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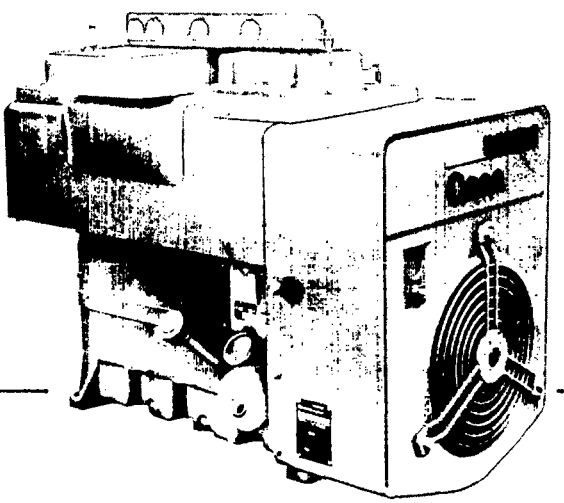
Onan

Operators and Service Manual

JB-JC Industrial Engine



967-0754
JB (SPEC A-T)
JC (SPEC A-V)
1-96
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 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.

GENERAL INFORMATION

FOREWORD

This manual covers the operation, maintenance and service procedures for the two-cylinder, 60 cu. in. 21.6 horsepower JB engine and the four-cylinder 120 cu. in. 42.5 horsepower JC engine.

The two engines are very similar. Both are 4 cycle, vertical, in-line, air-cooled engines with overhead valves. Normal engine speed ranges up to 2700 rpm. An internal, constant speed, flyball-type mechanical governor, externally adjustable, is standard. Optional two-speed and variable-speed governors are available.

Each engine is test-run at the factory for several hours and adjusted for correct operation. Any damage incurred through transit must be corrected before operating the engine.

Unless specified, all instructions and procedures in this manual apply to both the JB and JC. When instructions apply to a specific engine model, refer to the engine nameplate for the model and specification number.

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WARNING

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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.

⚠ WARNING: ⚠

The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

SPECIFICATIONS

SPECIFICATIONS	MANUAL STARTING		ELECTRIC STARTING	
	JB	JC	JB	JC
Dimension in Inches Height	26-3/8	28-5/16	26	26
Width	17-7/8	19-1/2	18	20
Length	24-5/8	37-1/2	25	37
Weight	220	375	220	375
Number of Cylinders	2	4	2	4
Displacement (cu. in.)	60	120	60	120
Bore	3-1/4	3-1/4	3-1/4	3-1/4
Stroke	3-5/8	3-5/8	3-5/8	3-5/8
H.P. @ 2700 rpm	21.6	42.5	21.6	42.5
Compression Ratio (Natural Gas Only 9:1 - Spec U & W)	6.5:1	6.5:1	6.5:1	6.5:1
Connecting Rod Bearings Tri-metal, Replaceable	STD	STD	STD	STD
Main Bearings are Steel-backed, Bronze Sleeve Type; Replaceable Precision Inserts	2	3	2	3
Battery Ignition **Breaker Points and Coil **Distributor and Coil	** NA NA	 NA NA	 STD NA	 NA STD
Magneto **Flywheel Type	STD	NA	NA	NA
Gear Driven	NA	STD	NA	NA
Battery Voltage	12	12	12	12
Combustion Air (CFM) @ 2700 rpm	48	96	48	96
†Cooling Air (CFM) @ 2700 rpm	850	1250	850	1250
Inlet Vent (sq. ft.)	7	12	7	12
*Outlet Vent (sq. in.)	80	160	80	160
Air Cleaner	DRY	DRY	DRY	DRY
Choke	Manual	Manual	Manual	Manual
Fuel Pump Lift (feet)	6	6	6	6
Oil Filter (Full Flow)	STD	STD	STD	STD
***Oil Capacity, Refill (US Quarts)	3	6	3	6
Power Take-Off Shaft Length (inches)	4	4	4	4
Shaft Diameter (inches)	1-3/4	1-3/4	1-3/4	1-3/4
Keyway Length	3	3	3	3
Keyway Width	3/8	3/8	3/8	3/8
Keyway Depth	3/16	3/16	3/16	3/16

* - Area when duct is used; without duct, make vent as large as possible.
** - NA means not available.
*** - Plus an additional 1/2 quart when replacing oil filter.
† - For Vacu-Flo cooling: JB-610 CFM @ 1800 RPM, JC-1600 @ 1800 RPM

DIMENSIONS AND CLEARANCES

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

	Minimum	Maximum
CAMSHAFT		
Bearing Journal Diameter, Front	2.500	2.505
Bearing Journal Diameter, Rear	1.1875	1.1880
Bearing Journal Diameter, Center (JC)	1.2580	1.2582
Bearing Clearance Limit	.0012	.0037
End Play, Camshaft	.007	.039
Cam Tappet Hole Diameter (Prior to Spec P)	.7505	.7515
Cam Tappet Hole Diameter (Begin Spec P)	.8755	.8765
Cam Tappet Diameter (Prior to Spec P)	.7475	.7480
Cam Tappet Diameter (Begin Spec P)	.8725	.8730
CONNECTING RODS		
Large Bearing Bore Diameter	2.1871	2.1876
Small Bushing Bore Diameter	1.044	1.045
Distance, Center Large Bearing Bore to Small Bushing Bore	5.998	6.002
Clearance, Large Bearing to Crankshaft	.001	.003
Piston Pin Bushing Inside Diameter (bushing reamed)	.9903	.9906
CYLINDER		
Cylinder Bore Honed Diameter	3.2495	3.2505
Maximum Allowable Taper		0.005
Maximum Allowable Out-of-Round		0.002
CRANKSHAFT		
Main Bearing Journal Diameter (JB)	2.2437	2.2445
Main Bearing Journal Diameter (JC)	2.2427	2.2435
Crankshaft Main Bearing Clearance (JB)	.0014	.0052
Crankshaft Main Bearing Clearance (JC)	.0024	.0062
Connecting Rod Journal Diameter	2.0600	2.0605
Connecting Rod Bearing Clearance	.0010	.0033
End Play, Crankshaft	.010	.015
PISTON		
Piston Clearance to Cylinder Wall	.0012	.0032
PISTON PIN		
Length	2.753	2.738
Diameter	.9899	.9901
Piston Pin in Piston	Thumb Push Fit	
Connecting Rod Bushing Clearance	.0002	.0007
PISTON RINGS		
Ring Type		
Top	Compression	
2nd	Compression	
3rd	Oil Control	
Ring End Gap	.010	.020
VALVE INTAKE		
Stem Diameter	.3405	.3415
Clearance in Guide	.001	.003
Seat Angle		42°
VALVE, EXHAUST (Stellite Faced)		
Stem Diameter	.3405	.3415
Clearance in Guide	.0030	.0050
Seat Angle		45°

VALVE GUIDE

Length		1-25/32
Outside Diameter	.4690	.4695
Cylinder Block Bore Diameter	.467	.468
Inside Diameter (after Reaming)		
Exhaust	.344	.345
Intake	.342	.343

VALVE SEATS (Stellite)

Valve Seat Bore (diameter)		
Intake	1.547	1.548
Exhaust	1.361	1.362
Depth (from Cylinder Head Face)	.433	.439
Seat Outside Diameter		
Exhaust	1.364	1.365
Intake	1.550	1.551
Seat Width	3/64	1/16
Seat Angle		45°
Available Oversizes		.002, .005, .010, .025

VALVE SPRINGS

Free Length		1-7/8
Length, Valve Closed		1.528
Load, Valve Closed		45-49 lbs.
Length, Valve Open		1.214
Load, Valve Open		83-93 lbs.
Valve Stem to Guide (intake)	.0005	.0025
Valve Stem to Guide (exhaust)	.0025	.0045
Valve Face and Seat Angle		45°
Valve Spring Tension		
Valve open — Prior to Spec P	83 lbs.	93 lbs.
Spec P and later	87.2 lbs.	97.2 lbs.
Valve closed — Prior to Spec P	45 lbs.	49 lbs.
Spec P and later	45 lbs.	49 lbs.
Distributor Stem Diameter (JC)	1.061	1.062
Distributor Hole Diameter (JC)	1.063	1.064

Tune-Up Specifications

Valve Clearance — Intake (cold - 10° to 45° ATC on power stroke)	
Prior to Spec C	.010
Begin Spec C	*.012
Valve Clearance — Exhaust (cold - 10° to 45° ATC on power stroke)	
Prior to Spec C	.013
Begin Spec C	**.015
ONAN Ignition Breaker Point Gap	.020
WICO Magneto Breaker Point Gap	.015
Distributor Breaker Point Gap (JC)	.018-.022
Spark Plug Gap:	
JB	.025
JC	.035
Start-Disconnect Switch Point Gap	.020
Ignition Timing Spark Advance - 25°BTC for gasoline, 35°BTC for natural gas, LPG, or combination gas/gasoline	
Firing Order (JC)	1-2-4-3

* - Exception: with natural gas fuel, intake is .013.
** - Exception: with natural gas fuel, exhaust is .020.

ASSEMBLY TORQUES AND SPECIAL TOOLS

ASSEMBLY TORQUES

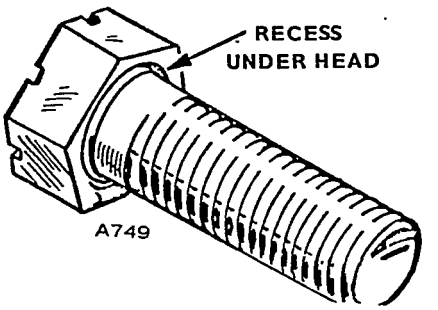
The assembly torques given here will assure proper tightness without danger of stripping threads. If a torque wrench is not available, be careful not to strip threads. Use reasonable force only and a wrench of normal length.

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	28-30
Exhaust Manifold Nuts	13-15**
Flywheel Mounting Screw	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.



PLACE BOLTS

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 (JC only)	420-0254
Driver, Combination Main and Cam	420-0326
Reamer, Ridge	420-0260
Valve Guide Remover and Driver	420-0300

OPTIONAL EQUIPMENT

1. **Solenoid Shift Starting Motor** — 12 volt or 24-32 volt; less solenoid switch.
2. **Auto-Cycle Starting Motor** — 12 volt DC or 120 volt AC; 18 to 1 gear reduction; gear train lubricated by crankcase oil; one-way, sprag-type engaging clutch.
3. **Flywheel Alternator** — For battery charging; integral; no brushes or commutator; two step regulator; maximum charge rate at 2400 rpm; 14.5 amperes into 70 AH discharged battery.
4. **Low Oil Pressure Cut-Off** — Shuts down plant if oil pressure fails. Crankcase oil level must be checked regularly.
5. **Two-Speed Governor** — Two springs for low- and high-speed control of engine.
6. **Gas-Gasoline Carburetor** — One carburetor with gasoline and gaseous fuel provisions. Available as a factory modification or as a field conversion kit.

INSTALLATION

GENERAL

The initial installation is very important. Plan it carefully to ensure maximum operating efficiency. Use this manual as a general guide. Recommendations are based on extensive tests under favorable operating conditions. Conform to local, state or federal codes regulating the installation and operation of internal combustion engines.

LOCATION

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

MOUNTING

Secure the engine to a rigid, level foundation. See Figures 1 and 2 for typical installations. Foundations must be sturdy enough to withstand distortion and to retain alignment with related equipment.

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

VENTILATION

Provide sufficient fresh air intake and exhaust ventilation to support combustion and cool the engine and generator. Avoid recirculation of ventilating air to prevent engine overheating. See *Specifications* for air flow requirements and vent sizes.

Locate vents so the flow of air from the inlet to the outlet passes over the engine. The outlet should be slightly higher than the inlet. Allow for heat produced by related equipment. See Figures 1 and 2.

An optional air shutter may be used at the outlet vent to control engine temperature by regulating air flow. Air shutters also prevent the backflow of cold air during engine shut-down.

When air ducts are used between the engine and outlet vent, use a section of canvas to restrict vibration, as shown in Figure 2.

EXHAUST

WARNING **Exhaust gas is poisonous. Pipe exhaust gases outside. Exhaust pipes must not terminate near ventilation system inlet vents.**

1. Avoid sharp bends.
2. Use sweeping, long-radius elbows.
3. Use a section of seamless, flexible tubing between the engine and any rigid piping to isolate vibration.
4. Increase pipes one size for each additional 10-foot span.
5. Protect walls and partitions through which exhaust pipes pass with a metal thimble, Figure 2.

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

CAUTION **Some installations may require unusually long exhaust pipes and/or numerous elbows. A poor exhaust system will increase back pressure at the engine, and can cause low engine power with reduced efficiency, overheating and eventual damage.**

To check exhaust back pressure, install a tee or adapter in exhaust line next to the manifold. Connect a manometer or pressure gauge to the adapter. If there is a condensation trap next to the manifold, this fitting can be used for connecting the manometer. Permissible maximum back pressure is 27" water column (2" mercury) at full load for all models. At no-load, maximum limit is 5.1" water column (3/8" mercury) for the two-cylinder and 4.7" water column (1/3" mercury) for the four-cylinder engine. Check at full load for the best measurement. If the reading is higher than maximum limit, the exhaust system should be disassembled and cleaned or altered to reduce back pressure.

GASOLINE FUEL

Locate separate fuel tanks no lower than six feet below the engine fuel pump. Auxiliary fuel pumps are available to provide an additional six-foot lift.

WARNING **To prevent fuel loss and fire hazards due to leaks from line breaks, avoid gravity feed of fuel to the engine from tanks not mounted on the engine.**

CAUTION **When sharing a fuel tank, do not connect lines at a point above the fuel supply level to prevent starving the engine.**

Install the fuel supply line from the tank to the 1/8" pipe inlet in the fuel pump. Use an approved flexible fuel line at the fuel pump to absorb vibration.

Fuel supply line must be leaktight. Install a shut-off valve at the fuel tank for service convenience. Run a vent pipe from the fuel tank to the outside of the compartment to remove gasoline fumes to the outside atmosphere.

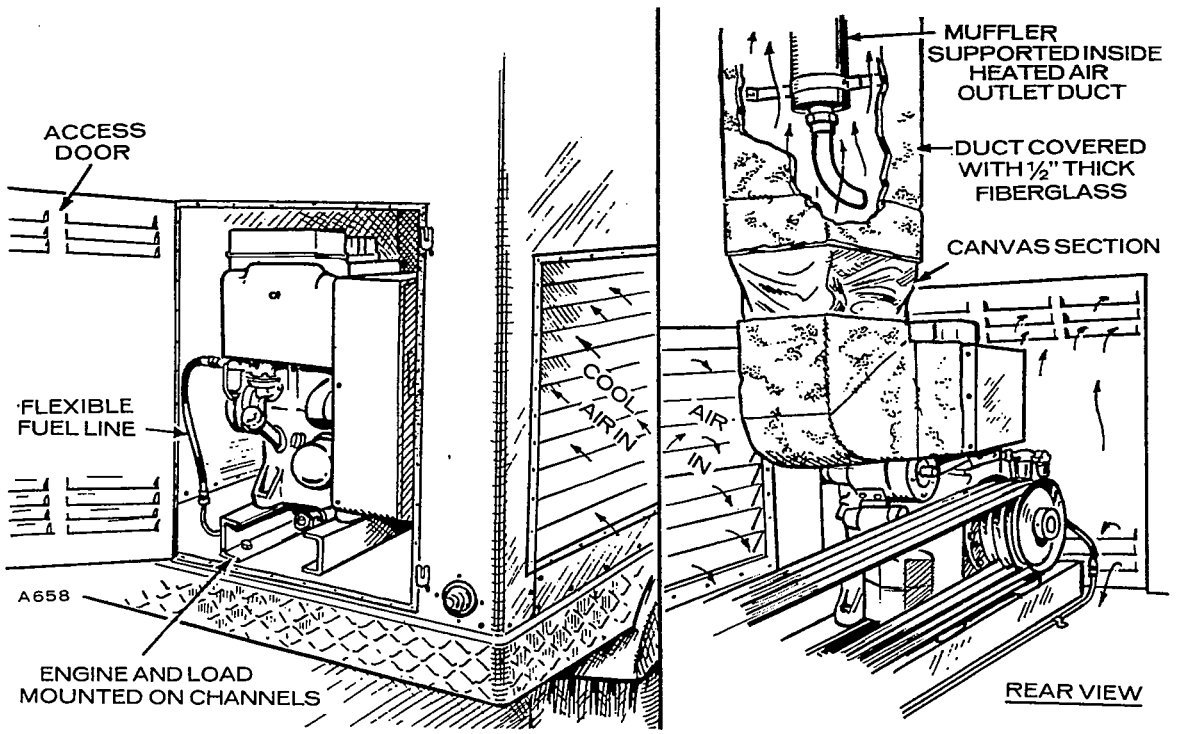


FIGURE 1. MOBILE INSTALLATION

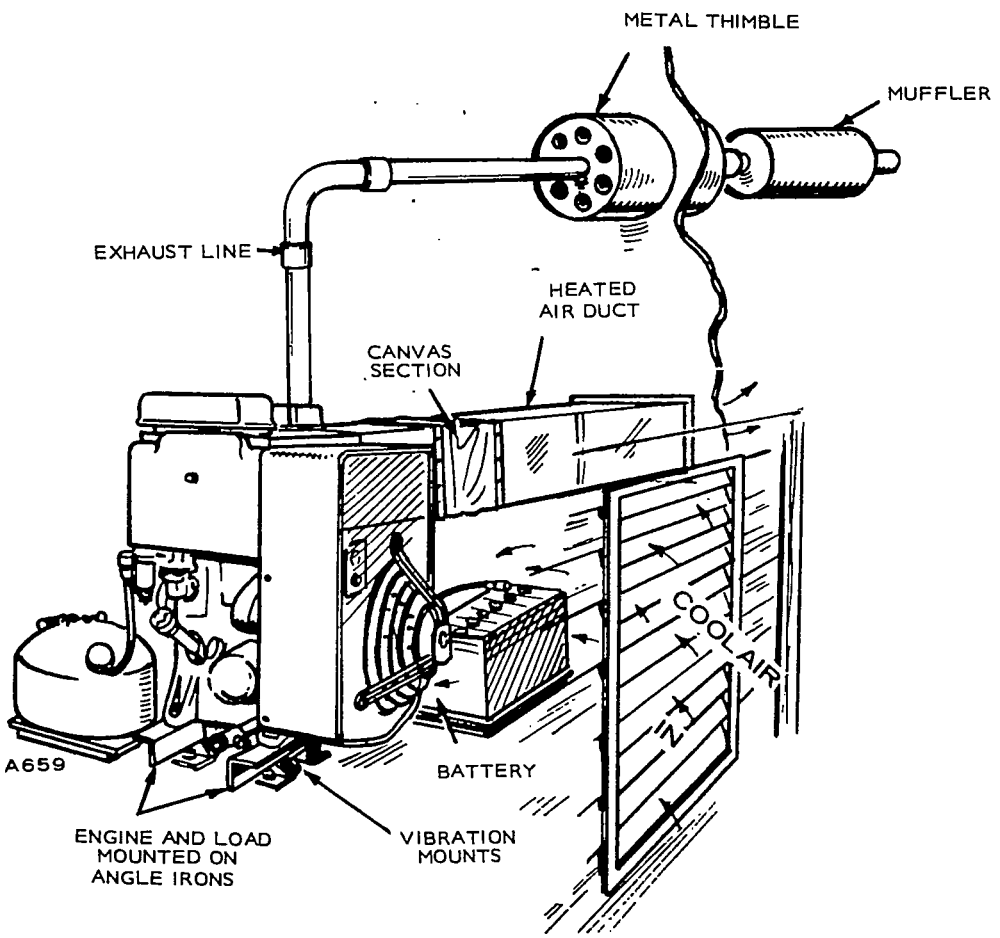


FIGURE 2. STATIONARY INSTALLATION

GASEOUS FUEL

Check with your supplier for local regulations covering the use and handling of gaseous fuel supplies and equipment. Seal gas line connections with shellac or some other compound approved for use in gaseous fuel systems. Thread-sealing compounds with a lead base are not satisfactory. Engines with electric controls may require a solenoid primer and a shut-off valve.

Install a manual shut-off valve as the first component in the supply line. Install a "dry gas" filter and fuel solenoid valve if recommended by your gas supplier or local code. Install the demand-type regulator according to the instructions supplied. Use shortest possible hose between the regulator and carburetor for best starting. See Figure 3.

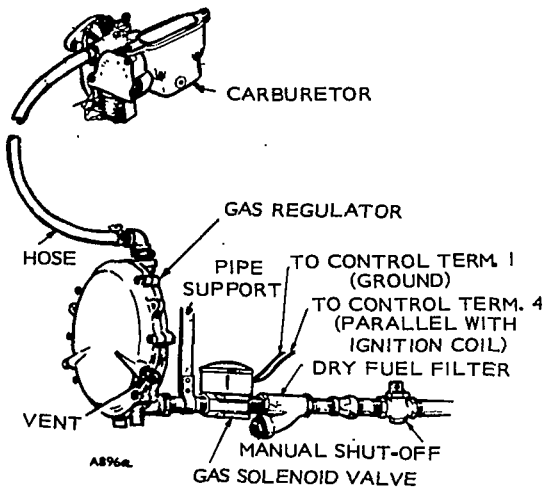


FIGURE 3. GASEOUS FUEL SYSTEM

OIL DRAIN EXTENSION

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

BATTERY

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

BATTERY CONNECTIONS

On engine with flywheel alternator, ground the negative terminal of the batteries to the engine.

CAUTION **Failure to ground the battery negative terminal will result in destruction of the selenium rectifiers.**

Connection of battery positive terminals depends on the type of starting motor used for cranking, as follows:

1. **Bendix (standard on cranking models):** Connect positive from a suitable source of DC to start switch. Connect negative to a good ground on engine.
2. **Solenoid Shift (optional on cranking models):** Connect positive from a suitable DC source to B+ terminal on start solenoid. Connect negative to a good ground on engine.
3. **Auto-cycle (optional on cranking models):** 12 volt DC and 120 volt AC starters have 2 wire connections through a sensing device for automatic starting.

OPERATION

PRE-STARTING

Preparations for the initial and each additional starting operation should include careful checks of the oil, fuel, cooling, and electrical systems. The cylinder air housing door should be closed with all air shrouds in place.

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

CRANKCASE OIL

Use a heavy duty detergent oil that meets the API (American Petroleum Institute) service designations MS, MS/DG, SE or SE/CC. Oil should be labeled as having passed the MS Sequence Tests (also known as the ASTMG-IV Sequence Tests) and the MIL-L-2104B Tests. Recommended SAE oil numbers for expected ambient temperatures are as follows:

30° F to 90° F	SAE 30
0° F to 30° F	SAE 10W
Below 0° F	SAE 5W (5W-30 if 5W is not available)

Do not use service DS oil. Do not mix brands nor grades. Refer to *Maintenance* section for recommended oil changes.

RECOMMENDED GASOLINE

Use clean, fresh *regular* grade, automotive gasoline. For new engines, most satisfactory results are obtained by using nonleaded gasoline. For older engines that have previously used leaded gasoline, heads must be taken off and all lead deposits removed from engine before switching to nonleaded gasoline.

CAUTION **If lead deposits are not removed from engine before switching from leaded to nonleaded gasoline, pre-ignition could occur causing severe damage to the engine.**

WARNING **To prevent hazardous gasoline spillage, never fill the tank when the engine is running and leave some fuel expansion space. Observe safety precautions when handling gasoline.**

INITIAL START

Check the engine to make sure it has been filled with oil and fuel. Cylinder air housing door must be closed.

If engine fails to start at first attempt, rust inhibitor oil used at the factory may have fouled the spark plugs — remove, clean in solvent, dry thoroughly and install. Heavy exhaust smoke when the engine is first started is normal and is caused by the inhibitor oil.

WARNING **Use extreme caution when cleaning with petroleum-base cleansers due to fire hazard.**

STARTING

1. Push *start-stop* switch to start position.
2. Release the switch after engine starts and reaches speed.
3. Oil pressure gauge should read at least 20 psi (pressure relief is not adjustable).

If the unit control has a reset button, push it to reset only after a shutdown resulting from oil pressure failure occurs. Find the cause before restarting the engine. On early sets, reset or temporarily switch to manual to start after oil filter change.

Leave *elec start-hand crank* switch at *elec start* position. This avoids battery discharge. **Exception:** While emergency hand-cranking, switch to manual start position, then return switch to *elec start* position after starting. (Older models with manual start only.)

If a false start occurs with a starter motor equipped set, make sure the centrifugal switch closes during speed build-up.

Extremes in starting temperatures may require a slight electric choke adjustment. If engine fails to start quickly, rest engine several seconds before successive cranking attempts to allow choke to cool and close.

STARTING SEQUENCE

The starting and stopping (Figure 4) sequence shows the manual, mechanical, and electrical events required for satisfactory start, run, and stop cycles.

ELECTRIC CRANKING

1. Turn ignition switch on.
2. Set hand choke as required by temperature.
3. Engage START switch.
4. Release START switch when engine starts.
5. See that oil pressure is at least 20 psi (not adjustable).
6. Readjust manual choke as engine warms up.

CAUTION **Do not apply overvoltage to the starting circuit at any time. If it becomes necessary to use an additional source of power to start the set — use a 12 volt battery connected in parallel.**

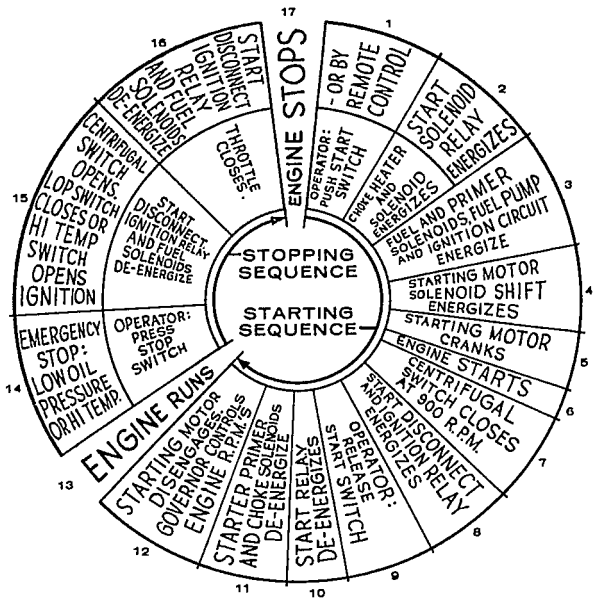


FIGURE 4. OPERATING CYCLE

MANUAL CRANKING (Older Models)

1. Prime carburetor. Make certain priming lever is down when finished.
2. Set hand choke as required by temperature.
3. Engage crank with crank dog.
4. Position crank handle at 7 o'clock.
5. Pull crank with hard, steady pull to 12 o'clock.
6. See that oil pressure is at least 20 psi.
7. Readjust choke as engine warms up.

ENGINE SHUT-DOWN

Disconnect as much load as practical from the engine before shut-down. Stop engines having momentary-contact Stop switches by holding switch to Stop position until engine stops completely. Releasing switch before engine is fully stopped will allow engine to continue to run.

APPLYING THE LOAD

Apply the load for new and reconditioned engines in four steps. Wait 30 minutes between each step. Maximum end thrust on the main bearings should not exceed 1000 pounds.

INSPECTION

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

OPERATION WITH GAS-GASO CARBURETORS

Gas-gaso carburetors installed at the factory are adjusted with 1000 BTU natural gas. Readjust the carburetor when using gas of a different BTU rating. Readjust the carburetor when operating above 2500 feet for best fuel/air mixture. Derate engine power 4 percent for each 1000 foot increase in altitude above 1000 feet from sea level. Make necessary adjustments only after checking engine performance.

CHANGING TO GASOLINE

Use the following procedure to change from gas to gasoline:

1. Close gas supply shut-off valve.
2. Open gasoline supply shut-off valve.
3. Unlock optional electric choke.
4. Start engine; follow normal procedure.

CHANGING TO GAS

Use the following procedure to change from gasoline to gas:

1. Close gasoline supply shut-off valve.
2. Open gas supply shut-off valve (on the initial start only, operate the primer to force air from the line).
3. Open manual choke (optional electric choke held open by lock wire inserted through hole in choke shaft). Choking not required. Starting at low temperatures may be aided by pressing priming button on Algas regulator.
4. Start engine; follow normal procedure.

HIGH TEMPERATURES

1. See that nothing obstructs air flow to and from engine.
2. Keep cooling fins clean. See that air housings are properly installed and undamaged.
3. Keep ignition timing properly adjusted.
4. Be sure fuel-air mixture gives best operation.

LOW TEMPERATURES

1. Use proper SAE No. oil for temperature conditions. Change oil only when warm from running. If an unexpected temperature drop occurs, move engine to a warm location, or apply flameless heat directly to crankcase until oil flows freely.
2. Use fresh, regular (not "premium" type) gasoline. Protect against moisture condensation. Below 0° F, open carburetor main jet one additional turn.
3. Keep breaker points and spark plugs clean and properly adjusted. Keep batteries in a well-charged condition.
4. Partially restrict flow of cooling air. However, use care to avoid overheating.

DUST AND DIRT

1. Keep engine clean. Do not allow cooling fins to become coated or obstructed with debris.
2. Service air cleaner as frequently as necessary.
3. Change crankcase oil every 100 operating hours.
4. Keep oil and gasoline supplies in dust-tight containers.
5. Keep governor linkage connections clean.

HIGH ALTITUDE

For operation at altitudes of 2500 feet or more, close the carburetor main jet adjustment slightly to maintain proper air-to-fuel ratio. Refer to the *Adjustments* section. Maximum power will be reduced about 4 percent for each 1000 feet increase in altitude.

PROTECTION FOR EXTENDED OUT-OF-SERVICE PERIOD

Protect an engine that is to be out-of-service for more than 30 days as follows:

1. Run engine until thoroughly warmed up.
2. Turn off fuel supply and run until engine stops from lack of fuel.
3. Drain oil from oil base while still warm. Attach a warning to refill before operation.
4. Remove each spark plug. Pour one ounce (two tablespoons) of rust inhibitor (or SAE #50) oil into cylinder. Crank engine over a few times. Leave at top center position. Reinstall each spark plug.
5. Service air cleaner.
6. Lubricate governor linkage. Protect against dust, etc. by wrapping with a clean cloth.
7. Plug exhaust outlet to prevent entrance of moisture or dirt.
8. Wipe entire unit clean. Coat parts likely to rust with a light film of grease or oil.
9. Provide a suitable cover for entire unit.
10. Disconnect battery and follow standard battery storage procedure.

CAUTION **Discharged batteries are subject to severe damage if exposed to freezing temperatures. Store all batteries in a fully charged condition and maintain charge during storage.**

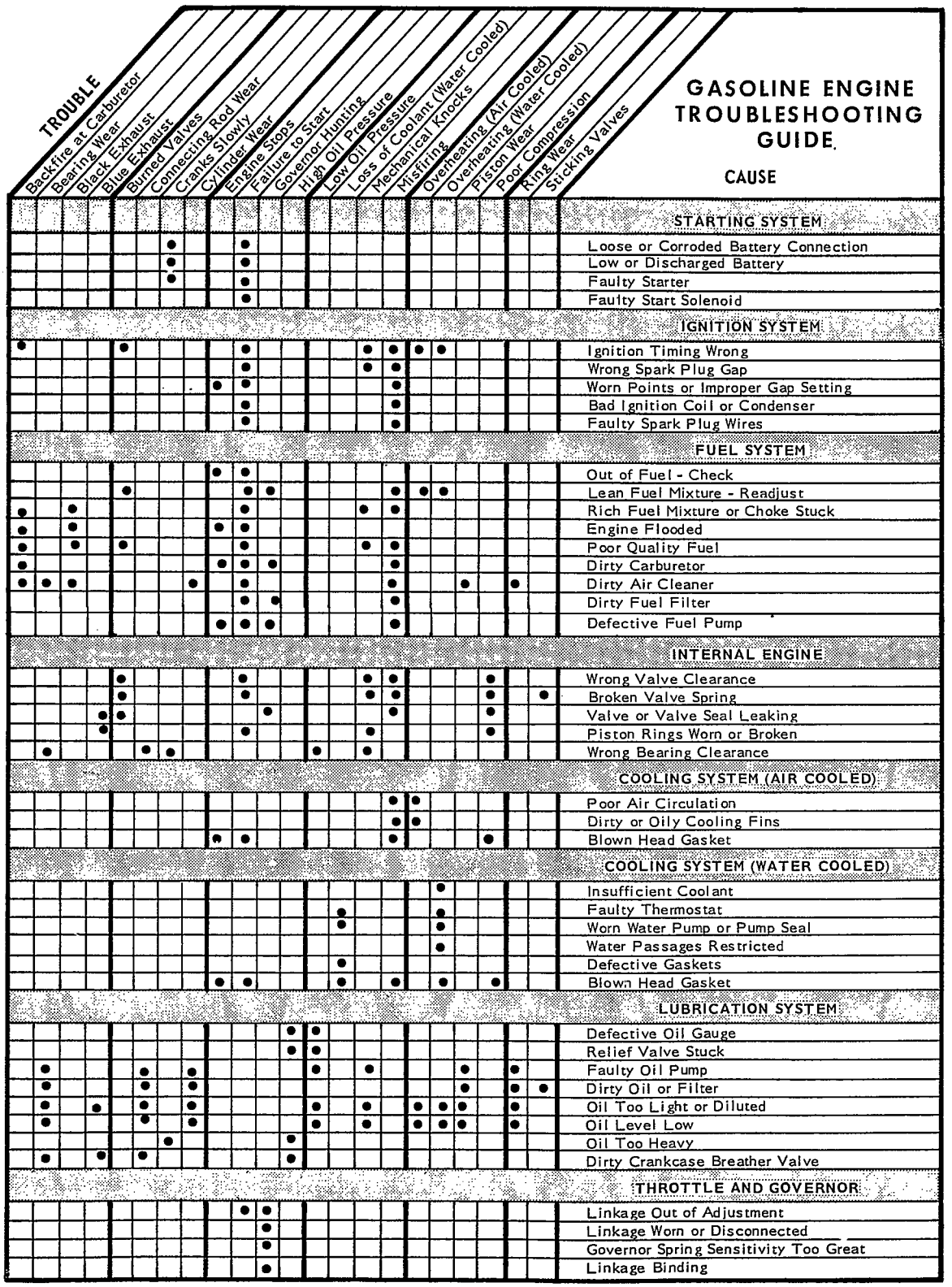
RETURNING THE SET TO OPERATION

1. CHECK SERVICE IDENTIFICATION TAGS to properly service the set.
2. Uncover and remove all storage seals from unit. Remove any dust, dirt, or foreign matter.
3. CHECK fuel supply tanks for moisture accumulations (drain tanks if necessary). CHECK lubricating oil for moisture or contamination (drain if necessary). CHECK fuel line connections, all wiring connections, and exhaust line connections.
4. Service air cleaner (if used). Bleed fuel system (if moisture or contamination are found in fuel, replace filters and clean fuel pump sediment bowl).
5. Check tag on oil base and verify that oil viscosity is still correct for existing ambient temperature.
6. Clean and check battery. Measure specific gravity (1.260 at 25° C (77° F) and verify level to be at split ring. If specific gravity is low, charge until correct value is obtained. If level is low, add distilled water and charge until specific gravity is correct. DO NOT OVERCHARGE.

   WARNING **Do not smoke while servicing batteries. Explosive gases are emitted from batteries in operation. Ignition of these gases can cause severe personal injury.**
7. Check entire unit for fuel or oil leaks. Correct leakage as required.
8. Install fully charged batteries.
9. Start set in normal method. Check while running set for leaks, correct voltage output, proper cooling.

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

TROUBLESHOOTING GUIDE



SERVICE AND MAINTENANCE

The following maintenance is recommended to keep the engine in good condition. Neglect of routine service may result in failure of the engine at a time when it is urgently needed. The chart is based on units operating under favorable conditions, with proper installation, recommended fuel and oil, normal load, etc. See Table 1.

SERVICE NOTES

These supplement the *Periodic Service Chart.*

A. Inspect for leaks, loose connections, etc. Keep Engine Clean.

B. **FUEL SUPPLY.** Check supply to avoid running out of fuel. Never fill tank while engine is running. Use clean, fresh "regular" grade gasoline. Never fill completely; allow some space for expansion.

C. **OIL LEVEL.** Keep level to F (full) mark on indicator, Figure 5. When adding, use same brand and type as in crankcase.

D. **GOVERNOR LINKAGE.** Plastic-type joints require cleaning only. On metal-type joint, use lubricating graphite on ball joint, Figure 6, and link-to-throttle. If graphite is not available, use a light machine oil, Figure 6.

E. **AIR CLEANER.** See Figure 7.

1. Foam type—Wash element in suitable solvent or diesel fuel every 200 hours. Saturate with engine oil and squeeze as dry as possible.
2. Oil Bath—Clean cup and refill to indicated level with same grade of oil as used in crankcase.

TABLE 1. PERIODIC SERVICE CHART

SERVICE THESE ITEMS	AFTER EACH CYCLE OF INDICATED HOURS						SEE SERVICE NOTES
	8	100	200	500	1000	5000	
Inspect Engine Generally	x**						A
Check Fuel Supply	x						B
Check Oil Level	x						C
Lubricate Governor Linkage		x*					D
Service Air Cleaner Oil Bath		x*					E
Service Air Cleaner Foam Type		x*					E
Change Crankcase Oil		+	x				F
Clean Crankcase Breather			x				G
Clean and Adjust Spark Plugs			x				H
Check Breaker Points			x				I
Check Battery Electrolyte Level			x				J
Empty Fuel Sediment Bowl			x				K
Check Valve Clearance	£			x			M
Replace Oil Filter		†	x				L
Clean Carburetor				x			M
Clean Rocker Box Oil Line Holes					x		M
Clean Combustion Chamber					x		M
Grind Valves					x		M
Complete Reconditioning						x	M

* - Service more often under extreme dust conditions.
\+ - See service note F.
£ - Tighten head bolts and adjust valve clearance after first 50 hours on a new or overhauled engine.
† - See service note L.
** - With engine running, visually and audibly check for fuel and exhaust leaks which are a potential hazard. See Note N.

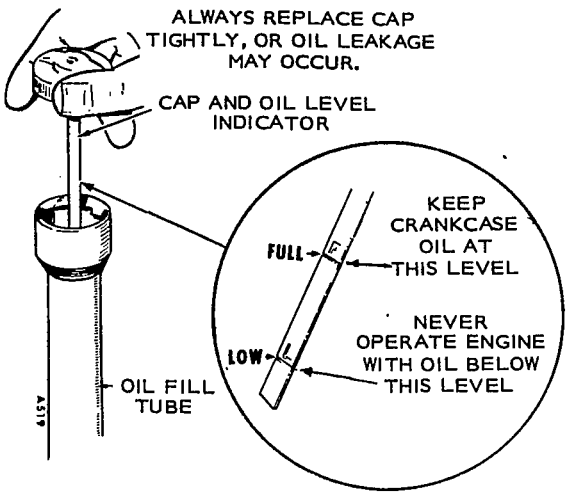


FIGURE 5. OIL LEVEL

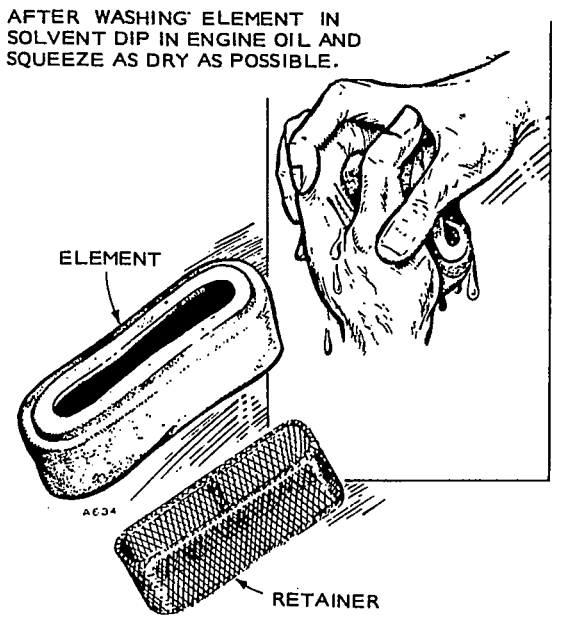
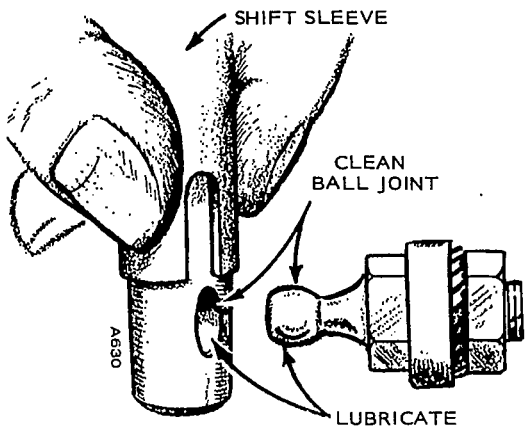


FIGURE 7. AIR CLEANER ELEMENT



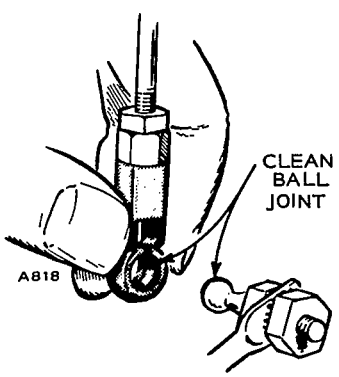


FIGURE 6. GOVERNOR LINKAGE

F. **CRANKCASE OIL.** Change oil only when warm after operating. If oil is too cold to flow, do not start engine. Move to a warm location or apply flameless heat externally until oil flows freely. Oil Filter is a full-flow type.

Change oil every 100 operating hours when operated in extremely low temperatures, under extreme dust or dirt conditions, when using highly leaded gasoline, or running for short periods of time.

G. **BREATHER VALVE.** The breather valve maintains a partial vacuum in crankcase. If faulty, install a new valve. Lift off rubber breather cap, Figure 8. Carefully pry valve from cap, or squeeze top of cap to release valve from rubber cap. Wash this fabric flapper-type check valve in fuel. Dry and reinstall with perforated disc toward engine. A flapper valve is not used on JC engines.

H. **SPARK PLUGS.** Remove spark plugs. Clean and adjust electrode gap. See *Dimensions and Clearances.* If engine runs rough or if plug fails to pass a standard test, install new spark plugs.

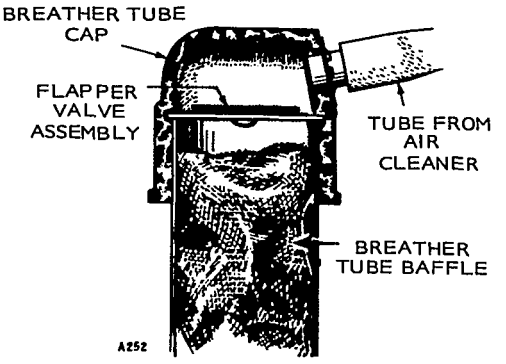
I. **BREAKER POINTS.** Refer to *Tune-up Specifications* for correct gap. Replace burned or faulty points. If only slightly burned, dress smooth with file or fine stone. Measure gap with thickness gauge.

Ignition breaker points must be correctly gapped. Crank engine to fully open breaker points (1/4 turn past top center for JB). Loosen and move stationary contact to set correct gap. Retighten and recheck gap.

Ignition points should break contact just as timing mark aligns with degree of spark advance

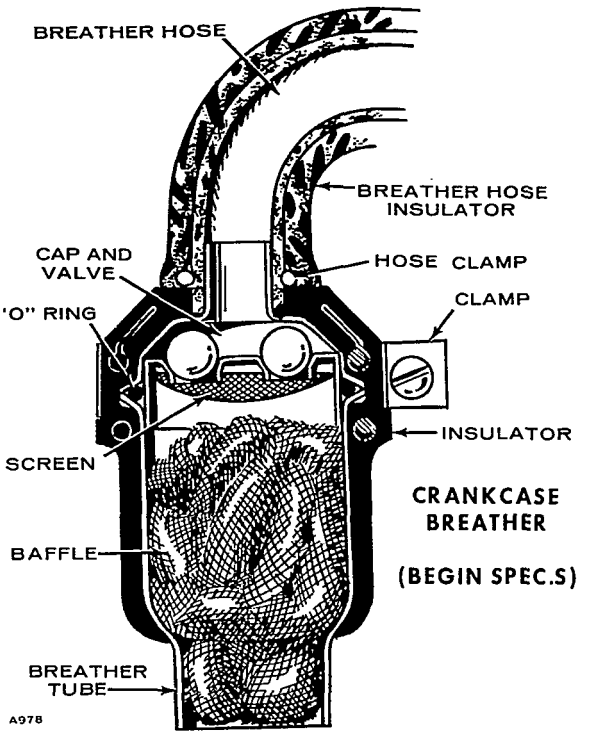
JB SERIES, PRIOR TO SPEC. S AND ALL MODELS PRIOR TO SPEC T

NOTE: FLAPPER VALVE IS NOT USED ON JC SERIES. JC SERIES USE PCV VALVE BEGINNING SPEC T.



CRANKCASE BREATHER

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



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

FIGURE 8. BREATHER VALVES

specified in *Tune-up Specifications*. Replace condenser if spark is weak or if points burn readily.

J. **BATTERY.** Check charge condition. Check electrolyte level. Add distilled water to keep electrolyte at its proper level. In freezing weather, run engine immediately after adding water. Keep battery connections tight and clean.

K. **FUEL SEDIMENT.** Empty carburetor and fuel filter (strainer) bowls of any accumulated sediment. Clean filter screen thoroughly. Reassemble and check for leaks.

L. **OIL FILTER.** The oil filter is a full-flow type (all oil is filtered enroute to bearings). A by-pass permits unfiltered oil to reach bearings if filter becomes clogged. Place a drip pan below filter. Unscrew oil filter counterclockwise, using both hands or a filter wrench (box-end or strap-type). Clean filter mounting area. Lubricate filter gasket with engine oil. Turn new filter on hand tight, then 1/2 turn further, using a filter wrench. Do not overtighten. Change oil filter more often if oil becomes too dirty to read dipstick markings. This can happen under extreme dust conditions or in freezing temperatures. When adding new oil to crankcase, allow an additional 1/2 quart for oil filter.

M. **MAJOR ENGINE SERVICE.** Remove carbon and lead deposits from combustion chamber, valves, etc. as often as experience dictates, depending on operating conditions. Adjust valve clearances when cold. Flush rocker box cover oil line in solvent and clean small holes using fine wire (do not enlarge holes). Clean entire engine to ensure efficient cooling and operation. Perform other services as inspection or operation shows necessary.

N. **EXHAUST SYSTEM.** Make regular inspections of the exhaust system throughout the entire life of the engine. Locate leaks in muffler and piping while the engine is operating.

WARNING **Leaky exhaust systems emit noxious carbon monoxide fumes which are a potential health hazard in enclosed areas.**

COOLING SYSTEM

JB and JC engines use a pressure-air cooling system. Blades on the engine flywheel draw air into the front of the engine housing and force it past the cylinders and out the right side of the engine. The engine air outlet may use an air duct and an optional shutter assembly. Figure 9 shows the air flow through the engine housing.

MAINTENANCE

Clean the engine cooling area (fins on cylinder block and cylinder heads) at regular intervals, normally every 1000 hours, but more often under dirty operating conditions.

OVERHEATING

The first signs of overheating are usually indicated by dark exhaust smoke, loss of engine power, and a speed loss. If possible, the engine should be stopped at the first sign of speed or power loss before the engine seizes.

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

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

The most common installation problems leading to overheating are:

1. Installation with duct size too small for sufficient air flow.
2. Installation in a small room with no ducts and insufficient air ventilation.
3. Air inlet and outlet ducts positioned so air outlet feeds back to the inlet.

AIR SHUTTER (Optional)

The shutter assembly mounts on the engine air outlet on the right side of the cylinder shroud (Figure 10). A thermostatic element (Figure 11) controls the shutter closing, which limits air flow when the engine is cold. When the air temperature reaches 120° F the element plunger begins to move outward, opening the shutters. The shutters are completely open by 140° F.

On early models, a high temperature cut-off switch mounts on the air shutter assembly.

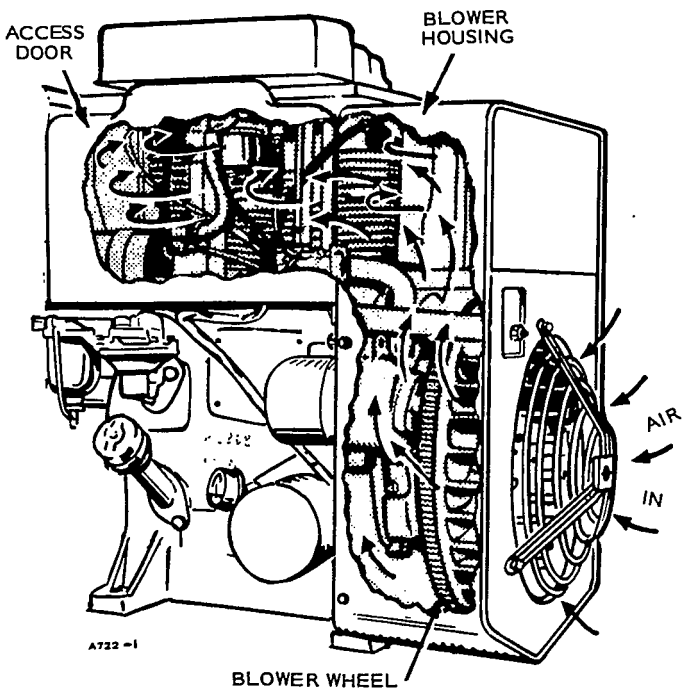


FIGURE 9. PRESSURE AIR COOLING SYSTEM

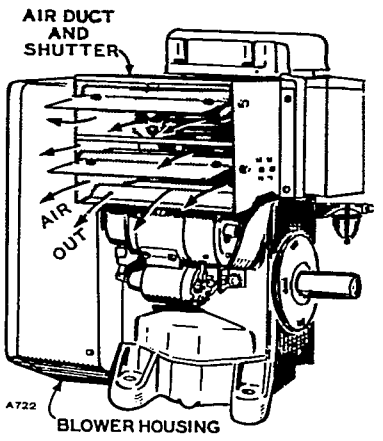


FIGURE 10. OPTIONAL AIR SHUTTER

The shutter opening temperature isn't adjustable. The power element plunger must contact the shutter roll pin at room temperature. To adjust, loosen the power element mounting screws and slide the assembly until it touches the roll pin with the shutter closed (Figure 11).

REPAIR

If the shutter won't open, check the power element for defects or binding of the plunger. Check the shutter for binding against the housing.

To test the power element, remove it from the assembly and apply heat. When the element reaches about 120°F, the plunger should start to move out. Total movement should be at least 13/64-inch.

If the shutter won't close, check for a weak return spring, binding in the nylon bearings, or dirt in the power element plunger. If the nylon bearings are worn or cause binding, replace them. Remove the shutters and pull out the actuating arm (stub) shafts. Push out the old bearings and push in new bearings from the inside of the shutter housing. The larger bearing surface acts as a spacer bushing and must be on the inside of the housing.

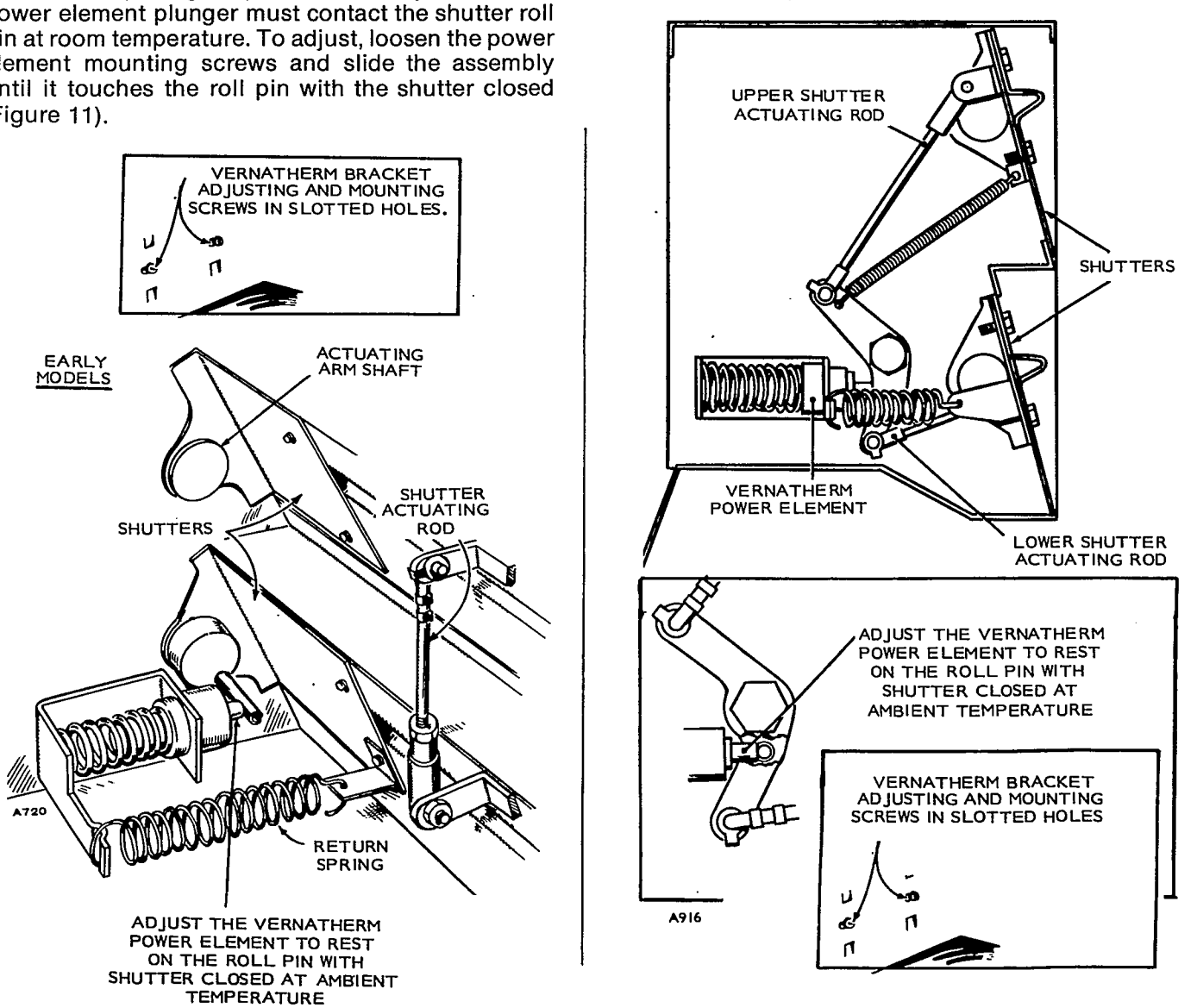


FIGURE 11. AIR SHUTTER ADJUSTMENTS

FUEL SYSTEM

Standard JB and JC engines use a gasoline-carbureted fuel system to deliver a mixture of fuel and air to the combustion chamber. The system draws fuel from a tank, delivers it through a filter and fuel pump (Figure 12), to the carburetor float chamber. Air passing through the carburetor venturi draws fuel from the float chamber.

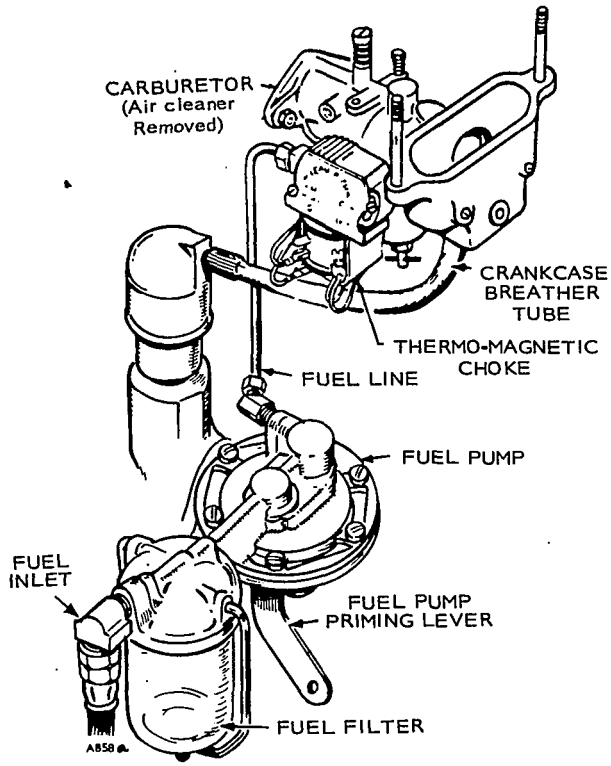


FIGURE 12. GASOLINE FUEL SYSTEM

Options: 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 13) to control the flow of gas from the lines to the carburetor. At the carburetor, the gaseous fuel is mixed with the incoming air.

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

FUELS

Use regular grade gasoline. Premium fuels contain more Tetra Ethyl lead than regular; the lead quantity also varies between fuel brands. In constant-speed operation, the buildup of deposits in the combustion chambers is proportional to the amount of lead in the gasoline.

Excessive lead causes more deposits and more frequent head removal for cleaning. Engines then require frequent combustion chamber cleaning.

If fuel is stored for any great length of time, it oxidizes, forms gums and becomes stale. ONAN recommends changing fuel as often as every season to ensure fresh fuel, especially where there is a great change in weather between seasons.

MAINTENANCE

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

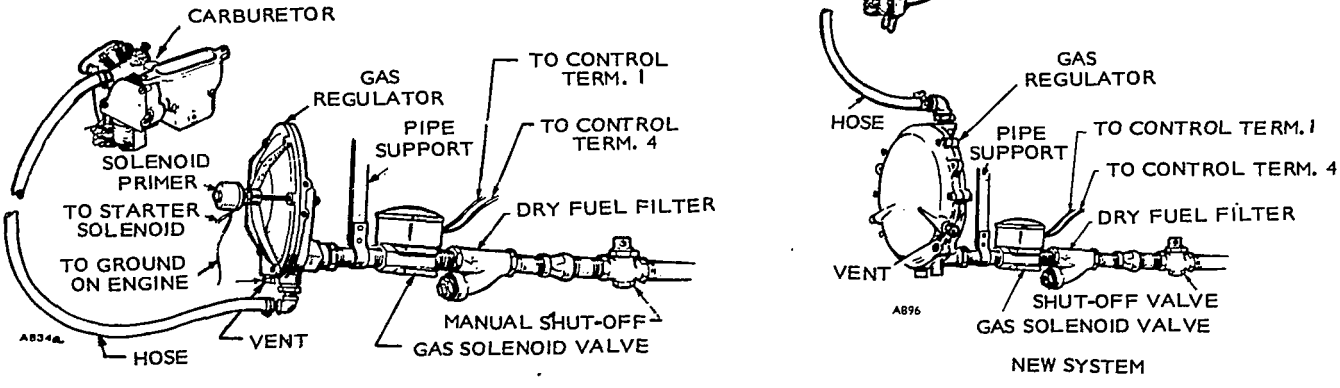


FIGURE 13. GASEOUS FUEL CARBURETION SYSTEMS

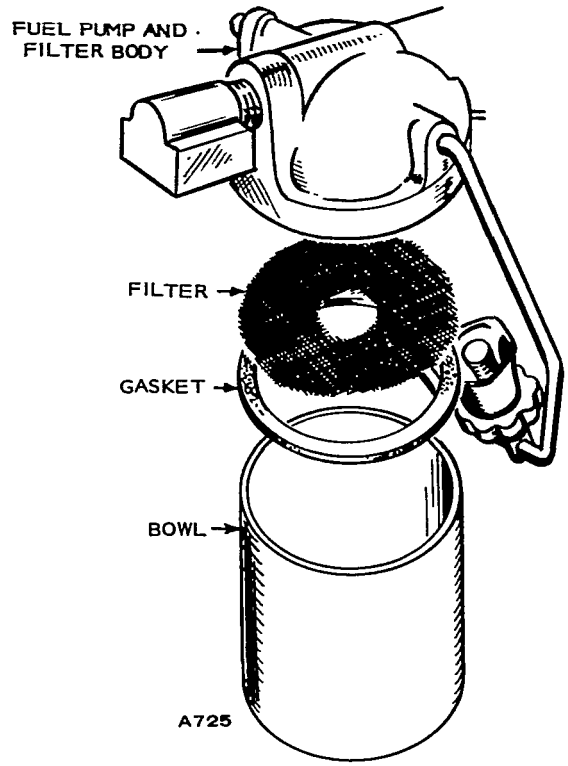


FIGURE 14. FUEL STRAINER CLEANING

To clean the fuel strainer, remove the fuel sediment bowl and the screen (Figure 14) 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 the air cleaner, carburetor adjustment, inspection of hoses, etc. and cleaning the optional dry fuel filter.

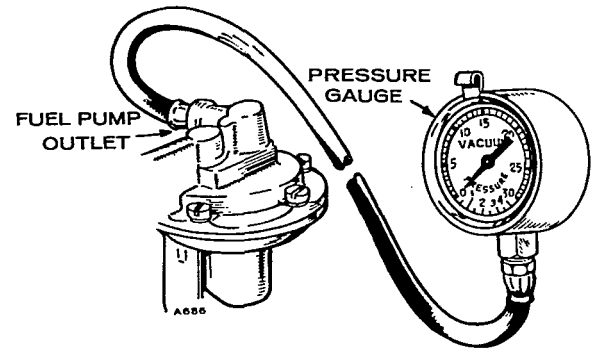


FIGURE 16. TESTING FUEL PUMP PRESSURE

Fuel Pump (Gasoline Fuel System)

The fuel pump (Figure 15) is located on the left side of the engine. If fuel doesn't reach the carburetor, make the following checks:

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

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

1. Disconnect pump outlet line and install the pressure gauge (Figure 16).
2. Test valves and diaphragm by operating priming lever a few times. The pressure shouldn't drop off rapidly after priming has stopped.
3. Run engine at governed speed on fuel remaining

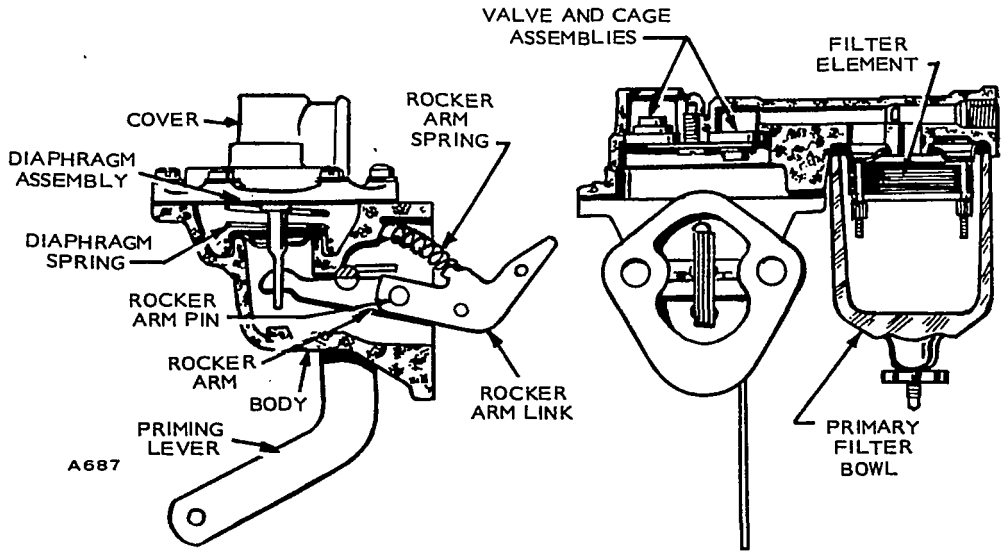


FIGURE 15. FUEL PUMP

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 the pump. If the reading is above maximum, the diaphragm is probably too tight or the diaphragm spring too strong. This can also be caused by fuel seeping under the diaphragm retainer nut and between the diaphragm layers, causing a bulge in the diaphragm. Overhaul the pump and replace the defective parts.

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

Removal and Disassembly:

1. Remove pump inlet and outlet (Figure 16). 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. Don't pry them apart; this may damage diaphragm.
4. Lift out diaphragm assembly and diaphragm spring.

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

Assembly:

1. Before installing a new diaphragm, soak it in fuel. Insert diaphragm spring and 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 the screws but don't tighten. Push the rocker arm in full stroke and hold in this position to flex diaphragm.

   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 the engine and repeat pressure test.

Choke (Gasoline Fuel System)

Electric-starting engines use an automatic electric choke (Figure 12); manual-starting engines use a hand choke (Figure 17). An electric element controls the automatic electric choke. Before the engine starts, the choke is partially closed. When the engine starts, the charging generator supplies current to the heating element which heats the bimetal coil, opening the choke.

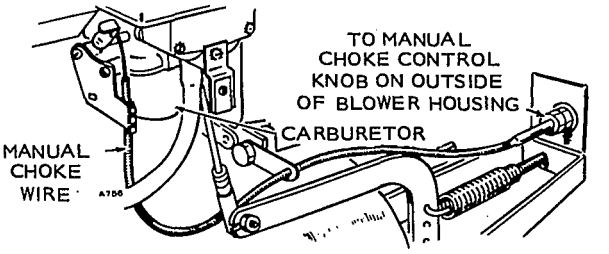


FIGURE 17. HAND CHOKE FOR MANUAL STARTING ENGINES

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

The bimetal is calibrated to position the choke to the proper opening under any ambient condition. The 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 the engine has been shut down for at least one hour. Remove the air cleaner to expose the carburetor throat. Loosen the screw which secures the choke body assembly. Refer to Figure 18 for correct choke setting according to temperature. Use a drill bit to measure the choke opening. Rotating the choke body clockwise richens the mixture and rotating it counterclockwise leans the choking effect. Tighten screw that secures choke body.

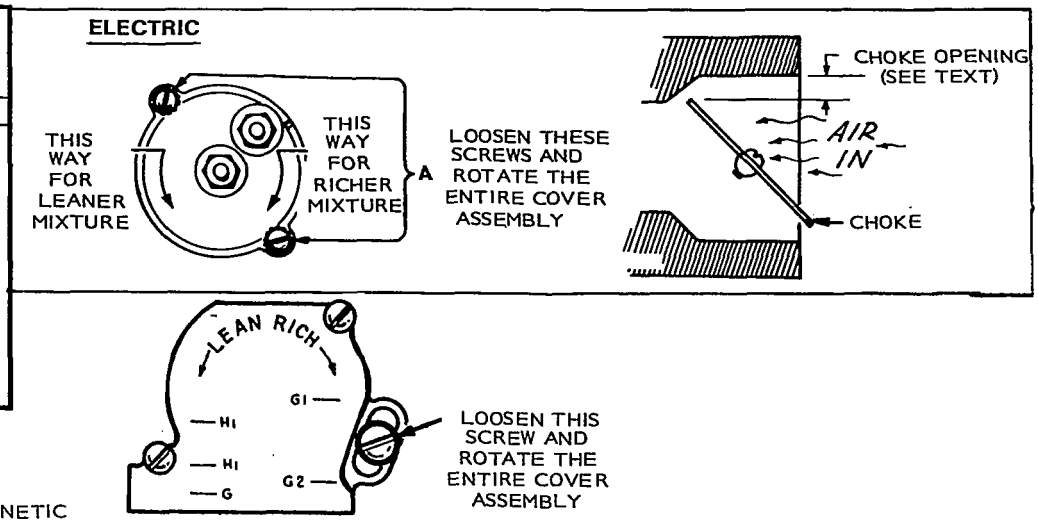
Disassembly and Repair, Electric and Thermo-Magnetic Choke: If the choke does not operate, or will not maintain its adjustment, disassemble it for repair. If it will not close, check for binding, incorrect adjustment or incorrect assembly of the coil. If it will not open after the engine starts, check for heating. The choke should be warm to the touch within a minute or two of engine starting. To disassemble choke, refer to Figure 19.

Electric Choke: If the choke will not heat properly, check for a broken heating coil or high-resistance electrical connections. Check the coil resistance with

an ohmmeter. With the 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 the coil is defective, replace the thermostat cover.

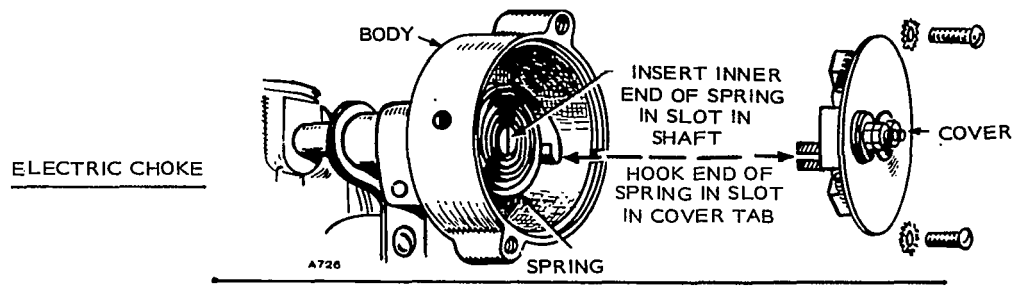
When assembling electric choke be sure the slot in the cover tab straddles and holds the outer end of the coil spring and that the spring winds in a clockwise direction from center.

AVERAGE CHOKE SETTINGS		
AMBIENT TEMP. - F	CHOKE TO BODY JB	JC
68	3/16	0
72	7/32	1/64
76	1/4	3/64
80	9/32	1/16
84	5/16	3/32
88	11/32	7/64
92	3/8	1/8
96	13/32	9/64
100	7/16	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 18. CHOKE ADJUSTMENTS



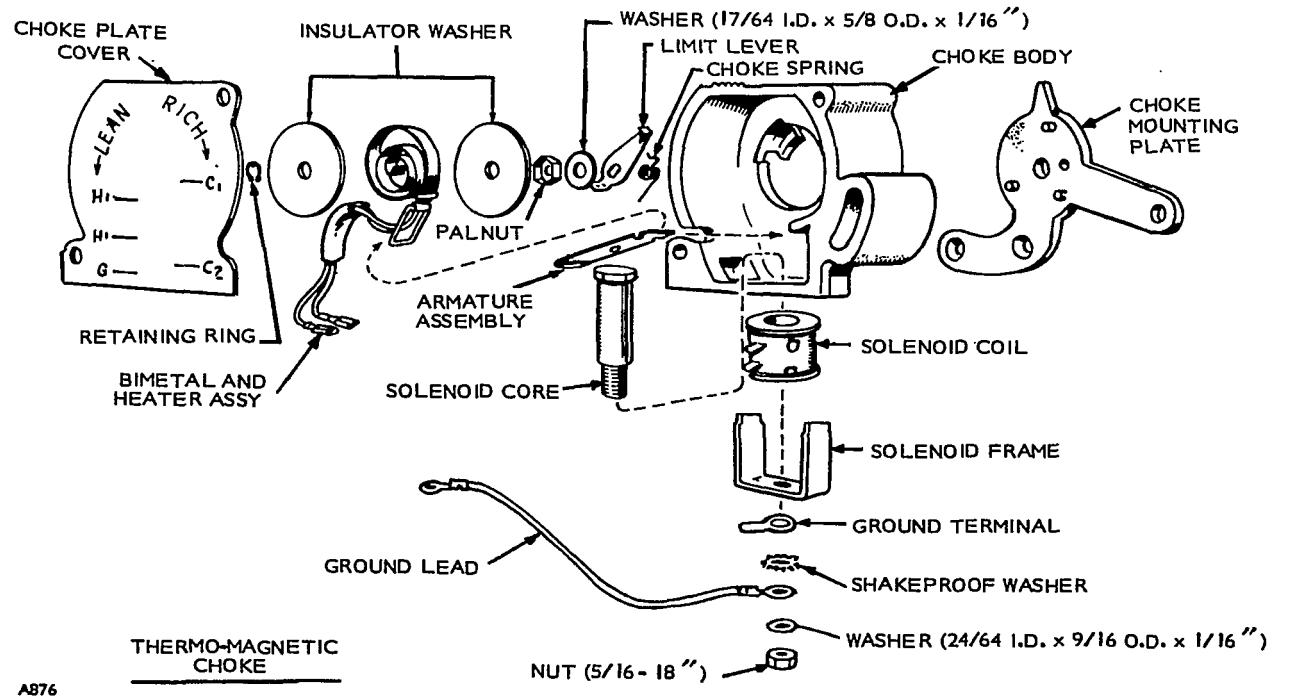


FIGURE 19. DISASSEMBLY OF ELECTRIC AND THERMO-ELECTRIC CHOKE

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 the element at room temperature, check the heater resistance with an ohmmeter. The resistance should be about 30.6 to 37.4 ohms for a 12 volt system. If the heater is defective, replace it with a new one. When the start button is engaged, the solenoid should cause the spring-loaded armature to contact the solenoid core.

If this does not occur, check for broken lead wires or a defective solenoid coil. There must be slack in the lead wires between the 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 the cover on the thermostat and heater assembly, be certain that the choke heater lead wires have been correctly installed in the choke housing. Improper replacement of the lead wires can cause the choke assembly to malfunction.

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

When assembling the 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 H^1 terminal on solenoid core.

GASOLINE CARBURETOR

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

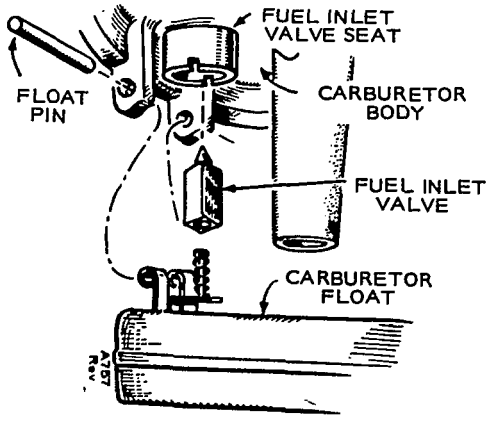
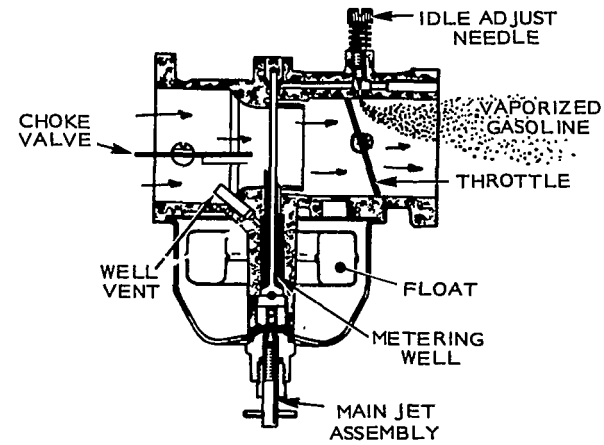


FIGURE 20. CARBURETOR INLET VALVE

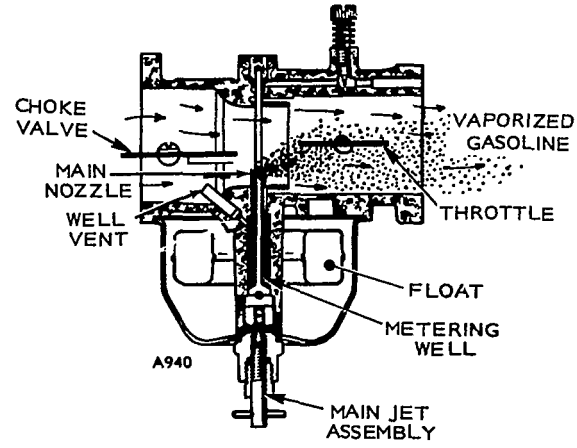
Fuel enters the carburetor through the valve (Figure 20) and passes into the float chamber. The float controls fuel level in the bowl by closing the inlet valve when fuel reaches a certain height and opening it when the fuel level drops.

The idle circuit (Figure 21 and 22) supplies fuel during no-load operation and for small loads. the throttle is nearly closed at no load, and the intake manifold vacuum is high. The pressure difference between the manifold and float chamber causes fuel to flow through the idle circuit. The pressure difference draws fuel up through the hollow center of the main adjusting needle, through passages in the carburetor body to the idle port. Bleed holes in the main adjusting needle allow air to mix with the fuel. When the throttle is almost completely closed, the fuel passes out through the idle port. As the throttle is opened to increase power, fuel is also drawn out through the idle transfer port in the hollow main adjusting needle.

When the load increases, the engine governor opens the throttle further. The carburetor air flow increases, which produces a low pressure at the venturi (narrow



IDLE JET OPERATING



MAIN JET OPERATING

FIGURE 21. CARBURETOR CIRCUITS BEGIN SPEC R

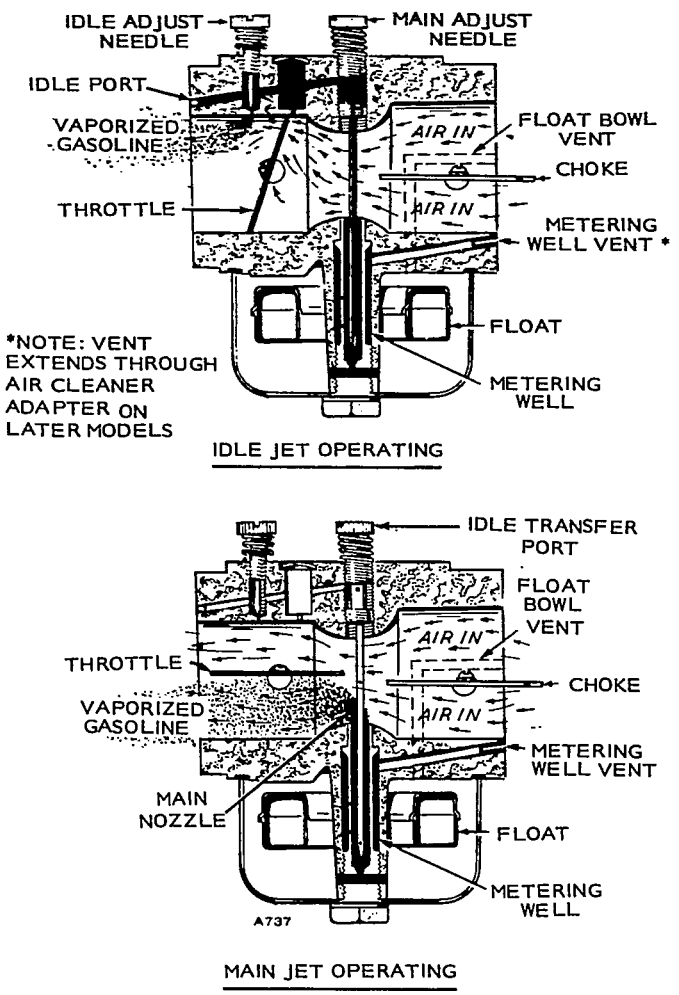


FIGURE 22. CARBURETOR CIRCUITS PRIOR TO SPEC R

section of the carburetor throat). This pressure drop operates the load circuit drawing fuel up the main nozzle where it mixes with air at the nozzle opening. The main adjusting needle controls fuel delivery.

As the throttle opens, the manifold vacuum decreases so the 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 the load circuit in operation, as the load is increased, the throttle opens to deliver more fuel. The main nozzle won't immediately deliver this increased fuel because of the jets controlled by the adjusting needle. To prevent lag when load is increased, a metering well around the outside of the nozzle delivers fuel until the main jet can catch up with the increased demand.

Adjustment, Electric Choke: Under normal operation, adjust the choke so the distance measured between the choke and carburetor throat (Figure 18) is as shown in the table with the engine cold. Use the straight shank end of a drill bit to measure the gap. The upturned air cleaner must be removed for choke adjustment. To adjust the choke, loosen the two screws on the cover plate and rotate the 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.**

Adjustment, With Load: The carburetor should be adjusted in 2 steps — first the idle adjustment and then the load adjustment. See Figure 23.

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

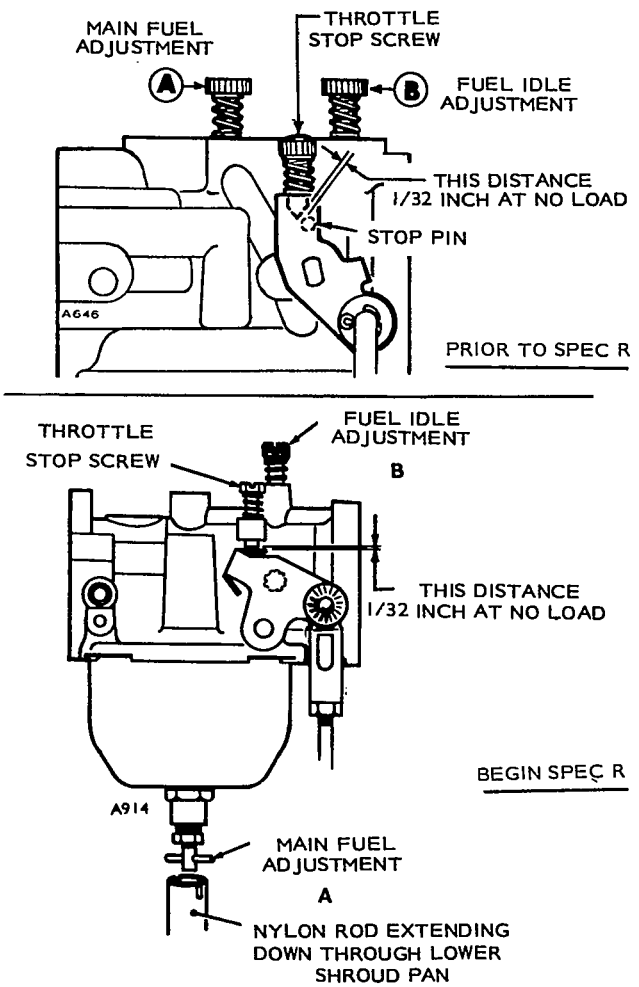


FIGURE 23. ADJUSTING GASOLINE CARBURETOR

Before adjusting the carburetor, be sure the ignition system is working properly and the governor is adjusted. Then allow the 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.

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 the carburetor and governor adjusted, and the engine running with no load (Figure 23), allow 1/32-inch clearance at stop pin to prevent excessive hunting when a large load is suddenly removed.

Removal and Disassembly:

1. Remove air housing door and top panel, 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 the 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 the carburetor bore, especially in the area of the throttle. Blow out the passages with compressed air. If possible, avoid using wire to clean out the passages.

Check the adjusting needles and nozzle for damage. If the float is loaded with fuel or damaged, replace it. The float should fit freely on its pin without binding. Invert the carburetor body and measure the float level (Figure 24).

To check float level, remove the entire main fuel adjustment assembly from the float bowl. Unscrew the large nut from the float bowl. Adjust the float level by bending the tab on the float as shown in Figure 24. With the full weight of the float on the spring, the float-to-gasket gap should be 1/16-inch.

Do not apply excessive pressure to the float valve.

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

Check the choke and throttle shafts for excessive side play and replace if necessary. Don't remove the teflon coating on the throttle shaft which reduces wear and friction between the shaft and carburetor body.

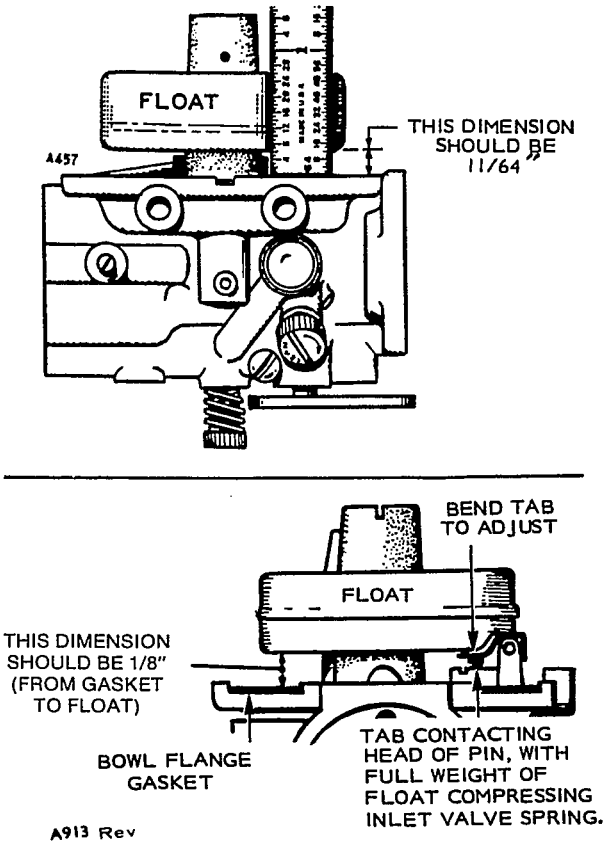


FIGURE 24. SETTING FLOAT LEVEL

Assembly and Installation:

1. Install throttle shaft and valve, using new screws. Install as shown in Figure 21 with bevel mated to carburetor body. On valve plates marked "C", install with mark on side toward idle port when viewed from flange end of carburetor. To center valve, back off stop screw, close throttle lever and seat valve by tapping it with a small screwdriver; then tighten two screws.
2. Install choke shaft and valve. Center valve in same manner as throttle valve (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 doesn't ride against it.
6. Check float level with carburetor casting inverted. Set the carburetor float 11/64-inch between the free end of the float and the carburetor body. See Figure 24.
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 and air housing top and door.

GASEOUS FUEL CARBURETOR

The gaseous fuel carburetor (Figure 25) is similar to the gasoline carburetor in shape, but it differs in operation. The gaseous carburetor contains two major sections, the idle circuit and the load circuit. Fuel delivery depends on the demand created on the fuel inlet line, Figure 26. A small vacuum on the inlet line opens the fuel regulator, delivering fuel. For no-load operation, the idle adjustment controls the quantity of fuel allowed through the idle port. The throttle is almost closed, so the increased vacuum on the engine side of the carburetor draws fuel through the idle passage. When load increases, the flow of air through the carburetor draws fuel from the main fuel port located at the venturi of the carburetor.

Adjustment: Set the carburetor idle adjustment and then the load adjustment.

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

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

Removal and Disassembly:

1. Remove air housing door and top panel, 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 26.
5. Remove throttle plate screws and plate and pull out throttle shaft.

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

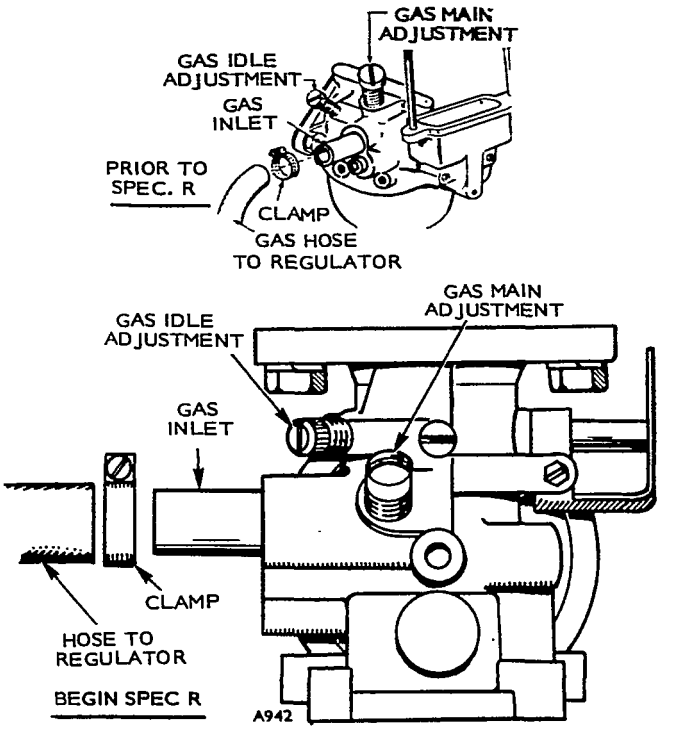


FIGURE 25. GASEOUS FUEL CARBURETOR

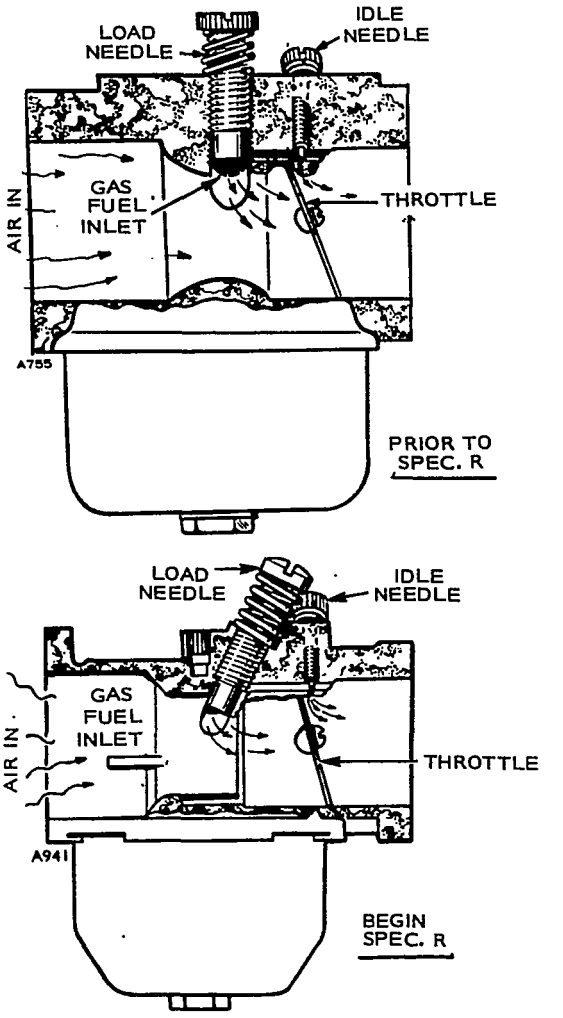


FIGURE 26. GASEOUS FUEL ADJUSTMENTS

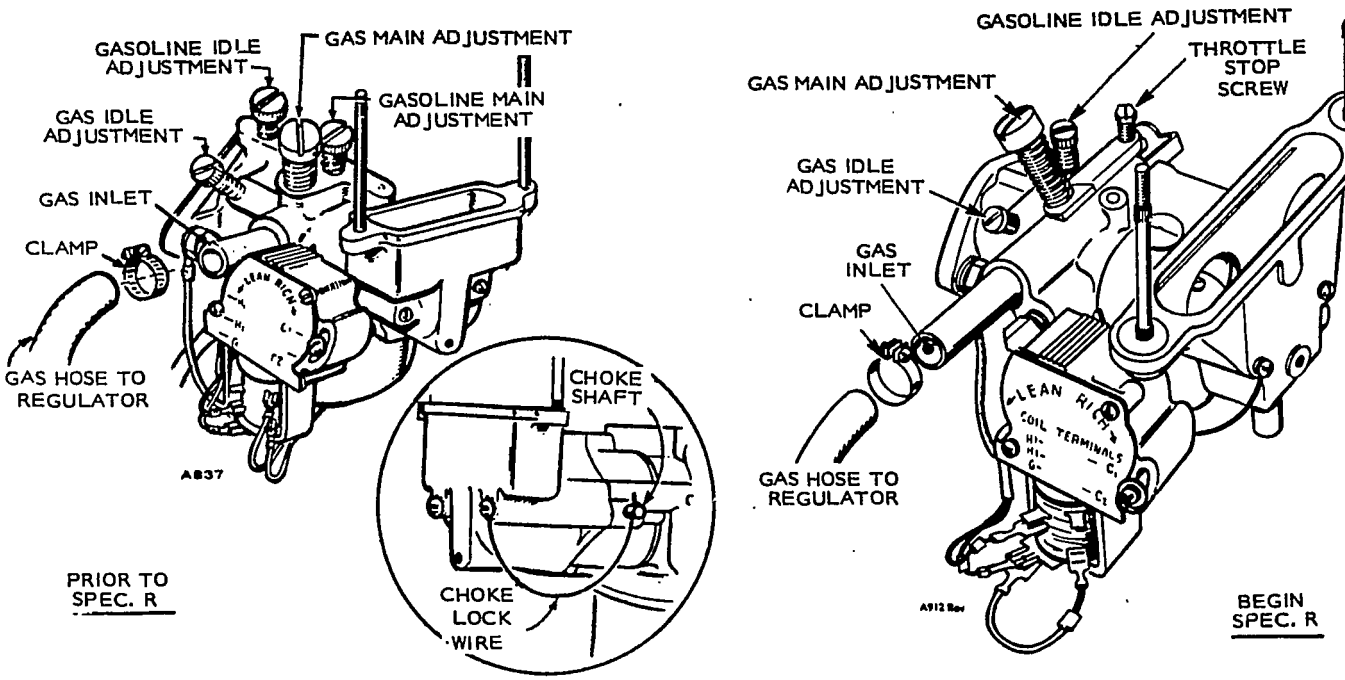


FIGURE 27. COMBINATION CARBURETOR ADJUSTMENTS

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 the gasoline and gaseous fuel carburetors on a single casting.

The combination gas-gasoline carburetor adjustment is the same as for gasoline. See Figure 27 for location of the 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

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 the engine is stopped, or when there is no demand.

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

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

A water manometer (Figure 28) is the standard tool for testing regulator inlet pressure, which must be within the limits specified for your regulator. Use the chart in Figure 28 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 29.

Gas Regulator (Garretson): The 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. The regulator has an adjustment to control the 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 the regulator for shut off when there is no demand, to prevent gas leaks. The factory adjusted shut-off is between 2 and 4 ounces. If gas line pressure is between 4 and 8 ounces, readjust the screw (Figure 30).

To adjust the regulator, the gas line should be connected and the outlet hose removed. Make a coarse adjustment by turning the adjusting screw

.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

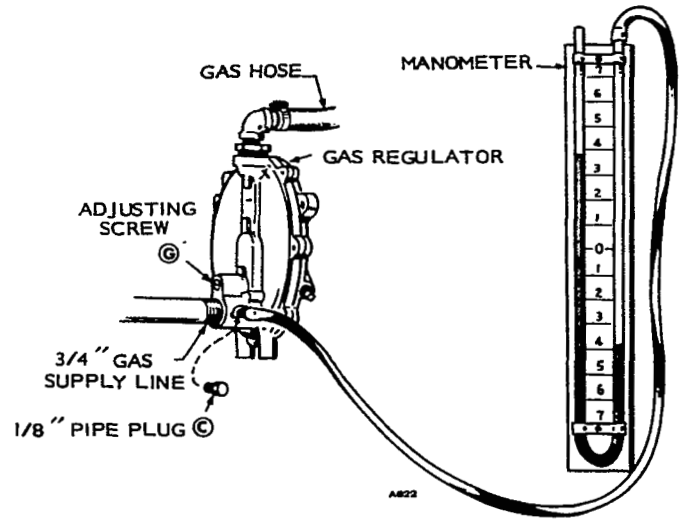


FIGURE 28. WATER MANOMETER

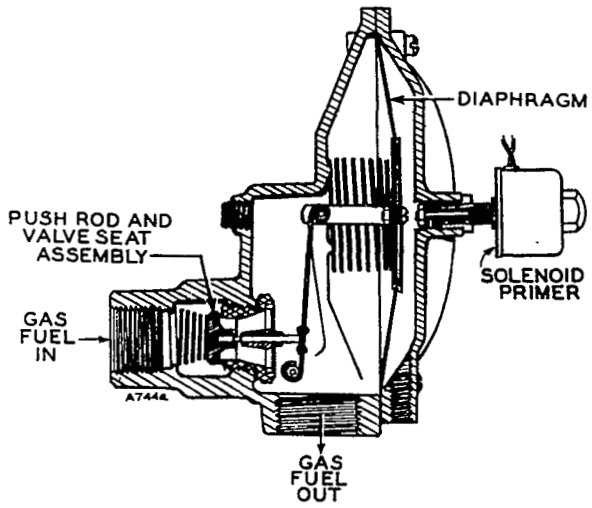


FIGURE 29. ALGAS GAS REGULATOR

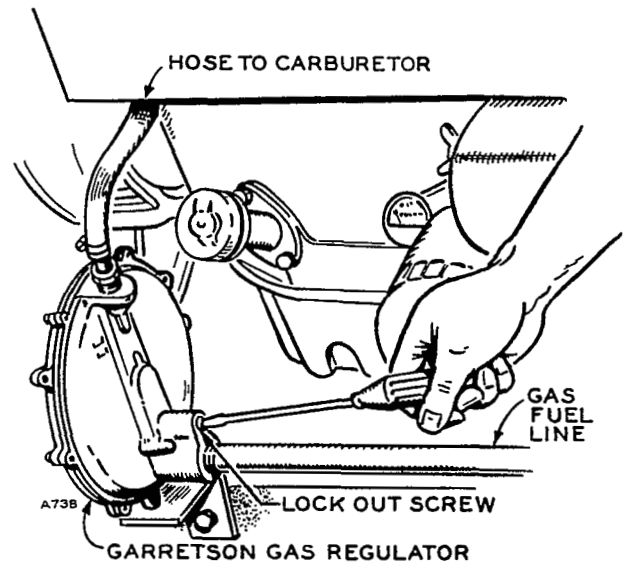


FIGURE 30. ADJUSTING GAS REGULATOR

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

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

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

If this regulator appears defective; won't open, won't close, or delivers insufficient fuel, check the 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 31) holds the regulator open during engine cranking. It can be adjusted for a rich or lean mixture by loosening the lock nut and turning the primer in our out. Turning the primer clockwise richens the mixture.

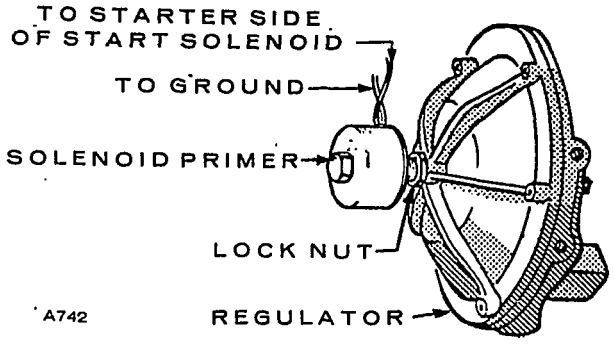


FIGURE 31. ALGAS SOLENOID PRIMER

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

Coarse 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.

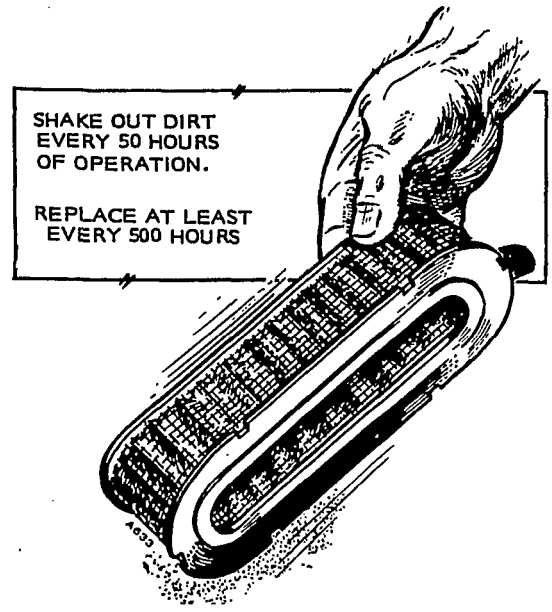
If the engine starts within 3 seconds, the primer is correctly adjusted. If not, remove the hose at the regulator and crank the engine for a few seconds to empty the hose and carburetor of gas and readjust the primer slightly. Connect the hose and attempt to start. Continue until the engine starts within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

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

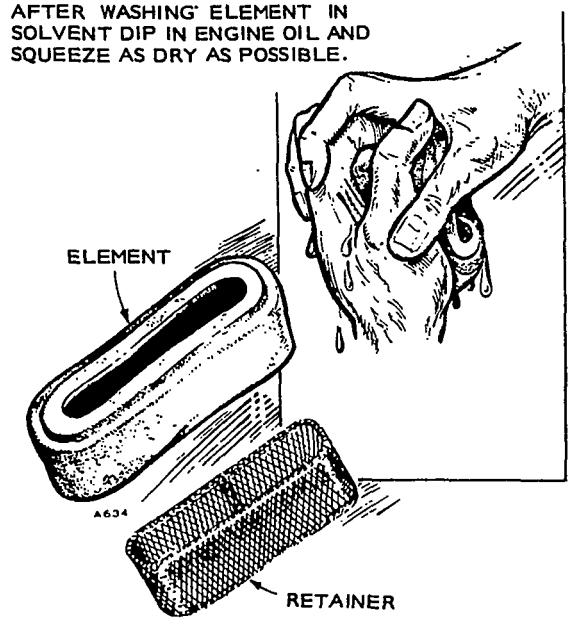
AIR CLEANER

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

Dry Paper Type (Early JB Engines Only): See Figure 32. Remove and clean, either by shaking, or blowing out with compressed air at least every 100 hours. Don't wash it. When using compressed air, hold the nozzle far enough from the cartridge so it won't rupture. Replace the cartridge at least every 500 hours. If the paper cartridge has a foam wrapper, remove the wrapper before cleaning, wash it in clean solvent, dry and install on the cartridge.



EARLY JB DRY PAPER-TYPE FILTER



FOAM-TYPE AIR FILTER

FIGURE 32. AIR CLEANERS

Foam Type Cleaner: This cleaner consists of a foam element over a metal retainer(Figure 32). About every 200 hours, remove the foam element and wash it thoroughly in a suitable solvent. Then dip it in crankcase grade oil and squeeze as dry as possible. The element should be replaced only if damaged.

Oil Bath Air Cleaner (Optional): Clean and refill the oil cup (Figure 33) at regular intervals, depending on the ambient operating conditions. In severe conditions, service the cleaner daily. Establish a regular cleaning

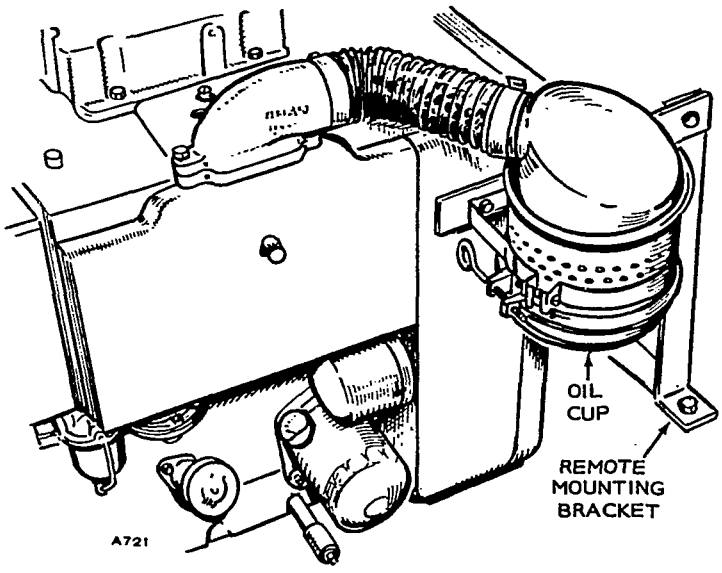


FIGURE 33. OPTIONAL OIL BATH AIR CLEANER

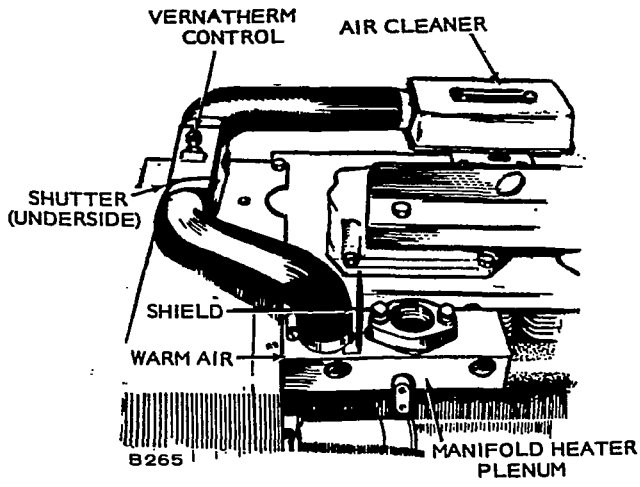


FIGURE 34. OPTIONAL CARBURETOR AIR PRE-HEATER

interval so the operator can correctly clean the cup before the dirt accumulates in the bottom to a depth of 1/2 inch, or the oil appears too heavy to spray or circulate properly. Use crankcase-grade oil. When changing oil, inspect the wire screen filtering element and remove any accumulation of lint, etc. The air cleaner mounts remotely; the flexible hose must have slack.

CARBURETOR AIR PRE-HEATER (Optional)

Heated air supplied to the air cleaner (Figure 34) during cold weather prevents carburetor icing. The air source is automatically selected by the Vernatherm (thermo-static element) which operates a shutter in the intake air stream. The shutter is fully closed at 80°F (just touches bottom), is half open at 90°F, and is fully open to ambient air at 100°F.

The flange of the hose adapter (where used) is positioned inside the manifold heater plenum, and one sheet metal screw holds air outlet hose shield (where used next to vertical exhaust). Check shutter for binding. Mounting depth of Vernatherm adjusts temperature control plunger to just touch shutter at 70°F. Grease points of contact.

Gaseous fuels (natural gas) do not require pre-heated air.

IGNITION SYSTEM

Three different types of ignition systems cover the manual- and electric-starting models on two- and four-cylinder engines. The manual-starting two-cylinder model (JB-M) uses a magneto system. The two-cylinder remote and electric-starting engines (JB-R, JB-E) use a battery ignition system. The four-cylinder model (JC) uses a battery ignition system with an automotive distributor. For details of specially suppressed systems (not covered here), request suppression drawing.

TESTING

Remove each plug, install the ignition wire to each plug and hold the plug base against bare engine metal. Crank the 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. Defective ignition 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 a defective high tension wire.

BATTERY IGNITION (JB Electric and Remote Starting Engines)

This model (Figure 35) uses a single coil battery ignition to fire both spark plugs simultaneously. One spark plug fires on the exhaust stroke while the other is firing at the end of the compression stroke. A spark advance on the breaker point mechanism advances the spark from 5° ATC (after top center) at cranking speed, to 25° BTC (before top center) when running at rated speed, Figure 36.

Advance 10 degrees more for gas fuel.

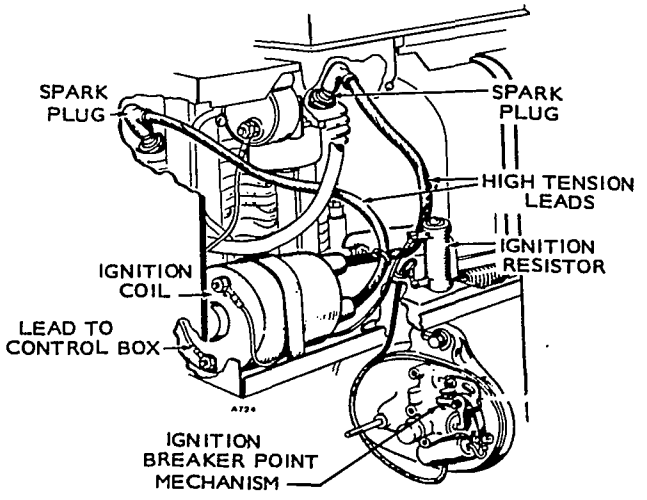


FIGURE 35. BATTERY IGNITION SYSTEM

Maintenance

Periodic maintenance should include:

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

The JB engine with a flywheel magneto must always fire at 25° BTC, regardless of type of fuel. The JB engines have an automatic advance of 30°; the JC engines 26°.

Breaker Point Gap:

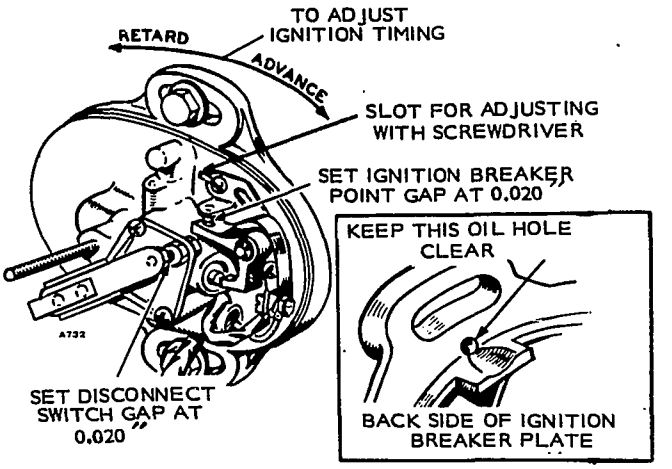


FIGURE 36. ADJUSTING BREAKER GAP

Check point gap with a feeler gauge for .020 inch. Adjust gap by loosening the adjustment screw and moving the stationary contact. Tighten screw and check gap (Figure 36). Check points for cleanliness and pitting. Clean points with paper or gauze tape. If they are defective or excessively pitted, replace them.

Adjust the breaker point gap before timing the ignition.

Timing Procedure, Engine Stopped:

1. Remove access door in air housing. Remove breaker point 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 37). Then slowly rotate flywheel clockwise until light goes out, indicating that points have opened. This is the ignition point. If timing is correct, ignition occurs at 5° ATC.

Some early engines had no 5° ATC mark on the flywheel. On these models, open the breaker box and rotate the flywheel until the breaker points open to maximum gap.

3. If ignition timing isn't correct, align 5° ATC mark and timing pointer, then loosen breaker plate capscrews and rotate plate until light goes out. Clockwise rotation advances timing, counterclockwise rotation retards it (Figure 37).

4. Tighten plate and check timing, step 2. If timing isn't correct, readjust plate. If correct, connect ignition lead and install cover.

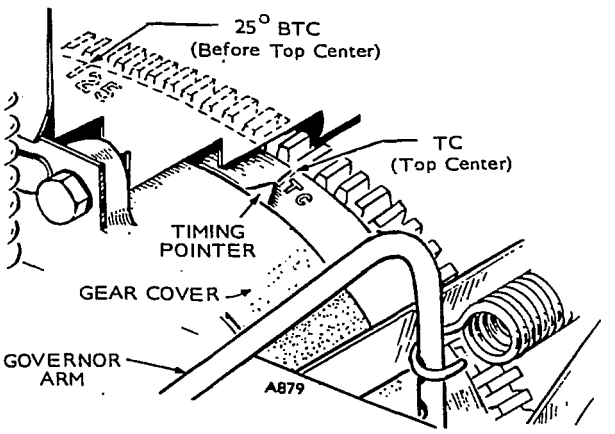


FIGURE 37. JB-JC TIMING MARK

Timing Procedure, Engine Running:

CAUTION **Do not run the engine for more than a minute or two with access door open or removed. The engine overheats rapidly and can damage itself. Run without load.**

1. Remove access door and install an automotive timing light on either of spark plug leads.
2. Run engine at rated speed and check timing with light. If timing is incorrect, loosen breaker plate mounting screw and correct it by rotating plate. Rotating clockwise advances timing; turning counterclockwise retards it. Tighten plate and recheck timing point.
3. Adjust timing at 25° BTC (35° for Gas or Gas/Gasoline), tighten breaker plate and then recheck ignition point gap.

If the breaker points can't be adjusted to specifications, either the timing gear or camshaft gear is incorrectly installed, or the centrifugal advance mechanism is defective. Disassemble the breaker mechanism for repair.

Breaker Points

The breaker points 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 point cover and disconnect wires from start-disconnect switch (if used) and ignition breaker points.
3. Remove two capscrews holding breaker plate assembly and pull off 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 plunger and plunger diaphragm.

Repair: Thoroughly clean the gear and cam assembly. The weights should move freely in and out without catching in either end position. Inspect the gear ramp for notches or other defects. If any part of the cam weight and gear assembly sticks, replace the complete assembly. If the cam is loose on the gear replace the complete assembly. Clean and inspect the bearing surfaces in the breaker plate and gear case. Clean the oil trickle holes into these bearings. Check the oil spray hole in the gear case to be sure it is open. If the breaker points won't maintain the proper gap, check for excess wear in both the cam and the ignition breaker plunger.

Assembly:

1. Install springs on weight assemblies. Install cam on gear shaft, being sure to align timing marks (Figure 39), and install cam spring. Weights should snap outward between 1000 and 1075 rpm. If necessary, adjust by lightly bending one or both spring anchor pins toward center of gear.
2. Install spacer and thrust washer on gear shaft assembly and install assembly into gearcase, matching timing marks on timing gear and camshaft gear.
3. Install spring and plunger on end of shaft.
4. Install breaker plate. Install ignition plunger and diaphragm and diagram cup (Figure 40).
5. Install start-disconnect diaphragm (when used), and plunger, and install start-disconnect breaker points.
6. Adjust start-disconnect breaker point gap to .020 inch.

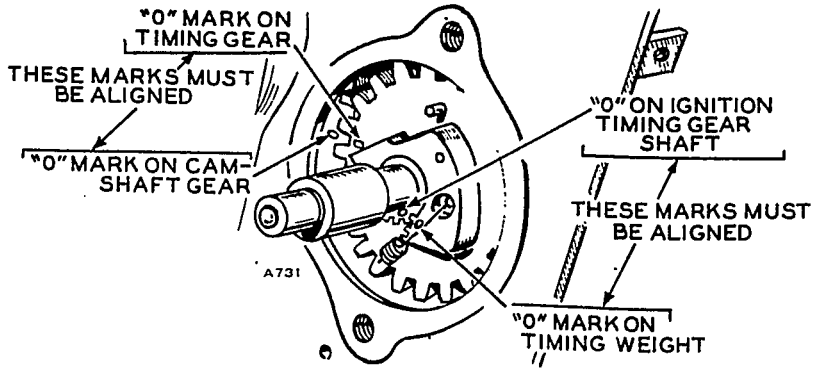


FIGURE 39.. ALIGNING TIMING MARKS

7. Install ignition breaker points and adjust gap. Time ignition.

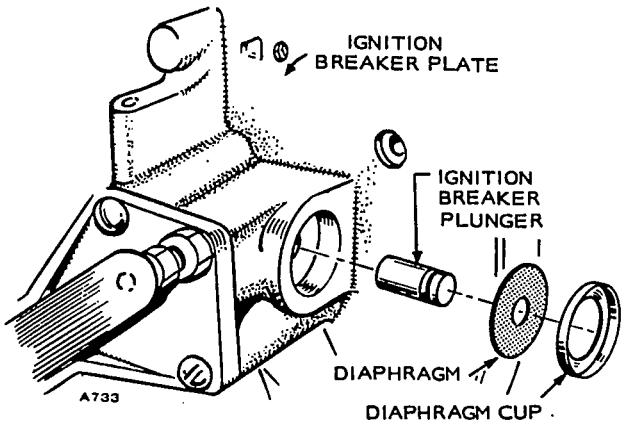


FIGURE 40. BREAKER PLATE ASSEMBLY

Condenser

The .3 mfd condenser mounted on the breaker plate aids primary field breakdown when the points open and prolongs the life of the breaker points 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 defects.

Coil

If spark is weak or there is no spark, and the breaker points are clean and properly adjusted, test the coil for possible defects. Disconnect both spark plug leads, ground one and hold the other about 3/8 inch from the engine. Crank the engine. If there is a good spark the coil is operating. Also test the coil as follows:

1. Disconnect breaker point lead at breaker points and measure resistance from that lead to ground. It should be about one ohm.

2. Disconnect both spark plug leads at plugs and measure resistance between them. Resistance should be between 7000 and 10,000 ohms. If it is higher, either the high tension terminals or spark plug leads are defective. Remove leads and check resistance of coil between hi-tension terminals. Check terminals for corrosion. Check leads for resistance. Replace any that show a high resistance. If resistance is low, coil is probably shorted, and should be replaced.

3. Check for shorting between primary and secondary coils by checking for continuity between a primary terminal and secondary terminal.

Test this coil using a six-volt tester only.

MAGNETO IGNITION (JB, Manual Start)

This ignition system is similar to the JB battery ignition except that it uses a magneto as a source of power. The magneto is behind the flywheel and consists of both stator and secondary windings, energized by permanent magnets on the flywheel. Figure 41 shows the magneto ignition system.

For maintenance, timing, condenser repair, and for breaker repair, refer to the applicable section in *Battery Ignition.*

Magneto Coil: The magneto coil is located behind the engine flywheel and reached by removing the flywheel. If ignition spark at the spark plugs is defective, first inspect the breaker points. To test the coil, remove both spark plug leads; ground one to bare engine metal. Hold the other about 3/8 inch away from bare metal and crank the engine. A good spark should occur between the lead and engine. If not, the coil, flywheel magnets, or high tension leads are defective. Test the coil as follows:

1. With an ohmmeter, check resistance between breaker point lead (disconnected from the points) and a good ground on the engine. Resistance should be about 0.6 ohms.

2. Remove both spark plug leads from plugs and

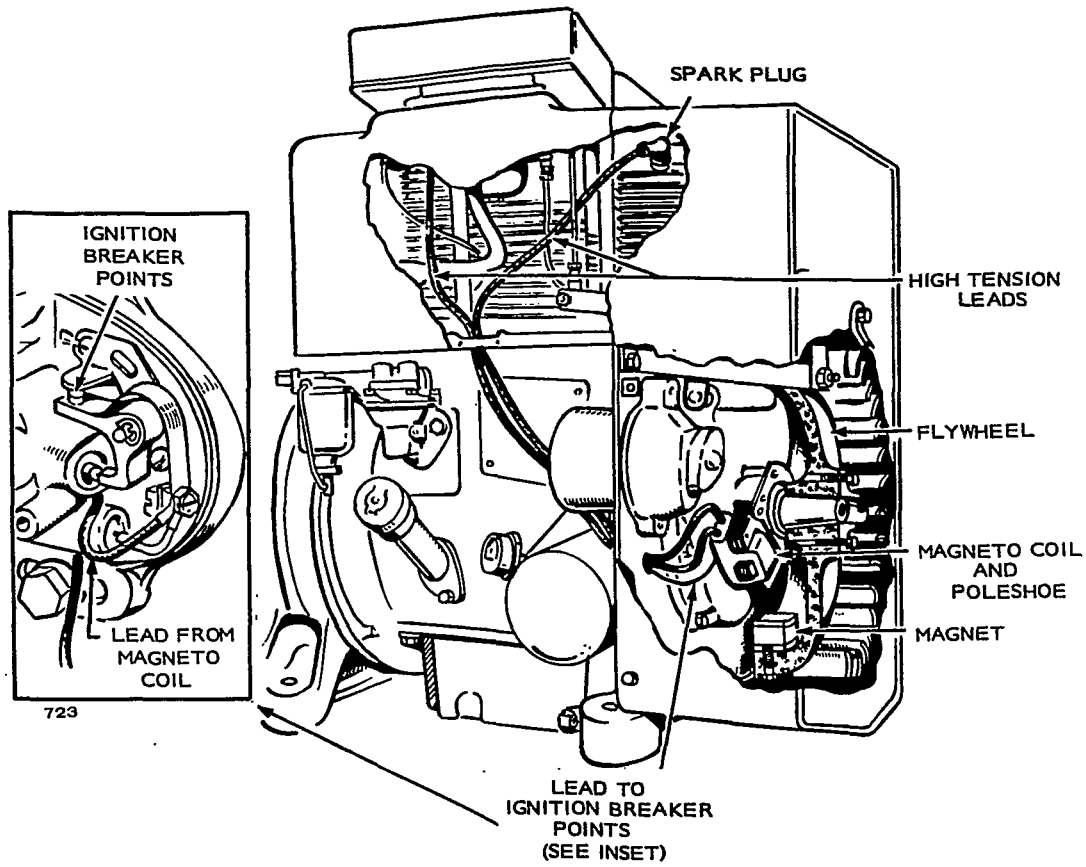


FIGURE 41. MAGNETO IGNITION SYSTEM

measure resistance between leads. Resistance should be about 11,000 ohms. If it is greater, either the leads or magneto high tension coils contain a high resistance or are open-circuited. The magneto should be removed to test resistances of the coil and leads separately. Inspect the high tension terminals on the coil for corrosion. If the resistance is low, the secondary winding is probably shorted and the coil must be replaced.

3. Check for shorting between primary and secondary circuits by measuring resistance from breaker lead to a spark plug lead. Any continuity indicates a defective coil.

Flywheel Magnets: Permanent magnets mounted on the flywheel provide a magnetic field for the magneto coils. Never remove these magnets from the flywheel. It may destroy their alignment and seriously weaken the magnets.

A piece of steel held close to the magnets must be drawn strongly to them.

The magnets shouldn't lose strength with age or be affected by dropping the flywheel. If the magnetism is lost, return the flywheel to the factory for recharging. Some flywheel magnet chargers can recharge the magnets in the field, but makeshift equipment will probably reduce the magnetism further. To recharge the magnet it must have the correct polarity. The north-seeking end of a compass needle must be attracted toward the leading magnet pole.

JC IGNITION SYSTEM

The JC engine uses a battery ignition system with an automotive distributor to produce and distribute spark (Figure 42).

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

Maintenance: Periodic maintenance of the system should include oiling the distributor, cleaning and adjusting the breaker points, checking ignition timing, cleaning and adjusting the spark plugs, and inspecting the ignition system wiring.

At regular intervals, add 3 to 5 drops of medium engine oil to the oiler on the distributor. Add 1 drop of light engine oil to the breaker arm hinge pin and 3 to 5 drops to the felt in the top of the breaker cam and to the governor weight pivots. Wipe grease lightly on each lobe of the breaker arm. Don't over-lubricate the distributor.

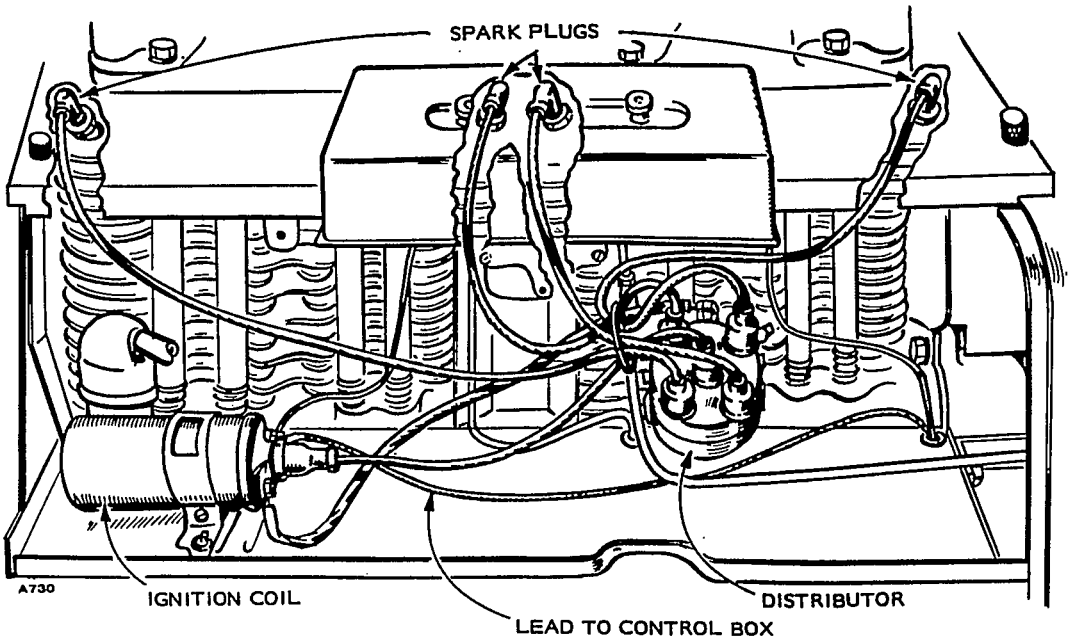


FIGURE 42. JC BATTERY IGNITION SYSTEM WITH AUTOMOTIVE DISTRIBUTOR

To adjust the breaker points, remove the distributor cap and rotor. Rotate the crankshaft to get maximum breaker gap. The gap should be between .018 inch and .022 inch. At the same time, inspect the points for dirt or pitting. Dirty points can be cleaned with tape and solvent. If the points are excessively pitted, they must be replaced. See Figure 43.

Check the distributor cap for cracks, carbon runners, corroded high tension terminals or excessively-burned inserts.

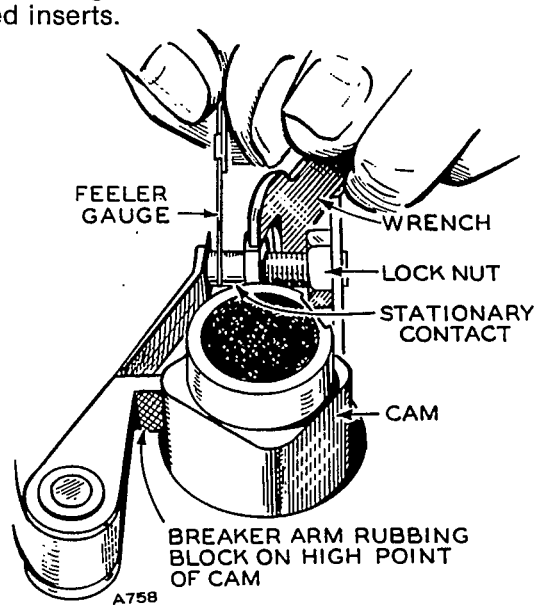


FIGURE 43. SETTING BREAKER POINTS

Timing: The JC ignition system may be timed either with the engine stopped or running. Before timing the ignition, be sure the breaker points are clean and properly adjusted. Set the timing at 25° BTC (running) of each compression stroke (35° BTC for gaseous fuel or combination gasoline-gaseous fuels).

Timing Procedure, Engine Stopped:

1. Disconnect low voltage lead to distributor and connect a test lamp and battery so lamp lights when breaker points are closed.
2. Remove spark plug from #1 cylinder and rotate flywheel clockwise until air is forced out of spark plug hole.
3. Continue rotating flywheel slowly until test lamp goes out, indicating that breaker points have opened. If TC mark on flywheel and ignition timing pointer are aligned, timing is correct.
4. To adjust timing, align flywheel TC mark and timing pointer. Loosen distributor body and rotate it (clockwise if ignition occurred early and counterclockwise if late), until light goes out. Tighten distributor body in new position and check timing, step 3. If timing still does not occur at correct point, repeat step 4.

Timing, Engine Running:

1. Remove access door and install an automotive timing light on spark plug for cylinder #1. Run engine at rated speed. Aim flashing timing light in through access door opening and toward flywheel.

CAUTION **Do not run the engine for more than a minute or two with the access door open or removed. The engine overheats rapidly and can damage itself. Run without load.**

2. The timing pointer on gear cover must indicate 25° BTC. To adjust timing, loosen distributor body clamp and rotate distributor body. If timing is early (25° mark to the right of the point), rotate distributor clockwise to retard ignition point.

Tighten distributor in its mount and recheck timing.

CAUTION **If the relative position of the timing marks doesn't remain steady, the distributor may be defective. This can be caused by pitted or misaligned breaker points, incorrect breaker point spring tension, worn or loose breaker plate, or a worn distributor shaft or bushing.**

Distributor: The distributor contains and opens the breaker points at the proper time, contains an automatic spark advance mechanism, and distributes the spark to the proper cylinder.

Testing: Remove the distributor and test it on a commercial tester. Following the equipment manufacturer's instructions, check the centrifugal advance mechanism and cam dwell angle. The cam dwell angle should be 51 ± 3 degrees. Do not set breaker gap by cam dwell. With the proper point gap, if cam dwell is outside the above limits, check for worn distributor cam.

If a distributor tester isn't available, test as follows:

To check the spark advance mechanism, remove the distributor cap and rotate the rotor several degrees clockwise. If the advance mechanism is operating properly, the rotor will return to its original position.

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

Using a spring scale, measure the tension of the points as they break contact (Figure 44).. Tension should be 17 to 20 ounces. If it is greater, it causes excess wear; if less, it causes contact bounce. To adjust tension, refer to *Distributor Assembly.*

Removal and Disassembly:

1. Remove distributor cap by releasing clips on distributor. Remove primary lead from distributor terminal.
2. Record distributor body position and rotor position for easier assembly.
3. Remove distributor hold-down capscrew and pull distributor out of crankcase.
4. Remove 3 screws holding breaker plate to distributor housing and loosen primary lead mounting terminal. Lift breaker arm off its hinge.
5. Rotate breaker plate counterclockwise about 45 degrees and pull it out of distributor body. Remove two centrifugal advance springs.
6. Remove spring clip (cam retaining spring) holding cam to drive shaft and lift out cam. The

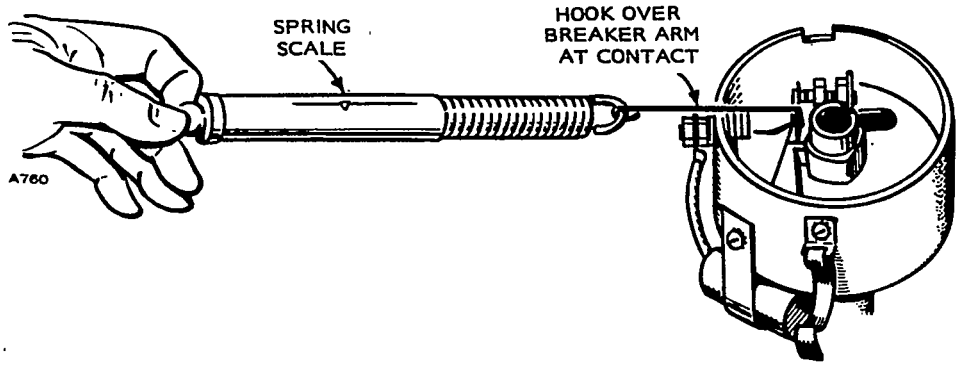


FIGURE 44. CHECKING BREAKER POINT SPRING TENSION

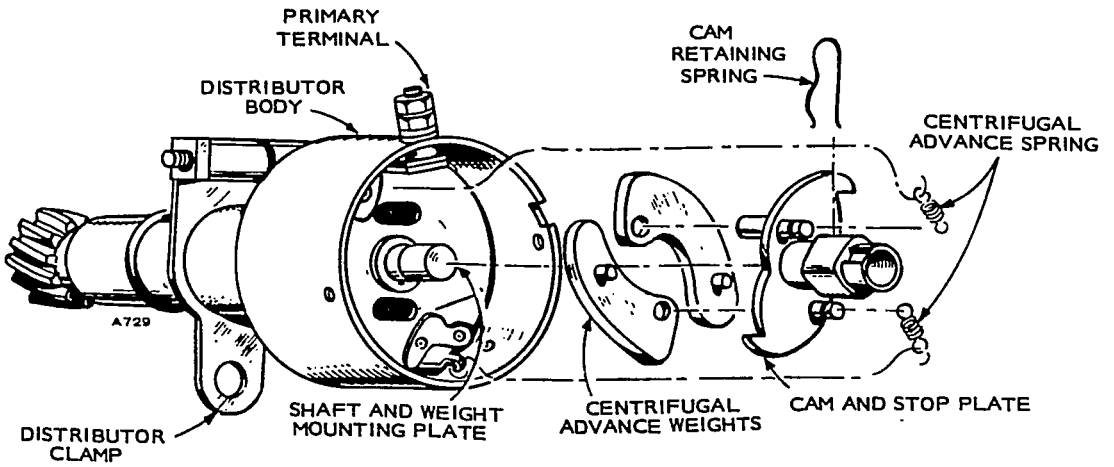


FIGURE 45. DISTRIBUTOR DISASSEMBLY

weights are now free and can be lifted out (Figure 45).

7. To remove drive shaft, grind or file off peened-over end of pin holding drive gear to shaft. Drive out pin, then remove gear and pull shaft out through distributor body.
8. If necessary, press two bronze bearings out of distributor body.

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

To check bearing wear, set the drive shaft into the body and measure the side play at the top of the cam with a dial indicator. Mount the indicator on the distributor body, and measure the side play by pulling the shaft directly away from the indicator with a force of about five pounds. Side play should be less than .005 inch. If not, the bearings must be replaced. ONAN does not recommend field replacement of bronze shaft bearings unless the required equipment is available. This can be done by an authorized service station.

Distributor Assembly:

1. Install shaft assembly with upper drive shaft thrust washer in distributor body. Install lower drive shaft thrust washer and drive gear. Install a pin through drive gear and shaft and peen it into place.
2. Check drive shaft end play (Figure 46). 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 gear.

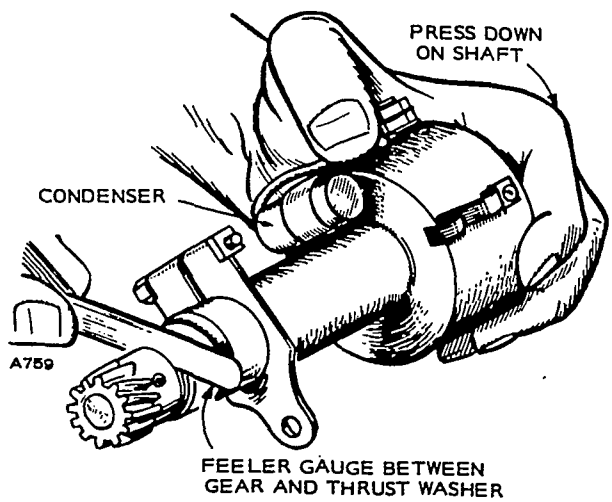


FIGURE 46. CHECKING DRIVE SHAFT END PLAY

3. Set centrifugal advance weights into place and install cam. Be sure pivots on cam fit into hole in each weight. Secure cam with spring clip and install weight springs.
4. Install and secure breaker plate.
5. Mount breaker arm on its pivot and place control spring end between end of terminal stud and square metal washer. Then tighten primary terminal.
6. Align contacts so they make contact at center. Bend stationary contact bracket, not breaker arm, to align contacts.
7. Check tension of breaker spring with a spring scale hooked on arm at contact and held at right angles to contact surfaces (Figure 44). Tension should be 17 to 20 ounces. Adjust it by loosening screw holding end of contact spring and installing spacing washers or sliding end of spring in or out.
8. Rotate drive shaft to obtain maximum breaker gap and set gap for .020 inches (Figure 43).

Distributor Installation: Install the distributor in exactly the same position as before removal. When setting the distributor into position, the rotor should be 1/8 turn counterclockwise from the position when removed, to allow the gears to mesh.

If the exact position of both distributor body and rotor was not recorded or the crankshaft was rotated, use the following procedure.

1. Remove spark plug from #1 cylinder. Place a finger over spark plug hole and rotate flywheel clockwise until cylinder builds up pressure. Continue rotating until TC mark of flywheel aligns with timing pointer.
2. Install rotor on distributor shaft and "O" ring on body.
3. While holding distributor in position shown in Figure 47 and the rotor 1/8 turn counterclockwise

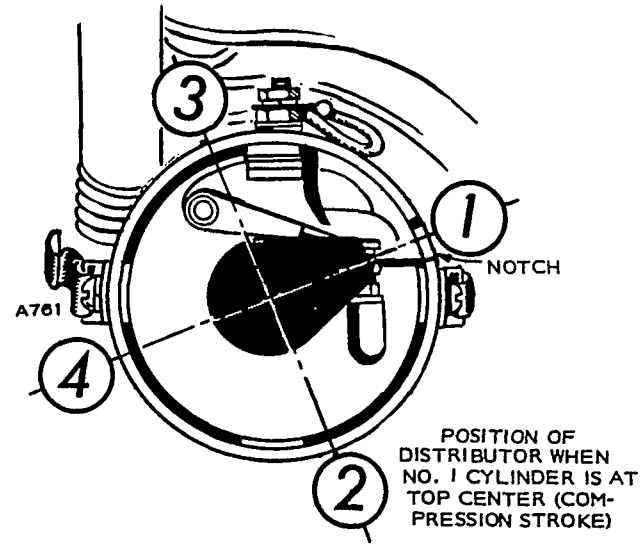


FIGURE 47. DISTRIBUTOR POSITIONING

from the position shown, push the distributor into its mounting hole. If necessary, turn the rotor slightly to align teeth of gear. If the rotor is not in position shown, repeat the procedure, changing the gear alignment.

4. Install distributor clamp screw. If spark plug leads were removed from distributor cap, reinstall them in proper order, (Figure 42). Time ignition system.

Ignition Coil: The JC engine uses a standard automotive ignition coil mounted on the air shroud near the engine access door. Inspect and tighten the primary terminals. Inspect the secondary terminal and clean it if necessary.

Test the coil either on a standard automotive tester or by checking primary and secondary winding resistances. Resistance from the high tension terminal to the ground (-) terminal should be 7,000 to 10,000 ohms; resistance between the primary terminals, about 1 ohm.

A quick coil check can be made by simply disconnecting the high tension lead between coil and distributor at the distributor, holding the end about 1/4 inch from bare engine metal and cranking the engine. A spark between the lead and engine indicates the coil is operating, although it might be weak. No spark indicates that the coil, points, or control circuit to the coil are defective. Check for voltage between the coil negative (-) terminal and ground while cranking the engine, and inspect the breaker points.

Ignition Condenser: The condenser is mounted on the outside of the distributor, Figure 46. Refer to *JB Battery Ignition* section for test procedure. Capacitance should be .25 to .28 mfd.

MAGNETO IGNITION (JC)

Magnetos (Wico or Fairbanks-Morse) are sometimes supplied with JC engines. If the magneto has been removed from the engine for any reason, it must be retimed to the firing order of the engine (1-2-4-3) at the time of installation. Follow the procedure below for installation instructions.

Align the flywheel 19-1/2 teeth before the TDC (top dead center) mark with the pointer on the front cover. No. 1 piston on compression stroke. This procedure is for both magnetos.

Fairbanks-Morse Magneto

Install a piece of ignition wire in the number one cylinder high tension terminal. (See Figure 48 for firing order.) The other end should be stripped and held 1/2 inch from magneto body. Rotate the magneto drive gear clockwise until a spark is observed from the wire to the magneto body. (This occurs when impulse

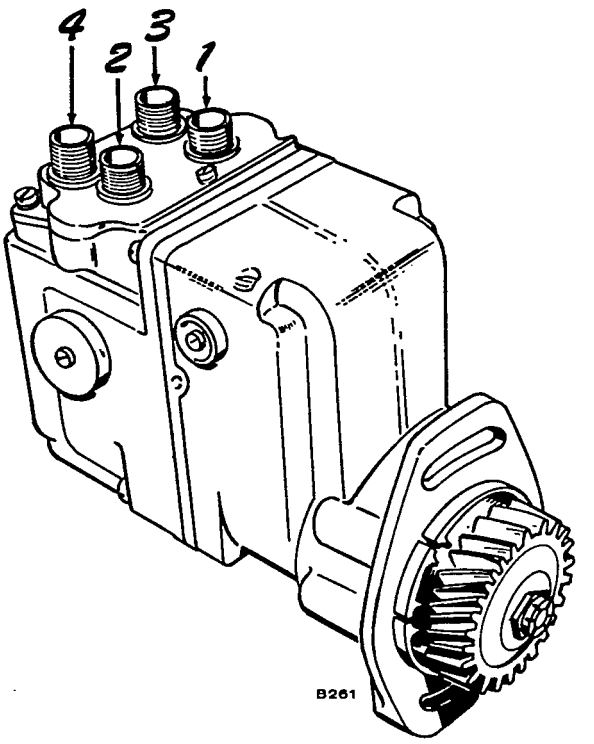


FIGURE 48. FAIRBANKS-MORSE MAGNETO

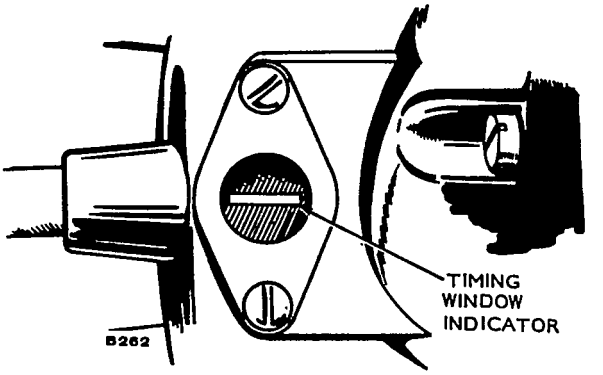


FIGURE 49. WICO MAGNETO

snaps.) After the spark occurs, turn the drive gear counterclockwise until a slight click is heard, then turn clockwise, holding the gear against the impulse. Install magneto on engine, set the magneto in the the mid position on the adjustment slots. Connect a timing light on the number one high tension lead; adjust timing when engine is running for the specific fuel being used.

Wico Magneto

The timing procedure is the same as for the Fairbanks-Morse magneto except for locating and positioning the number one firing position on the magneto.

A timing window with an internal indicator is provided to locate the number one position (see Figure 49).

Rotate the drive gear counterclockwise until the indicator is observed in the window; continue rotation slightly more until a slight click is heard. This will be the impulse point. The impulse coupling will be locked when turning clockwise. Hold the gear against the impulse and install the magneto on the engine in the mid position of the adjustment slots. Use a timing light; adjust the timing for the specific fuel being used. Magneto firing order is clockwise when viewed from terminal end.

SPARK PLUGS

JB and JC air cooled engines use standard automotive spark plugs, Champion H-8 or equivalent. Clean and inspect the plugs at regular intervals. Clean on a commercial plug cleaner and gap. The spark plug gap should be set at .025-inch for JB engines and .035-inch for JC engines. When spark plug electrodes become worn, of if the plugs are damaged, replace them. When installing spark plugs always use new gaskets.

GOVERNOR SYSTEM

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

Variations in engine speed change the position of the governor cup on its shaft. This change is transmitted by the shaft, arm, and linkage to the carburetor throttle lever. Engine speed is determined by the 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 the governor linkage with lubricating graphite or light non-gumming oil. Also, inspect the governor linkage for binding or excessive slack or wear.

Adjustments

Prior to Spec R, both the governed speed and the governor sensitivity are adjusted with the stud and nut on the front of the engine air housing (Figure 50). Beginning with Spec R, the sensitivity is adjusted with an adjusting ratchet.

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

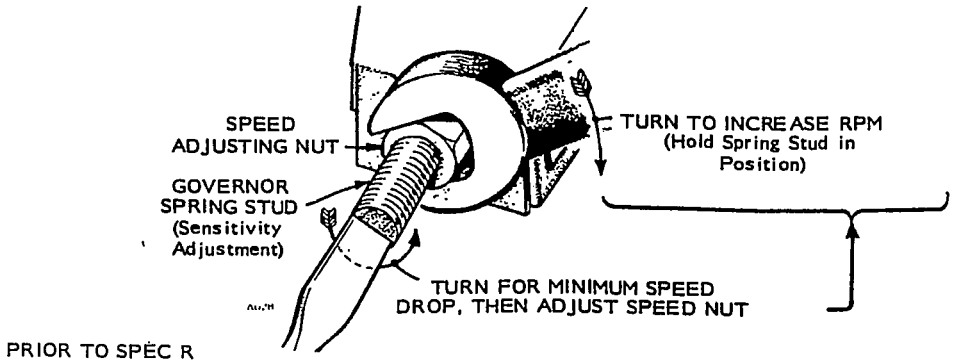
Sensitivity Adjustment (Prior to Spec R): To adjust the sensitivity, turn the governor spring stud; turning counterclockwise gives more sensitivity (less speed drop). If the governor is too sensitive, a hunting condition occurs (alternate increasing and decreasing speed). Adjust for maximum sensitivity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

Speed Adjustment (Begin Spec R): Adjust engine speed (RPM) by turning governor speed adjusting nut, Figure 50. Turn nut clockwise to increase speed, counterclockwise to decrease speed.

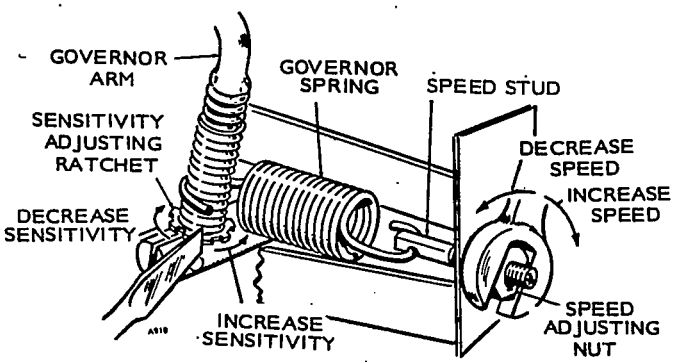
Sensitivity Adjustment (Begin Spec R): Sensitivity (no-load to full-load speed droop) is adjusted by turning the sensitivity-adjusting ratchet nut accessible through hole in side of blower housing. If speed drops too much when full load is applied, turn the ratchet nut counterclockwise to increase spring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

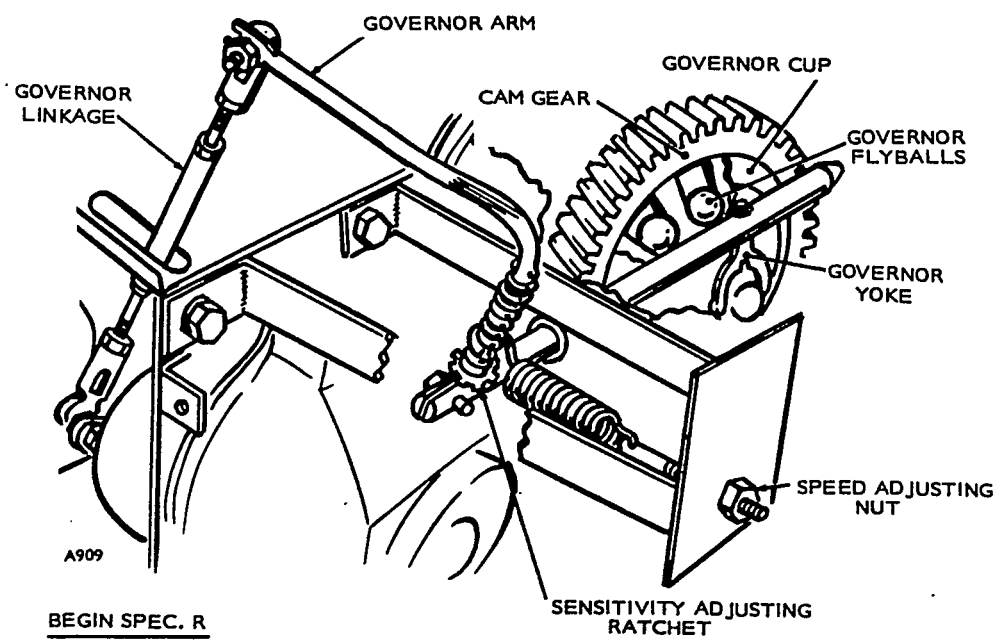
After adjusting speed and sensitivity, replace the dot button in blower housing (air-cooled units only) and secure speed stud lock nut.

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



PRIOR TO SPEC R





BEGIN SPEC. R

FIGURE 50. GOVERNOR ADJUSTMENTS

OIL SYSTEM

J-Series engines have pressure lubrication to all working parts of the engine. The 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 the engine. Oil is held in the oil base, drawn by the pump, and delivered through the oil filter. Oil lines lead to the rocker housing, with drillings through the crankcase to the 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 51.

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

MAINTENANCE

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

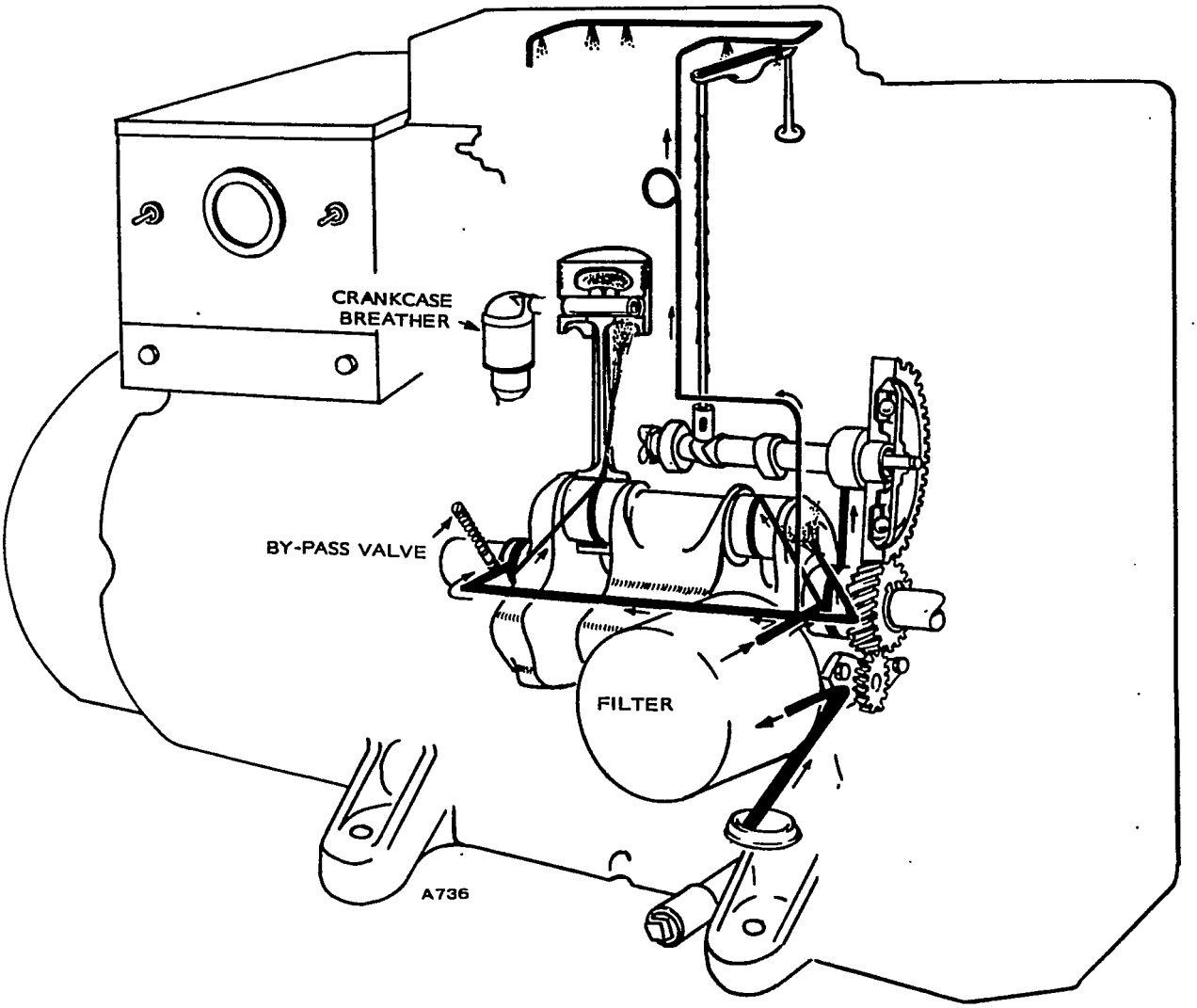


FIGURE 51. ENGINE PRESSURE LUBRICATION SYSTEM

OIL PRESSURE GAUGE

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

OIL PUMP

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

Removal:

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

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

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

BY-PASS VALVE

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

To remove the valve, unscrew the recessed plug in the rear bearing plate and lift out the spring and plunger assembly (Figure 52). Determine proper valve operation by checking the spring and plunger according to the following measurements.

Plunger Diameter	.3365" to .3380"
Spring	
Free Length	2-5/16" — 1/16"

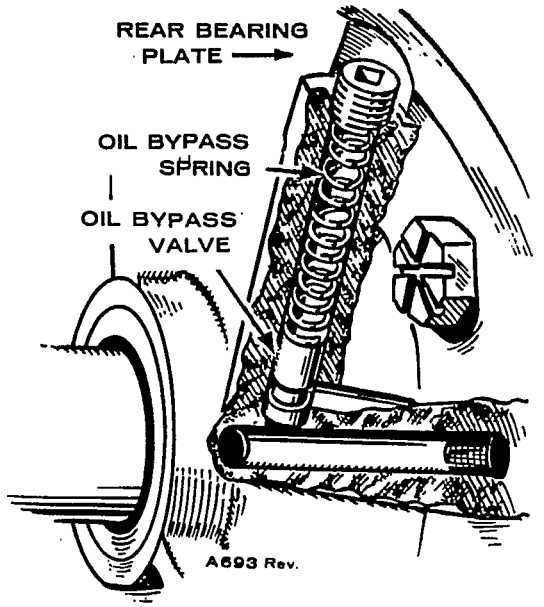
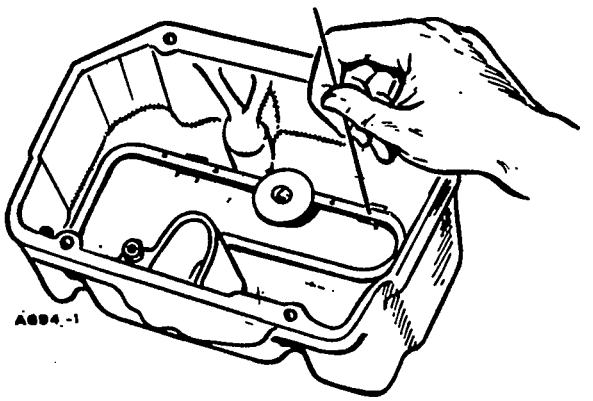


FIGURE 52. BY-PASS VALVE



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

FIGURE 53. CLEANING ROCKER BOX OIL LINE

OIL FILTER

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

OIL LINES

The rocker box oil line (Figure 53), should be flushed with solvent and the small holes cleaned with fine wire at regular intervals. Clean other oil lines and drillings with compressed air whenever the engine is disassembled or overhauled. Remove the oil mounting plate to reach the oil gauge passage.

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

CRANKCASE BREATHER

The crankcase breather, located in the rear left corner of the crankcase maintains a partial vacuum in the crankcase during operation to control oil loss and ventilate the crankcase. The older type includes a metal filter packed into the tube on the crankcase, a rubber cap with flapper valve, and hose connecting it to the engine air horn. This breather is shown in Figure 8.

To disassemble, remove the rubber cap from the crankcase tube and pry the valve out of the cap. Wash the valve in fuel at regular intervals and, if defective, replace it. Also, pull the baffle out of the breather tube and clean it. Install the valve with the perforated disk toward the engine.

Beginning with Spec T, the JC uses a PCV (Positive Crankcase Ventilation) valve mounted under the rocker boxes. See Figure 54.

Beginning with Spec S, the JB uses the new style breather shown in Figure 55. The JC, prior to Spec T, retains the older breather system without the valve.

Every 500 hours remove the PCV valve; wash in diesel fuel or kerosene, and inspect for carbon residue. If the valve appears to be unusually gummy, it may have to be disassembled (Figure 56) for cleaning. Replacement with a new valve is preferable under these conditions.

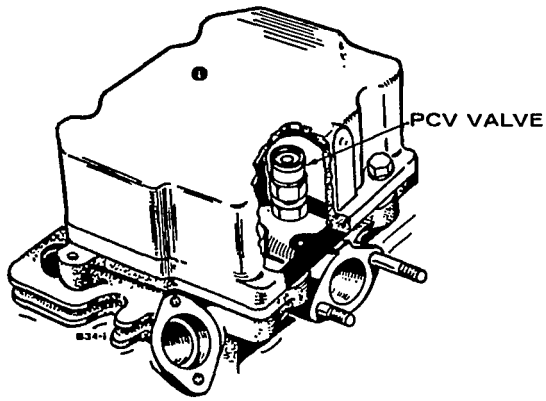
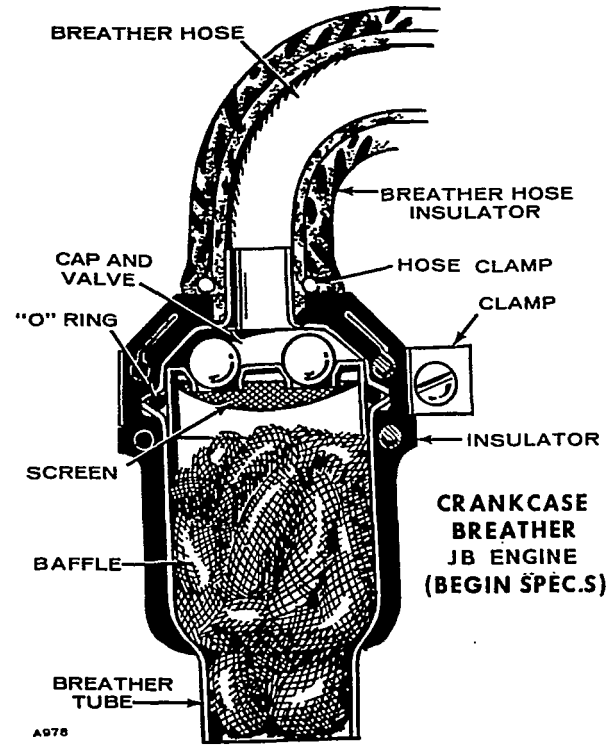


FIGURE 54. CRANKCASE BREATHER WITH PCV VALVE



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

FIGURE 55. CRANKCASE BREATHER

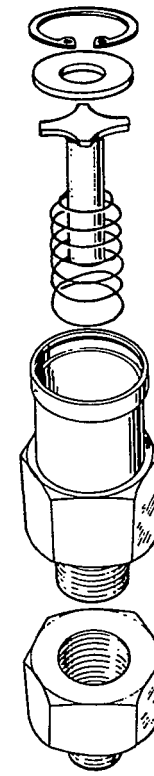


FIGURE 56. PCV VALVE

STARTING SYSTEM

Most engine installations use a starting motor, as shown in Figure 57. The starting motor mounts on the right side of the engine and drives the flywheel for starting. It is a standard automotive starting motor with solenoid shift and over-running clutch, controlled by a start solenoid in the control box. When the control box solenoid energizes, the solenoid on the motor operates, shifting the starter pinion to engage the flywheel ring gear and closing the circuit to the starting motor. The starting motor remains engaged until after the engine starts when the control circuit centrifugal switch closes, completing the starting cycle. The over-running clutch protects the starter armature from overspeeds.

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

MAINTENANCE

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

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

TESTING

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

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

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

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

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

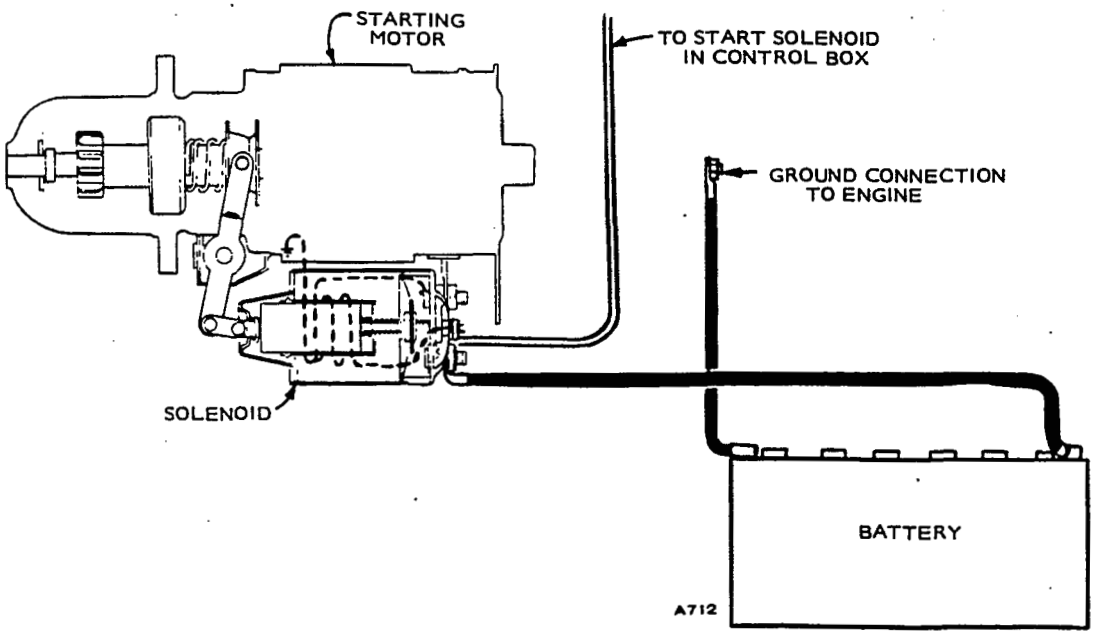


FIGURE 57. STARTING SYSTEM

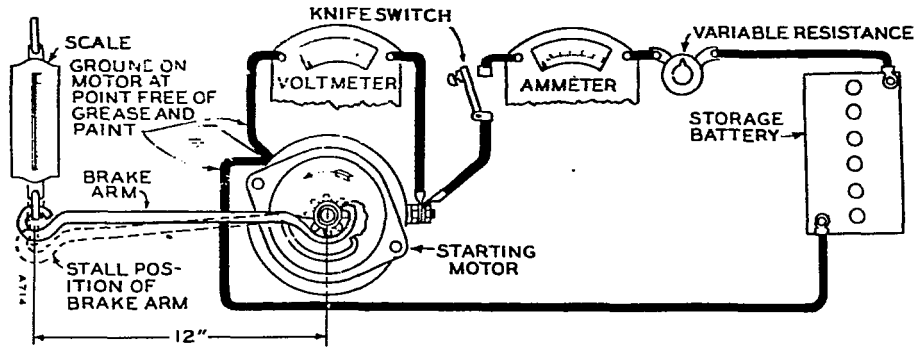


FIGURE 58. TESTING FOR TORQUE

The torque test (Figure 58) requires a spring scale and torque arm, voltmeter, ammeter and variable resistance to apply the voltage specified by the test characteristics. The voltage drop across the solenoid on the starting motor should be less than 1.50 volts. If not, remove it for repair.

BATTERY

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

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

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

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

REPAIR

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

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

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

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

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

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

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

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

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

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

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

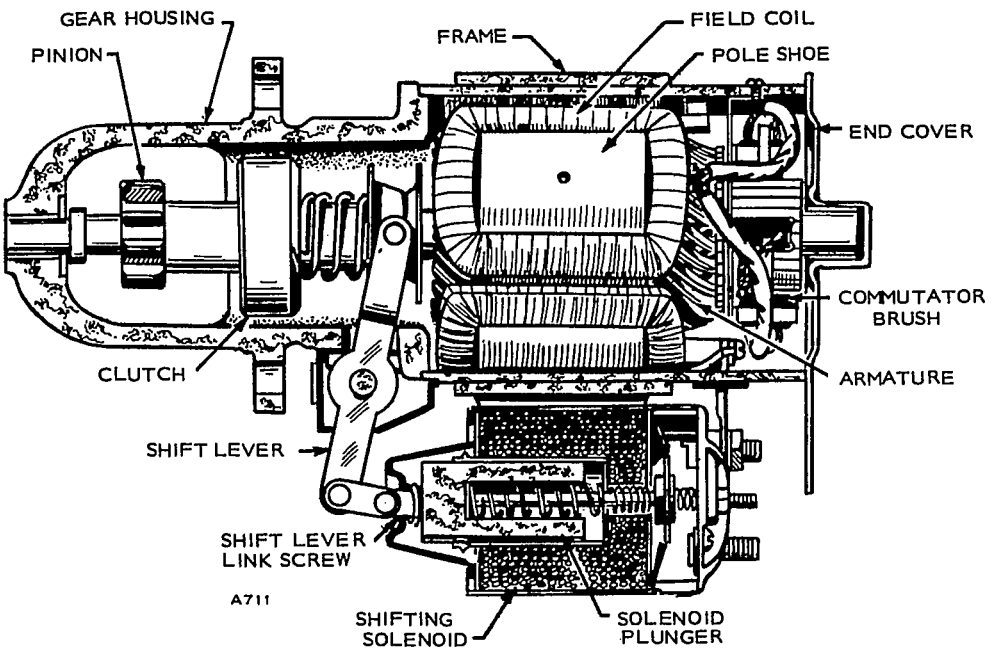


FIGURE 59. PRESTOLITE STARTER

PRESTOLITE STARTER REMOVAL AND DISASSEMBLY

1. Remove electrical connections to control box and battery at the shifting solenoid, Figure 59. Remove the engine front air housing and remove the flywheel.
2. Remove the nut holding the starter rear mounting bracket to the engine. Remove the three capscrews holding the starting motor mounting flange to the crankcase. Then pull the starting motor off the engine. Be careful not to lose any shims that might be behind the flange.
3. Remove the link pin holding the shift lever to the solenoid plunger and remove the shift lever pivot pin.
4. Remove the thru bolts from the commutator end of the motor. Pull off the end cover and lift the brushes off their seats. Pull the cast housing from the front end of the motor and lift the armature and clutch out of the motor frame.
5. To remove the over-running clutch from the armature, drive the retainer away from the ringlock near the front end of the shaft, remove the ringlock and pull the assembly off. Do not attempt to disassemble the clutch assembly.
6. If necessary to service the solenoid, remove the four capscrews and electrical connection holding it to the motor frame. To reach the switch contacts, remove the two screws on the 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 the bronze bearings in oil. They are absorbent bearings, designed to hold up to 25 percent of their own weight in oil. Be sure the felt oil pad is in the outer end of the commutator end bearing.

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

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

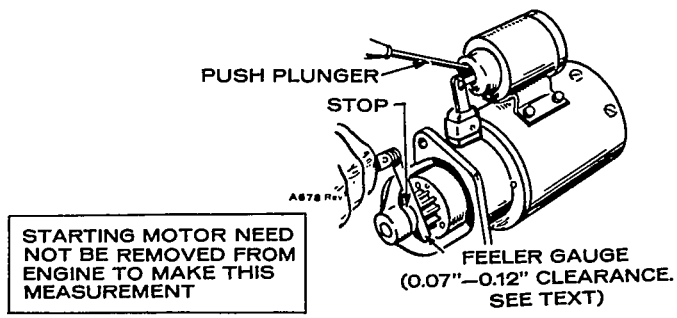
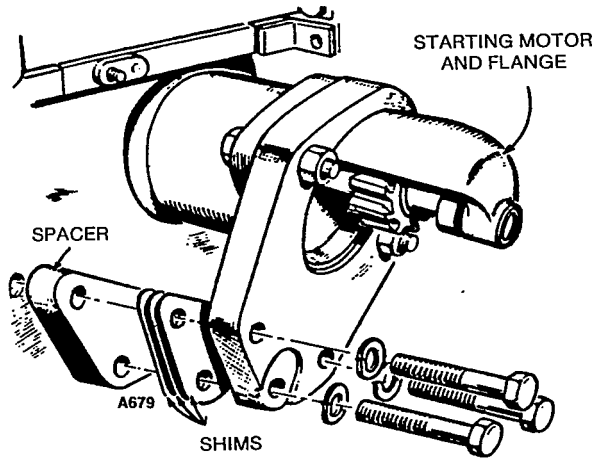


FIGURE 60. CHECKING PINION CLEARANCE

Press on solenoid core to shift the pinion into full mesh and measure the clearance between pinion and pinion stop, Figure 60. This should be between 0.07-inch and 0.12-inch (3.05 mm) (as near to 0.070-inch [1.78 mm] as possible.) Adjust the link screw on the end of the solenoid plunger for proper clearance.

On engines built before May 1962, it was necessary to maintain the gap between ring gear and starter pinion in the relaxed position at less than 1/8-inch to ensure starter engagement. When installing these motors, check this gap. If it is too great, a shim kit is available to reduce it (Figure 61).



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

FIGURE 61. STARTING MOTOR MOUNTING SHIMS

MITSUBISHI STARTER REMOVAL AND INSTALLATION

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

MITSUBISHI STARTER DISASSEMBLY

1. Remove "M" terminal nut and wire lead from solenoid.
2. Remove the two solenoid mounting screws and remove solenoid.
3. Remove the two through bolts and brush holder retaining screws. Remove rear bracket (Figure 61a).

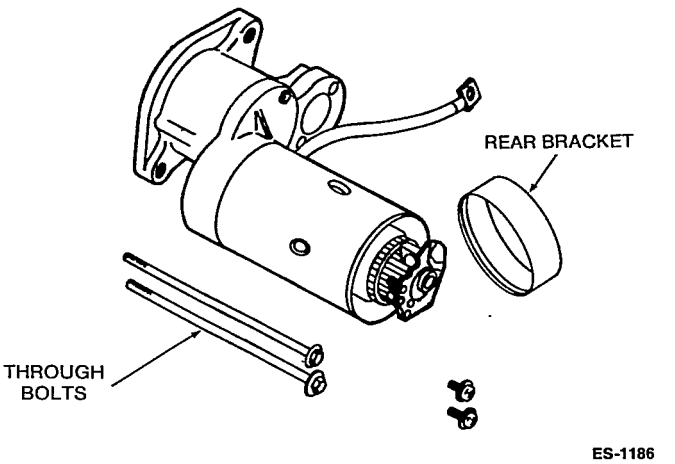


FIGURE 61a. REMOVING REAR BRACKET

4. Remove frame assembly, and brush holder assembly while pulling the brushes upward. Then remove armature assembly.
5. Remove cover assembly, (snap ring and washer) from the pinion shaft (Figure 61b).

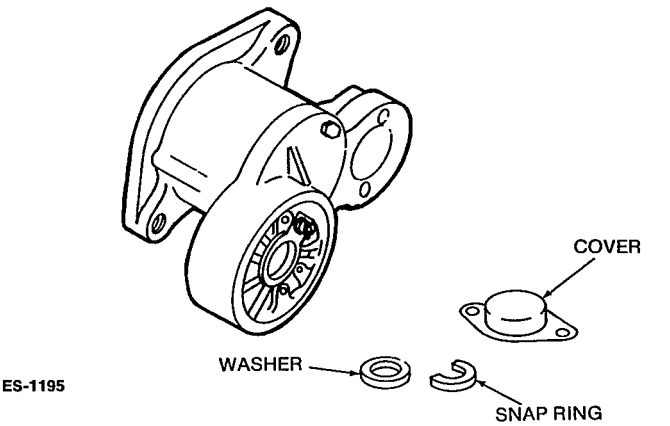


FIGURE 61b. REMOVING SNAP RING AND WASHER

6. Remove capscrew that secures center bracket to front bracket. Remove the center bracket; several washers used to adjust pinion shaft end play can now be removed (Figure 61c).

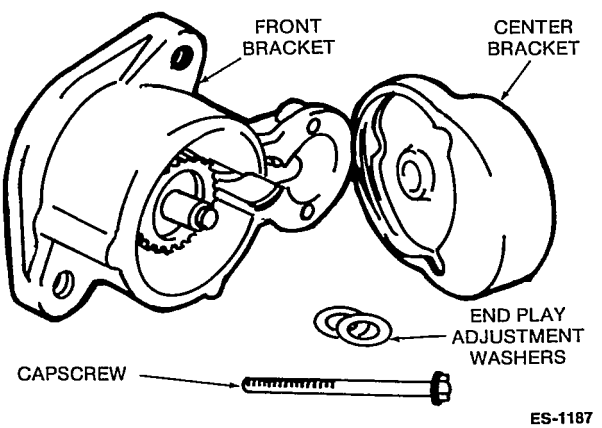


FIGURE 61c. REMOVING CENTER BRACKET

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

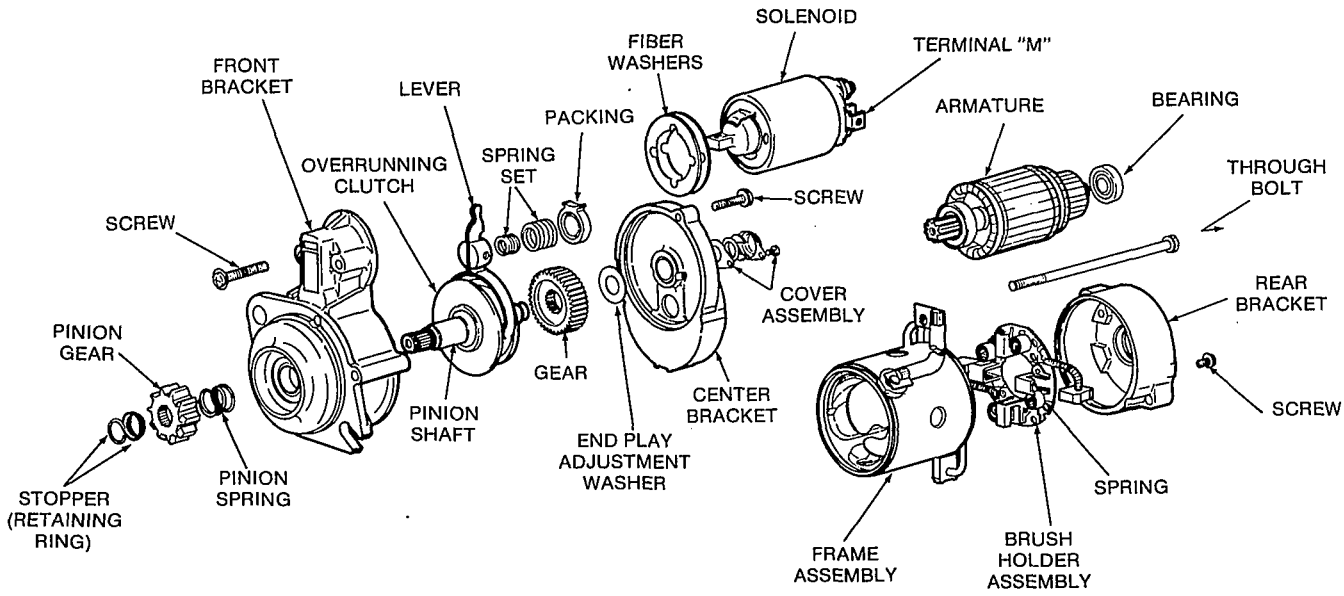


FIGURE 61d. MITSUBISHI STARTER

MITSUBISHI STARTER ASSEMBLY

For assembly reverse the disassembly procedure, but note the following items. See Figure 61d.

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

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

Pinion Shaft End Play Adjustment

Adjust end play so that it is 0.1 to 0.8 mm (.0039 to .0315 inch) with the adjusting washers placed between center bracket and reduction gear (Figure 61e).

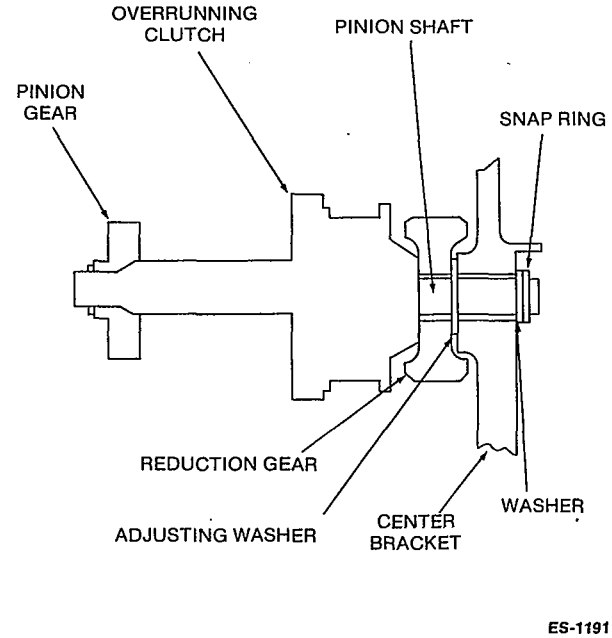


FIGURE 61e. ADJUSTING PINION SHAFT END PLAY

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

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

Pinion Gear Installation

Place spring and pinion gear onto pinion shaft. Slide stop ring onto pinion shaft and install retaining ring in groove. Pull stop ring over retaining ring (Figure 61f).

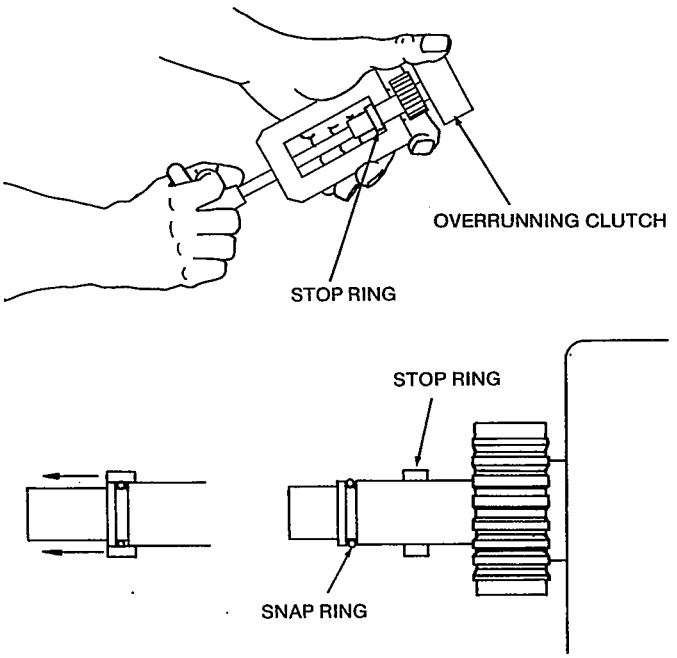


FIGURE 61f. PINION GEAR INSTALLATION

Lever Assembly Installation

Figure 61g shows the correct method of installing the lever assembly, spring, and packing. Pay close attention to direction of lever.

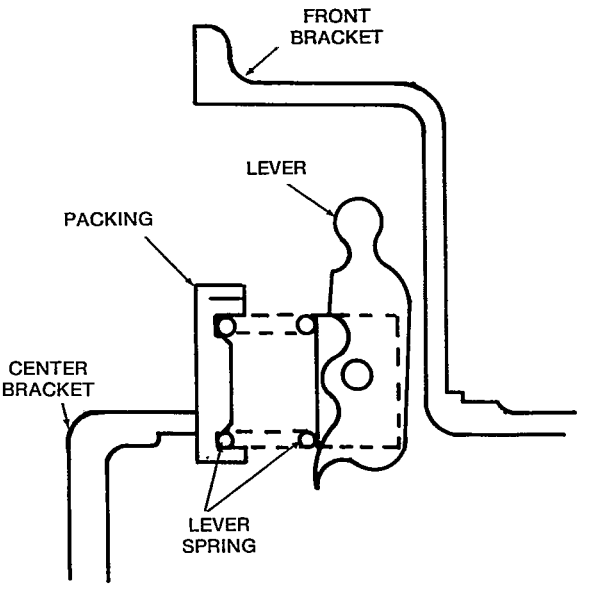


FIGURE 61g. LEVER INSTALLATION

Pinion Gap Adjustment

After assembling starter motor, adjust pinion gap.

1. Remove "M" terminal nut and wire from solenoid.
2. Connect positive terminal of battery to "S" terminal on solenoid and negative terminal to starter body. With battery connected pinion gear will shift into the cranking position.
3. Gently push pinion shaft back towards front bracket and measure the amount of travel (Figure 61h).

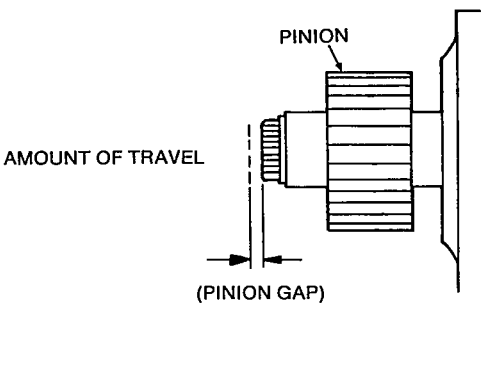


FIGURE 61h. PINION GAP ADJUSTMENT

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

FLYWHEEL ALTERNATOR

DESCRIPTION

The battery charging flywheel alternator (Figures 62 and 63) has a permanent magnet on the flywheel that provides a rotating magnetic field. A group of coils (stator) is mounted behind the flywheel on the gear cover to "cut" the magnetic field, thus producing an AC voltage. A solid-state voltage regulator controls this AC voltage and a full wave rectifier converts the regulated AC voltage to DC. This DC voltage is used for keeping the battery charged and supplying power to the electrical system.

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

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

The battery charge voltage furnished by the flywheel alternator (beginning with Spec T) is regulated by solid state rectifiers with the combination regulator-rectifier mounted on the blower housing. The regulator automatically controls the battery charge rate. There is no adjustment in the regulator. Maintenance consists of keeping the heat-sink fins clean at all times to permit adequate cooling. The following is a list of do's and don'ts.

1. *Do Be Sure* Output Control Plug (connector) is properly inserted in the stator receptacle. This means the plug must push into and solidly bottom in the receptacle so as to eliminate any resistance due to a poor connection. Keep it clean and tight.
2. *Do Be Sure* the Output Control (regulator) has a good clean ground connection to operate properly. This means the mating surface where the control unit mounts on the housing must be clean and fastening bolts tightened properly.
3. Battery - *Don't* reverse battery leads. Reverse polarity will destroy the output control.

The voltage regulator prior to Spec T provides two different rates of current output. The smaller output connects to the charge circuit for a continuous low charge rate. The larger output is controlled by the mechanical regulator, with two relays, one of which is voltage sensitive. When battery voltage falls and the voltage sensitive relay is de-energized, contacts close to provide a circuit to the other relay, which makes a circuit for the high rate charge. See wiring schematics, Figure 64. The voltage at which the sensitive relay is energized varies with the temperature.

The final result is a charge rate of 12 amperes into a 70-amp hour, 12-volt battery when the engine is running at 1,800-rpm. The maximum continuous DC load is limited to 10 amperes at 1,800-rpm. Reverse current through the rectifiers is 5- to 10-milliamperes, so no special reverse current protection is needed.

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

MAINTENANCE

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

GENERAL

Several simple tests can help service personnel to isolate the defective component in the charging system.

1. Check voltages at battery, regulator and alternator terminals.
   a. Measure these readings while system is operating satisfactorily.
   b. This data will make it easy to spot a trouble source when it occurs.
   c. Record separate readings taken from each engine, as they vary from system to system.
2. Check all accessories with an ammeter to make sure they are drawing rated amperes and are not loading system excessively.

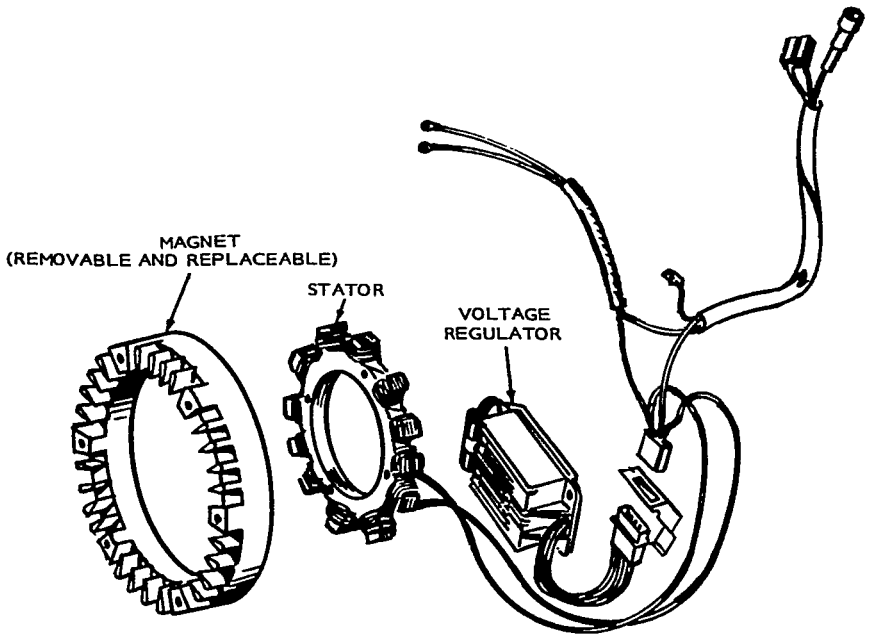


FIGURE 62. WICO 20 AMP FLYWHEEL ALTERNATOR ASSEMBLY (BEGIN SPEC T)

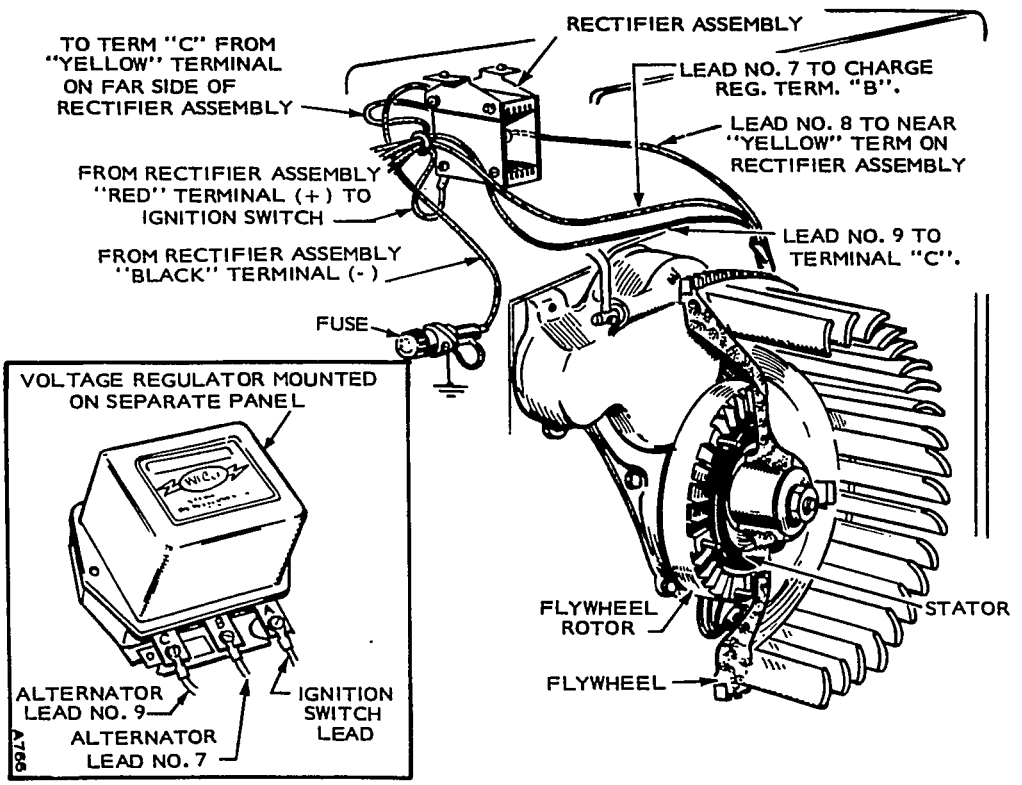


FIGURE 63. FLYWHEEL ALTERNATOR AND VOLTAGE REGULATOR (PRIOR TO SPEC T)

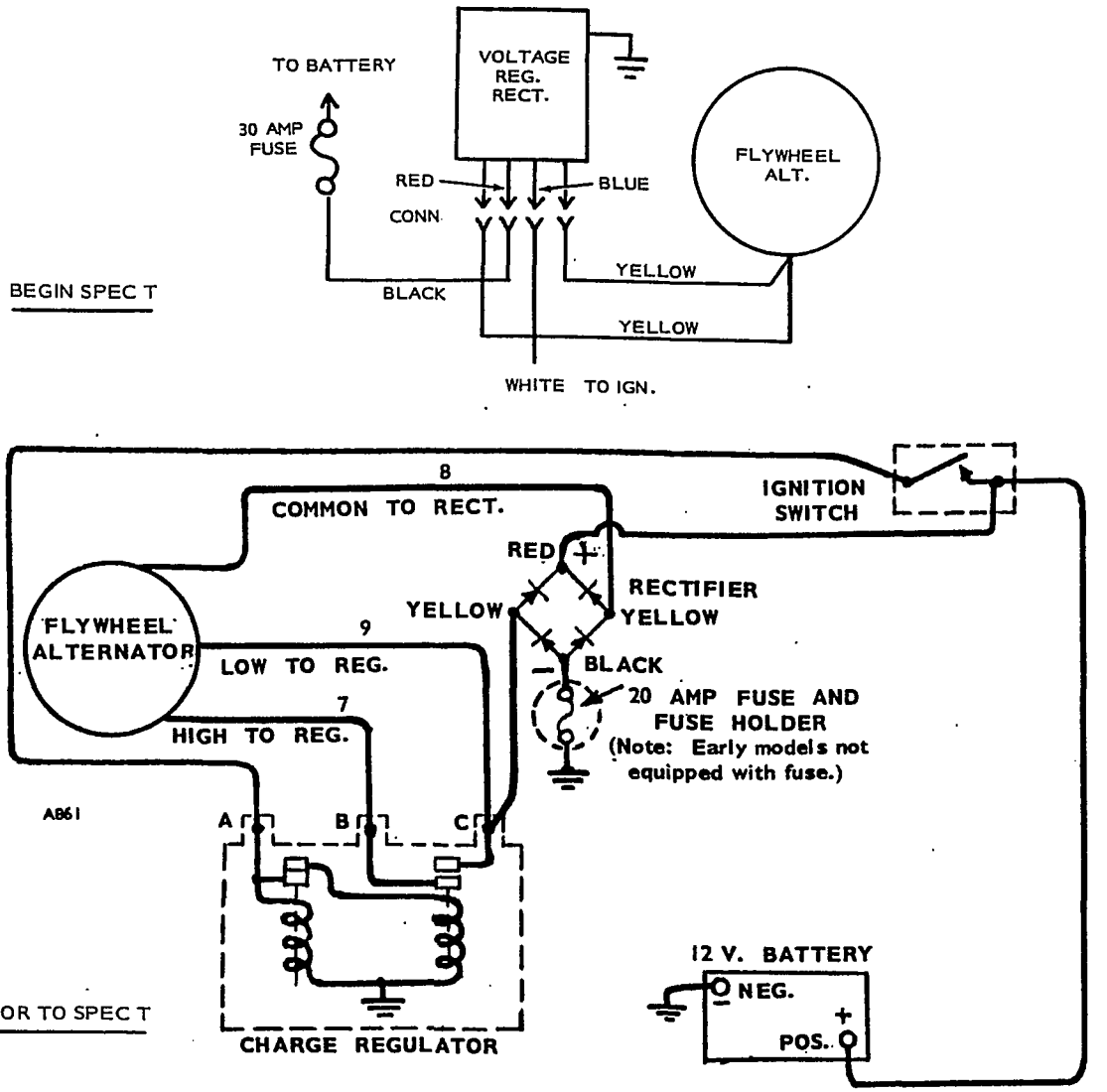


FIGURE 64. CHARGING CIRCUIT SCHEMATICS

PRECAUTIONS

1. Check battery to be sure it is fully charged. If not, replace with a fully charged battery.
2. Make sure of battery polarity (negative ground only). Otherwise system could be damaged.
3. Be sure output connector is properly inserted into stator receptacle. This means plug must push into and solidly bottom in receptacle.
4. Be sure all electrical connections are clean and tight.
5. Do not operate system without a battery. Damage will occur to regulator and battery ignition coil.
6. The regulator case must be grounded on Onan flywheel alternator systems through its mounting bolts.

TROUBLESHOOTING

When electrical system trouble occurs there are three general areas to check:

1. Battery and associated wiring.
2. Regulator-Rectifier
3. Alternator

Battery

The battery often reveals the symptoms of a faulty electrical system. The battery is also the culprit in many cases. If the charging system is operating properly, you should expect and get long battery life. But even the best battery has a definite life expectancy and eventually it will fail.

Since batteries have a definite bearing on system operation, it is important to check them often as part of a periodic maintenance program. The charging system is operating adequately if 75 percent or more of the full-rated charge is read in each cell of a warm battery. If the reading exceeds this figure, there is no problem unless there is over-charging which shows up, as high battery water usage. Also, if specific gravity varies by more than 25 points between cells, it is likely that one of the cells has failed, or is near the failing point. Replacing the battery is advisable.

A poor battery causes problems and should be checked first during electrical system troubleshooting or maintenance. The better the care, the longer all components will last and the more profitable, trouble-free service you'll receive.

Regulator-Rectifier

To see if the regulator is performing satisfactorily, place a DC voltmeter across the battery terminals with the engine NOT running. Record this voltage. Then start the engine and accelerate to a fast idle (1800 rpm or higher). If the voltage does not rise from original reading after a few minutes, the system is not operating properly, and the regulator should be suspected. However, check the alternator output before concluding that the regulator is at fault.

Alternator

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

TESTING

To check alternator output, connect an ammeter between the red terminal on the rectifier and the ignition switch. With the engine running at 1,800-rpm, the ammeter should indicate about 8-amperes into a fully discharged battery, and progressively less as the battery becomes charged. The regulator switches from high to low charge at about 14-1/2 volts and from low to high at about 13 volts. Current at low charge should be about 2-amperes. If output is unsatisfactory, do the following tests.

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

CAUTION **Be sure to check torque of bolts fastening magnet ring group to the flywheel.**

Regulator-Rectifier Test (Begin Spec T):

1. Charge battery and check its condition to be sure it is serviceable. See Table 3.

Charging system tests require a fully charged battery.

TABLE 3. TESTING WICO 20 AMP SYSTEM

TEST	VALUE
Battery voltage - unit not running	12 volts DC
Battery voltage with unit running at 1800 rpm or more (fully charged battery)	13.4 - 14 volts DC
AC voltage from stator with plug disconnected and unit running at about 1800 rpm	17 volts AC + 10%
Ohmmeter reading at plug when checking two AC stator leads - unit not running.	Less than .8 Ohms

2. Connect a voltmeter across battery. Start engine and operate between 1800 and 3600 rpm. The voltmeter should read 13.4 to 14 volts.
3. If voltage is below 13.4 volts, install a new regulator-rectifier and re-test. Be sure regulator-rectifier has a good clean ground connection and that the wire connector is properly seated.
4. When meter reads 13.4 volts, no further testing is required. If new regulator-rectifier has been installed and meter does not register 13.4 volts minimum, then proceed to test the stator group.

Flywheel Stator Test — Engine Running:

With engine running at 1800 rpm, disconnect connector at regulator and insert an AC voltmeter between the two yellow wires. The AC voltage should read approximately 17 volts or higher.

Flywheel Stator Test — Engine Not Running:

Use a Simpson Model 270 V.O.M. or equivalent for testing stator. Set voltage selector switch to DC+. Be sure test meter is in good condition and if battery powered, that the battery is good. Be sure the meter is zeroed before each reading and each time you change scales.

1. Disconnect connector plug at regulator. Zero meter on Rx1 scale.
2. Connect meter leads to the two outside terminals of the female plug (both yellow wires). Meter should read less than .8 ohms. This test checks stator winding for continuity. If no reading shows on meter, winding is open. Replace stator.
3. To check for grounded stator winding, touch red meter lead to yellow wire plug and other meter lead to metal core. Meter should read infinity. If

meter shows a reading then winding is grounded—replace stator.

4. Disconnect the stator leads and test each one with a 12-volt test lamp for grounding. Touch one probe to the lead and the other probe to a good ground on the engine. None of the leads should show a ground, which will be indicated if the lamp lights. If a ground is indicated, replace the stator.
5. To test for shorted coils or opened circuits, use an ohmmeter, set to read the proper range of resistances; the resistance values are as follows:

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

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

Rectifier (Prior to Spec T): Completely isolate the rectifier assembly from the charging circuit by disconnecting all four wires. Test each rectifier separately with an ohmmeter (Figure 65) or test lamp.

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

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

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

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

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

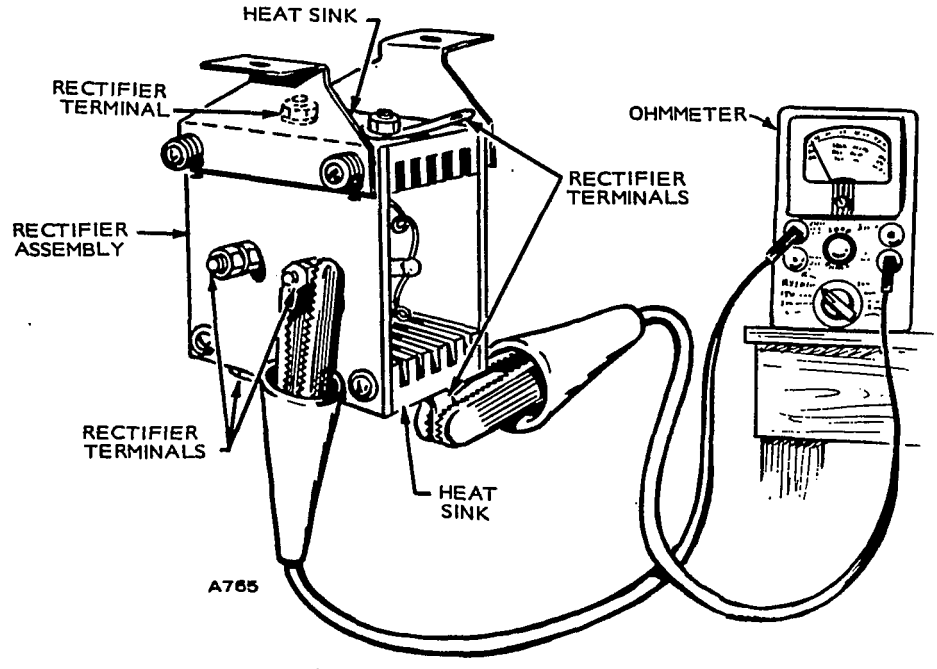


FIGURE 65. RECTIFIER TESTS (PRIOR TO SPEC T)

ENGINE DISASSEMBLY AND REPAIR

This section covers the various assemblies and parts of the 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. The valve assemblies are operated by pushrods running through the cylinder head and push rod shields to the camshaft. Exhaust valves are hardened chrome alloy-faced, and ride on hardened chrome-alloy seat inserts. All valves have release-type rotators.

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

Adjustment

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

JB Series

Adjust valve clearance on the JB engines as follows, obtaining valve clearances from Table 4.

1. Turn the flywheel so the piston of the valve to be checked is between 10 degrees and 45 degrees after TDC (about 2 inches after TDC) of the compression stroke.
2. Turn the flywheel until the TC (top center) mark on the flywheel lines up with the timing pointer on the gear cover. Then turn the flywheel in a clockwise direction for an additional 10 to 45 degrees. There is no timing mark for this position so it must be estimated. With the piston located in this position the cylinder will be in its power stroke with both valves completely closed.
3. Check the cylinder head-bolt torque.
4. Using a feeler gauge, check the clearance between the rocker arm and the valve (see Figure 66). Increase or reduce the clearance until the proper gap is established, adjusting with the locknut which secures the rocker arm to the cylinder head. Refer to Table 4 for correct valve clearance setting for your particular engine.

JC Series

Adjust valve clearance on the four cylinder JC-Series engine as follows:

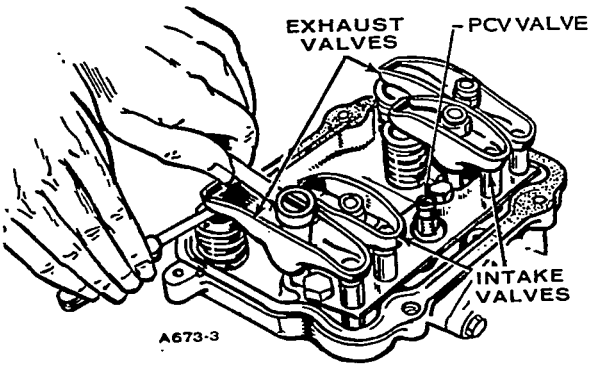


FIGURE 66. SETTING VALVE CLEARANCE

1. Adjust the valve clearance in the firing order (1-2-4-3) sequence. After the cooling period, set timing for number 1 cylinder and the valve clearance.
2. To adjust valve clearance for number 2 cylinder, turn the 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 the flywheel.

3. After timing number 2 cylinder, adjust valve clearance (refer to two-cylinder adjustment).
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 the number 3 cylinder, adjust the valve clearance.

TABLE 4. VALVE CLEARANCES

	PRIOR SPEC D	BEGIN SPEC D
	GASOLINE	
Intake	.010	.012
Exhaust	.013	.015
	GAS, GAS-GASOLINE	
Intake	.013	.013
Exhaust	.020	.020

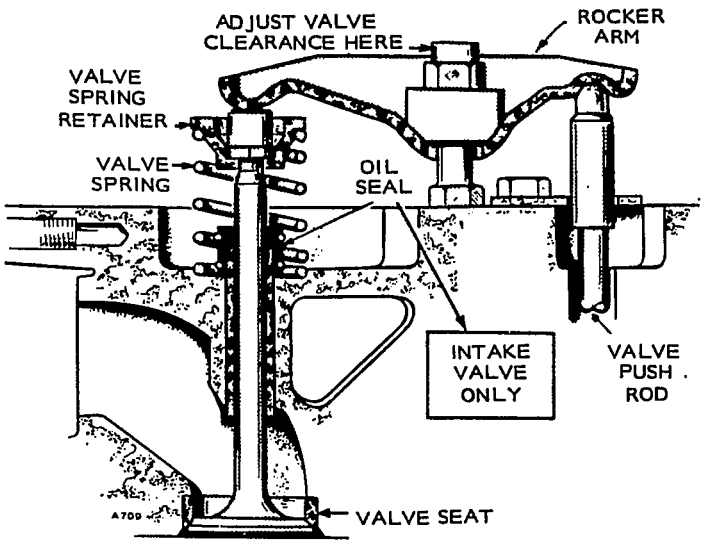


FIGURE 67. VALVE MECHANISM

Compression Test: Run the engine until thoroughly warm. Stop and remove all spark plugs. Insert the compression gauge in a spark plug hole, crank the engine and note the reading. To check for piston blow-by, squirt a small amount of SAE 50 oil into the cylinder and repeat the check. An increase in compression with oil in the cylinder indicates piston blow-by.

Compression of a standard new engine cranking at about 300 rpm is about 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. There the 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 the 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 the carbon deposits from the 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. But, 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 the valve face and rotating it against the seat.

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

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

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

Use ONAN #420-0272 in a drill press (Figure 68) to remove each valve seat. Adjust the tool to cut 1/64-inch from the edge of the seat.

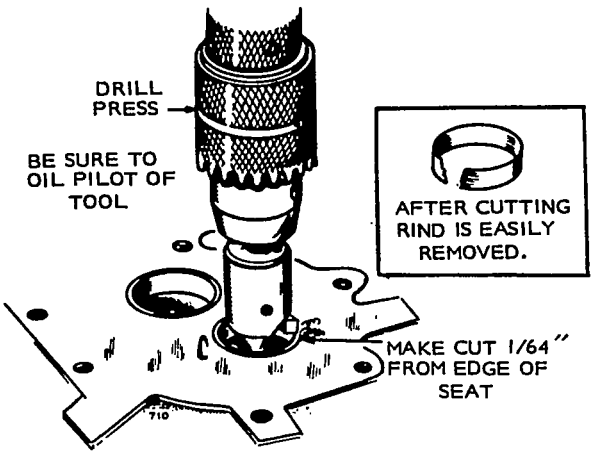


FIGURE 68. REMOVING VALVE SEATS

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

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

After installation, and before facing the new seats, peen the head material against the valve seat in the three areas between the machine roll marks (Figure 69).

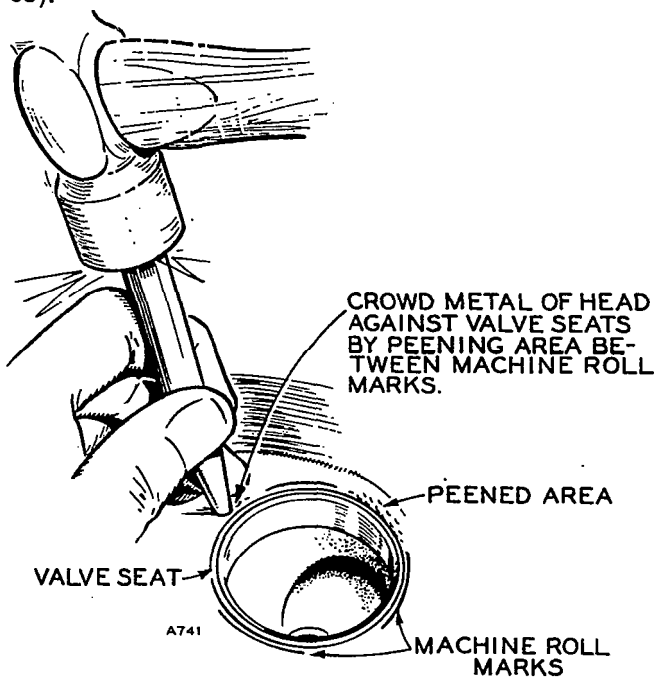


FIGURE 69. PEENING VALVE SEAT AREA

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

Check the 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.

   Engines built before June 1962 had no valve seals.

2. Oil stem of each valve lightly and insert each in its own guide.
3. Check each valve for a tight seat with an air pressure type-tester. If a tester isn't available, make pencil marks at intervals on the valve face and observe if marks rub off uniformly when valve is rotated part of a turn in seat. If the seat isn't 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 head 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 70) on one end of rod and a spring, washer and "O" ring on opposite end. Lift cylinder heads and install pushrod shield assemblies.

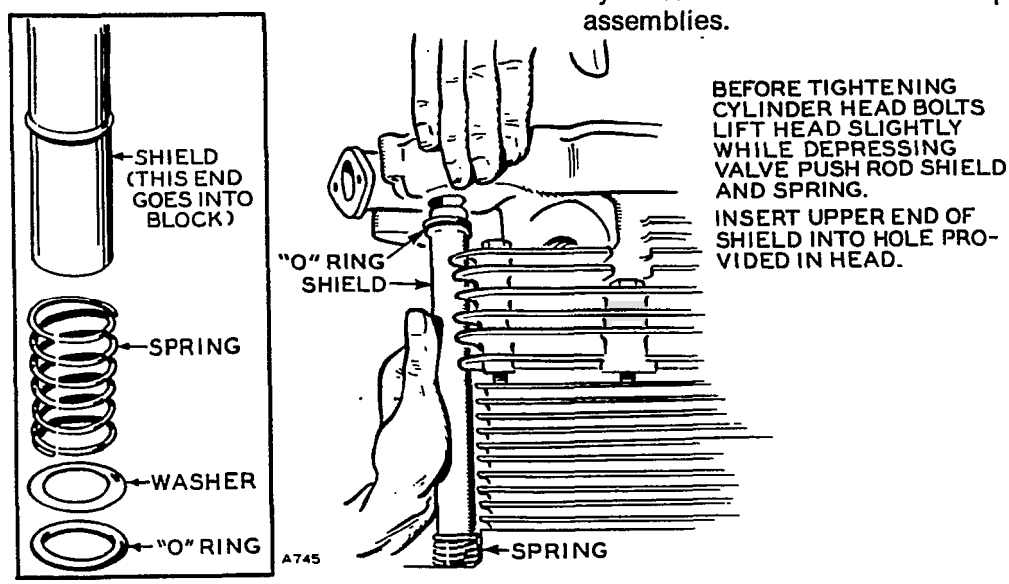


FIGURE 70. INSTALLING PUSH ROD SHIELDS

7. Tighten the head bolts to 28 to 30 lbs. ft. following the sequence in Figure 71.

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 71.

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. See Table 4 for clearances.

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

10. Reinstall rocker box cover, air housing and access door.

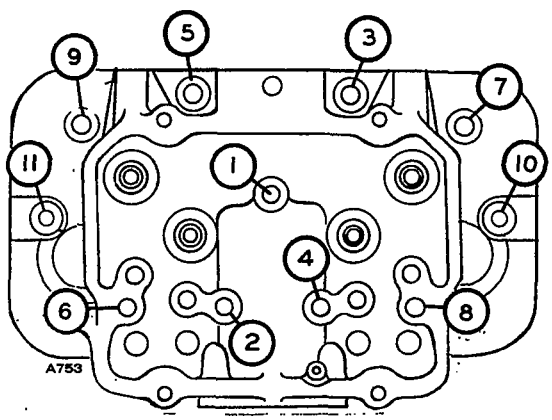


FIGURE 71. CYLINDER HEAD BOLT TORQUE SEQUENCE

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 the piston to its connecting rod. The lower end of each connecting rod contains half shell, precision bearings and the upper end, semi-finished bushings.

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

Removal and Disassembly: Connecting rods and caps are stamped with numbers for installation in the 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 the connecting rod cap and push the assembly through the top of the cylinder bore. If the ridge at the top of the cylinder interferes with piston removal, cut it down with a ridge remover before taking the piston assembly out.
4. Using a ring expander, remove the rings from each piston.
5. Remove the two retaining rings and push the piston pin from each piston.

Cylinders: The cylinder walls should be free of scratches, pitting and 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".

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

Pistons: Clean the carbon from the 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" to .0032". If it exceeds the limits, replace the piston and check the cylinder bore size.

Piston Pins: Each pin should be a thumb push fit into its piston at room temperatures. If the pin is excessively loose, install a new pin or the next oversize pin. If the piston is worn so that the oversize pin won't fit, replace the piston.

Rings: Inspect each ring carefully for fit in the piston grooves (Figure 72) and seating on the cylinder wall. Fit each ring to the cylinder wall at the bottom of its travel, using a piston to square the ring in the bore. Check the end gap with a feeler gauge, Figure 73. It should be .010" to .020". If the gap is too small, file the butt ends of the rings. Do not use rings that need a lot of filing, as they won't seat properly on the cylinder walls. If oversize pistons are used, use the correct oversize rings.

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

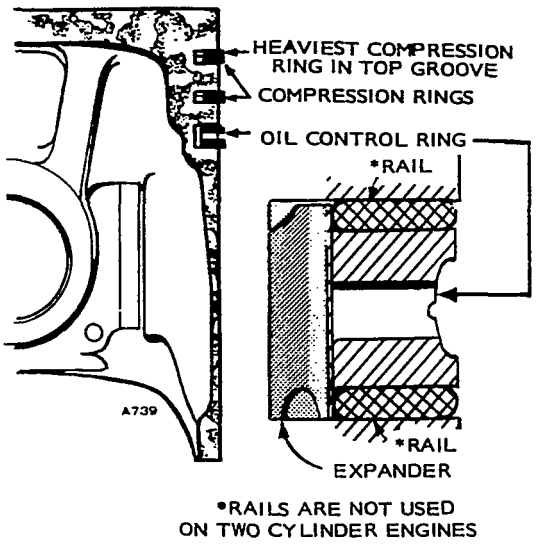


FIGURE 72. PISTON RINGS

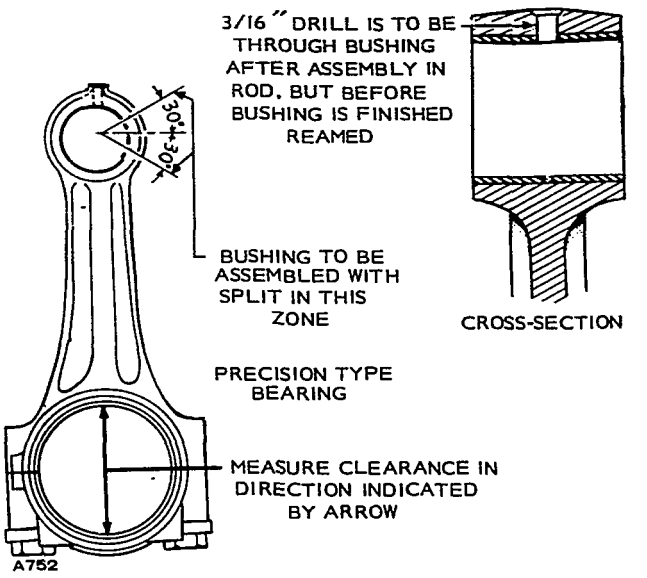


FIGURE 74. CONNECTING ROD BUSHINGS

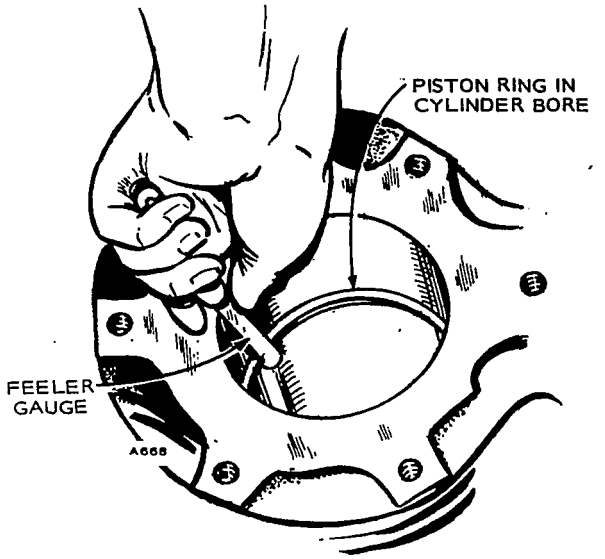


FIGURE 73. CHECKING PISTON RING END GAP

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

Connecting Rods: Clean each connecting rod and check for defects. Check the upper connecting rod bushings for proper piston pin clearance. Clearance should be .0002" to .0007".

Press out excessively worn bushings and install new bushings. Press the new bushings in until they are centered in the connecting rod (Figure 74). After installation, drill the bushings with a 3/16-inch drill through the counterbored hole in the connecting rod top. Be sure the connecting rod oil spray hole is open.

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

1. Install the connecting rods on each piston with pins and retaining pins. Install so the 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 the piston. Space the ring gaps 1/3 of the way around the piston from one another. No gap should be in line with the piston pin. Oil the rings and pistons.

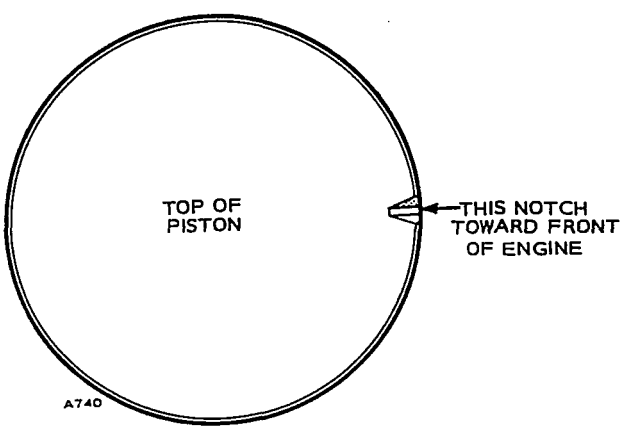


FIGURE 75. PISTON TOP IDENTIFICATION

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 75.
5. Position each connecting rod on the crankshaft, oil the journal and install its rod cap with bearing half. When installing the rod cap, position so the raised witness mark on the forging matches the mark on the connecting rod (Figure 76).
6. Tighten connecting rod capscrews to specified torque (27-29 ft. lbs.).

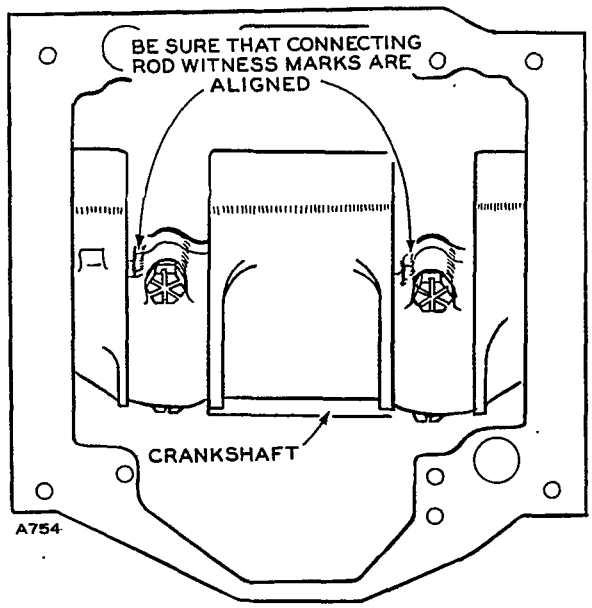


FIGURE 76. CONNECTING ROD WITNESS MARKS

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 the 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.

The 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. To remove the flywheel, first remove the blower housing. The flywheel is then removed by using the crank dog as a puller as follows: first remove the crank dog and flywheel mounting capscrew. Then remove the large washer from the flywheel mounting capscrew and reinstall the screw part way. Install the washer into the crank dog and mount the crank dog so the washer bears against the end of the flywheel mounting screw. Tighten the two crank dog capscrews alternately until the flywheel comes loose. See Figure 77.

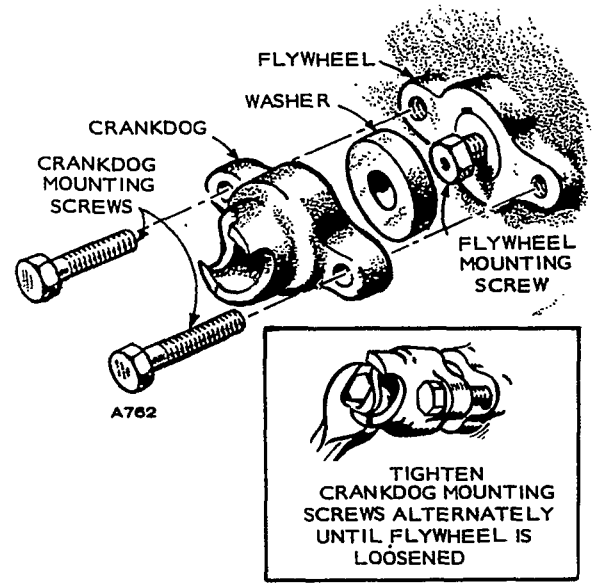


FIGURE 77. PULLING FLYWHEEL

Ring Gear: Remove the 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 the flywheel. If it binds, drive it into place with a hammer. Do it fast and do not damage the gear teeth. The ring will contract rapidly and may shrink to the flywheel before it is in place. If this occurs, a new ring gear may be required.

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

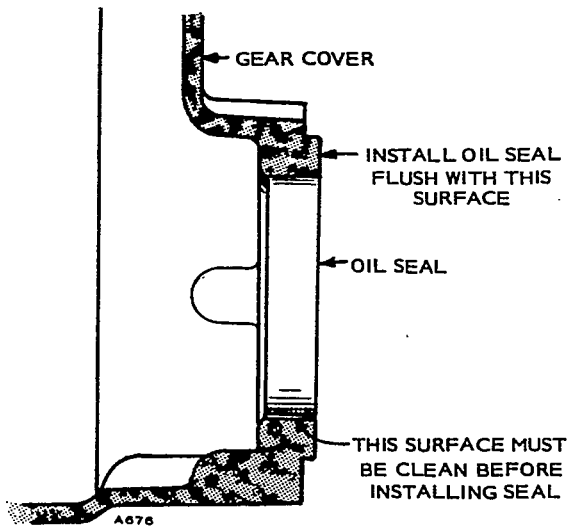


FIGURE 78. GEAR COVER OIL SEAL

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

Gear Cover Oil Seal: Replace the oil seal if damaged or worn. Drive the old seal out from inside the gear cover. Lay the cover on a board so the seal boss is supported. Using an oil seal driver, insert the new seal from the inside with rubber lip toward outside of gear cover (open side of seal inward) and drive it flush with the outside surface (Figure 78). During gear cover installation, reverse the driver to protect the oil seal. Lubricate lips with heavy grease.

1. Operate governor shaft to check for binding and see that governor shaft end thrust ball is in place (Figure 79).
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 79).
4. Install and time ignition points on JB (see *Ignition System*). Install and gap centrifugal switch on JC (see *Control System*).

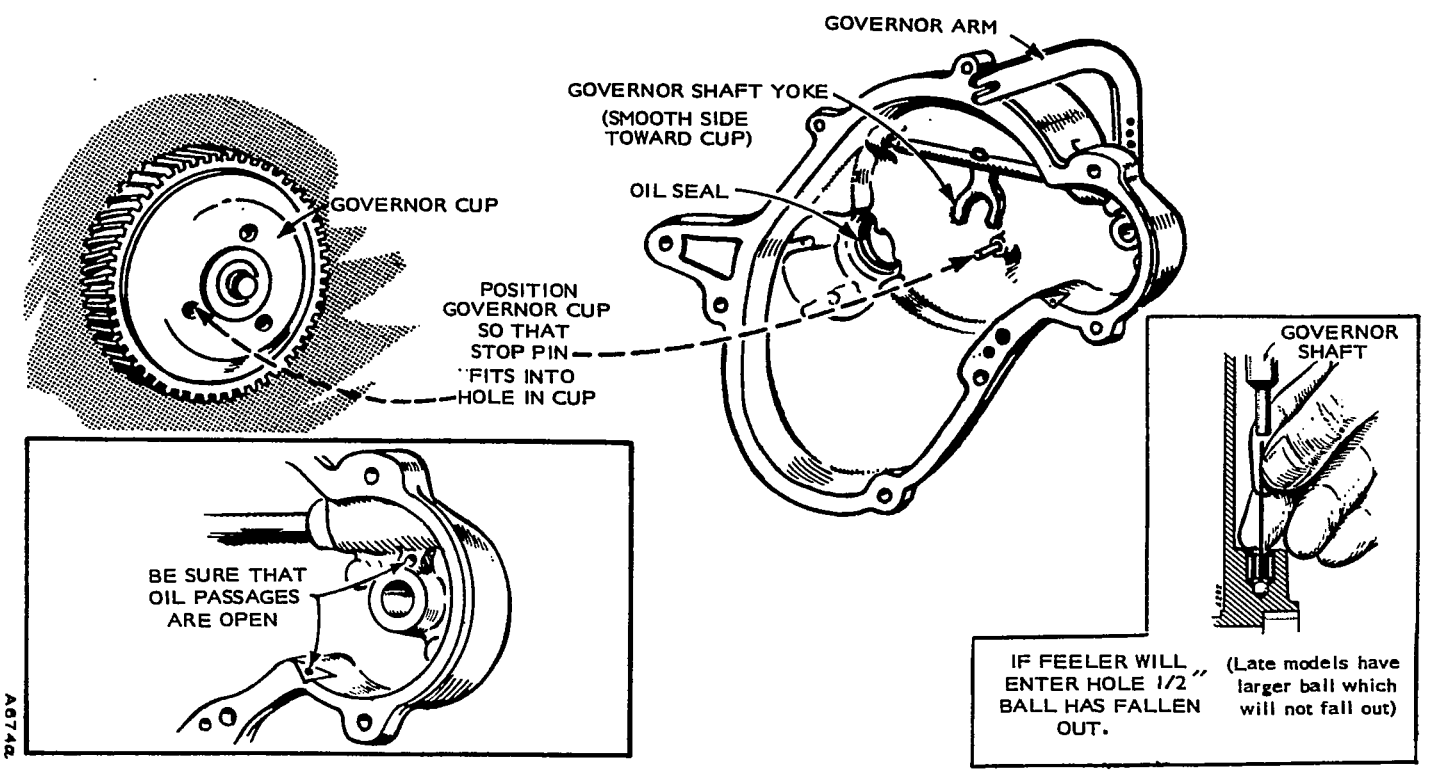


FIGURE 79. GEAR COVER ASSEMBLY

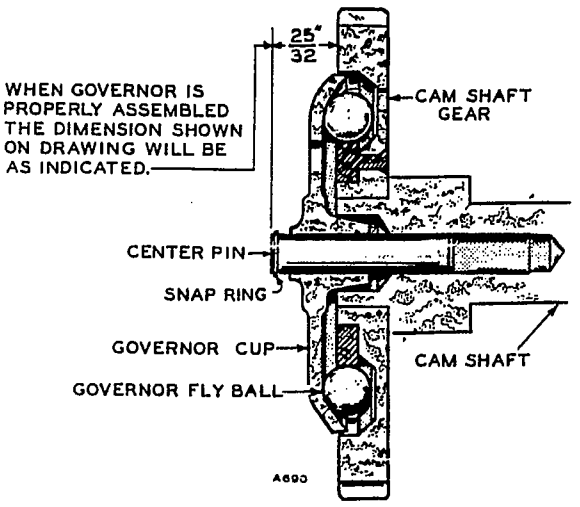


FIGURE 80. GOVERNOR CUP

Governor Cup: To remove the governor cup, remove the snap ring from the camshaft center pin and slide the cup off. Catch the 10 flyballs that will fall out when the cup is removed. Replace any flyballs with flat spots or grooves. Replace the cup if the race surface is grooved or rough. The governor cup must be a free spinning fit on the camshaft center pin, but should be replaced if excessively loose or wobbly. See Figure 80.

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

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

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

Remove the camshaft as follows:

1. Remove rocker arms and pushrods from valve chambers.
2. Remove fuel pump from the engine. Remove distributor (JC 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 the 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 the camshaft is badly worn or scored, replace it.

The camshaft gear is a press fit on the 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 the camshaft out of the gear bore. Be careful not to damage the center pin.

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

The camshaft to bearing clearance should be .0012" to .0037". To check the rear bearing, remove the expansion plug at the rear of the crankcase.

Press new bearings into place (Figure 81) using bearing driving tool. Press the rear bearing flush with the bottom of expansion plug recess. Press the front bearing in flush with the crankcase front surface so the crankcase and bearing oil passages align. After the rear bearing is installed, insert a new expansion plug in the recess, using sealing compound, and expand it into place with sharp blows at its center. The bearings are a precision-type and do not require reaming. Install the camshaft assembly as follows:

1. Install key and press camshaft gear on its shaft, Figure 82. 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 83).
5. Replace pushrods and fuel pump. Install and retime distributor (JC only).

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

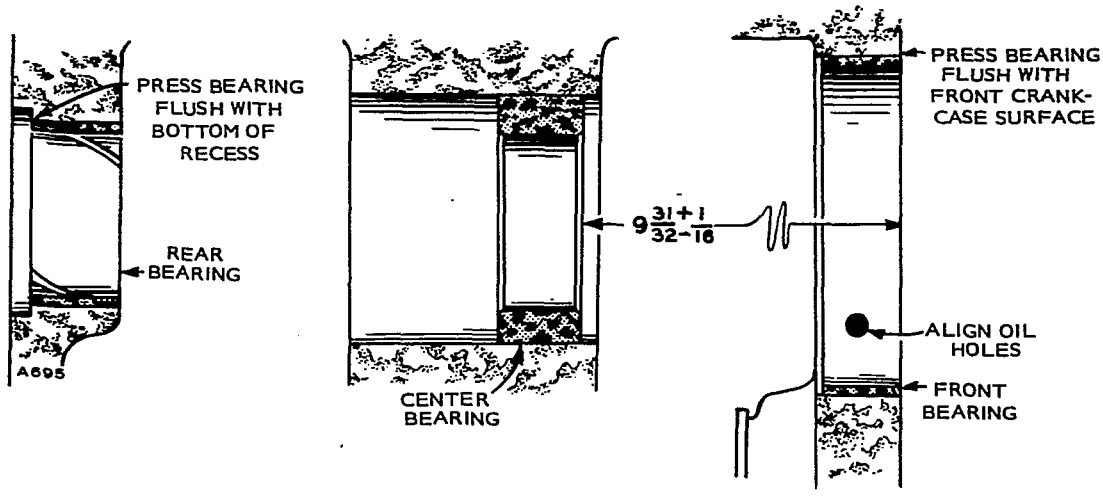


FIGURE 81. CAMSHAFT BEARINGS

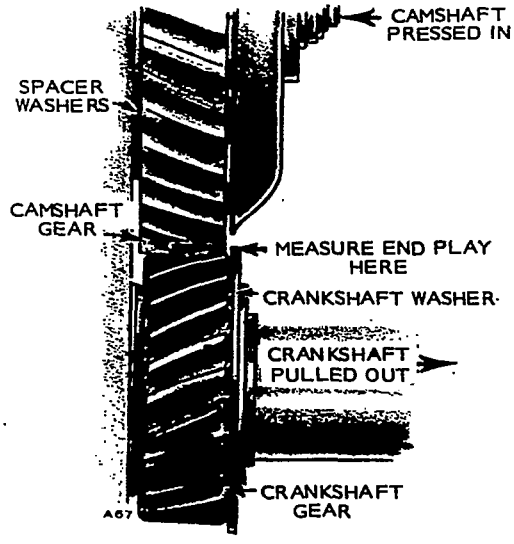


FIGURE 82. CAMSHAFT END PLAY

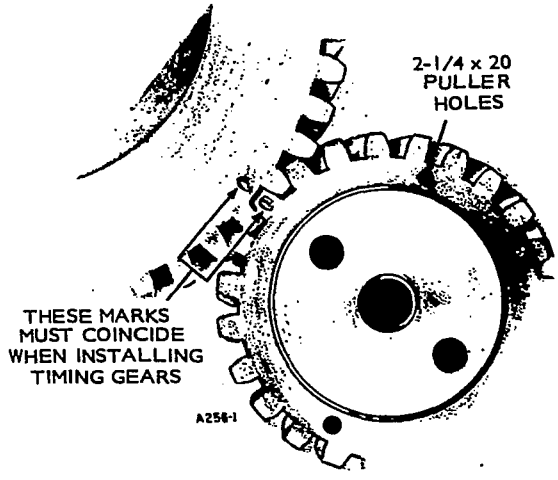


FIGURE 83. TIMING MARKS

The four-cylinder model uses an additional split center main bearing.

Remove the crankshaft as follows:

1. Remove the lock ring and retaining washer in front of the crankshaft gear.
2. Pull off crankshaft gear, Figure 84. 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.
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.)

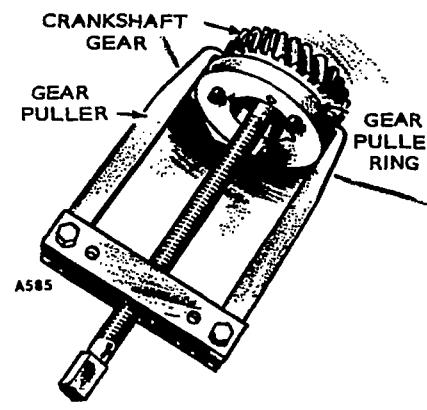


FIGURE 84. REMOVING CRANKSHAFT GEAR

Thoroughly clean and inspect the 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 the oil hole areas which indicate neglect of oil cleanliness.

If the journal dimensions are not within the limits, or the 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", .020" and .030" undersize.

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

Align the oil holes and press the new bearings into the front and rear housings. Insert the JC center bearing when the crankshaft is installed. See Figure 85.

The crankshaft rear oil seal is in the rear bearing plate. If damaged, drive it out from the inside of the plate. Using the oil seal installing tool, install a new seal with the rubber lip facing outward (open side of seal

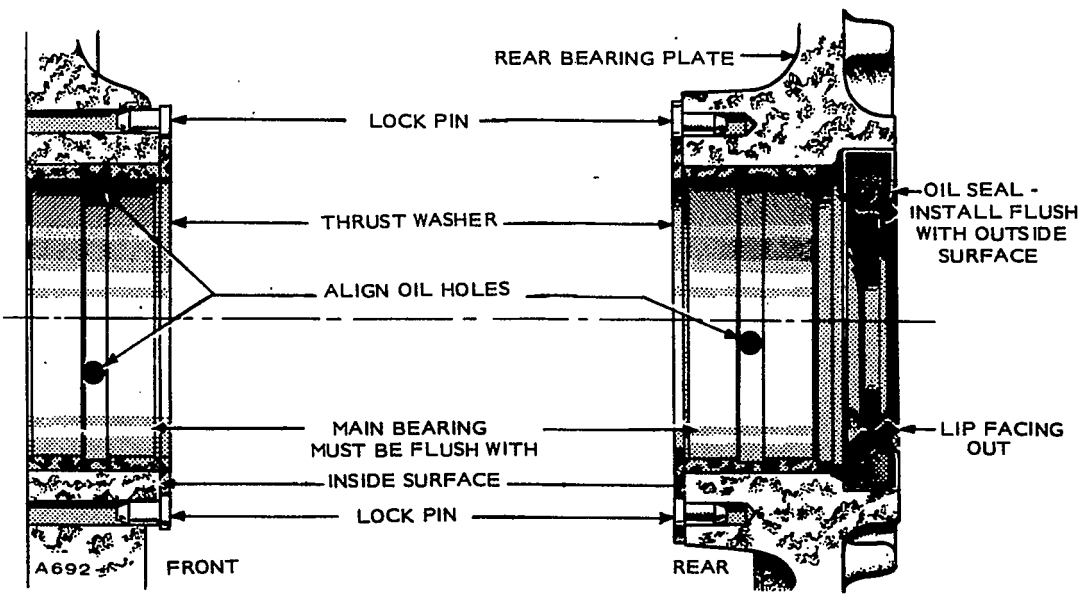


FIGURE 85. MAIN BEARING INSTALLATION

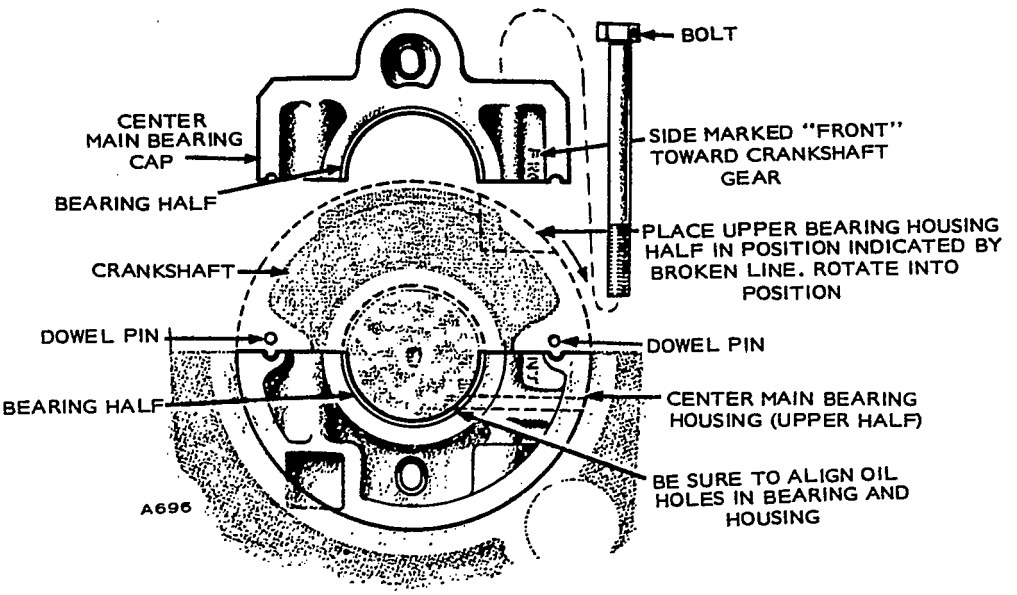


FIGURE 86. CENTER MAIN BEARING (FOUR CYLINDER ONLY)

inward). Drive the new seal flush with the rear surface of the bearing plate. Leave the seal installer on during bearing plate installation to protect the oil seal. Lubricate lips with heavy (high temperature) grease.

Install the crankshaft as follows. After each step, turn the 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.
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 86).
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 the four cylinder model, if the center main beairng support requires replacement, the whole crankcase must be replaced or returned to the factory to have a new housing fitted.

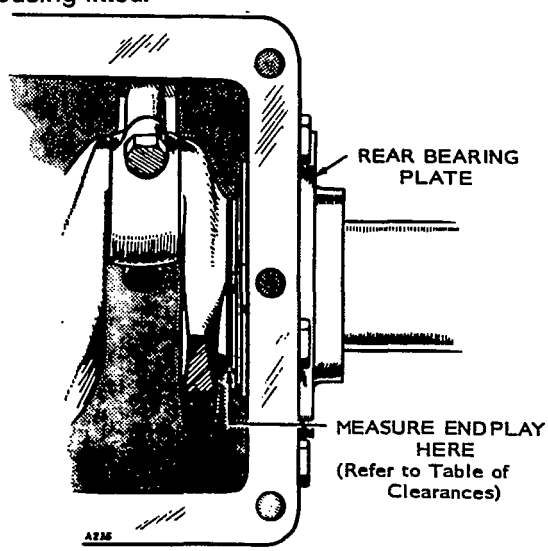


FIGURE 87. CRANKSHAFT END PLAY

REPLACING VALVE GUIDES

Use this procedure for removing and replacing J series valve guides in the 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 the guide wall in the cylinder head if this procedure is not followed.**

2. Place removal tool 420-0300 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.**

Installation

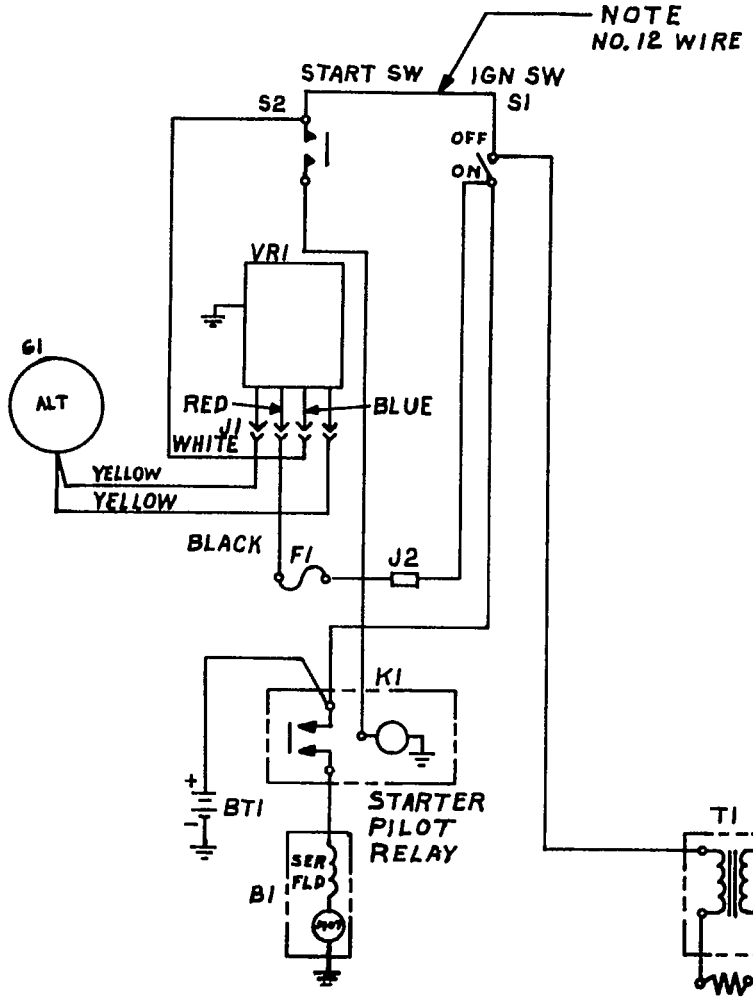
1. Coat outer edge of new guide with oil (or other lubricant). Position guide notch up in cylinder head and press in until guide protrudes 11/32-inch from the rocker box side of head.
2. Place valve guide reamer in drill press (if not available, use an electric drill). Two different size reamers are 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.

WIRING DIAGRAMS

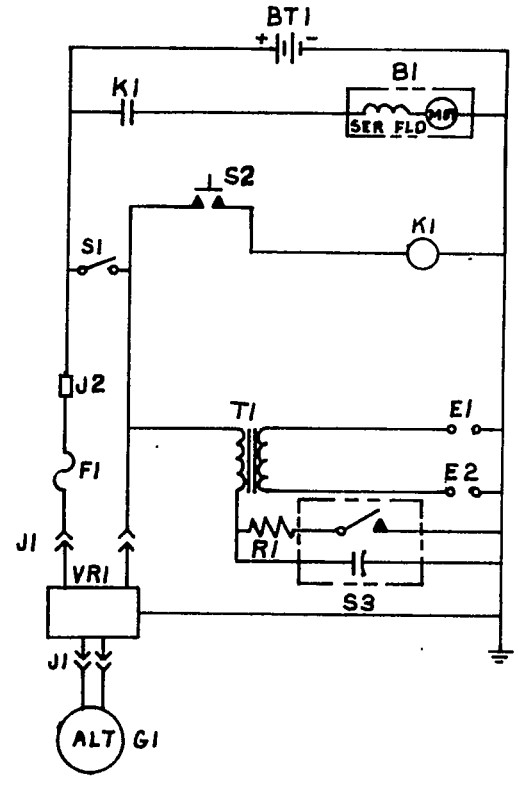
The wiring and schematic diagrams in this section are for newer and older model JB and JC series industrial engine controls.

JB-MS/2609U ..... Dwg. 622-0365
JC-MS/1918W ..... Dwg. 622-0378
J60 (JB now) MS Spec 78B ..... Dwg. 622-0076

WIRING DIAGRAM



SCHEMATIC



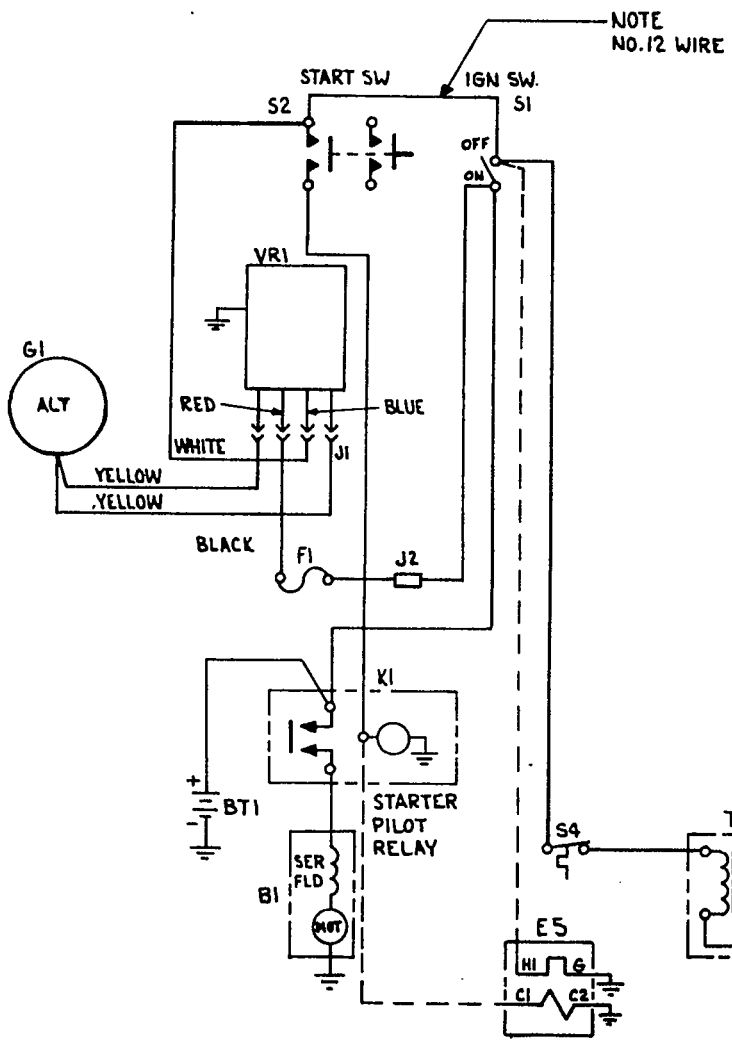
PARTS LIST	
REF. DES.	DESCRIPTION
B1	STARTER
BT1	BATTERY 12 V
E1, 2	SPARK PLUGS
F1	FUSE-30 AMP
G1	ALTERNATOR-FLYWHEEL
J1	CONNECTOR
J2	CONNECTOR
K1	RELAY-STARTER PILOT
R1	RESISTOR-IGNITION(HYTEMCO)1.72 Ω 12W
S1	SWITCH-IGNITION
S2	SWITCH-START
S3	POINTS-BREAKER
T1	COIL-IGNITION
VR1	REGULATOR-VOLTAGE

LET	REVISION	CKD	DATE

Onan — DIVISION OF STUDEBAKER CORPORATION, Minneapolis, Minnesota

-01	MODEL NO: JB-MS/2609U	DATE: 7-11-73	BY: D. BAACK	CKD: G. F. T.
		NAME: CONTROL-ENG (WIRING DIAGRAM)		
	12 VOLT STARTING	DWG. NO.: 622-0365		B

WIRING DIAGRAM



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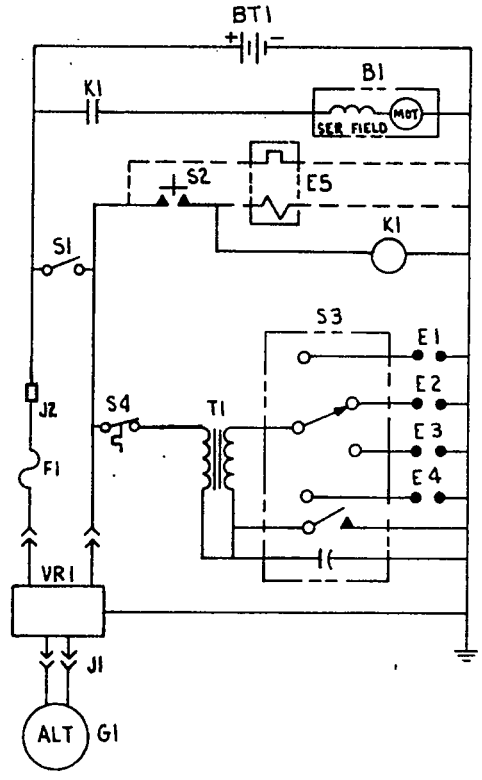
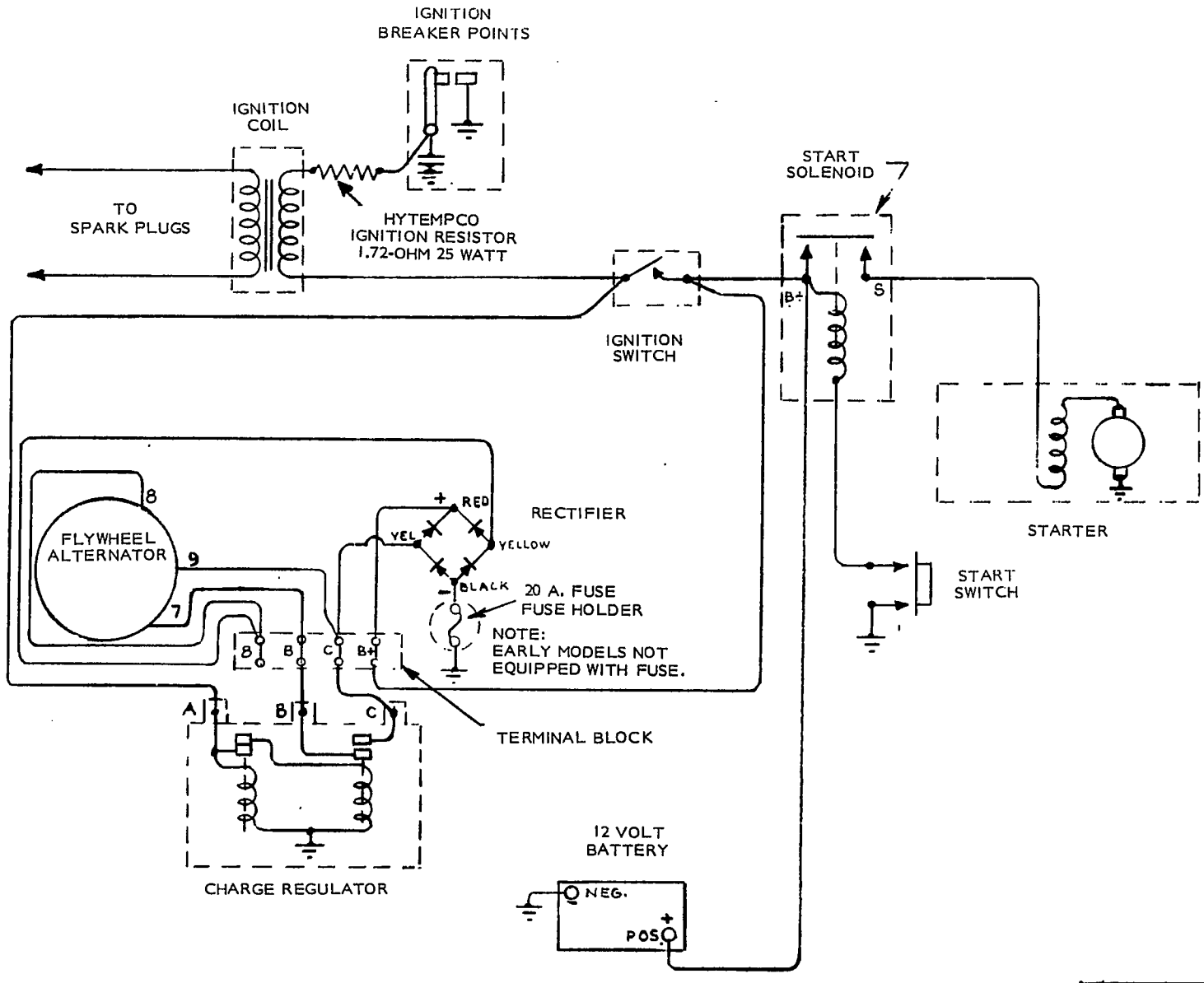


PARTS LIST	
REF. DES.	DESCRIPTION
B1	STARTER
BT1	BATTERY 12 V
E1.2.3.4	SPARK PLUG
E5	CHOKE-ELECT
F1	FUSE - 30 A
G1	ALTERNATOR-STATOR
K1	RELAY - STARTER PILOT
S1	SWITCH - IGNITION
S2	SWITCH - START
	JUMPER
S3	DISTRIBUTOR ASSEMBLY
+ S4	SWITCH - HIGH AIR TEMP
T1	COIL - IGNITION
VR1	REGULATOR - VOLTAGE
J1	CONNECTOR
J2	CONNECTOR

+ WHEN USED

	Onan DIVISION OF STUDEBAKER CORPORATION Minneapolis, Minnesota	
MODEL NO JC-MS/1918W	DATE 11-15-73 / DR EE / CKD	
	NAME CONTROL-ENG (WIRING DIAGRAM)	
12 VOLT STARTING	DWG NO 622-0378	DWG SIZE B



MAT'L	WIRING DIAGRAM
Onan	DIVISION OF STUDEBAKER-PACKARD CORPORATION, MINNEAPOLIS, MINNESOTA
DR. C.K.H.	CH. G.R.T. SC. ——
J60-MS SPEC 781B 12 VOLT BAT. IGN.	
DATE 9-28-51	DWG. NO. 622-0076

Onan

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