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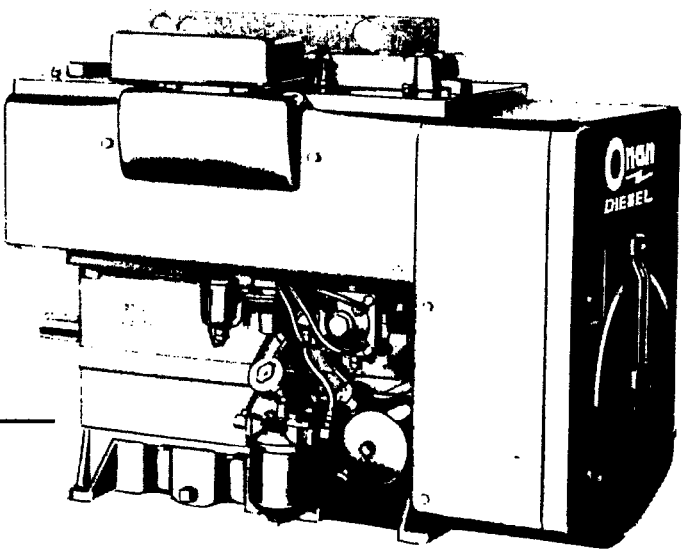
Onan

Service Manual

DJBA
DJB
DJC
DJE
Diesel Engines



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3-88
Printed in U.S.A.

Safety Precautions

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

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

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

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

Safety Codes

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

General

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

Protect Against Moving Parts

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

Batteries

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

Fuel System

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

Exhaust System

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

Exhaust Gas is Deadly!

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

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

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

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

Cooling System

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

Keep the Unit and Surrounding Area Clean

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

Table of Contents

WARNING

INCORRECT SERVICE OR REPLACEMENT OF PARTS MIGHT RESULT IN SEVERE PERSONAL INJURY AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.

General Information

INTRODUCTION

This manual deals with specific mechanical and electrical information needed by engine mechanics for troubleshooting, servicing, repairing, or overhauling the engine.

Use the table of contents for a quick reference to the separate engine system sections.

Use the separate Parts Catalogs available at the dealer level, for parts identification and for establishing their proper location on assemblies.

The *troubleshooting guide* is provided as a quick reference for locating and correcting engine trouble.

The illustrations and procedures presented in each section apply to the engines listed on the cover. The flywheel end of the engine is the front end, so right and left sides are determined by viewing the engine from the front.

The disassembly section contains major overhaul procedures for step by step removal, disassembly, inspection, repair and assembly of the engine components.

If a major repair or an overhaul is necessary, a competent mechanic should either do the job or supervise and check the work of the mechanic assigned to do the job to ensure that all dimensions, clearances and torque values are within the specified tolerances.

The wiring diagram on the last page of the manual shows how the electrical components are interconnected.

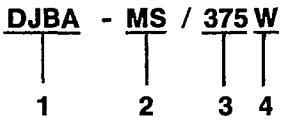
A *parts catalog* (available at the dealer level) contains detailed exploded views of each assembly and the individual piece part numbers and their proper names for ordering replacement parts.

Use only Genuine Onan replacement parts to ensure quality and the best possible repair and overhaul results. When ordering parts, always use the complete Model and Spec number as well as the Serial number shown on the nameplate.

ENGINE MODEL REFERENCE

Identify your model by referring to the MODEL and SPEC (specification) NO. as shown on the unit nameplate. Always use this number and the engine serial number when making reference to your engine.

How to interpret MODEL and SPEC NO.



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.

Specifications

All dimensions in U.S. customary units of measure (metric in parentheses) unless otherwise specified.

SPECIFICATION	UNIT OF MEASURE	SERIES			
		DJB	DJBA	DJE	DJC
Number of Cylinders		2	2	2	4
Diesel Fuel		ASTM2-D	ASTM2-D	ASTM2-D	ASTM2-D
Bore	in	3.25	3.25	3.5	3.25
	(mm)	(82.55)	(82.55)	(88.90)	(82.55)
Stroke	in	3.625	3.625	3.625	3.625
	(mm)	(92.08)	(92.08)	(92.08)	(92.08)
Displacement	cu in	60	60	70	120
	(litre)	(0.98)	(0.98)	(1.2)	(1.97)
Compression Ratio		19 to 1	19 to 1	19 to 1	19 to 1
Firing Order			1-2	1-2	1-2-4-3
Crankshaft Rotation (viewed from flywheel)		Clockwise	Clockwise	Clockwise	Clockwise
Governor		Adjustable Mechanical			
Valve Clearance		Spec A-C	Begin Spec D		
Intake	in	0.004	0.009	0.009	0.010	0.009
	(mm)	(0.10)	(0.23)	(0.23)	(0.25)	(0.23)
Exhaust	in	0.004	0.009	0.007	0.007	0.007
	(mm)	(0.10)	(0.23)	(0.18)	(0.18)	(0.18
Oil Filter		Full Flow		Full Flow	Full Flow	Full Flow
Crankcase Capacity with filter change	Qt	3.5		3.5	3.5	6.5
	(litre)	(3.3)		(3.3)	(3.3)	(6.2)

NOTE: DJB and DJBA engines differ only in crankshaft, injection pump, camshaft, and their associated piece parts. DJB is even-firing (pistons move up and down together); DJBA is odd-firing (one piston moves up as the other moves down.

Dimensions and Clearances

All clearances given at room temperature of 70°F (21°C).
All dimensions in inches (millimeters in parentheses) unless otherwise specified.

CAMSHAFT

Bearing Journal Diameter, Front	2.2500-2.2505 (57.150-57.163)
Bearing Journal Diameter, Center (DJC)	[illegible]
Bearing Journal Diameter, Rear	1.1875-1.1880 (30.163-30.175)
Bearing Clearance Limit (Original)	.0015-.0030 (.038-.076)
Bearing Clearance Limit (Replacement)	.0012-.0049 (.030-.123)
End Play	.007-.039 (0.2-1.0)
Cam Tappet Diameter (Prior to Spec P)	.7475-.7480 (18.987-18.999)
Cam Tappet Hole Diameter (Prior to Spec P)	.7507-.7515 (19.068-19.088)
Cam Tappet Diameter (Begin Spec P)	.8725-.8730 (22.162-22.174)
Cam Tappet Hole Diameter (Begin Spec P)	.8755-.8765 (22.238-22.263)

CONNECTING RODS

Large Bore Diameter	2.1871-2.1876 (55.5523-55.5650)
Small Bore Diameter	1.043-1.045 (26.4922-26.543)
Large Bearing Bore to Small Bearing Bore (Center-to-Center)	5.998-6.002 (152.3492-152.4508)
Connecting Rod End Play	.002-.016 (.05-.41)

CYLINDER

Bore Honed Diameter	3.2495-3.2505 (82.537-82.563)
Bore Honed Diameter (DJE)	3.4995-3.5005 (88.887-88.913)
Maximum Allowable Taper	0.005 (0.127)
Maximum Allowable Out-Of-Round	0.001 (0.025)

CRANKSHAFT

Main Bearing Journal Diameter	2.2437-2.2445 (56.99-57.01)
Main Bearing Journal Diameter (DJC)	2.2427-2.2435 (56.965-56.985)
Center Main Bearing Clearance (DJC)	.0024-.0052 (.061-.132)
Front and Rear Main Bearing Clearance (Original) (DJC)	.0030-.0043 (.076-.109)
Front and Rear Main Bearing Clearance (Replacement) (DJC)	.0024-.0062 (.06-.16)
Main Bearing Clearance (Original)	.002-.0033 (.051-.084)
Main Bearing Clearance (Replacement)	.0014-.0052 (.04-.13)
Connecting Rod Journal Diameter	2.0597-2.0605 (52.316-52.337)
Rod Bearing Clearance	.001-.0033 (.025-.084)
End Play	.010-.015 (.254-.381)

PISTONS AND RINGS

Clearance in Cylinder	
Measure 90° to pin, just below oil ring	
(Prior to Spec P)	.0050-.0070 (.127-.178)
(Begin Spec P)	.0055-.0075 (.140-.191)
Ring Groove Width	
Top	.0970-.0980 (2.464-2.489)
No. 2	.0965-.0975 (2.451-2.477)
No. 3	.0965-.0975 (2.451-2.477)
No. 4	.1880-.1897 (4.775-4.818)
Ring Gap	.010-.020 (.25-.51)

PISTON PIN

Clearance in Piston	Thumb Push Fit
Connecting Rod Bushing Clearance	.0002-.0007 (.005-.018)

STARTING MOTOR (Prestolite)

Rotation	Counterclockwise
Pinion Clearance to Pinion Stop (Solenoid Plunger Bottomed)	.070-.120 (1.78-3.05)
Armature End Play	.005-.030 (.030-.760)

VALVE—INTAKE

Stem Diameter (Stem is tapered)	
**Center	.3401-.3411 (8.639-8.664)
**Face	.3386-.3396 (8.601-8.626)
Valve Face	44°
Guide Clearance	.0015-.003 (.038-.076)

VALVE—EXHAUST

Stem Diameter	.3405-.3415 (8.649-8.674)
Guide Clearance	.0030-.0050 (.076-.127)
Valve Face	45°

VALVE GUIDE

Length	1.7812 (45.2424)
Outside Diameter	.4690-.4695 (11.9126-11.9253)
Inside Diameter (after reaming)	
Exhaust	.3445-.3455 (8.750-8.776)
Intake	.3425-.3435 (8.700-8.725)
Cylinder Block Bore Diameter	.467-.468 (11.8618-11.8872)

VALVE SEATS

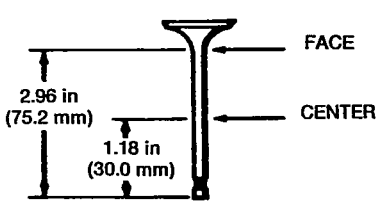
Valve Seat Bore (Diameter)	
Intake	1.547-1.548 (39.29-39.32)
Exhaust	1.361-1.362 (34.570-34.595)
Depth (from Cylinder Head Face)	.433-.439 (10.99-11.15)
Seat Outside Diameter	
Exhaust	1.364-1.365 (34.6456-34.6710)
Intake	1.550-1.551 (39.37-39.39)
Seat Width	.047-.062 (1.19-1.57)
Angle	45°
Available Insert Oversizes	.002 (.0508)
	.005 (.127)
	.010 (.254)
	.025 (.635)

VALVE SPRINGS

Load—Valve Closed	45-49 lb (200-218 N*)
Load—Valve Open (Prior to Spec P)	83-93 lb (369-414 N*)
Load—Valve Open (Begin Spec P)	87-97 lb (388-432 N*)

* N. Base unit, Newtons. Unit of force.
** Measure intake valve stem at points indicated.

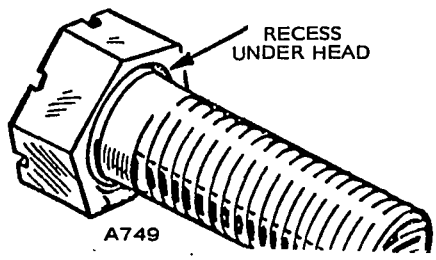
Valve Stem Diameter (Intake)



Assembly Torques

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

Specially designed place bolts do not require a lockwasher or gasket. Check all studs, nuts and screws often and tighten as needed to keep them from working loose.



TORQUE SPECIFICATIONS	Ft.-Lb.	N•m
Center main bolt (4 cylinder)	97-102	(131-138)
Connecting rod bolt	27-29	(37-39)
Rocker-Box cover	8-10	(11-14)
Cylinder head bolt	44-46	(60-62)
Exhaust manifold nuts	13-15*	(18-20)
Flywheel mounting screw	65-70	(88-95)
Hub to flywheel screws (4 cylinder)	17-21	(23-28)
Fuel pump mounting screws	15-20	(20-27)
Gear case cover	15-20	(20-27)
Glow Plug	10-15	(18-20)
Injection nozzle mounting screws	20-21	(27-28)
Injection pump mounting screws	15-16	(20-22)
Intake manifold	13-15	(18-20)
Oil base mounting screws	45-50	(61-68)
Oil filter	Hand tight plus 1/4 to 1/2 turn	
Oil pump mounting screws	15-20	(20-27)
Rear bearing plate	40-45	(54-61)
Rocker arm nut	4-10**	(5-13)
Rocker arm stud	35-40	(47-54)

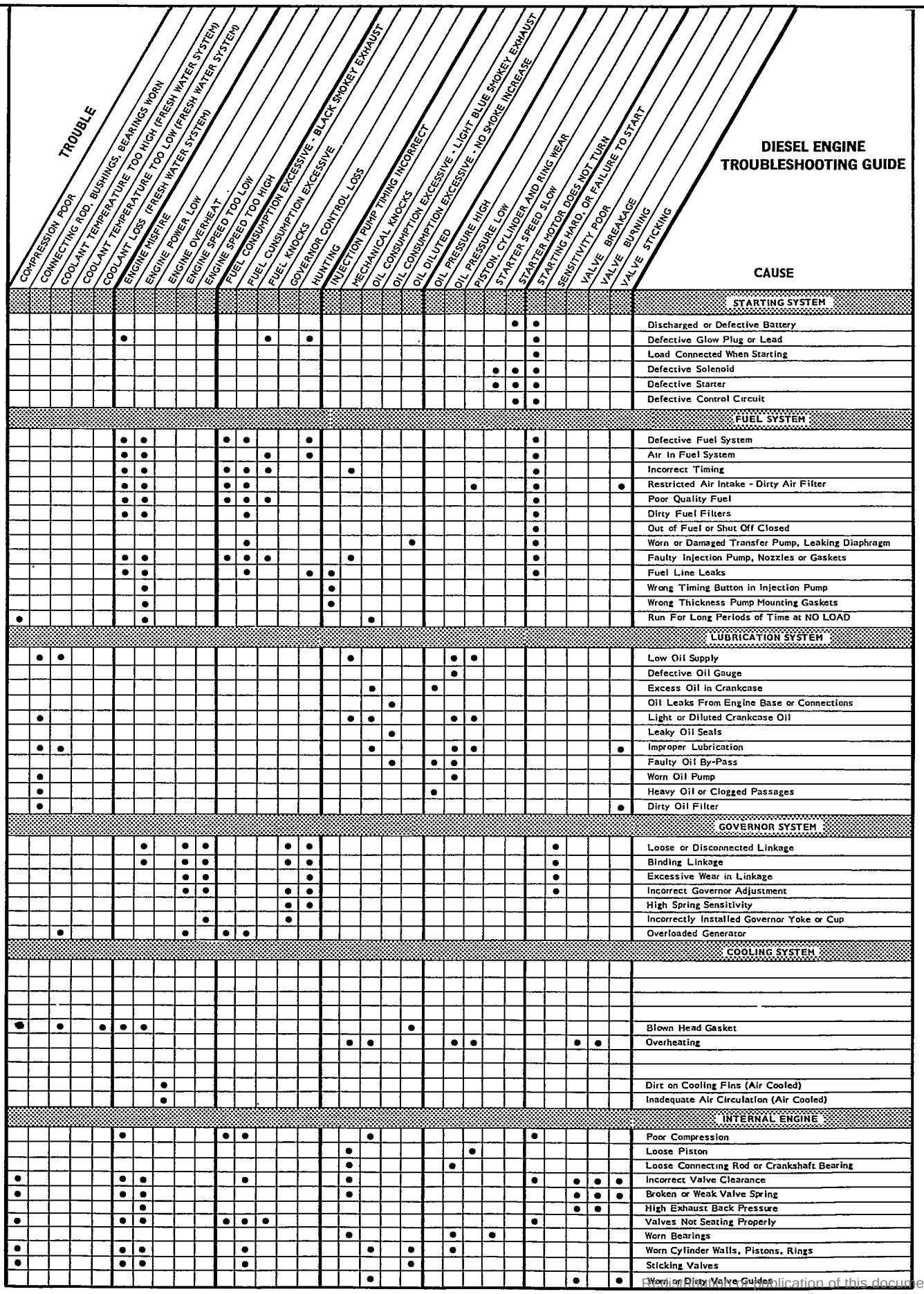
* - Exhaust nuts must be tightened evenly.
** - This torque is due to friction between the threads only and locks the nuts in place. Use the rocker arm nut to adjust valve lash.

Special Tools

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

Driver, Valve Seat	420-0270
Oil Seal Guide and Driver	420-0456
Valve Seat Remover	420-0311
Replacement Blades for 420-0272	420-0274
Crankshaft Gear Pulling Ring	420-0409
Driver, Center Camshaft Bearing (4 Cyl.)	420-0254
Driver, Combination Main and Cam	420-0326
Reamer, Ridge	420-0260
Valve Guide Remover and Driver	420-0300
Diesel Nozzle Tester	420-0184
Diesel Pintle Nozzle Cleaning Tool Set (Includes Injection Nozzle Centering Tool)	420-0208

Engine Troubleshooting



Service and Maintenance

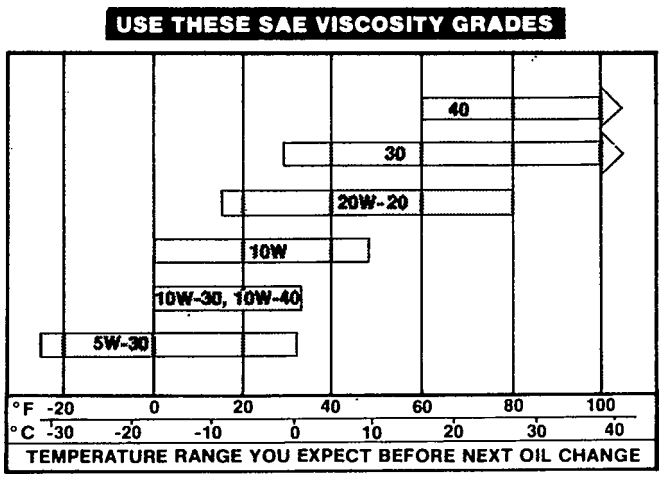
PRE-STARTING

Preparations for the initial and each additional starting operation should include careful checks of the oil, fuel, cooling, and electrical systems.

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. The engine should be kept free of dust, dirt, and spilled oil or fuel. Be sure proper operating procedure is followed.

Crankcase Oil

Multi-grade oils (such as 5W-30) are recommended for service in ambient temperatures of 32°F and colder. On Onan J Diesel engines, SAE 15W-40 or 20W-40 oils (CD/SE Service Designation) may be used in an ambient temperature range of 15°F (-10°C) through 90°F (32°C). Refer to the oil chart below for recommended viscosity grades at various temperature ambients.



Use oil with an API classification of CD/SE (all viscosity grades) or CC/SE (grades 10W-30, 10W-40, or 5W-30 only).

When adding oil between oil changes, it is preferable to use the same brand, as various brands of oil may not be compatible. Refer to Maintenance Schedule for recommended oil change intervals and procedures.

WARNING ***Crankcase pressure could blow out hot oil and cause serious burns. Do NOT check oil while the engine is operating.***

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 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.***

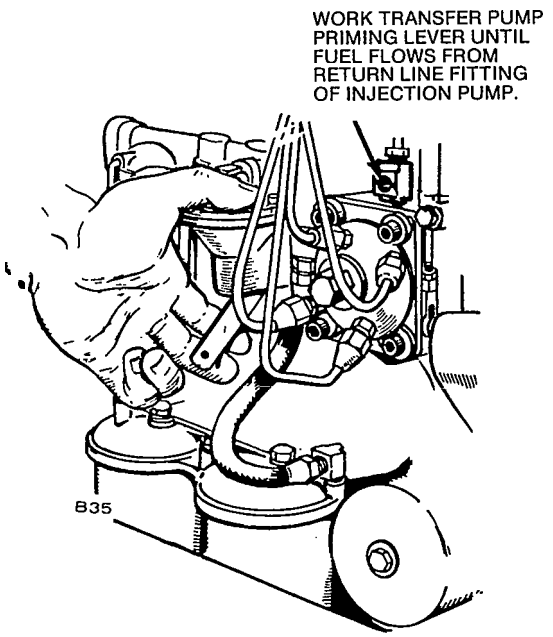


FIGURE 1. BLEED FUEL SYSTEM

If the camshaft pump lobe is up, crank engine one revolution to permit hand priming. When finished, return priming lever inward (disengaged position) to permit normal pump operation.

Bleeding Fuel System

Bleed air from fuel system as follows: Disconnect fuel return line, Figure 1. Operate hand priming lever on fuel transfer pump until fuel flowing from fuel return line is free of air bubbles. Then reconnect the fuel return line.

PRE-HEATING AND STARTING

Preheating for 60 seconds is recommended on all DJ-Series Diesels at 55°F (13°C) or lower, and 30 seconds for temperatures above 55°F (13°C). Refer to *Onan Diesel Starting Guide*, for additional starting guidelines.

WARNING ***Inhalation of exhaust gases might result in serious personal injury or death. Be sure deadly exhaust gas is piped outside and away from windows, doors, or other inlets to building.***

WARNING ***Use of ether as a starting aid might cause an explosion resulting in severe personal injury and engine damage. Do not use ether as a starting aid; heat or compression or heat from the glow plugs may cause a sudden ignition of the ether vapor.***

1. Engage PREHEAT switch for the time period recommended below:
   30 seconds if above 55°F (13°C)
   60 seconds if below 55°F (13°C)
2. Engage START switch while continuing preheat. Hold until engine comes up to speed.
3. If engine fails to start in 15-20 seconds, repeat steps 1 & 2. Absence of blue exhaust smoke during cranking indicates no fuel being delivered. Determine cause.
4. In extreme cold 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 exceed the one minute preheat periods to prevent heater burn out and conserve the battery. Longer preheating time prior to cranking the engine can ruin the manifold heater and glow plugs because there is no incoming air flow to cool them. Additional operation of the preheaters for a few seconds during cranking in cold weather may help to preheat the incoming combustion air and prevent misfires as the engine starts running.***

5. Verify that oil pressure gauge reads at least 20 psi after engine reaches speed (pressure relief valve is not adjustable).

CAUTION ***Do not apply overvoltage to the starting circuit at any time. Overvoltage will destroy the glow plugs and air heater. If it becomes necessary to use an additional source of power to start the set, use a 12 volt battery connected in parallel.***

STOPPING

1. Push fuel solenoid switch to *Stop* position.
2. Release switch when set stops. If stop circuit fails, close fuel valve.

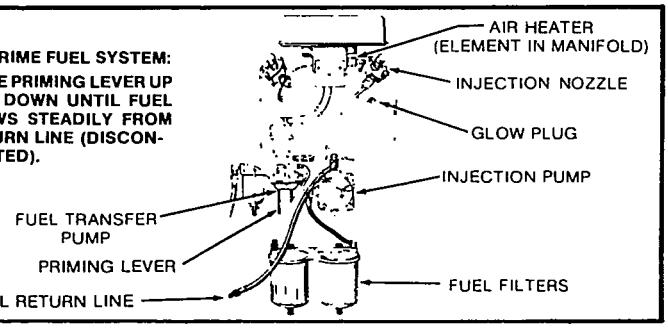
ONAN DIESEL STARTING GUIDE - INDUSTRIAL ENGINES

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 FUEL SYSTEM:
MOVE PRIMING LEVER UP AND DOWN UNTIL FUEL FLOWS STEADILY FROM RETURN LINE (DISCONNECTED).



TO START:

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

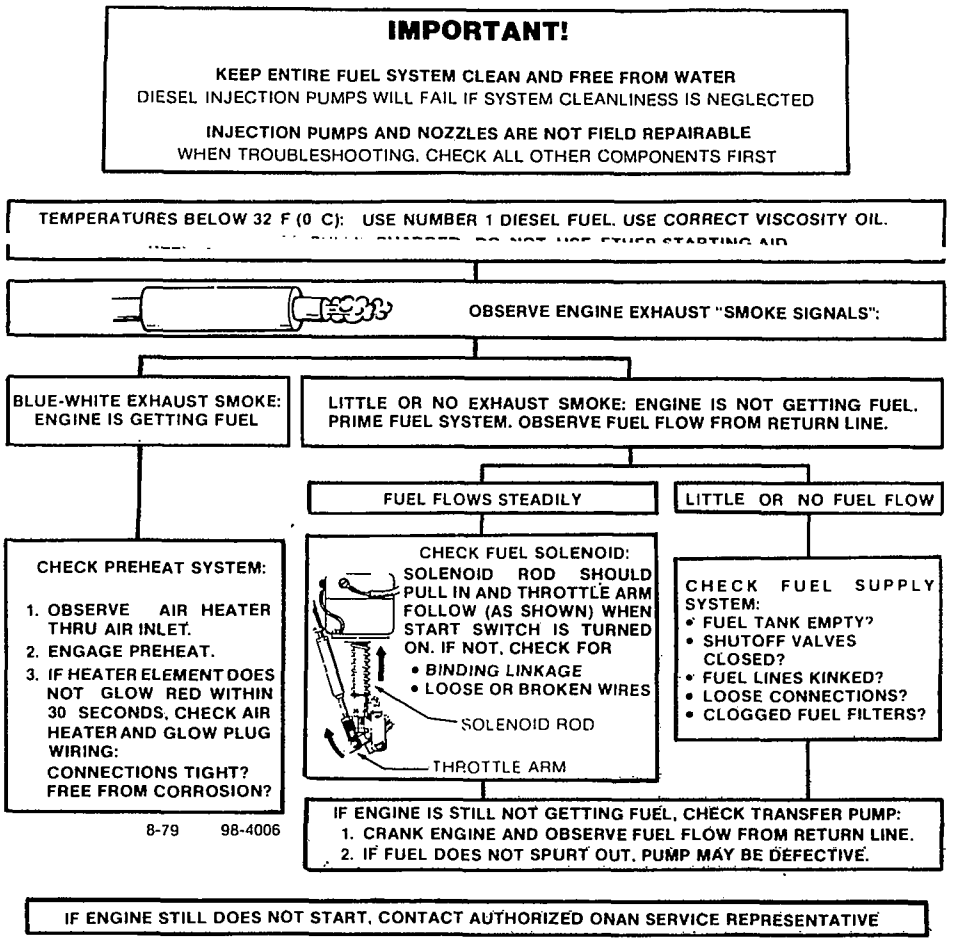
NEVER PREHEAT MORE THAN 60 SECONDS.

ENGAGE FUEL SOLENOID SWITCH IF SO EQUIPPED

ENGAGE START SWITCH WHILE CONTINUING PREHEAT

IF ENGINE FIRES BUT DOES NOT START, REPEAT ABOVE PROCEDURES, INCLUDING PREHEAT. LIMIT CRANKING TO 15 TO 20 SECONDS TO CONSERVE BATTERY. IF ENGINE STILL DOES NOT START, SEE "IF ENGINE FAILS TO START" INFORMATION.

IF ENGINE FAILS TO START:



AUTOMATIC STARTING AND STOPPING

Optional controls may be used for automatic start and stop, but must provide engine preheating.

The automatic control should have a time delay relay to preheat glow plugs and the manifold heater for at least 20 seconds before cranking occurs. The time delay relay prevents immediate engagement of the starter in case the load is reapplied before the engine stops.

APPLYING LOAD

If practicable, allow engine to warm up before connecting a heavy load. Continuous overloading causes high operating temperatures that can damage the engine. The exhaust system may form carbon deposits during operation at light loads; apply full load occasionally before shut-down to prevent excessive carbon accumulations.

Try to apply the load in steps instead of full load at one time.

BREAK-IN PROCEDURE

The unit should be run in the following sequence:

1. One half hour at 1/2 load.
2. One half hour at 3/4 load.
3. Full load.

Continuous running under one half load during the first few hundred hours may result in poor piston ring seating, causing higher than normal oil consumption and blowby.

Drain and replace the crankcase oil after first 50 hours of operation; drain while the engine is still hot.

INSPECTION

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

WARNING ***Contact with rotating machinery might cause serious personal injury or death. Stay clear of rotating components and ensure that protective shields and guards are in place and secured before operating machinery.***

VENTILATION

Good ventilation is needed to cool the engine and to support combustion. Avoid recirculation of ventilating air.

WARNING ***Inhalation of exhaust gases might result in serious personal injury or death. Do not use exhaust heat to warm a room, compartment or storage area.***

EXHAUST

Pipe exhaust gas outside any enclosure: exhaust gas is poisonous. Exhaust pipes must not terminate near inlet vents. Avoid sharp bends. Use sweeping, large-radius elbows. Use a section of seamless, flexible tubing between the engine and any rigid pipe to restrict vibration.

BATTERIES

Check the condition of the starting batteries at least every two weeks. See that connections are clean and tight. A light coating of non-conductive grease will retard corrosion at terminals. Keep the electrolyte at the proper level above the plates by adding distilled water. Check specific gravity; recharge if below 1.260.

DUST AND DIRT

1. Keep inlet screen free of dirt, etc.
2. Service air cleaner as frequently as necessary.
3. Change crankcase oil every 50 operating hours.
4. Keep oil and fuel in dust-tight containers.
5. Keep governor linkage clean.

HIGH ALTITUDE

Maximum power will be reduced approximately 4 percent for each 1000 feet (310 m) above sea level, after the first 1000 feet (310 m).

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 heated air (never use open flame) externally until oil flows freely.
2. Use fresh fuel. Protect against moisture condensation.
3. Keep fuel system clean, and batteries in a well charged condition.
4. Use additional preheat cycles during cold starts.

CAUTION ***Do not exceed one minute preheat periods; longer periods can ruin the heater elements.***

OPERATOR AND SERVICE MAINTENANCE SCHEDULE

HOURS OF OPERATION	MAINTENANCE TASK
8	• Inspect exhaust system • Inspect engine • Check fuel supply, see Note 1 • Check oil level. See Figure 2.
50 (more often in dusty conditions)	• Check air cleaner.
100	• Clean governor linkage • Change crankcase oil • Drain fuel condensation traps in lines and filters, see Note 1
200	• Replace oil filter • Check battery condition
500	• Clean breather standpipes • Check start-disconnect circuit • Check valve clearances
600	• Change primary fuel filter
2000	• Grind valves (if required) • Clean holes in rocker box oil line orifices • Check nozzle spray pattern, see Note 2
3000	• Change secondary fuel filter
5000	• General overhaul (if required), see Note 3

NOTE 1. Water or foreign material in fuel can ruin the injection system. If daily inspection shows water or excessive dirt in sediment bowl fuel, handling and storing facilities should be checked and situation corrected. Primary and secondary fuel filters must be replaced following correction of fuel contamination problem.

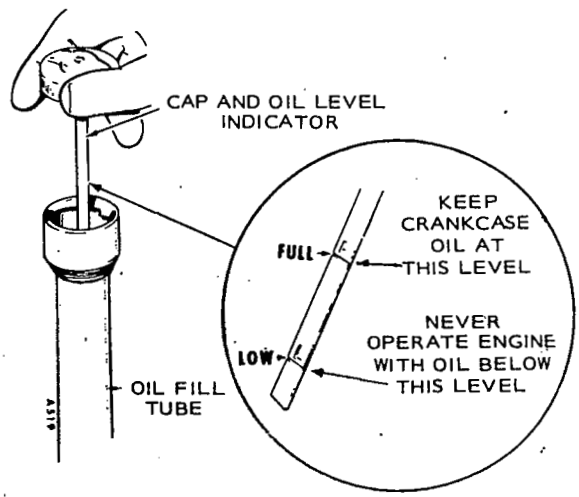
2. This service must be conducted by trained diesel injection equipment personnel with suitable test facilities. Omit this service until these conditions can be met.

3. Tighten head bolts and adjust valve clearance after first 50 hours on an overhauled engine.

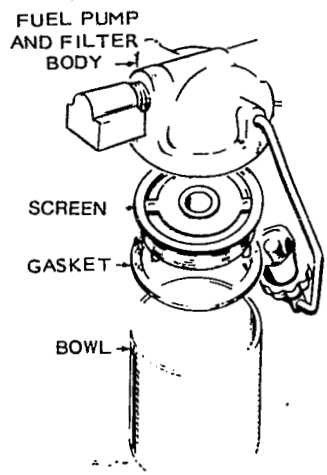
OIL FILTER CHANGE

Place pan under old filter and remove 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 1/2 turn.

WARNING ***Crankcase pressure could blow out hot oil and cause serious burns. Do NOT check oil while the engine is operating.***



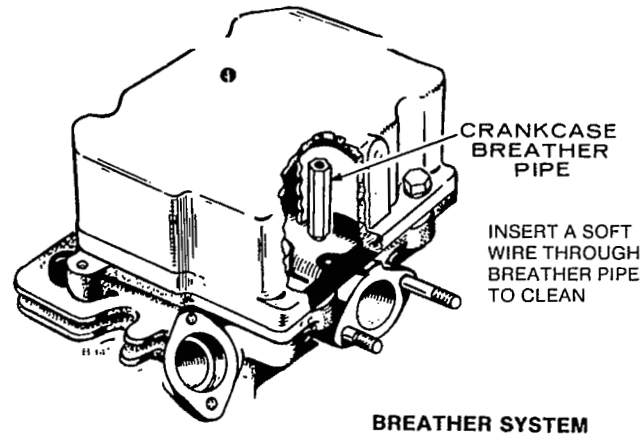
OIL LEVEL INDICATOR



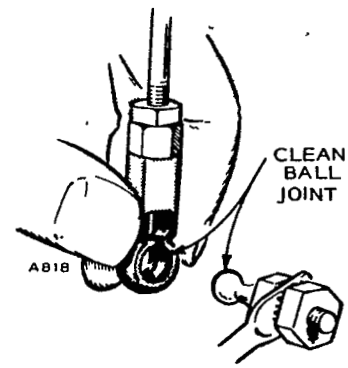
FUEL TRANSFER PUMP

OIL DRAIN EXTENSION

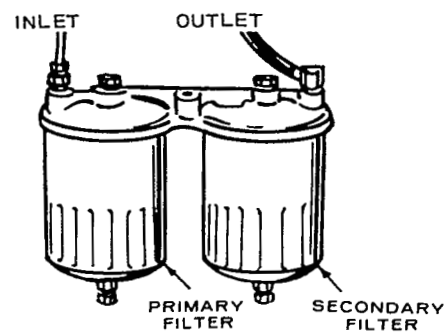
For service convenience, install a short (less than 10 inches [254 mm]) oil drain extension made from standard pipe and fittings, in the 1/2-inch (12.70 mm) pipe-tapped oil drain hole in the base.



BREATHER SYSTEM



BALL JOINT



DUAL FUEL FILTER SYSTEM

FIGURE 2. MAINTENANCE PROCEDURES

OUT-OF-SERVICE PROTECTION

The natural lubricating qualities of No. 2 diesel fuel should protect a diesel engine for at least 30-days when unit is not in service. To protect an engine that will be out of service for more than 30 days, proceed as follows:

1. Run engine until thoroughly warm; under at least 50 percent load.
2. Shut down engine and drain oil base while still warm. Refill and attach a warning tag indicating viscosity of oil used.
3. Remove glow plugs. Pour 1-ounce of rust inhibitor (or SAE #10 oil) into each cylinder. Install glow plugs.

CAUTION ***Crank engine by hand only to distribute oil in cylinder. Starter cranking is too fast; oil or inhibitor fluid will fire if cranked with starter at normal room temperature.***

4. Service air cleaner per *Maintenance Schedule.*
5. Clean throttle and governor linkage and protect by wrapping with a clean cloth.
6. Plug exhaust outlets to prevent entrance of moisture, bugs, dirt, etc.
7. Clean and wipe entire unit. Coat parts susceptible to rust with a light coat of grease or oil.
8. Disconnect battery and follow standard battery storage procedure.

Returning a Unit to Service

1. Remove cover and all protective wrapping. Remove plug from exhaust outlet.
2. Check warning tag on oil base and verify that oil viscosity is still correct for existing ambient temperature.
3. Clean and check battery. Measure specific gravity (1.260 at 77° F [25° C]) and verify level is at split ring. If specific gravity is low, charge until correct value is obtained. If level is low, add distilled water and charge until specific gravity is correct. DO NOT OVERCHARGE.

WARNING ***Ignition of explosive battery gases might cause severe personal injury. Do not smoke while servicing batteries.***

4. Check that fuel injectors and fuel lines are secure and correctly torqued.
5. Clean heat exchanger.
6. Connect batteries.
7. Verify that no loads are connected to engine.

WARNING ***Inhalation of exhaust gases might result in serious personal injury or death. Be sure deadly exhaust gas is piped outside and away from windows, doors, or other inlets to building.***

8. Start engine.

After engine has started, excessive amount of blue smoke will be exhausted until the rust inhibitor or oil has burned away.

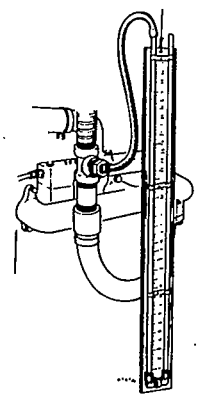
WARNING ***Accidental starting of the engine might cause severe personal injury or death. Disconnect the battery cable when repairs are made to the engine, controls, or generator.***

Exhaust System

GENERAL

The exhaust system must efficiently expel all engine combustion products and muffle exhaust noises with minimum back pressure. If back pressure is too high, the volumetric efficiency of the engine is reduced, fuel economy drops, exhaust temperature increases, and valve life is shortened.

Back pressure must not exceed 27 inches (686 mm) of water column for the rated load when measured with a manometer at the exhaust manifold. See Figure.



Units of Measurement	Full Load	No Load
2 Cylinder		
Inches of Water	27	5.1
Inches of Mercury	2	3/8
Ounces	15.6 oz.	2.9
4 Cylinder		
Inches of Water	27	4.7
Inches of Mercury	2	1/3
Ounces	15.6 oz.	2.7 oz.

BACK PRESSURE TEST WITH MANOMETER

Exhaust Smoke

A light gray or light blue smoke is a result of low ambient temperature and light load. This smoke is unburned fuel (not harmful to the engine) and disappears when more load is applied.

Black smoke indicates overfueling (more fuel than oxygen) and is usually caused by overloading. The smoke or unburned fuel becomes carbon when raised to a high temperature. Carbon contributes to engine damage because it sticks to rings and fuel injection nozzles.

WARNING ***Inhalation of exhaust gases might result in serious personal injury or death. Do not use exhaust heat to warm a room, compartment, or storage area.***

Vent exhaust gases outside. Use flexible tubing only between the engine exhaust outlet and rigid piping.

WARNING ***Inhalation of exhaust gases might result in serious personal injury or death. Inspect exhaust system audibly and visually for leaks daily. Repair any leaks immediately.***

INSTALLATION TIPS

Points to remember when installing an exhaust system are:

- Exhaust pipes should be as short as possible with a minimum of fittings.
- The muffler must be as close to the engine as possible. Mufflers which are too far from the manifold remain cool and collect carbon residue.
- Pitch exhaust pipe upward from exhaust outlets to avoid entrapment of raw diesel fumes in muffler at shutdown.
- Avoid sharp bends by using large radius elbow.
- Check back pressure with a mercury or water column type manometer.
- Position the exhaust outlet away from the engine air intake.

Exhaust noise can be suppressed or reduced by:

- Using a heavy duty exhaust system with a more efficient muffler.
- Avoiding use of flexible lines.
- Installing a deflector at the exhaust outlet to direct exhaust toward the ground, but away from the operator.
- Using a resonator in addition to a muffler.

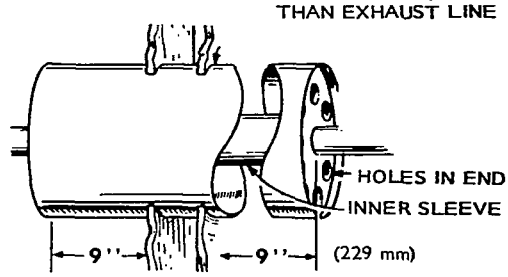
The importance of exhaust systems (normally supplied by the customer) cannot be over-emphasized. A poor or clogged system causes low power, overheating and engine damage. A poor exhaust system increases back pressure which reduces efficiency.

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.

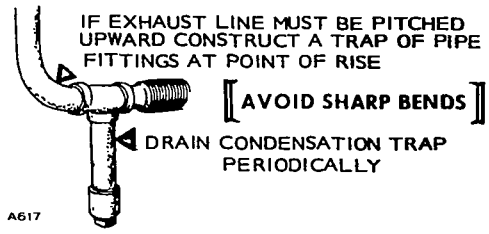
INDOOR INSTALLATIONS

Locate exhaust outlet far from air inlet to avoid recirculation. The engine exhaust is tapped for 1-1/2 inch thread. Use flexible tubing to connect the engine exhaust to rigid pipe or muffler. Shield the line if it passes through a combustible wall (Figure). If turns are necessary, use sweeping (large radius) elbows. If pitched upward, install a condensation trap at point of rise, Figure .



EXHAUST LINE PASSING THROUGH WALL OR PARTITION

EXHAUST SHIELD



CONDENSATION TRAP

WARNING

EXHAUST GAS IS DEADLY!

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

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

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

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

Cooling System

To remove the heat produced during operation, engines use a pressure air-cooled system. Blades on the engine flywheel draw air in the front of the engine housing, force the air past all the cylinders and out the right side of the engine. Figure 3 shows this airflow path through the engine.

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

MAINTENANCE

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

HIGH TEMPERATURES

1. See that nothing obstructs air flow to and from the set.
2. Keep cooling fins clean. Air housing should be properly installed and undamaged.

OVERHEATING

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

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

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

The most common installation problems leading to overheating are as follows:

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

AIR SHUTTER (Optional)

When used, the air shutter assembly is mounted at the engine air outlet, on the right side of the cylinder shroud. The air shutter is shown in Figure 4. A thermostatic element (Figure 5) controls the shutters so they close and limit air flow when the engine is cold. When the air temperature reaches 120° F (48° C), the power element plunger begins to move outward, opening the shutters. The shutters are completely open by 140° F (60° C).

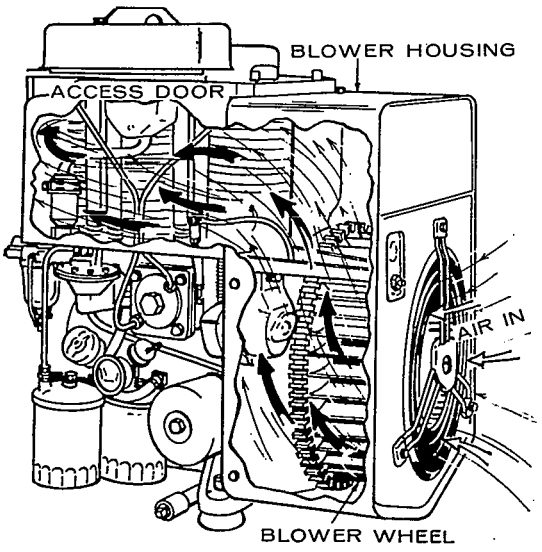


FIGURE 3. COOLING AIR FLOW

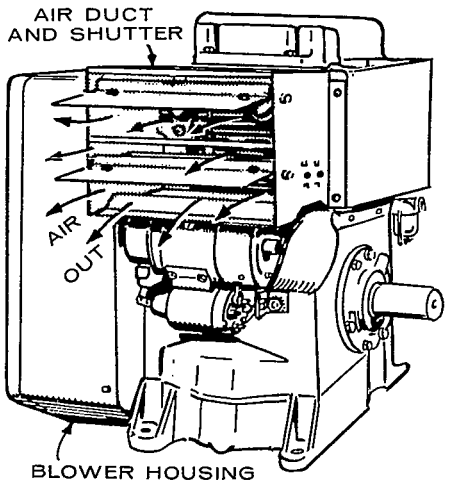


FIGURE 4. OPTIONAL AIR SHUTTER

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

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 (48° C) the plunger should start to move out. Total movement should be at least 1/5-inch (5.08 mm). Do not overheat.

If the unit will not close, check for a weak return spring, binding in the nylon bearings or dirt in the power element plunger. If the nylon bearings are worn or bind, replace them. Remove the shutters and pull out the stub shaft. Push out the old and push in new bearings from the inside of the shutter housing. The large bearing surface serves as a spacer bushing, so must be on the inside of the housing. The shutters should be adjusted to obtain an end thrust clearance of not more than 1/32-inch (0.03125 mm).

HIGH TEMPERATURE CUTOFF

When the optional automatic air discharge shutter is used, an optional high temperature cutoff switch may be used. This switch protects the engine if shutter fails to open. The switch is in series with the governor solenoid. The switch is normally closed, and opens at about 240° F (115° C). When it opens, the solenoid is de-energized, stopping the unit. The switch closes again at about 195° F (90° C).

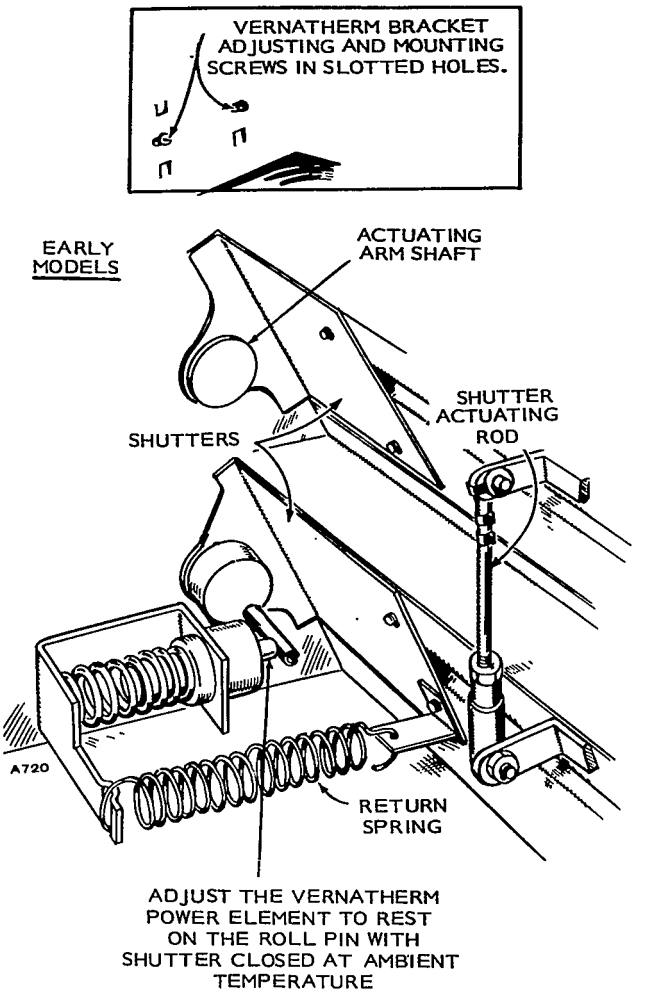


FIGURE 5. AIR SHUTTER THERMOSTAT ADJUSTMENTS

Fuel System

The diesel fuel system provides a means of filtering, transporting and delivering fuel in a fine spray to the engine cylinder at the correct time for ignition. The system consists of a primary fuel filter, fuel transfer pump, secondary fuel filter, injection pump and an injection nozzle. Figure 6 shows the fuel system prior to Spec S. Later models have dual filters.

The fuel system, located on the service side of the engine, uses a transfer pump to deliver fuel from the tank to a high pressure injection pump at about 12 to 14 psi (83-97 kPa). The injection lines deliver fuel to the injectors at high pressure and act as fuel distributors to the injectors. The time interval between individual injectors is varied in the pump by engine speed. From the injection pump, metered fuel is forced through a delivery valve to the injector lines at about 1900 psi (13,110 kPa). When the cylinder air reaches about 1000°F (538°C) on the compression stroke, the injector sprays fuel into the hot compressed air where it ignites. The delivery valve in the injection pump and a pintle valve in the injector assists the precision timed injection of fuel into the cylinder.

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.

WARNING ***Fuel vapors create fire and explosion hazards which might result in severe personal injury or death. Do not add gasoline, gasohol, or alcohol to diesel fuel. Do not permit any flame, cigarette, or other igniter near the fuel system.***

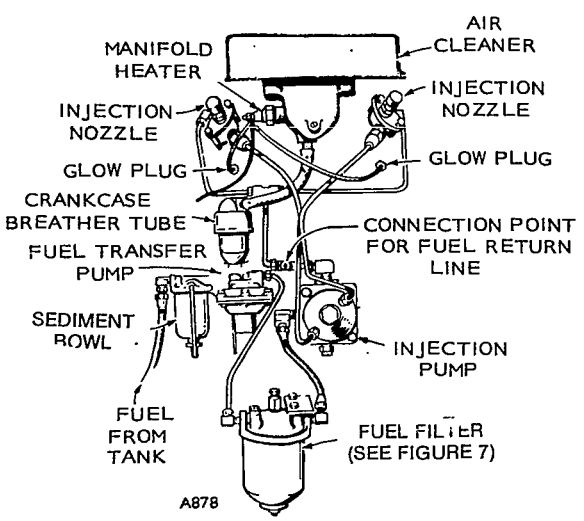


FIGURE 6. FUEL SYSTEM (PRIOR TO SPEC S)

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

FILTER SYSTEM

The sediment bowl has a fine mesh screen which blocks dirt and water entry into the transfer pump, Figure 6. The dirt and water remain in the sediment bowl which should be removed for cleaning as required. The primary and secondary fuel filters are replaceable spin-on units that clean the fuel of extremely fine particles before it goes to the injection pump, Figure 7.

These filters are mounted on a common casting which bolts to the oil fill tube. Positive filtration is assured because the engine won't run when either filter is loose or missing.

Average pore size of the second filter is .0005 (0.0127 mm) smaller than the first filter. This means most particles escaping the first filter are trapped in the second filter.

In addition to the regular service periods (3000 hours), change the secondary fuel filter cartridge whenever the engine shows sign of starving from lack of fuel. Remove the secondary filter by removing the large cap screw in the center of the filter cover. Use care when replacing the filter cover.

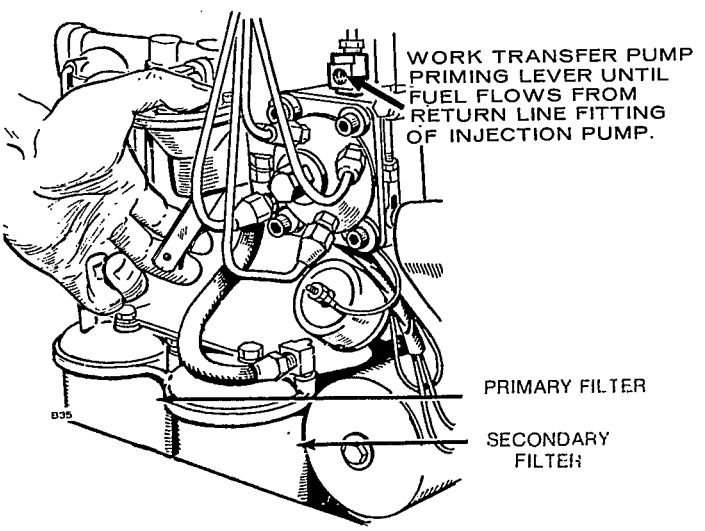


FIGURE 7. BLEEDING FUEL SYSTEM (BEGIN SPEC S)

BLEEDING FUEL SYSTEM

After replacing or cleaning the filters, bleed the fuel system of air.

Beginning Spec S: Starting with Spec S, the fuel filtration system has both primary and secondary fuel filters on a common mounting which is bolted to the oil fill tube. The engine cannot be run with either filter loose or missing, thus assuring proper filtration at all times.

Bleed air from fuel system as follows: Disconnect the fuel return line. See Figure 7. Operate the hand priming lever on diaphragm type fuel transfer pump until there are no air bubbles in fuel flowing from the fuel return line fitting. Then connect the fuel return line.

If the camshaft's pump lobe is up, crank engine one revolution to permit hand priming. When finished, return priming lever inward (disengaged position) to permit normal pump operation.

Prior to Spec S: Remove bleed plug from top of fuel filter on early models (prior to Spec S) Figure 6. Operate hand priming lever on transfer pump until all air bubbles clear fuel system. Reinstall bleed plug and return priming lever to inactive position.

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

FUEL TANK AND LINES

Where a separate fuel tank is used, install so the vertical distance from bottom of the tank to the fuel pump does not exceed six feet. Auxiliary fuel pumps are available to provide an additional eight-foot lift.

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

These diesel engines requires a fuel supply line and a separate return line. Install the fuel supply line from tank to the 1/8-inch pipe inlet in the fuel pump. Connect fuel return line to fitting at injection pump. See Figure 7. 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.

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 fuel tank and see that shutoff valve is open.
2. Remove fuel line from transfer pump outlet and work priming lever on the pump. Fuel should spurt out of pump. If not, remove 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 8).

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

Run the engine at governed speed on fuel provided by gravity feed and measure the fuel pressure developed. Pressure should be between 12 and 14 psi (82.8 and 96.6 kPa) with the gauge 16 inches (406.4 mm) above the fuel pump.

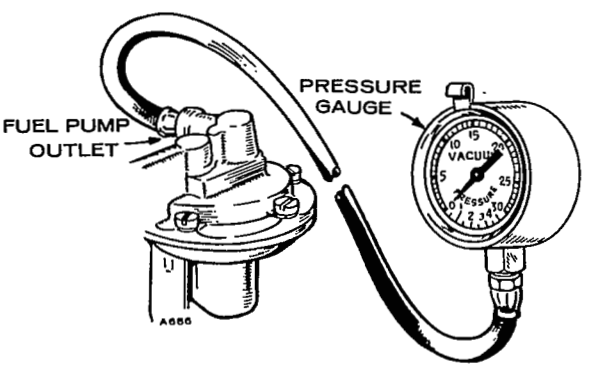


FIGURE 8. FUEL PRESSURE GAUGE

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 9 shows the fuel transfer pump.

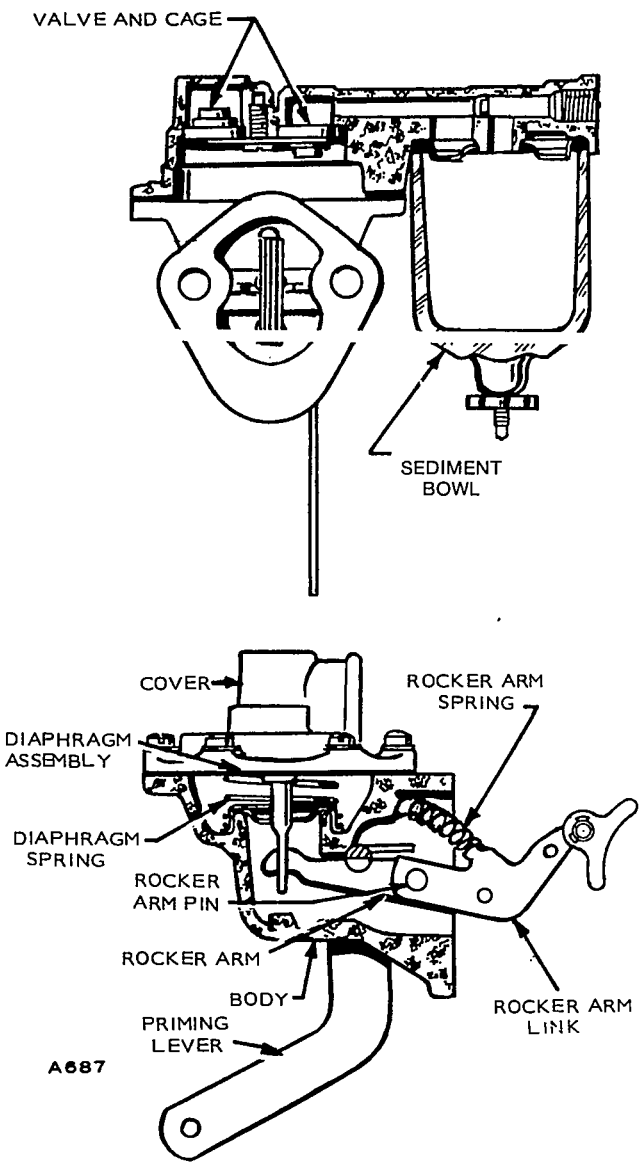


FIGURE 9. FUEL TRANSFER PUMP

Fuel Pump Removal Disassembly:

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

Repair: Transfer pump failure is usually due to a leaking diaphragm, valve or valve gasket, Figure 9. A kit is available for replacement of these parts.

Because the extent of wear cannot be detected by the eye, replace all parts in the kit. If the diaphragm is broken, or leaks, check for diluted crankcase oil and replace.

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

Assembly:

1. When installing a new diaphragm, soak it in fuel before assembling. Insert diaphragm spring and soaked diaphragm into pump body.
2. Insert link and rocker arm into body and hook it over diaphragm pull rod. Align rocker arm with rocker arm pin hole and drive in pin. The priming lever must be in position shown in Figure 9 when installing rocker arm.
3. Compress rocker spring and install between the body and rocker arm.
4. Assemble cover to body with notch marks lined up. Install screws, but do not tighten.

WARNING ***Fuel leakage is a fire and explosion hazard that might cause severe personal injury or death. Use care when reassembling fuel pump. All parts must align perfectly or pump will leak fuel.***

5. Push rocker arm in full stroke and hold in this position to flex diaphragm.

IMPORTANT: The diaphragm must be flexed, or it will deliver too much fuel pressure.

6. Tighten cover screws alternately and securely, then release rocker arm.
7. Install pump on the engine and repeat pressure test.

INJECTION PUMP

Onan DJ series diesels are equipped with Model 50 fuel injection pumps. Four cylinder engines use the model PSU pump. Until recently, the two cylinder diesel engines have been using a PSU pump. Now, the DJE engines use either a Bryce or a Kiki fuel injection pump. For Bryce/Kiki pump information, turn to the back of this section. The fuel injection pumps are constant stroke, lapped plunger type, and operated by the engine camshaft. They deliver an accurately measured quantity of fuel under high pressure to the injection nozzles.

A constant bleed-check valve is furnished with the PSU pump. The bleed valve automatically bleeds off a restricted amount of fuel, fuel vapors, and small quantities of air to prevent air accumulation in the fuel sump area of the pumps. This valve should open at air pressures between 0.9 and 3.0 psi (6.2 and 20.7 kPa).

One adjustment screw, located on the injection pump control assembly, sets the maximum injection point. Set the maximum stop screw while gradually increasing the load to stop the throttle at the smoke point.

Repair: Most fuel system troubles are not due to a faulty injection pump; test the rest of the fuel system before condemning the injection pump.

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

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

When removing the pump for replacment, record the button thickness and port closing dimensions stamped on the side of the pump mounting flange (Figure 10). These values are important in timing the new pump to the engine.

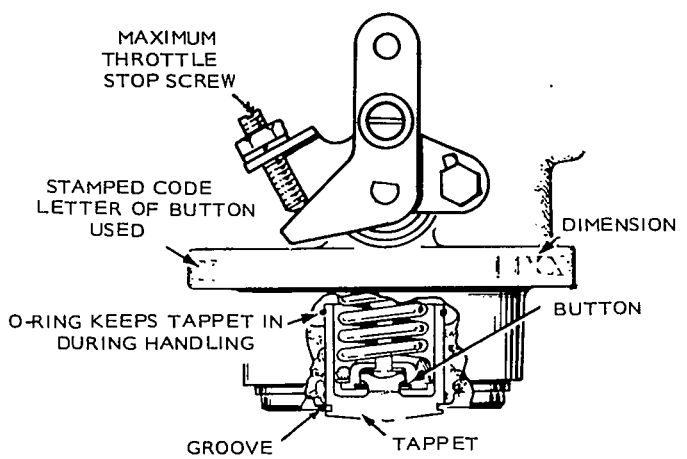


FIGURE 10. INJECTION PUMP BUTTON INSTALLATION

CAUTION ***Keeping the fuel system clean is extremely important. A fine particle of dirt can ruin the injection system in a very short time. If the fuel system is opened for any reason, cap all openings and place the parts removed in clean diesel fuel. Before installing new or used parts, wash them in clean fuel and install them wet.***

CAUTION ***Preservative oil applied to the new injection pump during assembly may cause the pump to stick. Forcing the plunger or gear will damage the pump. Dissolve preservative by soaking pump in clean filtered diesel fuel for 15 to 30 minutes.***

TIMING BUTTON CODE

The timing button has a code number or letter stamped on it that corresponds with its dimension in thousandths of an inch. See Table 1. Figure 11 shows the timing button. One button will provide the correct port closing.

FIGURE 11. TIMING BUTTON CODE

TIMING BUTTON THICKNESS

Injection pump kits include a pump and four buttons which will time most of the engines. The button and retainer ring are not assembled.

The injection pump on each engine must be timed to that engine by using a timing button of specific thickness. Each new pump has its port closing dimension stamped on the pump mounting flange. This port closing dimension is measured at the factory using a number 11 or standard button.

Pump timing is critical. Use one of the two timing methods to determine correct new button thickness. If the correct button is not supplied with the replacement pump refer to Table 1 and order the correct one from your Onan dealer.

TABLE 1. TIMING BUTTONS

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				

TIMING PSU OR MODEL 50 INJECTION PUMPS

One of two methods can be used to determine the proper timing button to time the fuel injection pump correctly to the engine.

Method 1-Timing by Calculation

This procedure is used when all dimensions are available for replacing an old pump, before the pump is installed. Timing by calculation requires the port closing dimension and button thickness from the pump being replaced. It also requires the port closing dimension of the new pump. Put the dimensions in the PORT CLOSING FORMULA and calculate the new button thickness. After determining the timing button thickness find the button code in Table 1.

If injection pump is removed from the engine, make sure the steel shims between pump and cylinder block mounting remain the same. These shims maintain proper gear backlash.

CAUTION ***Do not change the pump mounting shim's total thickness or the proper pump gear to camshaft gear mesh will be affected. The shim thickness is established at the factory during engine assembly and does not change unless a new cylinder block is installed.***

Port Closing Formula: The procedure for determining the proper port closing (PC) timing button for a new or replacement pump is as follows:

1. Remove old pump.
2. Determine port closing dimensions and original button thickness from old pump.
   A. Write down port closing dimension given on old pump flange and port closing dimension given on new pump flange. See example.
   B. Use a pair of channel lock pliers or screwdriver to remove tappet, retaining ring, and timing button from old injection pump (Figure 12). Use number or letter code on timing button to obtain dimension of old timing button from Table 1. This code should be the same as the code number stamped on injection pump (Figure 12).

CAUTION ***On all PSU pumps be sure to hold the pump drive gear securely against the pump body when removing the tappet. If not, the pump will come apart and be difficult to assemble. The metering sleeve will drop off the plunger if the gear and plunger are removed. If the plunger port is not closed by the sleeve, there will be no fuel delivery and the pump will not operate.***

3. Add dimension on old pump flange to timing button dimension. See example.

Example:	Inches	(mm)
Port closing dimension of old pump	1.109	(28.169)
Button thickness of old pump	+ .107	(2.719)
Total	1.216	(30.887)
Port closing dimension of new pump	-1.094	(27.788)
Required button thickness of new pump	.122	(3.099)

4. Subtract port closing dimension given on new pump flange from total dimension for old pump.
5. Use dimension calculated to select new timing button that is nearest the calculated dimension. Install new timing button in pump and install tappet on pump.
6. Install injection pump. Refer to *INJECTION PUMP INSTALLATION.*

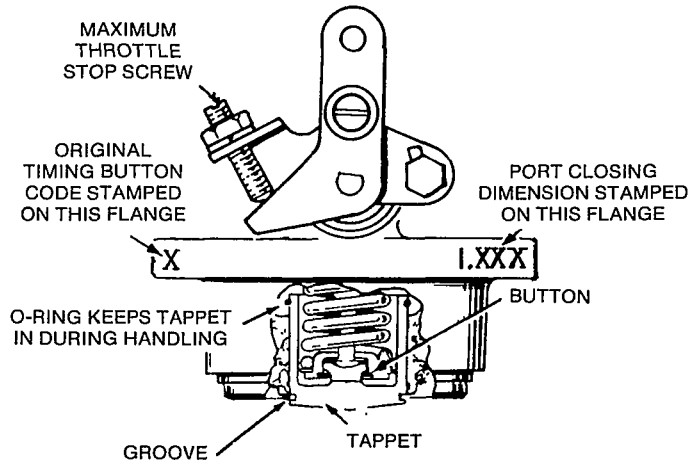


FIGURE 12. TAPPET REMOVAL

Method 2-Flow Timing Injection Pump

This procedure is used when dimensions from the old pump are lost or when a new cylinder block is installed. Clean diesel fuel is used, when flow timing, to determine if the proper timing button has been installed.

If the pump is removed from the engine, be sure the steel shims between the pump and the cylinder block mounting are the same. These shims maintain proper gear backlash. The number stamped on the cylinder block injection pump mounting pad indicates the proper shim thickness. This thickness does not change when a new pump is installed. It changes only when a new cylinder block is installed.

1. Install No. 12 timing button in new injection pump. Remove delivery valve cap nut and holder, take out spring and replace valve holder and cap nut (Figure 13 and 14).

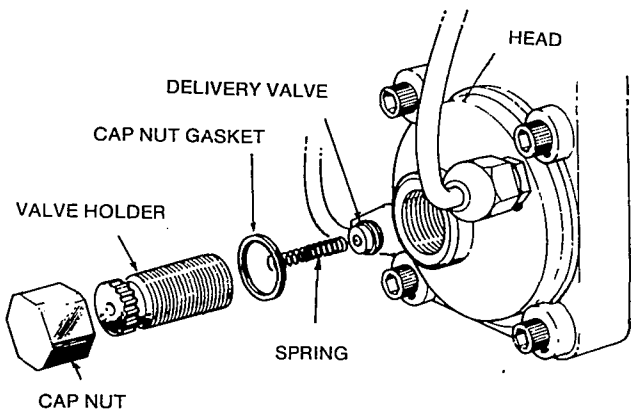


FIGURE 13. LATE MODEL DELIVERY VALVE ASSEMBLY

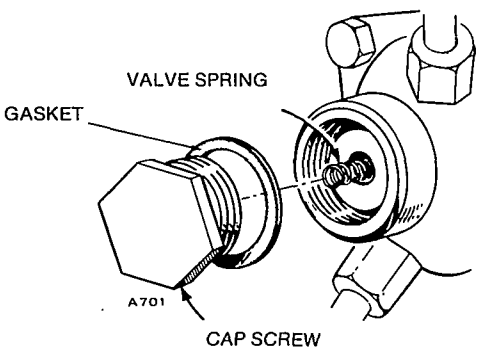


FIGURE 14. EARLY MODEL DELIVERY VALVE HOLDER

2. Install new injection pump. Refer to *INJECTION PUMP INSTALLATION.*

3. Remove No. 1 injection line. Install No. 1 injection line with top end of line in pump outlet. Place an open container under open end of No. 1 injection line (Figure 15).

4. Disconnect governor linkage at ball joint and hold control arm up at maximum fuel position.

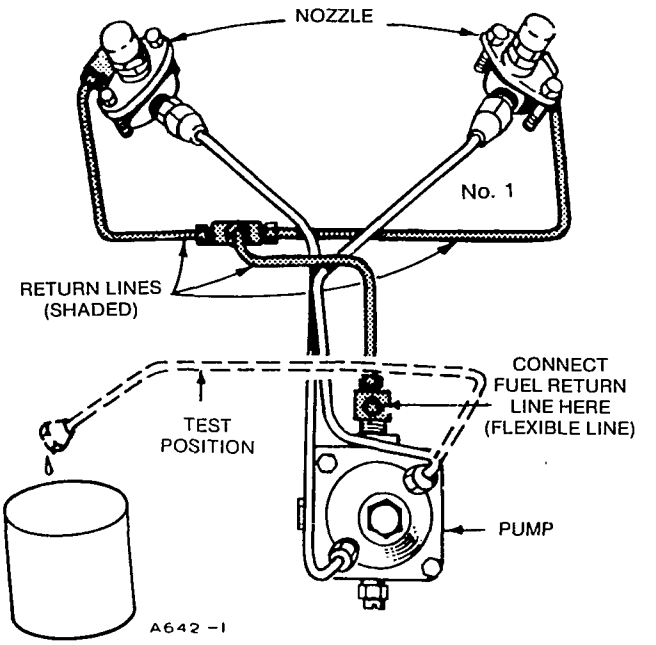


FIGURE 15. FUEL LINE TO INJECTORS

5. Rotate flywheel clockwise (when facing front of engine [Figure 16] to point where PC mark on flywheel is about 15 degrees (1.25 to 1.50 inch [32-38 mm]) before timing pointer on gear cover (compression stroke of No. 1 cylinder).

   Make sure that both rocker arms on No. 1 cylinder are free to move indicating the valves are closed.

   If fuel tank is disconnected, use a separate container of fuel and connect a short fuel line between the transfer pump inlet and the fuel container. The pump has enough suction to pull fuel out of the container.

WARNING ***Ignition of fuel might cause serious personal injury or death by fire or explosion. Do not permit any flame, cigarette, or other igniter near the fuel system.***

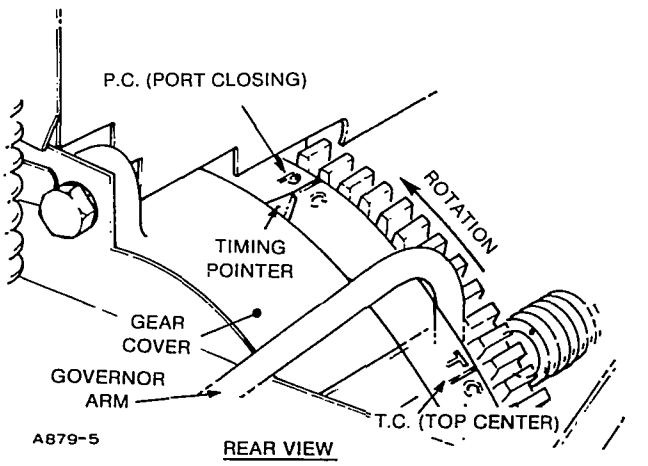


FIGURE 16. PORT CLOSING POSITION

6. Manually operate fuel transfer pump (Figure 17) until fuel, free of air, flows from open end of No. 1 injection line into container (Figure 15).

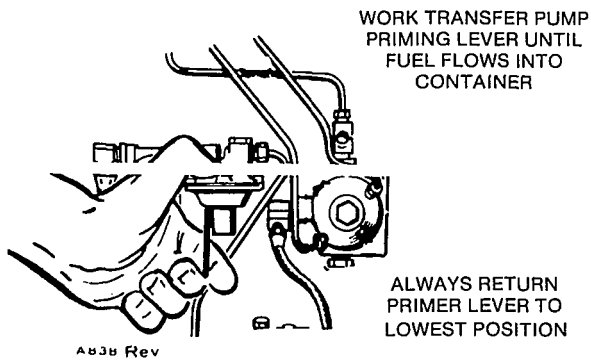


FIGURE 17. OPERATING TRANSFER PUMP MANUALLY

7. Continue operating transfer pump while assistant rotates flywheel slowly in clockwise direction. Stop flywheel rotation at exact point that fuel stops flowing from No. 1 injection line (one drop in 2 to 5 seconds is allowed). This point is the injection pump plunger port closing, regardless of flywheel position.

   Timing is correct if port closign occurs when PC mark on flywheel aligns with timing pointer (Figure 16). If the marks do not line up, timing is either early or late and the timing button must be changed.

   If Step 7 indicates port closing is incorrect (late or early) proceed as follows (See Examples):

   A. Mark flywheel in 0.1 inch (2.54 mm) graduations (about five marks each direction) from PC mark for calculating required change in button thickness, Figure 18.

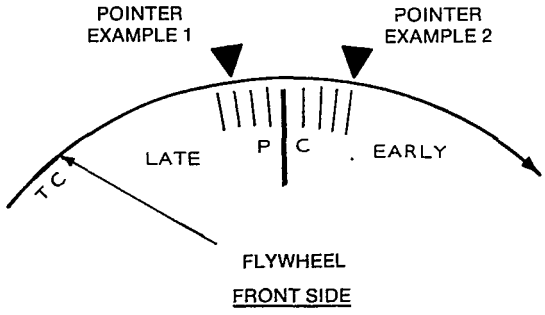


FIGURE 18. TIMING MARKS

   B. Measure distance in tenths of an inch (or mm) from PC mark on flywheel to point of actual port closing found in Step 7.

   C. Multiply distance measured times .003 inch (0.76 mm) to determine the difference in thickness required for new button.

One degree of crankshaft rotation equals the 0.1-inch graduation or .003-inch button thickness for timing.

Example 1. The port closing time is late by 0.3 inch (7.6 mm) measurement (3 × .003" = .009" [3 × .076 = .229 mm]).

Since 0.1 inch (2.54 mm) equals .003 inch (.076 mm) in button thickness, the installed button is too thin by .009 inch (0.229 mm). This means a button .009 inch (0.229 mm) thicker than the one installed is required to time port closing so that PC mark on flywheel aligns at the timing pointer when fuel flow stops.

Example 2. If PC timing is too *early* by 0.4-inch (10.2 mm), multiply 4 × .003 = .0 12 inch (4 × .076 mm ■ 0.305 mm). In this case, a button .012 inch (0.305 mm) thinner than the one installed is required.

   D. After determining which timing button is required, remove injection pump and install the correct button.

8. Install new injection pump with No. 1 injection line connected to injection nozzle.

9. On early model (Figure 14) injection pumps, remove capscrew and install valve spring and capscrew with gasket. Torque capscrew to 75 to 89 ft.-lb. (102-120 Nm).

10. On late model (Figure 13) injection pumps, remove delivery valve capnut and holder to install spring. Before installing delivery valve spring, push delivery valve back onto its seat using your little finger. Install spring and valve holder.

CAUTION ***If the spring is not seated properly the valve holder can be tightened only about one-fourth of the way down. When the spring is properly seated the valve holder can be tightened about three-fourths of the way down by hand. Make certain that the spring is seated properly in the valve holder and on the delivery valve before torquing.***

Torque valve holder to 70 to 75 ft.-lb. (95 to 102 Nm). Loosen valve holder and retorque to 65 to 70 ft.-lb. (88 to 95 Nm). Install and torque capnut with gasket to 50 to 55 ft.-lb. (70 to 75 Nm). Loosen capnut and retorque to 60 to 65 ft.-lb. (81 to 88 Nm).

INJECTION PUMP INSTALLATION

Be sure the steel shims between the pump and the cylinder block mounting are the same. These shims maintain proper gear backlash. The number stamped on the cylinder block injection pump mounting pad indicates the proper shim thickness. This thickness does not change when a new pump is installed. It changes only when a new cylinder block is installed.

The port closing (PC) mark is not stamped on replacement flywheels. Therefore, the PC mark must be established by measuring the piston drop with the cylinder head removed prior to injection pump timing. Since injection occurs at the port closing position, the PC mark can be located only by comparing the old flywheel with the new one, or by measuring the piston drop from its top enter position on the compression stroke of number one cylinder. Piston drop data is given in Table 2.

TABLE 2. PISTON DROP DATA

PISTON DROP		ENGINE	PORT CLOSING
Inches	mm		BTC
0.128	3.25	DJB, DJBA & DJC (Begin Spec P)	19 degrees
0.155	3.94	DJB, DJBA, DJC (Prior to Spec P)	21 degrees
0.128	3.25	DJE Spec A-AA	19 degrees
0.115	2.9	DJE Begin Spec AB	18 degrees

1. Turn engine in direction of rotation (clockwise when viewed from the front of engine) until number one cylinder is on a compression stroke and the PC mark on flywheel lines up with timing pointer on gearcase (Figure 16). Rotation clockwise also takes out all gear backlash in that direction.

   Look into injection pump mounting hole to verify that one intake lobe points outward and down 45 degrees.

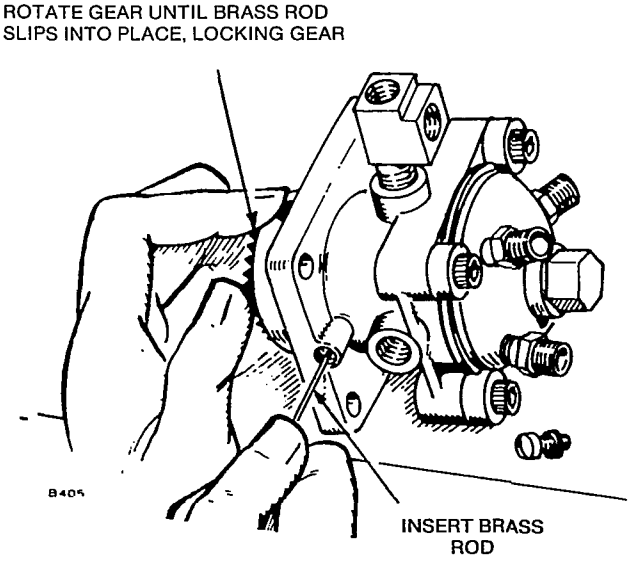


FIGURE 18a. LOCKING THE DRIVE GEAR

2. Remove screw (Figure 18a) on side of injection pump. Rotate drive gear until a 0.125 inch (3.175 mm) brass rod can be inserted into drive gear slot. This locks the gear in position when installing injection pump on engine.

3. With injection pump drive gear locked, place pump in mounting hole. Hold pump firmly against cylinder block. A slight spring pressure indicates that the pump and camshaft gears are meshed (Figure 18b).

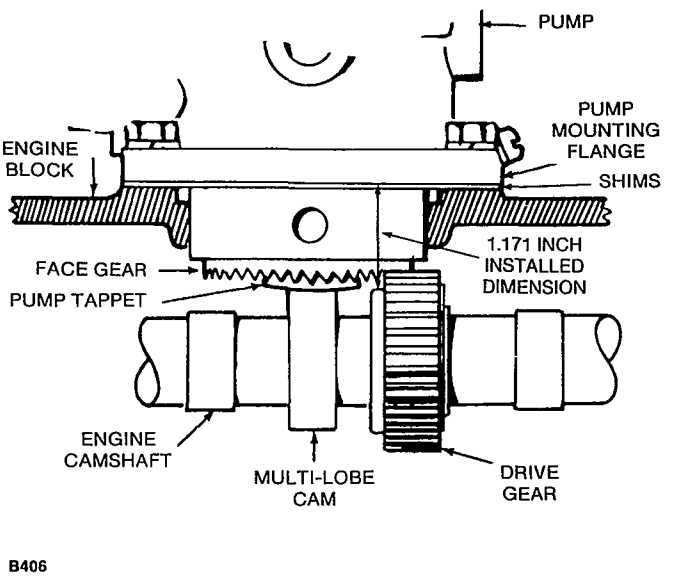


FIGURE 18b. PUMP INSTALLED

4. If gears mesh, secure pump using a flat washer, lock washer, and nut on each stud. Torque nuts evenly to 15 to 16 ft.-lb. (20 to 22 Nm).

5. Remove brass rod and install timing hole washer and screw.

NOZZLES

Onan diesel engines use hydraulically operated, pintle-type injection nozzles, Figure 19. They are factory adjusted to open at 1900 to 1950 psi (13,110 to 13,455 kPa). However, after several hundred hours of operation the nozzle pressure will decrease to about 1750 psi (12,075 kPa). Do not attempt to disassemble the nozzles or adjust nozzle pressure without the proper test equipment. A nozzle pressure tester is essential to do this work.

Refer to the throttling pintle type nozzle information at the end of this section for information regarding [illegible] engines using [illegible] Kiki fuel systems.

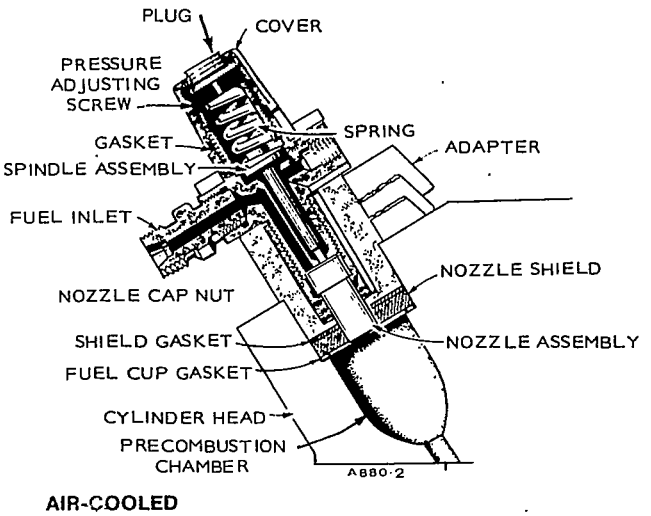


FIGURE 19. NOZZLE ASSEMBLY

Inspection: To inspect the nozzle spray pattern remove the nozzle from the cylinder head. Crank the engine, let the nozzle spray into the air and watch the pattern. The spray should be cone shaped with a solid appearing center surrounded by cloudlike fog in which the spray is evenly atomized. An apparent chattering of the nozzle is normal. See Figure 19a.

WARNING ***Fuel penetration of the skin might cause severe personal injury. Do not let the nozzle high-pressure fuel spray against skin surfaces.***

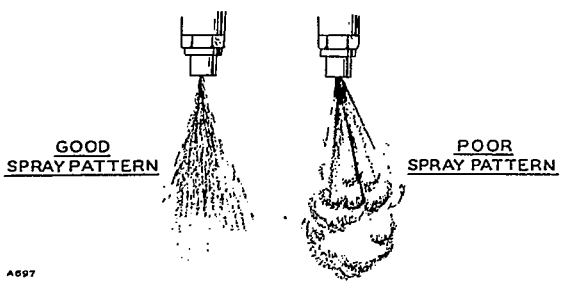


FIGURE 19a. NOZZLE SPRAY PATTERN

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.

Adjustment: To adjust the opening pressure, remove each nozzle from the engine and remove the cap nut over the adjusting screw of each. Install the nozzle to be tested on a static fuel nozzle testing fixture (may be purchased from Onan). Following the instructions on the tester, adjust the opening pressure to 1750 psi (12.075 kPa) by turning the adjusting screw. Clockwise increases the pressure and counterclockwise decreases it. Do not try to adjust the pressure without a testing fixture.

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

1. Remove each nozzle assembly from engine and remove fuel inlet and return lines.
2. Clamp nozzle holder body in a vise and remove nozzle cap nut and nozzle.
3. Install nozzle cap nut loosely to protect lapped surface for the holder body.
4. If necessary to further disassemble nozzle, reverse pressure adjusting screw and lift out 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 a supply of clean, lint-free wiping rags.

CAUTION ***Do not attempt to disassemble the nozzles or adjust nozzle pressure without the proper test equipment. A nozzle pressure tester is essential to do a satisfactory job.***

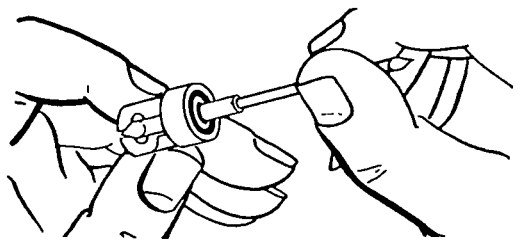
The cleaning procedure (Figure 19b) is extremely important. When disassembling injection equipment, always rinse in clean fuel before assembling.

Nozzle Tester: Testing and adjustment can be performed only with a nozzle tester. Do not attempt to disassemble the nozzles or adjust nozzle pressure without the proper test equipment.

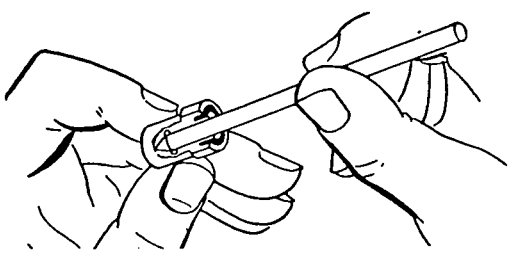
Opening pressure, leakage, and spray pattern can be checked using the tester. If any of the above conditions appear (except opening pressure), inspect the nozzle valve and seat with a magnifying glass for erosion, scoring, etc. If cleaning with solvent does not correct the condition, a new nozzle tip will be required. The opening pressure can then be set and spray pattern checked.

CAUTION ***Never use hard or sharp tools, emery paper, grinding powder, or abrasives of any kind on nozzles or they may be damaged.***

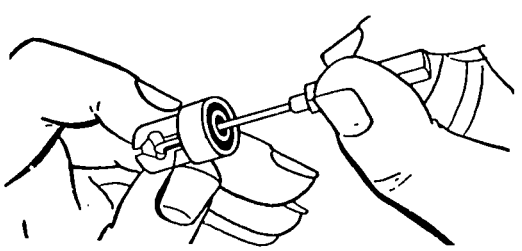
Soak each nozzle in fuel to loosen dirt. Then clean inside with a small strip of wood soaked in oil. Clean spray hole with a wood splinter. If necessary, clean the outer surfaces of the nozzle body with a brass brush but do not attempt to scrape carbon from the nozzle surfaces. This can severely damage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



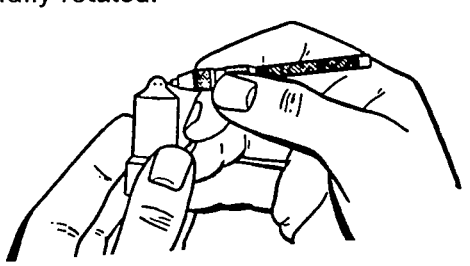
1. Use a brass type scraper tool to remove hard carbon depositis from nozzle body valve seat.



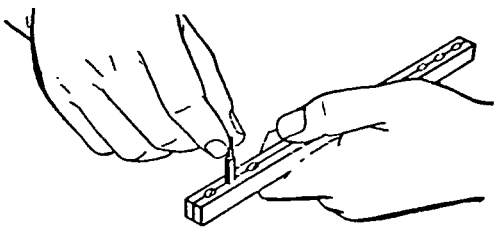
2. After scraping the carbon, polish the valve seat by using a round pointed stick dipped in tallow. Polishing should restore seat to its original finish unless it is scored.



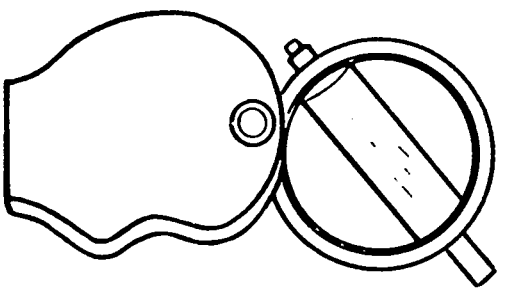
3. Use a special hooked type scraper to clean the nozzle pressure chamber gallery. The hooked end of scraper is inserted into the gallery and then carefully rotated.



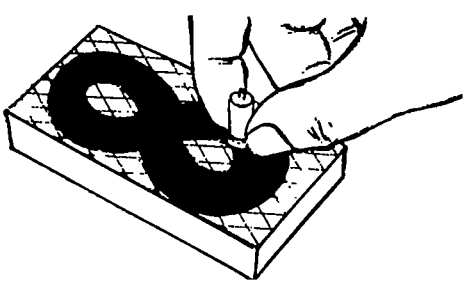
4. Small holes in tip of nozzle body can be cleaned with a fine wire slightly smaller than the size of the hole.



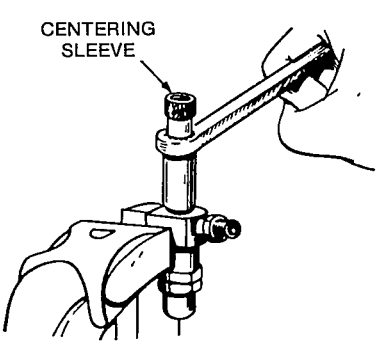
5. Clean nozzle valve and polish with tallow and a wooden polishing fixture. Take care to remove all traces of tallow when finished.



6. Examine nozzle valve and body with a magnifying glass. If erosion and scoring conditions are found, replace the valve and body.



7. Use a lapping plate and compound for flat lapping of nozzle parts which depend on a lapped surface for sealing. A figure "8" motion is used.



8. It is essential that the nozzle body be perfectly centered in the cap nut when reassembling nozzle. A centering sleeve, as shown, is used for this purpose.

FIGURE 19b. NOZZLE CLEANING

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

1. Remove all pressure on nozzle spring by adjusting pressure adjusting screw.
2. Clamp nozzle holder body in a vise.
3. Set valve in body and set nozzle over it.
4. Install nozzle cap nut loosely.
5. Place centering sleeve over nozzle (Figure 20) 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 50-55 foot pounds.

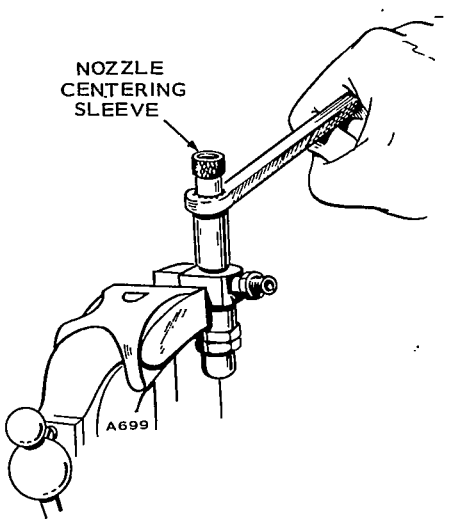


FIGURE 20. TIGHTEN NOZZLE

Installation: Before installing the injection nozzles in the engine, thoroughly clean each mounting recess.

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

1. Install a new heat shield to head gasket in cylinder head recess.
2. Install heat shield, a new nozzle gasket and nozzle adapter.
3. Insert nozzle assembly into recess. Do not strike tip against any hard surface.
4. Install nozzle flange and two cap screws. Tighten cap screws alternately to avoid cocking nozzle assembly. Tighten each to 20-21 foot-pounds (27-28 N•m).

PREHEATING CIRCUIT

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

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

FUEL SOLENOID

This solenoid is also referred to as a governor solenoid as it over-rides the governor, Figure 21. 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 operating arm to shut off fuel. The solenoid has two coils. Both are energized for pulling the plunger up. When the plunger reaches top, it opens a set of contacts, de-energizing the pull-in coil. The other coil holds the plunger up.

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

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

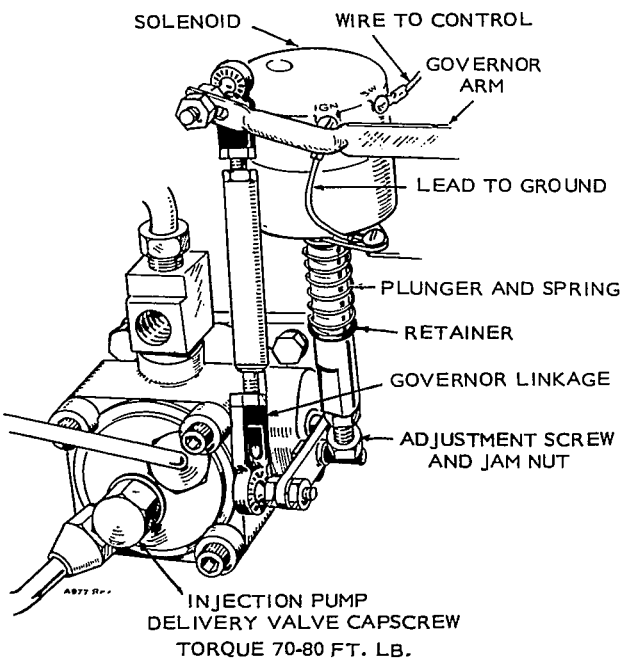


FIGURE 21. FUEL (GOVERNOR) SOLENOID

BRYCE/KIKI FUEL SYSTEM

The Bryce or Kiki fuel injection system (Figure 21a) is located near the center on the left side of the engine crankcase on DJE engines. The pump is mounted on an adapter casting. Two lobes of the cam shaft operate the pump plungers, one plunger and cam lobe for each cylinder. The fuel is pumped at high pressure by the plungers through the delivery valves to the injection nozzles.

Fuel control from idle to maximum speed and power is accomplished by rotating the helix on each pump plunger. Both pump plungers and barrel assemblies are rotated (0 to 180 degrees) by a fuel control arm, yoke, and a rack gear. Rotating the reciprocating plunger changes the effective length of the plunger strokes, and hence, the amount of fuel it delivers to the injection nozzle.

The fuel transfer pump and the primary and secondary fuel filters in this system are identical to those described for and used on the other DJ-series engines.

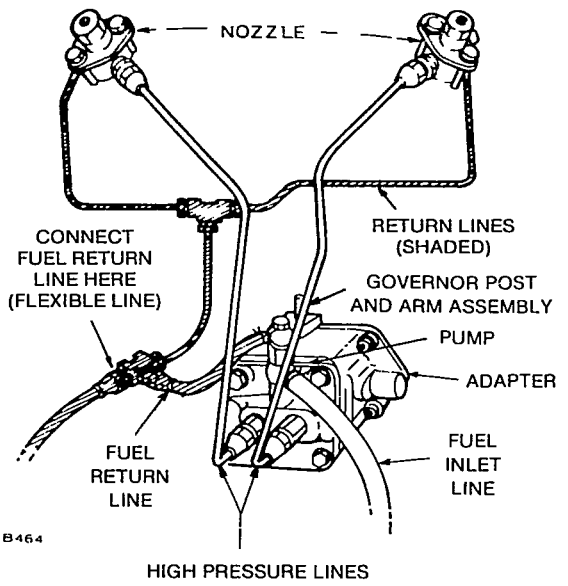


FIGURE 21a. FUEL LINES TO INJECTORS

Nozzles

The DJE fuel injection system uses either a Diesel Kiki or C.A.C. throttling-pintle type nozzle. The nozzle holders are either Yanmar or Diesel Kiki and have a plated nozzle retaining nut that distinguishes them from Bosch nozzle holders, which have a black oxide finish. The nozzle tips are interchangeable in Kiki and Yanmar holders, but internal components of these holders are not interchangeable. The opening pressure for new nozzles should be 2133 to 2204 psi (14,707-15,196 kPa).

High Pressure Injection Lines

Both high pressure fuel lines between the injection pump and the two nozzles are designed to be installed without any bending. Lines that fit on Bryce pump installtions also fit on Kiki pump installations, and vice versa. Whenever the lines must be removed, disconnect both ends. Do not bend the lines.

Bleeding Fuel System

After replacing or cleaning the filters, bleed the fuel system of air. Bleed air from fuel system as follows:

1. Disconnect fuel return line at the tee near the transfer pump. Use container to catch fuel.
2. Operate hand priming lever on diaphragm type fuel transfer pump until there are no air bubbles in fuel flowing from the fuel return line, Figure 21b.

   If fuel tank is disconnected, use a separate container of fuel and connect a short hose line between the transfer pump inlet and the fuel container. The pump has enough suction to pull the fuel out of the container.

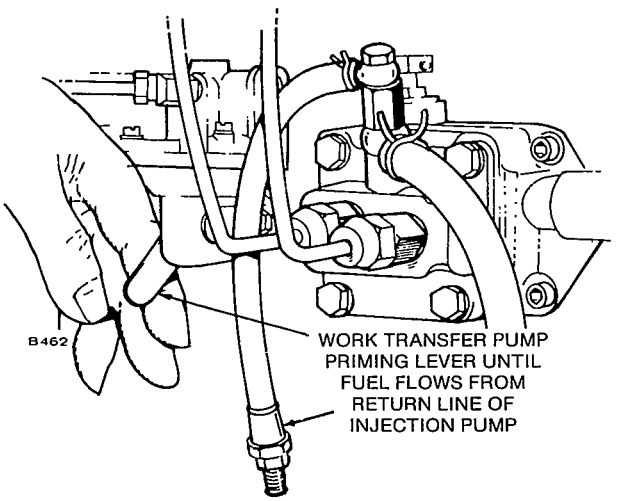


FIGURE 21b. BLEEDING FUEL SYSTEM

If the camshaft transfer pump lobe is up, crank engine one revolution to permit hand priming. When finished, return priming lever inward (disengaged position) to permit normal pump operation.

3. Connect the fuel return line at tee.

CAUTION ***A diesel engine cannot tolerate dirt in the fuel system. Dirt is one of the major causes of diesel engine failure. A tiny piece of dirt in the injection system may stop your unit. When opening any part of the fuel system beyond the secondary fuel filter, place all parts in a pan of clean diesel fuel as they are removed. Before installing new or used parts, flush them thoroughly with clean fuel and install while still wet.***

BRYCE/KIKI FUEL INJECTION PUMPS

The Bryce/Kiki Injection Pumps are similar in design, appearance, and performance, Figure 21c. Both units mount two plunger and barrel assemblies in a single housing and use a common rack (gear) to rotate the control sleeves and regulate the fuel output of both pumps. Although the pumps are interchangeable on the DJE engines, internal components of the Bryce and Kiki Pumps are not interchangeable. One external difference is that the Bryce Pump uses an alignment dowel pin to fit it on the adapter assembly.

The delivery valves on both pumps are also similar, but the Bryce has one copper sealing gasket while the Kiki uses a combintion sandwich type seal that requires a special delivery valve pulling tool to remove it.

Both pumps use roller type tappets as cam followers, which are held in place by pins and lock wire. Each pump has an air bleed fitting to vent air and permit easy priming.

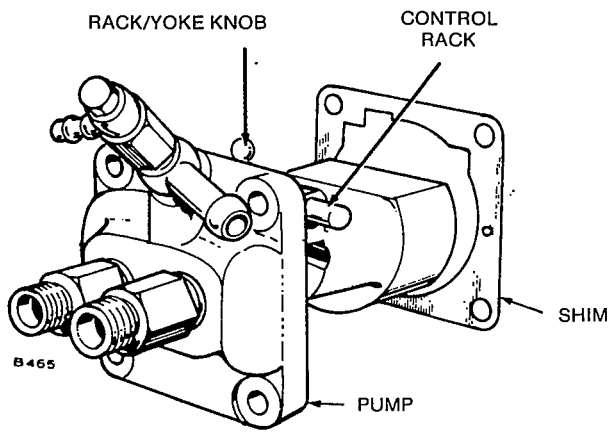


FIGURE 21c. INJECTION PUMP

Repair

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

Onan discourages field repair of the injection pump because of the exceptionally close tolerances between parts and because of the need for 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.

Removal

If the rest of the fuel system is in working order and fuel delivery abnormal, remove the pump for replacement or repair.

1. Locate injection pump on service side of engine, and remove necessary sheet metal and hardware to make pump accessible.
2. Remove fuel inlet and return line, Figure 21a.
3. Remove high pressure lines between pump and injector nozzles (both ends).
4. Cap all lines and fittings, using extreme care to keep all fuel system components clean.
5. Remove four socket head screws holding pump to adapter assembly.
6. Position fuel control shaft and yoke as shown in Figure 21e. Then, lift pump off of adapter assembly.
7. Carefully clean injection pump assembly and place it in a clean place. Retain shims between pump and adapter, as they are needed for reassembly.

INJECTION PUMP ADAPTER

The cast iron adapter (Figure 21d) is the crankcase mounting fixture for the fuel injection pump and its fuel control arm, yoke, and overfueling control device. A composition gasket is used between the adapter and the crankcase.

The fuel control arm and the shaft and yoke assembly transmit governor action to the injection pump control rack. The overfueling device provides maximum (excess) fuel during engine starting and limits the maximum amount of fuel and engine power output to protect the engine from excessive loading.

CAUTION ***Do not change the adjustment of this device unless absolutely required. The warranty may be voided if the fuel stop is intentionally altered to increase engine power above 10 percent overload at rated speed and load.***

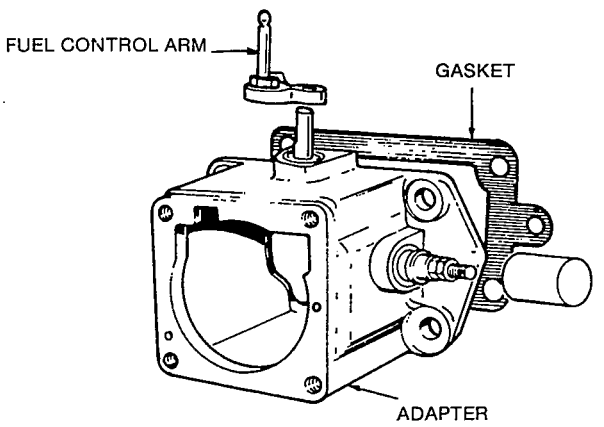


FIGURE 21d. ADAPTER ASSEMBLY

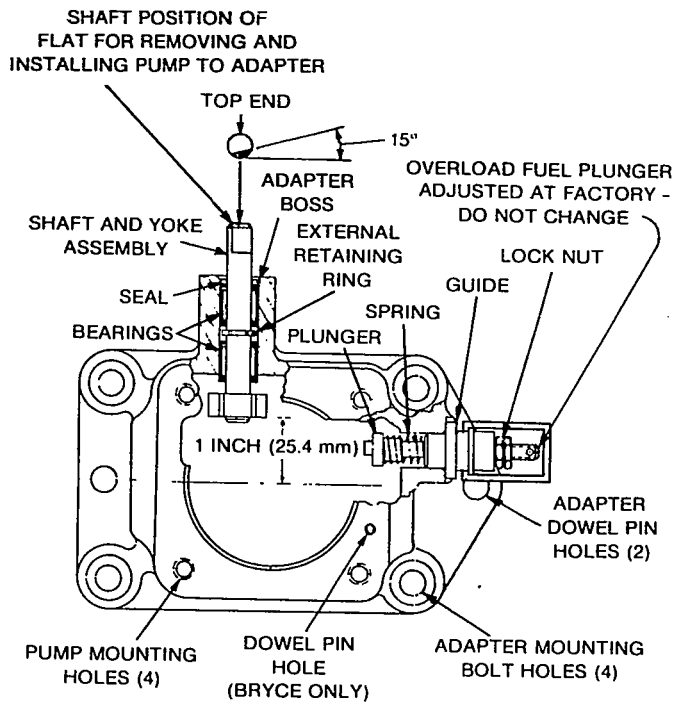


FIGURE 21e. INJECTION PUMP ADAPTER ASSEMBLY

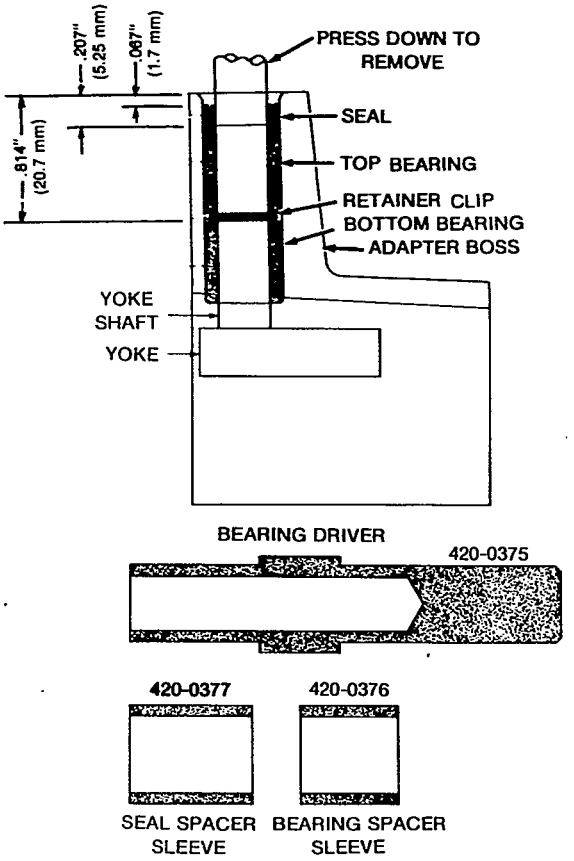


FIGURE 21f. BEARING INSTALLATION AND TOOL PACKAGE (420-0374)

CAUTION ***A diesel engine cannot tolerate dirt in the fuel system. Dirt is one of the major causes of diesel engine failure. A tiny piece of dirt in the injection system may stop your unit. When opening any part of the fuel system beyond the secondary fuel filter, place all parts in a pan of clean diesel fuel as they are removed. Before installing new or used parts, flush them thoroughly, and install while still wet.***

Removal

1. Remove fuel control arm.
2. Remove four mounting bolts and lift adapter, assembly off of engine block. It may be necessary to tap assembly with lead or plastic hammer in order to loosen adapter from gasket.
3. Discard old gasket and clean area on engine block. A new gasket is required for reassembly of adapter to prevent oil leaks.
4. Thoroughly clean adapter assembly before replacing new bearings and oil seal.
5. Place adapter assembly in suitable holder for removing and installing bearings and seal.

CAUTION ***Do not clamp in a vise unless machined surfaces are protected from damage by the jaws of the vise.***

Bearing and Seal Replacement Procedure

After adapter assembly has been removed from the engine, replace the bearings and seal on the yoke shaft as follows:

1. Referring to Figure 21f, press shaft and yoke assembly towards center of adapter until shaft and bottom bearing slips out bottom end.
2. Using solid end of bearing driver, press top bearing and seal out bottom end.
3. Remove external retaining ring and slide bearing off yoke shaft.
4. Thoroughly clean and oil yoke and shaft assembly and adapter for installing new bearings and seal.
5. Install bottom bearing from top of adapter casting, using hollow end of bearing driver. Make sure "lettered" side of bearing faces upward and that tool bottoms against top of adapter boss.
6. Slide yoke and shaft assembly up through bearing, then support yoke and shaft assembly for installing the retaining ring.

7. Using hollow end of bearing driver, press retaining ring on shaft, far enough so ring snaps into groove on shaft.
8. Slide bearing spacer sleeve (shortest sleeve) over hollow end of bearing driver; then use tool to press top bearing into adapter. Make sure tool bottoms against top of adapter boss and that "lettered" side of the bearing faces upward.
9. Replace bearing spacer sleeve with seal spacer sleeve (longest sleeve), and then use tool to press oil seal over shaft at top of adapter. Make sure seal is installed with "lettered" side down, facing the bearing, and that tool bottoms against top of adapter boss.
10. Reinstall adapter and injection pump assemblies.

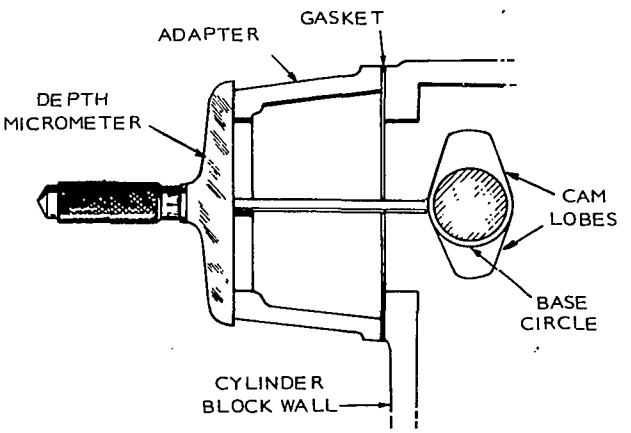


FIGURE 21g. MEASURING DEPTH FOR SHIM THICKNESS

Installation

Proceed as follows:

1. Place new gasket on engine block dowel pins and install adapter using four socket head screws and lock washers; torque screws to 20 to 24 ft.-lb. (27 to 33 Nm).
2. Determine shim thickness required between pump and adapter, because the new gasket may not be the same thickness as the original one. See Figure 21g.

   The proper shim thickness is stamped on the block for the shim combination required during the original factory installation of the injection pump.

3. To measure for shim thickness:

   A. Rotate crankshaft to position injection pump cam lobes on the camshaft in a vertical position so the base circle of each lobe faces the adapter opening.

   B. Using a depth micrometer, measure the distance from the mounting face of the adapter to the base circle of either cam lobe.

      The shim kit contains shims in the following thicknesses: 0.002, 0.003, 0.006, 0.010, 0.014, and 0.018 inches. If one shim is not enough, the required shim thickness (between 0.004 and 0.020) can be obtained within 0.001 inch by combining two of the above shims. The thickness in inches is stamped on each shim. For the greatest accuracy, measure the total shim thickness with a micrometer.

4. To calculate the shim thickness, determine the following:

   Standard installation depth of pump is .....3.2598* inches (82.8 mm)

   Distance from adapter flange to cam lobe base circle as measured (subtract from above) _____ inches (mm)

   Required shim thickness = _____

* Many earlier DJE engines spec AB have an installation dimension of 3.2540 inch (82.652 mm). On these units, a silkscreen print indicates this dimension. If so, 3.2540 should be substituted for 3.2598 in Step 4.

INJECTION PUMP INSTALLATION

Install injection pump on adapter assembly as follows:

1. Rotate crankshaft to position camshaft so that the pump rollers contact the camshaft base circle (low point of the pump cam lobes). One lobe should be up, the other lobe down. See Figure 21g.
2. Using proper shim thickness (Figure 21h), install pump to adapter with four socket head capscrews and lockwashers. Torque to 20 to 24 ft.-lb. (27 to 33 Nm).

   CAUTION ***Be sure the control rack ball fits between the yoke fingers for proper operation. If the rack ball is not properly placed in the yoke, engine operation will be uncontrollable and must be stopped immediately. In such as emergency, the engine can be stopped by blocking the air intake, or by loosening (just cracking) the fuel injector line fittings at the pump end.***

3. Connect flexible fuel inlet line to pump inlet.
4. Connect each high pressure fuel line to proper pump outlet and nozzle inlet. Torque nuts to 16 to 18 ft.-lb. (22 to 24 Nm).
5. Reinstall fuel control arm on yoke and shaft assembly, Figure 21h. Tighten socket head screw, but do not over tighten.

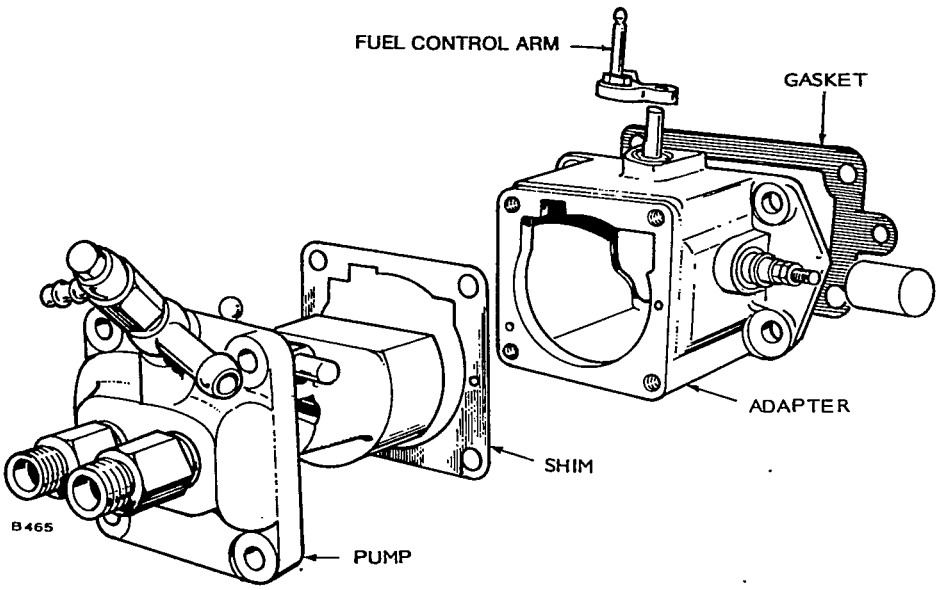


FIGURE 21h. PUMP AND ADAPTER ASSEMBLY

6. Adjust fuel solenoid plunger so that a 0.010 to 0.030 inch (0.25 to 0.76 mm) clearance exists (see Figure21k)between the plunger adjustment screw and the fuel control arm with the solenoid in de-energized position. To adjust the plunger length, hold the plunger and adjust the screw on the plunger lever pin at the fuel shutoff position. Retighten locknut.

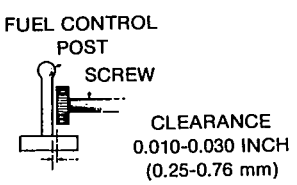


FIGURE 21k. FUEL SOLENOID ADJUSTMENT

Flow Timing - Troubleshooting Only

Flow timing is performed at either injection line to establish or confirm the port closing (PC) point of each fuel injection cycle. The PC point should be about the same for each cylinder, but an allowable difference between cylinders is 2.5 crankshaft degrees of rotation, measured on the flywheel rim. Approximately 0.1-inch (2.54 mm) is equivalent to 1 degree of rotation. At 1500 and 1800 rpm, PC should occur at 18° BTC±4° on DJE engines. If piston drop is measured to determine the PC point, the nominal value is 0.115 inch (2.9 mm); the allowable range is 0.171 to 0.070 inch (4.3 to 1.8 mm).

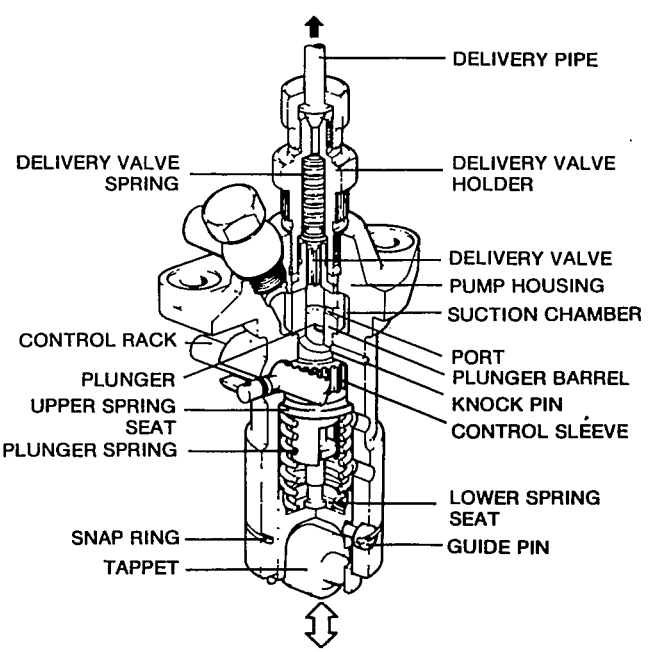


FIGURE 21m. SINGLE INJECTION PUMP ASSEMBLY

Flow Timing Procedure

To determine PC, proceed as follows:

1. Remove one high pressure line (both ends), and the corresponding delivery valve holder, spring, volume reducer, and delivery valve, Figure 21m. Leave gasket and seat in pump.

   Place the spring and volume reducer in a clean container of fuel until re-installed.

2. Re-install delivery valve holder (without spring and volume reducer).
3. Install high pressure line on delivery valve outlet so that drops of fuel can be easily counted and collected in a receptacle at the open end of the line.
4. Move the fuel control arm toward the front of the engine to full fuel range.

   The fuel solenoid must be energized or held (blocked) to keep the plunger out of the way.

5. Manually operate transfer pump lever to provide fuel pressure to injection pump.
6. Rotate flywheel clockwise very slowly by hand until fuel stops flowing from open line, even though transfer pump operation is continued.
7. Rotate flywheel counterclockwise until fuel flows freely; then, clockwise very slowly to position where fuel drops can be counted at one drop per second with the transfer pump operating.

   This is the PC point; it should be marked on the flywheel opposite the timing pointer.

8. After flow timing is completed, remove high pressure line and delivery valve holder; then, reinstall delivery valve, spring, and volume reducer.

   CAUTION ***Make sure all parts are clean.***

9. Reinstall delivery valve holder and torque Bryce holder to 29 to 33 ft.-lb. (39 to 44 Nm). Torque Kiki holder to 44 to 47 ft.-lb. (60-64 Nm). If fuel leakage occurs, replace the delivery valve gasket.
10. Reinstall high pressure line between pump and nozzle.
11. Using the same procedure, flow timing can be performed on the other cylinder to determine PC or the difference in degrees between cylinders; 2.5 degrees is allowable.

Engine Performance

Engine performance at 1500 and 1800 rpm varies within acceptable limits when PC occurs between 14° and 22° BTC. Generally, retarded timing results in lower smoke but higher fuel consumption; and the opposite is the case when timing is advanced.

Torque Instructions

The following torque instructions are for Bryce/Kiki Injection Systems on Onan DJE Engines, Figure 21n.

Bryce Pump Model FAOBRO70E0686
Kiki Pump Model NP-PFR2K70/1NP22
and 1NP23.

- Delivery Valve Retainer
  Bryce: 28.5 to 32 ft.-lb. (39 to 43 Nm)
  Kiki: 43.5 to 47 ft.-lb. (60 to 64 Nm)

When using a new delivery valve gasket on Kiki pumps, tighten the valve to full torque value and loosen twice; then, torque retainer a third time to seat the gasket finally.

- Fuel Inlet Stud (both) 15 to 18 ft.-lb. (20 to 24 Nm).
- Bleed Fitting Retainer (both) 35 to 52 lb. inch (47 to 70 Nm).
- All Adapter & Pump Mounting Screws 20 to 24 ft.-lb. (27 to 33 Nm).

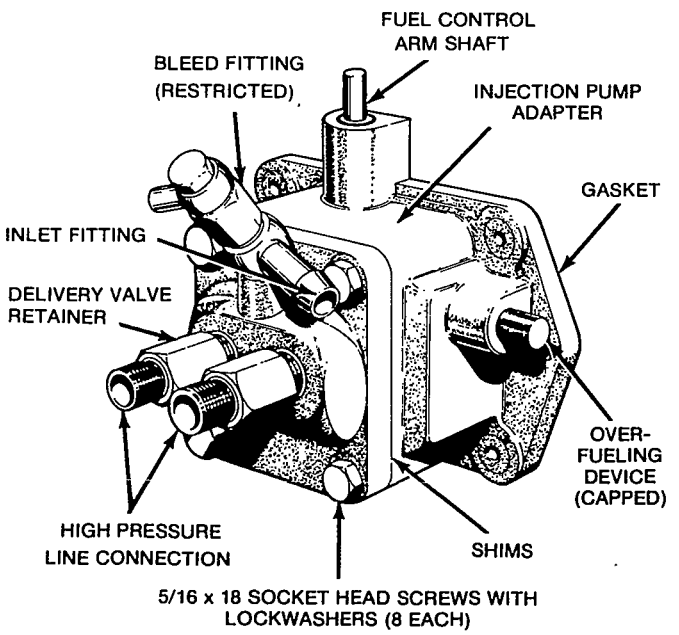


FIGURE 21n. BRYCE/KIKI PUMP AND ADAPTER ASSEMBLY

TROUBLESHOOTING PUMP PROBLEMS

Normally, little goes wrong with the injection pump after it is installed on the engine as long as timing is correct and clean fuel is used continually.

The most common problem is caused by a delivery valve that may be held open by dirt or metal chips that entered the pump or fuel system during assembly and installation. That is the reason protective covers must be used to keep foreign matter out of unassembled fuel system components.

If the pump is suspected of causing misfires or poor operation:

- Check the temperature of each nozzle holder and exhaust port; the coolest cylinder is the faulty one.

WARNING ***Fuel penetration of the skin might cause severe personal injury. Do not let the nozzle high-pressure fuel spray against skin surfaces.***

- Loosen (crack) the high pressure injection lines, one cylinder at a time (like disconnecting a spark plug wire), to determine the faulty cylinder; the cylinder that looses the least power is misfiring, or not firing.

Pump disassembly by unqualified personnel is not authorized and may void the pump warranty.

Return all faulty pumps to the Onan factory for repairs, or replacement if still under warranty. Otherwise, refer all Service problems to authorized Bryce/Lucas and Diesel Kiki service centers.

THROTTLING PINTLE NOZZLE TESTS

The following tests will determine nozzle conditions using a manually operated test stand. Each nozzle must be removed from the engine for testing. Prior to testing, each nozzle must be cleaned, decarboned, and inspected, as described for non- throttling pintle type nozzles earlier in this section. New or reconditioned nozzles must be thoroughly cleaned in cleaning solvent or test oil to remove all traces of preservative grease before testing.

The nozzle valve and nozzle body are lap-fitted together and must not be interchanged.

Visual Check

Using Illuminated Magnifier:

1. Inspect nozzle valve for damaged or rough seat.
2. Inspect pintle for wear, damage, or out-of-round spray hole.
3. Check nozzle body for damaged or carboned seat.

Slide Test

1. Dip clean nozzle valve in filtered diesel fuel or test oil.
2. Insert valve in nozzle body, Figure 22.
3. Holding body almost vertically, pull valve out to one-third of its engaged length; then release valve.
4. The released valve (because of its weight) should slide down to its seat.

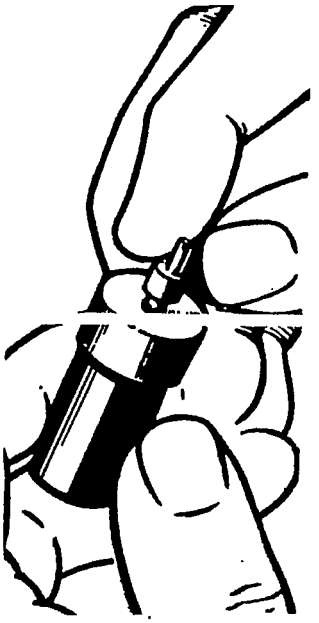


FIGURE 22. SLIDE TEST

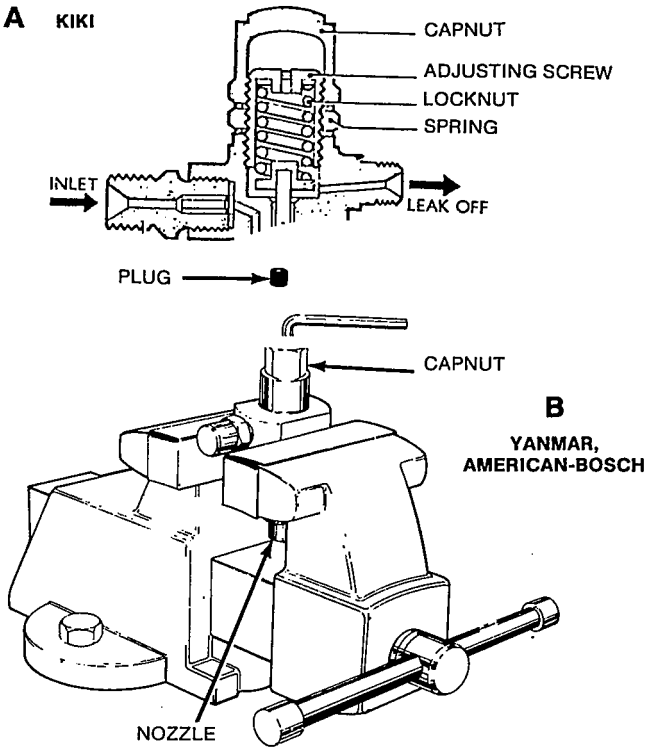


FIGURE 22a. NOZZLE ADJUSTMENT

Testing Nozzles with Hand Operated Tester

The proper tester can be used to check opening pressure, leak-down rate, chatter, and spray pattern. Install cleaned and inspected nozzle in tester and proceed as follows:

1. Place nozzle in holder.
2. Tighten nozzle nut finger tight, then using proper size wrench, tighten nut to 45 to 50 ft.-lb. (61 to 68 Nm).
3. Connect delivery line between nozzle holder and test stand; be sure that fittings match properly.
4. Test nozzle for jamming:
   A. Bypass pressure gauge.
   B. Press nozzle tester hand lever down quickly so that nozzle opens 6 to 8 times per second.
   C. Nozzle should chatter with a shrill whistling sound, if valve moves properly.

WARNING ***Fuel penetration of the skin might cause severe personal injury. Do not let the nozzle high-pressure fuel spray against skin surfaces.***

KIKI NOZZLE ADJUSTMENT

If the opening pressure is incorrect, connect nozzle to a tester and hold the nozzle in a suitable holder or smooth jaw vise.

1. Remove cap nut, Figure 22a.
2. Loosen locknut.
3. Turn adjusting screw to desired opening pressure.
4. Tighten locknut to 45 to 50 ft.-lb. (61 to 68 Nm).
5. Tighten cap nut to 45 to 50 ft.-lb. (61 to 68 Nm).
6. Remove nozzle from tester and holder.

YANMAR-AMERICAN BOSCH NOZZLE ADJUSTMENT

If the opening pressure is incorrect, connect nozzle to tester and hold nozzle in a suitable holder or smooth jaw vise.

1. Remove plug from cap nut, Figure 22a.
2. Loosen locknut.
3. Turn adjusting screw to desired opening pressure.
4. Tighten cap nut to 45 to 50 ft.-lb. (61 to 68 Nm).
5. Install plug using a thread sealant.
6. Remove nozzle from tester and holder.

OPENING PRESSURE

The correct opening pressure should be 2133-2204 psi (14718-15208 kPa) for new nozzles. It may be about 200 psi (1380 kPa) less after the nozzles have operated a few hundred hours. Open pressure gauge to obtain reading.

Leakage Test

1. Slowly depress hand lever until nozzle test gauge indicates 285 psi (1966 kPa) below specified opening pressure.
2. Consider nozzle leak-proof if no fuel (not even one drop) emerges from nozzle tip within 10 seconds.

Chatter Test

1. Operate hand lever downward (1 or 2 nozzle opening cycles per second) until nozzle ejects a stream of fuel with a soft chattering sound.
2. Take pressure readings from gauge..
3. Slightly increase hand lever movements (2 or 3 nozzle opening cycles per second), the stream velocity should increase and create a hissing sound.
4. Accelerate lever movements to 4 to 6 nozzle opening cycles per second. The nozzle should create a shrill whistling sound and a spray pattern.

SPRAY PATTERN

The spray pattern must be compact and well atomized at full lift to be correct. The pressures between nozzle opening and full lift causes the fuel to emerge in a stream, change to flag-like formations, and finally reach atomized spray pattern at full lift, with lever movements producing 4 to 6 nozzle opening cycles per second. See Figure 22b.

BLEEDING FUEL SYSTEM

Bleed fuel system whenever the filters are changed or when there is air in the lines.

Procedure:

Manually actuate fuel transfer pump until air bubbles are all out and clear fuel flows from the bleed valve automatically, Figure 22c.

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

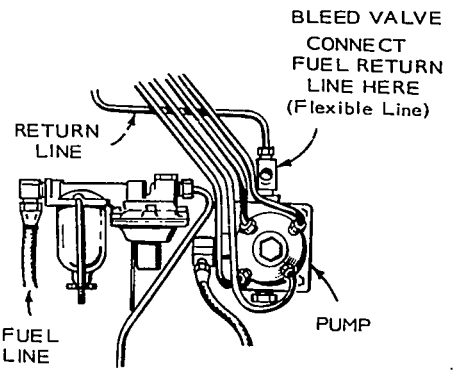


FIGURE 22c. BLEEDING FUEL SYSTEM

PREHEATING CIRCUIT

This 12 volt battery circuit consists partly of manifold heaters that raise the combustion air temperature at the intake manifold and a glow plug in each cylinder that heats the precombustion chamber for engine starting, Figure 22d. The manifold heater and glow plugs are wired in parallel and are controlled by a preheat switch on the control box.

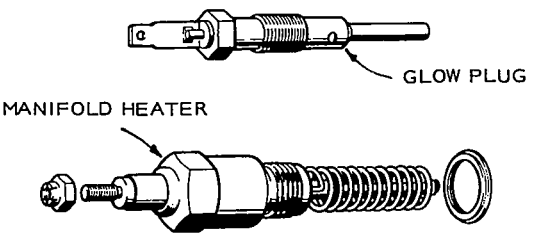


FIGURE 22d. GLOW PLUG AND MANIFOLD HEATER

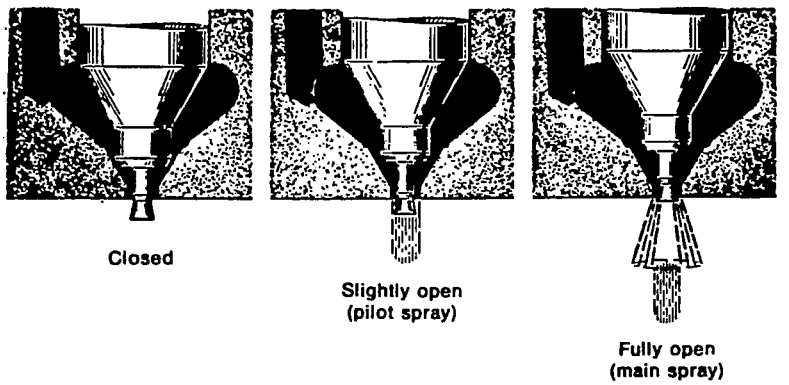


FIGURE 22b. NOZZLE SPRAY ACTION

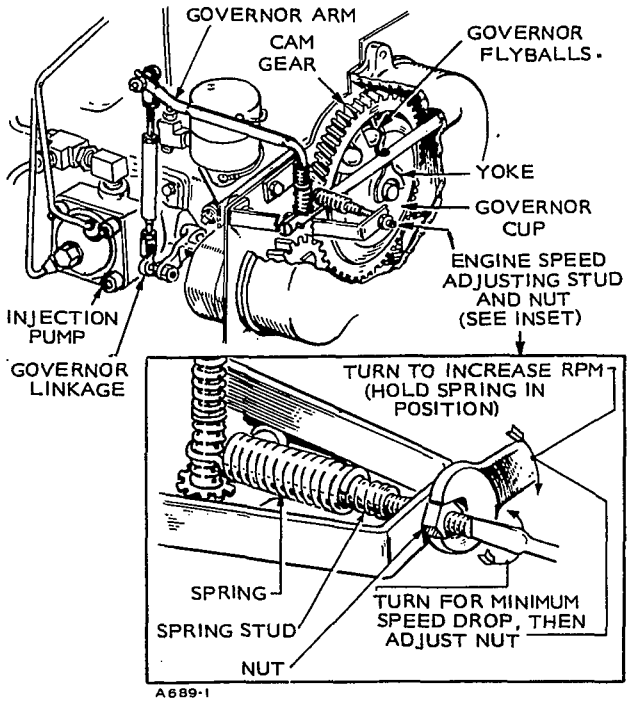
Governor System

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. Two types of governors are used and covered here: A constant-speed governor is standard; a two-speed governor is optional.

GOVERNORS

The constant-speed governor (Figure 23) maintains engine speed up to 2400-rpm. The speed-sensing device is a ball and cup mechanism on the camshaft gear. A yoke, resting on the cup, is connected to the governor arm which, in turn, is connected to the throttle lever. Any change in engine speed is transmitted from the cup to the yoke, and on to the throttle.

Tension on the governor spring determines the speed at which the engine is governed. A hub turns on the governor arm (accessible through the left hand side of the blower housing) to obtain the desired sensitivity—the speed drop from no load to full load.



EARLY MODELS ONLY

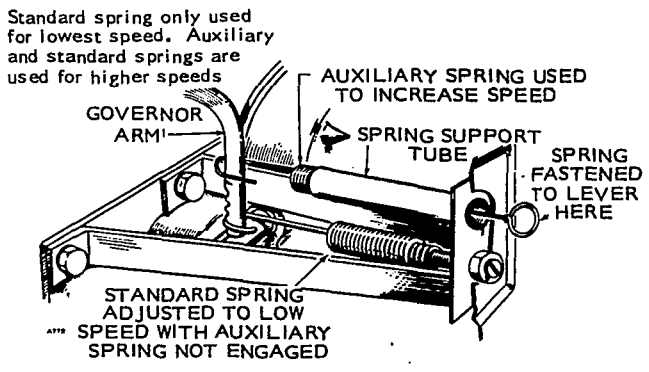


FIGURE 23. GOVERNOR ASSEMBLY AND ADJUSTMENTS

The two-speed Onan governor is 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. See Figure 23. The low-speed adjustments are the same as the constant-speed adjustments. High speed is solenoid controlled, two-speed systems can be adjusted by changing the length of the solenoid rod.

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

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

To test spring rates, use a spring-type scale. Compare the measured rates with those in Table 3.

TABLE 3. GOVERNOR SPRING DATA

Engine Model	Governor Type	Spring Number	Spring Rate	Coil No Load Length	Active Coils
DJBA DJE	Constant	150-0846	—	1-3/8 (34.9 mm)	13-3/4
DJB DJC	Constant	150-1084	69★	15/16 (23.8 mm)	8
DJBA DJB,DJC	†2 Speed	150-0921	21★ (28 N•m)	1-13/32 (35.719 mm)	21
DJBA DJB,DJC	*2 Speed	150-0922	16★ (22 N•m)	1-15/16 (49.213 mm)	28

* 1800 rpm † 2400 rpm ★ lbs./in.

ADJUSTMENTS BEGINNING SPEC R

Speed Adjustment: To change the governor speed, change the spring tension by turning the governor spring nut(Figure 23a).Turn the nut clockwise (more spring tension) to increase RPM and counterclockwise to reduce governed speed. Hold a tachometer against flywheel cap screw.

Sensitivity Adjustment: To adjust governor sensitivity (no load to full load speed droop) turn the sensitivity adjusting ratchet accessible through a covered access hole on the side of the blower housing. Counterclockwise gives more sensitivity (less speed drop when full load is applied), clockwise gives less sensitivity (more speed drop). If the governor is too sensitive, a rapid hunting condition occurs (alternate increasing and decreasing speed). Adjust for maximum sensitivity without hunting. After sensitivity adjustment, the speed will require readjustment. After adjusting the governor, replace the knockout plug in the blower housing and secure speed stud lock nut.

Excessive droop may be caused by engine misfiring. Correct this condition before adjusting governor.

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

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

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

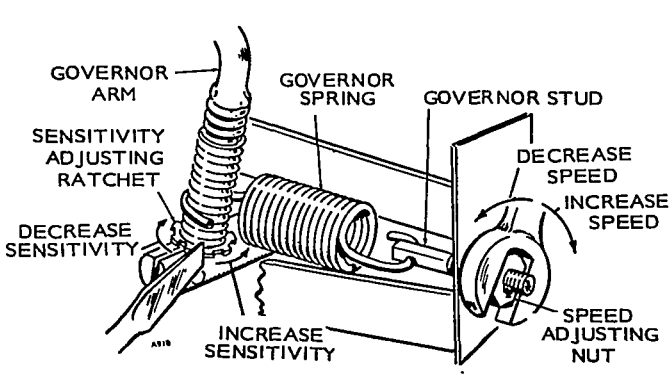
Sensitivity: There are coarse and fine adjustments for sensitivity. The coarse adjustment is made by relocating the spring in the notches in the governor arm. Moving the spring up on the governor arm will decrease sensitivity. The fine adjustment is made by changing the number of effective coils in the governor spring by turning the sensitivity stud farther in or out. Turn the stud counterclockwise to increase sensitivity. Adjust for maximum sensitivity without a hunting condition..

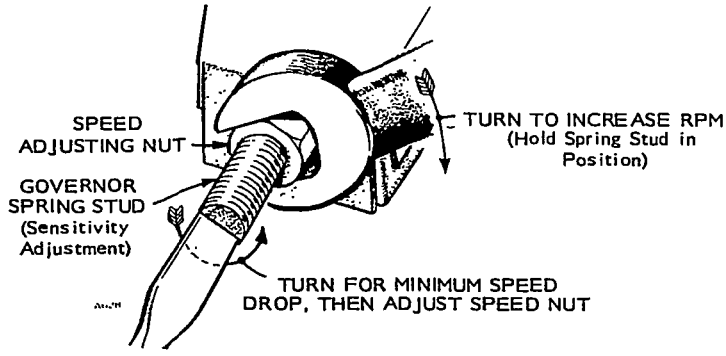
Governor High Speed Solenoid: This solenoid mounts on the blower housing. When energized, the plunger is in solenoid body. This exerts a greater than normal force on the governor arm auxiliary spring, holding the governor wide open for high speed operation. When de-energized, the solenoid spring forces 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 solenodi 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.

BEGIN SPEC R





EARLY MODELS ONLY

FIGURE 23a. VARIABLE SPEED GOVERNOR ADJUSTMENTS

Oil System

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

Figure 24 shows the pressure oil system. Because it aids oil consumption control, the crankcase breather is included in this system.

Normal oil pressure should be 25 psi (172.5 kPa) or higher when the engine is at operating temperature. If pressure drops below 20 psi (138 kPa) at governed speed, inspect the oil system for faulty components.

MAINTENANCE

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

OIL PUMP

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

Removal:

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

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

Installation: Before installing, fill the pump intake and outlet with oil to be sure it is primed. Mount the pump on the engine and adjust the 0.005-inch (0.127 mm) lash between the pump gear and crankshaft gear. Mount the intake cup on the pump so it is parallel to the bottom of the crankcase.

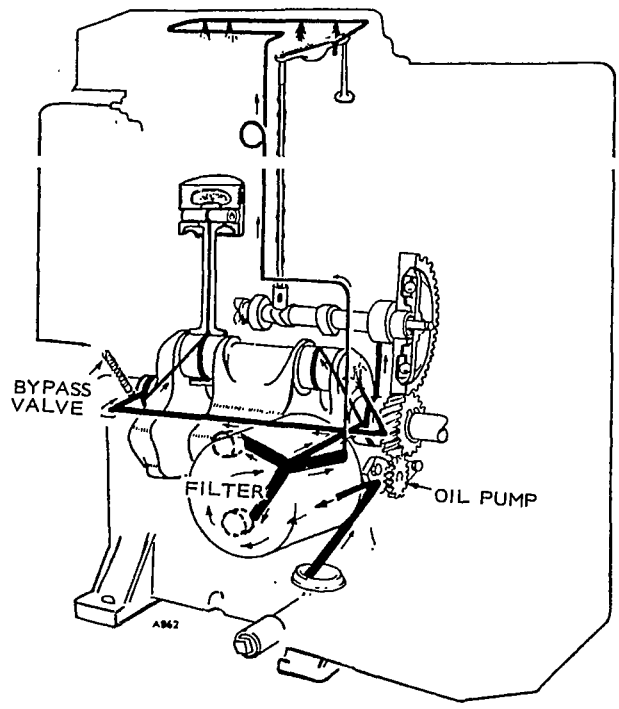


FIGURE 24. OIL PRESSURE SYSTEM

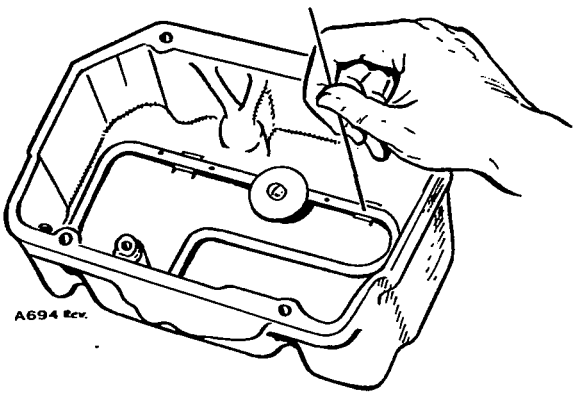
BYPASS VALVE

Located on the outside of the rear bearing plate, the bypass valve (Figure 25) controls oil pressure by allowing excess oil to flow directly back to the crankcase. Normally the valve begins to open at about 25 psi (172.5 kPa). It is non-adjustable, and normally needs no maintenance.

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

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

Plunger Diameter	0.3365 inch to 0.3380 inch (8.547 to 8.585 mm)
Spring -	
Free Length	2-5/16 inches, + 1/16 inch (74.613, + 1.588 mm)
	2.225 lb. 0.11 lb. at 1-3/16 inches (compressed) (1.01 kg) (0.05 kg) at (30.163 mm) (compressed)



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

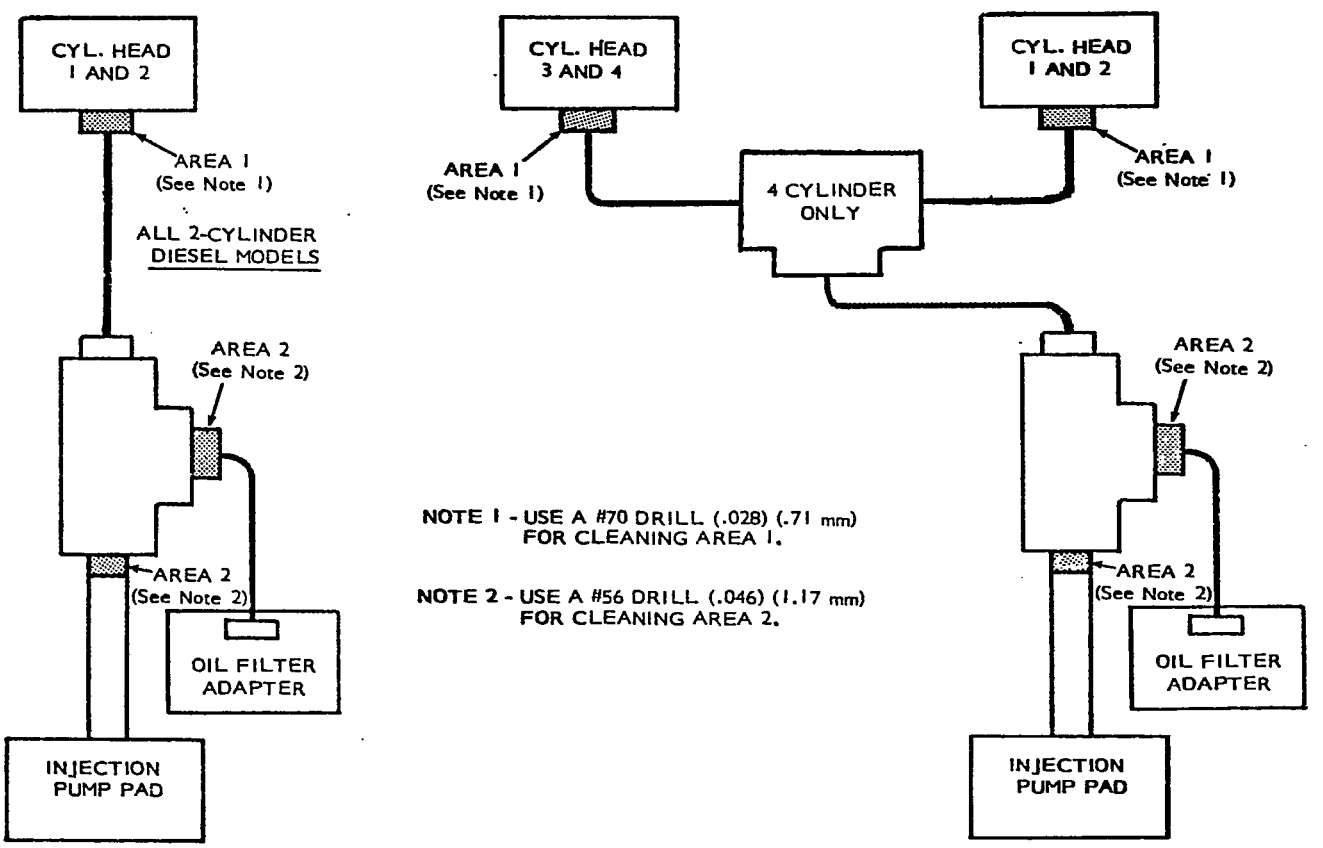


FIGURE 26. CLEANING ROCKER BOX OIL LINE AND RESTRICTION ORIFICES

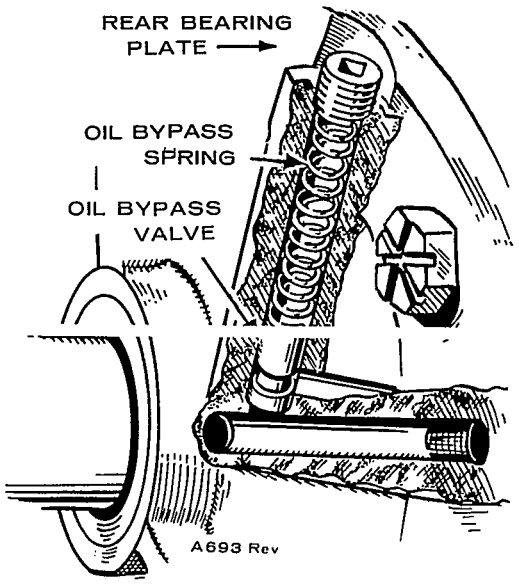


FIGURE 25. BYPASS VALVE

OIL LINES

At overhaul time the rocker box oil line should be flushed with fuel, and a fine wire used to clean the small holes (Figure 26). Clean standpipe breather on four cylinder engines.

Clean out all other oil lines and drillings with compressed air whenever the engine is disassembled or overhauled. Reach the oil gauge passage by removing the oil filter mounting plate.

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

CAUTION ***The external lube oil line has restriction orifices at the injection pump inlet tee of 0.028 inch (71 mm) and in the inlet fittings at the heads of 0.0465 inch (1.17 mm). These orifices must be kept open or the lack of lubricating oil will damage the injection pump and the rocker box components.***

GAUGE

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

OIL COOLER (DJC Only)

The oil cooler is mounted in the upper right hand corner of the blower housing facing the engine. Oil flow is controlled by a thermostat located in the oil filter adapter casting. When the oil is cold, it goes through a passage directly to the full flow filter. As the oil heats up, the thermostat starts to open at 140° F to 145° F (60° to 62° C) and is fully open at 165° F (72° C). When the thermostat opens, this shuts off the passage to the filter, and oil is then diverted through the oil cooler before entering the filter.

Clean out all other oil lines and drillings with compressed air whenever the engine is disassembled or overhauled. Reach the oil gauge passage by removing the oil filter mounting plate.

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

LOW OIL PRESSURE CIRCUIT

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

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

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

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

The system for engines with factory-mounted controls uses a normally-open low-oil-pressure switch. A special start switch mounted on the rear cylinder air housing jumpers the cut-off switch during starting to allow the engine to build up oil pressure and close the switch. The switch closes at 13 to 15 psi (90 to 102 kPa) under increasing pressure. If oil pressure fails below 13 psi (90 kPa) the switch opens, de-energizing the fuel solenoid, stopping the engine.

The system for engines with fabricator-mounted controls uses a normally-closed low-oil-pressure switch. During starts, a relay provides a time delay to allow the engine to build up oil pressure and open the switch. If the oil pressure falls below 13 psi (90 kPa), the switch closes, energizing the emergency relay.

Emergency Relay (Time Delay): For engines with optional low oil pressure cut-off, this relay is supplied loose and mounted by customer. The relay, used in conjunction with a one ohm, 10 watt resistor, provides a 15- to 30-seconds time delay when starting, so the engine can build up sufficient oil pressure to open the low oil pressure cut-off switch. When oil pressure drops below 13 psi (90 kPa), the relay stops the engine and prevents it from restarting until the *Reset* button is pushed.

Centrifugal Switch: The start-disconnect switch, assembly (Figure 27), mounted on the gear cover backplate, operates centrifugally off the camshaft gearing. This normally open switch closes when the engine speed reaches 900 rpm to de-energize the starter motor.

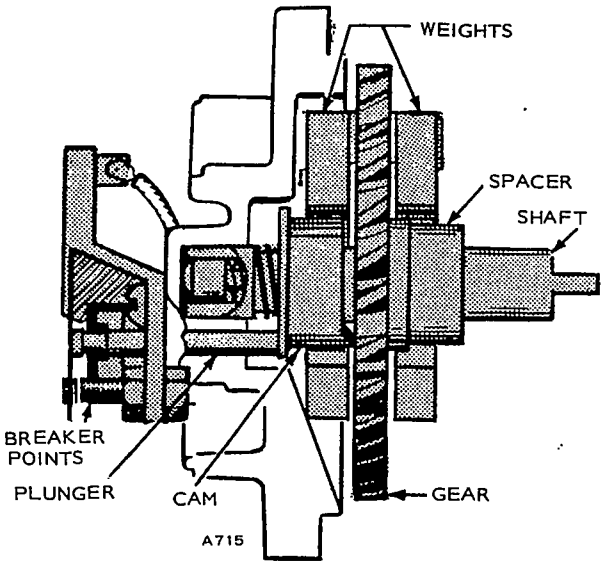


FIGURE 27. CENTRIFUGAL SWITCH ASSEMBLY

For correct operation, maintain the switch gap at 0.020 inch (0.51 mm). See Figure 28.

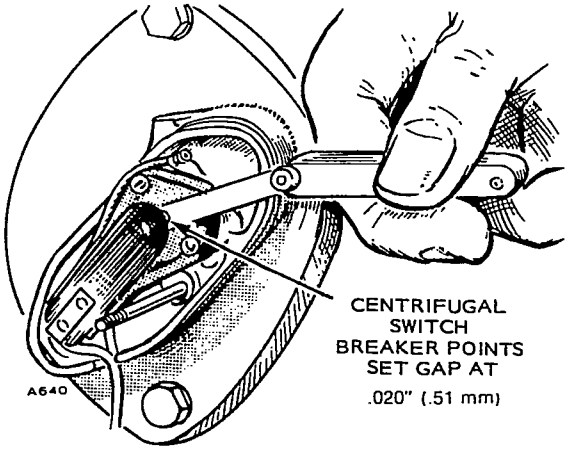


FIGURE 28. BREAKER POINTS

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

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

REPAIR

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

Check for wear in the spacer, fibre plunger and the spring-loaded shaft plunger. The spacer must be at least 0.35-inch (8.89 mm) long. If not, replace it immediately. Push the weights outward; they should move freely. If they do not or if any part of the assembly is sticking or worn, replace the cam and weight assembly. If the cam is loose on the gear shaft, replace the assembly.

If the breaker gap cannot be maintained at 0.020 inch (0.051 mm), check the fibre plunger and spacer for wear.

ASSEMBLY

1. Install spacer on shaft and install shaft assembly into gear case. Match it with cam gear.
2. Install spring and plunger into end of shaft.
3. Install breaker plate.
4. Install plunger and diaphragm.
5. Install breaker points on breaker plate and set gap at 0.020 inch.
6. Install the switch cover and reconnect the battery.

DJBA AND DJC BREATHER SYSTEM

The DJBA (Begin Spec V) and DJC (Begin Spec T) are equipped with a crankcase breather standpipe that vents crankcase fumes directly from the rocker box cover to the cylinder head intake port. The crankcase breather pipe must be cleaned after every 500 hours of engine operation.

A clogged breather pipe may result in oil leakage at the rocker box gaskets and oil filter seal. See Figure 29.

CAUTION ***Do not remove breather standpipe. Clean only. Use a small wire or pipe cleaner.***

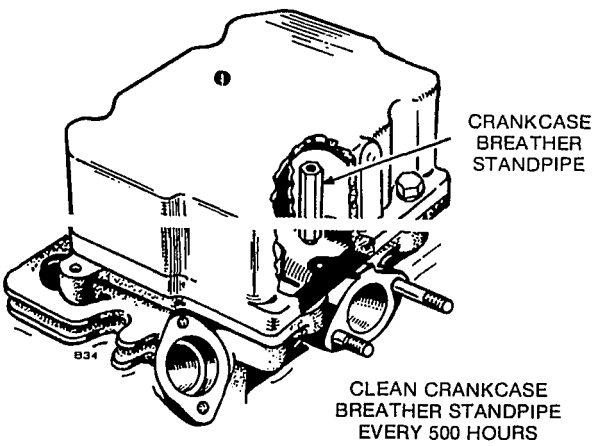


FIGURE 29. BREATHER SYSTEM

DJB CRANKCASE BREATHER (Spec S)

The DJB is equipped with a ball check valve for maintaining crankcase vacuum. The only maintenance required is to clean the components periodically. Remove the hose clamp, breather hose and breather cap clamp to release the breather cap and valve assembly. Wash the cap, valve assembly and filter in a suitable solvent and reinstall. See Figure 30.

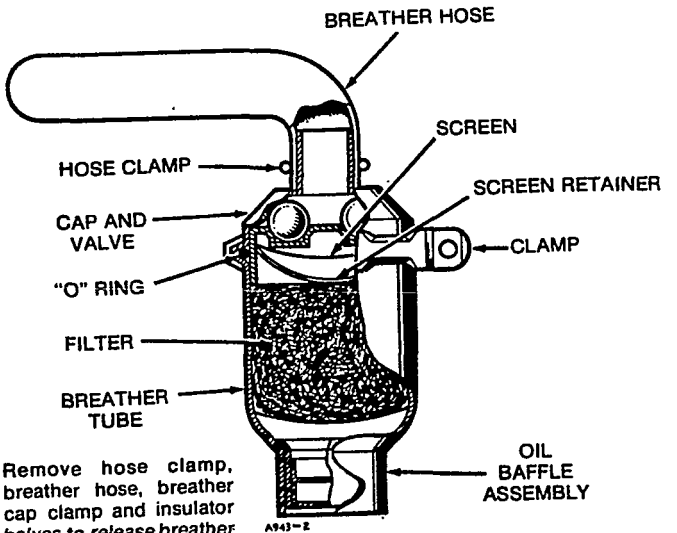


FIGURE 30. CRANKCASE BREATHER

PULSATION DAMPER

The early DJC models up to Spec S are equipped with a pulsation damper that serves two major functions. It dampens pulsations which occur in the intake manifold and contribute to oil carry-over. The pulsation damper also acts as an oil separator to condense oil vapor and small oil droplets preventing them from getting into the intake manifold and combustion chamber. When this occurs it causes excessive coke deposits in the valve ports. See Figure 31.

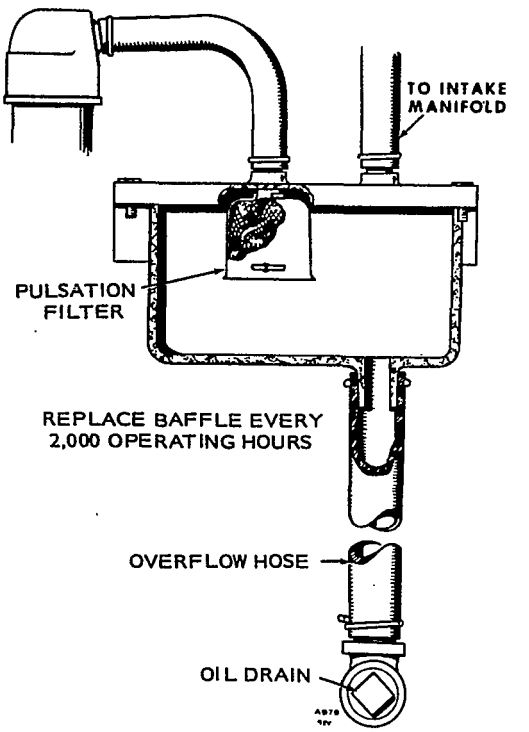


FIGURE 31. PULSATION DAMPER

OIL DRAIN EXTENSION

For service convenience, install a short (less than 10 inches [254 mm]) oil drain extension made from standard pipe and fittings in the 1/2-inch (12.70 mm) pipe-tapped oil drain hole in the base.

Starting System

These models use a separate 12 volt starting motor mounted on the right hand side of the engine to drive the flywheel. It is a standard automotive starting motor with a solenoid for engaging the pinion and an over-running clutch. When the solenoid is energized, its core pulls in, shifting the pinion into engagement with the flywheel ring gear. At the same time, contacts in the solenoid close to provide a circuit for the starter motor. The starting motor remains engaged until the starting switch is released by operation.

If engine is equipped with a start-disconnect switch, the starter motor will automatically disengage flywheel gear when engine speed reaches about 900 rpm.

The starter is protected from over-speed by an over-running clutch which permits the engine to run faster than the starter before the pinion is disengaged. Figure 32 shows the starting circuit.

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

MAINTENANCE

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

TESTING

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

Check the charge condition of the battery with a hydrometer.

Specific gravity should be between 1.260 and 1.225 when 75 percent charged. If not, recharge the battery. Check electrolyte level. If battery will not recharge, replace it. Keep battery connections tight and clean.

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

If starting motor tests are required, remove the motor from the engine and test it on a bench. Test the free-running voltage and current.

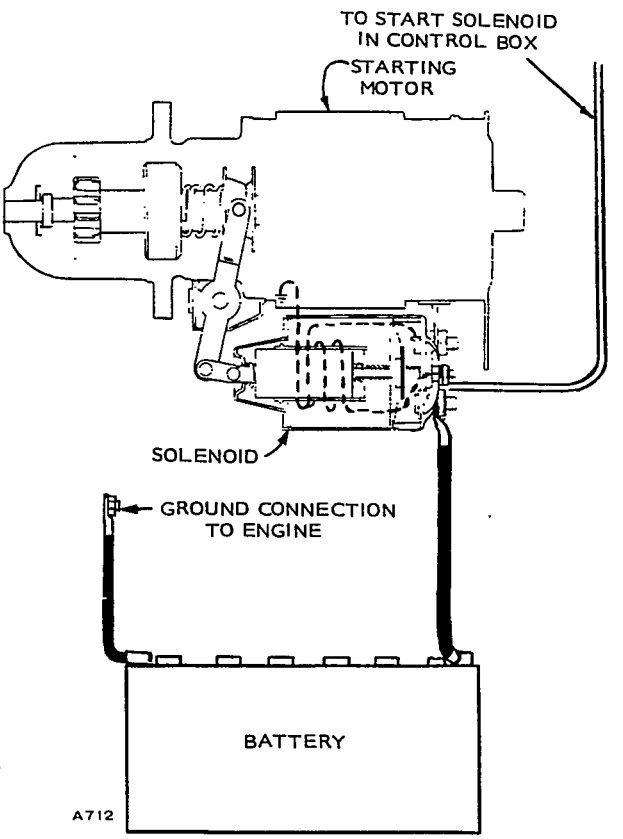


FIGURE 32. STARTING SYSTEM

Using a spring scale and torque arm, test the stall torque (Figure 33). Multiply the spring scale reading by the arm length for the torque value.

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

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

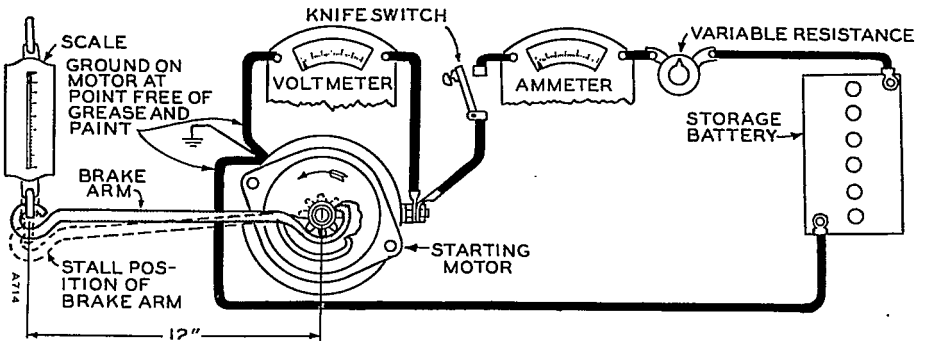


FIGURE 33. TESTING STALL TORQUE

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

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

BATTERY

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

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

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

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

REPAIR

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

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

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

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

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

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

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

Replace Prestolite brushes when excessively worn, or when worn to 5/8 inch in length. Replace Mitsubishi, brushes when excessively worn or when worn to 7/16 inch in length. Some brushes are soldered to the field coil. To remove these brushes, unsolder the lead and open the loop in the field coil lead. Insert the new brush pigtail completely into the loop and clinch before resoldering. A good soldering job is necessary to ensure good contact and low voltage drop across the connection.

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

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

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

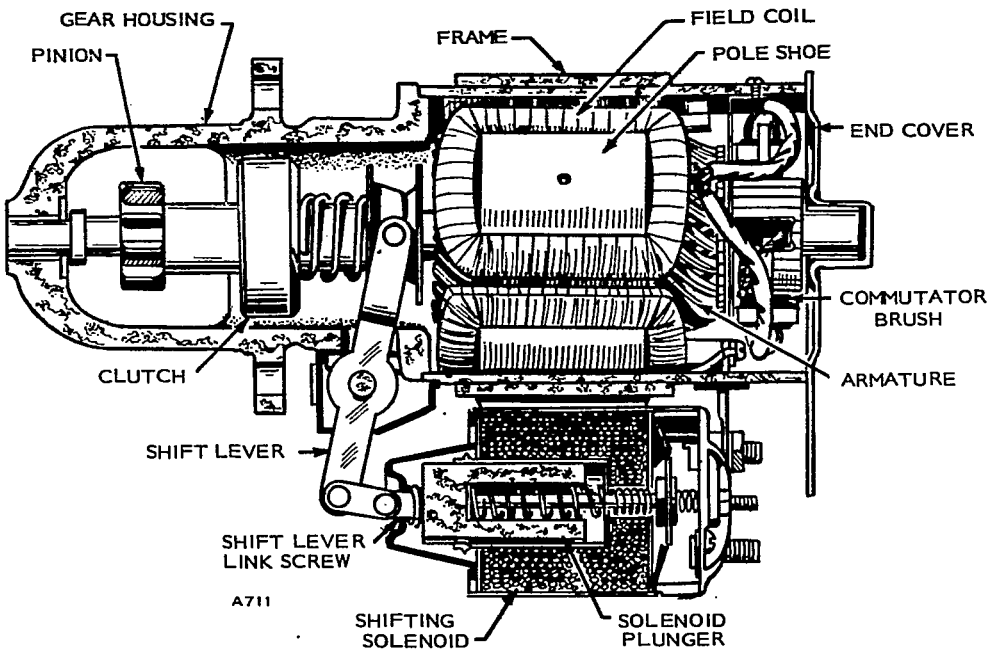


FIGURE 34. STARTING MOTOR

PRESTOLITE STARTER REMOVAL AND DISASSEMBLY

1. Remove connections to controls and battery at shifting solenoid. See Figure 34.
2. Remove nut holding rear mounting bracket to engine.
3. Remove blower housing.
4. Remove flywheel (early models).
5. Remove three cap screws holding starting motor flange to engine and pull out motor.
6. Remove link pin holding the shift lever to solenoid plunger and remove shift lever center pin.
7. Remove through bolts from commutator end of motor. Pull off end cover and lift brushes off their seats.
8. Pull pinion housing from front end of motor and lift armature and clutch out of motor frame.
9. To remove over-running clutch from armature, drive retainer away from lock ring near front end of shaft, remove lock ring and pull assembly off. Do not attempt to disassemble clutch assembly.
10. If necessary to service solenoid, remove four cap screws and electrical connection holding it to motor frame. Remove two screws on rear of solenoid to reach switch contacts.
11. If necessary to remove starting motor flange (Figure 35), watch for shims between flange and crankcase surface. Save any shims, as they must be reinstalled to position the starter correctly.
12. Connect battery cables to battery. Connect ground cable last.

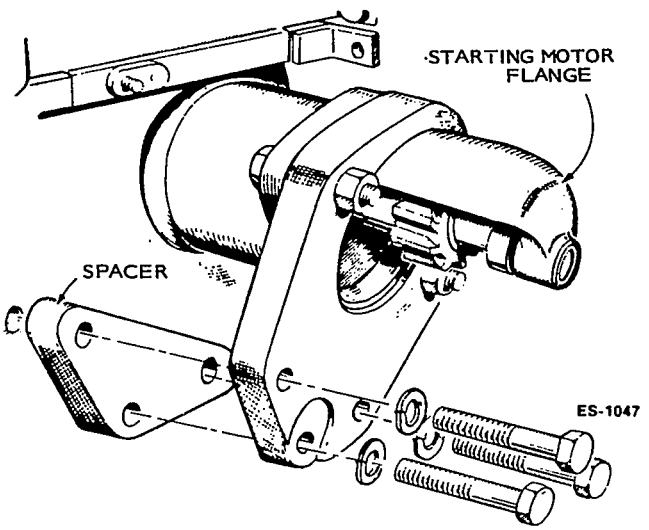


FIGURE 35. STARTING MOTOR FLANGE

PRESTOLITE STARTER ASSEMBLY

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

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

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

IMPORTANT: On units built prior to serial number 679677, it was necessary to maintain the gap between ring gear and starter pinion in the retracted position at less than 1/8 inch (3.18 mm) to ensure starter engagement. When installing these motors, check this gap. If it is too great, a shim kit is available to reduce it.

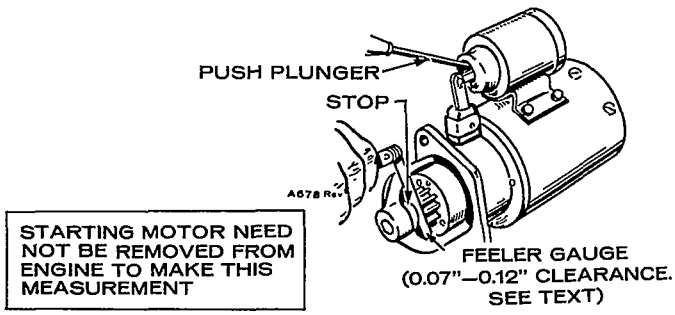


FIGURE 36. PINION CLEARANCE

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 36a).

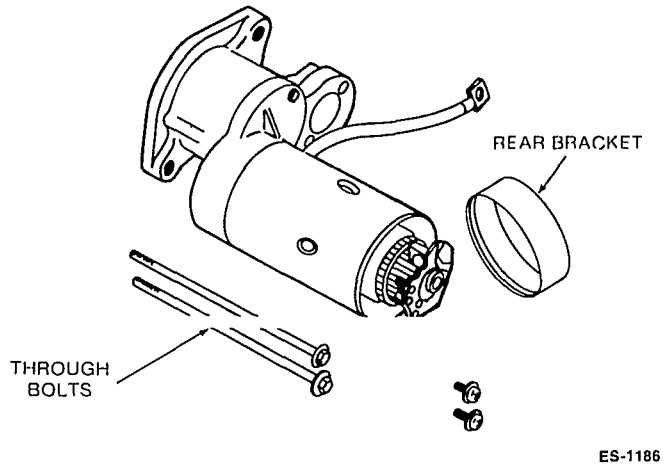


FIGURE 36a. REMOVING REAR BRACKET

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 36b).

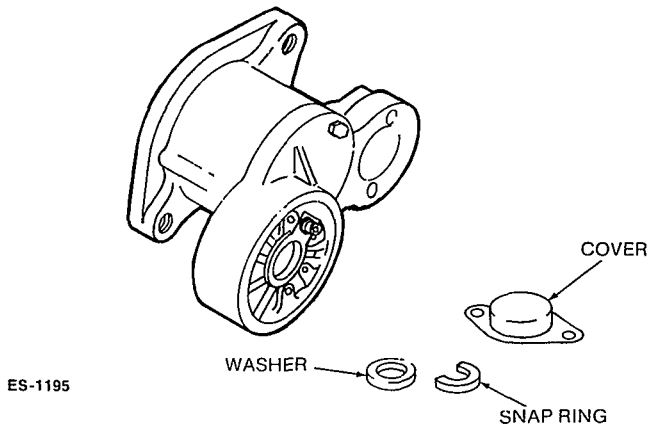


FIGURE 36b. REMOVING SNAP RING AND WASHER

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 36c).

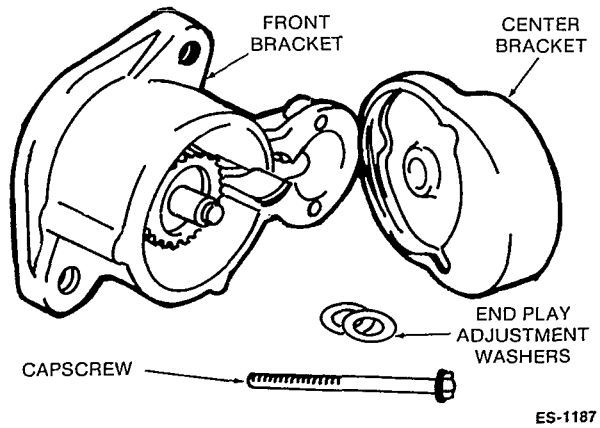


FIGURE 36c. REMOVING CENTER BRACKET

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.

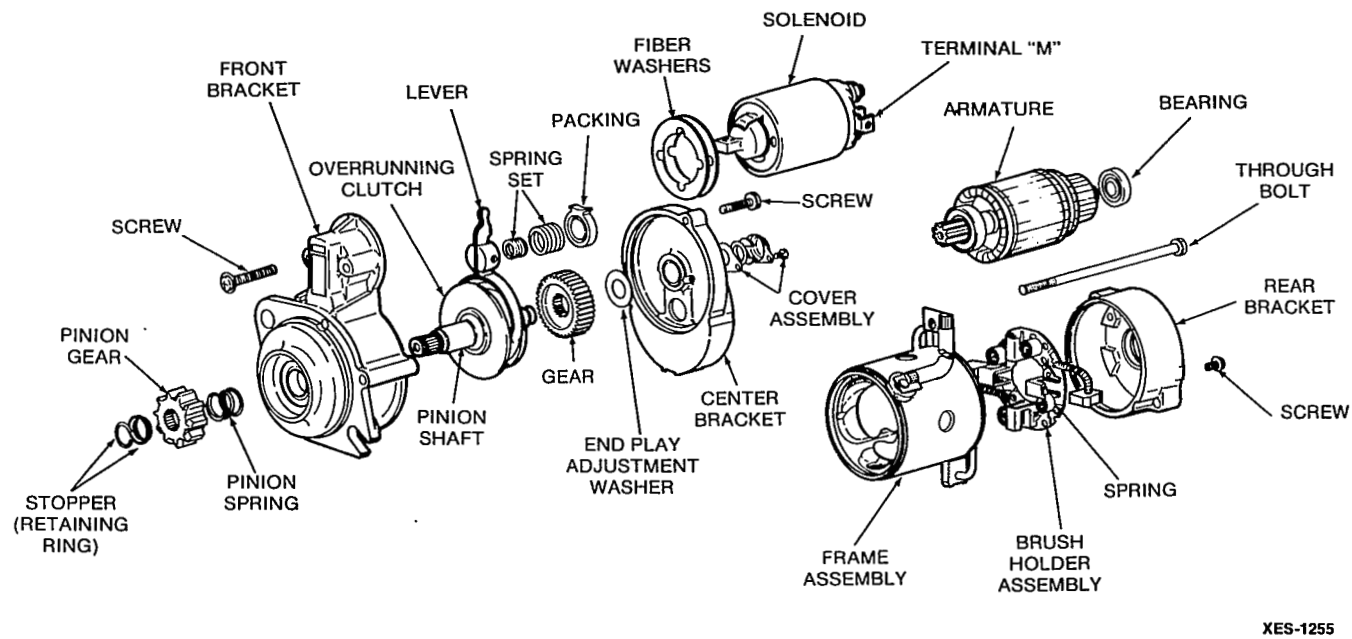


FIGURE 36d. MITSUBISHI STARTER

MITSUBISHI STARTER ASSEMBLY

For assembly reverse the disassembly procedure, but note the following items. See Figure 36d.

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 36e).

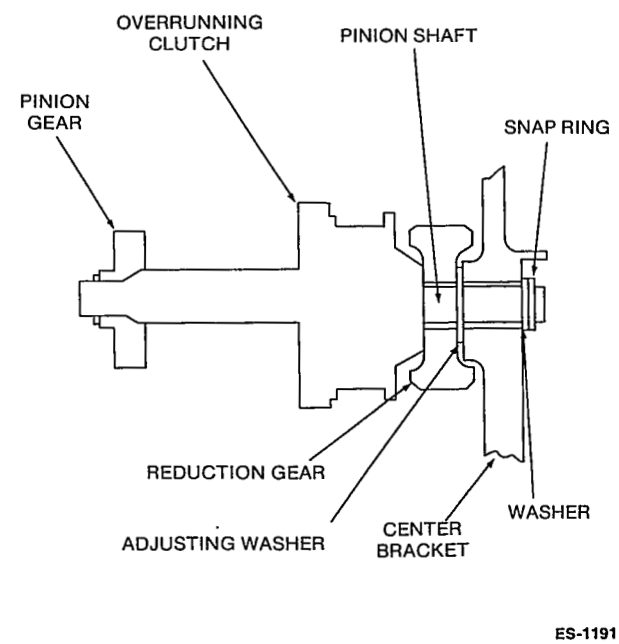


FIGURE 36e. ADJUSTING PINION SHAFT END PLAY

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 36f).

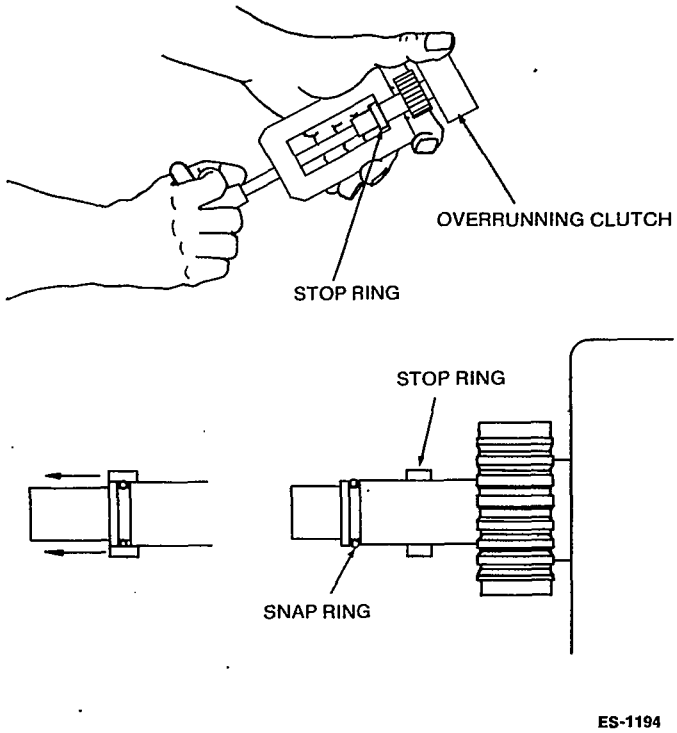


FIGURE 36f. PINION GEAR INSTALLATION

Lever Assembly Installation

Figure 36g shows the correct method of installing the lever assembly, spring, and packing. Pay close attention to direction of lever.

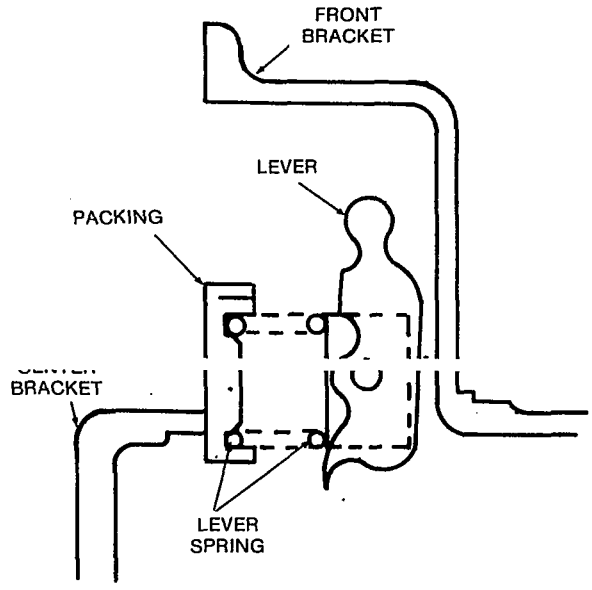


FIGURE 36g. LEVER INSTALLATION

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 36h).

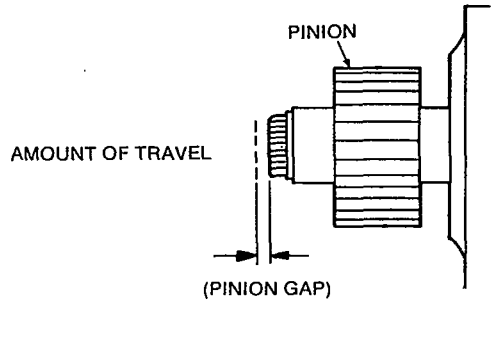


FIGURE 36h. PINION GAP ADJUSTMENT

4. The pinion gap should be 0.3 to 2.0 mm (0.0118 to .0787 inch).
   fiber washers used on solenoid mounting surface. Increasing the number of fiber washers decreases clearance. Decreasing the number of washers increases clearance.

Flywheel Alternator

DJB, DJBA, and DJC BEGIN SPEC V

The Wico flywheel alternator (Figure 37) is rated 20 amps at 3600 rpm. It is a permanent magnet alternator; a solid state voltage regulator-rectifier controls the output. The maximum output on DJB, DJBA, and DJC engines is only 15 amps at 2400 rpm.

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.

A discharged battery indicates trouble in the charging system, but always check the battery for serviceability first.

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

1. Be sure output control plug (connector) is inserted properly. The plug must bottom in receptacle to eliminate any resistance due to a poor connection. Keep clean and tight.
2. Be sure regulator-rectifier output control has a good ground connection. Mating surface for mounting must be clean and fasteners tightened properly.

CAUTION ***Never reverse battery leads. Reverse polarity will blow the fuse.***

Regulator-Rectifier Tests:

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

BATTERY VOLTAGE

1. Connect a voltmeter across battery. Start engine and operate at 1800 rpm.
2. Voltmeter should read 13.4 to 14.0 volts. If not, check alternator output first then install a new regulator-rectifier and retest. Be sure it has a good ground connection and the connector is properly seated.

ALTERNATOR TESTS

To check alternator output, unplug connector and insert and AC voltmeter into two stator output leads. Start engine and accelerate to approximately 1800 rpm. Voltmeter should read approximately 17-30 AC volts. If voltage is considerably less than these figures, either the alternator stator or rotating magnet group is defective. Test stator windings with an ohmmeter (engine not running). Stator winding values are usually less than one ohm. If readings are within limits, then the magnet group is defective.

Stator Tests

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

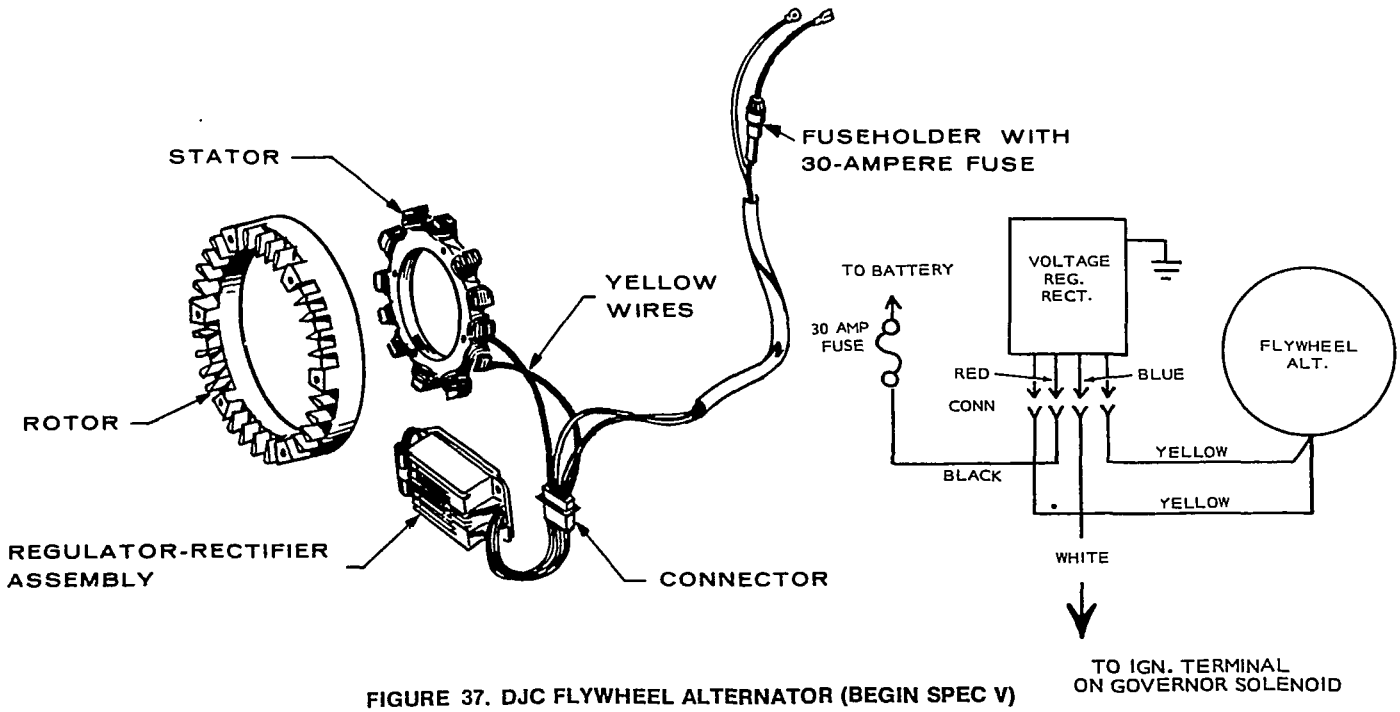


FIGURE 37. DJC FLYWHEEL ALTERNATOR (BEGIN SPEC V)

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 connector (Figure 37) and connect meter leads to two terminals of female plug with 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.

DJB, DJBA, AND DJC PRIOR TO SPEC V

There are four major components in this battery charging system: (1) a permanet magnet on the flywheel provides a rotating magnetic field; (2) a group of coils mounted behind the flywheel on the gear cover cut the field to produce a voltage; (3) a two-step mechanical regulator controls the AC voltage to the rectifier, and (4) a full wave rectifier converts the regulated AC to DC for battery charging. These are shown in Figures 38 and 39.

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

The alternator develops two different rates of current output. The smaller output is connected in the charge circuit for a continuous low-rate charge. The larger output is controlled by the mechanical regulator which has two relays, one of which is voltage-sensitive. When battery voltage falls and the voltage-sensitive relay is de-energized, contacts close to provide a circuit to the other relay, which makes a circuit for the high-rate charge. See Figure 41 wiring schematic. The voltage at which the sensitive relay is energized varies with the temperature.

The final result is a charge rate of 12 amperes into a 70 amp hour, 12 volt battery when the engine is running at 1800 rpm. The maximum continuous DC load is limited to 10 amperes at 1800 rpm. Reverse current through the rectifiers is 5 to 10 milliamperes, so no special reverse current protection is needed.

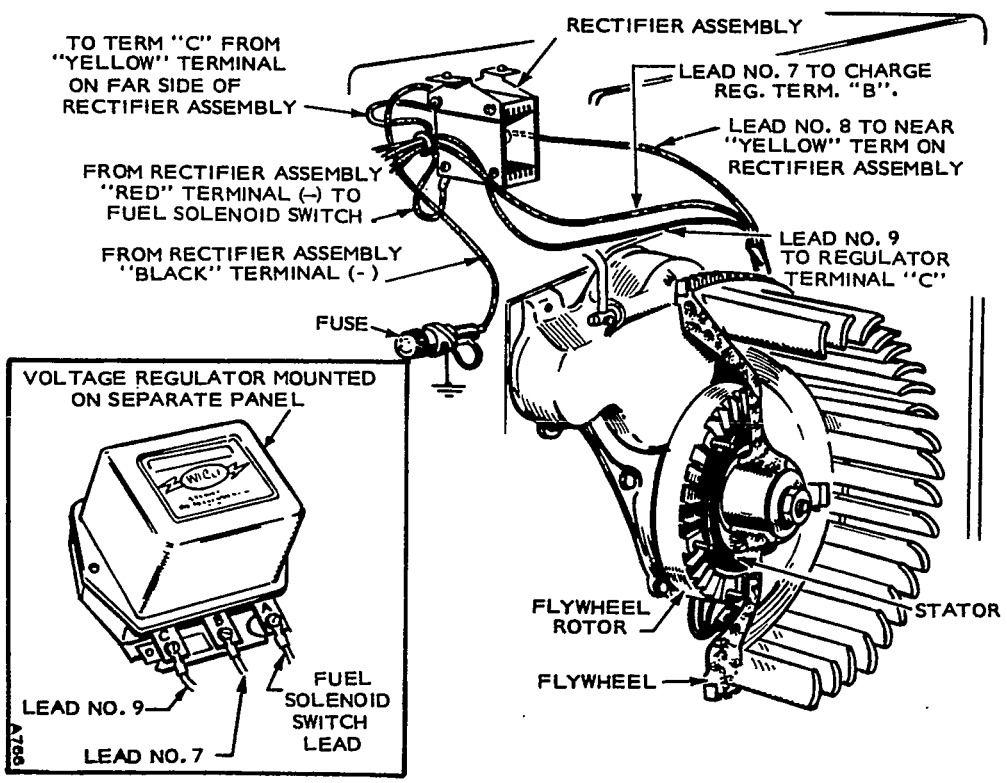


FIGURE 38. FLYWHEEL ALTERNATOR (PRIOR TO SPEC V).

The engine should not be run while the battery is disconnected, but if the battery is accidentally disconnected, the system will not be damaged.

MAINTENANCE

Maintenance is limited to keeping the components in good condition. When the flywheel is off, clean the rotor and stator and check the wires. In general, see that all connections are secure and all components clean. If the alternator is operating satisfactorily, do not tamper with it.

TESTING

To check alternator output, connect an ammeter between the red terminal on the rectifier and the ignition switch. With the engine running at 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. Current at low charge should be about 2 amperes. If output is unsatisfactory, do the following tests.

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

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

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

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

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

Voltage Regulator: If the low-rate charge is satisfactory, but high rate is not

1. Connect a jumper between terminals B and C, Figure 39.
2. Run engine and check charge rate at battery; it should be about 8 amperes.
3. If it is, either the regulator or its power circuit is defective.
4. With a 12 volt test lamp, check input to the voltage-sensitive coil at terminal A. If the lamp lights, input is sufficient and the regulator is defective.
5. If charge rate with B and C jumped is low, look to alternator or its wiring for cause.

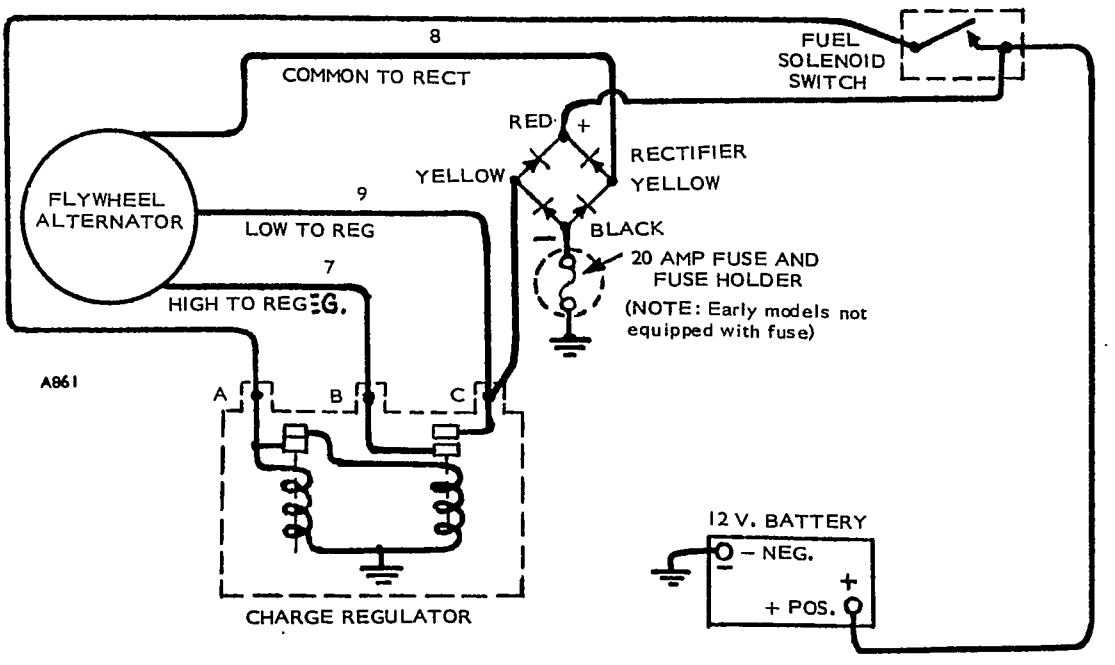


FIGURE 39. BATTERY CHARGING SCHEMATIC DIAGRAM

Rectifier: Completely isolate the rectifier assembly from the charging circuit by disconnecting all four wires. Test each rectifier separately with an ohmmeter or 12 Volt test lamp. See Figure 40.

1. With an ohmmeter, connect one test lead to rectifier lead and other test lead to rectifier base. Take the reading and then reverse test probes.
2. If the rectifier is good, one reading will be much higher than the other.
3. If a 12 volt test lamp is used, touch test probes together and observe brightness of bulb.
4. Touch probes across rectifier. If the rectifier is good, bulb will light dimly. If bulb lights brightly or not at all, rectifier is defective, and must be replaced.

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

ENGINE CONTROLS

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 nearly always differs. Therefore the manufacturer or fabricator generally provides 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. See "WIRING DIAGRAM" section.

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

MAINTENANCE

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

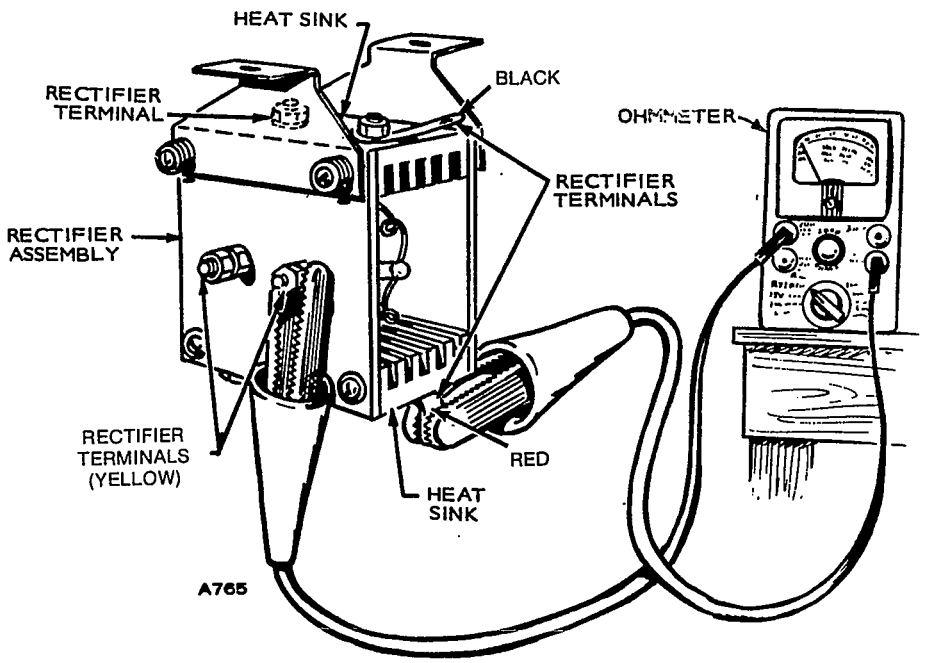


FIGURE 40. RECTIFIER TESTING

Engine Disassembly

ENGINE REBUILDING

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

Disassembly:

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

Assembly (Use Genuine Onan Parts):

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

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

1. See Onan Tool Catalog (900-0019) - many items require a *special tool* for correct installation. Some of these tools are:
   a. Oil seal driver and guide, bearing driver.
   b. Valve spring compressor, valve lock replacer, valve guide driver, and valve seat remover.
   c. Gear puller and gear puller rings.
   d. Piston ring spreader and compressor.
   e. Flywheel puller, pry bar, armature puller.
   f. Torque wrench, plastigauge (for correct bearing clearance).
   g. Load test panel, armature growler, gas pressure gauge (or manometer).
2. Wet holes in crankcase (holes through crankcase) - always use copper (gasket) washers.
3. Nuts, bolts and screws that do not require exact torque should be tightened snugly, then 1/4 extra turn.
4. Select proper length of any screw or bolt and position in hole. Make sure they do not *bottom.*
5. Gasket kits sometimes cover more than one engine. Therefore, select gasket of correct size and shape for part being used. Always use new gaskets.

6. When disassembling engine, *mike* bearing plate gasket thickness. Then select proper shim thickness for correct end play.

   Shims establish end play. Only one thickness gasket is included in kit.

7. When assembling crankshaft, make sure bearing thrust washers are in proper position supported by bearing stop pins. Use cup grease to hold in place.
8. When adjusting valve lash on J-Series, tap rocker arm so it is straight when checking with feeler gauge.
9. Crank gears are easier to remove and install if heated a slight amount.

   CAUTION ***Do not heat ring gear to a bright red as heat treatment will be lost and ring gear may warp.***

10. See *FUEL SYSTEM* section for correct engine timing for specific model.
11. Allow some gear lash (approximately 0.005-inch) in oil pump. *Do not install gears tightly against each other!*

TESTING AND ADJUSTING ENGINES

Preparation

Check the following:

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

OPERATION

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

ADJUSTMENTS

Adjust governor for speed and sensitivity.

IMPORTANT: For complete customer satisfaction, repaint unit (Onan Green, spray can 525-0137, or Onan White, spray can 525-0216) and apply instructions from Kit 98-1100C or Marine Kit 98-1807.

CYLINDER HEADS, VALVES

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

Maintenance:

Check the valve clearances at regular intervals (see *SERVICE AND MAINTENANCE* section). In addition, clean the combustion chambers and valve seats at regular intervals.

Adjustments:

After engine has reached a stable temperature condition the valve clearances may be adjusted. It is recommended that the valve clearance be set with engine at room temperature (about 75° F [24° C]). Allow at least two hours cooling time after engine operation.

1. To adjust valve clearance on two-cylinder J-Series engine proceed as follows:
   a. Turn flywheel until cylinder which is to have its valve adjusted is on its compression stroke, which follows closing of intake valve.
   b. Turn flywheel until TC (top center) mark on flywheel lines up with timing pointer on gear cover. Then turn flywheel in a clockwise direction for an additional 10 to 45 degrees. The timing mark for this position must be established. In this position, the piston will be in its power stroke with both valves completely closed.
   c. Using a feeler gauge, check clearance between rocker arm and valve, Figure 41. Increase or reduce clearance until proper gap is established; adjust with lock nut which secures rocker arm to cylinder head, Figure 42. Refer to *SPECIFICATIONS* for correct valve clearance setting for your particular engine.

Adjust valve lash after 50 hours of operation following engine overhaul.

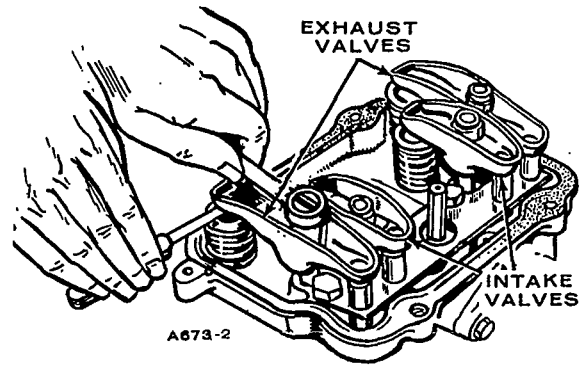


FIGURE 41. CHECKING VALVE CLEARANCES

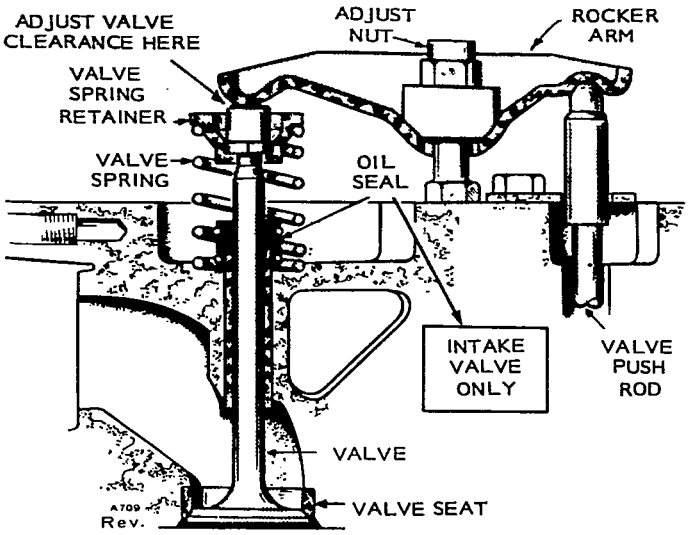


FIGURE 42. SETTING VALVE CLEARANCE

2. To adjust valve clearance on four-cylinder J-Series engine proceed as follows:

   a. Adjust valve clearance in firing order (1-2-4-3) sequence. After the cooling period, adjust number 1 cylinder according to Steps 1a. and 1b. After timing the number 1 cylinder, adjust valve clearance according to Steps 1c.

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

   IMPORTANT: Four-cylinder engines do not have a BC mark on the flywheel.

   c. After timing number 2 cylinder, adjust valve clearance according to step 1c.

   d. To adjust valve clearance for the number 4 cylinder, turn flywheel in a clockwise direction 180 degrees (1/2 revolution). The flywheel should be between 10 degrees and 45 degrees past flywheel TC mark.

   e. After timing number 4 cylinder, adjust valve clearance according to Step 1c.

   f. To adjust valve clearance for the number 3 cylinder, turn flywheel in a clockwise direction 180 degrees (1/2 revolution). The flywheel should be between 10 degrees and 45 degrees past BC.

   g. After timing number 3 cylinder, adjust valve clearance according to Step 1c.

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 42a and proceed as follows:

1. Remove the cap from the valve tip and measure the depth of the cavity in the cap with a depth micrometer.

2. Measure the valve tip height from the cavity depth to determine the clearance. It should be between 0.001 and 0.005 inch (0.025 and 0.127 mm).

3. 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 inch (0.076 mm) 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.

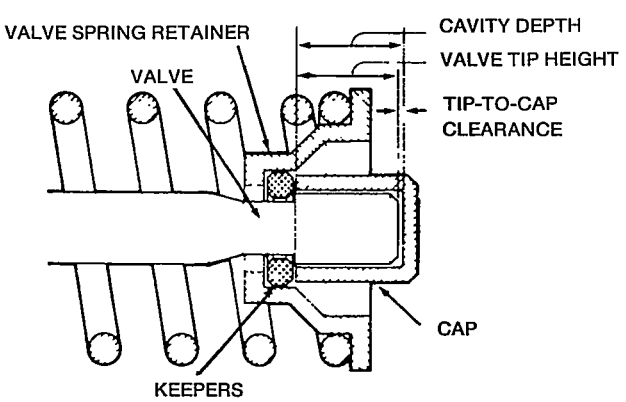


FIGURE 42a. MEASURING VALVE TIP-TO-CAP CLEARANCE

Testing:

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

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

Compression of a standard new engine cranking at about 300 rpm is about 300-350 psi (2070 to 2415 kPa) prior to Spec P and 350-400 psi (2415 to 2760 kPa) Spec P and later. Compression should be fairly uniform, normally with less than 10 psi (69 kPa) difference between the highest and lowest cylinder, taken at the same cranking rpm. Excessively high readings indicate carboned combustion chambers.

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

Disassembly:

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

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

Repair:

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

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

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

Valve Guides: Check valve guide to valve clearance. See the *DIMENSIONS AND CLEARANCES* section. If the proper clearances cannot be obtained by replacing the valves, replace the valve guides. Drive the old valve guides into the valve chambers. Drive new guides in until they protrude 11/32 inch (8.731 mm) from the rocker box side of the head. Ream the new valve guide to obtain the proper clearance.

Valve Seats: If the valve seats are pitted, refinish them. Using conventional seat-grinding equipment, reface each seat to a 45 degree angle and a seat width of 3/64 inch to 1/16 inch (1.191 to 1.588 mm) You should be able to reface each seat several times before it becomes necessary to replace it.

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

Use Onan tool number 420-0272 in a drill press (Figure 43) to remove each valve seat. Adjust the tool to cut 1/64 inch (0.397 mm) 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.

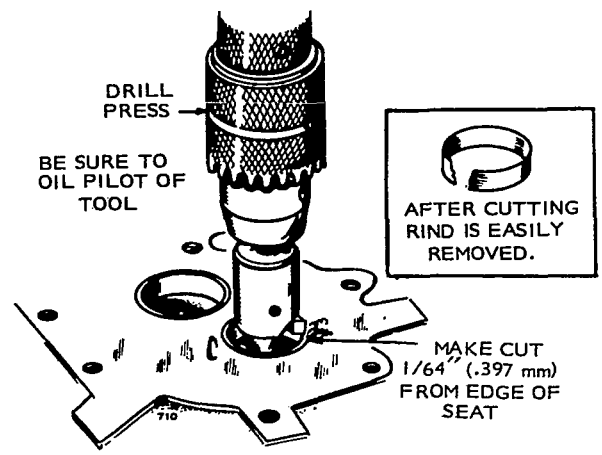


FIGURE 43. REMOVING VALVE SEATS

Thoroughly clean the valve seat counterbore and remove any burrs from the edges. If the counterbore is damaged, it will have to be machined for an oversize seat. Oversize seats are available in 0.002 inch, 0.005 inch, 0.010 inch and 0.025 inch (0.58, 0.056, 0.068, and 0.09 mm). 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 (162° C) for about 1/2 hour and cool the valve seats in dry ice.

Face each new seat to a 45 degree angle and a width of approximately 3/64 inch (1.191 mm). The finished seat face should contact the approximate center of the valve face. Use Prussian Blue on each valve face to check this. Make any corrections on the seat, not the valve face.

When the new seats are installed and faced, insert the valve into each, and check the clearance from the valve head to the face of the cylinder head. This must be at least 0.025 inch (0.64 mm). If it is not, regrind the seat.

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

Oil Seal

Installation: Use the following procedure on all "J" series engines and generator sets, regardless of which valve stem oil seal is used.

Apply SAE 50 engine oil to valve stem oil seals (before installing valve), valves and valve stems.

1. Support valve stem seal when installing valves. Spring retainer should never contact valve stem seal when compressing valve springs to install spring retainer locks.

   IMPORTANT: Units built before June 1962 had no valve seals.

2. Oil stem of each valve lightly and insert each in its own guide.
3. Check each valve for a tight seat with an air-pressure type tester. If a tester is not available, make pencil marks at intervals on valve face; observe if marks rub off uniformly when valve is rotated part of a turn in seat. If seat is not tight, regrind valves.
4. Using a valve spring compressor, compress each valve spring and insert valve spring retainer and retainer locks.
5. Install head assembly and gasket to cylinder block. Tighten head bolts to 44 to 46 foot-pounds (60-62 N•m). Follow sequence in Figure 44 and Steps a. through c.

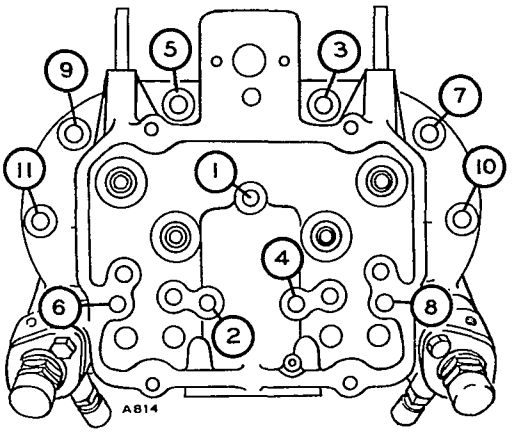


FIGURE 44. HEAD BOLT TORQUE SEQUENCE

Use Never-Seez, Fel-Pro C5-A or equivalent thread lubricant when installing cylinder head bolts.

a. Tighten cylinder head bolts finger-tight.

b. Install exhaust manifold and tighten (four cylinder models only).

   Installing manifold now aligns all four exhaust ports with the exhaust manifold before the heads are torqued down.

   Add exhaust manifold lock tabs to prevent manifold nuts from coming loose.

c. Tighten cylinder head bolts in sequence shown in Figure 44 to 25-30 foot-pounds (34-41 N•m).

d. Tighten cylinder head bolts in same sequence to 44-46 foot-pounds (60-62 N•m).

e. After 60 seconds, retighten cylinder head bolts in sequence to 44-46 foot-pounds (60-62 N•m). This step compensates for the compress of the cylinder gasket.

6. Install intake manifold, nozzles, glow plugs and oil lines.
7. Install valve stem cap.
8. Install push rods, rocker arms and rocker arm nuts.
9. Set valve clearance. See Figure 42.

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

INTERNAL DISASSEMBLY

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

FLYWHEEL

Remove the blower housing. The flywheel is a tapered fit on the crankshaft. Improvise a puller, using at least a 7/16 inch bar (11.113 mm), and drill two 7/16 inch (11.113 mm) holes 2-7/8 inches (73.025 mm) between centers. Loosen the flywheel mounting screw a few turns. Place bar against the flywheel screw and attach bar, using two 3/8-16 thread screws in the holes provided in flywheel. Alternately tighten the screws until flywheel is free.

FLYWHEEL REPLACEMENT

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

With the flywheel mounted, remove the head and install a depth gauge over the front piston. Rotate the flywheel to find the TDC position on the compression stroke and mark this point on the flywheel. Next, turn the flywheel counterclockwise until the piston drops exactly 0.128 inch (3.25 mm) on Spec P and later engines. The port closing point occurs at 19° BTDC. On engines prior to Spec P the piston drop is 0.155 inch (3.937 mm), and PC occurs at 21° BTDC. On DJE engines piston drop is 0.115 (2.9 mm), and PC occurs at 18° BTDC. Mark both TDC and piston drop to PC point on the flywheel.

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

To install a new ring gear, place it in an oven heated to 380° F - 400° F (192° to 204° C) for 30 to 40 minutes.

CAUTION ***Do not heat ring gear to a bright red as ring gear may warp and the heat treatment will be destroyed.***

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

GEAR COVER

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

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

Governor Shaft: The governor shaft is supported by two sets of needle bearings. To remove the shaft, remove the yoke and pull the shaft from the gear cover. If the shaft is binding, clean the bearings. If loose, replace the bearings. To remove the larger bearing, drive both bearing and oil seal out from the outside of the gear cover. Remove the smaller bearing with an Easy-Out or similar tool. Press new bearings and oil seal into place. See Figure 45.

Gear Cover Oil Seal: Replace the oil seal if damaged or worn. Drive the oil 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 46.

Assembly, Gear Cover:

1. Work governor shaft to check for binding and see that the governor shaft end-thrust ball is in place (Figure 45). Later models have larger ball which will not fall out.
2. Turn governor yoke so smooth side is toward governor cup.
3. Turn governor cup so stop pin in gear cover will fit into one of the holes in the cup surface (Figure 47). Measure distance from end of stop pin to mounting face of cover. It should be 25/32 inch (19.844 mm). If it is not, replace pin. Pin should be positioned with open end facing crankshaft seal.
4. Coat oil seal lip with oil or grease. Set a piece of shim stock over the crankshaft keyway to protect seal and install gear cover. Tighten mounting screws to 15 to 20 foot-pounds (20 to 27 N•m). Before tightening screws, be sure the stop pin is in governor hole.

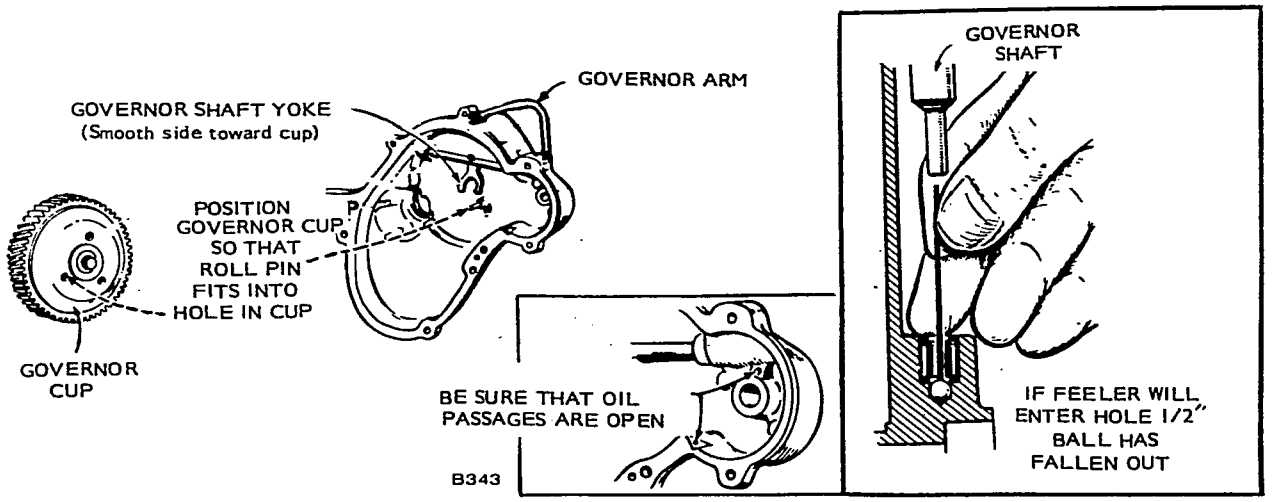


FIGURE 45. GEAR COVER ASSEMBLY

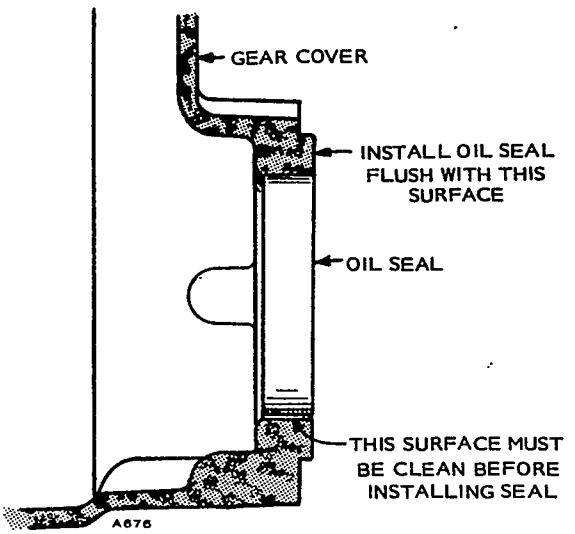


FIGURE 46. GEAR COVER OIL SEAL

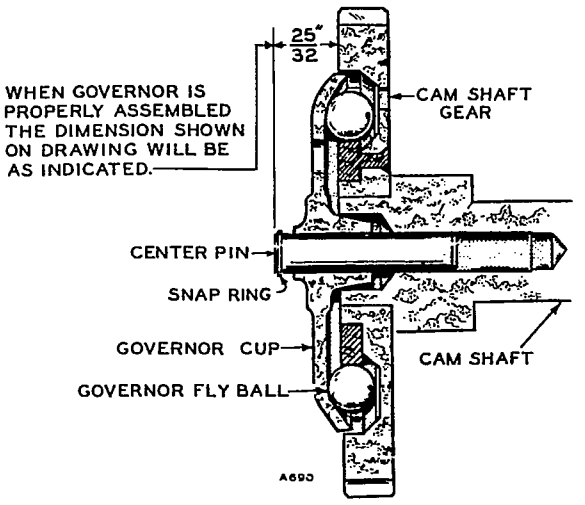


FIGURE 47. GOVERNOR CUP

GOVERNOR CUP

To remove the governor cup, remove the snap ring from the camshaft center pin and slide the cup off. Be sure to catch the ten flyballs that will fall out when the cup is removed. Figure 47 shows the governor cup.

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

Check the distance the center pin extends from the camshaft gear; this distance must be 25/32 inch (19.844 mm) to give the proper travel distance for the cup. If it is less, the engine may race; if more, the cup will not hold the balls properly. If the distance is too great, drive or press the center pin in. If it is too small, replace the pin; it cannot be removed without damaging the surface. In some cases, if the distance is too small, the head of the governor cup can be ground to give the necessary 7/32 inch (5.556 mm) travel distance.

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

PISTONS, RINGS, CONNECTING RODS

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

Some engines are fitted with 0.005 inch (0.127 mm) oversize pistons at the factory. These engines are marked with an E following the engine serial number. Use 0.005 inch (0.127 mm) oversize rings for these pistons.

Removal and Disassembly:

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

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

Cylinders:

The cylinder walls should be free of scratches, pitting and scuffing. Check each with an inside reading micrometer for out-of-round and wear. The bore should measure between 3.2495 inches (82.54 mm) and 3.2505 inches (82.56 mm), DJE 3.4995 inches (88.89 mm) and 3.5005 inches (88.91 mm), and be less than 0.001 inch (0.0254 mm) out-of-round.

If necessary, rebore the cylinder to fit the next available oversize piston. Pistons and rings are available in 0.005 inch (0.127 mm), 0.010 inch (2.540 mm), 0.020 inch (0.508 mm) 0.030 inch (0.762 mm) and 0.040 inch (1.016 mm) oversize. If the cylinders do not need refinishing, remove any existing ridges from the top of the walls with a fine stone.

Pistons:

Clean thoroughly and inspect each piston. Clean the carbon from the ring grooves and be sure all oil holes are open. If any piston is badly scored or burred, loose in the cylinder, has badly worn ring grooves or otherwise is not in good condition, replace it. See Figure 48.

CAUTION ***Install pistons with valve relief recess facing the camshaft side of engine to match valve positions.***

Check the clearances 90 degrees from the axis of the piston pin and below the oil control ring. Clearance should be 0.005 inch - 0.0070 inch (0.127 to 0.178 mm). If not, replace the piston and check the cylinder for possible reconditioning.

PISTON PINS

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

RINGS

Inspect each ring carefully for fit in the piston grooves and seating on the cylinder wall. Fit each ring to the cylinder wall at the bottom of its travel, using a piston to square the ring in the bore. Check the gap with a feeler gauge. It should be 0.010 inch to 0.020 inch (0.254 to 0.0508 mm). The practice of filing ring ends to increase the end gap is not recommended. If the ring end gap does not meet specifications, check for the correct set of rings and the correct bore size.

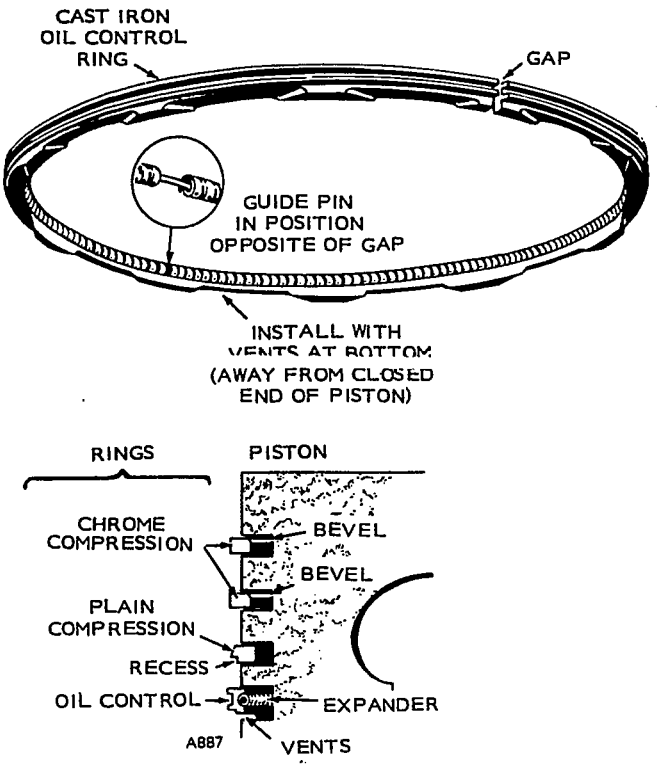


FIGURE 48. PISTON RINGS

CONNECTING RODS

Clean the connecting rods and check each for defects. Check the connecting rod bushings for proper clearance with the piston pin. Clearance should be 0.0002 inch to 0.0007 inch (0.0051 to 0.0178 mm).

If the bushings are excessively worn, press them out and install one new bushing from each side of the bushing bore. Press the new bushings only until flush with the sides of the rod to leave 1/16 inch to 7/64 inch (1.588 to 2.776 mm) oil groove in the center. See Figure 49.

CONNECTING ROD BEARINGS

Inspect the connecting rod bearings for burrs, breaks, pitts and wear. Measure the clearance between bearings and the crankshaft journal. The clearance should be 0.001 inch to 0.003 inch (0.0254 to 0.076 mm). If necessary, replace with new standard or oversize precision bearings.

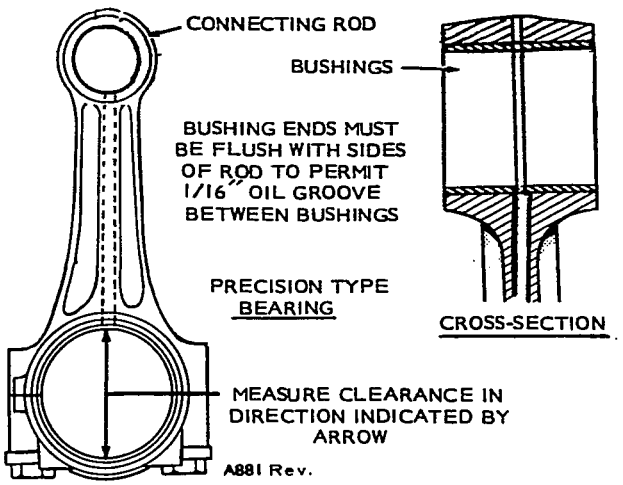


FIGURE 49. CONNECTING ROD BUSHINGS

ASSEMBLEY AND INSTALLATION

1. Install connecting rods on each piston with pins and retaining rings. If new bushings were installed, check to see that ends are flush with connecting rod to provide for oil recess in 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 closed end of piston. Space ring gaps 1/4 of way around piston from one another. No gap should be in line with the piston pin Oil rings and pistons.
3. Position a bearing half in each connecting rod. Be sure there is no dirt under bearing. This could cause high spots and early bearing failure.
4. Oil cylinder walls. Install each piston in proper cylinder using a suitable installer. Each assembly should be installed with stamp on piston facing same direction as when removed.
5. Position each connecting rod on crankshaft, oil the journal, and install its rod cap with bearing half. When installing rod cap, position so raised witness mark on forging matches mark on connecting rod. See Figure 50.
6. Tighten cap screws to specified torque.
7. Crank engine over by hand to see that all bearings are free.
8. Install oil base with a new gasket.
9. Install cylinder heads using proper bolt tightening sequence.
10. Replace oil.

CAMSHAFT

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

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

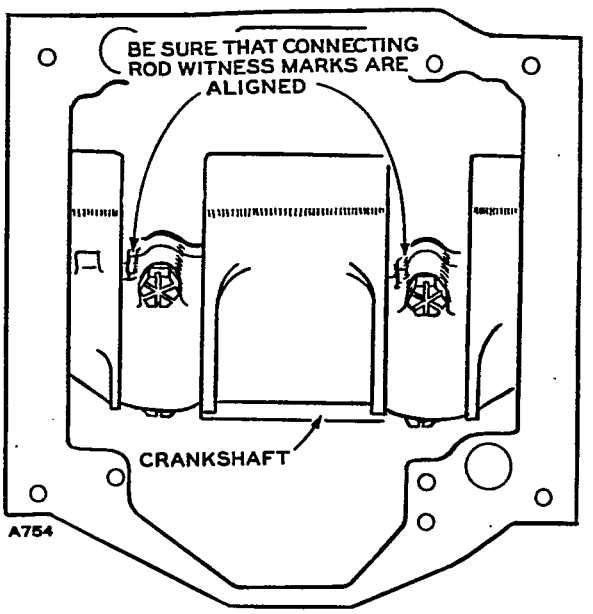


FIGURE 50. CONNECTING ROD CAP

Removal:

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

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

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

Camshaft Bearings: The camshaft bearings should be replaced if the clearance to the camshaft is greater than specified, the bearings show cracks, breaks, burrs, excessive wear, or other defects. The camshaft-to-bearing clearance should be 0.0015 inch to 0.0030 inch (0.038 to 0.076 mm). To check the rear bearing, remove the expansion plug at the rear of the crankcase.

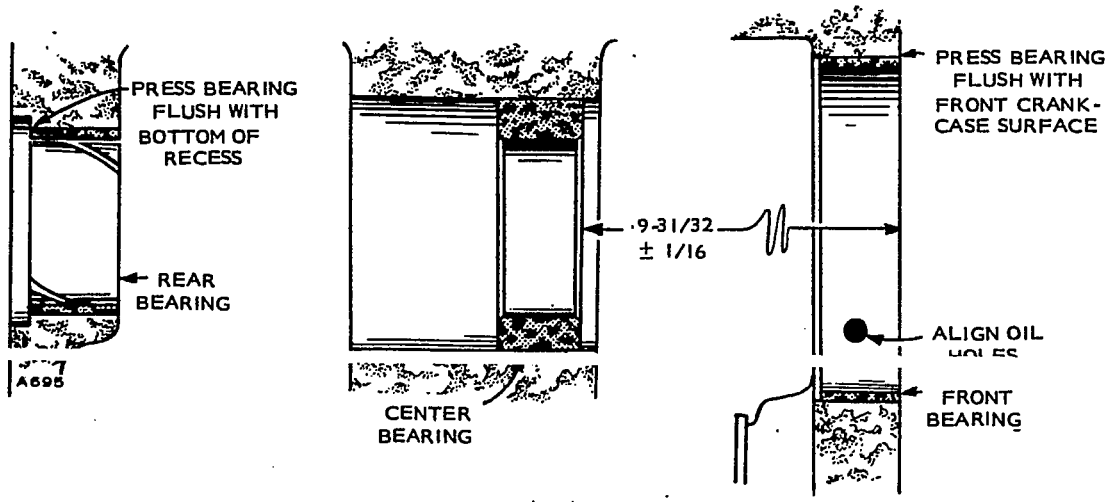


FIGURE 51. CAMSHAFT BEARINGS

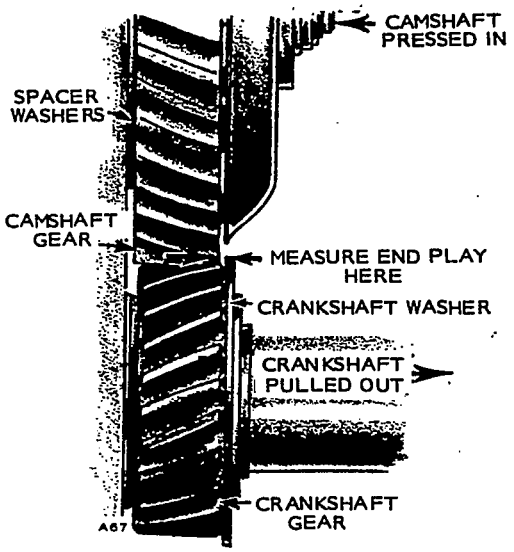


FIGURE 52. CAMSHAFT ENDPLAY

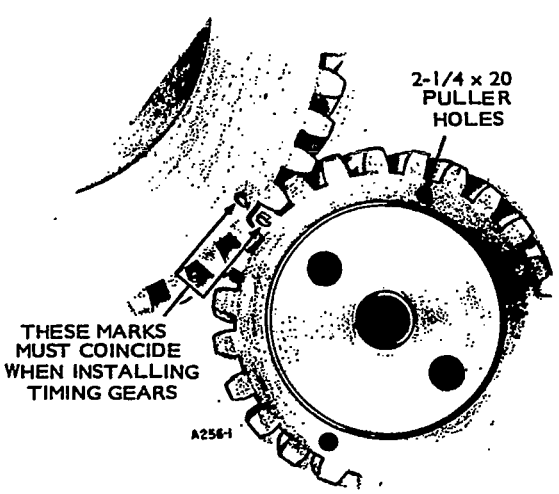


FIGURE 53. TIMING MARKS

Press new bearings into place (Figure 51). Press the rear bearing flush with the bottom of the expansion plug recess. Press the front bearing in flush with the crankcase front surface so the oil passages are aligned. Do not attempt to ream the bearings as they are a precision type. After the rear bearing is installed, insert a new expansion plug in the recess, using sealing compound, and expand it into place with sharp blows at its center.

Installation, Camshaft Assembly:

1. Install key and press camshaft gear on camshaft until it bottoms on flange with no clearance.
2. Install governor components.
3. Slide thrust washer onto shaft. Measure camshaft end play; it should be 0.007 inch to 0.039 inch (0.178 to 0.991 mm). See Figure 52.
4. Lay engine on its side or end and insert push rod tappets.
5. Install camshaft assembly in engine. Align timing marks on camshaft gear and crankshaft gear. See Figure 53.
6. Replace push rods and fuel transfer pump.
7. When engine is reassembled, install injection pump following the steps for *Injection Pump Installation* in the *FUEL SYSTEM* section. This step is critical.

CRANKSHAFT

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

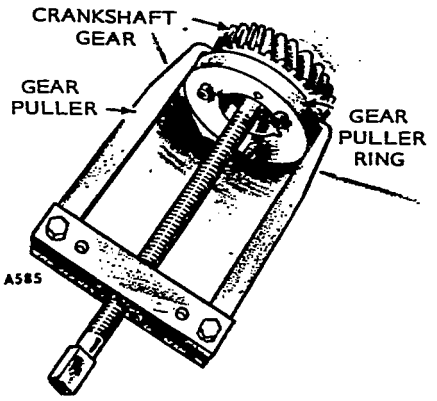


FIGURE 54. REMOVING CAMSHAFT GEAR

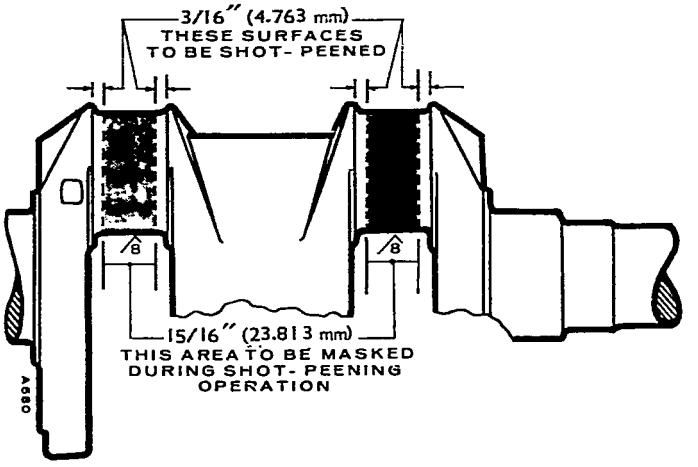


FIGURE 55. SHOT-PEENING THE CRANKSHAFT

Removal:

1. Remove lock ring and retaining washer in front of crankshaft gear.
2. Pull off crankshaft gear. It has 2-1/4-20 UNC tapped holes for attaching a gear pulling ring. Use care not to damage teeth if the gear is to be re-used. See Figure 54.
3. Remove oil pan, piston, and connecting rod.
4. Remove bearing cap from center main bearing (four cylinder only).
5. Remove rear bearing plate from crankcase.
6. Remove crankshaft through rear opening in crankcase (four cylinder only: Catch upper half of center main bearing support as it slides off its mounting surface).

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

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

Crankshaft Grinding: Crankshaft grinding requires a trained, experienced operator working with precision equipment. Procedures which may be satisfactory for some spark-ignition engines may well be unsatisfactory for diesel applications, resulting in expensive failures. Onan emphasizes that if facilities or trained personnel are not available, the crankshaft may be sent to the factory.

Special procedures must be observed when reworking diesel crankshafts. In addition to machining, the crankshaft must be shot-peened and super-finished. Failure to *shot-peen* the crankpin fillets is likely to cause early failure. When the shaft is machined, follow this data and Figure 55 to shotpeen each crank pin fillet.

1. Almen gauge reading 0.012-A (0.305).
2. Peen with 0.019 inch (0.482 mm) diameter cast steel shot.
3. Peen for 45 seconds on each crankpin fillet.
4. Mask off connecting rod bearing areas.

Undersize bearings and connecting rods are available to rework the shaft to 0.010inch (0.254 mm), 0.020 inch (0.508 mm), and 0.030 inch (0.762 mm) undersize.

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

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

Align the oil holes and press the new bearings into the front and rear housings. Insert the center bearing of the DJC when the crankshaft is reinstalled.

Rear Oil Seal: The rear oil seal is in the rear bearing plate. If damaged, drive it out from the inside of the plate. Using the oil seal installing tool, install a new seal with the rubber lip facing outward (open side of seal inward). See Figure 56. 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 front and rear main bearings into place, align bearing and bearing housing oil holes. Do not attempt to drive a bearing into a cold block or rear bearing plate.
2. Install thrust washers and locking pins.
3. Oil bearing surfaces and install crankshaft from rear of crankcase through rear bearing plate hole.

4. Mount and secure rear bearing plate.
5. Heat timing gear on an electric burner or even to about 350° F (175° C). Install key on crankshaft, then drive gear into place. Install retaining washer and lock ring.
6. Four cylinder only: Set upper half of center main housing on crankshaft and rotate it into place. See Figure 57. Be sure it is installed with the side marked *front* toward crankshaft gear. Set the two positioning dowels on the upper bearing mount. Install center main bearing cap and torque bolts to 97-102 foot-pounds (131-138 Nem).
7. Check crankshaft end play. Use enough rear bearing plate shims and gaskets to provide 0.010 inch (0.254 mm) to 0.015 inch (0.381 mm) end play. If gaskets of more than 0.015 inch (0.381 mm) total thickness is required, use a steel shim of proper thickness and a thin gasket on each side of shim. This avoids excessive gasket compression and maintains bolt torque.
8. Install piston assemblies.

CRANKCASE

If the crankcase requires replacement, a new set of injection pump shims will be furnished with the new crankcase. These must be used and, in addition, the injection pump must be retimed to the engine. If, on the four cylinder models, the center main bearing support requires replacement, the whole crankcase must be replaced or returned to the factory to have a new housing fitted.

BREAK-IN PERIOD

Whenever new rings or pistons are installed or the cylinder refinished, the engine must be run-in before regular operation can be resumed. Run the engine for 15 to 20 minutes at no load, about 30 minutes at 1/3 load, and 2 to 3 hours at 2/3 load. Regular operation can then be resumed. Avoid light load operation during the following several hours for best ring seating to control oil.

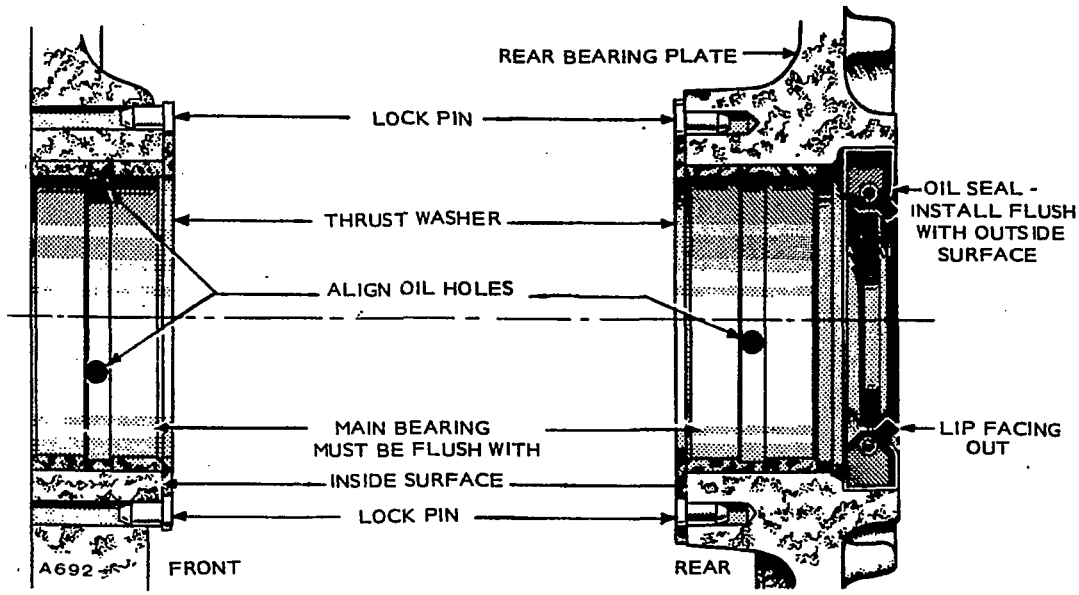


FIGURE 56. MAIN BEARING INSTALLATION

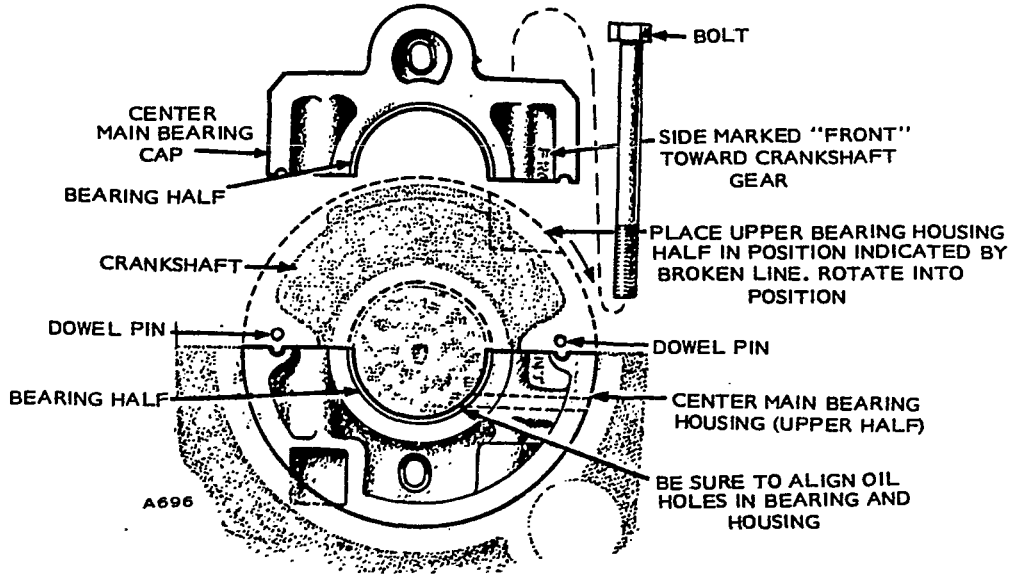


FIGURE 57. MAIN BEARING HOUSING

Special Equipment

CLUTCH

This information is intended for users of engines having a Rockford 8 inch clutch (Figure 62).

Adjusting - After clutch has been installed on engine, 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 camshaft 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 respective positions.

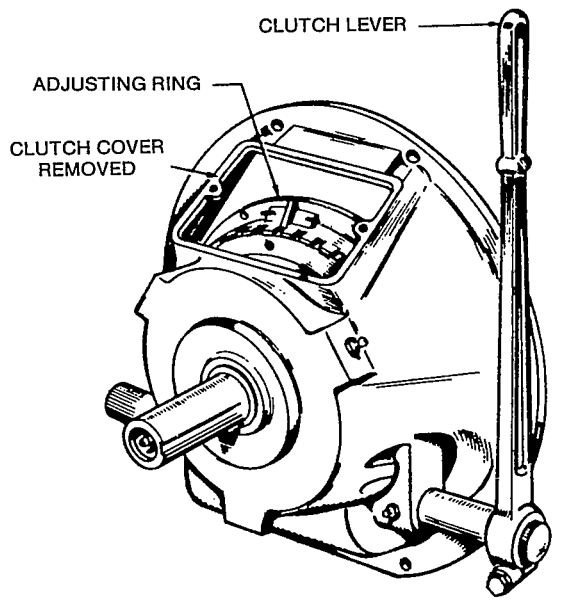


FIGURE 62. ROCKFORD CLUTCH

Control System

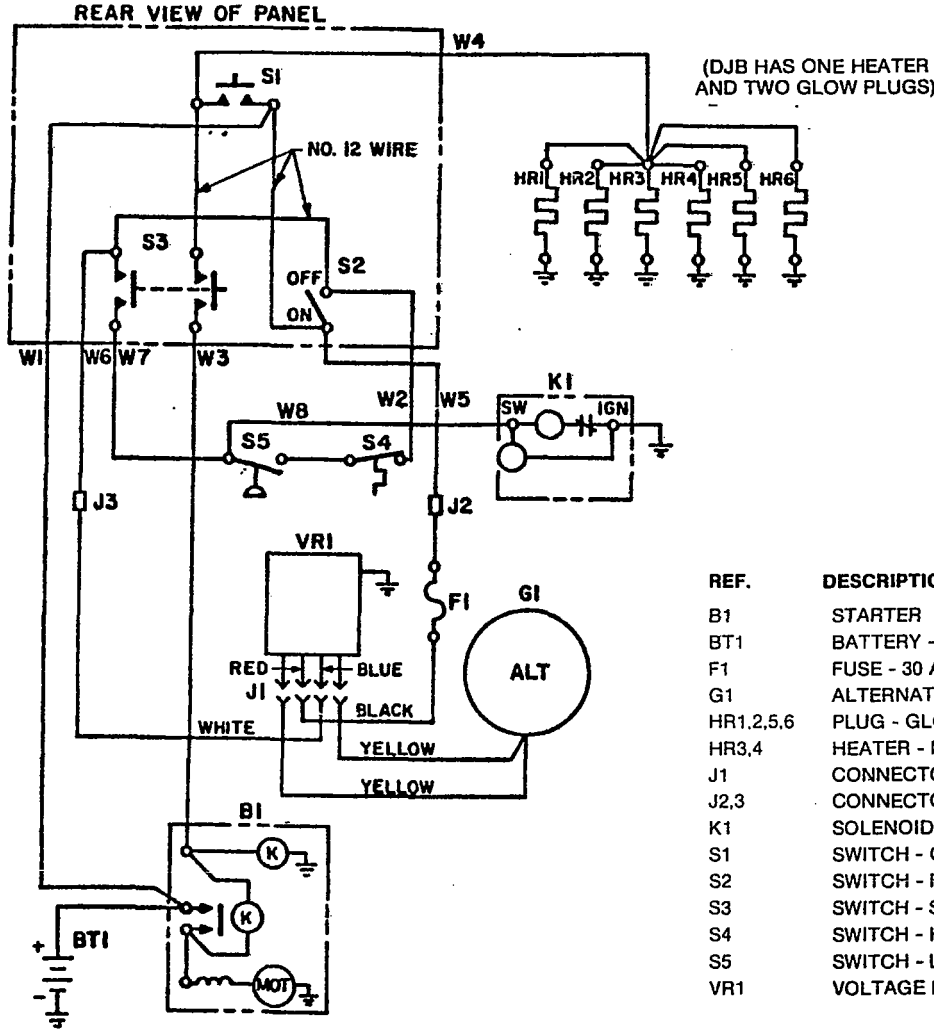
Due to the wide variety of uses to which these engines are adapted, operating controls are not supplied with the majority of these engines. The engines, in most cases, are used for prime power to operate other manufacturers equipment. Installation nearly always differs. Therefore the manufacturer or fabricator generally provides 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. See *WIRING DIAGRAMS* section.

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

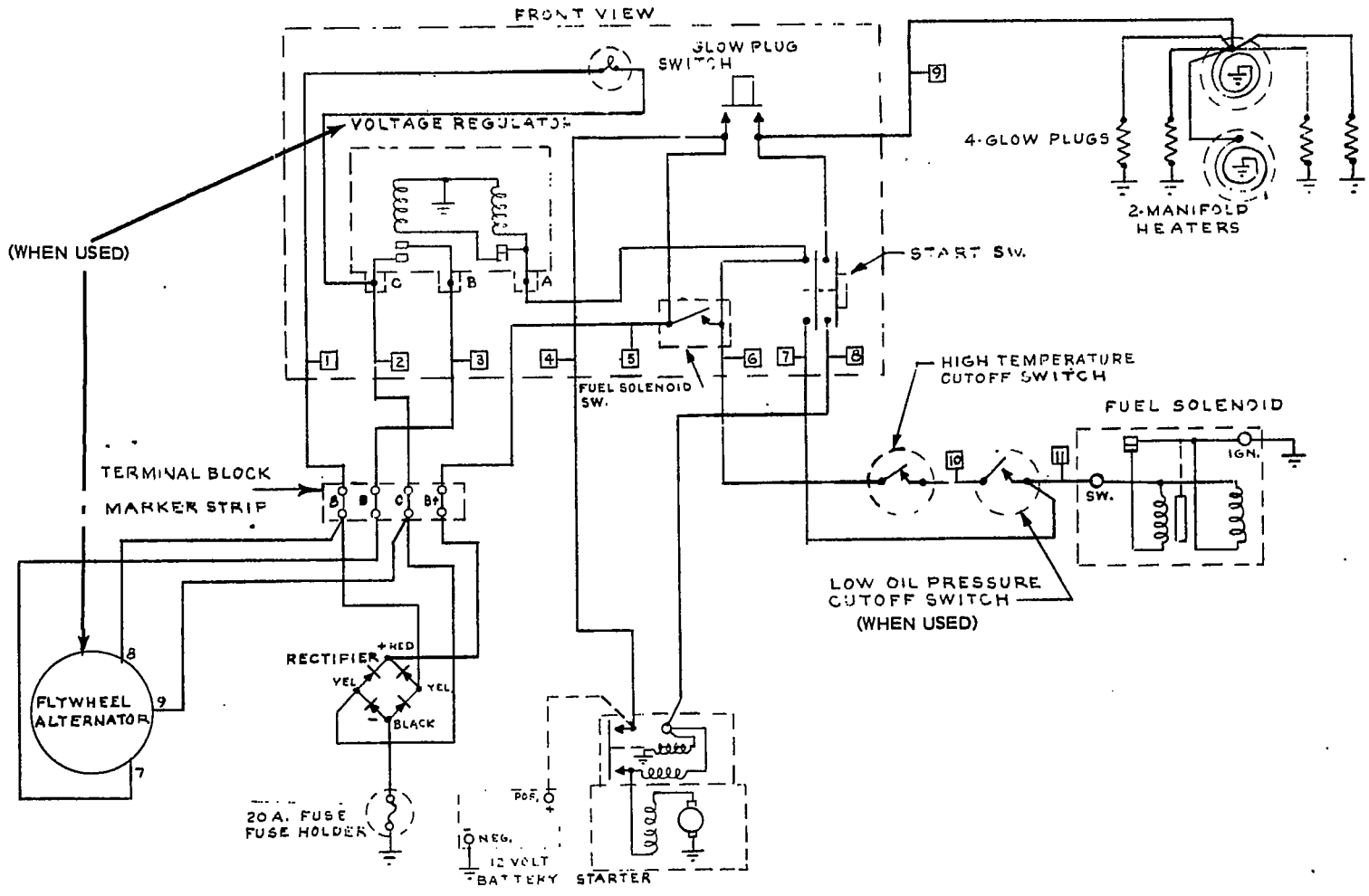
MAINTENANCE

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



REF.	DESCRIPTION
B1	STARTER
BT1	BATTERY - 12 V
F1	FUSE - 30 A
G1	ALTERNATOR - FLYWHEEL
HR1,2,5,6	PLUG - GLOW (DJC)
HR3,4	HEATER - MANIFOLD (DJC)
J1	CONNECTOR
J2,3	CONNECTOR
K1	SOLENOID - FUEL
S1	SWITCH - GLOW PLUG
S2	SWITCH - FUEL SOLENOID
S3	SWITCH - STARTER
S4	SWITCH - HIGH AIR TEMP
S5	SWITCH - LOW OIL PRESS
VR1	VOLTAGE REGULATOR

WIRING DIAGRAM FOR DJB AND DJC (BEGIN SPEC V).



WIRING DIAGRAM FOR DJB AND SPEC A THROUGH T DJC.

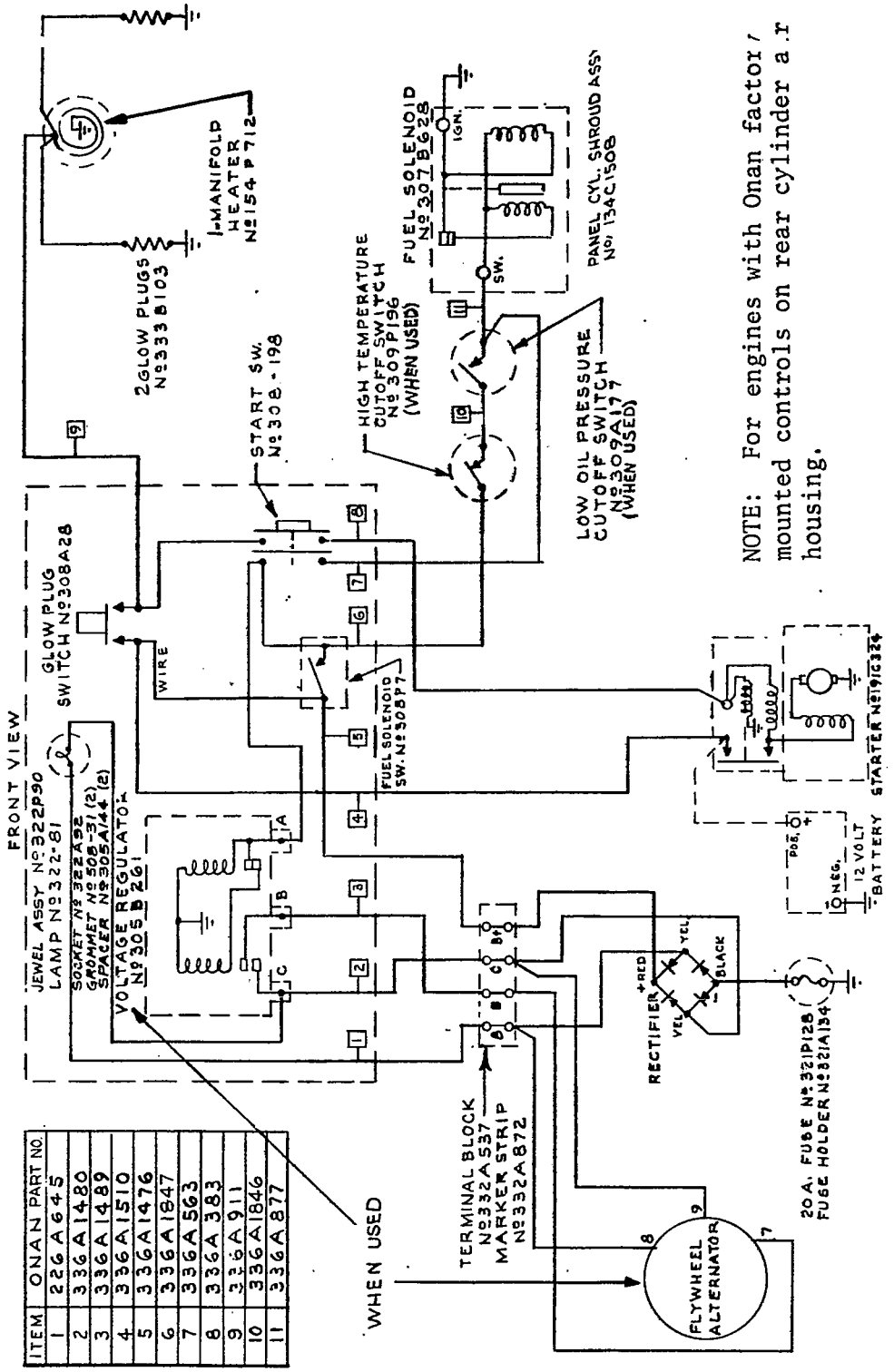
***NOTE**: For standard engines with Onan factory mounted controls on rear cylinder air housing.

WIRING DIAGRAM

WIRING DIAGRAMS

DJBA-MS PRIOR TO SPEC V

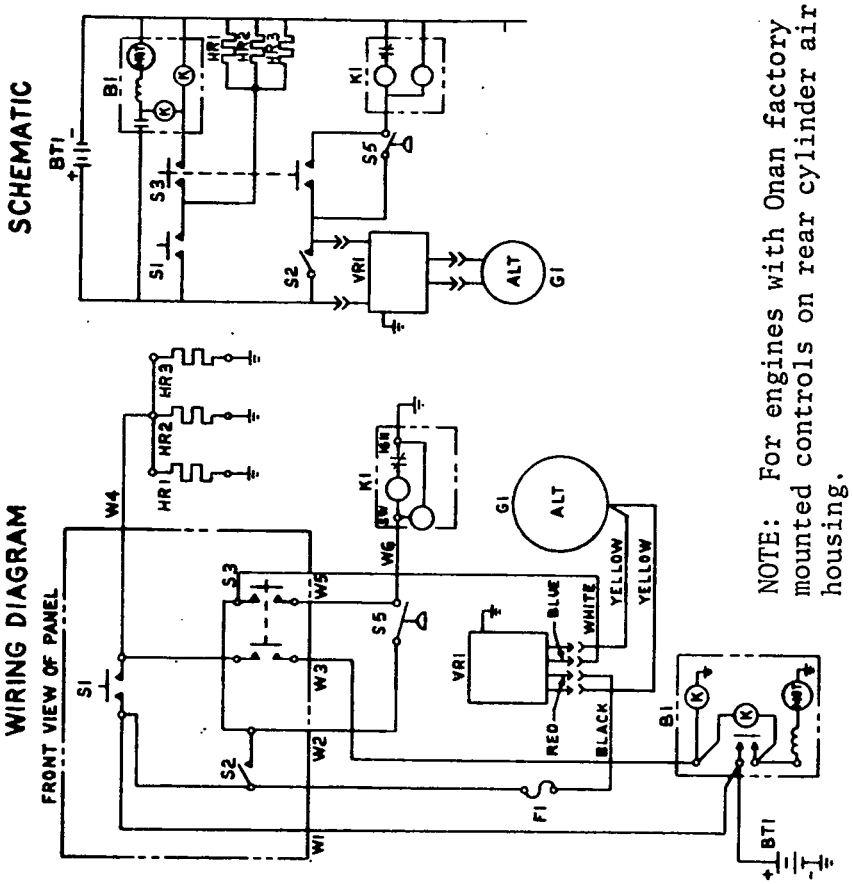
(some options shown)



NOTE: For engines with Onan factor / mounted controls on rear cylinder a.r housing.

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

DJBA-MS BEGIN SPEC V
(some options shown)



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

REF DES	PART NO.	QTY	PARTS LIST 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	307868 (REF)	1	SOLENOID-FUEL
S1	308428	1	SWITCH-GLOW PLUG
S2	308987	1	SWITCH-FUEL SOLENOID
S3	308-198	1	SWITCH-START
S5		1	SWITCH-LOW OIL PRESSURE
VR1		1	VOLTAGE REGULATOR

Onan

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