X-7425

1973 GMC Motorhome Maintenance Manual

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SECTION 5
BRAKES

Contents of this section are listed below:

GENERAL INFORMATION

The Motor Home is equipped with disc brakes on the front wheels, and has drum brakes on the rear wheels. They are hydraulically powered by a split hydraulic system.

When the brake pedal is depressed, the piston in the master cylinder forces fluid under pressure to a wheel cylinder at each wheel, which in turn, pushes the brake shoes against the brake drum. As the shoes contact the drum, the friction between the shoes and the rotating drum moves the primary shoe downward against the adjusting screw which acts as a link to transmit the force of the primary shoe to the lower end of the secondary shoe. With the upper end of the secondary shoe being held by the stationary anchor pin, the secondary shoe is wedged against the drum. This wedging action, due to frictional force impacts the self-energizing action to the braking effort and thereby decreases the effort required by the driver to stop the car.

SELF-ADJUSTING BRAKE

The Motor Home is equipped with self-adjusting brakes. The self-adjusting brake mechanism consists of an actuating link, adjuster lever, adjuster lever return spring, override spring and override pivot.

OPERATION (DRUM TYPE)

The self-adjusting brake mechanism operates only when the brakes are applied while the vehicle is moving rearward and only when the secondary shoe moves a predetermined distance toward the brake drum.

As the vehicle moves rearward and the brakes are applied, friction between the primary shoe and the drum forces the primary shoe against the anchor pin. Hydraulic pressure in the wheel cylinder forces the upper end of the secondary shoe away from the anchor pin. As the secondary shoe moves away from the anchor pin, the upper end of the adjuster lever is prevented from moving by the actuating link. This causes the adjuster lever to pivot on the secondary shoe forcing the adjuster lever against the adjusting screw sprocket. If the brake linings are worn enough to allow the secondary shoe to move the predetermined distance, the adjuster lever will turn the adjusting screw sprocket one or two teeth, depending on lining wear. If the secondary shoe does not move the predetermined distance, movement of the adjuster lever will not be great enough to rotate the adjusting screw sprocket.

When the brakes are released, the adjusting lever return spring will move the adjuster lever into the adjusting position on the sprocket.

An override feature is build into the self-adjusting brake which allows the secondary shoe to be applied in reverse in the event the adjusting screw becomes "frozen" preventing the self-adjuster from operating.

When the vehicle is moving forward and the brakes are applied, the upper end of the secondary shoe is forced against the anchor pin due to the self-energizing action of the brakes and the self-adjuster does not operate.

OPERATION (DISC TYPE)

The significant feature of the single piston caliper operation is that it is free to slide on the two mounting bolts which thread into the support bracket.

At application of the brakes, the hydraulic pressure behind the piston increases. Pressure is exerted equally against the bottom of the piston and also against the bottom of the piston bore. The pressure applied to the piston is transmitted to the inboard shoe and lining, forcing the lining against the inboard disc surface. The pressure applied to the bottom of the piston bore forces the caliper to slide or move inboard on the mounting bolts. Since the caliper is one piece, this movement toward the vehicle causes the outboard section of the caliper to apply pressure against the back of the outboard shoe and lining assembly, forcing the lining against the outboard disc surface. As hydraulic pressure builds up, the shoe and lining assemblies are pressed against the disc surfaces with increased force, bring the vehicle to a stop.

In actual practice, the application and release of the brake pressure causes a very slight movement of the piston and caliper. Upon release of the braking effort, the piston and caliper merely relax into a released position. In the released position, the shoes do not retract any appreciable distance from the disc surfaces.

As the brake lining wears, the piston moves out of the caliper bore and the caliper repositions itself on the mounting bolts and equal distance inboard. In this manner the caliper assembly maintains the inboard and outboard shoe and lining in the same relationship with the disc surface throughout the full life of the lining.

MASTER CYLINDER

DESCRIPTION

The dual master cylinder is designed so that the front and rear brakes have separate hydraulic systems. The hydraulic pressure developed in both systems is equal at all times since the front piston is balanced between the hydraulic pressure in each system.

Malfunction in either system has no effect on the other system but is immediately evident to the driver because of the additional pedal travel required to actuate the remaining half of the dual brake system. Also, a pressure differential sensing switch in the system actuates a warning light on the instrument panel.

OPERATION

Two brake fluid reservoirs are cast integrally with the master cylinder and supply fluid to the areas ahead of the primary seals through the compensating ports and between the primary and secondary piston seals through by-pass ports in the casting.

Within the bore of the master cylinder is the rear piston assembly, which is composed of the piston, return spring, retainer, spacer and screw. Also in the bore is the front piston with a primary and two secondary piston seals are a front piston return spring and retainer.

Fluid is directed to the wheels through two hydraulic outlets, one for the front brakes and one for the rear brakes.

In the event the engine stalls, the vacuum chambers within the power cylinder provides adequate vacuum reserve for two or three brake applications. If the vacuum check valve is defective or braking has depleted the vacuum reserve, the driver can still operate the brakes in a conventional manner but more effort is required due to the loss of power assist.

WHEEL CYLINDER

OPERATION

Each wheel cylinder contains two pistons and two rubber cups which are held in contact with the pistons by a central coil spring with cup expanders to provide a fluid-tight seal. The wheel cylinder cups are of a special heat resisting rubber. Cups of this material must have an expander to hold the lips of the cup out against the wheel cylinder bore. These cup expanders are crimped on each end of the wheel cylinder spring. The inlet port for brake fluid is located between the pistons so that when fluid pressure is applied, both pistons move outward toward the ends of wheel cylinders. The pistons impart movement to the brake shoes by means of connecting links which seat in the pistons and bear against webs of the shoes. Rubber boots enclose both ends of the cylinder to exclude foreign matter. A valve for bleeding the brake pipes and wheel cylinder is located above the inlet port.

COMBINATION VALVE

A combination is incorporated into the brake system. It performs three functions; a balance function, a metering function, and a warning switch.

METERING VALVE FUNCTION

The metering section of the combination valve operates to "hold off" hydraulic flow (pressure) until about 130 psi has been built up in the system before applying the front brakes. The pressure then blends to full line pressure at approx. 400-600 psi line pressure. There is no flow restriction when the brakes are released.

BALANCE FUNCTION OR WARNING SWITCH

The fluid from front and rear systems is separated by a hydraulically balanced sealed piston. A spring loaded switch plunger rides in a groove in the switch piston. Any pressure differential sufficient to overcome the switch plunger spring and friction causes a shift of the piston in the direction of reduced pressure, causing the switch plunger to ride up out of its groove and the switch to make contact and light the warning light. (100-300 psi differential is required).

In addition, this piston is designed to hydraulically recenter itself once the pressure balance is restored (leak is fixed.)

PARKING BRAKE

OPERATION

The parking brake control system, which applies the four rear brakes, uses a hand operated lever, cables and brake shoe levers and struts. The front cable runs from the hand lever along the underbody to the front equalizer. The intermediate cable then runs to outside of each frame rail, and back to an intermediate equalizer. From this point a cable runs to each of the four brake drums. Each of these cables connects to the free lower end of a brake shoe lever. These levers (one in each rear brake shoe assembly) pivot on the secondary shoes. Struts are mounted between the brake shoe lever and the primary shoes. When the parking brake lever is raised, all cables are put in tension and the rear brake shoes are expanded against the drums.

POWER CYLINDER

The Power Brake Unit is a self-contained hydraulic and vacuum unit, utilizing manifold vacuum and atmospheric pressure for its power.

This unit permits the use of a low brake pedal as well as less pedal effort than is required with the conventional (nonpower) hydraulic brake system. The unit is mounted on the front side of the dash panel and directly connected to the brake pedal.

A power brake is used with the brake system to reduce the braking effort required by the driver. A combined vacuum and hydraulic unit, which utilizes engine manifold vacuum and atmospheric pressure, is used to provide power assisted application of vehicle brakes.

The unit is used in conjunction with a conventional brake system. From the master cylinder connection outward to the wheel units, there is no other change in the brake system.

In addition to the master cylinder connections, the unit requires a vacuum connection to the engine intake manifold (through a vacuum check valve) and a mechanical connection to the brake pedal. This unit is self-contained.

The vacuum power unit contains the power piston assembly, which houses the control valve and reaction mechanism, and the power piston return spring. The control valve is composed of the air valve (valve plunger), the floating control valve assembly, and the push rod. The reaction mechanism consists of a hydraulic piston reaction plate and a series of levers. An air filter, air silencer, and filter retainer are assembled around the valve operating rod filling the cavity inside the hub of the power piston. The push rod or valve operating rod, which operates the air valve, projects out of the end of the power unit housing through a rubber dust guard. A vacuum check valve assembly is mounted in the front housing assembly for connection to the vacuum source.

BRAKE SYSTEM TROUBLE DIAGNOSIS

TESTING FOR LEAK IN HYDRAULIC SYSTEM

NOTE: If there is any evidence of air in system, brakes must be bled before making this test.

1. Apply brakes manually, holding as steady a force as possible.

2. If pedal sinks slowly toward floor, a leak is indicated. Check for location of the leak by examining all lines, connections and wheel cylinders. If external leak is not found, remove master cylinder, disassemble and inspect parts. Leaks will usually be past primary piston cup due to porous or damaged cup or cylinder bore.

MASTER CYLINDER, WHEEL CYLINDER AND DRUM BRAKES

TROUBLE DIAGNOSIS CHART

SPRINGY, SPONDY PEDAL

Cause	Remedy
Air trapped in hydraulic system.	Remove air by bleeding (check compensating port for clearance of cup to provide full open port).
Brake adjustment not correct.	Adjust brakes.
Bent shoes	Replace.
Compensating port closed.	See ALL BRAKES DRAG.
Improper brake fluid.	Flush and bleed system using GM Hydraulic Brake Fluid Supreme No. 11 (or equivalent).
Improper lining thickness or location.	Install new lining or replace shoe and lining.
Drums worn too thin.	Replace drums.
Master cylinder filler vent clogged.	Clean vent or replace cap; bleed brakes.

LOW PEDAL

Cause	Remedy
Hydraulic System Failure.	Check master cylinder for empty reservoir. Check for leak at master cylinder, wheel cylinder, hoses, metal pipes, and all connections.
Self adjustors not working.	Inspect for incorrect installation or frozen adjuster screw and correct as necessary.
Low fluid level in master cylinder reservoir.	Low fluid level in reservoir will permit air to be pumped into hydraulic lines. This necessitates refilling reservoir and bleeding lines. Find cause of low fluid and correct.

LOW PEDAL

Cause	Remedy
External leak in hydraulic system, or leak past master cylinder primary piston cup.	Check for leak in system as outlined above.
Air trapped in hydraulic system.	Air trapped in hydraulic system gives pedal a very soft feel at the beginning of travel. Bleed brakes.
Incorrect fluid.	Incorrect fluid may boil at high temperature. Flush system and refill with Brake Fluid No. 5464831 or equivalent.
Excessive clearance between linings and drum.	Adjust brakes.

*BRAKES FADE

Cause	Remedy
1. Incorrect lining.	1. Replace with new lining.
2. Thin drum.	2. Replace drums.
3. Dragging brakes.	3. Adjust or correct cause.

*Fade is a temporary reduction of brake effectiveness resulting from heat.

ONE WHEEL DRAGS

Cause	Remedy
Improperly adjusted parking brake cables or stuck cable.	Adjust parking brake cables and lubricate.
Weak or broken brake shoe return springs.	Replace defective brake shoe springs and lubricate brake shoe ledges and shoe contact at anchor pin with brake lubricant No. 1050110 or equivalent.
Brake shoe to drum clearance too small.	Readjust brakes.
Wheel cylinder piston cups swollen or distorted or piston stuck.	Replace inoperative or damaged parts. Look for evidence of dirt in hydraulic system which could cause damage to the cylinders or cups. See first item under ALL BRAKES DRAG.
Obstruction in line.	Obstruction in line may be caused by foreign material or flattened or kinked tube. If dirt is found in line, remove obstruction and flush hydraulic system with fresh brake fluid. If tube is flattened or kinked, replace damaged parts.
Backing plate shoe pad grooved.	Grind or file pads smooth and lubricate with brake lubricant No. 1050110 or equivalent.
Incorrect brake shoe radius.	Replace malfunctioning brake shoe.

BRAKES DO NOT AUTOMATICALLY ADJUST

Cause	Remedy
Worn, bent or distorted adjuster lever.	Replace adjuster lever.
Improper secondary lining to drum clearance.	Adjust clearance.
Brake linings excessively worn.	Install new linings.

VEHICLE PULLS TO ONE SIDE

Cause	Remedy
Grease or fluid on lining.	Replace with new linings. Linings with even a slight trace of grease or fluid may effect the operation of the brakes and can seldom be salvaged by cleaning. Correct cause of grease or fluid reaching linings.
Improper lining contact with drum.	Grind or replace lining.
Wheel bearings excessively loose.	Adjust wheel bearings.
Loose backing plate.	Tighten backing plate.
Linings not to specifications, or primary and secondary shoes reversed. New and used linings mixed on one end of vehicle.	Various kinds of linings have different frictional effects on the drums and on each other. Each wheel must have similar linings. The primary and secondary linings must not be interchanged. Use only factory specified linings.
Tires not properly inflated or unequal wear of tread. Different tread design.	Inflate tires to specified pressures. Rearrange tires so that a pair with non-skid tread surfaces of similar design and equal wear will be installed on front wheels and pairs with like tread will be installed on rear wheels.
Linings charred or drums scored.	Sand surfaces of linings and drums. Remove particles of metal that have become embedded in surfaces of linings. Seriously charred linings should be replaced.
Wheel cylinder link off shoe.	Check boot for holes. Check for burrs on wheel cylinder piston caused by piston forced against stop. Reinstall link.
Defective wheel cylinder.	Repair or replace as required.
Obstruction in line.	Clear or replace as required.
Water, mud, etc., in brakes.	Remove any foreign material from all brake parts and the inside of drums. Lubricate shoe ledges and rear brake cable ramps with grease. Examine support assembly for damage.
Loose steering gear, etc.	Adjust steering gear, etc.
Incorrect geometry setting of front suspension.	Adjust geometry so that vehicle does not have a tendency to lead when driven on a level road.
Weak or broken retracting springs.	Check springs-replace bent, open-coiled or cracked springs.
Out-of-round drums.	Resurface or replace drums in left and right hand pairs (both front and both rear).
Clogged or crimped hydraulic line.	Repair or replace line.

EXCESSIVE PEDAL PRESSURE REQUIRED TO STOP VEHICLE

Cause	Remedy
Brake adjustment not correct.	Adjust brakes.
Improper lining.	Install factory specified shoes.
Improper shoes.	Install factory specified shoes.
Grease or fluid soaked linings.	Correct cause and replace linings, if necessary.
Rusted wheel cylinder.	Replace.
Wheel cylinder link incorrectly aligned.	Check wheel cylinder piston and boot for damage. Install link.
Compensating port not cleared.	Check pedal linkage, stop light switch adjustment.
Brake pedal binding on shaft.	Lubricate with Delco Brake Lube #5450032 (or equivalent).
Glazed linings.	Sand surface of linings.
Bellmouthed, barrel-shaped or scored drums.	Replace or resurface drums in left and right hand pairs.

CRUNCH OR GROAN, HOLDING VEHICLE ON HILL

Cause	Remedy
Brake dust and possibly linings which have been overheated.	Sand linings and remove dust from brakes.

HIGH PITCH SQUEAK WHILE BRAKES OPERATE

Cause	Remedy
New linings not yet fully burnished.	Burnish further or sand off high spots of linings.
Persistent squeak-no apparent cause.	Sand linings for temporary cure or mild cases. Install drum springs for stubborn cases of high pitch squeak.

REAR BRAKES DRAG

Probable Cause	Remedy
1. Maladjustment.	1. Adjust brake shoes and parking brake mechanism.
2. Parking brake cables frozen.	2. Lubricate with Delco Brake Lube #5450032 (or equivalent).

ALL BRAKES DRAG OR PEDAL BUILDS UP WITH USE AFTER ADJUSTMENT IS CHECKED AND FOUND TO BE CORRECT

Cause	Remedy
Mineral oil, etc., in system.	The presense in the hydraulic system of any mineral oil, kerosene, gasoline, shock absorber or transmission fluid, or carbon tetrachloride will cause swelling of rubber piston cups, and valves, so they become inoperative. This is first noticed in the master cylinder. Brakes will not release freely if master cylinder primary piston cup has swollen sufficiently to obstruct the compensating port. Flush system thoroughly with a good grade of clean brake fluid and replace all internal rubber parts in brake system.
Pedal does not return freely.	Lubricate pedal linkage and make certain no bind exists. See that stop light switch is not defective, incorrectly adjusted, or that switch plunger is not binding on pedal due to lack of lubrication.
Compensating port of master cylinder closed.	The compensating port in master cylinder must be completely clear when pedal is in released position. 1. See that pedal returns freely and is not stopped by contact with stop light switch body or pedal bracket. 2. See that compensating ports are not plugged by dirt. To check compensating port, remove master cylinder reservoir cover and watch the fluid in the cylinder as the brake pedal is moved. A "geyser" should be seen as the pedal is first depressed. If no geyser is seen, the compensating port is blocked. 3. Inspect master cylinder primary piston cup and if found to be swollen or elongated, flush system and replace damaged parts.

LOUD LOW PITCH SQUEAL AT END OF HIGH RATE STOP

Cause	Remedy
New linings not fully burnished.	Check adjustment. Sand lining high spots.
Angle on shoe web at adjusting screw notch.	File straight.
Bent backing plate. Top of shoe webs should be in line with each other looking down on them. Check after pushing shoes toward backing plate at top.	Straighten or replace.
Incorrect adjustment.	Adjust brakes. (NOTE: Drum springs not effective against low pitch squeal or howl.)

PEDAL THROB AT LIGHT APPLICATIONS AT LOW SPEED

Cause	Remedy
Drum out-of-round or off center.	Turn down.

ROUGH FEEL DURING HIGH RATE STOPS FROM MODERATE SPEED

Cause	Remedy
Tool chatter. Look for faint light and darker stripes running across the braking surface.	Turn drum.

LIGHT PEDAL PRESSURE–BRAKES TOO SEVERE

Cause	Remedy
Brake adjustment not correct.	Adjust brakes.
Loose support assembly.	Tighten rear backing plates. Adjust brakes.
Small amount of grease or fluid on linings.	Correct cause and replace linings.
Charred linings or scored drums.	Sand surfaces of linings and drums. Clean loose dust from brake. In severe cases replace shoes. Warn owner regarding abuse of brakes. Remove all particles that have become imbedded in surfaces of linings. Slightly scored drums do not require replacing or turning.
Improper linings.	Install factory specified linings.

SQUEAK IN BRAKE WITH VEHICLE STATIONARY (SOMETIMES MISTAKEN FOR PEDAL SQUEAK)

Cause	Remedy
Shoe pads on backing plates dry and rusty.	Pry shoes out with screwdriver-apply grease sparingly to shoe pads with feeler stock.

CREAK WHEN BRAKES ARE APPLIED AT LOW VEHICLE SPEED

Cause	Remedy
Anchor pins dry.	Grease anchor pins where shoes bear.

SCRAPE IN BRAKES AS PEDAL IS APPLIED, VEHICLE STATIONARY

Cause	Remedy
Hold-down nail heads dry.	Lubricate. Although adjusting brakes temporarily changes these noises, lubrication will remedy.

PEDAL SQUEAK

Cause	Remedy
Dry pedal bushings or stop light switch rubbing pedal.	Lubricate.

CLICKS DURING HIGH RATE STOPS, USUALLY ONCE PER WHEEL REVOLUTION IN ONE WHEEL ONLY

Cause	Remedy
Threaded drum.	Cross sand.

CHATTER AT HIGH SPEED

Cause	Remedy
Drum out-of-round with 2 or more distinct high spots in circumference.	Turn drum.

CLICK FIRST APPLICATION AFTER REVERSING

Cause	Remedy
Shoes out from anchor pins.	File shoe pads on backing plates; lubricate. Although adjusting brakes temporarily changes these noises, lubrication will remedy.

TROUBLE DIAGNOSIS CHART

SINGLE PISTON DISC BRAKES

PULLS

Cause	Correction
Incorrect tire pressures.	Inflate evenly on both sides to the recommended pressures.
Front end out of line.	Check and align to specifications.
Unmatched tires on front of vehicle.	Tires with approximately the same amount of tread should be used on the same axle.
Restricted brake tubes or hoses.	Check for soft hoses and damaged lines. Replace with new hoses and new double-walled steel brake tubing.
Malfunctioning caliper assembly.	Check for stuck or sluggish pistons, proper lubrication.
Defective or damaged shoe and lining (grease or brake fluid on lining or bent shoe).	Install new shoe and lining in complete axle sets.
Malfunctioning rear brakes.	Check for inoperative auto adjusting mechanism, defective lining (grease or brake fluid on lining) or defective wheel cylinders. Repair as necessary.
Loose suspension parts.	Check all suspension mountings.
Loose calipers.	Check and torque bolts to specifications.

BRAKE ROUGHNESS OR CHATTER (PEDAL PULSATES)

Cause	Correction
Excessive lateral runout.	Check and replace or machine the rotor, if not within specifications.
Parallelism not within specifications.	Check and replace or machine the rotor, if not within specifications.
Rear drums out of round.	Check runout and, if not within specifications, turn the drums (not over maximum of 0.060″ on the diameter).
Shoe reversed (steel against iron).	Replace shoe and lining and machine rotor within specifications.

EXCESSIVE PEDAL EFFORT

Cause	Correction
Malfunctioning power brake.	Check power brake and repair if necessary.
Partial system failure.	Check front and rear brake system and repair, if necessary. Also check brake warning light, if a failed system is found and light did not function, repair as necessary.

EXCESSIVE PEDAL EFFORT

Cause	Correction
Excessively worn shoe and lining.	Check and replace in axle sets.
Piston in caliper stuck or sluggish.	Remove caliper and rebuild or replace.
Fading brakes due to incorrect lining.	Remove and replace with original equipment lining.

EXCESSIVE PEDAL TRAVEL

Cause	Correction
Partial brake system failure.	Check both front and rear system for a failure and repair. Also, check warning light. It should have indicated a failure.
Insufficient fluid in master cylinder.	Fill reservoirs with approved brake fluid. Check for leaks. Check warning light.
Air trapped in system.	Bleed system.
Rear brake not adjusting.	Adjust rear brakes and repair adjusters.
Bent shoe and lining.	Replace axle set of shoe and lining.

GRABBING OR UNEVEN BRAKING ACTION

Cause	Correction
All conditions listed under "PULLS."	All corrections listed under "PULLS."
Malfunction of combination valve.	Replace and bleed system.
Malfunction of power brake unit.	Check operation and repair, if necessary.

DRAGGING BRAKES

Cause	Correction
(NOTE: A very light drag is present in all disc brakes immediately after pedal is released.)	
Master cylinder pistons not returning correctly.	With reservoir cover off, check for fluid spurt at bypass holes as pedal is depressed. Check power cylinder push rod, if necessary, or rebuild master cylinder.
Restricted brake tubes or hoses.	Check for soft hoses or damaged tubes and replace with new hoses and new double-walled steel brake tubing.
Incorrect parking brake adjustment on rear brakes.	Check and readjust to correct specifications.

POWER CYLINDER TROUBLE DIAGNOSIS CHART

Before checking the power brake system for the source of trouble, refer to the trouble diagnosis of drum and disc brakes. After these possible causes have been eliminated, check for the cause as outlined in the following chart:

BRAKES FAIL TO RELEASE

Cause	Correction
Blocked passage in diaphragm plate	Inspect and repair or replace as necessary.
Air valve sticking shut.	Check for proper lubrication of air valve "O" rin
Broken piston return spring.	Replace.
Broken air valve spring.	Replace.
Tight pedal linkage.	Repair or replace as necessary.

HARD PEDAL

Cause	Correction
Broken or damaged hydraulic brake lines.	Inspect and replace as necessary.
Vacuum Failure.	Check for: Faulty vacuum check valve or grommet-replace. Collapsed or damaged vacuum hose-replace. Plugged or loose vacuum fitting-repair. Faulty air valve seal or support plate seal-replace. Damaged control valve-replace. Bad stud welds on front or rear housing or power head-replace, unless easily repaired.
Defective diaphragm.	Replace.
Restricted air filter element.	Replace.
Worn or badly-distorted reaction disc.	Replace reaction disc.
Incorrect reaction disc.	Replace with correct disc.

GRABBY BRAKES (Apparent Off-On Condition)

Cause	Correction
Broken or damaged hydrualic brake lines.	Inspect and replace as necessary.
Insufficient fluid in master cylinder	Fill reservoirs with approved brake fluid, check for leaks.
Defective master cylinder seals.	Repair or replace as necessary.
Cracked master cylinder casting.	Replace.
Leaks at front disc brake calipers or rear wheel cylinders in pipes or connections.	Inspect and repair as necessary.
Air in hydraulic system.	Bleed system.

ON-VEHICLE SERVICING

BLEEDING BRAKE SYSTEM

A bleeding operation is necessary to remove air whenever it is introduced into the hydraulic brake system. Since air is compressible and hydraulic fluid is not, the presence of air in the system is indicated by a springy, spongy feeling of the brake pedal accompanied by poor braking action.

Air can be introduced into the hydraulic system if the brake pedal is operated when the fluid is too low in master cylinder reservoir. Air will also enter the system whenever any part of hydraulic system is disconnected.

It may be necessary to bleed the hydraulic system at all six wheels if air has been introduced through low fluid level or by disconnecting brake lines at master cylinder. If the brake line is disconnected at any wheel cylinder, then that wheel cylinder only need be bled. If lines are disconnected at any fitting located between master cylinder and wheel cylinders, then all wheel cylinders served by the disconnected line must be bled.

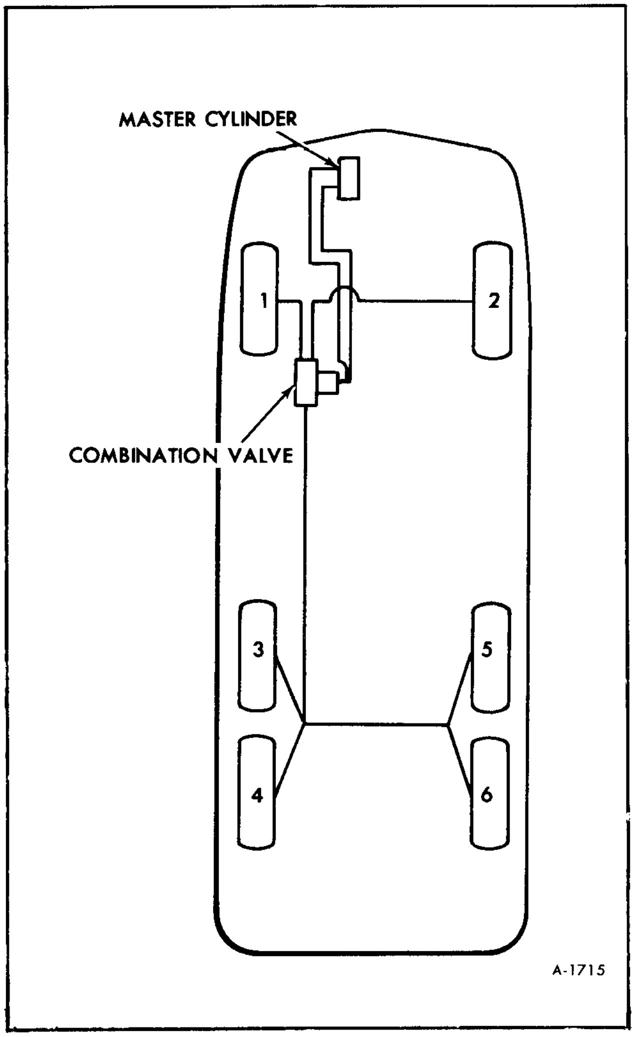


Figure 1–Brake Bleeding Sequence

SEQUENCE FOR BLEEDING WHEEL CYLINDERS

It is advisable to bleed one wheel cylinder at a time to avoid allowing fluid level in reservoir to become dangerously low. For the proper sequence refer to Figure 1.

Do not perform bleeding operation while any brake drum or disc pad is removed.

BLEEDING WHEEL CYLINDER WITHOUT PRESSURE TANK

1. Fill master cylinder.

2. Install bleeder wrench on bleeder valve. Slip a brake bleeder hose over ball of wheel cylinder bleeder valve (See figure 2). Place lower end of bleeder tube in a glass jar that is partially filled with clean brake fluid. Position end of tube so that it will remain

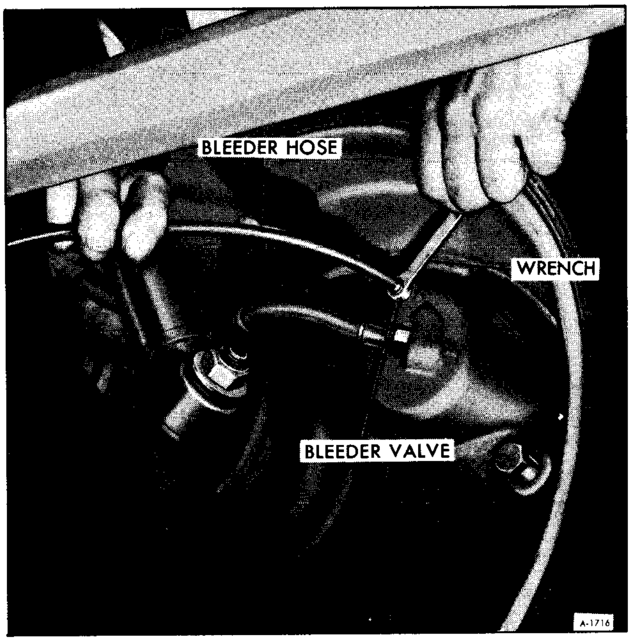


Figure 2–Brake Bleeder Wrench and Hose

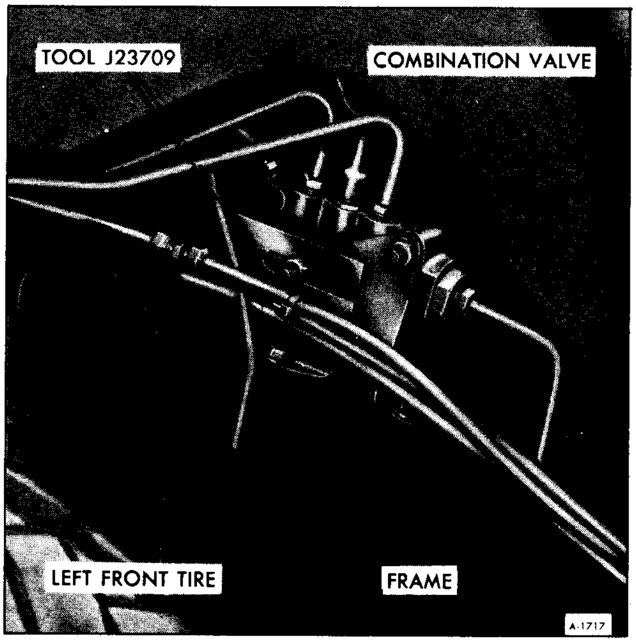


Figure 3–Tool J-23709 Installed

submerged under fluid during bleeding operation. Unscrew bleeder valve 3/4 of a turn.

Attach J-23709 to the combination valve (figure 3) to hold the push rod in and allow the pressure in the line to flow through the valve requiring less pressure to bleed the front cylinders.

3. Depress brake pedal a full stroke, close bleeder valve, then allow pedal to return slowly to released position. Allowing pedal to return quickly may draw air into system. Continue operating pedal in this manner until fluid flows from bleeder tube into glass jar in a solid stream that is free of air bubbles, then close the bleeder valve securely and remove bleeder tube and wrench.

4. Frequently check master cylinder to make sure that is contains fluid. Allowing reservoir to be emptied will cause air to be drawn into hydraulic system.

5. When bleeding operation is completed at all wheel cylinders where needed, make sure that fluid level is no more than 1/4" below lip of reservoir, then install rubber diaphragm and cover.

6. Discard the brake fluid deposited in glass jar during bleeding operation.

BLEEDING WHEEL CYLINDER WITH PRESSURE TANK

When using a pressure tank, air bubbles may form in the tank and enter the brake hydraulic system. To avoid this, observe the following points when handling a pressure tank: (1) Do not shake or agitate the pressure tank after air pressure has been added or is being added. (2) Allow pressure tank to stand in one position as much as possible and bring air hose over to tank when adding head of air. (3) Make certain the valves on the pressure tank lines are not defective, allowing air to be sucked in when fluid passes through the lines. (4) Pressure tank should be kept at least 1/3 full of fluid to avoid air bubbles forming. (5) If pressure tank is full of air bubbles, release air pressure and those bubbles will increase in size, be forced to top of fluid and escape.

It is recommended that pressure bleeding equipment must be of the diaphragm type; that is, it must have a rubber diaphragm between the air supply and the brake fluid to prevent air, moisture, oil, and other contaminants from entering the hydraulic system.

1. Thoroughly clean master cylinder reservoir cover and surrounding area; then remove cover and diaphragm.

2. Make sure that pressure tank is at least 1/3 full of specified brake fluid and that hose and master cylinder reservoir are filled with fluid. Attach hose to master cylinder reservoir adapter.

3. Install Bleeder Wrench on bleeder valve. Slip a brake bleeder tube over ball of wheel cylinder bleeder valve (figure 2). Place lower end of bleeder tube in a clean glass jar. Unscrew bleeder valve 3/4 of a turn.

Attach J-23709 to the combination valve to hold the push rod in and allow the pressure in the line to flow through the valve (figure 3).

4. Open pressure tank hose valve to apply fluid to master cylinder under pressure that does not exceed 35 pounds. It is not necessary to pump the brake pedal when using pressure tank.

5. When fluid flows from bleeder tube into glass jar in a solid stream that is free of air bubbles, that particular cylinder and line are bled; tighten bleeder valve securely and remove bleeder tube.

6. When bleeding operation is completed at all wheel cylinders, where needed, make sure that fluid level is 1/4" from the lowest portion of the top of each reservoir. Install rubber diaphragm and cover.

FLUSHING BRAKE HYDRAULIC SYSTEM

It is recommended that the entire hydraulic system be thoroughly flushed with clean brake fluid whenever new parts are installed in the hydraulic system.

Flushing is also recommended if there is any doubt as to the grade of fluid in the system or if fluid has been used which contains the slightest trace of mineral oil.

Flushing is performed at each wheel cylinder in turn, and in the same manner as the bleeding operation except that bleeder valve is opened 1-1/2 turns and the fluid is forced through the pipes and wheel cylinder until it emerges clear in color. Approximately two quarts of fluid is required to flush the hydraulic system thoroughly.

When flushing is completed at all wheel cylinders, make certain that master cylinder reservoir is filled to proper level.

PARKING BRAKE ADJUSTMENT

Normal driver adjustment of the parking brake can be done at the parking brake lever. The knob on top of the lever can be used to increase or decrease the tension on the cable (figure 4).

If the tension on the cable cannot be adjusted at the lever it should be adjusted at the intermediate equalizer.

1. Turn the adjusting knob on top of parking brake lever counterclockwise until it comes up against its stop.

2. Apply and release parking brake lever.

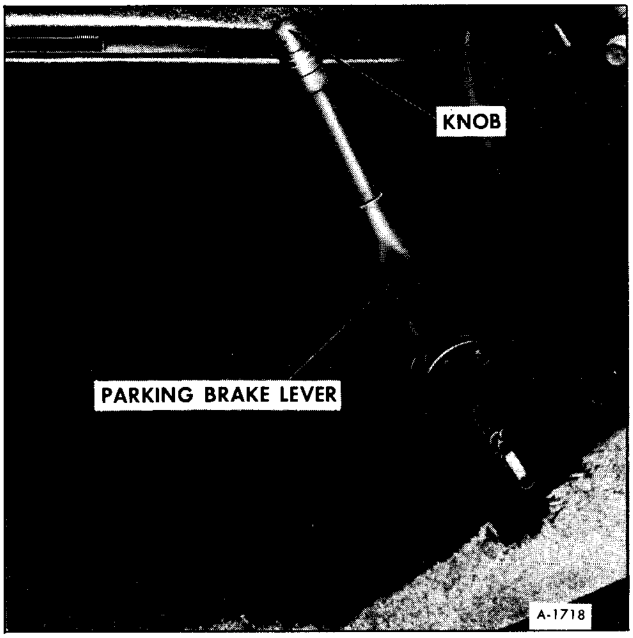


Figure 4–Parking Brake Lever Knob

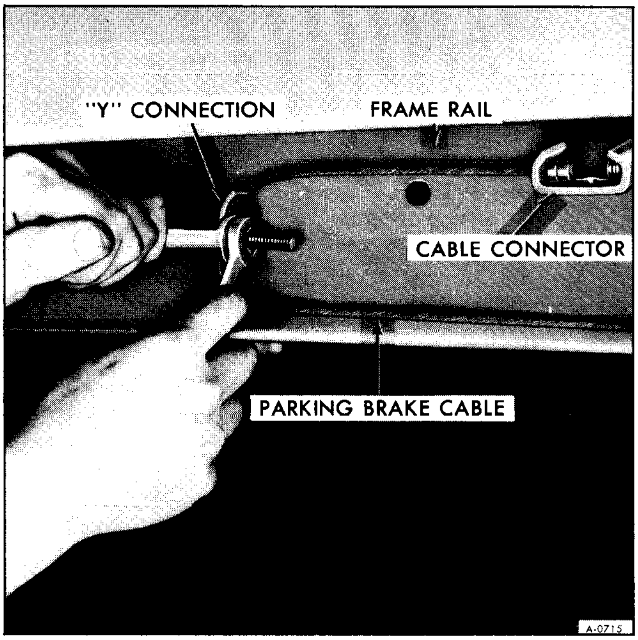


Figure 5–Loosening Intermediate Adjusting Nuts

3. Jack up rear wheels.

4. Loosen lock nut at intermediate cable equalizer as shown in Figure 5 and adjust front nut to give light drag at rear wheels.

5. Back off front nut until drag is just removed and lock.

6. Apply lever and re-adjust parking brake lever knob to give a definite snap-over-center feel.

7. Fully release parking brake and rotate rear wheels. No drag should be present.

8. Lower vehicle to floor.

BRAKE SHOE ADJUSTMENT (DRUM INSTALLED)

1. If shoes are being adjusted for the first time a suitable punch, is used to knock out lanced area in brake backing plate, refer to Figure 6. If this is done with the drum installed on Motor Home, the drum must be removed and all metal cleaned out of the brake assembly. Be sure to procure a new hole cover and install it in the backing plate after adjustment to prevent dirt and water from getting into brakes. Use J-4735 to turn brake adjusting screw; expand brake shoes at each wheel until the wheel can just be turned by hand. The drag should be equal at all wheels.

2. Back off brake adjusting screw (figure 7) at each wheel 30 notches. If shoes drag lightly on drum,

Figure 6–Lanced Area in Backing Plate

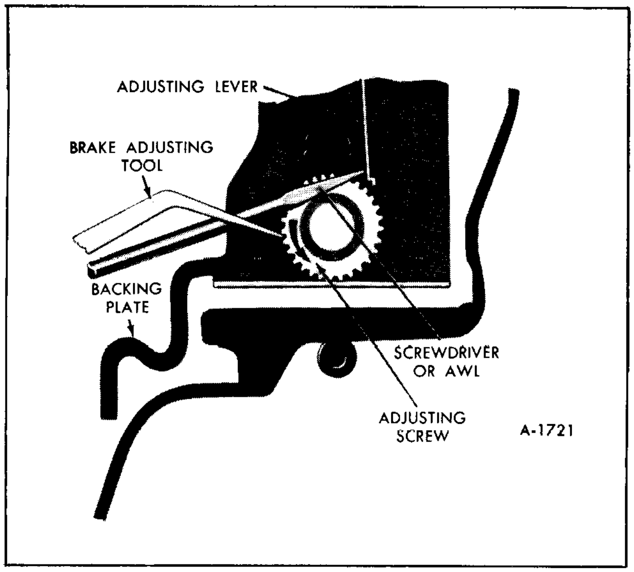


Figure 7–Backing Off Brake Adjustment

back off adjusting screw one or two additional notches.

NOTE: Brake should be free of drag when screw has been backed off approximately 12 notches. Heavy drag at this point indicates tight parking brake cables.

3. Install adjusting hole cover in brake backing plate when adjustment is completed.

4. Check parking brake adjustment as described earlier in this section.

DISC BRAKE ADJUSTMENT

The disc brakes on the front of the Motor Home require no periodic adjustment. They are adjusted with each brake application. As the piston in the caliper compensates for wear of the brake lining it requires more fluid. For this reason the master cylinder fluid level should be checked frequently.

COMPONENT REMOVAL

BRAKE DRUM REMOVAL

1. Hoist rear wheels off ground.

NOTE: It may be necessary to back off the brake shoe adjustment before the brake drum can be removed. To back off brake shoe adjustment, refer to Figure 7.

2. Remove wheel and tire.

3. Remove dust cap as shown in Figure 8.

4. Remove cotter pin and castillated nut from hub as shown in Figure 9.

5. Hub and drum assembly can now be removed. See Figure 10.

REAR BRAKE SHOE REMOVAL (FIGURE 11)

1. Hoist vehicle remove wheel and brake drum.

Figure 8–Removing Dust Cap

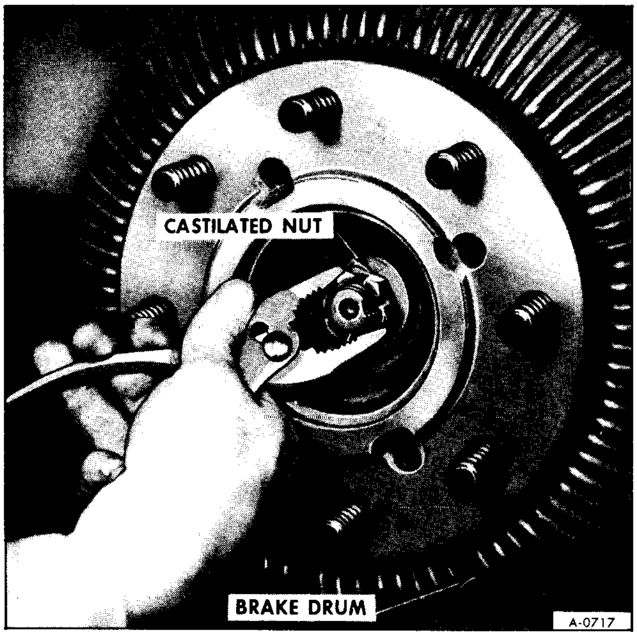


Figure 9–Removing Castillated Nut

2. Remove the brake shoe return springs actuating link and guide.

3. Remove the brake shoe hold-down springs, the adjuster lever and return spring and the parking brake lever strut and spring.

4. Spread shoes to clear wheel cylinder links then remove the brake shoes as an assembly.

5. Disconnect the parking brake cable from the operating lever.

Figure 10–Removing Hub and Drum

DISC BRAKE SHOE REMOVAL

1. Remove caliper as described later in this section under "Disc Removal."

2. Remove inboard shoe.

3. Remove outboard shoe.

4. Remove pad support spring from inboard shoe.

5. Remove sleeves from inboard ears of caliper.

6. Remove the rubber bushing from the grooves in each of the four caliper ears (figure 12).

COMBINATION VALVE REMOVAL (FIGURE 13)

No attempt should be made to disassemble or repair the valve. If any failure should occur, the complete valve should be replaced.

1. Disconnect all brake lines at valve. Plug lines to prevent loss of fluid and entrance of dirt.

2. Disconnect warning switch wiring connector from valve switch terminal.

3. Remove valve assembly from mounting bracket.

MASTER CYLINDER REMOVAL

The master cylinder can be removed without removing the power cylinder.

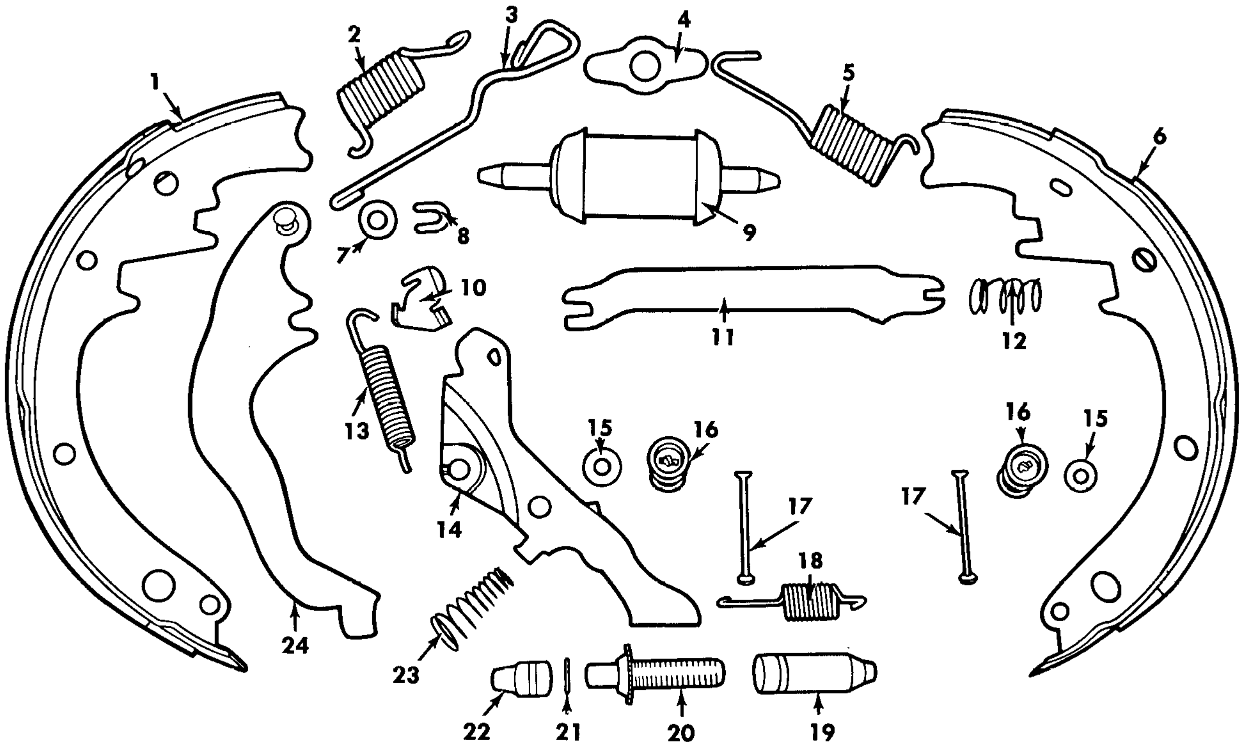
1. Be sure area around master cylinder is clean, then disconnect the hydraulic lines at the master cylinder (Refer to figure 14). Plug or tape ends of lines to prevent entrance of dirt of loss of brake fluid.

2. Remove two master cylinder attaching nuts and remove master cylinder as shown in Figure 15.

DISC REMOVAL

1. Siphon approximately two-thirds of the brake fluid from the front reservoir of the master cylinder. Discard fluid.

NOTE: Do not empty front reservoir or it will be necessary to bleed the brake system.



1. Secondary Shoe And Lining
2. Return Spring
3. Actuating Link
4. Guide Plate
5. Return Spring
6. Primary Shoe And Lining
7. Washer
8. Clip
9. Wheel Cylinder
10. Pivot
11. Strut
12. Spring
13. Override Spring
14. Adjuster Lever
15. Washer
16. Hold Down Spring
17. Pin
18. Spring
19. Nut
20. Adjusting Screw
21. Washer
22. Socket
23. Return Spring
24. Lever

A-1725

Figure 11–Brake Assembly (Rear)

2. Hoist Motor Home and remove wheel.

3. Remove cotter pin, and drive axle nut and washer.

4. Position Tool J-22269 on caliper as shown in Figure 16.

5. Tighten screw of tool until caliper moves outboard far enough to push piston to bottom of piston bore. This will allow the shoes to back off from disc surface. Remove Tool J-22269.

6. Remove the two caliper to knuckle attaching bolts.

7. Carefully lift caliper assembly from disc and position so that brake hose is not kinked or stretched.

8. Loosen uniformly and remove the three bolts securing the retainer to the knuckle (figure 17).

9. Position tool No. J-24717 on hub as shown in Figure 18.

10. Operate slide hammer, tool No. J-2619, until assembly is free of knuckle.

11. Remove slide hammer and tool No. J-24717.

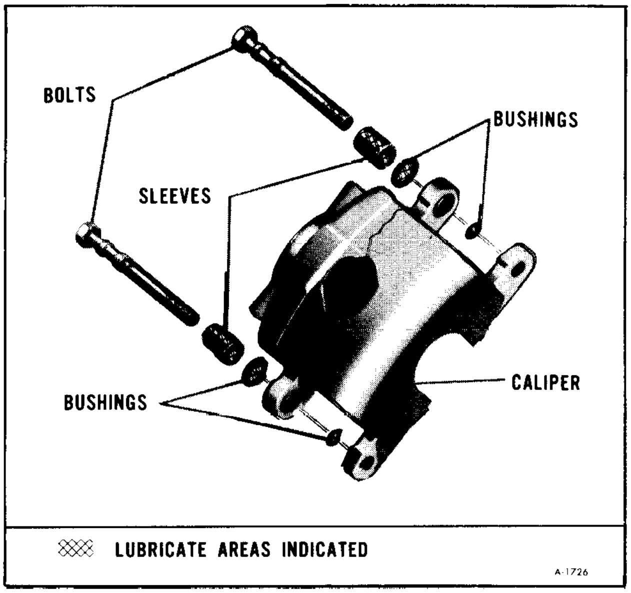


Figure 12–Caliper Sleeve and Bushing Location

12. Assemble tool No. J-23345 to tool No. J-8433-1.

13. Position tool assembly as shown in Figure 19.

14. With tool No. J-22214-6 in place, and a clamp in position tighten center screw until bearing is free of hub.

15. Remove seal and retainer.

16. Remove four bolts and separate disc from hub as shown in Figure 58.

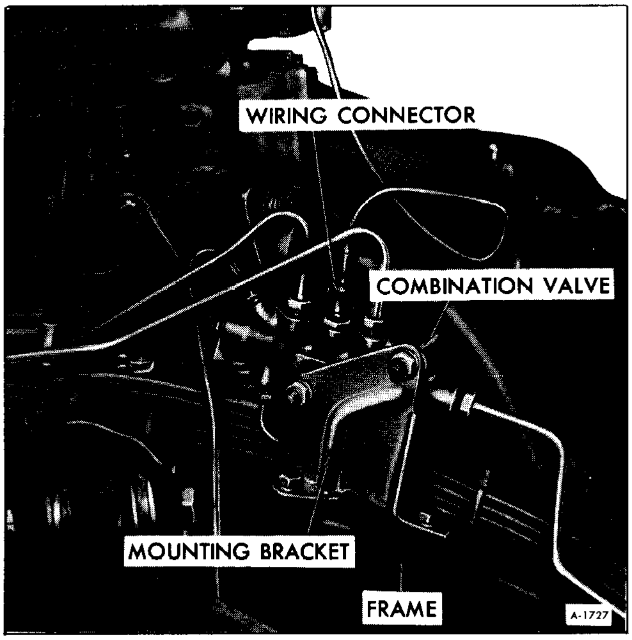


Figure 13–Combination Valve Mounting

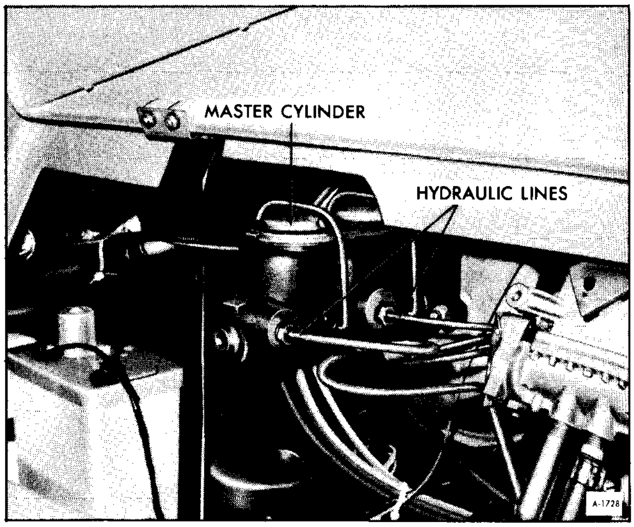


Figure 14–Hydraulic Lines at Master Cylinder

POWER BRAKE BOOSTER REMOVAL

1. Remove four (4) screws from power level control panel.

2. Pull panel and valve assemblies out of the way, as shown in Figure 20.

3. Remove clevis pin from brake pedal (Refer to figure 21).

4. Remove master cylinder, see "Master Cylinder Removal" earlier in this section.

Figure 15–Removing Master Cylinder

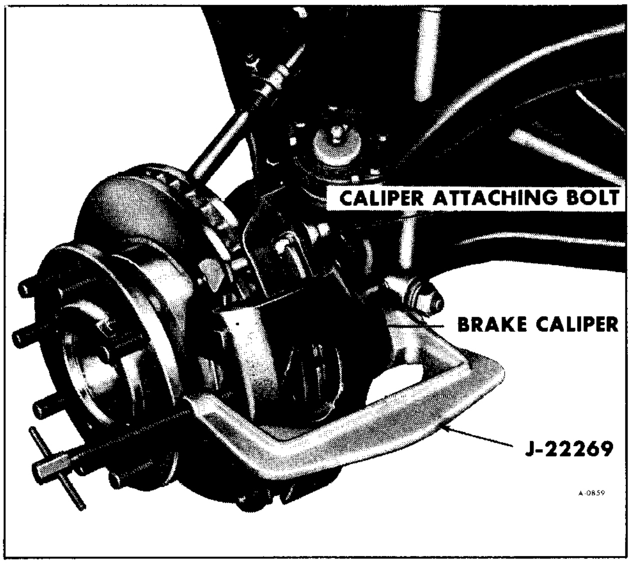


Figure 16–Tool J-22269 on Caliper

5. Remove master cylinder bracket by removing two bolts from top of bracket.

6. Remove vacuum line to power brake booster.

7. Remove four nuts retaining booster assembly to firewall, as shown in Figure 22.

8. Remove booster assembly through left front access door.

PARKING BRAKE LEVER REMOVAL

1. Remove four nuts and bolts retaining lever to toe board (Refer to figure 23).

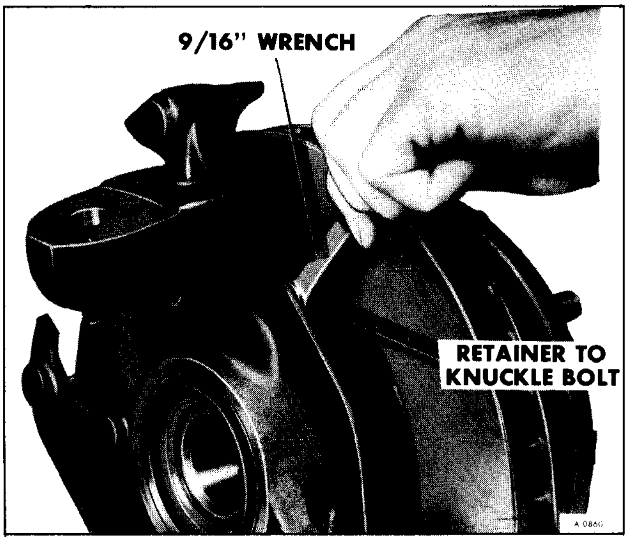


Figure 17–Removing Retainer from Knuckle

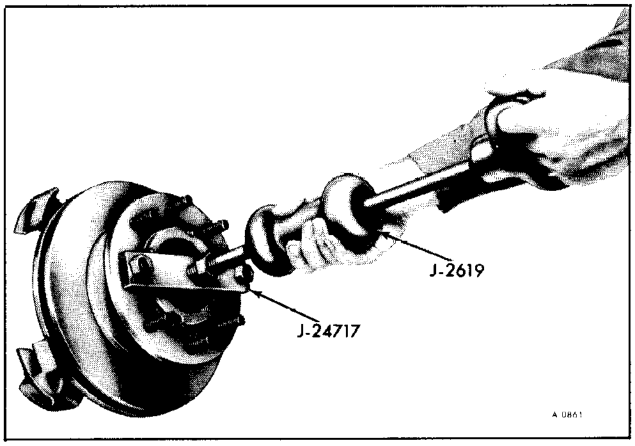


Figure 18–Installing Tool J-24717

2. Remove two nuts and bolts on cable retaining bracket, as shown in Figure 24.

3. Remove pin from bracket retaining cable end.

4. Remove one screw holding switch to parking brake lever.

5. Remove lever.

FRONT PARKING BRAKE CABLE REMOVAL

1. Raise Motor Home with suitable lifting device.

2. Remove lock nut and adjusting nut from front equalizer (Refer to figure 25).

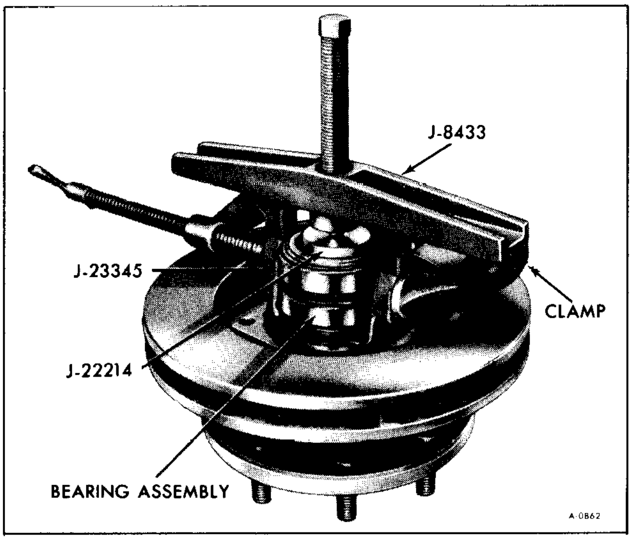


Figure 19–Bearing Removal

Figure 20–Power Level Panel Removed

3. Remove cable clip at shift relay bracket.

4. Remove retaining pin in parking brake lever.

5. Remove cable.

INTERMEDIATE PARKING BRAKE CABLE REMOVAL

1. Hoist vehicle.

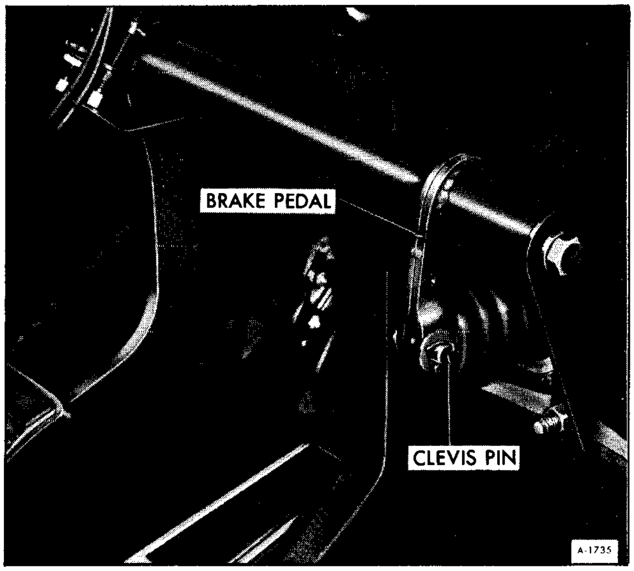


Figure 21–Clevis Pin Location

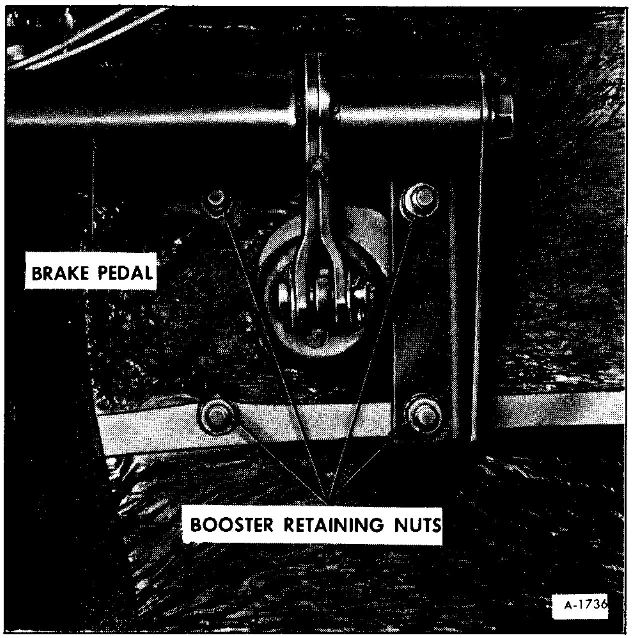


Figure 22–Booster Assembly Retaining Nuts

2. Remove lock nut and adjusting nut from two intermediate equalizers on the outside of each frame rail (Refer to figure 5).

3. Remove lock nut and adjusting nut from front equalizer as shown in Figure 25.

4. Disconnect cable from guide on frame cross-member (figure 26).

Figure 23–Removing Parking Brake Lever Retaining Nuts

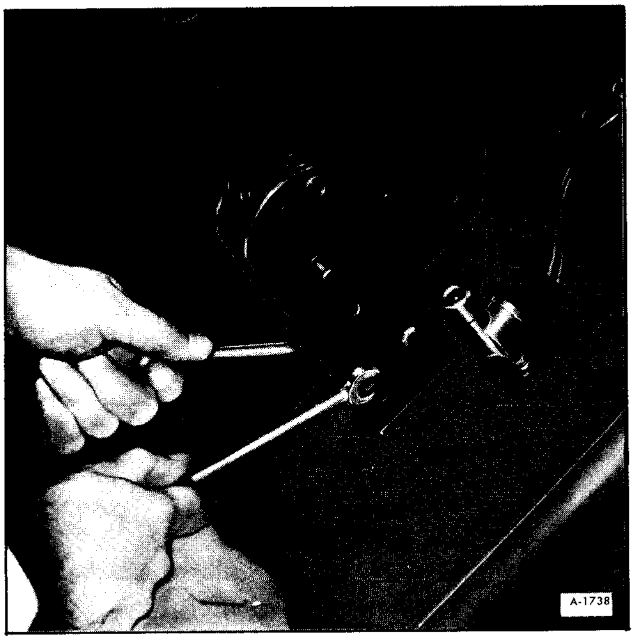


Figure 24–Removing Cable Retaining Bracket

5. Disconnect cable from guides at points where cable passes through frame rails as shown in Figure 27.

6. Remove cable.

REAR PARKING BRAKE CABLE REMOVAL

1. Disconnect intermediate equalizer by removing locking and adjusting nuts (figure 5).

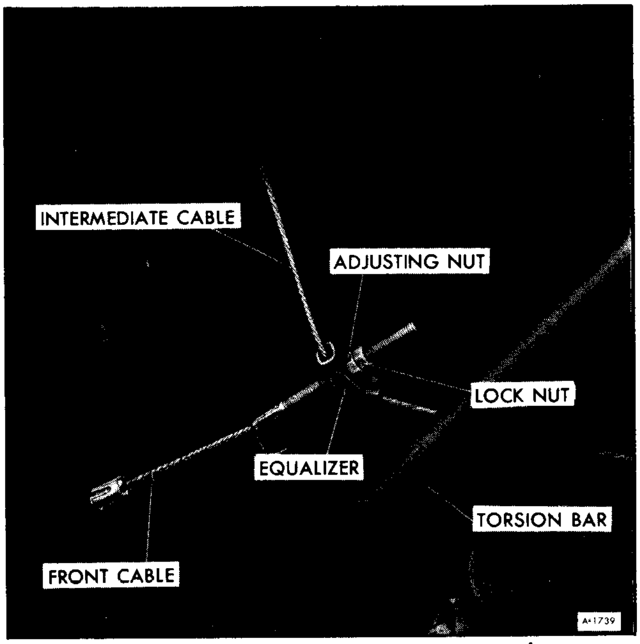


Figure 25–Parking Brake Cable

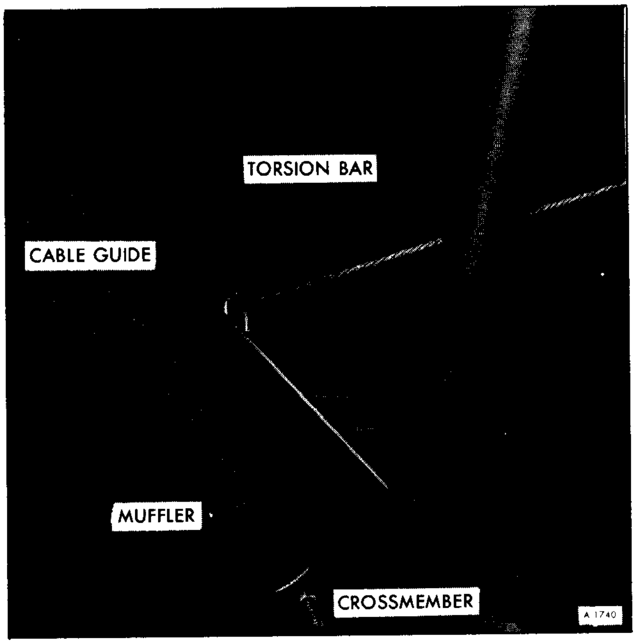


Figure 26–Cable Guide on Crossmember

2. Pull wire clips at retainers on frame rails (See figure 28).

3. Remove ends of cables from cable connectors. Feed ends of cables through retainers on frame rails.

4. Remove hubs and drums.

5. Release end of cable from parking brake lever.

6. Compress the locking fingers and pull the rear cable from the backing plate refer to Figure 29.

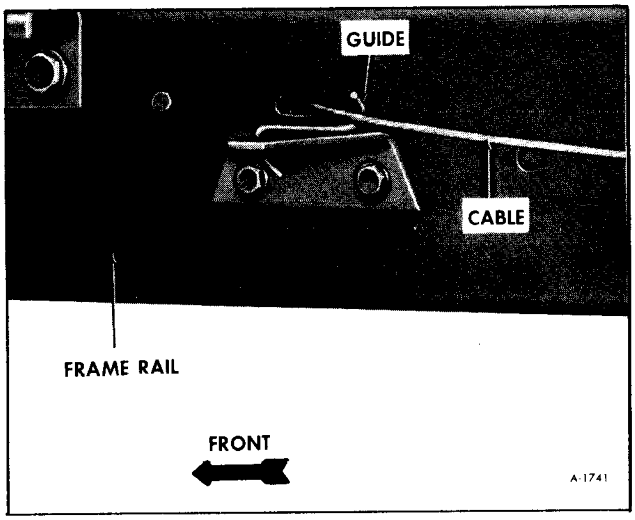


Figure 27–Cable Guide on Frame Rail

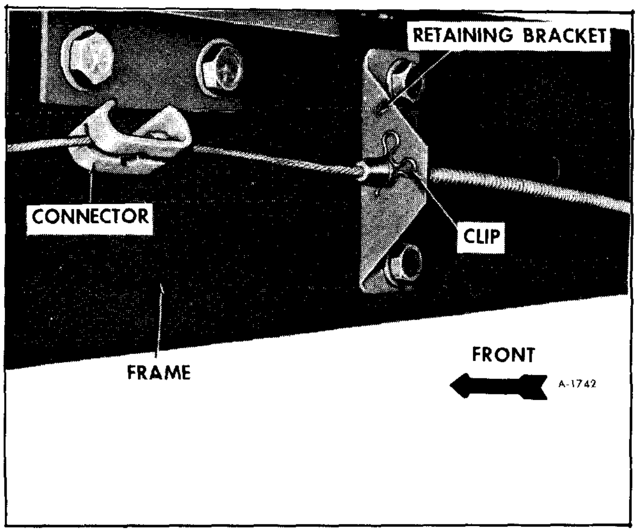


Figure 28–Clip on Frame Rail Retaining Bracket

BRAKE PEDAL REMOVAL

1. Remove four screws from power lever control mounting panel, and pull valves and panel out (figure 20).

2. Remove stop light switch from top of brake pedal. If equipped with cruise control remove the switch next to the stop light switch (figure 30).

3. Remove cotter pin from pin retaining power booster clevis to brake pedal. Remove clevis pin (figure 21).

4. Remove nuts from each end of pedal assembly (figure 31).

5. Loosen left-hand brake lever pivot bracket.

6. Remove brake pedal assembly.

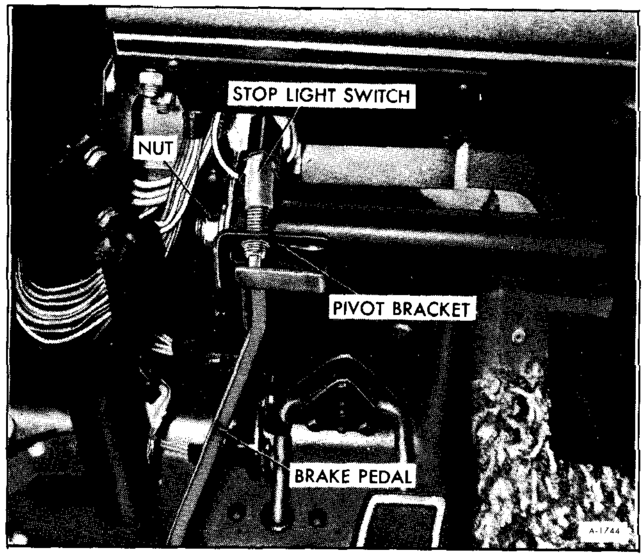


Figure 30–Brake Pedal Assembly (Left Side)

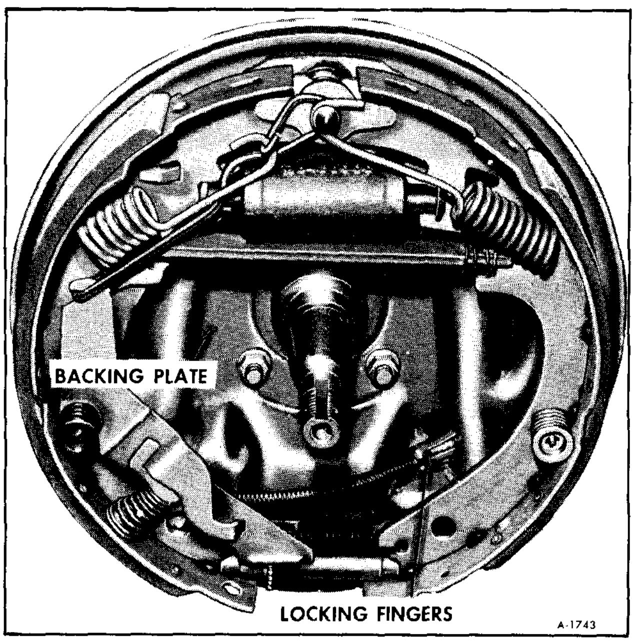


Figure 29–Locking Fingers

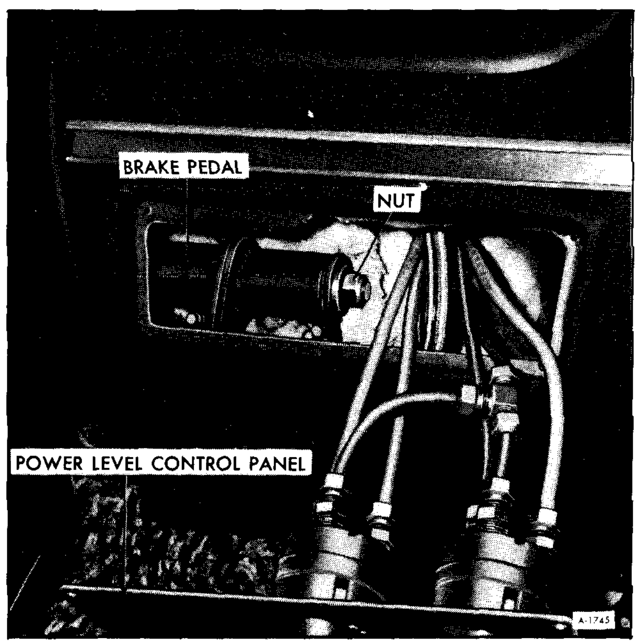


Figure 31–Brake Pedal Assembly (Right Side)

COMPONENT OVERHAUL

MASTER CYLINDER OVERHAUL

DISASSEMBLY (FIGURE 32)

1. Remove the small secondary piston stop screw from the bottom of the front fluid reservoir of the master cylinder.

2. Place the master cylinder in the vise so that the lock ring can be removed from the small groove in the I.D. of the bore. Remove the lock ring and primary piston assembly. Remove the secondary piston, secondary piston spring and retainer by blowing air through the stop screw hole. If air is not available, a piece of wire may be used. Bend approximately 1/4" of one end of the wire into a right angle. Hook this end under the edge of the secondary piston and pull the secondary piston from the bore.

NOTE: The brass tube-fitting insert need not be removed unless visual inspection indicates the insert is damaged.

3. To replace a defective insert or check valve, the following procedure should be practiced:

a. Place the master cylinder in a vise, so that the outlet holes are up. Enlarge the outlet holes in the tube seats using a 13/64" drill. Tap a 1/4"–20 thread in these holes. Place a heavy washer over the outlet on the master cylinder and thread a 1/4"–20 x 3/4" hex head bolt into the tube seat. Tighten the bolt until the tube seat is unseated.

b. A more preferable way to remove a defective insert involves use of a self-tapping screw and a claw hammer. With a box-end or socket wrench, thread a #6–32 x 5/8" long self-tapping screw into the tube-fitting insert. Using the claw end of the hammer, remove the screw and insert.

4. Remove the casting from the vise and inspect the bore for corrosion, pits and foreign matter. Be sure the outlet ports are clean. Inspect the fluid reservoirs for foreign matter. Check the bypass and compensating ports to the master cylinder bore to determine if they are restricted.

MASTER CYLINDER INSPECTION CHART

Part	Inspect For:	Corrective Action:
Master cylinder body.	Scratches, scores, pits, other damage affecting sealing or sliding action of piston seals in master cylinder bore. Damaged threads. Cracks, structural damage. By-pass and compensating holes to be open.	Polish light damage smooth with crocus cloth; replace piece, if damage does not clean up quickly. Clean up or replace. Replace. Open and clean passage.
Spring retainers.	Check for cracks, deformation.	Replace.
Master cylinder primary and secondary pistons.	Nicks, scratches, corrosion on finished O.D. surfaces. Small holes in end open. Try fit in master cylinder to be free with slight play.	Do not repair; replace. Clean. Replace piston cylinder or both if tight or sloppy.
Master cylinder reservoir diaphragm.	Hardness, holes, punch marks, cuts or abrasion.	Replace.

5. Remove the primary seal, primary seal protector and secondary seals from the secondary piston.

CLEANING AND INSPECTION

Use clean brake fluid to thoroughly clean all reusable brake parts. Immerse in the cleaning fluid and brush metal parts with hair brush to remove foreign matter. Blow out all passages, orifices and valve holes. Air dry and place cleaned parts on clean paper or lint free clean cloth. If slight rust is found inside either the front or rear half housing assemblies, polish clean with crocus cloth or fine emery paper, washing clean afterwards.

CAUTION: *Be sure to keep parts clean until reassembly. Re-wash at re-assembly if there is any occasion to doubt cleanliness–such as parts dropped or left exposed for eight hours or longer.*

IF there is any suspicion of contamination or any evidence of corrosion, completely flush the vehicle hydraulic brake system. Failure to clean the hydraulic brake system can result in early repetition of trouble. Use of gasoline, kerosene, anti-freeze, alcohol or any other cleaner, with even a trace of mineral oil, will damage rubber parts.

Rubber Parts

Wipe fluid from the rubber parts and carefully inspect each rubber part for cuts, nicks or other damage. These parts are the key to the control of fluid or air flow. If the unit is in for overhaul, or if there is any question as to the serviceability of rubber parts, REPLACE them! Inspect in accordance with the following table. The table is organized by power brake unit groups. Badly damaged items, or those which would take extensive work or time to repair, should be replaced. In case of doubt, install new parts. Do not rely on the brake unit being overhauled at an early or proper interval. New parts will provide more satisfactory service, even if the brake unit is allowed to go beyond the desired overhaul period.

ASSEMBLY (FIGURE 32)

If the brass tube inserts were removed, place the master cylinder in a vise so that the outlet holes are up. Position the new brass tube inserts in the outlet holes, making sure they are not cocked. The recommended method of seating these inserts is to thread a spare brake line tube nut into each outlet hole and turn the nuts down until the insert bottoms.

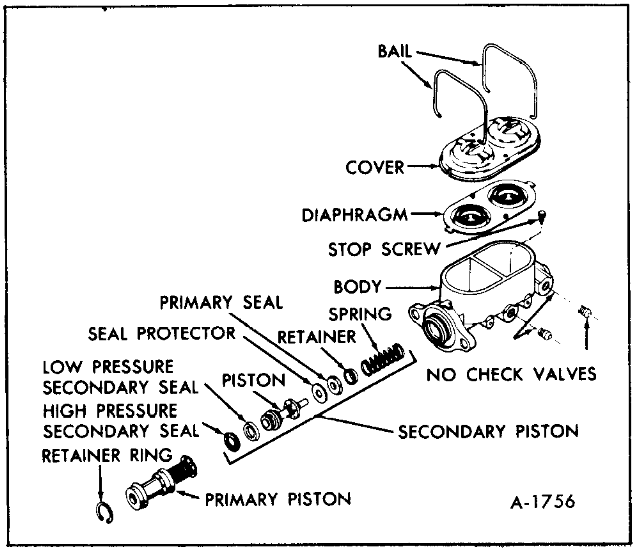


Figure 32–Master Cylinder (Exploded View)

(Remove the tube nut and check the outlet hole for loose brass burrs, which might have been turned up when the insert was pressed into position.)

Each vehicle application of these cylinders is designed to produce the correct displacement of fluid from both the front and rear chambers under normal, failed and partially failed conditions. Delco Moraine dual cylinders are designed so that this variable displacement requirement is controlled within each bore size by the dimensions A and C on the secondary piston.

Because the pistons vary in length, it is necessary to mark them with identification rings. It is imperative that exact replacements be made when servicing the master cylinders.

With all of the variables to be found in master cylinders, which look similar externally, it is important that the complete assemblies be properly identified. For this purpose a two-letter metal stamp will be found on the end of each master cylinder. This two-letter stamp indicates the displacement capabilities of a particular master cylinder. It is, therefore, mandatory that when master cylinders are replaced, they are replaced with cylinders bearing the same two-letter stamp.

1. Place new secondary seals in the two grooves in the flat end of the secondary piston assembly. The seal which is nearest the flat end will have its lips facing toward this flat end. The seal in the second groove should have its lips facing toward the end of the secondary piston which contains the small compensating holes.

2. Assemble a new primary seal and primary seal protector over the end of the secondary piston oppo-

site the secondary seals, so that the flat side of the seal seats against the flange of the piston which contains the small compensating holes.

3. In order to insure correct assembly of the primary piston assembly, a complete primary piston assembly is included in the repair kits.

4. Coat the bore of the master cylinder with clean brake fluid. Coat the primary and secondary seals on the secondary piston with clean brake fluid. Insert the secondary piston spring retainer into the secondary piston spring. Place the retainer and spring down over the end of the secondary piston so that the retainer locates inside the lips of the primary seal.

5. Holding the master cylinder with the open end of the bore up or down, push the secondary piston into the bore so that the spring will seat in against the closed end of the bore. Use a small wooden rod to push the secondary piston to seat.

6. Place the master cylinder in a vise with the open end of the bore up. Coat the primary and secondary seals on the primary piston with clean brake fluid. Push the primary piston, secondary piston stop first, into the bore of the master cylinder. Hold the piston down and snap the lock ring into position in the small groove in the I.D. of the bore.

7. Continue to hold the primary piston down. This will also move the secondary piston forward and will insure that the secondary piston will be forward far enough to clear the stop screw hole, which is in the bottom of the front fluid reservoir. The stop screw is now positioned in its hole and tightened to a torque of 25-40 inch-pounds.

8. Install a new reservoir diaphragm in the reservoir cover and install the cover on the master cylinder. Assemble the bail wires into position to retain the reservoir cover.

WHEEL CYLINDER OVERHAUL

DISASSEMBLY

1. Pull boots from cylinder ends and discard boots.

2. Remove and discard pistons and cups.

CLEANING AND INSPECTION

1. Inspect cylinder bore for scoring or corrosion. It is best to replace a corroded cylinder.

NOTE: Staining is not to be confused with corrosion. Corrosion can be identified as pits or excessive roughness.

2. Polish any discolored or stained area with crocus cloth by revolving cylinder on cloth supported by a finger. Do not slide cloth in a lengthwise manner under pressure.

Do not use any other form of abrasive or abrasive cloth.

3. Rinse cylinder in Declene or equivalent.

4. Shake excessive rinsing fluid from cylinder. Do not use a rag to dry cylinder, as lint from the rag cannot be kept from cylinder bore surfaces.

ASSEMBLY

1. Lubricate cylinder bore and counterbore with clean brake fluid and insert spring expander assembly.

2. Install new cups. (Be sure cups are lint and dirt free). Do not lubricate cups prior to assembly.

3. Install new pistons in the "as Received" condition–do not lubricate pistons with brake fluid.

4. Press new boots into cylinder counterbores by hand. Do not lubricate boots prior to assembly.

CALIPER OVERHAUL

DISASSEMBLY

Before beginning disassembly, thoroughly clean the exterior of the caliper using clean Declene or equivalent. Place the caliper on a clean work surface.

Rmove the brake hose from the caliper, discarding the copper gasket. Check the hose for worn spots, cracks or other signs of deterioration. Discard the hose, if damaged, replace with a new hose at reassembly. Drain brake fluid from the caliper.

WARNING: DO NOT PLACE THE FINGERS IN FRONT OF THE PISTON IN AN ATTEMPT TO CATCH OR PROTECT IT WHEN APPLYING COMPRESSED AIR. THIS COULD RESULT IN SERIOUS INJURY.

Remove the piston by directing compressed air into the caliper inlet hole. As shown in Figure 33.

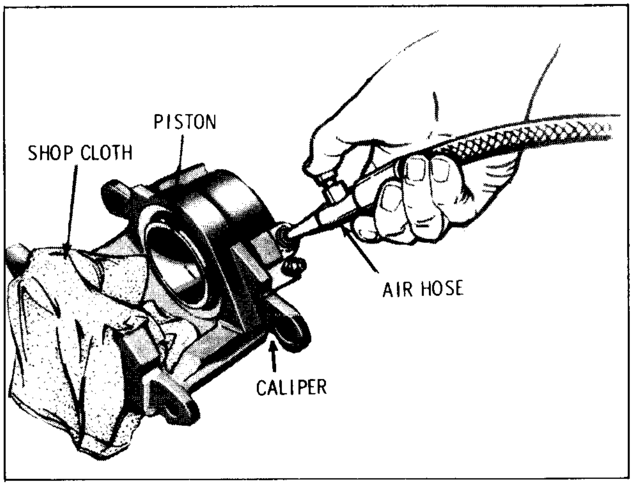


Figure 33–Removing Piston

CAUTION: *Use just enough air pressure to ease the piston out of the bore. If the piston is blown out-even with padding provided–it may become damaged.*

Use a screwdriver to pry the boot out of the caliper. Extend the screwdriver across the caliper bore, under the boot, and pry up. Be careful not to scratch the caliper bore (figure 34).

Use a piece of wood or plastic to remove the piston seal from its groove in the caliper bore. DO NOT USE A METAL TOOL OF ANY TYPE FOR THIS OPERATION.

Remove the bleeder valve from the caliper.

CLEANING AND INSPECTION

The boot, piston seal, rubber bushings and

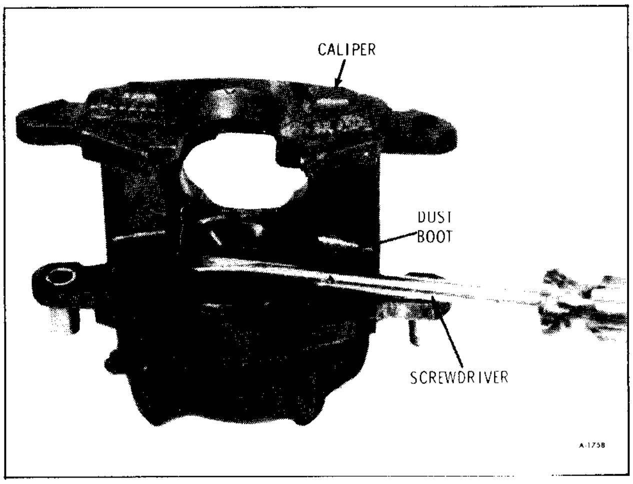


Figure 34–Removing Boot from Caliper

sleeves are to be replaced each time the caliper is overhauled.

Clean all other parts in clean Declene or equivalent. Use dry, filtered compressed air to dry parts and blow out all passages in the caliper and bleeder valve.

WARNING: THE USE OF LUBRICATED SHOP AIR WILL LEAVE A FILM OF MINERAL OIL ON THE METAL PARTS. THIS MAY DAMAGE RUBBER PARTS WHEN THEY COME IN CONTACT AFTER REASSEMBLY.

Check the mounting bolts for corrosion, breaks in the plating or other damage. Do not use abrasives in an attempt to clean the bolts. If bolts are damaged, replace them.

Carefully examine the piston OD for scoring, nicks, corrosion and worn or damaged chrome plating. If any surface defects are detected, replace the piston.

NOTE: The piston OD is the primary sealing surface in the caliper assembly. It is manufactured and plated to close tolerances. Refinishing by any means or the use of any abrasive is not acceptable.

Check the bore in the caliper for the same defects as the piston. The piston bore is not plated and stains or minor corrosion can be polished with crocus cloth. Do not use emery cloth or any other form of abrasive. Thoroughly clean the caliper after the use of crocus cloth. If the bore can not be cleaned up in this manner, replace the caliper.

ASSEMBLY

Lubricate the bore in the caliper and the new piston seal with clean brake fluid. Position the seal in the caliper bore groove. Lubricate the piston with clean brake fluid and assemble a new boot into the groove in the piston so that the fold faces the open end of the piston. Insert the piston into the caliper bore, using care not to unseat the seal and force down to the bottom in the bore. This will require a force of 50 to 100 pounds.

Position the OD of the boot in the caliper counterbore and seat with Tool J-22904 (figure 35).

Check the boot installation to make sure that the retaining ring molded into the boot is not bent and that the boot is installed fully-below the caliper face–and evenly all around. Otherwise dirt or moisture may enter the bore and cause damage or corrosion.

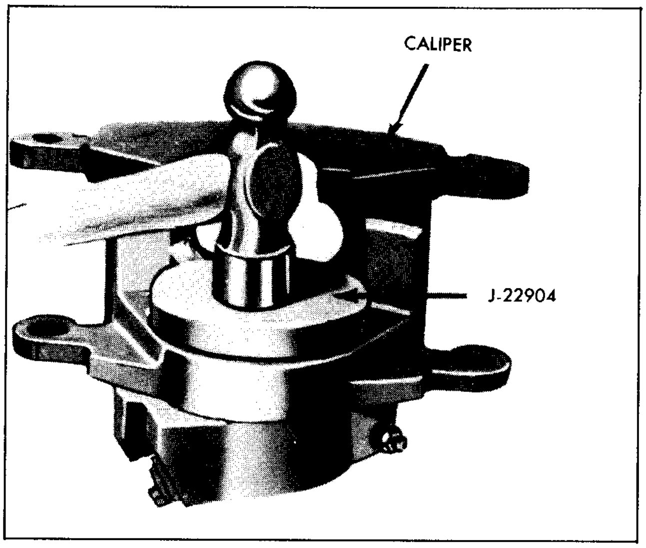


Figure 35–Boot Installation

Install the brake hose in the caliper inlet using a NEW copper gasket.

POWER BRAKE BOOSTER OVERHAUL

DISASSEMBLY

CAUTION: *Care must be used in handling the diaphragm of power piston assembly. Guard diaphragm against grease, oil, foreign matter and nicks or cuts.*

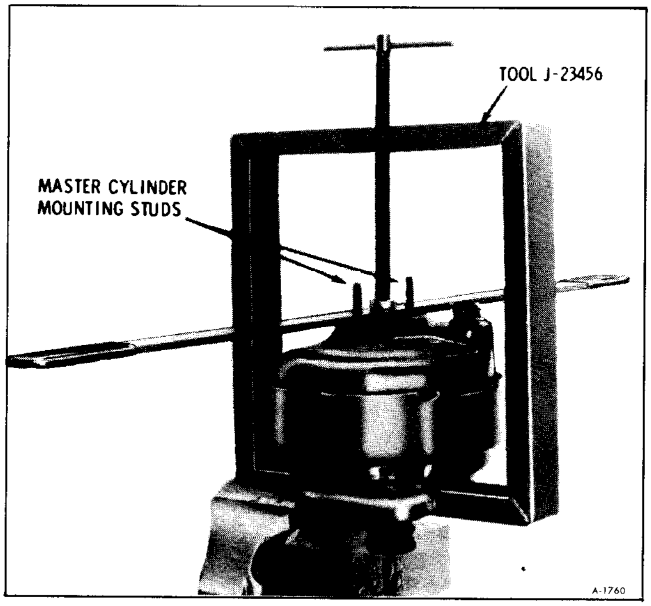


Figure 36–Separating Halves

1. Scribe front and rear housing.

2. Remove master cylinder attaching nuts and remove master cylinder from front housing.

3. Remove front housing seal and master cylinder piston push rod.

4. Install Tandem Diaphragm Separating Tool J-23456 as shown in Figure 36.

5. With cylinder clamped slightly, rotate bar counterclockwise and unlock shells.

6. Back off on hold down sufficiently to remove front shell, return spring retainer plate and piston rod retainer.

7. Remove assembly from tool and remove tool from vise.

8. Remove the dust boot retainer and boot from the rear housing and push rod. Remove the felt silencer from inside the boot.

9. Remove the power piston assembly from the rear shell and remove the primary power piston bearing from the center opening of the rear shell.

10. Lift the bead on the outside diameter of the secondary diaphragm and remove the diaphragm support ring. (figure 37)

11. Mount Piston Unlocking Tool, J-23101, in a vise with wide jaws up. Position the secondary power piston so that the two radial slots in the piston fit over the jaws of the tool. (figure 38)

12. Fold back primary diaphragm from the outside diameter of the primary support plate. Grip the edge of the support plate and rotate counterclockwise to unscrew the primary power piston from the secondary power piston. (figure 39)

NOTE: It is possible that the primary support plate will unlock from the primary piston before the primary piston unscrews from the secondary piston. If this happens, continue to turn the primary support plate counterclockwise. Tabs ("stops") on the primary support plate will temporarily lock the primary support plate to the primary power piston and permit continued counterclockwise rotation to unscrew the primary power piston from the secondary power piston.

13. Remove the housing divider from the secondary power piston. Remove the secondary power piston bearing from the housing divider.

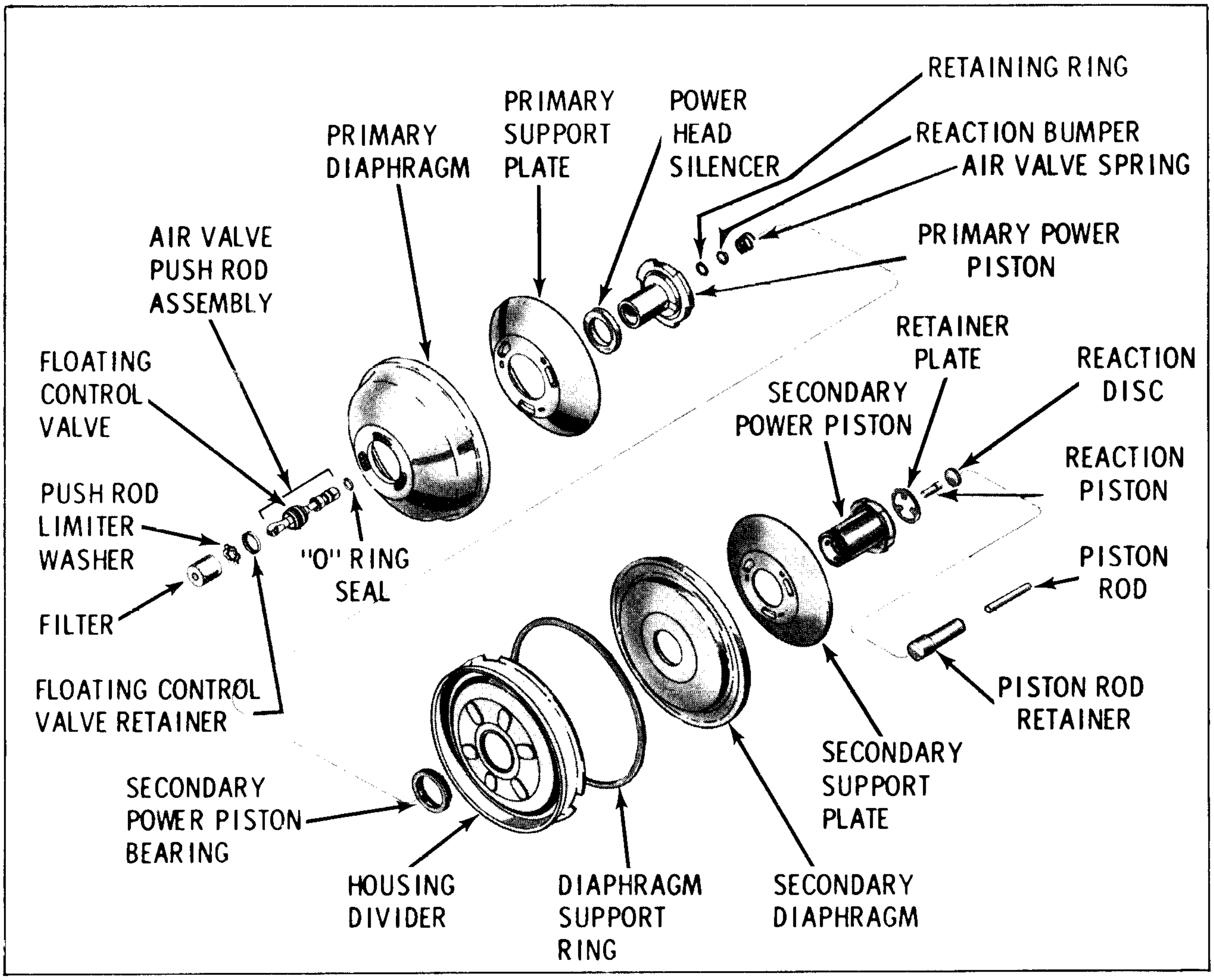


Figure 37–Exploded View of Power Piston

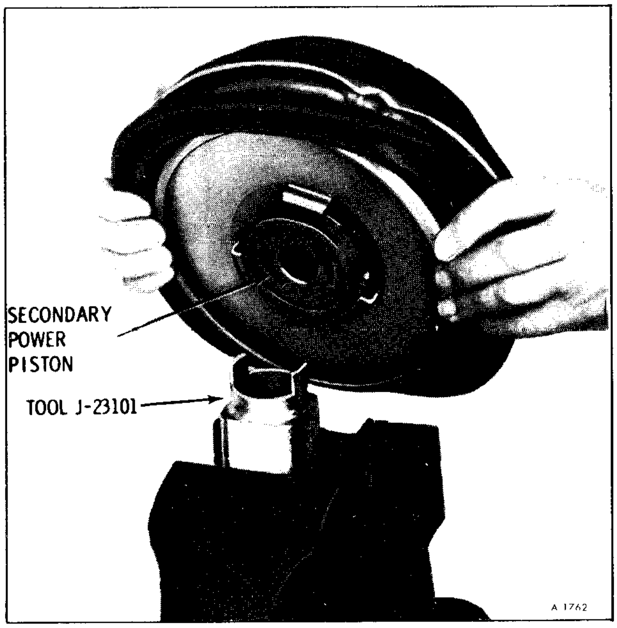


Figure 38–Positioning Secondary Power Piston

Figure 39–Unlocking Power Piston

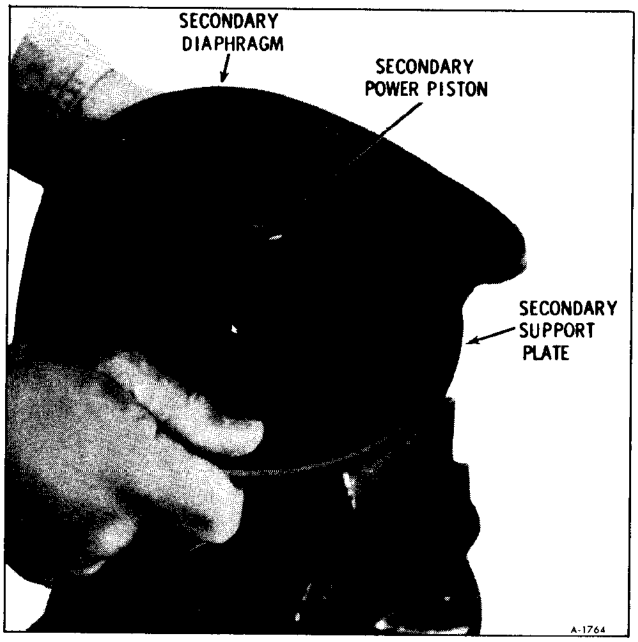


Figure 40–Removing Secondary Diaphragm

14. The secondary power piston should still be positioned on Tool J-23101. Fold back secondary diaphragm from O.D. of secondary support plate. Grip the edges of the support plate and rotate clockwise to unlock the secondary support plate from the secondary power piston. (figure 40).

15. Remove the secondary diaphragm from the secondary support plate.

16. Remove the reaction piston and reaction disc from the center of the secondary power piston by

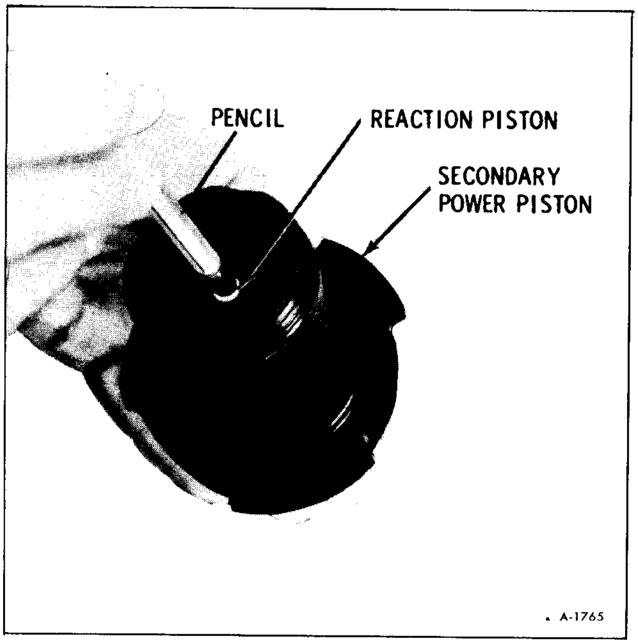


Figure 41–Removing Reaction Piston

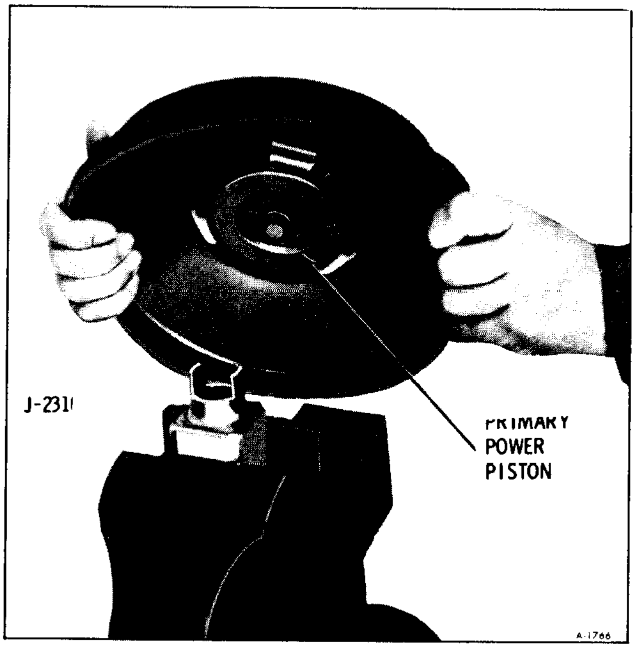


Figure 42–Positioning Primary Power Piston

pushing down on the end of the reaction piston with a small object, such as a pencil, wooden dowel or metal rod. (figure 41)

17. Remove the air valve spring from the end of the air valve.

18. Mount Tool J-23101 in a vise with small jaws up. Position the primary power piston so that the two radial slots in the piston fit over the jaws of the tool. (figure 42)

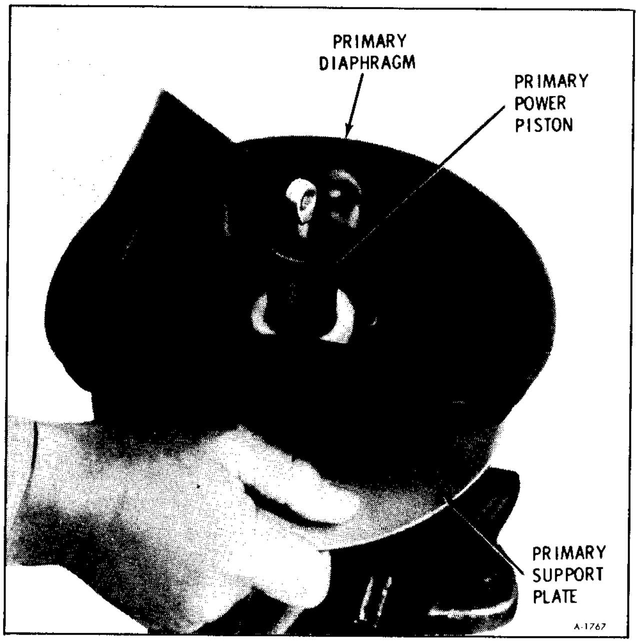


Figure 43–Removing Primary Diaphragm

19. Fold back primary diaphragm from the support plate. Grip the edge of the support plate and rotate in a counterclockwise direction to unlock the primary support plate from the primary power piston. (figure 43)

20. Remove the primary diaphragm from the primary support plate.

21. Remove the air filter and push rod limiter washer from the tubular section of the primary power piston.

22. Remove the power head silencer from the neck of the power piston tube.

23. Remove the rubber reaction bumper from the end of the air valve.

24. Remove the snap ring from the air valve. (figure 44)

25. Remove the air valve-push rod assembly from the tube end of the primary power piston by pulling on the primary power piston. (figure 45)

26. Removal of the air valve push rod assembly will disassemble the floating control valve retainer.

27. Remove the "O" ring seal from the air valve.

28. The air valve push rod assembly will be serviced using a complete assembly, since the floating control valve cannot be removed over the eye end of the push rod.

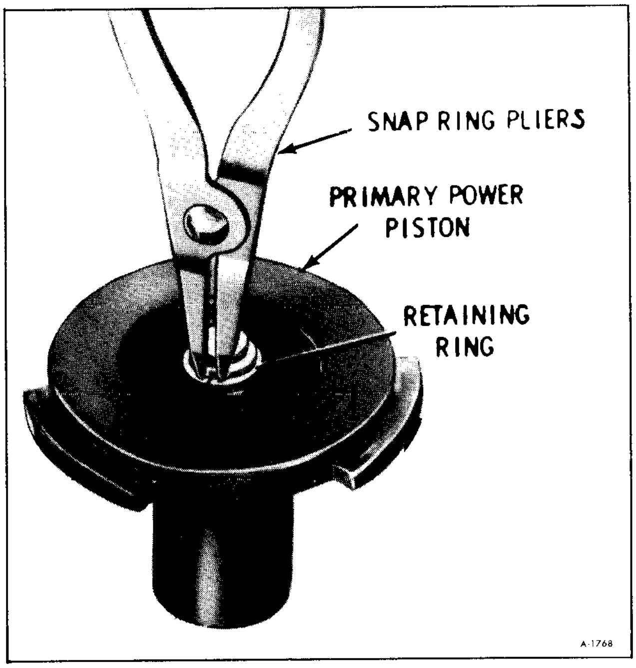


Figure 44–Removing Snap Ring from Air Valve

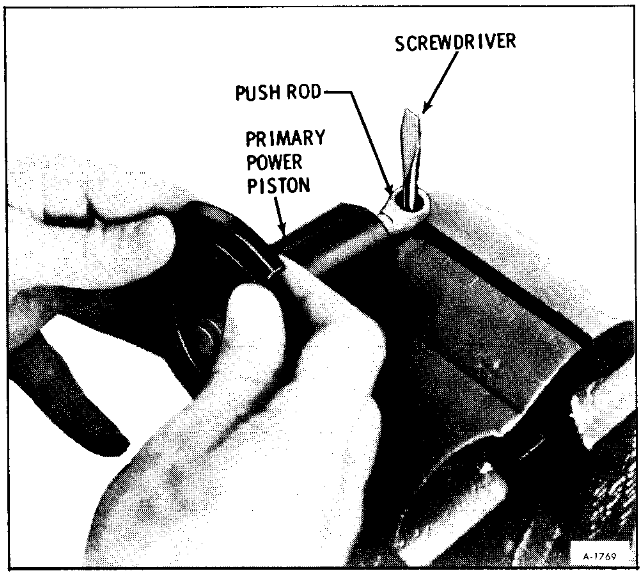


Figure 45–Removing Air Valve Push Rod Assembly

CLEANING AND INSPECTION

CAUTION: *If there is any suspicion of contamination or any evidence of corrosion, completely flush the hydraulic brake system. Failure to clean hydraulic brake system can result in early repetition of trouble. Do not use gasoline, kerosene, anti-freeze alcohol or any other cleaner with even a trace of mineral oil.*

After disassembly, immerse all metal parts in metal cleaner. Plastic parts, as well as the rubber power diaphragms, should be cleaned in Declene or equivalent. Care should be taken to avoid chipping or damaging plastic parts in handling. After parts have been thoroughly cleaned, those parts which come in contact with hydraulic brake fluid (that is, all master cylinder parts and the power section push rod) should be thoroughly washed in Declene or equivalent before assembly. Use air to blow out dirt and cleaning solvent from recesses and internal passages. DISCARD ALL RUBBER PARTS EXCEPT THE POWER DIAPHRAGMS.

ASSEMBLY

NOTE: During assembly, when a lubricant is specified, use either the lubricant furnished with the repair kit or Seal Lubricant No. 1050169 or equivalent.

1. Lubricate the "O" ring seal, Figure 37 and place on the air valve.

2. Wipe a thin film of lubricant on the large and small O.D. of the floating control valve.

3. If the floating control valve needs replacement, replace the complete air valve push rod assembly.

4. Place the air valve end of the air valve push rod assembly into the tube of the primary power piston. Manually press the air valve push rod assembly so that the floating control valve bottoms on the tube section of the primary power piston.

5. Place lip of retainer on the O.D. of Tool J-23175. (figure 46) Manually press the retainer until seated in the primary power piston tube. (figure 47)

6. Place the push rod limiter washer over the push rod and position on the floating control valve.

7. Install filter element over the push rod eye and press into the primary power piston tube.

8. Using snap ring pliers, place the snap ring into the groove in the air valve.

9. Install the rubber reaction bumper on the air valve.

NOTE: Tolerances of component parts affecting output of the tandem power brake are very critical. To maintain correct power brake output, the power piston assembly is serviced as an assembly which includes a pre-selected REACTION PISTON, PRIMARY POWER PISTON, and SECONDARY POWER PISTON. NO gauging operation is required when power piston service package is used.

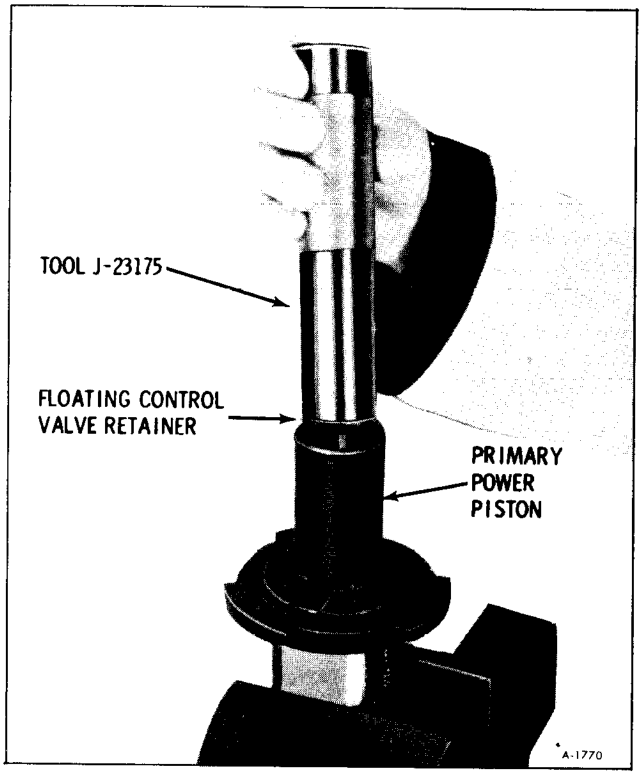


Figure 46–Installing Retainer Ring

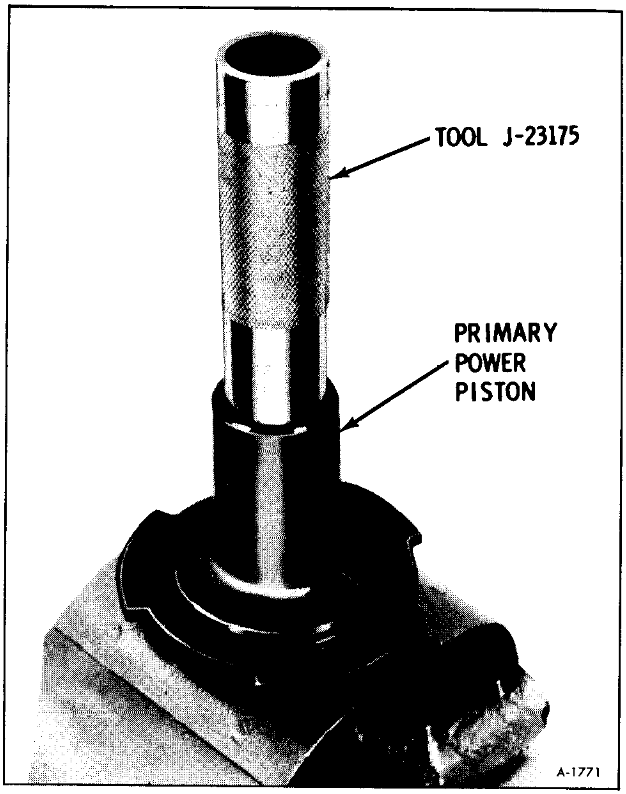


Figure 47–Retainer Ring Seated

10. Assemble the primary diaphragm to the primary support plate from the side of the support plate opposite the locking tangs. Press the raised flange on the I.D. of the diaphragm through the center hole of the support plate. Be sure that the edge of the support plate center hole fits into the groove in the raised flange of the diaphragm. Lubricate the diaphragm I.D. and the raised surface of the flange (that fits into a groove in the primary power piston) with a light coat of lubricant.

11. Mount Tool J-23101, in a vise, small jaws up. Position the primary power piston so that the two radial slots in the piston fit over the jaws of the tool. (figure 42)

12. Fold the primary diaphragm away from the O.D. of the primary support plate.

13. Holding the edges of the support plate, with the locking tangs down, place the primary support plate and diaphragm assembly over the tube of the primary power piston. The flange on the I.D. of the

primary diaphragm will fit into a groove in the primary power piston.

14. Grip the edges of the primary support plate, press down, and rotate clockwise until the tabs on the primary power piston contact the stops on the support plate. (figure 43)

15. Place the power head silencer on the tube of the primary power piston so that the holes at the base of the tube are covered.

16. Apply a very light film of lubricant to the O.D. of the primary power piston tube.

17. Remove the primary piston assembly from Tool J-23101.

18. Assemble the secondary diaphragm to the secondary support plate from the side of the support plate opposite the locking tangs. Press the raised flange on the I.D. of the diaphragm through the center hole of the support plate. Be sure that the edge of the support plate center hole fits into the groove in the raised flange of the diaphragm. Apply a thin coat of lubricant to the I.D. of the secondary diaphragm and the raised surface of the flange (that fits into a groove in the secondary power piston.)

19. Mount Tool J-23101 in a vise with large jaws up. Position the secondary power piston so that the radial slots in the piston fit over the jaws of the tool. (figure 38) Apply a light coat of lubricant to the tube of the secondary power piston.

20. Fold the secondary diaphragm away from the O.D. of the secondary support plate.

21. Holding the edges of the support plate, with the locking tangs down, place the secondary diaphragm and support plate assembly over the tube of the secondary power piston. The flange on the I.D. of the secondary diaphragm will fit into the groove in the secondary piston.

22. Grip the edges of the secondary support plate, press down, and rotate counterclockwise until the tabs on the secondary power piston contact the stops on the support plate. (figure 40) Fold the secondary diaphragm back into position on the secondary support plate. Leave the secondary power piston assembly on Tool J-23101 in the vise.

23. Apply a light coat of lubricant to the bead on the O.D. of the secondary diaphragm. This will facilitate assembly of front and rear housings.

24. Place the secondary diaphragm support ring on the secondary power piston assembly so that it rests on the edge of the diaphragm.

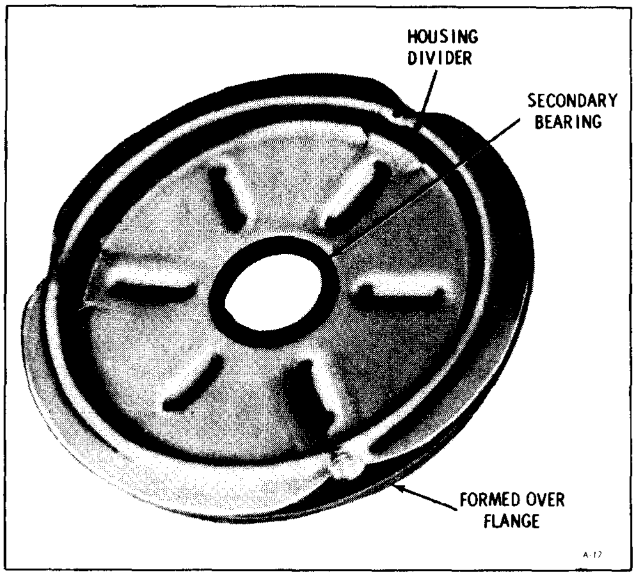


Figure 48–Installing Secondary Bearing

25. Hold the housing divider so that the formed lip (that holds the primary diaphragm) of the divider faces down. Place the secondary bearing in the I.D. of the divider so that the extended lip of the bearing faces up. (figure 48)

26. Lubricate the I.D. of the secondary bearing.

27. Position Tool J-23188, on the threaded end of the secondary power piston. (figure 49)

28. Hold the housing divider with the formed lip (that holds the primary diaphragm) facing up. Press the divider down over the tool and onto the secondary power piston tube where it will rest against the diaphragm support ring. Remove Tool J-23188 from secondary power piston. Do not remove the secondary power piston subassembly from Tool J-23101.

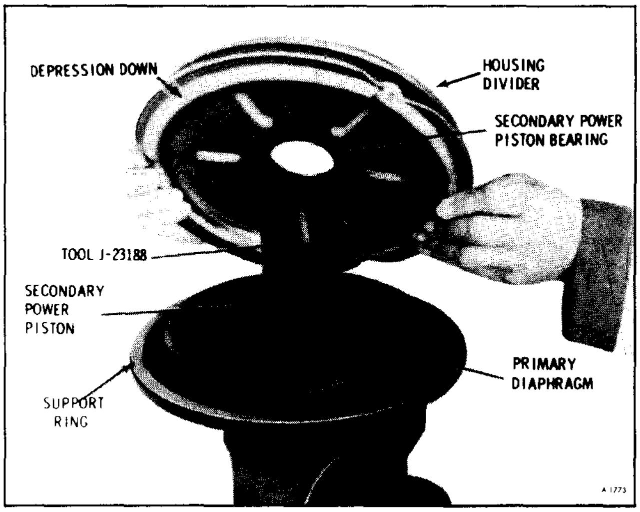


Figure 49–Installing Housing Divider

29. Pick up the primary power assembly and position the small end of the air valve return spring on the air valve so that it contacts the air valve retaining ring.

30. Fold the primary diaphragm away from the O.D. of the primary support plate.

31. Position the primary power piston on the tubular portion of the secondary power piston, making sure that the air valve return spring seats down over the raised center section of the secondary piston.

32. Grip the edge of the primary support plate, press down, and start the threads on the secondary power piston into the threaded portion of the primary power piston by rotating in a clockwise direction. (figure 39)

33. Continue to tighten the primary power piston until it is securely attached to the secondary power piston.

34. Fold the primary diaphragm back into position on the primary support plate and pull the diaphragm O.D. over the formed lip of the housing divider. Check that the bead on the diaphragm is seated evenly around the complete circumference.

35. Wipe a thin film of lubricant on the O.D. of the piston rod retainer. Insert the master cylinder piston rod retainer into the cavity in the secondary power piston so that the flat end bottoms against the rubber reaction disc in the bottom of the cavity.

36. Place the primary power piston bearing in rear housing center hole so that the formed flange of the housing center hole fits into the groove of the primary power piston bearing. The thin lip of the bearing will protrude to the outside of the housing. (figure 50)

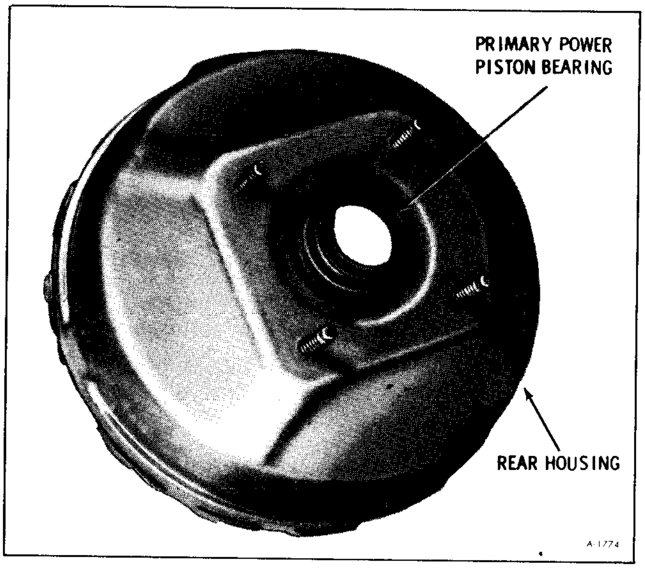


Figure 50–Installing Primary Power Piston Bearing

37. Coat the I.D. of the primary power piston bearing with a thin film of lubricant.

38. Assemble the power piston assembly to the rear shell by pressing the tube of the primary power piston through the rear housing bearing. Press down until the housing divider seats in the rear shell and the primary power piston bottoms against the shell.

39. Mount Tool J-23456 in vise and position rear shell in tool.

40. Place piston rod retainer plate on the end of the power piston and install power piston return spring.

41. Lower front shell over rear shell and position bar on front shell with bearing.

42. Tighten down on front shell and fit the tangs in the appropriate slots on the rear shell.

43. Rotate the bar clockwise into the locked position and remove power head from Tool J-23456.

44. Place the filter in the power head boot. Stretch the boot over the push rod and over the flange of the rear housing and install boot retainer.

45. Place the power head assembly in a vise with the front shell facing up. Insert the master cylinder piston rod, flat end first, into the piston rod retainer.

46. Press down on the master cylinder piston rod to be sure it is properly seated.

NOTE: To assure that no vacuum is in the power head while gauging, front housing seal must not be installed at this time.

47. Place gauge J-23337 over the piston rod in a position which will allow the gauge to be moved to the left or right without contacting the studs. (figure 51)

48. Position gauge over piston rod. The adjustment is correct if the lower step contacts the piston rod and the upper step clears the piston rod.

49. If the push rod is not within specifications and the push rod does not have an adjusting screw, a new service adjustable push rod must be installed and adjusted to specification. If the push rod being checked has an adjusting screw, adjust the push rod to specification.

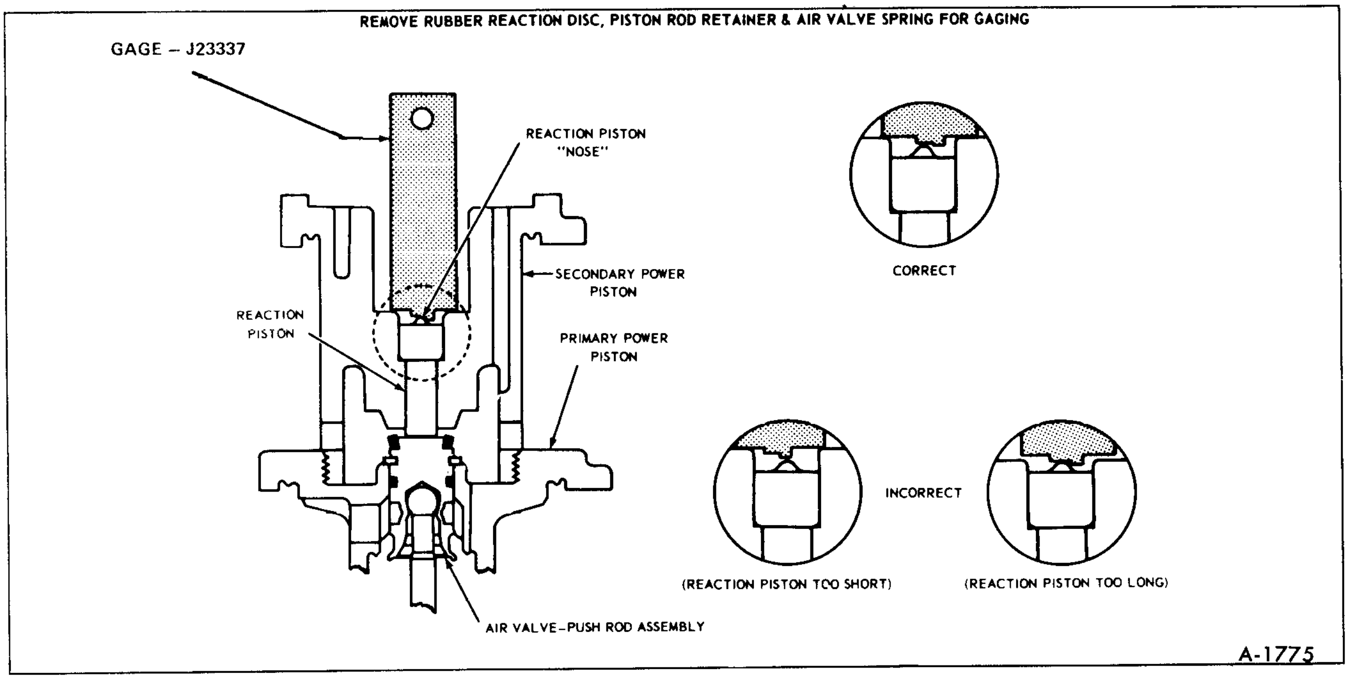


Figure 51–Gauging Piston Rod

50. Wipe a thin film of lubricant on the I.D. of the front housing seal and position seal in the depression in the housing.

51. Position the master cylinder assembly on the front housing. Install the locknuts on the studs and torque to 28 ft. lbs.

52. Install power unit into Motor Home.

TESTING OF POWER BRAKE UNIT

1. Road test brakes by making a brake application at about 20 mph to determine if vehicle stops evenly and quickly. If pedal has a spongy feel when applying brakes, air may be present in hydraulic system. Bleed system as described in BLEEDING SYSTEM.

2. With engine stopped and transmission in neutral, apply brakes several times to deplete all vacuum reserve in system. Depress brake pedal, hold light-foot pressure on pedal and start engine. If vacuum system is operating, pedal will tend to fall away under foot pressure and less pressure will be required to hold pedal in applied position. If no action is felt, vacuum system is not functioning.

3. Stop engine. Again deplete all vacuum reserve in system. Depress brake pedal and hold foot pressure on pedal. If pedal gradually falls away under foot pressure, hydraulic system is leaking internally or externally.

4. If brake pedal travels to within one inch of toeboard, brake shoes are not adjusting or require relining.

5. Start engine with brakes off and transmission in neutral. Run engine to medium speed and turn off ignition. Immediately close throttle. This builds up vacuum. Wait no less than 90 seconds, then try brake action. If not vacuum-assisted for two or more applications, vacuum check is faulty or there is a leak in vacuum system.

MAJOR COMPONENT INSPECTION

COMBINATION VALVE

No attempt should be made to disassemble or repair either valve. If any failure should occur, the complete valve should be replaced.

REAR BRAKE SHOES AND BACKING PLATE

1. Inspect linings for wear. If linings are worn

nearly flush with rivets new linings should be installed.

2. Check wheel cylinder for leakage by removing the link. If leak exists, remove wheel cylinder for service or replacement.

3. Clean inner surfaces of brake backing plates and all shoe contacting points.

4. Clean exposed portions of parking brake cables.

5. Disassemble the adjusting screw assembly. Clean and inspect as follows:

a. Check thrust washer and mating surfaces for burrs of excessive wear.

b. Inspect teeth on sprocket for wear.

c. Remove all foreign material from adjusting screw and nut. Nut must rotate freely on threads.

6. Check the foot of the adjuster lever for wear. Replace if necessary.

7. Check the override pivot for wear or deformed parts.

8. Check brake drum inner diameter for build-up rust and dirt. Remove build-up so that drums can be installed over pre-adjusted linings. Check drum for cracks and an out-of-round condition.

DISC BRAKE SHOE AND LINING

LINING INSPECTION

Inspect the brake linings any time that the wheels are removed (tire rotation, etc.). Check both ends of the outboard shoe by looking in at each end of the caliper. These are the poinst at which the highest rate of wear normally occurs. However, at the same time, check the lining thickness on the inboard shoe to make sure that it has not worn prematurely. Look down through the inspection hole in the top of the caliper to view the inboard shoe. Whenever the thickness of any lining is worn to the approximate thickness of the metal shoe, all shoe and lining assemblies should be replaced.

Front disc brakes have a wear indicator that makes a noise when the linings wear to a degree where replacement is required. (figure 52) The spring clip is in an intergral part of the inboard shoe and lining. When the lining is worn the clip contacts the rotor and produces a warning noise.

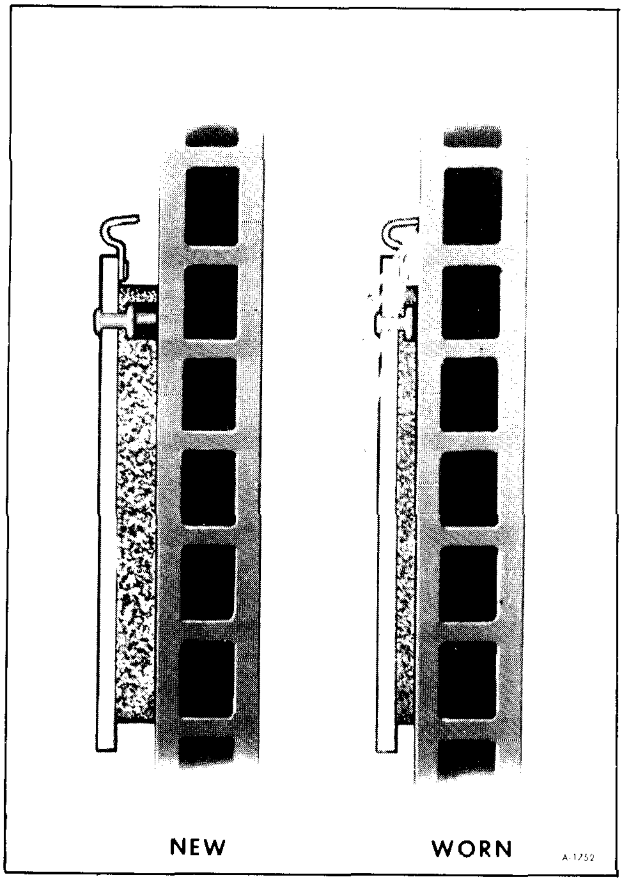


Figure 52–Wear Indicators

Check flatness of brake pads. Place inboard and outboard pad surfaces together and check for gap between pad surfaces. If more than .005″ gap is measured at middle of pad (midway between attaching lugs), pad must not be used. This applies to new or used brake pads.

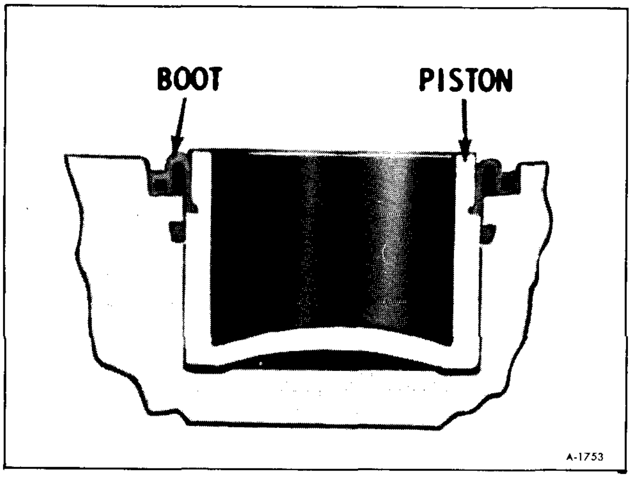


Figure 53–Boot Installation

CLEANING AND INSPECTION

1. Thoroughly clean the holes and the bushing grooves in the caliper ears. Wipe all dirt from the mounting bolts. Do not use abrasives on the bolts since this will damage the plating. If the bolts are corroded, or damaged, they should be replaced.

2. Examine the inside of the caliper for evidence of fluid leakage. If leakage is noted, the caliper should be overhauled. Wipe the inside of the caliper clean, including the exterior of the dust boot. Check the boot for cuts, cracks or other damage. Make sure that the boot is properly engaged in the groove in the piston and also in the caliper counter-bore. (figure 53)

CAUTION: *Do not use compressed air to clean the inside of the caliper since this may cause the dust boot to become unseated.*

DISC INSPECTION

Light scoring .010-.020 inch deep, of the disc braking surface will normally occur during brake application, turning is not required unless they are severely scored. It is not necessary to remove all score marks when turning. Precision equipment must be used when turning discs and the following specifications must be carefully observed. DO NOT reduce total thickness of the braking surface anymore than the turning dimension of 1.185". If too much is removed, even maximum pedal travel will not apply the brakes if pads are worn.

Disc runout can be checked by clamping a dial indicator to the caliper or plain arm so that the stylus touches the disc about an inch from its outer edge. Rotate disc and check indicator reading. If the lateral runout exceeds specifications the disc should be replaced or refinished.

After turning, brake surface thickness must not vary more than .0005". Lateral runout must not exceed specifications. Surface finish must be non-directional and smoothness maintained at 30-50 micro inches.

If only one disc requires turning, the disc on the opposite wheel should be sanded with 60 or 80 grit emery cloth to give braking surfaces a non-directional surface.

A discard dimension 1.170" is stamped on all production installed brake disc's (See figure 54). This is the allowable wear dimension and NOT the allowable turning dimension. There must be .015" left for wear after turning disc's.

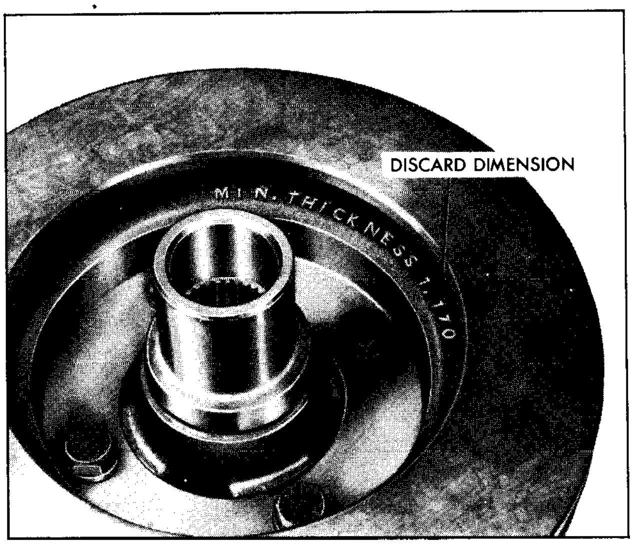


Figure 54–Discard Dimension (Disc)

BRAKE DRUMS

INSPECTING AND RECONDITIONING BRAKE DRUMS

Whenever brake drums are removed, they should be thoroughly cleaned and inspected for cracks, scores, deep grooves and out-of-round. Any of these conditions must be corrected since they can impair the efficiency of brake operation and cause premature failure of other parts.

CRACKED, SCORED, OR GROOVED DRUM

NOTE: A cracked drum is unsafe for further service and must be replaced. Do not attempt to weld a cracked drum.

Smooth up any slight scores by polishing with fine emery cloth. Heavy or extensive scoring will cause excessive brake lining wear, and it will probably be necessary to rebore in order to true up the braking surface.

If the brake linings are slightly worn and the drum is grooved, the drum should be turned just enough to remove grooves and the ridges in the lining should be lightly removed with a lining grinder

If brake linings are to be replaced, a grooved drum should be turned for use with oversize linings. A grooved drum, if used with new lining, will not only wear the lining, but will make it difficult, if not impossible to obtain efficient brake performance.

OUT-OF-ROUND OR TAPERED DRUM

An out-of-round drum makes accurate brake shoe adjustment impossible and is likely to cause excessive wear of other parts of brake mechanism due to its eccentric action. An out-of-round drum can also cause severe and irregular tire tread wear as well as a pulsating brake pedal. When the braking surface of a brake drum exceeds the factory specification limits in taper (and/or) being out-of-round, the drum should be turned to true up the braking surface.

Drum out-of-round can be measured with a dial indicator and extension rod. Out-of-round measurements exceeding .006", (total indicator reading) require turning or replacement of drum.

TURNING DRUMS

If irregularities in the braking surface of the drum cannot be removed with emery cloth or out-of-round exceeds .006" (total indicator reading), the drum can be turned to .060" greater than the original inside diameter. If a drum has smooth score marks .010" to .020", it is serviceable without turning.

If a drum is turned to a diameter less than .030" standard replacement linings may be used. Over .030" oversize linings should be used.

A discard dimension 11.090" (figure 55) is stamped on all production installed brake drums.

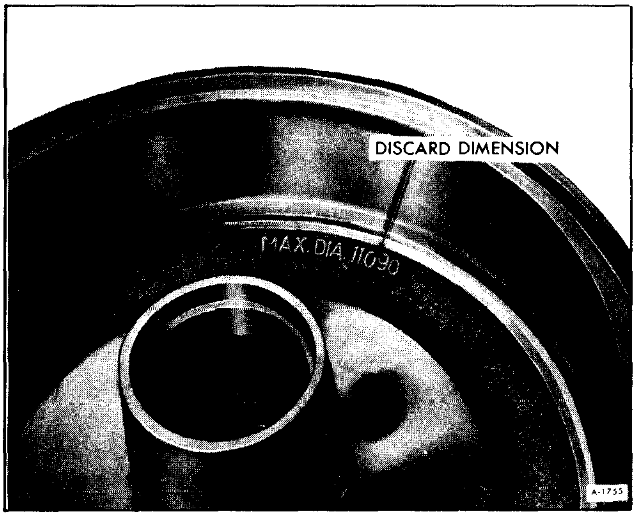


Figure 55–Discard Dimension (Drum)

This is the allowable wear dimension and NOT the allowable turning dimension. There must be .030" left for wear after turning drums. The maximum turning diameter is 11.060".

REPLACING DRUMS

Whenever new drums are to be installed, the braking surface of the drum must be thoroughly cleaned with lacquer thinner to remove the rust-proof coating.

COMPONENT INSTALLATION

BRAKE DRUM INSTALLATION

1. Install hub and drum assembly (figure 10).

2. Install flat washer and castillated nut on hub while rotating hub and drum assembly.

3. Tighten castillated nut to 25-30 lbs. ft. torque to position bearings. (Be sure drum is rotating while tightening nut).

4. Back off nut 1/2 turn.

5. Retighten nut finger tight, secure if possible with cotter pin.

6. If unable to secure at finger tight, back off nut to first securing position.

7. Check end play between hub and spindle it should be .001 to .005 inch.

REAR BRAKE SHOE INSTALLATION

1. Lubricate the adjusting screw threads, thrust washer mating surfaces and backing plate ledges with brake lubricant, such as Part No. 1050110 or equivalent.

2. Assemble the adjusting screw.

3. Attach the primary to secondary shoe spring to the shoes and install the adjusting screw. The primary to secondary shoe spring must not contact the adjusting screw sprocket.

4. Position shoe assembly on the backing plate. Be sure wheel cylinder links are properly positioned in the shoe notches.

5. Position the upper end of the actuating link on the brake shoe guide.

6. Engage the actuating link with the override pivot. Then position the adjuster lever and return spring on the secondary shoe. Position sleeve in the hole in secondary shoe and fasten to backing plate with hold-down spring assembly and pin.

7. Install the remaining primary hold-down spring, washer and pin.

8. Install the primary and secondary brake shoe return springs.

9. Adjust brake shoes as outlined under BRAKE SHOE ADJUSTMENT.

10. Install the hub and drum assembly. Adjust wheel bearings.

11. If wheel cylinder was removed, bleed brakes.

12. Check fluid level in master cylinder. Fluid level should be no more than 1/4" below the reservoir opening at rear.

DISC BRAKE SHOE INSTALLATION

1. Using Silicone Lube, No. 1050018, or equivalent, lubricate new sleeves, on all surfaces. Lubricate new rubber bushings, bushing grooves and the small ends of bushings in all four caliper ears. Install rubber bushings in all four caliper ears.

> **CAUTION:** *It is essential that the new sleeves and rubber bushings be used and that lubrication instructions be followed in order to insure the proper functioning of the sliding caliper design.*

2. Install the sleeves. Position the sleeves so that the end toward the shoe and lining assemblies is flush with the machined surface of the ear.

3. Install the shoe support spring by placing the single tang end of the spring over the notch in the center of the edge of the shoe. Then press the two tangs at the spring end of the inboard shoe spring over the bottom edge of the shoe so that they engage the shoe securely.

4. Position the new inboard shoe and lining assembly (with spring attached) in the caliper so that the ear end of the shoe and lining is down and the bottom end up at an angle with the spring resting on the piston I.D. (figure 56). Press down on both ends of the shoe until the shoe is in a flat position, resting on the piston. The spring end of the inboard shoe support spring should be resting on the I.D. of the piston.

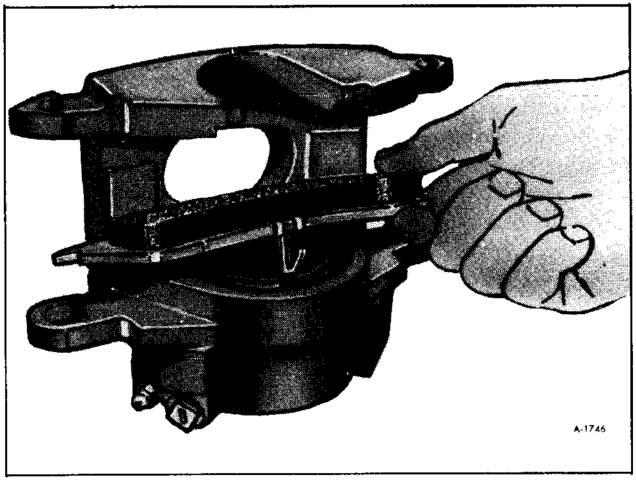


Figure 56–Installing Inboard Shoe

> **NOTE:** If the shoe support spring is not installed correctly, a low or no brake pedal could occur.

5. Insert new outboard shoe into caliper making sure no clearance exists between shoe and caliper face. (figure 57)

6. Position the caliper over the disc, aligning the holes in the caliper ears with the holes in the mounting bracket.

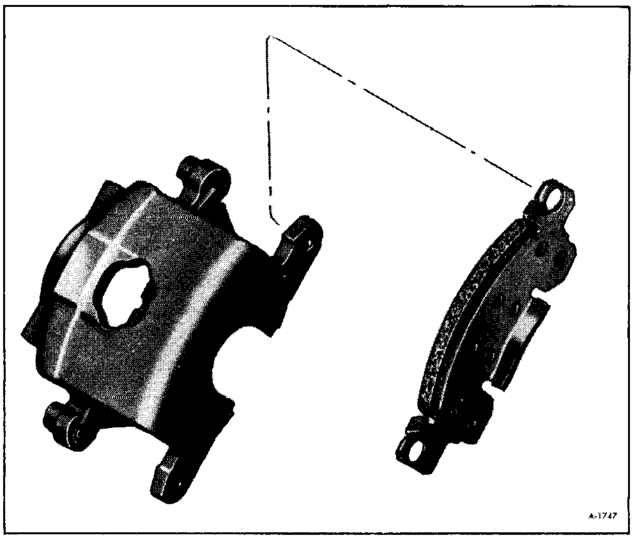


Figure 57–Installing Outboard Shoe

Make sure that the brake hose is not twisted or kinked. Start the bolts through the sleeves in the inboard caliper ears and through the mounting bracket making sure that the ends of the bolts pass under the retaining ears on the inboard shoe. Push bolts on through to engage the holes in the outboard shoes and the outboard caliper ears at the same time threading the bolts into the mounting brackets. Torque the bolts to 35 ft. lbs.

7. Fill master cylinder reservoir with new brake fluid No. 5464831 or equivalent to within 1/4" of top of reservoir.

8. Depress brake pedal to seat linings against rotor.

9. Clinch upper ears of outboard shoe by positioning channel lock pliers with one jaw on top of upper ear and one jaw in notch on bottom of shoe, opposite upper ear.

10. After clinching, ears must be flat against caliper housing with no radial clearance.

11. If radial clearance exists, repeat clinching procedure.

12. Replace the shoe and linings on the other front wheel disc brake in the same manner. Relining is to be done in full sets only.

NOTE: Right and left calipers must not be interchanged. When installed properly, the bleed screw will be on top.

13. When completed, reinstall the wheel and tire assemblies. Lower the Motor Home to the floor. Add brake fluid to the master cylinder reservoirs to bring the level up to within 1/4" of the top.

NOTE: Do not move vehicle until firm brake pedal is obtained.

Whenever the front wheel disc brakes are relined, the rear drum brakes should be checked also.

COMBINATION VALVE INSTALLATION (FIGURE 13)

1. Install valve on mounting bracket.

2. Connect wiring to switch terminal on valve.

3. Connect all brake lines to valve.

4. Bleed entire brake system. Refer to "BLEEDING BRAKE SYSTEM" as described earlier in this section.

MASTER CYLINDER INSTALLATION

1. Position master cylinder on power cylinder so push-rod enters cavity in master cylinder piston.

2. Install two attaching nuts (figure 15).

3. Connect two hydraulic lines to master cylinder and tighten fittings securely. (figure 14).

4. Fill master cylinder reservoir with brake fluid, No. 5464831, and bleed all wheel cylinders as outlined under "BLEEDING BRAKE SYSTEM".

DISC INSTALLATION

1. Install four hub to disc attaching bolts, and torque to 35 ft. lbs. (figure 58). See caution on page 1 of "FRONT SUSPENSION" section 3A.

2. Position retainer over hub.

3. Lubricate seal lips with Special Seal Lubricant No. 1050169 or equivalent then position seal over hub with metal end toward retainer.

4. Install bearing as shown in Figure 59.

Lubricate O.D. of bearing with E.P. chassis grease.

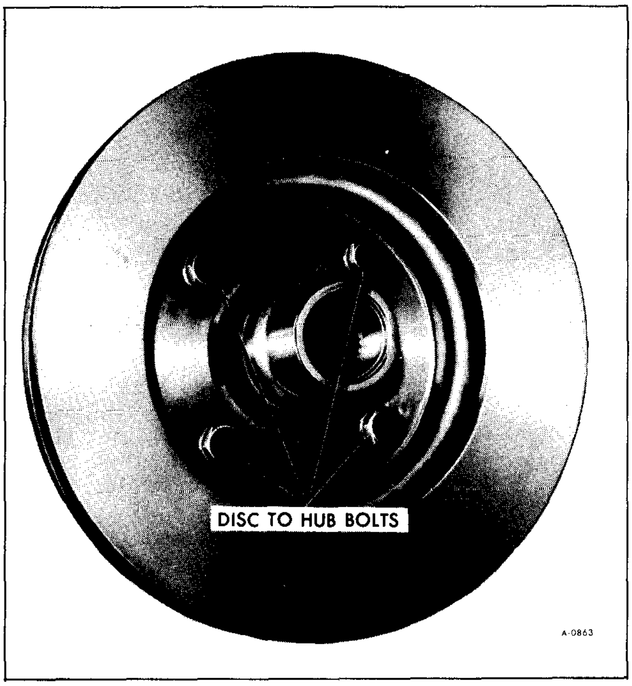


Figure 58–Hub to Disc Bolts

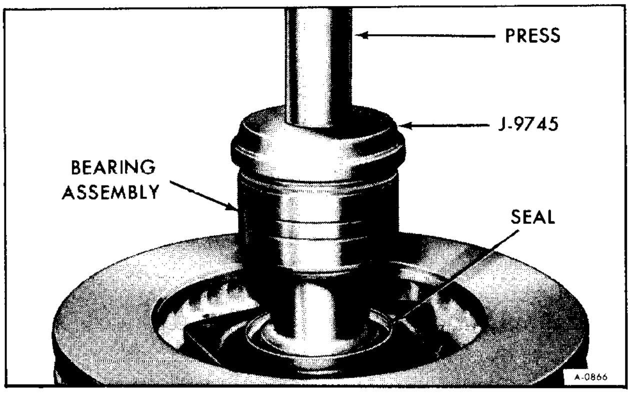


Figure 59–Installing Bearing

The outer race of the bearing is a snug fit into knuckle. Light tapping on the hubs outer surface not the disc will aid assembly.

Care must be used when installing hub assembly over drive axle splines so that splines are in correct alignment.

5. Install three bolts attaching bearing retainer to knuckle. Torque to 35 ft. lbs.

6. Install drive axle washer and nut. Torque nut to 150 ft. lbs. If necessary to align cotter pin slot, tighten nut and install NEW cotter pin and crimp. Torque not to exceed 280 ft. lbs.

NOTE: Do not back off nut to install cotter pin.

POWER BRAKE BOOSTER INSTALLATION

1. Position booster assembly on firewall and install four retaining bolts. (figure 22).

2. Connect vacuum line to booster assembly.

3. Install master cylinder mounting bracket from booster assembly to firewall.

4. Install master cylinder, refer to "Master Cylinder Installation".

5. Install clevis pin retaining brake pedal to brake booster assembly clevis. Secure with cotter pin refer to Figure 21.

6. Install power level control panel and secure with four screws.

PARKING BRAKE LEVER INSTALLATION

1. Position lever on toe board.

2. Position cable in its retaining bracket and install pin.

3. Install parking brake switch.

4. Install two nuts and bolts holding cable retaining bracket to lever base (figure 24).

5. Install four nuts and bolts holding lever to toe board (figure 23).

FRONT PARKING BRAKE CABLE INSTALLATION

1. Position cable through toe board.

2. Install retainer and retainer pin on end of cable through lever.

3. Install clip to retain cable at shift relay bracket.

4. Install end of cable in front equalizer with front cable on top of intermediate cable. Install adjusting nut and lock nut (figure 25).

5. Adjust parking brake as described earlier in this section.

INTERMEDIATE PARKING BRAKE CABLE INSTALLATION

1. Position cable through frame rails.

2. Place cable in guides at frame rails (figure 27).

3. Place cable in guide at crossmember (figure 26).

4. Install cable at front equalizer with intermediate cable under front cable. Install adjusting nut and lock nut (figure 25).

5. Install intermediate equalizers including adjusting and lock nuts (figure 5).

6. Adjust parking brake as described earlier in this section.

REAR PARKING BRAKE CABLE INSTALLATION

1. Install the rear cable through the backing plate and connect the ball to the lever. Make sure the locking fingers are fully expanded on the backing plate (figure 29).

2. Install hubs and drums as described under "Brake Drum Installation".

3. Feed ends of cables through brackets on frame rails and install clips (figure 28).

4. Connect ends of cables and install intermediate equalizer, with intermediate cable on top of rear cable (figure 25).

5. Adjust parking brake as described earlier in this section.

BRAKE PEDAL INSTALLATION

1. Properly position brake pedal assembly.

2. Install two nuts, one at each end of pedal assembly (figure 30 & 31).

3. Tighten left hand brake lever pivot bracket.

4. Insert clevis pin into clevis and brake pedal assembly. Secure with a cotter pin (figure 21).

5. Install brake light switch.

6. Install power level valve mounting panel and secure with four screws.

BRAKE LINE TUBING INSTALLATION

WARNING: DOUBLE FLARING TOOL MUST BE USED AS SINGLE FLARING TOOLS CANNOT PRODUCE A FLARE STRONG ENOUGH TO HOLD THE NECESSARY PRESSURE.

Hydraulic brake tubing is a double layer annealed steel terne plate tubing which resists corrosion and has the physical strength to stand up under the high pressures which are developed when applying the brakes. In making up hydraulic brake pipes, it is important that the proper flaring tool be used to flare the ends of the tubing for the compression couplings. Unless the tubing is properly flared, the connections will leak and the brakes will become ineffective.

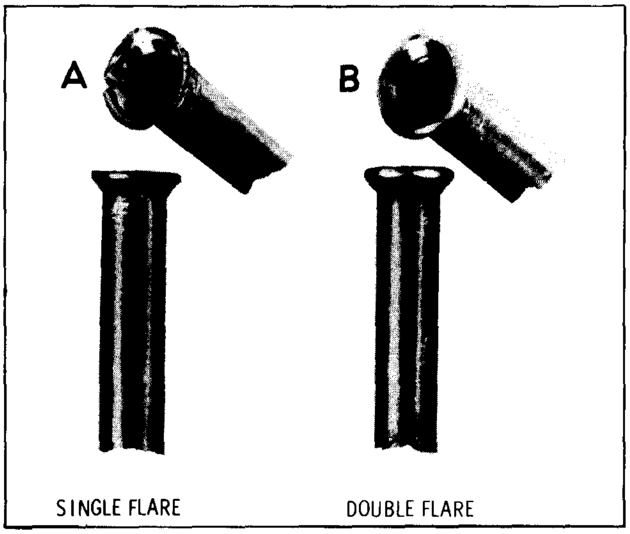


Figure 60–Single and Double Lap Flare

WARNING: NEVER USE COPPER TUBING BECAUSE COPPER IS SUBJECT TO FATIGUE CRACKING WHICH WOULD RESULT IN BRAKE FAILURE.

Steel tubing must be double-lap flared at the ends in order to produce a strong leakproof joint.

Special tools are available from tool companies for making double-lap flares. Do not attempt to flare steel tubing without proper tools. Figure 60 shows a single and a double-lap flare, note the split in the single-lap flare. The double-lap is well formed and unbroken due to the reinforcement of the double wall.

Refer to Figure 61 for brake line routing and attachment.

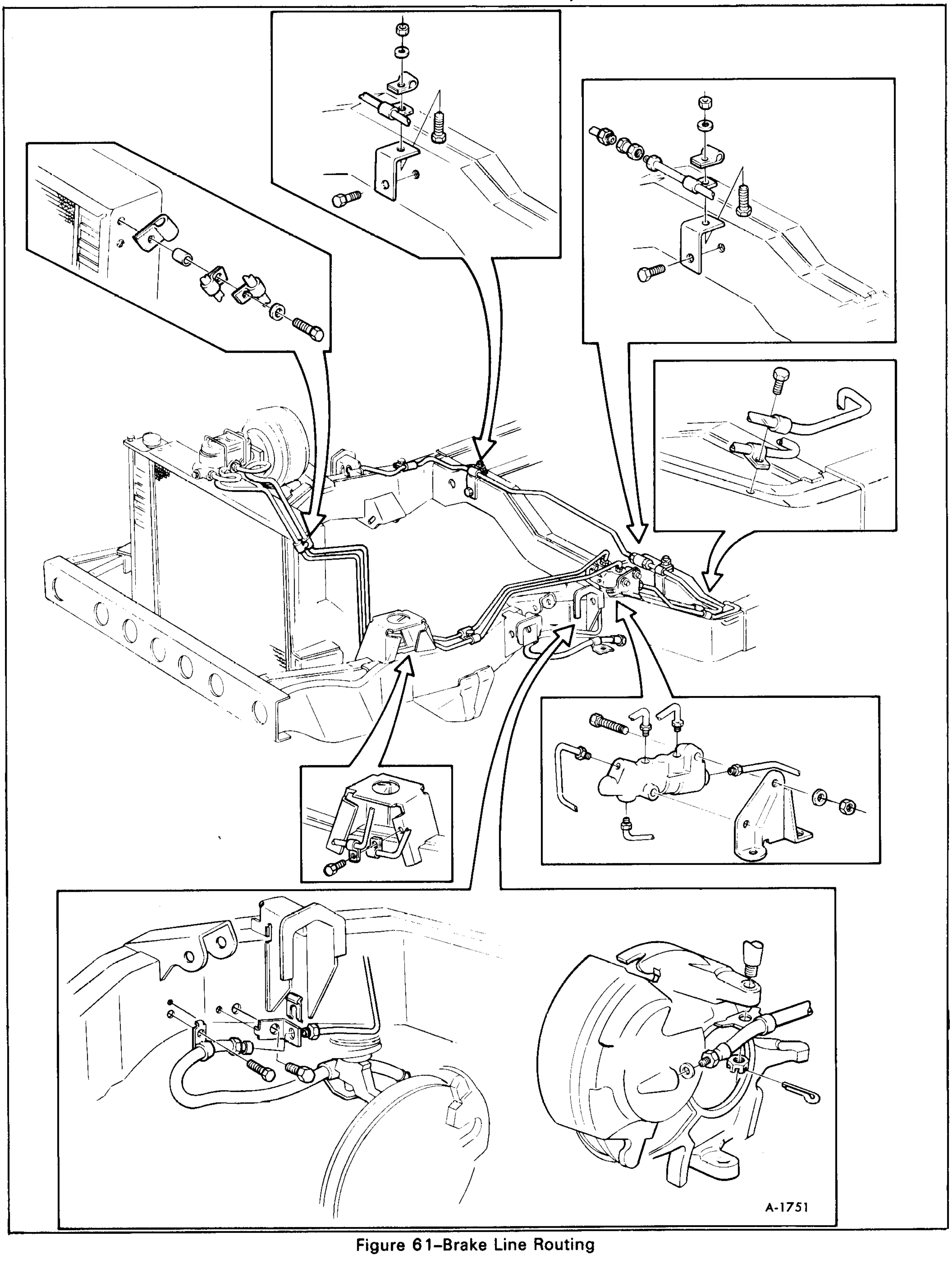


Figure 61–Brake Line Routing

SPECIFICATIONS

Drums
- Inside Diameter
  - Original .... 11"
  - Maximum .... 11.090"
  - Max. Out-of-Round .... (Total Indicator Reading .006")

Discs
- Outside Diameter .... 11"
- Lateral Runout .... .005"
- Thickness Variation .... .0005"
- Disc Thickness
  - Original .... 1.200"
  - Minimum .... 1.170"

Linings
- Drums
  - Length-Primary .... 8.90"
  - Length-Secondary .... 11.60"
  - Width .... 2.0"
  - Thickness-Primary .... .200"
  - Thickness-Secondary .... .290"
- Discs
  - Length .... 5.4"
  - Thickness-Inner .... .43"
  - Thickness-Outer .... .40"

Fluid Type .... Delco Supreme 11 or DOT-3 fluid or equivalent

TORQUE SPECIFICATIONS

Combination Valve to Mounting Bracket
- Nut Torque .... 8-12 ft. lbs.

Combination Valve Mounting Bracket to Frame Rail
- Screw Torque .... 72 in. lb. min. (Fully Driven not Stripped)

Power Cylinder to Firewall
- Nut Torque .... 12-16 ft. lbs.

Master Cylinder Bracket to Firewall
- Bolt Torque .... 15-20 ft. lbs.

Brake Lever Pivot Bolt
- Bolt Torque .... 30-35 ft. lbs.

Brake Lever Pivot Bracket to Firewall
- Nut Torque .... 25-30 ft. lbs.

Power Cylinder to Master Cylinder
- Nut Torque .... 28 ft. lbs.

Hub to Drum Bolt Torque .... 70-85 ft. lbs.

Drum to Spindle Nut Torque .... 25-30 ft. lbs.

J 22904	Dust Boot Seal Installer
J 23101	Diaphragm Plate Separator
J 23175	Control Valve Installer
J 23188	Secondary Power Piston Bearing Seal Protector
J 23337	Reaction Piston Gauge
J 23456	Brake Booster Separating Fixture
J 23518	Tandem Brake Bleeder Adapter
J 23709	Combination Valve-Metering Valve Actuator

GMC MOTOR HOME SERVICE

SECTION 6A
ENGINE

Contents of this section are listed below:

GENERAL INFORMATION

DESCRIPTION

This section of manual provides instructions for servicing the various items and 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.

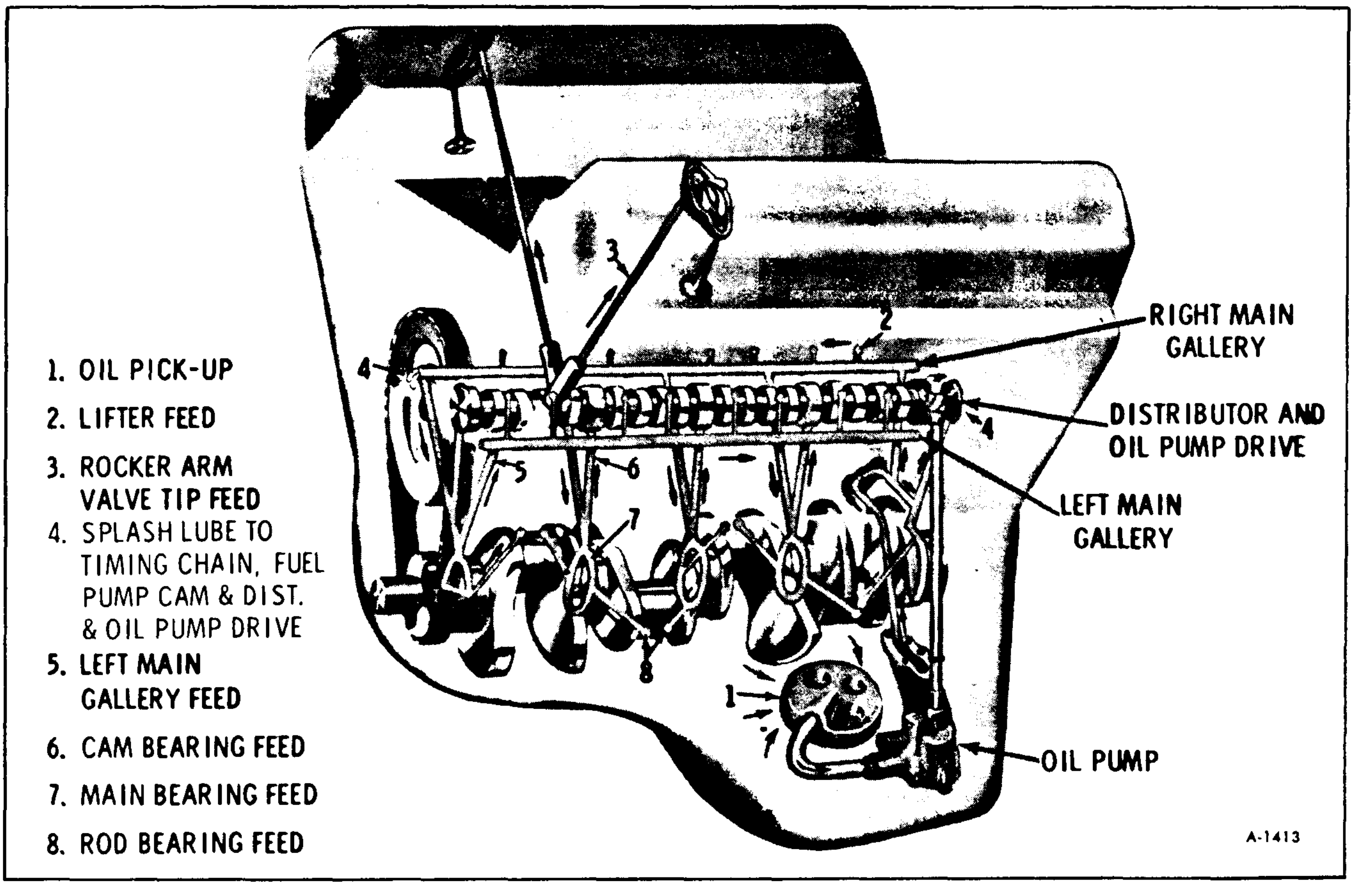


Figure 1–Engine Lubrication

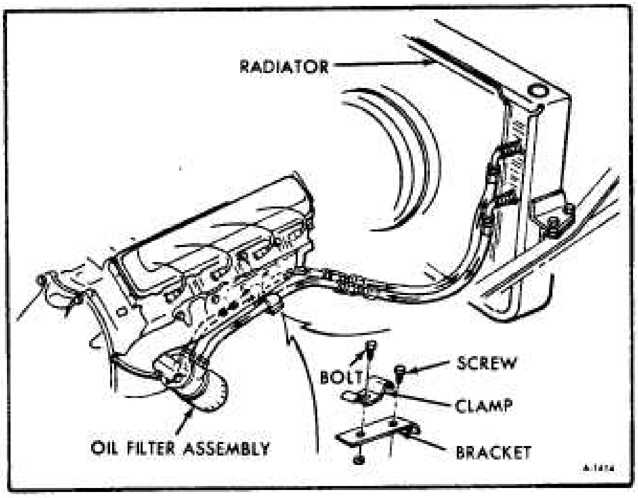


Figure 2–Oil Lines to Cooler

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

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 COOLING 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 COOLING 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 Cooling" 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 Cooling" 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 Cooling" 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 COOLING" in Section 6K).
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 Cooling"" 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 Cooling" 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 hoises.

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 clutch 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. Piston pin rubs against cylinder wall, caused by lock screw being loose or snap ring broken

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., 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 motor home.

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.

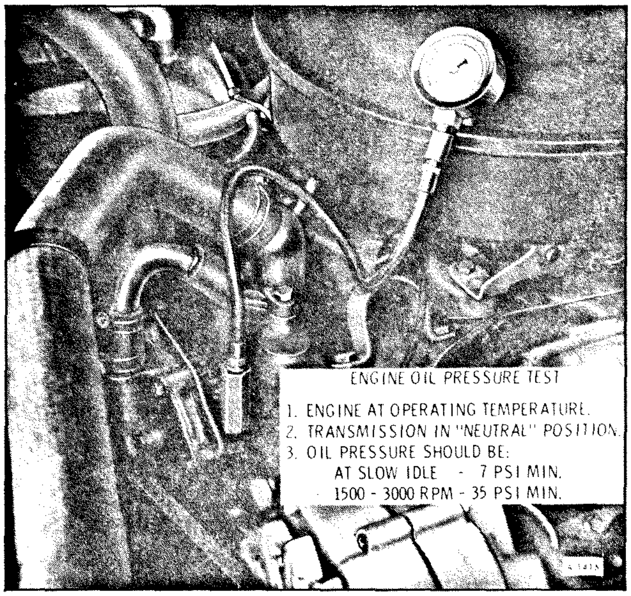


Figure 3--Checking Engine Oil Pressure

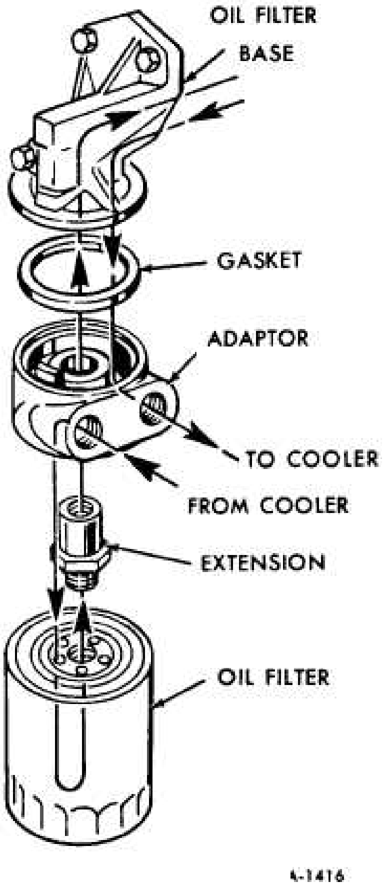


Figure 4–Oil Filter

INSTALLATION

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

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

3. Reposition oil cooler lines and attach to adaptor.

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

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.

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

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

4. Adjust tool No. J-24603 so that the front of the engine 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, 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 as shown in Figure 5.

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

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

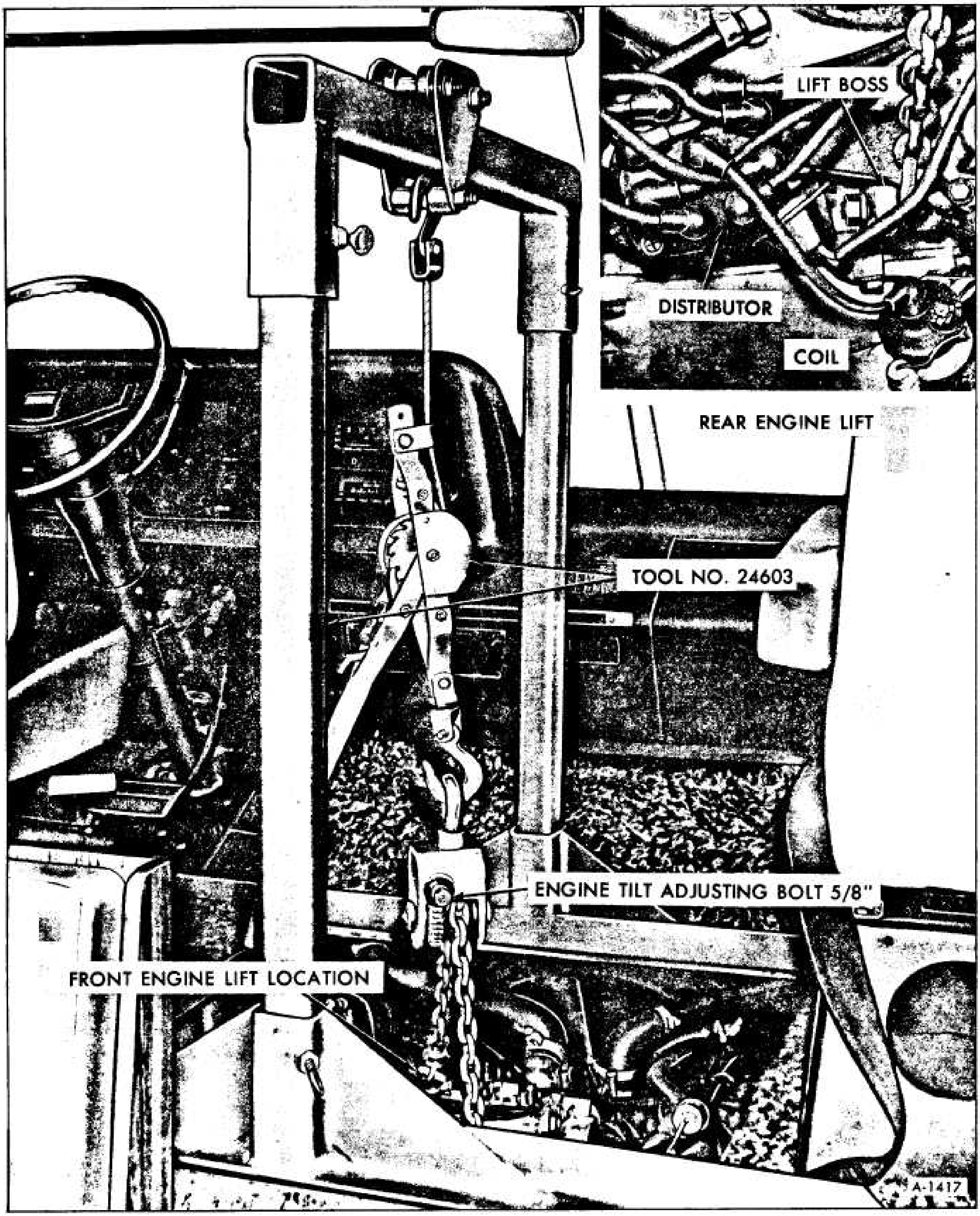


Figure 5–Attaching Engine Removal Tool

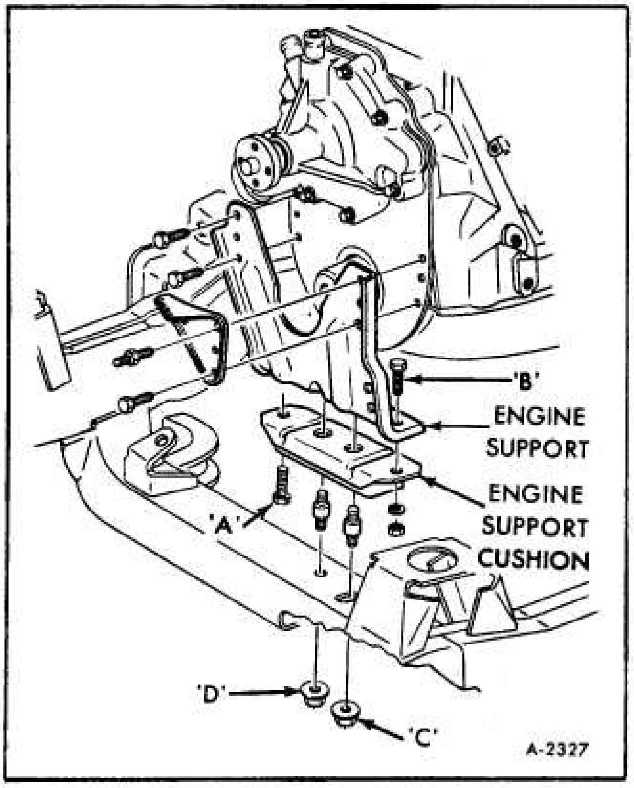


Figure 6–Front Engine Mounting

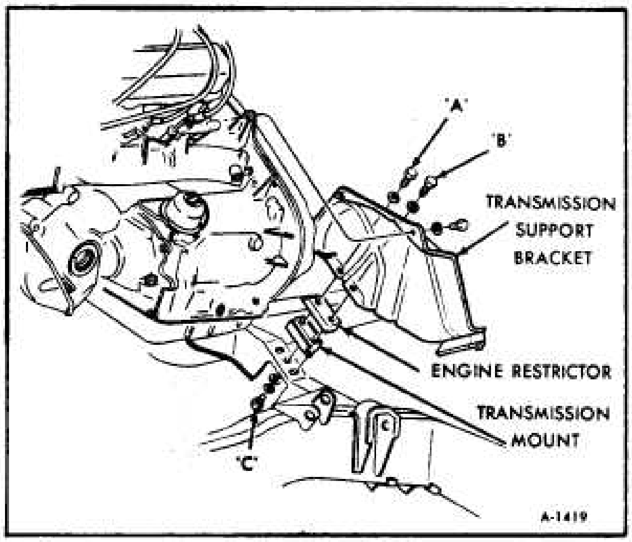


Figure 7–Engine Rear Mounting

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.

5. Remove tool No. J-24603, 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 8. Vehicles without air conditioning require removal of L.H. upper venturi ring only.

5. If vehicle is equipped with the standard 61 amp. generator loosen belt and remove brackets shown in Figure 9.

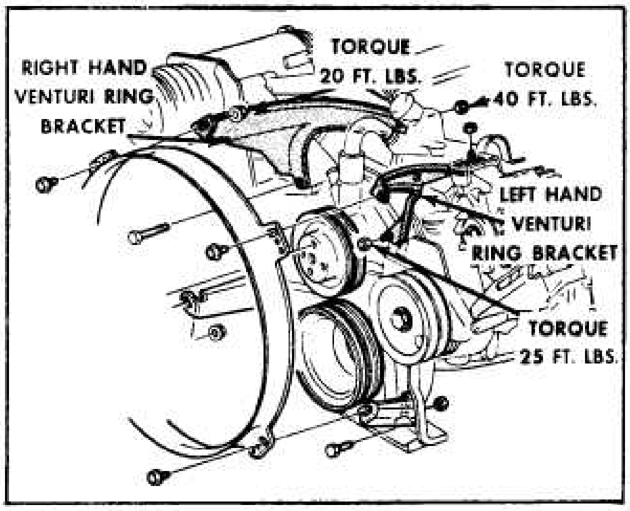


Figure 8–Upper Venturi Ring Brackets

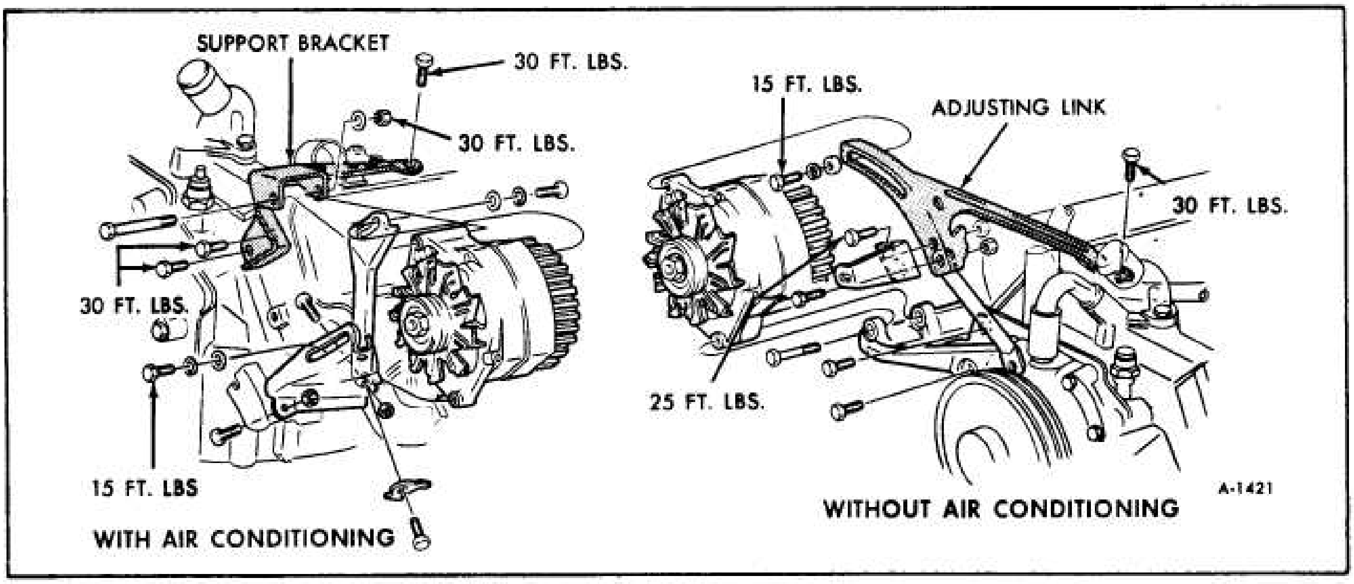


Figure 9–Generator Mounting

NOTE: Vehicles equipped with optional 80 amp. generator require no generator bracket removal.

6. Remove air conditioning compressor bracket (if so equipped). See Figure 10.

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

8. Disconnect temperature gauge wire.

9. Disconnect throttle cable, and cruise control rod (if equipped) from carburetor throttle lever. (See figure 11). Remove cruise control rod.

10. Remove fuel line from fuel pump to carburetor.

11. Disconnect vacuum lines from the distributor and tee as shown in Figure 12. Disconnect vacuum line from the front of the carburetor which leads to the carbon canister. Referring to Figure 11, disconnect from the intake manifold–vacuum lines to the brake booster (B), heater control (C) and cruise control (A) (if so equipped).

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

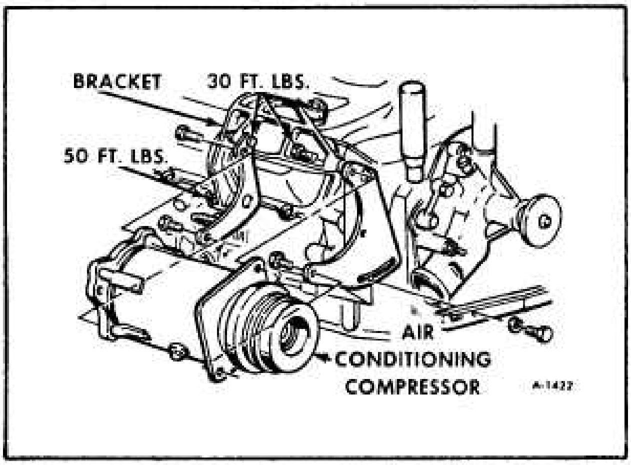


Figure 10–Air Conditioning Compressor Mounting

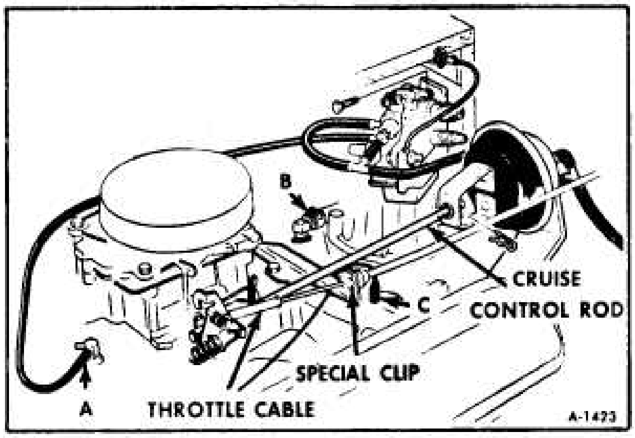


Figure 11–Location for Disconnecting Vacuum Hoses and Throttle Cable

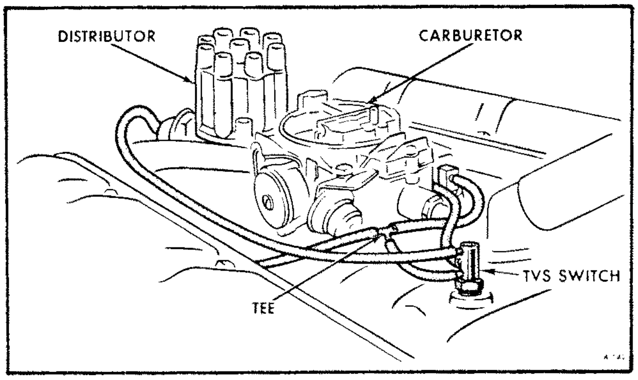


Figure 12–Distributor and Transmission Vacuum Lines

13. 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.

14. Remove coil mounting bolts. Wires may be left connected to the coil if desired.

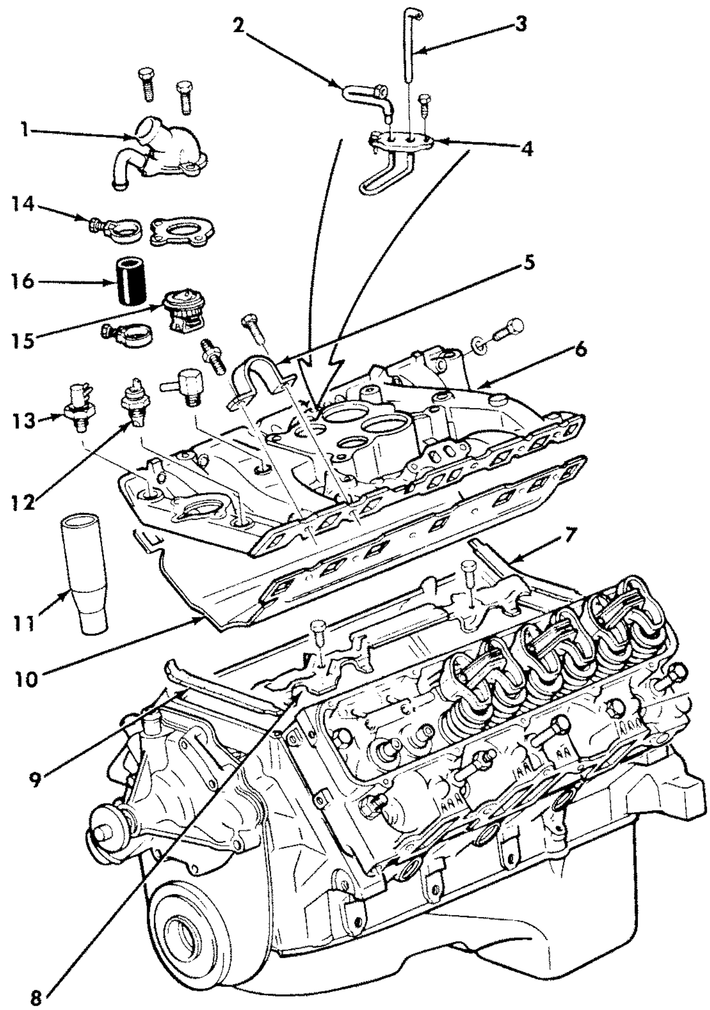
15. Remove intake manifold bolts, then remove manifold with carburetor attached.

16. 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 intake manifold gasket at the sealing area with sealer 1050026 or equivalent. (See figure 13).

2. Install intake manifold. Lubricate bolts entirely with engine oil, install and torque to 15 ft. lbs. in sequence. See Figure 14. Retorque in sequence to 40 ft. lbs.



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

Figure 13–Intake Manifold and Gasket

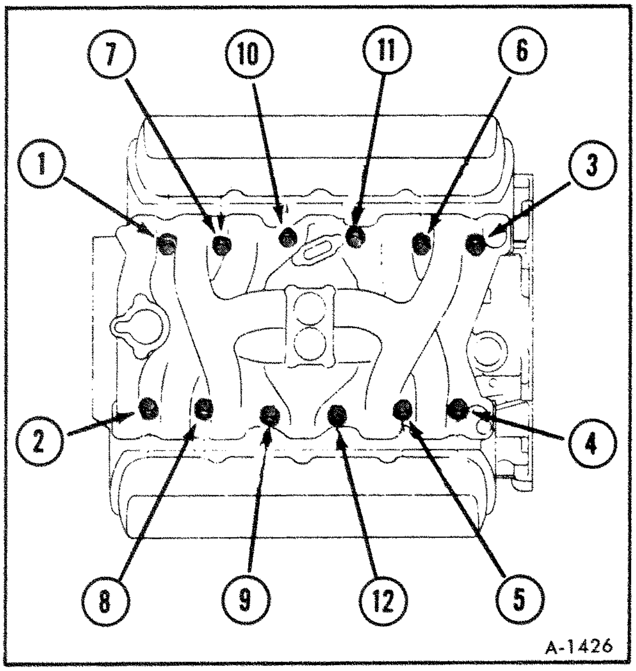


Figure 14–Intake Manifold Torque Sequence

3. Install coil mounting bolt and torque to 15 ft. lbs.

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

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

6. Connect vacuum lines to the distributor and tee as shown in Figure 12. 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 11.

7. Connect throttle cable, and cruise control (if equipped). See Figure 11.

8. Install fuel line.

9. Connect temperature gauge wire.

10. Install air conditioning bracket (if equipped). See Figure 10.

11. Install oil fill tube and flexible elbow.

12. Install generator mounting bracket, if removed. See Figure 9.

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

14. Install venturi ring brace(s). See Figure 8.

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

16. Install air cleaner.

17. Connect battery negative cables to the batteries.

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

L.H. EXHAUST MANIFOLD

REMOVAL

1. Remove air cleaner.

2. Remove hot air shroud as shown in Figure 15.

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 15).

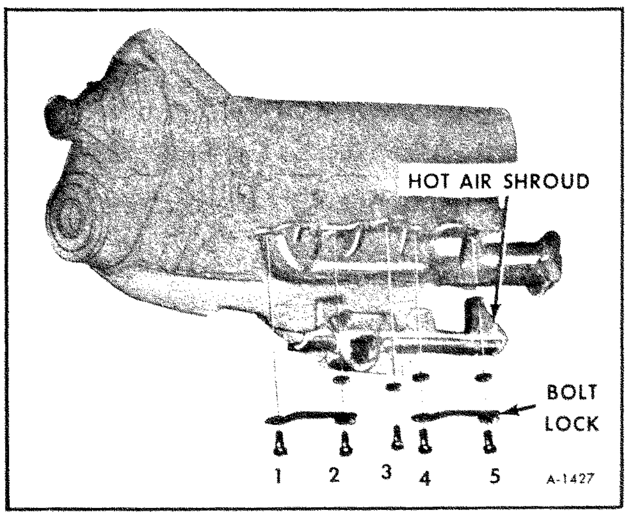


Figure 15–Hot Air Shroud

2. Position hot air shroud, power steering and generator 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.

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 until bolts bottom on spacers.

3. Lower vehicle.

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 10.

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. Apply part No. 1050026 sealer or equivalent to the valve cover side and install a new gasket in the cover.

2. Install valve cover and torque attaching screws as shown in Figure 16.

3. Install accessories and mounting brackets as 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 17)

REMOVAL

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

2. Remove rocker arm, flanged bolts, pivot and rocker arms.

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

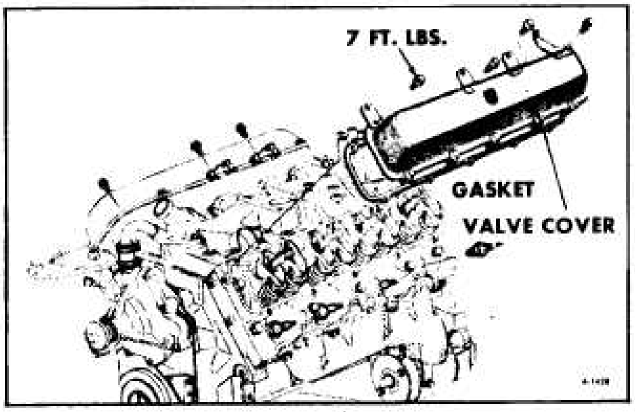


Figure 16–Valve Cover.

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 and hole in the lifter plunger. Oil is then metered past the oil metering valve in the lifter, through the push-rods 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 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 18.

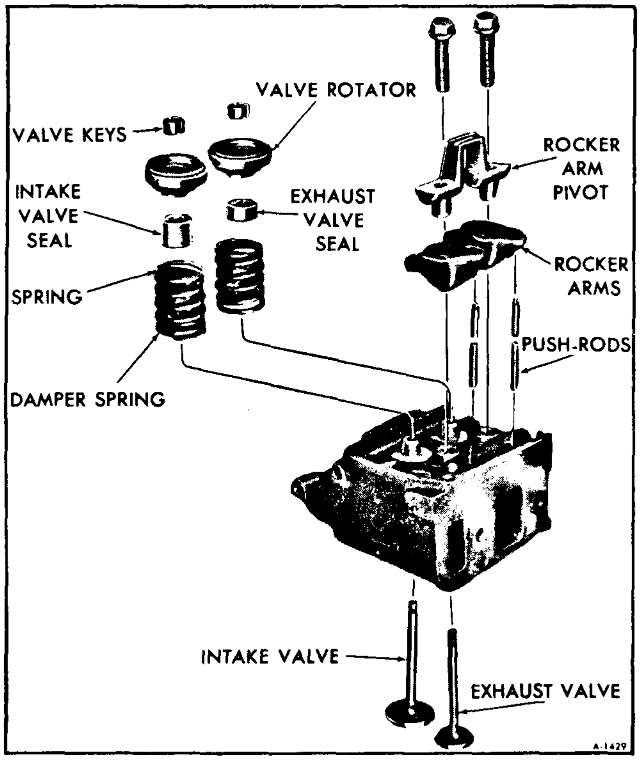


Figure 17–Cylinder Head–Exploded View

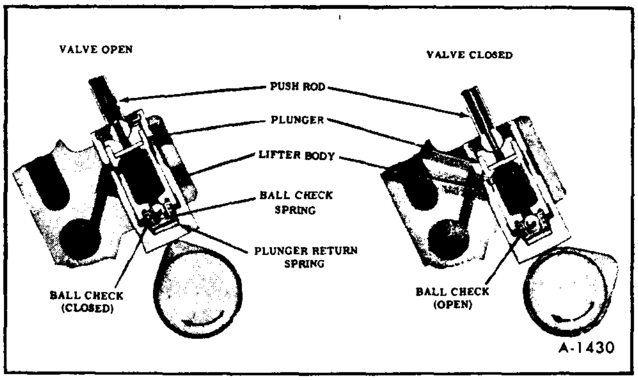


Figure 18–Valve Lifter Cutaway

Valve Lifter Diagnosis

1. Momentarily Noisy When Vehicle Is Starter:

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.

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 at 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 at 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 19.

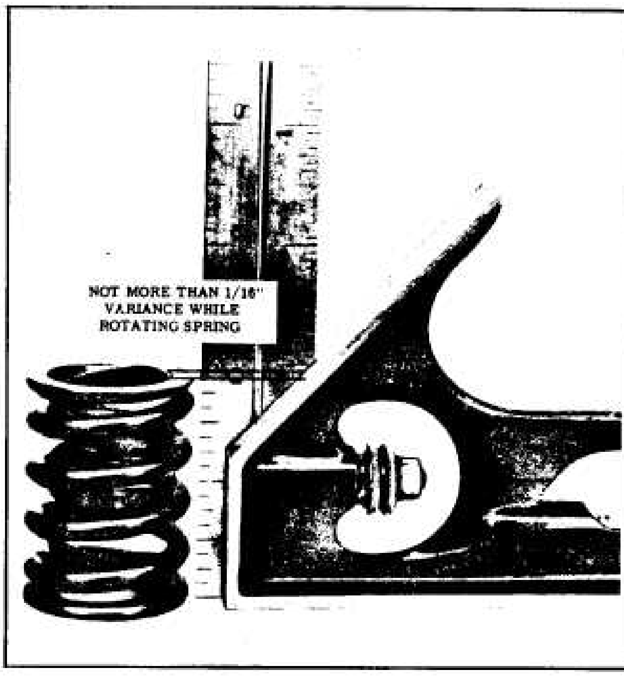


Figure 19–Checking Valve Spring

b. Observe rocker arm pad for excessive wear or excessive off square. Replace as required. See Figure 20.

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.

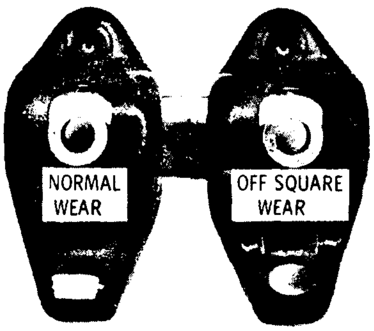


Figure 20–Rocker Arm Wear

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 21. 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 22. 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 17.

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

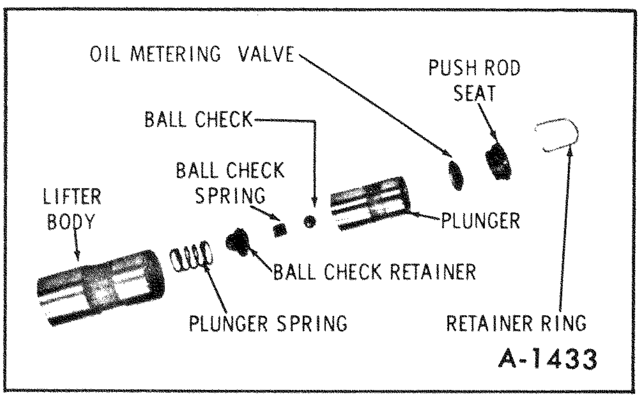


Figure 21–Valve Lifter–Exploded View

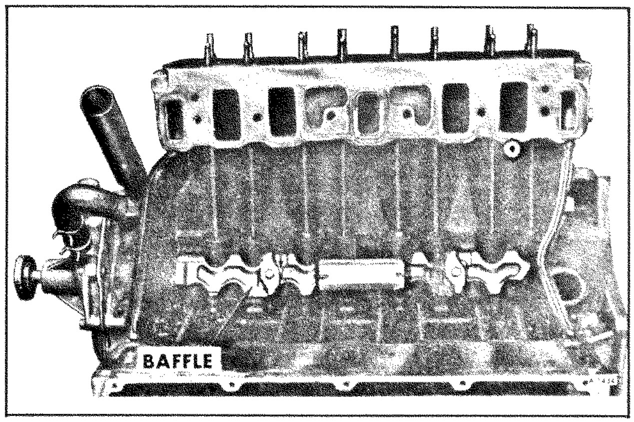


Figure 22–Baffle Installation

CYLINDER HEAD AND GASKET

REMOVAL

1. Drain radiator. Drain cock located at lower left side of radiator. By raising the rear wheels approximately 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 17.

> **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.

> **CAUTION:** *Gasket surfaces on both the head and the block must be clean of any foreigh 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.*

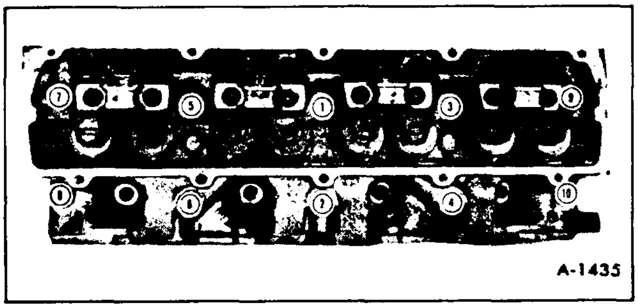


Figure 23–Cylinder Head Torque Sequence

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. Dip cylinder head bolts in engine oil.

3. Install cylinder head and torque bolts to 60 ft. lbs. in sequence as shown in Figure 23. Then re-torque in sequence to 85 ft. lbs.

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.

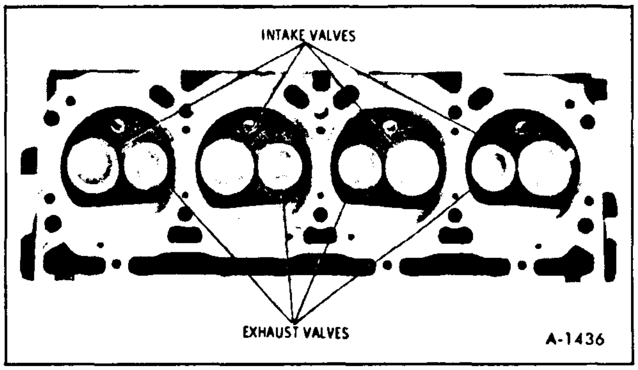


Figure 24–Valve Location

9. Add engine coolant.

10. Start engine and check for leaks.

VALVES AND SPRINGS WITH HEAD REMOVED

REMOVAL

1. Remove spark plugs.

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 24

INSTALLATION

1. Install valves in their respective guides.

2. Install new oil seals over valve stem, using Tool J-24725. See Figure 25.

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

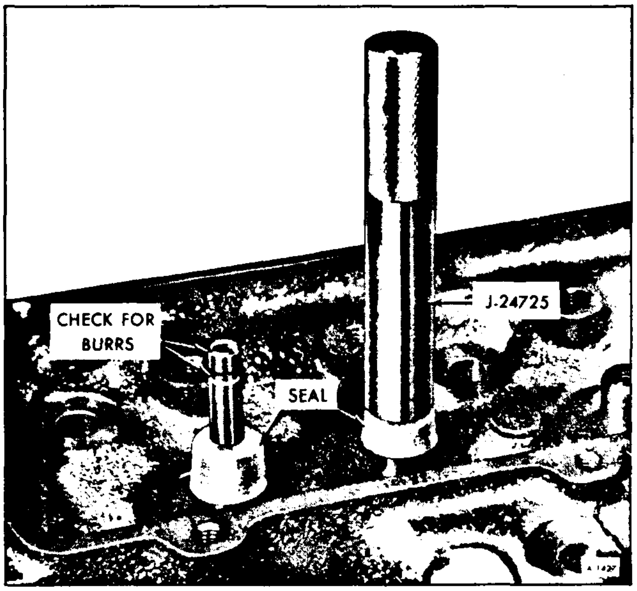


Figure 25–Valve Seal Installation

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.

Reconditioning Valves

When reconditioning valves and valve seats, clean carbon from cylinder heads and valves using care not to 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 26 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.

NOTE: Exhaust valve seats are 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".

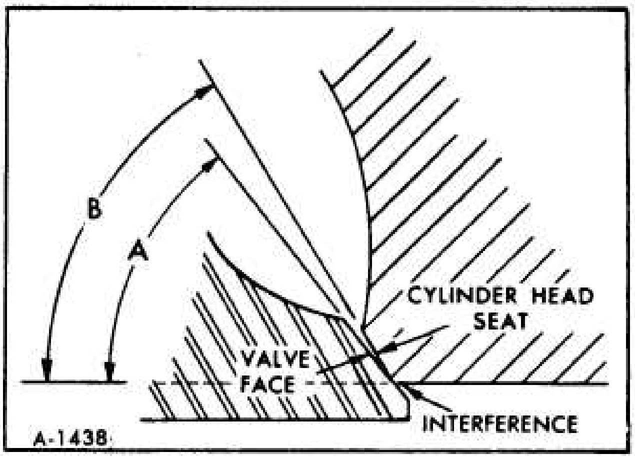


Figure 26–Relation of Valve and Seat Angles

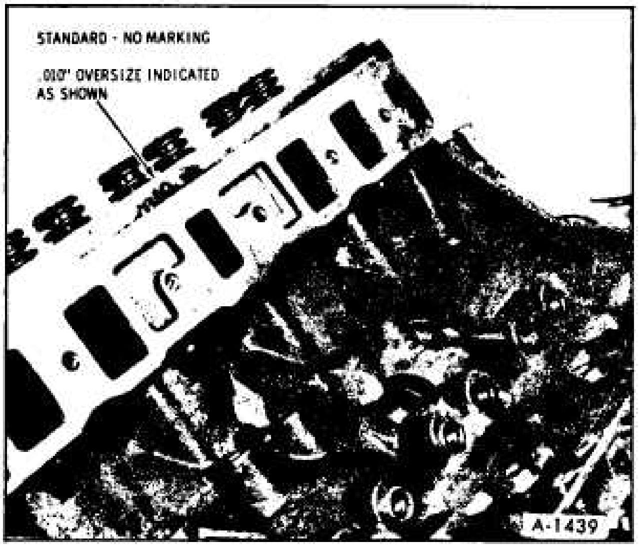


Figure 27–Valve Guide Bore Marking

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

.13" 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.

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 27). 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 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.

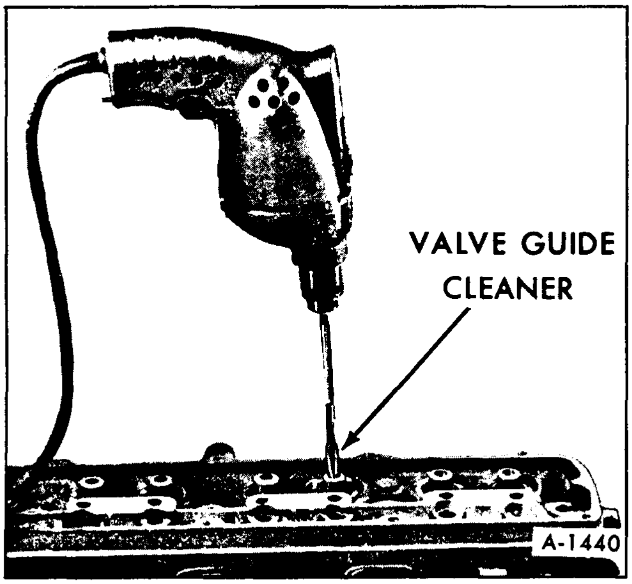


Figure 28–Cleaning Valve Guide Bores

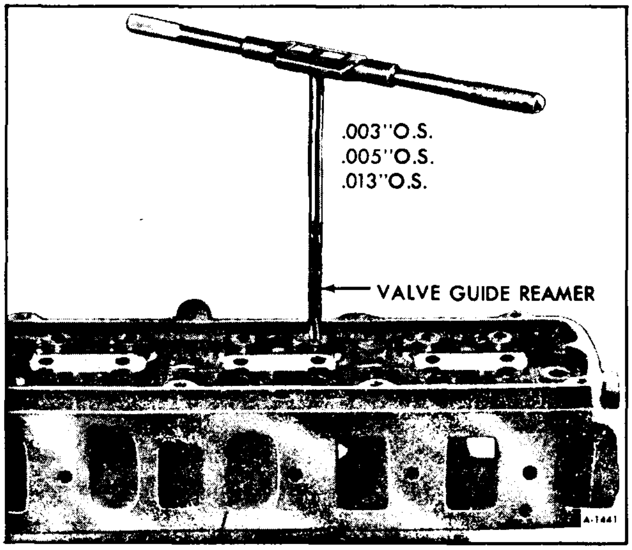


Figure 29–Reaming Valve Guide Bores

Reaming Procedure

Before attempting to ream the valve guide bores they should be cleaned using a tool as shown in Figure 28.

This procedure to ream valve guide bores using a reamer is shown in Figure 29. 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 30).

4. Install Tool J-5892-1. See Figure 30. Compress 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.

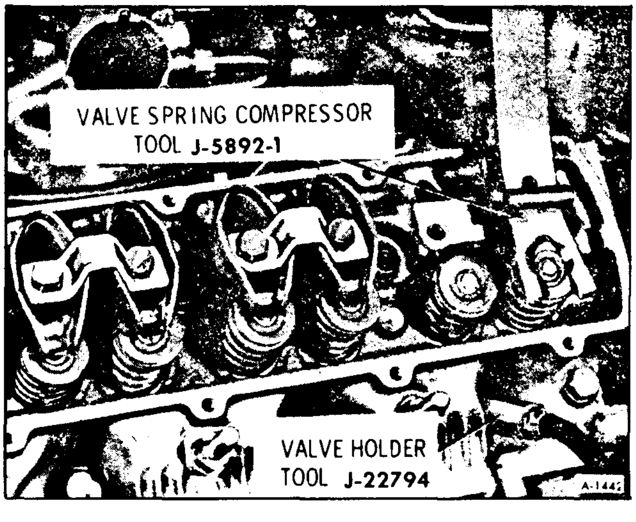


Figure 30–Removing Valve Spring

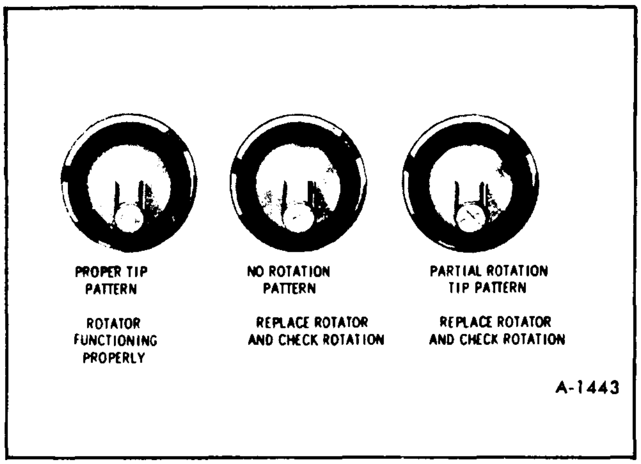


Figure 31–Valve Stem Wear

Anytime the valves are removed for service the tips should be inspected for improper pattern which could indicate valve rotator malfunction. See Figure 31.

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.

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 32.

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 6.

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.

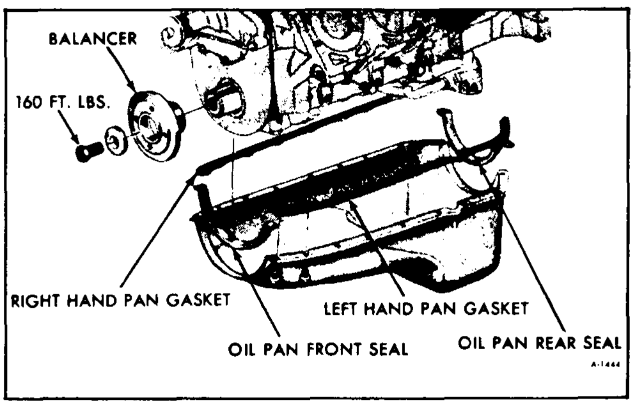


Figure 32–Oil Pan Assembly

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.

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 33)

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 34.

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.

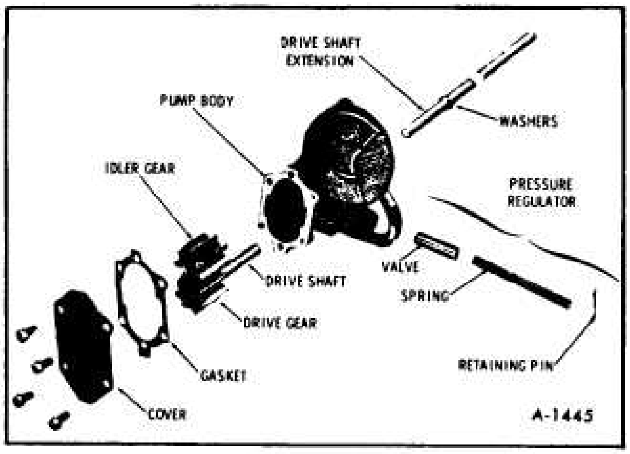


Figure 33–Oil Pump Exploded View

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.

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.

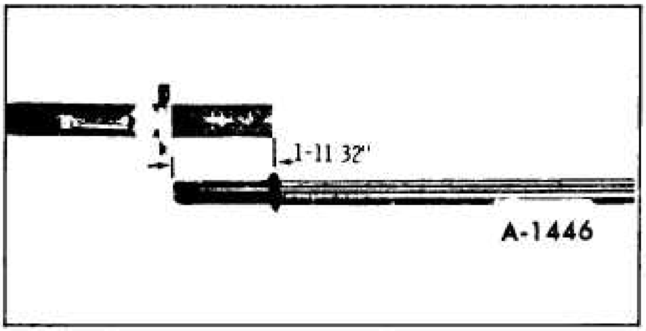


Figure 34–Oil Pump Shaft Extension

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 35.

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

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 36.

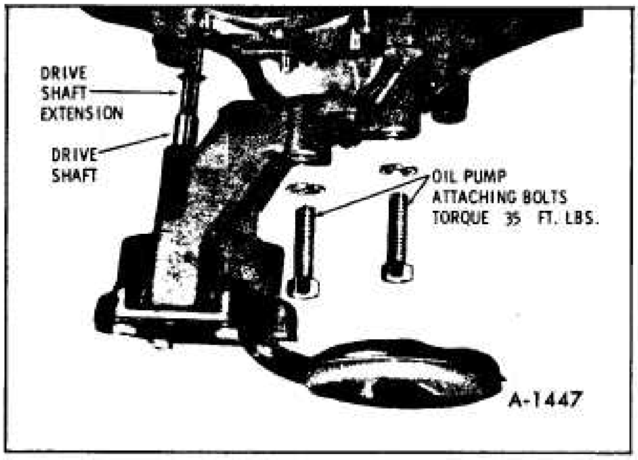


Figure 35–Oil Pump Installation

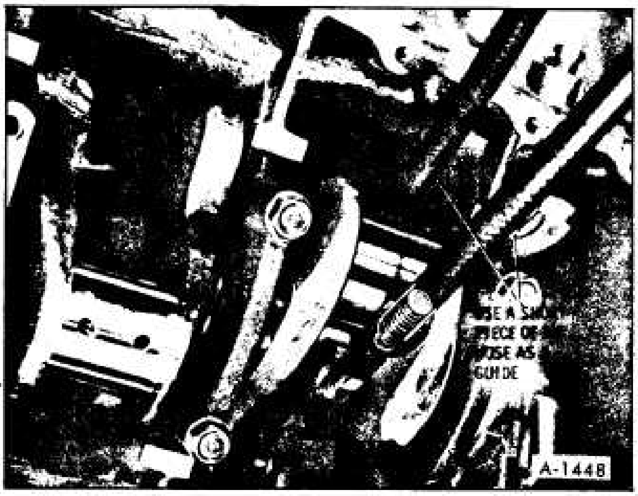


Figure 36–Connecting Rod Bolt Guide

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 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.

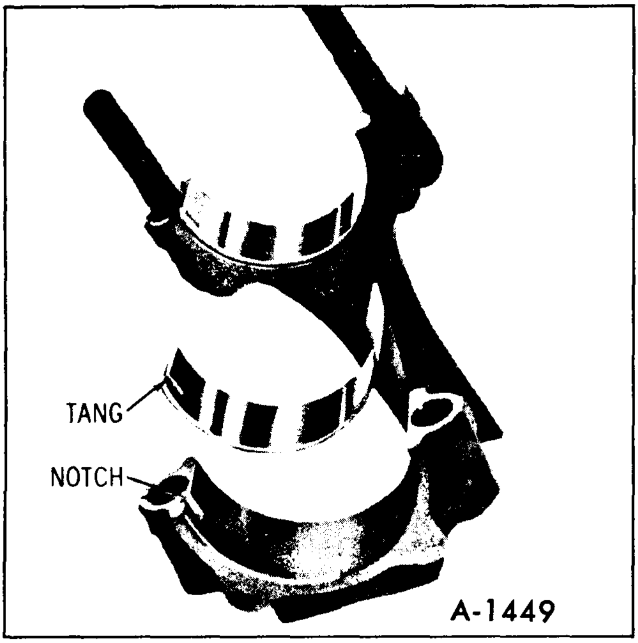


Figure 37–Bearing Tang and Notch

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.

If Plastigauge is to be used:

5. Clean oil from journal bearing cap, connecting rod and outer and inner surface of bearing inserts.

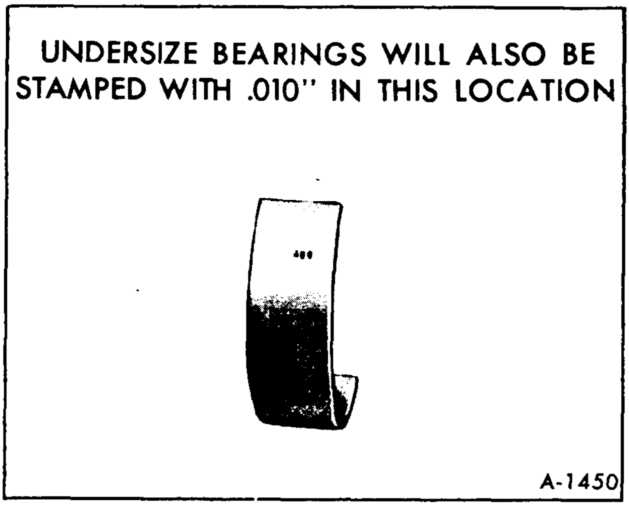


Figure 38–Bearing Identification

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.

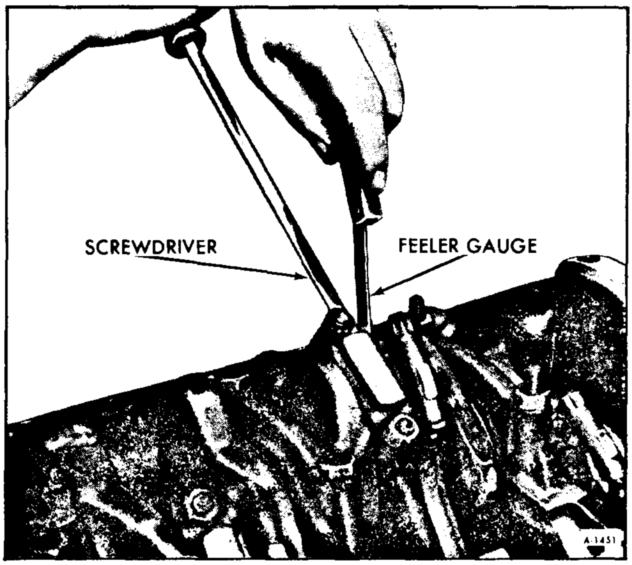


Figure 39–Connecting Rod Side Clearance

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".

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.

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

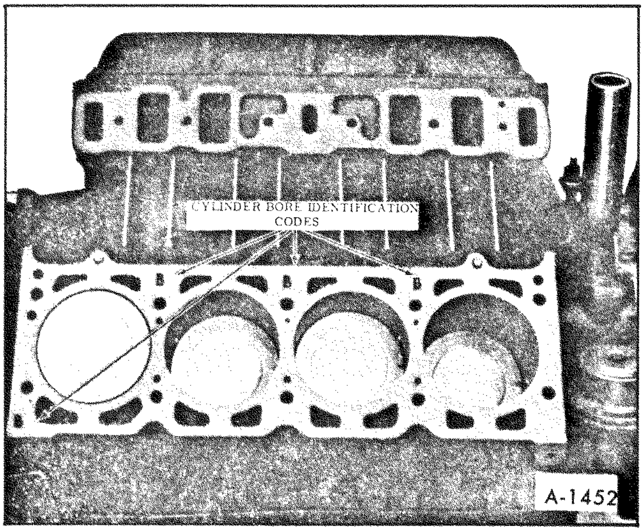


Figure 40–Cylinder Bore Marking

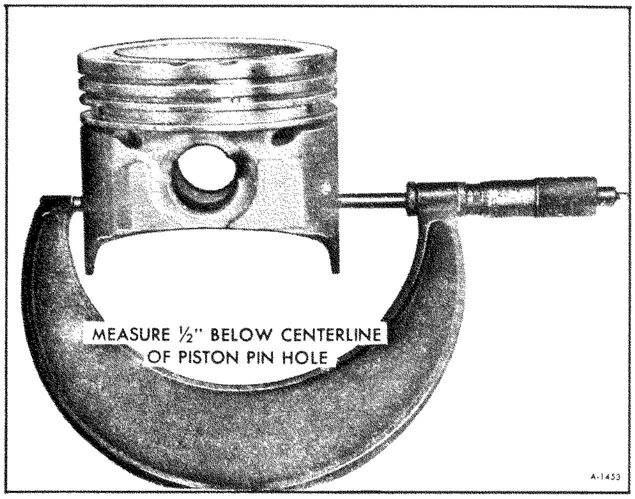


Figure 41–Measuring Piston

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.

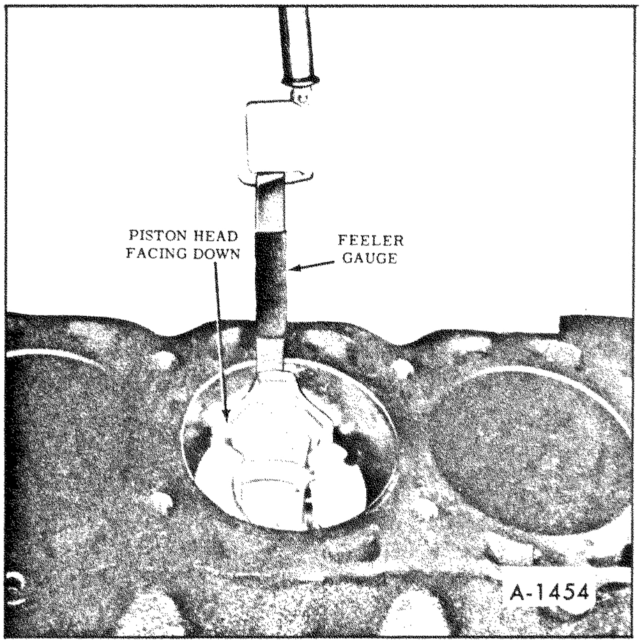


Figure 42–Checking Piston Clearance

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.

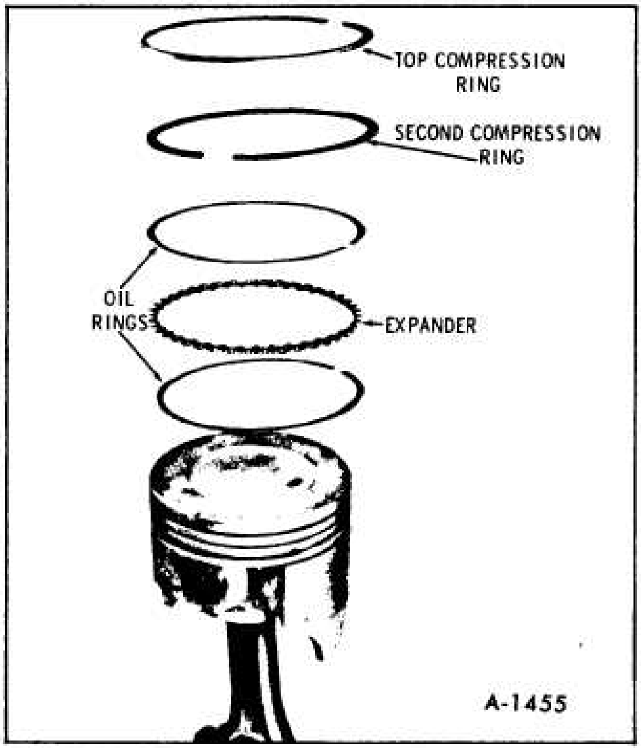


Figure 43–Piston Rings

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 43)

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:

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 44.

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 45. The Piston grooves must be cleaned before checking ring for side clearance.

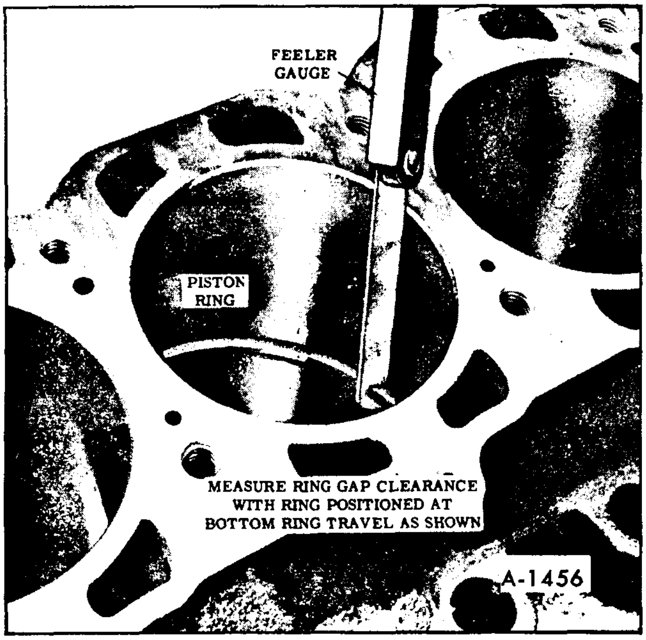


Figure 44–Measuring Piston Ring Gap

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 36).

2. Apply engine oil to rings and piston, then install piston ring compressing tool on piston. See Figure 46.

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

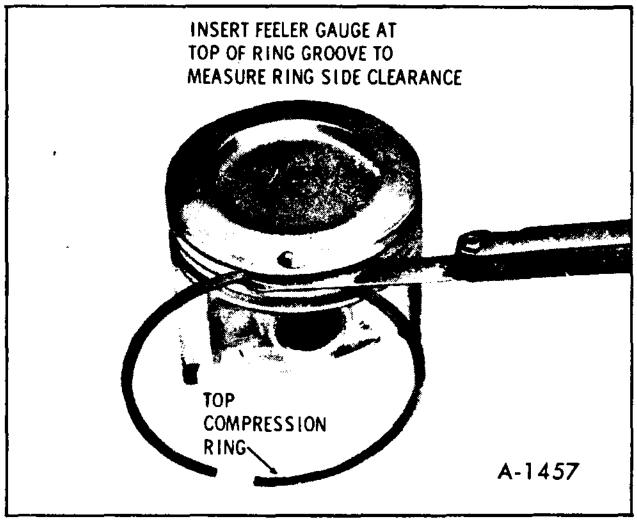


Figure 45–Piston Ring Side Clearance

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 39.

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

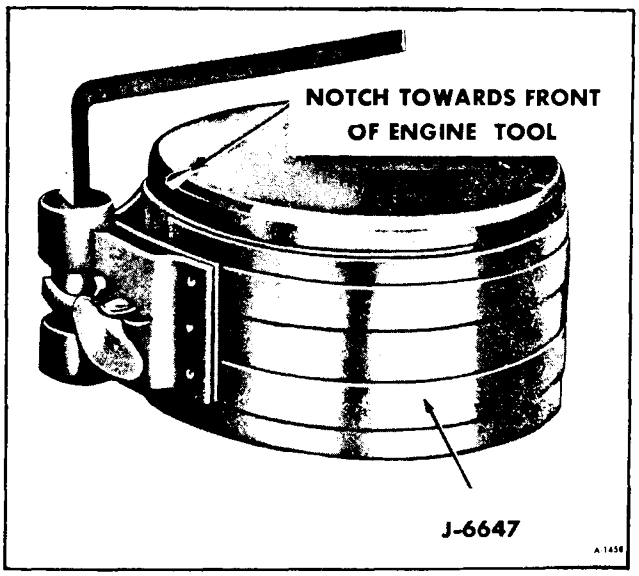


Figure 46–Piston Ring Compressor

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 letter "F" on piston facing up.

2. Press out piston pin.

INSTALLATION

1. Place piston on piston pin installer with letter "F" 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 J-23600 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.

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

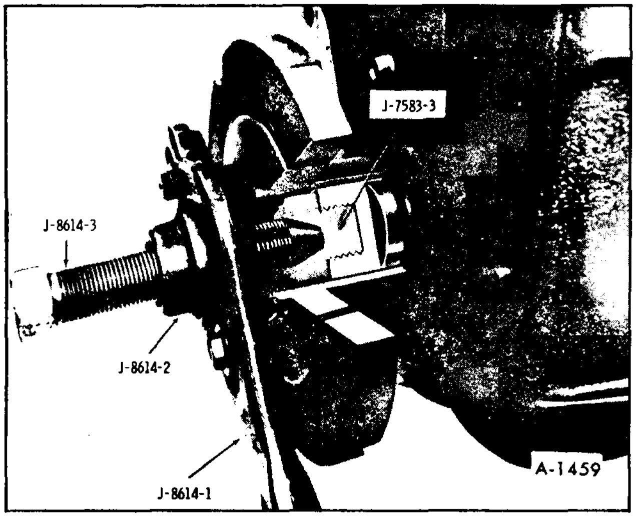


Figure 47–Removing Harmonic Balancer

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.

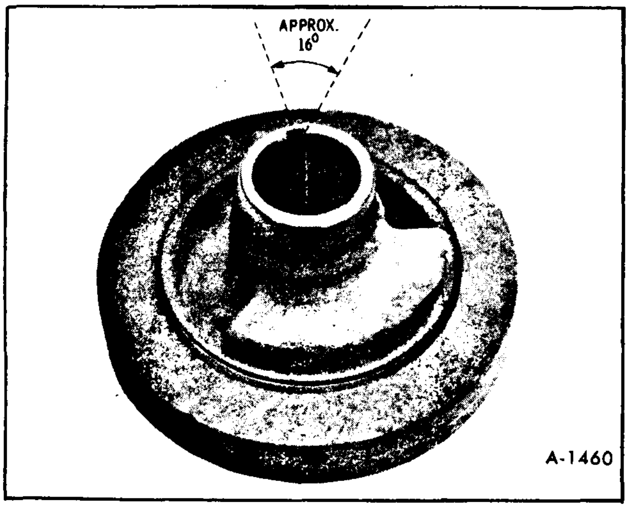


Figure 48–Harmonic Balancer

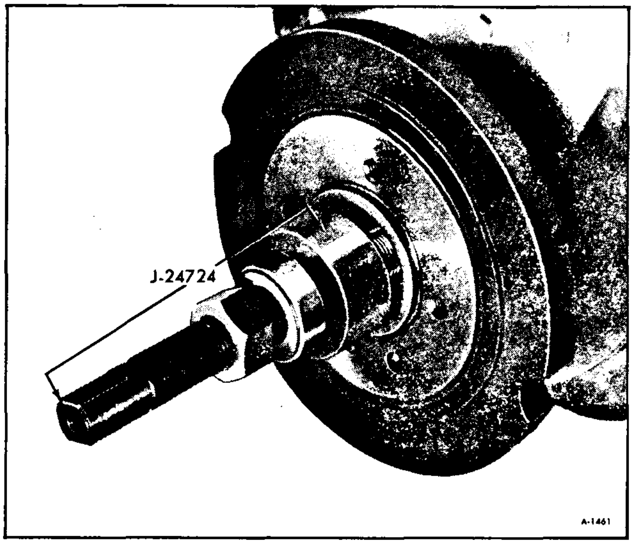


Figure 49–Installing Harmonic Balancer

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 motor home.

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.

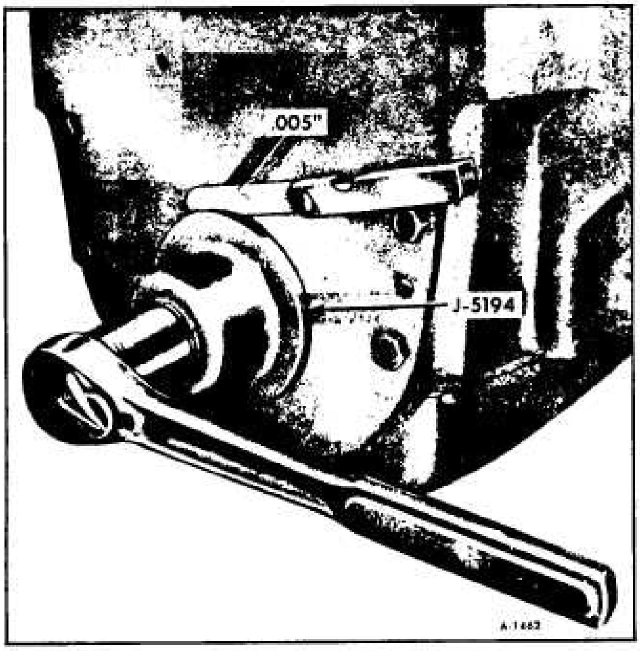


Figure 50–Front Cover Oil Seal Installation

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, install oil seal as shown in Figure 50. 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 motor home.

FRONT COVER

REMOVAL

1. Raise motor home.

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

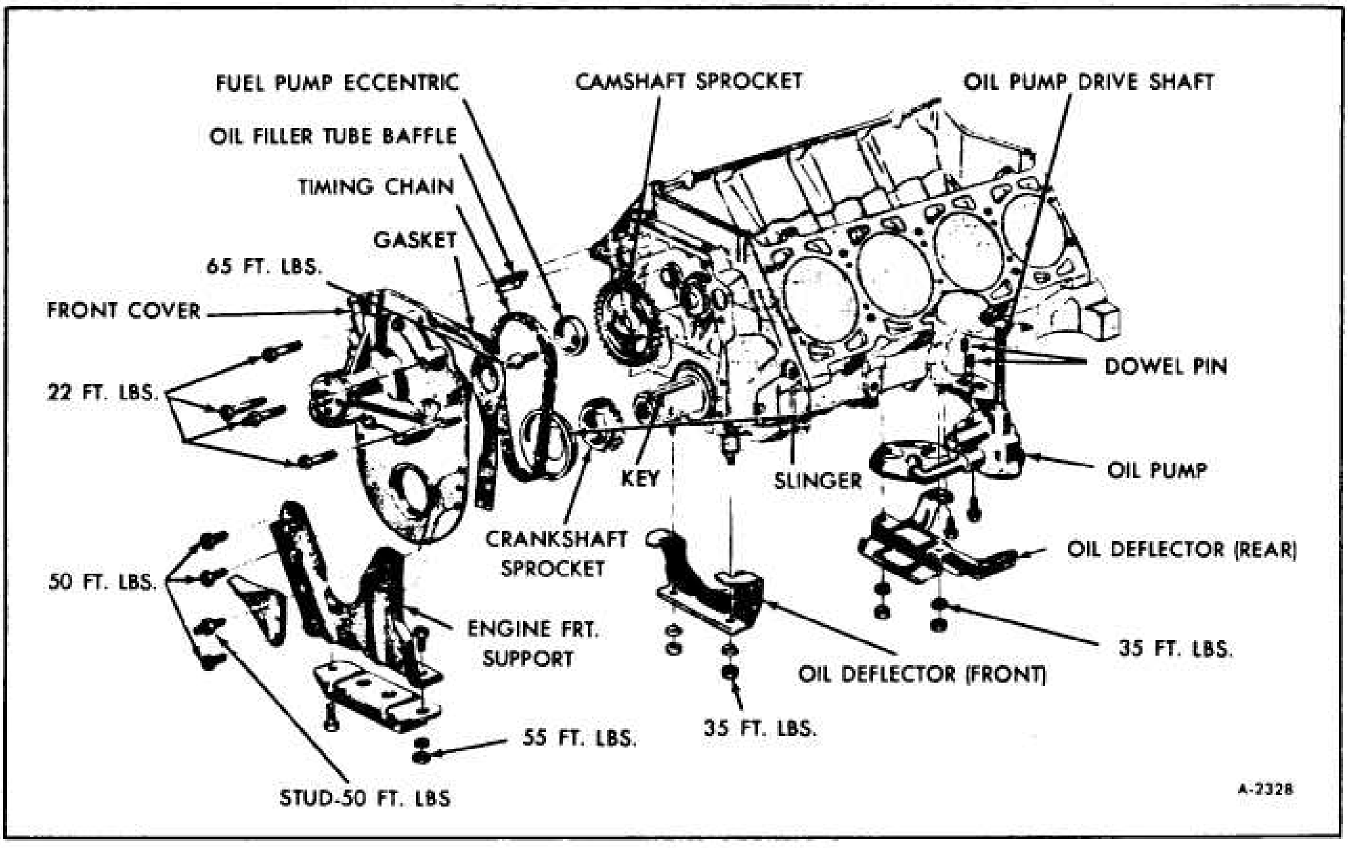


Figure 51–Engine Front Cover Exploded View

3. Drain oil.

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 51).

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 52.

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.

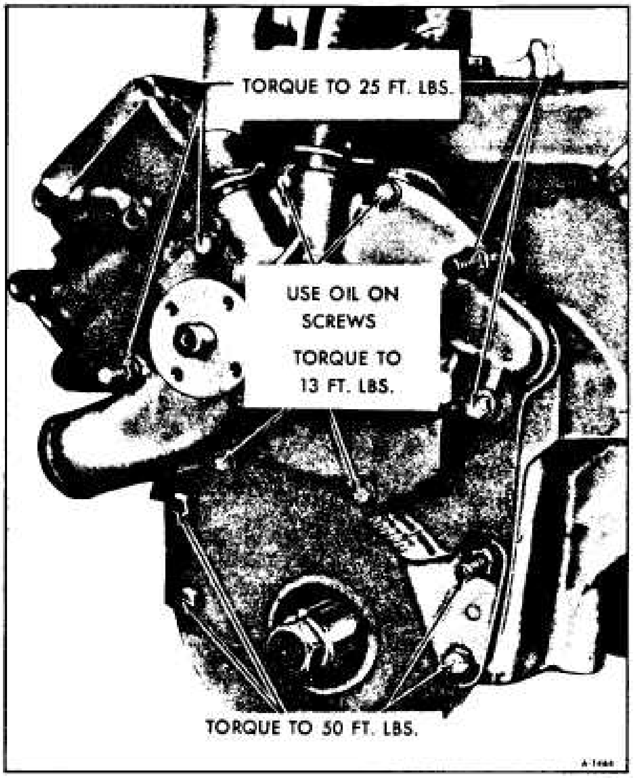


Figure 52–Engine Front Cover Bolts

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

12. Lower motor home.

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

TIMING CHAIN AND GEARS

REMOVAL

1. Raise motor home.

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

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 53).

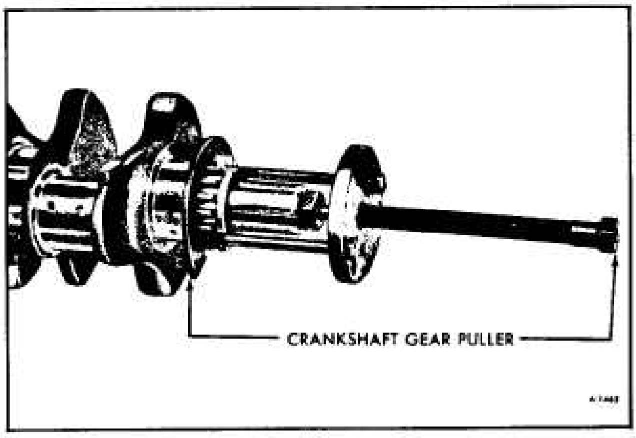


Figure 53–Crankshaft Gear Removal

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 54.

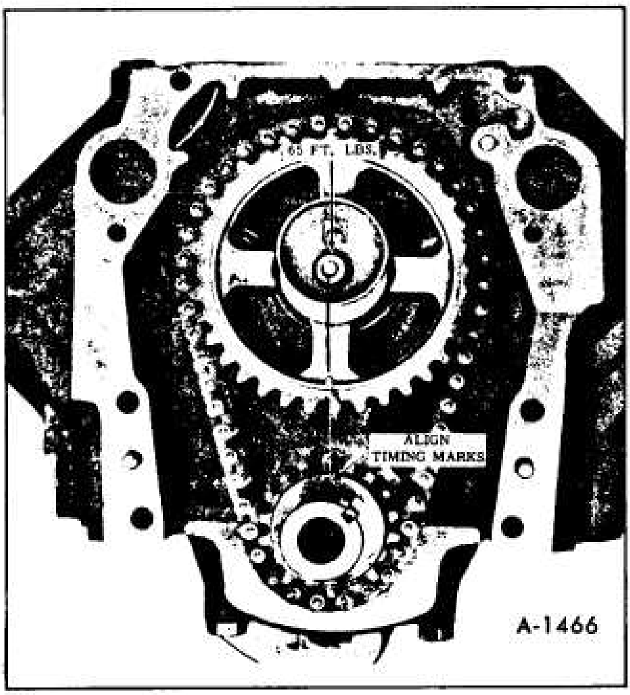


Figure 54–Timing Gear Position

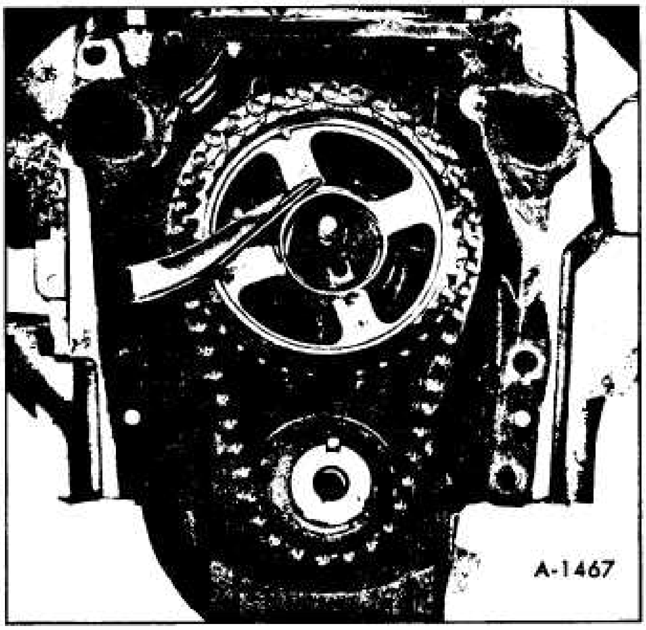


Figure 55–Fuel Pump Eccentric

2. Install fuel pump eccentric with flat side rearward. See Figure 55. Torque bolt to 65 ft. lbs.

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 motor home.

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.

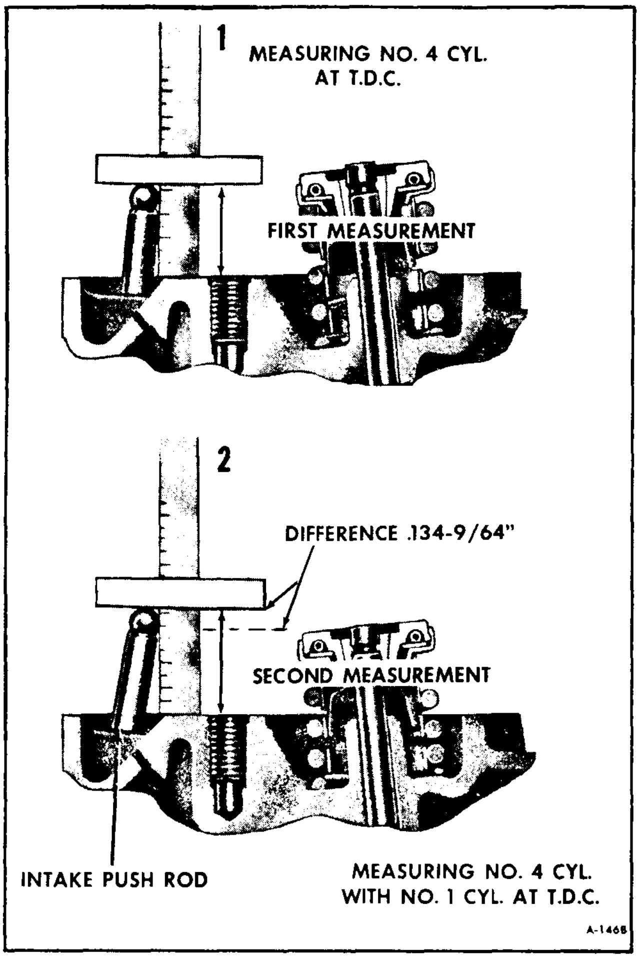


Figure 56–Checking Valve Timing

4. Measure from pivot boss on head surface to top of No. 4 intake push-rod. Record measurement. See Figure 56.

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 56.

7. Measurement should increase over the first measurement as shown in Figure 56.

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.

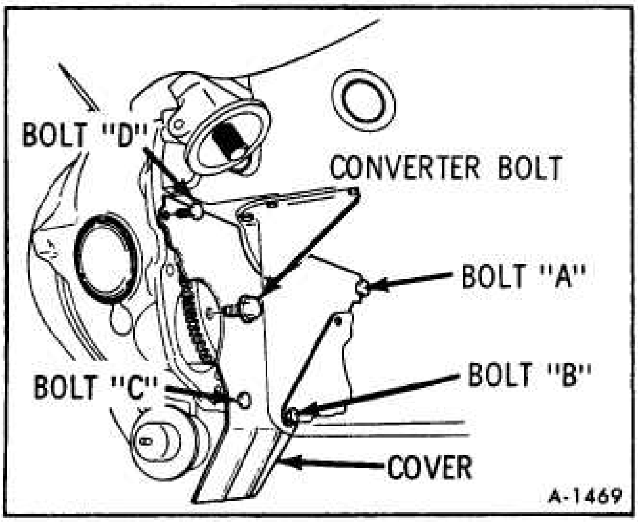


Figure 57–Flywheel Cover Removal

2. Remove engine cover, remove air cleaner, disconnect coil bracket and position engine removal Tool No. J-24603 to the engine. Adjust lift mechanism until all slack is removed from the cable. (See figure 5).

3. Raise motor home. See **WARNING** at the beginning of "Engine Replacement".

4. Disconnect wires from starter solenoid.

5. Remove starter motor.

6. Referring to Figure 57, 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.

12. Disconnect L.H. drive axle from flange at final drive and reposition axle [illegible] the flange.

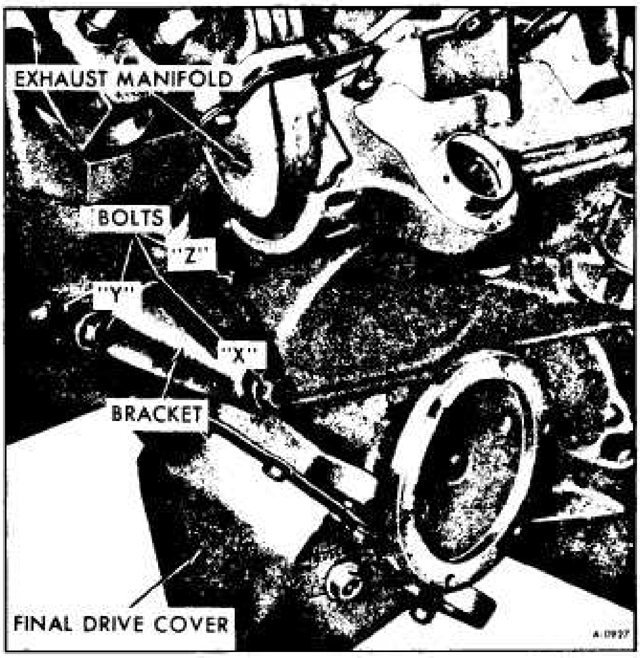


Figure 58–Disconnecting Final Drive From Engine

13. Remove bolt "Z". (See figure 58).

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

NOTE: Rotate flywheel to gain access (Refer to figure 57).

15. Remove three (3) transmission to support bracket bolts (Figure 7).

16. Remove support bracket to crossmember bolts.

17. Position transmission jack under transmission as shown in Figure 59.

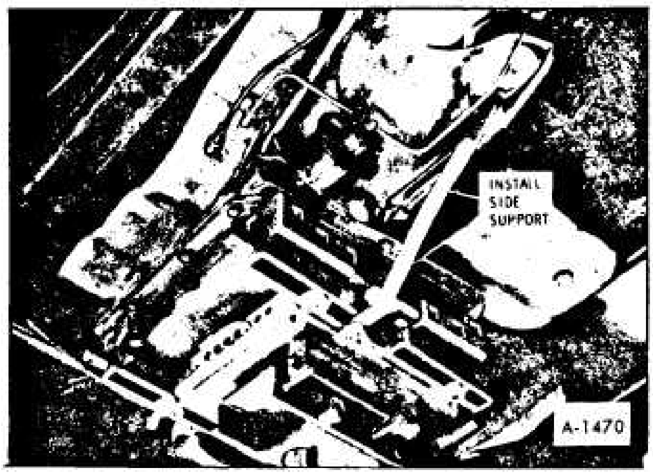


Figure 59–Transmission Jack Installation

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 11).

25. Disconnect coil bracket 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. Remove fan and clutch assembly.

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.

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 as shown in Figure 5, 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 57.

7. Referring to Figure 58, 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 57, 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.

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

29. Install generator. See Figure 9 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 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.

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.

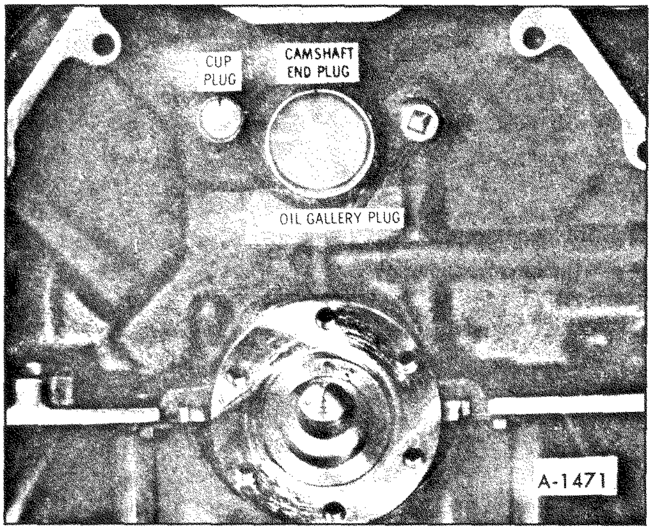


Figure 60–Camshaft and Oil Galley Plug

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.

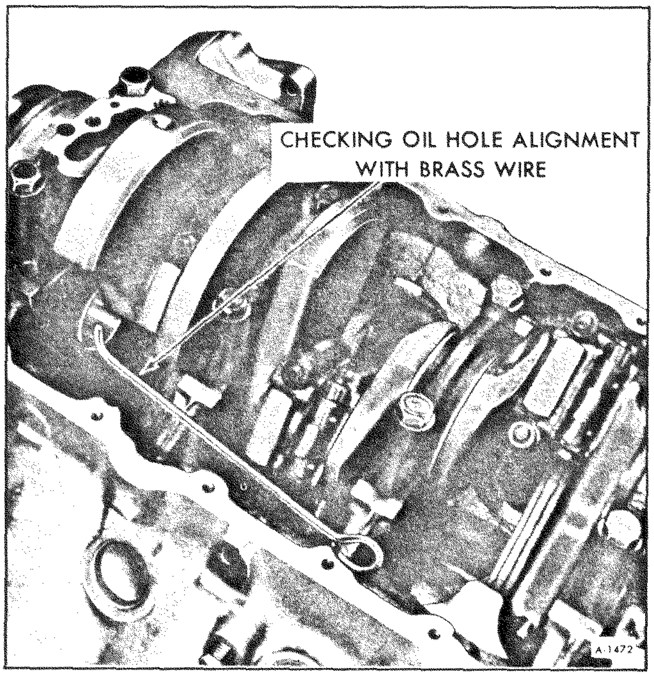


Figure 61–Checking Oil Hole Alignment

2. Drive No. 5 camshaft bearing into place and check oil hole alignment as shown in Figure 61.

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

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 62 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.

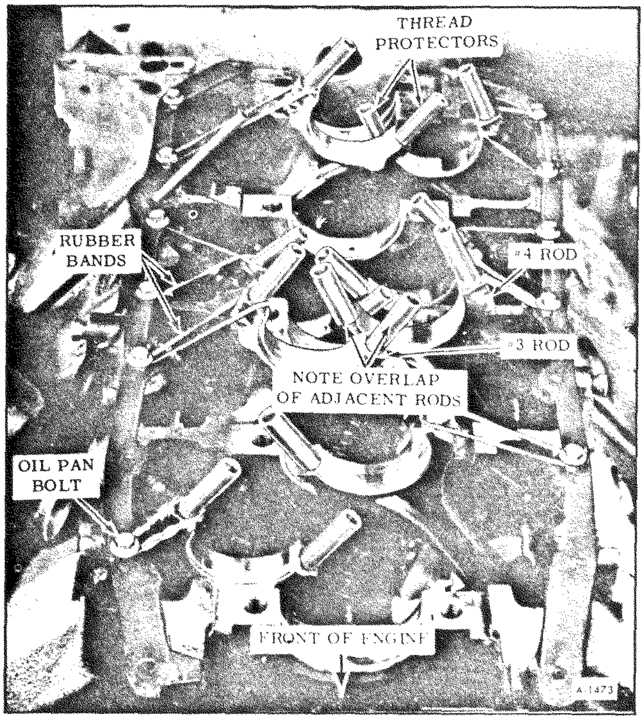


Figure 62–Crankshaft Removal

INSTALLATION

1. Install sufficient oil pan bolts in pan rails to align rods with rubber bands as shown in Figure 62.

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 63) 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.

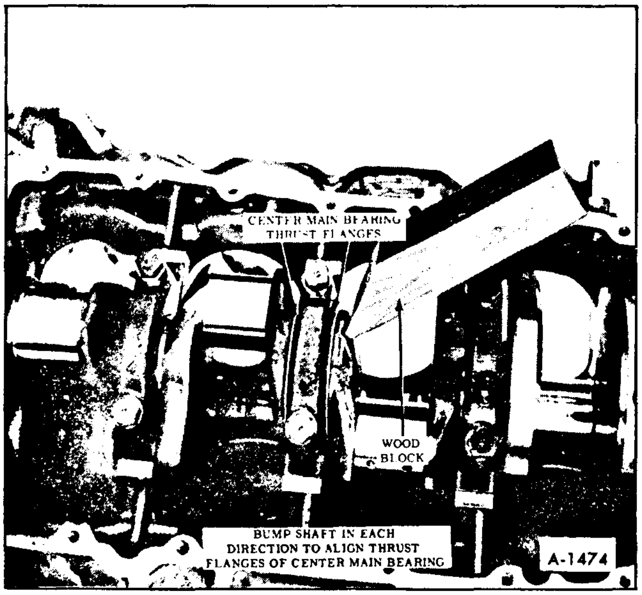


Figure 63–Aligning Center Main Bearing Flanges

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.

5. 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 64) If this clearance is greater than .0035" REPLACE BOTH BEARING SHELLS AS A SET. Recheck clearance after replacing shells.

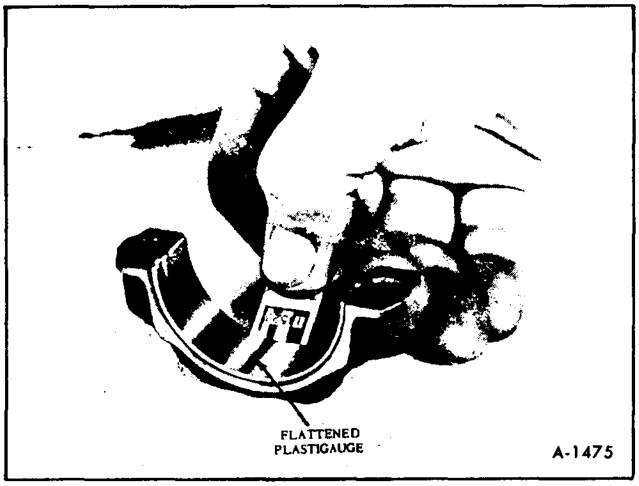


Figure 64–Checking Bearing Clearance

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 65). Sizes of the bearings are located on the tang (figure 66). It is possible to have more than one bearing size in the same engine.

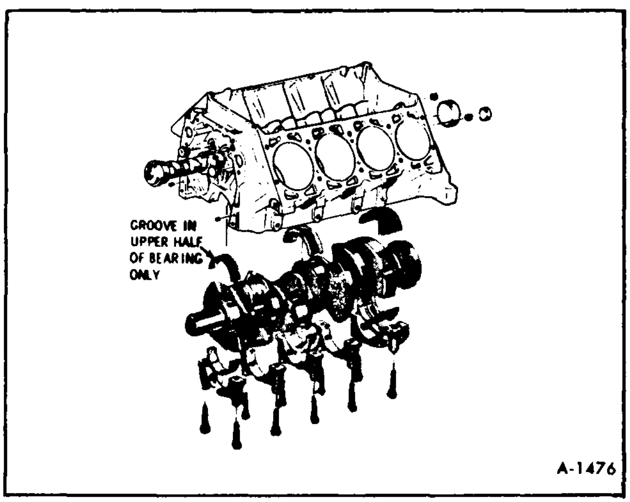


Figure 65–Crankshaft Exploded View

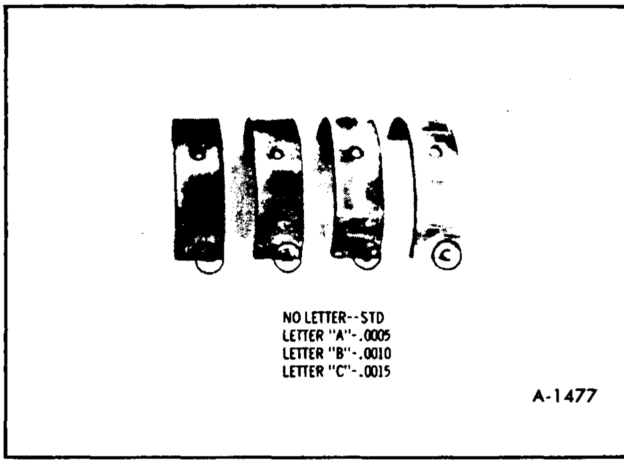


Figure 66–Main Bearing

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 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".

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 67.

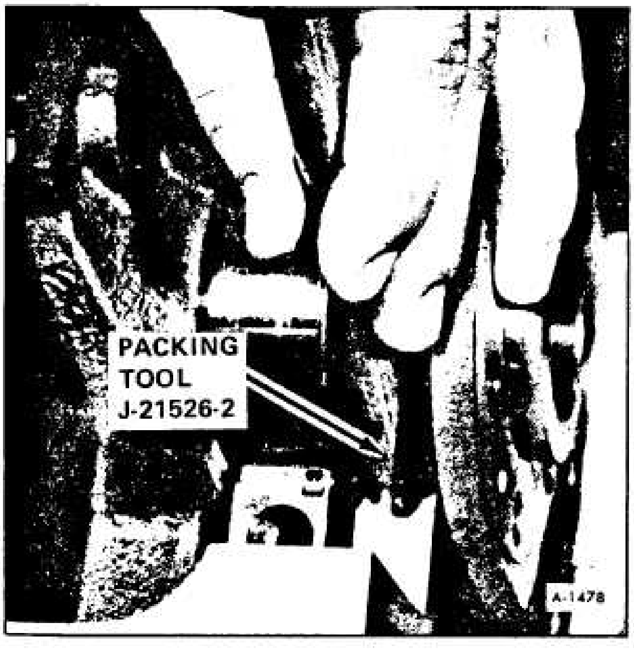


Figure 67–Packing Seal Into Cylinder Block

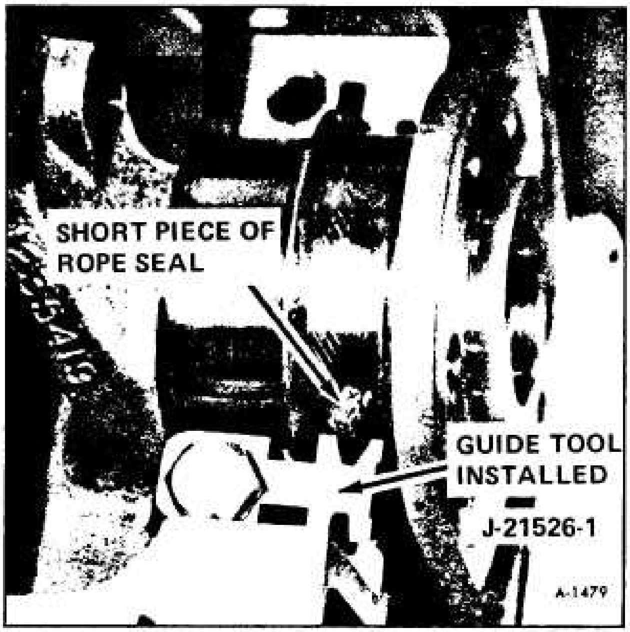


Figure 68–Guide Tool Installed

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, 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 68. Using packing tool, pack these short pieces up into the block. See Figure 69.

> **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.

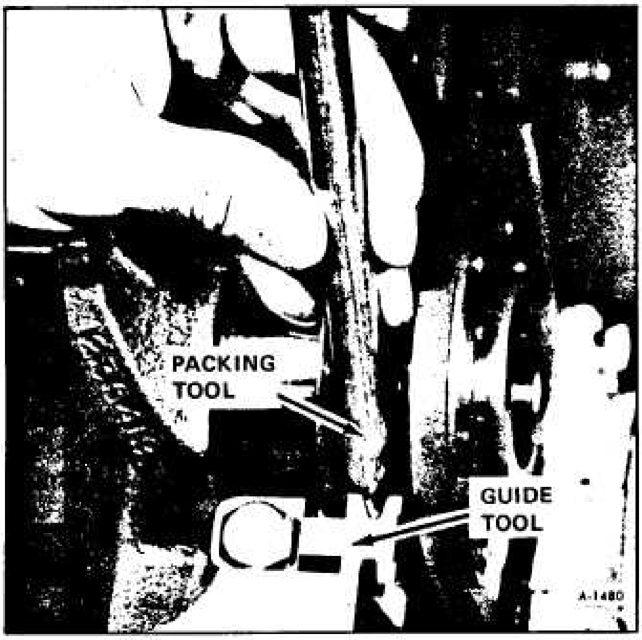


Figure 69–Packing Seal Into Guide and Cylinder Block

2. Remove upper oil seal.

3. Install a new rear main bearing upper seal. Use tool J-7588 as shown in Figure 70.

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.

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.

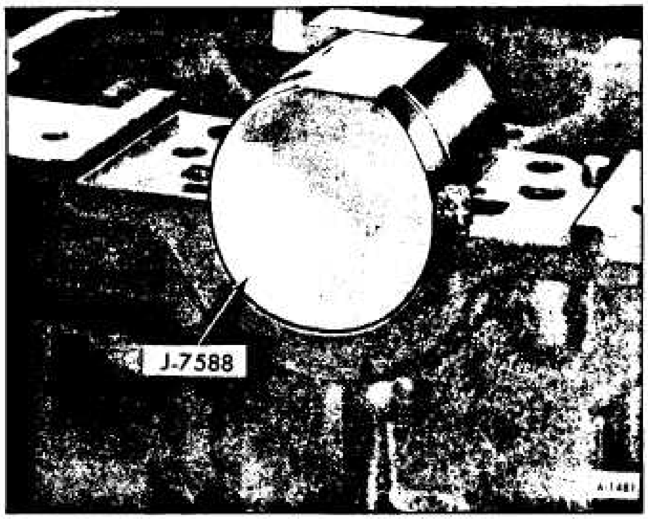


Figure 70–Installing Rear Main Seal-Upper Half

2. Using seal installer J-7588 hammer seal into groove. (See figure 71).

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.

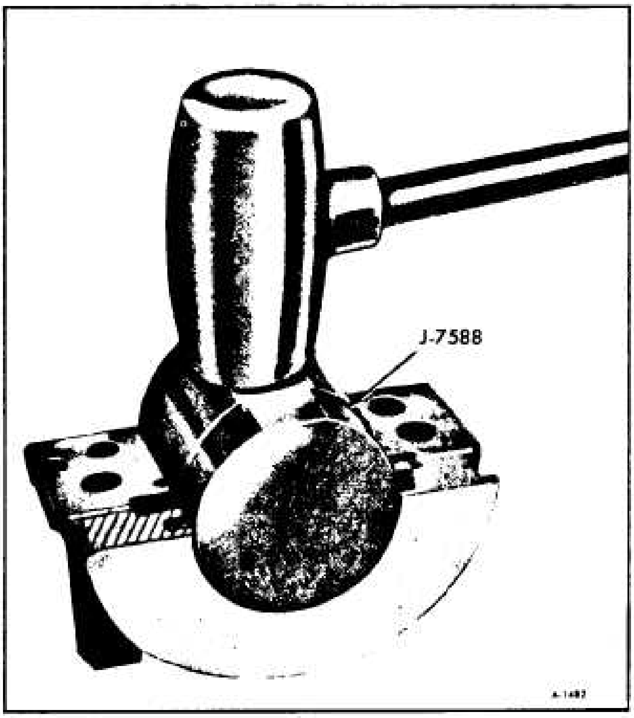


Figure 71–Installing Rear Main Seal-Lower Half

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.

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. 26	30°
Angle - Valve Seat (B°) See Fig. 26	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	.529" - .521"
Pitch	.500"
No. of Teeth	.471" - .461"

CRANKSHAFT SPROCKET

Width of Sprocket	.529" - .521"
Overall Width of Gear	1.001" - .991"
Pitch	.500"
No. of Teeth	18

TIMING CHAIN
- Width .... Morse-.762, Linkbelt-.844"
- 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	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-5194	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-7588	Rear Main Bearing Oil Seal Installer
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	Engine Removal Fixture
J-24724	Crankshaft Harmonic Balancer Installer
J-24725	Valve Stem Seal Installer
J-23600	Belt Tension Gauge

GMC MOTOR HOME SERVICE

OCTOBER, 1973

SECTION 6K
ENGINE COOLING

Contents of this section are listed below:

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 degrees F.

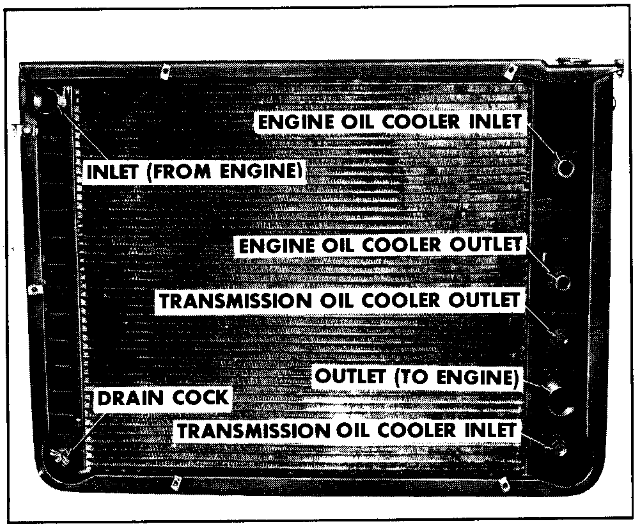


Figure 1–Radiator Core

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 figure 2). 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 the reservoir will be drqwn 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 when the engine is cold.

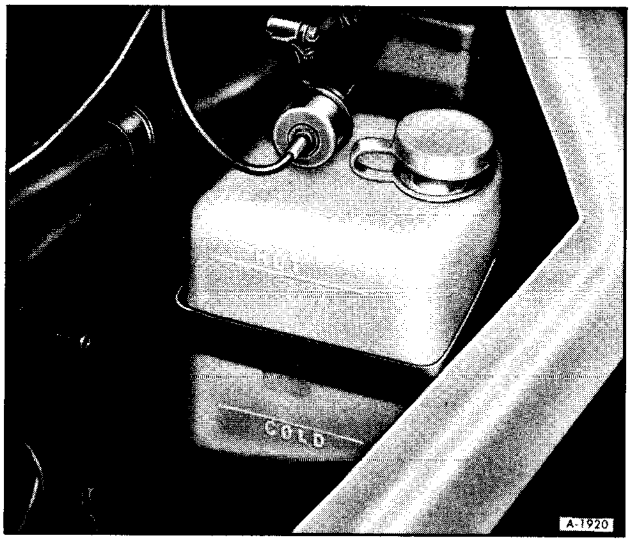


Figure 2–Coolant Recovery Reservoir

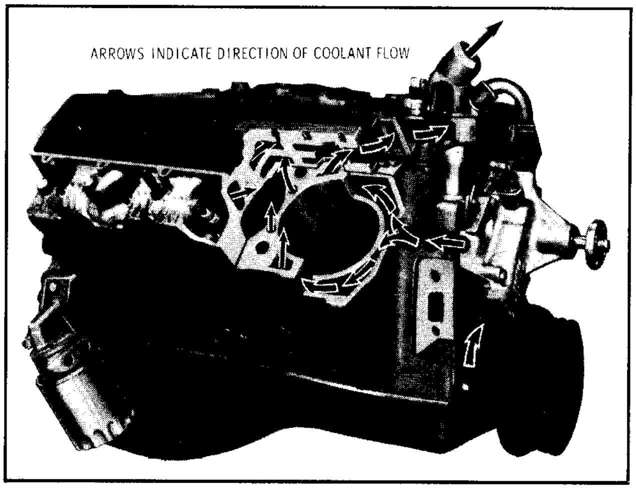


Figure 3–Cooling System Circulation

COOLING SYSTEM CIRCULATION (FIGURE 3)

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 degrees F.) 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 -20°).	Test solution. Add 50/50 coolant/water solution as required.
	Belt tension too low.	Check with J-23600. 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.
	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.
	Cylinder head or gaskets, cylinder block or core plug, heater core or heater water valve leaking.	Repair or replace as necessary to correct.

COOLING SYSTEM TROUBLE DIAGNOSIS (Cont'd.)

Problem	Possible Cause	Correction
Loss of coolant.	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.

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.

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.

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 44 percent solution for -20°F.) Install radiator cap.

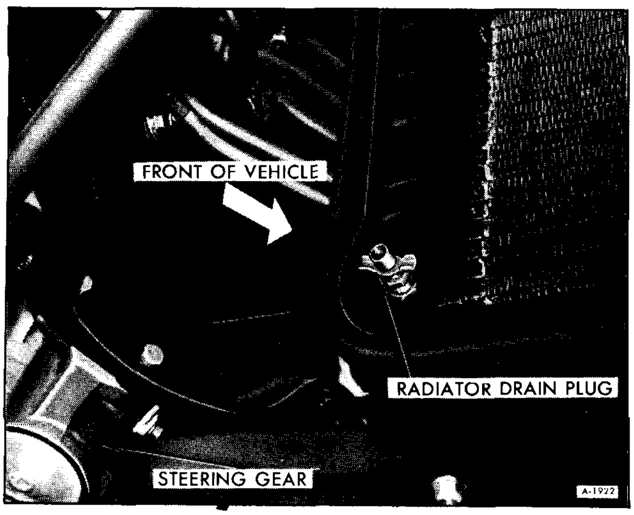


Figure 4–Radiator Drain Plug

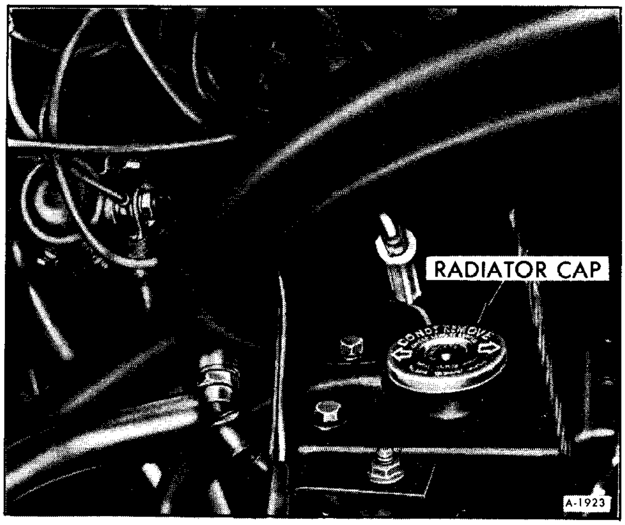


Figure 5–Radiator Cap

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 normalze 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.

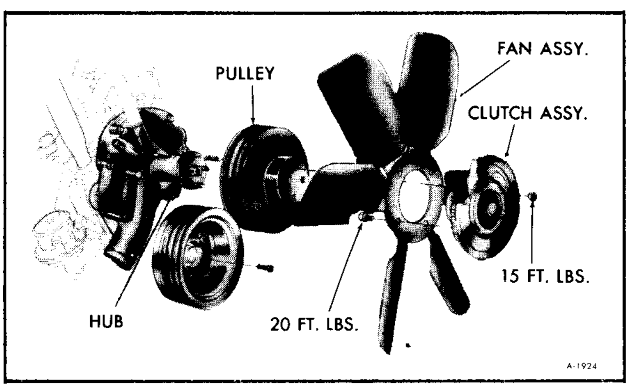


Figure 6–Fan Installation

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.

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" in Section 6A in this manual.

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. 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.

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. 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. With the valve completely submerged and the solution agitated thoroughly, the valve should close completely.

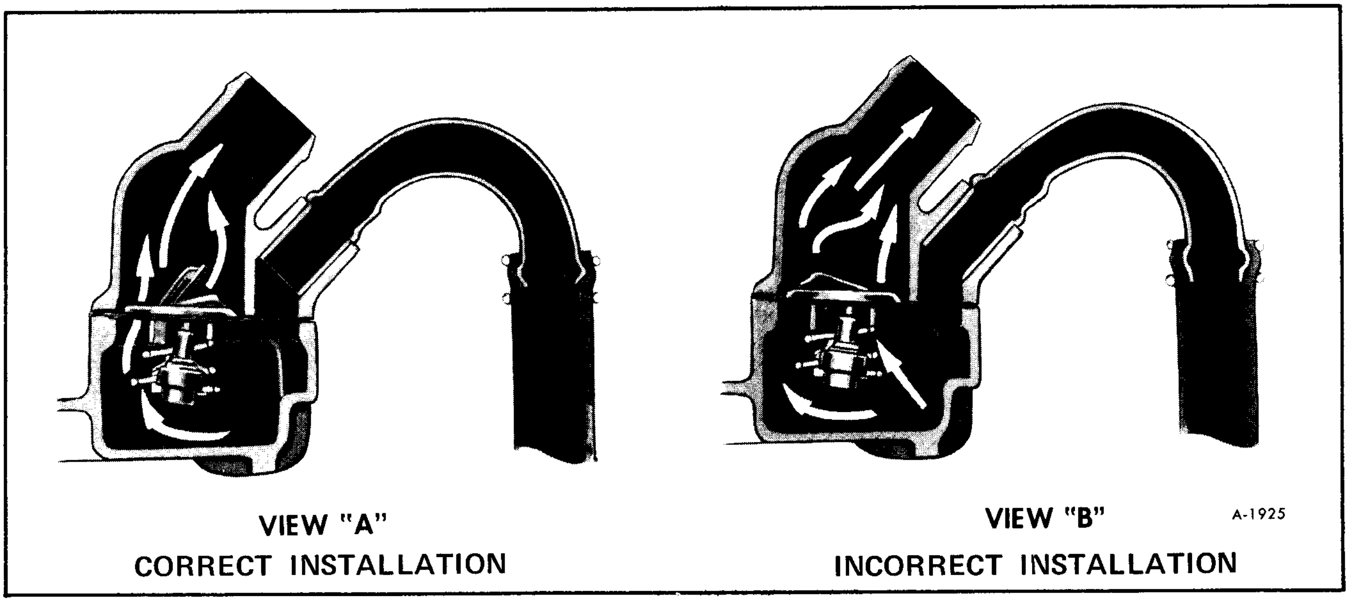


Figure 7–Thermostat Installation

FAN AND FAN CLUTCH

REMOVAL

1. Raise motor home.

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 15 ft. lbs.

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

5. Install seal retainer strap.

6. Lower Motor Home.

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.

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

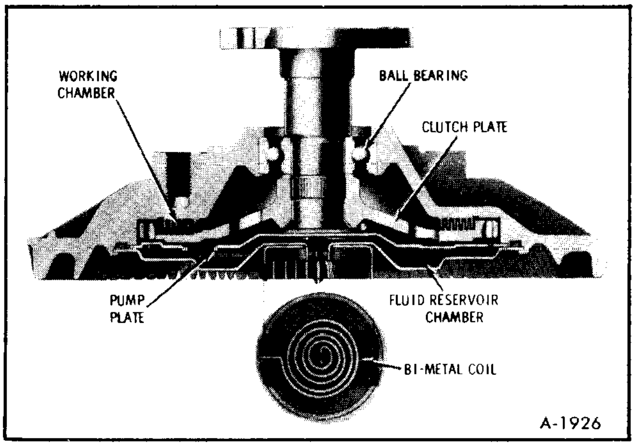


Figure 8–Fan Clutch Assembly

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 workking 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 Motor Home.

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 degrees F. 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 degrees F, the unit should be replaced. Do not continue test past a thermometer reading of 190 degrees F. 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.

OCTOBER, 1973

SECTION 6M
ENGINE FUEL SYSTEM

Contents of this section are listed below:

CARBURETOR

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.

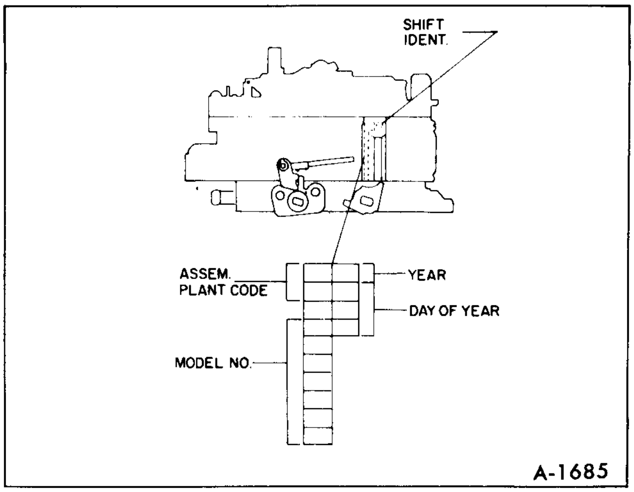


Figure 1–Carburetor Identification

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.

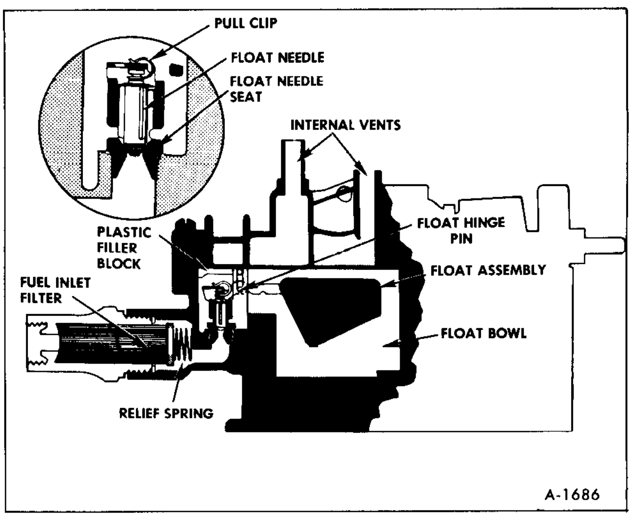


Figure 2–Float System

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 bead located just above the idle channel restriction. The mixture continues downward

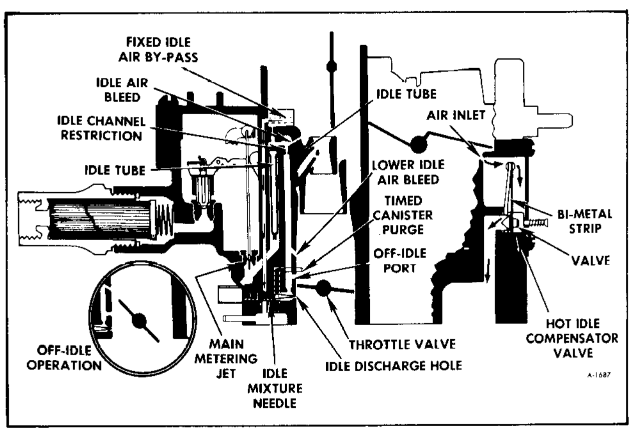


Figure 3–Idle System

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.

In that the fuel tank will not be vented 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:

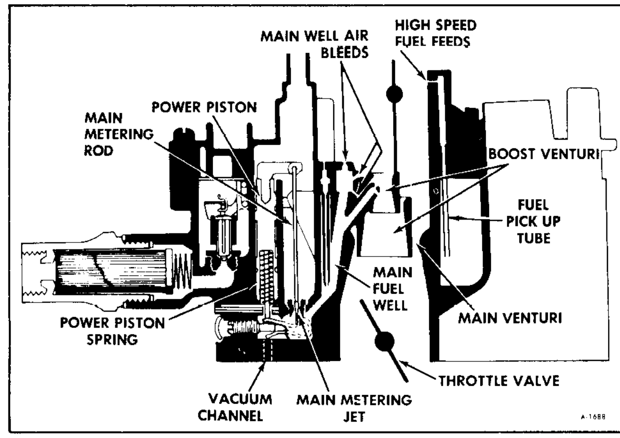


Figure 4–Main Metering System

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 presure in the samll 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 fuel well 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 hoses.

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 protudes 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 of this feature is to give improved 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 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

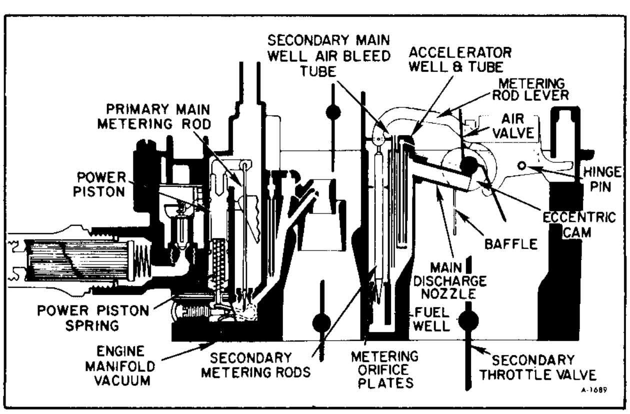


Figure 5–Power System

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 discs. Fuel flows from the float bowl through the secondary orifice discs 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-

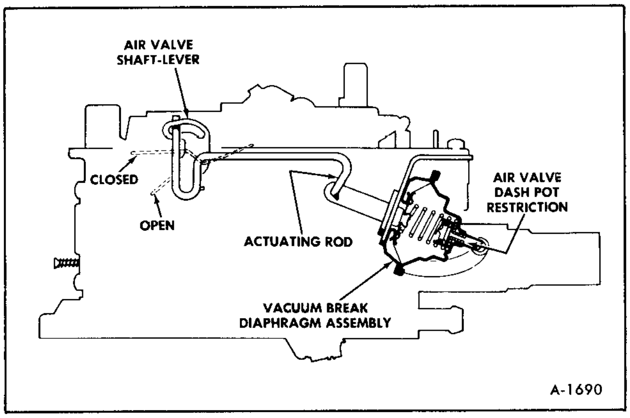


Figure 6–Air Valve Dashpot

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 main metering rods in the orifice discs 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 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 additional 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

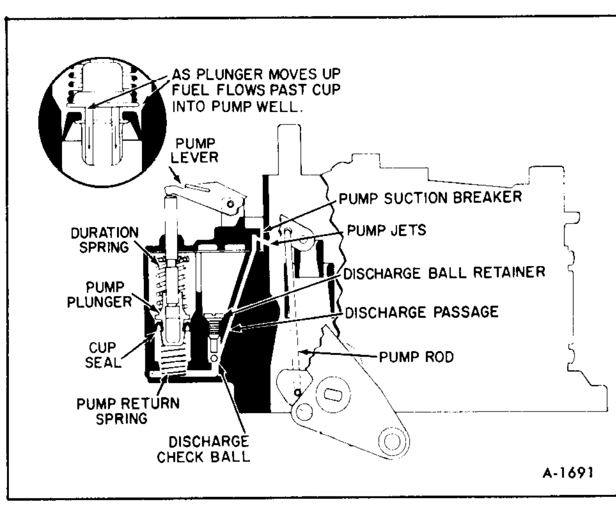


Figure 7–Accelerating Pump System

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

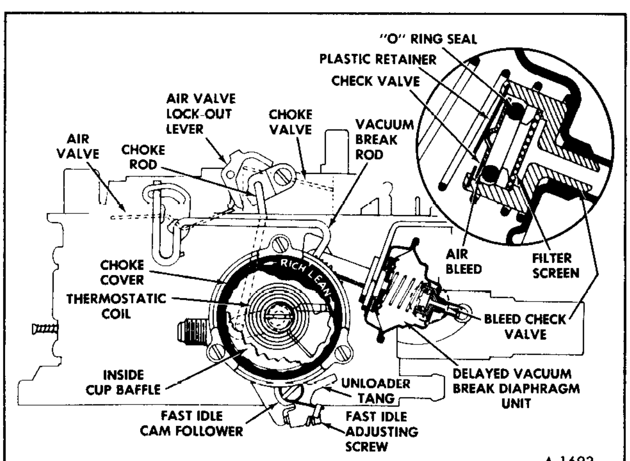


Figure 8–Choke System

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 thermostaic 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 being connected and in proper 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., check the following. a. Inspect fuel filter. If plugged, replace. b. If filter are 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 float for being loaded with fuel, 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 being open. 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 1.	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 float for being loaded with fuel, 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 being disconnected. 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 1.	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 being loaded with fuel, 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.
Secondary throttle valve lockout.	1. Free-up and check for proper operation. 2. Adjust secondary throttle 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.
Secondary throttle valves not unlocking after engine warms up.	Free-up and adjust secondary throttle lockout.
Air valves binding, stuck closed or wide 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 dischar 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 (4) carburetor to manifold attaching bolts.

8. Remove carburetor.

INSTALLATION

1. Install a new carburetor to manifold gasket.

2. Install carburetor. Torque attaching bolts to 15 ft. lbs. in sequence as shown in Figure 10.

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.

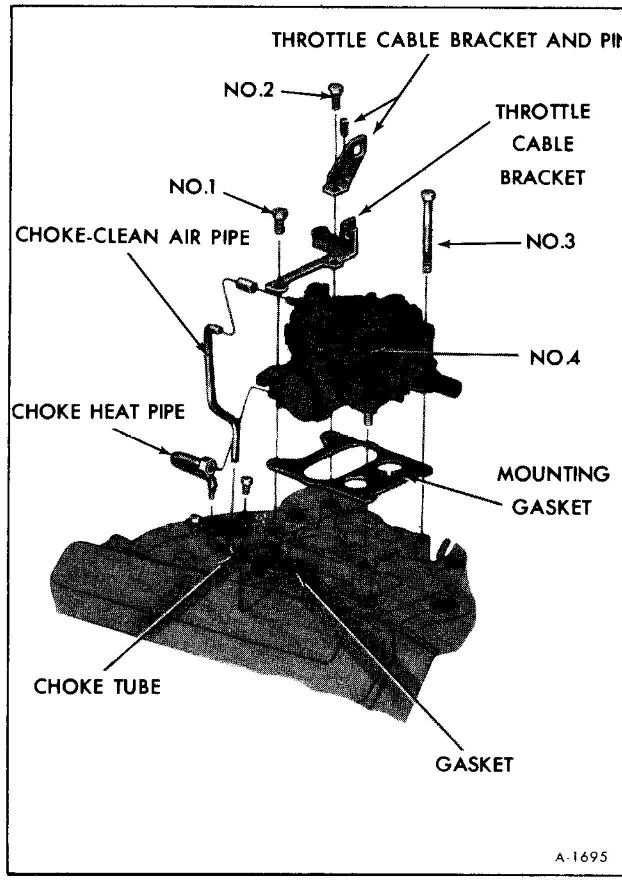


Figure 10–Carburetor Installation

AIR HORN REMOVAL

1. Remove air cleaner assembly.

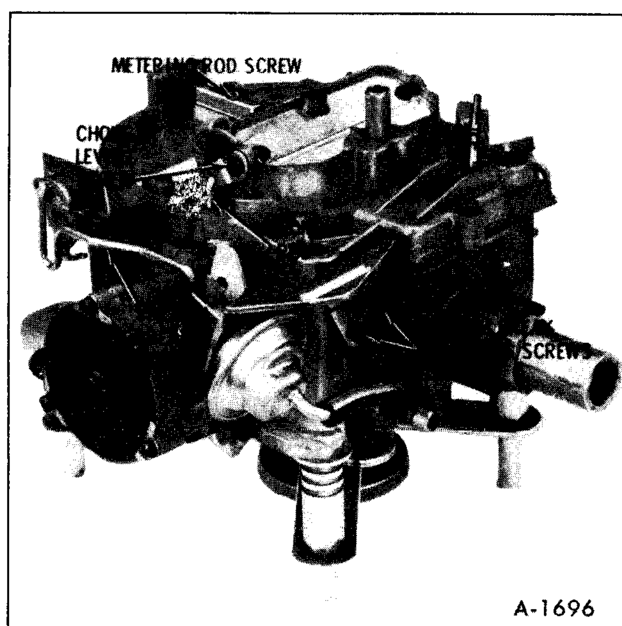


Figure 11–Carburetor Assembly

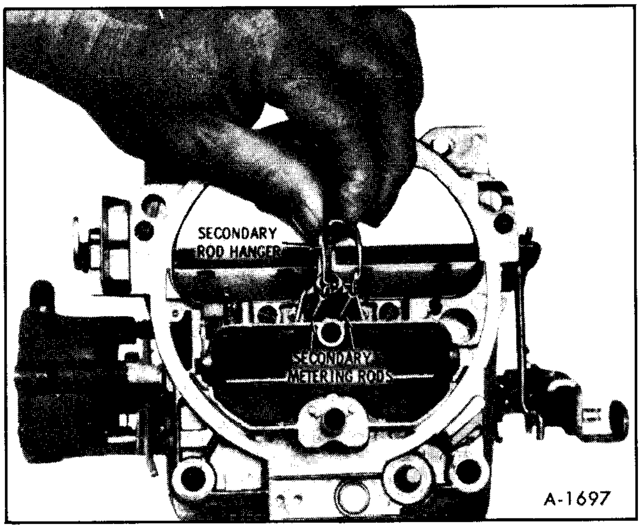


Figure 12–Secondary Metering Rods

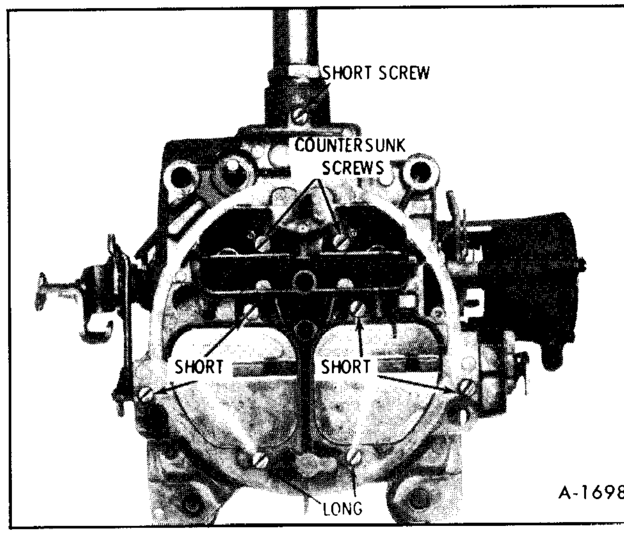


Figure 13–Air Horn Attaching Screws

2. Remove upper choke lever from the end of choke shaft by removing retaining screw (figure 11). 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 12).

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 13.

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 14.

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.

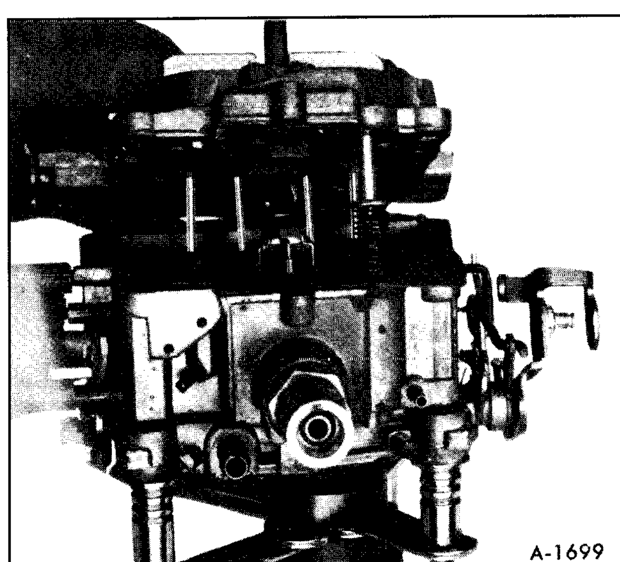


Figure 14–Removing Air Horn

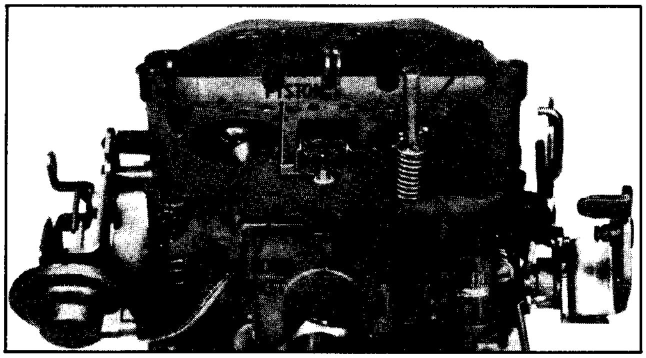


Figure 15–Float Bowl Assembly

FLOAT BOWL DISASSEMBLY

1. Remove pump plunger from pump well. See Figure 15.

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 16.

7. Remove float assembly and float needle by pulling up on retaining pin. Remove float needle seat and gasket (figure 17).

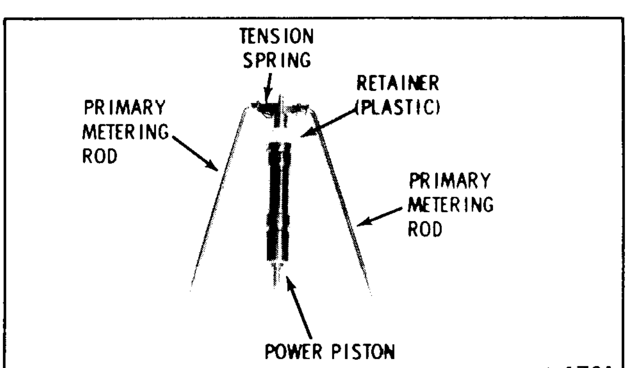


Figure 16–Power Piston and Metering Rod

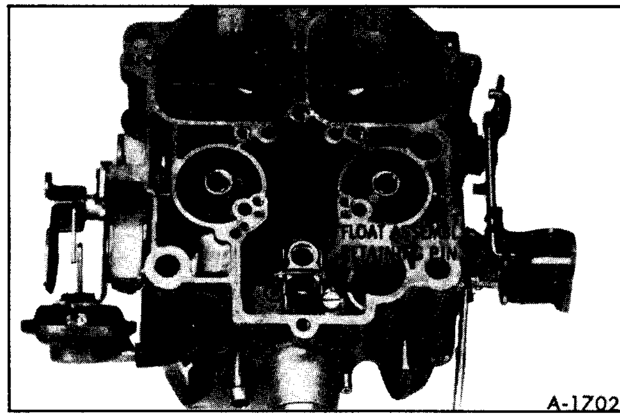


Figure 17–Float Assembly

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 retaning screws and retainers from choke cover and coil assembly. Then pull straight outward and remove cover and coil assembly from choke housing. See Figure 19.

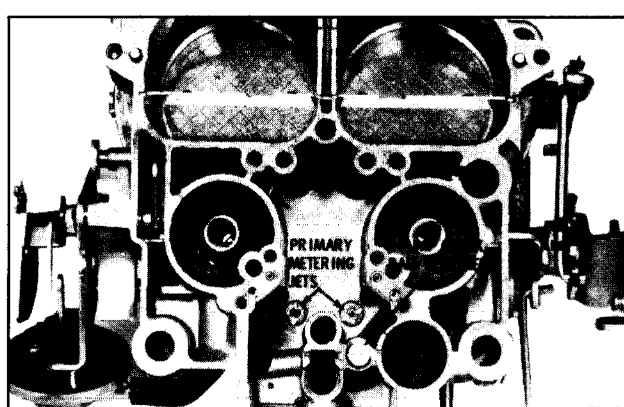


Figure 18–Primary Metering Jets

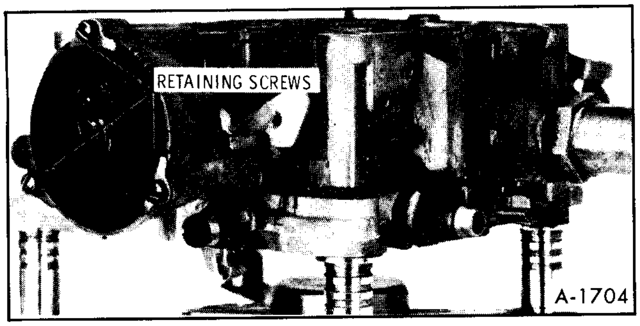


Figure 19–Choke Housing

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 20). 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 21). 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 22.

CAUTION: *Remove the cup seal from inside choke housing shaft hole, if the housing is to be immersed in carburetor cleaner. Also,*

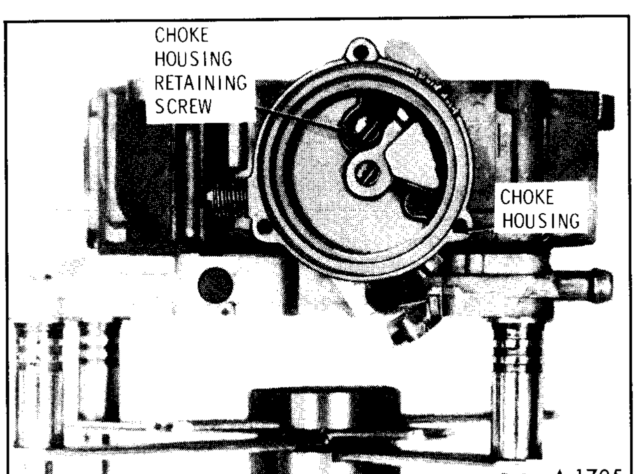


Figure 20–Choke Housing Attachment

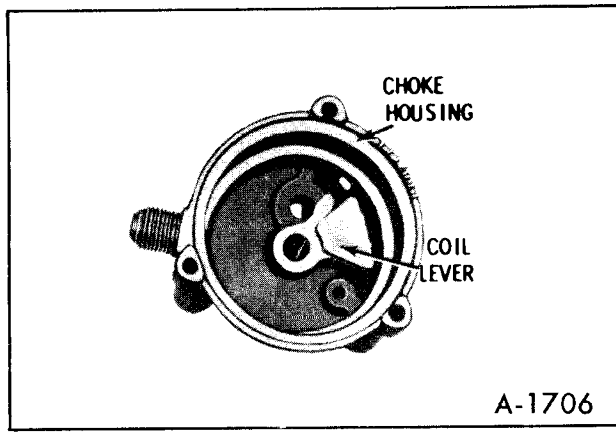


Figure 21–Choke Coil Lever

remove the cup seal from the float bowl plastic insert for bowl cleaning purposes. Do not attempt to remove plastic insert.

DISASSEMBLY OF REMAINING FLOAT BOWL PARTS

1. Remove fuel inlet nut, gasket and filter. See Figure 23.

2. Remove throttle body by removing throttle body to bowl attaching screws as shown in Figure 24.

3. Remove throttle body to bowl insulator gasket. See Figure 25.

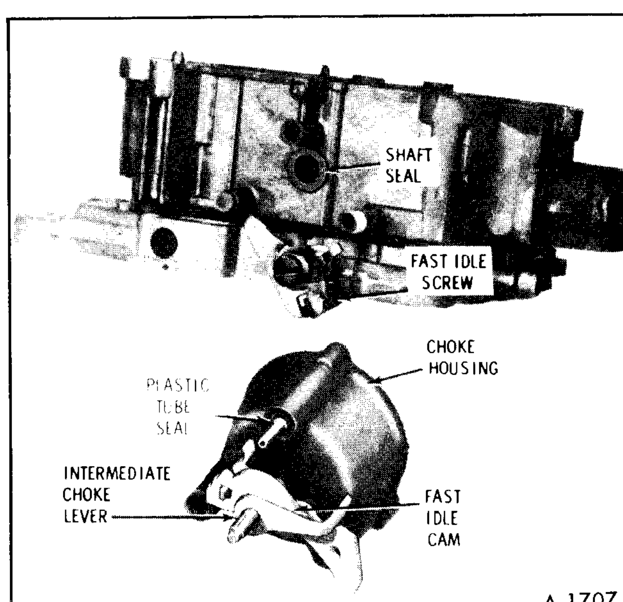


Figure 22–Choke Housing Sealing

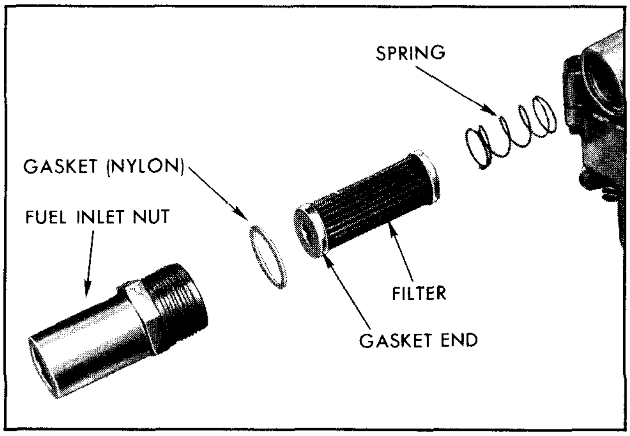


Figure 23–Fuel Filter

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.

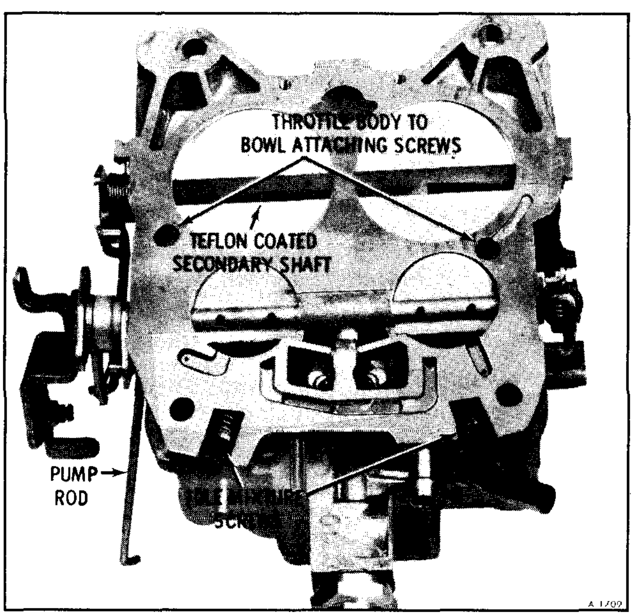


Figure 24–Throttle Body Attaching Screws

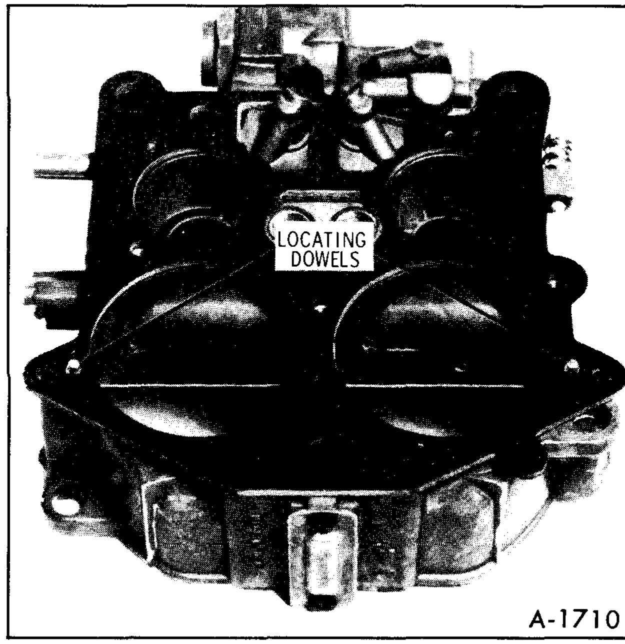


Figure 25–Throttle Body Gasket

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 25.

2. Install throttle body making certain throttle body is properly located over dowels on float bowl then install throttle body to bowl screws and tighten evenly and securely. See Figure 24.

3. Install fuel inlet filter spring, new gasket and inlet nut and tighten nut securely (18 ft. lbs.) as shown in Figure 23.

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 22.

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 26.

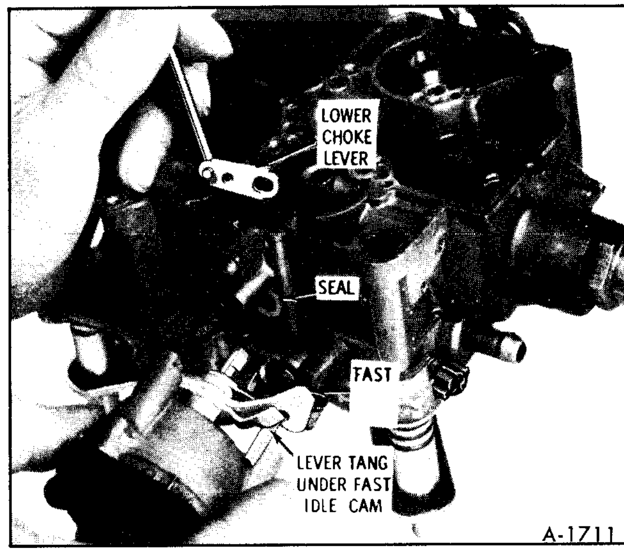


Figure 26–Lower Choke Lever

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. See On Vehicle Adjustment Chart (figure 9).

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 18.

4. Install new needle seat assembly.

NOTE: To make adjustment easier, bend float arm upward at notch in arm before assembly.

5. Install float by sliding float lever under pull clip from front to back. With float lever in pull clip, hold float assembly at toe and in tall 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, re-intall making sure that tension spring is connected to top of each rod (figure 16). 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

1. 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 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 27.

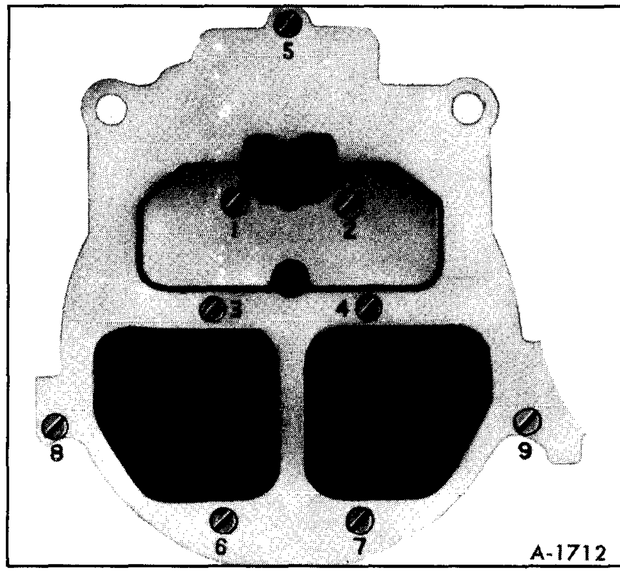


Figure 27–Air Horn Tightening Sequence

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 28, 29, 30 and 31) 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.

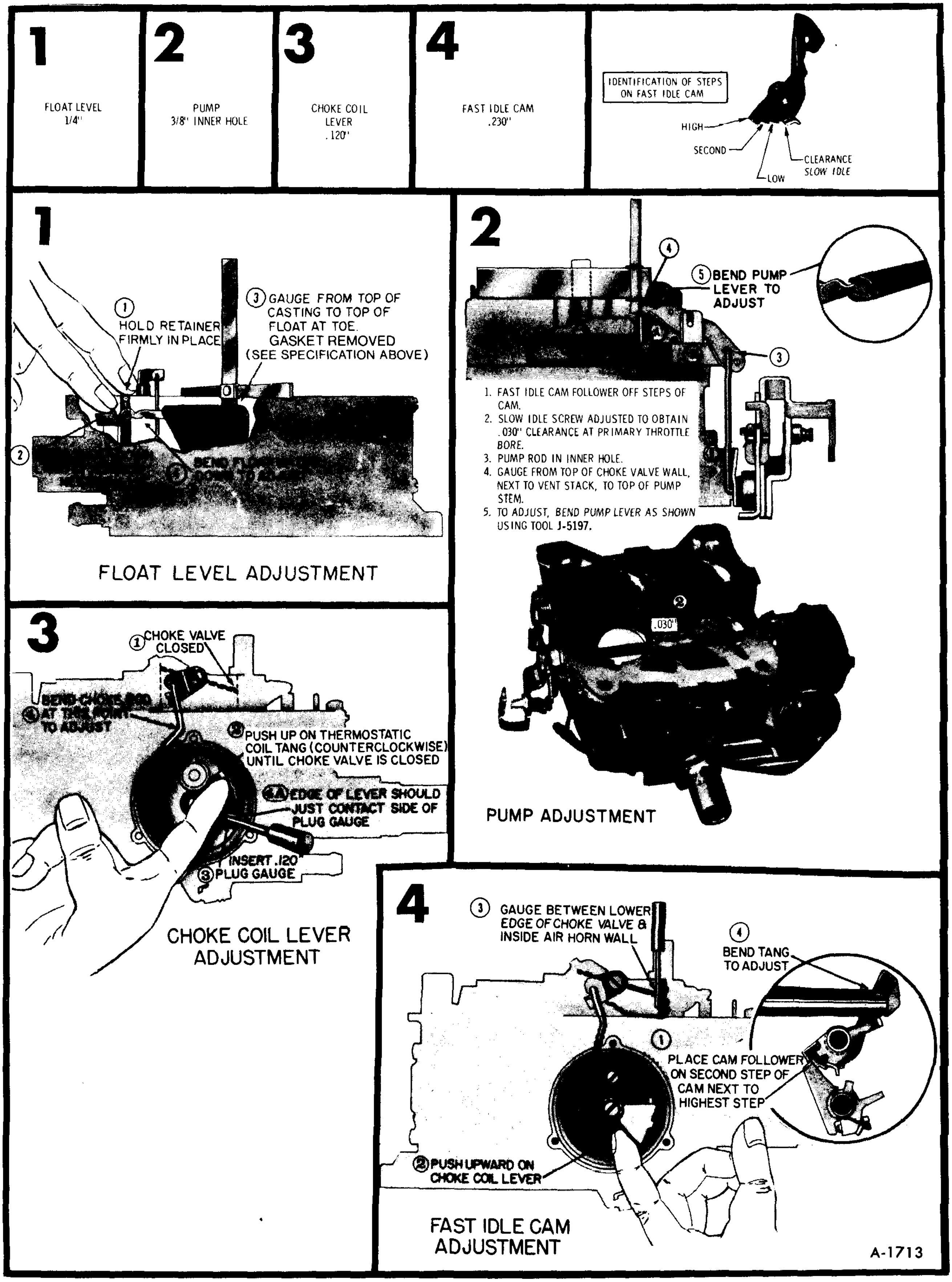
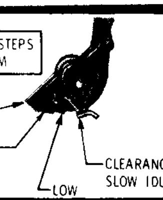


Figure 28–Carburetor Adjustments

5	6	7	8	9	10	
AIR VALVE DASHPOT .050"	CHOKE COIL ADJUSTMENT	VACUUM BREAK (1973)—.215 (1974)—.275	UNLOADER .300"	AIR VALVE LOCKOUT .035"	SECONDARY OPENING .070"	IDENTIFICATION OF STEPS ON FAST IDLE CAM



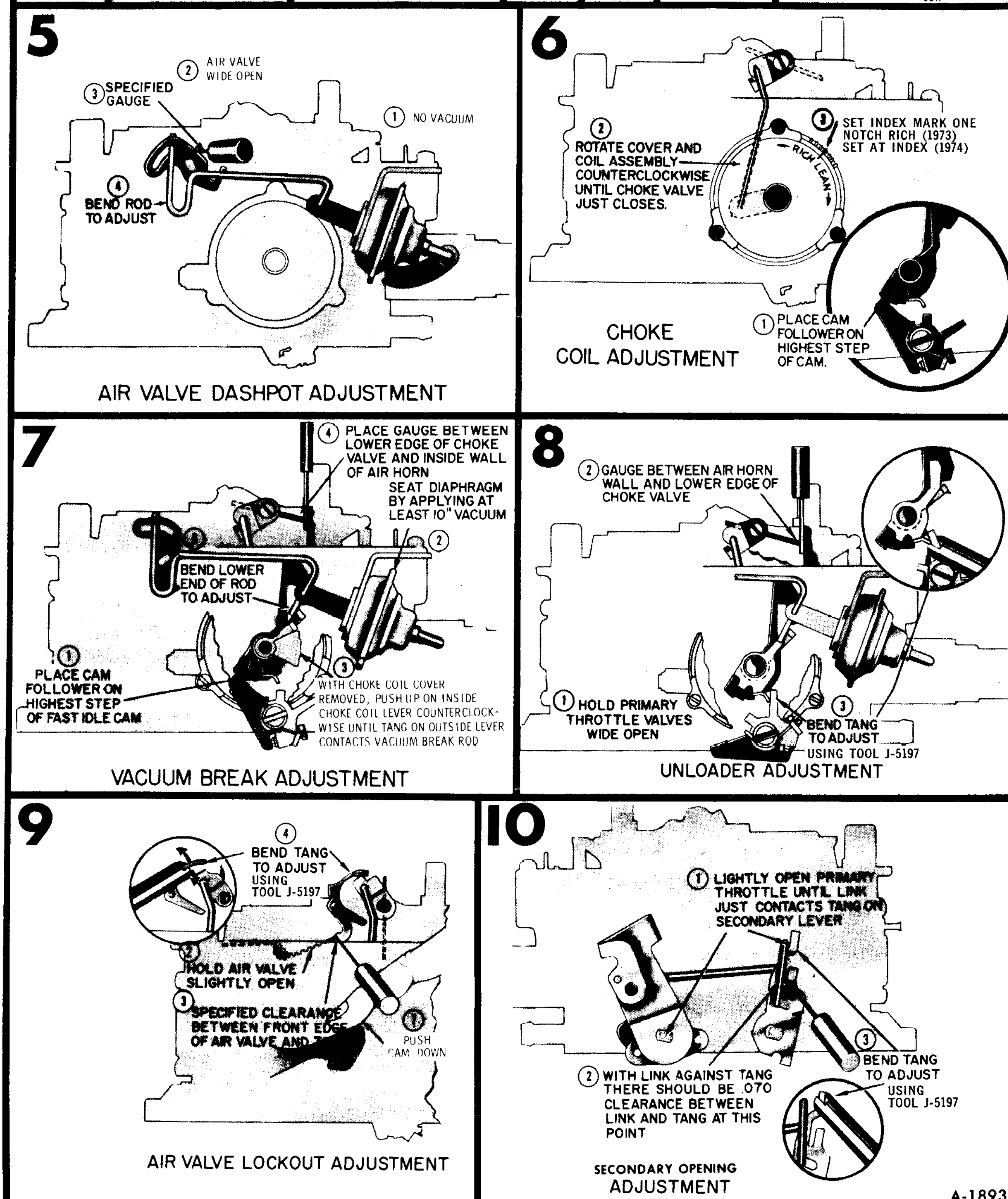


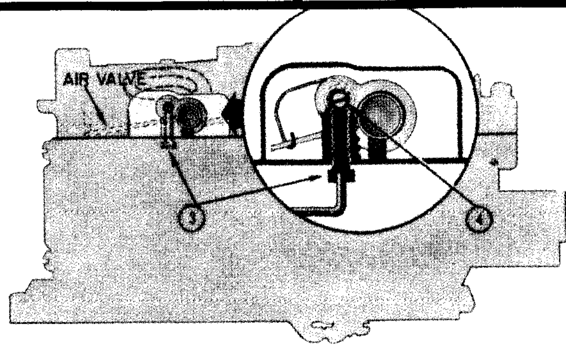
Figure 29–Carburetor Adjustments

11 AIR VALVE SPRING

12 SLOW IDLE
SEE STEP 12 BELOW

13 FAST IDLE
SEE STEP 13 BELOW

11



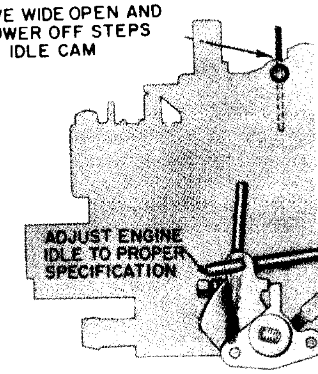
AIR VALVE SPRING ADJUSTMENT

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

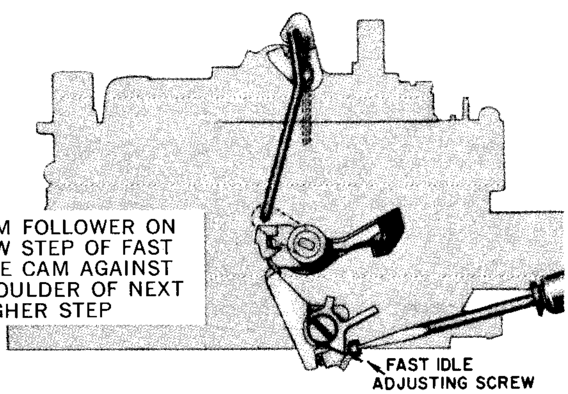
CHOKE VALVE WIDE OPEN AND CAM FOLLOWER OFF STEPS OF FAST IDLE CAM

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-1894

Figure 30–Carburetor Adjustments

14 IDLE MIXTURE ADJUSTMENT

ENGINES CERTIFIED FOR 1973

(REFER TO LABEL ON R.H. VALVE COVER FOR YEAR OF CERTIFICATION)

IN CASE OF HIGH IDLE CO (OVER 1.0%) MAJOR OVERHAUL, THROTTLE BODY REPLACEMENT, OR WHEN POOR IDLE QUALITY IS APPARENT, REQUIRING REMOVAL OF THE IDLE LIMITER CAPS, THE FOLLOWING PROCEDURE MUST BE USED.

(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.

1. WITH ENGINE AT OPERATING TEMPERATURE, STOP ENGINE AND DISCONNECT CARBURETOR HOSE FROM VAPOR CANISTER AND PLUG HOSE.
2. REMOVE IDLE LIMITER CAPS.
3. LIGHTLY SEAT IDLE MIXTURE SCREWS, THEN BACK OUT 6 FULL TURNS
4. CONNECT CO METER TO THE EXHAUST SYSTEM.
5. WITH ENGINE RUNNING AT NORMAL CURB IDLE SET PARKING BRAKE AND BLOCK DRIVE WHEELS, AUTOMATIC TRANSMISSION IN DRIVE. ADJUST EACH IDLE MIXTURE SCREW AN EQUAL NUMBER OF TURNS TO OBTAIN A SATISFACTORY IDLE AT 600 RPM WITH A MAXIMUM CO READING OF .3%.
6. TEMPORARILY PLACE AIR CLEANER ON CARBURETOR AND RECHECK CO. READING MUST NOT BE ABOVE .3%. ADJUST IDLE MIXTURE SCREWS IF NECESSARY.
7. INSTALL NEW IDLE LIMITER CAPS (RED). INSTALL AIR CLEANER AND CARBURETOR HOSE TO CANISTER.

ENGINES CERTIFIED FOR 1974

(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.

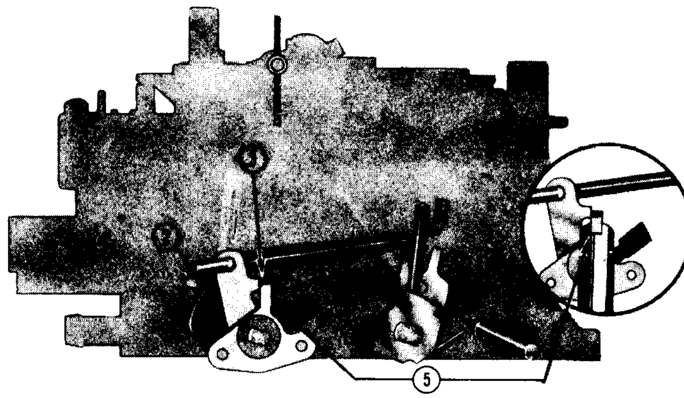
A-2224

Figure 31–Carburetor Adjustments

15 SECONDARY CLOSING .020"	16 DOWNSHIFT SWITCH ADJUSTMENT

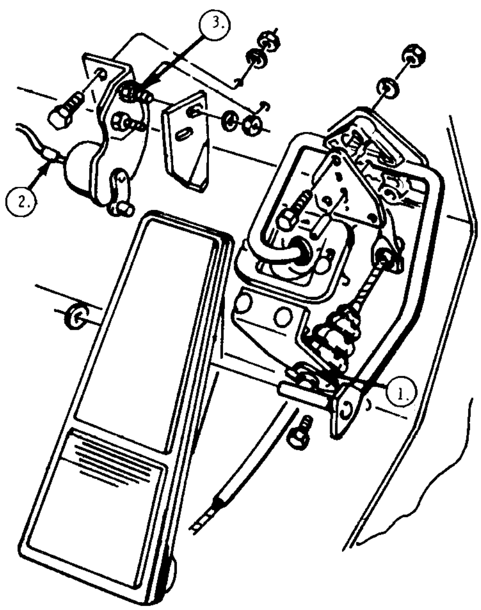
15

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



1. INSPECT TO ASSURE THAT VEHICLE HAS FULL THROTTLE TRAVEL, ADJUST TOE PANEL ACCELERATOR CABLE BRACKET IF NECESSARY.
2. CONNECT TEST LIGHT TO UPPER TERMINAL ON DOWNSHIFT SWITCH.
3. LOOSEN DOWNSHIFT SWITCH MOUNTING BOLTS.
4. FULLY DEPRESS ACCELERATOR PEDAL AND TURN IGNITION TO RUN POSITION.
5. ROTATE DOWNSHIFT SWITCH UPWARD UNTIL TEST LAMP LIGHTS—CONTINUE ROTATION 10°.
6. TIGHTEN DOWNSHIFT SWITCH MOUNTING BOLTS.

A-1895

Figure 32–Carburetor Adjustments

ACCELERATOR LINKAGE

The accelerator control system is of the cable type. By repositioning the cable mounting bracket below the accelerator pedal some adjustment in cable length may be made to assure a full throttle position at the carburetor is obtained.

THROTTLE CABLE ADJUSTMENT (FIGURE 33)

1. Loosen nuts "A" and "B" located on the underside of the toe panel.

2. Adjust cable until a dimension of 4-1/16" is obtained at "C".

3. Tighten nuts and torque to 7 ft. lbs.

4. Inspect carburetor during accelerator pedal operation to make certain that full throttle is obtained without overtravel.

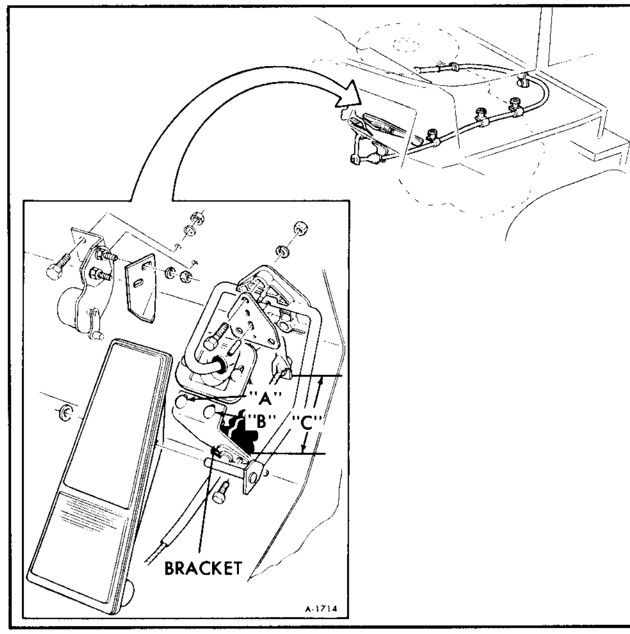


Figure 33–Accelerator Linkage

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 ghrough 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 insuffcent 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, guage 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 Motor Home.

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 Motor Home.

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 34.

4. Lift air cleaner housing off carburetor high enough to reach underneath it and disconnect the vacuum hose from the intake manifold. See Figure 34.

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.

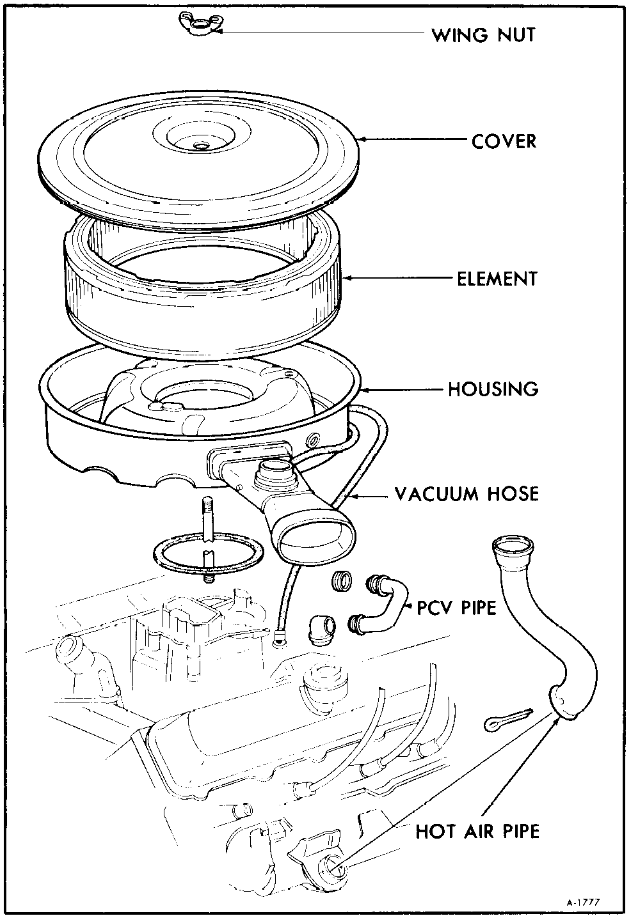


Figure 34–Air Cleaner

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.

GMC MOTOR HOME SERVICE

OCTOBER, 1973

SECTION 6T
EMISSION CONTROL SYSTEMS

Contents of this section are listed below:

POSITIVE CRANKCASE VENTILATION (P.C.V.)

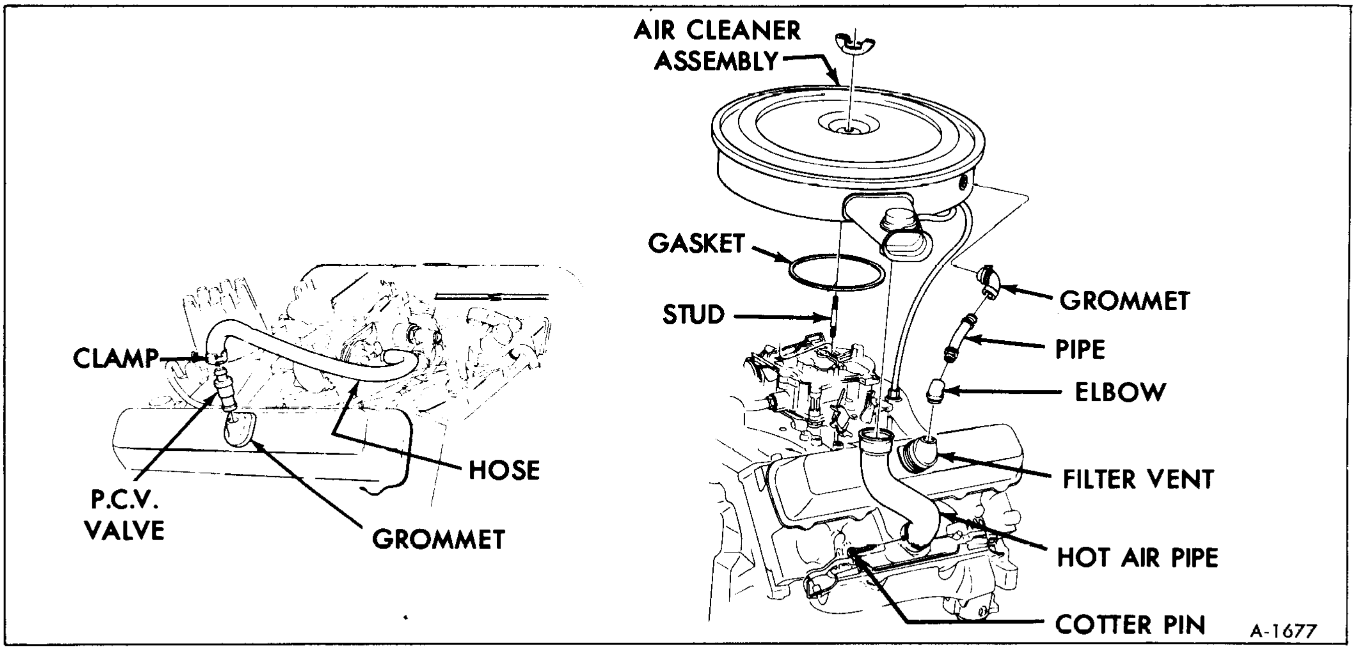


Figure 1–Positivie Crankcase Ventilation System

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 either 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.

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.

P.C.V. DIAGNOSIS CHART (USING CT-3 TESTER)

WINDOW READING	PROBABLE CAUSE	CORRECTION
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 degrees F. 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

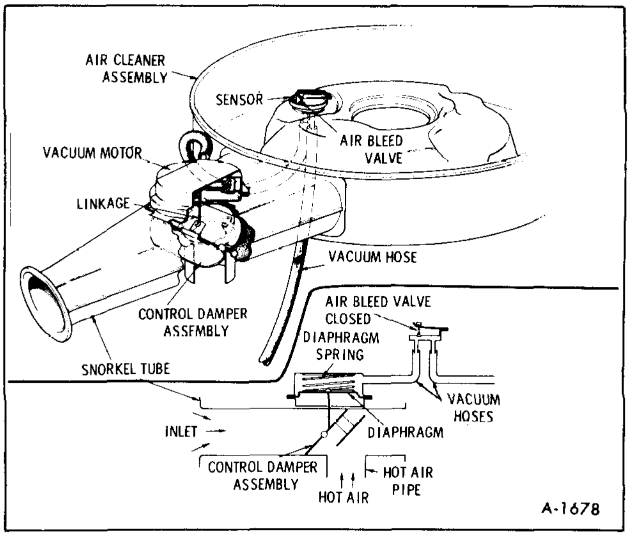


Figure 2–Hot Air Delivery Mode

flows up through the hot air pipe and adapter into the air cleaner. As the temperature inside the air cleaner reaches approximately 123 degrees F. 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 degrees F. if the ambient temperature is 123°F 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

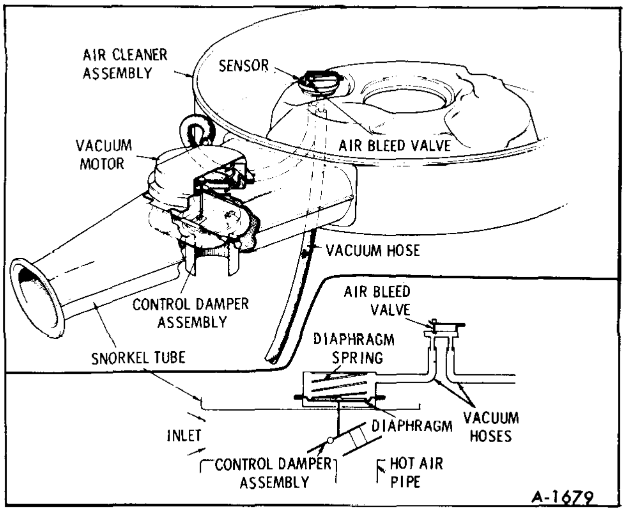


Figure 3–Regulating Mode

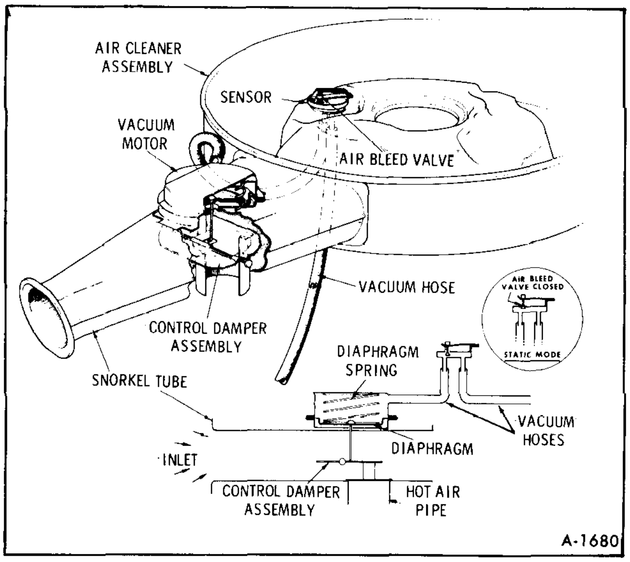


Figure 4–Cold Air Delivery Mode

and tape thermometer J-5421 in air cleaner next to sensor (See figure 5).

NOTE: If temperature is below 79 degrees F. continue to Step 2. If temperature is above 79 degrees F remove air cleaner and allow to cool to at least 72 degrees F.

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.

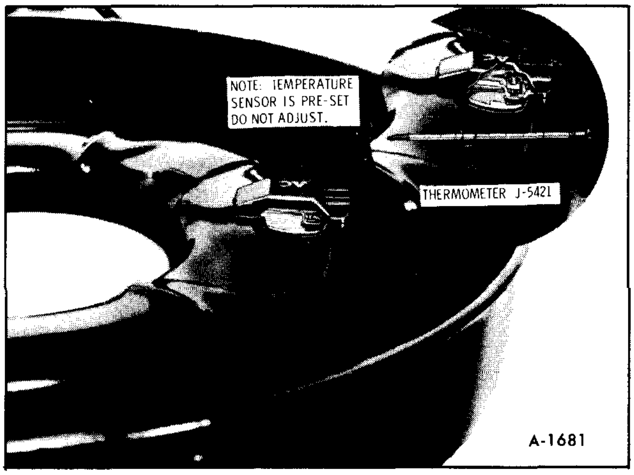


Figure 5–Checking Sensor

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.

SPECIFICATIONS FOR DAMPER OPERATION

Temperature:

79 degrees F. or lower, damper fully closed.

123 degrees F. or higher, damper fully open.

Vacuum:

3 in. hg. of vacuum or lower, damper fully open below 79 degrees F.

7 in. hg. of vacuum or higher, damper fully closed below 79 degrees F.

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.

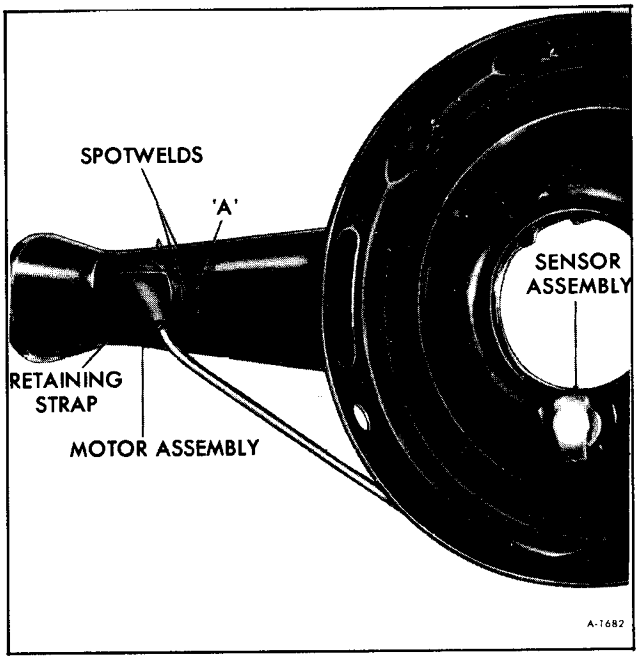


Figure 6–Air Cleaner Spot Welds

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.

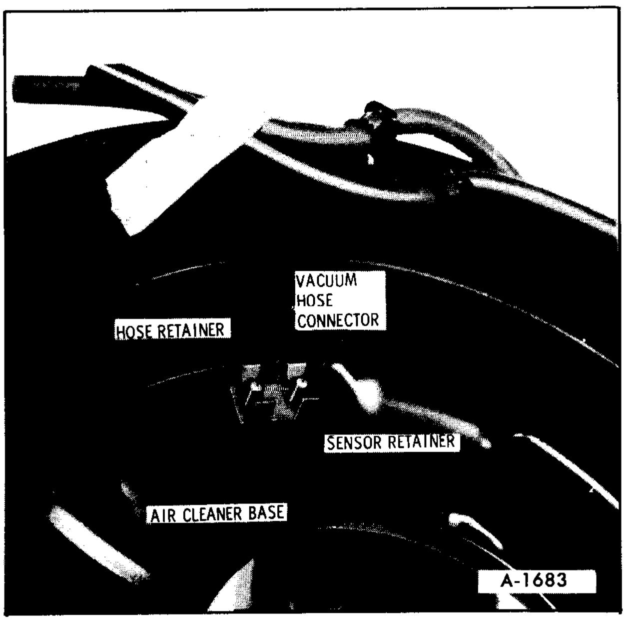


Figure 7–Sensor Retainer

SENSOR REPLACEMENT

REMOVAL

1. Remove air cleaner.

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.

2. Press retainer clip on hose connectors.

3. Connect vacuum hoses and install air cleaner on engine.

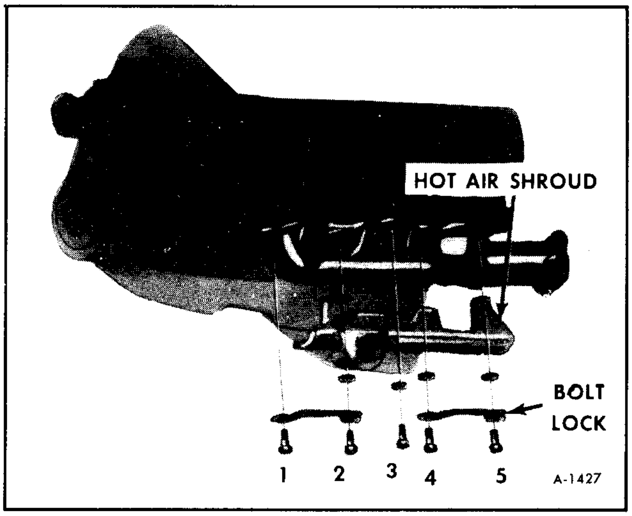


Figure 8–Hot Air Shroud

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 (216°F.), the valve opens against spring pressure and directs manifold vacuum to the advance mechanism. This advances the spark timing slightly and speeds up the engine. The result is less heat rejected to the coolant together with higher fan

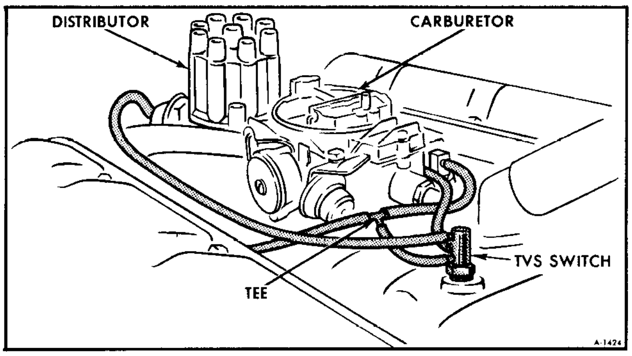


Figure 9–T.V.S. Location

speeds for better cooling action. When the engine has cooled down, 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 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.

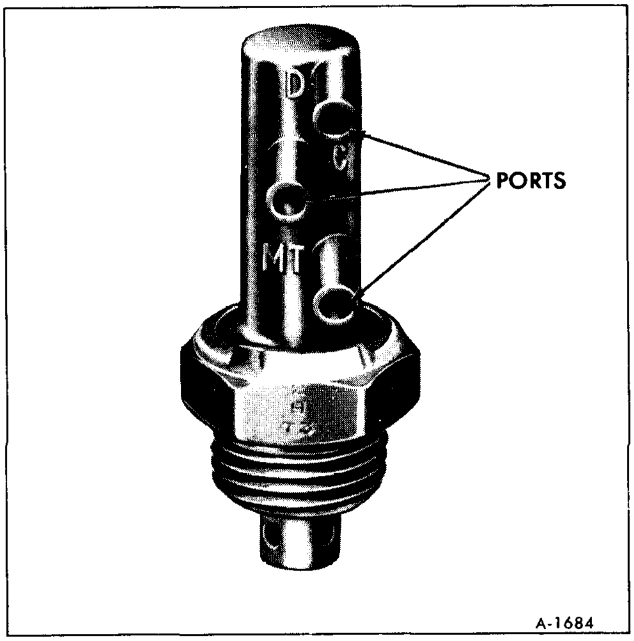


Figure 10–Thermostatic Vacuum Switch

The switch must be installed with a soft setting sealant on the threads.

GMC MOTOR HOME SERVICE

SECTION 6Y
ENGINE ELECTRICAL

Contents of this section are listed below:

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.*

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.

The Motor Home will have two batteries mounted behind the right front access door and a third near the motor generator if the vehicle is so equipped.

The GMC Dual Battery System provides power from two batteries to the Motor Home 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. The main battery (or automotive battery) supplies power to the chassis circuit; i.e., engine, external lights, etc. The auxiliary battery (living area battery) powers the Motor Home living area, i.e., internal lights, refrigerator, etc.

In all cases the batteries are all Delco Energizers and the service information in this section will pertain to all of them.

NOTE: Current production batteries are not equipped with the "Delco Eye" level indicator as shown in Figure 1. In addition the vent plugs are now equipped with a sintered carbide insert which acts as a flame arrestor.

The energizer (figure 1) 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. 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.

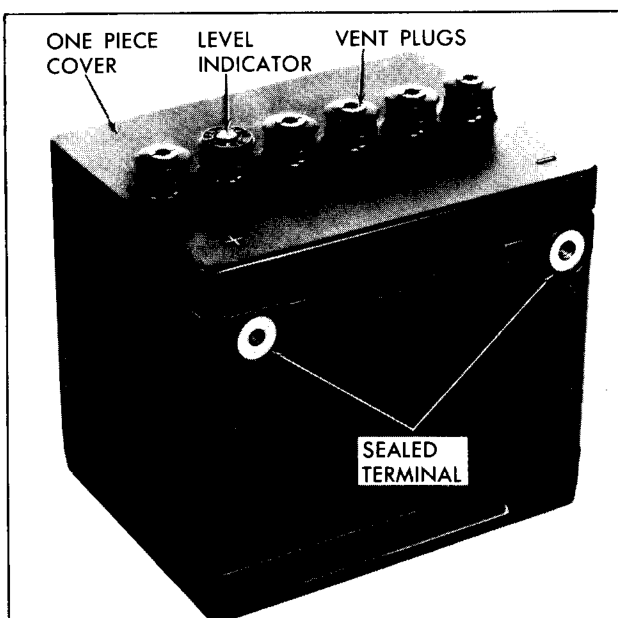


Figure 1–Energizer

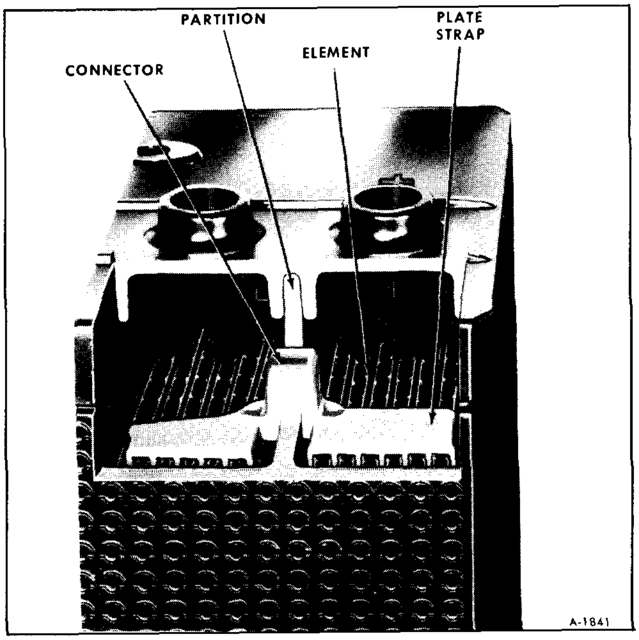


Figure 2–Internal View of Energizer

The elements are connected in series electrically by connectors that pass directly through the case partitions between cells. The energizer top is a one piece cover. The cell connectors, by passing through the cell partitions, connect the elements along the shortest practical path (figure 2). With the length of the electrical circuit inside the Energizer 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 Energizer, 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 Energizer. 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 Energizer 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 Energizer 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 Energizers, the "dry charge" type and the "wet charge" type. The difference in types depends on the method of manufacture. A "dry charge" Energizer contains fully charged elements which have been thoroughly washed and dried. This type of Energizer 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" Energizer.

Each vent well in a "dry charge" Energizer 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 Energizer (figure 3). 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" Energizer, the hard rubber seals are broken simply by pushing the 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 Energizer contains fully charged elements which are filled with electrolyte before being shipped from the factory.

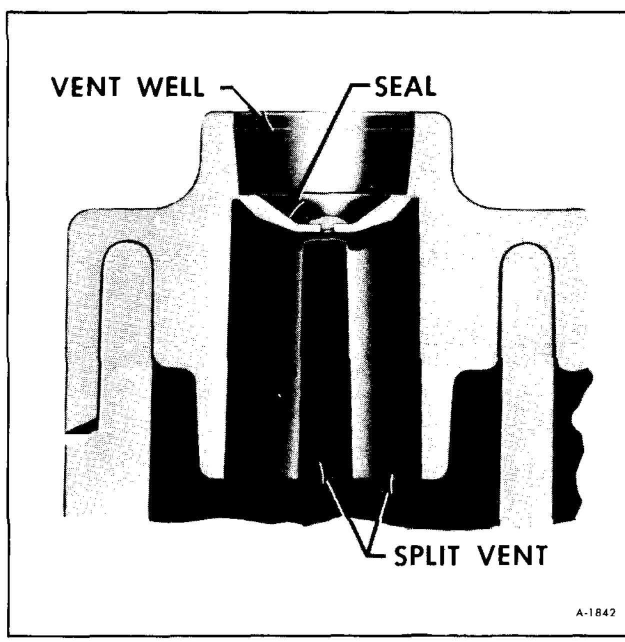


Figure 3–Vent Well Construction

THEORY OF OPERATION

The lead-acid Energizer 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 4).

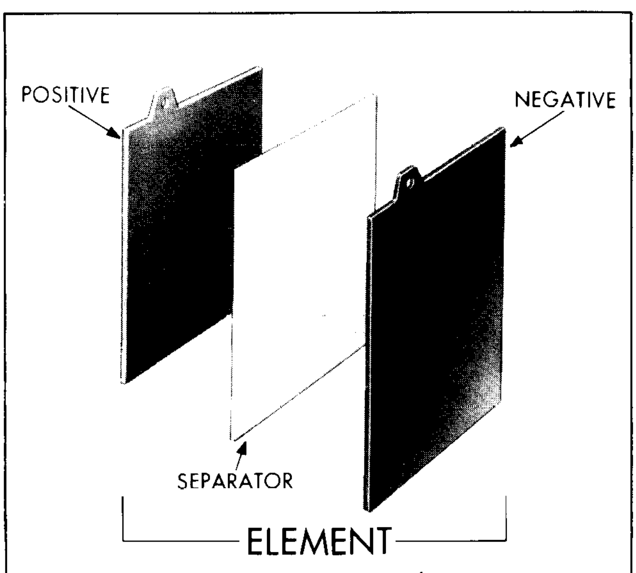


Figure 4–Battery Element

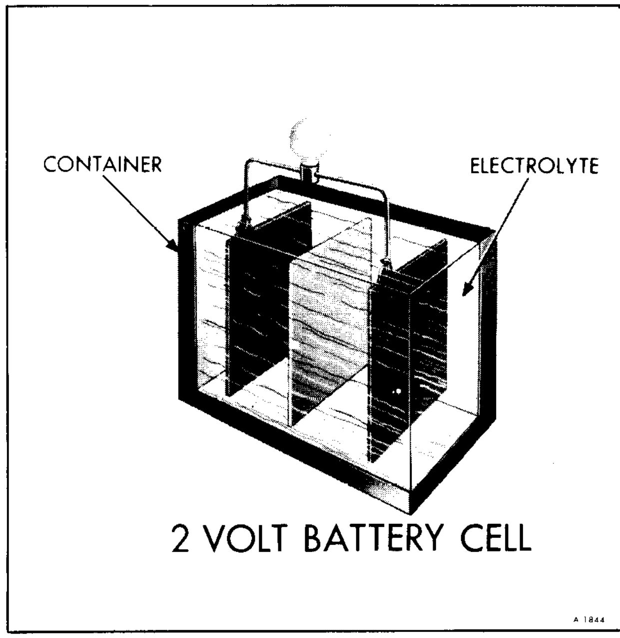


Figure 5–Two Volt Battery Cell

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 5).

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 6).

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 7).

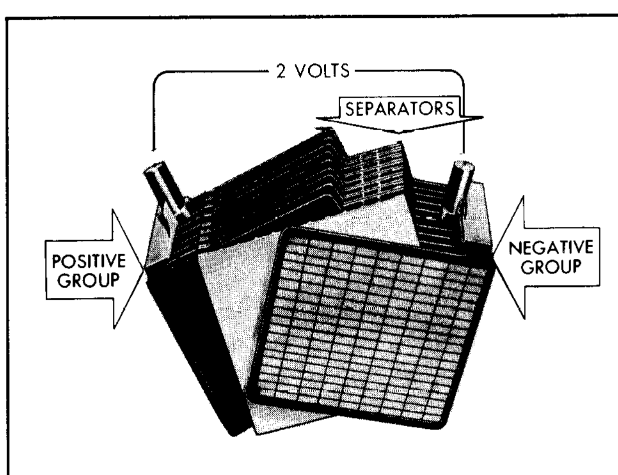


Figure 6–Battery Element (Compound)

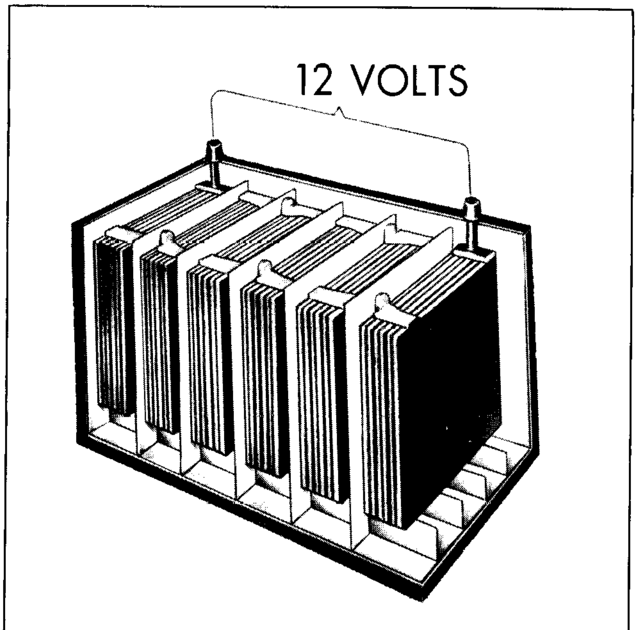


Figure 7–Typical 12-Volt Battery Cell Arrangement

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.

ENERGIZER RATING

Each battery generally has two classifications of ratings: (1) a 20 hour rating at 80° F and, (2) a cold rating at 0° F 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 Energizer's cold cranking ability. The numerical rating is embossed on each case at the base of the Energizer. 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. Analysis of battery conditions can be accomplished by performing a visual inspection, instrument test and the full charge hydrometer test. Refer to test procedure chart in this section.

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.

Instrument Test

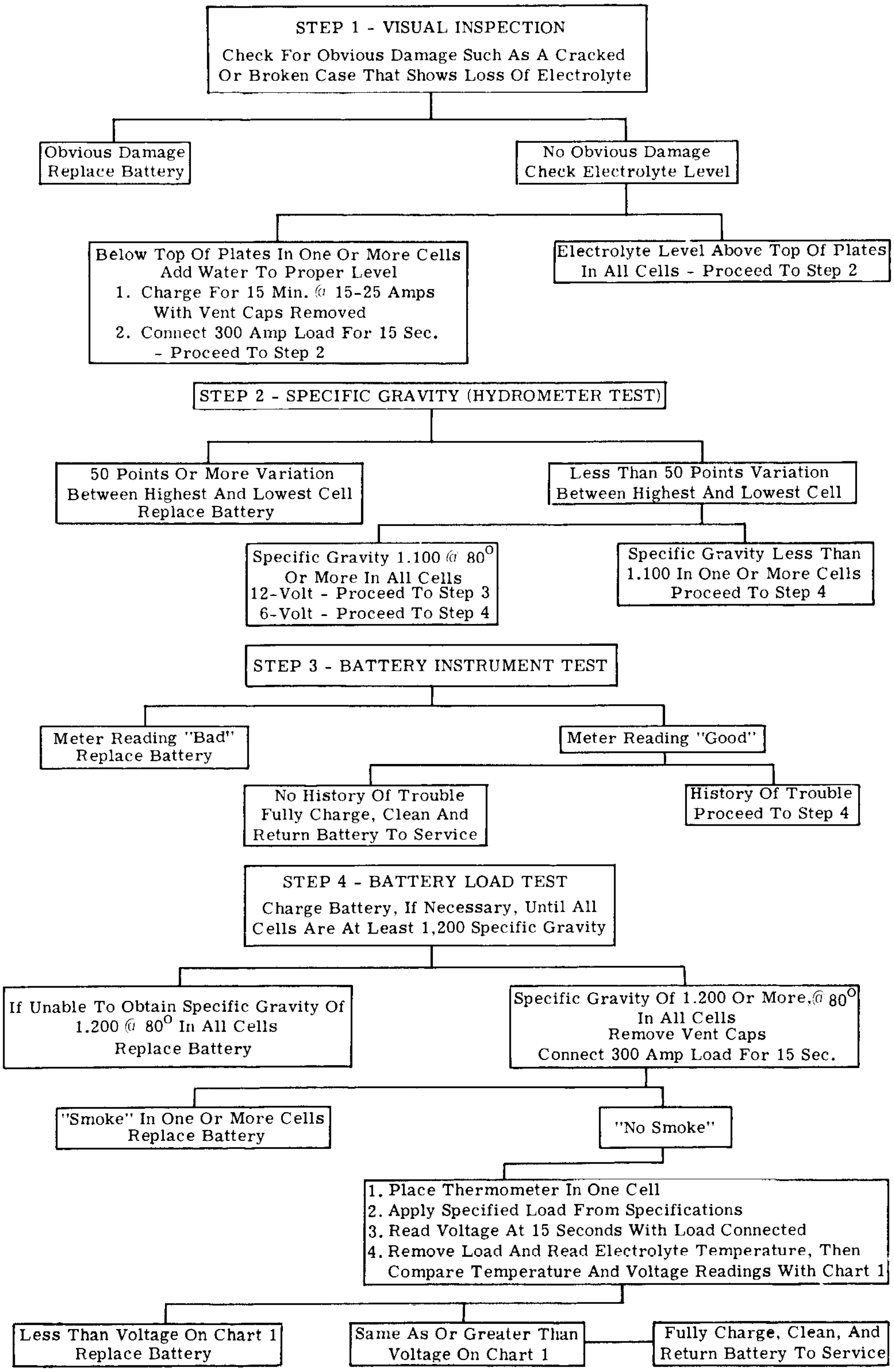
A number of suppliers have approved testing equipment available. These testers have a programmed test procedure consisting of a series of timed discharge and charge events, requiring approximately 2 to 3 minutes, that will determine the condition of the battery with a high degree of accuracy. When using these testers, the procedure recommended by the tester manufacturer should be followed. Batteries should not be charged prior to testing as doing so may alter the test results. If a tester is not available for testing, the "Specific Gravity Cell Comparison Test" may be used or an alternate method, but with a sacrifice in testing accuracy.

> **NOTE:** New energizers which have become completely discharged over a relatively long period of time, such as during vehicle storage, should be tested by the hydrometer method. Energizers discharged to this degree cannot be accurately tested using equipment requiring load capability comparison tests.

Full Charge Hydrometer Test

This test should be used only on Energizers which test good with testing equipment or "Specific Gravity Cell Comparison Test" but which subsequently fail in service.

BATTERY TEST PROCEDURE



NOTE: Chart No. 1 is in Specifications

T-8031

Battery Test Procedure

• Remove the Energizer from the vehicle, and adjust the electrolyte level as necessary, by adding colorless, odorless, drinking water.

• Fully charge the Energizer 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, in all cells, replace battery.

2. If able to obtain a specific gravity of 1.200 or more @ 80°F. 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 chart No. 2.

   a. If reading is less than voltage on chart No. 1, replace battery.

   b. If reading is same as or greater than voltage on chart No. 1, fully charge, clean and return battery to service.

Specific Gravity Readings (Figure 8)

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:

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

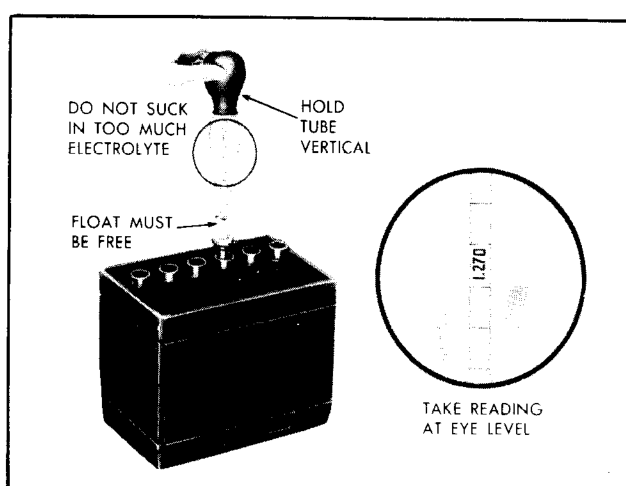


Figure 8–Checking Specific Gravity

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. If the electrolyte temperature is above or below 80°F, additions or subtractions must be made in order to obtain a hydrometer reading corrected to the 80°F standard. For every 10° above 80°F, add four specific gravity points (.004) to the hydrometer reading. Example: A hydrometer reading of 1.260 at 110°F would be 1.272 corrected to 80°F, indicating a fully charged Battery. For every 10° below 80°F, subtract four points (.004) from the reading. Example: A hydrometer reading of 1.272 at 0°F would be 1.240 corrected to 80°F, indicating a partially charged Battery.

Specific Gravity Cell Comparison Test

This test may be used when an instrument tester is not available. 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 Energizer is a perishable item which requires periodic servicing, a good maintenance program will insure the longest possible Battery life. If the Energizer 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.

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 (60-80 in. 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.
- Torque cable connections at battery to 60-90 pound inches.
- Check polarity to be sure the Battery is not reversed with respect to the charging system.

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:

1. Set parking brake and place transmission in "PARK." Turn off lights, heater and other electrical loads.

2. Remove vent caps from both the booster and the discharged batteries. Lay a cloth over the open vent wells of each battery. These two actions help reduce the explosion hazard always present in either battery when connecting "live" booster batteries to "dead" batteries.

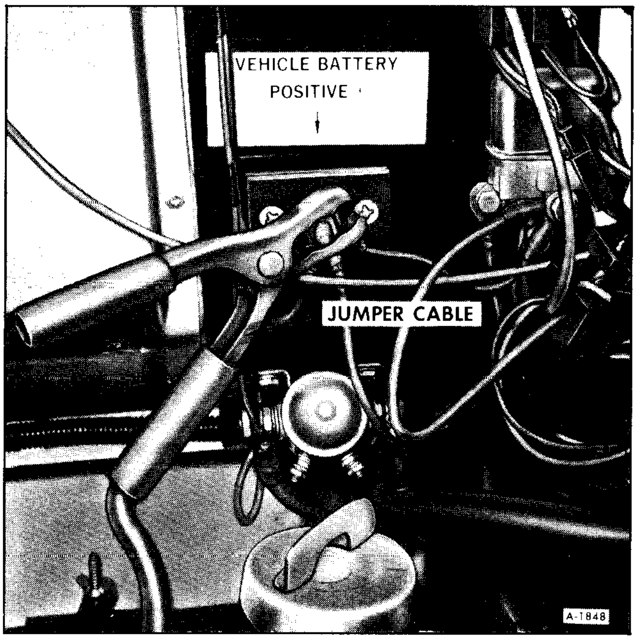


Figure 9–Connecting Jumper Cable to "Vehicle Battery Positive" Stud

3. Attach one end of one jumper cable to the positive terminal of the booster battery (identified by a red color "+" or "P" on the battery case, post or clamp) and the other end of same cable to positive terminal junction block stud NUT, marked "VEHICLE BATTERY POSITIVE." This is located behind the right access door above the batteries. Do NOT permit vehicles to touch each other, as this could establish a ground connection and counteract the benefits of this procedure. (figure 9)

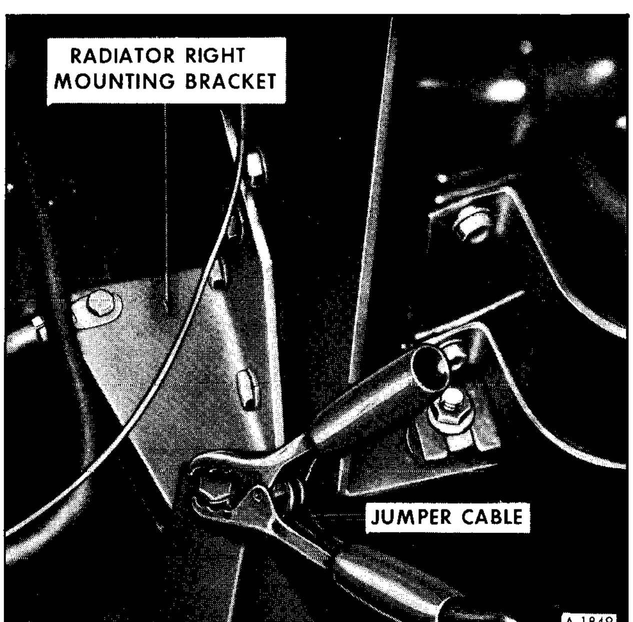


Figure 10–Connecting Jumper Cable to Right Radiator Mounting Bracket

4. Attach one end of the remaining negative cable to the negative terminal (black color, "–" or "N") of the booster battery, and the other end to the right radiator mounting bracket (do not connect directly to negative post of dead battery). Make sure that clamps from one cable do not inadvertently touch the clamps on the other cable. Do not lean over the battery when making this connection. (figure 10)

Reverse this sequence exactly when removing the jumper cables. Re-install vent caps and throw cloths away as the cloths may have corrosive acid on them.

CAUTION: *Any procedure other than the preceding could result in: (1) personal injury caused by electrolye squirting out the battery vents, (2) personal injury or property damage due to battery explosion or electrical burns, (3) damage to the charging system of the booster vehicle or of the immobilized vehicle.*

SAFETY PRECAUTIONS

When Energizers 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 energizer itself if ventilation is poor. This explosive gas may remain in or around the energizer for several hours after it has been charged. Sparks or flames can ignite this gas causing an internal explosion which may shatter the energizer.

The following precautions should be observed to prevent an explosion:

1. Do not smoke near energizers being charged or which have been very recently charged.

2. Do not break live circuits at the terminals of energizers 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 an energizer the electrolyte level must be checked and adjusted if needed. Energizer 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 an energizer due to the following factors:

1. The size, or electrical capacity in ampere-hours (A.H.), of the Energizer.

EXAMPLE: A completely discharged 70 A.H. energizer requires almost twice the recharging as a 40 A.H. ENERGIZER.

2. Temperature of the energizer electrolyte.

EXAMPLE: About two hours longer will be needed to charge a 0°F. energizer than a 80°F. energizer.

3. Energizer state-of-charge at the start of the charging period.

EXAMPLE: A completely discharged energizer requires twice as much charge in ampere-hours as a one-half charged energizer.

Energizer age and condition.

EXAMPLE: An energizer that has been subjected to severe service will require up to 50% more ampere-hour charging input than a relatively new energizer.

The following basic rule applies to any energizer charging situation.

"Any energizer 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. If spewing of electrolyte occurs, or if electrolyte temperature exceeds 120°F., the charging rate in amperes must be reduced or temporarily halted to avoid damage to the Energizer.

The energizer 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.

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 energizer 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.

When out of the vehicle, the sealed side terminal battery will require adapters (figure 11) 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 energizer.*

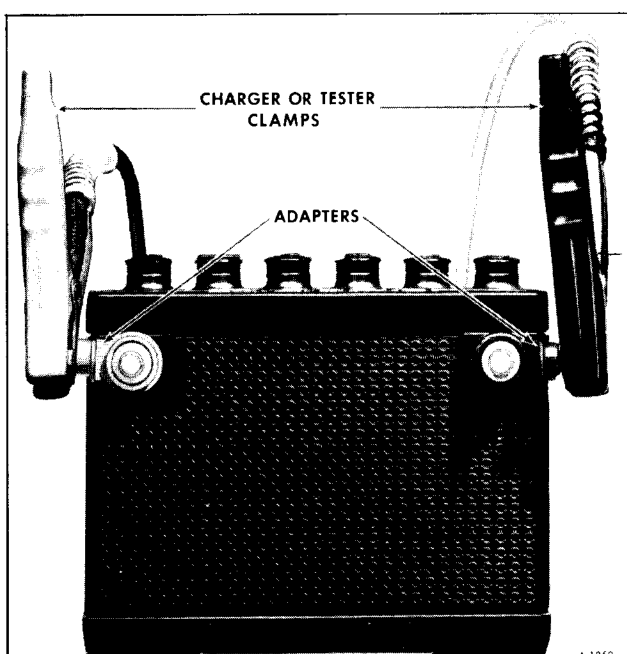


Figure 11–Charging Lead Adapters

CHARGING GUIDE

BATTERY MAINTENANCE

CARE OF ENERGIZER

Energizer Storage

Since the "dry charge" Energizer 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" Energizer, the following procedures should be followed:

1. Keep the Energizer in its shipping carton until activated.

2. Do not stack the "dry charge" Energizer in cartons more than four high.

3. Rotate stocks regularly.

4. Maintain the storage area at 60°F or higher to aid activation.

A wet charged Energizer will not maintain its charged condition during storage, and must be recharged periodically. During storage, even though the Energizer is not in use, a slow reaction takes place between the chemicals inside the Energizer which causes the Energizer 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 Energizer stored in an area at 100°F 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 for the same length of time.

To minimize self-discharge, a wet Energizer should be stored in as cool a place as possible, provided the electrolyte does not freeze.

A wet Energizer 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 Energizer 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 Energizer in a satisfactory condition while in storage. See paragraph "Charging Wet Energizer in Storage."

Charging Wet Energizer in Storage

Before placing an Energizer 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 Energizer should be brought to a fully charged condition every 30 days by charging as covered under heading of "Energizer Charging."

Trickle charging should not be used to maintain an Energizer in a charged condition when in storage.

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.

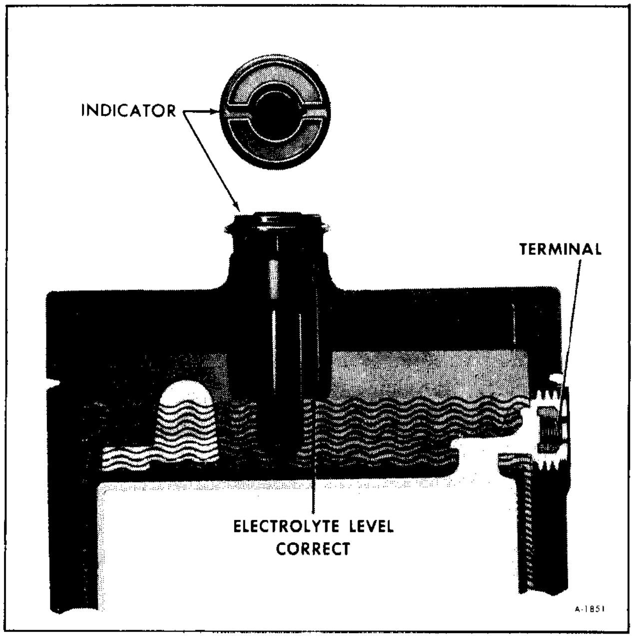


Figure 12–Electrolyte at Proper Level

The low charge rate method applied every 30 days is the best method of maintaining a wet charged Energizer 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.

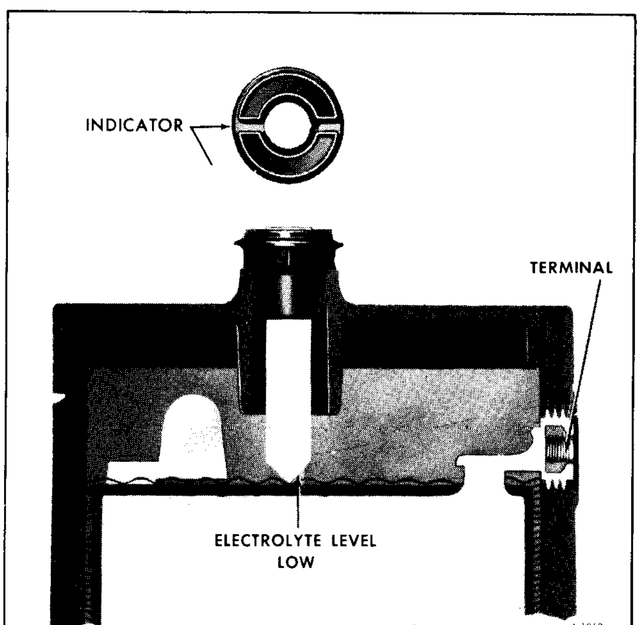


Figure 13–Electrolyte at Low Level

Since freezing may ruin a wet Energizer, it should be protected against freezing by keeping it in a charged condition. This is true whether the wet Energizer is in storage or in service. Antifreeze should never be added to the Energizer to prevent if from freezing as this practice is very harmful.

Electrolyte Level Indicator

The Energizer features an electrolyte level indicator, which is a specially designed vent plug with a transparent rod extending through the center. When the electrolyte is at the proper level, the lower tip of the rod is immersed, and the exposed top of the rod will appear very dark (figure 12) when the level falls below the tip of the rod, the top will glow (figure 13).

See NOTE on page 6Y-1.

Value of Specific Gravity Corrected to 80°F.	Freezing Temp. Deg. F.	Value of Specific Gravity Corrected to 80°F.	Freezing Temp. Deg. F.
1.100	18	1.220	-13
1.120	13	1.240	-50
1.140	8	1.260	-75
1.160	1	1.280	-92
1.180	-6	1.300	-95
1.200	-17		

The indicator reveals at a glance if water is needed, without the necessity of removing the vent plugs.

The Level Indicator is used on only one cell (second cell cap from positve terminal) because when the electrolyte level is low in one cell, it is normally low in all cells. Thus when the indicator shows water is needed, check the level in all six cells.

An alternate method of checking the electrolyte level is to 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 14).

Electrolyte Level

The electrolyte level in the Energizer 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,

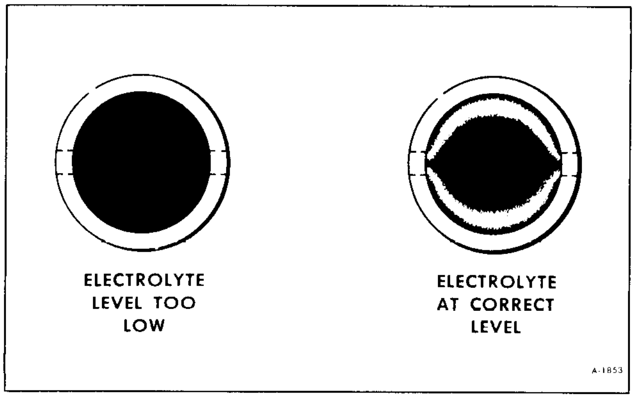


Figure 14–View Inside Vent Well

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.

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.

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.

Carrier and Hold-Down

The Energizer 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 Energizer should be checked periodically for damage such as cracked cover, case and vent plugs or for the presence of dirt and corrosion. The Energizer 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 Energizers, 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 ENERGIZER

Long and troublefree service can be more assured when the capacity or wattage rating of the replacement Energizer is at least equal to the wattage rating of the Energizer originally engineered for the application by the manufacturer.

The use of an undersize Energizer may result in poor performance and early failure. Energizer power shrinks while the need for engine cranking power increases with falling temperatures. Sub zero temperatures reduce capacity of a fully charged Energizer 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 Energizer. 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 Energizer has ample capacity to cope with these conditions.

An Energizer 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 Energizer 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 Energizer life and improve Energizer performance.

BATTERY SPECIFICATIONS

	Type
Main (Automotive) Bat.	E5000 R91
Auxiliary (Living Area) Bat.	E5000 R91
Motor Generator Bat.	E3000 Y87

E5000 R91 Rated 3350 Watts @ 0°F.
E3000 Y87 Rated 2300 Watts @ 0°F.

Part No.	1980224	1980199
Make	Delco-Remy	Delco-Remy
Model No.	E5000	E3000
Catalog	R91	Y87
Volts	12	12
No. of Plates Per Cell	13	11
Cranking Power @ 0° F. (Watts)	3350	2300
Amp. Hr. Capacity @ 20 Hr. Rate	73	45
Load Test Amp. *	220	130

*Apply Load Indicated Then Read Voltage at End of 15 Seconds with Load Connected. Compare
Voltage Reading with Voltages and Temperatures Shown in "Voltage and Temperature Chart"
following.

VOLTAGE AND TEMPERATURE CHART NO. 1

Electrolyte Temperature	80°F.	70°F.	60°F.	50°F.	40°F.	30°F.	20°F.	10°F.	0°F.
Voltage Minimum–12-Volt	9.6	9.6	9.5	9.4	9.3	9.1	8.9	8.7	8.5

NOTE: Voltage must not drop below minimum listed at given temperature when battery is subjected to the proper Load for 15 seconds and is 1.200 specific gravity at 80°F. or more.

GENERATING SYSTEM

GENERAL DESCRIPTION

The 61-amp. (10 SI type 100) generator illustrated in Figure 15 and the 80-amp. (27 SI type 100) generator illustrated in Figure 16 feature a solid state regulator mounted inside the generator slip ring end frame. All regulator components are enclosed in a soild mold. This unit, along with the brush holder assembly, is 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 61-, and 80-amp integral type charging system is shown in Figure 17. The basic operating principles are explained as follows:

When ignition switch is closed, current from the battery flows through the resistor 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 ignition resistor

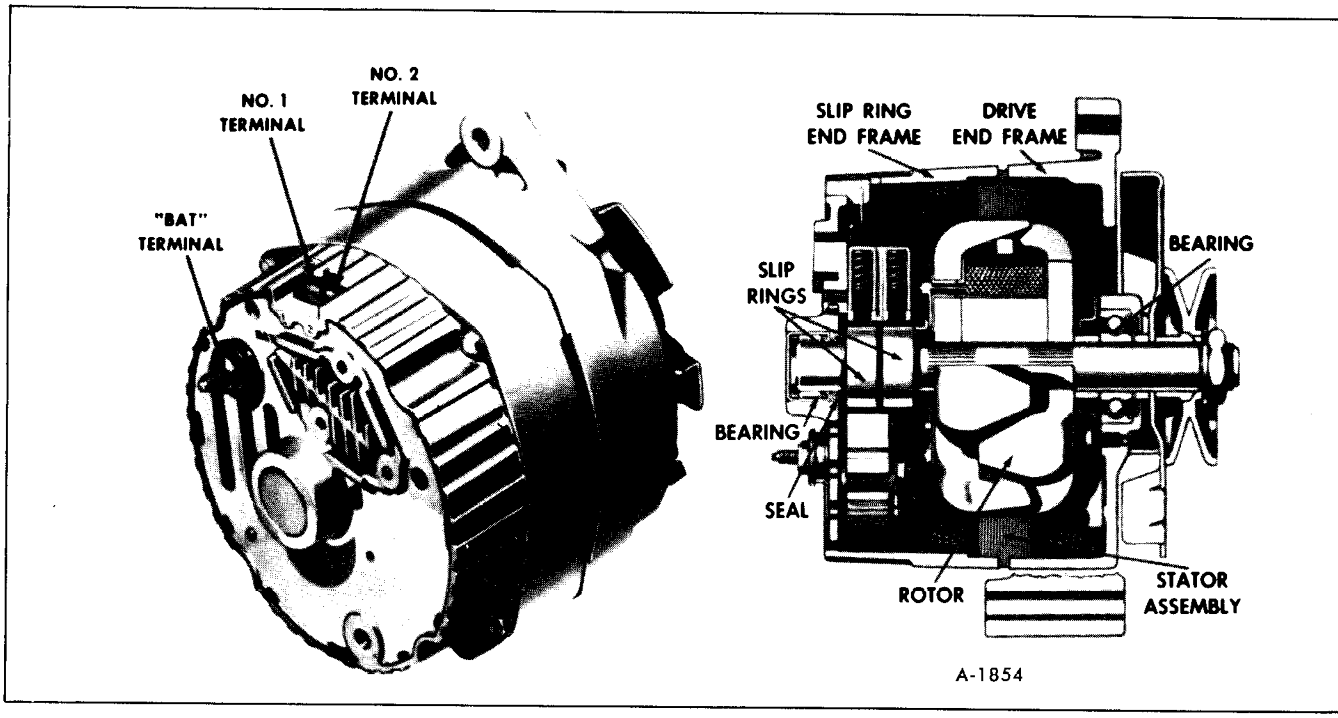


Figure 15-61 - Amp. Integral Type AC Generator

reduces total circuit resistance to provide higher field current for initial voltage build-up.

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

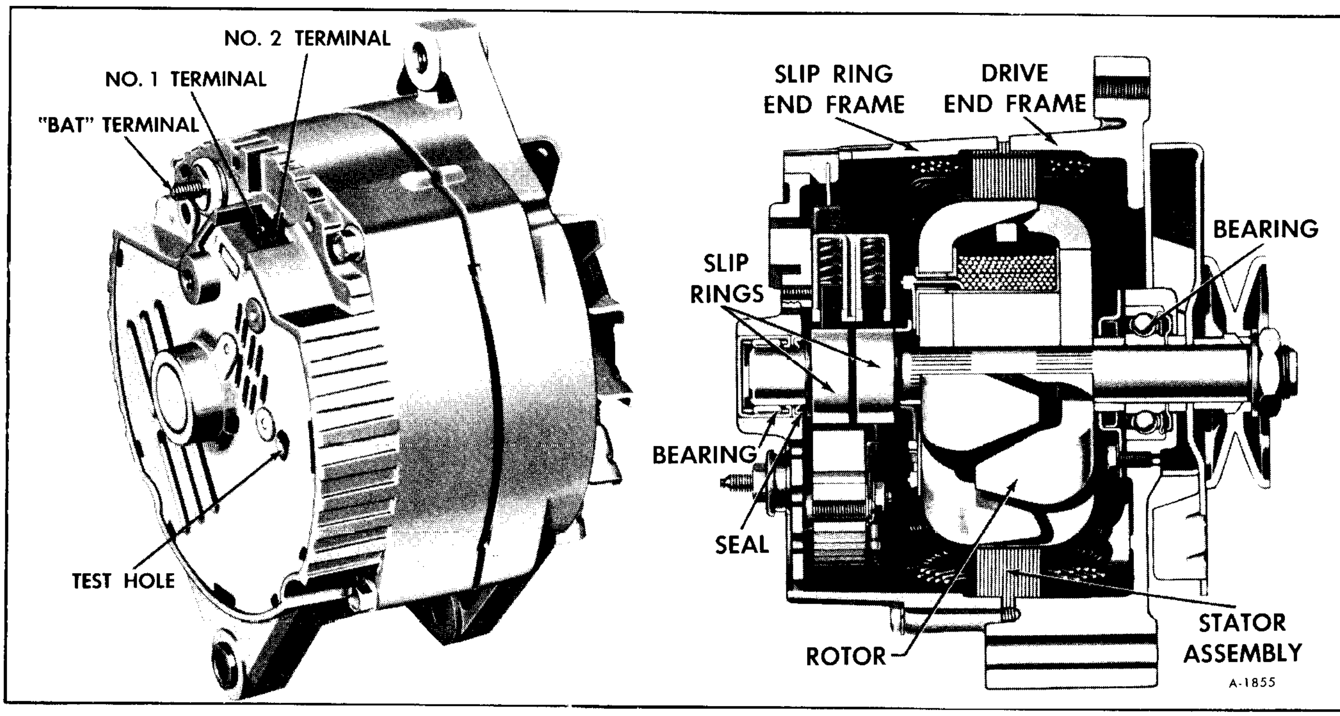


Figure 16-80 - Amp. Integral Type AC Generator

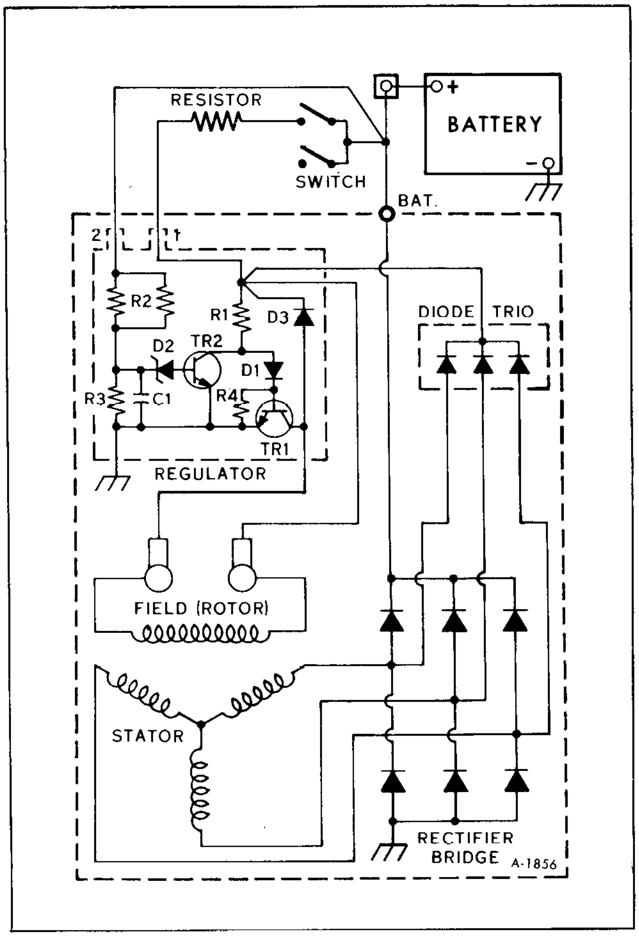


Figure 17–Schematic Diagram of Generating System (Typical)

generator "BAT" terminal. As generator speed increases, current is provided for charging the battery and operating electrical accessories.

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.

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).

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.

GENERATOR ON-VEHICLE TESTS

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 Output Test" 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.

GENERATING SYSTEM DIAGNOSIS

BATTERY UNDERCHARGED

Replace glazed generator belt(s). Check drive belt for proper tension and check wiring connections at generator and battery cables.

- Low → Adjust to specifications
- OK → Check Battery per test procedure under "BATTERY"
  - Bad → Replace battery
  - OK → Turn ignition switch on

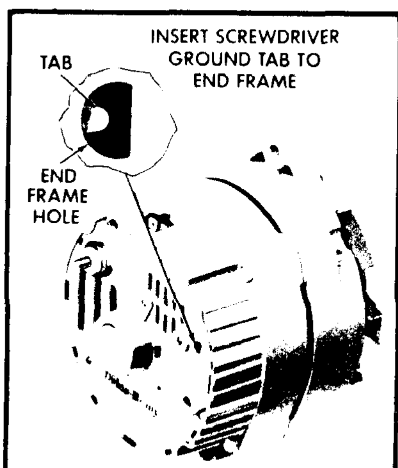
Connect voltmeter to "BAT" terminal on generator and chassis ground. Turn ignition key on.

- Zero voltage → Repair open circuit between "BAT" terminal on generator and junction block.
- Battery voltage → Disconnect No. 1 and No. 2 connector at generator. Connect voltmeter from No. 1 connector to chassis ground.
  - Zero Voltage → Repair open circuit in No. 1 wire from connector to ignition switch.
  - Battery voltage → Install No. 1 and No. 2 connector
    - Disconnect negative battery cable from battery.
    - Disconnect red wire from "BAT." terminal on generator.
    - Connect ammeter black lead to red wire and red ammeter lead to "BAT" terminal.
    - Connect negative battery cable to battery.
    - Turn on all accessories, lights on high beam, and blower on high speed.
    - Run engine as required to obtain maximum current output and record ammeter reading. *

* If battery is fully charged, use the starter to partially discharge it before recording maximum current output.

- Output within 10 amps of rated output stamped on generator frame NORMAL
- Output within 10 amps of rated output stamped on generator frame → Insert screwdriver into test hole. End of screwdriver must touch tab and side of screwdriver ground against end frame. Run engine as before and recheck output.
  - Output within 10 amps of rated output stamped on generator frame → Replace Regulator
  - Output not within 10 amps of rated output stamped on generator frame.
    - Remove generator.
    - Check rotor windings, diode trio, rectifier bridge, stator and regulator mounting screw insulators.

      If no defect is found, replace regulator.



BATTERY OVERCHARGED

Check battery as explained under "Battery Tests" in "BATTERY" previously

- Bad → Recharge or replace battery
- Good → Connect voltmeter from No. 2 terminal on generator to ground note reading.
  - Not zero → Remove generator and repair.
  - Zero reading → Repair open between No. 2 terminal and ignition switch.

Generating System Diagnosis

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.

To check for a defective diode or stator, perform "Generator Output Test" explained later in this section. If a defect is indicated by this test, remove generator and repair.

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.

UNDERCHARGED BATTERY CONDITION CHECK

This condition, as evidenced by slow cranking and low specific gravity readings, can be caused by one or more of the following conditions: 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. Check battery. Test is not valid unless battery is good and fully charged.

4. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the slip connectors at the generator and fire wall, and the cable clamps and battery posts.

5. With ignition switch on connect a voltmeter from generator "BAT" terminal to ground. A zero reading indicates an open between voltmeter connection and battery. Also, disconnect wiring harness at generator No. 1 and No. 2 terminals, and connect voltmeter from No. 1 harness terminal to ground. A zero reading indicates an open between voltmeter connection and battery. Reconnect harness to No. 1 and No. 2 terminals.

NOTE: If previous Steps 1 through 5 check satisfactorily, check generator as follows:

6. Connect a voltmeter in the circuit at the "BAT" terminal of the generator.

7. Operate engine at moderate speed (approximately 1500-2000 rpm) and turn on electrical loads (high beam headlights, windshield wiper, heater or A/C blower, radio, etc.).

NOTE: Without sufficient electrical load to demand maximum generator output the following voltage check is invalid.

8. Observe voltmeter reading:

a. If reading is 12.8 volts or more, generator is not defective. Turn off electrical loads, stop engine and disconnect test equipment. Recheck Steps 1 through 5.

b. If reading is less than 12.8 volts, ground field winding by inserting a screwdriver into the test hole in the end frame (figure 18).

CAUTION: *Tab is within 3/4-inch of casting surface. Do not force screwdriver deeper than 1-inch into end frame.*

(1) If voltage increases (13 volts and above) regulator is defective and must be replaced. Repeat Steps 7 and 8 after new regulator unit has been installed.

(2) If voltage does not increase significantly remove generator and repair.

9. Turn off electrical loads, shut off engine and disconnect all test equipment.

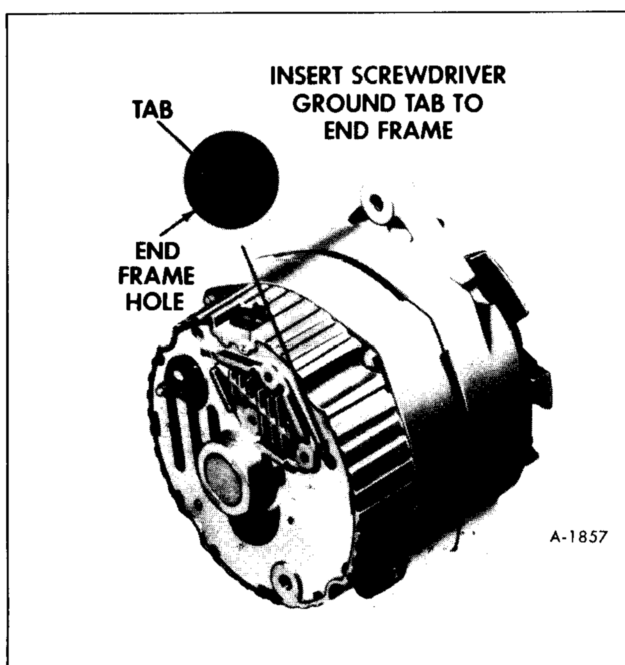


Figure 18–End View of Generator (Typical)

OVERCHARGED BATTERY CONDITION CHECK

1. Determine condition of battery. Test is not valid if battery is not good and fully charged.

2. Connect a voltmeter from generator No. 2 terminal to ground. If reading is zero, No. 2 lead circuit is open, which will cause an overcharged condition.

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. Remove the generator, then remove 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.

b. Connect ohmmeter using lowest range scale from brush lead clip to end frame as shown in Step 1 in Figure 19 then reverse lead connections.

c. If both readings are zero, either the brush lead clip is grounded or regulator is defective.

d. A grounded brush lead clip can result from omission of insulating washer (figure 19) omission of insulating sleeve over screw, or damaged insulating sleeve. Remove screw to inspect sleeve. If satisfactory, replace regulator.

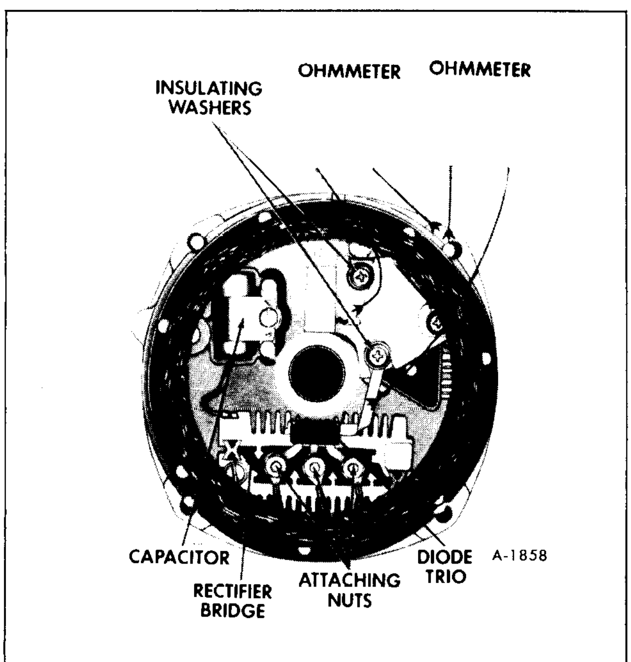


Figure 19–Slip Ring End Frame

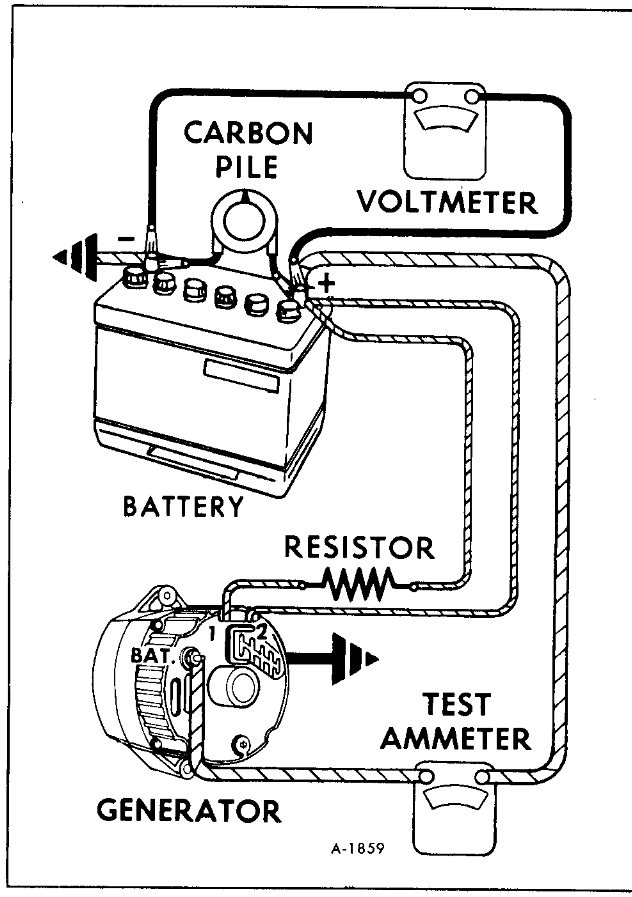


Figure 20–Connections for Testing Generator Output

e. Assemble generator, then check for rated output as explained later in this section.

GENERATOR OUTPUT TEST

To check the generator in a test stand, proceed as follows:

1. Make connections as shown in Figure 20 except leave the carbon pile disconnected. Use a fully charged battery and a 10-ohm resistor rated at 6 watts or more between the generator No. 1 terminal and the battery.

NOTE: Battery must be fully charged when making this check. An undercharged battery would be charged during the test procedure, thus producing varied ammeter and voltmeter readings.

2. Slowly increase generator speed and observe the voltage.

3. If voltage is uncontrolled with speed and increases above 16 volts, check for a grounded brush lead clip as explained previously under "Over-

charged Battery," Step 3. If not grounded, replace the regulator.

4. Connect the carbon pile as shown in Figure 20.

5. Operate the generator at moderate speed as required and adjust carbon pile as required to obtain maximum current output.

6. If output is within 10% of rated output, as listed in "Specifications" at end of this section, generator is good.

7. If output is not within 10% of rated output, ground the generator field (figure 18)

CAUTION: *Tab is within 3/4-inch of casting surface. Do not force screwdriver deeper than 1-inch into end frame.*

8. Operate generator at moderate speed and adjust carbon pile as required to obtain maximum output.

9. If output is within 10% of rated output, replace the regulator (figure 19).

10. If output is not within 10% of rated output, check the field winding, diode trio, rectifier bridge and stator as previously covered.

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 21.

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).

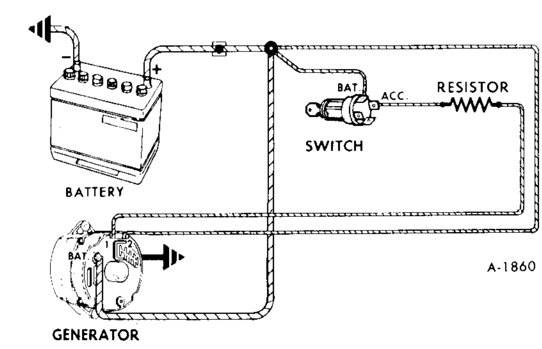


Figure 21–Typical Lead Connections

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.

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.

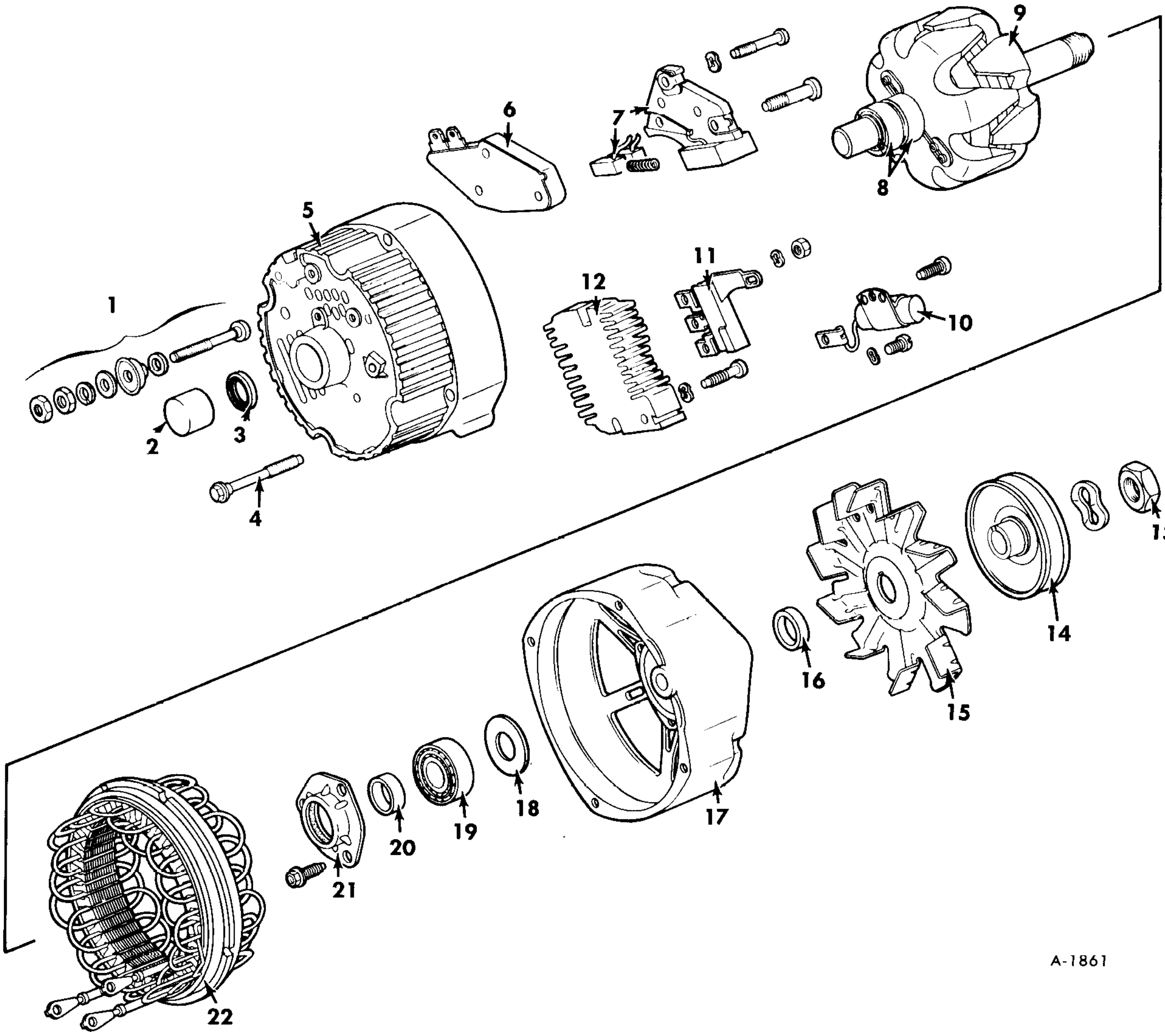
9. Always disconnect battery negative cables when replacing electrical system components. This eliminates accidental shorting at generator terminals where battery voltage is available.

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).

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



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. Slip Rings
9. Rotor
10. Capacitor
11. Diode (Trio)
12. Bridge-Rectifier
13. Drive Shaft Nut
14. Pulley
15. Fan
16. Drive Shaft Collar (Outside)
17. Frame-Drive End
18. Washer-Grease Slinger
19. Bearing-Drive End
20. Drive Shaft Collar (Inside)
21. Retainer Plate
22. Stator

Figure 22–Delcotron Generator (Typical)

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.

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 22)

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 22).

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 22). 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 19. First, connect an ohmmeter using lowest range scale from diode trio long connector to end frame as shown in Step 2, Figure 19, then reverse lead connections. If both readings are the same, check for grounded brush lead clip caused by omission of insulating washer (figure 19), 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 23). 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 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.

NOTE: Figures 19 and 23 illustrate two diode trios differing in appearance. Either one of these diode trios may be used in these generators, and the two are completely interchangeable.

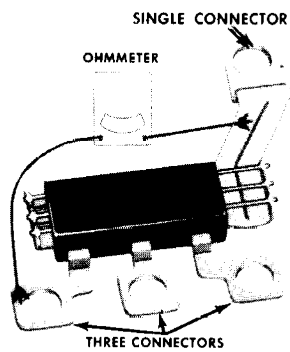


Figure 23–Diode Trio Check

RECTIFIER BRIDGE CHECK

Note that the rectifier bridge has a grounded heat sink and an insulated heat sink connected to the output terminal. Also, note the insulating washer located between the insulated heat sink and end frame on 10-SI generators.

To check the rectifier bridge, connect the ohmmeter to the grounded heat sink and one of the three terminals, (figure 24). 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. Note the insulator between the insulated heat sink and end frame (figure 24). Rectifier bridges may vary in appearance but are completely interchangeable in these generators.

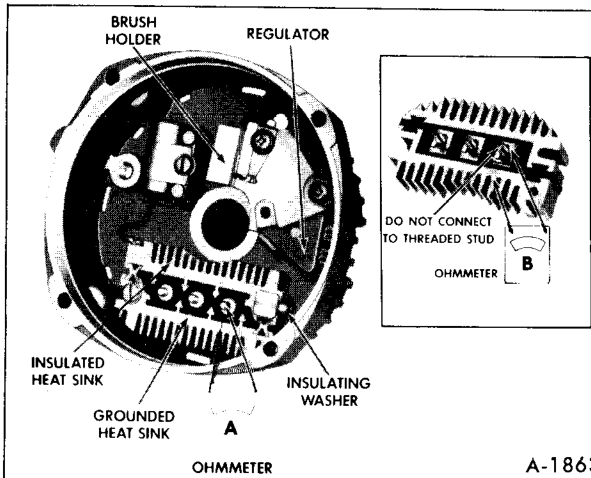


Figure 24–Rectifier Bridge Check

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. If the lamp fails to light, or if the meter reading is high when successively connected between each pair of stator leads on 10-SI Series, the windings are open.

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 24) 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 19, 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 equivalent before reassembly. CAUTION: Do not overfill, as this 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.

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 BENCH CHECK

To check the generator in a test stand, proceed as follows:

1. Make connections as shown in Figure 20 except leave the carbon pile disconnected.

IMPORTANT: Ground polarity of Energizer and generator must be the same. Use a fully charged Energizer or battery, and a 10 ohm resistor rated at six watts or more between the generator No. 1 terminal and the Energizer.

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 ENERGIZER," Step 3. If not grounded, replace the regulator, and check field winding.

NOTE: The Energizer or battery must be fully charged when making this check.

4. If voltage is below 15.5 volts, 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 percent of rated output as stamped on generator frame, generator is good.

7. If output is not within 10 percent of rated output, keep Energizer or battery loaded with carbon pile, and ground generator field.

8. Operate generator at moderate speed and adjust carbon pile as required to obtain maximum output.

9. If output is within 10 percent of rated output, replace regulator as covered in "Regulator Replacement" section, and check field winding.

10. If output is not within 10 percent of rated output, check the field winding, diode trio, rectifier bridge, and stator as previously covered.

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 J-23600 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 recommmended 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 and 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	(61 Amp.) 1102368	(80 Amp.) 1101015
Make	Delco-Remy	Delco-Remy
Series	10SI	27 SI
Type	100	100
Rotation (Viewing Drive End)	CW	CW
Field Current at 80°F.		
Amps.	4.0-4.5	4.0-4.5
Volts	12	12
Cold Output		
Specified Volts	(a)	(a)
Amps.	55	74
Generator RPM (Approx.)	5000	5000
Rated Hot Output (Amps.) (b)	61	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.

IGNITION SYSTEM

GENERAL DESCRIPTION

The ignition system used on the Motor Home 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 matcrials 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 on 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.

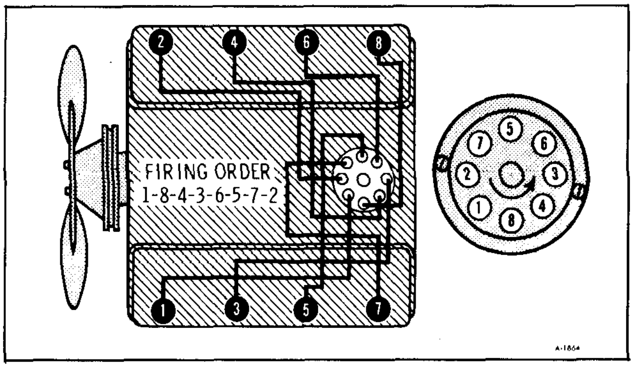


Figure 25–Secondary Wiring

SECONDARY IGNITION CABLES (FIGURE 25)

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.

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.

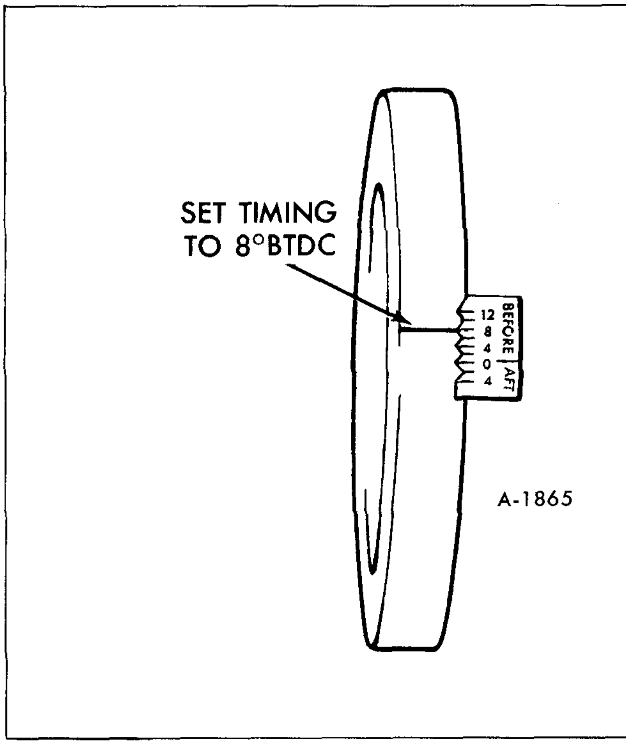


Figure 26–Engine Ignition Timing

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 26)

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 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 27)

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.

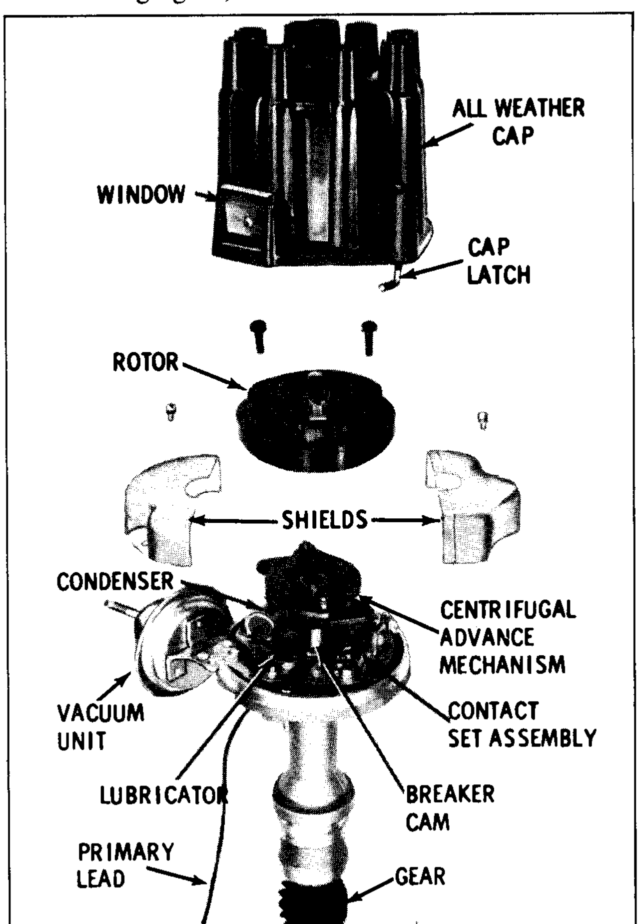


Figure 27–Distributor Components

CONTACT POINT REMOVAL

1. Remove distributor cap and rotor. (figure 28)

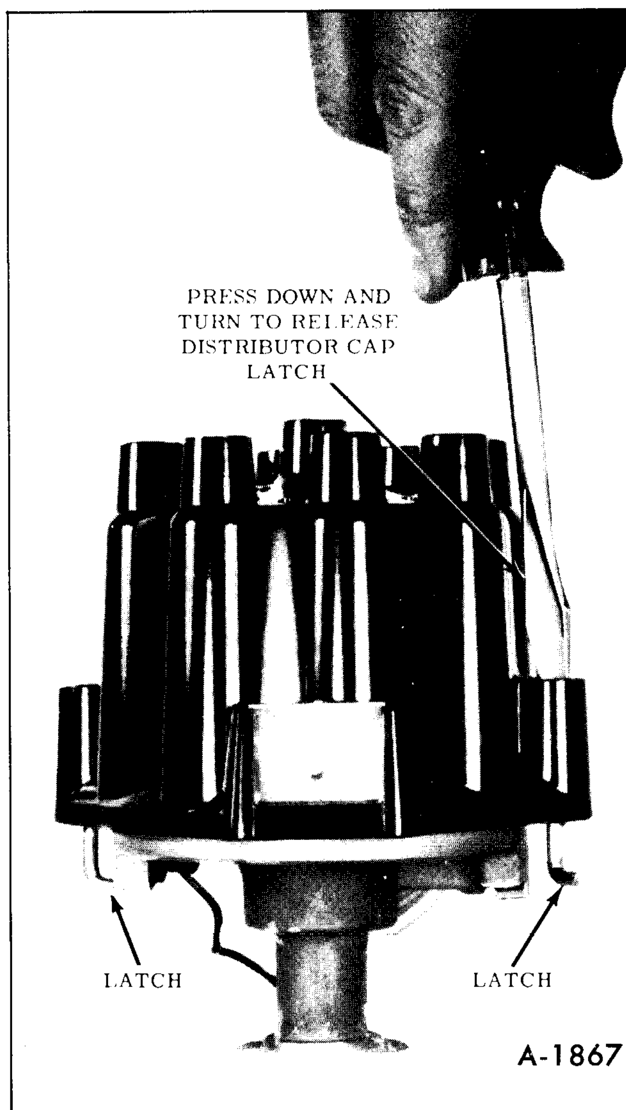


Figure 28–Removing Distributor Cap

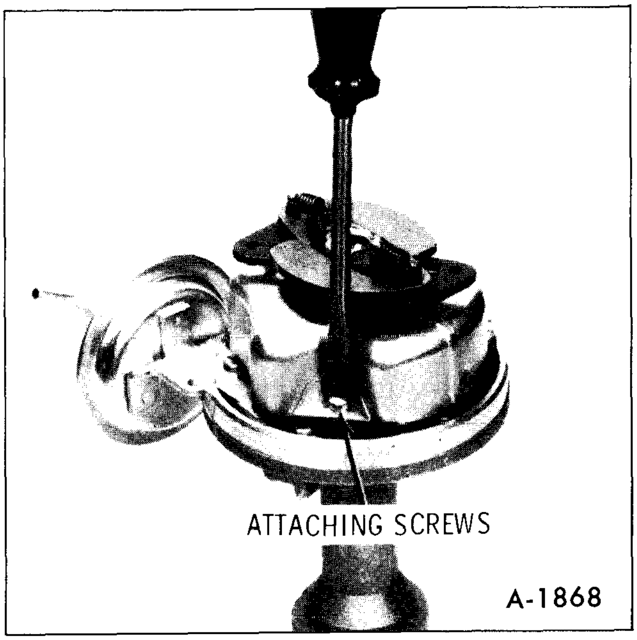


Figure 29–Removing Point Shield

2. Remove two piece metal shield attaching screws and shields. Figure 29.

3. Lift the two wiring terminals out of the snap-lock retainer, Figure 30, and remove the two screws and contact points.

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.

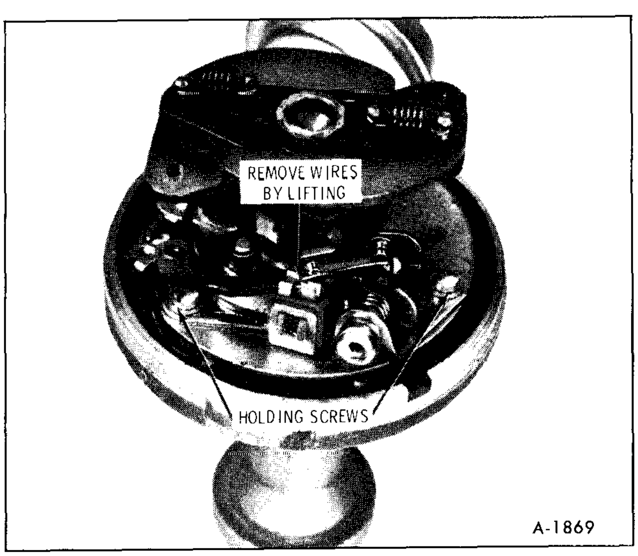


Figure 30–Removing Contact Points

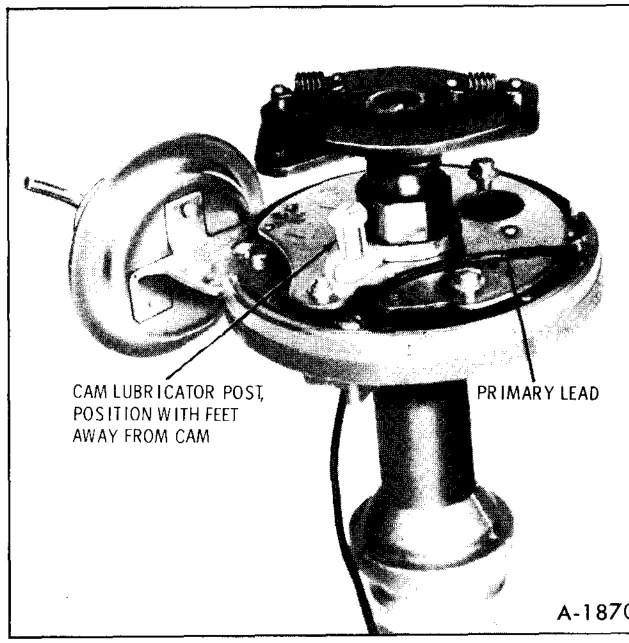


Figure 31–Cam Lubrication

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 31. Apply a

Figure 32–Installing Point Shield

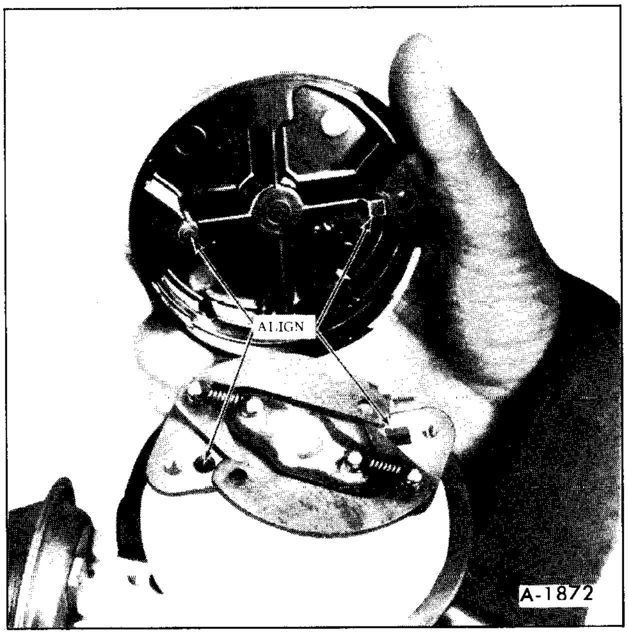


Figure 33–Installing Rotor

thin film of lubricant 1948792 or equivalent to cam, not the wick.

4. Place one-half of shield over contact points, Figure 32, 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.

6. Install rotor, Figure 33.

7. Install distributor cap.

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.

3. Raise window on side of distributor cap.

4. With the engine running at idle speed, insert 1/8" Allen wrench into the head of the adjusting screw as shown in Figure 34 and adjust dwell angle to 30 degrees.

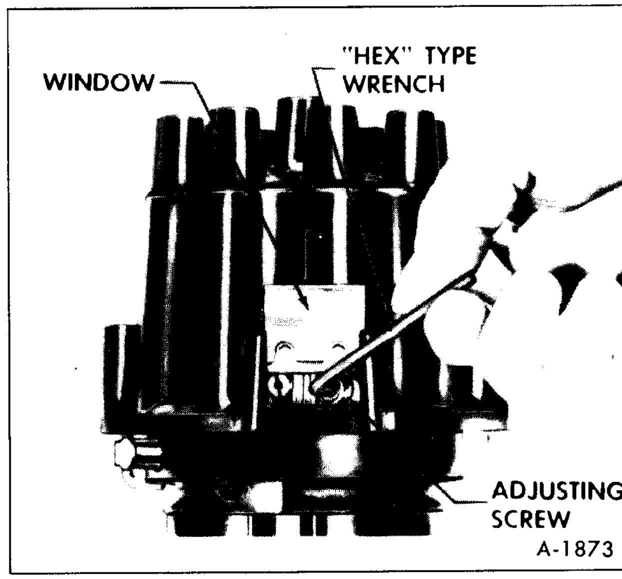


Figure 34–Adjusting Dwell Angle

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.

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 35)

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.

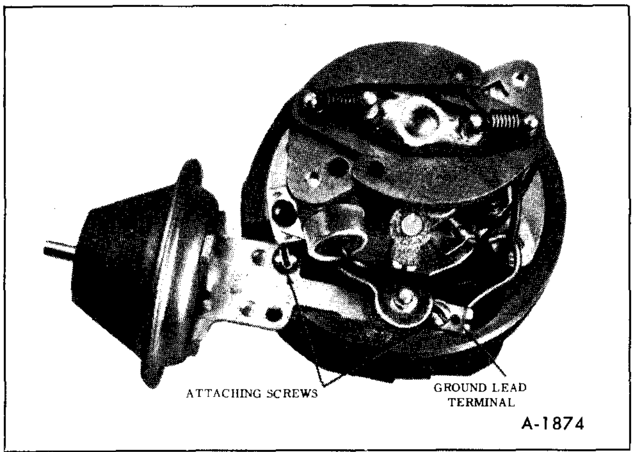


Figure 35–Vacuum Advance Unit

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 35) Install the shield and distributor cap.

DISTRIBUTOR REMOVAL

1. Disconnect the distributor wire from coil.

2. Remove distributor cap as shown in Figure 28.

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 25)

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.

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 36)

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 37)

5. Remove the two retaining screws and the vacuum advance unit.

CLEANING AND INSPECTION

1. Wash all parts in cleaning solvent except cap,

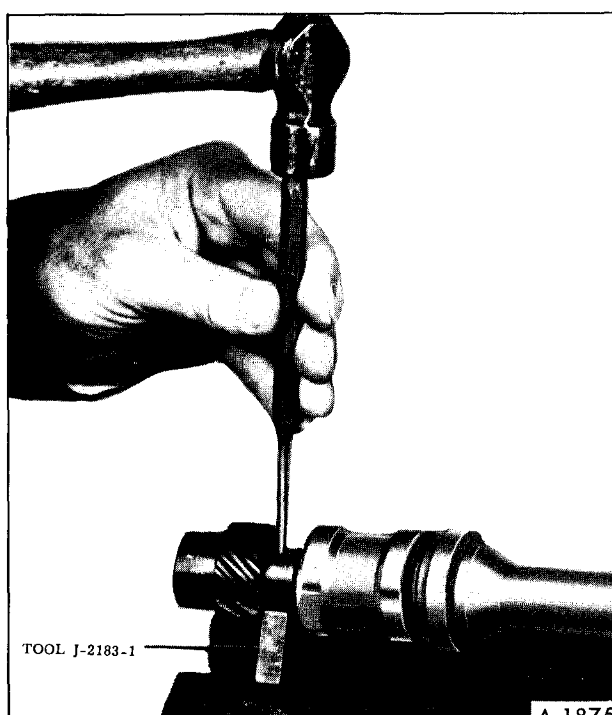


Figure 36–Removing Roll Pin

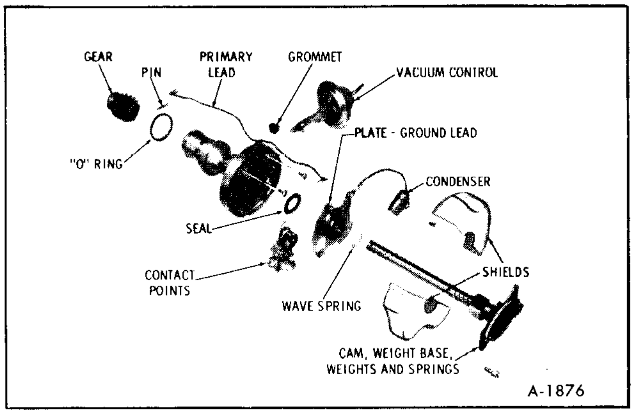


Figure 37–Distributor Disassembled

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 35)

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 33)

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 25).

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 38) Do not file center electrode on new plugs.

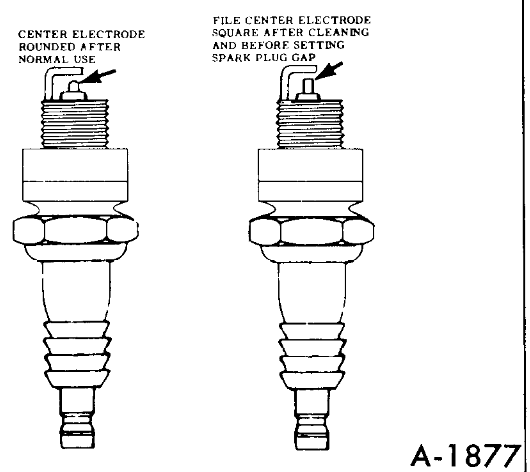


Figure 38–Spark Plug Electrodes

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 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.

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

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 39 is used on all Motor Homes.

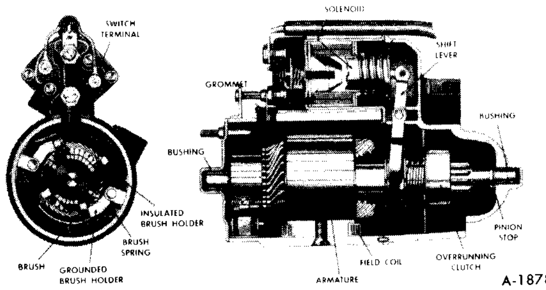


Figure 39–Starter Assembly

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.

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 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 the Motor Home.

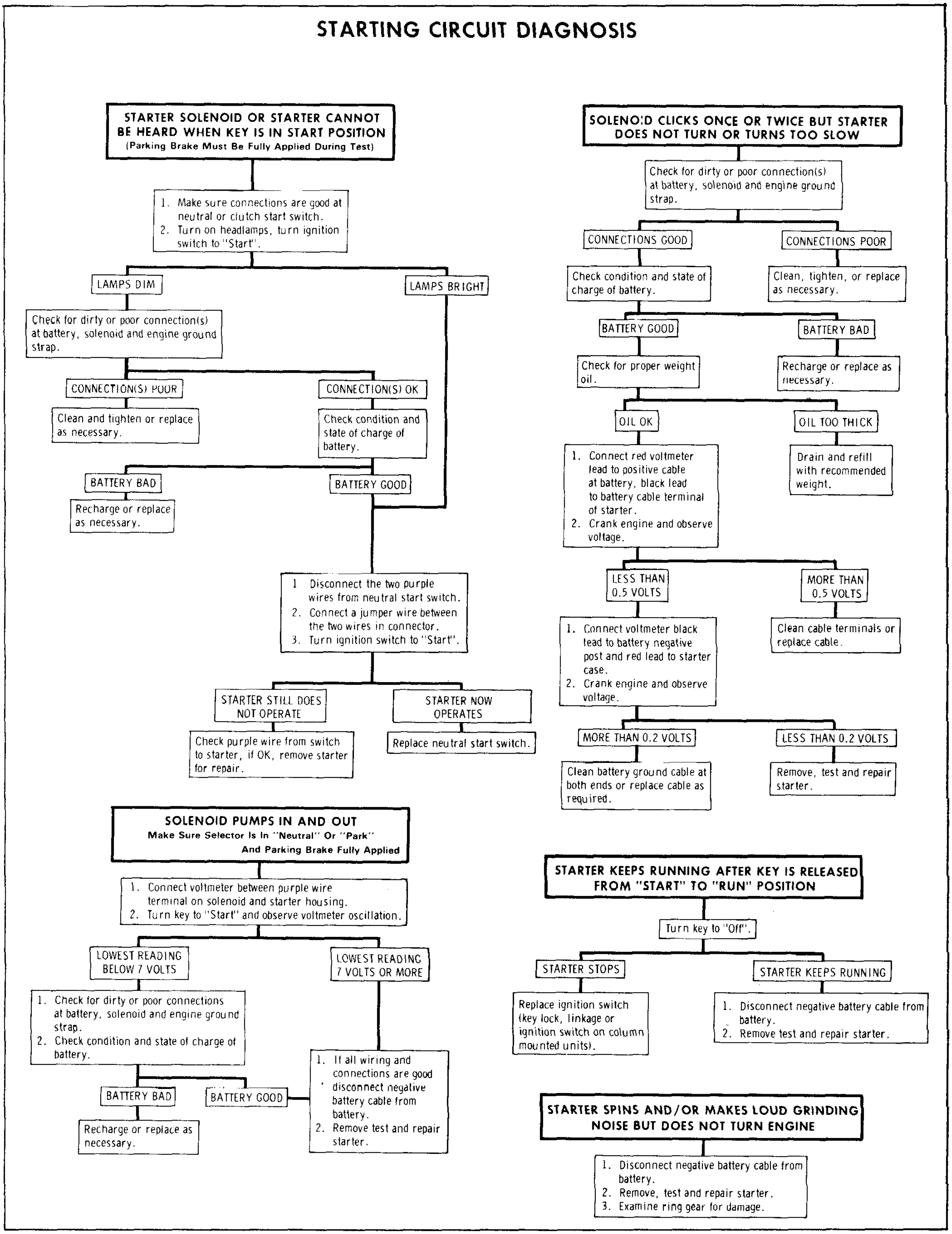
2. Remove two attaching bolts and move starter for easier access to wires.

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 en-



Starting Circuit Diagnosis

gine, 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 40)

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.

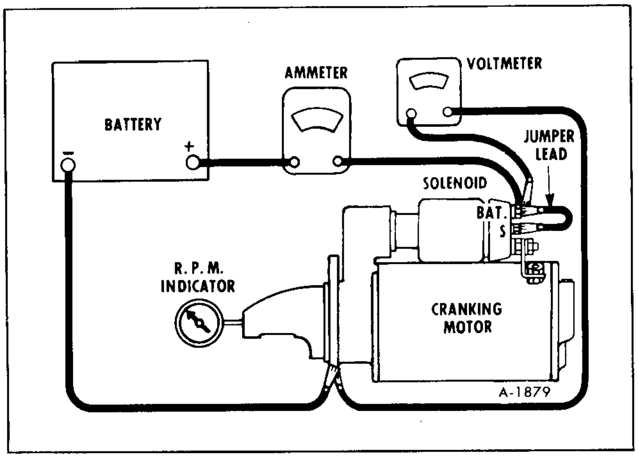


Figure 40–No-Load Test

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).

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 41)

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

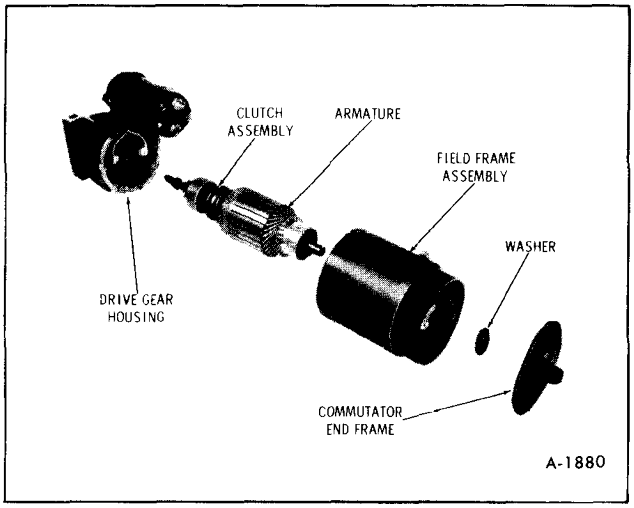


Figure 41–Starter Assembly Components

assembling the cranking motor. Following are general instructions for disassembling a typical overrunning clutch drive cranking motor:

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 42)

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 43) With armature shaft supported on wood block, tap end of driving tool until retainer clears snap ring.

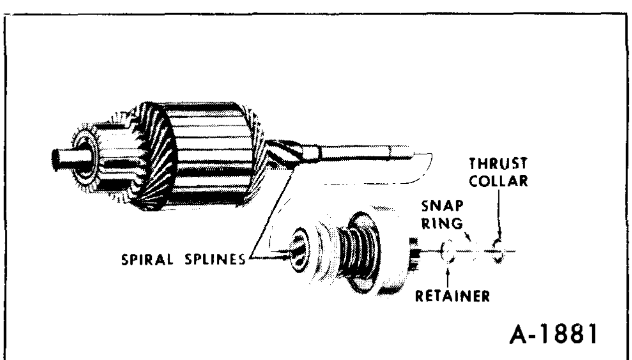


Figure 42–Starter Clutch

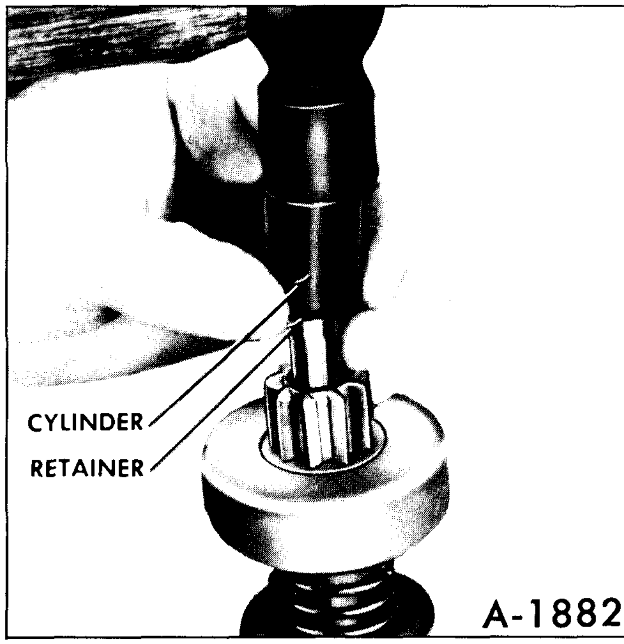


Figure 43–Removing Pinion Retainer

c. Remove snap ring from groove in shaft 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 44, 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.

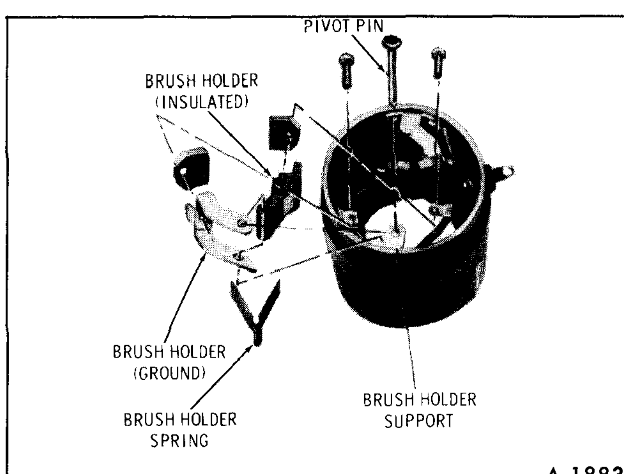


Figure44–Brush Installation

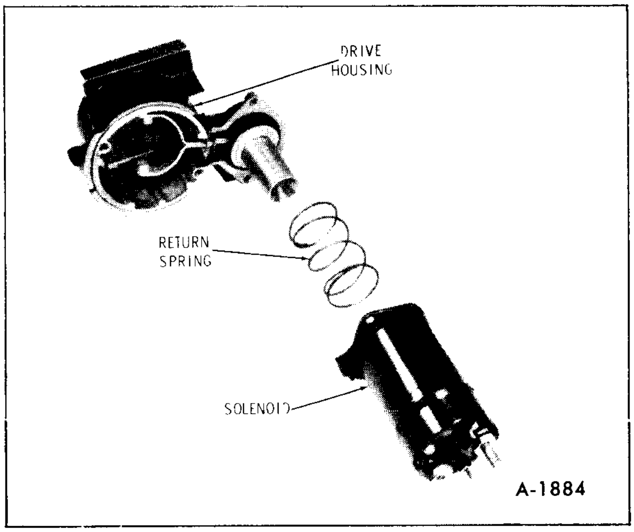


Figure 45–Solenoid Removal

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 45)

b. To remove shift lever and/or plunger, remove shift lever pivot bolt (figure 46).

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.

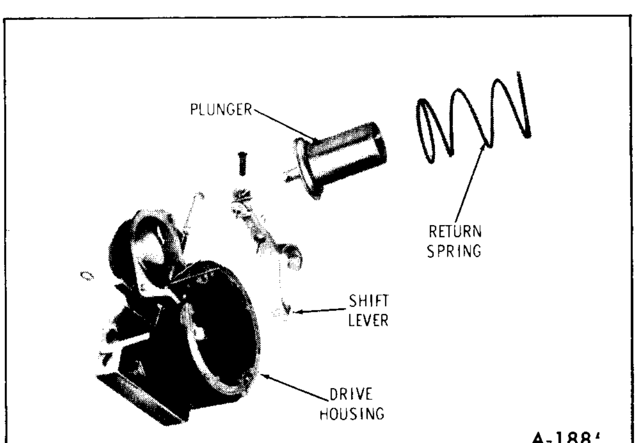


Figure 46–Shift Lever Removal

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 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.

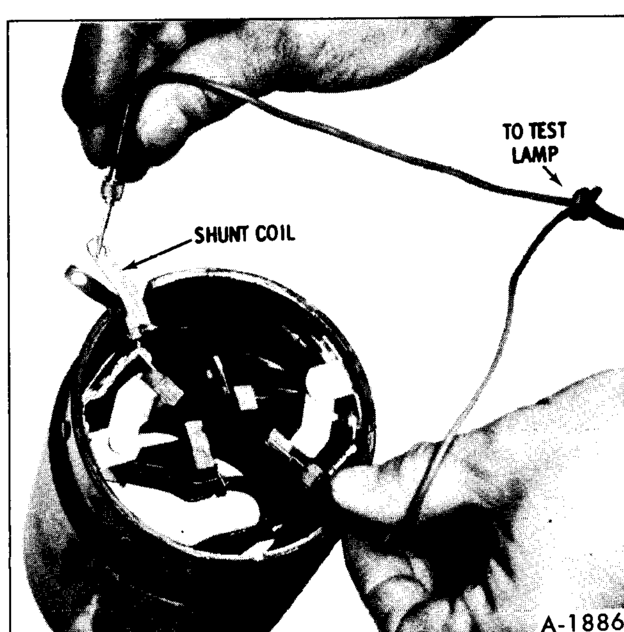


Figure 47–Checking Shunt Field Coil

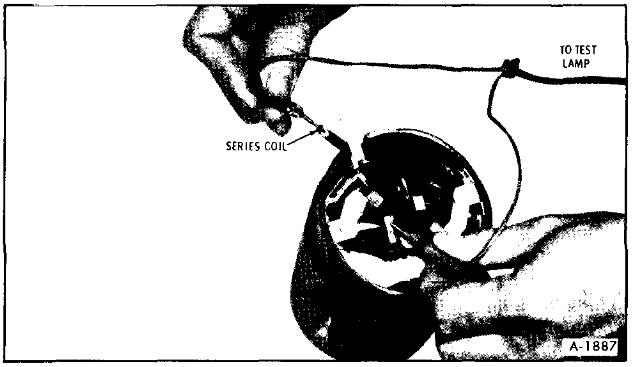


Figure 48–Checking Series Field Coil

b. Using a test lamp, place one lead on the shunt coil terminal and connect the other lead to a ground brush. (figure 47).

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 48) 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 insulated brush. (figure 49) 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 50).

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.

To check both windings, connect the ammeter, variable resistance and voltmeter as for previous test. Ground the solenoid motor terminal. Adjust the

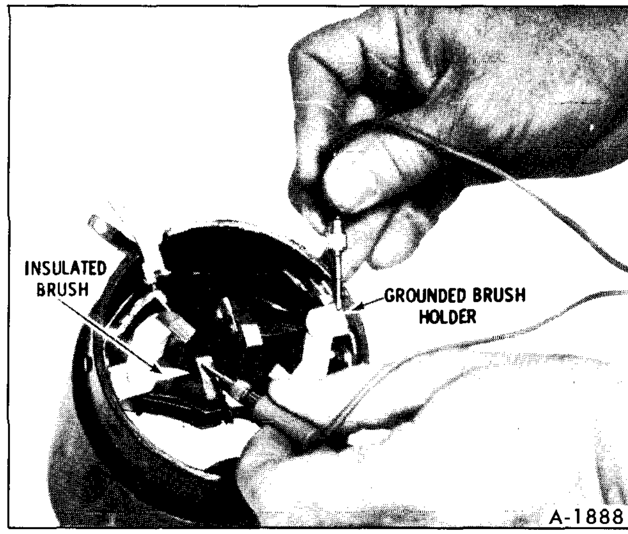


Figure 49–Checking Field Coil for Ground

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:

a. Assemble shift lever and plunger.

b. Position shift lever and plunger assembly in

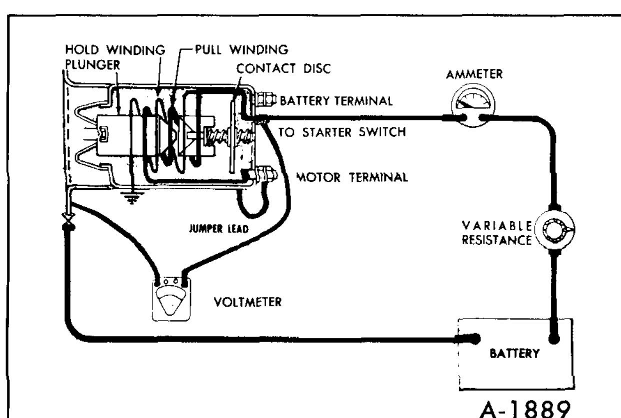


Figure 50–Checking Solenoid Wiring

drive gear housing and install lever pivot bolt. (figure 46)

c. Install solenoid assembly to drive gear housing. (figure 45)

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 42)

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 51)

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 drive gear housing and engage clutch with shift lever yoke.

5. Apply sealer, No. 1050026 or equivalent on solenoid flange as shown in (figurc 52).

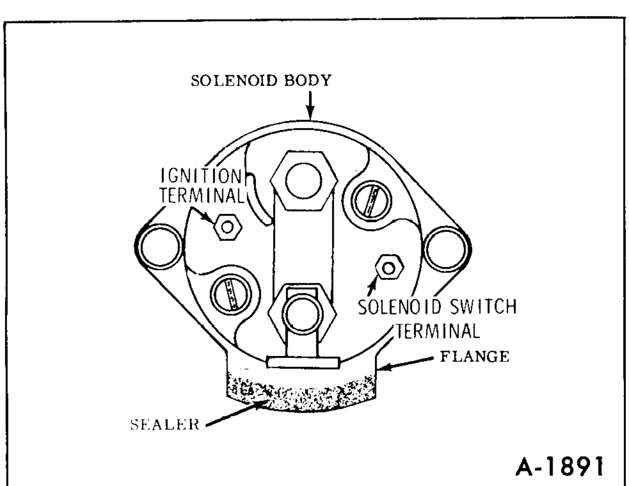


Figure 51–Installing Retainer and Snap Ring

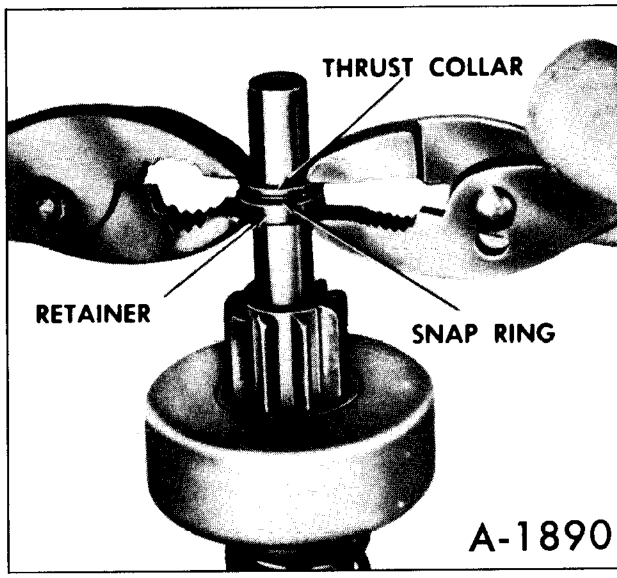


Figure 52–Solenoid Terminals and Sealing

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.

PRESS ON CLUTCH AS SHOWN TO TAKE UP MOVEMENT

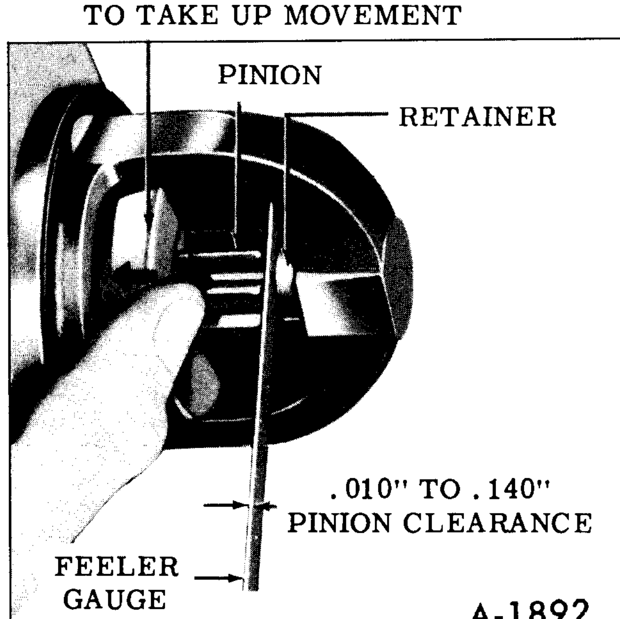


Figure 53–Checking Pinion Clearance

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 52).

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 53). 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.

STARTER SPECIFICATIONS

STARTER MODEL	1108522
Make	Delco-Remy
Series	10 MT
Type	100
Rotation (viewed at Drive End)	CW
No Load Test	
Volts	9
Minimum Amps*	65*
Maximum Amps*	95*
Minimum RPM	7,500
Maximum RPM	10,500
Pinion Clearance	.010″-.140″
*Includes Solenoid	
STARTER SOLENOID	
Model	114356
Rated Voltage	12
Current Consumption	
Pull-In Winding	
Amps.	13.0-15.5
Volts	5
Hold-In Winding	
Amps.	14.5-16.5
Volts	10

SPECIAL TOOLS

J-23600 Belt Tension Gauge