CHILTON'S
REPAIR & TUNE-UP GUIDE
CAMARO 1982 to 1985
All U.S. and Canadian models including Z-28 and IROC Z-28

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SAFETY NOTICE

Proper service and repair procedures are vital to the safe, reliable operation of all motor vehicles, as well as the personal safety of those performing repairs. This book outlines procedures for servicing and repairing vehicles using safe, effective methods. The procedures contain many NOTES, CAUTIONS and WARNINGS which should be followed along with standard safety procedures to eliminate the possibility of personal injury or improper service which could damage the vehicle or compromise its safety.

It is important to note that repair procedures and techniques, tools and parts for servicing motor vehicles, as well as the skill and experience of the individual performing the work vary widely. It is not possible to anticipate all of the conceivable ways or conditions under which vehicles may be serviced, or to provide cautions as to all of the possible hazards that may result. Standard and accepted safety precautions and equipment should be used when handling toxic or flammable fluids, and safety goggles or other protection should be used during cutting, grinding, chiseling, prying, or any other process that can cause material removal or projectiles.

Some procedures require the use of tools specially designed for a specific purpose. Before substituting another tool or procedure, you must be completely satisfied that neither your personal safety, nor the performance of the vehicle will be endangered.

Although information in this guide is based on industry sources and is as complete as possible at the time of publication, the possibility exists that the manufacturer made later changes which could not be included here. While striving for total accuracy, Chilton Book Company cannot assume responsibility for any errors, changes, or omissions that may occur in the compilation of this data.

PART NUMBERS

Part numbers listed in this reference are not recommendations by Chilton for any product by brand name. They are references that can be used with interchange manuals and aftermarket supplier catalogs to locate each brand supplier's discrete part number.

SPECIAL TOOLS

Special tools are recommended by the vehicle manufacturer to perform their specific job. Use has been kept to a minimum, but where absolutely necessary, they are referred to in the text by the part number of the tool manufacturer. These tools can be purchased, under the appropriate part number, from the Service Tool Division, Kent-Moore Corporation, 1501 South Jackson Street, Jackson, MI 49203, or an equivalent tool can be purchased locally from a tool supplier or parts outlet. Before substituting any tool for the one recommended, read the SAFETY NOTICE at the top of this page.

ACKNOWLEDGMENTS

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Information has been selected from Chevrolet shop manuals, owners manuals, service bulletins and technical training manuals.

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CONTENTS

Quick Reference Specifications For Your Vehicle

Fill in this chart with the most commonly used specifications for your vehicle. Specifications can be found in Chapters 1 through 3 or on the tune-up decal under the hood of the vehicle.

Tune-Up

Firing Order_____

Spark Plugs:

Type_____

Gap (in.)_____

Torque (ft. lbs.)_____

Idle Speed (rpm)_____

Ignition Timing (°)_____

Vacuum or Electronic Advance (Connected/Disconnected)_____

Valve Clearance (in.)

Intake_____ **Exhaust**_____

Capacities

Engine Oil Type (API Rating)_____

With Filter Change (qts)_____

Without Filter Change (qts)_____

Cooling System (qts)_____

Manual Transmission (pts)_____

Type_____

Automatic Transmission (pts)_____

Type_____

Front Differential (pts)_____

Type_____

Rear Differential (pts)_____

Type_____

Transfer Case (pts)_____

Type_____

FREQUENTLY REPLACED PARTS

Use these spaces to record the part numbers of frequently replaced parts.

PCV VALVE	OIL FILTER	AIR FILTER	FUEL FILTER
Type_____	Type_____	Type_____	Type_____
Part No._____	Part No._____	Part No._____	Part No._____

General Information and Maintenance

HOW TO USE THIS BOOK

Chilton's Repair and Tune-Up Guide is intended to teach you more about the inner workings of your automobile and save you money on its upkeep. Chapters One and Two will probably be the most frequently used in the book. The first chapter contains all the information that may be required at a moment's notice. Aside from giving the location of various serial numbers and the proper towing instructions, it also contains all the information on basic day-to-day maintenance that you will need to ensure good performance and long component life. Chapter Two contains the necessary tune-up procedures to assist you not only in keeping the engine running properly and at peak performance levels, but also in restoring some of the more delicate components to operating condition in the event of a failure.

The remaining chapters cover repairs (rather than maintenance) for various portions of your car, with each chapter covering either one separate system or two related systems. The appendix then lists general information which may be useful in rebuilding the engine or performing some other operation on any car.

When using the Table of Contents, refer to the bold listings for the subject of the chapter and the smaller listings (or the index) for information on a particular component.

In general, there are three things a proficient mechanic has which must be allowed for when a non-professional does work on his/her car. These are:

1. A sound knowledge of the construction of the parts he is working with; their order of assembly, etc.
2. A knowledge of potentially hazardous situations; particularly how to prevent them.
3. Manual dexterity.

This book provides step-by-step instructions and illustrations whenever possible. Use them carefully and wisely—don't just jump headlong into disassembly. When there is doubt about being able to readily reassemble something, make a careful drawing of the component before taking it apart. Assembly always looks simple when everything is still assembled.

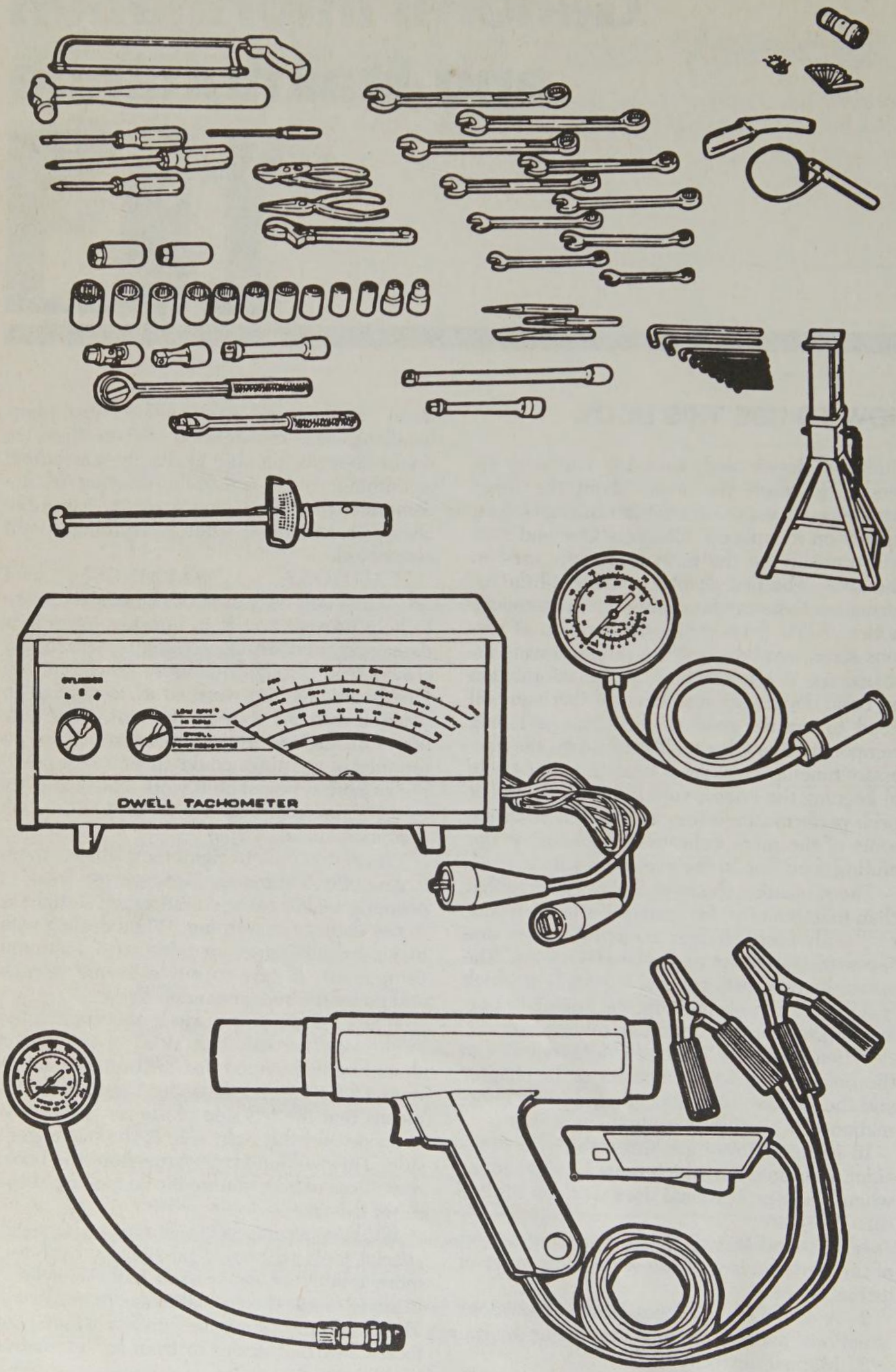
"CAUTIONS," "WARNINGS" and "NOTES" will be provided where appropriate to help prevent you from injuring yourself or damaging your car. Consequently, you should always read through the entire procedure before beginning the work so as to familiarize yourself with any special problems which may occur during the given procedure. Since no number of warnings could cover every possible situation, you should work slowly and try to envision what is going to happen in each operation ahead of time.

When it comes to tightening things, there is generally a slim area between too loose to properly seal or resist vibration and so tight as to risk damage or warping. When dealing with major engine parts, or with any aluminum component, it pays to buy a torque wrench and go by the recommended figures.

When reference is made in this book to the "right side" or the "left side" of the car, it should be understood that the positions are always to be viewed from the front seat. This means that the left side of the car is the driver's side and the right side is the passenger's side. This will hold true throughout the book, regardless of how you might be looking at the car at the time.

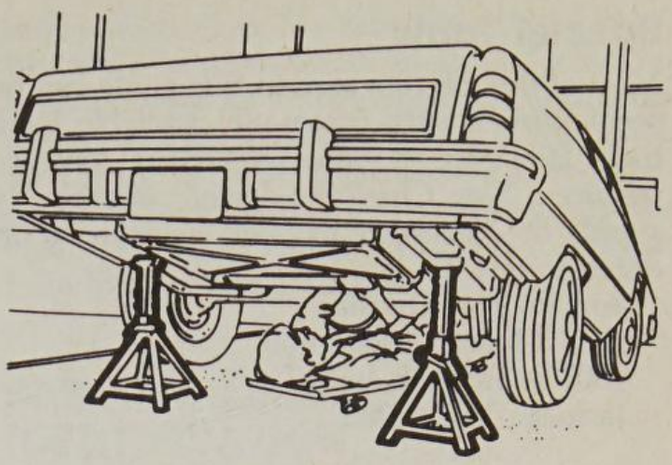
We have attempted to eliminate the use of special tools whenever possible, substituting more readily available hand tools. However, in some cases, the special tools are necessary. These tools can usually be purchased from your local Chevrolet dealer or from an automotive parts store.

Always be conscious of the need for safety



You need only a basic assortment of hand tools for most maintenance and repair jobs

in your work. Never get under a car unless it is firmly supported by jack stands or ramps. Never smoke near, or allow flame to get near the battery or the fuel system. Keep your clothing, hands and hair clear of the fan and pulleys when working near the engine if it is running. Most importantly, try to be patient, even in the midst of an argument with a stubborn bolt; reaching for the largest hammer in the garage is usually a cause for later regret and more extensive repair. As you gain confidence and experience, working on your car will become a source of pride and satisfaction.



Always support the car securely with jackstands; never use cinder blocks or tire changing jacks.

TOOLS AND EQUIPMENT

It would be impossible to catalog each and every tool that you may need to perform all the operations included in this book. It would also not be wise for the amateur to rush out and buy an expensive set of tools on the theory that he may need one of them at some time. The best approach is to proceed slowly, gathering together a good quality set of those tools that are used most frequently. Don't be misled by the low cost of bargain tools. It is far better to spend a little more for quality, name brand tools. Forged wrenches, 6 or 12 point sockets and fine-tooth ratchets are by far preferable to their less expensive counterparts. As any good mechanic can tell you, there are few worse experiences than trying to work on a car or truck with bad tools. Your monetary savings will be far outweighed by frustration and mangled knuckles.

Begin accumulating those tools that are used most frequently; those associated with routine maintenance and tune-up. In addition to the normal assortment of screwdrivers and pliers, you should have the following tools for routine maintenance jobs:

1. SAE and Metric wrenches, sockets and combination open end/box end wrenches.
2. Jackstands—for support;
3. Oil filter wrench;
4. Oil filler spout or funnel;
5. Grease gun—for chassis lubrication;
6. Hydrometer—for checking the battery;
7. A low flat pan for draining oil;
8. Lots of rags for wiping up the inevitable mess.

In addition to these items there are several others which are not absolutely necessary, but handy to have around. These include a transmission funnel and filler tube, a drop light on a long cord, and adjustable wrench and a pair of slip joint pliers.

A more advanced set of tools, suitable for tune-up work, can be drawn up easily. While the tools are slightly more sophisticated, they need not be outrageously expensive. The key to these purchases is to make them with an eye toward adaptability and wide range. A basic list of tune-up tools could include:

1. Tachometer/dwell meter;
2. Spark plug gauge and gapping tool;
3. Feeler gauges for valve adjustment;
4. Timing light.

A tachometer/dwell meter will ensure accurate tune-up work on cars without electronic ignition. The choice of a timing light should be made carefully. A light which works on the DC current supplied by the car battery is the best choice; it should have a xenon tube for brightness. Since some later models have an electronic ignition system, the timing light should have an inductive pickup which clamps around the No. 1 spark plug cable (the timing light illustrated has one of these pickups).

In addition to these basic tools, there are several other tools and gauges which, though not particularly necessary for basic tune-up work, you may find to be quite useful. These include:

1. A compression gauge. The screw-in type is slower to use but eliminates the possibility of a faulty reading due to escaping pressure;
2. A manifold vacuum gauge;
3. A test light;
4. A combination volt/ohmmeter;
5. An induction meter, used to determine whether or not there is current flowing through a wire. An extremely helpful tool for electrical troubleshooting.

Finally, you will find a torque wrench necessary for all but the most basic of work. The beam-type models are perfectly adequate. The newer click-type (breakaway) torque wrenches are more accurate, but are also much more expensive and must be periodically recalibrated.

Special Tools

Most of the jobs covered in this guide can be accomplished with commonly available hand tools. However, in some cases special tools are required. Your Chevrolet dealer can probably supply the necessary tools or they can be ordered from:

Service Tool Division
Kent-Moore Corporation
1501 South Jackson St.
Jackson, MI. 49203

HISTORY

In 1967, Chevrolet entered the "pony car" market with an all-new car, the Camaro. Available in two body styles, a convertible and a two-door sports coupe, the Camaro could be ordered with one of five engines. Choices ranged from the economical 230 cubic inch (cu in.) 6-cylinder to the new 350 cu. in., 295 horsepower (hp) V8. The 350 engine was new in 1967. The 350 is actually a 327 that has been enlarged by increasing the stroke from 3.25 in. to 3.48 in. Installed in the SS 350 (a sporty, performance model), the engine produced a respectable 0–60 miles per hour (mph) time of 7.8 seconds. Later in that model year Chevrolet released a limited number of high-performance Camaros. The Z28, as it was called, came equipped with one standard engine, the 302 cu in. V8 rated very conservatively at 290 hp. Dual exhausts, four-barrel carburetor, four-speed transmission, solid valve lifters and high-compression pistons and heads were just a few of the standard equipment heavy duty components. The 1967 Z28, easily recognized by its contrasting color racing stripes and throaty roar, has become a highly desirable car among Camaro enthusiasts. The 1968 Camaro changed little in appearance while the 302 Z28 increased in popularity and production. The 1969 model showed minor styling changes and offered as standard V8 engines the 307 and the 350. Due to a complete restyling, the 1970 Camaro didn't appear in the showrooms until February of that year. The convertible was killed by lagging public demand and high insurance rates.

As the muscle car field diminished, it was felt that the Camaro would either have to change radically or vanish altogether from the field. It did neither; instead gradually losing the fire-breathing, street racer image and V8s larger than 350 cu in. to become a sporty grand touring car. While the engines gradually lessened in size and performance, the rest of the Camaro has been upgraded to form a responsive handling car.

The 82 and later Camaro is a completely redesigned body style. It has shed a few hundred excess pounds thereby becoming more fuel efficient than previous models. This new body style has greatly enhanced Camaro's appeal to buyers of all ages.

SERVICING YOUR CAR SAFELY

It is virtually impossible to anticipate all of the hazards involved with automotive maintenance and service, but care and common sense will prevent most accidents.

The rules of safety for mechanics range from "don't smoke around gasoline," to "use the proper tool for the job." The trick to avoid injuries is to develop safe work habits and take every possible precaution.

Dos

- Do keep a fire extinguisher and first aid kit within easy reach.
- Do wear safety glasses or goggles when cutting, drilling, grinding or prying, even if you have 20-20 vision. If you wear glasses for the sake of vision, they should be made of hardened glass that can serve also as safety glasses, or wear safety goggles over your regular glasses.
- Do shield your eyes whenever you work around the battery. Batteries contain sulphuric acid. In case of contact with the eyes or skin, flush the area with water or a mixture of water and baking soda and get medical attention immediately.
- Do use safety stands for any undercar service. Jacks are for raising vehicles; safety stands are for making sure the vehicle stays raised until you want to come down. Whenever the car is raised, block the wheels remaining on the ground and set the parking brake.
- Do use adequate ventilation when working with any chemicals or hazardous materials. Like carbon monoxide, the asbestos dust resulting from brake lining wear can be poisonous in sufficient quantities.
- Do disconnect the negative battery cable when working on the electrical system. The secondary ignition system can contain up to 40,000 volts.
- Do follow manufacturer's directions whenever working with potentially hazardous materials. Both brake fluid and antifreeze are poisonous if taken internally.
- Do properly maintain your tools. Loose hammerheads, mushroomed punches and chisels, frayed or poorly grounded electrical cords, excessively worn screwdrivers, spread

wrenches (open end), cracked sockets, slipping ratchets, or faulty droplight sockets can cause accidents.

- Do use the proper size and type of tool for the job being done.
- Do when possible, pull on a wrench handle rather than push on it, and adjust your stance to prevent a fall.
- Do be sure that adjustable wrenches are tightly closed on the nut or bolt and pulled so that the face is on the side of the fixed jaw.
- Do select a wrench or socket that fits the nut or bolt. The wrench or socket should sit straight, not cocked.
- Do strike squarely with a hammer; avoid glancing blows.
- Do set the parking brake and block the drive wheels if the work requires the engine running.

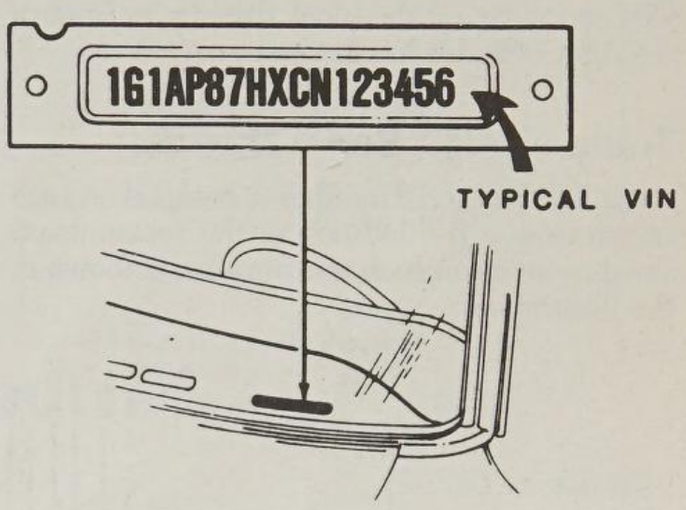
Don'ts

- Don't run an engine in a garage or anywhere else without proper ventilation—EVER! Carbon monoxide is poisonous; it takes a long time to leave the human body and you can build up a deadly supply of it in your system by simply breathing in a little every day. You may not realize you are slowly poisoning yourself. Always use power vents, windows, fans or open the garage doors.
- Don't work around moving parts while wearing a necktie or other loose clothing. Short sleeves are much safer than long, loose sleeves; hard-toed shoes with neoprene soles protect your toes and give a better grip on slippery surfaces. Jewelry such as watches, fancy belt buckles, beads or body adornment of any kind is not safe working around a car. Long hair should be hidden under a hat or cap.
- Don't use pockets for toolboxes. A fall or bump can drive a screwdriver deep into your body. Even a wiping cloth hanging from the back pocket can wrap around a spinning shaft or fan.
- Don't smoke when working around gasoline, cleaning solvent or other flammable material.
- Don't smoke when working around the battery. When the battery is being charged, it gives off explosive hydrogen gas.
- Don't use gasoline to wash your hands; there are excellent soaps available. Gasoline may contain lead, and lead can enter the body through a cut, accumulating in the body until you are very ill. Gasoline also removes all the natural oils from the skin so that bone dry hands will suck up oil and grease.
- Don't service the air conditioning system unless you are equipped with the necessary tools and training. The refrigerant, R-12, is extremely cold when compressed, and when released into the air will instantly freeze any surface it contacts, including your eyes. Although the refrigerant is normally non-toxic, R-12 becomes a deadly poisonous gas in the presence of an open flame. One good whiff of the vapors from burning refrigerant can be fatal.

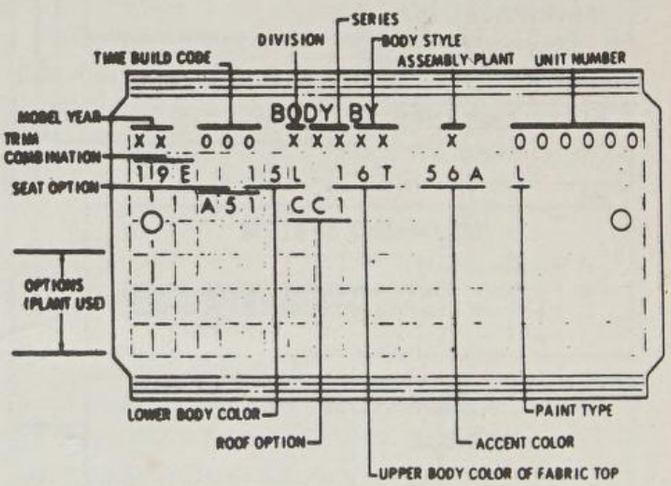
SERIAL NUMBER IDENTIFICATION

Vehicle Serial Number

The vehicle identification number (VIN) is stamped on a plate located on the top left-hand side (driver's side) of the instrument panel so that it can be seen by looking through the windshield.



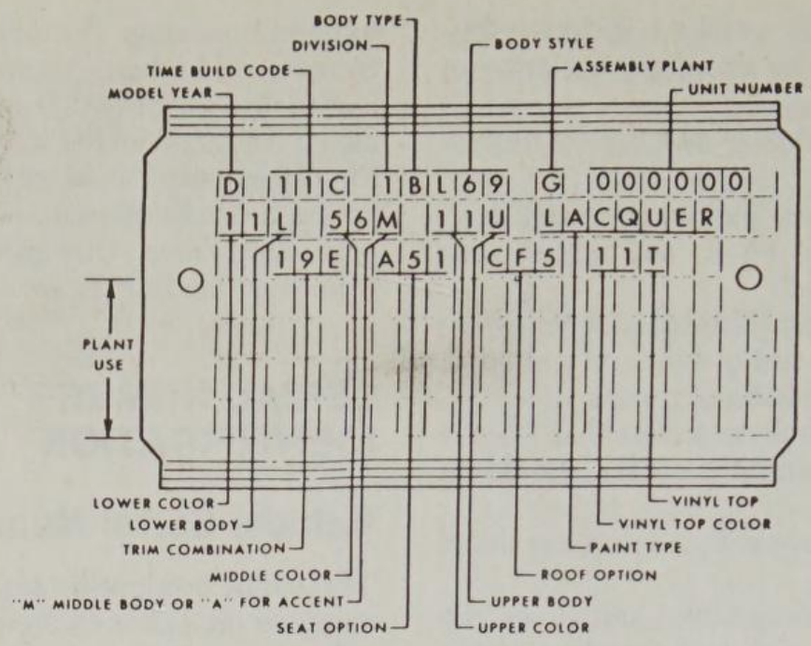
Vehicle Identification Number Location



Body Identification Plate—1982

Engine

The four cylinder engine VIN code is stamped on a pad at the right front of the cylinder block below the cylinder head. The V6 VIN code is stamped on a pad at the left front of the cylin-



Body Identification Plate—1983 and later

der block below the cylinder head. V8 engine VIN codes are on the block directly in front of the right cylinder head.

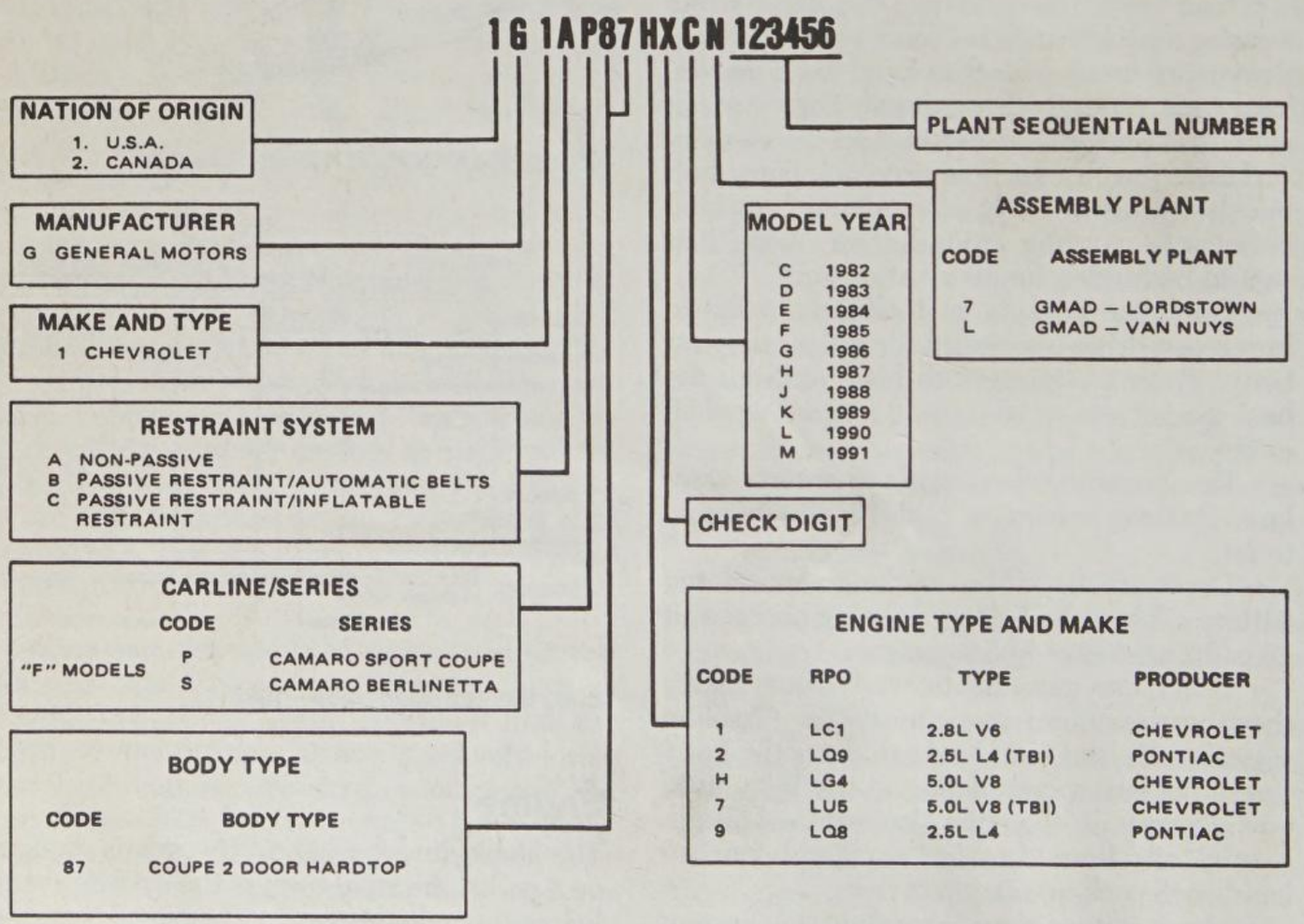
Transmission Serial Number

A transmission serial number is stamped on each transmission. The location of the transmission serial number on each transmission is shown in the illustration.

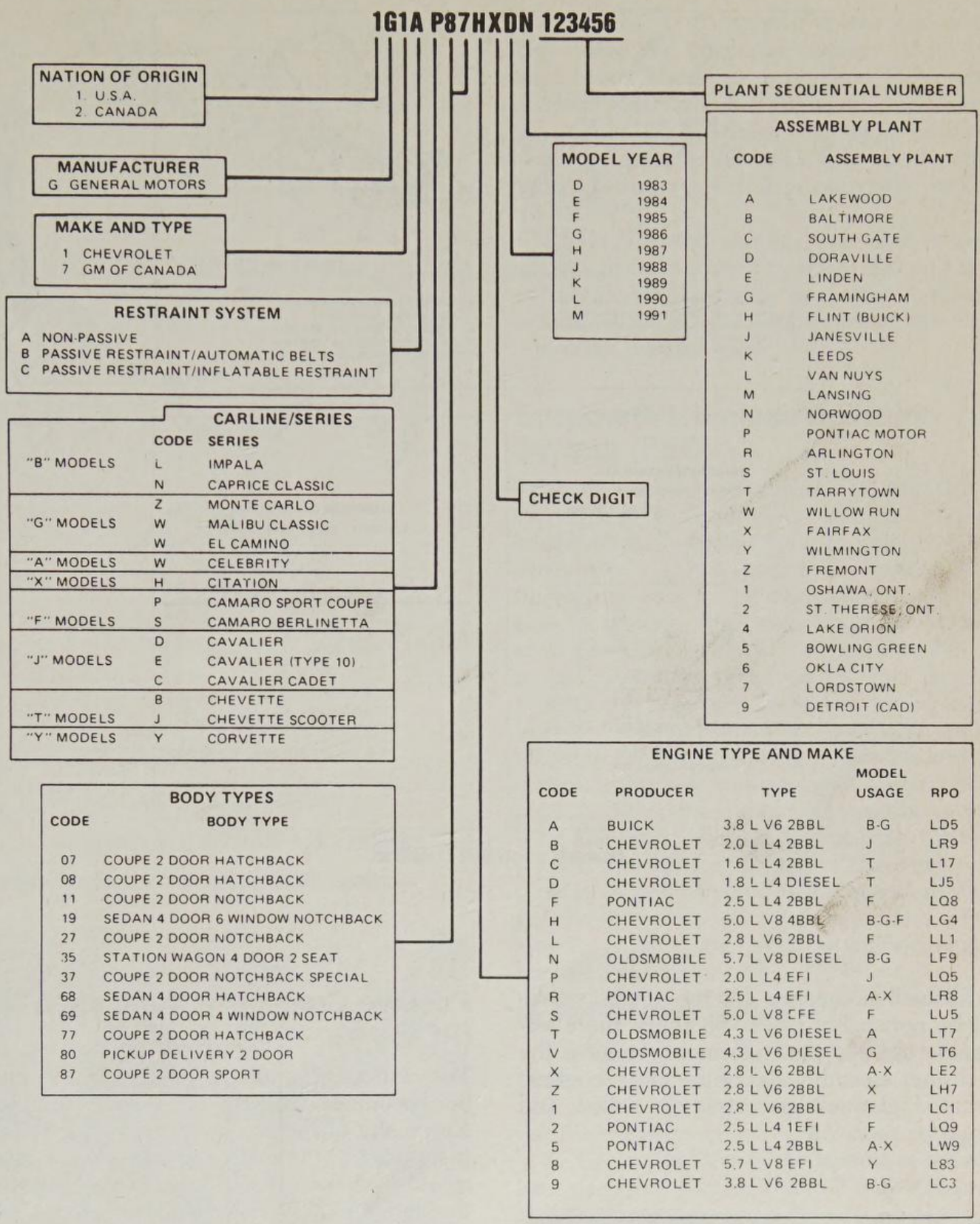
ROUTINE MAINTENANCE

Air Cleaner

The air cleaner has a dual purpose. It not only filters the air going to the carburetor, but also acts as a flame arrester if the engine should backfire through the carburetor. If an engine maintenance procedure requires the temporary removal of the air cleaner, remove it; oth-

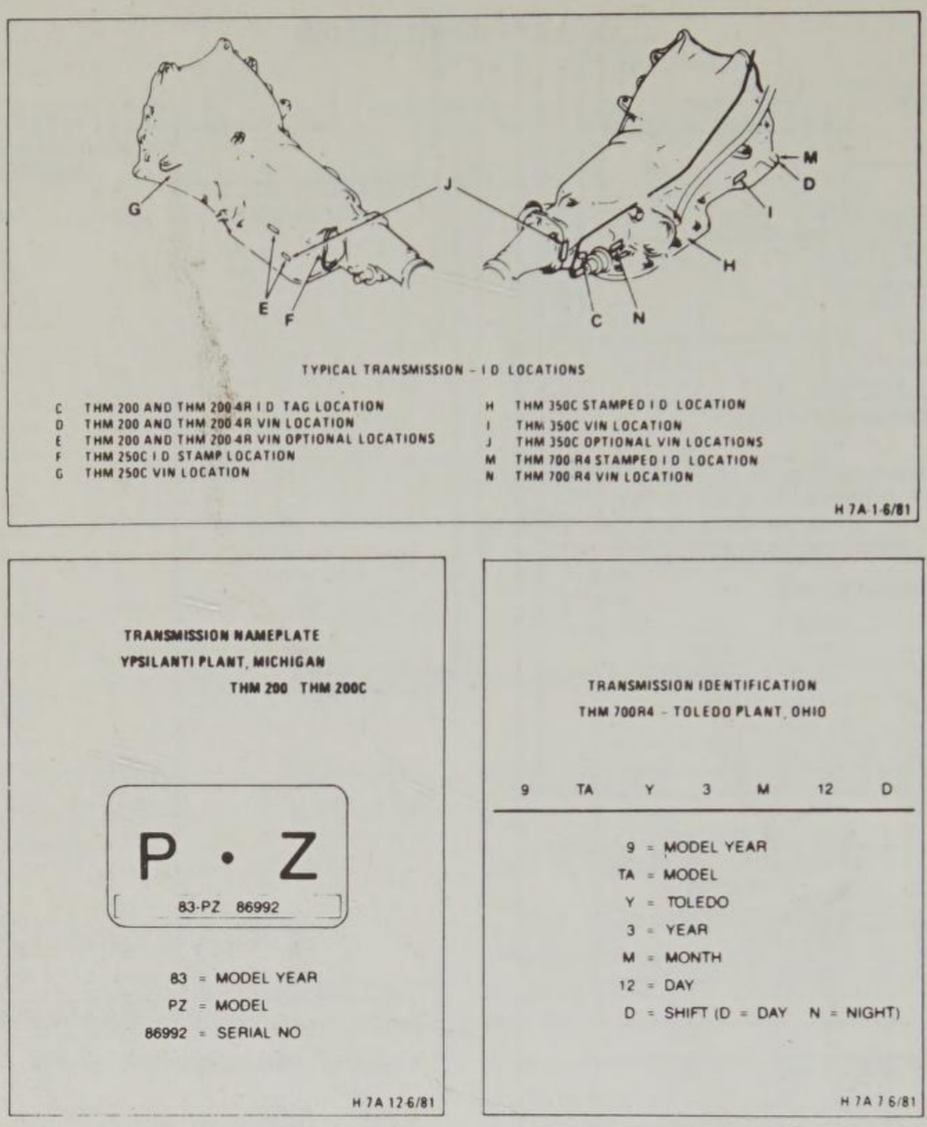


Vehicle Identification Number Codes—1982



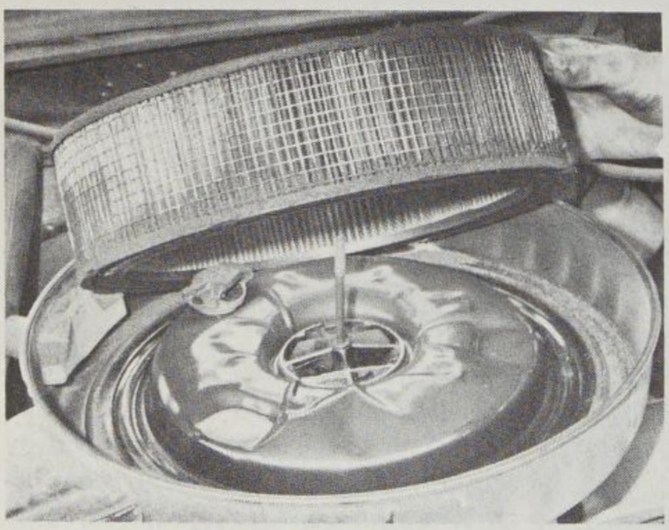
Vehicle Identification Number Codes—1983 and later

erwise, never run the engine without it. Operating a car without its air cleaner results in some throaty sounds from the carburetor giving the impression of increased power but will only cause trouble. Unfiltered air to the carburetor will eventually result in a dirty, inefficient carburetor and engine. A dirty carburetor increases the chances of carburetor backfire and, without the protection of an air cleaner, fire becomes a probable danger. The air cleaner assembly consists of the air cleaner itself, which is the large metal container that fits over the carburetor, the paper element, and the crankcase breather element. The air cleaner element should be replaced at 30,000 mile intervals. Inspections and replacements should be more frequent if the car is operated in a dirty, dusty environment. When inspecting the element, look for dust leaks, holes or an overly dirty appearance. If the element is excessively dirty, it may cause a reduction in clean air intake. If air has trouble getting through a dirty element, the carburetor fuel mixture will become richer (more gas, less air),



Transmission VIN Location

the idle will be rougher, and the exhaust smoke will be noticeably black. To check the effectiveness of your paper element, remove the air cleaner assembly and, if the idle increases, then the element is restricting airflow and should be replaced.

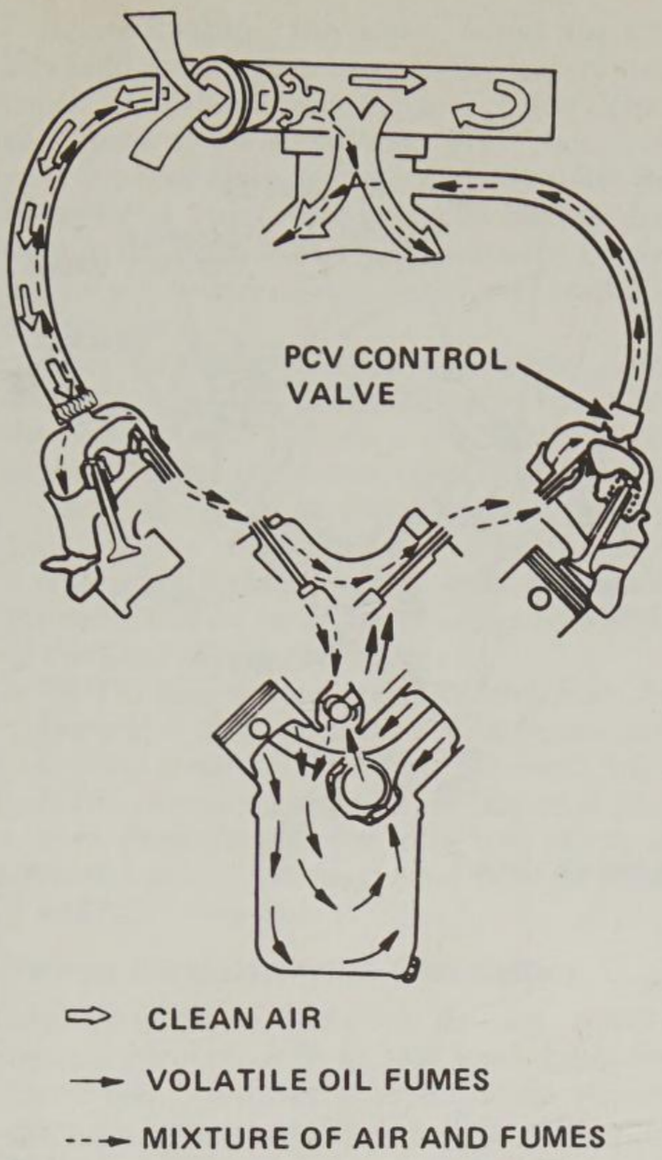


Remove and discard the old filter

Positive Crankcase Ventilation (PCV)

The crankcase ventilation system (PCV) must be operating correctly to provide complete scavenging of the crankcase vapors. Fresh air is supplied to the crankcase from the air filter, mixed with the internal exhaust gases, passed through the PCV valve and into the intake manifold.

Check the small crankcase breather



Positive Crankcase Ventilation (PCV) System

Puling out the PCV valve from the rocker cover

The PCV valve meters the flow at a rate depending upon the manifold vacuum. If the manifold vacuum is high, the PCV restricts the flow to the intake manifold. If abnormal, operating conditions occur, excessive amounts of internal exhaust gases back flow through the crankcase vent tube into the air filter to be burned by normal combustion.

If the engine is idling roughly, a quick check of the PCV valve can be made. While the engine is idling, pull the PCV valve from the valve cover, place your thumb over the end of the PCV valve and check for vacuum. If no vacuum exists, check for a plugged PCV valve, manifold port, hoses or deteriorated hoses. Turn the engine "OFF", remove the PCV valve and shake it. Listen for the rattle of the check needle inside the valve.. If it does not rattle, replace the valve.

The PCV system should be checked at every oil change and serviced every 30,000 miles.

NOTE: *Never operate an engine without a PCV valve or a ventilation system, for it can become damaged.*

Evaporative Emission Control System (EEC)

To limit gasoline vapor discharge into the air this system is designed to trap fuel vapors, which normally escape from the fuel tank and carburetor. Vapor arrest is accomplished through the use of the charcoal canister. This canister absorbs fuel vapors and stores them until they can be removed to be burned in the engine. Removal of the vapors from the canister to the engine is accomplished by a carburetor, solenoid operated bowl vent. In addition to the carburetor modifications and the canister, the fuel tank requires a non-vented gas cap. The domed fuel tank positions a vent high enough above the fuel to keep the vent pipe in the vapor at all times. The single vent pipe is routed directly to the canister. From the canister, the vapors are routed to the PCV system, where they will be burned during normal combustion.

FILTER REPLACEMENT

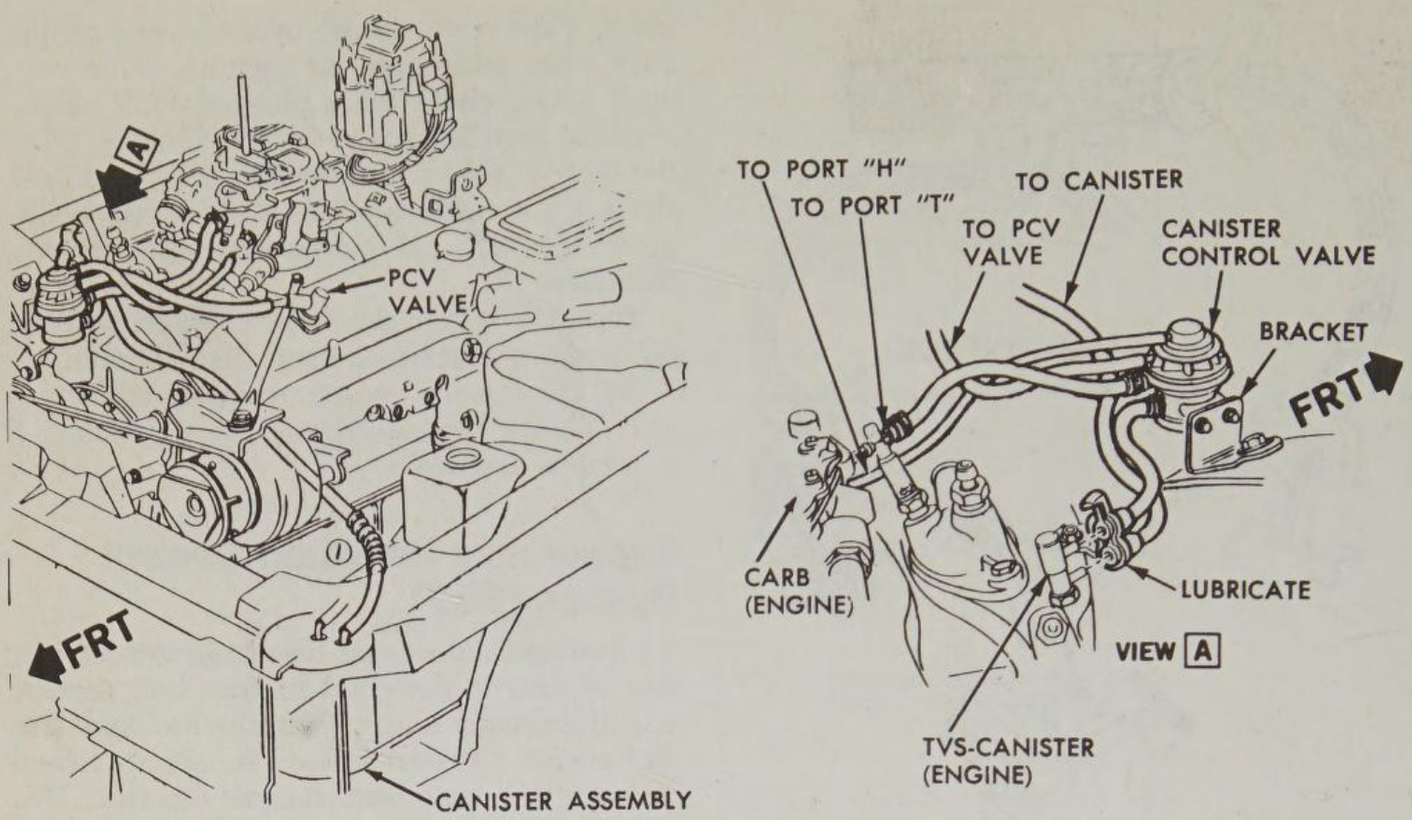
1. Tag and disconnect all hoses connected to the charcoal canister.
2. Loosen the retaining clamps and then lift out the canister.
3. Grasp the filter in the bottom of the canister with your fingers and pull it out. Replace it with a new one.
4. Installation of the remaining components is in the reverse order of removal.

NOTE: *Some models do not have replaceable filters.*

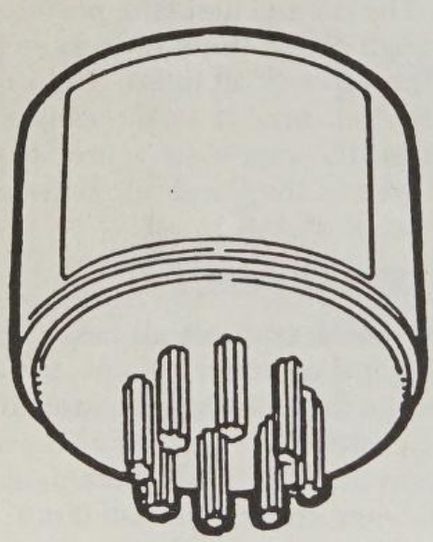
Battery

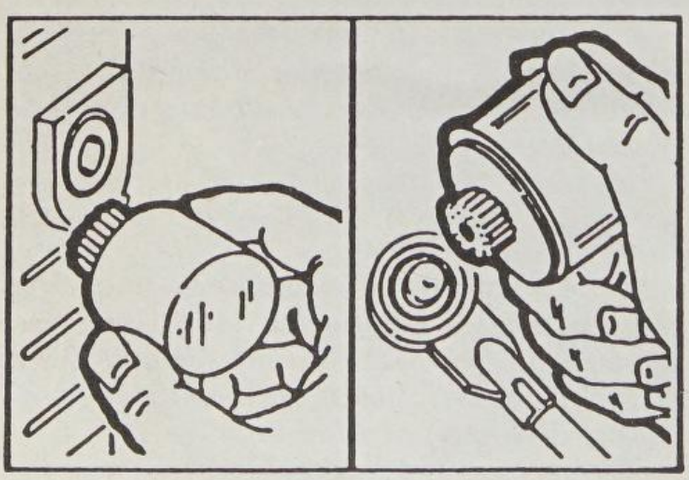
All G.M. cars have a "maintenance free" battery as standard equipment, eliminating the need for fluid level checks and the possibility of specific gravity tests. Never-the-less, the battery does require some attention.

Once a year, the battery terminals and the cable clamps should be cleaned. Remove the side terminal bolts and the cables, negative



EEC System; V8 engine (others similar)

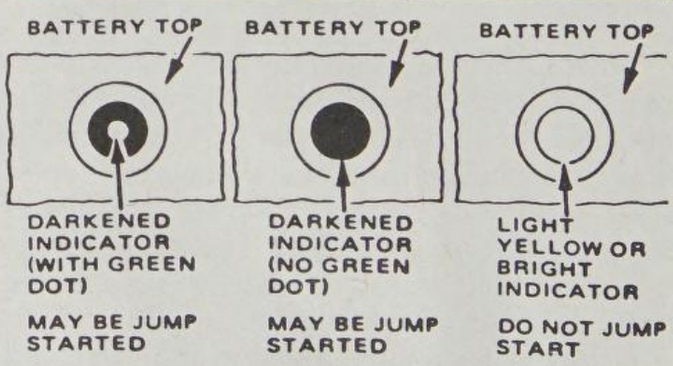




A special tool is available for cleaning the side terminals and clamps

cable first. Clean the cable clamps and the battery terminals with a wire brush until all corrosion, grease, etc. is removed and the metal is shiny. It is especially important to clean the inside of the clamp thoroughly, since a small deposit of foreign material or oxidation there will prevent a sound electrical connection and inhibit either starting or charging. Special tools are available for cleaning the side terminal clamps and terminals.

Charging Rate Amps	Time
75	40 min
50	1 hr
25	2 hr
10	5 hr



Maintenance-free batteries contain their own built in hydrometer

Before installing the cables, loosen the battery hold-down clamp, remove the battery, and check the battery tray. Clear it of any debris and check it for soundness. Rust should be wire-brushed away, and the metal given a coat of anti-rust paint. Replace the battery and tighten the hold-down clamp securely, but be careful not to overtighten, which will crack the battery case.

After the clamps and terminals are clean, reinstall the cables, negative cable last. Give the clamps and terminals a thin external coat of grease after installation, to retard corrosion.

Check the cables at the same time that the terminals are cleaned. If the cable insulation is cracked or broken, or if the ends are frayed, the cable should be replaced with a new cable of the same length and gauge.

NOTE: *Keep flames or sparks away from the battery; it gives off explosive hydrogen gas. Battery electrolyte contains sulphuric acid. If you should get any on your skin or in your eyes, flush the affected areas with plenty of clear water; if it lands in your eyes, get medical help immediately.*

Testing the Maintenance-Free Battery

Maintenance-free batteries do not require normal attention as far as fluid level checks are concerned. However, the terminals require periodic cleaning, which should be performed at least once a year.

The sealed-top battery cannot be checked for charge in the normal manner, since there is no provision for access to the electrolyte. To check the condition of the battery:

1. If the indicator eye on top of the battery is dark, the battery has enough fluid. If the eye is light, the electrolyte fluid is too low and the battery must be replaced.

2. If a green dot appears in the middle of the eye, the battery is sufficiently charged. Proceed to Step 4. If no green dot is visible, charge the battery as in Step 3.

3. Charge the battery at this rate:

CAUTION: *Do not charge the battery for more than 50 amp/hours. If the green dot appears, or if electrolyte squirts out of the vent hole, stop the charge and proceed to Step 4.*

It may be necessary to tip the battery from side to side to get the green dot to appear after charging.

4. Connect a battery load tester and a voltmeter across the battery terminals (the battery cables should be disconnected from the battery). Apply a 300 amp load to the battery for 15 seconds to remove the surface charge. Remove the load.

5. Wait 15 seconds to allow the battery to recover. Apply the appropriate test load, as specified in the following chart:

BATTERY	TEST LOAD (AMPS)
70-315	150
70-355	170
75-500	250

Battery Load Test

Apply the load for 15 seconds while reading the voltage. Disconnect the load.

6. Check the results against the following chart. If the battery voltage is at or above the specified voltage for the temperature listed, the battery is good. If the voltage falls below what's listed, the battery should be replaced.

ESTIMATED TEMPERATURE	MINIMUM VOLTAGE
70° F. (21° C.)	9.6
50° F. (10° C.)	9.4
30° F. (0° C.)	9.1
15° F. (−10° C.)	8.8
0° F. (−18° C.)	8.5
0° F. (BELOW: −18° C.)	8.0

Early Fuel Evaporation (EFE) System

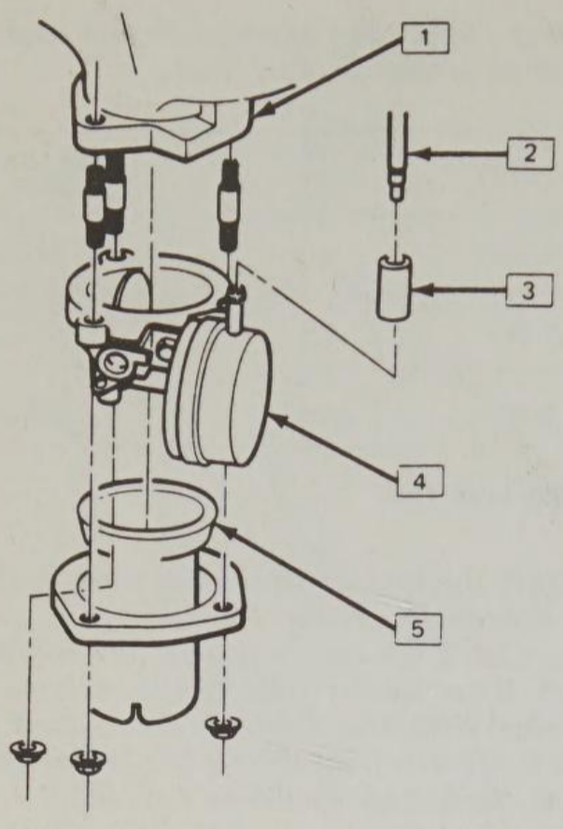
The EFE system is used on some engines to provide a source of quick heat to the engine induction system during cold driveaway. There are two types of EFE systems: the vacuum servo type (located in the exhaust manifold) and the electric grid type (located under the carburetor).

The vacuum servo type consists of a valve in the exhaust manifold and a Thermo Vacuum Switch (TVS) mounted on the engine coolant outlet housing.

The electrical type consists of an electrical grid plate, mounted directly under the carburetor.

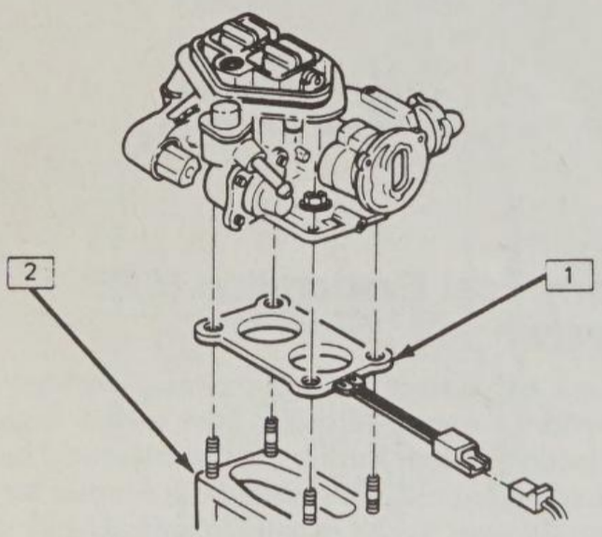
Both types are designed to produce rapid heating of the intake manifold, providing quick fuel evaporation and a more even distribution of fuel to aid in cold engine operation.

Every 30,000 miles, check the EFE valve (make sure it is free, not sticking) and the hoses are cracking or deterioration. If necessary, replace or lubricate.



1. Exhaust manifold
2. Vacuum source
3. Hose
4. EFE actuator
5. Exhaust pipe

EFE Vacuum Servo Valve



1. EFE heater
2. Intake manifold

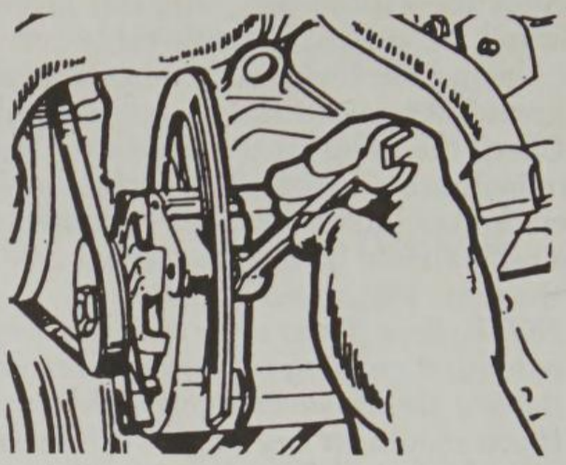
EFE Electrically Heated Grid

Belts

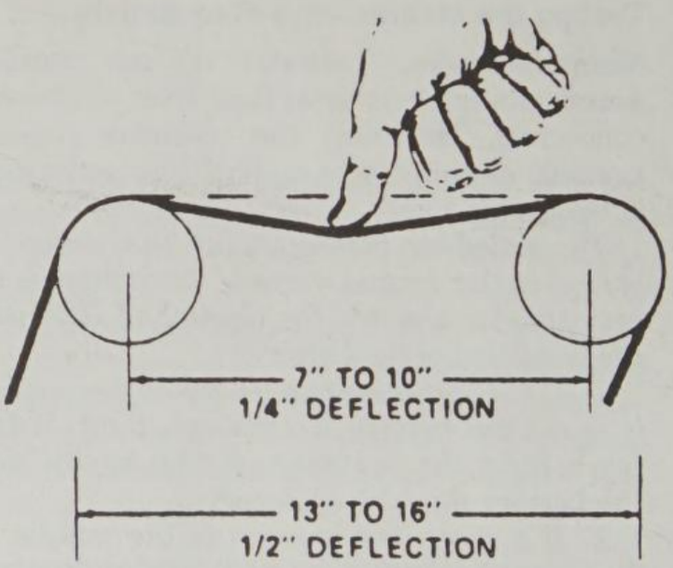
TENSION CHECKING AND ADJUSTMENT

Check the drive belts every 15,000 miles or twelve months for evidence of wear such as cracking, fraying, and incorrect tension. Determine belt tension at a point halfway between the pulleys by pressing on the belt with moderate thumb pressure. If the distance between the pulleys (measured at the center of the pulley) is 13–16 in., the belt should deflect ½ in. at the halfway point or ¼ in. if the distance is 7–10 in. If the deflection is found to be too much or too little, loosen the mounting bolts and make the adjustments.

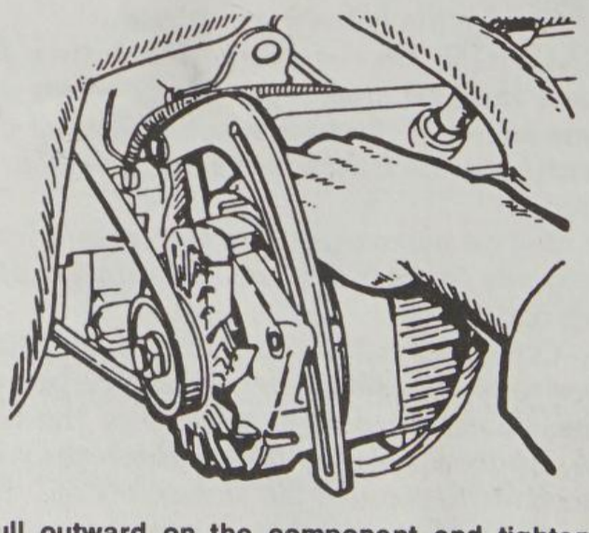
Before you attempt to adjust any of your engine's belts, you should take an old rag soaked in solvent and clean the mounting bolts of any road grime which has accumulated there. On some of the harder-to-reach bolts, an applica-



To adjust belt tension or to replace belts, first loosen the component's mounting and adjusting bolts slightly



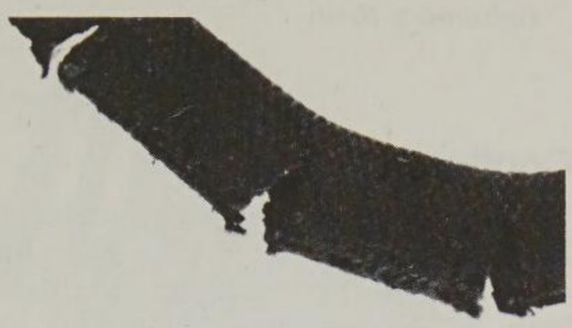
A gauge is recommended, but you can check belt tension with thumb pressure



Pull outward on the component and tighten the mounting bolts

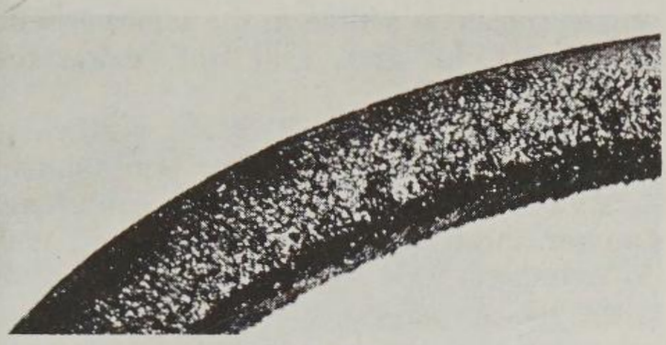
HOW TO SPOT WORN V-BELTS

V-Belts are vital to efficient engine operation—they drive the fan, water pump and other accessories. They require little maintenance (occasional tightening) but they will not last forever. Slipping or failure of the V-belt will lead to overheating. If your V-belt looks like any of these, it should be replaced.



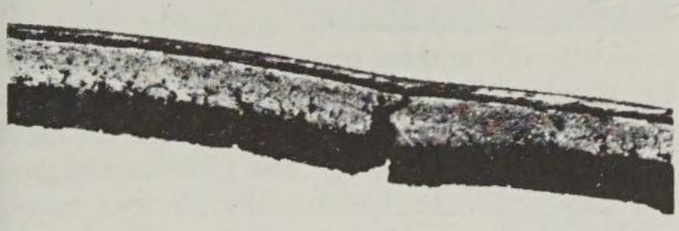
Cracking or weathering

This belt has deep cracks, which cause it to flex. Too much flexing leads to heat build-up and premature failure. These cracks can be caused by using the belt on a pulley that is too small. Notched belts are available for small diameter pulleys.



Softening (grease and oil)

Oil and grease on a belt can cause the belt's rubber compounds to soften and separate from the reinforcing cords that hold the belt together. The belt will first slip, then finally fail altogether.

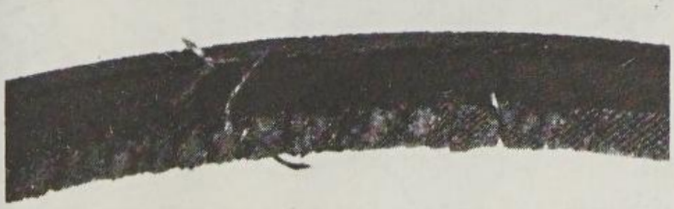


Glazing

Glazing is caused by a belt that is slipping. A slipping belt can cause a run-down battery, erratic power steering, overheating or poor accessory performance. The more the belt slips, the more glazing will be built up on the surface of the belt. The more the belt is glazed, the more it will slip. If the glazing is light, tighten the belt.

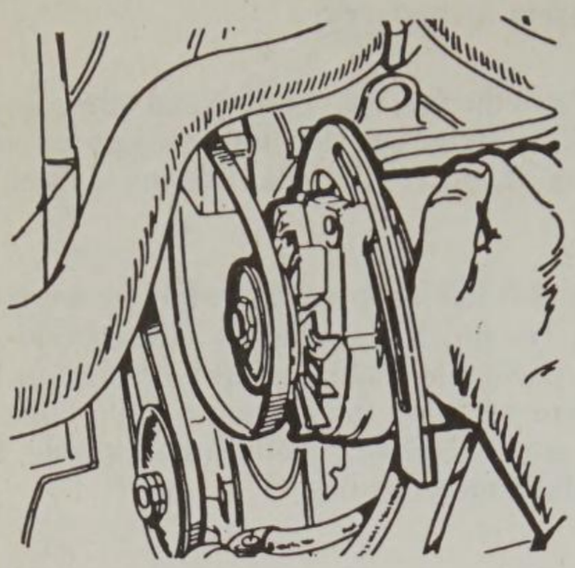
Worn cover

The cover of this belt is worn off and is peeling away. The reinforcing cords will begin to wear and the belt will shortly break. When the belt cover wears in spots or has a rough jagged appearance, check the pulley grooves for roughness.

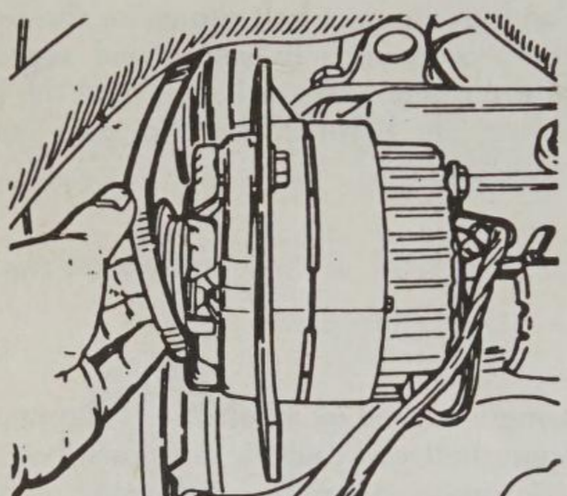


Separation

This belt is on the verge of breaking and leaving you stranded. The layers of the belt are separating and the reinforcing cords are exposed. It's just a matter of time before it breaks completely.



Push the component toward the engine and slip off the belt



Slip the new belt over the pulley

tion of penetrating oil will make them easier to loosen. When you're adjusting belts, especially on V8's with air conditioning and power steering, it would be especially helpful to have a variety of socket extensions and universals to get to those hard-to-reach bolts.

NOTE: *When adjusting the air pump belt, if you are using a pry bar, make sure that you pry against the cast iron end cover and not against the aluminum housing. Excessive force on the housing itself will damage it.*

Hoses

HOSE REPLACEMENT

Upper and lower radiator hoses and all heater hoses should be checked for deterioration, leaks and loose hose clamps every 15,000 miles. To remove the hoses:

1. Drain the radiator.
2. Loosen the hose clamps at each end of the hose to be removed.
3. Working the hose back and forth, slide it off its connection and then install a new hose if necessary.
4. Position the hose clamps at least ¼ in. from the end of the hose and tighten them.

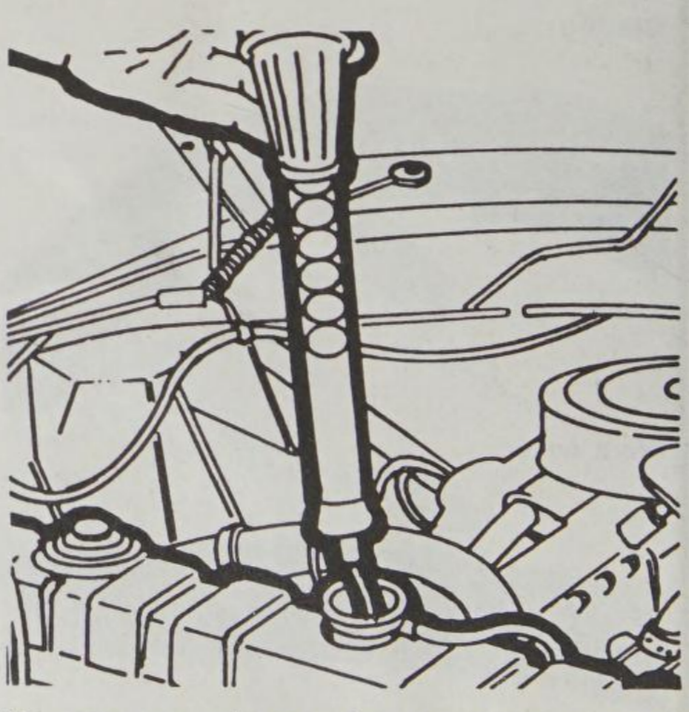
NOTE: *Always make sure that the hose clamps are beyond the bead and placed in the center of the clamping surface before tightening them.*

Cooling System

Once a month, the engine coolant level should be checked. This is quickly accomplished by observing the level of coolant in the recovery tank, which is the translucent tank mounted to the right of the radiator, and connected to the radiator filler neck by a length of hose. As long as coolant is visible in the tank between the "Full Cold" and "Full Hot" marks the coolant level is OK.

If coolant is needed, a 50/50 mix of ethylene glycol-base antifreeze and clear water should always be used for additions, both winter and summer. Add coolant to the recovery tank through the capped opening. If adding coolant to the radiator, make sure the engine is cool before removing the radiator cap.

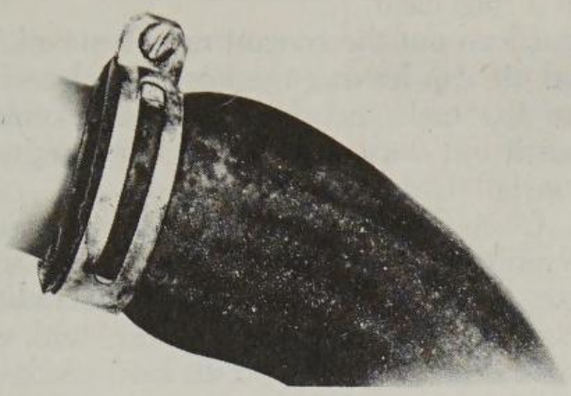
The radiator hoses, clamps, and radiator cap should be checked at the same time as the coolant level. Hoses which are brittle, cracked, or swollen should be replaced. Clamps should be checked for tightness (screwdriver tight only—do not allow the clamp to cut into the hose or crush the fitting). The radiator cap gasket should be checked for any obvious tears, cracks or swelling, or any signs of incorrect seating in the radiator neck.



You can use an inexpensive tester to check antifreeze protection

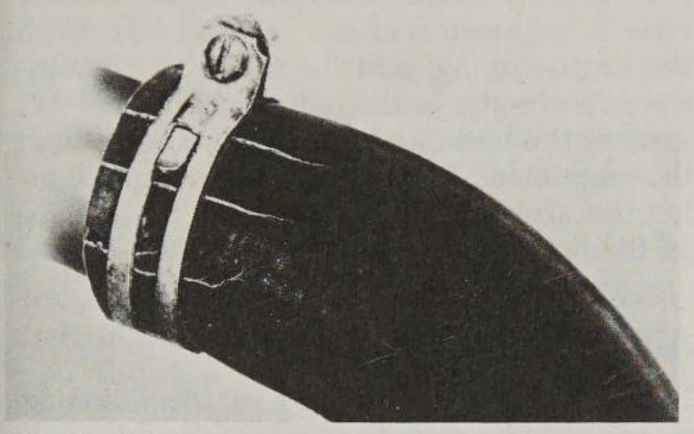
HOW TO SPOT BAD HOSES

Both the upper and lower radiator hoses are called upon to perform difficult jobs in an inhospitable environment. They are subject to nearly 18 psi at under hood temperatures often over 280°F., and must circulate nearly 7500 gallons of coolant an hour—3 good reasons to have good hoses.



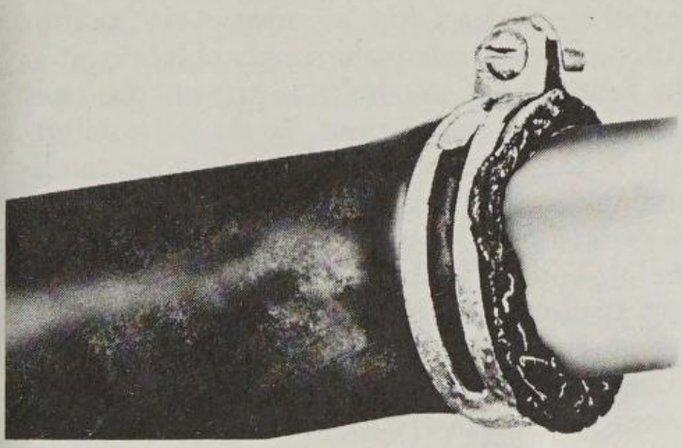
Swollen hose

A good test for any hose is to feel it for soft or spongy spots. Frequently these will appear as swollen areas of the hose. The most likely cause is oil soaking. This hose could burst at any time, when hot or under pressure.



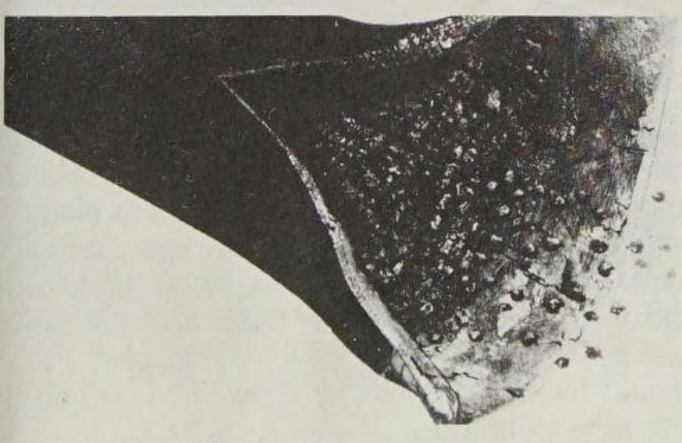
Cracked hose

Cracked hoses can usually be seen but feel the hoses to be sure they have not hardened; a prime cause of cracking. This hose has cracked down to the reinforcing cords and could split at any of the cracks.



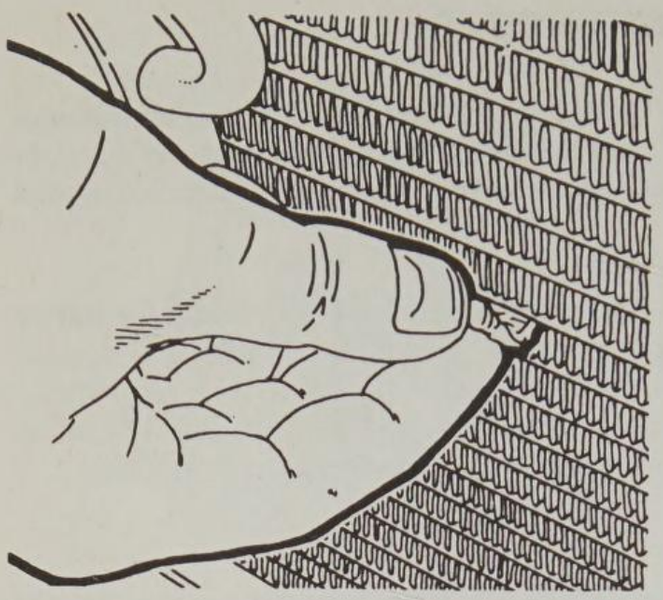
Frayed hose end (due to weak clamp)

Weakened clamps frequently are the cause of hose and cooling system failure. The connection between the pipe and hose has deteriorated enough to allow coolant to escape when the engine is hot.



Debris in cooling system

Debris, rust and scale in the cooling system can cause the inside of a hose to weaken. This can usually be felt on the outside of the hose as soft or thinner areas.

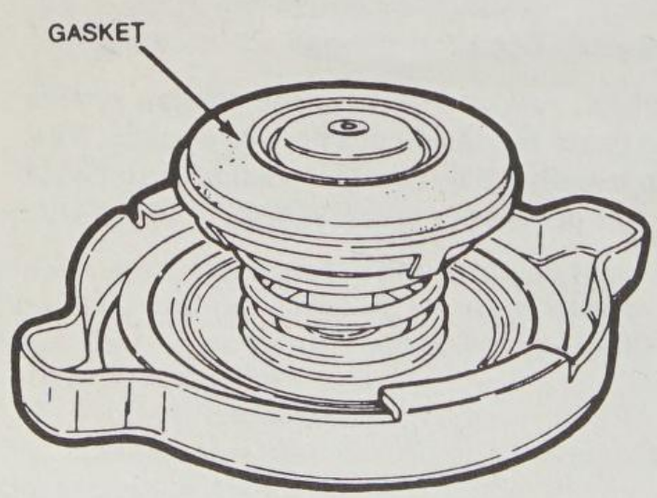


Clean the front of the radiator of any bugs, leaves, or other debris at every yearly coolant change

CAUTION: *To avoid injury when working with a hot engine, cover the radiator cap with a thick cloth. Wear a heavy glove to protect your hand. Turn the radiator cap slowly to the first stop, and allow all the pressure to vent (indicated when the hissing noise stops). When the pressure has been released, press down and remove the cap the rest of the way.*

The cooling system should be drained, flushed and refilled every two years or 30,000 miles, according to the manufacturer's recommendations. However, many mechanics prefer to change the coolant every year; it is cheap insurance against corrosion, overheating or freezing.

1. Remove the radiator cap when the engine is cool. See the preceding "CAUTION" about removing the cap.
2. With the radiator cap removed, run the engine until heat can be felt in the upper hose, indicating that the thermostat is open. The heater should be turned on to its maximum heat position, so that the core is flushed out.
3. Shut off the engine and open the drain cock in the bottom of the radiator. Drain the radiator.
4. Close the drain cock and fill the system with clear water. A cooling system flushing additive can be added, if desired.
5. Run the engine until it is hot again.
6. Drain the system, then flush with water until it runs clear.
7. Clean out the coolant recovery tank: remove the cap leaving the hoses in place. Remove the tank and drain it of any coolant. Clean it out with soap and water, empty it, and install it.
8. Close the drain cock and fill the radiator with a 50/50 mix of ethylene glycol-base antifreeze and water to the base of the radiator filler neck. Fill the coolant recovery tank with the same mixture to the "Full Hot" mark. Install the recovery tank cap.
9. Run the engine until the upper radiator hose is hot again (radiator cap still off). With the engine idling, add the 50/50 mix of antifreeze and water to the radiator until the level reaches the bottom of the filler neck. Shut off the engine and install the radiator cap, aligning the arrows with the overflow tube. Turn off the heater.



Check the condition of the radiator cap gasket

Air Conditioning System

Regular maintenance of the air conditioning system includes periodic checks of the drive belt tension. In addition, the system should be operated for at least five minutes every month. This ensures an adequate supply of lubricant to the bearings and also helps to prevent the seals and hoses from drying out. To do this comfortably in the winter months, turn the air conditioning "ON", place the temperature control lever on "WARM" or "HI" position and turn the blower fan to its highest setting. This will engage the compressor, circulating the lubricating oils within the system, but prevents the discharge of cold air. The system should be checked for proper refrigerant charge using the procedure given below.

CHECKING THE SYSTEM

Checking for Oil Leaks

Refrigerant leaks show up as oil areas on the various components because the compressor oil is transported around the entire system along with the refrigerant. Look for oily spots on all the hoses and lines, and especially on the hose and tubing connections. If there are oily deposits, the system may have a leak, and you should have it checked by a qualified air conditioning technician.

NOTE: *A small area of oil on the front of*

the compressor is normal and no cause for alarm.

Check the Compressor Belt

Refer to the section in this chapter on "Drive Belts."

Keep the Condenser Clean

Periodically inspect the front of the condenser for bent fins or foreign material (dirt, bugs, leaves, etc.). If any cooling fins are bent, straighten them carefully with needlenosed pliers. You can remove any debris with a stiff bristle brush or hose.

CAUTION: *Do not attempt to charge or discharge the refirgerant system unless you are thoroughly familiar with its operation and the hazards involved. The compressed refrigerant used in the air conditioning system expands and evaporates (boils) into the atmosphere at a temperature of −21.7°F (−29.8°C) or less. This will freeze any surface that it contacts, including your eyes. In addition, the refrigerant decomposes into a poisonous gas in the presence of flame.*

QUICK CHECK PROCEDURE

The air conditioning system on these cars have no sight glass.

1. Run the engine until it reaches normal operating temperature.
2. Open the hood and all the doors.
3. Turn the air conditioning to "NORM", move the temperature selector to "COLD" and run the blower on "HI".
4. Idle the engine at 1000 rpm.
5. Feel the temperature of the evaporator inlet and the accumulator outlet with the compressor clutch engaged.
6. Both lines should be cold. If the inlet pipe is colder than the outlet pipe, the system is low on charge. DO NOT attempt to charge the system yourself.

Windshield Wipers

For maximum effectiveness and longest element life, the windshield and wiper blades should be kept clean. Dirt, tree sap, road tar and so on will cause streaking, smearing and blade deterioration if left on the glass. It is advisable to wash the windshield carefully with a commercial glass cleaner at least once a month. Wipe off the rubber blades with the wet rag afterwards.

If the blades are found to be cracked, broken or torn, they should be replaced immediately. Replacement intervals will vary with usage, although ozone deterioration usually limits blade life to about one year. If the wiper pattern is smeared or streaked, or if the blade chatters across the glass, the elements should be replaced. It is easiest and most sensible to replace the elements in pairs.

WIPER REFILL REPLACEMENT

The element of the wiper blade uses a spring type retainer on the end of the element. To remove the element, insert and rotate a screwdriver. Slide the element upward out of the housing retaining tabs.

To install the new element, slide it into the housing retaining tabs, lining up the slot in the element with the housing tab and snap the element into place.

BLADE AND ARM REPLACEMENT

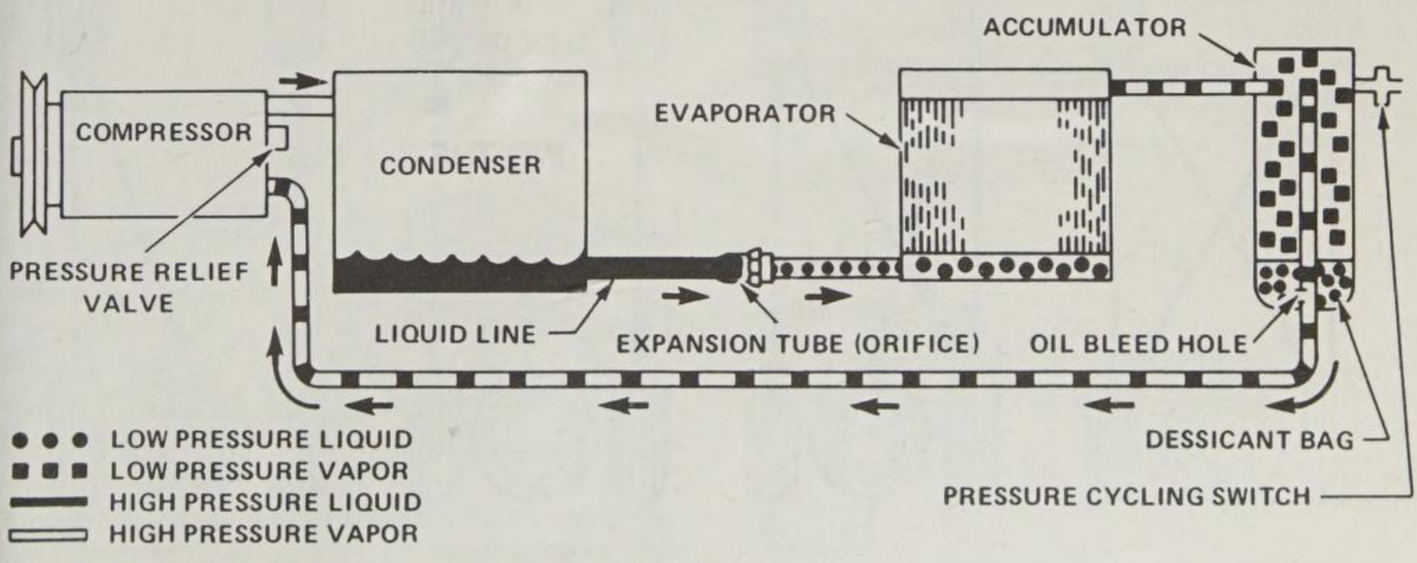
The wiper blade is equipped with a press type release lever. By pushing the release lever up or down, the blade assembly can be slid off the wiper arm.

To install, snap the wiper assembly into place.

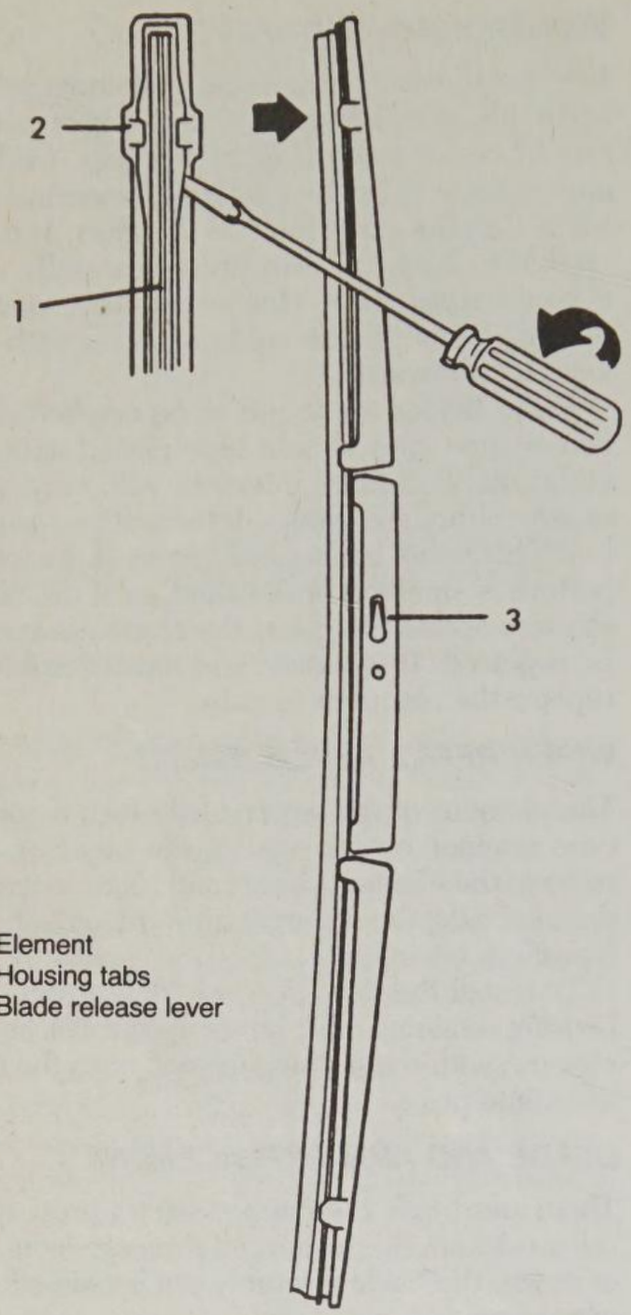
Tires

TIRE ROTATION

Tire rotation is recommended every 6000 miles or so, to obtain maximum tire wear. The pat-



Air Conditioning System



1. Element
2. Housing tabs
3. Blade release lever

The rubber element can be changed without replacing the entire blade assembly

tern you use depends on whether or not your car has a usable spare. Radial tires should not be cross-switched (from one side of the car to the other); they last longer if their direction of rotation is not changed. Snow tires sometimes have directional arrows molded into the side of the carcass; the arrow shows the direction of rotation. They will wear very rapidly if the rotation is reversed. Studded tires will lose their studs if their rotational direction is reversed.

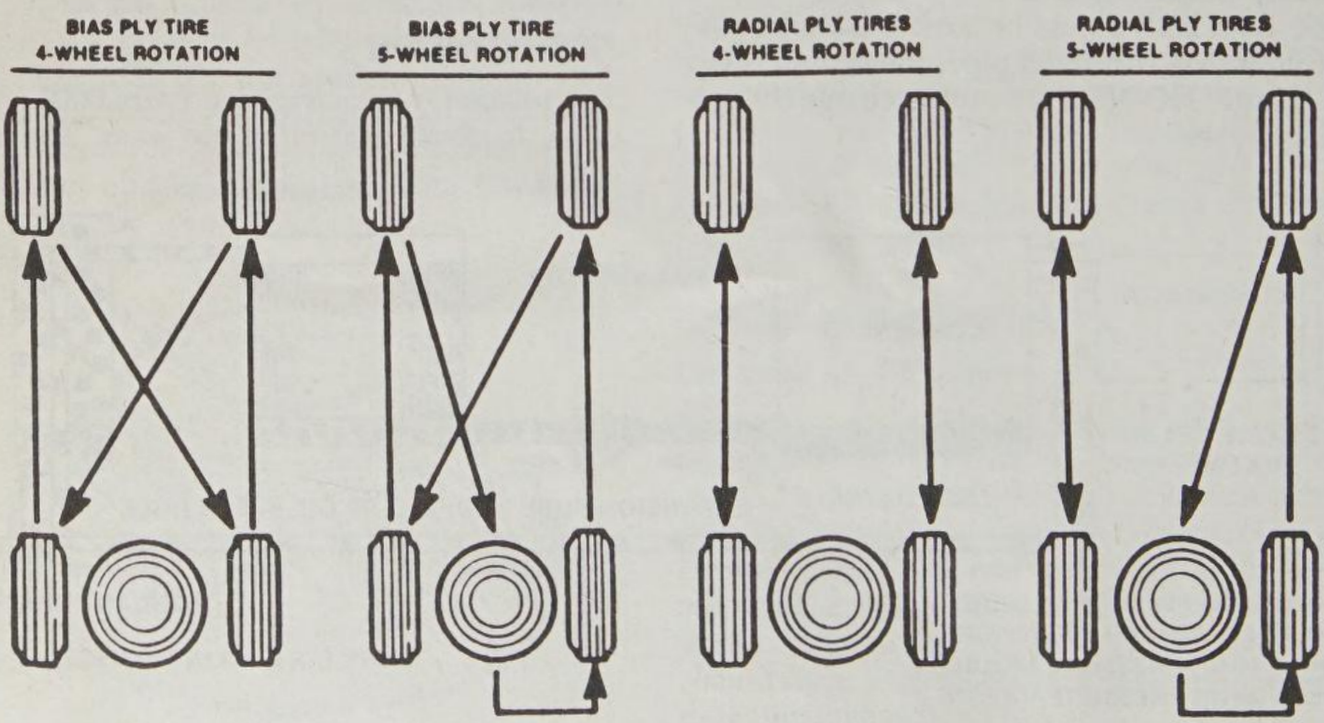
NOTE: *Mark the wheel position or direction of rotation on radial tires or studded snow tires before removing them.*

INFLATION PRESSURE

Tires should be checked weekly for proper air pressure. A chart, located either in the glove compartment or on the driver's or passenger's door, gives the recommended inflation pressures. Maximum fuel economy and tire life will result if the pressure is maintained at the highest figure given on the chart. Pressures should be checked before driving since pressure can increase as much as six pounds per square inch (psi) due to heat buildup. It is a good idea to have your own accurate pressure gauge, because not all gauges on service station air pumps can be trusted. When checking pressures, do not neglect the spare tire. Note that some spare tires require pressures considerably higher than those used in the other tires.

While you are about the task of checking air pressure, inspect the tire treads for cuts, bruises and other damage. Check the air valves to be sure that they are tight. Replace any missing valve caps.

Check the tires for uneven wear that might



Tire rotation diagrams; note that radials should NOT be cross-switched

indicate the need for front end alignment or tire rotation. Tires should be replaced when a tread wear indicator appears as a solid band across the tread.

When buying new tires, give some thought to the following points, especially if you are considering a switch to larger tires or a different profile series:

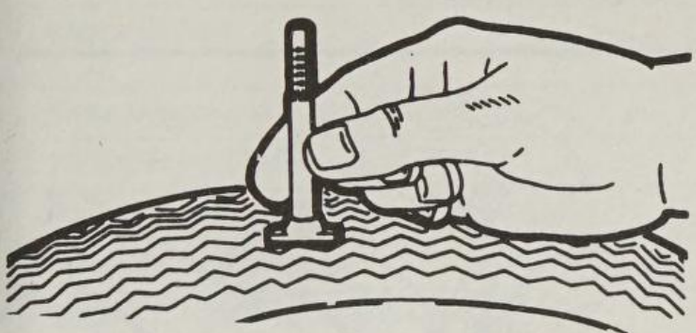
1. All four tires must be of the same construction type. This rule cannot be violated. Radial, bias, and bias-belted tires must not be mixed.

2. The wheels should be the correct width for the tire. Tire dealers have charts of tire and rim compatibility. A mismatch will cause sloppy handling and rapid tire wear. The tread width should match the rim width (inside bead to inside bead) within an inch. For radial tires, the rim width should be 80% or less of the tire (not tread) width.

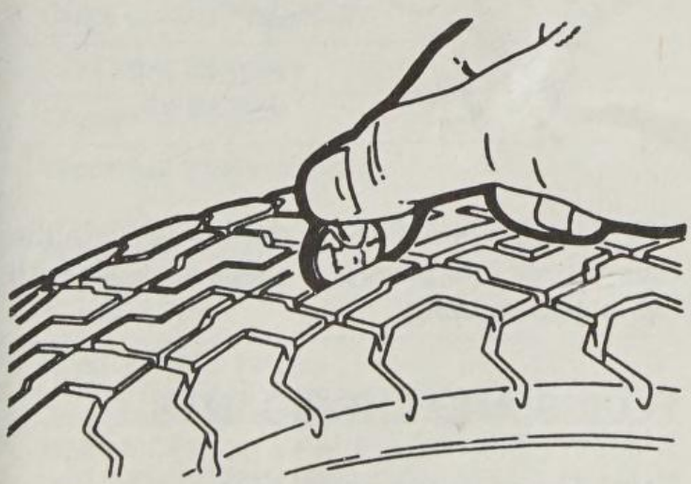
3. The height (mounted diameter) of the new tires can change speedometer accuracy, engine speed at a given road speed, fuel mileage, acceleration, and ground clearance. Tire manufacturers furnish full measurement specifications.

4. The spare tire should be usable, at least for short distance and low speed operation, with the new tires.

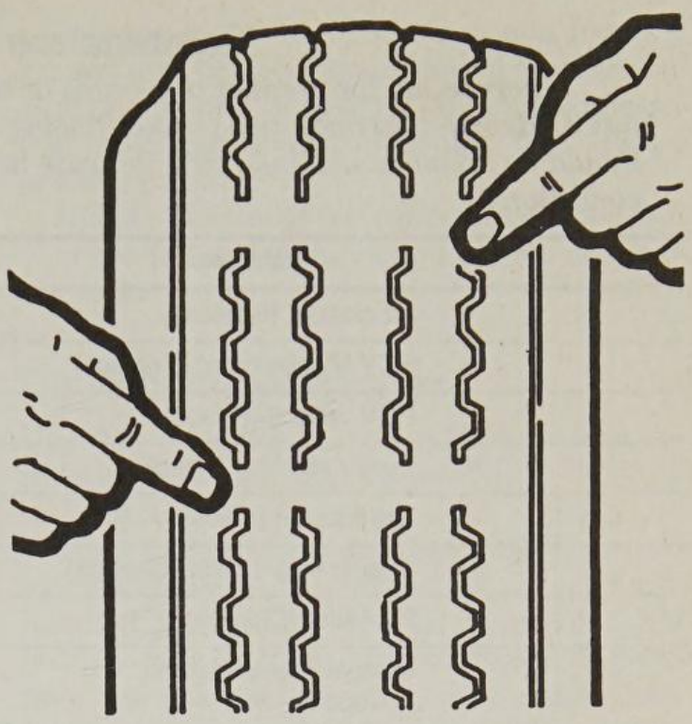
5. There shouldn't be any body interference when loaded, on bumps, or in turns.



Tread depth can be checked with an inexpensive gauge



A penny works as well as anything for checking the tire tread depth; when you can see the top of Lincoln's head, it's time for a new tire



Tread wear indicators will appear when the tire is worn out

NOTE: *The tires will perform well at all normal loads when inflated as recommended on the Tire Placard (located on the driver's door of your car).*

STORAGE

Store the tires at the proper inflation pressure if they are mounted on wheels. Keep them in a cool dry place, laid on their sides. If the tires are stored in the garage or basement, do not let them stand on a concrete floor; set them on strips of wood.

Fuel Filter

Carburated engines have a paper fuel filter and check valve assembly located in the carburetor inlet. Throttle Body Injection engines have an in-line fuel filter (located in the fuel feed line) and a fine screen filter in the injector head. All ears have a woven plastic filter in the fuel tank on the lower end of the pick-up pipe.

CAUTION: *Only change the fuel filter when the engine is cold, otherwise a chance of an explosion may occur.*

FUEL FILTER REPLACEMENT

Carburetor Type

1. Disconnect the fuel line connection at the intake filter nut. Plug the opening to prevent the loss of fuel.

2. Remove the intake filter nut from the carburetor. Remove the filter element and spring.

3. Install a new filter with the hole facing

Maintenance Intervals Chart

Intervals are for number of months or thousands of miles, whichever comes first.

NOTE: *Heavy-duty operation (trailer towing, prolonged idling, severe stop and start driving) should be accompanied by a 50% increase in maintenance. Cut the interval in half for these conditions.*

Maintenance	Service Intervals
Air cleaner (Replace)	30,000 mi. (48,000 km.)
PCV filter element (Replace)	30,000 mi. (48,000 km.)
PCV valve (Replace)	30,000 mi. (48,000 km.)
Power steering (Check)	12 mo/7,500 mi. (12,000 km.)
Belt tension (Adjust)	12 mo/15,000 mi. (24,000 km.)
Engine oil and filter (Change)	12 mo/7,500 mi. (12,000 km.)
Fuel filter (Change)	15,000 mi. (24,000 km.)
Manual Transmission	
Check	12 mo/15,000 mi. (24,000 km.)
Change	100,000 mi. (160,000 km.)
Automatic Transmission	
Check	12 mo/15,000 mi. (24,000 km.)
Change (including filter)	100,000 mi. (160,000 km.)
Engine coolant	
Check	Weekly
Change	24 mo/30,000 mi. (24,000 km.)
Chassis lubrication	12 mo/7,500 mi. (12,000 km.)
Rotate tires	7,500 mi. (12,000 km.)
Brake fluid (Check)	6 mo/7,500 mi. (12,000 km.)
Spark plugs and wires, ignition timing, idle speed	30,000 mi. (48,000 km.)

the inlet tube. Install a new gasket on the filter nut and install the nut. Install the fuel line.

In-line Type

1. Use a pair of pliers to expand the hose clamps, then slide the clamps away from the rubber hose.
2. Gently twist and pull the hoses free of the filter pipes. Remove and discard the old filter.

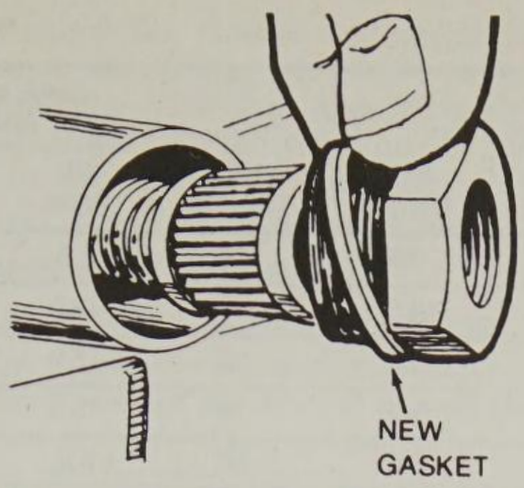
The fuel filter is located behind the large fuel line inlet nut on the carburetor

3. Install a new filter in the hoses, slide the clamps back into place and check for leaks with the engine running.

FLUIDS AND LUBRICANTS

Fuel Recommendations

The engine is designed to operate on unleaded gasoline ONLY and is essential for the proper



Install the new filter and spring. Certain early models use a bronze filter element but most are made of paper

operation of the emission control system. The use of unleaded fuel will reduce spark plug fouling, exhaust system corrosion and engine oil deterioration.

In most parts of the United States, fuel with an octane rating of 87 should be used; in high altitude areas, fuel with an octane rating as low as 85 may be used.

In some areas, fuel consisting of a blend of alcohol may be used; this blend of gasoline and alcohol is known as gasohol. When using gasohol, never use blends exceeding 10% ethanol or 5% methanol.

NOTE: *The use of fuel with excessive amounts of alcohol may jeopardize the new car warranties.*

Oil Recommendations

Use only oil which has the API (American Petroleum Institute) designation "SF", "SF/CC" or "SF/CD".

Since fuel economy is effected by the viscosity (thickness) of the engine oil, it is recommended to select an oil with reference to the outside temperature. For satisfactory lubrication, use a lower viscosity oil for colder temperatures and a higher viscosity oil for warmer temperatures.

OIL LEVEL CHECK

Every time you stop for fuel, check the engine oil as follows:

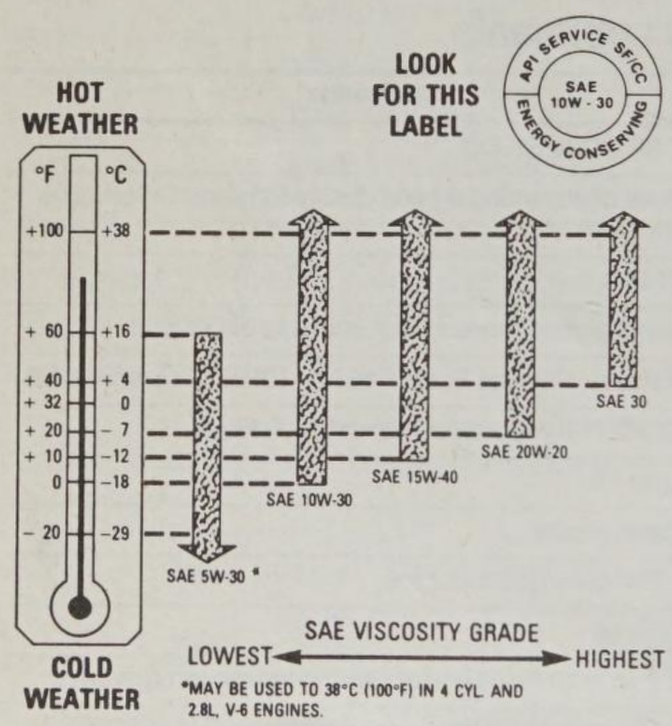
Recommended Lubricants

Lubricant	Classification
Engine Oil	SF, SF/CC or SF/CD
Engine Coolant	Mixture of water and a good quality Ethylene Glycol base anti freeze
Brake System and Master Cylinder	DOT 3
Parking Brake Cables	Chassis grease meeting requirements of GM 6031-M
Power Steering System & Pump Reservoir	GM Power Steering Fluid, Part No. 1050017 or equivalent
Automatic Transmission	DEXRON® II Automatic Transmission Fluid
Automatic Transmission Shift Linkage	Engine Oil
Manual Transmission Shift Linkage	Chassis grease
Manual Transmission	SAE 80-90W GL5 lubricant
Clutch Linkage Pivot Points	Engine oil
Front Wheel Bearings	GM Part #1051344 wheel bearing grease or equivalent
Chassis Lubrication	Chassis grease meeting requirements of GM 6031-M
Windshield Washer Solvent	GM Optikleen Washer Solvent, Part No. 1051515 or equivalent
Hood Latch Assembly a. pivots and spring anchor b. release pawl	 a. Engine oil b. Chassis grease meeting requirements of GM 6031-M
Hood and Door Hinges	Engine oil
Body door hinge pins, station wagon tailgate hinge and linkage, station wagon folding seat, fuel door hinge, rear compartment hinges	Engine oil
Key Lock Cylinders	WD-40 Spray lubricant or equivalent

Capacities

Year	Engine No. Cyl. Displacement (cu. in.)	Engine Crankcase Add 1 qt for New Filter	Transmission Pts to Refill After Draining		Drive Axle (pts)	Gasoline Tank (gals)	Cooling System (qts)	
			Manual 4-Speed	Automatic ①			With Heater	With A/C
'82	4-151	3②	3.5	7	3.5	16	8.8	9.1
	6-173	4②	3.5	7	3.5	16	12.5	12.5
	8-305③	4	3.5	7	3.5	16	15.0	15.0
	8-305④	4	—	7	3.5	16	15.0	15.0
'83	4-151	3②	3.5⑤	7	3.5	16	8.8	9.1
	6-173	4②	⑤	7	3.5	16	12.5	12.5
	8-305③	4	⑤	7	3.5	16	15.0	15.0
	8-305④	4	—	7	3.5	16	15.0	15.0
'84–'85	4-151	3②	3.5⑤	7	3.5	16	8.8	9.1
	6-173	4②	⑤	7	3.5	16	12.5	12.5
	8-305③	4	⑤	7	3.5	16	15.0	15.0
	8-305④	4	⑤	7	3.5	16	15.0	15.0

—Not applicable
① Drain and refill only—does not include torque convertor
② Capacity same with or without filter change
③ With 4 bbl. carburetor
④ With throttle body fuel injection
⑤ 5.3 pints on the 5 speed transmission



Select the lowest SAE viscosity grade oil for the expected temperature range

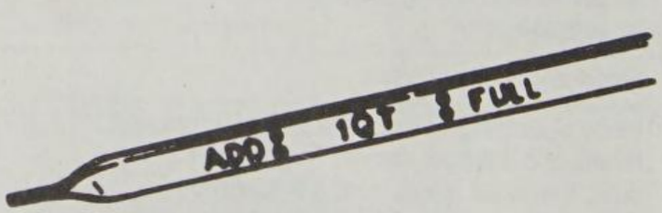
1. Make sure the car is parked on level ground.

2. When checking the oil level it is best for the engine to be at normal operating temperature, although checking the oil immediately after stopping will lead to a false reading. Wait a few minutes after turning off the engine to allow the oil to drain back into the crankcase.

3. Open the hood and locate the dipstick which will be on either the right or left side depending upon your particular engine. Pull the dipstick from its tube, wipe it clean and then reinsert it.

4. Pull the dipstick out again and, holding it horizontally, read the oil level. The oil should be between the "FULL" and "ADD" marks on the dipstick. If the oil is below the "ADD" mark, add oil of the proper viscosity through the capped opening in the top of the cylinder head cover.

The oil level is checked with the dipstick



The oil level should be between the "ADD" and "Full" marks on the dipstick

5. Replace the dipstick and check the oil level again after adding any oil. Be careful not to overfill the crankcase. Approximately one quart of oil will raise the level from the "ADD" mark to the "FULL" mark. Excess oil will generally be consumed at an accelerated rate.

CHANGING OIL AND FILTER

The oil is to be changed every 7,500 miles or 12 months, which ever occurs first. Under normal conditions, change the filter at first oil change and then at every other oil change, unless 12 months pass between changes.

If driving under such conditions, such as: dusty areas, trailer towing, idling for long periods of time, low speed operation, or when operating with temperatures below freezing and driving short distances (under 4 miles), change the oil and filter every 3,000 miles or 3 months.

Removal and Installation

1. Raise the car and support on jack stands. Remove the oil pan plug and drain oil into a catch pan.
2. Using an oil filter wrench, remove the oil filter and place it in the oil catch pan. Using a clean rag, wipe oil filter mounting surface.
3. To install, reverse the removal procedure. When installing the oil filter, place a small amount of oil on the sealing gasket and tighten the filter only finger tight.
4. Using a funnel, add oil through the valve cover cap. Lower car, start the engine and inspect for oil leaks.

Transmission

FLUID RECOMMENDATION

Manual

Use only standard GL-5 hypoid type gear oil, SAE 80W or SAE 80W/90.

Automatic

Use only Dexron® II Automatic Transmission Fluid.

FLUID LEVEL CHECK

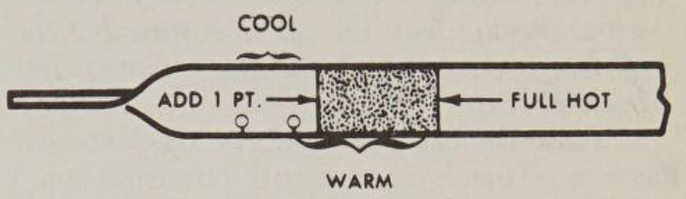
Manual

The oil in the manual transmission should be checked every 12 months or 15,000 miles.

1. With the car parked on a level surface, remove the filler plug from the side of the transmission housing.
2. If lubricant begins to trickle out of the hole, there is enough and you need not go any further. Otherwise, carefully insert your finger (watch out for sharp threads) and check to see if the oil is up to the edge of the hole.
3. If not, add oil through the hole until the level is at the edge of the hole. Most gear lubricants come in a plastic squeeze bottle with a nozzle; making additions simple.
4. Replace the filler plug, run the engine and check for leaks.

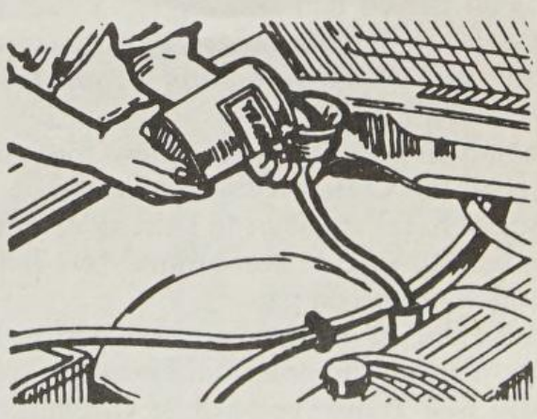
Automatic

Check the automatic transmission fluid level at least every 15,000 miles or 12 months. The dipstick can be found in the rear of the engine compartment. The fluid level should be checked only when the transmission is hot (normal operating temperature). The transmission is considered hot after about 20 miles of highway driving.



Automatic transmission dipstick marks; the proper level is within the shaded area

1. Park the car on a level surface with the engine idling. Shift the transmission into Neutral and set the parking brake.
2. Remove the dipstick, wipe it clean and then reinsert it firmly. Be sure that it has been pushed all the way in. Remove the dipstick again and check the fluid level while holding it horizontally. With the engine running, the fluid level should be between the second notch and the "FULL HOT" line. If the fluid must be checked when it is cool, the level should be between the first and second notches.
3. If the fluid level is below the second notch (engine hot) or the first notch (engine cold), add Dexron® II automatic transmission fluid through the dipstick tube. This is easily done with the aid of a funnel. Check the level often as you are filling the transmission. Be extremely careful not to overfill it. Overfilling will cause slippage, seal damage and overheating. Approximately one pint of ATF will



Add automatic transmission fluid through the dipstick tube

raise the fluid level from one notch/line to the other.

NOTE: *Use only Dexron II® ATF. The use of any other fluid will cause severe damage to the transmission.*

The fluid on the dipstick should always be a bright red color. If it is discolored (brown or black), or smells burnt, serious transmission troubles, probably due to overheating, should be suspected. The transmission should be inspected by a qualified technician to locate the cause of the burnt fluid.

DRAIN AND REFILL

Manual

NOTE: *Before removing the oil from the transmission, drive the car to ensure that the oil has been warmed and the sediment has been stirred.*

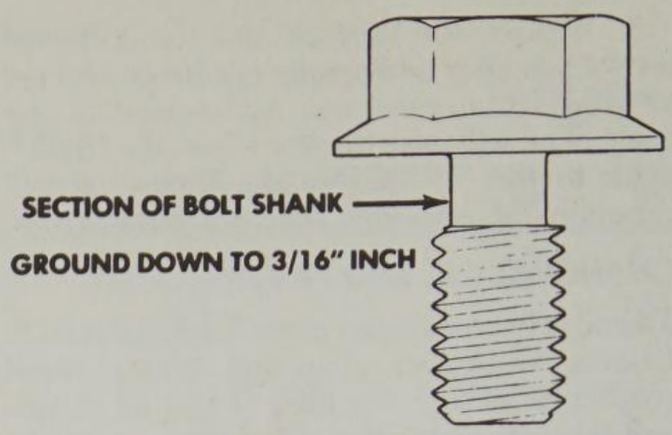
1. Raise the car and support on jack stands. Place an oil catch pan under the transmission.
2. Remove the plugs from the bottom and the side of the transmission. Allow the oil to drain into the pan.
3. Replace the bottom plug. Install the new oil through the hole in the side of the transmission. Fill until the oil is level with the fill hole. Replace the plug and lower the car.

Automatic

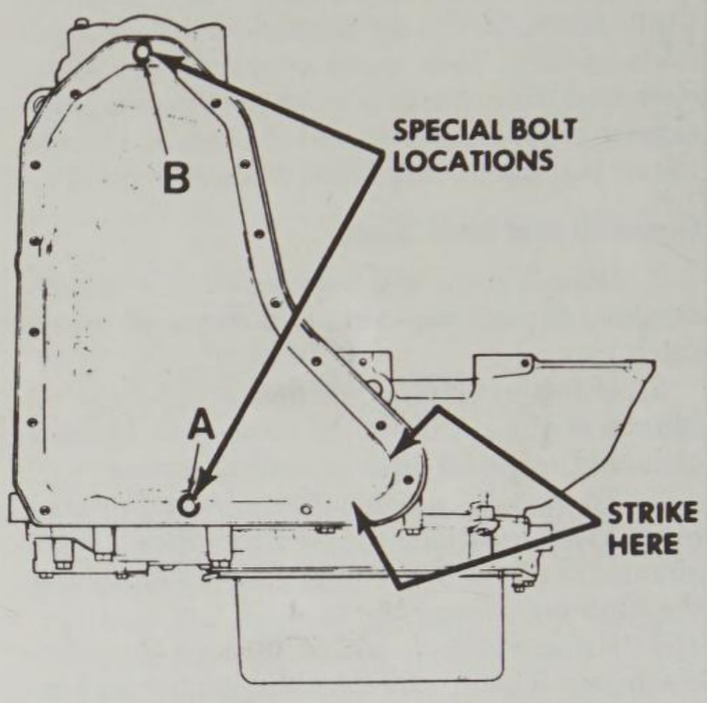
1. Raise and support the car on jack stands. Place an oil catch pan under the transmission.

NOTE: *A special bolt is required when removing an oil pan which has been installed with R.T.V. sealant. It can be fashioned from an extra transmission bolt by grinding a 3/16 in. section of the shank diameter, just under the bolt head.*

2. Remove all of the oil pan bolts, except "B", which must be loosened 4 complete turns. Install the special bolt into position "A" (finger tight).
3. Using a rubber mallet, strike the indicated corner of the pan. Allow the fluid to drain and remove the pan. Remove the filter/screen and the "O" ring.
4. Clean the oil pan and screen. Clean the mating surface of the transmission with a scraper. Wash the mating surfaces with solvent to remove the oil film.
5. Install the screen with a new filter and O-ring (coat the O-ring with petrolatum).
6. Apply R.T.V. sealant to both sides of the new gasket (be sure to seal around bolt holes) and position on the oil pan.
7. Raise the oil pan into position and install the bolts. Torque the bolts and lower the car.
8. Add new transmission fluid through the dipstick tube. Operate the engine and transmission and check for leaks.



Special bolt is used to aid in the oil pan removal



Using special bolts to remove the oil pan

Differential (Drive Axle)

FLUID RECOMMENDATION

Use only standard GL-5 hypoid type gear oil, SAE 80W or SAE 80W/90.

FLUID LEVEL CHECK

With the car parked on a level surface, remove the filler plug from the differential housing. Check to see if the fluid is level with the bottom of the filler hole. Replace the plug.

DRAIN AND REFILL

1. Raise and support the car on 4 jack stands. Place a container under the differential to catch the fluid.
2. If a bottom plug exists, remove it, if not, remove the bolts retaining the cover to the housing. Pry the cover from the differential housing and allow the fluid to drain into the catch pan.
3. Clean and inspect the differential. With the cover and housing washed free of oil, apply sealer to the mating surfaces.

4. Using a new gasket, install the cover and torque the bolts. Fill the differential with fluid (if a bottom plug was removed, replace it), installing it through the filler plug hole.

5. When the fluid level has reached the bottom of the filler hole, replace the filler plug. Lower the car and inspect for leaks.

Coolant

FLUID RECOMMENDATION

When adding or changing the fluid in the system, create a 50/50 mixture of high quality ethylene glycol antifreeze and water.

LEVEL CHECK

The fluid level may be checked by observing the fluid level marks of the recovery tank. The level should be below the "ADD" mark when the system is cold. At normal operating temperatures, the level should be between the "ADD" and the "FULL" marks. Only add coolant to bring the level to the "FULL" mark.

CAUTION: *Should it be necessary to remove the radiator cap, make sure that the system has had time to cool, reducing the internal pressure.*

DRAIN, FLUSH AND REFILL

The cooling system should be drained, thoroughly flushed and refilled at least every 30,000 miles or 24 months. These operations should be done with the engine cold.

1. Remove the radiator and recovery tank caps. Run the engine until the upper radiator hose gets hot. This means that the thermostat is open and the coolant is flowing through the system.

2. Turn the engine "OFF" and place a large container under the radiator. Open the drain valve at the bottom of the radiator. Open the block drain plugs to speed up the draining process.

3. Close the drain valves and add water until the system is full. Repeat the draining and filling process several times, until the liquid is nearly colorless.

4. After the last draining, fill the system with a 50/50 mixture of ethylene glycol and water. Run the engine until the system is hot and add coolant, if necessary. Replace the caps and check for any leaks.

Master Cylinder

FLUID RECOMMENDATION

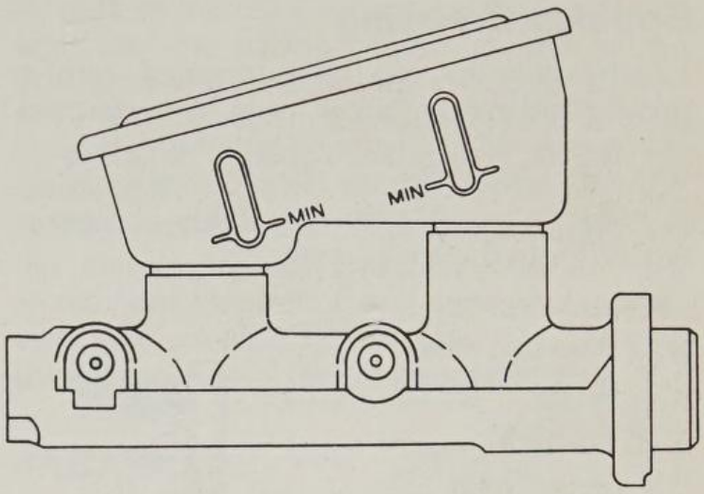
When adding or replacing the brake fluid, always use a top quality fluid, such as Delco Supreme 11 or DOT-3. DO NOT allow the brake fluid container or master cylinder reservoir to remain open for long periods of time; brake fluid absorbs moisture from the air, reducing its effectiveness and causing corrosion in the lines.

FLUID LEVEL

The master cylinder—located in the left rear section of the engine compartment—consists of an aluminum body and a translucent nylon reservoir with minimum fill indicators. The fluid level of the reservoirs should be kept near the top of the observation windows.

NOTE: *Be careful not to spill any brake fluid on painted surfaces, for it eats the paint.*

NOTE: *Any sudden decrease in the fluid level indicates a possible leak in the system and should be checked out immediately.*

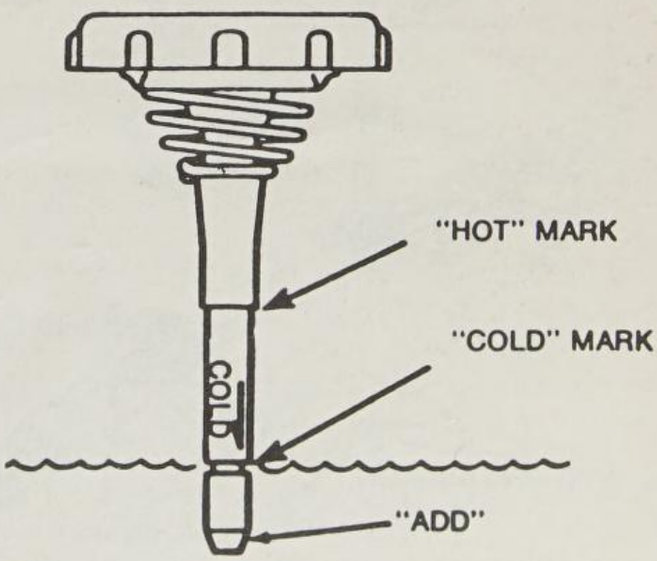


The fluid should be level with the top of the observation windows

Power Steering Pump

FLUID RECOMMENDATION

When filling or replacing the fluid of the power steering pump reservoir, use GM part #1050017 or Dexron® II Automatic Transmission Fluid.



Use the dipstick to check the power steering fluid

LEVEL CHECK

Power steering fluid level should be checked at least once every 12 months or 7,500 miles. To prevent possible overfilling, check the fluid level only when the fluid has warmed to operating temperatures and the wheels are turned straight ahead. If the level is low, fill the pump reservoir until the fluid level measures "full" on the reservoir dipstick. Low fluid level usually produces a moaning sound as the wheels are turned (especially when standing still or parking) and increases steering wheel effort.

NOTE: *GM recommends that you use power steering fluid, GM part #1050017 or its equal. Dexron II® is an acceptable substitute.*

Chassis Greasing

Chassis greasing can be performed with a pressurized grease gun or it can be performed at home by using a hand-operated grease gun. Wipe the grease fittings clean before greasing in order to prevent the possibility of forcing any dirt into the component.

Body Lubrication

HOOD LATCH AND HINGES

Clean the latch surfaces and apply clean engine oil to the latch pilot bolts and the spring anchor. Use the engine oil to lubricate the hood hinges as well. Use a chassis grease to lubricate all the pivot points in the latch release mechanism.

DOOR HINGES

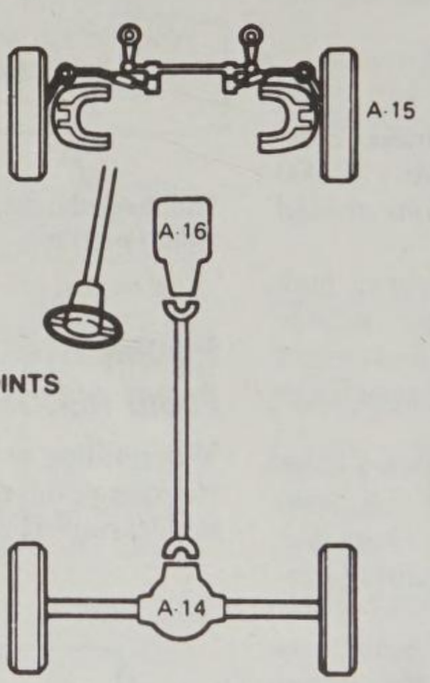
The gas tank filler door, car door, and rear hatch or trunk lid hinges should be wiped clean and lubricated with clean engine oil. Silicone spray also works well on these parts, but must be applied more often. Use engine oil to lubricate the trunk or hatch lock mechanism and the lock bolt and striker. The door lock cylinders can be lubricated easily with a shot silicone spray or one of the many dry penetrating lubricants commercially available.

PARKING BRAKE LINKAGE

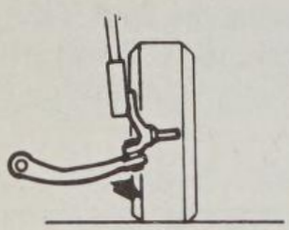
Use chassis grease on the parking brake cable where it contacts the guides, links, levers, and

LUBRICATION POINTS

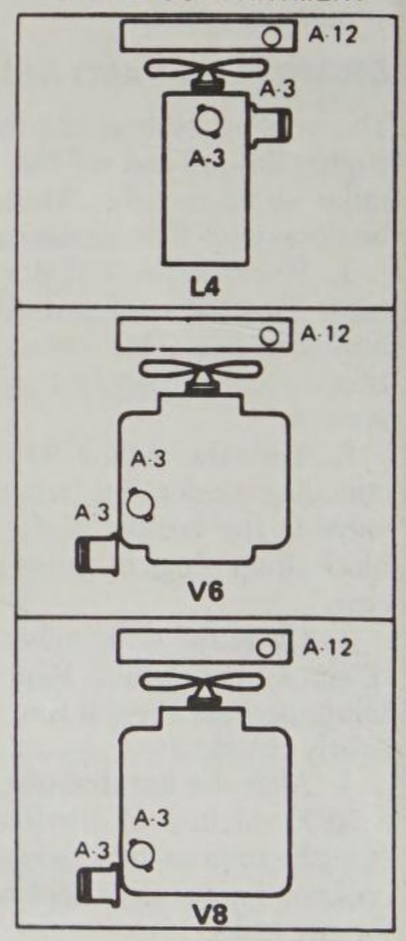
A-1	CHASSIS — SEE MAINTENANCE SCHEDULE
A-2	FLUIDS — SEE MAINTENANCE SCHEDULE
A-3	ENGINE OIL AND FILTER
A-12	COOLING SYSTEM
A-14	REAR AXLE LUBRICANT
A-15	WHEEL BEARINGS
A-16	AUTO TRANSMISSION FLUID

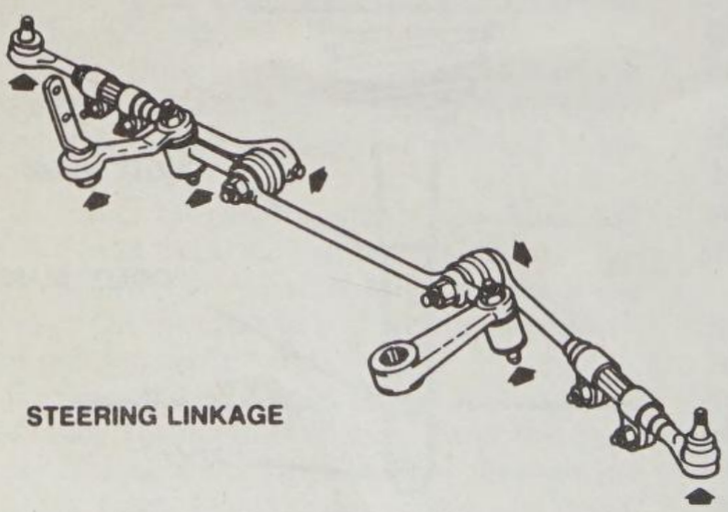


LOWER CONTROL ARM BALL JOINTS



ENGINE COMPARTMENT





STEERING LINKAGE

Lubrication points

pulleys. The grease should be a water resistant one for durability under the car.

ACCELERATOR LINKAGE

Lubricate the carburetor stud, carburetor lever, and the accelerator pedal lever at the support inside the car with clean engine oil.

TRANSMISSION SHIFT LINKAGE

Lubricate the shift linkage with water resistant chassis grease which meets GM Specification 6031M or its equal.

Wheel Bearings

Once every 30,000 miles, clean and repack wheel bearings with a wheel bearing grease. Use only enough grease to completely coat the rollers. Remove any excess grease from the exposed surface of the hub and seal.

It is important that wheel bearings be properly adjusted after installation. Improperly adjusted wheel bearings can cause steering instability, front-end shimmy and wander, and increased tire wear. For complete lubrication and adjustment procedures, see the "Wheel Bearing" section in Chapter 9.

PUSHING AND TOWING

Push Starting

This is the last recommended method of starting a car and should be used only in an extreme case. Chances of body damage are high, so be sure that the pushcar's bumper does not override your bumper. If your Chevrolet has an automatic transmission it cannot be push started. In an emergency, you can start a manual transmission car by pushing. With the bumpers evenly matched, get in your car, switch on the ignition, and place the gearshift in Second or Third gear—do not engage the clutch. Start off slowly. When the speed of the car reaches about 15–20 mph, release the clutch.

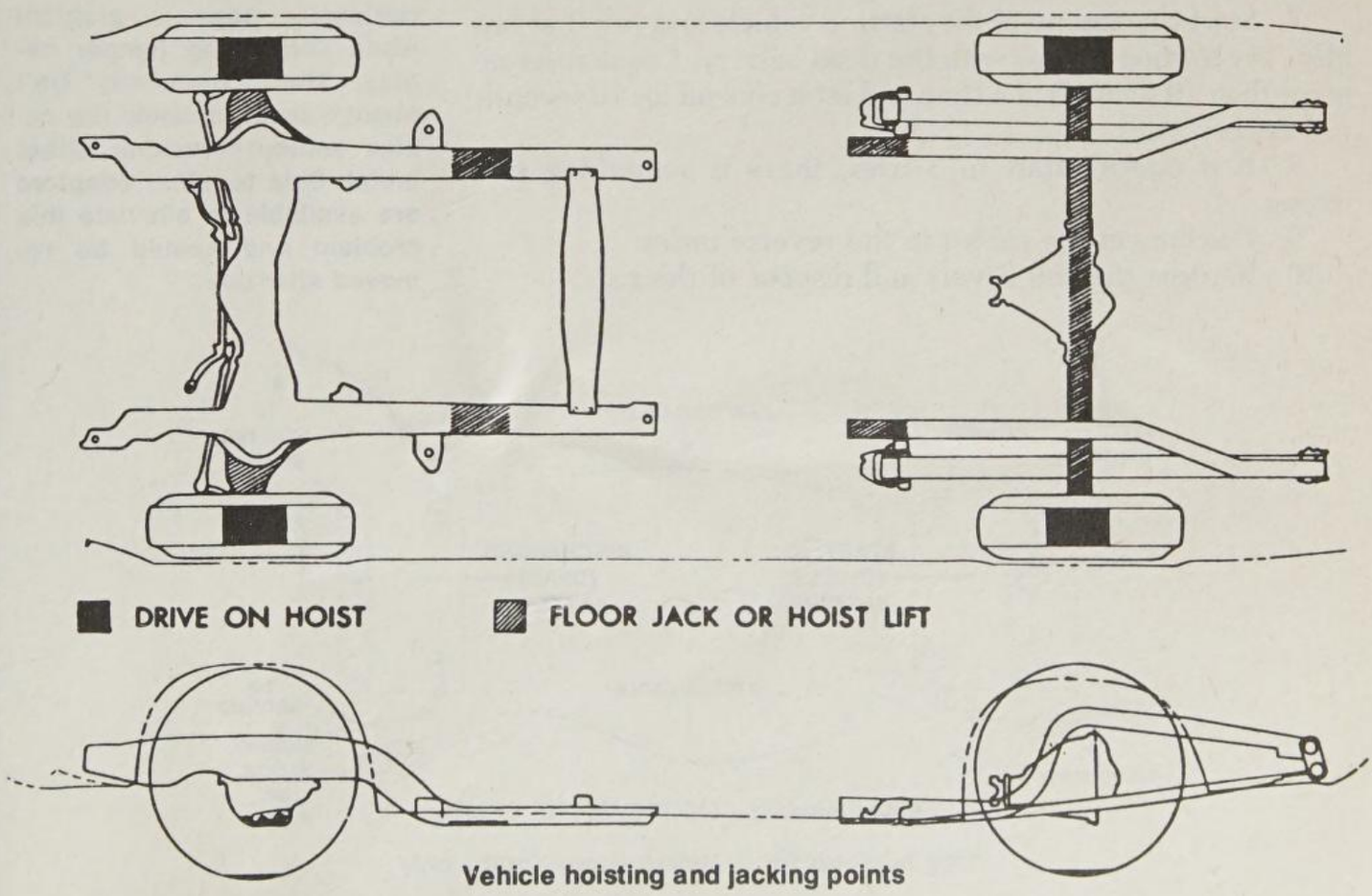
Towing

The car can be towed safely (with the transmission in Neutral) from the front at speeds of 35 mph or less. The car must either be towed with the rear wheels off the ground or the driveshaft disconnected if: towing speeds are to be over 35 mph, or towing distance is over 50 miles, or transmission or rear axle problems exist.

When towing the car on its front wheels, the steering wheel must be secured in a straight-ahead position and the steering column unlocked. Tire-to-ground clearance should not exceed 6 in. during towing.

JACKING

The standard jack utilizes slots in the bumper to raise the car. The jack supplied with the car should never be used for any service operation



Vehicle hoisting and jacking points

JUMP STARTING A DEAD BATTERY

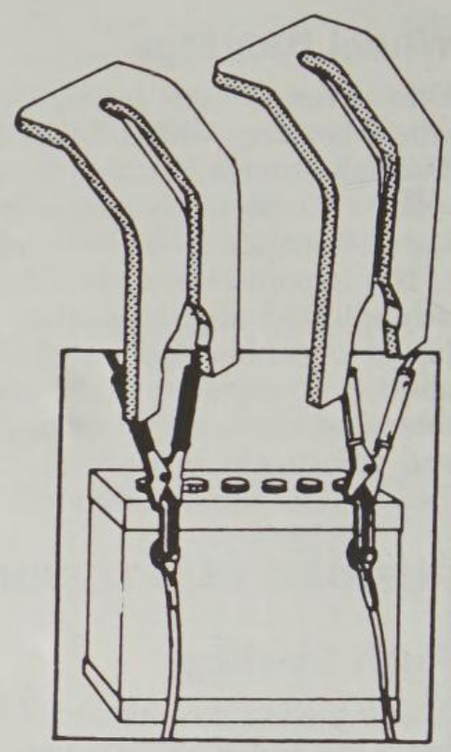
The chemical reaction in a battery produces explosive hydrogen gas. This is the safe way to jump start a dead battery, reducing the chances of an accidental spark that could cause an explosion.

Jump Starting Precautions

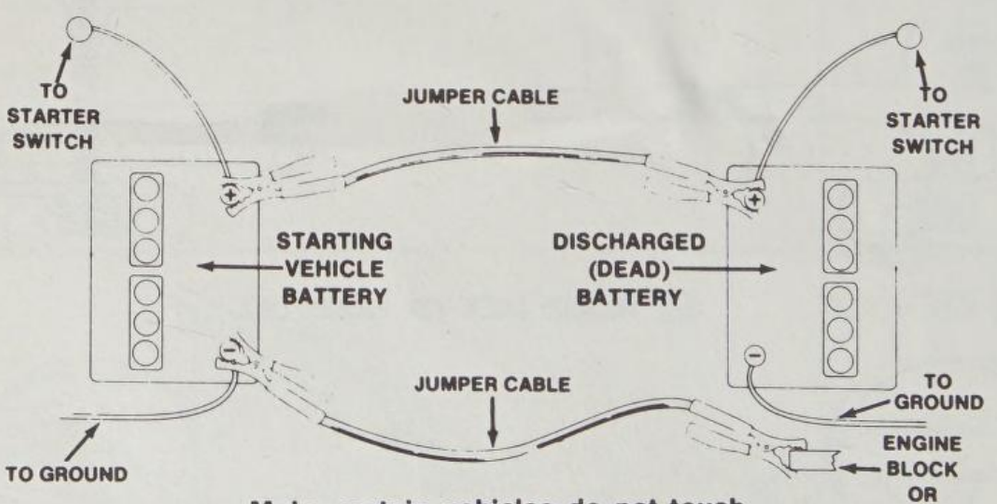
1. Be sure both batteries are of the same voltage.
2. Be sure both batteries are of the same polarity (have the same grounded terminal).
3. Be sure the vehicles are not touching.
4. Be sure the vent cap holes are not obstructed.
5. Do not smoke or allow sparks around the battery.
6. In cold weather, check for frozen electrolyte in the battery.
7. Do not allow electrolyte on your skin or clothing.
8. Be sure the electrolyte is not frozen.

Jump Starting Procedure

1. Determine voltages of the two batteries; they must be the same.
2. Bring the starting vehicle close (they must not touch) so that the batteries can be reached easily.
3. Turn off all accessories and both engines. Put both cars in Neutral or Park and set the handbrake.
4. Cover the cell caps with a rag—do not cover terminals.
5. If the terminals on the run-down battery are heavily corroded, clean them.
6. Identify the positive and negative posts on both batteries and connect the cables in the order shown.
7. Start the engine of the starting vehicle and run it at fast idle. Try to start the car with the dead battery. Crank it for no more than 10 seconds at a time and let it cool off for 20 seconds in between tries.
8. If it doesn't start in 3 tries, there is something else wrong.
9. Disconnect the cables in the reverse order.
10. Replace the cell covers and dispose of the rags.



Side terminal batteries occasionally pose a problem when connecting jumper cables. There frequently isn't enough room to clamp the cables without touching sheet metal. Side terminal adaptors are available to alleviate this problem and should be removed after use.



Make certain vehicles do not touch

This hook-up for negative ground cars only

other than tire changing. Never get under the car while it is supported by only a jack. Always block the wheels when changing tires.

The service operations in this book often require that one end or the other, or both, of the car be raised and safely supported. The ideal method, of course, would be a hydraulic hoist. Since this is beyond both the resource and requirement of the do-it-yourselfer, a small hydraulic, screw or scissors jack will suffice for the procedures in this guide. Two sturdy jackstands should be acquired if you intend to work under the car at any time. An alternate method of raising the car would be drive-on ramps. These are available commercially or can be fabricated from heavy boards or steel. Be sure to block the wheels when using ramps. Never use concrete blocks to support the car. They may break if the load is not evenly distributed.

Regardless of the method of jacking or hoisting the car, there are only certain areas of the undercarriage and suspension you can safely use to support it. See the illustration and make sure that only the shaded areas are used. In addition, be especially careful that you do not damage the catalytic converter. Remember that various cross braces and supports on a lift can sometimes contact low-hanging parts of the car.

Tune-Up and Performance Maintenance

Tune-Up Specifications

When analyzing compression test results, look for uniformity among cylinders rather than specific pressures.

Year	Engine No. Cyl Displacement (cu in.)	Spark Plugs Type	Spark Plugs Gap (in.)	Distributor	Ignition Timing	Fuel Pump Pressure (psi)	Idle Speed
'82	4-151	R-44TSX	0.060	Electronic	①	9–13	①
	6-173	R-43TS ③	0.045	Electronic	①	5½–6½	①
	8-305	R-45TS	0.045	Electronic	①	5½–6½	①
	8-305	R-45TS ②	0.045	Electronic	①	9–13	①
'83	4-151	R-44TSX	0.060	Electronic	①	9–13	①
	6-173	R-43CTS ④	0.045	Electronic	①	5½–6½	①
	8-305	R-45TS	0.045	Electronic	①	5½–6½	①
	8-305	R-45TS	0.045	Electronic	①	9–13	①
'84–'85	4-151	R-43TSX	0.060	Electronic	①	9–13	①
	6-173	R-43CTS ④	0.045	Electronic	①	5½–6½	①
	8-305	R-45TS	0.045	Electronic	①	5½–6½	①
	8-305	R-45TS	0.045	Electronic	①	9–13	①

NOTE: Underhood specifications sticker often reflects tune-up specification changes made during the production run. Sticker figures must always be used if they disagree with those in this chart. Part numbers in this chart are not recommendations by Chilton for any product by brand name.

All models use electronic ignition systems.

① These functions are controlled by the emissions computer. In rare instances when adjustment is necessary, it should be performed by a professional technician.

② Use R-44TS if a colder plug is needed

③ Use R-42TS for high performance operation.

④ Use R-42CTS for high performance operation.

TUNE-UP PROCEDURES

In order to extract the full measure of performance and economy from your engine it is essential that it is properly tuned at regular intervals. A regular tune-up will keep your Camaro's engine running smoothly and will prevent the annoying breakdowns and poor performance associated with an untuned engine.

A complete tune-up should be performed every 30,000 miles. This interval should be halved if the car is operated under severe conditions such as trailer towing, prolonged idling, start-and-stop driving, or if starting or running problems are noticed. It is assumed that the

routine maintenance described in Chapter 1 has been kept up, as this will have a decided effect on the results of a tune-up. All of the applicable steps of a tune-up should be followed in order, as the result is a cumulative one.

If the specifications on the underhood tune-up sticker in the engine compartment of your car disagree with the "Tune-Up Specifications" chart in this chapter, the figures on the sticker must be used. The sticker often reflects changes made during the production run.

NOTE: *All Camaros use electronic ignition.*

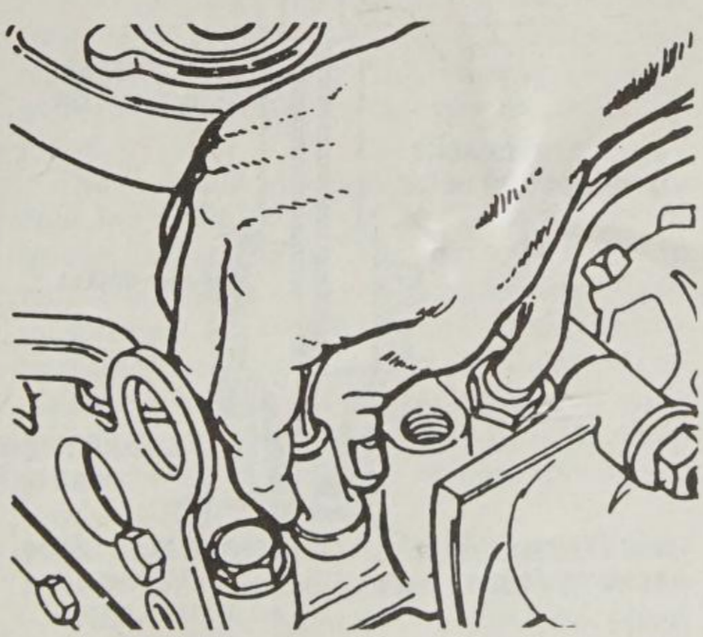
Spark Plugs

REPLACEMENT

Removal

When you're removing spark plugs, you should work on one at a time. Don't start by removing the plug wires all at once because unless you number them, they're going to get mixed up. On some models though, it will be more convenient for you to remove all the wires before you start to work on the plugs. If this is necessary, take a minute before you begin and number the wires with tape before you take them off. The time you spend here will pay off later on.

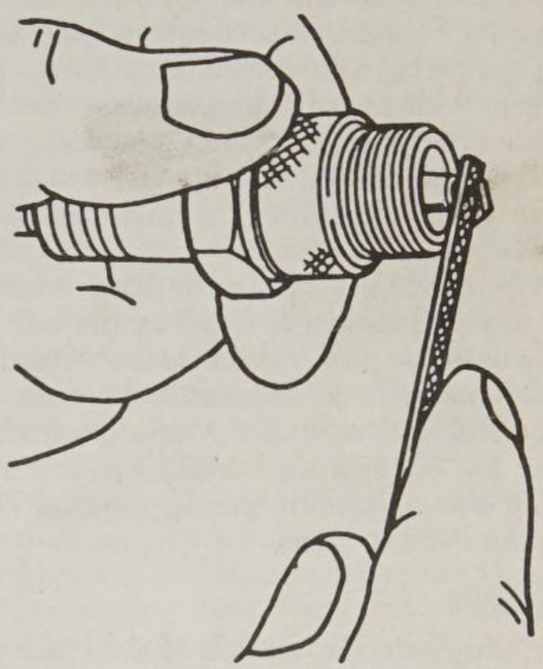
1. Twist the spark plug boot and remove the boot from the plug. You may also use a plug wire removal tool designed especially for this purpose. *Do not pull on the wire itself.* When the wire has been removed, take a wire brush and clean the area around the plug. Make sure that all the grime is removed so that none will enter the cylinder after the plug has been removed.
2. Remove the plug using the proper size socket, extensions, and universals as necessary.
3. If removing the plug is difficult, drip some penetrating oil on the plug threads, allow it to work, then remove the plug. Also, be sure that the socket is straight on the plug, especially on those hard to reach plugs.



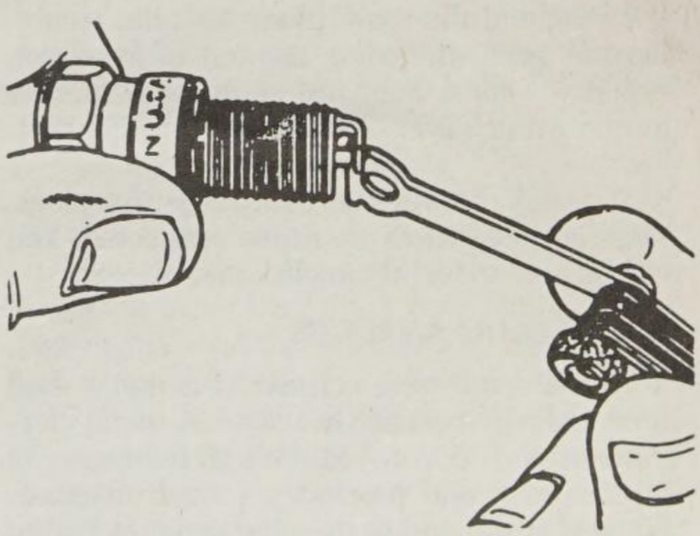
Twist and pull on the rubber boot to remove the spark plug wires; never pull on the wire itself

Inspection

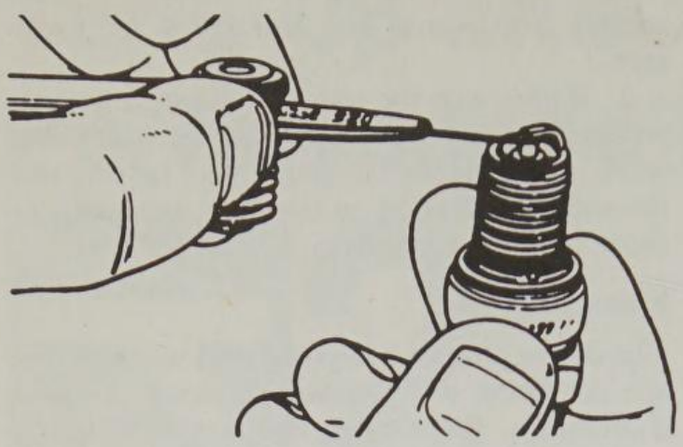
Check the plugs for deposits and wear. If they are not going to be replaced, clean the plugs thoroughly. Remember that any kind of deposit will decrease the efficiency of the plug. Plugs can be cleaned on a spark plug cleaning machine, which can sometimes be found in service stations, or you can do an acceptable job of cleaning with a stiff brush. If the plugs are cleaned, the electrodes must be filed flat. Use an ignition points file, not an emery board or the like, which will leave deposits. The electrodes must be filed perfectly flat with sharp



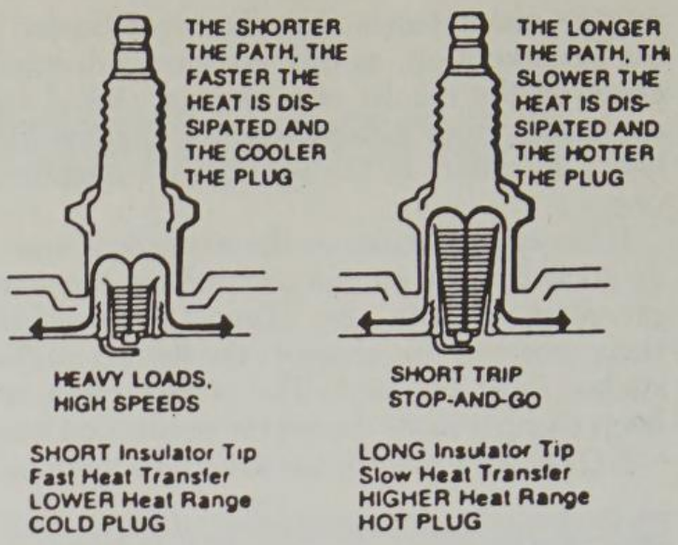
Plugs that are in good condition can be filed and re-used



Adjust the electrode gap by bending the side electrode



Always use a wire gauge to check the electrode gap



Spark plug heat range

edges; rounded edges reduce the spark plug voltage by as much as 50%.

Check spark plug gap before installation. The ground electrode (the L-shaped one connected to the body of the plug) must be parallel to the center electrode and the specified size wire gauge (see "Tune-Up Specifications") should pass through the lap with a slight drag. Always check the gap with a slight drag. Always check the gap on new plugs, they are not always set correctly at the factory. Do not use a flat feeler gauge when measuring the gap, because the reading will be inaccurate.

Wire gapping tools usually have a bending tool attached. Use that to adjust the side electrode until the proper distance is obtained. *Absolutely never bend the center electrode.* Also, be careful not to bend the side electrode too far or too often; it may weaken and break off within the engine, requiring removal of the cylinder head to retrieve it.

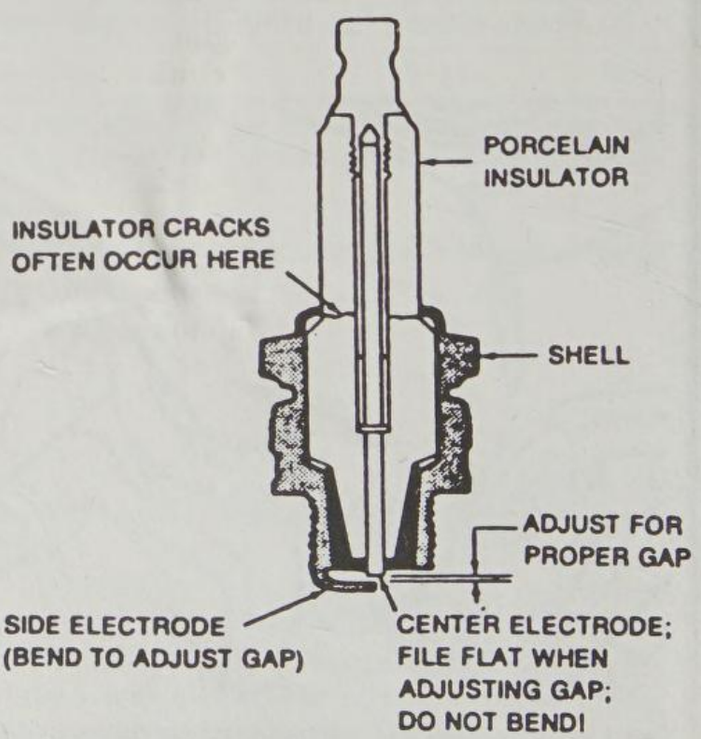
Installation

1. Lubricate the threads of the spark plugs with a drop of oil. Install the plugs and tighten them hand-tight. Take care not to cross-thread them.
2. Tighten the spark plugs with the socket. Do not apply the same amount of force you would use for a bolt; just snug them in. If a torque wrench is available, tighten to 11–15 ft. lbs.
3. Install the wires on their respective plugs. Make sure the wires are firmly connected. You will be able to feel them click into place.

SPARK PLUG ANALYSIS

A typical spark plug consists of a metal shell surrounding a ceramic insulator. A metal electrode extends downward through the center of the insulator and protrudes a small distance. Located at the end of the plug and attached to the side of the outer metal shell is the side electrode. This side electrode bends in at 90° so its tip is even with, and parallel to, the tip of the center electrode. This distance between these two electrodes (measured in thousandths of an inch) is called spark plug gap. The spark plug in no way produces a spark but merely provides a gap across which the current can arc. The coil produces approximately 80,000 volts, which travels to the distributor where it is distributed through the spark plug wires to the plugs. The current passes along the center electrode and jumps the gap to the side electrode and, in so doing, ignites the air/fuel mixture in the combustion chamber. All plugs used in Camaros have a resistor built into the center electrode to reduce interference to any nearby radio and television receivers. The resistor also cuts down on erosion of plug electrodes caused by excessively long sparking. Resistor spark plug wiring is original equipment on all Camaros.

Spark plug life and efficiency depend upon the condition of the engine and the tempera-



Cross section of a spark plug

tures to which the plug is exposed. Combustion chamber temperatures are affected by many factors such as compression ratio of the engine, fuel/air mixtures, exhaust emission equipment, and the type of driving you do. Spark plugs are designed and classified by number according to the heat range at which they will operate most efficiently. The amount of heat that the plug absorbs is determined by the length of the lower insulator. The longer the insulator (it extends farther into the engine), the hotter the plug will operate; the shorter it is, the cooler it will operate.

A plug that has a short path for heat transfer and remains too cool will quickly accumulate deposits of oil and carbon since it is not hot enough to burn them off. This leads to plug fouling and consequently to misfiring. A plug that has a long path for heat transfer will have no deposits but, due to the excessive heat, the electrodes will burn away quickly and, in some instances, pre-ignition may result.

Pre-ignition takes place when plug tips get so hot that they glow sufficiently to ignite the fuel/air mixture before the spark does. This early ignition will usually cause a pinging (sounding much like castanets) during low speeds and heavy loads. In severe cases, the heat may become enough to start the fuel/air mixture burning throughout the combustion chamber rather than just to the front of the plug as in normal operation. At this time, the piston is rising in the cylinder making its compression stroke. The burning mass is compressed and an explosion results producing tremendous pressure. Something has to give, and it does—pistons are often damaged. Obviously, this detonation (explosion) is a destructive condition that can be avoided by installing a spark plug designed and specified for your particular engine.

A set of spark plugs usually requires replacement after 10,000 to 12,000 miles depending on the type of driving. This interval has been increased to 30,000 miles, with electronic ignition.

The electrode on a new spark plug has a sharp edge but, with use, this edge becomes rounded by erosion causing the plug gap to increase. In normal operation, plug gap increases about 0.001 in. in every 1,000–2,000 miles. As the gap increases, the plug's voltage requirement also increases. It requires a greater voltage to jump the wider gap and about two to three times as much voltage to fire a plug at high speeds and acceleration than at idle.

The higher voltage produced by the HEI ignition coil is one of the primary reasons for the prolonged replacement interval for spark plugs. A consistently hotter spark prevents the fouling of plugs for much longer than could normally be expected; this spark is also able to jump across a larger gap more efficiently than a spark from a conventional system. However, even plugs used with the HEI system wear after time in the engine.

Worn plugs become obvious during acceleration. Voltage requirement is greatest during acceleration and a plug with an enlarged gap may require more voltage than the coil is able to produce. As a result, the engine misses and sputters until acceleration is reduced. Reducing acceleration reduces the plug's voltage requirement and the engine runs smoother. Slow, city driving is hard on plugs. The long periods of idle experienced in traffic creates an overly rich gas mixture. The engine isn't running fast enough to completely burn the gas and, consequently, the plugs are fouled with gas deposits and engine idle becomes rough. In many cases, driving under right conditions can effectively clean these fouled plugs.

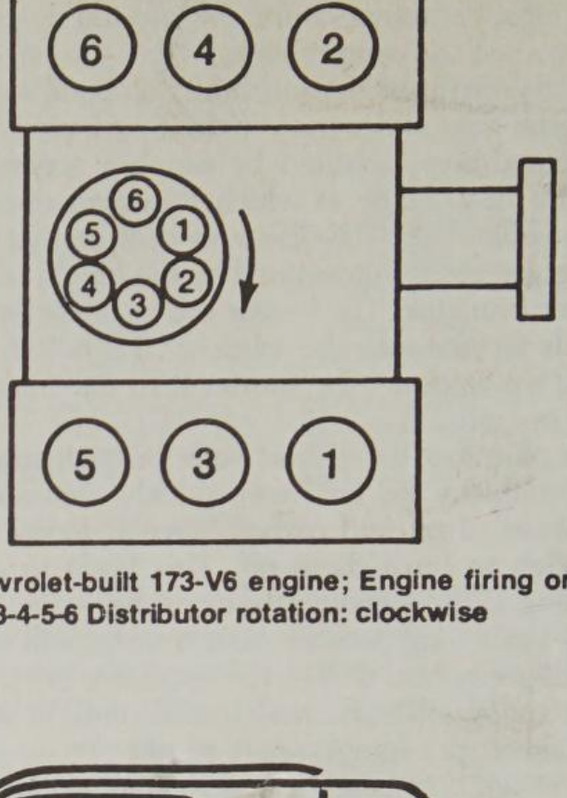
NOTE: *There are several reasons why a spark plug will foul and you can usually learn which is at fault by just looking at the plug. A few of the most common reasons for plug fouling, and a description of the fouled plug's appearance, can be found in the color insert in this book.*

Accelerate your car to the speed where the engine begins to miss and then slow down to the point where the engine smooths out. Run at this speed for a few minutes and then accelerate again to the point of engine miss. With each repetition this engine miss should occur at increasingly higher speeds and then disappear altogether. Do not attempt to shortcut this procedure by hard acceleration. This approach will compound problems by fusing deposits into a hard permanent glaze. Dirty, fouled plugs may be cleaned by sandblasting. Many shops have a spark plug sandblaster. After sandblasting, the electrode should be filed to a sharp, square shape and then gapped to specifications. Gapping a plug too close will produce a rough idle while gapping it too wide will increase its voltage requirement and cause missing at high speeds and during acceleration.

The type of driving you do may require a change in spark plug heat range. If the majority of your driving is done in the city and rarely at high speeds, plug fouling may necessitate changing to a plug with a heat range number one higher than that specified by the car manufacturer. For example, a 1985 Camaro with a 305 cu in. engine requires an R-45TS plug. Frequent city driving may foul these plugs making engine operation rough. An R-46TS is the next hottest plug in the AC heat range (the higher the AC number, the hotter the plug) and its insulator is longer than the R-45TS so

that it can absorb and retain more heat. This hotter R-46TS burns off deposits even at low city speeds but would be too hot for prolonged turnpike driving. Using this plug at high speeds would create dangerous pre-ignition.

If the car is used for abnormal driving (as in the examples above), or the engine has been modified for higher performance, then a change to a plug of a different heat range may be necessary. For a modified car it is always wise to go to a colder plug as a protection against pre-ignition. It will require more frequent plug cleaning, but destructive detonation during acceleration will be avoided.



Chevrolet-built 173-V6 engine; Engine firing order: 1-2-3-4-5-6 Distributor rotation: clockwise

SPARK PLUG WIRES

Checking and Replacing

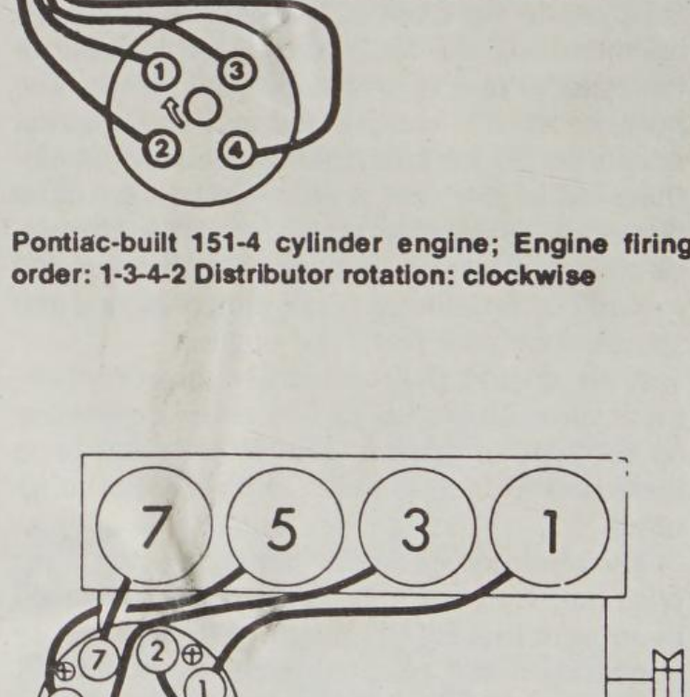
Every 15,000 miles, inspect the spark plug wires for burns, cuts, or breaks in the insulation. Check the boots and the nipples on the distributor cap. Replace any damaged wiring.

Every 45,000 miles or so, the resistance of the wires should be checked with an ohmmeter. Wires with excessive resistance will cause misfiring, and may make the engine difficult to start in damp weather. Generally, the useful life of the cables is 45,000–60,000 miles.

To check resistance, remove the distributor cap, leaving the wires in place. Connect one lead of an ohmmeter to an electrode within the cap; connect the other lead to the corresponding spark plug terminal (remove it from the spark plug for this test). Replace any wire which shows a resistance over 30,000 ohms. Generally speaking, however, resistance should not be over 25,000 ohms, and 30,000 ohms must be considered the outer limit of acceptability.

It should be remembered that resistance is also a function of length; the longer the wire, the greater the resistance. Thus, if the wires on your car are longer than the factory originals, resistance will be higher, quite possibly outside these limits.

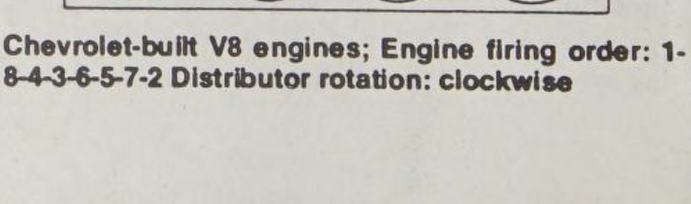
When installing new wires, replace them one at a time to avoid mixups. Start by replacing the longest one first. Install the boot firmly over the spark plug. Route the wire over the same path as the original. Insert the nipple firmly onto the tower on the distributor cap, then install the cap cover and latches to secure the wires.



Pontiac-built 151-4 cylinder engine; Engine firing order: 1-3-4-2 Distributor rotation: clockwise

Firing Order

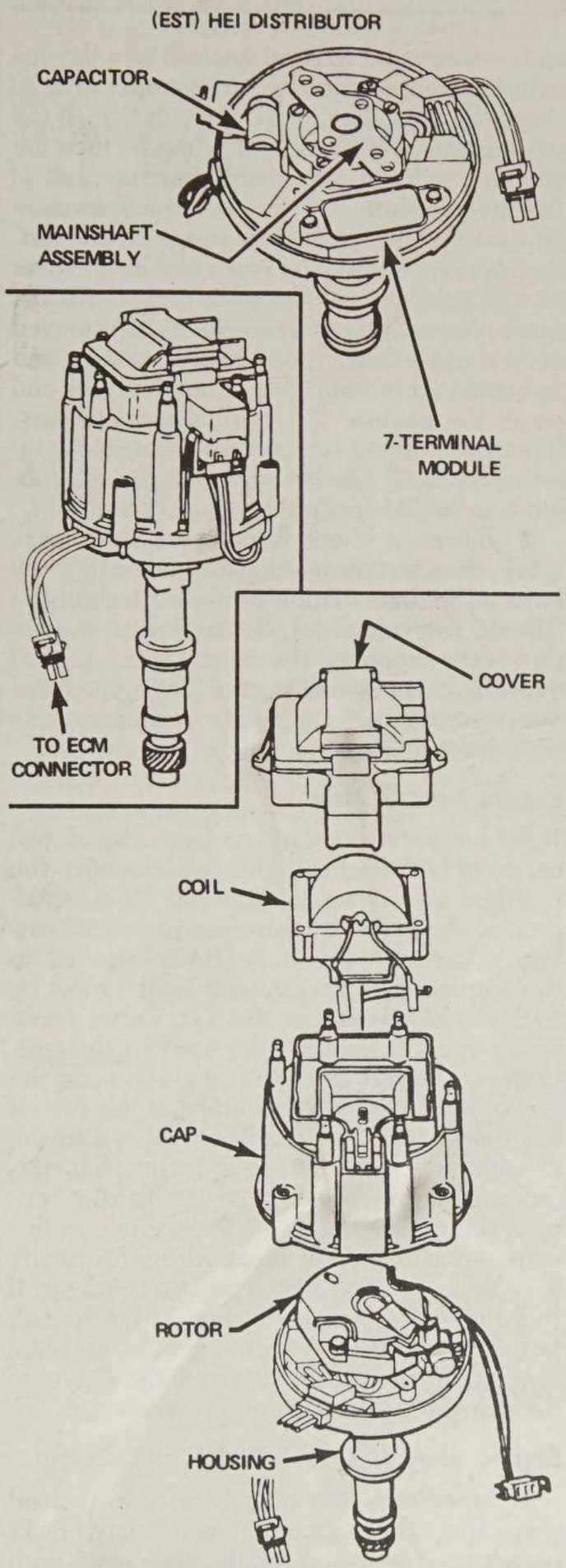
To avoid confusion, replace spark plug wires one at a time.



Chevrolet-built V8 engines; Engine firing order: 1-8-4-3-6-5-7-2 Distributor rotation: clockwise

High Energy Ignition (HEI) System

The General Motors HEI system is a pulse-triggered, transistor-controlled, inductive discharge ignition system. It is a completely self-contained unit—all parts are contained within the distributor.



H.E.I. (EST) distributor

The distributor contains the electronic control module, and the magnetic triggering device. The magnetic pick-up assembly contains a permanent magnet, a pole piece with internal "teeth," and a pickup coil (not to be confused with the ignition coil).

For 1982 and later, an HEI distributor with Electronic Spark Timing is used (for more information on EST, refer to Chapter 4). It is unlike most other HEI distributors, which use an externally mounted ignition coil connected to the distributor by means of a high tension wire.

All spark timing changes are done electronically by the Electronic Control Module (ECM) which monitors information from various engine sensors, computes the desired spark timing and then signals the distributor to change the timing accordingly. No vacuum or mechanical advance systems are used.

In the HEI system, as in other electronic ignition systems, the breaker points have been replaced with an electronic switch—a transistor—which is located *within* the control module. This switching transistor performs the same function the points did in a conventional ignition system; it simply turns the coil's primary current on and off at the correct time. Essentially electronic and conventional ignition systems operate on the same principle.

The module which houses the switching transistor is controlled (turned on and off) by a magnetically generated impulse induced in the pick-up coil. When the teeth of the rotating timer align with the teeth of the pole piece, the induced voltage in the pick-up coil signals the electronic module to open the coil primary circuit. The primary current then decreases, and a high voltage is induced in the ignition coil secondary windings which is then directed through the rotor and high voltage leads (spark plug wires) to fire the spark plugs.

In essence, the pick-up coil module system simply replaces the conventional breaker points and condenser. The condenser found within the distributor is for radio suppression purposes only and has nothing to do with the ignition process. The module automatically controls the dwell period, increasing it with increasing engine speed. Since dwell is automatically controlled, it cannot be adjusted. The module itself is non-adjustable and non-repairable and must be replaced if found defective.

HEI SYSTEM PRECAUTIONS

Before going on to troubleshooting, it might be a good idea to take note of the following precautions:

Timing Light Use

Inductive pick-up timing lights are the best kind to use with HEI. Timing lights which connect between the spark plug and the spark plug wire occasionally (not always) give false readings.

Spark Plug Wires

The plug wires used with HEI systems are of a different construction than conventional wires. When replacing them, make sure you get the correct wires, since conventional wires won't carry the voltage. Also, handle them carefully to avoid cracking or splitting them and *never* pierce them.

Tachometer Use

Not all tachometers will operate or indicate correctly when used on a HEI system. While some tachometers may give a reading, this does not necessarily mean the reading is correct. In addition, some tachometers hook up differently from others. If you can't figure out whether or not your tachometer will work on your car, check with the tachometer manufacturer. Dwell readings, of course, have no significance at all.

HEI System Testers

Instruments designed specifically for testing HEI systems are available from several tool manufacturers. Some of these will even test the module itself. However, the tests given in the following section will require only an ohmmeter and a voltmeter.

TROUBLESHOOTING THE HEI SYSTEM

The symptoms of a defective component within the HEI system are exactly the same as those you would encounter in a conventional system. Some of these symptoms are:

- Hard or no Starting
- Rough Idle
- Poor Fuel Economy
- Engine misses under load or while accelerating.

If you suspect a problem in your ignition system, there are certain preliminary checks which you should carry out before you begin to check the electronic portions of the system. First, it is extremely important to make sure the vehicle battery is in good state of charge. A defective or poorly charged battery will cause the various components of the ignition system to read incorrectly when they are being tested. Second, make sure all wiring connections are clean and tight, not only at the battery, but also at the distributor cap, ignition coil, and at the electronic control module.

Since the only change between electronic and conventional ignition systems is in the distributor component area, it is imperative to check the secondary ignition circuit first. If the secondary circuit checks out properly, then the engine condition is probably not the fault of the ignition system. To check the secondary ignition system, perform a simple spark test. Remove one of the plug wires and insert some sort of extension in the plug socket. An old spark plug with the ground electrode removed makes a good extension. Hold the wire and extension about ¼ in. away from the block and crank the engine. If a normal spark occurs, then the problem is most likely *not* in the ignition system. Check for fuel system problems, or fouled spark plugs.

If, however, there is no spark or a weak spark, then further ignition system testing will have to be done. Troubleshooting techniques fall into two categories, depending on the nature of the problem. The categories are (1) Engine cranks, but won't start or (2) Engine runs, but runs rough or cuts out. To begin with, let's consider the first case.

HEI Plug Wire Resistance Chart

Wire Length	Minimum	Maximum
0–15 inches	3000 ohms	10,000 ohms
15–25 inches	4000 ohms	15,000 ohms
25–35 inches	6000 ohms	20,000 ohms
Over 35 inches		25,000 ohms

Engine Fails to Start

If the engine won't start, perform a spark test as described earlier. This will narrow the problem area down considerably. If no spark occurs, check for the presence of normal battery voltage at the battery (BAT) terminal on the ignition coil. The ignition switch must be in the "ON" position for this test. Either a voltmeter or a test light may be used for this test. Connect the test light wire to ground and the probe end to the BAT terminal at the coil. If the light comes on, you have voltage to the distributor. If the light fails to come on, this indicates an open circuit in the ignition primary wiring leading to the distributor. In this case, you will have to check wiring continuity back to the ignition switch using a test light. If there is battery voltage at the BAT terminal, but no spark at the plugs, then the problem lies within the distributor assembly. Go on to the distributor components test section.

Engine Runs, But Runs Rough or Cuts Out

1. Make sure the plug wires are in good shape first. There should be no obvious cracks or breaks. You can check the plug wires with an ohmmeter, but *do not* pierce the wires with

a probe. Check the chart for the correct plug wire resistance.

2. If the plug wires are OK, remove the cap assembly and check for moisture, cracks, chips, or carbon tracks, or any other high voltage leaks or failures. Replace the cap if any defects are found. Make sure the timer wheel rotates when the engine is cranked. If everything is all right so far, go on to the distributor components test section following.

DISTRIBUTOR COMPONENTS TESTING

If the trouble has been narrowed down to the units within the distributor, the following tests can help pinpoint the defective component. An ohmmeter with both high and low ranges should be used. These tests are made with the cap assembly removed and the battery wire disconnected. If a tachometer is connected to the TACH terminal, disconnect it before making these tests.

1. Connect an ohmmeter between the TACH and BAT terminals on the ignition coil. The primary coil resistance should be less than one ohm.

2. To check the coil secondary resistance, connect an ohmmeter between the high tension terminal and the BAT terminal. Note the reading. Connect the ohmmeter between the high tension terminal and the TACH terminal. Note the reading. The resistance in both cases should be between 6,000 and 30,000 ohms. Be sure to test between the high tension terminal and both the BAT and TACH terminals.

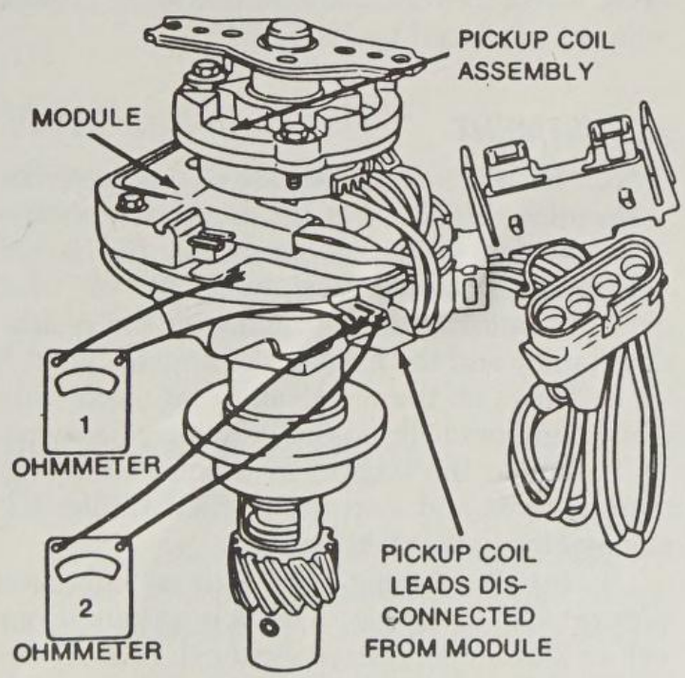
3. Replace the coil *only* if the readings in Step 1 and Step 2 are infinite.

NOTE: *These resistance checks will not disclose shorted coil windings. This condition can only be detected with scope analysis or a suitably designed coil tester. If these instruments are unavailable, replace the coil with a known good coil as a final coil test.*

4. To test the pick-up coil, first disconnect the white and green module leads. Set the ohmmeter on the high scale and connect it between a ground and either the white or green lead. Any resistance measurement *less* than infinity requires replacement of the pick-up coil.

5. Pick-up coil continuity is tested by connecting the ohmmeter (on low range) between the white and green leads. Normal resistance is between 500 and 1500 ohms. If a vacuum unit is used, move the vacuum advance arm while performing this test. This will detect any break in coil continuity. Such a condition can cause intermittent misfiring. Replace the pick-up coil if the reading is outside the specified limits.

6. If no defects have been found at this time, and you still have a problem, then the module will have to be checked. If you do not have access to a module tester, the only possible alternative is a substitution test. If the module fails the substitution test, replace it.



Ohmmeter 1 shows the connections for testing the pick-up coil. Ohmmeter 2 shows the connections for testing the pick-up coil continuity

HEI SYSTEM MAINTENANCE

Except for periodic checks on the spark plug wires, and an occasional check of the distributor cap for cracks (see Steps 1 and 2 under "Engine Runs, But Runs Rough or Cuts Out" for details), no maintenance is required on the HEI system. No periodic lubrication is necessary; engine oil lubricates the lower bushing, and an oil-filled reservoir lubricates the upper bushing.

DISTRIBUTOR CAP REMOVAL AND INSTALLATION

1. Disconnect the ignition switch wire from the distributor cap. Also disconnect the tachometer wire, if so equipped.

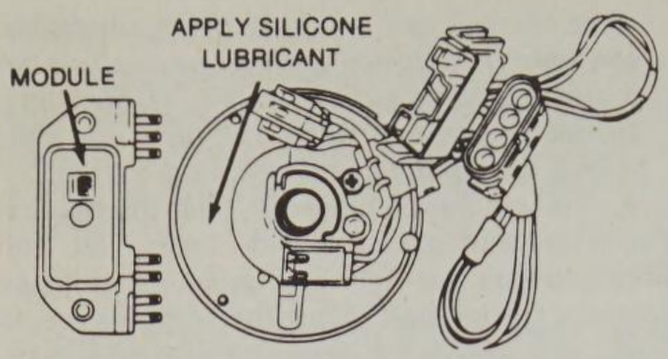
2. Release the coil connectors from the cap.

3. Remove the distributor cap by turning the four latches (the L4 distributor has 2 latches) counterclockwise.

4. Remove the cap. Installation is the reverse of removal. Be sure you get the ignition and tachometer wires connected to the correct terminals.

Rotor

1. Disconnect the negative battery cable.
2. Remove the distributor cap.
3. Unscrew the two rotor attaching screws and then lift off the rotor.



Module replacement; be sure to coat the mating surfaces with silicone lubricant

4. Installation is in the reverse order of removal.

Pick-Up Coil

1. Disconnect the negative battery cable.
2. Remove the distributor cap and then the rotor.
3. Remove 3 screws from the magnetic shield. Remove the magnetic shield and "c" washer. Remove the magnet, pole piece and pick-up coil.
4. Installation is the reverse of the removal procedure.

Ignition Timing

DESCRIPTION

Ignition timing is the measurement, in degrees of crankshaft rotation, of the point at which the spark plugs fire in each of the cylinders. It is measured in degrees before or after Top Dead Center (TDC) of the compression stroke.

Because it takes a fraction of a second for the spark plug to ignite the mixture in the cylinder, the spark plug must fire a little before the piston reaches TDC. Otherwise, the mixture will not be completely ignited as the piston passes TDC and the full power of the explosion will not be used by the engine.

The timing measurement is given in degrees of crankshaft rotation before the piston reaches TDC (BTDC). If the setting for the ignition timing is 5° BTDC, the spark plug must fire 5° before each piston reaches TDC. This only holds true, however, when the engine is at idle speed.

As the engine speed increases, the pistons go faster. The spark plugs have to ignite the fuel even sooner if it is to be completely ignited when the piston reaches TDC.

If the ignition is set too far advanced (BTDC), the ignition and expansion of the fuel in the cylinder will occur too soon and tend to force the piston down while it is still traveling up. This causes engine ping. If the ignition spark is set too far retarded, after TDC (ATDC), the piston will have already passed TDC and started on its way down when the fuel is ignited. This will cause the piston to be forced down for only a portion of its travel. This will result in poor engine performance and lack of power.

When timing the engine, the Number 1 plug wire should be used to trigger the timing light. The notch for the No. 1 cylinder is scribed across all three edges of the double sheave pulley. Another notch located 180 degrees away from the No. 1 cylinder notch is scribed only across the center section of the pulley to make it distinguishable from the No. 1 cylinder notch.

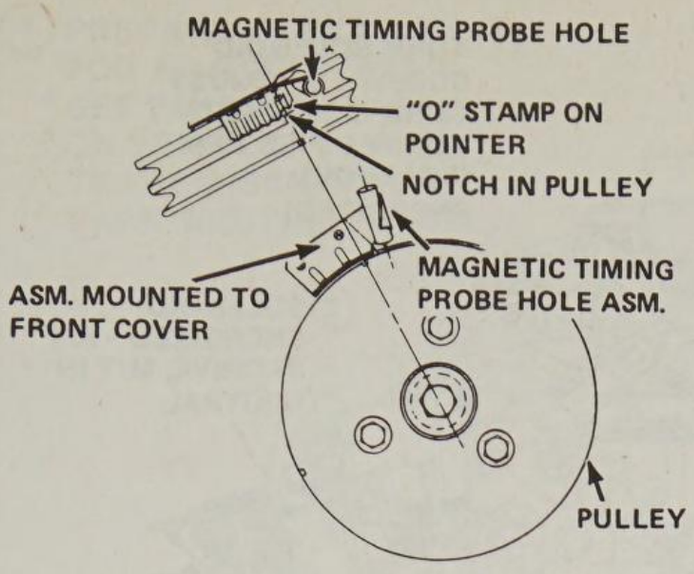
There are two basic types of timing lights available. The first type of light operates from the car's battery. Two alligator clips connect to the battery terminals, while a third wire connects to the spark plug with an adapter or to the spark plug wire with an inductive pickup. This type of light is more expensive, but the xenon bulb provides a nice bright flash which can even be seen in sunlight. The second type replaces the battery source with 110 volt house current. Some timing lights have other functions built into them, such as dwell meters, tachometers, or remote starting switches. These are convenient, in that they reduce the tangle of wires under the hood, but may duplicate the functions of tools you already have.

Because the car has electronic ignition, you should use a timing light with an inductive pickup. This pickup simply clamps around the Number 1 spark plug wire (in this case, the coil wire), eliminating the adapter. It is not susceptible to crossfiring or false triggering, which may occur with a conventional light due to the greater voltages produced by HEI.

ADJUSTMENT

NOTE: *When adjusting the timing, refer to the instructions on the emission control sticker inside the engine compartment. Follow all instructions on the label.*

1. Locate the timing marks on the crankshaft pulley and the front of the engine.
2. Clean off the marks and coat them with white paint or chalk, so that they may be seen.
3. Warm the engine to normal operating temperatures and stop the engine. Connect a tachometer to the distributor.
4. Install a timing light with an inductive pick-up lead to the No. 1 spark plug wire; front cyl. of 2.5L engine, front right cyl. of 2.8L engine and front left cyl. of 5.0L engine.
5. For 2.5L engines, follow emission control sticker instructions. For 2.8L and 5.0L VIN



View of the timing marks, located at the front of the engine

H engines, disconnect the 4-wire connector at the distributor. For the 5.0L VIN S engine, disconnect the Tan/Black wire at the right valve cover to place the EST into the by-pass mode; DO NOT disconnect the 4-wire connector at the distributor.

6. Turn "OFF" all accessories, place the transmission in "NEUTRAL" for manual and "PARK" for auto. Set the parking brake.

7. Loosen the distributor bolt so that the distributor may be turned.

8. Start the engine and aim the timing light at the timing marks. With the engine idling, adjust the timing marks.

9. Turn the engine "OFF" and tighten the distributor bolt. Turn the engine "ON" and recheck the timing marks.

10. Turn the engine "OFF" and disconnect the timing light and tachometer. Reconnect the distributor connectors.

Valve Lash

All models utilize a hydraulic valve lifter system to obtain zero lash. No adjustment is necessary. An initial adjustment is required anytime that the lifters are removed or the valve train is disturbed, this procedure is covered in Chapter 3.

Idle Speed and Mixture Adjustments

NOTE: *Idle mixture adjustments are factory set and sealed; no adjustment attempt should be made, except by an authorized GM dealer.*

NOTE: *Idle speed settings, for the 4-barrel and the TBI (Throttle Body Injection), are factory adjusted; adjustments should be made by an authorized GM dealer ONLY.*

IDLE SPEED (2-BARREL)

Without A/C

1. Refer to the emission label on the vehicle and prepare the engine for adjustments (set the timing). Set the parking brake. Connect a tachometer to the distributor connector.

2. Place the transmission in "DRIVE" for A/T and "NEUTRAL" for M/T; make sure that the solenoid is energized.

3. Open the throttle slightly to allow the solenoid plunger to extend. Adjust the curb idle speed to the specified rpm by turning the solenoid screw.

4. De-energize the solenoid by disconnecting the electrical lead.

5. Set the basic idle speed rpm by turning the idle speed screw. After adjustment, reconnect the solenoid electrical lead.

6. Remove the tachometer and install the air cleaner.

With A/C

1. Refer to the emission label on the vehicle and prepare the engine for adjustments (set the timing). Remove the air cleaner and set the parking brake. Connect a tachometer to the distributor connector.

2. Place the transmission in "DRIVE" for A/T and "NEUTRAL" for M/T. Turn the A/C "OFF" and set the curb idle speed by turning the idle speed screw.

3. Disconnect the A/C lead at the A/C compressor; make sure the solenoid is energized. Open the throttle slightly to allow the solenoid plunger to extend.

4. Turn the solenoid screw to adjust to the specified rpm. After adjustment, reconnect the A/C compressor lead, remove the tachometer and install the air cleaner.

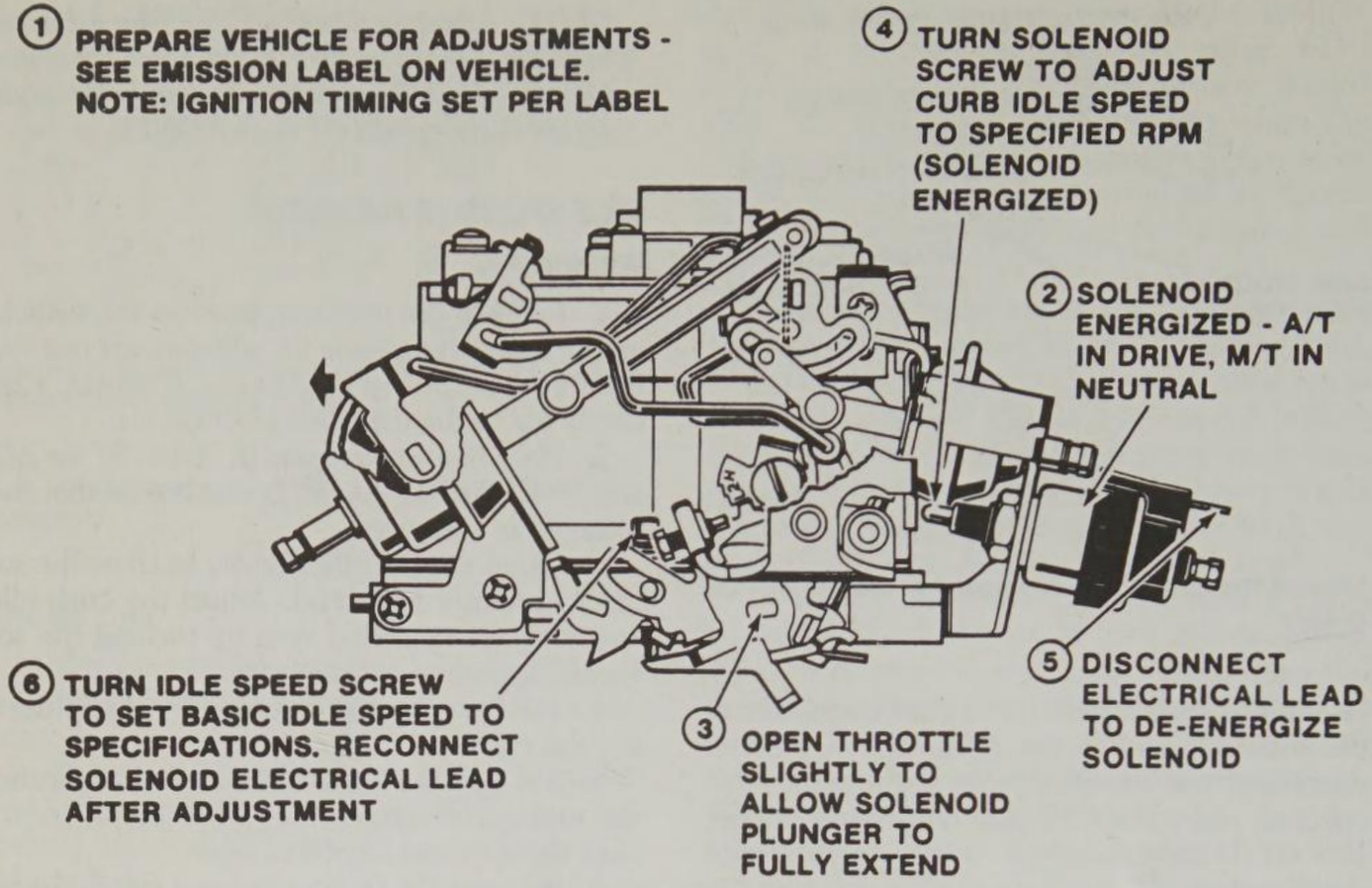
FAST IDLE (2-BARREL)

NOTE: *Following the adjustment of the idle speed, the fast idle speed may be adjusted.*

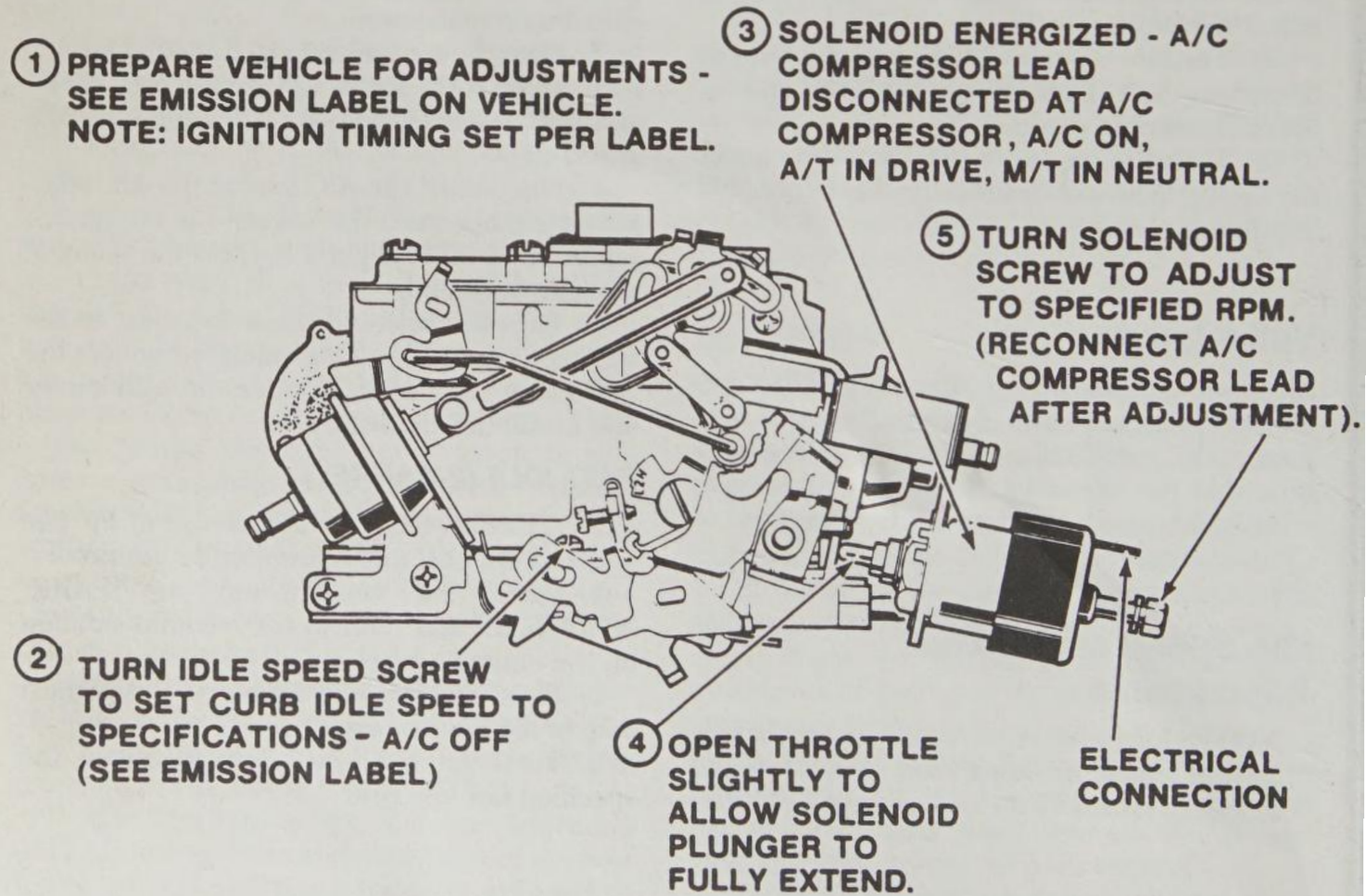
1. Place the transmission in "PARK/NEUTRAL" and refer to the recommendation on the emission label.

2. Place the fast idle screw on the highest step of the fast idle cam.

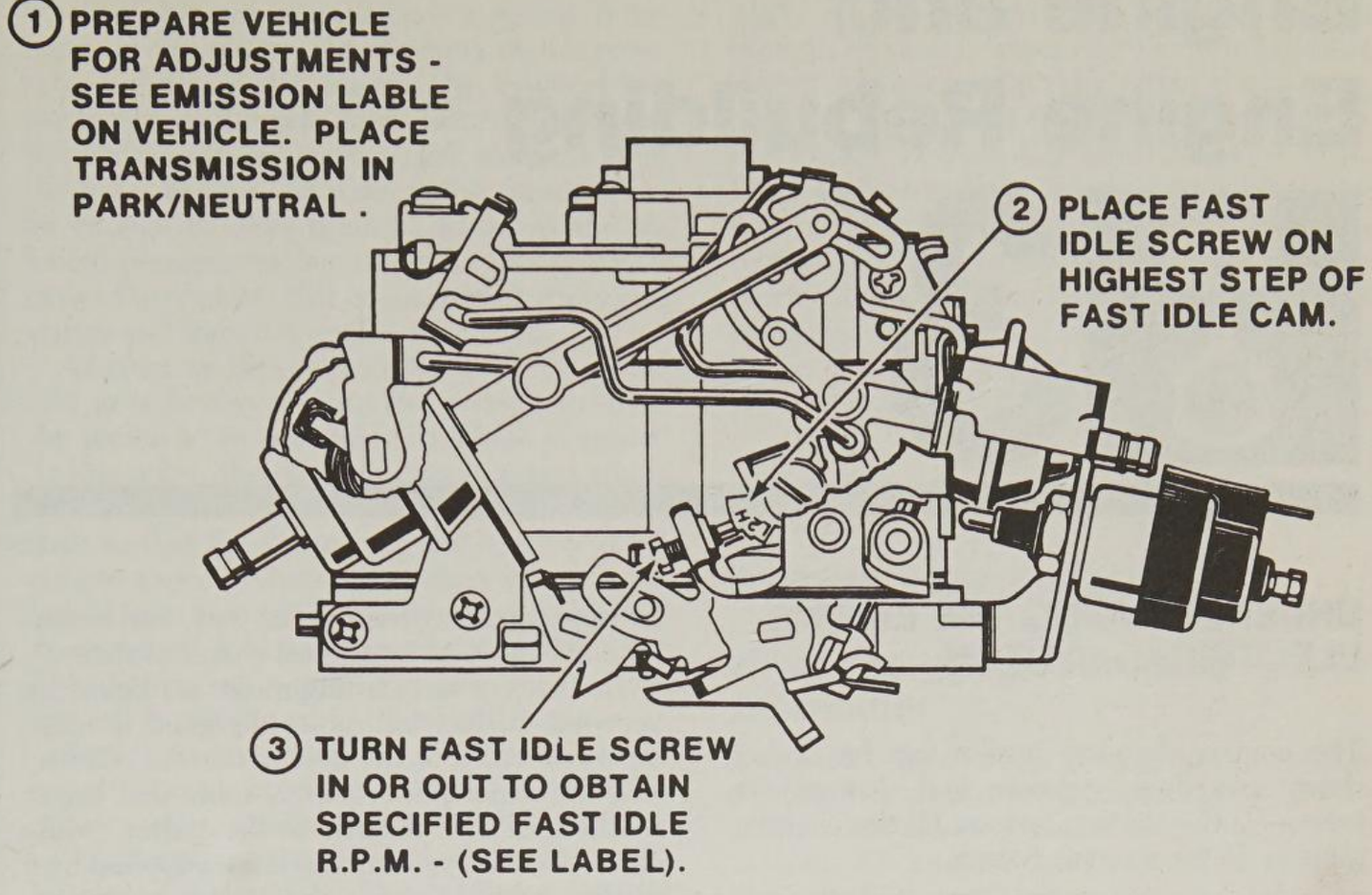
3. Turn the fast idle screw to obtain the specified fast idle rpm.



Idle speed adjustment—without A/C

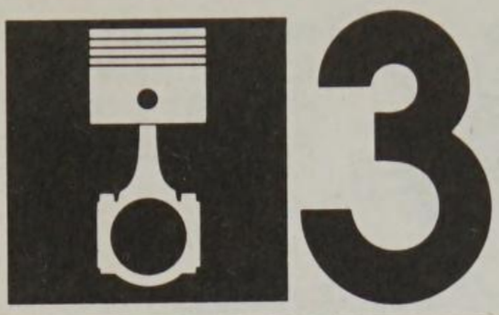


Idle speed adjustment—with A/C



Fast Idle Adjustment Procedure

Engine and Engine Rebuilding



3

UNDERSTANDING THE ENGINE ELECTRICAL SYSTEM

The engine electrical system can be broken down into three separate and distinct systems—(1) the starting system; (2) the charging system; (3) the ignition system.

Battery and Starting System

The battery is the first link in the chain of mechanisms which work together to provide cranking of the automobile engine. In most modern cars, the battery is a lead-acid electrochemical device consisting of six two-volt (2 V) subsections connected in series so the unit is capable of producing approximately 12 V of electrical pressure. Each subsection, or cell, consists of a series of positive and negative plates held a short distance apart in a solution of sulfuric acid and water. The two types of plates are of dissimilar metals. This causes a chemical reaction to be set up, and it is this reaction which produces current flow from the battery when its positive and negative terminals are connected to an electrical appliance such as a lamp or motor.

The continued transfer of electrons would eventually convert the sulfuric acid in the electrolyte to water and make the two plates identical in chemical composition. As electrical energy is removed from the battery, its voltage output tends to drop. Thus, measuring battery voltage and battery electrolyte composition are two ways of checking the ability of the unit to supply power. During the starting of the engine, electrical energy is removed from the battery. However, if the charging circuit is in good condition and the operating conditions are normal, the power removed from the battery will be replaced by the generator (or alternator) which will force electrons back through the battery, reversing the normal flow, and restoring the battery to its original chemical state.

The battery and starting motor are linked by very heavy electrical cables designed to minimize resistance to the flow of current. Generally, the major power supply cable that leaves the battery goes directly to the starter, while other electrical system needs are supplied by a smaller cable. During the starter operation, power flows from the battery to the starter and is grounded through the car's frame and the battery's negative ground strap.

The starting motor is a specially designed, direct current electric motor capable of producing a very great amount of power for its size. One thing that allows the motor to produce a great deal of power is its tremendous rotating speed. It drives the engine through a tiny pinion gear (attached to the starter's armature), which drives the very large flywheel ring gear at a greatly reduced speed. Another factor allowing it to produce so much power is that only intermittent operation is required of it. Thus, little allowance for air circulation is required, and the windings can be built into a very small space.

The starter solenoid is a magnetic device which employs the small current supplied by the starting switch circuit of the ignition switch. This magnetic action moves a plunger which mechanically engages the starter and electrically closes the heavy switch which connects it to the battery. The starting switch circuit consists of the starting switch contained within the ignition switch, a transmission neutral safety switch or clutch pedal switch, and the wiring necessary to connect these with the starter solenoid or relay.

A pinion, which is a small gear, is mounted to a one-way drive clutch. This clutch is splined to the starter armature shaft. When the ignition switch is moved to the "start" position, the solenoid plunger slides the pinion toward the

flywheel ring gear via a collar and spring. If the teeth on the pinion and flywheel match properly, the pinion will engage the flywheel immediately. If the gear teeth butt one another, the spring will be compressed and will force the gears to mesh as soon as the starter turns far enough to allow them to do so. As the solenoid plunger reaches the end of its travel, it closes the contacts that connect the battery and starter and then the engine is cranked.

As soon as the engine starts, the flywheel ring gear begins turning fast enough to drive the pinion at an extremely high rate of speed. At this point, the one-way clutch begins allowing the pinion to spin faster than the starter shaft so that the starter will not operate at excessive speed. When the ignition switch is released from the starter position, the solenoid is de-energized, and a spring contained within the solenoid assembly pulls the gear out of mesh and interrupts the curent flow to the starter.

Some starters employ a separate relay, mounted away from the starter, to switch the motor and solenoid current on and off. The relay thus replaces the solenoid electrical switch, but does not eliminate the need for a solendoid mounted on the starter used to mechanically engage the starter drive gears. The relay is used to reduce the amount of current the starting switch must carry.

The Charging System

The automobile charging system provides electrical power for operation of the vehicle's ignition and starting systems and all the electrical accessories. The battery serves as an electrical surge or storage tank, storing (in chemical form) the energy originally produced by the engine-driven generator. The system also provides a means of regulating alternator output to protect the battery from being overcharged and to avoid excessive voltage to the accessories.

The storage battery is a chemical device incorporating parallel lead plates in a tank containing a sulfuric acid-water solution. Adjacent plates are slightly dissimilar, and the chemical reaction of the two dissimilar plates produces electrical energy when the battery is conneced to a load such as the starter motor. The chemical reaction is reversible, so that when the generator is producing a voltage (electrical pressure) greater than that produced by the battery, electricity is forced into the battery, and the battery is returned to its fully charged state.

Alternators are used on the modern automobiles for they are lighter, more efficient, can rotate at higher speeds and have fewer brush problems. In an alternator, the field rotates while all the current produced passes only through the stator windings. The brushes bear against continuous slip rings rather than a commutator. This causes the current produced to periodically reverse the direction of its flow. Diodes (electrical one-way switches) block the flow of current from traveling in the wrong direction. A series of diodes is wired together to permit the alternating flow of the stator to be converted to a pulsating, but unidirectional flow at the alternator output. The alternator's field is wired in series with the voltage regulator.

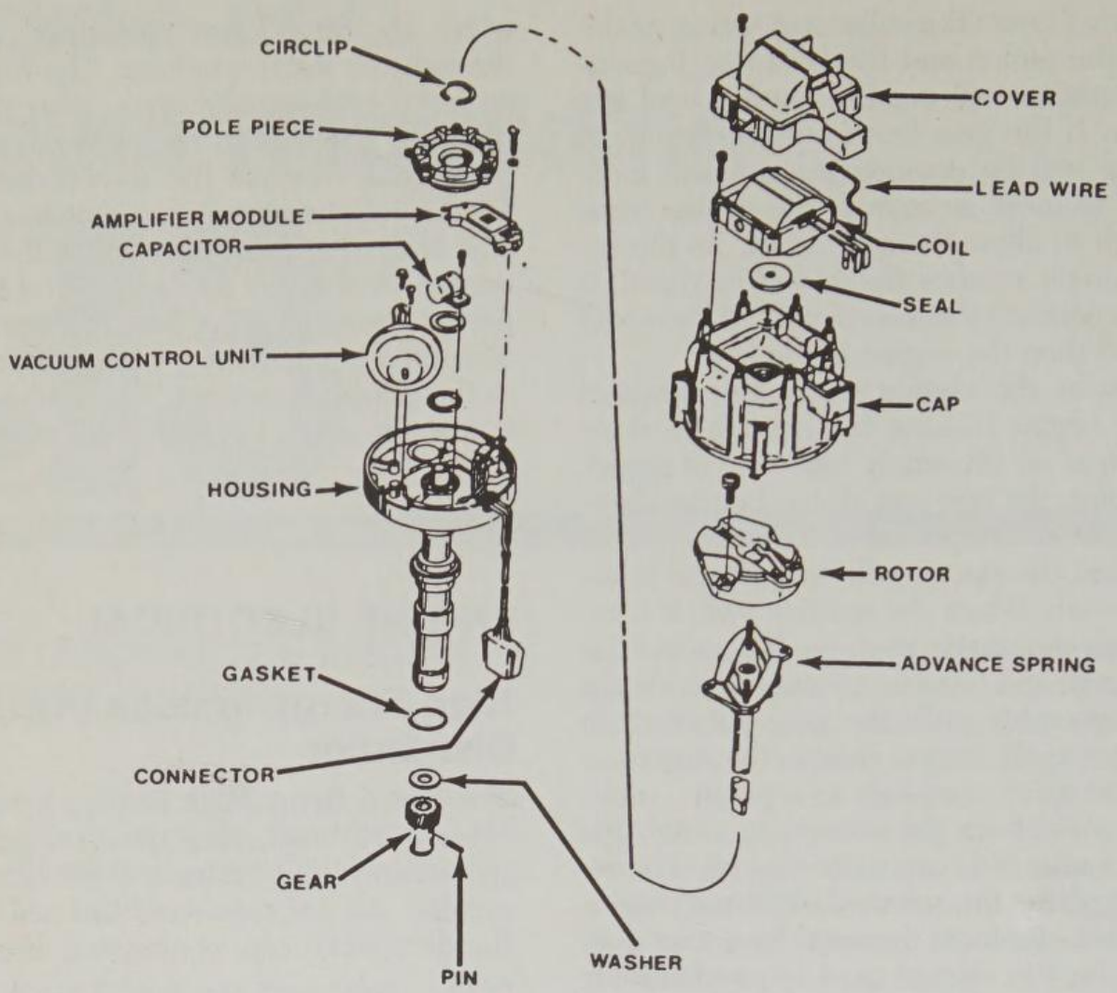
ENGINE ELECTRICAL

High Energy Ignition (HEI) Distributor

The Delco-Remy High Energy Ignition (HEI) System is a breakerless, pulse triggered, transistor controlled, inductive discharge ignition system. All engines have the coil located in the distributor cap, connecting directly to the rotor.

The magnetic pick-up assembly located inside the distributor contains a permanent magnet, a pole piece with internal teeth, and a pick-up coil. When the teeth of the rotating timer core and pole piece align, an induced voltage in the pick-up coil signals the electronic module to open the coil primary circuit. As the primary current decreases, a high voltage is induced in the secondary windings of the ignition coil, directing a spark through the rotor and high voltage leads to fire the spark plugs. The dwell period is automatically controlled by the electronic module and is increased with increasing engine rpm. The HEI System features a longer spark duration which is instrumental in firing lean and EGR diluted fuel/air mixtures. The condenser (capacitor) located within the HEI distributor is provided for noise (static) suppression purposes only and is not a regularly replaced ignition system component.

As already noted Camaros use the HEI distributor which incorporates an Electronic Spark Timing System. With the new EST system, all spark timing changes are performed electronically by the Electronic Control Module (ECM) which monitors information from various engine sensors, computes the desired spark timing and then signals the distributor to change the timing accordingly. Because all timing changes are controlled electronically, no vacuum or mechanical advance systems are used whatsoever.



Exploded view of the HEI distributor

REMOVAL AND INSTALLATION

Engine Undisturbed with Distributor Removed

1. Disconnect the ground cable from the battery.
2. Tag and disconnect the feed and module terminal connectors from the distributor cap.
3. Disconnect the hose at the vacuum advance unit, if so equipped.
4. Depress and release the 4 distributor cap-to-housing retainers and lift off the cap assembly.
5. Using crayon or chalk, make locating marks on the rotor, the module, the distributor housing and the engine for installation purposes.
6. Loosen and remove the distributor clamp bolt and clamp, and lift the distributor out of the engine. Noting the relative position of the rotor and module alignment marks, make a second mark on the rotor to align it with the one mark on the module.
7. Install a new O-ring on the distributor housing. Align the second mark on the rotor with the mark on the module, install the distributor, taking care to align the mark on the housing with the one on the engine. It may be necessary to lift the distributor and turn the rotor slightly to align the gears and the oil pump driveshaft.
8. With the respective marks aligned, install the clamp and bolt finger-tight.
9. Install and secure the distributor cap.
10. Connect the feed and module connectors to the distributor cap.
11. Connect a timing light to the engine and plug the vacuum hose, if so equipped.
12. Connect the ground cable to the battery.
13. Start the engine and set the timing.
14. Turn the engine off and tighten the distributor clamp bolt. Disconnect the timing light and unplug and connect the hose to the vacuum advance.

Engine Disturbed with Distributor Removed

1. Turn the engine to bring No. 1 piston to the top of its compression stroke. This may be determined by inserting a rag into the No. 1 spark plug hole and slowly turning the engine over. When the timing mark on the crankshaft pulley aligns with the 0 on the timing scale and the rag is blown out by compression, No. 1 piston is at top-dead-center (TDC).
2. Turn the rotor so that it will point to the No. 1 terminal in the cap.

3. Install the distributor into the engine block. It may be necessary to turn the rotor a little in either direction in order to engage the gears.

4. Tap the starter a few times to ensure that the oil pump shaft is mated to the distributor shaft.

5. Bring the engine to No. 1 TDC again and check to see that the rotor is indeed pointing toward the No. 1 terminal of the cap.

6. Set the ignition timing with a timing light.

Alternator

DESCRIPTION

The alternating current generator (alternator) supplies a continuous output of electrical energy at all engine speeds. The alternator generates electrical energy and recharges the battery by supplying it with electrical current. This unit consists of four main assemblies: two end frame assemblies, a rotor assembly, and a stator assembly. The rotor assembly is supported in the drive end frame by a ball bearing and at the other end by a roller bearing. These bearings are lubricated during assembly and require no maintenance. There are six diodes in the end frame assembly. These diodes are electrical check valves that also change the alternating current developed within the stator windings to a direct (DC) current at the output (BAT) terminal. Three of these diodes are negative and are mounted flush with the end frame while the other three are positive and are mounted into a strip called a heat sink. The positive diodes are easily identified as the ones within small cavities or depressions.

PRECAUTIONS

To prevent serious damage to the alternator and the rest of the charging system, the following precautions must be observed:

1. When installing a battery, make sure that the positive cable is connected to the positive terminal and the negative to the negative.

2. When jump-starting the car with another battery, make sure that like terminals are connected. This also applies when using a battery charger.

3. Never operate the alternator with the battery disconnected or otherwise on an uncontrolled open circuit. Double-check to see that all connections are tight.

4. Do not short across or ground any alternator or regulator terminals.

5. Do not try to polarize the alternator.

6. Do not apply full battery voltage to the field (brown) connector.

7. Always disconnect the battery ground cable before disconnecting the alternator lead.

REMOVAL AND INSTALLATION

1. Disconnect the battery ground cable to prevent diode damage.

2. Tag and disconnect the alternator wiring.

3. Remove the alternator brace bolt. If the car is equipped with power steering, loosen the pump brace and mount nuts. Detach the drive belt(s).

4. Support the alternator and remove the mount bolt(s). Remove the unit from the vehicle.

5. Installation is the reverse of the previous steps. Tighten belt enough to allow approximately ½" of play on the longest run between pulleys.

Alternator Specifications

Year	Engine	Output (Amps)
1982	2.5L	42, 63, 70, 85
	2.8L	42, 63, 70, 85
	5.0L	55, 70, 85
	5.0L (TBI)	55, 70, 85
1983	2.5L	42, 63, 78
	2.8L	46, 63, 78
	5.0L	42, 78
	5.0L (TBI)	70, 85
1984 & Later	2.5L	42, 66, 94
	2.8L	42, 66, 78
	5.0L	42, 78
	5.0L (TBI)	70, 85

① Regulator is integrated with Alternator

Voltage Regulator

REMOVAL AND INSTALLATION

NOTE: *This procedure is to be performed with the alternator removed from the vehicle.*

1. Make scribe marks on the end frames to make reassembly easier.

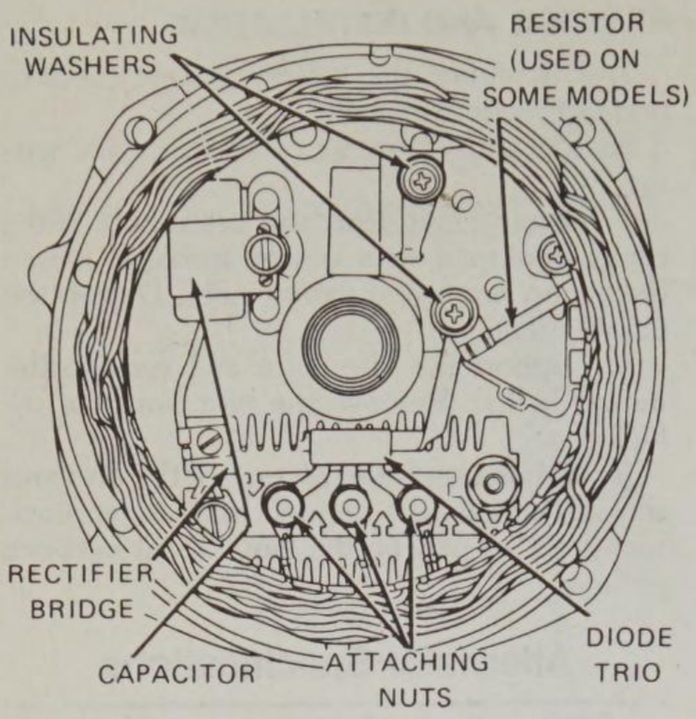
2. Remove the 4 thru-bolts and separate the drive end frame assembly from the rectifier end frame assembly.

3. Remove the 3 diode trio attaching nuts and the 3 regulator attaching screws.

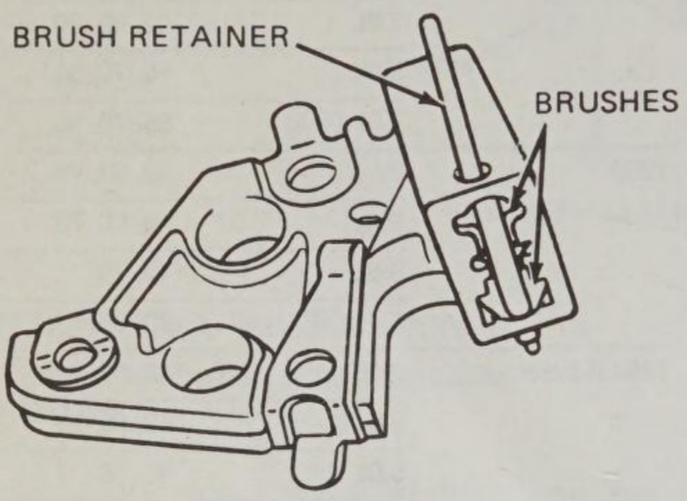
4. Remove the diode trio and the regulator from the end frame.

NOTE: *Before installing the regulator, push the brushes into the brush holder and install a brush retainer or a tooth pick to hold the brushes in place.*

5. To install the regulator, reverse the re-



View of the alternator end frame



Voltage regulator with the brushes depressed

moval procedures. After the alternator is assembled, remove the brush retainer.

VOLTAGE ADJUSTMENT

The voltage regulator is electronic and is housed within the alternator. Adjustments to the regulator are not possible. Should replacement of the regulator become necessary, the alternator must be disassembled.

Starter

REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable.
2. Raise the car to a convenient working height, and support with jackstands.
3. Disconnect all wiring from the starter solenoid. Replace each nut as the connector is removed, as thread sizes differ from connector to connector. Note or tag the wiring positions for installation.
4. Remove the bracket from the starter and the two mounting bolts. On engines with a solenoid heat shield, remove the front bracket upper bolt and detach the bracket from the starter.

Chilton Time Saver

Starter removal on certain models may necessitate the removal of the frame support. This support runs from the corner of the frame to the front crossmember. To remove:

1. Loosen the mounting bolt that attaches the support to the corner of the frame.
2. Loosen and remove the mounting bolt that attaches the support to the front crossmember and then swing the support out of the way.
3. Installation is in the reverse order of removal.

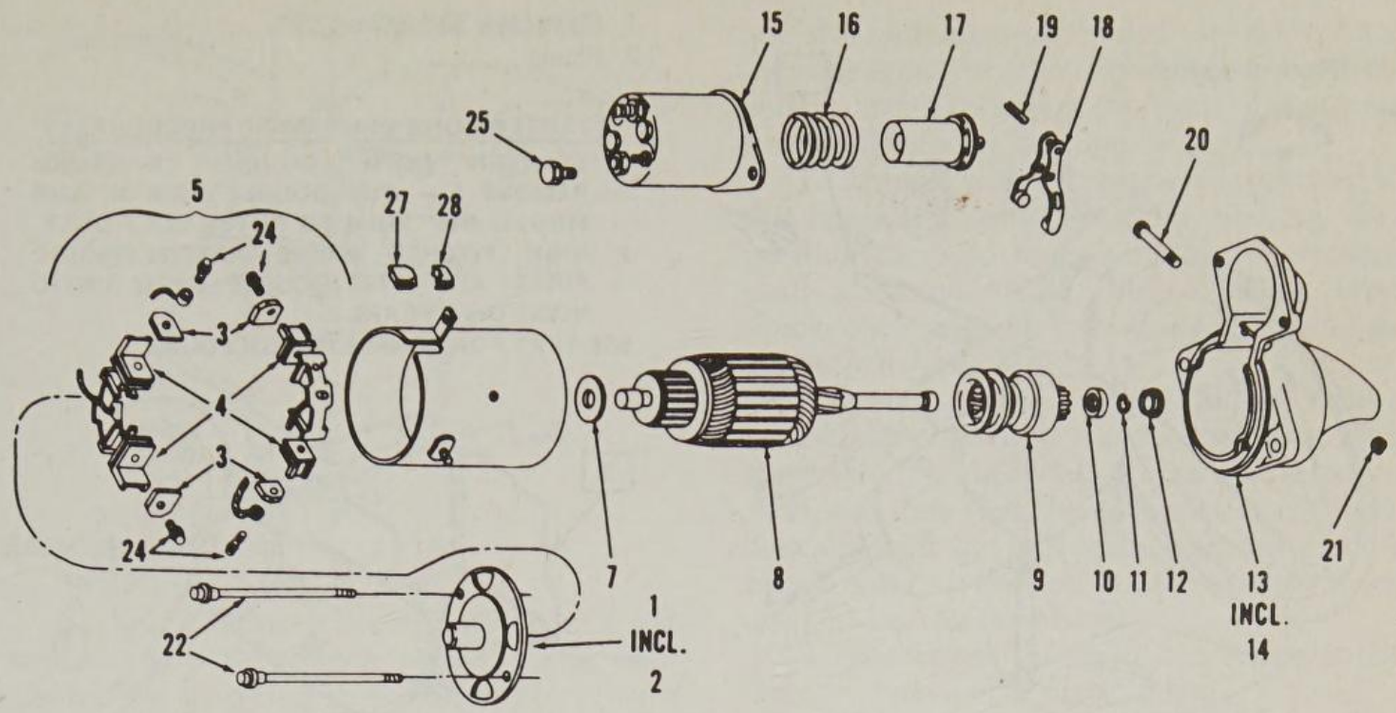
5. Remove the front bracket bolt or nut. Lower the starter front end first, and then remove the unit from the car.
6. Reverse the removal procedures to install the starter. Torque the two mounting bolts to 25–35 ft. lbs.

NOTE: *If shims were placed between the starter and engine block, they must be replaced in their original locations.*

STARTER OVERHAUL

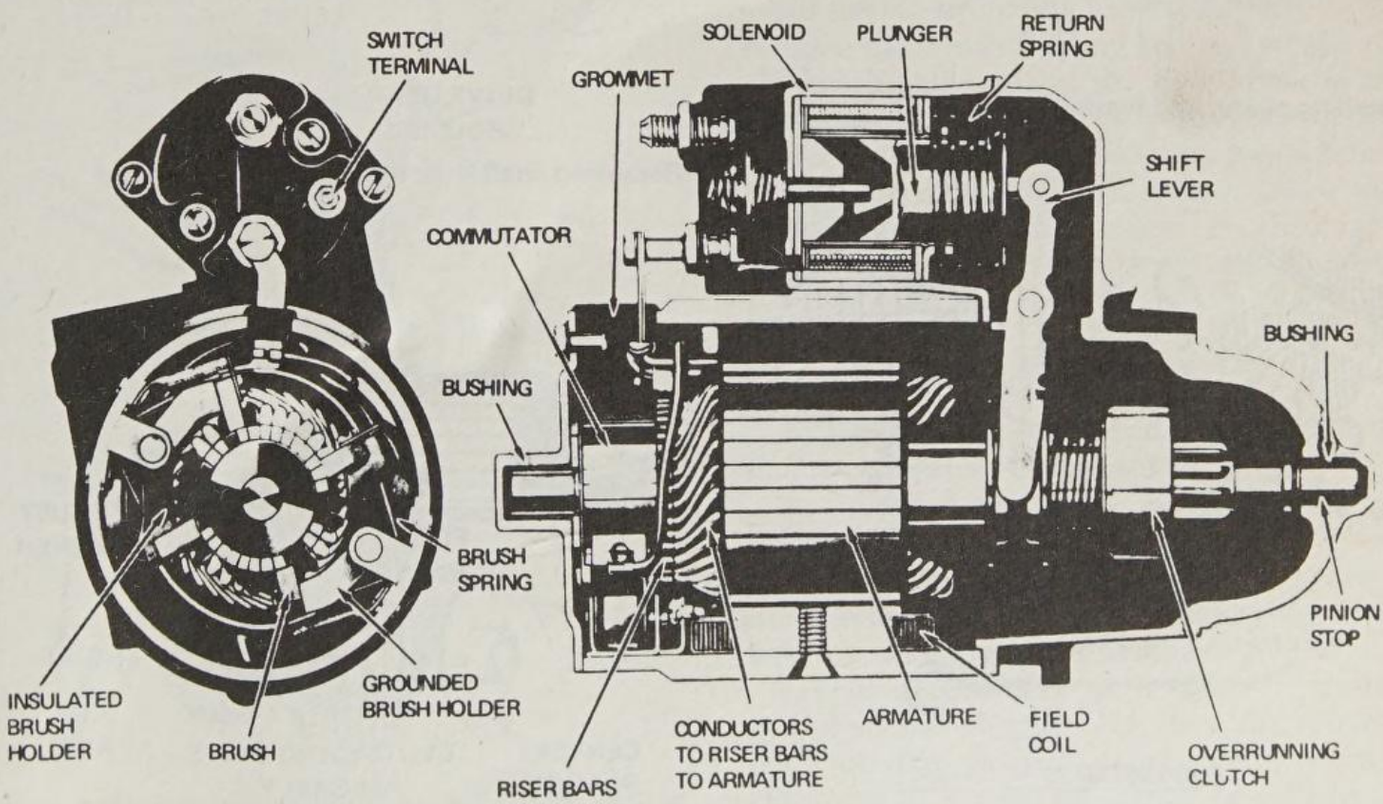
Drive Replacement

1. Disconnect the field coil straps from the solenoid.
2. Remove the through bolts, and separate commutator end frame, field frame assembly, drive housing, and armature assembly from each other.
3. Slide the two piece thrust collar off the end of the armature shaft.
4. Slide a suitably sized metal cylinder, such as a standard half-inch pipe coupling, or an old pinion, onto the shaft so that the end of the coupling or pinion butts up against the edge of the pinion retainer.
5. Support the lower end of the armature securely on a soft surface, such as a wooden block, and tap the end of the coupling or pinion, driving the retainer towards the armature end of the snap ring.
6. Remove the snap ring from the groove in the armature shaft with a pair of pliers. Then, slide the retainer and starter drive from the shaft.
7. To reassemble, lubricate the drive end of the armature shaft with silicone lubricant, and then slide the starter drive onto the shaft *with the pinion facing outward.* Slide the retainer onto the shaft *with the cupped surface facing outward.*

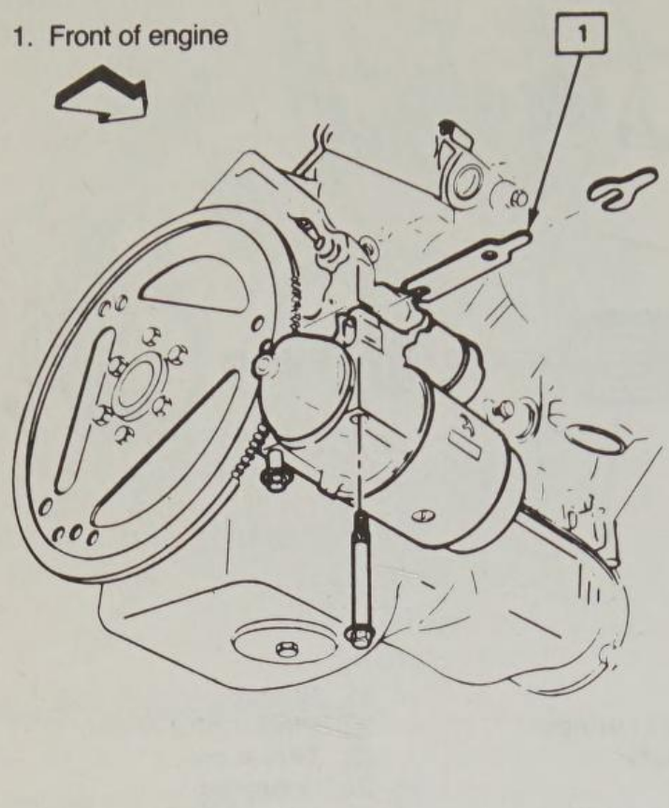


1. Frame—commutator end
2. Brush and holder pkg.
3. Brush
4. Brush holder
5. Housing—drive end
6. Frame and field asm.
7. Solenoid switch
8. Armature
9. Drive asm.
10. Plunger
11. Shift lever
12. Plunger return springer
13. Shift lever shaft
14. Lock washer
15. Screw—brush attaching
16. Screw—field lead to switch
17. Screw—switch attaching
18. Washer—brake
19. Thru bolt
20. Bushing—commutator end
21. Bushing—drive end
22. Pinion stop collar
23. Thrust collar
24. Grommet
25. Grommet
26. Plunger pin
27. Pinion stop retainer ring
28. Lever shaft retaining ring

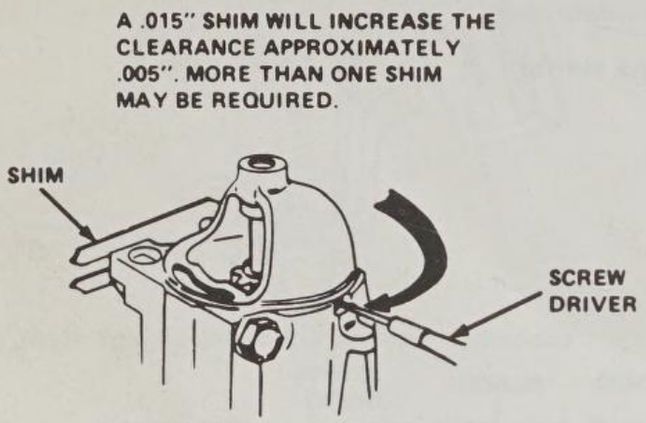
Exploded view of the starter



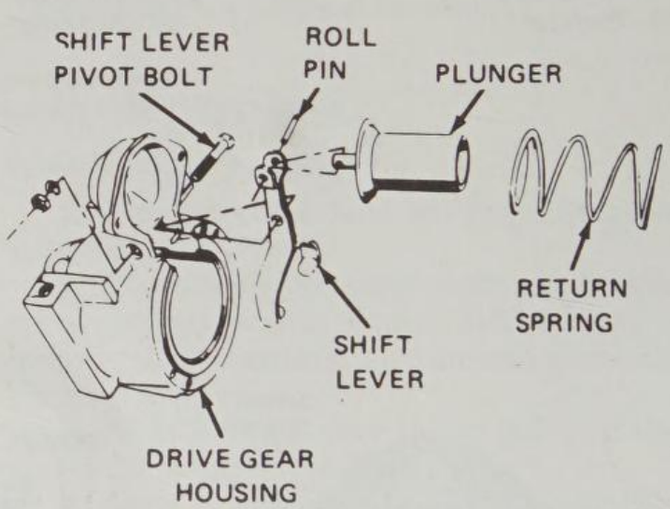
Cross section of a typical starter



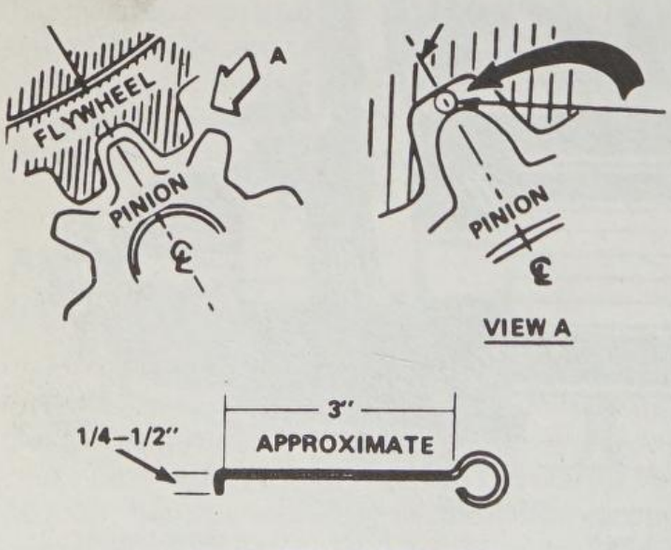
Starter motor mounting; V6 at left, diesel at right. Others similar



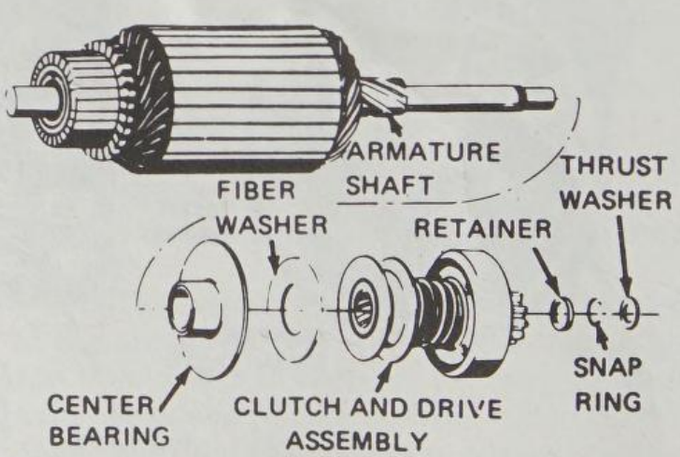
Meshing starter and flywheel teeth



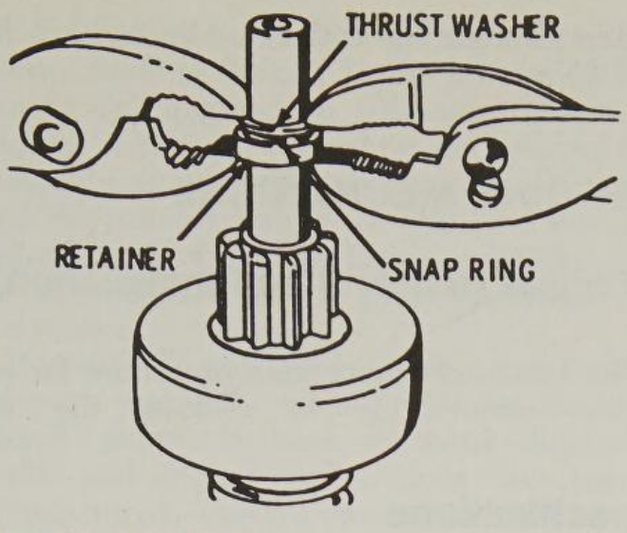
Removing shaft lever and plunger from starter



Flywheel-to-pinion clearance



Starter and drive assembly removed

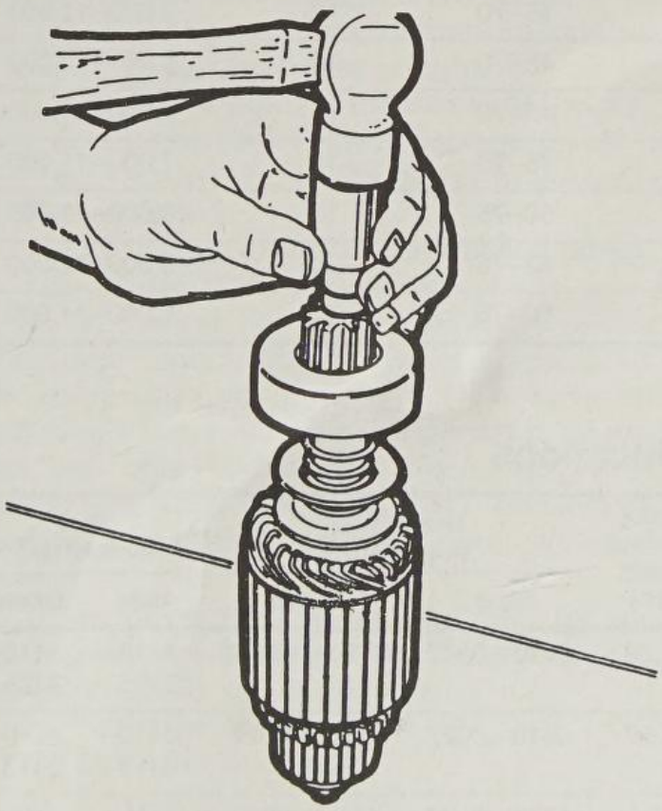


Snap ring installation

8. Again support the armature on a soft surface, with the pinion at the upper end. Center the snap ring on the top of shaft (use a new snap ring if the original was damaged during removal). Gently place a block of wood flat on top of the snap ring so as not to move it from a centered position. Tap the wooden block with a hammer in order to force the snap ring around the shaft. Then, slide the ring down into the snap ring groove.

9. Lay the armature down flat on the surface you're working on. Slide the retainer close up on to the shaft and position it and the thrust collar next to the snap ring. Using two pairs of pliers on opposite sides of the shaft, squeeze the thrust collar and the retainer together until the snap ring is forced into the retainer.

10. Lube the drive housing bushing with a silicone lubricant. Then, install the armature and the clutch assembly into the drive housing, engaging the solenoid shift lever with the clutch, and positioning the front of the armature shaft into the bushing.



Use a piece of pipe to drive the retainer toward the snap-ring

11. Apply a sealing compound approved for this application onto the drive housing; then position the field frame around the armature shaft and against the drive housing. *Work slowly and carefully to prevent damaging the starter brushes.*

12. Lubricate the bushing in the commutator end frame with a silicone lubricant, place the leather brake washer onto the armature shaft, and then slide the commutator end frame over the shaft and into position against the field frame. Line up the bolt holes, and then install and tighten the thru-bolts.

13. Reconnect the field coil straps to the "motor" terminal of the solenoid.

NOTE: *If replacement of the starter drive fails to cure improper engagement of starter pinion to flywheel, there are probably defective parts in the solenoid and/or shift lever. The best procedure would probably be to take the assembly to a shop where a pinion clearance check can be made by energizing the solenoid on a test bench. If the pinion clearance is incorrect, disassemble the solenoid and shift lever, inspect, and replace worn parts.*

Brush Replacement

1. Disassemble the starter by following Steps 1 and 2 of the "Drive Replacement" procedure above.

2. Replace the brushes one at a time to avoid having to mark wiring. For each brush: remove the brush holding screw; remove the old brush and position the new brush in the same direction (large end toward center of field frame; position wire connector on top of brush, line up holes, and reinstall screw. Make sure screw is snug enough to ensure good contact.

3. Reassemble starter according to Steps 10–13 above.

Solenoid Replacement

1. Remove the screw and washer from the motor connector strap terminal.

2. Remove the two solenoid retaining screws.

3. Twist the solenoid housing clockwise to remove the flange key from the keyway in the housing. Then remove the housing.

4. To re-install the unit, place the return spring on the plunger and place the solenoid body on the drive housing. Turn counterclockwise to engage the flange key. Place the two retaining screws in position and install the

screw and washer which secures the strap terminal. Install the unit on the starter.

Battery

REMOVAL AND INSTALLATION

1. Remove the negative battery cable and then the positive battery cable.
2. Remove the battery retainer screw and the retainer. Remove the battery.
3. To install, reverse the removal procedure. Torque the battery cables to 19 ft. lbs. (12 Nm).

ENGINE MECHANICAL

Engine Removal and Installation

The factory recommended procedure for engine removal is to remove the en-

General Engine Specifications

Year	Engine Displacement	Fuel System Type	Horsepower @ rpm■	Torque @ rpm (ft. lbs.)■	Bore and Stroke (in.)	Compression Ratio	Oil Pressure @ 1000 rpm
'82 & Later	2.5L	T.B.I.	90 @ 4000	134 @ 2400	4.000 x 3.000	9.0:1	36–41
	2.8L	2 bbl.	102 @ 4800	145 @ 2400	3.503 x 2.992	8.5:1	40
	5.0L	4 bbl.	145 @ 4000	240 @ 2400	3.736 x 3.480	8.6:1	40
	5.0L	T.B.I.	165 @ 4200	240 @ 2400	3.736 x 3.480	9.5:1	40

■ Horsepower and torque are SAE net figures. They are measured at the rear of the transmission with all accessories installed and operating. Since the figures vary when a given engine is installed in different models, some are representative, rather than exact.
T.B.I.—Throttle Body Injection

Battery and Starter Specifications

Year	Engine	Battery	Starter		
		Cold Crank (Amps)	Amps	Volts	RPM
1982	2.5L	315, 465	45–70	10	7,000–11,900
	2.8L	315, 465	45–70	10	7,000–11,900
	5.0L	370, 465	45–70	10	7,000–11,900
1983	2.5L	355	45–70	10	6,000–12,000
	2.8L	315	45–70	10	7,000–11,900
	5.0L	405, 500	45–70	10	7,000–11,900
1984 & Later	2.5L	405	50–75	10	6,000–11,900
	2.8L	315	52–76	10	6,000–12,000
	5.0L	500	50–75	10	6,000–11,900

Valve Specifications

Year	Engine Displacement (Liters)	Seat Angle (deg)	Face Angle (deg)	Spring Test Pressure (lbs. @ in.)	Spring Installed Height (in.)	Stem to Guide Clearance (in.)		Stem Diameter (in.)	
						Intake	Exhaust	Intake	Exhaust
'82 & Later	2.5L	46	45	122–180 @ 1.25	1.69	.0010–.0027	.0010–.0027 ①	.3418–.3425	.3418–.3425
	2.8L	46	45	194 @ 1.18	1.57	.0010–.0027	.0010–.0027	.3410–.3416	.3410–.3416
	5.0L	46	45	194–206 @ 1.25	1 23/32	.0010–.0027	.0010–.0027	.3414	.3414

① Figure given is measured at the top of the guide; .0020–.0037 is measured at the bottom of the guide.

gine/transmission as a unit and then separate them outside of the car. In the process of removing the engine you will come across a number of steps which call for the removal of a separate component or system, i.e. "Disconnect the exhaust system" or "Remove the radiator." In all of these instances, a detailed removal procedure can be found elsewhere in this section.

It is virtually impossible to list each individual wire and hose which must be disconnected, simply because so many different model and engine combinations have been manufactured. Careful observation and common sense are the best possible additions to any repair procedure. Be absolutely sure to tag any wire or hose before disconnecting it, so that it may be reconnected properly during installation.

1. Remove the hood. Scribe lines around the hinges so that the hood can be installed in its original location.
2. Remove the air cleaner.
3. Disconnect the battery cables at the battery.
4. Remove the radiator and shroud.
5. Remove the fan blade and pulley.
6. Disconnect and label wires at:
   a. Emission control components.
   b. Distributor.
   c. Temperature switch.
   d. Alternator.
   e. Starter solenoid.
   f. Oil pressure sending unit.
7. Disconnect:
   a. Accelerator linkage at the pedal.
   b. Cruise control and/or transmission cable at the carburetor (as equipped).
   c. Exhaust pipes at the manifold flanges.
   d. Engine cooler lines, if so equipped.
   e. Vacuum line to the power brake unit, if so equipped.
   f. Fuel line (front tank) at the fuel pump.
   g. Hoses at the carbon canister.
8. If the car has air conditioning, unbolt the compressor, leaving the hoses attached. Set the compressor out of the way. *Do not disconnect any air conditioning refrigerant lines unless you are familiar with discharge procedures.* Escaping refrigerant can freeze any surface it contacts, including your skin and eyes.
9. Remove the power steering pump, leaving the hoses attached to the pump. Set the pump aside, out of the way.
10. Raise the car on a hoist.
11. Drain the crankcase.
12. Remove the driveshaft.

NOTE: *If a plug for the driveshaft opening in the transmission is not available, drain the transmission.*

13. Disconnect:
   a. Shift linkage at the transmission.
   b. Speedometer cable at the transmission.
   c. Transmission cooler lines, if so equipped.
14. On vehicles with manual transmissions, disconnect the clutch linkage at the cross-shaft then remove the cross-shaft at the frame bracket.
15. Lower the vehicle, remove the rocker arm covers and install an engine lifting adapter on the cylinder heads.
16. Raise the engine enough to take the weight off the front mounts, then remove the front mount thru-bolts.
17. Remove the rear mount to cross-member bolts.

NOTE: *If your vehicle is equipped with transmission mount shims, they must be reinstalled. These shims affect drive line angle.*

18. Raise the engine enough to take the weight off the rear mount, then remove the crossmember.

NOTE: *It is necessary to remove the mount from the transmission before the crossmember can be removed.*

19. Remove the engine/transmission assembly as a unit.
20. To remove the clutch and manual transmission from the engine:
   a. Remove the clutch housing cover plate screws.
   b. Remove the clutch housing to engine attaching bolts, then, remove the transmission and clutch housing as a unit.

CAUTION: *Do not let the weight of the transmission hang on the spline because the clutch disc may be easily damaged.*

   c. Remove the starter and clutch housing rear cover plate.
   d. Loosen the clutch mounting bolts one turn at a time (to prevent distortion of the clutch cover) until the spring pressure is released. Remove all the bolts, clutch disc and pressure plate assembly.
21. To remove the automatic transmission:
   a. Remove the starter and the converter housing underpan.
   b. Remove the flywheel to converter attaching bolts.
   c. Supporting both the engine and transmission, remove the transmission-to-engine mounting bolts.
   d. Slowly guide the engine from the transmission.

To install:

1. Attach the engine to the transmission in the reverse order of removal.
2. Bolt the engine lifting tool to the engine

Crankshaft and Connecting Rod Specifications

(All measurements are given in inches)

Year	Engine Displacement (Liters)	Crankshaft				Connecting Rod		
		Main Brg Journal Dia.	Main Brg Oil Clearance	Shaft End-Play	Thrust on No.	Journal Diameter	Oil Clearance	Side Clearance
'82 & Later	2.5L	2.300	.0005–.0022	.0035–.0085	5	2.000	.0005–.0026	.006–.022
	2.8L	2.493–2.494	.0017–.0029	.0019–.0066	3	1.998–1.999	.0014–.0035	.0060–.0170
	5.0L	①	②	.0020–.0060	5	2.098–2.099	.0018–.0039	.0080–.0140

① No. 1—2.4484–2.4493
Nos. 2, 3, 4—2.4481–2.4490
No. 5—2.4479–2.4488

② No. 1—0.0008–0.0020
Nos. 2, 3, 4—0.0011–0.0023
No. 5—0.0017–0.0032

Piston and Ring Specifications

(All measurements are given in inches)

Year	Engine Displacement	Ring Gap			Ring Side Clearance			Piston-to-Bore Clearance (in.)
		Top Compression	Bottom Compression	Oil Control	Top Compression	Bottom Compression	Oil Control	
'82 & Later	2.5L	.0100–.0220	.0100–.0270	.0150–.055	.0015–.0030	.0015–.0030	.0010–.0050	.0017–② .0033
	2.8L	.0098–.0196	.0098–.0196	.0020–.0550	.0011–.0027	.0015–.0037	.0078 max.	.0007–.0027
	5.0L	.0100–.0200	.0100–.0250	.0150–.0550	.0012–.0032	.0012–.0032	.0020–.0070	.0007–① .0027

① .75″ below piston pin centerline
② 2.25″ from top of cylinder (bore); $1\frac{13}{16}$″ from top of piston

Camshaft Specifications

(All measurements in inches)

Year	Engine Displacement (Liters)	Journal Diameter					Lobe Lift		Camshaft End Play
		1	2	3	4	5	Intake	Exhaust	
'82 & Later	2.5L	All 1.869					.398	.398	.0015–.0050
	2.8L	All 1.8976–1.8996					.235	.266	.001–.004
	5.0L	All 1.8682–1.8692					.234 ①	.257 ①	.004–.012

① TBI engine .269 intake—.276 exhaust

Torque Specifications

(All readings in ft. lbs.)

Year	Engine Displacement (Liters)	Cylinder Head Bolts	Rod Bearing Bolts	Main Bearing Bolts	Crankshaft Pulley Bolts	Flywheel-to-Crankshaft Bolts	Manifold	
							Intake	Exhaust
'82 & Later	2.5L	85	32	70	160	44	29	44
	2.8L	65–75	34–40	63–74	66–84	45–55	20–25	22–28
	5.0L	65	45	70	60	60	30 ①	20

① 20–34 for T.B.I. plate bolts

and then lower the engine and the transmission into the chassis as a unit. Guide the engine so as to align the front engine mounts with the mounts on the frame.

3. Install one rear transmission crossmember side bolt, swing the crossmember up under the transmission mount and install the bolt in the opposite side rail.

4. Align and install the rear mount bolts.

5. Install the engine front mount bolts and then remove the lifting tool from the engine.

6. Installation of the remaining components is in the reverse order of removal.

Rocker Arm Cover

REMOVAL AND INSTALLATION

1. Remove the air cleaner.

2. Remove the throttle cable on EFI engines.

3. Remove the PCV valve.

4. Remove the spark plug wires and clips from the valve cover(s). Disconnect any necessary lines and hoses.

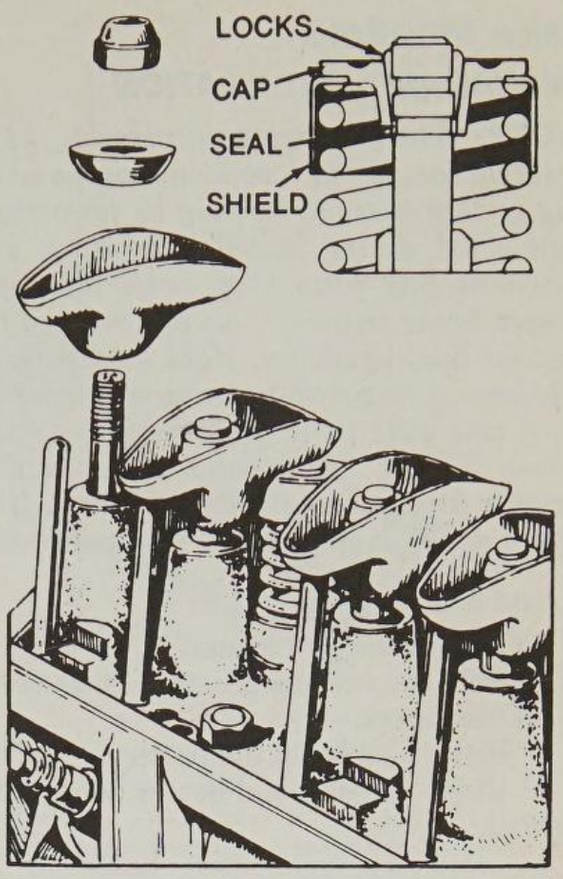
5. Remove the fuel return line if necessary.

6. Remove the EGR valve.

7. Remove the retaining bolts. Gently tap the cover with a rubber mallet to remove it.

8. Installation is the reverse of removal.

NOTE: *Most valve covers use RTV sealer in place of gaskets. Thoroughly clean the mating surfaces before applying new sealer.*



Rocker arm components

Rocker Arms

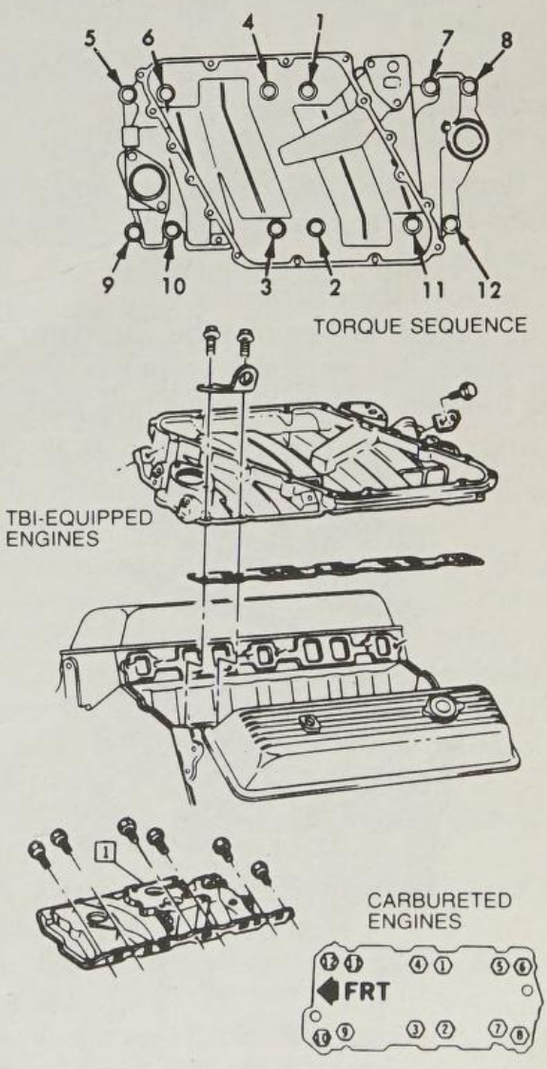
REMOVAL AND INSTALLATION

Rocker arms are removed by removing the adjusting nut. Be sure to adjust the valve lash after replacing the rocker arms. Coat the replacement rocker arm and ball with engine oil before installation.

NOTE: *When replacing an exhaust rocker, move an old intake rocker to the exhaust rocker arm stud and install the new rocker arm on the intake stud. This will prevent burning of the new rocker arm on the exhaust position.*

Rocker arms studs that have damaged threads or are loose in the cylinder heads may be replaced by reaming the bore and installing oversize studs. Oversizes available are .003 and .013 in. The bore may also be tapped and screw-in studs installed. Several aftermarket companies produce complete rocker arm stud kits with installation tools.

NOTE: *2.5L engines use bolts instead of studs, 2.8L engines use threaded studs, and 5.0L engines use press fit studs.*



Intake manifold bolt tightening sequence of all Chevrolet-built V8 engines. Note that the lower sequence is used for all carbureted engines, whereas the upper sequence is used for all TBI-equipped engines

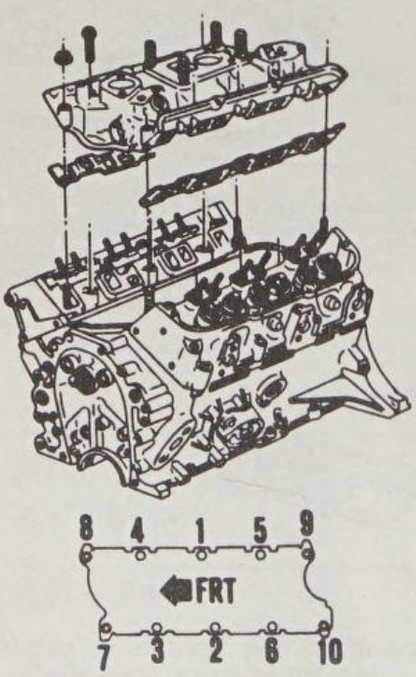
Intake Manifold

REMOVAL AND INSTALLATION

NOTE: *When servicing all vehicles, be absolutely sure to mark vacuum hoses and wiring so that these items may be properly reconnected during installation. Also, when disconnecting fittings of metal lines (fuel, power brake vacuum), always use two flare nut (or line) wrenches. Hold the wrench on the large fitting with pressure on the wrench as if you were tightening the fitting (clockwise), THEN loosen and disconnect the smaller fitting from the larger fitting. If this is not done, damage to the line will result.*

2.8L and 5.0L Engines

1. Remove the air cleaner.
2. Drain the radiator.
3. Disconnect:
   a. Battery cables at the battery.
   b. Upper radiator and heater hoses at the manifold.
   c. Crankcase ventilation hoses as required.
   d. Fuel line at the carburetor.
   e. Accelerator linkage.
   f. Vacuum hose at the distributor, if equipped.
   g. Power brake hose at the carburetor base or manifold, if applicable.
   h. Temperature sending switch wires.
4. Remove the distributor cap and scribe the rotor position relative to the distributor body, and engine.
5. Remove the distributor.
6. If applicable, remove the alternator upper bracket. As required, remove the air cleaner bracket, and accelerator bellcrank.



Intake manifold bolt tightening sequence for the 173-V6 engine

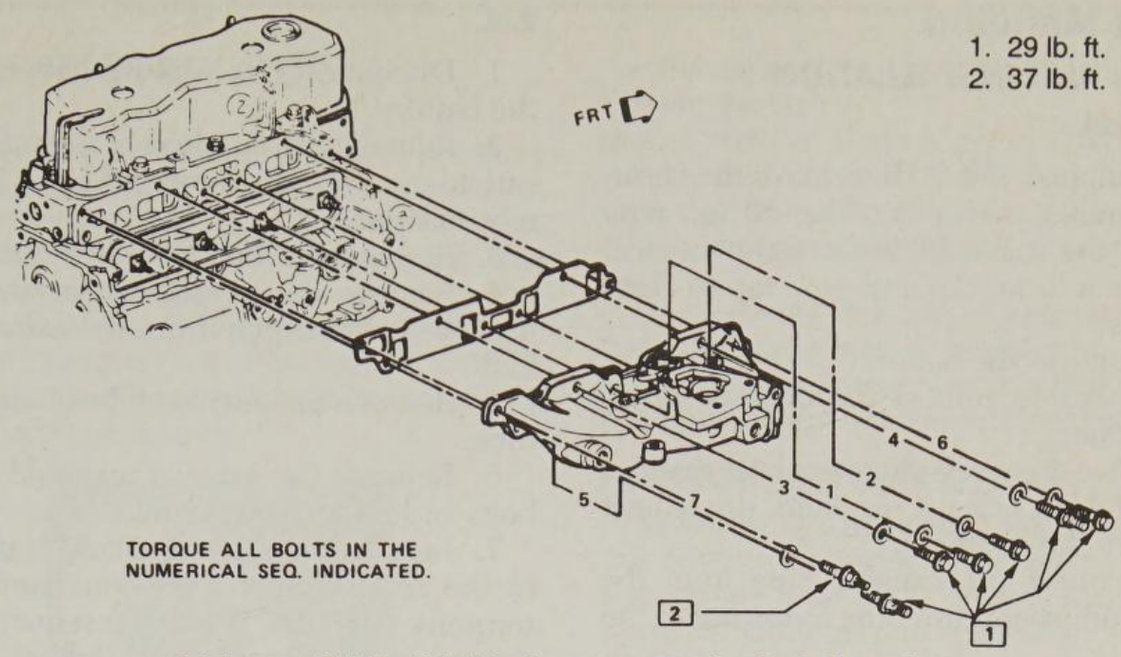
7. Remove the manifold-to-head attaching bolts, then remove the manifold and carburetor as an assembly.
8. Mark and disconnect all emission-related items (e.g.—wiring, vacuum hoses, etc.) which are connected to manifold-mounted items.
9. If the manifold is to be replaced, transfer the carburetor (and mounting studs), water outlet and thermostat (use a new gasket) heater hose adapter, EGR valve (use new gasket) and, if applicable, TVS switch(s) and the choke coil.
10. Before installing the manifold, thoroughly clean the gasket and seal surfaces of the cylinder heads and manifold.
11. Install the manifold end seals, folding the tabs if applicable, and the manifold/head gaskets, using a sealing compound around the water passages.

NOTE: *Make sure that the new manifold gaskets match the old ones EXACTLY.*

12. When installing the manifold, care should be taken not to dislocate the end seals. It is helpful to use a pilot in the distributor opening. Tighten the manifold bolts to 30 ft. lbs. for 5.0L or 20–25 ft. lbs. for 2.8L in the sequence illustrated.
13. Install the distributor with the rotor in its original location as indicated by the scribe line. If the engine has been disturbed, refer to the previous "Distributor Removal and Installation" procedure.
14. If applicable, install the alternator upper bracket and adjust the belt tension.
15. Connect all disconnected components at their original locations.
16. Fill the cooling system, start the engine, check for leaks and adjust the ignition timing and carburetor idle speed and mixture.

2.5L Engine

1. Disconnect the negative battery cable at the battery.
2. Remove the air cleaner assembly.
3. Remove the PCV valve and hose.
4. Drain the cooling system.
5. Disconnect the fuel lines from the Throttle Body Injection (TBI) unit.
6. Mark and disconnect the vacuum lines and the electrical connections from the TBI unit.
7. Disconnect the linkage from the TBI unit (throttle, downshift, and/or cruise control, as applicable).
8. Disconnect the coolant inlet and outlet hoses from the intake manifold.
9. Remove the air conditioning compressor support brackets and the compressor. DO NOT disconnect the refrigerant lines from the compressor. Lay the compressor aside.



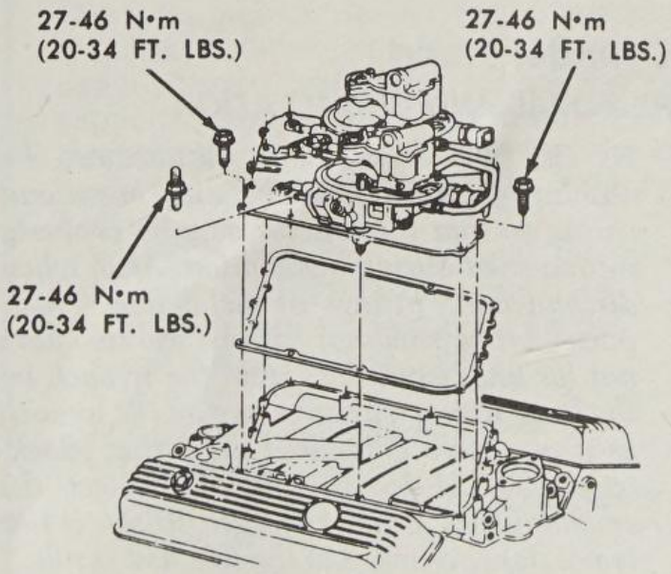
Intake manifold bolt tightening sequence for the 2.5L engine

10. Remove the manifold attaching bolts and remove the manifold.

11. Installation is performed in the reverse of the previous steps. Be sure to torque the manifold bolts to 29 ft. lbs., following the sequence in the accompanying illustration. Replenish the cooling system and check for leaks after the engine is started.

TBI-Equipped 5.0L Engine

1. Disconnect the negative battery cable at the battery.
2. Remove the air cleaner assembly.
3. Drain the cooling system.
4. Disconnect the fuel inlet line at the front Throttle Body Injection (TBI) unit.
5. Remove the exhaust gas recirculation (EGR) solenoid.



TBI plate and gasket installation on V8 engines so equipped

6. Disconnect the wiring from the idle air motors, injectors, and the throttle position sensor (TPS).
7. Disconnect the fuel return line at the rear TBI unit.
8. Remove the power brake booster line.
9. Disconnect the accelerator and cruise control cables, unbolt the cable bracket from the manifold and tie the cable and bracket assembly out of the way.
10. Disconnect the air injection hose at the check valve and the air control valve.
11. Unbolt the air injection pump and move it out of the way.
12. Disconnect the positive crankcase ventilation valve hose at the manifold and move the hose aside.
13. Mark and disconnect any vacuum hoses which will interfere with removal of the manifold.
14. If you plan on removing the TBI units from the upper manifold plate, remove the fuel balance tube (connecting the units) at this time.
15. Remove the bolts which attach the upper manifold plate (or TBI plate) to the intake manifold. Lift the TBI and plate assembly off of the intake manifold.
16. Remove the distributor as previously outlined.
17. Disconnect the upper radiator hose from the thermostat housing.
18. Disconnect the heater hose from the intake manifold.
19. Remove the intake manifold-to-cylinder head bolts and lift the intake manifold assembly off of the engine.
20. Installation is the reverse of removal procedure.

Exhaust Manifold

REMOVAL AND INSTALLATION

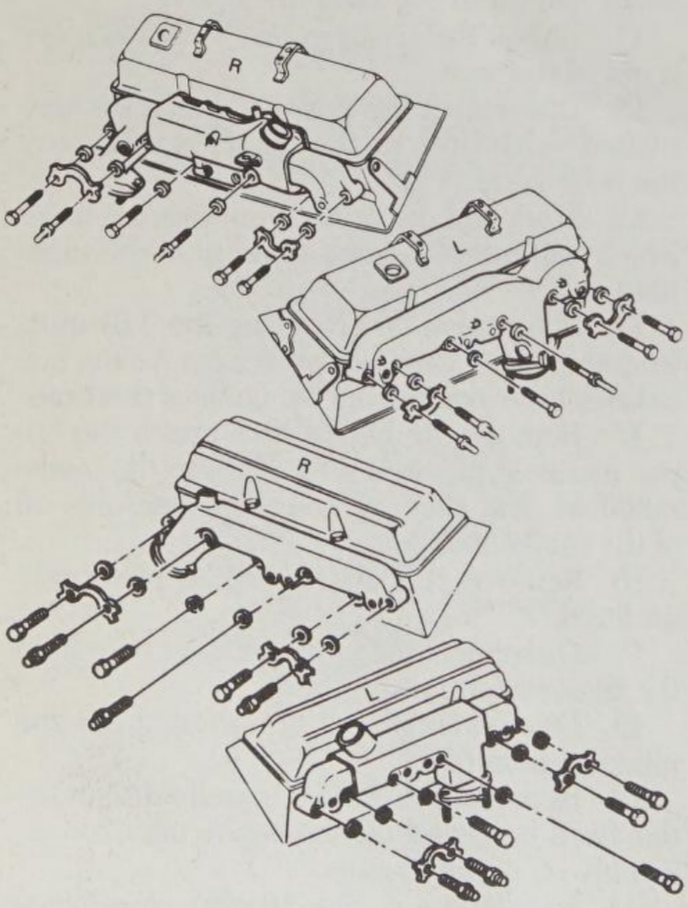
2.8L and 5.0L

1. If equipped with AIR, remove the air injector manifold assembly. The ¼ in. pipe threads in the manifold are straight threads. Do not use a ¼ in. tapered pipe tap to clean the threads.
2. Disconnect the battery.
3. If applicable, remove the air cleaner preheater shroud.
4. Remove the spark plug wire heat shields.
5. On the left exhaust manifold, disconnect and remove the alternator.
6. Disconnect the exhaust pipe from the manifold and hang it from the frame out of the way.
7. Bend the locktabs and remove the end bolts, then the center bolts. Remove the manifold.

NOTE: *A 9/16 in. thin wall 6-point socket, sharpened at the leading edge and tapped onto the head of the bolt, simplifies bending the locktabs.*

When installing a new manifold on the right side you must transfer the heat stove from the old manifold to the new one.

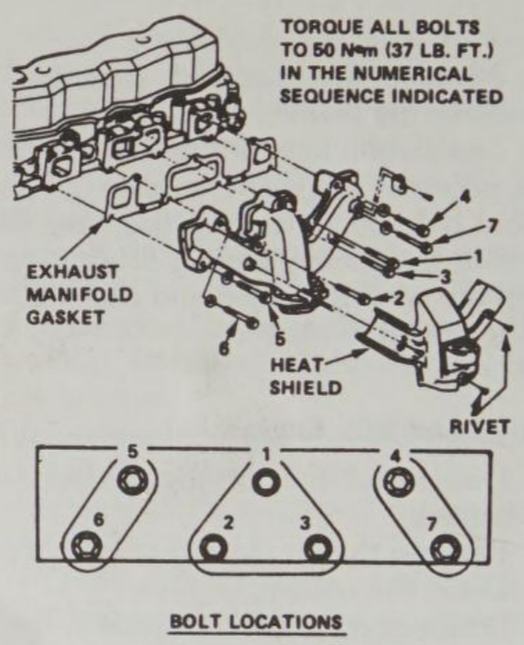
8. Installation is the reverse of removal. Clean all mating surfaces and use new gaskets. Torque all bolts to specifications from the inside working out.



Exhaust manifold installation

2.5L

1. Disconnect the negative battery cable at the battery.
2. Remove the air cleaner assembly, being sure to mark any disconnected hoses for proper reinstallation.
3. Remove the E.F.I. preheat tube.
4. Remove the oxygen sensor and disconnect the exhaust pipe from the exhaust manifold.
5. Remove the engine oil level dipstick and tube.
6. Remove the exhaust manifold attaching bolts and remove the manifold.
7. Installation of the manifold is performed in the reverse of the previous steps. When torquing the bolts, follow the sequence in the accompanying diagram and tighten each bolt to 44 ft. lbs.



Exhaust manifold bolt tightening sequence for 2.8L engine

Cylinder Head

REMOVAL AND INSTALLATION

NOTE: *When servicing the engine, be absolutely sure to mark vacuum hoses and wiring so that these items may be properly reconnected during installation. Also, when disconnecting fittings of metal lines (fuel, power brake vacuum), always use two flare nut (or line) wrenches. Hold the wrench on the large fitting with pressure on the wrench as if you were tightening the fitting (clockwise), THEN loosen and disconnect the smaller fitting from the larger fitting. If this is not done, damage to the line will result.*

1. Disconnect the battery cables at the battery.

ENGINE OVERHAUL

Most engine overhaul procedures are fairly standard. In addition to specific parts replacement procedures and complete specifications for your individual engine, this chapter also is a guide to accepted rebuilding procedures. Examples of standard rebuilding practice are shown and should be used along with specific details concerning your particular engine.

Competent and accurate machine shop services will ensure maximum performance, reliability and engine life. Procedures marked with the symbol shown above should be performed by a competent machine shop, and are provided so that you will be familiar with the procedures necessary to a successful overhaul.

In most instances it is more profitable for the do-it-yourself mechanic to remove, clean and inspect the component, buy the necessary parts and deliver these to a shop for actual machine work.

On the other hand, much of the rebuilding work (crankshaft, block, bearings, pistons, rods, and other components) is well within the scope of the do-it-yourself mechanic.

Tools

The tools required for an engine overhaul or parts replacement will depend on the depth of your involvement. With a few exceptions, they will be the tools found in a mechanic's tool kit (see Chapter 1). More in-depth work will require any or all of the following:

- a dial indicator (reading in thousandths) mounted on a universal base
- micrometers and telescope gauges
- jaw and screw-type pullers
- scraper
- valve spring compressor
- ring groove cleaner
- piston ring expander and compressor
- ridge reamer
- cylinder hone or glaze breaker
- Plastigage®
- engine stand

Use of most of these tools is illustrated in this chapter. Many can be rented for a one-time use from a local parts jobber or tool supply house specializing in automotive work.

Occasionally, the use of special tools is called for. See the information on Special Tools and the Safety Notice in the front of this book before substituting another tool.

Inspection Techniques

Procedures and specifications are given in this chapter for inspecting, cleaning and assessing the wear limits of most major components. Other procedures such as Magnaflux and Zyglo can be used to locate material flaws and stress cracks. Magnaflux is a magnetic process applicable only to ferrous materials. The Zyglo process coats the material with a flourescent dye penetrant and can be used on any material. Check for suspected surface cracks can be more readily made using spot check dye. The dye is sprayed onto the suspected area, wiped off and the area sprayed with a developer. Cracks will show up brightly.

Overhaul Tips

Aluminum has become extremely popular for use in engines, due to its low weight. Observe the following precautions when handling aluminum parts:

- Never hot tank aluminum parts (the caustic hot-tank solution will eat the aluminum)
- Remove all aluminum parts (identification tag, etc.) from engine parts prior to hot-tanking.
- Always coat threads lightly with engine oil or anti-seize compounds before installation, to prevent seizure.
- Never over-torque bolts or spark plugs, especially in aluminum threads.

Stripped threads in any component can be repaired using any of several commercial repair kits (Heli-Coil, Microdot, Keenserts, etc.)

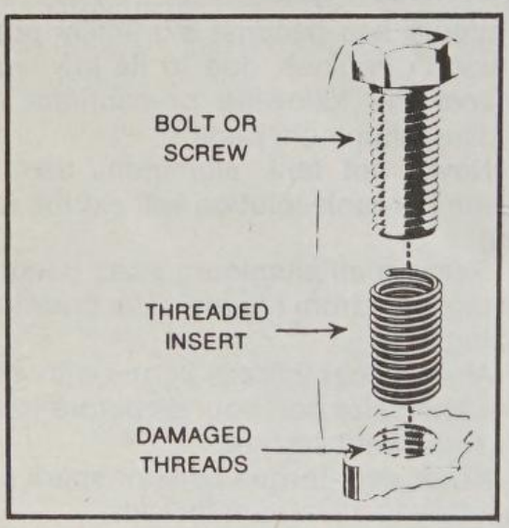
When assembling the engine, any parts that will be in frictional contact must be prelubed to provide lubrication at initial start-up. Any product specifically formulated for this purpose can be used, but engine oil is not recommended as a pre-lube.

When semi-permanent (locked, but removable) installation of bolts or nuts is desired, threads should be cleaned and coated with Loctite® or other similar, commercial non-hardening sealant.

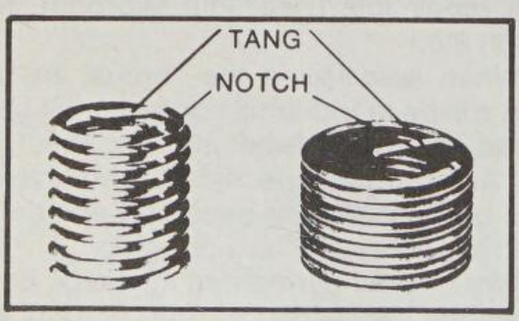
Repairing Damaged Threads

Several methods of repairing damaged threads are available. Heli-Coil® (shown here), Keenserts® and Microdot® are among the most widely used. All involve basically the same principle—drilling out stripped threads, tapping the hole and installing a prewound insert—making welding, plugging and oversize fasteners unnecessary.

Two types of thread repair inserts are usually supplied—a standard type for most Inch Coarse, Inch Fine, Metric Coarse and Metric Fine thread sizes and a spark plug type to fit most spark plug port sizes. Consult the individual manufacturer's catalog to determine exact applications. Typical thread repair kits will contain a selection of prewound threaded inserts, a tap (corresponding to the outside diameter threads of the insert) and an installation tool. Spark plug inserts usually differ because they require a tap equipped with pilot threads and a combined reamer/tap section. Most manufacturers also supply blister-packed thread repair inserts separately in addition to a master kit containing a variety of taps and inserts plus installation tools.

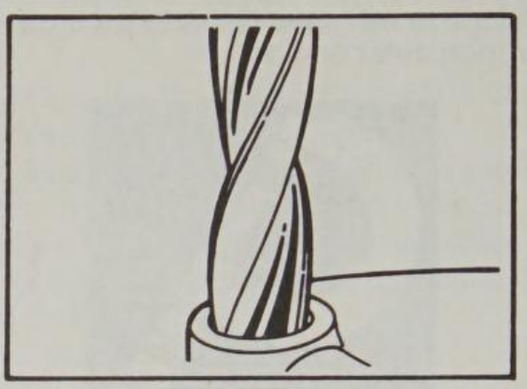


Damaged bolt holes can be repaired with thread repair inserts

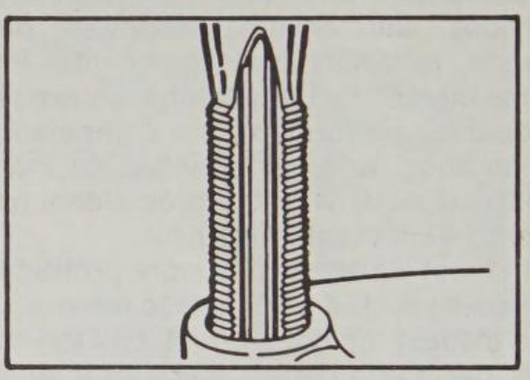


Standard thread repair insert (left) and spark plug thread insert (right)

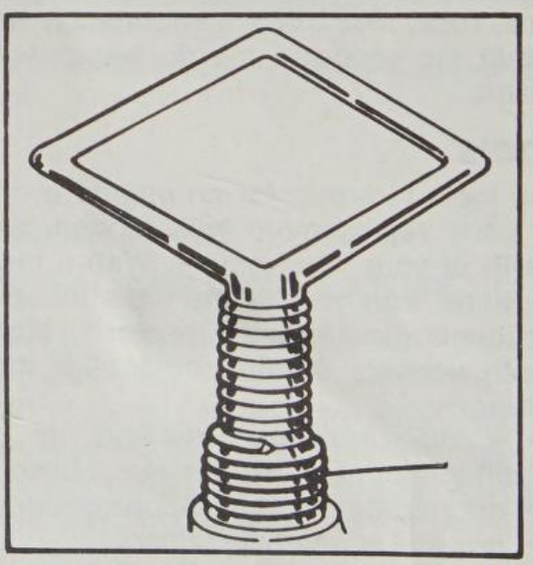
Before effecting a repair to a threaded hole, remove any snapped, broken or damaged bolts or studs. Penetrating oil can be used to free frozen threads; the offending item can be removed with locking pliers or with a screw or stud extractor. After the hole is clear, the thread can be repaired, as follows:



Drill out the damaged threads with specified drill. Drill completely through the hole or to the bottom of a blind hole



With the tap supplied, tap the hole to receive the thread insert. Keep the tap well oiled and back it out frequently to avoid clogging the threads



Screw the threaded insert onto the installation tool until the tang engages the slot. Screw the insert into the tapped hole until it is ¼–½ turn below the top surface. After installation break off the tang with a hammer and punch

Standard Torque Specifications and Fastener Markings

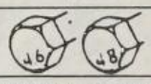
In the absence of specific torques, the following chart can be used as a guide to the maximum safe torque of a particular size/grade of fastener.

- There is no torque difference for fine or coarse threads.
- Torque values are based on clean, dry threads. Reduce the value by 10% if threads are oiled prior to assembly.
- The torque required for aluminum components or fasteners is considerably less.

U.S. Bolts

SAE Grade Number	1 or 2			5			6 or 7		
Number of lines always 2 less than the grade number.									
Bolt Size (Inches)—(Thread)	Maximum Torque			Maximum Torque			Maximum Torque		
	Ft./Lbs.	Kgm	Nm	Ft./Lbs.	Kgm	Nm	Ft./Lbs.	Kgm	Nm
1/4—20	5	0.7	6.8	8	1.1	10.8	10	1.4	13.5
—28	6	0.8	8.1	10	1.4	13.6			
5/16—18	11	1.5	14.9	17	2.3	23.0	19	2.6	25.8
—24	13	1.8	17.6	19	2.6	25.7			
3/8—16	18	2.5	24.4	31	4.3	42.0	34	4.7	46.0
—24	20	2.75	27.1	35	4.8	47.5			
7/16—14	28	3.8	37.0	49	6.8	66.4	55	7.6	74.5
—20	30	4.2	40.7	55	7.6	74.5			
1/2—13	39	5.4	52.8	75	10.4	101.7	85	11.75	115.2
—20	41	5.7	55.6	85	11.7	115.2			
9/16—12	51	7.0	69.2	110	15.2	149.1	120	16.6	162.7
—18	55	7.6	74.5	120	16.6	162.7			
5/8—11	83	11.5	112.5	150	20.7	203.3	167	23.0	226.5
—18	95	13.1	128.8	170	23.5	230.5			
3/4—10	105	14.5	142.3	270	37.3	366.0	280	38.7	379.6
—16	115	15.9	155.9	295	40.8	400.0			
7/8— 9	160	22.1	216.9	395	54.6	535.5	440	60.9	596.5
—14	175	24.2	237.2	435	60.1	589.7			
1— 8	236	32.5	318.6	590	81.6	799.9	660	91.3	894.8
—14	250	34.6	338.9	660	91.3	849.8			

Metric Bolts

Relative Strength Marking	4.6, 4.8			8.8		
Bolt Markings						
Bolt Size Thread Size x Pitch (mm)	Maximum Torque			Maximum Torque		
	Ft./Lbs.	Kgm	Nm	Ft./Lbs.	Kgm	Nm
6 x 1.0	2–3	.2–.4	3–4	3–6	.4–.8	5–8
8 x 1.25	6–8	.8–1	8–12	9–14	1.2–1.9	13–19
10 x 1.25	12–17	1.5–2.3	16–23	20–29	2.7–4.0	27–39
12 x 1.25	21–32	2.9–4.4	29–43	35–53	4.8–7.3	47–72
14 x 1.5	35–52	4.8–7.1	48–70	57–85	7.8–11.7	77–110
16 x 1.5	51–77	7.0–10.6	67–100	90–120	12.4–16.5	130–160
18 x 1.5	74–110	10.2–15.1	100–150	130–170	17.9–23.4	180–230
20 x 1.5	110–140	15.1–19.3	150–190	190–240	26.2–46.9	160–320
22 x 1.5	150–190	22.0–26.2	200–260	250–320	34.5–44.1	340–430
24 x 1.5	190–240	26.2–46.9	260–320	310–410	42.7–56.5	420–550

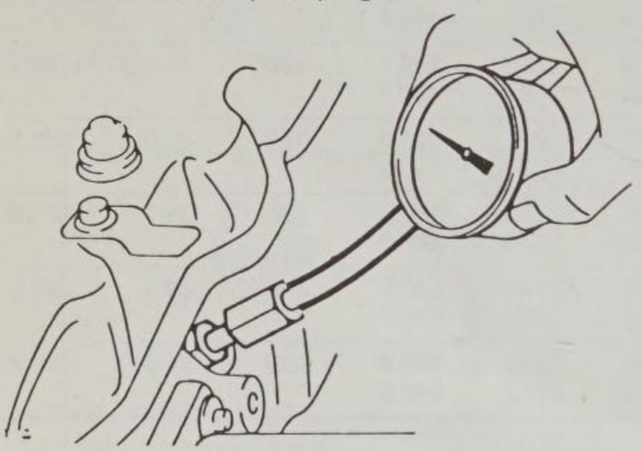
CHECKING ENGINE COMPRESSION

A noticeable lack of engine power, excessive oil consumption and/or poor fuel mileage measured over an extended period are all indicators of internal engine wear. Worn piston rings, scored or worn cylinder bores, blown head gaskets, sticking or burnt valves and worn valve seats are all possible culprits here. A check of each cylinder's compression will help you locate the problems.

As mentioned in the "Tools and Equipment" section of Chapter 1, a screw-in type compression gauge is more accurate than the type you simply hold against the spark plug hole, although it takes slightly longer to use. It's worth it to obtain a more accurate reading. Follow the procedures below for gasoline and diesel-engined cars.

Gasoline Engines

1. Warm up the engine to normal operating temperature.
2. Remove all spark plugs.



The screw-in type compression gauge is more accurate

3. Disconnect the high-tension lead from the ignition coil.
4. On carbureted cars, fully open the throttle either by operating the carburetor throttle linkage by hand or by having an assistant "floor" the accelerator pedal. On fuel-injected cars, disconnect the cold start valve and all injector connections.
5. Screw the compression gauge into the No. 1 spark plug hole until the fitting is snug.

NOTE: *Be careful not to crossthread the plug hole. On aluminum cylinder heads use extra care, as the threads in these heads are easily ruined.*

6. Ask an assistant to depress the accelerator pedal fully on both carbureted and fuel-injected cars. Then, while you read the compression gauge, ask the assistant to crank the engine two or three times in short bursts using the ignition switch.
7. Read the compression gauge at the end of each series of cranks, and record the highest of these readings. Repeat this procedure for each of the engine's cylinders. Compare the highest reading of each cylinder to the compression pressure specifications in the "Tune-Up Specifications" chart in Chapter 2. The specs in this chart are maximum values.

A cylinder's compression pressure is usually acceptable if it is not less than 80% of maximum. The difference between each cylinder should be no more than 12–14 pounds.

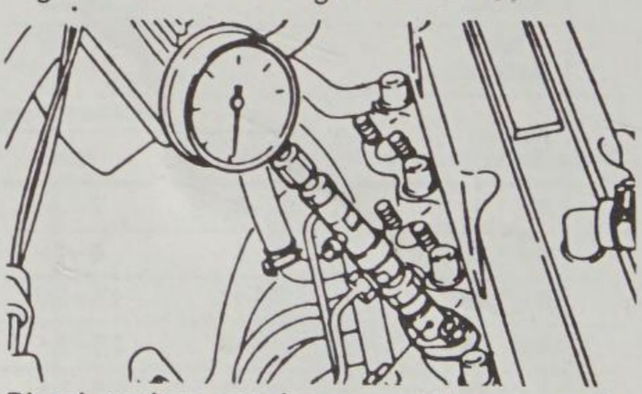
8. If a cylinder is unusually low, pour a tablespoon of clean engine oil into the cylinder through the spark plug hole and repeat the compression test. If the compression comes up after adding the oil, it appears that that cylinder's piston rings or bore are damaged or worn. If the pressure remains low, the valves may not be seating properly (a valve job is needed), or the head gasket may be blown near that cylinder. If compression in any two adjacent cylinders is low, and if the addition of oil doesn't help the compression, there is leakage past the head gasket. Oil and coolant water in the combustion chamber can result from this problem. There may be evidence of water droplets on the engine dipstick when a head gasket has blown.

Diesel Engines

Checking cylinder compression on diesel engines is basically the same procedure as on gasoline engines except for the following:

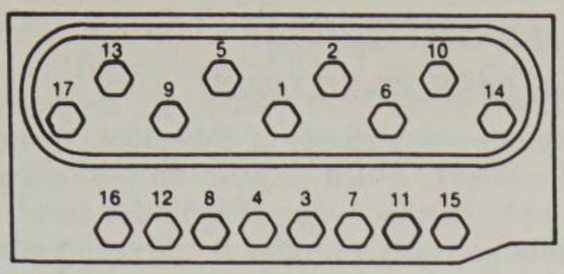
1. A special compression gauge adaptor suitable for diesel engines (because these engines have much greater compression pressures) must be used.
2. Remove the injector tubes and remove the injectors from each cylinder.

NOTE: *Don't forget to remove the washer underneath each injector; otherwise, it may get lost when the engine is cranked.*

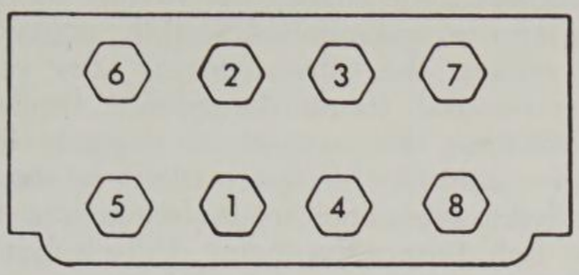


Diesel engines require a special compression gauge adaptor

3. When fitting the compression gauge adaptor to the cylinder head, make sure the bleeder of the gauge (if equipped) is closed.
4. When reinstalling the injector assemblies, install new washers underneath each injector.



Tightening sequence for the 5.0L engine cylinder head



Tightening sequence for 2.8L cylinder head

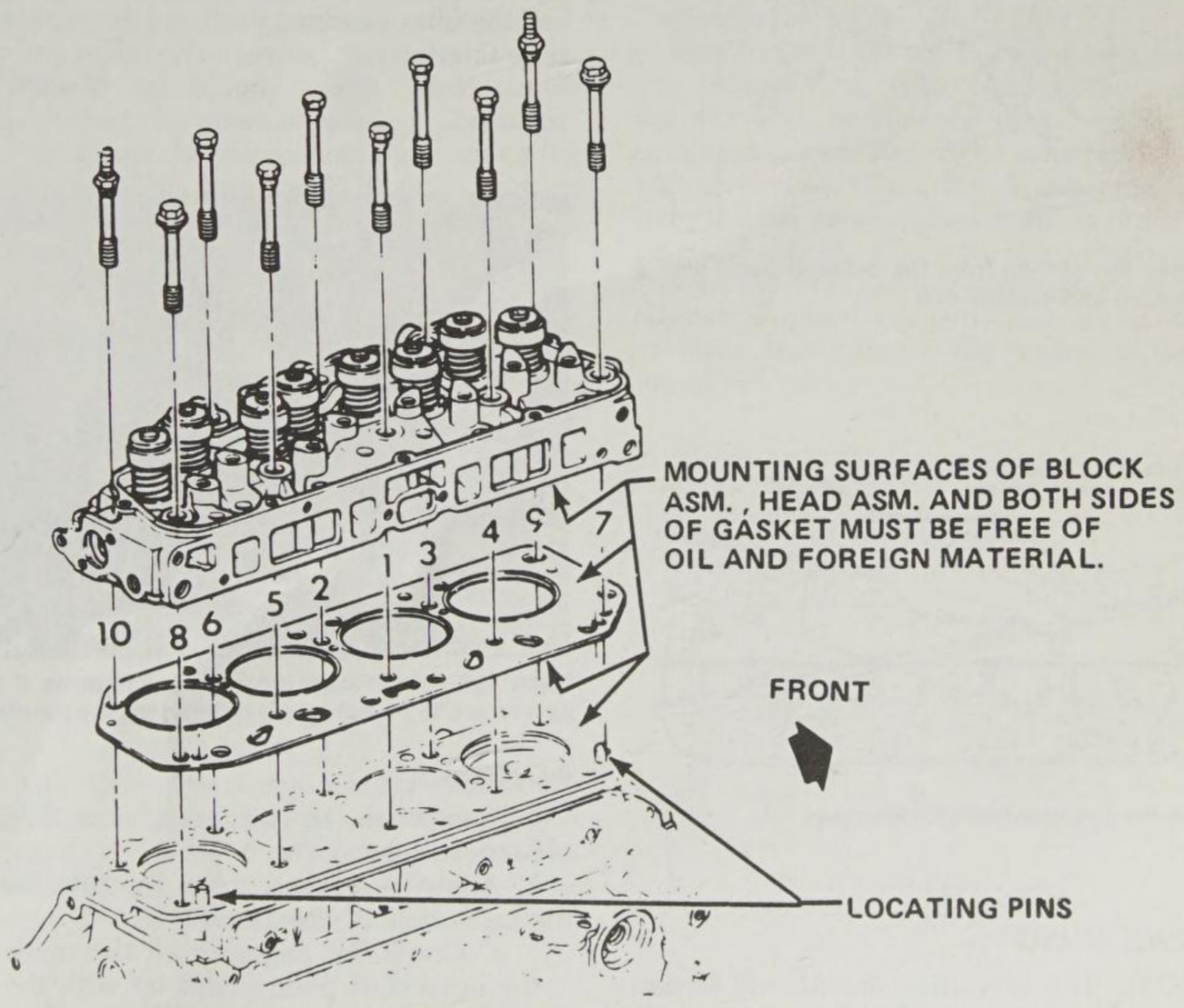
2. Drain the engine block of coolant.
3. Remove the intake manifold as previously described. Remove the alternator and lay the unit aside. If necessary, remove the alternator brackets.
4. Remove the exhaust manifold(s). If the vehicle has air conditioning, remove the compressor and position it out of the way. Do not disconnect the refrigerant lines.
5. Back off the rocker arm nuts/bolts and pivot the rocker arms out of the way so that the pushrods can be removed. Identify the pushrods so that they can be reinstalled in their original locations.
6. Remove the cylinder head bolts and cylinder head(s).
7. Install using new gaskets. The head gasket is installed with the bead up.

NOTE: *Clean the bolt threads, apply sealing compound and install the bolts finger tight.*

8. Tighten the head bolts a little at a time in the sequence illustrated to the specified torque.
9. Install the exhaust and intake manifolds as previously outlined.
10. Adjust the valves.

CLEANING AND INSPECTION

Chip carbon away from the valve heads, combustion chambers, and ports, using a chisel made of hardwood. Remove the remaining deposits with a stiff wire brush.



Tightening sequence for the 2.5L cylinder head

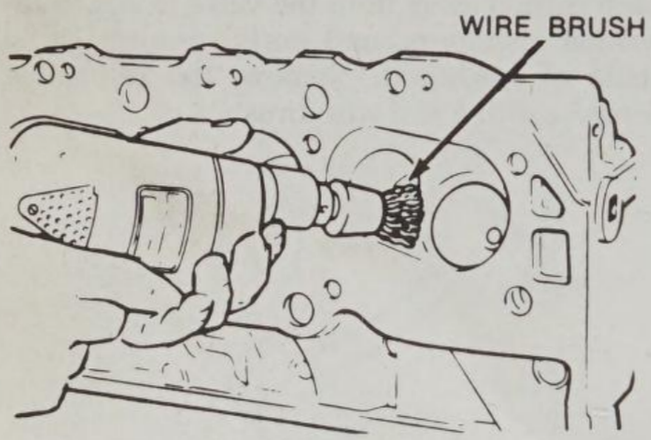
NOTE: *Be sure that the deposits are actually removed, rather than burnished.*

Have the cylinder head hot-tanked to remove grease, corrosion, and scale from the water passages. Clean the remaining cylinder head parts in an engine cleaning solvent. Do not remove the protective coating from the springs.

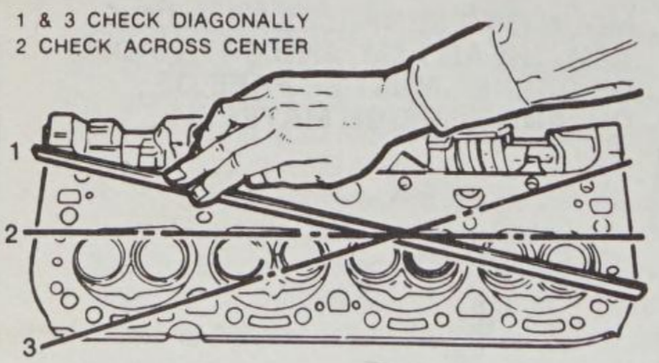
Place a straight-edge across the gasket surface of the cylinder head. Using feeler gauges, determine the clearance at the center of the straightedge. If warpage exceeds .003" in a 6" span, or .006" over the total length, the cylinder head must be resurfaced.

NOTE: *If warpage exceeds the manufacturer's maximum tolerance for material removal, the cylinder head must be replaced.*

NOTE: *When milling the cylinder heads of V-type engines, the intake manifold mounting position is altered, and must be corrected by milling the manifold flange a proportionate amount.*



Remove the carbon from the cylinder head with a wire brush and electric drill



Check the cylinder head for warpage

RESURFACING

NOTE: *This procedure should only be performed by a machine shop.*

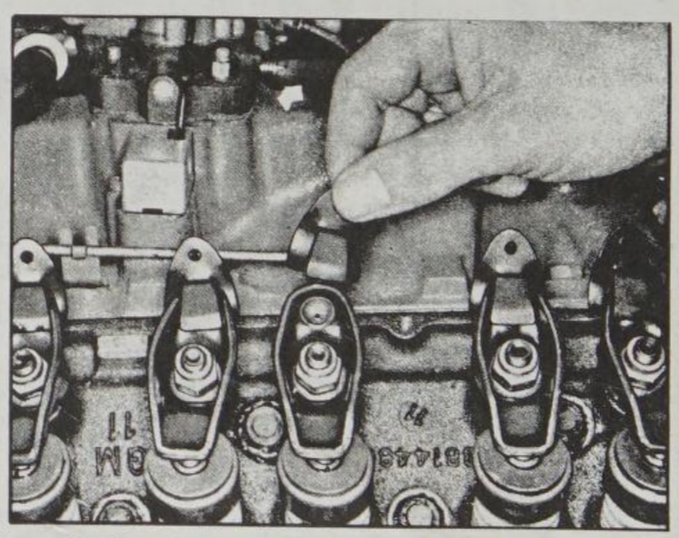
Valves and Springs

VALVE LASH ADJUSTMENT

All engines described in this book use hydraulic lifters, which require no periodic adjustment. In the event of cylinder head removal or any operation that requires disturbing the rocker arms, the rocker arms will have to be adjusted.

Normalize the engine temperature by running it for several minutes. Shut the engine off and remove the valve cover(s). After valve cover removal, torque the cylinder heads to specification. The use of oil stopper clips, readily available on the market, is recommended to prevent oil splatter when adjusting valve lash. Restart the engine. Valve lash is set with the engine warm and idling.

Turn the rocker arm nut counterclockwise until the rocker arm begins to clatter. Reverse the direction and turn the rocker arm down slowly until the clatter just stops. This is the zero lash position. Turn the nut down an additional ¼ turn and wait ten seconds until the engine runs smoothly. Continue with additional ¼ turns, waiting ten seconds each time, until the nut has been turned down one full turn from the zero lash position. This one turn, pre-load adjustment must be performed to allow the lifter to adjust itself and prevents possible interference between the valves and pistons. Noisy lifters should be cleaned or replaced.



Install oil splash clips on the rocker arms if the valves are to be adjusted with the engine running

4-Cylinder

1. Remove the air cleaner. Remove the cylinder head valve cover.

2. Adjust the valves when the lifter is on the base circle of a camshaft lobe:

   a. Crank the engine until the mark on the crankshaft pulley lines up with the '0' mark on the timing tab. Make sure that the

engine is in the No. 1 firing position. Place your fingers on the No. 1 rocker arms as the mark on the crank pulley comes near the '0' mark. If the valves are not moving, the engine is in the No. 1 firing position. If the valves move, the engine is in the No. 4 firing position; rotate the engine one complete revolution and it will be in the No. 1 position.

b. When the engine is in the No. 1 firing position, adjust the following valves:

- Exhaust—1, 3
- Intake—1, 2

c. Back the adjusting nut out until lash can be felt at the push rod, then turn the nut until all lash is removed (this can be determined by rotating the push rod while turning the adjusting nut). When all lash has been removed, turn the nut in 1½ additional turns, this will center the lifter plunger.

d. Crank the engine one complete revolution until the timing tab and the '0' mark are again in alignment. Now the engine is in the No. 4 firing position. Adjust the following valves:

- Exhaust—2, 4
- Intake—3, 4

3. Installation of the remaining components is in the reverse order of removal.

V6 and V8

1. Adjust the valves as follows:

a. Crank the engine until the mark on the damper aligns with the TDC or 0° mark on the timing tab and the engine is in No. 1 firing position. This can be determined by placing the fingers on the No. 1 cylinder valves as the marks align. If the valves do not move, it is in No. 1 firing position. If the valves move, it is in No. 4 (V6) or No. 6 (V8) firing position and the crankshaft should be rotated one more revolution to the No. 1 firing position.

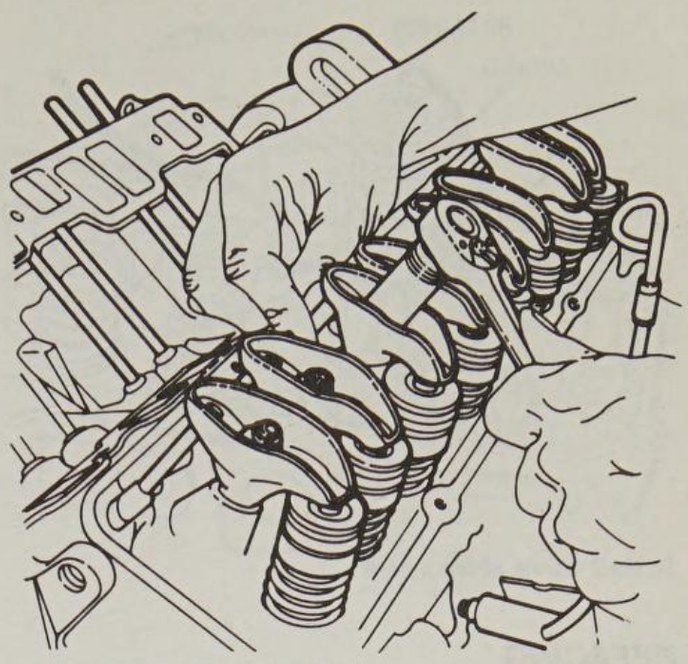
b. The adjustment is made in the same manner on both engines.

c. With the engine in No. 1 firing position, the following valves can be adjusted:

- V8-Exhaust—1, 3, 4, 8
- V8-Intake—1, 2, 5, 7
- V6-Exhaust—1, 2, 3
- V6-Intake—1, 5, 6

d. Crank the engine 1 full revolution until the marks are again in alignment. This is No. 4 (V6) or No. 6 (V8) firing position. The following valves can now be adjusted:

- V8-Exhaust—2, 5, 6, 7
- V8-Intake—3, 4, 6, 8
- V6-Exhaust—2, 3, 4
- V6-Intake—4, 5, 6



Valve adjustment—typical

2. Reinstall the rocker arm covers using new gaskets or sealer.

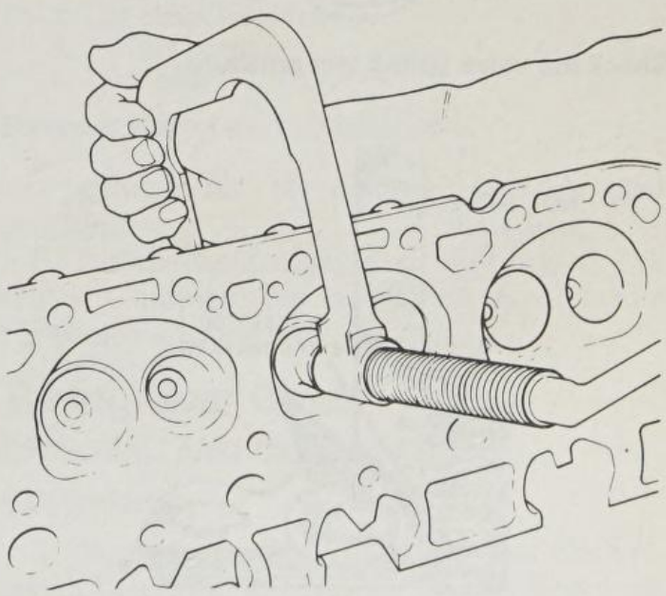
3. Install the distributor cap and wire assembly.

4. Adjust the carburetor idle speed.

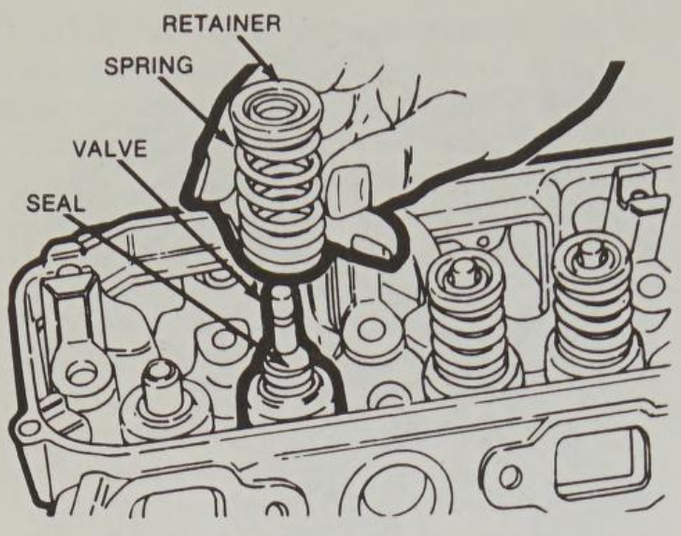
REMOVAL AND INSTALLATION

NOTE: *Invert the cylinder head, and number the valve faces front to rear, using a permanent felt-tip marker.*

Using an appropriate valve spring compressor, compress the valve springs. Lift out the keepers with needlenose pliers, release the compressor, and remove the valve, spring, and spring retainer. Clean the valve stem with lacquer thinner or a similar solvent to remove all gum and varnish. Clean the valve guides using solvent and an expanding wire-type valve guide cleaner. Replace any parts that are damaged or worn. Installation is the reverse of the removal procedure.



Compressing valve spring—typical



Install valve stem seals

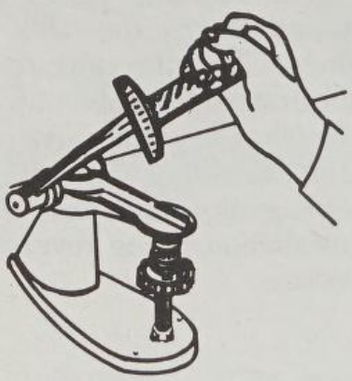
REFACING

NOTE: *This procedure should only be performed by a qualified machine shop.*

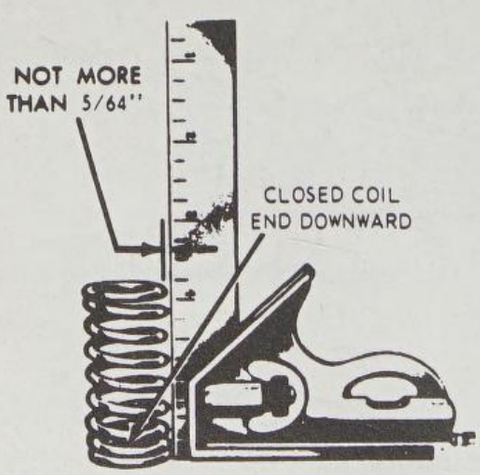
CHECK SPRINGS

Place the spring on a flat surface next to a square. Measure the height of the spring, and rotate it against the edge of the square to measure distortion. If spring height varies (by comparison) by more than 1/16" or if distortion exceeds 1/16", replace the spring.

In addition to evaluating the spring as above, test the spring pressure at the installed and compressed (installed height minus valve lift) height using a valve spring tester. Springs used on small displacement engines (up to 3 liters) should be ±1 lb of all other springs in either position. A tolerance of ±5 lbs is permissible on larger engines.



Check the valve spring test pressure



Check the valve spring free length and squareness

Valve Guides

NOTE: *The valve guides are not removable, they are an integral part of the cylinder head. Any cutting or grinding operation performed on the valve guides, should be done by a qualified machine shop.*

KNURLING

Valve guides which are not excessively worn or distorted may, in some cases, be knurled. Knurling is a process in which metal is displaced and raised, thereby reducing clearance. Knurling also provides excellent oil control.

This procedure should only be performed by a qualified machine shop.

Valve Seats

NOTE: *The valve seats are not removable, they are an integral part of the cylinder head. Any cutting or grinding operation performed on the valve guides, should be done by a qualified machine shop.*

LAPPING THE VALVES

When valve faces and seats have been re-faced and re-cut, or if they are determined to be in good condition, the valves must be "lapped in" to ensure efficient sealing when the valve closes against the seat.

1. Invert the cylinder head so that the combustion chambers are facing up.
2. Lightly lubricate the valve stems with clean oil, and coat the valve seats with valve grinding compound. Install the valves in the head as numbered.
3. Attach the suction cup of a valve lapping tool to a valve head. *You'll probably have to*

Lapping the valves by hand

Home made valve lapping tool

moisten the cup to securely attach the tool to the valve.

4. Rotate the tool between the palms, changing position and lifting the tool often to prevent grooving. Lap the valve until a smooth, polished seat is evident (you may have to add a bit more compound after some lapping is done).

5. Remove the valve and tool, and remove ALL traces of grinding compound with solvent-soaked rag, or rinse the head with solvent.

NOTE: *Valve lapping can also be done by fastening a suction cup to a piece of drill rod in a hand "eggbeater" type drill. Proceed as above, using the drill as a lapping tool. Due to the higher speeds involved when using the hand drill, care must be exercised to avoid grooving the seat. Lift the tool and change direction of rotation often.*

Valve Lifters

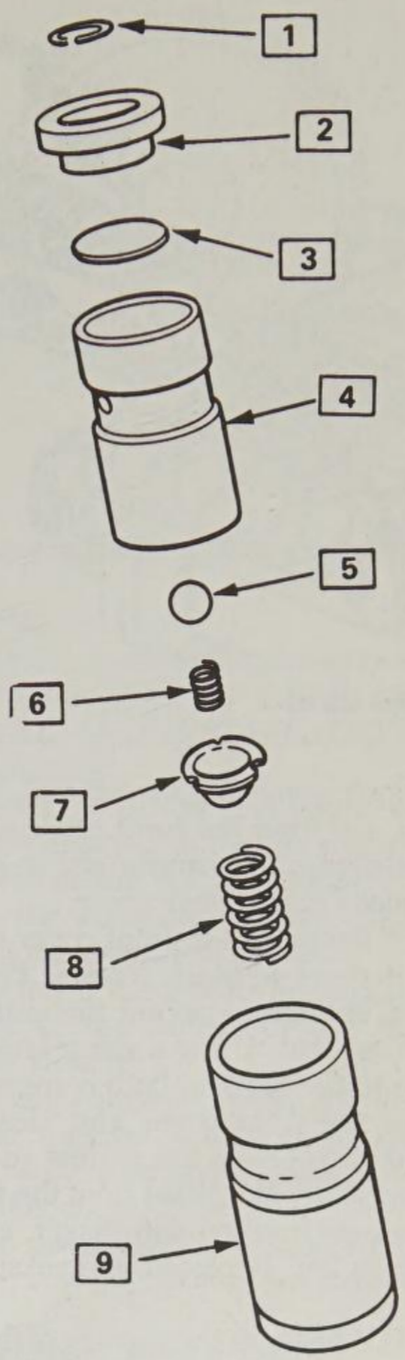
REMOVAL AND INSTALLATION

1. Remove the intake manifold, valve cover and push rod cover (4-cylinder). Disassemble the rocker arms and remove the push rods.

2. Remove the lifters. If they are coated with varnish, clean with carburetor cleaning solvent.

3. If installing new lifters or you have disassembled the lifters, they must be primed before installation. Submerge the lifters in SAE 10 oil and carefully push down on the plunger with a ⅛ in. drift. Hold the plunger down (DO NOT pump), then release the plunger slowly. The lifter is now primed.

4. Coat the bottoms of the lifters with Molykote® before installation. Install the lifters



1. Retainer spring
2. Push rod seat
3. Rocker feed metering valve
4. Plunger
5. Ball check valve
6. Ball check valve spring (high ball lifter only)
7. Ball check valve retainer
8. Plunger spring
9. Lifter body

Exploded view of the hydraulic valve

and pushrods into the engine in their original position.

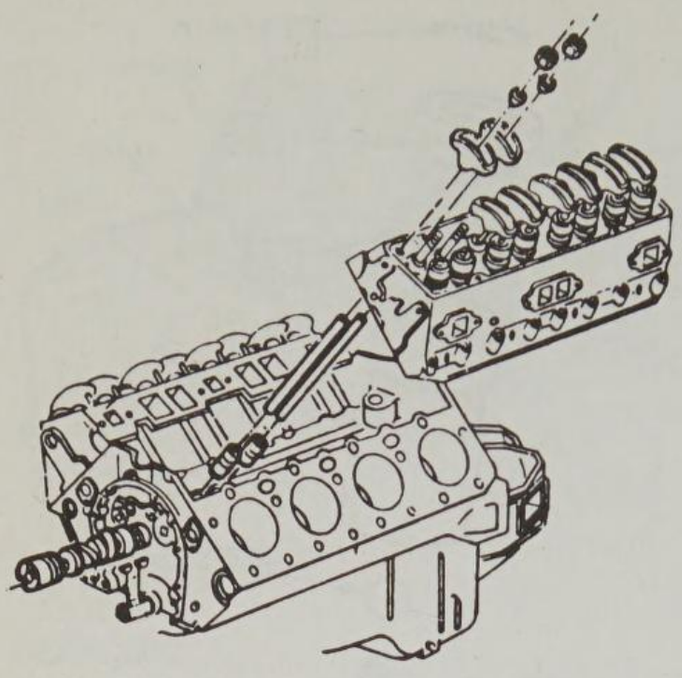
5. Install the rocker arms and adjust the valves. Complete the installation by reversing the removal procedure.

Timing Gear Cover

REMOVAL AND INSTALLATION

4-Cylinder

1. Remove the drive belts. Remove the hub center bolt, then slide the hub and pulleys from the crankshaft.



View of V8 valve lifters

NOTE: *If only removing the oil seal, simply pry the oil seal from the front cover using a large screwdriver. Be careful not to distort the sheet metal timing gear cover.*

2. Remove the oil pan-to-front cover screws and the front cover-to-block screws. Pull the cover forward enough to permit the cutting of the oil pan front seal. Using a sharp knife, cut the seal close to the block at both corners.

3. Remove the front cover and clean any portion of old gasket from the sealing surfaces. Clean portions of the old gasket from the block.

4. Using a new front oil pan gasket, cut the tabs from the gasket. Replace the crankshaft oil seal.

5. Place RTV sealer in the corners of the new oil pan gasket and the new timing gear cover gasket.

6. To complete the installation, reverse the removal procedures.

6V and 8V

1. Disconnect the battery ground cable. Drain the cooling system.

2. Remove the fan shroud or the upper radiator support and drive belts. Remove the fan and pulley from the water pump.

3. Remove the generator upper and lower brackets, air brace and brackets, and lower bracket of the power steering, move it aside.

4. Remove the radiator lower hose and the heater hose from the water pump. Remove the water pump bolts and the water pump.

5. If A/C equipped, remove the compressor and move aside. Remove the compressor mounting bracket.

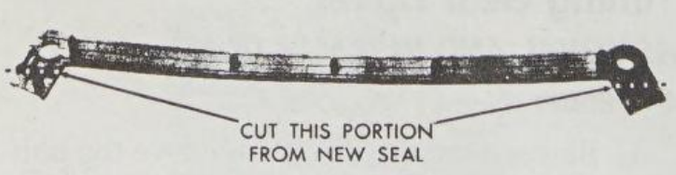
6. Remove the damper pulley retaining bolt and the damper pulley.

7. Remove the timing gear cover bolts and the timing gear cover.

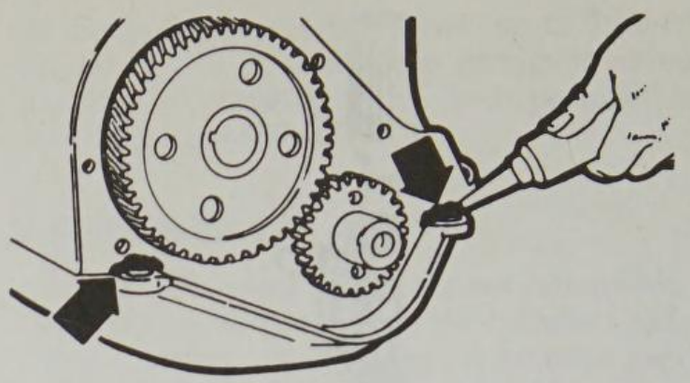
NOTE: *With the timing gear cover removed, use a large screwdriver to pry the oil seal from the cover. To install the new oil seal, lubricate it with engine oil and drive it into place.*

8. Prepare the mating surfaces for reinstallation of the timing gear cover. Coat the new gasket with RTV sealer.

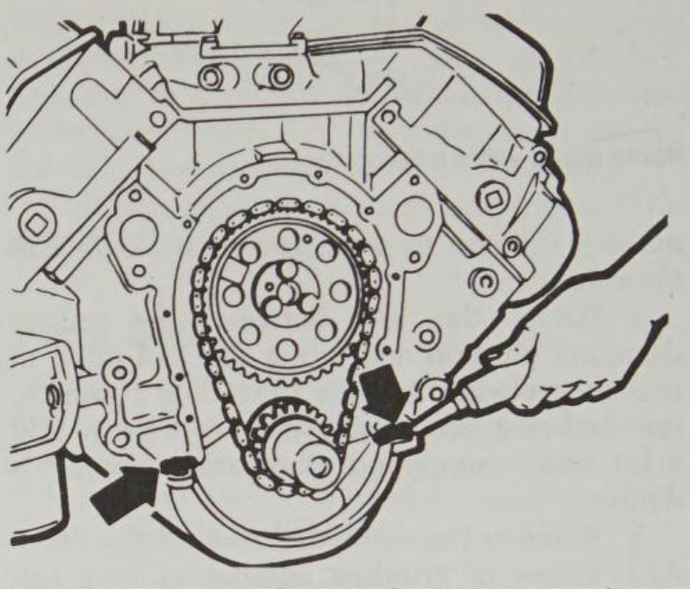
9. To complete the installation, reverse the removal procedures.



Cut a new front cover seal along the lines indicated to replace the seal without removing the oil pan



Use sealer at the timing cover-to-oil pan and the oil pan-to-cylinder block joints; 4-151 engine

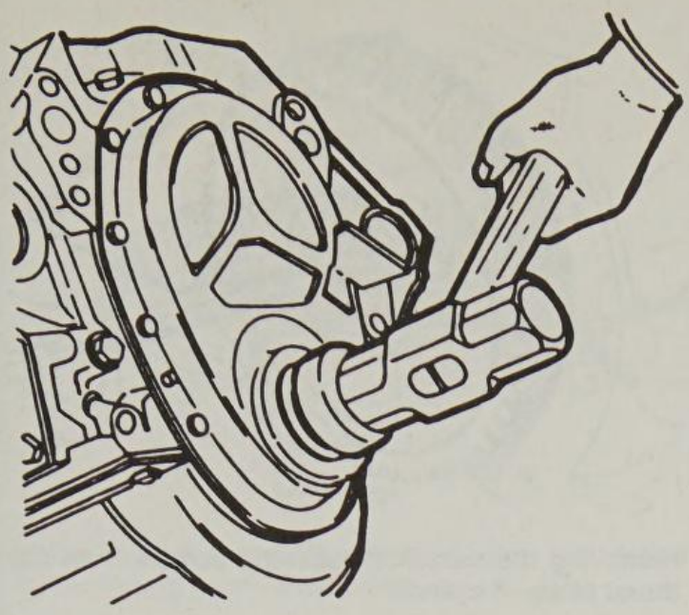


Apply sealer to the front pads at the area shown (V8) V6 similar

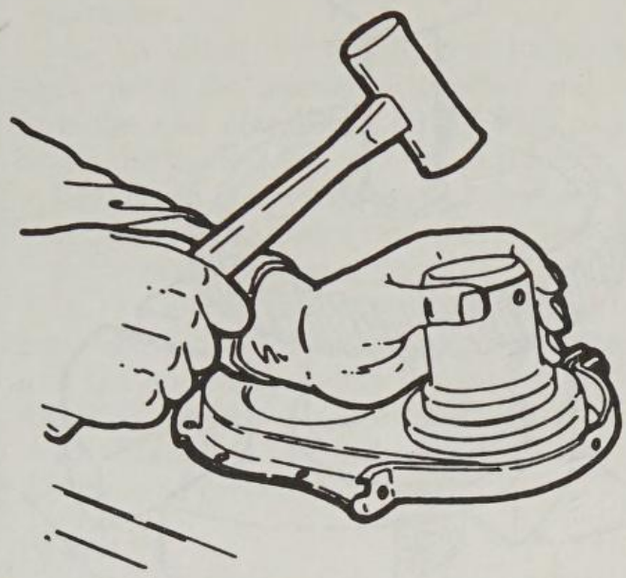
TIMING GEAR COVER OIL SEAL REPLACEMENT

All Engines

1. After removing the gear cover, pry the oil seal out of the front of the cover with a small prybar or an oil seal removal tool.



Oil seal installation with the cover installed



Oil seal installation with the cover removed

2. Install a new lip seal with the lip (open side of seal) inside and drive or press the seal into place.

3. Lightly coat seal with engine oil before replacing cover on block.

Timing Chain or Gear

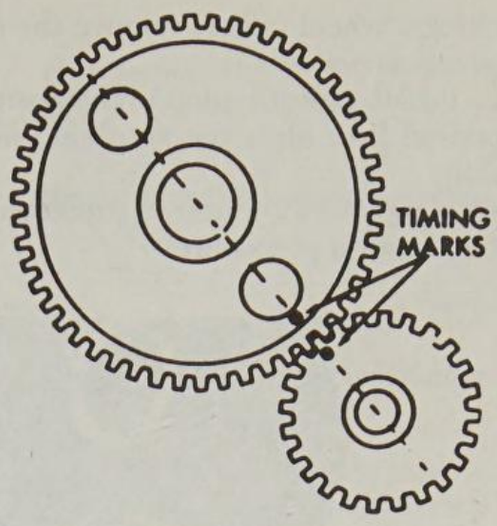
REMOVAL AND INSTALLATION

4-Cylinder

The 4-cylinder engine uses a gear driven camshaft. To remove the timing gear, refer to the camshaft removal section, for the camshaft must be removed from the engine so that the timing gear may be pressed from the shaft.

CAUTION: *The thrust plate must be positioned so that the woodruff key in the shaft does not damage it when the shaft is pressed out of the gear. Support the hub of the gear or the gear will be seriously damaged.*

The crankshaft gear may be removed with a gear puller while in place in the block.



Timing gear alignment inline 4 cylinder

V6 and V8

NOTE: *To remove the timing gear cover, refer to the TIMING GEAR COVER REMOVAL AND INSTALLATION section in this chapter.*

1. With the timing gear cover removed, rotate the engine so that the No. 6 cylinder T.D.C. mark (V8) or the No. 4 cylinder T.D.C. mark (V6) on the camshaft sprocket, aligns with the mark on the crankshaft sprocket.

2. Remove the 3 bolts holding the camshaft sprocket to the camshaft. Pull the camshaft sprocket forward.

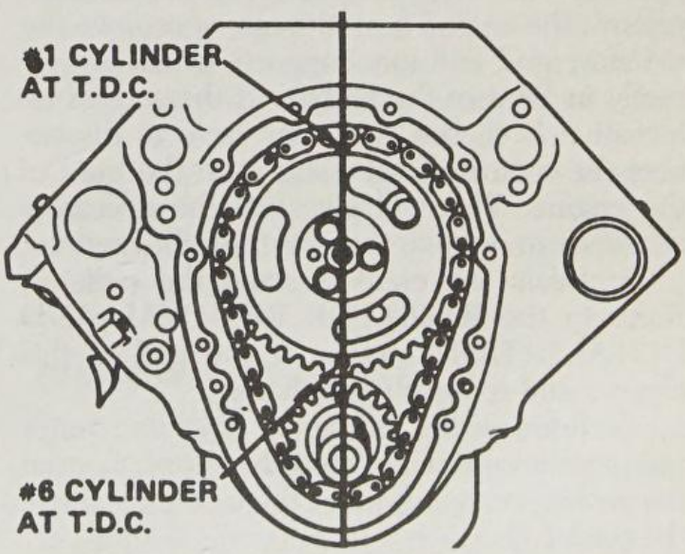
3. If the camshaft sprocket will not move, give the sprocket a light blow with a plastic mallet, on the lower edge. Remove the sprocket and timing chain.

4. To install, without changing the engines position, reverse the removal procedures.

Crankshaft Sprocket

REMOVAL AND INSTALLATION

1. Should it be necessary to remove the crankshaft sprocket, it may be necessary to remove the radiator.

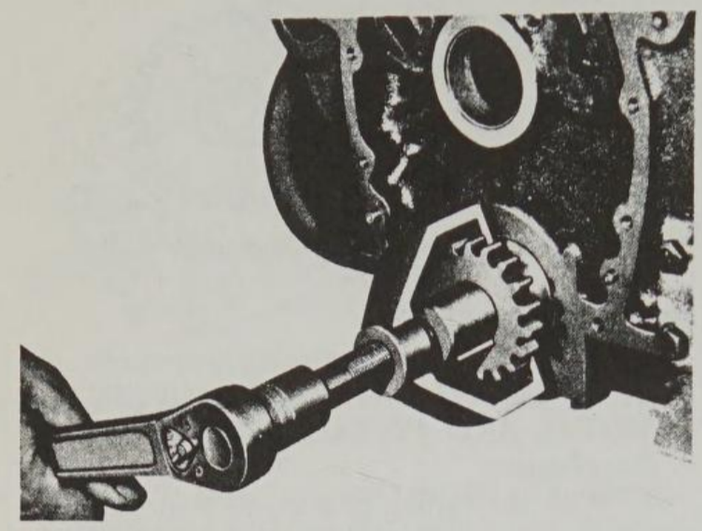


Timing sprocket alignment—V8. On V6, the #4 cylinder mark will align with the crankshaft sprocket

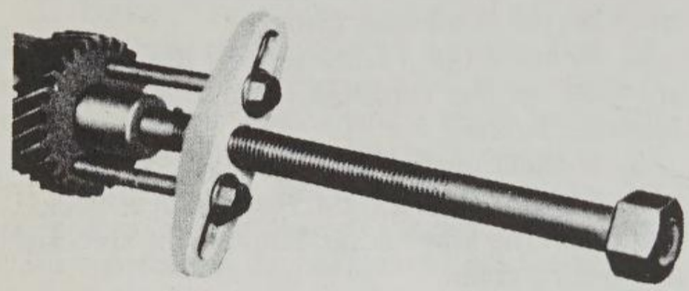
2. Using a wheel puller, remove the crankshaft sprocket.

3. To install, pay attention to the position of the woodruff key. Slide the sprocket onto the crankshaft.

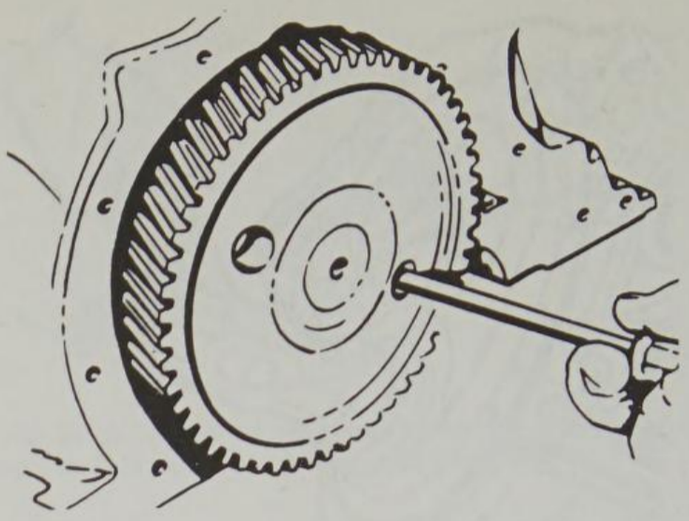
4. To complete the removal procedure, reverse the removal procedure.



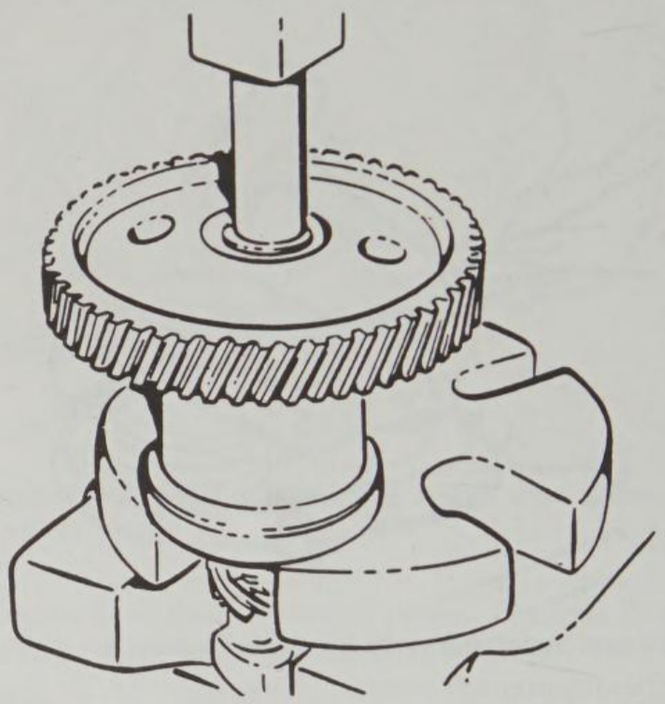
V6 and V8 crankshaft sprocket removal



The inline 4-cylinder crankshaft gear is removed with a gear plier



Removing the camshaft retaining screws from the thrust plate—4 cylinder



Pressing the timing gear from the camshaft—4 cylinder

Camshaft and Bearings

REMOVAL AND INSTALLATION

4-Cylinder

There are two ways to go about this task: either remove the engine from the car, or remove the radiator, grill and any supports which are directly in front of the engine. If the second alternative is chosen, you may have to disconnect the motor mounts, and raise the front of the engine. This will give you the necessary clearance to remove the cam from the engine.

1. Drain the crankcase and the radiator. Refer to the RADIATOR REMOVAL AND INSTALLATION section at the end of this chapter and remove the radiator.

2. Remove the fan, drive belts and water pump pulley. Remove the valve cover. Loosen the rocker arms and pivot them, then remove the push rods.

3. Remove the oil pump drive shaft and gear assembly. Remove the spark plugs.

4. Mark the position of the distributor rotor, housing, and engine block. Remove the distributor.

5. Remove the valve lifters. Refer to the TIMING GEAR COVER REMOVAL AND INSTALLATION section in this chapter and remove the timing gear cover.

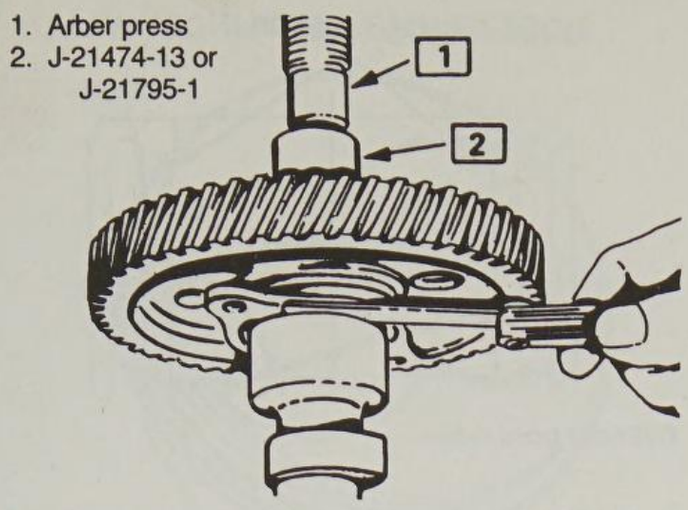
6. Insert a screwdriver through the holes in the timing gear and remove the 2 camshaft thrust plate screws.

7. Pull the camshaft and gear assembly out through the front of the engine glock.

NOTE: *When removing the camshaft, be careful not to damage the camshaft bearings.*

8. If the camshaft is to be removed from the timing gear, Place the assembly in an arbor press and separate.

CAUTION: *When removing the timing gear from the camshaft, the thrust plate must be*



Checking the camshaft clearance upon installation of the timing gear—4 cylinder

positioned so that the woodruff key does not damage it.

9. To install the timing gear to the camshaft, press the assembly together and measure the end clearance (.0015–.0050 in.) between the thrust plate and the camshaft.

NOTE: *If the clearance is less than .0015 in., replace the spacer ring; if more than .0050 in., replace the thrust ring.*

10. To install, lubricate the camshaft, bearings, and lifters. Slide the camshaft assembly into the engine and align the timing marks of the camshaft gear and crankshaft gear.

11. Complete the installation by reversing the removal procedure.

V6 and V8

1. Drain the cooling system and remove the radiator by referring to the RADIATOR REMOVAL AND INSTALLATION section in this chapter.

2. Refer to the TIMING GEAR COVER and TIMING CHAIN REMOVAL AND INSTALLATION sections in this chapter, then remove the timing gear cover and chain.

3. Remove the intake manifold and valve covers. Loosen the rocker arms and pivot out of way. Remove the push rods and valve lifters.

4. Mark the distributor rotor, housing and engine block, then remove the distributor. Remove the fuel pump and fuel pump push rod.

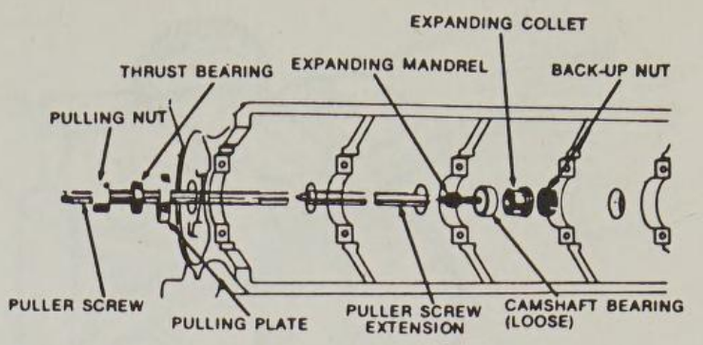
5. Slide the camshaft toward the front of the engine (be careful not to damage the camshaft bearings).

6. To install, lubricate all parts and reverse the removal procedure. When installing the timing gear and chain, align the timing marks.

BEARING REMOVAL AND INSTALLATION

NOTE: *It is recommended that the engine be removed from the vehicle before attempting this procedure.*

NOTE: *On the 4-Cylinder engine, the camshaft, lifters, flywheel and the expansion plug (at the rear of the camshaft) must be removed. Drive the expansion plug out from the inside of the engine block.*



Camshaft bearing removal and installation tool

All Engines

To remove the camshaft bearings, the camshaft, lifters, flywheel, rear camshaft expansion plug, and crankshaft must be removed.

Camshaft bearings can be replaced with engine completely or partially disassembled. To replace bearings without complete disassembly remove the camshaft and crankshaft leaving cylinder heads attached and pistons in place. Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Fasten connecting rods against sides of engine so they will not be in the way while replacing camshaft bearings.

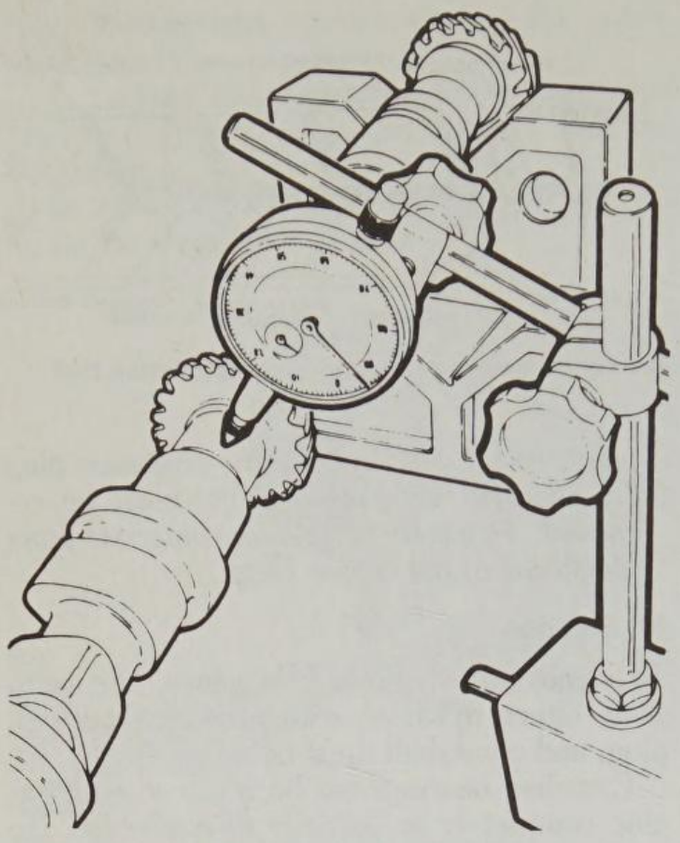
If excessive wear is indicated, or if the engine is being completely rebuilt, camshaft bearings should be replaced as follows: Drive the camshaft rear plug from the block. Assemble the removal puller with its shoulder on the bearing to be removed. Gradually tighten the puller nut until bearing is removed. Remove remaining bearings, leaving the front and rear for last. To remove front and rear bearings, reverse position of the tool, so as to pull the bearings in toward the center of the block. Leave the tool in this position, pilot the new front and rear bearings on the installer, and pull them into position: Return the tool to its original position and pull remaining bearings into position.

NOTE: *Ensure that oil holes align when installing bearings.*

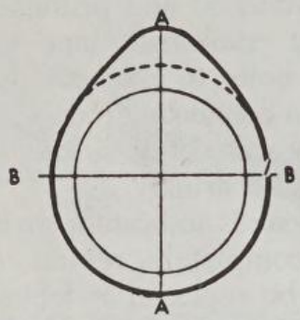
Replace camshaft rear plug, and stake it into position to aid retention.

CHECKING CAMSHAFT

Degrease the camshaft, using solvent, and clean out all oil holes. Visually inspect cam lobes and bearing journals for excessive wear. If a lobe is questionable, check all lobes as indicated below. If a journal or lobe is worn, the camshaft must be reground or replaced.



Check the camshaft for straightness



Camshaft lobe measurement

NOTE: *If a journal is worn, there is a good chance that the bushings are worn.*

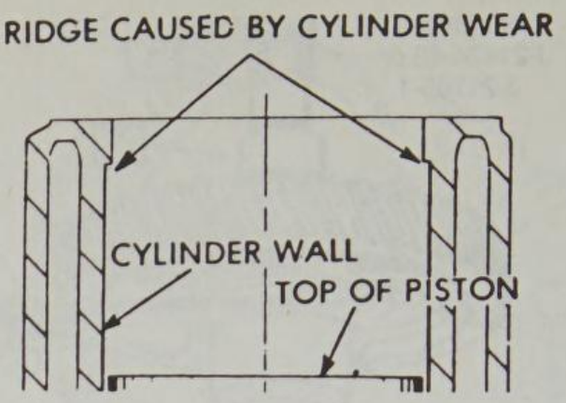
If lobes and journals appear intact, place the front and rear journals in V-blocks, and rest a dial indicator on the center journal. Rotate the camshaft to check straightness. If deviation exceeds .001", replace the camshaft.

Check the camshaft lobes with a micrometer, by measuring the lobes from the nose to base and again at 90° (see illustration). The lift is determined by subtracting the second measurement from the first. If all exhaust lobes and all intake lobes are not identical, the camshaft must be reground or replaced.

Pistons and Connecting Rods

REMOVAL

Before removal of connecting rod(s) and cap(s), mark them with their respective cylinder number. This will insure a proper match during reinstallation.



Cylinder bore ridge

NOTE: *This procedure is easily completed if the engine has been removed from the car.*

1. Remove the cylinder head(s), intake manifold, exhaust manifold, oil pan, and oil pump as outlined in this chapter.

2. Mount the engine on a stand. In order to facilitate removal of the piston and connecting rod, the ridge at the top of the cylinder (unworn area; see illustration) must be removed. Place the piston at the bottom of the bore, and cover it with a rag. Cut the ridge away using a ridge reamer, exercising extreme care to avoid cutting too deeply. Remove the rag, and remove cuttings that remain on the piston.

CAUTION: *If the ridge is not removed, and new rings are installed, damage to rings will result.*

3. Remove the connecting rod bearing caps and bearings.

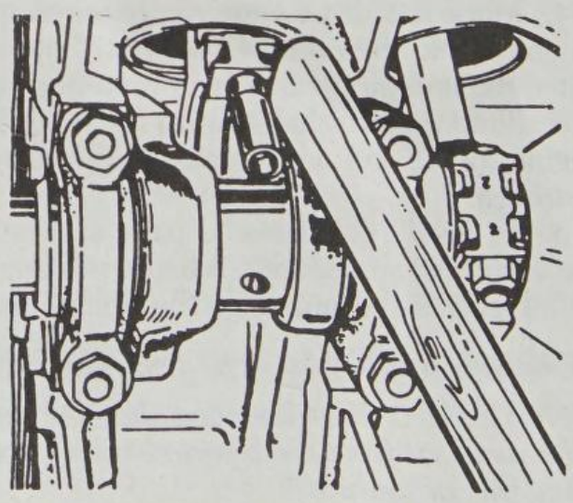
4. Install a section of rubber hose over the connecting rod bolts to prevent damage to the crankshaft.

5. Slide the piston/connecting rod assembly through the top of the cylinder block.

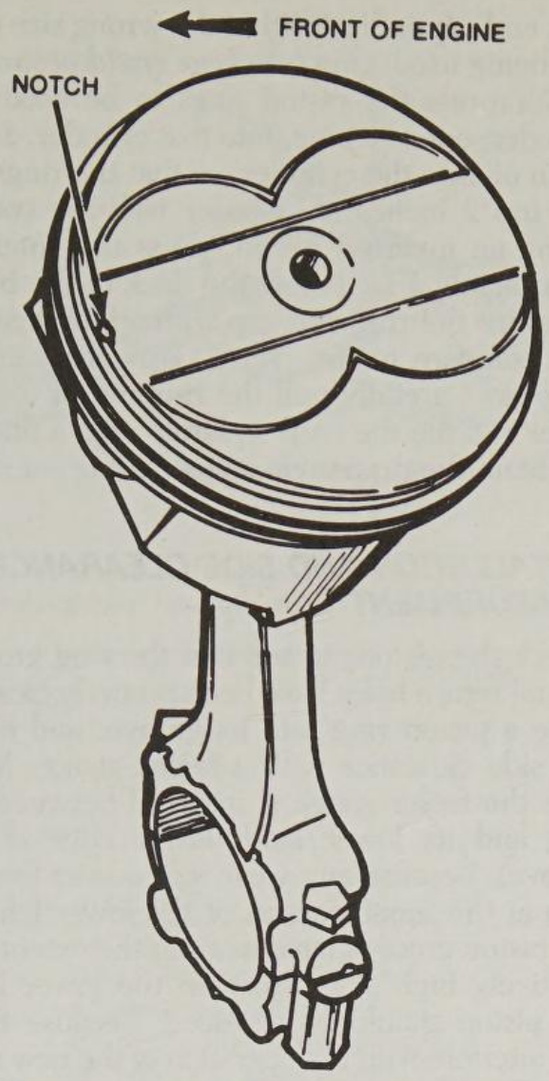
CAUTION: *Do not attempt to force the piston past the cylinder ridge (see above).*

POSITIONING

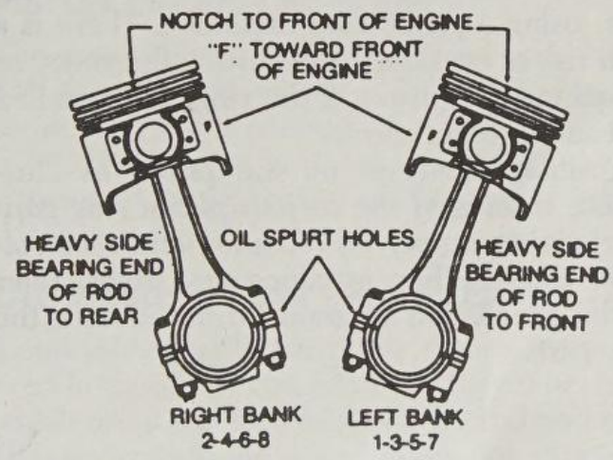
NOTE: *Most pistons are notched or marked to indicate which way they should be in-*



Push the piston out with a hammer handle



Install the pistons with the notch facing the front of the engine

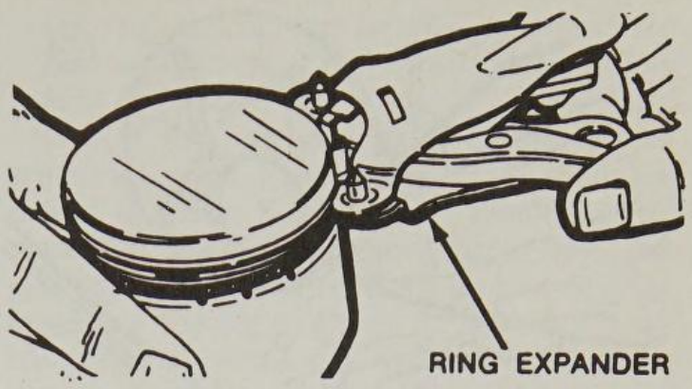


Small block V8 piston-to-rod relationship

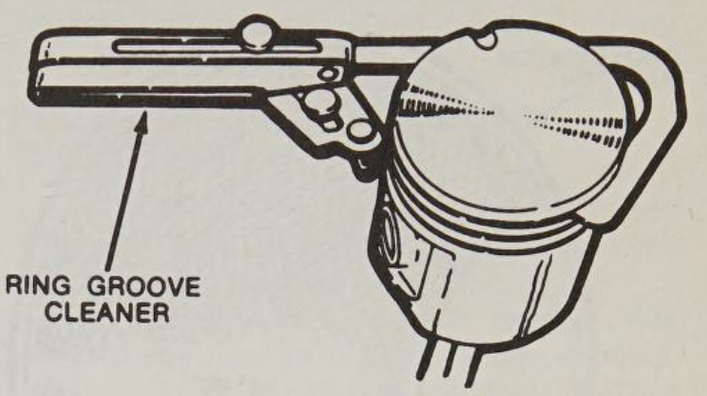
stalled. If your pistons are not marked, mark them before removal. Then reinstall them in the proper position.

CLEANING AND INSPECTING

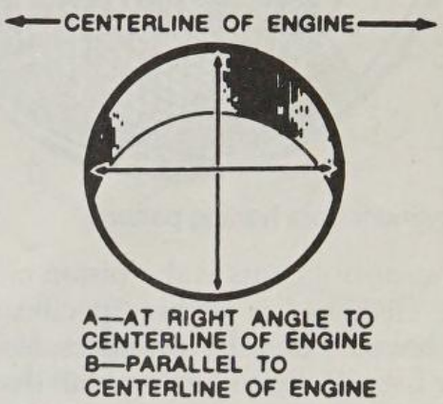
A piston ring expander is necessary for removing piston rings without damaging them; any other method (screwdriver blades, pliers, etc.) usually results in the rings being bent, scratched or distorted, or the piston itself being damaged. When the rings are removed, clean the



Removing the piston rings



Cleaning the piston ring grooves using a ring groove cleaner



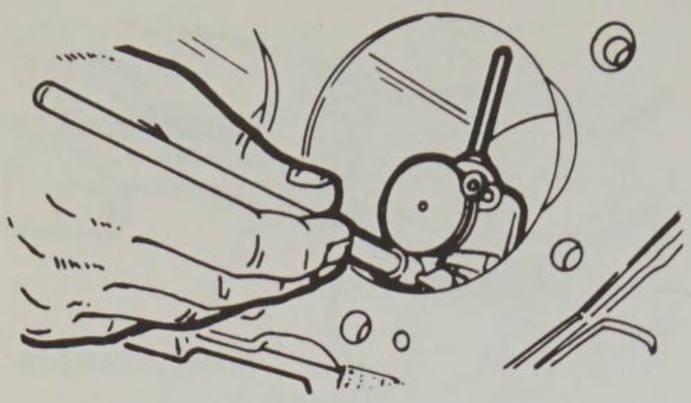
Cylinder bore measuring points

ring grooves using an appropriate ring groove cleaning tool, using care not to cut too deeply. Thoroughly clean all carbon and varnish from the piston with solvent.

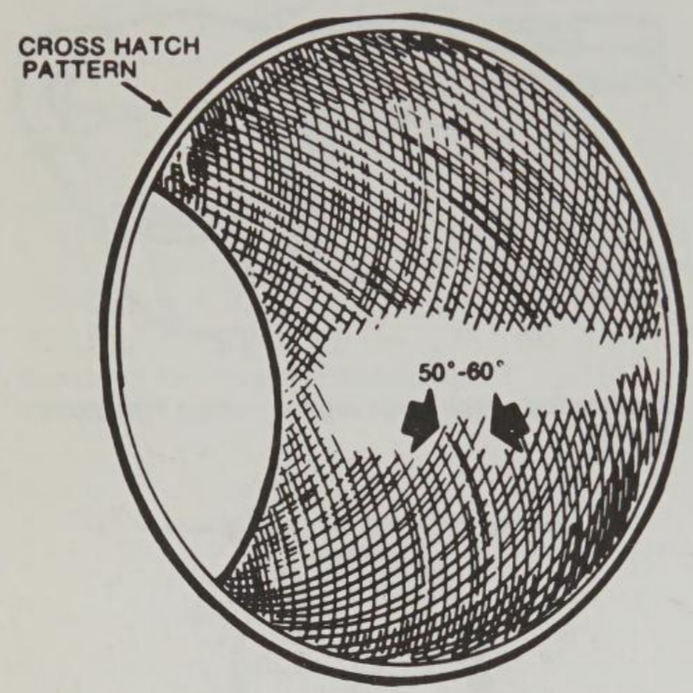
CAUTION: *Do not use a wire brush or caustic solvent (acids, etc.) on piston.*

Inspect the pistons for scuffing, scoring, cracks, pitting, or excessive ring groove wear. If these are evident, the piston must be replaced.

The piston should also be checked in relation to the cylinder diameter. Using a telescoping gauge and micrometer, or a dial gauge, measure the cylinder bore diameter perpendicular (90%) to the piston pin, 2½ in. below the cylinder block deck (surface where the block mates with the heads). Then, with the micrometer, measure the piston perpendicular to its wrist pin on the skirt. The difference between



Measuring the cylinder bore with a dial gauge



Correct cylinder bore honing pattern

the two measurements is the piston clearance.

If the clearance is within specifications or slightly below (after the cylinders have been bored or honed), finish honing is all that is necessary. If the clearance is excessive, try to obtain a slightly larger piston to bring clearance to within specifications. If this is not possible obtain the first oversize piston and hone (or if necessary, bore) the cylinder to size. Generally, if the cylinder bore is tapered .005 in. or more or is out-of-round .003 in. or more, it is advisable to rebore for the smallest possible oversize piston and rings. After measuring, mark pistons with a felt-tip pen for reference and for assembly.

NOTE: *Cylinder block boring should be performed by a reputable machine shop with the proper equipment. In some cases, "clean-up" honing can be done with the cylinder block in the car, but most excessive honing and all cylinder boring must be done with the block stripped and removed from the car.*

CHECKING RING END GAP

Piston ring end gap should be checked while the rings are removed from the pistons. Incorrect end gap indicates that the wrong size rings are being used; *ring breakage could occur.*

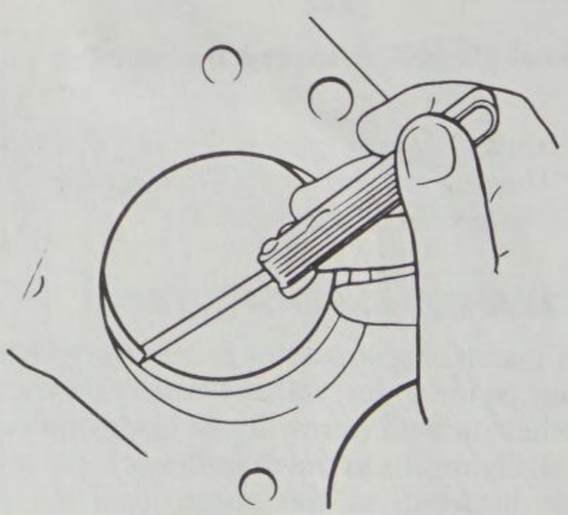
Compress the piston rings to be used in a cylinder, one at a time, into that cylinder. Squirt clean oil into the cylinder, so that the rings and the top 2 inches of cylinder wall are coated. Using an inverted piston, press the rings approximately 1 in. below the deck of the block. Measure the ring end gap with a feeler gauge, and compare to the "Ring Gap" chart in this chapter. Carefully pull the ring out of the cylinder and file the ends squarely with a fine file to obtain the proper clearance.

INSTALLATION AND SIDE CLEARANCE MEASUREMENT

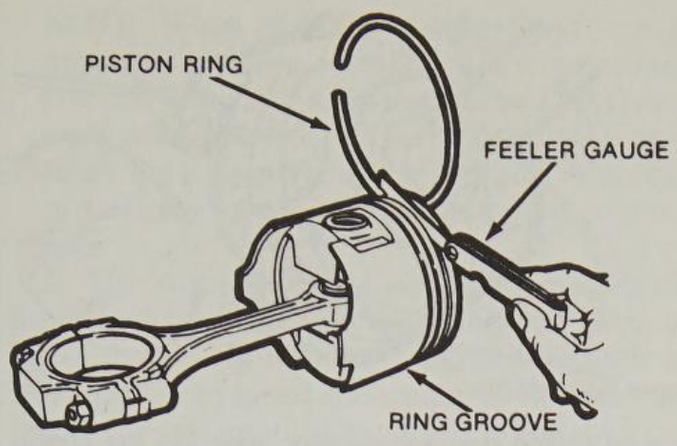
Check the pistons to see that the ring grooves and oil return holes have been properly cleaned. Slide a piston ring into its groove, and check the side clearance with a feeler gauge. Make sure the feeler gauge is inserted between the ring and its lower land (lower edge of the groove), because any wear that occurs forms a step at the inner portion of the lower land. If the piston grooves have worn to the extent that relatively high steps exist on the lower land, the piston should be replaced, because these will interfere with the operation of the new rings and ring clearances will be excessive. Piston rings are not furnished in oversize widths to compensate for ring groove wear.

Install the rings on the piston, *lowest ring first,* using a piston ring expander. There is a high risk of breaking or distorting the rings, or scratching the piston, if the rings are installed by hand or other means.

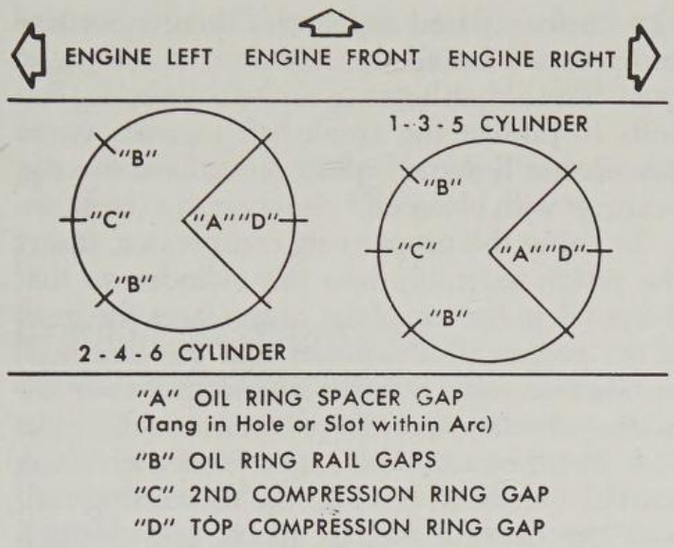
Position the rings on the piston as illustrated; *spacing of the various piston ring gaps is crucial to proper oil retention and even cylinder wear.* When installing new rings, refer to the installation diagram furnished with the new parts.



Check the piston ring end gap



Check the piston ring side clearance



Locating the ring gaps

PISTON PIN REPLACEMENT

The piston pins are made of chromium steel. The fit within the piston is floating and in the connecting rod is pressed.

NOTE: *Pin replacement should only be attempted by a qualified machine shop.*

Connecting Rod Bearings

Connecting rod bearings for the engines covered in this guide consist of two halves or shells which are interchangeable in the rod and cap. When the shells are placed in position, the ends extend slightly beyond the rod and cap surfaces so that when the rod bolts are torqued the shells will be clamped tightly in place to insure positive seating and to prevent turning. A tang holds the shells in place.

NOTE: *The ends of the bearing shells must never be filed flush with the mating surface of the rod and cap.*

If a rod bearing becomes noisy or is worn so that its clearance on the crank journal is excessive, a new bearing of the correct undersize must be selected and installed since there is no provision for adjustment.

CAUTION: *Under no circumstances should the rod end or cap be filed to adjust the bearing clearance, nor should shims of any kind be used.*

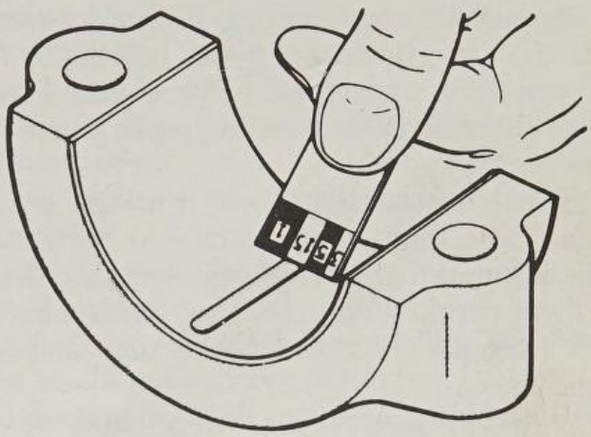
Inspect the rod bearings while the rod assemblies are out of the engine. If the shells are scored or show flaking, they should be replaced. If they are in good shape check for proper clearance on the crank journal (see below). Any scoring or ridges on the crank journal means the crankshaft must be replaced, or reground and fitted with undersized bearings.

NOTE: *If journals are deeply scored or ridged the crankshaft must be replaced, as regrinding will reduce the durability of the crankshaft.*

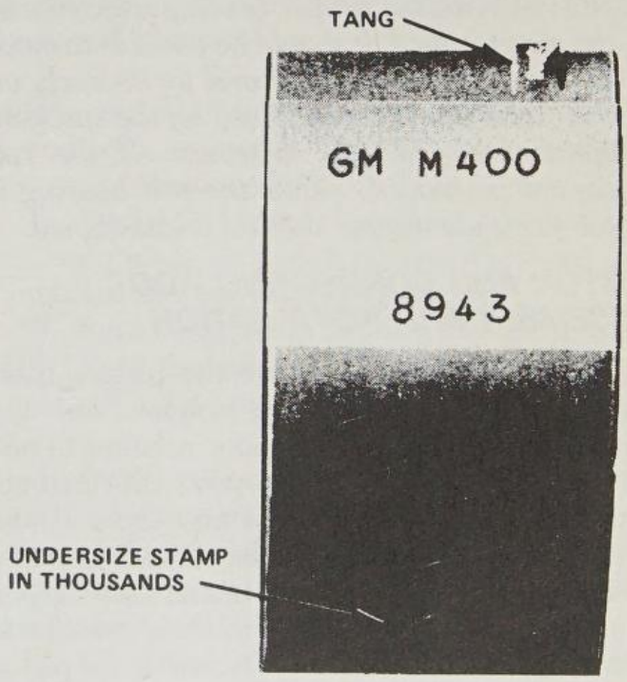
ROD BEARING INSPECTION AND REPLACEMENT

NOTE: *Make sure connecting rods and their caps are kept together, and that the caps are installed in the proper direction.*

Replacement bearings are available in standard size, and in undersizes for reground



Measure Plastigage® to determine bearing (rod or main) clearance



Undersize marks are stamped on the bearing shells. The tang fits in the notch on the rod and cap

crankshafts. Connecting rod-to-crankshaft bearing clearance is checked using Plastigage® at either the top or bottom of each crank journal. The Plastigage® has a range of .001 in. to .003.

1. Remove the rod cap with the bearing shell. Completely clean the bearing shell and the crank journal, and blow any oil from the oil hole in the crankshaft; Plastigage® lengthwise along the bottom center of the lower bearing shell, then install the cap with shell and torque the bolt or nuts to specification. DO NOT turn the crankshaft with Plastigage® in the bearing.

3. Remove the bearing cap with the shell. The flattened Plastigage® will be found sticking to either the bearing shell or crank journal. *Do not remove it yet.*

4. Use the scale printed on the Plastigage® envelope to measure the flattened material at its widest point. The number within the scale which most closely corresponds to the width of the Plastigage® indicates bearing clearance in thousandths of an inch.

5. Check the specifications chart in this chapter for the desired clearance. It is advisable to install a new bearing if clearance exceeds .003 in.; however, if the bearing is in good condition and is not being checked because of bearing noise, bearing replacement is not necessary.

6. If you are installing new bearings, try a standard size, then each undersize in order until one is found that is within the specified limits when checked for clearance with Plastigage®. Each undersize shell has its size stamped on it.

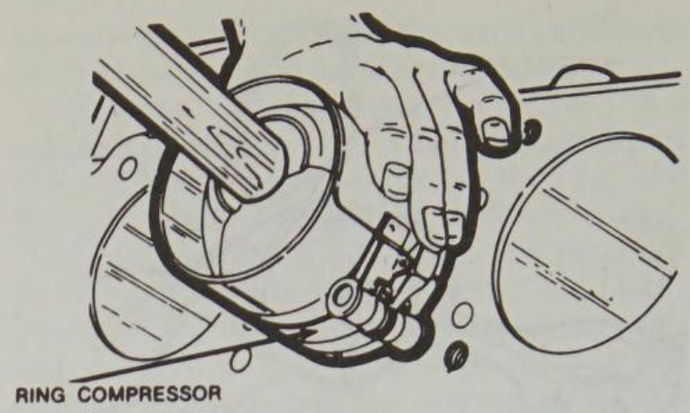
7. When the proper size shell is found, clean off the Plastigage®, oil the bearing thoroughly, reinstall the cap with its shell and torque the rod bolt nuts to specification.

NOTE: *With the proper bearing selected and the nuts torqued, it should be possible to move the connecting rod back and forth freely on the crank journal as allowed by the specified connecting rod end clearance. If the rod cannot be moved, either the rod bearing is too far undersize or the rod is misaligned.*

PISTON AND CONNECTING ROD ASSEMBLY AND INSTALLATION

Install the connecting rod to the piston, making sure piston installation notches and any marks on the rod are in proper relation to one another. Lubricate the wrist pin with clean engine oil, and install the pin into the rod and piston assembly, either by hand or by using a wrist pin press as required. Install snap rings if equipped, and rotate them in their grooves to make sure they are seated. To install the piston and connecting rod assembly:

1. Make sure connecting rod big-end bearings (including end cap) are of the correct size and properly installed.



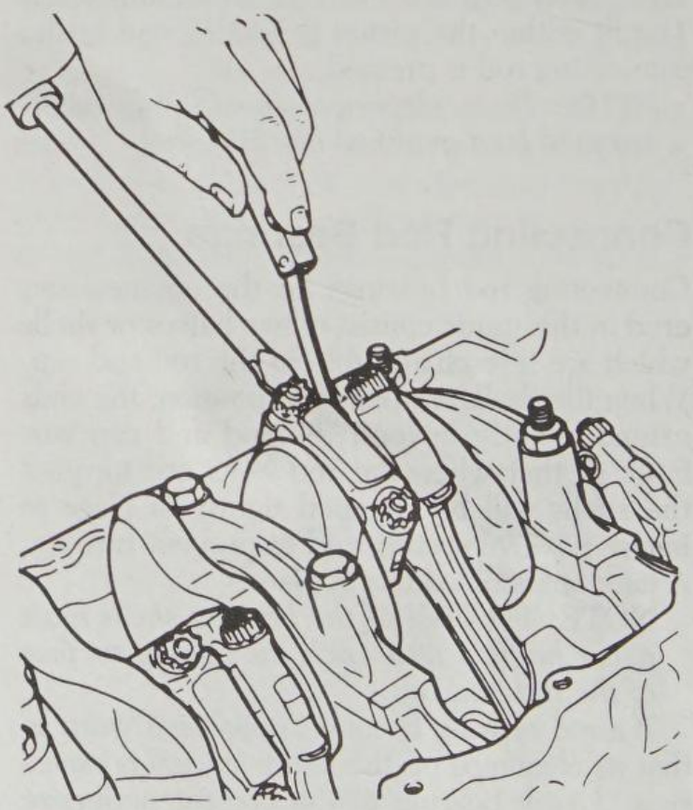
Install piston ring compressor, then tap the piston into the cylinder bore. Make sure that the piston front marks are correctly positioned when installing

2. Fit rubber hoses over the connecting rod bolts to protect the crankshaft journals, as in the "Piston Removal" procedure. Coat the rod bearings with clean oil.

3. Using the proper ring compressor, insert the piston assembly into the cylinder so that the notch in the top of the piston faces the front of the engine (this assumes that the dimple(s) or other markings on the connecting rods are in correct relation to the piston notch(s).

4. From beneath the engine, coat each crank journal with clean oil. Pull the connecting rod, with the bearing shell in place, into position against the crank journal.

5. Remove the rubber hoses. Install the bearing cap and cap nuts and torque to specification.



Check the connecting rod side clearance with a feeler gauge. Use a small pry bar to carefully spread the rods to specified clearance

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 ease the installation of the remaining piston assembles.*

6. Check the clearance between the sides of the connecting rods and the crankshaft using a feeler gauge. Spread the rods slightly with a small prybar to insert the gauge. If clearance is below the minimum tolerance, the rod may be machined to provide adequate clearance. If clearance is excessive, substitute an unworn rod, and recheck. If clearance is still outside specifications, the crankshaft must be welded and reground, or replaced.

7. Replace the oil pump, if removed, and the oil pan.

8. Install the cylinder head(s) and intake manifold, as previously described.

Crankshaft Servicing

Crankshaft servicing literally makes or breaks any engine; especially a high performance one.

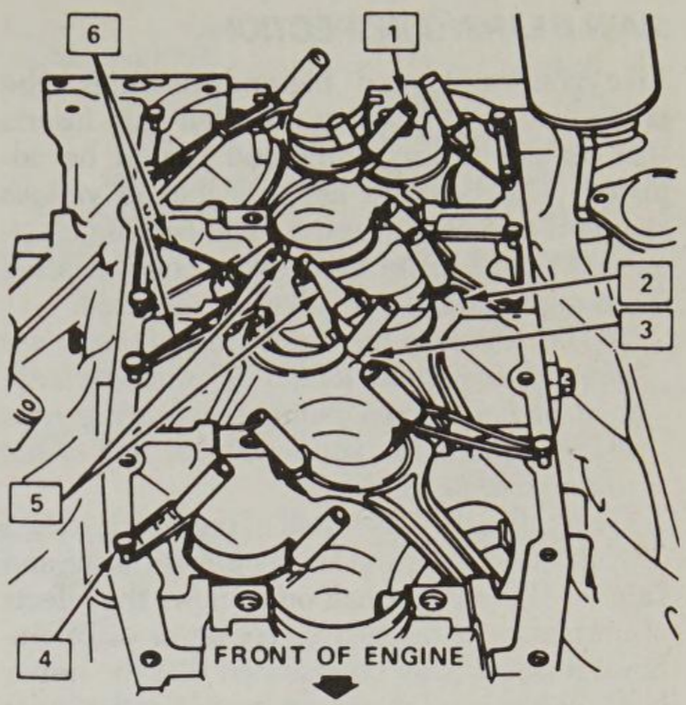
The most critical maintenance operation is the replacement of the crankshaft main bearings. These bearings are of the precision insert design and do not require adjustment through shims. They are offered in undersizes of 0.001 in., 0.002 in., 0.009 in. 0.010 in., 0.020 in., and 0.030 in.

Despite the advent of these inserts and accompanying precision machine work, it does happen that sizing mistakes are made and no crankshaft should be installed in a block without checking clearances. One of the simplest means of doing so is to use Plastigage®. This is a wax-like plastic material that is formed into precision threads. It will compress evenly between two surfaces, without damage, and when measured, will indicate the actual clearance.

It is easiest to check bearing clearance with the engine removed from the car and the block inverted. This ensures that the crank is resting against the upper bearing shells. If Plastigage is to be used on an engine still in the vehicle, it will be necessary to support the crankshaft at both ends so that clearance between the crankshaft and the upper bearing shells is eliminated.

REMOVAL

1. Drain the engine oil and remove the engine from the car. Mount the engine on a work stand in a suitable working area. Invert the engine, so the oil pan is facing up.



1. Rubber hose
2. #4 rod
3. #3 rod
4. Oil pan bolt
5. Note overlap of adjacent rods
6. Rubber bands

Support the connecting rods with rubber bands and install rubber rod bolt caps when the crankshaft is removed—V6

2. Remove the engine water pump and front (timing) cover.

3. Remove the timing chain (if equipped) and gears.

4. Remove the oil pan.

5. Remove the oil pump.

6. Stamp or mark the cylinder number on the machined surfaces of the bolt bosses of the connecting rods and caps for identification when reinstalling. If the pistons are to be removed from the connecting rod, mark the cylinder number on the pistons with silver paint or felt-tip pen for proper cylinder identification and cap-to-rod location.

7. Remove the connecting rod caps. Install lengths of rubber hose on each of the connecting rod bolts, to protect the crank journals when the crank is removed.

8. Mark the main bearing caps with a number punch or punch so that they can be reinstalled in their original positions.

9. Remove all main bearing caps.

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

11. Install rubber bands between a bolt on each connecting rod and oil pan bolts that have been reinstalled in the block (see illustration). This will keep the rods from banging on the block when the crank is removed.

12. Carefully lift the crankshaft out of the block. The rods will pivot to the center of the engine when the crank is removed.

MAIN BEARING INSPECTION

Like connecting rod big-end bearings, the crankshaft main bearings are shell-type inserts that do not utilize shims and cannot be adjusted. The bearings are available in various standard and undersizes; if main bearing clearance is found to be excessive, a new bearing (both upper and lower halves) is required.

NOTE: *Factory-undersized crankshafts are marked, sometimes with a "9" and/or a large spot of light green paint; the bearing caps also will have the paint on each side of the undersized journal.*

Generally, the lower half of the bearing shell (except No. 1 bearing) shows greater wear and fatigue. If the lower half only shows the effects of normal wear (no heavy scoring or discoloration), it can usually be assumed that the upper half is also in good shape; conversely, if the lower half is heavily worn or damaged, both halves should be replaced. *Never replace one bearing half without replacing the other.*

MEASURING MAIN BEARING CLEARANCE

Main bearing clearance can be checked both with the crankshaft in the car and with the engine out of the car. If the engine block is still in the car, the crankshaft should be supported both front and rear (by the damper and the transmission) to remove clearance from the upper bearing. Total clearance can then be measured between the lower bearing and journal. If the block has been removed from the car, and is inverted, the crank will rest on the upper bearings and the total clearance can be measured between the lower bearing and journal. Clearance is checked in the same manner as the connecting rod bearings, with plastigage®.

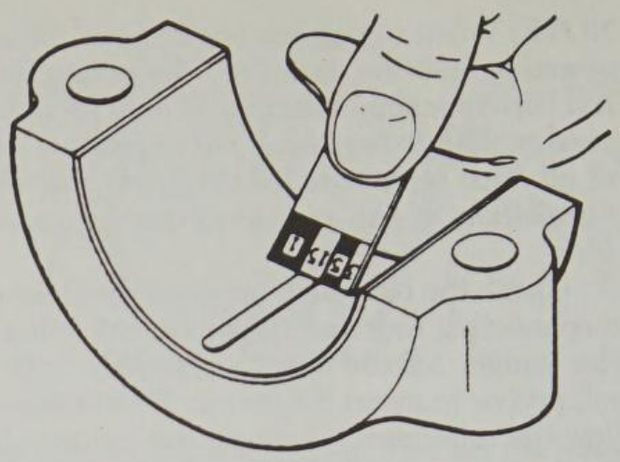
NOTE: *Crankshaft bearing caps and bearing shells should NEVER be filed flush with the cap-to-block mating surface to adjust for wear in the old bearings. Always install new bearings.*

1. If the crankshaft has been removed, install it (block removed from car). If the block is still in the car, remove the oil pan and oil pump. Starting with the rear bearing cap, remove the cap and wipe all oil from the crank journal and bearing cap.

2. Place a strip of Plastigage® the full width of the bearing, (parallel to the crankshaft), on the journal.

NOTE: *Plastigage® is soluble in oil; therefore, oil on the journal or bearing could result in erroneous readings.*

CAUTION: *Do not rotate the crankshaft while the gaging material is between the bearing and the journal.*



Measure the main bearing clearance by comparing the flattened strip to the Plasticgage scale as shown

3. Install the bearing cap and evenly torque the cap bolts to specification.

4. Remove the bearing cap. The flattened Plastigage® will be sticking to either the bearing shell or the crank journal.

5. Use the graduated scale on the Plastigage® envelope to measure the material at its widest point. *If the flattened Plastigage® tapers toward the middle or ends, there is a difference in clearance indicating the bearing or journal has a taper, low spot or other irregularity. If this is indicated, measure the crank journal with a micrometer.*

6. If bearing clearance is within specifications, the bearing insert is in good shape. Replace the insert if the clearance is not within specifications. *Always replace both upper and lower inserts as a unit.*

7. Standard, .001 in. or .002 in. undersize bearings should produce the proper clearance. If these sizes still produce too sloppy a fit, the crankshaft must be reground for use with the next undersize bearing. Recheck all clearances after installing new bearings.

8. Replace the rest of the bearings in the same manner. After all bearings have been checked, rotate the crankshaft to make sure there is no excessive drag. When checking the No. 1 main bearing, loosen the accessory drive belts (engine in car) to prevent a tapered reading with the Plastigage.®

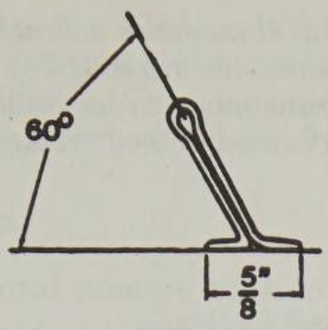
MAIN BEARING REPLACEMENT

Engine Out of Car

1. Remove and inspect the crankshaft.

2. Remove the main bearings from the bearing saddles in the cylinder block and main bearing caps.

3. Coat the bearing surfaces of the new, correct size main bearings with clean engine oil



Fabricate a roll-out pin as illustrated, if necessary

and install them in the bearing saddles in the block and in the main bearing caps.

4. Install the crankshaft. See "Crankshaft Installation."

Engine in Car

1. With the oil pan, oil pump and spark plugs removed, remove the cap from the main bearing needing replacement and remove the bearing from the cap.

2. Make a bearing roll-out pin, using a bent cotter pin as shown in the illustration. Install the end of the pin in the oil hole in the crankshaft journal.

3. Rotate the crankshaft clockwise as viewed from the front of the engine. This will roll the upper bearing out of the block.

4. Lube the new upper bearing with clean engine oil and insert the plain (unnotched) end between the crankshaft and the indented or notched side of the block. Roll the bearing into place, making sure that the oil holes are aligned. Remove the roll pin from the oil hole.

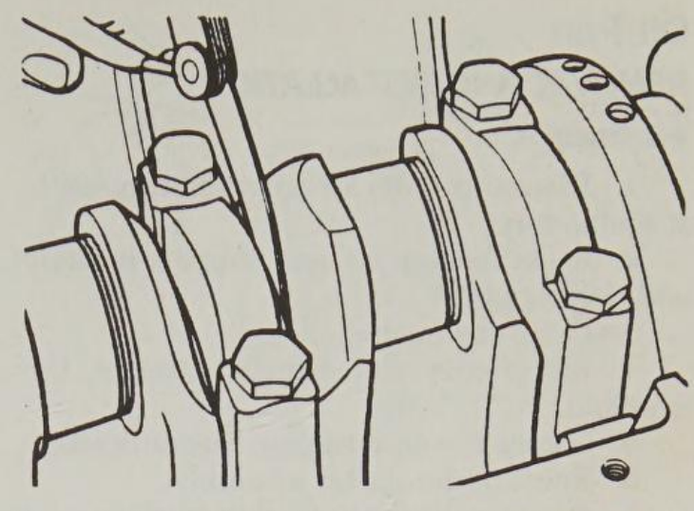
5. Lube the new lower bearing and install the main bearing cap. Install the main bearing cap, making sure it is positioned in proper direction with the matchmarks in alignment.

6. Torque the main bearing cap bolts to specification.

NOTE: *The thrust bearing must be aligned before torquing cap bolts.*

REGRINDING JOURNALS

NOTE: *Regrinding rod and/or main bearing journals should be performed by a qualified machine shop.*



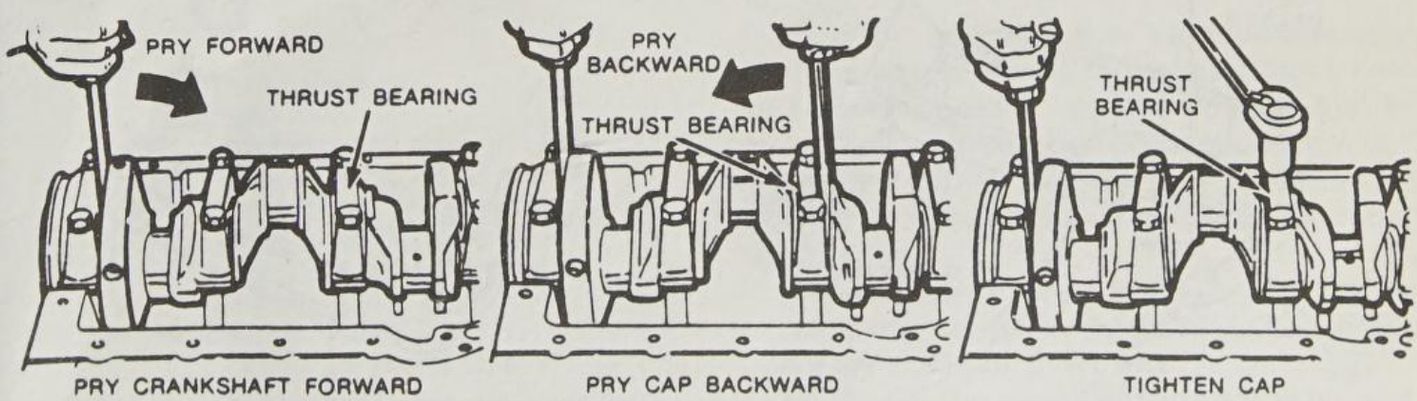
Use a feeler gauge to check the crankshaft end play during assembly

CRANKSHAFT INSTALLATION

When main bearing clearance has been checked, bearings examined and/or replaced, the crankshaft can be installed. Thoroughly clean the upper and lower bearing surfaces, and lube them with clean engine oil. Install the crankshaft and main bearing caps.

Dip all main bearing cap bolts in clean oil, and torque all main bearing caps, excluding the thrust bearing cap, to specifications (see the "Crankshaft and Connecting Rod" chart in this chapter to determine which bearing is the thrust bearing). Tighten the thrust bearing bolts finger tight. To align the thrust bearing, pry the crankshaft the extent of its axial travel several times, holding the last movement toward the front of the engine. Add thrust washers if required for proper alignment. Torque the thrust bearing cap to specifications.

To check crankshaft end-play, pry the crankshaft to the extreme rear of its axial travel, then to the extreme front of its travel. Using a feeler gauge, measure the end-play at the front of the rear main bearing. End play may also be measured at the thrust bearing. Install a new rear main bearing oil seal in the cylinder block and main bearing cap. Continue to reassemble the engine in reverse of disassembly procedures.



Align the thrust bearing as illustrated. Torque the caps to specifications

Oil Pan

REMOVAL AND INSTALLATION

4-Cylinder

1. Disconnect the negative battery cable at the battery.
2. Raise the vehicle and support it safely with jackstands.
3. Drain the engine oil.
4. Disconnect the exhaust pipe at the manifold.
5. Loosen the exhaust pipe hanger bracket.
6. Remove the starter assembly.
7. Remove the flywheel dust cover.
8. Remove the front engine mount through-bolts.
9. Carefully raise the engine enough to provide sufficient clearance to lower the oil pan.
10. Remove the oil pan retaining bolts and remove the oil pan.
11. Clean all old RTV from the mating surfaces.
12. Install the rear gasket into the rear main bearing cap and apply a small amount of RTV where the gasket engages into the engine block.
13. Install the front gasket.
14. Install the side gaskets, using grease as a retainer. Apply a small amount of RTV where the side gaskets meet the front gasket.
15. Install the oil pan.

NOTE: *Install the oil pan-to-timing cover bolts last, as these holes will not align until the other pan bolts are snug.*

16. The remainder of the installation procedure is performed in the reverse of removal.

V6 and V8

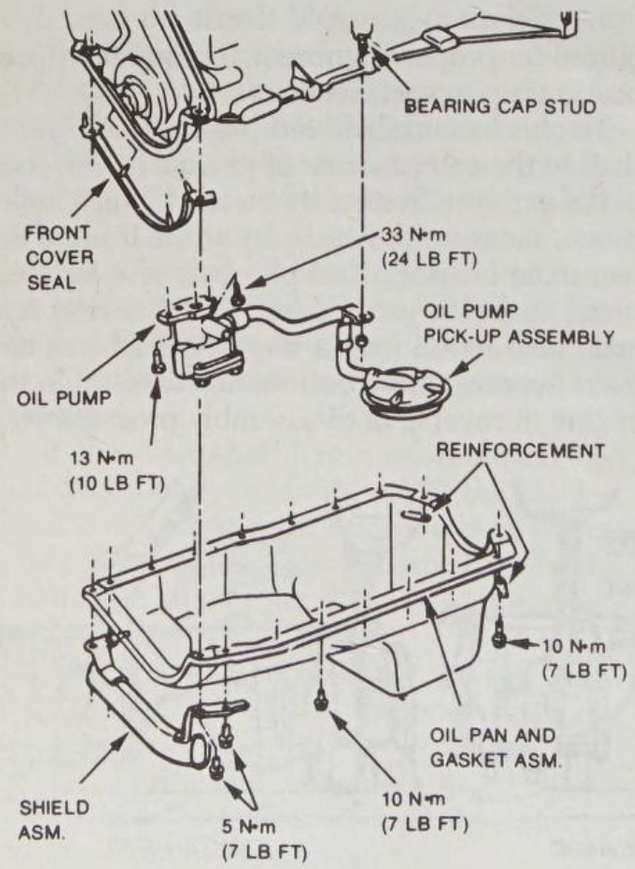
1. Disconnect the negative battery cable at the battery and air cleaner.
2. Remove the distributor cap. Remove the fan shroud assembly.
3. Raise the vehicle and support it safely with jackstands.
4. Drain the engine oil.

CAUTION: *Be sure that the catalytic converter is cool before proceeding.*

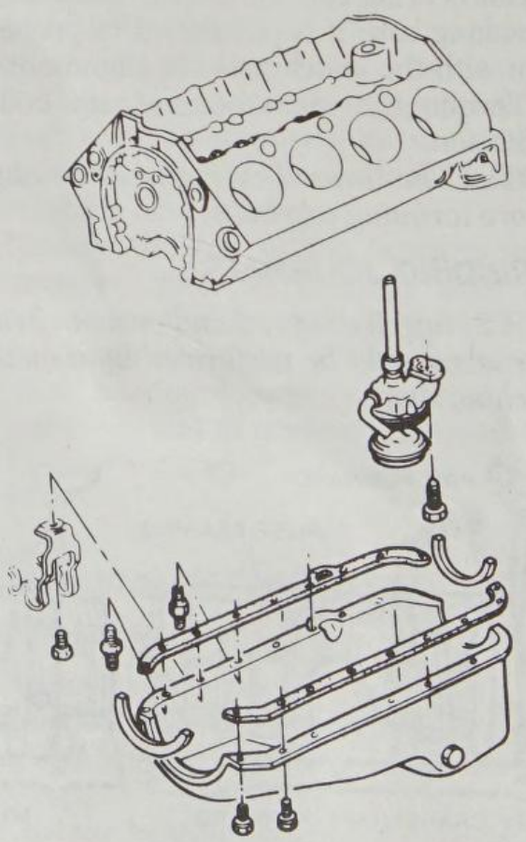
5. Remove the air injection pipe at the catalytic convertor.
6. Remove the catalytic converter hanger bolts. Disconnect the exhaust pipe at the manifold.
7. Remove the starter bolts, loosen the starter brace, then lay the starter aside.
8. Remove the front engine mount through-bolts.
9. Raise the engine enough to provide sufficient clearance for oil pan removal.
10. Remove the oil pan bolts.

NOTE: *If the front crankshaft throw prohibits removal of the pan, turn the crankshaft to position the throw horizontally.*

11. Remove the oil pan from the vehicle.
12. Remove all old RTV from the oil pan and engine block.
13. Run a ⅛" bead of RTV around the oil



Four cylinder oil pan and pump installation details



Oil pan components

pan sealing surface. Remember to keep the RTV on the INSIDE of the bolt holes.

14. Install the pan and reverse the removal steps to complete the operation.

Oil Pump

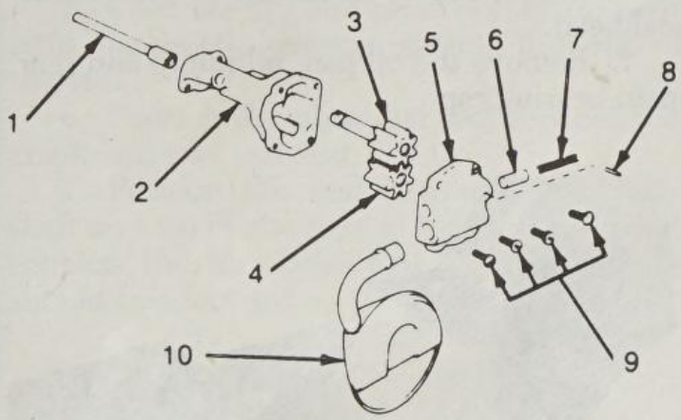
REMOVAL

1. Drain and remove the oil pan.
2. Remove the oil pump-to-rear main bearing cap bolt. Remove the pump and the extension shaft.
3. Remove the cotter pin, spring and pressure regulator valve.

NOTE: *Place your thumb over the pressure regulators bore before removing the cotter pin, as the spring is under pressure.*

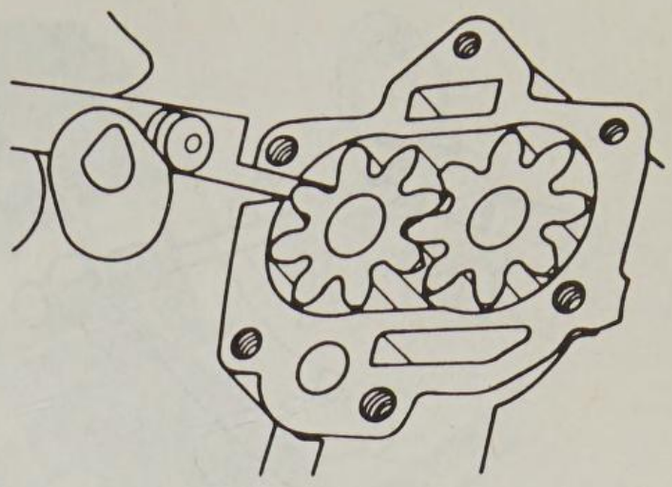
OVERHAUL

1. Remove the pump cover attaching screws and the pump cover.
2. Mark gear teeth so they may be reassembled with the same teeth indexing. Remove the idler gear, drive gear and shaft from the pump body.
3. Remove the pressure regulator valve retaining pin, pressure regulator valve and related parts.
4. If the pickup screen and pipe assembly need replacing, mount the pump in a soft-jawed vise and extract pipe from pump. Do not disturb the pickup screen on the pipe. This is serviced as an assembly.
5. Wash all parts in cleaning solvent and dry with compressed air.
6. Inspect the pump body and cover for cracks or excessive wear. Inspect pump gears for damage or excessive wear.

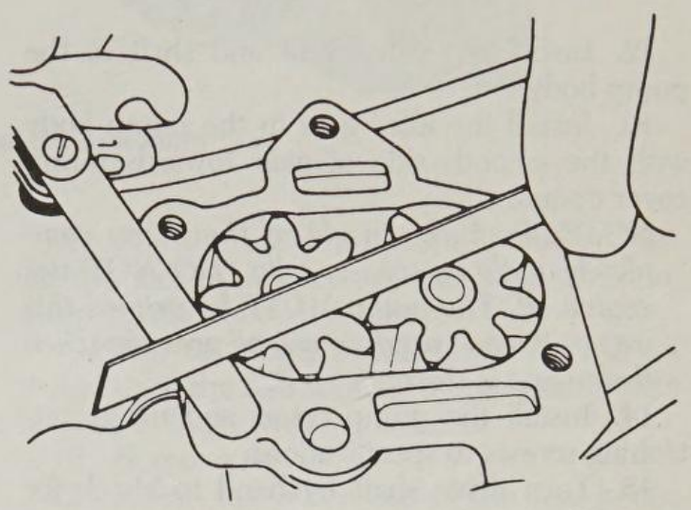


1. Shaft extension
2. Pump body
3. Drive gear and shaft
4. Idler gear
5. Pump cover
6. Pressure regulator valve
7. Pressure regulator spring
8. Retaining pin
9. Screws
10. Pickup screen and pipe

Exploded view of a small block oil pump, others are similar



Removing the lower half of the rear main oil seal



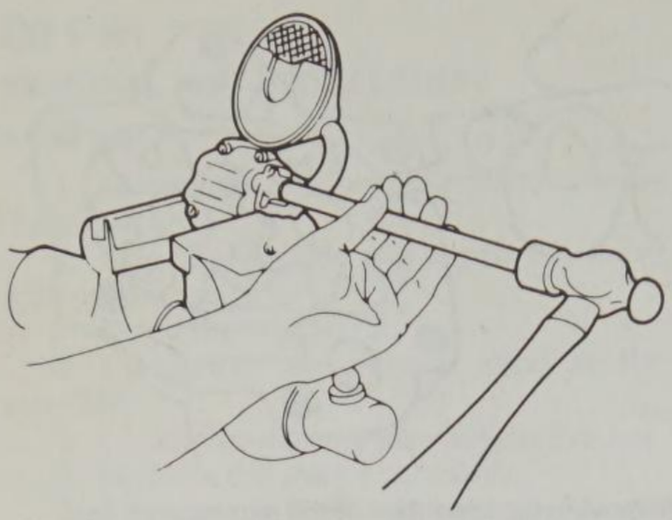
Measure the oil pump end clearance with a feeler gauge and straightedge

NOTE: *The pump gears and body are not serviced separately. If the pump gears or body are damaged or worn, replacement of the entire oil pump assembly is necessary.*

7. Check the drive gear shaft for looseness in the pump body. Inspect inside of pump cover for wear that would permit oil to leak past the ends of the gears.
8. Inspect the pickup screen and pipe assembly for damage to screen, pipe or relief grommet.
9. Check the pressure regulator valve for fit.
10. If the pickup screen and pipe assembly was removed, it should be replaced with a new part. Loss of press fit condition could result in an air leak and loss of oil pressure. Mount the pump in a soft-jawed vise, apply sealer to end of pipe, and use a suitable tool to tap the pipe in place.

NOTE: *Be careful of twisting, shearing or collapsing pipe while installing in pump. Do not use excessive force.*

11. Install the pressure regulator valve and related parts.



Install the oil pump screen by tapping lightly

12. Install the drive gear and shaft in the pump body.

13. Install the idler gear in the pump body with the smooth side of gear towards pump cover opening.

NOTE: *Pack the inside of the pump completely with petroleum jelly. DO NOT use engine oil. The pump MUST be primed this way or it won't produce any oil pressure when the engine is started.*

14. Install the pump cover and torque attaching screws to specifications.

15. Turn drive shaft by hand to check for smooth operation.

INSTALLATION

1. Assemble pump and extension shaft to rear main bearing cap, aligning slot on top end of extension shaft with drive tang on lower end of distributor drive shaft.

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.*

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

3. Install the pump onto the rear main bearing cap and install the attaching bolts. Torque the bolts to specifications.

4. Install the oil pan and fill the crankcase with engine oil.

Rear Main Oil Seal

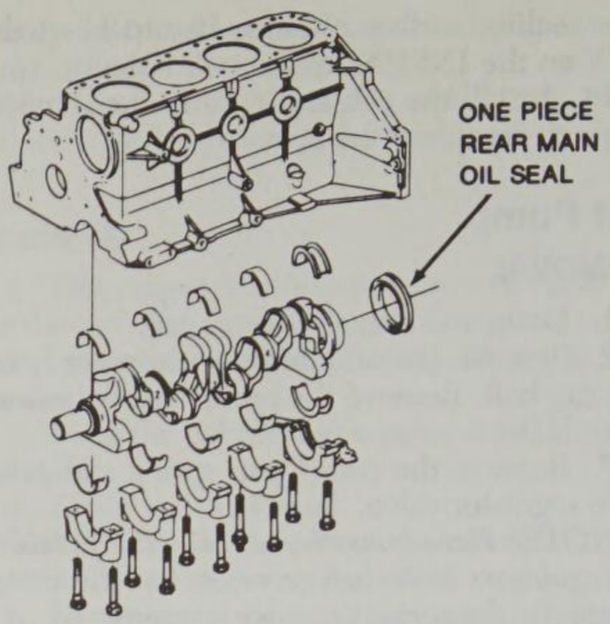
REMOVAL AND INSTALLATION

4-Cylinder

NOTE: *The rear main seal is a one piece unit. It can be removed or installed without removing the oil pan or crankshaft.*

1. Jack up your vehicle and support it with jackstands.

2. Remove the transmission.



The four cylinder has a one piece ring type rear main seal

3. If equipped with a manual transmission remove the clutch and pressure plate.

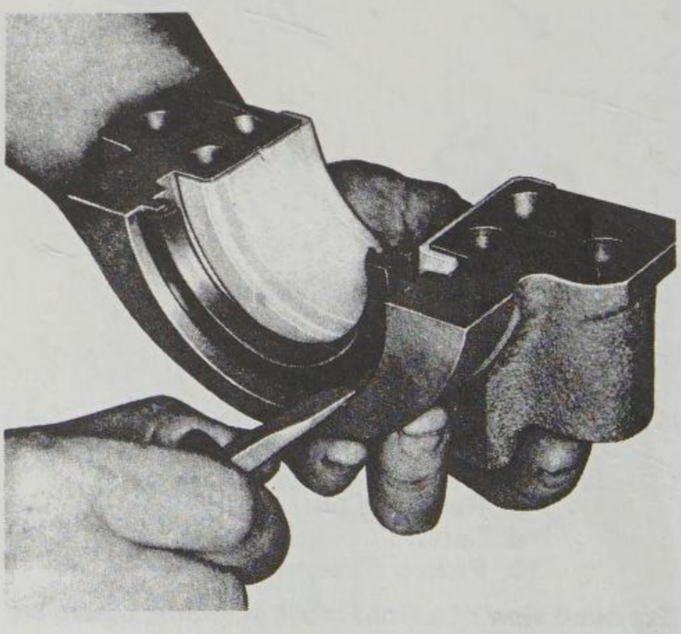
4. With a suitable tool remove the seal.

5. Installation is the reverse of removal. Coat the seal with engine oil for easy installation.

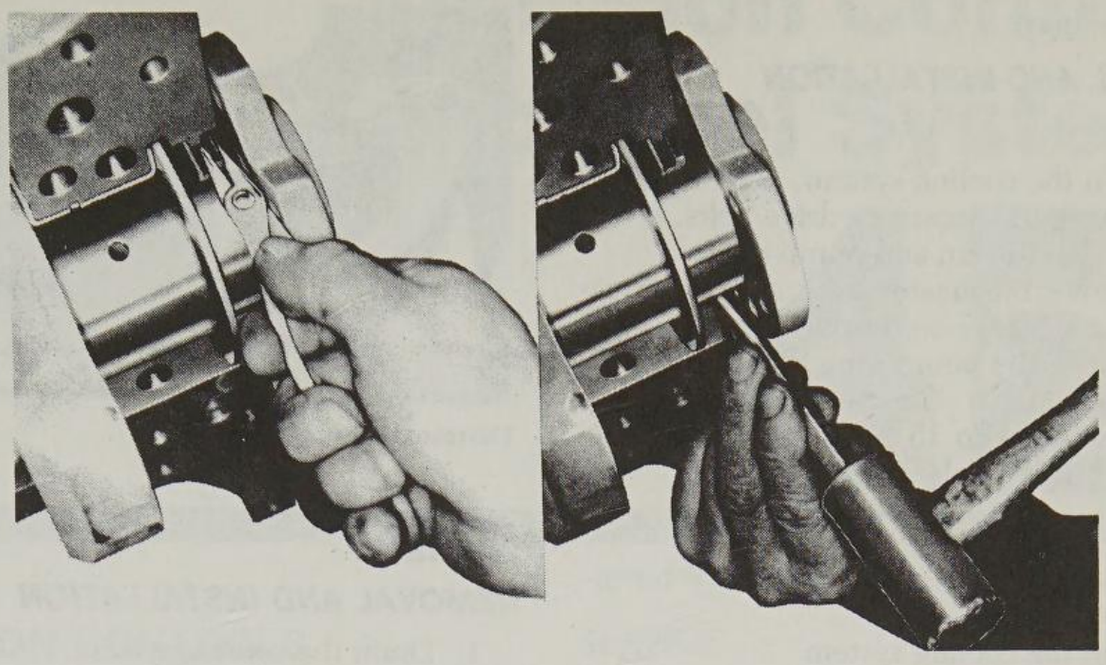
V6 and V8

Both halves of the rear main oil seal can be replaced without removing the crankshaft. Always replace the upper and lower seal together. The lip should face the front of the engine. Be very careful that you do not break the sealing bead in the channel on the outside portion of the seal while installing it. An installation tool can be fabricated to protect the seal bead.

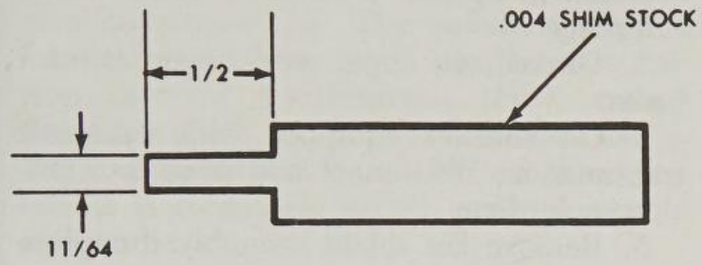
1. Remove the oil pan, oil pump and rear main bearing cap.



Remove the old seal from the cap



Removing the block half of the rear main seal



Oil seal installation tool dimensions

2. Remove the oil seal from the bearing cap by prying it out.

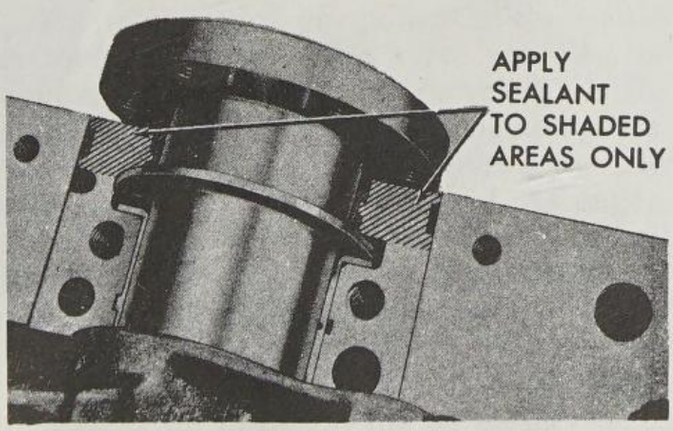
3. Remove the upper half of the seal with a small punch. Drive it around far enough to be gripped with pliers.

4. Clean the crankshaft and bearing cap.

5. Coat the lips and bead of the seal with light engine oil, keeping oil from the ends of the seal.

6. Position the fabricated tool between the crankshaft and seal seat.

7. Position the seal between the crankshaft and tip of the tool so that the seal bead contacts the tip of the tool. The oil seal lip should face forward.



Rear main cap sealer application on the block

8. Roll the seal around the crankshaft using the tool to protect the seal bead from the sharp corners of the crankcase.

9. The installation tool should be left installed until the seal is properly positioned with both ends flush with the block.

10. Remove the tool.

11. Install the other half of the seal in the bearing cap using the tool in the same manner as before. Light thumb pressure should install the seal.

12. Install the bearing cap with sealant applied to the mating areas of the cap and block. Keep sealant from the ends of the seal.

13. Torque the rear main bearing cap to specifications.

14. Installation is the reverse of removal.

Flywheel and Ring Gear

REMOVAL AND INSTALLATION

The ring gear is an integral part of the flywheel and is not replaceable.

1. Remove the transmission.

2. Remove the six bolts attaching the flywheel to the crankshaft flange. Remove the flywheel.

3. Inspect the flywheel for cracks, and inspect the ring gear for burrs or worn teeth. Replace the flywheel if any damage is apparent. Remove burrs with a mill file.

4. Install the flywheel. The flywheel will only attach to the crankshaft in one position, as the bolt holes are unevenly spaced. Install the bolts and torque to specification. Tighten bolts in crisscross pattern.

Water Pump

REMOVAL AND INSTALLATION

4-Cylinder

1. Drain the cooling system.
2. Remove the accessory drive belts.
3. Remove the fan and pump pulley.
4. Remove the heater hose and lower radiator hose from the water pump.
5. Remove the pump from the block.
6. Installation is the reverse of removal. Torque the bolts to 15 ft. lbs. Coat the new gasket with RTV Sealer.

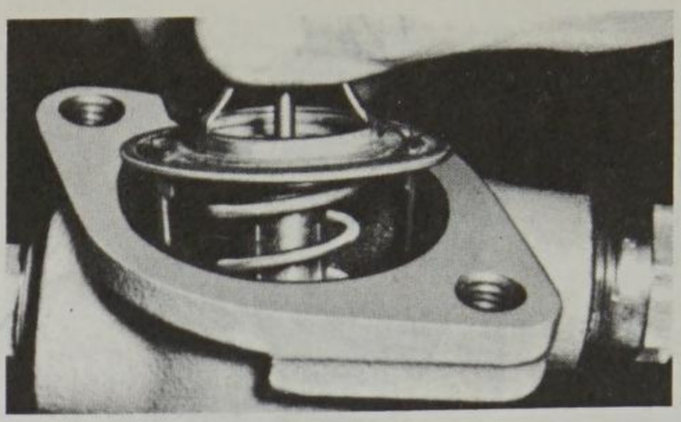
V6 and V8

1. Disconnect the negative battery terminal.
2. Drain the cooling system.
3. Remove the fan shroud and/or radiator support, as applicable.
4. Remove all drive belts.
5. Remove the fan and pulley from the water pump.
6. Remove the alternator upper and lower brackets. Remove the power steering pump lower bracket and swing aside.
7. Remove the bottom radiator hose and heater hose from the pump.
8. Remove the water pump.
9. Installation is the reverse of removal. Torque the pump bolts 15–25 ft. lbs. Coat the new gasket with RTV Sealer.

Thermostat

REMOVAL AND INSTALLATION

1. Drain the cooling system to below the thermostat level.
2. It is not necessary to remove the radiator hose from the thermostat housing.
3. Remove the two retaining bolts from the thermostat housing and remove the thermostat.
4. Use a new gasket when replacing the thermostat. Coat the gasket with RTV Sealer.



Thermostat installation

Radiator

REMOVAL AND INSTALLATION

1. Drain the cooling system.
2. Remove the fan.

NOTE: *On fan clutch equipped cars, store clutch in upright position to prevent seal leakage.*

3. Disconnect upper and lower radiator hoses.
4. On vehicles equipped with automatic transmission, disconnect and plug transmission cooler lines.
5. Remove fan shield assembly if applicable.
6. Remove radiator and shroud assembly by lifting straight up.

NOTE: *The radiator assembly is held at the bottom by two cradles secured to the radiator support.*

7. If installing a new radiator, transfer fittings from old radiator to new radiator.
8. Replace radiator assembly by reversing the above steps, checking to assure radiator lower cradles are located properly in radiator recess.
9. Refill radiator. Run engine for a short period of time and check for leaks. If the radiator was removed from a car with an automatic transmission, recheck the transmission fluid.

Emission Controls and Fuel Systems

EMISSION CONTROLS

There are three sources of automotive pollutants: crankcase fumes, exhaust gases, and gasoline evaporation. The pollutants formed from these substances fall into three categories: unburnt hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NO_x). The equipment that is used to limit these pollutants is commonly called emission control equipment.

Positive Crankcase Ventilation System

OPERATION

The positive crankcase ventilation (PCV) system is used to control crankcase blow-by vapors. The system functions as follows:

The crankcase (blow-by) gases are recycled in the following way: as the engine is running, clean, filtered air is drawn through the air filter and into the crankcase. As the air passes through the crankcase, it picks up the combustion gases and carries them out of the crankcase, through the PCV valve, and into the induction system. As they enter the intake manifold, they are drawn into the combustion chamber where they are reburned.

The most critical component in the system is the PCV valve. This valve controls the amount of gases which are recycled into the combustion chamber. At low engine speeds, the valve is partially closed, limiting the flow of gases into the intake manifold. As engine speed increases, the valve opens to admit greater quantities of gases into the intake manifold. If the PCV valve becomes clogged, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase tube into the air cleaner to be consumed by normal combustion.

SERVICE

Inspect the PCV system hose and connections at each tune-up and replace any deteriorated hoses. Check the PCV valve at every tune-up and replace it at 30,000 mile intervals.

TESTING

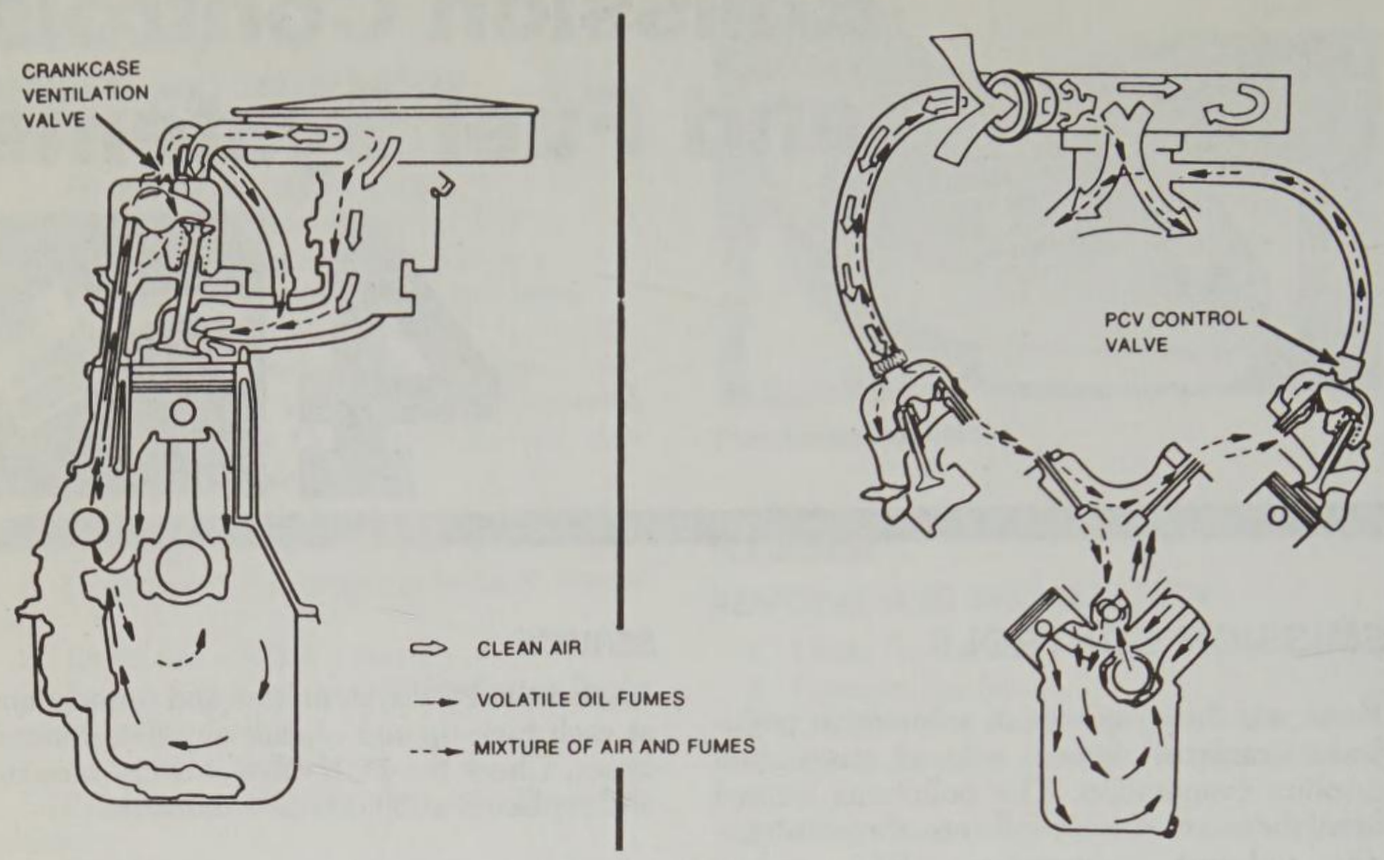
1. Remove the PCV valve from the intake manifold or valve cover.
2. Run the engine at idle.
3. Place your thumb over the end of the valve. Check for vacuum. If there is no vacuum at the valve, check for plugged valve or vacuum lines.
4. Shut off the engine. Shake the valve and listen for the rattle. If valve doesn't rattle, replace it.

Evaporative Emission Control System

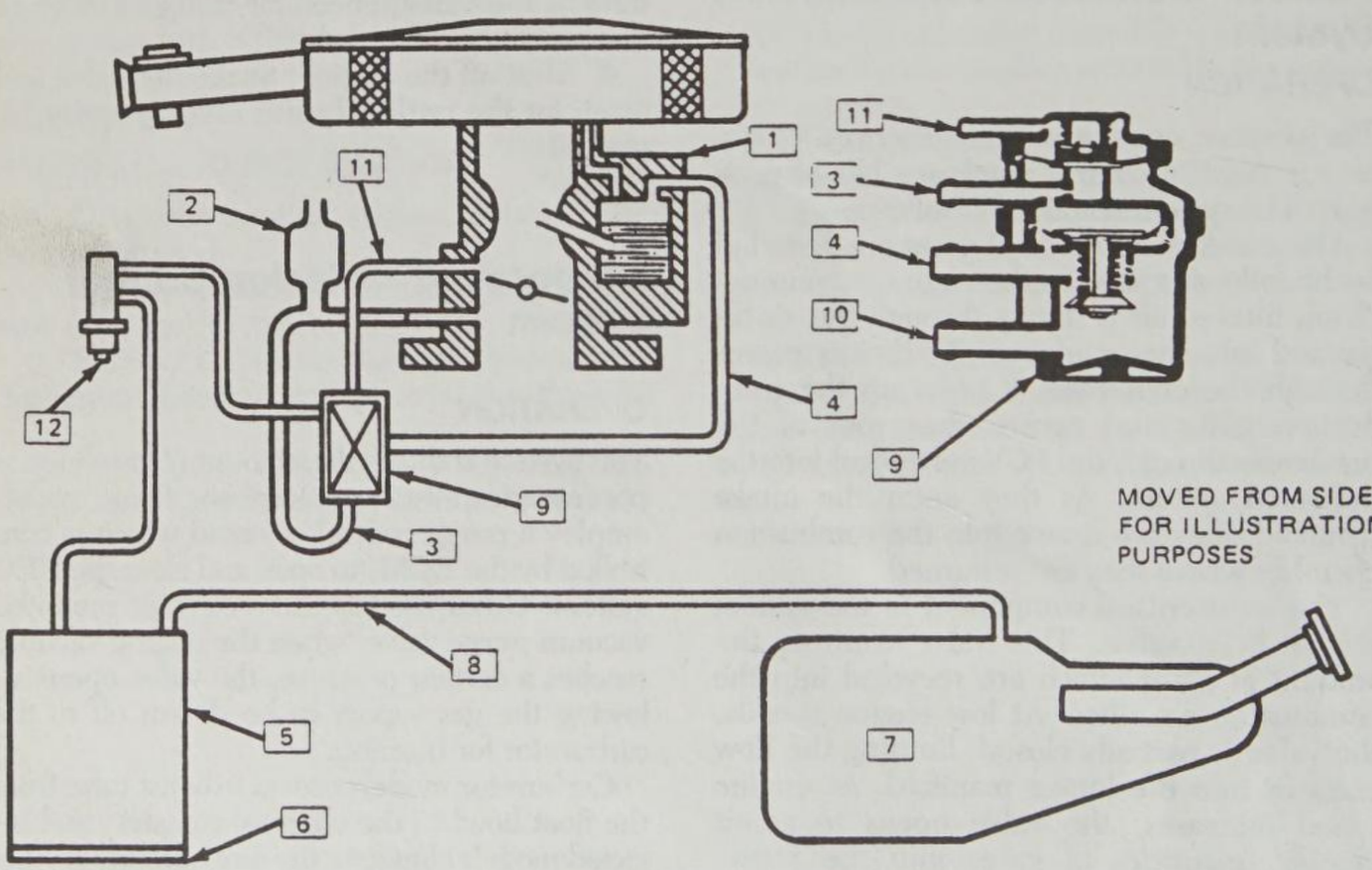
OPERATION

This system reduces the amount of gasoline vapors escaping into the atmosphere. Some models employ a purge control solenoid which is controlled by the ECM, to open and close the EEC system. Other models use a canister mounted vacuum purge valve; when the engine vacuum reaches a certain pressure, the valve opens allowing the gas vapors to be drawn off to the carburetor for burning.

Carburetor models use an exhaust tube from the float bowl to the charcoal canister; fuel injected models eliminate the fuel bowl tube. Fuel vapors from the gas tank travel from the tank to the vapor canister, where they are collected. Although the system may vary from vehicle to vehicle, the operations are basically the same.

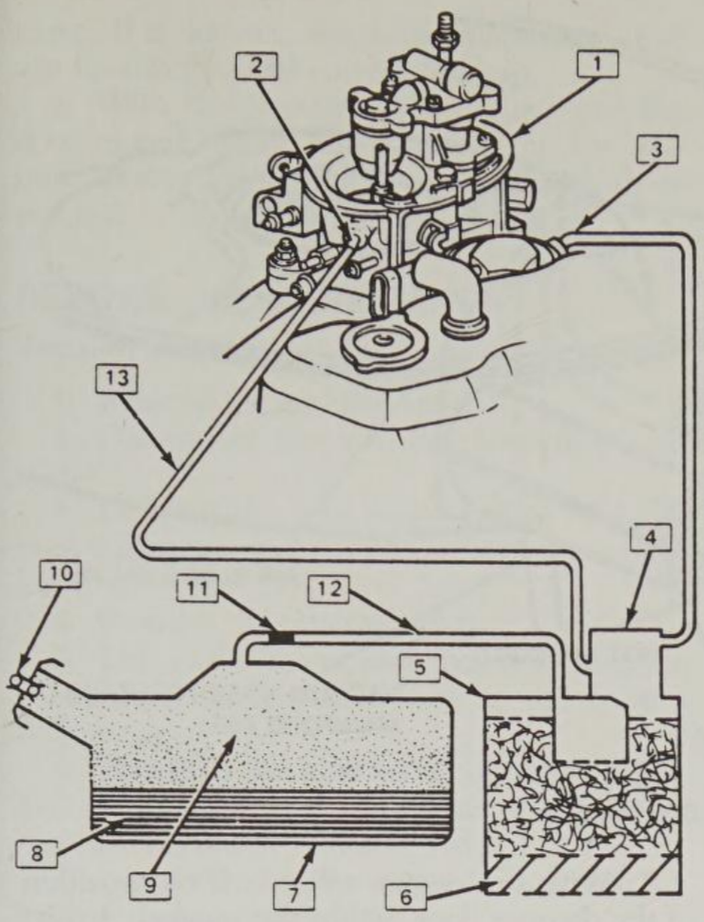


Typical PCV flow



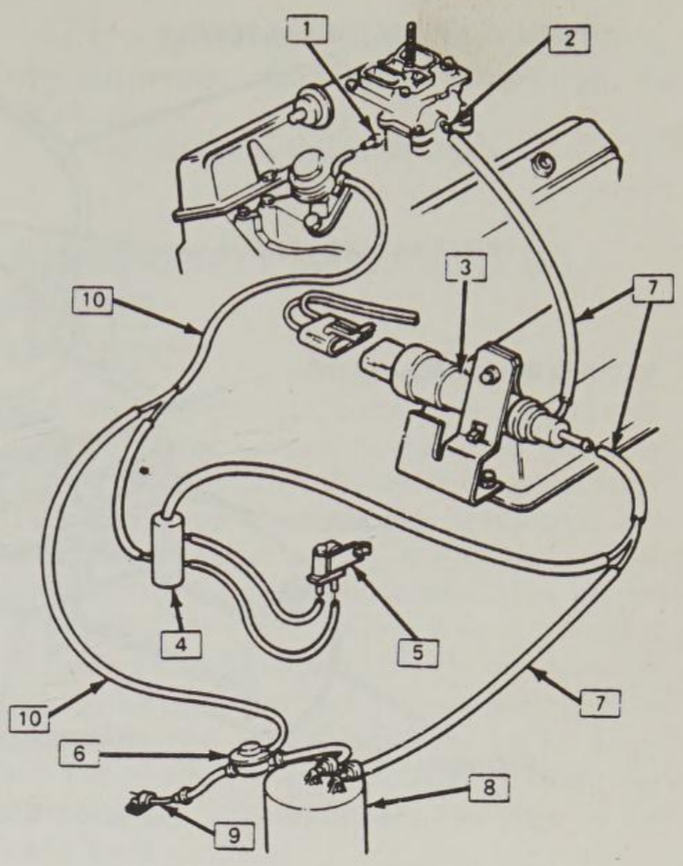
1. Carburetor
2. PCV valve
3. Manifold vacuum from PCV
4. Carburetor bowl tube
5. Vapor storage canister
6. Purge air
7. Fuel tank
8. Fuel tank vent pipe
9. Canister control valve
10. Canister tube
11. Tube control vacuum
12. T.V.S. switch

Evaporative Emission Control System (EECS)—5.0L engine



1. TBI
2. Canister purge port
3. Vacuum signal
4. Purge valve
5. Vapor storage canister
6. Purge air
7. Fuel tank
8. Fuel
9. Vapor
10. Pressure-vacuum relief gas cap
11. Vent restricter
12. Fuel tank vent
13. Purge line

Evaporative Emission Control (EEC) System—2.5L engine



1. Port "B" ported vacuum
2. Port "F" bowl vent
3. Fuel bowl vent solenoid
4. Fuel vapor connector
5. Fuel vapor purge solenoid
6. Tank pressure control valve
7. Vent/purge hose
8. Canister
9. Tank vapor vent pipe
10. Ported vacuum line

EEC System—2.8L engine

CANISTER REMOVAL AND INSTALLATION

1. Loosen the screw holding the canister retaining bracket.
2. Rotate the canister retaining bracket and remove the canister.
3. Tag and disconnect the hoses leading from the canister.
4. Installation is in the reverse order of removal.

FILTER REPLACEMENT

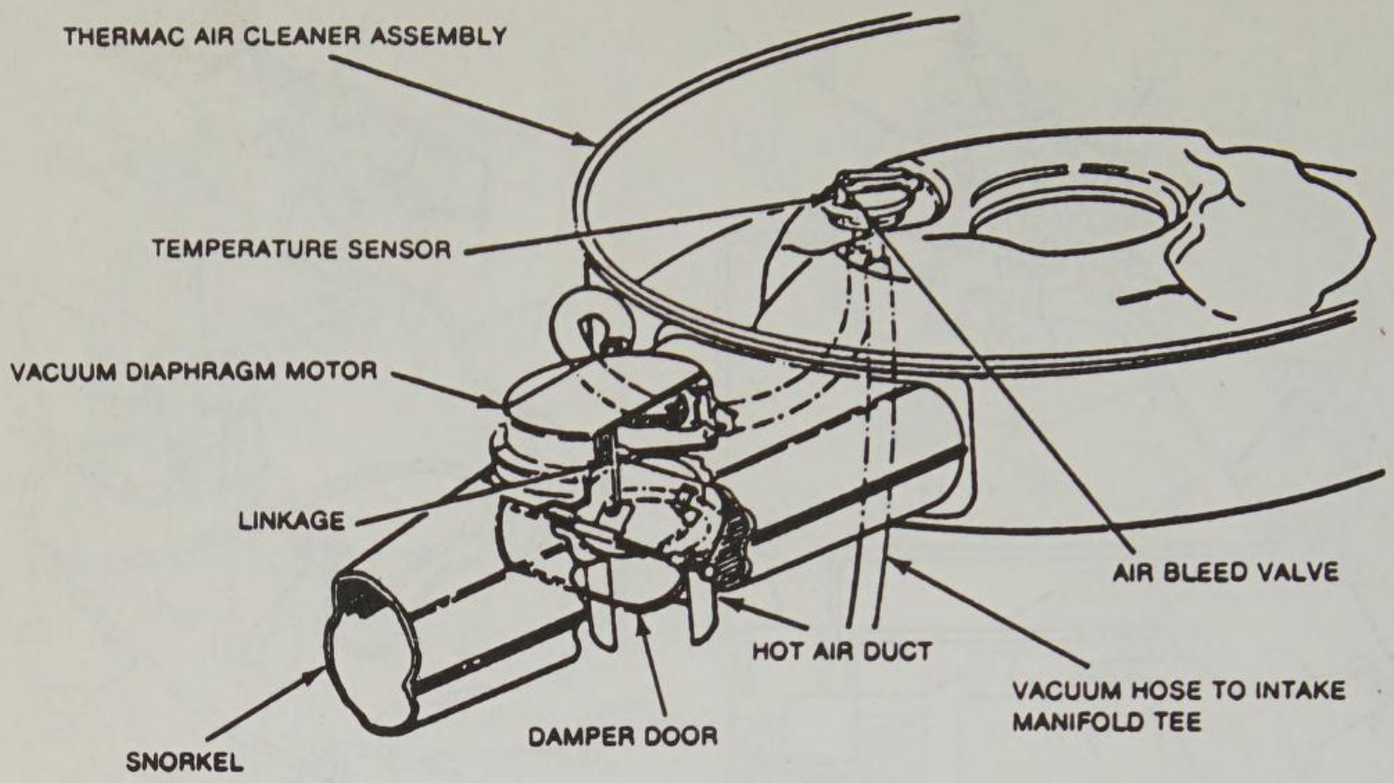
1. Remove the vapor canister.
2. Pull the filter out from the bottom of the canister.
3. Install a new filter and then replace the canister.

Thermostatic Air Cleaner (THERMAC)

OPERATION

All engines use the THERMAC system. This system is designed to warm the air entering the carburetor when underhood temperatures are low, and to maintain a controlled air temperature into the carburetor at all times. By allowing preheated air to enter the carburetor, the amount of time the choke is on is reduced, resulting in better fuel economy and lower emissions. Engine warm-up time is also reduced.

The THERMAC system is composed of the air cleaner body, a filter, sensor unit, vacuum diaphragm, damper door, and associated hoses and connections. Heat radiating from the exhaust manifold is trapped by a heat stove and is ducted to the air cleaner to supply heated air to the carburetor. A movable door in the air cleaner case snorkel allows air to be drawn in from the heat stove (cold operation). The door position is controlled by the vacuum mo-



Typical THERMAC air cleaner

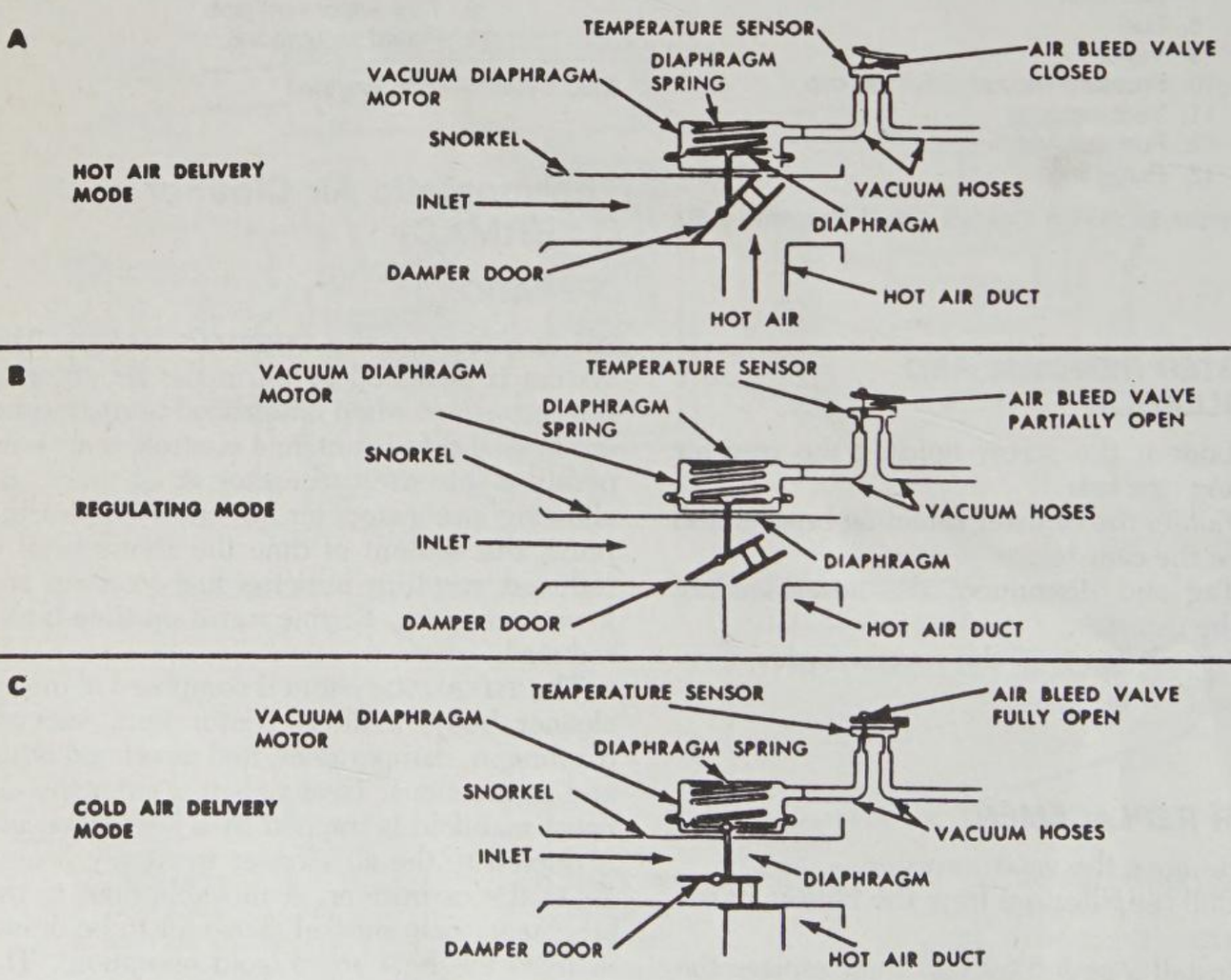
tor, which receives intake manifold vacuum as modulated by the temperature sensor.

SYSTEM CHECKS

1. Check the vacuum hoses for leaks, kinks, breaks, or improper connections and correct any defects.

2. With the engine off, check the position of the damper door within the snorkel. A mirror can be used to make this job easier. The damper door should be open to admit outside air.

3. Apply at least 7 in. Hg of vacuum to the damper diaphragm unit. The door should



Schematic of the vacuum motor operation

close. If it doesn't, check the diaphragm linkage for binding and correct hookup.

4. With the vacuum still applied and the door closed, clamp the tube to trap the vacuum. If the door doesn't remain closed, there is a leak in the diaphragm assembly.

REMOVAL AND INSTALLATION

Vacuum Motor

1. Remove the air cleaner.
2. Disconnect the vacuum hose from the motor.
3. Drill out the spot welds with a 1/8" hole, then enlarge as necessary to remove the retaining strap.
4. Remove the retaining strap.
5. Lift up the motor and cock it to one side to unhook the motor linkage at the control damper assembly.
6. To install the new vacuum motor, drill a 7/64" hole in the snorkel tube as the center of the vacuum motor retaining strap.
7. Insert the vacuum motor linkage into the control damper assembly.
8. Use the motor retaining strap and a sheet metal screw to secure the retaining strap and motor to the snorkel tube.

NOTE: *Make sure the screw does not interfere with the operation of the damper assembly. Shorten the screw if necessary.*

Temperature Sensor

1. Remove the air cleaner.
2. Disconnect the hoses at the air cleaner.
3. Pry up the tabs on the sensor retaining clip and remove the clip and sensor from the air cleaner.
4. Installation is the reverse of removal.

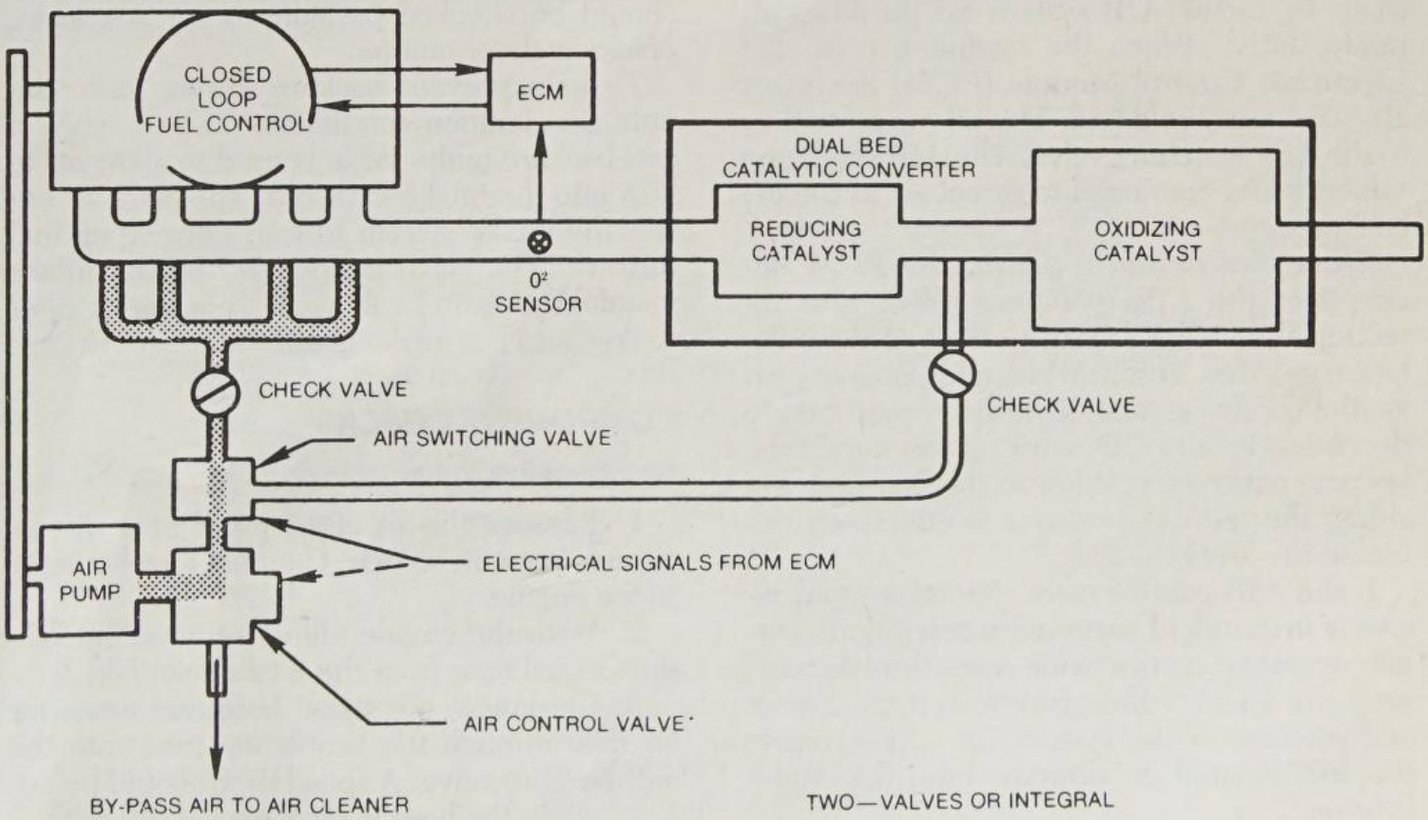
Air Injection Reaction (A.I.R.) System

OPERATION

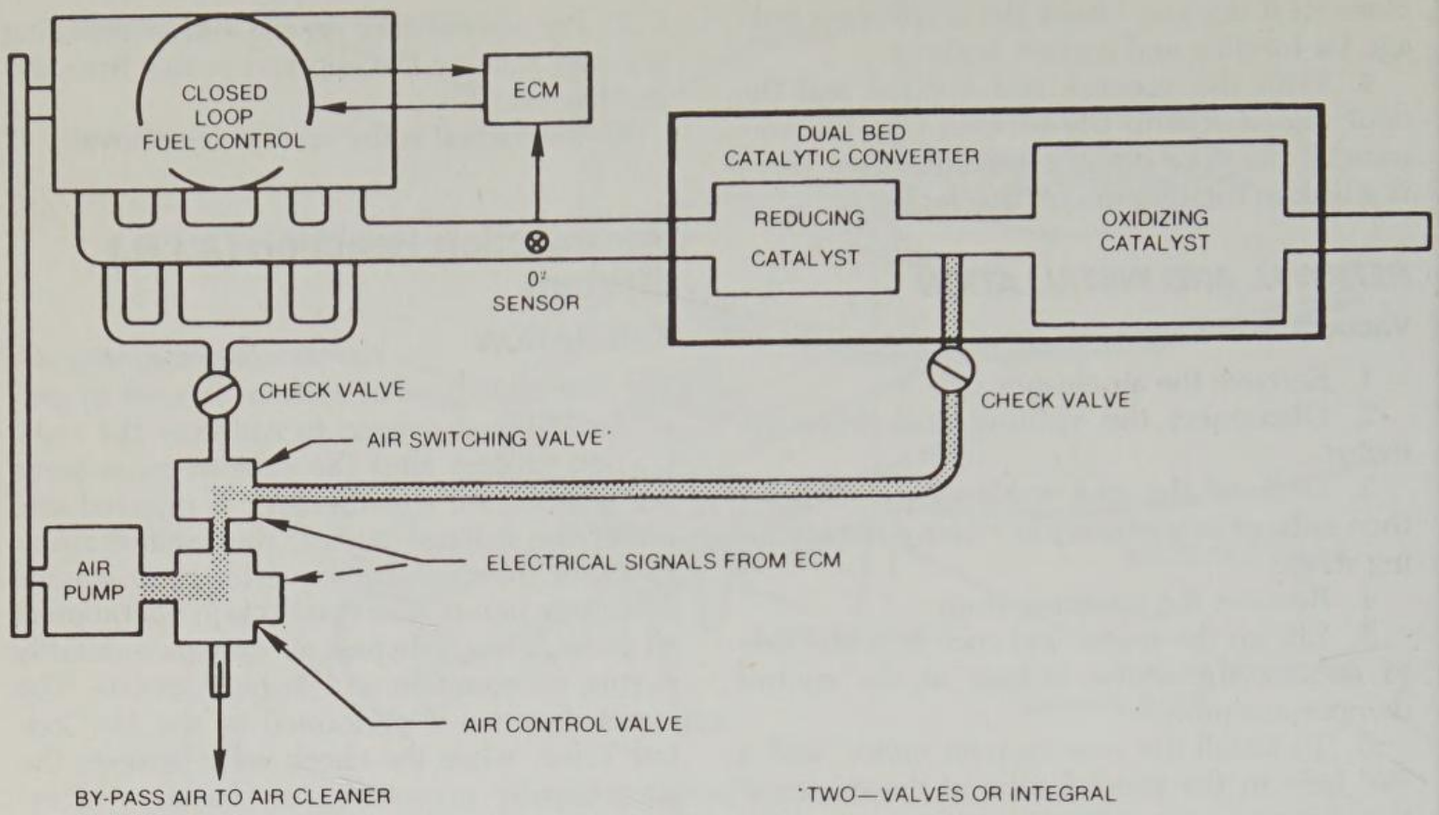
The AIR management system, is used to provide additional oxygen to continue the combustion process after the exhaust gases leave the combustion chamber. Air is injected into either the exhaust port(s), the exhaust manifold(s) or the catalytic converter by an engine driven air pump. The system is in operation at all times and will bypass air only momentarily during deceleration and at high speeds. The bypass function is performed by the Air Control Valve, while the check valve protects the air pump by preventing any backflow of exhaust gases.

The AIR system helps reduce HC and CO content in the exhaust gases by injecting air into the exhaust ports during cold engine operation. This air injection also helps the catalytic converter to reach the proper temperature quicker during warmup. When the engine is warm (Closed Loop), the AIR system injects air into the beds of a three-way converter to lower the HC and the CO content in the exhaust.

The Air Injection Reduction system utilizes the following components:



Air Injection Reaction System—Cold Engine



Air Injection Reaction System—Warm Engine

1. An engine driven AIR pump
2. AIR Control valves (Air Control, Air Switching)
3. Air flow and control hoses
4. Check valves
5. A dual-bed, three-way catalytic converter.
6. A deceleration back-fire control valve—2.8L only.

The belt driven, vane-type air pump is located at the front of the engine and supplies clean air to the AIR system for purposes already stated. When the engine is cold, the Electronic Control Module (ECM) energizes an AIR control solenoid. This allows air to flow to the AIR switching valve. The AIR switching valve is then energized to direct air to the exhaust ports.

When the engine is warm, the ECM deenergizes the AIR switching valve, thus directing the air between the beds of the catalytic converter. This provides additional oxygen for the oxidizing catalyst in the second bed to decrease HC and CO, while at the same time keeping oxygen levels low in the first bed, enabling the reducing catalyst to effectively decrease the levels of NO_x.

If the AIR control valve detects a rapid increase in manifold vacuum (deceleration), certain operating modes (wide open throttle, etc.) or if the ECM self-diagnostic system detects any problem in the system, air is diverted to the air cleaner or directly into the atmosphere.

The primary purpose of the ECM's divert mode is to prevent backfiring. Throttle closure at the beginning of deceleration will temporarily create air/fuel mixtures which are too rich to burn completely. These mixtures become burnable when they reach the exhaust if combined with the injection air. The next firing of the engine will ignite this mixture causing an exhaust backfire. Momentary diverting of the injection air from the exhaust prevents this.

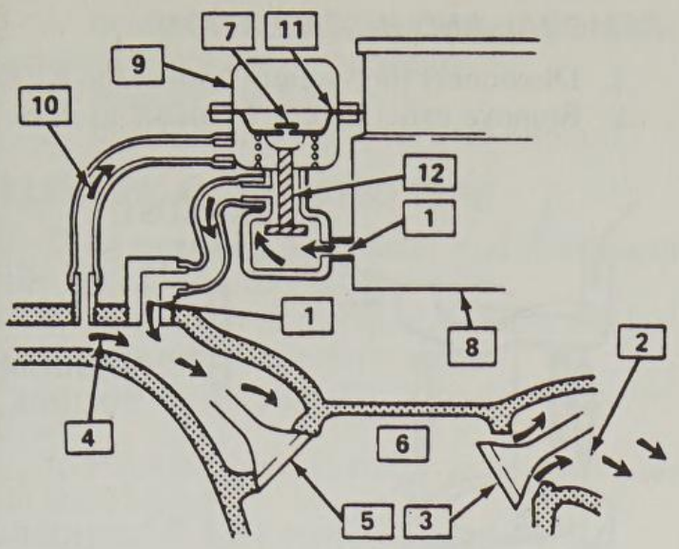
The AIR system check valves and hoses should be checked periodically for any leaks, cracks or deterioration.

To help prevent backfire during high vacuum deceleration conditions, on 2.8L only, a anti-backfire (gulp) valve is used to allow air to flow into the intake manifold. The extra air enters the intake system to lean the rich air/fuel mixture. The valve is operated by the intake manifold vacuum to allow air from the air filter to flow into the intake manifold.

COMPONENT CHECKS

Anti-Backfire Valve

1. Remove the air cleaner and plug the air cleaner vacuum source. Connect a tachometer to the engine.
2. With the engine idling, remove the vacuum signal hose from the intake manifold.
3. Reconnect the signal hose and listen for air flow through the ventilation tube into the anti-backfire valve. A speed drop should be noticed when the hose is reconnected.
4. If these conditions are not found, check



1. Air flow
2. Exhaust gas
3. Exhaust valve
4. Intake flow
5. Intake valve
6. Combustion chamber
7. Vacuum bleed valve
8. Air cleaner
9. Deceleration valve
10. Manifold vacuum
11. Diaphragm
12. Valve

Anti-Backfire Control Valve—2.8L ONLY

hoses for restrictions or leaks. If hoses are OK, replace the anti-backfire valve.

Air Pump

1. Check the drive belt tension.
2. Increase the engine speed and observe an increase in air flow. If air flow does not increase, replace the air pump.

Control Valve

1. Remove the hoses. Blow through the valve (toward the cylinder head).
2. Then, suck through the valve. If air flows in one direction, the valve is operative. If not, replace the control valve.

REMOVAL AND INSTALLATION

Air Pump

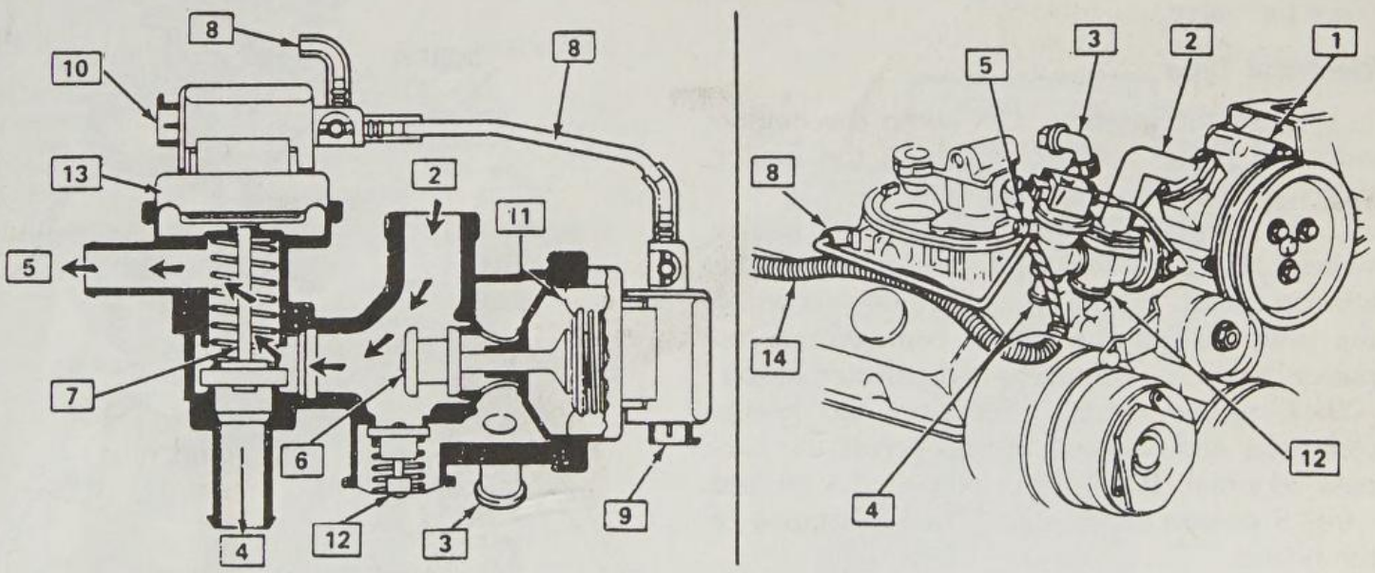
1. Remove the AIR control valves and/or adapter at the pump.
2. Loosen the air pump adjustment bolt and remove the drive belt.
3. Unscrew the pump mounting bolts and then remove the pump pulley.
4. Unscrew the pump mounting bolts and then remove the pump.
5. Installation is in the reverse order of removal. Be sure to adjust the drive belt tension after installing it.

Check Valve

1. Release the clamp and disconnect the air hoses from the valve.
2. Unscrew the check valve from the air injection pipe.
3. Installation is in the reverse order of removal.

Air Control Valve

1. Disconnect the negative battery cable.
2. Remove the air cleaner.
3. Tag and disconnect the vacuum hose from the valve.
4. Tag and disconnect the air outlet hoses from the valve.
5. Bend back the lock tabs and then remove the bolts holding the elbow to the valve.
6. Tag and disconnect any electrical connections at the valve and then remove the valve from the elbow.
7. Installation is in the reverse order of removal.



1. Air pump
2. Air from pump
3. Diverted air to air cleaner
4. Air to exhaust ports
5. Air to catalytic converter
6. Air control valve
7. Air switching valve
8. Manifold vacuum
9. ECM (term. 16 blk) control
10. ECM (term. 14 blk) control
11. Diaphragm
12. Pressure relief valve
13. Vacuum chamber
14. Wiring harness

Air Injection Reaction System Control Valve

Early Fuel Evaporation (EFE)

OPERATION

The EFE system is used on some of the engines to provide a source of rapid engine heat up during cold operations. It helps reduce the time that carburetor choking is required and helps reduce exhaust emissions.

Of the 2 types of EFE systems, the Vacuum Servo type—consisting of a valve, an actuator and a Thermal Vacuum Switch (TVS)—the valve is located in the exhaust manifold and the TVS switch is on the engine coolant housing.

The electrical type—consisting of a ceramic grid is located under the base of the carburetor—it supplies heat to the incoming air/fuel mixture. The system uses a relay which is mounted on the left side of the firewall in the engine compartment.

A check of the operation should be made at regular maintenance intervals.

SYSTEM CHECKS

Vacuum Servo Type

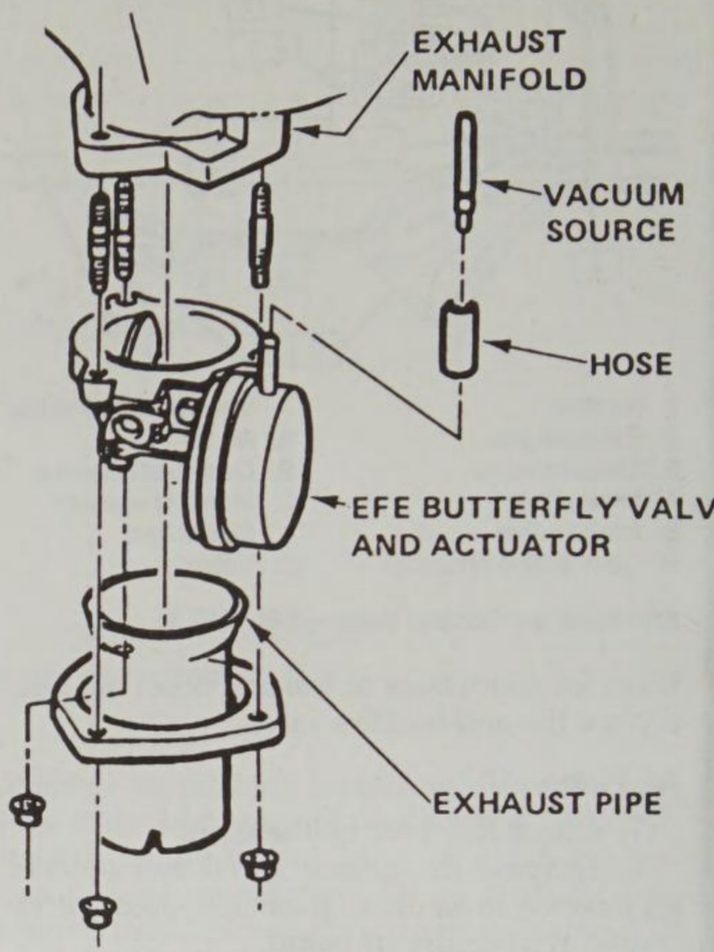
1. With the engine cold, observe the position of the actuator arm. Start the engine. The arm should move toward the diaphragm (closing the valve).
2. If the arm does not move, remove the hose and check for vacuum. If still no vacuum, remove the top hose from the TVS switch and check for vacuum.
3. If vacuum is present in the top hose, replace the TVS switch.
4. If vacuum is present at the actuator and it does not move, try to free the valve or replace the valve.

Electrical Type

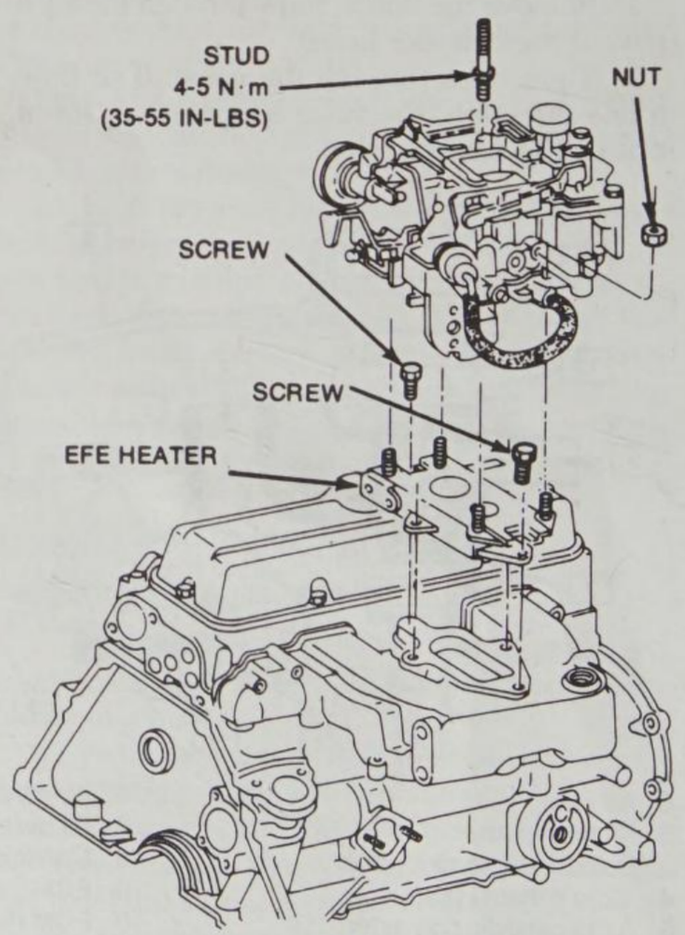
1. Turn the ignition "ON" with the engine cold and probe both terminals of the heater switch connector with a test light.
2. If 1 wire has power, replace the heater switch; if neither wire has power, repair the ignition circuit. If both wires have power, probe the pink wire at the heater connector; if no power, repair the connector of the heater switch.
3. If power exists, disconnect the heater connector and connect a tester across the harness terminal. If no power, repair the ground wire; if power exists, check the resistance of the heater.
4. If heater is over 3 ohms, replace the heater. If under 3 ohms, replace the connector, start the engine (operate to normal temperature) and probe the pink wire. If no power, the system is OK; if power exists, replace the heater switch.

REMOVAL AND INSTALLATION

1. Disconnect the vacuum hose at the EFE.
2. Remove exhaust pipe to manifold nuts.



EFE system—vacuum servo type



EFE heater grid

3. Remove the crossover pipe. Complete removal is not always necessary.
4. Remove the EFE valve.
5. Installation is the reverse of removal.

ELECTRICALLY HEATED TYPE

1. Remove the air cleaner and disconnect the negative battery cable.
2. Disconnect all electrical, vacuum and fuel connections from the carburetor.
3. Disconnect the EFE heater electrical lead.
4. Remove the carburetor as detailed later in this chapter.
5. Lift off the EFE heater grid.
6. Installation is in the reverse order of removal.

EFE HEATER RELAY REPLACEMENT

1. Disconnect the negative battery cable.
2. Remove the retaining bracket.
3. Tag and disconnect all electrical connections.
4. Unscrew the retaining bolts and remove the relay.
5. Installation is in the reverse order of removal.

Exhaust Gas Recirculation (EGR)

OPERATIONS

All models are equipped with this system, which consists of a metering valve, a vacuum line to the carburetor or intake manifold, and cast-in exhaust passages in the intake manifold. The EGR valve is controlled by vacuum, and opens and closes in response to the vacuum signals to admit exhaust gases into the air/fuel mixture. The exhaust gases lower peak combustion temperatures, reducing the formation of NO_x. The valve is closed at idle and wide open throttle, but is open between the two extreme positions.

There are actually three types of EGR systems: Ported, Positive Back-Pressure and Negative Backpressure. The principle of both systems is the same; the only difference is in the method used to control how far the EGR valve opens.

Ported Valve

In the Ported system, the amount of exhaust gas admitted into the intake manifold depends on a ported vacuum signal. A ported vacuum signal is one taken from the carburetor above the throttle plates; thus, the vacuum signal (amount of vacuum) is dependent on how far the throttle plates are opened. When the throttle is closed (idle or deceleration) there is no vacuum signal. Thus, the EGR valve is closed, and no exhaust gas enters the intake manifold. As the throttle is opened, a vacuum is produced, which opens the EGR valve, admitting exhaust gas into the intake manifold.

Positive Backpressure Valve

This valve operates the same as the ported, except, it has an internal air bleed that acts as a vacuum regulator. The bleed valve controls the

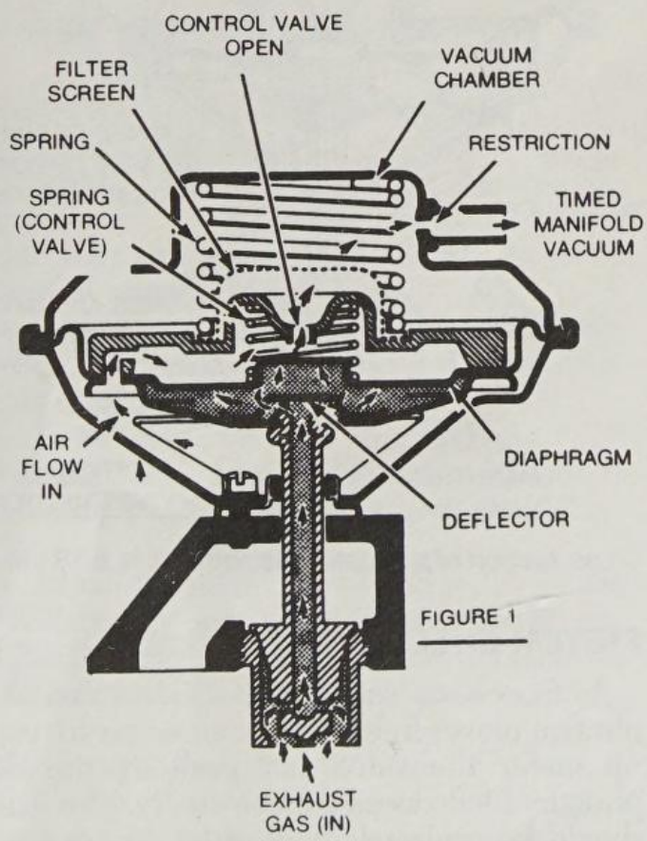


FIGURE 1

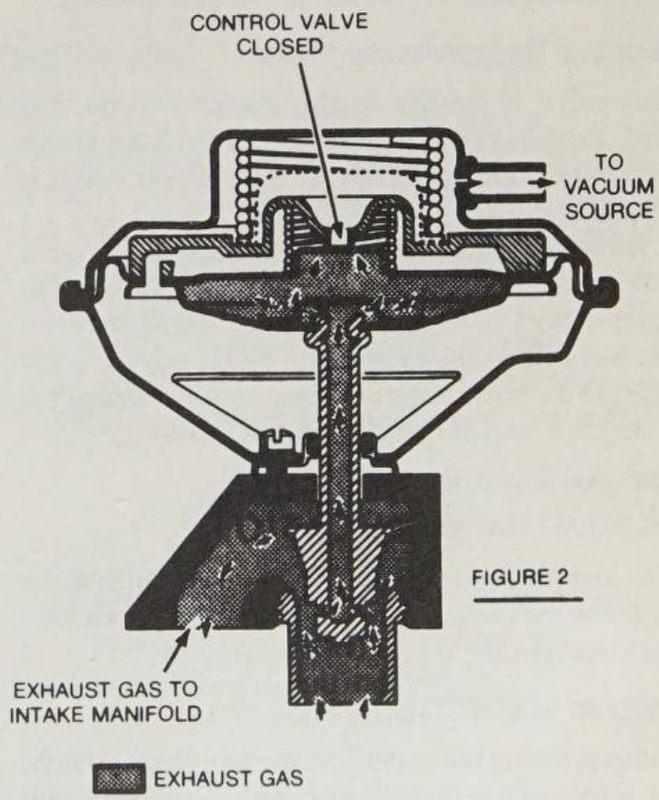
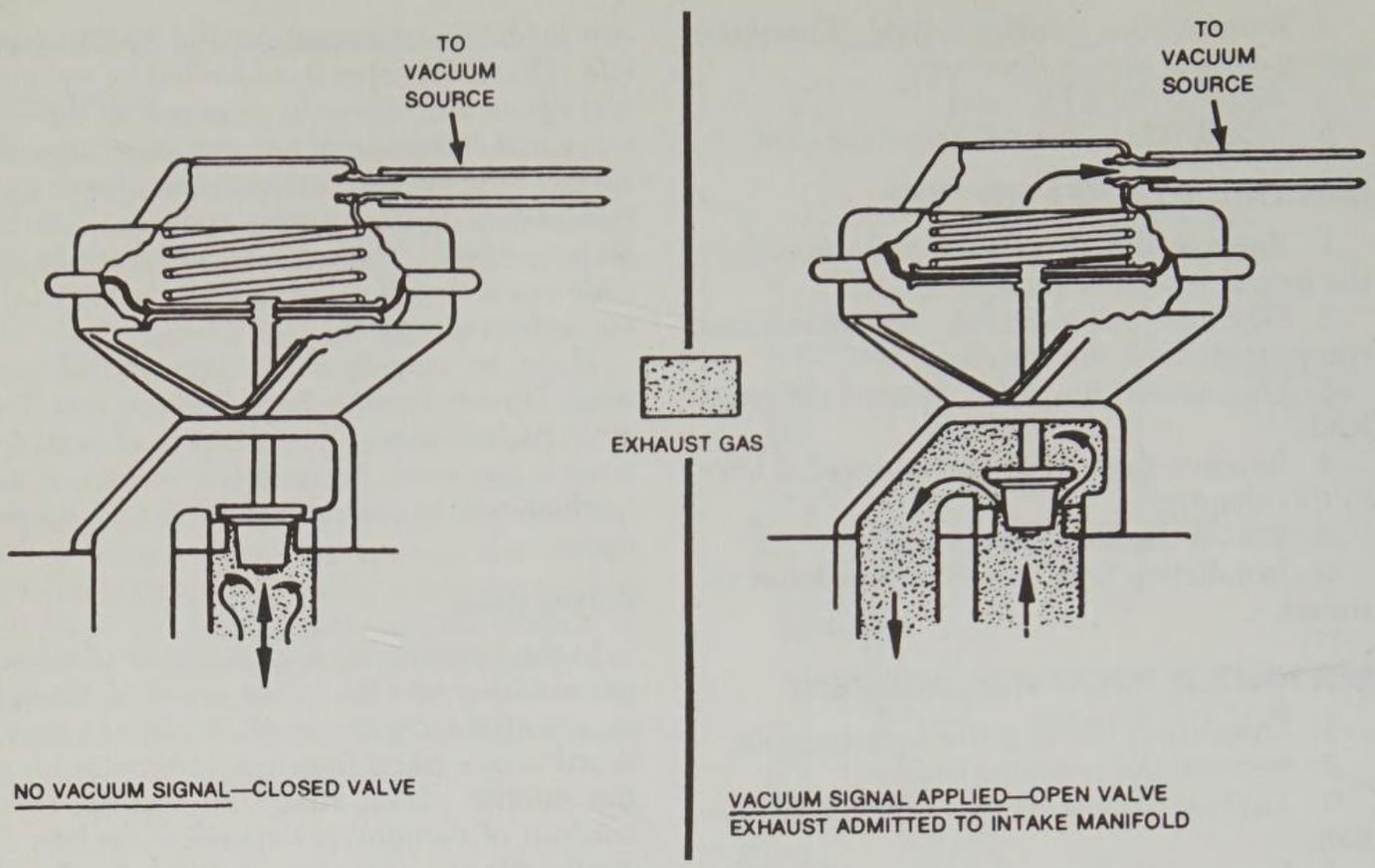


FIGURE 2

Positive Backpressure EGR Valve



Vacuum operated EGR valve

amount of vacuum inside the vacuum chamber during operation. When the valve receives sufficient exhaust back-pressure through the hollow shaft, it closes the bleed; at this point the EGR valve opens.

NOTE: *This valve will not open, with vacuum applied to it, while the engine is idling or stopped.*

Negative Backpressure Valve

This valve is similar to the Positive Type, except, the bleed valve spring is moved from above the diaphragm to below it. The bleed valve is normally closed.

At certain manifold pressures, the EGR valve will open. When the manifold vacuum combines with the negative exhaust backpressure, the bleed hole opens and the EGR valve closes.

NOTE: *This valve will open when vacuum is applied and the engine is not running.*

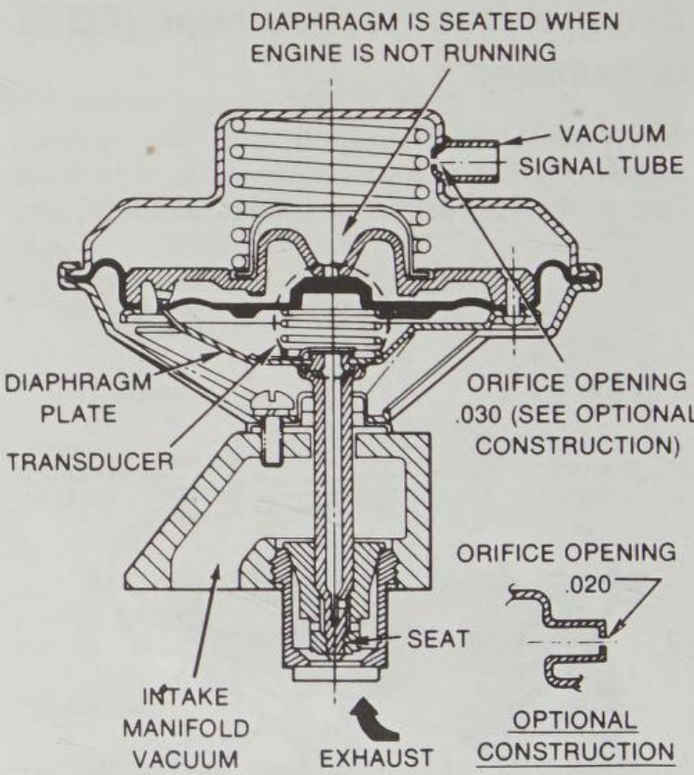
Optional Controls

THERMOSTATIC VACUUM SWITCH (TVS)

The switch is sometimes used in combination with the EGR valve to close off vacuum during cold operation.

VACUUM/SOLENOID CONTROL

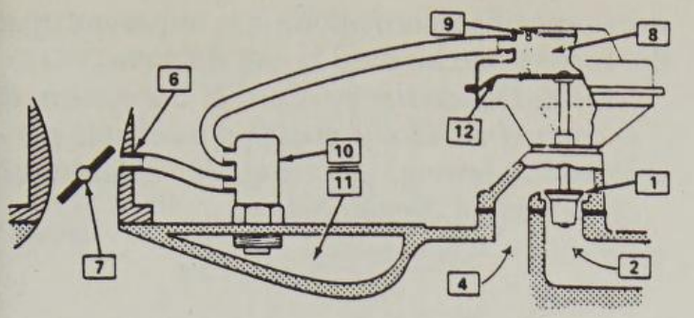
Some systems use a coolant temperature switch, throttle position switch and pressure sensor with the EGR valve.



Cross section of a negative backpressure EGR valve

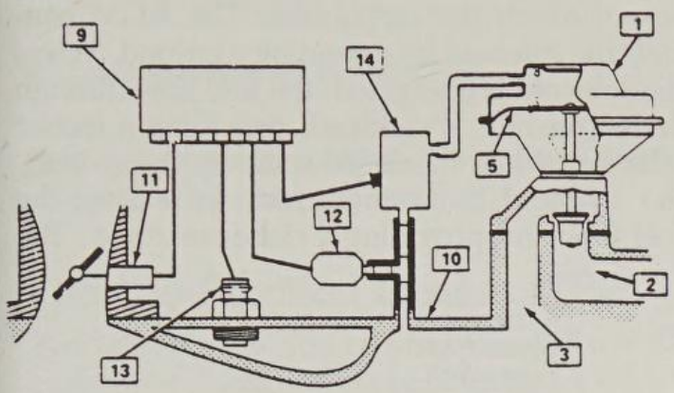
SYSTEM CHECKS

1. Check to see if the EGR valve diaphragm moves freely. Use your finger to reach up under the valve and push on the diaphragm. If it doesn't move freely, the valve should be replaced. The use of a mirror will aid the inspection process.



1. EGR valve
2. Exhaust gas
4. Intake flow
6. Vacuum port
7. Throttle valve
8. Vacuum chamber
9. Valve return spring
10. Thermal vacuum switch
11. Coolant
12. Diaphragm

Thermostatic Vacuum Switch Controlled EGR System



1. EGR valve
2. Exhaust gas
3. Intake air
5. Diaphragm
9. Electronic control module
10. Manifold vacuum
11. Throttle position sensor
12. Manifold pressure sensor
13. Coolant temperature sensor
14. EGR control solenoid

Electronic controlled EGR system

CAUTION: *If the engine is hot, wear a glove to protect your hand.*

2. Install a vacuum gauge into the vacuum line between the EGR valve and the carburetor. Start the engine and allow it to reach operating temperature.

3. With the car in either Park or Neutral, increase the engine speed until at least 5 in. Hg. is showing on the gauge.

4. Remove the vacuum hose from the EGR valve. The diaphragm should move downward (valve closed). The engine speed should increase.

5. Install the vacuum hose and watch for the EGR valve to open (diaphragm moving upward). The engine speed should decrease to its former level, indicating exhaust recirculation.

If the diaphragm doesn't move:

1. Check engine vacuum; it should be at least 5 in. Hg. with the throttle open and engine running.

2. Check to see that the engine is at normal operating temperature.

3. Check for vacuum at the EGR hose. If no vacuum is present, check the hose for leaks, breaks, kinks, improper connections, etc., and replace as necessary.

If the diaphragm moves, but the engine speed doesn't change, check the EGR passages in the intake manifold for blockage.

REMOVAL AND INSTALLATION

1. Disconnect the vacuum hose.
2. Remove the bolts or nuts holding the EGR valve to the engine.
3. Remove the valve.
4. Clean the mounting surfaces before replacing the valve. Install the valve onto the manifold, using a new gasket. Be sure to install the spacer, if used. Connect the vacuum hose and check the valve operation.

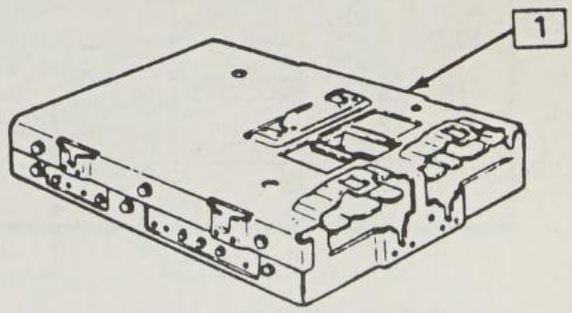
Computer Command Control System (CCC)

The Computer Command Control System (CCC) is an electronically controlled exhaust emission system that can monitor and control a large number of interrelated emission control systems. It can monitor up to 15 various engine/vehicle operating conditions and then use this information to control as many as 9 engine related systems. The "System" is thereby making constant adjustments to maintain good vehicle performance under all normal driving conditions while at the same time allowing the catalytic converter to effectively control the emissions of HC, CO and NO_x.

OPERATION

ECM

The Electronic Control Module (ECM) is the control center of the fuel control system. It constantly monitors various information from the sensors and controls the systems that affect the vehicle performance. The ECM has two parts: a Controller (the ECM without the PROM) and a separate calibrator (the PROM). The ECM is located under the right-hand side of the dash.



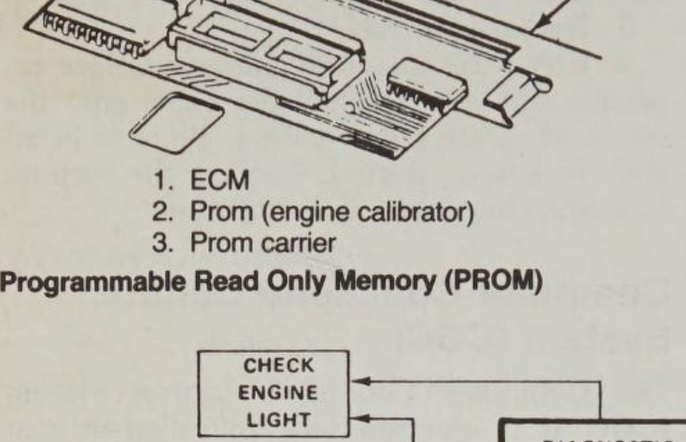
1. Electronic control module (ECM)

Electronic Control Module (ECM)

Prom

To allow the Controller to be used in many different vehicles, a device called a Calibrator or Programmable Read Only Memory (PROM) is used. The PROM which is located inside the ECM, stores information such as: the vehicle's weight, engine, transmission, axle ratio, and many other specifications. Since the PROM stores specific information, it is important that the correct one be used in the right car.

NOTE: *Due to the intricacy of the system, it is advised to have a qualified mechanic perform any testing, adjusting, or replacement of the system components.*



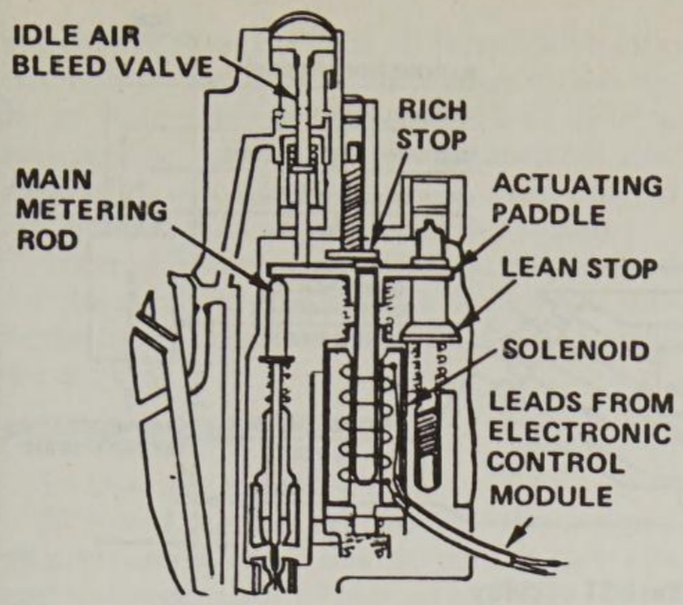
1. ECM
2. Prom (engine calibrator)
3. Prom carrier

Programmable Read Only Memory (PROM)

Mixture Control Solenoid (M/C)

The fuel flow through the carburetor idle main metering circuits is controlled by a mixture control (M/C) solenoid located in the carburetor. The M/C solenoid changes the air/fuel mixture to the engine by controlling the fuel flow through the carburetor. The ECM controls the solenoid by providing a ground. When the solenoid is energized, the fuel flow through the carburetor is reduced, providing a leaner mixture. When the ECM removes the ground, the solenoid is de-energized, increasing the fuel flow and providing a richer mixture. The

Computer Control Command schematic



M/C solenoid, models E2ME, E4ME

M/C solenoid is energized and de-energized at a rate of 10 times per second.

Throttle Position Sensor (TPS)

The throttle position sensor is mounted in the carburetor body and is used to supply throttle position information to the ECM. The ECM memory stores an average of operating conditions with the ideal air/fuel ratios for each of those conditions. When the ECM receives a signal that indicates throttle position change, it immediately shifts to the last remembered set of operating conditions that resulted in an ideal air/fuel ratio control. The memory is continually being updated during normal operations.

Idle Speed Control (ISC)

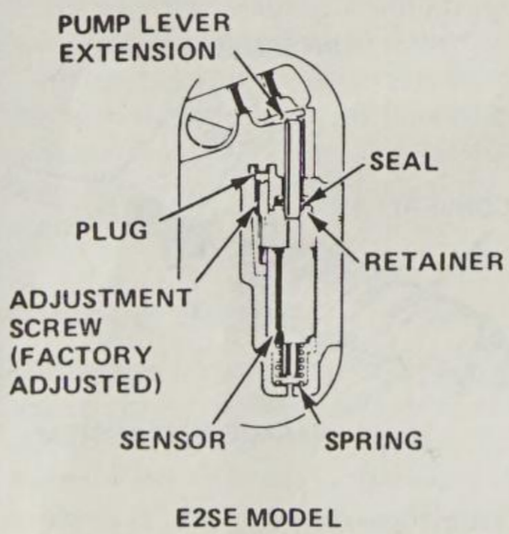
The idle speed control does just what its name implies—it controls the idle. The ISC is used to maintain low engine speeds while at the same time preventing stalling due to engine load changes. The system consists of a motor assembly mounted on the carburetor which moves the throttle lever so as to open or close the throttle blades.

The whole operation is controlled by the ECM. The ECM monitors engine load to determine the proper idle speed. To prevent stalling, it monitors the air conditioning compressor switch, the transmission, the park/neutral switch and the ISC throttle switch. The ECM processes all this information and then uses it to control the ISC motor which in turn will vary the idle speed as necessary.

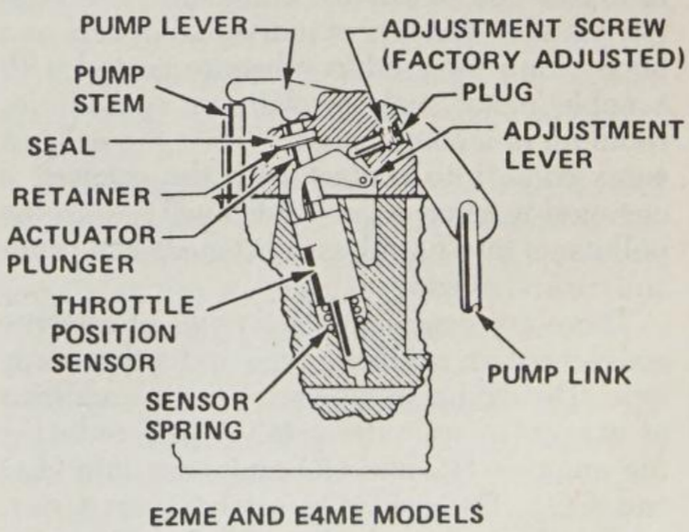
Electronic Spark Timing (EST)

All models use EST. The EST distributor, as described in an earlier chapter, contains no vacuum or centrifugal advance mechanism and uses a seven terminal HEI module. It has four wires going to a four terminal connector in addition to the connectors normally found on HEI distributors. A reference pulse, indicating engine rpm is sent to the ECM. The ECM determines the proper spark advance for the engine operating conditions and then sends an 'EST' pulse back to the distributor.

Under most normal operating conditions, the ECM will control the spark advance. However, under certain operating conditions such as cranking or when setting base timing, the distributor is capable of operating without ECM control. This condition is called BYPASS and is determined by the BYPASS lead which runs from the ECM to the distributor. When the BYPASS lead is at the proper voltage (over 2 volts), the ECM will control the spark. If the lead is grounded or open circuited, the HEI module itself will control the spark. Disconnecting the 4-terminal EST con-

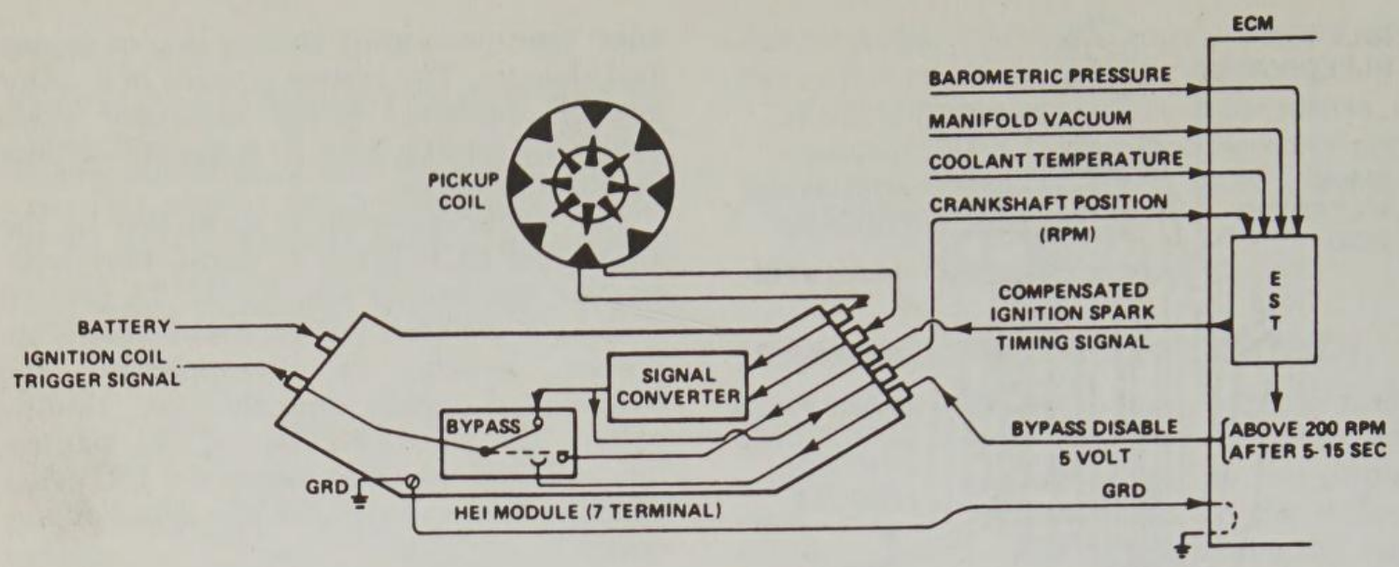


E2SE MODEL



E2ME AND E4ME MODELS

Throttle Position Sensor (TPS)



A schematic view of the EST circuitry

nector will also cause the engine to operate in the BYPASS mode.

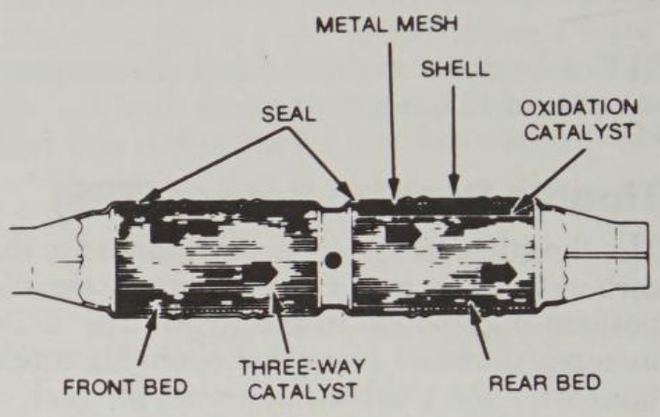
Transmission Converter Clutch (TCC)

All models with an automatic transmission use TCC. The ECM controls the converter by means of a solenoid mounted in the transmission. When the vehicle speed reaches a certain level, the ECM energizes the solenoid and allows the torque converter to mechanically couple the transmission to the engine. When the operating conditions indicate that the transmission should operate as a normal fluid coupled transmission, the ECM will de-energize the solenoid. Depressing the brake will also return the transmission to normal automatic operation.

Catalytic Converter

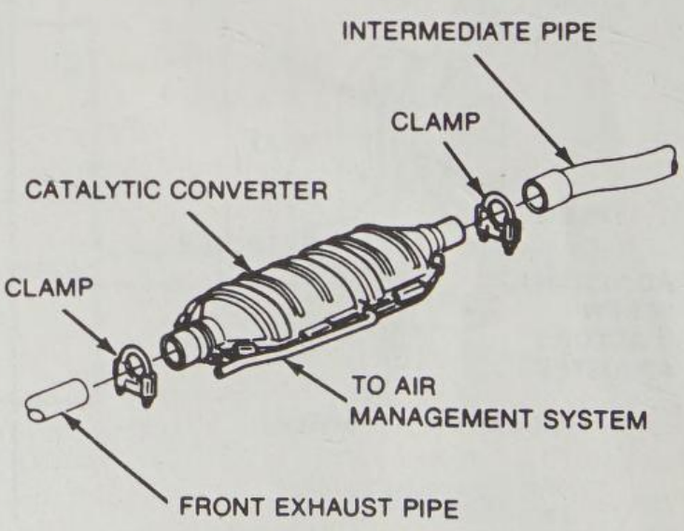
The catalytic converter is a muffler-like container built into the exhaust system to aid in the reduction of exhaust emissions. The catalyst element consists of individual pellets or a honeycomb monolithic substrate coated with a noble metal such as platinum, palladium, rhodium or a combination. When the exhaust gases come into contact with the catalyst, a chemical reaction occurs which will reduce the pollutants into harmless substances like water and carbon dioxide.

There are essentially two types of catalytic converters: an oxidizing type and a three-way type. The oxidizing type requires the addition of oxygen to spur the catalyst into reducing the engine's HC and CO emissions into H_2O and CO_2. The oxidizing catalytic converter, while effectively reducing HC and CO emissions, does little, if anything, in the way of reducing NO_x emissions. Thus, the three-way catalytic converter.



Cutaway view of the typical three-way catalytic converter

The three-way converter, unlike the oxidizing type, is capable of reducing HC, CO and NO_x emissions; all at the same time. In theory, it seems impossible to reduce all three pollutants in one system since the reduction of HC and CO requires the addition of oxygen, while the reduction of NO_x calls for the removal of oxygen. In actuality, the three-way



The catalytic converter is upstream of the muffler

system really can reduce all three pollutants, but only if the amount of oxygen in the exhaust system is precisely controlled. Due to this precise oxygen control requirement, the three-way converter system is used only in conjunction with an oxygen sensor system.

There are no service procedures required for the catalytic converter, although the converter body should be inspected occasionally for damage.

PRECAUTIONS

1. Use only unleaded fuel.
2. Avoid prolonged idling; the engine should run no longer than 20 min. at curb idle and no longer than 10 min. at fast idle.
3. Do not disconnect any of the spark plug leads while the engine is running.
4. Make engine compression checks as quickly as possible.

CATALYST TESTING

At the present time there is no known way to reliably test catalytic converter operation in the field. The only reliable test is a 12 hour and 40 min. "soak" test (CVS) which must be done in a laboratory.

An infrared HC/CO tester is not sensitive enough to measure the higher tailpipe emissions from a failing converter. Thus, a bad converter may allow enough emissions to escape so that the car is no longer in compliance with Federal or state standards, but will still not cause the needle on a tester to move off zero.

The chemical reactions which occur inside a catalytic converter generate a great deal of heat. Most converter problems can be traced to fuel or ignition system problems which cause unusually high emissions. As a result of the increased intensity of the chemical reactions, the converter literally burns itself up.

A completely failed converter might cause a tester to show a slight reading. As a result, it is occasionally possible to detect one of these.

As long as you avoid severe overheating and the use of leaded fuels it is reasonably safe to assume that the converter is working properly. If you are in doubt, take the car to a diagnostic center that has a tester.

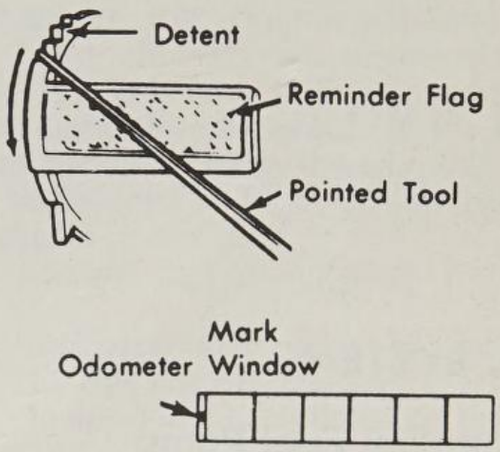
Oxygen Sensor

An oxygen sensor is used on all models. The sensor protrudes into the exhaust stream and monitors the oxygen content of the exhaust gases. The difference between the oxygen content of the exhaust gases and that of the outside air generates a voltage signal to the ECM. The ECM monitors this voltage and, depending upon the value of the signal received, issues a command to adjust for a rich or a lean condition.

No attempt should ever be made to measure the voltage output of the sensor. The current drain of any conventional voltmeter would be such that it would permanently damage the sensor. No jumpers, test leads or any other electrical connections should ever be made to the sensor. Use these tools ONLY on the ECM side of the wiring harness connector AFTER disconnecting it from the sensor.

A "sensor" flag on the instrument panel indicates when the oxygen sensor must be replaced.

NOTE: *To reset the "Emission" flag on the speedometer face, remove the instrument cluster lens. Insert a long, pointed instrument diagonally into the detents on the upper left side of the "Emission" wheel. Rotate the wheel downward until an alignment mark is visible in the left side of the odometer window.*

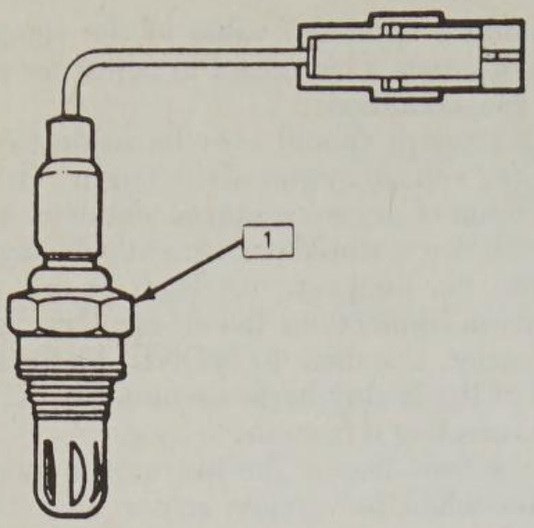


Resetting the emission odometer flag

REMOVAL AND INSTALLATION

The oxygen sensor must be replaced every 30,000 miles (48,000 km.). The sensor may be difficult to remove when the engine temperature is below 120°F (48°C). Excessive removal force may damage the threads in the exhaust manifold or pipe; follow the removal procedure carefully.

1. Locate the oxygen sensor. It protrudes from the center of the exhaust manifold at the front of the engine compartment (it looks somewhat like a spark plug).
2. Disconnect the electrical connector from the oxygen sensor.
3. Spray a commercial solvent onto the sensor threads and allow it to soak in for at least five minutes.
4. Carefully unscrew and remove the sensor.
5. To install, first coat the new sensor's



Oxygen sensor

threads with G.M. anti-seize compound No. 5613695 or the equivalent. This is *not* a conventional anti-seize paste. The use of a regular compound may electrically insulate the sensor, rendering it inoperative. You must coat the threads with an electrically conductive anti-seize compound.

6. Installation torque is 30 ft. lbs. (42 Nm.). Do not overtighten.

7. Reconnect the electrical connector. Be careful not to damage the electrical pigtail. Check the sensor boot for proper fit and installation.

FUEL SYSTEM

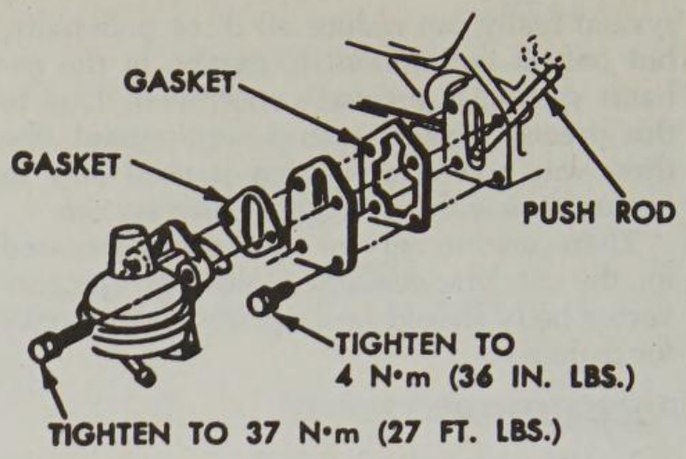
Mechanical Fuel Pump

The fuel pump is a single action AC diaphragm type. All fuel pumps used on V6 and V8 engines are of the diaphragm type and because of the design are serviced by replacement only. No adjustments or repairs are possible. The fuel pump is mounted on the right front (V6) and left front (V8) of the engine.

The fuel pumps are also equipped with vapor return lines for purposes of emission control and to reduce vapor lock. All pumps are operated by an eccentric on the camshaft. On V6 and V8 engines, a pushrod between the camshaft eccentric and the fuel pump operates the pump rocker arm.

TESTING THE FUEL PUMP

To determine if the pump is in good condition, tests for both volume and pressure should be performed. The tests are made with the pump installed, and the engine at normal operating temperature and idle speed. Never replace a fuel pump without first performing these simple tests.



V8 fuel pump

Be sure that the fuel filter has been changed at the specified interval. If in doubt, install a new filter first.

Pressure Test

1. Disconnect the fuel line at the carburetor and connect a fuel pump pressure gauge. Fill the carburetor float bowl with gasoline.

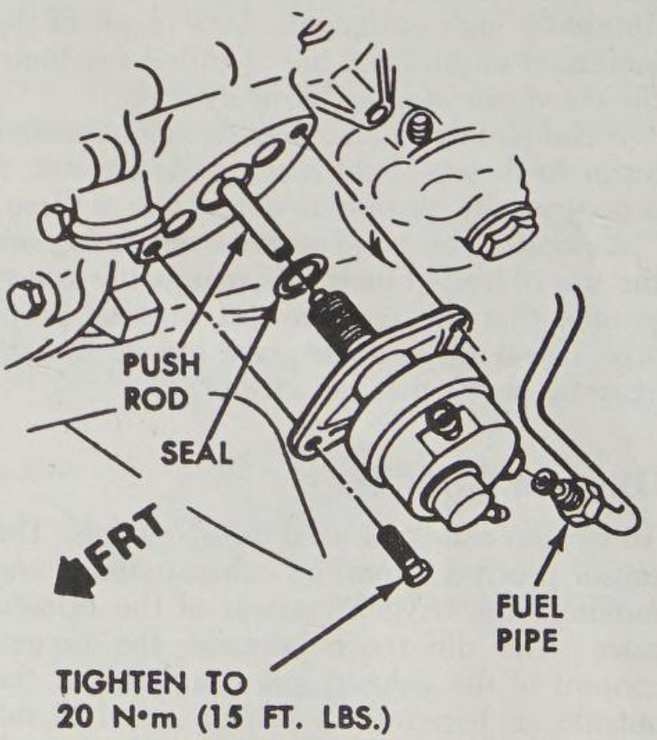
2. Start the engine and check the pressure with the engine at idle. If the pump has a vapor return hose, squeeze it off so that an accurate reading can be obtained. Pressure should be 5½–6½ psi.

3. If the pressure is incorrect, replace the pump. If it is ok, go on to the volume test.

Volume Test

1. Disconnect the pressure gauge. Run the fuel line into a graduated container.

2. Run the engine at idle until one pint of



V6 fuel pump

gasoline has been pumped. One pint should be delivered in 30 seconds or less. There is normally enough fuel in the carburetor float bowl to perform this test, but refill it if necessary.

3. If the delivery rate is below the minimum, check the lines for restrictions or leaks, then replace the pump.

REMOVAL AND INSTALLATION

NOTE: *When you connect the fuel pump outlet fitting, always use 2 wrenches to avoid damaging the pump.*

1. Disconnect the fuel intake and outlet lines at the pump and plug the pump intake line.
2. Remove the two pump mounting bolts and lockwashers; remove the pump and its gasket.
3. If the rocker arm pushrod is to be removed from V8, remove the two adapter bolts and lockwashers and remove the adapter and its gasket.
4. Install the fuel pump with a new gasket reversing the removal procedure. Coat the mating surfaces with sealer.
5. Connect the fuel lines and check for leaks.

Electric Fuel Pump (TBI)

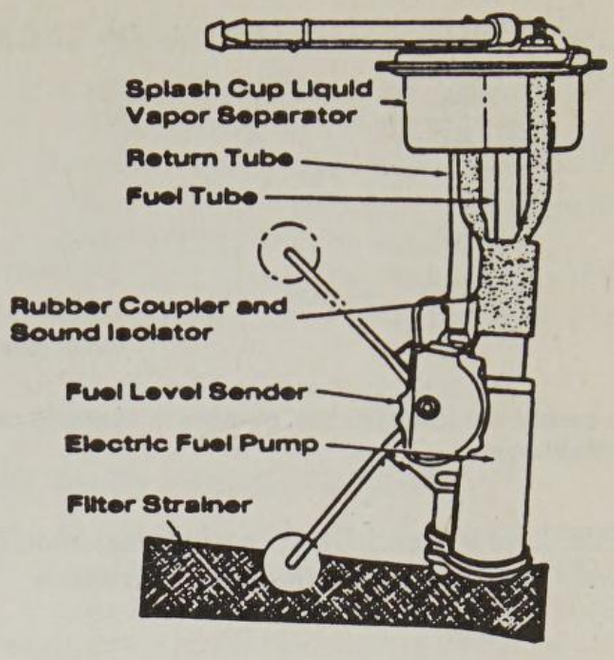
REMOVAL AND INSTALLATION

NOTE: *To reduce the risk of fire and personal injury the fuel pressure must be relieved. Perform the following steps:*

1. Remove the fuel pump fuse from the fuse block.
2. Start the engine. Allow it to run out of fuel.
3. Engage starter to make sure it is out of fuel.
4. Turn the car off. Replace the fuse.
5. Drain the fuel tank.
6. Jack up your vehicle and support it with jack stands.
7. Disconnect the exhaust system allowing it to hang over the axle assembly.
8. Remove the heat shield.
9. Remove the filler neck shield.
10. Remove the rear suspension track bar and its brace.
11. Disconnect the fuel pump/gauge connector.

NOTE: *The wiring harness on the fuel pump/gauge assembly is a permanent part of the assembly. Do not pry on the cover connector. Disconnect at body harness connector.*

12. Disconnect all fuel lines.
13. Remove the fuel pipe retaining bracket on the left side. Also remove the brake line clip from the bracket.



TBI fuel pump

14. Position a jack under the axle assembly.
15. Disconnect the lower end of the shock absorbers.
16. Lower the axle and remove the coil springs.
17. Remove the tank strap bolts.
18. Remove the tank. The rear suspension must be lowered as far as possible without damaging the brake lines.
19. Remove fuel pump/gauge from the tank.
20. Installation is the reverse of removal.

NOTE: *This procedure applies to all models. On non-TBI models delete the first four steps.*

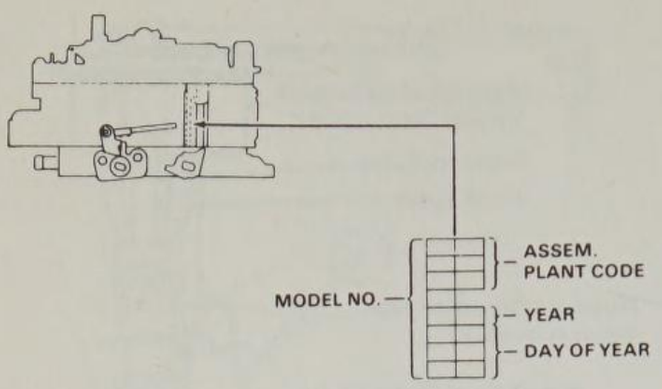
Carburetors

The V6 engine is equipped with the Rochester E2SE carburetor, V8 engines use the E4ME and E4MC. These carburetors are of the downdraft design used in conjunction with the CCC system of fuel control. They have special design features for optimum air/fuel mixture control during all ranges of engine operation.

MODEL IDENTIFICATION

General Motors Rochester carburetors are identified by their model code. The first number indicates the number of barrels, while one of the last letters indicates the type of choke used. These are V for the manifold mounted choke coil, C for the choke coil mounted in the carburetor body, and E for electric choke, also mounted on the carburetor. Model codes ending in A indicate an altitude-compensating carburetor.

NOTE: *Because of their intricate nature*



The carburetor identification number is stamped on the float bowl

E2SE, E4ME and E4MC carburetors should only be serviced by a qualified technician.

OVERHAUL

Efficient carburetion depends greatly on careful cleaning and inspection during overhaul, since dirt, gum, water, or varnish in or on the carburetor parts are often responsible for poor performance.

Overhaul your carburetor in a clean, dust-free area. Carefully dissassemble the carburetor, referring often to the exploded views and directions packaged with the rebuilding kit. Keep all similar and look-alike parts segregated during disassembly and cleaning to avoid accidental interchange during assembly. Make a note of all jet sizes.

When the carburetor is disassembled, wash all parts (except diaphragms, electric choke units, pump plunger, and any other plastic, leather, fiber, or rubber parts) in clean carburetor solvent. Do not leave parts in the solvent any longer than is necessary to sufficiently loosen the deposits. Excessive cleaning may remove the special finish from the float bowl and choke valve bodies, leaving these parts unfit for service. Rinse all parts in clean solvent and blow them dry with compressed air or allow them to air dry. Wipe clean all cork, plastic, leather, and fiber parts with a clean, lint-free cloth.

Blow out all passages and jets with compressed air and be sure that there are no restrictions or blockages. Never use wire or similar tools to clean jets, fuel passages, or air bleeds. Clean all jets and valves separately to avoid accidental interchange.

Check all parts for wear or damage. If wear or damage is found, replace the defective parts. Especially check the following:

1. Check the float needle and seat for wear. If wear is found, replace the complete assembly.
2. Check the float hinge pin for wear and the float(s) for dents or distortion. Replace the float if fuel has leaked into it.
3. Check the throttle and choke shaft bores for wear or an out-of-round condition. Damage or wear to the throttle arm, shaft, or shaft bore will often require replacement of the throttle body. These parts require a close tolerance of fit; wear may allow air leakage, which could affect starting and idling.

NOTE: *Throttle shafts and bushings are not included in overhaul kits. They can be purchased separately.*

4. Inspect the idle mixture adjusting needles for burrs or grooves. Any such condition requires replacement of the needle, since you will not be able to obtain a satisfactory idle.
5. Test the accelerator pump check valves. They should pass air one way but not the other. Test for proper seating by blowing and sucking on the valve. Replace the valve check ball and spring as necessary. If the valve is satisfactory, wash the valve parts again to remove breath moisture.
6. Check the bowl cover for warped surfaces with a straightedge.
7. Closely inspect the accelerator pump plunger for wear and damage, replacing as necessary.
8. After the carburetor is assembled, check the choke valve for freedom of operation.

Carburetor overhaul kits are recommended for each overhaul. These kits contain all gaskets and new parts to replace those which deteriorate most rapidly. Failure to replace all parts supplied with the kit (especially gaskets) can result in poor performance later.

Some carburetor manufacturers supply overhaul kits for three basic types: minor repair; major repair; and gasket kits. Basically, they contain the following:

Minor Repair Kits:
- All gaskets
- Float needle valve
- All diagrams
- Spring for the pump diaphragm

Major Repair Kits:
- All jets and gaskets
- All diaphragms
- Float needle valve
- Pump ball valve
- Float
- Complete intermediate rod
- Intermediate pump lever
- Some cover hold-down screws and washers

Gasket kits:
- All gaskets

After cleaning and checking all components, reassemble the carburetor, using new parts and referring to the exploded view. When

reassembling, make sure that all screws and jets are tight in their seats, but do not overtighten as the tips will be distorted. Tighten all screws gradually, in rotation. Do not tighten needle valves into their seats; uneven jetting will result. Always use new gaskets. Be sure to adjust the float level when reassembling.

PRELIMINARY CHECKS

The following should be observed before attempting any adjustments.

1. Thoroughly warm the engine. If the engine is cold, be sure that it reaches operating temperature.
2. Check the torque of all carburetor mounting nuts and assembly screws. Also check the intake manifold-to-cylinder head bolts. If air is leaking at any of these points, any attempts at adjustment will inevitably lead to frustration.
3. Check the manifold heat control valve (if used) to be sure that it is free.
4. Check and adjust the choke as necessary.
5. Adjust the idle speed and mixture. If the mixture screws are capped, don't adjust them unless all other causes of rough idle have been eliminated. If any adjustments are performed that might possibly change the idle speed or mixture, adjust the idle and mixture again when you are finished.

Before you make any carburetor adjustments make sure that the engine is in tune. Many problems which are thought to be carburetor-related can be traced to an engine which is simply out-of-tune. Any trouble in these areas will have symptoms like those of carburetor problems.

Rochester E2SE

REMOVAL AND INSTALLATION

1. Remove the air cleaner and gasket.
2. Disconnect the fuel tube and the vacuum lines.
3. Disconnect the electrical connectors.
4. Disconnect the accelerator linkage.
5. Disconnect the downshift cable, if equipped with an automatic transmission.
6. If equipped, disconnect the cruise control linkage.
7. Remove the carburetor attaching bolts.
8. Remove the carburetor and the EFE heater, if equipped.
9. To install, reverse the removal procedures and check the curb and fast idle.

THROTTLE LINKAGE ADJUSTMENT

No adjustment of the throttle cable can be made.

FLOAT ADJUSTMENT

1. Remove the air horn and gasket.
2. While holding the retainer in place, push the float down lightly against the needle.
3. Place a measuring gauge on the float at the farthest point from the float hinge.
4. To adjust, remove the float and bend the arm up or down. Also check the float alignment.
5. Install the air horn and gasket.

AIR VALVE SPRING ADJUSTMENT

1. If necessary, remove the intermediate choke rod to gain access to the lock screw.
2. Loosen the lock screw and turn the tension adjusting screw clockwise until the air valve opens slightly.
3. Turn the adjusting screw counterclockwise until the air valve just closes; continue turning the screw counterclockwise according to specifications.
4. Tighten the lock screw. Apply lithium grease to the spring and pin.

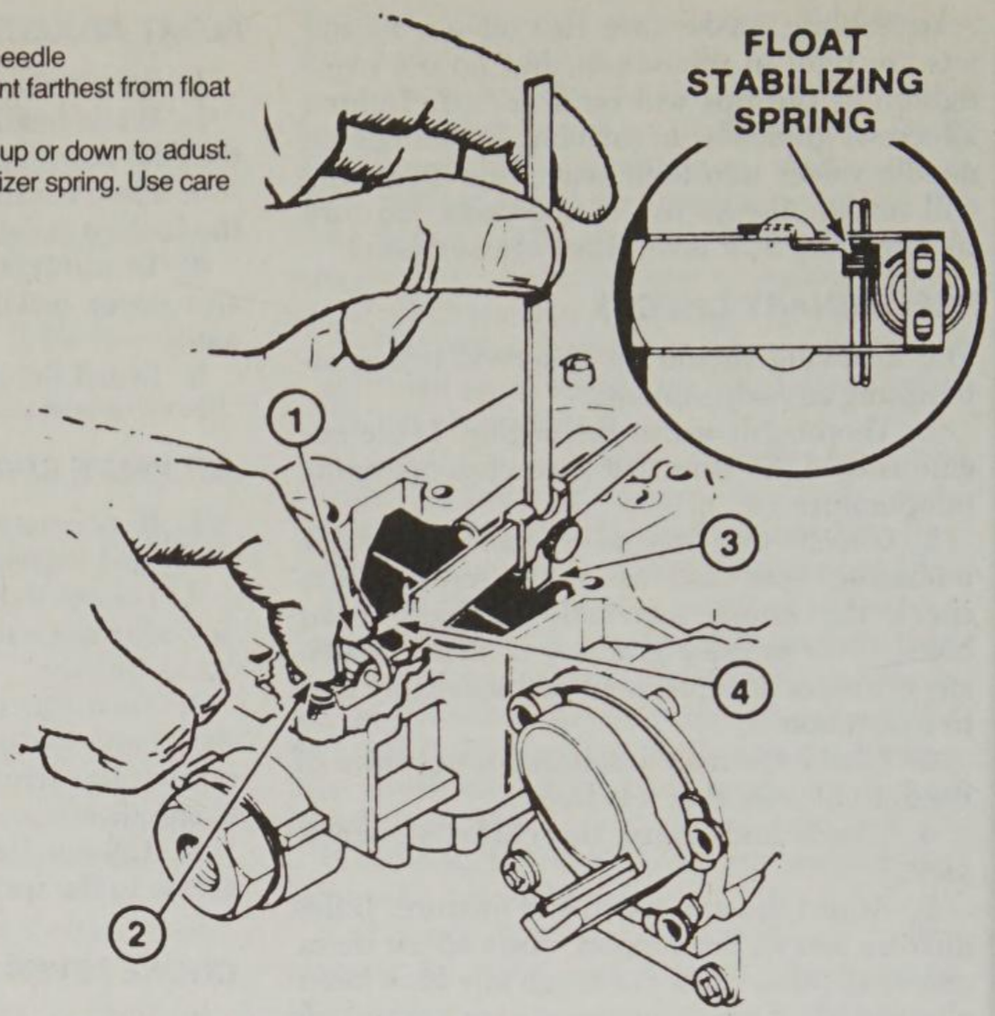
CHOKE LEVER ADJUSTMENT

1. If the choke cover is riveted, drill out the rivets and remove the choke cover with the spring assembly.
2. Place the fast idle screw on the high step of the fast idle cam. Push the intermediate choke lever until the choke valve is closed.
3. Place a .085 in. plug gauge in the choke housing hole and move the choke lever to touch the plug gauge.
4. Support the intermediate choke rod and bend it to make adjustment. Refer to the accompanying illustration to perform this adjustment.
5. To install choke cover, use pop rivets.

CHOKE ROD FAST IDLE CAM ADJUSTMENT

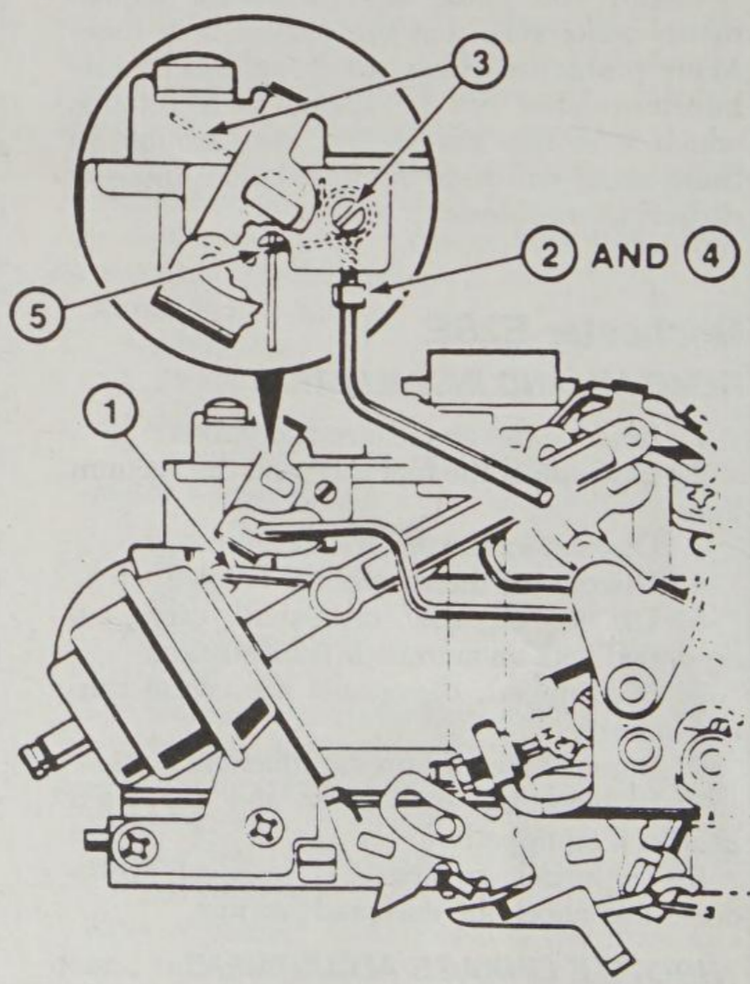
1. Attach a rubber band to the intermediate choke lever and open the throttle to allow the choke plate to close.
2. Set up the angle gauge and set the angle to specifications.
3. Place the fast idle screw on the second step of the cam, against the high step.
4. Move the choke shaft lever, to open the choke valve, make contact with the black closing tang.
5. Support the fast idle cam rod and bend the rod to make the adjustment. Adjustment is when the bubble of the angle gauge is level. Refer to the accompanying illustration to perform this adjustment.

1. Hold retainer in place
2. Push float down lightly against needle
3. Gauge at large toe of float, at point farthest from float hinge
4. Remove float and bend float arm up or down to adust. (Some models have float stabilizer spring. Use care in removing.)
5. Visually check float alignment



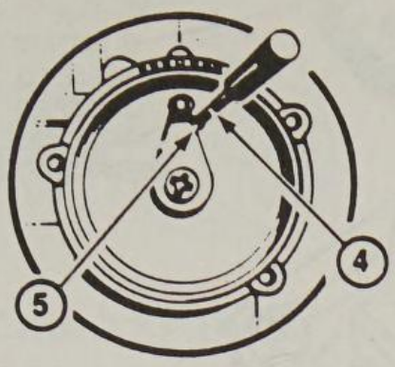
Float Level Adjustment—E2SE

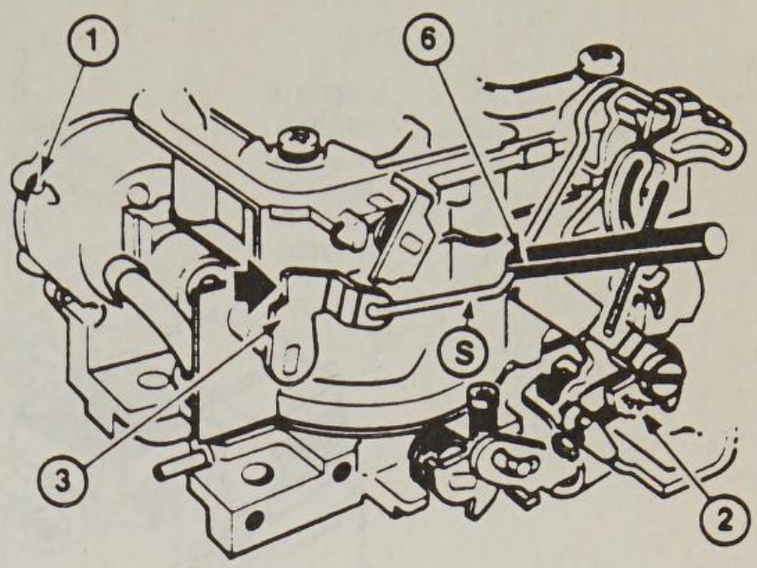
1. If necessary, remove intermediate choke rod, to gain access to lock screw
2. Loosen lock screw using 3/32" (2.381mm) hex wrench
3. Turn tension-adjusting screw clockwise until air valve opens slightly
   Turn adjusting screw counterclockwise until air valve just closes. Continue counterclockwise specified number of turns
4. Tighten lock screw
5. Apply lithium base grease to lubricate pin and spring contact area



Air Valve Spring Adjustment—E2SE

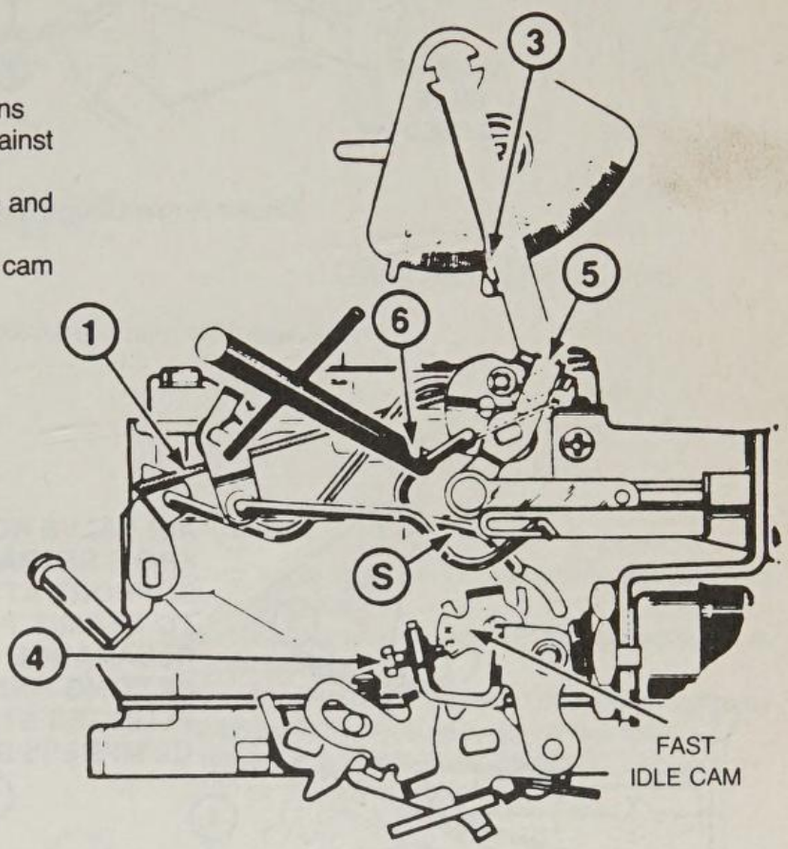
1. If riveted, drill out and remove rivets. Remove choke cover and coil assembly
2. Place fast idle screw on high step of fast idle cam
3. Push on intermediate choke lever until choke valve is closed
4. Insert .085" (2.18mm) plug gage in hole
5. Edge of lever should just contact side of gage
6. Support at "S" and bend intermediate choke rod to adjust





Choke Lever Adjustment—E2SE

1. Attach rubber band to intermediate choke lever
2. Open throttle to allow choke valve to close
3. Set up angle gage and set angle to specifications
4. Place fast idle screw on second step of cam against rise of high step
5. Push on choke shaft lever to open choke valve and to make contact with black closing tang
6. Support at "S" and adjust by bending fast idle cam rod until bubble is centered



Choke Rod Fast Idle Cam Adjustment—E2SE

PRIMARY VACUUM BREAK ADJUSTMENT

1. Connect a rubber band to the intermediate choke lever and open the throttle to allow the choke valve to close.

2. Set up the angle gauge and set the gauge to specifications.

3. Using a vacuum source, retract the vacuum break plunger. Make sure that the air valve rod does not interfere with the retraction of the vacuum break plunger.

4. Support the vacuum break rod and make the adjustment by bending the rod. Refer to the accompanying illustration to perform this adjustment.

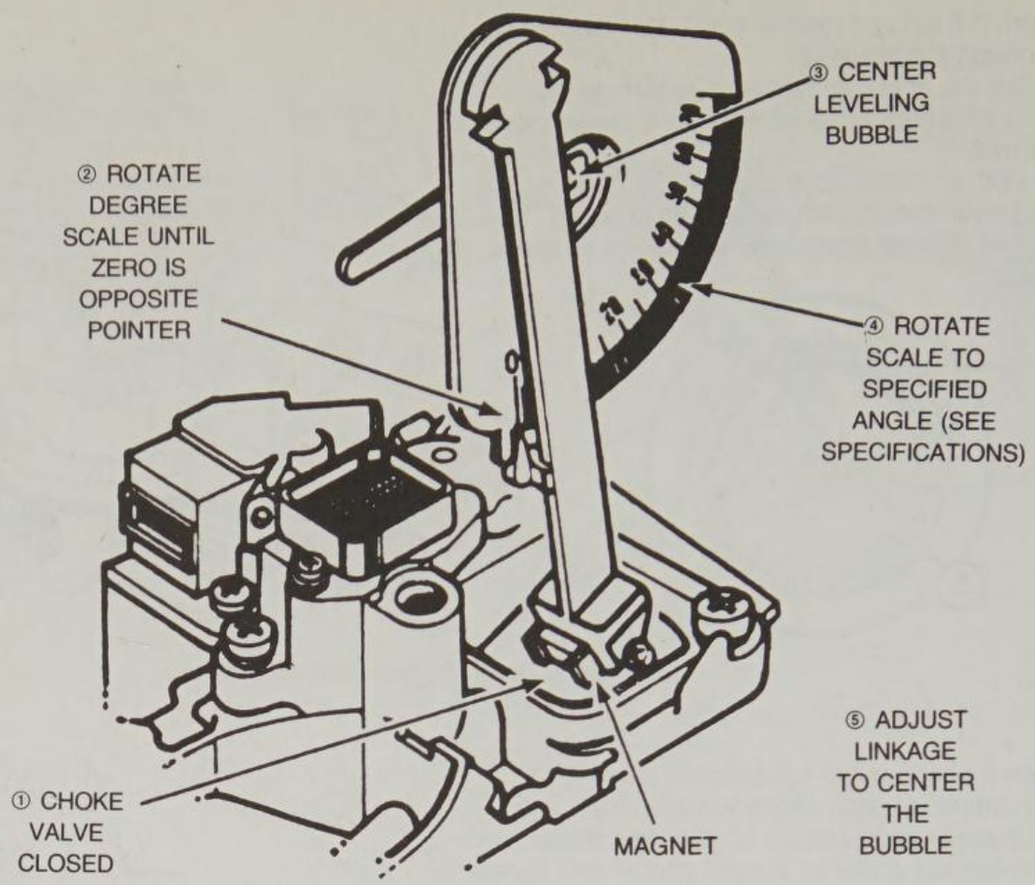
AIR VALVE ROD ADJUSTMENT

1. Set up the angle gauge on the air valve and set the angle to specification.

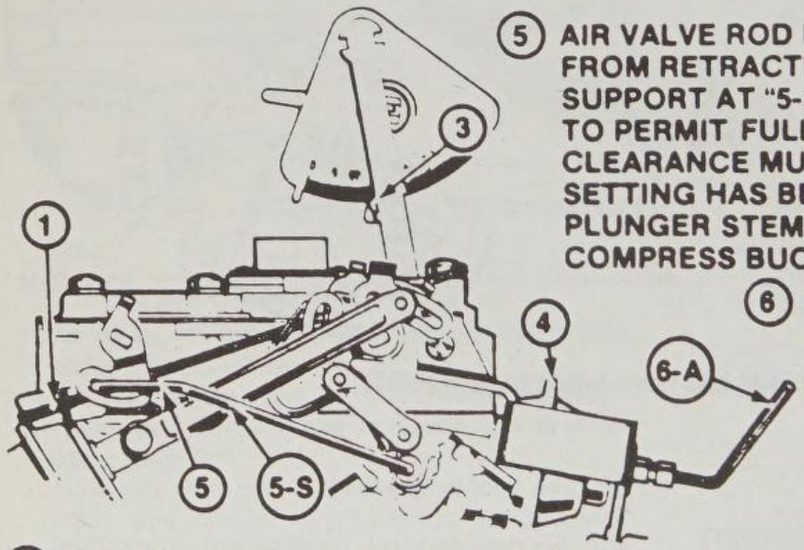
2. Use a vacuum source to seat the vacuum break plunger.

3. By applying light pressure to the air valve lever, rotate it in the opening direction.

4. Support the air valve rod and bend it to



Choke Angle Gauge Installation



(5) AIR VALVE ROD MUST NOT RESTRICT PLUNGER FROM RETRACTING FULLY. IF NECESSARY, SUPPORT AT "5-S" AND BEND ROD (SEE ARROW) TO PERMIT FULL PLUNGER TRAVEL. FINAL ROD CLEARANCE MUST BE SET AFTER VACUUM BREAK SETTING HAS BEEN MADE. WHERE APPLICABLE, PLUNGER STEM MUST BE EXTENDED FULLY TO COMPRESS BUCKING SPRING.

(6) TO CENTER BUBBLE, EITHER:

A ADJUST WITH 1/8" (3.175 mm) HEX WRENCH (VACUUM STILL APPLIED).

-OR-

B SUPPORT AT "6-S" AND BEND WIRE-FORM VACUUM BREAK ROD. (VACUUM STILL APPLIED).

(1) ATTACH RUBBER BAND TO INTERMEDIATE CHOKE LEVER.

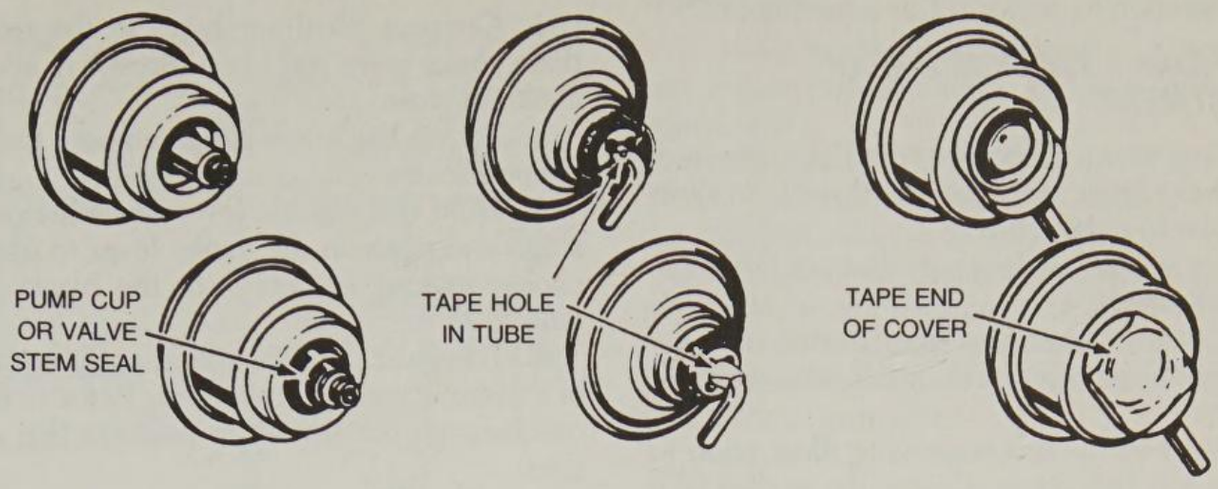
(2) OPEN THROTTLE TO ALLOW CHOKE VALVE TO CLOSE.

(3) SET UP ANGLE GAGE AND SET ANGLE TO SPECIFICATION.

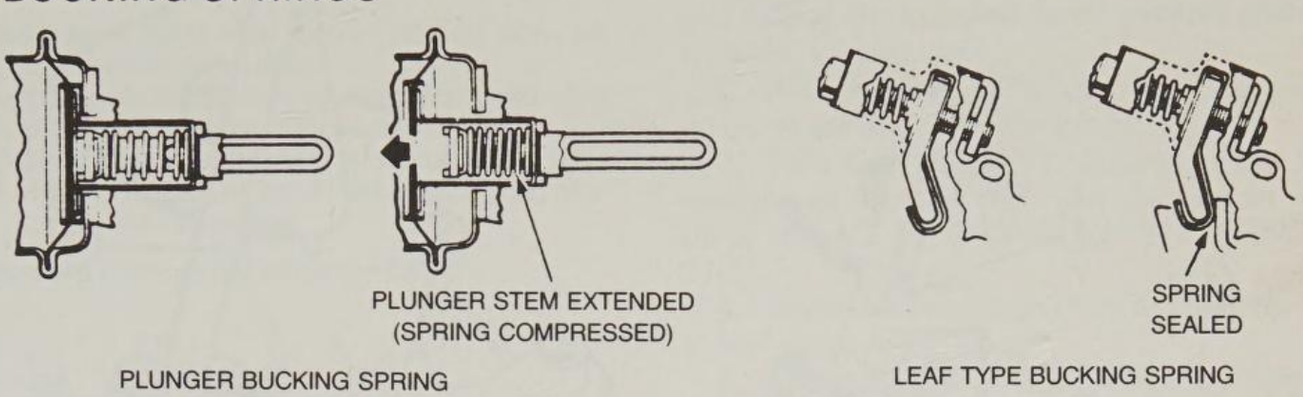
(4) RETRACT VACUUM BREAK PLUNGER USING VACUUM SOURCE, AT LEAST 18" HG. PLUG AIR BLEED HOLES WHERE APPLICABLE.

Primary Vacuum Break Adjustment—E2SE

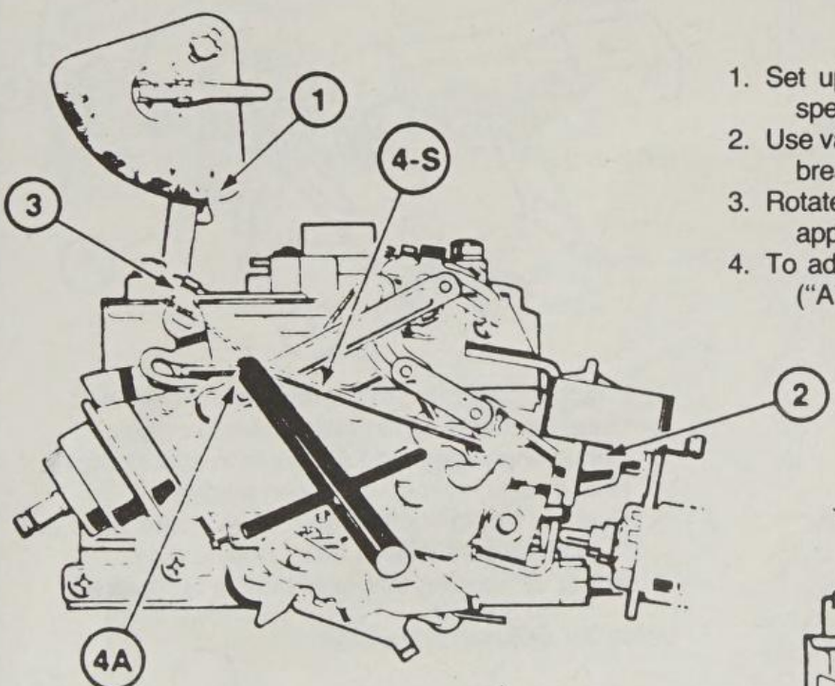
PLUGGING AIR BLEED HOLES



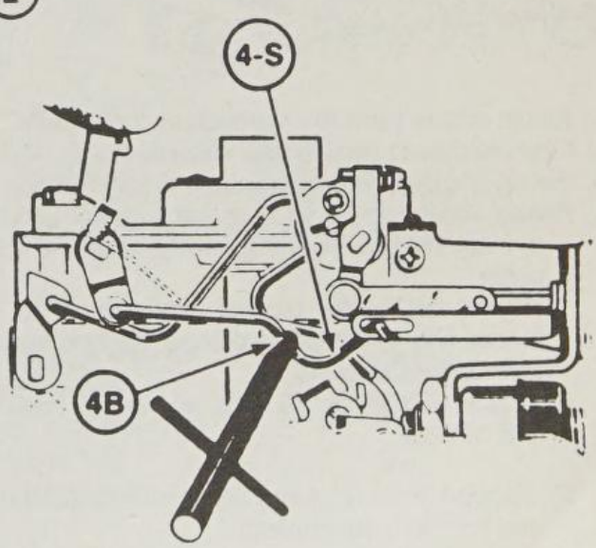
BUCKING SPRINGS



Vacuum Break Adjustment Information



1. Set up angle gage on *air valve* and set angle to specifications
2. Use vacuum source, at least 18" hg., to seat vacuum break plunger
3. Rotate air valve in the direction of open air valve by applying light pressure to air valve lever
4. To adjust, support at "4-S" and bend air valve rod ("A" or "B") until bubble is centered

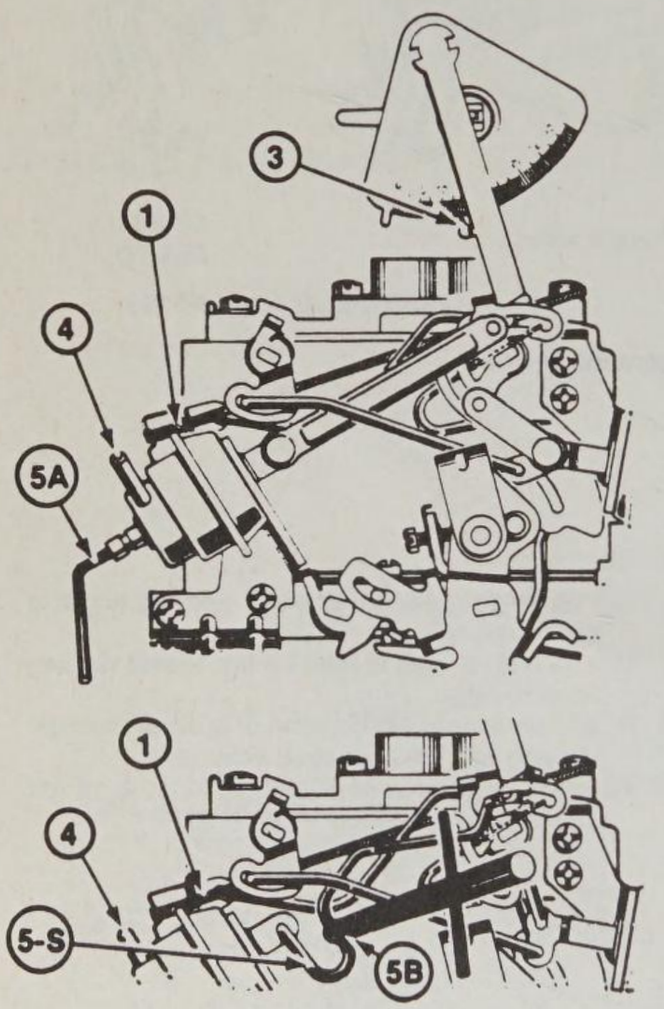


Air Valve Rod Adjustment—E2SE

make the adjustment. Refer to the accompanying illustration to perform this adjustment.

SECONDARY VACUUM BREAK ADJUSTMENT

1. Connect a rubber band to the intermediate choke lever and open the throttle to allow the choke to close.
2. Set up the angle gauge and set the angle to specifications.
3. Using a vacuum source, retract the vacuum break plunger and retain the vacuum pressure.
4. Refer to the accompanying illustration to perform this procedure. Center the angle gauge bubble by turning an ⅛ in. allen wrench or bending vacuum break rod.

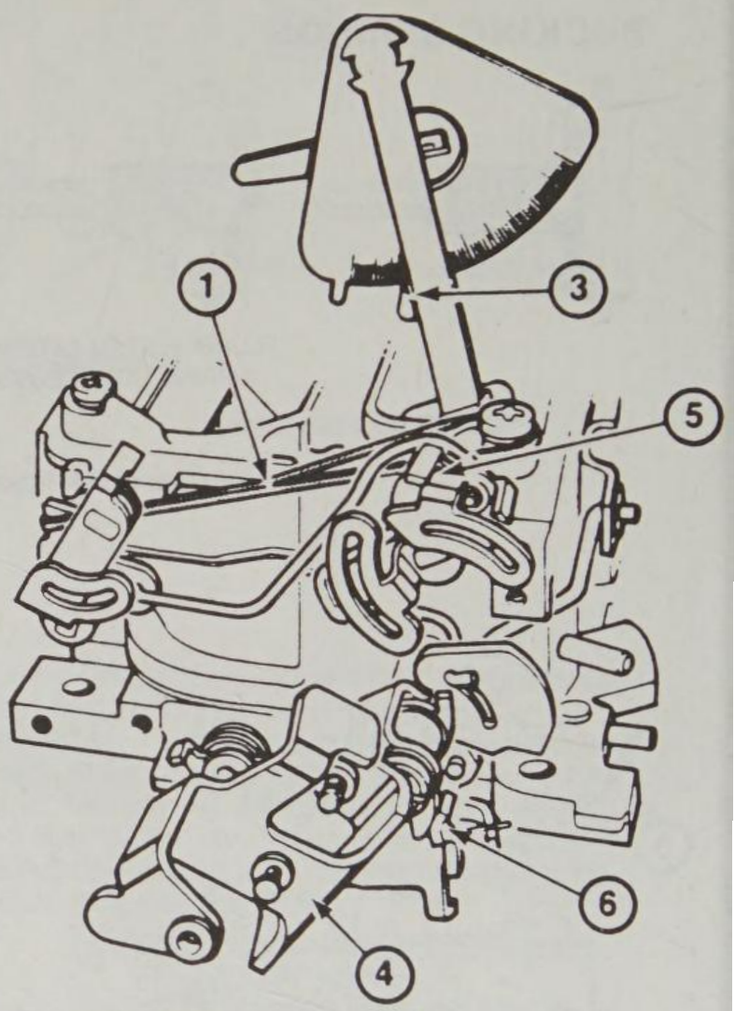


1. Attach rubber band to intermediate choke lever
2. Open throttle to allow choke valve to close
3. Set up angle gage and set angle to specification
4. Retract vacuum break plunger using vacuum source, at least 18" hg. Plug air bleed holes where applicable
   Where applicable, plunger stem must be extended fully to compress plunger bucking spring
5. To center bubble, either:
   A. Adjust with ⅛" (3.175 mm) hex wrench (vacuum still applied)
   -or
   B. Support at "5-S", bend wireform vacuum break rod (vacuum still applied)

Secondary Vacuum Break Adjustment—E2SE

UNLOADER ADJUSTMENT

1. Connect a rubber band to the intermediate choke lever and open throttle to allow the choke to close.
2. Set up the angle gauge and set the angle to specifications.
3. Hold the throttle lever in wide-open position and push on the choke lever to open the choke, making contact with the black closing tang.
4. To adjust, bend the tang until the bubble of the angle gauge is centered. Refer to the accompanying illustration to perform this procedure.

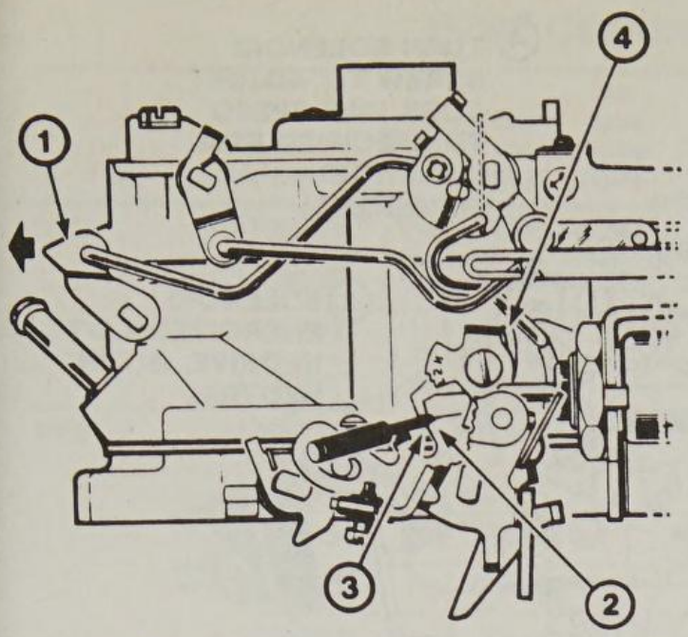


1. Attach rubber band to intermediate choke lever
2. Open throttle to allow choke valve to close
3. Set up angle gage and set angle to specifications
4. Hold throttle lever in wide open position
5. Push on choke shaft lever to open choke valve and to make contact with black closing tang
6. Adjust by bending tang until bubble is centered

Unloader Adjustment—E2SE

SECONDARY LOCKOUT ADJUSTMENT

1. Push down on the intermediate choke lever to hold the choke valve wide-open.
2. Open the throttle lever until the end of the secondary actuating lever is opposite the toe of the lockout lever.
3. Insert a .025 in. plug gauge. Refer to the



1. Hold choke valve wide open by pushing down on intermediate choke lever
2. Open throttle lever until end of secondary actuating lever is opposite toe of lockout lever
3. Gage clearance—dimension should be .025"
4. If necessary to adjust, bend lockout lever gang contacting fast idle cam

Secondary Lockout Adjustment—E2SE

accompanying illustration to perform this procedure.

4. To adjust, bend the lockout lever tang into contact with the fast idle cam.

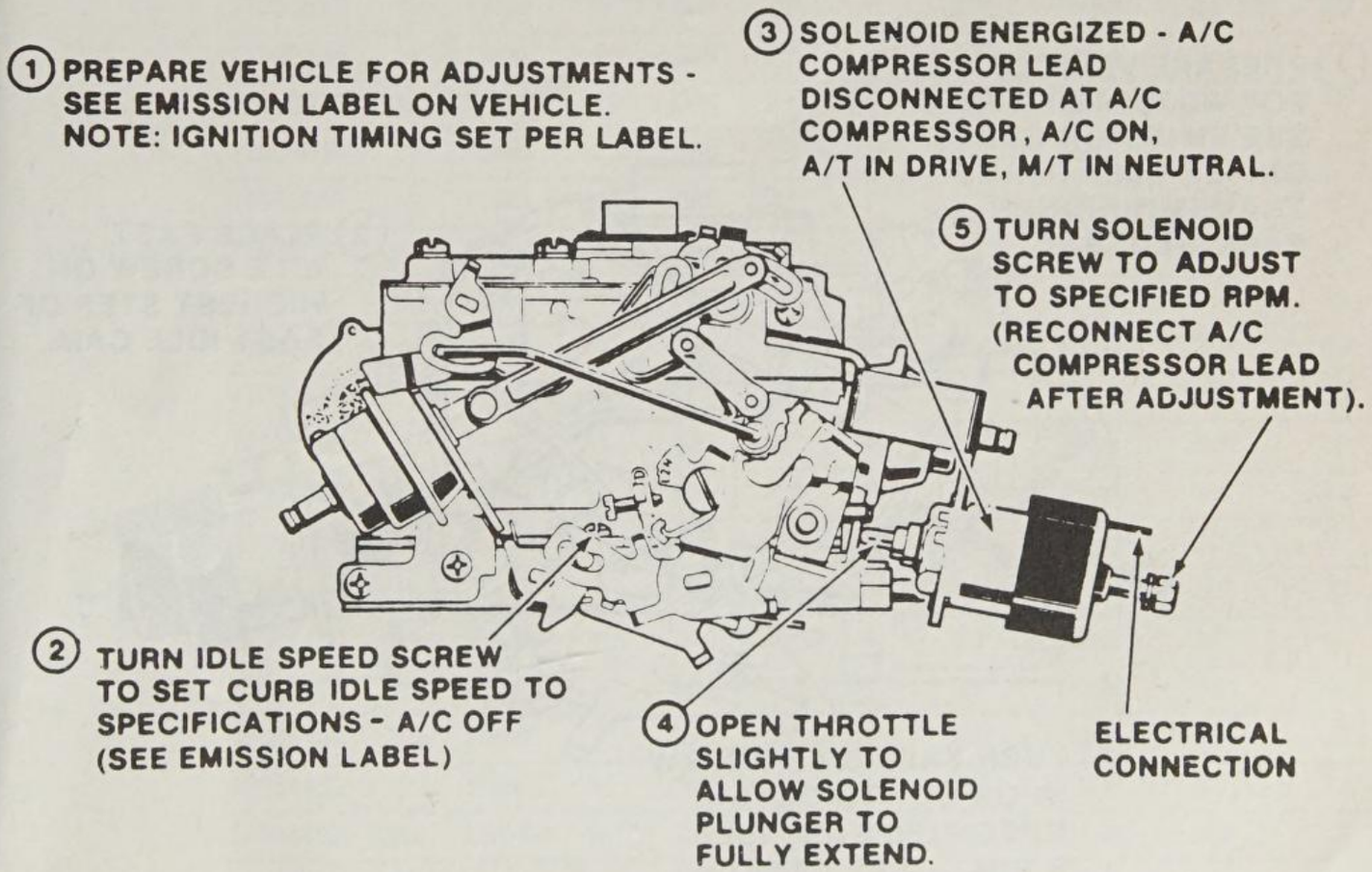
IDLE SPEED ADJUSTMENT

Without A/C

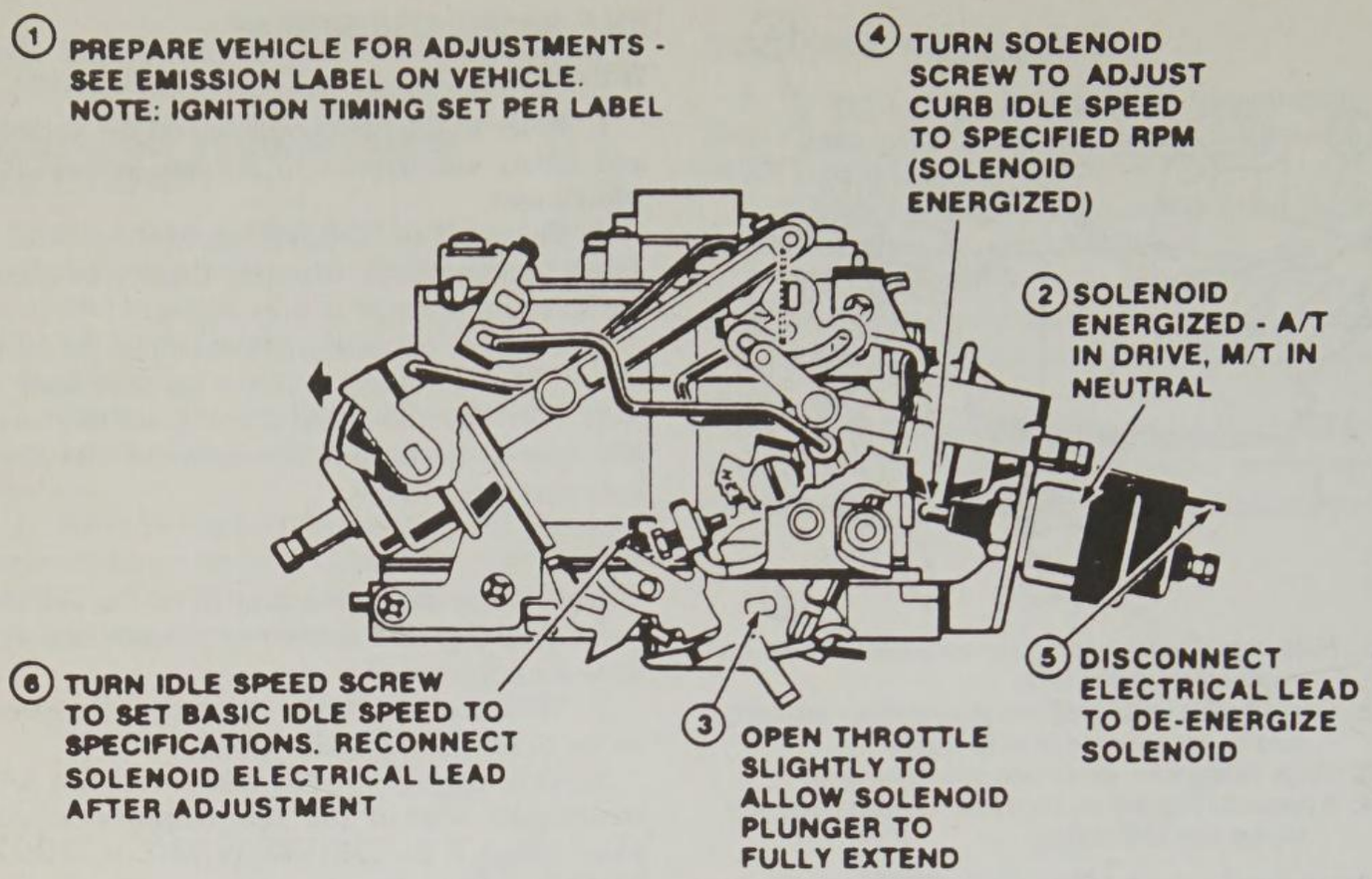
1. Refer to the emission label on the vehicle and follow instructions to prepare vehicle for adjustment.
2. Place A/T in "DRIVE" or M/T in "NEUTRAL" and turn the throttle slightly to allow the solenoid plunger to fully extend.
3. Turn the solenoid screw to adjust the curb idle RPM; then disconnect the solenoid lead.
4. Turn the idle speed screw to set the basic idle speed. Reconnect the solenoid electrical lead after adjustment.

With A/C

1. Refer to the emission label on the vehicle and follow the instructions to prepare the vehicle for adjustment.
2. With the A/C "OFF", turn the idle speed screw to set the curb idle speed.
3. Turn the A/C "ON", disconnect the A/C compressor lead at the A/C compressor and place the A/T in "DRIVE" or M/T in "NEUTRAL".
4. Open the throttle slightly to allow the solenoid plunger to extend.
5. Adjust to the specified RPM by turning the solenoid screw. After adjustment, reconnect the A/C compressor lead.
6. Turn the A/C "OFF". Set the curb idle speed by turning the idle speed screw.



Idle Speed Adjustment—without A/C—E2SE



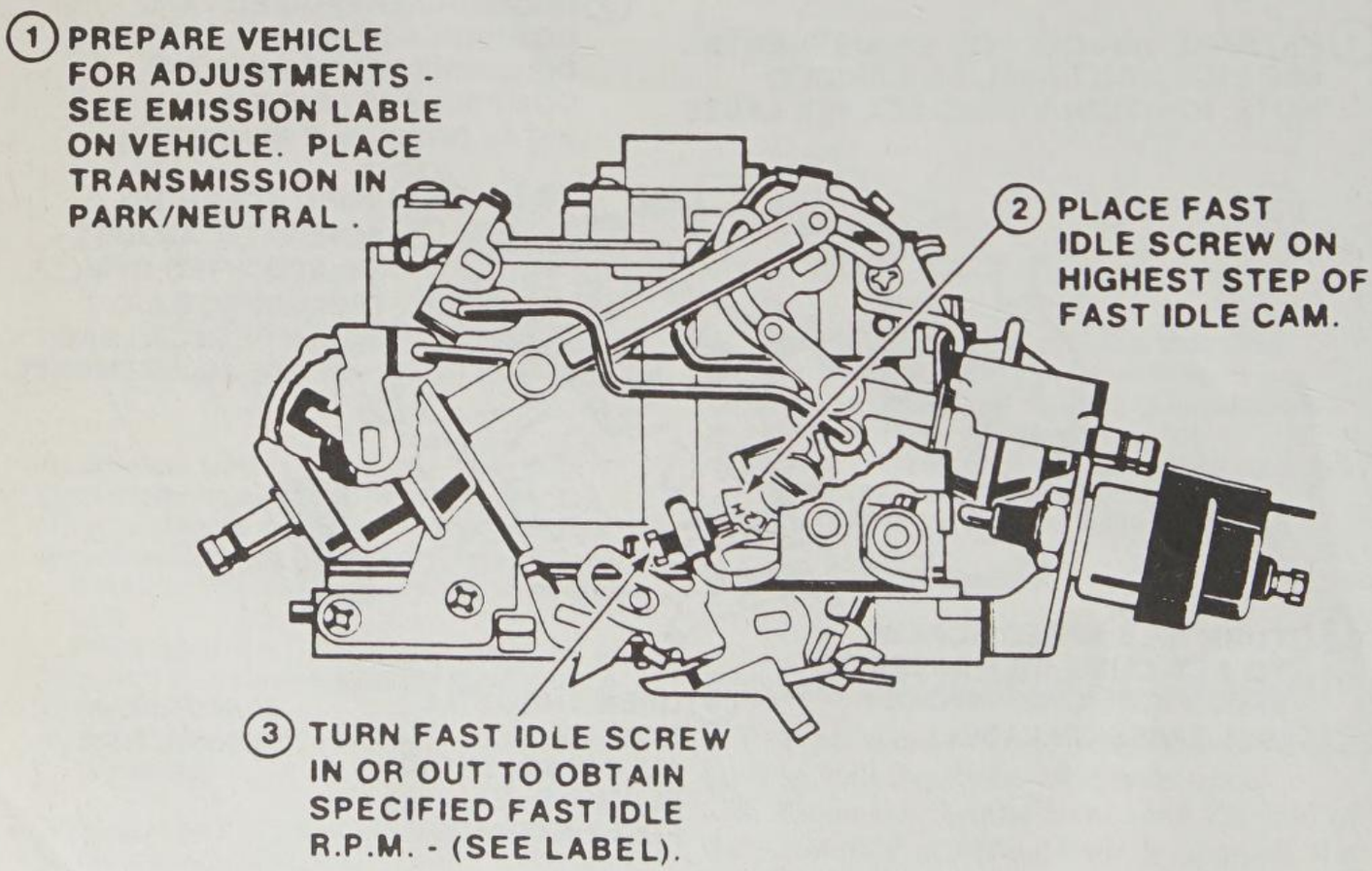
Idle Speed Adjustment—with A/C—E2SE

FAST IDLE ADJUSTMENT

1. Refer to the emission label and prepare the vehicle for adjustment.
2. Place the transmission in "PARK or DRIVE".
3. Place the fast idle screw on the highest step of the fast idle cam.
4. Turn the fast idle screw to obtain the fast idle speed.

PUMP ADJUSTMENT

E2SE carburetors have a non-adjustable pump lever. No adjustments are either necessary or possible.



Fast Idle Adjustment—E2SE

E2SE Carburetor Specifications

Year	Carburetor Identification	Float Level (in.)	Pump Rod (in.)	Air Valve Spring (Turns)	Choke Coil Level (in.)	Fast Idle Cam (deg.)	Air Valve Rod (deg.)	Primary Vacuum Break (deg.)	Choke Setting (notches)	Secondary Vacuum Break (deg.)	Choke Unloader (deg.)
1982	17082390	13/32	Fixed	1	.085	17°	1°	26°	Fixed	34°	35°
	17082391	13/32	Fixed	1	.085	25°	1°	29°	Fixed	35°	35°
	17082490	13/32	Fixed	1	.085	17°	1°	26°	Fixed	34°	35°
	17082491	13/32	Fixed	1	.085	25°	1°	29°	Fixed	35°	35°
1983	17083356	13/32	Fixed	1	.085	22°	1°	25°	Fixed	35°	30°
	17083357	13/32	Fixed	1	.085	22°	1°	25°	Fixed	35°	30°
	17083358	13/32	Fixed	1	.085	22°	1°	25°	Fixed	35°	30°
	17083359	13/32	Fixed	1	.085	22°	1°	25°	Fixed	35°	30°
	17083368	1/8	Fixed	1	.085	22°	1°	25°	Fixed	35°	30°
	17083370	1/8	Fixed	1	.085	22°	1°	25°	Fixed	35°	30°
	17083450	1/8	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083451	1/8	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083452	1/8	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083453	1/8	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083454	1/8	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083455	1/8	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083456	1/8	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083630	1/4	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083631	1/4	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083632	1/4	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083633	1/4	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083634	1/4	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083635	1/4	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083636	1/4	Fixed	1	.085	28°	1°	27°	Fixed	35°	45°
	17083650	1/8	Fixed	1/2	.085	28°	1°	27°	Fixed	35°	45°
1984 & Later	17072683	9/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17074812	9/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084356	9/32	Fixed	3/4	.085	22°	1°	25°	Fixed	30°	30°
	17084357	9/32	Fixed	3/4	.085	22°	1°	25°	Fixed	30°	30°
	17084358	9/32	Fixed	3/4	.085	22°	1°	25°	Fixed	30°	30°
	17084359	9/32	Fixed	3/4	.085	22°	1°	25°	Fixed	30°	30°
	17084368	1/8	Fixed	3/4	.085	22°	1°	25°	Fixed	30°	30°
	17084370	1/8	Fixed	3/4	.085	22°	1°	25°	Fixed	30°	30°
	17084430	11/32	Fixed	1	.085	15°	1°	26°	Fixed	38°	42°
	17084431	11/32	Fixed	1	.085	15°	1°	26°	Fixed	38°	42°
	17084434	11/32	Fixed	1	.085	15°	1°	26°	Fixed	38°	42°
	17084435	11/32	Fixed	1	.085	15°	1°	26°	Fixed	38°	42°
	17084452	5/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084453	5/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°

E2SE Carburetor Specifications (cont.)

Year	Carburetor Identification	Float Level (in.)	Pump Rod (in.)	Air Valve Spring (Turns)	Choke Coil Level (in.)	Fast Idle Cam (deg.)	Air Valve Rod (deg.)	Primary Vacuum Break (deg.)	Choke Setting (notches)	Secondary Vacuum Break (deg.)	Choke Unloader (deg.)
1984 & Later	17084455	5/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084456	5/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084458	5/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084532	5/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084534	5/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084535	5/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084537	5/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084538	5/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084540	5/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084542	1/8	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084632	9/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084633	9/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084635	9/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°
	17084636	9/32	Fixed	1/2	.085	28°	1°	25°	Fixed	35°	45°

Rochester E4ME and E4MC

REMOVAL AND INSTALLATION

1. Disconnect the battery and remove the air cleaner.
2. Disconnect the accelerator linkage.
3. Disconnect the transmission detent cable.
4. If equipped, remove the cruise control.
5. Disconnect all of the necessary vacuum lines.
6. Disconnect the fuel line at the carburetor inlet.
7. Remove the attaching bolts and remove the carburetor.
8. To install, reverse the removal procedures.

THROTTLE LINKAGE ADJUSTMENT

Due to the design of the throttle cable for the carburetor and TBI systems, no adjustments of the throttle linkage can be made.

FLOAT LEVEL ADJUSTMENT

1. Remove the air horn and gasket from the float bowl. Hold the float retainer down firmly. Push the float down (lightly) against the needle.
2. Position a "T" scale over the toe of the float (3/16 in. from the end of the float toe).
3. If the float level varies more than 1/16 in. from the specified setting, it must be reset.

Float Level Too High

1. Hold the float retainer in place.
2. Push down on the center of the float until the correct level is obtained.

Float Level Too Low

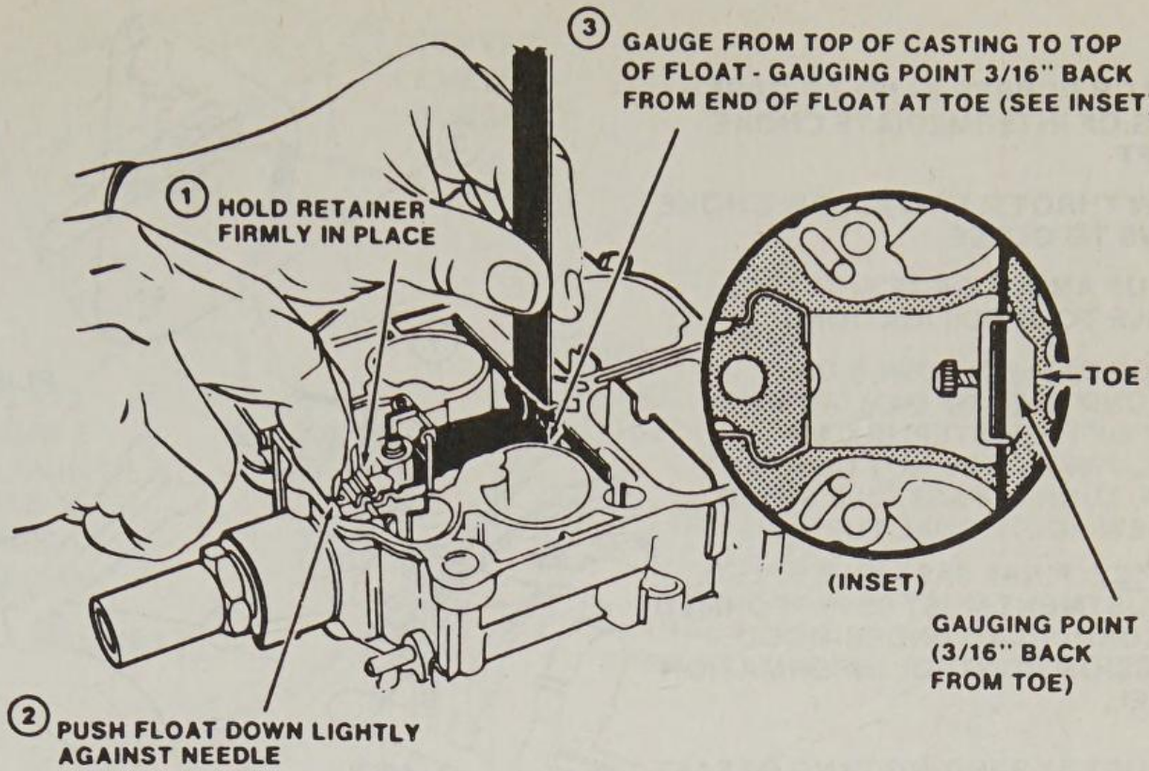
1. Lift out the metering rods and remove the solenoid connector screws.
2. Turn the lean mixture solenoid screw clockwise, counting and recording the number of turns required to seat the screw in the float bowl.
3. Turn the screw counterclockwise and remove it. Lift the solenoid and the connector from the float bowl.
4. Remove the float and bend the arm up to adjust. The float must be correctly aligned after adjustment.
5. To install the components, reverse the order of removal. Back out the solenoid mixture screw the number of turns that were recorded in step 2.

PUMP ADJUSTMENT

E4ME and E4MC carburetors have a non-adjustable pump lever. No adjustments are necessary or possible.

CHOKE LEVER ADJUSTMENT

1. If the choke cover plate is riveted, drill out the rivets and remove the plate assembly.



IF FLOAT LEVEL VARIES OVER ± 1/16" FROM SPECIFICATIONS,
FOR LEVEL TOO HIGH, HOLD RETAINER IN PLACE AND PUSH DOWN ON CENTER OF FLOAT PONTOON TO OBTAIN CORRECT SETTING.
FOR LEVEL TOO LOW,
IF E4M REMOVE METERING RODS, SOLENOID CONNECTOR SCREW. COUNT, AND RECORD FOR REASSEMBLY, THE NUMBER OF TURNS NEEDED TO LIGHTLY BOTTOM LEAN MIXTURE SCREW. BACK OUT AND REMOVE SCREW, SOLENOID, CONNECTOR. REMOVE FLOAT AND FLOAT ARM UPWARD TO ADJUST. REINSTALL PARTS, RESET LEAN MIXTURE SCREW. VISUALLY CHECK FLOAT ALIGNMENT.

Float Level Adjustment—E4ME/E4MC

2. Place the fast idle cam follower on the high step of the fast idle cam.

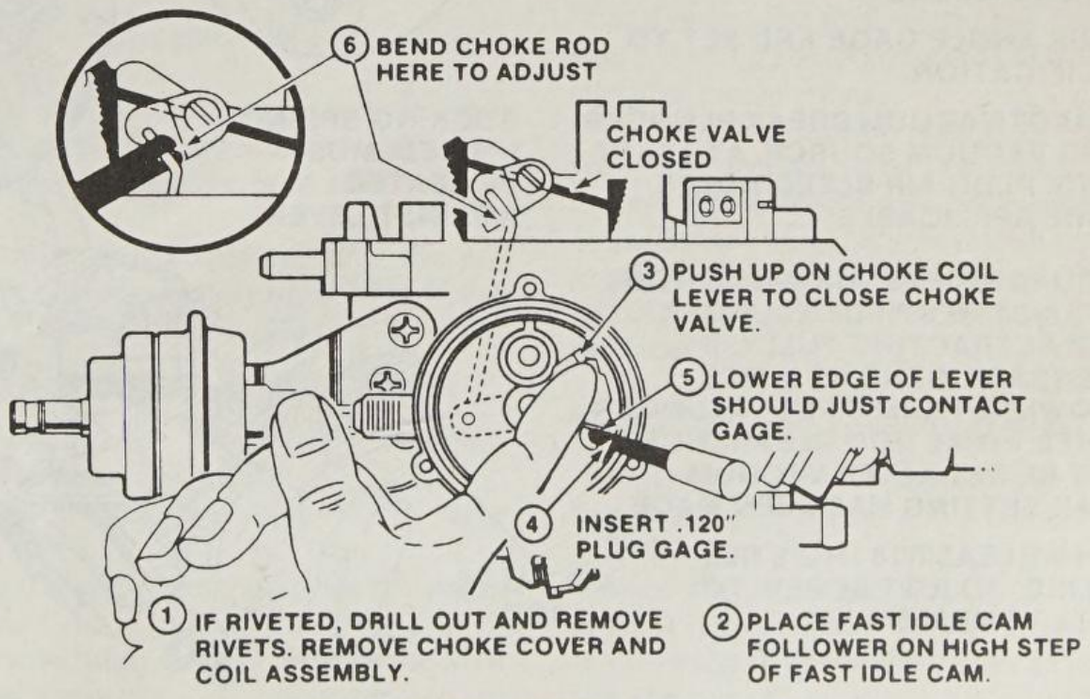
3. Lift up on the choke lever to close the choke valve and insert a .120 in. plug gauge into the choke housing hole. The choke lever should just touch the gauge.

4. To adjust, bend the choke rod. Refer to the accompanying illustration when performing this adjustment.

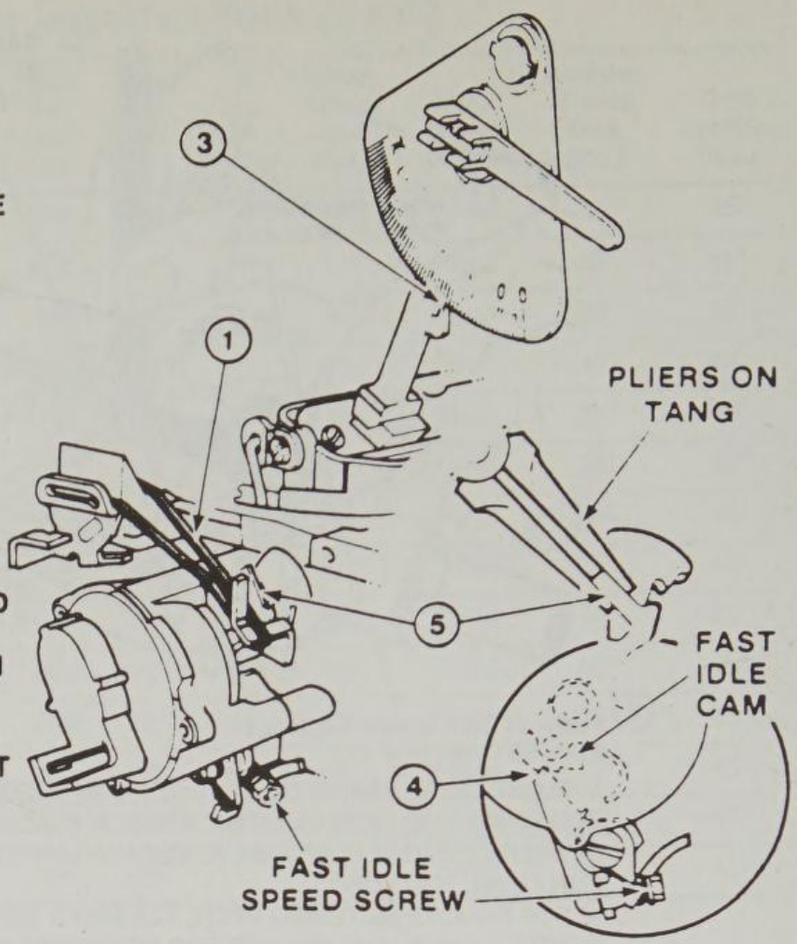
5. To replace the cover plate, rivet in place.

CHOKE ROD—FAST IDLE CAM ADJUSTMENT

1. Connect a rubber band to the green tang of the intermediate choke shaft.

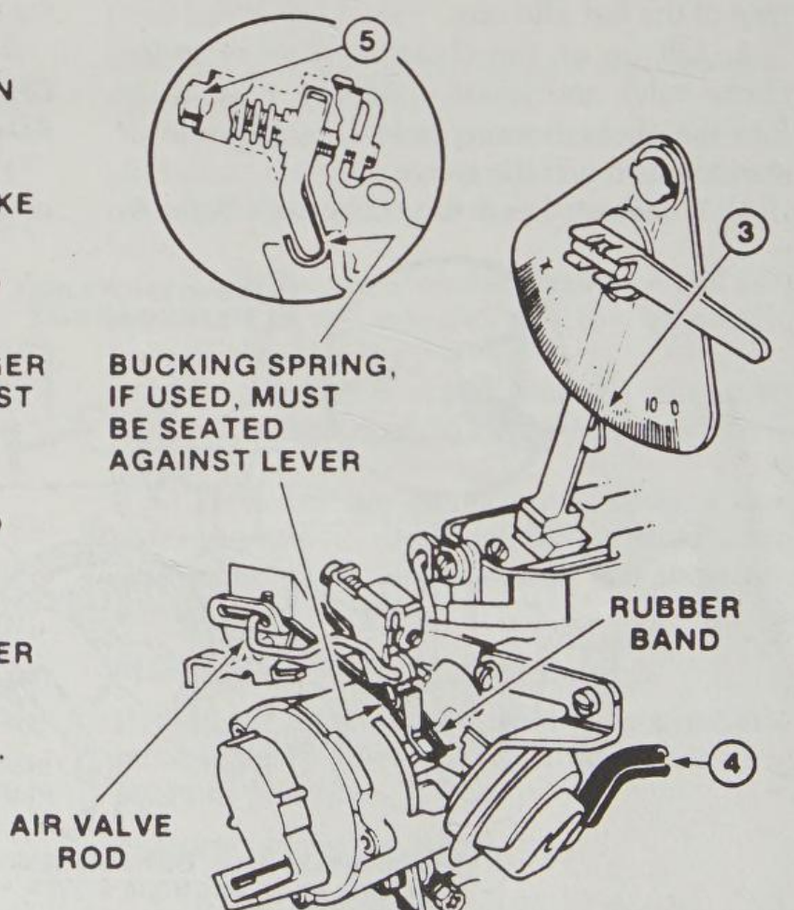


Choke Lever Adjustment—E4ME/E4MC

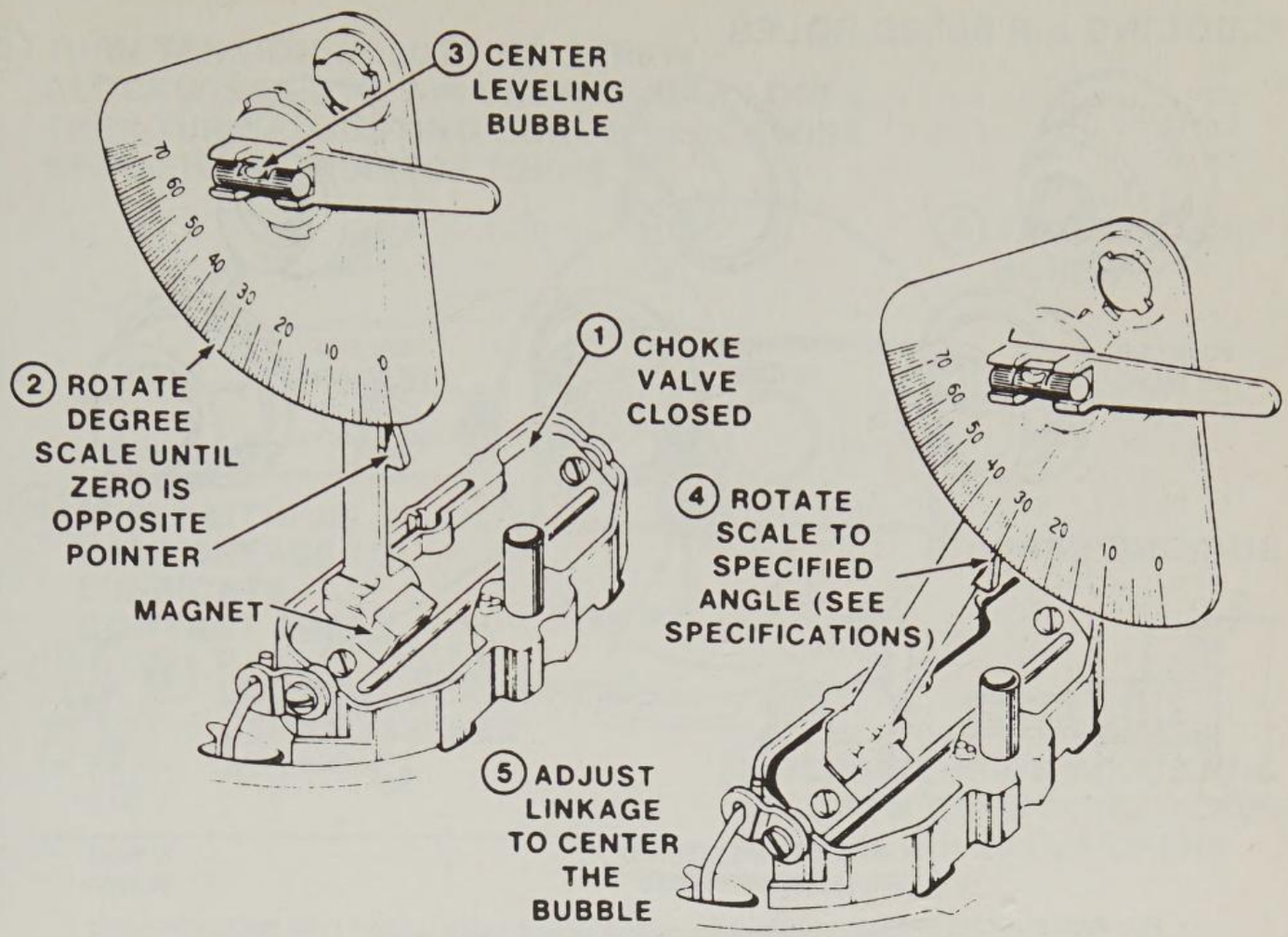


Choke Rod—Fast Idle Cam Adjustment—E4ME/E4MC

2. Open the throttle to allow the choke valve to close.
3. Set up the angle gauge and set the angle to specifications.
4. Place the cam follower on the second step of the fast idle cam, against the rise of the first step. If the cam follower does not contact the cam, turn the fast idle screw additional turns.
5. To adjust, bend the tang of the fast idle cam until the gauge bubble is centered.



Front Vacuum Break Adjustment—E4ME/E4MC



Choke Valve Angle Gauge

NOTE: *The final fast idle speed adjustment must be performed according to the emission control label.*

6. Refer to the accompanying illustration to perform the adjustment.

FRONT VACUUM BREAK ADJUSTMENT

1. Connect a rubber band to the green tang of the intermediate choke shaft.
2. Open the throttle to allow the choke valve to close.
3. Set up the angle gauge and set to specifications.
4. Using a vacuum source, retract the vacuum break plunger. The air valve rod must not restrict the breaker plunger from fully retracting.
5. With the vacuum applied, turn the adjusting screw until the centering bubble of the angle gauge is level.

REAR VACUUM BREAK ADJUSTMENT

1. Connect a rubber band to the green tang of the intermediate choke shaft.
2. Open the throttle to allow the choke valve to close.
3. Set up the angle gauge and set the angle to specification.
4. Using a vacuum source, retract the vacuum break plunger.

NOTE: *The air valve rod must not restrict the vacuum break plunger from fully retracting.*

5. With the vacuum applied, turn the adjusting screw or bend the vacuum break rod until the bubble of the angle gauge is centered. Refer to the accompanying illustration to perform this adjustment.

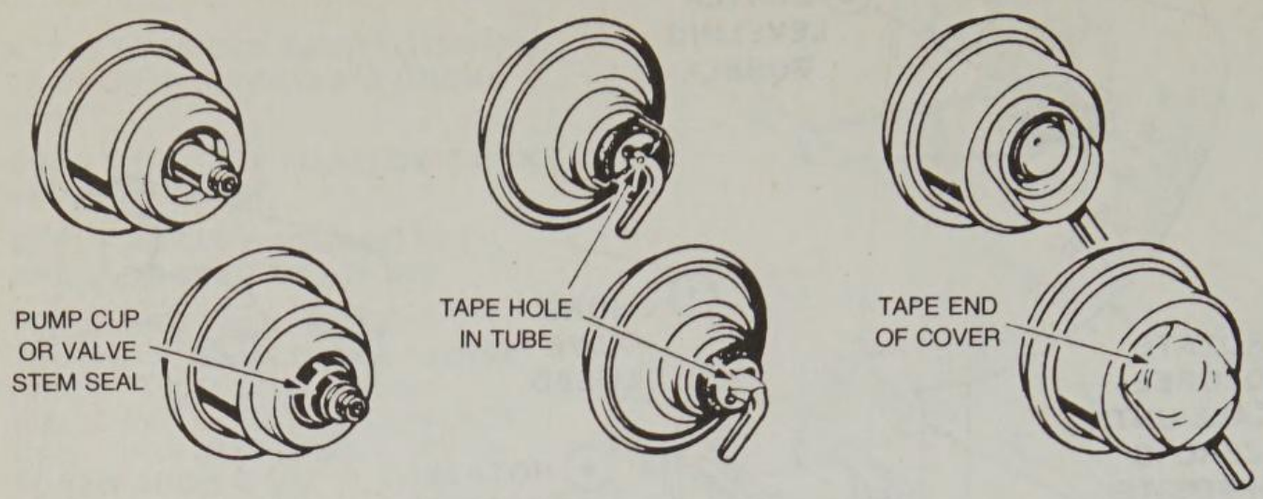
AIR VALVE SPRING ADJUSTMENT

1. Loosen the lock screw and turn the tension adjusting screw counterclockwise until the air valve partly opens.
2. Turn the tension adjusting screw clockwise until the air valve just closes, then turn the screw clockwise a specified number of turns.
3. Tighten the lock screw and apply lithium grease to the spring contact area. Refer to the accompanying illustration to perform this adjustment.

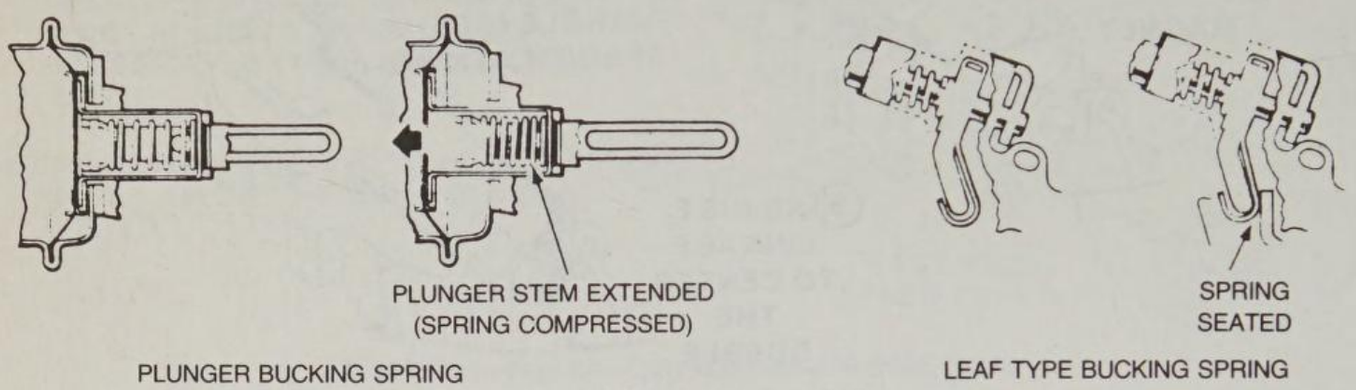
FRONT AIR VALVE ROD ADJUSTMENT

1. Using a vacuum source, seat the vacuum break plunger. The air valve must be closed.
2. Insert a .025 in. plug gauge between the rod and the end of the slot.
3. To adjust, bend the air valve rod. Refer to the accompanying illustration to perform this adjustment.

PLUGGING AIR BLEED HOLES



BUCKING SPRINGS



Vacuum Break Information (Adjustment)

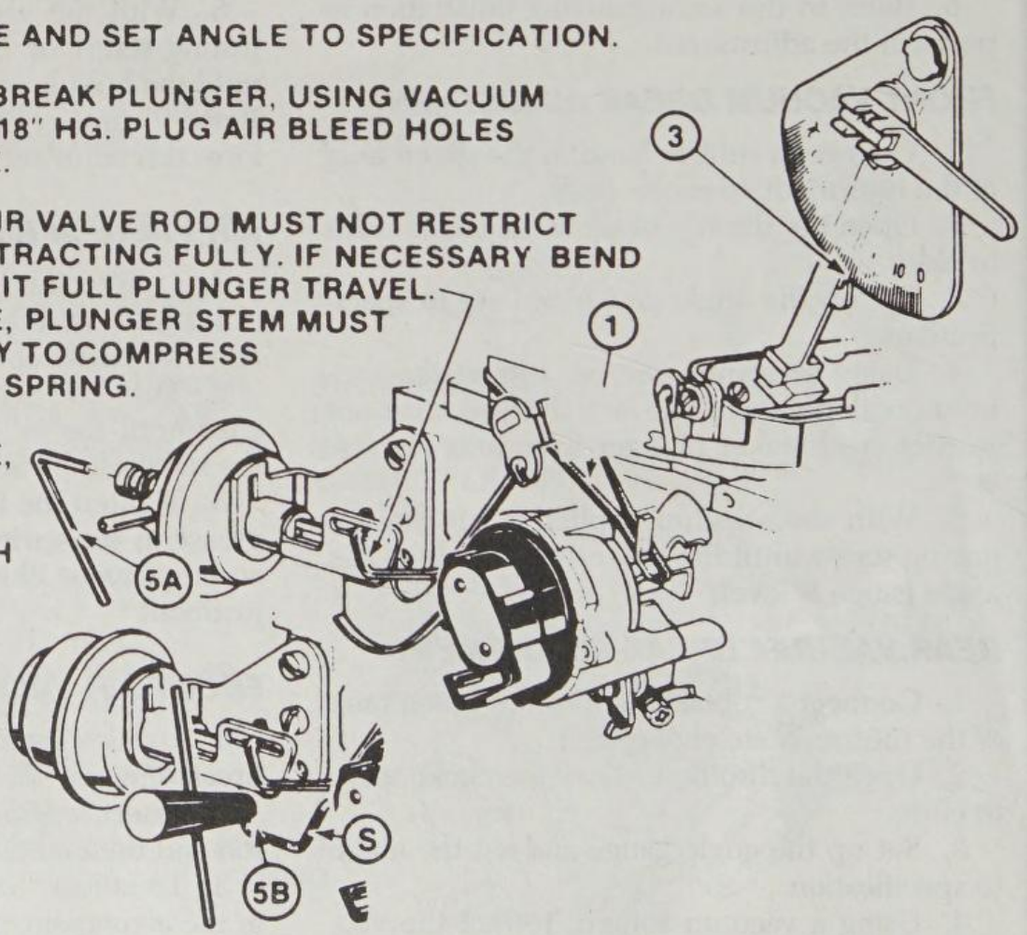
1. ATTACH RUBBER BAND TO GREEN TANG OF INTERMEDIATE CHOKE SHAFT.
2. OPEN THROTTLE TO ALLOW CHOKE VALVE TO CLOSE.
3. SET UP ANGLE GAGE AND SET ANGLE TO SPECIFICATION.
4. RETRACT VACUUM BREAK PLUNGER, USING VACUUM SOURCE. AT LEAST 18" HG. PLUG AIR BLEED HOLES WHERE APPLICABLE.

4A. ON QUADRAJETS, AIR VALVE ROD MUST NOT RESTRICT PLUNGER FROM RETRACTING FULLY. IF NECESSARY BEND ROD HERE TO PERMIT FULL PLUNGER TRAVEL. WHERE APPLICABLE, PLUNGER STEM MUST BE EXTENDED FULLY TO COMPRESS PLUNGER BUCKING SPRING.

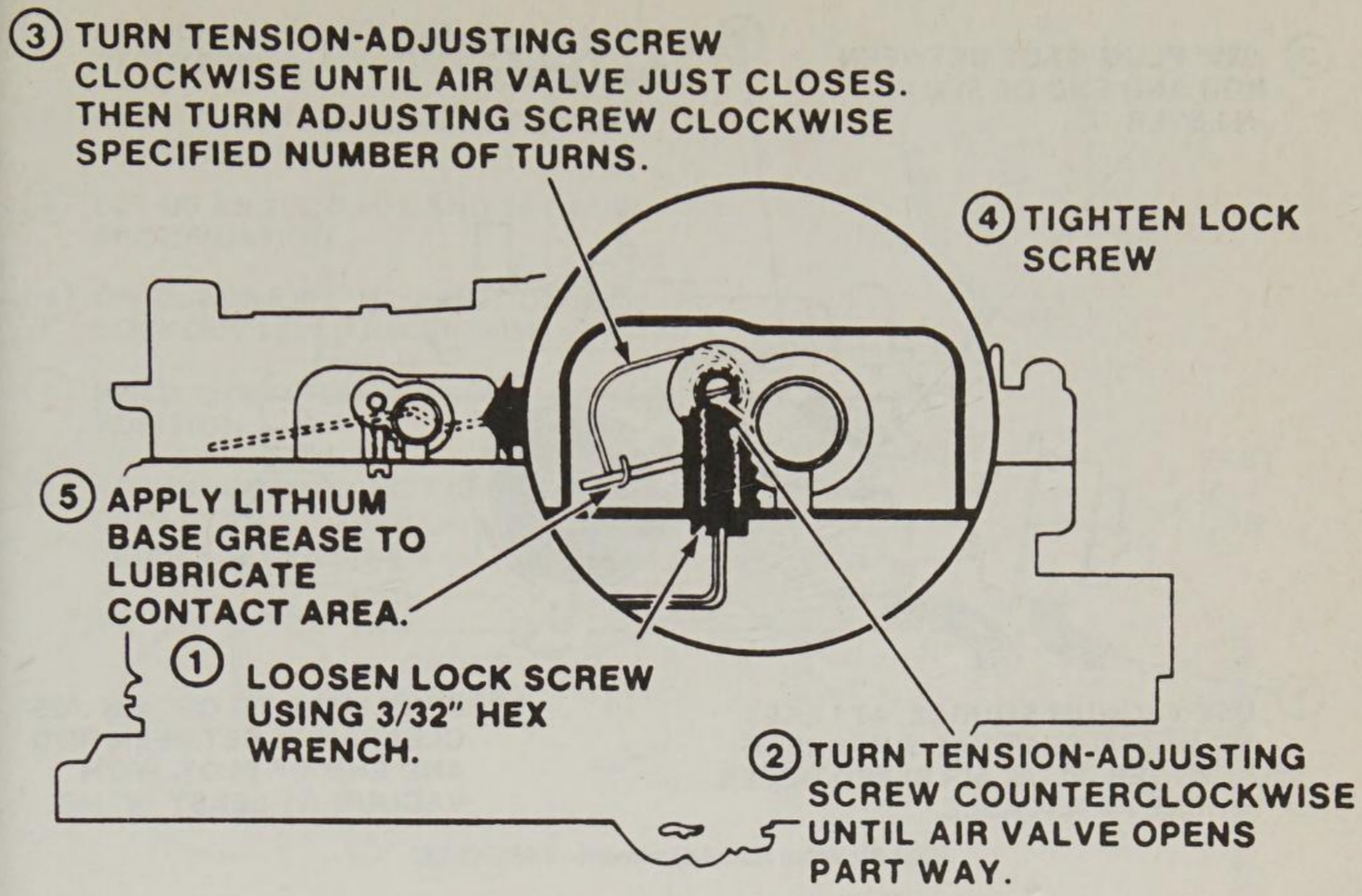
5. TO CENTER BUBBLE, EITHER:
   A. ADJUST WITH 1/8" HEX WRENCH (VACUUM STILL APPLIED)

   -OR-

   B. SUPPORT AT "S" AND BEND VACUUM BREAK ROD (VACUUM STILL APPLIED)



Rear Vacuum Break Adjustment—E4ME/E4MC



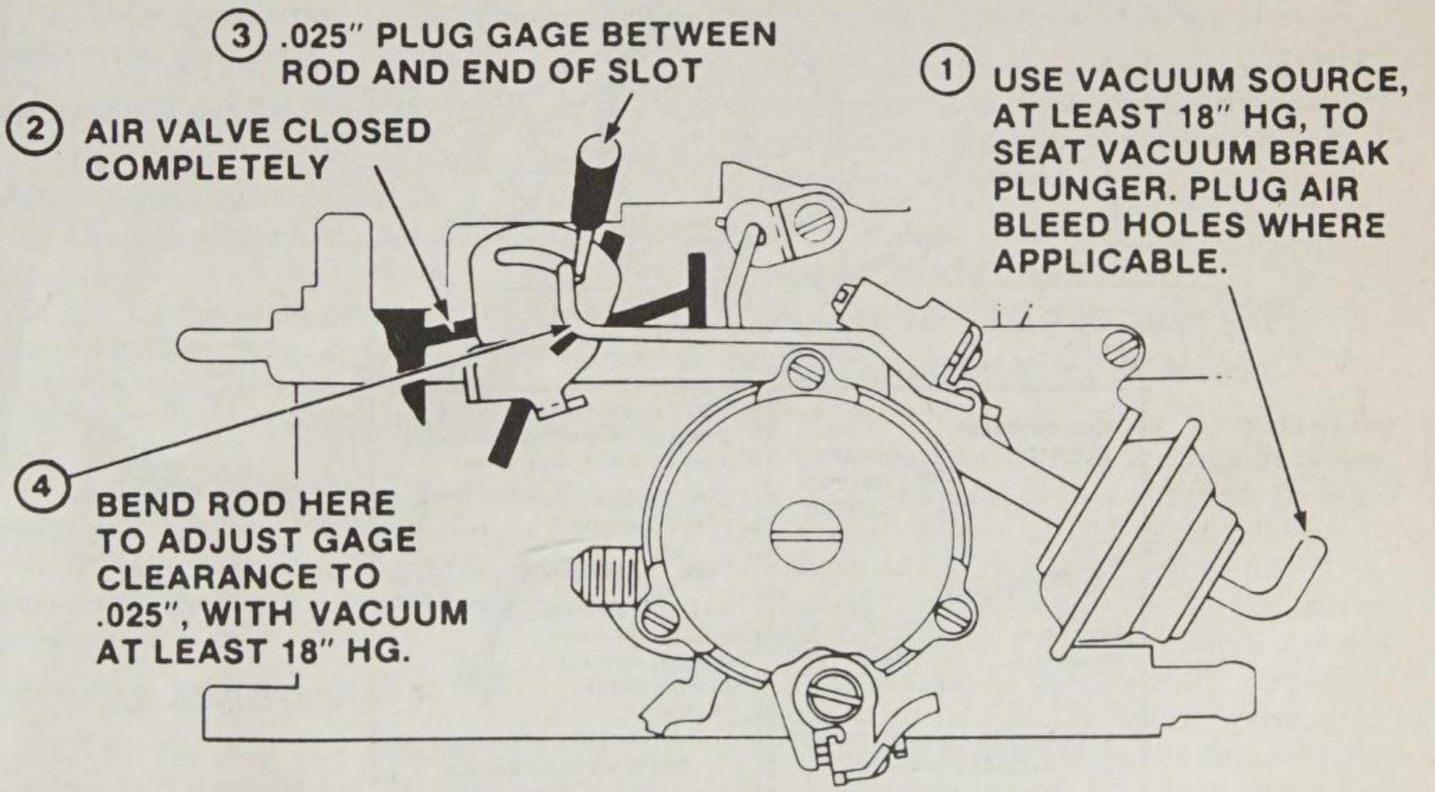
Air Valve Spring Adjustment—E4ME/E4MC

REAR AIR VALVE ROD ADJUSTMENT

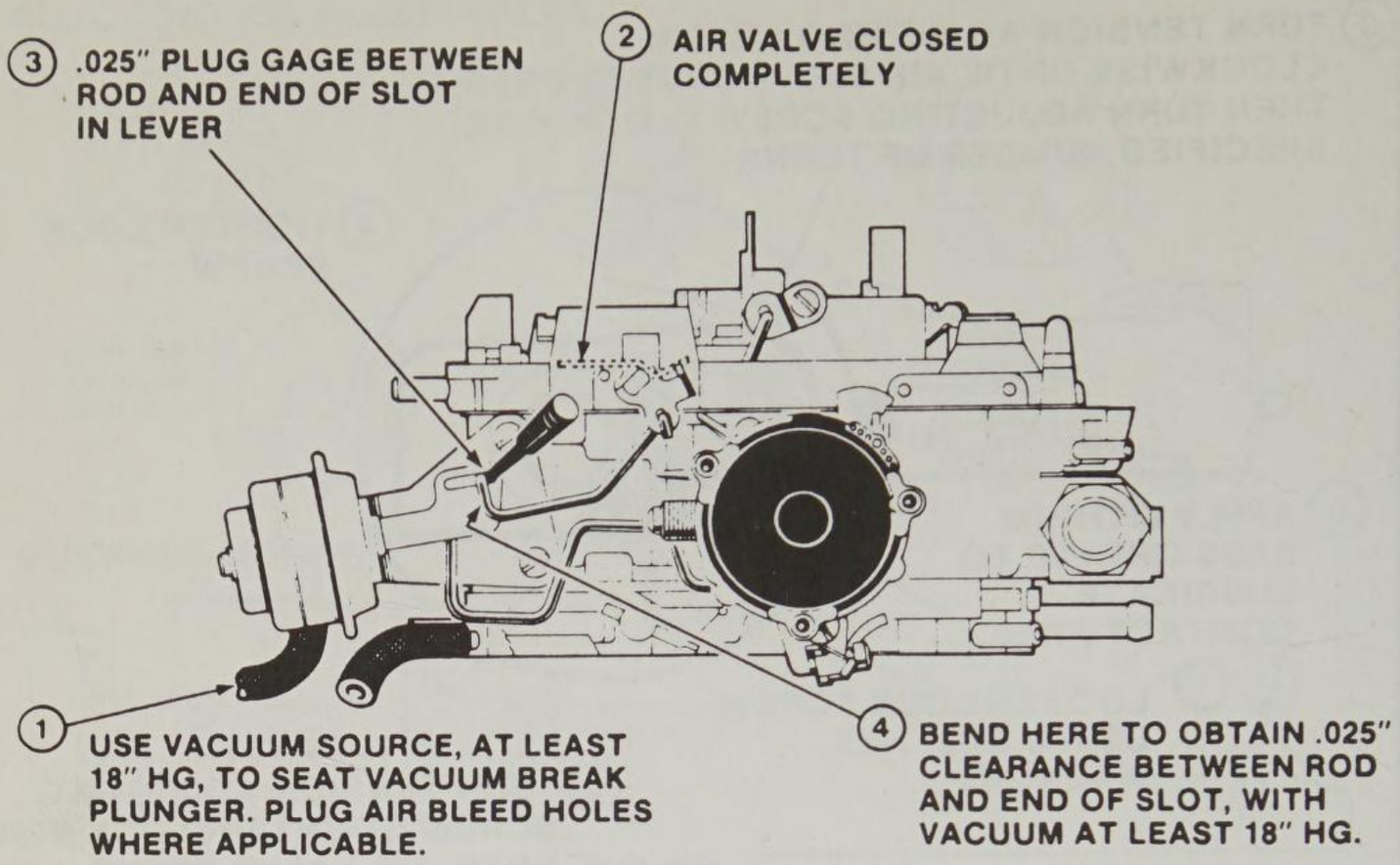
1. Using a vacuum source, seat the vacuum break plunger. Make sure the air valve is closed completely.
2. Insert a .025 in. plug gauge between the rod and the slot in the lever.
3. To adjust, bend the air valve rod. Refer to the accompanying illustration to perform this adjustment.

SECONDARY LOCKOUT ADJUSTMENT

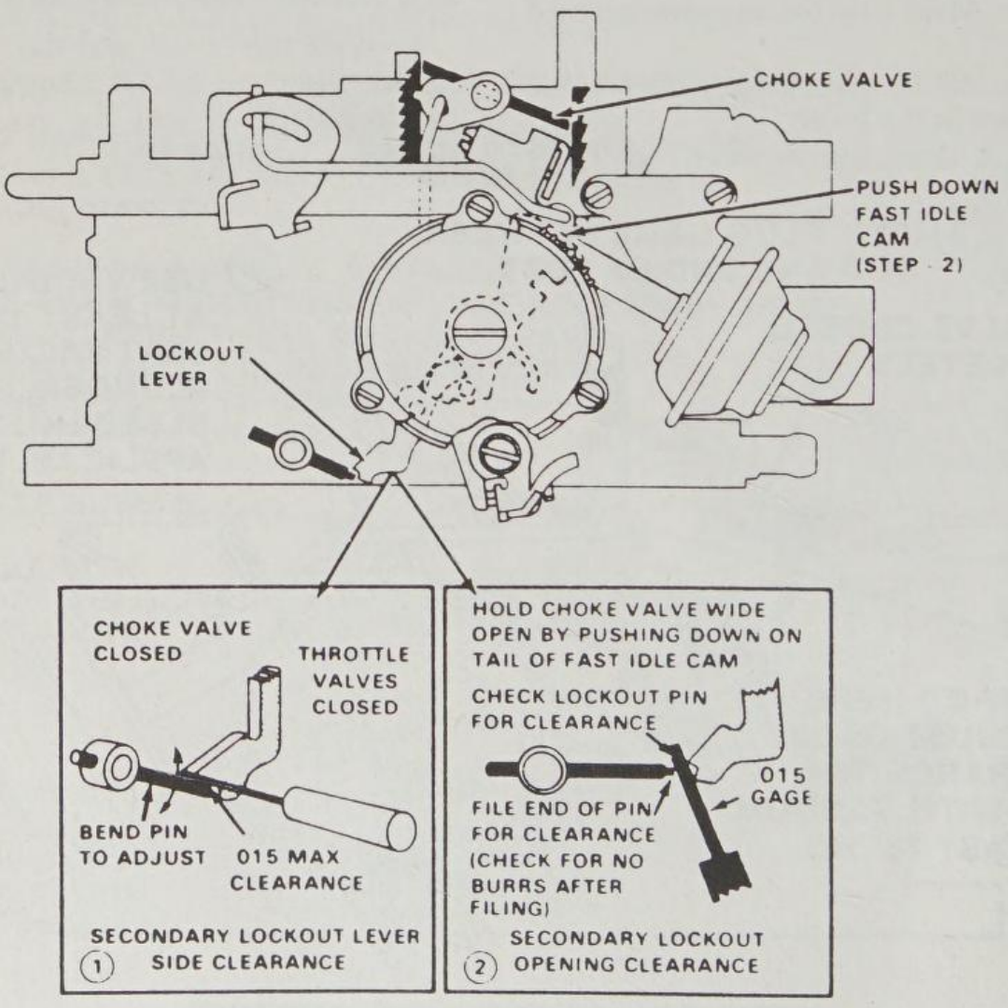
1. With the choke and the throttle valves closed, insert a .015 in. plug gauge between the lockout lever and the pin. To establish clearance, bend the pin.



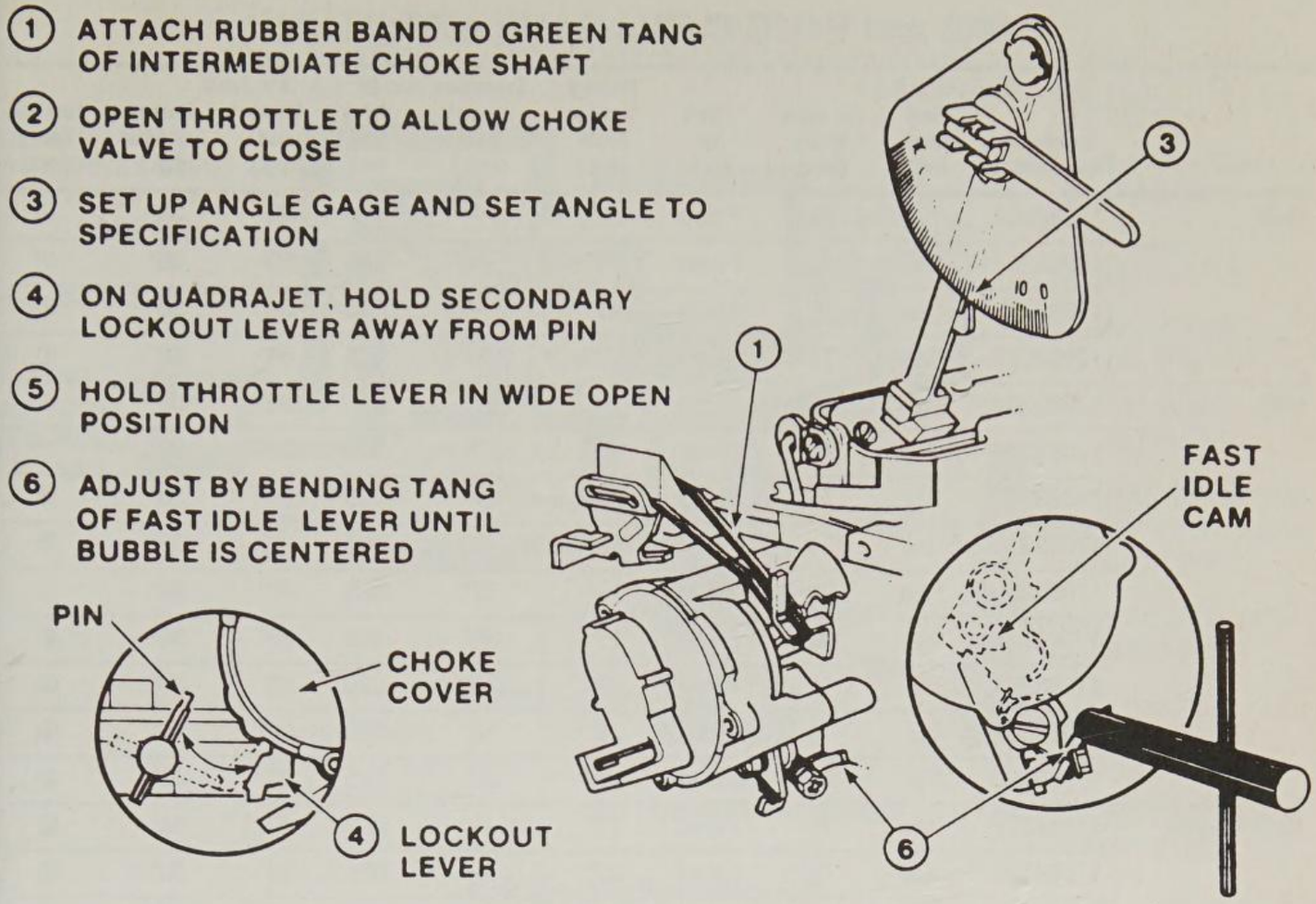
Front Air Valve Rod Adjustment—E4ME/E4MC



Rear Air Valve Rod Adjustment—E4ME/E4MC



Secondary Lockout Adjustment—E4ME/E4MC



Unloader Adjustment—E4ME/E4MC

2. Push down on the fast idle cam and hold the choke valve wide open.

3. Insert a .015 in. plug gauge sideways between the lockout lever and the pin. To adjust, file the end of the pin.

4. Refer to the accompanying illustration to perform this procedure.

UNLOADER ADJUSTMENT

1. Connect a rubber band to the green tang of the intermediate shaft.

2. Open the throttle to allow the choke valve to close.

3. Set up the angle gauge and set the angle to specification. Refer to the accompanying illustration to perform this procedure.

4. Hold the secondary lockout lever away from the pin.

5. Hold the throttle lever in the wide-open position.

6. To adjust, bend the tang of the fast idle lever until the bubble of the angle gauge is centered.

FAST IDLE ADJUSTMENT

NOTE: *The fast idle adjustment must be performed according to the directions of the emissions label.*

IDLE SPEED ADJUSTMENT

NOTE: *No idle speed adjustment is necessary, for the idle speed is controlled by the ECM.*

DISASSEMBLY AND ASSEMBLY

NOTE: *Due to the complex nature of the carburetor, it is recommended that a qualified mechanic perform any disassembly or assembly operations.*

Throttle Body Injection (TBI)/Cross-Fire Injection (CFI)

THROTTLE BODY INJECTION (TBI)

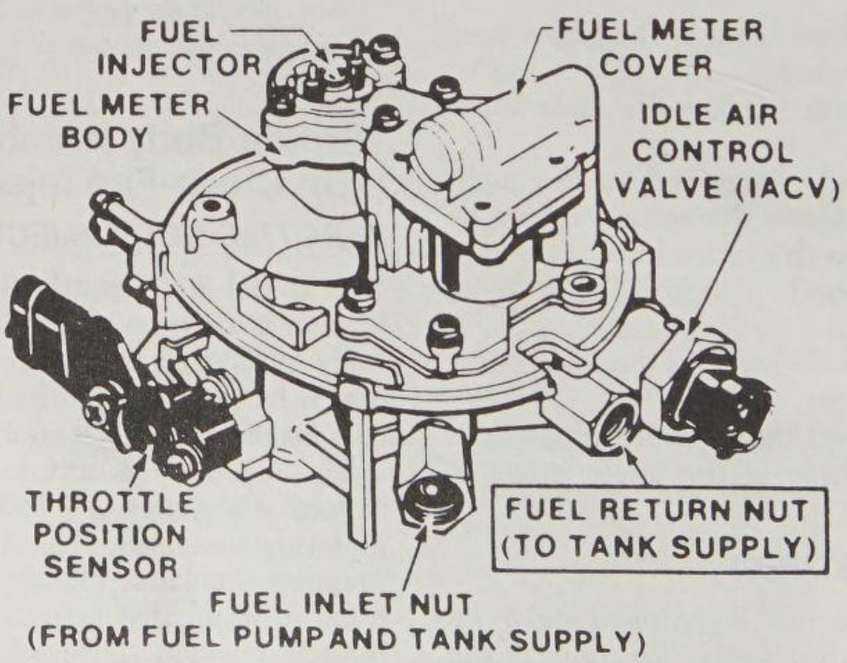
The Model 300 Throttle Body Injection (TBI) System is used on all 2.5L engines. It is centrally located on the intake manifold. Its function is to supply an air/fuel mixture to the intake manifold, which is controlled by the ECM.

The assembly is simple. It consists of two casting assemblies: a throttle body and a fuel metering assembly. The assembly contains a pressure regulator, idle air control valve, electrical solenoid that activates the fuel injector, throttle position sensor, fuel inlet and a fuel return fitting.

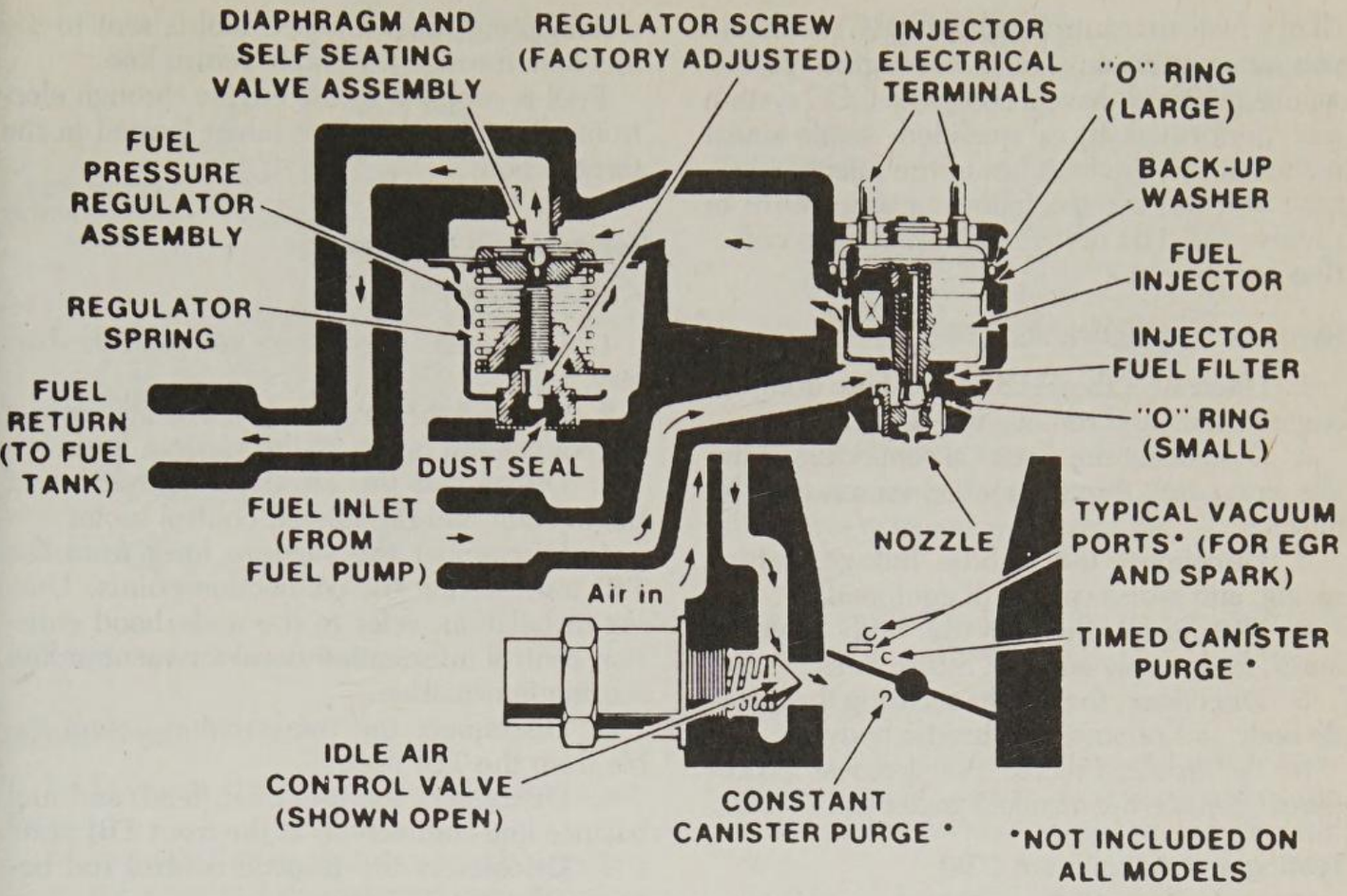
E4ME and E4MC Carburetor Specifications

Year	Carburetor Identification	Float Level (in.)	Air Valve Spring (turn)	Pump Rod (in.)	Primary Vacuum Break (deg.)	Secondary Vacuum Break (deg.)	Air Valve Rod (in.)	Choke Rod (deg.)	Choke Unloader (deg.)	Fast Idle Speed (rpm)
1982	17082202	11/32	7/8	Fixed	27°	—	.025	20°	38°	①
	17082204	11/32	7/8	Fixed	27°	—	.025	20°	38°	①
	17082203	11/32	7/8	Fixed	27°	—	.025	38°	38°	①
	17082207	11/32	7/8	Fixed	27°	—	.025	38°	38°	①
1983	17083204	11/32	7/8	Fixed	—	27°	.025	20°	38°	②
	17083206	11/32	7/8	Fixed	—	27°	.025	20°	38°	②
	17083207	11/32	7/8	Fixed	—	27°	.025	38°	38°	②
	17083218	11/32	7/8	Fixed	—	27°	.025	20°	38°	②
	17083236	11/32	7/8	Fixed	—	27°	.025	20°	38°	②
	17083506	7/16	7/8	Fixed	27°	36°	.025	20°	36°	②
	17083508	7/16	7/8	Fixed	27°	36°	.025	20°	36°	②
	17083524	7/16	7/8	Fixed	25°	36°	.025	20°	36°	②
	17083526	7/16	7/8	Fixed	25°	36°	.025	20°	36°	②
1984 & Later	17084201	11/32	7/8	Fixed	27°	—	.025	20°	38°	②
	17084205	11/32	7/8	Fixed	27°	—	.025	38°	38°	②
	17084208	11/32	7/8	Fixed	27°	—	.025	20°	38°	②
	17084209	11/32	7/8	Fixed	27°	—	.025	38°	38°	②
	17084210	11/32	7/8	Fixed	27°	—	.025	20°	38°	②
	17084507	7/16	1	Fixed	27°	36°	.025	20°	36°	②
	17084509	7/16	1	Fixed	27°	36°	.025	20°	36°	②
	17084525	7/16	1	Fixed	25°	36°	.025	20°	36°	②
	17084527	7/16	1	Fixed	25°	36°	.025	20°	36°	②

① 3 turns after contacting lever for preliminary setting
② Refer to Emission Label



Model 300—TBI

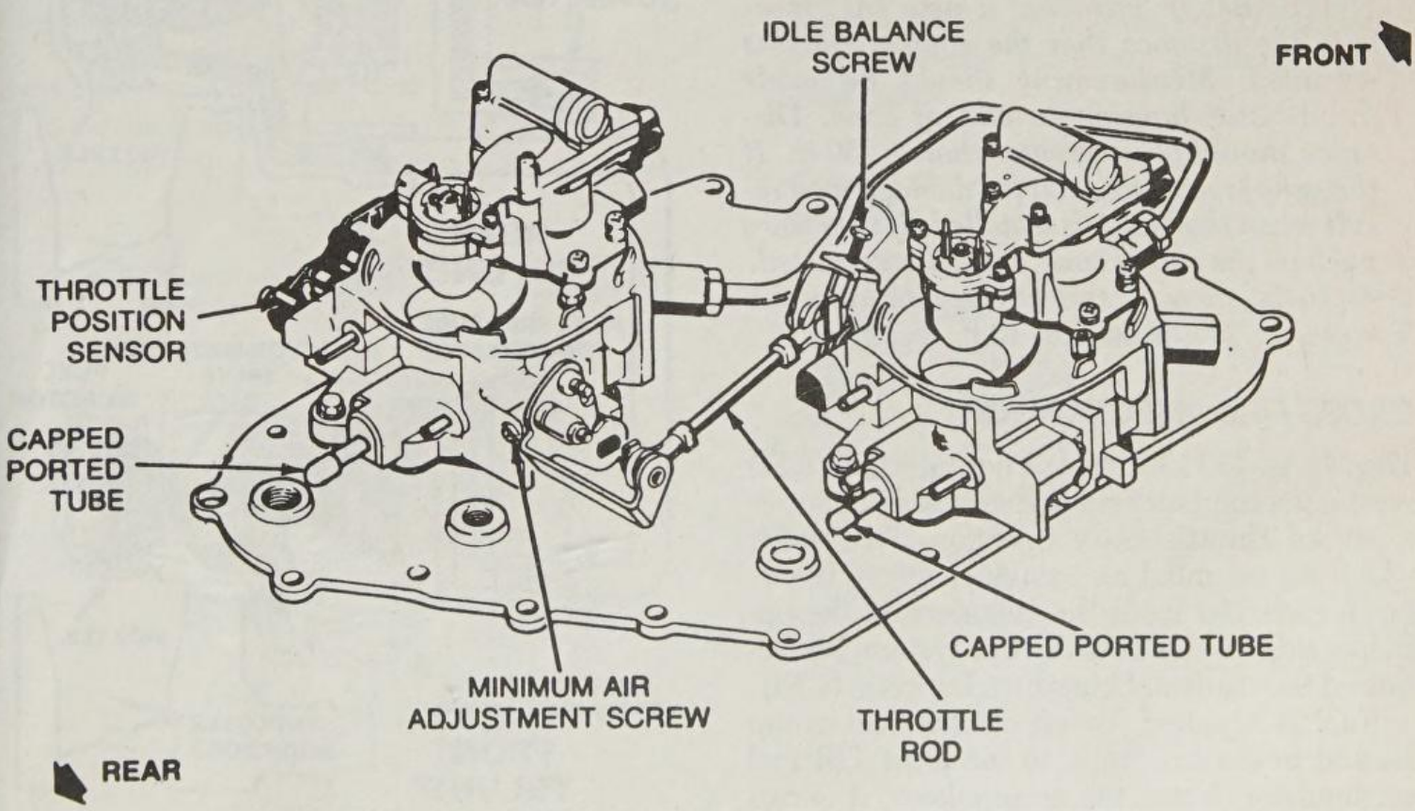


Fuel Metering Schematic—TBI

The Throttle Body Injection identification number is stamped on the lower mounting flange located near the TPS. The number is in alphabetical code and should be noted before servicing the unit.

An oxygen sensor in the main exhaust system functions to provide "feedback" information to the ECM as to oxygen content, lean or rich in the exhaust. The ECM then uses this information to modify fuel delivery to achieve as near as possible an ideal air/fuel ratio of 14.7:1. This ratio permits the catalytic converter to become more effective in reducing emissions while providing acceptable driveability.

Trouble diagnosis of the injection system is nearly impossible for the novice mechanic to perform, because of the interaction between the injection, emissions, and ignition systems;



Cross-Fire Injection System (CFI)—Twin Throttle Body Injectors (TBI)

all of which are controlled by the ECM. Should you encounter any type of engine performance problem, have a complete CCC system test performed by a qualified, professional technician. If the fault lies in the injection system, you can use the following procedures to remove the TBI unit(s) and replace the defective component(s).

Removal and Installation (TBI)

1. Disconnect the THERMAC hose from the engine fitting and remove the air cleaner.
2. Disconnect the electrical connectors at the idle air control, throttle position sensor, and the injector.
3. Disconnect the throttle linkage, return spring, and cruise control (if equipped).
4. Disconnect the throttle body vacuum hoses, fuel supply and fuel return lines.
5. Disconnect the 3 bolts securing the throttle body and remove the throttle body.
6. To install, reverse the removal procedures. Replace the manifold gasket and O-rings.

Testing and Adjustment (TBI)

NOTE: *To perform these adjustments, refer to the section on Cross-Fire Injection (CFI) in this chapter.*

Idle Air Control Assembly (IAC) Removal and Installation

1. Remove the air cleaner.
2. Disconnect the electrical connection from the idle air control assembly.
3. Using a 1¼ in. wrench, remove the IAC from the throttle body.

NOTE: *Before installing a new IAC measure the distance that the conical valve is extended. Measurement should be made from motor housing to end of cone. Distance should be no greater than 1.259 in. If the cone is extended too far damage may result when the motor is installed. If necessary push on the end of cone, until it is retracted.*

4. Installation is the reverse of removal. Torque the motor bolts to 13 ft. lbs.

CROSS-FIRE INJECTION (CFI)

The Model 400 Electronic Fuel Injection (EFI) system is a computer controlled system that uses a pair of Throttle Body Injection (TBI) units, which are mounted on a single manifold cover. Since each TBI feeds the cylinders on the opposite side of the engine, the system has acquired the name of Cross-Fire Injection (CFI).

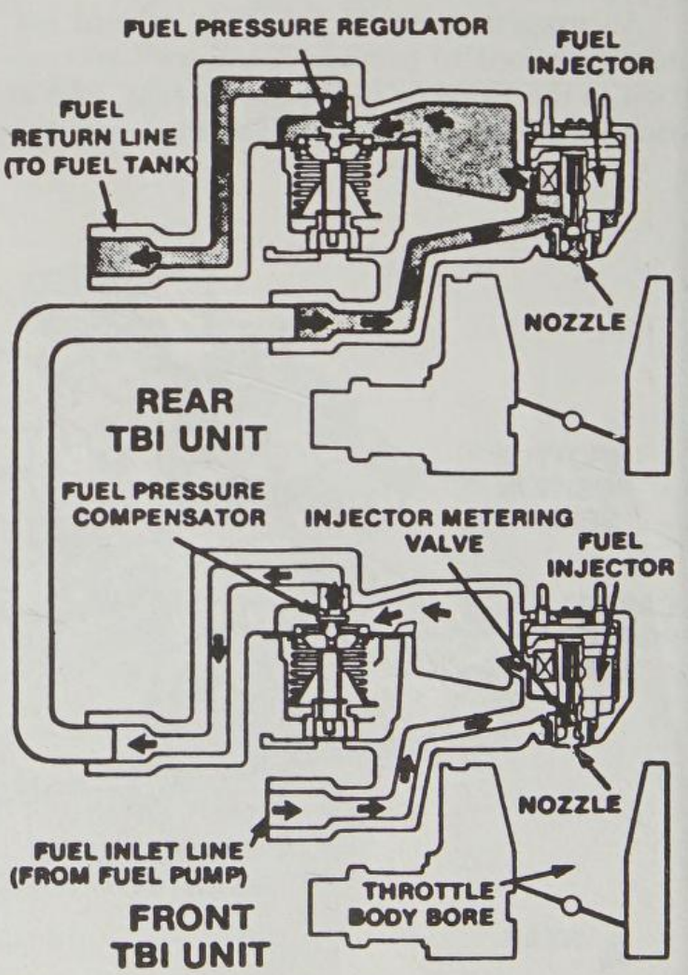
Fuel is supplied, by an electric fuel pump located in the fuel tank, to the front TBI fuel accumulator. From the accumulator, it is carried to the rear TBI fuel pressure regulator by a connecting tube. Unused fuel is sent to the fuel tank through a separate return line.

Fuel is supplied to the engine through electronically pulsed injector valves located in the throttle body.

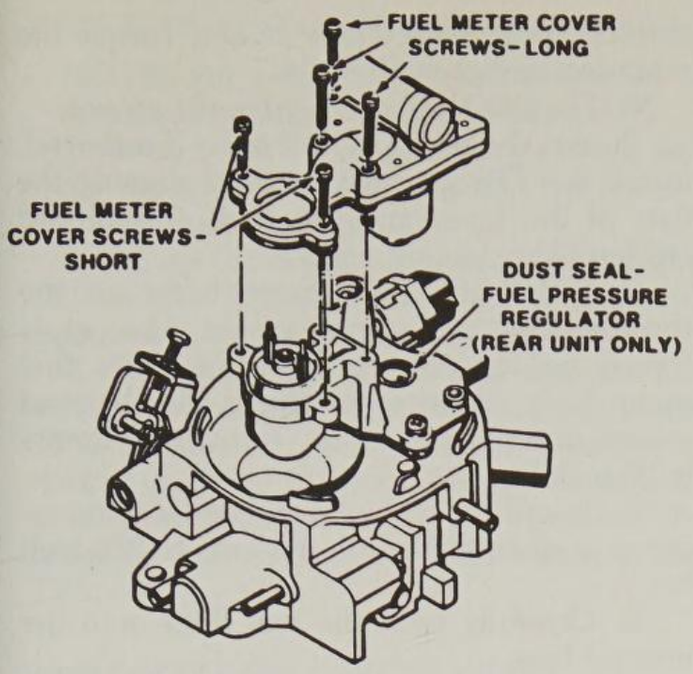
Removal and Installation

FRONT TBI UNIT

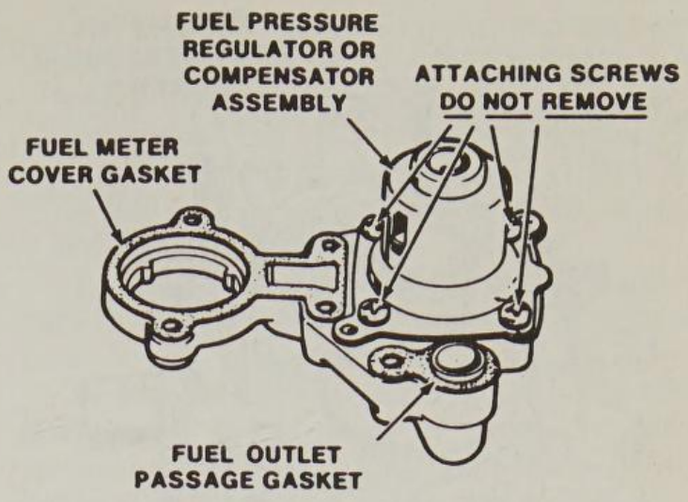
1. Disconnect the battery cables at the battery.
2. Remove the air cleaner assembly, noting the connection points of the vacuum lines.
3. Disconnect the electrical connectors at the injector and the idle air control motor.
4. Disconnect the vacuum lines from the TBI unit, noting the connection points. During installation, refer to the underhood emission control information decal for vacuum line routing information.
5. Disconnect the transmission detent cable from the TBI unit.
6. Disconnect the fuel inlet (feed) and fuel balance line connections at the front TBI unit.
7. Disconnect the throttle control rod between the two TBI units.
8. Unbolt and remove the TBI unit.
9. Installation is the reverse of the previous steps. Torque the TBI bolts to 120–168 inch lbs. during installation.



TBIs' fuel flow schematic CFI System



TBI fuel meter cover screws (five)



Bottom view of the fuel meter cover assembly—do not remove th four screws indicated

REAR TBI UNIT

1. Disconnect the battery cables at the battery.
2. Remove the air cleaner assembly, noting the connection points of the vacuum lines.
3. Disconnect the electrical connectors at the injector, idle air control motor, and throttle position sensor.
4. Disconnect the vacuum lines from the TBI unit, noting the connection points. During installation, refer to the underhood emission control information decal for vacuum line routing information.
5. Disconnect the throttle and cruise control (if so equipped) cables at the TBI unit.
6. Disconnect the fuel return and balance line connections from the rear TBI unit.
7. Disconnect the throttle control rod between the two units.
8. Unbolt and remove the TBI unit.
9. Installation is the reverse of the previous steps. Torque the TBI bolts to 120–168 inch lbs. during installation.

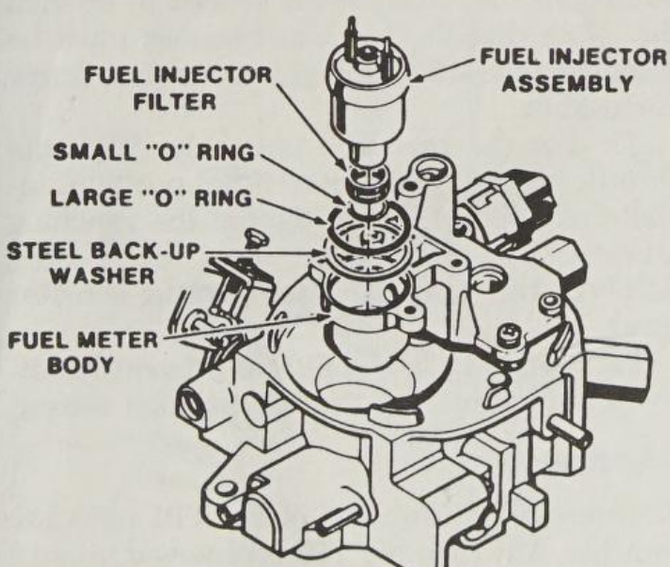
Disassembly

CAUTION: *Use extreme care when handling the TBI unit to avoid damage to the swirl plates located beneath the throttle valve.*

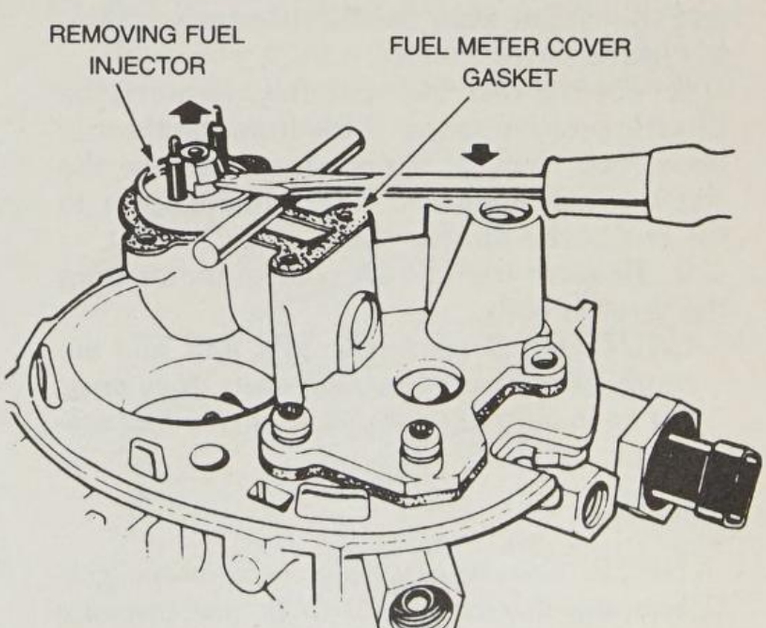
NOTE: *If both TBI units are to be disassembled, DO NOT mix parts between either unit.*

1. Remove the fuel meter cover assembly (five screws). Remove the gaskets after the cover has been removed. The fuel meter cover assembly is serviced only as a unit. If necessary, the entire unit must be replaced.

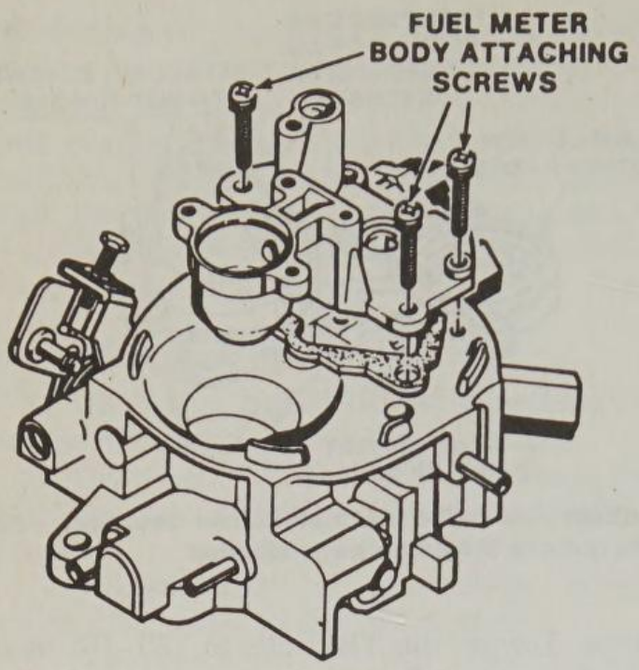
CAUTION: *DO NOT remove the four screws which retain the pressure regulator (rear unit) or pressure compensator (front unit). There is a spring beneath the cover which is under great pressure. If the cover is accidentally released, personal injury could result.*



Fuel injector installation



Removing the fuel injector



Fuel meter body attaching screws

Do not immerse the fuel meter cover in any type of cleaning solvent.

2. Remove the foam dust seal from the meter body of the rear unit.

3. a. Using a screwdriver and rod, lift the fuel injector from the TBI.

b. Use a twisting motion when removing the fuel injector.

c. If the injectors are to be removed from both TBI units, mark them so that they may be reinstalled in their original units.

4. Remove the filter from the base of the injector by rotating it back and forth.

5. Remove the O-ring and the steel washer from the top of the fuel meter body, then remove the small O-ring from the bottom of the injector cavity.

6. Remove the fuel inlet and outlet nuts (and gaskets) from the fuel meter body.

7. Remove the fuel meter body assembly and the gasket from the throttle body assembly (three screws).

8. For the rear TBI unit only: Remove the throttle position sensor (TPS) from the throttle body (two screws). If necessary, remove the screw which holds the TPS actuator lever to the end of the throttle shaft.

9. Remove the idle air control motor from the throttle body.

CAUTION: *Because the TPS and idle air control motors are electrical units, they must not be immersed in any type of cleaning solvent.*

Assembly

NOTE: *During assembly, replace the gaskets, injector washer, O-rings, and pressure regulator dust seal with new equivalents.*

1. Install the idle air control motor in the throttle body, using a new gasket. Torque the retaining screws to 13 ft. lbs.

NOTE: *DO NOT overtighten the screws.*

2. For the rear TBI unit only: If removed, install the TPS actuator lever by aligning the flats of the lever and the shaft. Install and tighten the retaining screw.

3. Install the fuel meter body on the throttle body, using a new gasket. Also, apply thread locking compound to the three fuel meter body screws according to the chemical manufacturers instructions. Torque the screws to 35 inch lbs.

4. Install the fuel inlet and outlet nuts, using new gaskets. Torque the nuts to 260 inch lbs.

5. Carefully twist the fuel filter onto the injector base.

6. Lubricate the new O-rings with lithium grease.

7. Install the small O-ring onto the injector, pressing it up against the fuel filter.

8. Install the steel washer into the injector cavity recess of the fuel meter body. Install the large O-ring above the steel washer, in the cavity recess. The O-ring must be flush with the fuel meter body surface.

9. Using a pushing/twisting motion, carefully install the injector. Center the nozzle O-ring in the bottom of the injector cavity and align the raised lug on the injector base with the notch in the fuel meter body cavity. Make sure the injector is seated fully in the cavity. The electrical connections should be parallel to the throttle shaft of the throttle body.

10. For the rear TBI unit only: Install the new pressure regulator dust seal into the fuel meter body recess.

11. Install the new fuel meter cover and fuel outlet passage gaskets on the fuel meter cover.

12. Install the fuel meter cover assembly, using thread locking compound on the five retaining screws. Torque the screws to 28 inch lbs. Note that the two short screws must be installed alongside the fuel injector (one screw each side).

13. For the rear TBI unit only: With the throttle valve in the closed (idle) position, install the TPS but do not tighten the attaching screws. The TPS lever must be located ABOVE the tang on the throttle actuator lever.

14. Install the TBI unit(s) as previously outlined and adjust the throttle position sensor.

Adjustments

No internal adjustments of the TBI units are possible. Any time the TPS is removed, it must be readjusted according to the following procedure.

THROTTLE POSITION SENSOR (TPS) ADJUSTMENT

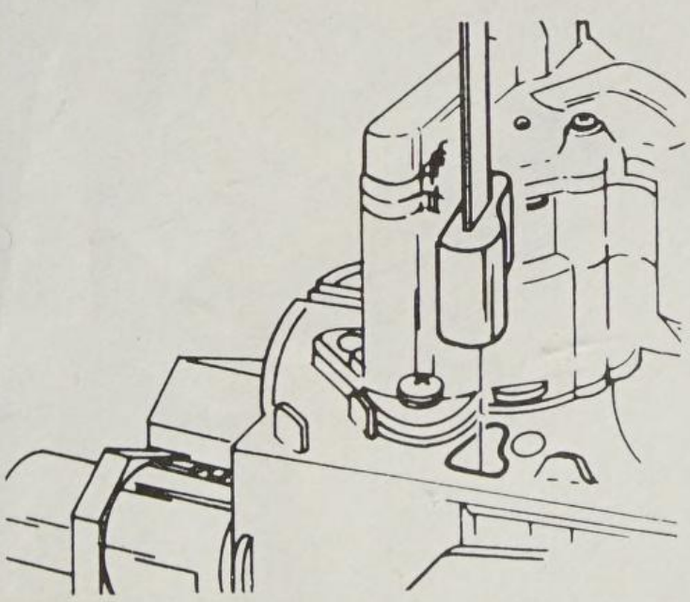
NOTE: *An accurate digital voltmeter is needed to perform this adjustment.*

1. Remove the TPS attaching screws and apply thread locking compound to the screws. Reinstall the screws loosely.
2. Install three jumper wires between the TPS and the TPS wiring terminal connections, as shown in the accompanying illustration.
3. Turn the ignition ON and measure the voltage between the B and C terminals of the TPS. Rotate the TPS to obtain a voltmeter reading of .450–1.250 volts. Tighten the screws.
4. Turn the ignition OFF, remove the jumpers, and connect the TPS wiring to the TPS.

MINIMUM IDLE AND THROTTLE VALVE SYNCHRONIZING

The throttle position of each throttle body must be balanced so that the throttle plates are synchronized and open simultaneously. Adjustment should be performed only when a manifold cover, TBI unit or throttle body has been replaced.

1. Remove the air cleaner and plug the vacuum port on the rear TBI unit for the thermostatic air cleaner.
2. Remove the tamper resistant plugs covering both unit throttle stop screws. Make sure both throttle valves are slightly open to allow fuel to bypass them.
3. Block the drive wheels and apply the parking brake.
4. Connect a tachometer to measure rpm.
5. Disconnect the idle air control (IAC) valve electrical connectors.
6. Plug the idle air passages of each throttle body with plugs (J-33047 or equivalent). Make sure the plugs are seated fully in the passage so that no air leaks exist.



Plug the idle passages of each throttle body as shown

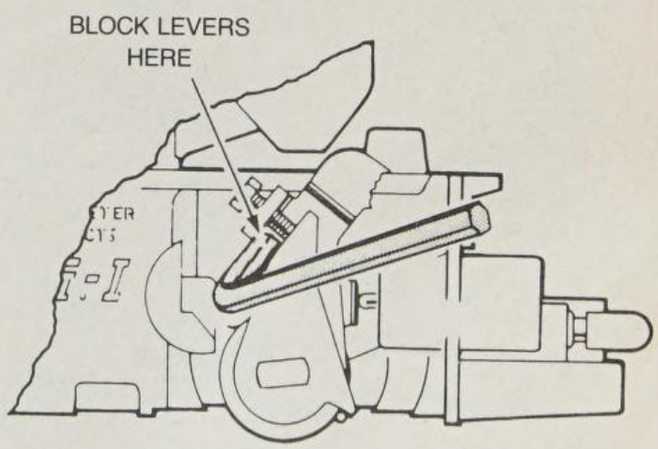
CAUTION: *To prevent the engine from running at high rpm, be sure the ignition switch is OFF and transmission is in NEUTRAL before connecting IAC valves or removing or installing idle air passage plugs. Failure to do this may result in vehicle movement and possible personal injury.*

7. Start the engine and allow the engine rpm to stabilize at normal operating temperature.
8. Place the transmission in DRIVE while holding the brake pedal to prevent vehicle movement. The engine rpm should decrease below curb idle speed. If the engine rpm does not decrease, check for a vacuum leak.
9. Remove the cap from the ported tube on the rear TBI unit and connect a vacuum gauge or water manometer.
10. Adjust the rear unit throttle stop screw to obtain approximately ½ in. of mercury as read on the vacuum gauge, or 6 in. of water as read on the manometer. If not able to adjust to this level, check that the front unit throttle stop is not limiting throttle travel.
11. Remove the vacuum gauge or manometer from the rear unit and install the cap on the ported vacuum tube.
12. Remove the cap from the ported vacuum tube on the front TBI unit and install the gauge or manometer as before. If the reading is not the same as the rear unit, proceed as follows:

a. Locate the throttle synchronizing screw and collar on the front TBI unit. The screw retaining collar is welded to the throttle lever to discourage tampering with this adjustment.

b. If the collar is in place, grind off the weld from the screw collar and throttle lever.

c. Block possible movement of the throttle lever as illustrated, relieving the force of the heavy spring against the throttle synchronizing screw, to prevent the levers from coming into contact.



Block throttle lever movement as shown

NOTE: *If the lever is not blocked before the throttle synchronizing screw is removed, the screw may be damaged and reinstallation will be done only with great difficulty.*

d. Remove the screw and collar and discard the collar.

e. Reinstall the throttle synchronizing screw, using thread locking compound.

f. Adjust the screw to obtain ½ in. of mercury on the vacuum gauge, or 6 in. of water on the manometer.

13. Remove the gauge or manometer from the ported tube and reinstall the cap.

14. Adjust the rear throttle stop screw to obtain 475 rpm, with the transmission in DRIVE and the parking brake applied. On manual transmission models, leave the gear selector in NEUTRAL.

15. Turn the ignition OFF and place automatic transmission in NEUTRAL.

16. Adjust the front throttle stop screw to obtain .005 in. clearance between the front throttle stop screw and the throttle lever tang.

17. Remove idle air passage plugs and reconnect IAC valves.

18. Start the engine. It may run at a high rpm but the engine speed should decrease when the idle air control valves close the air passages. Stop the engine when the rpm decreases.

19. The throttle position sensor (TPS) voltage should be checked and adjusted, if necessary. See "TPS Adjustment" for procedures.

20. Install the air cleaner gasket, connect the vacuum line to the TBI unit and install the air cleaner.

21. Reset the idle speed control motors by driving the vehicle to 30 mph.

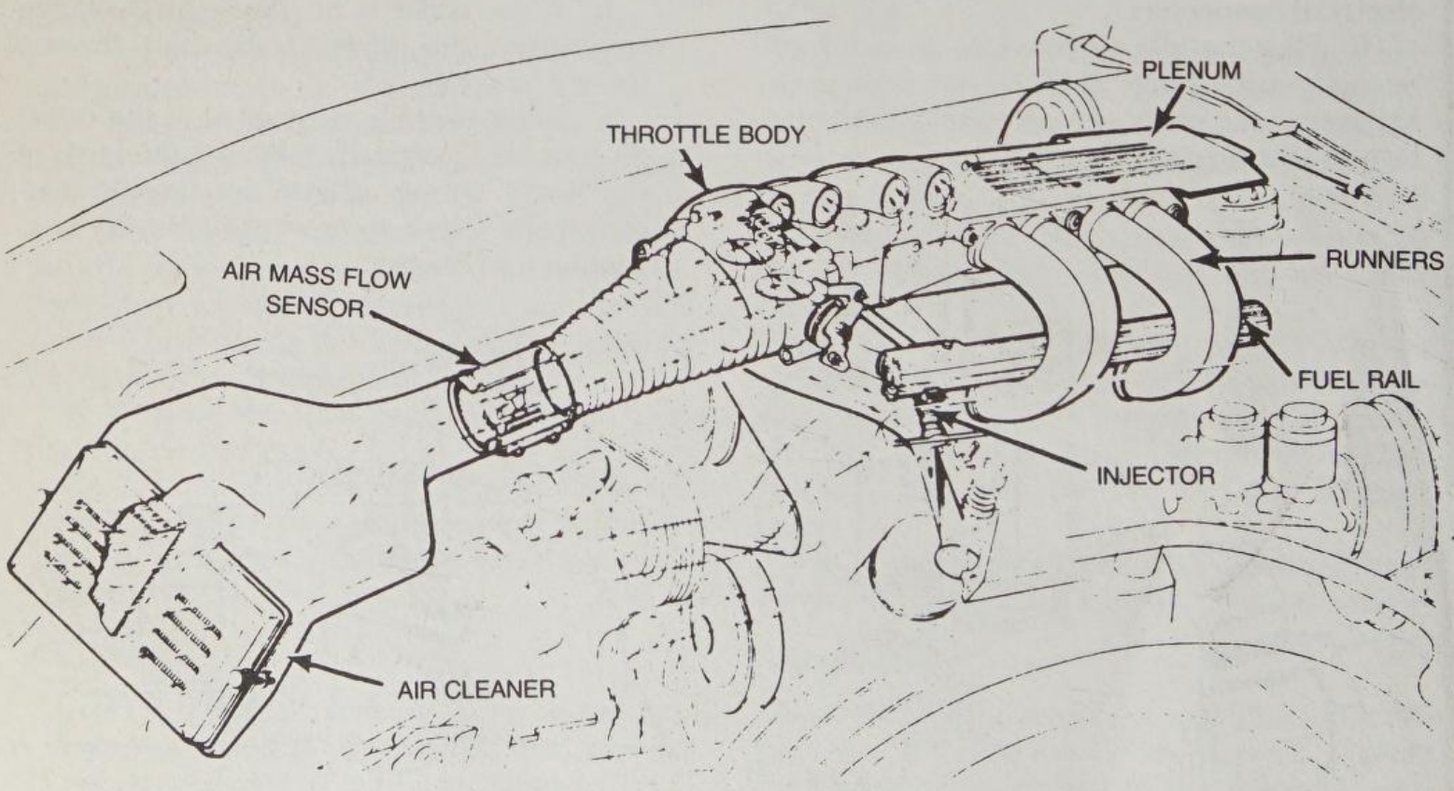
Multi-Port Fuel Injection (MFI)/Tuned Port Injection (TPI) Systems

On 1985 models, two new fuel injection systems were introduced: Multi-Port Fuel Injection (MFI) for use with the 2.8L engine and Tuned Port Injection (TPI) for use with the 5.0L engine. Although both systems are basically identical, the Tuned Port Injection (TPI) offers a significant increase in engine torque and power.

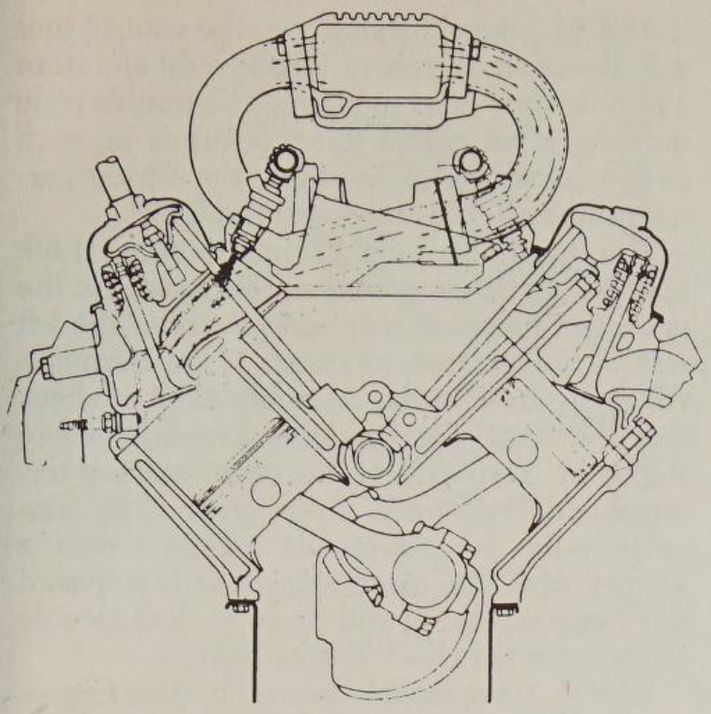
The systems are controlled by an Electronic Control Module (ECM) which monitors the engine operations and generates output signals to provide the correct air/fuel mixture, ignition timing and idle speed. Input information to the ECM is provided by the oxygen sensor, temperature sensor, detonation sensor, mass air flow sensor and throttle position sensor. The ECM also receives information concerning engine rpm, road speed, transmission gear position, power steering and air conditioning.

The systems consist of a large front mounted air cleaner, a mass air flow sensor (TPI uses a burn off filament), a cast throttle body assembly (TPI has dual throttle blades), a large cast plenum (TPI uses individual tuned runners) and dual (TPI) or single (MFI) fuel rail assemblies with computer controlled injectors.

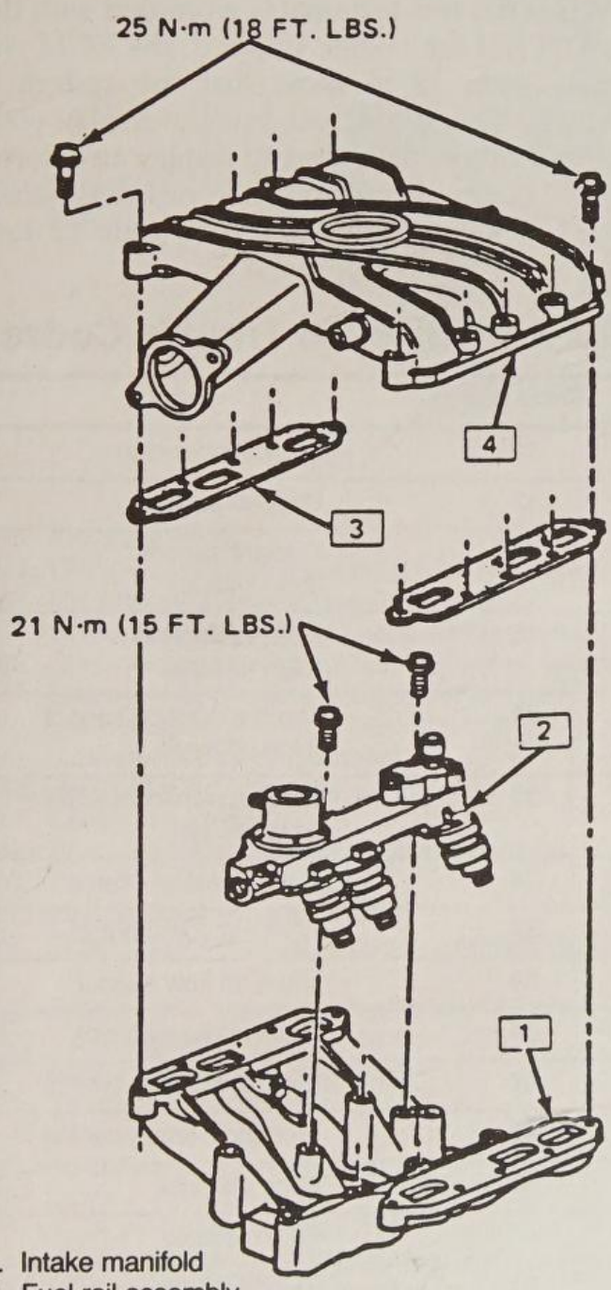
The tuned runners (TPI) are designed to provide excellent throttle responses throughout the driving range. Their configuration en-



Tuned Port Injection (TPI) System

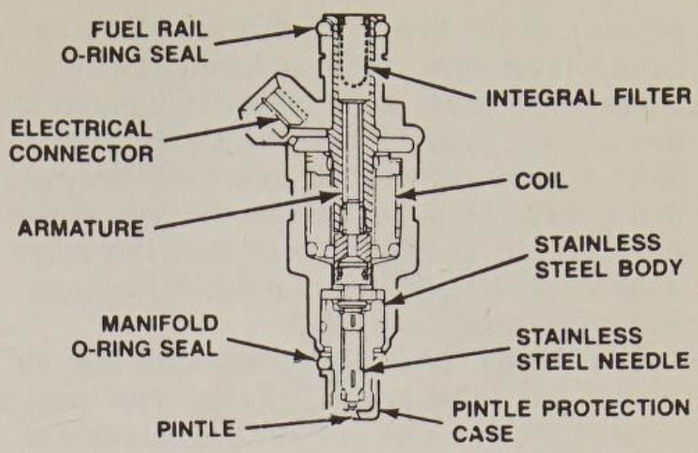


Cross section view of Tuned Port Injection System



1. Intake manifold
2. Fuel rail assembly
3. Gasket
4. Plenum

Multi-Port Fuel Injection Components



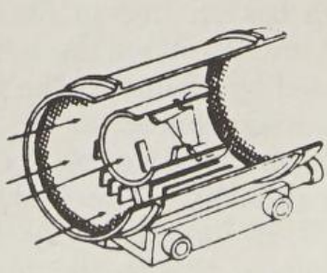
Sectional view of Fuel Injector

ables large volumes of high pressure air to be present at each intake valve, resulting in improved cylinder charging and operation efficiency.

Both systems use Bosch injectors, one at each intake port, rather than the single injector found on the earlier throttle body system. The injectors are mounted on a fuel rail and are activated by a signal from the electronic control module. The injector is a solenoid-operated valve which remains open depending on the width of the electronic pulses (length of the signal) from the ECM; the longer the open time, the more fuel is injected. In this manner, the air/fuel mixture can be precisely controlled for maximum performance with minimum emissions.

Fuel is pumped from the tank by a high pressure fuel pump, located inside the fuel tank. It is a positive displacement roller vane pump. The impeller serves as a vapor separator and pre-charges the high pressure assembly. A pressure regulator maintains 44 psi in the fuel line to the injectors and the excess fuel is fed back to the tank. A fuel accumulator is used to dampen the hydraulic line hammer in the system created when all injectors open simutaneously.

The Mass Air Flow Sensor is used to measure the mass of air that is drawn into the engine cylinders. It is located just ahead of the air throttle in the intake system and consists of a heated film which measures the mass of air, rather than just the volume. A resistor is used to measure the temperature of the incoming air and the air mass sensor maintains the tem-



Sectional view of Air Mass Flow Sensor

perature of the film at 75 degrees above ambient temperature. As the ambient (outside) air temperature rises, more energy is required to maintain the heated film at the higher temperature and the control unit uses this difference in required energy to calculate the mass of the incoming air. The control unit uses this information to determine the duration of fuel injection pulse, timing and EGR.

The throttle body incorporates an idle air control (IAC) that provides for a bypass channel through which air can flow. It consists of an orifice and pintle which is controlled by the ECM through a stepper motor. The IAC provides air flow for idle and allows additional air during cold start until the engine reaches operating temperature. As the engine temperature rises, the opening through which air passes is slowly closed.

The throttle position sensor (TPS) provides the control unit with information on throttle position, in order to determine injector pulse width and hence correct mixture. The TPS is connected to the throttle shaft on the throttle body and consists of a potentiometer with one end connected to a 5 volt source from the ECM and the other to ground. A third wire is connected to the ECM to measure the voltage output from the TPS which changes as the throttle valve angle is changed (accelerator pedal moves). At the closed throttle position, the output is low (approximately .4 volts); as the throttle valve opens, the output increases to a maximum 5 volts at wide open throttle (WOT). The TPS can be misadjusted open, shorted, or loose and if it is out of adjustment, the idle quality or WOT performance may be poor. A loose TPS can cause intermittent bursts of fuel from the injectors and an unstable idle because the ECM thinks the throttle is moving. This should cause a trouble code to be set. Once a trouble code is set, the ECM will use a preset value for TPS and some vehicle performance may return. A small amount of engine coolant is routed through the throttle assembly to prevent freezing inside the throttle bore during cold operation.

TROUBLESHOOTING

The "check engine" light on the instrument panel is used as a warning lamp to tell the driver that a problem has occured in the electronic engine control system. When the self-diagnosis mode is activated by grounding the test terminal of the diagnostic connector, the check engine light will flash stored trouble codes to help isolate system problems. The electronic control module (ECM) has a memory that knows what certain engine sensors should be under certain conditions. If a sensor reading is not what the ECM thinks it should be, the control unit will illuminate the check engine light and store a trouble code in its memory. The trouble code indicates what circuit the problem is in, each circuit consisting of a sensor, the wiring harness and connectors to it and the ECM.

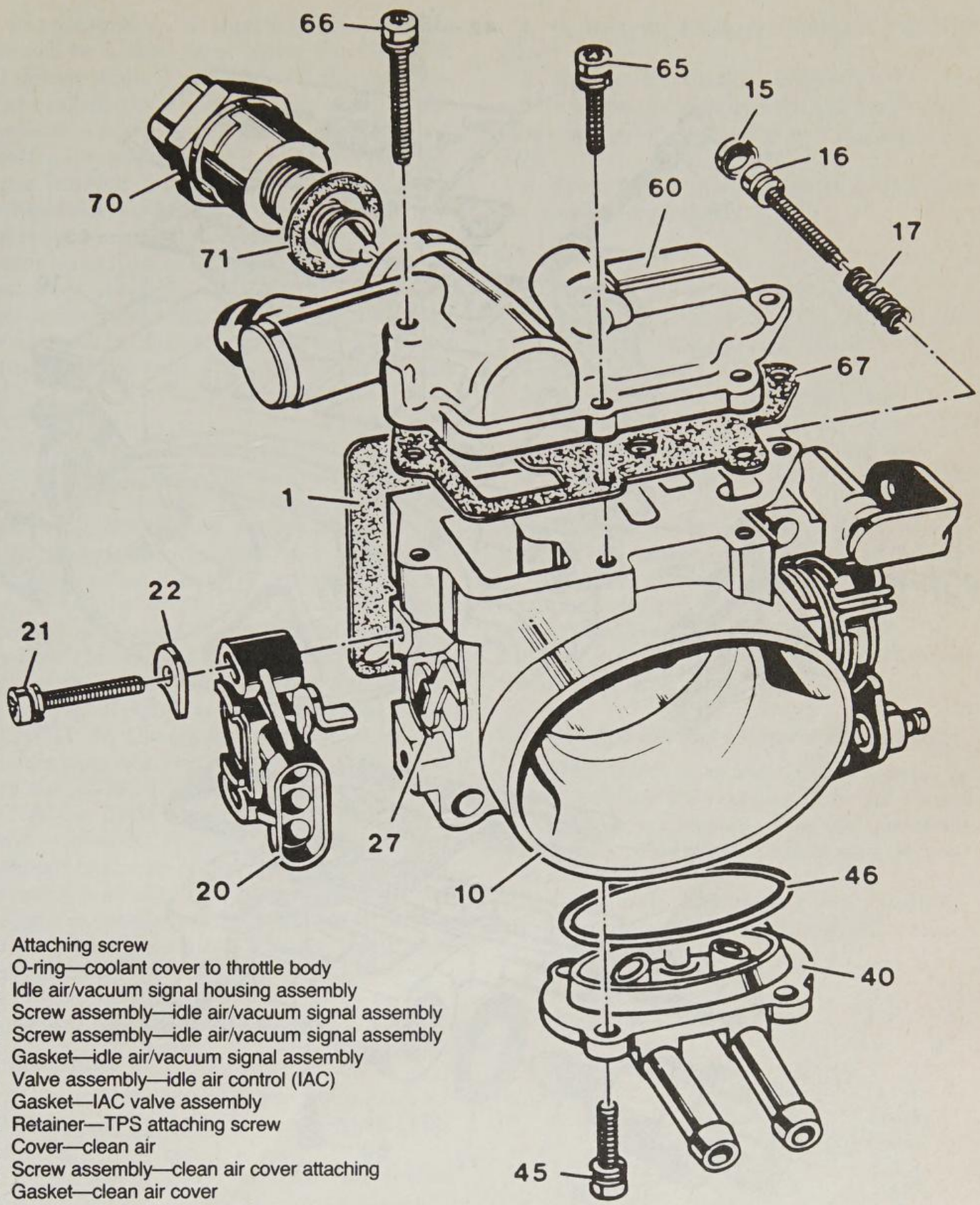
The Assembly Line Communications Link (ALCL) is a diagnostic connector located in the passenger compartment, usually under the left side of the instrument panel. It has terminals which are used in the assembly plant to check that the engine is operating properly before shipment. Terminal B is the diagnostic test terminal and Terminal A is the ground. By connecting the two terminals together with a jumper wire, the diagnostic mode is activated and the control unit will begin to flash trouble codes using the check engine light.

NOTE: *Some models have a "Service Engine Soon" light instead of a "Check Engine" display.*

When the test terminal is grounded with the key ON and the engine stopped, the ECM will display code 12 to show that the system is working. The ECM will usually display code 12 three times, then start to display any stored trouble codes. If no trouble codes are stored, the ECM will continue to display code 12 until

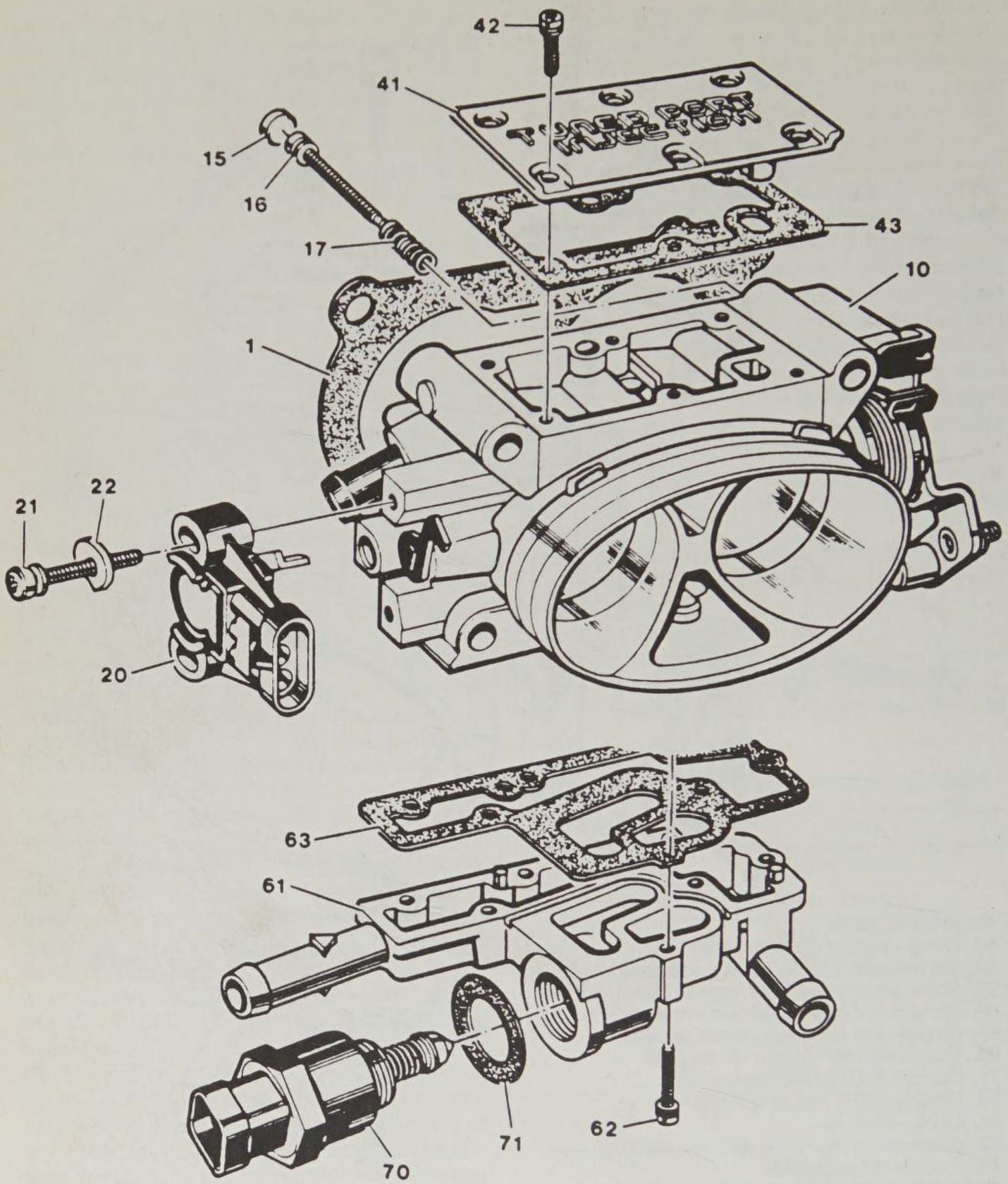
GM Port Injection Trouble Codes

Trouble Code	Circuit
12	Normal operation
13	Oxygen sensor
14	Coolant sensor (low voltage)
15	Coolant sensor (high voltage)
21	Throttle position sensor (high voltage)
22	Throttle position sensor (low voltage)
24	Speed sensor
32	EGR vacuum control
33	Mass air flow sensor
34	Mass air flow sensor
42	Electronic spark timing
43	Electronic spark control
44	Lean exhaust
45	Rich exhaust
51	PROM failure
52	CALPAK
55	ECM failure



45. Attaching screw
46. O-ring—coolant cover to throttle body
60. Idle air/vacuum signal housing assembly
65. Screw assembly—idle air/vacuum signal assembly
66. Screw assembly—idle air/vacuum signal assembly
67. Gasket—idle air/vacuum signal assembly
70. Valve assembly—idle air control (IAC)
71. Gasket—IAC valve assembly
22. Retainer—TPS attaching screw
41. Cover—clean air
42. Screw assembly—clean air cover attaching
43. Gasket—clean air cover
61. IACV/coolant cover assembly
62. Screw assembly—IACV cover assembly to throttle body
63. Gasket—IACV/coolant cover to throttle body
70. Valve assembly—idle air control (IAC)
71. Gasket—IAC valve assembly
10. Throttle body assembly
15. Plug—idle stop screw
16. Screw assembly—idle stop
17. Spring—idle stop screw
20. Sensor—throttle position (TPS)
21. Screw assembly—TPS attaching
22. Retainer—TPS attaching screw
40. Cover—coolant cavity

Exploded view of Multi-Port Fuel Injection (MFI) Throttle Body



45. Attaching screw
46. O-ring—coolant cover to throttle body
60. Idle air/vacuum signal housing assembly
65. Screw assembly—idle air/vacuum signal assembly
66. Screw assembly—idle air/vacuum signal assembly
67. Gasket—idle air/vacuum signal assembly
70. Valve assembly—idle air control (IAC)
71. Gasket—IAC valve asembly
22. Retainer—TPS attaching screw
41. Cover—clean air
42. Screw assembly—clean air cover attaching
43. Gasket—clean air cover
61. IACV/coolant cover assembly
62. Screw assembly—IACV cover assembly to throttle body
63. Gasket—IACV/coolant cover to throttle body
70. Valve assembly—idle air control (IAC)
71. Gasket—IAC valve assembly
1. Gasket—flange
10. Throttle body assembly
15. Plug—idle stop screw
16. Screw assembly—idle stop
17. Spring—idle stop screw
20. Sensor—throttle position (TPS)
21. Screw assembly—TPS attaching

Exploded view of Tuned Port Injection (TPI) Throttle Body

the test terminal is disconnected. Each trouble code will be flashed three times, then code 12 will display again. The ECM will also energize all controlled relays and solenoids when in the diagnostic mode to check function.

When the test terminal is grounded with the engine running, it will cause the ECM to enter the Field Service Mode. In this mode, the service engine soon light will indicate whether the system is in Open or Closed loop operation. In open loop, the light will flash 2½ times per second; in closed loop, the light will flash once per second. In closed loop, the light will stay out most of the time if the system is too lean and will stay on most of the time if the system is too rich.

NOTE: *The vehicle may be driven in the Field Service mode and system evaluated at any steady road speed. This mode is useful in diagnosing driveability problems where the system is rich or lean too long.*

Trouble codes should be cleared after service is completed. To clear the trouble code memory, disconnect the battery for at least 10 seconds. This may be accomplished by disconnecting the ECM harness from the positive battery pigtail or by removing the ECM fuse.

CAUTION: *The ignition switch must be OFF when disconnecting or reconnecting power to the ECM. The vehicle should be driven after the ECM memory is cleared to allow the system to readjust itself. The vehicle should be driven at part throttle under moderate acceleration with the engine at normal operating temperature. A change in performance should be noted initially, but normal performance should return quickly.*

REMOVAL AND INSTALLATION

Throttle Body

1. Remove the air inlet duct, Idle Air Control (IAC) and Throttle Position Sensor (TPS) connectors.
2. Remove the vacuum lines and coolant hoses.
3. Remove the throttle cable and the cruise control cables, if equipped.
4. Remove the throttle body retaining screws and the throttle body.
5. To install, reverse the removal procedures.

Plenum

2.8L ENGINE

1. Remove the negative battery cable.
2. Remove the air inlet duct at the throttle body.
3. Remove the throttle body retaining bolts and the throttle body.
4. Remove the EGR pipe bolts and the EGR valve.
5. Remove the throttle cable bracket.
6. Remove the plenum bolts and the plenum. Clean the gasket material from the sealing surfaces.
7. To install, use new gaskets and reverse the removal procedures.

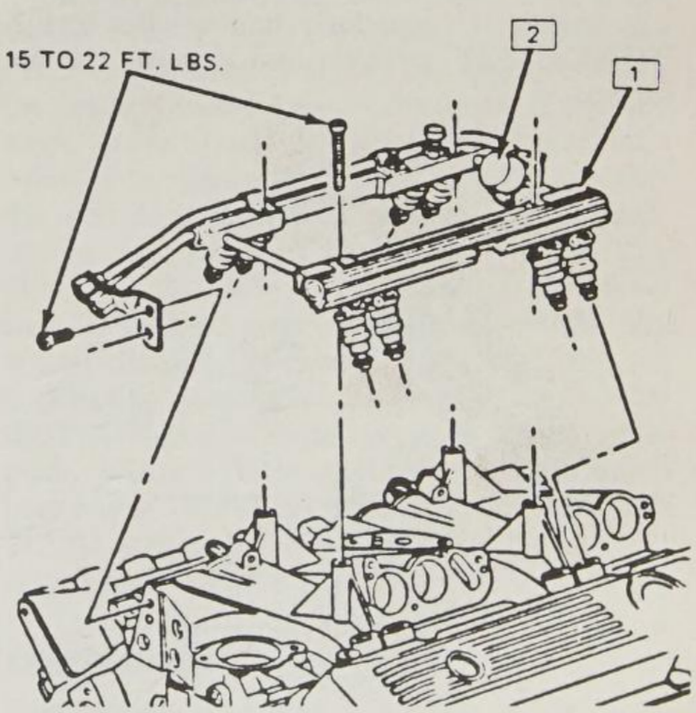
5.0L ENGINE

1. Remove the negative battery cable.
2. Remove the throttle cable, thermal vacuum connector, and the cruise control cable, if equipped.
3. Remove the cable retaining bracket.
4. Remove the Throttle Position Sensor (TPS) and the Idle Air Control (IAC) connectors.
5. Remove the throttle body bolts and the throttle body.
6. Remove the brake booster pipe, vacuum hose and the canister control valve fresh air pipe.
7. Remove the right runners, the plenum retaining bolts and the plenum. Clean the gasket material from the sealing surfaces.
8. To install, use new gaskets and reverse the removal procedures.

Fuel Rail and Pressure Regulator Assembly

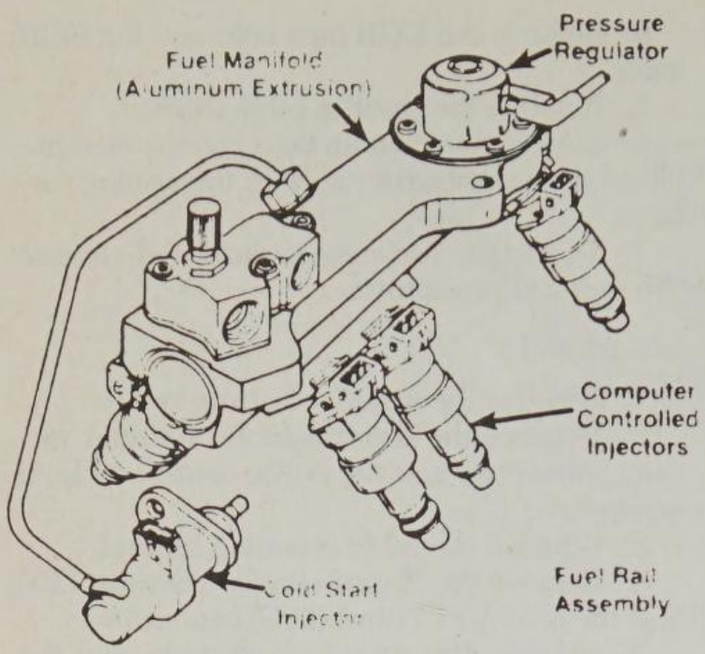
NOTE: *When servicing the fuel system, be sure to relieve the pressure of the system and drain the fuel into an approved container. DO NOT allow dirt or other contaminants to enter the system.*

1. Refer to the Plenum Removal and Installation procedures in this section and remove the plenum.



1. Fuel rail
2. Pressure regulator

Tuned Port Injection Fuel Rail



Multi-Port Fuel Injection Fuel Rail

2. Remove the fuel lines and the cold start valve. Remove the injector harness connectors.

3. On the 2.8L engine, remove the vacuum line at the pressure regulator.

4. Remove the fuel rail retaining bolts, the fuel rail and injectors.

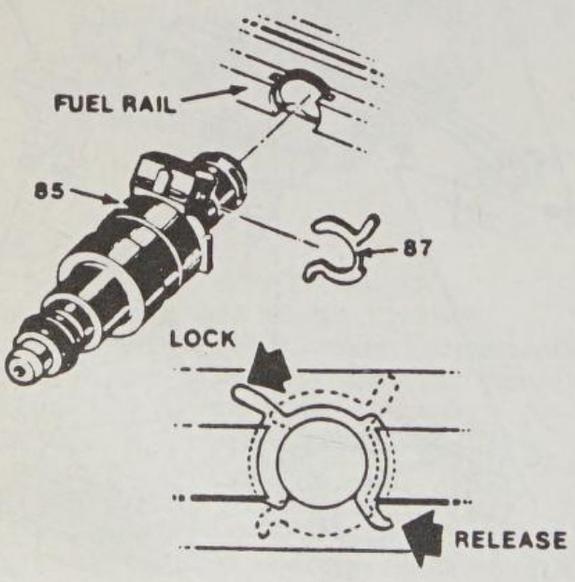
5. To install, replace the O-rings of the fuel injectors, coat the O-rings with engine oil and reverse the removal procedure.

6. Turn the ignition "ON" and "OFF" several times and inspect for leaks.

Fuel Injectors

1. Refer the Fuel Rail and Pressure Regulator Removal and Installation procedures in this section and remove the fuel rail.

2. Rotate the injector retaining clips to the "UNLOCKED" position and remove the injectors.



85. Injector—port
87. Clip—injector retainer

Removing fuel injector from the fuel rail

3. To install, replace the O-rings, coat them with engine oil and reverse the removal procedures.

Cold Start Valve

NOTE: *On the 2.8L engine, refer to the Plenum Removal and Installation procedures in this section and remove the plenum. Also remove the distributor cap.*

1. Remove the negative battery cable and brake booster line.

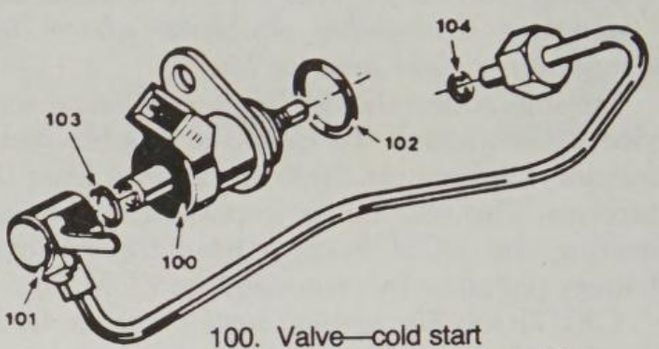
2. Disconnect the fuel line at the fuel rail.

3. Disconnect the wiring harness.

4. Remove the pollution control valve pipe retaining screw.

5. Remove the valve retaining bolt and valve.

6. To install, use new O-rings and reverse the removal procedures.



100. Valve—cold start
101. Tube and body assembly
102. O-ring seal—valve
103. O-ring seal—body
104. O-ring seal—tube

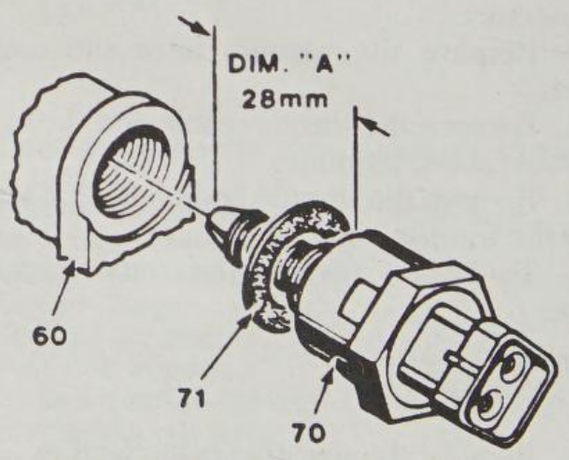
Cold Start Valve Assembly

Idle Air Control Valve

1. Remove electrical connector from idle air control valve.

2. Remove the idle air control valve.

3. Installation is the reverse of removal. Before installing the idle air control valve, measure the distance that the valve is extended. Measurement should be made from the motor



60. Idle air/vacuum signal housing
70. Idle air control valve (IAC)
71. IAC gasket

Idle Air Control Valve Assembly

housing to the end of the cone. The distance should not exceed 1⅛ inches, or damage to the valve may occur when installed. Use a new gasket and turn the ignition on then off again to allow the ECM to reset the idle air control valve.

NOTE: *Identify replacement IAC valve as being either Type 1 (with collar at electric terminal end) or Type 2 (without collar). If measuring distance is greater than specified above, proceed as follows:*
Type 1: Press on valve firmly to retract it
Type 2: Compress retaining spring from valve while turning valve in with a clockwise motion. Return spring to original position with straight portion of spring end aligned with flat surface of valve.

Throttle Position Sensor

1. Disconnect the electrical connector from the sensor.
2. Remove the attaching screws, lockwashers and retainers.
3. Remove the throttle position sensor. If necessary, remove the screw holding the actuator to the end of the throttle shaft.
4. With the throttle valve in the normal closed idle position, install the throttle position sensor on the throttle body assembly, making sure the sensor pickup lever is located above the tang on the throttle actuator lever.
5. Install the retainers, screws and lockwashers using a thread locking compound. DO NOT tighten the screws until the throttle position switch is adjusted.
6. Install three jumper wires between the throttle position switch and the harness connector.
7. With the ignition switch ON, use a digital voltmeter connected to terminals B and C and adjust the switch to obtain 0.35–0.45 volts.
8. Tighten the mounting screws, then recheck the reading to insure that the adjustment hasn't changed.
9. Turn ignition OFF, remove jumper wires, then reconnect harness to throttle position switch.

Oxygen Sensor

NOTE: *The oxygen sensor uses a permanently attached pigtail and connector. This pigtail should not be removed from the oxygen sensor. Damage or removal of the pigtail or connector could affect proper operation of the oxygen sensor.*

The oxygen sensor is installed in the exhaust manifold and is removed in the same manner as a spark plug. The sensor may be difficult to remove when the engine temperature is below 120 deg. F (48 deg. C) and excessive force may damage threads in the exhaust manifold or exhaust pipe. Exercise care when handling the oxygen sensor; the electrical connector and louvered end must be kept free of grease, dirt, or other contaminants. Avoid using cleaning solvents of any kind and don't drop or roughly handle the sensor. A special anti-seize compound is used on the oxygen sensor threads when installing and care should be used NOT to get compound on the sensor itself. Disconnect the negative battery cable when servicing the oxygen sensor and torque to 30 ft. lbs. (41 Nm) when installing.

Electronic Control Module

To remove the ECM, first disconnect the battery. Remove the wiring harness and mounting hardware, then remove the ECM from the passenger compartment. The PROM and CALPAK are located under the access cover on the top of the control unit. Using the rocker type PROM removal tool, or equivalent, engage one end of the PROM carrier with the hook end of the tool. Press on the vertical bar end of the tool and rock the engaged end of the PROM carrier up as far as possible. Engage the opposite end of the PROM carrier in the same manner and rock this end up as far as possible. Repeat this process until the PROM carrier and PROM are free of the socket. The PROM carrier should only be removed with the removal tool or damage to the PROM or PROM socket may occur. When installing the PROM carrier in the PROM socket, the small notch of the carrier should be aligned with the small notch in the socket. Press on the PROM carrier until it is firmly seated in the socket. DO NOT press on the PROM; only the carrier. To check the PROM installation, reinstall the ECM and turn the ignition switch ON. Activate the diagnostic mode as previously described and check that a code 12 is displayed. Code 12 indicates that the PROM is installed correctly and is functioning normally. If trouble code 51 is displayed, or the "service engine soon" light is on steadily with no codes, the PROM is not fully seated, installed backwards, has bent pins, or is defective. Bent pins may be straightened and the PROM can be seated properly with a gentle push, but a PROM that has been installed backwards should be replaced. Any time the PROM is installed backwards and the ignition is switched ON, the PROM is destroyed.

TESTING

Fuel System Pressure

When the ignition switch is turned ON, the in-tank fuel pump is energized for as long as the engine is cranking or running and the control

unit is receiving signals from the HEI distributor. If there are no reference pulses, the control unit will shut off the fuel pump within two seconds. The pump will deliver fuel to the fuel rail and injectors, then the pressure regulator where the system pressure is controlled to maintain 26–46 psi.

1. Connect pressure gauge J-34370-1, or equivalent, to fuel pressure test point on the fuel rail. Wrap a rag around the pressure tap to absorb any leakage that may occur when installing the gauge.
2. Turn the ignition ON and check that pump pressure is 34–40 psi. This pressure is controlled by spring pressure within the regulator assembly.
3. Start the engine and allow it to idle. The fuel pressure should drop to 28–32 psi due to the lower manifold pressure.

NOTE: *The idle pressure will vary somewhat depending on barometric pressure. Check for a drop in pressure indicating regulator control, rather than specific values.*

4. If the fuel pressure drops, check the operation of the check valve, the pump coupling connection, fuel pressure regulator valve and the injectors. A restricted fuel line or filter may also cause a pressure drop. To check the fuel pump output, restrict the fuel return line and run 12 volts to the pump. The fuel pressure should rise to approximately 75 psi with the return line restricted.

CAUTION: *Before attempting to remove or service any fuel system component, it is necessary to relieve the fuel system pressure.*

Relieving Fuel System Pressure

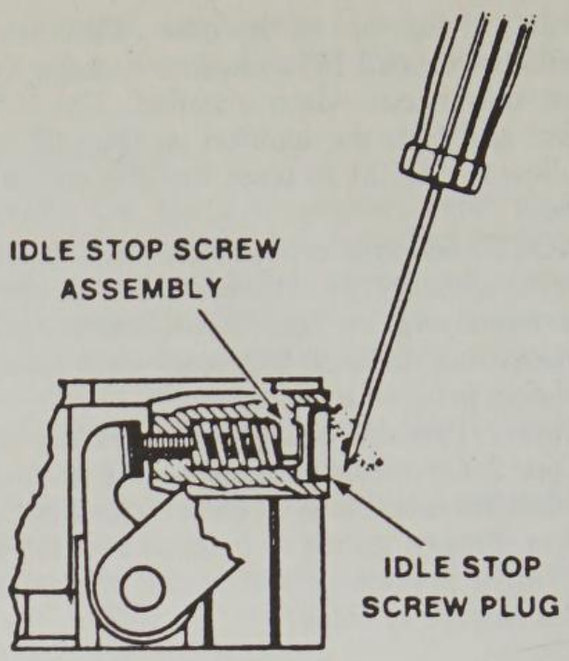
1. Remove the fuel pump fuse from the fuse block.
2. Start the engine. It should run and then stall when the fuel in the lines is exhausted. When the engine stops, crank the starter for about three seconds to make sure all pressure in the fuel lines is released.
3. Replace the fuel pump fuse.

ADJUSTMENTS

NOTE: *Due to the complexity of the system, any adjustments should be performed by a qualified mechanic.*

Idle Speed Adjustment

1. Remove the idle stop screw plug by piercing it with an awl.
2. With idle air control motor connected, ground the diagnostic connector.
3. Turn the ignition "ON" and wait 30 seconds, DO NOT start the engine.
4. Disconnect the idle air control connector with the ignition "ON".



Removing the Idle Stop Screw Plug

5. Remove the ground from the diagnostic connector and start the engine.
6. On 2.8L engines, adjust the idle stop screw to 450–550 rpm, in "DRIVE" for automatic transmissions or 550–650 rpm for manual transmissions.
7. On 5.0L engines, adjust the idle stop screw to 450–550 rpm, in "DRIVE".
8. Turn the ignition "OFF" and reconnect the idle air control motor connector.
9. Remove the throttle position sensor connector and install three jumper wires between the connector and the sensor. Connect a digital voltmeter to terminals "A" and "B".
10. Turn the ignition "ON" and adjust the sensor to .50–.60 volt for the 2.8L engine or .475–.615 volt for the 5.0L engine.
11. Tighten the screws, remove the jumper wires with the ignition "OFF" and reconnect the harness connector.
12. Start the engine and check for proper idle operation.

Cold Start Valve Adjustment

1. With the valve removed from the engine, turn the valve completely into the body.
2. Turn the valve back one complete turn until the electrical connector is at the top position.
3. Bend the body tang forward so the valve cannot turn more than one full turn.
4. Reinstall the valve to the engine.

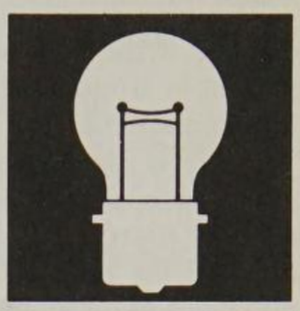
Fuel Tank

REMOVAL AND INSTALLATION

NOTE: *Refer to the Electric Fuel Pump (TBI) section.*

Chassis Electrical

5



UNDERSTANDING AND TROUBLESHOOTING ELECTRICAL SYSTEMS

For any electrical system to operate, it must make a complete circuit. This simply means that the power flow from the battery must make a complete circle. When an electrical component is operating, power flows from the battery to the component, passes through the component causing it to perform its function (lighting a light bulb, for example) and then returns to the battery through the ground of the circuit. This ground is usually (but not always) the metal part of the car on which the electrical component is mounted.

Perhaps the easiest way to visualize this is to think of connecting a light bulb with two wires attached to it to your car battery. The battery in your car has two posts (negative and positive). If one of the two wires attached to the light bulb was attached to the negative post of the battery and the other wire was attached to the positive post of the battery, you would have a complete circuit. Current from the battery would flow out one post, through the wire attached to it and then to the light bulb, causing it to light. It would then leave the light bulb, travel through the other wire, and return to the other post of the battery.

The normal automotive circuit differs from this simple example in two ways. First, instead of having a return wire from the bulb to the battery, the light bulb returns the current to the battery through the chassis of the vehicle. Since the negative battery cable is attached to the chassis and the chassis is made of electrically conductive metal, the chassis of the vehicle can serve as a ground wire to complete the circuit. Secondly, most automotive circuits contain switches to turn components on and off as required.

There are many types of switches, but the most common simply serves to prevent the passage of current when it is turned off. Since the switch is a part of the circle necessary for a complete circuit, it operates to leave an opening in the circuit, and thus an incomplete or open circuit, when it is turned off.

Some electrical components which require a large amount of current to operate also have a relay in their circuit. Since these circuits carry a large amount of current, the thickness of the wire (gauge size) in the circuit is also greater. If this large wire were connected from the component to the control switch on the instrument panel, and then back to the component, a voltage drop would occur in the circuit. To prevent this potential drop in voltage, an electromagnetic switch (relay) is used. The large wires in the circuit are connected from the car battery to one side of the relay, and from the opposite side of the relay to the component. The relay is normally open, preventing current from passing through the circuit. An additional, smaller, wire is connected from the relay to the control switch for the circuit. When the control switch is turned on, it grounds the smaller wire from the relay and completes the circuit. This closes the relay and allows current to flow from the battery to the component. The horn, headlight, and starter circuits are three which use relays.

You have probably noticed how the car's instrument panel lights get brighter the faster you rev the engine. This happens because your alternator (which supplies the battery) puts out more current at speeds above idle. This is normal. However, it is possible for larger surges of current to pass through the electrical system of your car. If this surge of current were to reach an electrical component, it could burn the component out. To prevent this from happening, fuses are connected into the current supply wires of most of the major electrical sys-

tems of your car. The fuse serves to head off the surge at the pass. When an electrical current of excessive power passes through the component's fuse, the fuse blows out and breaks the circuit, saving it from destruction.

The fuse also protects the component from damage if the power supply wire to the component is grounded before the current reaches the component.

There is another important rule to the complete circle circuit. *Every complete circuit from a power source must include a component which is using the power from the power source.* If you were to disconnect the light bulb (from the previous example of a light bulb being connected to the battery by two wires together—take our word for it—don't try it) the result would literally be shocking. A similar thing happens (on a smaller scale) when the power supply wire to a component or the electrical component itself becomes grounded before the normal ground connection for the circuit. To prevent damage to the system, the fuse for the circuit blows to interrupt the circuit—protecting the components from damage. Because grounding a wire from a power source makes a complete circuit—less the required component to use the power—this phenomenon is called a short circuit. The most common causes of short circuits are: the rubber insulation on a wire breaking or rubbing through to expose the current carrying core of the wire to a metal part of the car, or a short switch.

Some electrical systems on the car are protected by a circuit breaker which is, basically, a self-repairing fuse. When either of the above-described events takes place in a system which is protected by a circuit breaker, the circuit breaker opens the circuit the same way a fuse does. However, when either the short is removed from the circuit or the surge subsides, the circuit breaker resets itself and does not have to be replaced as a fuse does.

The final protective device in the chassis electrical system is a fuse link. A fuse link is a wire that acts as a fuse. It is connected between the starter relay and the main wiring harness for the car. This connection is under the hood, very near a similar fuse link which protects all the chassis electrical components. It is the probable cause of trouble when none of the electrical components function, unless the battery is disconnected or dead.

Electrical problems generally fall into one of three areas:

1. The component that is not functioning is not receiving current.
2. The component itself is not functioning.
3. The component is not properly grounded.

Problems that fall into the first category are by far the most complicated. It is the current supply system to the component which contains all the switches, relays, fuses, etc.

The electrical system can be checked with a test light and a jumper wire. A test light is a device that looks like a pointed screwdriver with a wire attached to it. It has a light bulb in its handle. A jumper wire is a piece of insulated wire with an alligator clip attached to each end.

If a light bulb is not working, you must follow a systematic plan to determine which of the three causes is the villain.

1. Turn on the switch that controls the inoperable bulb.
2. Disconnect the power supply wire from the bulb.
3. Attach the ground wire on the test light to a good metal ground.
4. Touch the probe end of the test light to the end of the power supply wire that was disconnected from the bulb. If the bulb is receiving current, the test light will go on.

NOTE: *If the bulb is one which works only when the ignition key is turned on (turn signal), make sure the key is turned on.*

If the test light does not go on, then the problem is in the circuit between the battery and the bulb. As mentioned before, this includes all the switches, fuses, and relays in the system. The problem is an open circuit between the battery and the bulb. If the fuse is blown and, when replaced, immediately blows again, there is a short circuit in the system which must be located and repaired. If there is a switch in the system, bypass it with a jumper wire. This is done by connecting one end of the jumper wire to the power supply wire into the switch, and the other end of the jumper wire to the wire coming out of the switch. If the test light lights with the jumper wire installed, the switch or whatever was bypassed is defective.

NOTE: *Never substitute the jumper wire for the bulb, as the bulb is the component required to use the power from the power source.*

5. If the bulb in the test light goes on, then the current is getting to the bulb that is not working in the car. This eliminates the first of the three possible causes. Connect the power supply wire and connect a jumper wire from the bulb to a good metal ground. Do this with the switch which controls the bulb turned on, and also the ignition switch turned on if it is required for the light to work. If the bulb works with the jumper wire installed, then it has a bad ground. This is usually caused by the metal area on which the bulb mounts to the car being coated with some type of foreign matter or rust.
6. If neither test located the source of the trouble, then the light bulb itself is defective.

The above test procedure can be applied to any of the components of the chassis electrical system by substituting the component that is not working for the light bulb. Remember that for any electrical system to work, all connections must be clean and tight.

HEATER

Blower Motor

REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable.
2. Remove all electrical connections.
3. Remove the blower motor cooling tube.
4. Remove the retaining screws and the blower motor.
5. Installation is the reverse of removal.

Core

REMOVAL AND INSTALLATION

1. Drain the cooling system.
2. Remove both heater hoses.
3. Remove the lower right hush panel.
4. Remove the lower right instrument panel and the ESC module if necessary.
5. Remove the lower right instrument panel to cowl screw.
6. Remove the heater case screws.

NOTE: *The upper left screw may be reached with a long socket extension. Carefully lift the lower right corner of the instrument panel to align the extension.*

7. Remove the case cover.
8. Remove the support plate and baffle screws.
9. Remove the heater core and baffle plate from the housing.
10. Installation is the reverse of removal.

RADIO

Sport Coupe Model

REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable.
2. Remove the console bezel screws.
3. Remove the radio to console attaching screws.
4. Remove the radio and disconnect the electrical connector.
5. Installation is the reverse of removal.

NOTE: *Always connect the speakers before applying power to the radio as radio damage may result.*

Berlinetta Model

REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable. Remove the 4 screws at the console trim plate.
2. Lift the receiver, with the connector attached, and turn to one side.
3. Remove the 4 control head mounting bracket screws. Remove the control head by pulling back on the pawl spring and pulling up on the control head.
4. Disconnect the electrical connectors from the control head.
5. Remove 4 screws at the receiver bracket and a slotted screw at the receiver.
6. Disconnect the electrical connector and remove the receiver.
7. To install, reverse the removal procedures.

WINDSHIELD WIPERS

Wiper Motor

REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable at the battery.
2. Remove the screen or grille that covers the cowl area.
3. Working under the hood, disconnect the motor wiring. Then, reach through the cowl opening and loosen, but do not remove, the nuts which attach the transmission drive link to the motor crank arm. Then, disconnect the drive link from the crank arm.
4. Remove the three motor attaching screws, and remove the motor, guiding the crank arm through the hole.
5. Installation is in the reverse order of removal. The motor must be in the park position before assembling the crank arm to the transmission drive link(s).

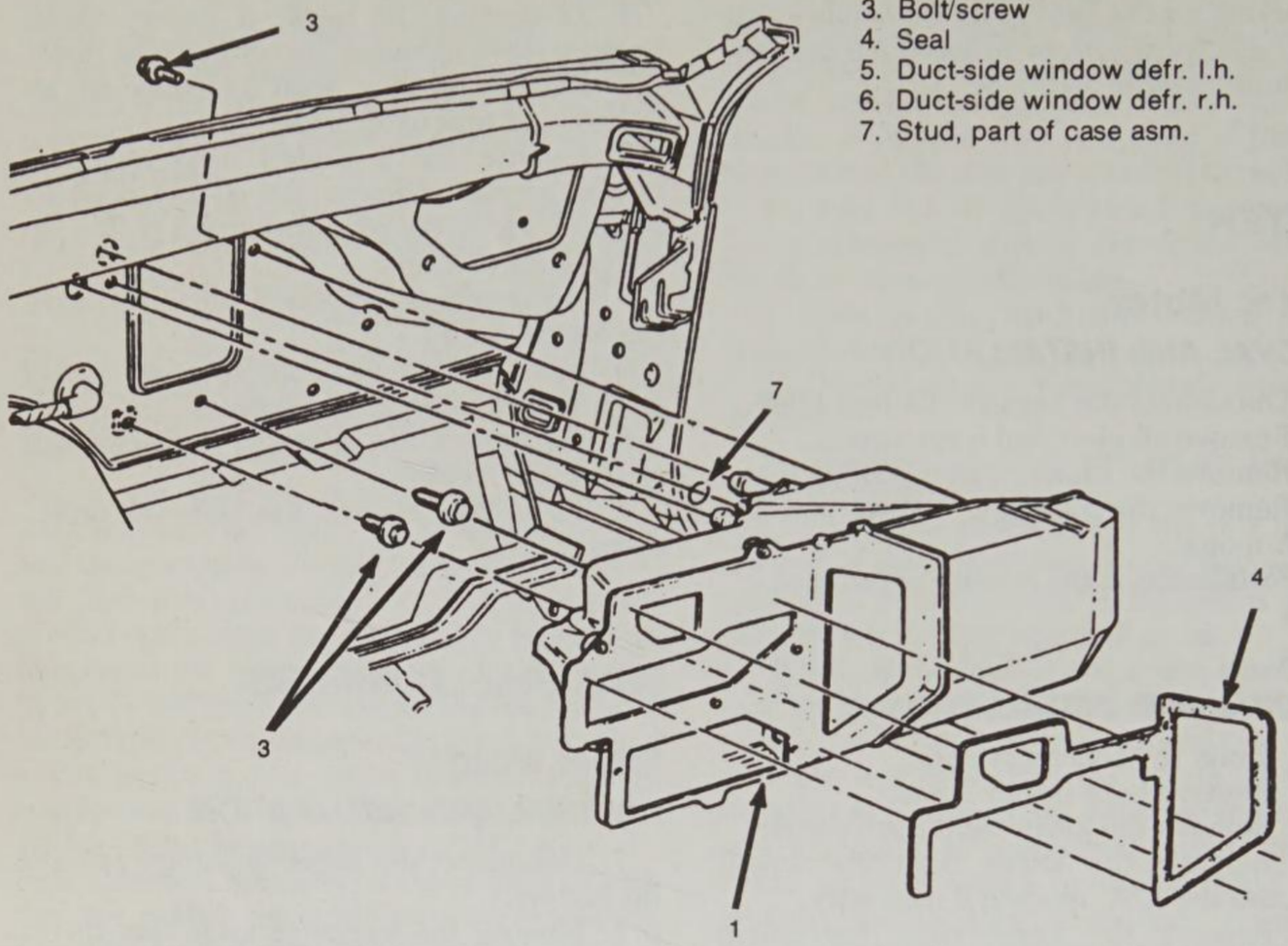
Wiper Arms and Blades

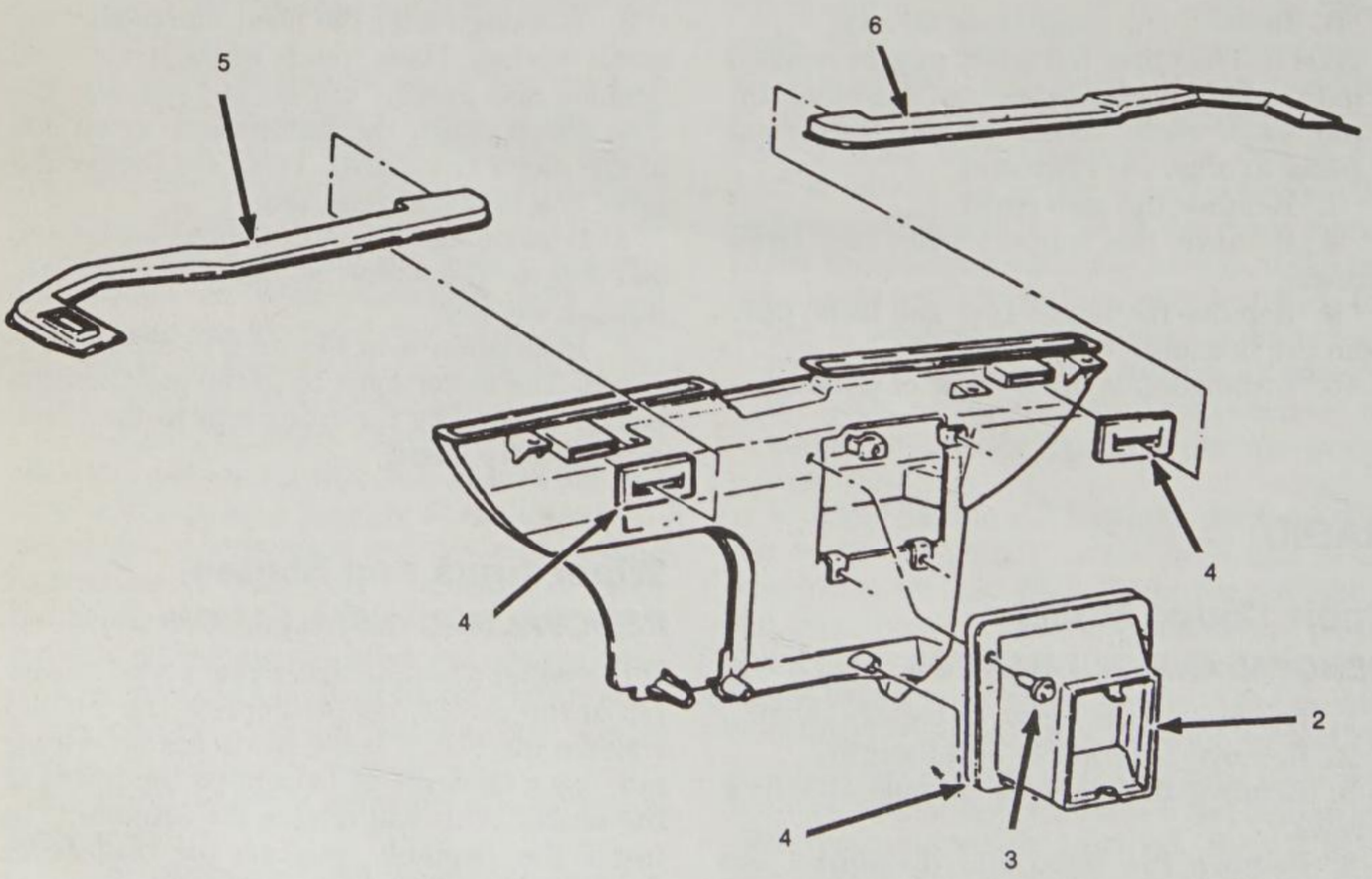
REMOVAL AND INSTALLATION

If the wiper assembly has a press type release tab at the center, simply depress the tab and remove the blade. If the blade has no release tab, use a screwdriver to depress the spring at the center. This will release the assembly. To install the assembly, position the blade over the pin at the tip of the arm and press until the spring retainer engages the groove in the pin.

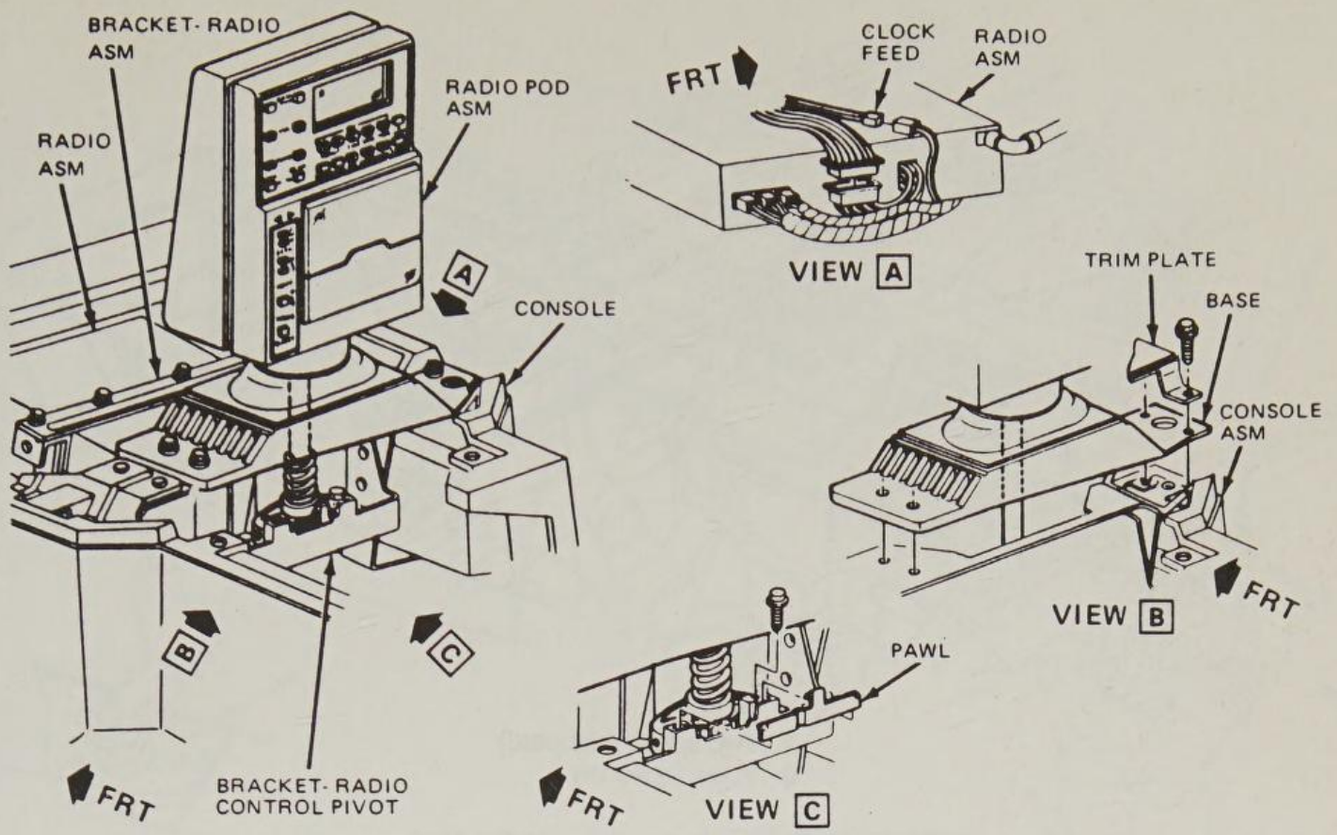
To remove the element, either depress the release button or squeeze the spring type re-

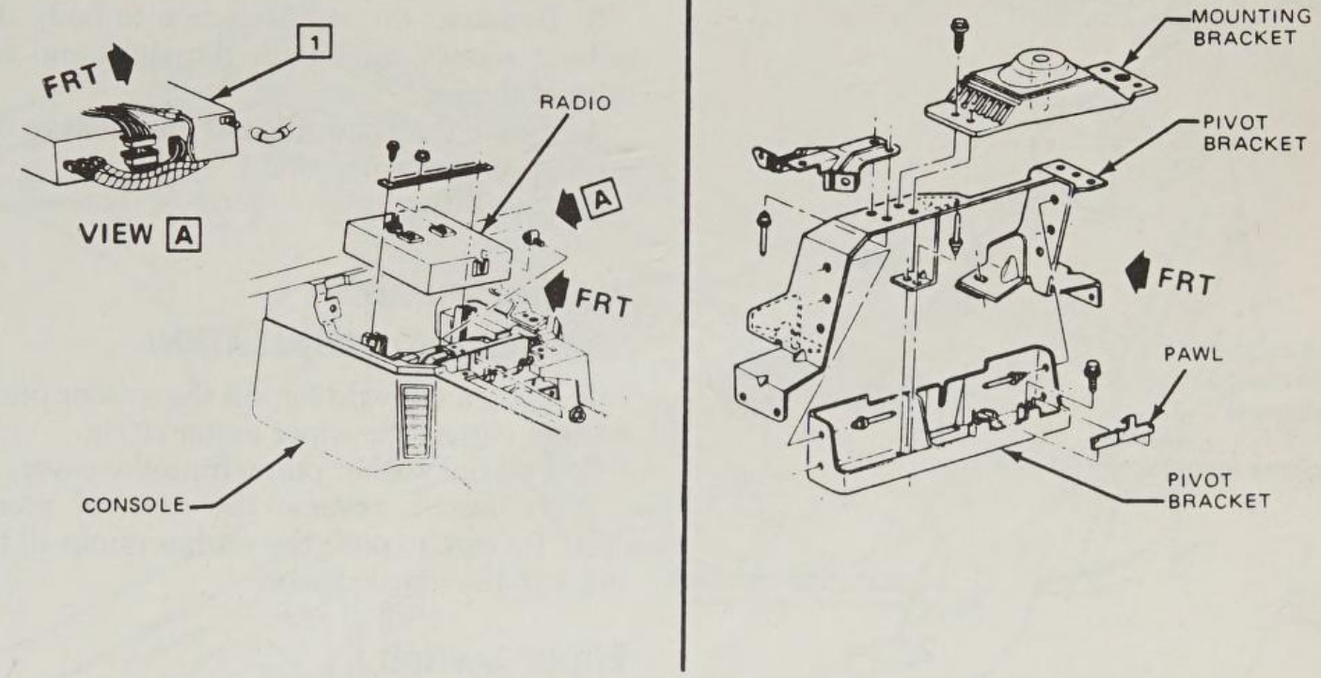
1. Core & case asm.
2. Duct asm. dist. ctr.
3. Bolt/screw
4. Seal
5. Duct-side window defr. l.h.
6. Duct-side window defr. r.h.
7. Stud, part of case asm.





Heater controller and mode cables





Berlinetta Radio Control Assembly

tainer clip at the outer end together, and slide the blade element out. Just slide the new element in until it latches.

Removal of the wiper arms requires the use of a special tool, G.M. J8966 or its equivalent. Versions of this tool are generally available in auto parts stores.

1. Insert the tool under the wiper arm and lever the arm off the shaft.

NOTE: *Raising the hood on most later models will facilitate easier wiper arm removal.*

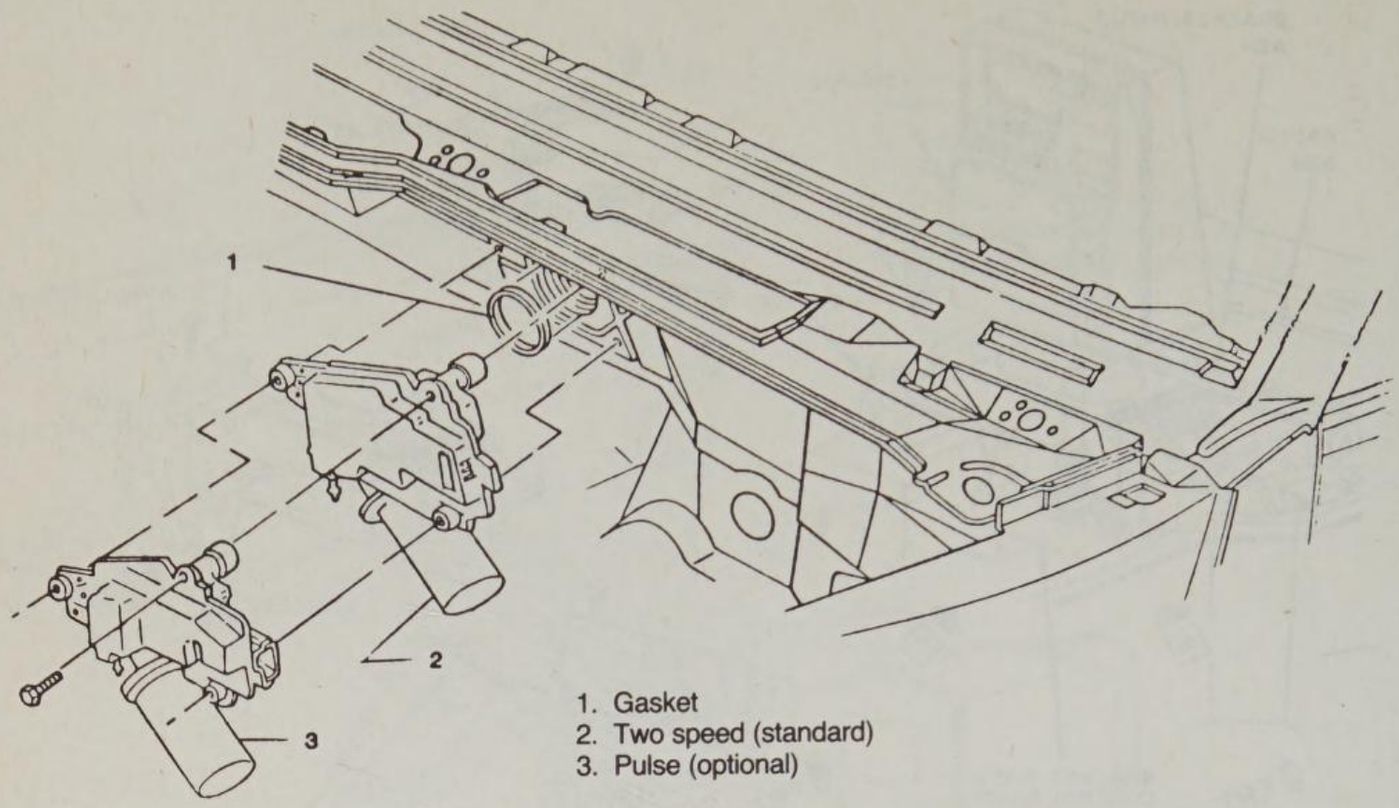
2. Disconnect the washer hose from the arm (if so equipped). Remove the arm.

3. Installation is in the reverse order of removal. Be sure that the motor is in the park position before installing the arms.

Wiper Linkage

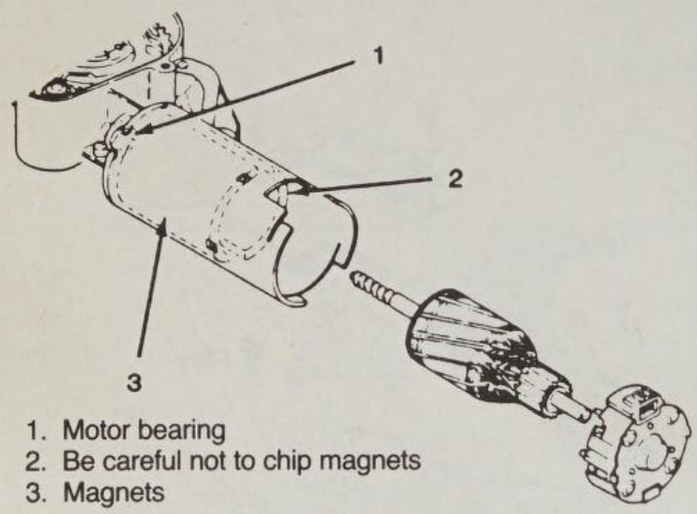
REMOVAL AND INSTALLATION

1. Remove the wiper arms and blades. Remove the cowl screen or grille.



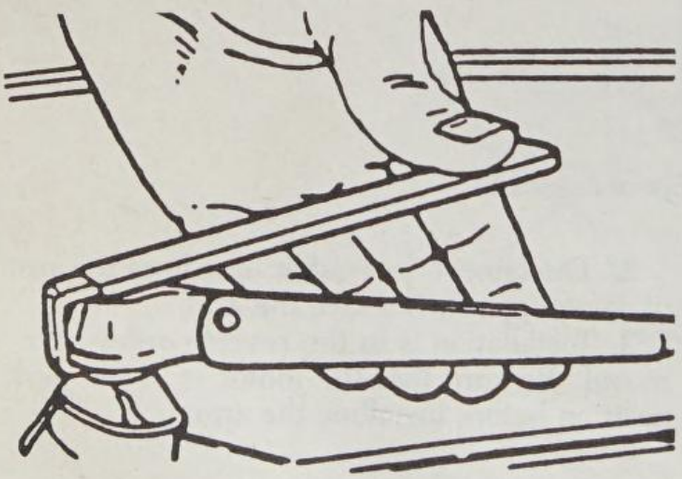
1. Gasket
2. Two speed (standard)
3. Pulse (optional)

Wiper Motor Installation ('82–'83 Similiar)



1. Motor bearing
2. Be careful not to chip magnets
3. Magnets

Armature Installation ('84 and Later)



Remove the wiper arm with the special tool

2. Disconnect the wiring from the wiper motor. Loosen, but do not remove the nuts which attach the transmission drive link to the motor crank arm. Then, disconnect the drive link from the arm.

3. Remove the transmission-to-body attaching screws from both the right and left sides of the car.

4. Guide the transmissions and linkage out through the cowl opening.

5. Installation is the reverse of removal.

Washer Pump

REMOVAL AND INSTALLATION

1. using a screwdriver, lift the washer pump retainer clip on the wiper motor cover.

2. Pull the washer pump from the cover.

3. To install, reverse the removal procedure. Be sure to push the washer pump all the way into the female socket.

Wiper Switch

REMOVAL AND INSTALLATION

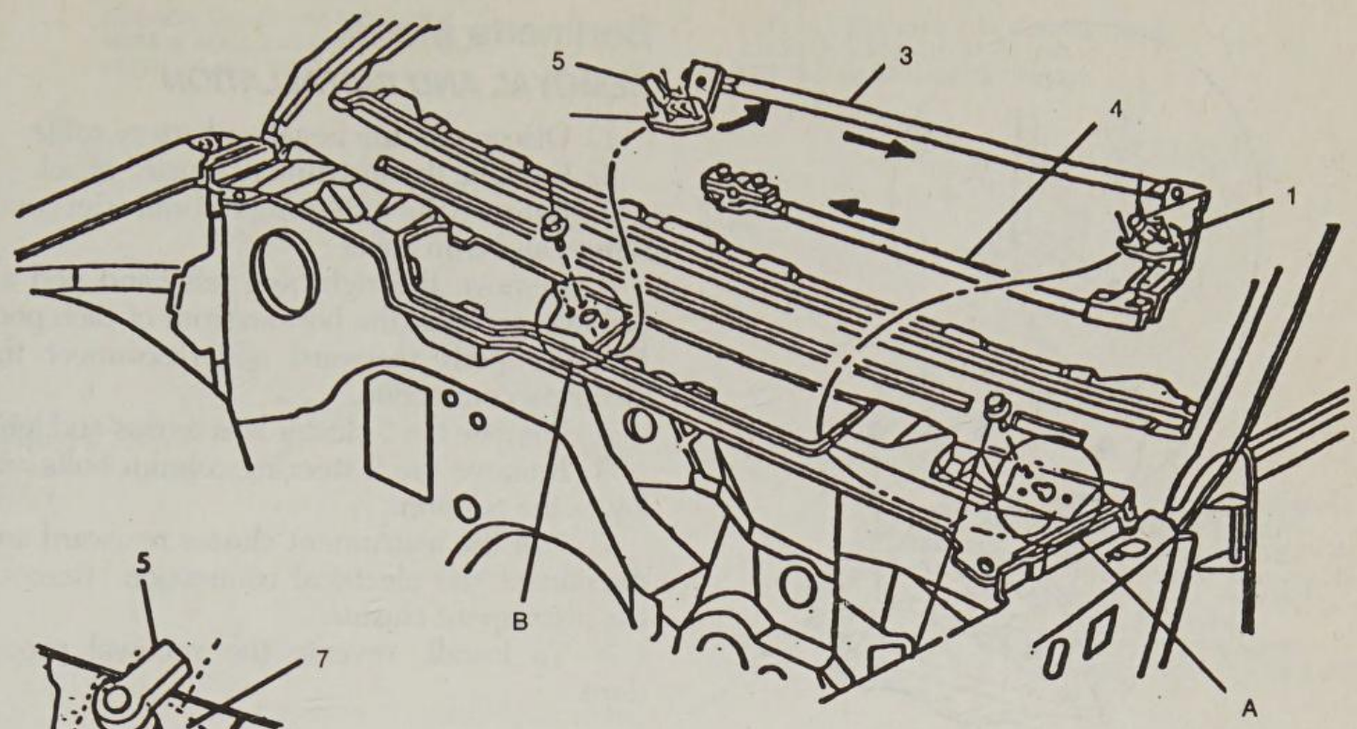
NOTE: *The wiper switch is part of the multi-function lever, located on the steering wheel column.*

1. Disconnect the electrical connector of the multi-function lever, located under the steering wheel.

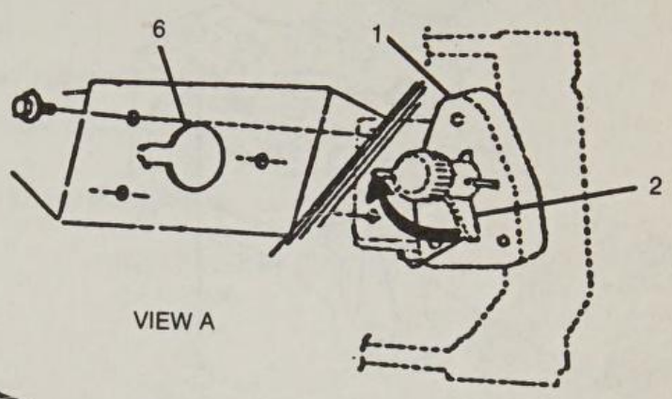
2. Remove the protective cover from the wire.

3. Grasp the lever firmly, twist and pull (the tang on the lever must align with the socket) the lever straight out.

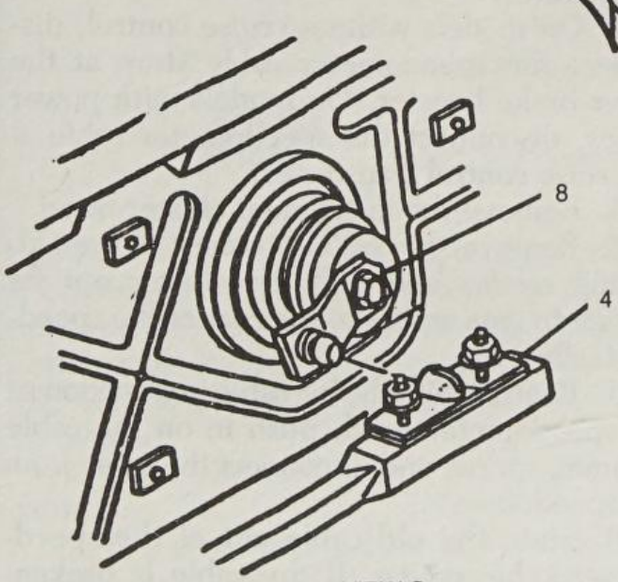
4. Pull the wire through the steering column.



VIEW B



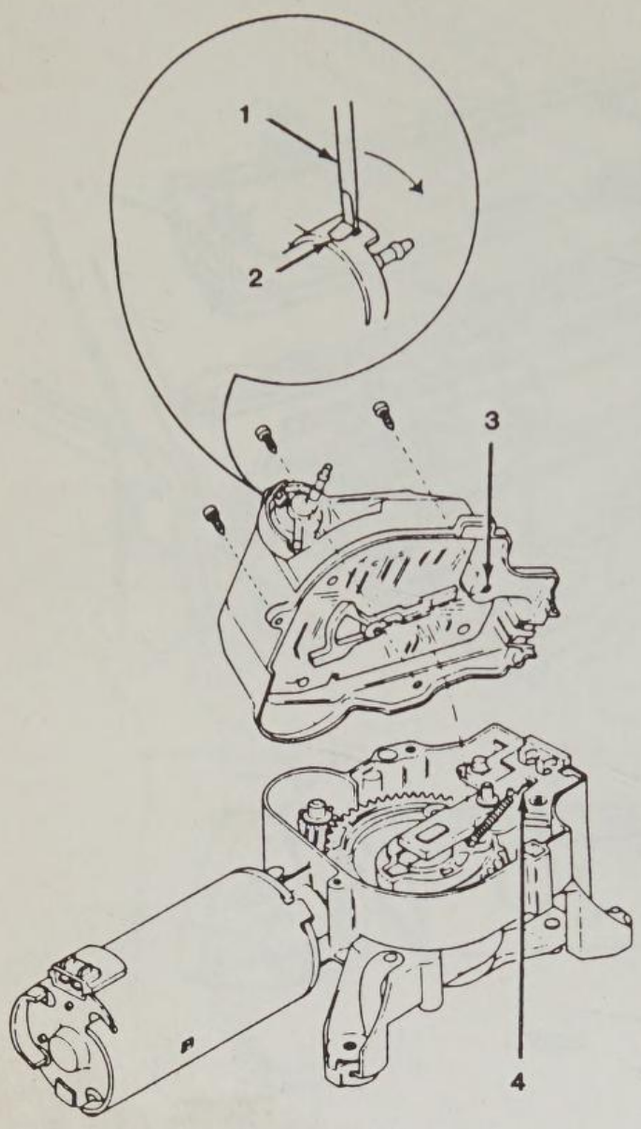
VIEW A



VIEW C

1. Left side driver housing
2. Locator rib
3. Forward motor link
4. Rearward wiper link
5. Right drive shaft
6. Clearance hole
7. Right side driver housing
8. Motor crank arm

Windshield wiper transmission installation



1. Screwdriver (rotate)
2. Retaining clip
3. Align cam arm with this hole
4. Wiper in park position

Washer Pump/Wiper Cover Replacement ('84 and Later)

5. To install, slide a music wire tool through the steering column and connect the lever wire to the tool wire; pull the wire through the steering column.

6. Push the control lever into the spring loaded socket (be sure to align the tang).

7. Reverse the removal procedures.

INSTRUMENT CLUSTER

Sport Coupe Model

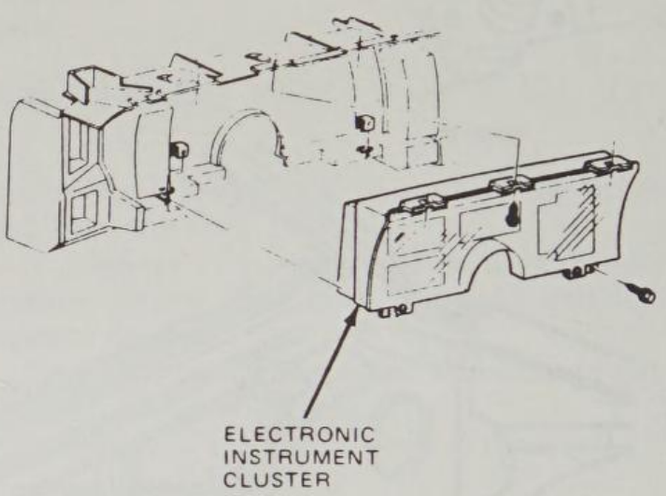
REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable.
2. Remove the instrument cluster bezel.
3. Remove the cluster attachment screws.
4. Pull the cluster out. Disconnect the speedometer cable and electrical connections.
5. Remove the cluster lens.
6. Installation is the reverse of removal.

Berlinetta Model

REMOVAL AND INSTALLATION

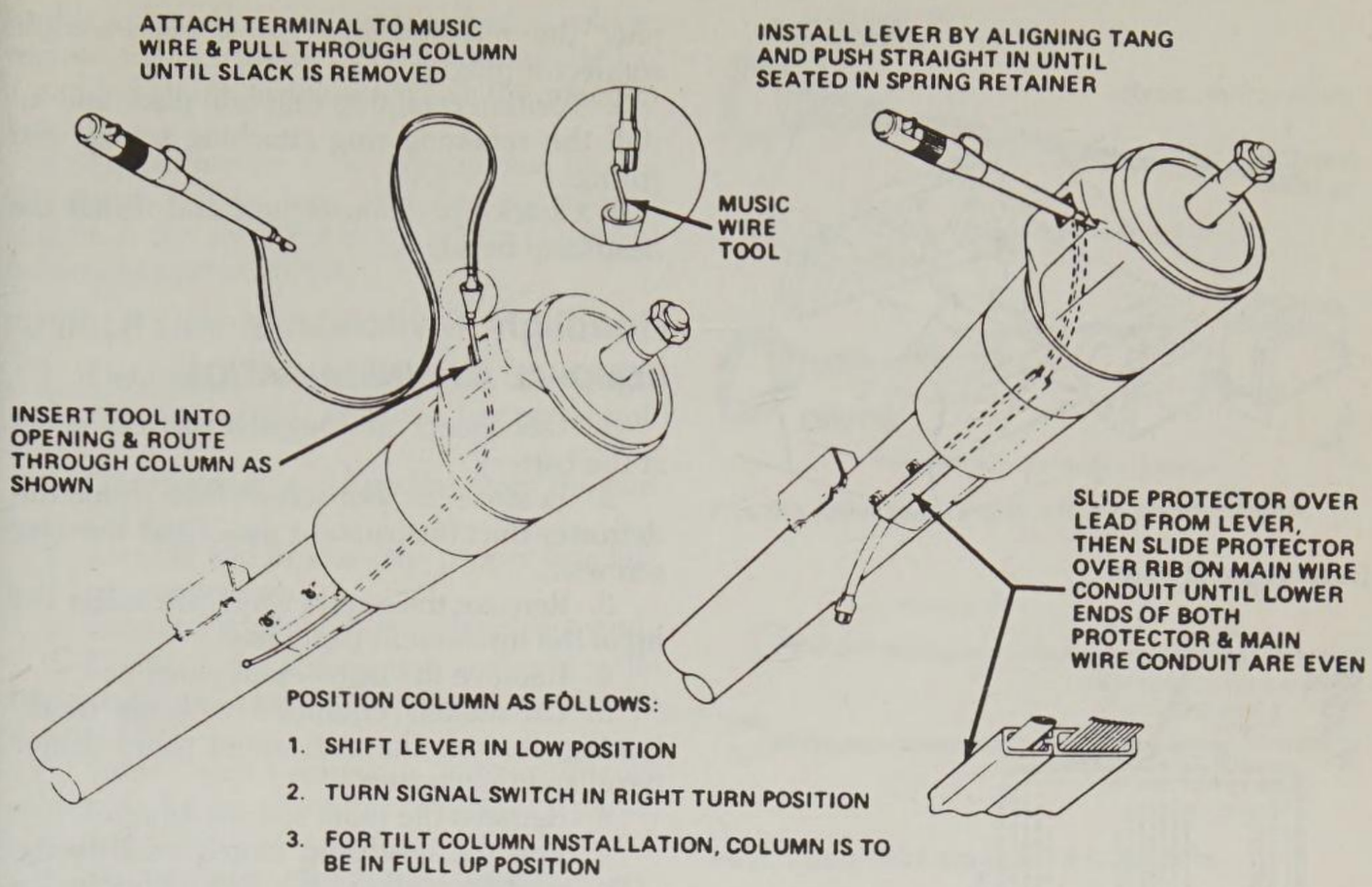
1. Disconnect the negative battery cable.
2. Remove the instrument cluster bezel.
3. Remove the 8 steering column trim cover screws and trim cover.
4. Remove the right and left hand pod attaching screws at the bottom front of each pod. Pull the pods rearward and disconnect the electrical connection.
5. Remove the 5 cluster lens screws and lens.
6. Remove the 2 steering column bolts and lower the column.
7. Pull the instrument cluster rearward and disconnect the electrical connection. Remove the instrument cluster.
8. To install, reverse the removal procedure.



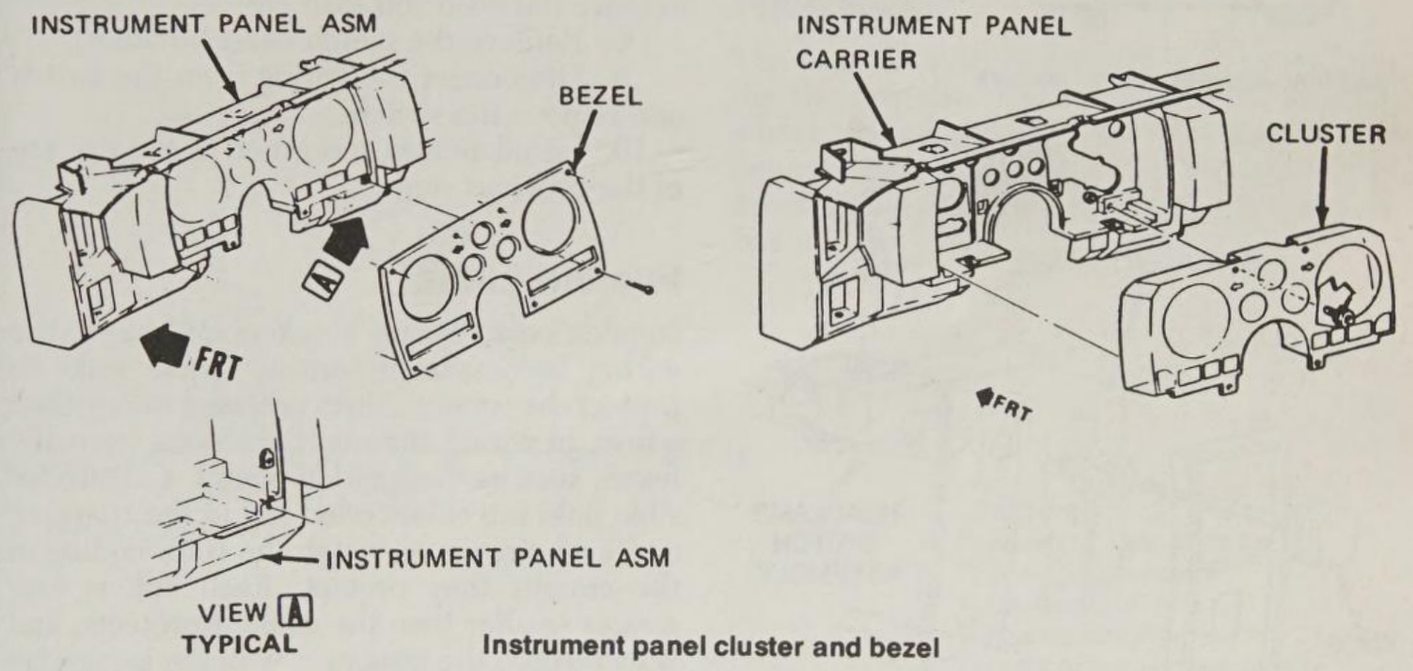
Berlinetta Instrument Cluster

SPEEDOMETER CABLE REPLACEMENT

1. Disconnect the negative battery cable at the battery.
2. On models without cruise control, disconnect the speedometer cable strap at the power brake booster. On models with power brakes, disconnect the speedometer cable at the cruise control transducer.
3. Remove the instrument cluster bezel.
4. Remove the six instrument cluster attaching screws and pull the cluster out far enough to gain access to the rear of the speedometer head.
5. Reach beneath the cable connection at the speedometer head, push in on the cable retaining spring, and disconnect the cable from the speedometer.
6. Slide the old cable out of the speedometer cable casing. If the cable is broken, remove the cable from both ends of the casing. Using a short piece of the old cable to fit the speedometer connection, turn the speedometer to increase the speed indicated on the



Multi-Function Lever Installation



Instrument panel cluster and bezel

dial and check for any binding during rotation. If binding is noted, the speedometer must be removed for repair or replacement. Check the entire cable casing for extreme bends, chafing, breaks, etc., and replace if necessary.

To install:

7. Wipe the cable clean using a lint-free cloth.

8. If the old casing is to be reused, flush the casing with petroleum spirits and blow dry with compressed air.

9. Lubricate the speedometer cable with an appropriate lubricant, being sure to cover the lower two-thirds of the cable.

10. Insert the cable into the casing, then connect the cable and casing assembly to the speedometer.

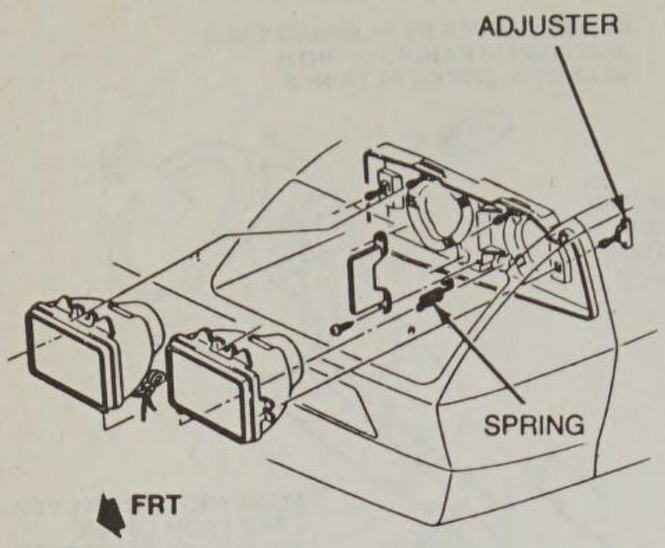
11. The remainder of the procedure is the reverse of steps 1–4.

LIGHTING

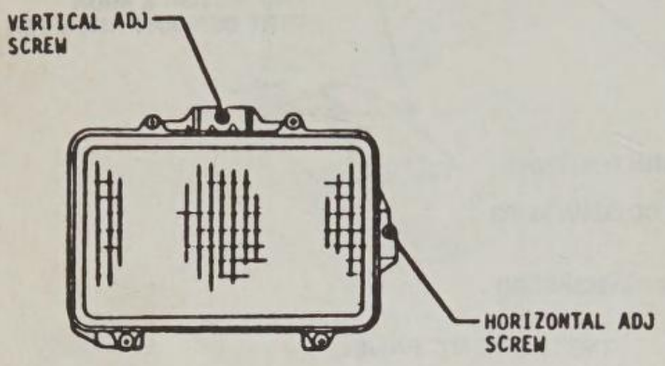
Headlights

REMOVAL AND INSTALLATION

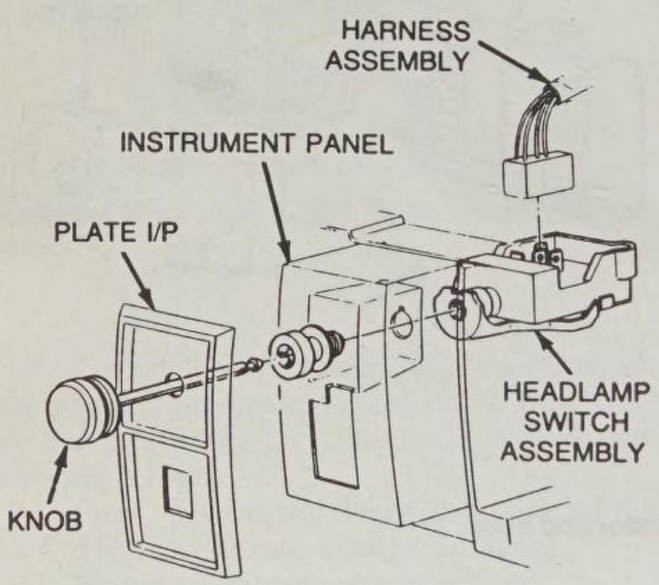
1. Remove headlamp bezel retaining screws and remove bezel.



Headlamp and bezel



Headlamp system aiming screws



Headlight switch

2. Disengage spring from the retaining ring with a cotter pin removal tool and remove two attaching screws.

3. Remove retaining ring, disconnect sealed beam unit at wiring connector and remove the unit.

4. Attach connector to replacement unit and position unit in place making sure the number molded into the lens face is at the top.

In the dual headlamp installation the inboard unit (No. 1) takes a double connector plug, the outboard unit (No. 2) takes a triple connector plug.

5. Position retaining ring into place and install the retaining ring attaching screws and spring.

6. Check operation of unit and install the headlamp bezel.

Headlight Switch

REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable at the battery.

2. Remove the four screws from inside the defroster duct (instrument panel pad securing screws).

3. Remove the screws which are under the lip of the instrument panel pad.

4. Remove the instrument panel pad.

5. On models equipped with air conditioning, remove the instrument panel cluster bezel and the cluster.

6. Remove the radio speaker bracket.

7. Pull the headlamp switch knob to the "ON" position, depress the locking button for the knob and shaft (located on the switch), and remove the knob and shaft.

8. Remove the switch bezel (retainer).

9. Disconnect the wiring from the switch and remove the switch.

10. Installation is performed in the reverse of the previous steps.

Fusible Links

In addition to circuit breakers and fuses, the wiring harness incorporates fusible links to protect the wiring. Links are used rather than a fuse, in wiring circuits that are not normally fused, such as the ignition circuit. Camaro fusible links are color coded red in the charging and load circuits to match the color coding of the circuits they protect. Each link is four gauges smaller than the cable it protects, and is marked on the insulation with the gauge size because the insulation makes it appear heavier than it really is.

The engine compartment wiring harness has several fusible links. The same size wire with a special hypalon insulation must be used when replacing a fusible link.

The links are located in the following areas:

1. A molded splice at the starter solenoid "Bat" terminal, a 14 gauge red wire.

2. A 16 gauge red fusible link at the junction block to protect the unfused wiring of 12 gauge or larger wire. This link stops at the bulkhead connector.

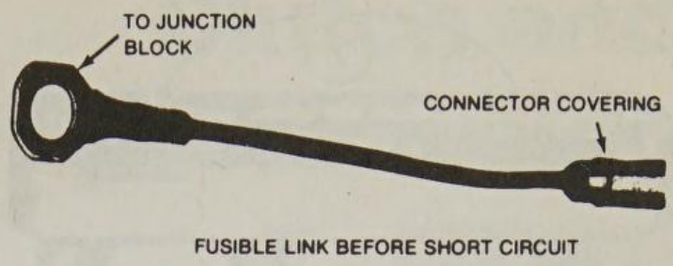
3. The alternator warning light and field circuitry is protected by a 20 gauge red wire

fusible link used in the "battery feed to voltage regulator #3 terminal." The link is installed as a molded splice in the circuit at the junction block.

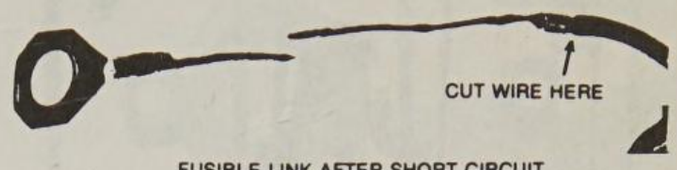
4. The ammeter circuit is protected by two 20 gauge fusible links installed as molded splices in the circuit at the junction block and battery to starter circuit.

FUSIBLE LINK REPAIR

1. Determine the circuit that is damaged.
2. Disconnect the negative battery terminal.
3. Cut the damaged fuse link from the harness and discard it.
4. Identify and procure the proper fuse link and butt connectors.
5. Strip the wire about ½ inch on each end.
6. Connect the fusible link and crimp the butt connectors making sure that the wires are secure.
7. Solder each connection with resin core solder, and wrap the connections with plastic electrical tape.
8. Reinstall the wire in the harness.
9. Connect the negative battery terminal and test the system for proper operation.

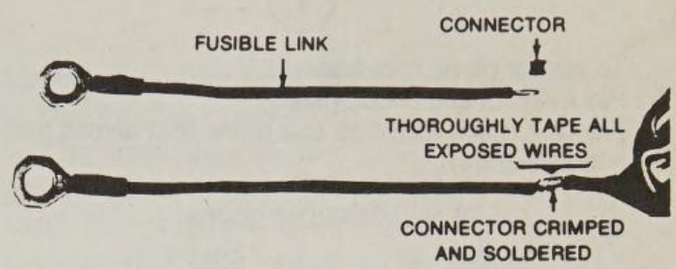


FUSIBLE LINK BEFORE SHORT CIRCUIT



FUSIBLE LINK AFTER SHORT CIRCUIT

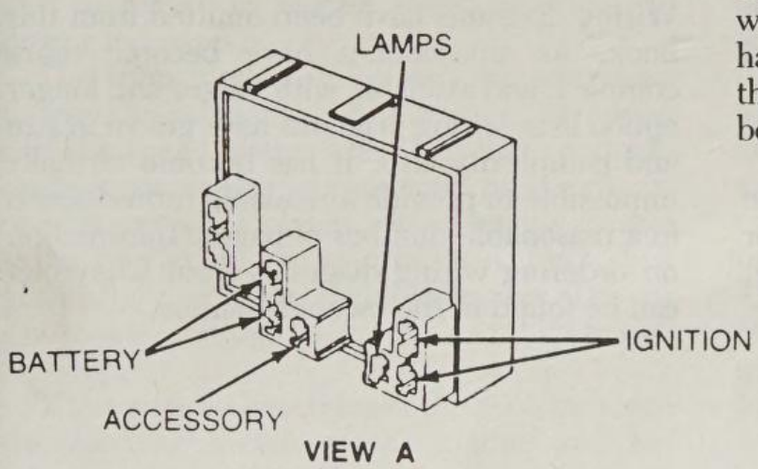
Fusible links before and after a short circuit



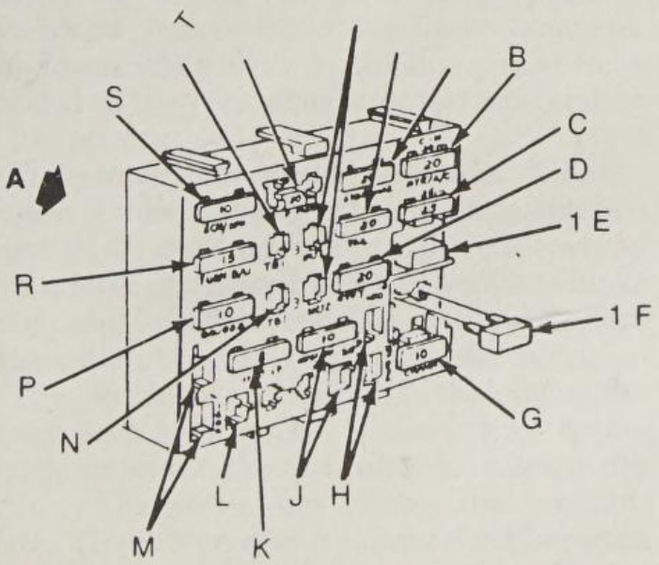
New fusible links are spliced to the wire

Fuse Block

The fuse block on some models is located under the instrument panel next to the steering wheel and is a swing down unit. Other models have the fuse block located on the right side of the dash and access is gained through the glove box.

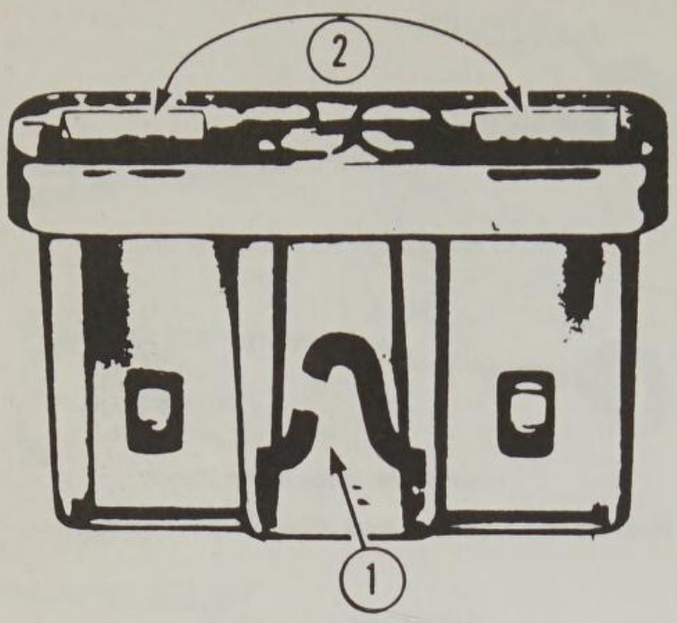


VIEW A



1. Circuit breaker
A. Fuse-stop & hazard lamps
B. Fuse—choke—heater
C. Fuse—heater & A/C
D. Fuse—courtesy lamp
E. Circuit breaker—power window
F. Circuit breaker—AU3/C49/AU6
G. Fuse—crank
H. Receptacle—battery
J. Fuse—receptacle—radio—wiper
K. Fuse & receptacle—instrument lamps
L. Receptacle—lamps
M. Receptacle—ignition
N. Receptacle—TB1
P. Fuse—gages
R. Fuse—turn & B/U lamps
S. Fuse—ECM—ignition
T. Receptacle—TB1
U. Fuse—fuel pump
V. Fuse—tail lamp
W. Receptacles—injector 1 & 2

Fuse Block and Designations



To test for blown mini-fuse:
1. Pull fuse out and check visually
2. With the circuit activated use a test light across the points shown

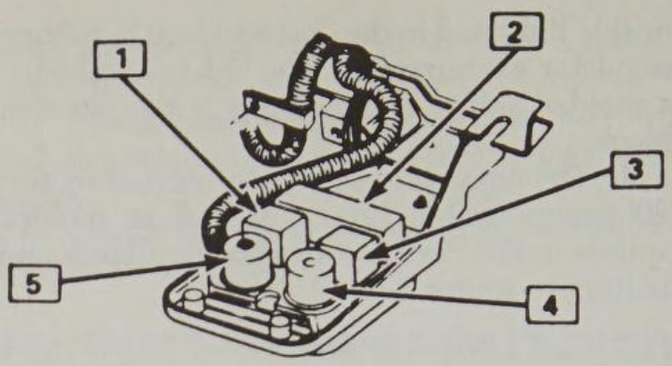
MINI FUSE COLOR CODES

RATING	COLOR
5 AMP	TAN
10 AMP	RED
20 AMP	YELLOW
25 AMP	WHITE

Blown Fuse

Each fuse block uses miniature fuses which are designed for increased circuit protection and greater reliability. The compact fuse is a blade terminal design which allows fingertip removal and replacement.

Although the fuses are interchangeable, the amperage values are molded in bold, color coded, easy to read numbers on the fuse body. Use only fuses of equal replacement valve.



1. Horn relay
2. Seat belt—ignition key—headlight buzzer
3. Choke relay (vacant w/EFI)
4. Hazard flasher
5. Signal flasher

Convenience Center and Components

A blown fuse can easily be checked by visual inspection or by continuity checking.

Buzzers, Relays, and Flashers

The electrical protection devices are located in the convenience center, which is a swing down unit located under the instrument panel. All units are serviced by plug-in replacements.

WIRING DIAGRAMS

Wiring diagrams have been omitted from this book. As automobiles have become more complex, and available with longer and longer option lists, wiring diagrams have grown in size and complexity also. It has become virtually impossible to provide a readable reproduction in a reasonable number of pages. Information on ordering wiring diagrams from Chevrolet can be found in the owner's manual.

Clutch and Transmission

MANUAL TRANSMISSION

Understanding the Manual Transmission and Clutch

Because of the way the gasoline engine breathes, it can produce torque, or twisting force, only within a narrow speed range. Most modern engines must turn at about 2,500 rpm to produce their peak torque. By 4,500 rpm they are producing so little torque that continued increases in engine speed produce no power increases.

The transmission and clutch are employed to vary the relationship between engine speed and the speed of the wheels so that adequate engine power can be produced under all circumstances. The clutch allows engine torque to be applied to the transmission input shaft gradually, due to mechanical slippage. The car can, consequently, be started smoothly from a full stop.

The transmission changes the ratio between the rotating speeds of the engine and the wheels by the use of gears. Four-speed or five-speed transmissions are most common. The lower gears allow full engine power to be applied to the rear wheels during acceleration at low speeds.

The clutch driven plate is a thin disc, the center of which is splined to the transmission input shaft. Both sides of the disc are covered with a layer of material which is similar to brake lining and which is capable of allowing slippage without roughness or excessive noise.

The clutch cover is bolted to the engine flywheel and incorporates a diaphragm spring which provides the pressure to engage the clutch. The cover also houses the pressure plate. The driven disc is sandwiched between the pressure plate and the smooth surface of the flywheel when the clutch pedal is released, thus forcing it to turn at the same speed as the engine crankshaft.

The transmission contains a mainshaft which passes all the way through the transmission, from the clutch to the driveshaft. This shaft is separated at one point, so that front and rear portions can turn at different speeds.

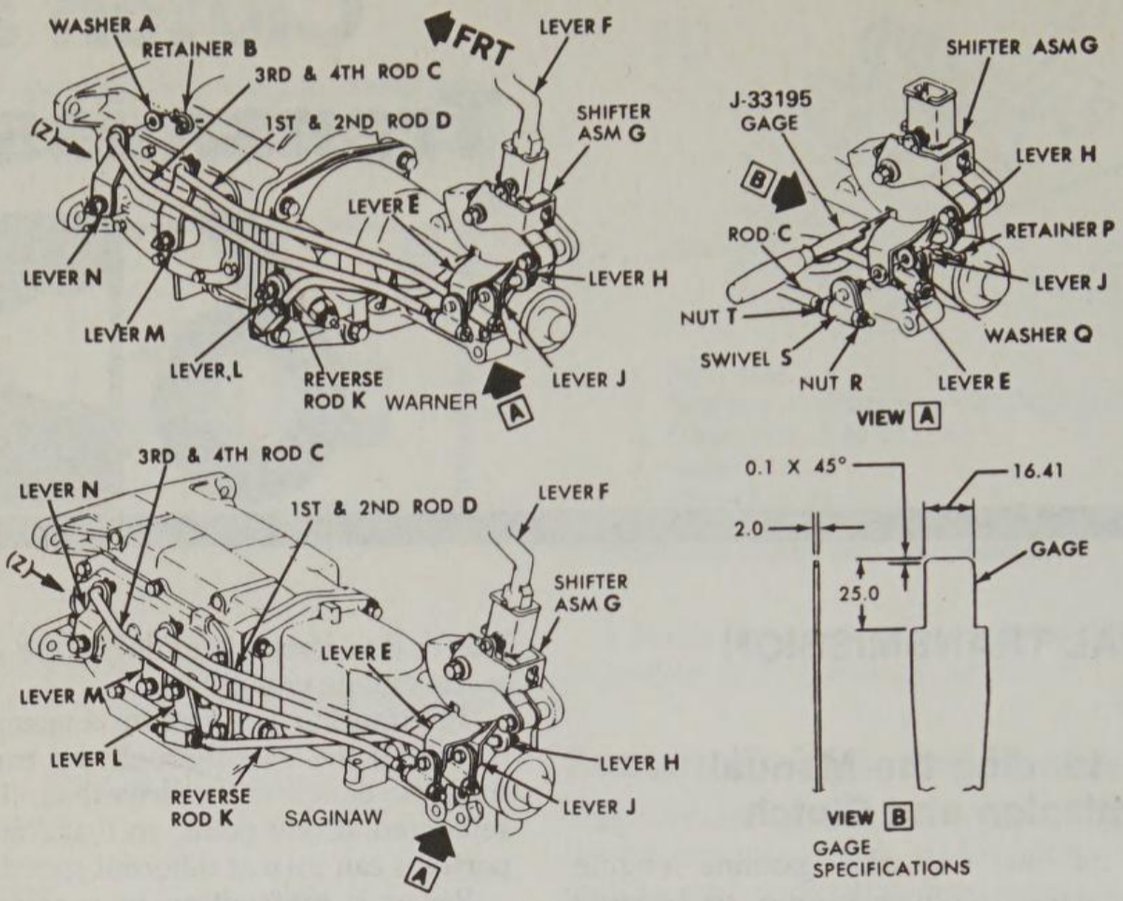
Power is transmitted by a countershaft in the lower gears and reverse. The gears of the countershaft mesh with gears on the mainshaft, allowing power to be carried from one to the other. All the countershaft gears are integral with that shaft, while several of the mainshaft gears can either rotate independently of the shaft or be locked to it. Shifting from one gear to the next causes one of the gears to be freed from rotating with the shaft, and locks another to it. Gears are locked and unlocked by internal dog clutches which slide between the center of the gear and the shaft. The forward gears usually employ synchronizers: friction members which smoothly bring gear and shaft to the same speed before the toothed dog clutches are engaged.

The clutch is operating properly if:

1. It will stall the engine when released with the vehicle held stationary.
2. The shift lever can be moved freely between first and reverse gears when the vehicle is stationary and the clutch disengaged.

A clutch pedal free-play adjustment is incorporated in the linkage. If there is about 1–2 in. of motion before the pedal begins to release the clutch, it is adjusted properly. Inadequate free-play wears all parts of the clutch releasing mechanisms and may cause slippage. Excessive free-play may cause inadequate release and hard shifting of gears.

All '84 and later clutches use a hydraulic system in place of a mechanical linkage. If the clutch fails to release, fill the clutch master cylinder with fluid to the proper level and pump the clutch pedal to fill the system with fluid.



Transmission shift linkage adjustment

Bleed the system in the same way as a brake system. If leaks are located, tighten the loose connections or overhaul the master or slave cylinder as necessary.

LINKAGE ADJUSTMENT

NOTE: *All terms used in the following procedure match those which are used in the accompanying illustration. No linkage adjustment is possible on the five speed transmission.*

1. Disconnect the negative battery cable at the battery.
2. Place the shift control lever (F) in Neutral.
3. Raise the vehicle and support it safely with jackstands.
4. Remove the swivel retainers (P) from the levers (E,H, and J).
5. Remove the swivels (S) from the shifter assembly (G), and loosen the swivel locknuts (R and T).
6. Make sure that levers L,M, and N are in their Neutral positions (center detents).
7. Align the holes of levers E,H, and J with the notch in the shifter assembly (G). Insert an alignment gauge (J-33195) to hold the levers in this position.
8. Insert swivel S into lever E and install washer Q. Secure with retainer P.
9. Apply rearward pressure (Z) to lever N. Tighten locknuts R and T (at the same time) against swivel S to 25 ft. lbs.
10. Repeat steps 8 and 9 for rod D and levers J and M.
11. Repeat steps 8 and 9 for rod K and levers H and L.
12. Remove the alignment gauge, lower the vehicle, and check the operation of the shifting mechanism.
13. Reconnect the negative battery cable.

REMOVAL AND INSTALLATION

NOTE: *On five speed transmissions remove the shift lever boot and the shift lever prior to transmission removal.*

1. Disconnect the negative battery cable at the battery.
2. Raise the vehicle and support it safely with jackstands.
3. Drain the lubricant from the transmission.
4. Remove the torque arm from the vehicle as outlined under "Rear Suspension".
5. Mark the driveshaft and the rear axle pinion flange to indicate their relationship. Unbolt the rear universal joint straps. Lower the rear of the driveshaft, being careful to keep the universal joint caps in place. Withdraw the driveshaft from the transmission and remove it from the vehicle.
6. Disconnect the speedometer cable and the electrical connectors from the transmission.
7. Remove the exhaust pipe brace.
8. Remove the transmission shifter sup-

port attaching bolts from the transmission.

NOTE: *Step 9 is not applicable to five speed transmissions.*

9. Disconnect the shift linkage at the shifter.

10. Raise the transmission slightly with a jack, then remove the crossmember attaching bolts.

11. Remove the transmission mount attaching bolts and remove the mount and crossmember from the vehicle.

12. Remove the transmission attaching bolts, and with the aid of an assistant, move the transmission rearward and downward out of the vehicle.

13. Installation is performed in the reverse order of the previous steps. Note the following during installation:

a. Apply a light coating of high temperature grease to the main drive gear bearing retainer and to the splined portion of the main drive gear. This will assure free movement of the clutch and transmission components during assembly.

b. Adjust the shift linkage (as outlined later).

c. Refill the transmission with the proper amount and quality of transmission lubricant.

d. Observe the following torque specifications:

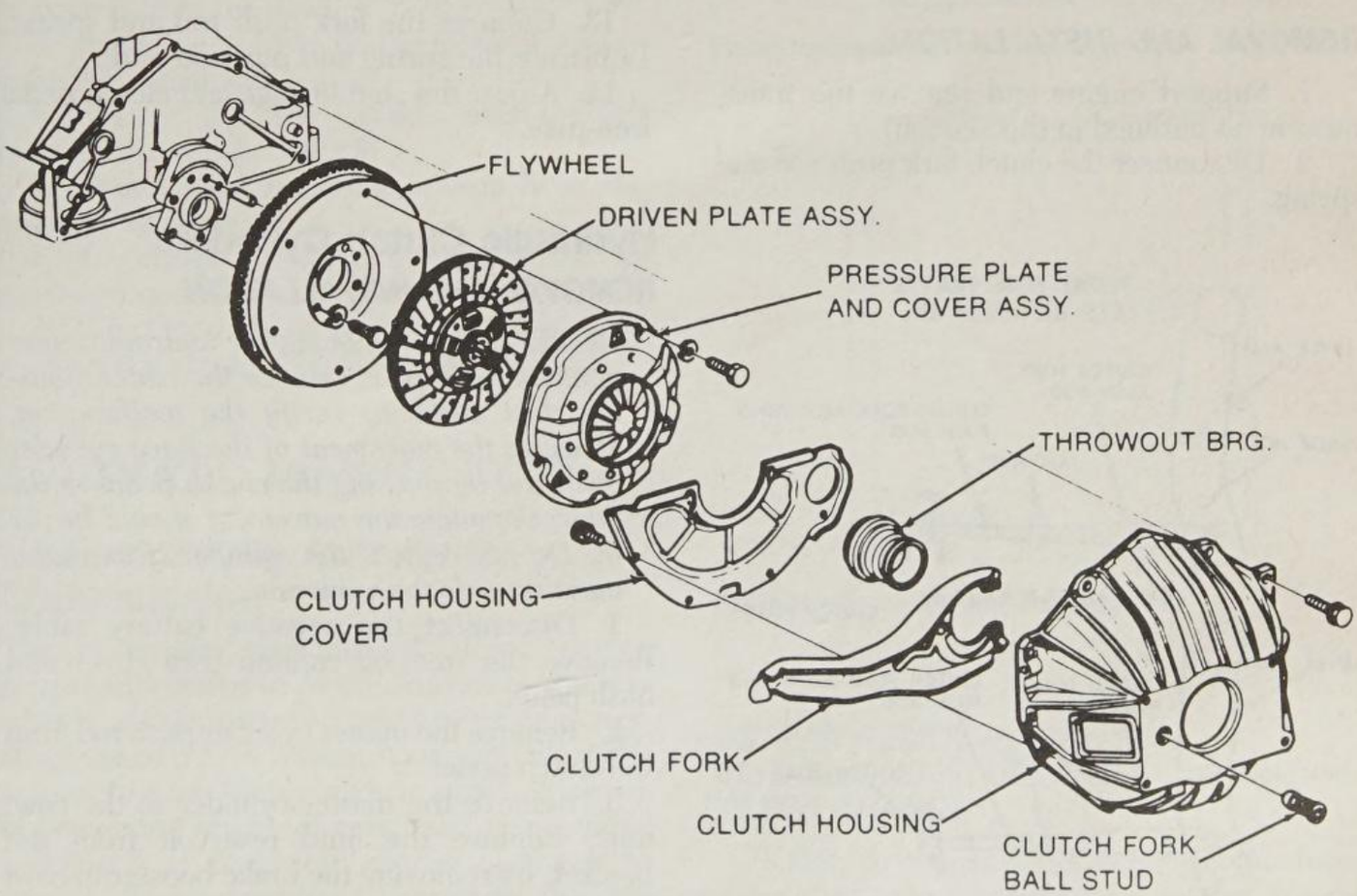
- Filler plug—15 ft. lbs.
- Transmission-to-clutch housing bolts—55 ft. lbs.
- Crossmember-to-body bolts—35 ft. lbs.
- Mount-to-crossmember bolts—35 ft. lbs.
- Mount-to-transmission bolts—35 ft. lbs.
- Shifter bracket-to-extension housing—25 ft. lbs.

CLUTCH

All vehicles in '82–'83 use a mechanical (non-hydraulic) clutch; '84 and later models use a hydraulic clutch. With the hydraulic clutch, no adjustment of the clutch pedal or the linkage is required. On the mechanical type, the only required adjustment is to maintain the proper clutch pedal freeplay. The freeplay adjustment is very important, for it determines the engaging and disengaging characteristics of the clutch assembly.

The clutch assembly consists of: a flywheel, a pressure plate, a throwout bearing and fork, a clutch pedal, and an actuating lever (non-hydraulic) or a master cylinder/slave cylinder (hydraulic).

The hydraulic system utilizes a remote res-



Exploded View of the Clutch and Flywheel Assembly

ervoir which is mounted to the power brake booster, a master cylinder mounted to the cowl panel and a slave cylinder that is mounted to the bell housing. The system is operated directly by the clutch pedal. When adding fluid to the reservoir, always use a type which meets DOT 3 specifications.

Non-Hydraulic

FREE-PLAY ADJUSTMENT

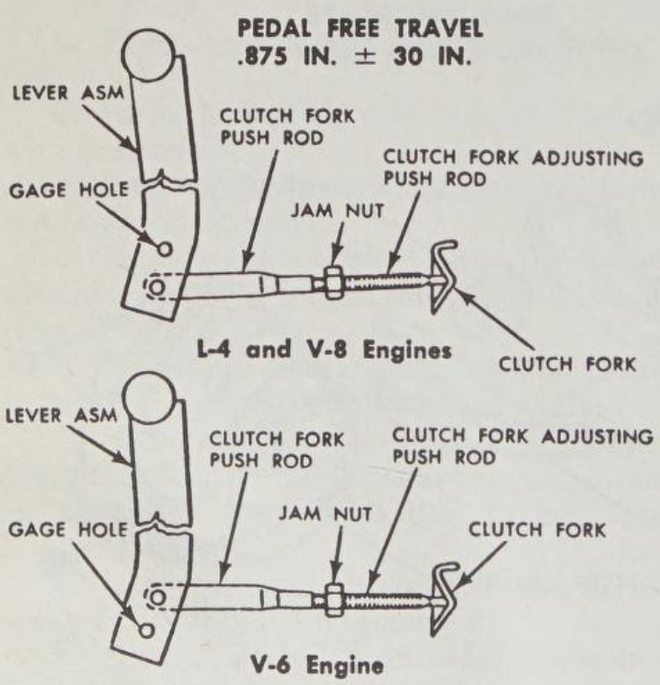
1. Disconnect the return spring at the clutch fork.
2. Hold the pedal against the rubber bumper on the dash brace.
3. Push the clutch fork so that the throwout bearing lightly contacts the pressure plate fingers.
4. Loosen the locknut and adjust the length of the rod so that the swivel or rod can slip freely into the gauge hole in the lever. Increase the length of the rod until all free-play is removed.
5. Remove the rod or swivel from the gauge hole and insert it in the other (original) hole on the lever. Install the retainer and tighten the locknut.
6. Install the return spring and check free-play measurement at the pedal pad.

CROSS SHAFT LUBRICATION

Once every 36,000 miles, sooner if necessary, lubricate the shaft with chassis lube.

REMOVAL AND INSTALLATION

1. Support engine and remove the transmission (as outlined in this section).
2. Disconnect the clutch fork push rod and spring.



Clutch pedal free travel

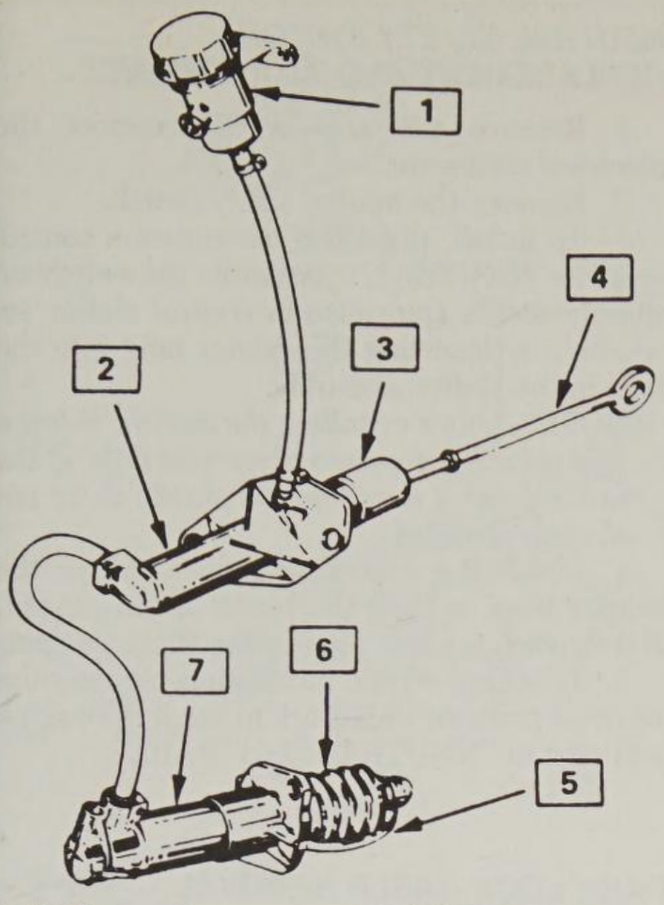
3. Remove the flywheel housing.
4. Slide the clutch fork from the ball stud and remove the fork from the dust boot. The ball stud is threaded into the clutch housing and may be replaced, if necessary.
5. Install an alignment tool to support the clutch assembly during removal. Mark the flywheel and clutch cover for reinstallation, if they do not already have "X" marks.
6. Loosen the clutch-to-flywheel attaching bolts evenly, one turn at a time, until spring pressure is released. Remove the bolts and clutch assembly.
7. Clean the pressure plate and flywheel face.
8. Support the clutch disc and pressure plate with an alignment tool. The driven disc is installed with the damper springs on the transmission side.
9. Turn the clutch assembly until the mark on the cover lines up with the mark on the flywheel, then install the bolts. Tighten down evenly and gradually to avoid distortion.
10. Remove the alignment tool.
11. Lubricate the ball socket and fork fingers at the release bearing end with high melting-point grease. Lubricate the recess on the inside of the throwout bearing and throwout fork groove with a light coat of graphite grease.
12. Install the clutch fork and dust boot into the housing. Install the throwout bearing to the throwout fork. Install the flywheel housing. Install the transmission.
13. Connect the fork push rod and spring. Lubricate the spring and pushrod ends.
14. Adjust the shift linkage and clutch pedal free-play.

Hydraulic Clutch Cylinders

REMOVAL AND INSTALLATION

NOTE: *Before removing the hydraulic components for repair, remove the clutch housing dust cover to verify the malfunction. Measure the movement of the slave cylinder push rod by pushing the clutch pedal to the floor; the minimum movement should be .57 in. Do not replace the cylinder if its movement exceeds the minimum.*

1. Disconnect the negative battery cable. Remove the steering column trim cover and hush panel.
2. Remove the master cylinder push rod from the clutch pedal.
3. Remove the master cylinder to the cowl nuts. Remove the fluid reservoir from the bracket, by removing the brake booster to cowl nuts.
4. Pull the brake master cylinder forward to



1. Fluid reservoir
2. Clutch master cylinder
3. Boot
4. Push rod
5. Shipping strap
6. Boot
7. Clutch slave cylinder

Hydraulic Clutch System

gain access to the clutch master cylinder and remove it from the cowl.

5. Raise the vehicle and remove the slave cylinder heat shield.

6. Remove the slave cylinder from the bell housing. Lower the vehicle.

7. Remove the hydraulic system from the engine compartment.

8. To install the system, reverse the removal procedures.

NOTE: *Overhaul of the cylinders is not possible; it is serviced by replacement ONLY.*

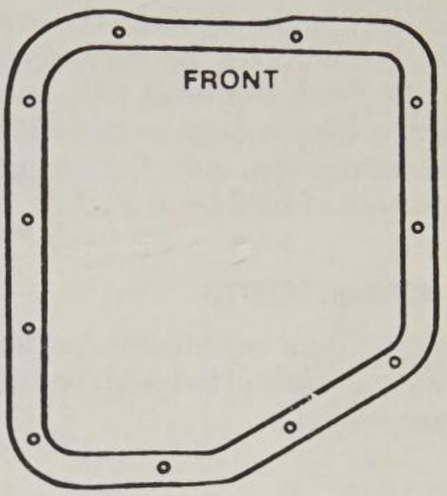
AUTOMATIC TRANSMISSION

Understanding Automatic Transmission

The automatic transmission allows engine torque and power to be transmitted to the rear wheels within a narrow range of engine operating speeds. The transmission will allow the engine to turn fast enough to produce plenty of power and torque at very low speeds, while keeping it at a sensible rpm at high vehicle speeds. The transmission performs this job entirely without driver assistance. The transmission uses a light fluid as the medium for the transmission of power. This fluid also works in the operation of various hydraulic control circuits and as a lubricant. Because the transmission fluid performs all of these three functions, trouble within the unit can easily travel from one part to another. For this reason, and because of the complexity and unusual operating principles of the transmission, a very sound understanding of the basic principles of operation will simplify troubleshooting.

Identification

Two types of transmissions are used on the vehicles; Turbo Hydra-Matic 200C (3-Speed) and Turbo Hydra-Matic 700-R4 (4-Speed). A picture of the pan gaskets used is shown in the illustration.



Turbo Hydra-Matic 200C Gasket

Turbo Hydra-Matic 700-R4 Gasket

OIL PAN REMOVAL AND INSTALLATION/FLUID AND FILTER CHANGE

NOTE: *To remove the oil pan which has been installed with sealant, refer to the oil pan removal section of Chapter 1.*

The fluid should be changed with the trans-

mission warm. A 20 minute drive at highway speeds should accomplish this.

1. Raise and support the vehicle.
2. Place a large pan under the transmission pan. Remove all the front and side pan bolts. Loosen the rear bolts about four turns.
3. Pry the pan loose and let it drain.
4. Remove the pan and gasket. Clean the pan thoroughly with solvent and air dry it. Be very careful not to get any lint from rags in the pan.
5. Remove the filter and gasket.
6. Install a new filter and gasket.
7. Reinstall the pan with a new gasket.
8. Lower the car. Add Dexron II® automatic transmission fluid through the fill tube.
9. Start the engine in Park and let it idle. Do not race the engine. Shift into each shift lever position, shift back into Park, and check the fluid level on the dipstick. The level should be ¼ in. below ADD. Be very careful not to overfill. Recheck the level after the car has been driven long enough to thoroughly warm up the transmission. Add fluid as necessary. The level should then be at FULL.

BAND ADJUSTMENTS

There are no band adjustments possible or required for the Turbo Hydra-Matic 200 or 700-R4 transmissions.

NEUTRAL SAFETY SWITCH REPLACEMENT AND ADJUSTMENT

1. Remove the console. Disconnect the electrical connector.
2. Remove the neutral safety switch.
3. To install, place the transmission control lever in "NEUTRAL". Assemble the switch assembly to the transmission control shifter assembly, by inserting the carrier tang into the hole in the shifter assembly.

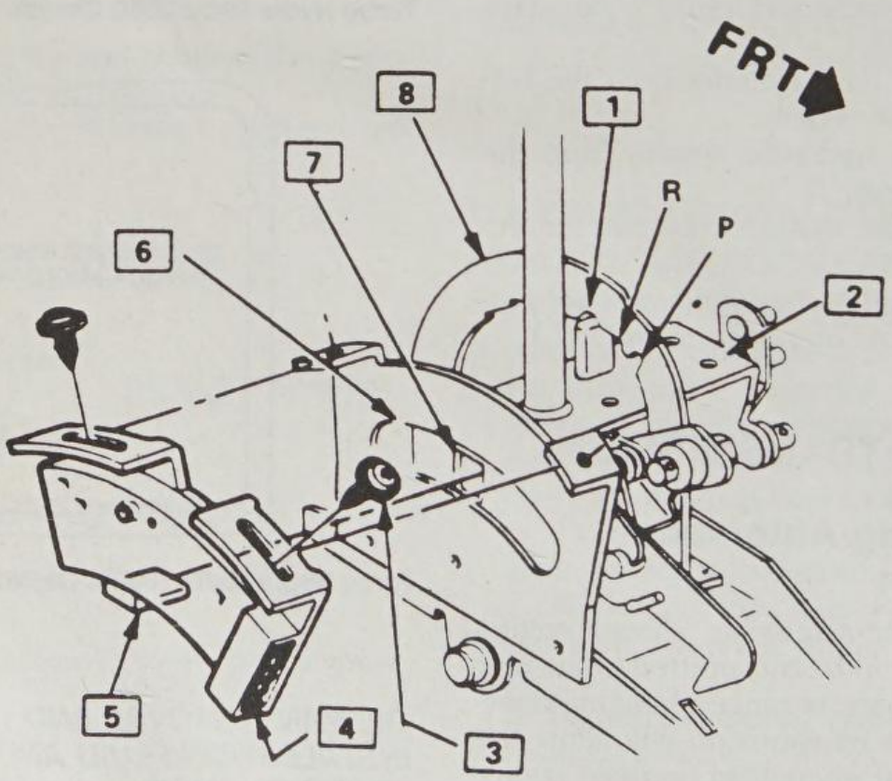
NOTE: *Before installing the switch, insert a .234 in. pin gauge into alignment hole. If the switch is new, it will have a plastic shear pin already installed.*

4. Install the mounting screws. Move the shifting lever to shear the plastic alignment pin. If the switch is used, remove the alignment pin.
5. To complete the installation, reverse the removal procedures. Check to see if the engine will start in "NEUTRAL" and "PARK".

PARK LOCK CABLE REMOVAL AND INSTALLATION

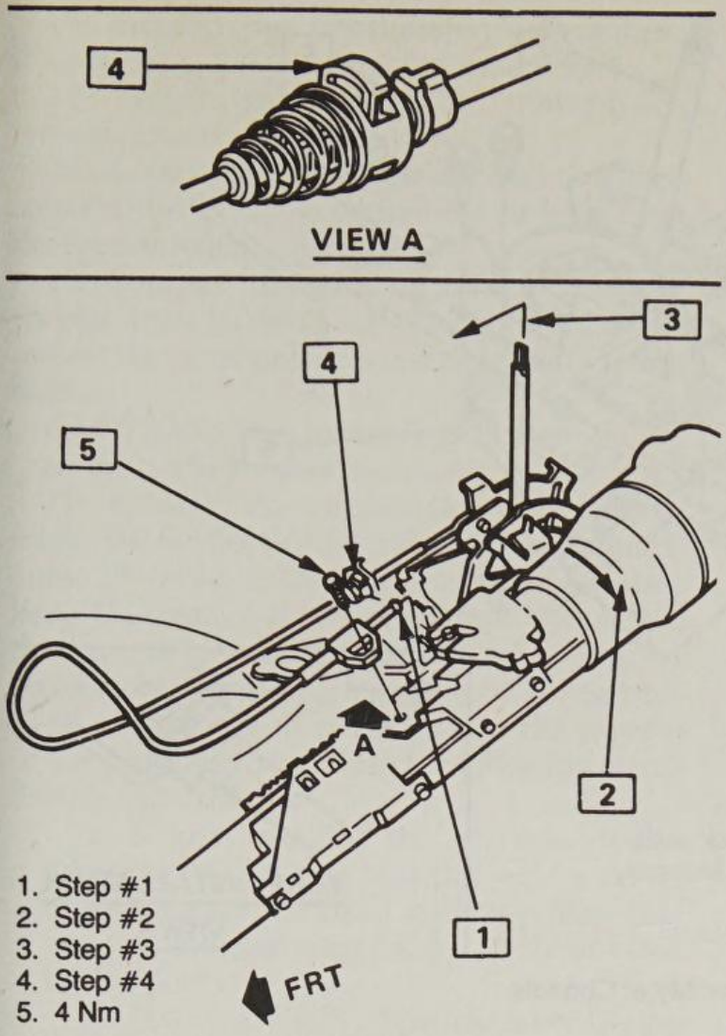
1982–'83

1. Remove the console and steering column covers. Remove cable retaining screw from the steering column slider and disconnect the cable.



1. "Neutral" notch
2. Transmission control shifter
3. 2 N·m (1.5 ft. lb.) bolt screw
4. Switch assembly
5. Carrier tang
6. Tang slot
7. Tang hole
8. Detent plate

Neutral Safety Switch Assembly



1. Step #1
2. Step #2
3. Step #3
4. Step #4
5. 4 Nm

Park Lock Cable Assembly ('82–'83)

2. At the shifter bracket, pull out the lock button on the cable housing and remove the yoke.

3. Disconnect the cable from the shifter.

4. To install, place the shifter lever in "PARK". Rotate the steering column shift bowl to the "PARK" position and lock the column.

5. To complete the installation, reverse the removal procedure.

1984 and Later

1. Place the shifter lever in the "PARK" position. Remove the negative battery cable.

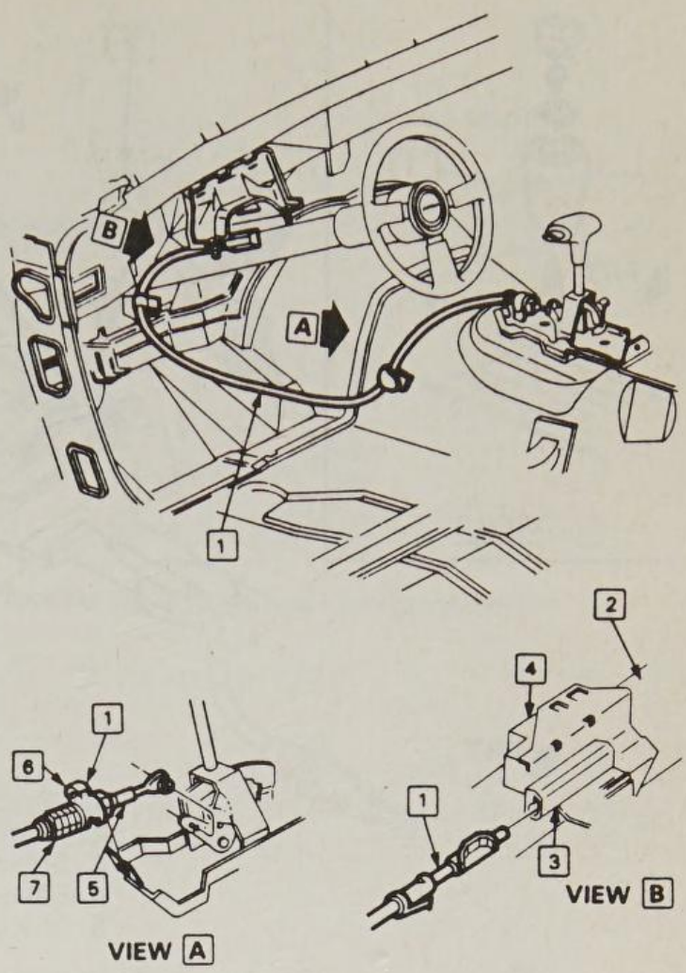
2. Turn the key to "RUN". Release the cable from the inhibitor switch by inserting a screwdriver into the switch slot.

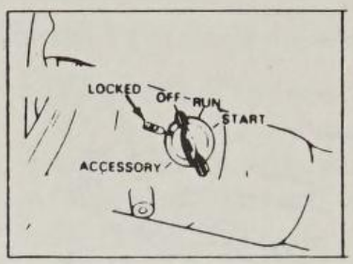
3. Push the cable lock button to the "UP" position and remove the cable from the park lever lock pin.

4. Depress the 2 cable connector latches at the shifter base and remove the cable. Remove the cable clips.

5. To install, place the shifter lever into the "PARK" position and the ignition key to the "RUN" position.

6. After installing the cable ends, push the cable connector nose toward the connector as far as possible and push the connector lock button down.





1. Cable
2. Steering column
3. Inhibitor
4. Ignition switch
5. Hose
6. Cable lock
7. Connector

Park Lock Cable Assembly ('84 and Later)

7. Complete the installation by reversing the removal procedure.

PARK LOCK CABLE ADJUSTMENT

NOTE: *The adjustment procedures are covered under the Park Lock Cable Removal and Installation procedures.*

SHIFT LINKAGE ADJUSTMENT

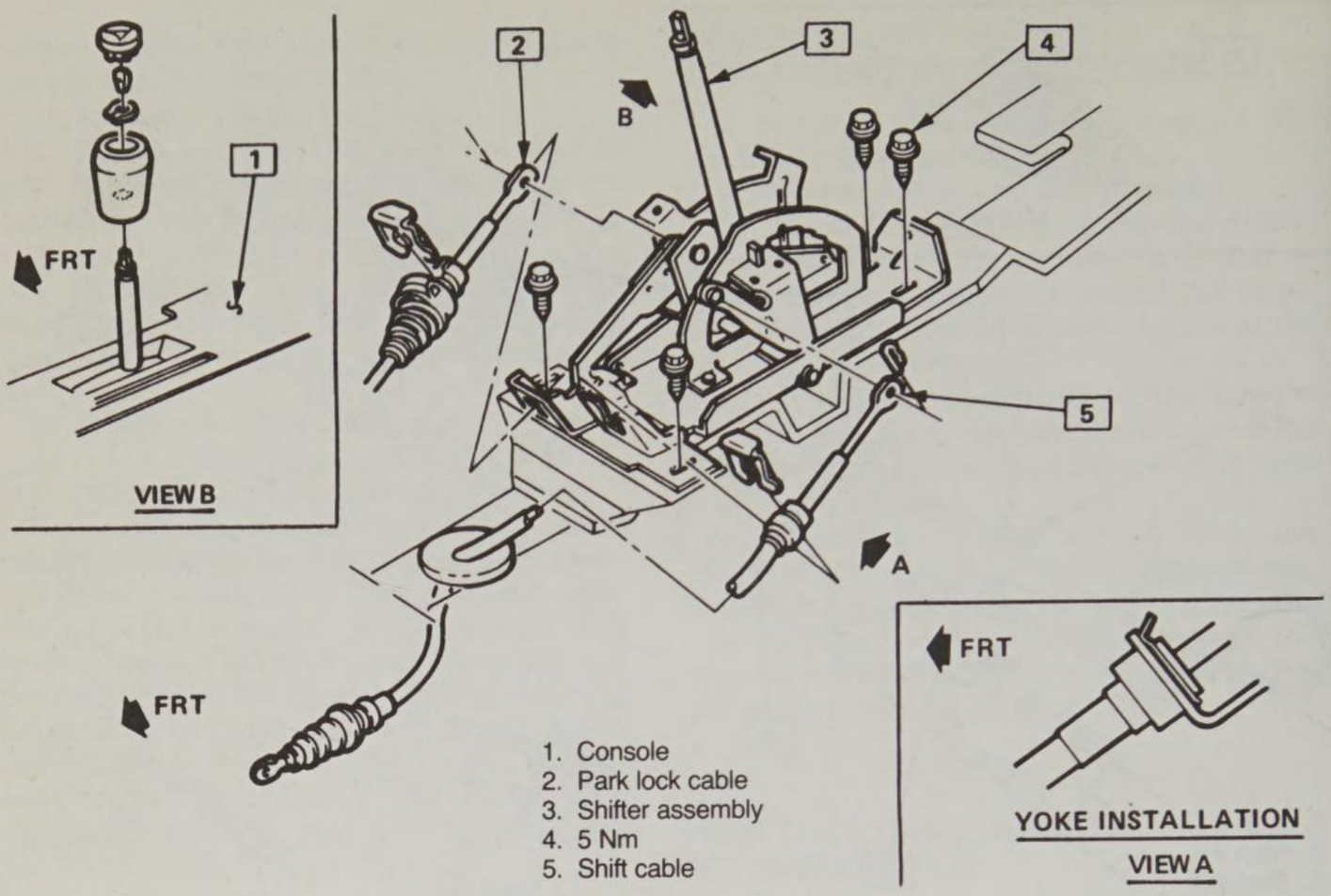
1. Place the manual shaft of the transmission in "NEUTRAL". Place the console shift lever in "NEUTRAL".

2. Install the cable in the slot of the shift lever. Adjust the cable so that the pin has free movement.

3. Install and tighten the nut to the pin.

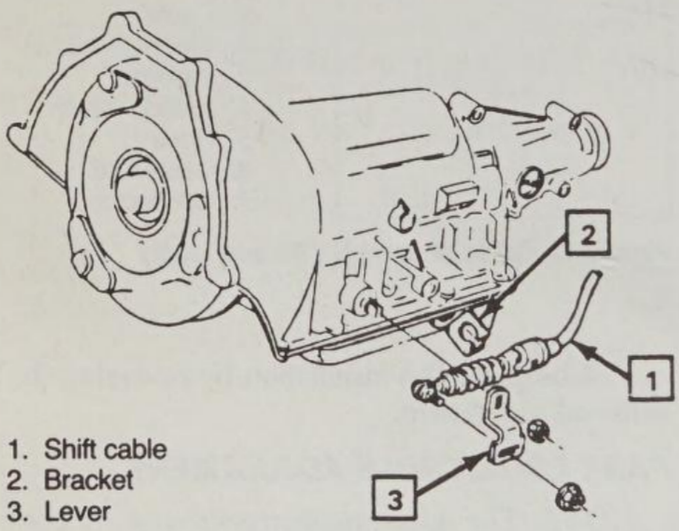
TORQUE CONVERTER CLUTCH BRAKE SWITCH ADJUSTMENT

The torque converter clutch brake switch must be adjusted to prevent the vehicle from stalling at idle. Adjust the plunger so it just touches the



1. Console
2. Park lock cable
3. Shifter assembly
4. 5 Nm
5. Shift cable

Shift Cable Assembly at Console



1. Shift cable
2. Bracket
3. Lever

Shift Cable Assembly at Transmission

brake pedal lever but ensure that the brake pedal is fully released.

TRANSMISSION REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable at the battery.
2. Remove the air cleaner assembly.
3. Disconnect the throttle valve (TV) control cable at the carburetor.
4. Remove the transmission oil dipstick. Unbolt and remove the dipstick tube.
5. Raise the vehicle and support it safely with jackstands.

NOTE: *In order to provide adequate clearance for transmission removal, it may be necessary to raise both the front and the rear of the vehicle.*

6. Mark the relationship between the driveshaft and the rear pinion flange so that the driveshaft may be reinstalled in its original position.
7. Unbolt the universal joint straps from the pinion flange (use care to keep the universal joint caps in place), lower and remove the driveshaft from the vehicle.
8. Disconnect the catalytic convertor support bracket at the transmission.
9. Disconnect the speedometer cable, electrical connectors and the shift control cable from the transmission.

CAUTION: *During the next step, rear spring force will cause the torque arm to move toward the floor pan. When disconnecting the arm from the transmission, carefully place a piece of wood between the floor pan and the torque arm. This will prevent possible personal injury and/or floor pan damage.*

10. Remove the torque arm-to-transmission bolts.
11. Remove the flywheel cover, then mark the relationship between the torque convertor and the flywheel so that these parts may be reassembled in the same relationship.
12. Remove the torque convertor-to-flywheel attaching bolts.

13. Support the transmission with a jack, then remove the transmission mount bolt.

14. Unbolt and remove the transmission crossmember.

15. Lower the transmission slightly. Disconnect the TV cable and oil cooler lines from the transmission.

16. Support the engine using Chevrolet special tool BT-6424 or its equivalent. Remove the transmission-to-engine mounting bolts.

CAUTION: *The transmission must be secured to the transmission jack.*

17. Remove the transmission from the vehicle. Be careful not to damage the oil cooler lines, TV cable, or the shift control cable. Also, keep the rear of the transmission lower than the front to avoid the possibility of the torque convertor disengaging from the transmission.

18. Installation is performed in the reverse of the previous steps. Note the following points during installation:

a. Before installing the convertor-to-flywheel bolts, be sure that the weld nuts on the convertor are flush with the flywheel, and that the convertor rotates freely by hand in this position.

b. Install a NEW dipstick tube O-ring before installing the tube.

THROTTLE VALVE CABLE ADJUSTMENT

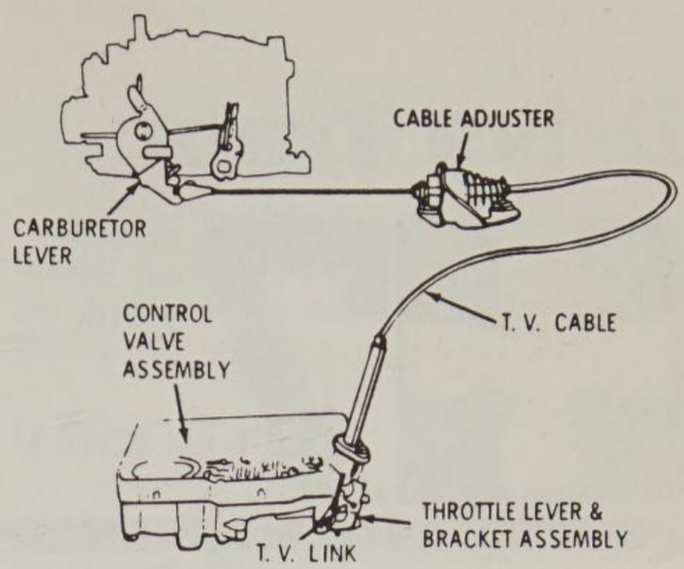
1. Check the oil level in the transmission.

2. Be sure engine is operating properly, and the brakes are not dragging.

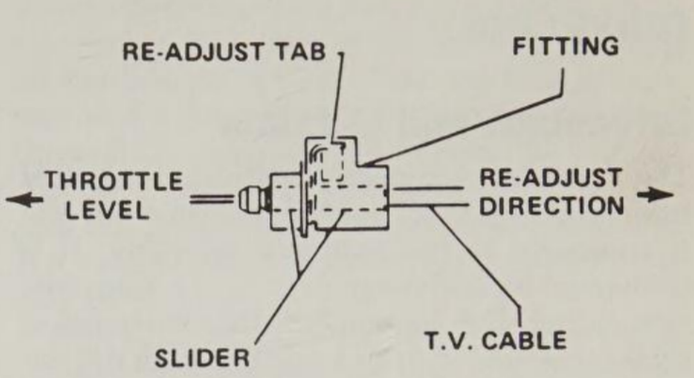
3. Adjust the cable as follows:

A. Stop the engine.

B. Depress the readjust tab. Move the slider back through the fitting away from throttle body or pump lever, until it stops against the fitting.



Throttle Valve Cable and Linkage Assembly



Throttle Valve Cable Adjuster

C. Release the readjust tab.

D. V6 & V8: Manually open carburetor lever to full throttle stop position. The cable will ratchet through its slider to automatically adjust itself. Release the lever.

E. 4-Cylinder: Rotate the idler lever to its maximum travel stop position. The cable will then ratchet to automatically adjust itself. Release the throttle idler lever. Do not adjust the 4-151 engine TV cable using the TBI or carburetor lever.

Drive Train

7

DRIVELINE

Driveshaft and U-Joints

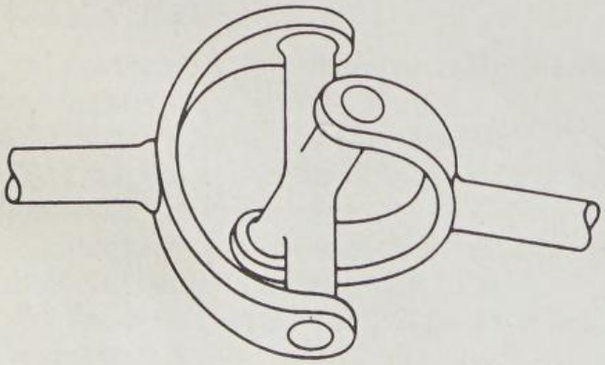
The driveshaft (propeller shaft) is a long steel tube that transmits engine power from the transmission to the rear axle assembly. It is connected to, and revolves with, the transmission output shaft (remember, the transmission shaft is connected to and revolves with the engine crankshaft) whenever the transmission is put into gear. With the transmission in neutral, the driveshaft does not move. Located at each end of the driveshaft is a flexible joint that rotates with the shaft. These flexible joints, known as U-joints (universal joints) perform an important function. The rear axle assembly moves with the car. It moves up and down with every bump or dip in the road. The driveshaft by itself is a rigid tube incapable of bending. When combined with the flexing capabilities of the U-joints, however, it can do so.

A slip joint is coupled to the front of the driveshaft by a universal joint. This U-joint allows the yoke (slip joint) to move up and down with the car. The yoke is a cylinder containing splines that slide over the meshes with the splines on the transmission output shaft. When the rear axle moves up and down, the yoke slides back and forth a small amount on the transmission shaft. Therefore, it combines with the U-joints in allowing the driveshaft to move with the movements of the car. The rear universal joint is secured to a companion flange which is attached to, and revolves with, the rear axle drive pinion.

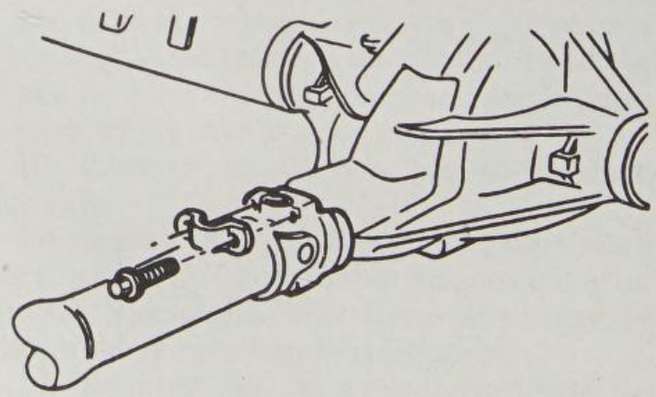
A U-joint consists of a cross piece (trunnion) and, on each of the four ends, a dust seal and a series of needle bearings that fit into a bearing cup. Each U-joint connects one yoke with another and the bearings allow the joints to revolve within each yoke.

A Camaro U-joint is secured to the yoke in one of two ways. Dana and Cleveland shafts use a conventional snap-ring to hold each bearing cup in the yoke. The snap-ring fits into a groove located in each yoke end just on top of each bearing cup. The Saginaw design shaft secures its U-joints in another way. Nylon material is injected through a small hole in the yoke and flows along a circular groove between the U-joint and the yoke, creating a synthetic snap-ring. Disassembly of the Saginaw U-joint requires the joint to be pressed from the yoke. This results in damage to the bearing cups and destruction of the nylon rings.

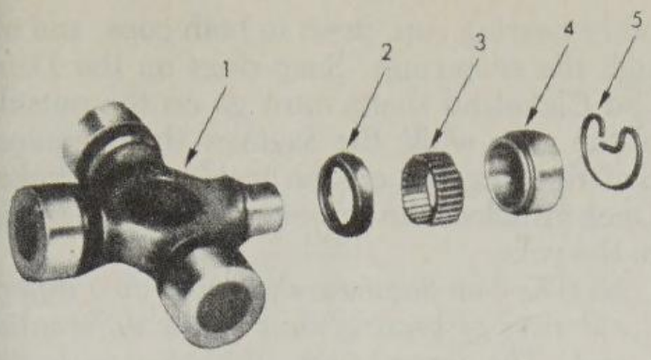
Replacement kits include new bearing cups and conventional snap-rings to replace the original nylon rings. These replacement rings



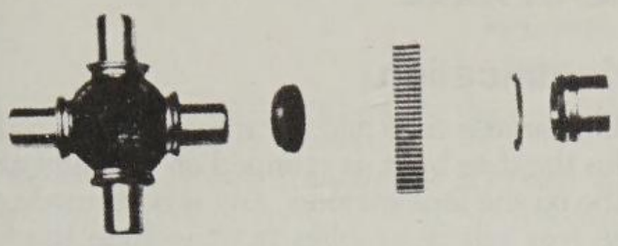
Simplified example of a universal joint



Strap-type retainer on driveshaft



Driveshaft trunnion (Dana)



Driveshaft trunnion (Saginaw)

must go inboard of the yoke in contrast to outboard mounting of the Dana and Cleveland designs. Previous service to the Saginaw U-joints can be recognized by the presence of snap-rings inboard of the yoke.

Bad U-joints, requiring replacement, will produce a clunking sound when the car is put into gear. This is due to worn needle bearings or a scored trunnion end possibly caused by improper lubrication during assembly. Camaro U-joints require no periodic maintenance and therefore have no lubrication fittings.

Driveshaft

REMOVAL

1. Raise the vehicle and safely support it on jackstands. Paint a reference line from the rear end of the driveshaft to the companion flange so that they can be reassembled in the same position.
2. Disconnect the rear universal joint by removing the U-bolts, retaining straps, or the flange bolts.
3. To prevent loss of the needle bearings, tape the bearing caps to the trunnion.
4. Remove the driveshaft from the transmission by sliding it rearward.

NOTE: *Do not be alarmed by oil leakage at the transmission output shaft. This oil is there to lubricate the splines of the front yoke.*

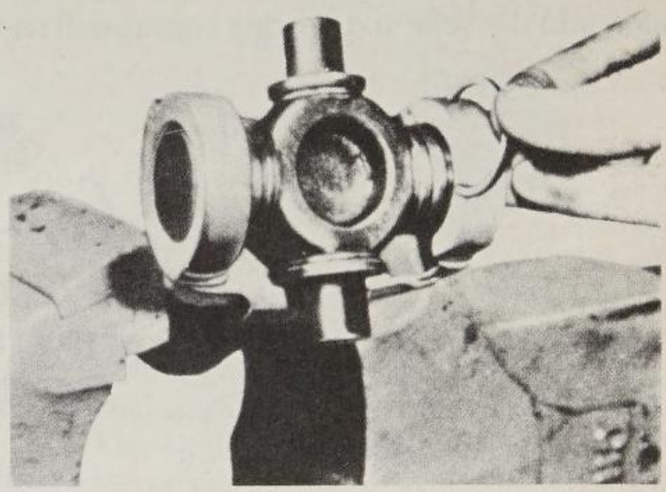
INSTALLATION

1. Check the yoke seal in the transmission case extension and replace it if necessary. See the transmission section for replacement procedures.
2. Position the driveshaft and insert the front yoke into the transmission so that the splines mesh with the splines of the transmission shaft.
3. Using reference marks made during removal, align the driveshaft with the companion flange and secure it with U-bolts or, retaining straps.

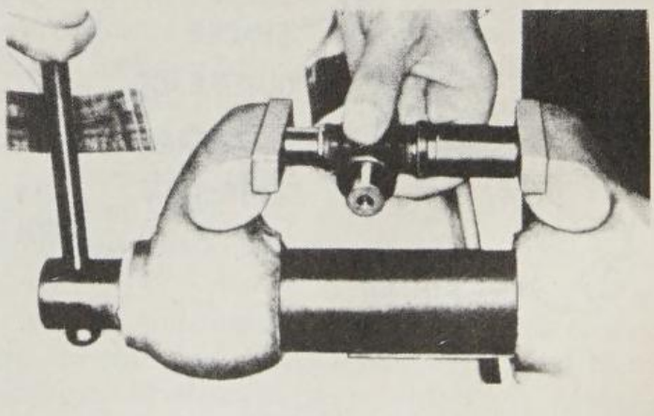
U-Joint Overhaul

1. Remove the driveshaft as explained above and remove the snap-rings from the ends of the bearing cup.
2. After removing the snap-rings, place the driveshaft on the floor and place a large diameter socket under one of the bearing cups. Tap on the bearing opposite this one with a hammer and a drift. This will push the trunnion through the yoke enough to force the bearing cup out of the yoke and into the socket. Repeat this procedure for the other bearing cups. If a hammer fails to loosen the cups, a press may be necessary.

NOTE: *A Saginaw driveshaft secures its U-joints in a different manner than the conventional snap-rings of the Dana and Cleveland designs.*



Installing trunnion snap ring



Installing U-joint trunnion seal

Nylon is injected through a small hole in the yoke and flows along a circular groove between the U-joint and the yoke, thus creating a synthetic snap-ring. Disassembly of this Saginaw U-joint requires the joint to be pressed from the yoke. If a press is not available, it may be carefully hammered out using the same procedure (step two) as the Dana design, although it will require more force to break the nylon ring. Either method, press or hammer, will damage the bearing cups and destroy the nylon rings. Replacement kits include new bearing cups and conventional metal snap-rings to replace the original nylon rings.

3. Thoroughly clean the entire U-joint assembly with solvent. Inspect for excessive wear in the yoke bores and on the four ends of the trunnion. The needle bearings should not be scored, broken, or loose in their cups. Bearing cups may suffer slight distortion during removal and should be replaced.

4. Pack the bearings with chassis lube (lithium base) and completely fill each trunnion end with the same lubricant.

5. Place new dust seals on the trunnions with the cavity of the seal toward the end of the trunnion. Care must be taken to avoid distortion of the seal. A suitable size socket and a vise can be used to press on the seal.

6. Insert one bearing cup about a quarter of the way into the yoke and place the trunnion into the yoke and bearing cup. Install another bearing cup, press in both cups, and install the snap-rings. Snap-rings on the Dana and Cleveland shafts must go on the outside of the yoke while the Saginaw shaft requires that the rings go on the inside of the yoke. Once installed, the trunnion must move freely in the yoke.

NOTE: *The Saginaw shaft uses two different sizes of bearing cups at the differential end. The larger cups (the ones with the groove) fit into the driveshaft yoke.*

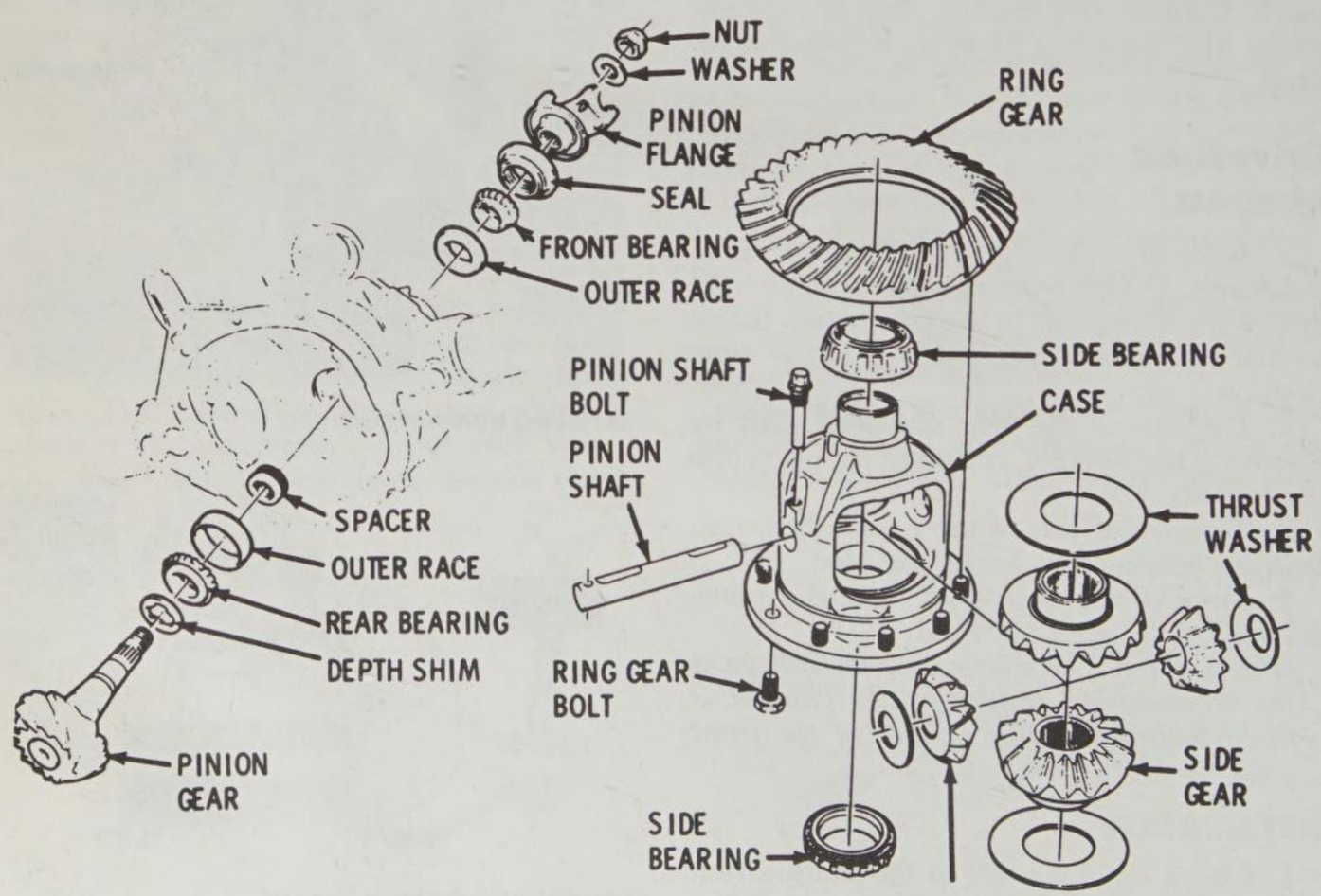
REAR AXLE

Identification

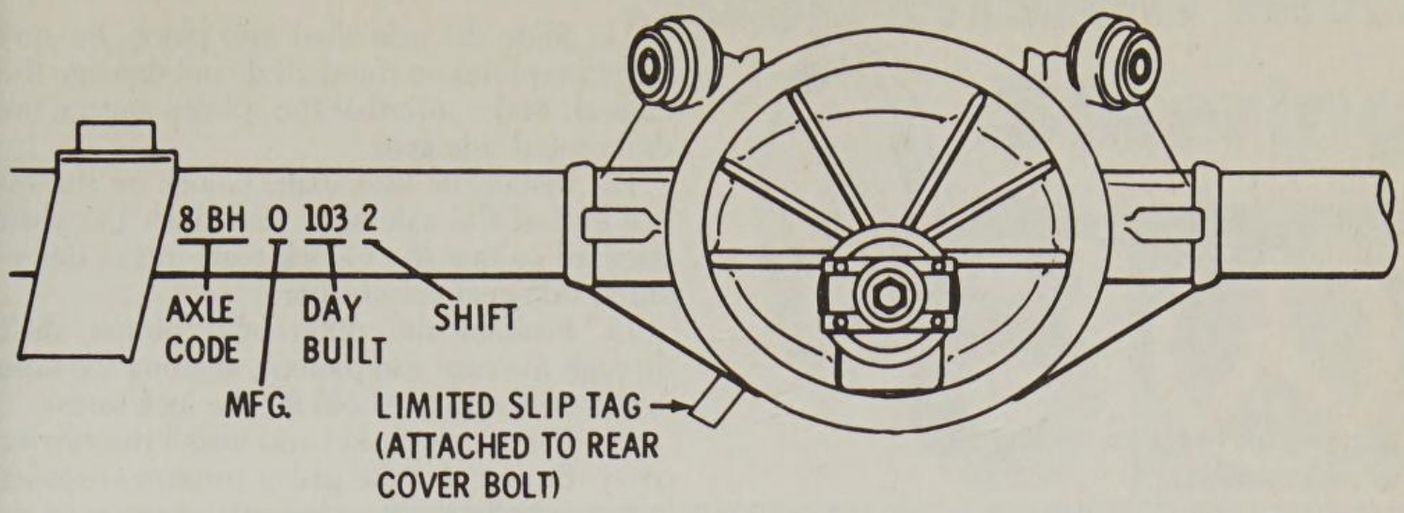
The rear axle code and the manufacturers code, plus the date built, is stamped on the right axle tube on the forward side. Any reports made on the rear axle assemblies must include the full code letters and the date built numbers. The anti-slip differentials are identified by a tag attached to the lower right section of the axle.

Axle Shaft

Axle shafts are the last link in the chain of components working to transmit engine power to the rear wheels. The splined end of each shaft meshes with the internal splines of each differential side gear. As the side gears turn,



Exploded view of the rear axle



Rear Axle Identification Code

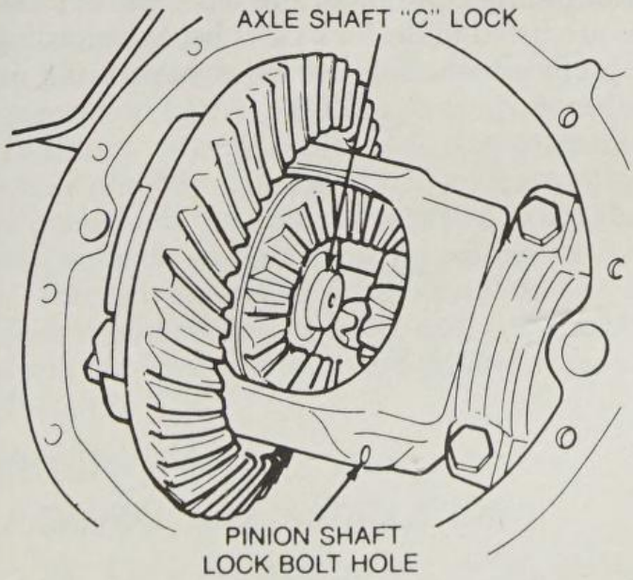
so do the axle shafts, and, since they are also connected, so do the wheels.

Each shaft passes through the side gear and is locked into place by a "C" lock. As the name implies, the "C" lock is a flat, C-shaped piece of metal that fits into a groove at the end of the shaft. A round pinion shaft is wedged in between the end of the shafts. This pinion shaft prevents the shafts from sliding inward and makes the "C" locks functional by pushing them tightly against each side gear. Removing this pinion shaft allows the shafts to slide inward making the "C" locks accessible for removal. Once the "C" locks are removed, the axle shafts can be pulled from the car.

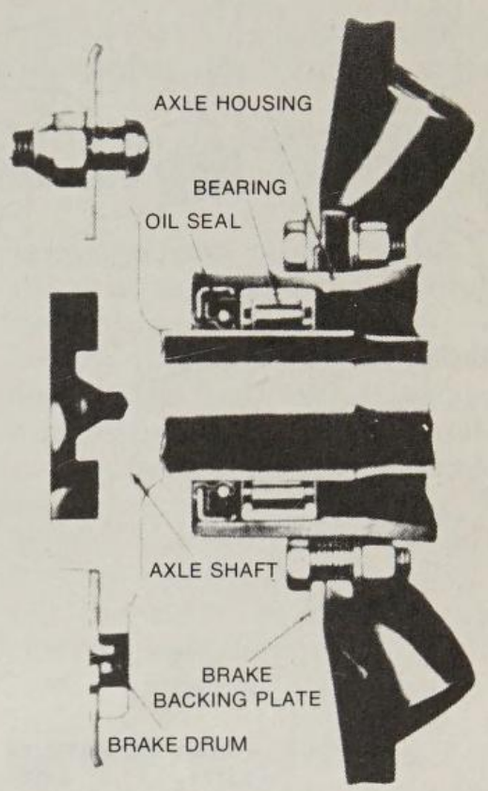
The wheel end of each shaft is flanged and pressed into it are five wheel lug bolts serving to hold on the wheel. Each axle shaft is supported by an axle bearing (wheel bearing) and oil seal located within the axle shaft housing just to the outside of the brake backing plate.

REMOVAL AND INSTALLATION

1. Raise the vehicle and remove the wheels and brake drums.



Rear Axle Assembly



Axle housing components

2. Thoroughly clean the area around the differential carrier cover.

3. Place a drain pan under the carrier and then remove the cover.

4. Remove the differential pinion shaft lockscrew and the differential pinion shaft.

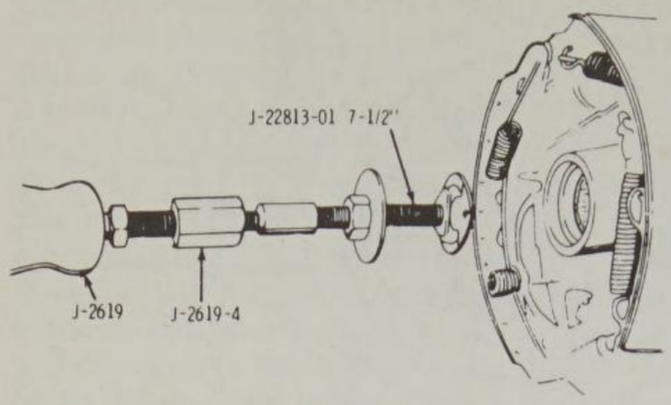
5. Push the flanged end of the axle shaft toward the center of the vehicle and remove the "C" lock from the end of the shaft.

6. Remove the axle shaft from the housing, being careful not to damage the oil seal.

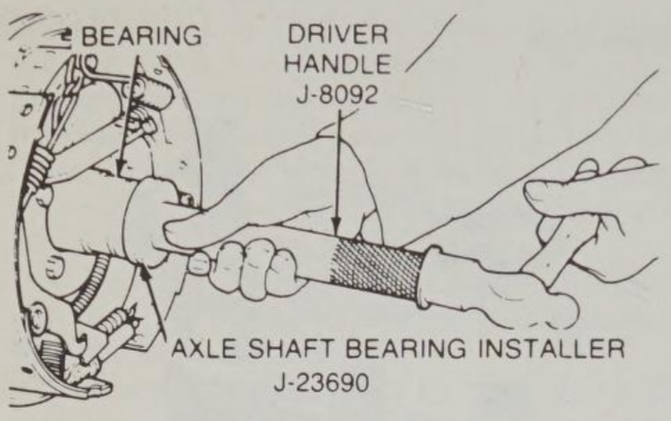
7. Remove the oil seal by inserting the button end of the axle shaft behind the steel case of the oil seal. Pry the seal loose from the bore.

8. Seat the legs of the bearing puller behind the bearing. Seat a washer against the bearing and hold it in place with a nut. Use a slide hammer to pull the bearing.

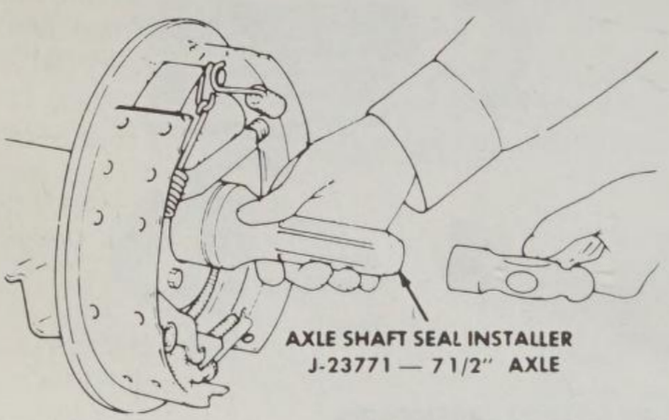
9. Lubricate the lips of a new seal with gear



Removing the Rear Axle Bearing



Installing the Rear Axle Bearing



Installing the Rear Axle Seal

lubricant and lubricate a new wheel bearing with same.

10. Use a suitable driver and install the bearing until it bottoms against the tube. Install the oil seal.

11. Slide the axle shaft into place. Be sure that the splines on the shaft do not damage the oil seal. Make sure that the splines engage the differential side gear.

12. Install the axle shaft, C-lock on the inner end of the axle shaft and push the shaft outward so that the C-lock seats in the differential side gear counterbore.

13. Position the differential pinion shaft through the case and pinions, aligning the hole in the case with the hold for the lock screw.

14. Use a new gasket and install the carrier cover. Be sure that the gasket surfaces are clean before installing the gasket and cover.

15. Fill the axle with lubricant to the bottom of the filler hole.

16. Install the brake drum and wheels and lower the car. Check for leaks and road test the car.

AXLE RATIO

An axle ratio is obtained by dividing the number of teeth on the drive pinion gear into the number of teeth on the ring gear. For instance, on a 4.11 ratio, the driveshaft will turn 4.11 times for every turn of the rear wheel.

The most accurate way to determine the axle ratio is to drain the differential, remove the cover, and count the number of teeth on the ring and pinion.

An easier method is to jack and support the car so that both rear wheels are off the ground. Make a chalk mark on the rear wheel and the driveshaft. Block the front wheels and put the transmission in Neutral. Turn the rear wheel one complete revolution and count the number of turns made by the driveshaft. The number of driveshaft rotations is the axle ratio. More accuracy can be obtained by going more than one tire revolution and dividing the result by the number of tire rotations.

The axle ratio is also identified by the axle serial number prefix on the axle; the axle ratios are listed in dealer's parts books according to prefix number. Some axles have a tag on the cover.

Suspension and Steering

FRONT SUSPENSION

The front suspension is designed to allow each wheel to compensate for changes in the road surface level without appreciably affecting the opposite wheel. Each wheel is independently connected to the frame by a steering knuckle, strut assembly, ball joint, and lower control arm. The steering knuckles move in a prescribed three dimensional arc. The front wheels are held in proper relationship to each other by two tie rods which are connected to the steering knuckles and to a relay rod assembly.

Coil chassis springs are mounted between the spring housings on the front crossmember and the lower control arms. Ride control is provided by double, direct acting strut assemblies. The upper portion of each strut assembly extends through the fender well and attaches to the upper mount assembly with a nut.

Side roll of the front suspension is controlled by a spring steel stabilizer shaft. It is mounted in rubber bushings which are held to the frame side rails by brackets. The ends of the stabilizer are connected to the lower control arms by link bolts isolated by rubber grommets.

The inner ends of the lower control arm have pressed-in bushings. Bolts, passing through the bushings, attach the arm to the suspension crossmember. The lower ball joint assembly is a press fit in the arm and attaches to the steering knuckle with a torque prevailing nut.

Rubber grease seals are provided at ball socket assemblies to keep dirt and moisture from entering the joint and damaging bearing surfaces.

Struts

REMOVAL AND INSTALLATION

1. Place the ignition key in the unlocked position so that the front wheels can be moved.
2. From inside the engine compartment, remove the upper strut to upper mount fastener.

CAUTION: *Do not attempt to move the vehicle with the upper strut fastener disconnected.*

3. Raise the front of the vehicle by the lower control arms, and position safety stands under the vehicle.
4. Remove the wheel and tire assembly.
5. Remove the brake caliper without disconnecting the fluid hose, and hang out of the way on a wire. Do not allow the caliper to hang by its fluid hose.
6. Remove the two lower bolts attaching the strut to the steering knuckle.
7. Lift the strut up from the steering knuckle to compress the rod, then pull down and remove the strut.

To install:

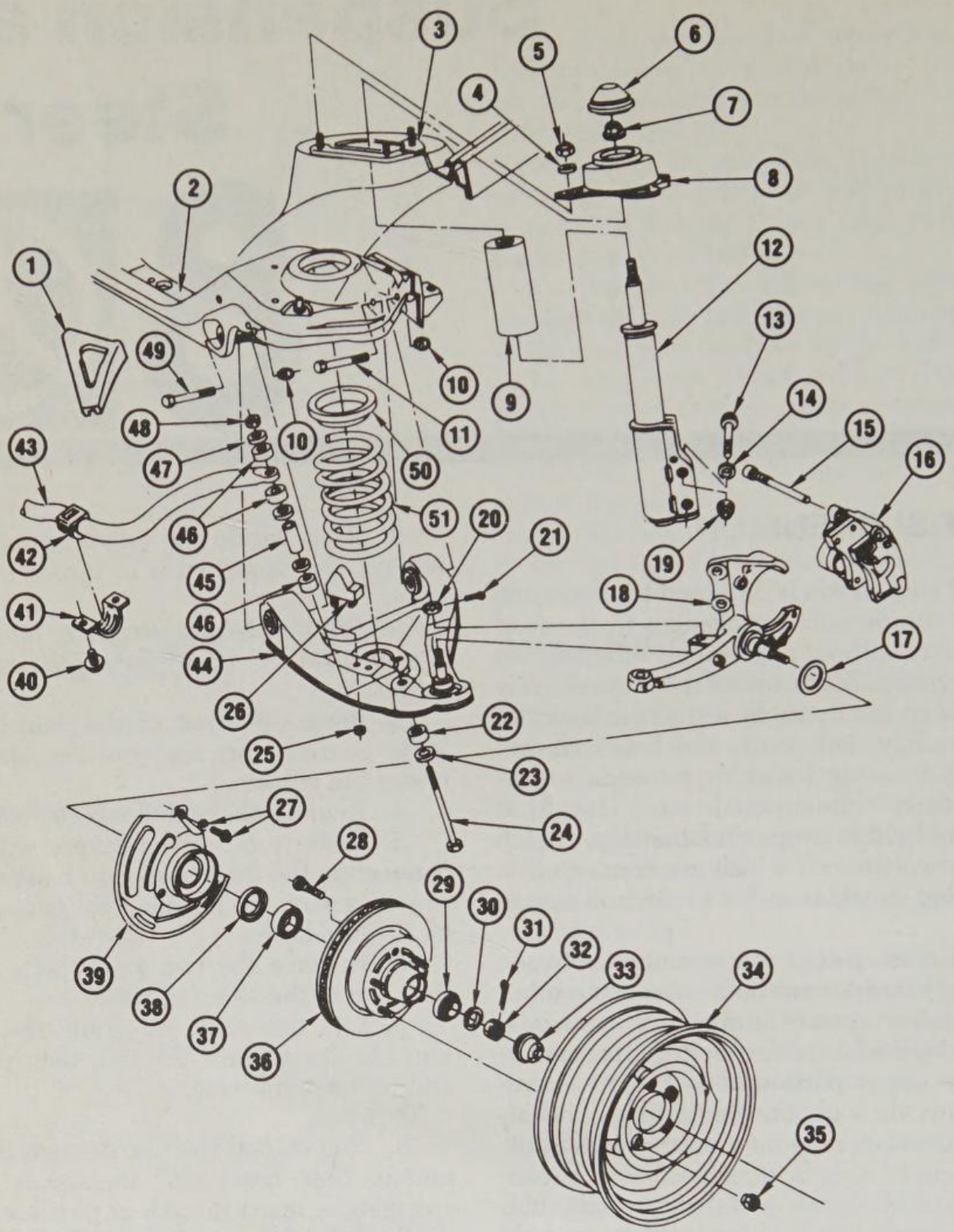
8. Half extend the rod through the upper mount, then hand start the upper fastener, engaging as many threads as possible.
9. Extend the strut and position it onto the steering knuckle.
10. Install the lower mount bolts hand tight.
11. Tighten the upper fastener fully.
12. Fully tighten the lower bolts only when the front suspension is on the ground. Remaining installation is the reverse of removal.

OVERHAUL

Most OEM domestic struts are serviced by replacement of the entire unit. There is no strut cartridge to replace.

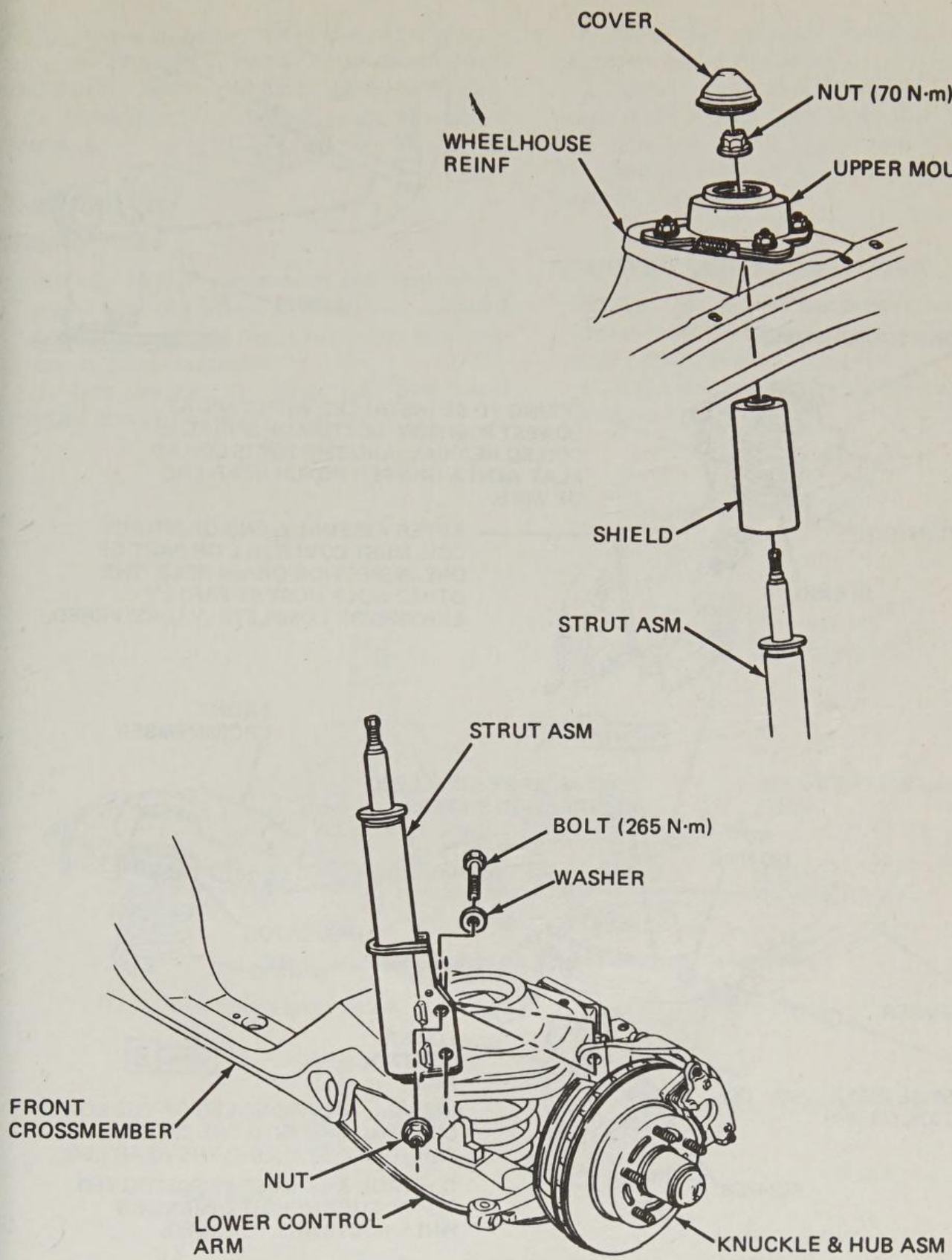
Sealed units can also be serviced by replacement with an aftermarket unit, that will permit future servicing by cartridge replacement.

1. Place the strut assembly in a vise.
2. Compress the coil spring and remove it.
3. Using a pipe cutter, cut open the strut body at the scribed line.



1. Crossmember brace
2. Crossmember
3. Retainer
4. Washer
5. Nut (M8 × 1.25)
6. Washer
7. Nut (M14 × 2)
8. Mount
9. Shield
10. Nut (M12 × 1.75)
11. Bolt (M12 × 1.75 × 95)
12. Absorber w/strut
13. Bolt
14. Washer
15. Bolt
16. Caliper
17. Gasket
18. Knuckle
19. Nut (M16 × 2)
20. Nut ($^{9}/_{16}$-18)
21. Cotter pin ($^{1}/_{8}$ × 1)
22. Grommet
23. Retainer
24. Bolt ($^{5}/_{16}$-18 × 7)
25. Nut ($^{7}/_{16}$-14)
26. Bumper
27. Bolt
28. Bolt
29. Outer front wheel bearing
30. Washer
31. Cotter pin (M3.2 × 25)
32. Nut
33. Cap
34. Wheel
35. Nut
36. Hub
37. Inner front wheel bearing
38. Seal
39. Shield
40. Bolt (M10 × 1.5 × 30)
41. Bracket
42. Insulator
43. Front stabilizer shaft
44. Lower control arm
45. Spacer
46. Grommet
47. Retainer
48. Nut
49. Bolt (M12 × 1.75 × 115)
50. Insulator

Front suspension



Remove/Install strut

NOTE: *It is important that the cut be made on the cut-line only.*

4. Remove the cartridge and oil from the strut.

5. Note the threads on the inside of the strut. Deburr the top of the strut body if necessary.

6. Installation is the reverse of removal.

NOTE: *Upon installation of the strut cartridge place about one ounce of oil into the strut body.*

Springs

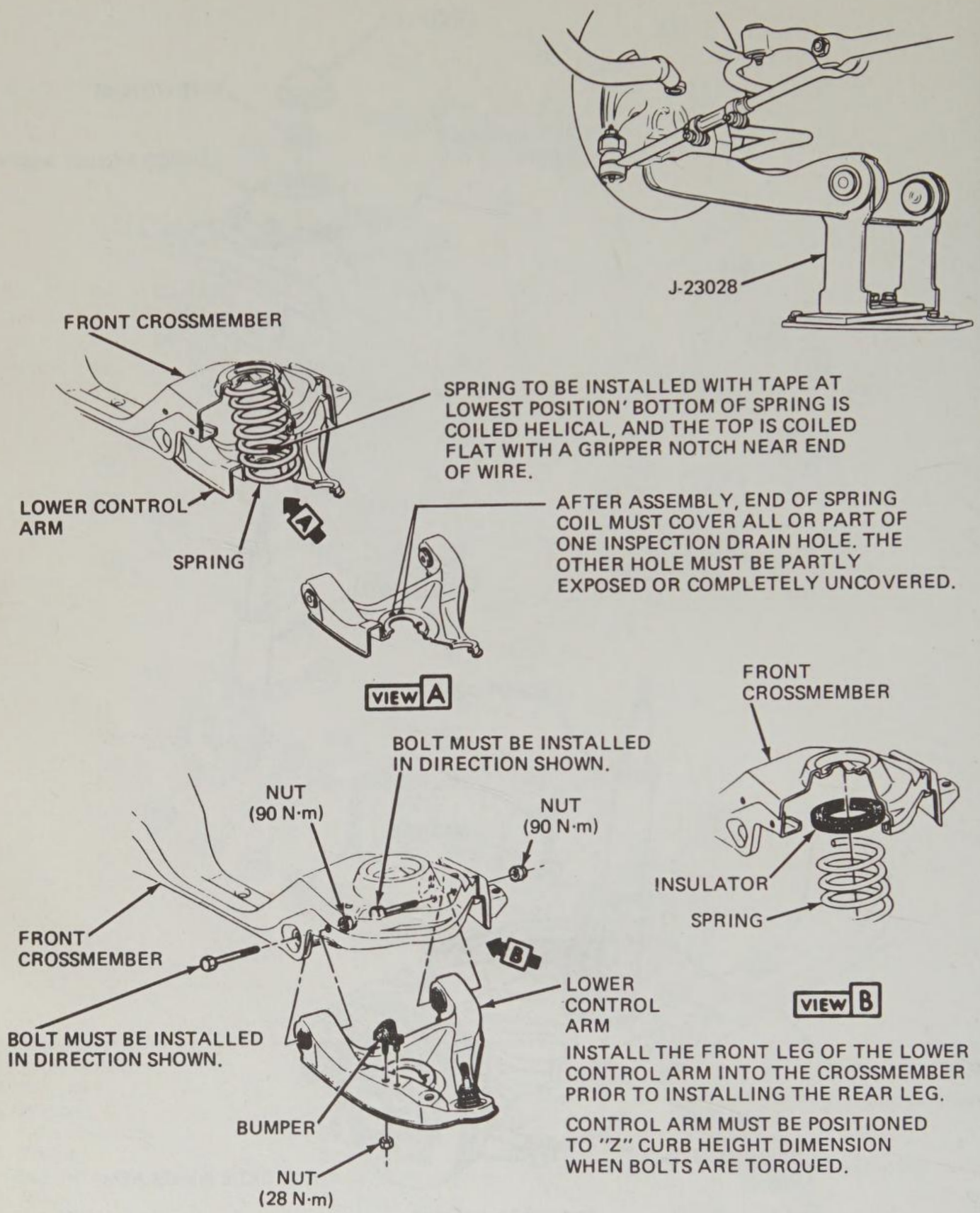
REMOVAL AND INSTALLATION

1. Raise the front of the vehicle and support it on jack stands.

2. Remove the road wheel(s).

3. Disconnect the stabilizer link from the lower control arm.

4. If the steering gear hinders removal pro-



Remove/Install coil spring/lower control arm

cedures, disattach the unit and move it out of the way.

5. Disconnect the tie-rod from the steering knuckle using a ball joint remover.

6. Using an internal-fit coil spring compressor, compress the coil spring so that it is loose in its seat.

CAUTION: *Be sure to follow manufacturer's instructions when using spring compressor. Coil springs in a compressed state contain enormous energy which, if released accidentally, could cause serious injury.*

7. To remove the coil spring, disconnect the lower control arm from the crossmember at the pivot bolts. If additional clearance is necessary, disconnect the lower control arm from the steering knuckle at the ball joint.

8. To install, compress the coil spring until spring height is the same as when removed, then position the spring on the control arm.

Make sure the lower end of the coil spring is properly positioned in the lower control arm and that the upper end fits correctly in its pad.

9. Remaining installation is the reverse of removal.

Ball Joints

INSPECTION

NOTE: *Before performing this inspection, make sure the wheel bearings are adjusted correctly and that the control arm bushings are in good condition.*

1. Jack the car up under the front lower control arm at the spring seat.

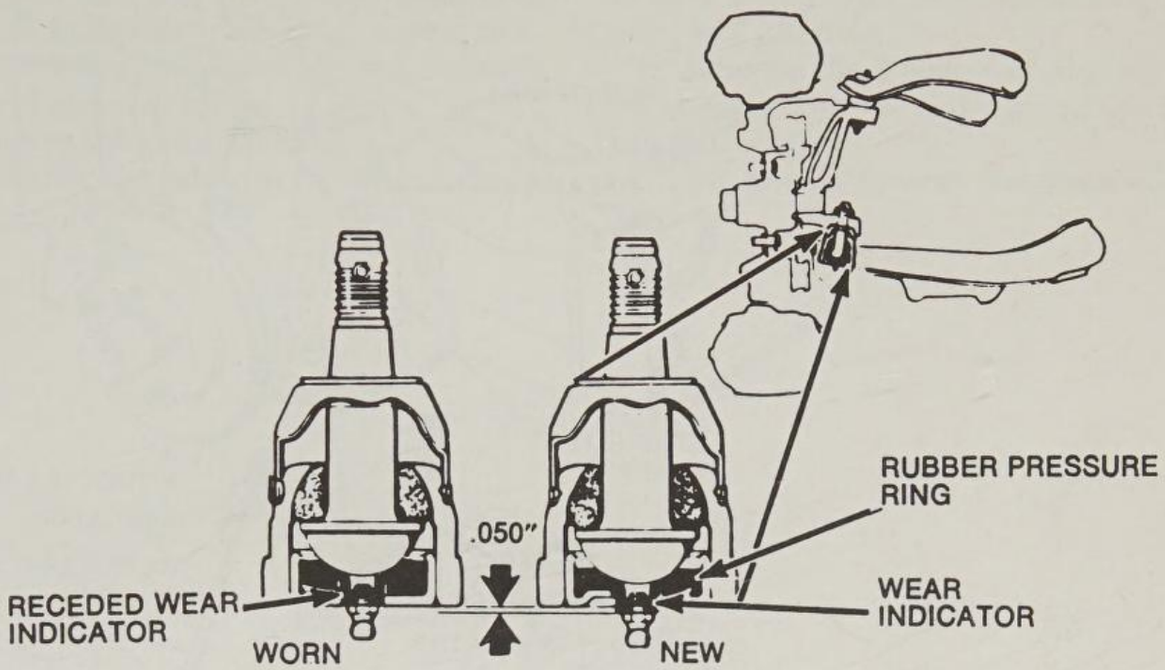
2. Raise the car until there is 1–2 in. of clearance under the wheel.

3. Insert a bar under the wheel and pry upward. If the wheel raises more than ⅛ in., the ball joints are worn. Determine if the lower ball joint is worn by visual inspection while prying on the wheel.

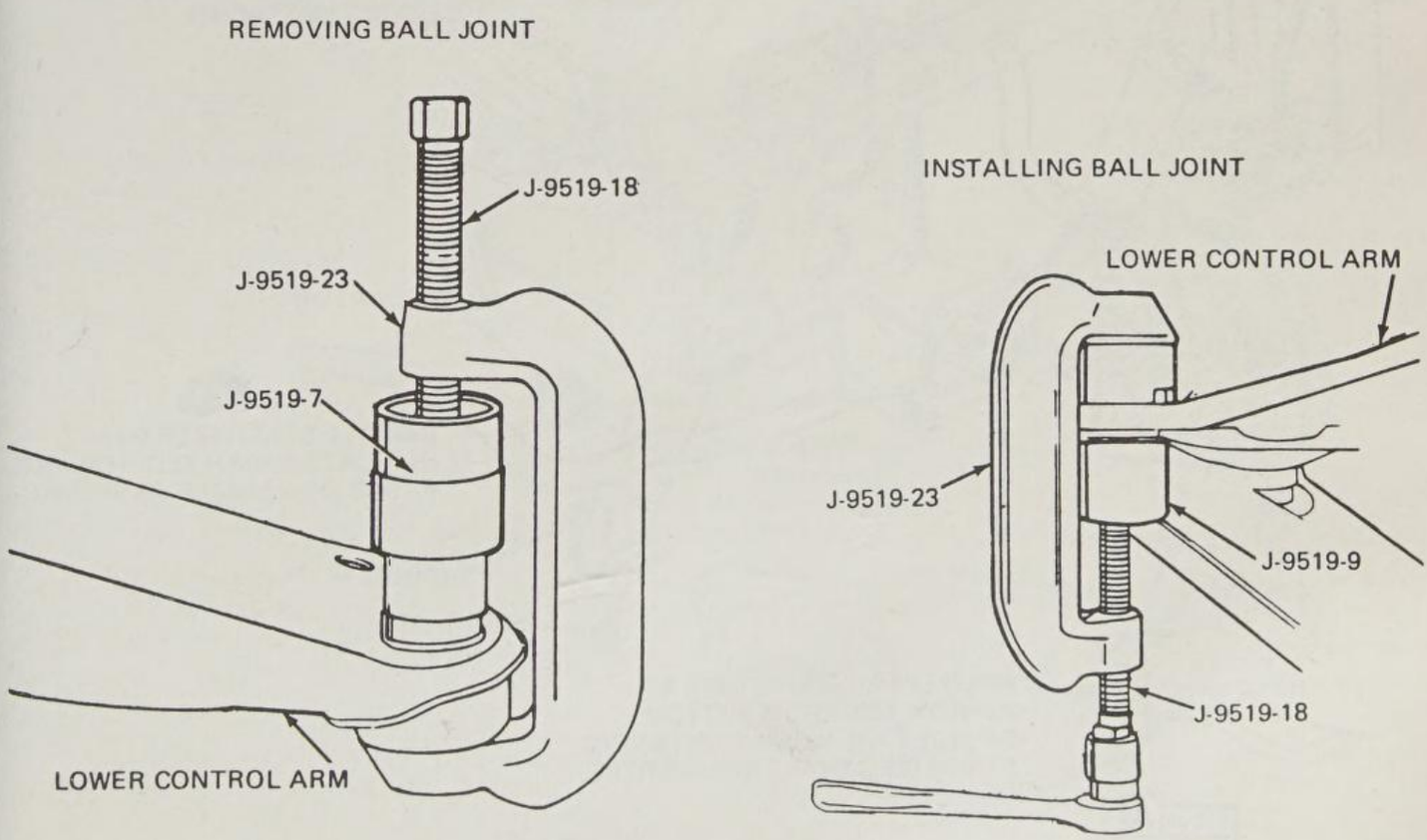
REMOVAL AND INSTALLATION

NOTE: *To prevent component damage, an on-car ball joint press, such as Kent-Moore tool J-9519-23 should be used.*

1. Raise the vehicle on a hoist and remove the wheel.

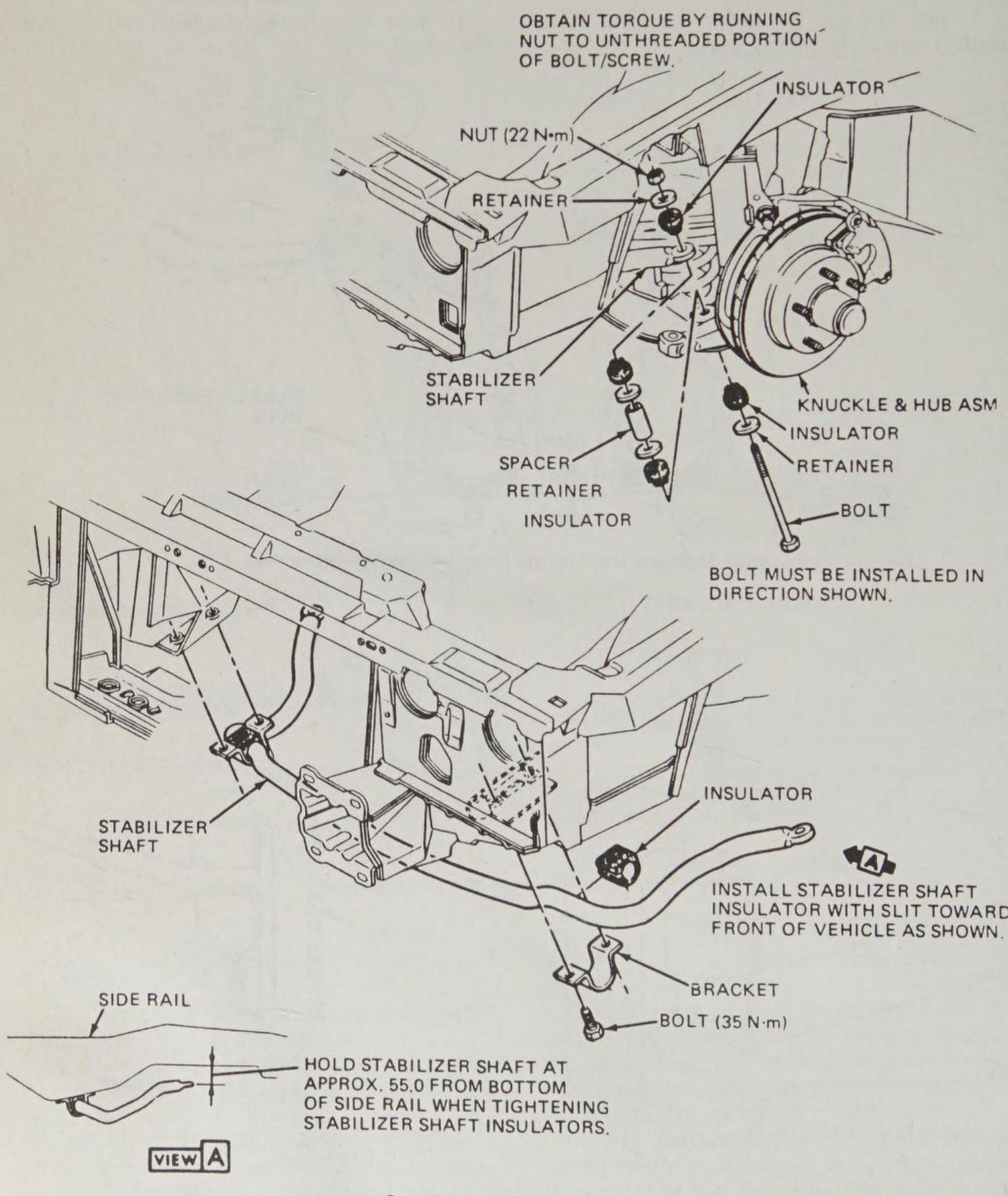


Wear indicator used on the lower ball joints—all models



Remove/Install ball joint

2. Support the lower control arm spring seat with a jack.
3. Loosen the lower ball stud nut. Break the ball stud loose. Remove the ball stud nut.
4. Remove the ball stud from the steering knuckle.
5. The ball joint is pressed in and must be pressed out.
6. Install the new ball joint, using the bolts supplied with the service ball joint. The thick-headed bolt is installed on the forward side of control arm. Press in the ball joint.
7. Install the ball stud in the steering knuckle boss. This may be done by raising the lower control arm with the jack.
8. Install the nut on the ball stud, tightening to 90 ft. lbs. on all models. Continue to tighten the nut until the cotter pin holes align and install the pin. Do not back off the nut to align the holes.
9. Install the lube fitting.



Stabilizer Shaft Assembly

Lower Control Arm

REMOVAL AND INSTALLATION

1. Remove the spring as described earlier in this section.
2. Remove the ball stud from the steering knuckle.
3. Remove the control arm.
4. To install, reverse the above procedure.

Stabilizer Shaft

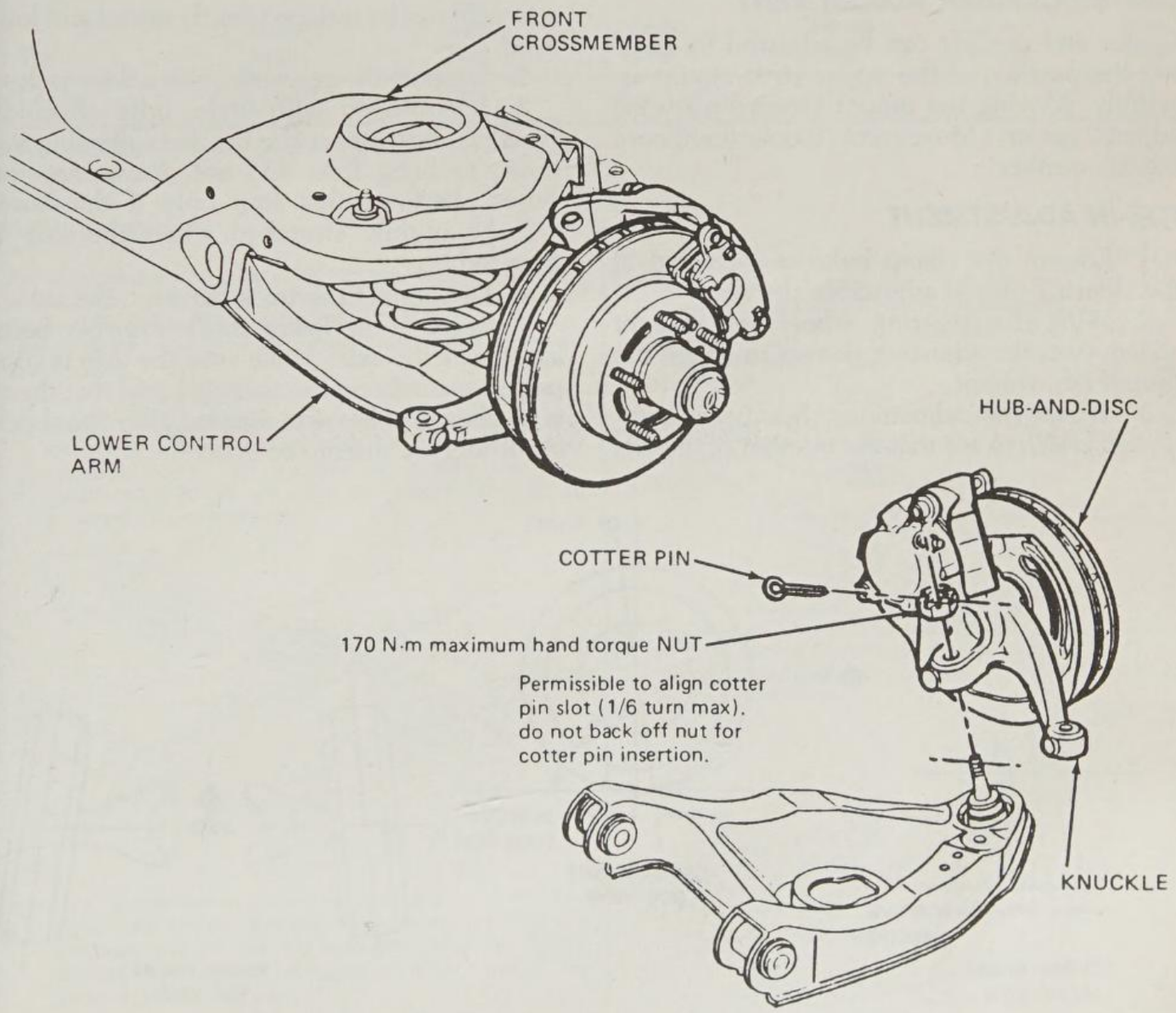
REMOVAL AND INSTALLATION

1. Raise and support the vehicle on jack stands.
2. Remove the link bolts, nuts, grommets, spacers and retainers at each lower control arm.
3. Remove the insulators and brackets which are connected to the frame.
4. Remove the stabilizer shaft.
5. To install, reverse the removal procedures.

Steering Knuckle

REMOVAL AND INSTALLATION

1. Siphon some brake fluid from the master cylinder. Raise and support the vehicle.
2. Remove the wheel and tire. Remove the brake hose from the strut.
3. Remove the caliper and support on a wire. Refer to chapter 9 for removal and installation procedures of the hub-and-disc, then remove the hub-and-disc.
4. Remove the splash shield. Disconnect the tie rod from the steering knuckle.
5. Support the lower control arm and disconnect the ball joint from the steering knuckle using tool J-24292A.
6. Remove the 2 bolts securing the strut to the steering knuckle and remove the steering knuckle.
7. To install, reverse the removal procedure.



Steering Knuckle Assembly

Front End Alignment

CAMBER

Camber is the inward or outward tilting of the front wheels from the vertical. When the wheels tilt outward at the top, the camber is said to be positive (+). When the wheels tilt inward at the top, the camber is said to be negative (−). The amount of tilt is measured in degrees from the vertical and this measurement is called the camber angle.

CASTER

Caster is the tilting of the front steering axis either forward or backward from the vertical. A backward tilt is said to be positive (+) and a forward tilt is said to be negative (−).

TOE-IN

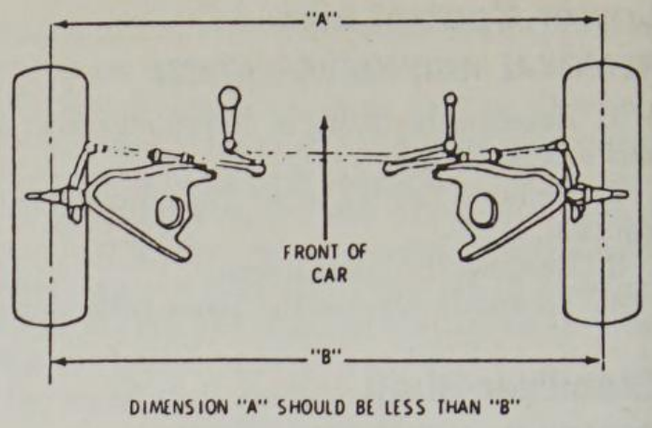
Toe-in is the turning in of the front wheels. The actual amount of toe-in is normally only a fraction of a degree. The purpose of toe-in is to ensure parallel rolling of the front wheels. (Excessive toe-in or toe-out will cause tire wear.)

CASTER/CAMBER ADJUSTMENT

Caster and camber can be adjusted by moving the position of the upper strut mount assembly. Moving the mount forward/rearward adjusts caster. Movement inboard/outboard adjusts camber.

TOE-IN ADJUSTMENT

1. Loosen the clamp bolts at each end of the steering tie rod adjustable sleeves.
2. With the steering wheel set straight ahead, turn the adjusting sleeves to obtain the proper adjustment.
3. When the adjustment has been completed, check to see that the number of threads showing on each end of the sleeve are equal. Also check that tie rod end housings are at the right angles to the steering arm.



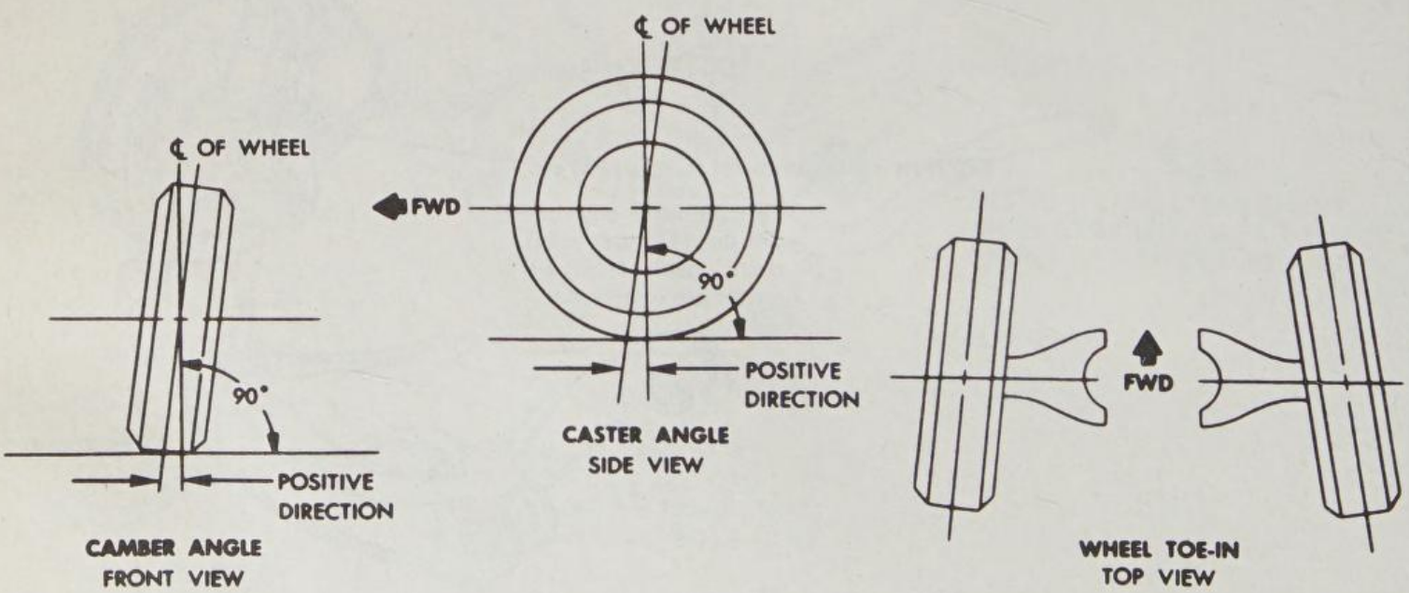
Toe-in

REAR SUSPENSION

Springs

REMOVAL AND INSTALLATION

1. Raise the car by the frame so that the rear axle can be independently raised and lowered.
2. Support the rear axle with a floor jack.
3. If equipped with brake hose attaching brackets, disconnect the brackets allowing the hoses to hang free. Do not disconnect the hoses. Perform this step only if the hoses will be unduly stretched when the axle is lowered.
4. Disconnect the track bar from the axle.
5. Remove the lower shock absorber bolts and lower the axle. Make sure the axle is supported securely on the floor jack and that there is no chance of the axle slipping after the shock absorbers are disconnected.



Caster, camber, toe-in

NOTE: *On vehicles equipped with a 4-cyl. engine, remove the drive shaft.*

6. Lower the axle and remove the coil spring. Do not lower the axle past the limits of the brake lines or the lines will be damaged.

7. Installation is the reverse of removal. Make sure the spring is seated in the same position as before removal.

Shock Absorbers

REMOVAL AND INSTALLATION

1. Jack up the car to a convenient working height. Support the axle assembly with jack stands.

2. Disconnect the upper shock attaching nuts.

3. Remove the lower shock to axle mounting bolt.

4. Remove the shock absorber.

5. Installation is the reverse of removal. Torque the upper nuts to 13 ft. lbs.; the lower to 70 ft. lbs.

TESTING

Visually inspect the shock absorber. If there is evidence of leakage and the shock absorber is covered with oil, the shock is defective and should be replaced.

If there is no sign of excessive leakage (a small amount of weeping is normal) bounce the car at one corner by pressing down on the fender or bumper and releasing. When you have the car bouncing as much as you can, release the fender or bumper. The car should stop bouncing after the first rebound. If the bouncing continues past the center point of the bounce more than once, the shock absorbers are worn and should be replaced.

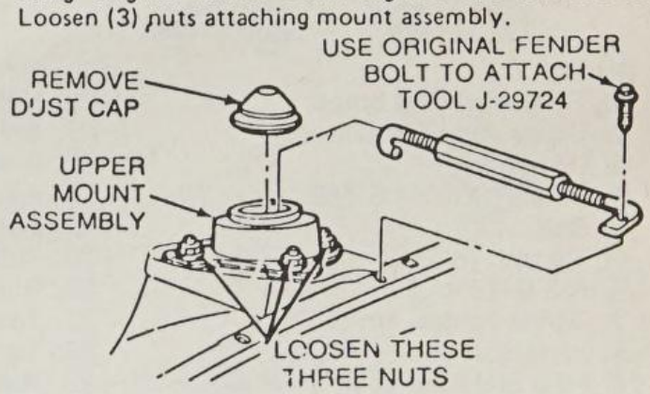
Wheel Alignment Specifications

Year	Caster Range (deg)	Caster Pref Setting (deg)	Camber Range (deg)	Camber Pref Setting (deg)	Toe-in (in.)	Steering Axis Inclin (deg)
'82–Later	2½P to 3½P	3P	½P to 1½P	1P	①	NA

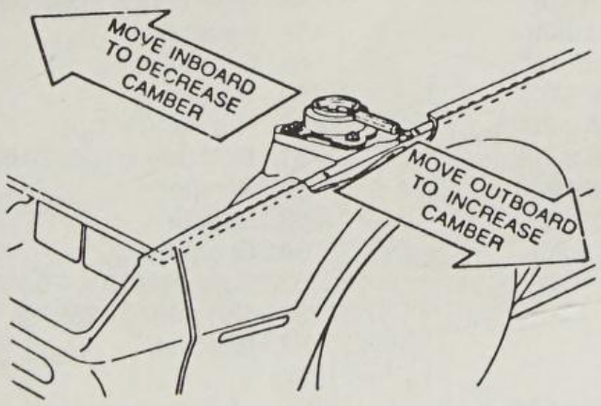
① Except Z28—.2° ± .05°; Z-28—.15° ± .05°
N—Negative
P—Positive
NA—Not available

An alignment verification label on the upper mount-to-wheelhouse tower verifies the accuracy of camber and caster adjustment. If a steering problem exists, it is important to check other possible causes before adjusting camber or caster.

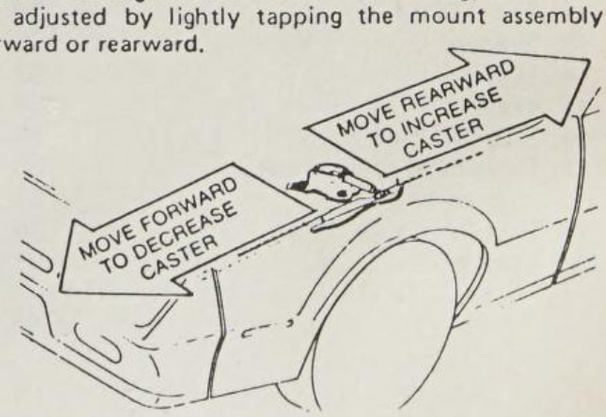
(1) Remove dust cap and fender bolt. Attach J-29724, using original fender bolt. Tighten the turnbuckle. Loosen (3) nuts attaching mount assembly.



(2) Using reliable alignment equipment, follow the manufacturer's instructions to obtain camber and caster readings. Adjust the camber by rotating the turnbuckle on J-29724 to allow the mount assembly to move inboard or outboard.

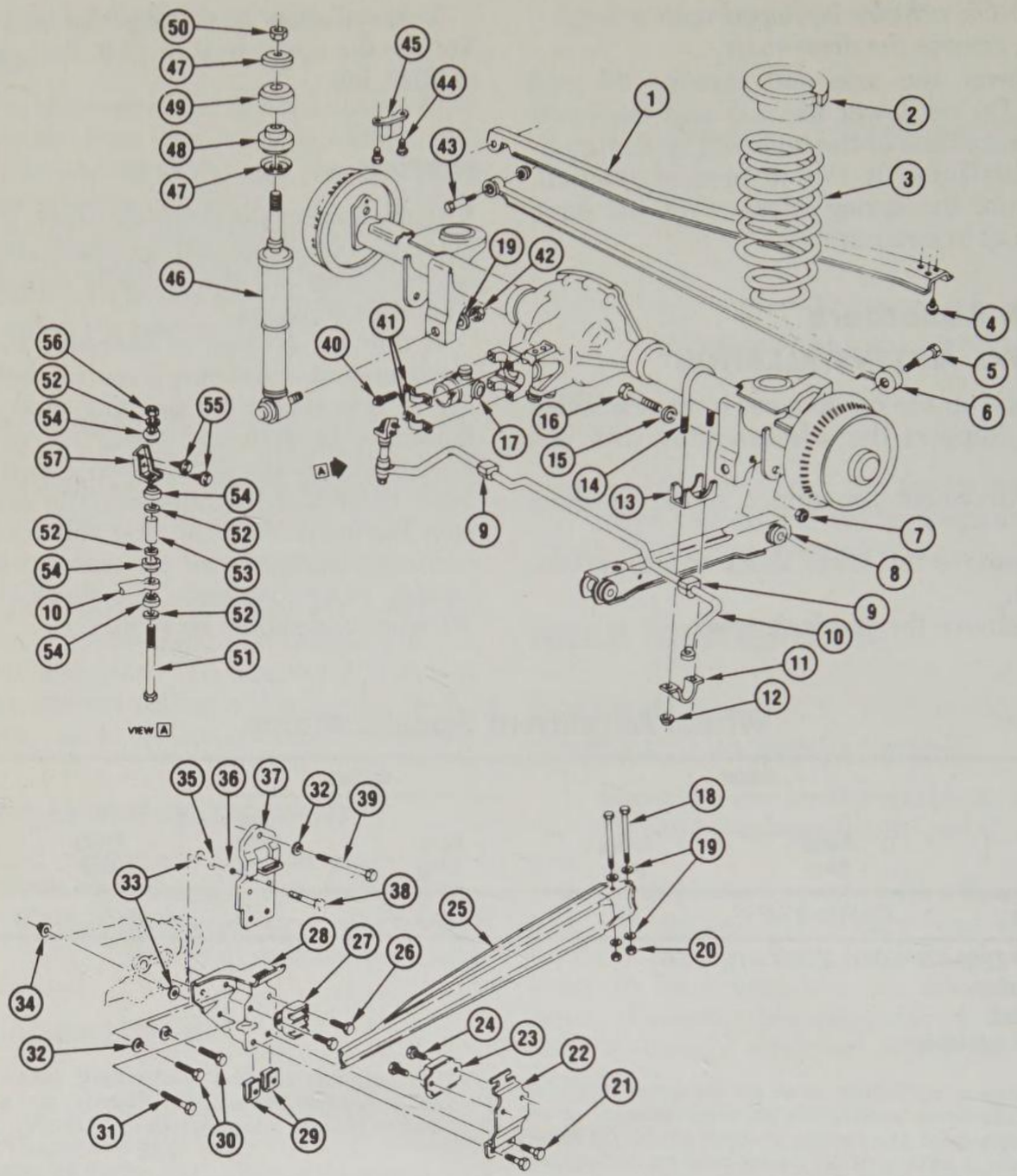


(3) After obtaining the correct camber reading, caster can be adjusted by lightly tapping the mount assembly forward or rearward.



(4) When the correct camber and caster readings are obtained, tighten the (3) nuts attaching the mount assembly to 28 N·m. Remove J-29724. Install the fender bolt and dust cap.

Caster and camber adjustment



1. Tie rod bracket brace
2. Upper spring insulator
3. Coil spring
4. Screw (M10 × 1.5 × 32)
5. Bolt
6. Tie rod
7. Nut (M12 × 1.75)
8. Lower control arm
9. Insulator
10. Rear stabilizer shaft
11. Clamp
12. Nut (M8 × 1.25)
13. Bracket
14. Bolt
15. Washer
16. Bolt (M12 × 1.75 × 95)
17. Driveshaft w/universal joint
18. Bolt (M14 × 2 × 185)
19. Washer
20. Nut (M14 × 2)
21. Bolt (M8 × 1.25 × 25)
22. Bracket
23. Insulator
24. Bolt (M5 × 0.8 × 10)
25. Torque arm
26. Bolt (M5 × 0.8 × 10)
27. Torque arm insulator
28. Torque arm bracket
29. Nut, "U" (M8 × 1.25)
30. Bolt (M10 × 1.5 × 20)
31. Bolt (M10 × 1.5 × 70)
32. Washer (M10 × 18.3)
33. Spacer
34. Bolt (M4 × 0.7 × 20)
35. Psh-nut
36. Spacer
37. Bracket
38. Bolt
39. Bolt (M10 × 1.5 × 110)
40. Bolt
41. Strap
42. Nut (M14.0 × 2)
43. Bolt w/screw
44. Bolt (M8 × 1.25 × 16)
45. Bumper
46. Rear shock absorber
47. Retainer
48. Grommet
49. Grommet
50. Nut (M10 × 1.5)
51. Bolt (M8 × 1.25 × 180)
52. Washer
53. Spacer
54. Grommet
55. Screw (M10 × 1.5 × 32)
56. Nut (M8 × 1.25)(*2)
57. Bracket

Coil spring rear suspension

Track Bar

REMOVAL AND INSTALLATION

1. Raise the rear of the vehicle, place jackstands under the rear axle, then lower the jack so that the stands are supporting all of the weight.
2. Remove the track bar mounting fasteners. Remove the track bar.

To install:

3. Clean all of the track bar fasteners.
4. Position the track bar in the body bracket and loosely install the bolt and the nut.
5. Position the track bar to the axle assembly and install the bolt and the nut. Torque the bolt to 93 ft. lbs.
6. Torque the body bracket nut to 58 ft. lbs.

Track Bar Brace

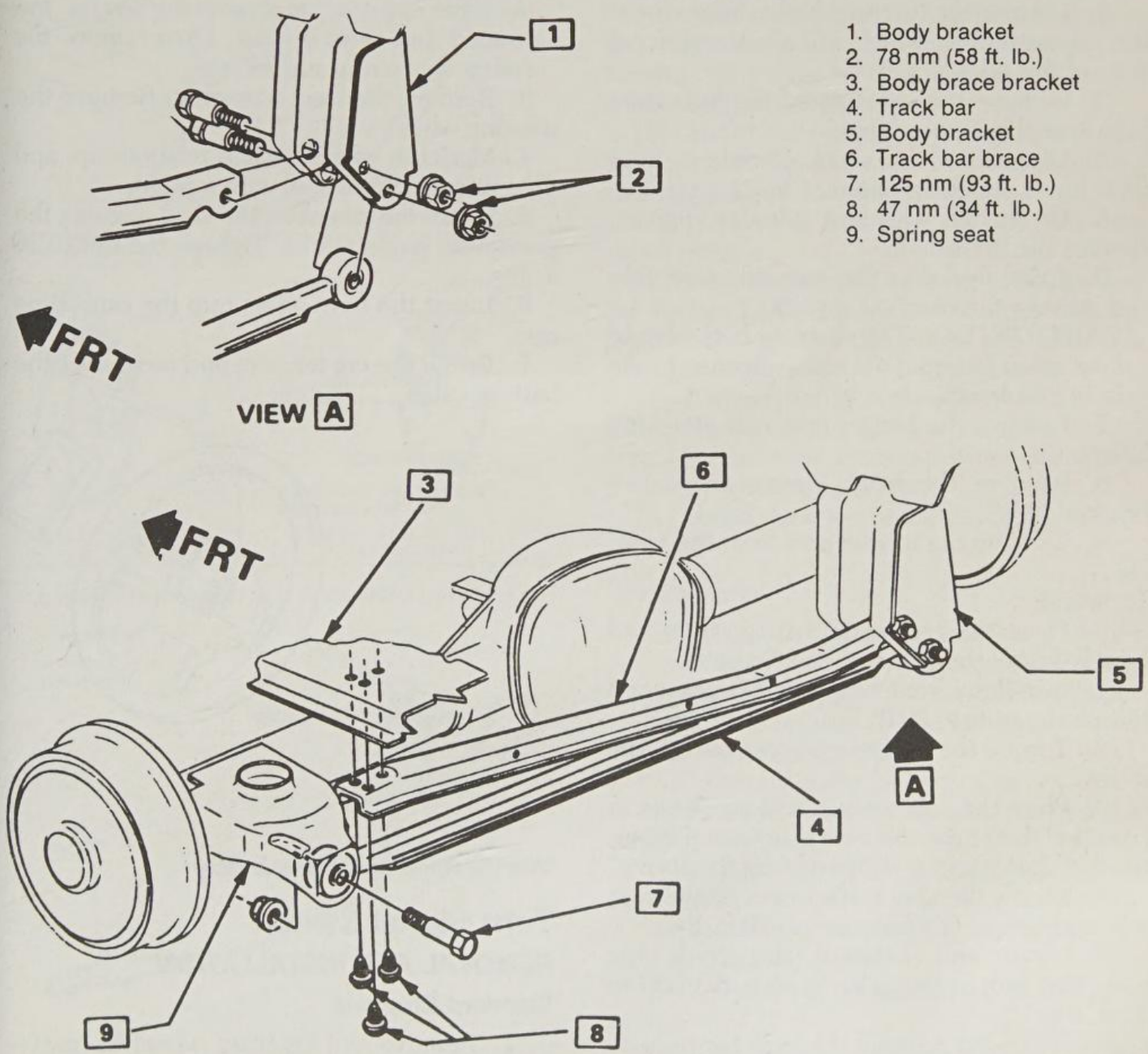
REMOVAL AND INSTALLATION

1. Raise the rear of the vehicle, place jackstands under the rear axle, then lower the jack so that the stands are supporting all of the weight.
2. Remove the heat shield screws from the track bar brace.
3. Remove the three track bar brace-to-body brace screws.
4. Remove the track bar-to-body bracket fasteners and remove the track bar brace.
5. Installation is performed in the reverse of the previous steps. Torque the body brace fasteners to 58 ft. lbs., and the body bracket fasteners to 34 ft. lbs.

Rear Lower Control Arm

REMOVAL AND INSTALLATION

NOTE: *Remove/reinstall only one lower control arm at a time. If both arms are removed at the same time, the axle could roll or slip sideways, making reinstallation of the arms very difficult.*



1. Body bracket
2. 78 nm (58 ft. lb.)
3. Body brace bracket
4. Track bar
5. Body bracket
6. Track bar brace
7. 125 nm (93 ft. lb.)
8. 47 nm (34 ft. lb.)
9. Spring seat

Track bar and track bar brace

1. Raise the rear of the vehicle, place jackstands under the rear axle, then lower the jack so that the stands are supporting all of the weight.
2. Remove the control arm attaching fasteners, then remove the control arm.
3. Installation is a simple matter of bolting the arm into place. Torque the fasteners to 68 ft. lbs.

Torque Arm

REMOVAL AND INSTALLATION

NOTE: *The coil springs must be removed BEFORE the torque arm. If the torque arm is removed first, vehicle damage will result.*
NOTE: *In order to proceed, the vehicle must be supported in a manner which will allow the rear axle height to be adjusted independently of the body height.*

1. Remove the track bar mounting bolt at the axle assembly, then loosen the track bar bolt at the body brace.
2. Disconnect the rear brake hose clip at the axle assembly, which will allow additional drop of the axle.
3. Remove the lower attaching nuts from both rear shock absorbers.
4. Disconnect the shock absorbers from their lower attaching points.
5. On models with four cylinder engines, remove the driveshaft.
6. Carefully lower the rear axle assembly and remove the rear coil springs.

CAUTION: *DO NOT overtstress the brake hose when lowering the axle—damage to the hose will result.*

7. Remove the torque arm rear attaching bolts.
8. Remove the front torque arm outer bracket.
9. Remove the torque arm from the vehicle.

To install:

10. Place the torque arm in position and loosely install the rear torque arm bolts.
11. Install the front torque arm bracket and torque the nuts to 20 ft. lbs.
12. Torque the rear torque arm nuts to 100 ft. lbs.
13. Place the rear springs and insulators in position, then raise the rear axle assembly until all of the weight is supported by the spring.
14. Attach the shock absorbers to the rear axle and torque the fasteners to 70 ft. lbs.
15. Clean and reinstall the track bar mounting bolt at the axle. Torque the bolt to 93 ft. lbs.
16. Clean and reinstall the track bar-to-body bracket nut. Torque the nut to 58 ft. lbs.
17. Install the brake line clip to the underbody.
18. On four cylinder models, reinstall the driveshaft.
19. Lower the vehicle.

STEERING

Steering Wheel

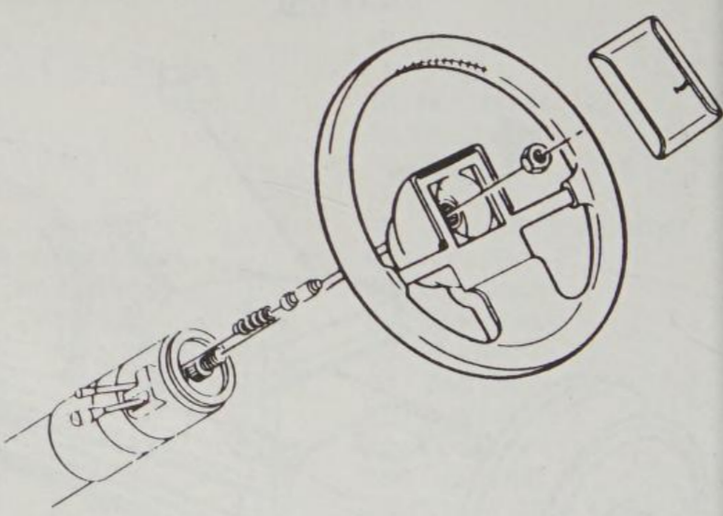
REMOVAL AND INSTALLATION

CAUTION: *Disconnect the battery ground cable before removing the steering wheel. When installing a steering wheel, always make sure that the turn signal lever is in the neutral position.*

1. Remove the trim retaining screws from behind the wheel. On wheels with a center cap, pull off the cap.
2. Lift the trim off and pull the horn wires from the turn signal cancelling cam.

NOTE: *On the tilt-telescope wheel, remove the three upper contact retaining screws, the contact and shim if used. Then remove the center star screw and lever.*

3. Remove the shaft snap-ring. Remove the steering wheel nut.
4. Mark the wheel-to-shaft relationship, and then remove the wheel with a puller.
5. Install the wheel on the shaft aligning the previously made marks. Tighten the nut to 30 ft. lbs.
6. Insert the horn wires into the cancelling cam.
7. Install the center trim and reconnect the battery cable.



Steering Wheel and Hub Assembly

Turn Signal Switch

REMOVAL AND INSTALLATION

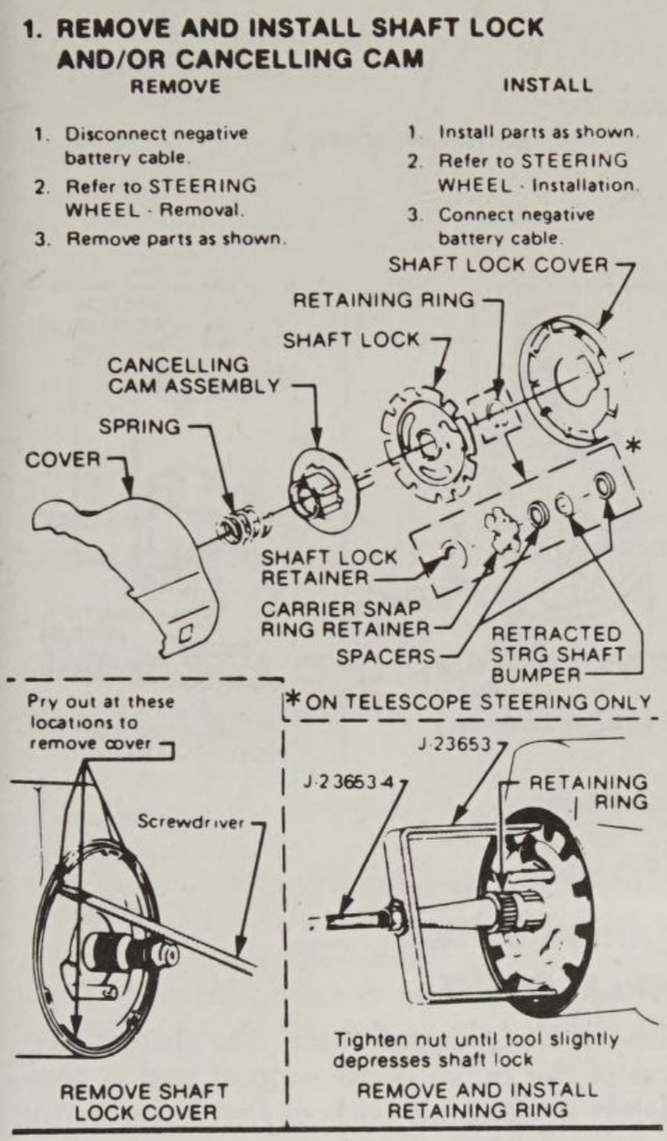
Standard Columns

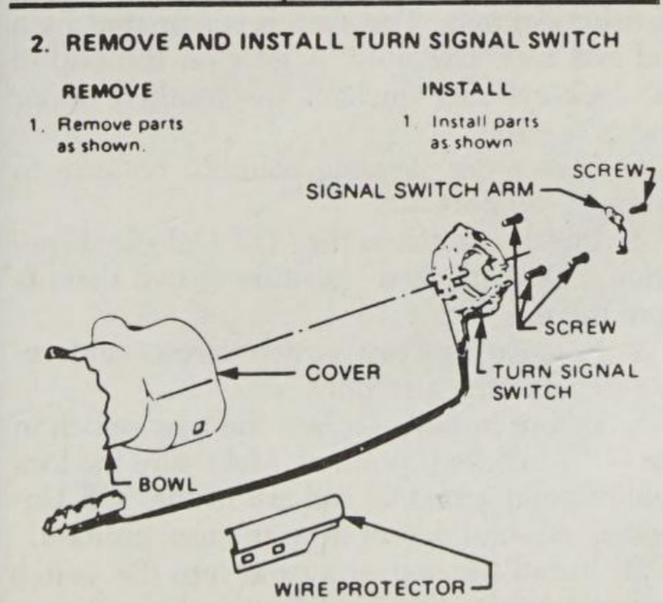
1. Remove the steering wheel as previously outlined. Remove the trim cover.

2. Pry the cover off, and lift the cover off the shaft.

3. Position the U-shaped lockplate compressing tool on the end of the steering shaft and compress the lock plate by turning the shaft nut clockwise. Pry the wire snap-ring out of the shaft groove.

4. Remove the tool and lift the lockplate off the shaft.





Turn Signal Switch Assembly

5. Remove the cancelling cam assembly and upper bearing preload spring from the shaft.

6. Remove the turn signal lever. Push the flasher knob in and unscrew it. On models equipped with a button and a knob, remove the button retaining screw, then remove the button, spring, and knob.

7. Pull the switch connector out the mast jacket and tape the upper part to facilitate switch removal. Attach a long piece of wire to the turn signal switch connector. When installing the turn signal switch, feed this wire through the column first, and then use this wire to pull the switch connector into position. On tilt wheels, place the turn signal and shifter housing in low position and remove the harness cover.

8. Remove the three switch mounting screws. Remove the switch by pulling it straight up while guiding the wiring harness cover through the column.

9. Install the replacement switch by working the connector and cover down through the housing and under the bracket. On tilt models, the connector is worked down through the housing, under the bracket, and then the cover is installed on the harness.

10. Install the switch mounting screws and the connector on the mast jacket bracket. Install the column-to-dash trim plate.

11. Install the flasher knob and the turn signal lever.

12. With the turn signal lever in neutral and the flasher knob out, slide the upper bearing preload spring, and cancelling cam assembly onto the shaft.

13. Position the lock plate on the shaft and press it down until a new snap-ring can be inserted in the shaft groove. Always use a new snap-ring when assembling.

14. Install the cover and the steering wheel.

Tilt Columns

CAUTION: *All elements of energy-absorbing (telescopic) steering columns are very sensitive to damage. Do not strike any part of the column (nuts, bolts, etc.) as this could ruin the entire assembly.*

1. Disconnect the battery cable.

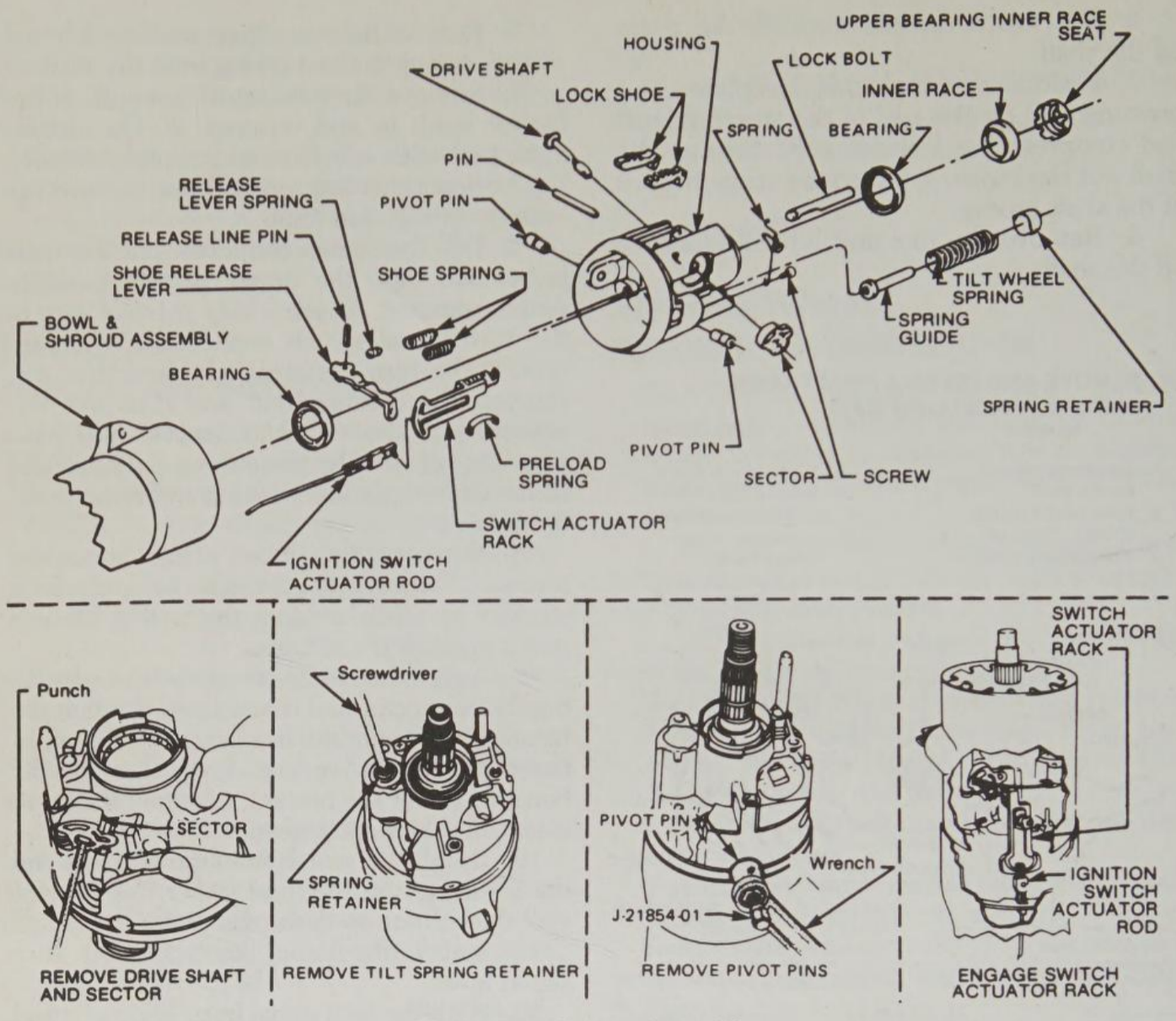
2. Remove the steering wheel as outlined earlier.

3. Remove the cover from the steering column shaft.

4. Press down on the lockplate and pry the snap-ring from the shaft.

5. Remove the lockplate and the canceling cam.

6. Remove the upper bearing preload spring.



Tilt Steering Column Assembly

7. Remove the turn signal lever and the hazard flasher knob.

8. Lift up on the tilt lever and position the housing in its central position.

9. Remove the switch attaching screws.

10. Remove the lower trim cap from the instrument panel and disconnect the turn signal connector from the wiring harness.

11. Remove the four bolts which secure the bracket assembly to the jacket.

12. Loosen the screw that holds the shift indicator needle and disconnect the clip from the link.

13. Remove the two nuts from the column support bracket while holding the column in position. Remove the bracket assembly and wire protector from the wiring, then loosely install the support column bracket.

14. Tape the turn signal wires at the connector to keep them fit and parallel.

15. Carefully remove the turn signal switch and wiring from the column.

16. To install, reverse the removal procedure, using a new snap-ring.

Ignition Switch

REPLACEMENT

The switch is located inside the channel section of the brake pedal support and is completely inaccessible without first lowering the steering column. The switch is actuated by a rod and rack assembly. A gear on the end of the lock cylinder engages the toothed upper end of the rod.

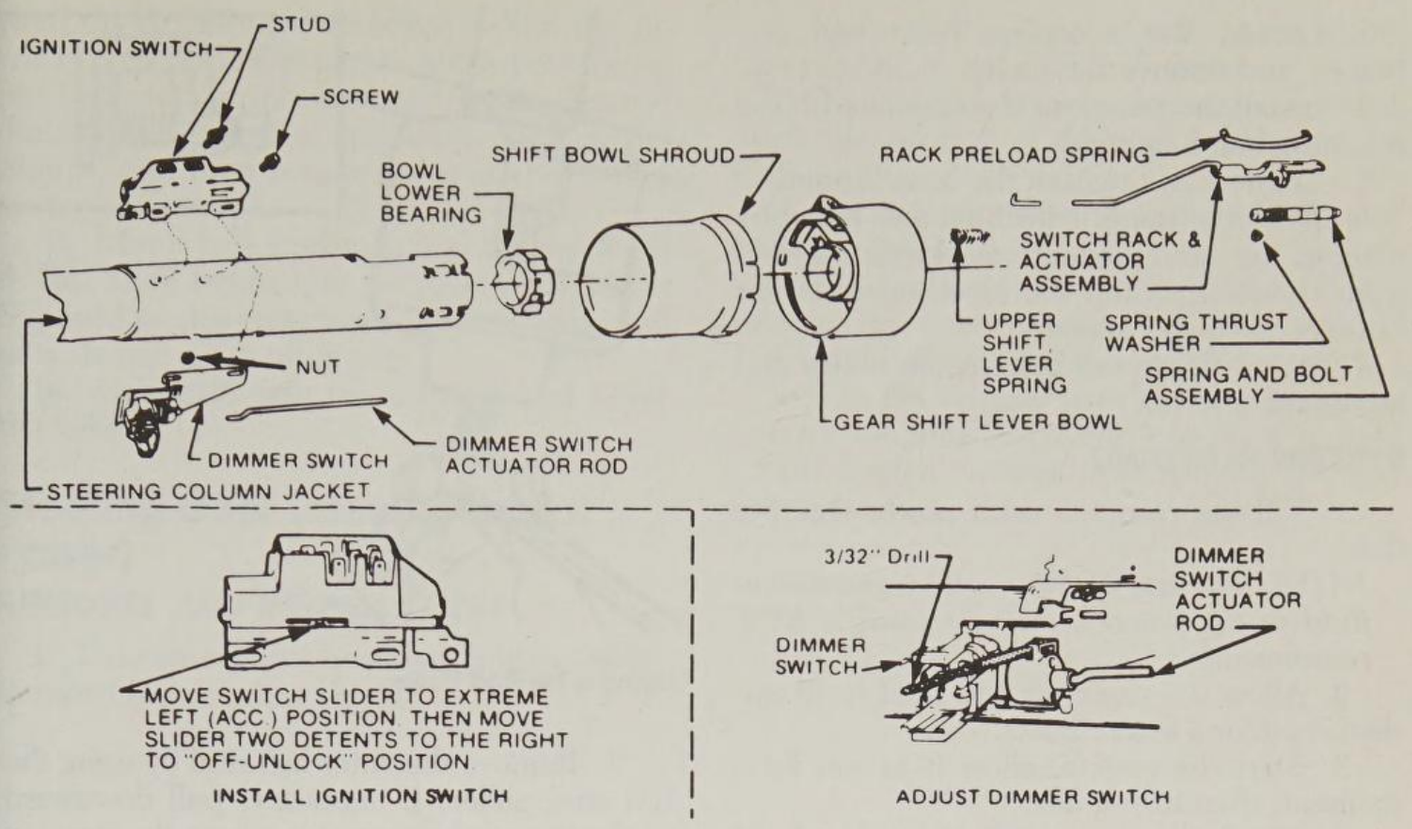
1. Lower the steering column; be sure to properly support it.

2. Put the switch in the "Off-Unlocked" position. "Off-Unlocked" position is two detents from the top.

3. Remove the two switch screws and remove the switch assembly.

4. Before installing, place the new switch in the "Off-Unlocked" position. Make sure the lock cylinder and actuating rod are in the "Off-Unlocked" (second detent from the top) position.

5. Install the activating rod into the switch and assemble the switch on the column. Tighten the mounting screws. Use only the



Ignition Switch Assembly

specified screws since overlength screws could impair the collapsibility of the column.

6. Reinstall the steering column.

Ignition Lock Cylinder

REPLACEMENT

1. Place the lock in the "Run" position.
2. Remove the lock plate, turn signal switch and buzzer switch.
3. Remove the screw and lock cylinder.

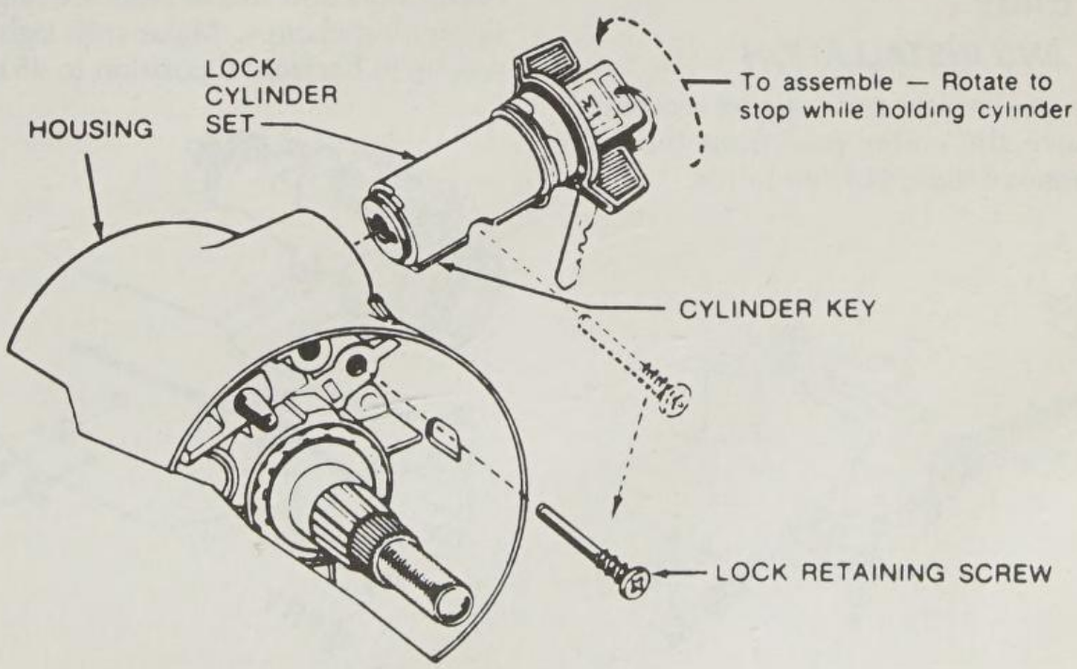
CAUTION: *If the screw is dropped on removal, it could fall into the column, requiring complete disassembly to retrieve the screw.*

4. Rotate the cylinder clockwise to align cylinder key with the keyway in the housing.
5. Push the lock all the way in.
6. Install the screw. Tighten the screw to 14 in. lb. for adjustable columns and 25 in. lb. for standard columns.

Power Steering Pump

REMOVAL AND INSTALLATION

1. Remove the hoses at the pump and tape the openings shut to prevent contamination. Position the disconnected lines in a raised position to prevent leakage.
2. Remove the pump belt.



Ignition lock cylinder replacement

3. Loosen the retaining bolts and any braces, and remove the pump.
4. Install the pump on the engine with the retaining bolt handtight.
5. Connect and tighten the hose fittings.
6. Refill the pump with fluid and bleed by turning the pulley counterclockwise (viewed from the front). Stop the bleeding when air bubbles no longer appear.
7. Install the pump belt on the pulley and adjust the tension.

SYSTEM BLEEDING

1. Fill the reservoir with power steering fluid.

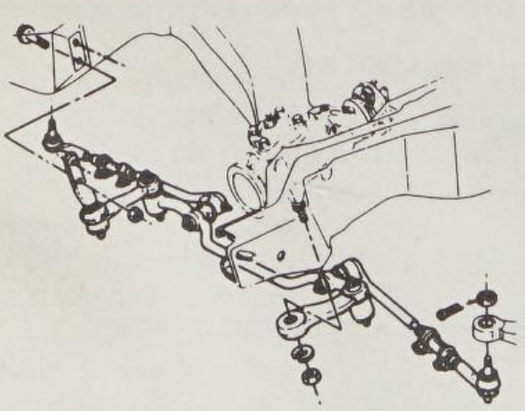
NOTE: *The use of automatic transmission fluid in the power steering system is NOT recommended.*

2. Allow the reservoir and fluid to sit undisturbed for a few minutes.
3. Start the engine, allow it to run for a moment, then turn it off.
4. Check the reservoir fluid level and add fluid if necessary.
5. Repeat the above steps until the fluid level stabilizes.
6. Raise the front of the vehicle so that the wheels are off of the ground.
7. Start the engine and increase the engine speed to about 1500 rpm.
8. Turn the front wheels right to left (and back) several times, lightly contacting the wheel stops at the ends of travel.
9. Check the reservoir fluid level. Add fluid as required.
10. Repeat step 8 until the fluid level in the reservoir stabilizes.
11. Lower the vehicle and repeat steps 8 and 9.

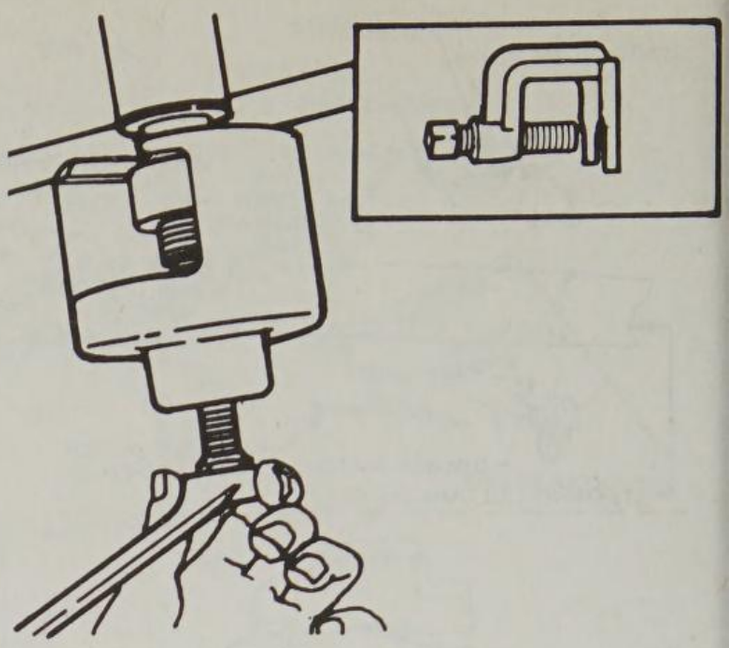
Tie Rod Ends

REMOVAL AND INSTALLATION

1. Raise the vehicle and support securely.
2. Remove the cotter pins from the ball studs and remove the castellated nuts.

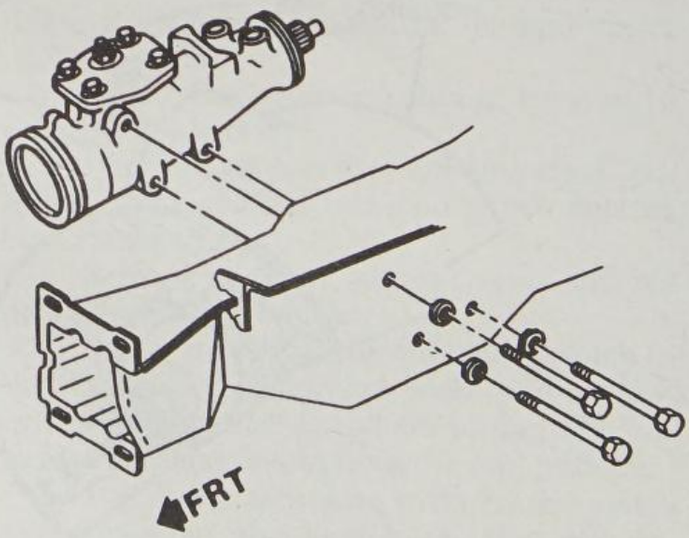


Steering linkage—typical of all models



Using a Tie Rod Puller

3. Remove the outer ball stud by using the ball stud puller. If necessary, pull downward on the tie rod to disconnect it from the steering arm.
4. Remove the inner ball stud from the relay rod using a similar procedure.
5. Remove the tie rod end or ends to be replaced by loosening the clamp bolt and unscrewing them.
6. Lubricate tie rod threads with chassis grease and install new tie rod(s). Make sure both ends are an equal distance from the tie rod and tighten clamp bolts.
7. Make sure ball studs, tapered surfaces, and all threaded surfaces are clean and smooth, and free of grease. Install seals on ball studs. Install ball stud in steering arm and relay rod.
8. Rotate both inner and outer tie rod housings rearward to the limit of ball joint travel before tightening clamps. Make sure clamp slots and sleeve slots are aligned before tightening clamps. Make sure tightened bolts will be in horizontal position to 45 degrees up-



Power steering gear mounting

ward (in the forward direction) when the tie rod is in its normal position. Make sure the tie rod end stays in position relative to the rod during the tightening operation. Tighten the clamps, and then return the assembly to the center of its travel.

9. Install ball stud nuts and torque to 35 ft. lbs. Then tighten (*do not loosen*) further as required to align cotter pin holes in studs and nuts. Install new cotter pins.

10. Lubricate new tie rod ends and lower the vehicle.

Steering Gear (Manual and/or Power)

REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable. Remove the coupling shield.

2. Remove the retaining bolts at the steering coupling to steering shaft flange.

3. Remove the pitman arm nut and washer. Mark the relation of the arm position to the shaft.

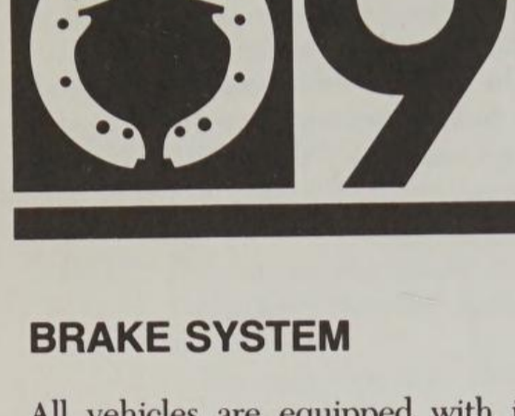
4. Remove pitman arm using special tool J-6632 or its equal.

5. Remove the steering box to frame bolts. Remove the steering box.

6. Installation is the reverse of removal.

NOTE: *On vehicles with power steering remove the fluid hoses and cap them to prevent foreign material from entering the system.*

Brakes



BRAKE SYSTEM

All vehicles are equipped with independent front and rear brake systems. The systems consist of a power booster, a master cylinder, a combination valve, front disc assemblies and rear disc or drum assemblies.

The master cylinder, mounted on the left firewall or power booster, consists of two fluid reservoirs, a primary (rear) cylinder, a secondary (front) cylinder and springs. The reservoirs, being independent of one another, are contained within the same housing; fluid cannot pass from one to the other. The rear reservoir supplies fluid to the front brakes while the front reservoir supplies fluid to the rear brakes.

During operation, fluid drains from the reservoirs to the master cylinder. When the brake pedal is applied, fluid from the master cylinder is sent to the combination valve (mounted on the left front fender or frame side rail beneath the master cylinder), here it is monitored and proportionally distributed to the front or rear brake systems. Should a loss of pressure occur in one system, the other system will provide enough braking pressure to stop the vehicle. Also, should a loss of pressure in one system occur, the differential warning switch (located on the combination valve) will turn "ON" the brake warning light (located on the dash board).

As the fluid enters each brake caliper or wheel cylinder, the pistons are forced outward. The outward movement of the pistons force the brake pads against a round flat disc or brake shoes against a round metal drum. The brake lining attached to the pads or shoes comes in contact with the revolving disc or drum causing friction, which brings the wheel to a stop.

In time, the brake linings wear down. If not replaced, their metal support plates (bonded type) or rivet heads (riveted type) will come in contact with the disc or drum; damage to the disc or drum will occur. Never use brake pads or shoes with a lining thickness less than 1/32 inch.

Most manufacturers provide a wear sensor, a piece of spring steel, attached to the rear edge of the inner brake pad. When the pad wears to the replacement thickness, the sensor will produce a high pitched squeal.

Adjustment

DISC BRAKES

Disc brakes are self-adjusting. No adjustment is possible or necessary. Check fluid level of reservoir, for as brake pads wear the piston moves out and the piston void must be replaced with brake fluid.

DRUM BRAKES

The drum brakes are designed to self-adjust when applied with the car moving in reverse. However, they can also be adjusted manually. This manual adjustment should also be performed whenever the linings are replaced.

1. Use a punch to knock out the stamped area on the brake drum. If this is done with the drum installed on the car, the drum must then be removed to clean out all metal pieces. After adjustments are complete, obtain a hole cover to prevent entry of dirt and water into the brakes.

2. Use an adjusting tool especially made for the purpose to turn the brake adjusting screw star wheel. Use a small screwdriver to push the adjusting lever away from star wheel when adjusting brakes. Expand the shoes until the drum can just barely be turned by hand.

3. Back off the adjusting screw 12 notches. If the shoes still are dragging lightly, back off the adjusting screw one or two additional notches. If the brakes still drag, the parking brake adjustment is incorrect or the parking brake is applied. Fix and start over.

4. Install the hole cover into the drum.
5. Check the parking brake adjustment.

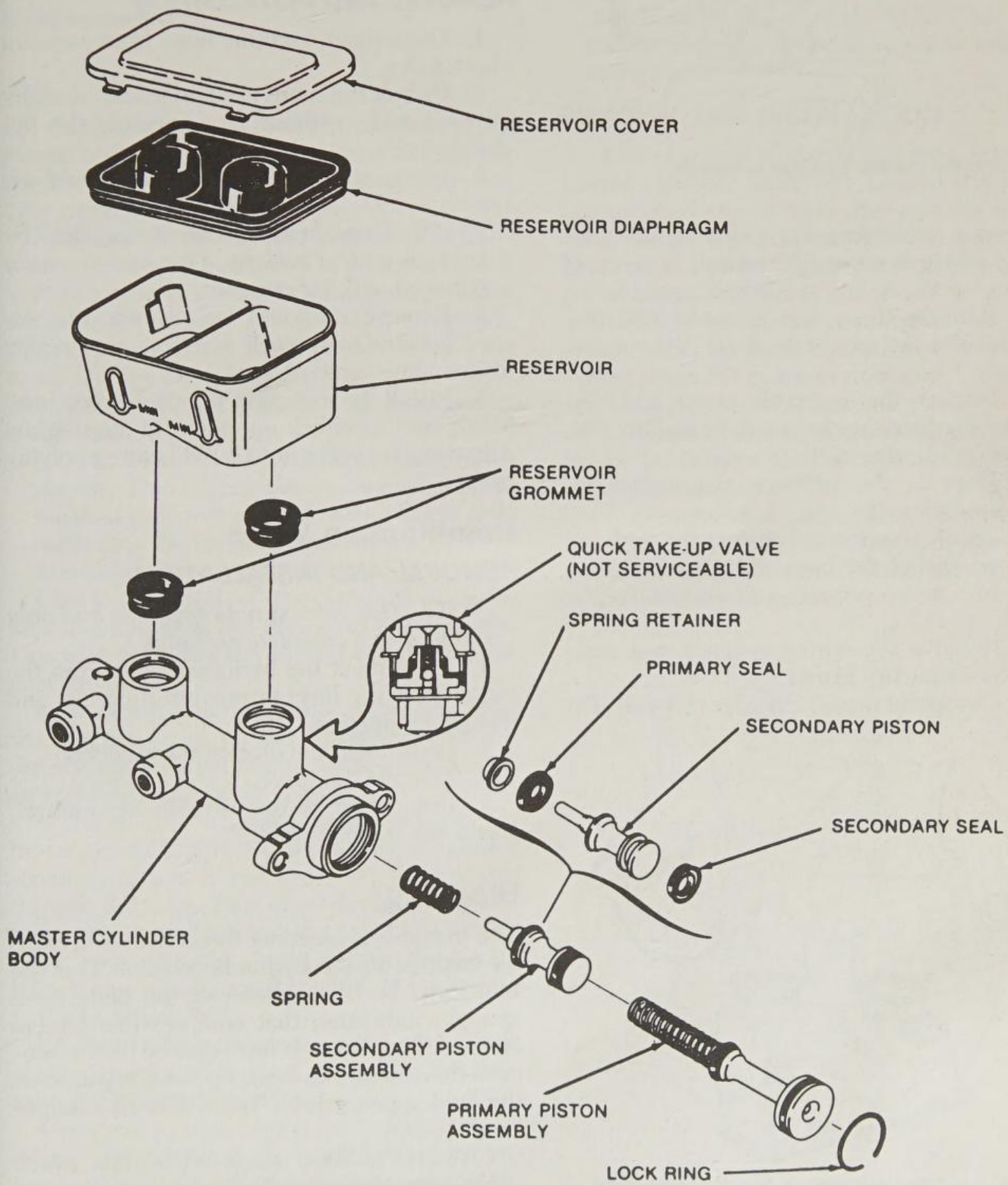
Master Cylinder

REMOVAL AND INSTALLATION

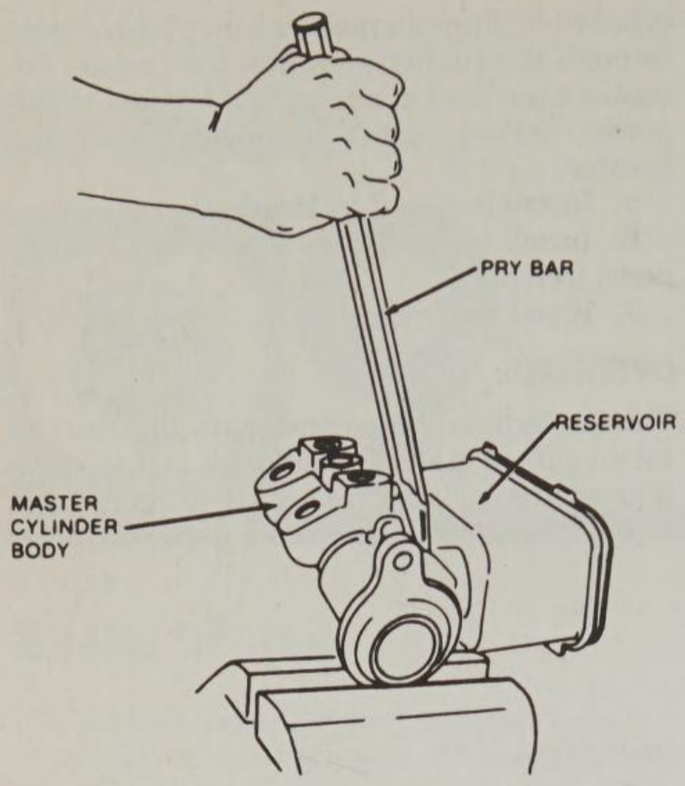
1. Disconnect hydraulic lines at master cylinder.
2. Remove the retaining nuts and lockwashers that hold cylinder to firewall or the brake booster. Disconnect pushrod at brake pedal (non-power brakes only).
3. Remove the master cylinder, gasket and rubber boot.
4. On non-power brakes, position master cylinder on firewall, making sure pushrod goes through the rubber boot into the piston. Reconnect pushrod clevis to brake pedal. With power brakes, install the cylinder on the booster.
5. Install nuts and lockwashers.
6. Install hydraulic lines then check brake pedal free play.
7. Bleed the brakes.

OVERHAUL

This is a tedious, time-consuming job. You can save yourself a lot of trouble by buying a rebuilt master cylinder from your dealer or parts supply house. The small difference in price



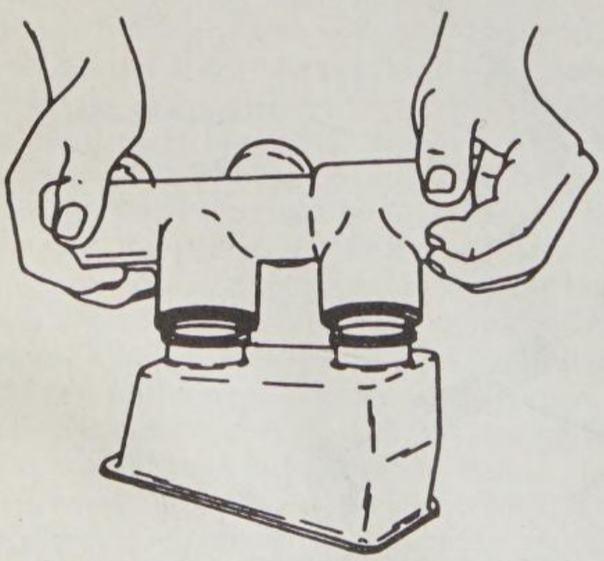
Quick take-up master cylinder assembly



Removing the master cylinder reservoir

between a rebuilding kit and a rebuilt part usually makes it more economical, in terms of time and work, to buy the rebuilt part.

1. Remove the reservoir cover and diaphragm. Discard any brake fluid in the reservoir.
2. Inspect the reservoir cover and diaphragm for cuts, cracks, or deformation. Replace any defective parts.
3. Depress the primary piston and remove the lock ring.
4. Direct compressed air into the outlet at the blind end of the bore and plug the other outlet to remove primary and secondary piston.
5. Remove the spring retainer and seals from the secondary piston.
6. Clamp the master cylinder in a vise. Do not clamp it on the master cylinder body. Using a pry bar, remove the reservoir.
7. Do not attempt to remove the quick take-up valve from the body. This valve is not serviced separately.
8. Remove the reservoir grommets.
9. Inspect the master cylinder bore for corrosion. If corroded, replace the master cylinder. Do not use any abrasive on the bore.
10. Reassemble, using new seals and grommets. Lubricate all parts with brake fluid. To install, reverse removal procedure. Bleed brake system.



Install the master cylinder to the reservoir with a rocking motion

Power Brake Booster

REMOVAL AND INSTALLATION

1. Disconnect vacuum hose from vacuum check valve.
2. Unbolt the master cylinder and carefully move it aside without disconnecting the hydraulic lines.
3. Disconnect pushrod at brake pedal assembly.

NOTE: *Some brake boosters may also be held on with a sealant. This can be easily removed with tar remover.*

4. Remove nuts and lockwashers that secure booster to firewall and remove booster from engine compartment.
5. Install by reversing removal procedure. Make sure to check operation of stop lights. Allow engine vacuum to build before applying brakes.

Combination Valve

REMOVAL AND INSTALLATION

NOTE: *This valve is not repairable and only serviced as a complete assembly.*

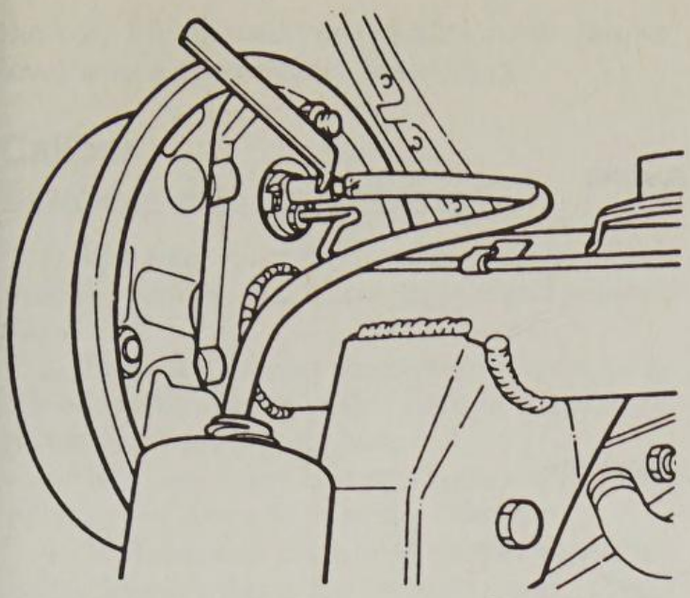
1. Disconnect the hydraulic lines from the valve. Plug the lines to prevent fluid loss and dirt contamination.
2. Disconnect the electrical connection.
3. Remove the valve.
4. Installation is the reverse of removal. Bleed the brake system.

Bleeding

The purpose of bleeding the brakes is to expel air trapped in the hydraulic system. The system must be bled whenever the pedal feels spongy, indicating that compressible air has entered the system. It must also be bled whenever the system has been opened, repaired or the fluid appears dirty. You will need a helper for this job.

CAUTION: *Never reuse brake fluid which has been bled from the brake system.*

1. The sequence for bleeding is right rear,



Bleeding the brakes

left rear, right front and left front. If the car has power brakes, remove the vacuum by applying the brakes several times. Do not run the engine while bleeding the brakes.

2. Clean all the bleeder screws. You may want to give each one a shot of penetrating solvent to loosen it; seizure is a common problem with bleeder screws, which then break off, sometimes requiring replacement of the part to which they are attached.

3. Fill the master cylinder with good quality brake fluid.

NOTE: *Brake fluid absorbs moisture from the air. Don't leave the master cylinder or the fluid container uncovered any longer than necessary. Be careful handling the fluid—it eats paint.*

Check the level of the fluid often when bleeding and refill the reservoirs as necessary. Don't let them run dry or you will have to repeat the process.

4. Attach a length of clear vinyl tubing to the bleeder screw on the wheel cylinder. Insert the other end of the tube into a clear, clean jar half filled with brake fluid.

5. Have your assistant slowly depress the brake pedal. As this is done, open the bleeder screw ¾ of a turn and allow the fluid to run through the tube. Then close the bleeder screw before the pedal reaches the end of its travel. Have your assistant slowly release the pedal. Repeat this process until no air bubbles appear in the expelled fluid.

6. Repeat the procedure on the other three brakes, checking the level of fluid in the master cylinder reservoir often.

Upon completion, check the brake pedal for sponginess and the brake warning light for unbalanced pressure. If necessary, repeat the entire bleeding procedure.

FRONT DISC BRAKES

Disc Brake Pads

INSPECTION

The pad thickness should be inspected every time that the tires are removed for rotation. The outer pad can be checked by looking in each end, which is the point at which the highest rate of wear occurs. The inner pad can be checked by looking down through the inspection hole in the top of the caliper. If the thickness of the pad is worn to within 0.030 in. (0.76 mm) of the rivet at either end of the pad, all the pads should be replaced.

NOTE: *Always replace all pads on both front wheels at the same time. Failure to do so will result in uneven braking action and premature wear.*

REMOVAL AND INSTALLATION

1. Siphon ⅔ of the brake fluid from the master cylinder reservoir. Loosen the wheel lug nuts and raise the car. Remove the wheel.

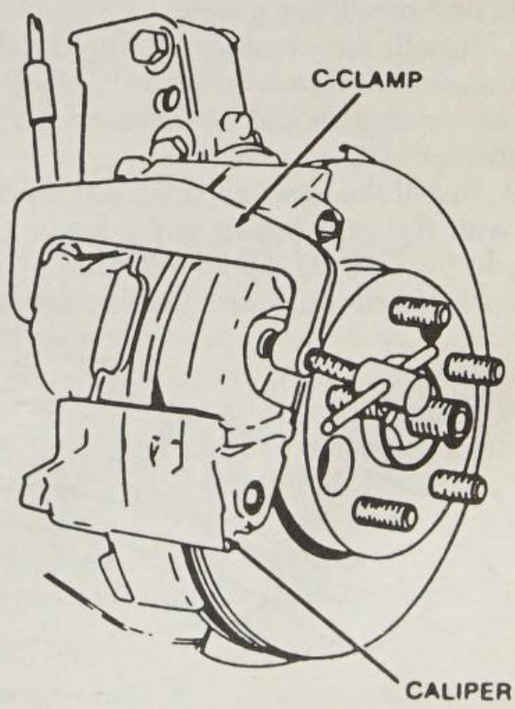
2. Position a C-clamp across the caliper and press on the pads. Tighten it until the caliper piston bottoms in its bore.

NOTE: *If you haven't removed some brake fluid from the master cylinder, it may overflow when the piston is retracted.*

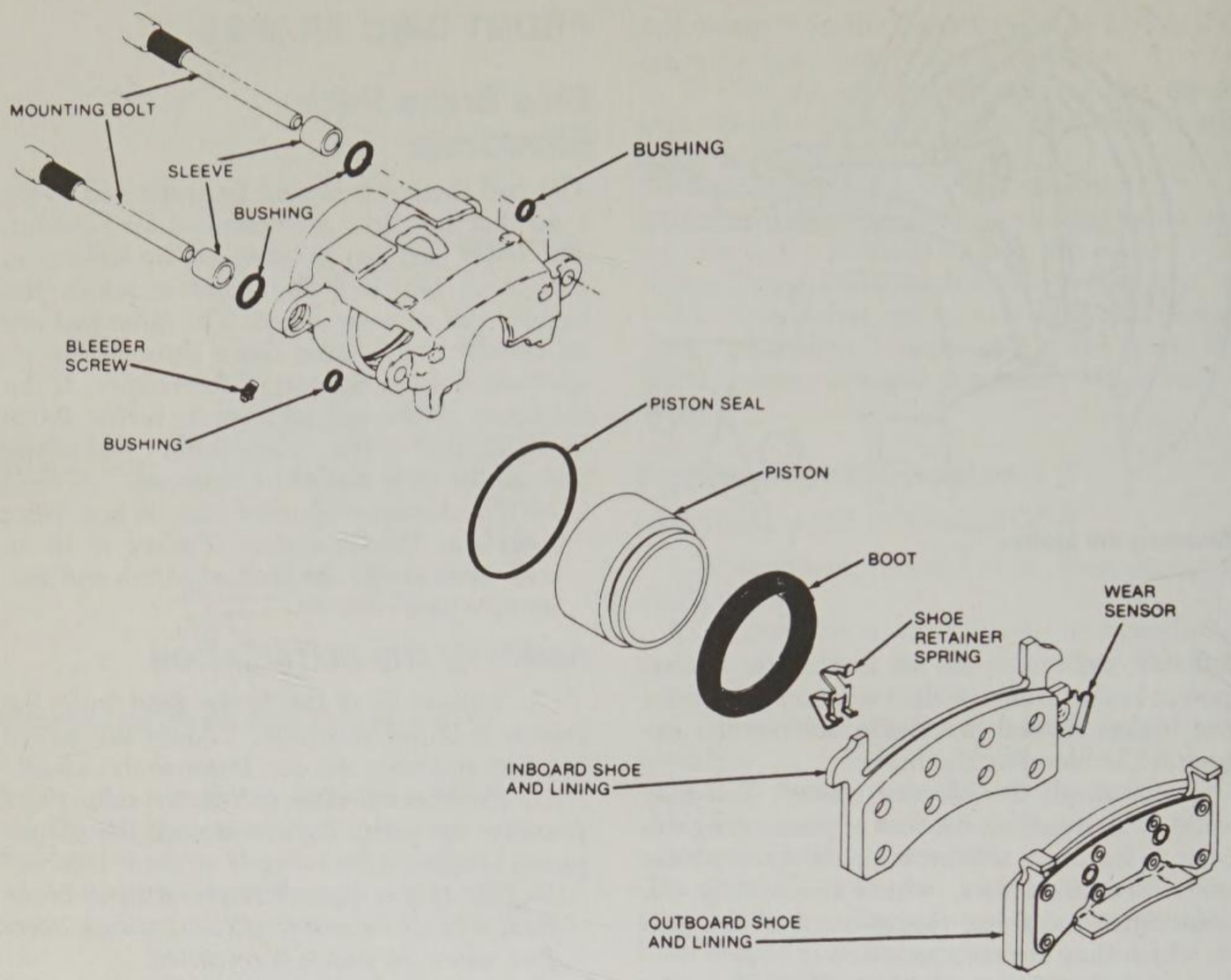
3. Remove the C-clamp.

4. Remove the allen head caliper mounting bolts. Inspect the bolts for corrosion and replace as necessary.

5. Remove the caliper from the steering knuckle and suspend it from the body of the car with a length of wire. Do not allow the caliper to hang by its hose.



Install a C-clamp to retract the brake pads



Exploded View of the Front Disc Brake Caliper

6. Remove the pad retaining springs and remove the pads from the caliper.

7. Remove the plastic sleeves and the rubber bushings from the mounting bolt holes.

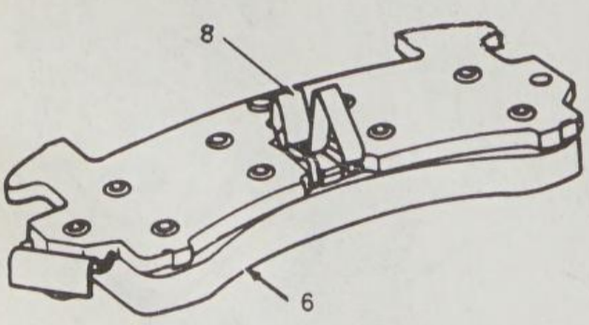
8. Obtain a pad replacement kit. Lubricate and install the new sleeves and bushings with a light coat of silicone grease.

9. Install the retainer spring on the inboard pad.

A new spring should be included in the pad replacement kit.

10. Install the new inboard pad into the caliper with the wear sensor at the leading of the shoe during forward wheel rotation.

11. Install the outboard pad into the caliper.

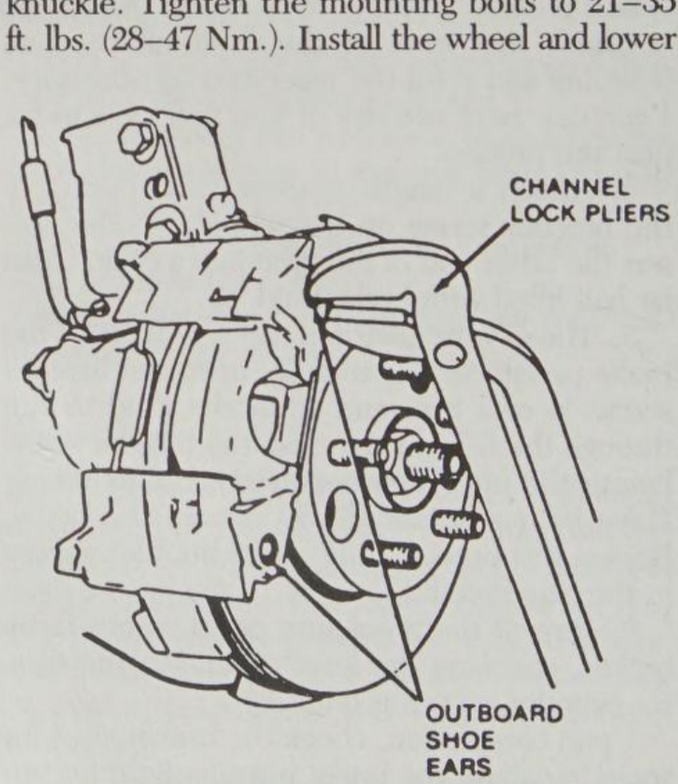


6. Inboard shoe & lining 8. Shoe retainer spring

Install the retaining spring on the inboard pad

12. Use a large pair of slip joint pliers to bend the outer pad ears down over the caliper.

13. Install the caliper onto the steering knuckle. Tighten the mounting bolts to 21–35 ft. lbs. (28–47 Nm.). Install the wheel and lower



Bend the outboard pad ears into place with a large pair of slipjoint pliers

the car. Fill the master cylinder to its proper level with a good quality brake fluid.

Caliper

REMOVAL AND INSTALLATION

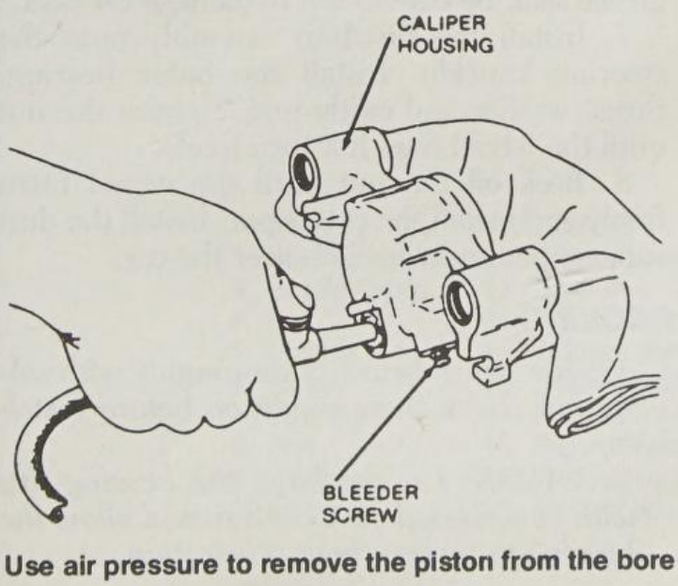
1. Remove ⅔ of the brake fluid from the master cylinder. Raise the vehicle and remove the wheel.
2. Place a C-clamp across the caliper, positioned on the brake pads. Tighten it until the piston is forced into its bore.
3. Remove the C-clamp. Remove the bolt holding the brake hose to the caliper.
4. Remove the allen head caliper mounting bolts. Inspect them for corrosion and replace them if necessary. Remove the caliper.
5. To install, reverse removal procedure. Mounting bolt torque is 21–35 ft. lbs. (28–47 Nm.) for the caliper. The brake hose fitting should be tightened to 18–30 ft. lbs. (24–40 Nm.).

OVERHAUL

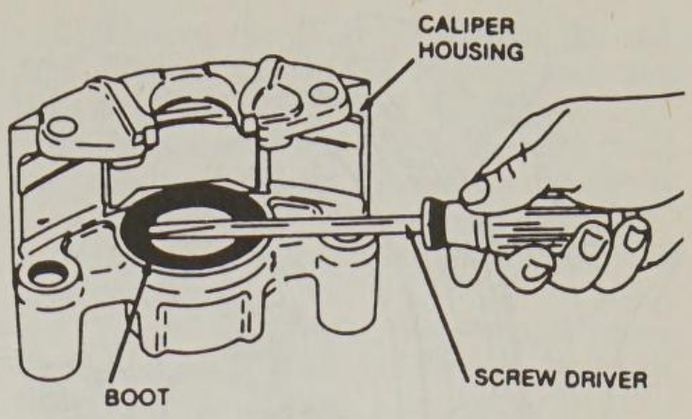
1. Remove the caliper.
2. Remove the pads.
3. Place some cloths or a slat of wood in front of the piston. Remove the piston by applying compressed air to the fluid inlet fitting. Use just enough air pressure to ease the piston from the bore.

CAUTION: *Do not try to catch the piston with your fingers, it can result in serious injury.*

4. Remove the piston boot with a screwdriver, working carefully so that the piston bore is not scratched.
5. Remove the bleeder screw.
6. Inspect the piston for scoring, nicks, corrosion, wear, etc., and damaged or worn chrome plating. Replace the piston if any defects are found.
7. Remove the piston seal from the caliper bore groove using a piece of pointed wood or plastic. Do not use a screwdriver, which will damage the bore. Inspect the caliper bore for nicks, corrosion, and wear. Very light wear can be cleaned up with crocus cloth. Use finger pressure to rub the crocus cloth around the circumference of the bore—do not slide it in and out. More extensive wear or corrosion warrants replacement of the part.



Use air pressure to remove the piston from the bore



Remove the piston boot with an awl

8. Clean any parts which are to be reused in denatured alcohol. Dry them with compressed air or allow to air dry. Don't wipe the parts dry with a cloth, which will leave behind bits of lint.
9. Lubricate the new seal, provided in the repair kit, with clean brake fluid. Install the seal in its groove, making sure it is fully seated and not twisted.
10. Install the new dust boot on the piston. Lubricate the bore of the caliper with clean brake fluid and insert the piston into its bore. Position the boot in the caliper housing and seat with a seal driver of the appropriate size, or G.M. tool no. J-26267.
11. Install the bleeder screw, tightening to 80–140 in. lbs. (9–16 Nm.). Do not overtighten.
12. Install the pads, install the caliper, and bleed the brakes.

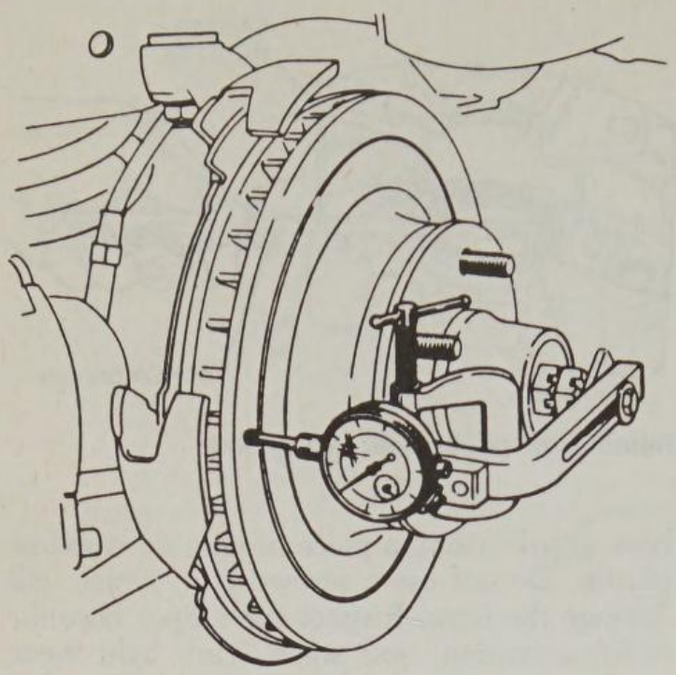
Disc (Rotor)

REMOVAL AND INSTALLATION

1. Remove the caliper by following instructions of caliper removal procedure.
2. Remove dust cap, cotter pin, castle nut, thrust washer and outside wheel bearing. Pull the disc/hub assembly from the steering knuckle.
3. To install, reverse the removal procedure. Tighten the castle nut until the bearing is snug. Back off the nut ¼ turn, install the cotter pin and complete the installation.

INSPECTION

1. Check the rotor surface for wear, scoring, grooves or rust pitting. Rotor damage can be



Check the runout with a dial indicator

corrected by refacing, consult your local garage or machine shop. If the damage exceeds the minimum thickness, which is stamped on the rotor, replace the rotor.

2. Check the rotor parallelism at four or more points around the circumference, it must not vary more than .0005 in. (.013 mm). Make all measurements at the same distance in from the edge of the rotor. Refinish the rotor if it fails to meet specification.

3. Measure the disc runout with a dial indicator. If runout exceeds 0.004 in. (0.10 mm), and the wheel bearings are OK (runout is measured with the disc on the car), the rotor must be refaced or replaced.

Front Wheel Bearings

ADJUSTMENT

1. Raise the car and support it at the lower arm.

2. Remove the hub dust cover and spindle cotter pin. Loosen the nut.

3. While spinning the wheel, snug the nut down to seat the bearings. Do not exert over 12 ft. lbs. of force on the nut.

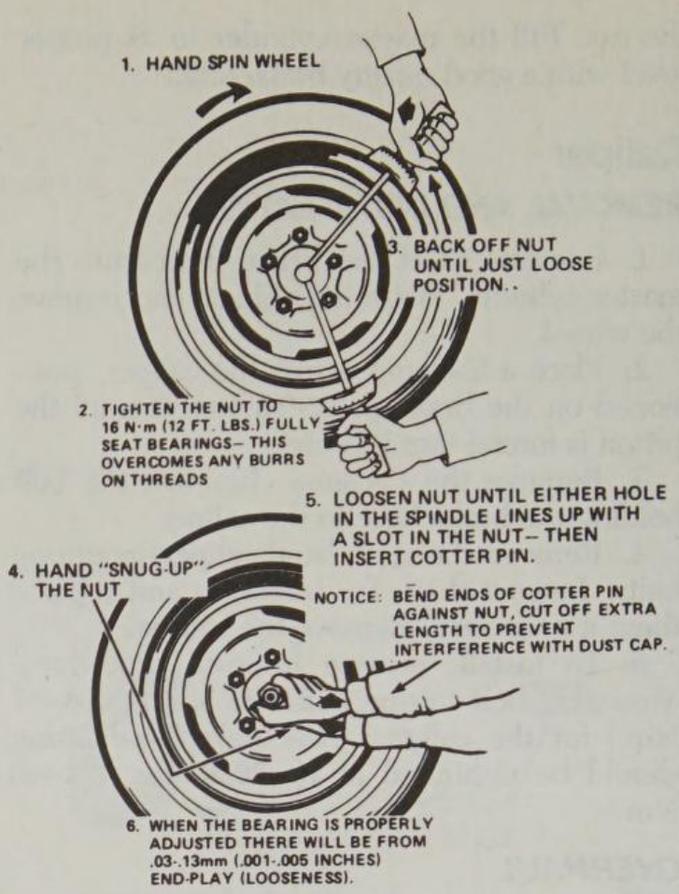
4. Back the nut off ¼ turn or until it is just lose. Line up the cotter pin hole in the spindle with the hole in the nut.

5. Insert a new cotter pin. Endplay should be between 0.001–0.005 in. (0.03–0.13 mm). If play exceeds this tolerance, the wheel bearings should be replaced.

REMOVAL AND INSTALLATION

1. Raise the car and support it at the lower arm. Remove the wheel. Remove the brake caliper and support it on a wire.

2. Remove the dust cap, cotter pin, castle



Wheel bearing adjustment

nut, thrust washer and outside wheel bearing. Pull the disc/hub assembly from the steering knuckle.

3. Pry out the inner seal and remove the inner bearing. If necessary to remove the inner bearing races, use a hammer and a brass drift to drive the bearing races from the hub.

4. Clean all parts in kerosene or equivalent, DO NOT use gasoline. After cleaning, check parts for excessive wear and replace damaged parts.

5. Smear grease inside of hub. Install the bearing races into hub, using a hammer and a brass drift. Drive the races in until they seat against the shoulder of the hub.

6. Pack the bearings with grease and install the inner bearing in the hub. Install a new grease seal, be careful not to damage the seal.

7. Install the disc/hub assembly onto the steering knuckle. Install the outer bearing, thrust washer and castle nut. Tighten the nut until the wheel does not turn freely.

8. Back off the nut until the wheel turns freely and install the cotter pin. Install the dust cap, caliper and wheel. Lower the car.

PACKING

Clean the wheel bearings thoroughly with solvent and check their condition before installation.

CAUTION: *Do not blow the bearing dry with compressed air as this would allow the bearing to turn without lubrication.*

Apply a sizable amount of lubricant to the palm of one hand. Using your other hand, work the bearing into the lubricant so that the grease is pushed through the rollers and out the other side. Keep rotating the bearing while continuing to push the lubricant through it.

REAR DISC BRAKES

Disc Brake Pads

INSPECTION

Refer to the Front Disc Brake Inspection procedure.

REMOVAL AND INSTALLATION

1. To remove the brake caliper, refer to the Rear Caliper Removal procedure.

2. Remove the brake pads from the calipers. Remove the sleeves from the mounting bolts and the bushings from the caliper.

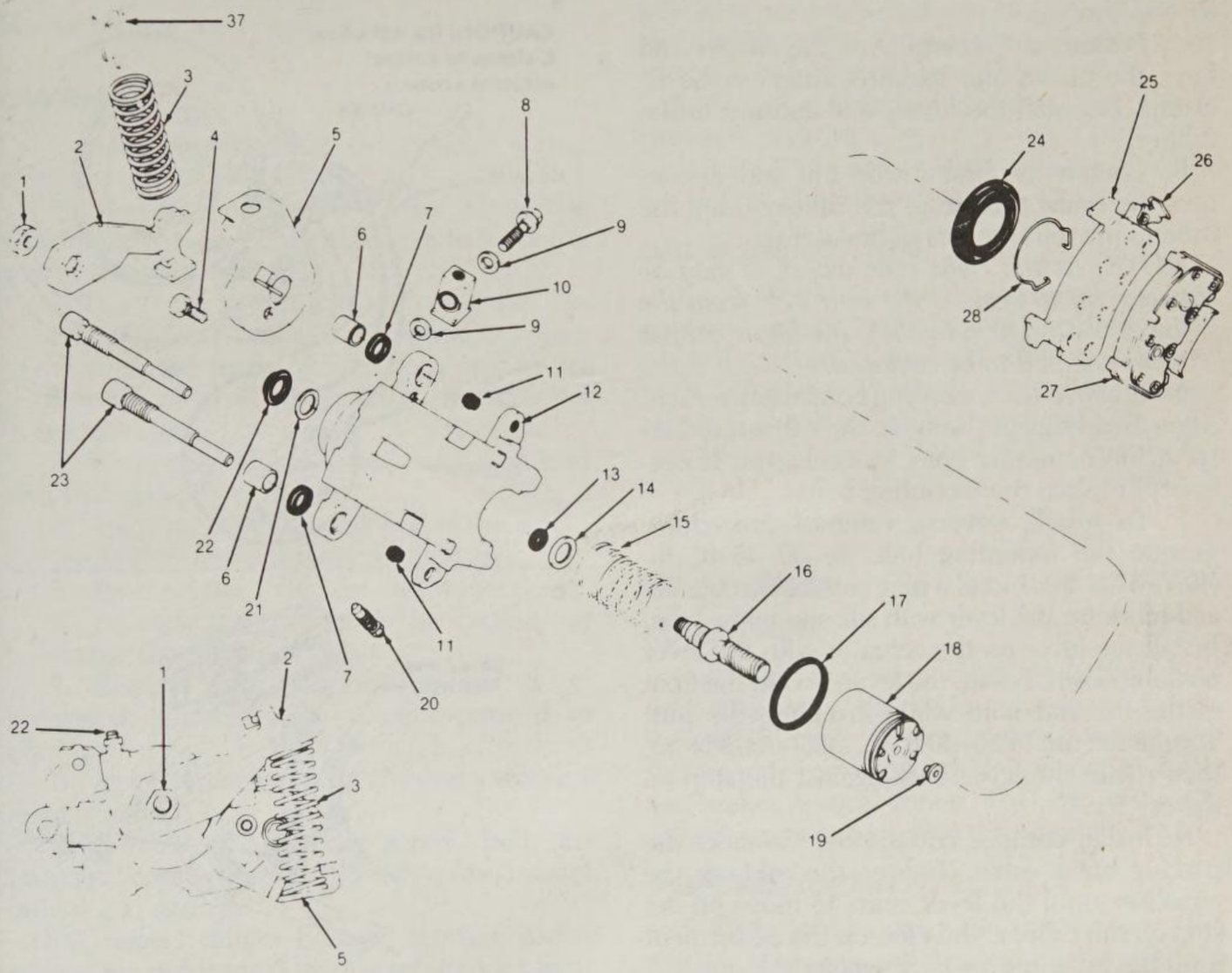
3. Using a small screwdriver, remove the 2-way check valve from the end of the piston. Clean and check the valve for leakage.

NOTE: *If leakage is noted, the caliper must be overhauled.*

4. To install, reverse the removal procedures. Lubricate and install new bushings, sleeves and check valve.

5. When installing the inner brake pad, make sure that the "D" shaped tab of the pad engages with the "D" shaped notch of the piston.

6. Upon installation of the inner pad, make sure that the wear sensor of the pad is at the leading edge of the shoe during forward wheel rotation. Slide the metal edge of the pad under



1. Nut
2. Washer
3. Return spring
4. Bolt
5. Bracket
6. Sleeve
7. Bushing
8. Bolt
9. Washer
10. Fitting
11. Bushing
12. Caliper housing
13. Shaft seal
14. Thrust washer
15. Balance spring
16. Actuator screw
17. Piston seal
18. Piston assembly
19. Two way check valve
20. Bleeder screw
21. Anti-friction washer
22. Lever seal
23. Mounting bolt
24. Boot
25. Inboard shoe & lining
26. Wear sensor
27. Outboard shoe & lining
28. Shoe dampening spring
37. Damper

Rear caliper—exploded view

the ends of the dampening spring and snap the pad into position against the piston.

7. Install the outer pad and caliper. After installing the caliper, apply the brakes, then bend the ears of the outer pad against the caliper and ensure that there is no radical clearance.

Rear Caliper

REMOVAL AND INSTALLATION

1. Remove ⅔ of the brake fluid from the master cylinder. Raise the car. Remove the wheel. Reinstall a wheel nut, with the flat side toward the rotor, to hold the rotor in place.

2. Loosen the parking brake cable at the equalizer. At the caliper, remove the parking brake cable, damper and spring from the lever.

3. Hold the parking brake lever and remove the lock nut. Remove the lever, seal and anti-friction washer.

4. Position a C-clamp over the caliper and force the piston into its bore. Remove the C-clamp. Reinstall the lever, seal and nut to the caliper.

5. Loosen the brake tube nut and disconnect the brake tube from the caliper. Plug the tube to prevent the loss of brake fluid.

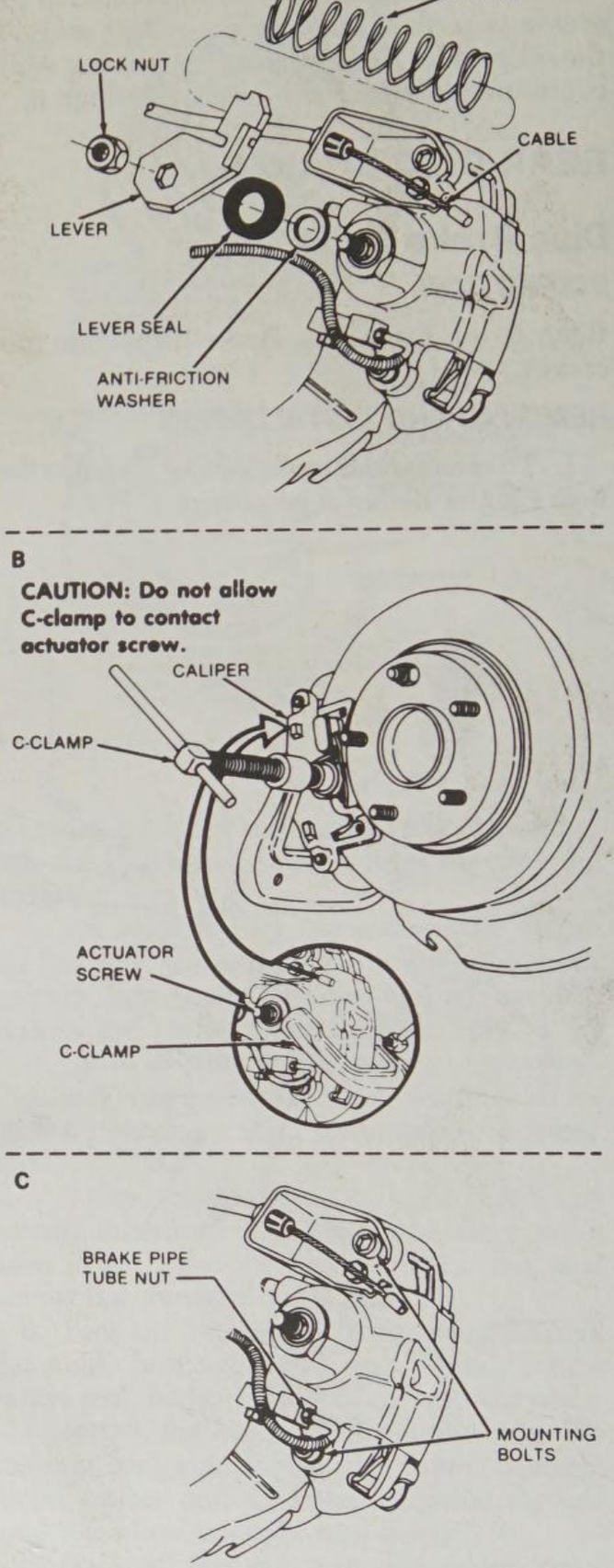
NOTE: *At the right rear wheel, it may be necessary to remove the rear bolt from the lower control arm to allow the lower caliper mounting bolt to be removed.*

6. Remove the mounting bolts using a ⅜ in. Allen Head socket. Remove the caliper and inspect the mounting bolts for corrosion. If necessary, replace the mounting bolts.

7. To install, reverse removal procedure. Torque the mounting bolts to 30–45 ft. lb. (40.7–61 N.m). Install a new anti-friction washer and lubricate the lever with silicone brake lube. Install the lever on the actuator with the lever pointing down. Rotate the lever toward the front of the car and hold while installing the nut. Torque the nut to 30–40 ft. lb. (40.7–54.2 N.m), then rotate the lever back against the stop on the caliper.

8. Install damper and spring. Connect the parking brake cable. Tighten the cable at the equalizer until the lever starts to move off the stop on the caliper, then loosen the adjustment until the lever moves back against the stop.

9. Remove the nut holding the rotor in place and install the wheel. Lower the car and fill the master cylinder with brake fluid.



Remove and install rear caliper

Rear Disc (Rotor)

REMOVAL AND INSTALLATION

1. Raise and support the car. Remove the wheel.

2. Remove the caliper by referring to the Rear Caliper Removal procedure. Pull the brake disc from the axle.

3. To install, reverse the removal procedure.

INSPECTION

1. Raise and support the car. Remove the wheel. Replace wheel nuts to hold rotor in place.
2. Check the rotor surface for wear, scoring, grooves or rust pitting. Rotor damage can be corrected by refacing, consult your local garage or machine shop. If the damage exceeds the minimum thickness, which is stamped on the rotor, replace the rotor.
3. Using a dial indicator, check the rotor parallelism at several points around the circumference. The difference must not vary more than .0005 in. (.013 mm). Make all measurements at the same distance in from the edge of the rotor.
4. Using the same dial indicator, measure the rotor runout. The runout should not exceed .004 in. (.10 mm).
5. If any of these conditions are not met, reface or replace the rotor.

OVERHAUL

1. Remove the shoe dampening spring from the end of the piston.
2. Place the caliper in a vise. Move the parking brake lever back and forth to work the piston out of the caliper.

NOTE: *If the piston will not come out, remove the lever and use a wrench to rotate the adjusting screw. Rotate the screw in the direction of brake application. Remove the balance spring.*

3. Remove the nut, lever, lever seal, and anti-friction washer.
4. Press on the threaded end of the actuator screw to remove it from the housing.
5. Remove the shaft seal and washer.
6. Remove the dust boot. Be careful not to scratch the housing bore.
7. Remove the locator retainer if so equipped. Remove the piston locator if so equipped.
8. Remove the piston seal using a wooden or plastic tool.
9. Remove the bleeder screw, bolt, fitting, and copper washer. Remove the bracket only if it is damaged.
10. Inspect caliper bore for scoring, nicks, corrosion, and wear. Use crocus cloth for light corrosion. Replace caliper if bore will not clean up.
11. Installation is the reverse of removal. Lubricate seals and piston with brake fluid prior to reinstallation.
12. It may be necessary to rotate the parking brake lever away from the stop to install the nut. Torque the nut 30–40 ft. lb. (41–54 N.m) and rotate the lever back to the stop.

NOTE: *It may be necessary to move the parking brake lever off the stop, extending the piston slightly, making the dampening spring groove accessible. If the piston is extended, push it back into the caliper before installing the caliper on the car.*

REAR DRUM BRAKES

Brake Drum

REMOVAL AND INSTALLATION

1. Raise and support the car.
2. Remove the wheel or wheels.
3. Pull the brake drum off. It may be necessary to gently tap the rear edges of the drum to start it off the studs.
4. If extreme resistance to removal is encountered, it will be necessary to retract the adjusting screw. Knock out the access hole in the backing plate and turn the adjuster to retract the linings away from the drum.
5. Install a replacement hole cover before reinstalling drum.
6. Install the drums in the same position on the hub as removed.

DRUM INSPECTION

1. Check the drums for any cracks, scores, grooves, or an out-of-round condition. Replace if cracked. Slight scores can be removed with fine emery cloth while extensive scoring requires turning the drum on a lathe.
2. Never have a drum turned more than 0.060 in.

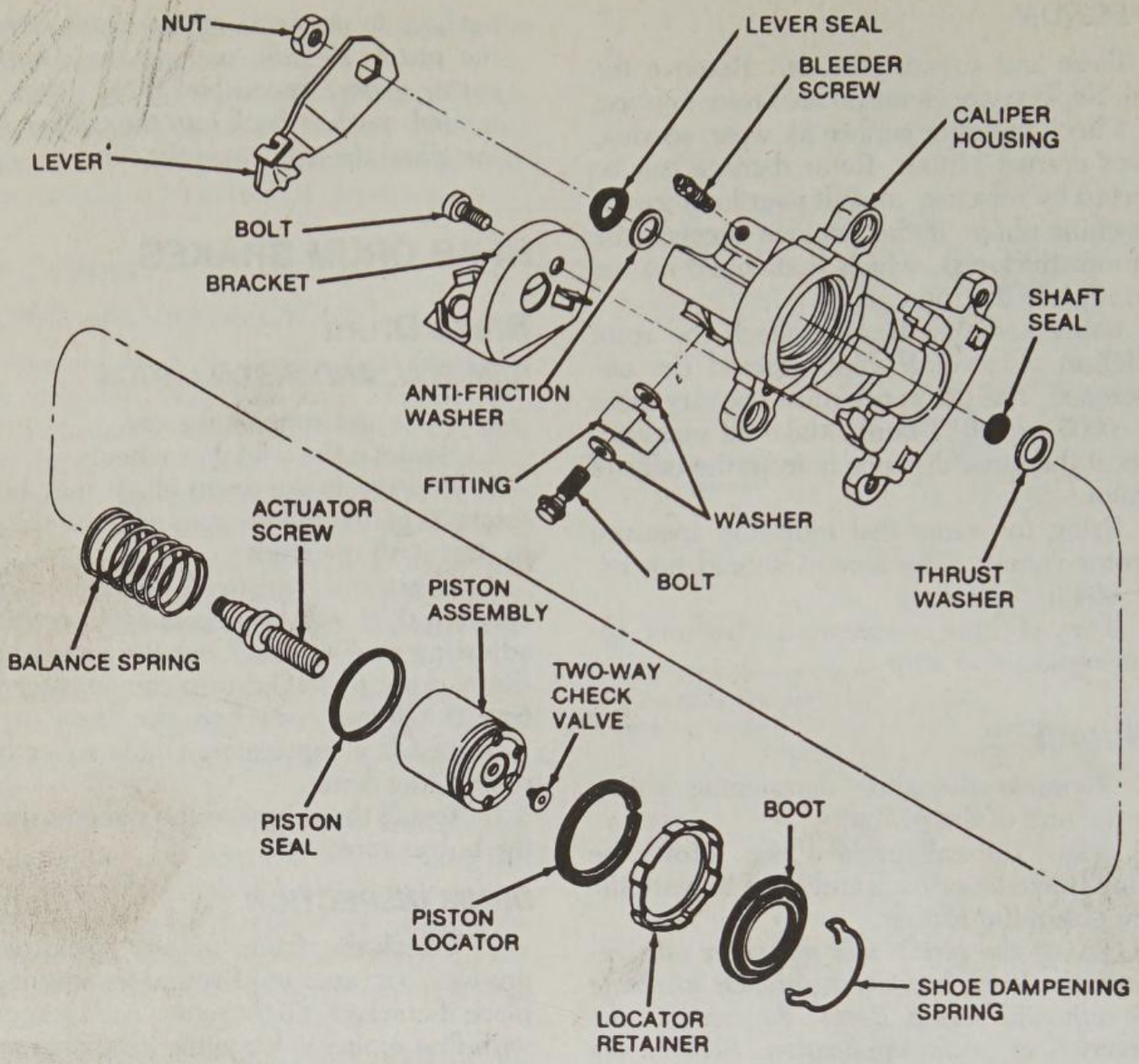
Brake Shoe

ADJUSTMENT

Rotate the star wheel adjuster until a slight drag is felt between the shoes and drum, then back off 12 clicks on the adjusting wheel. Put the car in reverse and, while backing up, apply the brakes several times. This will allow the self-adjusters to complete the adjustment.

REMOVAL AND INSTALLATION

1. Raise and support the car. Remove the wheel. Mark the relationship of the drum to the axle, then remove the drum.
2. Using a set of brake spring pliers, remove the return springs and the hold down springs. Remove the hold down pins.
3. Lift up on the actuator lever and remove the actuating link. Remove the actuator lever, pawl and return spring. Remove the shoe guide.
4. Remove the parking brake strut and spring by spreading the shoes apart. Spread the shoes to clear the axle flange. Disconnect the parking



Rear caliper overhaul

brake cable from the primary shoe and the parking brake lever. Remove the shoes.

5. Remove the adjusting screw and spring from the shoes. (DO NOT interchange the adjusting screws from the right or left brake assemblies).

6. Remove the parking brake lever from the secondary shoe slot. Discard worn out shoes.

NOTE: *Any part which may appear doubtful due to discoloration, stress or wear, should be replaced.*

7. Clean dirt from all parts and wirebrush raised pads on backing plate. Lubricate backing plate pads and adjusting screw with brake grease.

NOTE: *Avoid breathing brake dust, it may be hazardous to your health.*

8. To install brake components, reverse removal procedures. Adjust brake shoe clearance.

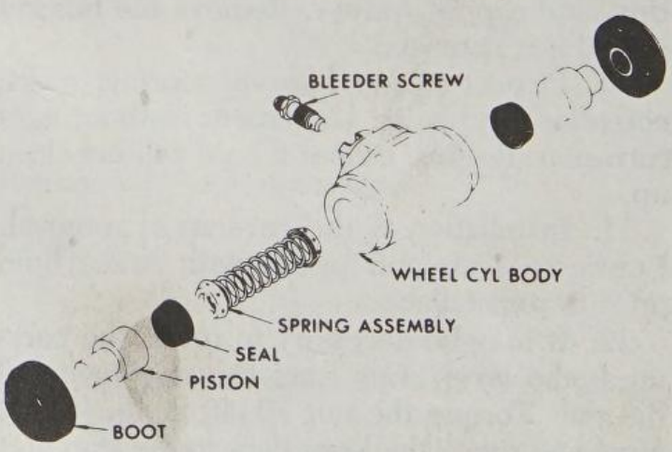
Wheel Cylinders

OVERHAUL

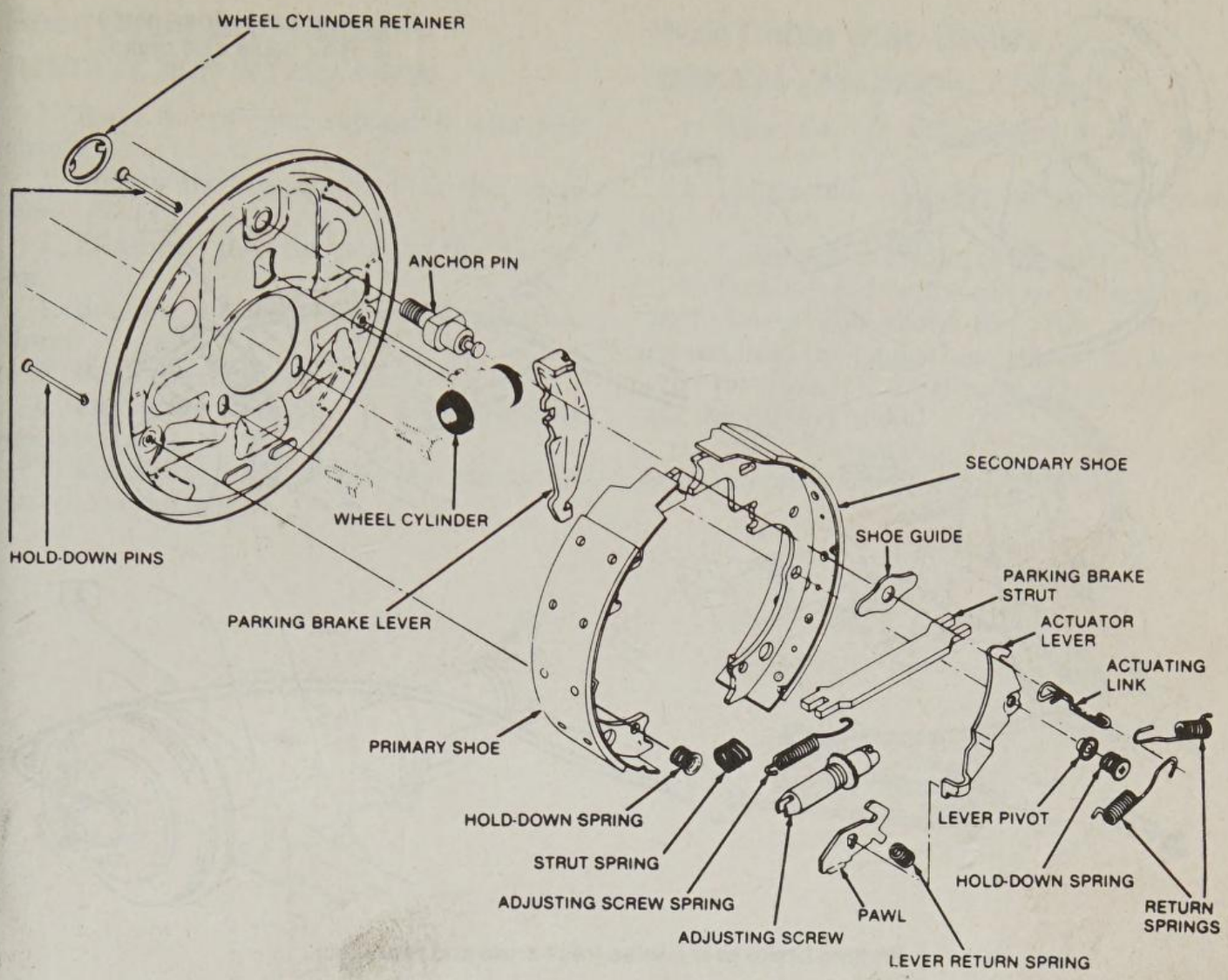
Overhaul kits for wheel cylinders are readily available. When rebuilding and installing wheel cylinders, avoid getting any contaminants into the system. Always install clean, new high-quality brake fluid. If dirty or improper fluid has been used, it will be necessary to drain the entire system, flush the system with proper brake fluid, replace all rubber components, refill, and bleed the system.

1. Remove the wheel cylinder by referring to the Wheel Cylinder Removal procedure.

2. Remove the rubber boots from the cylinder ends with pliers. Discard the boots. Remove and discard the pistons and cups.



Exploded view of a typical wheel cylinder



Exploded View of the Rear Brake Drum

3. Wash the cylinder and metal parts in denatured alcohol or clean brake fluid.

CAUTION: *Never use a mineral-based solvent such as gasoline, kerosene, or paint thinner for cleaning purposes. These solvents will swell rubber components and quickly deteriorate them.*

4. Allow the parts to air dry or use compressed air. Do not use rags for cleaning since lint will remain in the cylinder bore.

5. Inspect the piston and replace it if it shows scratches.

6. Lubricate the cylinder bore and counterbore with clean brake fluid.

7. Install the seals (flat side out) and then the pistons (flat side in).

8. Insert new boots into the counterbores by hand. Do not lubricate the boots.

9. To install the wheel cylinder refer to the Wheel Cylinder Installation procedure.

REMOVAL AND INSTALLATION

1. Raise and support the car. Remove the wheel. Remove the brake shoes by following the Brake Shoe Replacement procedure.

2. Remove dirt from around the wheel cylinder inlet and pilot. Disconnect the inlet tube.

3. Using 2 awls (⅛ in. dia.), remove the wheel cylinder retainer. Insert the awls into the access slots between the wheel cylinder pilot and retainer. Simultaneously, bend both tabs away from each other. Remove the wheel cylinder.

4. To install, place wheel cylinder into position and place a block of wood between it and the axle flange. Install a new retainer over the end of the wheel cylinder. Using a 1⅛ in. 12-point socket with an extension, drive the new retainer into position.

5. Connect the inlet tube and torque 120–280 in. lb. (13.6–20 N.m.). Complete installation by reversing the removal procedure. Bleed the brakes.

PARKING BRAKE

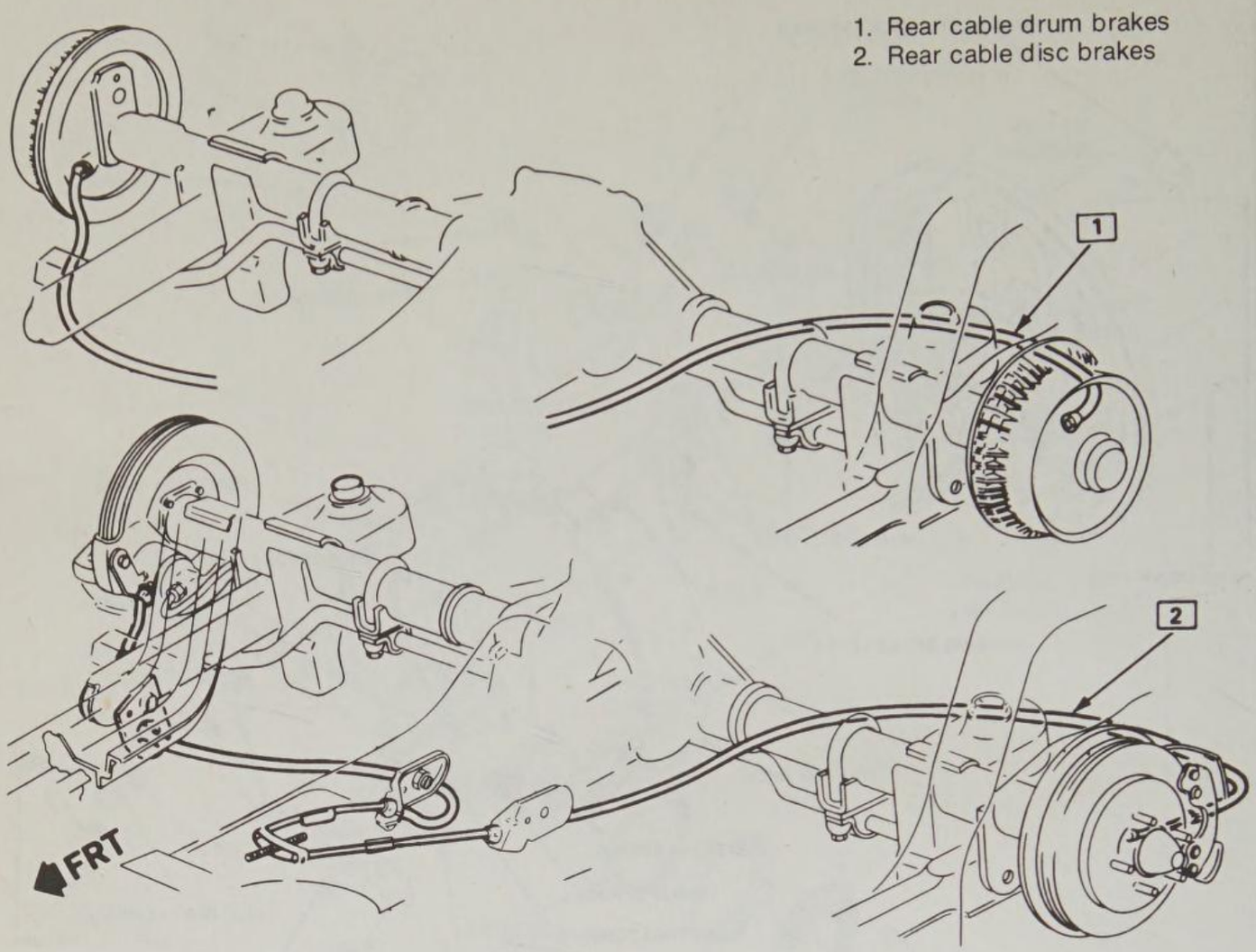
Cable

ADJUSTMENT

Models With Rear Drum Brakes

1. Depress the parking brake lever exactly two rachet clicks.

2. Raise the rear of the vehicle and support safely with jackstands.



Parking brake rear cables (rear drum and rear disc)

3. Tighten the brake cable adjusting nut until the left rear wheel can be turned rearward with both hands, but locks when forward rotation is attempted.

4. Release the parking brake lever; both rear wheels must turn freely in either direction without brake drag.

5. Lower the vehicle.

Models With Rear Disc Brakes

1. Check for free movement of the parking brake cables and lubricate the underbody rub points of the cables. Also lubricate the equalizer hooks.

2. Release the parking brake lever completely.

3. Raise the rear of the vehicle and support it safely with jackstands.

4. Hold the brake cable stud from turning, then tighten the adjusting nut until all cable slack is taken up.

NOTE: *Check that the parking brake levers on the rear calipers are against the stops on the caliper housing. If the levers are not contacting the stops, loosen the cable adjusting nut until the levers just contact the stops.*

5. Operate the parking brake cable several times. Parking brake pedal travel should be 14 clicks with approximately 130–170 lbs. of force applied to the pedal.

6. Readjust if necessary.

7. Make sure that the levers contact the caliper stops after adjustments.

8. Lower the vehicle.

Front Cable

REMOVAL AND INSTALLATION

1. Raise the car and support it with jackstands.

2. Remove the adjusting nut at the equalizer.

3. Remove the spring retainer clip from the bracket.

4. Lower the car. Remove the upper console cover and lower console rear screws.

5. Lift the rear of the lower console for access to the cable retainer at the hand lever.

6. Remove the cable retainer pin, cable retainer, then the cable.

7. Installation is the reverse of removal. Adjust the parking brake.

Rear Cable Drum Brakes

REMOVAL AND INSTALLATION

1. Raise the car and support it with jackstands.
2. Loosen the adjusting nut at the equalizer.
3. Disengage the rear cable at the connector.
4. Remove the wheel assembly and brake drum.
5. Bend the retainer fingers.
6. Disengage the cable at the brake shoe operating lever.
7. Installation is the reverse of removal. Adjust the parking brake.

Rear Cable Disc Bakes

REMOVAL AND INSTALLATION

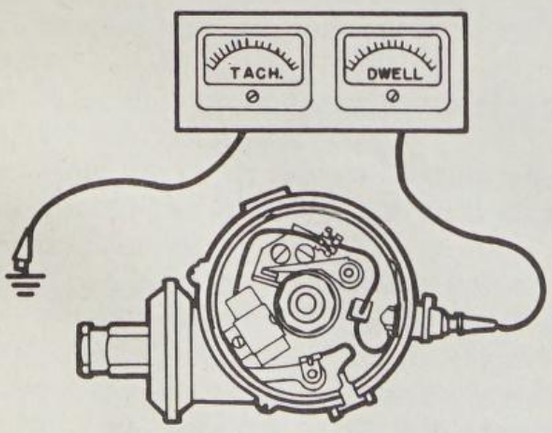
1. Raise the car and support it with jackstands.
2. Loosen the adjusting nut at the equalizer.
3. Disengage the cable at the connector.
4. Push forward on the caliper parking brake apply lever. This allows the cable to be removed from the tang. Then, release the lever.
5. Installation is the reverse of removal. Adjust the parking brake.
6. Apply the parking brake 3 times with heavy pressure and repeat adjustment.

Troubleshooting

This section is designed to aid in the quick, accurate diagnosis of automotive problems. While automotive repairs can be made by many people, accurate troubleshooting is a rare skill for the amateur and professional alike.

In its simplest state, troubleshooting is an exercise in logic. It is essential to realize that an automobile is really composed of a series of systems. Some of these systems are interrelated; others are not. Automobiles operate within a framework of logical rules and physical laws, and the key to troubleshooting is a good understanding of all the automotive systems.

This section breaks the car or truck down into its component systems, allowing the problem to be isolated. The charts and diagnostic road maps list the most common problems and the most probable causes of trouble. Obviously it would be impossible to list every possible problem that could happen along with every possible cause, but it will locate MOST problems and eliminate a lot of unnecessary guesswork. The systematic format will locate problems within a given system, but, because many automotive systems are interrelated, the solution to your particular problem may be found in a number of systems on the car or truck.



Tach-dwell hooked-up to distributor

USING THE TROUBLESHOOTING CHARTS

This book contains all of the specific information that the average do-it-yourself mechanic needs to repair and maintain his or her car or truck. The troubleshooting charts are designed to be used in conjunction with the specific procedures and information in the text. For instance, troubleshooting a point-type ignition system is fairly standard for all models, but you may be directed to the text to find procedures for troubleshooting an individual type of electronic ignition. You will also have to refer to the specification charts throughout the book for specifications applicable to your car or truck.

TOOLS AND EQUIPMENT

The tools illustrated in Chapter 1 (plus two more diagnostic pieces) will be adequate to troubleshoot most problems. The two other tools needed are a voltmeter and an ohmmeter. These can be purchased separately or in combination, known as a VOM meter.

In the event that other tools are required, they will be noted in the procedures.

Troubleshooting Engine Problems

See Chapters 2, 3, 4 for more information and service procedures.

Index to Systems

System	To Test	Group
Battery	Engine need not be running	1
Starting system	Engine need not be running	2
Primary electrical system	Engine need not be running	3
Secondary electrical system	Engine need not be running	4
Fuel system	Engine need not be running	5
Engine compression	Engine need not be running	6
Engine vacuum	Engine must be running	7
Secondary electrical system	Engine must be running	8
Valve train	Engine must be running	9
Exhaust system	Engine must be running	10
Cooling system	Engine must be running	11
Engine lubrication	Engine must be running	12

Index to Problems

Problem: Symptom	Begin at Specific Diagnosis, Number ___
Engine Won't Start:	
Starter doesn't turn	1.1, 2.1
Starter turns, engine doesn't	2.1
Starter turns engine very slowly	1.1, 2.4
Starter turns engine normally	3.1, 4.1
Starter turns engine very quickly	6.1
Engine fires intermittently	4.1
Engine fires consistently	5.1, 6.1
Engine Runs Poorly:	
Hard starting	3.1, 4.1, 5.1, 8.1
Rough idle	4.1, 5.1, 8.1
Stalling	3.1, 4.1, 5.1, 8.1
Engine dies at high speeds	4.1, 5.1
Hesitation (on acceleration from standing stop)	5.1, 8.1
Poor pickup	4.1, 5.1, 8.1
Lack of power	3.1, 4.1, 5.1, 8.1
Backfire through the carburetor	4.1, 8.1, 9.1
Backfire through the exhaust	4.1, 8.1, 9.1
Blue exhaust gases	6.1, 7.1
Black exhaust gases	5.1
Running on (after the ignition is shut off)	3.1, 8.1
Susceptible to moisture	4.1
Engine misfires under load	4.1, 7.1, 8.4, 9.1
Engine misfires at speed	4.1, 8.4
Engine misfires at idle	3.1, 4.1, 5.1, 7.1, 8.4

Sample Section

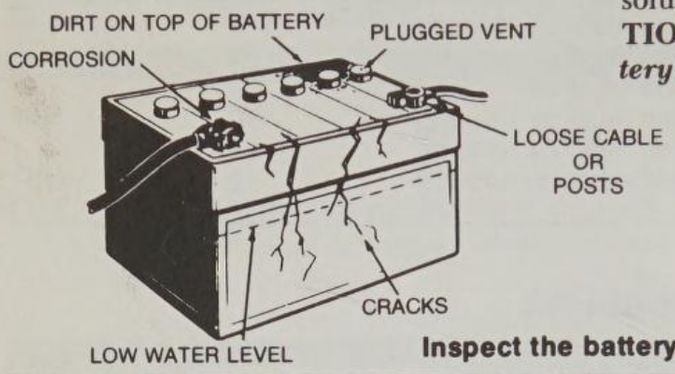
Test and Procedure	Results and Indications	Proceed to
4.1—Check for spark: Hold each spark plug wire approximately ¼" from ground with gloves or a heavy, dry rag. Crank the engine and observe the spark.	→ If no spark is evident:	**4.2**
	→ If spark is good in some cases:	**4.3**
	→ If spark is good in all cases:	**4.6**

Specific Diagnosis

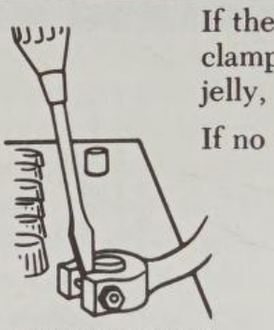
This section is arranged so that following each test, instructions are given to proceed to another, until a problem is diagnosed.

Section 1—Battery

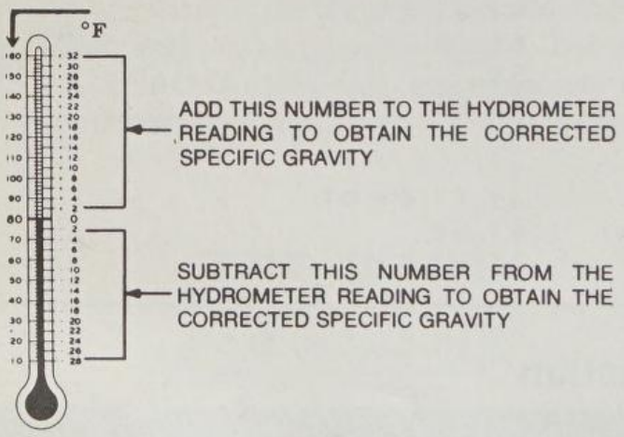
Test and Procedure	Results and Indications	Proceed to
1.1—Inspect the battery visually for case condition (corrosion, cracks) and water level.	If case is cracked, replace battery:	**1.4**
	If the case is intact, remove corrosion with a solution of baking soda and water (**CAUTION:** ***do not get the solution into the battery***), and fill with water:	**1.2**
1.2—Check the battery cable connections: Insert a screwdriver between the battery post and the cable clamp. Turn the headlights on high beam, and observe them as the screwdriver is gently twisted to ensure good metal to metal contact.	If the lights brighten, remove and clean the clamp and post; coat the post with petroleum jelly, install and tighten the clamp:	**1.4**
	If no improvement is noted:	**1.3**
1.3—Test the state of charge of the battery using an individual cell tester or hydrometer.	If indicated, charge the battery. **NOTE:** ***If no obvious reason exists for the low state of charge (i.e., battery age, prolonged storage), proceed to:***	**1.4**
1.4—Visually inspect battery cables for cracking, bad connection to ground, or bad connection to starter.	If necessary, tighten connections or replace the cables:	**2.1**



Inspect the battery case



TESTING BATTERY CABLE CONNECTIONS USING A SCREWDRIVER



Specific Gravity (@ 80° F.)

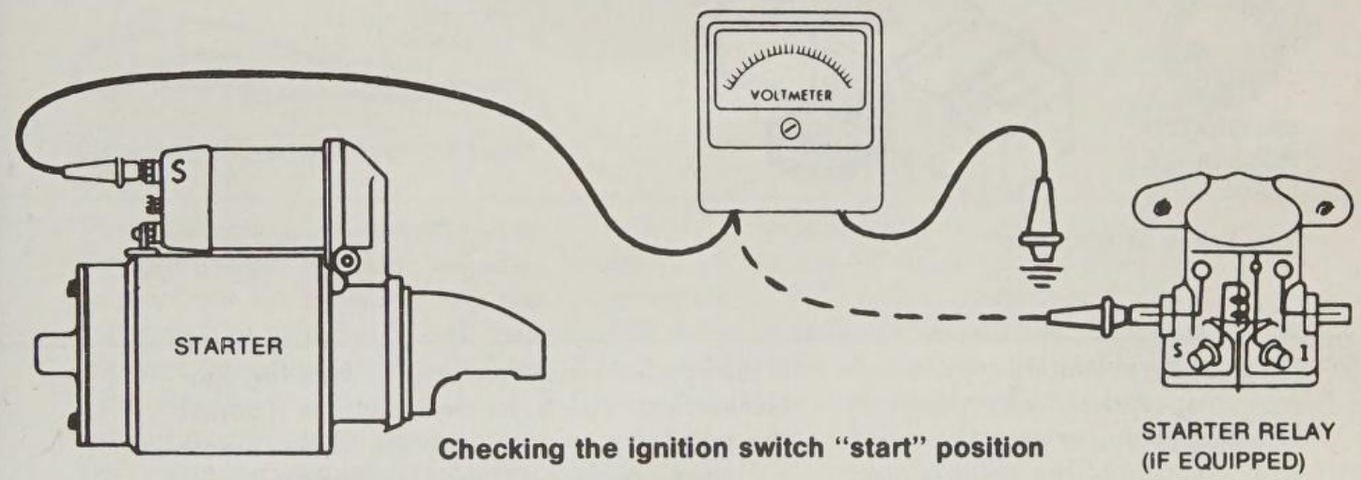
Minimum	*Battery Charge*
1.260	100% Charged
1.230	75% Charged
1.200	50% Charged
1.170	25% Charged
1.140	Very Little Power Left
1.110	Completely Discharged

The effects of temperature on battery specific gravity (left) and amount of battery charge in relation to specific gravity (right)

Section 2—Starting System

See Chapter 3 for service procedures

Test and Procedure	Results and Indications	Proceed to
Note: Tests in Group 2 are performed with coil high tension lead disconnected to prevent accidental starting.		
2.1—Test the starter motor and solenoid: Connect a jumper from the battery post of the solenoid (or relay) to the starter post of the solenoid (or relay).	If starter turns the engine normally:	**2.2**
	If the starter buzzes, or turns the engine very slowly:	**2.4**
	If no response, replace the solenoid (or relay).	**3.1**
	If the starter turns, but the engine doesn't, ensure that the flywheel ring gear is intact. If the gear is undamaged, replace the starter drive.	**3.1**
2.2—Determine whether ignition override switches are functioning properly (clutch start switch, neutral safety switch), by connecting a jumper across the switch(es), and turning the ignition switch to "start".	If starter operates, adjust or replace switch:	**3.1**
	If the starter doesn't operate:	**2.3**
2.3—Check the ignition switch "start" position: Connect a 12V test lamp or voltmeter between the starter post of the solenoid (or relay) and ground. Turn the ignition switch to the "start" position, and jiggle the key.	If the lamp doesn't light or the meter needle doesn't move when the switch is turned, check the ignition switch for loose connections, cracked insulation, or broken wires. Repair or replace as necessary:	**3.1**
	If the lamp flickers or needle moves when the key is jiggled, replace the ignition switch.	**3.3**



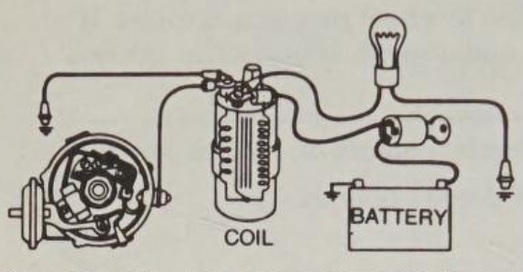
Checking the ignition switch "start" position

STARTER RELAY (IF EQUIPPED)

2.4—Remove and bench test the starter, according to specifications in the engine electrical section.	If the starter does not meet specifications, repair or replace as needed:	**3.1**
	If the starter is operating properly:	**2.5**
2.5—Determine whether the engine can turn freely: Remove the spark plugs, and check for water in the cylinders. Check for water on the dipstick, or oil in the radiator. Attempt to turn the engine using an 18" flex drive and socket on the crankshaft pulley nut or bolt.	If the engine will turn freely only with the spark plugs out, and hydrostatic lock (water in the cylinders) is ruled out, check valve timing:	**9.2**
	If engine will not turn freely, and it is known that the clutch and transmission are free, the engine must be disassembled for further evaluation:	**Chapter 3**

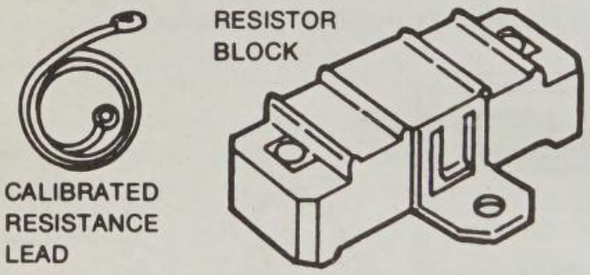
Section 3—Primary Electrical System

Test and Procedure	Results and Indications	Proceed to
3.1—Check the ignition switch "on" position: Connect a jumper wire between the distributor side of the coil and ground, and a 12V test lamp between the switch side of the coil and ground. Remove the high tension lead from the coil. Turn the ignition switch on and jiggle the key.	If the lamp lights:	**3.2**
	If the lamp flickers when the key is jiggled, replace the ignition switch:	**3.3**
	If the lamp doesn't light, check for loose or open connections. If none are found, remove the ignition switch and check for continuity. If the switch is faulty, replace it:	**3.3**



Checking the ignition switch "on" position

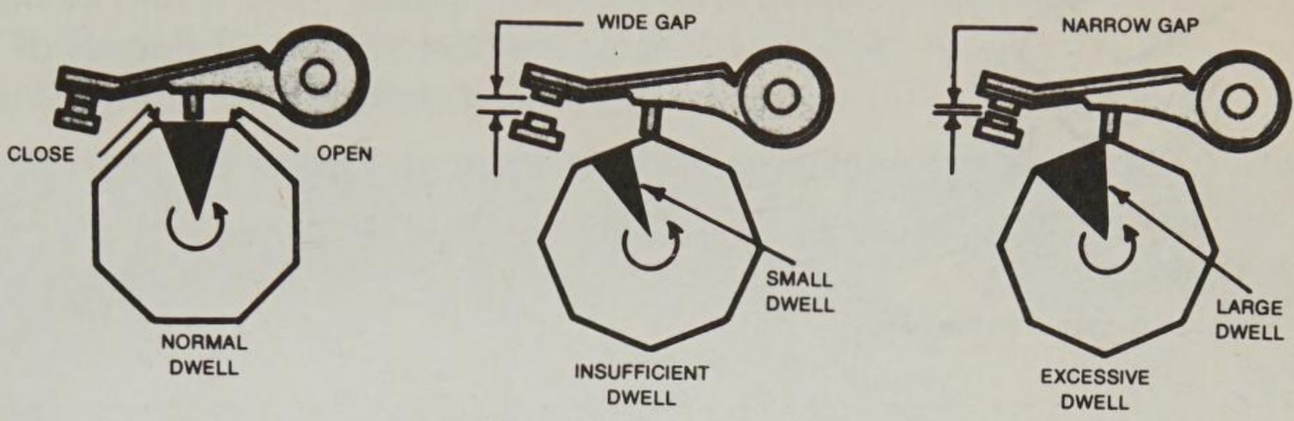
3.2—Check the ballast resistor or resistance wire for an open circuit, using an ohmmeter. See Chapter 3 for specific tests.	Replace the resistor or resistance wire if the resistance is zero. **NOTE:** ***Some ignition systems have no ballast resistor.***	**3.3**



Two types of resistors

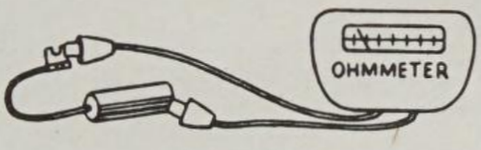
3.3—On point-type ignition systems, visually inspect the breaker points for burning, pitting or excessive wear. Gray coloring of the point contact surfaces is normal. Rotate the crankshaft until the contact heel rests on a high point of the distributor cam and adjust the point gap to specifications. On electronic ignition models, remove the distributor cap and visually inspect the armature. Ensure that the armature pin is in place, and that the armature is on tight and rotates when the engine is cranked. Make sure there are no cracks, chips or rounded edges on the armature.	If the breaker points are intact, clean the contact surfaces with fine emery cloth, and adjust the point gap to specifications. If the points are worn, replace them. On electronic systems, replace any parts which appear defective. If condition persists:	**3.4**

Test and Procedure	Results and Indications	Proceed to
3.4—On point-type ignition systems, connect a dwell-meter between the distributor primary lead and ground. Crank the engine and observe the point dwell angle. On electronic ignition systems, conduct a stator (magnetic pickup assembly) test. See Chapter 3.	On point-type systems, adjust the dwell angle if necessary. **NOTE:** ***Increasing the point gap decreases the dwell angle and vice-versa.***	**3.6**
	If the dwell meter shows little or no reading;	**3.5**
	On electronic ignition systems, if the stator is bad, replace the stator. If the stator is good, proceed to the other tests in Chapter 3.	



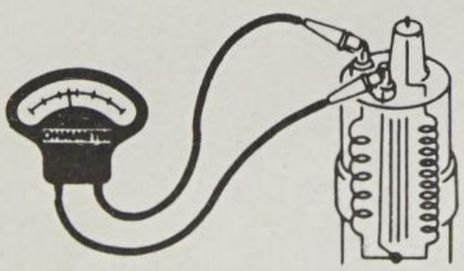
Dwell is a function of point gap

3.5—On the point-type ignition systems, check the condenser for short: connect an ohmeter across the condenser body and the pigtail lead.	If any reading other than infinite is noted, replace the condenser	**3.6**



Checking the condenser for short

3.6—Test the coil primary resistance: On point-type ignition systems, connect an ohmmeter across the coil primary terminals, and read the resistance on the low scale. Note whether an external ballast resistor or resistance wire is used. On electronic ignition systems, test the coil primary resistance as in Chapter 3.	Point-type ignition coils utilizing ballast resistors or resistance wires should have approximately 1.0 ohms resistance. Coils with internal resistors should have approximately 4.0 ohms resistance. If values far from the above are noted, replace the coil.	**4.1**

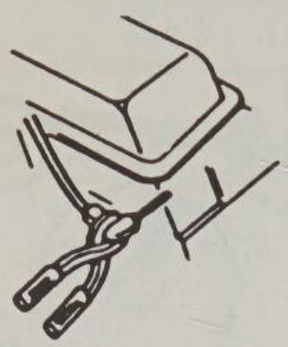


Check the coil primary resistance

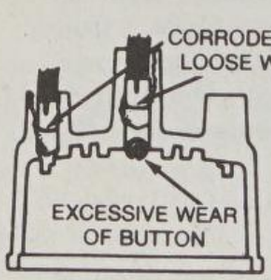
Section 4—Secondary Electrical System

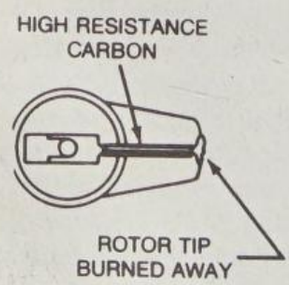
See Chapters 2–3 for service procedures

Test and Procedure	Results and Indications	Proceed to
4.1—Check for spark: Hold each spark plug wire approximately ¼" from ground with gloves or a heavy, dry rag. Crank the engine, and observe the spark.	If no spark is evident:	**4.2**
	If spark is good in some cylinders:	**4.3**
	If spark is good in all cylinders:	**4.6**
4.2—Check for spark at the coil high tension lead: Remove the coil high tension lead from the distributor and position it approximately ¼" from ground. Crank the engine and observe spark. **CAUTION:** ***This test should not be performed on engines equipped with electronic ignition.***	If the spark is good and consistent:	**4.3**
	If the spark is good but intermittent, test the primary electrical system starting at 3.3:	**3.3**
	If the spark is weak or non-existent, replace the coil high tension lead, clean and tighten all connections and retest. If no improvement is noted:	**4.4**
4.3—Visually inspect the distributor cap and rotor for burned or corroded contacts, cracks, carbon tracks, or moisture. Also check the fit of the rotor on the distributor shaft (where applicable).	If moisture is present, dry thoroughly, and retest per 4.1:	**4.1**
	If burned or excessively corroded contacts, cracks, or carbon tracks are noted, replace the defective part(s) and retest per 4.1:	**4.1**
	If the rotor and cap appear intact, or are only slightly corroded, clean the contacts thoroughly (including the cap towers and spark plug wire ends) and retest per 4.1:	
	If the spark is good in all cases:	**4.6**
	If the spark is poor in all cases:	**4.5**



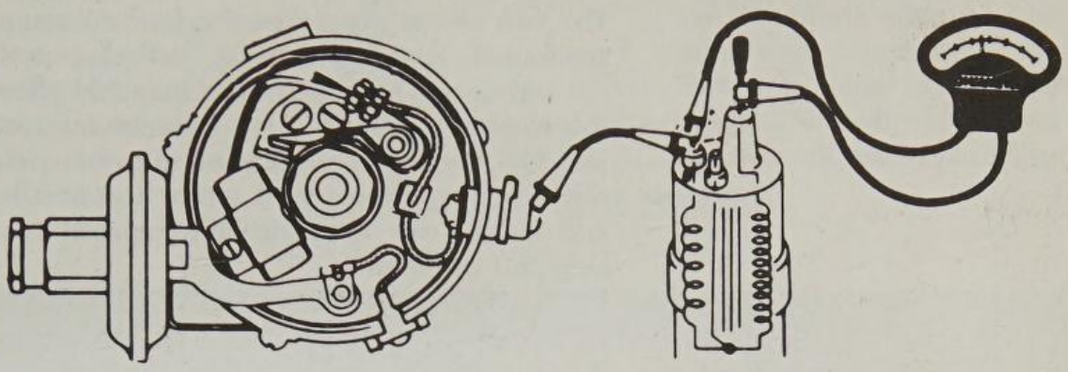
Check for spark at the plugs





Inspect the distributor cap and rotor

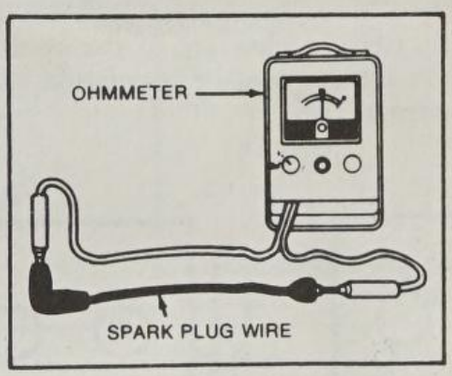
Test and Procedure	Results and Indications	Proceed to
4.4—Check the coil secondary resistance: On point-type systems connect an ohmmeter across the distributor side of the coil and the coil tower. Read the resistance on the high scale of the ohmmeter. On electronic ignition systems, see Chapter 3 for specific tests.	The resistance of a satisfactory coil should be between 4,000 and 10,000 ohms. If resistance is considerably higher (i.e., 40,000 ohms) replace the coil and retest per 4.1. **NOTE:** ***This does not apply to high performance coils.***	



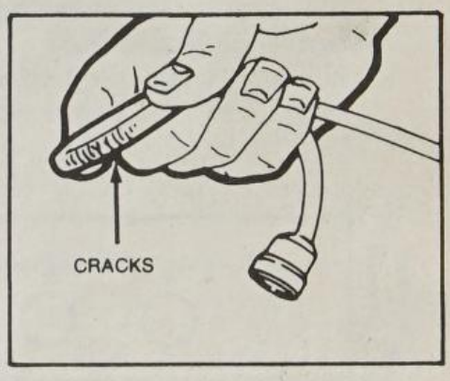
Testing the coil secondary resistance

4.5—Visually inspect the spark plug wires for cracking or brittleness. Ensure that no two wires are positioned so as to cause induction firing (adjacent and parallel). Remove each wire, one by one, and check resistance with an ohmmeter.	Replace any cracked or brittle wires. If any of the wires are defective, replace the entire set. Replace any wires with excessive resistance (over 8000 Ω per foot for suppression wire), and separate any wires that might cause induction firing.	**4.6**

Misfiring can be the result of spark plug leads to adjacent, consecutively firing cylinders running parallel and too close together



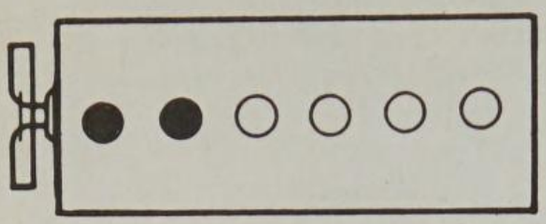
On point-type ignition systems, check the spark plug wires as shown. On electronic ignitions, do not remove the wire from the distributor cap terminal; instead, test through the cap



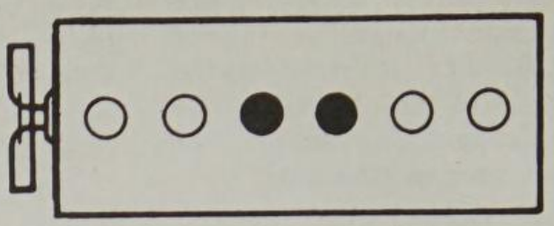
Spark plug wires can be checked visually by bending them in a loop over your finger. This will reveal any cracks, burned or broken insulation. Any wire with cracked insulation should be replaced

4.6—Remove the spark plugs, noting the cylinders from which they were removed, and evaluate according to the color photos in the middle of this book.	See following.	**See following.**

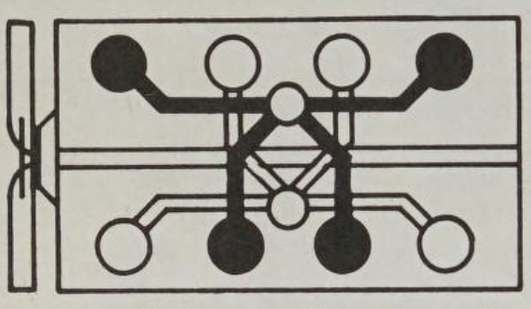
Test and Procedure	Results and Indications	Proceed to
4.7—Examine the location of all the plugs.	The following diagrams illustrate some of the conditions that the location of plugs will reveal.	**4.8**



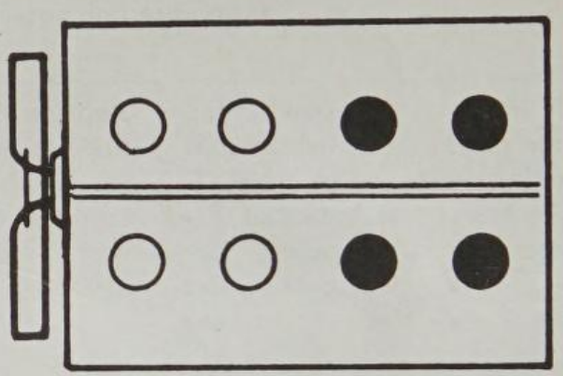
Two adjacent plugs are fouled in a 6-cylinder engine, 4-cylinder engine or either bank of a V-8. This is probably due to a blown head gasket between the two cylinders



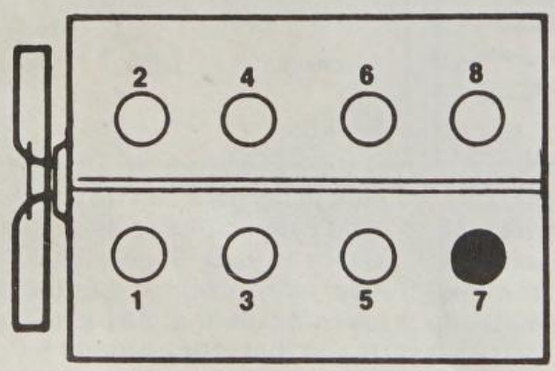
The two center plugs in a 6-cylinder engine are fouled. Raw fuel may be "boiled" out of the carburetor into the intake manifold after the engine is shut-off. Stop-start driving can also foul the center plugs, due to overly rich mixture. Proper float level, a new float needle and seat or use of an insulating spacer may help this problem



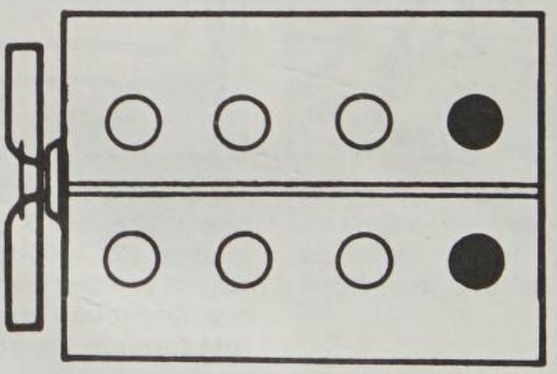
An unbalanced carburetor is indicated. Following the fuel flow on this particular design shows that the cylinders fed by the right-hand barrel are fouled from overly rich mixture, while the cylinders fed by the left-hand barrel are normal



If the four rear plugs are overheated, a cooling system problem is suggested. A thorough cleaning of the cooling system may restore coolant circulation and cure the problem



Finding one plug overheated may indicate an intake manifold leak near the affected cylinder. If the overheated plug is the second of two adjacent, consecutively firing plugs, it could be the result of ignition cross-firing. Separating the leads to these two plugs will eliminate cross-fire



Occasionally, the two rear plugs in large, lightly used V-8's will become oil fouled. High oil consumption and smoky exhaust may also be noticed. It is probably due to plugged oil drain holes in the rear of the cylinder head, causing oil to be sucked in around the valve stems. This usually occurs in the rear cylinders first, because the engine slants that way

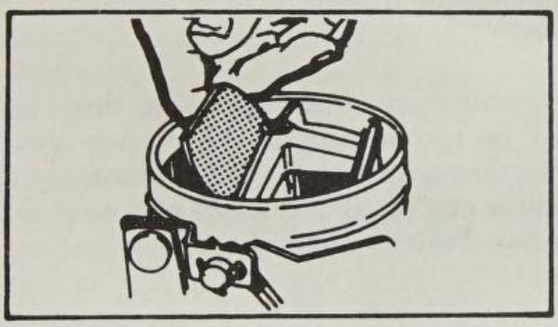
Test and Procedure	Results and Indications	Proceed to
4.8—Determine the static ignition timing. Using the crankshaft pulley timing marks as a guide, locate top dead center on the compression stroke of the number one cylinder.	The rotor should be pointing toward the No. 1 tower in the distributor cap, and, on electronic ignitions, the armature spoke for that cylinder should be lined up with the stator.	**4.8**
4.9—Check coil polarity: Connect a voltmeter negative lead to the coil high tension lead, and the positive lead to ground (**NOTE: *Reverse the hook-up for positive ground systems***). Crank the engine momentarily.	If the voltmeter reads up-scale, the polarity is correct: If the voltmeter reads down-scale, reverse the coil polarity (switch the primary leads):	**5.1** **5.1**

Checking coil polarity

Section 5—Fuel System

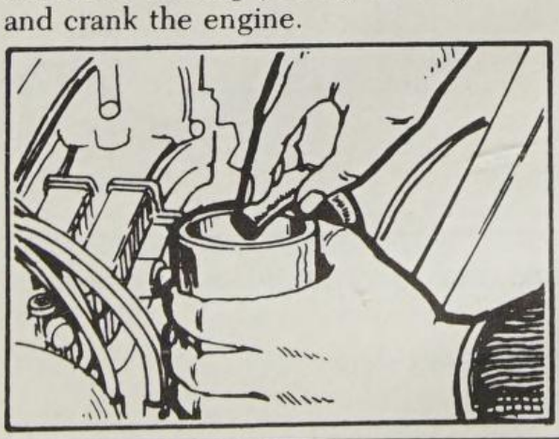
See Chapter 4 for service procedures

Test and Procedure	Results and Indications	Proceed to
5.1—Determine that the air filter is functioning efficiently: Hold paper elements up to a strong light, and attempt to see light through the filter.	Clean permanent air filters in solvent (or manufacturer's recommendation), and allow to dry. Replace paper elements through which light cannot be seen:	**5.2**
5.2—Determine whether a flooding condition exists: Flooding is identified by a strong gasoline odor, and excessive gasoline present in the throttle bore(s) of the carburetor.	If flooding is not evident: If flooding is evident, permit the gasoline to dry for a few moments and restart. If flooding doesn't recur: If flooding is persistent:	**5.3** **5.7** **5.5**



If the engine floods repeatedly, check the choke butterfly flap

5.3—Check that fuel is reaching the carburetor: Detach the fuel line at the carburetor inlet. Hold the end of the line in a cup (not styrofoam), and crank the engine.	If fuel flows smoothly: If fuel doesn't flow (**NOTE: *Make sure that there is fuel in the tank***), or flows erratically:	**5.7** **5.4**



Check the fuel pump by disconnecting the output line (fuel pump-to-carburetor) at the carburetor and operating the starter briefly

Test and Procedure	Results and Indications	Proceed to
5.4—Test the fuel pump: Disconnect all fuel lines from the fuel pump. Hold a finger over the input fitting, crank the engine (with electric pump, turn the ignition or pump on); and feel for suction.	If suction is evident, blow out the fuel line to the tank with low pressure compressed air until bubbling is heard from the fuel filler neck. Also blow out the carburetor fuel line (both ends disconnected):	**5.7**
	If no suction is evident, replace or repair the fuel pump:	**5.7**
	NOTE: ***Repeated oil fouling of the spark plugs, or a no-start condition, could be the result of a ruptured vacuum booster pump diaphragm, through which oil or gasoline is being drawn into the intake manifold (where applicable).***	
5.5—Occasionally, small specks of dirt will clog the small jets and orifices in the carburetor. With the engine cold, hold a flat piece of wood or similar material over the carburetor, where possible, and crank the engine.	If the engine starts, but runs roughly the engine is probably not run enough. If the engine won't start:	**5.9**
5.6—Check the needle and seat: Tap the carburetor in the area of the needle and seat.	If flooding stops, a gasoline additive (e.g., Gumout) will often cure the problem:	**5.7**
	If flooding continues, check the fuel pump for excessive pressure at the carburetor (according to specifications). If the pressure is normal, the needle and seat must be removed and checked, and/or the float level adjusted:	**5.7**
5.7—Test the accelerator pump by looking into the throttle bores while operating the throttle.	If the accelerator pump appears to be operating normally:	**5.8**
	If the accelerator pump is not operating, the pump must be reconditioned. Where possible, service the pump with the carburetor(s) installed on the engine. If necessary, remove the carburetor. Prior to removal:	**5.8**
5.8—Determine whether the carburetor main fuel system is functioning: Spray a commercial starting fluid into the carburetor while attempting to start the engine.	If the engine starts, runs for a few seconds, and dies:	**5.9**
	If the engine doesn't start:	**6.1**

Check for gas at the carburetor by looking down the carburetor throat while someone moves the accelerator

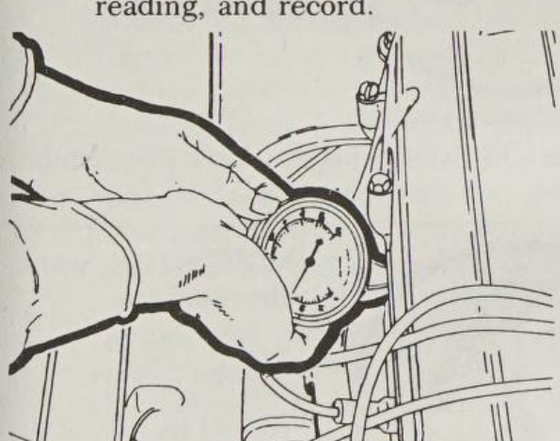
Test and Procedure	Results and Indications	Proceed to
5.9—Uncommon fuel system malfunctions: See below:	If the problem is solved:	**6.1**
	If the problem remains, remove and recondition the carburetor.	

Condition	Indication	Test	Prevailing Weather Conditions	Remedy
Vapor lock	Engine will not restart shortly after running.	Cool the components of the fuel system until the engine starts. Vapor lock can be cured faster by draping a wet cloth over a mechanical fuel pump.	Hot to very hot	Ensure that the exhaust manifold heat control valve is operating. Check with the vehicle manufacturer for the recommended solution to vapor lock on the model in question.
Carburetor icing	Engine will not idle, stalls at low speeds.	Visually inspect the throttle plate area of the throttle bores for frost.	High humidity, 32–40° F.	Ensure that the exhaust manifold heat control valve is operating, and that the intake manifold heat riser is not blocked.
Water in the fuel	Engine sputters and stalls; may not start.	Pump a small amount of fuel into a glass jar. Allow to stand, and inspect for droplets or a layer of water.	High humidity, extreme temperature changes.	For droplets, use one or two cans of commercial gas line anti-freeze. For a layer of water, the tank must be drained, and the fuel lines blown out with compressed air.

Section 6—Engine Compression

See Chapter 3 for service procedures

6.1—Test engine compression: Remove all spark plugs. Block the throttle wide open. Insert a compression gauge into a spark plug port, crank the engine to obtain the maximum reading, and record.	If compression is within limits on all cylinders:	**7.1**
	If gauge reading is extremely low on all cylinders:	**6.2**
	If gauge reading is low on one or two cylinders: (If gauge readings are identical and low on two or more adjacent cylinders, the head gasket must be replaced.)	**6.2**



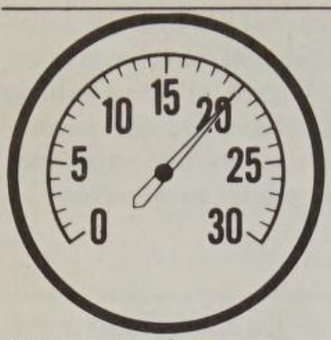
Checking compression

6.2—Test engine compression (wet): Squirt approximately 30 cc. of engine oil into each cylinder, and retest per 6.1.	If the readings improve, worn or cracked rings or broken pistons are indicated:	**See Chapter 3**
	If the readings do not improve, burned or excessively carboned valves or a jumped timing chain are indicated:	**7.1**
	NOTE: ***A jumped timing chain is often indicated by difficult cranking.***	

Section 7—Engine Vacuum

See Chapter 3 for service procedures

Test and Procedure	Results and Indications	Proceed to
7.1—Attach a vacuum gauge to the intake manifold beyond the throttle plate. Start the engine, and observe the action of the needle over the range of engine speeds.	See below.	See below

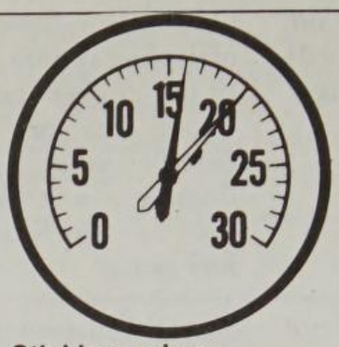


Normal engine

INDICATION: normal engine in good condition

Proceed to: 8.1

Gauge reading: steady, from 17–22 in./Hg.

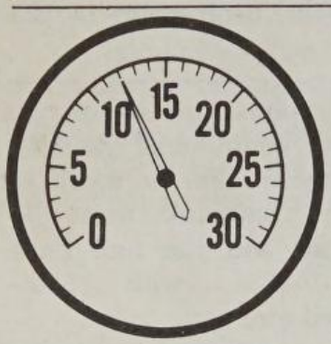


Sticking valves

INDICATION: sticking valves or ignition miss

Proceed to: 9.1, 8.3

Gauge reading: intermittent fluctuation at idle

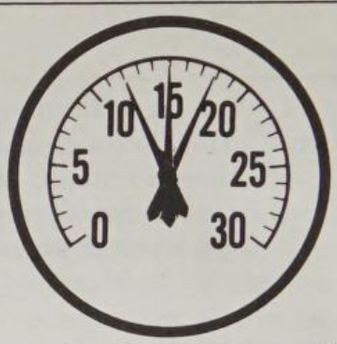


Incorrect valve timing

INDICATION: late ignition or valve timing, low compression, stuck throttle valve, leaking carburetor or manifold gasket

Proceed to: 6.1

Gauge reading: low (10–15 in./Hg) but steady

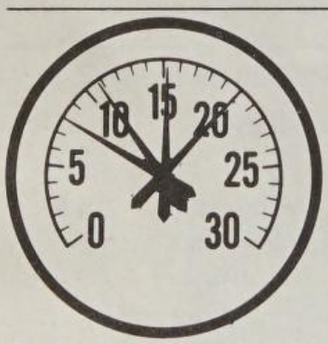


Carburetor requires adjustment

INDICATION: improper carburetor adjustment or minor intake leak.

Proceed to: 7.2

Gauge reading: drifting needle

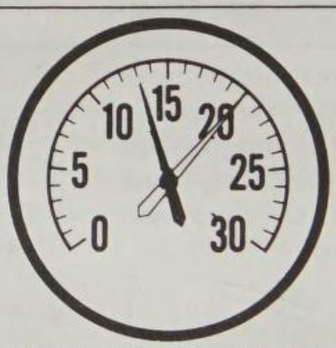


Blown head gasket

INDICATION: ignition miss, blown cylinder head gasket, leaking valve or weak valve spring

Proceed to: 8.3, 6.1

Gauge reading: needle fluctuates as engine speed increases

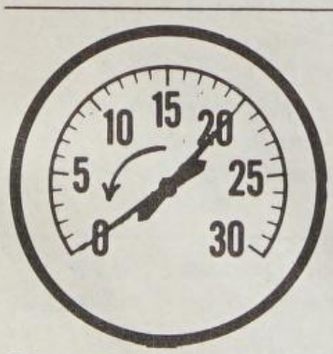


Burnt or leaking valves

INDICATION: burnt valve or faulty valve clearance. Needle will fall when defective valve operates

Proceed to: 9.1

Gauge reading: steady needle, but drops regularly

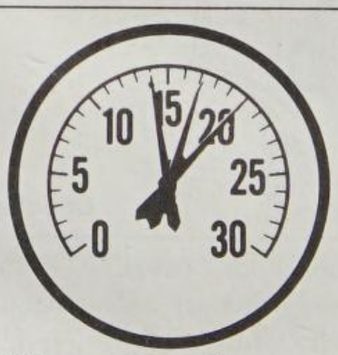


Clogged exhaust system

INDICATION: choked muffler, excessive back pressure in system

Proceed to: 10.1

Gauge reading: gradual drop in reading at idle



Worn valve guides

INDICATION: worn valve guides

Proceed to: 9.1

Gauge reading: needle vibrates excessively at idle, but steadies as engine speed increases

White pointer = steady gauge hand

Black pointer = fluctuating gauge hand

Test and Procedure	Results and Indications	Proceed to
7.2—Attach a vacuum gauge per 7.1, and test for an intake manifold leak. Squirt a small amount of oil around the intake manifold gaskets, carburetor gaskets, plugs and fittings. Observe the action of the vacuum gauge.	If the reading improves, replace the indicated gasket, or seal the indicated fitting or plug: If the reading remains low:	**8.1** **7.3**
7.3—Test all vacuum hoses and accessories for leaks as described in 7.2. Also check the carburetor body (dashpots, automatic choke mechanism, throttle shafts) for leaks in the same manner.	If the reading improves, service or replace the offending part(s): If the reading remains low:	**8.1** **6.1**

Section 8—Secondary Electrical System

See Chapter 2 for service procedures

Test and Procedure	Results and Indications	Proceed to
8.1—Remove the distributor cap and check to make sure that the rotor turns when the engine is cranked. Visually inspect the distributor components.	Clean, tighten or replace any components which appear defective.	**8.2**
8.2—Connect a timing light (per manufacturer's recommendation) and check the dynamic ignition timing. Disconnect and plug the vacuum hose(s) to the distributor if specified, start the engine, and observe the timing marks at the specified engine speed.	If the timing is not correct, adjust to specifications by rotating the distributor in the engine: (Advance timing by rotating distributor opposite normal direction of rotor rotation, retard timing by rotating distributor in same direction as rotor rotation.)	**8.3**
8.3—Check the operation of the distributor advance mechanism(s): To test the mechanical advance, disconnect the vacuum lines from the distributor advance unit and observe the timing marks with a timing light as the engine speed is increased from idle. If the mark moves smoothly, without hesitation, it may be assumed that the mechanical advance is functioning properly. To test vacuum advance and/or retard systems, alternately crimp and release the vacuum line, and observe the timing mark for movement. If movement is noted, the system is operating.	If the systems are functioning: If the systems are not functioning, remove the distributor, and test on a distributor tester:	**8.4** **8.4**
8.4—Locate an ignition miss: With the engine running, remove each spark plug wire, one at a time, until one is found that doesn't cause the engine to roughen and slow down.	When the missing cylinder is identified:	**4.1**

Section 9—Valve Train

See Chapter 3 for service procedures

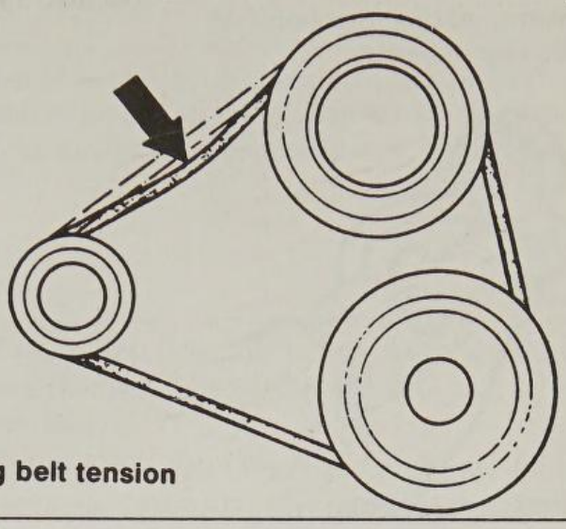
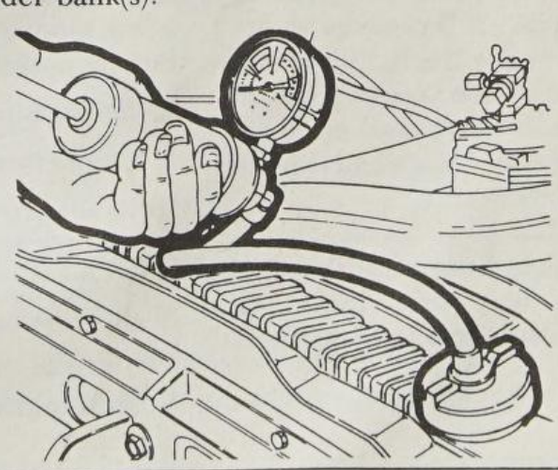
Test and Procedure	Results and Indications	Proceed to
9.1—Evaluate the valve train: Remove the valve cover, and ensure that the valves are adjusted to specifications. A mechanic's stethoscope may be used to aid in the diagnosis of the valve train. By pushing the probe on or near push rods or rockers, valve noise often can be isolated. A timing light also may be used to diagnose valve problems. Connect the light according to manufacturer's recommendations, and start the engine. Vary the firing moment of the light by increasing the engine speed (and therefore the ignition advance), and moving the trigger from cylinder to cylinder. Observe the movement of each valve.	Sticking valves or erratic valve train motion can be observed with the timing light. The cylinder head must be disassembled for repairs.	**See Chapter 3**
9.2—Check the valve timing: Locate top dead center of the No. 1 piston, and install a degree wheel or tape on the crankshaft pulley or damper with zero corresponding to an index mark on the engine. Rotate the crankshaft in its direction of rotation, and observe the opening of the No. 1 cylinder intake valve. The opening should correspond with the correct mark on the degree wheel according to specifications.	If the timing is not correct, the timing cover must be removed for further investigation.	**See Chapter 3**

Section 10—Exhaust System

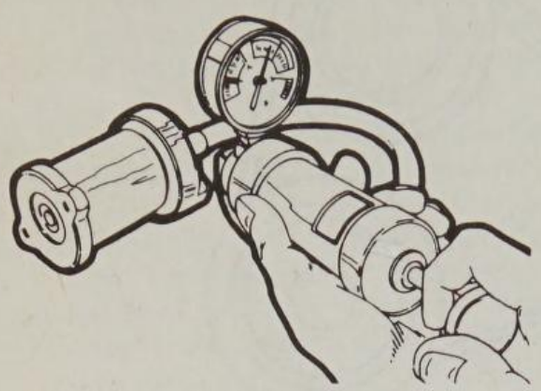
Test and Procedure	Results and Indications	Proceed to
10.1—Determine whether the exhaust manifold heat control valve is operating: Operate the valve by hand to determine whether it is free to move. If the valve is free, run the engine to operating temperature and observe the action of the valve, to ensure that it is opening.	If the valve sticks, spray it with a suitable solvent, open and close the valve to free it, and retest. If the valve functions properly: If the valve does not free, or does not operate, replace the valve:	 **10.2** **10.2**
10.2—Ensure that there are no exhaust restrictions: Visually inspect the exhaust system for kinks, dents, or crushing. Also note that gases are flowing freely from the tailpipe at all engine speeds, indicating no restriction in the muffler or resonator.	Replace any damaged portion of the system:	**11.1**

Section 11—Cooling System

See Chapter 3 for service procedures

Test and Procedure	Results and Indications	Proceed to
11.1—Visually inspect the fan belt for glazing, cracks, and fraying, and replace if necessary. Tighten the belt so that the longest span has approximately ½" play at its midpoint under thumb pressure (see Chapter 1).	Replace or tighten the fan belt as necessary:	**11.2**
	 **Checking belt tension**	
11.2—Check the fluid level of the cooling system.	If full or slightly low, fill as necessary:	**11.5**
	If extremely low:	**11.3**
11.3—Visually inspect the external portions of the cooling system (radiator, radiator hoses, thermostat elbow, water pump seals, heater hoses, etc.) for leaks. If none are found, pressurize the cooling system to 14–15 psi.	If cooling system holds the pressure:	**11.5**
	If cooling system loses pressure rapidly, reinspect external parts of the system for leaks under pressure. If none are found, check dipstick for coolant in crankcase. If no coolant is present, but pressure loss continues:	**11.4**
	If coolant is evident in crankcase, remove cylinder head(s), and check gasket(s). If gaskets are intact, block and cylinder head(s) should be checked for cracks or holes. If the gasket(s) is blown, replace, and purge the crankcase of coolant:	**12.6**
	NOTE: ***Occasionally, due to atmospheric and driving conditions, condensation of water can occur in the crankcase. This causes the oil to appear milky white. To remedy, run the engine until hot, and change the oil and oil filter.***	
11.4—Check for combustion leaks into the cooling system: Pressurize the cooling system as above. Start the engine, and observe the pressure gauge. If the needle fluctuates, remove each spark plug wire, one at a time, noting which cylinder(s) reduce or eliminate the fluctuation.	Cylinders which reduce or eliminate the fluctuation, when the spark plug wire is removed, are leaking into the cooling system. Replace the head gasket on the affected cylinder bank(s).	
	 **Pressurizing the cooling system**	

Test and Procedure	Results and Indications	Proceed to
11.5—Check the radiator pressure cap: Attach a radiator pressure tester to the radiator cap (wet the seal prior to installation). Quickly pump up the pressure, noting the point at which the cap releases.	If the cap releases within ± 1 psi of the specified rating, it is operating properly:	**11.6**
	If the cap releases at more than ± 1 psi of the specified rating, it should be replaced:	**11.6**
11.6—Test the thermostat: Start the engine cold, remove the radiator cap, and insert a thermometer into the radiator. Allow the engine to idle. After a short while, there will be a sudden, rapid increase in coolant temperature. The temperature at which this sharp rise stops is the thermostat opening temperature.	If the thermostat opens at or about the specified temperature:	**11.7**
	If the temperature doesn't increase: (If the temperature increases slowly and gradually, replace the thermostat.)	**11.7**
11.7—Check the water pump: Remove the thermostat elbow and the thermostat, disconnect the coil high tension lead (to prevent starting), and crank the engine momentarily.	If coolant flows, replace the thermostat and retest per 11.6:	**11.6**
	If coolant doesn't flow, reverse flush the cooling system to alleviate any blockage that might exist. If system is not blocked, and coolant will not flow, replace the water pump.	



Checking radiator pressure cap

Section 12—Lubrication

See Chapter 3 for service procedures

Test and Procedure	Results and Indications	Proceed to
12.1—Check the oil pressure gauge or warning light: If the gauge shows low pressure, or the light is on for no obvious reason, remove the oil pressure sender. Install an accurate oil pressure gauge and run the engine momentarily.	If oil pressure builds normally, run engine for a few moments to determine that it is functioning normally, and replace the sender.	—
	If the pressure remains low:	**12.2**
	If the pressure surges:	**12.3**
	If the oil pressure is zero:	**12.3**
12.2—Visually inspect the oil: If the oil is watery or very thin, milky, or foamy, replace the oil and oil filter.	If the oil is normal:	**12.3**
	If after replacing oil the pressure remains low:	**12.3**
	If after replacing oil the pressure becomes normal:	—

Test and Procedure	Results and Indications	Proceed to
12.3—Inspect the oil pressure relief valve and spring, to ensure that it is not sticking or stuck. Remove and thoroughly clean the valve, spring, and the valve body.	If the oil pressure improves: If no improvement is noted:	— **12.4**
12.4—Check to ensure that the oil pump is not cavitating (sucking air instead of oil): See that the crankcase is neither over nor underfull, and that the pickup in the sump is in the proper position and free from sludge.	Fill or drain the crankcase to the proper capacity, and clean the pickup screen in solvent if necessary. If no improvement is noted:	**12.5**
12.5—Inspect the oil pump drive and the oil pump:	If the pump drive or the oil pump appear to be defective, service as necessary and retest per 12.1: If the pump drive and pump appear to be operating normally, the engine should be disassembled to determine where blockage exists:	**12.1** **See Chapter 3**
12.6—Purge the engine of ethylene glycol coolant: Completely drain the crankcase and the oil filter. Obtain a commercial butyl cellosolve base solvent, designated for this purpose, and follow the instructions precisely. Following this, install a new oil filter and refill the crankcase with the proper weight oil. The next oil and filter change should follow shortly thereafter (1000 miles).		

TROUBLESHOOTING EMISSION CONTROL SYSTEMS

See Chapter 4 for procedures applicable to individual emission control systems used on specific combinations of engine/transmission/model.

TROUBLESHOOTING THE CARBURETOR

See Chapter 4 for service procedures

Carburetor problems cannot be effectively isolated unless all other engine systems (particularly ignition and emission) are functioning properly and the engine is properly tuned.

Condition	Possible Cause
Engine cranks, but does not start	1. Improper starting procedure 2. No fuel in tank 3. Clogged fuel line or filter 4. Defective fuel pump 5. Choke valve not closing properly 6. Engine flooded 7. Choke valve not unloading 8. Throttle linkage not making full travel 9. Stuck needle or float 10. Leaking float needle or seat 11. Improper float adjustment
Engine stalls	1. Improperly adjusted idle speed or mixture **Engine hot** 2. Improperly adjusted dashpot 3. Defective or improperly adjusted solenoid 4. Incorrect fuel level in fuel bowl 5. Fuel pump pressure too high 6. Leaking float needle seat 7. Secondary throttle valve stuck open 8. Air or fuel leaks 9. Idle air bleeds plugged or missing 10. Idle passages plugged **Engine Cold** 11. Incorrectly adjusted choke 12. Improperly adjusted fast idle speed 13. Air leaks 14. Plugged idle or idle air passages 15. Stuck choke valve or binding linkage 16. Stuck secondary throttle valves 17. Engine flooding—high fuel level 18. Leaking or misaligned float
Engine hesitates on acceleration	1. Clogged fuel filter 2. Leaking fuel pump diaphragm 3. Low fuel pump pressure 4. Secondary throttle valves stuck, bent or misadjusted 5. Sticking or binding air valve 6. Defective accelerator pump 7. Vacuum leaks 8. Clogged air filter 9. Incorrect choke adjustment (engine cold)
Engine feels sluggish or flat on acceleration	1. Improperly adjusted idle speed or mixture 2. Clogged fuel filter 3. Defective accelerator pump 4. Dirty, plugged or incorrect main metering jets 5. Bent or sticking main metering rods 6. Sticking throttle valves 7. Stuck heat riser 8. Binding or stuck air valve 9. Dirty, plugged or incorrect secondary jets 10. Bent or sticking secondary metering rods. 11. Throttle body or manifold heat passages plugged 12. Improperly adjusted choke or choke vacuum break.
Carburetor floods	1. Defective fuel pump. Pressure too high. 2. Stuck choke valve 3. Dirty, worn or damaged float or needle valve/seat 4. Incorrect float/fuel level 5. Leaking float bowl

Condition	Possible Cause
Engine idles roughly and stalls	1. Incorrect idle speed 2. Clogged fuel filter 3. Dirt in fuel system or carburetor 4. Loose carburetor screws or attaching bolts 5. Broken carburetor gaskets 6. Air leaks 7. Dirty carburetor 8. Worn idle mixture needles 9. Throttle valves stuck open 10. Incorrectly adjusted float or fuel level 11. Clogged air filter
Engine runs unevenly or surges	1. Defective fuel pump 2. Dirty or clogged fuel filter 3. Plugged, loose or incorrect main metering jets or rods 4. Air leaks 5. Bent or sticking main metering rods 6. Stuck power piston 7. Incorrect float adjustment 8. Incorrect idle speed or mixture 9. Dirty or plugged idle system passages 10. Hard, brittle or broken gaskets 11. Loose attaching or mounting screws 12. Stuck or misaligned secondary throttle valves
Poor fuel economy	1. Poor driving habits 2. Stuck choke valve 3. Binding choke linkage 4. Stuck heat riser 5. Incorrect idle mixture 6. Defective accelerator pump 7. Air leaks 8. Plugged, loose or incorrect main metering jets 9. Improperly adjusted float or fuel level 10. Bent, misaligned or fuel-clogged float 11. Leaking float needle seat 12. Fuel leak 13. Accelerator pump discharge ball not seating properly 14. Incorrect main jets
Engine lacks high speed performance or power	1. Incorrect throttle linkage adjustment 2. Stuck or binding power piston 3. Defective accelerator pump 4. Air leaks 5. Incorrect float setting or fuel level 6. Dirty, plugged, worn or incorrect main metering jets or rods 7. Binding or sticking air valve 8. Brittle or cracked gaskets 9. Bent, incorrect or improperly adjusted secondary metering rods 10. Clogged fuel filter 11. Clogged air filter 12. Defective fuel pump

TROUBLESHOOTING FUEL INJECTION PROBLEMS

Each fuel injection system has its own unique components and test procedures, for which it is impossible to generalize. Refer to Chapter 4 of this Repair & Tune-Up Guide for specific test and repair procedures, if the vehicle is equipped with fuel injection.

TROUBLESHOOTING ELECTRICAL PROBLEMS

See Chapter 5 for service procedures

For any electrical system to operate, it must make a complete circuit. This simply means that the power flow from the battery must make a complete circle. When an electrical component is operating, power flows from the battery to the component, passes through the component causing it to perform its function (lighting a light bulb), and then returns to the battery through the ground of the circuit. This ground is usually (but not always) the metal part of the car or truck on which the electrical component is mounted.

Perhaps the easiest way to visualize this is to think of connecting a light bulb with two wires attached to it to the battery. If one of the two wires attached to the light bulb were attached to the negative post of the battery and the other were attached to the positive post of the battery, you would have a complete circuit. Current from the battery would flow to the light bulb, causing it to light, and return to the negative post of the battery.

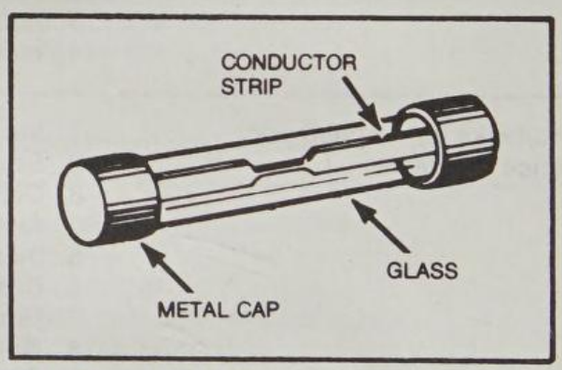
The normal automotive circuit differs from this simple example in two ways. First, instead of having a return wire from the bulb to the battery, the light bulb returns the current to the battery through the chassis of the vehicle. Since the negative battery cable is attached to the chassis and the chassis is made of electrically conductive metal, the chassis of the vehicle can serve as a ground wire to complete the circuit. Secondly, most automotive circuits contain switches to turn components on and off as required.

Every complete circuit from a power source must include a component which is using the power from the power source. If you were to disconnect the light bulb from the wires and touch the two wires together (don't do this) the power supply wire to the component would be grounded before the normal ground connection for the circuit.

Because grounding a wire from a power source makes a complete circuit—less the required component to use the power—this phenomenon is called a short circuit. Common causes are: broken insulation (exposing the metal wire to a metal part of the car or truck), or a shorted switch.

Some electrical components which require a large amount of current to operate also have a relay in their circuit. Since these circuits carry a large amount of current, the thickness of the wire in the circuit (gauge size) is also greater. If this large wire were connected from the component to the control switch on the instrument panel, and then back to the component, a voltage drop would occur in the circuit. To prevent this potential drop in voltage, an electromagnetic switch (relay) is used. The large wires in the circuit are connected from the battery to one side of the relay, and from the opposite side of the relay to the component. The relay is normally open, preventing current from passing through the circuit. An additional, smaller, wire is connected from the relay to the control switch for the circuit. When the control switch is turned on, it grounds the smaller wire from the relay and completes the circuit. This closes the relay and allows current to flow from the battery to the component. The horn, headlight, and starter circuits are three which use relays.

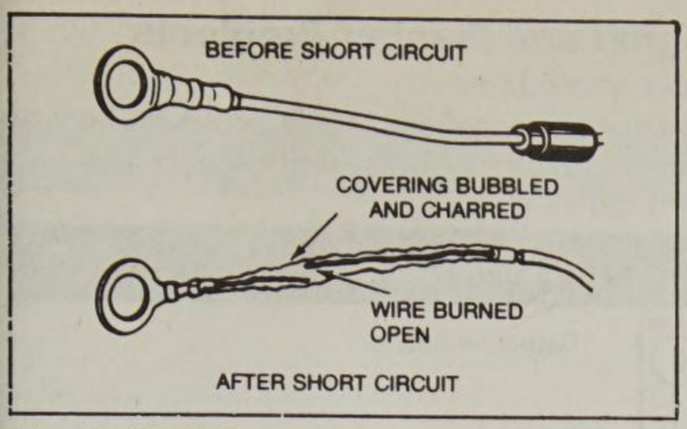
It is possible for larger surges of current to pass through the electrical system of your car or truck. If this surge of current were to reach an electrical component, it could burn it out. To prevent this, fuses, circuit breakers or fusible links are connected into the current supply wires of most of the major electrical systems. When an electrical current of excessive power passes through the component's fuse, the fuse blows out and breaks the circuit, saving the component from destruction.



Typical automotive fuse

A circuit breaker is basically a self-repairing fuse. The circuit breaker opens the circuit the same way a fuse does. However, when either the short is removed from the circuit or the surge subsides, the circuit breaker resets itself and does not have to be replaced as a fuse does.

A fuse link is a wire that acts as a fuse. It is normally connected between the starter relay and the main wiring harness. This connection is usually under the hood. The fuse link (if installed) protects all the



Most fusible links show a charred, melted insulation when they burn out

chassis electrical components, and is the probable cause of trouble when none of the electrical components function, unless the battery is disconnected or dead.

Electrical problems generally fall into one of three areas:

1. The component that is not functioning is not receiving current.
2. The component itself is not functioning.
3. The component is not properly grounded.

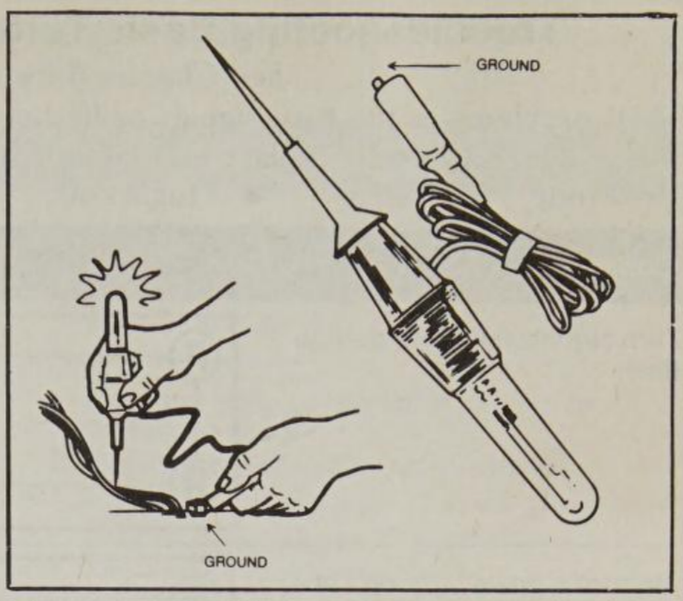
The electrical system can be checked with a test light and a jumper wire. A test light is a device that looks like a pointed screwdriver with a wire attached to it and has a light bulb in its handle. A jumper wire is a piece of insulated wire with an alligator clip attached to each end.

If a component is not working, you must follow a systematic plan to determine which of the three causes is the villain.

1. Turn on the switch that controls the inoperable component.
2. Disconnect the power supply wire from the component.
3. Attach the ground wire on the test light to a good metal ground.
4. Touch the probe end of the test light to the end of the power supply wire that was disconnected from the component. If the component is receiving current, the test light will go on.

NOTE: ***Some components work only when the ignition switch is turned on.***

If the test light does not go on, then the problem is in the circuit between the battery and the component. This includes all the switches, fuses, and relays in the system. Follow the wire that runs back to the battery. The problem is an open circuit between the



The test light will show the presence of current when touched to a hot wire and grounded at the other end

battery and the component. If the fuse is blown and, when replaced, immediately blows again, there is a short circuit in the system which must be located and repaired. If there is a switch in the system, bypass it with a jumper wire. This is done by connecting one end of the jumper wire to the power supply wire into the switch and the other end of the jumper wire to the wire coming out of the switch. If the test light lights with the jumper wire installed, the switch or whatever was bypassed is defective.

NOTE: ***Never substitute the jumper wire for the component, since it is required to use the power from the power source.***

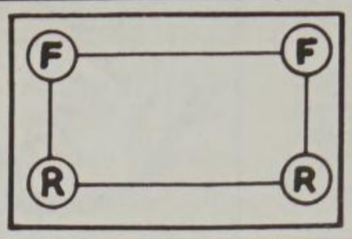
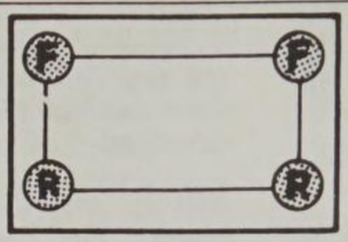
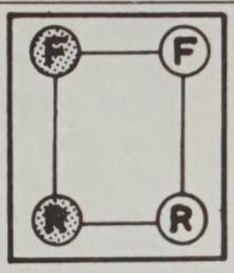
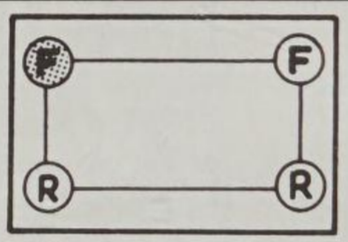
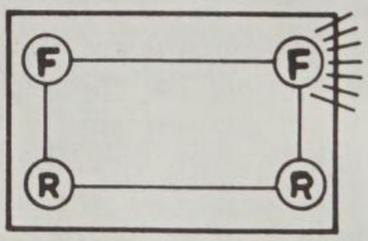
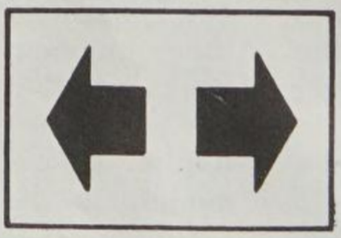
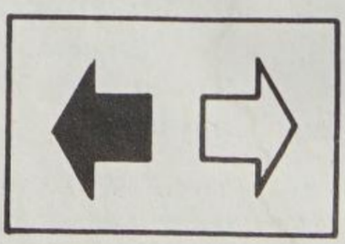
5. If the bulb in the test light goes on, then the current is getting to the component that is not working. This eliminates the first of the three possible causes. Connect the power supply wire and connect a jumper wire from the component to a good metal ground. Do this with the switch which controls the component turned on, and also the ignition switch turned on if it is required for the component to work. If the component works with the jumper wire installed, then it has a bad ground. This is usually caused by the metal area on which the component mounts to the chassis being coated with some type of foreign matter.
6. If neither test located the source of the trouble, then the component itself is defective. Remember that for any electrical system to work, all connections must be clean and tight.

Troubleshooting Basic Turn Signal and Flasher Problems

See Chapter 5 for service procedures

Most problems in the turn signals or flasher system can be reduced to defective flashers or bulbs, which are easily replaced. Occasionally, the turn signal switch will prove defective.

F = Front R = Rear ● = Lights off ○ = Lights on

Condition		Possible Cause
Turn signals light, but do not flash		Defective flasher
No turn signals light on either side		Blown fuse. Replace if defective. Defective flasher. Check by substitution. Open circuit, short circuit or poor ground.
Both turn signals on one side don't work		Bad bulbs. Bad ground in both (or either) housings.
One turn signal light on one side doesn't work		Defective bulb. Corrosion in socket. Clean contacts. Poor ground at socket.
Turn signal flashes too fast or too slowly		Check any bulb on the side flashing too fast. A heavy-duty bulb is probably installed in place of a regular bulb. Check the bulb flashing too slowly. A standard bulb was probably installed in place of a heavy-duty bulb. Loose connections or corrosion at the bulb socket.
Indicator lights don't work in either direction		Check if the turn signals are working. Check the dash indicator lights. Check the flasher by substitution.
One indicator light doesn't light		On systems with one dash indicator: See if the lights work on the same side. Often the filaments have been reversed in systems combining stoplights with taillights and turn signals. Check the flasher by substitution. On systems with two indicators: Check the bulbs on the same side. Check the indicator light bulb. Check the flasher by substitution.

Troubleshooting Lighting Problems

See Chapter 5 for service procedures

Condition	Possible Cause
One or more lights don't work, but others do	1. Defective bulb(s) 2. Blown fuse(s) 3. Dirty fuse clips or light sockets 4. Poor ground circuit
Lights burn out quickly	1. Incorrect voltage regulator setting or defective regulator 2. Poor battery/alternator connections
Lights go dim	1. Low/discharged battery 2. Alternator not charging 3. Corroded sockets or connections 4. Low voltage output
Lights flicker	1. Loose connection 2. Poor ground. (Run ground wire from light housing to frame) 3. Circuit breaker operating (short circuit)
Lights "flare"—Some flare is normal on acceleration—If excessive, see "Lights Burn Out Quickly"	High voltage setting
Lights glare—approaching drivers are blinded	1. Lights adjusted too high 2. Rear springs or shocks sagging 3. Rear tires soft

Troubleshooting Dash Gauge Problems

Most problems can be traced to a defective sending unit or faulty wiring. Occasionally, the gauge itself is at fault. See Chapter 5 for service procedures.

Condition	Possible Cause
COOLANT TEMPERATURE GAUGE	
Gauge reads erratically or not at all	1. Loose or dirty connections 2. Defective sending unit. 3. Defective gauge. To test a bi-metal gauge, remove the wire from the sending unit. Ground the wire for an instant. If the gauge registers, replace the sending unit. To test a magnetic gauge, disconnect the wire at the sending unit. With ignition ON gauge should register COLD. Ground the wire; gauge should register HOT.
AMMETER GAUGE—TURN HEADLIGHTS ON (DO NOT START ENGINE). NOTE REACTION	
Ammeter shows charge Ammeter shows discharge Ammeter does not move	1. Connections reversed on gauge 2. Ammeter is OK 3. Loose connections or faulty wiring 4. Defective gauge

Condition	Possible Cause
OIL PRESSURE GAUGE	
Gauge does not register or is inaccurate	1. On mechanical gauge, Bourdon tube may be bent or kinked. 2. Low oil pressure. Remove sending unit. Idle the engine briefly. If no oil flows from sending unit hole, problem is in engine. 3. Defective gauge. Remove the wire from the sending unit and ground it for an instant with the ignition ON. A good gauge will go to the top of the scale. 4. Defective wiring. Check the wiring to the gauge. If it's OK and the gauge doesn't register when grounded, replace the gauge. 5. Defective sending unit.
ALL GAUGES	
All gauges do not operate	1. Blown fuse 2. Defective instrument regulator
All gauges read low or erratically All gauges pegged	3. Defective or dirty instrument voltage regulator 4. Loss of ground between instrument voltage regulator and frame 5. Defective instrument regulator
WARNING LIGHTS	
Light(s) do not come on when ignition is ON, but engine is not started	1. Defective bulb 2. Defective wire 3. Defective sending unit. Disconnect the wire from the sending unit and ground it. Replace the sending unit if the light comes on with the ignition ON.
Light comes on with engine running	4. Problem in individual system 5. Defective sending unit

Troubleshooting Clutch Problems

It is false economy to replace individual clutch components. The pressure plate, clutch plate and throwout bearing should be replaced as a set, and the flywheel face inspected, whenever the clutch is overhauled. See Chapter 6 for service procedures.

Condition	Possible Cause
Clutch chatter	1. Grease on driven plate (disc) facing 2. Binding clutch linkage or cable 3. Loose, damaged facings on driven plate (disc) 4. Engine mounts loose 5. Incorrect height adjustment of pressure plate release levers 6. Clutch housing or housing to transmission adapter misalignment 7. Loose driven plate hub
Clutch grabbing	1. Oil, grease on driven plate (disc) facing 2. Broken pressure plate 3. Warped or binding driven plate. Driven plate binding on clutch shaft
Clutch slips	1. Lack of lubrication in clutch linkage or cable (linkage or cable binds, causes incomplete engagement) 2. Incorrect pedal, or linkage adjustment 3. Broken pressure plate springs 4. Weak pressure plate springs 5. Grease on driven plate facings (disc)

Troubleshooting Clutch Problems (cont.)

Condition	Possible Cause
Incomplete clutch release	1. Incorrect pedal or linkage adjustment or linkage or cable binding 2. Incorrect height adjustment on pressure plate release levers 3. Loose, broken facings on driven plate (disc) 4. Bent, dished, warped driven plate caused by overheating
Grinding, whirring grating noise when pedal is depressed	1. Worn or defective throwout bearing 2. Starter drive teeth contacting flywheel ring gear teeth. Look for milled or polished teeth on ring gear.
Squeal, howl, trumpeting noise when pedal is being released (occurs during first inch to inch and one-half of pedal travel)	Pilot bushing worn or lack of lubricant. If bushing appears OK, polish bushing with emery cloth, soak lube wick in oil, lube bushing with oil, apply film of chassis grease to clutch shaft pilot hub, reassemble. NOTE: Bushing wear may be due to misalignment of clutch housing or housing to transmission adapter
Vibration or clutch pedal pulsation with clutch disengaged (pedal fully depressed)	1. Worn or defective engine transmission mounts 2. Flywheel run out. (Flywheel run out at face not to exceed 0.005") 3. Damaged or defective clutch components

Troubleshooting Manual Transmission Problems

See Chapter 6 for service procedures

Condition	Possible Cause
Transmission jumps out of gear	1. Misalignment of transmission case or clutch housing. 2. Worn pilot bearing in crankshaft. 3. Bent transmission shaft. 4. Worn high speed sliding gear. 5. Worn teeth or end-play in clutch shaft. 6. Insufficient spring tension on shifter rail plunger. 7. Bent or loose shifter fork. 8. Gears not engaging completely. 9. Loose or worn bearings on clutch shaft or mainshaft. 10. Worn gear teeth. 11. Worn or damaged detent balls.
Transmission sticks in gear	1. Clutch not releasing fully. 2. Burred or battered teeth on clutch shaft, or sliding sleeve. 3. Burred or battered transmission mainshaft. 4. Frozen synchronizing clutch. 5. Stuck shifter rail plunger. 6. Gearshift lever twisting and binding shifter rail. 7. Battered teeth on high speed sliding gear or on sleeve. 8. Improper lubrication, or lack of lubrication. 9. Corroded transmission parts. 10. Defective mainshaft pilot bearing. 11. Locked gear bearings will give same effect as stuck in gear.
Transmission gears will not synchronize	1. Binding pilot bearing on mainshaft, will synchronize in high gear only. 2. Clutch not releasing fully. 3. Detent spring weak or broken. 4. Weak or broken springs under balls in sliding gear sleeve. 5. Binding bearing on clutch shaft, or binding countershaft. 6. Binding pilot bearing in crankshaft. 7. Badly worn gear teeth. 8. Improper lubrication. 9. Constant mesh gear not turning freely on transmission mainshaft. Will synchronize in that gear only.

Condition	Possible Cause
Gears spinning when shifting into gear from neutral	1. Clutch not releasing fully. 2. In some cases an extremely light lubricant in transmission will cause gears to continue to spin for a short time after clutch is released. 3. Binding pilot bearing in crankshaft.
Transmission noisy in all gears	1. Insufficient lubricant, or improper lubricant. 2. Worn countergear bearings. 3. Worn or damaged main drive gear or countergear. 4. Damaged main drive gear or mainshaft bearings. 5. Worn or damaged countergear anti-lash plate.
Transmission noisy in neutral only	1. Damaged main drive gear bearing. 2. Damaged or loose mainshaft pilot bearing. 3. Worn or damaged countergear anti-lash plate. 4. Worn countergear bearings.
Transmission noisy in one gear only	1. Damaged or worn constant mesh gears. 2. Worn or damaged countergear bearings. 3. Damaged or worn synchronizer.
Transmission noisy in reverse only	1. Worn or damaged reverse idler gear or idler bushing. 2. Worn or damaged mainshaft reverse gear. 3. Worn or damaged reverse countergear. 4. Damaged shift mechanism.

TROUBLESHOOTING AUTOMATIC TRANSMISSION PROBLEMS

Keeping alert to changes in the operating characteristics of the transmission (changing shift points, noises, etc.) can prevent small problems from becoming large ones. If the problem cannot be traced to loose bolts, fluid level, misadjusted linkage, clogged filters or similar problems, you should probably seek professional service.

Transmission Fluid Indications

The appearance and odor of the transmission fluid can give valuable clues to the overall condition of the transmission. Always note the appearance of the fluid when you check the fluid level or change the fluid. Rub a small amount of fluid between your fingers to feel for grit and smell the fluid on the dipstick.

If the fluid appears:	It indicates:
Clear and red colored	Normal operation
Discolored (extremely dark red or brownish) or smells burned	Band or clutch pack failure, usually caused by an overheated transmission. Hauling very heavy loads with insufficient power or failure to change the fluid often result in overheating. Do not confuse this appearance with newer fluids that have a darker red color and a strong odor (though not a burned odor).
Foamy or aerated (light in color and full of bubbles)	1. The level is too high (gear train is churning oil) 2. An internal air leak (air is mixing with the fluid). Have the transmission checked professionally.
Solid residue in the fluid	Defective bands, clutch pack or bearings. Bits of band material or metal abrasives are clinging to the dipstick. Have the transmission checked professionally.
Varnish coating on the dipstick	The transmission fluid is overheating

TROUBLESHOOTING DRIVE AXLE PROBLEMS

First, determine when the noise is most noticeable.

Drive Noise: Produced under vehicle acceleration.

Coast Noise: Produced while coasting with a closed throttle.

Float Noise: Occurs while maintaining constant speed (just enough to keep speed constant) on a level road.

External Noise Elimination

It is advisable to make a thorough road test to determine whether the noise originates in the rear axle or whether it originates from the tires, engine, transmission, wheel bearings or road surface. Noise originating from other places cannot be corrected by servicing the rear axle.

ROAD NOISE

Brick or rough surfaced concrete roads produce noises that seem to come from the rear axle. Road noise is usually identical in Drive or Coast and driving on a different type of road will tell whether the road is the problem.

TIRE NOISE

Tire noise can be mistaken as rear axle noise, even though the tires on the front are at fault. Snow tread and mud tread tires or tires worn unevenly will frequently cause vibrations which seem to originate elsewhere; *temporarily, and for test purposes only,* inflate the tires to 40–50 lbs. This will significantly alter the noise produced by the tires, but will not alter noise from the rear axle. Noises from the rear axle will normally cease at speeds below 30 mph on coast, while tire noise will continue at lower tone as speed is decreased. The rear axle noise will usually change from drive conditions to coast conditions, while tire noise will not. Do not forget to lower the tire pressure to normal after the test is complete.

ENGINE/TRANSMISSION NOISE

Determine at what speed the noise is most pronounced, then stop in a quiet place. With the transmission in Neutral, run the engine through speeds corresponding to road speeds where the noise was noticed. Noises produced with the vehicle standing still are coming from the engine or transmission.

FRONT WHEEL BEARINGS

Front wheel bearing noises, sometimes confused with rear axle noises, will not change when comparing drive and coast conditions. While holding the speed steady, lightly apply the footbrake. This will often cause wheel bearing noise to lessen, as some of the weight is taken off the bearing. Front wheel bearings are easily checked by jacking up the wheels and spinning the wheels. Shaking the wheels will also determine if the wheel bearings are excessively loose.

REAR AXLE NOISES

Eliminating other possible sources can narrow the cause to the rear axle, which normally produces noise from worn gears or bearings. Gear noises tend to peak in a narrow speed range, while bearing noises will usually vary in pitch with engine speeds.

Noise Diagnosis

The Noise Is:	*Most Probably Produced By:*
1. Identical under Drive or Coast	Road surface, tires or front wheel bearings
2. Different depending on road surface	Road surface or tires
3. Lower as speed is lowered	Tires
4. Similar when standing or moving	Engine or transmission
5. A vibration	Unbalanced tires, rear wheel bearing, unbalanced driveshaft or worn U-joint
6. A knock or click about every two tire revolutions	Rear wheel bearing
7. Most pronounced on turns	Damaged differential gears
8. A steady low-pitched whirring or scraping, starting at low speeds	Damaged or worn pinion bearing
9. A chattering vibration on turns	Wrong differential lubricant or worn clutch plates (limited slip rear axle)
10. Noticed only in Drive, Coast or Float conditions	Worn ring gear and/or pinion gear

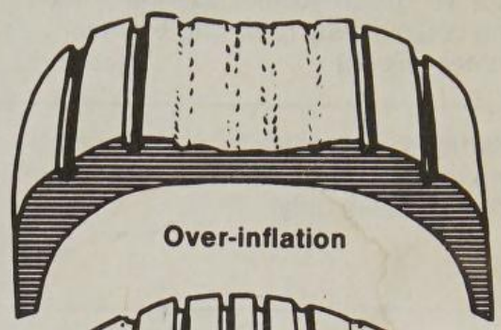
Troubleshooting Steering & Suspension Problems

Condition	Possible Cause
Hard steering (wheel is hard to turn)	1. Improper tire pressure 2. Loose or glazed pump drive belt 3. Low or incorrect fluid 4. Loose, bent or poorly lubricated front end parts 5. Improper front end alignment (excessive caster) 6. Bind in steering column or linkage 7. Kinked hydraulic hose 8. Air in hydraulic system 9. Low pump output or leaks in system 10. Obstruction in lines 11. Pump valves sticking or out of adjustment 12. Incorrect wheel alignment
Loose steering (too much play in steering wheel)	1. Loose wheel bearings 2. Faulty shocks 3. Worn linkage or suspension components 4. Loose steering gear mounting or linkage points 5. Steering mechanism worn or improperly adjusted 6. Valve spool improperly adjusted 7. Worn ball joints, tie-rod ends, etc.
Veers or wanders (pulls to one side with hands off steering wheel)	1. Improper tire pressure 2. Improper front end alignment 3. Dragging or improperly adjusted brakes 4. Bent frame 5. Improper rear end alignment 6. Faulty shocks or springs 7. Loose or bent front end components 8. Play in Pitman arm 9. Steering gear mountings loose 10. Loose wheel bearings 11. Binding Pitman arm 12. Spool valve sticking or improperly adjusted 13. Worn ball joints
Wheel oscillation or vibration transmitted through steering wheel	1. Low or uneven tire pressure 2. Loose wheel bearings 3. Improper front end alignment 4. Bent spindle 5. Worn, bent or broken front end components 6. Tires out of round or out of balance 7. Excessive lateral runout in disc brake rotor 8. Loose or bent shock absorber or strut
Noises (see also "Troubleshooting Drive Axle Problems")	1. Loose belts 2. Low fluid, air in system 3. Foreign matter in system 4. Improper lubrication 5. Interference or chafing in linkage 6. Steering gear mountings loose 7. Incorrect adjustment or wear in gear box 8. Faulty valves or wear in pump 9. Kinked hydraulic lines 10. Worn wheel bearings
Poor return of steering	1. Over-inflated tires 2. Improperly aligned front end (excessive caster) 3. Binding in steering column 4. No lubrication in front end 5. Steering gear adjusted too tight
Uneven tire wear (see "How To Read Tire Wear")	1. Incorrect tire pressure 2. Improperly aligned front end 3. Tires out-of-balance 4. Bent or worn suspension parts

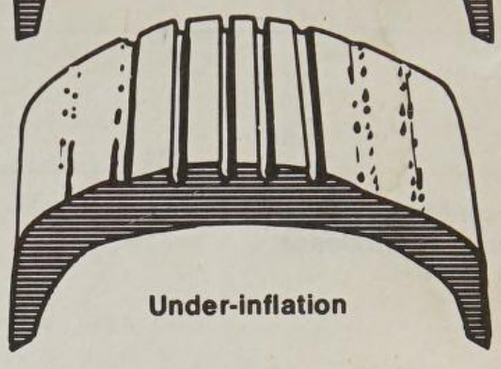
HOW TO READ TIRE WEAR

The way your tires wear is a good indicator of other parts of the suspension. Abnormal wear patterns are often caused by the need for simple tire maintenance, or for front end alignment.

Excessive wear at the center of the tread indicates that the air pressure in the tire is consistently too high. The tire is riding on the center of the tread and wearing it prematurely. Occasionally, this wear pattern can result from outrageously wide tires on narrow rims. The cure for this is to replace either the tires or the wheels.


Over-inflation

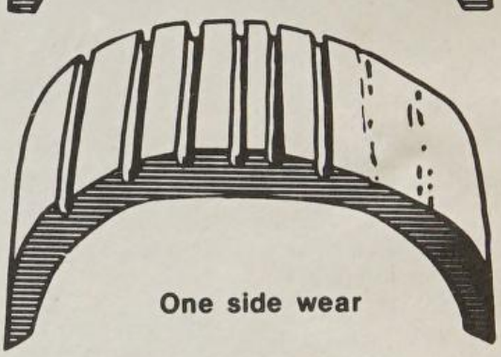
This type of wear usually results from consistent under-inflation. When a tire is under-inflated, there is too much contact with the road by the outer treads, which wear prematurely. When this type of wear occurs, and the tire pressure is known to be consistently correct, a bent or worn steering component or the need for wheel alignment could be indicated.


Under-inflation

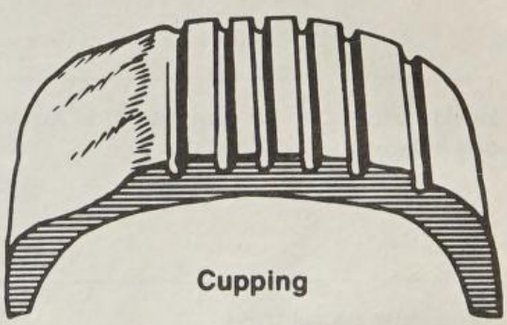
Feathering is a condition when the edge of each tread rib develops a slightly rounded edge on one side and a sharp edge on the other. By running your hand over the tire, you can usually feel the sharper edges before you'll be able to see them. The most common causes of feathering are incorrect toe-in setting or deteriorated bushings in the front suspension.


Feathering

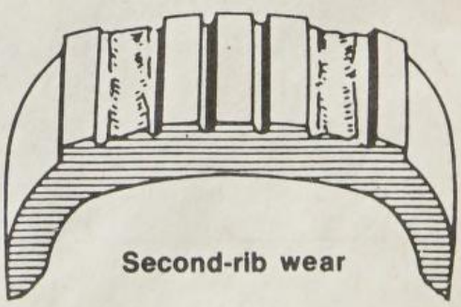
When an inner or outer rib wears faster than the rest of the tire, the need for wheel alignment is indicated. There is excessive camber in the front suspension, causing the wheel to lean too much putting excessive load on one side of the tire. Misalignment could also be due to sagging springs, worn ball joints, or worn control arm bushings. Be sure the vehicle is loaded the way it's normally driven when you have the wheels aligned.


One side wear

Cups or scalloped dips appearing around the edge of the tread almost always indicate worn (sometimes bent) suspension parts. Adjustment of wheel alignment alone will seldom cure the problem. Any worn component that connects the wheel to the suspension can cause this type of wear. Occasionally, wheels that are out of balance will wear like this, but wheel imbalance usually shows up as bald spots between the outside edges and center of the tread.


Cupping

Second-rib wear is usually found only in radial tires, and appears where the steel belts end in relation to the tread. It can be kept to a minimum by paying careful attention to tire pressure and frequently rotating the tires. This is often considered normal wear but excessive amounts indicate that the tires are too wide for the wheels.


Second-rib wear

Troubleshooting Disc Brake Problems

Condition	Possible Cause
Noise—groan—brake noise emanating when slowly releasing brakes (creep-groan)	Not detrimental to function of disc brakes—no corrective action required. (This noise may be eliminated by slightly increasing or decreasing brake pedal efforts.)
Rattle—brake noise or rattle emanating at low speeds on rough roads, (front wheels only).	1. Shoe anti-rattle spring missing or not properly positioned. 2. Excessive clearance between shoe and caliper. 3. Soft or broken caliper seals. 4. Deformed or misaligned disc. 5. Loose caliper.
Scraping	1. Mounting bolts too long. 2. Loose wheel bearings. 3. Bent, loose, or misaligned splash shield.
Front brakes heat up during driving and fail to release	1. Operator riding brake pedal. 2. Stop light switch improperly adjusted. 3. Sticking pedal linkage. 4. Frozen or seized piston. 5. Residual pressure valve in master cylinder. 6. Power brake malfunction. 7. Proportioning valve malfunction.
Leaky brake caliper	1. Damaged or worn caliper piston seal. 2. Scores or corrosion on surface of cylinder bore.
Grabbing or uneven brake action—Brakes pull to one side	1. Causes listed under "Brakes Pull". 2. Power brake malfunction. 3. Low fluid level in master cylinder. 4. Air in hydraulic system. 5. Brake fluid, oil or grease on linings. 6. Unmatched linings. 7. Distorted brake pads. 8. Frozen or seized pistons. 9. Incorrect tire pressure. 10. Front end out of alignment. 11. Broken rear spring. 12. Brake caliper pistons sticking. 13. Restricted hose or line. 14. Caliper not in proper alignment to braking disc. 15. Stuck or malfunctioning metering valve. 16. Soft or broken caliper seals. 17. Loose caliper.
Brake pedal can be depressed without braking effect	1. Air in hydraulic system or improper bleeding procedure. 2. Leak past primary cup in master cylinder. 3. Leak in system. 4. Rear brakes out of adjustment. 5. Bleeder screw open.
Excessive pedal travel	1. Air, leak, or insufficient fluid in system or caliper. 2. Warped or excessively tapered shoe and lining assembly. 3. Excessive disc runout. 4. Rear brake adjustment required. 5. Loose wheel bearing adjustment. 6. Damaged caliper piston seal. 7. Improper brake fluid (boil). 8. Power brake malfunction. 9. Weak or soft hoses.

Troubleshooting Disc Brake Problems (cont.)

Condition	Possible Cause
Brake roughness or chatter (pedal pumping)	1. Excessive thickness variation of braking disc. 2. Excessive lateral runout of braking disc. 3. Rear brake drums out-of-round. 4. Excessive front bearing clearance.
Excessive pedal effort	1. Brake fluid, oil or grease on linings. 2. Incorrect lining. 3. Frozen or seized pistons. 4. Power brake malfunction. 5. Kinked or collapsed hose or line. 6. Stuck metering valve. 7. Scored caliper or master cylinder bore. 8. Seized caliper pistons.
Brake pedal fades (pedal travel increases with foot on brake)	1. Rough master cylinder or caliper bore. 2. Loose or broken hydraulic lines/connections. 3. Air in hydraulic system. 4. Fluid level low. 5. Weak or soft hoses. 6. Inferior quality brake shoes or fluid. 7. Worn master cylinder piston cups or seals.

Troubleshooting Drum Brakes

Condition	Possible Cause
Pedal goes to floor	1. Fluid low in reservoir. 2. Air in hydraulic system. 3. Improperly adjusted brake. 4. Leaking wheel cylinders. 5. Loose or broken brake lines. 6. Leaking or worn master cylinder. 7. Excessively worn brake lining.
Spongy brake pedal	1. Air in hydraulic system. 2. Improper brake fluid (low boiling point). 3. Excessively worn or cracked brake drums. 4. Broken pedal pivot bushing.
Brakes pulling	1. Contaminated lining. 2. Front end out of alignment. 3. Incorrect brake adjustment. 4. Unmatched brake lining. 5. Brake drums out of round. 6. Brake shoes distorted. 7. Restricted brake hose or line. 8. Broken rear spring. 9. Worn brake linings. 10. Uneven lining wear. 11. Glazed brake lining. 12. Excessive brake lining dust. 13. Heat spotted brake drums. 14. Weak brake return springs. 15. Faulty automatic adjusters. 16. Low or incorrect tire pressure.

Condition	Possible Cause
Squealing brakes	1. Glazed brake lining. 2. Saturated brake lining. 3. Weak or broken brake shoe retaining spring. 4. Broken or weak brake shoe return spring. 5. Incorrect brake lining. 6. Distorted brake shoes. 7. Bent support plate. 8. Dust in brakes or scored brake drums. 9. Linings worn below limit. 10. Uneven brake lining wear. 11. Heat spotted brake drums.
Chirping brakes	1. Out of round drum or eccentric axle flange pilot.
Dragging brakes	1. Incorrect wheel or parking brake adjustment. 2. Parking brakes engaged or improperly adjusted. 3. Weak or broken brake shoe return spring. 4. Brake pedal binding. 5. Master cylinder cup sticking. 6. Obstructed master cylinder relief port. 7. Saturated brake lining. 8. Bent or out of round brake drum. 9. Contaminated or improper brake fluid. 10. Sticking wheel cylinder pistons. 11. Driver riding brake pedal. 12. Defective proportioning valve. 13. Insufficient brake shoe lubricant.
Hard pedal	1. Brake booster inoperative. 2. Incorrect brake lining. 3. Restricted brake line or hose. 4. Frozen brake pedal linkage. 5. Stuck wheel cylinder. 6. Binding pedal linkage. 7. Faulty proportioning valve.
Wheel locks	1. Contaminated brake lining. 2. Loose or torn brake lining. 3. Wheel cylinder cups sticking. 4. Incorrect wheel bearing adjustment. 5. Faulty proportioning valve.
Brakes fade (high speed)	1. Incorrect lining. 2. Overheated brake drums. 3. Incorrect brake fluid (low boiling temperature). 4. Saturated brake lining. 5. Leak in hydraulic system. 6. Faulty automatic adjusters.
Pedal pulsates	1. Bent or out of round brake drum.
Brake chatter and shoe knock	1. Out of round brake drum. 2. Loose support plate. 3. Bent support plate. 4. Distorted brake shoes. 5. Machine grooves in contact face of brake drum (Shoe Knock). 6. Contaminated brake lining. 7. Missing or loose components. 8. Incorrect lining material. 9. Out-of-round brake drums. 10. Heat spotted or scored brake drums. 11. Out-of-balance wheels.

Troubleshooting Drum Brakes (cont.)

Condition	Possible Cause
Brakes do not self adjust	1. Adjuster screw frozen in thread. 2. Adjuster screw corroded at thrust washer. 3. Adjuster lever does not engage star wheel. 4. Adjuster installed on wrong wheel.
Brake light glows	1. Leak in the hydraulic system. 2. Air in the system. 3. Improperly adjusted master cylinder pushrod. 4. Uneven lining wear. 5. Failure to center combination valve or proportioning valve.

Mechanic's Data

General Conversion Table

Multiply By	To Convert	To	
	LENGTH		
2.54	Inches	Centimeters	.3937
25.4	Inches	Millimeters	.03937
30.48	Feet	Centimeters	.0328
.304	Feet	Meters	3.28
.914	Yards	Meters	1.094
1.609	Miles	Kilometers	.621
	VOLUME		
.473	Pints	Liters	2.11
.946	Quarts	Liters	1.06
3.785	Gallons	Liters	.264
.016	Cubic inches	Liters	61.02
16.39	Cubic inches	Cubic cms.	.061
28.3	Cubic feet	Liters	.0353
	MASS (Weight)		
28.35	Ounces	Grams	.035
.4536	Pounds	Kilograms	2.20
—	To obtain	From	Multiply by

Multiply By	To Convert	To	
	AREA		
.645	Square inches	Square cms.	.155
.836	Square yds.	Square meters	1.196
	FORCE		
4.448	Pounds	Newtons	.225
.138	Ft./lbs.	Kilogram/meters	7.23
1.36	Ft./lbs.	Newton-meters	.737
.112	In./lbs.	Newton-meters	8.844
	PRESSURE		
.068	Psi	Atmospheres	14.7
6.89	Psi	Kilopascals	.145
	OTHER		
1.104	Horsepower (DIN)	Horsepower (SAE)	.9861
.746	Horsepower (SAE)	Kilowatts (KW)	1.34
1.60	Mph	Km/h	.625
.425	Mpg	Km/1	2.35
—	To obtain	From	Multiply by

Tap Drill Sizes

National Coarse or U.S.S.

Screw & Tap Size	Threads Per Inch	Use Drill Number
No. 5	40	39
No. 6	32	36
No. 8	32	29
No. 10	24	25
No. 12	24	17
1/4	20	8
5/16	18	F
3/8	16	5/16
7/16	14	U
1/2	13	27/64
9/16	12	31/64
5/8	11	17/32
3/4	10	21/32
7/8	9	49/64

National Coarse or U.S.S.

Screw & Tap Size	Threads Per Inch	Use Drill Number
1	8	7/8
1 1/8	7	63/64
1 1/4	7	1 7/64
1 1/2	6	1 11/32

National Fine or S.A.E.

Screw & Tap Size	Threads Per Inch	Use Drill Number
No. 5	44	37
No. 6	40	33
No. 8	36	29
No. 10	32	21

National Fine or S.A.E.

Screw & Tap Size	Threads Per Inch	Use Drill Number
No. 12	28	15
1/4	28	3
6/16	24	1
3/8	24	Q
7/16	20	W
1/2	20	29/64
9/16	18	33/64
5/8	18	37/64
3/4	16	11/16
7/8	14	13/16
1 1/8	12	1 3/64
1 1/4	12	1 11/64
1 1/2	12	1 27/64

Index

U

V

W