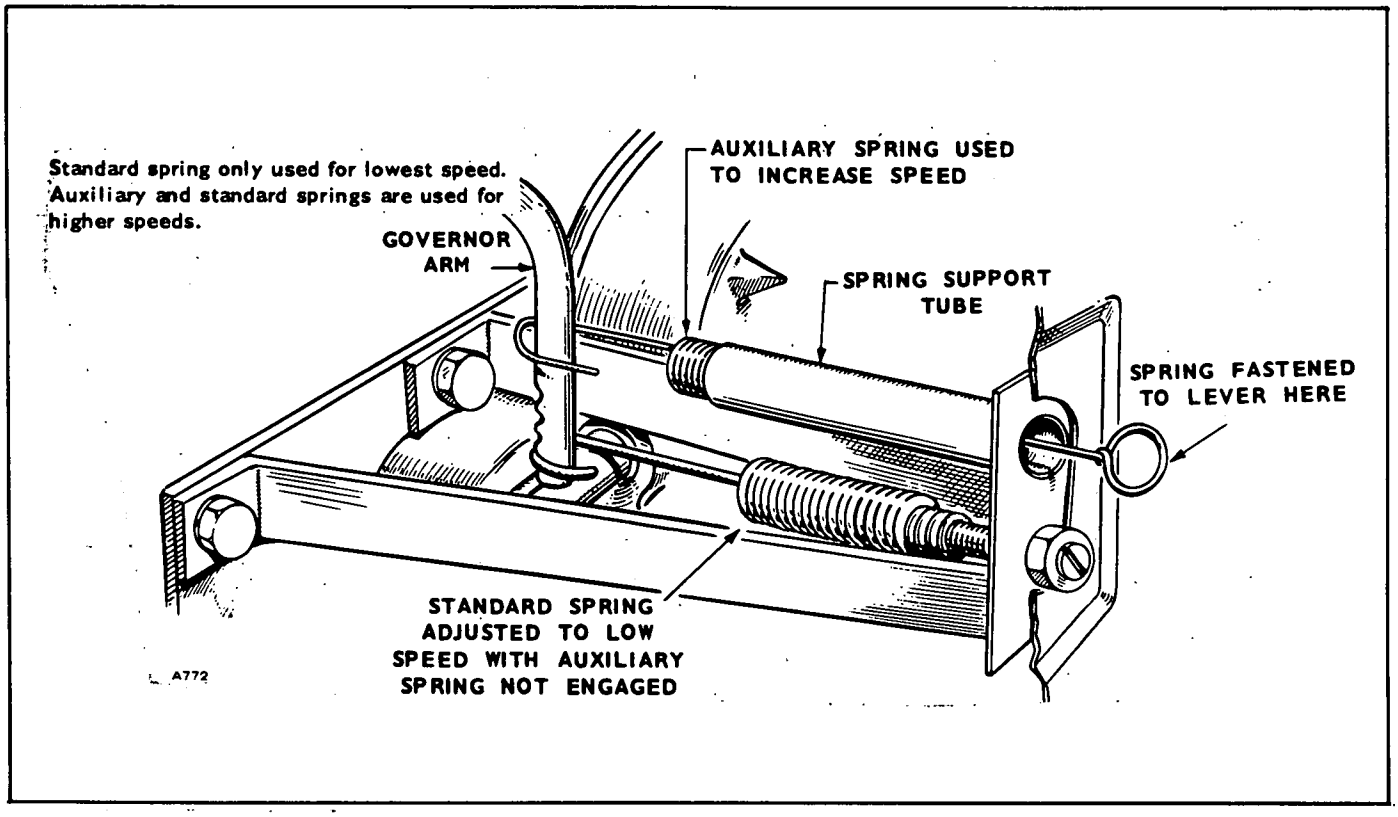


FIGURE 25. VARIABLE SPEED GOVERNOR

Sensitivity: 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 on the governor arm will decrease sensitivity. The 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. Effective with Spec "R", the governor sensitivity adjustment is changed. Adjust sensitivity by turning a screwdriver inserted through a dot button hole on the accessory side of the blower housing.

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, 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 the length of the 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 will not open. If the plunger sticks, remove and clean the plunger and recess in solenoid.

OIL SYSTEM

DJ-Series engines have pressure lubrication to all working parts of the engine. The oil system includes an oil intake cup, a gear-type oil pump, a by-pass valve, an oil pressure gauge, a full-flow oil filter and passages and drillings through the block for oil delivery. Oil from the oil base is pumped through the oil filter and then through lines and drillings to the crankshaft bearings and front camshaft bearing, connecting rod bearings and piston pin bushings. Figure 26 shows the pressure oil system. Because it aids oil consumption control, the crankcase breather is included in this system.

Normal oil pressure should be 25 psi or higher when the engine is at 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.

OIL PUMP

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

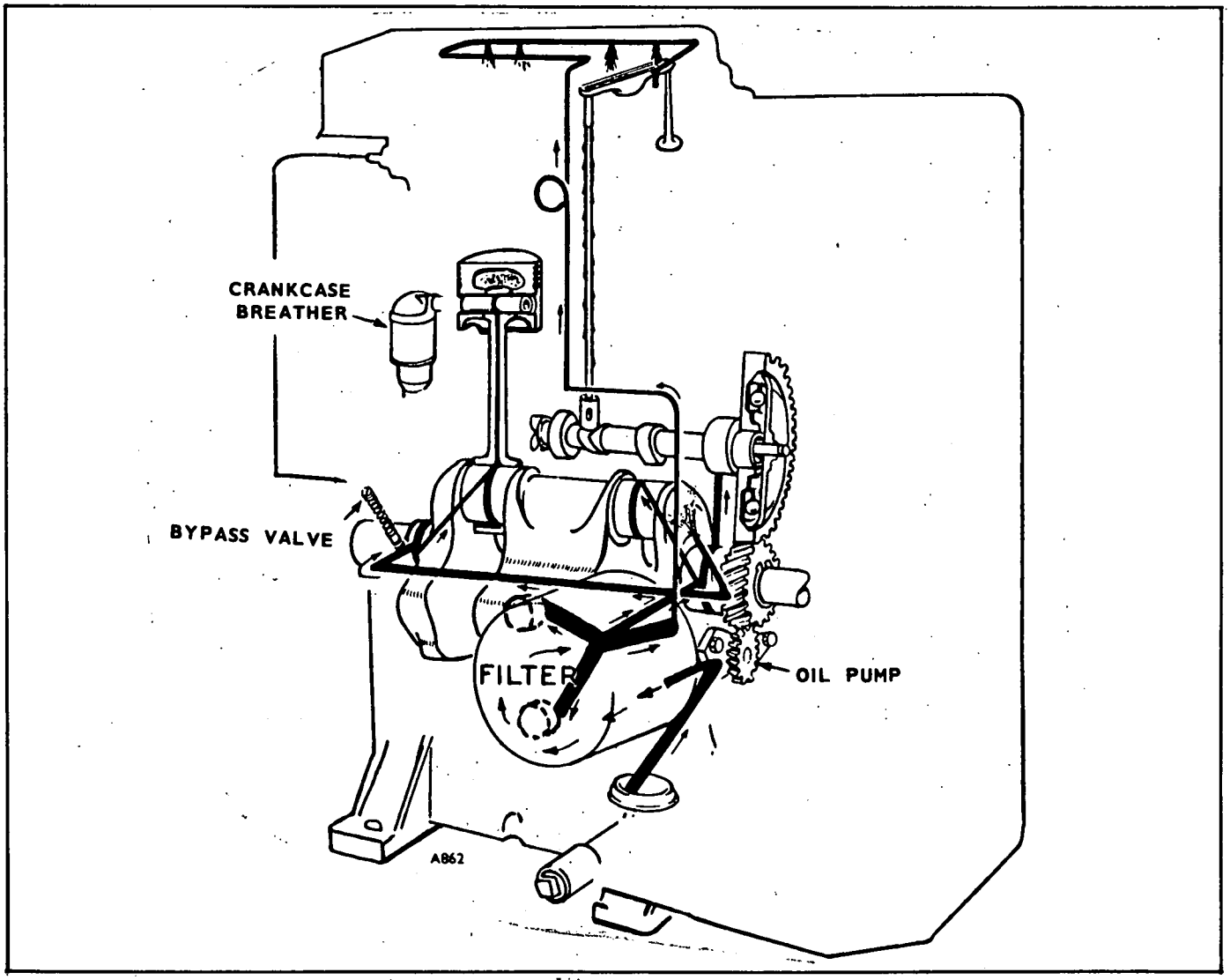


FIGURE 26. PRESSURE OIL SYSTEM

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 27) controls oil pressure by allowing excess oil to flow directly back to the crankcase. Normally the valve begins to open at about 25 psi. It is non-adjustable, and normally needs 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 given values:

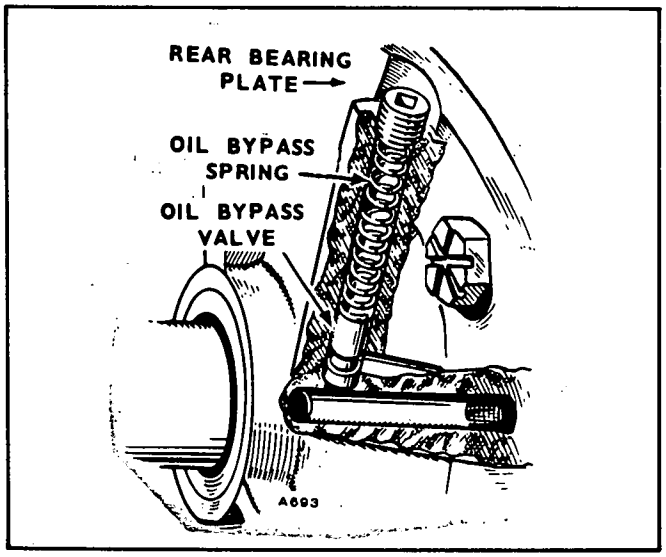


FIGURE 27. BYPASS VALVE

Plunger Diameter 0.3365 inch to 0.3380 inch
Spring -
Free Length 2-5/16 inches, + 1/16 inch
2.225 lb. 0.11 lb. at 1-3/16 inches (compressed)

OIL LINES

At overhaul time the rocker box oil line should be flushed with fuel, and a fine wire used to clean the small holes (Figure 28).

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.

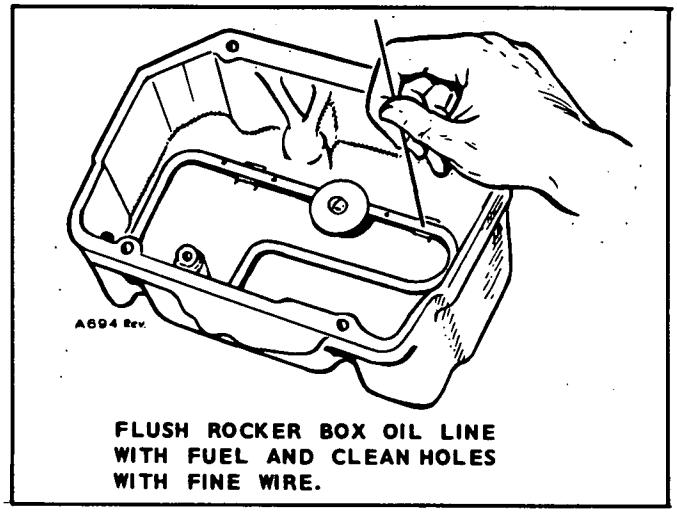


FIGURE 28. CLEANING ROCKER BOX OIL LINE

GAUGE

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

OIL COOLER (DJC Only)

The oil cooler is mounted in the upper right hand corner of the blower housing facing the engine. Oil flow is controlled by a thermostat located in the oil filter adapter casting. When the oil is cold, it goes through a passage directly to the full flow filter. As the oil heats up, the thermostat starts to open at 140° to 145°F and is fully open at 165°F. When the thermostat opens, this shuts off the passage to the filter, and oil is then diverted through the oil cooler before entering the filter.

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.

Periodically inspect the oil hose and connections. Keep the oil cooler fins clean.

LOW OIL PRESSURE CIRCUIT

Either of two systems is used, depending on the application and whether the engine is equipped with factory-mounted controls or controls mounted by fabricator.

For engines with factory-mounted controls, the low oil pressure system includes a low oil pressure switch and a special start switch to jumper the cut-off switch during starting.

For engines with fabricator-mounted controls the low oil pressure system includes a low oil pressure switch, emergency time delay relay, resistor and centrifugal switch.

Low Oil Pressure Switch: The switch is located on the oil filter adapter plate below the oil filter.

The system for engines with factory-mounted controls uses a normally-open low-oil-pressure switch. A special start switch mounted on the rear cylinder air housing jumpers the cut-off switch during starting to allow the engine to build up oil pressure and close the switch. The switch closes at 13 to 15 psi under increasing pressure. If oil pressure fails below 13 psi the switch opens, de-energizing the fuel solenoid stopping the engine.

The system for engines with fabricator-mounted controls uses a normally-closed low-oil-pressure switch. During starting, a relay provides a time delay to allow the engine to build up oil pressure and open the switch. If the oil pressure falls below 13 psi, the switch closes, energizing the emergency relay.

Emergency Relay (Time Delay): For engines with optional low oil pressure cut-off, this relay is supplied loose and mounted by customer. The relay, used in conjunction with a one ohm, 10 watt resistor, provides a 15- to 30-second time delay when starting, so the engine can build up sufficient oil pressure to open the low oil pressure cut-off switch. When oil pressure drops below 13 psi, the relay stops the engine and prevents it from restarting until the *Reset* button is pushed.

Centrifugal Switch: This switch, for low oil pressure cut-off, is mounted on the gear cover backplate and operates directly off the camshaft gear. Normally open, the switch closes when engine speed builds up to about 900 rpm. This allows the engine to build up sufficient oil pressure and the unit can be started. See Figure 29.

For correct operation, maintain the switch gap at 0.040-inch. See Figure 30.

Check the contacts for dirt or pitting when adjusting the gap. Clean the contacts with paper or replace them if badly pitted.

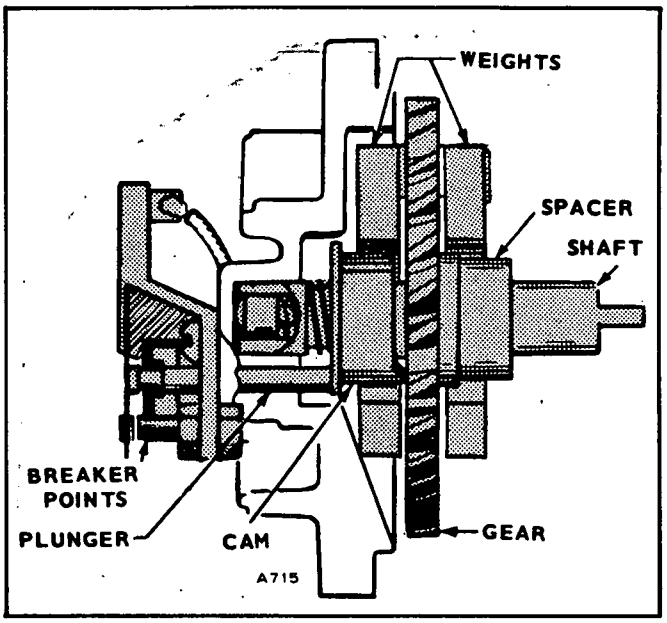


FIGURE 29. CENTRIFUGAL SWITCH ASSEMBLY

DISASSEMBLY

1. Disconnect the battery to prevent accidental shorts.
2. Remove the switch cover, revealing the point set.
3. Remove the point set assembly by removing the screws holding it to the plate. Pull out the plunger and plunger diaphragm.
4. Remove the centrifugal switch plate, revealing the cam and weight assembly.
5. Pull out the cam and weight assembly.

CAUTION *Be careful not to lose the spacer mounted on the gear shaft behind the gear.*

REPAIR

Thoroughly clean the gear and cam assembly, the bearing surfaces in the gear case and breaker plate, and the oil trickle holes to these bearings. Check the oil spray hole in the gear case to be sure that it is open.

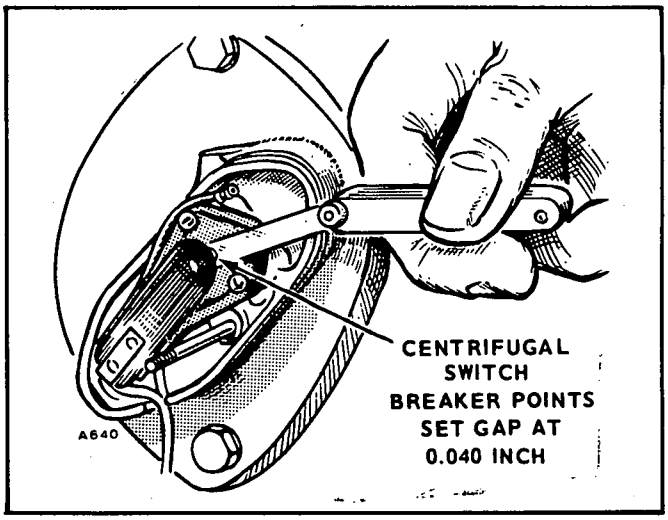


FIGURE 30. BREAKER POINTS

Check for wear in the spacer, fibre plunger and the spring-loaded shaft plunger. The spacer must be at least 0.35-inch long. If not, replace it immediately. Push the weights outward; they should move freely. If they do not or if any part of the assembly is sticking or worn, replace the cam and weight assembly. If the cam is loose on the gear shaft, replace the assembly.

If the breaker gap cannot be maintained at 0.040-inch, check the fibre plunger and spacer for wear.

ASSEMBLY

1. Install the spacer on the shaft and install the shaft assembly into the gear case. Match it with the cam gear.
2. Install the spring and plunger into the end of the shaft.
3. Install the breaker plate.
4. Install the plunger and diaphragm.
5. Install the breaker points on the breaker plate and set the gap at 0.040-inch.
6. Install the switch cover and reconnect the battery.

DJB CRANKCASE BREATHER (Spec S)

The DJB is equipped with a ball check valve for maintaining crankcase vacuum. This valve is installed to prevent freeze up. The only maintenance involved is to clean the components periodically. Remove the hose clamp, breather hose and breather cap clamp to release the breather cap and valve assembly. Wash the cap, valve assembly and baffle in a suitable solvent and reinstall. See Figure 31.

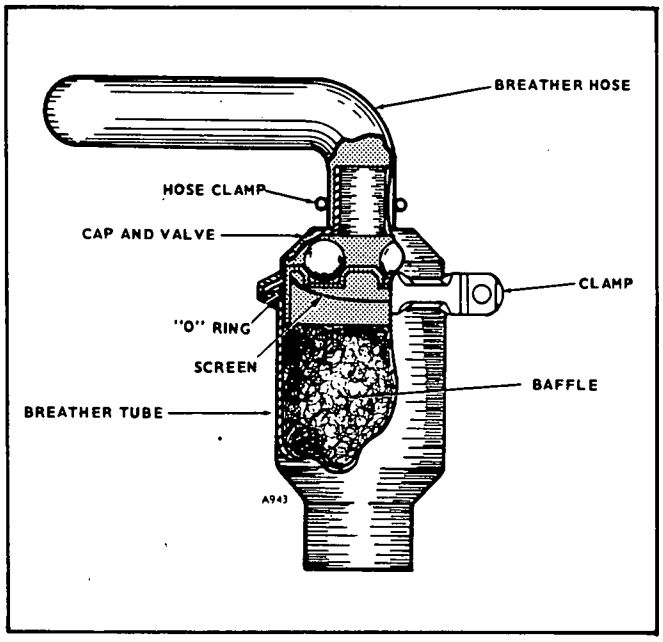


FIGURE 31. CRANKCASE BREATHER

DJC PULSATION DAMPER (Spec S)

The DJC is equipped with a pulsation damper that serves two major functions. It dampens pulsations which occur in the intake manifold and contribute to oil carry-over. The pulsation damper also acts as an oil separator to condense oil vapor and small oil droplets preventing them from getting into the intake manifold and combustion chamber. When this occurs it causes excessive coke deposits in the valve ports. See Figure 32.

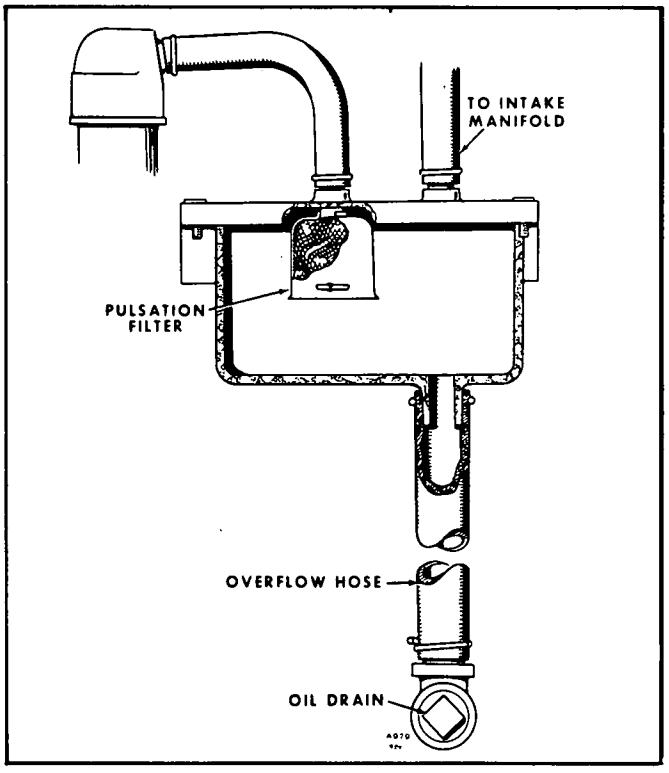


FIGURE 32. PULSATION DAMPER

DJC BREATHER SYSTEM (Spec T)

The DJC (effective Spec T) is equipped with a crankcase breather pipe that vents crankcase fumes directly from the rocker box cover to the cylinder head intake port. The crankcase breather pipe must be removed and cleaned after every 500 hours of engine operation. A clogged breather pipe may result in oil leakage at the rocker box gaskets and oil filter seal. See Figure 33.

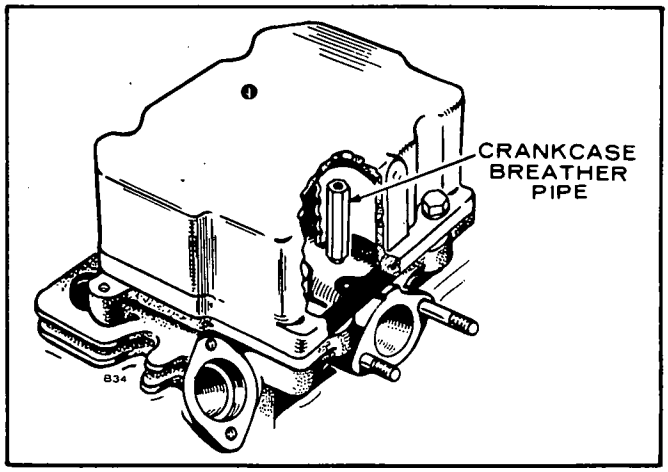


FIGURE 33. BREATHER SYSTEM

STARTING SYSTEM

These models use a separate 12-volt Prestolite starting motor mounted on the right hand side of the engine to drive the flywheel. It is a standard automotive starting motor with a solenoid for engaging the pinion and an over-running clutch. When the solenoid is energized, its core pulls in, shifting the pinion into engagement with the flywheel ring gear. At the same time, contacts in the solenoid close to provide a circuit for the starter motor. The starting motor remains engaged until the starting switch is released by operator. The starter is protected from over-speed by an over-running clutch which permits the engine to run faster than the starter before the pinion is disengaged. Figure 34 shows the starting circuit.

IMPORTANT: *Onan does not stock parts for the Prestolite starting motor. See a Prestolite dealer.*

MAINTENANCE

Periodically check the starting circuit wiring for loose or dirty connections. Inspect the starter commutator and if it is dirty, clean with number 00 sandpaper (do not use emery cloth or emery paper). Check the brushes for poor seating on the commutator and for excessive wear.

TESTING

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

Check the charge condition of the battery with a hydrometer.

Specific gravity should be between 1.290 and 1.225 when 75 percent charged. If not, recharge the battery. Check electrolyte level. Add approved water to keep electrolyte at its proper level. If battery will not recharge, replace it. Keep battery connections tight and clean.

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. Normally, each of these should be less than two 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.

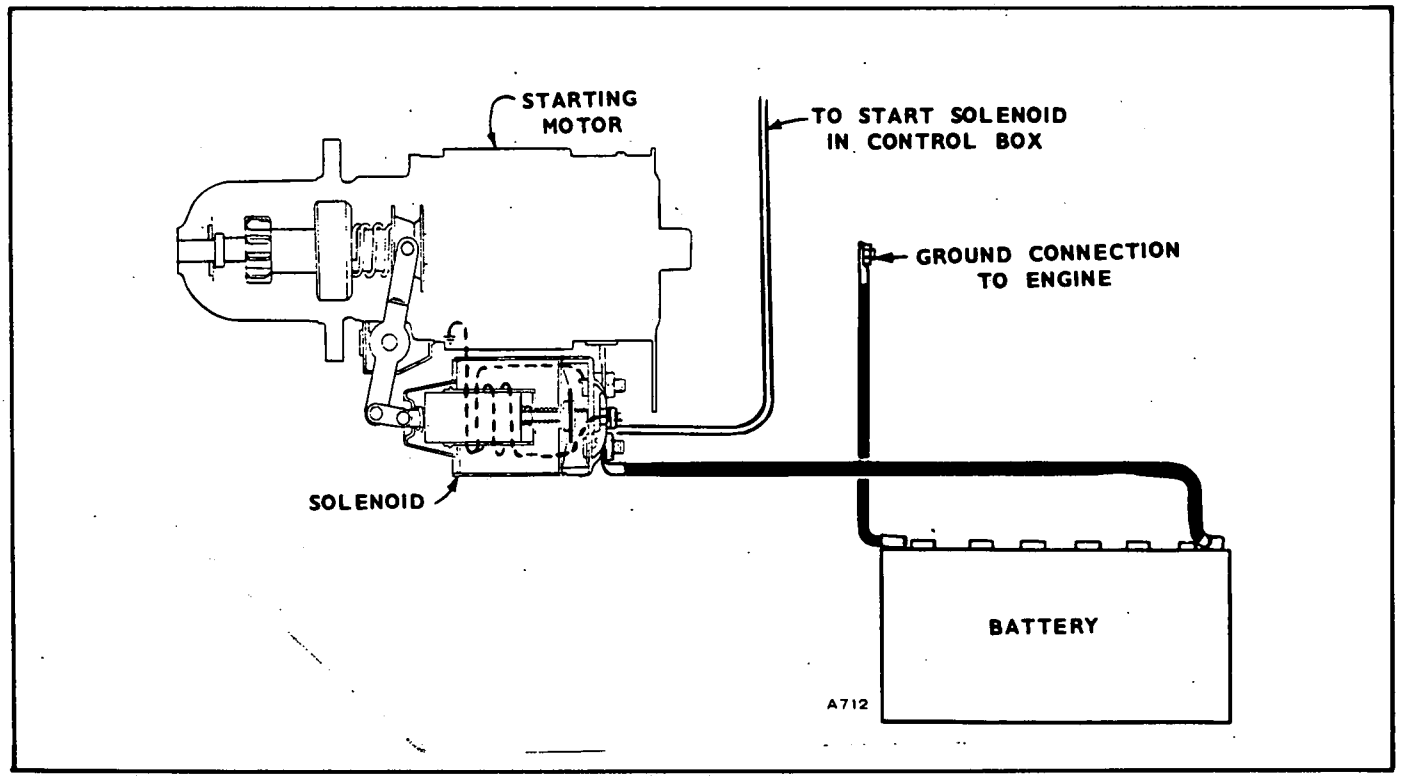


FIGURE 34. STARTING SYSTEM

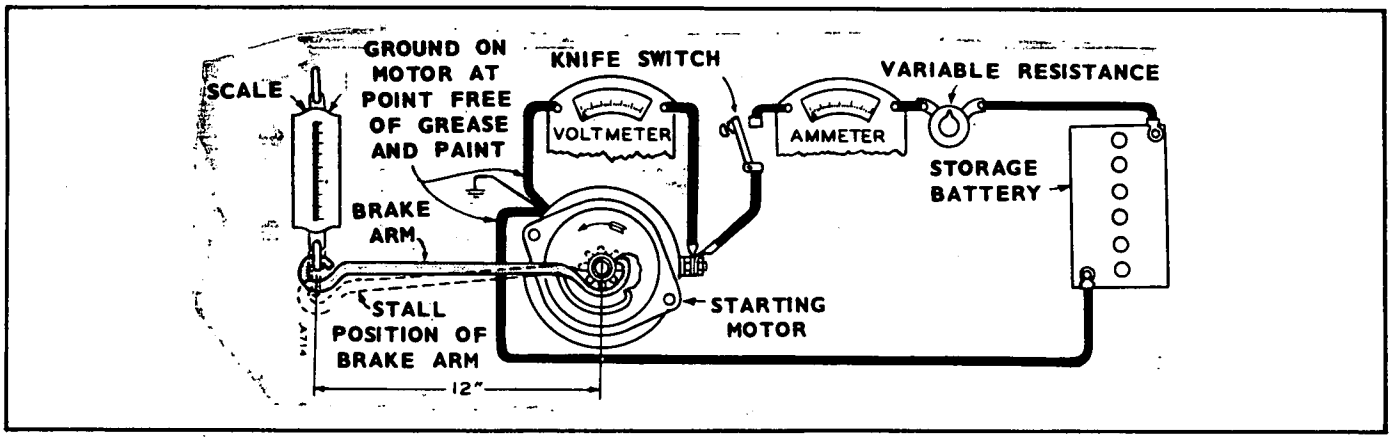


FIGURE 35. TESTING STALL TORQUE

If starting motor tests are required, remove the motor from the engine and test it on a bench. Test the free-running voltage and current. Limits are given in the Table of *Dimensions and Clearances.*

Using a spring scale and torque arm, test the stall torque (Figure 35). Multiply the spring scale reading by the arm length for the torque value.

If free running speed is low, and starter has a high current draw with low stall torque, check for tight, dirty or worn bushings, bent armature shaft, or loose field pole screws, allowing armature to drag. Check also for shorted or grounded armature and field.

A low free speed with low torque and low current draw indicates an open field winding, high internal resistance due to poor connections, defective leads, broken or worn brushes, or scored, worn, or dirty commutator.

High free speed with low developed torque and high current draw indicates shorted fields. Since there is no easy way to detect shorted field coils, replace and check for improved performance.

The voltage drop across the solenoid on the starting motor should be less than 1.5 volts. If not, remove it for repair.

REMOVAL AND DISASSEMBLY, STARTING MOTOR

1. Remove connections to controls and battery at the shifting solenoid. See Figure 36.
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.

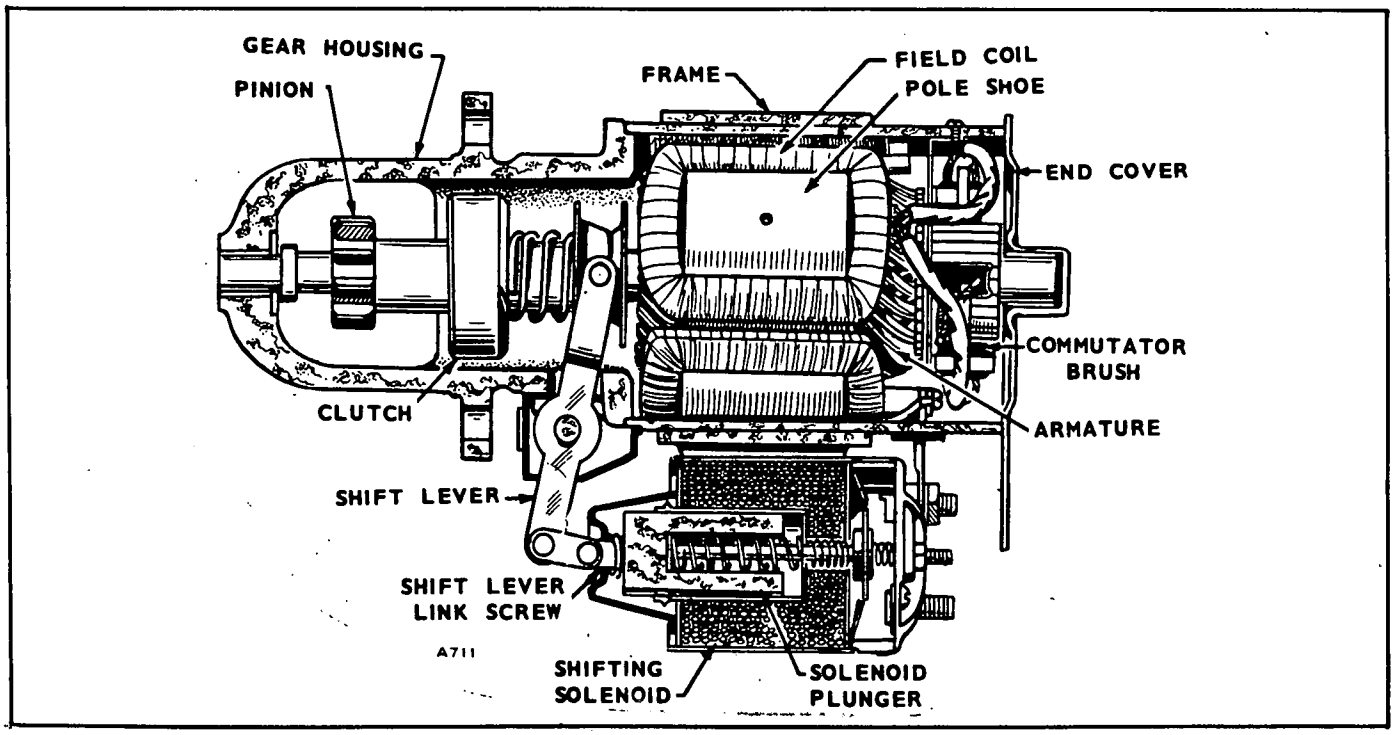


FIGURE 36. STARTING MOTOR

6. Remove the link pin holding the shift lever to the solenoid plunger and remove the shift lever center pin.
7. Remove the thru 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 over-running clutch from the armature, drive the retainer away from 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 connection 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 37), watch for shims between the flange and crankcase surface. Save any shims, as they must be reinstalled to position the starter correctly.

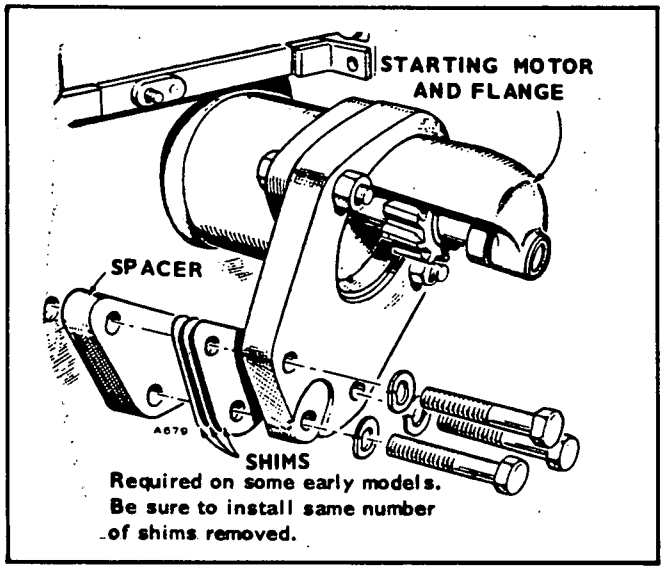


FIGURE 37. STARTING MOTOR SHIMS

REPAIR, STARTING MOTOR

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; 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 number 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 120-volt 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 test at the beginning of this section.

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. The outer pinion bearing must be flush with the bearing bore on the inside of the bearing.

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-nose pliers.

If brushes are excessively worn, replace them.

Some brushes are soldered to the field coil lead. 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; it should instantly lock and unlock. Replace the clutch if operation is defective, or pinion is worn or damaged.

Shifting Solenoid: Check to be sure plunger moves freely in coil. Measure the pull-in coil current draw by connecting a battery, voltmeter and ammeter to the control terminal and the terminal to the motor. Measure the hold-in coil draw from the control terminal to ground. Inspect the switch for corrosion and clean the contacts if necessary. Replace the solenoid if the current draw is not within limits when cleaned.

ASSEMBLY, STARTING MOTOR

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 and 0.030-inch. 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 insure starter engagement. Press on solenoid core to shift the pinion into full mesh and measure the clearance between pinion and pinion stop (Figure 38). This should be between 0.07-inch and 0.12-inch (as near to 0.070-inch as possible). Adjust the link screw on the end of the solenoid plunger for proper clearance.

IMPORTANT: *On units built prior to serial number 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 insure starter engagement. When installing these motors, check this gap. If it is too great, a shim kit is available to reduce it (Figure 37).*

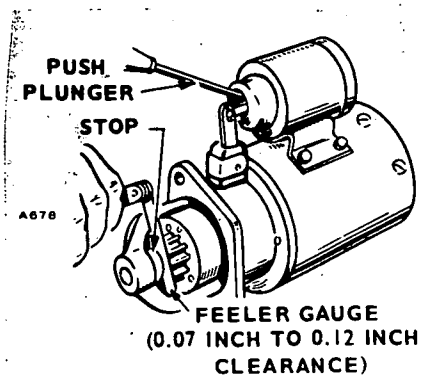


FIGURE 38. PINION CLEARANCE

FLYWHEEL ALTERNATOR

DJC MODELS BEGINNING WITH SPEC V

The flywheel alternator is a permanent magnet alternator and uses a solid-state voltage regulator-rectifier for controlling output (Figure 39).

A 30-ampere fuse is included in the battery charging system to protect the alternator in case the battery cables are accidently 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:

NOTE: *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.

   NOTE: *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.
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.

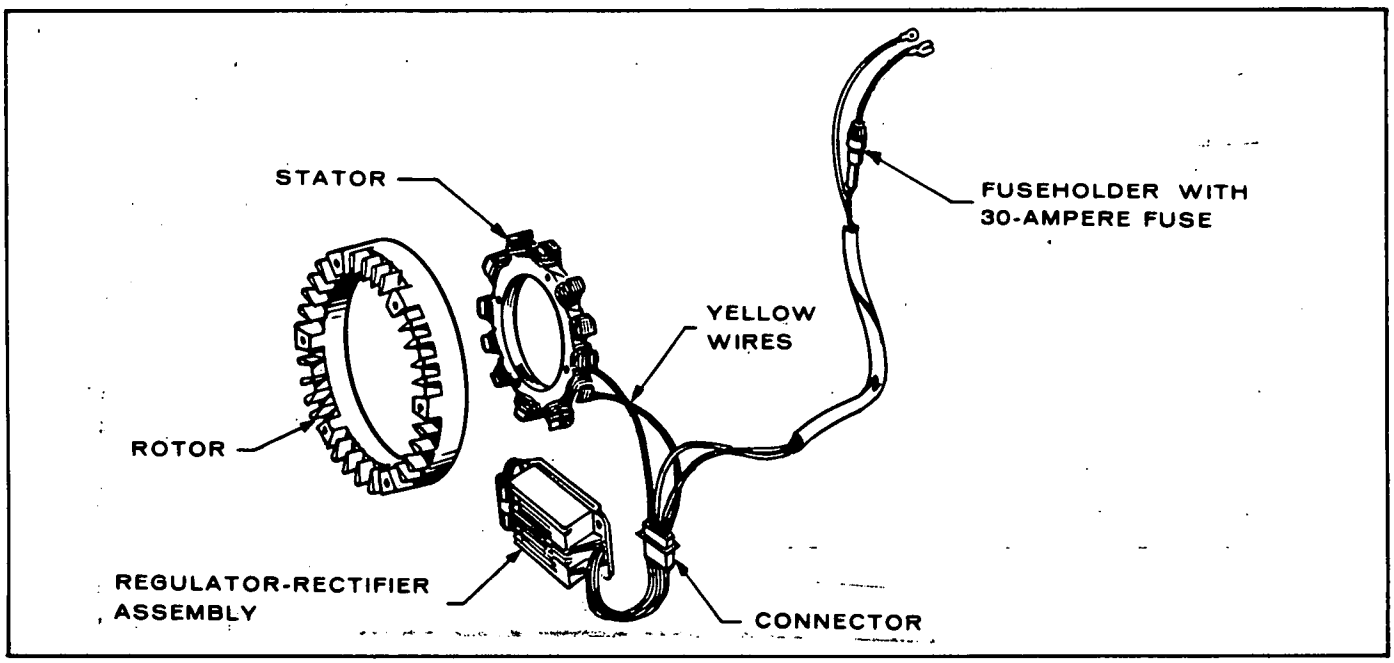


FIGURE 39. DJC FLYWHEEL ALTERNATOR (BEGINNING WITH SPEC V)

FLYWHEEL ALTERNATOR

DJC (Prior to Spec V) AND DJB

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 cut 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. These are shown in Figure 40.

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 41 wiring schematic. 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 1800rpm. The maximum continuous DC load is limited to 10 amperes at 1800rpm. 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.

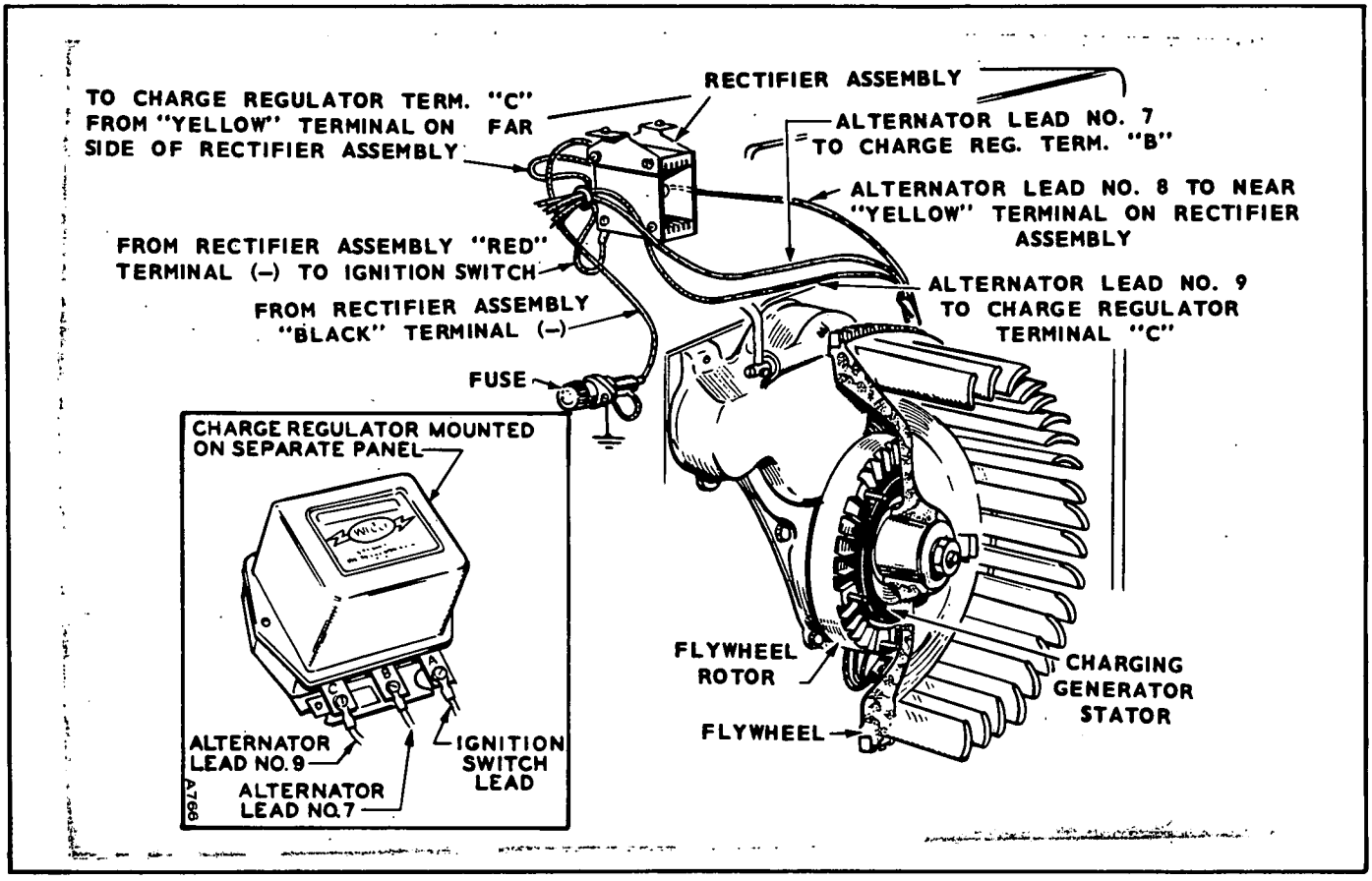


FIGURE 40. FLYWHEEL ALTERNATOR

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.

TESTING

To check alternator output, connect an ammeter between the red terminal on the rectifier and the ignition switch. With the engine running at 1800rpm, 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 from 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 test 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 the ground is indicated, replace the stator.

To test for shorted coils or opened circuits, use an ohmmeter, set to read the proper range of resistance. 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 from 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 or test lamp. See Figure 42.

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

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.

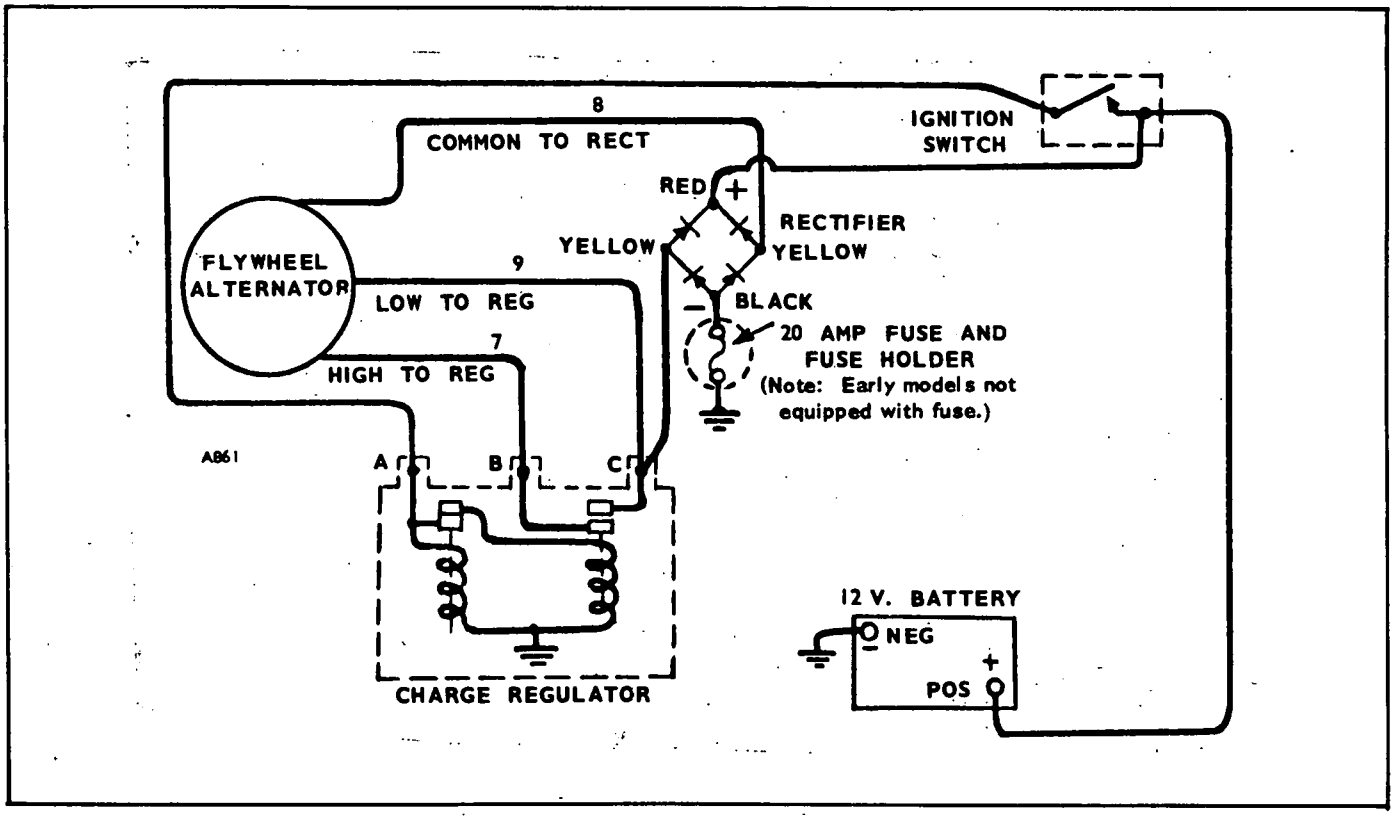


FIGURE 41. BATTERY CHARGING SCHEMATIC DIAGRAM

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 sufficient and the regulator is defective.

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

Indicator Light: This light is used on engines with factory-mounted controls. The light mounts on the rear cylinder air housing, and lights red when the alternator is charging.

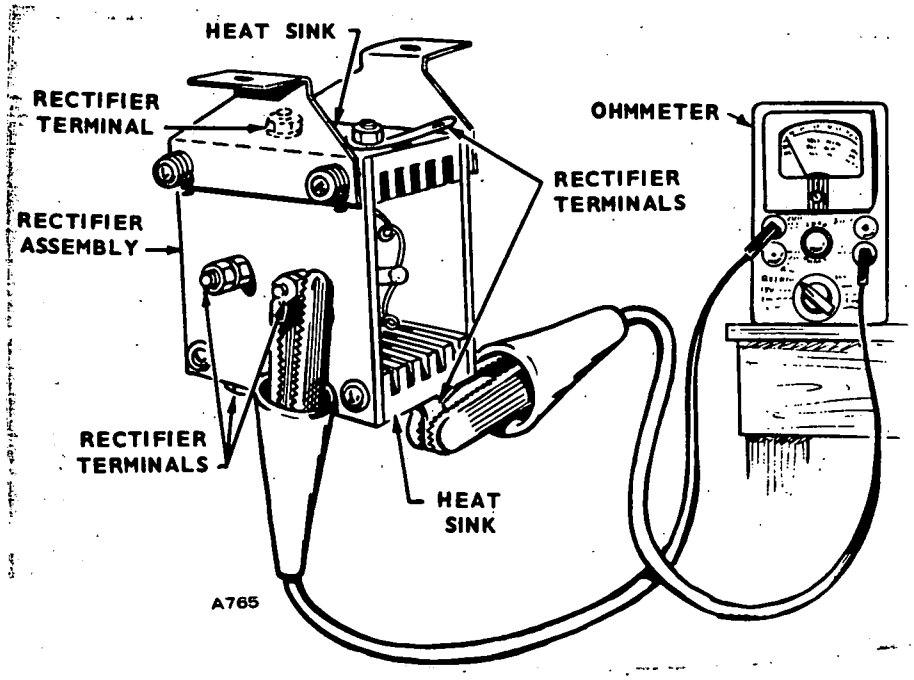


FIGURE 42. RECTIFIER TESTING

ENGINE DISASSEMBLY

ENGINE REBUILDING

When engine disassembly is necessary, remove complete assemblies (tear down individual components like fuel pump, breaker mechanism, etc., as bench jobs). *Use special tools available.*

Disassembly:

1. Common sense will dictate proper order of disassembly. As disassembly progresses, the order may be changed, as will become self-evident.
2. A suggested procedure would be as follows:
   a. Housings, shrouds, blower housing, air cleaner.
   b. Flywheel – using puller or pry-bar method.
   c. Gear Cover - protect oil seal from keyway damage.
   d. Crank Gear - use puller and gear puller ring.
   e. Loosen accessories such as fuel pumps, oil filter and starter.
   f. Control box; tag all wires for identification.
   g. Drain oil - discard oil removed.
   h. Cylinder head.
   i. Valves, springs, rocker arms.
   j. Camshaft and gear, rear bearing plate, oil pump.
   k. Piston, connecting rod bearings.
   l. Crankshaft.
   m. Try to analyze reasons for any parts failure and necessity of the repair.
   n. Cleanliness and neat, orderly work area makes the job easier to do.
   o. Use proper meters and gauges. Observe if cylinder requires boring, crankshaft needs grinding, or if other major shop work is necessary.

Assembly (Use Genuine Onan Parts):

1. Engine assembling procedure is normally the reverse of disassembly - observing proper clearances of bearings, connecting rod, proper fitting and sizing of piston, rings, etc.
2. Follow proper recommended procedure for fit of valves, adjusting clearances, and torque of all special items. Use a torque wrench to assure proper tightness without danger of stripping threads.
3. As each internal engine part is assembled, use crank (or wrench) and turn over engine, making certain it turns freely. If tightness is noted after any operation you then know your last step is responsible.
4. As each internal engine part is assembled, coat it heavily with oil (the same grade to be used in the crankcase). During the first few critical moments of operation the engine will depend on this lubrication.
5. After you have the internal engine parts reassembled, the engine should turn over freely when cranked. If reasonable care and attention has been given, the engine will operate efficiently.
6. At this point, it is a matter of mechanically adding the outside accessory items to the block assembly. *Order of assembly is reverse of disassembly.*
7. When engine is complete, install unit control. Check the tagged wires. Use wiring diagram to connect leads to control, and from control to engine. All wires are marked for correct identification. If the unit is to work properly, wires must be connected correctly.
8. The engine is now ready for testing. Follow suggestions given on *Testing and Adjusting Engines.* Before final test and adjustments, run the unit about 15 minutes under light load to reach normal operating temperature.

ASSEMBLY SUGGESTIONS (Things to keep in mind during engine assembly)

1. See *Onan Tool Catalog (900-19)* - many items require a *special tool* for correct installation. Some of these tools are:
   a. Oil seal driver and guide, bearing driver.
   b. Valve spring compressor, valve lock replacer, valve guide driver, and valve seat remover.
   c. Gear puller and gear puller rings.
   d. Piston ring spreader and compressor.
   e. Flywheel puller, pry bar, armature puller.
   f. Torque wrench, plastigauge (for correct bearing clearance).
   g. Load test panel, armature growler, gas pressure gauge (or manometer).
2. Wet holes in crankcase (holes through crankcase) - always use copper (gasket) washers.
3. Nuts, bolts and screws that do not require exact torque should be tightened snugly, then 1/4 extra turn.
4. Select proper length of any screw or bolt and position in hole. Make sure they do not *bottom.*
5. Gasket kits sometimes cover more than one engine. Therefore, select gasket of correct size and shape for part being used. Always use new gaskets.
6. When disassembling engine, *mike* bearing plate gasket thickness. Then select proper gasket thickness for correct end play.
7. When assembling crankshaft, make sure bearing thrust washers are in proper position supported by bearing stop pins. Use cup grease to hold in place.

8. When adjusting valve lash on J-Series, tap the rocker arm so it is straight when checking with feeler gauge.
9. When installing gearcase cover, put a dab of grease on roll pin so governor cup can be aligned.
10. Crank gears are easier to remove and install if heated.
11. See the *Fuel System* section for correct engine timing for the specific model.
12. Allow some gear lash (approximately 0.005-inch) in oil pump. *Do not install gears tightly against each other!*

TESTING AND ADJUSTING ENGINES

Preparation

Check the following:

1. Put proper oil in crankcase.
2. Service the air cleaner.
3. Connect the fuel line.
4. Connect the load.
5. Connect fully charged battery.
6. Check ventilation for proper cooling.

OPERATION

1. Start engine.
2. Check oil pressure.
3. Run unit 15 minutes to bring up to operating temperature.
4. Check for oil leaks, loose electrical connections, tight fuel lines and tight exhaust connections.

ADJUSTMENTS

Adjust governor for speed and sensitivity.

IMPORTANT: *For complete customer satisfaction, repaint unit (Onan Green, spray can 525P137, or Onan White, spray can 525P216) and apply instructions from Kit 98-1100C or Marine Kit 98-1807.*

CYLINDER HEADS, VALVES

Each cast iron cylinder head assembly has alloy hardened-faced valves, release-type rotators, alloy hardened inserts, guides, rocker arms, injection nozzles and glow plugs. The push rods run through shields.

Maintenance:

Check the valve clearances at regular intervals (see *Service and Maintenance Section*). In addition, clean the combustion chambers and valve seats at regular intervals.

After engine has reached a stable temperature condition the valve clearances may be adjusted. It is recommended that the valve clearance be set with engine at room temperature (approximately 75°F). Allow at least two hours cooling time after engine operation.

1. To adjust valve clearance on the two-cylinder J-Series engine proceed as follows:
   a. Turn the flywheel until the cylinder which is to have its valve adjusted is on its compression stroke, which follows closing of intake valve.
   b. Turn the flywheel until the TC (top center) mark on the flywheel lines up with the timing pointer on the gear cover. Then turn the flywheel in a clockwise direction 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 the cylinder will be in its power stroke with both valves completely closed.
   c. Check the cylinder head-bolt torque.
   d. Using a feeler gauge, check the clearance between the rocker arm and the valve (see Figure 43). Increase or reduce the clearance until the proper gap is established, adjusting with the lock nut which secures the rocker arm to the cylinder head (Figure 44). Refer to table 4 for correct valve clearance setting for your particular engine.

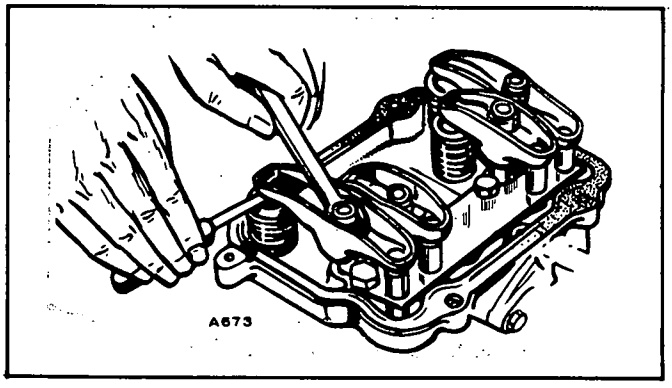


FIGURE 43. CHECKING VALVE CLEARANCE

TABLE 4. VALVE CLEARANCES

	DJB PRIOR to SPEC D	DJB BEGIN SPEC D	DJC
Intake	0.004	0.009	0.009
Exhaust	0.004	0.007	0.007

2. To adjust valve clearance on the four-cylinder J-Series engine proceed as follows:
   a. Adjust the valve clearance in the firing order (1-2-4-3) sequence. After the cooling period, adjust the number 1 cylinder according to 1.a and 1.b. After timing the number 1 cylinder, adjust the valve clearance according to steps 1.c and 1.d.
   b. To adjust the valve clearance for the number 2 cylinder, turn the flywheel in a clockwise direction 180 degrees (1/2 revolution) from the position used in step 2.a. The flywheel position should be between 10 degrees and 45 degrees past the BC (bottom center) flywheel mark.

   IMPORTANT: *Early model four-cylinder engines do not have a BC mark on the flywheel.*

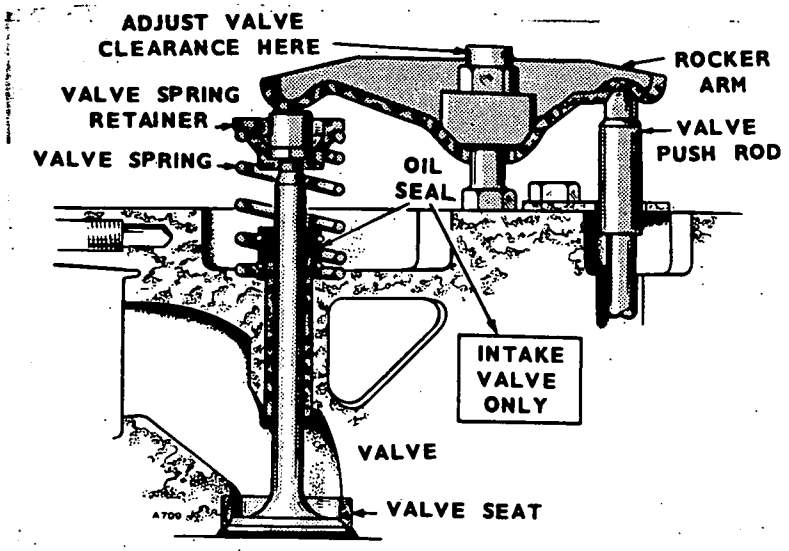


FIGURE 44. SETTING VALVE CLEARANCE

c. After timing the number 2 cylinder, adjust the valve clearance according to steps 1.c and 1.d.
d. To adjust the valve clearance for the number 4 cylinder, turn the flywheel in a clockwise direction 180 degrees (1/2 revolution). The flywheel should be between 10 degrees and 45 degrees past the TC flywheel mark.
e. After timing the number 4 cylinder, adjust the valve clearance according to steps 1.c and 1.d.
f. To adjust the valve clearance for the number 3 cylinder, turn the flywheel in a clockwise direction 180 degrees (1/2 revolution). The flywheel should be between 10 degrees and 45 degrees past the BC flywheel mark.
g. After timing the number 3 cylinder, adjust the valve clearance according to steps 1.c and 1.d.

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

To check compression, run the engine until thoroughly warm. Stop it and remove all injection nozzles. Insert the compression gauge in an injection nozzle, crank the engine and note the reading. To check for piston blow-by, squirt a small amount of SAE 50 oil into the cylinder and repeat the check. An increase in compression with oil in the cylinder indicates piston blow-by.

Compression of a standard new engine cranking at about 300 rpm is about 300-350 psi prior to Spec P and 350-400 psi Spec P and later. Compression should be fairly uniform, normally with less than 10 psi difference between the highest and lowest cylinder, taken at the same cranking rpm. Excessively high readings indicate carboned combustion chambers.

Compression readings 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 the pressure difference between cylinders or a compression increase when oil is added to the cylinder.

Disassembly:

NOTE: *Keep rocker arms, rocker arm nuts, push rods and tappets in order, so they go back in the same valve train position.*

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

Repair:
Thoroughly clean all components of the cylinder head assemblies. 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 a warped stem. Refinish valves that are slightly pitted or burned on an accurate valve grinder. Refinish intake valves to a 42 degree angle and exhaust valves to a 45 degree angle. If they are badly pitted or have a thin edge when refacing, replace them.

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 the *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 inch to 1/16 inch. You should be able to reface each seat several times before it becomes necessary to replace it.

If the valve seats are loose or cannot be refaced, replace them.

Use Onan tool number 420B272 in a drill press (Figure 45) 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.

Thoroughly clean the valve seat counterbore and remove any burrs from the edges. If the counterbore is damaged, it will have to be machined 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 dry ice.

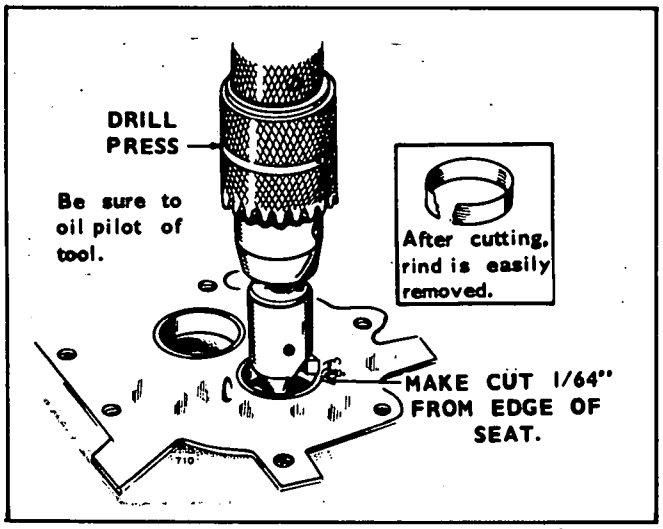


FIGURE 45. REMOVING VALVE SEATS

Face each new seat to a 45 degree angle and a width of approximately 3/64 inch. The finished seat face should contact the approximate 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 the 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 seat stem oil seal onto each intake valve guide and clamp in place. Then oil the inside surface of each seal.

   IMPORTANT: *Units built before June 1962 had no valve seals.*
2. Oil the stem of each valve lightly and insert each in its own guide.
3. Check each valve for a tight seat 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.
5. Install the head assembly and gasket to the cylinder block. Tighten the head bolts to 44 to 46 foot-pounds. Follow the sequence in Figure 46 and steps a through c.

CAUTION *Always use Never-Seez, Fel-Pro C5-A or equivalent thread lubricant when installing cylinder head bolts.*

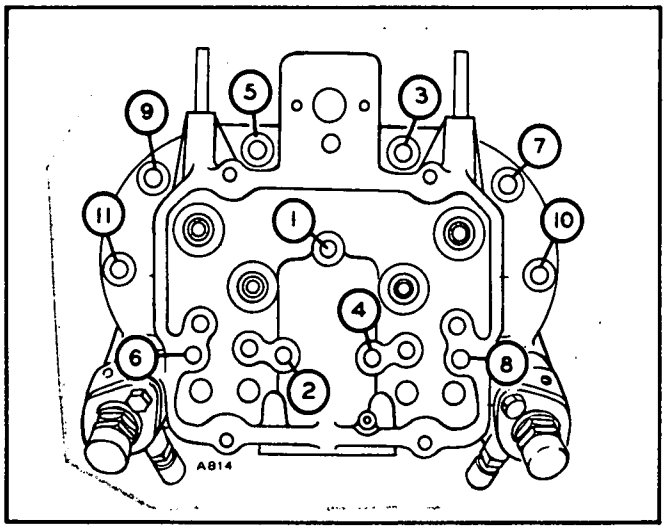


FIGURE 46. HEAD BOLT TIGHTENING SEQUENCE

a. Tighten cylinder head bolts finger-tight.
b. Install exhaust manifold and tighten (four cylinder models only).
c. Tighten cylinder head bolts in the sequence shown in Figure 46 to 25-30 foot-pounds.
d. Tighten cylinder head bolts in the same sequence to 44-46 foot-pounds.
e. After 60 seconds, retighten cylinder head bolts in sequence to 44-46 foot-pounds. This step compensates for the compress of the cylinder gasket.

6. Install the intake 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 44.

IMPORTANT: *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 drill 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 and 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 0.155 inch from TDC. This is the port closing point, 21 degrees 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°F - 400°F for 30 to 40 minutes.

CAUTION *Do not heat with a torch.*

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. See Figure 47.

Gear Cover Oil Seal: Replace the oil seal if damaged or worn. Drive the old seal out from inside the gear cover. 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. See Figure 48.

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 47). 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 47). 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 crankshaft keyway to protect the seal and install the gear cover. Tighten the mounting screws to 15 to 20 foot-pounds. Before tightening screws, be sure the stop pin is in the governor hole.

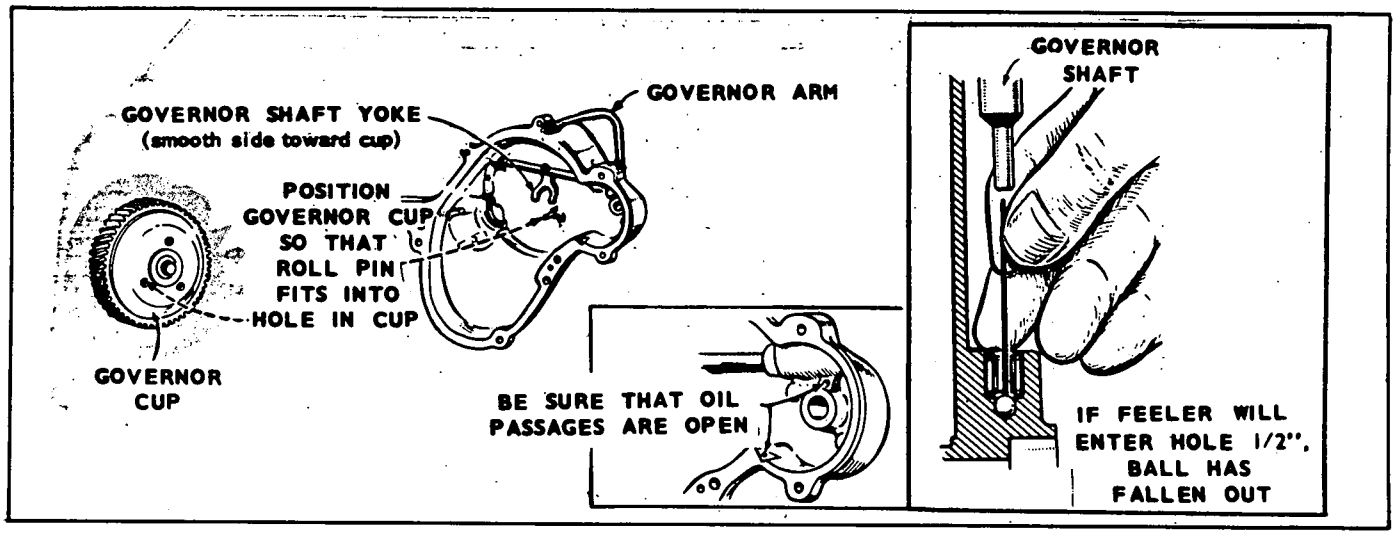


FIGURE 47. GEAR COVER ASSEMBLY

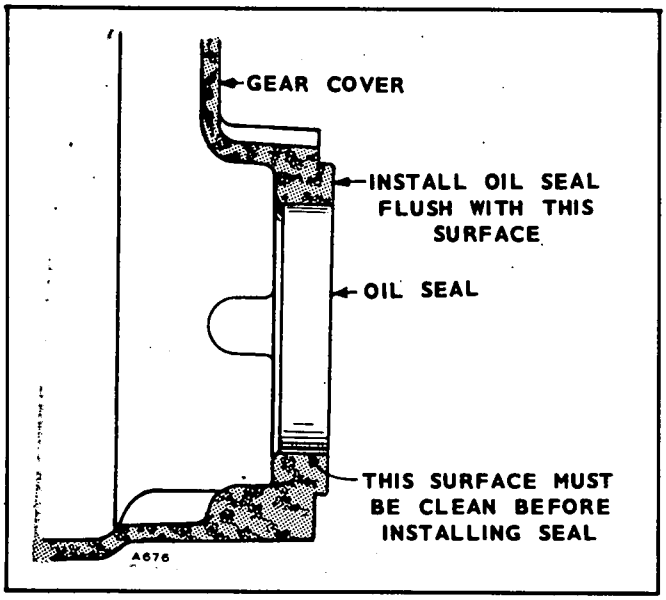


FIGURE 48. GEAR COVER OIL SEAL

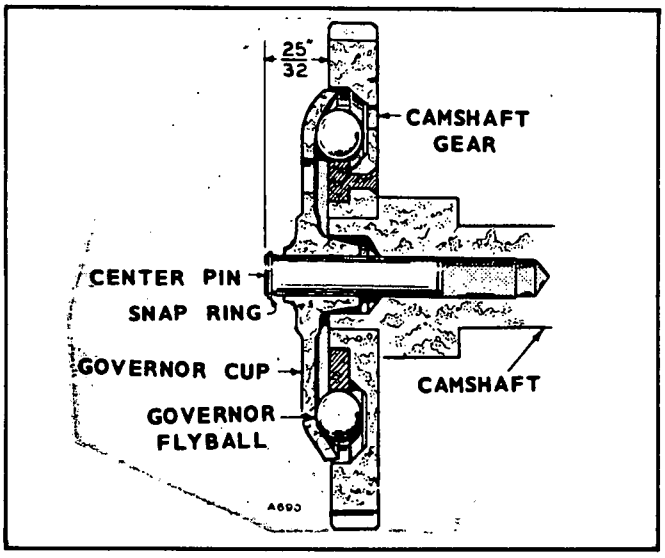


FIGURE 49. GOVERNOR CUP

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 ten flyballs that will fall out when the cup is removed. Figure 49 shows the governor cup.

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.

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, CONNECTING RODS

DJ engines use cam-ground aluminum pistons. Each piston is tapered and fitted with three compression rings and an oil control ring. Full-floating piston pins connect the piston to its connecting rod. The pins are held in place with a snap ring at each end. The lower end of each connecting rod contains half-shell precision bearings and the upper end, semi-finished bushings.

IMPORTANT: *Some engines are fitted with 0.005 inch oversize pistons at the factory. These engines are marked with an E following the engine serial number. Use 0.005 inch oversize rings for these pistons.*

Removal and Disassembly:
On 2- and 4-cylinder engines the connecting rod and cap are stamped for installation in the proper cylinder. When removing piston assemblies, check the marking so each can be installed in the proper cylinder.

1. Drain the crankcase oil and remove the oil base.
2. Remove the cylinder heads.
3. Before pushing pistons out, scrape carbon at top of cylinder bore.
4. Remove the cap from each connecting rod and push the assembly through the top of the cylinder bore. Replace the cap and bearing inserts in the proper assembly.
5. Using a ring expander, remove the rings from each piston.
6. Remove the two retaining rings and push the piston pin from each piston.

Cylinders:
The cylinder walls should be free of scratches, pitting and scuffing. Check each with an inside reading micrometer for out-of-round and wear. The bore should measure between 3.2495 inches 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 cylinders do not need refinishing, remove any existing ridges from the top of the walls with a fine stone.

Pistons:
Clean thoroughly and inspect each piston. Clean the carbon from the ring grooves and be sure all oil holes are open. If any piston is badly scored or burred, loose in the cylinder, has badly worn ring grooves or otherwise is not in good condition, replace it. See Figure 50.

CAUTION *The notch or the word FRONT on each piston top must face the front of the engine.*

Check the clearance 90 degrees from the axis of the piston pin and below the oil control ring. Clearance should be 0.0050 inch - 0.0070 inch. If not, replace the piston and check the cylinder for possible reconditioning.

PISTON PINS
Each piston pin should be a thumb push fit into its piston at room temperatures. If the pin is excessively loose, install a new one. If the condition is not corrected, install the next oversize pin. If the piston is worn enough so 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 a 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 walls. If oversize pistons are used, use the correct oversize rings.

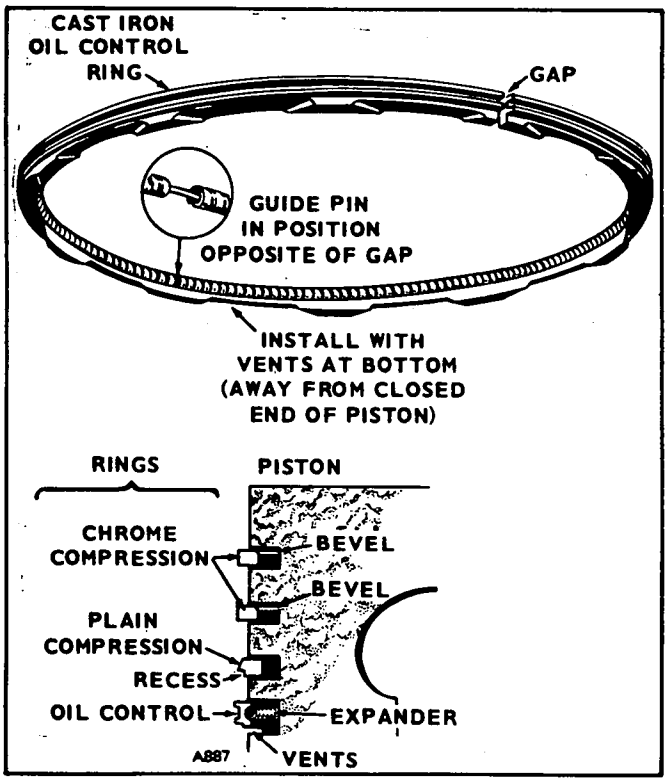


FIGURE 50. PISTON RINGS

CONNECTING RODS
Clean the connecting rods and check each for defects. Check the connecting rod bushings for proper clearance with the piston pin. Clearance should be 0.0002 inch to 0.0007 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 sides of the rod to leave 1/16 inch to 7/64 inch oil groove in the center. See Figure 51.

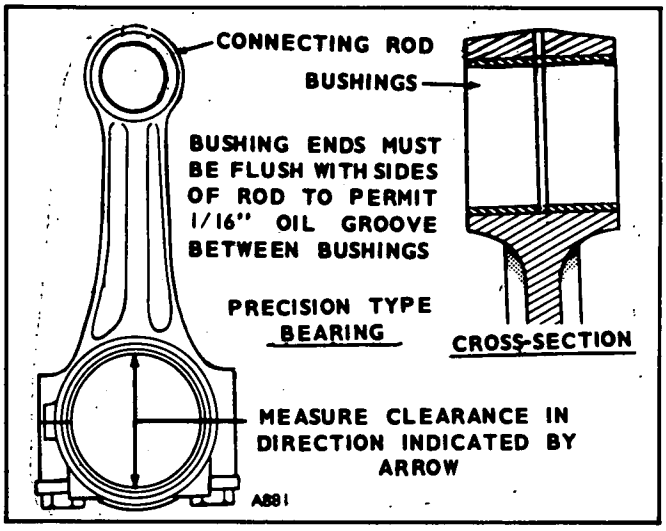


FIGURE 51. CONNECTING ROD BUSHINGS

CONNECTING ROD BEARINGS

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

ASSEMBLY AND INSTALLATION

1. Install the connecting rods on each piston with pins 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 all rings on each piston. Tapered-type 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 pistons.
3. Position a bearing half in each connecting rod. Be sure there is no dirt under the bearing. This could cause high spots and early bearing failure.
4. Oil the cylinder walls. Install each piston in the proper cylinder using a suitable installer. Each assembly should be installed with the stamp on the piston facing the same direction as when removed.
5. Position each connecting rod on the crankshaft and 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. See Figure 52.
6. Tighten the cap screws to the specified torque.
7. Crank the engine over by hand to see that all bearings are free.
8. Install the oil base with a new gasket.
9. Install the cylinder heads using proper bolt tightening sequence.
10. Replace oil.

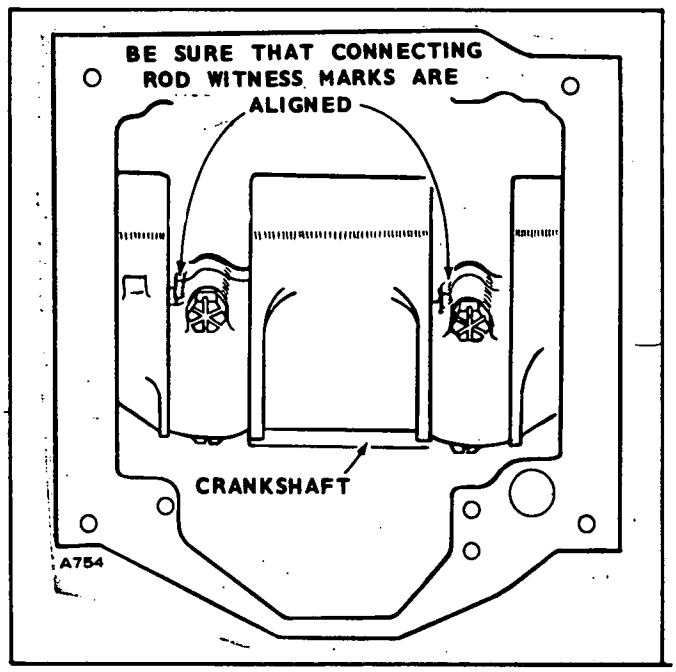


FIGURE 52. CONNECTING ROD CAP

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 its 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 53). Press the 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 as 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.

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. Measure camshaft end play; it should be 0.007 inch to 0.039 inch. See Figure 54.
4. Lay the engine on its side or end and insert the push rod tappets.

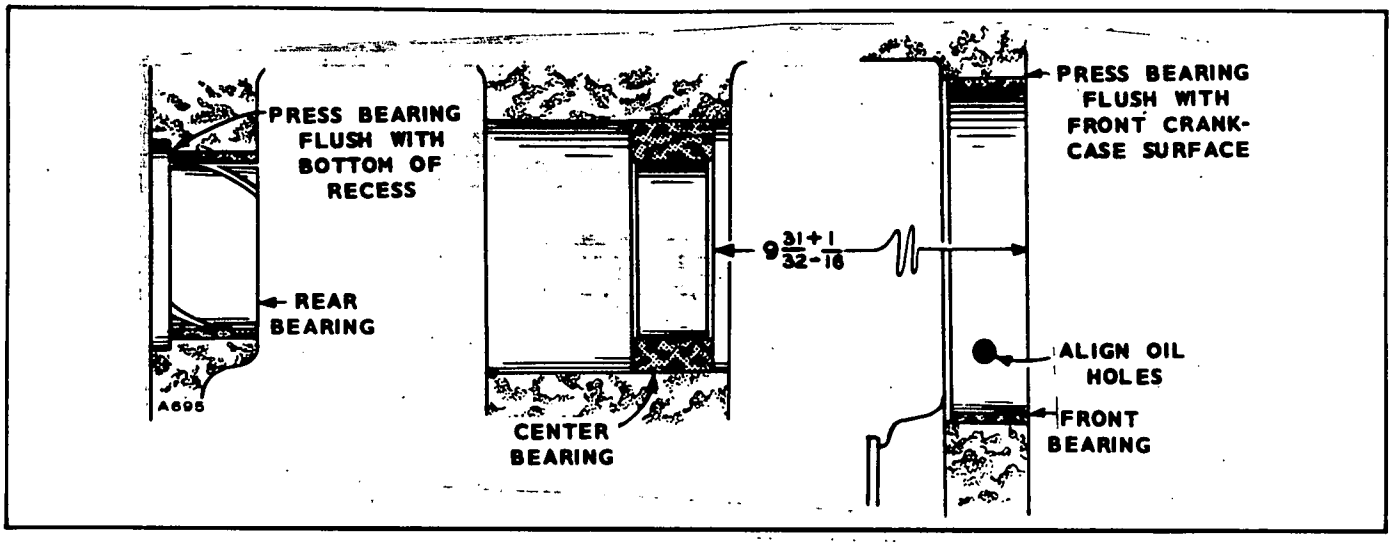


FIGURE 53. CAMSHAFT BEARINGS

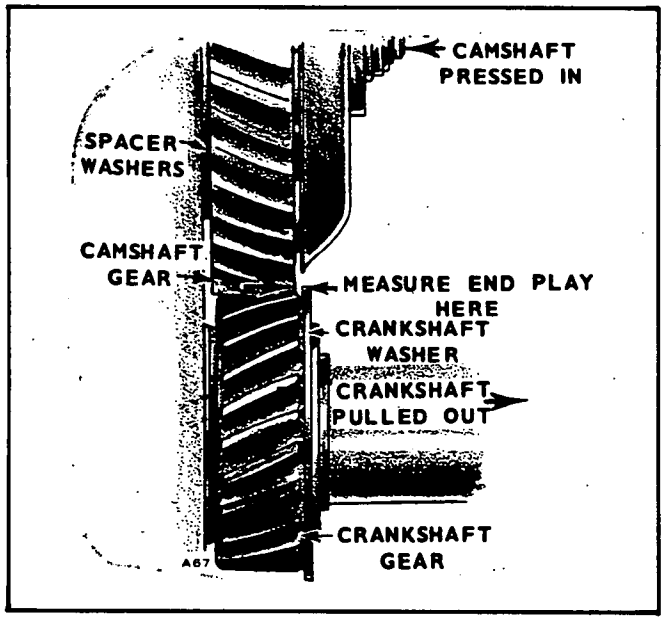


FIGURE 54. CAMSHAFT ENDPLAY

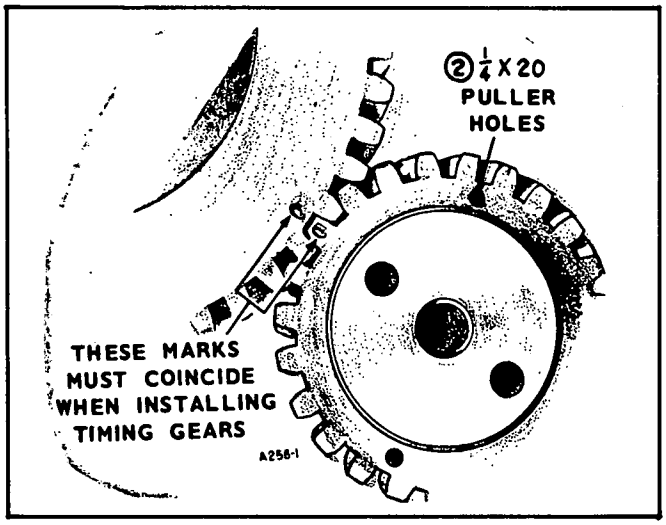


FIGURE 55. TIMING MARKS

5. Install the camshaft assembly in the engine. Align the timing marks on the camshaft gear and crankshaft gear. See Figure 55.
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.

CRANKSHAFT

The DJ series engines use a counter-balanced, ductile iron crankshaft. To increase the shaft fatigue durability, all crankpin fillets are shot-peened during manufacture. The two-cylinder crankshafts ride on two lead-bronze bearings, the front one housed in the crankcase and the rear one in the bearing plate. The four-cylinder model uses an additional split-center main bearing.

Removal:

1. Remove the lock ring and retaining washer in front of the crankshaft gear.
2. Pull off the crankshaft gear. 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 re-used. See Figure 56.
3. Remove the oil pan, piston, and connecting rod.
4. Remove the bearing cap from the center main bearing (four cylinder only).
5. Remove the rear bearing plate from the crankcase.
6. Remove the crankshaft through the rear opening in the crankcase (four cylinder only: Catch the upper half of the center main bearing support as it slides off its mounting surface).

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 areas. 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.

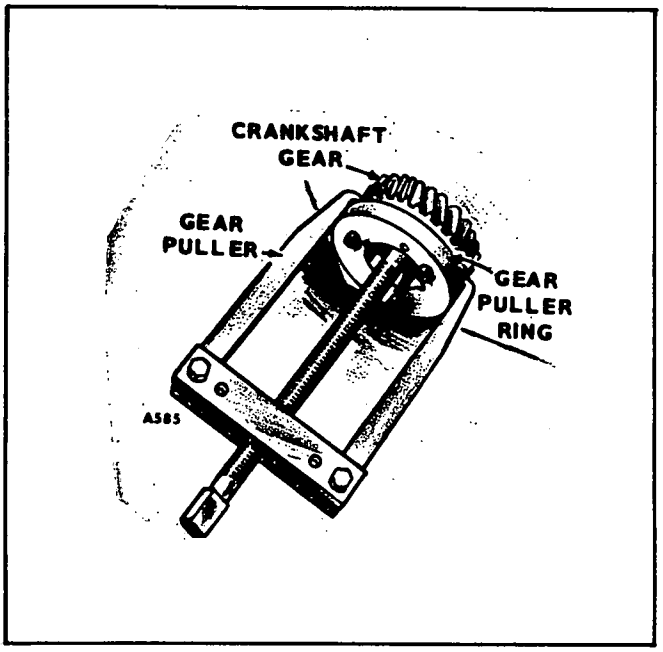


FIGURE 56. REMOVING CRANKSHAFT GEAR

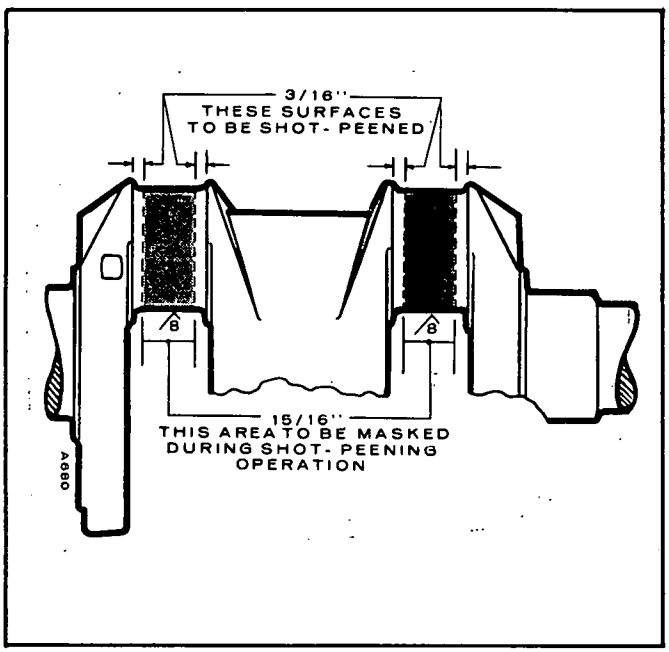


FIGURE 57. SHOT-PEENING THE CRANKSHAFT

Crankshaft Grinding: Crankshaft grinding requires a trained, experienced operator working with precision equipment. Procedures which may be satisfactory for some spark-ignition engines may well be unsatisfactory for diesel applications, resulting in expensive failures. 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 57 to shot-peen each crank pin fillet.

1. Almen gauge reading 0.012-A.
2. Peen with 0.019 inch diameter cast steel shot.
3. Peen for 30 seconds on each crankpin fillet.
4. Mask off connecting rod bearing areas.

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

Main Bearings: Replace main bearings if clearances are greater than limits or if the bearings are worn, grooved, or broken.

Precision replacement 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. Insert the center bearing of the DJC when the crankshaft is reinstalled.

Rear Oil Seal: 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 58. 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.

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. See Figure 58.
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. Four cylinder only: Set the upper half of the center main housing on the crankshaft and rotate it into place. See Figure 59. Be sure it is installed with the side marked *front* toward the crankshaft gear. Set the two positioning dowels on the upper bearing mount. Install the center main bearing cap and torque the bolts to 97-102 foot-pounds.
7. 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 is required, 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.

8. Install piston assemblies.

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. If, on the four cylinder models, the center main bearing support requires replacement, the whole crankcase must be replaced or returned to the factory to have a new housing fitted.

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 to 20 minutes at no load, about 30 minutes at 1/3 load, and 2 to 3 hours at 2/3 load. Regular operation can then be resumed. Avoid light load operation during the following several hours for best ring seating to control oil.

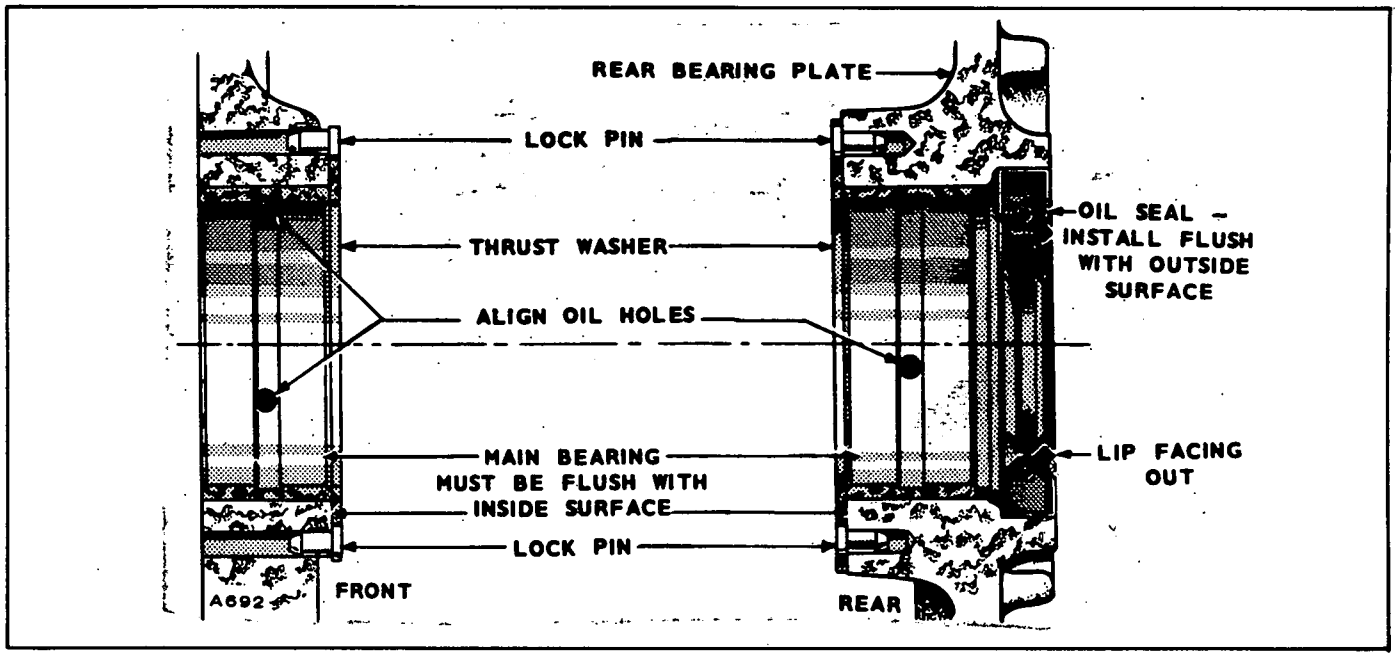


FIGURE 58. MAIN BEARING INSTALLATION

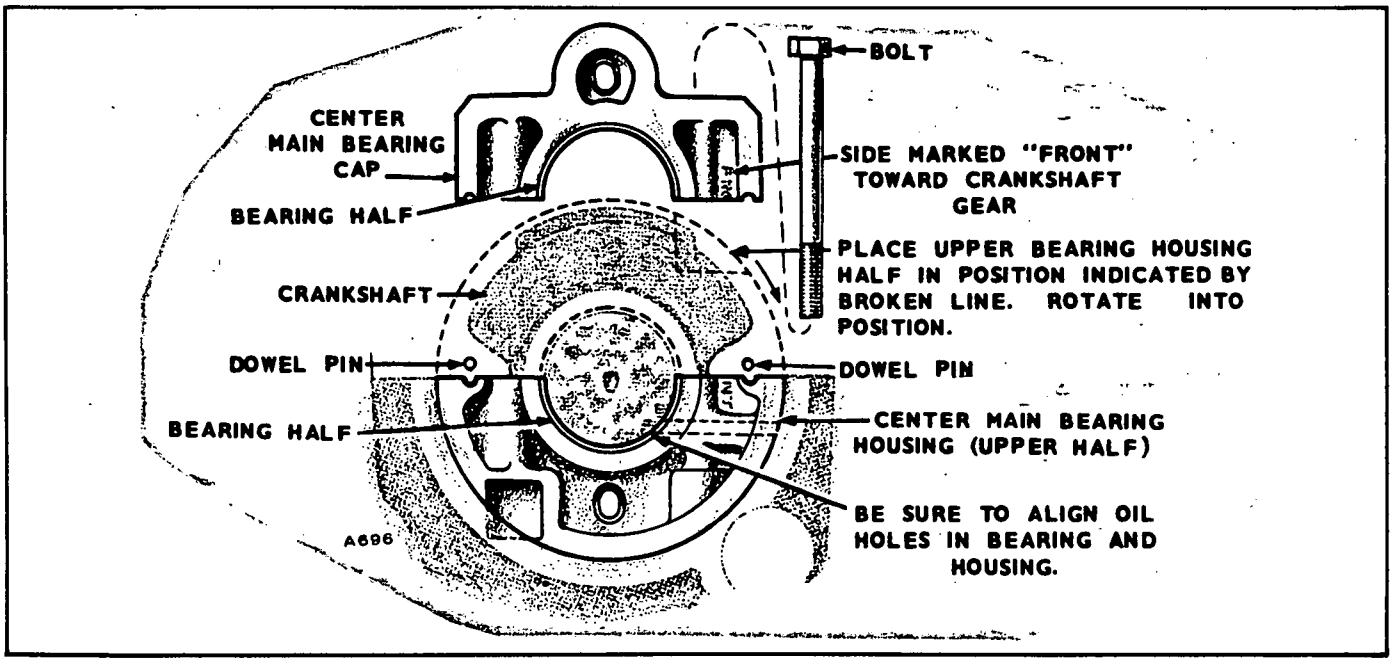


FIGURE 59. MAIN BEARING HOUSING