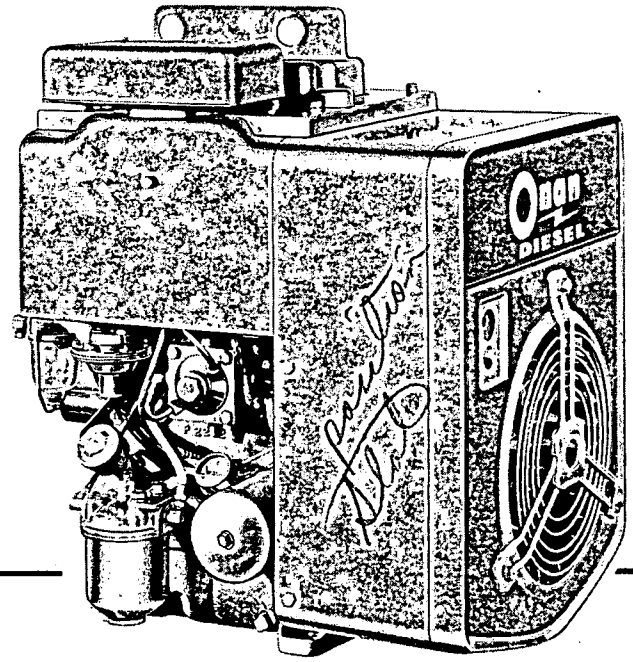
McGRAW-EDISON

Onan

Operators and Service Manual

DJBA

Diesel Engines



967-0756
(SPEC P-W)
6-79
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Safety Precautions

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

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

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

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

Safety Codes

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

General

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

Protect Against Moving Parts

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

Batteries

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

Fuel System

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

Exhaust System

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

Exhaust Gas is Deadly!

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

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

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

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

Cooling System

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

Keep the Unit and Surrounding Area Clean

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

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GENERAL INFORMATION

These instructions apply to the DJBA industrial engine. There are many options which can be added to this engine. Identify your particular model by referring to the unit nameplate.

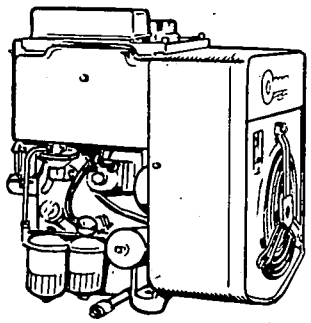
How to interpret MODEL and SPEC NO.

DJBA - MS / 375 W

1 2 3 4

1. Factory code for general identification purposes.
2. Specific Type:

   MS - ELECTRIC starting with stub shaft.
3. Factory code for optional equipment supplied.
4. Specification (Spec Letter) advances with factory production modification.



TYPICAL DJBA ENGINE

SPECIFICATIONS

(All values given in inches unless otherwise specified.)

Dimensions	
Height	26 (660 mm)
Width	18-3/8 (467 mm)
Length	23-5/16 (592 mm)
Weight	288 (131 kg)
Number of Cylinders	2
Displacement (cu. in.)	60 (.98 litre)
Bore	3-1/4 (82.55 mm)
Stroke	3-5/8 (92.08 mm)
H.P. at 2400 rpm (nominal)	14.6 (10.9 kW)
Compression Ratio	19:1
Main Bearings are Leaded Bronze, Precision Type for Replacement (Qty.)	2
Connecting Rod Bearings Tri-Metal Replaceable	Yes
Piston Rings (chrome plated)	
Oil Control	1
Compression	3
Hardened Chrome - Cobalt Alloy Faced Valves	Yes
Hardened Chrome - Cobalt Alloy Replaceable Valve Seats	Yes
Valve Rotator	Yes
Governor (internal flyball type - externally adjustable)	Yes
Governor Regulation %	5
Nominal Battery Voltage	12
Battery Size	
SAE Group 1H (number used)	Two
Amp/Hr. SAE 20 hr. Minimum	105 (378 kC)
Solenoid Shift Starter	Yes
Engine cooling air CFM at 1800 rpm £	590
Total cu. ft. per min. of air required	613.8 (17.38 m^3/min)
Combustion Air (cfm) *	42 (.3 m^3/min)
Cooling Air (cfm) *	850 (16.71 m^3/min)
Inlet Vent (sq. ft.)	7 (.7 m^2)
Outlet Vent (sq. in.) **	80 (.05 m^2)
Air Cleaner (std.)	Oil Wetted
Glow Plugs and Air Heater to Aid Starting	Yes
Injection Pump (American Bosch Type)	PSU
Primary and Secondary Fuel Filters	Yes
Fuel Pump Lift (Feet, maximum)	6 (1.83 m)
Oil Pump (Gear Type)	Yes
Oil Filter (full flow)	Yes
Oil Capacity (U.S. quarts) ££	3-1/3 (3.3 litres)
Exhaust Connections (Pipe Tapped)	1-1/4 (31.75 mm)
Power Take-off (inches)	
Shaft Length	4 (101.16 mm)
Shaft Diameter	1-3/4 (44.45 mm)
Keyway Length	3 (76.2 mm)
Keyway Width	3/8 (9.5 mm)
Keyway Depth	3/16 (4.76 mm)

* - Air requirements at 2400 rpm.

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

£ - Pressure-cooled type air flow.

££ - Includes 1/2 quart for (.47 litres) for oil filter.

DIMENSIONS AND CLEARANCES

(All values given in inches unless otherwise specified.)

	MINIMUM	MAXIMUM
CAMSHAFT		
Bearing Journal Diameter, Front	2.500 (63.5 mm)	2.505 (63.63 mm)
Bearing Journal Diameter, Rear	1.1875 (47.63 mm)	1.1880 (30.18 mm)
Bearing Clearance Limit	.0012 (.031 mm)	.0037 (.094 mm)
End Play, Camshaft	.007 (.18 mm)	.039 (.99 mm)
Cam Tappet Hole Diameter	.8755 (22.24 mm)	.8765 (22.26 mm)
Cam Tappet Diameter	.8725 (22.16 mm)	.8730 (22.17 mm)
CONNECTING RODS		
Large Bearing Bore Diameter	2.1871 (55.55 mm)	2.1876 (55.57 mm)
Small Bushing Bore Diameter	1.044 (26.52 mm)	1.045 (26.54 mm)
Distance Center Large Bearing Bore to Small Bushing Bore	5.998 (152.35 mm)	6.002 (152.45 mm)
Clearance, Large Bearing to Crankshaft	.0010 (.025 mm)	.0033 (.084 mm)
CRANKSHAFT		
Main Bearing Journal Diameter	2.2437 (56.99 mm)	2.2445 (57.01 mm)
Crankshaft Main Bearing Clearance	.0020 (.051 mm)	.0033 (.084 mm)
Connecting Rod Journal Diameter	2.0597 (52.32 mm)	2.0605 (52.34 mm)
End Play, Crankshaft	.010 (.25 mm)	.015 (.38 mm)
CYLINDER		
Cylinder Bore	3-1/4 (82.55 mm)	
Cylinder Diameter Limits	3.2495 (82.54 mm)	3.2505 (82.56 mm)
PISTON		
Piston Clearance to Cylinder Wall	.0055 (.140 mm)	.0075 (.191 mm)
Piston Pin Hole Diameter	.99005 (25.15 mm)	.99025 (25.15 mm)
Ring Groove Width, Top	.097 (2.46 mm)	.098 (2.49 mm)
Ring Groove Width, 2nd	.0965 (2.45 mm)	.0975 (2.48 mm)
Ring Groove Width, 3rd	.0965 (2.45 mm)	.0975 (2.48 mm)
Ring Groove Width, 4th	.1880 (4.78 mm)	.1895 (4.81 mm)
Ring Side Clearance	.002 (.051 mm)	.006 (.152 mm)
PISTON PIN		
Length	2.738 (69.55 mm)	2.753 (69.93 mm)
Diameter	.9899 (25.14 mm)	.9901 (25.15 mm)
Piston Clearance @ 70° F	.00005 (.0013 mm)	.00025 (.0064 mm)
Connecting Rod Bushing Clearance	.0002 (.005 mm)	.0007 (.018 mm)
PISTON RINGS		
Ring Type		
Top		Compression
2nd		Compression
3rd		Compression
4th		Oil Control
Ring Width		
Top	.0925 (2.35 mm)	.0935 (2.37 mm)
2nd	.0925 (2.35 mm)	.0935 (2.37 mm)
3rd	.0925 (2.35 mm)	.0935 (2.37 mm)
Ring Gap in Cylinder	.010 (.25 mm)	
STARTING MOTOR (Prestolite)		
Rotation	Counterclockwise	
Pinion Clearance to Pinion Stop (Solenoid Plunger Bottomed)	.070 (1.78 mm)	.120 (3.05 mm)
Pinion Rest Position - Distance from Pinion Housing Mounting Face to Outer Edge of Pinion	1-9/32 (32.54 mm)	1-15/32 (37.31 mm)

Armature End Play	.005 (.13 mm)	.030 (.76 mm)
Test Specifications		
No Load	10 Volt - 80 Amps 5000 rpm Minimum	
Stall Torque	4 Volt - 420 Amps 7.8 ft. lbs. Min. (10.6 N•m)	
Brush Spring Tension	32 - 40 oz. with new brushes (.91 kg - 1.13 kg)	
VALVE, INTAKE (Cobalt-Chrome Alloy)		
Stem Diameter	.3405 (8.650 mm)	.3410 (8.66 mm)
Clearance in Guide	.0015 (.038 mm)	.0030 (.076 mm)
Face Angle	42°	
Valve Clearance (cold)	.009 Intake (.229 mm)	
VALVE, EXHAUST (Cobalt-Chrome Alloy)		
Stem Diameter	.3405 (8.65 mm)	.3415 (8.67 mm)
Clearance in Guide	.0030 (.076 mm)	.0050 (.127 mm)
Face Angle	45°	
Valve Clearance (cold)	.007 Exhaust (.178 mm)	
VALVE GUIDE		
Length	1-25/32 (45.24 mm)	
Outside Diameter	.4690 (11.91 mm)	.4695 (11.93 mm)
Cylinder Head Bore Diameter	.467 (11.86 mm)	.468 (11.89 mm)
Inside Diameter (after Reaming)		
Exhaust	.3445 (8.75 mm)	.3455 (8.78 mm)
Intake	.3425 (8.70 mm)	.3435 (8.73 mm)
VALVE SEATS (Stellite)		
Valve Seat Bore Diameter	1.361 (34.57 mm)	1.362 (34.60 mm)
Depth (from Cylinder Head Face)	.433 (11.00 mm)	.439 (11.15 mm)
Seat Outside Diameter	1.364 (34.65 mm)	1.365 (34.67 mm)
Seat Width	3/64 (1.19 mm)	1/16 (1.59 mm)
Seat Angle	45°	
VALVE SPRINGS		
Free Length	1-7/8 (47.63 mm)	
Length, Valve Closed	1.528 (38.81 mm)	
Load, Valve Closed	45 (20.41 kg)	49 lbs. (22.23 kg)
Length Valve Open	1.182 (30.02 mm)	
Load, Valve Open	87 lbs. (39.46 mm)	97 lbs. (42.1848)
VALVE LIFTERS		
Lifter Diameter	.8725 (22.16 mm)	.8730 (22.17 mm)
Lifter Bore	.8755 (22.24 mm)	.8765 (22.26 mm)
OIL PUMP BYPASS VALVE		
Plunger Diameter	.3365 (8.55 mm)	.3380 (8.59 mm)
Spring Free Length	2-1/4 (57.15 mm)	2-3/8 (60.33 mm)
Spring Tension (at 1-3/16 inch compressed)	2.225 lb. + .11 lb. (1.01 kg + .05 kg)	

ASSEMBLY TORQUES AND SPECIAL TOOLS

The assembly torques given here will assure proper tightness without danger of stripping threads. Use reasonable force only and a wrench of normal length.

Specially designed Place Bolts (Figure 1) 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.

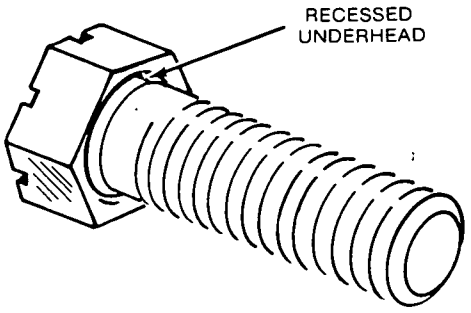


FIGURE 1. SPECIAL PLACE BOLT

TORQUE SPECIFICATIONS	LB-FT
Connecting Rod Bolt	27-29
Cover-Rocker Box	8-10
Cylinder Head Bolt	44-46
Exhaust Manifold Nuts	13-15**
Flywheel Mounting Screw	65-70
Fuel Pump Mounting Screws	15-20
Gear Case Cover	18-20
Glow Plug	10-15
Injection Nozzle Mounting Screws	20-21
Injection Pump Mounting Screws	15-16
Intake Manifold	13-15
Oil Base Mounting Screws	45-50
Oil Filter	Hand Tight + 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

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

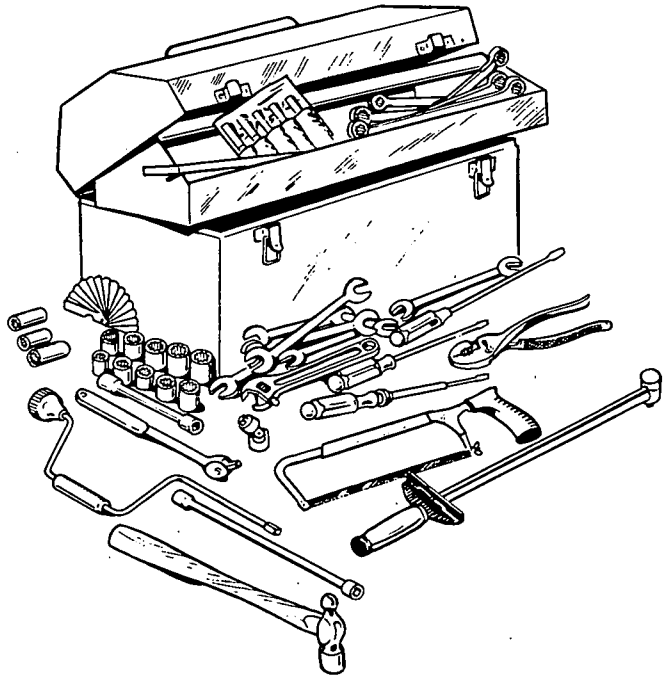
** - **Caution:** Tighten nuts evenly to avoid manifold damage.

SPECIAL TOOLS AND EQUIPMENT

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

Crankshaft Gear Pulling Ring	420-0275
Diesel Nozzle Tester	420-0184
Diesel Pintle Nozzle Cleaning Tool Set (Includes Injection Nozzle Centering Tool)	420-0208
Nozzle Centering Sleeve	420-0321
Delivery Valve Test Fixture	†420-0322
Combination Main and Cam Bearing driver	420-0326
Driver, Valve Seat	420-0270
Oil Seal Guide and Driver	
Bearing Plate	420-0250
Gear Cover	420-0281
Ridge Reamer	420-0260
Replacement Cutter Blade for 420-0260	420-0261
Diesel Compression Tester	420-0283
Valve Seat Remover	420-0311
Replacement Blades for 420-0311	420-0274
Valve Guide Driver	420-0327

† - Used with diesel nozzle tester.



ONAN
DIESEL ENGINE
TROUBLE-SHOOTING

Hard Starting or Failure to Start	Excessive Oil Consumption Light Blue Smoky Exh	Excessive Oil Consumption No Smoke Increase	Excessive Fuel Consumption Black Smoky Exhaust	Mechanical Knocks	Engine Misfires	Low Engine Power	Cooling Temperature Too High	Excessive Fuel Consumption	Fuel Knocks	Incorrect Injection Pump Timing	Speed Too High	Speed Too Low	Hunting Condition	Poor Sensitivity	No Governor Control	Diluted Oil	Crankcase Sludge	Low Oil Pressure	High Oil Pressure	Starter Motor Doesn't Turn	Slow Starter Speed	Starter Won't Engage Flywheel	Poor Compression	Valve Breakage	Valve Burning	Piston and Cylinder and Ring Wear	Worn Connecting Rod, Bushings and Bearings	Sticking Valves	CAUSE
	●																				●								Battery Discharged or Defective
	●																				●								Crankcase Oil Too Heavy For Low Temperature
	●																												Control Circuit Defective
	●																				●								Poor Starter Brush Contact
	●																												Load Connected When Starting
	●				●				●					●															Defective Glow Plug or Lead
	●			●	●	●			●					●															Defective Fuel System
	●				●	●			●					●															Air in Fuel System
	●	●		●	●	●		●						●															Poor Compression
	●			●	●	●		●	●					●															Incorrect Timing
	●			●	●	●		●						●														●	Restricted Air Intake, Dirty Air Cleaner
	●				●	●		●	●					●														●	Poor Quality Fuel
	●				●	●		●																					Dirty Fuel Filters
	●																												Out of Fuel or Shut-off Closed
●						●											●						●						Run for Long Periods of Time at No Load
	●								●																				Worn or Damaged Fuel Transfer Pump
	●				●													●											Crankcase Oil Too Light or Diluted
	●																		●										Excess Oil in Crankcase
	●			●	●																								Overheating
			●																										Oil Leaks from Oil Base or Connections
			●																										Leaky Oil Seals
	●			●	●	●			●																				Faulty Injection Pump or Nozzles, or Gaskets
	●				●		●																						Low Oil Supply
	●				●																								Loose Piston
					●																								Loose Connecting Rod or Crankshaft Bearing
	●				●	●		●																●	●	●		●		Incorrect Valve Clearance
	●				●	●		●																●	●	●				Broken or Weak Valve Spring
						●		●																●	●	●				High Exhaust Back Pressure
	●				●	●		●	●				●											●	●	●				Fuel Line Leaks
	●			●	●	●			●														●						Valves Not Seating Properly
						●				●																			Wrong Timing Button in Injection Pump
						●				●																			Wrong Thickness Pump Mounting Gaskets
														●	●														Incorrect Governor Adjustment
														●															Linkage Binding
														●															Governor Yoke or Cup Incorrectly Installed
●											●												●						Low Engine Power
													●																Governor Spring Sensitivity Too Great
														●	●														Excessive Wear in Linkage
						●								●															Linkage Disconnected
									●							●													Fuel Transfer Pump Diaphragm Leaks
					●													●			●								Worn Bearings
		●																●											Oil By-Pass Stuck Open
																		●											Worn Oil Pump
																		●											Defective Oil Gauge
																			●	●									Oil By-Pass Stuck Closed
		●																		●									Heavy Oil or Clogged Passages
																				●									Frozen Shaft Bushings (Starter)
																				●									Grounded Switch Terminals, or Fields
																				●									Open Armature Coils (Starter)
																				●									Open Field Circuit (Starter)
																				●									Open Solenoid
																				●									Broken or Weakened Brush Spring
																				●									High Mica, Worn Brushes
																				●	●								High Resistance In Starting Circuit
																				●	●								Dirty Commutator (Starter)
																				●									Burned Solenoid Contacts
																				●									Open or Shorted Field Windings (Starter)
																						●							Defective Ring Gear or Pinion
	●				●	●			●								●						●						Worn Rings
	●				●	●			●								●						●						Worn Cylinder Walls and Pistons
					●	●			●								●												Valves Sticking
																							●				●		Worn or Dirty Valve Guides
	●	●															●												Dirty Oil Filter

INSTALLATION

GENERAL

The initial installation is very important. Plan it carefully to ensure maximum operating efficiency. Use this manual as a general guide. Recommendations in this manual are based on extensive tests under favorable operating conditions. Abide by pertinent local codes regulating 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 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° 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 the flow of air from the inlet to the outlet will pass over the engine. The outlet should be slightly higher than the inlet.

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

When using ventiducts between the engine and outlet vent, provide a section of canvas to restrict vibration.

EXHAUST

WARNING **Pipe exhaust gases out of any enclosure. Inhalation of exhaust gases can result in serious personal injury.**

Pipe exhaust gas outside any enclosure. 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.

Use a metal shield to protect walls and partitions through which exhaust pipes pass. See Figure 2.

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

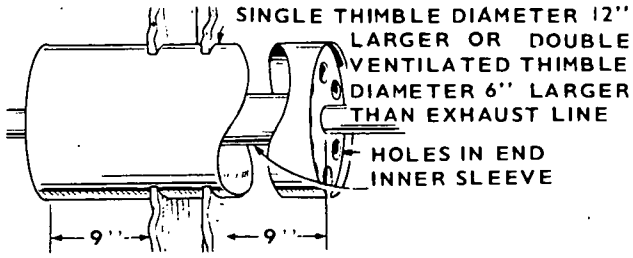


FIGURE 2. EXHAUST LINE PASSING THROUGH WALL OR PARTITION

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 6 feet. Auxiliary fuel pumps are available to provide an additional 8 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" pipe inlet in the fuel pump. Connect fuel return line to fitting at injection pump, see Figure 3. 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.

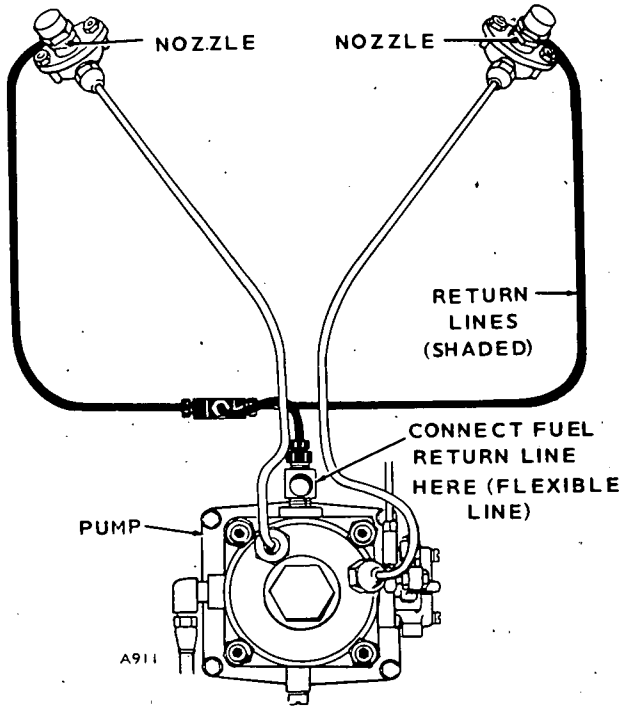


FIGURE 3. FUEL RETURN LINES

BATTERY

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

BATTERY CONNECTIONS

Connect the battery cable marked "POS." to the battery positive (+) terminal (Figure 4). Connect the unmarked terminal to the battery negative (-) terminal. Always keep cable connections tight and clean. A fuse protects the charging system if the battery is connected with reverse polarity.

Prior to Spec V only: If battery positive must be grounded to agree with related equipment, reverse the two connections on the rectifier (Figure 5).

Connect the remaining lead from a suitable DC source to the larger terminal on the starting motor solenoid (Figure 4).

OIL DRAIN EXTENSION

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

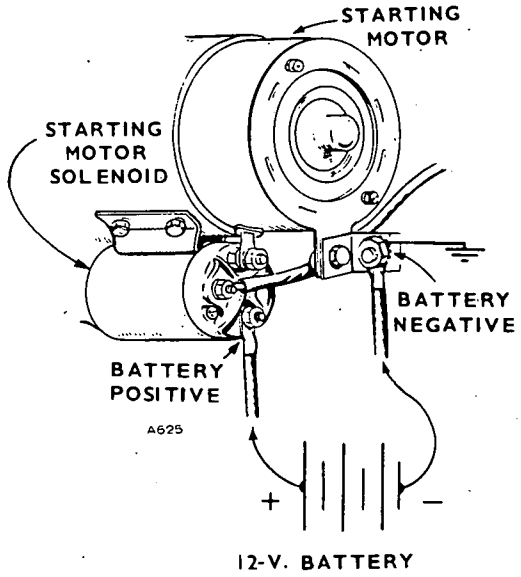


FIGURE 4. STARTING SYSTEM

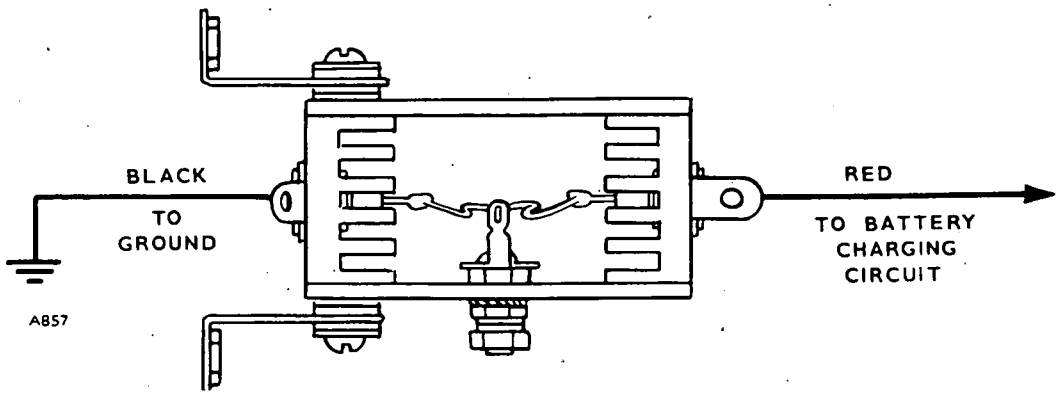


FIGURE 5. NEGATIVE GROUND SYSTEM (PRIOR TO SPEC V ONLY)

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.

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

OIL BATH AIR CLEANER (Optional)

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

Recommended Fuel

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

1. When ambient temperatures are below 32° F (0° C);
2. During long periods of light engine load; or no load.

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

Use low sulfur content fuel having a pour point (ability to filter) of at least 10° F (6° C) below the lowest expected temperature. Keep the fuel clean and protected from adverse weather. Leave some room for expansion when filling the fuel tank.

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

BLEEDING FUEL SYSTEM

Remove the fuel return line, Figure 6. Operate the priming lever on the fuel transfer pump until bubbles cease to appear in the fuel flowing from the bleed hole. Replace fuel return line.

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.

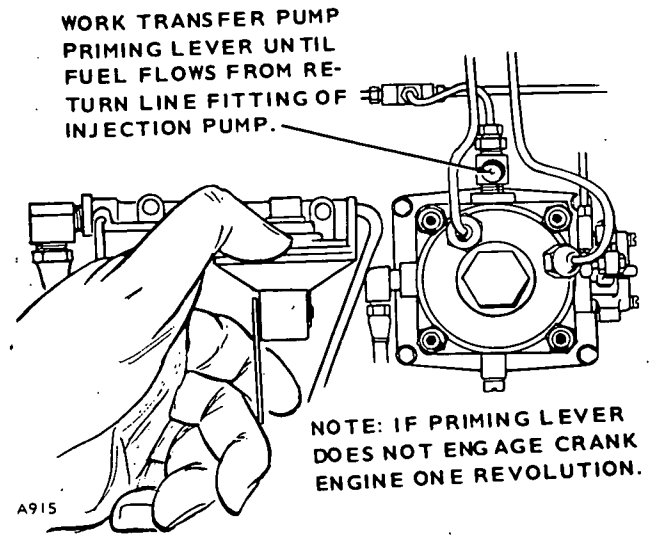


FIGURE 6. BLEEDING FUEL SYSTEM

GOVERNOR LINKAGE

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

INITIAL START

Check the engine to make sure it has been filled w oil and fuel. If necessary to prime a *dry* fuel system, return the priming lever to the disengaged position

after priming. For more detailed starting information see Starting Guide page 51.

IMPORTANT: This unit has been run and tested for approximately 4 hours at the factory. Additional break-in time is required and will vary depending upon load conditions, oil used, etc.

Run as follows:

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

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

STARTING

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

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

When restarting engine after short periods of shut-down, pre-heat is usually not necessary.

STOPPING

Disconnect as much load as practical from the engine before shut-down. 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 5 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 tag to refill before operating.
3. Service the air cleaner.
4. Lubricate governor linkage. Protect from dirt by wrapping with a clean cloth.
5. Plug exhaust outlet to keep out moisture and dirt.
6. Clean entire unit. Coat parts likely to rust with light grease or oil.
7. Provide a suitable cover for the entire unit.
8. Disconnect battery and follow standard battery storage procedures.

HIGH TEMPERATURES

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

LOW TEMPERATURES

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

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

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

DUST AND DIRT

1. Keep engine clean.
2. Service air cleaner as often as necessary.
3. Change crankcase oil every 100 operating hours.
4. Keep oil and fuel supplies in dust-tight containers.
5. Keep governor linkage connections clean.

HIGH ALTITUDE

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

SERVICE AND MAINTENANCE

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

ENGINE ROUTINE CHECK CHART

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

MAINTENANCE SCHEDULE

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

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

OPERATOR MAINTENANCE SCHEDULE

MAINTENANCE ITEMS	OPERATIONAL HOURS					
	8	50	100	200	600	3000
Inspect Engine	x					
Check Fuel	x3					
Check Oil Level	x					
Check Air Cleaner		x1				
Clean Governor Linkage		x1				
Change Crankcase Oil			x2			
Replace Primary Fuel Filter					x1	
Replace Secondary Fuel Filter						x1
Check Battery Electrolyte Level				x		
Replace Oil Filter				x1		
Empty Fuel Sediment Bowl				x		

x1 - More often under extremely dusty conditions.
x2 - See Operation section for recommended oils.
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.

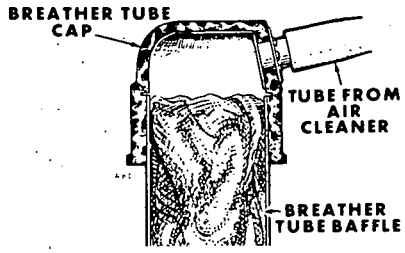
CRITICAL MAINTENANCE SCHEDULE

MAINTENANCE ITEMS	OPERATIONAL HOURS			
	200	500	1000	5000
Check Valve Clearance	*	x		
Clean Rocker Box Oil Line Holes			x	
Inspect Valves, Grind if Necessary			x	
Remove and Clean Oil Base				x
Clean Fuel System		x		
Clean Engine			x	
Complete Reconditioning				x
Clean Crankcase Breather			x	
Check Injection Nozzles**			x	
Clean Crankcase Breather Pipe (Begin Spec V)		x		

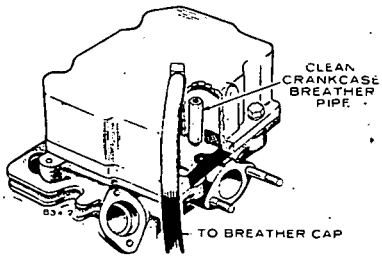
* - Tighten head bolts and adjust valve clearance after first 50 hours on a new or overhauled engine.
** - Service only by trained diesel equipment personnel with specialized equipment.

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

CRANKCASE BREATHER (PRIOR TO SPEC.S)

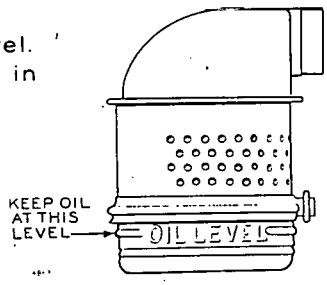


BEGIN SPEC. V

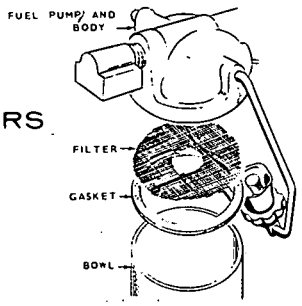


OPTIONAL AIR CLEANER

Keep oil at oil bath level. Use same grade oil as in crankcase.

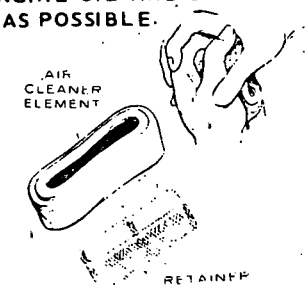


EMPTY FUEL SEDIMENT BOWL EVERY 200 HOURS

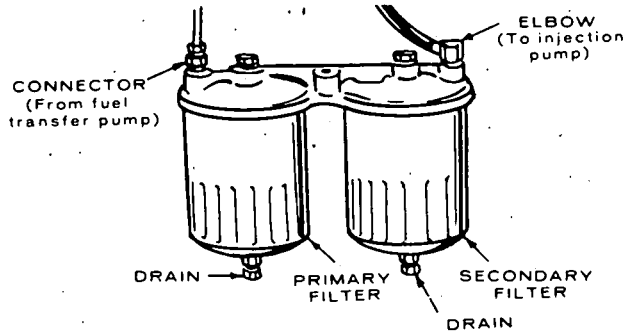


SERVICING STANDARD AIR CLEANER

AFTER WASHING ELEMENT DIP IN ENGINE OIL AND SQUEEZE AS DRY AS POSSIBLE.



FUEL FILTERS



Drain water periodically as required. Replace primary filter every 600 hours.

Replace secondary filter every 3000 hours.

Perform more often in extremely dusty conditions.

OIL FILTER CHANGE (See Schedule)

Place pan under old filter and remove it by turning counterclockwise. Clean filter mounting area. Lubricate gasket on new filter with oil and screw filter on clockwise until gasket touches mounting base, then tighten ½ turn.

FIGURE 7. MAINTENANCE PROCEDURES

COOLING SYSTEM

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

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

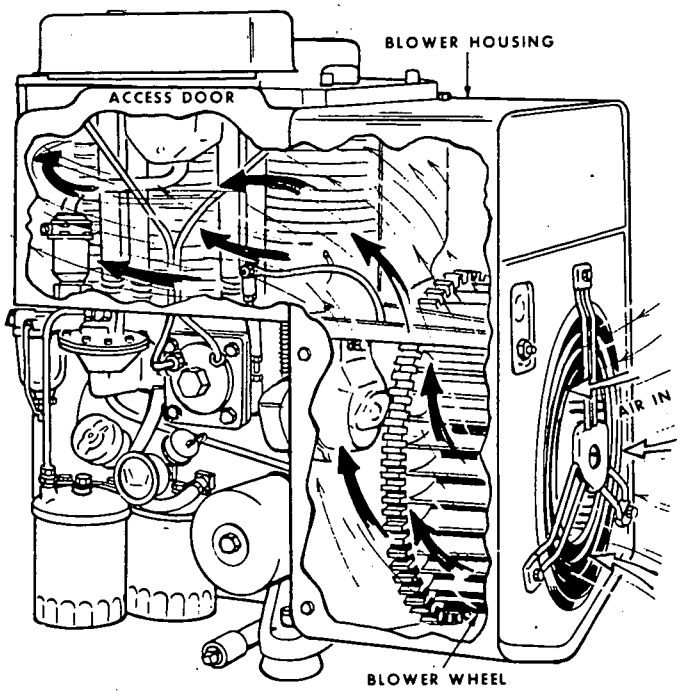


FIGURE 8. COOLING FLOW

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

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

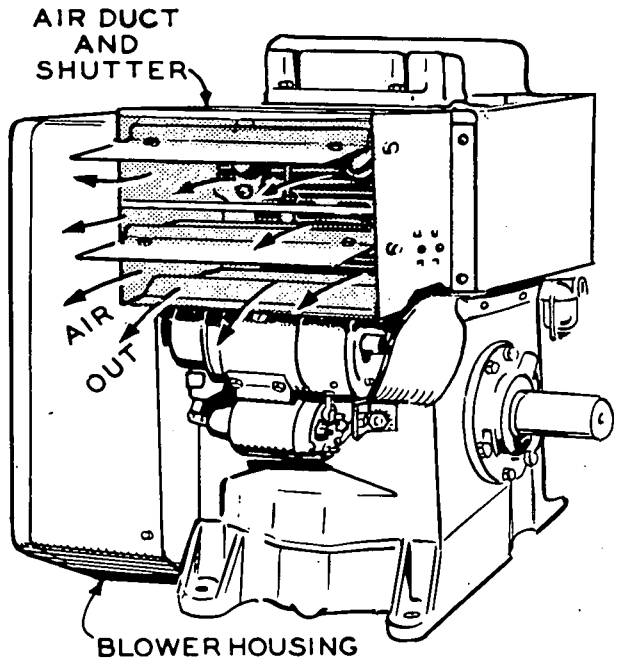


FIGURE 9. OPTIONAL SHUTTER ASSEMBLY

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 could 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 a 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. A thermostatic element (Figure 10) 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 at 140° F.

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

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 7/32". 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 space bushing so it must be on the inside of the housing. The shutters should be adjusted to obtain an end thrust clearance of not more than 1/32".

HIGH TEMPERATURE CUT-OFF

A high temperature cut-off switch protects the engine if shutter fails to open. The switch is in series with the governor solenoid. Switch is normally closed and opens at about 240° F. When it opens, the solenoid de-energizes, stopping the unit. The switch closes again at about 195° F.

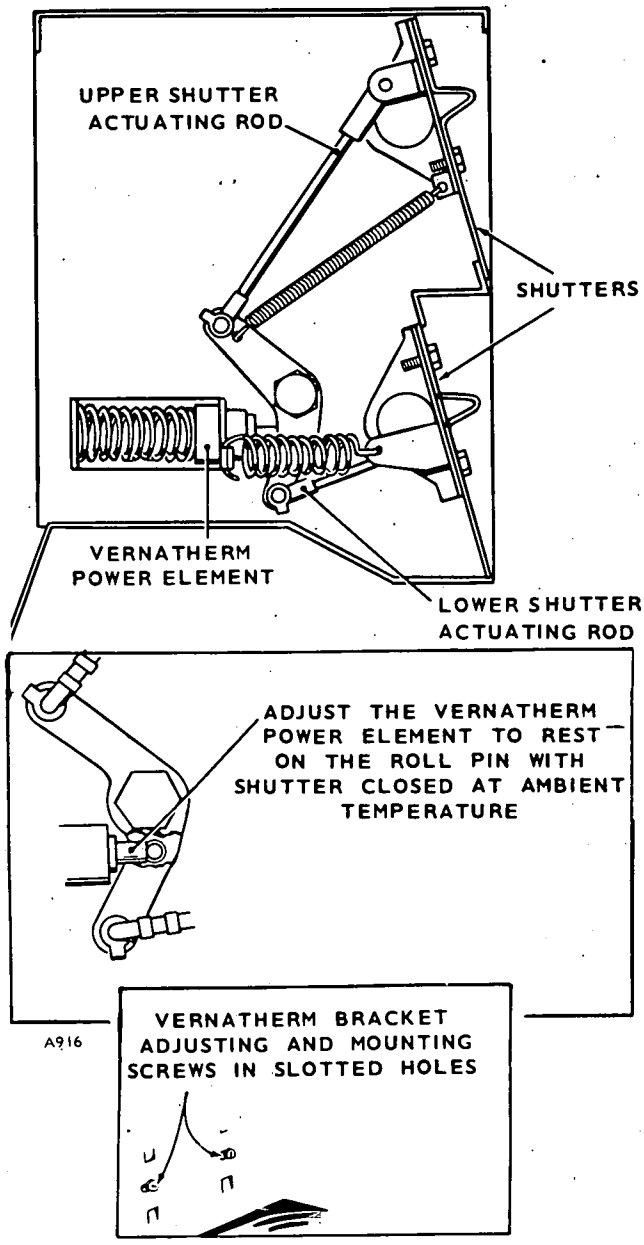


FIGURE 10. SHUTTER CONTROLS

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 11 shows the fuel system.

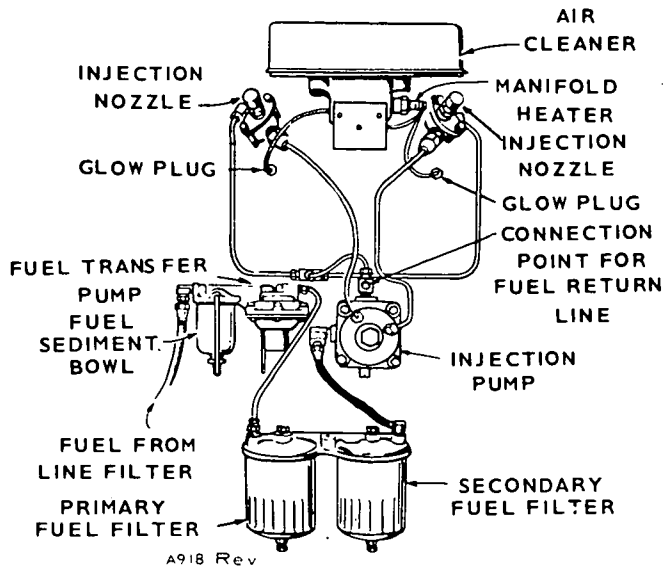


FIGURE 11. FUEL SYSTEM

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 leak-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 can stop your unit. When opening any part of the fuel system beyond the secondary fuel filter, place all parts in a pan of clean diesel fuel as they are removed. Before installing new or used parts, flush them thoroughly, and install while still wet.**

MAINTENANCE

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

When replacing or cleaning the filters, bleed the fuel system. Operate the hand priming lever on the transfer pump until no air bubbles flow from the return line fitting of the injection pump. Return the priming lever to its original position. See Figure 12.

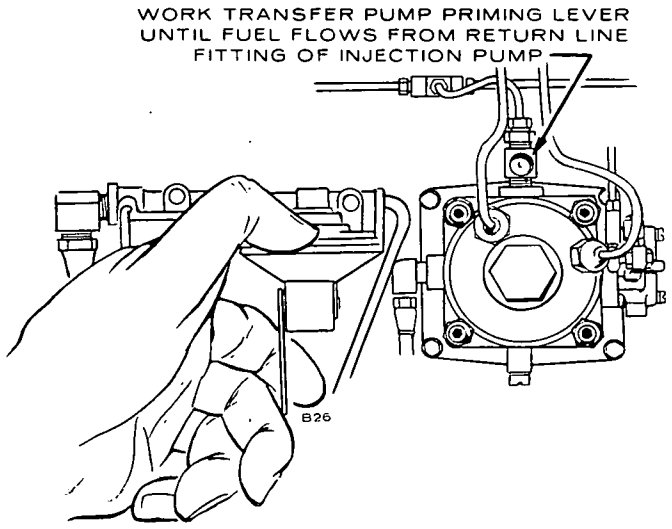


FIGURE 12. BLEEDING FUEL SYSTEM

CAUTION **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 ensuring proper filtration at all times.

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

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.
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 13).

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

Next, run the engine at governed speed on fuel provided by gravity feed and measure the fuel pump pressure developed. Pressure should be between 12 and 14 psi with the gauge 16" 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 14 shows the fuel transfer pump.

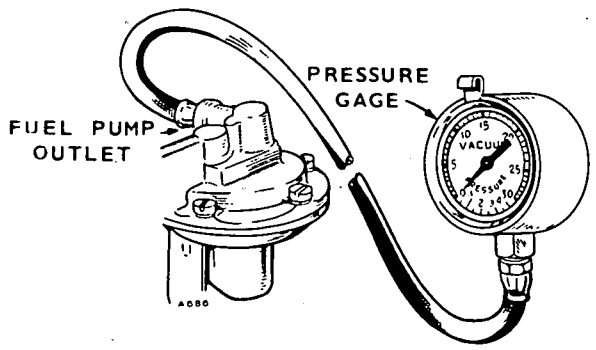


FIGURE 13. FUEL PRESSURE GAUGE

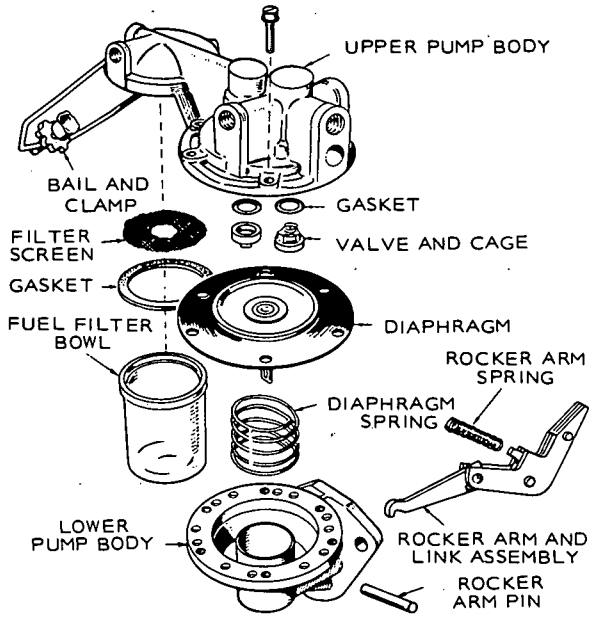


FIGURE 14. EXPLODED VIEW OF J-SERIES PUMP

Repair

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

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

Fuel Pump Removal Disassembly

1. After the pump is removed from the engine, scribe a line on the flanges of the upper and lower pump bodies to assure correct positioning when reassembling.
2. Remove the securing screws and separate the upper and lower pump bodies (Figure 14).
3. To release the pump diaphragm, press down on the base of the diaphragm at the edge farthest from the pump mounting flange. Without releasing this edge, press down on the opposite edge. This action will unhook the diaphragm actuating rod from the rocker arm link (Figure 15).

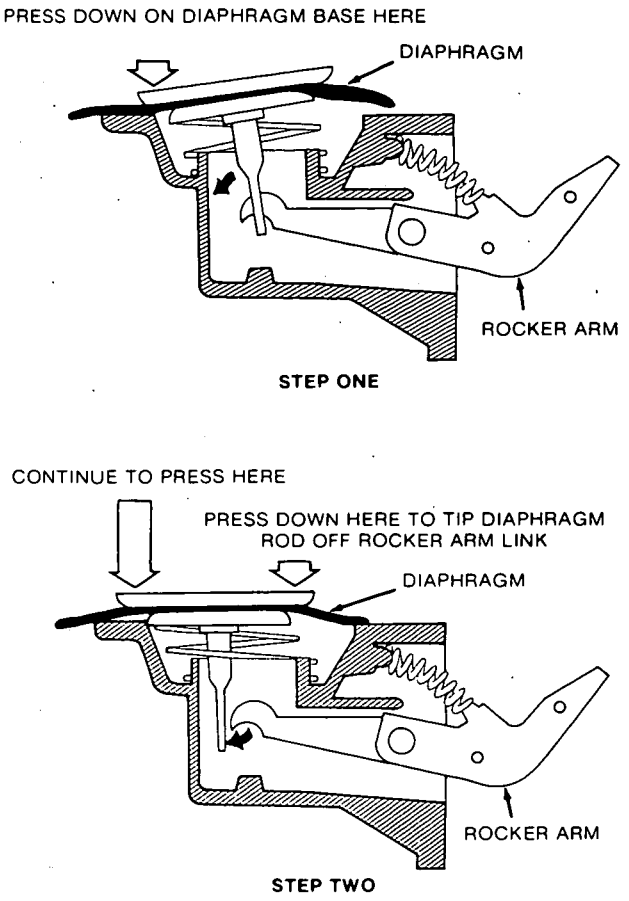


FIGURE 15. REMOVAL OF J-SERIES DIAPHRAGM ASSEMBLY

4. With the aid of a pliers or screwdriver, push and tip the rocker arm return spring off the catch on the rocker arm and remove from pump.
5. Clean and inspect all pump components not included in the repair kit. If damage is apparent, replace the pump.

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

Assembly

1. Lubricate the diaphragm actuating rod and install the new diaphragm in the pump. Reverse the procedure used for removal, rolling back the diaphragm fabric to view the rocker arm link (Figure 15). Hold the pump body upside-down so that the weight of the link will keep it within reach of the diaphragm actuating rod.
2. Install the new rocker arm return spring.
3. Place the upper and lower bodies of the pump together with the scribe marks aligned. Start the six securing screws, making sure they do not chew into the diaphragm fabric. Leave the screws 2 or 3 turns loose.
4. Operate the rocker arm several times to fully flex the new diaphragm. While holding the rocker arm fully flexed, tighten the securing screws.

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

NOZZLE

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

Inspection

To inspect the nozzle spray pattern, remove the nozzle from the cylinder head. Crank the engine, let the nozzle spray into the air and watch the pattern. The spray should be cone shaped with a solid appearing center surrounded by cloudlike fog in which the spray is evenly atomized. See Figure 16. An apparent chattering of the nozzle is normal.

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

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

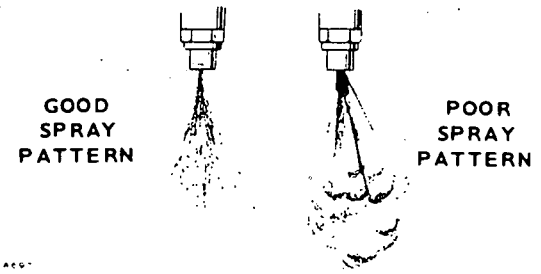


FIGURE 16. NOZZLE SPRAY PATTERN

Adjustment

To adjust the opening pressure, remove the nozzle from the engine. Remove access plug and loosen cover, adjust pressure adjusting screw with small allen (Hex) wrench. Install nozzle on a static fuel nozzle testing fixture (may be purchased from Onan). Following the tester instructions, adjust the opening pressure to 1750 psi by turning the adjusting screw. See Figure 17. Clockwise increases the pressure and counterclockwise decreases it. *Do not* try to adjust the pressure without a testing fixture.

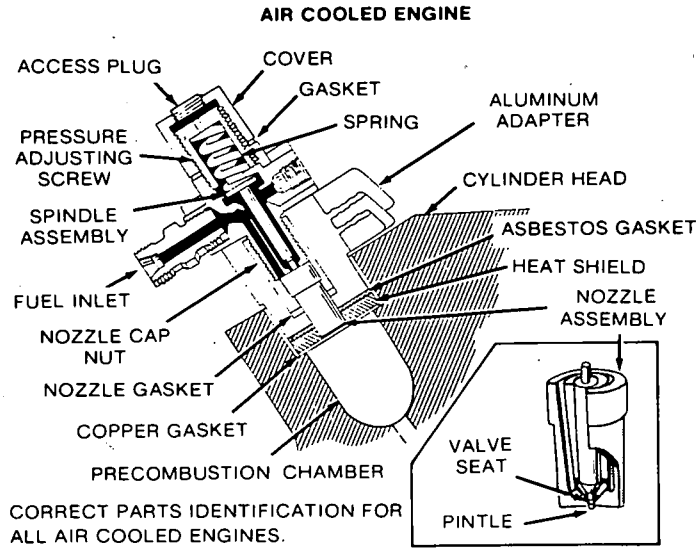


FIGURE 17. NOZZLE ASSEMBLY

Disassembly

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

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

Cleaning

The most important part of nozzle cleaning is cleanliness.

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

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

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

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

Repair

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

Assembly

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

1. Remove all pressure on the nozzle spring by adjusting the pressure adjusting screw.
2. Clamp the nozzle holder body in a vise.
3. Set the valve in the body and set the nozzle over it.
4. Install the nozzle cap nut loosely.
5. Place the centering sleeve over the nozzle (Figure 18) 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.

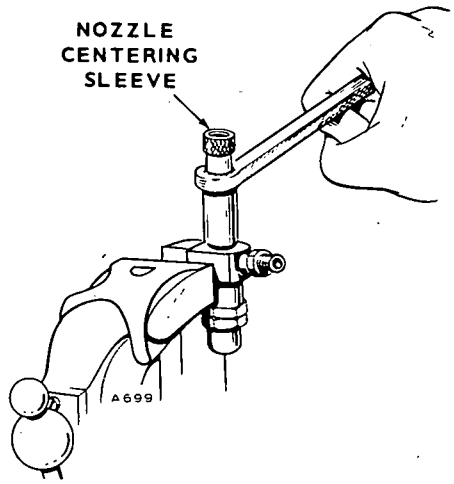


FIGURE 18. TIGHTENING NOZZLE CAP NUT

Installation

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

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

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

PREHEATING CIRCUIT

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

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

FUEL SOLENOID

This solenoid (Figure 19) is also referred to as a governor solenoid as it over-rides the governor. 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 the 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.

Adjust the solenoid plunger 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.

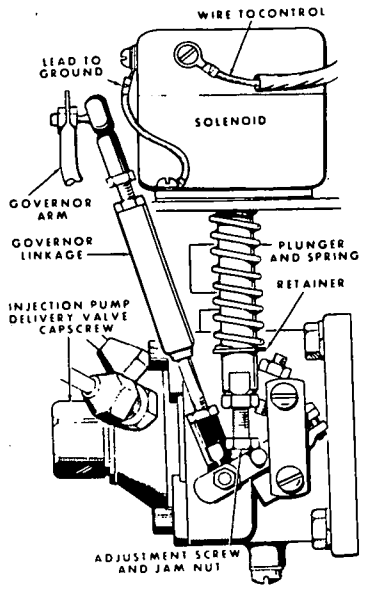


FIGURE 19. FUEL (GOVERNOR) SOLENOID

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 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 19° BTC (21° prior to Spec P). The control 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 injection rate. Set the maximum stop screw while gradually increasing the load to stop the throttle at the smoke point.

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.

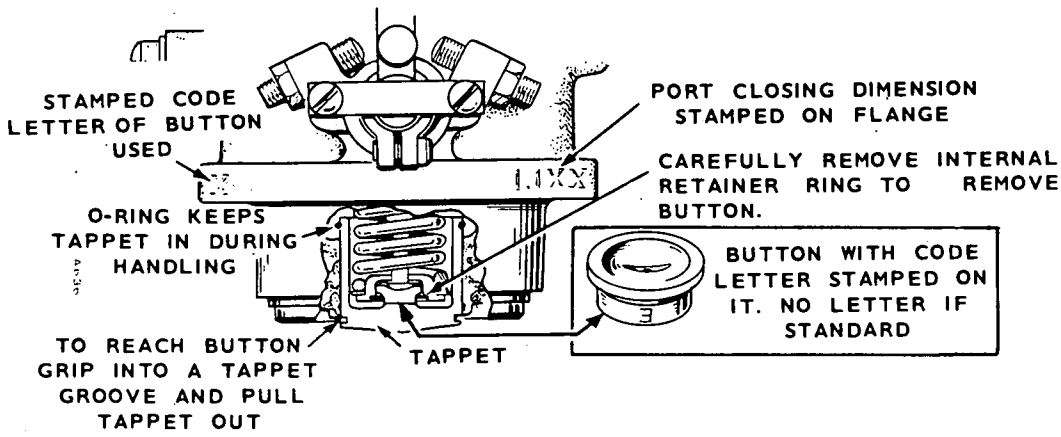


FIGURE 20. INJECTION PUMP TIMING BUTTON INSTALLATION

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 for proper pump operation; by providing 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 20). 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 is timed to the engine at the factory so the port closing for injection occurs at 19° BTC (21° BTC prior to Spec P). See Figure 21.

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.

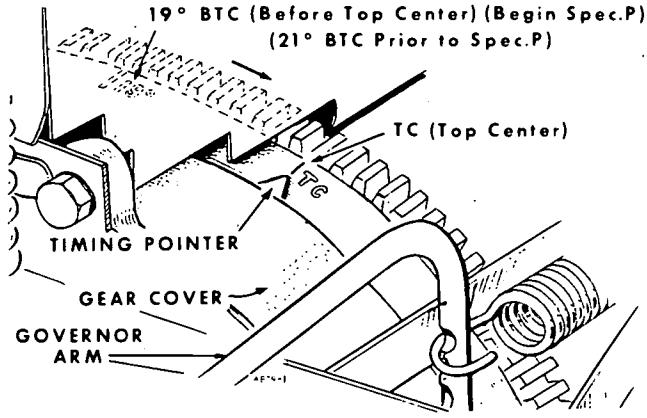


FIGURE 21. INJECTION PUMP TIMING

Example Formula:

Port closing dimension of old pump	1.090
Button thickness of old pump	.098
	1.188
Port closing dimension of new pump	1.095
Button thickness of new pump	.093
	Use 9 or K Button

Install the correct button in the pump (Figure 20) and install the pump following the instructions under Injection Pump Installation.

CAUTION **Be sure to hold the pump drive securely to the pump body when removing the tappet. If not, the pump will come apart and be difficult to reassemble. Also, the metering sleeve may drop off the plunger into the sump when the plunger is removed. If the mechanic is not aware of it, he could reassemble the pump, unaware it will not operate. If the plunger port is not enclosed by the sleeve, there will be no fuel delivery.**

TABLE 1. TIMING BUTTON CODES

GROUP 1 *				GROUP 2				GROUP 3			
CODE	PART NO.	SIZE		CODE	PART NO.	SIZE		CODE	PART NO.	SIZE	
		Inch	mm			Inch	mm			Inch	mm
16 or S	147-0186	.134	3.404	1 or A	147-0147	.119	3.023	6 or F	147-0152	.101	2.565
15 or R	147-0187	.131	3.357	2 or B	147-0148	.116	2.946	7 or H	147-0153	.098	2.489
14 or P	147-0188	.128	3.251	3 or C	147-0149	.113	2.870	8 or I	147-0154	.095	2.413
13 or N	147-0189	.125	3.175	4 or D	147-0150	.110	2.794	9 or K	147-0155	.092	2.337
12 or M	147-0190	.122	3.099	5 or E	147-0151	.107	2.718	10 or L	147-0156	.089	2.261
				11 or STD	147-0161	.104	2.642				

* - Not used on DJBA.

Method 2, Flowing the Pump: This is the procedure for timing the injection pump when the dimensions from the old pump are not available.

1. A standard timing button (NOT MARKED OR NO. 11) is in the pump. Install the pump per instructions under Injection Pump Installation.
2. Remove the delivery valve cap nut (also delivery valve holder on later models, Figure 22, and lift out the delivery valve spring. Reinstall the delivery valve cap nut and holder.
3. Rotate the flywheel (counterclockwise) to a point about 15° before the port closing mark (compression stroke No. 1 cylinder).
4. Position the fuel control in the full fuel position. Disconnect No. 1 injection line from the nozzle and position line so fuel flow is visible. Pump the priming lever while turning the flywheel clockwise until fuel stops coming out of the injection line. This is the port closing point or the point where injection begins.
5. Check the position of the port closing mark in reference to the timing pointer. If the button thickness is correct, the pointer will coincide with the port closing mark. See Figure 23. If the timing pointer is before port closing (early timing) a thinner button is needed. If the timing pointer is between port closing and top center (late timing) a thicker button is needed. To determine the correct button, measure the distance between the port closing mark and the timing pointer. For each .1" difference, one button either larger or smaller, depending on whether timing is early or late, is required. Refer to Table 2. A distance of .1" on the flywheel represents .003" button thickness.
6. Replace the delivery valve spring (Figure 22). Be sure all components of the delivery valve are installed and properly torqued. The delivery valve holder must be retorqued prior to installation of cap nut.
7. Finish injection pump installation procedure.

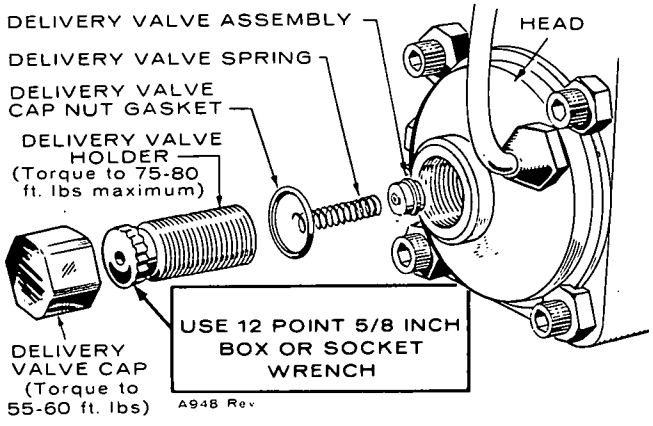


FIGURE 22. DELIVERY VALVE ASSEMBLY

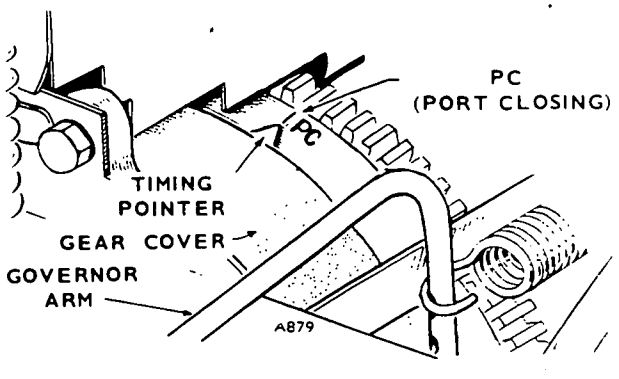


FIGURE 23. PORT CLOSING

TABLE 2. TIMING BUTTONS

TIMING EARLY	USE BUTTON	TIMING LATE	USE BUTTON
.1"	6 or F	.1"	5 or E
.2"	7 or H	.2"	4 or D
.3"	8 or J	.4"	3 or C
.4"	9 or K	.4"	2 or B
.5"	10 or L	.5"	1 or A

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" diameter brass wire into the hole (Figure 24).
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 (Figure 19).
11. Run the engine and adjust the throttle maximum and minimum stops.

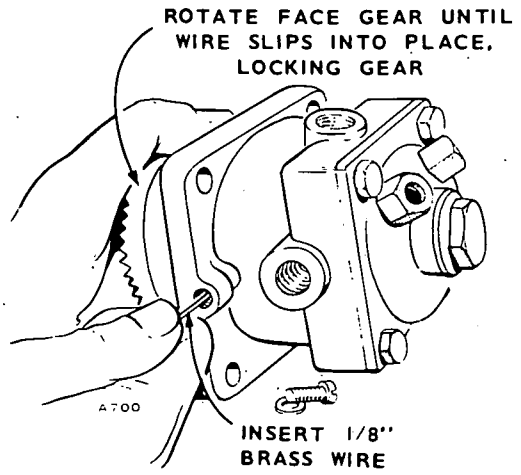


FIGURE 24. INJECTION PUMP

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. The constant speed governor which is standard, the two speed and variable speed governors which are optional.

GOVERNORS

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

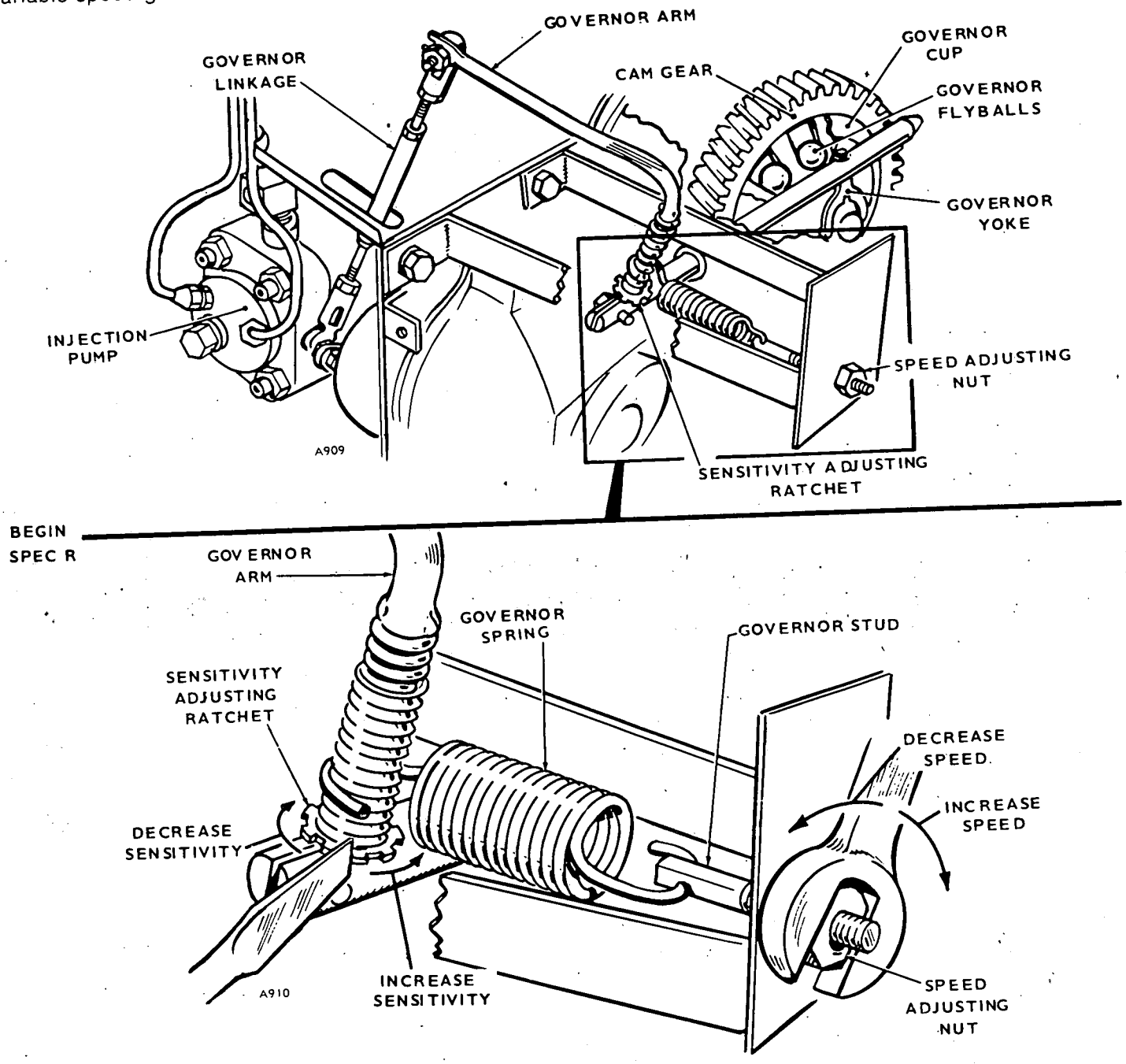


FIGURE 25. GOVERNOR ADJUSTMENT (BEGIN SPEC R)

throttle lever. Any change in engine speed is transmitted from the cup to the yoke and onto the throttle.

Tension on the the governor spring determines the speed at which the engine is governed. Sensitivity is controlled by the threaded portion of the governor arm which changes governor spring action controlling the speed drop from no load to full load.

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 26. 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 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 rated with those in Table 3.

TABLE 3. GOVERNOR SPRING DATA

GOVERNOR TYPE	SPRING NO.	SPRING RATE	COIL NO LOAD LENGTH	ACTIVE COILS
Constant	150-0846		1-3/8	13-3/4
Variable**	150-0921	21 #/in.	1-13/32	21
or				
2 Speed				
2 Speed*	150-0922	16 #/in	1-15/16	28

* - 1800 rpm
** - 2400 rpm

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, Begin Spec R: Change the spring tension with the speed adjusting nut. 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.

Speed, Spec P Models Only: Change the spring tension with the speed adjusting nut while holding the sensitivity stud in place with a screwdriver. More tension gives more speed. See Figure 27.

Sensitivity: The sensitivity adjustment is made by moving the spring up or down on the governor arm. Moving the spring up (ratchet clockwise) on the governor arm will decrease sensitivity. Turn the ratchet counterclockwise to increase sensitivity. Adjust for maximum sensitivity without a hunting condition.

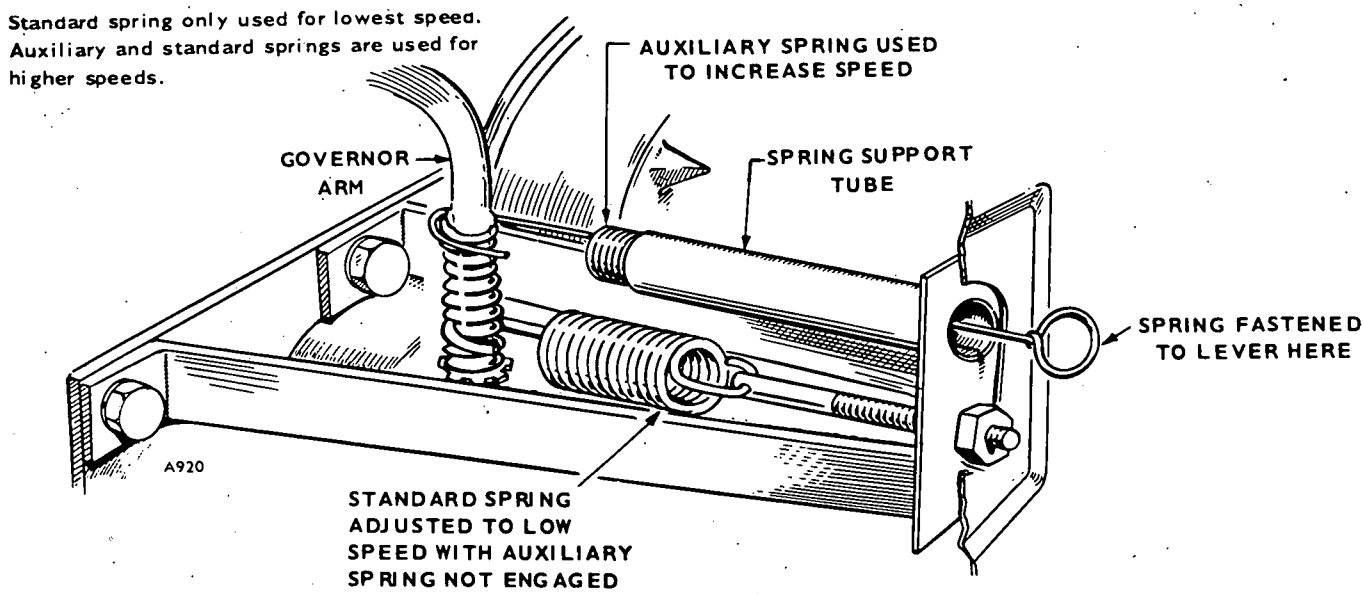


FIGURE 26. VARIABLE SPEED GOVERNOR

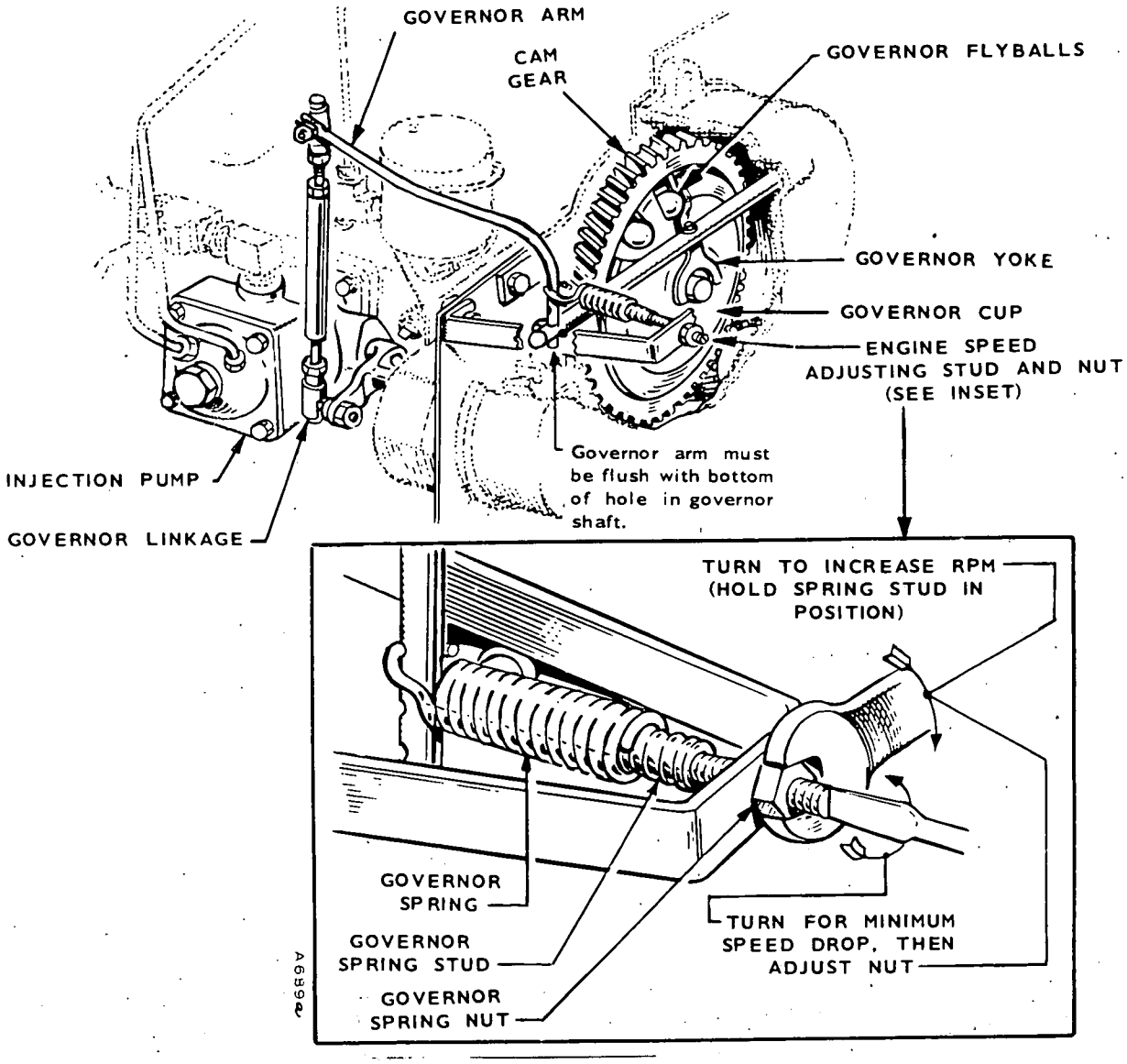


FIGURE 27. GOVERNOR ADJUSTMENTS (SPEC P ONLY)

Governor High Speed Solenoid: This solenoid mounts on the blower housing. When energized, the plunger is in 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. Adjust 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 1 amp. If it is much greater the contacts did not open. If the plunger sticks remove and clean the plunger and recess in solenoid.

OIL SYSTEM

DJBA engines have pressure lubrication to all working engine parts. The oil system (Figure 28) includes:

Oil intake cup
Gear type oil pump
By-pass valve
Oil pressure gauge
Full-flow oil filter
Oil passages to deliver oil throughout the engine.

The pump draws from the crankcase and delivers it through the oil filter to the rocker housing, drillings through the crankcase to the crankshaft bearings, camshaft passages to connecting rod bearings and connecting rod passages to piston pin bushings.

Because it aids oil consumption control, the crankcase breather is included in the oil 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.

The engine is equipped with a low oil pressure cut out switch. This switch allows oil pressure build-up while starting and shuts down the engine through the latching relay if the oil pressure falls below 14 psi. If this happens check the engine thoroughly to determine the cause. After the cause of the trouble has been corrected, a reset button must be manually reset

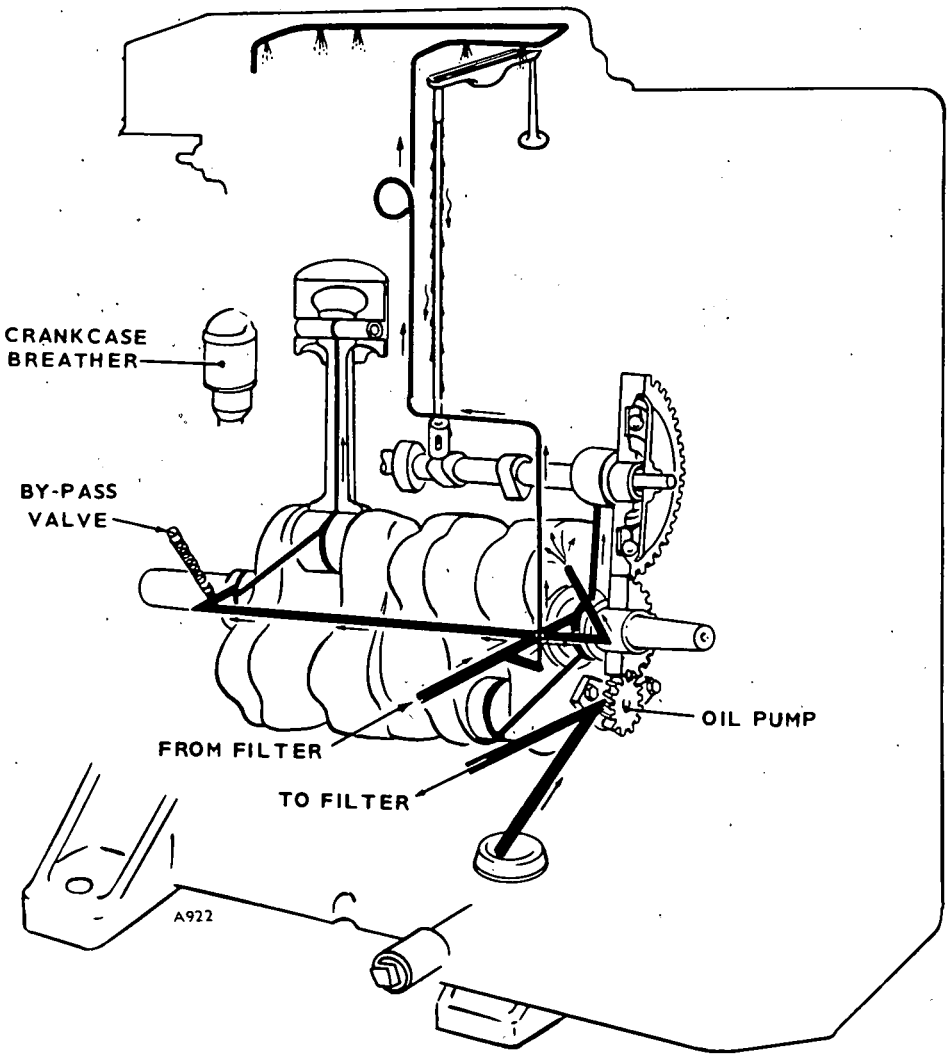


FIGURE 28. OIL SYSTEM

before the engine can be started again. Also see Control System.

MAINTENANCE

Maintenance of the oil system includes changing crankcase oil, cleaning the crankcase breather and rocker box oil lines, and replacing the oil filter. Consult the periodic service chart for recommended service.

Use an oil with the API designation CD/SD or CD/SC. 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.

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

OIL PUMP

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

Oil Pump Removal

1. Remove the gear cover and oil base.
2. Unscrew the intake cup from the pump.
3. Remove the crankshaft lock ring and gear retaining washer.
4. Loosen two cap screws holding the pump and lift out.

Repair parts for the pump are not individually available except for gaskets. If the pump is excessively worn, replace it. Disassemble the pump by removing two cap screws holding the pump cover to the body. To improve pump performance, adjust the gear end clearance by changing gasket thickness between the pump body and cover. Use the thinnest gasket permitting free movement of the pump shaft. Oil all parts when assembling the pump.

Installation includes filling the pump intake and outlet with oil to be sure it is primed before installing.

Mount pump on the engine and adjust for .005" minimum lash between the pump gear and crankshaft gear. Mount pump intake cup so it is parallel with the bottom of the crankcase.

BY-PASS VALVE

The by-pass valve (located on the outside of the rear bearing plate) controls oil pressure by returning excess oil back to the crankcase. Normally, the valve opens at 25 psi.

High oil pressure may be caused by the plunger sticking closed, and low oil pressure by the plunger sticking open.

To inspect the valve (Figure 29), unscrew the recessed plug in the rear bearing plate. Then lift out the spring and plunger assembly. Determine valve operation by comparing spring and plunger to specification below.

Plunger Diameter	.3365" to .3380"
Spring Free Length	2-5/16" ± 1/16"
Spring Tension	2.225 lb. + .11 lb. at 1-3/16"

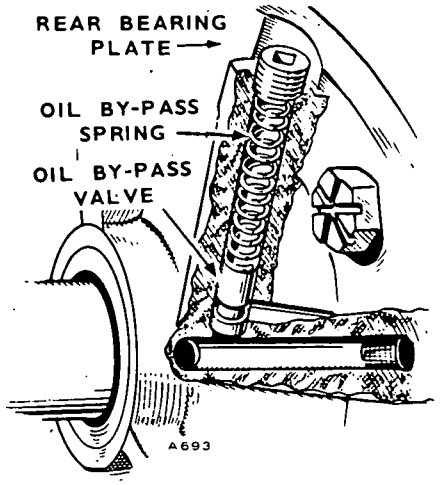
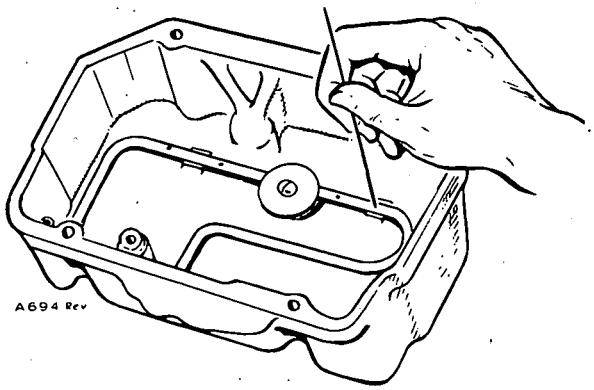


FIGURE 29. OIL BY-PASS VALVE

OIL LINES

The oil lines in the rocker box (Figure 30) should be flushed with an approved solvent and the small holes opened with fine wire. Blow out all other oil lines and drillings with compressed air whenever the engine is disassembled. Reach the oil gauge passage by removing the oil filter mounting plate.

All external oil lines, rocker box oil line and the internal oil line to the center and rear bearing are replaceable.



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

FIGURE 30. ROCKER BOX OIL LINE

OIL PRESSURE GAUGE

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

OIL FILTER (FULL FLOW)

The oil filter mounts on the filter plate at the left front crankcase corner. It requires replacement every 200 hours of normal operation. Remove filter by turning counterclockwise using a filter wrench. Install new filter finger-tight plus 1/4 to 1/2 turn.

If oil becomes so dirty that markings on the dip stick cannot be seen, change the oil filter and shorten filter service period.

BREATHER SYSTEM (Begin Spec V)

The DJBA (effective Spec V) is equipped with a crankcase breather pipe that vents crankcase fumes directly from the rocker box cover to the cylinder head intake port (see Figure 31). The crankcase breather pipe must not be removed, but cleaned with wire or pipe cleaner 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.

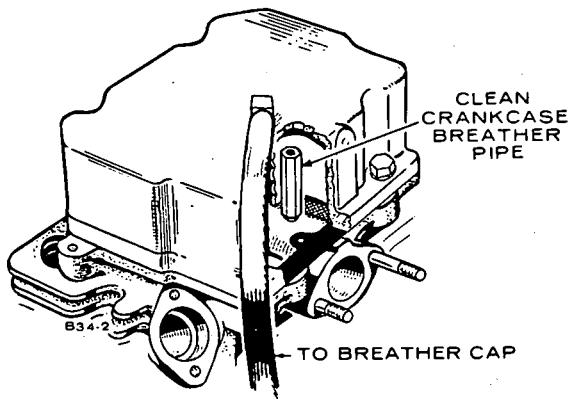


FIGURE 31. BREATHER PIPE (BEGIN SPEC V)

STARTING SYSTEM

This engine uses a separate 12-volt starting motor (Figure 32) mounted on the right hand side of the engine, to drive the flywheel. It is a standard automative type with solenoid shift and over-running clutch controlled by a start solenoid. When the solenoid energizes, the motor solenoid operates, shifting the starter pinion to engage the flywheel ring gear and closing the starting motor circuit. The starting motor remains engaged until after the engine starts. Then the control circuit centrifugal switch closes, completing the starting cycle. The over-running clutch protects the starter armature from overspeed.

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

MAINTENANCE

Periodically inspect the starting system to assure that it is in peak condition.
Inspect motors every 500 hours for loose or dirty connections. Inspect the starter commutator and clean with #00 sandpaper if dirty. Check the brushes for excessive wear and reduced armature seating.

Test for poor cranking performance caused by a faulty starting motor, defective battery or high resistance in the starting circuit.

Battery charge condition should be tested with a hydrometer every 100 hours. Specific gravity should read from 1.225 to 1.260. If not, charge the battery. If the battery won't charge, replace it.

Wiring should be checked 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.
3. From the battery positive post to the battery terminal stud on the solenoid.

Normally, each of these should be less than 0.2 volts. If extra-long cables are used, voltage drops may be higher. Clean all circuit connections showing excessively high voltage drops.

Starting motor tests should include testing of free running voltage, speed and current, and tests of stall torque, voltage and current. Always remove motor for these tests.

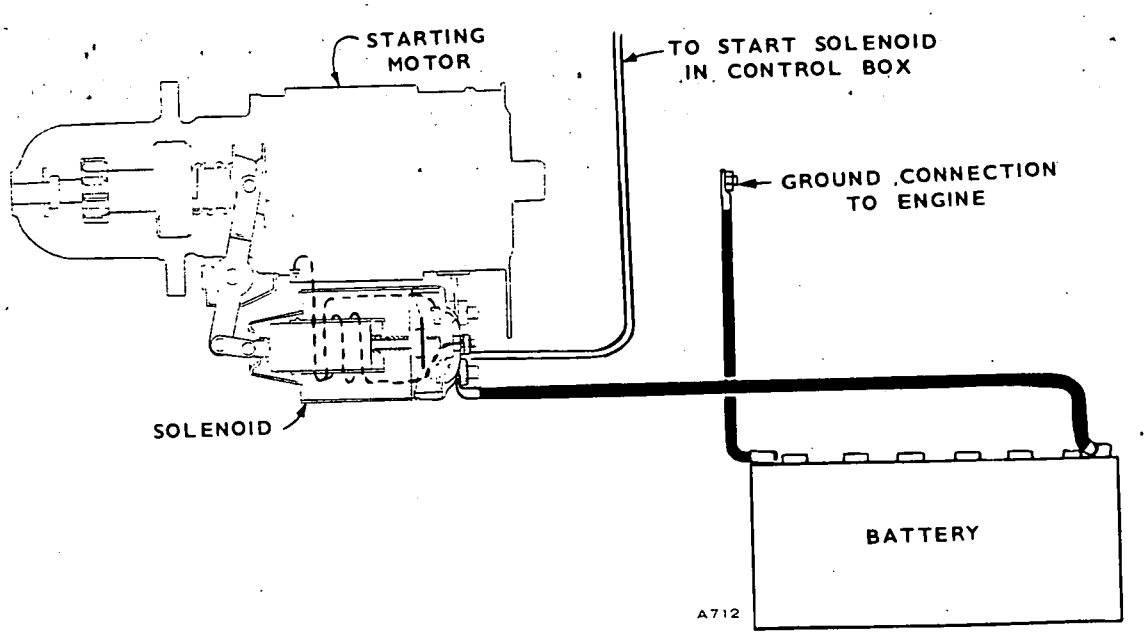


FIGURE 32. STARTING SYSTEM

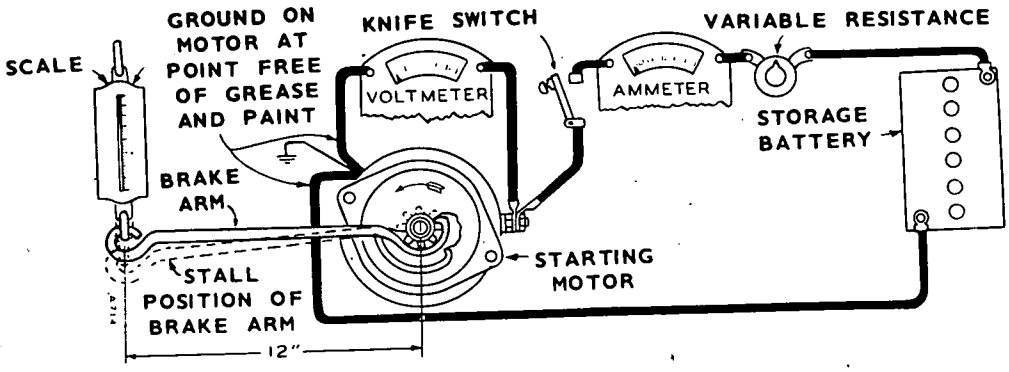


FIGURE 33. STARTING MOTOR STALL TORQUE TEST

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

The torque test (Figure 33) requires a spring scale and torque arm, voltmeter, ammeter and variable resistance to apply the voltage specified by the test characteristics.

The voltage drop across the solenoid on the starting motor should be less than 1.50 volts. If not, remove and repair.

Two 6 volt, 105 amp/hr batteries in series are used. The set charging system maintains the battery at or near full charge at all times. If it doesn't maintain charge, adjust the charge rate if battery is in good condition.

Added accessories draw battery current and require charging rate adjustment.

If battery discharge (or failure to charge) can't be traced to the charging system, test the battery. Replace if necessary.

STARTING MOTOR REPAIR

Armature: Inspect armature for mechanical defects before testing for grounds or shorted coils.

Test for grounds with an ohmmeter. Check between each commutator segment and the shaft. A low ohmmeter reading indicates a grounded armature. ~~See Figure 35.~~

Use a growler to test for shorted coils. Place armature in growler and run a steel strip over the armature surface. If a coil is shorting, the steel strip becomes magnetized and vibrates. Rotate armature slightly and repeat test for one complete revolution of the armature. If armature is defective, replace it. ~~See Figure 36.~~

Clean commutator with #00 or #000 sandpaper. Blow the sand out of motor after cleaning. If heavily scored or worn, turn it down in a lathe.

Field Coils: Field coils are checked with an ohmmeter. Check for motor frame grounds or open circuit. All connections should be clinched and soldered. Inspect the insulation for evidence of damage. The only way to check for field coil shorts is to use the starting motor test.

CONDITION	CHECK FOR
Low Free Speed, High Current	Tight, dirty or worn bearings, bent armature shaft or loose field power screws which would allow the armature to drag, a shorted armature or a grounded armature or field.
Won't Operate, High Current	Direct ground in switch terminal, field, or frozen shaft bearings.
Won't Operate, No Current	Open field circuit, open armature coils, broken or weakened brush springs, worn brushes, high mica on commutator.
Low Free Speed, Low Torque, Low Current	Open field winding, or high internal resistance due to poor connections, defective leads, or dirty commutator.
High Free Speed, Low Torque, High Current	Shorted field windings. Since there is no easy way to detect shorted field coils because of their low resistance, replace them and check for improved performance.

Bearings: Starter motor bearings should be replaced if they show excessive wear. Drive out old bearings using an arbor press. Press new bearings into place.

Brushes: Brushes should slide freely in their holders. Inspect for wear or improper seating. Check brush spring tension with a spring scale. Change spring tension by twisting spring at the holder with needle-nosed pliers.

Replace Prestolite brushes when excessively worn, or when worn to 5/8 inch in length. Replace Mitsubishi brushes when excessively worn or when worn to 3/8 inch in length.

Some brushes are soldered to the field coil load. To remove brushes, unsolder the lead and open the loop in the field coil lead. Insert the new brush pigtail into the loop and clinch before soldering. A good soldering job is necessary to ensure good contact and low voltage drop across the connection.

Over-running Clutch: Over-running clutch should be thoroughly cleaned (do not dip in solvent). It can't be repacked with grease. It should slide easily on the armature shaft without binding. Turn the pinion; it should rotate smoothly but not freely. The clutch should instantly lock and unlock when reversing rotation direction. If the clutch is defective (pinion worn or damaged), replace it.

Shifting Solenoid: Shift solenoid plunger should move freely in the coil. Test pull-in continuity (between solenoid control terminal and solenoid connection to the motor) and hold-in coil continuity (between solenoid control terminal and engine ground).

PRESTOLITE STARTER MOTOR REMOVAL AND DISASSEMBLY

1. Remove electrical connections to control box, battery and at the starter shift solenoid.
2. Remove the muffler heat shield.
3. Remove rear starter mounting bracket nut.
4. Remove two cap screws holding starting motor to the starter mounting flange. Then pull starting motor off the engine.
5. Remove link pin holding shift lever to solenoid plunger and remove the shift lever pivot pin. See Figure 34.
6. Extract thru bolts from commutator end of motor. Remove end cover and lift brushes off their seats.
7. Pull the cast housing from the front end of the motor and lift the armature and clutch out of the motor frame.
8. Remove over-running clutch by driving the retainer away from lock-ring near the front end of the shaft. Remove lock-ring and pull off assembly. Do not disassemble the clutch.
9. To service the solenoid, remove four cap screws and electrical connection holding it to the motor frame. Remove two screws at solenoid rear to reach the switch contacts.
10. Mount starter motor to engine by a direct reversal of the removal procedure. Connect battery cable and wires to starter.
11. Connect battery cables to battery. Connect ground cable last.

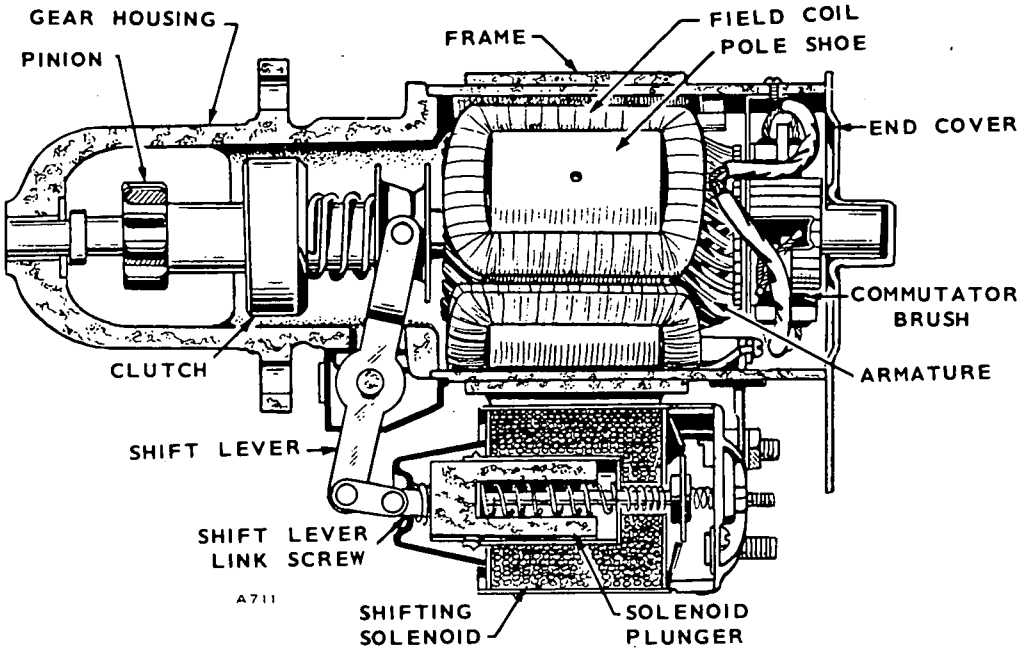


FIGURE 34. STARTING MOTOR

On units built prior to serial #679677, it was necessary to maintain the gap between ring gear and starter pinion in the relaxed position at less than 1/8" to ensure starter engagement. When installing these motors, check this gap. If it is too great, a shim kit is available to reduce it (Figure 35).

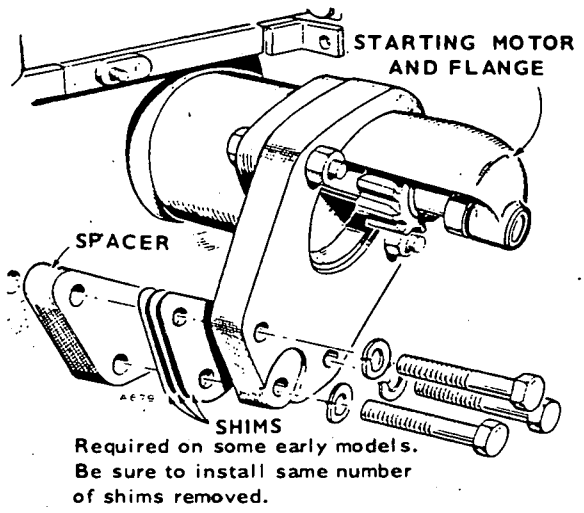


FIGURE 35. STARTER INSTALLATION

Before installing, check the pinion clearance. Proper clearance is important to ensure starter engagement. Press on solenoid core to shift the pinion into full mesh and measure the clearance between pinion and pinion stop, Figure 36. This should be between 0.07-inch and 0.12-inch (3.05 mm) (as near to 0.070-inch [1.78 mm] as possible). Adjust the link screw on the end of the solenoid plunger for proper clearance.

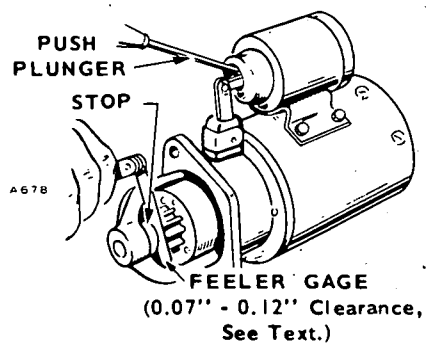


FIGURE 36. STARTER PINION CLEARANCE

MITSUBISHI STARTER REMOVAL AND INSTALLATION

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

MITSUBISHI STARTER DISASSEMBLY

1. Remove "M" terminal nut and wire lead from solenoid.
2. Remove the two solenoid mounting screws and remove solenoid.
3. Remove the two through bolts and brush holder retaining screws. Remove rear bracket (Figure 37a).

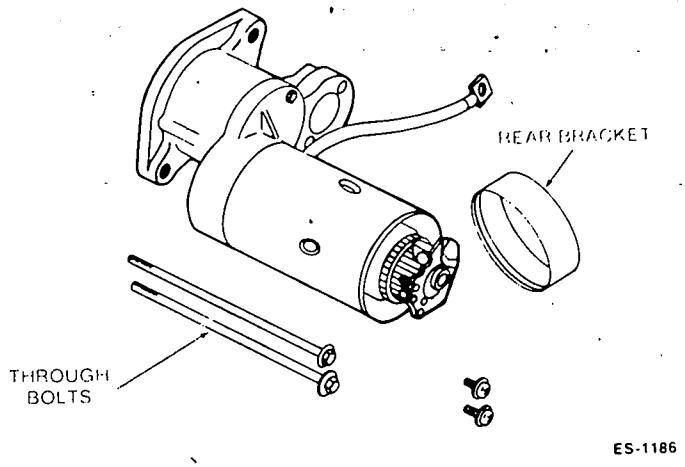


FIGURE 37a. REMOVING REAR BRACKET

4. Remove frame assembly, and brush holder assembly while pulling the brushes upward. Then remove armature assembly.
5. Remove cover assembly, (snap ring and washer) from the pinion shaft (Figure 37b).

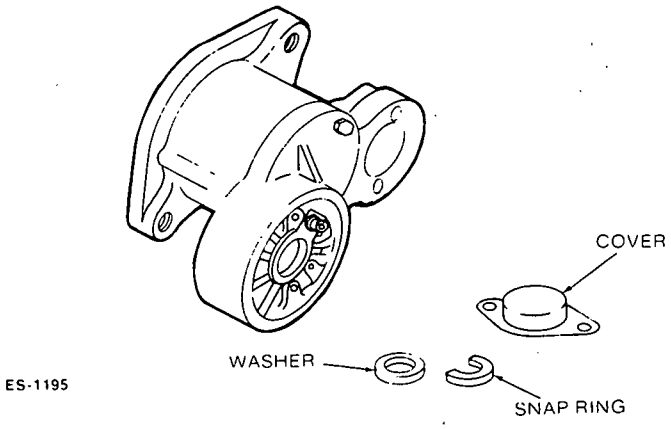


FIGURE 37b. REMOVING SNAP RING AND WASHER

6. Remove capscrew that secures center bracket to front bracket. Remove the center bracket; several washers used to adjust pinion shaft end play can now be removed (Figure 37c).

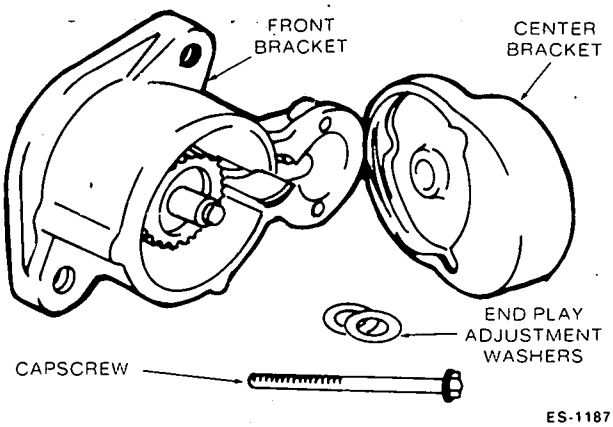


FIGURE 37c. REMOVING CENTER BRACKET

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

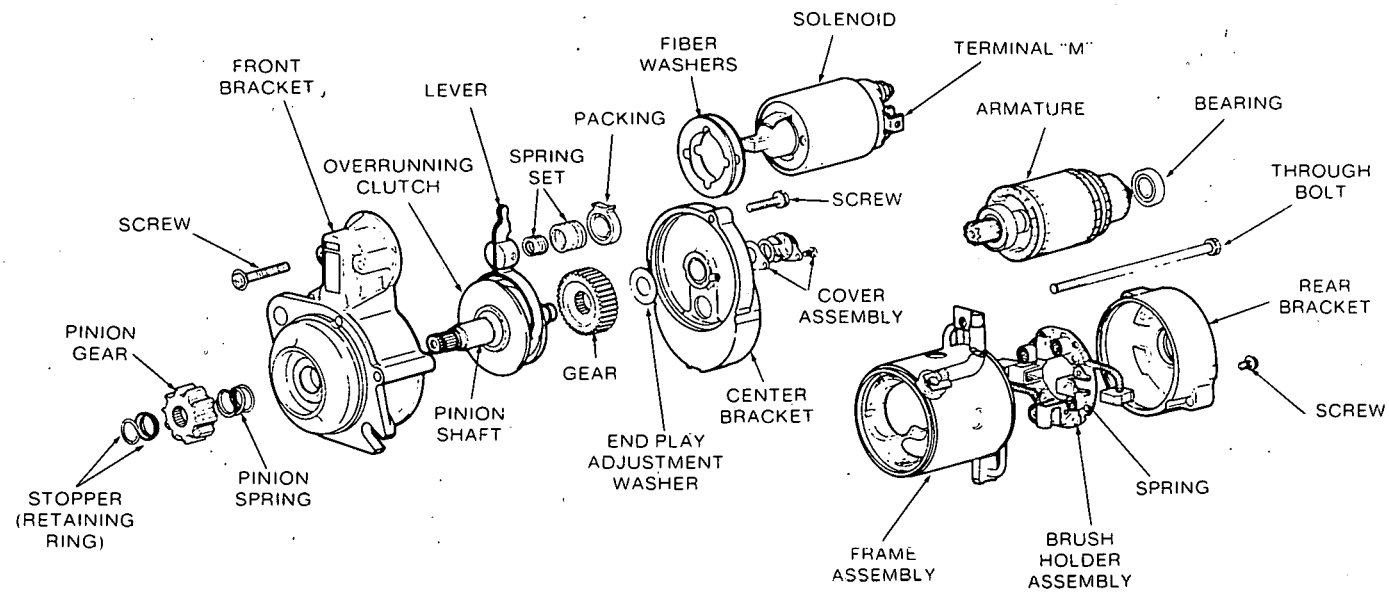


FIGURE 37d. MITSUBISHI STARTER

MITSUBISHI STARTER ASSEMBLY

For assembly reverse the disassembly procedure, but note the following items. See Figure 37d.

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

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

Pinion Shaft End Play Adjustment

Adjust end play so that it is 0.1 to 0.8 mm (.0039 to .0315 inch) with the adjusting washers placed between center bracket and reduction gear (Figure 37e).

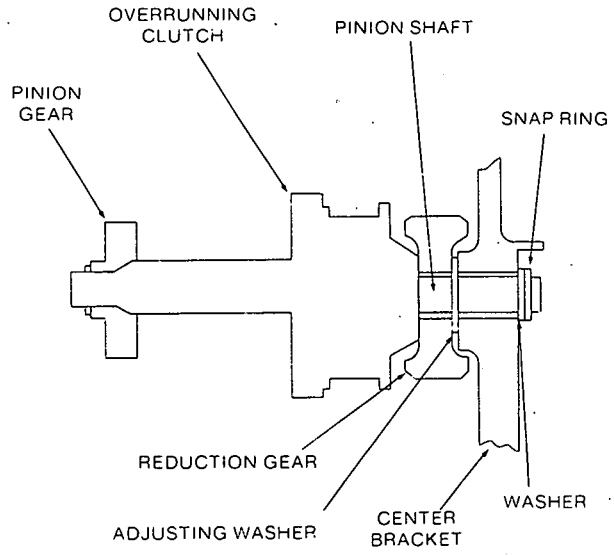


FIGURE 37e. ADJUSTING PINION SHAFT END PLAY

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

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

Pinion Gear Installation

Place spring and pinion gear onto pinion shaft. Slide stop ring onto pinion shaft and install retaining ring in groove. Pull stop ring over retaining ring (Figure 37f).

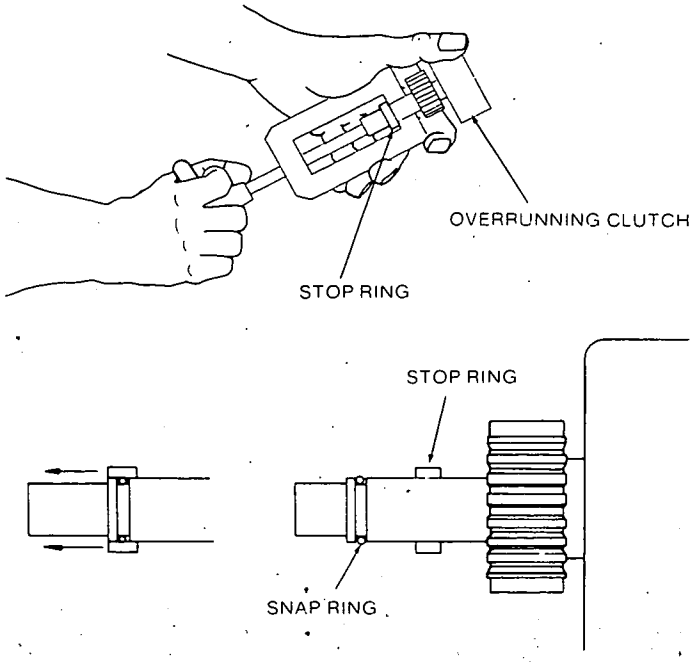


FIGURE 37f. PINION GEAR INSTALLATION

Lever Assembly Installation

Figure 37g shows the correct method of installing the lever assembly, spring, and packing. Pay close attention to direction of lever.

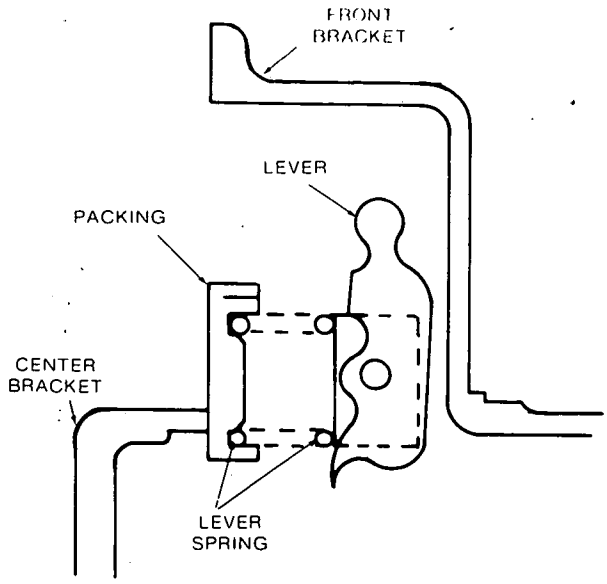


FIGURE 37g. LEVER INSTALLATION

Pinion Gap Adjustment

After assembling starter motor, adjust pinion gap.

1. Remove "M" terminal nut and wire from solenoid.
2. Connect positive terminal of battery to "S" terminal on solenoid and negative terminal to starter body. With battery connected pinion gear will shift into the cranking position.
3. Gently push pinion shaft back towards front bracket and measure the amount of travel (Figure 37h).

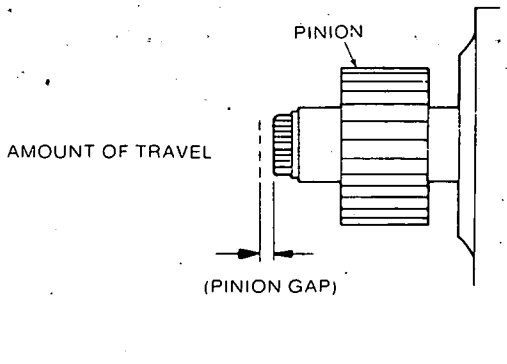


FIGURE 37h. PINION GAP ADJUSTMENT

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

FLYWHEEL ALTERNATOR

Two descriptions and troubleshooting techniques for battery charging are given: engines prior to Spec V and begin Spec V.

Both types of battery charging systems have a permanent magnet (rotor) which is held to the flywheel by screws. The stator windings have an epoxy resin coating for moisture protection. Cooling the stator is done by special fins of the rotor. A fuse protects the battery charging system from damage if the battery is connected accidently in reverse polarity.

FLYWHEEL ALTERNATOR (Prior to Spec V)

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. See Figure 39.

A 20-ampere fuse is included in the battery charging system to protect the alternator in case the battery cables are accidently reversed. It's located on the left side of the blower housing. Check this fuse before performing following tests.

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

Rotor: To test the 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.

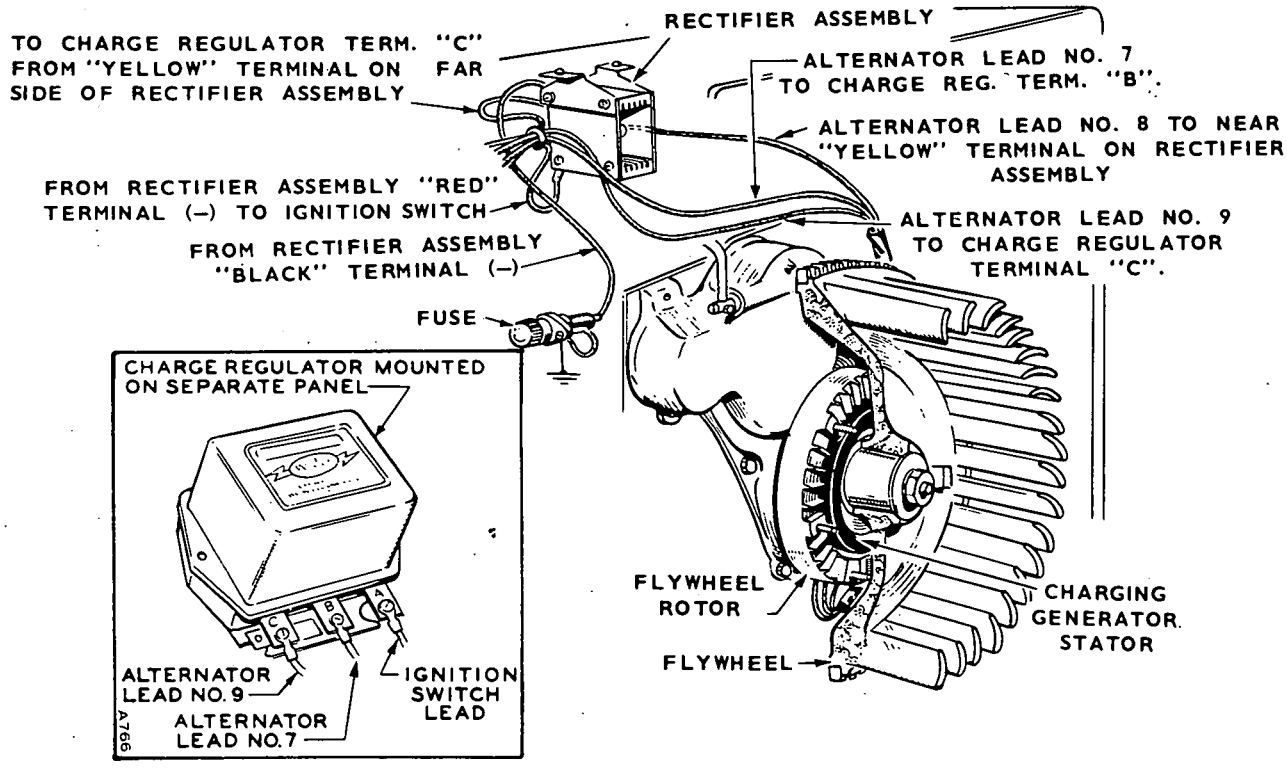


FIGURE 39. FLYWHEEL ALTERNATOR (PRIOR TO SPEC V)

Stator

1. 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 a ground is indicated, replace the stator.
2. To test for shorted coils or opened circuits, use an ohmmeter set to read the proper range of resistances. The resistance values are as follows:

   Lead 7 to 8 — .25 ohms
   Lead 8 to 9 — .95 ohms
   Lead 9 to 7 — 1.10 ohms

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

Rectifier

1. Completely isolate the rectifier assembly from the charging circuit by disconnecting all four wires. Test each rectifier separately with an ohmmeter or test lamp (Figure 40).
2. With an ohmmeter, connect one test lead to the rectifier 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 using a test lamp, 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

1. If the low charge rate is satisfactory, but high rate is not, connect a jumper between terminals B and C.
2. Run the engine and check the charge rate at the battery — should be 8 amperes. If it is, either the regulator or its power circuit is defective.
3. With a 12-volt test lamp, check input to the voltage sensitive coil at terminal A. If the lamp lights, input is okay and the regulator is defective.
4. If the charge rate with B and C jumpered is low, look to the alternator or its wiring for the cause.

FLYWHEEL ALTERNATOR (Begin Spec V)

The flywheel alternator is a permanent magnet alternator and uses a solid-state voltage regulator-rectifier for controlling output (Figure 41).

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.

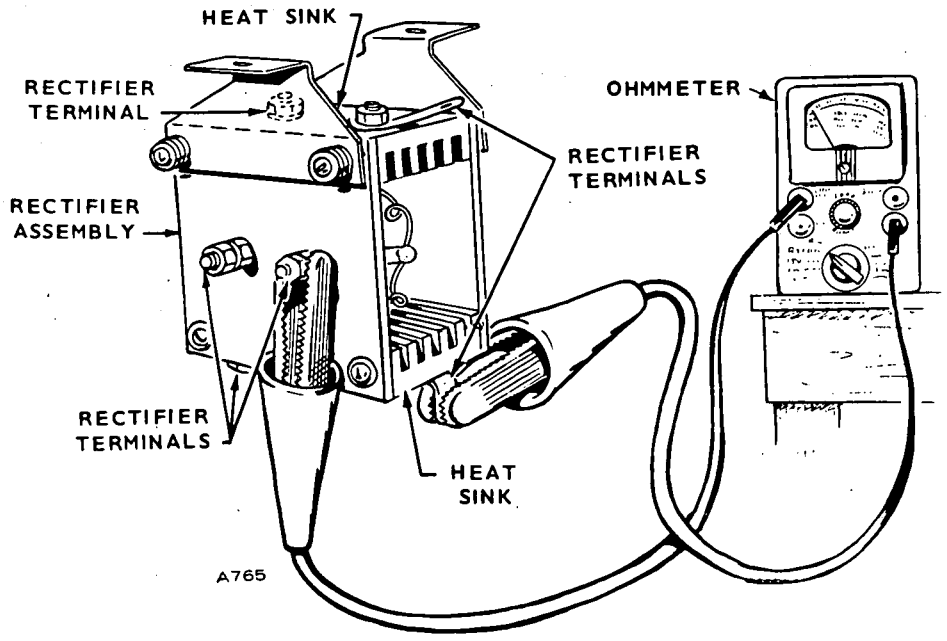


FIGURE 40. CHECKING RECTIFIERS (PRIOR TO SPEC V)

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—eliminates 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.

Regulator-Rectifier Tests:

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

1. Connect a voltmeter across the battery. Start the engine and operate at 2400 rpm.
2. Voltmeter should read 13.4 to 14.5 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 VOM or equivalent. Be sure test meter and battery, if battery powered, are in good condition. Check with engine NOT running.

1. Set voltage selector switch to DC+ and zero meter on RX1 scale.
   Zero the meter before each reading and each time scales are changed.
2. Unplug the connector and connect the meter leads to the two terminals of the female plug with the yellow wires. Meter should read less than 0.8 ohms if stator has continuity. If meter shows no reading winding is open and stator should be replaced.
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.

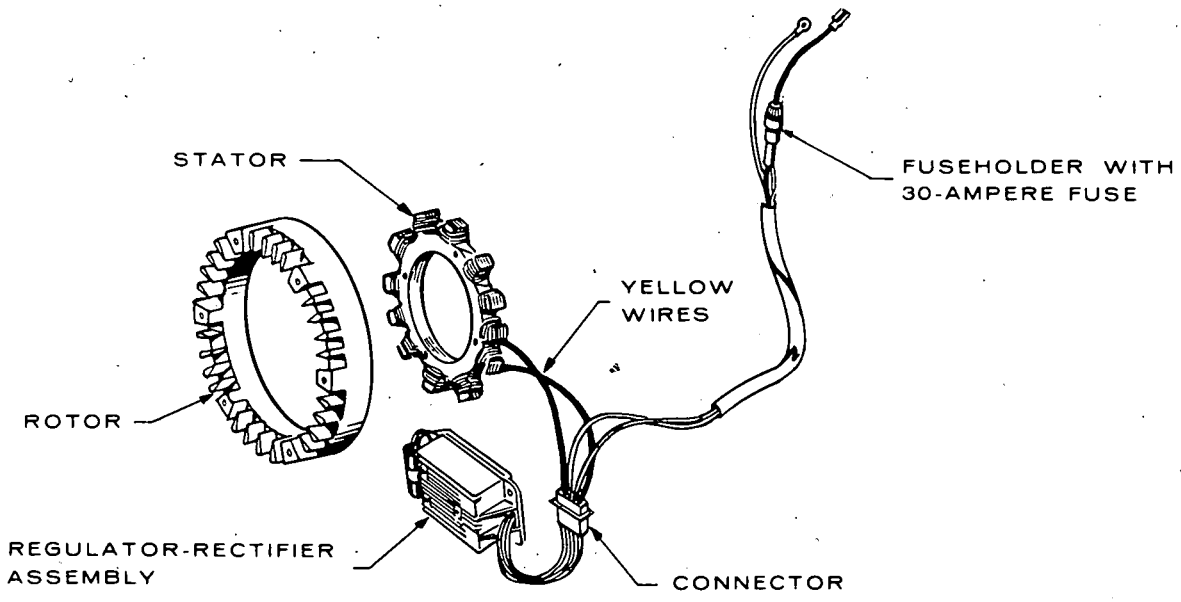
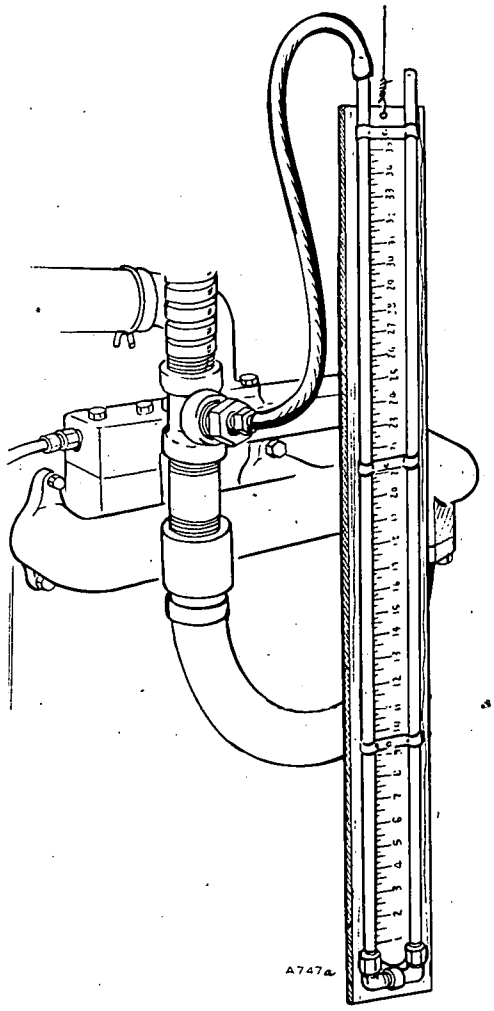


FIGURE 41. FLYWHEEL ALTERNATOR (BEGIN SPEC V)

EXHAUST SYSTEM

The importance of exhaust systems (normally supplied by the customer) cannot be over-emphasized. A poor or clogged system causes low power, overheating and engine damage. A poor exhaust system increases back pressure which reduces efficiency. If high back pressure is suspected, follow procedure outlined below.

Test the exhaust system by installing an adapter (or tee) in the exhaust line at the manifold. Connect a manometer or pressure gauge to the adapter. If there is a condensation trap next to the manifold, use it for the manometer connection. Run engine under full load and observe the manometer. See Figure 42 for maximum values. If the reading is higher, the exhaust system should either be disassembled and cleaned or altered to reduce back pressure.



UNITS OF MEASUREMENT	FULL LOAD
Inches of water	40
Inches of Mercury	3
Ounces	23 Oz.

FIGURE 42. EXHAUST BACK PRESSURE MEASUREMENT

ENGINE 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" bar and drilling two 7/16" holes 2-7/8" between centers. Loosen the flywheel mounting screw a few turns. Place bar against the flywheel screw, attach bar using two 3/8 in. 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 to .135" or more. Then turn to .128". This is the port closing point 19° BTC. Prior to Spec P - turn beyond .155" then turn clockwise to .155". This is 21° BTC. Mark this position on the flywheel.

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

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

CAUTION **Do not heat with a torch. 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 (Figure 43), 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.

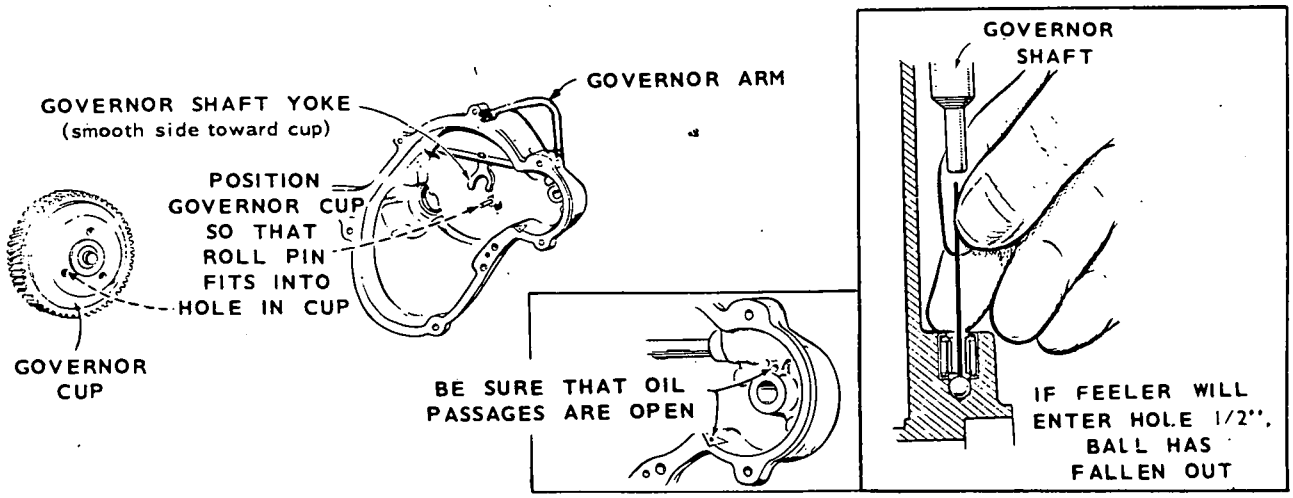


FIGURE 43. GEAR COVER

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 44.

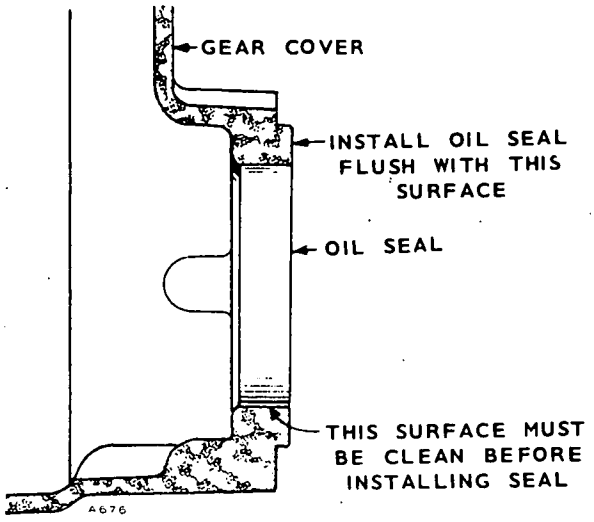


FIGURE 44. GEAR COVER OIL SEAL

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 43). Later models have a 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 fits into one of the holes in the cup surface. Measure the distance from the end of the stop pin to the mounting face of the cover. It should be 25/32". 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 specified torque. Before tightening screws, be sure the stop pin is in the governor hole.

GOVERNOR CUP

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

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 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 to give the proper travel distance for the cup. (See Figure 45). 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" 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.

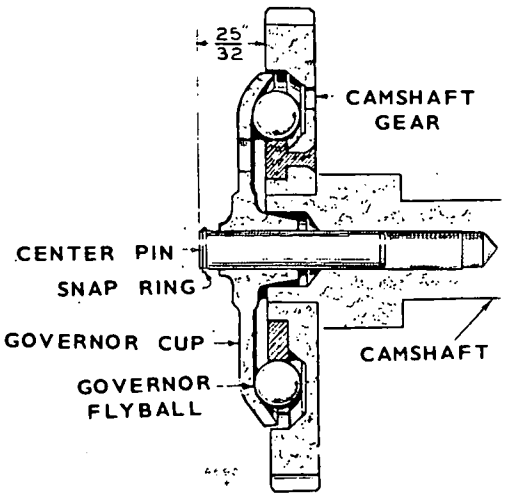


FIGURE 45. GOVERNOR CUP

CYLINDER HEADS, VALVES

The 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 chart). In addition, clean 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 is 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 DJBA engine proceed as follows:
   a. Turn the flywheel until #1 cylinder 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 for 44 - 46 ft. lb.
   d. Using a feeler gauge, check the clearance between the rocker arm and the valve. (See Figure 46). 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.

      The proper valve clearance for the DJBA engine is .009 intake and .007 exhaust.

   e. To adjust the valve clearance for the number 2 cylinder, turn the flywheel in a clockwise direction 180° (1/2 revolution) from the position used in step 2-a. The flywheel position should be between 10° and 45° past bottom center.

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

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

To check the clearance, refer to Figure 47 and procees as follows:

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

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

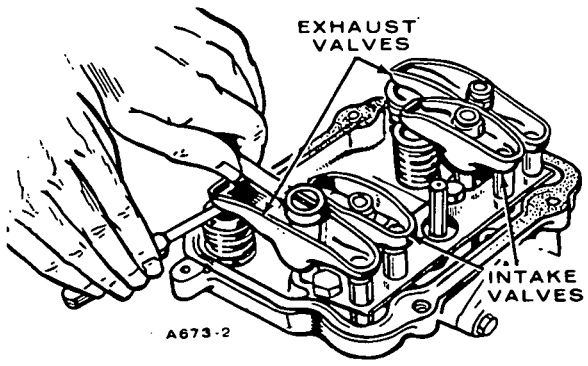


FIGURE 46. ADJUSTING VALVES

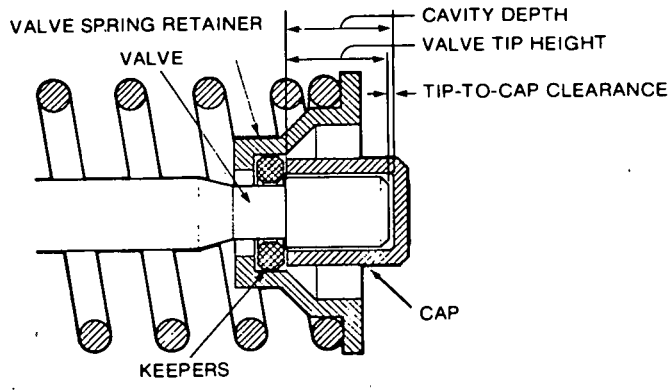


FIGURE 47. MEASURING VALVE TIP-TO-CAP CLEARANCE

TESTING

Use the cylinder compression test 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.

Compression of a standard new engine cranking at about 300 rpm is approximately 350 to 400 psi.

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.

DISASSEMBLY

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 rocker arms and push rods.
4. Remove the capscrews holding each cylinder head to the cylinder block.
5. Remove each head. If it sticks, rap it sharply with a soft hammer. Do not use a pry.
6. Using a valve spring compressor, disassemble the valve assemblies. See Figure 48.

Identify valve parts for identical reassembly.

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 warped stem. Valves that are slightly pitted or burned, refinish on an accurate valve grinder. Refinish intake valves to a 42° angle and exhaust valves to a 45° angle. But, if they are badly pitted, or will have a thin edge when refacing, replace them.

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

Check refinished valve 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 Table of Clearances. 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" 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° angle and seat width of 3/64 to 1/16". You should be able to reface each seat several times before it becomes necessary to replace it.

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

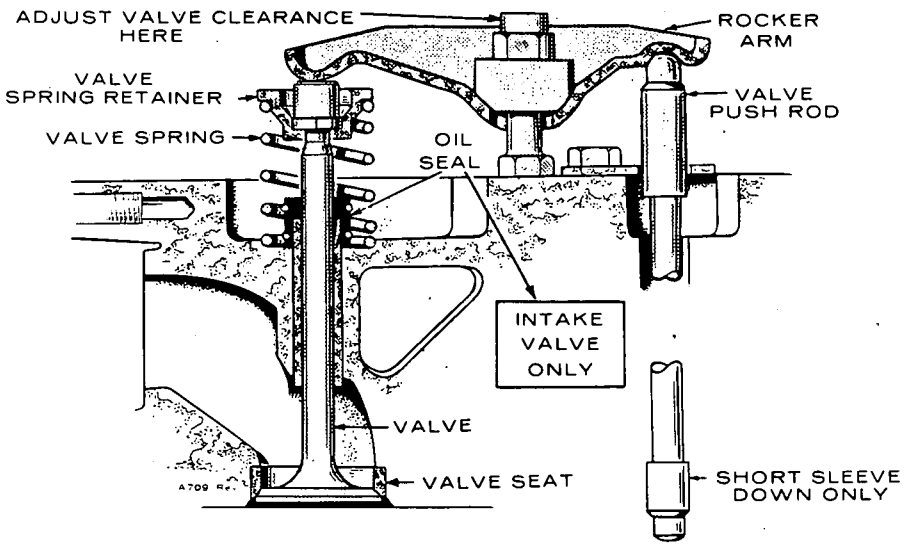


FIGURE 48. VALVE TRAIN

Use Onan tool #420-0311 in a drill press (Figure 49) to remove each valve seat. Adjust the tool to cut 1/64" from the edge of the seat. Oil the pilot to prevent it from seizing in the valve guide. Cut each seat down to a narrow rind on edges and bottom and break it out with a sharp tool. Be careful not to cut into the counterbore bottom.

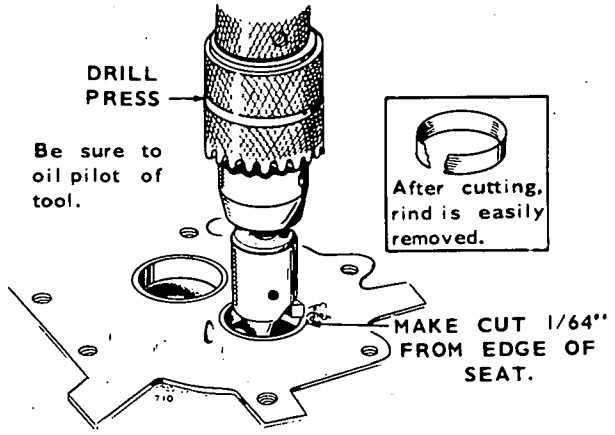


FIGURE 49. REMOVING VALVE SEAT

Thoroughly clean the valve seat counterbore and remove any burrs from the edges. If the counterbore is damaged, it will have to be remachined for an oversize seat. Oversize seats are available in .002", .005", .010" and .025". 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.

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

When the new seats are installed and faced, insert the valve into each and check the clearance from valve head to the face of the cylinder head. This must be at least .030". 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 Table of Clearances. Replace any spring that is weak, cracked or pitted or has ends out of square.

INSTALLATION

1. Push a valve stem oil seal onto each intake valve guide and clamp in place. Then oil the seal with SAE 50 engine oil. Support valve stem seal when installing valves.
2. Oil the stem of each valve lightly with SAE 50 engine oil and insert each valve in its own guide.
3. Check each valve for a tight 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. Spring retainer should never contact valve stem seal when compressing valve springs to install spring retainer locks.
5. Install the head assembly and gasket to the cylinder block. Tighten the head bolts to 44 to 46 ft. lbs. following the sequence in Figure 50.
6. Install the exhaust manifold, nozzles, glow plugs and oil lines.
7. Install the valve stem caps.
8. Install the push rods, rocker arms and rocker arm nuts.
9. Set the valve clearance.

After the first 50 hours of operation, on a new or overhauled engine, retighten the cylinder head bolts and check valve clearance.

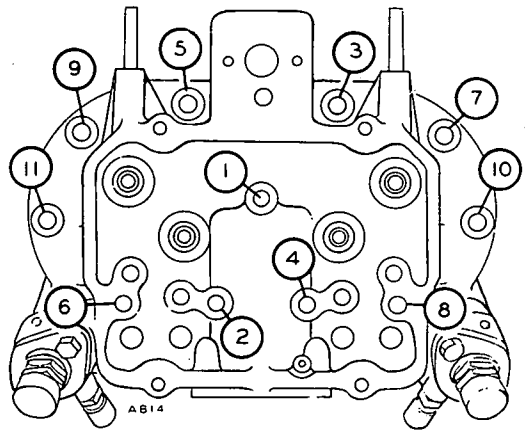


FIGURE 50. HEAD TIGHTENING SEQUENCE

PISTONS, RINGS, CONNECTING RODS

DJBA 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.

Some engines are fitted with .005" oversize pistons at the factory. These engines are marked with an E following the engine serial number. Use 0.005" oversize rings for these pistons.

REMOVAL AND DISASSEMBLY

The connecting rod and cap are stamped for proper 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. Remove carbon from bore.
3. 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.
4. Using a ring expander, remove the rings from each piston.
5. 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" and 3.2505" and be less than .001" out-of-round.

If necessary, rebore the cylinder to fit the next available oversize piston. Pistons and rings are available in .005", .010", .020", .030" and .040" oversize. If the cylinders do not need refinishing, remove any existing ridges from the top of the wall 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 cylinders, has badly worn ring grooves or otherwise is not in good condition, replace it.

Check the clearance 90° from the axis of the piston pin and below the oil control ring. Clearance should be .0055 - .0075". 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.

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 .010" to .020". 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. See Figure 51.

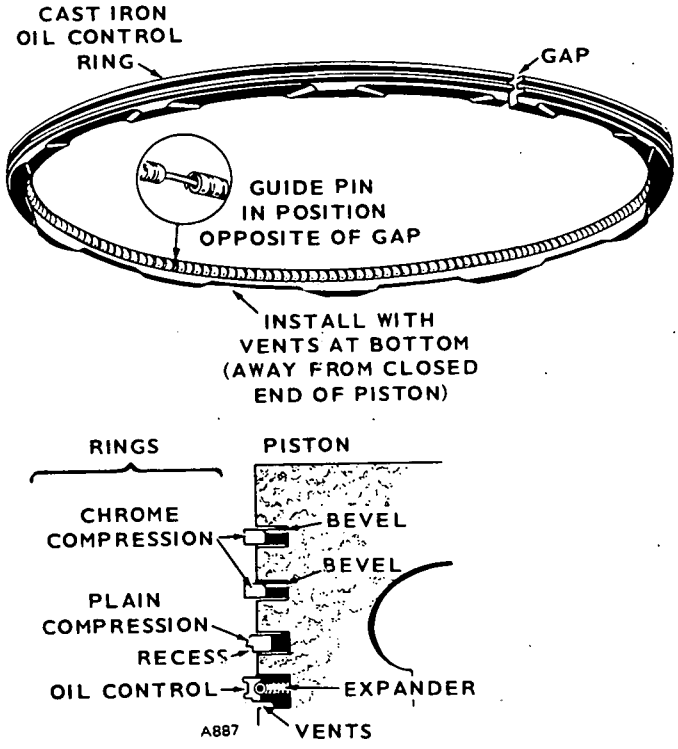


FIGURE 51. PISTON RINGS

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 .0002" to .0007".

If the bushings are excessively worn, press them out and install one new bushing from each side of the bushbore. Press the new bushings only until flush with the sides of the rod to leave 1/16" to 7/64" oil groove in the center (Figure 52).

Connecting Rod Bearings: Inspect the connecting rod bearings for burrs, breaks, pits and wear. Measure the clearance between bearings and the crankshaft journal. The clearance should be .0010" to .0033". If necessary, replace with new standard or oversize precision bearings.

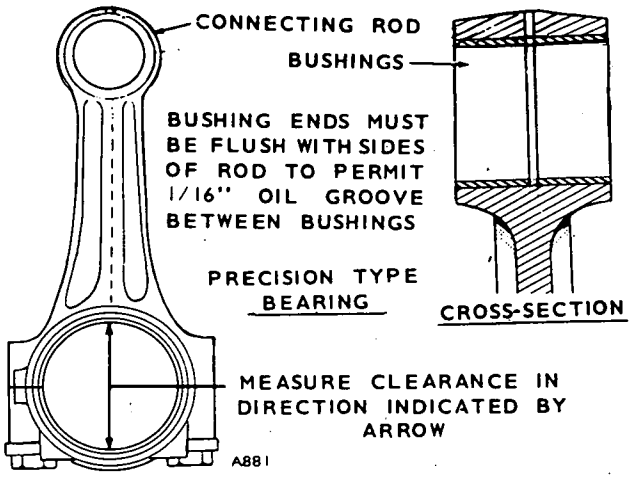


FIGURE 52. CONNECTING ROD BUSHINGS

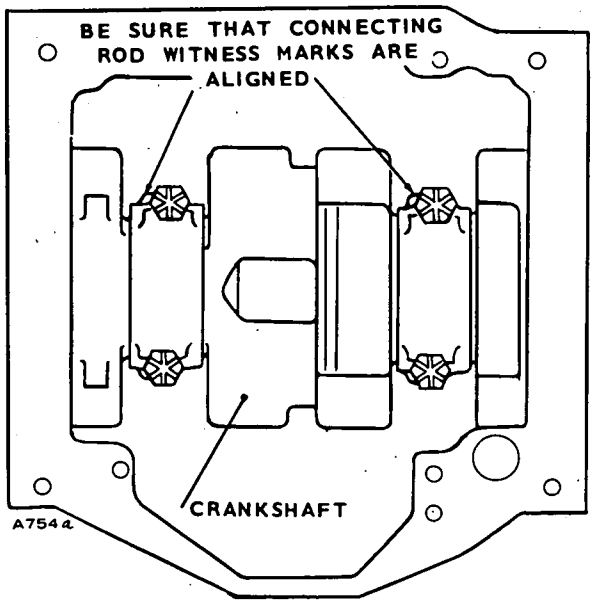


FIGURE 53. CONNECTING ROD CAP

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 in 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 (Figure 53).
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.

CAMSHAFT

The camshaft is a 1-piece machine casting, driven through gears by the crankshaft. It rides on sleeve bearings pressed into the crankcase.

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

Removal:

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

Repair: If 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 .0012" to .0037". To check the rear bearing, remove the expansion plug at the rear of the crankcase.

Press new bearings into place (Figure 54). 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, 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. Check camshaft endplay. Refer to Dimensions and Clearances. See Figure 55.

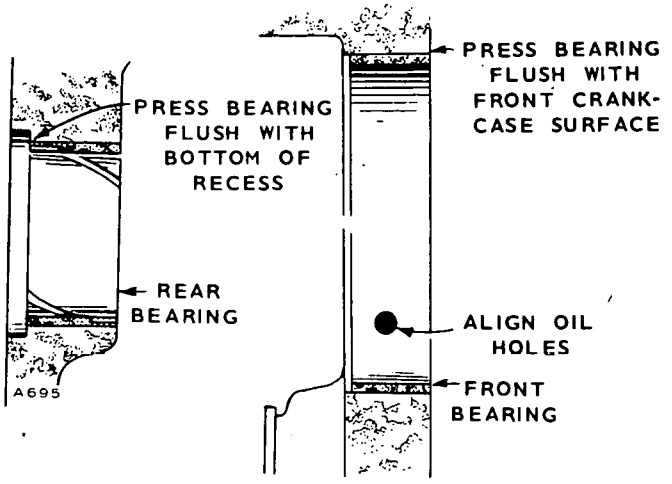


FIGURE 54. CAMSHAFT BEARINGS

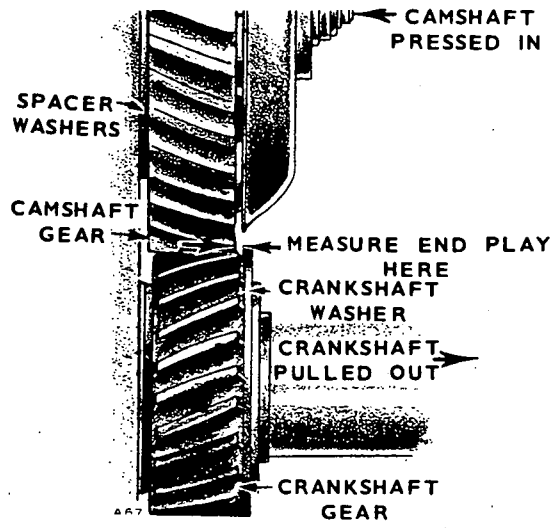


FIGURE 55. CAMSHAFT END PLAY

CRANKSHAFT

The DJBA series engines use a counter-balanced, ductile iron crankshaft. To increase the shaft's fatigue durability, all crankpin fillets are shot-peened during manufacturing. The 2 cylinder crankshafts ride on two lead-bronze bearings, the front one housed in the crankcase and the rear one in the bearing plate.

Removal:

1. Remove the lock ring and retaining washer in front of the crankshaft gear.
2. Pull off the crankshaft gear. It has two, 1/4-20 UNC tapped holes for attaching a gear pulling ring. Use care not to damage teeth if the gear is to be reused. See Figure 57.
3. Remove the oil pan, piston, and connecting rod.
4. Remove the rear bearing plate from the crankcase.
5. Remove the crankshaft from crankcase.

Installation, Camshaft Assembly:

1. Install the key and press the camshaft gear on its shaft.
2. Install the governor components.
3. Slide the thrust washer onto the shaft.
4. Lay the engine on side or end and insert the push rod tappets.
5. Install the camshaft assembly in the engine. Align the timing marks on the camshaft gear and crankshaft gear (Figure 56).
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. This step is critical.

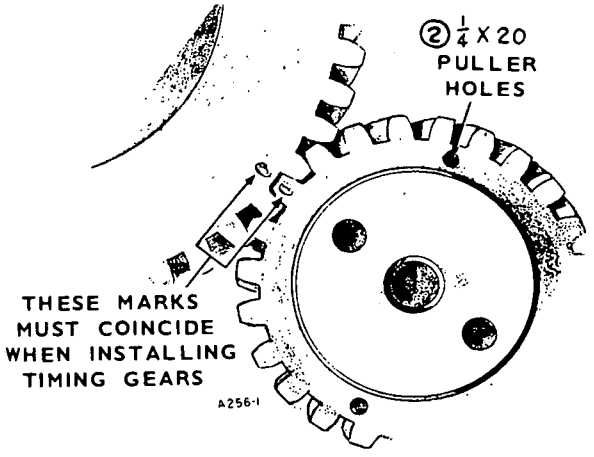


FIGURE 56. TIMING MARKS

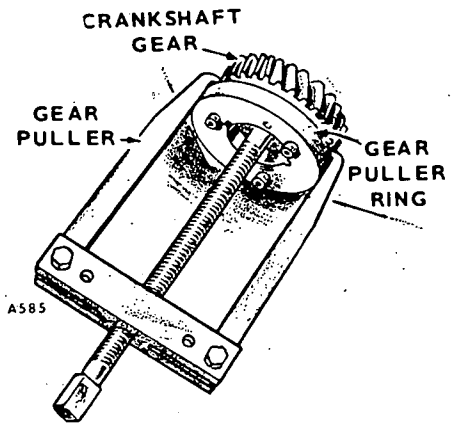


FIGURE 57. REMOVING CRANKSHAFT GEAR

Inspection: Clean the crankshaft and blow out all oil passages. Check journals for out-of-round, taper, grooving or ridges. Pay particular attention to ridges or grooves on either side of the oil hole 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.

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

Special procedures must be observed when reworking diesel crankshafts. In addition to machining, the crankshaft must be *shot-peened* and super-finished. Failure to *shot-peen* the crankpin fillets is likely to cause early failure. When the shaft is machined, follow this data and Figure 58 to shot-peen each crankpin fillet.

1. Almen gauge reading, .012-A.
2. Peen with .019" diameter cast steel shot.
3. Peen for 15 seconds on each crankpin fillet.
4. Mask off connecting rod bearing areas.

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

Precision replacement bearing inserts and thrust washers are available for all main bearings. Do not ream the bearings.

Align the oil holes and press the new bearings into the front and rear housings.

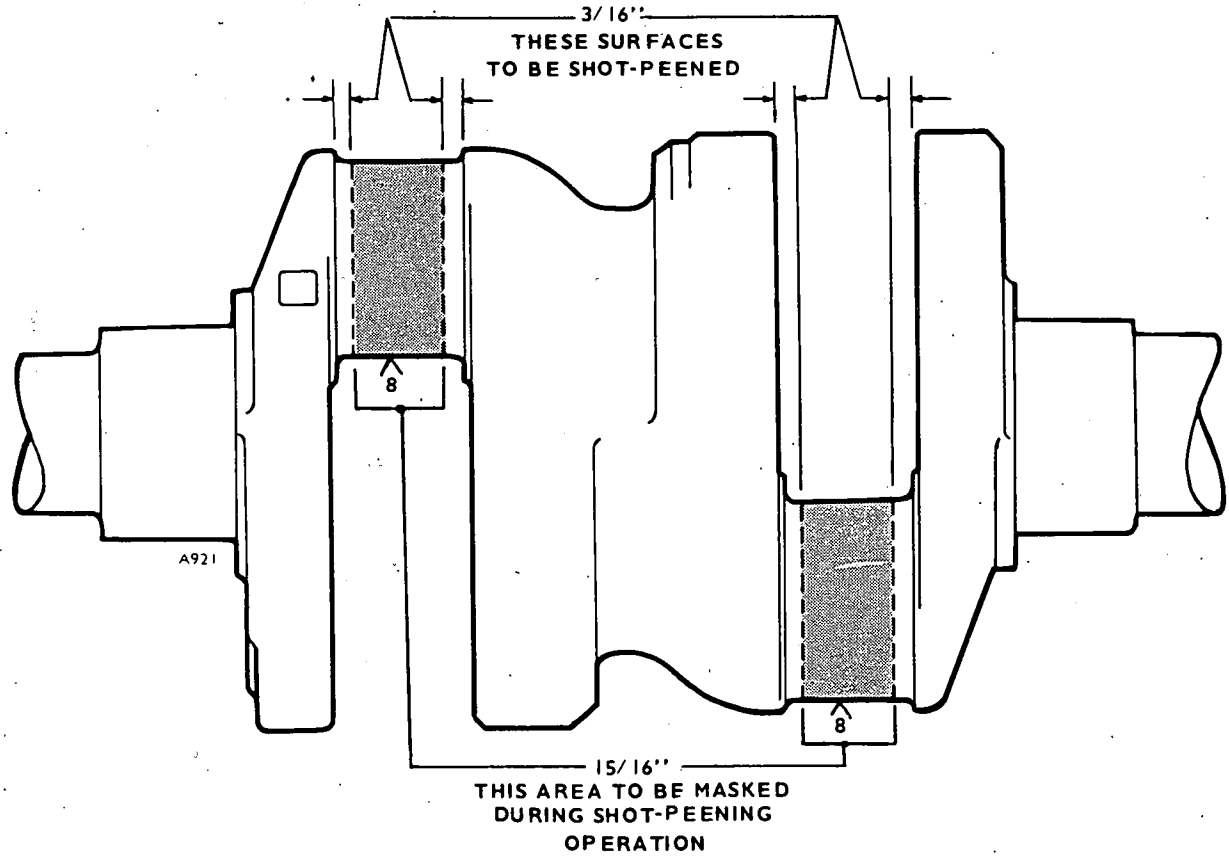


FIGURE 58. SHOT-PEENING CRANKSHAFT

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) Figure 59. 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.
2. Install the thrust washers and locking pins.
3. Oil the bearing surfaces and install the crankshaft from the rear of the crankcase, through the rear bearing plate hole.
4. Mount and secure the rear bearing plate.
5. Heat the timing gear on an electric burner or oven to about 350°F. Install the key on the crankshaft, then drive the gear into place. Install the retaining washer and lock ring.
6. Check the crankshaft end play. Use enough rear bearing plate gaskets or shims and gaskets to provide .010" to .015" end play. If gaskets of more than .015" total thickness are required, then use a steel shim of proper thickness and a thin gasket on each side of shim. This avoids excessive gasket compression and maintains bolt torque.
7. Install 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.

BREAK-IN PERIOD

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

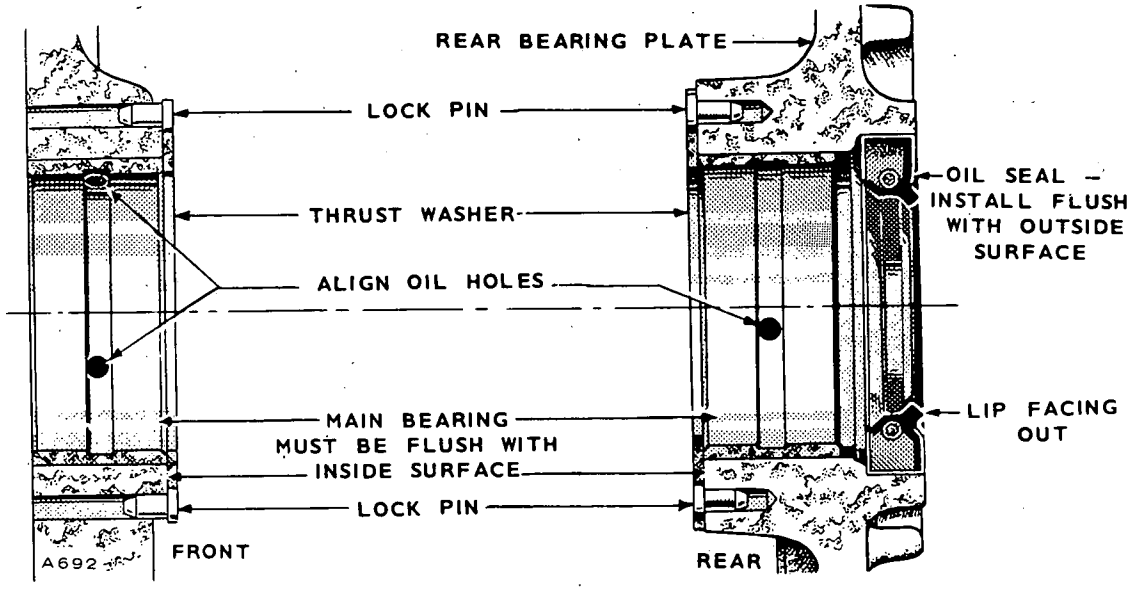


FIGURE 59. MAIN BEARING HOUSING

CONTROL SYSTEM

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

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

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

LOW OIL PRESSURE CIRCUIT(Optional)

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 use 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 switch. The switch closes at 14± 1 psi under increasing pressure. If oil pressure falls below 14 ± 1 psi the switch opens, de-energizing the fuel solenoid stopping the engine.

The system for engines with fabricator mounted controls use a normally closed low oil pressure switch. During starting a relay provides a time delay to allow engine to build up oil pressure and open switch. If the oil pressure falls below 14 ± 1 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 1-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 14 ± 1 psi, the relay stops the engine prevents it from restarting until the reset button is pushed.

Centrifugal Switch: For engines with optional low oil pressure cut-off, this switch 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 engine to build up sufficient oil pressure and unit can be started.

For correct operation, maintain the switch gap at .020". See Figure 60.

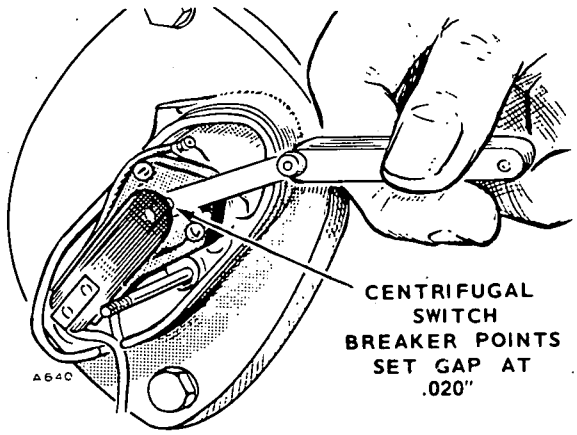


FIGURE 60. CENTRIFUGAL SWITCH ADJUSTMENT

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

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 oil trickle holes to these bearings. Check the oil spray hole in the gear case to be sure it is open.

Check for wear in the spacer, fibre plunger and the spring loaded shaft plunger. The spacer must be at least .35" long. If not, replace it immediately. Push the weights outward, they should move freely. If not or 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 .020" check the fibre plunger and spacer for wear. See Figure 61.

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 .020".
6. Install switch cover and reconnect battery.

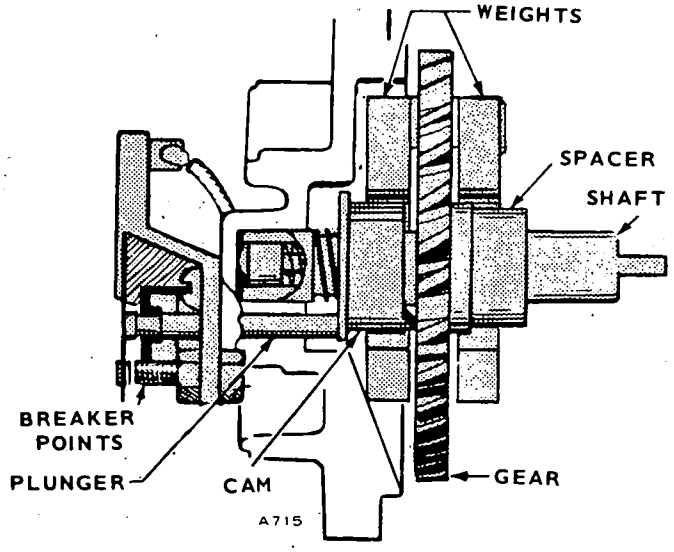


FIGURE 61. CENTRIFUGAL SWITCH

SPECIAL EQUIPMENT

CLUTCH

This information is intended for engines which use a Rockford 8 inch clutch (Figure 62).

Adjusting - After clutch has been installed in machine, turn adjusting ring clockwise one notch at a time until it is impossible to engage the clutch. Then back off two or three notches. Re-engage adjusting lock between adjusting ring and notches in back plate.

Lubrication - Apply a film of grease in the cam cradles of the pressure plate at time of assembly. After assembly has been completed, apply grease to fittings on cam shaft and release bearing.

Disassembly - After clutch has been removed from flywheel, place on bench or flat surface with release bearing up.

During disassembly, identify all parts so they can be returned to their respective positions.

With release sleeve and bearing in the released position, disengage the lock from between the adjusting ring and the notches in the back plate. Remove the adjusting ring and wear plate and then remove the pressure plate return springs. Then lift back plate up from drive lugs in pressure plate.

Inspect all parts and replace as needed.

Assembly - Replace all components in same order as removed into their respective positions.

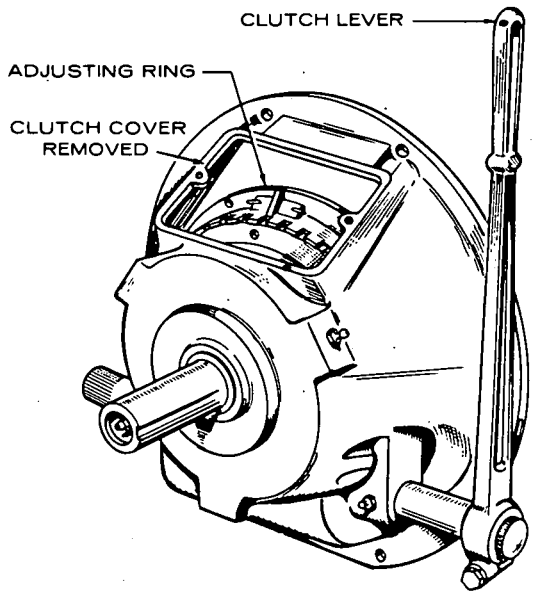


FIGURE 62. ROCKFORD CLUTCH

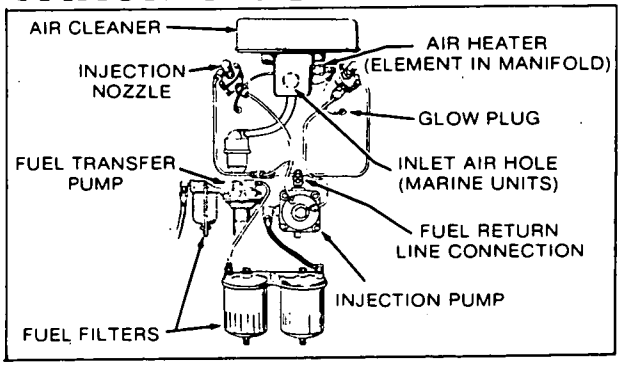
ONAN DIESEL STARTING GUIDE

IMPORTANT!

KEEP ENTIRE FUEL SYSTEM CLEAN AND FREE FROM WATER
- DIESEL INJECTION PUMPS WILL FAIL IF SYSTEM CLEANLINESS IS NEGLECTED

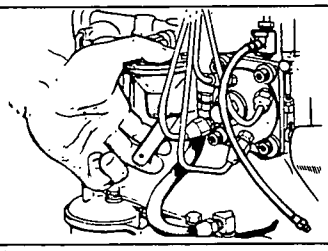
INJECTION PUMPS AND NOZZLES ARE NOT FIELD REPAIRABLE
- WHEN TROUBLESHOOTING, CHECK ALL OTHER COMPONENTS FIRST

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



BEFORE STARTING:

CHECK FUEL SUPPLY. BE SURE SHUTOFF VALVES ARE OPEN.



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

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

PREHEAT COLD ENGINE: PUSH PREHEAT SWITCH AND HOLD —
- **30 SECONDS IF ABOVE 55°F (13°C);**
- **60 SECONDS IF BELOW 55°F (13°C).**

TO START:

RELEASE PREHEAT

ENGAGE START SWITCH

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

IF ENGINE DOES NOT START:

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

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

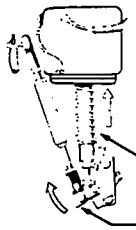
OBSERVE ENGINE EXHAUST "SIGNALS":

BLUE-WHITE EXHAUST SMOKE: ENGINE IS GETTING FUEL

1. **OBSERVE AIR HEATER THRU AIR INLET HOLE OR BY REMOVING AIR CLEANER.**
2. **ENGAGE PREHEAT.**
3. **IF HEATER ELEMENT DOES NOT GLOW RED WITHIN 30 SECONDS, CHECK AIR HEATER AND GLOW PLUG WIRING:**
   - **CONNECTIONS TIGHT?**
   - **FREE FROM CORROSION?**

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

FUEL FLOWS STEADILY



CHECK FUEL SOLENOID: SOLENOID ROD SHOULD PULL IN AND THROTTLE ARM FOLLOW (AS SHOWN) WHEN START SWITCH IS TURNED ON. IF NOT, CHECK FOR
- **BINDING LINKAGE**
- **LOOSE OR BROKEN WIRES**

LITTLE OR NO FUEL FLOW

CHECK FUEL SUPPLY SYSTEM:
- **FUEL TANK EMPTY?**
- **SHUTOFF VALVES CLOSED?**
- **FUEL LINES KINKED?**
- **LOOSE CONNECTIONS?**
- **CLOGGED FUEL FILTERS?**

IF ENGINE IS STILL NOT GETTING FUEL, CHECK TRANSFER PUMP:
1. **CRANK ENGINE AND OBSERVE FUEL FLOW FROM RETURN LINE.**
2. **IF FUEL DOES NOT SPURT OUT, PUMP MAY BE DEFECTIVE.**

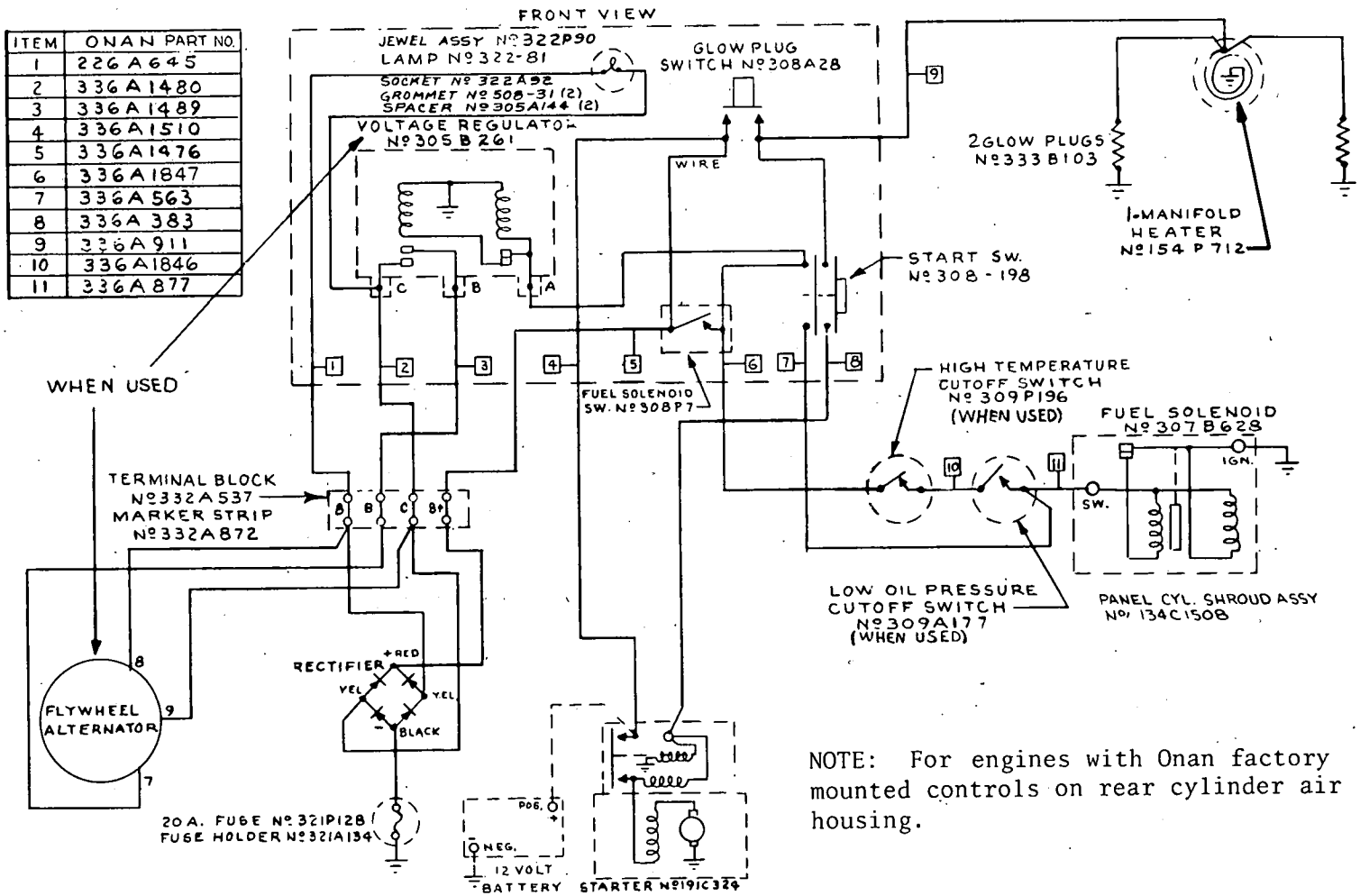
IF ENGINE STILL DOES NOT START, CONTACT AUTHORIZED ONAN SERVICE REPRESENTATIVE

2-79 900-0217

WIRING DIAGRAMS

DJBA-MS PRIOR TO SPEC V
(some options shown)

ITEM	ONAN PART NO.
1	226A645
2	336A1480
3	336A1489
4	336A1510
5	336A1476
6	336A1847
7	336A563
8	336A383
9	336A911
10	336A1846
11	336A877

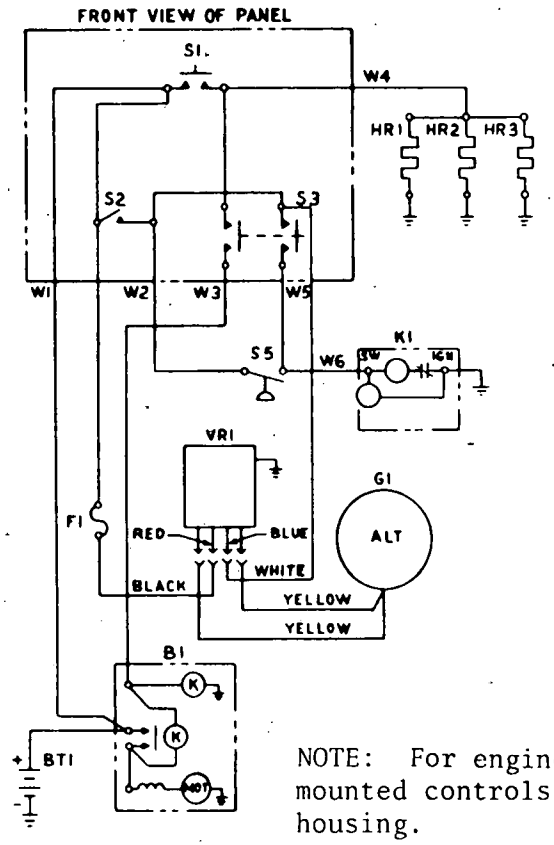


NOTE: For engines with Onan factory mounted controls on rear cylinder air housing.

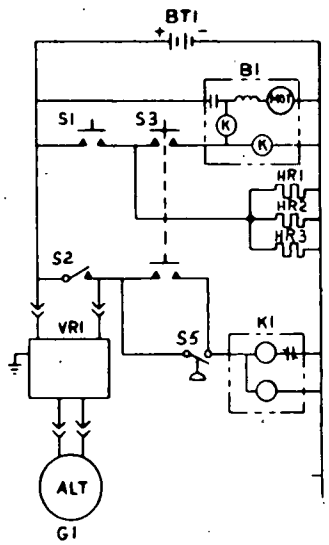
PARTS LIST

REF DES.	PART NO.	QTY	DESCRIPTION
B1		1	STARTER
BT1		1	BATTERY, 12 V
F1		1	FUSE-30 A
G1		1	ALTERNATOR-FLYWHEEL
HR1, 3		2	PLUG-GLOW
HR2		1	HEATER-MANIFLOD
K1	3078628 (REF)	1	SOLENOID-FUEL
S1	308A28	1	SWITCH-GLOW PLUG
S2	308P7	1	SWITCH-FUEL SOLENOID
S3	308-198	1	SWITCH-START
S5		1	SWITCH-LOW OIL PRESSURE
VR1		1	VOLTAGE REGULATOR

WIRING DIAGRAM



SCHEMATIC



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