Onan

Service Manual

MJB
MJC
RJC
Gasoline Engine

967-0757
11-86
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 degrees F (100 degrees 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

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 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.

12.5	RJC	18	R	/	96	AC
1	2	3	4		5	6

1. Kilowatt rating of unit.
2. Factory code for series identification.
3. 18 – Reconnectible for various voltages.
   3C – Reconnectible for 120/240 volts.
4. Specific Type:
   E – ELECTRIC. Electric starting at the set only.
   R – REMOTE. Electric starting. For permanent installation, can be connected to optional accessory equipment for remote or automatic control of starting and stopping.
5. Factory code for optional equipment.
6. Specification (Spec) letter advances when factory makes production modifications.

Specifications

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

SPECIFICATION	UNIT OF MEASURE	SERIES MJB	MJC	RJC
Number of Cylinders		2	4	4
Bore	in (mm)	3.250 (82.55)	3.250 (82.55)	3.250 (82.55)
Stroke	in (mm)	3.625 (92.07)	3.625 (92.07)	3.625 (92.07)
Displacement	cu in (cm^3)	60 (983)	120 (1966)	120 (1966)
Compression Ratio		6.5 to 1	6.5 to 1	6.5 to 1
Firing Order			1-2-4-3	1-2-4-3
Oil Filter		Full Flow	Full Flow	Full Flow
Oil Capacity Without Filter	Qt (litre)	3 (2.8)	6 (5.7)	6 (5.7)
Oil Capacity With Filter Change	Qt (litre)	3.5 (3.3)	6.5 (6.2)	6.5 (6.2)
Crankshaft Rotation (viewed from flywheel)		Clockwise	Clockwise	Clockwise
Governor		Variable Speed Mechanical		
Valve Clearance (Cold)		Spec A-C	Begin Spec D	
Intake	in (mm)	0.010 (0.25)	0.014 (0.36)	0.015 (0.38)	0.015 (0.38)
Exhaust	in (mm)	0.010 (0.25)	0.018 (0.46)	0.020 (0.51)	0.020 (0.51)
Spark Plug Gap	in (mm)	0.025 (0.64)		0.035 (0.89)	0.035 (0.89)
Breaker Point Gap - Static (Full Separation and Engine Cold)	in (mm)	(0.020) (0.51)		(0.020) (0.51)	0.015① 0.020② (0.38)① (0.51)②
Ignition Timing (Static)		5° ATC		10° BTC	10° ATC③ 9° BTC④
Ignition Timing (Running)		25° BTC		25° BTC	25° BTC③ 35° BTC④
Start Disconnect Point Gap	in (mm)	0.020 (0.51)		0.020 (0.51)	0.020 (0.51)
Distributor Dwell Angle				48°-54°	48°-54°

① - Magneto Ignition
② - Battery Ignition
③ - Gasoline Fuel
④ - Gas Fuel

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 (MJC, RJC)	1.2580-1.2582 (31.953-31.958)
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)
Maximum Allowable Taper	0.005 (0.127)
Maximum Allowable Out of Round	0.002 (0.051)

CRANKSHAFT

Main Bearing Journal Diameter (MJB)	2.2437-2.2445 (56.99-57.01)
Main Bearing Journal Diameter (MJC, RJC)	2.2427-2.2435 (56.965-56.985)
Center Main Bearing Clearance (MJC, RJC)	.0024-.0052 (.061-.132)
Front and Rear Main Bearing Clearance (Original) (MJC, RJC)	.0030-.0043 (.076-.109)
Front and Rear Main Bearing Clearance (Replacement) (MJC, RJC)	.0024-.0062 (.06-.16)
Main Bearing Clearance (Original) (MJB)	.002-.0033 (.051-.084)
Main Bearing Clearance (Replacement) (MJB)	.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	.0012-.0032 (.030-.081)
Ring Groove Width	
Top	.0960-.0970 (2.438-2.464)
No. 2	.0955-.0965 (2.426-2.451)
No. 3	.1880-.1895 (4.775-4.813)
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	45°
Guide Clearance	.001-.003 (.025-.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

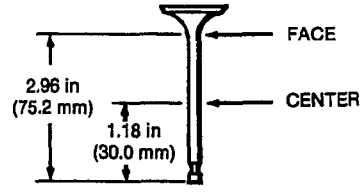
Valve Seat Bore (Diameter)	
Intake	1.547-1.548 (39.29-39.32)
Exhaust	1.361-1.362 (34.570-34.595)
Depth (from Cylinder Head Face)	.433-.439 (10.99-11.15)
Seat Outside Diameter	
Exhaust	1.364-1.365 (34.6456-34.6710)
Intake	1.550-1.551 (39.37-39.39)
Seat Width	.047-.062 (1.19-1.57)
Angle	45°
Available Insert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

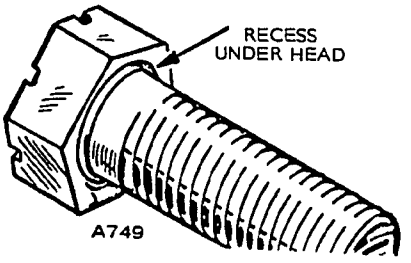
Valve Stem Diameter (Intake)



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. Lbs)
Center Main Bolt (4 cylinder)	97-102
Connecting Rod Bolt	27-29
Cover-Rocker Box	8-10
Cylinder Head Bolt	44-46
Exhaust Manifold Nuts	13-15**
Flywheel Mounting Screws	65-70
Hub-to-Flywheel Screws (4 cylinder)	17-21
Fuel Pump Mounting Screws	15-20
Gear Case Cover	18-20
Intake Manifold	13-15
Oil Base Mounting Screws	45-50
Oil Filter	Hand Tight + 1/2 Turn
Oil Pump Mounting Screws	15-20
Rear Bearing Plate	40-45
Rocker Arm Nut	4-10*
Rocker Arm Stud	35-40
Spark Plug	25-30

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

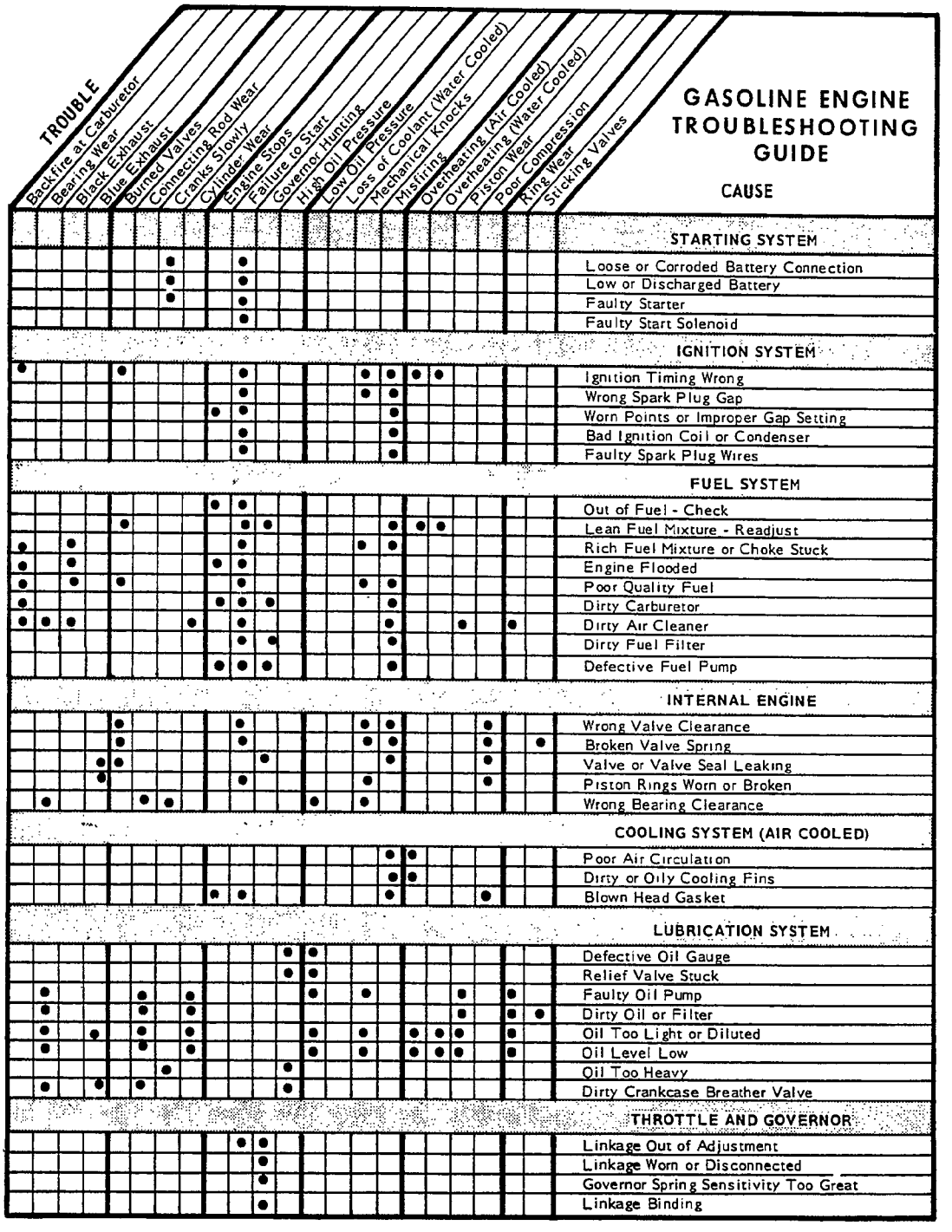
** – Tighten nuts evenly to avoid manifold damage.

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	420-0248
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

Troubleshooting Guide



Cooling System

PURPOSE OF COOLING SYSTEM

Purpose of the cooling system is to carry heat away from hot engine components to maintain proper running conditions and clearances. Overheating can severely damage engines. The cooling system must carry off excess heat.

Regulating coolant temperature helps keep the engine at optimal heat levels for each operating condition. After starting, engine must warm up quickly. During periods of peak output, it must be adequately cooled.

ANTI-FREEZE AND CORROSION

Corrosion can shorten engine life by plugging up radiator cores, building up around hot spots near the exhaust valves, and settling in low areas of the block. The corrosive sediment insulates against proper heat transfer and holds heat in. Most of the metals used in cooling systems are susceptible to corrosion damage that causes coolant leaks and temperature to rise above safe, normal limits.

To prevent corrosion, a mixture of anti-freeze and water should always be used as an engine coolant, even when freezing temperatures are not expected. Besides preventing coolant freeze up, anti-freeze contains rust inhibitors that prevent corrosion. Most anti-freeze manufacturers recommend a minimum 50-50 mix of ethylene glycol anti-freeze and water for winter and summer in closed water systems, with a complete change every year to avoid corrosion and more expensive damage.

HIGH TEMPERATURE CUT-OFF SWITCH

The high temperature cut-off switch shuts down engine if coolant reaches a dangerously high temperature. This normally closed switch senses coolant temperature in engine cooling jacket. When engine temperature rises beyond a specific point the switch opens, breaking the circuit to fuel solenoid. When coolant temperature falls to a safe operating range the switch closes, permitting engine restarting.

Stopping of engine due to action of high temperature cut-off switch is not a normal condition. Examine cooling system to determine the cause of overheating, and repair as required.

COOLING SYSTEM MAINTENANCE

The cooling system, including block and radiator, should be cleaned and flushed at least once a year. This is especially important in cold weather conditions or when preparing unit for extended storage (over 30 days or more)!

The cooling system can work efficiently only when it is clean. Scale and rust in the cooling system slow down heat absorption and restrict water flow.

The thermostat is calibrated to open at a specific temperature. It should be checked to be sure it is operating.

An appropriate anti-freeze mixture should be used in colder climates as necessary.

Check fan belt tension periodically. For proper operation of water pump, fan belt should be tight enough to prevent slipping.

Check water pump for wear periodically. Loosen fan belt and move fan and water pump pulley back and forth. If wear is excessive, replace bearing.

Cleaning and Flushing Cooling System

To clean rust and scale deposits from cooling system, drain system and then fill with clean water and cleaner solution. Use an approved chemical cleaner (such as type used for cleaning automotive cooling systems) and follow instructions provided by the supplier.

WARNING ***Cleaning solutions typically contain strong chemicals that can cause burns or other injury if used improperly. Read all warning labels carefully before using.***

When cleaning is complete, drain cleaning solution and flush system. For best results engine and radiator, or heat exchanger, should be reverse flushed. Allow engine to cool as much as possible before flushing with cold water.

CAUTION ***Never pour cold water into a hot engine. Doing so may crack head or cylinder block. Do not operate engine without coolant for even a few minutes.***

Flush system if engine operation indicates clogged passages or overheating.

WARNING ***Contact with hot coolant might result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.***

Engine Water Jacket and Cylinder Head

External coolant leakage may occur at any joint in the engine water jacket, such as drain plugs, core hole plugs, or cylinder head joint. Since expansion or contraction can aggravate leakage, the block should be inspected both hot and cold while engine is running.

Internal leakage occurs when coolant passes into engine oil through a loose cylinder head joint or a cracked or porous casting. The leakage is not visible but may cause extensive damage to engine. Coolant mixes with the oil to form sludge, which causes lubrication failure. Heavy sludge accumulations followed by sticking piston rings, valves, and tappets are symptoms of internal leakage.

Sometimes internal leaks are small enough to prevent coolant leakage but can permit exhaust gases to enter cooling system. The exhaust gases dissolve in the coolant, depleting rust inhibitors and forming acid which causes corrosion.

Thermostat

Replace thermostat if it is broken, corroded, or sticks in open or closed position. If engine overheats or does not reach and maintain a minimum operating temperature, thermostat should be removed and tested as a possible cause.

1. Remove thermostat from cylinder head.
2. Heat a pan of water to approximately 150°F. Check temperature, using a thermometer immersed in water.
3. With thermostat suspended in water at temperature of 150°F, thermostat should start to open.
4. After thermostat has opened completely, remove it from hot water and allow it to cool in surrounding air. The thermostat should close within a short time.
5. If thermostat sticks or does not operate properly, replace it with a new one.
6. Always install a new gasket when replacing thermostat.

Draining Cooling System

Whenever draining cooling system to change anti-freeze solution or for out-of-service protection when only water is used, be sure to open all drains and hose connections where water could be trapped.

The following drain plugs must be opened or removed to allow complete flushing of the cooling system.

Radiator: One petcock lower right front corner.

Engine Block: One drain plug left front near water pump.

Water Pumps: One drain plug under cover or by loosening cover.

If an optional water jacket tank heater is used it should be drained and flushed also. The lower hose must be disconnected at tank heater. There is no drain plug.

WARNING ***Contact with hot coolant might result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.***

After making repairs on cooling system, tighten all connections thoroughly. Use Permatex or thread sealing compound on all threaded connections to prevent leaks or entry of air into system.

Read instructions on Permatex Sealer can before applying sealer to engine parts.

Pressure Cap

The pressure cap increases boiling point of coolant by allowing pressure to build up in cooling system. The increase in boiling point reduces the chances for coolant loss due to boil over. A 15 psi (103.5 kPa) pressure cap will raise boiling point of water to 250°F (122°C) and boiling point of a 50/50 mixture of water and anti-freeze to 265°F (132°C). Pressure caps should be inspected periodically for freedom of operation, and gasket should be checked for proper sealing. Replace pressure cap if it malfunctions.

RADIATOR COOLING SYSTEM

On radiator cooled models (Figure 1), the water pump draws cooled water from radiator through the bottom hose and forces it into cylinder water jacket at the front of engine. Water circulates through the cylinder water jacket up through cylinder heads to thermostat and flows through the outlet hose into top of radiator. It circulates down through radiator while the fan blows cooling air across radiator. Water is drawn from the bottom of radiator by the pump to be recirculated.

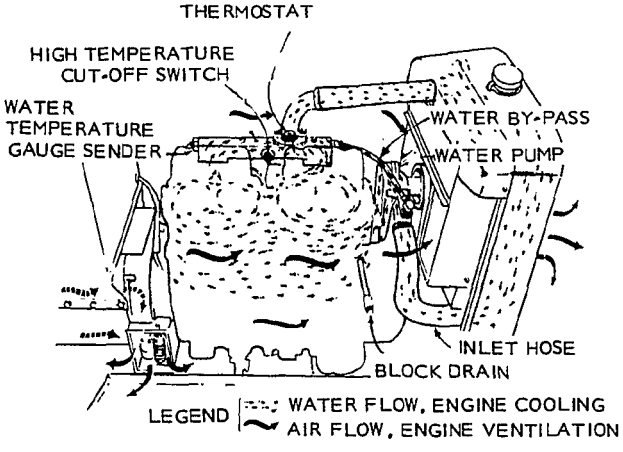


FIGURE 1. RADIATOR COOLING SYSTEM

During engine warmup, when thermostat is closed, water bypasses radiator. It flows through a bypass line from the water outlet housing to pump and recirculates through the engine. When water in engine block reaches normal operating temperature, thermostat opens. This permits heated water to flow into radiator to be cooled.

Recirculation ensures both rapid and even temperature increase of all engine parts during warmup.

Ventilation for radiator cooled models requires an inlet opening for fresh air and an outlet opening for heated air to prevent recirculation of heated air. The openings should be at least the size of radiator.

CAUTION ***An expansion area in the closed cooling system maintains proper coolant level by preventing overflow and loss of coolant when engine heats up.***

Water Pump

A centrifugal type water pump (Figure 2) circulates coolant through cooling system. The water pump is secured to cylinder block with capscrews and is belt driven from the crankshaft pulley. Coolant is drawn through pump inlet opening by impeller and forced through outlet opening in backside of pump into cylinder block. A gasket on water pump outlet assures a leakproof connection.

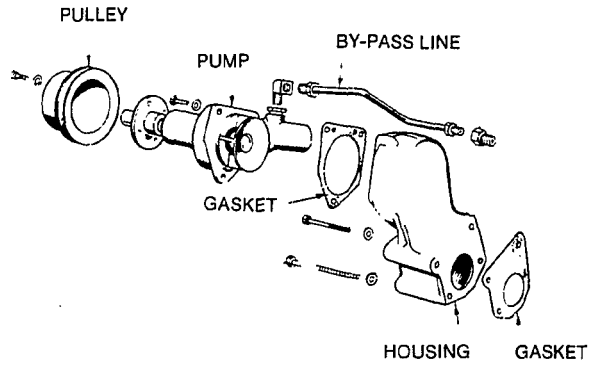


FIGURE 2. WATER PUMP–EXPLODED VIEW

Water pump is constructed to provide long life with a minimum amount of attention when proper corrosion preventive coolant is used. Care must be taken to keep grit and abrasive material from being circulated through cooling system. Water containing scale-forming materials is especially harmful to pump parts.

Pump cannot be rebuilt and must be replaced as a unit. Check condition of bearing and shaft assembly by turning water pump pulley. If bearing feels rough or binds, seal is leaking, or housing is cracked, the pump must be replaced.

Removal and Installation:

1. Drain cooling system at radiator and engine block.

WARNING ***Contact with hot coolant might result in serious burns. Allow cooling system to cool before releasing pressure and loosening lines.***

2. Remove housing from radiator as necessary.
3. Disconnect both hoses from radiator.
4. Remove radiator.
5. Loosen fan belt.
6. Remove fan and water pump pulley.
7. Disconnect by-pass line and radiator lower hose from pump.
8. Remove water pump from water pump housing.
9. Installation is the reverse of removal.

CITY WATER COOLED

On city water cooled models (Figure 3) the lockshield valve is manually adjusted with a key to provide the required minimum rate of water flow for cooling. Whenever ignition is turned on, the solenoid valve opens pressurized water inlet line.

During operation, water from pressurized source flows through lockshield valve and solenoid valve and through inlet line and enters at the bottom of cylinder water jacket at two places, one entry for each pair of cylinders. Water circulates around and up cylinder jacket through cylinder heads where it leaves engine through a thermostat and cover at each of the two cylinder heads. From the thermostat covers, water passes through exhaust manifold and is drained from engine cooling system.

During engine warmup, when the thermostats are closed, a water by-pass line controls the amount of water through cylinder water jacket until thermostats open. The by-pass line also continues to function during operation because it contains the high water temperature cut-off switch and water temperature sender unit.

Ventilation for these models is necessary for sufficient fresh air movement to cool generator and support combustion for the engine.

Check thermostat opening and closing with thermostat immersed in a water bath. Thermostat should start to open when water temperature reaches 145°F and should be fully open at 165°F. Take thermostat out of water and it should close in approximately 60 seconds. If it does not operate properly, replace it.

HEAT EXCHANGER COOLING (OPTIONAL)

ONAN heat exchanger cooling is available either factory installed or as a kit for customer installation. A complete heat exchanger installation (Figure 4) contains two independent water systems:

1. a closed water system

2. an open (raw) water system

In the closed water system, a centrifugal pump draws water from an expansion tank and pumps it through cooling tubes in a heat exchanger and into the engine water jacket where it circulates out through a thermostat back into expansion tank for recirculation. In the open water system, pressurized water is forced around the cooling tubes through heat exchanger and through exhaust manifold where it is discharged.

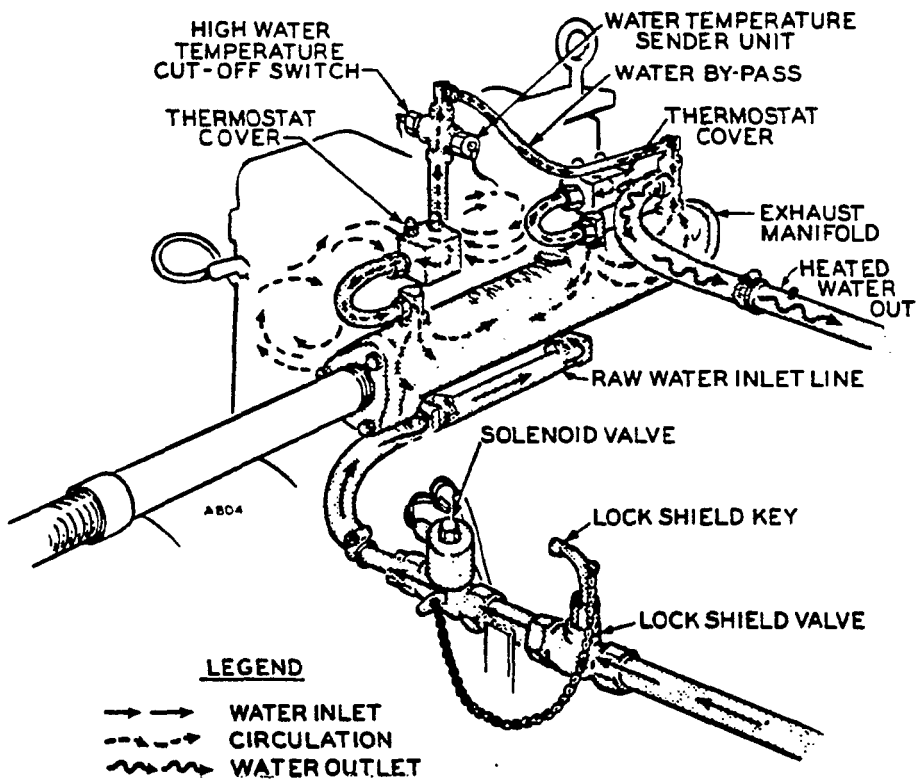


FIGURE 3. CITY WATER COOLING SYSTEM

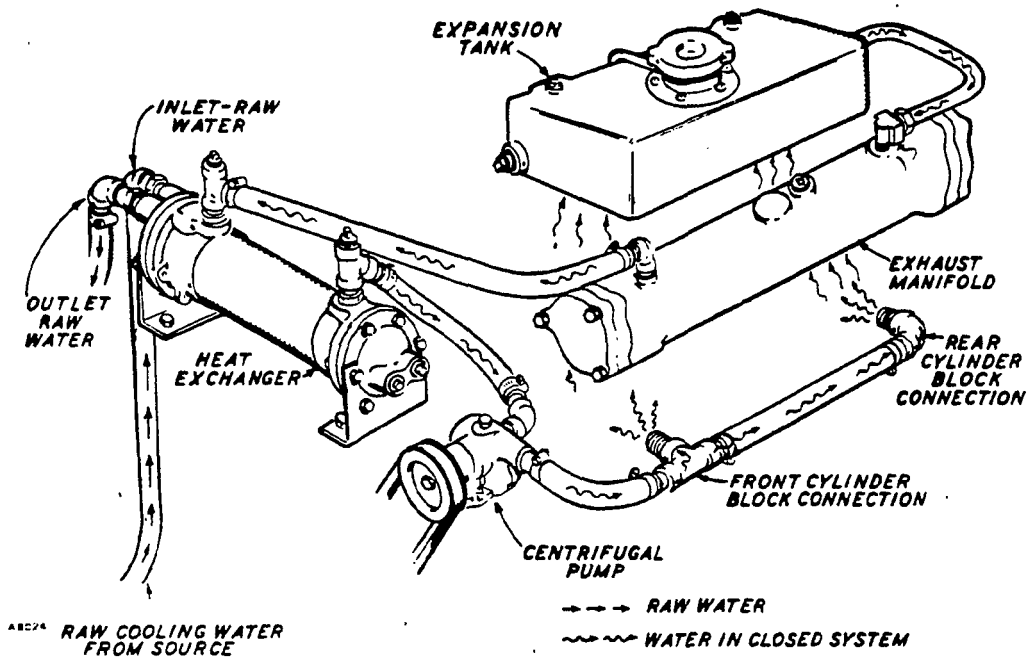


FIGURE 4. HEAT EXCHANGER COOLING SYSTEM

Maintenance of closed water system is the same as radiator cooled system. Clean and flush it once a year and use anti-freeze if there is danger of freezing. Use a rust inhibitor in the expansion tank (closed water system).

In an open water system, check periodically for air leaks, wear or damage, or restricted lines.

Open water portion of heat exchanger is protected from corrosion by a zinc pencil mounted on a pipe plug in one end of the heat exchanger. Inspect the pencil at least every two months and replace if deteriorated to less than one half original size (Figure 5).

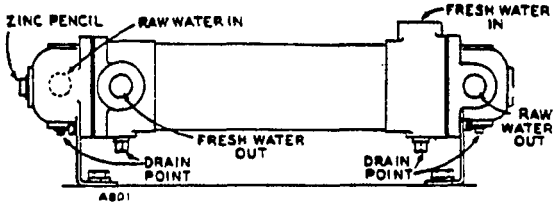


FIGURE 5. HEAT EXCHANGER AND ZINC PENCIL

Clean and flush cooling system if conditions warrant. To clean closed water system, drain and refill with radiator cleaner. When chemical cleaning is completed, according to the cleaner manufacturers instructions, flush cooling system to wash out deposits loosened by chemical cleaning action.

Flush the engine water jacket. Hose from engine water jacket to heat exchanger should be removed for water outlet. Flush both closed water portion and raw water portion of heat exchanger. Remove lockshield valve and solenoid valve to flush raw water portion. Also flush water cooled exhaust manifold. When flushing is completed, check system thoroughly for any leaks uncovered by cleaning operation.

Repair and test raw water system for air leaks and insufficient water flow.

Heat exchanger repair, if it should become clogged, consists of removing the ends and cleaning the tubes.

Water Pump (Centrifugal)

Pump repair is necessary if pump is leaking or bearings are worn. Disassemble pump and replace worn components (Figure 6).

1. Remove water inlet fitting, drive belt pulley, cover screws, and pump cover gasket.
2. Unscrew threaded impeller from pump shaft by turning impeller in a counterclockwise direction when facing impeller.
3. Slide seal seat, wear face, and bellows assembly off the shaft. Loosen clamp screw and slide pump body off the pedestal.
4. Remove bearing lock ring and drive, shaft and bearing assembly out of the pedestal. Bearing is press fit on the shaft and comes off in one integral part. The bearing is packed with a lifelong lubricant and is sealed at each end.

Replace all worn components such as bearings, seals, wear face, and impeller, and use a new cover gasket. Assembly sequence is the reverse of the disassembly procedure.

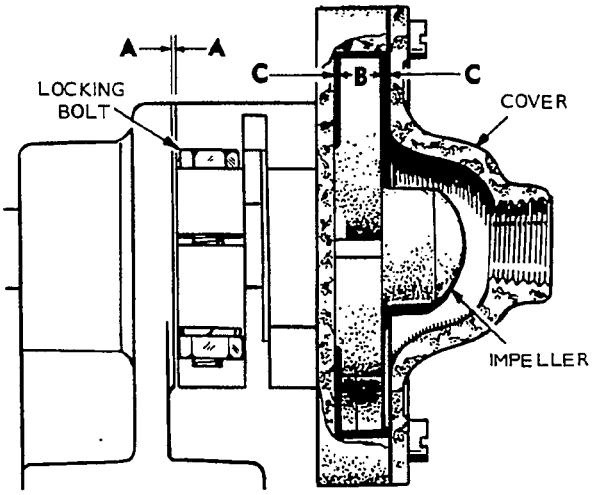


FIGURE 7. WATER PUMP CLEARANCES

After pump has been assembled (see Figure 7), the impeller (B) must be centered in body cover space (C-C). Adjustment is made by moving pump body fore and aft until shaft can be rotated freely by hand without binding. Pump must be adjusted with the drive belt off. If not centered properly, impeller will rub on the body or cover and quickly overheat. Clearance (A-A) may vary from zero to 1/16 inch (1.6 mm). Tighten lock screw when adjustment is correct being careful not to alter the setting.

When pump is installed on the engine, check to see that pump pulley is aligned with crankshaft pulley and adjust as required.

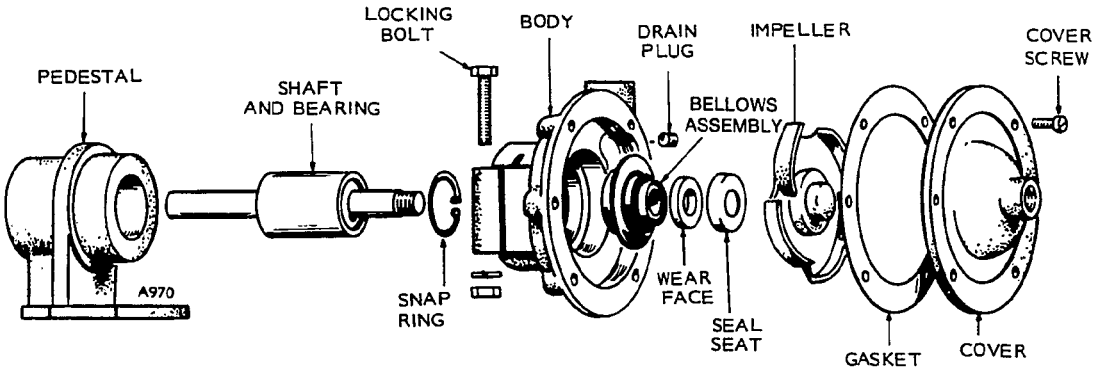


FIGURE 6. WATER PUMP ASSEMBLY

MARINE COOLED SYSTEM

The cooling system on MJB and MJC engines is a liquid coolant, pressure circulating, open system that uses raw water coolant (sea water).

Factory installed heat exchangers for a closed system are available as an optional feature and are discussed separately.

In a raw water cooling system (Figure 8), water enters pump located on the front left side of engine. The pump delivers water to bottom of cylinder jacket and it flows up the jacket and out an opening in cylinder head, which is controlled by the thermostat. For engine warm-up, when thermostat is closed, a by-pass from the cylinder block entrance to thermostat cover allows water flow. In addition, a notch in thermostat allows some water flow through cylinder jacket and heads. From thermostat, water passes through water cooled exhaust manifold and out of engine cooling system.

Maintenance

Cooling system maintenance should include periodic inspection for leaks, inspection of the rubber pump impeller, and periodic flushing and cleaning.

WARNING ***Contact with hot coolant might result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.***

The rubber impeller, because of continuous flexing, deteriorates with time and must eventually be replaced. If, however, the impeller fails after short service (usually under 500 hours) check for possible defects.

Only a clean cooling system can operate efficiently. Scale slows down heat absorption and restricts water flow. Flush system at least once a year and more often if operation indicates clogged passages or over-heating. To flush engine, remove thermostat, Figure 10, and water pump cover. Restrict the pump opening partially so cylinder block fills with water. Attach flushing gun nozzle to thermostat opening and fill block with water, then apply air pressure. Repeat process until water coming from block is clean.

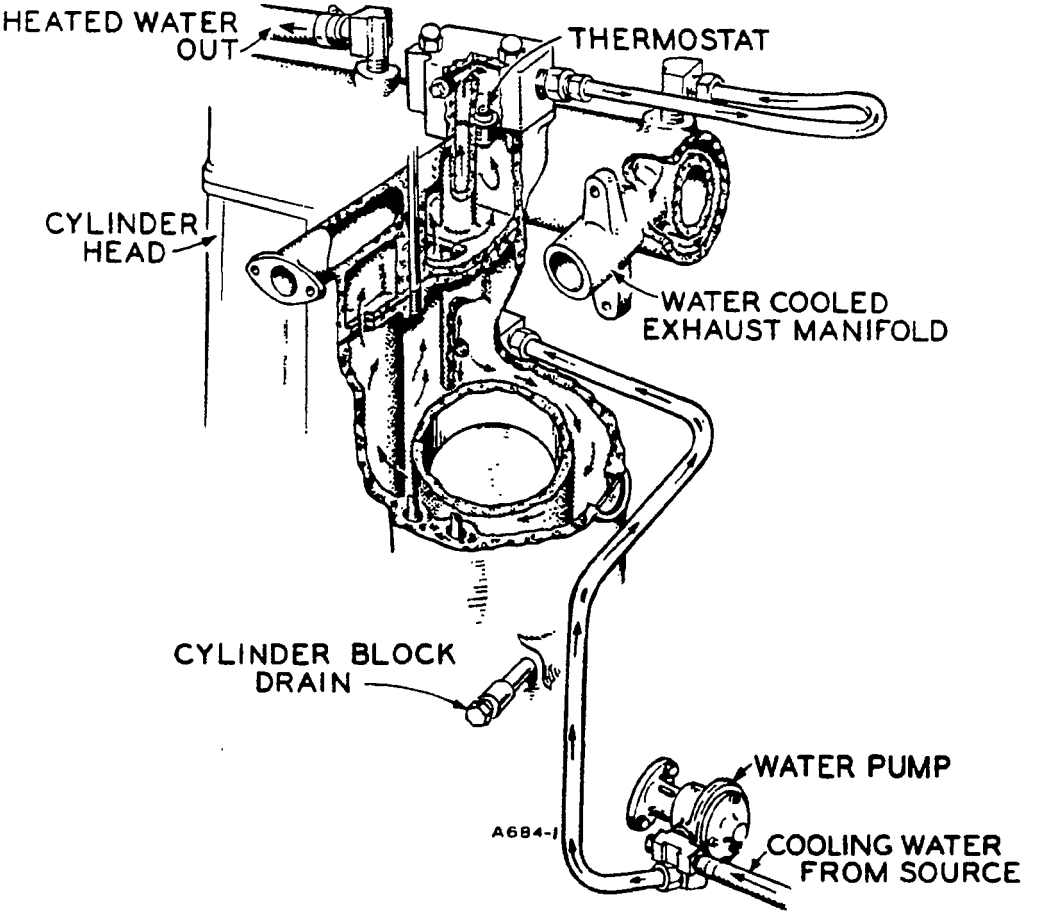


FIGURE 8. COOLING SYSTEM

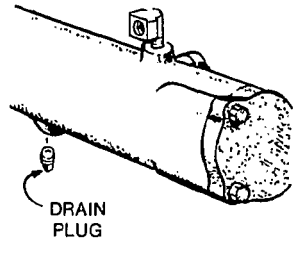
Testing

The cooling system can be tested for 2 abnormal conditions: (1) insufficient water flow and (2) air leaks.

1. To measure water flow, install a tank of known quantity at the water outlet. Run engine until thermostat opens and then measure the length of time necessary to fill the tank. From this obtain the flow in gallons per minute (GPM). If water flow is below minimum, check pump operation and inspect passages and water lines for clogging.
2. Air leaks are an important cause of premature impeller failure. To test for air in cooling system, run engine, insert cooling system outlet into a tank of water, and watch for bubbles. If bubbles appear, inspect cooling system thoroughly to find the source.

Repair

Whenever making repairs on cooling system, tighten all connections thoroughly. Use thread sealing compound on all threaded connections. This is especially important because of the damage air can cause.



EXHAUST MANIFOLD

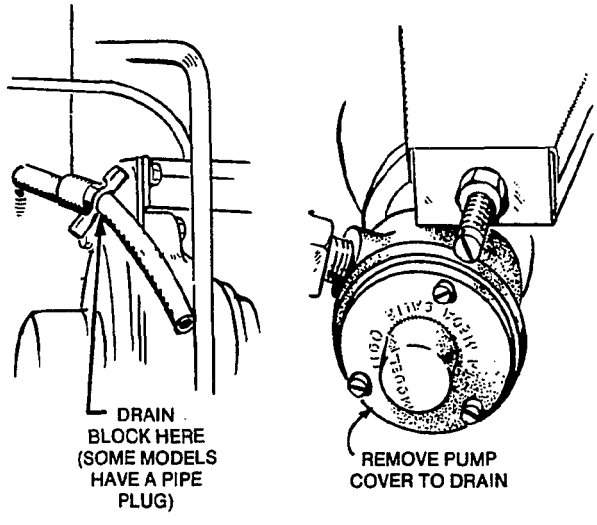


FIGURE 9. COOLING SYSTEM DRAINS

All water lines should be 1/2 inch inside diameter or larger. Long runs of pipe or hose need larger inside diameters to reduce resistance. Remember, the final test is always correct water flow.

Thermostat

A thermostat is located on right side of each cylinder head, connected by tubing to water cooled manifold. Replace thermostat if damaged by corrosion or other causes.

Check thermostat opening and closing with a thermometer in a water bath. Thermostat should start to open when water temperature reaches 145°F and be fully open at 165°F. Lift it out of the water and it should close in a short time. Replace thermostat if it doesn't operate properly.

Water Pump

The positive-displacement, rubber-impeller water pump is located on the upper left corner of the gear cover. Most water pump failures are caused by rubber impeller failure. If impeller fails, check for pock marks on its end surfaces. This is a sign of air in cooling system, which reduces pump lubrication and causes overheating.

If pump leaks water along its shaft, replace water seals (early models) or seal assembly (late models). If cam, wear plate, or end cover show excessive wear, replace it.

Disassembly (Early Models):

1. Loosen pump end plate screws and remove end plate.

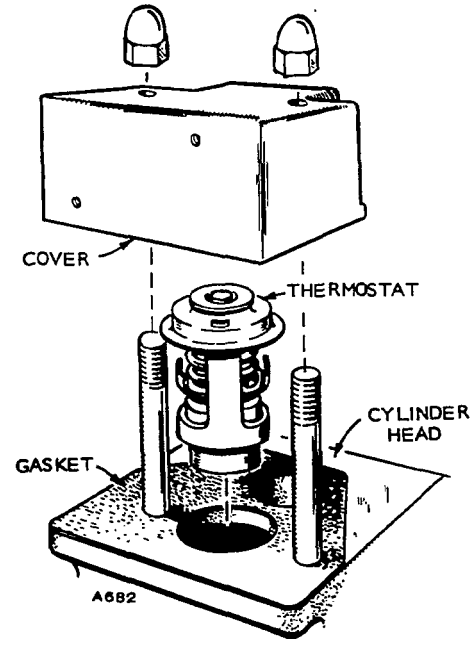


FIGURE 10. THERMOSTAT

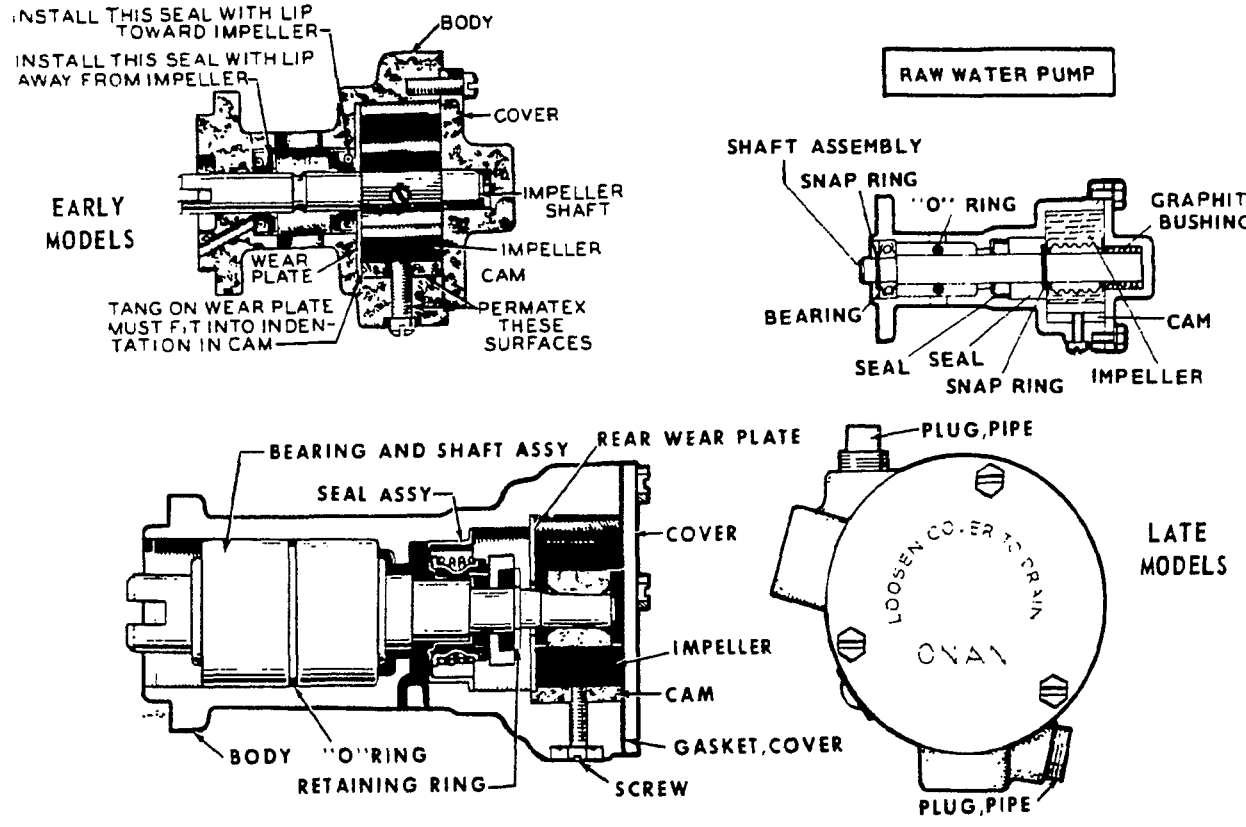


FIGURE 11. WATER PUMPS

2. Pull impeller and shaft out with a pair of pliers.

3. If further disassembly is necessary, remove pump from engine by removing the two capscrews on its mounting base.

4. Loosen set screw on side of pump by three or four turns, and tap it lightly to free cam from the pump body. Lift out cam and wear plate.

5. Drive the two water seals out from the drive end of the pump.

Remove only if they are to be replaced.

Disassembly (Late Models):

1. Loosen pump end plate screws and remove end plate.

2. Pull impeller out with a pair of pliers or by prying with screwdrivers (avoid damage to body).

3. If further disassembly is necessary, remove pump from engine by removing the two capscrews on its mounting base.

4. Loosen set screw on side of pump by three or four turns, and tap it lightly to free cam from pump body. Lift out cam and wear plate.

5. Remove seal assembly by prying through drain slots. (Install with faces clean and oiled.)

6. To remove bearing and shaft assembly, drive out by striking impeller end of shaft using a brass or wood dowel to avoid damage.

Remove only if O-Ring or bearing is to be replaced.

Assembly: Before beginning assembly, clean all old sealer from inside surfaces of pump body, cam and wear plate.

Early Models. Use suitable sealer on top surface and back face of cam as well as screw threads. Line up hole in cam with tang on wear plate.

Late Models. Use suitable sealer on screw threads only. Line up hole in wear plate with tang on the cam.

Assembly instructions are reverse of disassembly instructions.

HEAT EXCHANGER COOLING (OPTIONAL)

ONAN Marine Heat Exchanger cooling is available either factory installed or as a kit for customer installation. A completed heat exchanger installation contains two water systems, the closed water system and raw water system (Figure 12). The closed water system continuously recirculates water through engine water jacket, expansion tank, exhaust manifold, centrifugal pump, and one side of heat exchanger. The raw water system uses an engine-mounted, rubber-impeller pump to draw sea or city water and circulate it through heat exchanger, before discharging it.

COOLING SYSTEM CAPACITIES OF UNITS EQUIPPED WITH ONAN HEAT EXCHANGERS

MJB	4.5 qts.
MJC	9.5 qts.

CAUTION ***When planning to install any brand of heat exchanger other than ONAN approved, or any keel cooler, consult the factory or an ONAN distributor. To insure an adequate installation, the engine cooling system must be modified.***

Maintenance

Maintain closed water system the same as an automatic radiator cooling system. Clean and flush it once a year and use an anti-freeze if there is danger of freezing. Use of a rust inhibitor in the expansion tank (closed water system) is recommended.

In sea water system, check periodically for air leaks, rubber impeller wear or damage, and restricted lines.

Raw water side of heat exchanger is protected from corrosion by a zinc pencil mounted on a pipe plug in one end of heat exchanger. Inspect pencil at least every 2 months and replace if deteriorated to less than 1/2 original size, Figure 13.

Cleaning

Clean and flush cooling system at least once a year and more often if conditions warrant. To clean closed water system, drain and refill with radiator cleaner. When chemical cleaning is completed, according to cleaner manufacturer's instructions, flush the cooling system to wash out loosened deposits.

Flush engine water jacket as discussed in Maintenance Section, except that the hose from engine water jacket to heat exchanger should be removed from water outlet. Flush both closed water side and raw water side of heat exchanger. Remove rubber impeller pump cover to flush raw water side. Also flush water cooled exhaust manifold. When flushing is completed, check system thoroughly for leaks uncovered by cleaning operations.

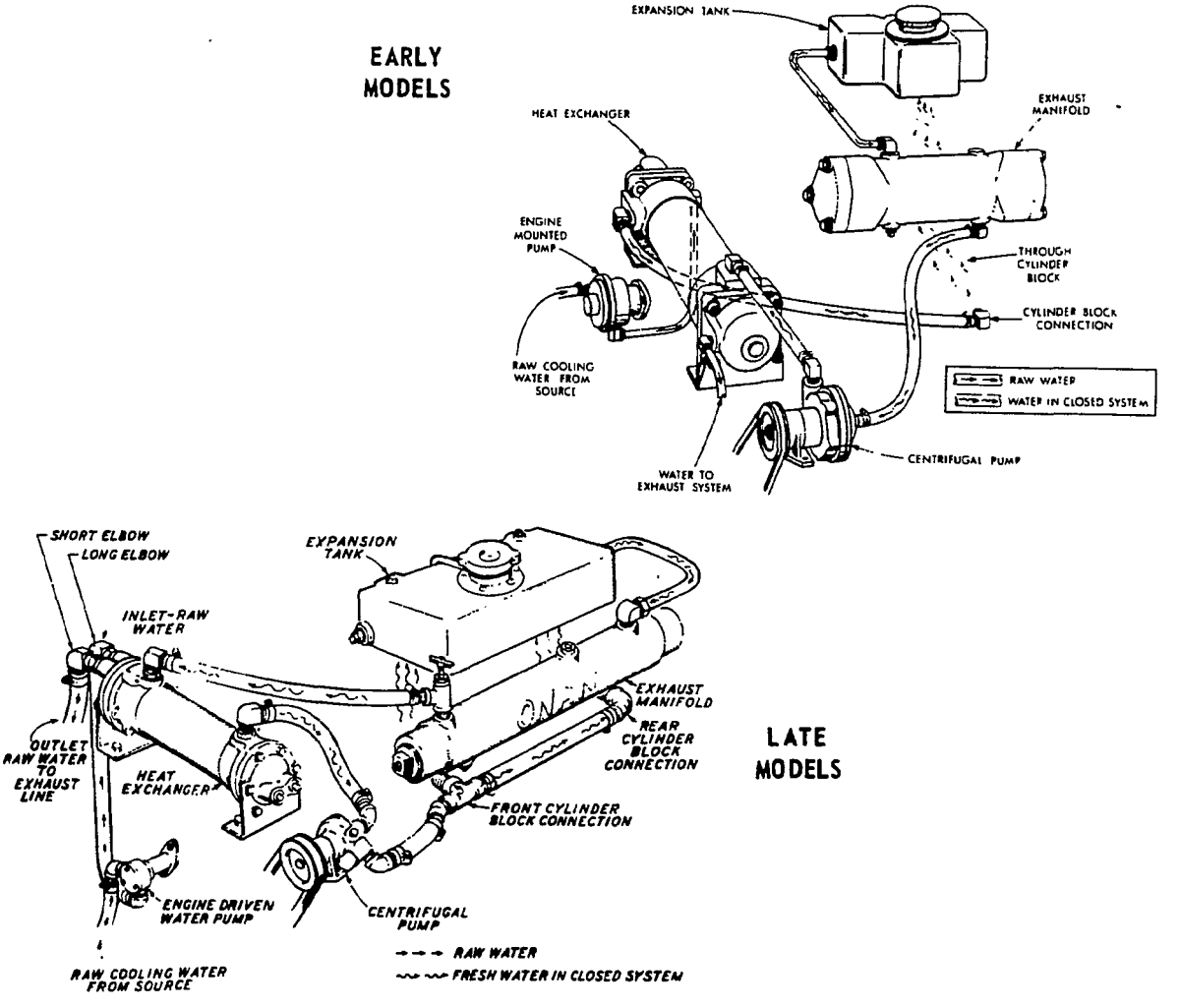


FIGURE 12. HEAT EXCHANGER COOLING

Heat Exchanger Repair

The heat exchanger should never require any repair under normal service conditions. However, if it should become clogged, remove ends and clean out tubes.

CENTRIFUGAL PUMP REPAIR

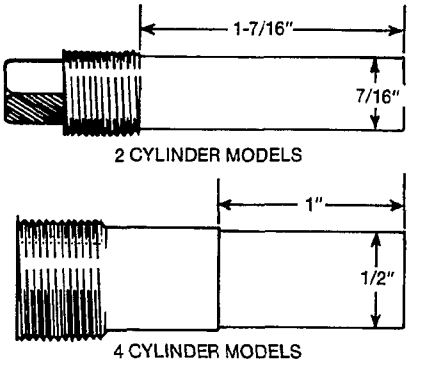
The centrifugal fresh water pump is mounted on the heat exchanger bracket. If it should leak, or if bearings should require replacement, disassemble it and replace the worn components (Figure 6).

THERMOSTATS AND EXPANSION TANK

On MJB engines, the expansion tank serves as the thermostat housing. On MJC engines, it houses the thermostat for the front two cylinders.

To remove expansion tank, remove two capscrews extending down through the tank. When installing tank, be sure all connections are tight.

Check the expansion tank fill cap. This is a pressurized cap, designed to hold 12-15 psi. Correct cap, good gaskets, and smooth gasket surfaces are essential for preventing loss of coolant.



ACTUAL SIZE - REPLACE WHEN DETERIORATED TO ONE HALF OF ORIGINAL SIZE.

FIGURE 13. ZINC PENCIL

Fuel System RJC

Standard RJC engines use a gasoline-carbureted fuel system to deliver a mixture of fuel and air to combustion chamber. The system draws fuel from a tank, delivers it through a filter and fuel pump (Figure 14), to the carburetor float chamber. Air passing through the carburetor venturi draws fuel from the float chamber.

A combination gasoline-gaseous fuel carburetor or straight gaseous fuel carburetors are available for use with gaseous fuels. A gaseous fuel system uses a fuel regulator (Figure 15) to control the flow of gas from lines to carburetor. At carburetor, the gaseous fuel is mixed with incoming air.

All fuel system components are described in the following paragraphs. Select the components that apply to your engine.

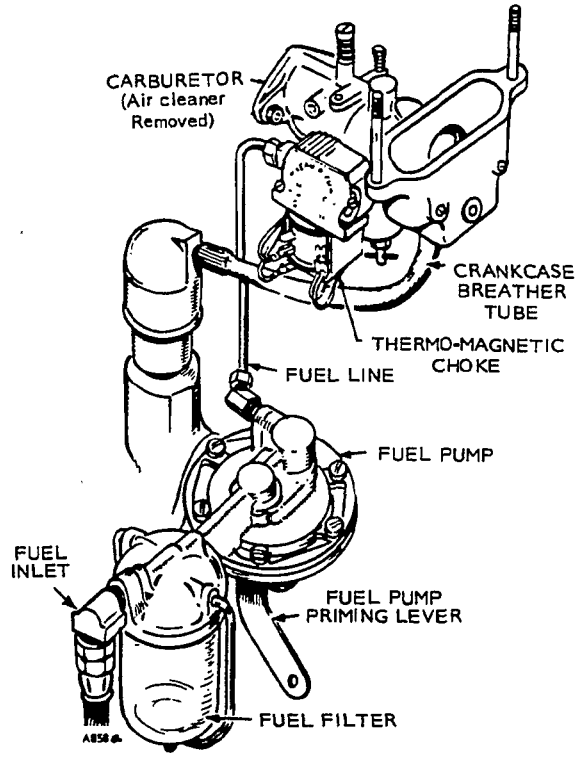


FIGURE 14. GASOLINE FUEL SYSTEM

FUELS

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.***

Onan recommends the use of clean, fresh, unleaded gasoline. Regular leaded gasoline may be used. Do not use highly leaded premium fuels. Using unleaded gasoline results in less maintenance.

If regular gasoline is used continually, carbon and lead deposits must be removed from cylinder heads as required because of engine power loss. Unleaded gasoline may be used safely after lead deposits have been removed.

CAUTION ***Failure to remove lead deposits prior to use of unleaded fuel can cause pre-ignition and possible engine damage.***

MAINTENANCE

On gasoline fuel systems, periodic maintenance consists of cleaning fuel strainer, cleaning or replacing air cleaner, carburetor adjustment and complete cleaning.

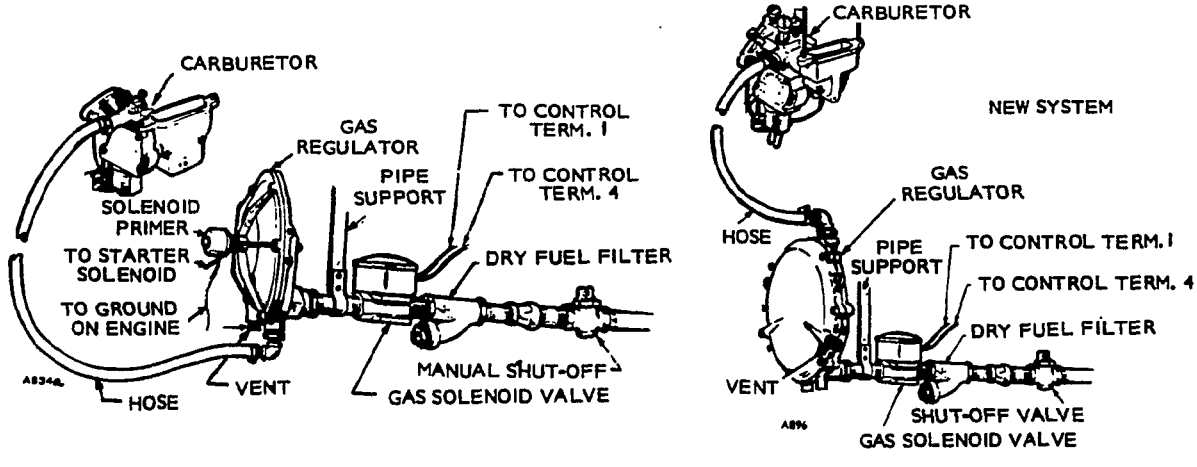


FIGURE 15. GASEOUS FUEL CARBURETION SYSTEMS

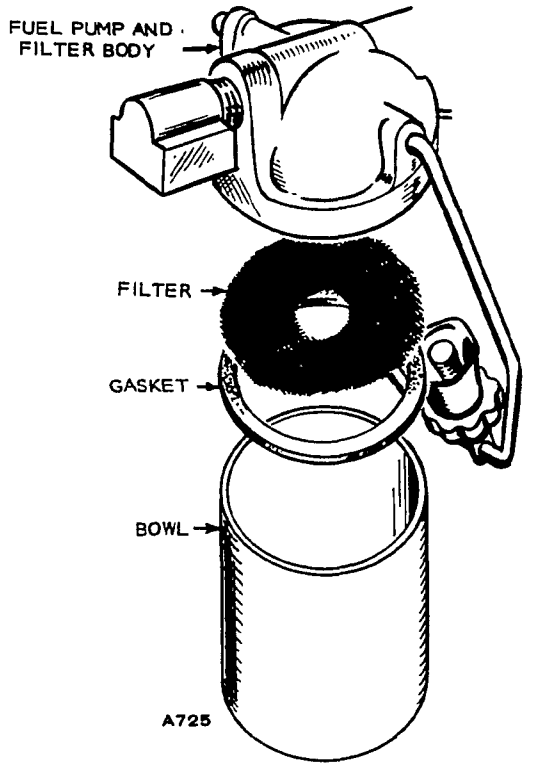


FIGURE 16. FUEL STRAINER CLEANING

To clean fuel strainer, remove fuel sediment bowl and screen (Figure 16) and thoroughly wash the screen. At the same time, remove and clean carburetor float bowl. Assemble and check for leaks.

On gaseous fuel systems, periodic service should include cleaning or replacing air cleaner, carburetor adjustment, inspection of hoses, etc. and cleaning optional dry fuel filter.

FUEL PUMP (GASOLINE FUEL SYSTEM)

The fuel pump (Figure 18) is located on left side of engine. If fuel does not reach carburetor, make the following checks:

1. Check fuel tank and see that shut-off valve is open.
2. Remove fuel line from pump outlet. Connect a fuel pump pressure gauge to pump outlet and crank engine over several times. On manual models, operate priming lever instead of cranking engine. Fuel pressure should be 1-2 psi. If not, remove pump for repair or replacement.

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.***

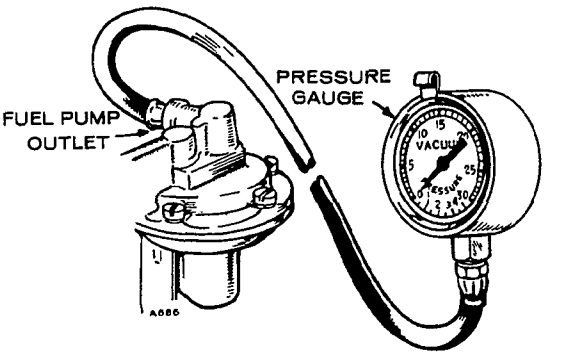


FIGURE 17. TESTING FUEL PUMP PRESSURE

Testing

Perform these tests before removing pump from the engine. If fuel pump delivers fuel, test it with a pressure gauge or manometer.

1. Disconnect pump outlet line and install pressure gauge (Figure 17).
2. Test valves and diaphragm by operating priming lever a few times. The pressure should not drop off rapidly after priming has stopped.
3. Run engine with adequate ventilation at governed speed on fuel remaining in carburetor, and measure fuel pump pressure developed. Pressure should be between 2 and 3 psi with gauge held 16 inches above fuel pump.

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

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

Removal and Disassembly

1. Remove pump inlet and outlet (Figure 18). Remove two capscrews holding pump to engine and lift it off.
2. Notch pump cover and body with a file for assembly in same relative position, and remove six screws holding them together.
3. Tap body with a screwdriver to separate two parts. Do not pry them apart; this may damage diaphragm.
4. Lift out diaphragm assembly and diaphragm spring.

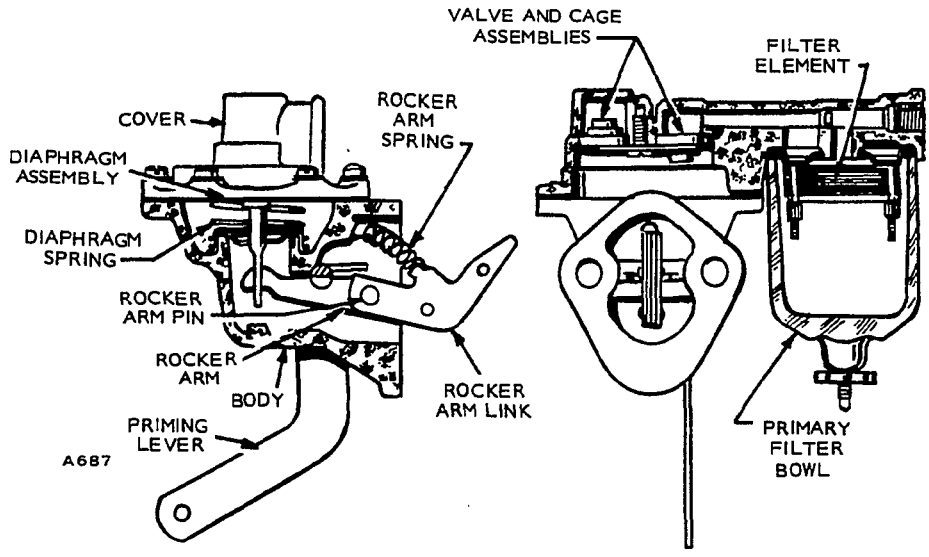


FIGURE 18. FUEL PUMP

Repair

Fuel pump failure is usually due to a leaking diaphragm, valve, or valve gasket. A kit is available for replacement of these parts. Because extent of wear cannot easily be detected, replace all parts in the kit. If diaphragm is broken or leaks, check for diluted crankcase oil. Occasionally, failure is due to a broken or weak spring, or to wear in the linkage. In this case, install a new pump.

Assembly

1. Before installing new diaphragm, soak it in fuel. Insert diaphragm spring and fuel-soaked diaphragm into pump body.
2. Compress rocker spring and install between body and rocker arm.
3. Assemble cover to body with notch marks lined up. Install screws but don't tighten. Push rocker arm in a full stroke and hold in this position to flex diaphragm.

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.***

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

4. Tighten cover screws alternately and securely, then release rocker arm.
5. Install pump on engine and repeat pressure test.

CHOKE (GASOLINE FUEL SYSTEM)

The choke on remote starting RJC engines, built prior to Spec C, is an automatic electric type (Figure 20). An electric element controls the choke. When engine is started, the generator supplies current to heating element which heats a bi-metal choke coil. As this coil heats, it winds tighter, opening the choke.

Electric choke adjustment for normal operation is done by measuring distance (Figure 20) between choke plate and carburetor throat with engine cold. Use straight shank end of a drill bit to measure gap. Air cleaner must be removed for choke adjustment. To adjust choke, loosen retaining screws on the end plate and rotate cover assembly.

Extreme temperature conditions may necessitate readjusting choke. Increase choke by turning cover clockwise; to decrease turn it counterclockwise.

Operation and Adjustment, Thermo-Magnetic Choke

This choke uses a strip heating element and a heat-sensitive bimetal spring to control choke position. A solenoid, actuated during engine cranking, closes choke all or part way, depending on ambient temperature.

The bimetal is calibrated to position choke at the proper opening under any ambient condition. Choke is adjusted at the factory. If, for any reason, readjustment is required, use the following procedure.

Adjustment must be made with the bimetal at ambient temperature. Do not attempt adjustments until engine has been shut down for at least one hour. Remove air cleaner to expose carburetor throat. Loosen screw which secures the choke body assembly. Refer to Figure 19 for correct choke setting according to temperature. Use a drill bit to measure the choke opening. Rotating the choke body clockwise richens mixture, and rotating it counterclockwise leans the choking effect. Tighten screw that secures choke body.

Disassembly and Repair, Electric and Thermo-Magnetic Choke

If choke does not operate, or will not maintain its adjustment, diassemble it for repair. If it will not close, check for binding, incorrect adjustment, or incorrect assembly of coil. If it will not open after engine starts, check for heating. Choke should be warm to the touch within a minute or two of engine starting. To disassemble choke, refer to Figure 20.

Electric Choke

If choke will not heat properly, check for a broken heating coil or high-resistance electrical connections. Check coil resistance with ohmmeter. With element at room temperature, resistance should be about 5 to 6 ohms for 12 volt models, about 25 ohms for 24 volt models, and about 16 ohms for 32 volt models. If coil is defective, replace thermostat cover.

When assembling electric choke be sure slot in cover tab straddles and holds outer end of coil spring and that the spring winds in a clockwise direction from center.

Thermo-Magnetic Choke (Begin Spec C)

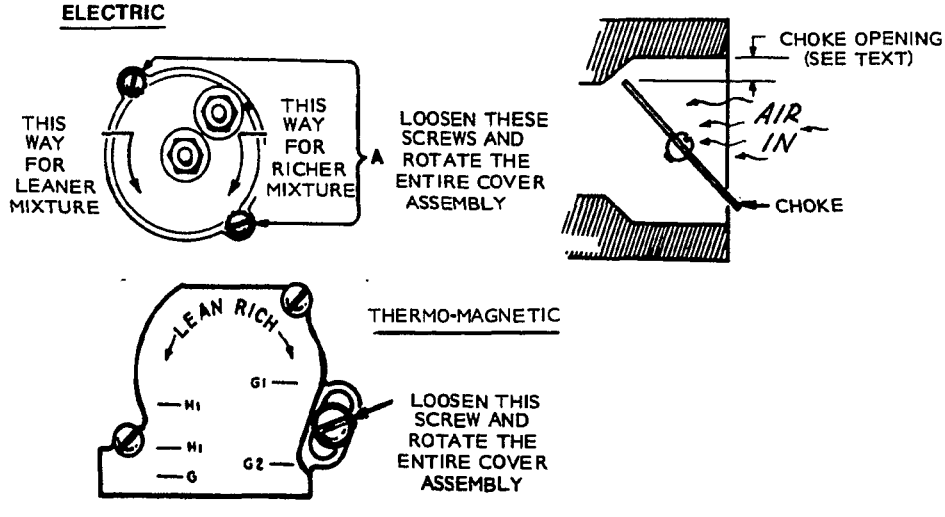
If choke will not heat properly, check for broken heater wire, high-resistance connections, or broken lead wires to bimetal and heater assembly. With element at room temperature, check heater resistance with an ohmmeter. Resistance should be about 30.6 to 37.4 ohms for a 12 volt system. If heater is defective, replace it with a new one. When start button is engaged, the solenoid should cause spring-loaded armature to contact solenoid core.

If this does not occur, check for broken lead wires or a defective solenoid coil. There must be slack in lead wires between choke body and the bimetal and heater assembly. Solenoid coil resistance should be 2.09 to 2.31 ohms in a 12 volt system.

When replacing cover on thermostat and heater assembly, be certain that choke heater lead wires have been correctly installed in choke housing. Improper replacement of lead wires can cause choke assembly to malfunction.

The wires enter choke assembly through a small notch that is cut in the edge of the housing. A cover holds wires in place and prevents movement when tightened. When properly installed, lead wires will hang freely under bimetal coil when choke is in either the open or closed position. The end of heater wire sleeve should be located from 1/8 inch inside choke housing to flush with inside wall.

AVERAGE CHOKE SETTINGS	
AMBIENT TEMP. - F	CHOKE TO BODY
68	0
72	1/64
76	3/64
80	1/16
84	3/32
88	7/64
92	1/8
96	9/64
100	11/64



AMBIENT TEMP. (°F)	60	65	70	75	80	85	90	95	100
CHOKE OPENING (Inches)	1/8	9/64	5/32	11/64	3/16	13/64	7/32	15/64	1/4

FIGURE 19. CHOKE ADJUSTMENTS

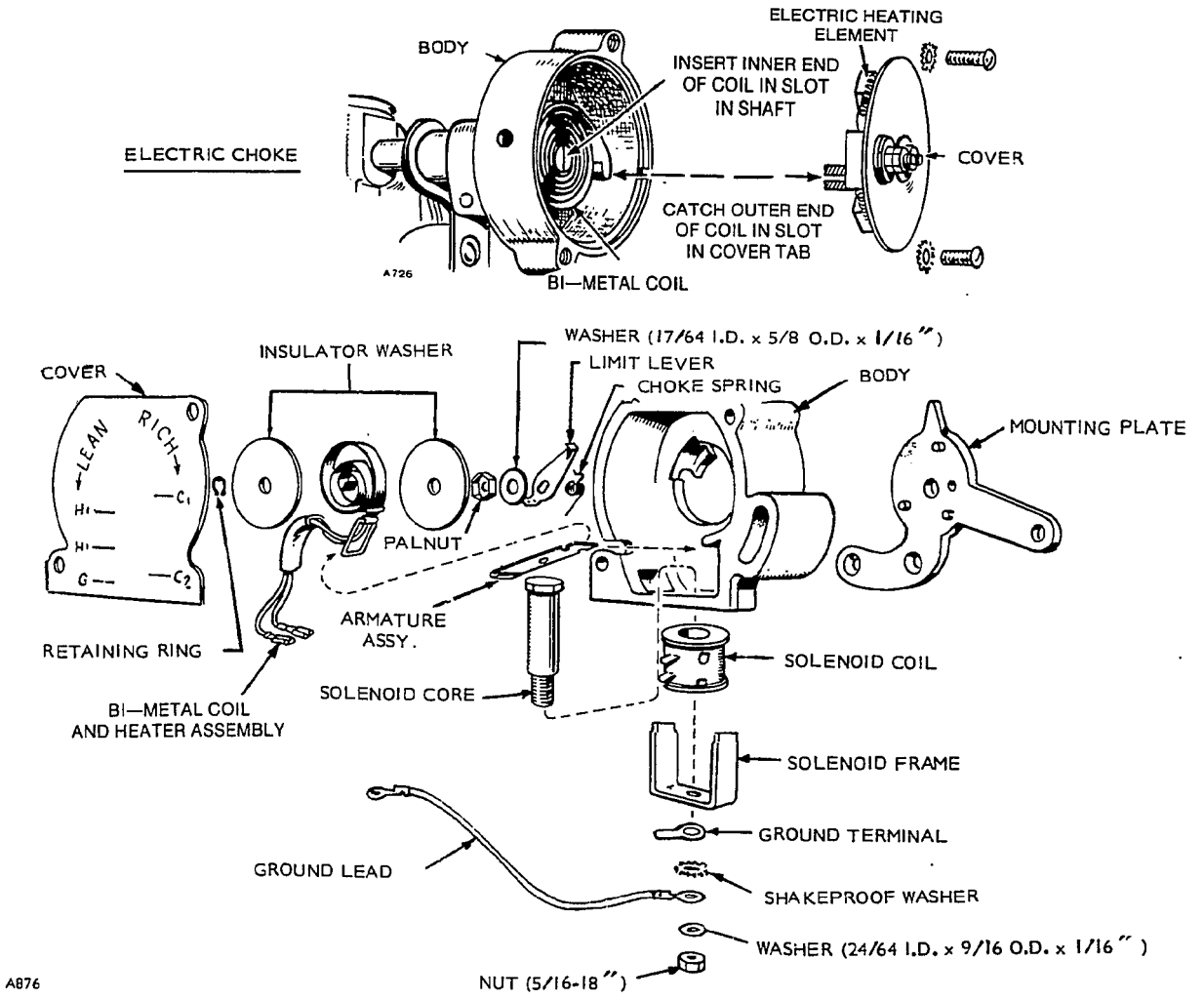


FIGURE 20. DISASSEMBLY OF ELECTRIC AND THERMO-ELECTRIC CHOKE

When assembling thermo-magnetic choke, bimetal and heater assembly is connected as follows:

1. Lead tagged G goes to ground terminal on coil solenoid.
2. Lead tagged H goes to either of the H¹ terminals on solenoid core.

GASOLINE CARBURETOR

The gasoline carburetor is a horizontal draft type. It consists of three major sections: bowl and float, idle circuit, and load circuit.

Fuel enters carburetor through the valve (Figure 21) and passes into float chamber. The float controls fuel level in bowl by closing inlet valve when fuel reaches a certain height and opening it when fuel level drops.

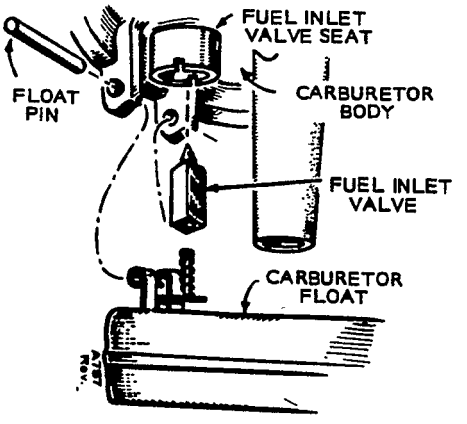


FIGURE 21. CABURETOR INLET VALVE

The idle circuit (Figure 22 and 23) supplies fuel during no-load operation and for small loads. Throttle is nearly closed at no load, and intake manifold vacuum is high. Pressure difference between manifold and float chamber causes fuel to flow through the idle circuit. The pressure difference draws fuel up through the hollow center of main adjusting needle, through passages in carburetor body to the idle port. Bleed holes in main adjusting needle allow air to mix with the fuel. When throttle is almost completely closed, fuel passes out through the idle port. As throttle is opened to increase power, fuel is also drawn out through idle transfer port in the hollow main adjusting needle.

When load increases, engine governor opens the throttle further. As carburetor air flow increases, this produces a low pressure at venturi (narrow section of carburetor throat). This pressure drop operates load circuit drawing fuel up main nozzle where it mixes with air at the nozzle opening. Main adjusting needle controls fuel delivery.

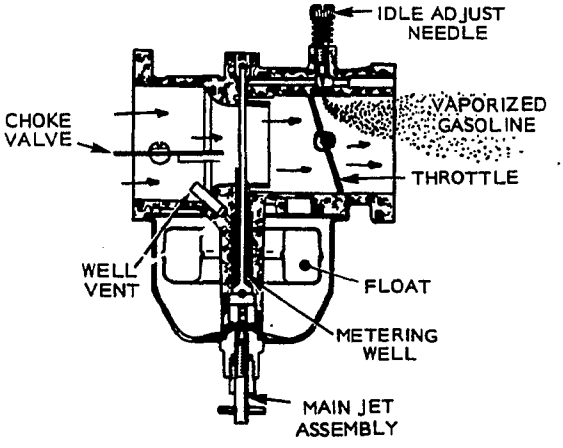
As throttle opens, manifold vacuum decreases so idle circuit becomes less effective. In a certain range, the two circuits blend; both delivering fuel, but as load is increased, the load circuit takes over.

With load circuit in operation, as load is increased, the throttle opens to deliver more fuel. Main nozzle will not immediately deliver this increased fuel, because of the jets controlled by adjusting needle. To prevent lag when load is increased, a metering well around the outside of the nozzle delivers fuel until main jet can catch up with increased demand.

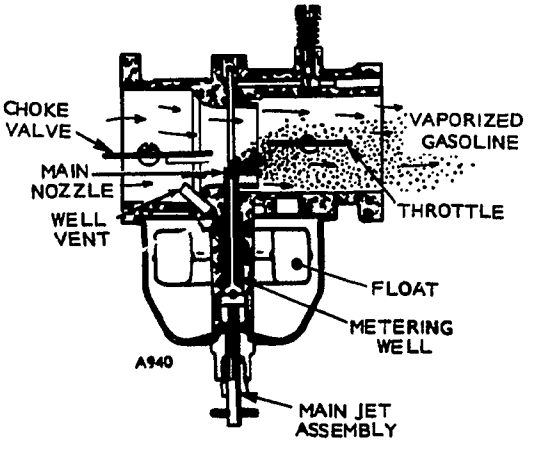
Adjustment, Electric Choke

Under normal operation, adjust choke so distance measured between choke and carburetor throat (Figure 19) is as shown in table with the engine cold. Use the straight shank end of a drill bit to measure gap. The upturned air cleaner must be removed for choke adjustment. To adjust choke, loosen the two screws on cover plate and rotate cover assembly.

CAUTION ***Forcing the needle against its seat will bend the needle. The needle does not shut off fuel completely when turned all the way in.***

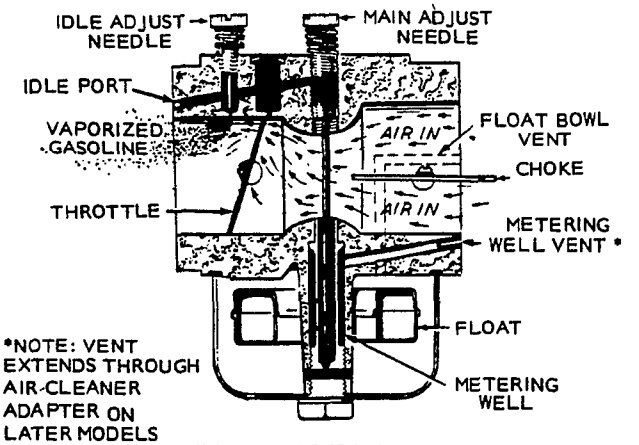


IDLE JET OPERATING

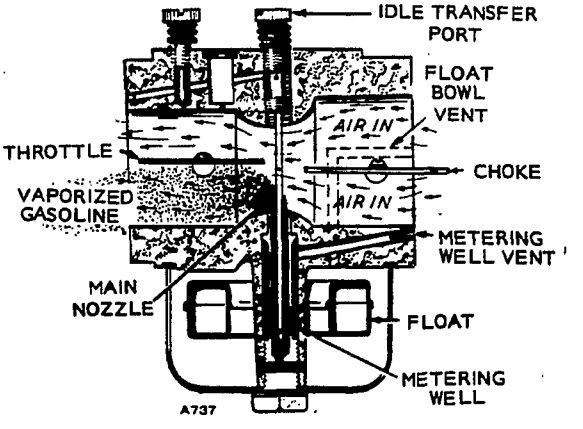


MAIN JET OPERATING

FIGURE 22. CARBURETOR CIRCUITS BEGIN SPEC R



IDLE JET OPERATING



MAIN JET OPERATING

FIGURE 23. CARBURETOR CIRCUITS PRIOR TO SPEC R

Adjustment, With Load

Carburetor should be adjusted in 2 steps — first the idle adjustment and then the load adjustment. See Figure 24.

If the carburetor is completely out of adjustment so the engine will not run, open both needle valves 1 to 1-1/2 turns off their seats to permit starting. Do not force needle valves against their seats. This will damage the needle.

Before adjusting carburetor, be sure ignition system is working properly and governor is adjusted. Then allow engine to warm up.

1. With no engine load, turn idle adjustment out until engine speed drops slightly below normal. Then turn needle in until speed returns to normal.
2. Apply a full load to engine. Carefully turn main adjustment in until speed drops slightly below normal. Then turn needle out until speed returns to normal.

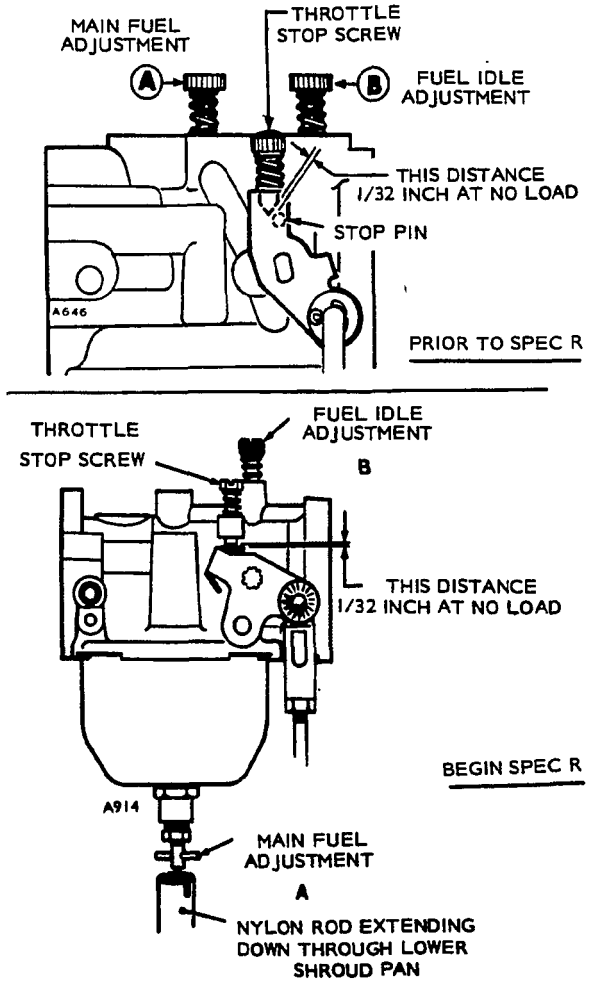


FIGURE 24. ADJUSTING GASOLINE CARBURETOR

Adjustment, Without Load

1. Start engine and allow it to warm up. Push in on governor mechanism to slow engine down to about 400 to 500 rpm.
2. Set idle adjustment screw for even operation (so engine is firing on all cylinders and running smoothly).
3. Release governor mechanism to allow engine to accelerate. Engine should accelerate evenly and without a lag. If not, adjust needle outward about 1/2 turn and again slow down engine and release governor mechanism. Continue until engine accelerates evenly and without a lag after releasing governor.

With carburetor and governor adjusted, and engine running with no load (Figure 24), allow 1/32-inch clearance at stop pin to prevent excessive hunting when a large load is suddenly removed.

Removal and Disassembly

1. Remove fuel line, governor linkage, and electric choke wire.
2. Remove two carburetor mounting nuts and pull off carburetor.
3. Remove air cleaner adapter and choke from carburetor.
4. Remove main fuel adjustment needle (begin Spec R) and float bowl nut and pull off bowl. Remove float pin and float.
5. Lift out float valve and unscrew its seat.
6. Remove no-load adjusting needle, load adjusting needle (prior to Spec R) and spring.
7. Remove throttle plate screws and plate, and pull out throttle shaft.
8. Remove choke plate screws and plate and pull out choke shaft.

Cleaning and Repair

Soak all components thoroughly in a carburetor cleaner, following the cleaner manufacturer's instructions. Clean all carbon from carburetor bore, especially in area of the throttle. Blow out passages with compressed air. If possible, avoid using wire to clean out the passages.

Check adjusting needles and nozzle for damage. If float is loaded with fuel or damaged, replace it. Float should fit freely on its pin without binding. Invert carburetor body and measure float level (Figure 25).

To check float level, remove entire main fuel adjustment assembly from float bowl. Unscrew large nut from the float bowl. Adjust float level by bending tab on the float as shown in Figure 25. With full weight of float on the spring, float-to-gasket gap should be 1/16-inch.

Do not apply excessive pressure to float valve.

To adjust float level, bend small tab that inlet valve rides on.

Check choke and throttle shafts for excessive side play, and replace if necessary. Do not remove teflon coating on throttle shaft. Coating reduces wear and friction between shaft and carburetor body.

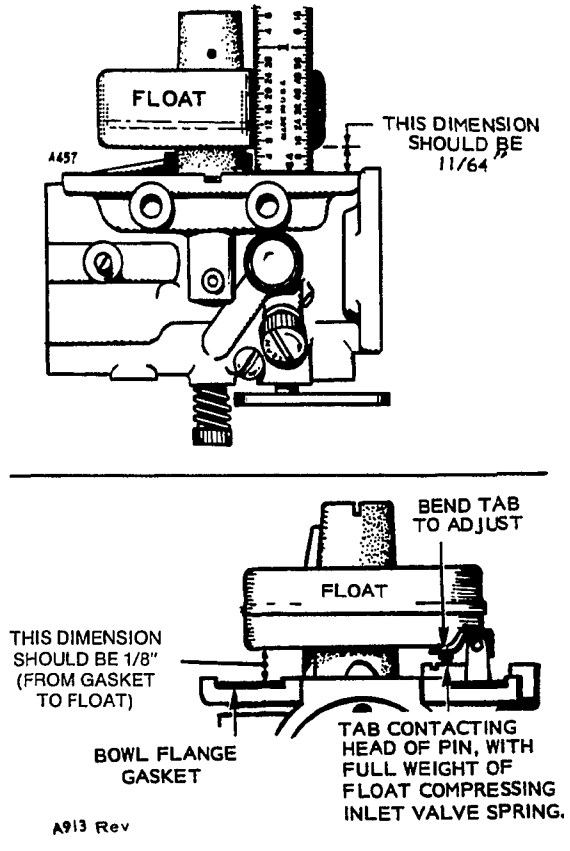


FIGURE 25. SETTING FLOAT LEVEL

Assembly and Installation

1. Install throttle shaft and plate, using new screws. Install with bevel mated to carburetor body. On plates marked C, install with mark on side toward idle port when viewed from flange end of carburetor. To center plate, back off stop screw, close throttle lever and seat plate by tapping it with a small screwdriver; then tighten two screws.
2. Install choke shaft and plate. Center plate in same manner as throttle plate (Step 1). Always use new screws.
3. Install main nozzle (prior to Spec R), making sure it seats in body casting.
4. Install fuel inlet valve seat and valve.
5. Install float and float pin. Center pin so float bowl does not ride against it.
6. Check float level with carburetor casting inverted. Set carburetor float 11/64-inch between free end of float and carburetor body. See Figure 25.
7. Install bowl ring gasket, bowl and bowl nut (and main nozzle begin Spec R). Make sure that bowl is centered in gasket and tighten nut securely.
8. Install adjusting needle with its spring. Turn in until main seats and back out 1 to 1-1/2 turns.
9. Install idle adjusting screw finger tight. Then back out 1 to 1-1/2 turns.
10. Reinstall choke and adjust.
11. Install air horn assembly and gasket.
12. Install carburetor on engine and connect gasoline inlet, governor mechanism breather hose and choke.
13. Install air cleaner.

GASEOUS FUEL CARBURETOR

The gaseous fuel carburetor (Figure 26) is similar to the gasoline carburetor in shape, but it differs in operation. Gaseous carburetors contain two major sections, the idle circuit and the load circuit. Fuel delivery depends on demand created on fuel inlet line, Figure 27. A small vacuum on inlet line opens fuel regulator, delivering fuel. For no-load operation, idle adjustment controls quantity of fuel allowed through the idle port. The throttle is almost closed, so increased vacuum on engine side of carburetor draws fuel through the idle passage. When load increases, the flow of air through carburetor draws fuel from main fuel port located at venturi of the carburetor.

Adjustment

Set carburetor idle adjustment and then the load adjustment.

If carburetor is completely out of adjustment so the engine will not run, open idle adjustment one or two turns; then crank engine while opening main adjustment, until engine starts.

Adjust carburetor in the same manner as gasoline carburetor. Usually idle adjustment will have little effect on operation, because of the high engine speed.

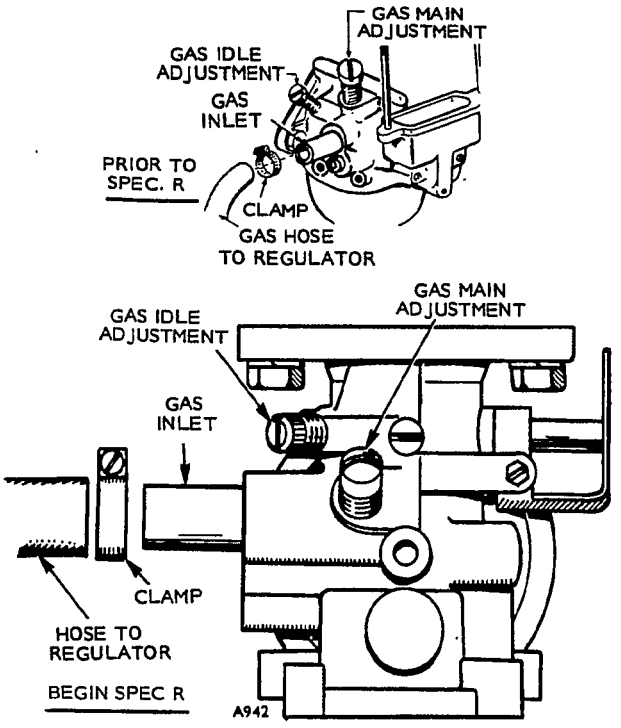


FIGURE 26. GASEOUS FUEL CARBURETOR

Removal and Disassembly

1. Remove fuel hose and governor linkage.
2. Remove two carburetor mounting nuts and pull off carburetor.
3. Remove float bowl (and main adjustment screw begin Spec R), Figure 27.
4. Remove throttle plate screws and plate and pull out throttle shaft.

Repair and Assembly

Clean in a suitable carburetor cleaner and blow out idle passage. Check idle needle for wear or damage and main adjustment for worn threads. For assembly, reverse the disassembly procedure.

COMBINATION GAS-GASOLINE CARBURETOR

This carburetor operates on either gasoline or gaseous fuels. To switch operating fuels, make adjustments according to Table 2. The combination carburetor consists of both gasoline and gaseous fuel carburetors on a single casting.

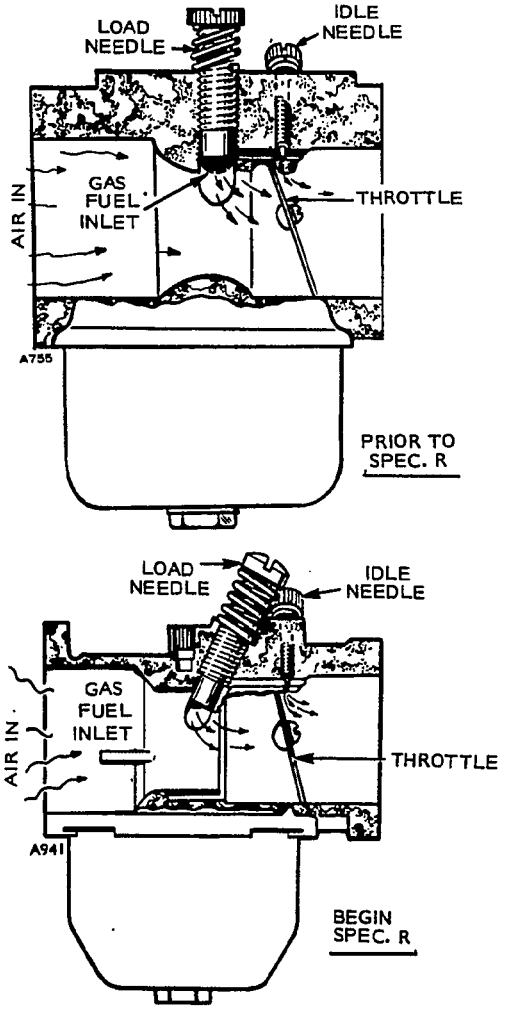


FIGURE 27. GASEOUS FUEL ADJUSTMENTS

The combination gas-gasoline carburetor adjustment is the same as for gasoline. See Figure 28 for location of adjustment needles.

TABLE 2. FUEL CHANGE CONVERSIONS

Modification	To Gasoline	To Gaseous Fuel
Gas supply valve	Close	Open
Carburetor float and needle valve	Replace if removed for gas	Remove if for extended operation on gas — reduces wear
Choke	Remove lock wire	Install lock wire
Spark plug gap	Set at .025"	Set at .025"
Gasoline fuel supply valve	Open	Close

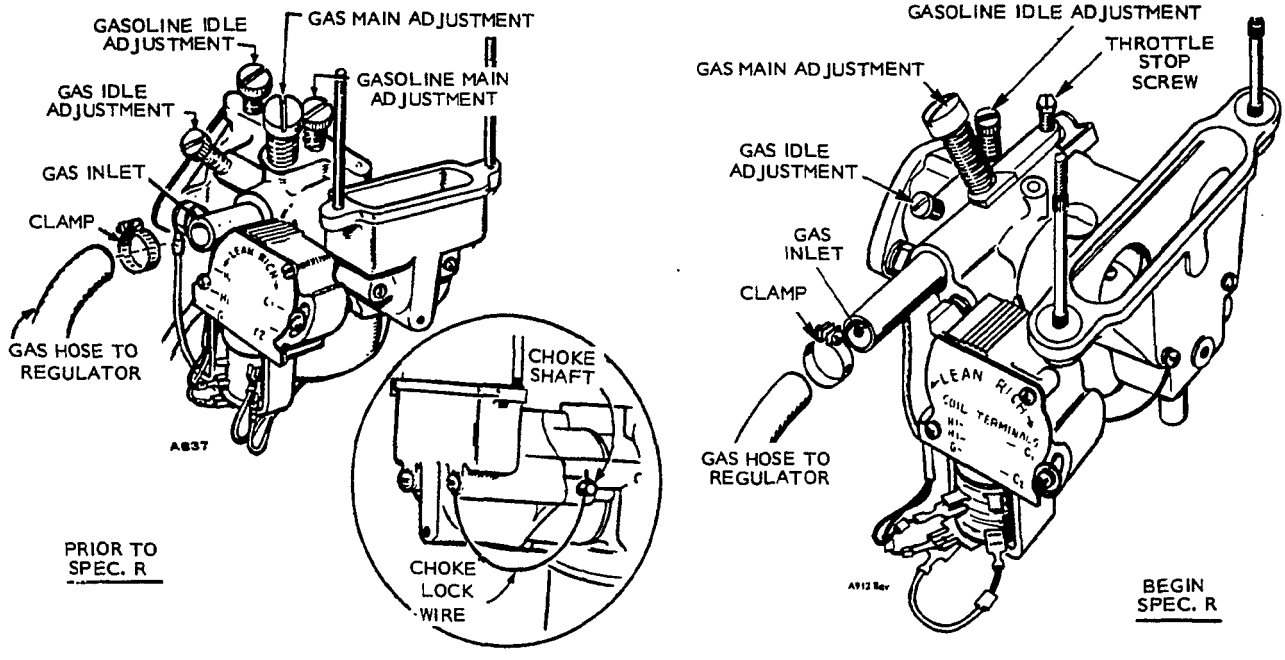


FIGURE 28. COMBINATION CARBURETOR ADJUSTMENTS

GASEOUS FUEL REGULATOR

The demand-type regulator opens upon a small vacuum from the carburetor. It supplies fuel on demand, and shuts off fuel flow when engine is stopped, or when there is no demand.

Regulator is simply a diaphragm with linkage connecting it to a valve in the gas line. A small vacuum from engine moves the diaphragm, opening delivery valve.

Testing

Blow into diaphragm vent hole on regulator cover; this should open the valve. An audible hiss indicates that the regulator is opening.

A water manometer (Figure 29) is the standard tool for testing regulator inlet pressure, which must be within the limits specified for your regulator. Use chart in Figure 29 to convert the difference in water level between the two tubes to pressure in ounces.

Gas Regulator (Algas)

The Algas regulator has no adjustments, and features a positive lock-off if pressure increases above the regulator setting. Maximum inlet pressure is 5 psi and minimum, 6 ounces.

The standard ONAN supplied solenoid shut-off valve #307-0312, locks off at a gas inlet pressure of slightly over one pound. An optional valve is available with pressure rating to 5 psi. See Figure 30.

Gas Regulator (Garretson)

Maximum allowable inlet pressure is 8 ounces; minimum 2 ounces. If gas line pressure is greater than 8 ounces, install a primary regulator to reduce the pressure. Regulator has an adjustment to control maximum pressure at which the regulator shuts off when there is no demand. To obtain maximum regulator sensitivity, adjust it to just shut off at your line pressure when there is no demand. Adjust regulator for shut off when there is no demand, to prevent gas leaks. Factory adjusted shut-off is between 2 and 4 ounces. If gas line pressure is between 4 and 8 ounces, readjust the screw (Figure 31).

To adjust regulator, gas line should be connected and the outlet hose removed. Make a coarse adjustment by turning adjusting screw inward until hissing of escaping gas at outlet stops. Install a water manometer on inlet side of regulator to make the fine adjustment. With gas on, cover regulator outlet for a few seconds and then open. If regulator is leaking, the pressure shown on manometer will drop slightly or waver, indicating that the valve is opening. Turn screw inward slightly and repeat test. Continue until manometer holds steady as outlet is closed for a few seconds and then opened.

If regulator does not deliver fuel, check inlet pressure. If pressure is over 5 psi (1 psi with optional solenoid valve) a primary regulator is required to reduce inlet pressure. If inlet pressure is within the required limits and regulator will not deliver fuel or leaks, disassemble it for repair.

To disassemble regulator, carefully remove cover and separate the diaphragm from the cover and body. A kit is available from ONAN to repair the regulator.

.OZ	INCHES OF WATER*
1	1.73
2	3.46
3	5.2
4	6.9
5	8.7
6	10.4
8	13.8
10	17.3
12	21
14	24
16	28

*INDICATES EQUIVALENT OF WATER LEVEL DIFFERENCE IN OUNCES

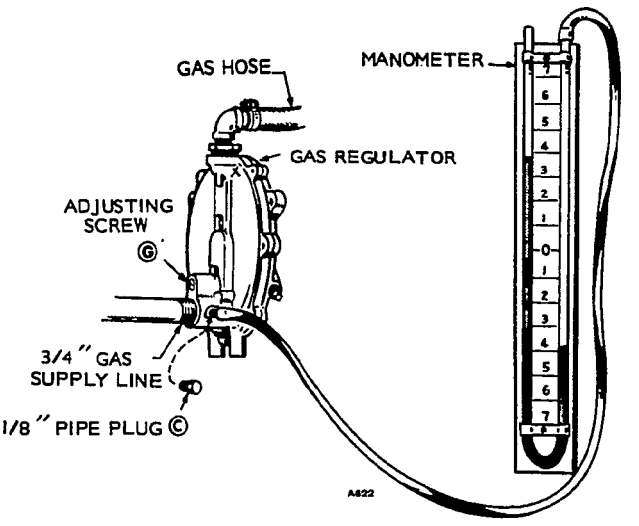


FIGURE 29. WATER MANOMETER

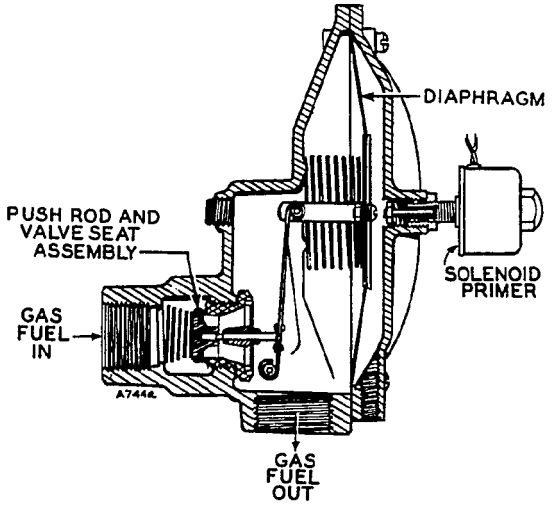


FIGURE 30. ALGAS GAS REGULATOR

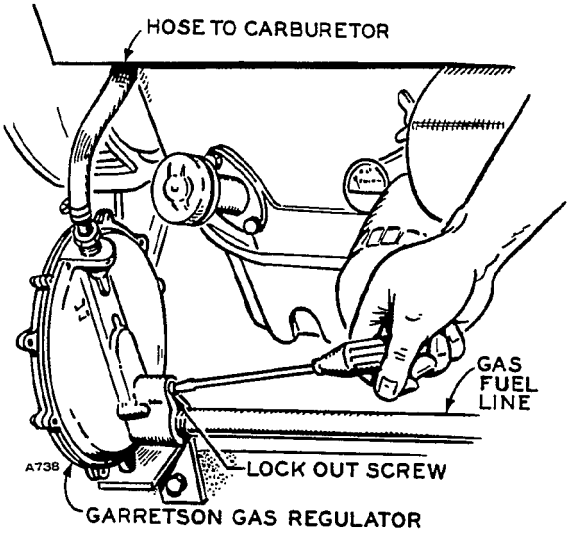


FIGURE 31. ADJUSTING GAS REGULATOR

If this regulator appears defective, will not open or close, or delivers insufficient fuel, check shut off pressure adjustment. A kit is available from ONAN to replace both the diaphragm and valve.

Solenoid Primer (Algas Regulator Only)

Algas regulators use an optional solenoid primer to provide quick engine starting. The primer (Figure 32) holds regulator open during engine cranking. It can be adjusted for a rich or lean mixture by loosening lock nut and turning the primer in or out. Turning primer clockwise richens mixture.

To adjust for proper priming of a cold engine, set primer so a hot engine (one with gas in regulator-carburetor hose and caburetor) sounds slightly rough and produces slightly dark exhaust when engine first starts firing.

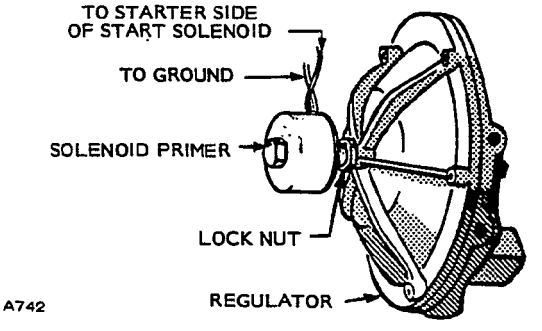


FIGURE 32. ALGAS SOLENOID PRIMER

Initial Adjustment

1. Remove regulator-carburetor hose at regulator and apply battery voltage across primer.
2. Turn primer clockwise (richer) until you can hear a small flow of gas at outlet.
3. Remove voltage, connect hose and attempt to start engine.

If engine starts within 3 seconds, primer is correctly adjusted. If not, remove hose at regulator and crank engine for a few seconds to empty hose and carburetor of gas and readjust primer slightly. Connect hose and attempt to start. Continue until the engine starts within 3 seconds from an empty hose and carburetor. When primer is properly adjusted, be sure regulator locks off when unit stops.

To test primer, remove it from regulator, noting the number of turns necessary to unscrew it and operate the start switch. Plunger must extend out. If not, wiring or primer solenoid may be defective or plunger is stuck in the primer body.

AIR CLEANER

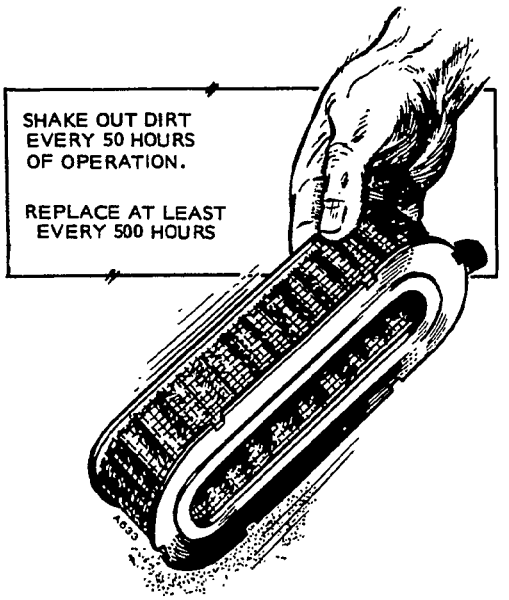
Two types of air cleaners are used; a dry paper type (folded paper), and a moistened foam type (synthetic sponge).

Dry Paper Type

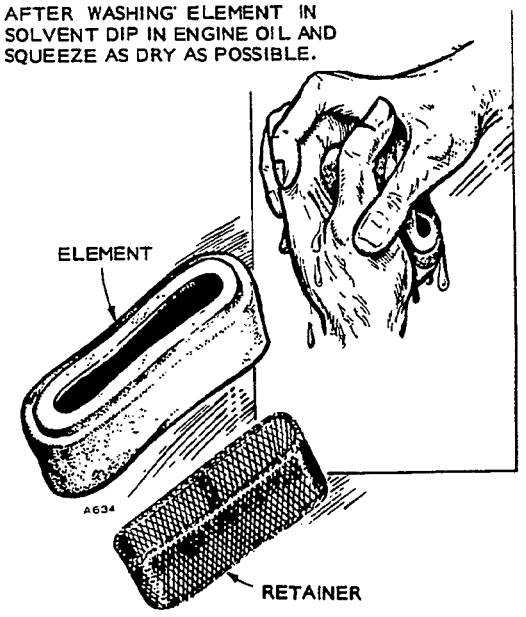
(See Figure 33.) Remove and clean, either by shaking or blowing out with compressed air at least every 100 hours. Do not wash it. When using compressed air, hold nozzle far enough from cartridge so it will not rupture. Replace cartridge at least every 500 hours. If paper cartridge has a foam wrapper, remove wrapper before cleaning, wash it in clean solvent, dry, and install on the cartridge.

Foam Type Cleaner

This cleaner consists of a foam element over a metal retainer (Figure 33). About every 200 hours, remove foam element and wash it thoroughly in a suitable solvent. Then dip it in clean crankcase grade oil and squeeze as dry as possible. The element should be replaced only if damaged.



EARLY JB DRY PAPER-TYPE FILTER



FOAM-TYPE AIR FILTER

FIGURE 33. AIR CLEANERS

Fuel System MJB-MJC

Standard MJB and MJC engines use a gasoline, carbureted, fuel system, to deliver a mixture of fuel and air to the combustion chamber. The fuel system draws fuel from a tank, delivers it through the filter and fuel pump to the carburetor float chamber. Air passing through carburetor venturi section draws fuel from the float chamber.

All fuel system components are described in the following paragraphs. Select the components that apply to your engine.

FUELS

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.***

Onan recommends the use of clean, fresh, unleaded gasoline. Regular leaded gasoline may be used. Do not use highly leaded premium fuels. Using unleaded gasoline results in less maintenance.

If regular gasoline is used continually, carbon and lead deposits must be removed from the cylinder heads, as required, because of engine power loss. Unleaded gasoline may be used safely after lead deposits have been removed.

CAUTION ***Failure to remove lead deposits prior to use of unleaded fuel can cause pre-ignition and possible engine damage.***

Maintenance

On gasoline fuel systems, periodic maintenance should consist of cleaning fuel strainer, cleaning or replacing air silencer or flame arrester, carburetor adjustment, and complete carburetor cleaning.

To clean fuel strainer, remove fuel sediment bowl and screen (Figure 35) and wash the screen thoroughly. At the same time, remove carburetor float bowl and clean it. Assemble and check for leaks.

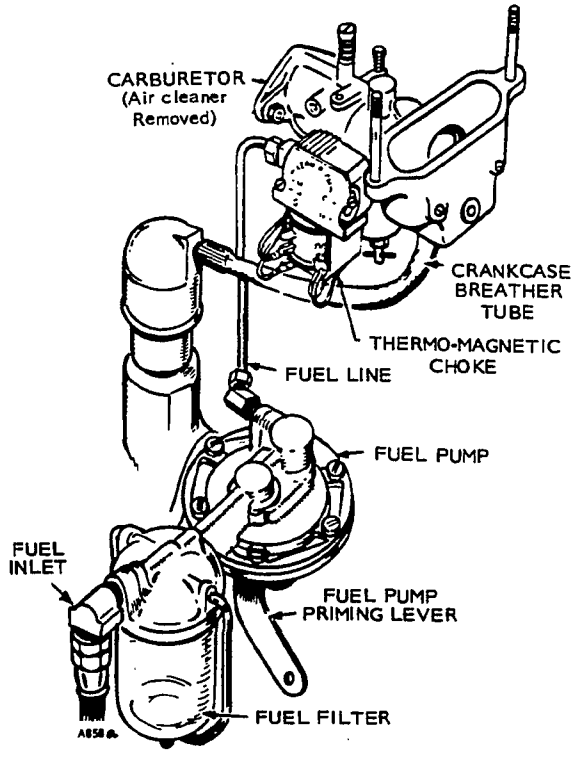


FIGURE 34. FUEL SYSTEM

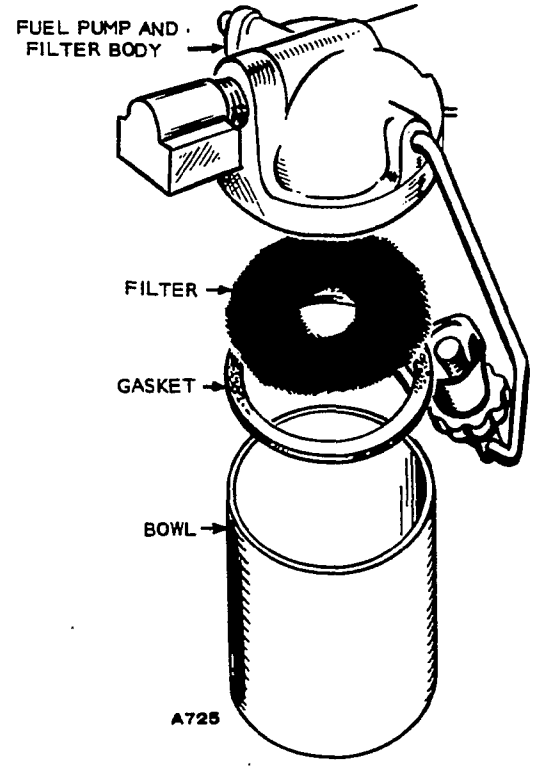


FIGURE 35. SEDIMENT BOWL

FUEL PUMP

The fuel pump is located on left side of engine near the rear. If fuel does not reach carburetor, make the following checks:

1. Check fuel tank and see that shut-off valve is open.
2. Remove fuel line from pump outlet. Connect a fuel pump pressure gauge to pump outlet and crank engine over several times. Fuel pressure should be 1-2 psi. If not, remove pump for repair or replacement.

Testing

If fuel pump delivers fuel, test it with a pressure gauge or manometer. Perform these tests before removing pump from engine. Disconnect pump outlet line and install pressure gauge (Figure 36).

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

Next, run engine at governed speed on fuel remaining in carburetor and measure fuel pump pressure developed. Pressure should be between 2 and 3-psi with gauge held 16 inches above fuel pump.

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

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

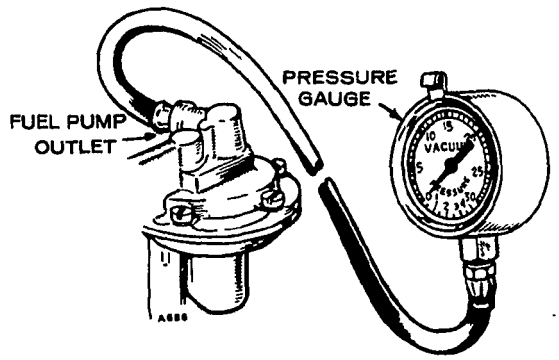


FIGURE 36. TESTING FUEL PUMP PRESSURE

Removal and Disassembly

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

Assembly (Figure 37)

1. When installing a new diaphragm, soak it in fuel before assembling. Insert diaphragm spring and fuel soaked diaphragm into pump body.
2. Insert link and rocker arm into body and hook it over diaphragm pull rod. Align rocker arm with pin hole and drive in pin.

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.***

3. Compress rocker spring and install between body and rocker arm.
4. Insert valve cages, gaskets, and valve cover plate. Position inlet valve with spring showing and outlet valve with spring in cover recess.
5. Assemble cover to body with notch marks lined up. Install screws but do not tighten.
6. Push rocker arm in a full stroke and hold in this position to flex diaphragm.

Diaphragm must be flexed or it will deliver too much fuel pressure.

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

CHOKE

Remote starting engines use either an automatic electric or a thermo magnetic choke. These chokes are easily identified by their outside appearance (Figure 38 and Figure 39).

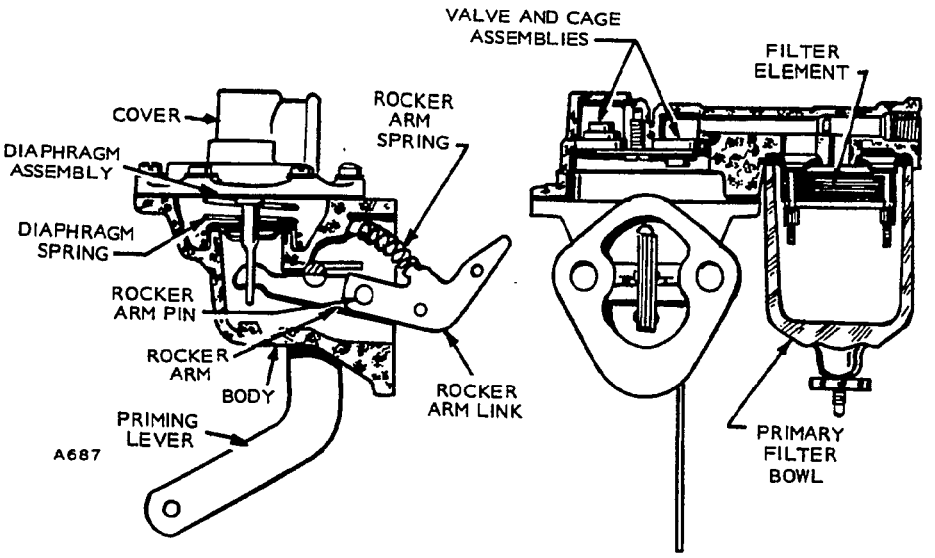
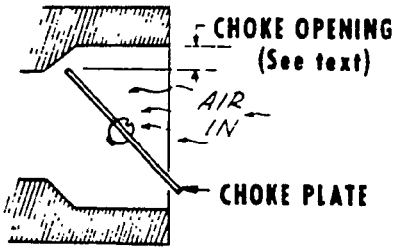
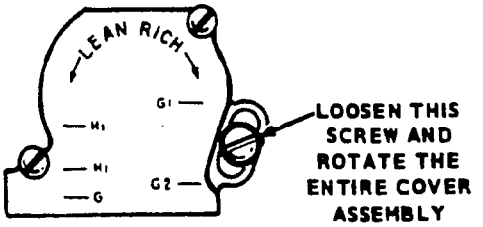


FIGURE 37. PUMP ASSEMBLY

CHOKE OPENING FOR PLANTS PRIOR TO SPEC S

AMBIENT TEMP. (°F)	60	65	70	75	80	85	90	95	100
CHOKE OPENING (Inches)	1/8	9/64	5/32	11/64	3/16	13/64	7/32	15/64	1/4





CHOKE OPENING FOR PLANTS BEGINNING SPEC S

AMBIENT TEMP. (°F)	10	20	30	40	50	60	70	75
CHOKE OPENING (Inches)	1/4	5/16	11/32	3/8	7/16	15/32	1/2	9/16

ELECTRIC CHOKE AVERAGE SETTINGS

MODEL	AMBIENT TEMPERATURE (°F)								
MJB-MJC	68	72	76	80	84	88	92	96	100
	CHOKE OPENING - INCHES								
MJB	3/16	7/32	1/4	9/32	5/16	11/32	3/8	13/32	7/16
MJC	0	1/64	3/64	1/16	3/32	7/64	1/8	9-64	11/64

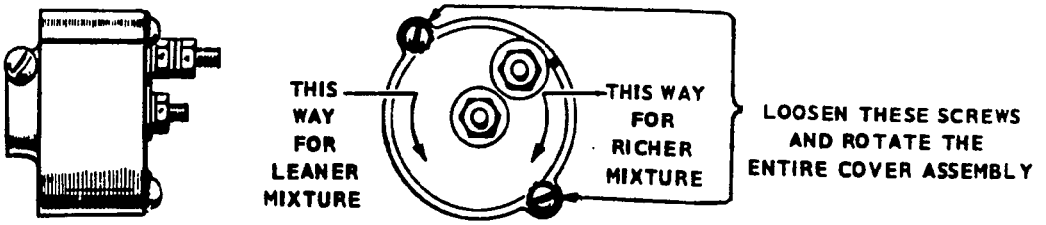
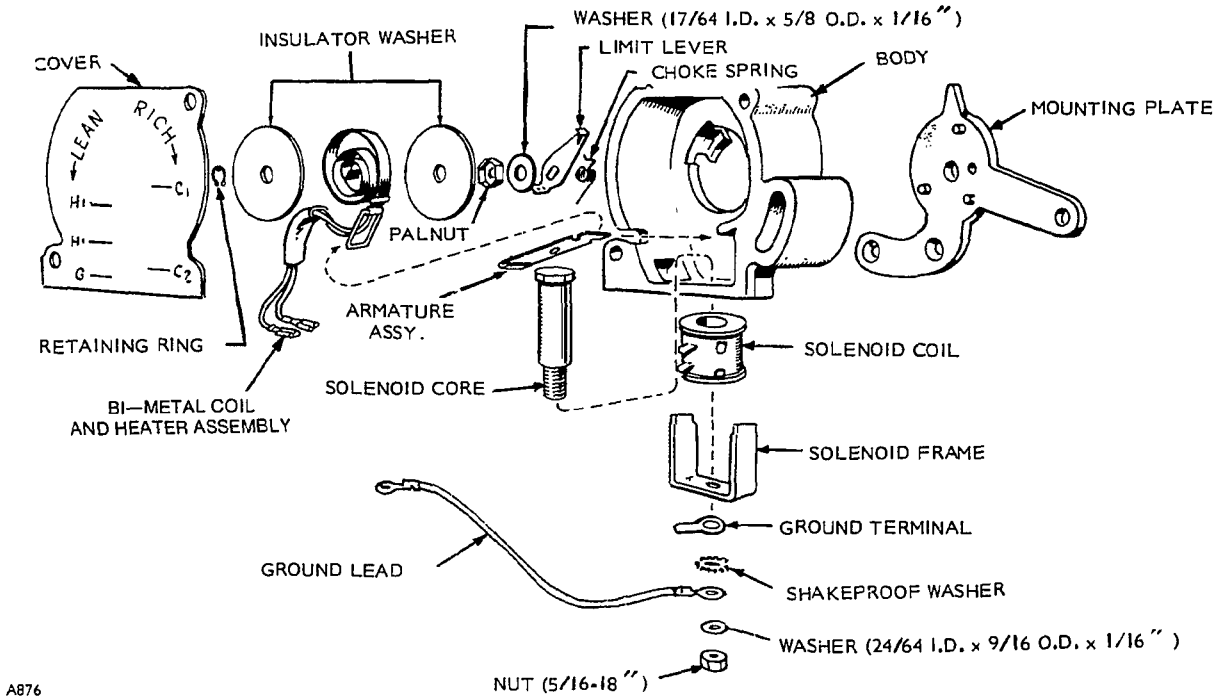


FIGURE 38. CHOKE ADJUSTMENTS



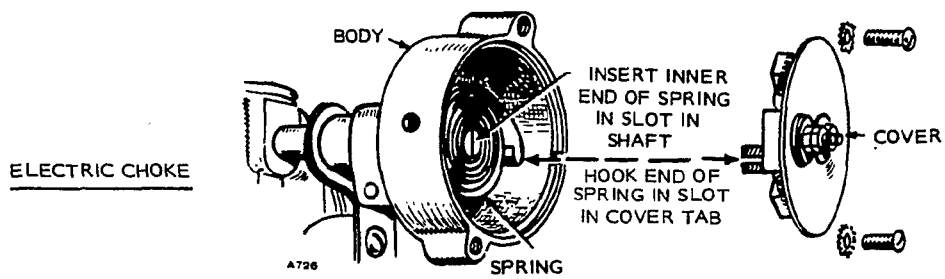


FIGURE 39. DISASSEMBLY OF ELECTRIC AND THERMO-ELECTRIC CHOKE

Operation and Adjustment, Electric Choke

This choke is controlled by an electric element. Before engine starts, choke is closed. When engine has started, the generator supplies current to the heating element, which heats chokes bi-metal coil. As coil heats, it winds tighter, opening choke plate.

Under normal operation, adjust choke so the distance measured between choke plate and carburetor throat, Figure 38, is as shown in the table and with engine cold. Use straight shank end of a drill bit to measure gap. The air cleaner or flame arrester must be removed for choke adjustment. To adjust choke, loosen the two screws on end plate and rotate cover assembly.

Under extreme temperature conditions it may be necessary to re-adjust choke for best operation. For more choking, turn cover clockwise; for less choking, turn it counterclockwise.

Operation and Adjustment, Thermo-Magnetic Choke

This choke uses a strip heating element and a heat sensitive bimetal coil in addition to magnetic solenoid. During cranking solenoid is energized, further closing choke.

The bimetal is calibrated to position choke at the proper opening under any ambient condition. Choke is adjusted at the factory. If, for any reason, adjustment is required, use the following procedure:

Adjustment must be made with the bimetal at ambient temperature. Do not attempt adjustments until engine has been shut down for at least one hour. Remove flame arrester and adapter to expose choke plate. Loosen screw which secures the choke body assembly. Refer to Figure 38 for correct choke setting according to temperature. Use a drill rod or shank of a drill bit to measure choke opening. Rotating choke body clockwise richens and counterclockwise leans the choking effect. Tighten screw that secures choke body.

Disassembly and Repair, Electric and Thermo-Magnetic Choke

If choke does not operate, or will not maintain its adjustment, disassemble for repair. If choke plate will not close, check for binding, incorrect adjustment, or incorrect assembly of coil. If it will not open after engine starts, check for heating. Choke should be warm to the touch within a minute or two of engine starting.

To disassemble choke refer to Figure 39.

Electric Choke

If choke will not heat properly, check for a broken heating coil or high resistance electrical connections. Check coil resistance with an ohmmeter. With element at room temperature, resistance should be about 5 - 6 ohms for 12-volt models, about 25 ohms for 24-volt models and about 16 ohms for 32-volt models. If coil is defective, replace the thermostat cover.

Thermo-Magnetic Choke

If choke will not heat properly, check for broken heater wire, high-resistance connections or broken lead wires to the bimetal and heater assembly. With element at room temperature, check the heater resistance with an ohmmeter. Resistance should be about 30.6 to 37.4 ohms for a 12 volt system. If heater is defective, replace it with a new one. When start button is engaged, solenoid should cause spring-loaded armature to contact solenoid core.

If this does not occur, check for broken lead wires or a defective solenoid coil. There must be slack in lead wires between choke body and the bimetal and heater assembly. The solenoid coil resistance should be 2.09 to 2.31 ohms in a 12 volt system.

When replacing cover on thermostat and heater assembly, be certain that the choke heater lead wires have been correctly installed in choke housing. Improper replacement of lead wires can cause choke assembly to malfunction.

Wires enter choke assembly through a small notch that is cut in edge of the housing. A cover holds wires in place and prevents movement when tightened. When properly installed, lead wires will hang freely under bimetal coil when choke is in either open or closed position. End of heater wire sleeve should be located from 1/8 inch inside choke housing to flush with inside wall.

When assembling thermo-magnetic choke, the bimetal and heater assembly is connected as follows:

1. Lead tagged G goes to ground terminal on coil solenoid.

2. Lead tagged H goes to either of the H^1 terminals on solenoid core.

CARBURETOR

The gasoline carburetor is a horizontal draft type, with upturned intake horn (air silencer adapter). The carburetor consists of three major sections — bowl and float, idle circuit, and load circuit.

Fuel enters carburetor through inlet valve (Figure 40) and passes into float chamber. To control fuel level in the bowl, the float closes the inlet valve when fuel reaches a certain height, and opens it when fuel level drops.

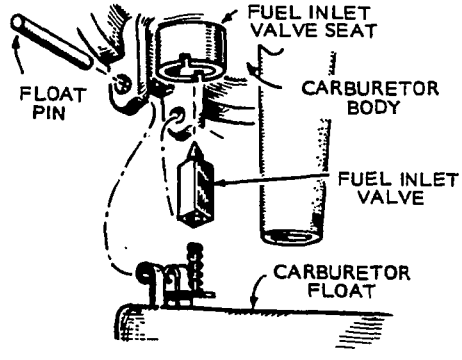


FIGURE 40. CARBURETOR INLET VALVE

The idle circuit (Figure 41) supplies fuel during no-load operation and for light loads. Since throttle plate is nearly closed at no-load, intake manifold vacuum is high and pressure difference between manifold and float chamber causes fuel to flow through the idle circuit. The pressure difference draws fuel up through hollow center of main adjusting needle, through passages in carburetor body to the idle port. Bleed holes in main adjusting needle allow air to bleed in and mix with the fuel. When throttle is almost completely closed, fuel passes out through idle port, controlled by the idle adjusting needle. As throttle is opened to increase power, it gradually exposes idle transfer port. Fuel is also drawn out through this port.

As engine governor opens throttle further, under increased load, the increased air flow through carburetor produces a low pressure at the venturi (narrow section of carburetor throat). This pressure drop draws fuel up the main nozzle to be mixed with air at the nozzle opening. This is the load circuit (Figure 41). The main adjust needle controls its fuel delivery.

At the same time, because throttle is open, manifold vacuum decreases so idle circuit becomes less effective. In a certain range, the two circuits blend, both delivering fuel; but, as load is increased, load circuit takes over.

Whenever load is increased, with load circuit in operation, the governor opens throttle to deliver more fuel. Main nozzle will not immediately deliver this increased fuel because of the jet controlled by adjusting needle. To reduce power lag when load is suddenly increased, a by-pass jet around the metering jet delivers fuel to nozzle until main jet can supply the increased demand.

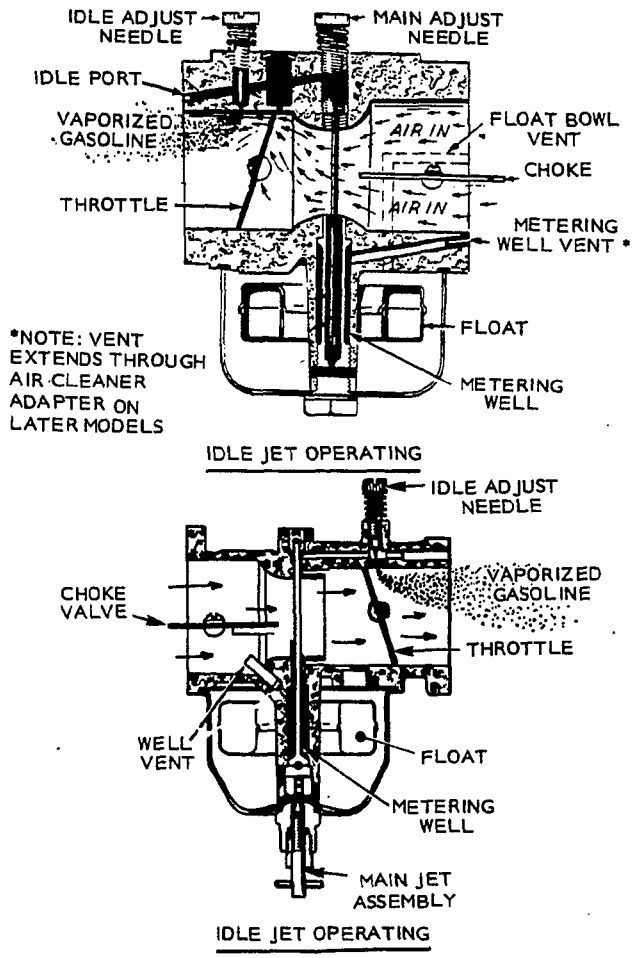


FIGURE 41. CARBURETOR CIRCUITS

Adjustment

Adjusting carburetor means obtaining the correct fuel-to-air mixture for smooth, efficient operation. Carburetor should be adjusted in two steps — first load adjustment and then idle adjustment.

If carburetor is completely out of adjustment so engine will not run, open both needle valves 1 to 1-1/2 turns off their seats to permit starting. Do not force needle valves against their seats. This will bend the needle.

Before adjusting carburetor, be sure ignition system is working properly and governor is adjusted. Allow engine to warm up before making adjustment.

1. Apply a full load to the generator.
2. Carefully turn main adjustment in until speed drops slightly below normal. Then turn needle out until speed returns to normal.
3. With no load on the engine, turn idle adjustment out until engine speed drops slightly below normal. Then turn needle in until speed returns to normal.

Alternate Method, Use When Loading Engine Is Not Possible:

1. Start engine and allow it to warm up.
2. Manually close throttle to slow engine down to about 600 - 700 rpm.
3. Set idle adjustment screw for even operation (so engine is firing on all cylinders and running smoothly).
4. Release governor mechanism allowing engine to accelerate. If engine accelerates evenly and without a lag, main adjustment is correct. If not, adjust needle outward about 1/2 turn and again slow down engine and release the mechanism. Continue until engine accelerates evenly and without a time lag after releasing governor.

With carburetor and governor adjusted, set throttle stop screw (Figure 42) to allow 1/32" clearance to the stop pin with engine operating at no load. This improves governor stability when a large load is suddenly removed.

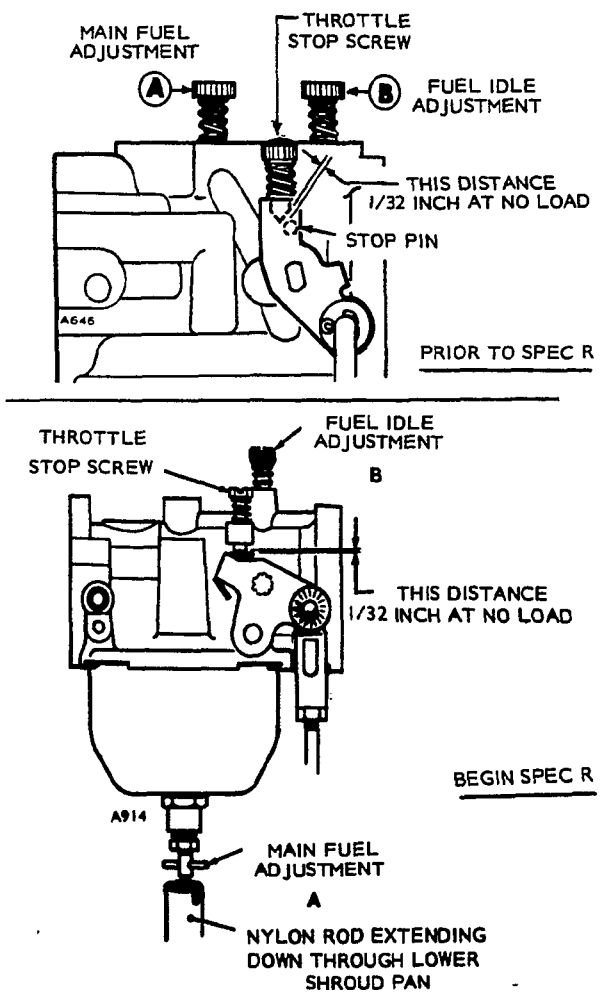


FIGURE 42. CARBURETOR ADJUSTMENT

Removal and Disassembly

1. Remove fuel line, governor linkage and electric choke wires.
2. Remove air silencer adapter from the carburetor.
3. Remove 2 carburetor mounting nuts and remove carburetor.
4. Remove choke coil from carburetor.
5. Remove float bowl nut and pull off bowl.
6. Remove the float pin and float.
7. Lift out float valve and unscrew its seat.
8. Remove no-load adjusting needle and spring.
9. Remove load-adjusting needle and spring.
10. Remove throttle plate screws and plate, and pull out throttle shaft.
11. Remove choke plate screws and plate, and pull out choke shaft.

Cleaning and Repair

To clean carburetor, soak all components thoroughly in a good carburetor cleaner, following cleaner manufacturer's instructions. Be sure all deposits are cleaned from carburetor bore, especially in the area of the throttle valve. Blow out passages with compressed air. If possible, avoid using wire to clean out passages.

Check adjusting needles and nozzle for damage. If float is loaded with fuel or damaged, replace. Float should fit freely on its pin without binding. Invert carburetor body and measure float level (Figure 43).

If necessary, bend small lip on float to adjust float level.

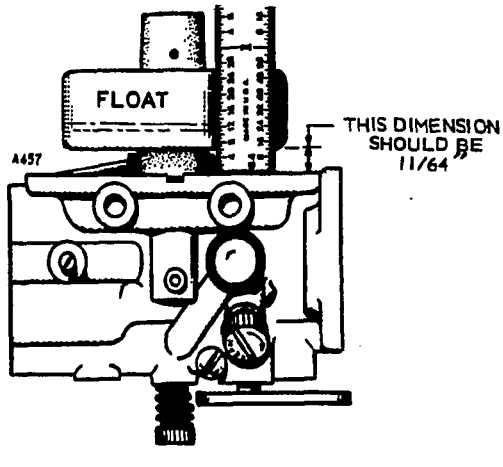


FIGURE 43. FLOAT LEVEL

Check choke and throttle shafts for excessive side play and replace if necessary. Do not remove teflon coating on the throttle shaft. Coating reduces wear and friction between the shaft and carburetor body.

Assembly and Installation

1. Install throttle shaft and plate using new screws and lockwashers. Install with plate bevel mated to the carburetor body. On plates marked with the letter C, install with mark on side toward idle port when viewed from manifold mounting flange end of carburetor. To center plate, back off idle stop screw, close throttle, and seat plate by tapping it with a small screwdriver; then tighten the two screws.
2. Install choke shaft and plate. Center plate in same manner as throttle plate (step 1). Use new screws and lockwashers.
3. Install main nozzle, making sure it seats in body casting.
4. Install inlet valve seat and valve.
5. Install float and float pin. Center pin so float bowl does not ride against it.
6. Check float level with carburetor casting inverted. See Figure 43.
7. Install bowl ring gasket, bowl, and bowl nut. Make sure that bowl is centered in gasket, and tighten nut securely.
8. Install load adjusting needle with its spring. Turn in until it seats, and back out 1 to 1-1/2 turns.
9. Install idle adjusting screw finger tight. Then back out 1 to 1-1/2 turns.
10. Install choke and adjust.
11. Install air horn assembly and gasket.
12. Install carburetor on engine, and connect gasoline inlet, governor mechanism, breather hose, and choke wires.
13. Install air silencer or flame arrester.

AIR SILENCER AND FLAME ARRESTER

Metal filter element serves also as a flame arrester. As a safety precaution do not substitute with non-metal air cleaner. Clean regularly and assemble dry. Replace element if damaged.

EXHAUST SYSTEM

The exhaust system is normally supplied by user, and installed in the field. However, importance of a correct exhaust system cannot be over emphasized. A poor or clogged system can cause low power, overheating, and eventual engine damage. The effect of a poor exhaust system is to increase back pressure at engine, reducing efficiency. If excessive back pressure is suspected, test engine according to the following procedure.

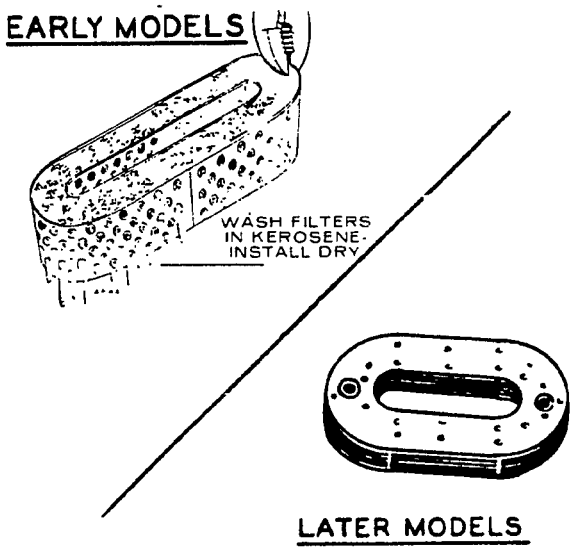
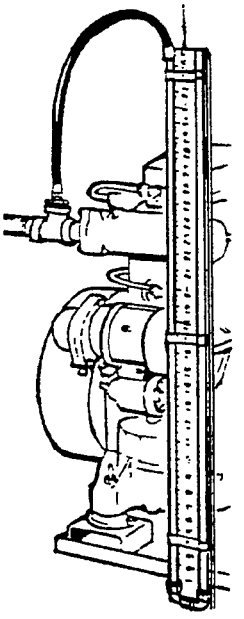


FIGURE 44. AIR SILENCER

Testing

Install an adapter or tee in exhaust line next to manifold. Connect a manometer or pressure gauge to adapter. If there is a condensation trap next to manifold, this can be used for manometer connection. Run engine under full-load and observe manometer. See Figure 45 for maximum values. If reading is higher, exhaust system should either be disassembled and cleaned or altered to reduce back pressure.

WARNING ***Inhalation of exhaust gases might result in serious personal injury or death. Pipe exhaust outside the hull and do NOT terminate exhaust pipe near any window or bulkhead door openings.***



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 oz.
4 Cylinder		
Inches of Water	27	4.7
Inches of Mercury	2	1/3
Ounces	15.6 oz.	2.7 oz.

FIGURE 45. MANOMETER

Governor System

Governor system controls engine speed with and without load. The system consists of a governor cup with steel flyballs on the chamshaft, a yoke, shaft, and arm, governor spring and adjusting screw, and linkage to carburetor.

Variations in engine speed change the position of governor cup on its shaft. This change is transmitted by the shaft, arm, and linkage to carburetor throttle lever. Engine speed is determined by tension on the governor spring. Sensitivity (speed drop from no-load to full-load) is controlled by the number of spring coils used. More coils give less speed drop from no-load to full-load (greater sensitivity).

MAINTENANCE

Periodically lubricate governor linkage with lubricating graphite or light non-gumming oil. Also, inspect governor linkage for binding or excessive slack or wear.

Adjustments

Prior to Spec R, both governed speed and governor sensitivity are adjusted with the stud and nut on the front of engine air housing (Figure 46). Beginning with Spec R, sensitivity is adjusted with an adjusting ratchet.

Speed Adjustment (Prior to Spec R): To adjust governed speed, hold governor spring stud in position and turn governor spring nut with a wrench. A mechanical tachometer may be used for speed adjustment.

Sensitivity Adjustment (Prior to Spec R): To adjust sensitivity, turn governor spring stud; turning counterclockwise gives more sensitivity (less speed drop). If governor is too sensitive, a hunting condition occurs (alternate increasing and decreasing speed). Adjust for maximum sensitivity without hunting. After a sensitivity adjustment, speed may require readjustment.

Speed Adjustment (Begin Spec R): Adjust engine speed (RPM) by turning governor speed adjusting nut, Figure 46. Turn nut clockwise to increase speed, counterclockwise to decrease speed.

Sensitivity Adjustment (Begin Spec R): Sensitivity (no-load to full-load speed drop) is adjusted by turning sensitivity-adjusting ratchet nut accessible through hole in side of blower housing. If speed drops too much when full load is applied, turn ratchet nut counterclockwise to increase spring tension and compensate for reduced rpm. An over-sensitive adjustment, approaching no speed drop when load is applied, may result in a hunting condition (alternate increase and decrease in speed).

After adjusting speed and sensitivity, secure speed stud lock nut.

If governor is too sensitive or not sensitive enough, and cannot be adjusted with stud or ratchet, the sensitivity can be adjusted by changing spring attachment on the governor arm. Moving this point further from the governor shaft decreases governor sensitivity.

WARNING

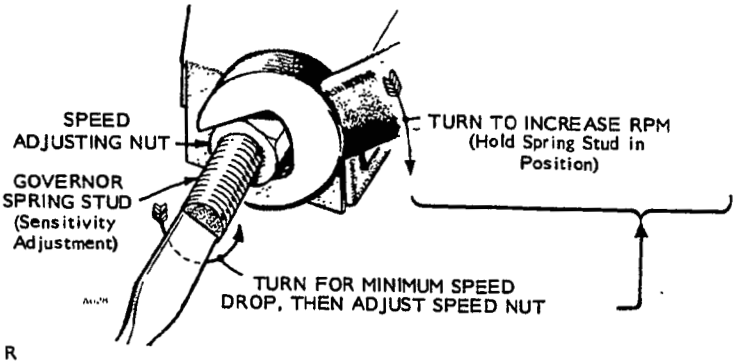
EXHAUST GAS IS DEADLY!

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:

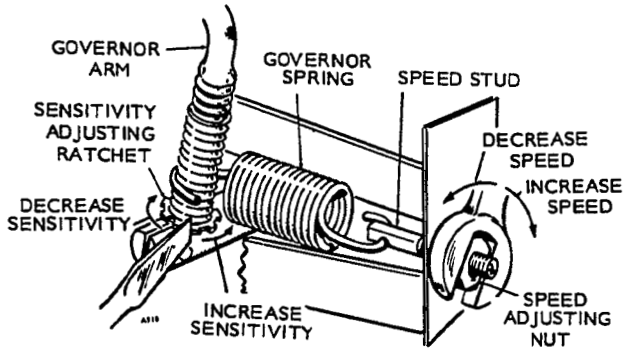
- ***Dizziness***
- ***Headache***
- ***Weakness and Sleepiness***
- ***Vomiting***
- ***Muscular Twitching***
- ***Throbbing in Temples***

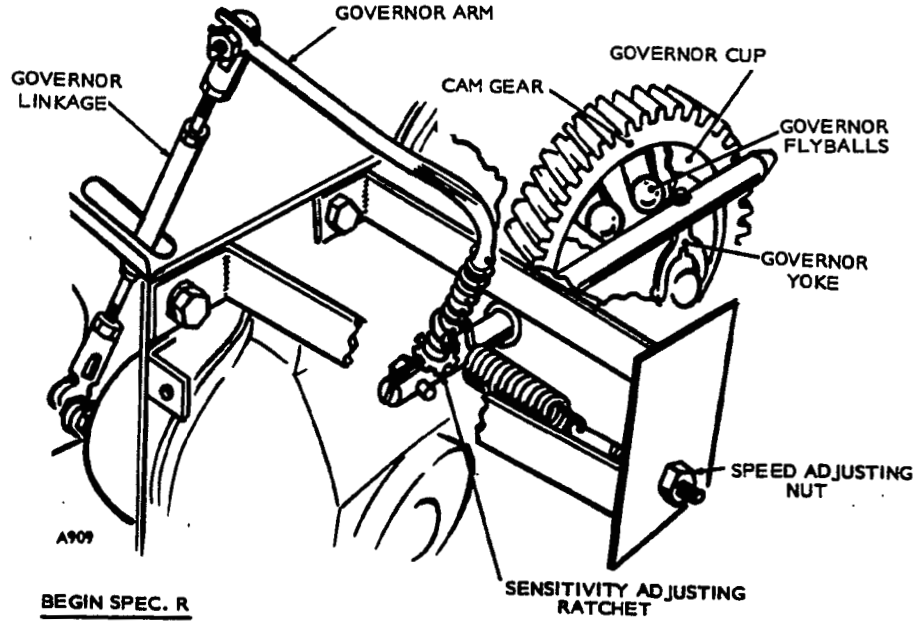
If you experience any of these symptoms, get out into fresh air immediately, shut down the unit and do not use until it has been inspected.

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.



PRIOR TO SPEC R





BEGIN SPEC. R

FIGURE 46. GOVERNOR ADJUSTMENTS

Ignition System RJC

The ignition system in the RJC engine uses a battery ignition system with automotive distributor to produce and distribute spark (Figure 47).

The ignition system includes ignition coil, distributor with spark advance and breaker points, and spark plugs.

For satisfactory performance of ignition system all components must be in good condition, and the spark must be properly timed. Hard starting, low power, and erratic operation can often be caused by faulty ignition. If poor ignition is suspected, the first thing to do is to determine if the ignition system is actually at fault. A simple operational test will determine this.

Remove spark plugs, install ignition wire, and lay plug on grounded engine metal. Crank engine and watch plug. Strong blue spark indicates high current in ignition system; weak, yellow, or no spark indicates low current. Poor ignition can be caused by defective breaker points, coil, condenser, or wiring. A weak spark on only one plug indicates a defective plug or high tension wire.

Maintenance of ignition system should include oiling the distributor, cleaning and adjusting breaker points, spark plugs, checking ignition timing, and general inspection of the ignition system wiring.

At regular intervals, add three to five drops of medium engine oil to distributor oiler (Figure 48). Add one drop of light engine oil to breaker arm hinge pin and three to five drops to felt in top of shaft and to governor weight pivots. Lightly grease each lobe of breaker cam. Do not over-lubricate the distributor.

Adjust breaker points by rotating crankshaft until rubbing block is on high point of cam. Gap should be 0.020 inch. Inspect points for dirt or pitting. Dirty points can be cleaned, but pitted points should be replaced.

Inspect distributor for cracks, carbon, corroded or excessively burned inserts. In normal use, vertical surfaces of cap inserts become slightly burned. Clean but do not file the inserts. If they are excessively burned, replace distributor cap. Clean rotor and inspect for cracks. Severely burned or pitted rotors should be replaced.

Time ignition by adjusting distributor so each plug fires at 25° BTC (before top dead center) 35° BTC for gaseous fuel on the compression stroke.

Ignition system can be timed with the engine stopped or running. Always clean and adjust breaker points before timing.

TIMING PROCEDURE - ENGINE STOPPED

1. Disconnect low voltage lead to distributor. Connect a test lamp (with battery) to light when breaker points close.
2. Remove number one spark plug and rotate flywheel clockwise until test lamp goes out. Breaker points are now open. This is the igniting point.
3. If the "TC" mark on flywheel and ignition timing pointer are aligned, timing is correct.

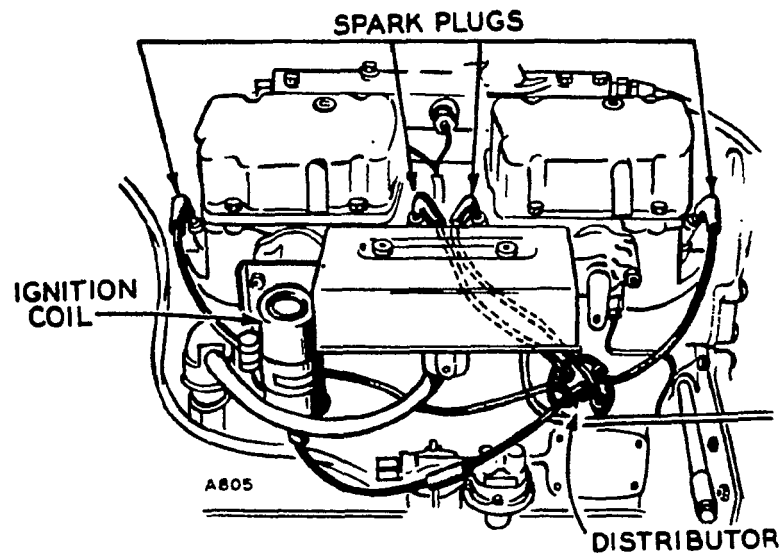


FIGURE 47. IGNITION SYSTEM

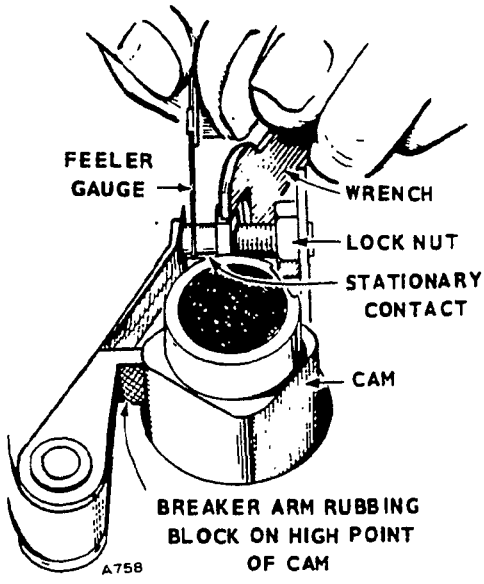


FIGURE 48. BREAKER POINT GAP

4. If timing needs correction, align flywheel TC mark and timing pointer. Loosen distributor body and rotate it (clockwise if ignition occurred early, counterclockwise if late) until the light goes out.

5. Tighten distributor clamp and recheck timing step 3. If timing still does not occur at the correct point, repeat step 4.

TIMING PROCEDURE – ENGINE RUNNING

1. Connect an automotive timing light to number one spark plug (follow manufacturer's instructions).

2. Run engine at rated speed. Aim timing light at timing pointer. If light flashes as pointer and timing mark are aligned, timing is correct.

3. To adjust timing, loosen distributor body clamp and rotate distributor slowly. If timing is early (mark is at right of pointer) rotate distributor clockwise. When pointer and marks are aligned, tighten distributor.

Fluctuating timing marks usually mean a defective distributor. Check for pitted or misaligned points, incorrect point spring tension, worn (or loose) breaker plate, or worn distributor shaft bushing.

DISTRIBUTOR

The distributor's function is three-fold. It opens the breaker points at the proper time, advances timing automatically, and sends current to the proper plug.

Testing

Test distributors on a commercial distributor tester (following equipment manufacturer's instructions). Centrifugal advance mechanism should be in good working condition. The cam dwell angle should be 51 ± 3° (never set breaker gap by cam dwell). If cam dwell is outside the above limits with proper point gap, check for worn distributor cam.

If a distributor tester is not available, follow this procedure:

To check spark advance, remove distributor tower and rotate the rotor several degrees clockwise. If the automatic advance is working properly, rotor will return to its original position when released. If it binds, overhaul the distributor.

Inspect breaker points to determine if movable contact turns freely on its pivot.

Use a spring scale (Figure 49) to measure point spring tension. Tension should be 17-20 ounces with rubbing block off the cam. Greater tension causes excess wear; less tension causes point bounce.

Disassembly

1. Remove distributor cap and primary lead from distributor primary terminal (Figure 50).

2. Mark position of distributor body and rotor position for reassembly without changing timing.

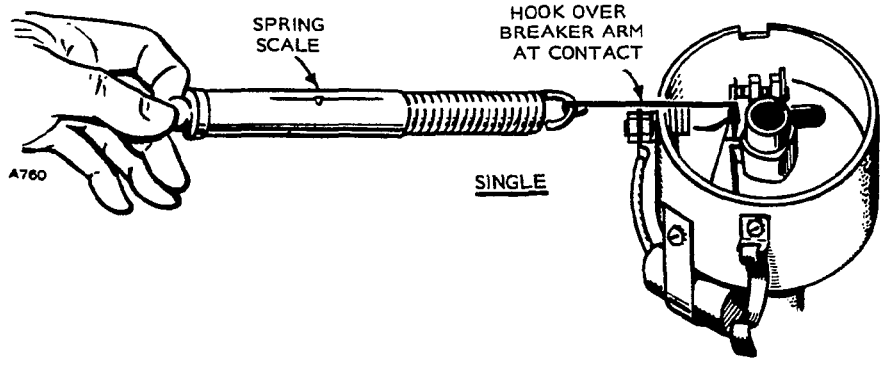


FIGURE 49. POINT SPRING TENSION

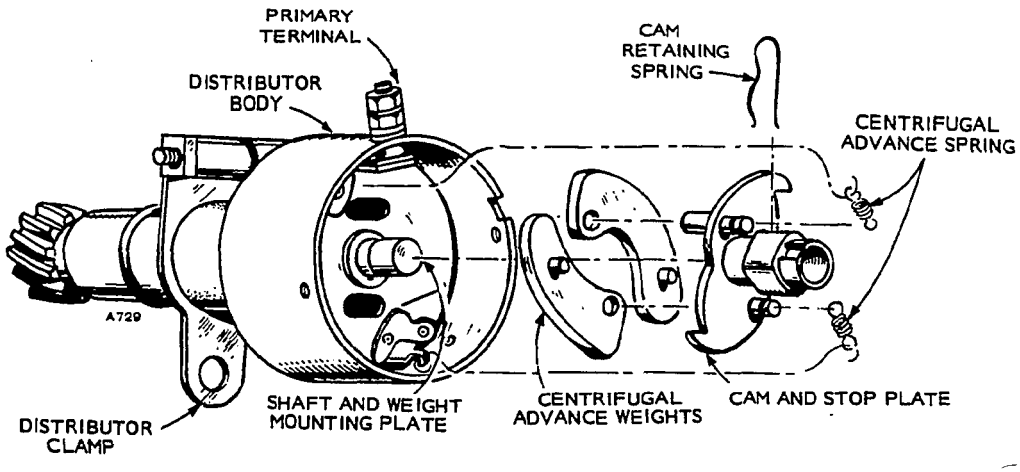


FIGURE 50. DISTRIBUTOR CENTRIFUGAL ADVANCE

3. Remove distributor hold-down capscrew and pull out distributor.
4. Remove three screws holding breaker plate to distributor housing and loosen primary terminal.
5. Lift breaker arm off its hinge.
6. Rotate breaker plate 45° counterclockwise and lift it out.
7. Remove two centrifugal advance springs.
8. Remove cam retaining spring clip holding cam to shaft and lift out the cam. The advance weights are now free and can be removed.
9. File off peened end of drive gear retaining pin and punch out the pin. Then remove the gear and pull shaft out through the distributor body.
10. If necessary, press the two bronze bearings out of the distributor body.
11. Clean all parts (except condenser, points, bushings) in light cleaning solvent. Inspect centrifugal advance parts and replace any that appear worn or otherwise damaged. Inspect cam and shaft for wear. If either is scored, replace it.

To check for bearing wear, measure side play at the top of cam with a dial indicator. Mount indicator on distributor body and measure side play by pulling shaft directly away from indicator with a force of about five pounds. If side play exceeds .005 inch, bearings must be replaced. ONAN does not recommend field replacement of bronze shaft bearings unless special sizing and driving equipment is available. This can be done by an Autolite Service Station.

Assembly

1. Inspect upper shaft thrust washer and install shaft assembly.
2. Install lower shaft thrust washer and drive gear. Insert drive gear retainer pin and peen ends.
3. Distributor shaft end play should be .003 inch to .010 inch (Figure 51). If end play is less, tap lower end of distributor shaft lightly with a soft hammer. If too great, check thrust washer installation or reinstall the gear.

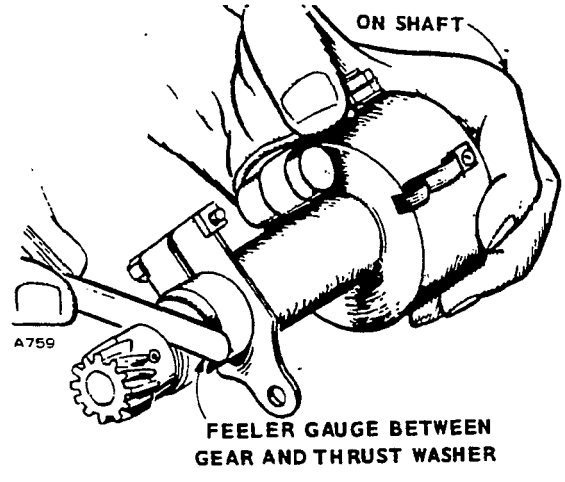


FIGURE 51. DISTRIBUTOR SHAFT END PLAY CHECK

4. Set centrifugal advance weights into place and install cam. Be sure cam weight pivots fit into hole in each weight.
5. Insert cam retainer spring clip and install weight springs.
6. Install breaker plate.
7. Mount movable breaker point. Insert point spring between end of terminal stud and square metal washer. Then tighten the primary terminal.
8. Align breaker points by bending stationary contact bracket.

9. Check breaker spring tension with a spring scale hooked at the movable arm contact and rubbing block off cam. Hold at right angles to contact surfaces (Figure 49). Tension should be 17 to 20 ounces. If not, adjust it by loosening screw holding end of contact spring and installing spacing washer or sliding end of the spring in or out.

10. Rotate drive shaft to obtain maximum breaker gap and set gap for 0.020 inch (Figure 48).

Installation

Install distributor in exactly the same position prior to removal. The rotor should be 1/8 turn counterclockwise from previous installed position to allow gears to mesh. After installing, perform steps 4, 5, and 6 below.

If exact position of distributor body and rotor were not recorded (before removal) or if crankshaft was rotated, follow procedure outlined below.

1. Remove spark plug from No. 1 cylinder. Place a finger over the plug port and rotate flywheel clockwise until cylinder builds up pressure. Continue rotating until flywheel "TC" mark aligns with timing pointer.

2. Install rotor on distributor shaft and the O-ring on the body.

3. While holding distributor in the position shown in Figure 52 and the rotor 1/8 turn counterclockwise from position shown, seat the distributor. It may be necessary to turn rotor slightly to mesh distributor and camshaft gears. The rotor will move about 1/8 turn as gears mesh and should be in the position shown in Figure 52 when distributor is in place. If it is not, pull distributor upward until gears do not mesh and re-install.

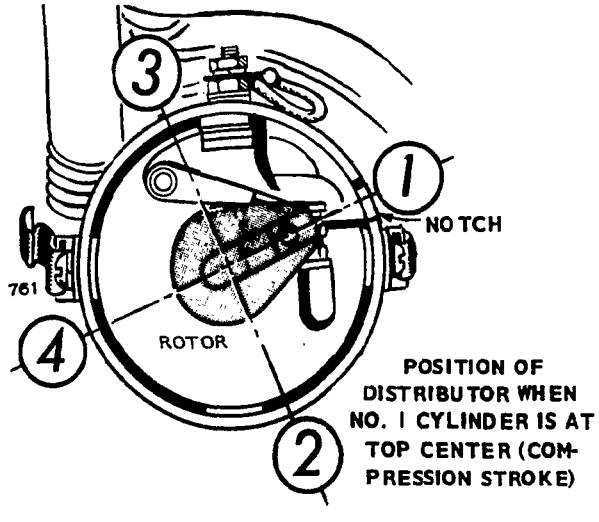


FIGURE 52. DISTRIBUTOR INSTALLATION POSITION

4. Install distributor clamp screw.

5. If spark plug leads were removed from distributor cap, connect them in the 1-2-4-3 firing order (Figure 47).

6. Time ignition system.

IGNITION COIL

RJC ignition coils are standard automotive type mounted on the engine. Normal maintenance includes inspecting, tightening, and cleaning the primary and secondary terminals.

Coils can be tested on standard automotive testers or by checking primary and secondary winding resistance. Resistance from high tension terminal to the ground (–) terminal should be 7,000 to 10,000 ohm; resistance between the primary terminals should be about 1 ohm.

Check coil failure by simply disconnecting high tension lead at the distributor. Hold about 1/4 inch from block and crank engine. A strong spark between lead and engine indicates coil is operating. No spark indicates coil, points, or control circuit to the coil are defective. Before discarding coil, check for voltage between coil terminal and ground while cranking engine. Inspect breaker points. If coil effectiveness is in doubt after tests replace it.

Ignition capacitor mounts on outer side of distributor. If suspected of being defective, test and replace if necessary. Capacitance should be .25 to .28 mfd.

HIGH TENSION LEADS

Inspect ignition leads for cracks or breaks in insulation that may weaken the current before it reaches a plug. A ground wire touching metal at some point may make operation unsatisfactory.

SPARK PLUG

Engine misfire or generally poor operation is often caused by a spark plug in poor condition or with the wrong gap setting. Remove spark plug and carefully check for the following conditions:

- Porcelain insulator cracked or coated with oil.
- Electrodes burned or worn away.
- Wrong gap setting.

If porcelain insulator is cracked or broken or if the electrodes are badly worn or burned, replace spark plug with a new one.

If not, it can probably be restored to good operating condition by the following steps:

1. Degrease wet or oily plug and dry thoroughly.

2. File center electrode to a flat surface.
3. Adjust gap to 0.035 inch. Use a round wire gauge for more accurate measurement (Figure 53).
4. Install plug. Tighten to torque value of 25-30 ft.-lb.
5. Always use new gaskets.

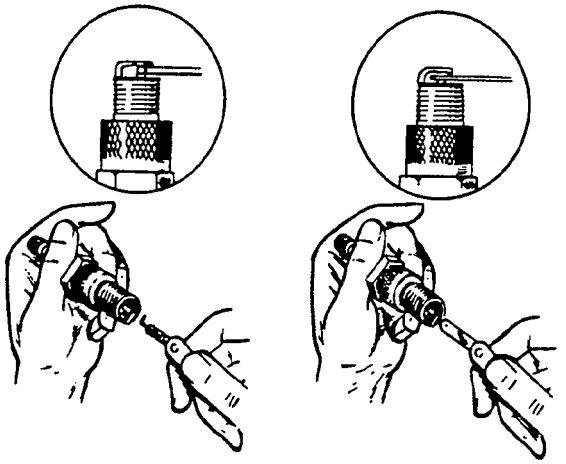


FIGURE 53. SPARK PLUG ADJUSTMENT

Ignition System MJB, MJC

All models are equipped with a 12-volt battery ignition system. The function of this system is to provide a spark in each cylinder at the correct time to ignite the fuel air mixture. All systems use suppressed ignition components to minimize radio interference. The 4-cylinder model (MJC) uses a battery ignition system with dual breaker points and ignition coils.

TESTING

The most complete test for an ignition system is to check the final result — spark on at spark plugs. Remove each plug in turn, install ignition wire to that plug and hold plug base against a piece of bare engine metal. Crank engine and watch the spark. A good blue spark indicates a healthy ignition system; a weak or yellow spark, or no spark indicates a poor ignition system. The defect can be caused by defective breaker points, coil, condenser, or wiring. A good spark on all but one cylinder indicates a defective spark plug or defective high tension wire.

MJB IGNITION SYSTEM

This ignition system uses battery ignition and a single 4-volt coil to fire both spark plugs simultaneously (Figure 54). This means one spark plug fires on exhaust stroke while the other is firing at the end of the compression stroke. A spark advance on breaker point mechanism advances spark from 5° ATC (after top center) when cranked to 25° BTC (before top center) when running at rated speed and using gasoline.

Maintenance

Operating with a weak spark is detrimental to the engine, so periodic service is extremely important. Periodic maintenance should include:

1. Checking the ignition breaker point gap.
2. Checking and cleaning spark plugs.
3. Inspecting both low and hi voltage wiring.
4. Checking the ignition timing.

To adjust breaker gap, rotate crankshaft clockwise until 55° ATC mark on flywheel matches the timing pointer (Figure 55). This is the point of maximum breaker opening.

Breaker point gap should be 0.020 inch; check it with a feeler gauge. If gap is not correct, loosen adjustment screw and move the stationary contact. Tighten screw and recheck the gap.

When adjusting points, check to be sure they are clean and not pitted. If necessary, clean points with paper or gauze tape. If they are defective or excessively pitted, replace them.

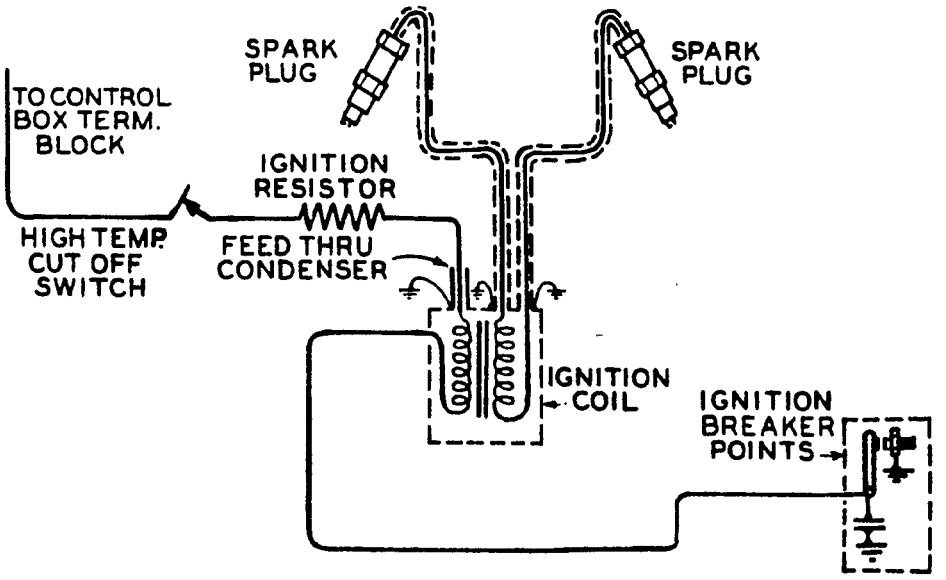


FIGURE 54. MJB IGNITION SYSTEM

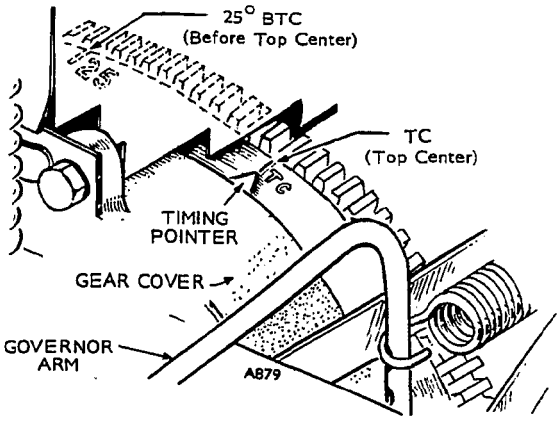


FIGURE 55. TIMING MARKS

Timing

The engine can be timed either stopped or running at rated speed. With engine stopped, timing should be set for ignition at 5° ATC; with engine running at rated speed, 25° BTC. Always adjust breaker point gap before timing the ignition. Time the engine as follows:

Engine Stopped:

1. Remove breaker box cover. Disconnect lead to ignition points and install a continuity test lamp and battery so lamp lights when points are closed.
2. Rotate flywheel clockwise until TC mark on flywheel approaches timing indicator (Figure 55).
3. Slowly rotate flywheel clockwise until light goes out indicating that the points have opened. This is the ignition point. If timing is correct, ignition will occur at 5° ATC.
4. If ignition timing isn't correct, align 5° ATC mark and timing pointer, then loosen breaker plate capscrews and rotate plate so the light goes out. Rotating clockwise advances timing, counterclockwise retards timing.
5. Tighten plate and check timing (step 3). If timing is not correct, adjust plate again. If it is correct reconnect ignition lead and replace cover.

Engine Running:

1. Install an automotive timing light on either of the spark plug leads.
2. Run engine at rated speed and check timing with the light. If timing is incorrect, loosen breaker plate mounting screws and correct by rotating the plate. Rotating clockwise advances timing; rotating counterclockwise retards timing. Tighten plate before rechecking the timing point.
3. Adjust timing, retighten breaker plate, and recheck the ignition point gap.

If ignition point gap cannot be adjusted to specifications, either timing gear or camshaft gear is incorrectly installed, or the centrifugal advance mechanism is defective and breaker mechanism must be disassembled for repair.

Breaker Points

Ignition breaker points (Figure 56) operate from a cam located on the timing or start-disconnect gear. This gear is driven by the camshaft gear.

Disassembly:

1. Disconnect battery to prevent accidental shorts.
2. Remove breaker box cover and disconnect wires from the start-disconnect switch (if used) and ignition breaker points.
3. Remove the two capscrews that hold breaker plate assembly, and pull off the plate.
4. Pull out cam and weight assembly. Be careful not to lose spacer mounted on gear shaft.
5. To disassemble breaker plate assembly, remove condenser and points and pull out the plunger and plunger diaphragm.

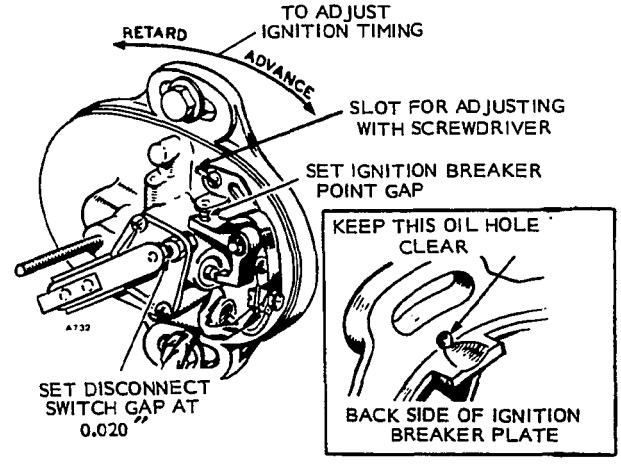


FIGURE 56. BREAKER POINTS

Repair:

Thoroughly clean gear and cam assembly. Weights should move freely without catching in either end position. Inspect gear ramp for notches or other defects. If any part of cam, weight, and gear assembly sticks, the complete assembly, including springs, must be replaced. If cam is loose on gear shaft, the complete assembly must be replaced. Clean and inspect bearing surfaces

in breaker plate and gear case; be sure to clean the oil trickle holes to these bearings. Check oil spray hole in gearcase to be sure it is open. If breaker points will not maintain the proper gap, check for excess wear in both cam and ignition breaker plunger.

Assembly:

1. Install springs on weight assemblies. Install cam on the gear shaft, being sure to align timing marks (Figure 58), and install the cam spring.
2. Install spacer and thrust washer on gear shaft assembly, and install assembly into the gearcase. Match timing marks on timing gear and camshaft gear (Figure 58).
3. Install spring and plunger on the end of shaft.
4. Install the breaker plate. Install ignition plunger, diaphragm, and diaphragm cup (Figure 59).
5. Install start-disconnect diaphragm and plunger, when used, and install start-disconnect breaker points.
6. Adjust start-disconnect breaker point gap (if used) to .020 inch.
7. Install ignition breaker points and adjust gap.
8. Time ignition.

Before resetting start disconnect point gap, rotate engine crankshaft a few degrees counterclockwise. This will enable start disconnect mechanism to assume a normal position.

Condenser

The 0.3 mfd condenser mounted on breaker plate aids primary field breakdown when points open and prolongs breaker point life by reducing the arc across them. A defective condenser causes a weak spark and rapid breaker point wear. Use a standard commercial condenser checker to test the condenser for leakage, openings or grounding. If no tester is available, check for shorts or defective leads and replace the condenser if you suspect it is defective.

Coil

If spark is weak or there is no spark, and breaker points are clean and properly adjusted, test coil for possible defects. As a general test of the coil, disconnect spark plug leads, ground one, hold the other lead 1/4 inch from engine. Crank the engine. A good spark indicates coil is operating.

Further tests of the coil are as follows:

1. With an ohmmeter check resistance of the coil windings. Normal resistance readings range from 0.5 to 2 ohms for primary winding and from 4000 - 10000 ohms for the secondary winding. Extremely low resistance usually indicates a shorted winding and extremely high resistance usually indicates an open in the winding.

CAUTION ***The 4-volt coils can be tested on a 6-volt tester. However, a 12-volt tester will destroy the coil in a few seconds.***

2. If a coil passes all the above-mentioned tests and fails to operate, it should then be tested on a standard coil and winding tester for which test data is available.

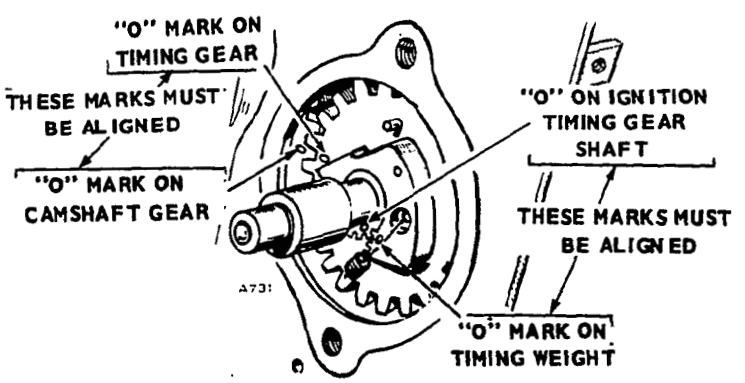


FIGURE 58. TIMING MARKS

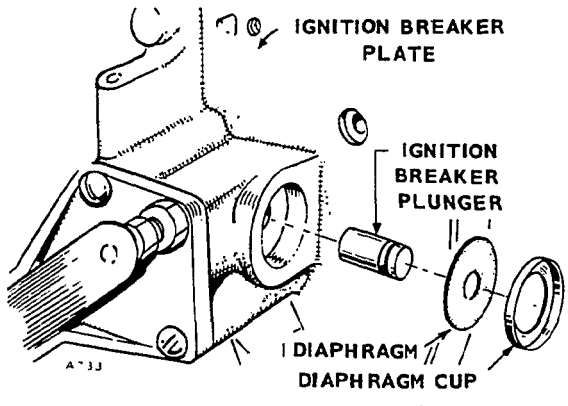


FIGURE 59. IGNITION PLUNGER

MJC IGNITION SYSTEM

The MJC engine uses a radio-suppressed battery ignition system with dual breaker points to produce and distribute spark voltage to the four cylinders (Figure 60).

The ignition system includes two ignition coils, distributor with spark advance and two sets of breaker points, and two spark plugs. Breaker point set No. 1 fires cylinders 1 and 4; point set No. 2 fires cylinders 2 and 3. (See Figure 60).

Maintenance

Periodic maintenance of the MJC ignition system should include oiling the distributor, cleaning and adjusting breaker points, checking ignition timing, cleaning and adjusting spark plugs, and general inspection of ignition system wiring.

At regular intervals, add 3 to 5 drops of clean medium grade engine oil to oiler on distributor. Add 1 drop of light engine oil to breaker arm hinge pin and 3 to 5 drops to the centrifugal weight pivots. Wipe grease lightly onto each lobe of the breaker cam. Do not over lubricate distributor.

To adjust breaker points, remove distributor cap and rotate the crankshaft to get maximum breaker gap. The gap should be 0.020 inch. At the same time, inspect points for dirt or pitting.

Dirty points can be cleaned with tape and chlorothene. But if points are excessively pitted, they must be replaced.

Timing

Ignition timing means adjusting distributor so the spark for each cylinder fires at the correct time for maximum power (25° BTC of each compression stroke).

The MJC ignition system may be timed either with the engine stopped or running. But before timing ignition, be sure both sets of breaker points are clean and properly adjusted. Breaker point set No. 1 opens to fire cylinders 1 and 4 simultaneously and point set No. 2 opens to fire cylinders 2 and 3 simultaneously. Time engine as follows:

Engine Stopped:

1. Disconnect low voltage lead to distributor and connect a test lamp and battery so lamp lights when the No. 1 set of breaker points are closed.
2. Remove spark plug from No. 1 cylinder and rotate flywheel clockwise until air is forced out of the spark plug hole (compression stroke).

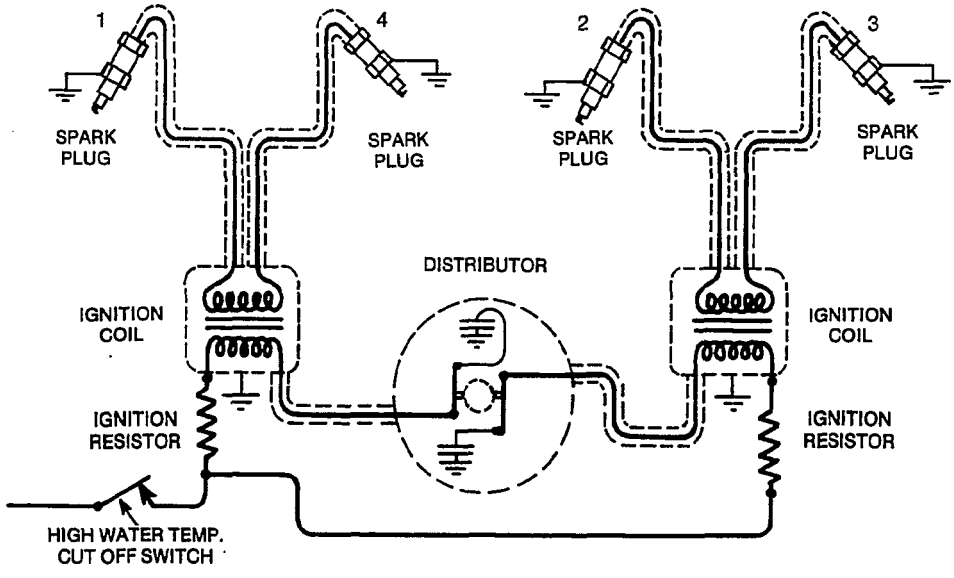


FIGURE 60. MJC IGNITION SYSTEM

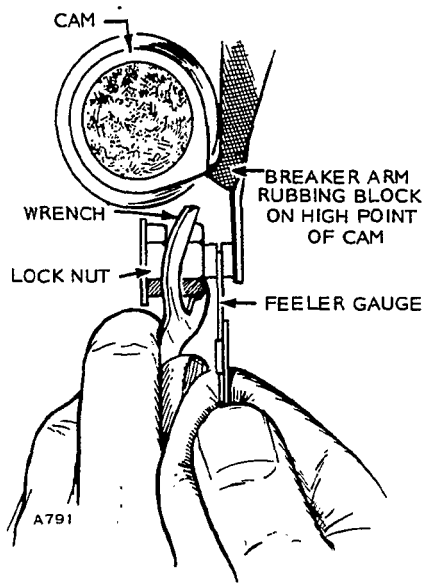


FIGURE 61. POINT ADJUSTMENT

3. Continue rotating the flywheel slowly until test lamp goes out, indicating that the breaker points have opened. This is the ignition point. If TC mark on flywheel and ignition timing pointer are aligned, timing is correct; if not, distributor will have to be adjusted.

4. To correct timing, align flywheel TC mark and timing pointer. Then loosen distributor body and rotate it (clockwise if ignition occurred early, and counterclockwise if late), until light goes out.

5. Retighten distributor body in new position and recheck timing, step 3. If timing still does not occur at the correct point, repeat step 4.

6. The No. 2 set of points should be properly timed to open if the gap is correct (0.020 inch) and No. 1 set of points has been properly adjusted. However, they may be checked for proper timing by placing a timing mark on the flywheel, 180° from the TC mark. Then repeat steps 1-5, substituting cylinder 2 for cylinder 1 and the new timing mark for TC. Later flywheels have BC (Bottom Center) mark.

Engine Running:

1. Install an automotive timing light on spark plug for No. 1 cylinder following the manufacturer's instructions.

2. Run engine at rated speed. Aim the flashing timing light toward the flywheel.

3. If timing pointer on gear cover indicates 25° BTC, timing is correct. If not, loosen distributor body clamp and rotate distributor clockwise to retard the ignition point. Tighten distributor in its mount and recheck timing with the light.

4. The No. 1 set of breaker points fires cylinders 1 and 4. Breaker point set No. 2 fires cylinders 2 and 3 and should be properly timed to open if gap is correct (0.020 inch). The timing may be checked by placing a timing mark on flywheel, 180° from the 25° BTC mark (155° ATC). Then repeat steps 1 - 3, substituting cylinder 2 for cylinder 1 and the new timing mark for 25° BTC.

If relative position of timing marks do not remain steady, distributor is probably defective. This can be caused by pitted or misaligned breaker points, by incorrect breaker point spring tension, or by worn or loose breaker plate, distributor shaft, or bushing.

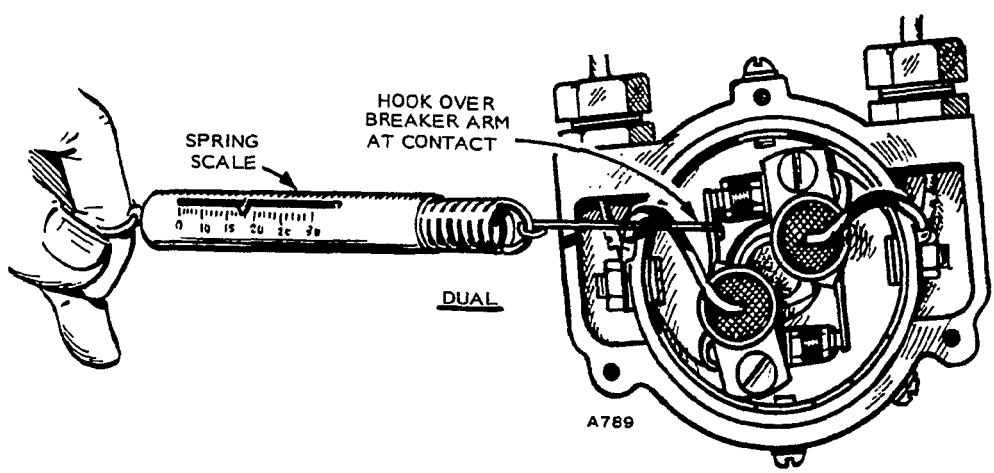


FIGURE 62. POINT SPRING TENSION

Distributor

The distributor serves three functions. It contains and opens breaker points at the proper time, provides an automatic spark advance mechanism, and serves the two coils which supply high voltage to spark plugs.

Testing: The point opening should be adjusted to 0.020 inch.

Thoroughly inspect breaker points and check to be sure the movable contact turns freely on its pivot.

Using a spring scale, measure tension of the points as they break contact. Tension should be 17 to 20 ounces. If it is greater, it causes excess wear; if less, the contact will bounce. See step 9, subsection D, distributor assembly, to adjust tension.

Removal and Disassembly:

1. Remove distributor cap by removing the three mounting screws.
2. Remove the two primary leads from distributor terminals.
3. Remove the two coil leads from breaker box cover adapter.
4. Record position of the distributor body for easier assembly.
5. Remove distributor hold down capscrew and pull distributor out of crankcase.
6. Remove the three screws holding breaker plate to distributor housing and loosen primary lead mounting terminals.
7. Lift breaker arms off their pivot pins.
8. Rotate breaker plate counterclockwise about 45° and pull it out of distributor body.
9. Remove the two centrifugal advance springs.
10. Remove spring clip (cam retaining spring) holding cam to drive shaft and lift out the cam. The weights are now free and can be lifted out.
11. If necessary, press the two bronze bearings out of distributor body. To check for bearing wear, see Repair.

Repair: Clean all disassembled components except the condenser, breaker points, and bushings in light cleaning solvent. When dry, inspect all components. Inspect centrifugal advance component for signs of wear, and replace any that appear worn or otherwise damaged. Inspect cam and shaft for wear or score marks. If either is scored, replace it.

To check for excess bearing wear, set the drive shaft into body and measure side play at top of cam with a dial indicator. Mount indicator on distributor body, and measure side play that occurs when pulling shaft directly away from indicator with a force of about 5 pounds. Side play should be less than .005 inch. If not, bearings must be replaced. But, because of the great care that should be exercised during replacement and a special driver required to size the bearings correctly, ONAN does not recommend field replacement of bronze shaft bearings unless the special equipment is available. An authorized service station can do this work.

Assembly:

1. Install shaft assembly with upper drive shaft thrust washer in distributor body.
2. Install lower drive shaft thrust washer and drive gear. Install a pin through drive gear and shaft and peen it into place.

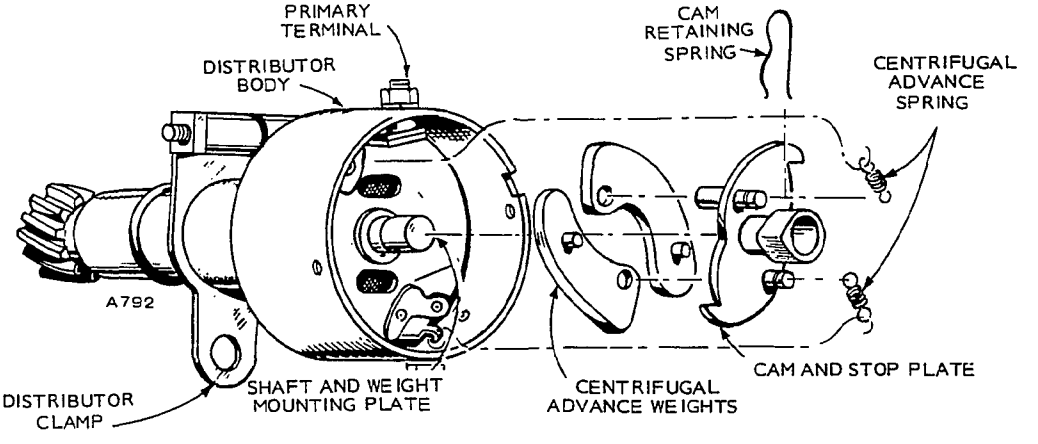


FIGURE 63. DISTRIBUTOR ASSEMBLY

3. Check drive shaft end play. It should be between .003 inch and .010 inch. If end play is too small, tap lower end of distributor drive shaft lightly with a soft hammer to increase play. If it is too great, check thrust washer installation or reinstall the gear (Figure 64).

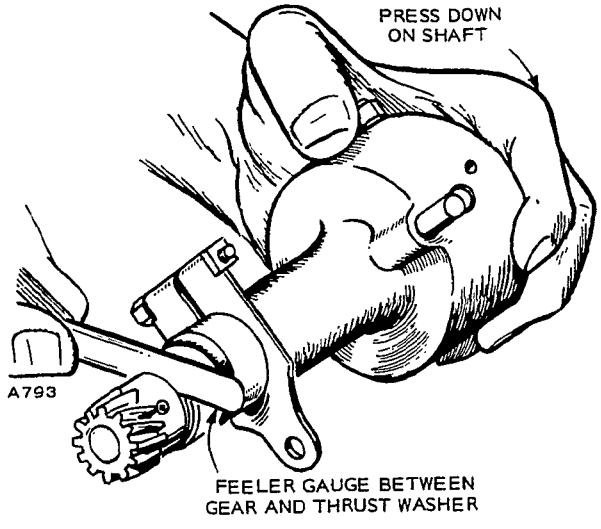


FIGURE 64. DISTRIBUTOR SHAFT END PLAY

4. Set centrifugal advance weights into place and install cam. Be sure the pivots on cam fit into hole in each weight.
5. Secure cam with spring clip and install weight springs.
6. Install and secure breaker plate.
7. Mount breaker arms on their pivots and place control-spring end between end of the terminal stud and the square metal washer. Then tighten primary terminals.
8. Align contacts so they make contact near the center. To do this, bend stationary contact bracket, not the breaker arm.
9. After aligning the points, check tension of breaker spring with a spring scale hooked on the arm at the contact and held at right angles to contact surfaces (Figure 62). Tension should be 17 to 20 oz. If not, adjust it by loosening screw holding end of contact spring and installing spacing washers or by sliding end of the spring in or out.
10. Rotate drive shaft to obtain maximum breaker point gap and set gap for .020 in. (Figure 61).

Installation, Distributor: If you know the position of the distributor when removed and the crankshaft was not moved after distributor removal, distributor can be installed in exactly the same position. After installing, perform steps 3, 4, 5, and 6 below.

If exact position of both distributor body and rotor were not recorded or if the crankshaft was rotated, follow the complete procedure below.

1. Remove spark plug from No. 1 cylinder. Place a finger over the spark plug hole and rotate flywheel clockwise until cylinder builds up pressure. Continue rotating until TC mark on flywheel aligns with timing pointer.
2. With points in the "Breaking Open" position, push distributor into its mounting hole. It may be necessary to rotate distributor slightly to position and mesh distributor and camshaft gears.
3. Install distributor clamp screw.
4. Connect coil leads to breaker box cover adapter. See Figure 60.
5. Connect primary leads to distributor terminals.
6. Time ignition system.

MJC Ignition Coils

The MJC engine uses two suppressed ignition coils mounted on the intake manifold. Normal ignition coil maintenance should include inspecting, tightening, and cleaning terminals, if necessary.

A quick check for possible coil failure can be made by simply disconnecting the high tension spark plug leads (cyl. 1 or 4 for coil nearest cyl. 1 — cyl. 2 or 3 for other coil). See Figure 60. Then hold end of the leads 1/4 inch from bare engine metal and crank engine. A spark between lead end and engine indicates coil is operating, although it (one coil or the other) may be weak, which could be checked only on a tester or by checking resistance. No spark indicates that coil, points, or control circuit to the coil is defective. Before discarding the coil, if there is no spark, check hi-tension lead for voltage while cranking engine and inspect breaker points.

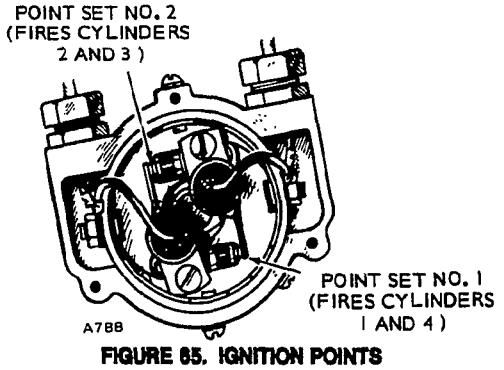


FIGURE 65. IGNITION POINTS

MJC Ignition Condensers

Two condensers are mounted in a vertical position inside the distributor. If they are suspected of being defective, test and replace if necessary. Capacitance should be 0.3 mfd.

SPARK PLUGS

MJB and MJC engines use aviation spark plugs equipped to accept suppressed ignition leads. Fouled spark plugs indicate that they are too cold. Consult engine parts catalog for the factory recommended plug. Remove and inspect plugs at regular intervals.

Replace spark plugs when electrodes become excessively worn or if the plugs are damaged.

When replacing or re-installing spark plugs, always install new gaskets.

Oil System

J-Series engines have pressure lubrication to all working parts of the engine. Oil system includes an oil intake cup, gear-type oil pump, bypass valve, oil pressure gauge, full-flow oil filter, and crankcase passages and drillings to deliver oil throughout engine. Oil is held in the oil base, drawn by oil pump, and delivered through the oil filter. Oil lines lead to rocker housing, with drillings through the crankcase to crankshaft bearings and camshaft front bearing; crankshaft passages to connecting rod bearings and connecting rod passages to piston pin bushings complete the oil system. The crankcase breather in this system aids oil consumption control, Figure 66.

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

MAINTENANCE

Periodic oil system maintenance should include changing crankcase oil, cleaning crankcase breather, cleaning rocker box oil lines, and replacing oil filter.

WARNING ***Hot crankcase oil can cause burns if it is spilled or splashed on skin. Keep fingers and hands clear when removing the oil drain plug and wear protective clothing.***

OIL PRESSURE GAUGE

The gauge is located on lower front corner of cylinder block. If it is damaged, replace it. Before replacing, check for a clogged oil passage behind the gauge.

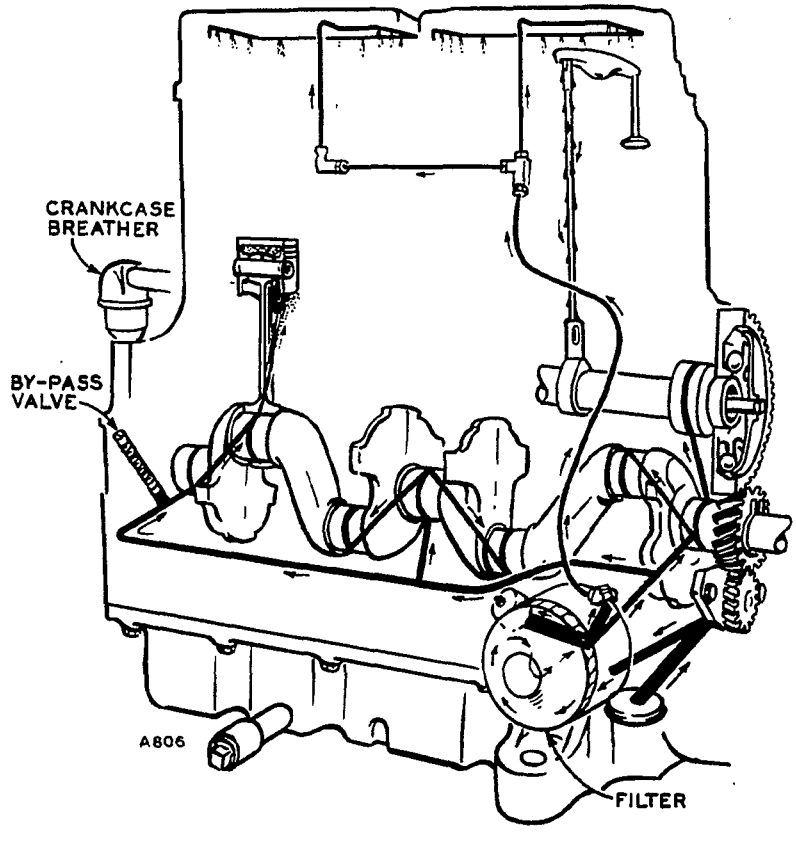


FIGURE 66. ENGINE PRESSURE LUBRICATION SYSTEM

OIL PUMP

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

Removal

1. Remove gear cover and oil base (refer to *Engine Repair* section). Unscrew intake cup from the pump.
2. Remove crankshaft lock ring and gear retaining washer.
3. Loosen the two capscrews holding pump to the crankcase, and remove pump.

Repair

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

Installation

Before installing, fill pump intake and outlet with oil. Mount pump on engine and adjust for .005-inch lash between pump gear and crankshaft gear. Mount intake cup on the pump so it is parallel with the bottom of crankcase.

BY-PASS VALVE

The by-pass valve (located on outside of rear bearing plate) controls oil pressure by allowing excess oil to flow directly back to the crankcase. Normally valve begins to open at about 25 psi. It is non-adjustable and normally needs no maintenance. To determine if abnormal (high or low) oil pressure is caused by a sticking plunger, clean and inspect valve.

To remove valve, unscrew the recessed plug in rear bearing plate and lift out spring and plunger assembly (Figure 67). Determine proper valve operation by checking spring and plunger according to the following measurements.

Plunger Diameter . . . . . .3365 to .3380 inch

Spring
Free Length . . . . . 2-5/16 inches — 1/16 inch

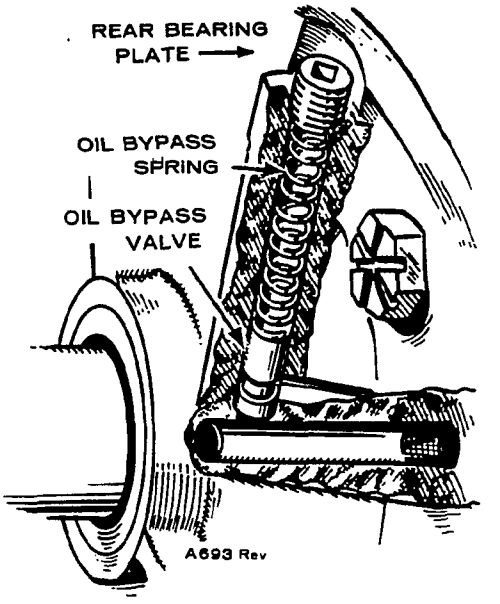


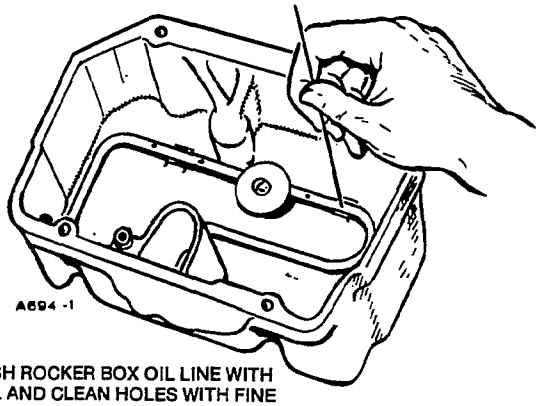
FIGURE 67. BY-PASS VALVE

OIL FILTER

The full-flow filter is mounted on filter plate at left front corner of crankcase. Replace normally after every 200 hours of operation. Remove filter by turning counterclockwise. Lubricate gasket on new filter with engine oil. Install filter until the gasket touches base and tighten 1/2 turn; do not overtighten.

OIL LINES

Rocker box oil line (Figure 68), should be flushed with solvent and small holes cleaned with fine wire at regular intervals. Clean other oil lines and drillings with compressed air whenever engine is disassembled or overhauled. Remove oil mounting plate to reach the oil gauge passage.



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

FIGURE 68. CLEANING ROCKER BOX OIL LINE

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

CRANKCASE BREATHER

This breather maintains a partial vacuum in crankcase during operation, to control oil loss and ventilation. It includes a metal filter packed into tube on crankcase, a rubber cap, and a hose connecting it to engine air horn (Figure 69).

To disassemble, remove breather cap from breather tube. At the same time, pull baffle out of breather tube and clean it.

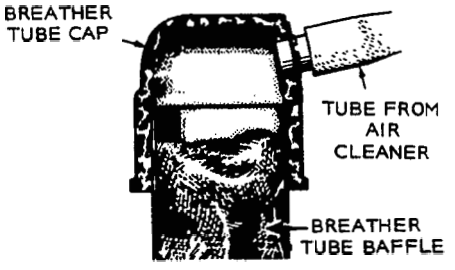


FIGURE 69. CRANKCASE BREATHER

Starting System

Most engine installations use a starting motor, as shown in Figure 70. Starting motor mounts on right side of engine and drives flywheel for starting. It is a standard automotive starting motor with solenoid shift and over-running clutch, controlled by a start solenoid in control box. When control box solenoid energizes, solenoid on motor operates, shifting starter pinion to engage flywheel ring gear and closing circuit to starting motor. Starting motor remains engaged until after engine starts when control circuit centrifugal switch closes, completing starting cycle. Over-running clutch protects starter armature from overspeeds.

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

MAINTENANCE

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

Separate Starting Motor

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

TESTING

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

Battery

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

Wiring

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

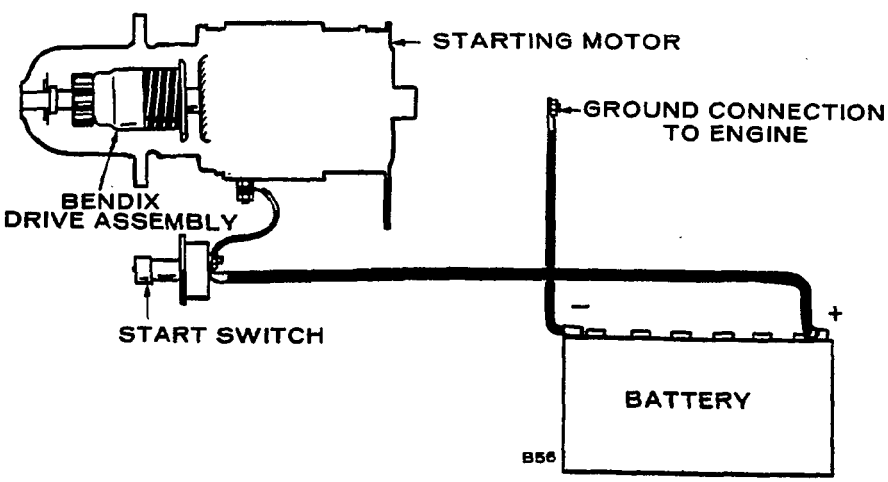


FIGURE 70. STARTING SYSTEM

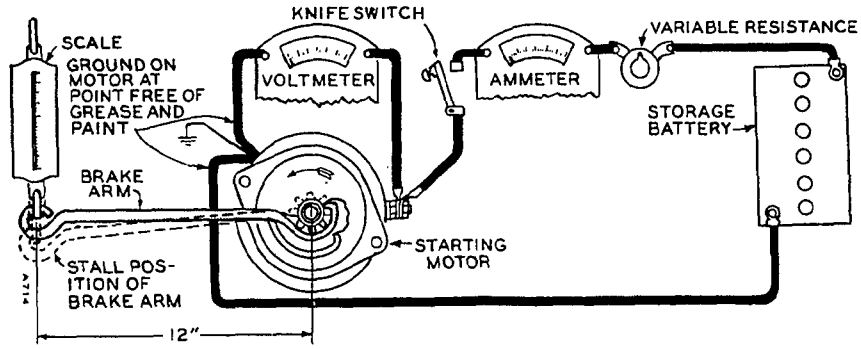


FIGURE 71. TESTING FOR TORQUE

Starting Motor

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

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

The torque test (Figure 71) requires a spring scale and torque arm, voltmeter, ammeter, and variable resistance to apply voltage specified by test characteristics. The voltage drop across solenoid on starting motor should be less than 1.50 volts. If not, remove it for repair.

BATTERY

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

The battery charging system maintains batteries at or near full charge at all times. Inspect 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 charge rate.

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

REPAIR

Armature

Inspect 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 commutator and shaft. Do not touch probes to the commutator brush surfaces, as this will burn smooth surfaces.

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

If commutator is only dirty or discolored, clean it with 00 or 000 sandpaper. Blow 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 field coils for grounding to 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 front or rear bearings show excessive wear, replace them. Drive old bearings out, and using an arbor press and proper arbor, press new bearings into place.

Brushes

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

Replace Prestolite brushes when excessively worn, or when worn to 5/8 inch in length. Replace Mitsubishi brushes when excessively worn or when worn to 3/8 inch in length. Brushes are soldered to the field coil. To remove Prestolite brushes, unsolder the lead and open the loop in field coil lead. Insert 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 connection.

Over-running Clutch

Clean clutch thoroughly but do not dip in solvent. It cannot be repacked with grease.

It should slide easily on armature shaft with no binding. Turn the pinion. It should rotate smoothly, but not necessarily freely. Reverse 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 plunger moves freely in the coil. Check pull-in coil continuity between solenoid control terminal and solenoid connection to motor. Check hold-in coil continuity between solenoid control terminal and ground on the motor.

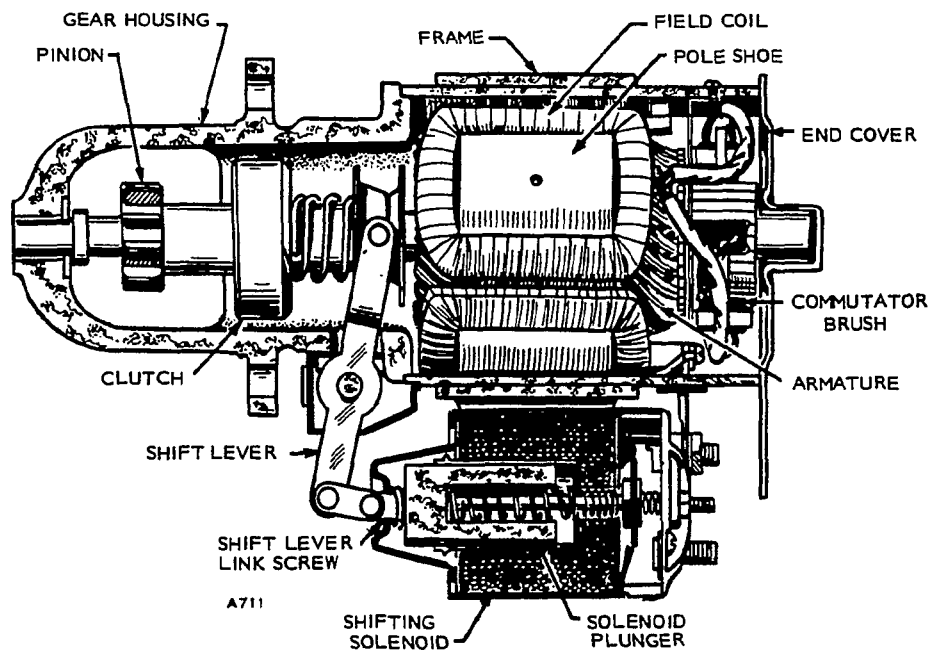


FIGURE 73. PRESTOLITE STARTER

PRESTOLITE STARTER REMOVAL AND DISASSEMBLY

1. Remove electrical connections to control and battery at the shifting solenoid, Figure 73.
2. Remove nut holding starter rear mounting bracket to engine. Remove the three capscrews holding starting motor mounting flange to the crankcase. Then pull starting motor off engine. Be careful not to lose any shims that might be behind the flange.
3. Remove link pin holding shift lever to the solenoid plunger and remove shift lever pivot pin.
4. Remove thru bolts from the commutator end of motor. Pull off end cover and lift brushes off their seats. Pull cast housing from the front end of motor and lift armature and clutch out of motor frame.
5. To remove over-running clutch from armature, drive the retainer away from the ringlock near front end of shaft, remove ringlock and pull the assembly off. Do not attempt to disassemble clutch assembly.
6. If necessary to service the solenoid, remove four capscrews and electrical connection holding it to motor frame. To reach the switch contacts, remove two screws on rear of the solenoid.
7. Mount starter motor to engine by a direct reversal of the removal procedure. Connect battery cable and wires to starter.
8. Connect battery cables to battery. Connect ground cable last.

PRESTOLITE STARTER ASSEMBLY

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

When motor is assembled, check 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 commutator end of the armature.

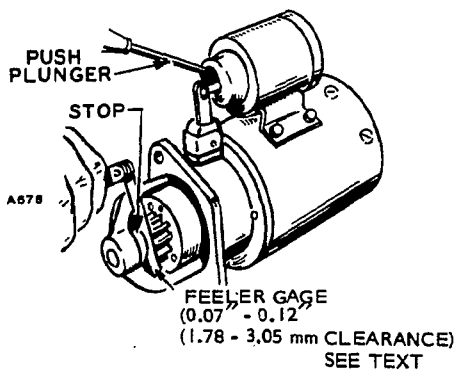
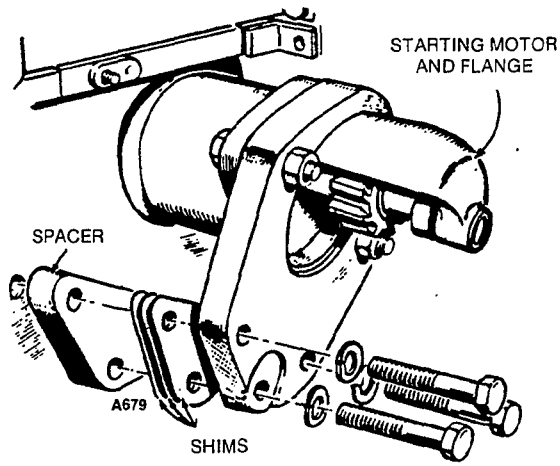


FIGURE 74. CHECKING PINION CLEARANCE

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

Press-on solenoid core to shift pinion into full mesh, and measure clearance between pinion and pinion stop, Figure 74. 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 link screw on end of solenoid plunger for proper clearance.

On engines built before May 1962, it was necessary to maintain gap between ring gear and starter pinion in relaxed position at less than 1/8-inch to ensure starter engagement. When installing these motors, check this gap. If it is too great, a shim kit is available to reduce it (Figure 75).



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

FIGURE 75. STARTING MOTOR MOUNTING SHIMS

MITSUBISHI STARTER REMOVAL AND INSTALLATION

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

MITSUBISHI STARTER DISASSEMBLY

1. Remove "M" terminal nut and wire lead from solenoid.
2. Remove two solenoid mounting screws, and remove solenoid.
3. Remove two through bolts and brush holder retaining screws. Remove rear bracket (Figure 76).

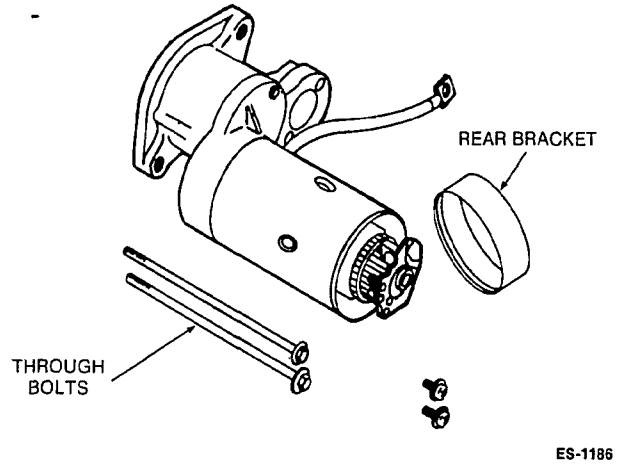


FIGURE 76. REMOVING REAR BRACKET

4. Remove frame assembly, and brush holder assembly, while pulling brushes upward. Then remove armature assembly.
5. Remove cover assembly (snap ring and washer) from the pinion shaft (Figure 77).

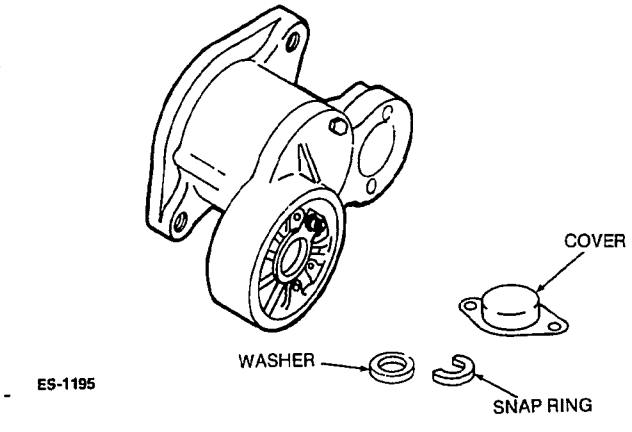


FIGURE 77. REMOVING SNAP RING AND WASHER

6. Remove capscrew that secures center bracket to front bracket. Remove center bracket; several washers used to adjust pinion shaft end play can now be removed (Figure 78).
7. Remove gear, spring set, and lever assembly from front bracket. Note direction in which lever assembly is installed.

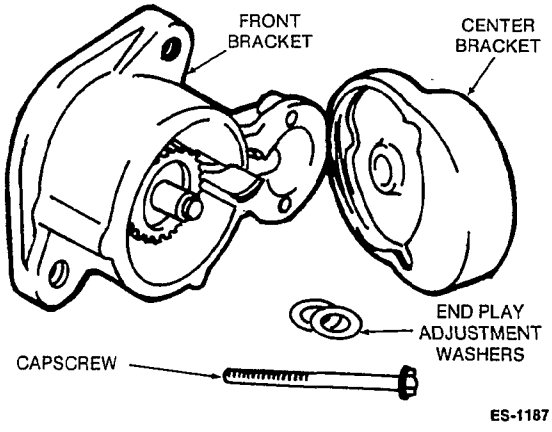


FIGURE 78. REMOVING CENTER BRACKET

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. Front bearing is not replaceable and must be replaced with bracket.

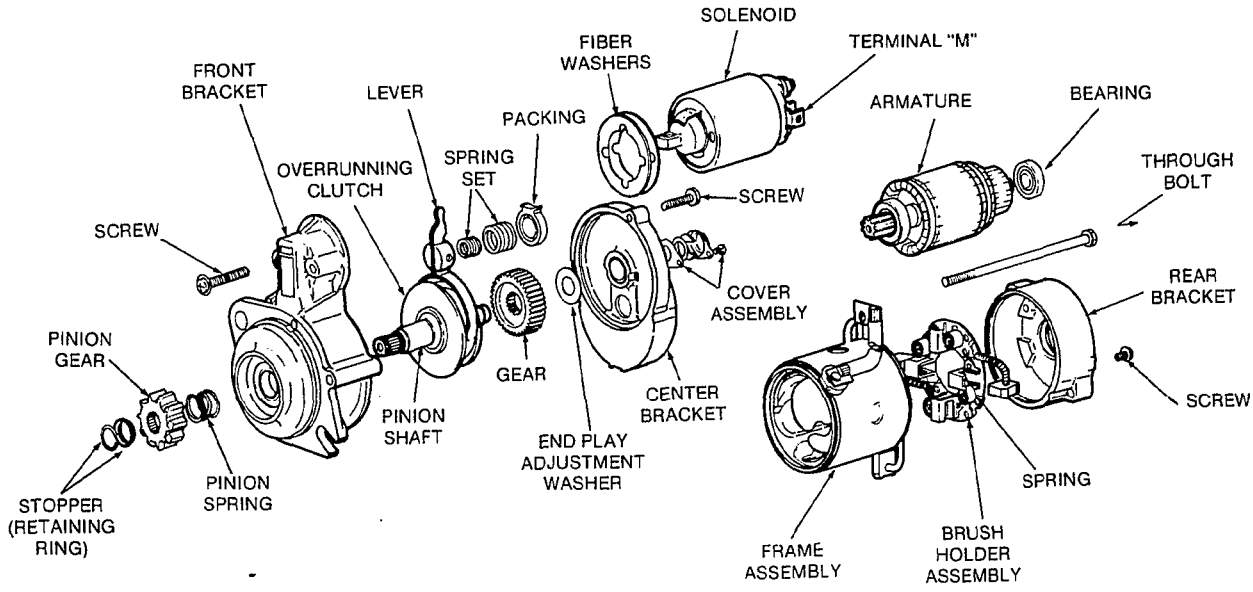


FIGURE 79. MITSUBISHI STARTER

MITSUBISHI STARTER ASSEMBLY

For assembly reverse disassembly procedure, but note following items. See Figure 79.

Whenever starter motor is disassembled apply grease to each of 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 adjusting washers placed between center bracket and reduction gear (Figure 80).

With pinion gear removed, install reduction gear onto pinion shaft. Place pinion shaft into center bracket and secure with washer and snap ring. Measure 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.

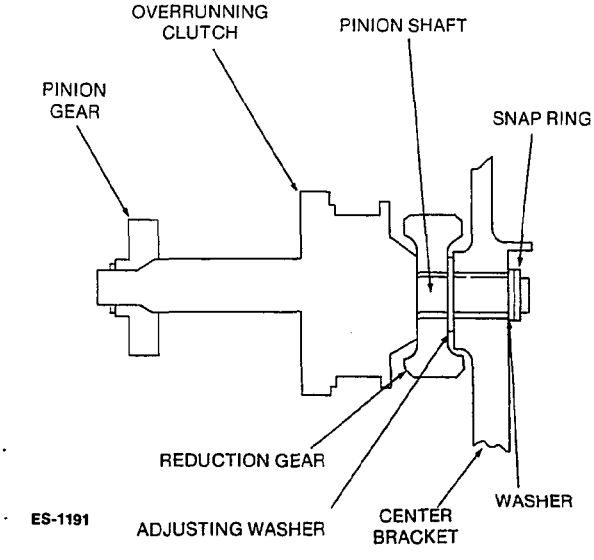


FIGURE 80. ADJUSTING PINION SHAFT END PLAY

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 81).

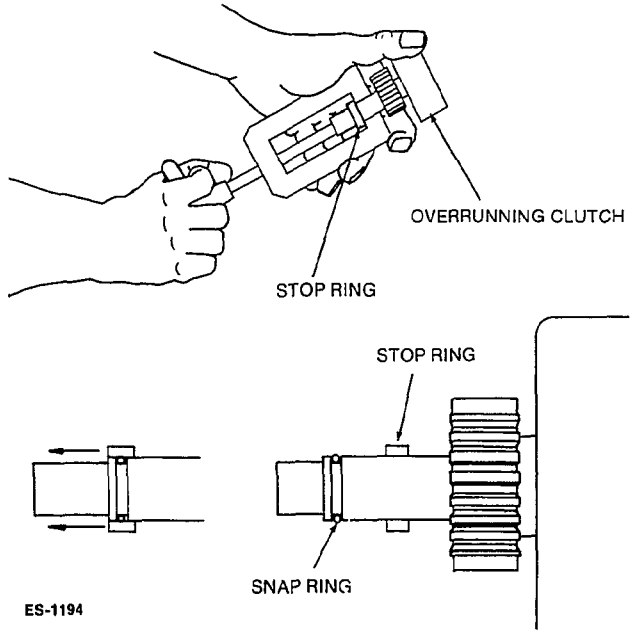


FIGURE 81. PINION GEAR INSTALLATION

Lever Assembly Installation

Figure 82 shows correct method of installing the lever assembly, spring, and packing. Pay close attention to direction of lever.

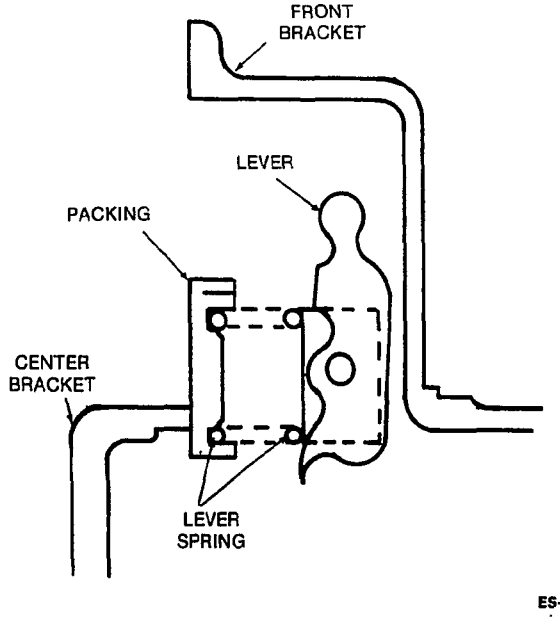


FIGURE 82. LEVER INSTALLATION

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.

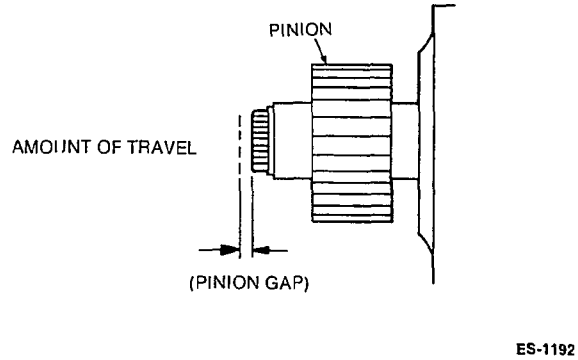


FIGURE 83. PINION GAP ADJUSTMENT

3. Gently push pinion shaft back towards front bracket and measure the amount of travel (Figure 83).
4. The pinion gap should be 0.3 to 2.0 mm (0.118 to .0787 inch). Adjust by changing number of fiber washers used on solenoid mounting surface. Increasing number of fiber washers decreases clearance. Decreasing number of washers increases clearance.

Engine Disassembly

This section covers various assemblies and parts of engine. All repairs should be done by a competent mechanic. Maintain factory limits and clearances (see *Dimensions and Clearances* section).

CYLINDER HEADS AND VALVES

Each cylinder head assembly contains valves, valve seat inserts and guides, rocker arms and spark plugs. Valve assemblies are operated by pushrods running through cylinder head and push rod shields to camshaft. Exhaust valves are hardened chrome alloy-faced and ride on hardened chrome-alloy seat inserts. All valves have release-type rotators.

Check valve clearances at regular intervals. In addition, scrape combustion chambers clean and inspect the valves and valve seats regularly. If combustion chambers show excessive carbon buildup, reduce the interval between cleaning.

Valve Adjustment

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

MJB Series

Adjust valve clearance on the MJB engine as follows, obtaining valve clearances from *Specifications* section.

1. Turn flywheel so piston of valve to be checked is between 10 degrees and 45 degrees after TDC (about 2 inches after TDC) of the compression stroke.
2. Turn flywheel until the 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. There is no timing mark for this position so it must be estimated. With piston located in this position the cylinder will be in its power stroke with both valves completely closed.
3. Check cylinder head-bolt torque.
4. Using a feeler gauge, check the clearance between the rocker arm and the valve (see Figure 84). Increase or reduce the clearance until proper gap is established, adjusting with the locknut which secures rocker arm to cylinder head.

MJC, RJC Series

Adjust valve clearance on the four cylinder engine as follows:

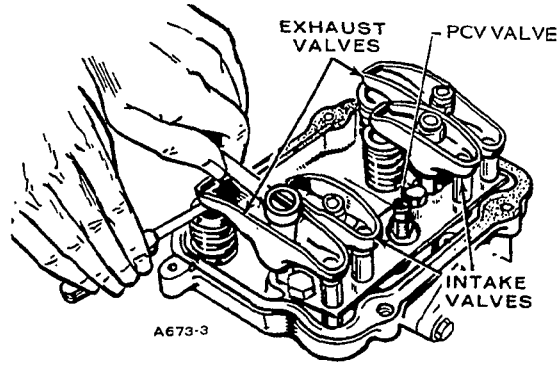


FIGURE 84. SETTING VALVE CLEARANCE

1. Adjust valve clearance in the firing order (1-2-4-3) sequence. After the cooling period, set timing for number 1 cylinder and valve clearance.
2. To adjust valve clearance for number 2 cylinder, turn flywheel in a clockwise direction 180 degrees (1/2 revolution) from position used in step 1. The flywheel position should be between 10 degrees and 45 degrees past the BC (bottom center) flywheel mark.

   Early model four-cylinder engines do not have a BC mark on flywheel.
3. After timing number 2 cylinder, adjust valve clearance.
4. To adjust valve clearance for 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 TC flywheel mark.
5. After timing number 4 cylinder, adjust valve clearance.
6. To adjust valve clearance for 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 flywheel mark.
7. After timing number 3 cylinder, adjust valve clearance.

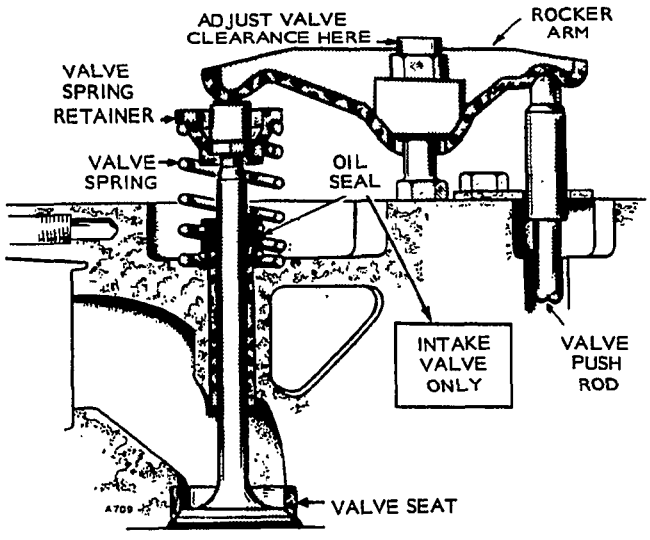


FIGURE 85. VALVE MECHANISM

Compression Test

Run engine until thoroughly warm. Stop and remove all spark plugs. Insert compression gauge in a spark plug hole, crank engine and note the reading. To check for piston blow-by, squirt a small amount of SAE 50 oil into 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 110 psi. Compression should be fairly uniform, normally with less than 10 psi differences between the highest and lowest cylinder, taken at the same cranking rpm. Excessively high readings indicate carboned combustion chambers.

Compression readings will change because of differences in cranking speed, altitude and ambient temperature conditions. Compression limits are 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

Valves, tappets, rocker arms and pushrods should be kept in order and returned in same order.

1. Remove rocker box cover, spark plugs and connecting oil lines to cylinder heads. Remove intake and exhaust manifold.
2. Remove capscrews holding each cylinder head to cylinder block.
3. Remove each head. If it sticks, rap it sharply with a soft hammer. Do not use a pry.
4. Remove rocker arms and pushrods.
5. Using a valve spring compressor, disassemble valve assemblies.

Repair

Thoroughly clean all components of the cylinder assemblies. Remove all carbon deposits from combustion chambers and clean all gasket surfaces.

Remove all carbon and check each valve for burning, pitting or warped stem. Valves that are slightly pitted or burned should be refinished on an accurate valve grinder to a 45 degree angle. If they are badly pitted, or will have a thin edge when refaced, replace them.

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

Check valve guide-to-valve clearance. If proper clearances cannot be obtained by replacing valves, replace the valve guides. Drive old valve guides in until they protrude 11/32-inch from the rocker box side of the head. Ream new valve guide to obtain the proper clearances (see *Dimensions and Clearances* section).

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

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

Use valve seal remover in a drill press (Figure 86) to remove each valve seat. Adjust the tool to cut 1/64-inch from the edge of seat.

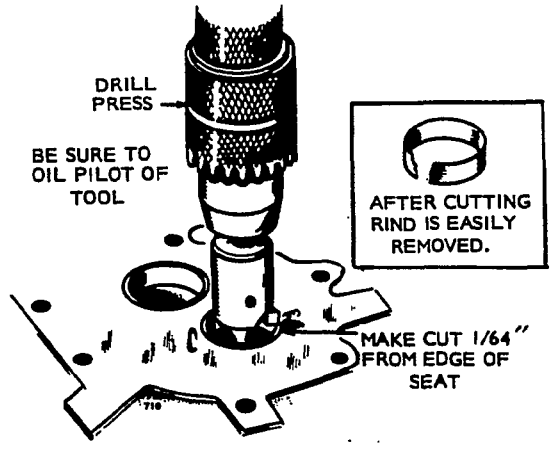


FIGURE 86. REMOVING VALVE SEATS

Oil pilot to prevent seizing in the valve guide. Cut each seat down to a narrow rind on edges and bottom and break it out with a sharp tool. Be careful not to cut into the counterbore bottom.

Thoroughly clean valve seat counterbore and remove any burrs from edges. If counterbore is damaged, machine for oversize seat. Oversize seats are available in .002 inch, .005 inch, .010 inch and .025 inch. Otherwise, install new standard-size seat inserts.

Drive new valve seat inserts into place. Each seat must rest solidly on bottom of the counterbore at all points. To ease installation, heat cylinder head in an oven at 325°F for about 1/2 hour and cool valve seats in dry ice.

After installation, and before facing new seats, peen the head material against the valve seat in three areas between the machine roll marks (Figure 87).

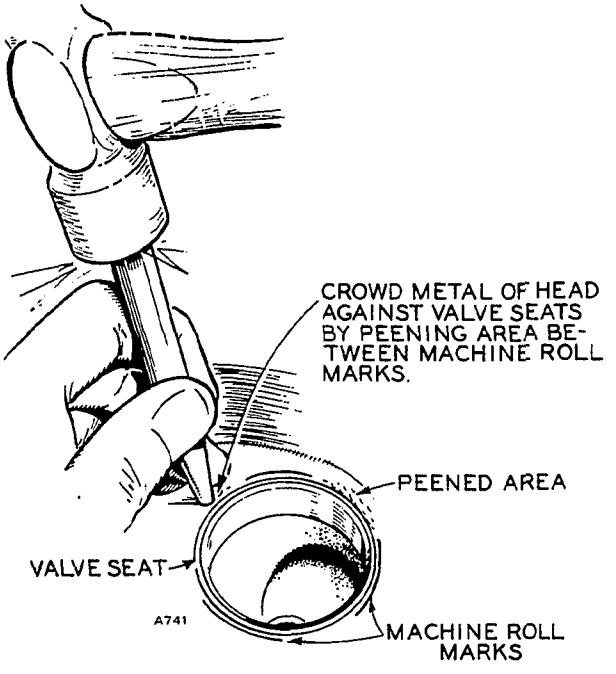


FIGURE 87. PEENING VALVE SEAT AREA

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

Check valve springs on an accurate compression scale. Replace any spring that is weak, cracked or pitted, or has ends out of square. See *Dimensions and Clearances* section for valve spring data.

Installation

1. Push a new valve stem oil seal onto each intake valve guide and clamp in place. Then oil the inside surface of each seal.
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 and observe if marks rub off uniformly when valve is rotated part of a turn in seat. If the seat is not tight, regrind valves.
4. Using a valve spring compressor, compress each valve spring with its spring retainer in place and insert retainer locks.

   Spring retainer should never contact valve stem seal when compressing valve springs.
5. Coat both sides of heat gasket with Permatex No. 3 (pliable sealer). Install head assembly and gasket to cylinder block. Tighten head bolts 1 or 2 turns.
6. Make up pushrod shield assemblies by installing an O-ring (Figure 88) on one end of rod and a spring, washer and O-ring on opposite end. Lift cylinder heads and install pushrod shield assemblies.

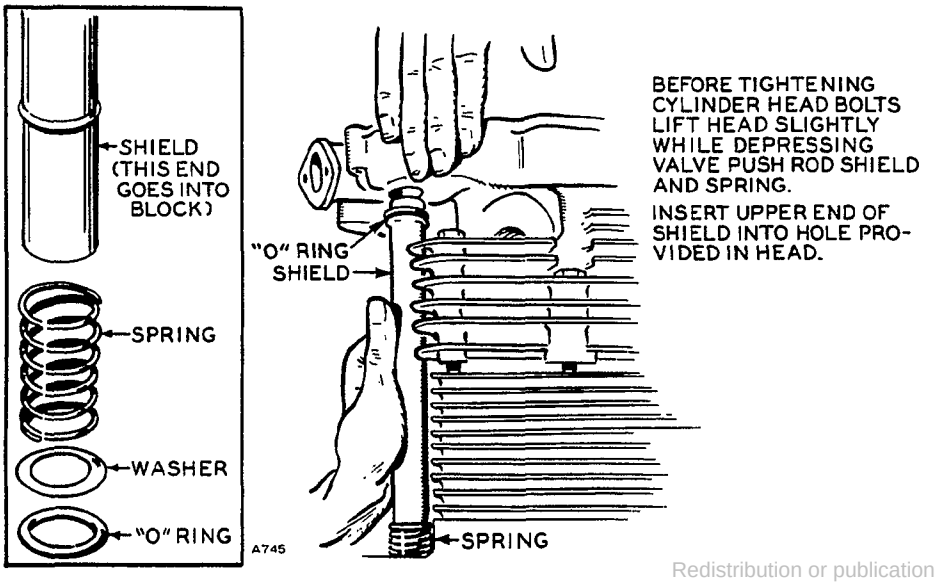


FIGURE 88. INSTALLING PUSH ROD SHIELDS

7. Tighten head bolts to 44 to 46 lbs. ft. following the sequence in Figure 89.

Four cylinder models; observe the following special procedure to align the two heads and prevent air leaks.

a. Assemble heads, gaskets and pushrod shields to block and install capscrews, but do not tighten.
b. Install intake manifold to heads and tighten nuts to 13-15 lbs. ft.
c. Tighten cylinder head capscrews, following sequence in Figure 89.

8. Install exhaust manifold, oil lines, spark plugs and carburetor. Install valve stem caps. Install pushrods, rocker arms and rocker arm nuts.

9. Set valve clearance.

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

10. Reinstall rocker box cover.

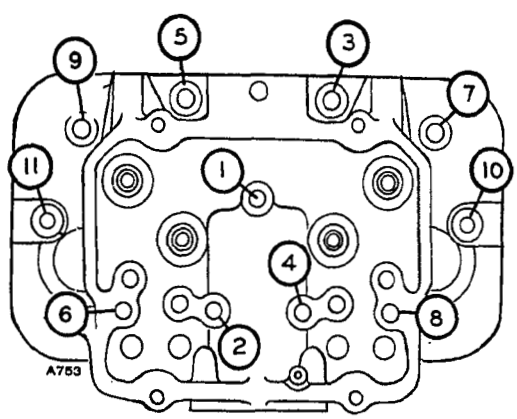


FIGURE 89. CYLINDER HEAD BOLT TORQUE SEQUENCE

PISTONS, CONNECTING RODS, CYLINDERS

Each cam-ground aluminum piston is tapered and fitted with two compression rings and an oil control ring. Full floating piston pins held in place with snap rings connect piston to its connecting rod. Lower end of each connecting rod contains half shell, precision bearings and upper end, semi-finished bushings.

Engines marked with an E following engine serial number are fitted with .005-inch oversize pistons at factory. Use standard rings for these pistons.

Removal and Disassembly

Connecting rods and caps are stamped with numbers for installation in proper cylinder. When removing piston assemblies, check marking so each can be reinstalled in the proper cylinder. Keep all components of each piston assembly together.

1. Drain crankcase oil and remove oil base, air housing, and cylinder heads.

2. Scrape off carbon ring at top of each cylinder to prevent damaging rings or pistons.

3. Remove connecting rod cap and push assembly through the top of cylinder bore. If ridge at the top of cylinder interferes with piston removal, cut it down with a ridge remover before taking piston assembly out.

4. Using a ring expander, remove rings from each piston.

5. Remove the two retaining rings and push piston pin from each piston.

Cylinders

Cylinder walls should be free of scratches, pitting, and evidence of wear. Check with an inside-reading micrometer for excessive out-of-round or taper. New cylinder dimensions are 3.2495 to 3.2505 inch.

If necessary, rebore cylinder to fit the next oversize piston. Pistons and ring sets are available in .010 inch, .020 inch and .030 inch oversize. If refinishing is not required, remove any ridges from top of the wall with a ridge cutter, or if ridge is small, a de-glazing stone.

Pistons

Clean carbon from ring grooves and make sure all oil holes are open. If any piston is badly scored or burred, loose in the cylinders, has badly worn ring grooves or shows excessive wear, replace it.

Check clearance by inserting each piston in its cylinder. Check the clearance 90 degrees from the axis of the piston pin and 3/8-inch below the oil control ring. Clearance should be .0012 inch to .0032 inch. If it exceeds the limits, replace piston and check cylinder bore size.

Piston Pins

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

Rings

Inspect each ring carefully for fit in piston grooves (Figure 90) and for seating on cylinder wall. Fit each ring to cylinder wall at the bottom of its travel, using a piston to square ring in the bore. Check end gap with a feeler gauge, Figure 91. It should be .010 inch to .020 inch. If gap is too small, file the butt ends of the rings. Do not

use rings that need a lot of filing, as they won't seat properly on cylinder walls. If oversize pistons are used, use the correct oversize rings.

During piston ring replacement de-glaze cylinder walls with either a de-glazing hone or emery paper. Do not change diameter of cylinder bore.

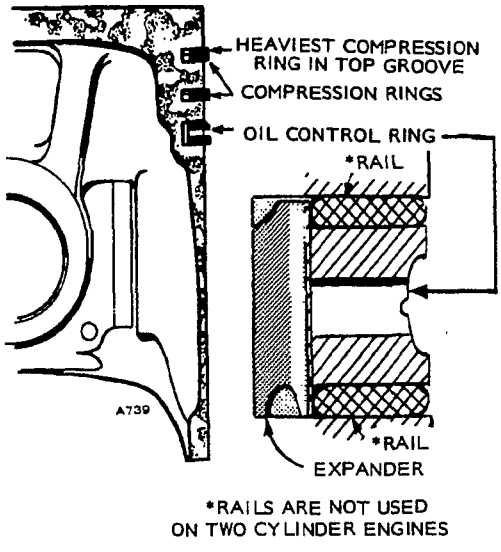


FIGURE 90. PISTON RINGS

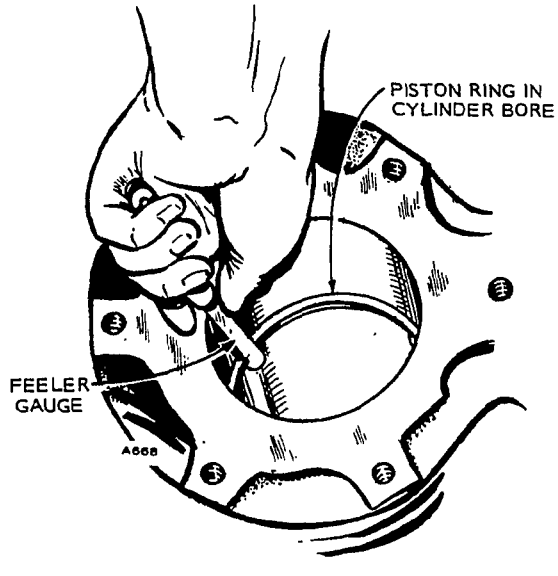


FIGURE 91. CHECKING PISTON RING END GAP

Create a cross hatch pattern on cylinder walls. After de-glazing, be sure to completely clean cylinder walls and the rest of engine to remove all residue.

Connecting Rods

Clean each connecting rod and check for defects. Check upper connecting rod bushings for proper piston pin clearance. Clearance should be .0002 inch to .0007 inch. Press out excessively worn bushings and install new bushings. Press new bushings in until they are centered in connecting rod (Figure 92). After installation, drill the bushings with a 3/16-inch drill through the counterbored hole in connecting rod top. Be sure connecting rod oil spray hole is open.

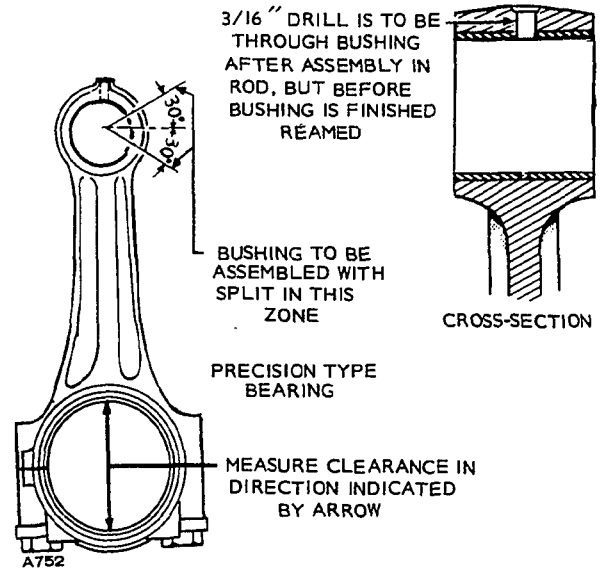


FIGURE 92. CONNECTING ROD BUSHINGS

Connecting Rod Bearings

Inspect connecting rod bearings for burrs, breaks, pitts and wear. Measure clearance between bearings and crankshaft journal. Clearance should be .001 inch to .003 inch. If necessary, replace with new standard or oversize precision bearings. Refer to *Dimensions and Clearances* section for journal size.

1. Install connecting rods on each piston with pins and retaining pins. Install so connecting rod oil spray hole is on the same side as the V notch in each piston.
2. Install all rings on each piston. Tapered-type rings are marked TOP or identified in some other manner. Place this mark toward the closed end of piston. Space ring gaps 1/3 of the way around piston from one another. No gap should be in line with 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 and pistons. Install each piston in proper cylinder using a suitable installer. Each assembly should be installed with V mark on piston toward front of engine. The word "Front" may be found on some piston tops. See Figure 93.

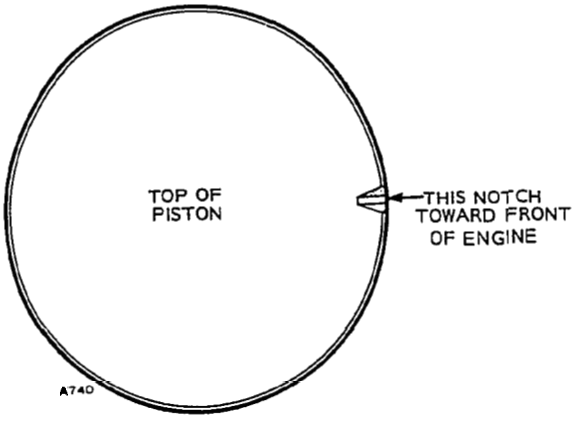


FIGURE 93. PISTON TOP IDENTIFICATION

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 the forging matches mark on connecting rod (Figure 94).

6. Tighten connecting rod capscrews to specified torque (27-29 ft.-lb.).

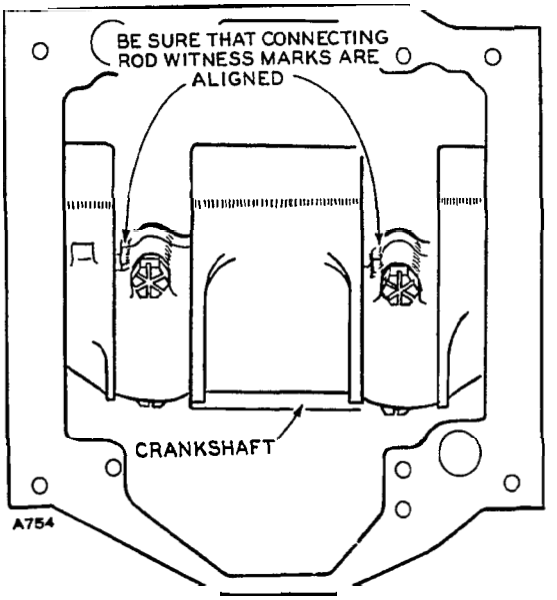


FIGURE 94. CONNECTING ROD WITNESS MARKS

7. Crank engine over by hand to see that all bearings are free.

8. Install oil base with a new gasket. Install cylinder heads.

Break-In Period

Whenever new rings or pistons are installed, or the cylinder refinished, the engine must be run-in before regular operation. Run the engine for 15 to 20 minutes at no load, about 1/2 hour at 1/3 load and 2 to 3 hours at 2/3 load. Then resume regular operation.

Avoid light loads during balance of the break-in period to best seat rings for oil control.

ENGINE DISASSEMBLY

During engine disassembly, observe the following order (i.e., Flywheel, Gear Cover, etc.). As disassembly progresses, the order may be changed somewhat as will be self-evident.

Engine assembly procedure is the reverse of disassembly. Any special assembly instructions for a particular component are included. When reassembling, check for special assembly instructions or procedures.

Flywheel

The flywheel is a tapered fit on the crankshaft. Flywheel is removed by using crank dog as a puller as follows: first remove crank dog and flywheel mounting capscrew. Then remove larger washer from flywheel mounting capscrew and reinstall the screw part way. Install the washer into crank dog and mount crank dog so the washer bears against the end of flywheel mounting screw. Tighten two crank dog capscrews alternately until flywheel comes loose. See Figure 95.

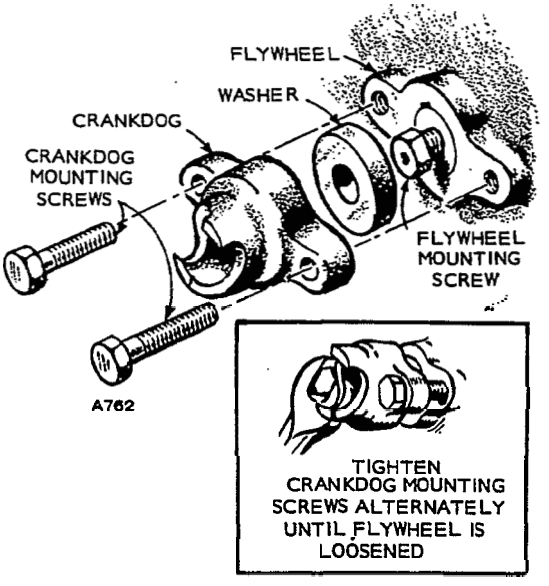


FIGURE 95. PULLING FLYWHEEL

Ring Gear

Remove ring gear by sawing part way through, then break it, using a cold chisel and heavy hammer.

To install a new ring gear, place it in an oven heated to 380-400 degrees for 30 to 40 minutes. When heated properly, the ring will fall into place on flywheel. If it binds, drive it into place with a hammer. Do it fast and do not damage gear teeth. Ring will contract rapidly and may shrink to flywheel before it is in place. If this occurs, a new ring gear may be required.

Gear Cover

To remove gear cover, detach upper governor ball joint and remove the ignition breaker points (Start-Disconnect switch), plate and gear. Remove screws holding gear cover to the crankcase. To loosen gear cover, tap it with a soft hammer.

Governor Shaft

Two sets of needle bearings support the governor shaft. To remove shaft from gear cover, remove governor yoke and pull the shaft from gear cover. If shaft binds during operation, clean the bearings. If loose, replace bearings. To remove larger bearing, drive both bearing and oil seal out from the outside of gear cover. Remove smaller bearing with an Easy-Out or similar tool. Press new bearings and oil seal into place.

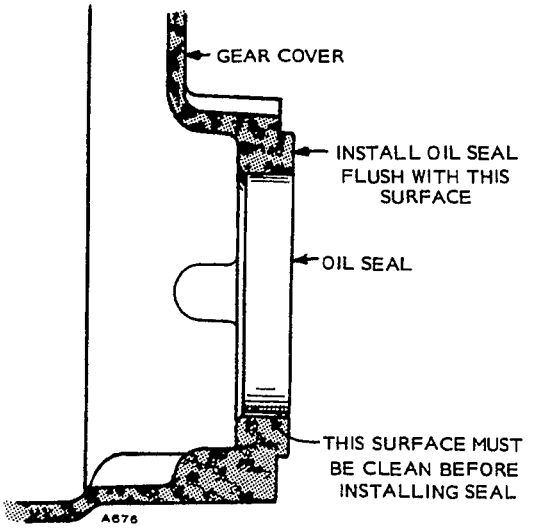


FIGURE 96. GEAR COVER OIL SEAL

Gear Cover Oil Seal

Replace oil seal if damaged or worn. Drive old seal out from inside gear cover. Lay cover on a board so the seal boss is supported. Using an oil seal driver, insert 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 (Figure 96). During gear cover installation, reverse the driver to protect oil seal. Lubricate lips with heavy grease.

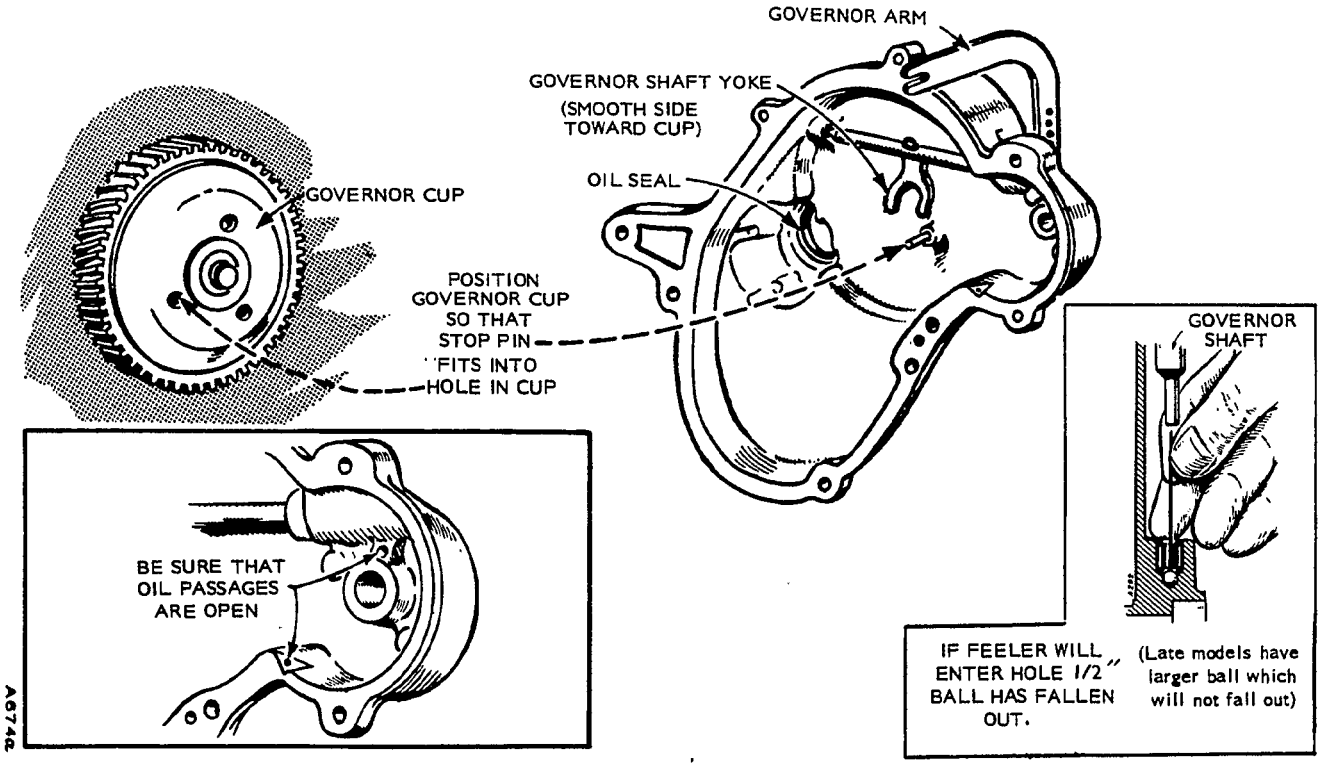


FIGURE 97. GEAR COVER ASSEMBLY

1. Operate governor shaft to check for binding and see that governor shaft end thrust ball is in place (Figure 97).

2. Turn governor yoke so smooth side is toward governor cup. Set governor cup so stop pin in gear cover will fit into one of holes in cup surface. Measure distance from end of stop pin to mounting face of cover. It should be 25/32-inch. If not, replace pin. Position open edge of pin toward crankshaft seal to avoid governor cup drag.

3. Use an oil seal driver (or a piece of shim stock over crankshaft keyway) to protect oil seal and install gear cover. Tighten mounting screws to specified torque. Before tightening screws, be sure stop pin is in governor cup hole (Figure 97).

4. Install and time ignition points on MJB engine (see *Ignition System*). Install and gap centrifugal switch on MJC and RJC.

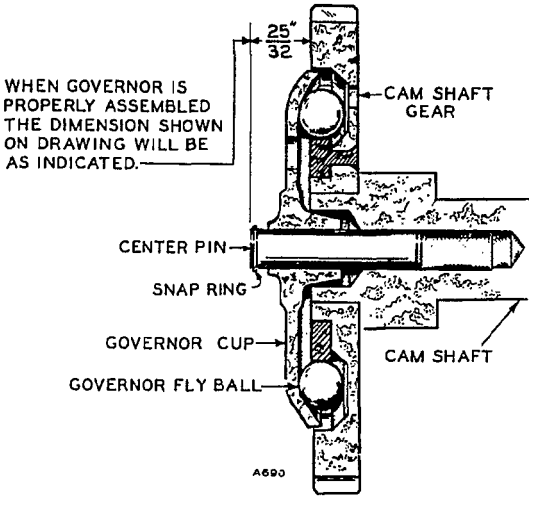


FIGURE 98. GOVERNOR CUP

Governor Cup

To remove governor cup, remove snap ring from camshaft center pin and slide the cup off. Catch the 10 flyballs that will fall out when cup is removed. Replace any flyballs with flat spots or grooves. Replace cup if the race surface is grooved or rough. Governor cup must be a free spinning fit on camshaft center pin, but should be replaced if excessively loose or wobbly. See Figure 98.

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

To install governor assembly, tip the front of engine upward. Set flyballs in their recesses and position governor cup on its shaft. Install snap ring on the center pin.

Camshaft

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

In addition to opening and closing valves, the camshaft operates the fuel pump and, on MJC/RJC engines, the distributor.

Remove camshaft as follows:

1. Remove rocker arms and pushrods from valve chambers.

2. Remove fuel pump from the engine. Remove distributor (MJC/RJC engines only).

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. If necessary, pry it out with a screwdriver between camshaft gear and crankcase.

CAUTION ***Be sure camshaft lobes do not catch on pushrod tappets during removal.***

5. Remove tappets from camshaft end of pushrod holes.

If a lobe is slightly scored, dress it smooth with a fine stone. If camshaft is badly worn or scored, replace it.

The camshaft gear is a press fit on camshaft and drives it at one half crankshaft speed. The gear drives the ignition timing (start-disconnect switch on four cylinder) gear on two cylinder models. To remove, use a hollow tool or pipe that will fit inside the gear bore and over the center pin. Press camshaft out of gear bore. Be careful not to damage center pin.

The camshaft bearings should be replaced if the clearance to the camshaft is greater than specified; or if bearings show cracks, breaks, burrs, excessive wear or other defects.

The camshaft to bearing clearance should be .0012 inch to .0049 inch. To check rear bearing, remove expansion plug at rear of the crankcase.

Press new bearings into place (Figure 99) using bearing driving tool. Press rear bearing flush with the bottom of expansion plug recess. Press front bearing in flush with the crankcase front surface so crankcase and bearing oil passages align. After 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. The bearings are a precision-type and do not require reaming. Install camshaft assembly as follows:

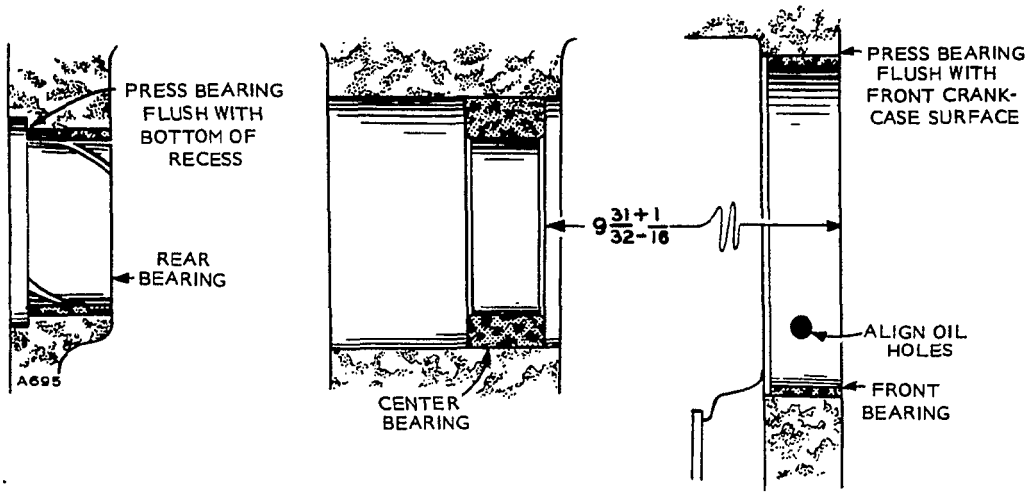


FIGURE 99. CAMSHAFT BEARINGS

1. Install key and press camshaft gear on its shaft, Figure 100. Mount governor components.
2. Slide thrust washer onto shaft.
3. Lay engine on side or end and insert pushrod tappets.
4. Install camshaft assembly in engine. Align timing marks on camshaft gear and crankshaft gear (Figure 101).
5. Replace pushrods and fuel pump. Install and retime distributor (MJC/RJC only).

Crankshaft

The engine uses a counterbalanced, ductile crankshaft. The two-cylinder crankshafts ride on two lead-bronze bearings, the front one housed in the crankcase, and rear one in bearing plate.

Four-cylinder model uses an additional split center main bearing.

Remove crankshaft as follows:

1. Remove lock ring and retaining washer in front of crankshaft gear.
2. Pull off crankshaft gear, Figure 102. It has two ¼–20 UNC tapped holes for attaching a gear pulling ring (ONAN tool 420-0275). Use care not to damage teeth if gear is to be reused.
3. Remove oil pan and piston and connecting rod assemblies.
4. **Four Cylinder Only.** Remove bearing cap from center main bearing.

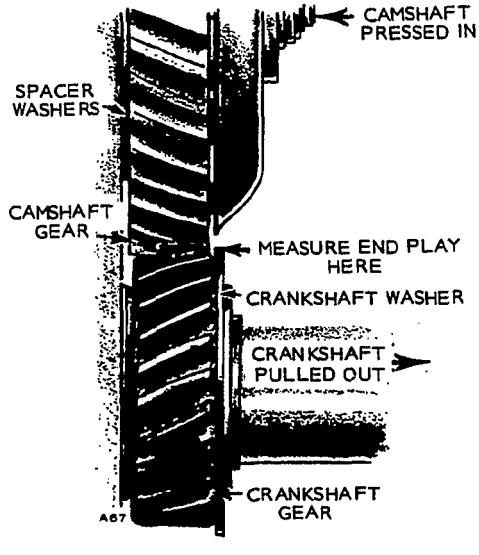


FIGURE 100. CAMSHAFT END PLAY

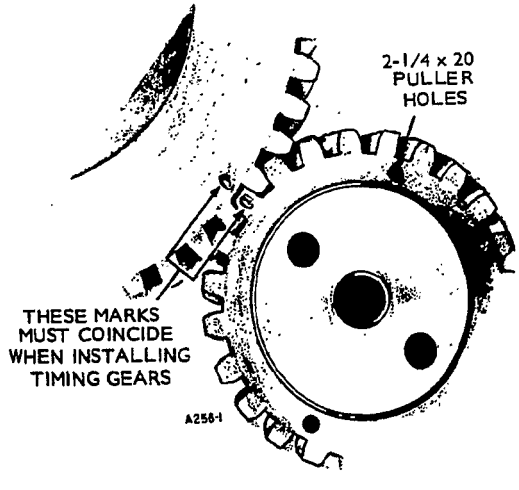


FIGURE 101. TIMING MARKS

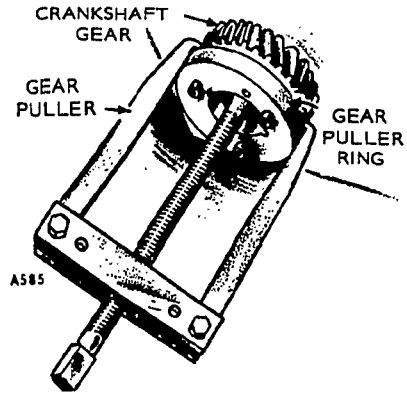


FIGURE 102. REMOVING CRANKSHAFT GEAR

5. Remove rear bearing plate from crankcase. Retain or measure thickness of rear bearing plate gaskets. These gaskets determine crankshaft endplay.

6. Remove crankshaft through rear opening in crankcase. (**Four Cylinder Only**—Catch upper half of main bearing support as it slides off its mounting surface.)

Thoroughly clean and inspect crankshaft and blow out all oil passages with compressed air. Check all journals for out-of-round, taper, grooving or ridges. Pay particular attention to ridges or grooves on either side of oil hole areas which indicate neglect of oil cleanliness.

If journal dimensions are not within the limits, or journals are scored, machine the crankshaft. Crankshaft machining requires a trained and experienced operator and suitable equipment.

Undersize bearings and connecting rods are available to rework the shaft to .010 inch, .020 inch and .030 inch undersize.

If main bearing clearances are greater than the limits or if bearings are worn, grooved, or broken, replace them. Precision replacement bearing inserts and thrust washers are available for all main bearings. Do not ream precision type bearings. Refer to *Dimensions and Clearances* for crankshaft tolerances.

Align oil holes and press new bearings into front and rear housings. Insert the MJC/RJC center bearing when crankshaft is installed. See Figure 103.

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

Install crankshaft as follows. After each step, turn crankshaft to be sure it has not seized.

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. Install thrust washers and locking pins.

2. Oil bearing surfaces and install crankshaft from rear of crankcase, through rear bearing plate hole.

3. Mount and secure rear bearing plate with same thickness of new gaskets as removed.

4. Heat crank gear to about 350°F. Install key on crankshaft, then drive gear into place. Install retaining washer and lock ring.

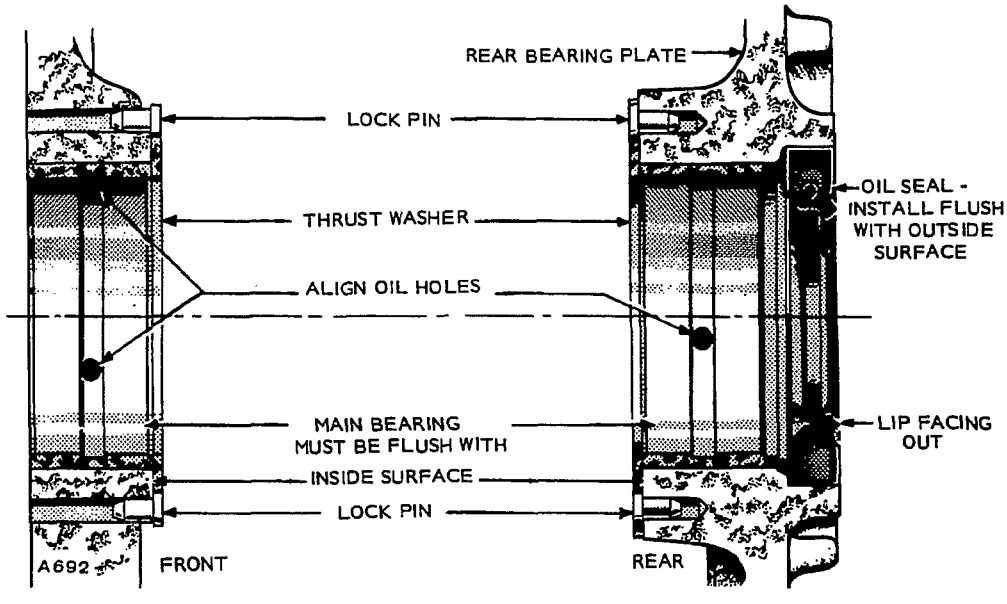


FIGURE 103. MAIN BEARING INSTALLATION

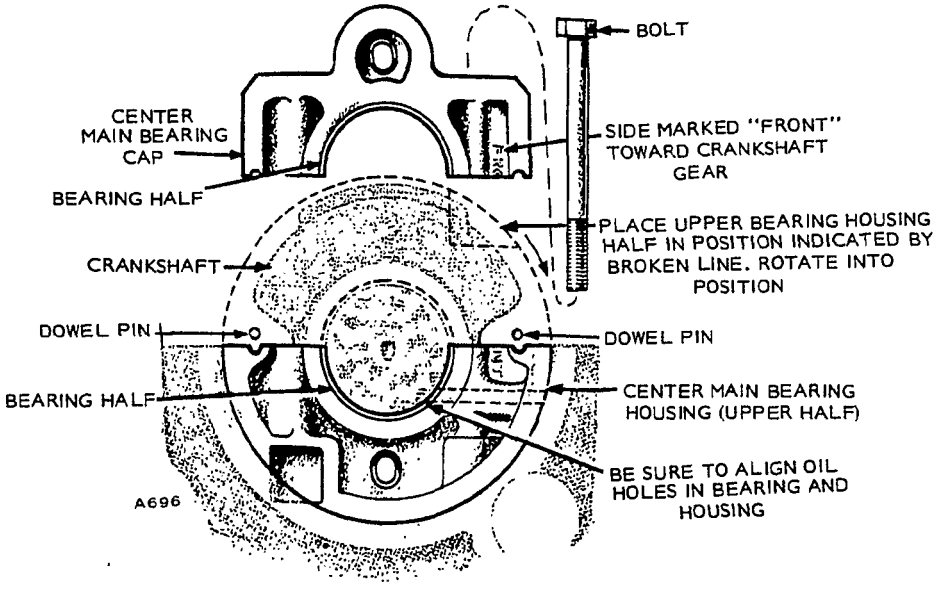


FIGURE 104. CENTER MAIN BEARING (FOUR CYLINDER ONLY)

5. **Four Cylinder Only.** Set upper half of center main housing on crankshaft and rotate it into place. Be sure side marked FRONT is toward crankshaft gear. Set two positioning dowels on upper bearing mount. Install center main bearing cap and torque bolts to 97-102 lb.-ft. (Figure 104).

6. 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.

7. Install piston assemblies.

Crankcase

On four cylinder model, if center main beairng support requires replacement, the whole crankcase must be replaced or returned to factory to have a new housing fitted.

REPLACING VALVE GUIDES

Use this procedure for removing and replacing J Series valve guides in cylinder head.

Removal

1. Before pressing guide out, use wire brush and electric drill to remove carbon and all other foreign matter from top surface of guide.

CAUTION ***Damage could occur to guide wall in cylinder head if this procedure is not followed.***

2. Place removal tool in guide and position in arbor press using care in pressing old guide out.

CAUTION ***Do not use hammer to remove old guides (or to install the new ones).***

3. Run fine crocus cloth on a small polishing rod through cylinder head valve guide hole to clean out carbon and other foreign materials.

CAUTION ***Be careful not to enlarge guide hole or excess oil consumption may result.***

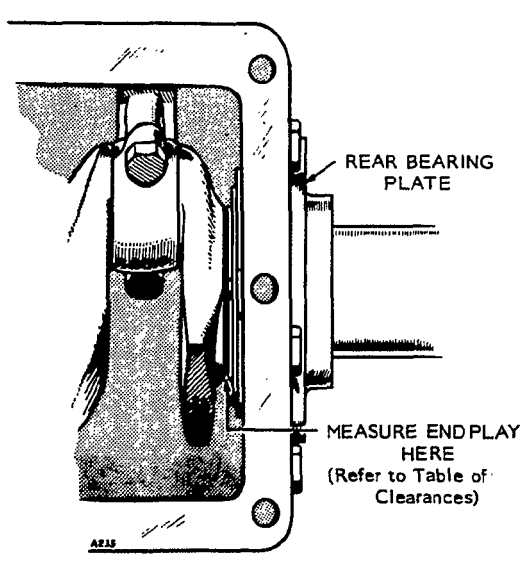


FIGURE 105. CRANKSHAFT END PLAY

Installation

Coat outer edge of new guide with oil (or other lubricant). Position guide notch up in cylinder head and press in until guide protrudes 11/32-inch from the rocker box side of head.

2. Place valve guide reamer in drill press (if not available, use an electric drill). Two different size reamers are used:

   - for intake guide, use reamer size 0.342 to 0.343 inch.

   - for exhaust guide, use reamer size 0.344 to 0.345 inch.

3. Use polishing rod and crocus cloth to obtain a good smooth honed finish after reaming.

4. Thoroughly wash cylinder head in solvent after reaming and honing are completed.

Onan

Cummins Power Generation
1400 73rd Avenue N.E.
Minneapolis, MN 55432
763-574-5000
Fax: 763-574-8087