X-7525

1975 AND 1976
MAINTENANCE MANUAL
MOTOR HOME
ZEO 6581

AND

TRANS MODES
ZEO 6083
ZEO 6583

GMC

TRUCK & COACH DIVISION
GENERAL MOTORS CORPORATION
PONTIAC, MICHIGAN 48053

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SECTION INDEX

General Information, Periodic Maintenance and Lubrication	0
Body, Heating and Air Conditioning	1
Frame	2
Front Suspension and Final Drive	3
Rear Suspension	4
Brakes	5
Engine	6A
Engine Cooling System	6K
Engine Fuel System	6M
Emission Control Systems	6T
Engine Electrical	6Y
Transmission	7
Fuel Tank and Exhaust	8
Steering System	9
Wheels and Tires	10
Chassis Electrical	12
Radiator and Coolant Recovery System	13
Bumpers	14
Miscellaneous GMC Living Area Facilities	24

ALPHABETICAL INDEX
WIRING DIAGRAMS

SECTION 6A
ENGINE

Contents of this section are listed below:

SUBJECT	PAGE NO.
General Information	6A- 2
Description	6A- 2
Engine Maintenance and Storage	6A- 2
Engine Lubrication System	6A- 2
Engine Diagnosis	6A- 3
In-Vehicle Service Operations	6A-26
Oil Pressure Test	6A-26
Oil Filter	6A-26
Front Engine Mounts	6A-28
Rear Engine Mounts	6A-28
Intake Manifold	6A-29
L.H. Exhaust Manifold	6A-32
R.H. Exhaust Manifold	6A-32
Valve Cover	6A-33
Rocker Arm Assemblies	6A-34
Valve Lifters	6A-34
Cylinder Head and Gasket	6A-37
Valves and Springs with Head Removed	6A-38
Valve Guide Bores	6A-40
Replacing Valve Spring (Head on Engine)	6A-41
Oil Pan	6A-42
Oil Pump	6A-42
Connecting Rod and Piston Assembly	6A-44
Rod Bearings	6A-44
Piston	6A-45
Checking Cylinder Bore	6A-47
Rings	6A-47
Rod and Piston Assembly	6A-48
Piston Pins	6A-48
Crankshaft Pulley	6A-48
Belt Tension	6A-49
Harmonic Balancer	6A-49
Front Cover Oil Seal	6A-50
Front Cover	6A-50
Timing Chain and Gears	6A-52
Engine Replacement	6A-53
Out of Vehicle Service Operations	6A-57
Camshaft	6A-57
Camshaft Bearings	6A-58
Crankshaft	6A-59
Main Bearings	6A-60
Main Bearing Replacement	6A-60
Rear Main Bearing Upper Oil Seal	6A-61
Rear Main Bearing Lower Oil Seal	6A-62
Engine Specifications	6A-63
Torque Specifications	6A-65
Special Tools	6A-66

6A

GENERAL INFORMATION

DESCRIPTION

This section of manual provides instructions for servicing the various items and tuning the engine. To adequately accomplish a satisfactory tune-up, reliable test equipment in the hands of trained personnel is necessary.

A definite, systematic maintenance program is required to assure satisfactory economical performance of engine. Included in maintenance program must be the servicing of related units and systems as well as regular servicing of engine.

ENGINE MAINTENANCE AND STORAGE

Refer to SECTION O at the beginning of this manual for recommendations pertaining to engine servicing intervals. Winterization and storage are also covered in SECTION 24A.

ENGINE LUBRICATION SYSTEM (FIGURE 1)

The engine oil pan forms a reservoir for engine oil to provide lubrication and also hydraulic fluid to operate the valve lifters. Oil pressure for lubrication is furnished by a gear type oil pump that is bolted to the rear main bearing cap and driven by the camshaft gear through a hexagonal drive shaft.

Oil enters the pump through a screened inlet located near the bottom rear of the oil pan. The pressurized oil from the pump passes through the engine oil cooler located in the radiator tank then to the oil filter located on the right rear side of the engine block, see Figure 2. The oil filter base has a by-pass valve which in the event of filter restriction will open at 5.3 to 6.3 psi. It then enters the right oil gallery where it is distributed to the five main bearings. The right bank valve lifters receive oil from this gallery from eight feed holes that intersect the gallery.

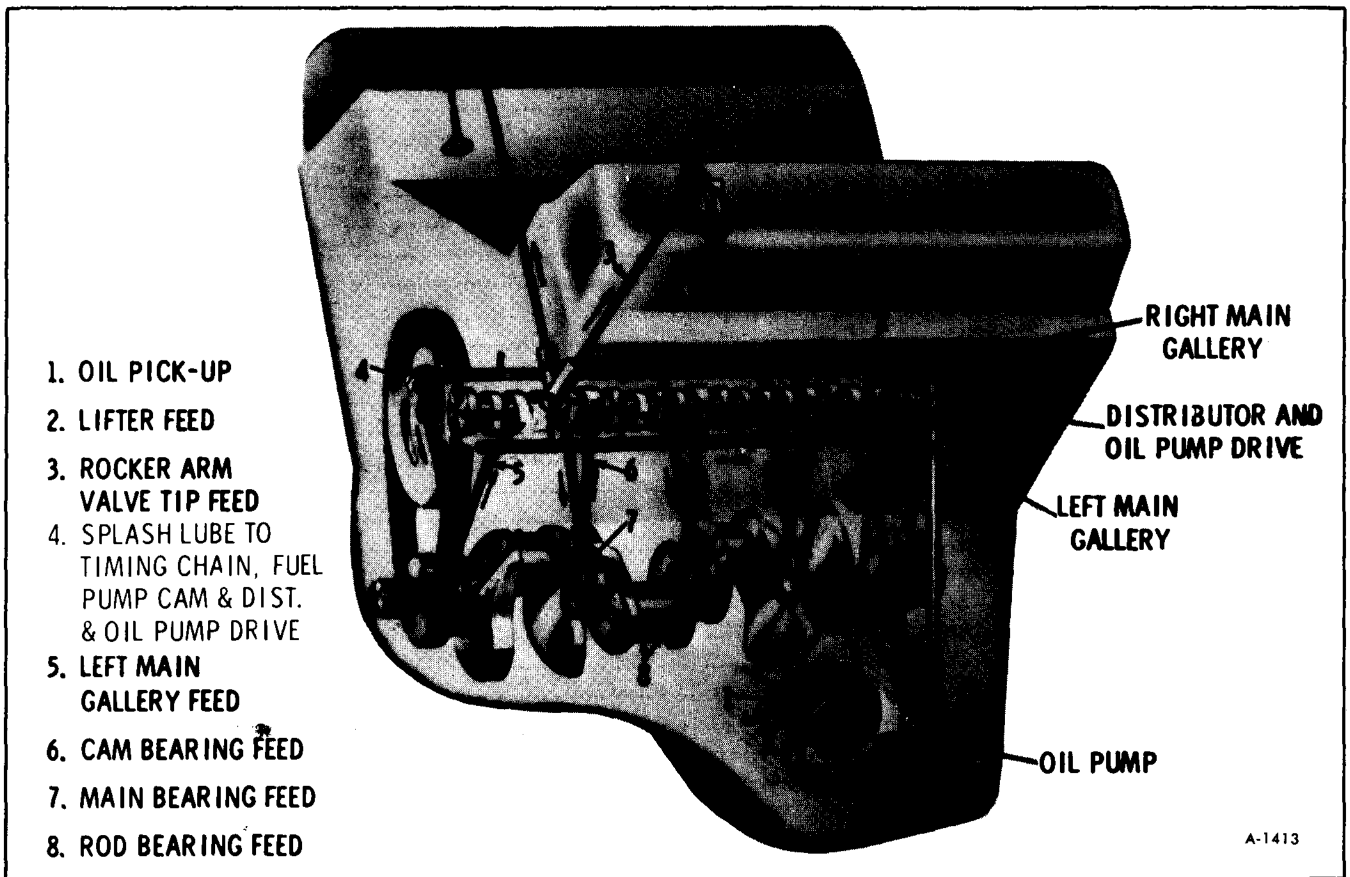


Figure 1—Engine Lubrication

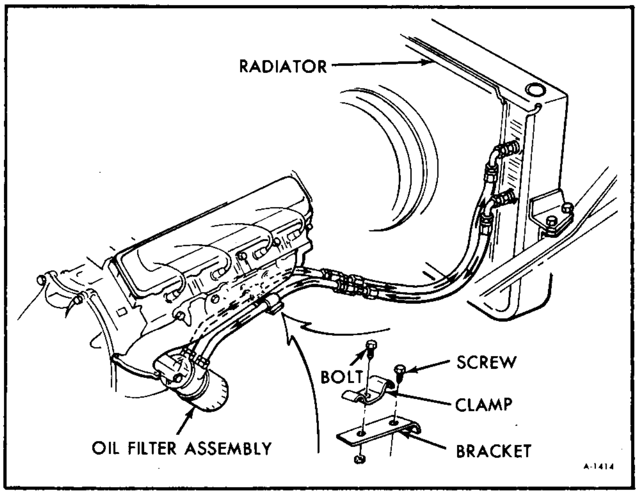


Figure 2—Oil Lines to Cooler

The five camshaft bearings are lubricated from vertical passages intersecting the main bearing oil passages. At the front main bearing a third passage connects the right main oil gallery to the left gallery which then feeds the left bank of valve lifters.

The engine oil pressure warning light switch is connected to the front of the left oil gallery. The switch is calibrated to turn on the instrument panel warning light when engine oil pressure is too low. The switch, normally closed, is set to open at 2-6 psi. The rear oil gallery plug has a .040" orifice to help purge contaminants from the gallery.

At the front end of the right gallery, a small orifice sprays oil to lubricate the fuel pump eccentric cam and the timing chain.

The oil pump and distributor drive gear are lubricated by splash from the rear cam bearing and connecting rod bearings.

The rocker arms and valve tips are lubricated by means of oil furnished through the hydraulic lifters and hollow push-rods. A disc valve in the lifter meters oil to the push rods.

The connecting rod bearings are oiled by constant oil flow from passages drilled through the crankshaft connecting the main journals to the rod journals. A groove around each main bearing furnished oil to the drilled crankshaft passages.

Oil returns to the oil pan reservoir from the rocker arms through passages at each end of the cylinder heads. Oil from the valve lifter compartment returns through clearance holes in the lower portion of the compartment near the camshaft. The timing chain compartment drains directly into the oil pan.

ENGINE DIAGNOSIS

NOTE: The numbers in parenthesis refer to GENERAL ENGINE CHECKS at the end of Engine Diagnosis.

SUBJECT	PAGE NO.
Engine Will Not Turn Over	6A- 5
Engine Turns Over Slowly But Does Not Start	6A- 5
Engine Turns Over at Normal Speed —Starts Hard When Cold	6A- 5
Engine Turns Over at Normal Speed —Starts Hard When Hot	6A- 6
Engine Starts - Fails to Keep Running or Stalls Hot or Cold	6A- 6
Engine Turns Over at Normal Speed But Does Not Start or Starts Hard	6A- 7
Engine Stalls at Idle - Engine Cold (OK When Hot)	6A- 8
Engine Stalls at Idle - Engine Hot (OK When Cold)	6A- 8
Rough Engine Idle	6A- 8
Engine Has Inconsistent Idle Speed (Lopes)	6A- 9
Engine Runs - Misses at Idle Only	6A- 9
Engine Runs - Misses at High Speed Only	6A-10
Engine Runs - Misses Erratically At All Speeds	6A-10

SUBJECT	PAGE NO.
Engine Runs - Misses Steadily at All Speeds	6A-11
Engine Runs - But Misses on One Cylinder	6A-11
Engine Runs - But Misses on Different Cylinders	6A-11
Engine Hesitates or Stalls During Acceleration (Spit-Back Thru Carburetor)	6A-12
Engine Surges	6A-12
Lack of Power or High Speed Performance	6A-12
Engine Fails to Reach Operating Temperature	6A-13
Engine Overheats	6A-13
Spark Knock, Ping, or Detonation	6A-14
Engine Continues to Run After Ignition Is Turned Off (Dieseling)	6A-14
Pre-Ignition	6A-14
Flat Spot (Sag, Stretchiness)	6A-15
Backfires, Popping Back, or Spitback Through Carburetor	6A-15
After-Burning or Muffler Explosion (Backfire)	6A-15
Smoke (Blue, Black, White)	6A-16
Excessive Fuel Comsumption	6A-16
Low Oil Pressure	6A-16
High Oil Pressure	6A-17
No Oil Pressure While Idling	6A-17
No Oil Pressure While Accelerating	6A-17
No Oil Pressure	6A-17
Burned, Sticking, or Broke Valves	6A-17
Excessive Oil Consumption	6A-18
Engine Noisy	6A-19
A. Noisy Main Bearings	6A-19
B. Noisy Rod Bearings	6A-20
C. Noisy Timing Gears	6A-20
D. Noisy Timing Chain	6A-20
E. Noisy Pistons	6A-21
F. Noisy Valve Mechanism	6A-21
G. Noisy Water Pump	6A-22
H. Noisy Generator	6A-22
I. Noisy Fan	6A-22
J. Noisy Fuel Pump	6A-22
K. Noisy Fan Belt	6A-23
L. Miscellaneous Noise	6A-23
M. Pre-Ignition or Spark Knock	6A-23
General Engine Checks	6A-24
1 Emission Control Check	6A-24
2 Battery Check	6A-24
3 Choke Check	6A-24
4 Flooding Check	6A-24
5 Carburetor Icing Check	6A-24
6 Spark Intensity Check	6A-24
7 Hard Starting Check	6A-24
8 Accelerating Pump Discharge Check	6A-24
9 Vacuum Leakage Check	6A-25
10 Excessive Fuel Consumption Check	6A-25
11 Vapor Lock Check	6A-25

ENGINE WILL NOT TURN OVER

IMPORTANT - Delcotron generator equipped vehicles cannot be push-started when battery or starter are inoperative, because unlike a conventional generator, there is no residual magnetism in the rotor.

GENERAL

Neutral safety switch (Automatic Transmission).

Check dipstick for congealed oil, improper viscosity, or presence of water in oil.

Remove spark plugs to check for hydrostatic lock (liquid in combustion chamber).

ELECTRICAL

Check ignition switch and wiring.

BATTERY

See "Battery Diagnosis Charts".

STARTER

See "Starter Diagnosis Charts".

MECHANICAL

Seized bearings, rings, and or pistons.

ENGINE TURNS OVER SLOWLY BUT DOES NOT START

GENERAL

Bad or corroded connections.
Undersized battery cable.
Poor ground.
Oil viscosity too heavy.

MECHANICAL

Tight bearings, rings, pistons, etc.

BATTERY

See "Battery Diagnosis Charts".

STARTER

See "Starter Diagnosis Charts".

ENGINE TURNS OVER AT NORMAL SPEED—STARTS HARD WHEN COLD (2) (7)

NOTE: Most conditions under "Does Not Start" may also cause hard starting when cold.

IGNITION

Engine timing and dwell.

FUEL (3) (4) (8)

If condition occurs only when ambient temperature is below 32°F., check for ice restriction in the fuel supply system. If necessary, thaw system and add anti-icing additive to the fuel. (5)

NOTE: In cold weather cranking speed is reduced by thickening of oil and reduction of battery efficiency.

ENGINE TURNS OVER AT NORMAL SPEED (1)—STARTS HARD WHEN HOT (7) (11)

NOTE: This condition is usually caused by an over-supply of fuel due to any of the items listed under "Does Not Start" due to excessive fuel supply.

GENERAL

Check proper starting procedure (setting choke, accelerator pumping, accelerator position, etc.).
Engine timing and dwell.
Air cleaner dirty.
Engine overheating. Refer to ENGINE OVERHEATS in this section.

MECHANICAL

Choke mechanism binding, sticking and/or improper adjustment. (3)

FUEL

Vapor lock.
Flooding. (4)
Accelerator pump. (8)
Carburetor faulty.
Fuel pump faulty.
Fuel restricted.

IGNITION

Check for faulty spark plugs. (6)

ENGINE STARTS — FAILS TO KEEP RUNNING OR STALLS HOT OR COLD (7)

GENERAL

Vapor lock. (11)
*Engine overheats.
*Engine runs too cool.
Idle speed too low.
Positive crankcase ventilation valve.
Leak in intake manifold (vacuum line faulty or disconnected). (9)
Exhaust crossover in intake manifold plugged.
Exhaust system restricted.
Air intake restricted.
Carburetor icing. (5)
Engine timing and dwell.

MECHANICAL

Throttle linkage defective or improperly adjusted.
Valve train faulty.
Valve lifter or valve clearance.
Low compression.
Choke valve faulty, stuck, or binding. (3)
Head cracked or gasket leaking.
Excessive engine friction.

FUEL

Dirt and/or water in fuel system.
Faulty fuel pump.
Float level too high. (4)
Idle adjustment incorrect.
Idle compensator valve faulty.
Needle valve seat faulty.
Mixture too rich or too lean.
Faulty carburetor.

IGNITION

Spark plugs damp or dirty and/or gap incorrectly set or not installed properly.
Faulty coil or condenser.
Distributor points incorrectly set, burned, pitted or dirty.
Distributor advance mechanism faulty or timing improperly set.
Worn rotor or distributor cap loose, corroded, poor connections, or incorrect wiring.

*Refer to ENGINE OVERHEATS in this section.

ENGINE TURNS OVER AT NORMAL SPEED BUT DOES NOT START OR STARTS HARD (7)

NOTE: If ignition is set too far advanced, spark may occur too early when engine is cranked. The first (and only) explosion runs the engine backward. A kickback may jam the starter or break the starter drive housing.

IGNITION (2)

OPEN PRIMARY

Burned or oxidized ignition points.
Coil resistance unit burned out or open.
Starting switch ignition coil resistance by-pass circuit open.
Ignition points not closing.
Breaker arm binding on pivot post, preventing closing of points.
Breaker arm spring weak or broken.
Breaker arm distorted or bent.
Dirty ignition points.
Primary lead connection loose at distributor or coil.
Primary windings in coil broken.
Open ignition switch circuit.

GROUNDED PRIMARY

NOTE: A grounded coil primary winding, a grounded ignition switch, or a grounded switch-to-coil primary lead will cause excessive current flow and will usually cause wires to burn.

Ignition points not opening or closing due to wear or improper adjustment.
Faulty bushing in breaker arm.
Cracked or faulty insulator at distributor primary terminal.
Grounded or faulty condenser.
Distributor-to-coil lead grounded.
Primary coil winding grounded.
Broken or loose ignition wire or faulty switch.

MECHANICAL

Choke binding, sticking, or improper adjustment.
Low or erratic compression. (Check valve train mechanism, rings, blown head gasket, etc.)

FAULTY SECONDARY (6)

Corroded spark plug cable terminals.
Chafed or cracked cable insulation.
Ignition coil weak or inoperative.
Moisture on ignition coil, terminals, distributor cover, spark plug procelains, or in distributor.
Improper type of spark plugs.
Cracked distributor cap or a burned carbon track from distributor cap center terminal to housing.
Improper installation of spark plug cables (not correct for firing order).
Spark plugs damaged, dirty, or wet, porcelains cracked, or gaps improperly spaced.
Rotor contact spring bent or broken.
Distributor rotor grounded.
Distributor cap center terminal (inner) broken or missing.
Broken or burned out radio suppressor in distributor cap.

FUEL (11)

Hot engine vapor lock.
No fuel or insufficient fuel.
Water and/or dirt (Fuel System).
Excessive fuel. (4)
Accelerator pump faulty. (8)
Fuel pump worn or defective.
Fuel filter dirty.
Carburetor dirty or defective.
Vent in fuel tank clogged or restricted.
Carburetor mounting bolts loose.

GENERAL

Check proper starting procedure (setting choke, accelerator pumping, accelerator position etc.).
Air cleaner dirty.
Engine timing.
Restricted exhaust.
Poor ground or faulty wiring.

ENGINE STALLS AT IDLE — ENGINE COLD (OK WHEN HOT)

CARBURETOR (3) (5)

Idle too low.
Choke high idle too low.

MECHANICAL

Linkage improperly adjusted or damaged.

ENGINE STALLS AT IDLE — ENGINE HOT (OK WHEN COLD)

GENERAL

Vapor lock. (11)
Engine overheats. (Refer to "Engine Overheats" in this section.)
Positive crankcase ventilation valve.

CARBURETOR (3) (4)

Idle set too low.

MECHANICAL

Throttle linkage improperly adjusted or faulty.

ROUGH ENGINE IDLE (1)

GENERAL

Check all vacuum hoses for proper routing, broken or disconnected hoses and/or caps. Also vacuum leaks. (9)
Restricted air cleaner (Remove air cleaner with engine running and note engine rpm.).
Incorrect timing and dwell.
Positive crankcase ventilation valve dirty or stuck.
Restricted exhaust.
Cold engine (Faulty thermostat).
Fuel volatility too high or low.

IGNITION (6)

Improper plug or plug gap.
Faulty plugs.
Improper point setting, worn or damaged.
Defective condenser and coil.
Faulty rotor or cap.
Loose wiring.
Damaged or corroded coil wiring or spark plug cables.
Moisture on wiring or in distributor cap.
Cracked distributor cap.

FUEL

Engine idle speed improper.
Mixture too rich or lean. (4)
Float level.
Dirt and water in fuel system.
Carburetor mounting bolts loose.

MECHANICAL

Choke linkage, secondary throttle plates sticking, binding or damaged. (3)
Low compression.
Valve train faulty (Burnt or sticky valves, broken spring, bent push rod etc.).
Loose engine mounts or worn insulation.
Improperly torqued cylinder head.
Leaking or worn valve guides.

NOTE: When repairs have been made it may be necessary to re-adjust idle speed.

ENGINE HAS INCONSISTENT IDLE SPEED (LOPES) (1)

NOTE: If idle speed is slow, unstable, rolling, frequent stalling, and oily engine compartment, the positive crankcase ventilation valve may be completely plugged, or the valve may be stuck in the "OPEN" position. A valve stuck in the "CLOSED" position is indicated by breather back-flow at heavy throttle and oily engine compartment. If the valve is stuck in the intermediate position it will be indicated by rough, fast idle and stalling.

GENERAL

Restricted exhaust.
Vacuum leak (Intake valve stem leaking, carburetor mounting gasket leaking, cabruetor throttle shaft in carburetor leaking, intake manifold or vacuum hoses leaking). (9)
Timing and dwell not correct.
Restricted air cleaner.
Overheated engine (Refer to "Engine Overheats" in this section). (11)
Blown head gasket.
Low compression.
Quality of fuel.
Lean idle mixture. (1)

FUEL

Dirt and/or water infuel system.
Too rich or lean mixture.
Filter restricted.
Faulty fuel pump. (4)
Faulty carburetor.

MECHANICAL

Throttle shaft, accelerator pedal and/or throttle linkage sticking or binding.
Timing chain or gears and/or camshaft lobes worn.
Burned, warped, pitted, leaky or sticking valves.
Inoperative choke.
Sticking hydraulic lifter.

IGNITION

Excessive oil or dirt on ignition system.
Spark plugs damp or gap incorrectly set.
Excessive moisture on ignition wires and caps.
Leaks in ignition wiring (Dirty, corroded, or faulty wiring).
Ignition wires making poor contact.
Burned, pitted, or incorrectly set contact points.
Faulty coil or condenser.
Worn distributor cam, or cracked distributor cap, radial contacts in distributor cap burned or worn.
Faulty spark advance mechanism.

ENGINE RUNS - MISSES AT IDLE ONLY (1)

GENERAL

Vacuum leak. (9)
Timing not correct.
Exhaust restriction.
Blown head gasket.
Low compression.
Fuel quality poor.
Air cleaner dirty.

MECHANICAL

Leaky or incorrect valve.
Worn or leaky valve guide.
Worn timing chain, gears, sprocket or camshaft lobe.
Dirt in hydraulic lifter.

IGNITION (2)

Spark plugs faulty or wrong gap.
Incorrect, worn, or gap incorrectly set.
Leaks in ignition wiring.
Burned, pitted, or incorrectly set contact points.
Faulty coil and/or condenser.
Faulty spark advance mechanism.
Defective or worn rotor and/or cap.

FUEL (4)

Flooding in carburetor.
Refer to "Engine Has Inconsistent Idle Speeds" above.

ENGINE RUNS - MISSES AT HIGH SPEED ONLY (1)

GENERAL

Overheating (Refer to "Engine Overheats" in this section).
Detonation or pre-ignition.
Sub-standard fuel.
Faulty or dirty air cleaner.
Valve train faulty or worn.
Mild vapor lock.
Exhaust vapor lock.
Exhaust manifold clogged or restricted.
Air cleaner plugged.

FUEL

Faulty fuel pump.
Restricted fuel filter.
Choke valve not completely closed.
Carburetor throttle lever loose on shaft.
Exhaust manifold clogged with carbon.
Exhaust manifold, muffler, or tail pipe restricted.
Intermittent delivery of fuel to carburetor so that momentarily the mixture is too weak for combustion.

IGNITION (2)

Clean, gap, and/or replace spark plugs, as necessary.
Too hot spark plugs—change to colder type, but note that a hot plug may be due to loose installation or lack of plug gasket (if gasket is called for).
Ignition point gap much too wide or pitted.
Breaker arm binding or sticking.
Breaker arm weak.
Weak spark, coil, or condenser.
Improper ignition timing and/or dwell.
Centrifical advance not functioning properly.
Distributor cam lobe or shaft worn.
Worn rotor or damaged distributor cap.

MECHANICAL

Incorrect valve timing.
Sticking hydraulic lifters.
Valve springs broken.
Valve springs shimmy.
Valve springs too weak to close valves promptly.

ENGINE RUNS - MISSES ERRATICALLY AT ALL SPEEDS (1)

GENERAL

Restricted exhaust.
Compression low.
Internal coolant leakage.
Engine overheating. (11)
Timing improperly set.

MECHANICAL

Compression leak at head gasket or between cylinders (This can be noted when missing occurs in two adjacent cylinders).
Intermittently sticking valves.
Broken valve spring.
Valve(s) held open slightly by faulty mechanism.

IGNITION (2)

Wrong type spark plugs.
Fouled spark plug or broken porcelain.
Faulty spark plug cables.
Low battery voltage.
Low generator voltage.
Burned or pitted ignition points.
Incorrect ignition point gap.
Faulty condenser or coil.
Weak spark or no spark in one or more cylinders.
Faulty distributor cap or rotor.
Primary circuit restricted or open intermittently.
Primary circuit detoured by short intermittently.
Secondary circuit restricted or open intermittently.
Secondary circuit detoured by short intermittently.

FUEL

Fuel pump faulty.
Needle valve in carburetor sticking.
Improper float lever. (4)
Mixture too rich or too lean.
Passage in carburetor dirty.

ENGINE RUNS - MISSES STEADILY AT ALL SPEEDS (1)

GENERAL

Worn camshaft lobes.
Compression low.
Vacuum leak in intake manifold. (9)
Dwell and timing off.
Fuel poor quality.

FUEL

Dirty jets in carburetor.
Water or dirt in fuel.
Fuel filter plugged.
Fuel pump worn or diaphragm faulty.

IGNITION (2)

Dirty or incorrectly set points.
Worn, dirty, or gap set too wide in spark plugs.
Worn distributor shaft.
Cam worn or burned distributor rotor.
Faulty coil or condenser.
Insufficient spring tension on points.

MECHANICAL

Valve train faulty.

ENGINE RUNS - BUT MISSES ON ONE CYLINDER

GENERAL

Compression leaking.
Vacuum leak at intake manifold. (9)
Timing and/or dwell improperly set.
Overheated engine. (Refer to "ENGINE OVERHEATS" in this section).
Clogged exhaust.

IGNITION (2)

Defective spark plug or spark plug wire.
Distributor cap defective.
Distributor cam worn.
Points worn or improperly aligned.

MECHANICAL

Valve train defective.
Stuck hydraulic lifter.
Defective rings or piston.

ENGINE RUNS - BUT MISSES ON DIFFERENT CYLINDERS

GENERAL

Compression leaking.
Vacuum leak at intake manifold or carburetor. (9)
Defective head gasket.
Dwell, timing off.
Poor grade fuel.
Carbon in engine.
Restricted exhaust.

FUEL

Fuel pump faulty.
Carburetor faulty.

IGNITION (2)

Spark plugs faulty.
Coil wire or distributor cap faulty.
Distributor cam worn.
Points worn or improperly set.
Distributor rotor faulty.

MECHANICAL

Faulty rings.
Faulty valve train.

ENGINE HESITATES OR STALLS DURING ACCELERATION (1) (SPITBACK THROUGH CARBURETOR)

GENERAL

Vapor lock. (11)
Carburetor icing. (5)
Restricted exhaust.
Compression low.
Intake manifold leaking (Carburetor attaching bolts loose). (9)
Partly blocked or dragging brake shoes (Refer to "Brake" chart).
Air cleaner dirty.
Engine timing.
Excessive carbon in engine.
Heavy oil in engine.
Wrong or poor grade fuel.
Excessive rolling resistance from low air in tires, applied brakes, wheel alignment, overloading etc.

IGNITION (2)

Distributor faulty.
Wiring oily or faulty.
Condenser or coil faulty.
Faulty plugs.
Vacuum advance faulty.

MECHANICAL

Accelerator pump stroke or throttle linkage improperly adjusted.
Stuck hydraulic lifters.
Intake manifold loose or leaking.
Carburetor mounting loose or leaking.
Valve train damaged or faulty.

ENGINE SURGES (1)

GENERAL

Exhaust system restricted or faulty.
Cylinder(s) not firing properly.
T.V.S. switch faulty. (1)
Vacuum leaks. (9)

IGNITION

Check out complete ignition system. (2)
Faulty spark plug wires.

FUEL (4)

Fuel pump faulty.
Faulty needle valve and seat.
Float level setting wrong.
Defective parts in carburetor.
Restrictions in fuel lines or filter.

LACK OF POWER OR HIGH SPEED PERFORMANCE

NOTE: It should be noted that the altitude of operation has a decided effect on performance. An engine adjusted for normal altitudes will lack performance at high altitudes, whereas an engine when operating normally at high altitudes may have a lean carburetor adjustment and show signs of pre-ignition when operated at sea level.

IGNITION (2)

Ignition timing or dwell incorrect.
Centrifugal governor advance not operating properly.
Vacuum advance not operating properly.
Ignition points burned, pitted, sticking, or bouncing. (Due to weak breaker arm spring).
Faulty spark plugs.
Faulty ignition cables.
Faulty ignition coil or condenser.
Worn or burned distributor rotor.
Worn distributor shaft or cam.
Poor ground.

GENERAL

Pre-ignition.
Engine overheating. (Refer to "Engine Overheats"" in this section).
Sub-standard fuel.
Overloading vehicle.
Excessive carbon in engine.
Converter defective.
Excessive rolling resistance (Dragging brakes, tight wheel bearings, underinflated tires).
Restricted exhaust.
Dirty air cleaner.
Transmission or power steering faulty.

MECHANICAL

Choke mechanism faulty.
Lack of engine compression.
Incorrect valve timing.
Inaccurate speedometer (Gives impression of lack of performance).
Valve spring weak, broken valves or valves sticking when hot.
Valve timing incorrect.
Worn camshaft lobes.
Blown cylinder head gasket.
Burned, warped or pitted valves.

ENGINE FAILS TO REACH OPERATING TEMPERATURE

GENERAL

Thermostat removed.

COOLING

Defective thermostat (stuck open).
Faulty temperature sending unit or dash unit.

ENGINE OVERHEATS

NOTE: Coolant is used to cool the engine and air is used to cool the coolant. Anything which prevents the coolant air system from working properly will cause engine to overheat. (Air, oil or grease in the coolant will reduce the ability of the coolant to absorb heat from the block and to transfer heat to the coolant in the radiator.)

GENERAL

Scale or rust deposits.
Slipping fan belt.
Low coolant. (Leaky system—internal or external.)
Pre-Ignition.
Detonation.
Excessive friction in engine or elsewhere in power transmitting units. (Brakes dragging, etc.)
Excessive back pressure in exhaust system.
Overloading vehicle.
High altitude.
Hot climate operation.
Insufficient oil in crankcase.

FUEL

Carburetor mixture too lean.

MECHANICAL

Cylinder head bolts loose.
Warped or damaged head or block.
Wrong head gasket.

IGNITION

Timing late.
Distributor advance faulty.
Valve timing off or late.

COOLING

Restricted flow of coolant. (Defective components—dirt, rust and scale.)
Leaking head gasket. (Permits air in cooling system and coolant in engine.)
Thermostat fails or wrong thermostat.
Hoses defective.
Exterior of radiator clogged with dirt, leaves, or insects.
Water pump defective or loose.
Wrong type of coolant.
Wrong fan or hydraulic fan inoperative, or defective.
Wrong pressure cap or faulty cap.
Radiator fins bent or mutilated.

SPARK KNOCK, PING, OR DETONATION

NOTE: A sharp metallic knock due to instantaneous abnormal combustion.

GENERAL

Low octane fuel.
Too high compression.
Timing advanced too far.
Heavy carbon deposits.
Manifold heat control valve faulty.
Faulty distributor advance mechanism.
Breaker point dwell (or gap) too low.

COOLING

Overheated engine. (See "Engine Overheats" in this section.)
Hot weather.
High altitude.

ENGINE CONTINUES TO RUN AFTER IGNITION IS TURNED OFF (DIESELING)

NOTE: When the engine won't stop as the ignition is turned off, the cause is often due to red hot carbon particles resting on heavy carbon deposit in a very hot engine.

GENERAL

Improper idle speed (too high). (1)
High engine temperature.
Poor grade fuel (octane too low).
Improper timing and dwell.
Quick shut-down of hot engine.

MECHANICAL

Improper valve timing.

IGNITION

Advanced timing.
Improper heat range or improperly installed spark plugs.
Electrical feed through ignition system (faulty switch).

FUEL

Carburetor too lean.
Throttle plates misaligned.

PRE-IGNITION

NOTE: Hot spot in combustion chamber ignites fuel before spark occurs. May not be noticed unless severe.

GENERAL

Overheated engine.
Carbon deposits.
Spark plugs not tight.
Spark plugs with wrong heat range.
Timing and dwell improperly set.

MECHANICAL

Leak at valve due to clearance, valve sticking, weak or broken spring.
Valve timing.

FLAT SPOT (SAG, STRETCHINESS)

NOTE: Does not respond promptly when throttle is opened quickly.

GENERAL

Poor fuel quality.
Vapor lock. (11)
Late ignition timing.

MECHANICAL

Accelerator pump linkage adjustment incorrect.
Accelerator linkage faulty or improperly adjusted.

FUEL

Low fuel pump pressure.
Accelerator pump piston or diaphragm leaks.
Accelerator pump valves leak or passages restricted.
Float level incorrect.
Defective fuel pump.
Carburetor defective or improperly set.
Fuel filter plugged.
Dirt in carburetor jets.

BACKFIRES, POPPING BACK OR SPITBACK THROUGH CARBURETOR (SUBDUED EXPLOSION IN INTAKE MANIFOLD)

GENERAL

Cold engine and choke too lean.
Loose carburetor mounting bolts. (9)
Loose intake manifold bolts. (9)
Incorrect timing and dwell.
Vacuum leaks (hoses etc.). (9)

IGNITION

Leaking distributor cap may cause backfire to occur in cylinder on intake stroke.
Two crossed spark plug wires may also cause backfire through carburetor.

FUEL

Lean mixture.
Dirt or water in fuel.
Faulty accelerator pump.

MECHANICAL

Leaky or sticky intake valve.
Weak or broken intake valve spring.
Faulty heat valve.
Plugged heat crossover passage.
Improper camshaft timing.
Improper valve lash.

AFTER-BURNING OR MUFFLER EXPLOSION (BACK FIRE)

NOTE: A subdued put-putting at the exhaust tailpipe may be due to leaky exhaust valves which permit the mixture to finish combustion in the muffler. If exhaust pipe or muffler is red hot, better let it cool, as there is some danger of setting the vehicle on fire. Most likely to occur when mixture is lean.

GENERAL

Late timing.
Burnt exhaust valve.
Air cleaner restricted.
Air leak in exhaust manifold or pipe.

MECHANICAL

Late valve timing.
Worn or broken exhaust valve spring.
Tight exhaust valve.
Choke stuck closed.

IGNITION

Intermittent open circuit in primary. (Ammeter needle swings further away from zero when generator is charging.)
Intermittent short in primary. (Ammeter swings toward zero when generator is charging.)
Short in coil or secondary coil wire.
If just a couple of explosions are heard and then no more for a time (even for days) the trouble may be due to a gradually failing condenser.

FUEL

Carburetor flooding.

SMOKE

WHITE

Condensing water vapor which is a normal product of combustion—no problem— usually seen on cold days.

BLACK

Excessively rich fuel mixture.
(See "Excessive Fuel Comsumption".)

BLUE

(Or Bluish White)

Excessive oil consumption
(See "Excessive Oil Consumption")

EXCESSIVE FUEL CONSUMPTION (1)

GENERAL

"Jack Rabbit" starts.
High speed.
Short drives.
Restricted Choke (partly closed).
Clogged air cleaner.
Loss of compression.
Excessive rolling resistance from low tires, dragging brakes, wheel misalignment, etc.
Restricted exhaust.
Engine overheating.
Crankcase ventilating system faulty.
Trailer towing.
Worn-out or badly tuned engine.

IGNITION

Faulty ignition system.

FUEL

Excessive fuel pump pressure.
Float level high. (4)
Faulty carburetor.
Leakage or loose fittings.
Idle speed settings incorrect.
Accelerator pump improperly adjusted.

MECHANICAL

Faulty valves or valve train.
Faulty rings.
Choke mechanism binding or improperly adjusted.
Accelerator linkage binding or improperly adjusted.
Fuel tank cap missing.

LOW OIL PRESSURE

GENERAL

Low oil level.
Clogged oil filter.
Thin or diluted oil (frequent stops in cold weather).
Viscosity (too light grade).
Oil has foam from water (condensation or leaking head gasket).
Overheating.

MECHANICAL

Faulty pressure sending unit, line, or gauge.
Worn oil pump.
Excessive bearing clearance.
Oil pump relief valve dirty, worn, spring weak or worn.
Oil pump suction tube loose or cracked.
Screen clogged (ice, gummy, sludge or dirt).
Air leak in oil pump (loose cover or too thick gasket).
Loose connections in oil lines.

HIGH OIL PRESSURE

GENERAL

Oil too heavy (viscosity).
Main oil passage on pressure side of pump clogged.

MECHANICAL

Faulty gauge.
Oil pressure relief valve adjustment too heavy.
Relief valve spring too stiff.
Oil pressure passage clogged.

NO OIL PRESSURE WHILE IDLING

GENERAL

Faulty oil gauge sending unit.
Leakage at internal oil passage.

MECHANICAL

Oil pump not functioning properly. (Valve stuck by foreign material.)
Excessive clearance at bearings (camshaft, rod or main).

NO OIL PRESSURE WHILE ACCELERATING

GENERAL

Low oil level in oil pan.

MECHANICAL

Leakage at internal oil passages.

NO OIL PRESSURE

GENERAL

Suction loss.
Oil pressure gauge faulty.
Not enough oil in pan.
Pipe to oil pressure gauge stopped up.
Oil passage on discharge side of pump stopped up.
Oil screen or passages on intake side of pump stopped up.

MECHANICAL

Oil pump inoperative.
Relief valve stuck open.

BURNED, STICKING OR BROKEN VALVES

GENERAL

Over-speeding engine.
Deposits on valve seats and/or gum formation on stems or guides.
Warped valves or faulty valve forgings.
Exhaust back pressure.
Improper ignition timing.

MECHANICAL

Weak valve springs.
Improper valve clearance.
Improper valve guide clearance and/or worn valve guides.
Out-of-round valve seats or incorrect valve seat width.

EXCESSIVE OIL CONSUMPTION

NOTE: Check the PCV valve for proper operation before checking causes of leak. A clogged crankcase vent valve can build up pressure in the crankcase which will cause seals and gaskets to leak.

EXTERNAL LEAKAGE

Oil pan drain plug loose or gasket missing.

Crack or hole in oil pan.

Oil pan gasket leaks due to:
(a) Loose screws; (b) Damaged gasket;
(c) Improperly installed gasket;
(d) Bent oil pan flange.

Oil pan gasket leaks due to:
(a) Loose screws; (b) Damaged gasket;
(c) Improperly installed gasket:
(d) Bent oil pan flange.

Timing case cover gasket leaks due to:
(a) Loose screws; (b) Damaged gasket;
(c) Improperly installed gasket;
(d) Bent cover flange;

Front crankshaft oil seal leaks due to:
(a) Worn oil seal; (b) Seal not properly installed; (c) Rough surface on crankshaft, or fan pulley or damper;
(d) Damper or pulley loose; (e) Seal or cover not centered on crankshaft; (f) Oil return passage to crankcase clogged up.

Rear main bearing oil seal leaks due to:
(a) Worn oil seal; (b) Improper oil seal installation; (c) Worn rear main bearing;
(d) Rough crankshaft. Oil passage to crankcase clogged.

Expansion plug in block at rear of camshaft leaks due to poor fit, careless installation, or corrosion.

Leakage at any external piping.

Plugs at ends of oil passages in cylinder block leak.

Oil filter leaks.

Leakage at distributor housing.

Valve cover leaks due to loose screws, defective gasket, improperly installed gasket or bent cover flange.

Rocker arm cover or push rod cover leaks due to loose screws, defective gasket, improper gasket installation or bent cover flange.

Pipe connections loose on oil gauge or oil filter lines.

Improperly seated or broken fuel pump gasket.

Broken push rod cover gasket, oil filter gasket, or timing chain cover gasket.

Worn timing chain cover oil seal.

Worn or improperly seated rear main bearing oil seal.

Loose oil line plugs.

Rear camshaft bearing drain hole plugged.

Loose rocker arm cover, gasket broken, or cover distorted or bent.

Rear main bearing side seal improperly installed.

INTERNAL LEAKAGE

Carbon in oil ring slot.

Rings fitted too tight in grooves.

Leaky piston rings due to wear, scuffs or broken.

Leaky piston rings due to sticking caused by gummy deposit. Try to free up with suitable solvent poured in fuel tank, Blue smoke at tail pipe indicates badly leaking rings.

Worn pistons and cylinders.

Cylinder block distorted by tightening cylinder head bolts unevenly.

Excessive clearance between intake valve stems and guides allows oil mist to be sucked into cylinders.

Worn main or rod bearings allow excessive leakage from bearings.

Result in cylinder walls are flooded with oil.

Oil pressure too high due to faulty action of oil pressure relief valve, or clogged relief passage.

If pressure lubricated, loose piston pins may permit excessive leakage to cylinder walls.

Grade of oil used is too light. A poor quality oil may become far too thin when engine is hot. Hard driving on hot days will also consume more oil.

Clogged crankcase ventilator system.

Intake valve seals damaged or missing.

Plugged drain back holes in head.

Intake manifold gasket leak in conjunction with rocker cover gasket leak.

Ring grooves or oil return slots clogged.

Rings sticking in ring grooves of piston.

Ring grooves worn excessively in piston.

Compression rings installed upside down.

Excessively worn or scored cylinder walls.

Cylinder walls not properly honed or finished.

Oil too thin (diluted).

Oil level too high.

Excessive main or connecting rod bearing clearance.

Piston ring gaps not staggered.

Incorrect size rings installed.

Piston rings out-of-round, broken or scored.

Insufficient piston ring tension due to engine overheating.

ENGINE NOISY

NOTE: When diagnosing engine noise problems, be careful that noises caused by accessories are not mistaken for engine noises. Removal of accessory drive belts will eliminate any noises caused by these units.

In general, engine noises are either synchronized to engine speed or one-half engine speed. Those that are timed to engine speed are sounds that have to do with the crankshaft, rods, pistons, and wrist pins. The sounds emitted at one-half engine speed are valve train noises.

The use of a stethoscope will often aid in locating an engine noise. Caution must be exercised, however, because noise will travel to other metal parts not involved in the problem. A timing light will aid in determining if the noise is synchronized with engine speed or at one-half engine speed.

Engine noise sometimes may be isolated by grounding the spark plug leads one at a time. If the noise lessens appreciably or disappears, it is confined to that particular cylinder.

No definite rule or test can be listed that will positively determine the source of a noise complaint.

Fuel pumps, distributors, flywheels, water pumps, drive belts, or carbon built up in the combustion chamber may contribute to noisy engine operation. The following information can therefore, be used only as a general guide to noise diagnosis. There is no substitute for experience.

A. NOISY MAIN BEARINGS

NOTE: A loose main bearing is indicated by a powerful, but dull, thud or knock when the engine is pulling. If all main bearings are loose a noticeable clatter will be audible.

The thud occurs regularly every other revolution. The noise is loudest when the engine is "lugging" or under heavy load. The sound is heavier and duller than a connecting rod noise. Low oil pressure also accompanies this condition. The knock can be confirmed by shorting spark plugs on cylinders adjacent to the bearing. Knock will disappear or be less when plugs are shorted. This test should be made at a fast idle equivalent to 15 mph. If bearing is not quite loose enough to produce a knock if oil is too thin or if there is no oil at the bearing.

Regular noise: worn main bearings; irregular; worn end-thrust bearings.

GENERAL

Insufficient oil supply.
Low oil pump pressure.
Thin or diluted oil.

MECHANICAL

Excessive bearing clearance.
Excessive crankshaft end play.
Eccentric or out-of-round crankshaft journals.
Sprung crankshaft.
Excessive belt tension.
Loose harmonic balancer.
Loose flywheel or torque converter.

IMPORTANT: Crankshaft End Play - Intermittent rap or knock that is sharper than a loose main bearing. Repeated disengagements of the transmission may cause a change in the rap.

B. NOISY ROD BEARINGS

NOTE: Rods with excessive clearance knock under all speeds and under both idle and load conditions. At the early stage of looseness, rod noise may easily be confused with piston slap or loose pins. Rod knock noise increases in intensity with engine speed. Low oil pressure also accompanies this condition.

GENERAL

Excessive bearing clearance.
Worn crankpin.
Lack of oil (thin or diluted).
Low oil pressure.
Journals out-of-round.
(A metallic knock which is usually loudest at about 30 mph with throttle closed. Knock can be reduced or even eliminated by shorting spark plug. If bearing is not loose enough to produce a knock by itself, the bearing may knock if oil is too thin or if there is no oil at the bearing.)

MECHANICAL

Misaligned rod.
Connecting rod bolts not tightened correctly. (Should connecting rod misalignment be suspected, check for a diagonal wear pattern on the piston skirt, and for excessive wear on the opposite edges of the connecting rod bearings.)

IMPORTANT: Automatic transmission coupling noise caused by loose transmission-to- engine bolts sounds like rod bearing noise.

C. NOISY TIMING GEARS

NOTE: A high frequency light knock difficult to isolate without a sound detecting device. It is about the same intensity whether the engine is idling or at high speeds or under load.

GENERAL

Gears misaligned.
Excessive backlash.
Chipped tooth—usually camshaft gear.

MECHANICAL

Gears loose on hubs or shafts.
Eccentric gear, usually due to high keys.
Teeth meshed too tight (new oversize gear).
Too much end play in camshaft or crankshaft.
Front camshaft bearing clearance excessive.

D. NOISY TIMING CHAIN

GENERAL

Chain loose due to wear.
Sprocket teeth worn.
Sprockets misaligned.
Loose vibration damper or drive pulley.

MECHANICAL

Sprocket loose on hubs or shaft.
Front camshaft bearing clearance excessive.
Front main bearing clearance excessive.

E. NOISY PISTONS

NOTE: Piston pin, piston and connecting rod noises are difficult to tell apart. A loose piston pin causes a sharp double knock which is usually heard when engine is idling. Severity of knock should increase when spark plug to this cylinder is short-circuited. However, on some engines the knock becomes more noticeable at 25 to 35 mph on the rod.

GENERAL

Worn or loose piston pin or bushing.

Improper fit of pin.

(Listen for a light ticking or tapping noise. More noticeable with no load on engine. May disappear completely under load. Generally piston pin noise can be noticed on deceleration of the engine.)

Piston-to-cylinder bore clearance excessive.

(Sounds very similar to tappet or lifter noise. Removing one spark plug wire at a time may be helpful in determining which cylinder is noisy. One indication of piston slap is a decrease in noise as the engine warms up. Piston slap is always louder when the engine is cold. Retard timing slightly, noise should decrease.)

Lack of lubrication.

Carbon deposits on top of piston strikes cylinder head.

Worn or broken piston ring land. (Most noticeable during acceleration.)

Broken or cracked piston.

Engine overheating.

Fuel of too low octane rating.

Operating without air cleaner.

MECHANICAL

Excessive rod bearing clearance.

Misaligned connecting rods.

Worn rings, cylinder walls, low ring tension, broken rings, out-of-round or tapered bores.

Top of piston strikes ridge at top of cylinder bore.

Piston rubs against cylinder head gasket.

Excessive side clearance of rings in groove, clearance between ring and groove and/or ring gap.

Undersize pistons installed.

Wrong type and/or size rings installed.

Cylinder bores tapered or eccentric.

Pins improperly assembled.

Insufficient ring gap clearance.

Pistons 180° out of position.

F. NOISY VALVE MECHANISM

GENERAL

Sticking or warped valves.

Bent push rods.

Dirty, worn, or scored parts.

Broken or weak springs.

Damaged valve lifter and/or camshaft lobes.

Insufficient or poor oil to valve mechanism. (Thin, foaming, or diluted.)

Excessive valve stem-to-guide clearance.

Valve lifter incorrectly fitted to bore size.

Pulled or loose rocker arm bolts.

MECHANICAL

Hydraulic lifter not working properly or faulty. (Faulty lifter can usually be located with the aid of a stethoscope.)

Hydraulic lifter :ıpumped up" from excessive speed—temporary noise.

G. NOISY WATER PUMP

NOTE: Listen for a ratchety or grinding sound which increases with engine rpm. In the early stages, the grinding noise may disappear at higher engine rpm. Disconnect the fan belt, and run engine. If noise disappears, trouble most likely is the water pump bearing. Bearing failure or start of failure can be detected by grasping the water pump pulley with both hands and moving it in a sidewise motion. If sloppiness is present, the bearing is unserviceable.

GENERAL

Rough bearing.
Pump seal too hard.

MECHANICAL

Shaft pulley loose.
Impeller loose on shaft.
Too much end play in pump shaft.
Too much clearance between shaft and bearings.
Impeller blades rubbing against pump housing.
Impeller pin sheared off.
Impeller broken.

H. NOISY GENERATOR
(Refer to Generator Diagnosis Charts)

GENERAL

Brush squeal.
Bearings.
Faulty diode or stator.

MECHANICAL

Loose mounts.
Belt too tight.

I. NOISY FAN

GENERAL

Fan blades bent.
Fan out-of-balance when made.
Fan shaft end play excessive.

MECHANICAL

Fan blades loose on clutch.
Fan blades strike shroud.

J. NOISY FUEL PUMP

NOTE: Diagnosis of fuel pumps suspected as noisy, requires that some form of sounding device be used. Judgment by ear alone is not sufficient, otherwise a fuel pump may be needlessly replaced in attempting to correct noise contributed by some other component. Use of a stethoscope, a long screwdriver, or a sounding rod is recommended to locate the area or component causing the noise. The sounding rod can easily be made from a length of copper tubing 1/4 to 3/16 inch in diameter. Dowel rods are also good.

If the noise has been isolated to the fuel pump, remove the pump and run the engine with the fuel remaining in the carburetor bowl. If the noise level does not change, the source of the noise is elsewhere and the original fuel pump should be reinstalled.

K. NOISY FAN BELT

GENERAL

Belt worn or burned.
Wrong belt. Does not fit pulley grooves properly.
Belt or pulley dirty or sticky with gummy oil.
Pulley bent, cracked or broken.

MECHANICAL

Belt too tight. Squeaks.
Belt pulleys misaligned.
Belt loose; squeaks when engine is accelerated.

L. MISCELLANEOUS NOISE

(Rattles, squeaks, etc., from loosely mounted accessories; generator, horn, oil pan, etc.)

LOOSE FLYWHEEL

A thud or click which is usually irregular. To test, idle the engine at about 20 mph and shut off the ignition. If thud is heard, the flywheel may be loose.

EXCESSIVE CRANKSHAFT END PLAY

A rather sharp rap which occurs at idling speed but may be heard at higher speeds also.

FAN SHROUD

Loose shroud or radiator.

ENGINE VIBRATION

Unequal compression in cylinders.
Missing at high speed.
Unbalances fan or loose fan blade.
Incorrect adjustment of engine mounts, or damaged mounts.
Loose engine mounts.
Engine support loose on frame or cylinder block.
Unbalanced or sprung crankshaft.
Excessive engine friction due to tight piston etc.
Defective vibration damper.

LOOSE ENGINE MOUNTINGS

Occasional thud with vehicle in operation. Most likely to be noticed at the moment the throttle is opened or closed.

M. PRE-IGNITION OR SPARK KNOCK

(Most noticable under heavy acceleration)

GENERAL

Low octance fuel being used.
Muffler or exhaust passage restricted.
Excessive carbon deposit in combustion chamber.
Hot spot in head—possibly caused by foreign matter clogging small water passages between head and block.
Engine lugging—produces unbalanced heat.
Compression too high for octane rating of fuel being used.
Overheated spark plug due to being too "hot" for the application, not seated properly, or not torqued to specifications.

IGNITION

Faulty ignition system or timing advance beyond specifications.
Dwell angle (or gap) too low.

FUEL

Carburetor mixture lean.
Operating with standard specifications at high altitudes allowing rich fuel mixture.

GENERAL ENGINE CHECKS

1. EMISSION CONTROL CHECK

To diagnose Emission Control Systems, refer to "Emission Control Charts" in this manual.

2. BATTERY CHECK

The battery must be fully charged before proceeding with engine diagnosis. When the battery has a low charge, determine and repair the cause of the low charge before proceeding with further diagnosis. Refer to "Battery Diagnosis Charts" in this manual.

3. CHOKE CHECK

Freedom of operation may be checked by holding the throttle in the open position and manually operating the automatic choke linkage. When possible, choke linkage should be checked on a cold carburetor. Refer to "Carburetor Diagnosis Charts" in this manual.

4. FLOODING CHECK

Flooding occurs when an excessive amount of fuel enters the cylinders and prevents ignition. If flooding is suspected, look for wet throttle plates, external leakage around the throttle plate shaft, external leakage at the bowl gasket and/or wet spark plugs. If the engine is running, a flooding condition will be indicated by a rough engine idle, poor acceleration, and heavy, black smoke from the exhaust system. Flooding is usually caused by improper operation of the carburetor fuel inlet system or a high float level setting. Additional causes are listed in"-Carburetor Diagnostic Procedures" in this manual.

5. CARBURETOR ICING CHECK

Carburetor icing generally occurs when ambient temperatures range from 30°F. to 50°F. (-1.1°C. to 10°C.), and the relative humidity is above 60%. Moisture from in-rushing air collects and freezes between the throttle plates and the throttle base, cutting off the air supply to the engine, and stalling the engine.

If icing occurs after the engine is at normal operating temperature, allow the engine to stand for a short period of time. The carburetor casting will absorb enough heat from the engine to thaw the ice. If the icing occurs while the engine is still cold, the ice may be melted by pouring a small amount of anti-icing additive directly into the carburetor. Neither of the above procedures will prevent a recurrence of the icing condition.

The most effective way to prevent icing is to add an anti-icing additive to the fuel.

6. SPARK INTENSITY CHECK

Disconnect a spark plug wire and install a terminal adapter in the terminal of the wire to be checked. Hold the adapter approximately 1/8" away from the exhaust manifold and crank the engine. The spark should jump the gap regularly and be blue in color. A good spark indicates that the ignition primary and secondary circuits are functioning properly. A weak spark (usually a pale orange color) or an intermittant spark indicates trouble within the primary and/or secondary ignition circuits.

7. HARD STARTING ENGINE CHECK

The problem of an engine that cranks normally but starts hard when cold can usually be traced to an excessively lean fuel mixture. Excessively lean fuel mixtures are usually caused by an improper choke setting or as insufficient amount of fuel being delivered to the cylinders.

If the engine starts OK cold, but is hard to start when hot, the problem may be due to an excessive amount of fuel being discharged through the carburetor. A hot engine hard start or no start condition may also be due to the coil breaking down after it becomes heated. Hard starting occurring only after a hot engine has been shut down for a few minutes, indicates carburetor percolation or vapor lock which causes a rich fuel condition. Refer to "Carburetor Diagnosis Charts" in this manual, for individual fuel problems. (Corroded or loosened terminal could be the cause.)

If the engine starts hard regardless of whether it is hot or cold, the problem can usually be traced to engine compression, fuel system, or ignition system. Refer to "Ignition System" or "Fuel System Diagnosis" charts in this manual for ignition and/or fuel problems.

8. ACCELERATING PUMP DISCHARGE CHECK

Remove the air cleaner and manually operate the throttle linkage while observing the fuel discharge from the accelerator pump nozzles. When the throttle plates are opened, a quick steady stream of fuel should be discharged into the carburetor. Failure of the accelerator pump to discharge a sufficient amount of fuel usually indicates a problem in the fuel delivery system between the supply tank and the carburetor. Refer to "Fuel Pump and/or Carburetor Diagnosis" charts in this manual. Insufficient fuel discharge, however, may also be due to the operation of the accelerator pump circuit within the carburetor.

9. VACUUM LEAKAGE CHECK

With the engine at idle speed, squirt a mixture of kerosene and 10W motor oil around areas where vacuum leakage may occur. A noticeable change in the engine idle when the mixture is squirted on a given point indicates a vacuum leak at that point.

CAUTION: *Kerosene and oil mixture is flammable. Careless application may result in fire. DO NOT use gasoline.*

10. EXCESSIVE FUEL CONSUMPTION CHECK

There are a number of factors, other than engine or carburetor problems, that will contribute to excessive fuel consumption. One of the most important of these is the driving habits of the operator.

When the operator habitually makes "jack-rabbit" starts and stops, "rides" the brake pedal, overloads the vehicle, drives at excessively high speeds for prolonged periods, fails to hold a consistent throttle position. (continuously accelerates, then coasts) and/or operates the vehicle under short run conditions (cold engine) the majority of the time, this could be the problem.

Vehicle air resistance at high speeds has a major affect on fuel consumption. Head winds, excessively high speeds, or added protrusions to the vehicle profile will cause an increase in fuel consumption.

When it has been determined that the operator is not at fault, make a fuel consumption test using a calibrated fuel measuring device. The amount of fuel used to drive the vehicle a measured distance should be recorded. Then record the amount of fuel used to return to the starting point. An average of the two readings should be used in determining the existence of a fuel consumption problem. While making the fuel consumption test, the vehicle odometer should be checked over a measured mile for proper calibration.

If the results of the fuel consumption test indicate that a fuel consumption problem does exist, the diagnostic procedures outlined in this manual under "Excessive Fuel Consumption in Carburetor" and/or "Ignition Diagnosis" charts should be followed.

11. VAPOR LOCK CHECK

The term "vapor lock" means the flow of fuel to the mixing chamber in the carburetor has been stopped (locked) by the formation of vaporized fuel pockets or bubbles caused by overheating the fuel by hot fuel pump, hot fuel lines or hot carburetor.

The more volatile the fuel the greater the tendency for it to vapor lock. Vapor lock is encouraged by high atmospheric temperature, hard driving, defective engine cooling and high altitude.

A mild case of vapor lock will cause missing and hard starting when engine is warm; also a "sag" during an acceleration or surge during cruise. Somewhat more severe vapor lock will stop the engine which cannot be started again until it has cooled off enough so that any vaporized fuel has condensed to a liquid.

IMPORTANT: Percolation means simply that gasoline in the carburetor bowl is boiling over into the intake manifold. This condition is most apt to occur immediately after a hot engine is shut off. The carburetor has provision for relieving the vapor pressure of overheated fuel in the carburetor bowl by means of internal vents. If, however, percolation should take place, the engine may be started by allowing it to cool slightly and then holding the throttle wide open while cranking to clear the intake manifold of excess fuel.

Some causes of vapor lock may be due to winter grade fuel used in summer (most vapor lock occurs in April due to this), or temperature under hood is too high.

NOTE: Applying wet cloths to fuel lines, fuel pump and/or carburetor can cause fuel to condense and permit engine to run.

IN-VEHICLE SERVICE OPERATIONS

ENGINE OIL PRESSURE TEST (FIGURE 3)

1. Remove oil pressure warning light switch from the left front of the engine.

2. Install oil pressure gauge in hole.

3. Set parking brake. Put transmission selector in "N", neutral position.

4. Start engine and run until normal operating temperature is obtained.

5. Oil pressure should be at idle - 7psi min. 1500-3000 rpm - 35psi min.

OIL FILTER (FIGURE 4)

REMOVAL

1. Hoist vehicle.

2. Remove oil filter.

3. Loosen oil cooler line clamp bolt. See Figure 2.

4. Loosen oil cooler line fittings from the adapter and slide lines forward approximately one inch.

5. Remove oil filter extension fitting and adaptor.

6. Remove three (3) bolts securing base to engine block.

7. Remove filter base and gasket.

INSTALLATION

1. Install gasket and filter base to engine block. Torque bolts to 35 ft. lbs.

2. Install adaptor and oil filter extension fitting to 55 ft. lbs.

3. Reposition oil cooler lines and attach to adaptor.

4. Torque cooler line clamp bolt to 9 ft. lbs.

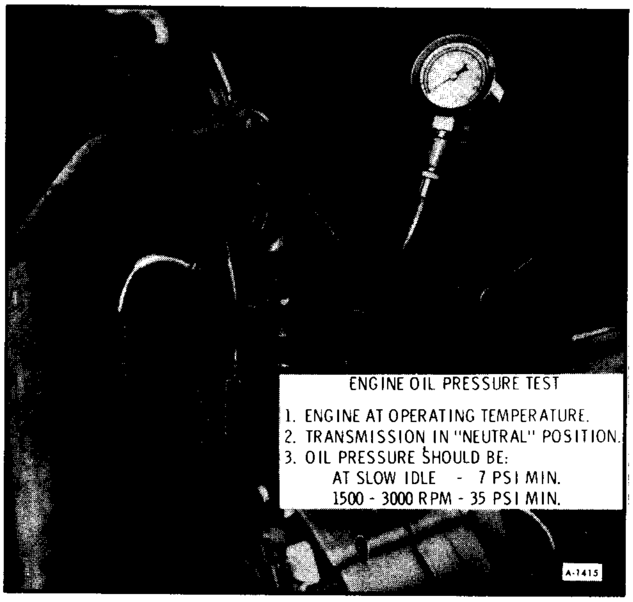


Figure 3—Checking Engine Oil Pressure

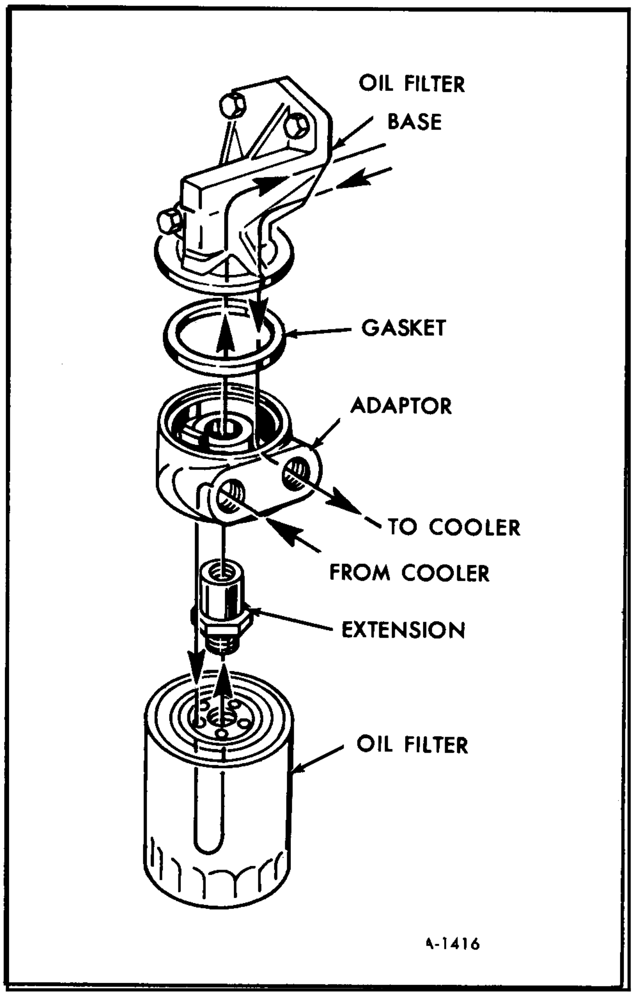


Figure 4—Oil Filter

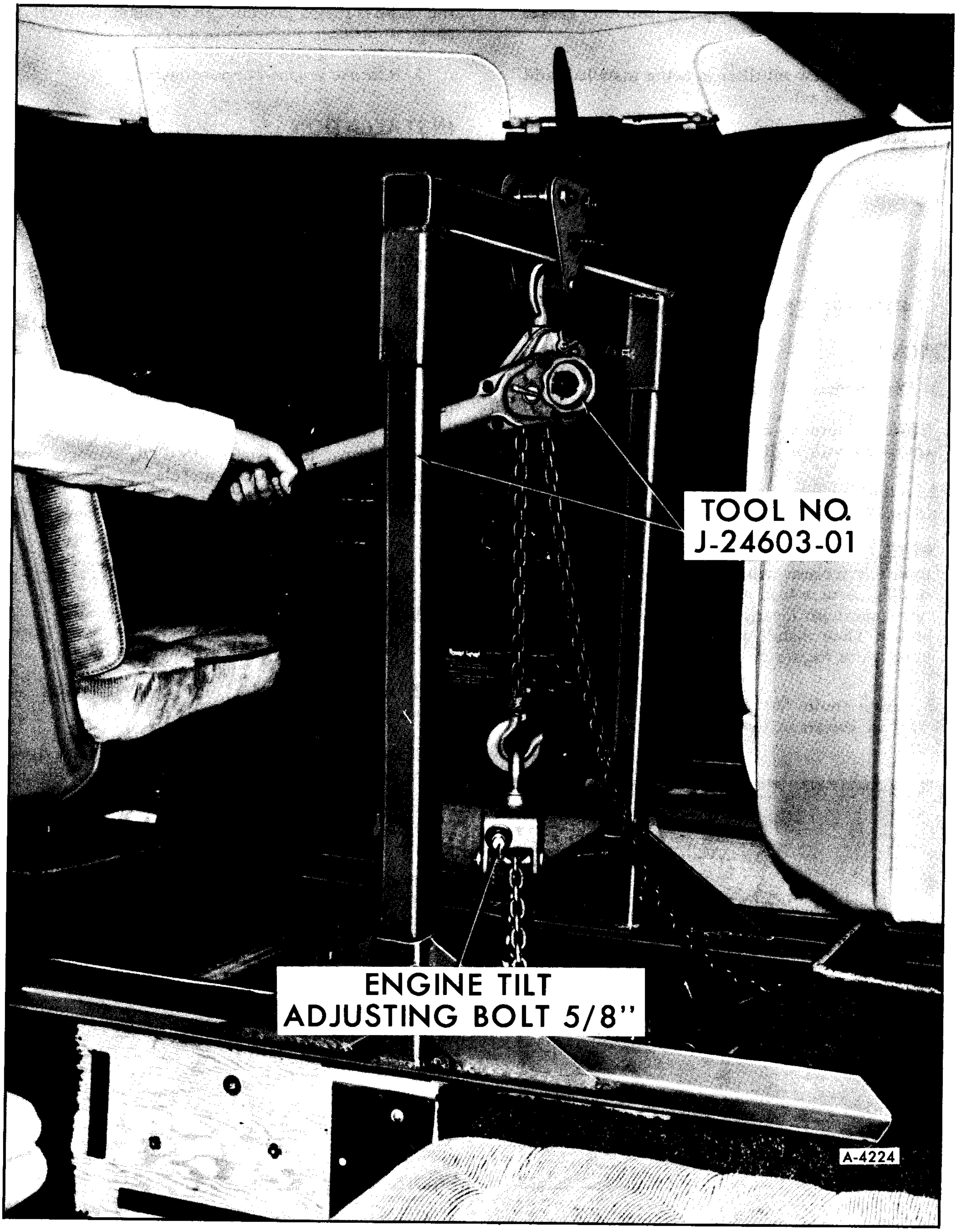


Figure 5—Attaching Engine Removal Tool

5. Apply a film of engine oil to the filter gasket and install torque by tightening 2/3 turn after gasket contacts adaptor.

NOTE: If a new oil filter is being installed, add one quart of oil.

6. Start engine, check for possible leaks. Stop engine and after several minutes check for proper engine oil level.

FRONT ENGINE MOUNTS

REMOVAL

1. Disconnect coil bracket from engine.

NOTE: There is no coil bracket on engines equipped with high energy ignition systems.

2. Attach engine lift Tool No. J-24603-01 as shown in Figure 5.

NOTE: To properly position engine removal tool, remove seat belt plate and anchor bolt assembly. Attach load adjuster chain to front and rear engine lift locations as shown in Figures 6 and 7. Then install support braces and winch hoise as in Figure 5.

3. Remove bolts "A" and "B". Remove nuts "C" and "D" as shown in Figure 6.

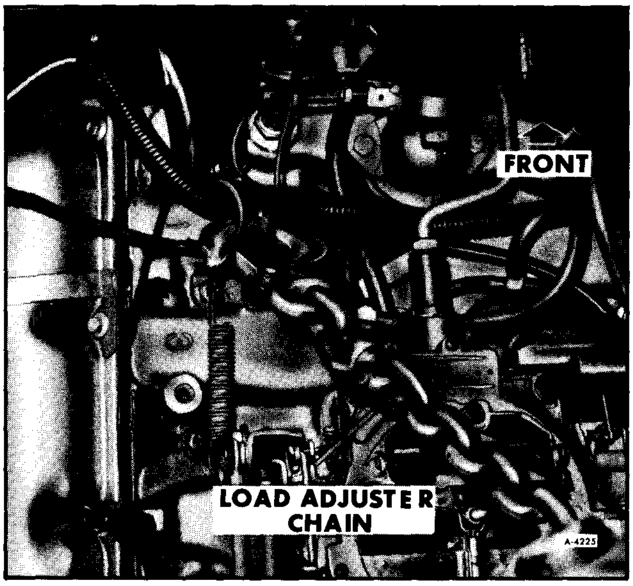


Figure 6—Front Engine Lift Location

4. Adjust tool No. J-24603-01 so that the front of the egine is raised just enough to enable removal of support cushion.

5. Remove engine support cushion.

INSTALLATION

1. Install new studs into engine support cushion and torque to 30 ft. lbs.

2. Install engine support cushion into place.

3. Lower engine making sure holes in engine support line up with holes in engine support cushion.

4. Install bolts "A" and "B" and torque nuts to 45 ft. lbs.

5. Install nuts "C" and "D" and torque to 30 ft. lbs.

6. Remove tool No. J-24603-01, connect coil bracket to engine. Install air cleaner and engine cover.

REAR ENGINE MOUNTS

REMOVAL

1. Disconnect coil bracket from engine.

2. Attach engine lift tool No. J-24603-01 as shown in Figure 5.

3. Remove bolts "A", "B" and "C" on both sides of the engine/transmission rear support (See figure 7).

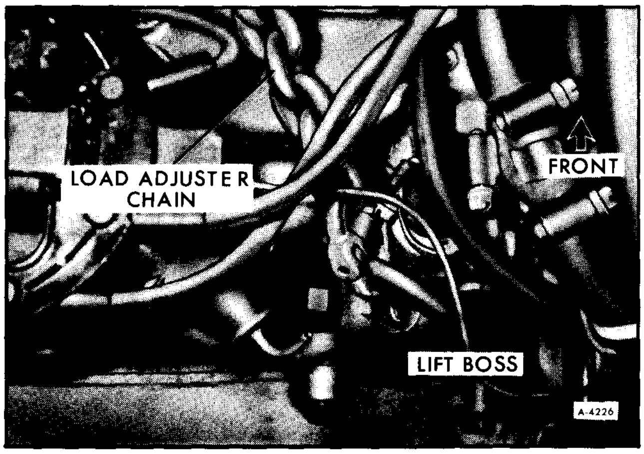


Figure 7—Rear Engine Lift Location

4. Adjust tool No. J-24603-01 so that the rear of the transmission is raised and there is enough clearance to remove the engine restrictor and transmission mount.

INSTALLATION

1. Install engine restrictor and transmission mount.

2. Lower engine.

3. Install all bolts and nuts finger tight to insure proper alignment.

4. Torque bolts "A" and "B" to 50 ft. lbs. Torque bolt "C" to 55 ft. lbs.

IMPORTANT: In late model vehicles, placement of the transmission mount is the reverse shown in Figure 9. Tab fits into the opposite slot. Observe placement of mount before removal and assemble mount with tab positioned as required by hole pattern.

5. Remove tool No. J-24603-01, connect coil bracket replace air cleaner, install engine cover.

INTAKE MANIFOLD

REMOVAL

1. Disconnect battery negative cables from both batteries.

2. Remove air cleaner assembly.

3. Drain radiator, then disconnect upper radiator hose and thermostat by-pass hose from water outlet. Disconnect heater hose at rear of manifold.

4. Remove both upper venturi ring braces on vehicles with air conditioning as shown on Figure 10. Vehicles without air conditioning require removal of L.H. upper venturi ring only.

NOTE: Generator bracket removal is not required, however, generator mounting is shown in Figure 11.

5. Remove air conditioning compressor bracket (if so equipped). See Figure 12.

6. Remove engine oil filler lower tube and flexible elbow.

7. Disconnect temperature gauge wire.

8. Disconnect throttle cable, and cruise control rod (if equipped) from carburetor throttle lever. (See figure 13). Remove cruise control rod.

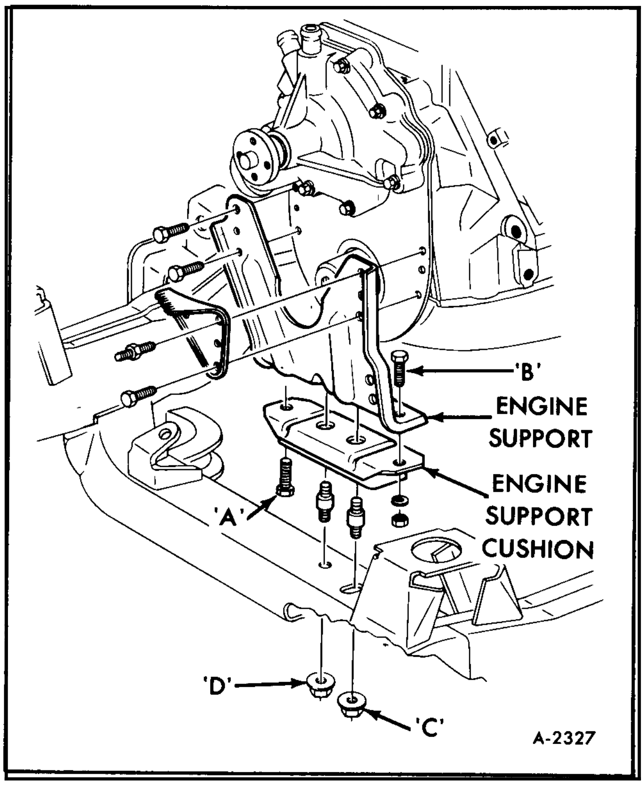


Figure 8—Front Engine Mounting

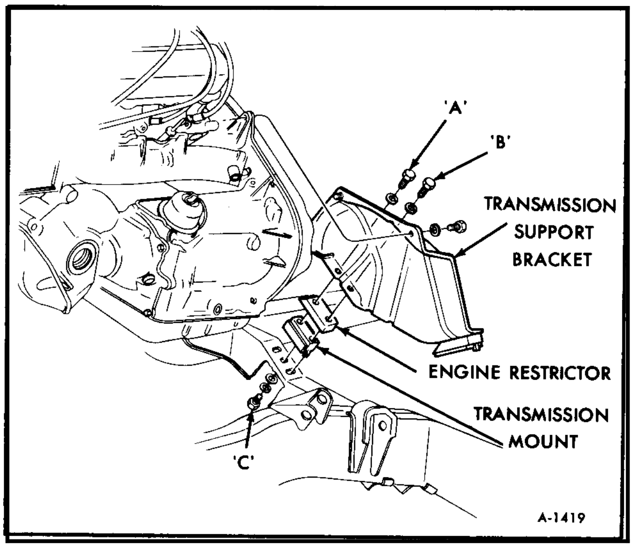


Figure 9—Rear Engine Mounting

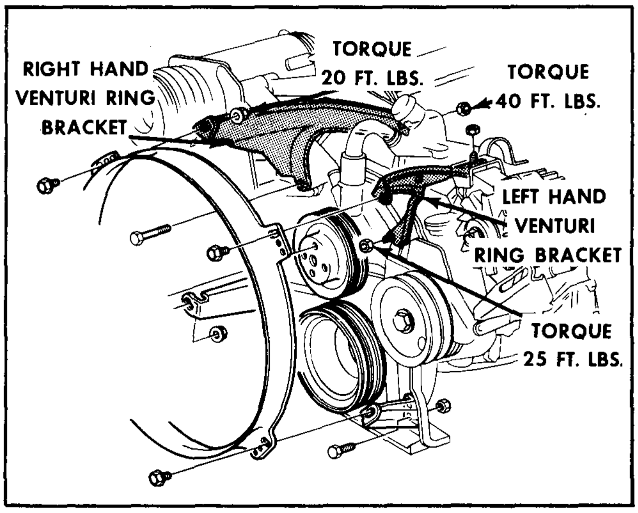


Figure 10—Upper Venturi Ring Brackets

9. Remove fuel line from fuel pump to carburetor.

10. Disconnect vacuum lines from the distributor and tee as shown in Figure 14. Disconnect vacuum line from the front of the carburetor which leads to the carbon canister. Referring to Figure 13, disconnect from the intake manifold—vacuum lines to the brake booster (B), heater control (C) and cruise control (A) (if so equipped).

11. Pull PCV valve from grommet in the right valve cover.

12. Disconnect spark plug cables that lead to cylinders No. 2, 4, 6 and 8 all on the right side, from the spark plugs. Disconnect distributor cap and carefully position cap and cables to the left and free of the work area.

13. Remove coil mounting bolts, if so equipped. Wires may be left connected to the coil if desired.

14. Remove intake manifold bolts, then remove manifold with carburetor attached.

15. Clean machined surfaces of cylinder head and intake manifold with a putty knife. Use care not to gouge or scratch machined surfaces.

INSTALLATION

1. Coat both sides of gasket sealing surface that seal the intake manifold to the head with 1050026 sealer or equivalent and position intake manifold gasket. (See figure 15).

2. Install front and rear end seals, making sure that ends are positioned under cylinder heads as shown in Figures 15 and 16.

3. Install intake manifold. Lubricate bolts entirely with engine oil, install and torque to 15 ft. lbs. in sequence. See Figure 17. Retorque in sequence to 40 ft. lbs.

4. Install coil mounting bolt, if so equipped, and torque to 15 ft. lbs.

5. Install distributor cap and secure. Connect spark plug cables 2, 4, 6 and 8 on the spark plugs.

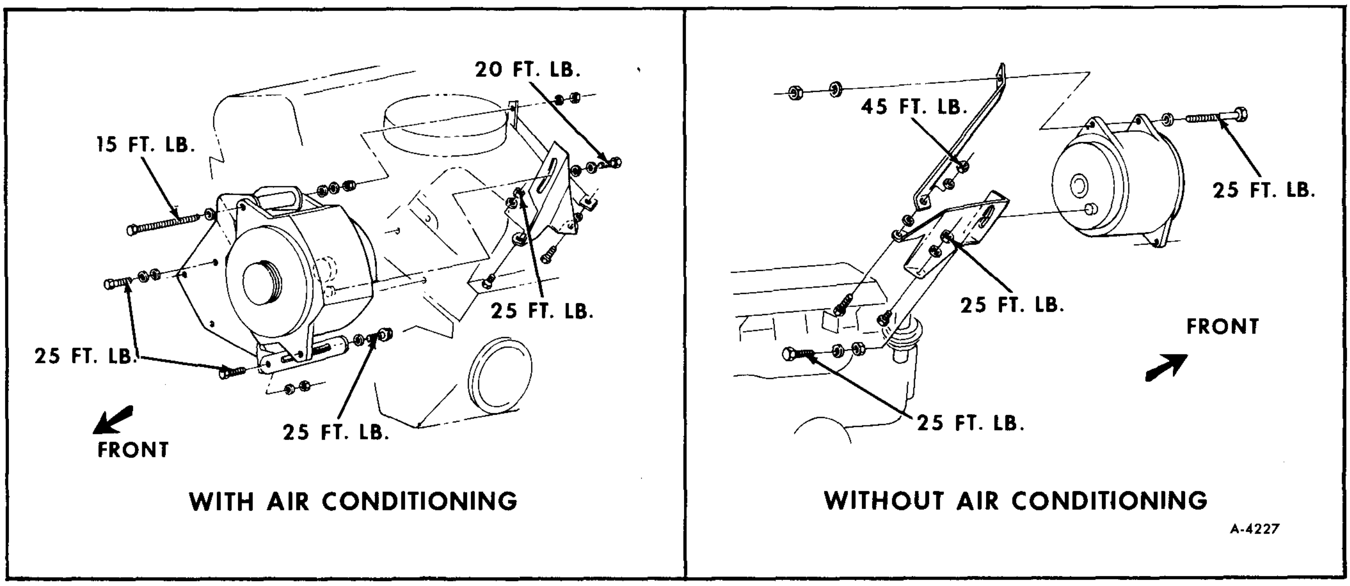


Figure 11—Generator Mounting

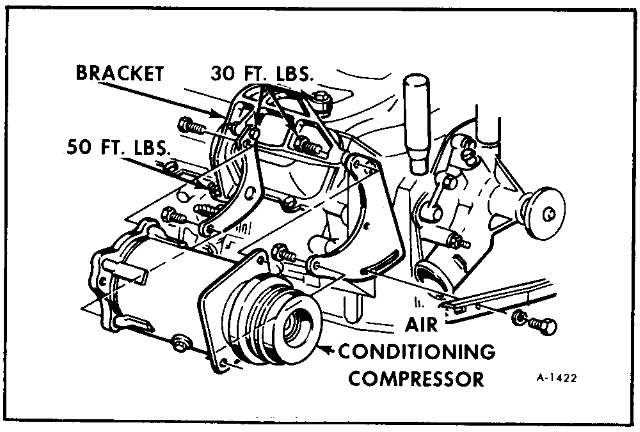


Figure 12—Air Conditioning Compressor Mounting

6. Install PCV valve into grommet on R.H. valve cover.

7. Connect vacuum lines to the distributor and tee as shown in Figure 14. Connect vacuum line to front of carburetor (from the carbon canister). Connect to the intake manifold vacuum lines, to the brake booster, heater control and cruise control (if equipped). See Figure 13.

8. Connect throttle cable, and cruise control (if equipped). See Figure 13.

9. Install fuel line.

10. Connect temperature gauge wire.

11. Install air conditioning bracket (if equipped). See Figure 12.

12. Install oil fill tube and flexible elbow.

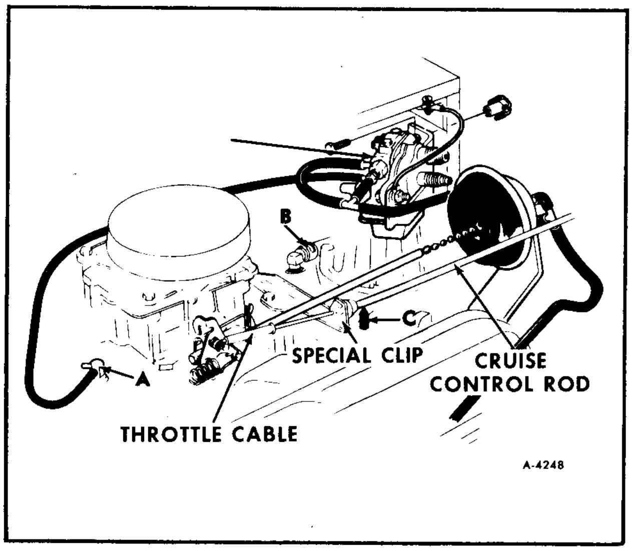


Figure 13—Location for Disconnecting Vacuum Hoses and Throttle Cable

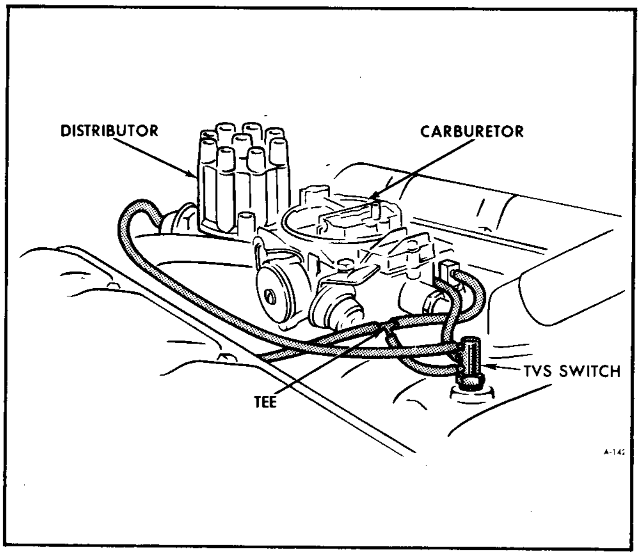


Figure 14—Distributor and Transmission Vacuum Lines (Typical)

13. Install generator mounting bracket, if removed. See Figure 11.

14. Adjust belt tension. Refer to "Belt Tension" later in this section.

15. Install venturi ring brace(s). See Figure 10.

16. Connect upper radiator hose, thermostat and by-pass hose to the water outlet. Connect heater hose at rear of manifold.

17. Install air cleaner.

18. Connect battery negative cables to the batteries.

19. Fill radiator. Start engine and check for leaks.

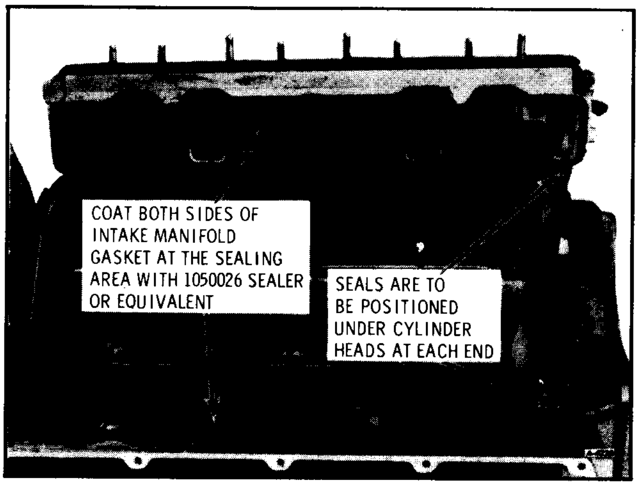
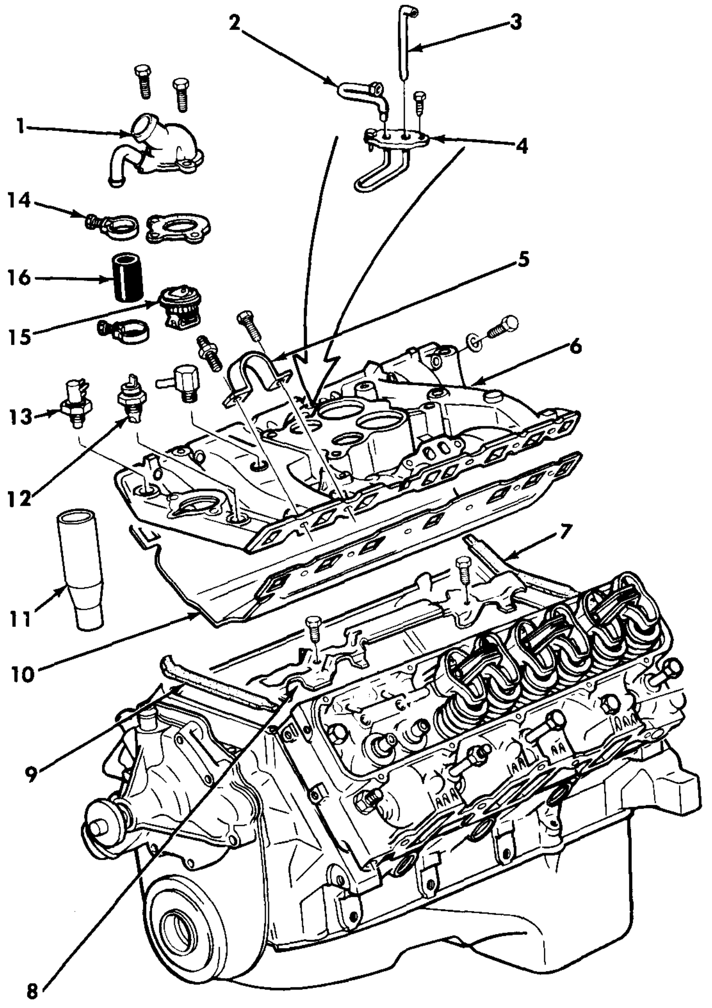


Figure 15—Intake Manifold Gasket



1 Engine Water Outlet
2 Choke Hot Air Pipe
3 Choke Clean Air Pipe
4 Choke Heater
5 Engine Lift Strap
6 Intake Manifold
7 Rear Seal
8 Intake Manifold Baffle
9 Front Seal
10 Intake Manifold Gasket
11 Oil Filler Lower Tube
12 Engine Water Temperature Switch
13 Thermal Vacuum Switch
14 Clamp
15 Thermostat
16 Thermostat By-Pass Hose

A-1425

Figure 16—Intake Manifold and Gasket

L.H. EXHAUST MANIFOLD

REMOVAL

1. Remove air cleaner.

2. Remove hot air shroud as shown in Figure 18.

NOTE: Shroud is attached to exhaust manifold by bolts No. 2 and 5.

3. Hoist vehicle.

4. Remove power steering or generator brackets as required.

5. Disconnect exhaust pipe.

6. Remove exhaust manifold.

INSTALLATION

1. Position exhaust manifold on engine and install bolts No. 3 and 4 finger tight. (See figure 18).

2. Position hot air shroud, power steering and generator braces (as required). Torque braces (as required) Torque bolts to 25 ft. lbs. and bend tabs around bolt heads.

3. Install power steering and generator brackets, using stud "A". Torque to 25 ft. lbs.

4. Connect exhaust pipe and tighten pipe to manifold bolts until they bottom on spacer.

5. Lower vehicle.

6. Install air cleaner.

R.H. EXHAUST MANIFOLD

REMOVAL

1. Hoist vehicle.

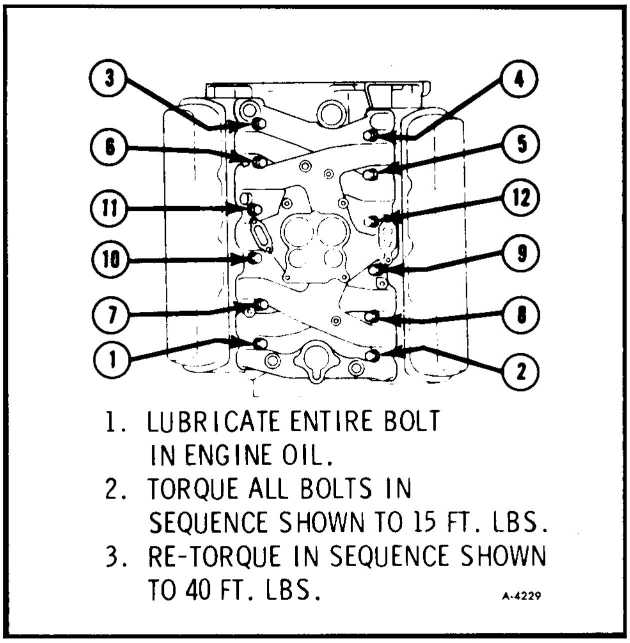


Figure 17—Intake Manifold Torque Sequence

2. Disconnect exhaust pipe.

3. Remove exhaust manifold.

INSTALLATION

1. Install exhaust manifold and torque bolts to 25 ft. lbs. Bend tabs around bolt heads.

2. Connect exhaust pipe and tighten pipe to manifold bolts bottom on spacers.

3. Lower vehicle.

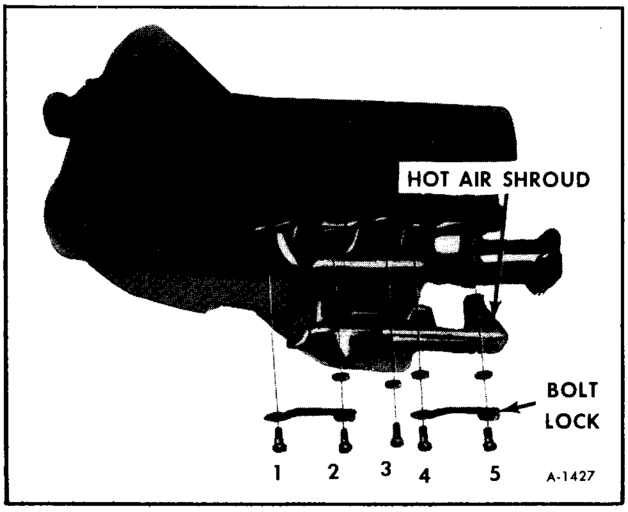


Figure 18—Hot Air Shroud

VALVE COVER

REMOVAL

1. Remove air cleaner.

2. Disconnect positive crankcase ventilation from valve cover (R.H. only).

3. Disconnect spark plug cables from spark plugs and move back and out of the way.

4. Loosen belts and remove accessories and mounting brackets as necessary. Vehicles with air conditioning, it will be necessary to wire the air conditioning compressor up for support after removing its bracket. See Figure 12.

NOTE: Freon lines do not have to be disconnected from the compressor.

5. Remove valve cover to cylinder head attaching screws as shown in Figure 16.

6. Clean gasket surfaces on cylinder head and valve cover.

INSTALLATION

1. Thoroughly clean the head and valve cover gasket surface. Then apply 1051435 R.T.V. (Room Temperature Vulcanizing) sealer or equivalent to the valve cover. See Figure 19.

IMPORTANT: In both production and service, a silastic sealer, GM No. 1051435, replaces the rubber gasket shown in Figure 20. Though the rubber service gasket is available, the silastic sealer makes a better oil seal. A tube wringer, Tool J-25027, insures uniform application.

2. Install valve cover and torque attaching screws as shown in Figure 20.

3. Install accessories and mounting brackets as

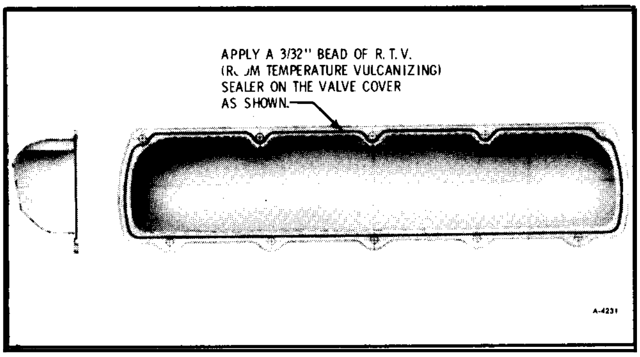


Figure 19—Applying Sealer on Valve Cover

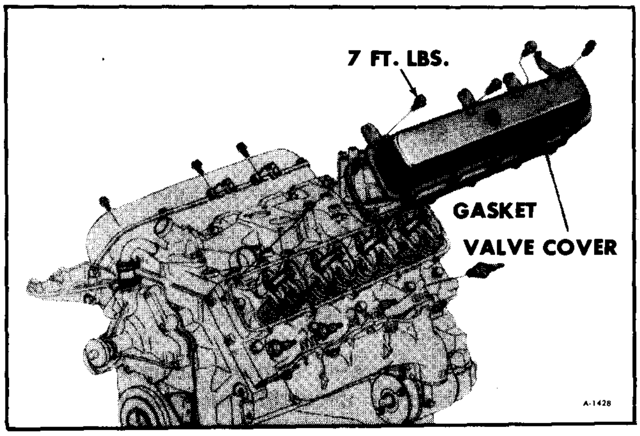


Figure 20—Valve Cover.

necessary. Adjust belt tension. Refer to "Belt Tension" later in this section.

4. Connect spark plug cables, and connect positive crankcase ventilation valve to cover (R.H. only).

5. Install air cleaner.

ROCKER ARM ASSEMBLIES (FIGURE 21)

REMOVAL

1. Remove valve cover. Refer to "Valve Cover" earlier in this section.

2. Remove rocker arm, flanged bolts, pivot and rocker arms. See Figure 22.

NOTE: Remove each set (one set per cylinder) as a unit.

INSTALLATION

1. Position a set of rocker arms (for one cylinder) in the proper location.

2. Lubricate wear points with 1050169 Lubricant or equivalent and install the pivots.

3. Install the hardened flanged bolts and tighten alternately. Torque bolts to 25 ft. lbs.

VALVE LIFTERS

OPERATION

Oil is supplied to the lifter through a hole in the side of the lifter body which indexes with a groove

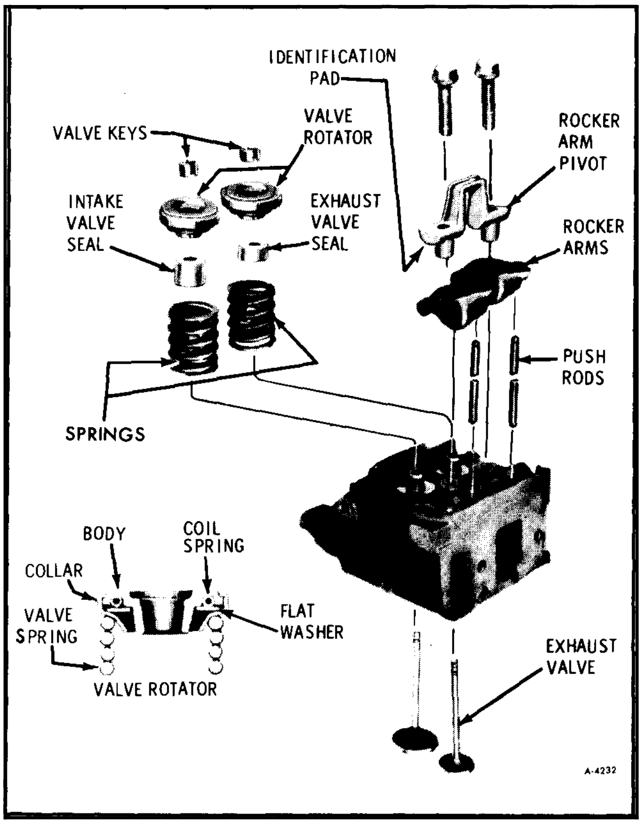


Figure 21—Cylinder Head—Exploded View

and hole in the lifter plunger. Oil is then metered past the oil metering valve in the lifter, through the pushrods to the rocker arms.

When the lifter begins to ride up the cam lobe, the ball check is held against its seat in the plunger by the ball check spring which traps the oil in the base of the lifter body below the plunger. The plunger and lifter body then raise as a unit, pushing

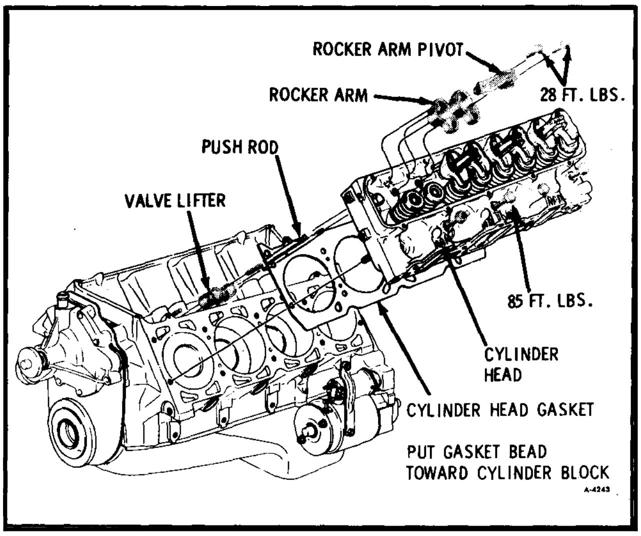


Figure 22—Removing Rocket Arms

up the push-rod to open the valve. The force of the valve spring which is exerted on the plunger through the rocker arm and push-rod causes a slight amount of leakage between the plunger and lifter body. This "leak-down" allows a slow escape of trapped oil in the base of the lifter body. As the lifter rides down the other side of the cam lobe and reaches the base circle or "valve closed" position, the plunger spring quickly moves the plunger back (up) to its original position. This movement causes the ball check to open against the ball spring and oil from within the plunger is drawn into the base of the lifter. This restores the lifter to zero lash. See Figure 23.

Valve Lifter Diagnosis

1. Momentarily Noisy When Vehicle Is Started:

This condition is normal. Oil drains from the lifters which are holding the valves open when the engine is not running. It will take a few seconds for the lifter to fill after the engine is started.

2. Intermittently Noisy on Idle Only, Disappearing When Engine Speed is Increased:

Intermittent clicking may be an indication of a flat or pitted ball, or it may be caused by dirt.

Correction: Clean the lifter and inspect. If ball is defective, replace lifter.

3. Noisy At Slow Idle or With Hot Oil, Quiet With Cold Oil or As Engine Speed is Increased:

Insert a .015" feeler gauge between the rocker arm and valve stem. If noise momentarily disappears and then reappears after a few seconds with the feeler still inserted, it is an indication that the lifter leak-down rate is too fast.

Correction: The lifter must be replaced.

4. Noisy at High Vehicle Speeds and Quiet at Low Speeds.

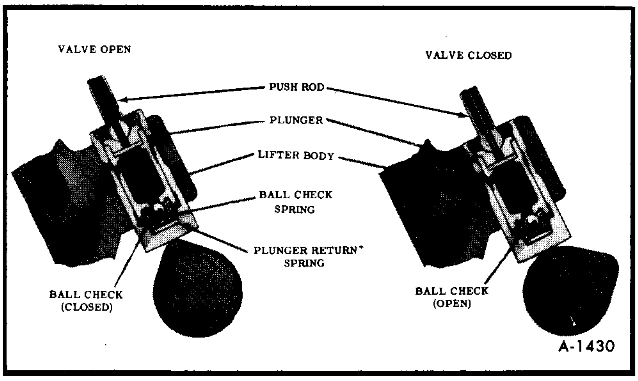


Figure 23—Valve Lifter Cutaway

a. High oil level - Oil level above the "Full" mark allows crankshaft counterweights to churn the oil into foam. When foam is pumped into the lifters, they will become noisy since a solid column of oil is required for proper operation.

Correction: Drain oil until proper level is obtained. See Section O in the beginning of this manual.

b. Low oil level - Oil level below the "Add" mark allows the pump to pump air at high speeds which results in noisy lifters.

Correction: Fill until proper oil level is obtained. See Section O in the beginning of this manual.

5. Noisy at Idle Becoming Louder as Engine Speed is Increased to 1500 rpm.

a. This noise is not connected with lifter malfunction. It becomes most noticeable in the vehicle at 10 to 15 mph "L" range, or 30 to 35 mph "D" range and is best described as a hashy sound. At slow idle, it may be entirely gone or appear as a light ticking noise in one or more valves. It is caused by one or more of the following:

1. Badly worn or scuffed valve tip and rocker arm pad.

2. Excessive valve stem to guide clearance.

3. Excessive valve seat runout.

4. Off square valve spring.

5. Off square rocker arm pad.

6. Excessive valve face runout.

7. Valve spring damper clicking on rotator.

Correction: Remove valve covers and while listening with a stethoscope, locate noisy valves by increasing engine speed slightly above idle, about 1500 rpm. With gloved hand, push side-ways on valve spring. Noise will change, either becoming louder or disappearing completely. Some noise will be present in all valve locations. It is necessary to determine which are actually responsible for the noise.

a. Occasionally this noise can be eliminated by rotating the valve spring and valve. Crank engine until noisy valve is off its seat. Rotate spring. This will also rotate valve. Repeat until valve becomes quiet. If correction is obtained, check for an off square valve spring. If spring is off square more than 1/16" in free position, replace spring. See Figure 24.

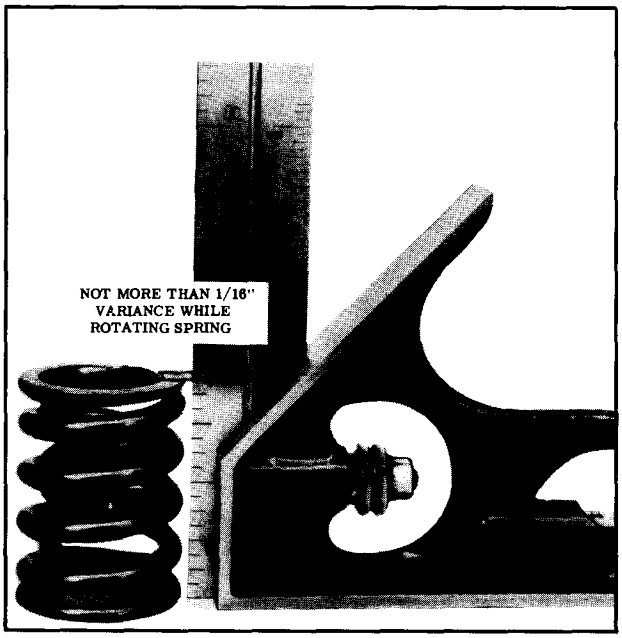


Figure 24—Checking Valve Spring

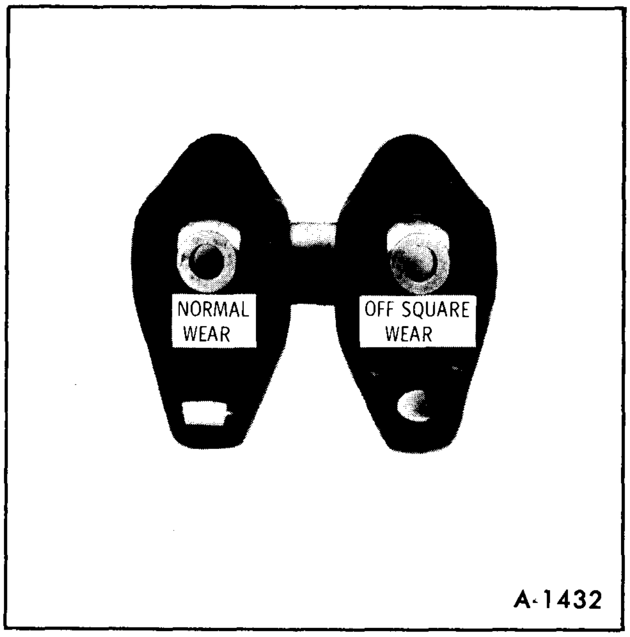


Figure 25—Rocker Arm Wear

b. Observe rocker arm pad for excessive wear or excessive off square. Replace as required. See Figure 25.

c. Check for excessive valve stem to guide clearance. If necessary, correct as required.

6. Valves Noisy Regardless of Engine Speed.

This condition can be caused by foreign particles or excessive valve lash.

Correction: a. With transmission in "park" and parking brake on, run the engine at a moderate speed.

If this method does not quiet the lifter, strike the rocker arm above the push-rod with a mallet while the engine is idling. This method of correction has proven successful for dislodging a foreign particle which is preventing the ball from seating properly.

b. Check for valve lash by turning engine so the piston in that cylinder is on top dead center of firing stroke. If valve lash is present, the push-rod can be freely moved up and down a certain amount with rocker arm held against valve.

Valve lash indicates one of the following:

1. Worn push-rod.

2. Worn rocker arm.

3. Lifter plunger stuck in down position due to dirt or varnish.

4. Defective lifter.

Checking of the above four items:

1. Observe upper end of push-rod. Excessive wear of the spherical surface indicates one of the following conditions.

a. Improper hardness of the push-rod ball. The push-rod and rocker arm must be replaced.

b. Improper lubrication of the push-rod. The push-rod and rocker arm must be replaced. The oiling system to the push-rod should be checked.

2. If push-rod appears in good condition and has been properly lubricated, replace rocker arm and recheck valve lash.

3. If valve lash exists and push-rod and rocker arm are okay, trouble is in the lifter. Lifter should be replaced.

REMOVAL

NOTE: Valve lifters and push-rods should be kept in order so they can be reinstalled in their original position. Some engines will have both standard and .010" oversize valve lifters, the .010" oversize lifter is etched "O" on the side of the lifter. The cylinder block will also be marked if the oversize lifter is used.

1. Remove intake manifold and gasket. Refer to "Intake Manifold" earlier in this section.

2. Remove valve covers, rocker arm assemblies and push-rods. Refer to those areas earlier in this section.

3. If lifters are varnished, apply carburetor cleaning solution to lifter body. Allow five minutes for solution to remove varnish. Remove valve lifters.

CAUTION: *Carburetor cleaning solvent should be used in a well ventilated room. Avoid contact with skin and prolonged breathing of fumes.*

DISASSEMBLY

1. Remove retainer ring with a small screwdriver.

2. Remove push-rod seat and oil metering valve.

3. Remove plunger and plunger spring. If plunger is stuck tight, allow lifter to soak in carburetor cleaning solvent for approximately five minutes, then remove.

4. Remove ball check retainer from plunger, then remove ball and spring.

CLEANING AND INSPECTION

After lifters are disassembled, all parts should be cleaned in clean solvent. A small particle of foreign material under the ball check valve will cause malfunctioning of the lifter. Close inspection should be made for nicks, burrs or scoring of parts. If either the body or plunger is defective, replace with a new lifter assembly.

NOTE: Do not condemn valve lifters that have a slight gap or show evidence of leakage where the lifter foot is welded to the lifter body.

Whenever lifters are removed, check the lifter foot for abnormal wear as follows:

1. Place a straight edge across the lifter foot.

NOTE: Lifter foot must be clean and dry.

2. While holding the lifter at eye level check for light between the straight edge and lifter foot.

3. If light indicates a flat or concave surface of the lifter foot, the lifter should be replaced and the camshaft inspected for wear. Wear at the CENTER of the cam base circle is NORMAL. The camshaft should be replaced ONLY when wear is present across FULL WIDTH of cam base circle.

ASSEMBLY

1. Assemble ball check, spring and retainer into plunger. See Figure 26. Make sure retainer flange is pressed tight against bottom of recess in plunger.

2. Install plunger spring over ball check retainer.

3. Hold plunger with spring up and insert into lifter body. Hold plunger vertically to prevent cocking spring.

4. Assemble oil metering valve and push rod seat and seat retaining ring in groove.

INSTALLATION

1. Install lifters and push-rods into original position in cylinder block. See note under Removal.

2. Install baffle as shown in Figure 27. Install manifold gaskets and manifold. Refer to "Intake Manifold" earlier in this section.

3. Position rocker arms, pivots and bolts on cylinder head as shown in Figure 21.

4. Install valve covers. Refer to "Valve Cover" earlier in this section.

CYLINDER HEAD AND GASKET

REMOVAL

1. Drain radiator. Drain cock located at lower left side of radiator. By raising the rear wheels ap-

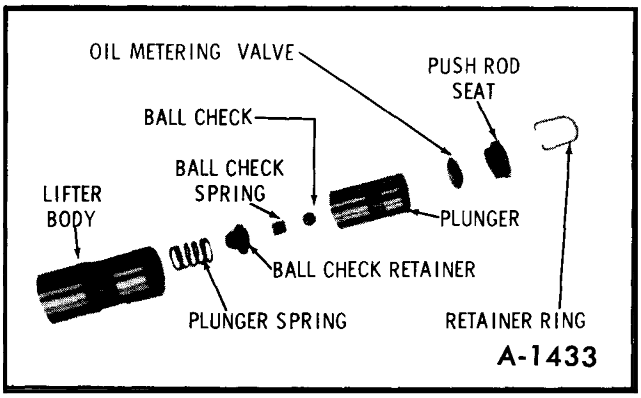


Figure 26—Valve Lifter—Exploded View

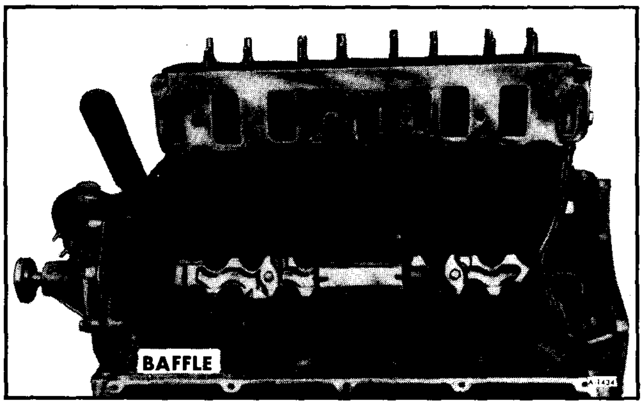


Figure 27—Baffle Installation

proximately 2-1/2 feet high, enough engine coolant will drain from the engine block to allow removal of the heads.

NOTE: To avoid overloading the front suspension raise front of the vehicle enough so front wheels are just off the ground.

2. Remove intake manifold. Refer to "Intake Manifold" earlier in this section.

3. Loosen exhaust pipe clamp at muffler. Remove exhaust manifold bolts and position exhaust manifold away from head.

4. Loosen or remove any accessory brackets which interfere with head removal.

5. Remove valve cover. Refer to "Valve Cover" earlier in this section.

6. Remove rocker arm bolts, pivots, rocker arms and push-rods as shown in Figure 21.

NOTE: Scribe pivots and keep rocker arms separated so they can be installed in their original locations.

7. Remove cylinder head bolts, then remove cylinder head.

NOTE: If a clearance problem is encountered for number 7 or 8 cylinder head bolts or push rods, pull these out far enough to clear the block, secure with rubberbands, and remove or install with the cylinder heads.

CAUTION: *Gasket surfaces on both the head and the block must be clean of any foreign matter and free of nicks or heavy scratches. The cylinder head bolt threads in the block and threads on cylinder head bolt must be cleaned. Dirt will affect bolt torque.*

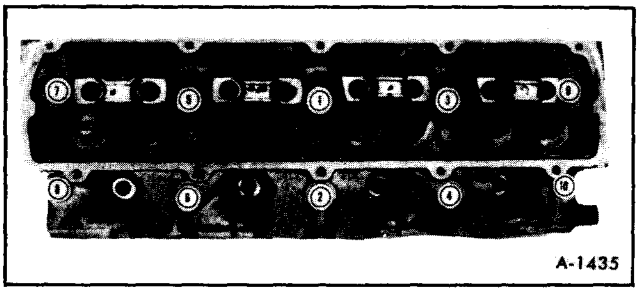


Figure 28—Cylinder Head Torque Sequence

INSTALLATION

1. Use a new head gasket and coat both sides with part No. 1050026 sealer or equivalent. Install gasket with bead facing cylinder.

2. Clean and dip cylinder head bolts in engine oil.

3. Install cylinder head and torque bolts to 60 ft. lbs. in sequence as shown in Figure 28. Then retorque in sequence to 85 ft. lbs.

NOTE: Torque head bolts before installing rocker arms and pivots if a clearance problem is encountered.

4. Install push rods, pivots, rocker arms and bolts. Torque rocker arm pivot bolts to 25 ft. lbs., tighten by alternating from side to side.

NOTE: Be sure to replace rocker arms and pivots to their original locations.

5. Install valve cover. Refer to "Valve Cover" earlier in this section.

6. Install intake manifold. Refer to "Intake Manifold" earlier in this section.

7. Install any accessory brackets that were removed previously.

8. Install exhaust manifold. Torque bolts to 25 ft. lbs. Bench tabs around bolt heads. Torque clamp on exhaust pipe at muffler to 20 ft. lbs.

9. Add engine coolant.

10. Start engine and check for leaks.

VALVES AND SPRINGS WITH HEAD REMOVED

REMOVAL

1. Remove spark plugs.

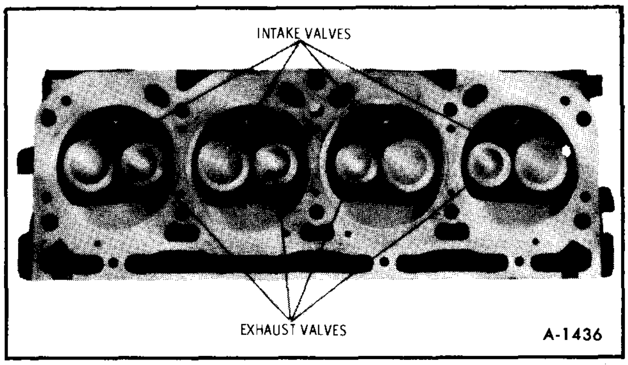


Figure 29—Valve Location

2. Remove valve keys by compressing valve spring with a tool J-5892-1.

3. Remove valve spring rotators or retainers and springs.

4. Remove oil seals from valve stems.

5. Remove valves. Keep valves separated so they can be installed in their original locations. See Figure 29.

INSTALLATION

1. Install valves in their respective guides.

2. Install new oil seals over valve stem, using Tool J-24725. See Figure 30.

Position seals down as far as possible on valve stem. The seals will correctly position themselves when the engine is started.

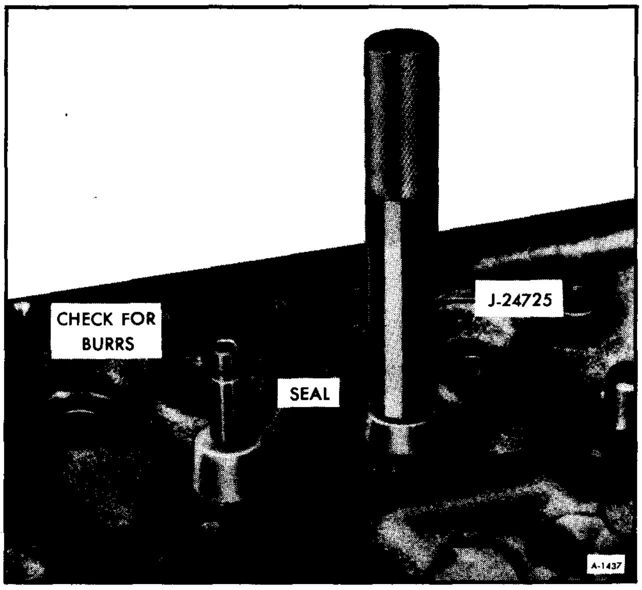


Figure 30—Valve Seal Installation

NOTE: Inspect seal for cracks after installation.

3. Position valve springs over valve stems.

4. Install valve rotators then compress springs with a tool J-5892-1 and install valve stem keys.

5. Check valve springs and keys to be sure they are properly seated.

6. Set spark plug gap. Lubricate plug threads with one drop of engine oil and re-install plugs. Torque to 35 ft. lbs. for vehicles equipped with breaker point ignition systems, and 25 ft. lbs. for high energy ignition systems.

Reconditioning Valves

When reconditioning valves and valve seats, clean carbon from cylinder heads and valves using care not ot gouge or scratch machined surfaces. A soft wire brush is suitable for this purpose. Whenever valves are replaced or new valves installed, the valve seats must be reconditioned.

Figure 31 shows the relation of valve angle and valve seat angle. Arc "A" should be 44° on the intake valve and 30° on the exhaust valve. Arc "B" should be 45° on the intake valve seat and 31° on the exhaust valve seat.

Narrow the valve seats to the specified width.

NOTE: This operation is done by grinding the portside with a 30° stone to lower the seat and a 60° stone to raise the seat.

See "Engine Specification" Chart for valve seat width.

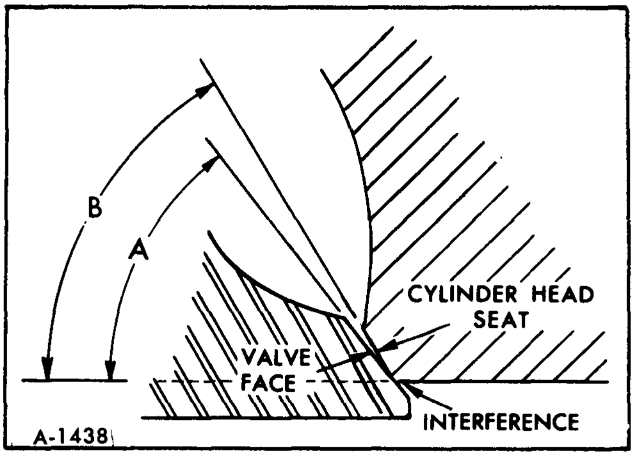


Figure 31—Relation of Valve and Seat Angles

NOTE: Exhaust valve seats are induction hardened and must be ground, Not cut.

If valve guide bores are worn excessively, they can be reamed oversize. This will require replacement of the valves with oversize valves (stems). The guide bores should be reamed before grinding the valve seats. Valve clearance in guide bore should be .001" to .004".

Measuring Valve Stem Height

Whenever a new valve is installed, or after grinding valves, it will be necessary to measure valve stem height. Install Gauge BT-6428. There should be at least .015" clearance on all valves between gauge surface and end of valve stem. (Valve stem can be gauged with or without the valve rotator on the valve). If clearance is less than .015", remove valve and grind tip of valve stems as required on a valve tachment to insure a smooth 90° end. Also be certain to break sharp edge on ground valve tip. Observe an original valve to determine chamfer.

After all valve keys have been installed on valves, tap each valve stem end with a hammer to seat valve rotators and keys. Re-gauge all valves between valve stem and gauge (.015" minimum) and valve rotator and gauge (.030" minimum). If any valve stem end is less than .005" above rotator, the valve is too short and a new valve must be installed.

NOTE: There must be a minimum of .030" clearance between valve rotator and gauge. Failure to maintain this clearance will cause rocker arm and valve rotator interference. Example:

Valve Rotator to Gauge Clearance	.038"
Minus Valve Stem to Gauge Clearance	-.035"
	.003"

This is less than .005" and a new valve should be installed.

VALVE GUIDE BORES

As previously stated, if the valve guide bores are worn excessively, they can be reamed oversize. The following reamers are available:

.003" Oversize Valve Guide Reamer

.005" Oversize Reamer

.013" Oversize Valve Guide Reamer

If a standard valve guide bore is being reamed, use the .003" or .005" oversize reamer. For the .010" oversize valve guide bore, use the .013" oversize reamer. If too large a reamer is used and the spiraling is removed, it is probable that the valve will not receive the proper lubrication.

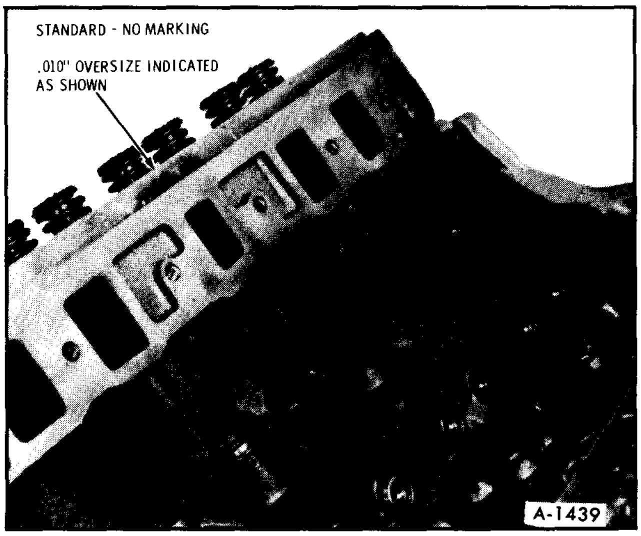


Figure 32—Valve Guide Bore Marking

Occasionally a valve guide bore will be oversize as manufactured. These are marked on the inboard side of the cylinder heads on the machined surface just above the intake manifold surface (figure 32). These markings are visible without removing any parts other than the air cleaner assembly. Before removing the cylinder heads to perform service to either the valves or valve guide bores, the cylinder heads should be inspected to determine if these markings are present. If no markings are present, the guide bores are standard. If oversize markings are present, any valve replacement will require an oversize valve. If the oversize marking is present, only

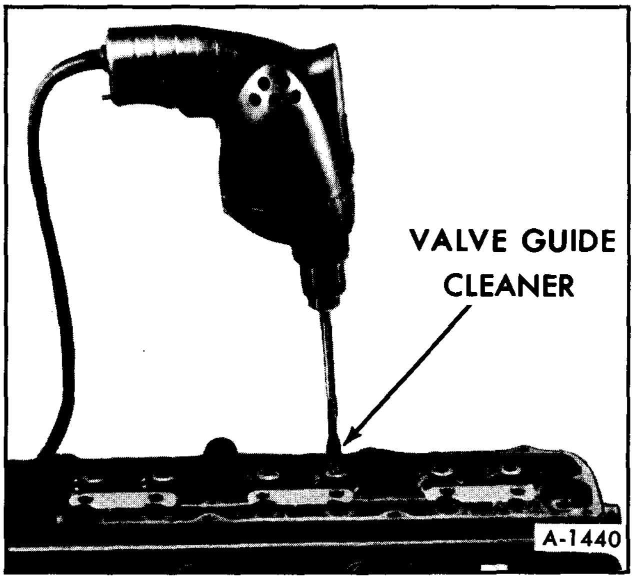


Figure 33—Cleaning Valve Guide Bores

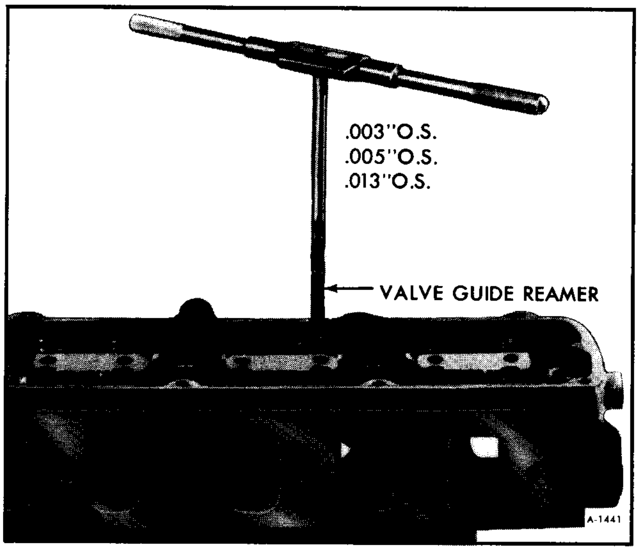


Figure 34—Reaming Valve Guide Bores

that particular bore would be oversize, not all bores in that cylinder head. Service valves are available in five different stem diameters: Standard, .003" oversize, .005" oversize, .010" oversize, and .013" oversize.

Reaming Procedure

Before attempting to ream the valve guide bores they should be cleaned using a tool as shown in Figure 33.

This procedure to ream valve guide bores using a reamer is shown in Figure 34. Use care to hold reamer straight in valve guide bore.

REPLACING VALVE SPRING (HEAD ON ENGINE)

To replace a worn or broken valve spring without removing the cylinder head proceed as follows:

REMOVAL

1. Remove valve covers. Refer to "Valve Cover" earlier in this section.

2. Remove rocker arm assemblies.

3. Remove spark plug and install Tool J-22794 into spark plug hole and attach to an air hose to hold the valve against its seat. (See figure 35).

4. Install Tool J-5892-1. See Figure 35. Compress

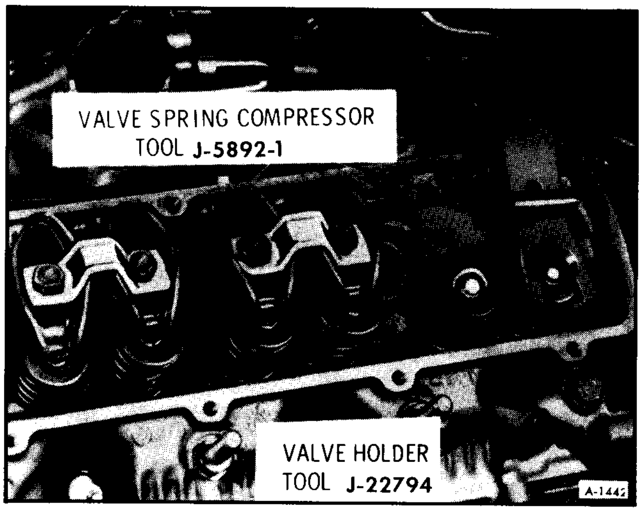


Figure 35—Removing Valve Spring

the valve spring until valve keys are accessible, then remove keys, valve rotators and springs.

NOTE: If valve spring does not compress, tap tool with a hammer to break bind at rotator and keys.

CHECKING ROTATORS

The rotators cannot be disassembled and require replacement only when they fail to rotate the valve.

Rotator action can be checked by applying a daub of paint across the top of the body and down the collar. Run engine approximately 1500 rpm, there should appear to be motion between the body and collar, the body will appear to "walk" around the collar. Rotator action can be either clockwise or counterclockwise, sometimes on removal and reinstallation; the direction of rotation will change but this does not matter so long as it rotates.

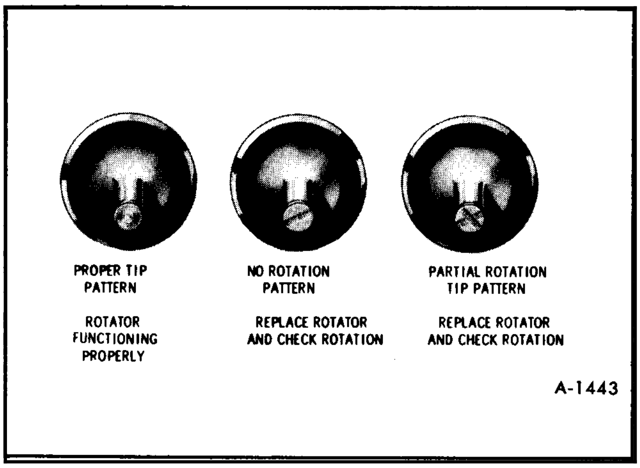


Figure 36—Valve Stem Wear

Anytime the valves are removed for service the tips should be inspected for improper pattern which could indicate valve rotator malfunction. See Figure 36.

INSTALLATION

1. Install valve spring and rotator. Using Tool J-5892-1, compress the valve spring until the valve keys can be installed.

2. Remove tool No. J-22794 and install spark plugs. Torque 35 ft. lbs. for vehicles equipped with breaker point ignition system, and 25 ft. lbs. for high energy ignition systems.

3. Install rocker arm assemblies.

4. Install valve covers. Refer to "Valve Cover" earlier in this section.

OIL PAN

REMOVAL

1. Remove transmission and final drive. Refer to "Engine Removal" later in this section.

2. Remove oil pan drain plug and drain oil.

3. Disconnect relay tie rod from the idler arm and the relay lever. Also disconnect steering shock absorber from crossmember bracket.

4. Remove L.H. lower venturi ring bracket.

5. Disconnect power steering pump.

6. Remove four (4) front support bolts and front motor mount bolts. Position support forward. (See figure 6).

7. Remove flywheel.

8. Remove oil pan bolts.

9. Raise front of engine enough so the oil pan can be removed (approximately one inch).

10. Clean gasket surfaces on the engine block and the oil pan.

INSTALLATION

1. Apply sealer 1050026 or equivalent to both sides of gaskets. Position all gaskets on engine block. See Figure 37.

2. Position oil pan on engine. Start all bolts and install until finger tight. Torque oil pan bolts to 10 ft. lbs.

3. Replace flywheel and torque bolts to 60 ft. lbs.

4. Lower engine to position. Install four (4) front support bolts and torque to 50 ft. lbs. See Figure 8.

5. Torque engine front support to 50 ft. lbs. (See figure 6).

6. Install power steering pump.

7. Install L.H. lower venturi ring bracket.

8. Connect relay tie rod and torque nuts to 50 ft. lbs., then insert cotter pin. Connect steering shock absorber to bracket at crossmember, torque nut to 40 ft. lbs.

9. Install oil pan drain plug. Torque to 30 ft. lbs.

10. Install transmission and final drive. Refer to "Engine Replacement" later in this section.

11. Lower vehicle.

12. Add engine oil. Refer to Section "O" for proper viscosity and quanity.

13. Start engine and check for leaks.

OIL PUMP

REMOVAL

1. Remove oil pan. Refer to "Oil Pan" earlier in this section.

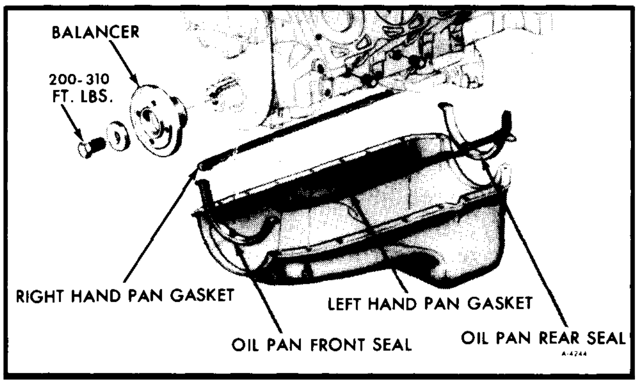


Figure 37—Oil Pan Assembly

2. Remove the oil pump to rear main bearing cap attaching bolts, then remove rear oil deflector, then remove pump and drive shaft extension.

DISASSEMBLY (FIGURE 38)

1. Remove the oil pump drive shaft extension.

NOTE: Do not attempt to remove the washers from the drive shaft extension. The drive shaft extension and washers must be serviced as an assembly. See Figure 39.

2. Remove the cotter pin, spring and the pressure regulator valve.

NOTE: Position thumb over pressure regulator bore before removing cotter pin, as the spring is under pressure.

3. Remove the oil pump cover attaching screws and remove the oil pump cover and gasket.

4. Remove the drive gear and idler gear from the pump body.

INSPECTION

Check the gears for scoring or other damage. If they are damaged, new gears should be installed. During assembly, the gear end clearance should be gauged. Proper end clearance is .0025" to .0065". Also check the pressure regulator valve, valve spring and bore for damage. Proper valve to bore clearance is .0025" to .0050".

ASSEMBLY

1. Install the drive gear into the pump with the hex ID of the drive shaft toward the oil pump mounting pad, then install the idler gear.

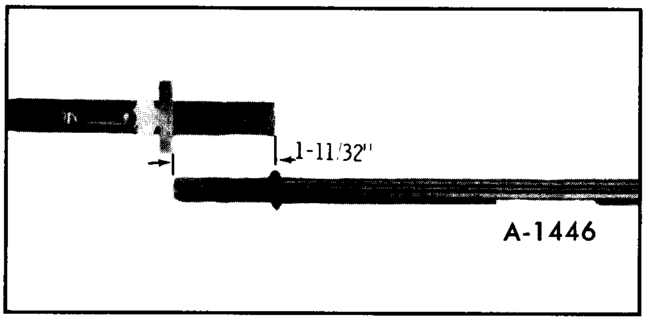


Figure 39—Oil Pump Shaft Extension

2. Position a new gasket on the pump body and install the oil pump cover. Tighten the cover screws to 8 ft. lbs.

3. Position the pressure regulator valve into the pump cover, closed end first, then install the spring and retaining pin.

NOTE: When assembling the drive shaft extension to the drive shaft, the END OF THE EXTENSION NEAREST THE WASHERS MUST BE INSERTED INTO THE DRIVE SHAFT.

INSTALLATION

1. Insert the drive shaft extension through the opening in the main bearing cap and block until the shaft mates into the distributor drive gear.

2. Position pump onto the rear main bearing cap replace rear oil deflector and install attaching bolts. Torque bolts to 35 ft. lbs. See Figure 40.

3. Install the oil pan. Refer to "Oil Pan" installation earlier in this section.

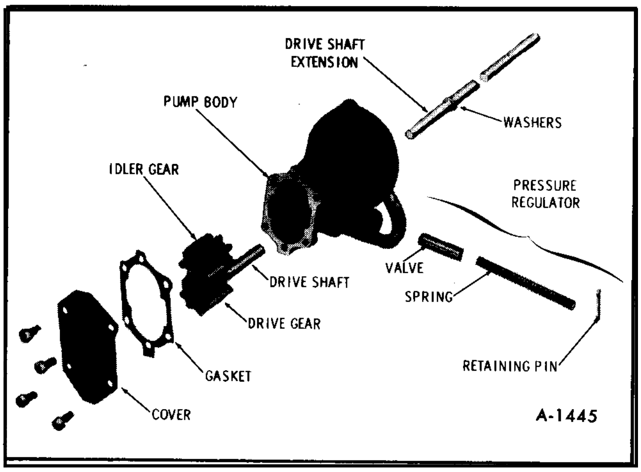


Figure 38—Oil Pump Exploded View

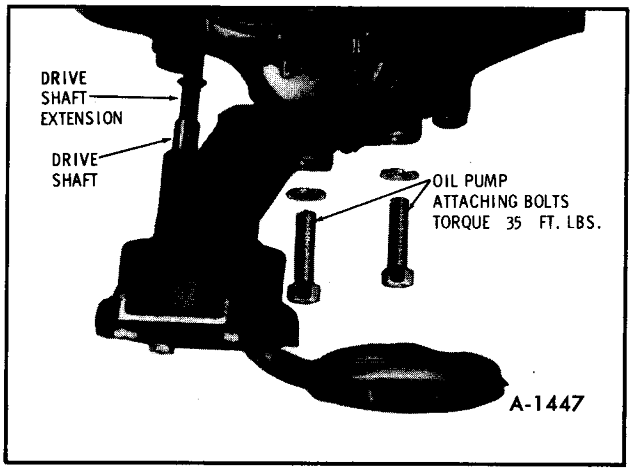


Figure 40—Oil Pump Installation

CONNECTING ROD AND PISTON ASSEMBLY

REMOVAL

1. Remove intake manifold. Refer to "Intake Manifold" earlier in this section.

2. Remove head or heads, oil pan and oil pump. Refer to those areas earlier in this section.

NOTE: Stamp cylinder number on the machined surfaces of the bolt bosses of the connecting rod and cap for identification when reinstalling. If the pistons are to be removed from the connecting rod, mark cylinder number on piston with a silver pencil or quick drying paint for proper cylinder identification and cap to rod location. The right bank is numbered 2-4-6-8, left bank 1-3-5-7.

Examine the cylinder bore above ring travel. If ridge exists, remove ridge with ridge reamer before attempting to remove the piston and rod assembly.

3. Remove rod bearing cap and bearing.

4. Install guide hose over threads of rod bolts. This is to prevent damage to bearing journal and rod bolt threads. See Figure 41.

5. Remove rod and piston assembly through the top of the cylinder bore.

6. Remove other rod and piston assemblies in the same manner.

ROD BEARINGS

The connecting rod bearings are designed to have

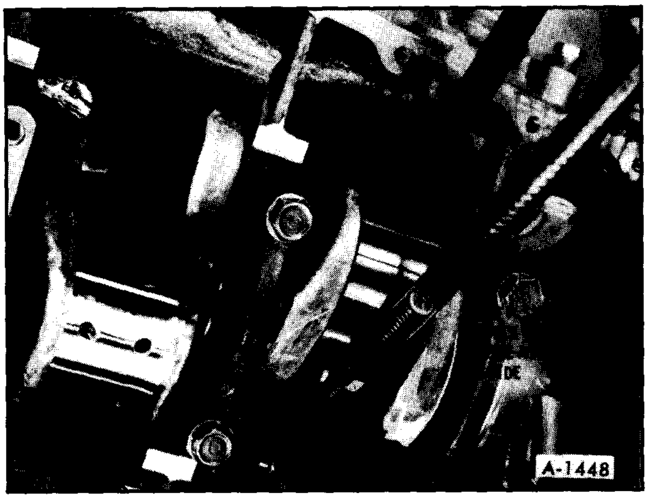


Figure 41—Connecting Rod Bolt Guide

a slight projection above the rod and cap faces to insure a positive contact.

Connecting rod bearings can be replaced without removing the rod and piston assembly from the engine.

REMOVAL

1. Remove oil pan. Refer to "Oil Pan" earlier in this section.

NOTE: It may be necessary to remove oil pump to provide access to rear connecting rod bearings.

2. With connecting rod journal at the bottom, stamp cylinder number on machined surfaces of connecting rod and cap for identification when reinstalling, then remove caps.

3. Inspect journals for roughness and wear. Slight roughness may be removed with a fine grit polishing cloth saturated with engine oil. Burrs may be removed with a fine oil stone by moving the stone on the journal circumference. Do not move the stone back and forth across the journal. If the journals are scored or ridged, the crankshaft must be replaced.

4. The connecting rod journals should be checked for out-of-round and correct size with a micrometer. Maximum out-of-round must not exceed .0015".

NOTE: Refer to "Engine Specifications" later in this section.

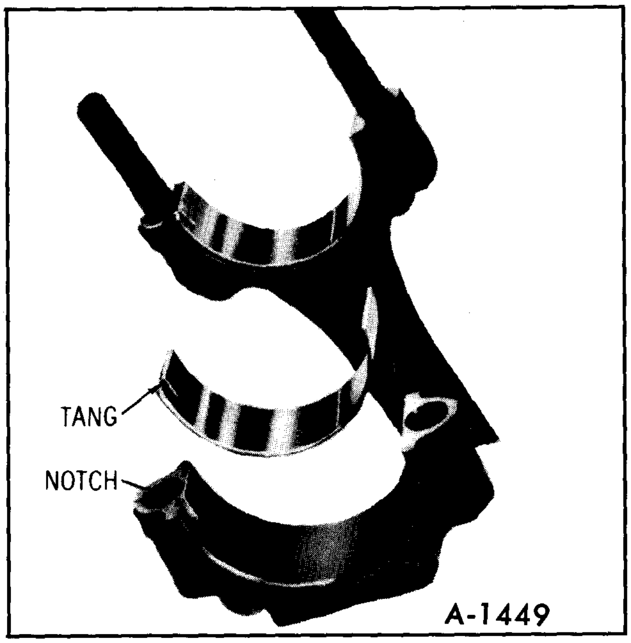


Figure 42—Bearing Tang and Notch

If Plastigauge is to be used:

5. Clean oil from journal bearing cap, connecting rod and outer and inner surface of bearing inserts. Position insert so that tang is properly aligned with notch in rod and cap. See Figure 37.

6. Place a piece of plastigauge in the center of lower bearing shell.

7. Reinstall bearing cap and torque to 42 ft. lbs.

8. Remove bearing cap and determine bearing clearances by comparing the width of the flattened plastigauge at its widest point with the graduation on the plastigauge container. The number within the graduation on the envelope indicates the clearance in thousandths of an inch. If this clearance is greater than .0035", replace the bearing and recheck clearance with plastigauge.

NOTE: Lubricate bearing with engine oil before installation. Repeat Steps 2 through 8 on remaining connecting rod bearings. All rods must be connected to their journals when rotating the crankshaft to prevent engine damage.

NOTE: Bearings are identified as shown in Figure 38.

9. Spread rods with screwdriver and measure the rod side clearance as shown in Figure 39. Clearance should be .006" to .020".

NOTE: If a rod is twisted or bent, a new rod must be installed. NO ATTEMPT SHOULD BE MADE TO STRAIGHTEN CONNECTING RODS.

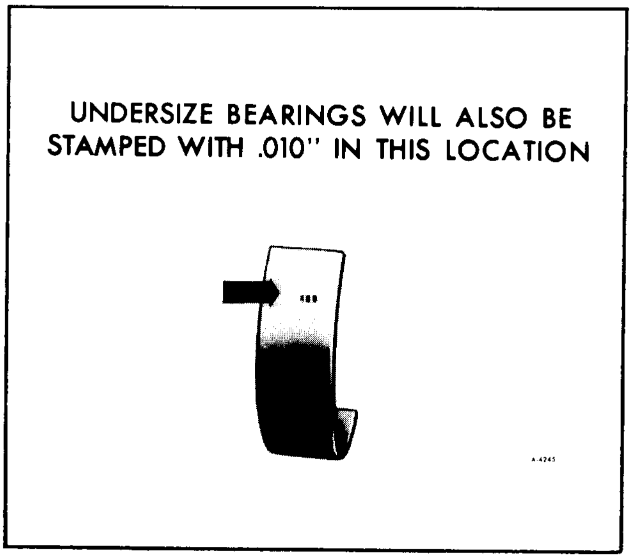


Figure 43—Bearing Identification

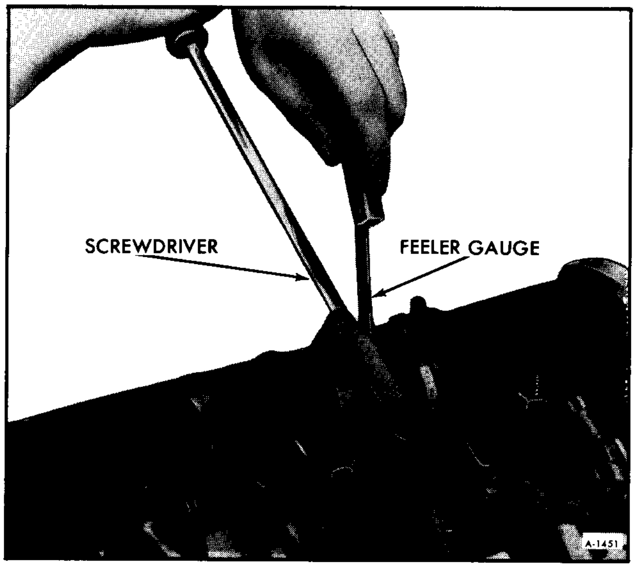


Figure 44—Connecting Rod Side Clearance

PISTON

MEASURING PISTON

NOTE: Refer to PISTON INFORMATION Chart. When replacing pistons, the original cylinder size is stamped with a code letter on the block near each cylinder on the cylinder head surface. See Figure 40.

When measuring piston for size or taper, measurement must be made on skirt 90° from piston pin hole (with the piston pin removed). See Figure 41.

When measuring taper, the largest reading must be at the bottom of the skirt. Allowable taper is .000" to .001".

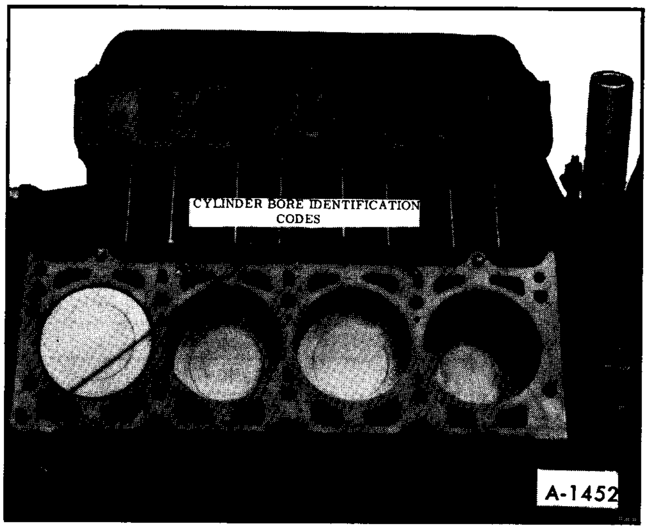


Figure 45—Cylinder Bore Marking

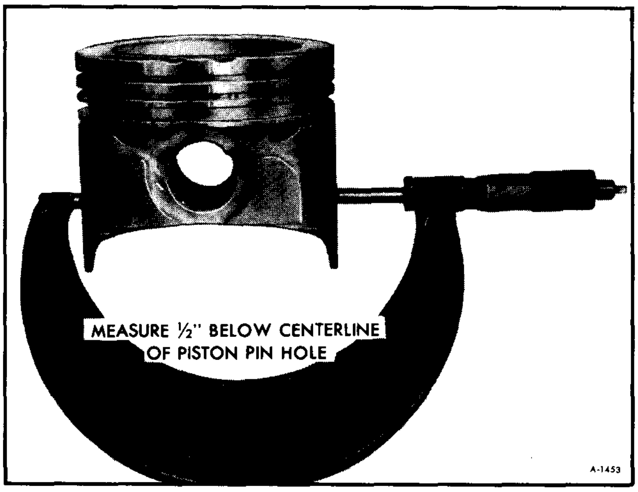


Figure 46—Measuring Piston

The piston and cylinder bore must be free of oil and at the same temperature.

NOTE: In some engines, oversize pistons may be found. These pistons will be .010" oversize.

1. Place a strip of .0015" feeler gauge against the upper side of the bore, at 90° to the normal piston pin location. Attach a scale which measures in pounds to a feeler gauge. See Figure 42.

2. Insert piston upside down with pin and rings removed, into bore.

3. While holding the piston in the center of its normal travel, slowly pull the scale in a straight line and note the reading on the scale. The reading should be between 3 to 12 pounds while pulling the feeler gauge out of the bore.

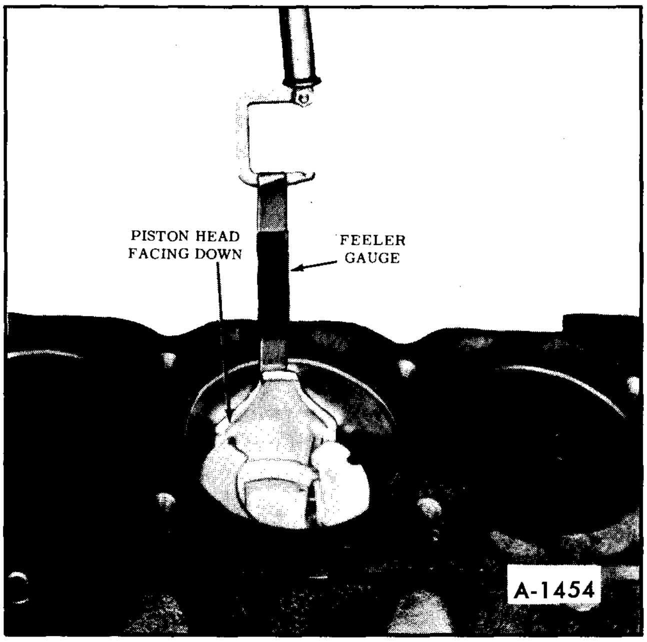


Figure 47—Checking Piston Clearance

Each piston should be fitted to its individual cylinder and marked for that cylinder.

CLEANING PISTON

Clean the pistons by scraping carbon off the top of the piston. Deposits in the ring grooves should be removed with a suitable ring groove cleaning tool. It is important that the ring grooves be completely free of deposits.

PISTON INFORMATION CHART

BORE DIAMETER	CYLINDER BORE SELECTION	BORE SIZES	PISTON SELECTION	PISTON SIZE	PISTON DIAMETER	PISTON TO CYL. BORE CLEARANCE	RING SIZE
4.1250-4.1270 Std.	A	4.1250-4.1255	A	4.1240-4.1235	4.1255-4.1235 Std.	.001 to .002	Std.
	B	4.1255-4.1260	B	4.1245-4.1240			
	C	4.1260-4.1265	C	4.1250-4.1245			
	D	4.1265-4.1270	D	4.1255-4.1250			
4.1350-4.1370 .010 O.S.	J	4.1350-4.1355	J	4.1340-4.1335	4.1355-4.1355 .010 O.S.		.010" O.S.
	K	4.1355-4.1360	K	4.1345-4.1340			
	L	4.1360-4.1365	L	4.1350-4.1345			
	M	4.1365-4.1370	M	4.1355-4.1350			

CHECKING CYLINDER BORE

NOTE: Refer to PISTON INFORMATION Chart.

Cylinder bore size can be measured with inside micrometers or a cylinder gauge. Maximum allowable taper of the cylinder bore is .001". The most wear will occur at the top of the ring travel.

Reconditioned cylinder bores should be held to not more than .001" out-of-round and .001" taper.

If the cylinder bores are smooth, the cylinder walls should not be deglazed. If the cylinder walls are scored the walls may have to be honed before installing new rings. It is important that reconditioned cylinder bores be thoroughly washed with a soap and water solution to remove all traces of abrasive material to eliminate premature wear.

RINGS (FIGURE 48)

The pistons have three rings (two compression rings and one oil ring). The oil ring consists of two rails and an expander.

RING TOLERANCES

When installing new rings, ring gap and side clearance should be checked as follows:

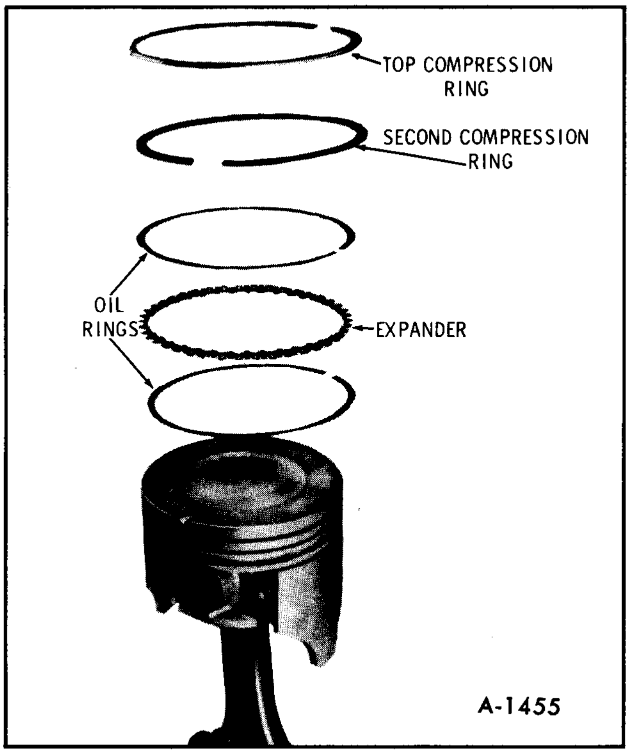


Figure 48—Piston Rings

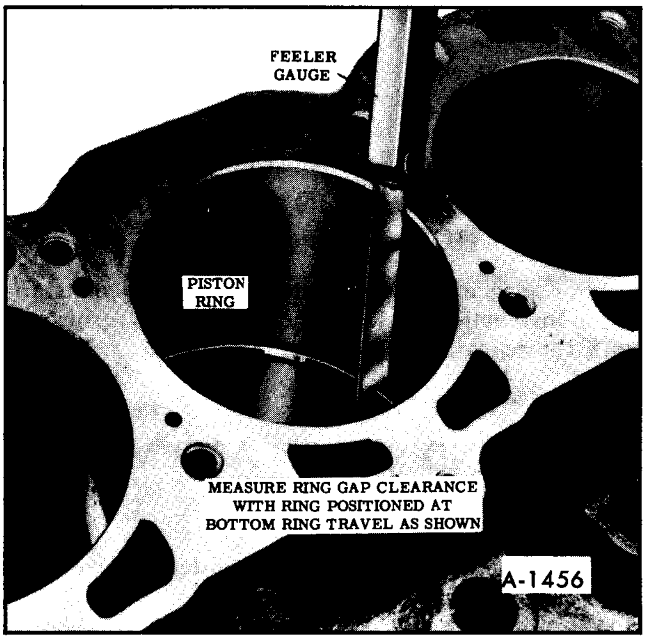


Figure 49—Measuring Piston Ring Gap

PISTON RING AND RAIL GAP

Each ring and rail gap must be measured with the ring or rail positioned squarely and at the bottom of the ring-travel area of the bore. See Figure 49.

The gap measurement should be .013" to .023" for compression rings and .015" to .055" for oil rings.

SIDE CLEARANCE

Each ring must be checked for side clearance in its respective piston groove by inserting a feeler gauge between the ring and its upper land. See Figure 50. The Piston grooves must be cleaned before checking ring for side clearance.

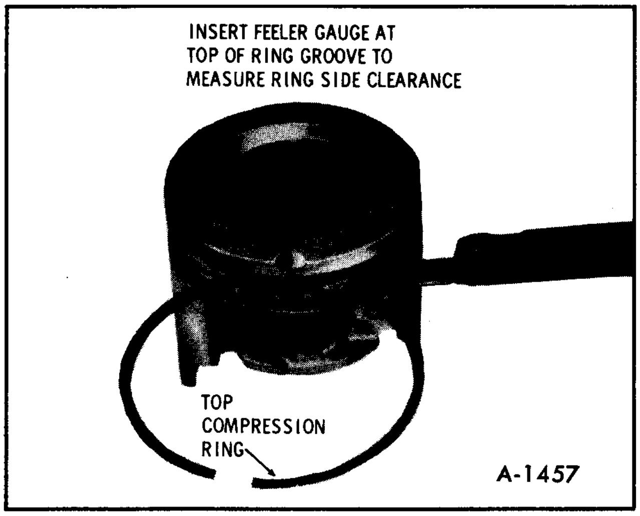


Figure 50—Piston Ring Side Clearance

NOTE: To check oil ring side clearance, the oil rings must be installed on the piston.

Allowable side clearance is:

Compression Rings	.002" to .004"
Oil Ring	.002" to .008"

RING IDENTIFICATION AND INSTALLATION

For service ring specifications and detailed installation instructions, refer to the instructions furnished with the parts package.

ROD AND PISTON ASSEMBLY

INSTALLATION

1. Install connecting rod bolt guide hose over rod bolt threads. (See figure 41).

2. Apply engine oil to rings and piston, then install piston ring compressing tool on piston. See Figure 51.

3. Install assembly in its respective cylinder bore so notch cast in top of piston is towards the front of engine.

4. Lubricate the crankshaft journal with engine oil and install connecting rod bearing and cap, with bearing index tang in rod and cap on same side.

NOTE: When more than one rod and piston assembly is being installed, the connecting rod cap attaching nuts should only be tightened enough to keep each rod in position until all have been installed. This will facilitate installation of remaining piston assemblies.

The clearance between the adjacent rods, when checked with a feeler gauge on each crankpin, should be from .006" to .020". Refer to Figure 44.

5. Torque rod bolt nuts to 42 ft. lbs.

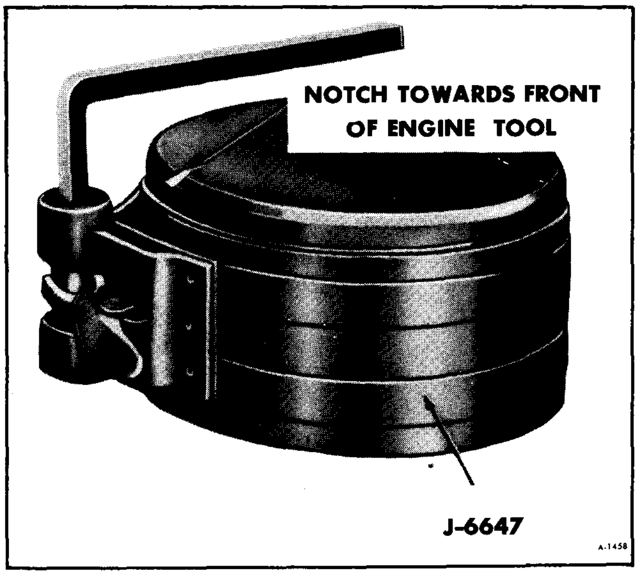


Figure 51—Piston Ring Compressor

PISTON PINS

The correct piston pin fit in the piston is .0003" to .0005" loose. If the pin to piston clearance is to the high limit (.0005"), the pin can be inserted in the piston with very little hand pressure and will fall through the piston by its own weight. If the clearance is .0003", the pin will not fall through. It is important that the piston pin hole be clean and free of oil when checking pin fit. The pin is a press fit in the connecting rod.

Whenever the replacement of a piston pin is necessary, use the following procedure.

REMOVAL

1. Place piston on piston pin remover with notch on piston facing up.

2. Press out piston pin.

INSTALLATION

1. Place piston on piston pin installer with notch on piston facing up.

2. Coat piston pin and hole with engine oil. Press in piston pin. Piston pin to connecting rod fit is .0008" to .0018" interference fit.

CRANKSHAFT PULLEY

REMOVAL

1. Loosen all belts enough so they may be slipped off crankshaft pulley.

2. Hoist motor home.

3. Remove four (4) pulley bolts and pulley.

INSTALLATION

1. Install pulley and four (4) bolts. Torque bolts to 10 ft. lbs.

2. Install belts. Refer to "Belt Tension" next in this section.

BELT TENSION

NOTE: All belt tension checks must be taken midway on the greatest span of that belt.

1. Using belt tension checking gauge BT-33-73F (Burroughs Tool) or other suitable gauge check power steering belt (vehicles equipped with automotive air conditioning MUST have power steering belt checked and adjusted if necessary first). A used power steering belt should be adjusted to 70-80 lbs. A new power steering belt should be adjusted to 110-140 lbs.

2. Check and adjust as required the generator and air conditioning compressor (if equipped) belts. Belt tension should be the same as above.

HARMONIC BALANCER

REMOVAL

1. Remove engine cover.

2. Loosen all accessory drive belts.

3. Raise vehicle.

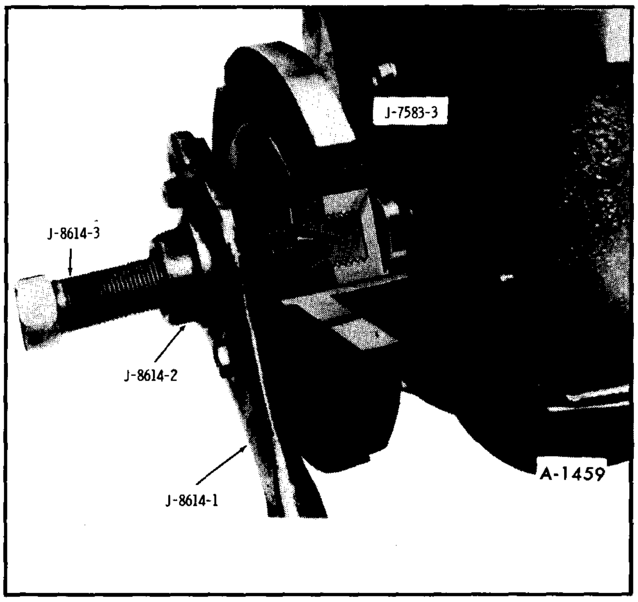


Figure 52—Removing Harmonic Balancer

4. Remove venturi ring seal retainer strap. Push seal forward and over shroud.

5. Slip belts off crankshaft pulley.

6. Remove four (4) crankshaft pulley bolts and remove pulley.

7. Remove harmonic balancer hub bolt and washer.

8. Using balancer puller, remove balancer as shown in Figure 47.

CAUTION: *Use of any other type puller such as a universal claw type which pulls on the outside of the hub can destroy the balancer. The outside ring of the balancer is bonded in rubber to the hub; by pulling on the outside, rather than the hub, it is possible to break the bond. The timing mark is on the outside ring of the balancer; if the bond between the hub and the outside ring is broken, the outside ring could slip which would change the location of the timing mark.*

If it is suspected that the bond has been broken and the timing mark changed, it can be visually checked as shown in Figure 48. Keyway should be approximately 16° from timing slot. In addition there are chisel aligning marks between the weight and hub. These marks should be aligned.

INSTALLATION

1. Apply sealer 1050026 or equivalent, to inside diameter of pulley hub and to crankshaft key to prevent possible oil leakage. Coat outside area of crankshaft pulley hub which enters seal with Special Seal Lubricant No. 1050169, or equivalent.

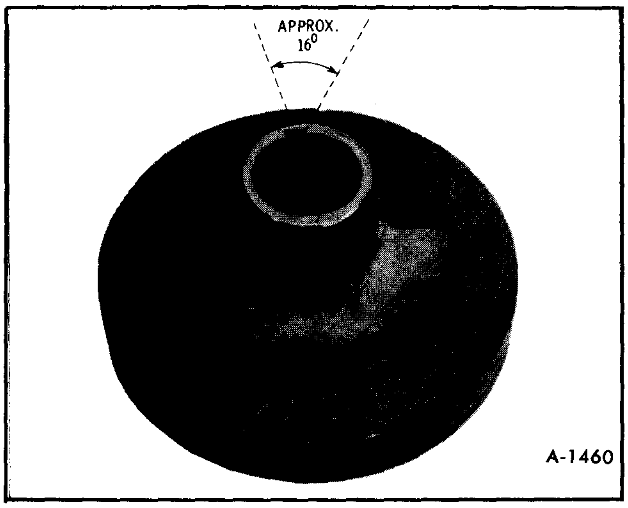


Figure 53—Harmonic Balancer

2. Install harmonic balancer on crankshaft (Figure 49). Use tool J-24724.

NOTE: Balancer to crankshaft fit is .001" tight to .0007" loose.

3. Install washer and bolt. Torque bolt to 160 ft. lbs.

4. Install crankshaft pulley and torque four (4) bolts to 10 ft. lbs.

5. Position belts over pulley.

6. Reposition venturi ring seal and install seal retainer strap.

7. Lower vehicle.

8. Tension drive belts. Refer to "Belt Tension" earlier in this section.

9. Install engine cover.

FRONT COVER OIL SEAL

REMOVAL (FRONT COVER INSTALLED)

1. Raise vehicle.

2. Loosen belts so they may be slipped off crankshaft pulley.

3. Remove crankshaft pulley and harmonic balancer. Refer to "Crankshaft Pulley" and "Harmonic Balancer" earlier in this section.

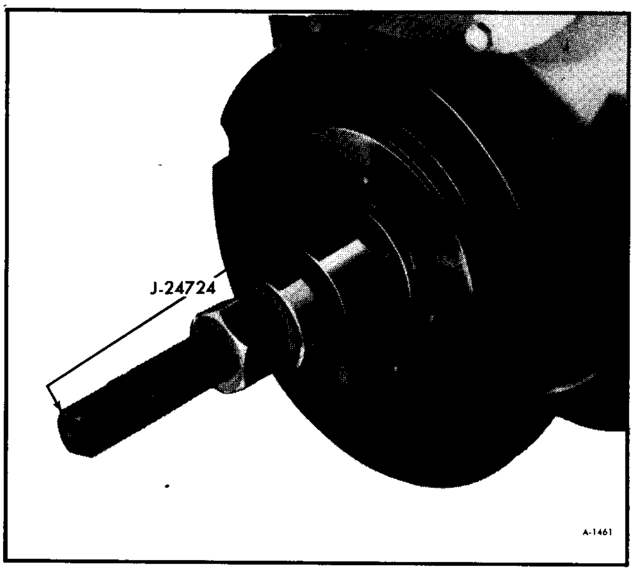


Figure 54—Installing Harmonic Balancer

4. Pry seal out of cover from the front with a large screwdriver, being careful not to damage the surface on the crankshaft.

INSTALLATION

1. Apply 1050026 sealer or equivalent to outside diameter of seal.

2. Using Tool J-5154-01, install oil seal as shown in Figure 55. Tighten until .005" feeler gauge will fit between front cover and tool.

3. Install crankshaft pulley and harmonic balancer. Refer to "Crankshaft Pulley" and "Harmonic Balancer" earlier in this section.

4. Install belts. Refer to "Belt Tension" earlier in this section.

5. Lower vehicle.

FRONT COVER

REMOVAL

1. Raise vehicle.

2. Drain cooling system. Disconnect radiator hoses, heater hoses, and by-pass hose from the water pump and radiator.

3. Drain oil.

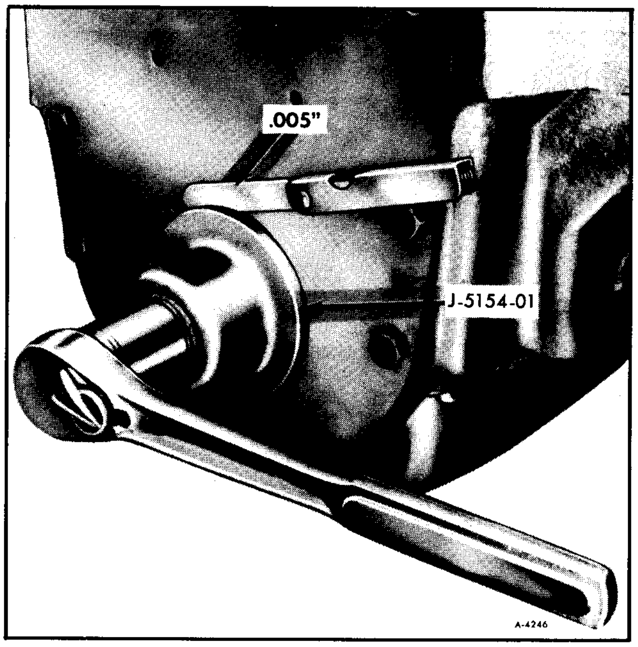


Figure 55—Front Cover Oil Seal Installation

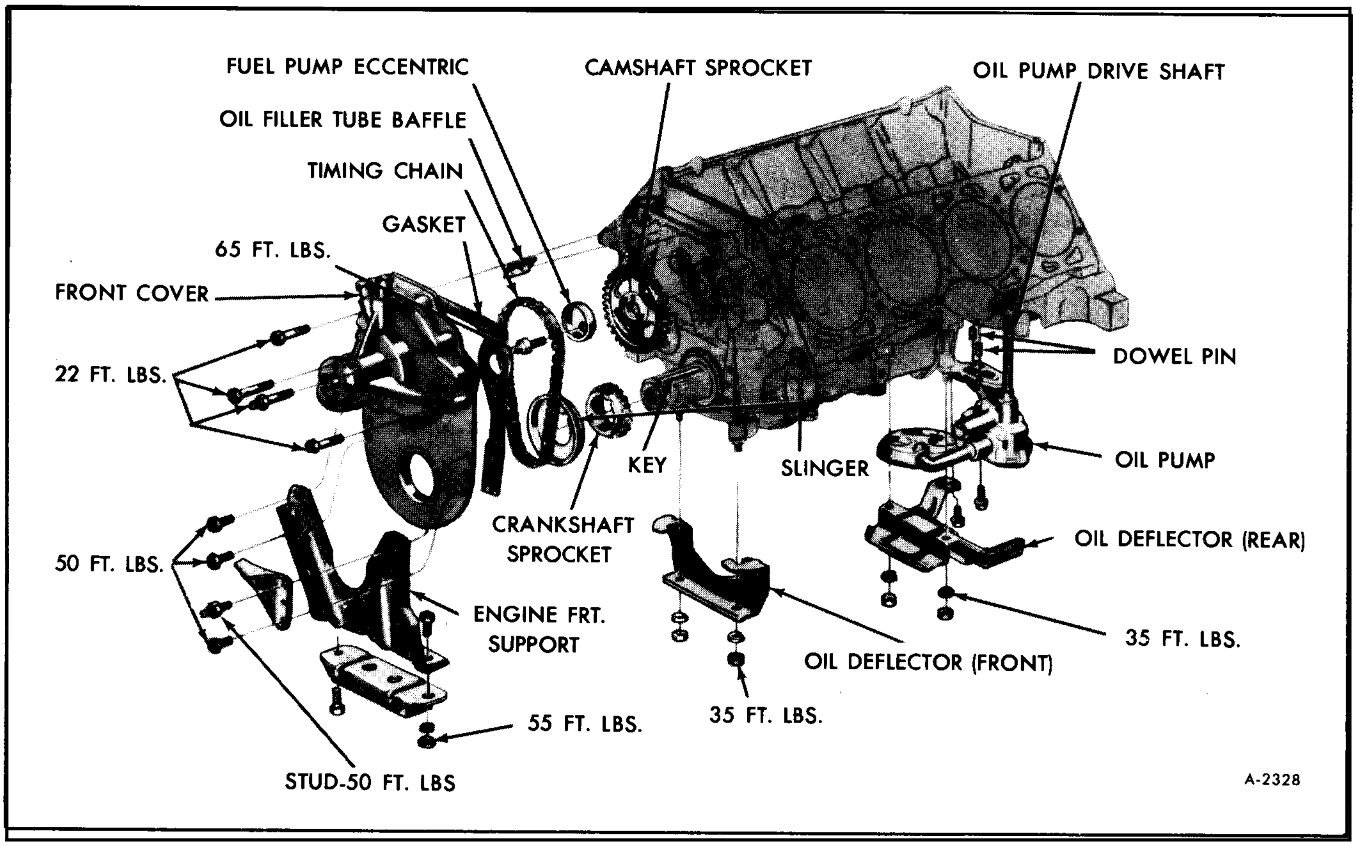


Figure 56—Engine Front Cover Exploded View

4. Remove shroud seal retainer strap.

5. Roll shroud to venturi ring seal over shroud.

6. Remove fan clutch assembly.

7. Remove venturi ring.

8. Remove engine drive belts.

9. Remove crankshaft pulley and harmonic balancer. See "Crankshaft Pulley" and "Harmonic Balancer" earlier in this section.

10. Remove oil pan. Refer to "Oil Pan" earlier in this section.

11. Remove front cover to block attaching bolts and remove front cover, timing indicator and water pump assembly (See figure 56).

INSTALLATION

1. Install new cover gasket. Apply 1050026 or equivalent, sealer to gasket around water holes and place gasket on block.

2. Install front cover, timing indicator and water pump assembly. Apply engine oil to bolts and torque bolts as shown in Figure 57.

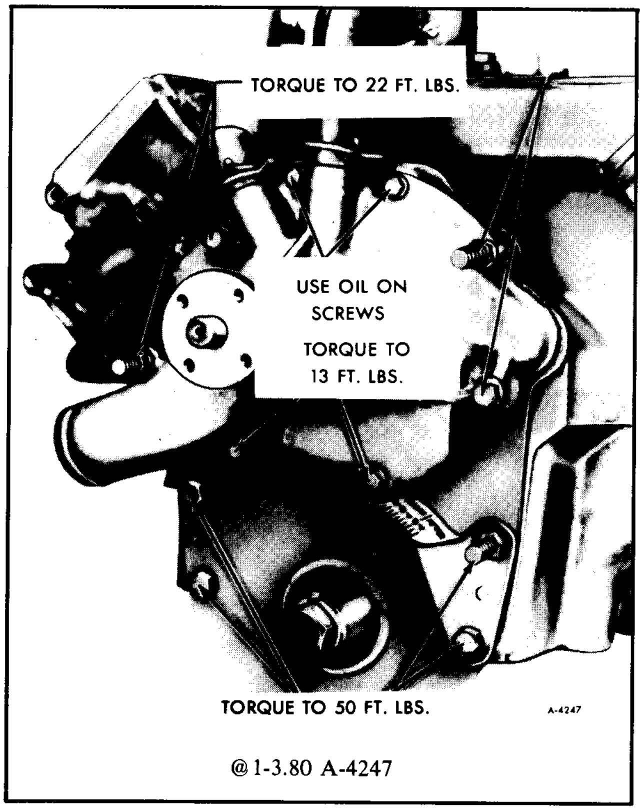


Figure 57—Engine Front Cover Bolts

3. Apply lubricant 1050169 or equivalent, on pulley hub seal surface.

4. Install oil pan. See "Oil Pan" earlier in this section.

5. Install harmonic balancer and crankshaft pulley. Refer to "Harmonic Balancer" and "Crankshaft Pulley" earlier in this section.

6. Install belts. Refer to "Belt Tension" earlier in this section.

7. Install venturi ring and torque nuts to 20 ft. lbs.

8. Install fan clutch assembly and torque nuts to 15 ft. lbs.

9. Roll shroud-to-venturi ring seal off of shroud and install shroud seal retainer strap.

10. Connect radiator hoses, heater hoses and by-pass hose to water pump and radiator.

11. Replace oil drain plug and shut radiator drain cock.

12. Lower vehicle.

13. Fill radiator and crankcase. Start engine and check for leaks.

TIMING CHAIN AND GEARS

REMOVAL

1. Raise vehicle.

2. Removė front cover. See "Front Cover" earlier in this section.

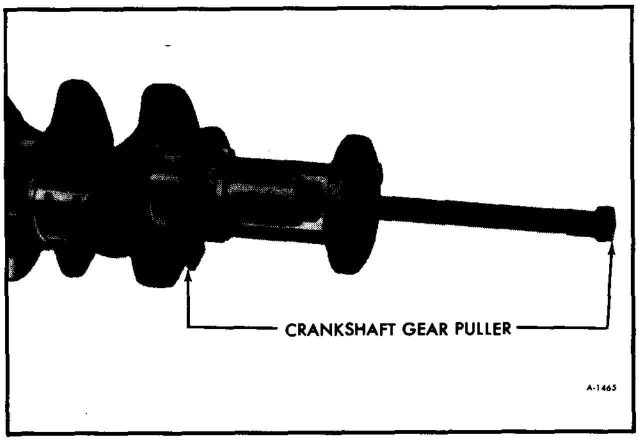


Figure 58—Crankshaft Gear Removal

3. Remove fuel pump eccentric.

4. Remove oil slinger, camshaft and timing chain.

5. Remove key then crankshaft gear.

NOTE: Gear to crankshaft fit tolerances may be such that a puller is necessary. (See figure 58).

CAUTION: *Remove crankshaft key, if possible before using puller; if not, align puller so that it does not overlap end of key when using puller, keyway is machined only part way in crankshaft gear and breakage would occur.*

INSTALLATION

1. Install camshaft gear crankshaft gear and timing chain together, and then align timing marks as shown in Figure 59.

NOTE: When the timing marks are in alignment (Figure 59), number six is at T.D.C. To obtain T.D.C. for number one cylinder, slowly rotate crankshaft one rotation, this will bring the cam mark to the top, number one will then be in the firing position.

2. Install fuel pump eccentric with flat side rearward. See Figure 60. Torque bolt to 65 ft. lbs.

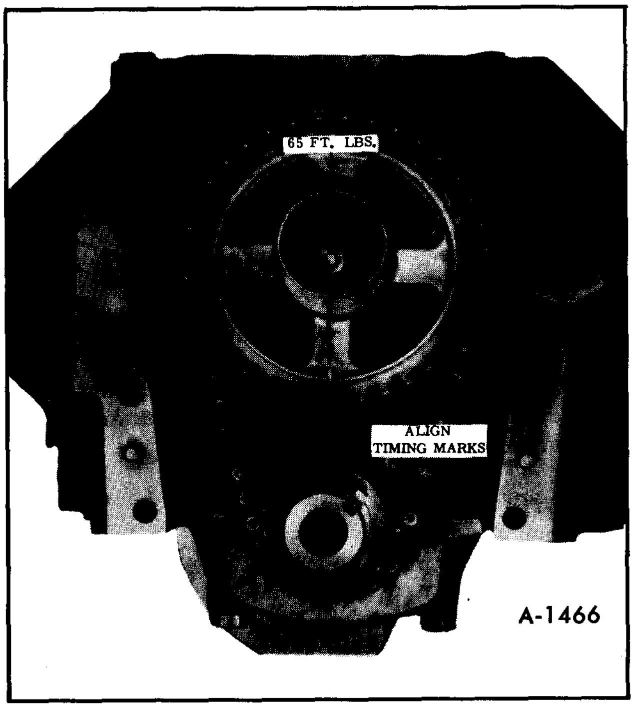


Figure 59—Timing Gear Position

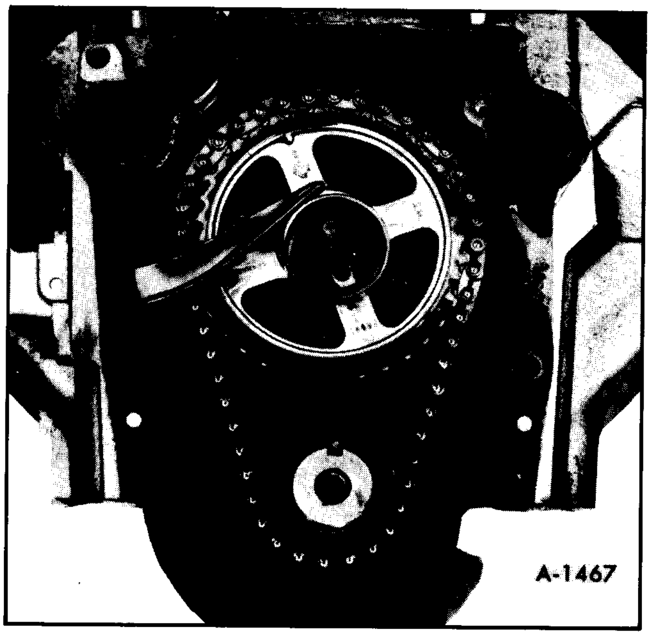


Figure 60—Fuel Pump Eccentric

3. Drive crankshaft gear key in with a brass hammer until it bottoms.

4. Install oil slinger.

5. Install front cover. See "Front Cover" earlier in this section.

6. Lower vehicle.

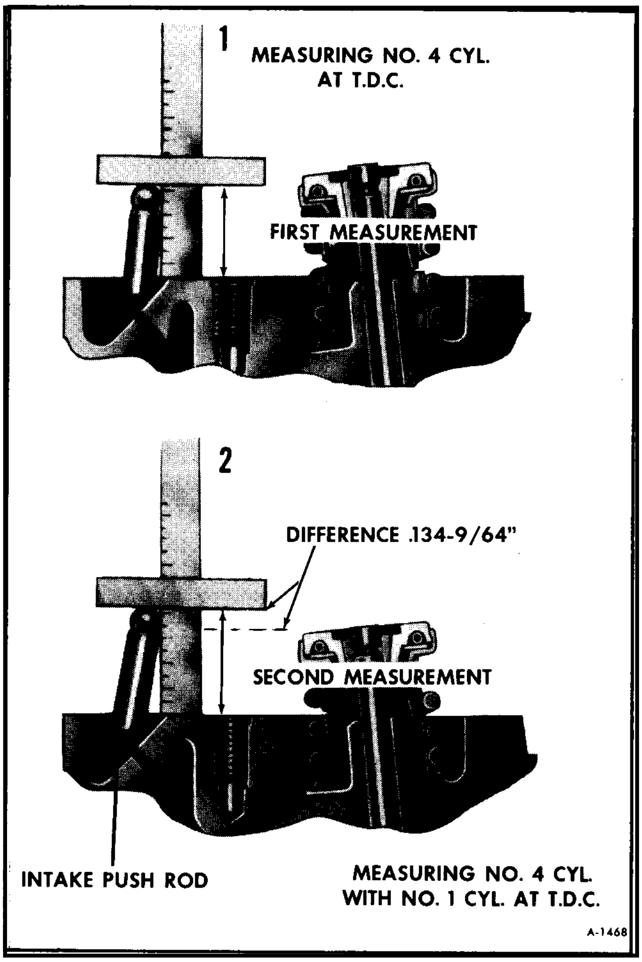


Figure 61—Checking Valve Timing

CHECKING VALVE TIMING WITHOUT REMOVING FRONT COVER

1. Remove distributor cap, right valve cover, No. 4 cylinder intake and exhaust rocker arms and pivot.

2. Ground coil wire to engine.

3. Turn ignition switch on. Crank engine until rotor is in line with No. 4 spark plug wire position. No. 4 piston will be approximately at the top of the cylinder.

4. Measure from pivot boss on head surface to top of No. 4 intake push-rod. Record measurement. See Figure 61.

5. Slowly turn engine 1-1/2 revolutions until rotor approaches No. 1 spark plug wire position. Continue to turn engine until timing mark on crank pulley is aligned with O on indicator. This is top dead center of No. 1 piston.

6. Again measure from pivot boss surface to top of No. 4 cylinder intake push-rod. See Figure 61.

7. Measurement should increase over the first measurement as shown in Figure 61.

8. If measurement increase is not within 1/32" of that shown on chart, camshaft is advanced or retarded.

ENGINE REPLACEMENT

The engine assembly may be removed with or without the transmission and final drive attached.

NOTE: It is recommended to remove the transmission and final drive from the vehicle before the engine.

In some situations repair to the engine (ie. piston replacement, oil pan gasket replacement, oil pump repair etc.) requires removal of the engine oil pan. If this is the case, refer to "Oil Pan" earlier in this section.

Refer to steps 1 through 20 for removal of transmission and final drive with engine remaining in vehicle.

Refer to steps 21 through 46 for removal of engine after the transmission and final drive have been removed.

WARNING: A VEHICLE OF THIS SIZE AND WEIGHT COMBINED WITH THE WEIGHT AND BULKINESS OF THE ENGINE AND/OR TRANSMISSION AND FINAL DRIVE DURING REMOVAL PRESENTS A POTENTIALLY DANGEROUS SITUATION TO PERSONNEL. ENGINE, TRANSMISSION AND FINAL DRIVE REMOVAL EITHER AS A UNIT OR SEPARATE COMPONENTS SHOULD BE PERFORMED WHILE USING A "TWIN POST" HOIST.

REMOVAL

1. Disconnect negative (—) battery cables from both the automotive and living area batteries.

NOTE: Drain radiator before raising vehicle.

2. Remove engine cover, remove air cleaner, disconnect coil bracket (only on vehicles equipped with breaker point ignition systems), and position engine removal Tool No. J-24603-01 to the engine. Adjust lift mechanism until all slack is removed from the cable. (See figure 5).

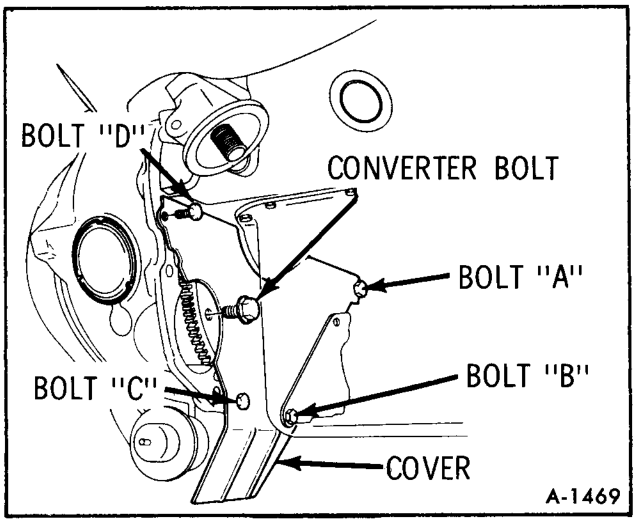


Figure 62—Flywheel Cover Removal

NOTE: To properly position engine removal tool, remove seat belt plate and anchor bolt assembly. Attach load adjustor chain to front and rear engine lift locations as shown in Figures 6 and 7. Then install support braces and chain fall as shown in Figures 5, 6 and 7.

3. Raise vehicle. See WARNING at the beginning of "Engine Replacement".

4. Disconnect wires from starter solenoid.

5. Remove starter motor.

6. Referring to Figure 62, remove flywheel cover bolts "B", "C" and "D". Loosen bolt "A" and pivot cover out of the upper L.H. bolt "A" slot.

7. Disconnect transmission shift linkage and speedometer cable from transmission and position to one side.

8. Disconnect transmission fluid cooler lines, detent solenoid wire and modulator tube from the transmission. Position all to the side.

9. Disconnect R.H. drive axle from the final drive output shaft. (Refer to Section 3B). Move drive axle rearward.

10. Remove lower R.H. venturi ring bracket.

11. Remove output shaft bracket from engine and remove R.H. output shaft assembly from final drive.

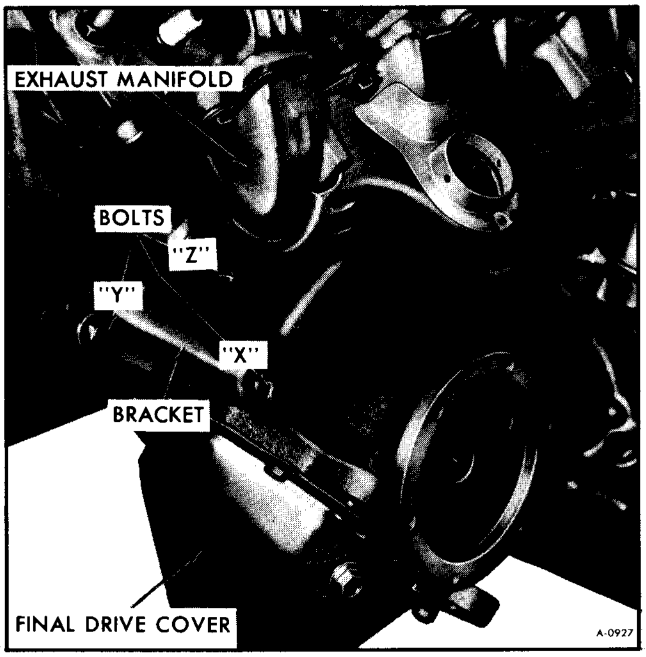


Figure 63—Disconnecting Final Drive From Engine

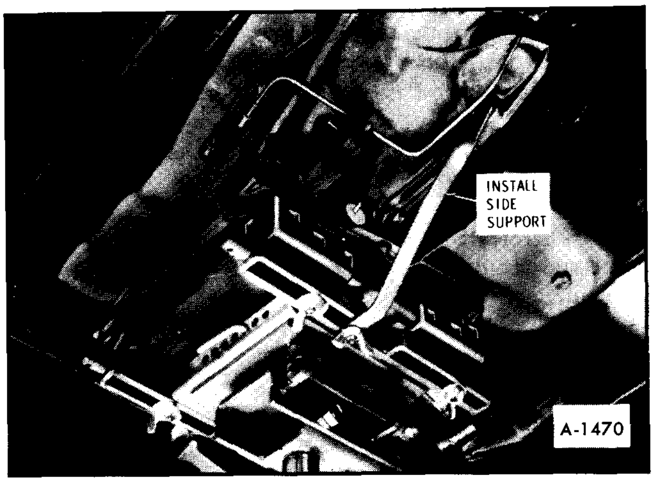


Figure 64—Transmission Jack Installation

12. Disconnect L.H. drive axle from flange at final drive and reposition axle forward and clear of the flange.

13. Remove bolt "Z". (See figure 63).

14. Remove three (3) bolts that secure the converter to the flywheel.

NOTE: Rotate flywheel to gain access (Refer to figure 62).

15. Remove three (3) transmission to support bracket bolts (Figure 9).

16. Remove support bracket to crossmember bolts.

17. Position transmission jack under transmission as shown in Figure 64.

18. Remove six (6) bolts that attach the flywheel housing to the engine.

19. Slide transmission rearward.

NOTE: Reposition transmission support bracket upward as required to obtain clearance between transmission and floor.

20. Remove transmission and final drive.

21. Lower vehicle.

22. Remove engine oil dipstick.

23. Disconnect vacuum lines to the brake booster and heater controls from the intake manifold. Disconnect the vacuum line to the carbon canister from the front of the carburetor.

24. Disconnect throttle linkage (See figure 13).

25. Disconnect coil bracket, if so equipped, from engine and position on top of intake manifold. Disconnect wire from the negative coil terminal.

26. Disconnect heater hoses.

27. Disconnect wire from brake combination valve.

28. Disconnect engine harness.

29. Remove engine oil filler upper tube.

30. Remove engine oil dipstick tube.

31. Disconnect upper radiator hose from engine.

32. Disconnect air conditioning compressor (if equipped) from bracket and with wire support it up and out of the way.

NOTE: Freon lines do not have to be disconnected.

33. Remove generator.

34. Remove both upper venturi ring brackets.

35. Raise vehicle.

36. Disconnect both R.H. and L.H. exhaust pipes at exhaust manifolds.

37. Disconnect engine oil cooler tubes from tube to hose union.

38. Disconnect fuel line from fuel pump.

39. Disconnect lower radiator hose.

40. Remove lower L.H. venturi ring bracket.

41. Remove venturi ring retainer strap. Remove venturi ring and radiator shroud.

42. Disconnect lower radiator hose.

43. Disconnect power steering hoses from the power steering pump.

44. Remove engine front mounting bolts.

45. Remove hub cap from L.H. hub. Remove cotter pin and axle nut. Tap lightly on outboard end of L.H. axle until splines are free. Remove L.H. drive assembly.

46. Raise engine assembly using engine removing tool J-24603-01.

47. Gradually remove engine assembly by alternately raising, tilting and lowering the engine assembly. Use care when supporting engine on dolly to prevent damage to oil pan.

INSTALLATION

1. Using tool J-24603-01 as shown in Figures 5, 6, and 7, raise engine assembly adjusting and tilting until engine front mount lines up so bolts may be installed. Install nuts finger tight.

2. Install L.H. drive axle into knuckle and torque axle nut to 110 ft. lbs. Advance nut to next castellation if necessary and install cotter pin.

NOTE: Do not allow drive axle to hang unsupported. Use a piece of wire to support drive axle.

3. Raise transmission and final drive using the transmission jack. Position transmission support bracket while raising the transmission.

4. Position transmission and install six (6) bolts that attach flywheel housing to engine torque bolts to 25 ft. lbs.

5. Position transmission support bracket and referring to Figure 7 torque bolts "A", "B" and "C" to 55 ft. lbs. Torque bolts "D" and "E" to 55 ft. lbs.

6. Install three (3) converter to flywheel bolts. Torque to 30 ft. lbs.

NOTE: Rotate flywheel to gain access. Refer to Figure 62.

7. Referring to Figure 63, install bolt "Z" and torque to 105 ft. lbs.

8. Properly position L.H. drive axle and torque NEW attaching bolts to 65 ft. lbs.

9. Install R.H. output shaft into final drive and attach support bolts to engine.

IMPORTANT: When attaching the right hand output shaft to the engine bracket, do not let the shaft hang. Assemble bracket bolts loosely, and by moving the flange end of the shaft up and down, and back and forth, find the center location. Hold the shaft in this position and then torque the bolts to 55 ft. lbs. on support.

10. Install lower R.H. venturi ring bracket. Torque nut on engine stud to 45 ft. lbs. Torque nut at venturi ring attachment to 20 ft. lbs.

11. Position R.H. drive axle and torque NEW attaching bolts to 65 ft. lbs.

12. Connect transmission cooler lines and tighten fittings to 20 foot-pounds and then connect detent solenoid wire and modulator tube.

13. Connect transmission shift linkage and speedometer cable.

14. Referring to Figure 62, install flywheel cover and tighten bolts "A", "B", "C" and "D" to 5 ft. lbs. torque.

15. Install starter and torque bolts to 30 ft. lbs. Connect wires to starter.

16. Tighten engine front mounting nuts to 50 ft. lbs. torque.

17. Connect power steering lines to the power steering pump.

18. Install fan shroud and torque bolts to 15 ft. lbs.

19. Install engine fan and clutch assembly. Torque nuts to 15 ft. lbs.

20. Install L.H.lower venturi ring bracket. Torque nuts to 20 ft. lbs.

21. Install venturi ring. Make sure seal overlaps the venturi ring.

22. Secure venturi ring to brackets by installing nuts and bolts finger right. Install shroud seal retainer strap.

23. Connect lower radiator hose. Torque clamp to 17 in. lbs.

24. Connect fuel line to fuel pump.

25. Connect engine oil cooler lines.

26. Connect R.H. and L.H. exhaust pipes. Tighten pipe to exhaust manifold bolts until they bottom on spacer.

27. Lower vehicle and remove engine removal tool J-24603-01.

28. Install both upper venturi ring brackets. Torque nuts to 25 ft. lbs.

29. Install generator. See Figure 11 for torque values. Refer to "Belt Tension" earlier in this section.

30. Install air conditioning compressor. See Figure 10 for torque values. Refer to "Belt Tension" earlier in this section.

31. Connect upper radiator hose to engine. Torque clamp to 17 in. lbs.

32. Install engine oil dipstick tube.

33. Install engine oil filler upper tube.

34. Connect engine harness.

35. Connect wire to the brake combination valve.

36. Connect heater hoses.

37. Connect coil bracket (if so equipped) to engine. Connect wire to negative coil terminal.

38. Connect throttle linkage.

39. Connect vacuum lines to the brake booster and heater controls to the intake manifold. Connect the vacuum line from the carbon canister to the front of the carburetor.

40. Add engine oil and transmission fluid, as required. Add engine coolant. Refer to "Engine Cooling" later in this manual. Refer to SECTION 7 for details on "Checking and Adding Transmission Fluid".

41. Connect battery negative(—) ground cables.

42. Check transmission shift linkage. Refer to SECTION 7 under "Linkage Adjustment".

43. Shut engine off. After several minutes check engine oil level.

OUT OF VEHICLE SERVICE OPERATIONS

CAMSHAFT

REMOVAL

1. Remove engine. Refer to "Engine Replacement" earlier in this section.

2. Remove oil pan. Refer to "Oil Pan" earlier in this section.

3. Remove crankshaft pulley and harmonic balancer. Refer to "Crankshaft Pulley" and "Harmonic Balancer" earlier in this section.

4. Remove front cover. Refer to "Front Cover" earlier in this section.

5. Remove valve covers. Refer to "Valve Covers" earlier in this section.

6. Remove spark plug cables and distributor cap intact.

7. Remove intake manifold. Refer to "Intake Manifold" earlier in this section.

8. Remove rocker arms, push rods and valve lifters. Refer to those items earlier in this section for removal.

NOTE: Parts position should be noted so they will be installed in their original location.

9. Remove bolt securing fuel pump eccentric, remove eccentric, camshaft gear, oil slinger and timing chain. Refer to "Timing Chain and Gears" in this section.

10. Remove camshaft by carefully sliding it out the front of the engine.

NOTE: Do not force shaft as damage can occur to camshaft bearings.

INSTALLATION

1. Coat camshaft and bearings liberally with Part No. 1051396 or equivalent before installing.

2. Slide camshaft into block.

NOTE: Do not force shaft as damage may occur to camshaft bearings.

3. Install gears, timing chain, eccentric and oil slinger. Refer to "Timing Chain and Gears" eariler in this section.

4. Install valve lifters, push rods and rocker arms. Refer to "Rocker Arm Assemblies" earlier in this section.

5. Install intake manifold. Refer to "Intake Manifold" earlier in this section. Install belts and adjust. Refer to "Belt Tension" as described earlier in this section.

6. Install distributor as described in SECTION 6Y of this manual.

7. Install valve covers. Connect spark plug cables.

8. Install front cover. Refer to "Front Cover" earlier in this section.

9. Install crankshaft pulley and harmonic balancer. Refer to "Harmonic Balancer" and "Crankshaft Pulley" earlier in this section.

10. Install oil pan. Refer to "Oil Pan" as described earlier in this section.

11. Install engine. Refer to "Engine Replacement" earlier in this section.

CAMSHAFT BEARINGS

The camshaft bearings must be replaced in complete sets. All bearings must be removed before any can be installed. No. 1 bearing must be removed first, then No. 2, then 3, 4, and 5. When installing the bearings, No. 5 must be installed first, then, 4, 3, 2 and 1.

REMOVAL

1. Remove camshaft as described in"Camshaft" earlier in this section.

NOTE: Each cam bearing is different in diameter and the correct sequence must be used both for removal and installation.

2. Using a cam bearing remover set drive out camshaft bearings starting with No. 1.

3. When removing No. 5 drive out rear cup plug, located behind No. 5 camshaft bearing. See Figure 60.

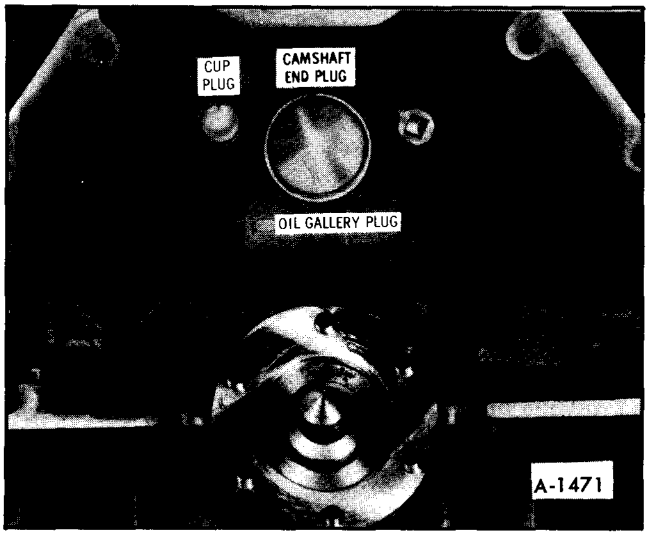


Figure 65—Camshaft and Oil Galley Plug

INSTALLATION

1. Install new cup plug in rear of No. 5 bearing bore and seal with a permanent type sealer.

NOTE: To aid aligning bearings with oil passages, place each bearing in the front bore with tapered edge toward block and align the oil hole in the bearing with the center of the oil slot in the bore. Mark top of bearing. When installing the bearings the mark will act as a guide.

2. Drive No. 5 camshaft bearing into place and check oil hole alignment as shown in Figure 66.

3. Install remaining bearing checking for proper alignment of oil holes. Wire must enter hole or the bearing will not receive sufficient lubrication.

Camshaft and Oil Gallery Plugs

(Figure 65)

The left hand rear oil gallery plug is not shown. It is a threaded plug in the end of the left gallery just rearward of the distributor. A small hole is provided in the plug for distributor lubrication. The cup plug shown provides access to the threaded plug.

The front oil gallery plugs (not shown) are threaded. The plug on the right side has a small hole which provides lubrication for the timing chain and gears.

To find out if the camshaft plug at the rear of the engine is properly installed: Place a straight edge

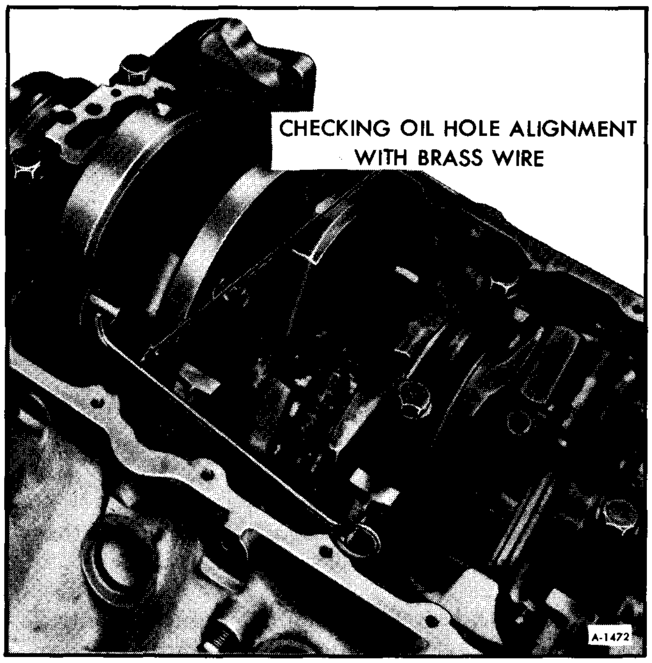


Figure 66—Checking Oil Hole Alignment

across the machined surface of the rear of the block and measure from the straight edge to the lip of the plug. Dimension should be .250" maximum to .160" minimum.

CRANKSHAFT

REMOVAL

1. With engine on stand and oil pan, oil pump and front cover removed, rotate crankshaft to the position where the connecting rod nuts are most accessible. Figure 67 shows No. 3 and No. 4 rods in the fully extended position.

2. Remove main bearing caps.

3. Remove connecting rod caps and install thread protectors.

4. Note position of keyway in crankshaft so it can be installed in the same position.

5. Lift crankshaft out of block. Rods will pivot to the center of the engine when the crankshaft is removed.

Do not allow pistons to move in their bore during or after crankshaft removal.

INSTALLATION

1. Install sufficient oil pan bolts in pan rails to align rods with rubber bands as shown in Figure 67.

Align rods so that the inner thread protectors of adjacent rods overlap approximately one inch as shown. Alignment can be adjusted by increasing tension on rubber bands with additional turns around the pan bolts or thread protectors.

2. Position upper half of main bearings in block and lubricate with engine oil.

3. Install a new rear main bearing seal.

4. After oil passages in crankshaft have been checked for being open and shaft is clean, place shaft in block. Lubricate thrust flanges of the center bearing with 1050169 Lubricant or equivalent. Install caps with lower half of bearing lubricated with engine oil. Lubricate cap bolts with No. 1050125 or equivalent, and install, but do not tighten.

5. With a block of wood (figure 68) bump shaft in each direction to align thrust flanges of center main bearing.

NOTE: After bumping shaft in each direction, wedge the shaft to the front and hold it while torquing No. 3 cap bolts.

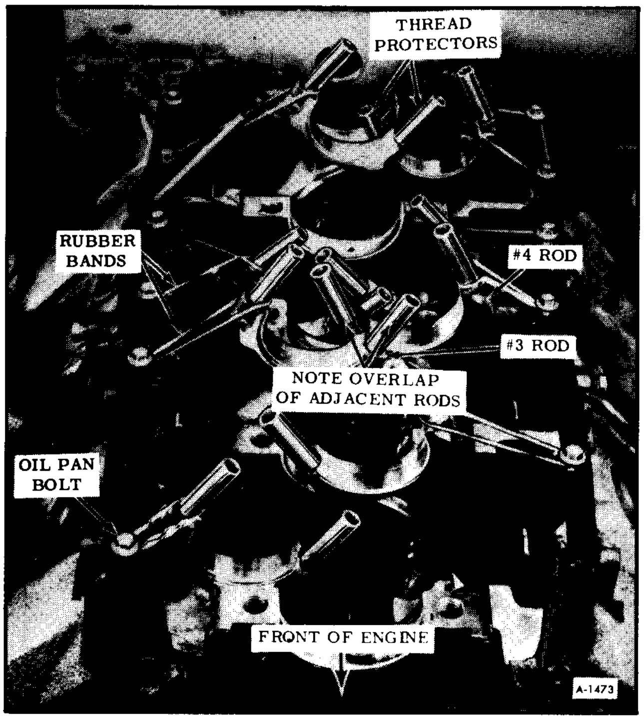


Figure 67—Crankshaft Removal

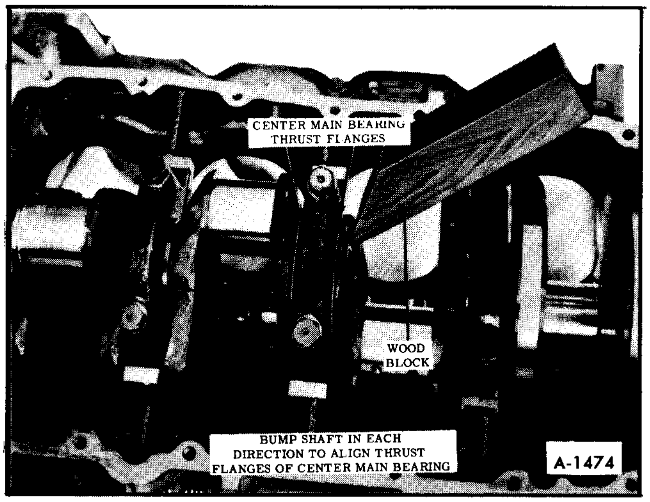


Figure 68—Aligning Center Main Bearing Flanges

6. Remove rubber bands, thread protectors and oil pan bolts.

7. Install main bearing caps and torque bolts to 120 ft. lbs.

8. Reassemble engine.

MAIN BEARINGS

Main bearing clearance must not exceed .0035″ on all bearings. The .0035″ clearance is permissible only if the engine is disassembled for other than a bearing noise condition. If bearings are noisy or if a visual inspection indicates defective bearings, new bearings must be installed within the specifications outlined under "Main Bearings".

Bearings which fall within the .0035″ specifications should not be rejected if the bearings show a normal wear pattern or slight radial grooves, unless it has been established to be defective.

CHECKING BEARING CLEARANCES

1. If not already removed, remove oil pan. Refer to "Oil Pan" earlier in this section.

2. Remove bearing cap and wipe oil from crankshaft journal and outer and inner surfaces of bearing shell.

3. Place a piece of plastigauge in the center of bearing.

4. Use a floor jack or other means to hold crankshaft against upper bearing shell. This is necessary to obtain accurate clearance readings when using plastigauge.

5. Reinstall bearing cap and bearing. Place Lubricant No. 1050125 or equivalent on cap bolts and install.

Torque to 120 ft. lbs. cap bolts.

6. Remove bearing cap and determine bearing clearance by comparing the width of the flattened plastigauge at its widest point with graduation on the plastigauge container. The number within the graduation on the envelope indicates the clearance in thousandths of an inch. (figure 69) If this clearance is greater than .0035″ REPLACE BOTH BEARING SHELLS AS A SET. Recheck clearance after replacing shells.

NOTE: Main bearing end thrust clearance should be .004″ to .008″ as checked with a dial indicator.

MAIN BEARING REPLACEMENT

Main bearing clearance must be corrected by the use of selective upper and lower shells. UNDER NO CIRCUMSTANCES should the use of shims behind the shells, to compensate for wear, be attempted.

NOTE: The upper and lower shells must be installed in pairs (figure 70). Sizes of the bearings are located on the tang (figure 71). It is possible to have more than one bearing size in the same engine.

To install main bearing shells, proceed as follows:

1. Remove bearing cap and remove lower shell.

2. Insert a flattened cotter pin, roll out pin or tool J-8080 (if available) in the oil passage hole in the

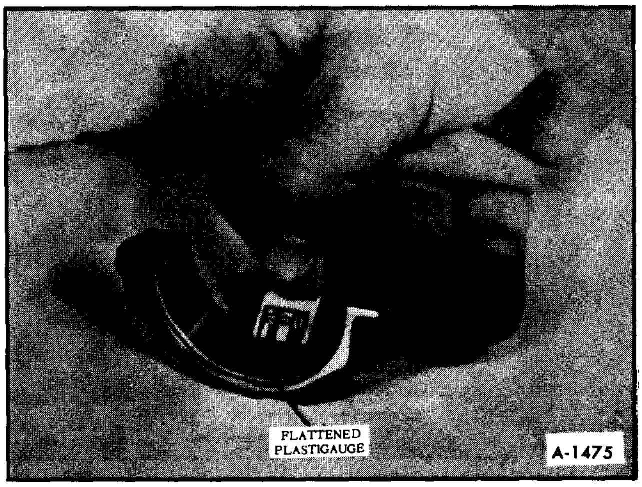


Figure 69—Checking Bearing Clearance

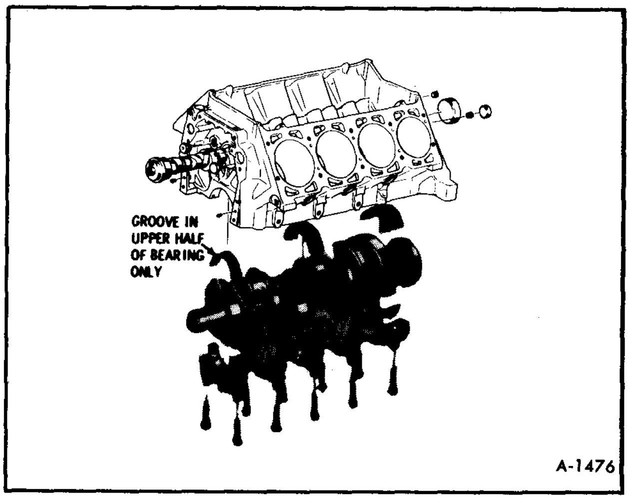


Figure 70—Crankshaft Exploded View

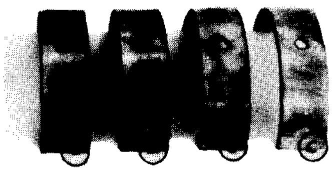


Figure 71—Main Bearing

crankshaft, then rotate the crankshaft in the direction opposite to cranking rotation. The pin will contact the upper shell and roll it out.

3. The main bearing journals should be checked for roughness and wear. Slight roughness may be removed with a fine grit polishing cloth saturated with engine oil. Burrs may be removed with a fine oil stone. If the journals are scored or ridged, the crankshaft must be replaced.

NOTE: The journals can be measured for out-of-round with the crankshaft installed by using a crankshaft caliper and inside micrometer or a main bearing micrometer. The upper bearing shell must be removed when measuring the crankshaft journals. Maximum out-of-round of the crankshaft journals must not exceed .0015".

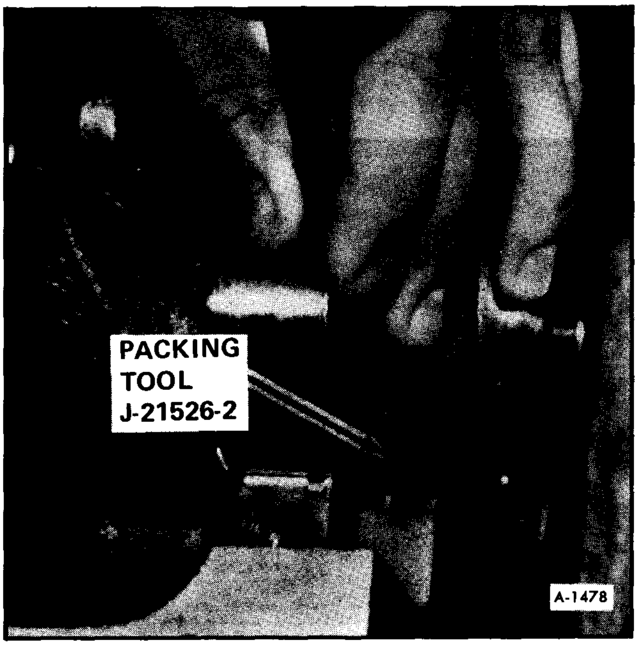


Figure 72—Packing Seal Into Cylinder Block

4. Clean crankshaft journals and bearing caps thoroughly before installing new main bearings.

5. Apply Special Lubricant, No. 1050169 or equivalent to the thrust flanges of bearing shells on No. 3 bearing.

6. Place new upper shell on crankshaft journal with locating tang in correct position and rotate shaft to turn it into place using cotter pin or roll out pin as during removal.

7. Place new bearing shell in bearing cap.

8. No. 5 bearing - Install new asbestos oil seal in the rear main bearing cap as described later in this section. Install sealer on cap as shown.

9. Install bearing caps, lubricate bolt threads with No. 1050125 Lubricant or equivalent, and install.

Torque cap bolts to 120 ft. lbs.

10. Install oil pan. Refer to "Oil Pan" earlier in this section.

REAR MAIN BEARING UPPER OIL SEAL

REPAIR

Tool J-21526 is available to provide a means of correcting engine rear main bearing upper seal leaks with the necessity of removing the crankshaft. Replacement of the rear main bearing upper oil seal requires crankshaft removal. The procedure for seal leak correction is listed below.

1. Drain oil and remove oil pan and rear main bearing cap.

2. Insert Packing Tool J-21526-2 against one end of seal in cylinder block and drive the old seal gently into the groove until it is packed tight. This varies from 1/4" to 3/4" depending on the amount of pack required. See Figure 72.

3. Repeat this on the other end of the seal in the cylinder block.

4. Measure the amount the seal was driven up on one side; add 1/16", then cut this length, from the old rear main lower oil seal removed from the cap,

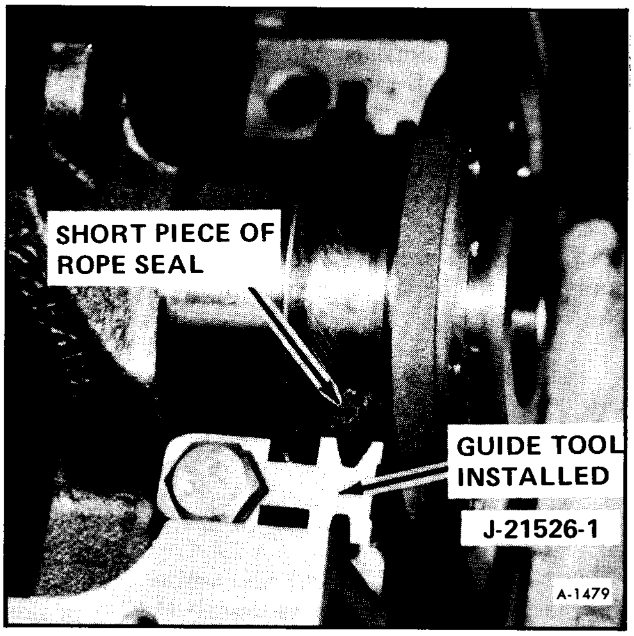


Figure 73—Guide Tool Installed

with a single edge razor blade. Measure the amount the seal was driven up on the other side. Add 1/16" and cut another length from old seal. Use main bearing cap as a holding fixture when cutting seal.

5. Place a drop of 1050026 Sealer or equivalent, on each end of seal and cap as indicated.

6. Work these two pieces of seal into the cylinder block (one piece on each side) with two small screwdrivers. Use guide tool J-21526-1 as shown in Figure 73. Using packing tool, pack these short pieces up into the block. See Figure 74.

NOTE: Place a piece of shim stock between seal and crankshaft to protect bearing surface before trimming.

7. Form a new rope seal in the rear main bearing cap. Refer to "Rear Main Lower Oil Seal" next in this section.

8. Assemble the cap to the block and torque to 120 ft. lbs.

REPLACEMENT

1. Remove crankshaft. Refer to "Crankshaft" earlier in this section.

2. Remove upper oil seal.

3. Install a new rear main bearing upper seal. Use tool J-26484 as shown in Figure 75.

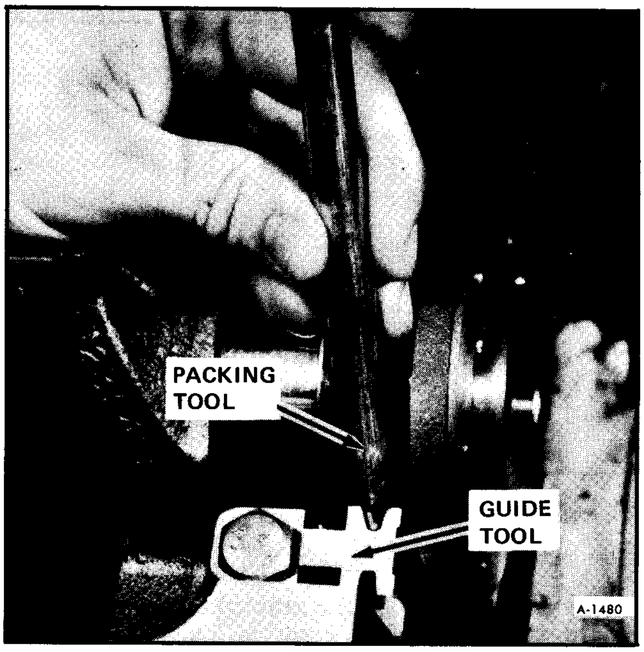


Figure 74—Packing Seal Into Guide and Cylinder Block

4. After correctly positioning seal, rotate tool slightly and cut off each end of seal flush with block.

5. Install crankshaft as described earlier in this section under "Crankshaft".

REAR MAIN LOWER OIL SEAL

REMOVAL

1. Remove oil pan. Refer to "Oil Pan" earlier in this section.

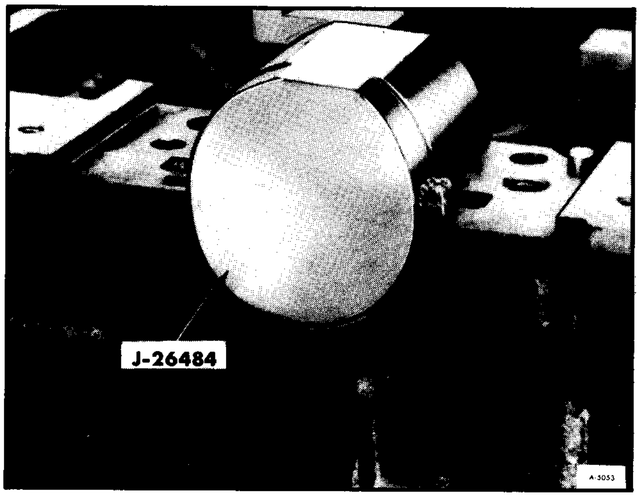


Figure 75—Installing Rear Main Seal-Upper Half

2. Remove the rear main bearing cap.

3. Remove rear main bearing insert and old seals.

4. Clean bearing cap and seal grooves and inspect for cracks.

INSTALLATION

1. Install seal into bearing cap, packing by hand.

2. Using seal installer J-26484 hammer seal into groove. (See figure 76).

NOTE: To check if seal is fully seated in the bearing cap, slide the tool away from seal. With tool fully seated in the bearing cap, slide tool against the seal. If undercut area of tool slides over the seal, the seal is fully seated. If tool butts against the seal, the seal must be driven further into the seal groove. Rotate tool before cutting off excess seal packing.

3. With tool slightly rotated, cut seal flush with mating surface. With screwdriver, pack seal end fibers towards center, away from edges. Rotate seal installer when cutting seal to avoid damage to tool.

4. Apply sealer on shaded areas of Figure 71.

5. Clean bearing insert and install in bearing cap.

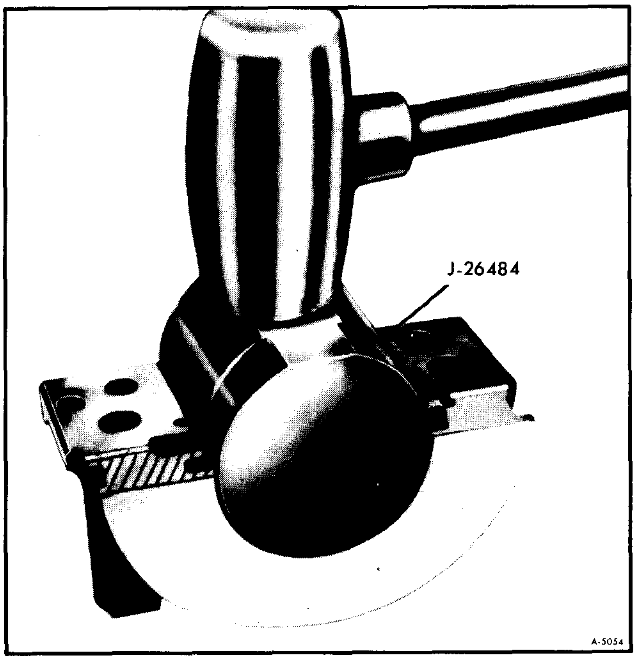


Figure 76—Installing Rear Main Seal-Lower Half

6. Clean crankshaft bearing journal and seal contact. Install sealer on cap as shown.

7. Install bearing caps, lubricate bolt threads with No. 1050125 Lubricant or equivalent and install. Torque bearing cap bolts to 120 ft. lbs.

8. Install oil pan. Refer to "Oil Pan" earlier in this section.

ENGINE SPECIFICATIONS

CYLINDER BLOCK	
Engine Type	90° V-Type
No. of Cylinders	8
Bore and Stroke	4.126" x 4.250"
Piston Displacement-455 cu. in.	
Compression	8.5:1
Firing Order	1-8-4-3-6-5-7-2
Main Bearing Bore (I.D.)	3.188" - 3.189"
CRANKSHAFT	
Diameter-Main Bearing Journal	3.0003" - 2.9993"
Width-Main Bearing Journal (with fillets)	
No. 1	1.185"
No. 2 & 4	1.156" - 1.166"
No. 3	1.199" - 2.001"
No. 5	1.882"
Diameter-Connecting Rod Bearing Journal	2.4998" - 2.4988"
Width-Connecting Rod Bearing (with fillets)	1.877" - 1.887"
Length-Overall Crankshaft	26.470"
Diameter - Oil Holes in Crankshaft	.201" - .223"
Clearance - Crankshaft End	.004" - .008"

MAIN BEARINGS
- Bearing Clearance - Crankshaft 1,2,3, & 4 .... .0005" - .0021"
  - (Vertical)5 .... .0020" - .0034"
- Width-Bearing Shell
  - No. 1,2, and 4 .... .970" - .980"
  - No. 3 .... 1.193" - 1.195"
  - No. 5 .... 1.624"

CONNECTING RODS
- Length-Center to Center .... 6.733" - 6.737"
- Diameter-Connecting Rod Bore .... 2.6243" - 2.6250"
- Diameter-Pin Bore .... .9789" - .9795"
- Bearing Clearance - (Vertical) .... .0004" - .0033"
- Side Clearance - Big End .... .006" - .020"

PISTON
- Diameter Nominal Outside .... 4.1245"
- Length Overall .... 3.490"
- Top of Piston to Center of Pin .... 1.738" - 1.742"
- Clearance at Thrust Surface (selective) .... .001" - .002"
- Weight Less Pin Rings .... 24.057 oz.
- Skirt Taper .... .0005" - .0015" Larger at Bottom
- Ring Width (2 compression) .... .0798" - .0808"
- Ring Width (1 oil) .... .1881" - .1891"

PISTON PINS
- Diameter .... .9803" - .9807"
- Length Overall .... 2.980"
- Pin to Piston Clearance .... .0003" - .0005"
- Pin to Rod Fit .... .0008" - .0018" Press

PISTON RINGS
- No. of Compression Rings (per piston) 2
- Width of Compression Rings (top bottom) .... .0770" - .0780"
- Gap Clearance Compression Rings .... .010" - .023"
- Clearance in Groove Compression Rings-Upper .... .0020" - .0040"
  - Lower .... .0020" - .0040"
- No. of Oil Rings (per piston) 1
- Gap Clearance, Oil Ring .... .015" - .055"

CAMSHAFT
- Bearing Journal Diameters
  - No. 1 .... 2.0365" - 2.0357"
  - No. 2 .... 2.0165" - 2.0157"
  - No. 3 .... 1.9965" - 1.9957"
  - No. 4 .... 1.9765" - 1.9757"
  - No. 5 .... 1.9565" - 1.9557"
- Width (including chamfers)
  - No. 1 .... .810"
  - No. 2, 3 and 4 .... .741"
  - No. 5 .... .788"
- Journal Clearance in Bearing (all) .... .0020" - .0058"
- End Clearance .... .011" - .077"
- Push Rod - Length .... 9.570"

VALVE - INTAKE
- Diameter Head .... 2.000" - 1.990"
- Diameter - Stem .... .3425" - .3432"
- Angle - Valve (A°) See Fig. 26 .... 44°
- Angle - Valve Seat (B°) See Fig. 26 .... 45°
- Width - Valve Seat (Cylinder Head) .... .037" - .075"
- Overall Length .... 4.667"
- Clearance in Guide .... .0010" - .0027"
- Lash .... Hydraulic

VALVE EXHAUST
- Diameter - Head .... 1.627" - 1.617"

Diameter - Stem .... .3420" - .3427"
Angle - Valve (A°) See Fig. 31 .... 30°
Angle - Valve Seat (B°) See Fig. 31 .... 31°
Width - Valve Seat (Cylinder Head) .... .050" - .090"
Overall Length .... 4.675"
Clearance In Guide .... .0015" - .0032"
Lash .... Hydraulic

VALVE SPRINGS
Length .... 1.96"
Diameter - Wire .... .192"
Inside Diameter .... 1.065" - 1.041"
Load .... 76 - 84 Lbs. @ 1.620"
Load @ 1.270" .... 180 - 194 Lbs.

VALVE LIFTERS
*Diameter - Body .... .8422" - .8427"
Length - Overall .... 2.000"
Clearance in Boss .... .0005" - .0020"
*Also available in .010" Over Size

CAMSHAFT SPROCKET
Width of Sprocket .... .400" - .420"
Pitch .... .500"
No. of Teeth 36

CRANKSHAFT SPROCKET
Width of Sprocket .... .400" - .410"
Overall Width of Gear .... 1.001" - .991"
Pitch .... .500"
No. of Teeth 18

TIMING CHAIN
Width .... Morse-.627, Linkbelt-.720" - .750"
No. of Links 48
Pitch .... .500"

FLYWHEEL
No. of Teeth on Starter Gear 166
No. of Teeth on Starter Pinion 9

LUBRICATION SYSTEM
Crankcase Capacity Drain and Refill .... 5 Qts.
Drain Refill with Filter Change .... 6 Qts.
Oil Pump
Clearance Pressure Relief Valve in Bore .... .0025" - .0050"
End Clearance-Gear .... .0025" - .0065"

TORQUE SPECIFICATIONS

Specified torque is for installation of parts only. Checking of torque during inspection may be 10% below specification.

APPLICATION .... FT. LBS.

FUEL PUMP
Fuel Pump to Block Bolt and Nut 25
Fuel Pump to Eccentric to Camshaft 65

EXHAUST SYSTEM 15-20

ENGINE
Crankshaft Bearing Cap Bolts 120
Flywheel to Crankshaft 60
Oil Pump to Bearing Cap Bolts 35
Oil Deflector to Bearing Cap 35
Oil Pump Cover to Pump Bolts 8
Rocker Arm Pivot Bolt to Head 25

Valve Cover Bolts	7
Oil Pan Bolts	10
Oil Pan Drain Plug	30
Crankshaft Balancer or Hub to Crankshaft Bolt	160 Min.
Oil Filter Element to Base	20
Oil Filter Assembly to Cylinder Block Bolts	35
Oil Filter Extension Fitting	55
Support/Front Cover Block	50
Fan Driving Pulley to Balancer Bolts	10
Fan Clutch Assembly to Pulley Nuts	15
Water Pump to Front Cover Bolts	13
Water Outlet to Manifold Bolts	20
*Intake Manifold to Cylinder Head Bolts	40
Exhaust Manifold to Cylinder Head Bolts	25
Carburetor to Intake Manifold Bolts	15
Choke Tube and Plate to Intake Manifold Bolts	15
Air Cleaner to Carburetor Stud	5
Engine Front Support Cushion Studs	30
Engine Support to Mount	45
Engine Mount to Crossmember Mount	30
Transmission Rear Mount to Crossmember	55
Transmission Rear Mount to Support	50
Starter to Cylinder Block Bolts	35
Distributor Clamp to Cylinder Block Bolt	17
Spark Plugs (High Energy Ignition)	25
Spark Plugs (Breaker Point Ignition)	35
Coil to Intake Manifold Bolt	15
*Cylinder Head Bolts	85
Connecting Rod Nuts	42

*Clean and dip entire bolt in engine oil before tightening to obtain a correct torque reading.

SPECIAL TOOLS

J-5154-01	Timing Cover Oil Seal Installer
J-5892-1	Valve Spring Compressor
J-6647	Piston Ring Compressor (3-7/8")
J-7583-3	Pilot (used with J-8614-01 Harmonic Balancer Remover)
J-8080	Main Bearing Shell Remover
J-21526-1	Rope Seal Repair Guide Tool
J-21526-2	Rope Seal Repair Packing Tool
J-22794	Valve Holder
J-24603-01	Engine Removal Fixture
J-24724	Crankshaft Harmonic Balancer Installer
J-24725	Valve Stem Seal Installer
J-26484	Rear Main Bearing Oil Seal Installer
BT-33-73F	Belt Tension Gauge
BT-6428	Valve Stem Height Gauge

SECTION 6K
ENGINE COOLING

Contents of this section are listed below:

SUBJECT	PAGE NO.
General Description	6K-1
Cooling System Trouble Diagnosis	6K-3
Draining, Flushing and Refilling Cooling System	6K-4
Water Pump	6K-5
Thermostat	6K-6
Fan/Fan Clutch	6K-7
Belt Tension	6K-9

IMPORTANT: For maintenance recommendations and cooling system capacities, refer to section 0 of this manual.

GENERAL DESCRIPTION

The engine cooling system is the closed-pressure type with thermostatic control of coolant circulation. The radiator is equipped with separate coolers in the right tank which aid in cooling engine oil and automatic transmission fluid (See figure 1).

The cooling system is sealed by a pressure type radiator filler cap which causes the system to operate at higher than atmospheric pressure. The higher pressure raises the boiling point of the coolant and increases the cooling effeciency of the radiator. The 9 pound pressure cap used raises the coolant boiling point approximately 22°F. (-5.5°C.)

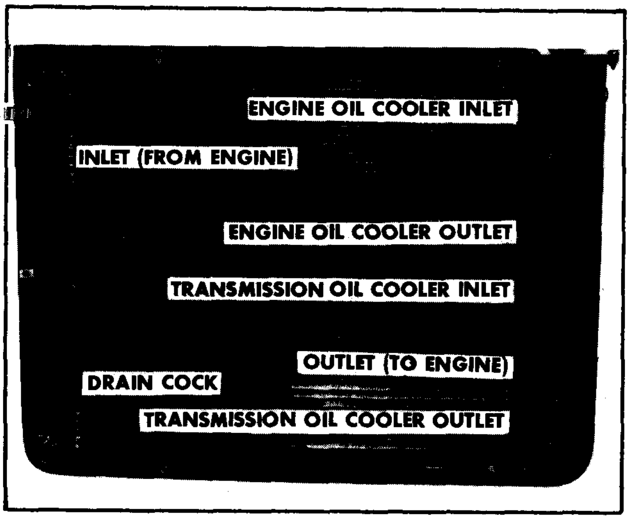


Figure 1—Radiator Core

The pressure type radiator filler cap contains a blow off or pressure valve and a vacuum or atmospheric valve. The pressure valve is held against its seat by a spring of predetermined strength which protects the radiator by relieving the pressure if the pressure should exceed that for which the radiator is designed.

The vacuum valve is held against its seat by a light spring which permits opening of the valve to relieve vacuum created when the system cools off.

A pressure-vacuum valve radiator cap is used which allows the coolant to expand through the pressure valve in the center of the cap without building unnecessary pressure. The expanding coolant flows into the coolant reservoir (See figures 2 and 3). The vent valve closes due to expansion and coolant flow. The nominal 9 pound pressure will not be reached until the system is working at maximum capacity.

Any air or vapor in the cooling system will be forced to the coolant reservoir under the liquid level and leave through the vent tube at the top of the reservoir. As the system cools, the extra coolant in

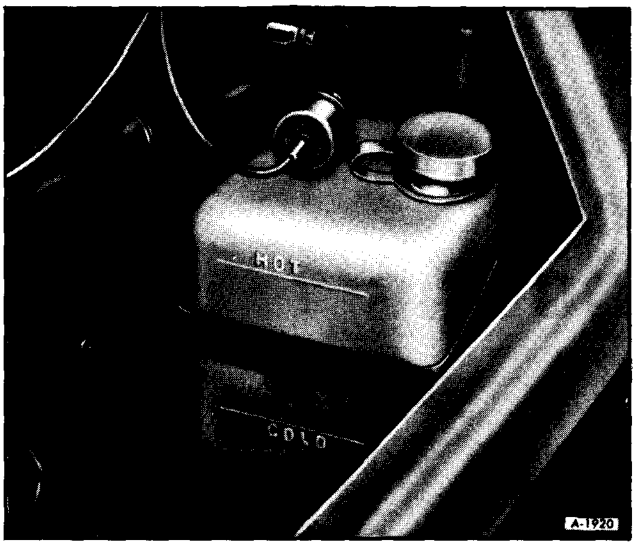


Figure 2—Coolant Recovery Reservoir Type I

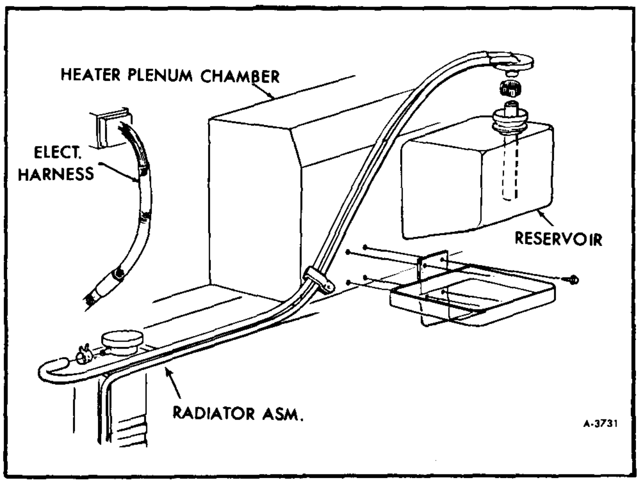


Figure 3—Coolant Recovery Reservoir, Type II

the reservoir will be drawn back to the radiator through the vent valve. In this manner, the radiator will keep itself full at all times. The need for additional coolant can be detected by observing the level of coolant in the reservoir at the "COLD" level line the engine is cold.

In vehicles equipped with a "Coolant Level" indicator system, the indicator light is designed to glow when additional coolant is required. For service and diagnosis of "Coolant Level" indicator system, refer to CHASSIS ELECTRICAL (SECTION 12).

COOLING SYSTEM CIRCULATION (FIGURE 4)

The coolant is circulated by a centrifugal pump mounted on the front engine cover which forms the outlet side of the pump. The engine fan and pulley(s) are bolted to the pump shaft hub at its forward end. Thus both the fan and pump are belt driven by a crankshaft pulley bolted to the harmonic balancer. The pump shaft and bearing assembly is pressed in the water pump cover. The bearings are permanently lubricated during manufacture and sealed to prevent loss of lubricant and entry of dirt. The pump is sealed against coolant leakage by a packless non-adjustable seal assembly mounted in the pump in position to bear against the impeller hub. The inlet pipe cast in the pump body feeds into the passage formed by the cover and the front face of the impeller, which is mounted on the bearing shaft with the vanes facing forward. Coolant flows through the inlet passage to the low pressure area at the center where it then flows radially through six openings in the impeller. Vanes on the rotating impeller cause the coolant to flow rearward through two discharge passages cast in the engine block. These passages deliver an equal quantity of coolant to each cylinder bank water jacket.

The coolant then flows rearward through the water jacket which surrounds each cylinder barrel and extends below the lower limit of piston ring travel. After flowing the full length of the cylinder banks, the coolant flows up through openings to the rear of the cylinder bank into the cylinder heads. The coolant flows forward in the cylinder heads to cool the combustion chamber areas.

Next, the coolant flows into the intake manifold water passage from the forward port of the cylinder heads to the thermostat housing and thermostat by-pass. A nipple in the pump body allows connection of the heater hose.

A pellet type thermostat housed in the forward (outlet) end of the intake manifold controls the circulation of water through the engine radiator. During cold engine operation when the thermostat is closed, a thermostat by-pass, open at all times, allows recirculation of coolant through the engine to provide rapid warm-up. When the thermostat opens, (195°F., 90.6°C.) coolant is directed to the left tank of the radiator, through the radiator core and right tank to the water pump inlet where the cycle is repeated.

COOLING SYSTEM TROUBLE DIAGNOSIS

Problem	Possible Cause	Correction
Engine overheats (Engine temperature gauge indicates coolant temperature is HOT or coolant overflows from reservoir onto ground while engine is running).	Loss of coolant.	See "Loss of Coolant" condition below. Pressure check system with suitable checking equipment. Correct as necessary.
	Low coolant protection (should be -34°F.) (-36°C.) Belt tension too low.	Test solution. Add 50/50 coolant/water solution as required. Check with BT-33-73F. Adjust if loose.
	Ignition timing retarded.	Set timing to specifications. See "Engine Electrical" later in this manual.
	Timing retarded by sticking or inoperative vacuum or mechanical advance.	Check and correct. See "Engine Electrical" later in this section.
	Thermal Vacuum Switch (T.V.S.) not switching.	Test and replace if necessary. See "Thermal Vacuum Switch" later in this section.
	Radiator fins obstructed.	Clean away bugs, leaves, etc. Flush system—add fresh coolant.
	Cooling system passages blocked by rust or scale.	Flush system—add fresh coolant.
	Reservoir hose pinched or kinked (especially at radiator filler neck).	Relieve kinks by re-routing. Replace if permanently kinked.
	Lower radiator hose collapses.	Check for hose spring position by squeezing lower end of hose. Replace if necessary.
	Defective fan clutch.	Replace fan clutch.
Loss of coolant.	Leaking radiator.	Inspect cooling system. Repair or replace as required.
	Radiator cap defective, or filler neck distorted.	Pressure check radiator and cap with suitable testing equipment. If neck upper sealing area is distorted, use wood block and mallet to reform evenly so cap will fit.
	Leaking coolant reservoir or hose.	Replace reservoir or hose.
	Loose or damaged hoses or connections.	Reseat or replace hoses or clamps. Include hoses to pre-heater if equipped.
	Water pump seal leaking.	Replace water pump.
	Water pump gasket leaking.	Replace gasket.
	Improper cylinder head bolt torque.	Torque bolts to 85 ft. lbs.

COOLING SYSTEM TROUBLE DIAGNOSIS (Cont'd.)

Problem	Possible Cause	Correction
	Cylinder head or gaskets, cylinder block or core plug, heater core or heater water valve leaking.	Repair or replace as necessary to correct.
	Thermostat stuck in closed position.	Replace thermostat.
Engine fails to reach normal operating temperature. Indicated by cool air blown from heater.	Thermostat stuck open or wrong type thermostat.	Install new thermostat of correct type and heat range.
	Coolant below add mark.	Add coolant (50/50-coolant/water solution).
HOT reading indicated on temperature gauge with no loss of coolant.	Defective engine temperature switch.	Replace switch.

IMPORTANT: If the level of the coolant in the coolant recovery tank is not changing from HOT to COLD, check for a leak in the upper portion of the engine cooling system.

DRAINING, FLUSHING AND REFILLING COOLING SYSTEM

Before draining the cooling system, inspect the system and perform any necessary service to insure that it is clean, does not leak and is in proper working order.

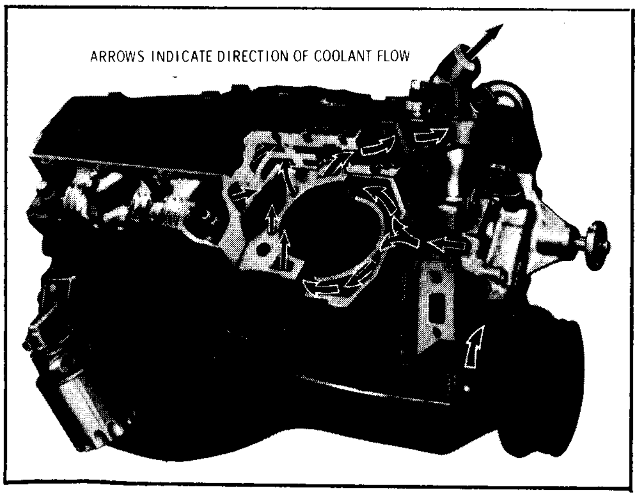


Figure 4—Cooling System Circulation

CAUTION: *To avoid the danger of being burned, and prevent loss of coolant, do not remove the radiator cap while the engine and radiator are still hot, because the cooling system will blow out scalding fluid and steam under pressure.*

1. Run engine, with radiator cap removed, until normal operating temperature is reached. On air conditioned models (automotive type), open water temperature control valve by moving the heater temperature control to maximum temperature position.

2. With engine stopped, drain radiator coolant by opening radiator drain valve located at the lower left corner of the radiator as shown in Figure 4. Remove engine block drain plug on right lower side of block if desired.

3. Close radiator drain valve, install block drain plug, if removed, add sufficient water to fill system.

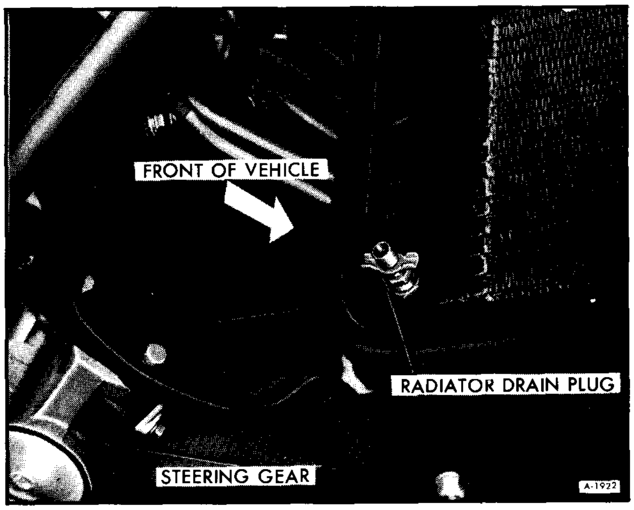


Figure 5—Radiator Drain Plug

4. Run engine, drain and refill the system, as described in Steps 1, 2 and 3, a sufficient number of times until the drained liquid is nearly colorless.

5. Allow system to drain completely and install block drain plugs, if removed.

6. Fill radiator to filler neck with coolant meeting GM Specification 1899-M (for ease and speed of filling use a 20-inch length of rubber hose and funnel to add coolant at radiator cap), to provide the required freezing and corrosion protection (at least a 50 percent solution for -34°F (-36°C). Install radiator cap. Make certain arrow on cap lines up with overflow tube. See Figure 5.

7. Fill reservoir to "COLD" level mark. See Figure 2.

8. Add anti-foam GM-1050531 to vehicles equipped with automotive air conditioning. Run engine with heater controls in "HEATER" and "HOT" position until normal operating temperature is reached.

9. Check and adjust coolant to proper level. Install coolant reservoir cap.

CAUTION: *Vehicles equipped with water heater pre-heat must have coolant checked at reservoir and coolant added as necessary after checking several times. The additional heater hose used for the pre-heat requires a longer period to normalize the cooling system.*

WATER PUMP

REMOVAL

1. Drain radiator. Disconnect bypass and remove heater hose from water pump. Loosen all belts.

2. Raise Motor Home. Disconnect lower radiator hose from water pump.

3. Remove venturi ring seal strap.

4. Fold venturi ring to shroud seal forward and over shroud.

5. Remove four (4) nuts attaching fan clutch to water pump hub. See Figure 6. Position fan and fan clutch assembly forward in the shroud. Be careful not to allow the assembly to damage the radiator core.

6. Remove the venturi ring.

7. Remove water pump pulley.

8. Disconnect the power steering pump and L.H. upper venturi ring bracket.

9. Remove water pump attaching bolts. Remove water pump.

10. Clean engine block of old gasket at sealing surfaces.

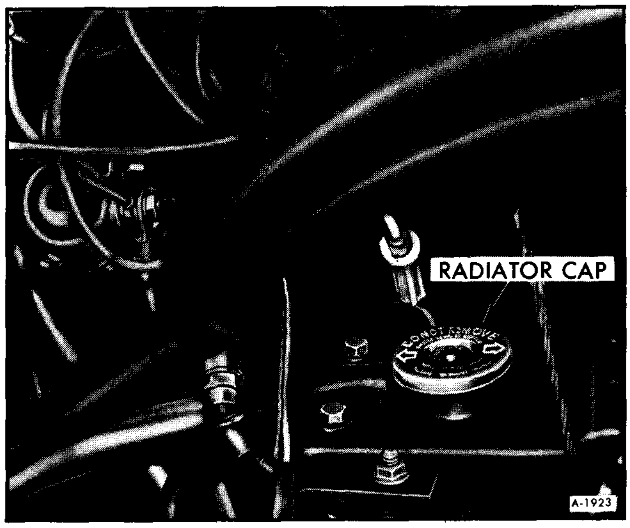


Figure 6—Radiator Cap

INSTALLATION

1. Apply a thin coat of 1050026 Sealer or equivalent to the pump housing to retain the new gasket, then position on the housing.

2. Install the pump assembly. Coat all bolts with engine oil and torque the self-tapping bolts to 13 ft. lbs. and torque the others to 25 ft. lbs.

3. Connect the power steering pump bracket and the L.H. upper venturi ring bracket. Torque nut to 22 ft. lbs.

4. Install venturi ring and torque nuts to 25 ft. lbs.

5. Install water pump pulley. Reposition all belts.

6. Install fan and fan clutch assembly. Torque four (4) nuts to 15 ft. lbs. (See figure 6).

7. Reposition shroud to venturi ring seal over venturi ring.

8. Install venturi ring seal strap.

9. Connect lower radiator hose to water pump.

10. Lower motor home.

11. Secure clamp on bypass hose and install heater hose to water pump.

12. Tension belts. Refer to "Belt Tension" later in this section.

13. Refill radiator. If new coolant is used refer to Section 0.

THERMOSTAT

The thermostat consists of a restriction valve actuated by a thermostatic element. A 195° thermostat is used and the use of thermostats rated above 195 degrees F (90°C) control temperatures are not recommended. This is mounted in the housing at the cylinder head water outlet above the water pump. The thermostat should be installed with the word FRONT up and toward the radiator. This way the coolant has a smooth unobstructed flow through the thermostat and water outlet. See Figure 7.

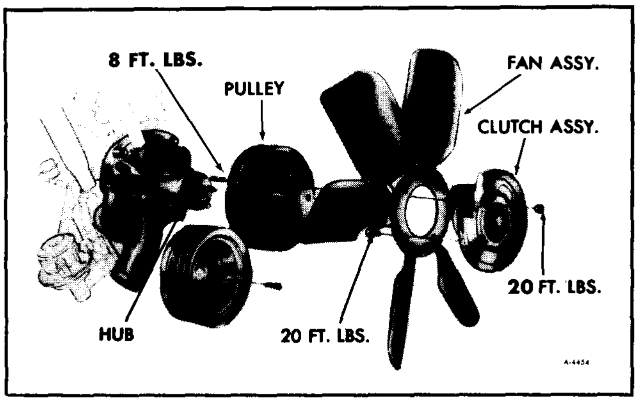


Figure 7—Fan Installation

When the thermostat is incorrectly installed, as in "B" shown in Figure 7, the thermostat valve acts as a baffle, forcing the coolant to change direction to pass around the valve. This change in direction interrupts the smooth unobstructed flow of coolant to the radiator and can possibly result in overheating conditions.

Thermostats are designed to open and close at predetermined temperatures and if not operating properly should be removed and tested.

An operational check of the thermostat can be made by hanging thermostat on a hook in a 33% glycol solution at 220°F (104.4°C). Submerge the valve completely and agitate the solution thoroughly. Under this condition the valve should open. Remove the thermostat and place in a solution of 33% glycol solution at 185°F (85°C). With the valve completely submerged and the solution agitated thoroughly, the valve should close completely.

FAN AND FAN CLUTCH

REMOVAL

1. Raise vehicle.

2. Remove shroud to venturi ring seal retainer strap.

3. Fold venturi ring to shroud seal forward and over shroud.

4. Remove the four (4) nuts attaching fan clutch to water pump hub (See figure 6).

5. With assembly in the shroud area and removed from the hub, remove the four (4) attaching bolts that secures fan clutch.

6. Remove fan and fan clutch after they are separated.

WARNING: IF A FAN BLADE IS BENT OR DAMAGED IN ANYWAY, NO ATTEMPT SHOULD BE MADE TO REPAIR AND REUSE THE DAMAGED PART. A BENT OR DAMAGED FAN ASSEMBLY SHOULD ALWAYS BE REPLACED WITH A NEW FAN ASSEMBLY. IT IS ESSENTIAL THAT FAN ASSEMBLIES REMAIN IN PROPER BALANCE AND PROPER BALANCE CANNOT BE ASSURED ONCE A FAN ASSEMBLY HAS BEEN BENT OR DAMAGED. A FAN ASSEMBLY THAT IS NOT IN PROPER BALANCE COULD FAIL AND FLY APART DURING SUBSEQUENT USE CREATING AN EXTREMELY DANGEROUS CONDITION.

INSTALLATION

1. Install fan and fan clutch separately into the area in the shroud between the water pump and the radiator. Be careful not to damage the radiator core.

2. Install four (4) attaching bolts that secure the fan to the fan clutch and torque to 20 ft. lbs. (See figure 6).

3. Position the assembly over the water pump hub studs and torque the attaching nuts to 20 ft. lbs.

4. Fold venturi ring to shroud seal back over the venturi ring.

5. Install seal retainer strap.

6. Lower vehicle.

FAN CLUTCH

Automatic fan clutches, Figure 8, are hydraulic devices used to vary the fan speed in relation to the engine temperature. Automatic fan clutches permit the use of a high delivery fan to insure adequate cooling at reduced engine speeds while eliminating overcooling, excessive noise, and power loss at high speeds.

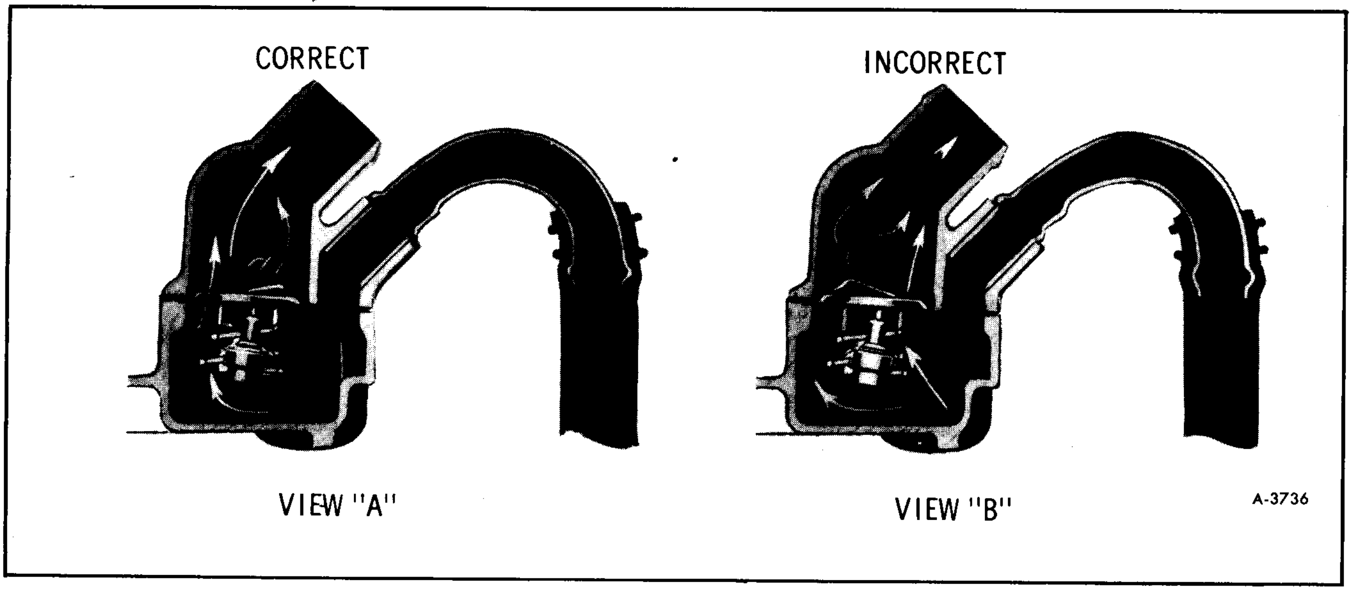


Figure 8—Thermostat Installation

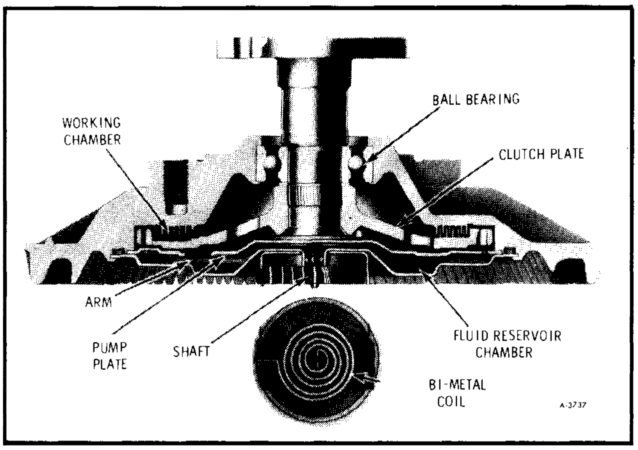


Figure 9—MotorHome Fan Clutch Assembly

The automatic fan clutch has two modes of operation, the engaged mode and the disengaged mode. The disengaged mode (engine cold or high speed driving) occurs when the silicone fluid is contained in the reservoir area of the fan clutch. As the temperature of the engine rises so does the temperature of the bimetallic coil. This bimetallic coil is connected to the arm shaft in such a way that as the temperature rises the shaft moves the arm exposing and opening the pump plate. This opening allows the silicone fluid to flow from the reservoir into the working chamber of the automatic fan clutch. The silicone fluid is kept circulating through the fan clutch by wipers located on the pump plate. A hole is located in front of each wiper.

The speed differential between the clutch plate and the pump plate develops high pressure areas in front of the wipers, thus the fluid is forced back into the reservoir. But as the temperature rises the arm uncovers more of the large opening and allows more of the silicone fluid to re-enter the working chamber. The automatic fan clutch becomes fully engaged when the silicone fluid, circulating between the working chamber and the reservoir, reaches a sufficient level in the working chamber to completely fill the grooves in the clutch body and clutch plate. The resistance of the silicone fluid to the shearing action caused by the speed differential between the grooves transmits torque to the clutch body. The reverse situation occurs when the temperature drops. The arm slowly closes off the return hole thus blocking the fluid flow from the reservoir into the working chamber. The continuous action of the wipers removes the silicone fluid from the grooves in the working chamber and reduces the shearing action. Thus, less torque is transmitted to the clutch body and the speed of the fan decreases.

The temperature at which the automatic fan clutch engages and disengages is controlled by the setting of the bimetallic coil. This setting is tailored to satisfy the cooling requirement of the vehicle ... Trans Mode fan clutch, not shown, is similar to the MotorHome fan clutch but, provides a greater cooling capacity required for commercial use.

FAN CLUTCH TROUBLE DIAGNOSIS

1. NOISE

Fan noise is sometimes evident under the following normal conditions:

a. When clutch is engaged for maximum cooling.

b. During first few minutes after start-up until the clutch can re-distribute the silicone fluid back to its normal disengaged operating condition after overnight setting.

However, fan noise or an excessive roar will generally occur continuously under all high engine speed conditions (2500) rpm and up) if the clutch assembly is locked up due to an internal failure. If the fan cannot be rotated by hand or there is a rough grating feel as the fan is turned, the clutch should be replaced.

2. LOOSENESS

Under various temperature conditions, there is a visible lateral movement that can be observed at the tip of the fan blade. This is normal condition due to the type of bearing used. Approximately 1/4" maximum lateral movement measured at the fan tip is allowable. This is not cause for replacement.

3. SILICONE FLUID LEAK

The operation of the unit is generally not affected by small fluid leaks which may occur in the area around the bearing assembly. However, if the degree of leakage appears excessive, proceed to item 4.

4. ENGINE OVERHEATING

a. Start with a cool engine to insure complete fan clutch disengagement.

b. If the fan and clutch assembly free-wheels with no drag (revolves over 5 times when spun by hand), the clutch should be replaced. If clutch performs properly with a slight drag go to Step C.

NOTE: Testing a fan clutch by holding the small hub with one hand and rotating the aluminum housing in a clockwise/counterclockwise motion will cause the clutch to free-wheel, which is normal condition when operated in this manner. This should not be considered a test by which replacement is determined.

c. Position thermometer so that it is located between the fan blades and radiator. This can be achieved by inserting the sensor through one of the existing holes in the fan shroud or fan guard, or by placing between the radiator and the shroud. On some models, it may be necessary to drill a 3/16" hole in the fan shroud to insert thermometer.

CAUTION: *Check for adequate clearance between fan blades and thermometer sensor before starting engine.*

d. With thermometer in position, cover radiator grille sufficiently to induce a high engine temperature. Start engine and turn on A/C if equipped, operated at 2,000 rpm.

e. Observe thermometer reading when clutch engages. It will take approximately 5 to 10 minutes for the temperature to become high enough to allow engagement of the fan clutch. This will be indicated by an increase or roar in fan air noise and by a drop in the thermometer reading of approximately 5-15 degrees F. If the clutch did not engage between 150-190°F (65.6-87.8°C) the unit should be replaced.

NOTE: Be sure fan clutch was disengaged at beginning of test.

If no sharp increase in fan noise or temperature drop was observed and the fan noise level was constantly high from start of test to 190°F (87.8°C), the unit should be replaced. Do not continue test past a thermometer reading of 190°F (87.8°C) to prevent engine overheating.

f. As soon as the clutch engages, remove the radiator grille cover and turn off the A/C to assist in engine cooling. The engine should be run at approximately 1500 rpm.

g. After several minutes the fan clutch should disengage, as indicated by a reduction in fan speed and roar.

If the fan clutch fails to function as described, it should be replaced.

BELT TENSION (FIGURE 10)

NOTE: All belt tension checks must be taken midway on the greatest span of that belt.

A belt that has been previously tensioned is considered to be a used belt and should be tightened to 70 to 80 pounds. A belt that has never been tensioned is considered to be a new belt and should be tightened to 110 to 140 pounds.

Vehicles equipped with automotive air conditioning MUST have power steering belt checked and adjusted if necessary first. Then check and adjust as required the generator and air conditioning compres-

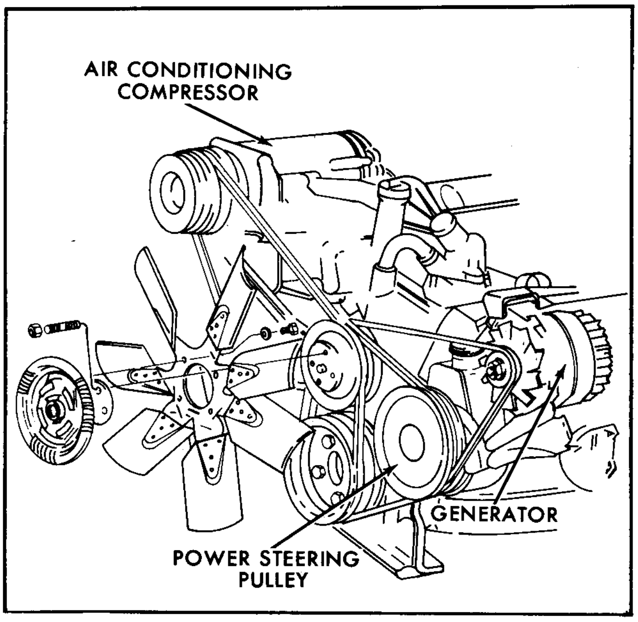


Figure 10—Fan and Drive Belts

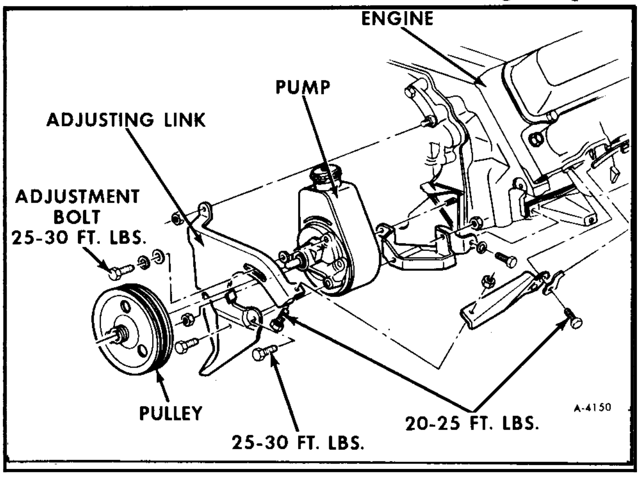


Figure 11—Power Steering Pump Mounting

sor (if equipped) belts. Use belt tension gauge (Burroughs Tool) BT-33-73F. If the belt tension is incorrect, proceed as follows:

ADJUSTING BELT TENSION

When adjusting a power steering pump belt, never pry against the pump reservoir or pull against the filler neck. To increase belt tension move the pump outward by prying against the bracket pry lugs or against the pump housing casting extension directly behind the pump drive pulley.

1. When power steering pump is driven by a single belt.

a. Loosen the pump attaching bolts and adjust the belt to correct tension by moving the pump outward, away from the engine.

b. Snug all pump mounting bolts and remove pry bar.

c. Tighten all pump mounting bolts to specified torque (figure 11).

d. Check belt tension and remove the belt tension gage.

2. When the power steering pump pulley is driven by one primary belt and is used as an idler for a second belt driving some other auxiliary:

a. Follow same checking and adjusting procedure for the primary power steering pump drive belt as for 1 above.

b. Recheck and adjust as necessary the pump belt tension after adjusting tension on belt driving the auxiliary.

3. To adjust generator or air conditioning compressor belts.

a. Loosen bolts at support bracket.

b. Move generator or air conditioning compressor away from engine to increase belt tension.

c. Tighten mounting bolts to specified torque (figures 12 and 13).

d. Check belt tension and remove belt tension gauge.

BELT REPLACEMENT

POWER STEERING PUMP BELT

Removal

a. Loosen generator attaching bolts. Loosen air conditioning compressor bolts (if so equipped).

b. Remove power steering pump belt.

Installation

a. Install belt.

b. Adjust belt tension, tighten bolts to specified torque (figure 11).

c. Check pump fluid level, add fluid as necessary.

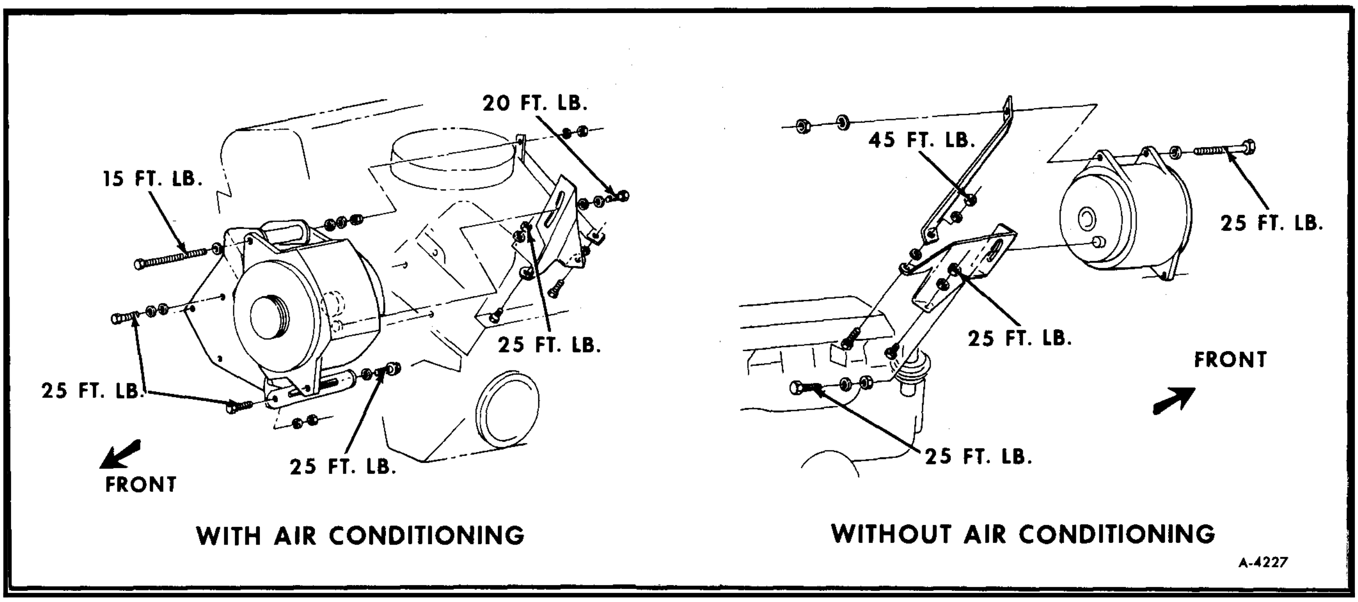


Figure 12—Generator Mounting

GENERATOR BELT

Removal

1. Loosen bolts at generator adjusting arm and loosen pivot bolt at generator support bracket.

2. Move generator toward engine until belt can be removed from pulley.

Installation

1. To install new belt, position belt on pulley and move generator away from engine until required tension is measured.

2. Tighten generator adjusting arm bolts and pivot bolt to specified torque (figure 12).

NOTE: Removal and installation of air conditioning compressor belt is accomplished in the same manner as described above. Refer to Figure 13 for specified torque of compressor mounting bolts.

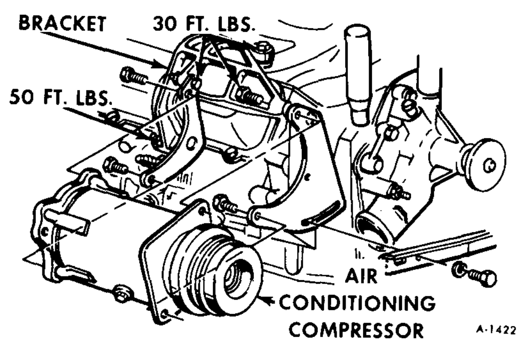


Figure 13—Air Conditioning Compressor Mounting

SECTION 6M ENGINE FUEL SYSTEM

Contents of this section are listed below:

SUBJECT	PAGE NO.
Carburetor	6M-1
General Description	6M-1
Theory of Operation	6M-2
Carburetor Diagnosis	6M-6
Carburetor Replacement	6M-14
Carburetor Adjustments	6M-21
Accelerator Linkage	6M-26
Fuel Pump	6M-26
Air Cleaner	6M-27

CARBURETOR

6M

GENERAL DESCRIPTION

The Model 4MC (Quadrajet) is a 4 barrel carburetor having two stages of operation.

The primary (fuel inlet) side has two small bores each with a triple venturi which are equipped with a discharge nozzle. Fuel is metered to the primary bores by two tapered metering rods connected to a power piston which is actuated by manifold vacuum.

The secondary side has two very large bores which have greatly increased air capacity to meet engine demands. The air valve opens as air velocity increases and thereby controls the air/fuel mixture in the secondary bores. This mixture combines with the fuel mixture in the primary side. Using the air valve principle, fuel is metered in direct proportion to the air passing through the secondary bores.

The fuel reservoir is centrally located and uses a single float pontoon.

A pleated paper fuel filter is mounted in the fuel inlet casting of the float bowl and is easily removed for replacement.

Carburetor identification information is located as shown on Figure 1. If replacing a float bowl assembly, follow the directions received in the service package to transfer the information.

The primary side of the carburetor has six systems of operation. They are float, idle, main metering, power, pump, and choke. The secondary side has one metering system for controlling the air/fuel mixture which combines with the primary side. The primary and secondary side receive fuel from a common float bowl.

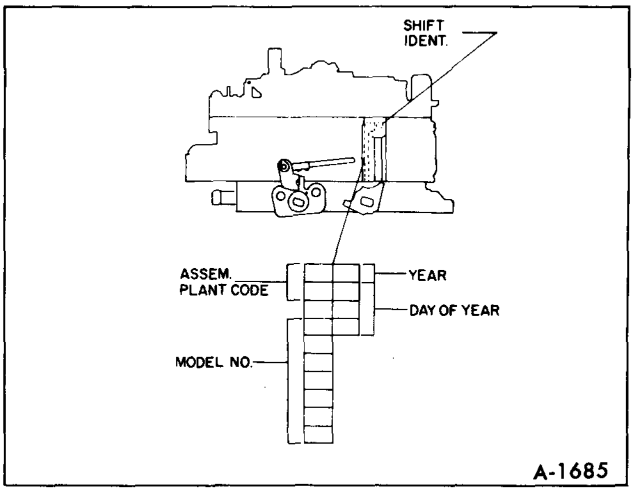


Figure 1–Carburetor Identification

THEORY OF OPERATION

FLOAT SYSTEM (FIGURE 2)

The float system consists of a float chamber, plastic float pontoon assembly, float hinge pin and retainer combination, a float valve and needle assembly and a needle valve pull clip. The float system operates as follows:

Fuel from the engine fuel pump enters the carburetor fuel inlet passage. It passes through the filter element and on into the float inlet valve chamber. The open needle valve allows fuel to enter the float bowl.

As incoming fuel fills the float bowl to the prescribed fuel level, the float pontoon rises and forces the fuel inlet valve closed, shutting off all fuel flow. As fuel is used from the float bowl, the float drops and allows more incoming fuel to enter the float bowl until the correct fuel level is reached. This cycle continues constantly maintaining a positive fuel level in the float bowl.

A needle valve pull clip is used to assist in lifting the needle valve off its seat whenever fuel pump pressure or the fuel level in the float bowl is low.

A plastic filler block is located in the top of the float chamber in the area just above the float valve. This block prevents fuel slosh on severe brake applications maintaining a more constant fuel level to prevent stalling.

The carburetor float bowl is internally vented. Internal vent tubes are located in the primary side of the carburetor air horn just above the float bowl. The purpose of the internal vents is to equalize the air pressure on the fuel in the float bowl with the air pressure within the air cleaner. Therefore, a balanced air/fuel mixture ratio can be maintained during part throttle and power operation because the same pressure acting upon the fuel in the float bowl will be balanced with the air flow through the carburetor bores. The internal vent tubes allow the escape of fuel vapors in the float bowl during hot engine operation. This prevents fuel vaporization from causing rich mixtures due to excessive pressure in the float bowl.

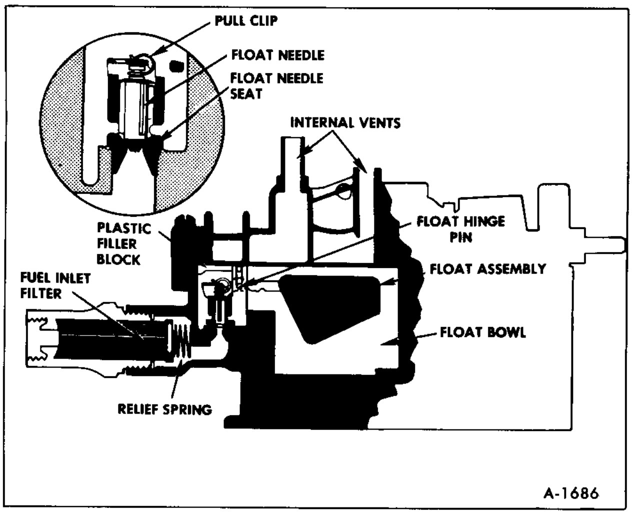


Figure 2–Float System

IDLE SYSTEM (FIGURE 3)

The idle system is only used in the two primary bores of the carburetor. Each bore has a separate idle system. They consist of: Idle tubes, idle passages, idle air bleeds, idle channel restrictions, idle mixture needles, and idle discharge holes. Idle mixture screw limiter caps are installed on all carburetors. The screws are preset at the factory and **SHOULD NOT BE REMOVED.**

During curb idle, the primary throttle valves are held slightly open by the throttle stop screw to give the engine the desired idle speed. Since the engine requires very little air for idle and low speeds, the idle discharge holes below the throttle valves are exposed directly to engine manifold vacuum. With the idle discharge holes in a very low pressure area and the fuel in the float bowl vented to atmosphere (high pressure), the idle system operates as follows:

Engine manifold vacuum at the idle discharge ports causes fuel to flow from the float bowl through the primary metering jets into the main fuel wells. The fuel is picked up and metered at the lower tip of the idle tubes. It passes up through the idle tubes, then through a cross channel in the air horn casting to the idle down channels where it is mixed with air at a side idle bleed located just above the idle channel restriction. The mixture continues downward

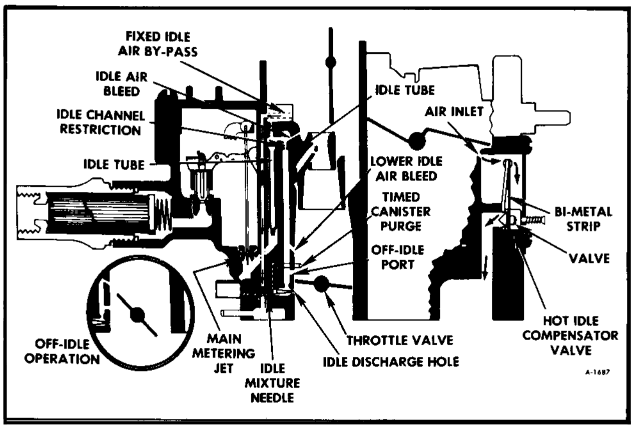


Figure 3–Idle System

through the calibrated idle channel restrictions, past the lower idle air bleeds and off-idle discharge ports, where it is further mixed with air. The air fuel mixture moves down to the idle mixture needle discharge holes where it enters the carburetor bores and blends with air passing the slightly open throttle valves. The combustible mixture then passes through the intake manifold to the engine cylinders.

A fixed idle air by-pass system is used to supplement the idle air passing by the slightly open throttle valves. The purpose of the idle air by-pass is to reduce the amount of air going through the carburetor bores and still maintain sufficient air for the correct idle speed. This reduces the amount of air passing through the venturi system to prevent the main fuel nozzles from feeding at idle. The venturi system is very sensitive to air flow and where large amounts of air is needed to maintain idle speeds, the fixed idle air by-pass system is used.

The fuel tank will not vent to atmosphere, all fuel vapors are collected in a vapor collection canister. A timed purge port is provided in the carburetor throttle body above the throttle valves adjacent to the off-idle discharge ports. The timed bleed purge holes provide adequate purge to remove all vapors that will be collected in the vapor canister. They will bleed constantly during off-idle and part throttle operation of the engine.

OFF-IDLE OPERATION

As the primary throttle valves are opened from curb idle, additional fuel is needed to combine with the extra air entering the engine. This is accomplished by the slotted, off-idle discharge ports. The primary throttle valves open gradually exposing the off-idle ports to high engine vacuum below the throttle valves. The additional fuel added from the off-idle ports mixes with the increasing air flow past the opening throttle valves to meet increased engine air and fuel demands.

Further opening of the throttle valves causes low pressure at the lower idle air bleeds. As a result, fuel begins to discharge from the lower idle air bleed hole and continues to do so from part throttle to wide open throttle.

MAIN METERING SYSTEM (FIGURE 4)

The main metering system consists of main metering jets, vacuum operated metering rods, main fuel well, main well air bleeds, fuel discharge nozzles, and triple venturi. The system operates as follows:

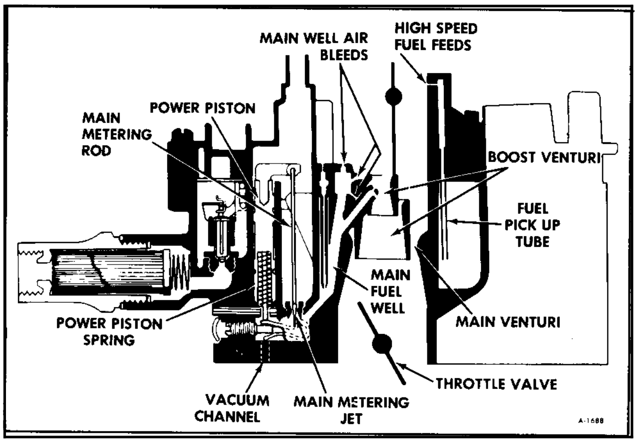


Figure 4–Main Metering System

During cruising speeds and light engine loads, engine manifold vacuum is high. Manifold vacuum holds the main metering rods down in the main metering jets against spring tension. Manifold vacuum is supplied through a channel to the vacuum operated power piston connected to the primary main metering rods. Fuel flow from the float bowl is metered between the metering rods and main metering jet orifice.

Primary throttle valves opened beyond off-idle range allows more air to enter the manifold which increases air velocity in the venturi. This causes a drop in pressure in the large venturi and a much greater drop in pressure in the small venturi. Low pressure in the small boost venturi causes air fuel to flow from the main discharge nozzle.

Fuel flows from the float bowl through the main metering jets into the main fuel well. The fuel in the main fuel well is mixed with air from the main well air bleeds then passes through the main discharge nozzles into the boost venturi.

The fuel mixture is combined with air in the boost venturi into a combustible mixture and passes through the throttle bores into the intake manifold.

CAUTION: *An adjustable part throttle feature is incorporated in all carburetors. This adjustment is made at the factory and no attempt should be made to adjust it in the field.*

The adjustable part throttle features a power piston with a pin pressed into it, which protrudes through the float bowl and gasket and contacts the adjustable link in the throttle body. The primary main metering rods have a double taper on the metering tip and can be identified by the suffix "B" stamped after the diameter on the rod. The purpose is to improve control of fuel during the main metering range.

Two calibrated holes, one in each primary bore are located just above the choke valve and feed fuel from the float bowl. During high carburetor air flows, low pressure created in the air horn bore pulls fuel from the high speed fuel feeds, supplementing fuel flow from the main metering system. The pull over enrichment system begins to feed fuel at approximately 8 lbs. of air per minute, and contines to feed at higher engine speeds to provide extra fuel necessary for good engine performance.

POWER SYSTEM (FIGURE 5)

The power system in the Quadrajet carburetor provides an extra rich mixture under heavy acceleration or high speed operation. The richer mixture is supplied through the main metering system in the primary and secondary sides of the carburetor.

The power system located in the primary side consists of a spring loaded power piston located in a cylinder which is exposed to manifold vacuum. The spring loaded power piston tends to push upward against manifold vacuum.

On part throttle and cruising ranges, manifold vacuum is sufficient to hold the power piston down against spring tension so that the larger diameter of the metering rod tip is held in the main metering jet orifice. When engine load is increased to a point where an extra rich mixture is required, the spring tension overcomes the vacuum pull on the power piston and the tapered primary metering rod tip moves upward in the main metering jet orifice. The smaller diameter of the metering rod tip allows more fuel to pass through the main metering jet and enrich the mixture flowing into the primary main wells and out the main discharge nozzles. When the engine

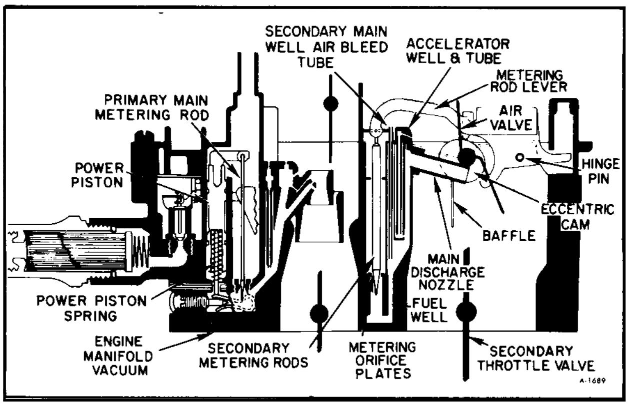


Figure 5–Power System

operation is returned to part throttle and cruising ranges, increased manifold vacuum overcomes the power piston spring and returns the larger portion of the metering rod into the metering jet orifice giving a leaner mixture.

When engine speed is increased to a point where the primary side of the carburetor cannot supply sufficient air and fuel requirements, the secondary side of the carburetor is used.

The secondary throttle valves are actuated by a connecting linkage to the primary throttle lever. With the throttle valves opened, a low pressure (vacuum) is created beneath the air valve. Atmospheric pressure on top of the offset spring loaded air valve forces the valve open allowing the required air to flow through the throttle bores to meet engine demands.

As the air valve opens, the upper edge passes the accelerating well port causing a low pressure (vacuum) at that point. Fuel starts flowing immediately and continues to flow until the well is empty.

The fuel from the accelerating ports prevents a momentary hesitation and provides an immediate charge of fuel until air/fuel begins to flow from the secondary discharge nozzles.

The secondary main discharge nozzles (one for each secondary bore) are located just below the air valve and above the secondary throttle valves in the area of lowest pressure. As the air valve opens, it rotates a plastic cam attached to the center of the main air valve shaft. The cam lifts a lever attached to the secondary main metering rods out of the secondary orifice plates. Fuel flows from the float bowl through the secondary orifice plates into secondary main wells, where it is mixed with air from the secondary mail well air bleed tubes. The air/fuel mixture travels from the main wells to the secondary discharge nozzles and is expelled into the secondary bores. The air/fuel mixture is mixed with more air traveling through the secondary bores and combined with the air/fuel mixture delivered from the primary bores enters the engine cylinders as a combustible mixture.

As the secondary throttle valve is opened further, the increase in air flow through the throttle bores opens the air valve which rotates the eccentric cam lifting the tapered secondary metering rods further out of the metering orifice discs, increasing fuel flow in direct portion to air passing through the secondary throttle bores. By using this principle a correct air/fuel ratio can be maintained throughout the operation of the secondary side of the carburetor.

A baffle plate is used in each secondary bore extending up and around the secondary fuel dis-

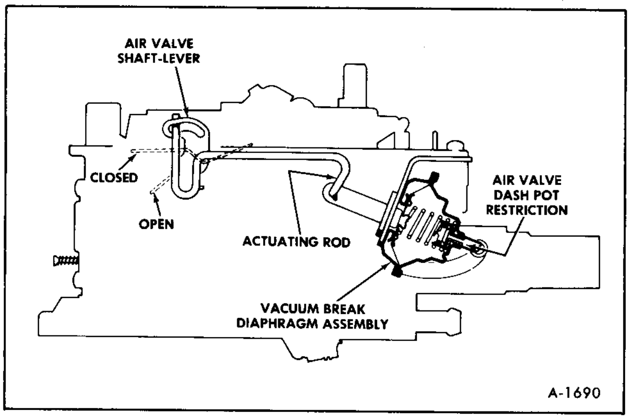


Figure 6–Air Valve Dashpot

charge nozzles. Their purpose is to provide good fuel distribution at lower air flows by preventing too much fuel from going to the front of the engine.

The depth of the secondary metering rods in the orifice plates in relation to the air valve position are factory adjusted to meet the air/fuel requirements for the specific engine model. No further adjustment should be required.

AIR VALVE DASHPOT (FIGURE 6)

The secondary air valve is connected to the vacuum break unit by a rod, to control the opening rate of the air valve and prevent any fuel lag from the secondary discharge nozzle.

Whenever manifold vacuum is above 5″ to 6″ vacuum, the vacuum break diaphragm stem is seated and pulls the rod to the end of the slot in the air valve shaft lever, holding the air valve closed. However, when the secondary valves are opened and manifold vacuum drops below 5″ to 6″ vacuum, the spring in the vacuum break unit will force the diaphragm off its seat and allow the air valve to open. The rate of movement of the air valve spring is controlled by a restriction in the internal check valve in the vacuum break unit.

ACCELERATING PUMP SYSTEM (FIGURE 7)

During quick acceleration when the throttle valves are opened rapidly, the sudden increase in air flow passing the fuel discharge nozzles tends to leave the fuel behind, which is heavier, causing a momentary leanness. The accelerator pump provides an aditional charge of fuel during this time.

The accelerating pump system is located in the primary side of the carburetor consisting of a spring loaded pump plunger and pump return spring, located in the pump bore. The pump plunger is operated by a pump lever on the air horn which is connected directly to the throttle lever by a pump rod.

As the throttle is returned from an open to a closed position, the pump return spring pushes the pump plunger upward against the pump lever. As the pump begins to move up, the discharge check ball immediately seats in the pump discharge passage so that no air will be drawn into the passage, which could cause a hesitation. The pump well is always filled with fuel from the float bowl through a slot in the top of the pump well which is lower than the fuel level. When the pump plunger moves up, the floating pump cup unseats (moves down) from the flat surface on the plunger head and allows free flowing of fuel through the inside of the cup into the bottom of the pump well. This also vents any vapors which may be in the bottom of the pump well so that a solid charge of fuel can be maintained in the fuel well. When the primary throttle valves are opened, the connecting linkage forces the pump plunger down instantly seating the pump cup against the plunger forcing fuel through the discharge passage unseating the discharge check ball. The fuel is then forced up through a passage to the pump jets located in the air horn and sprayed into the venturi area of each primary bore.

It should be noted that the pump plunger is spring loaded. The top pump duration spring is calibrated so as to deliver a smooth charge of fuel from the pump jets by applying a pressure on the fuel that remains constant through pump travel regardless of speed or distance the throttle linkage is moved. When the throttle valves are opened instantly to wide open position, the spring loaded plunger will continue to supply fuel until the plunger reaches the

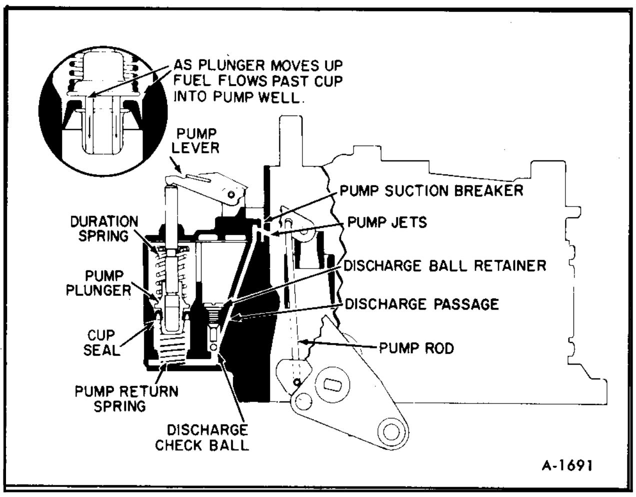


Figure 7–Accelerating Pump System

bottom of the pump well insuring an adequate fuel supply until the fuel starts to flow from the main discharge nozzle.

Due to vacuum at the pump jets during high speed operation, the pump discharge passage has been vented to the top of the air horn, outside the carburetor bores to balance the air pressure on the fuel in the pump discharge passage with the fuel in the float bowl. This prevents fuel from being pushed out of the pump jets when the pump is not in use.

CHOKE SYSTEM (FIGURE 8)

The choke system consists of a choke valve, a vacuum break diaphragm, a choke housing and coil located on the side of the float bowl, fast idle cam, connecting linkage and air valve lockout lever. The thermostatic coil holds the choke valve closed when the engine is cold. Opening the throttle valves allows the choke to close and move the fast idle cam to the high step. When the choke valve is closed, the air valve lockout lever keeps the air valve closed.

During engine cranking, the choke valve is held closed by the tension of the thermostatic coil. This restricts air flow through the carburetor to provide a richer starting mixture. When the engine starts, manifold vacuum applied to the vacuum diaphragm opens the choke valve to a point where the engine will run without loading or stalling. The vacuum diaphragm unit has an internal bleed check valve which delays the diaphragm action a few seconds before it becomes seated allowing the engine manifold to be wetted and engine friction to decrease so that when the vacuum break point is reached, the engine will run without loading or stalling. When the choke valve moves to the vacuum break position, the fast idle cam follower will drop from the high step on the fast idle cam to the next lower step when the

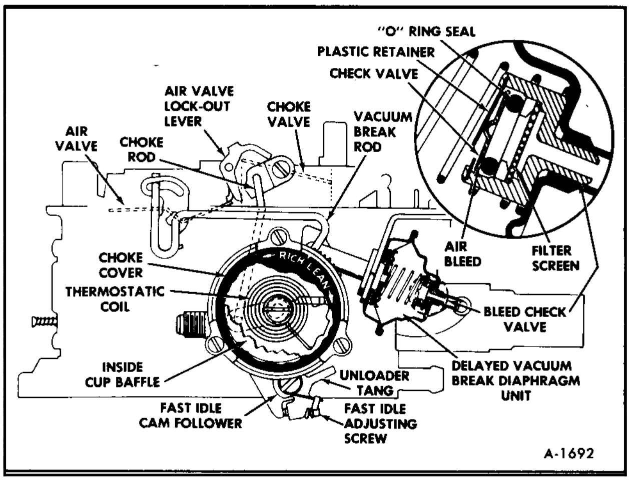


Figure 8–Choke System

throttle is opened. This gives the engine sufficient fast idle speed and correct fuel mixture for running until the engine begins to warm up and heat the thermostatic coil in the choke housing. Engine vacuum pulls heat from the manifold heat stove into the choke housing and gradually relaxes choke coil tension which allows the choke valve to continue opening through inlet air pressure pushing on the off set choke valve. Choke valve opening continues until the thermostatic coil is completely relaxed, at which point the choke valve is wide open and the engine is thoroughly warm.

During the last few degrees of choke valve opening, a tang on the choke lever contacts the secondary air valve lockout lever and rotates the lever counterclockwise so that the tang over the air valve will move completely away from the valve, allowing the air valves to open and operate.

The choke system is equipped with an unloader mechanism which is designed to partially open the choke valve, should the engine become loaded or flooded. To unload the engine the accelerator pedal must be depressed so that the throttle valves are held wide open. A tang on a lever on the choke side of the primary throttle shaft contacts the fast idle cam and through the intermediate choke shaft forces the choke valve slightly open. This allows extra air to enter the carburetor bores and pass on into the engine manifold and cylinders to lean out the fuel mixture so that the engine will start.

CARBURETOR DIAGNOSIS

Before proceeding with carburetor diagnosis it should be noted that proper carburetor operation is dependent upon the following:

1. Fuel supply.
2. Linkage and emission control systems.
3. Engine compression.
4. Ignition system firing voltage.
5. Ignition spark timing.
6. Secure intake manifold.
7. Engine temperature.
8. Carburetor adjustments.

ANY PROBLEMS IN THE ABOVE AREAS CAN CAUSE THE FOLLOWING:

1. No start or hard starting - (hot or cold)

2. Rough engine idle and stalling
3. Hesitation on acceleration
4. Loss of power on acceleration and top speed
5. Engine to run uneven or surge
6. Poor fuel economy
7. Excessive emissions

ENGINE CRANKS (TURNS OVER) WILL NOT START OR STARTS HARD WHEN COLD

Possible Cause	Corrective Action
Improper starting procedure used.	Check with the customer to determine if proper starting procedure is used, as outlined in the operating manual.
No fuel in gas tank.	Add fuel. Check fuel gauge for proper operation.
Choke valve not closing sufficiently when cold.	Adjust the choke thermostatic coil.
Choke valve or linkage binding or sticking.	Realign the choke valve or linkage as necessary. If caused by dirt and gum, clean with automatic choke cleaner. Do not oil choke linkage. If parts are replaced, check adjustments.
Vacuum leaks in carburetor base or intake manifold.	Check all manifold vacuum hoses for proper connection and location. Check manifold and carburetor base gaskets for leaks. Tighten or replace as necessary. Torque carburetor to manifold bolts to 15 ft. lbs.
No fuel in carburetor.	1. Remove fuel line at carburetor. Connect hose to fuel line and run into metal container. Remove the high tension coil wire from center tower on distributor cap and ground. Crank over engine - if there is no fuel discharge from the fuel line, check for kinked or bent lines. Disconnect fuel line at tank and blow out with air hose, reconnect line and check again for fuel discharge. If none, replace fuel pump. Check pump for adequate flow. 2. If fuel supply is o.k.: a. Inspect fuel filter. If plugged, replace. b. If filter is o.k., remove air horn and check for a bind in the float mechanism or a sticking float needle. If o.k., adjust float.

Possible Cause	Corrective Action
Engine flooded. NOTE: To check for flooding, remove air cleaner with engine off, and look into carburetor bores. Fuel will be dripping off discharge nozzles and carburetor bores will be very wet.	1. Check to determine if customer is using proper carburetor unloading procedure. Depress the accelerator to the floor and check carburetor to determine if the choke valve is opening. If not, adjust throttle linkage and unloader. 2. If choke unloader is working properly - check for carburetor flooding. NOTE: Before removing the carburetor air horn, use the following procedure which may eliminate the flooding. Remove the fuel line at carburetor and plug. Start and run the engine until the fuel bowl runs dry. Turn off engine and connect fuel line. Then restart and run engine. This will usually flush dirt past the carburetor float needle and seat. 3. If dirt is in the fuel system, clean the system and replace fuel filter as necessary. If excessive dirt is found, remove the carburetor unit. Disassemble and clean. 4. Check float needle and seat for proper seal. If a needle and seat tester is not available, apply mouth suction needle seat with needle installed. If needle and seat is defective, replace with factory matched set. 5. Check for fuel leaks into float, bent float arm or binds in the float hanger. Free up or replace parts as necessary. NOTE: A solid float can be checked for fuel absorption by lightly squeezing between fingers. If wetness appears on surface or float feels heavy (check with known good float), replace float assembly. 6. After making preceding checks, adjust float assembly.

ENGINE STARTS AND STALLS

Possible Cause	Corrective Action
Engine does not have enough fast idle speed when cold.	Check and reset fast idle screw and fast idle cam.
Choke vacuum break unit is not adjusted to specification or is defective.	1. Adjust choke vacuum break assembly to specifications. 2. If adjusted O.K., check the vacuum break unit for proper operation as follows. Connect a piece of hose to the nipple on the vacuum break unit and apply suction by mouth or vacuum source. Diaphragm plunger should move inward and hold vacuum. If not, replace diaphragm unit. NOTE: Always check fast idle cam (choke rod) adjustment first before adjusting vacuum break unit.

Possible Cause	Corrective Action
Choke coil rod out of adjustment.	Adjust choke coil rod.
Choke valve and/or linkage sticking or binding.	1. Clean and align choke valve and linkage. Replace if necessary. 2. Re-adjust if part replacement is necessary.
Idle speed setting.	Adjust idle speed to specifications on decal in engine compartment.
Not enough fuel in carburetor.	1. Test fuel pump pressure and volume, as outlined in service manual. 2. Check for partially plugged fuel inlet filter. Replace, if dirty. 3. Check fuel tank lines and tank vent lines for blockage. Clean as necessary. 4. Remove air horn and check float adjustment.
Carburetor flooding NOTE: Check for flooding by using procedure outlined under "Engine cranks - will not start - engine flooded" Page 8.	1. Check all fuel filters for dirt. Clean and replace as necessary. 2. If carburetor still floods, remove air horn and check float needle and seat for proper seal. If a needle seat tester is not available, mouth suction can be applied to the needle seat with needle installed. If needle seat leaks, replace with a factory matched set. 3. Check for fuel leaks into float, bent float arms or binds in float hanger. NOTE: A solid float can be checked for fuel absorption by lightly squeezing between fingers. If wetness appears on surface or float feels heavy (check with known good float), replace float assembly. 4. Check float adjustments. 5. If excessive dirt is found in the carburetor, clean fuel system and carburetor.

ENGINE IDLES ROUGH AND STALLS

Possible Cause	Corrective Action
Idle speed setting.	Re-set idle speed per instructions on decal in engine compartment.
Manifold vacuum hoses disconnected or improperly installed.	Check all vacuum hoses leading into the manifold or carburetor base for leaks or disconnection. Install or replace as necessary.
Carburetor loose on intake manifold.	Torque carburetor to manifold bolts (to 15 ft. lbs.).

Possible Cause	Corrective Action
Intake manifold is loose or gaskets are defective.	Using a pressure oil can, spray light oil or kerosene around manifold legs and carburetor base. If engine RPM changes, tighten or replace the manifold gaskets or carburetor base gaskets as necessary.
Hot idle compensator not operating (where used).	Normally the hot idle compensator should be closed when engine is running cold and open when engine is hot (approx. 140°F at comp.) replace if defective.
Air leaks into carburetor idle channels.	Tighten all carburetor screws. If gaskets are hard or cracked, replace as necessary.
Poor secondary throttle valve alignment.	If mis-aligned, loosen screws, align valves, tighten screws and re-stake as necessary.
Carburetor flooding. NOTE: Check by using procedure outlined under "engine flooded". Page 6M-8.	1. Remove air horn and check float adjustments. 2. Check float needle and seat for proper seal. If a needle seat tester is not available, mouth suction can be applied to the needle seat with needle installed. If needle and seat are defective, replace with factory matched set. 3. Check float for fuel leaks, bent float arm or binding float hanger. NOTE: A solid float can be checked for fuel absorption by lightly squeezing between fingers. If wetness appears on surface or float feels heavy (check with known good float), replace float assembly.
Dirt in idle channels.	If excessive dirt is found in carburetor or idle channels, clean fuel system and carburetor. Replace fuel filter as necessary.

ENGINE HESITATES ON ACCELERATION

Possible Cause	Corrective Action
Defective accelerator pump system. NOTE: A quick check of the pump system can be made as follows. With the engine off, remove air cleaner and look into carburetor bores and observe pump shooters, while briskly opening throttle valves. A full stream should emit from each pump jet and enter the center of the carburetor bore.	1. Remove carburetor air horn and check pump cup. If cracked, scored or distorted, replace pump plunger. Check pump discharge ball for proper seating and location. To check discharge ball for proper seating, fill cavity above discharge ball with fuel. If "leak down" occurs remove discharge ball and clean check ball seat and pump passages and jets. If clean, stake discharge ball seat by tapping ball lightly against seat with drift punch and small hammer. Replace with new discharge ball.

Possible Cause	Corrective Action
Dirt in pump passes or pump jet.	Clean and blow out with compressed air.
Float level	Check for sticking float needle or binding float. Free up or replace parts as necessary. Check and reset float level to specification.
Leaking air horn to float bowl gasket.	Torque air horn to float bowl using proper tightening procedure.
Carburetor loose on manifold.	Torque carburetor to manifold bolts (to 15 ft. lbs.).
Air valve binding (sticks open)	1. Torque air horn screws evenly using proper tightening sequence. 2. Free-up air valve shaft and align air valves. 3. Check air valve spring for closing tension. If defective, replace with spring kit part number 7035344.
Air valve lockout.	1. Free-up and check for proper operation. 2. Adjust air valve lockout.

NO POWER ON HEAVY ACCELERATION OR AT HIGH SPEED

Possible Cause	Corrective Action
Carburetor throttle valve not going wide open. (Check by pushing accelerator pedal to floor	Adjust throttle linkage to obtain wide open throttle in carburetor.
Dirty or plugged fuel filter.	Replace as necessary.
Air valves not unlocking after engine warms up.	Free-up and adjust air valve lockout.
Air valves binding, stuck closed or open.	1. Free-up air valve shaft and align air valves. 2. Torque air horn screws evenly using proper tightening sequence. 3. Check air valve spring for closing tension. If defective, replace with spring kit, part number 7035344.
Power system not operating.	1. Check power piston for free up and down movement. Proceed as follows. Use a .300 plug gauge or 19/64" drill and insert in front air horn vent stack. Push gently downward on top of power piston with engine off. Power piston should move downward approximately 1/4" and return to up position under spring tension. If power piston is sticking, remove the carburetor air horn and check power piston and cavity for dirt or scores. Check power piston spring for distortion.

Possible Cause	Corrective Action
Float level too low.	Check and reset float level.
Float not dropping far enough in bowl.	Check for bind in float hanger and float arm, float alignment in bowl and needle pull clip for sufficient clearance on float arm.
Main metering jets or metering rods dirty, plugged or incorrect part.	1. If the main metering jets are plugged or dirty or excessive dirt is in fuel bowl, the carburetor should be completely disassembled and cleaned. 2. If the jets or rods are incorrect size, consult the parts list for proper usage. The last two digits stamped on the primary rods and jets are the last two digits of the part number.

ENGINE STARTS HARD WHEN HOT

Possible Cause	Corrective Action
Choke valve not opening completely.	1. Check for binding choke valve and/or linkage. Clean and/or replace as necessary. Do not oil choke linkage. 2. Check and adjust choke thermostatic coil.
Engine flooded, carburetor flooding.	See procedure under "Engine cranks, will not start engine flooded."
No fuel in carburetor.	1. Check fuel pump. Run pressure and volume test. 2. Check float needle for sticking in seat, or binding float. 3. Check and adjust float level.
Leaking float bowl.	Fill bowl with fuel and look for leaks.

ENGINE RUNS UNEVEN OR SURGES.

Possible Cause	Corrective Action
Fuel restriction.	Check all hoses and fuel lines for bends, kinks or leaks. Straighten and secure in position. Check all fuel filters, if plugged or dirty - replace.
Dirt or water in fuel system.	Clean fuel tank, lines and filters. Remove and clean carburetor.
Fuel level.	Adjust float. Check for free float and float needle valve operation. Free up or replace as necessary.
Metering rods bent or incorrect part. Main metering jets dirty, defective, loose or incorrect part	Clean or replace as necessary.

Possible Cause	Corrective Action
Power system in carburetor not functioning properly. Power piston sticking.	Free up or replace as necessary.
Vacuum leakage.	It is absolutely necessary that all vacuum hoses and gaskets are properly installed with no air leaks. The carburetor and manifold should be evenly tightened to specified torque. Carburetor to manifold (to 15 ft. lbs.).
Secondary throttle valves sticking open or not seating properly.	Loosen secondary throttle valve screws. Align valves in carburetor bores and tighten securely.

POOR FUEL ECONOMY

Possible Cause	Corrective Action
Engine needs complete tune up.	Check engine compression, examine spark plugs, (if dirty or improperly gapped, clean and re-gap or replace), ignition point dwell, condition, re-adjust ignition points if necessary and check and reset ignition timing. Clean or replace air cleaner element if dirty. Check for restricted exhaust system and intake manifold for leakage. Make sure all vacuum hoses are connected correctly.
Choke valve not fully opening.	1. Clean choke and free-up linkage. 2. Check choke coil for proper adjustment.
Fuel leaks.	Check fuel tank, fuel lines and fuel pump for any fuel leakage.
High fuel level in carburetor or carburetor flooding.	1. Check for dirt in the needle and seat. Test using suction by mouth or needle seat tester. 2. Check for loaded float. 3. Re-set carburetor float. 4. If excessive dirt is present in the carburetor bowl, the carburetor should be cleaned.
Power system in carburetor not functioning properly. Power piston sticking in up position.	Free-up or replace as necessary.
Metering rods bent or incorrect part. Main metering jets, defective, loose or incorrect part	Clean or replace as necessary.
Fuel being pulled from accelerator system into venturi through pump jets.	Run engine at RPM where nozzles are feeding fuel. Observe pump jets. If fuel is feeding from jets, check pump discharge ball for proper seating by filling cavity above ball with fuel to level of casting. No "leak down" should occur with discharge ball in place, Re-stake or replace leaking check ball.
Air bleeds or fuel passages in carburetor dirty or plugged.	Clean carburetor or overhaul as necessary.

CARBURETOR REPLACEMENT

REMOVAL

1. Remove engine cover.

2. Remove air cleaner. Refer to "Air Cleaner" later in this section.

3. Disconnect vacuum hoses. Disconnect fuel inlet line.

4. Disconnect throttle cable. Disconnect cruise control rod if equipped.

5. Remove air cleaner stud.

6. Disconnect choke housing pipe.

7. Remove four carburetor to manifold attaching bolts.

8. Remove carburetor.

INSTALLATION

1. Install a new carburetor to manifold gasket.

2. Install carburetor. Torque attaching bolts diagonally to 48-96 in. lbs., then after all four are torqued, retorque diagonally to 12-17 ft. lbs. The sequence in Figure 9 is one, three, two, four.

3. Connect choke housing pipe.

4. Install air cleaner stud.

5. Connect throttle cable. Connect cruise control rod if removed.

6. Connect vacuum lines. Connect fuel inlet line. Hold fuel inlet nut while connecting fuel line to avoid damaging inlet nut nylon gasket.

7. Install air cleaner.

8. Install engine cover.

CARBURETOR OVERHAUL

NOTE: Before performing any service on the carburetor it is essential that the carburetor be placed on a holding fixture. The secondary throttle valves in the wide open position extend below the throttle body casting. Without the use of the carburetor fixture it is possible to bend or nick the aluminum throttle valves.

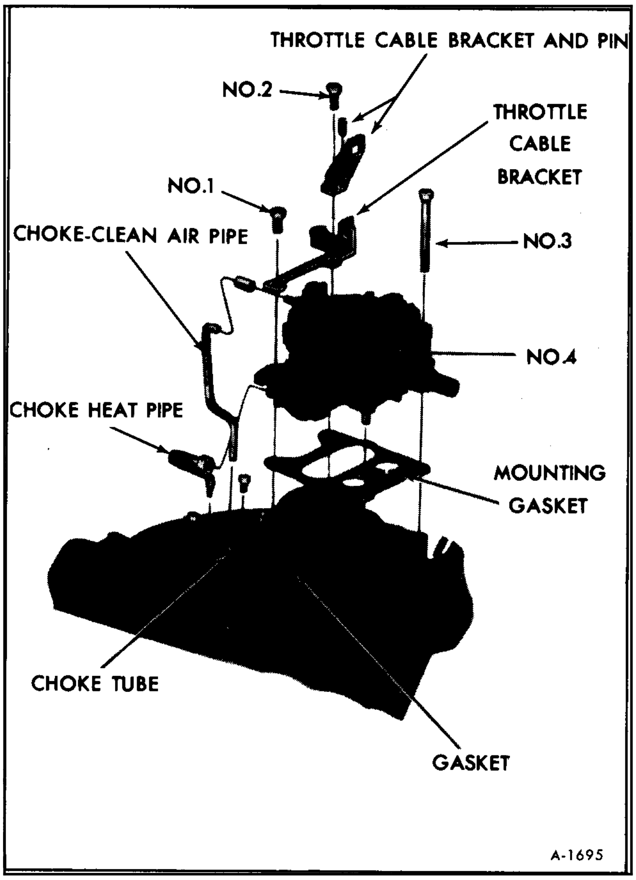


Figure 9—Carburetor Installation

AIR HORN REMOVAL

1. Remove air cleaner assembly.

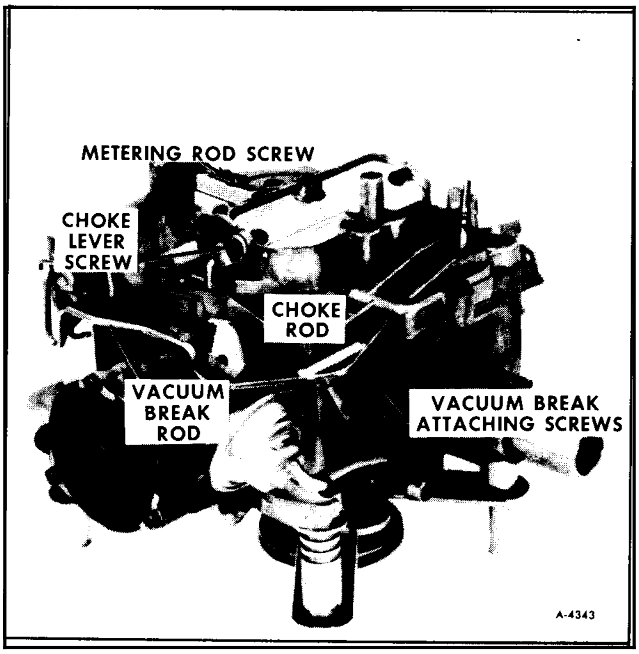


Figure 10—Carburetor Assembly

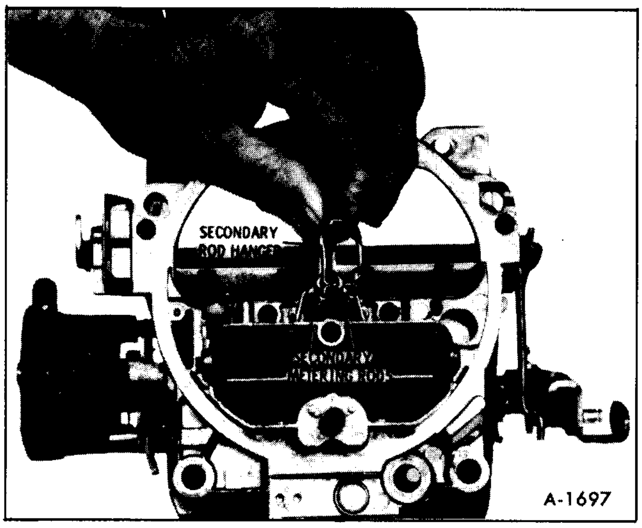


Figure 11—Secondary Metering Rods

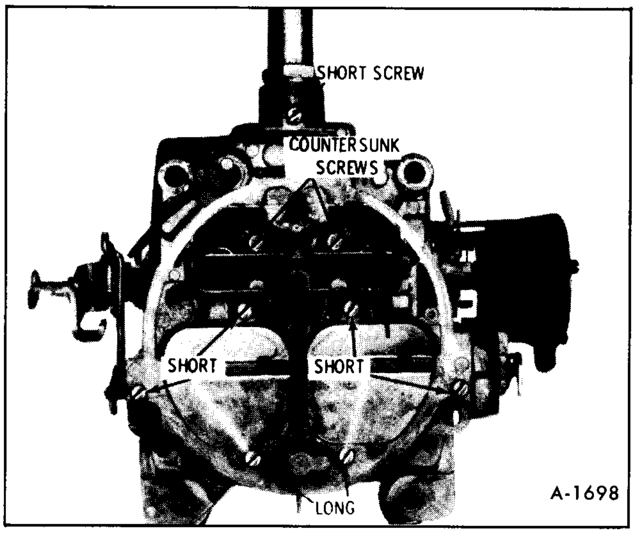


Figure 12—Air Horn Attaching Screws

2. Remove upper choke lever from the end of choke shaft by removing retaining screw (figure 10). Then remove the upper choke lever from the end of choke rod and choke rod from lower lever inside the float bowl casting.

> **NOTE:** Remove rod by holding lower lever outward with small screwdriver and twisting rod counterclockwise.

3. Remove vacuum break hose, remove vacuum break bracket attaching screws. The diaphragm assembly may now be removed from the dashpot rod and the dashpot rod from the air valve lever.

4. Remove secondary metering rods by removing the small screw in the top of the metering rod hanger. Lift upward on metering rod hanger until the secondary metering rods are completely out of the air horn. Metering rods may be disassembled from the hanger by rotating ends out of the holes in the end of the hanger (See figure 11).

5, Remove nine air horn to bowl attaching screws; two attaching screws are located next to the primary venturi. (Two long screws, five short screws, two countersunk screws.) See Figure 12.

6. The air horn assembly may now be removed from the float bowl by opening the throttle valve wide open and lifting up on the air horn and turning sideways until the pump rod disengages from the upper pump lever as shown in Figure 15.

> **CAUTION:** *Care must be taken not to bend the small bleed tubes and accelerating tubes in air horn casting. These are permanently pressed into casting. Do Not Remove.*

AIR HORN DISASSEMBLY

Further disassembly of the air horn is not recommended for cleaning purposes. If part replacement is required, proceed as follows:

1. Remove choke valve attaching screws, then remove choke valve and shaft from air horn.

> **NOTE:** Air valves and air valve shaft should not be removed. However, if it is necessary to replace the air valve closing spring or center plastic eccentric cam, a repair kit is available. Instructions for assembly are included in the repair kit.

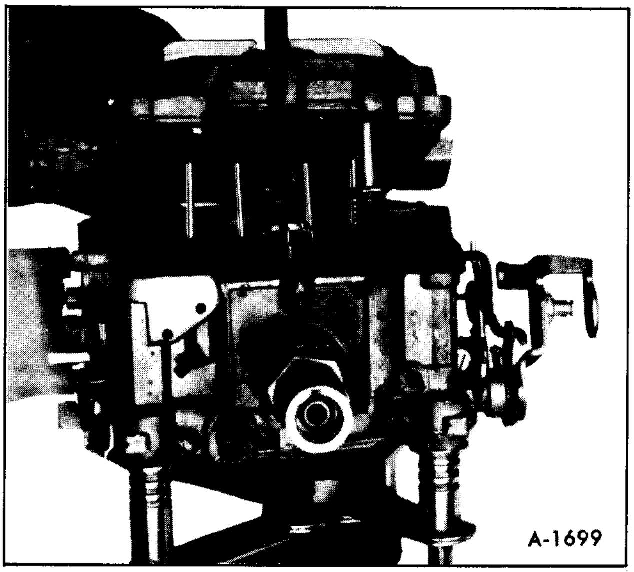


Figure 13—Removing Air Horn

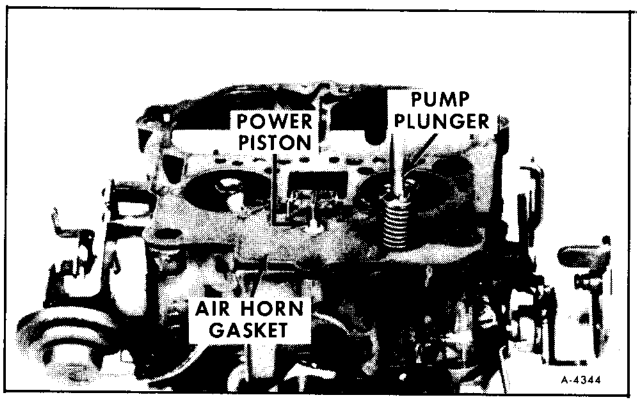


Figure 14—Float Bowl Assembly

FLOAT BOWL DISASSEMBLY

1. Remove pump plunger from pump well. See Figure 14.

2. Remove air horn gasket from float bowl.

3. Remove pump return spring from pump well.

4. Remove plastic filler over float valve.

5. Remove power piston and primary metering rods by depressing piston stem and allowing it to snap free. Remove power piston spring from well.

NOTE: Piston may require several snaps to come free.

6. Remove metering rods from power piston by disconnecting tension spring from top of each rod then rotating rod to remove from hanger as shown in Figure 15.

7. Remove float assembly and float needle by pulling up on retaining pin. Remove float needle seat and gasket (figure 16).

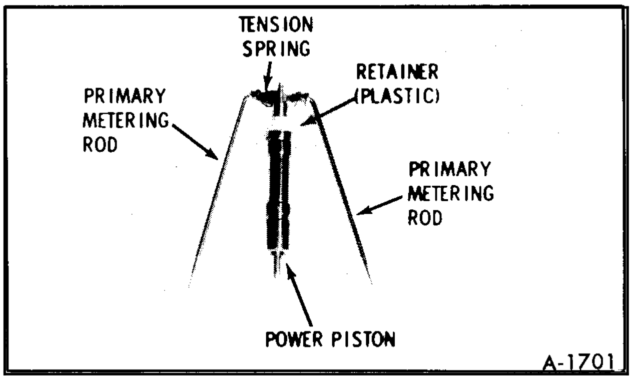


Figure 15—Power Piston and Metering Rod

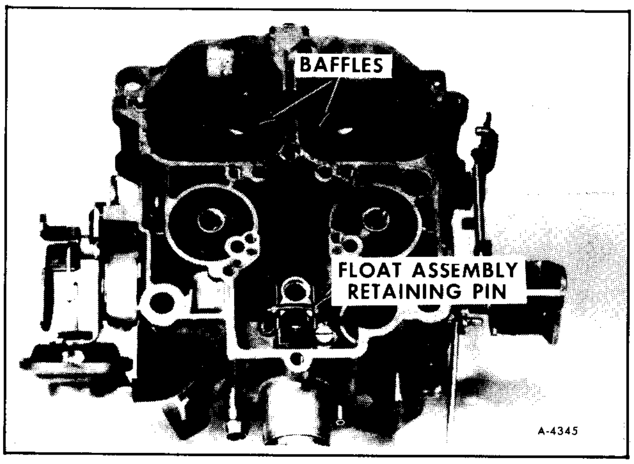


Figure 16—Float Assembly

8. Remove primary metering jets. No attempt should be made to remove secondary metering plates (figure 18).

9. Remove pump discharge check ball retainer and check ball.

10. Remove baffle from secondary side of bowl.

CAUTION: *Do not place vacuum break assembly in carburetor cleaner. Remove choke assembly. If further disassembly is necessary, spread the retaining ears on bracket next to vacuum break assembly, then remove vacuum break from bracket.*

CHOKE DISASSEMBLY

1. Remove three retaining screws and retainers from choke cover and coil assembly. Then pull straight outward and remove cover and coil assembly from choke housing. See Figure 18.

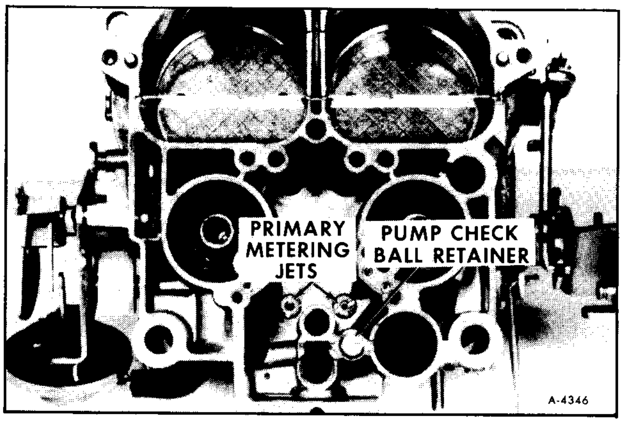


Figure 17—Primary Metering Jets

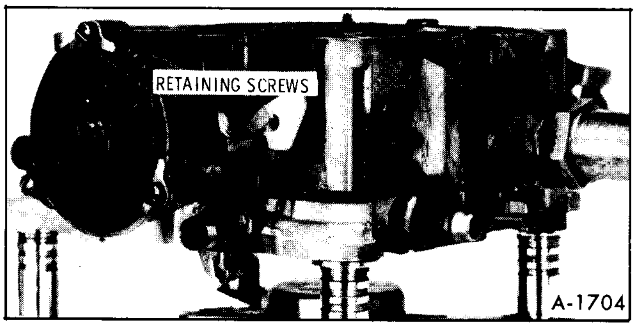


Figure 18—Choke Housing

NOTE: It is not necessary to remove baffle plate beneath the thermostatic coil. Distortion of the thermostatic coil may result if forced off the center retaining post on the choke cover.

2. Remove choke housing assembly from float bowl by removing retaining screw and washer inside the choke housing (figure 19). The complete choke assembly can be removed from the float bowl by sliding outward. Remove plastic tube seal from choke housing. Remove lower choke lever from inside float bowl cavity by inverting bowl.

CAUTION: *Plastic tube seal should not be immersed in carburetor cleaner.*

3. To disassemble intermediate choke shaft from choke housing, remove coil lever retaining screw at end of shaft inside the choke housing (figure 20). Then remove thermostatic coil lever from flats on intermediate choke shaft. Remove intermediate choke shaft from the choke housing by sliding outward. The fast idle cam can now be removed from the intermediate choke shaft. See Figure 21.

CAUTION: *Remove the cup seal from inside choke housing shaft hole, if the housing is to be immersed in carburetor cleaner. Also, remove the cup seal from the float bowl plastic insert for bowl cleaning purposes. Do not attempt to remove plastic insert.*

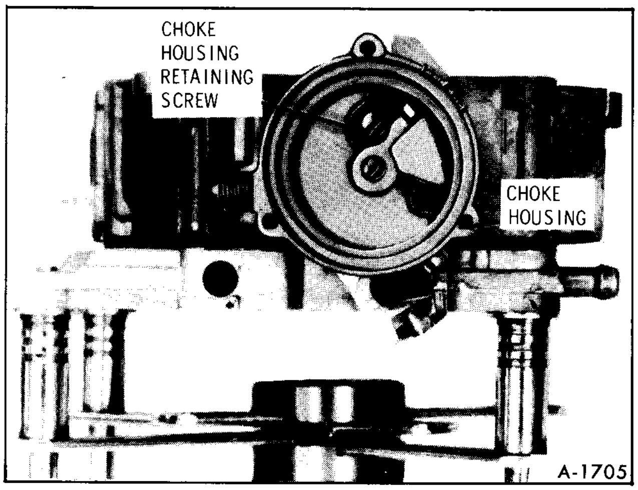


Figure 19—Choke Housing Attachment

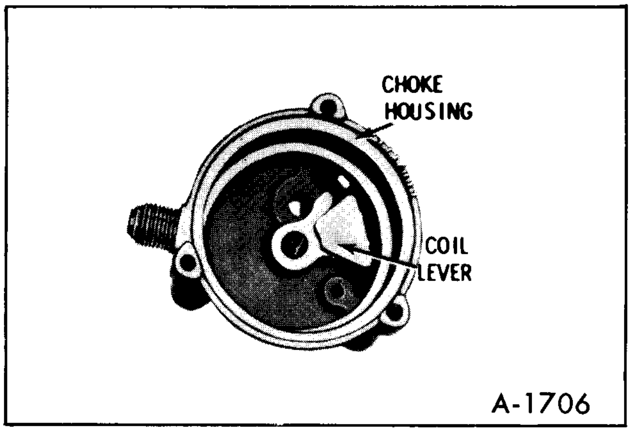


Figure 20—Choke Coil Lever

DISASSEMBLY OF REMAINING FLOAT BOWL PARTS

1. Remove fuel inlet nut, gasket and filter. See Figure 22.

2. Remove screws attaching throttle body to bowl as shown in Figure 23.

3. Remove throttle body to bowl insulator gasket. See Figure 25.

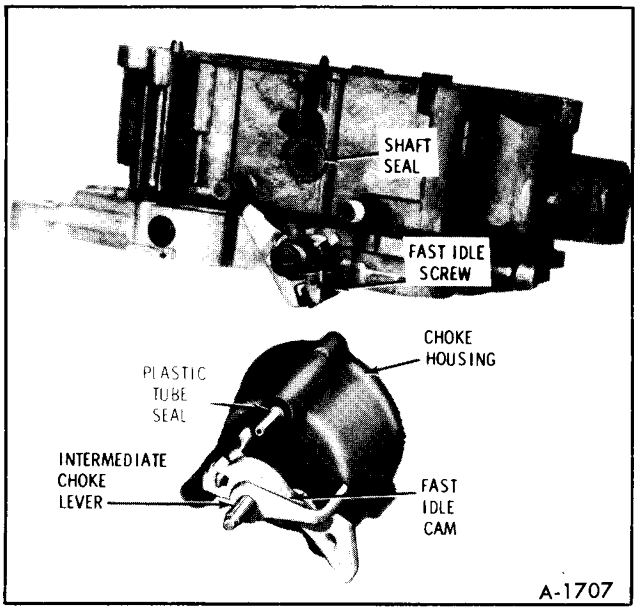


Figure 21—Choke Housing Sealing

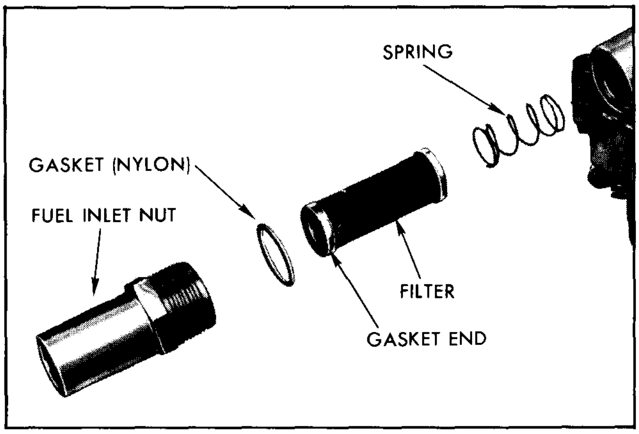


Figure 22—Fuel Filter

THROTTLE BODY DISASSEMBLY

1. Remove pump rod from throttle lever.

2. DO NOT REMOVE idle mixture limiter caps, unless it is necessary to replace the mixture needles or normal soaking and air pressure fails to clean the idle passages. If the idle mixture needles are removed, adjustment procedures will be covered in the "Carburetor Adjustment" chart. If necessary to remove the idle mixture needle, destroy plastic limiter cap. Do not install a replacement cap as a bare mixture screw is sufficient to indicate that the mixture has been readjusted.

CLEANING AND INSPECTION

1. Thoroughly clean carburetor castings and metal parts in an approved carburetor cleaner.

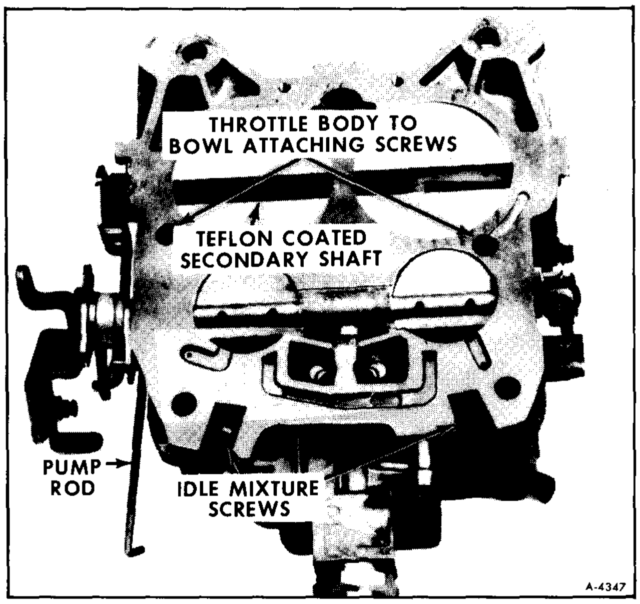


Figure 23—Throttle Body Attaching Screws

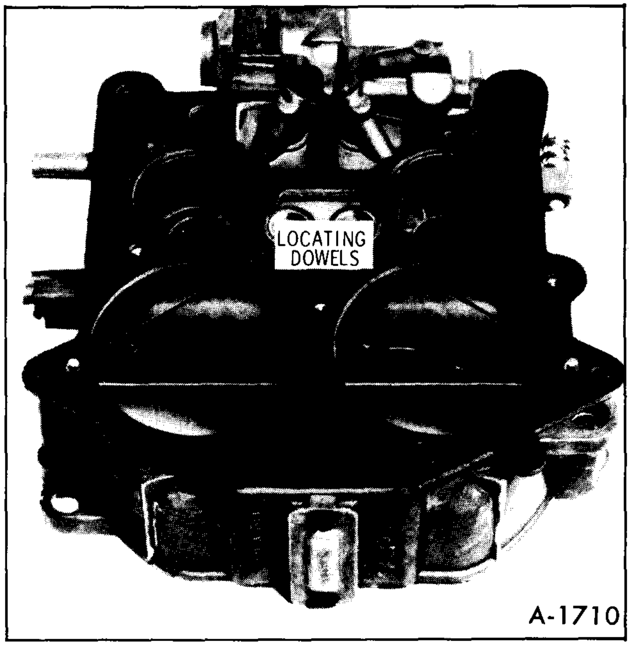


Figure 24—Throttle Body Gasket

CAUTION: *Rubber parts, plastic parts, and pump plungers should not be immersed in carburetor cleaner. However, the delrin cam on the air valve shaft and the throttle valve shafts will withstand normal cleaning in carburetor cleaner.*

2. Blow out all passages in castings with compressed air.

CAUTION: *Do not pass drills through jets or passages.*

3. Examine float needle and seat for wear. Replace if necessary with float needle assembly.

4. Inspect upper and lower surfaces of carburetor castings for damage.

5. Inspect holes in levers for excessive wear or out of round conditions. If worn, levers should be replaced.

6. Examine fast idle cam for wear or damage.

7. Check air valve for binding conditions. If air valve is damaged air horn assembly must be replaced.

8. Check all throttle levers and valves for binds or other damage.

THROTTLE BODY

1. If removed, install idle mixture needles and

springs until seated. Back out the mixture needles six turns as a preliminary idle adjustment. Final adjustment must be made on the engine using the procedure described under slow idle adjustment.

2. Install lower end of pump rod in throttle lever by aligning tang on rod with slot in lever. End of rod should point outwards towards throttle lever.

FLOAT BOWL ASSEMBLY

1. Install new throttle body to bowl gasket over two locating dowels on the bowl as shown in Figure 24.

2. Install throttle body, properly located over dowels on float bowl then install throttle body to bowl screws and tighten evenly. See Figure 23.

3. Install fuel inlet filter spring, new gasket and inlet nut (figure 22). Tighten nut (18 ft. lbs.).

> **CAUTION:** *Tightening beyond specified torque can damage nylon gasket.*

CHOKE HOUSING ASSEMBLY TO FLOAT BOWL

1. Install new cup seal into plastic insert on side of float bowl for intermediate choke shaft. Lip on cup seal faces outward.

2. Install fast idle cam onto the intermediate choke shaft (steps on fast idle cam face downward) as shown in Figure 21.

3. Install new rubber cup seal inside choke housing. Lips on seal face inward, towards inside of housing.

4. Carefully install fast idle cam and intermediate choke shaft assembly through seal in choke housing; then install thermostatic coil lever onto flats on intermediate choke shaft. Inside thermostatic choke coil level is properly aligned when both inside and outside levers face towards fuel inlet. Install inside lever retaining screw into end of intermediate choke shaft. Tighten securely.

5. Install lower choke rod lever into cavity in float bowl. Install plastic tube seal into cavity on choke housing before assembling choke housing to bowl. Install choke housing to bowl sliding intermediate choke shaft into lower choke lever. See Figure 25.

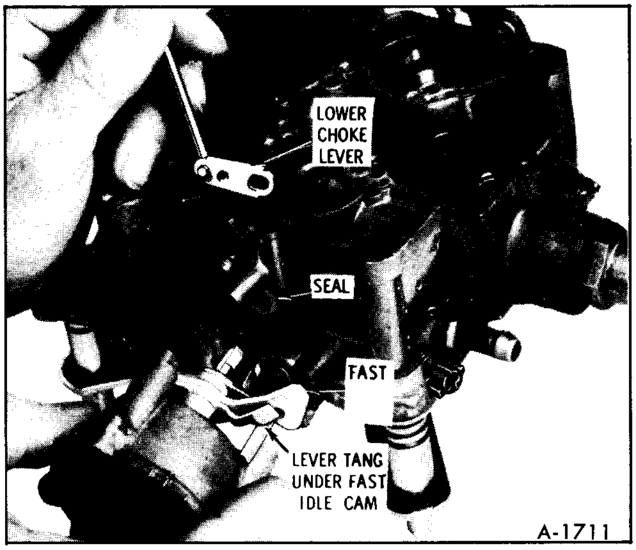


Figure 25—Lower Choke Lever

6. Install choke housing retaining screw and washer and tighten securely.

> **NOTE:** The intermediate choke shaft lever and fast idle cam are in correct relation when the tang on lever is beneath the fast idle cam. Do not install choke cover and coil assembly until inside coil lever is adjusted.

COMPLETION OF FLOAT BOWL ASSEMBLY

1. Install baffle in secondary side of float bowl with notches toward top of bowl.

2. Install pump discharge check ball and retainer in passage next to pump well. Tighten retainer securely.

3. Install primary metering jets. See Figure 17.

4. Install new needle seat and gasket assembly.

> **NOTE:** To make adjustment easier, bend float arm upward at notch in arm before assembly.

5. Install float needle by sliding float lever under pull clip from front to back. With float lever in pull clip, hold float assembly at toe and install retaining pin from pump well side.

> **NOTE:** Do not install float needle pull clip into holes in float arms.

6. Float level adjustment:

a. With adjustable T-scale, measure from top of float bowl gasket surface (gasket removed) to top of float at toe. Locate gauging point 1/16" back from toe.

Make sure float retainer is held firmly in place and arm of float is seated on float needle.

b. Bend float arm as necessary for proper adjustment by pushing on pontoon. Refer to adjustment chart for specification.

7. Install power piston spring into power piston well. If primary main metering rods were removed from hanger, reinstall making sure that tension spring is connected to top of each rod (figure 15). Install power piston assembly in well with metering rods properly positioned in metering jets. Press down firmly on plastic power piston retainer to make sure the retainer is seated in recess in bowl and the top is flush with the top of the bowl casting.

8. Install plastic filler block over float needle, pressing downward until properly seated.

9. Install pump return spring in pump well.

10. Install air horn gasket around primary main metering rods and piston. Position gasket over two dowels on secondary side of bowl.

11. Install pump plunger in pump well.

AIR HORN ASSEMBLY

If removed, install choke shaft, choke valve and two attaching screws. Tighten screws securely and stake lightly in place.

AIR HORN TO BOWL INSTALLATION

1. Holding the primary throttle valves wide open, rotate the air horn assembly so that the pump rod slides into inner hole in pump lever and then carefully lower air horn assembly onto the float bowl. Make sure that the bleed tubes and accelerating well tubes are positioned properly through the holes in the air horn gasket. Do not force the air horn assembly onto the bowl, but rather lightly lower in place.

2. Install two long air horn screws, five short screws, and two countersunk screws into primary venturi area. All screws must be tightened evenly and securely. See Figure 26.

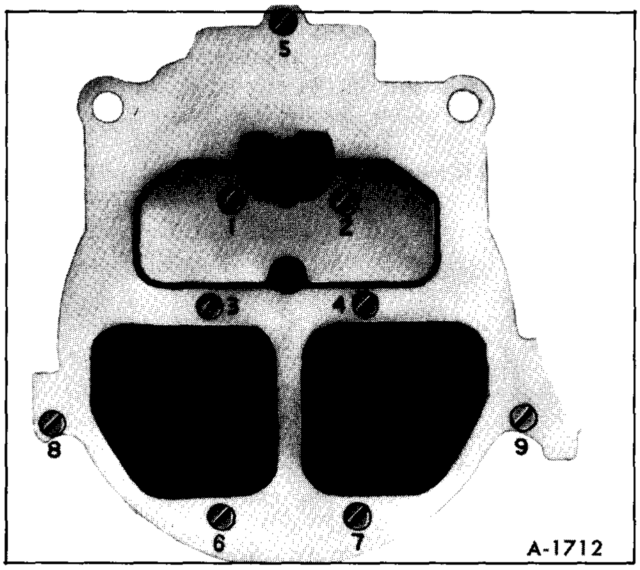


Figure 26—Air Horn Tightening Sequence

3. Install vacuum break diaphragm combination rod into the slot in lever on the end of the air valve shaft. Then install the other end of rod into hole in the vacuum diaphragm plunger. Install vacuum diaphragm assembly to float bowl using two retaining screws through bracket. Tighten securely.

4. Install rubber hose between the vacuum diaphragm and vacuum tube on float bowl.

5. Connect choke rod into lower choke lever inside bowl cavity; then install upper end of rod into upper choke lever and retain the choke lever to the end of choke shaft with attaching screw. Tighten securely.

NOTE: Make sure that the flats on the end of the choke shaft align with flats in the choke lever.

6. Install the secondary metering rods to the secondary metering rod hanger. The ends of the secondary metering rods point inward. Lower secondary metering rods into float bowl cavity and place hanger on actuating lever. Install small retaining screw and tighten lightly and securely.

NOTE: The thermostatic coil lever inside the choke housing has to be indexed properly before installing the choke thermostatic coil cover baffle and gasket assembly. Refer to adjustment charts (figures 27, 28, 29 and 30) for adjustment information.

After the inside thermostatic coil lever is adjusted, the thermostatic coil, cover and gasket assembly should be installed and rotated counterclockwise until the choke valve just closes. At this point, the index cover should be set as shown on adjustment chart (Choke Coil Adjustment). Install three choke cover retainers and screws and tighten securely.

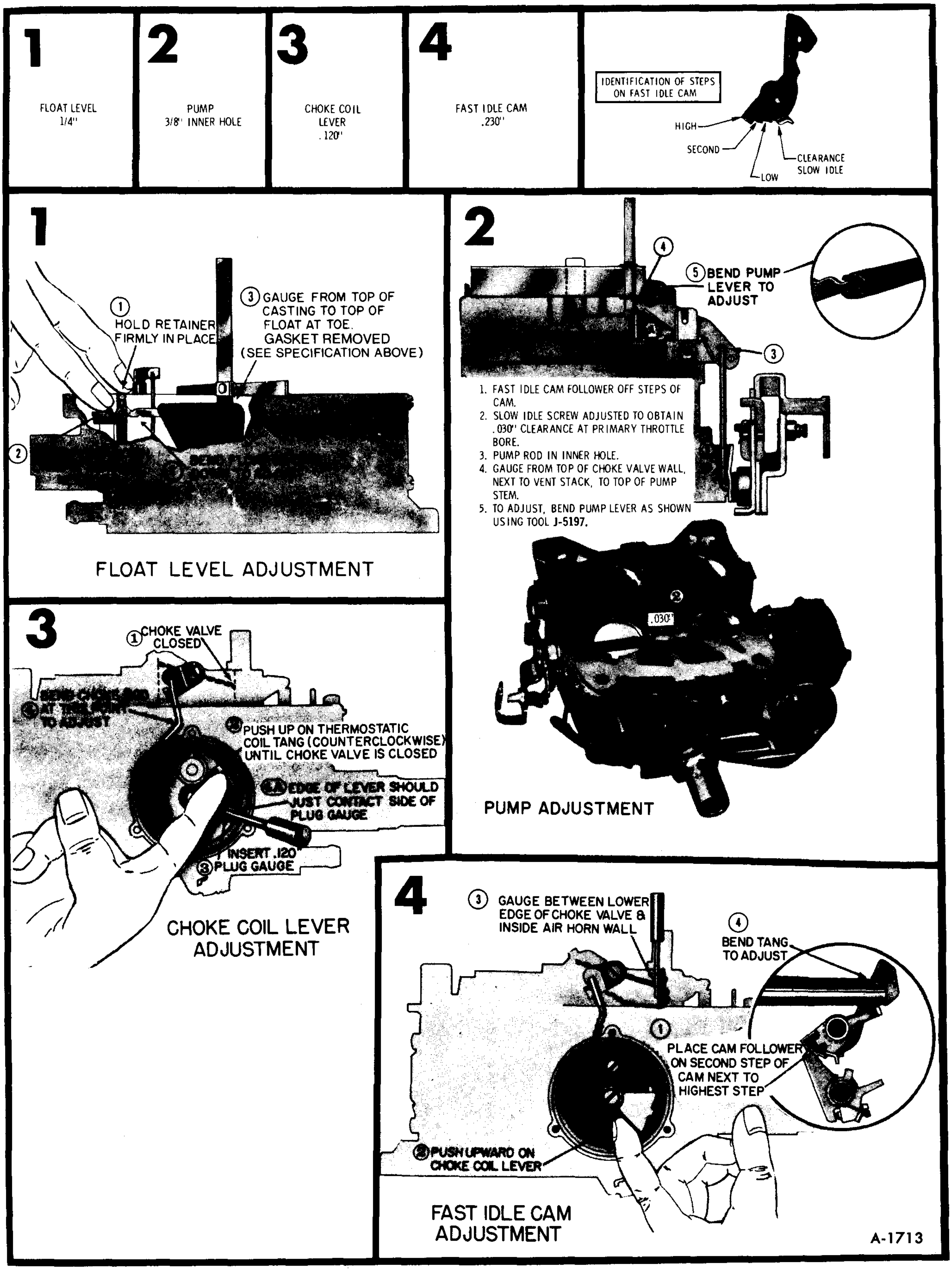


Figure 27—Carburetor Adjustments

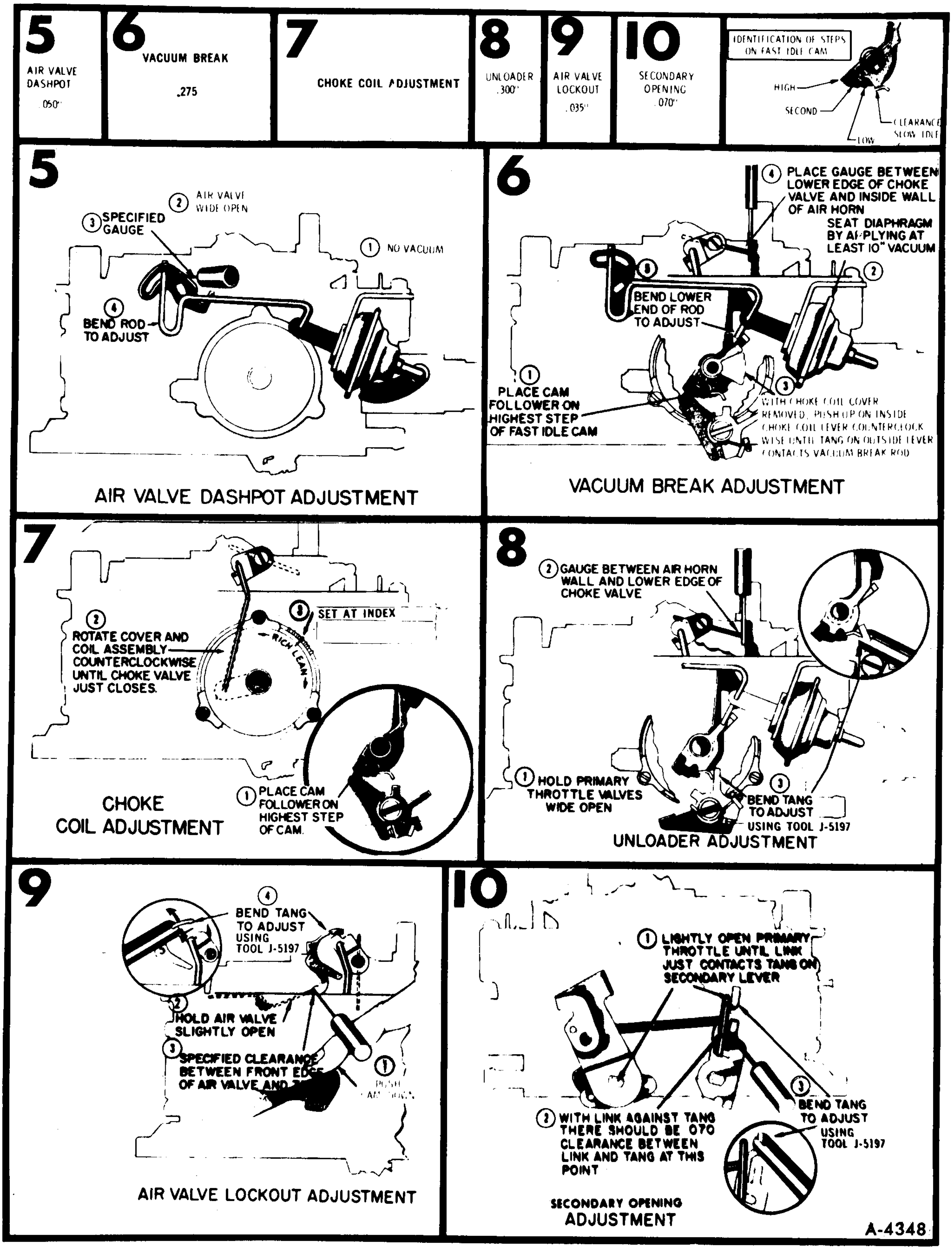


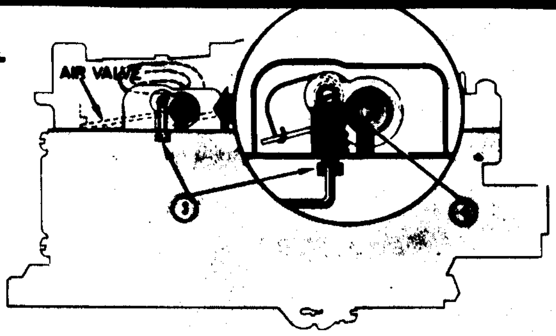
Figure 28—Carburetor Adjustments

11 AIR VALVE SPRING 3/4 TURN

12 SLOW IDLE SEE STEP 12 BELOW

13 FAST IDLE SEE STEP 13 BELOW

11



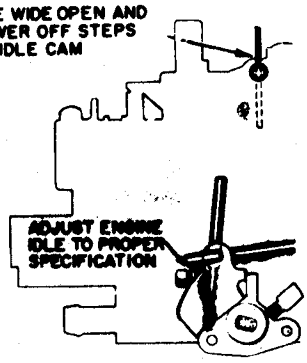
AIR VALVE SPRING ADJUSTMENT

1. REMOVE VACUUM BREAK DIAPHRAGM, AND ROD.
2. OPEN CHOKE VALVE.
3. LOOSEN LOCK SCREW (ALLEN HEAD).
4. TURN TENSION ADJUSTING SCREW COUNTER-CLOCKWISE UNTIL AIR VALVE OPENS PART WAY.
5. TURN TENSION ADJUSTING SCREW CLOCKWISE WHILE TAPPING LIGHTLY ON CASTING WITH HANDLE OF A SCREWDRIVER.
6. WHEN AIR VALVE JUST CLOSES, TURN TENSION ADJUSTING SCREW CLOCKWISE AN ADDITIONAL AMOUNT AS SPECIFIED ABOVE.
7. TIGHTEN LOCK SCREW AND REPLACE VACUUM BREAK DIAPHRAGM, AND ROD.

12

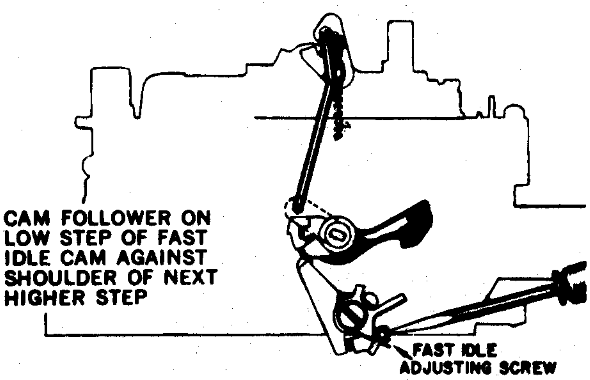
CHOKE VALVE WIDE OPEN AND CAM FOLLOWER OFF STEPS OF FAST IDLE CAM

SLOW IDLE ADJUSTMENT



1. ENGINE AT NORMAL OPERATING TEMPERATURE. REMOVE AIR CLEANER, DISCONNECT AIR CLEANER VACUUM HOSE AT INTAKE MANIFOLD, THEN PLUG FITTING.
2. CHOKE OPEN AND AIR CONDITIONING OFF.
3. SET PARKING BRAKE AND BLOCK DRIVE WHEELS.
4. DISCONNECT CARBURETOR HOSE FROM VAPOR CANISTER (PLUG HOSE).
5. DISCONNECT DISTRIBUTOR VACUUM HOSE AT DISTRIBUTOR AND PLUG.
6. WITH DWELL AND TIMING PROPERLY ADJUSTED AND TRANSMISSION IN DRIVE ADJUST IDLE SPEED TO OBTAIN 600 R.P.M.
7. CONNECT DISTRIBUTOR VACUUM HOSE, CONNECT CARBURETOR HOSE TO VAPOR CANISTER, CONNECT AIR CLEANER HOSE AND INSTALL AIR CLEANER.

13



FAST IDLE ADJUSTMENT (ON VEHICLE)

1. ENGINE AT NORMAL OPERATING TEMPERATURE. REMOVE AIR CLEANER, DISCONNECT AIR CLEANER VACUUM HOSE AT INTAKE MANIFOLD, THEN PLUG FITTING.
2. CHOKE OPEN AND AIR CONDITIONING OFF.
3. SET PARKING BRAKE AND BLOCK DRIVE WHEELS.
4. DISCONNECT CARBURETOR HOSE FROM VAPOR CANISTER AND PLUG
5. DISCONNECT DISTRIBUTOR VACUUM HOSE AT DISTRIBUTOR AND PLUG.
6. WITH DWELL AND TIMING PROPERLY ADJUSTED, PLACE CAM FOLLOWER ON LOW STOP AND AGAINST SHOULDER OF NEXT HIGHER STEP. ADJUST FAST IDLE SCREW TO OBTAIN 1100 RPM (TRANS. IN PARK).
7. UNPLUG DISTRIBUTOR VACUUM HOSE AND RECONNECT TO DISTRIBUTOR. UNPLUG VACUUM FITTING AT INTAKE MANIFOLD AND RECONNECT AIR CLEANER HOSE. CONNECT CARBURETOR HOSE TO CANISTER. INSTALL AIR CLEANER AND RECHECK IDLE RPM.

A-4349

Figure 29—Carburetor Adjustments

14 IDLE MIXTURE ADJUSTMENT

ENGINES CERTIFIED FOR 1974-1975-1976

(REFER TO LABEL ON R.H. VALVE COVER FOR YEAR OF CERTIFICATION)

IN THE CASE OF HIGH IDLE CO (OVER .5%) MAJOR CARBURETOR OVERHAUL, THROTTLE BODY REPLACEMENT, OR WHEN POOR IDLE QUALITY EXISTS, IDLE MIXTURE MAY BE ADJUSTED. TO PROPERLY SET IDLE MIXTURE TO ACHIEVE THE SMOOTHEST IDLE WHILE MAINTAINING EMISSION LEVELS WITHIN THE STANDARDS PRESCRIBED BY FEDERAL LAW, THE FOLLOWING PROCEDURES MUST BE FOLLOWED:

(HOWEVER)

BEFORE SUSPECTING THE CARBURETOR TO BE THE CAUSE OF POOR ENGINE PERFORMANCE OR ROUGH IDLE, CHECK IGNITION INCLUDING DISTRIBUTOR, CHECK TIMING, PLUGS AND WIRES, CHECK AIR CLEANER, EVAPORATIVE EMISSION SYSTEM, PCV SYSTEM AND COMPRESSION. ALSO, CHECK VACUUM HOSES FOR LEAK.

IF ACCURATE CO METER IS AVAILABLE.

1. WITH ENGINE AT NORMAL OPERATING TEMPERATURE, REMOVE AIR CLEANER AND DISCONNECT AIR CLEANER VACUUM HOSE AT INTAKE MANIFOLD, THEN PLUG FITTING.
2. CHOKE OPEN AIR CONDITIONING OFF.
3. SET PARKING BRAKE AND BLOCK FRONT DRIVE WHEELS.
4. DISCONNECT CARBURETOR HOSES FROM VAPOR CANISTER, DISTRIBUTOR, AND PLUG HOSES.
5. CONNECT CO METER TO EXHAUST SYSTEM TAILPIPE.
6. SET IDLE SPEED TO 600 RPM.
7. TURN EACH IDLE MIXTURE CAP IN EQUAL AMOUNTS (MAXIMUM ADJUSTMENT IS ONE HALF) UNTIL IDLE CO IS AT OR BELOW .2%. RESET IDLE SPEED, IF NECESSARY, WITH AIR CLEANER IN PLACE.
8. RECONNECT CARBURETOR TO CANISTER HOSE AND DISTRIBUTOR VACUUM ADVANCE HOSE. INSTALL AIR CLEANER AND CONNECT VACUUM HOSE.

NOTE: CO METER MUST BE CAPABLE OF LOW LEVEL, ACCURATE READINGS. METERS SHOULD BE ACCURATE WITHIN ± .1% CO IN THE SETTING RANGE SPECIFIED. THE METER SCALE SHOULD HAVE DIVISIONS OF .2% CO OR LESS.

IF ACCURATE CO METER IS NOT AVAILABLE.

1. WITH ENGINE AT NORMAL OPERATING TEMPERATURE, REMOVE AIR CLEANER AND DISCONNECT AIR CLEANER VACUUM HOSE AT INTAKE MANIFOLD, THEN PLUG FITTING.
2. CHOKE OPEN AIR CONDITIONING OFF.
3. SET PARKING BRAKE AND BLOCK FRONT DRIVE WHEELS.
4. DISCONNECT CARBURETOR HOSES FROM VAPOR CANISTER, DISTRIBUTOR AND PLUG HOSES.
5. SET DWELL. SET TIMING AT SPECIFIED RPM.
6. BREAK TABS OFF FROM IDLE MIXTURE SCREW CAPS.
7. CONNECT AN ACCURATE VACUUM GAUGE TO THE INTAKE MANIFOLD.
8. WITH TRANSMISSION IN DRIVE, ADJUST IDLE SPEED SCREW TO OBTAIN 600 RPM.
9. EQUALLY RICHEN (TURN OUT) MIXTURE SCREWS UNTIL MAXIMUM IDLE SPEED IS ACHIEVED. NOTE MANIFOLD VACUUM READING.

   NOTE: IF MIXTURE SCREWS ARE APPARENTLY OUT-OF-BALANCE OR CARBURETOR IS BEING OVER-HAULED, LIGHTLY SEAT IDLE MIXTURE SCREWS, THEN BACK OUT 4 FULL TURNS. ADJUST IDLE SPEED SCREW TO OBTAIN 650 RPM.
10. EQUALLY LEAN (TURN IN) MIXTURE SCREWS UNTIL THE IDLE SPEED IS 600 RPM. MANIFOLD VACUUM READING SHOULD NOT BE REDUCED BY MORE THAN 2 INCHES OF MERCURY FROM READING OBTAINED IN STEP 9. IF READING IS REDUCED MORE THAN 2 INCHES, REPEAT PROCEDURE.
11. RECONNECT DISTRIBUTOR AND CANISTER HOSES.
12. INSTALL AIR CLEANER AND AIR CLEANER VACUUM HOSE.
13. IDLE CO SHOULD BE .2% MAXIMUM.

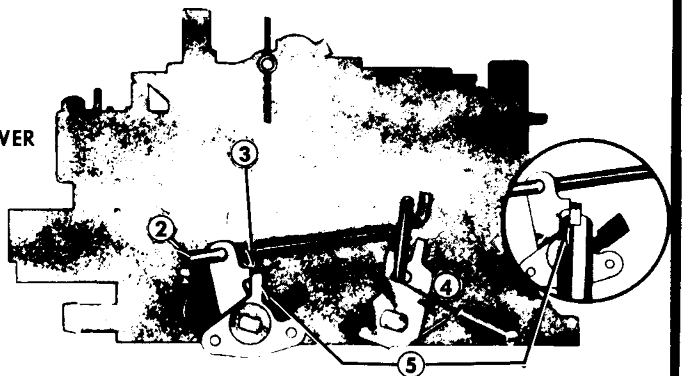
A-4350

Figure 30—Carburetor Adjustments

15 SECONDARY CLOSING .020"	**16** DOWNSHIFT SWITCH ADJUSTMENT

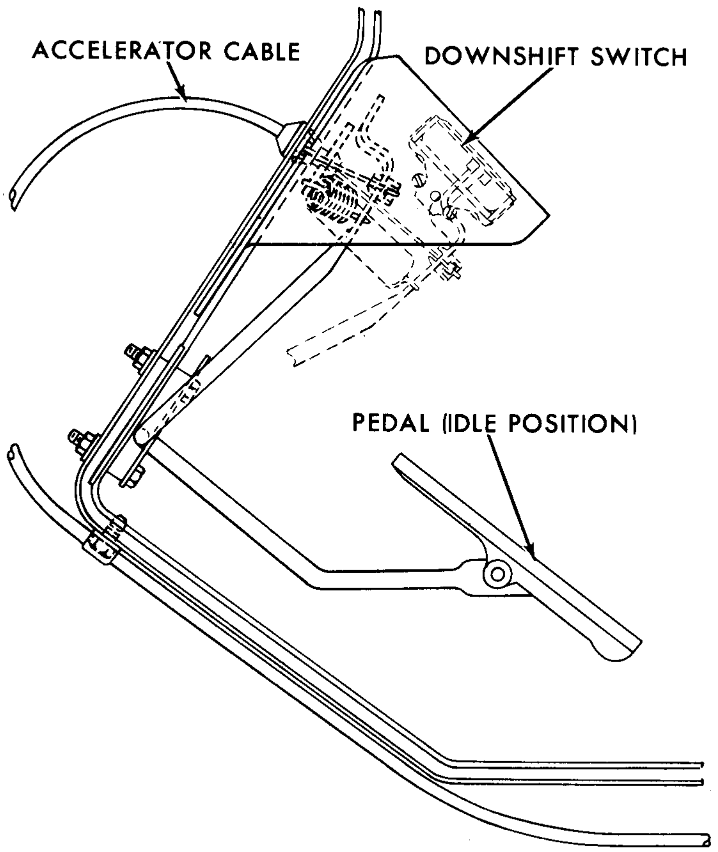
15

1. CHOKE FULLY OPEN AND FAST IDLE CAM FOLLOWER OFF STEPS OF FAST IDLE CAM.
2. SLOW IDLE PROPERLY SET.
3. MAKE SURE THROTTLE LEVER TANG IS AGAINST SECONDARY THROTTLE ROD OPERATING LEVER AS SHOWN IN 3.
4. GAUGE BETWEEN ROD AND END OF SLOT AS SHOWN IN 4. SEE SPECIFICATION ABOVE.
5. TO ADJUST OPEN THROTTLE SLIGHTLY AND BEND TANG WITH J-5197 AS SHOWN.



SECONDARY CLOSING ADJUSTMENT
(ON VEHICLE)

16



SWITCH ADJUSTMENT PROCEDURE

AFTER INSTALLING SWITCH PRESS PLUNGER AS FAR FORWARD AS POSSIBLE. THIS PRESETS SWITCH FOR ADJUSTMENT. SWITCH WILL ADJUST ITSELF PROPERLY WHEN PEDAL IS DEPRESSED TO FULL THROTTLE.

A-4351

Figure 31—Carburetor Adjustments

ACCELERATOR LINKAGE

The accelerator control system is a cable type. The pedal is mounted to a lever which is connected to the cable above the pedal, under the dash. As the pedal is depressed the lever moves back pulling the cable and engaging a transmission down shift switch. There is no adjustment on the pedal or lever, and it is important that the cable assembly NOT be lubricated.

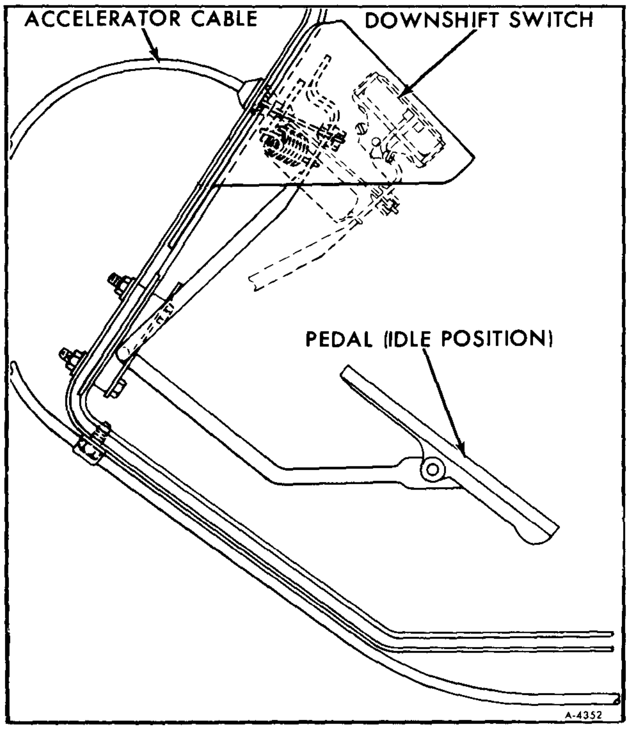


Figure 32—Accelerator Linkage

FUEL PUMP

The fuel pump rocker arm is held in constant engagement with the eccentric on the camshaft by the rocker arm spring. As the end of the rocker arm which is in contact with the eccentric moves upward, the fuel link pulls the fuel diaphragm downward. The action of the diaphragm enlarges the fuel chamber drawing fuel from the tank through the inlet valve and into the fuel chamber.

The pump delivers fuel to the carburetor only when the pressure in the outlet line is less than the pressure maintained by the diaphragm spring. Therefore, when the carburetor float needle valve opens, the spring will expand to move the diaphragm upward to force fuel past the outlet valve to the carburetor. When the carburetor float needle valve closes, the pump builds up pressure in the fuel chamber until the diaphragm spring is again compressed. The diaphragm will then remain stationary until more fuel is required by the carburetor.

INSPECTION AND TEST

There are three tests that can be preformed to evaluate the fuel pump without removing the pump from the engine. It is important that the pump performs properly using all three tests.

1. Be sure there is gasoline in the tank.

2. Check for loose line connections. A leak at the pressure side of the system (line from pump to carburetor) will be indicated by dripping fuel. A leak in the suction side of the system (line from gas tank to pump) will not be apparent except in its effect of reducing volume of fuel on the pressure side of the system.

3. Look for bends or kinks in lines or hoses which will reduce flow. Check the fuel pump inlet hose routing to be sure it is not bent or kinked.

Fuel Flow Test

a. Remove coil secondary wire from distributor and ground to block so that engine can be cranked without starting.

b. Disconnect fuel line at the carburetor inlet fitting. Install a rubber hose approximately 8-10" long over the end of the fuel line.

c. Place suitable container at end of the hose and crank engine a few revolutions.

NOTE: If little or no gasoline flows from open end of line, then the fuel line is restricted, gas tank filter restricted or the pump is inoperative. Before removing pump, disconnect fuel lines at fuel pump and at gas tank and blow through them with an air hose to make sure they are clear. Reconnect fuel lines to pump and gas tank.

d. Reconnect fuel line at the carburetor, tighten line fitting while holding carburetor fuel inlet nut. Start engine and check for leaks.

Pump (Inlet) Vacuum

Low vacuum or complete loss of vacuum provides insufficient fuel to the carburetor to operate the engine throughout normal speed range.

a. Disconnect hose from fuel tank to fuel pump at the fuel pump. Fasten hose in an up position so that fuel will not run out.

b. Connect one end of a short hose to the fuel pump inlet and attach a vacuum gauge to the other end. Start engine, gauge should register not less than 15 in. vacuum. If less than 15 in. of vacuum, replace pump.

Pump (Outlet) Pressure

Even if fuel flows in good volume from line at carburetor, it is advisable to make certain that pump is operating within limits.

a. Disconnect fuel line at the carburetor inlet fitting. Install a rubber hose approximately 8/10" long over the line and attach a low reading pressure gauge. Hold the gauge up so that it is approximately 16" above the fuel pump.

b. Start engine and run at slow idle (using gasoline in carburetor bowl) and note reading on pressure gauge.

c. If pump is operating properly, the pressure should be 5-1/2 to 6-1/2 constant. If pressure is too high or too low or varies materially at different engine speeds, the pump should be replaced.

FUEL PUMP REPLACEMENT

Removal

1. Raise vehicle.

2. Disconnect fuel line to carburetor and fuel hose from fuel tank.

3. Loosen nut securing top of fuel pump to block.

4. Remove bolt securing bottom of fuel pump to block.

5. Remove pump.

Installation

1. Install fuel pump with new gasket.

2. Install bolt and tighten alternately with nut to assure an even draw down of pump to block.

3. Connect fuel hose and line to fuel pump. Tighten fuel fittings to carburetor and fuel pump. Hold nut at carburetor inlet while applying torque.

4. Lower vehicle.

AIR CLEANER

REMOVAL

1. Remove engine cover.

2. Remove wing nut on top of air cleaner.

3. Disconnect P.C.V. pipe from the air cleaner housing. See Figure 33.

4. Lift air cleaner housing off carburetor high enough to reach underneath it and disconnect the vacuum hose from the intake manifold. See Figure 33.

5. Remove air cleaner housing.

6. Inspect air cleaner housing gasket on carburetor, replace gasket as needed.

NOTE: : To install new gasket:

1. Completely remove old gasket.

2. Remove protective paper from adhesive side of new gasket.

3. Install new gasket adhesive side down, on carburetor air horn.

INSTALLATION

1. While installation the air cleaner housing connect the vacuum hose to the intake manifold.

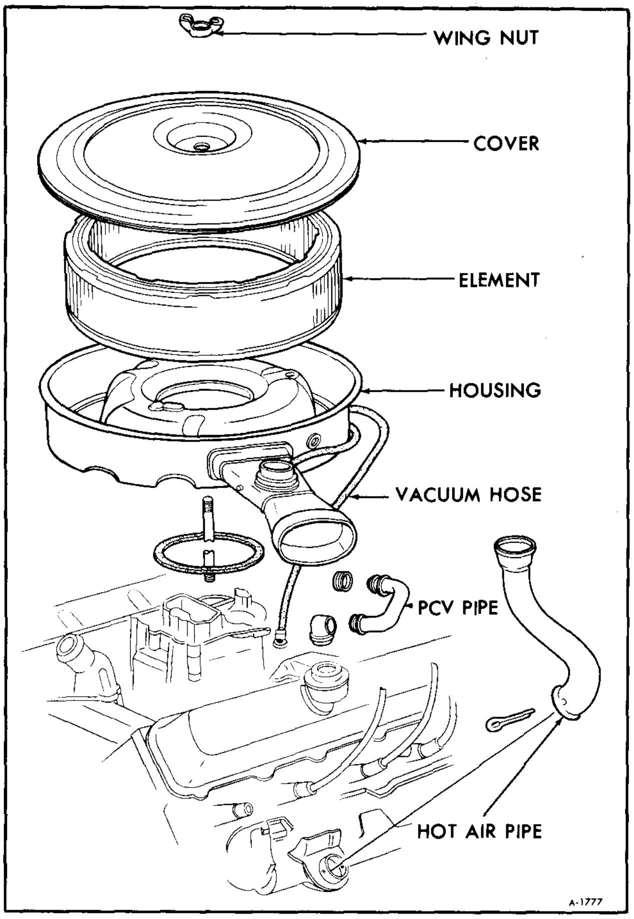


Figure 33–Air Cleaner

2. Position hot air pipe so it enters the air cleaner properly.

3. Connect P.C.V. pipe to the air cleaner housing.

4. Install wing nut and tighten.

5. Install engine cover.

AIR CLEANER ELEMENT

The air cleaner element should be replaced regularly according to the maintenance information in Section 0 of this manual.

The element is accessible by removing the wing nut and the air cleaner cover.

CARBURETOR PART NUMBER

	Federal	California
1974	7043254	7045554
1975	7045254	7045554
1976	7045254	7045554

SECTION 6T
EMISSION CONTROL SYSTEMS

Contents of this section are listed below:

SUBJECT	PAGE NO.
Positive Crankcase Ventilation (P.C.V.)	
Description	6T-1
P.C.V. System Testing	6T-2
Instruction For Testing P.C.V. Valve	6T-2
Instruction For Testing Complete System	6T-2
Controlled Combustion System (C.C.S.)	
Description	6T-3
Purpose	6T-3
Operation	6T-4
Diagnosis	6T-4
Vacuum Motor Replacement	6T-5
Sensor Replacement	6T-5
Exhaust Manifold Shroud	6T-6
Evaporation Control System (E.C.S.)	6T-6
Thermal Vacuum Switch (T.V.S.)	
Description	6T-6
Operation	6T-6
Vacuum Hose Routing	6T-7
Functional Check	6T-7
Throttle Return Control (T.R.C.)	6T-7

6

POSITIVE CRANKCASE VENTILATION (P.C.V.)

DESCRIPTION (FIGURE 1)

At idle or normal road speeds, intake manifold vacuum causes fresh air to be drawn through the engine air filter, then to the left valve cover where it joins with the crankcase vapors. This mixture is then drawn through the P.C.V. valve to the base of the carburetor where the vapors are mixed with normal fuel air mixture and burned.

When the engine is running at idle or the vehicle is traveling at normal speeds, intake manifold vacuum is sufficient to draw crankcase vapors caused by engine blow-by through the spring loaded P.C.V. valve.

At high road speeds or heavy acceleration, the engine blow-by is increased and at the same time, intake manifold vacuum decreased. When this occurs, there is a reverse action, crankcase vapors released through the crankcase filter are returned back into the intake manifold through the carburetor. When operating the engine under zero vacuum or a manifold pressure condition such as a backfire or during engine cranking, the check valve is closed by spring tension to prevent fuel vapor from entering the crankcase. The valve is also closed under wide-open throttle condition but since this is for a very short duration of time, no irregularity will exist.

NOTE: If vehicle has encountered dusty conditions, be sure PCV filter is cleaned immediately.

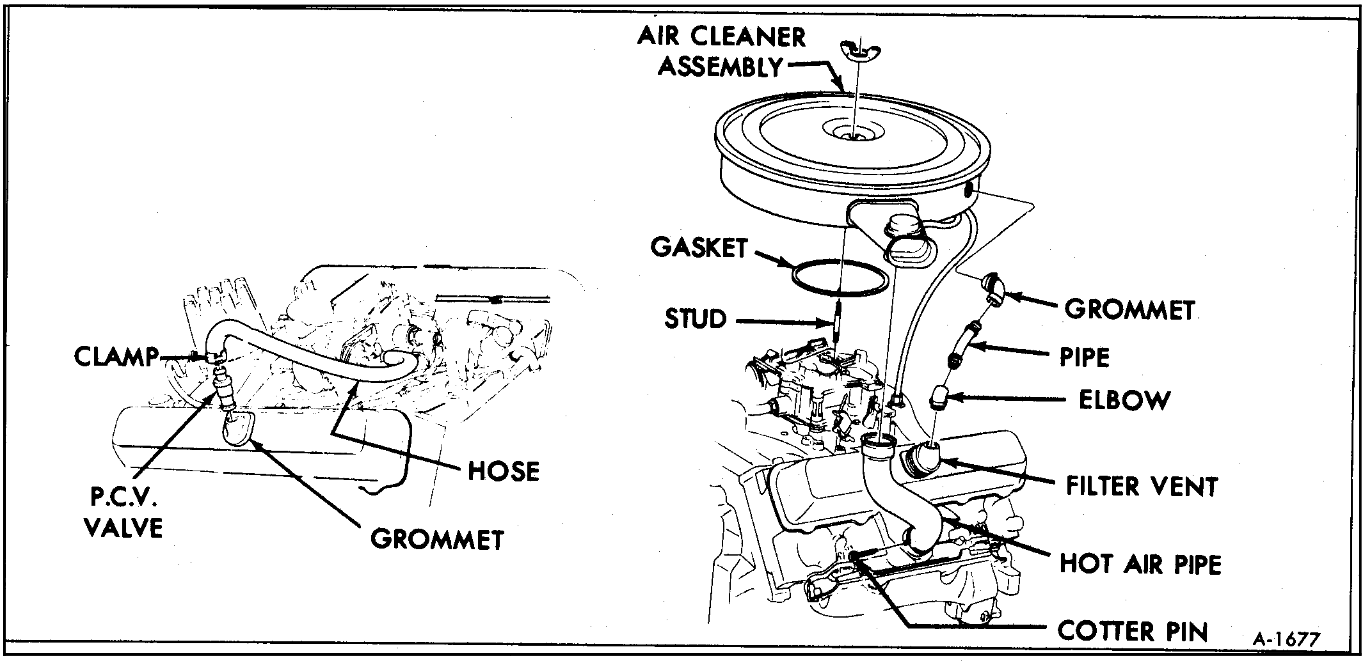


Figure 1—Positivie Crankcase Ventilation System

P.C.V. SYSTEM TESTING

The CT-3 tester is an extremely sensitive vacuum-pressure gauge designed to accurately indicate the small amount of vacuum or pressure in the system. The tester is also used to test the P.C.V. valve after it has been removed.

INSTRUCTIONS FOR TESTING P.C.V. VALVE

1. Disconnect P.C.V. valve from crankcase — leave valve connected to hose.

2. Adjust tester selector knob to "E".

3. Connect hose to tester body and vent valve adapter CT-18.

4. With engine at operating temperature, at idle and transmission in "PARK," hold the vent valve adapter CT-18 against the crankcase end of the vent valve.

5. Hold the tester upright and look directly into the test window and observe the color. Be sure the adapter is firmly sealed against the valve, there are no leaks and hose is not kinked.

6. An all "GREEN" window reading indicates valve is OK. Any "YELLOW" showing indicates the valve needs replacing.

INSTRUCTIONS FOR TESTING COMPLETE SYSTEM

1. Remove oil dipstick and plug hole with dipstick hole plug CT-12 (part of CT-3 tester).

2. Remove tube from elbow at air cleaner and plug tube with CT-11.

3. Adjust tester selector knob to "K".

4. Connect hose to tester body and tester adapter CT-14

5. Remove oil filler cap and place tester adapter CT-14 into opening.

6. With engine at operating temperature, running at idle and transmission in "PARK," hold tester upright and look directly into tester window and note the color, it should be green. If not, be sure there are no leaks and hose is not kinked. Refer to P.C.V. Diagnosis Chart for other items to look for.

P.C.V. DIAGNOSIS CHART (USING CT-3 TESTER)

WINDOW READING	PROBABLE CAUSE	CORRECTION
GREEN	System satisfactory. Vent valve partially plugged. Blow-by close to capacity of valve.	Check Valve.
YELLOW	Tester hose kinked or blocked. Crankcase not sealed properly. Tester "selector knob" set incorrectly. Vent-valve partially plugged. Slight kink in CT-3 tester hose.	Reposition or clean hose. Check tester plugs and other seal-off points. Check setting. Check vent valve. Reposition tester hose.
YELLOW-GREEN	Slight engine blow-by. Crankcase not sealed properly. Tester "selector knob" set incorrectly. Vent-valve partially or fully plugged.	Check vent valve. Check tester plugs and other seal-off points. Check setting. Check vent valve.
RED-YELLOW	Engine blow-by exceeds valve capacity. Rubber vent hose collapsed or plugged.	Engine overhaul indicated. Clean or replace hose.
RED	Vent-valve plugged. Vent-valve stuck at engine off position. Rubber vent hose collapsed or plugged. Extreme engine blow-by.	Check vent valve. Check vent valve. Replace hose. Engine requires major overhaul.

CONTROLLED COMBUSTION SYSTEM (C.C.S.)

A Controlled Combustion System is standard equipment on the engine. The Controlled Combustion System consists of an air cleaner assembly which includes a temperature sensor, vacuum motor, control damper assembly and connecting vacuum hoses. The motor is controlled by the temperature sensor. The vacuum motor operates the air control damper assembly to control the flow of pre-heated and non pre-heated air. The pre-heated air is obtained from the hot air pipe and shroud on the exhaust manifold.

PURPOSE

At underhood temperatures below 79 degrees F. the Control Combustion System directs heated air into the air cleaner. This system provides the most desirable emission control throughout the operating range of the engine and results in improved fuel economy, improved engine warm-up and eliminates tendency for ice to form in the carburetor.

OPERATION (FIGURES 2, 3 & 4)

During engine warm-up with engine compartment temperature at 79°F. (26.1°C.) the temperature sensor is closed. This allows engine vacuum to be directed to the vacuum motor closing the damper assembly to outside air. With the damper closed, the cool air will flow through the openings at the ends of the shroud where it is heated. The heated air then flows up through the hot air pipe and adapter into the air cleaner. As the temperature inside the air cleaner reaches approximately 123°F. (50.6°C.) the sensor bleeds off vacuum to the vacuum motor causing the control damper to open allowing underhood air to be mixed with the heated air as needed to keep the air temperature approximately 123°F. (50.6 C.) if the ambient temperature is 123°F. (50.6°C.) or below.

Under full throttle or below 3 in. Hg. to 7 in. Hg., the vacuum motor will no longer hold the valve open to hot air. The hot air pipe is closed off allowing only outside air to enter the air cleaner.

DIAGNOSIS

VACUUM MOTOR AND DAMPER ASSEMBLY

1. With the engine off, remove air cleaner cover and tape thermometer J-5421 in air cleaner next to sensor (See figure 5).

NOTE: If temperature is below 79 degrees F. (26.1°C.) continue to Step 2. If temperature is above 79 degrees F. (26.1°C.) remove air cleaner and allow to cool to at least 72 degrees F. (22.2°C.).

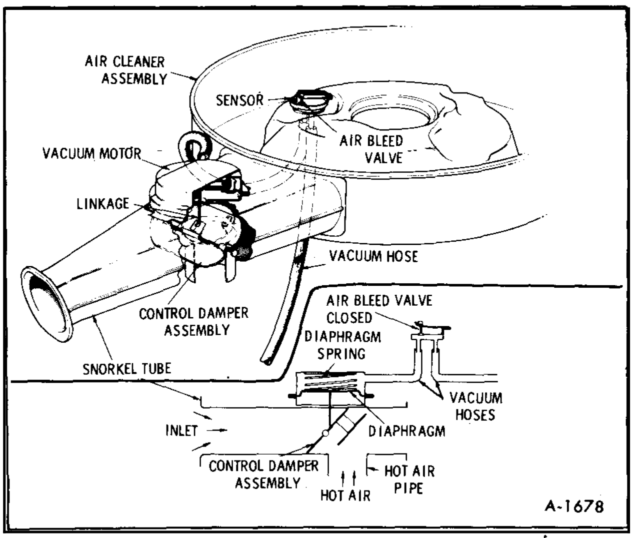


Figure 2—Hot Air Delivery Mode

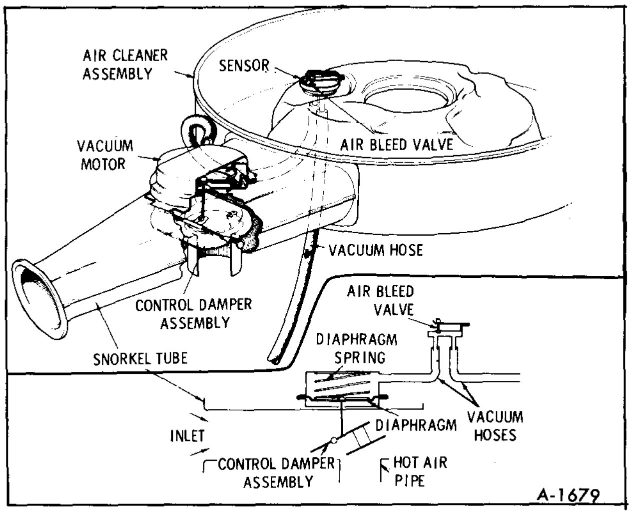


Figure 3—Regulating Mode

2. Install a tee in vacuum line at vacuum motor and connect a vacuum gauge in line.

3. With the engine off, the control damper should be open.

4. Install the cover on air cleaner without the wing nut and start the engine.

5. With engine at idle speed, the control damper should be closed with the ambient temperature at or below 79 degrees F. (26.1°C.).

6. Using a small mirror observe the control damper snorkel; when it reaches the full open position (outside air), quickly remove cover on air cleaner and record reading on thermometer and vacuum gauge.

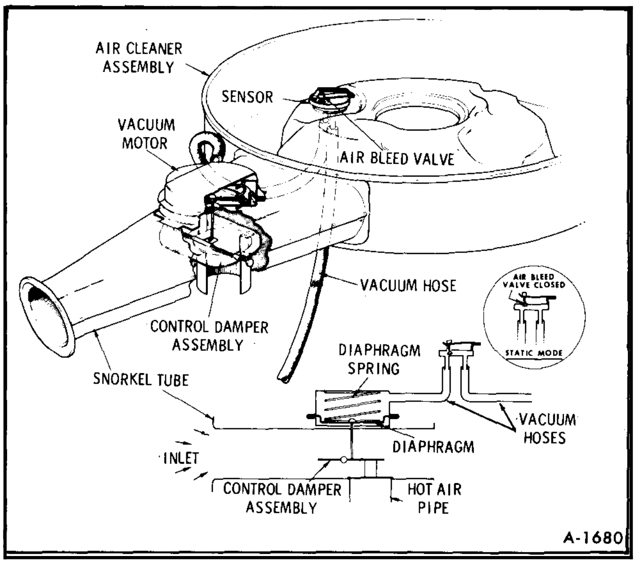


Figure 4—Cold Air Delivery Mode

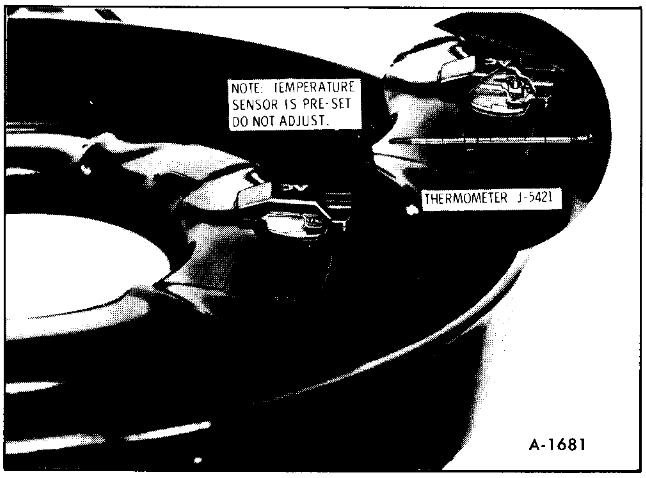


Figure 5—Checking Sensor

SPECIFICATIONS FOR DAMPER OPERATION

Temperature:	79 degrees F. (26.1°C.) or lower, damper fully closed. 123 degrees F. (50.6°C.) or higher, damper fully open.
Vacuum:	3 in. hg. of vacuum or lower, damper fully open below 79 degrees F. (26.1°C.) 7 in. hg. of vacuum or higher, damper fully closed below 79 degrees F. (26.1°C.)

1. If temperature is within specifications, Controlled Combustion System is functioning properly.

2. If temperature is out of specifications and vacuum is correct, replace sensor.

3. If both temperature and vacuum are within specifications and damper is not operating correctly, replace vacuum motor.

4. If both temperature and vacuum are not within specifications it is an indication that the vacuum motor diaphragm is leaking.

VACUUM MOTOR REPLACEMENT

REMOVAL

1. Remove air cleaner.

2. Disconnect vacuum hose from motor.

3. Drill out the two spot welds initially with a 1/16" drill, then enlarge as required to remove the retaining strap. Do not damage the snorkel tube (See figure 6.).

4. Remove motor retaining strap.

5. Lift up motor, cocking it to one side to unhook the motor linkage at the control damper assembly.

INSTALLATION

1. Drill a 7/64" hole in snorkel tube at point "A" as shown in Figure 6.

2. Insert vacuum motor linkage into control damper assembly.

3. Use the motor retaining strap and sheet metal screw provided in the motor service package to secure the retaining strap and motor to the snorkel tube.

4. Make sure the screw does not interfere with the operation of the damper assembly. Shorten screw if required.

5. Connect vacuum hose to motor and install air cleaner.

SENSOR REPLACEMENT

REMOVAL

1. Remove air cleaner.

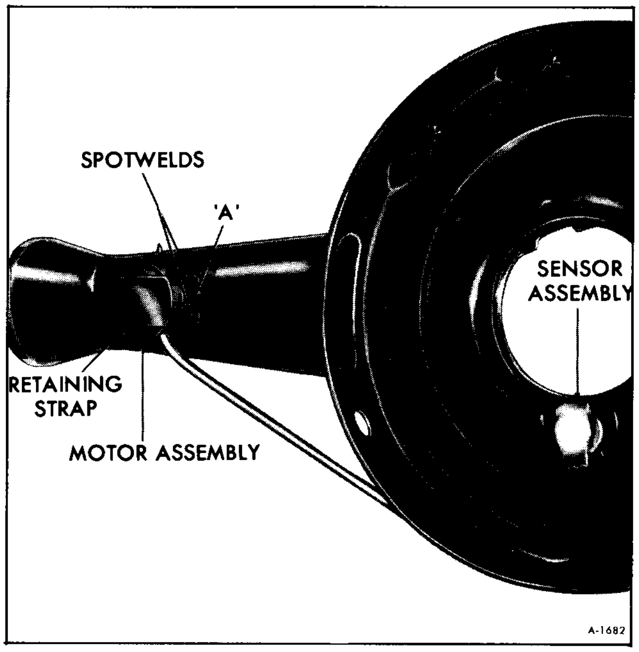


Figure 6—Air Cleaner Spot Welds

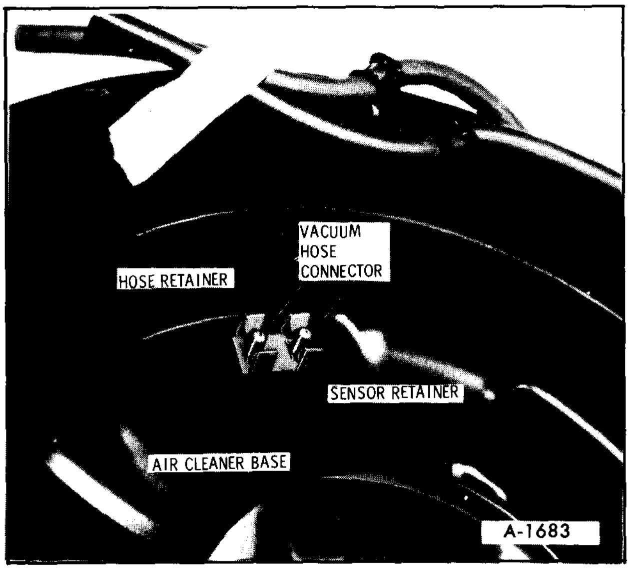


Figure 7—Sensor Retainer

2. Detach hoses at sensor.

3. Pry up tabs on sensor retaining clip and remove clip and sensor from air cleaner. Note position of sensor for installation (See figure 7).

INSTALLATION

1. Install sensor and gasket assembly in original position.

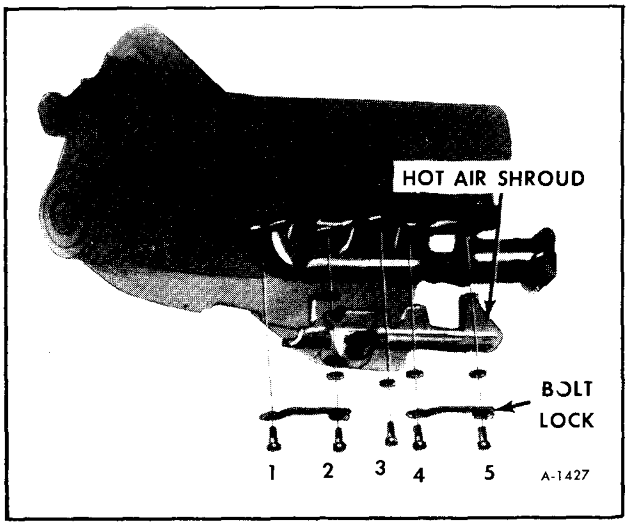


Figure 8—Hot Air Shroud

2. Press retainer clip on hose connectors.

3. Connect vacuum hoses and install air cleaner on engine.

EXHAUST MANIFOLD SHROUD

Exhaust manifold hot air shroud is shown in Figure 8. Refer to Section 6A for replacement procedures.

EVAPORATION CONTROL SYSTEM

This system is designed to reduce fuel vapor emissions that normally vent to atmosphere from the gasoline tank and carburetor fuel bowl. The air cleaner filter mounted at the bottom of the canister requires replacement at intervals specified in Section 0. All other parts are serviced as outlined in Section 8 of this manual.

THERMAL VACUUM SWITCH (T.V.S.)

DESCRIPTION

The retarded spark setting at idle speeds required for effective emission control makes engines tend to run hotter during idle or low speed conditions.

To protect against overheating, the engine is equipped with a thermostatic vacuum switch (T.V.S.). The temperature-sensitive switch and valve assembly is mounted in the engine cooling jacket near the right front of the engine, see Figure 9, and connected into the vacuum advance system.

OPERATION

When the engine coolant reaches a specified high temperature (224-230°F.) (106.7-110°C.), the valve opens against spring pressure and directs manifold vacuum to the advance mechanism. This advances

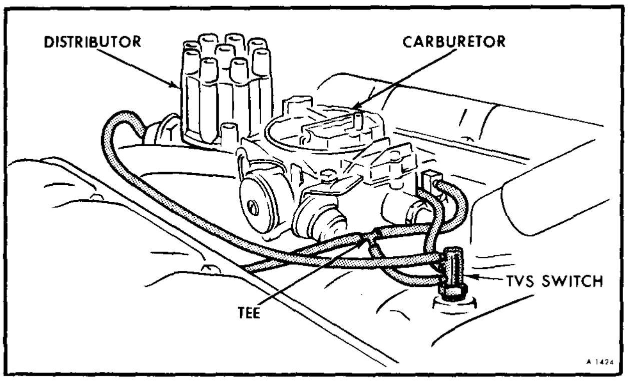


Figure 9—T.V.S. Location (Typical)

the spark timing slightly and speeds up the engine. The result is less heat rejected to the coolant together with higher fan speeds for better cooling action. When the engine has cooled down, 216°F. (102.2°C.) the TVS switch moves the valve back to retard spark timing.

VACUUM HOSE ROUTING TO T.V.S. SWITCH (FIGURE 9)

Port "D"	Vacuum hose to the distributor vacuum advance.
Port "C"	Vacuum hose to the carburetor ported spark port.
Port "MT"	Vacuum hose to intake manifold elbow.

FUNCTIONAL CHECK

To test the switch function, disconnect the distributor vacuum hose at port "D" of the T.V.S. switch, see Figure 10, connect a vacuum gauge and check for vacuum with the engine idling at normal operating temperature. If more than 5 in. Hg. of vacuum is present and the hoses are connected to the proper ports, check further with instruments designed to test the switch such as BT-7002.

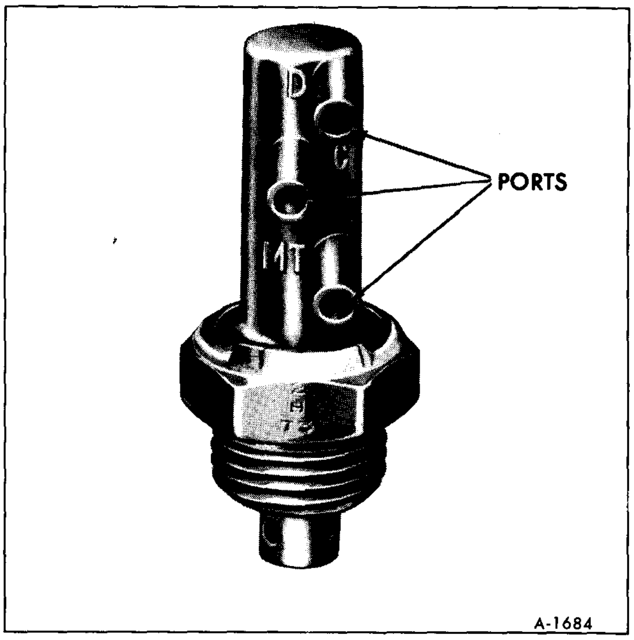


Figure 10—Thermostatic Vacuum Switch

The switch must be installed with a soft setting sealant on the threads.

THROTTLE RETURN CONTROL (TRC) (CALIFORNIA ONLY)

The Throttle Return Control system is designed to reduce hydrocarbon emissions during deceleration by controlling the rate of throttle closing, causing a more complete burning. The system consists of: throttle lever actuator; vacuum control valve; solenoid valve (figure 11).

THROTTLE LEVER ACTUATOR

The Throttle Lever Actuator is mounted as part of the carburetor assembly. This device controls the position of the primary throttle plates a preset amount in excess of curb idle when engine vacuum is applied. This actuating vacuum is controlled by a separate vacuum control valve.

The Throttle Lever Actuator bracket is secured by two bolts torqued to 20-25 ft. lbs. The actuator is mounted to the bracket by a single nut. This nut can be used to adjust the stem to a travel requirement of .260 inch (See "Throttle Actuator Adjustment").

VACUUM CONTROL VALVE

The Vacuum Control Valve is crimped to a

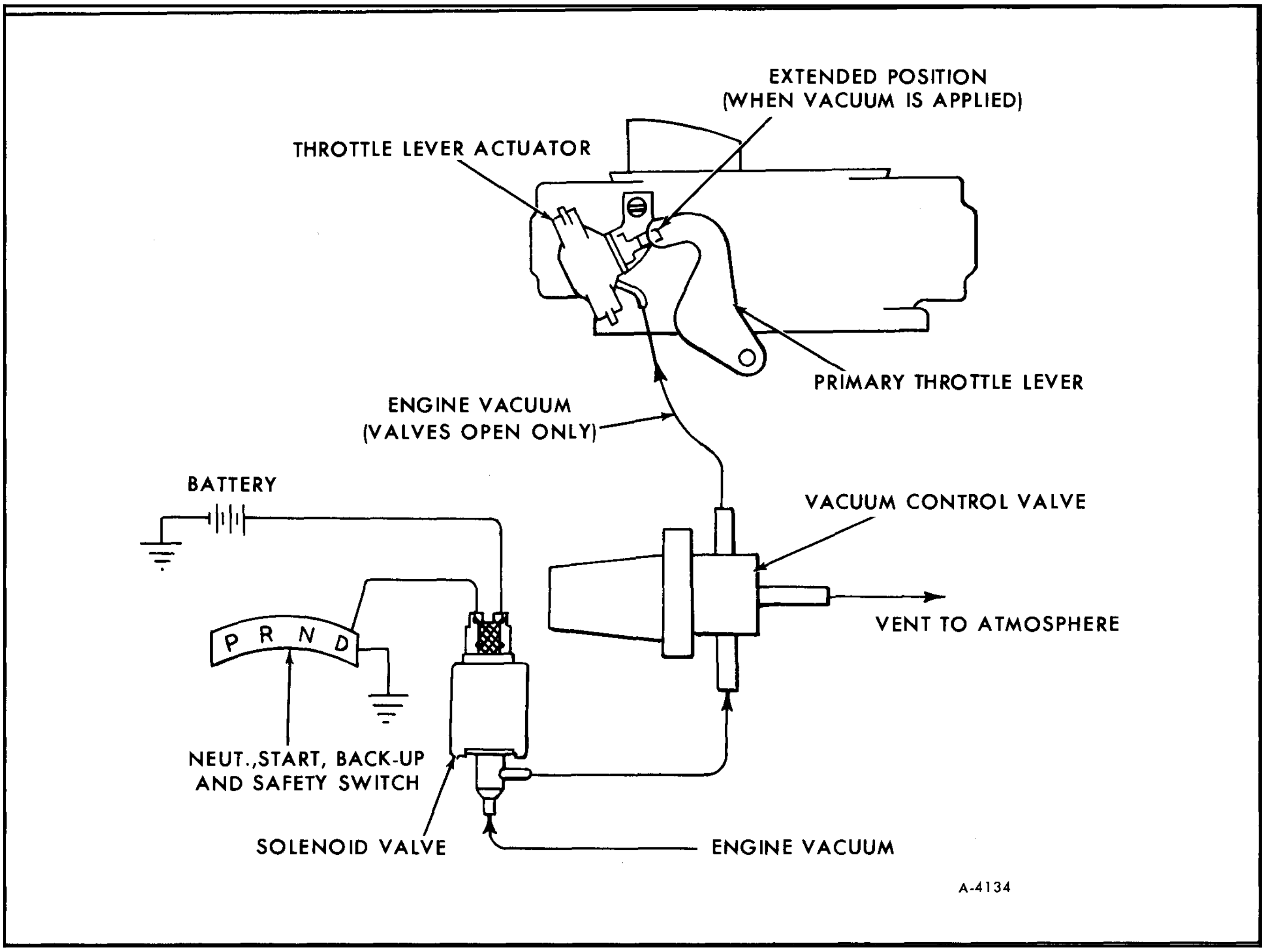


Figure 11—Throttle Return Control System

mounting bracket and mounted separately from the carburetor by one bolt turqued to 25-30 ft. lbs. This on/off valve senses engine vacuum when the solenoid valve is open, and opens above a preset high vacuum level. The valve, when open, allows a vacuum signal to be applied to the throttle lever actuator as long as the preset vacuum level is exceeded.

SOLENOID VALVE

The Solenoid Valve is mounted separately from the carburetor by one bolt torqued to 95-120 in. lbs. This on/off valve opens when the transmission selector lever is in a forward drive position, allowing engine vacuum to be applied to the vacuum control valve.

TRC SYSTEM DIAGNOSIS

CONTROL VALVE — CHECKING PROCEDURE:

1. Disconnect valve to carburetor hose at the carburetor and connect to an external vacuum source equipped with a vacuum gauge.

2. Disconnect the valve to actuator hose at the actuator and connect to a vacuum gauge. (figure 12).

3. Place finger firmly over the end of the bleed fitting (the foam air filter need not be removed).

4. Apply 23 in. Hg. vacuum to the control valve and seal off the vacuum source. The gauge on the actuator side should read the same as the source gauge. If not, then the valve is sticking or needs adjustment. A sticking valve must be replaced. If the vacuum drops off on either gauge (finger still on the bleed fitting), the valve is leaking and must be replaced.

5. With a 23 in. Hg. vacuum level in the valve, remove finger from bleed fitting. The vacuum reading on the actuator side will drop to zero and the reading on the source gauge will drop to a value which will be designated as the valve set point. If this

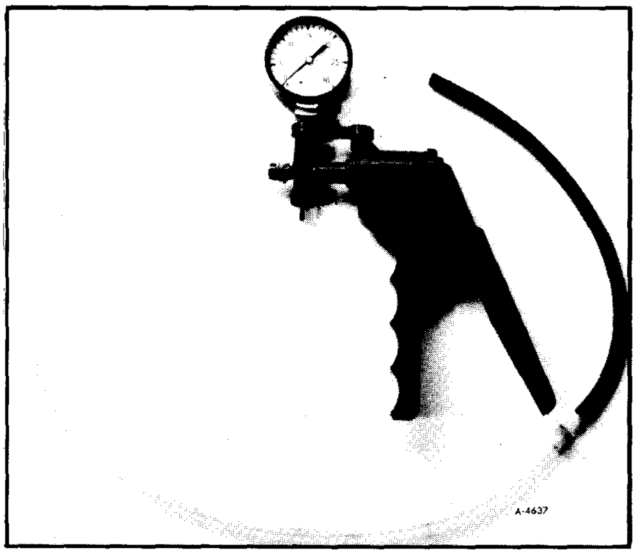


Figure 12—Vacuum Gauge (J-23738)

value is not within .50 in. Hg. of the specified valve set point, then the valve must be adjusted per the Control Valve Adjusting Procedure.

THROTTLE LEVER ACTUATOR — CHECKING PROCEDURE

1. Disconnect valve to actuator hose at valve and connect to an external vacuum source equipped with a vacuum gauge.

2. Apply 20 in. Hg. vacuum to the actuator and seal off the vacuum source. If the vacuum gauge reading drops, then the actuator is leaking and must be replaced.

3. To check the actuator for proper operation:

a. Check the throttle lever, shaft, and linkage to be sure that they operate freely without binding or sticking.

b. Start engine and run until warmed up and idle is stable. Note idle RPM.

c. Apply 20 in. Hg. vacuum to the actuator. Manually open the throttle slightly and allow to close against the extended actuator plunger. Note the engine RPM.

d. Release and reapply 20 in. Hg. vacuum to the actuator and note the RPM to which the engine speed increases (do not assist the actuator).

e. If the RPM obtained in step 3d is not within 150 RPM of that obtained in step 3c, then the actuator plunger may be binding due to dirt, corrosion, varnish, etc. or the actuator diaphragm may be too weak. If binding is not indicated or cannot be corrected then the actuator must be replaced.

f. Release the vacuum from the actuator and the engine speed should return to within 50 RPM of the idle speed noted in step 3b. If it does not, the plunger may be binding due to dirt, corrosion, varnish, etc. If the problem cannot be corrected, the actuator must be replaced.

CONTROL VALVE — ADJUSTING PROCEDURE: REFER TO (FIGURE 13)

1. Disconnect valve to carburetor hose at the carburetor and connect to an external vacuum source equipped with a vacuum gauge.

2. Disconnect the valve to actuator hose at the actuator and connect to a vacuum gauge.

3. Place finger firmly over the end of the bleed fitting (the foam air filter need not be removed).

4. Apply 23 in. Hg. vacuum to the control valve and seal off the vacuum source. Remove finger from bleed fitting. The vacuum reading on the actuator side will drop to zero and the reading on the source gage will drop to a value which will be designeated as the valve set point. If this value is not within .50 in. Hg. of the specified valve set point (22 in. Hg.), then the valve must be adjusted.

5. To adjust the valve set point:

a. Gently pry off the conical plastic cover.

b. Turn the adjusting screw in (clockwise) to raise the set point or out (counterclockwise) to lower the set point value.

c. Recheck the valve set point per steps No. 3 & 4.

d. Repeat steps 5b & c as necessary to obtain 20 in. Hg. value within .50 in. Hg.

e. Reinstall plastic cover.

THROTTLE LEVER ACTUATOR — ADJUSTING PROCEDURE (FIGURE 14)

1. Disconnect valve to actuator hose at valve and connect to an external vacuum source equipped with a vacuum gauge.

2. Check the throttle lever, shaft, and linkage to be sure that they operate freely without binding or sticking.

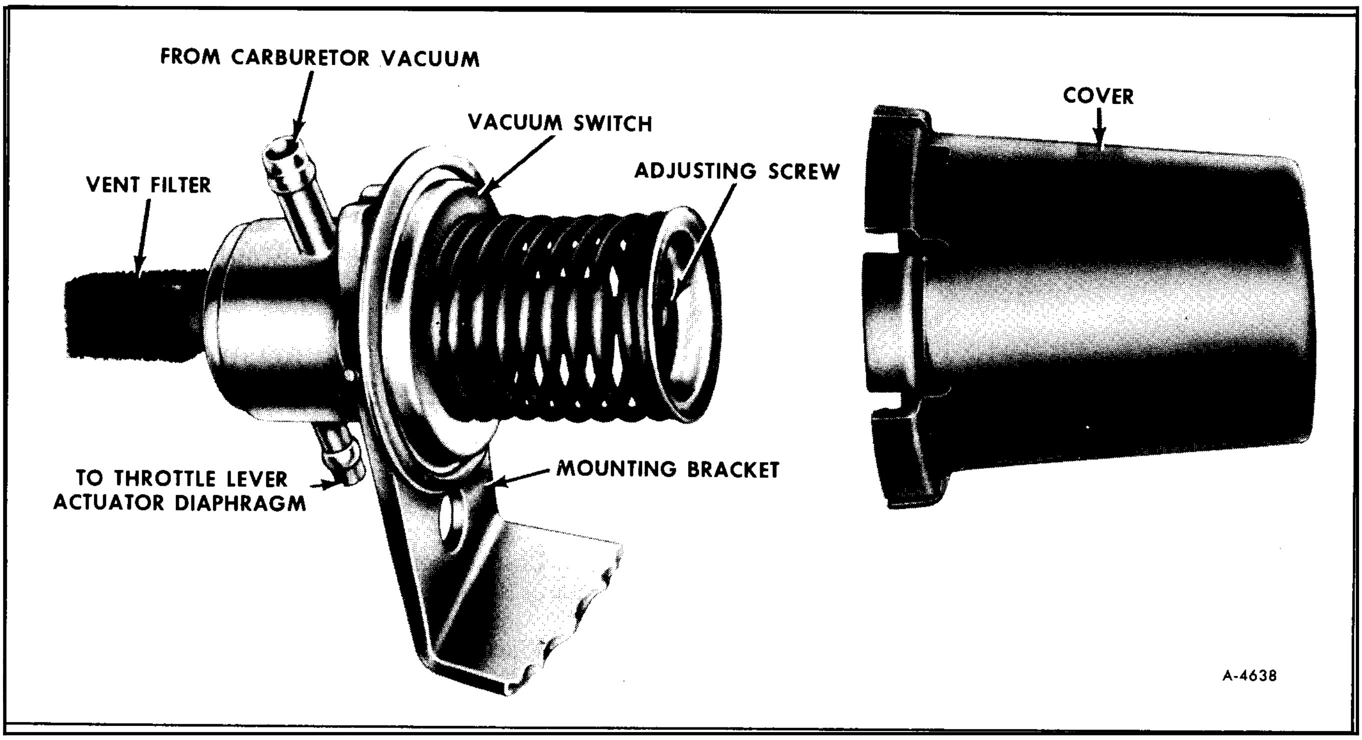


Figure 13—Control Valve Adjustment

3. Adjustment should be made with engine cold, and not running.

4. Apply 20 in. Hg. vacuum to the actuator. Manually open the throttle to allow the choke to set (top step on fast idle cam). The choke will set only if the engine is cold. If the engine is too warm and choke won't set, it can be set by hand.

5. Loosen stem nut. Adjust actuator by rotating until plunger tip contacts throttle lever.

6. Tighten stem nut, remove vacuum pump and complete hose connections.

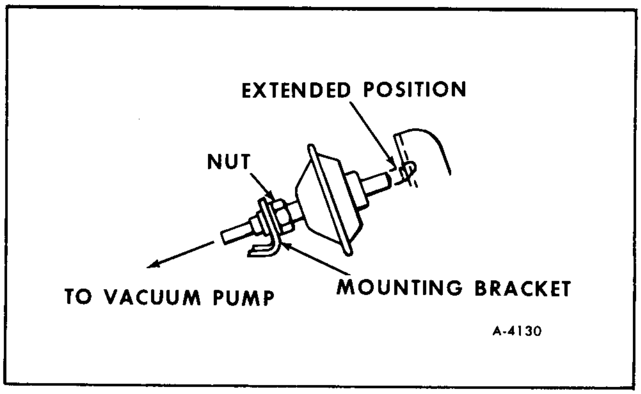


Figure 14—Throttle Actuator Adjustment

SECTION 6Y
ENGINE ELECTRICAL

Contents of this section are listed below:

SUBJECT	PAGE NO.
Batteries	6Y-1
Battery Specifications	6Y-16
Generating System	6Y-17
Generator Specifications	6Y-29
Breaker Point Ignition System	6Y-29
Breaker Point Ignition System Specifications	6Y-45
High Energy Ignition System	6Y-46
High Energy Ignition System Specifications	6Y-59
Starting System	6Y-60
Starter Specifications	6Y-68

BATTERIES

CAUTION: *Never expose battery to open flame or electric spark—battery action generates hydrogen gas which is flammable and explosive. Don't allow battery fluid to contact skin, eyes, fabrics, or painted surfaces—fluid is a sulfuric acid solution which could cause serious personal injury or property damage. Wear eye protection when working with battery.*

CAUTION: *Remove rings, metal watchbands and other metal jewelry before jump starting or working around a battery, and be careful in using metal tools—if such metal should contact the positive battery terminal (or metal in contact with it) and any other metal on the vehicle a short circuit may occur which could cause personal injury.*

Each vehicle is equipped with two batteries; the main (automotive) battery and an auxiliary battery. The GMC Dual Battery System provides power from two batteries to the vehicle 12-volt electrical system either in combination or singularly. The components used to provide charging and/or switching are conventional, except for a diode assembly with which both batteries will receive charging current whenever the vehicle is running. The diode assembly has separate outputs to the two batteries and provides isolation between the batteries and their associated circuits whenever the engine is not running.

- MotorHome—The main (automotive) battery (figure 1) is located behind the right front access door. The auxiliary (living area) battery is located in the storage or motor generator compartment.

- TransMode—The main (automotive) battery and the auxiliary battery are both located behind the right front access door. The main (automotive) battery sits in front of the auxiliary battery, Figure 2. Vehicles equipped with the optional motor generator include a cranking battery located in the motor generator or storage compartment, Figure 3.

In addition, two types of batteries are used; batteries with vent cap flame arrestor feature shown in Figure 4, or maintenance-free batteries shown in Figure 5.

Early model vehicles are entirely equipped with flame arrestor type filler/vent cap batteries. Later model MotorHomes have a maintenance-free main

Figure 1—MotorHome Automotive Battery

(automotive) battery and a flame arrestor type filler/vent cap auxiliary (living area) battery. Later model TransModes have maintenance-free main and auxiliary batteries. TransModes equipped with the motor generator option include a maintenance-free cranking battery located in the motor generator compartment along with the motor generator hour meter.

Follow maintenance and testing procedures applicable to the particular type battery being serviced.

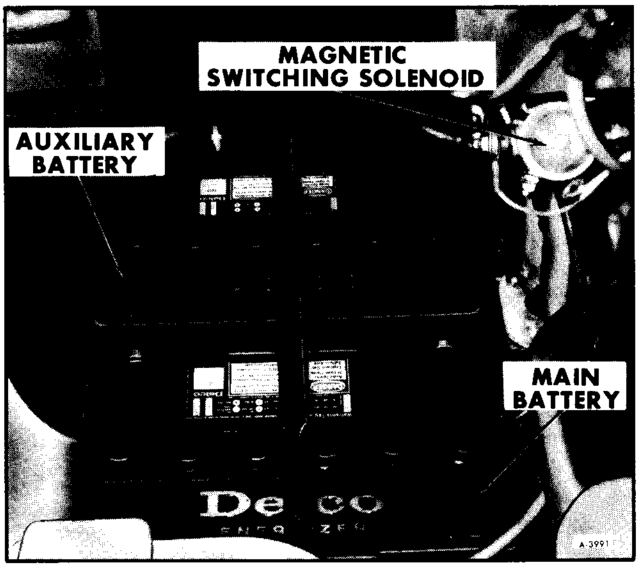


Figure 2—TransMode Main and Auxiliary Batteries

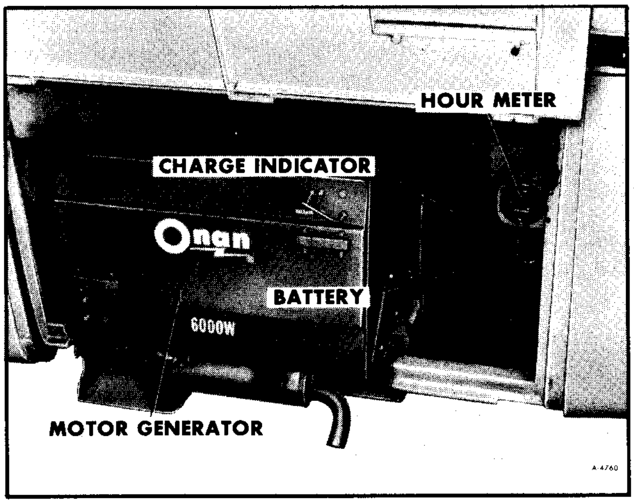


Figure 3—TransMode Motor Generator Cranking Battery (Optional)

BATTERY DESCRIPTION

BATTERIES WITH FLAME ARRESTOR VENT CAPS

Batteries with flame arrestor type filler/vent caps are identified by the small grey disc in the cap, as shown in Figure 4. This centered carbide section disperses battery fumes and acts as a screen to protect the battery from flame entry. These batteries require regular checking electrolyte level discussed later in this section under "Charging Guide".

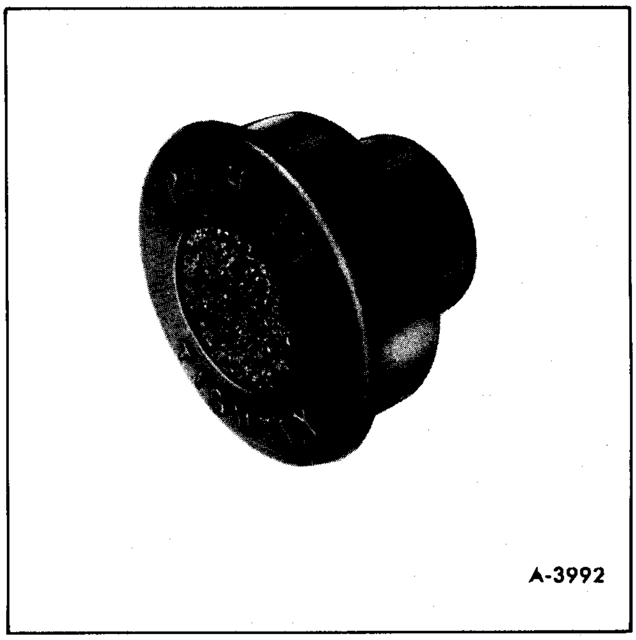


Figure 4—Flame Arrestor Cap

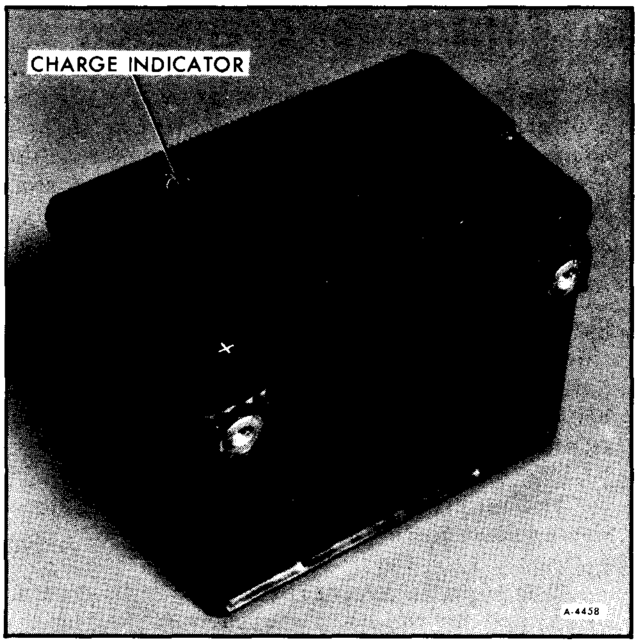


Figure 5—Maintenance-Free Battery

MAINTENANCE FREE BATTERIES

The maintenance-free batteries are identified by the absence of vent plugs on the cover (figure 5). The battery is completely sealed except for small vent holes on the sides. These vent holes allow what small amount of gases are produced in the battery to escape. The special chemical composition in the battery grid design reduces the production of gas to an extremely small amount at normal charging voltages. Water never needs to be added to the maintenance-free battery. A charge indicator in the cover indicates state of charge. This feature is discussed later in this section under "Charging Guide".

GENERAL DESCRIPTION

The battery is made up of a number of separate elements, each located in an individual cell in a hard rubber case. Each element consists of an assembly of positive plates and negative plates containing dissimilar active materials and kept apart by separators. In the maintenance-free battery these separators are replaced with negative plate envelopes. The elements are immersed in an electrolyte composed of dilute sulfuric acid. Plate straps located on the top of each element connect all the positive plates and all the negative plates into groups.

The elements are connected in series electrically by connectors that pass directly through the case partitions between cells. The battery top is a one piece cover. The cell connectors, by passing through the cell partitions, connect the elements along the shortest practical path (figure 6). With the length of the electrical circuit inside the battery reduced to a minimum, the internal voltage drop is decreased resulting in improved performance, particularly during engine cranking at low temperatures.

The terminals of this type battery, passing through the side of the case, are positioned out of the "wet" area surrounding the vent wells. Normal spillage, spewing, condensation and road splash are not as likely to reach or remain on the vertical sides where the terminals are located. This greatly decreases the cause of terminal corrosion. Also, construction of the terminals is such that the mating cable connector seals the junction and provides a permanently tight and clean connection. Power robbing resistance in the form of corrosion is thereby eliminated at these maintenance-free connections.

The hard, smooth, one piece cover greatly reduces the tendency for corrosion to form on the top of the battery. The cover is bonded to the case forming an air-tight seal between the cover and case.

Electrical energy is released by chemical reactions between the active materials in the two dissimilar plates and the electrolyte whenever the battery is being "discharged." Maximum electrical energy is released only when the cells are being discharged from a state of full charge.

As the cells discharge, chemical changes in the active materials in the plates gradually reduce the potential electrical energy available. "Recharging" the battery with a flow of direct current opposite to that during discharge reverses the chemical changes within the cells and restores them to their active condition and a state of full charge.

There are two types of batteries, the "dry charge" type and the "wet charge" type. The difference in types depends on the method of manufacture. A "dry charge" battery contains fully charged elements which have been thoroughly washed and dried. This type of battery contains no electrolyte until it is activated for service in the field and, therefore, leaves the factory in a dry state. Consequently, it is called a "dry charge" battery.

Each vent well in a "dry charge" battery has a hard rubber seal to prevent the entrance of air and moisture which would oxidize the negative active materials and reduce the freshness of the battery (figure 7). The hard rubber seals and the bonding between the case and one-piece cell cover make possible a vacuum sealed assembly which can be stored for very long periods of time without detrimental effects.

Before activating the "dry charge" battery, the hard rubber seals are broken simply by pushing the

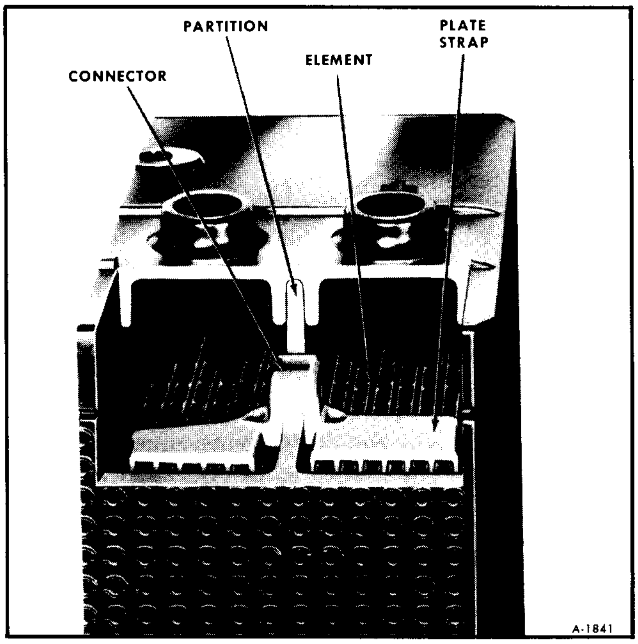


Figure 6—Internal View of Battery with Vent Wells

special vent plug down into each vent well. The seals drop into the cells, and can remain there since they are not chemically active and will cause no harm.

A wet charged battery contains fully charged elements which are filled with electrolyte before being shipped from the factory. The flame arrestor type filler/vent cap batteries can be wet or dry charged on shipping. The maintenance-free battery, which has no vent wells, is wet charged.

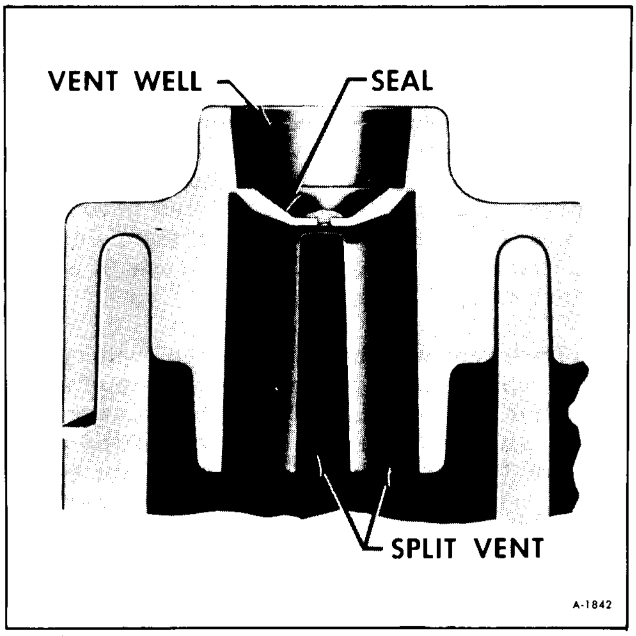


Figure 7—Vent Well Construction

THEORY OF OPERATION

The lead-acid battery or storage battery (figure 1) is an electrochemical device for converting chemical energy into electrical energy. It is not a storage tank for electricity as is often believed, but instead, stores electrical energy in chemical form.

Active materials within the battery react chemically to produce a flow of direct current whenever lights, radio, cranking motor, or other current consuming devices are connected to the battery terminal posts. This current is produced by chemical reaction between the active materials of the PLATES and sulfuric acid of the ELECTROLYTE.

The battery performs three functions in automotive applications:

1. It supplies electrical energy for the cranking motor and for the ignition system as the engine is started.

2. It supplies current for the lights, radio, heater, and other accessories when the electrical demands of these devices exceed the output of the generator.

3. The battery acts as a voltage stabilizer in the electrical system. Satisfactory operation of the vehicle is impossible unless the battery performs each of these functions.

The simplest unit of a lead-acid storage battery is made up of two unlike materials, a positive plate and a negative plate, kept apart by a porous separator. This assembly is called an "ELEMENT" (figure 8).

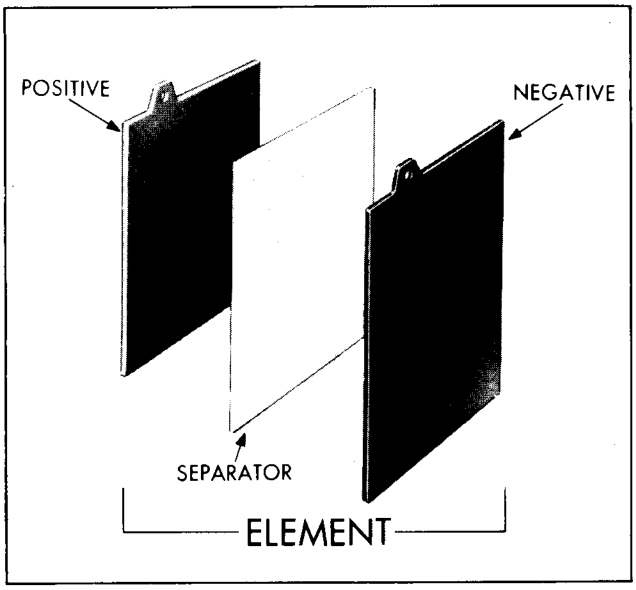


Figure 8—Battery Element

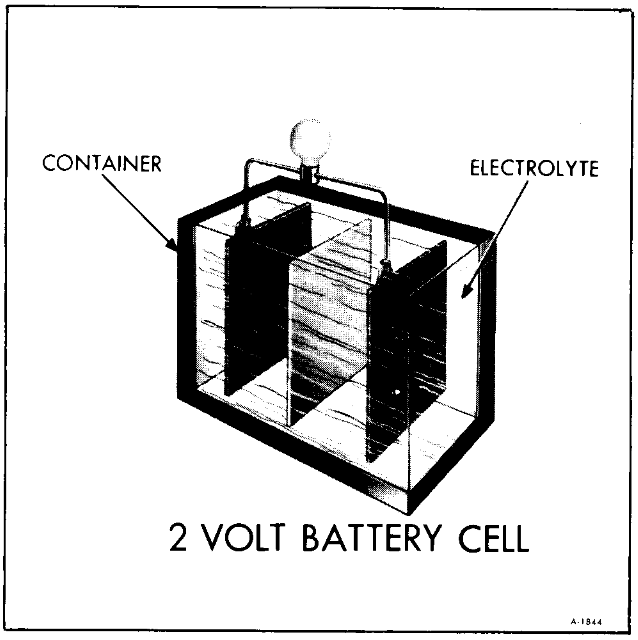


Figure 9—Two Volt Battery Cell

When this simple element is put in a container filled with a sulphuric acid and water solution called "electrolyte", a two-volt "cell" is formed. Electricity will flow when the plates are connected to an electrical load (figure 9).

An element made by grouping several positive plates together and several negative plates together with separators between them also generates two-volts but can produce more total electrical energy than a simple cell (figure 10).

When six cells are connected in series, a "battery" of cells is formed which produces six times as much electrical pressure as a simple cell, or a total of 12 volts (figure 11).

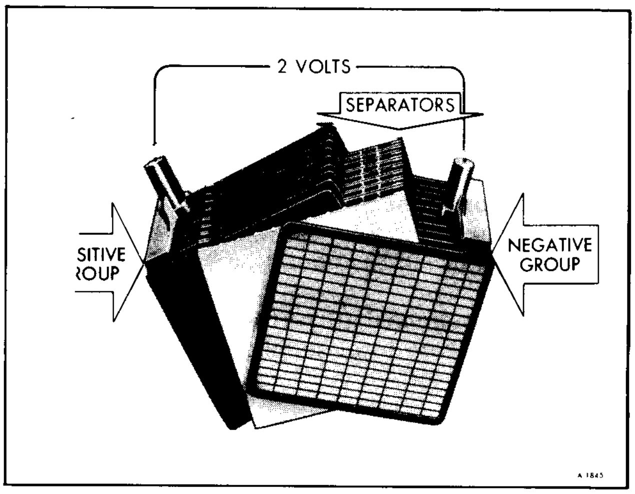


Figure 10—Battery Element (Compound)

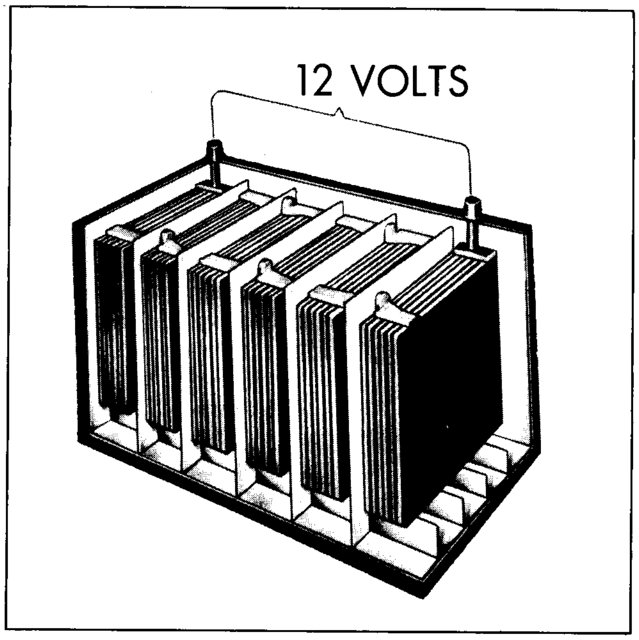


Figure 11—Typical 12-Volt Battery Cell Arrangement

If the battery continuously supplies current, it becomes run-down or discharged. This is where the generator gets into the act. The generator restores the chemical energy to the battery. This is done by sending current through the battery in a direction opposite to that during discharge. The generator current reverses the chemical actions in the battery and restores it to a charged condition.

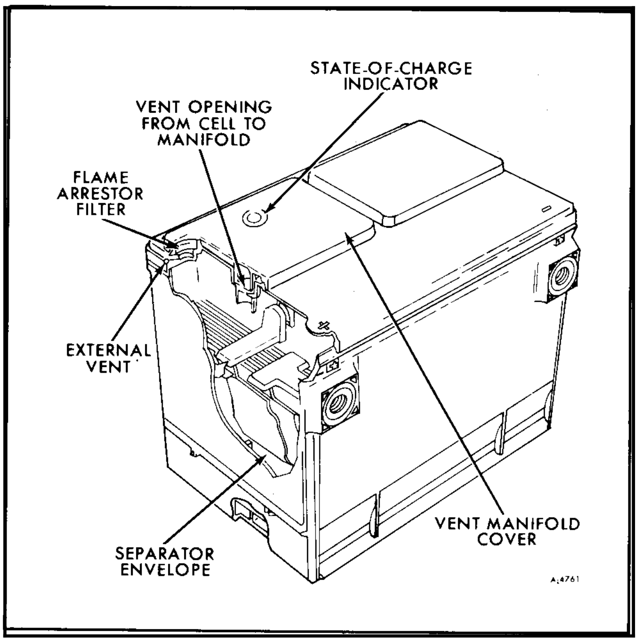


Figure 12—Internal View of Maintenance-Free Battery

The maintenance-free battery (figure 12) operates in the same manner as the standard battery, however, it differs slightly in construction. Negative plate envelopes replace the traditional flat separators greatly reducing the possibility of internal shorting.

The active plates in the maintenance-free battery utilize lead-calcium grids rather than the standard lead-antimony grid. This difference in grid construction results in a reduction of battery self-discharge, gassing, overcharging and the rate at which electrolyte is lost. The plates sit on the bottom of the case and are covered by a greater volume of electrolyte than in the standard battery. A vapor separator in the cover traps any liquid that accumulates and returns it to the battery. The battery cover is sealed on so that nothing can be added to contaminate or damage internal components.

BATTERY RATING

Each battery generally has two classifications of ratings: (1) a 20 hour rating at 80°F. (26.7°C.) and, (2) a cold rating at 0°F. (-17.8°C.) which indicates the cranking load capacity. The Ampere/Hour rating found on batteries was based on the 20 hour rating. That is, a battery capable of furnishing three (3) amperes for 20 hours while maintaining a specified average individual cell voltage would be classified as a 60 ampere hour battery (e.g. 3 amperes x 20 hours = 60 A.H.) a PWR (Peak Watt Rating) has been developed as a measure of the battery's cold cranking ability. The numerical rating is embossed on each case at the base of the battery. This value is determined by multiplying the max. current by the max. voltage. The PWR should not be confused with the ampere hour rating since two batteries with the same ampere hour rating can have quite different watt ratings. For battery replacement, a unit of at least equal power rating must be selected.

BATTERY DIAGNOSIS

TESTING PROCEDURES

Testing procedures are used to determine whether the battery is (1) good and usable, (2) requires recharging or (3) should be replaced. Refer to test procedures applicable to the battery in this vehicle.

BATTERIES WITH FLAME ARRESTOR VENT CAPS

Visual Inspection

The first step in testing the battery should be a visual inspection, which very often will save time and expense in determining battery condition.

- Check the outside of the battery for a broken or cracked case or a broken or cracked cover. If any damage is evident, the battery should be replaced.

- Note the electrolyte level. Levels that are too low or too high may cause poor performance, as covered in the section entitled "General Information".

- Check for loose cable connections. Correct as required before proceeding with tests.

Full Charge Hydrometer Test

This test should be used only on batterys which test good with testing equipment or "Specific Gravity Cell Comparison Test" but which subsequently fail in service.

- Remove the battery from the vehicle, and adjust the electrolyte level as necessary, by adding colorless, odorless, drinking water.

- Fully charge the battery at the Slow Charging rate as covered in the section entitled "Charging Procedures".

- Measure the specific gravity of the electrolyte in each cell and interpret as follows:

Hydrometer Reading Less Than 1.230—Full charge hydrometer readings less than 1.230 corrected for temperature indicate the Battery is defective and should be replaced.

Hydrometer Readings Above 1.310—Full charge hydrometer readings above 1.310 corrected for temperature indicate that the cells have been improperly filled (activation) or improperly serviced. Poor service and short Battery life will result.

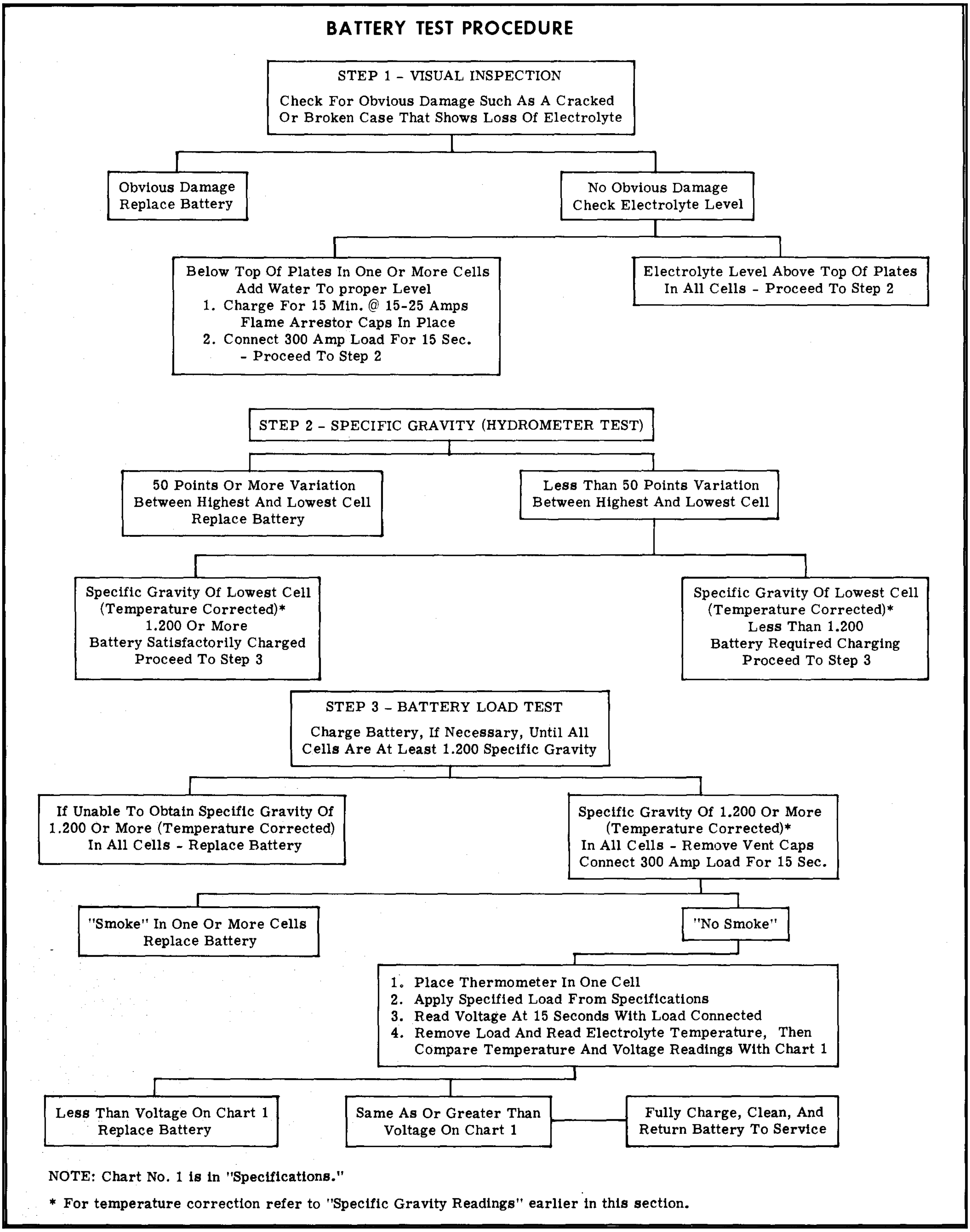
Load Test

In addition to the instrument test and full charge hydrometer test, the following load test may also be performed to check the condition of the battery.

> **NOTE:** Equipment to perform this test may be procured from local suppliers of testing equipment.

To begin, charge the battery, if necessary, until all cells are at least 1.200 specific gravity.

1. If unable to obtain specific gravity 1.200 @ 80°F. (26.7°C.), in all cells, replace battery.



Battery Test Procedure

2. If able to obtain a specific gravity of 1.200 or more @ 80°F. (26.7°C.) in all cells, remove the vent caps and connect a 300 amp. load for 15 seconds.

a. If smoke occurs in one or more cells, replace the battery.

b. If smoke does not occur proceed to step 3.

3. Place a thermometer in one cell and apply a specified load from specifications. Read the voltage at 15 seconds with load connected, then remove load and read electrolyte temperature. Compare temperature and voltage readings with voltage-temperature chart in "Battery Specifications".

a. If reading is less than voltage on chart, replace battery.

b. If reading is same as or greater than voltage on chart, fully charge, clean and return battery to service.

Specific Gravity Readings (Figure 13)

A hydrometer can be used to measure the specific gravity of the electrolyte in each cell.

The hydrometer measures the percentage of sulphuric acid in the battery electrolyte in terms of specific gravity. As a battery drops from a charged to a discharged condition, the acid leaves the solution and enters the plates, causing a decrease in specific gravity of electrolyte. An indication of the concentration of the electrolyte is obtained with a hydrometer.

When using a hydrometer, observe the following points:

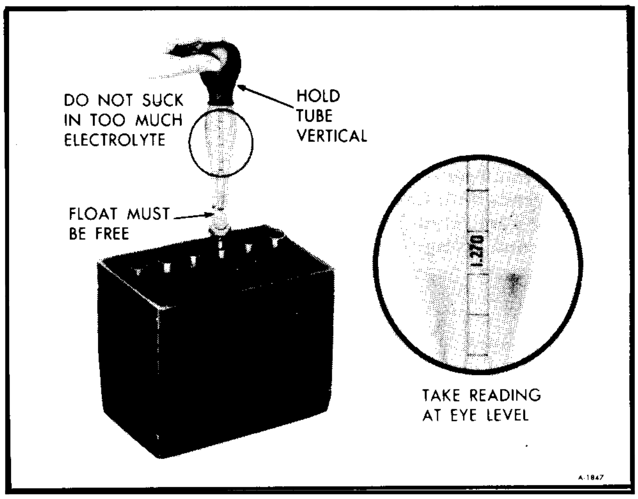


Figure 13—Checking Specific Gravity

1. Hydrometer must be clean, inside and out, to insure an accurate reading.

2. Hydrometer readings must never be taken immediately after water has been added. The water must be thoroughly mixed with the electrolyte by charging for at least 15 minutes at a rate high enough to cause vigorous gassing.

3. If hydrometer has built-in thermometer, draw liquid into it several times to insure correct temperature before taking reading.

4. Hold hydrometer vertically and draw in just enough liquid from battery cell so that float is free floating. Hold hydrometer at eye level so that float is vertical and free of outer tube, then take reading at surface of liquid. Disregard the curvature where the liquid rises against float stem due to surface tension.

5. Avoid dropping battery fluid on vehicle or clothing as it is extremely corrosive. Any fluid that drops should be washed off immediately with baking soda solution.

The specific gravity of the electrolyte varies not only with the percentage of acid in the liquid but also with temperature. As temperature increases, the electrolyte expands so that the specific gravity is reduced. As temperature drops, the electrolyte contracts so that the specific gravity increases. Unless these variations in specific gravity are taken into account, the specific gravity obtained by the hydrometer may not give a true indication of the concentration of acid in the electrolyte.

A fully charged Battery will have a specific gravity reading of approximately 1.270 at an electrolyte temperature of 80°F. (26.7°C.) If the electrolyte temperature is above or below 80°F. (26.7°C.), additions or subtractions must be made in order to obtain a hydrometer reading corrected to the 80°F. (26.7°C.) standard. For every 10° above 80°F. (26.7°C.), add four specific gravity points (.004) to the hydrometer reading. Example: A hydrometer reading of 1.260 at 110°F. (43.3°C.) would be 1.272 corrected to 80°C. (26.7°C.), indicating a fully charged battery. For every 10° below 80°F. (26.7°C.), subtract four points (.004) from the reading. Example: A hydrometer reading of 1.272 at 0°F. (-17.8°C.) would be 1.240 corrected to 80°F. (26.7°C), indicating a partially charged battery.

Specific Gravity Cell Comparison Test

To perform this test measure the specific gravity of each cell, regardless of state of charge, and interpret the results as follows:

• If specific gravity readings show a difference between the highest and lowest cell of .050 (50 points) or more, the Battery is defective and should be replaced.

Since the battery is a perishable item which requires periodic servicing, a good maintenance program will insure the longest possible Battery life. If the battery tests good but fails to perform satisfactorily in service for no apparent reason, the following are some of the more important factors that may point to the cause of the trouble.

1. Vehicle accessories inadvertently left on overnight to cause a discharge condition.

2. Slow speed driving of short duration, to cause an undercharged condition.

3. A vehicle electrical load exceeding the generator capacity.

4. Defect in the charging system such as high resistance, slipping fan belt, faulty generator or voltage regulator.

5. Battery abuse, including failure to keep the Battery top clean, cable attaching bolts clean and tight, and improper addition of water to the cells.

TESTING MAINTENANCE-FREE BATTERIES

Step 1—Visual Inspection

Check for obvious damage, such as cracked or broken case or cover that could permit loss of electrolyte. If obvious physical damage is noted, replace battery. Determine cause of damage and correct as needed.

Step 2—Charge Indicator

Check the charge indicator. For a detailed discussion on how to read the charge indicator, refer to "Charging Guide" later in this section.

a. Green dot visible. If the charge indicator is dark and has a green dot in the center, the battery is sufficiently charged for testing. Proceed to Step 3.

b. Dark green dot not visible. Battery must be charged before testing. Refer to "Chargine Guide" later in this section. Once battery is charged, proceed to Step 3.

NOTE: Battery should be charged until green dot appears, but not more than 60 ampere hours (for example—15 amperes for four hours). Some chargers are constant current chargers, but if a constant voltage charger is used, to get the green dot to appear after prolonged charging may require tipping the battery slightly from side to side a few times.

c. Light. DO NOT attempt charging or testing when charge indicator is light. Refer to "Charging Guide" later in this section.

CAUTION: *To avoid explosion hazard, NEVER attempt to charge or jump-start a maintenance-free battery which exhibits a light indicator condition. Departures from this procedure could result in serious personal injury or property damage.*

Step 3—Remove Surface Charge

Connect 300 ampere load across terminals for 15 seconds to remove surface charge from battery.

Step 4—Load Test

a. Connect voltmeter and 230 ampere load across terminals.

b. Read voltage after 15 seconds with load connected, then disconnect load.

c. If minimum voltage agrees with Chart (given in Specifications) battery is good.

d. If minimum voltage is less than given in Chart replace battery.

INSTALLING BATTERIES

To install a battery properly, it is important to observe the following precautions:

• Connect grounded terminal of Battery last to avoid short circuits which may damage the electrical system.

Do not connect primary lead until secondary negative cable wire has been grounded to sheet metal.

• Be sure there are no foreign objects in the carrier, so that the new Battery will rest properly in the bottom of the carrier.

• Tighten the hold-down evenly until snug (5-6 ft. lbs.). Do not draw down tight enough to distort or crack the case or cover.

• Be sure the cables are in good condition and the terminal bolts are clean and tight. Make sure the ground cable is clean and tight at engine block or frame.

• Check polarity to be sure the battery is not reversed with respect to the charging system.

• Torque cable connections at battery to 6 foot-pounds.

EMERGENCY STARTING

• Engine cannot be started by towing or pushing the vehicle.

• If only main (automotive) battery is discharged, hold battery switch on instrument panel momentarily in "BAT BOOST". This supplies current from the auxiliary battery. After use, switch on MotorHome is designed to return to the "BAT NORMAL" position. Switch on TransMode must be manually returned to the "BAT NORMAL" position.

NOTE: If the battery boost switch is left in the "BATTBOOST" position for extended periods, both batteries will become discharged.

• A vehicle with discharged batteries may be jump started. See "Jump Starting" procedure.

JUMP STARTING WITH AUXILIARY (BOOSTER) BATTERY

Both booster and discharged battery should be treated carefully when using jumper cables. Follow exactly the procedure outlined below, being careful not to cause sparks:

CAUTION: *Departures from these conditions or the procedure below could result in: (1) serious personal injury (particularly to eyes) or property damage from such causes as battery explosion, battery acid, or electrical burns; and/or (2) damage to electronic components of either vehicle.*

Never expose battery to open flame or electrical spark—batteries generate a gas which is flammable and explosive. Do not allow battery fluid to contact eyes, skin, fabrics, or painted surfaces—fluid is a corrosive acid. FLUSH ANY CONTACTED AREA WITH WATER IMMEDIATELY AND THOROUGHLY. Be careful that metal tools, or jumper cables do not contact the positive battery terminal (or metal in contact with it) and any other metal in the other vehicle, because a short circuit could occur. Batteries and battery acid should always be kept out of the reach of children.

• The battery in the other vehicle must be 12-volt and NEGATIVELY GROUNDED, like the batteries in THIS vehicle. (Check the other vehicle's owner's manual to see if it is).

• The batteries in THIS vehicle must be equipped with FLAME ARRESTOR TYPE FILLER/VENT CAPS on ALL filler openings (as was the original-equipment Delco batteries), or it must be a sealed-type battery which does not have filler openings or caps such as the Maintenance-Free batteries. (Each Delco battery flame arrestor cap has a grey disc rather than a small hole, see Figure 5).

• If the battery is a Delco sealed-type battery without filler openings or caps, its charge indicator MUST BE DARK, with or without green dot showing, see Figure 21. DO NOT attempt jump starting if the charge indicator has a light or bright center.

JUMP START PROCEDURE

1. WEAR EYE PROTECTION and remove rings, metal watch bands, and other metal jewelry.

2. Set parking brake firmly, and place automatic transmission in "PARK" in both vehicles (don't let vehicles touch); and turn ignition key to LOCK in vehicle with discharged battery (Neutral and "OFF" in vehicles with manual transmission). Also turn off lights, heater, and all unnecessary electrical loads.

3. Attach one end of a jumper cable to the positive terminal (identified by a red color, "+", or "P" on the battery case, post, or clamp), of the battery in the other vehicle and the other end of the same cable to positive terminal junction block stud, marked "VEHICLE BATTERY POSITIVE". This is located behind the right access door above the main (automotive) battery as shown in Figure 14.

4. Attach one end of the remaining jumper cable FIRST to the negative terminal (black color, "—", or "N") of the OTHER vehicle's battery, (regardless of which vehicle has the discharged battery) and THEN to the right radiator mounting bracket in THIS vehicle—thus taking advantage of your battery's flame arrestor feature, should a spark occur (figure 15).

5. Start the engine in the vehicle that is providing the jump start (if it was not running). Let run a few minutes, then start the engine in the vehicle that has the discharged battery.

6. Reverse the above sequence EXACTLY when removing the jumper cables, taking care to remove

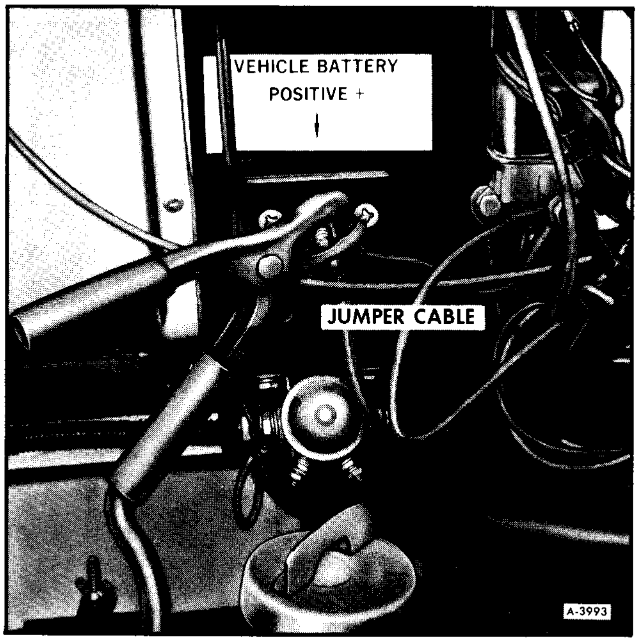


Figure 14—Connecting Jumper Cable to "Vehicle Battery Positive" Stud

the cable from the right radiator mounting bracket in THIS vehicle as the FIRST step.

SAFETY PRECAUTIONS

When batteries are being charged, an explosive gas mixture forms in each cell. Part of this gas escapes through the holes in the vent plugs and may form an explosive atmosphere around the battery

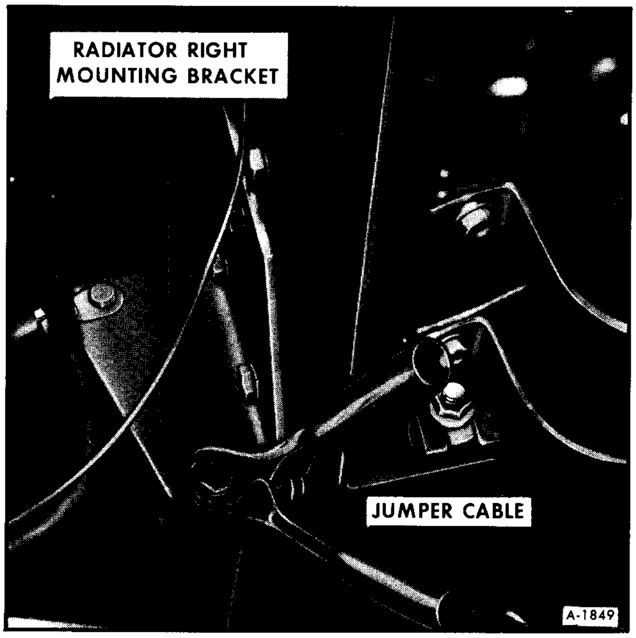


Figure 15—Connecting Jumper Cable to Right Radiator Mounting Bracket

itself if ventilation is poor. This explosive gas may remain in or around the battery for several hours after it has been charged. Sparks or flames can ignite this gas causing an internal explosion which may shatter the battery.

The following precautions should be observed to prevent an explosion:

1. Do not smoke near batteries being charged or which have been very recently charged.

2. Do not break live circuits at the terminals of batteries because a spark usually occurs at the point where a live circuit is broken. Care must always be taken when connecting or disconnecting booster leads or cable clamps on fast chargers. Poor connections are a common cause of electrical arcs which cause explosions.

CHARGING PROCEDURES

Before charging batteries equipped with flame arrestor type filler/vent caps, the electrolyte level must be checked and adjusted if need. If charging maintenance-free battery, do not charge more than 60 ampere hours (for example-15 amperes for four hours). Some chargers are constant current chargers, but if a constant voltage charger is used, to get the green dot to appear on the charge indicator, may require tipping the battery slightly from side to side a few times. A battery that required charging before testing may indicate a need to check the charging system of the vehicle.

Battery charging consists of applying a charge rate in amperes for a period of time in hours. Thus, a 10 ampere charge rate for seven hours would be a 70 ampere-hour (A.H.) charging input to the battery. Charging rates in the three to 50 ampere range are generally satisfactory. No particular charge rate or time can be specified for a energizer due to the following factors:

1. The size, or electrical capacity in ampere-hours (A.H.), of the battery.

EXAMPLE: A completely discharged 70 A.H. battery requires almost twice the recharging as a 40 A.H. BATTERY.

2. Temperature of the battery electrolyte.

EXAMPLE: About two hours longer will be needed to charge a 0°F. (-17.8°C.) battery than an 80°F. (26.7°C.) battery.

3. Battery state-of-charge at the start of the charging period.

EXAMPLE: A completely discharged battery requires twice as much charge in ampere-hours as a one-half charged battery.

EXAMPLE: A battery that has been subjected to severe service will require up to 50% more ampere-hour charging input than a relatively new battery.

A battery may be charged at any rate in amperes for as long as spewing of electrolyte due to violent gassing does not occur, and for as long as electrolyte temperature does not exceed 125°F. (49°C.) If spewing of electrolyte occurs, or if electrolyte temperature exceeds 120°F. (49°C.), the charging rate in amperes must be reduced or temporarily halted to avoid energizer.

The battery is fully charged when over a two-hour period at low charging rate in amperes all cells are gassing freely (not spewing liquid electrolyte), and no change in specific gravity occurs. The full charge specific gravity is 1.260-1.280, corrected for electrolyte temperature with the electrolyte level at the split ring, unless electrolyte loss has occurred due to age or overfilling in which case the specific gravity reading will be lower. For the most satisfactory charging, the lower charging rates in amperes are recommended.

Maintenance-Free batteries should not be charged more than 60 ampere-hours.

If after prolonged charging a specific gravity of at least 1.230 on all cells cannot be reached, the battery is not in an optimum condition and will not provide optimum performance; however, it may continue to provide additional service if it has performed satisfactorily in the past.

An "emergency boost charge", consisting of a high charging rate for a short period of time, may be applied as a temporary expedient in order to crank an engine. However, this procedure usually supplies insufficient battery reserve to crank a second and third time. Therefore, the "emergency boost charge" must be followed by a subsequent charging period of sufficient duration to restore the battery to a satisfactory state of charge. Refer to the charging guide in this section.

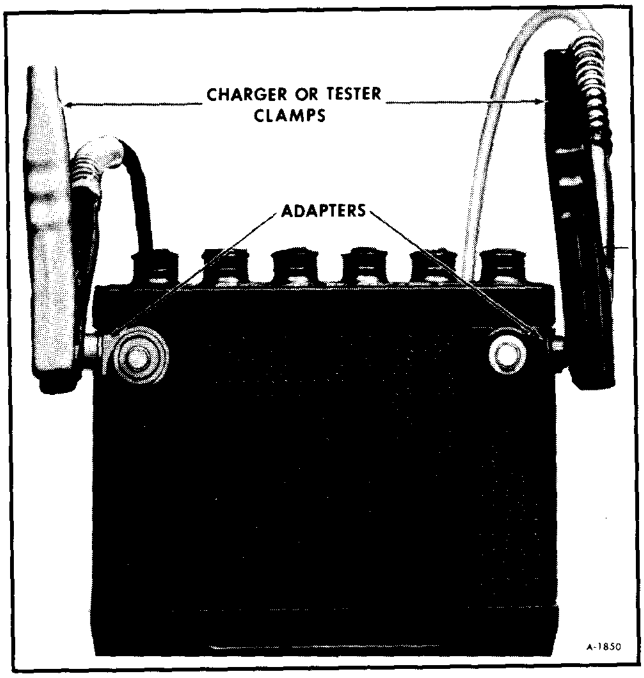


Figure 16—Charging Lead Adapters

When out of the vehicle, the sealed side terminal battery will require adapters (figure 16) for the terminals to provide a place for attachment of the charging leads. Adapters are available through local parts service.

When the side terminal battery is in the vehicle, the studs provided in the wiring harness are suitable for attachment of the charger's leads.

CAUTION: *Exercise care when attaching charger leads to side terminal studs to avoid contact with vehicle metal components which would result in damage to the battery.*

CHARGING GUIDE

BATTERY MAINTENANCE

CARE OF BATTERY

Energizer Storage

Since the "dry charge" battery is vacuum sealed against the entrance of moisture, it may be stored for very long periods of time without detrimental effects so long as the seals remain unbroken. When storing a "dry charge" battery, the following procedures should be followed:

1. Keep the battery in its shipping carton until activated.

2. Do not stack the "dry charge" battery in cartons more than four high.

3. Rotate stocks regularly.

RECOMMENDED RATE* AND TIME FOR FULLY DISCHARGED CONDITION

CAUTION: EXERCISE CARE WHEN ATTACHING CHARGER LEADS TO SIDE TERMINAL STUDS TO AVOID CONTACT WITH VEHICLE METAL COMPONENTS WHICH COULD RESULT IN DAMAGE TO THE ENERGIZER.

Watt Rating	5 Amperes	10 Amperes	20 Amperes	30 Amperes	40 Amperes	50 Amperes
Below 2450	10 Hours	5 Hours	2-1/2 Hours	2 Hours		
2450-2950	12 Hours	6 Hours	3 Hours	2 Hours	1-1/2 Hours	
Above 2950	15 Hours	7-1/2 Hours	3-1/4 Hours	2 Hours	1-3/4 Hours	1-1/2 Hours

* Initial rate for constant voltage taper rate charger.
To avoid damage, charging rate must be reduced or temporarily halted if:
1. Electrolyte temperature exceeds 125°F.
2. Violent gassing or spewing of electrolyte occurs.

Battery is fully charged when over a two hour period at a low charging rate in amperes all cells are gassing freely and no change in specific gravity occurs. For the most satisfactory charging, the lower charging rates in amperes are recommended. Full charge specific gravity is 1.260-1.280 corrected for temperature with electrolyte level at split ring.

4. Maintain the storage area at 60°F. (15.6°C.), or higher to aid activation.

A wet charged battery will not maintain its charged condition during storage, and must be recharged periodically. During storage, even though the battery is not in use, a slow reaction takes place between the chemicals inside the battery which causes the battery to lose charge and "wear out" slowly. This reaction is called "self-discharge." The rate at which self-discharge occurs varies directly with the temperature of the electrolyte.

Note that an battery stored in an area at 100°F. (37.8°C.) for 60 days has a much lower specific gravity and consequently a lower state of charge than one stored in an area at 60°F. (15.6°C.) for the same length of time.

To minimize self-discharge, a wet battery should be stored in as cool a place as possible, provided the electrolyte does not freeze.

A wet battery which has been allowed to stand idle for a long period of time without recharging may become so badly damaged by the growth of lead sulfate crystals (sulfation) in the plates that it can never be restored to a normal charged condition. An battery in this condition not only loses its capacity but also is subject to changes in its charging characteristics. These changes, due to self-discharge, are often serious enough to prevent satisfactory performance in a vehicle.

Periodic recharging, therefore, is necessary to maintain a wet charged battery in a satisfactory condition while in storage. See paragraph "Charging Wet battery in Storage."

Charging Wet Battery in Storage

Before placing a battery on charge, always check the electrolyte level and add water, as necessary, to bring the electrolyte up to the bottom of the split vent.

The battery should be brought to a fully charged condition every 30 days by charging as covered under heading of "Battery Charging Procedures".

Trickle charging should not be used to maintain on battery in a charged condition when in storage. The low charge rate method applied every 30 days is the best method of maintaining a wet charged battery in a fully charged condition without damage.

Electrolyte Freezing

The freezing point of electrolyte depends on its specific gravity. The following table gives the freezing temperatures of electrolyte at various specific gravities.

Value of Specific Gravity Corrected to 80°F. (26.7°C.)	Freezing Temp. Deg. F. (Deg. C.)	Value of Specific Gravity Corrected to 80°F. (26.7°C.)	Freezing Temp. Deg. F. (Deg. C.)
1.100	18 (-7.8)	1.220	-13(-25)
1.120	13 (-10.6)	1.240	-50 (-45.6)
1.140	8 (-13.3)	1.260	-75 (-60)
1.160	1 (-17.2)	1.280	-92 (-68.9)
1.180	-6 (-21.1)	1.300	-95 (-70.6)
1.200	-17 (-27.2)		

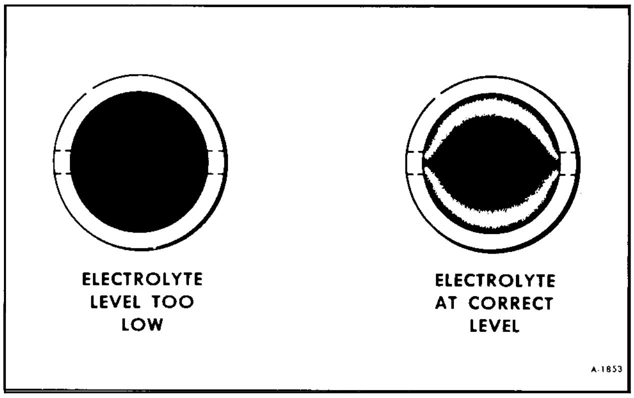


Figure 17—View Inside Vent Well

Electrolyte Level — Battery with Flame Arrestor Vent Caps

To check the electrolyte level, remove the vent plug and visually observe the electrolyte level in the vent well. The bottom of the vent well features a split vent which will cause the surface of the electrolyte to appear distorted when it makes contact. The electrolyte level is correct when the distortion first appears at the bottom of the split vent (figure 17).

The electrolyte level in the battery should be checked regularly. In hot weather, particularly during trip driving, checking should be more frequent because of more rapid loss of water. If the electrolyte level is found to be low, then colorless, ordorless, drinking water should be added to each cell until the liquid level rises to the split vent located in the bottom of the vent well. DO NOT OVERFILL because this will cause loss of electrolyte resulting in poor performance, short life, and excessive corrosion.

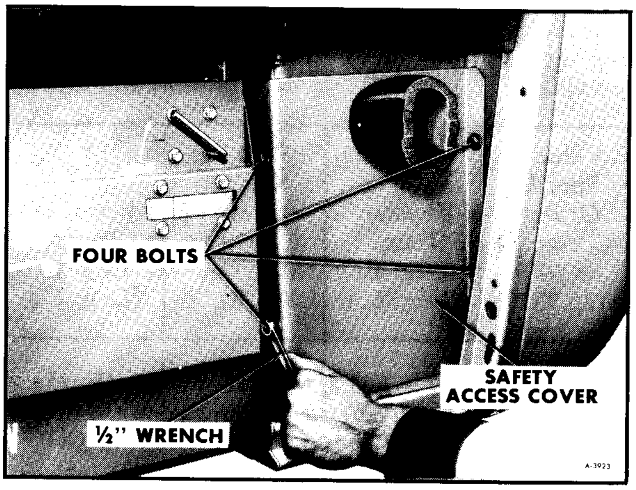


Figure 18—Removing MotorHome Living Area Battery Access Cover

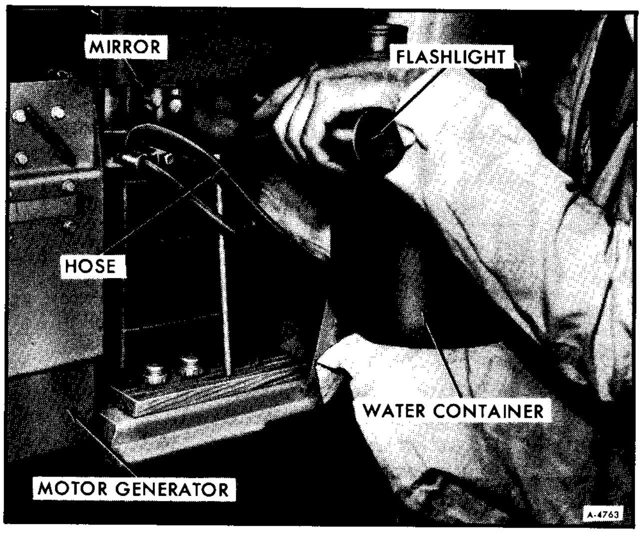


Figure 19—Checking and Adding Water to Living Area Battery

CAUTION: *During service only water should be added to the Battery, not electrolyte.*

The liquid level in the cells should never be allowed to drop below the top of the plates, as the portion of the plates exposed to air may be permanently damaged with a resulting loss in performance.

To service MotorHome auxiliary (living area) battery located in motor generator compartment, use a 1/2-inch wrench or socket to remove four bolts from safety access cover as shown in Figure 18. Remove cover. Position flashlight, mirror, water container, and hose as shown in Figure 19. Check fluid level and add water as required.

Water Usage

Excessive usage of water indicates the battery is being overcharged. The most common causes of overcharge are high battery operating temperatures, too high a voltage regulator setting, poor regulator ground wire connection. Normal battery water usage is approximately one to two ounces per month per battery.

Charge Indicator — Maintenance-Free Batteries

When reading the charge indicator on a maintenance-free battery while installed in the vehicle, a small hand mirror may be helpful. Hold the mirror as shown in Figure 20.

a. GREEN DOT VISIBLE—Figure 21. If the charge indicator is dark and has a green dot in the center, the battery is sufficiently charged.

b. DARK—GREEN DOT NOT VISIBLE—Figure 21. If the charge indicator is dark and the

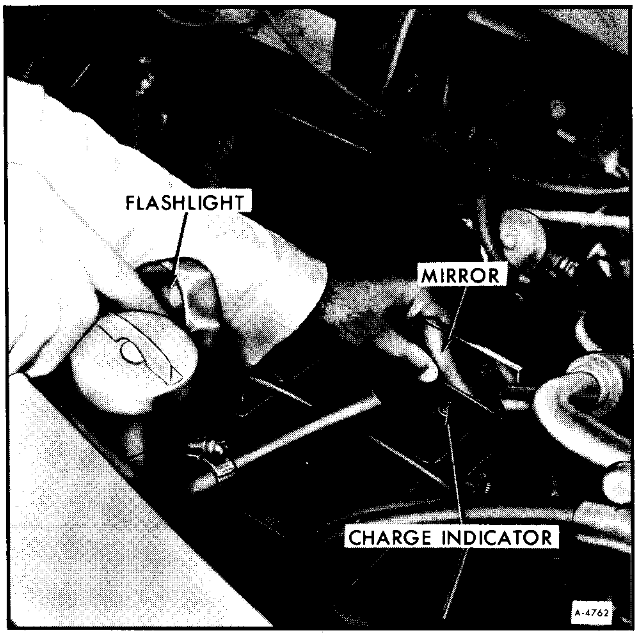


Figure 20—Checking Automotive Maintenance-Free Battery

green dot is not visible, charge battery until green dot appears, but not more than 60 ampere-hours—(for example—15 amperes for four hours).

c. LIGHT—Figure 21. If the charge indicator has a light or bright center and a cranking complaint has been experienced, replace battery (DO NOT attempt charging or testing when indicator has a light or bright center.

NOTE: A battery that failed prematurely, and exhibited a light indicator condition may indicate a need for checking the charging system of the vehicle.

Carrier and Hold-Down

The battery carrier and hold-down should be clean and free from corrosion before installing the Battery. The carrier should be in sound mechanical condition so that it will support the Battery securely and keep it level.

To prevent the Battery from shaking in its carrier, the wing nuts should be tight (60-80 in. lbs.). However, the wing nuts should not be tightened to the point where the Battery case or cover will be placed under a severe strain.

Cleaning

The external condition of the battery should be checked periodically for damage such as cracked cover, case and vent plugs or for the presence of dirt and corrosion. The battery should be kept clean. An accumulation of acid film and dirt may permit current to flow between the terminals, which will slowly discharge the Battery. For best results when cleaning batteries, wash first with a diluted ammonia or a soda solution to neutralize any acid present; then flush with clean water. Care must be taken to keep vent plugs tight, so that the neutralizing solution does not enter the cells.

SELECTING A REPLACEMENT BATTERY

Long and troublefree service can be more assured when the capacity or wattage rating of the replacement battery is at least equal to the wattage rating of the battery originally engineered for the application by the manufacturer.

The use of an undersize battery may result in poor performance and early failure. battery power

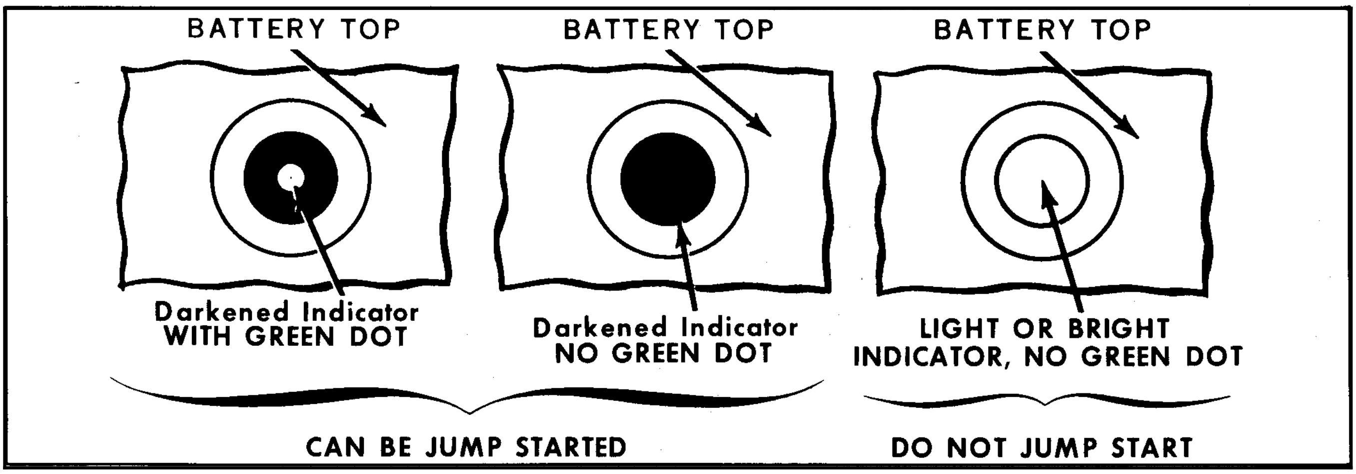


Figure 21—Charge Indicator Conditions

shrinks while the need for engine cranking power increases with falling temperatures. Sub zero temperatures reduce capacity of a fully charged battery to 45% of its normal power and at the same time increase cranking load to 3-1/2 times the normal warm weather load.

Hot weather can also place excessive electrical loads on the battery. Difficulty in starting may occur when cranking is attempted shortly after a hot engine has been turned off or stalls. In fact, modern high compression engines can be as difficult to start under such conditions as on the coldest winter day. Consequently, good performance can be obtained only if the battery has ample capacity to cope with these conditions.

A battery of greater capacity should be considered if the electrical load has been increased through the addition of accessories or if driving conditions are such that the generator cannot keep the battery in a charged condition.

On applications where heavy electrical loads are encountered, a higher output generator that will supply a charge during low speed operation may be required to increase battery life and improve battery performance.

BATTERY SPECIFICATIONS

BATTERIES - FLAME ARRESTOR TYPE FILLER/VENT CAP

	Type
MotorHome	
Main (Automotive) Battery	E5000 Catalog No. R91
Auxiliary (Living Area) Battery	Extra Duty Catalog No. 758
TransMode	
Main Battery	E5000 Catalog No. R91
Auxiliary Battery	E5000 Catalog No. R91

Part No.	1980224	1980231
Make	Delco-Remy	Delco-Remy
Model No.	E5000	Extra Duty
Catalog	R91	758
Volts	12	12
Watt Rating @0°F.(-17.8°C.)	3350 Watts	4500 Watts
Cold Cranking Rating @0°F. (-17.8°C.)	430 Amps	640 Amps
Cold Cranking Raging @-20°F. (-29°C.)	330 Amps	450 Amps
Minutes Reserve Capacity @ 25 Amps	140	285
Amps for Load Test	220	450

BATTERIES—MAINTENANCE-FREE

	Type
MotorHome	
Main (Automotive) Battery	Freedom Catalog No. R89-5
TransMode	
Main Battery	Freedom Catalog No. R89-5
Auxiliary Battery	Freedom Catalog No. R89-5
M.G. Cranking Battery (Optional)	Freedom Catalog No. R85-5

Part No.	1980402	1980400
Make	Delco-Remy	Delco-Remy
Model No.	Freedom Battery	Freedom Battery
Catalog No.	R89-5	R85-5
Volts	12	12
Watt Rating @0°F.(-17.8°C.)	4000	3200
Cold Cranking Rating @0°F. (-17.8°C.)	465	350
Cold Cranking Rating @-20°F. (-29°C.)	375	270
Minutes Reserve Capacity @ 25 Amps	125	80
Amps for Load Test	230	230

VOLTAGE AND TEMPERATURE CHART									
Electrolyte Temperature	80°F 26.7°C	70°F 21.1°C	60°F 15.6°C	50°F 10°C	40°F 4.4°C	30°F 1.1°C	20°F −6.7°C	10°F −12.2°C	0°F −17.8°C
Voltage Minimum	9.6	9.6	9.5	9.4	9.3	9.1	8.9	8.7	8.5

GENERATING SYSTEM

GENERAL DESCRIPTION

The 80 amp. (27 SI type 100) generator illustrated in Figure 22 feature a solid state regulator mounted inside the generator slip ring end frame. All regulator components are enclosed in a solid mold. This unit, along with the brush holder assembly, is

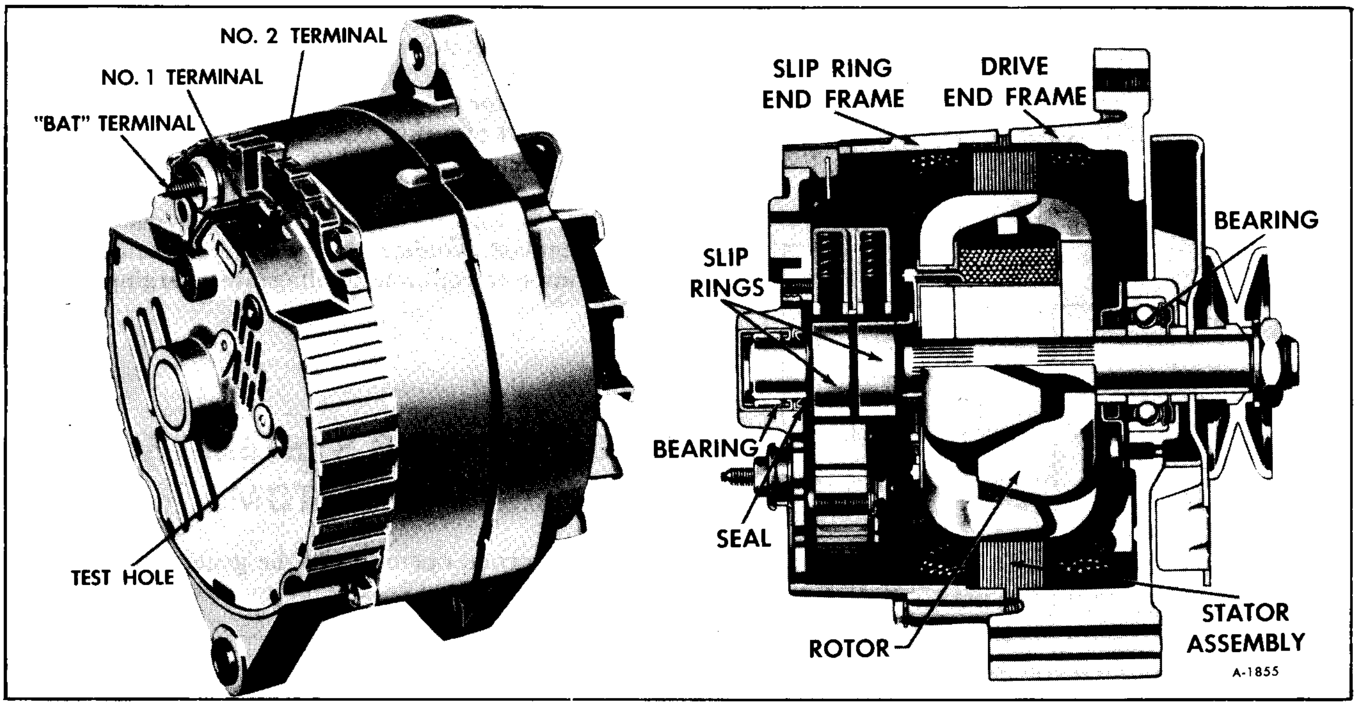


Figure 22—80 - Amp. Integral Type AC Generator

attached to the slip ring end frame. The regulator voltage setting is not adjustable.

The generator rotor bearings contain a supply of lubricant sufficiently adequate to eliminate the need for periodic lubrication. Two brushes carry current through two slip rings to the field coil. The stator windings are assembled on the inside of a laminated core that forms part of the generator frame. A rectifier bridge connected to the stator windings contains six diodes, and electrically changes the stator A.C. voltages to a D.C. voltage which appears at the generator output terminal. Generator field current is supplied through a diode trio connected to the stator windings. A capacitor, or condenser, mounted in the end frame protects the rectifier bridge and diode trio from high voltages, and suppresses radio noise.

OPERATING PRINCIPLES

A typical schematic wiring diagram of the 80-amp integral type charging system is shown in Figure 23. The basic operating principles are explained as follows:

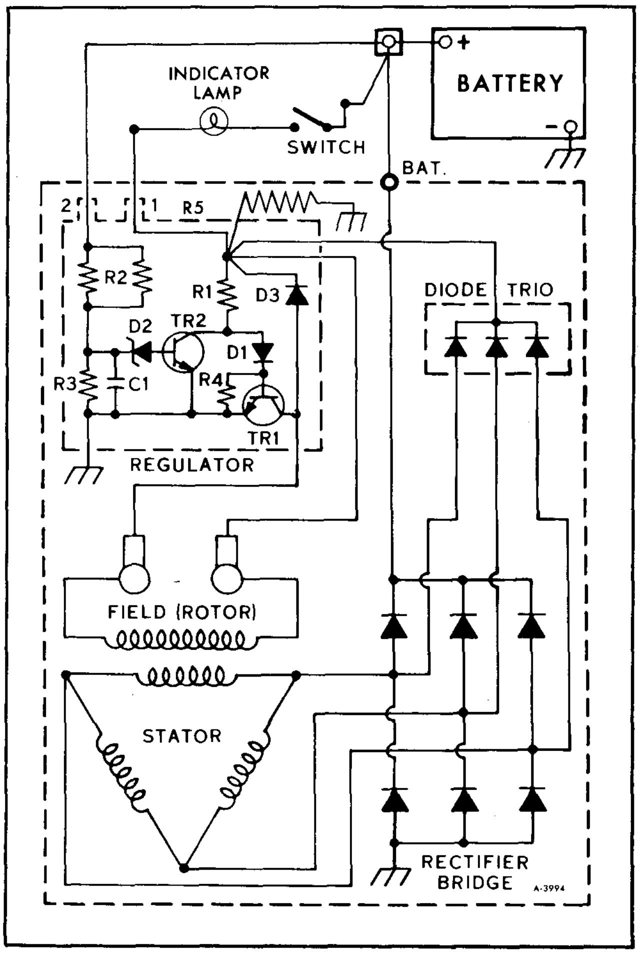


Figure 23—Schematic Diagram of Generating System (Typical)

When ignition switch is closed, current from the battery flows through the indicator lamp to generator No. 1 terminal, through resistor R1, diode D1, and the base-emitter of transistor TR1 to ground, then back to the battery. This turns on transistor TR1, and current flows through the generator field coil and TR1 back to the battery. The indicator lamp then turns on. Resistor R5 carries some of the indicator lamp current and is identified in Figure 23.

With generator operating, A.C. voltages are generated in the stator windings, and the stator supplies D.C. field current through the diode trio, the field, TR1, and then through the grounded diodes in the rectifier bridge back to the stator. The six diodes in the rectifier bridge change the stator A.C. voltages to a D.C. voltage which appears between ground and generator "BAT" terminal. As generator speed increases, current is provided for charging the battery and operating electrical accessories. Also, with the generator operating, the same voltage appears at the "BATT" and No. 1 terminals, and the indicator lamp goes out to indicate the generator is producing voltage.

The No. 2 terminal on the generator is always connected to the battery, but the discharge current is limited to a negligible value by the high resistances of R2 and R3. As generator speed and voltage increase, the voltage between resistors R2 and R3 increases to the point where zener diode D2 conducts. Transistor TR2 then turns on and TR1 turns off. With TR1 off, field current and system voltage decrease, and D2 blocks current flow, causing TR1 to turn back on. The field current and system voltage increase. This cycle repeats many times per second to limit generator voltage to a pre-set value.

Capacitor C1 smooths out the voltage across R3, resistor R4 prevents excessive current through TR1 at high temperatures, and diode D3 prevents high induced voltages in the field windings when TR1 turns off. Resistor R2 is a thermister which causes the regulated voltage to vary with temperature, thus providing the optimum voltage for charging the battery.

GENERATING SYSTEM TROUBLE SYMPTOMS

Abnormal operation of the generating system is usually indicated by one or more of the following symptoms:

1. Battery undercharged (low specific gravity of electrolyte).

GENERATING SYSTEM DIAGNOSIS

FAULTY INDICATOR LAMP OPERATION

Check the indicator lamp for normal operation as shown below:

Switch	Lamp	Engine
OFF	OFF	STOPPED
ON	ON	STOPPED
ON	OFF	RUNNING

If the indicator lamp operates normally, proceed to "Undercharged Battery" or "Overcharged Battery" section. Otherwise, proceed to either one of the following three abnormal conditions:

Switch On, Lamp On, Engine Running - Check for a blown fuse (where used) between indicator lamp and switch. The other possible causes of this condition are covered in "UNDERCHARGED BATTERY" on this page.

Switch Off, Lamp On - In this case, disconnect the two leads from the generator No. 1 and No. 2 terminals. If the lamp stays on, there is a short between these two leads. If the lamp goes out, replace the rectifier bridge as covered in the "GENERATOR REPAIR." This condition will cause an undercharged battery.

Switch On, Lamp Off, Engine Stopped - This condition can be caused by the defects listed in "Switch Off, Lamp On" under "GENERATOR TROUBLESHOOTING," or by an open in the circuit.

To determine where an open exists, check for a blown fuse, a burned out bulb, defective bulb, or an open in No. 1 lead circuit between generator and ignition switch.

If no defects are found, proceed to "UNDERCHARGED BATTERY" above.

UNDERCHARGED BATTERY

This condition, as evidenced by slow cranking and low specific gravity readings, can be caused by one or more of the following conditions even though the indicator lamp may be operating normally. The following procedure also applies to circuits with an ammeter:

1. Insure that the undercharged condition has not been caused by accessories having been left on for extended periods.
2. Check the drive belt for proper tension.
3. If a battery defect is suspected, see "Battery Service And Diagnosis" earlier in this section.
4. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the slip connectors at the generator and firewall, and the cable clamps and battery posts.
5. With ignition switch on, connect a voltmeter from:
   a. Generator "BAT" terminal to ground.
   b. Generator No. 1 terminal to ground.
   c. Generator No. 2 terminal to ground.
   A zero reading indicates an open between voltmeter connection and battery.
6. If previous Steps 1 through 5 check satisfactorily, check Delcotron Generator as follows:
   a. Disconnect battery ground cable.
   b. Connect an ammeter in the circuit at the "BAT" terminal of the generator.
   c. Reconnect battery ground cable.
   d. Turn on radio, windshield wipers, lights high beam and blower motor high speed. Connect a carbon pile across the battery.
   e. Operate engine at moderate speed as required, and adjust carbon pile as required, to obtain maximum current output.

If ampere output is within 10 amps of rated output as stamped on generator frame, generator is not defective; recheck Steps 1 through 5.

If amperes output is not within 10 amps of rated output, determine if test hole is accessible.

If test hole is accessible, ground the field winding by inserting a screwdriver into the test hole.

CAUTION: Tab is within 3/4-inch of casting surface. Do not force screwdriver deeper than 1-inch into end frame.

Operate engine at moderate speed as required, and adjust carbon pile as required to obtain maximum current output.

If test hole is not accessible, disassemble generator and make tests listed in "GENERATOR REPAIR."

If output is not within 10 amps of rated output, check the field winding, diode trio, rectifier bridge, and stator as covered in "GENERATOR REPAIR."

If output is within 10 amps of rated output, test regulator with an approved regulator tester, and check field winding as covered in "GENERATOR REPAIR."

OVERCHARGED BATTERY

1. To determine battery condition, see "Battery Service And Diagnosis" earlier in this section.
2. Connect a voltmeter from generator No. 2 terminal to ground. If reading is zero, No. 2 lead circuit is open.
3. If battery and No. 2 lead circuit check good, but an obvious overcharge condition exists as evidenced by excessive battery water usage, proceed as follows:
   a. Separate end frames as covered in "Disassembly" under heading of "GENERATOR REPAIR." Check field winding for grounds and shorts. If defective, replace rotor and test regulator with an approved regulator tester.
   b. Connect ohmmeter using lowest range scale from brush lead clip to end frame; then reverse lead connections.
   c. If both readings are zero, either the brush lead clip is grounded or regulator may be defective.
   d. A grounded brush lead clip can result from omission of insulating washer, omission of insulating sleeve over screw, or damaged insulating sleeve. Remove screw to inspect sleeve. If satisfactory, test regulator with an approved regulator tester.

Generating System Diagnosis

2. Battery using an excessive amount of water, indicating an extremely high charging rate.

3. Excessive generator noise or vibration.

4. Failure of indicator lamp to illuminate when ignition switch is turned on (engine not running).

5. Indicator lamp continues to glow with engine running.

6. Indicator lamp fails to go out when ignition or control switch is turned off.

The following is a list of the most common generator defects encountered:

1. Open or shorted generator diodes.

2. Open, shorted, or grounded stator winding.

3. Open, shorted, or grounded field winding.

4. Worn generator brushes.

5. Excessive generator noise.

Generator diodes and stator windings should be checked as explained under "Generator on Vehicle Output Test" in Steb b, later in this section. If a defect is indicated by this test, remove generator and repair.

Excessive generator noise is usually the result of one or more of the following:

1. Brush "squeal" caused by a hard spot on one of the brushes of rough or dirty slip rings. To check for brush "squeal," remove generator drive belt and spin generator drive pulley by hand. Lift brushes off slip rings and spin drive pulley again. If noise disappears, clean and inspect slip rings and replace brushes if worn.

2. Dry or rough bearings in end frame.

CAUTION: *Dry or rough bearings may be the result of over-tightening generator drive belt(s), loose generator mountings, or an unbalanced generator fan or pulley.*

3. A defective diode or stator resulting in an electrical unbalance.

STATIC CHECK

Before making any electrical checks, visually inspect all connections, including slip-on connectors, to make sure they are clean and tight. Inspect all wiring for cracked, frayed, or broken insulation. Be sure generator mounting bolts are tight and unit is properly grounded. Check for loose fan belt.

PRECAUTIONS

Observe the following precautions when performing service operations on the alternating current generating system. Failure to observe these precautions may result in serious damage to the charging system.

NOTE: A basic wiring diagram showing lead connections is shown in Figure 24.

1. Electrical system is NEGATIVE GROUND. Connecting the battery with positive terminal grounded will result in severe damage to generator, battery and battery cables.

2. DO NOT ground the field circuit at generator.

3. Never operate generator with open circuit, that is, with output wire disconnected from terminal and with field circuit externally energized. Be absolutely sure all connections in circuit are secure.

4. When using a booster battery, connect leads as explained under "Jump Starting with Auxiliary (Booster) Battery" in BATTERY (Sec. 6Y).

5. Disconnect battery leads while charging batteries. Do not use a fast charger as a booster for starting the engine. When attaching battery charger leads to battery, connect charger positive lead to battery positive terminal and connect charger negative lead to battery negative terminal.

6. Do not short across or ground any of the terminals in the charging circuit.

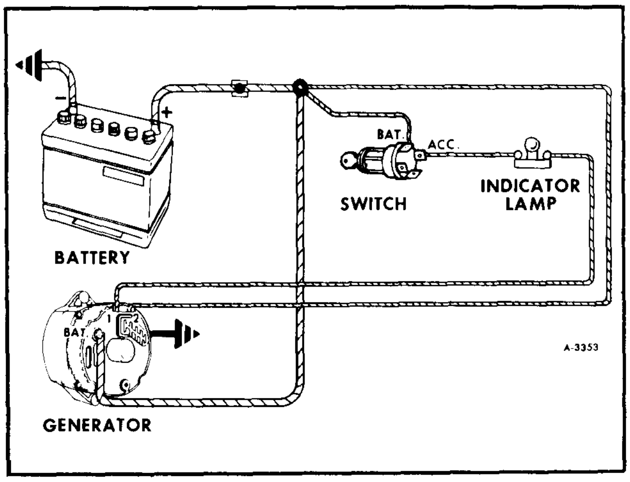


Figure 24—Typical Lead Connections

7. Do not attempt to polarize the generator.

8. When working near generator or regulator, disconnect battery cable to prevent accidental grounding at generator terminals.

9. Always disconnect battery negative cables when replacing electrical system components. This eliminates accidental shorting at generator terminals where battery voltage is available.

10. Disconnect battery negative cables before welding on vehicle, since a reverse current from the welder may damage generator diodes as well as other electrical components.

11. Never replace the special resistance wire in harness connected to the ignition switch unless it is of same material and of same length (approx. 60 inches long). Generating system will not function without this wire. Wire is identified in Engine and Chassis Wiring Diagram (Back of Manual).

NOT Close adherence to the Troubleshooting Procedures in order presented will lead to location and correction of charging system malfunctions in the shortest time possible. Only a portion of the procedures need to be performed in order to locate the trouble.

ON VEHICLE TESTS

FAULTY INDICATOR LAMP OPERATION

Check the indicator lamp for normal operation as shown below.

Switch	Lamp	Engine
OFF	OFF	STOPPED
ON	ON	STOPPED
ON	OFF	RUNNING

If the indicator lamp operates normally, proceed to "Undercharged Battery" or "Overcharged Battery" section. Otherwise, proceed to either one of the following three abnormal conditions.

1. **Switch Off, Lamp On**—In this case, disconnect the two leads from the generator No. 1 and No. 2 terminals. If the lamp stays on, there is a short between these two leads. If the lamp goes out, replace the rectifier bridge as covered in the "GENERATOR REPAIR" section. This condition will cause an undercharged battery.

2. **Switch On, Lamp Off, Engine Stopped**—This condition can be caused by the defects listed in Part 1 above, or by an open in the circuit. To determine where an open exists, proceed as follows:

a. Check for a blown fuse, a burned out bulb, defective bulb socket, or an open in No. 1 lead circuit between generator and ignition switch.

b. If no defects have been found, proceed to "Undercharged Battery" section.

3. **Switch On, Lamp On, Engine Running**—Check for a blown fuse (where used) between indicator lamp and switch. The other possible causes of this condition are covered in the "UNDERCHARGED BATTERY" section.

If a defect has been found and corrected at this point, no further checks need be made.

UNDERCHARGED BATTERY

This condition, as evidenced by slow cranking and low specific gravity readings, can be caused by one or more of the following conditions even though the indicator lamp may be operating normally.

1. Insure that the undercharged condition has not been caused by accessories having been left on for extended periods.

2. Check the drive belt for proper tension.

3. If a battery defect is suspected, check per applicable battery service and diagnosis given earlier in this section.

4. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the slip connectors at the generator and firewall, and the cable clamps and battery posts.

5. With ignition switch on and all wiring harness leads connected, connect a voltmeter from:

a. generator "BAT" terminal to ground

b. generator No. 1 terminal to ground

c. generator No. 2 terminal to ground

A zero reading indicates an open between voltmeter connection and battery. NOTE: An open No. 2 lead circuit on early production generators caused uncontrolled voltage, battery overcharge and possible damage to battery and accessories. Generators supplied for later applications have a built-in feature which avoids overcharge and accessory damage by preventing the generator from turning on if there is an **open** in the wiring harness connected to the No. 2 generator terminal. Opens in the wiring harness connected between the No. 2 generator terminal and battery may be between the terminals, at the crimp between the harness wire and terminal, or in the wire.

Generator on Vehicle Output Test

6. If previous Steps 1 through 5 check satisfactorily, check Delcotron generator as follows:

a. Disconnect battery ground cable.

b. Connect an ammeter in the circuit at the "BAT" terminal of the generator.

c. Reconnect battery ground cable.

d. Turn on radio, windshield wipers, lights high beam and blower motor high speed. Connect a carbon pile across the battery.

e. Operate engine at moderate speed as required, and adjust carbon pile as required, to obtain maximum current output.

f. If ampere output is within 10 amperes of rated output as stamped on generator frame, generator is not defective; recheck Steps 1 through 5.

g. If ampere output is not within 10 amperes of rated output, determine if test hole (figure 25) is accessible.

If accessible go to Step h. If not accessible go to Step l.

h. Ground the field winding by inserting a screwdriver into the test hole (figure 25). CAUTION: Tab is within 3/4 inch of casting surface. Do not force screwdriver deeper than one inch into end frame.

i. Operate engine at moderate speed as required, and adjust carbon pile as required to obtain maximum current output.

j. If output is within 10 amperes of rated output, check field winding as covered in "GENERATOR REPAIR" section, and test regulator with an approved regulator tester.

k. If output is not within 10 amperes of rated output, check the field winding, diode trio, rectifier bridge, and stator as covered in "GENERATOR REPAIR" section.

l. If test hole is not accessible, disassemble generator and make tests listed in "GENERATOR REPAIR" section.

OVERCHARGED BATTERY

1. To determine battery condition, check per applicable battery device and diagnosis given earlier in this section.

2. Connect a voltmeter from generator No. 2 terminal to ground. If reading is zero, No. 2 lead circuit is open.

3. If battery and No. 2 lead circuit check good, but an obvious overcharge condition exists as evidenced by excessive battery water usage, proceed as follows:

a. Separate and flames as covered in "Disassembly" section under heading of "GENERATOR REPAIR".

Check field winding for grounds and shorts. If defective replace rotor, and test regulator with an approved regulator tester.

b. Connect ohmmeter using lowest range scale from brush lead clip to end frame as shown in Step 1, Figure 26, then reverse lead connections.

c. If both readings are zero, either the brush lead clip is grounded or regulator may be defective.

d. A grounded brush lead clip can result from omission of insulating washer (figure 26), omission of insulating sleeve over screw, or damaged insulating sleeve. Remove screw to inspect sleeve. If satisfactory, test regulator with an approved regulator tester.

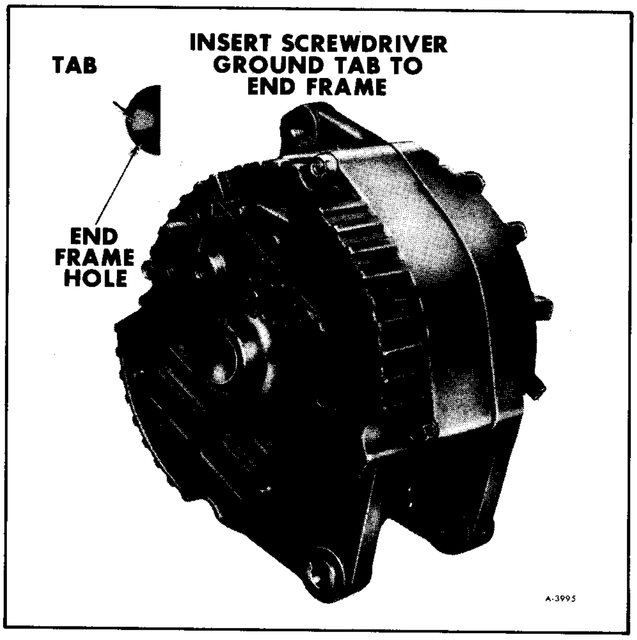


Figure 25—End View of Generator (Typical)

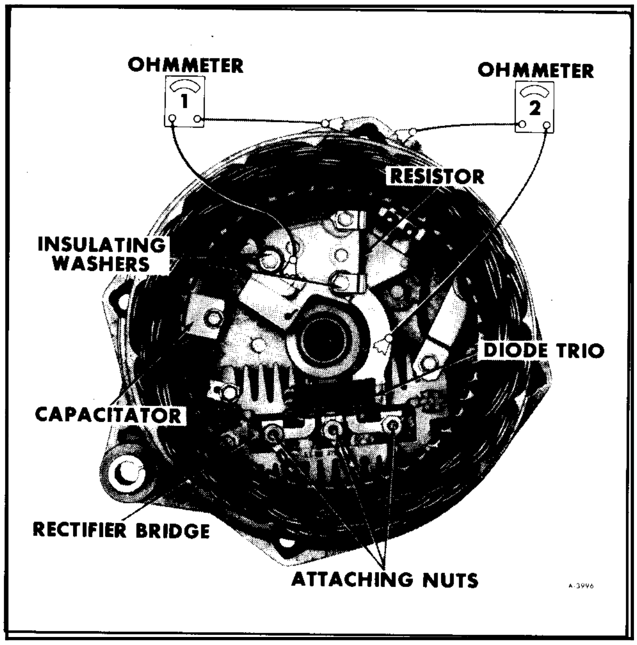


Figure 26—Slip Ring End Frame

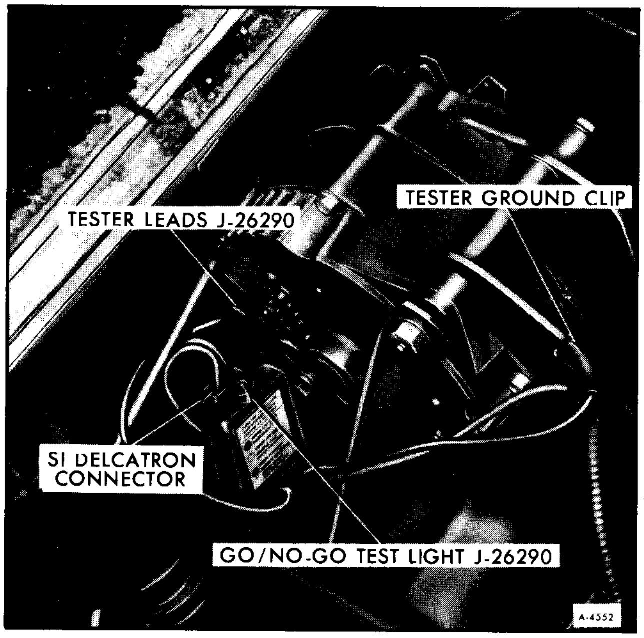


Figure 27—SI Delcotron Tester Tool J-26290

SI CHARGING SYSTEM DIAGNOSTIC TESTER J-26290

NOTE: For use on 120 volt negative ground vehicles only. Perform test with lights and all accessories off. After diagnosis has been made and the problem corrected, use GO/No-Go Test Light Indicator J-26290 again to verify proper operation of charging system.

With the engine stopped, detach field and sensing leads connector from the SI Delcotron and plug into tester. Next plug the tester leads into the SI Delcotron and attach tester ground clip to ground, as shown in Figure 27.

Engine Off

1. If tester light flashes, go to engine fast idle.

2. If tester light remains on, the tester itself is faulty.

3. If the tester light remains off, pull tester connector plug from Delcotron.

a. If tester light flashes, replace rectifier bridge.

b. If tester light remains off, faulty tester or no voltage to tester (broken or faulty connection).

Engine at Fast Idle (1000 RPM or More)

4. If tester light remains off Delcotron system is ok.

5. If tester light remains on, remove and check the Delcotron.

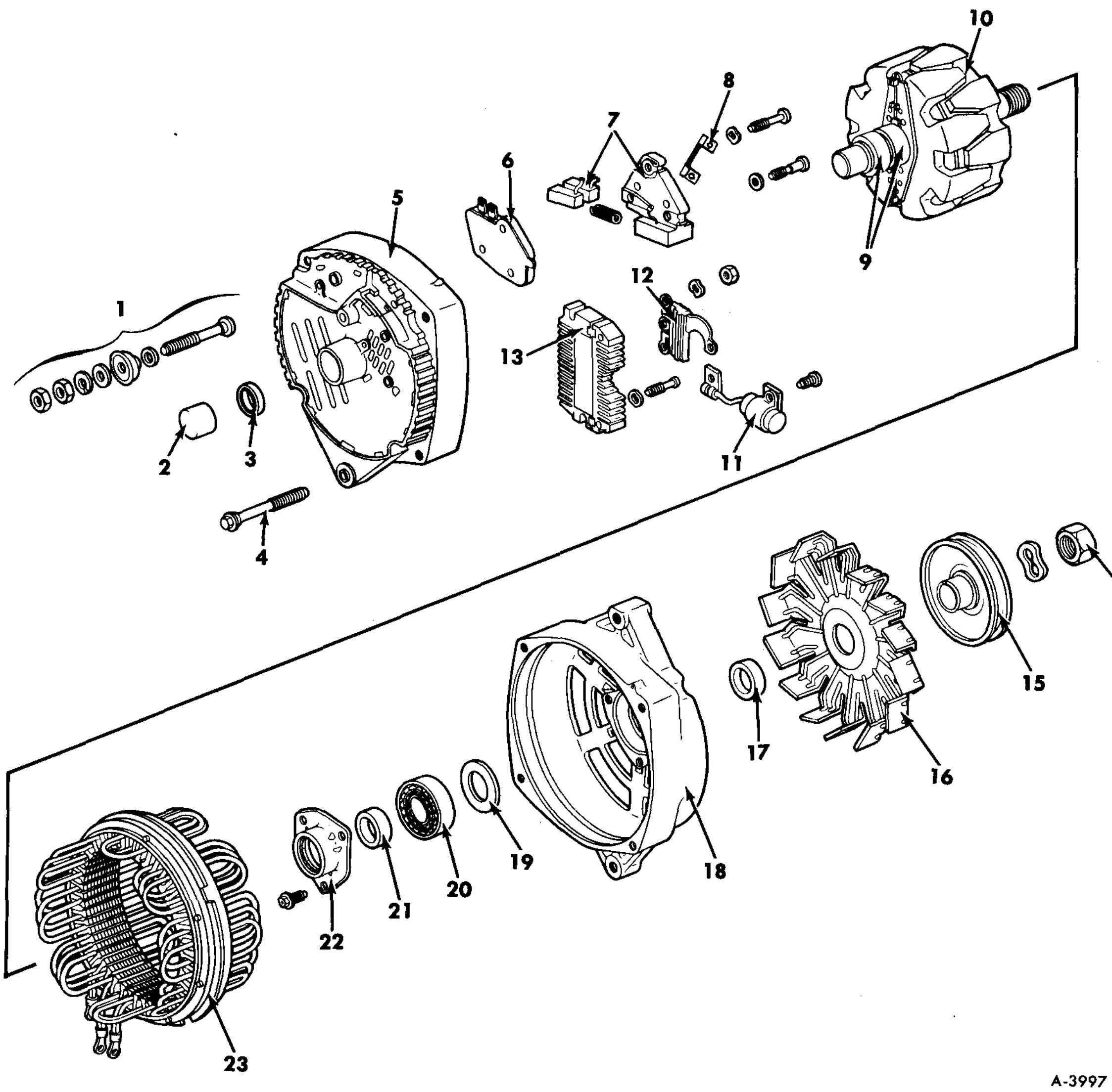
6. If the tester light flashes, remove Delcotron and check regulator, rotor field coil, brushes, and slip rings.

GENERATOR REMOVAL

NOTE: Due to variations in design and equipment, the replacement procedures will vary accordingly. The removal and installation instructions following are intended only as a guide. Additional operations will be required on some vehicles to remove other equipment to permit access to generator, belts, and/or brackets.

1. Disconnect negative cables from batteries.

2. Depress lock on connector and pull connector out of socket on generator. Pull rubber boot off "BAT" terminal and remove terminal nut. Disconnect ground (GRD) terminal and remove wiring clip.



1 Battery Terminal
2 Bearing-Roller, Slip Ring End
3 Seal
4 Bolt-Thru
5 Frame-Slip Ring End
6 Regulator
7 Brush Holder
8 Resistor
9 Slip Rings
10 Rotor
11 Capacitor
12 Diode (Trio)
13 Bridge-Rectifier
14 Drive Shaft Nut
15 Pulley
16 Fan
17 Drive Shaft Collar (Outside)
18 Frame-Drive End
19 Washer-Grease Slinger
20 Bearing-Drive End
21 Drive Shaft Collar (Inside)
22 Retainer Plate
23 Stator

Figure 28—Delcotron Generator Exploded View

3. Loosen bolt in adjusting arm and mounting bracket. Move generator to loosen drive belt (or belts); remove belt(s) from generator pulley.

4. Remove the bolt attaching the generator to mounting bracket, remove adjusting arm bolt, then remove generator from engine.

GENERATOR REPAIR

To repair the generator, observe the following procedure:

DISASSEMBLY (FIGURE 28)

To disassemble the generator, take out the four thru-bolts, and separate the drive end frame and rotor assembly from the stator assembly by prying apart with a screwdriver at the stator slot. A scribe mark will help locate the parts in the same position during assembly. After disassembly, place a piece of tape over the slip ring end frame bearing to prevent entry of dirt and other foreign material, and also place a piece of tape over the shaft on the slip ring end. If brushes are to be reused, clean with a soft dry cloth.

CAUTION: *Use pressure sensitive tape and not friction tape which would leave a gummy deposit on the shaft.*

To remove the drive end frame from the rotor, place the rotor in a vise and tighten only enough to permit removal of the shaft nut. CAUTION: Avoid excessive tightening as this may cause distortion of the rotor. Remove the shaft nut, washer, pulley, fan, and the collar, and then separate the drive end frame from the rotor shaft.

ROTOR FIELD WINDING CHECKS

To check for opens, connect the test lamp or ohmmeter to each slip ring. If the lamp fails to light, or if the ohmmeter reading is high (infinite), the winding is open (figure 28). Connect test lamp or ohmmeter from one slip ring to shaft. If lamp lights, or reading is low, the rotor winding is grounded.

The winding is checked for short circuits or excessive resistance by connecting a battery and ammeter in series with the edges of the two slip rings. Note the ammeter reading and refer to Generator Specifications. An ammeter reading above the specified value indicates shorted windings; a reading below the specified value indicates excessive resistance. An alternate method is to check the resistance of the field by connecting an ohmmeter to the two slip rings (figure 28). If the resistance reading is below the specified value, the winding is shorted; if above the specified value the winding has excessive resistance.

The specified resistance value can be determined by dividing the voltage by the current given in Generator Specifications. Remember that the winding resistance and ammeter readings will vary slightly with winding temperature changes. If the rotor is not defective, but the generator fails to supply rated output, the defect is in the diode trio, rectifier bridge or stator.

DIODE TRIO CHECK

The diode trio is identified in Figure 26. First, connect an ohmmeter using lowest range scale from diode trio long connector to end frame as shown in Step 2, Figure 26, then reverse lead connections. If both readings are the same, check for grounded brush lead clip caused by omission of insulating washer (figure 26), omission of insulating sleeve over screw, or damaged insulating sleeve. Remove screw to inspect sleeve. **If screw assembly is correct, and both ohmmeter readings are the same, replace regulator.**

To check the diode trio, remove it from the end frame assembly by detaching the three nuts, the attaching screw, and removing the stator assembly. Note that the insulating washer on the screw is assembled over the top of the diode trio connector. Connect an ohmmeter having a 1-1/2 volt cell, and using the lowest range scale, to the single connector and to one of the three connectors (figure 29). Observe the reading. Then reverse the ohmmeter leads to the same two connectors. If both readings are the same, replace the diode trio. A good diode trio will give one high and one low reading. Repeat this same

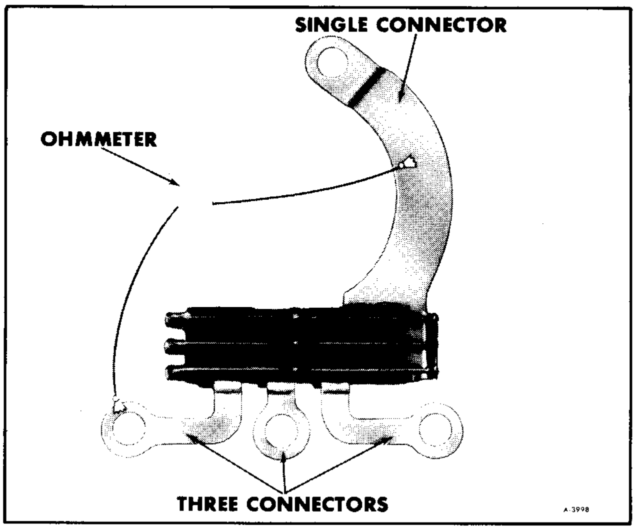


Figure 29—Diode Trio Check

test between the single connector and each of the other two connectors. Also, connect the ohmmeter to each pair of the three connectors (not illustrated). If any reading is zero, replace the diode trio.

RECTIFIER BRIDGE CHECK

Note that the rectifier bridge has a grounded heat sink and an insulated heat sink connected to the output terminal.

To check the rectifier bridge, connect the ohmmeter to the grounded heat sink and one of the three terminals, (figure 30). Connect to flat metal connector, and not onto threaded stud. Then reverse the lead connections to the grounded heat sink and same terminal. If both readings are the same, replace the rectifier bridge. A good rectifier bridge will give one high and one low reading. Repeat this same test between the grounded heat sink and the other two terminals, and between the insulated heat sink and each of the three terminals. This makes a total of six checks, with two readings taken for each check.

The ohmmeter check of the rectifier bridge, and of the diode trio as previously covered, is a valid and accurate check. **Do not** replace either unit unless at least one pair of readings is the same.

> **CAUTION:** *Do not use high voltage to check these units such as a 110 volt test lamp.*

To replace the rectifier bridge, remove the attaching screws, and disconnect the capacitor lead. Rectifier bridges may vary in appearance but are completely interchangeable in these generators.

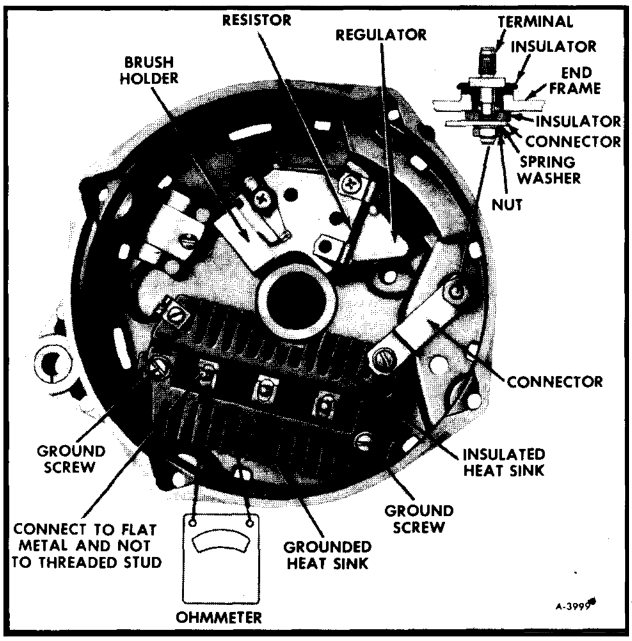


Figure 30—Rectifier Bridge Check

STATOR CHECKS

The stator windings may be checked with a 110-volt test lamp or an ohmmeter. If the lamp lights, or if the meter reading is low when connected from any stator lead to the frame, the windings are grounded.

> **NOTE:** Delta windings on 80-amp. generator cannot be checked for opens.

A short circuit in the stator windings is difficult to locate without laboratory test equipment due to the low resistance of the windings. However, if all other electrical checks are normal and the generator fails to supply rated output, shorted stator windings or an open delta winding on 80-amp. generator is indicated. Also, a shorted stator can cause the indicator lamp to be on with the engine at low speed.

BRUSH HOLDER AND REGULATOR REPLACEMENT

After removing the three attaching nuts, the stator, and diode trio screw (figure 30) the brush holder and regulator may be replaced by removing the two remaining screws. Note the two insulators located over the top of the brush clips in Figure 26, and that these two screws have special insulating sleeves over the screw body above the threads. The third mounting screw may or may not have an insulating sleeve. If not, this screw must not be interchanged with either one of the other two screws, as a ground may result, causing no output or uncontrolled generator output. Regulators may vary in appearance but are completely interchangeable in these generators.

SLIP RING SERVICING

If the slip rings are dirty, they may be cleaned and finished with 400 grain or finer polishing cloth. Spin the rotor, and hold the polishing cloth against the slip rings until they are clean.

> **CAUTION:** *The rotor must be rotated in order that the slip rings will be cleaned evenly. Cleaning the slip rings by hand without spinning the rotor may result in flat spots on the slip rings, causing brush noise.*

Slip rings which are rough or out of round should be trued in a lathe to .002 inch maximum indicator reading. Remove only enough material to make the rings smooth and round. Finish with 400 grain or finer polishing cloth and blow away all dust.

BEARING REPLACEMENT AND LUBRICATION

The bearing in the drive end frame can be removed by detaching the retainer plate screws, and then pressing the bearing from the end frame. If the bearing is in satisfactory condition, it may be reused, and it should be filled one-quarter full with Delco-Remy Lubricant No. 1948791 or before reassembly.

CAUTION: *Do not overfill, as they may cause the bearing to overheat.*

To install a new bearing, press in with a tube or collar that just fits over the outer race, with the bearing and slinger assembled into the end frame. It is recommended that a new retainer plate be installed if the felt seal in the retainer plate is hardened or excessively worn. Fill the cavity between the retainer plate and bearing with 1948791 lubricant.

The bearing in the slip ring end frame should be replaced if its grease supply is exhausted. No attempt should be made to re-lubricate and reuse the bearing. To remove the bearing from the slip ring end frame, press out with a tube or collar that just fits inside the end frame housing. Press from the outside of the housing towards the inside.

To install a new bearing, place a flat plate over the bearing and press in from the outside towards the inside of the frame until the bearing is flush with the outside of the end frame. Support the inside of the frame with a hollow cylinder to prevent breakage of the end frame. Use extreme care to avoid misalignment or otherwise placing undue stress on the bearing.

If the seal is separate from the bearing, it is recommended that a new seal be installed whenever the bearing is replaced. Press the seal in with the lip of the seal toward the rotor when assembled, that is, away from the bearing. Lightly coat the seal lip with oil to facilitate assembly of the shaft into the bearing.

GENERATOR BENCH OUTPUT TEST

To check the generator in a test stand, proceed as follows:

1. Make connections as shown in Figure 31, except leave the carbon pile disconnected. IMPORTANT—Ground polarity of battery and generator must be the same. Use a fully charged battery, and a 10 ohm resistor rated at six watts or more between the generator No. 1 terminal and the battery.

2. Slowly increase the generator speed and observe the voltage.

3. If the voltage is uncontrolled with speed and increases above 15.5 volts on a 12-volt system, check for a grounded brush lead clip as covered under heading of "OVERCHARGED BATTERY" Step 3. If not grounded, test regulator with an approved regulator tester, and check field winding. NOTE: The battery **must** be fully charged when making this check.

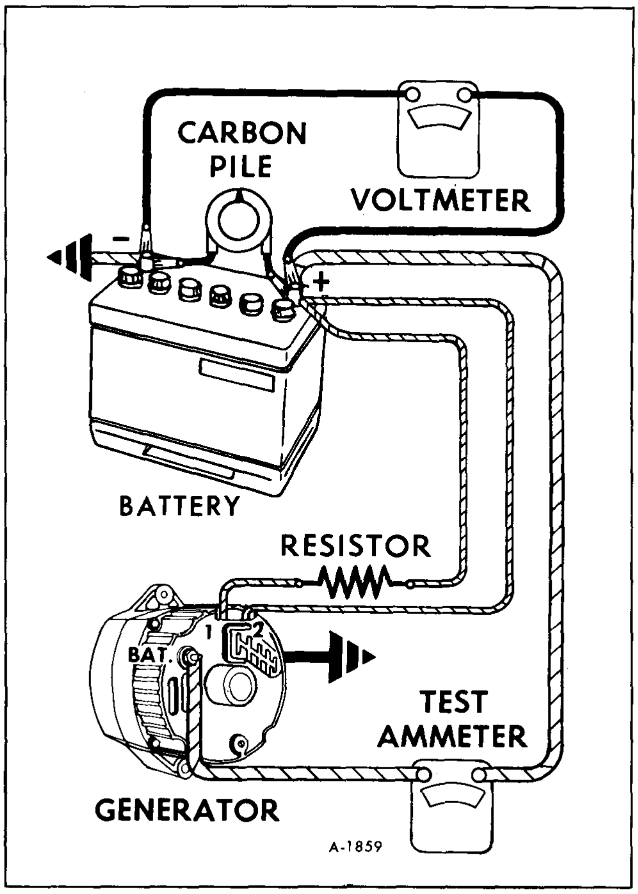


Figure 31—Connections for Testing Generator Output

4. If voltage is below 15.5 bolts on a 12-volt system, connect the carbon pile as shown.

5. Operate the generator at moderate speed as required and adjust the carbon pile as required to obtain maximum current output.

6. If output is within 10 amperes of rated output as stamped on generator frame, generator is good.

7. If output is not within 10 amperes of rated output, keep battery loaded with carbon pile, and ground generator field (figure 25).

8. Operate generator at moderate speed and adjust carbon pile as required to obtain maximum output.

9. If output is within 10 amperes of rated output, test regulator with an approved regulator tester, and check field winding.

10. If output is not within 10 amperes of rated output, check the field winding, diode trio, rectifier bridge, and stator as previously covered.

ASSEMBLY

Assembly is the reverse of disassembly.

Remember when assembling the pulley to secure the rotor in a vise only tight enough to permit tightening the shaft nut to 40-60 lb. ft. If excessive pressure is applied against the rotor, the assembly may become distorted. To install the slip ring end frame assembly to the rotor and drive end frame assembly, remove the tape over the bearing and shaft, and make sure the shaft is perfectly clean after removing the tape. Insert a pin through the holes to hold up the brushes. Carefully install the shaft into the slip ring end frame assembly to avoid damage to the seal. After tightening the thru-bolts remove the brush retaining pin to allow the brushes to fall down onto the slip rings.

GENERATOR INSTALLATION

1. Attach generator to mounting bracket and install adjusting arm. Tighten flange-type lock nuts securely.

2. Place drive belt(s) over generator drive pulley and adjust belt tension. Tighten mounting bolts and adjusting arm bolt when belt tension adjustment has been made. Refer to "Generator Drive Belt Tension Adjustment" later in this section.

3. Push the wiring harness connector into the socket making sure the lock on the connector engages the end frame. Place harness clip on ground terminal marked "GRD" and connect the ground wire to terminal.

4. Attach red wire to "BAT" terminal on generator and fit boot on terminal.

5. Perform "Generator Output Test" described earlier in this section to determine if generator is operating properly.

GENERATOR DRIVE BELT

TENSION ADJUSTMENT

Because of the higher inertia and load capacity of rotor used with A.C. generators, PROPER BELT TENSION MUST BE MAINTAINED.

All generators are pivot-base mounted with the belt tension adjustment arm at the top or bottom using belt tension Tool BT-33-73F (Burroughs Tool) or other suitable tool to check tension on each individual belt. If tension is not within 70-80 lbs. (used belts) or 110-140 lbs. (new belts), loosen adjustment arm clamp bolt and move generator to obtain recommended tension.

CAUTION: *When adjusting belt tension, apply pressure at center of generator, never against either end frame.*

NOTE: On a new vehicle, or after having installed new belts, check tension of belt(s) twice in first 200 miles of operation. When making adjustment, examine belt(s) and replace if necessary.

A loose or broken drive belt will affect operation of generator. A drive belt that is too tight will place too much strain on bearings.

GENERATING SYSTEM MAINTENANCE

Most charging system troubles show up as an undercharged or overcharged battery. Since the battery itself may be defective, it should be checked first to determine its condition. In the case of undercharged battery, check for battery drain caused by ground or by accessories being left on.

At regular intervals, inspect generating system to locate and correct potential causes of trouble before generating system performance is affected.

1. Check generator drive belt tension and adjust if necessary. See procedure earlier under "Generator Drive Belt Tension Adjustment."

2. Check generator mounting and adjusting arm bolts and tighten as necessary.

3. Check all electrical connections for tightness and corrosion. Clean and tighten connections as necessary. Be sure wiring insulation is in good condition, and that all wiring is securely clipped to prevent chafing the insulation.

4. With engine running, listen for noise and check generator for vibration. If generator is noisy or vibrates excessively, it should be removed for inspection and repair.

5. Check battery electrolyte level and specific gravity. Replenish electrolyte level, as necessary.

GENERATOR SPECIFICATIONS

Generator Model	(80 Amp.) 1101016	(80 Amp.) 1101015
Make	Delco-Remy	Delco-Remy
Series	27 SI	27 SI
Type	100	100
Rotation (Viewing Drive End)	Clockwise	Clockwise
Field Current at 80°F. (26.7°C.)		
Amps.	4.4-4.9	4.4-4.9
Volts	12	12
Cold Output		
Specified Volts	(a)	(a)
Amps.	76	76
Generator RPM (Approx.)	5000	5000
Rated Hot Output (Amps.) (b)	80	80

(a) Voltmeter not needed for cold output check. Load battery with a carbon pile to obtain maximum output.

(b) Rated hot output at maximum operating speed.

BREAKER POINT IGNITION SYSTEM

IMPORTANT: Identify ignition system before servicing. 1975 vehicles with 1974 certified engines are equipped with standard breaker point ignition system. 1975 and 1976 certified engines are equipped with high energy ignition systems. To determine year engine was certified, refer to decal on engine valve cover.

GENERAL DESCRIPTION

The ignition system used on the 1974 certified engine is the standard breaker point type consisting of a coil, condenser, distributor, switch, wiring, spark plugs and a source of electrical energy. The distributor contact points set, condenser, cam lubricator and spark plugs are the only system components that require periodic service. The remainder of the ignition system requires only periodic inspection to check the operation of the components, tightness of electrical connections, and condition of the wiring.

The distributor used is an external adjustment type and its function is to (1) cause a higher voltage surge from coil, (2) time these surges with regard to engine requirements through use of centrifugal and vacuum advance mechanisms, and (3) direct high voltage surges through distributor rotor, cap, and high tension wiring to the spark plugs.

The distributor houses the contact points that make and break the primary circuit, and also directs high voltage and current in proper sequence to the spark plugs. The contact point set is replaced as a complete assembly. The breaker lever spring tension and point alignment on the replacement set are factory adjusted, leaving only the dwell angle to be adjusted after installation.

The rotor located above the breaker plate assembly serves as a cover for the centrifugal advance mechanism, and distributes high voltage and current to fire the spark plugs. When the rotor is removed, the centrifugal advance mechanism should be inspected for lubricant. If necessary, a small amount of cam and bearing lubricant should be applied to the advance weights.

The ignition coil is an oil filled, hermetically sealed unit designed specifically for use with an external resistance. The number of turns in the primary winding results in a high inductance in this winding, which makes it possible for the coil to provide a higher secondary voltage output throughout the speed range. The primary current from the ignition switch passes through a resistance wire which lowers the voltage to approximately 8 volts. This lower voltage provides for longer contact life.

For optimum starting performance, the resistance is bypassed during cranking, thereby connecting the ignition coil directly to the battery. This provides full battery voltage at the coil and keeps ignition voltage as high as possible during cranking. The resistance is bypassed automatically through the ignition and starting switch when the switch is in the "Start" position.

The secondary ignition cables in the secondary or high tension system (coil to distributor and distributor to plugs) are resistant to grease, battery acid and road salt, and offers resistance to corona breakdown. Ignition cables have a multiple cloth thread core impregnated with a graphite solution to give the correct conductivity.

The spark plugs used are a resistor type plug. The plugs have a type number on the insulator which designates thread size as well as relative position of the plug in the heat range. The last digit of the type number indicates the heat range position of the plug. The higher the number the hotter the plug. Spark plugs should be replaced at least every 12 months or 12,000 miles depending on driving conditions with unleaded fuels or at 6 months or 6,000 miles with leaded fuels.

THEORY OF OPERATION

The basic ignition system consists of the ignition coil, condenser, ignition distributor, ignition switch, low and high tension wiring, spark plugs, and a source of electrical energy (battery or generator). The ignition system has the function of producing high voltage surges and directing them to the spark plugs in the engine cylinders. The sparks must be timed to appear at the plugs at the correct instant near the end of the compression stroke with relation to piston position. The spark ignites the fuel-air mixture under compression so that the power stroke follows in the engine.

There are two separate circuits through the ignition system. One of these is the primary circuit which includes the ignition switch, primary winding of the ignition coil, distributor contact points and condenser. The other is the secondary or high tension circuit which includes the secondary winding of the ignition coil, the high tension lead, distributor cap, rotor and spark plugs.

The basic operation is described as follows: With the switch closed, current flows through the primary circuit, that is from the battery through the primary winding of the ignition coil and closed distributor contacts to ground, and then back to the battery. A cam mounted on the rotating distributor shaft causes the distributor contacts to open and close. When the contacts open, the current decreases very rapidly in the ignition coil primary winding, and a high voltage is induced in the coil secondary winding.

This high voltage is impressed through the distributor cap and rotor across one of the spark plugs. As the voltage establishes an arc across the spark plug electrodes, the air-fuel mixture in the cylinder is ignited to provide the power stroke.

The secondary electrons flow from the coil secondary winding, across the distributor rotor gap and spark plug gap, and then back to the secondary winding through ground, the battery and switch. The distributor contacts then reclose, and the cycle repeats. The next-firing spark plug then will be the one connected to the distributor cap insert that is aligned with the rotor when the contacts separate. With the engine running, current flows through the coil primary calibrated resistance wire; the other lead connected between the coil and solenoid terminal is a by-pass feature that will be covered in the section entitled "Ignition Coils".

When the contacts separate, a high voltage is induced in the coil primary winding. This voltage may be as high as 250 volts, which causes an arc to form across the distributor contacts. To bring the primary current to a quick controlled stop, and in order to greatly reduce the size of the arc and thereby insure prolonged contact point life, a capacitor (condenser) is connected across the distributor contacts.

DISTRIBUTOR

The distributor has three jobs. First, it opens and closes the low tension circuit between the source of electrical energy and the ignition coil so that the primary winding is supplied with intermittent surges of current. Each surge of current builds up a magnetic field in the coil. The distributor then opens its circuit so that the magnetic field will collapse and cause the coil to produce a high voltage surge. The second job that the distributor has is to time these surges with regard to the engine requirements. This is accomplished by the centrifugal and vacuum advance mechanisms. Third, the distributor directs the high voltage surge through the distributor rotor, cap and high tension wiring to spark plug which is ready to fire.

The typical contact point type ignition distributor consists of a housing, shaft, centrifugal advance assembly, vacuum advance assembly, breaker plate assembly, capacitor or condenser, and rotor.

The cap, rotor, and high voltage leads in a distributor form a distribution system that conveys the high voltage surges to the spark plugs in correct sequence.

The breaker plate contains the breaker lever, contact support, and capacitor. When the breaker cam rotates, each cam lobe passes by and contacts the breaker lever rubbing block, separating the contact points and producing a high voltage surge in the ignition system. With every breaker cam revolution, one spark will be produced for each engine cylinder. Since each cylinder fires every other revolution in a four-cycle engine, the distributor rotates at one-half engine speed.

The shaft and weight base assembly is fitted in suitable bearings made of such materials as cast iron, bronze, or iron. Centrifugal advance weights are pivoted on studs in the weight base, and are free to move against calibrated weight springs which connect them to the breaker cam assembly. The breaker cam assembly fits on the top of the shaft (slip fit) and rotates with the shaft, being driven by the weight springs actuated by the advance weights.

Outward movement of the weights advances the cam assembly in relation to the shaft as engine speed is increased, providing an earlier spark.

It is possible to improve fuel economy on engines operating under part-throttle conditions by supplying additional spark advance. Vacuum advance mechanisms are provided on distriubtors for this purpose. The mechanism used rotates the breaker plate in order to time the spark earlier when the engine is operating at part throttle.

Centrifugal Advance

The centrifugal advance mechanism times the high voltage surge produced by the ignition coil so that it is delivered to the engine at the correct instant, as determined by engine speed.

When the engine is idling, the spark is timed to occur in the cylinder just before the piston reaches top dead center. At higher engine speeds, however, there is a shorter interval of time available for the fuel-air mixture to ignite, burn, and give up its power to the piston. Consequently, in order to obtain the maximum amount of power from the mixture, it is necessary at higher engine speeds for the ignition system to deliver the high voltage surge to the cylinder earlier in the cycle.

To illustrate this principle, assume that the burning time of a given gas mixture in an automotive engine is .003 of a second. To obtain full power from combustion, maximum pressure must be reached while the piston is between 10 degrees and 20 degrees past top dead center. At 1,000 engine rpm, the crankshaft travels through 18 degrees in .003 of a second, at 2,000 rpm, the crankshaft travels through 36 degrees. Since maximum pressure point is fixed, it is easy to see why the spark must be delivered into the cylinder earlier in the cycle in order to deliver full power, as engine speed increases.

As previously mentioned, the timing of the spark to engine speed is accomplished by the centrifugal advance mechanism, which is assembled on the distributor shaft. The mechanism, consists primarily of two weights and a cam assembly. The weights throw out against spring tension as engine speed increases. This motion of the weights turns the cam assembly so that the breaker cam is rotated in the direction of shaft rotation to advanced position with respect to the distributor drive shaft. The higher the engine speed, the more the weights throw out and the further the breaker cam is advanced.

The centrifugal advance required varies considerably between various engine models. In order to determine the advance for a given engine, the engine is operated on a dynamometer at various speeds with a wide-open throttle. Spark advance is varied at each speed until the range of advance that gives maximum power is found. The cam assembly, weights and springs are then selected to give this advance. Timing, consequently, varies from no advance at idle to full advance at high engine speed where the weights reach the outer limits of their travel.

Vacuum Advance

Under part-throttle operation a high vacuum develops in the intake manifold and a smaller amount of air and gasoline enters the cylinder. Under these conditions, additional spark advance (over and above advance provided by the centrifugal advance mechanism) will increase fuel economy. In order to realize maximum power, ignition must take place still earlier in the cycle.

To provide a spark advance based on intake manifold vacuum conditions, many distributors are equipped with a vacuum advance mechanism. The mechanism has a spring-loaded diaphragm connected by linkage to the distributor. The spring-loaded side of the diaphragm is air-tight, and is connected in many cases by a vacuum passage to an opening in the carburetor. This opening is on the atmospheric side of the throttle when the throttle is in the idling position. In this position, there is no vacuum in the passage.

When the throttle is partly opened, it swings past the opening of the vacuum passage. Intake manifold vacuum then can draw air from the air-tight chamber in the vacuum advance mechanism and this causes the diaphragm to be moved against the spring. This motion is transmitted by linkage to the distributor breaker assembly rotation is governed by the amount of vacuum in the intake manifold up to the limit imposed by the design of the vacuum advance mechanism.

When the distributor breaker plate assembly is rotated, the contact points are carried around the breaker cam to an advanced position, so that the breaker cam contacts the rubbing block and closes and opens the points earlier in the cycle. This provides a spark advance based on the amount of vacuum in the intake manifold. Thus, for varying compressions in the cylinder the spark advance will vary, permitting greater economy of engine operation. It should be recognized that the additional advance provided by vacuum control is effective in providing additional economy only on PART-THROTTLE operation.

At any particular engine speed there will be a certain definite advance resulting from operation of the centrifugal advance mechanism, plus a possible additional advance resulting from operation of the vacuum advance mechanism. For example, an initial timing advance of 5 degrees, plus a centrifugal advance of 10 degrees, makes a total of 15 degrees advance at 40 miles an hour. If the throttle is only partly opened, an additional vacuum advance of up to 15 degrees more may be obtained, making a total of 30 degrees. When the throttle is wide open there is no appreciable vacuum in the intake manifold, so this additional advance will not be obtained. All advance then is based on engine speed alone and is supplied by the centrifugal advance mechanism.

The vacuum advance mechanism is an economy device which will increase fuel economy when properly used. The driver who drives with wide-open throttle whether in low or high gear will not obtain this additional advance with its resulting increased fuel economy.

Cam Angle

The cam angle, often referred to as contact angle or dwell angle, is the number of degrees of cam rotation during which the distributor contact points remain closed. It is during this period of cam rotation that the current in the primary winding increases. Although the cam angle may not change, the length of time the contacts remain closed becomes less and less as the engine speed increases. At higher engine speeds, the ignition coil primary current does not reach its maximum value in the short length of time the contacts are closed. In order to store the maximum amount of energy obtainable or the coil, and consequently obtain sufficient energy to fire the plug, it is necessary to design a breaker lever assembly that will operate properly at high speeds. The distributor is equipped with a special-high rate-of-break cam and a special high speed breaker lever which is capable of following the cam shape at high speeds without bouncing. The high rate-of-break cam separates the contact points faster for each degree of rotation and permits closing earlier, thus increasing cam angle. With the special cam and breaker lever combination, it is possible to obtain the maximum cam angle and consequently optimum ignition performance at high speeds.

The point opening is the maximum distance that occurs between the separated contacts as the cam rotates. If the cam angle is properly set, the point opening most likely will also be according to specifications. In some cases, it may be necessary to measure point opening in addition to cam angle to insure that the contacts are properly set. A feeler gauge on new contacts, or a dial indicator on used contacts may be used to measure point opening.

Ignition Condenser (Capacitor)

The capacitor consists of a roll of two layers of thin metal foil separated by a thin sheet or sheets of insulating material. This assembly is sealed in a metal can with a flat spring washer providing a tight seal.

The high voltage induced in the coil primary causes the capacitor plates to charge when the contacts first separate; the capacitor acts initially like a short circuit and current flows into the capacitor to minimize arching at the contacts.

IGNITION COIL

An ignition coil is a pulse transformer that steps up the low voltage from the battery or generator to a voltage high enough to ionize the spark plug gap and ignite the air-fuel mixture in the cylinder. A typical coil is made up of a primary winding, consisting of a few hundred turns of relatively large wire, and a secondary winding, consisting of many thousand turns of a very small wire. These windings are assembled over a soft iron core and are enclosed by a soft iron shell. This assembly is inserted into a one-piece, steel or diecast aluminum coil case, which is filled with oil and hermetically sealed by a coil cap made of molded insulating material. The cap contains the primary and secondary high voltage terminals.

The ignition coils are hermetically sealed to prevent the entrance of moisture, which would cause coil failure. During manufacture, the coil case also is filled with oil at a high temperature. As the oil temperature decreases to more nearly match the temperature of the surrounding air, the oil contracts to occupy less volume thus allowing room for expansion when the coil heats up during normal operation. The oil acts as an insulator to prevent high voltage arc-over within the coil.

In the design of an ignition system, sufficient primary circuit resistance must be present to protect the distribution contacts from excessive arcing and burning. In some ignition systems, part of this resistance may take the form of a separate resistor or a calibrated resistance wire connected between the ignition switch and the coil primary terminal. Since the value of this resistor along with the resistances of the other components in the entire primary circuit affects the coil performance at higher engine speeds.

During cranking, the external resistance on most applications is by-passed to provide full battery voltage to the coil for improved performance and easier starting. The by-pass wire may be connected to an "R" terminal on the cranking motor solenoid which contacts the contact disk during cranking, or to a separate terminal on the ignition switch, as shown in the previous section. The higher currents during cranking are not sufficient to cause distributor contact deterioration because of the short periods of time in the life of contacts spent during cranking. Also, the lowered battery voltage during cranking causes a lower primary current, so the resistor by-pass feature is an offsetting factor. By-passing the resistor with the engine operating will cause very rapid failure of the distributor contacts.

SPARK PLUGS

The spark plug consists of a metal shell in which is fastened a porcelain insulator and an electrode extending through the center of the insulator. The metal shell has a short electrode attached to one side and bent in toward the center electrode. There are threads on the metal shell that allow it to be screwed into a tapped hole in the cylinder head. The two electrodes are of special heavy wire, and there is a specified gap between them. The electric spark jumps this gap to ignite the air-fuel mixture in the combustion chamber, passing from the center, or insulated, electrode. The seals between the metal base, porcelain, and center electrode as well as the porcelain itself, must be able to withstand the high pressure and temperature created in the combustion chamber during the power stroke.

Some spark plugs have been supplied with a built-in resistor which forms part of the center electrode. The purpose of this resistor is to reduce radio and television interference from the ignition system as well as to reduce spark-plug-electrode erosion caused by excessively long sparking. We have been talking of the high-voltage surge from the ignition-coil secondary as though it were a single powerful surge that almost instantly caused the spark to jump across the spark plug gap. Acutally, the action is more complex than that. There may be a whole series of preliminary surges before a full-fledged spark forms. At the end of the sparking cycle the spark may be quenched and may reform several times. All this takes place in only a few ten-thousandths of a second. The effect is that the ignition wiring acts like a radio transmitting antenna; the surges of high voltage send out impulses that causes radio and television interference. However, the resistors in the spark plugs tend to concentrate the surges in each sparking cycle, reduce their number, and thus reduce the interference and also the erosive effect on the plug electrodes.

Heat Range System

The "heat range" of a spark plug is determined primarily by the length of the lower insulator. The longer this is, the hotter the plug will operate; the shorter it is, the cooler the plug will operate.

Spark plugs, to give good performance in a particular engine, must operate within a certain temperature range (neither too hot or too cool). If the spark plug remains too cool: oil, soot, and carbon compounds will deposit on the insulator causing fouling and missing. If the plug runs too hot, electrodes will wear rapidly, and under extreme conditions, premature ignition (pre-ignition) of the fuel mixture may result.

Frequently, the wrong type of spark plugs, one with an improper heat range for the engine, may have been installed when replacing spark plugs originally fitted by the engine manufacturer and such misapplication may lead to poor performance. The heat range system makes it possible to select the type of spark plug that will operate within the correct temperature range for each specific engine.

Where abnormal operating conditions cause chronic carbon or oil fouling of the plugs, the use of a type one number higher (a "hotter" type) than recommended will generally remedy the trouble; and by the same formula, where chronic pre-ignition or rapid electrode wear is experienced, a type with one number lower (a "cooler" type) will generally be found satisfactory.

The last digit of the type number indicates the heat range position of the plug in the heat range system. Read the numbers as you would a thermometer—the higher the last digit, the "hotter" the spark plug will operate in the engine; the lower the last digit, the "cooler" the spark plug will operate.

Spark Plug Reach and Threads

Spark plugs are manufactured in a number of thread sizes and "reaches." Reach is the distance from the gasket seat to the end of the shell. Spark Plugs have a type number on the insulator which designates plug thread size as well as the relative position in the heat range system as previously explained.

SECONDARY IGNITION CABLES (FIGURE 32)

The secondary wiring consists of the high tension cables connected between the distributor cap, the spark plugs, and the high tension terminal of the ignition coil. These cables carry the high voltage surges to the spark plugs and are heavily insulated to contain the high voltages. The cables are neoprene jacketed and have a multiple cloth thread core impregnated with a graphite solution to give the correct conductivity and proper resistance for suppression of radio and television interference.

IGNITION SWITCH

The electrical switching portion of the assembly is separate from the key and lock cylinder. However, both are synchronized and work in conjunction with each other through the action of the actuator rod assembly. For a complete explanation of the key and lock cylinder, and the actuator rod assembly, refer to the Steering section of this manual.

The ignition switch is key operated through the actuator rod assembly to close the ignition primary circuit and to energize the starting motor solenoid for cranking. The ignition switch has five positions: OFF, LOCK, ACCESSORY, RUN and START. OFF is the center position of the key-lock cylinder, and LOCK is the next position to the left. ACCESSORY is located one more detent to the left of LOCK. Turning the key to the right of the OFF position until spring pressure is felt will put the ignition switch in the RUN position, and when turned fully to the right against spring pressure, the switch will be in the START position.

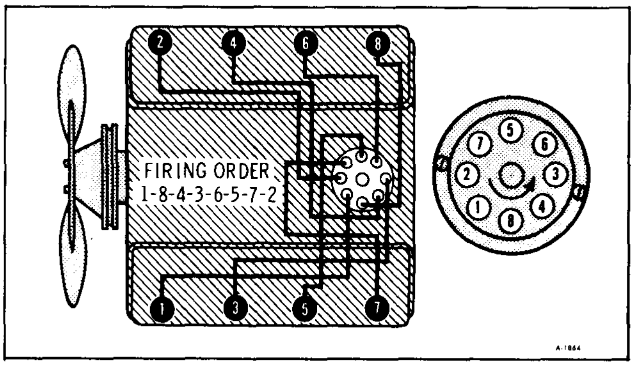


Figure 32—Secondary Wiring

In the RUN position, the ignition primary circuit is activated through a resistance wire. The ignition resistor wire is used in the ignition running circuit to reduce the voltage to the ignition coil. The resistor wire is bypassed when the engine is being started. The purpose of this is to compensate for the drop in voltage which occurs as the result of the heavy drain on the battery during starting, and to provide a hotter spark for starting.

All ignition switches have five terminals which are connected in different combinations for each of the three operating positions. A brass plate, inside the switch, has three contacts which connect these terminals, shows the positions of the contacts in all positions as viewed from the key side of the switch. There is also a ground pin in the switch which contacts the "ground" terminal when the ignition switch is in the START position. This pin contacts the IGN. terminal when in the OFF position.

Ignition Start and Run Circuit

The ignition switch is fed from a junction at the horn relay to the BAT. terminal of the switch. When the ignition switch is in the OFF position, no current flows through the switch. When the ignition switch is turned to the ACC. position, the BAT. terminal is connected to the ACC. terminal. This permits operation of accessories when the engine is not running.

When the ignition switch is turned to the START position, the BAT. terminal is connected to the SOL. and IGN. terminals. When the clutch or automatic transmission neutral start switches are closed, current flows to the starter solenoid. This energizes the solenoid windings. The solenoid has two sets of windings: a "pull-in" winding and a "hold-in" winding. Both windings are used to create the magnetic field to actuate the solenoid plunger and move the starter pinion into engagement with the flywheel. As the solenoid plunger reaches the end of its travel, it closes a switch which connects battery voltage to the starter motor. With battery voltage applied to both terminals of the "pull-in" windings, the "pull-in" winding is no longer energized, so that only the "hold-in" winding keeps the starter solenoid engaged.

During cranking, current is directed from the battery through the brass disc in the starter solenoid housing to the "B" terminal on the solenoid and then to the ignition coil, bypassing the ignition resistor wire.

NOTE: The instrument panel warning lights are fed from the ignition terminal of the ignition switch and have battery voltage applied to them when the ignition switch is in the START and RUN position. These circuits are explained in Chassis Electrical, Section 12.

When the ignition switch is released from the START to the RUN position, the IGN. terminal is still connected to the BAT. terminal, but the solenoid is no longer energized and so the feed for the coil from the IGN. terminal on the ignition switch, through the ignition resistor wire and to the coil, dropping the battery voltage at the coil to approximately nine volts. With the ignition switch in the RUN position, the BAT. terminal is connected to the IGN. terminal and the ACC. terminal. This permits operation of all accessories and the ignition system.

TROUBLE DIAGNOSIS

IGNITION SYSTEM

A. Engine Will Not Start But Cranks O.K.

1. Disconnect a spark plug wire and hold 1/4" away from the engine block, then crank engine.

a. If strong spark is seen, check timing. Adjust as necessary. If timing is correct, trouble is not in ignition system.

b. If no spark or an intermittent spark is seen, reconnect plug wire and proceed to step 2.

2. Disconnect distributor cap-to-coil lead from coil and place screwdriver blade across coil tower to engine block and crank engine.

a. If strong spark is seen between coil tower and metal bar, check distributor cap and rotor for cracks or carbon tracking. Check lead between distributor and coil for broken or burned terminals or cracks in insulation. Replace defective parts.

b. If no spark or intermittent spark is seen, proceed to step 3.

3. Connect jumper wire from battery plus (+) terminal to coil plus (+) terminal. Place a screwdriver blade across coil tower to engine block and crank engine.

a. If strong spark is seen, remove jumper wire and check wiring connections and switches between battery plus (+) terminal and coil (+) terminal. Opens, high resistance or intermittent contact will require repair or replacement.

b. If no spark or intermittent spark is seen, remove jumper wire and proceed to step 4.

4. Disconnect distributor lead from coil minus (—) terminal and connect test light from coil minus (—) terminal to engine block. Turn ignition switch to crank position.

a. If lamp does not light, replace coil.

b. If lamp lights proceed to step 5.

5. Connect test light from battery plus (+) terminal to distributor lead which is still detached from the coil. If necessary, rotate distributor until points close.

a. If lamp lights, check condenser and points. Replace defective parts.

b. If lamp does not light, proceed to step 6.

6. Connect test lamp from battery plus (+) terminal to connection of distributor lead and contact points. Make sure points are closed.

a. If lamp lights, replace distributor lead to coil.

b. If lamp does not light, proceed to step 7.

7. Connect test lamp from battery plus (+) terminal to screw holding points in place.

a. If lamp lights, replace points and check capacitor.

b. If lamp does not light, breaker plate or distributor is not grounded. Check plate-to-distributor ground wire or distributor-to-engine block connector.

B. Engine Starts But Will Not Continue to Run

1. Connect jumper wire from battery plus (+) terminal to ignition coil plus (+) terminal and start engine.

a. If engine does not continue to run, problem is not ignition.

b. If engine runs, proceed to step 2.

2. Remove jumper and disconnect leads from battery plus (+) terminal and coil (+) terminal. Connect ohmmeter and measure resistance between the ends of the leads just detached. Ignition switch should be in the run position.

a. If resistance exceeds 2.5 ohms, check wires and connections for loose or intermittent contact. Check by-pass resistor and ignition switch for opens.

b. If resistance is 1.0 to 2.5 ohms, check the output of the ignition coil.

c. If resistance is less than 1.0 ohm, replace shorted by-pass resistor and replace contact points.

C. Engine Runs Rough, Poor Power or Gas Mileage

1. Check all tune-up specifications (timing, dwell, carburetion, fouled plugs, etc.) If settings are improper, correct as required.

2. If settings are O.K. check both centrifugal and vacuum advance of distributor and correct with replacement parts, if necessary.

3. If distributor advance mechanisms are within specifications, check coil available voltage and plug required voltage.

a. High requirements or low availability of voltage will require a replacement of parts.

b. If coil and plugs are O.K., the problem is not in the ignition system.

IGNITION COIL TEST

A. Weak Coils

Most ignition coils that are replaced are classified as weak. Many coils rejected as weak actually test up to specifications and give normal performance. A coil that actually is weak will first effect engine performance when the ignition reserve is at a minimum. This may be in starting, low speed acceleration or top speed. Eventually the engine will fail to start.

High resistance connections in either the primary or secondary circuit wiring will react the same as a weak coil. Wide spark plug gaps, which require higher voltage than the coil can produce, put the coil under suspicion. High compression and lean carburetor increase the voltage requirements and lead to many needless coil changes. Leakage of high tension current through moisture on an unprotected coil terminal may produce carbon tracks which weaken the coil output voltage. For this reason the nipple on coil high tension terminal must be properly installed and in good condition.

When an ignition coil is suspected of being defective it should be tested as described below before being replaced.

B. Testing Coil for Open and Grounded Circuits

Before using a coil test instrument, the coil should be tested for open and grounded circuits, using a 110-volt test lamp and test points.

1. Apply test points to both primary terminals of coil. If test lamp does not light, the primary circuit is open.

2. Apply one test point to the high tension terminal, and the other test point to one of the primary terminals. If secondary circuit is not open, the lamp will not light but tiny sparks will appear at test points when they are rubbed over terminals. If secondary circuit is open, no sparks will occur.

3. Apply one test point to a clean spot on the metal coil case and touch the other point to the primary and high tension terminals. If the lamp lights, or tiny sparks appear at the points of contact, the coil windings are grounded.

4. A coil with open or grounded windings must be replaced since internal repairs cannot be made. It is unnecessary to test such a coil with instruments. If windings are not open or grounded, a test for short circuits and other internal defects should be made with a reliable coil test instrument.

C. Coil Test Instruments

Two general type of instruments are used in testing ignition coils. One type makes use of an open or protected spark gap, while the other reports the condition of the coil on a meter.

The spark gap type of tester should always be used comparatively, that is, the questionable coil should be compared with a coil of same model that is known to be good. Both coils must be at the same temperature and identical test leads must be used.

Certain variables caused by altitude, atmosphere or spark gap electrode conditions are usually present in the spark gap type of test.

The meter type testers are usually designed to permit testing the coil without making any connection to the secondary terminal. This eliminates the variables usually present in the spark type of test and avoids the necessity for comparison with a good coil.

Some different makes and models of coil testers differ in their methods of use, as well as in the markings on meters, the instructions of the manufacturer must be carefully followed when using any coil tester. The instrument must be frequently checked to make certain that it is accurately calibrated.

Regardless of instrument or method used, the coil must be tested at normal operating temperature because internal defects often fail to show up on a cold test.

DISTRIBUTOR CONDENSER TEST

When a condenser is suspected of being faulty it should be tested with a reliable condenser tester to determine whether it is actually the cause of ignition trouble. The condenser should be tested for (a) high series resistance (b) insufficient or excessive capacity (c) low insulation resistance.

A special condenser tester is required to make these tests. When using a condenser tester the instructions of the manufacturer must be carefully followed.

> **NOTE:** The condenser must be at normal operating temperature when it is being tested.

A. High Series Resistance

High series resistance in the condenser causes the condenser to be slow in taking the charge and, consequently, a higher than normal voltage is developed across the contact points when they first start to open. The higher voltage causes more disturbance at the contact points, which in turn causes more rapid wear and more tendency toward oxidized surfaces. The condition can become severe enough to cause complete failure of the ignition system. It would first show up during starting and low speed operation.

High series resistance may be caused by internal resistance in condenser or by resistance in the connections. Any defect caused by internal resistance should show up at low mileage since this does not change very much with time or use. The damaging changes are in the connections, in which looseness, corrosion, or broken strands may develop.

New condensers may have a series resistance as low as .05 ohm. Some condenser testers are set to reject condensers which have a resistance of .3 ohm; however, test show that the resistance can go to .5 ohm before ignition performance is affected.

B. Insufficient or Excessive Capacity

The condenser specified for use in the ignition system has a capacity of .18 to .23 microfarads.

If a condenser is used which does not have the specified capacity of .18 to .23 microfarads, excessive pitting of one contact point and a corresponding buildup of metal on the other contact point will result. A condenser having insufficient capacity will cause build-up of metal on the breaker arm (positive) point. A condenser having excessive capacity will cause build-up of metal on the contact support (negative) point.

In exceptional cases, pitting and metal buildup on contact points may be experienced even when condenser capacity is within the specified limits. In such cases the life of contact points will be improved by installing a condenser of high-limit capacity if metal build-up is on breaker arm point, or a condenser of low-limit capacity if metal build-up is on contact support point. There is usually sufficient variation in the capacities of stock condensers to permit selection of a high or low limit condenser by testing the available stock.

C. Low Insulation Resistance

A weak or leaking condenser is usually one that has absorbed water so that the insulation resistance of the winding is lowered to the extent that the condenser will not hold a charge satisfactorily. A condenser with low insulation resistance will drain sufficient energy from the ignition system to lower the secondary voltage seriously. The condenser specified for use in the ignition system is sealed to prevent absorption of water, and no other type should be used.

A leaky condenser usually does not affect engine performance except when hot. It is unlikely that a condenser with low insulation resistance would cause missing at low or medium speeds under conditions where the condenser does not get hot. A condenser that has low enough resistance to affect engine performance when cold would probably be indicated as broken down on most condenser testers.

Condenser testers equipped to check condensers for low insulation resistance usually give a reading megohms, a megohm being one million ohms. The scale is marked to indicate whether the condenser is good or bad.

When testing a condenser for low insulation resistance the lead should always be disconnected from the distributor. Since the distributor terminals and the connected circuit have much lower insulation resistance than the condenser, failure to disconnect the condenser lead will give a reading much too low.

IGNITION SYSTEM RESISTANCE TEST

Check for proper functioning of the resistance in the primary ignition circuit by turning on the ignition. With the engine not running, a voltmeter connected from the battery side of the coil to ground should read approximately 5 to 5.5 volts. If the reading is a full 12 volts, the ignition points may be open; "bump" the starter a few times until the engine comes to rest with the ignition points closed and again check for a 5.5 volt reading. A reading of 12 volts or over for all engine positions would indicate that the shorting switch is making contact all the time; this condition must be corrected immediately or ignition point life will be very short.

Check for proper closing of the shorting switch and also for proper functioning of the complete starting circuit by grounding the secondary coil wire so the engine won't start. With the engine cranking, a voltmeter connected from the battery side of the coil to ground should read at least 9 volts. A reading of under 5 volts would indicate that the shorting switch is not closing; this condition would result in hard cold starting.

Briefly, the advantages of our resistance with shorting switch system are: it sends full battery voltage to the coil for good cold weather starting, and it cuts down the voltage to the coil with the engine running for long ignition point life.

NOTE: Discourage any attempts to measure voltage at the coil with the engine running; because of variations in current flow at high speeds and in regulated voltage, this check would be meaningless. Voltage readings on a perfectly-functioning ignition system may go over 11 volts.

SPARK PLUGS

Under normal operating conditions, spark plugs wear out due to the destructive action, under intense heat, of sulphur and lead compounds in the fuel and the bombardment of the electric spark on the electrodes.

The same type of spark plug used in two different engines of the same make and model may frequently show wide variation in appearance. The cause of such differences lies in the condition of the engine, its piston rings, carburetor setting, kind of fuel used, and under what conditions the engine is operated, namely, sustained high speeds or heavy loads; or continual low speed, stop-and-go driving or light loads.

Spark Plugs are frequently blamed for faulty engine operation which they do not cause. Replacement of old spark plugs by new may temporarily improve poor engine performance because of the lessened demand new plugs make on the ignition system. This cannot permanently cure poor engine performance caused by worn rings or cylinders, weak coil, worn contact points, faulty carburetion or other engine ills.

IGNITION TIMING

The ignition timing marks are located on the engine front cover. A saw slot on the balancer indicates engine top dead center. (figure 33)

To adjust ignition timing, proceed as follows:

1. Remove air cleaner and plug manifold vacuum fitting.

2. Disconnect vacuum hoses at carburetor and plug fittings.

3. Connect tachometer and adjust engine speed to 1100 rpm with transmission in neutral.

4. With the use of a timing light, set timing to 8°BTDC by loosening the distributor clamp bolt and rotating the distributor until the specification is obtained.

NOTE: The indicator has four "V" slots, each representing 4°.

5. Tighten the distributor clamp bolt and recheck timing to make sure distributor was not moved during tightening of bolt.

NOTE: If a tuned engine detonates with this setting, the cause is low octane fuel or excessive carbon build-up in the combustion chamber. If

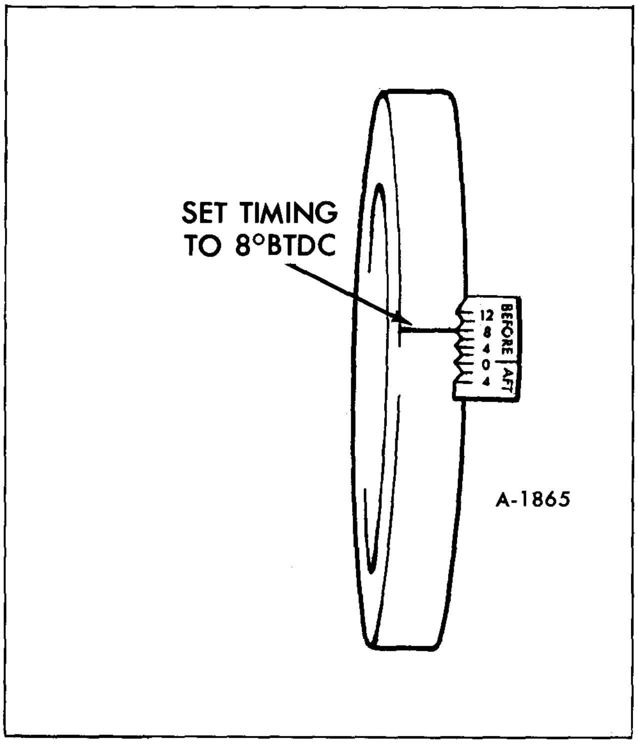


Figure 33—Engine Ignition Timing

these factors are not corrected, the timing should be retarded 2 degrees from the specified setting.

6. Remove plug from fittings and connect hoses to carburetor. Remove tape from manifold fitting and connect vacuum hose, install air cleaner.

DISTRIBUTOR (FIGURE 34)

DESCRIPTION

The distributor cap has a window for adjusting point opening (dwell angle) while the cap is mounted and the engine is running. The contact point set is replaced as one complete assembly. The service replacement contact set has the BREAKER LEVER SPRING TENSION AND POINT ALIGNMENT pre-adjusted. Only the POINT OPENING requires adjusting after replacement.

Under part throttle operation when the transmission is in high gear, intake manifold vacuum actuates the vacuum control diaphragm, thus advancing the spark and increasing fuel economy. During fast acceleration or when the engine is pulling heavily, vacuum is not sufficient to actuate the diaphragm; therefore, the movable breaker plate is held so that the ignition timing is retarded.

The centrifugal advance mechanism consists of a cam actuated by two centrifugal weights controlled by springs. As the speed of the distributor shaft increases with engine speed, centrifugal advance weights move outward which advances the cam, causing the contact points to open earlier, thus advancing the spark.

CONTACT POINT REMOVAL

1. Remove distributor cap and rotor. (figure 35)

2. Remove two piece metal shield attaching screws and shields. Figure 36.

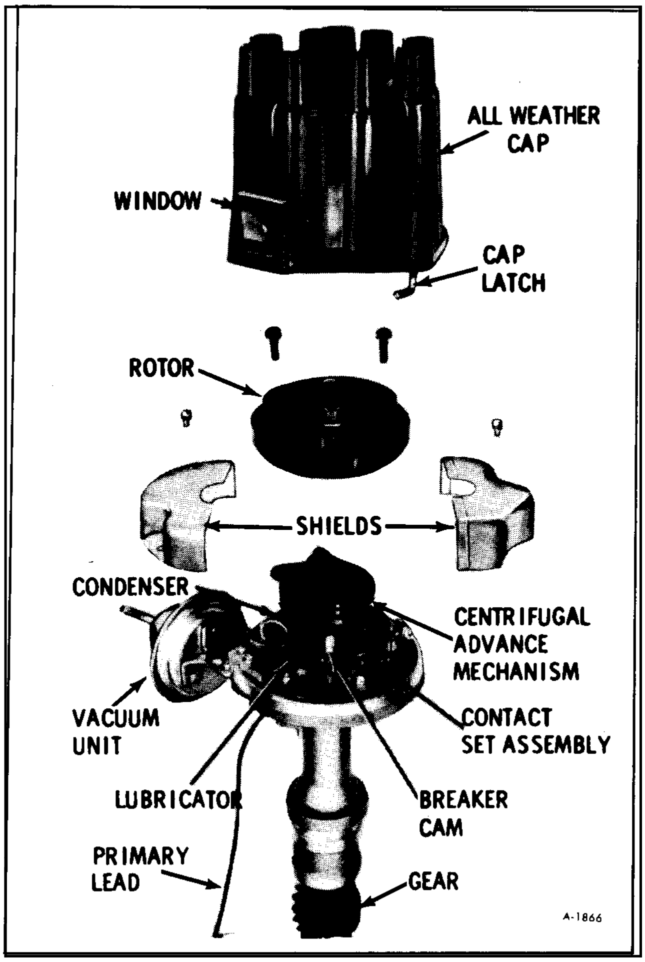


Figure 34—Distributor Components

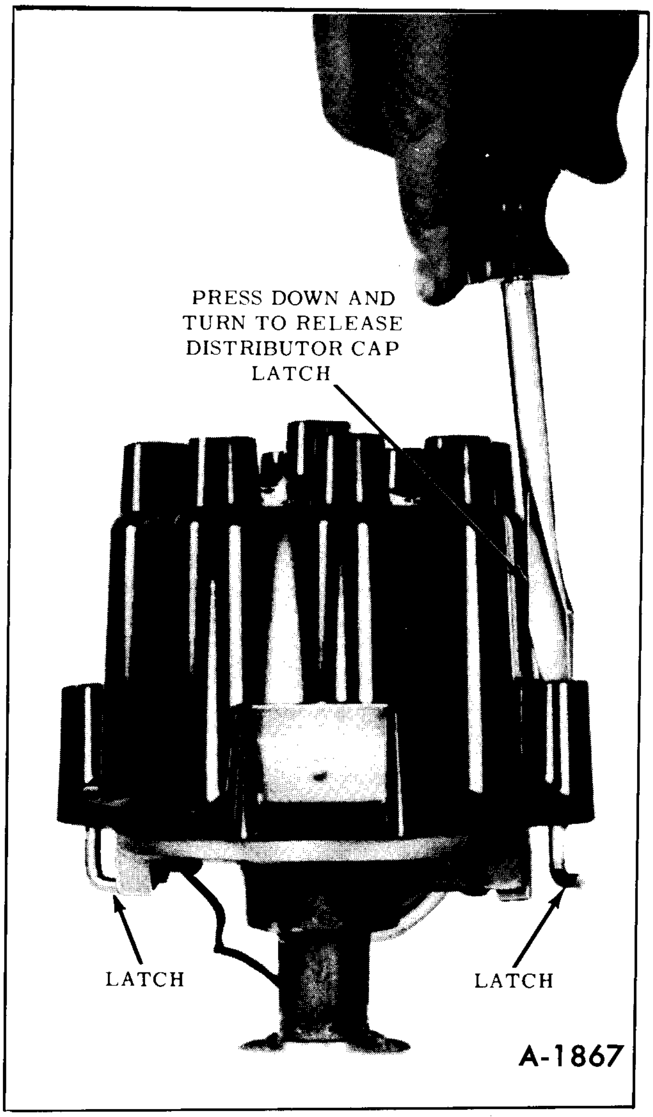


Figure 35—Removing Distributor Cap

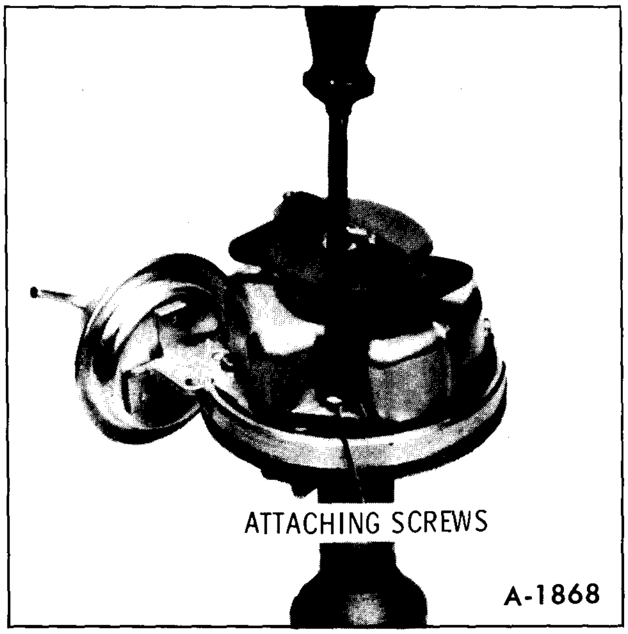


Figure 36—Removing Point Shield

3. Lift the two wiring terminals out of the snap-lock retainer, Figure 37, and remove the two screws and contact points.

ADJUSTING DWELL ANGLE

1. Remove the distributor cap, rotor, and shields. Inspect contact points; clean if necessary. Check cam lubricator for sufficient lubricant, if necessary apply a thin film of lubcitant No. 1948792 or equivalent to the breaker cam. Install shields, rotor and cap.

2. Connect a dwell meter to the distributor primary distributor negative lead terminal on the coil and ground.

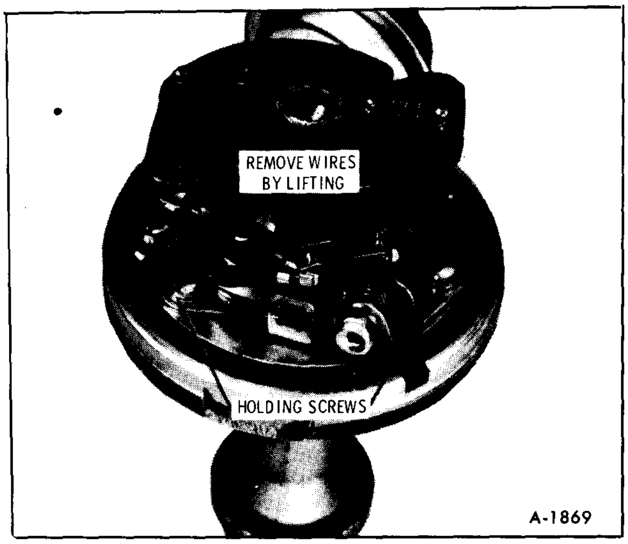


Figure 37—Removing Contact Points

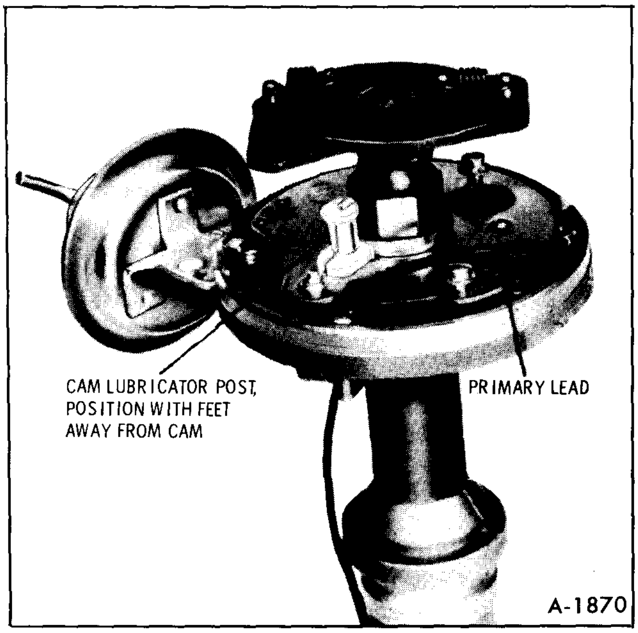


Figure 38—Cam Lubrication

3. Raise window on side of distributor cap.

4. With the engine running at idle speed, insert

CONTACT POINT INSTALLATION

NOTE: The two-piece shield suppresses radio interference and must be installed and screws tightened securely. Snap-lock (push in) terminal contact points have sufficient clearance between the shield and wire terminals to prevent accidental short circuiting. Screw terminal contact point sets may not have sufficient clearance. Wire terminals must be firmly pushed in and bent slightly toward cam to prevent them from touching the shield.

1. Install contact points on breaker plate.

2. Install primary and condenser wire terminals in snap-lock terminals. Seat them firmly and bend them slightly toward cam. Position wires to prevent interference with weights, rotor or distributor cap.

3. The cam lubricator is mounted on breaker plate with feet away from cam. Figure 38. Apply a thin film of lubricant 1948792 or equivalent to cam, not the wick.

4. Place one-half of shield over contact points, Figure 39, align screw hole, install and firmly tighten screw. Make sure wire terminals are not touching shield.

5. Install other half of shield, align screw hole, install and firmly tighten screw.

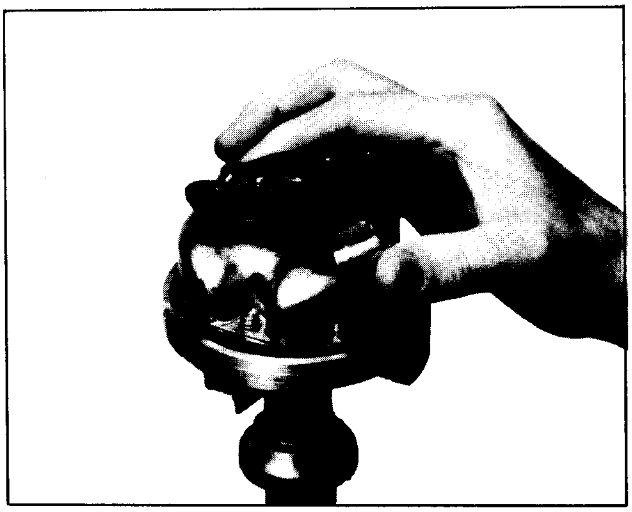


Figure 39—Installing Point Shield

6. Install rotor, Figure 40.

7. Install distributor cap.
1/8" Allen wrench into the head of the adjusting screw as shown in Figure 41 and adjust dwell angle to 30 degrees.

NOTE: If the dwell angle reading is erratic, check the contact points and condenser.

The dwell angle variation should not exceed 3 degrees at engine speeds between idle and 1750 rpm. Excessive variation indicates distributor wear.

Figure 40—Installing Rotor

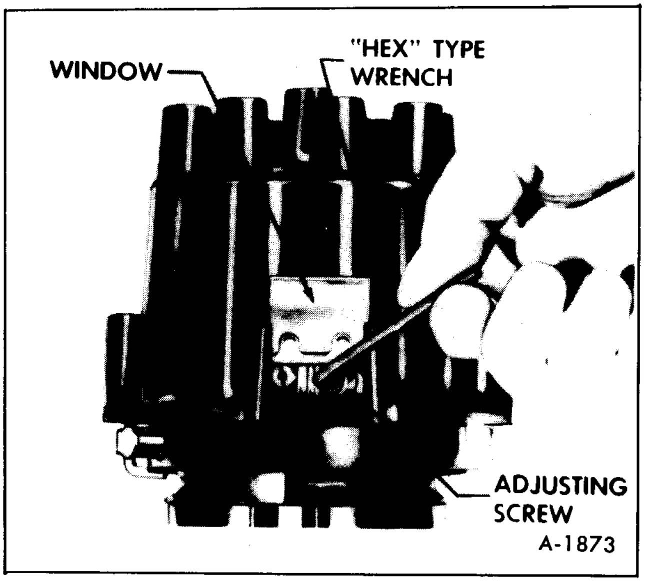


Figure 41—Adjusting Dwell Angle

MECHANICAL ADVANCE

The mechanical advance weights and springs are accessible by removing the rotor. The mechanical advance plate is assembled to the breaker cam. In order to remove the breaker cam and advance plate, follow the procedure for DISTRIBUTOR—DISASSEMBLY and ASSEMBLY.

VACUUM ADVANCE UNIT

Removal

1. Remove the distributor cap, shield and the two vacuum advance attaching screws. (figure 42)

2. Turn the breaker plate clockwise and push the rod end of the vacuum advance down so that it will disengage and clear the breaker plate. Remove vacuum advance unit.

Installation

1. Position the rubber sleeve over the rod end of the vacuum advance.

2. Insert the rod end of the unit between the housing and the breaker plate.

3. Turn the breaker plate clockwise so that the rod end can be inserted into the hole in the breaker plate.

4. Install the attaching screws with the ground lead terminal under the inner mounting screw. (figure 42) Install the shield and distributor cap.

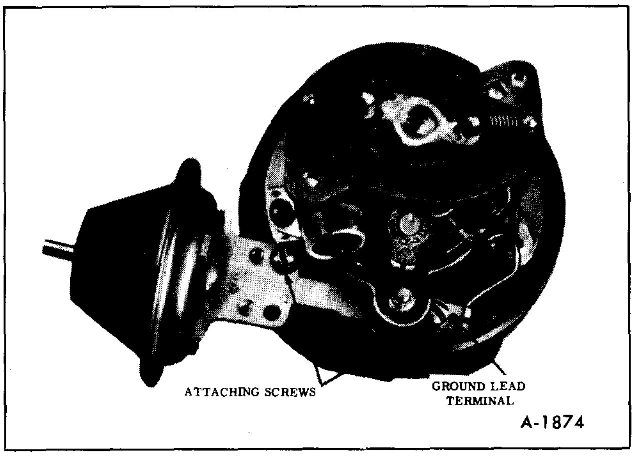


Figure 42—Vacuum Advance Unit

DISTRIBUTOR REMOVAL

1. Disconnect the distributor wire from coil.

2. Remove distributor cap as shown in Figure 35.

NOTE: If necessary to remove secondary wires from cap, note position on cap tower for lead to No. 1 cylinder. This will aid in installation of leads. (figure 32)

3. Remove vacuum hose line from vacuum advance unit.

4. Remove distributor clamp screw and hold-down clamp.

5. Note position of rotor, then pull distributor up until rotor just stops turning counterclockwise and again note position of rotor.

NOTE: To insure correct timing of the distributor, the distributor must be INSTALLED with the rotor correctly positioned as noted in Step 5.

If the engine has been turned after the distributor was removed, it will be necessary to install a jumper wire and crank engine until the timing mark on the harmonic balancer indexes with the 0 degree timing mark on the engine front cover. If both valves of the No. 1 cylinder are closed, the piston will be on top dead center in either the firing or exhaust stroke. Install distributor so that the rotor is pointing to No. 1 spark plug terminal in the cap when the distributor is fully seated. Install clamp and bolt, start engine. If engine fails to start or runs uneven, distributor is 180 degrees out of time. Lift up distributor, turn rotor one half revolution and install distributor.

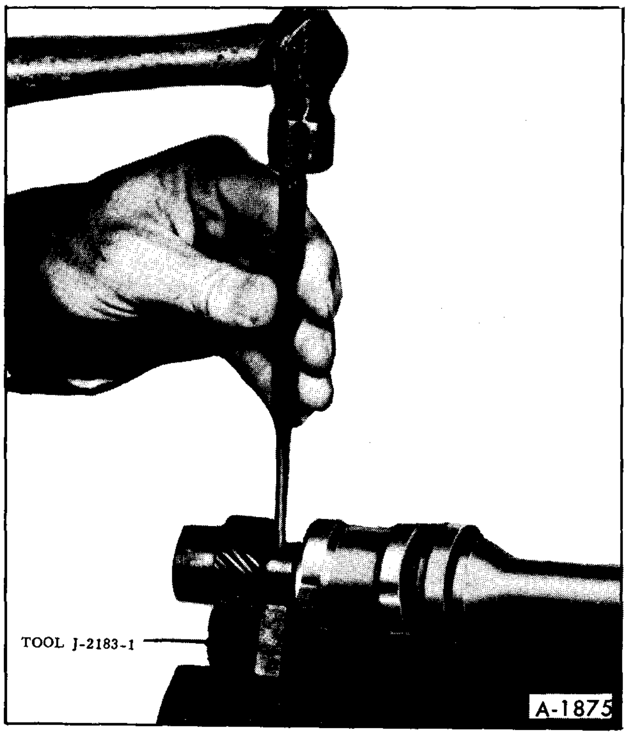


Figure 43—Removing Roll Pin

DISTRIBUTOR DISASSEMBLY

1. Mark distributor shaft and gear so that they may be reassembled in the same position.

2. Drive out the roll pin. (figure 43)

3. Pull the distributor assembly from the gear and pull the distributor shaft and breaker cam from the housing.

4. Remove the retaining ring from the upper bushing and lift the breaker plate and felt wick from the bushing. (figure 44)

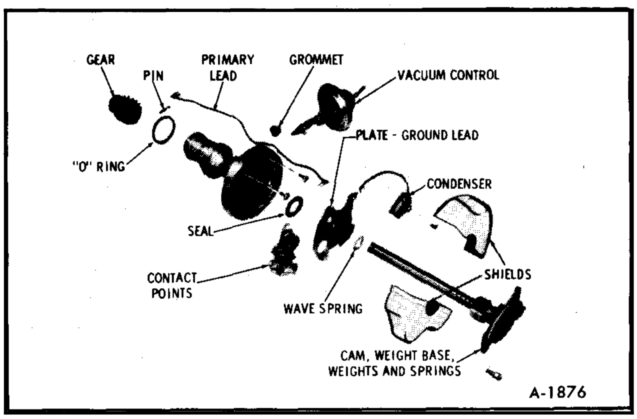


Figure 44—Distributor Disassembled

5. Remove the two retaining screws and the vacuum advance unit.

CLEANING AND INSPECTION

1. Wash all parts in cleaning solvent except cap, rotor, condenser, breaker plate assembly and vacuum control unit. Degreasing compounds may damage insulation of these parts or saturate the lubricating felt in the case of the breaker plate assembly.

2. Inspect the breaker plate assembly for damage or wear and replace if necessary.

3. Inspect the shaft for wear and check its fit in the bushings in the distributor body. If the shaft or bushings are worn, the parts should be replaced.

4. Mount the shaft in "V" block and check the shaft alignment with a dial gauge. The runout should not exceed .002".

5. Inspect the advance weights for wear or burrs and free fit on their pivot pins.

6. Inspect the cam for wear or roughness. Then check its fit on the end of the shaft. It should be absolutely free without any roughness.

7. Inspect the condition of the distributor points. Dirty points should be cleaned and badly pitted points should be replaced.

8. Test the condenser for series resistance, microfarad capacity (.18 to .23) and leakage or breakdown, following the instructions given by the manufacturer of the test equipment used.

9. Inspect the distributor cap and spark plug wires for damage and replace if necessary.

DISTRIBUTOR ASSEMBLY

1. Install the vacuum advance with the ground lead terminal under the inner mounting screw. (figure 42)

2. Place the felt wick on the upper bushing then place the breaker plate over the upper bushing and vacuum advance link.

3. Install the retaining ring on the upper housing.

4. Slide the distributor shaft through housing bushings.

5. Push the driven gear onto the distributor shaft with the holes aligned.

6. Install the roll pin.

7. Check and adjust dwell angle, vacuum advance and the mechanical advance. Refer to SPECIFICATIONS (Distributor).

ADJUSTING DISTRIBUTOR DWELL ANGLE

1. With distributor mounted in distributor testing machine, connect the dwell meter to the distributor primary lead.

2. Turn the adjusting screw to set the dwell angle at 30 degrees.

If a distributor tester is not available, the dwell angle may be adjusted as follows:

1. Mount distributor in a vise.

2. Connect a test lamp between the primary lead and ground.

3. Rotate the shaft until one of the breaker cam lobes is under the center of the rubbing block on the moveable point.

4. Turn the adjusting screw clockwise until the lamp lights, then turn the screw one-half turn in the opposite direction.

When distributor has been installed in vehicle, point opening must be reset by connecting a dwell meter to the primary distributor lead negative terminal on the coil and ground. The dwell angle must be set at 30 degrees with the engine running at idle speed.

ROTOR

The rotor is retained by two screws and is provided with round and square lugs which engage with the mechanical advance plate so that the rotor may be installed in only one position. (figure 40)

DISTRIBUTOR INSTALLATION

Engine Not Disturbed

1. Turn the rotor about 1/8 turn in a clockwise direction past the mark previously placed on the distributor housing to locate rotor.

2. Push the distributor down into position in the block with the housing in a normal "installed" position.

NOTE: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place.

3. Tighten the distributor clamp bolt snugly and connect vacuum line. Connect primary wire to coil terminal and install cap. Also install spark plug and high tension wires if removed.

NOTE: It is important that the spark plug wires be installed in their proper location in the supports and also in the cap. (figure 32).

4. Time ignition as previously described.

Installation—Engine Disturbed

1. Locate No. 1 piston in firing position by either of two methods described below.

a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in the No. 1 cylinder. Continue cranking until timing mark on crankshaft pulley lines up with timing tab attached to engine front cover.

b. Remove rocker cover (left bank) and crank engine until No. 1 intake valve closes and continue to crank slowly about 1/3 turn until timing mark on pulley lines up with timing tab.

2. Position distributor to opening in block in normal installed attitude, noting position of vacuum control unit.

3. Position rotor to point toward front of engine (with distributor housing held in installed attitude), then turn rotor counter-clockwise approximately 1/8 turn more toward left cylinder bank and push distributor down to engine camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.

4. While pressing firmly down on distributor housing, kick starter over a few times to make sure oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.

5. Turn distributor body slightly until points just open and tighten distributor clamp bolt.

6. Place distributor cap in position and check to see that rotor lines up with terminal for No. 1 spark plug.

7. Install cap, check all high tension wire connections and connect spark plug wires if they have been removed.

8. Connect vacuum line to distributor and distributor primary wire to coil terminal.

9. Start engine and set timing.

COIL REPLACEMENT

1. Disconnect battery ground cables.

2. Disconnect ignition switch and distributor leads from terminals on coil.

3. Pull high tension wire from center terminal of coil.

4. Remove the coil support mounting bolt or loosen friction clamp screw and remove coil.

5. Place new coil in position and install attaching bolt or tighten clamp screw.

6. Place high tension lead securely in center terminal of coil and connect ignition switch and distributor primary leads to terminals on coil.

7. Connect battery ground cables.

8. Start engine and check coil operation.

SPARK PLUGS

1. Remove foreign material from around the spark plug holes and remove the spark plugs.

2. Clean exterior of plugs and inspect for cracked insulators, poor sealing gaskets or excessively burned electrodes.

3. Clean all serviceable plugs with an abrasive type cleaner. File center electrode flat. (figure 45) Do not file center electrode on new plugs.

4. Adjust spark plug gap to .040" using a round feeler gauge.

5. Install plugs and torque to 35 ft. lbs.

NOTE: The spark plug gaskets are the captive type and are not to be replaced each time the plug is removed. The same gasket will usually seat even if the plug is removed up to four times.

HIGH AND LOW TENSION WIRES

High tension wires include the wires connecting the distributor cap to the spark plugs, and the wire connecting the center electrode of the distributor cap

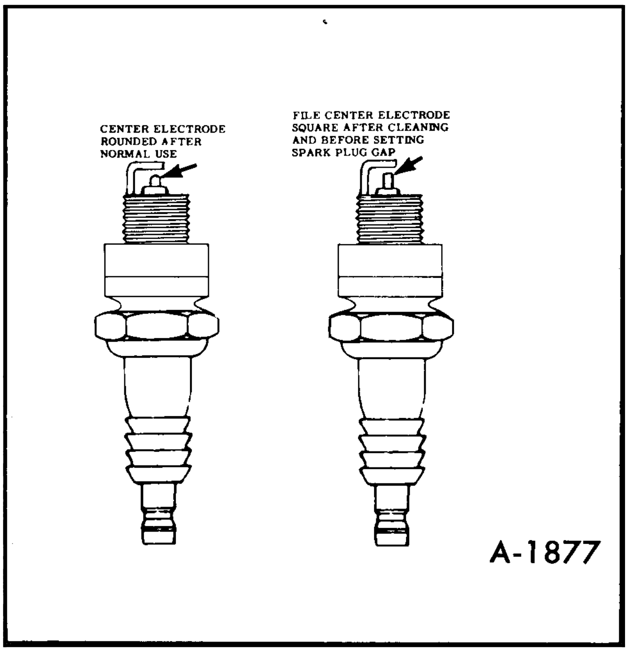


Figure 45—Spark Plug Electrodes

to the center terminal of the ignition coil. Low tension wires are the small wires connected to the primary terminals on the coil, and to the primary terminal at the distributor.

High tension wires have a built-in resistance of approximately 4,000 ohms per foot except coil wire which is 8,000 ohms per foot.

At regular intervals wires should be inspected for damage. If insulation is cracked or swollen, wires should be replaced.

IGNITION SWITCH

The electrical switching portion of the assembly is separate from the key and lock cylinder. However, both are synchronized and work in conjunction with each other through the action of the actuator rod assembly. For a complete explanation of the key and lock cylinder, and the actuator rod assembly, refer to the Steering section of this manual.

The ignition switch is key operated through the actuator rod assembly to close the ignition primary circuit and to energize the starting motor solenoid for cranking. The ignition switch has five positions: OFF, LOCK, ACCESSORY, RUN and START. OFF is the center position of the key-lock cylinder, and lock is the next position to the left. ACCESSORY is located one more detent to the left of LOCK. Turning the key to the right of the OFF position until spring pressure is felt will put the ignition in the RUN position, and when turned fully to the right against spring pressure, the switch will be in the START position.

In the RUN position, the ignition primary circuit is activated through a resistance wire. The ignition resistor wire is used in the ignition running circuit to reduce the voltage to the ignition coil. The resistor wire is bypassed when the engine is being started. The purpose of this is to compensate for the drop in voltage which occurs as the result of the heavy drain on the battery during starting, and to provide a hotter spark for starting.

BREAKER POINT IGNITION SYSTEM SPECIFICATIONS

DISTRIBUTOR	
Make	Delco-Remy
Model No.	1112172
Rotation (Viewed at Rotor)	Counterclockwise
Point Opening (In.)	.016
Cam Angle (Degrees)	30
Centrifugal Advance	
Start Distributor (Degrees)	0-2
R.P.M.	575
Intermediate Distributor (Degrees)	3.5-5.5
R.P.M.	1000
Maximum Advance Degrees	7-9
R.P.M.	1700
Firing Order	1-8-4-3-6-5-7-2

(*) Set with Vacuum in Retard Position.

IGNITION TIMING	
Idle Speed (R.P.M.)	1100
Distributor Setting	8° BTDC
(*) With Distributor Vacuum Ports on Carburetor Plugged.	
DISTRIBUTOR VACUUM CONTROL	
Model No.	1973408
Inches of Mercury to Start Advance	8-10
Inches of Mercury for Maximum Advance	18.5-20.5
Maximum Advance (Distributor Degrees)*	12.5
(*) Plus or Minus one Degree.	
IGNITION COIL	
Model No.	1115221
SPARK PLUGS	
Make	AC
Type	R-45S
Size	18MM
Point Gap	.040"
Torque (Ft. Lbs.)	35
Hex Size	13/16"
Distributor Clamp to Block Bolt (Ft. Lbs.)	12-17

HIGH ENERGY IGNITION SYSTEM

IMPORTANT: Identify ignition system before servicing 1975 vehicles with 1974 certified engines are equipped with standard breaker point ignition systems. 1975 certified engines are equipped with high energy ignition systems. To determine year engine was certified, refer to decal on engine valve cover.

GENERAL DESCRIPTION (FIGURE 46)

The eight cylinder HEI distributor combines all ignition components in one unit. The ignition coil is in the distributor cap and connects directly to the rotor. HEI operates basically in the same manner as a conventional ignition system except the module and pick-up coil of the HEI system replace the contact points of the conventional system.

The High Energy Ignition is a pulse triggered, transistor controlled, inductive discharge ignition system. The magnetic pick-up assembly located inside the distributor contains a permanent magnet, a pole piece with internal teeth, and a pick-up coil. When the teeth of the timer core rotating inside the pole piece line up with teeth of the pole piece, an induced voltage in the pick-up coil signals the all electronic module to open the coil primary circuit. The primary current decreases and a high voltage is induced in the ignition coil secondary winding which is directed through the rotor and high voltage leads to fire the spark plugs. The capacitor in the distributor is for radio noise suppression.

The module automatically controls the dwell period, stretching it with increasing engine speed. The HEI system also features a longer spark duration, made possible by the higher amount of energy stored in the coil primary. This is desirable for firing lean and EGR diluted mixtures.

IGNITION COIL

In the 8 cylinder HEI system, the ignition coil is built into the distributor cap. The coil is somewhat smaller physically than a conventional coil, but has more primary and secondary windings. It is built more like a true transformer with the windings surrounded by the laminated iron core. A conventional coil has the iron core inside the windings. Although the HEI coil operates in basically the same way as a conventional coil, it is more effective in generating higher secondary voltage when the primary circuit is broken.

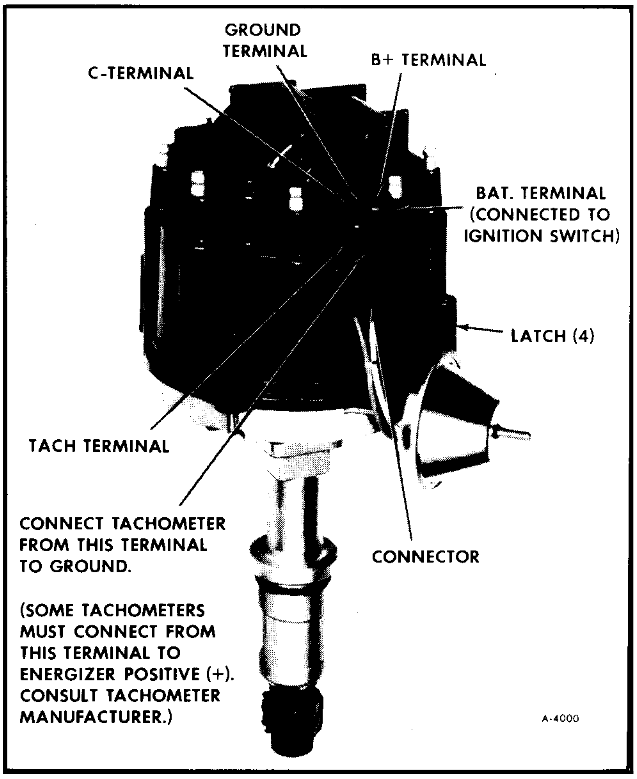


Figure 46—Typical High Energy Ignition

ELECTRONIC MODULE

The electronic module is a solid state unit containing five complete circuits which control spark triggering, switching, current limiting, dwell control and distributor pick-up. Dwell angle is controlled by a transistor circuit within the module and is varied in direct relation to engine speed.

POLE PIECE AND PLATE ASSEMBLY

The pole piece and plate assembly (often referred to as the pick-up coil assembly) consists of the following:

1. A stationary pole piece with internal teeth.

2. A pick-up coil and magnet which are located between the pole piece and a bottom plate.

CENTRIFUGAL AND VACUUM ADVANCE

The centrifugal and vacuum advance mechanisms are basically the same types of units that provide spark advance in the breaker-type system. Centrifugal advance is achieved through the rotation of the timer core in relation to the distributor shaft. Vacuum advance is achieved by attaching the pick-up coil and pole piece to the vacuum advance unit actuating arm.

THEORY OF OPERATION

The pick-up coil is connected to transistors in the electronic module. The electronic module is connected to the primary windings in the coil. As the distributor shaft turns the timer core teeth out of alignment with the teeth of the pole piece a voltage is created in the magnetic field of the pick-up coil.

The pick-up coil sends this voltage signal to the electronic module, which determines from RPM when to start current building in the primary windings of the ignition coil.

Each time the timer core teeth align with the pole piece teeth the pick-up coil magnetic field is changed creating a different voltage. The pick-up coil sends this different voltage signal to the electronic module which electronically shuts off the ignition coil primary circuit. This in turn collapses the coil magnetic field, induces high secondary voltage and fires one spark plug. A typical HEI schematic and basic wiring diagram are shown in Figures 47 and 48.

The electronic module delivers full battery voltage to the ignition coil which is limited to five to six amperes. There is no primary resistance wire in the HEI system. The electronic module triggers the closing and opening of the primary circuit instantaneously with no energy lost due to breaker point arcing or capacitor charging time lag. The capacitor in the HEI unit functions only as a radio noise suppressor.

The instantaneous and efficient circuit triggering enables the HEI system to deliver up to approximately 35,000 volts through the secondary wiring to the spark plugs.

An exploded view of the HEI system is shown in Figure 49.

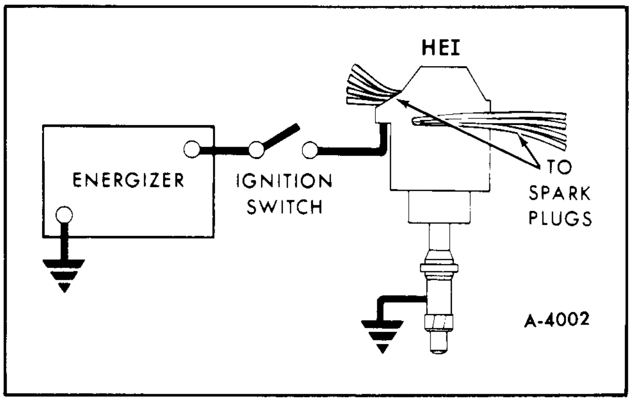


Figure 47—HEI Schematic

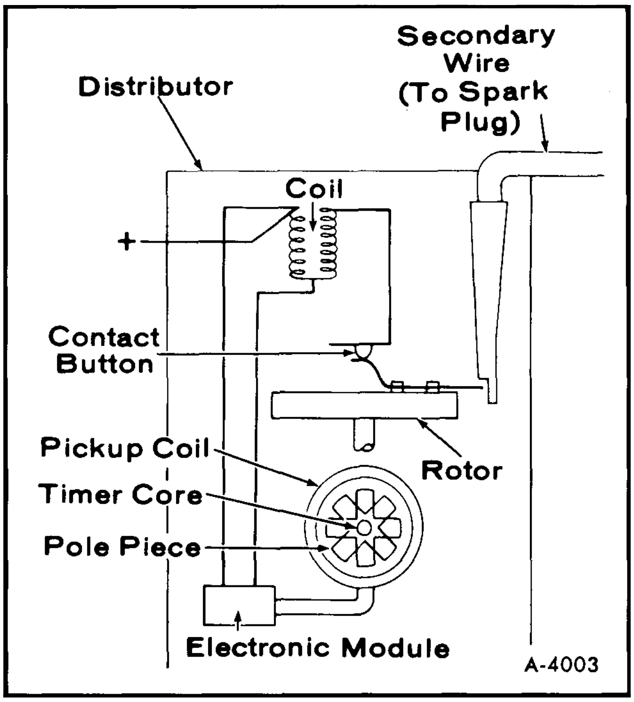


Figure 48—HEI Basic Wiring Diagram

SERVICE OPERATIONS

ROUTINE MAINTENANCE

The HEI system is designed to be free from routine maintenance. No periodic lubrication is required. Engine oil lubricates the lower bushing and an oil-filled reservoir provides lubrication for the upper bushing. There is no dwell adjustment as this is controlled by the module. Timing can be set in the same manner as the standard distributor. For proper operation, however, it is necessary to keep ignition wires and distributor clean and free of any corrosion. If component part replacement should become necessary, several items specific to the HEI system should be noted.

Electronic Module

The electronic module is serviced by complete replacement only. When replacing the module a liberal coating of special silicone grease MUST be applied to the metal mounting surface on which the module will be installed. If this grease is not applied the module will not cool properly which can cause the module to malfunction. A tube of this special silicone grease is supplied with each replacement module. Make certain the replacement module is the correct part number.

CAUTION: *When connecting battery, as in jump starting, reversing connections or polarity, can result in damage to the electronic module.*

Pole Piece and Plate Assembly

The pole piece and plate assembly (often referred to as the pick-up coil assembly) is also serviced by complete replacement only. Make certain the replacement assembly is the correct part number. The pole piece and plate assembly should not be unnecessarily disassembled as the polarity of the assembly could be changed and effect proper operation of the vehicle.

Spark Plug Wires (Figure 50)

Because of the higher voltage, the HEI system has larger diameter (8 millimeter) spark plug wires with silicone insulation. The silicone wire is gray in color, more heat resistant than standard black wire and less vulnerable to deterioration. Silicone insultaion is soft, however, and must not be mishandled.

The spark plug wire boots seal more tightly to the spark plugs. Twist the boot about a half turn in either direction to break the seal before pulling on the boot to remove the wire.

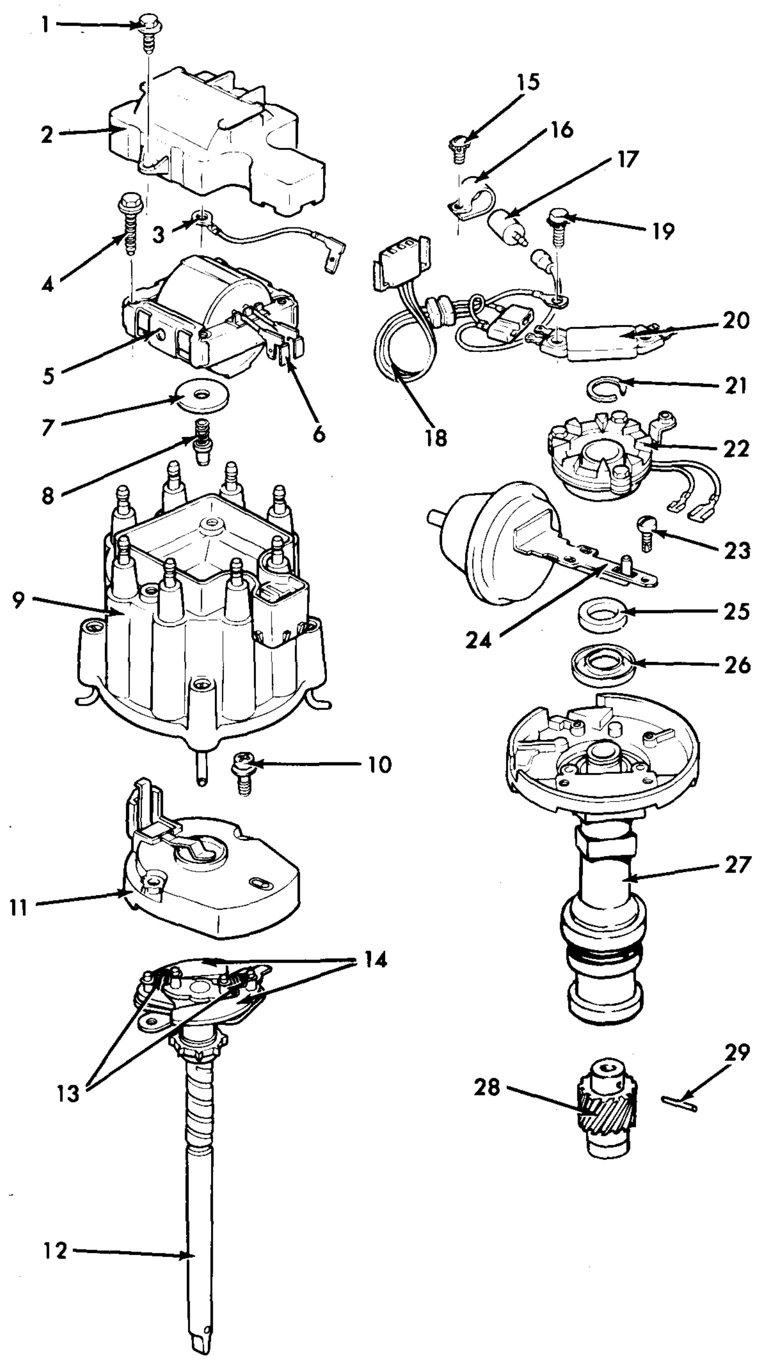
The spark plug cable retainer is designed to hold the wires firmly to prevent chafing or cutting. The wires cannot be repositioned until the cable retainer is unlocked. To unlock the cable retainer use a small screwdriver between the tub and the lock.

To remove wiring harness from cap, release wiring harness latch and remove wiring harness both right and left side (figure 51).

The eight spark plug wires and holder are replaceable only as an assembly. However, if it is necessary to remove an individual wire from the wiring harness assembly, hold grommet of wire down and press retainer tub out of wire holder. To reinstall, lightly lubricate tub end of spark plug wire with silicone. Rotate wire until seated in holder.

WARNING: DO NOT REMOVE SPARK PLUG WIRES WITH THE ENGINE RUNNING. THE HIGHER SECONDARY VOLTAGE IS CAPABLE OF JUMPING AN ARC OF GREATER DISTANCE AND COULD CAUSE AN ELECTRIC SHOCK. OPERATING THE ENGINE WITH ONE OR MORE SPARK PLUG WIRES DISCONNECTED CAN ALSO RESULT IN DAMAGE TO THE DISTRIBUTOR CAP.

Resistance specifications for both 7mm wires used with standard systems and 8mm wires used with HEI systems are identical (3,000 to 5,000 ohms per foot). Inspect all spark plug wires for high resistance and continuity with an ohmmeter. Ohmmeter should be set on high scale. Connect ohmmeter leads to the terminals at each end of the cable being tested.



1. Cover Attaching Screw (2)
2. Cover
3. Ground Lead
4. Coil Attaching Screw (4)
5. Ignition Coil
6. Coil Terminals
7. Rubber Seal
8. Brush (Spring and Button)
9. Cap
10. Rotor Attaching Screw (2)
11. Rotor
12. Shaft Assembly
13. Springs
14. Weights
15. Bracket Attaching Screw
16. Capacitator Bracket
17. Capacitator
18. Wiring Harness
19. Module Attaching Screw (2)
20. Electronic Module
21. Retainer (Thin "C" Washer)
22. Pole Piece and Plate Assembly (Pick-up Coil)
23. Vacuum Advance Attaching Screw (2)
24. Vacuum Advance Control
25. Felt Washer
26. Plastic Seal
27. Housing
28. Gear
29. Pin

Figure 49—HEI Distributor Exploded View

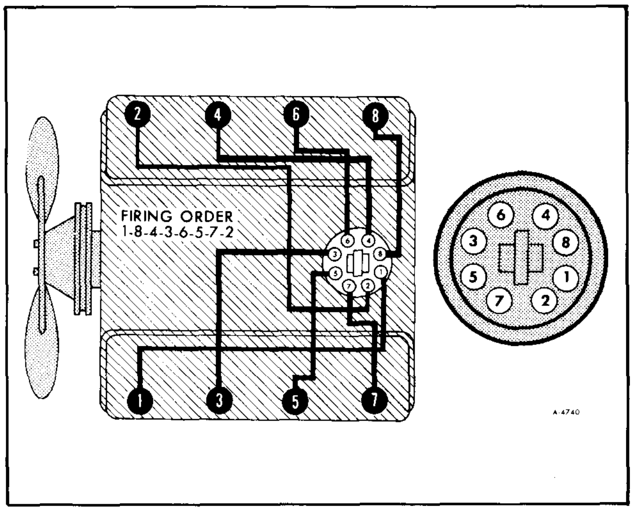


Figure 50—Secondary Wiring

Twist wire gently while observing ohmmeter. If the resistance of the assembly is not within the specified range, or if the ohmmeter reading fluctuates from infinity to any value, replace the cable.

Timing Light Connections

When using a timing light, connect an adapter between the No. 1 spark plug and the No. 1 spark plug wire (figure 50). Connect the timing light to the adapter. Do not pierce the plug bead. Once the insulation of the spark plug cable has been broken, voltage will jump to the nearest ground, and the spark plug will not fire properly. The timing procedure remains the same as the conventional breaker point ignition system.

Compression Check

When making compression checks on engines equipped with HEI, disconnect the ignition switch connector at the battery terminal of the distributor (figure 52).

Tachometer Connections

The tachometer terminal is next to the ignition switch connector on the distributor cap (figure 52). Most tachometers can be used, however, be sure the equipment is compatible with the HEI system. The tachometers without a relay cannot be used. If there is any doubt as to whether you have the right tachometer, a check can be made as follows:

a. Note reading on 1000 RPM scale.

b. Note reading on 5000 RPM scale.

c. Readings should be approximately the same. If they are not, get another tachometer.

Connect the tachometer to the distributor cap tachometer terminal and to ground. Some tachometers must connect from the tachometer terminal to the battery positive (+) terminal. Follow tachometer manufacturer's instructions.

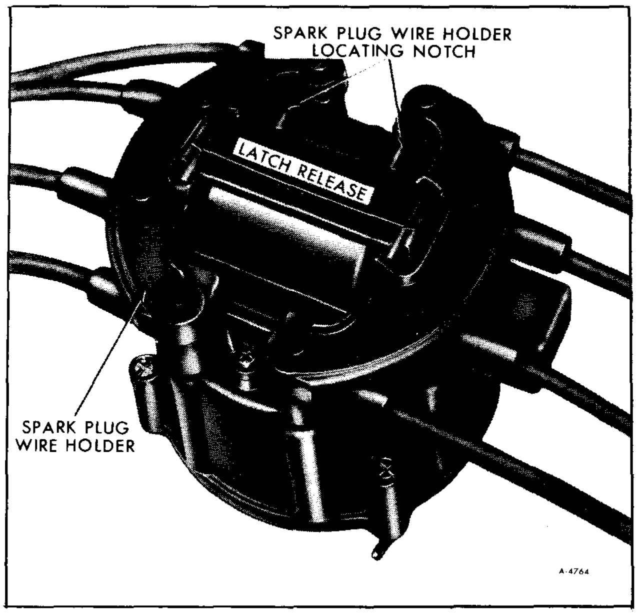


Figure 51—Distributor Cap Wiring

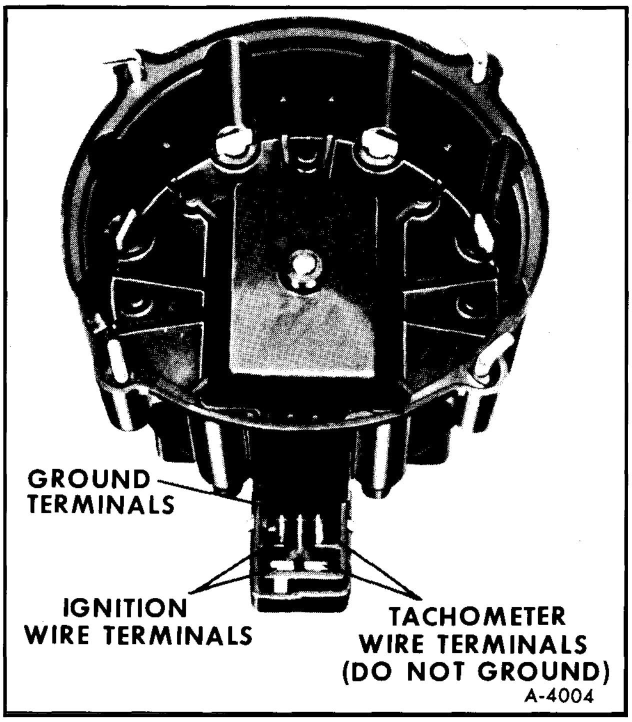


Figure 52—Terminals on Distributor Cap

CAUTION: *Grounding the distributor tachometer terminal could damage the HEI electronic module.*

Other Test Equipment

Oscilliscopes require special adapters. Distributor machines require a special amplifier. The equipment manufacturers have instructions and details necessary to modify test equipment for HEI diagnosis.

Vacuum and Centrifugal

Advance Specifications

Vacuum and centrifugal advance specifications are listed in Specifications at the end of this section.

Ignition Timing

The ignition timing marks are located on the engine front cover. A saw slot on the balancer indicates engine top dead center. (figure 53).

To adjust ignition timing, proceed as follows:

1. Remove air cleaner and plug manifold vacuum fitting.

2. Disconnect vacuum hoses at carburetor and plug fittings.

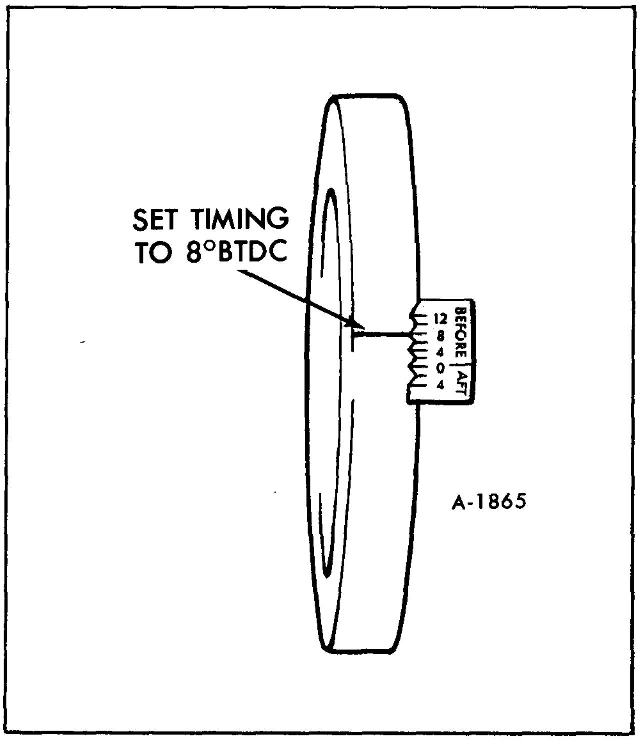


Figure 53—Engine Ignition Timing

3. Connect tachometer and adjust engine speed to 1100 rpm with transmission in neutral.

4. With the use of a timing light, set timing to 8°BTDC by loosening the distributor clamp bolt and rotating the distributor until the specification is obtained.

NOTE: The indicator has four "V" slots, each representing 4°.

5. Tighten the distributor clamp bolt and recheck timing to make sure distributor was not moved during tightening of bolt.

NOTE: If a tuned engine detonates with this setting, the the cause is low octane fuel or excessive carbon build-up in the combustion chamber. If these factors are not corrected, the timing should be retarded 2 degrees from the specified setting.

6. Remove plug from fittings and connect hoses to carburetor. Remove tape from manifold fitting and connect vacuum hose, install air cleaner.

Spark Plugs (Figure 54)

1. Remove foreign material from around the spark plug holes and remove the spark plugs.

2. Clean exterior of plugs and inspect for cracked insulators, poor sealing or excessively burned electrodes.

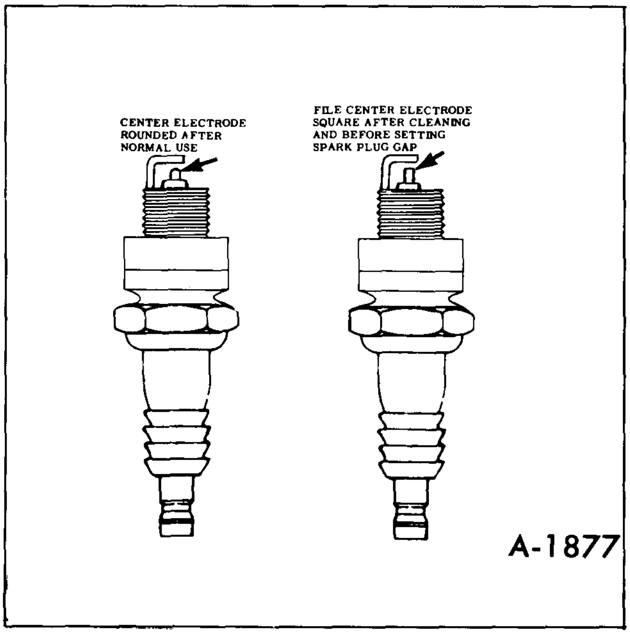


Figure 54—Spark Plug Electrodes

3. Clean all serviceable plugs with an abrasive type cleaner. File center electrode flat. Do not file center electrode on new plugs.

4. Adjust spark plug gap to .080" using a round feeler gauge.

5. Install plugs and torque to 25 ft. lbs.

DIAGNOSING HIGH ENERGY IGNITION SYSTEM

(Using Voltmeter or Test Light, Ohmmeter, and Module Tester J-24642).

NOTE: Careful adherence to the following procedures will lead to the location and correction of H.E.I. System problems. Normally, only a portion of the procedures need be performed.

Engine Will Not Start:

1. Insure that wiring connector is properly attached to connector at side of distributor.

2. Insure that all spark plug leads are properly connected at distributor and spark plugs.

3. Connect voltmeter or test light from "BAT" terminal lead on distributor to ground (figure 52).

4. Turn on ignition switch. If voltage is zero or test light does not come on, repair open circuit between "BAT" terminal and battery.

5. When reading is battery voltage, or test light lights, remove one spark plug lead by twisting spark plug boot to loosen. Insert extension, hold spark plug lead with insulating pliers so extension is 1/4 in. away from dry area or engine block while cranking engine, or install any good spark plug with .080 gap in lead and lay on engine block while cranking engine.

6. If sparking occurs trouble is not ignition distributor. Check fuel system and spark plugs. Check timing. Distributor may have shifted.

7. If no spark, make Test No. 1 with Module Tester J-24642 or equivalent as follows:

NOTE: Use Test No. 1 only in an engine no-start situation.

a. Disconnect module harness connector from the distributor cap (figure 55).

b. Connect J-24642 three-way connector to the module harness connector.

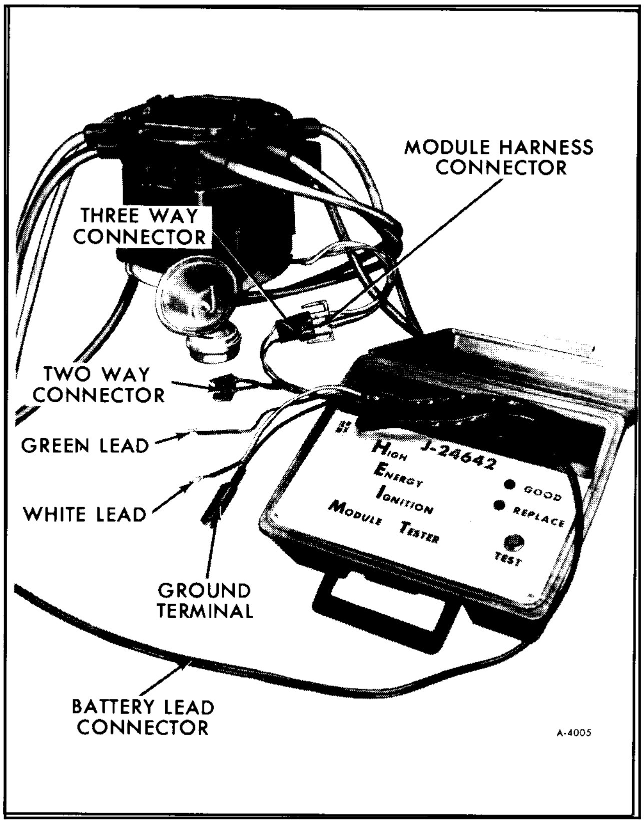


Figure 55—Test No. 1 Using Tool J-24642

NOTE: The three-way connector should connect only one way to the harness connector. Match wire colors between module harness connector and tester three way connector.

c. Connect red lead of J-24642 tester to battery positive terminal and black lead to battery negative terminal.

d. Press and hold test button of J-24642 tester while cranking engine.

NOTE: During cranking, battery voltage must be nine volts or more and engine speed 100 rpm or more for tester to be accurate.

e. Momentary if red light and then green light on Tester J-24642 comes on and stays on green. Module and pickup coil are both good. If red light stays on go to step 8 Test No. 2.

f. If pickup coil and module test good, remove distributor cap and coil assembly by turning four latches.

g. Check primary of ignition coil in cap for continuity (step 1, figure 56). Reading should be zero or near zero. If not, replace ignition coil.

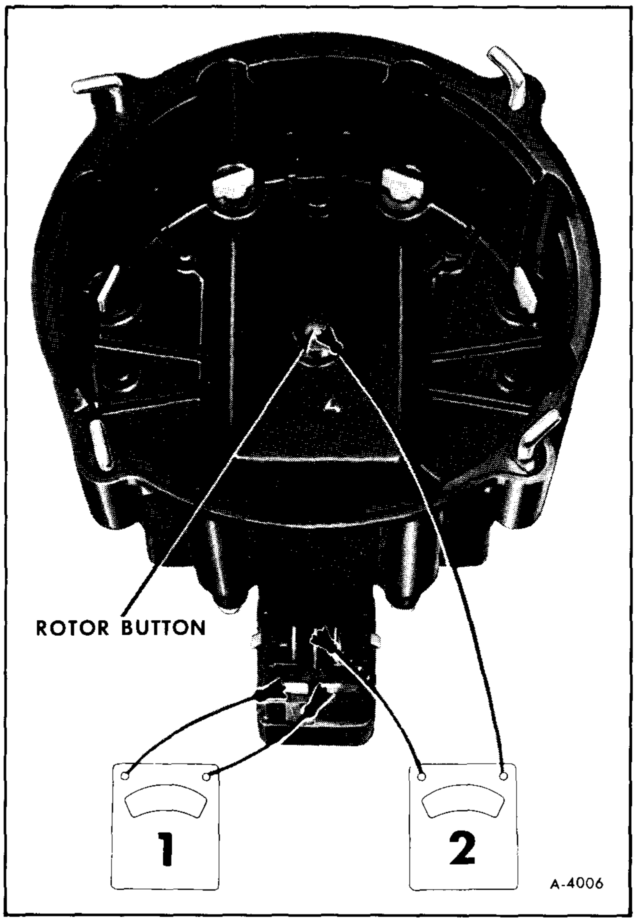


Figure 56—Ohmmeter Check of Ignition Coil

h. Check secondary of coil (step 2, figure 56). Use high scale. Reading should not be infinite.

i. If reading is infinite, check cap and rotor button for arced or burned condition. If necessary, replace cap. If cap and carbon button do not appear defective, replace ignition coil.

8. If red light on module tester J-24642 stays on, either the module or the pickup coil is defective. To determine which is defective, continue with Test No. 2 (figure 57).

a. With distributor cap removed and J-24642 module tester three-way connector and battery leads connected as in Test No. 1 connect green and white leads to module (figure 57).

NOTE: Green and white leads will connect only one way. Test connections now will test module only.

b. Press and hold test button on J-24642 tester. If green light now comes on, the module is okay, so the pick-up coil is defective. If the red light stays on, the module is defective.

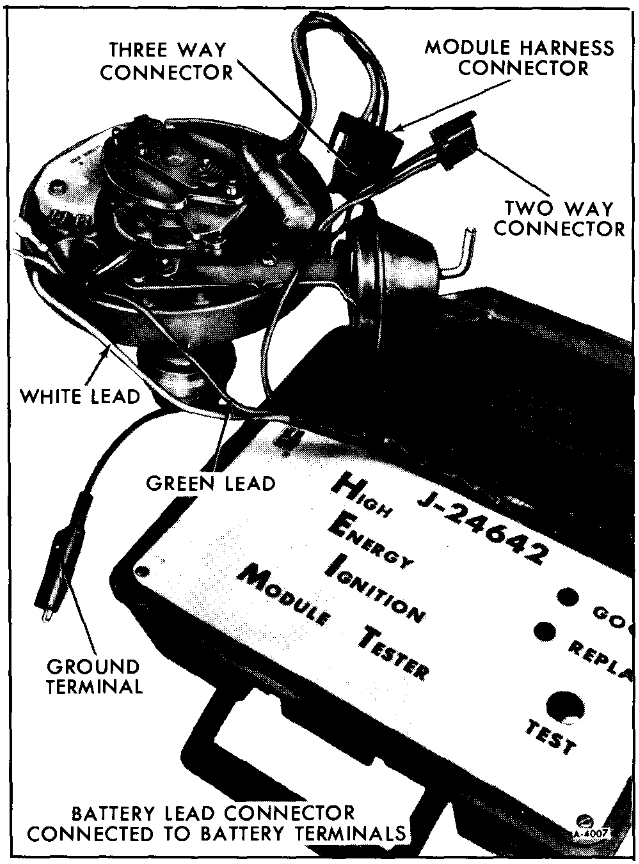


Figure 57—Test No. 2 Using Tool J-24642

NOTE: If necessary to replace pick-up coil, remove distributor from engine, drive pin from gear, remove rotor and shaft assembly from housing and remove thin "C" washer; to replace pick-up coil as described in this section under distributor disassembly.

If necessary to replace module, remove connector, white and green leads, to attaching screws and replace module. Special silicone grease as supplied with new module must be applied to distributor and module to dissipate heat.

c. Remove J-24642 test leads, replace parts as required, if removed, replace distributor and cap assembly.

9. Module may be tested on bench using Tester J-24642 (figure 58).

Connect the two-way connector of the analyzer to the module and the green and white analyzer leads to the corresponding green and white terminals of the module. Connect red elad of tester to 12 volt

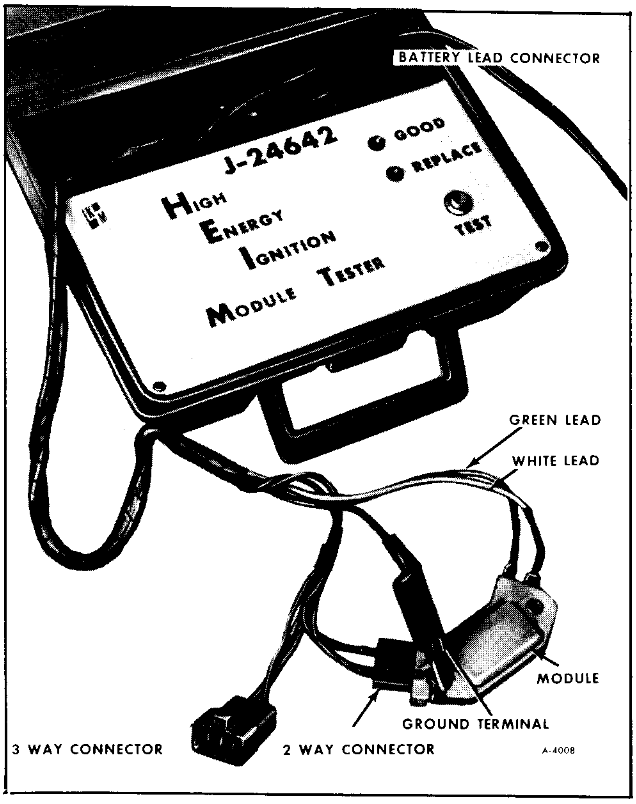


Figure 58—Bench Test of Module Using Tool J-24642

battery positive. Terminal and black lead to battery negative terminal. Connect ground terminal of analyzer to module ground as shown in (figure 58).

Press and hold test button momentary - red then green, module good; light stays red module is defective.

Engine Runs Rough:

1. Insure that proper fuel is being delivered to carburetor.

2. Check all vacuum hoses for leakage.

3. Visually inspect and listen for sparks jumping to ground.

4. Check initial timing, distributor may have shifted.

5. Check centrifugal advance on engine.

6. Remove all spark plugs and check for usual defects-proper gap, fouling, cracked insulators inside and out, etc.

7. Check spark plug wiring.

8. Remove distributor cap and coil assembly by turning four latches. Inspect cap, coil assembly and rotor for spark arc-over.

a. Check primary of ignition coil in cap for continuity (step 1, figure 56). Reading should be zero or near zero. If not, replace ignition coil.

b. Check secondary of coil (step 2, figure 56). Use high scale. Reading should not be infinite.

c. If reading is infinite, check cap and rotor button for arced or burned condition. If necessary, replace cap. If cap and carbon button do not appear defective, replace ignition coil.

9. If trouble has not been located, proceed with Test No. 2 using J-24642, step 8 (a thru c).

DISTRIBUTOR COMPONENT REPLACEMENT

Following is the complete distributor disassembly of which part or all can be used as required. When necessary to remove the distributor from the engine, the procedure is the same as for the standard distributor.

DISTRIBUTOR REMOVAL

1. Disconnect wiring harness connectors at side of distributor cap.

2. Remove distributor cap from housing by releasing four cap retaining latches. Position cap out of way.

> **NOTE:** Be careful not to damage latches. Position screwdriver at top of latch and turn.

3. Disconnect vacuum advance hose from vacuum advance mechanism.

4. Scribe a mark on engine in line with rotor. Note approximate position of distributor housing in relation to engine.

> **NOTE:** To insure correct timing of the distributor, the distributor must be installed with the rotor correctly positioned.

5. Remove distributor clamp screw and hold-down clamp.

6. Lift distributor from engine. Again note position of distributor housing in relation to engine.

DIAGNOSING HIGH ENERGY IGNITION SYSTEM WITHOUT USE OF MODULE TESTER J-24642

Careful adherence to the following procedures will lead to the location and correction of HEI system problems. Normally only a portion of the procedures need be performed.

1. Insure that wiring connector is properly attached to connector at side of distributor.
2. Insure that all spark plug leads are properly connected at distributor and spark plugs.

SYSTEM CHECKS ON THE VEHICLE

A. ENGINE WILL NOT START. USE VOLTMETER OR TESTLIGHT.

A-1. Connect voltmeter from "BAT" terminal lead on distributor to ground.

A-2. Turn on ignition switch.

A-3. If voltage is zero, repair open circuit between "BAT" terminal and battery.

A-4. If reading is Battery voltage, twist spark plug boot to loosen, remove lead, insert extension, hold spark plug lead with insulating pliers so extension is ¼" away from dry area of engine block while cranking engine or remove one spark plug lead. Install any good spark plug with .080 gap in lead and lay on engine block while cranking engine.

A-5. If sparking occurs trouble is not ignition distributor.

A-6. Check fuel system and spark plugs and secondary wiring. Check timing (distributor shifted).

A-7. Proceed to Component Checks.

B. ENGINE RUNS ROUGH.

B-1. Insure that proper fuel is being delivered to carburetor.

B-2. Check all hoses for leakage.

B-3. Visually inspect and listen for sparks jumping to ground.

B-4. Check initial timing (distributor shifted).

B-5. Check centrifugal advance on engine.

B-6. Twist boots to loosen, remove all spark plugs and check for usual defects — proper gap, fouling, cracked insulators, inside and out, etc. Check secondary wiring.

B-7. If no defects are found follow procedure under Component Checks.

C. COMPONENT CHECKS USING OHMMETER.

C-1. Remove cap and coil assembly by turning four locking latches.

C-2. Inspect cap and coil assembly and rotor for spark arc-over.

C-3. Check primary coil. Connect ohmmeter, Step 1, Figure 56. Use low scale. Reading should be zero. If not, replace coil.

C-4. Check secondary of coil. Connect ohmmeter, Step 2, Figure 44. Use high scale. Reading should not be infinite.

C-5. If reading is infinite, check cap and carbon button for arced or burned condition. If necessary, replace cap. If cap and rotor button do not appear defective, replace ignition coil.

C-6. Connect test stand vacuum source to vacuum unit.

C-7. If vacuum unit is inoperative, replace.

C-8. Check pick-up coil for broken wire or open. Connect ohmmeter, Step 1, Figure 59. Use middle scale. If ohmmeter reads less than 500 ohms or more than 1500 ohms (while flexing leads) replace pick-up coil. (C-10 below).

C-9. If Step 1 is ok, check pick-up coil for ground with ohmmeter, Step 2, Figure 59. Use high scale. If reading is not infinite (no deflection on meter) replace coil. (C-10 below).

C-10. Remove unit from engine, remove rotor and shaft assembly from housing and remove thin "C" washer to replace pick-up coil (refer to distributor component repair earlier in this section).

C-11. If no defects have been found, remove connector and two attaching screws and replace module.

Diagnosing HEI

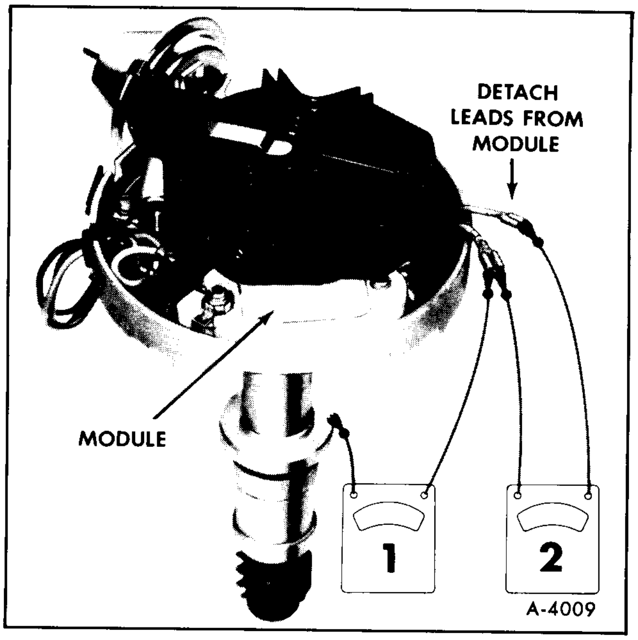


Figure 59—Ohmmeter Check of Pick-Up Coil

DISTRIBUTOR INSTALLATION

1. Push the distributor down into position in the engine block.

2. Install distributor hold-down clamp and tighten clamp screw snugly.

3. Move distributor housing to approximate position relative to engine as noted during removal.

4. Position distributor cap to housing with tab in base of cap aligned with notch in housing and secure with four latches.

5. Connect wiring harness connector to terminals on side of distributor cap. Connector will fit only one way. Connect battery ground cable.

6. Adjust ignition timing as described earlier in this section.

Installation—Engine Disturbed

NOTE: To insure correct timing of the distributor, the distributor must be installed with the rotor correctly positioned.

If the engine was accidentally cranked after the distributor was removed, the following procedure can be used for installing the distributor.

1. Remove No. 1 spark plug.

2. Disconnect feed wire connector at the "BAT" terminal from distributor to prevent engine from starting.

3. Place finger over No. 1 spark plug hold and crank engine slowly until compression is felt.

4. Align timing mark on crankshaft pulley to "0" on engine timing indicator.

5. Turn rotor to point between No. 1 and No. 8 spark plug towers on distributor.

6. Install distributor and connect feed wire.

7. Install distributor cap and spark plug wires.

8. Check engine timing.

DISTRIBUTOR DISASSEMBLY (FIGURE 49)

1. Remove distributor from engine as described above.

2. Remove rotor (figure 60) from distributor shaft by removing two screws.

3. Before removing gear from distributor shaft, scratch a mark on geat and shaft for correct reassembly. If gear is assembled 180° from original position, the timing will be changed one half tooth.

4. Using a small drift, drive out roll pin retaining gear to shaft.

CAUTION: *Distributor gear should be supported in push a way that no damage will damage will occur to the distributor shaft while removing pin.*

5. Remove driven gear. Some distributors may have washers between gear and distributor housing, or on the housing itself. Remove and replace washers as required.

6. Check role pin hole on shaft for burrs. Remove shaft and weight assembly from housing (figure 61).

7. If necessary, remove two advance springs, weight retainer, and advance weights.

8. Disengage plastic wiring insulator from housing. Disconnect wiring leads from module where connector may be removed from "B" and "C" terminals. Remove wires from "W" and "G" module terminals.

9. Remove retainer from upper end of distributor housing.

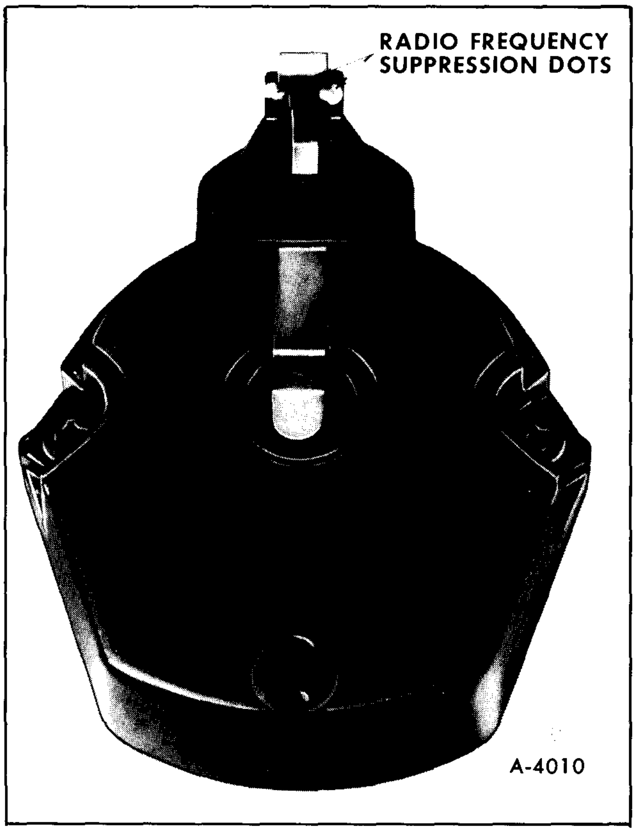


Figure 60—HEI Rotor

10. Remove pole piece and plate assembly from housing. Do not remove three securing screws (figure 62).

> **NOTE:** Pole piece and plate assembly is serviced as an assembly. It should not be unnecessarily disassembled as the polarity of the assembly could be changed and effect proper operation of the vehicle.

> **NOTE:** Do not wipe lubricant from module or distributor unless replacing module. Special lubricant is provided with new modules.

13. Remove capacitor attaching screw and disconnect wiring lead. Remove capacitor and bracket from housing.

14. Remove wiring harness connector from distributor.

15. Remove felt washer and plastic seal.

> **NOTE:** No attempt should be made to secure the shaft bushings in the housing.

16. Inspect and replace parts as required.

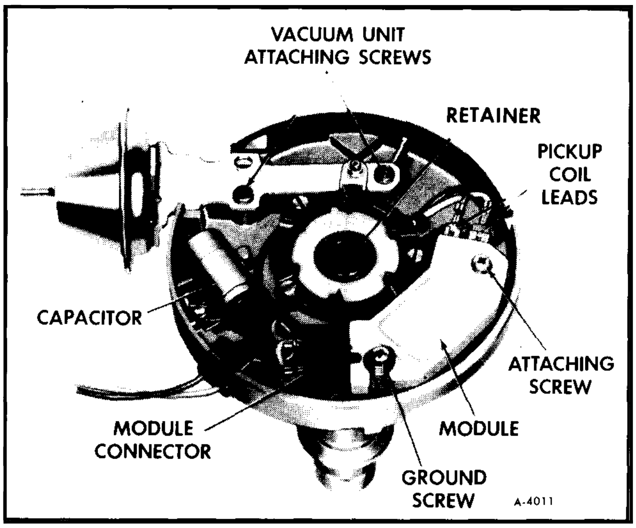


Figure 61—Top View of Distributor Housing with Shaft Removed

DISTRIBUTOR ASSEMBLY

1. Repack lube cavity in housing with Delco Distributor lubricant or equivalent.

2. Replace plastic seal and felt washer.

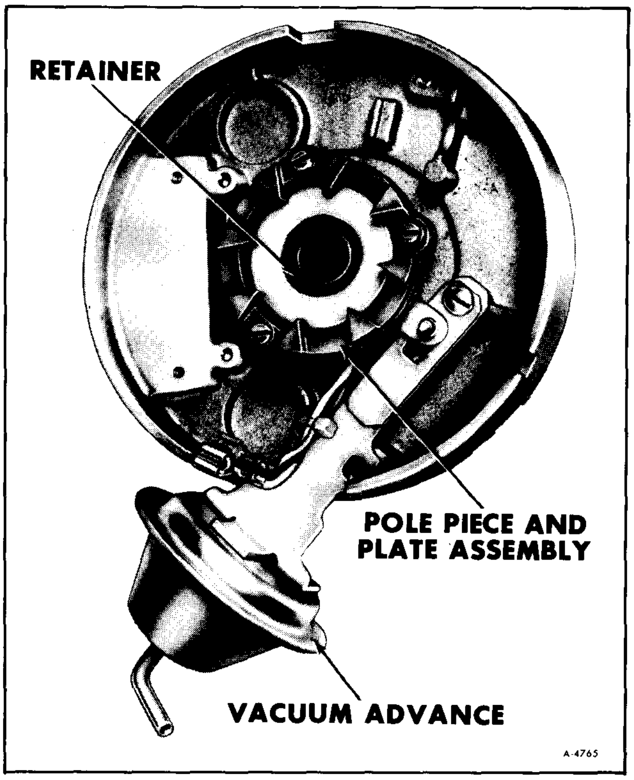


Figure 62—Pole Piece and Plate Assembly

3. Reinstall wiring harness assembly with from-met in distributor housing notch. Engage plastic wiring insulator to housing.

4. Attach lead wire from wiring harness to capacitator, if disassembled. Install capacitator and bracket securing ground wire from wiring harness with capacitator attaching screw.

NOTE: Lead wire attaching to capacitator is a fusible link.

5. Install module with two attaching screws.

NOTE: Apply a layer of special silicone lubricant between module and housing to improve heat transfer. Lubricant is included with new modules. If installing a new module, be sure part number is correct for this particular distributor.

6. Install vacuum advance unit, pin side up, with two attaching screws.

7. Position pole piece and plate assembly with arm over pin of vacuum advance unit.

NOTE: If arm of pole piece and plate assembly is not properly installed on pin of vacuum advance unit, the arm can float and cause timing to vary. If installing a new pole piece and plate assembly, be sure part number is correct for this particular distributor.

8. Install retainer to secure position of pole piece and plate assembly.

9. Install connector to "B" and "C" terminals on module with tab on top. Connect green wire to "G" terminal and white wire to "W" terminal.

10. Install distributor shift and rotate to check for even clearance all around between teeth on pick-up coil of pole piece and plate assembly and teeth on distributor shaft.

NOTE: If necessary to adjust for proper clearance, loosen three screws on pole piece and plate assembly. Move pole piece teeth to provide even clearance. Tighten three screws (figure 62).

11. Install washers between gear and housing, if distributor is so equipped. Slide gear onto shaft in same position as marked when removed.

12. Install roll pin into gear and shaft.

NOTE: To prevent damage to the permanent magnet in the pole piece and plate assembly, support the driven gear when installing the roll pin.

13. If removed, carefully reassemble advance weights and springs on advance weight plate.

14. Position rotor to advance weight plate and tighten retaining screws.

15. Position cap on housing making sure cap is properly seated (notch in housing matches tab in cap). Engage four locking latches.

IGNITION COIL REMOVAL

1. Disconnect battery, ground cable from automotive battery and harness connector from distributor cap.

2. Remove three screws securing coil cover to distributor cap.

3. Remove four screws securing ignition coil to distributor cap (figure 63).

4. Remove ground wire from coil, if coil is equipped with ground wire.

5. Push coil leads from underside of connectors and remove ignition coil from distributor cap.

6. Check condition of seal and resistor brush (spring and button) (figure 64).

NOTE: Do not wipe silicone lubricant from seal.

IGNITION COIL INSTALLATION

1. Position resistor brush (spring and button) and seal in distributor cap.

NOTE: Make sure seal is coated with silicone lubricant and properly positioned in place.

2. Position coil into distributor cap with terminals over connector at side of cap.

NOTE: If replacing ignition coil, be sure part number is correct.

3. Push coil lead wires into connector on side of cap.

4. Secure ignition coil with four screws. Place ground wire, if so equipped, under coil mounting screw.

5. Install coil cover onto distributor cap and secure with three screws.

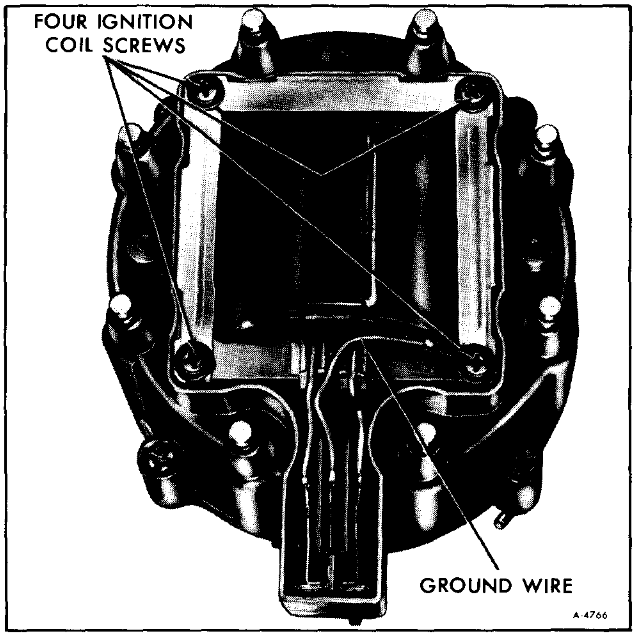


Figure 63—Ignition Coil (Typical)

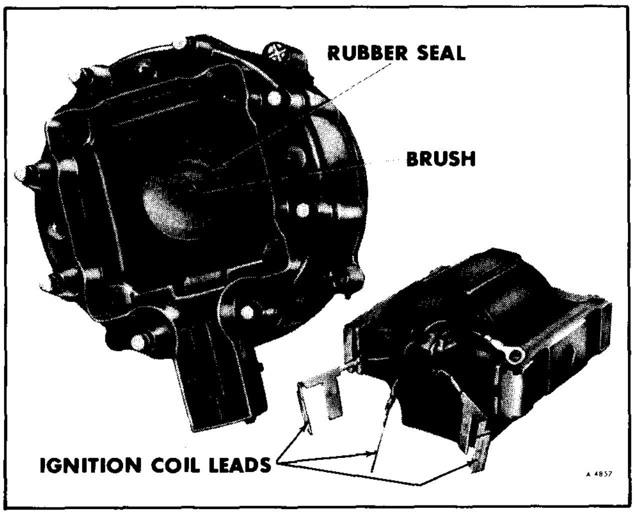


Figure 64—Ignition Coil and Seal (Typical)

6. Connect harness connector to distributor cap and ground cable to automotive battery.

HIGH ENERGY IGNITION SYSTEM SPECIFICATIONS

	Federal	California
DISTRIBUTOR		
Make	Delco-Remy	Delco-Remy
Model No.	1112893	1112945
Rotation (Viewed at Rotor)	Clockwise	Clockwise
Dwell	Electronic	Electronic
Centrifugal Advance		
Start Distributor (Degrees)	0	0
RPM	900	900
Intermediate Distributor (Degrees)	9	9
RPM	2000	2000
Maximum Advance Degrees	16	16
RPM	3400	3400
Firing Order	1-8-4-3-6-5-7-2	1-8-4-3-6-5-7-2

(*) Set with Vacuum in Retard Position.

IGNITION TIMING		
Idle Speed (RPM)	1100	1100
Distributor Setting	8°BDTC	8°BDTC

* With Distributor Vacuum Ports on Carburetor Plugged.

DISTRIBUTOR VACUUM CONTROL		
Model No.	1973523	1973560
Inches of Mercuty to Start Advance	8-10	14-15
Inches of Mercury for Maximum Advance	19-20	18-19
Maximum Advance (Distributor Degrees)*	12°	5°

*Plus or Minus one Degree.

SPARK PLUGS		
Make	AC	AC
Type	R46SX	R46SX
Size	14MM	14MM
Point Gap	.080″	.080″
Torque (Ft. Lbs.)	25	25
Hex Size	13/16	13/16
Distributor Clamp to Block Bolt (Ft. Lbs.)	17	17

STARTING SYSTEM

GENERAL DESCRIPTION

The cranking circuit consists of the battery, the starting motor which includes a drive assembly for engaging the flywheel ring gear during cranking, the starter solenoid, mounted on the starting motor for shifting the drive assembly and closing the motor circuit, the ignition or control switch which, when in the "START" position connects a lead from the battery to the solenoid switch and related electrical wiring. During cranking, the ignition switch also connects the battery directly to the ignition coil.

The solenoid operated overrunning clutch type starting motor, shown in Figure 65 is used on all vehicles.

The drive end housing is extended to enclose the shift lever mechanism and solenoid plunger. The solenoid flange is mounted on drive end housing and sealing compound is used between the flange and field frame. A compression type shift lever return spring located inside the solenoid case is used to operate the overrunning clutch. The primary circuit to the ignition coil is fed from the solenoid while the starter is operating.

With conventional ignition, to provide full battery voltage to the coil, the ignition resistor is by-passed during cranking. The resistor is by-passed at the "R" terminal or ignition terminal (See figure 78) on the starting motor.

With high energy ignition, there is no resistor, so there is no resistor by-pass wire from the starter motor. Since there is no longer any requirement for the electrical lead from the starter solenoid to the ignition coil, the "R" terminal (or ignition terminal) of the starter solenoid has been removed.

The solenoid contains two coil windings; the pull-in winding and the hold-in winding. Both windings are energized when ignition switch is closed to pull the plunger in and shift the drive pinion into mesh. The main contacts in the solenoid switch are closed to connect the battery directly to the cranking motor. Closing the main switch contacts will short out the pull-in winding. The magnetism produced by the hold-in winding is sufficient to hold the plunger in. When ignition switch is opened, the hold-in winding is disconnected from the battery; the shift lever spring withdraws the plunger from the solenoid opening the solenoid switch contacts while at the same time withdrawing the drive pinion from mesh.

STARTING SYSTEM OPERATION

When starter circuit is energized, the solenoid

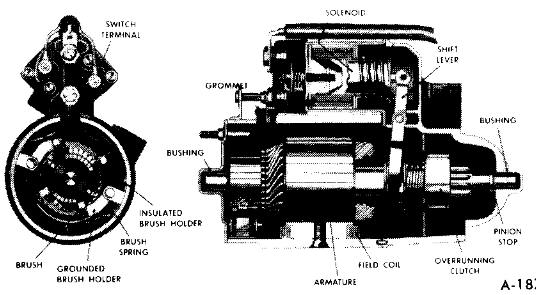


Figure 65—Starter Assembly

operated shift lever slides the pinion into mesh with the flywheel ring gear teeth. The rotary motion between the pinion and ring gear, provided by spiral splines on armature shaft, normally relieves tooth abutment on the first attempt to engage pinion and the engine flywheel ring gear. When the engine is started, pinion overrun protects the armature from excessive speed until the ignition or control switch is released, at which time the solenoid shift lever return spring causes the pinion to disengage. To prevent excessive overrun on vehicles equipped with these starting motors, the ignition or control switch must be released immediately when engine starts.

TROUBLE DIAGNOSIS

Wiring: Inspect the wiring for damage. Inspect all connections to the cranking motor, solenoid or magnetic switch, ignition switch or any other control switch, and battery, including all ground connections. Clean and tighten all connections as required.

Magnetic Switch or Solenoid and Control Switches: Inspect all switches to determine their condition. Connect a jumper lead around any switch suspected of being defective. If the system functions properly using this method, repair or replace the bypassed switch.

Motor: If the battery, wiring and switches are in satisfactory condition, and the engine is known to be functioning properly, remove the motor and follow the test procedures outlined.

Never operate the cranking motor more than 30 seconds at a time without pausing to allow it to cool for at least two minutes. Overheating, caused by excessive cranking will seriously damage the cranking motor.

STARTER REMOVAL

1. Disconnect batteries by removing ground straps and hoist vehicle.

2. Remove two attaching bolts and move starter for easier access to wires.

3. Note the position of the wires and disconnect the wires from starter.

4. Remove the starter.

CRANKING MOTOR TESTS

With the cranking motor removed from the engine, the pinion should be checked for freedom of operation by turning it on the screw shaft. The armature should be checked for freedom of rotation by prying the pinion with a screwdriver. Tight bearings, a bent armature shaft, or a loose pole shoe screw will cause the armature to not turn freely. If the armature does not turn freely the motor should be disassembled immediately. However, if the armature does rotate freely, the motor should be given a no-load test before disassembly.

NO-LOAD TEST (FIGURE 66)

Connect a voltmeter from the motor terminal to the motor frame, and use an rpm indicator to measure armature speed. Connect the motor and an ammeter in series with a fully charged battery of the specified voltage, and a switch in the open position from the solenoid battery terminal to the solenoid switch terminal. Close the switch and compare the rpm, current, and voltage readings with the specifications at the end of this section.

It is not necessary to obtain the exact voltage specified, as an accurate interpretation can be made by recognizing that if the voltage is slightly higher the rpm will be proportionately higher, with the current remaining essentially unchanged. However, if the exact voltage is desired, a carbon pile connected across the battery can be used to reduce the voltage to the specified value. If the specified current draw does not include the solenoid, deduct from the ammeter reading the specified current draw of the solenoid hold-in winding. Make disconnections only with the switch open. Interpret the test results as follows:

1. Rated current draw and no-load speed indicates normal condition of the cranking motor.

2. Low free speed and high current draw indicates:

a. Too much friction—tight, dirty, or worn bearings, bent armature shaft or loose pole shoes allowing armature to drag.

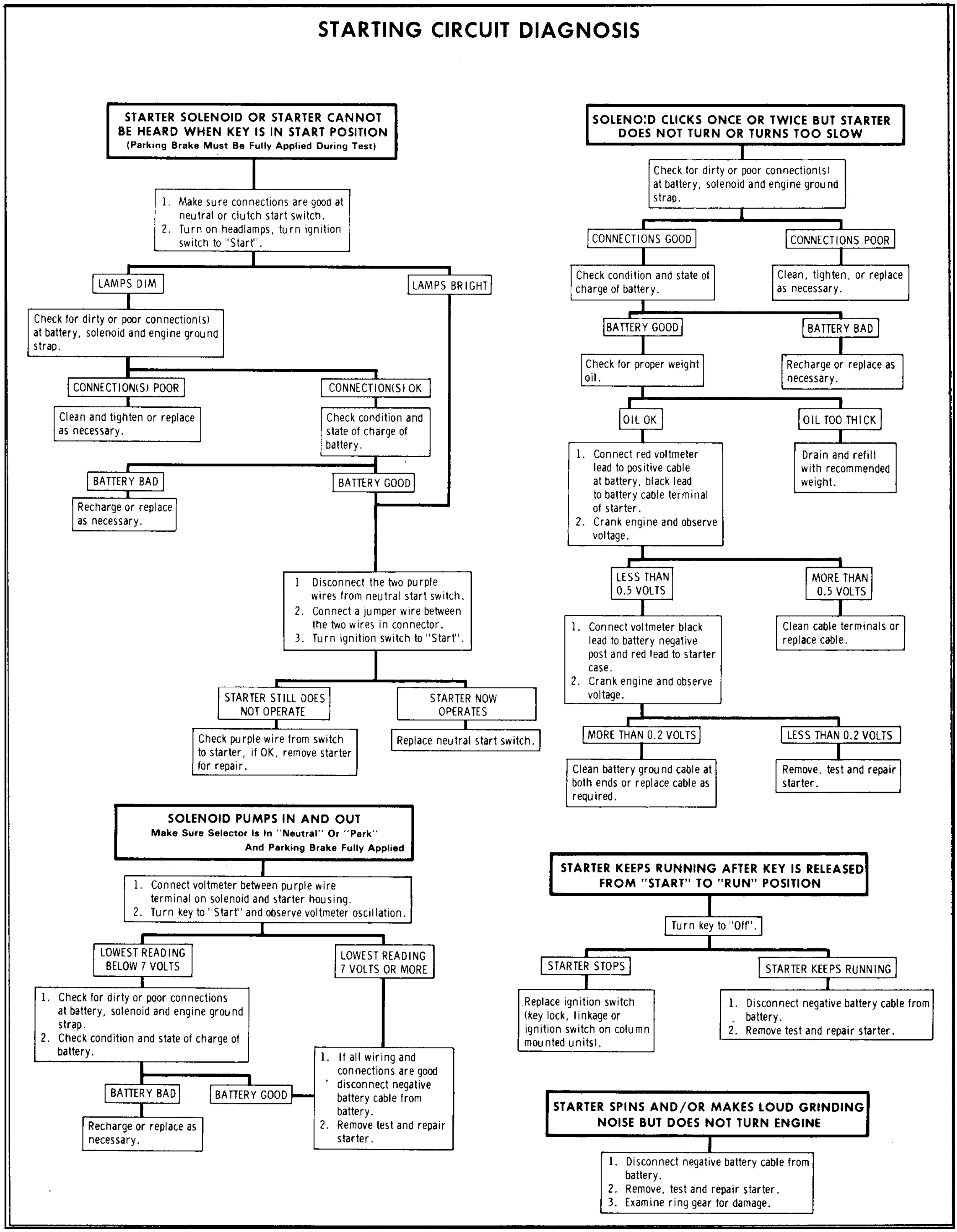
b. Shorted armature. This can be further checked on a growler after disassembly.

c. Grounded armature or fields. Check further after disassembly.

3. Failure to operate with high current draw indicates:

a. A direct ground in the terminal or fields.

b. "Frozen" bearings (this should have been determined by turning the armature by hand).



Starting Circuit Diagnosis

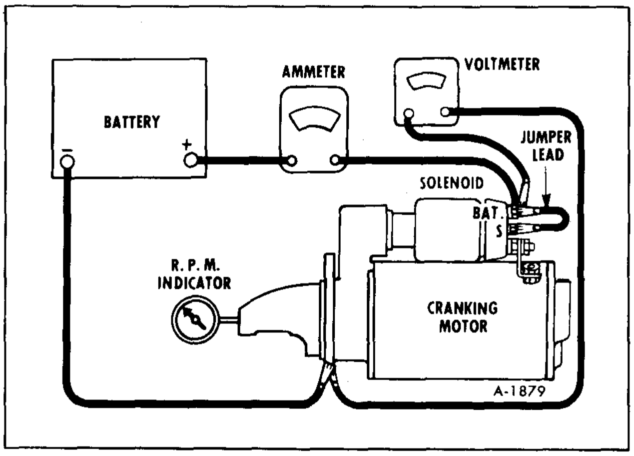


Figure 66—No-Load Test

4. Failure to operate with no current draw indicates:

a. Open field circuit. This can be checked after disassembly by inspecting internal connections and tracing circuit with a test lamp.

b. Open armature coils. Inspect the commutator for badly burned bars after disassembly.

c. Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.

5. Low no-load speed and low current draw indicates:

a. High internal resistance due to poor connections, defective leads, dirty commutator and causes listed under Number 4.

6. High free speed and high current draw indicate shorted fields. If shorted fields are suspected, replace the field coil assembly and check for improved performance.

DISASSEMBLY (FIGURE 67)

If the motor does not perform in accordance with published specifications, it may need to be disassembled for further testing of the components. Normally the cranking motor should be disassembled only so far as is necessary to make repair or replacement of the defective parts. As a precaution, it is suggested that safety glasses be worn when disassembling or assembling the cranking motor. Following are general instructions for disassembling a typical overrunning clutch drive cranking motor:

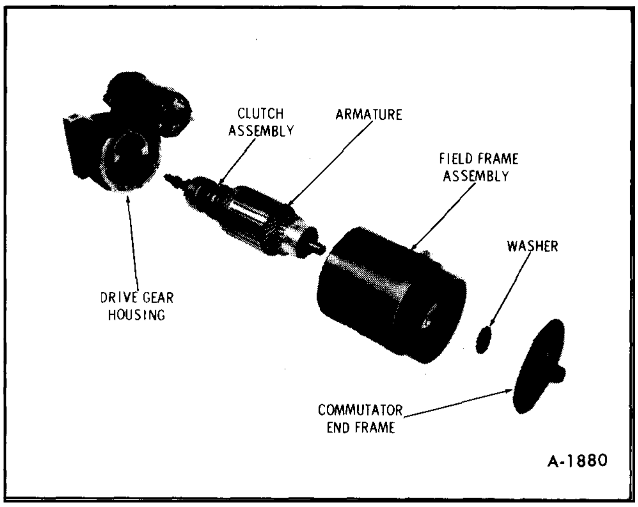


Figure 67—Starter Assembly Components

1. Disconnect the field coil connector from the motor solenoid terminal.

2. Remove through-bolts, then remove commutator end frame and washer.

3. Remove field frame assembly, armature, and clutch assembly from drive gear housing.

4. If necessary to remove overrunning clutch from armature shaft, proceed as follows:

a. Remove thrust collar from armature shaft. (figure 68)

b. Slide a standard half-inch pipe coupling or other metal cylinder of suitable size (an old pinion can be used if available) over shaft against retainer to be used as a driving tool. (figure 69) With armature shaft supported on wood block, tap end of driving tool until retainer clears snap ring.

c. Remove snap ring from groove in shaft

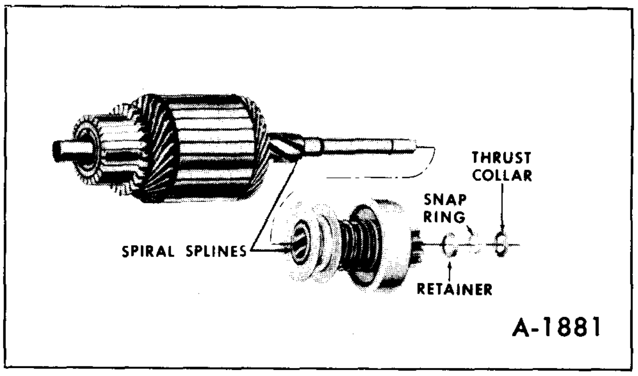


Figure 68—Starter Clutch

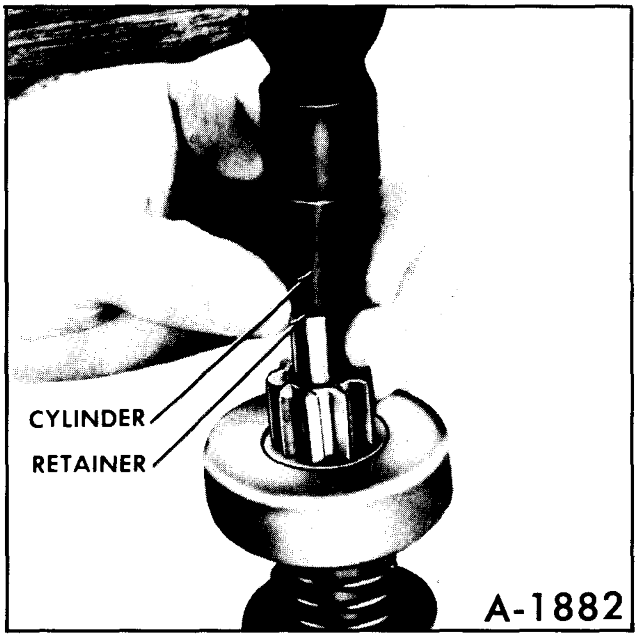


Figure 69—Removing Pinion Retainer

using pliers or other suitable tool. If the snap ring is distorted during removal, it will be necessary to use a new one upon reassembly.

d. Remove retainer and clutch assembly from armature shaft.

5. If necessary to replace brush holder parts, refer to Figure 70, then proceed as follows:

a. Remove brush holder pivot pin which positions one insulated and one grounded brush.

b. Remove brush spring.

c. Replace brushes as necessary.

6. If necessary to remove solenoid assembly or shift lever, proceed as follows:

a. Remove solenoid to drive gear housing attaching screws, then remove solenoid assembly. (figure 71)

b. To remove shift lever and/or plunger, remove shift lever pivot bolt (figure 72).

c. Disassemble shift lever from plunger.

CLEANING, INSPECTION AND TESTS

1. Clean all starting motor parts, but DO NOT USE GREASE DISSOLVING SOLVENTS FOR CLEANING THE OVERRUNNING CLUTCH, ARMATURE, AND FIELD COILS, since such solvent would dissolve the grease packed in the clutch mechanism and would damage armature and field coil insulation.

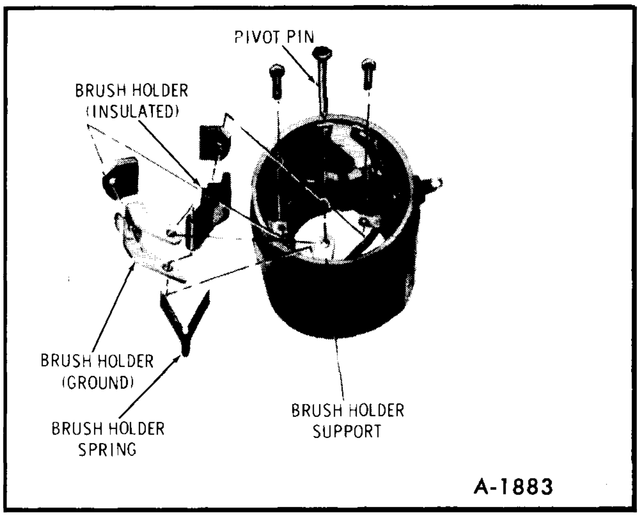


Figure70—Brush Installation

2. Test overrunning clutch action. The pinion should turn freely in the overruning direction. Check pinion teeth to see that they have not been chipped, cracked, or excessively worn. Replace clutch if worn or damaged.

3. Check brush holders to see that they are not deformed or bent and will properly hold brushes against the commutator.

4. Check fit of armature shaft in bushing in drive

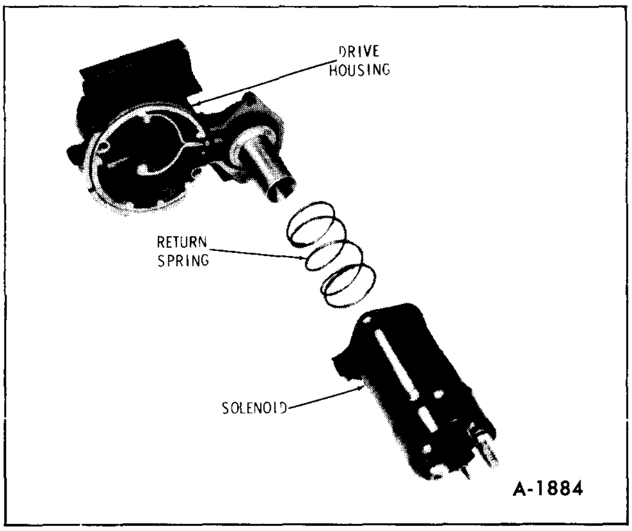


Figure 71—Solenoid Removal

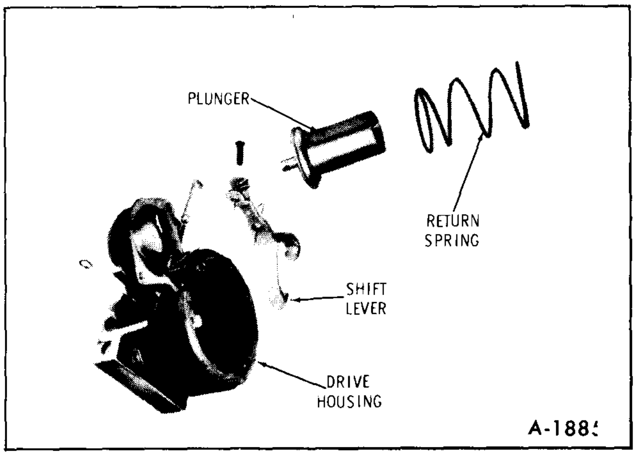


Figure 72—Shift Lever Removal

housing. Shaft should fit snugly in the bushing. If the bushing is worn, it should be replaced.

5. Inspect armature commutator. If commutator is rough or out-of-round, it should be turned down, do not undercut or turn to less than 1.650" O.D. Inspect the points where the armature conductors join the commutator bars to make sure they have a good connection. A burned commutator bar is usually evidence of a poor connection.

6. If test equipment is available:

a. Check the armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. If saw blade vibrates, armature is shorted. Recheck after cleaning between the commutator bars. If saw blade still vibrates, replace the armature.

b. Using a test lamp, place one lead on the shunt coil terminal and connect the other lead to a ground brush. (figure 73).

NOTE: This test should be made from both ground brushes to insure continuity through both brushes and leads. If the lamp fails to light, the field coil is open and will require repair or replacement.

c. Using a test lamp, place one lead on the series coil terminal and the other lead on the insulated brush. (figure 74) If the lamp fails to light, the series coil is open and will require repair or replacement.

NOTE: This test should be made from each insulated brush to check brush and lead continuity.

d. Using a test lamp, place one lead on the grounded brush holder and the other lead on either

Figure 73—Checking Shunt Field Coil

insulated brush. (figure 75) If the lamp lights, a grounded series coil is indicated and must be repaired or replaced.

e. Check the current draw of the solenoid winding as follows: (figure 76).

If solenoid is not removed from starting motor, the connector strap must be removed from the terminal on the solenoid before making these tests. Complete tests in a minimum of time to prevent overheating of the solenoid.

To check hold-in winding, connect an ammeter and a variable resistance in series with a 12-volt battery and the "switch" terminal on the solenoid. Connect a voltmeter to the "switch" terminal and to ground. Adjust the voltage to 10 volts and note the ammeter reading. It should be 14.5 to 16.5 amperes.

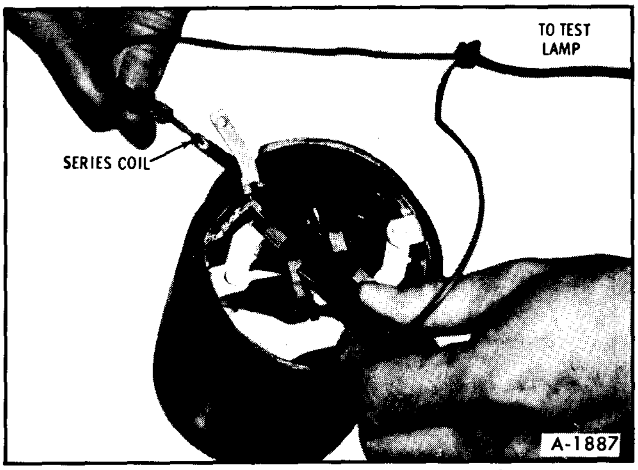


Figure 74—Checking Series Field Coil

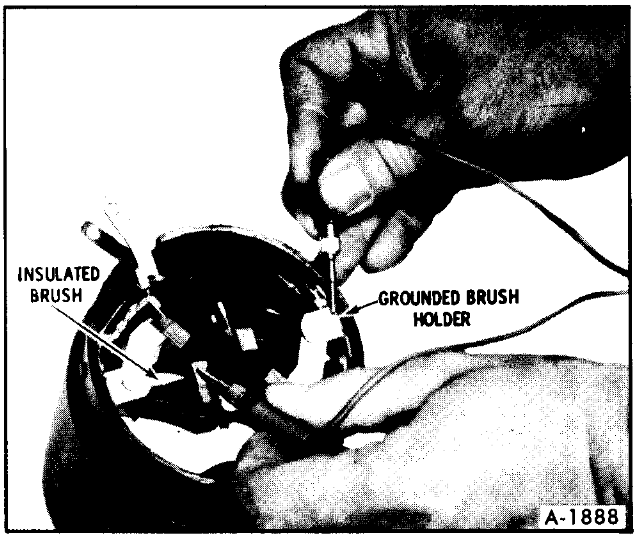


Figure 75—Checking Field Coil for Ground

To check both windings, connect the ammeter, variable resistance and voltmeter as for previous test. Ground the solenoid motor terminal. Adjust the voltage to 10 volts and note the ammeter reading. It should be 41 to 47 amperes for all starting motors.

Current draw readings that are over specifications indicate shorted turns or a ground in the windings of the solenoid and the solenoid should be replaced. Current draw readings that are under specifications indicate excessive resistance. No reading indicates an open circuit. Check connections then replace solenoid if necessary.

ASSEMBLY

1. If the solenoid assembly or shift lever was removed, proceed as follows:

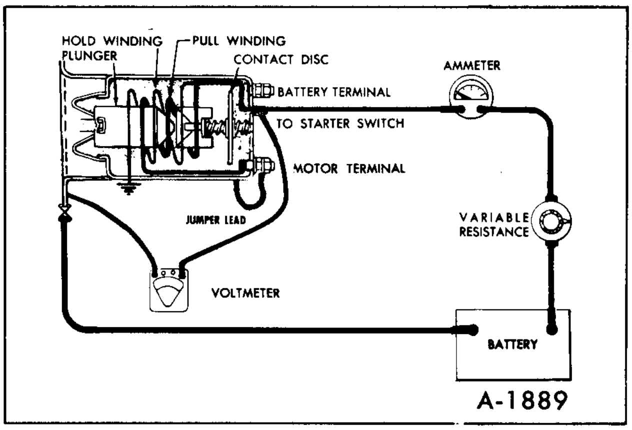


Figure 76—Checking Solenoid Wiring

a. Assemble shift lever and plunger.

b. Position shift lever and plunger assembly in drive gear housing and install lever pivot bolt. (figure 72)

c. Install solenoid assembly to drive gear housing. (figure 71)

2. If the overrunning clutch was removed from the armature shaft, assemble as follows:

a. Lubricate drive end of armature shaft with lubricant 1960954 or equivalent.

b. Slide clutch assembly onto armature shaft with pinion away from armature. (figure 68)

c. Slide retainer onto shaft with cupped surface facing away from clutch assembly.

d. Install snap ring into groove on armature shaft.

e. Assemble thrust collar onto shaft with shoulder next to snap ring.

f. Position retainer and thrust collar next to snap ring. Using two pliers, grip retainer and thrust collar and squeeze until snap ring is forced into retainer and is held securely in groove in armature shaft. (figure 77)

3. Lubricate drive gear housing bushing with lubricant 1960954 or equivalent.

4. With thrust collar in place against snap ring and retainer, slide armature and clutch assembly into

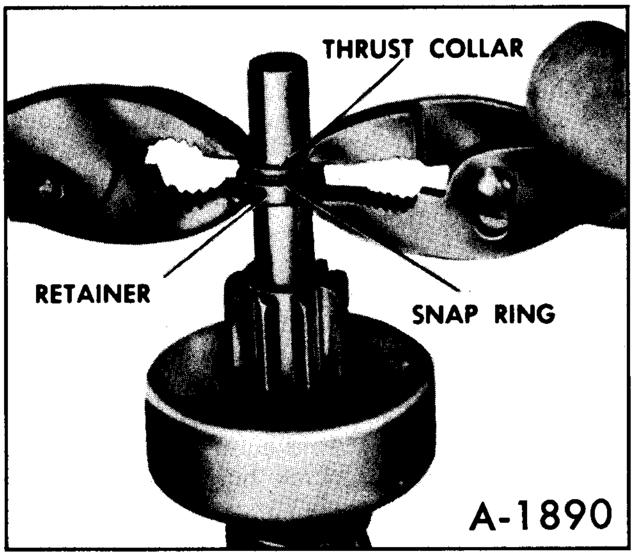


Figure 77—Installing Retainer and Snap Ring

drive gear housing and engage clutch with shift lever yoke.

5. Apply sealer, No. 1050026 or equivalent on solenoid flange as shown in (figure 78).

6. Position field frame against drive gear housing using care to prevent damage to brushes.

7. Lubricate commutator end-frame bushing with lubricant 1960954 or equivalent.

8. Install washer on armature shaft and slide end frame onto shaft then install and tighten through-bolts.

9. Connect the field coil connector to the motor solenoid terminal.

10. Check pinion clearance as outlined under PINION CLEARANCE.

PINION CLEARANCE

Whenever the cranking motor has been disassembled or the solenoid has been replaced, it is necessary to check the pinion clearance. Pinion clearance must be correct to prevent the buttons on the shift lever yoke from rubbing on the clutch collar during cranking.

To check, connect a voltage source of approximately 6 volts between the solenoid switch terminal and ground. (figure 78)

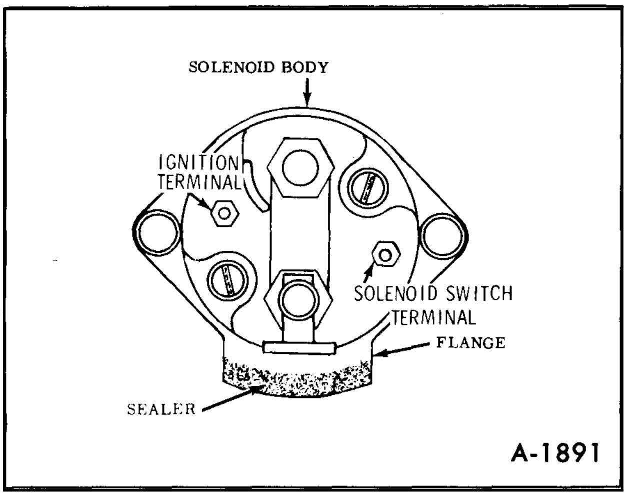


Figure 78—Solenoid Terminals and Sealing

NOTE: If a 6-volt battery is not available, a 12-volt battery may be used PROVIDING ONLY THREE CELLS ARE CONNECTED IN SERIES. TO PREVENT MOTORING, CONNECT A HEAVY JUMPER LEAD FROM THE SOLENOID MOTOR TERMINAL TO GROUND.

Energize the solenoid to shift the clutch, push the pinion back as far as possible to take up any movement, and check the clearance with a feeler gauge. (figure 79). The clearance should be .010" to .140".

Means for adjusting pinion clearance is not provided on the starter motor. If the clearance does not fall within limits, check for improper installation and replace all worn parts.

STARTER INSTALLATION

1. Connect the wires to the starter solenoid.

2. Position starter motor and secure with two bolts.

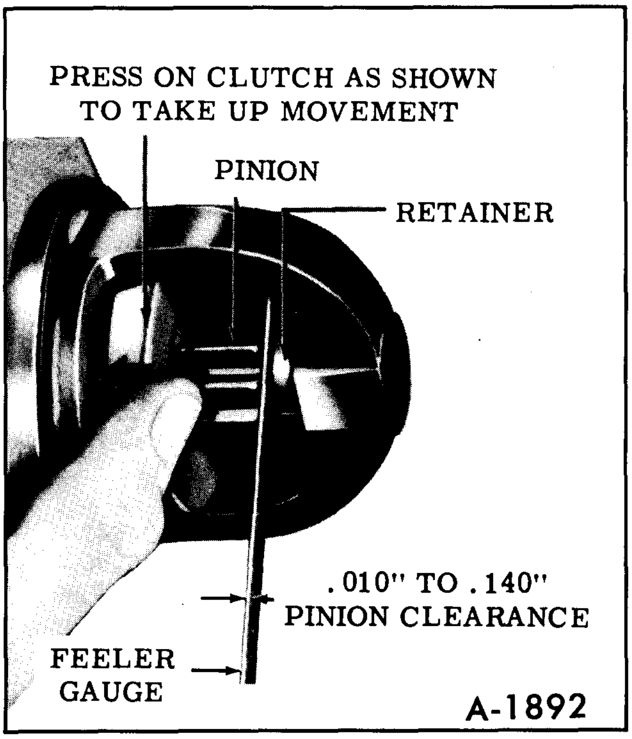


Figure 79—Checking Pinion Clearance

STARTER SPECIFICATIONS

STARTER MODEL	1108761	1108522
Make	Delco-Remy	Delco-Remy
Series	10MT	10MT
Type	100	100
Rotation (Viewed at Drive End)	CW	CW
No Load Test		
Volts	9	9
Minimum Amps*	65*	65*
Maximum Amps*	95*	95*
Minimum RPM	7,500	7,500
Maximum RPM	10,500	10,500
Pinion Clearance	010"-.140"	.010"-.140"
*Includes Solenoid		
STARTER SOLENOID		
Model	1114356	1114356
Rated Voltage	12	12
Current Consumption		
Pull-In Winding		
Amps	13.0-15.5	13.0-15.5
Volts	5	5
Hold-In Winding		
Amps	14.5-16.5	14.5-16.5
Volts	10	10
STARTER MODEL		1108522

IMPORTANT: 1975 vehicles with 1974 certified engines are equipped with starter model 1108522. 1975 and 1976 certified engines are equipped with starter model 1108761.

SPECIAL TOOLS

J-24642	HEI Module Tester
J-26290	SI Delcotron Tester
BT-33-73F	Belt Tension Gauge