CHILTON BOOK COMPANY
REPAIR MANUAL
PART NO. 7345

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FIREBIRD 1982 to 1990

Covers all models of Pontiac Firebird and Trans Am

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CHILTON BOOK COMPANY
Radnor, Pennsylvania
19089

CONTENTS

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 widley. 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 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 completly satisfied that neither your personal safety, nor the performance of the the vehicle will be endangered.

Although the 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 Service Tool Division, Kent-Moore Corporation, 29784 Little Mac, Roseville, MI 48066-2298, 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

Chilton Book Company expresses appreciation to General Motors Corporation for their generous assistance.

Published in Radnor, Pennsylvania 19089, by Chilton Book Company

Manufactured in the United States of America
1234567890 9876543210

Chilton's Repair Manual: Pontiac Firebird 1982–90
ISBN 0-8019-8060-7 pbk.
Library of Congress Catalog Card No. ~~90-055427~~
88-055427

General Information and Maintenance

1

HOW TO USE THIS BOOK

Chilton's Repair Manual for the 1982–90 Firebird is intended to help you learn more about the inner workings of your automobile and save you money on its upkeep. Chapters 1 and 2 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 2 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.

In general, there are 3 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 Pontiac dealer or from an automotive parts store.

Always be conscious of the need for safety 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.

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 and 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-toothed 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. Oil3 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, an 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. park plug gauge and gapping tool;
3. Feeler gauges for valve adjustment;
4. Timing light.

A tachometer/dwell meter will ensure accurate tune-up work. 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 all 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. This is an extremely helpful tool for electrical troubleshooting.

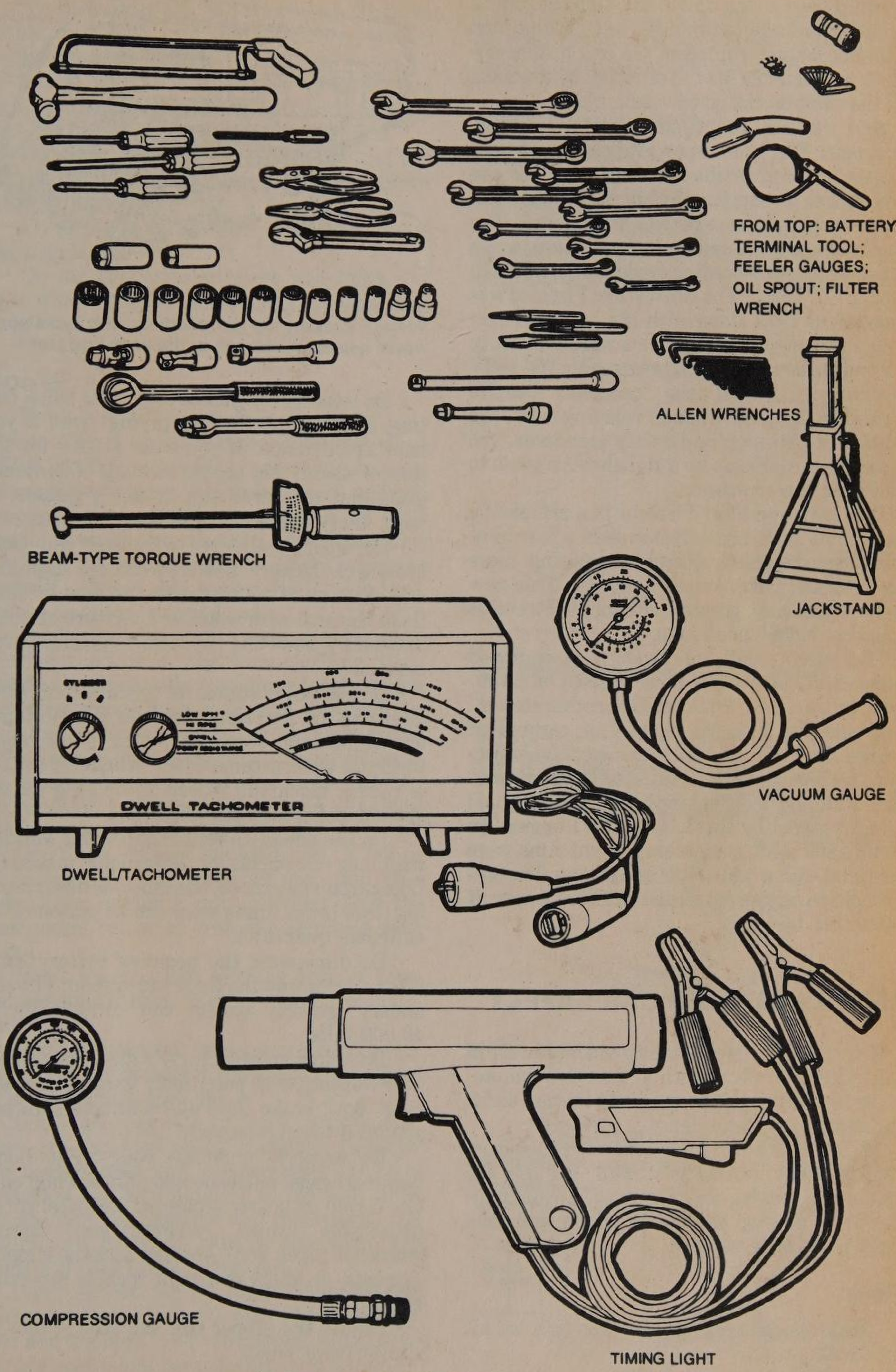
Finally, you will find a torque wrench necessary for all but the most basic of work. The beam-type models are perfectly adequate. The click-type (breakaway) torque wrenches are more accurate, but are also much more expensive and must be periodically recalibrated.

NOTE: *Special tools are occasionally necessary to perform a specific job or are recommended to make a job easier. Their use has been kept to a minimum. When a special tool is indicated, it will be referred to by manufacturer's part number, and, where possible, an illustration of the tool may be used. A list of tool manufacturers and their addresses follows:*

Service Tool Division Kent-Moore Corporation 1501 South Jackson St. Jackson, MI. 439203

HISTORY

After the introduction of the Ford Mustang and its immediate rise to popularity, Pontiac was quick to introduce its own "pony" or personal sports car, the Firebird was General Motors' entry into a burgeoning market. Customers could literally order blank "build" their



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

Firebird from a long option list. Choices ranged from 3-speed economy models to 400 cubic inch Ram Air, 4-speed supercars, GT and luxury outfits were available for the ordering by checking off the right blocks on the order blank.

1967 through 1969 were years of detail refinement. Firebirds were available as 2-door coupes and convertibles. A long wait for the new model proved worthwhile when, in 1970, the redesigned Firebird was introduced. The new body shell, shared with the Camaro, was a departure from preceding models and had a European GT flavor. The convertible Firebird was dropped in 1970 along with the overhead cam 6-cylinder engine. Body styles were limited to the 2-door coupe, while the conventional OHV 6-cylinder replaced the cammer. Despite rumors of its demise due to receding sales, the burden of emission and safety standards, the Firebird continues to be a stylish alternative to mundane transportation.

The 1982 and later Firebird 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 Firebirds appeal to buyers of all ages.

The early (1982–85) Firebird is equipped with a 2.5L L4 throttle body injected or carbureted engine, 2.8L V6 injected or carbureted engine and the 5.0L V8 injected or carbureted engine. The 5.7L V8 MFI (multi-port fuel injection) became an option in the 1987 model year. The 2.5L and 2.8L engines have discontinued being replaced by the 3.1L V6 MFI engine. In 1989, 1500 20th anniversary Trans Ams were produced with a 3.8L V6 Turbo engine. The special edition engine developed 245 horsepower at 340 ft. lbs. torque.

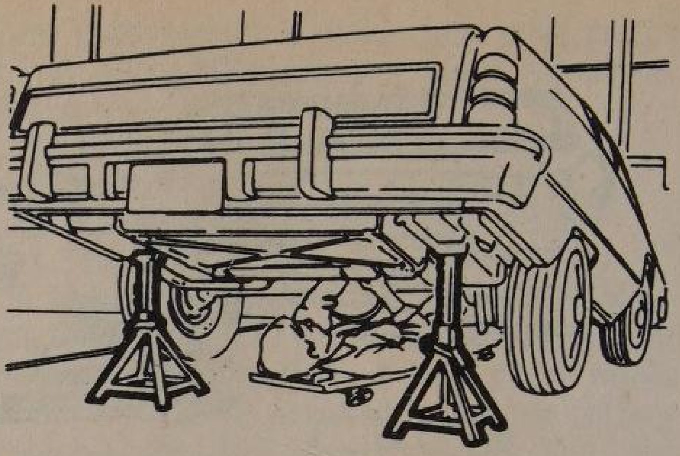
SERVICING YOUR CAR SAFELY

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.

Do's

• Do keep a fire extinguisher and first aid kit within easy reach.



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

• 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.

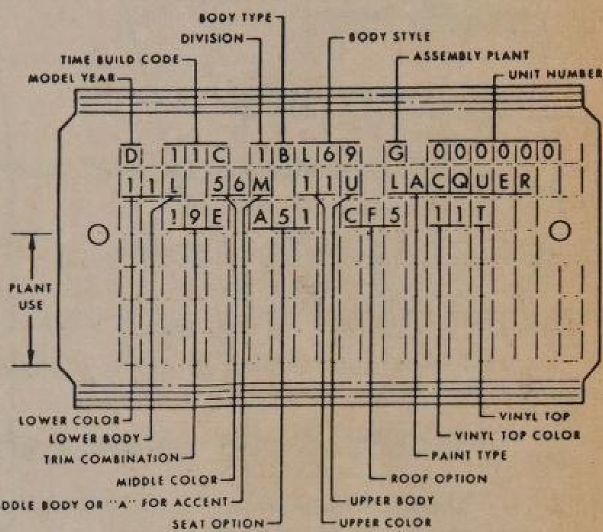
• Don't use gasoline to wash your hands; there are excellent soaps available. Gasoline may contain lead, and lead can enter the body through a cut, accumulating in the body until you are very ill. Gasoline also removes all the natural oils from the skin so that bone dry hands will suck up oil and grease.

• 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.

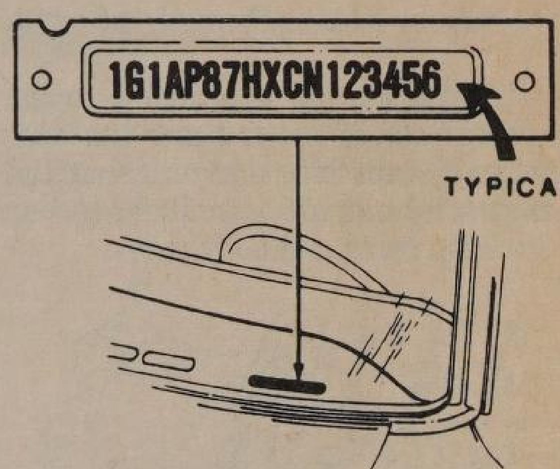
SERIAL NUMBER IDENTIFICATION

Vehicle Serial Number

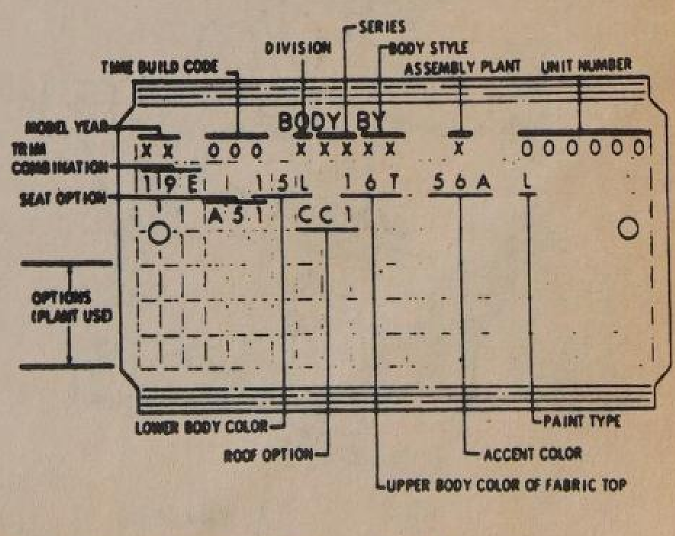
The vehicle identification number (VIN) is stamped on a plate located on the top left hand side (driver's side) of the instrument panel so



Body Identification Plate — 1983 and later



Vehicle Identification Number Location



Body Identification Plate — 1982

1 G 2 A W 8 7 H 6 C L 1 2 3 4 5 6

PLANT SEQUENCE NUMBER

CHECK DIGIT

NATION OF ORIGIN
1. U.S.A.
2. CANADA

MANUFACTURER
G GENERAL MOTORS

MAKE AND TYPE
2 PONTIAC

RESTRAINT SYSTEM
A. Non-Passive
B. Passive/Automatic Belts
C. Passive/Inflatable Restraint

PLANT CODE

PLANT CODE	PLANT
L	Van Nuys, CA
N	Norwood, OH

MODEL YEAR	
C	1982

SERIES CODE

BODY SERIES	SALES VIN CODE	VEHICLE
F	S	Firebird
F	W	T/A
F	X	S/E

BODY STYLE

STYLE VIN CODE	BODY STYLE
87	2-Door Hardtop Coupe

ENGINE CODE

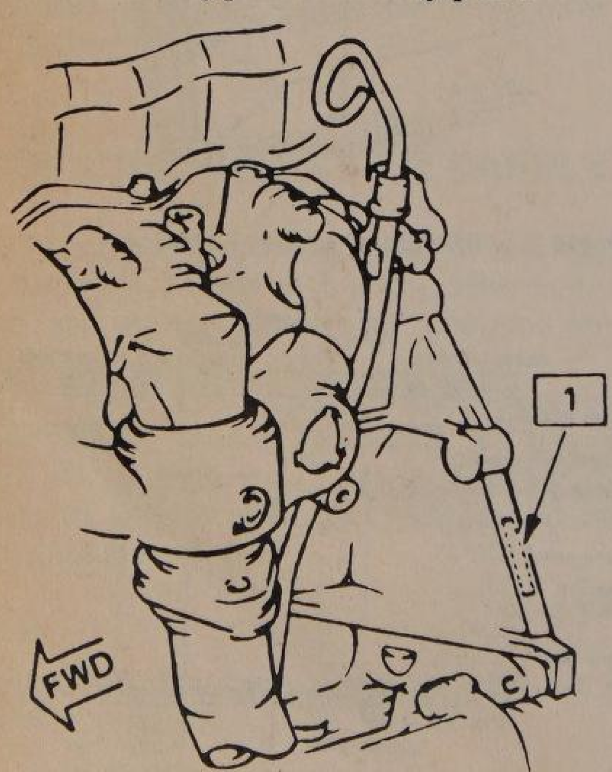
ENGINE CODE	ENGINE DISPLACEMENT	ENGINE TYPE	CARB. TYPE	MANU-FACTURER	SALES OPTION
1	2.8L 173 CID	V-6	2B	1	LC1
2	2.5L 151 CID	L4	EFI	2	LQ9
H	5.0L 305 CID	V-8	4	1 or *	LG4
7	5.0L 305 CID	V-8	EFI	1	LU5

1 Produced by GM – Chevrolet Motor Division
2 Produced by GM – Pontiac Motor Division
* GM of Canada

Vehicle Identification Numbers Codes – 1982

that it can be seen by looking through the windshield

A body identification tag is attached to the vehicle on the center of the radiator tie. This tag contains important information about the body, interior, paint and exterior. Refer to this tag when ordering paint and body parts.

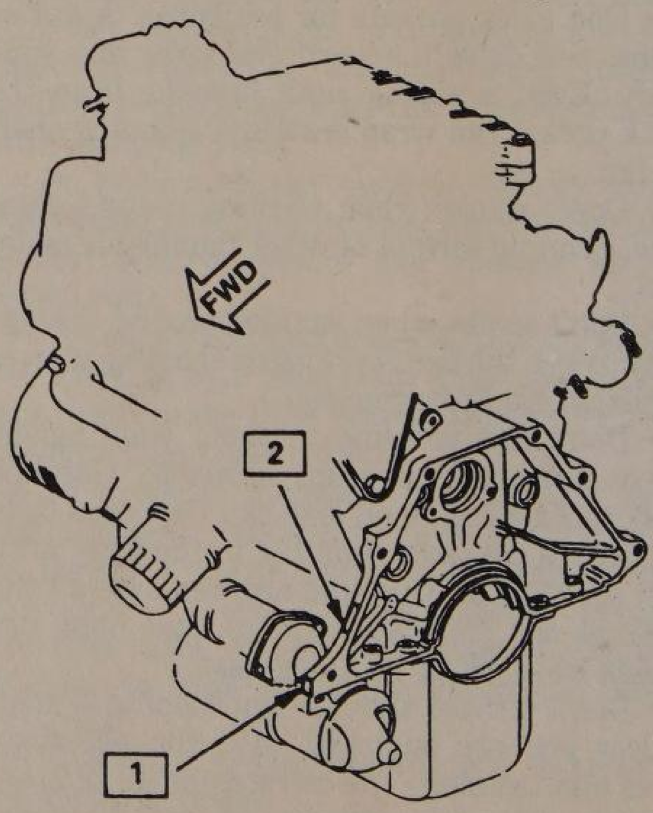


1. VIN code

2.3L L4 engine VIN code location

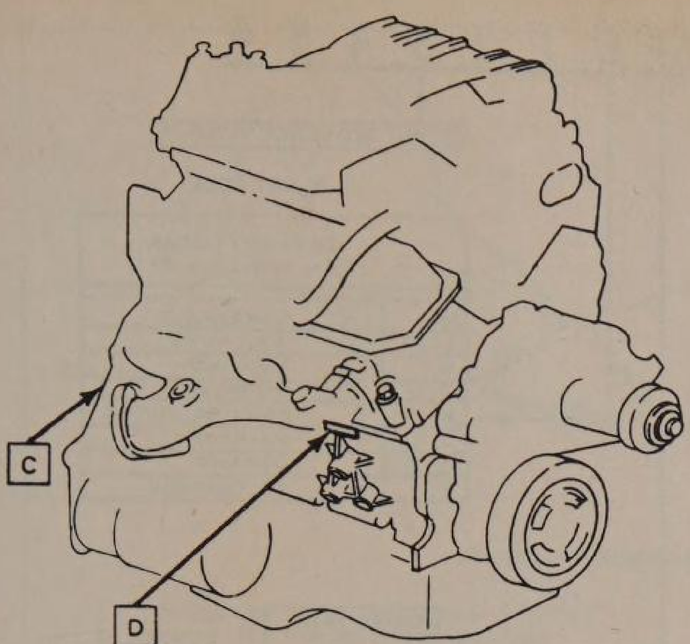
Engine

The 4-cylinder engine VIN code is stamped on a pad at the right front of the cylinder block below the cylinder head. The V6 engine VIN



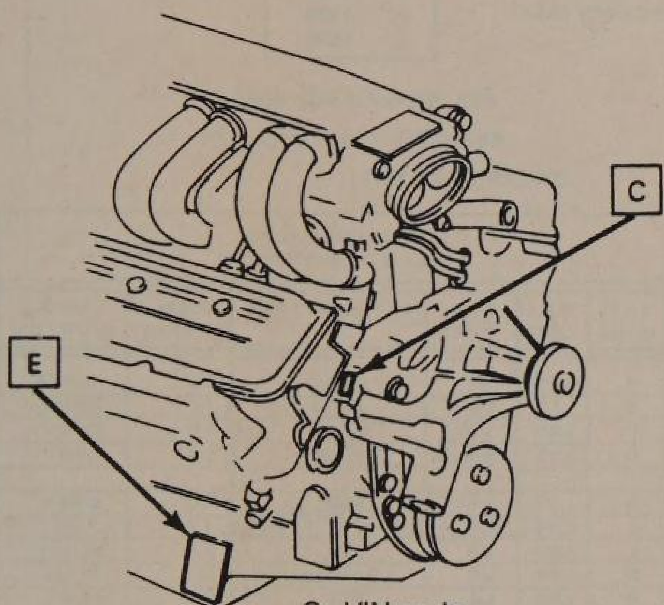
1. VIN code
2. Optional VIN code

2.8L V6 engine VIN code location



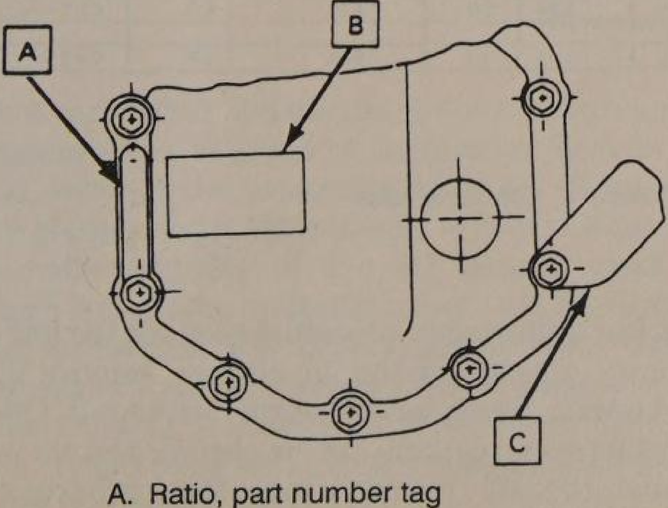
C. VIN code
D. VIN derivative

3.1L V6 engine VIN code location



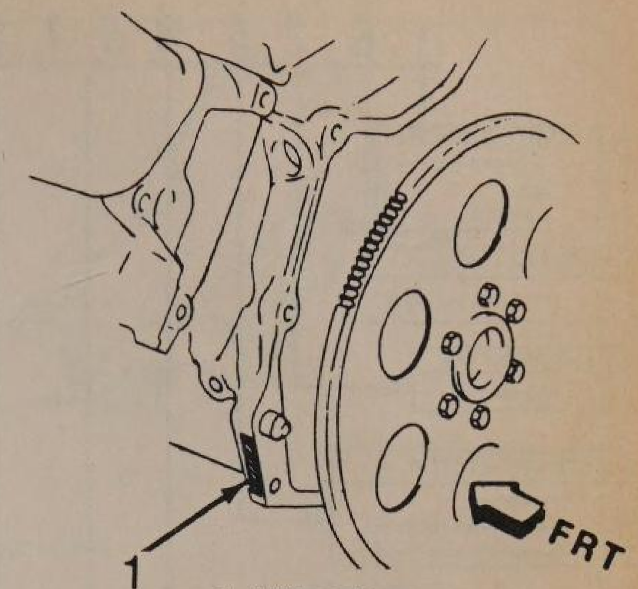
C. VIN code
D. Engine verification label

5.0L and 5.7L V8 engine VIN code location



A. Ratio, part number tag
B. Label
C. Limited slip tag

Borg Warner 7.75 rear axle identification



1. VIN code

1989 3.8L Turbo engine VIN code location

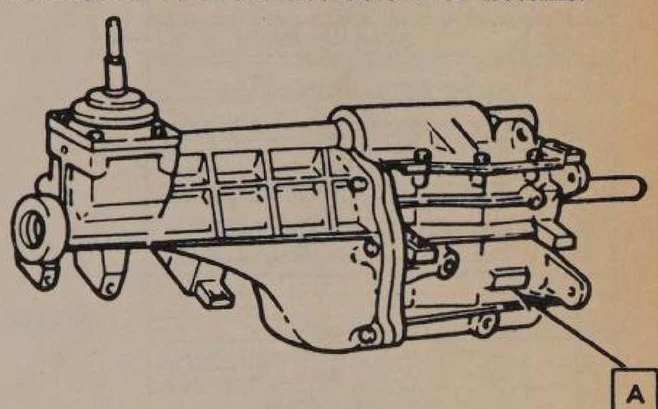
code is stamped on a pad at the left front of the cylinder block below the cylinder head. V8 engine VIN codes are on the block directly in front of the right cylinder head.

Transmission Serial Number

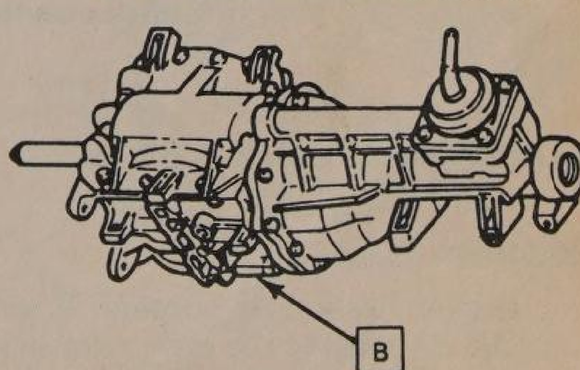
A transmission serial number is stamped on each transmission. The location of the transmission serial number on each transmission is shown in the illustration.

Rear Axle

Rear axle ratio, differential type, manufacturer and build date information are stamped on the right axle tube or on a tag at the rear cover. Refer to the illustration for details.



A. VIN derivative location
B. VIN derivative optional location



Manual transmission VIN location

1 G 2 A W 8 7 H 6 F L 1 2 3 4 5 6

NATION OF ORIGIN

1. U.S.A.
2. CANADA

MANUFACTURER

G GENERAL MOTORS

MAKE AND TYPE

2. PONTIAC

RESTRAINT SYSTEM

A. Non-Passive
B. Passive/Automatic Belts
C. Passive/Inflatable Restraint

SERIES CODE

SERIES/MODEL TABLE
(V.I.N. POSITION #5)

SERIES	MODEL POS #5	PONTIAC
A	H	6000 STE
A	G	6000 LE
A	F	6000
B	L	Parisienne
B	T	Parisienne Brougham
F	S	Firebird
F	W	Trans Am
F	X	Firebird SE
G	J	Grand Prix
G	K	Grand Prix LE
G	N	Bonneville
G	P	G.P. Brougham
G	R	Bonneville Brougham
G	S	Bonneville LE
J	B	Sunbird
J	C	Sunbird LE
J	D	Sunbird SE
N	E	Grand Am
N	V	Grand Am LE
P	E	Fiero Coupe
P	F	Fiero SE Coupe
P	G	Fiero GT Coupe
P	M	Fiero Sport Coupe
T	L	1000

BODY TYPES
(V.I.N. POSITIONS #6 & #7)

CODE	DESCRIPTION
08	Coupe—2 Door Hatchback
19	Sedan—4 Door 6 Window Notchback
27	Coupe—2 Door Notchback
35	Station Wagon—4 Door 3 Seat
37	Coupe—2 Door Notchback Special
67	Coupe—2 Door Convertible
68	Sedan—4 Door 4 Window Hatchback
69	Sedan—4 Door 4 Window Notchback
77	Coupe—2 Door Hatchback
87	Coupe—2 Door Sport

PLANT SEQUENCE NUMBER

PLANT CODE

GM PLANT CODES
(V.I.N. POSITION #11)

A	LAKEWOOD
L	VAN NUYS
M	LANSING
N	NORWOOD
P	PONTIAC MOTOR
X	FAIRFAX
1	OSHAWA
2	ST. THERESE

MODEL YEAR

B	1981
C	1982
D	1983
E	1984
F	1985
G	1986
H	1987
J	1988
K	1989
L	1990

CHECK DIGIT

ENGINE CODES
(V.I.N. POSITION #8)

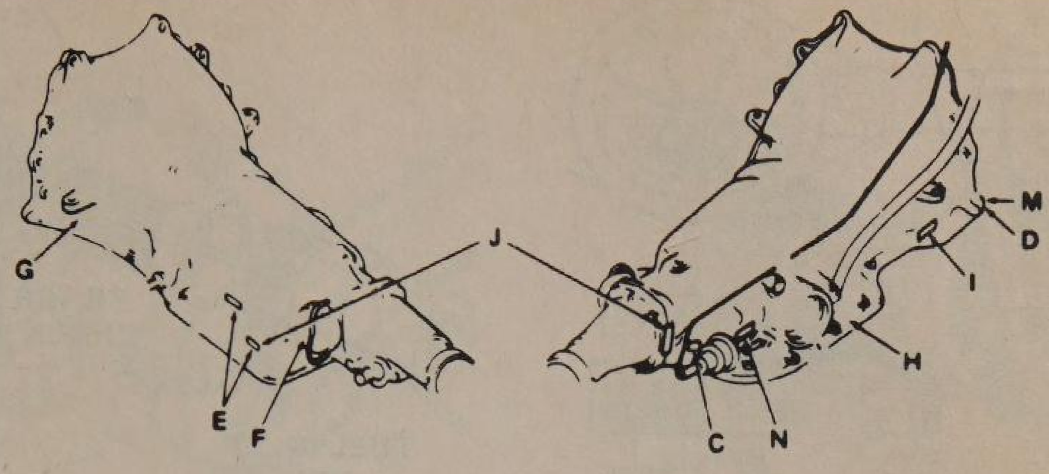
V.I.N. CODE	R.P.O CODE	ENG. TYPE	CARBURETION	DISPL. (LITRES)	MFG. DIVISION
A	LD5	V6	2BBL	3.8	BUICK
C	L17	L4	2BBL	1.6	CHEV.
F	LB9	V8	EFI	5.0	CHEV.
G	L69	V8	4BBL	5.0	CHEV.
H	LG4	V8	4BBL	5.0	CHEV.
J	LA5	L4	EFI TURBO	1.8	PONT.
L	LN7	V6	EFI	3.0	BUICK
N	LF9	V8	DIESEL	5.7	OLDS.
R	LR8	L4	EFI	2.5	PONT.
T	LT7	V6	DIESEL	4.3	OLDS.
U	L68	L4	EFI	2.5	PONT.
X	LE2	V6	2BBL	2.8	CHEV.
W	LB6	V6	EFI	2.8	CHEV.
0	LH8	L4	EFI	1.8	PONT.
2	LQ9	L4	EFI	2.5	PONT.
S	LB8	V6	EFI	2.8	CHEV.
Z	LB4	V6	EFI	4.3	CHEV.
9	L44	V6	EFI	2.8	CHEV.

Vehicle Identification Number Codes — 1983 and later

ROUTINE MAINTENANCE

Air Cleaner

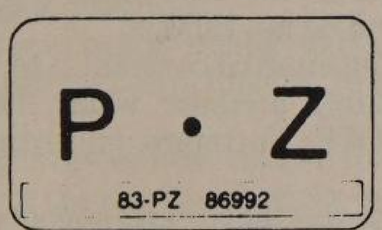
The air cleaner has a dual purpose. It not only filters the air going to the carburetor, but also acts as a flame arrester if the engine should backfire through the carburetor. If an engine maintenance procedure requires the temporary removal of the air cleaner, remove it; otherwise, never run the engine 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, ineffi-



TYPICAL TRANSMISSION - I D LOCATIONS

C THM 200 AND THM 200-4R I D TAG LOCATION
D THM 200 AND THM 200-4R VIN LOCATION
E THM 200 AND THM 200-4R VIN OPTIONAL LOCATIONS
F THM 250C I D STAMP LOCATION
G THM 250C VIN LOCATION
H THM 350C STAMPED I D LOCATION
I THM 350C VIN LOCATION
J THM 350C OPTIONAL VIN LOCATIONS
M THM 700-R4 STAMPED I D LOCATION
N THM 700 R4 VIN LOCATION

TRANSMISSION NAMEPLATE
YPSILANTI PLANT, MICHIGAN
THM 200 THM 200C



83 = MODEL YEAR
PZ = MODEL
86992 = SERIAL NO

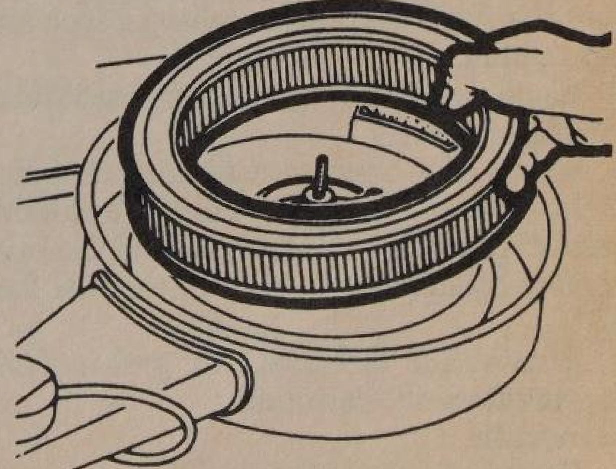
TRANSMISSION IDENTIFICATION
THM 700R4 - TOLEDO PLANT, OHIO

9 TA Y 3 M 12 D

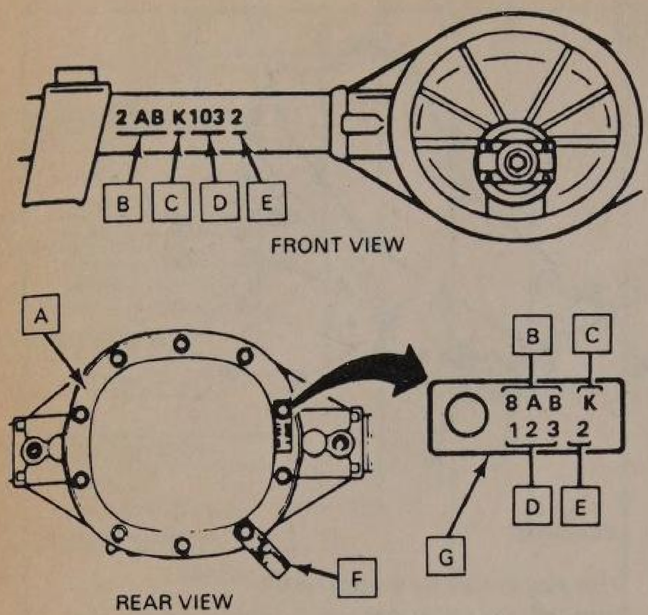
9 = MODEL YEAR
TA = MODEL
Y = TOLEDO
3 = YEAR
M = MONTH
12 = DAY
D = SHIFT (D = DAY N = NIGHT)

Transmission VIN location

cient 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



Remove and discard the old filter



A. Axle cover
B. Axle code
C. Manufacturer
D. Day built
E. Shift
F. Limited slip tag
G. Axle code tag

Standard rear axle identification

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), 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.

REMOVAL AND INSTALLATION

Remove the wing nut on top of the air cleaner assembly and remove the cover and filter. Port fuel injected vehicles have a remote filter. Remove the air intake hose, cover and filter.

Fuel Filter

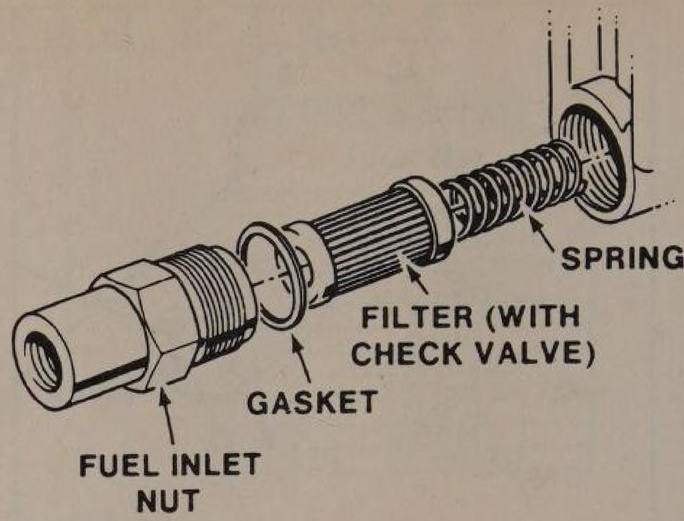
REMOVAL AND INSTALLATION

Carbureted Engines

1. Disconnect the negative (–) battery cable.
2. **Release the fuel system pressure.** Loosen the fuel filler cap to relieve vapor and do not tighten.
3. Clean the fuel feed pipe at the carburetor before disconnecting.
4. Using care, disconnect the fuel feed pipe from the filter and drain the fuel into a suitable container. Use a large wrench to hold the inlet nut before attempting to remove the fuel feed pipe.
5. Remove the fuel inlet nut, gasket, filter and spring from the carburetor.

To install:

1. Replace the fuel filter and gasket.
2. Install the filter into the inlet nut, gasket and spring and tighten the inlet nut to 20 ft. lbs. (27 Nm).
3. Install the fuel pipe.
4. Using a backup wrench so the inlet nut will not turn, torque the fittings to 20 ft. lbs. (27 Nm).
5. Tighten the filler cap and connect the negative battery cable.



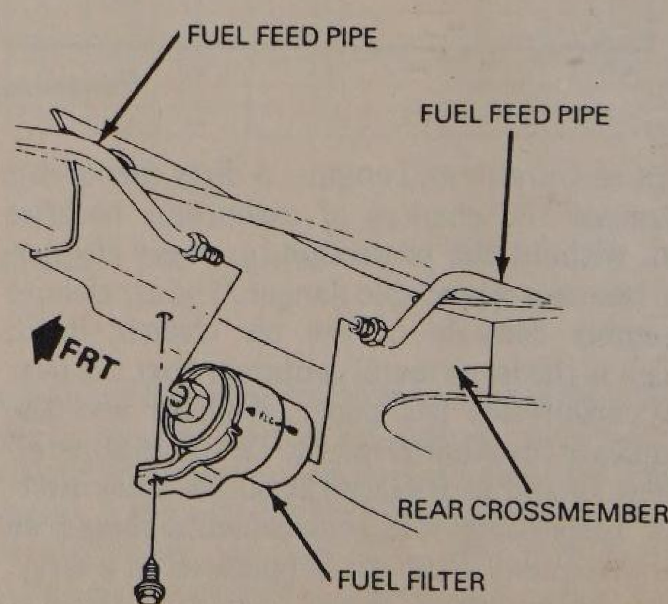
Fuel filter — carbureted engines

Throttle Body Injection

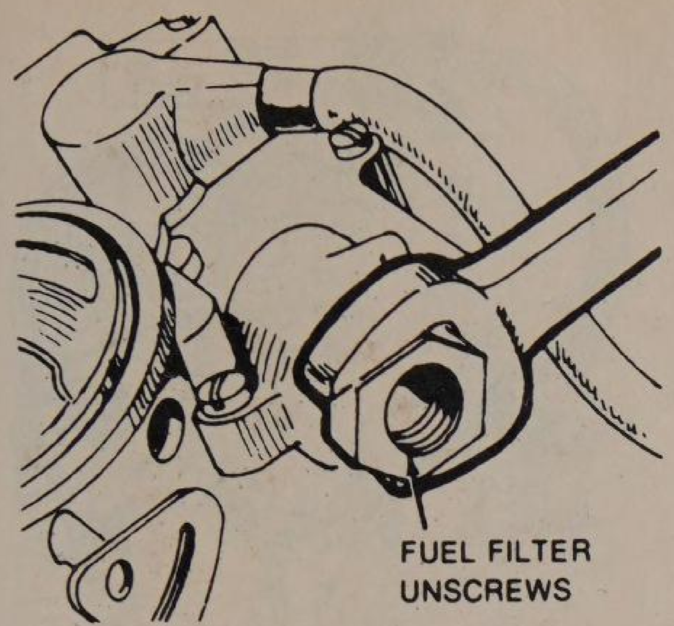
1. Disconnect the negative (–) battery cable.
2. **Release the fuel system pressure.**

   a. Loosen the fuel filler cap to relieve vapor and do not tighten.

   b. The internal constant bleed feature relieves pump pressure when the engine is turned OFF. Therefore, no further action is needed.
3. Raise the vehicle and support with Jackstands, except 2.5L engine. The 2.5L L4 engine's filter is located in the engine compartment.
4. Clean both fuel feed pipes at the inline filter before disconnecting.



Fuel filter — EFI engines



Removing the fuel filter retainer

5. Using care, disconnect the fuel feed pipe and rear pipe from the filter and drain the fuel into a suitable container.

6. Remove the filter bracket screw and slide the filter out of the bracket.

To install:

1. Replace the fuel pipe O-rings if damaged.

2. Install the filter into the bracket and tighten the bracket screw.

3. Install the two fuel pipes with the filter in the proper direction.

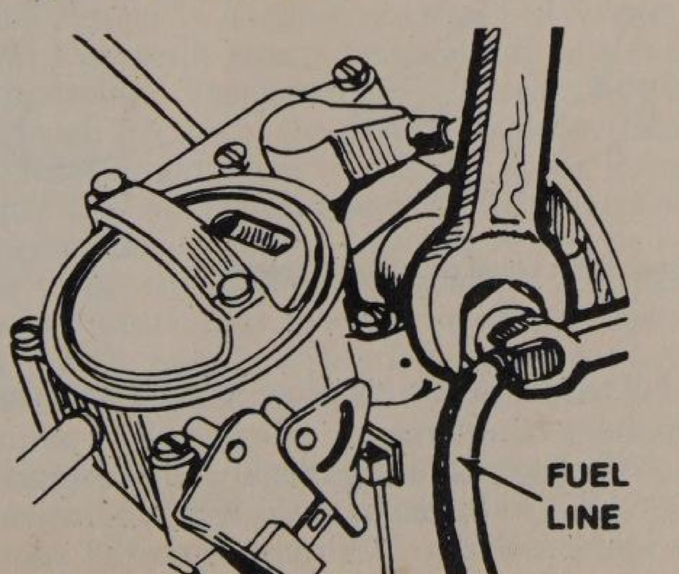
4. Using a backup wrench so the filter will not turn, torque the fittings to 20 ft. lbs. (27 Nm).

5. Lower the vehicle, tighten the filler cap and connect the negative battery cable.

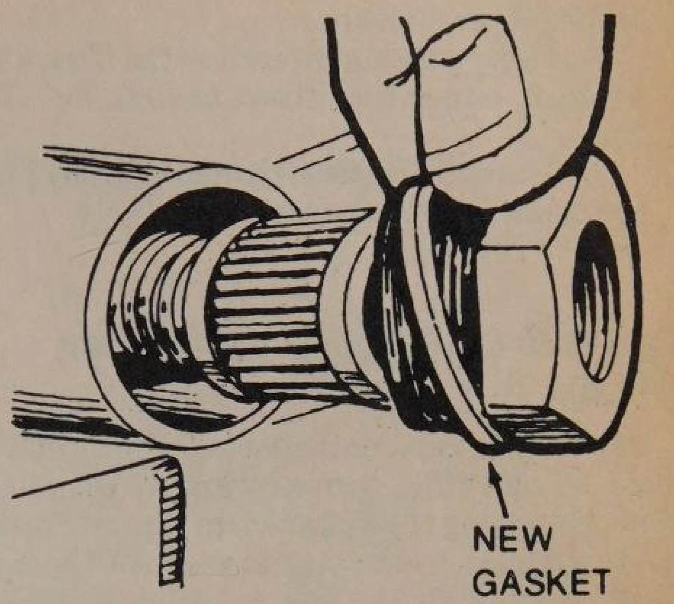
Port Fuel Injection

1. Disconnect the negative (–) battery cable.
2. **Release the fuel system pressure.**

a. Loosen the fuel filler cap to relieve vapor and do not tighten.



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



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

b. Connect Fuel Pressure gauge J–34730–1 or equivalent to the fuel pressure valve. Wrap a shop towel around the fitting while connecting the gauge.

c. Install a bleed hose into a suitable container and open the valve to bleed system pressure.

3. Raise the vehicle and support with Jackstands.

4. Clean both fuel feed pipes at the inline filter before disconnecting.

5. Using care, disconnect the fuel feed pipe and rear pipe from the filter and drain the fuel into a suitable container.

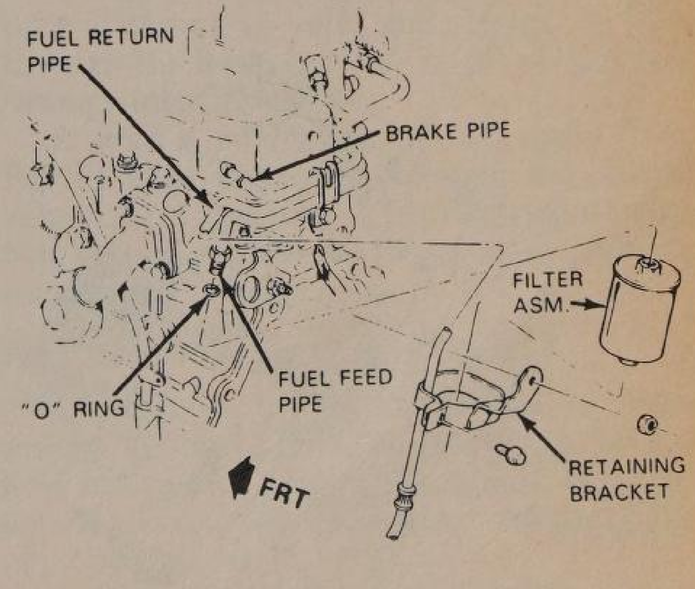
6. Remove the filter bracket screw and slide the filter out of the bracket.

To install:

1. Replace the fuel pipe O-rings if damaged.

2. Install the filter into the bracket and tighten the bracket screw.

3. Install the two fuel pipes with the filter



Fuel filter — 2.5L TBI engine

in the proper direction.

4. Using a backup wrench so the filter will not turn, torque the fittings to 20 ft. lbs. (27 Nm).

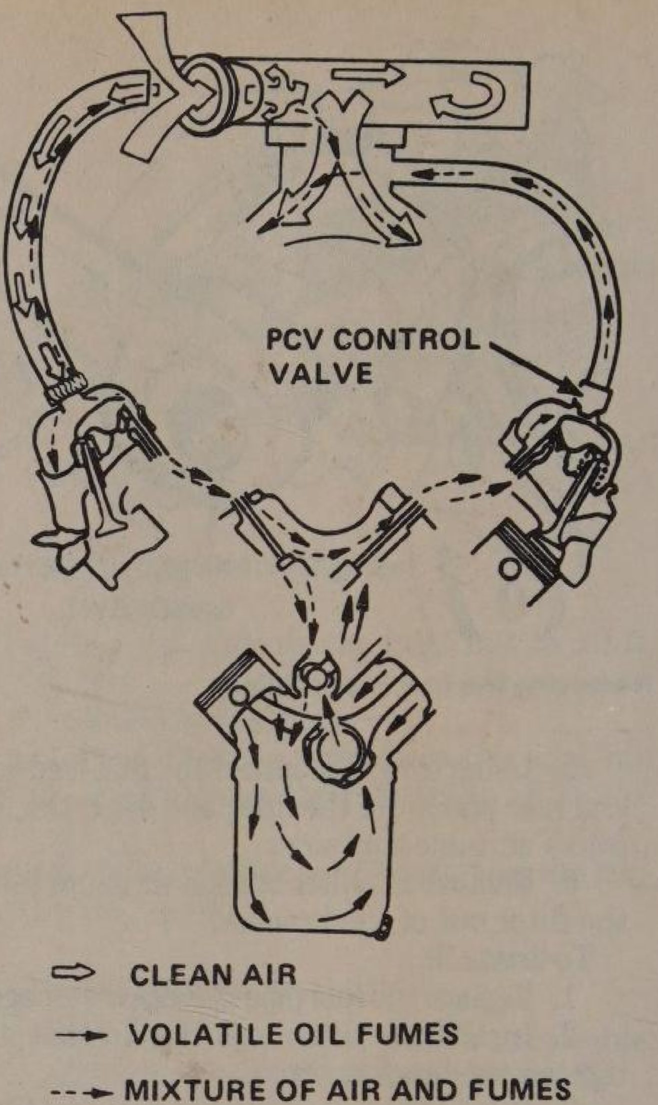
5. Lower the vehicle, tighten the filler cap and connect the negative battery cable.

Positive Crankcase Ventilation (PCV)

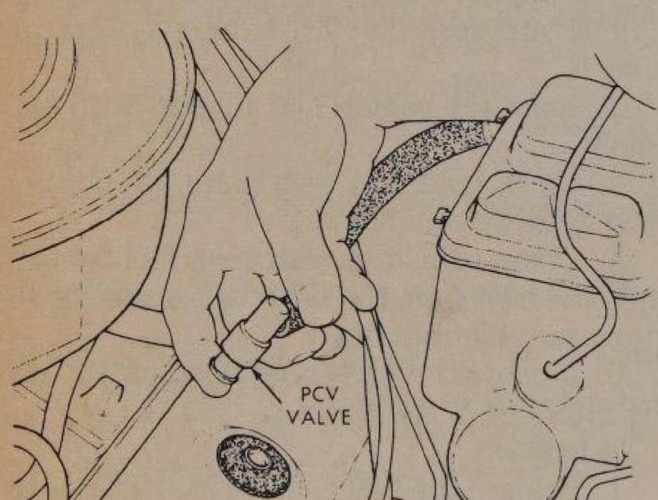
The crankcase ventilation system (PCV) must be operating correctly to provide complete scavenging of the crankcase vapors. Fresh air is supplied to the crankcase from the air filter, mixed with the internal exhaust gases, passed through the PCV valve and into the intake manifold.

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.

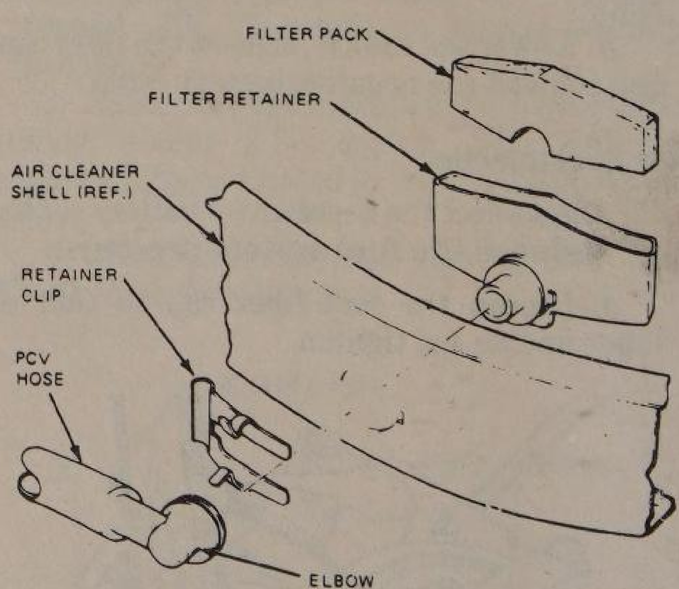
If the engine is idling roughly, a quick check of the PCV valve can be made. While the engine is idling, pull the PCV valve from the valve cover, place your thumb over the end of the PCV valve and check for vacuum. If no vacuum exists, check for a plugged PCV valve, manifold



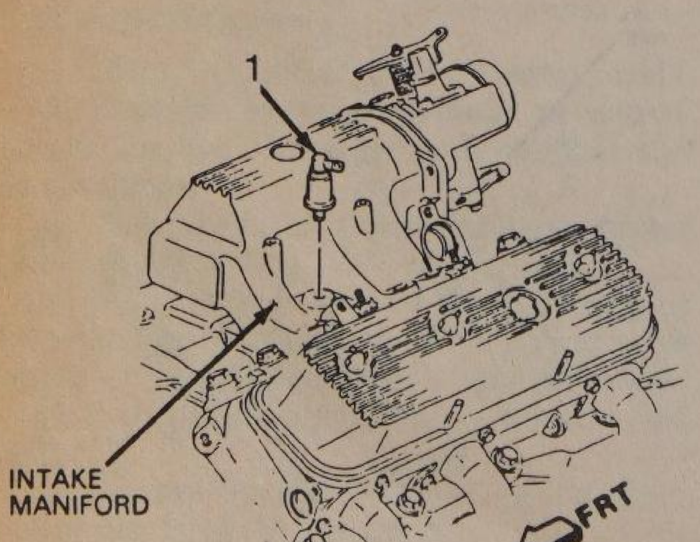
Positive Crankcase Ventilation (PCV) System



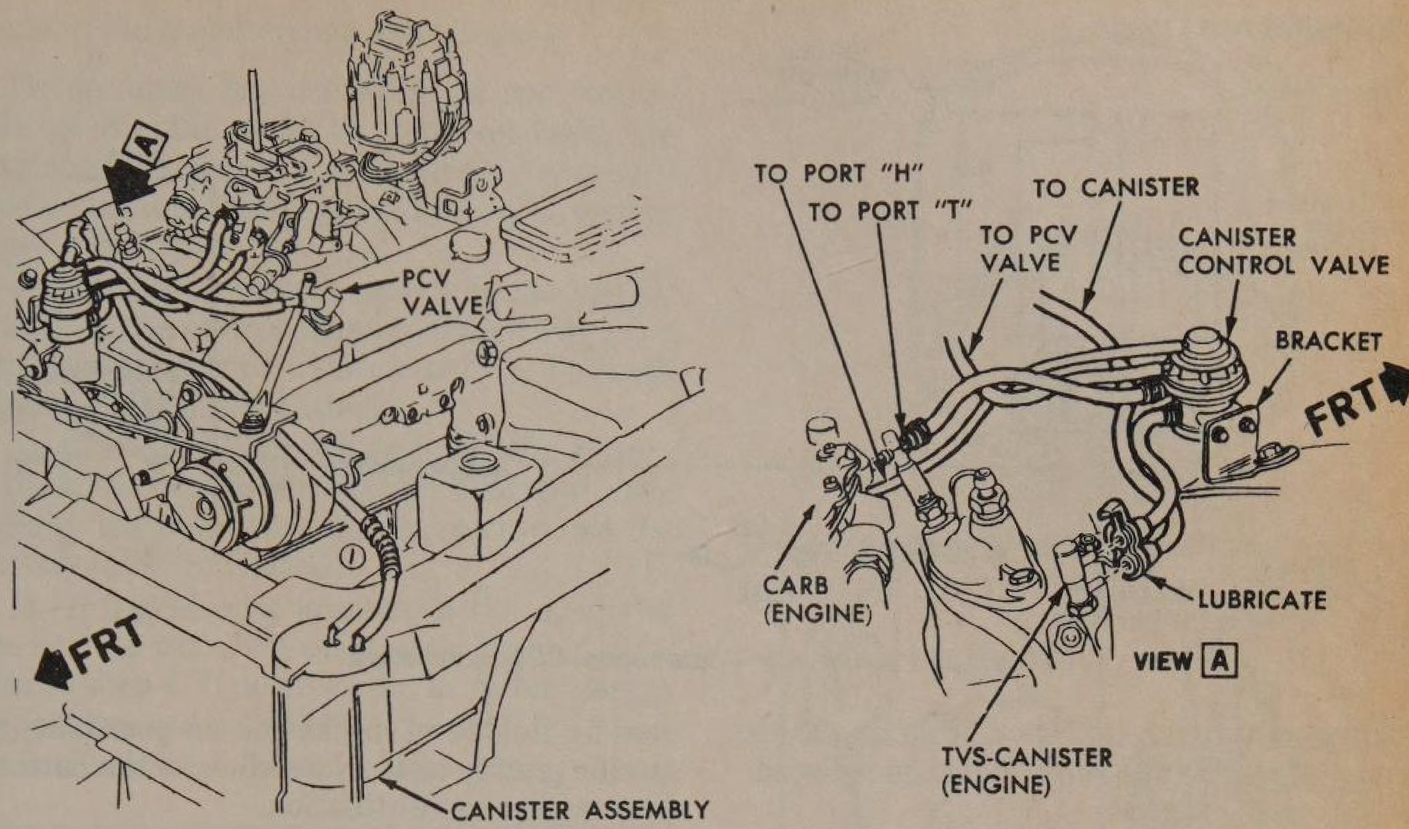
Pulling out the PCV valve from the rocker cover



Check the small crankcase breather



PCV valve — 3.8L Turbo



EEC System; V8 engine (other similar)

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, throttle body assembly or 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.*

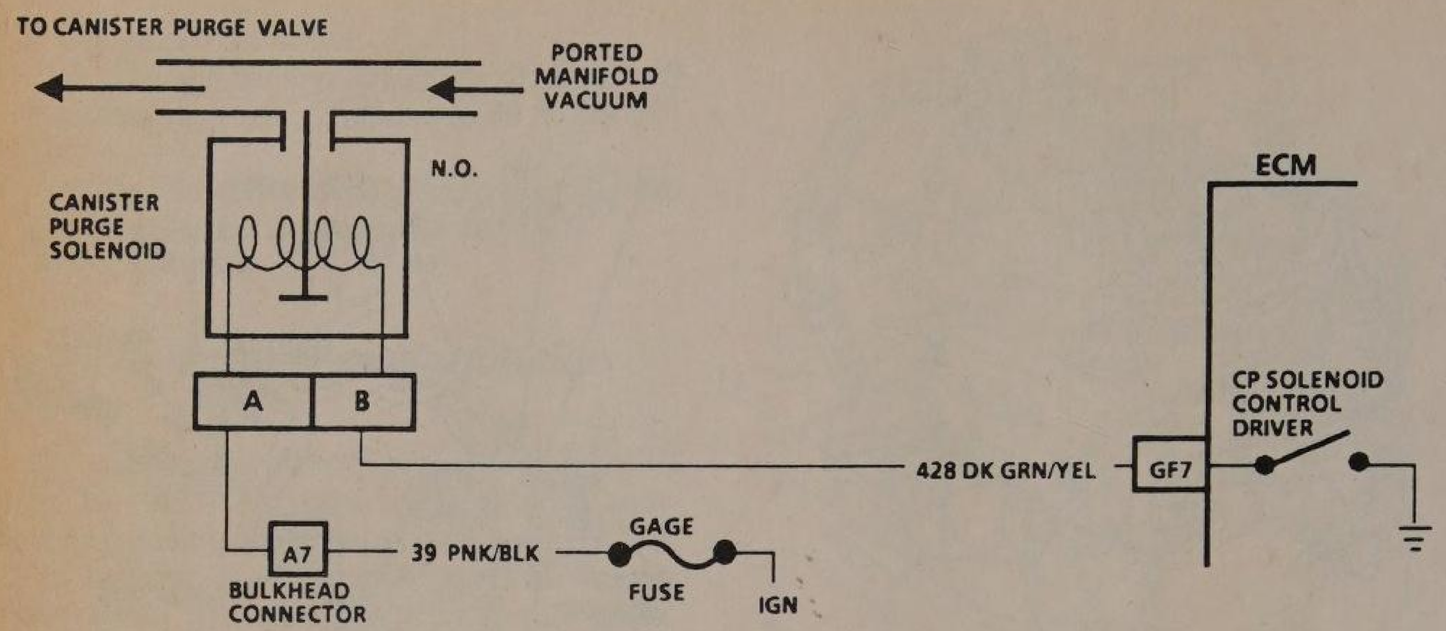
FUNCTIONAL TEST

Canister Purge Valve

1. Apply a short length of hose to the lower tube of the purge valve and attempt to blow through the hose. Little or no air should pass through into the canister.
2. With a hand vacuum pump, apply 15 in. Hg (51 kPa) of vacuum through the control valve tube (upper tube). The diaphragm should hold vacuum for at least 20 seconds, if not the canister has to be replaced.

Fuel Tank Pressure Control Valve

1. Apply 15 Hg (51 kPa) of vacuum to the control vacuum tube. The diaphragm should hold vacuum for at least 20 seconds. If it does not, the diaphragm is leaking and the valve must be replaced.
2. With the vacuum applied to the control vacuum tube, apply a short hose to the valve's tank tube side and blow into the tube. The air



EEC system schematic – late model ECM controlled

should pass through the valve. If no air passes through the valve, the valve should be replaced.

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. Nevertheless, the battery does require some attention.

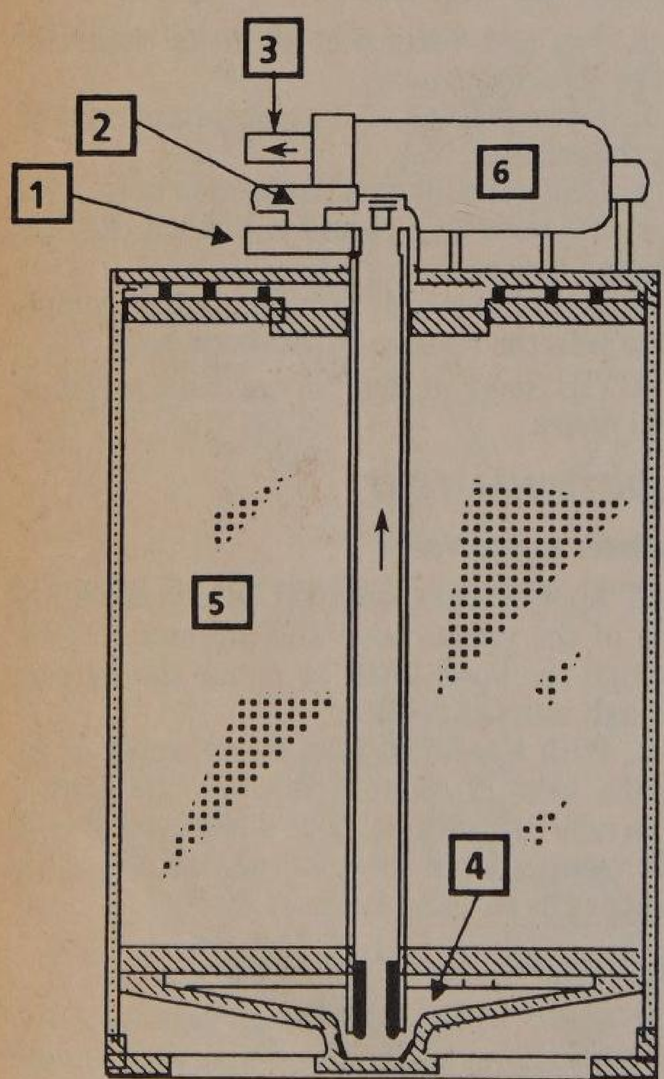
Once a year, the battery terminals and the cable clamps should be cleaned. Remove the side terminal bolts and the cables, negative cable first. Clean the cable clamps and the battery terminals with a wire brush until all corrosion, grease, etc. is removed and the metal is shiny. It is especially important 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.

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 over tighten, 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.*



1. Tank tube
2. Inlet air
3. Purge tube
4. Liquid fuel area
5. Vapor storage area
6. Purge solenoid

EEC canister

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.

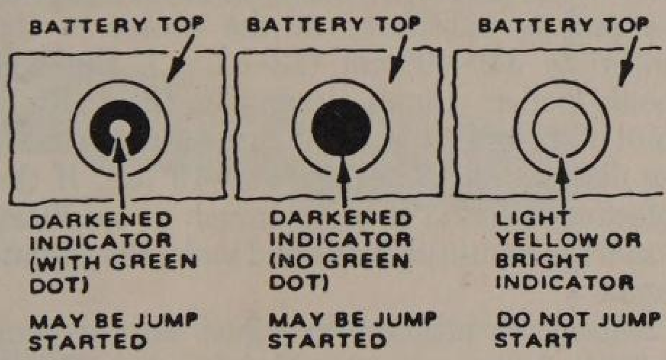
The sealed top battery cannot be checked for charge in the normal manner, since there is no provision for access to the electrolyte. To check the condition of the battery:

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:

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

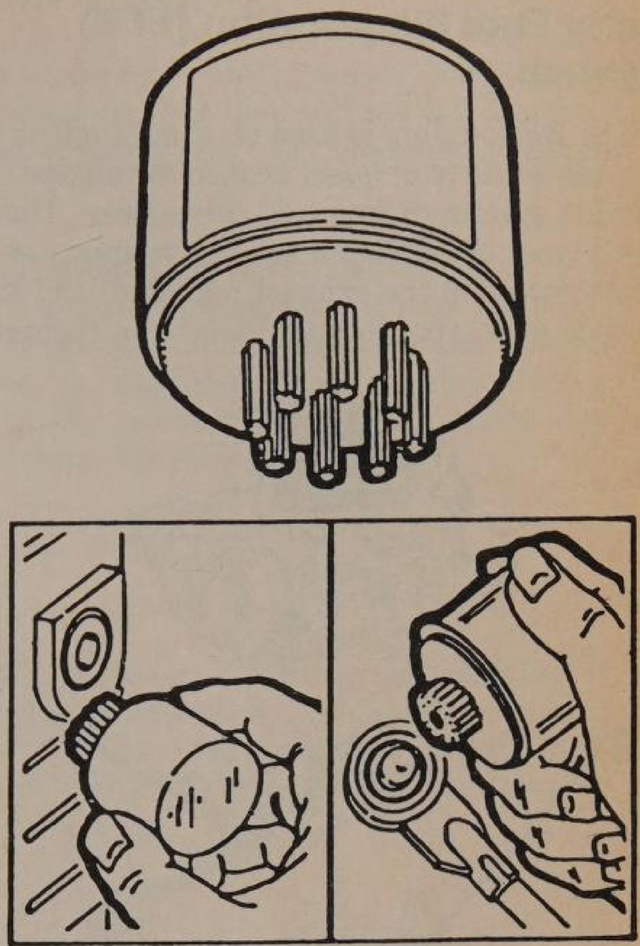


Maintenance-free batteries contain their own built in hydrometer

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.

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



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

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 load test chart in this section.

Battery Load Test

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

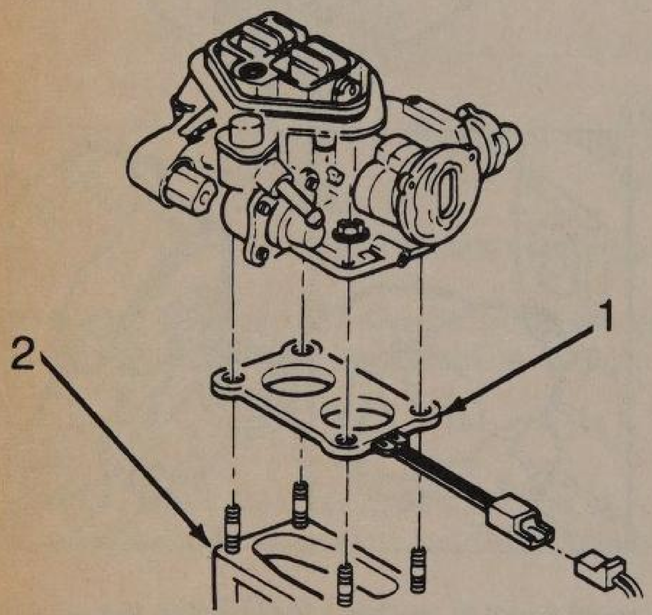
2. Check the results against the following chart. If the battery voltage is at or above the specified voltage for the temperature listed, the battery is good. If the voltage falls below what's listed, the battery should be replaced.

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

Battery Load Test

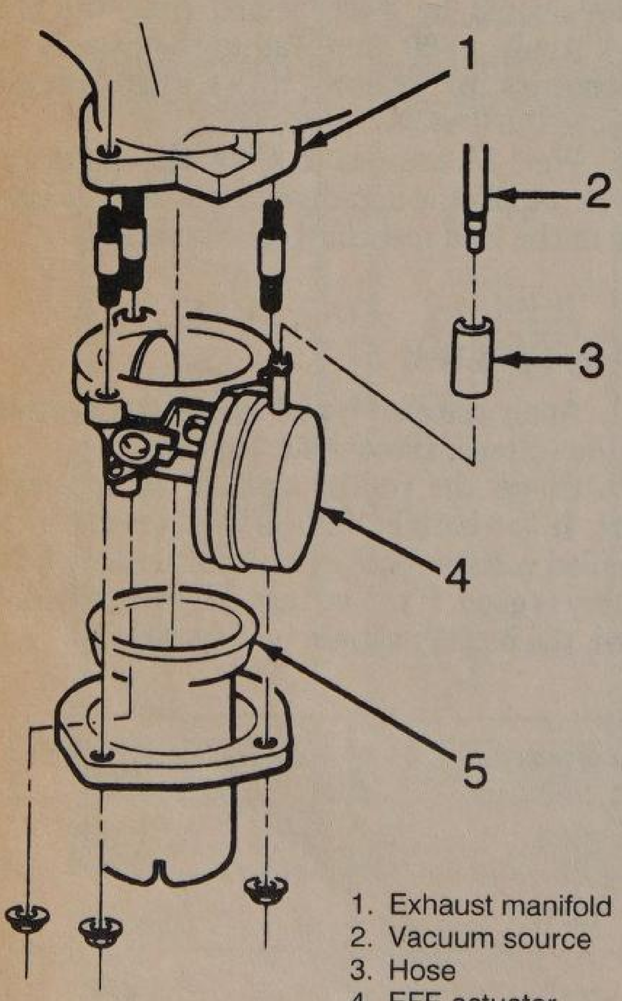
Early Fuel Evaporation (EFE) System

The EFE system is used on some engines to provide a source of quick heat to the engine induction system during cold drive-away. There are 2 types of EFE systems: the vacuum servo type (located in the exhaust manifold) and the electric grid type (located under the carburetor).



1. EFE heater
2. Intake manifold

EFE Electrically Heated Grid



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

EFE Vacuum Servo Valve

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.

Belts

TENSION CHECKING AND ADJUSTMENT

V-Belts

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 330–400mm (13–16 in.), the belt should deflect 13mm ($^1/_2$ in.) at the halfway point of its longest straight run; 6mm ($^1/_4$ in.) if the distance is 178–300mm (7–10 in.). If the defection 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 application 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.

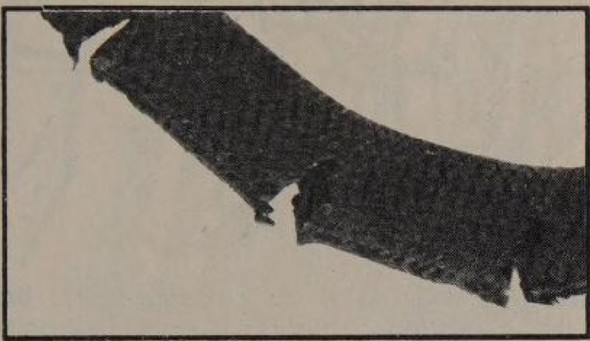
NOTE: *When adjusting the air pump belt, if you are using a pry bar, make sure that you pry against the cast iron end cover and not against the aluminum housing. Excessive force on the housing itself will damage it.*

Serpentine Belts

After 1986, most engines are equipped with a serpentine belt and automatic belt tensioner. The tension is maintained by a spring loaded pulley/tensioner. The indicator mark on the movable portion of the tensioner must be within the limits of the slotted area on the sta-

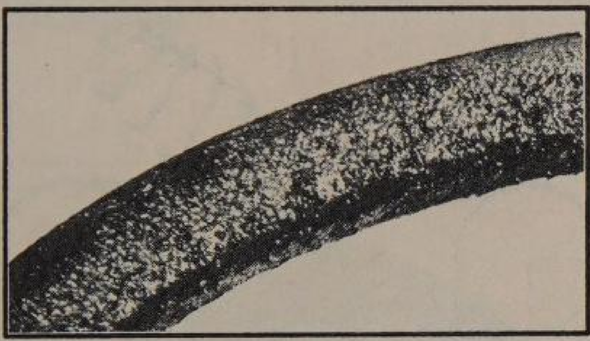
HOW TO SPOT WORN V-BELTS

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.



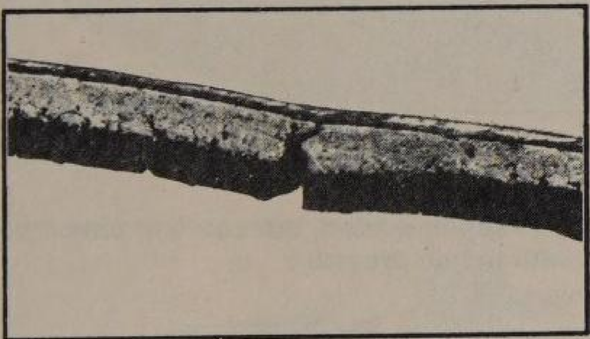
Cracking or weathering

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.

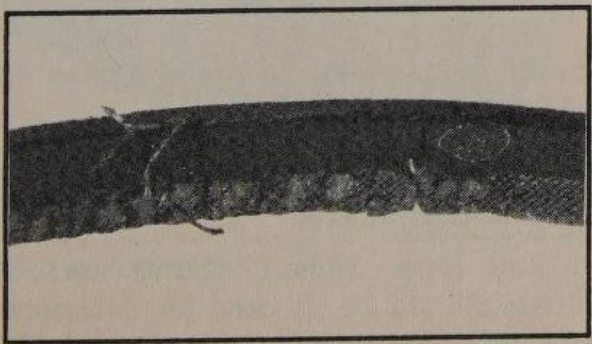


Glazing

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.

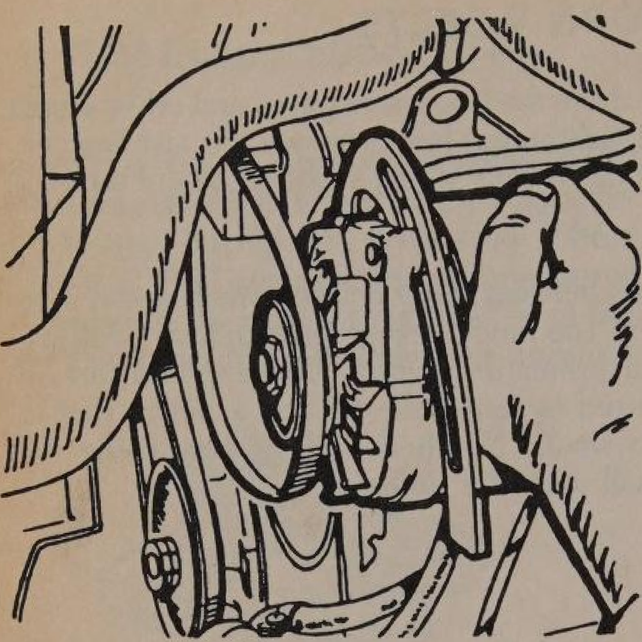
Worn cover

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.

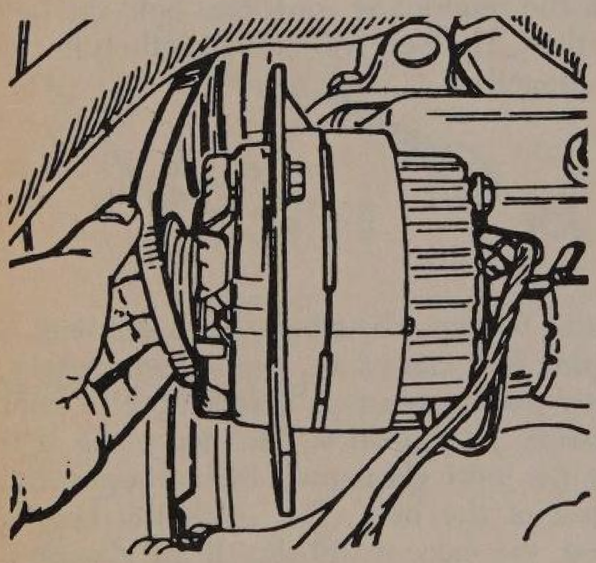


Separation

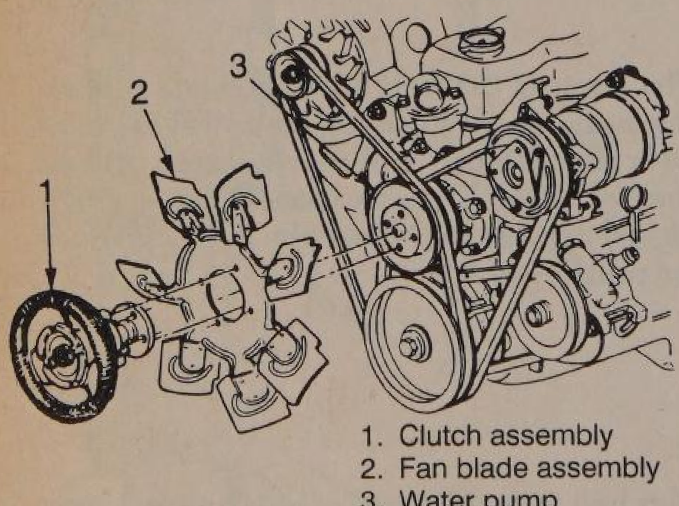
This belt is on the verge of breaking and leaving you stranded. The layers of the belt are separating and the reinforcing cords are exposed. It's just a matter of time before it breaks completely.



Push the component toward the engine and slip off the belt



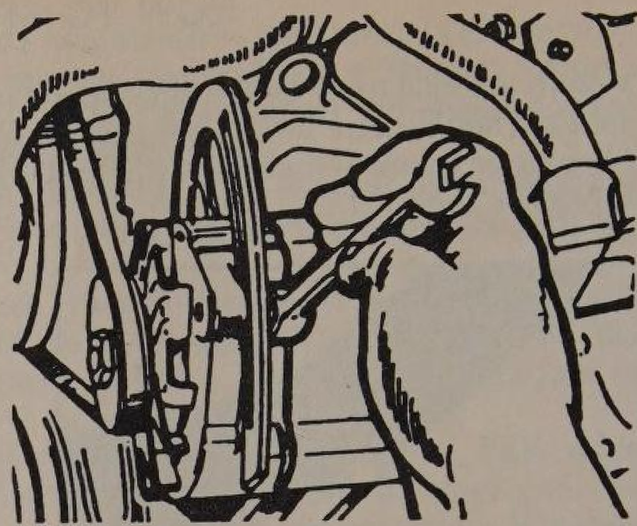
Slip the new belt over the pulley



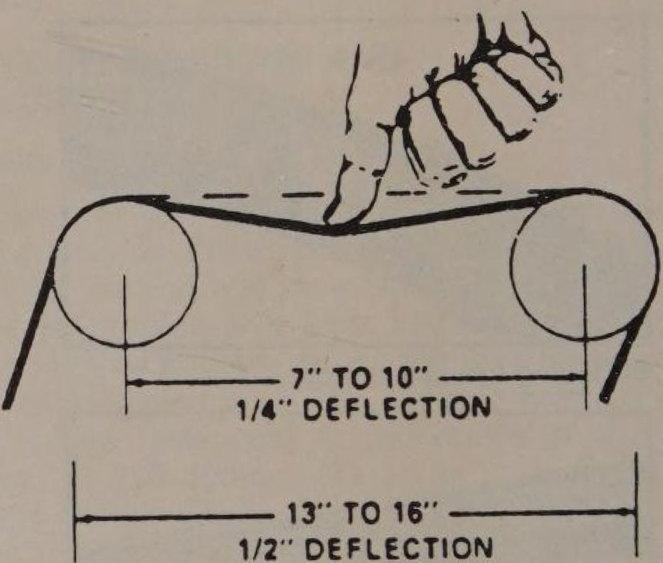
Belt routing – early model 2.5L engines

tionary portion of the tensioner. Any reading outside the limits indicates either a defective belt or tensioner.

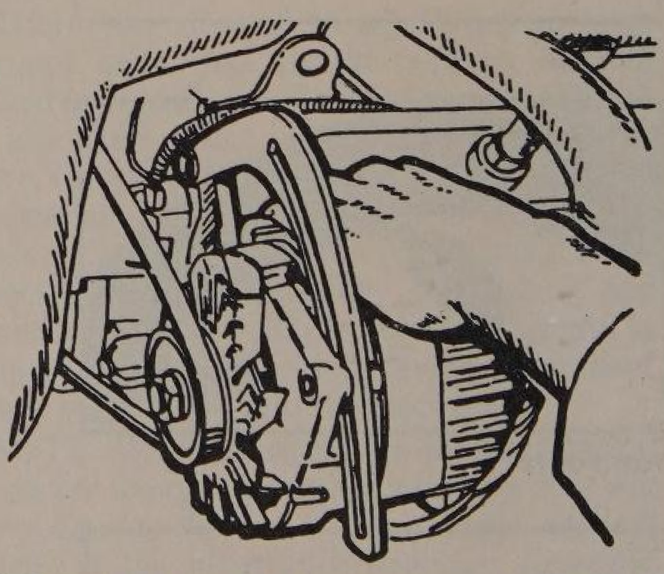
To remove the belt, install a half inch racket handle into the square slot in the tensioner and move far enough to slide the belt off the pulleys. Mark the belt routing for installation.



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

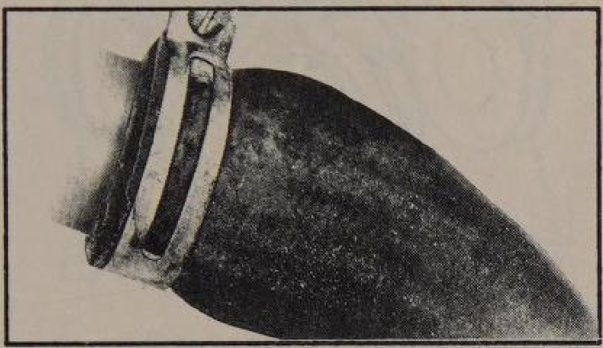
Hoses

HOSE REPLACEMENT

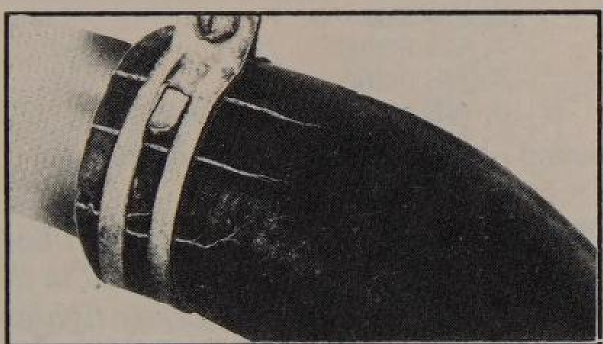
Upper and lower radiator hoses and all heater hoses should be checked for deterioration, leaks and loose hose clamps every 15,000 miles. To remove the hoses:

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

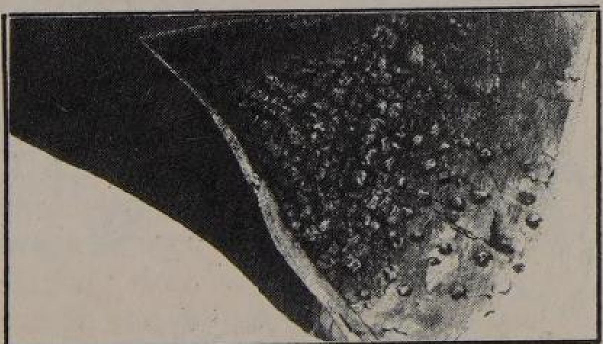
A good test for any hose is to feel it for soft or spongy spots. Frequently these will appear as swollen areas of the hose. The most likely cause is oil soaking. This hose could burst at any time, when hot or under pressure.


Cracked hose

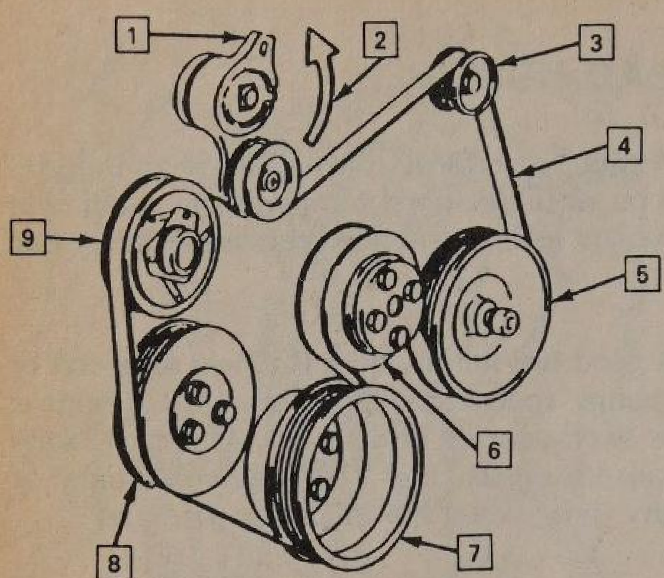
Cracked hoses can usually be seen but feel the hoses to be sure they have not hardened; a prime cause of cracking. This hose has cracked down to the reinforcing cords and could split at any of the cracks.


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.

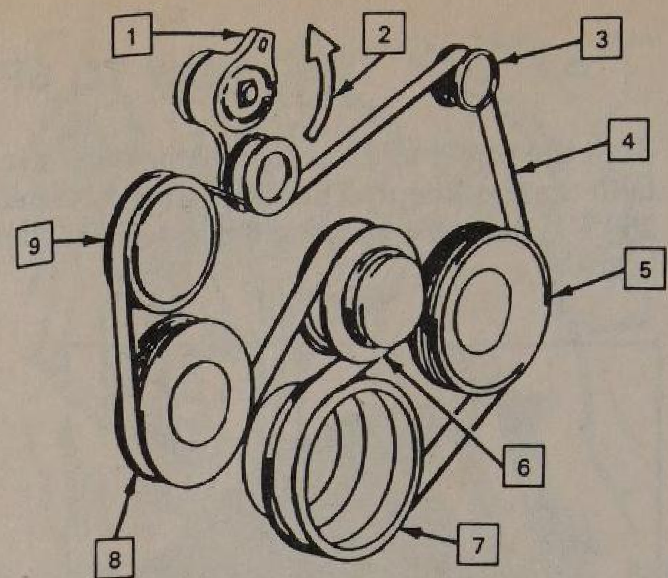

Debris in cooling system

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.



1. Tensioner assembly
2. Rotate tensioner in direction shown to install or remove belt
3. Alternator
4. Accessory drive belt
5. Power steering pump
6. Water pump
7. Crankshaft
8. AIR pump
9. A/C compressor or idler

Belt routing — 5.0L and 5.7L engines



1. Tensioner assembly
2. Rotate tensioner in direction shown to install or remove belt
3. Alternator
4. Accessory drive belt
5. Power steering pump
6. Water pump
7. Crankshaft
8. AIR pump
9. A/C compressor or idler

Belt routing — 1990 5.0L and 5.7L engines

1. Drain the radiator.

2. Loosen the hose clamps at each end of the hose to be removed.

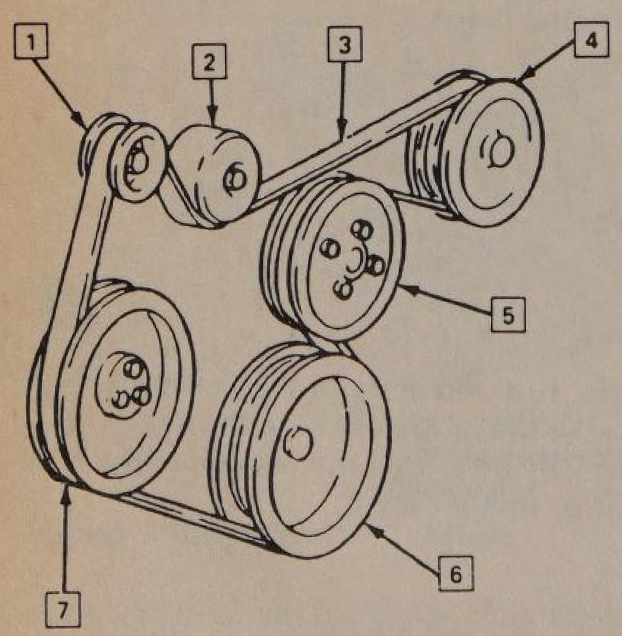
3. Working the hose back and forth, slide it off its connection and then install a new hose if necessary.

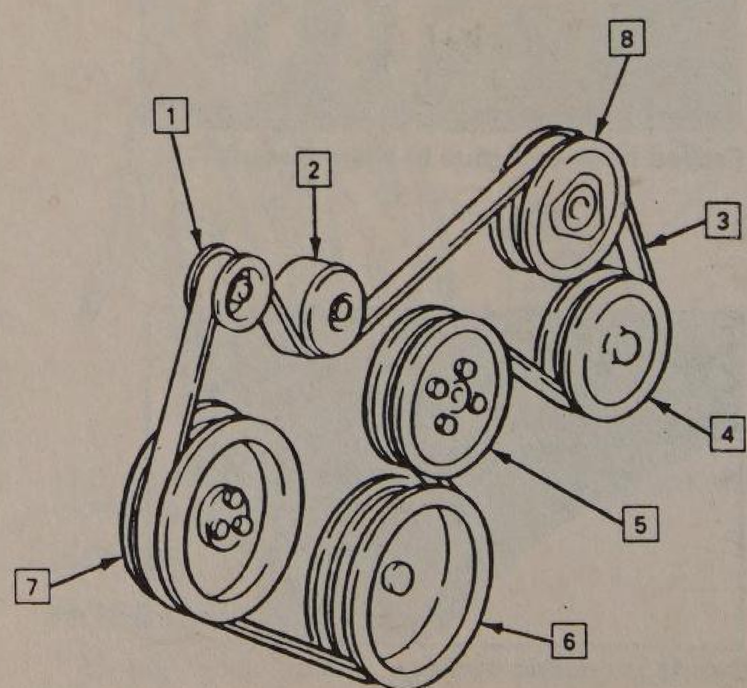
4. Position the hose clamps at least 6mm ($^1/_4$ in.) from the end of the hose and tighten them.

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

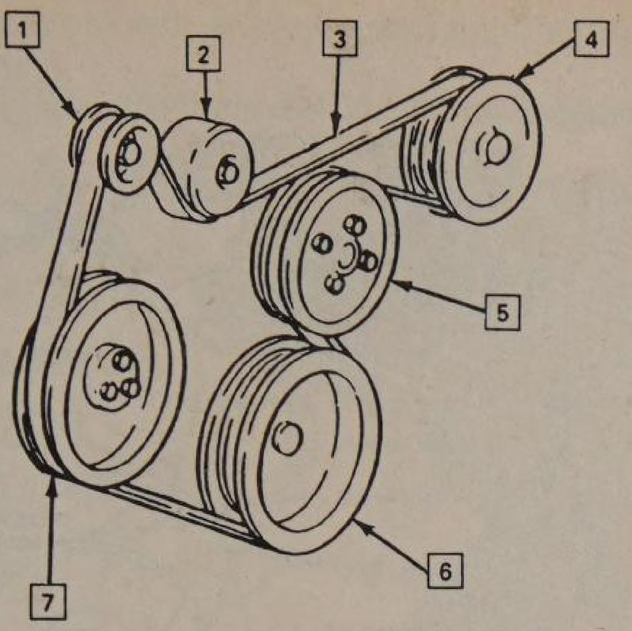
Once a month, the engine coolant level should be checked. This is quickly accomplished by observing the level of coolant in the

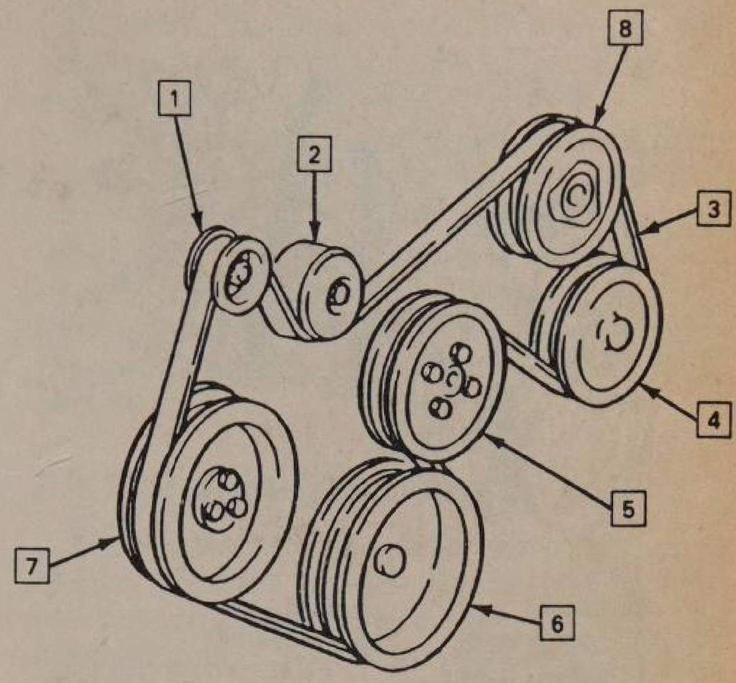




1. Alternator
2. Tensioner
3. Belt
4. Power steering pump
5. Water pump
6. Crankshaft
7. AIR pump
8. A/C compressor

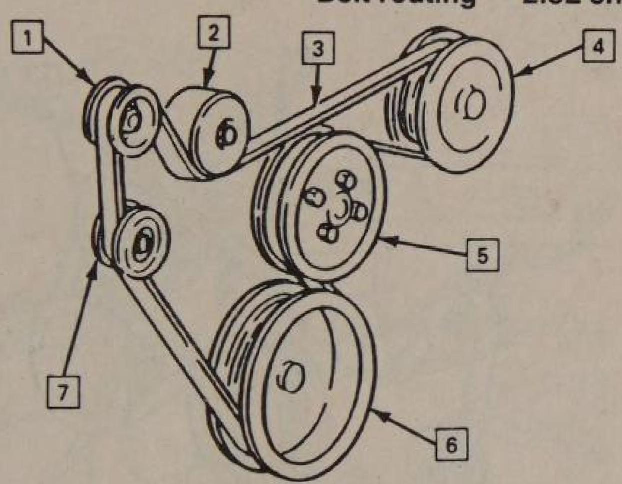
Belt routing — 1990 3.1L engine with manual transmission



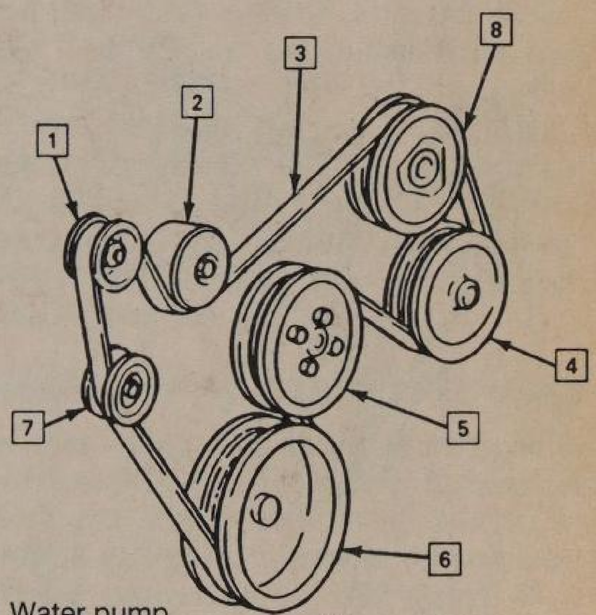


1. Alternator
2. Tensioner
3. Belt
4. Power steering pump
5. Water pump
6. Crankshaft
7. AIR pump
8. A/C compressor

Belt routing — 2.8L engine with manual transmission



W/O A/C



A/C

1. Alternator
2. Tensioner
3. Belt
4. Power steering pump
5. Water pump
6. Crankshaft
7. AIR pump
8. A/C compressor

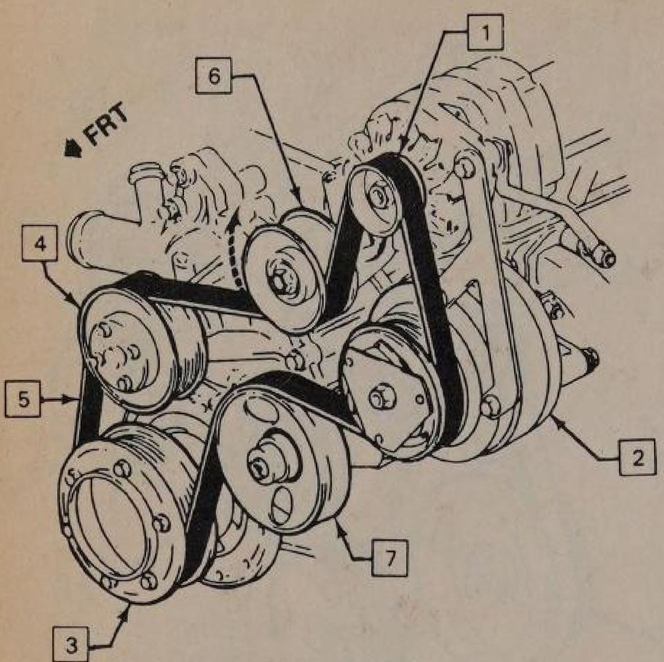
Belt routing — 2.8L engine with automatic transmission

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 O.K.

If coolant is needed, a 50/50 mix of ethylene glycol based 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.

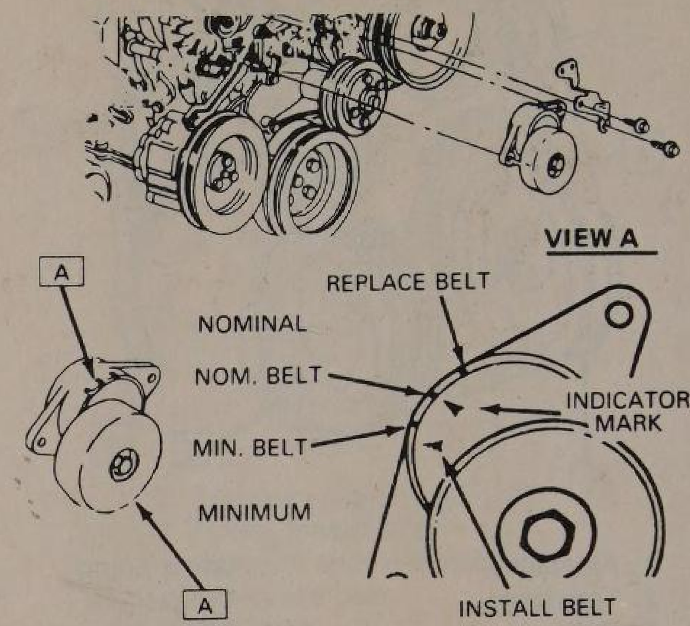
The radiator hoses, clamps, and radiator cap should be checked at the same time as the coolant level. Hoses which are brittle, cracked, or swollen should be replaced. Clamps should be checked for tightness (screwdriver-tight only – do not allow the clamp to cut into the hose or crush the fitting). The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

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).*

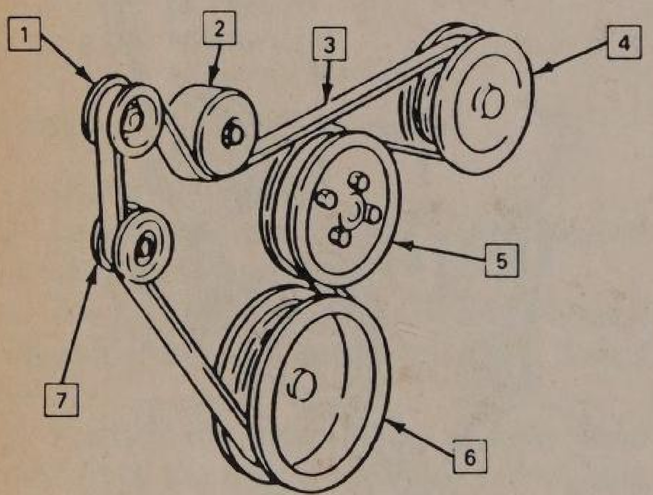


1. Alternator
2. A/C compressor
3. Crankshaft pulley
4. Water pump
5. Belt
6. Tensioner
7. Power steering pump

Belt routing — 1989 3.8L Turbo engine

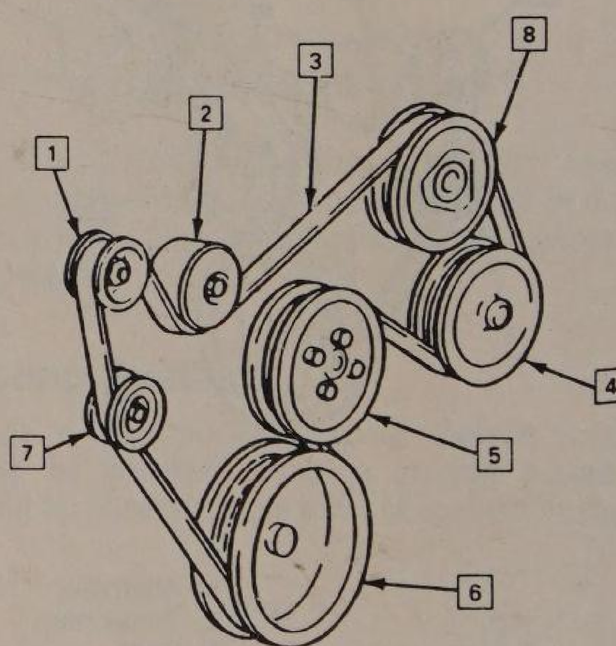


Automatic belt tensioner limits



1. Alternator
2. Tensioner
3. Belt
4. Power steering pump
5. Water pump
6. Crankshaft
7. AIR pump
8. A/C compressor

W/O A/C



A/C

Belt routing — 1990 3.1L engine with automatic transmission

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 2 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 desire.

5. Run the engine until it is hot again.

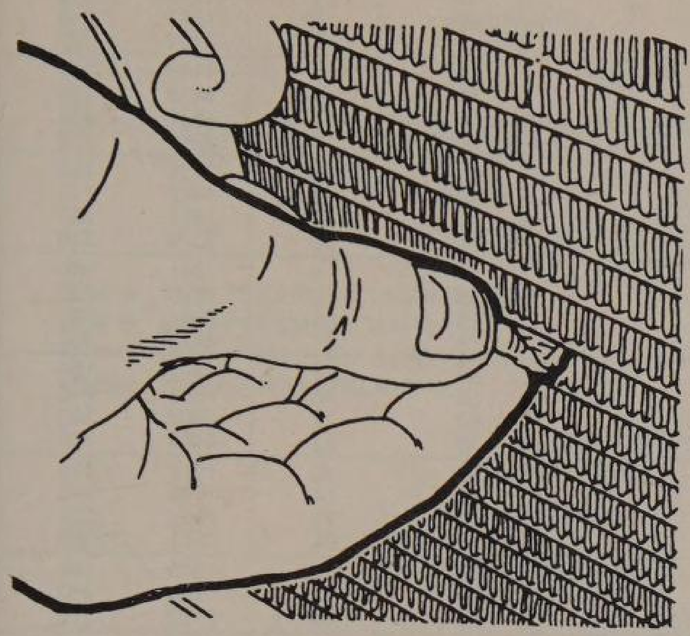
6. Drain the system, then flush with water until it runs clear.

7. Clean out the coolant recovery tank: remove the cap leaving the hoses in place. Remove the tank and drain it of any coolant.

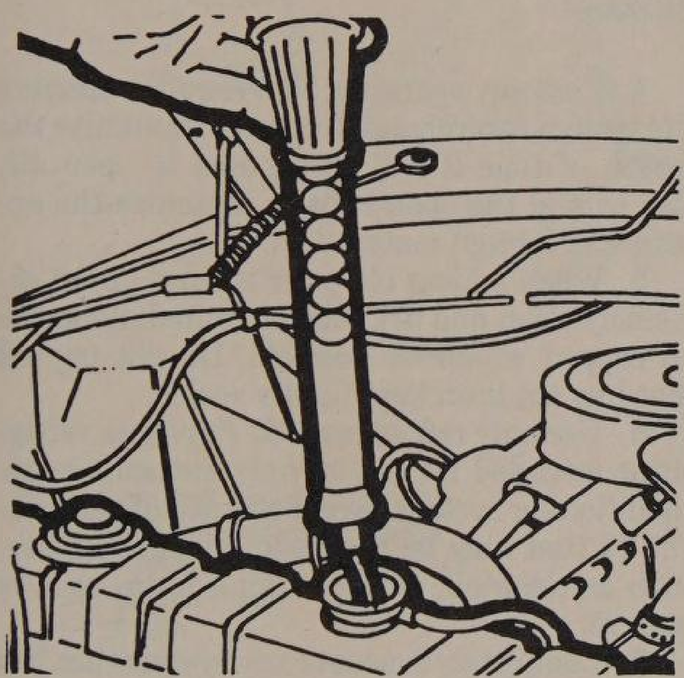
Clean it out with soap and water, empty it, and install it.

8. Close the drain cock and fill the radiator with a 50/50 mix of ethylene glycol based 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.

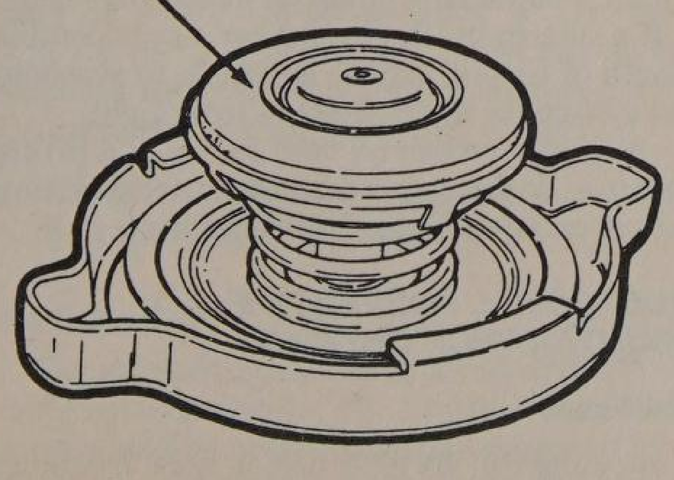
9. Run the engine until the upper radiator hose is hot again (radiator cap still off). With the engine idling, add the 50/50 mix of antifreeze and water to the radiator until the level reaches the bottom of the filler neck. Shut off the engine and install the radiator cap, aligning the arrows with the overflow tube. Turn off the heater.



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



You can use an inexpensive tester to check antifreeze protection



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 5 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.

GENERAL SERVICING PROCEDURES

The most important aspect of air conditioning service is the maintenance of pure and adequate charge of refrigerant in the system. A refrigeration system cannot function properly if a significant percentage of the charge is lost. Leaks are common because the severe vibration encountered in an automobile can easily cause a sufficient cracking or loosening of the air conditioning fittings. As a result, the extreme operating pressures of the system force refrigerant out.

The problem can be understood by considering what happens to the system as it is operated with a continuous leak. Because the fixed orifice (expansion)tube regulates the flow of refrigerant to the evaporator, the level of refrigerant there is fairly constant. The accumulator stores any excess of refrigerant, and so a loss will first appear there as a reduction in the level of liquid. As this level nears the bottom of the vessel, some refrigerant vapor bubbles will begin to appear in the stream of liquid supplied to the fixed orifice. This vapor decreases the capacity of the orifice tube very little. As the quantity of liquid in the condenser decreases, the operating pressure will drop there and through-

RELATIVE HUMIDITY (%)	AMBIENT AIR TEMP °F	AMBIENT AIR TEMP °C	LOW SIDE kPa	LOW SIDE PSIG	ENGINE SPEED (rpm)	CENTER DUCT AIR TEMPERATURE °F	CENTER DUCT AIR TEMPERATURE °C	HIGH SIDE kPa	HIGH SIDE PSIG
20	70	21	200	29	2000	40	4	1034	150
	80	27	200	29		44	7	1310	190
	90	32	207	30		48	9	1689	245
	100	38	214	31		57	14	2103	305
30	70	21	200	29	2000	42	6	1034	150
	80	27	207	30		47	8	1413	205
	90	32	214	31		51	11	1827	265
	100	38	221	32		61	16	2241	325
40	70	21	200	29	2000	45	7	1138	165
	80	27	207	30		49	9	1482	215
	90	32	221	32		55	13	1931	280
	100	38	269	39		65	18	2379	345
50	70	21	207	30	2000	47	8	1241	180
	80	27	221	32		53	12	1620	235
	90	32	234	34		59	15	2034	295
	100	38	276	40		69	21	2413	350
60	70	21	207	30	2000	48	9	1241	180
	80	27	228	33		56	13	1655	240
	90	32	249	36		63	17	2069	300
	100	38	296	43		73	23	2482	360
70	70	21	207	30	2000	50	10	1276	185
	80	27	234	34		58	14	1689	245
	90	32	262	38		65	18	2103	305
	100	38	303	44		75	24	2517	365
80	70	21	207	30	2000	50	10	1310	190
	80	27	234	34		59	15	1724	250
	90	32	269	39		67	19	2137	310
90	70	21	207	30	2000	50	10	1379	200
	80	27	249	36		62	17	1827	265
	90	32	290	42		71	22	2275	330

A/C performance chart

out the high side of the system. As the R-12 continues to be expelled, the pressure available to force the liquid through the orifice tube will continue to decrease, and, eventually, the orifice will prove to be too much of a restriction for adequate flow.

At this point, low side pressure will start to drop, and severe reduction in cooling capacity, marked by freeze-up of the evaporator coil, will result. Eventually, the operating pressure of the evaporator will be lower than the pressure of the atmosphere surrounding it, and air will be drawn into the system wherever there are leaks in the low side.

Because all atmospheric air contains at least some moisture, water will enter the system and mix with the R-12 and the oil. Trace amounts of moisture will cause sludging of the oil, and corrosion of the system. Saturation and clogging of the accumulator filter, and freezing of the orifice tube will eventually result. As air fills the system to a greater and greater extend, it will interfere more and more with the normal flows of refrigerant and heat.

A list of general precautions that should be observed while doing this follows:

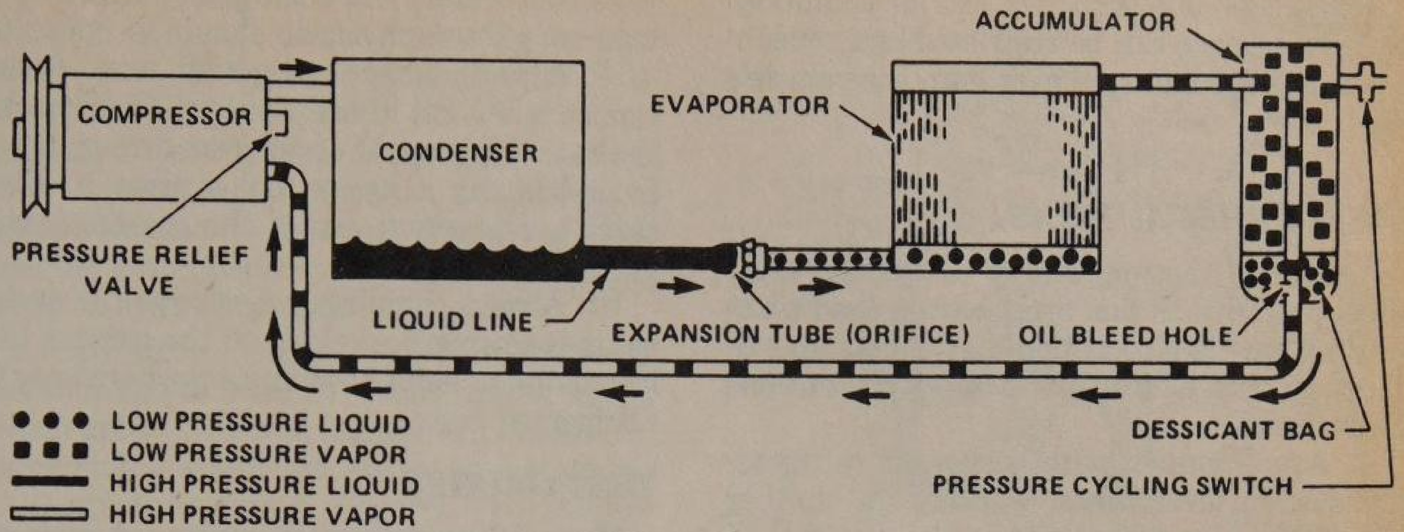
1. Keep all tools as clean and dry as possible.
2. Thoroughly purge the service gauges and hoses of air and moisture before connecting them to the system. Keep them capped when not in use.
3. Thoroughly clean any refrigerant fitting before disconnecting it, in order to minimize the entrance of dirt into the system.
4. Plan any operation that requires opening the system beforehand in order to minimize the length of time it will be exposed to open air. Cap or seal the open ends to minimize the entrance of foreign material.
5. When adding oil, pour it through an extremely clean and dry tube or funnel. Keep the oil capped whenever possible. Do not use oil that has not been kept tightly sealed.
6. Use only refrigerant 12. Purchase refrigerant intended for use in only automotive air conditioning system. Avoid the use of refrigerant 12 that may be packaged for another use, such as cleaning, or powering a horn, as it is impure.
7. Completely evacuate any system that has been opened to replace a component, other than when isolating the compressor, or that has leaked sufficiently to draw in moisture and air. This requires evacuating air and moisture with a good vacuum pump for at least one hour.

   If a system has been open for a considerable length of time it may be advisable to evacuate the system for up to 12 hours (overnight).
8. Use a wrench on both halves of a fitting that is to be disconnected, so as to avoid placing torque on any of the refrigerant lines.

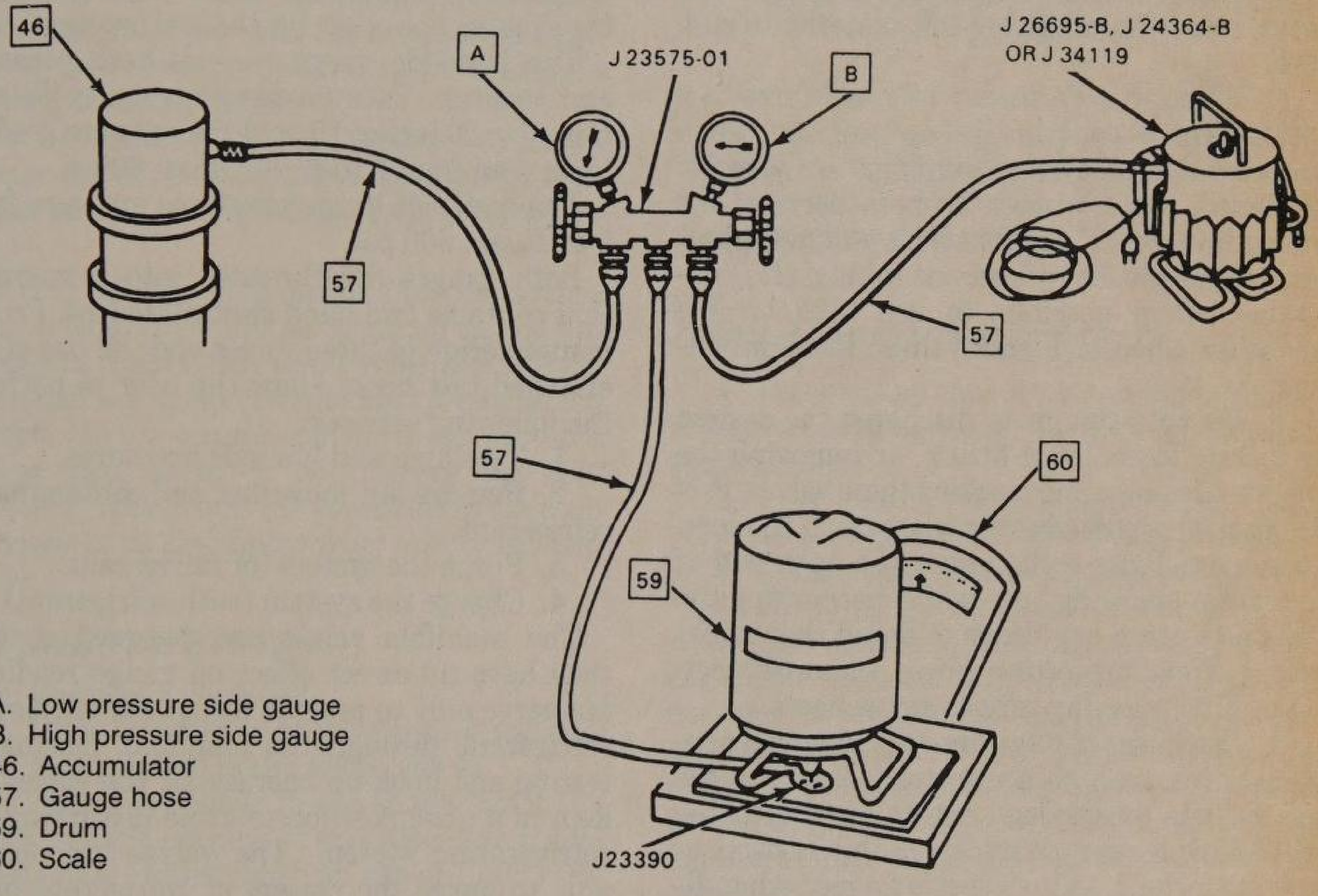
ADDITIONAL PREVENTIVE MAINTENANCE CHECKS

Antifreeze

In order to prevent heater core freeze-up during air conditioner operation, it is necessary to maintain permanent type antifreeze protec-



Air Conditioning System



A. Low pressure side gauge
B. High pressure side gauge
46. Accumulator
57. Gauge hose
59. Drum
60. Scale

A/C system service points

tion of +15°F (-9°C) or lower. A reading of -15°F (-26°C) is ideal since this protection also supplies sufficient corrosion inhibitors for the protection of the engine cooling system.

WARNING: *Do not use antifreeze longer than specified by the manufacturer.*

Radiator Cap

For efficient operation of an air conditioned car's cooling system, the radiator cap should have a holding pressure which meets manufacturer's specifications. A cap which fails to hold these pressure should be replaced.

Condenser

Any obstruction of or damage to the condenser configuration will restrict the air flow which is essential to its efficient operation. It is therefore, a good rule to keep this unit clean and in proper physical shape.

NOTE: *Bug screens are regarded as obstructions.*

Condensation Drain Tube

This single molded drain tube expels the condensation, which accumulates on the bottom of the evaporator housing, into the engine compartment.

If this tube is obstructed, the air conditioning performance can be restricted and condensation buildup can spill over onto the vehicle's floor.

SAFETY PRECAUTIONS

Because of the importance of the necessary safety precautions that must be exercised when working with air conditioning systems and R-12 refrigerant, a recap of the safety precautions are outlined.

1. Avoid contact with a charged refrigeration system, even when working on another part of the air conditioning system or vehicle. If a heavy tool comes into contact with a section of copper tubing or a heat exchanger, it can easily cause the relatively soft material to rupture.
2. When it is necessary to apply force to a fitting which contains refrigerant, as when checking that all system couplings are securely tightened, use a wrench on both parts of the fitting involved, if possible. This will avoid putting torque on the refrigerant tubing. (It is advisable, when possible, to use tube or line wrenches when tightening these flare nut fittings.)
3. Do not attempt to discharge the system by merely loosening a fitting, or removing the service valve caps and cracking these valves. Precise control is possibly only when using the service gauges. Place a rag under the open end of the center charging hose while discharging the system to catch any drops of liquid that might escape. Wear protective gloves when connecting or disconnecting service gauge hoses.
4. Discharge the system only in a well ventilated area, as high concentrations of the gas can exclude oxygen and act as an anesthetic. When leak testing or soldering this is particularly important, as toxic gas is formed when R-12 contacts any flame.
5. Never start a system without first verifying that both service valves are back seated, if equipped, and that all fittings throughout the system are snugly connected.
6. Avoid applying heat to any refrigerant line or storage vessel. Charging may be aided by using water heated to less than 125°F (52°C) to warm the refrigerant container. Never allow a refrigerant storage container to sit out in the sun, or near any other source of heat, such as a radiator.
7. Always wear goggles when working on a system to protect the eyes. If refrigerant contacts the eye, it is advisable in all cases to see a physician as soon as possible.
8. Frostbite from liquid refrigerant should be treated by first gradually warming the area with cool water, and then gently applying petroleum jelly. A physician should be consulted.
9. Always keep refrigerant can fittings capped when not in use. Avoid sudden shock to the can which might occur from dropping it, or from banging a heavy tool against it. Never carry a refrigerant can in the passenger compartment of a car.
10. Always completely discharge the system before painting the vehicle (if the paint is to be baked on), or before welding anywhere near the refrigerant lines.

TEST GAUGES

Most of the service work performed in air conditioning requires the use of a set of two gauges, one for the high (head) pressure side of the system, the other for the low (suction) side.

The low side gauge records both pressure and vacuum. Vacuum readings are calibrated from 0 to 30 inches Hg and the pressure graduations read from 0 to no less than 60 psi.

The high side gauge measures pressure from 0 to at last 600 psi.

Both gauges are threaded into a manifold that contains two hand shut-off valves. Proper manipulation of these valves and the use of the attached test hoses allow the user to perform the following services:

1. Test high and low side pressures.
2. Remove air, moisture, and contaminated refrigerant.
3. Purge the system (of refrigerant).
4. Charge the system (with refrigerant).

The manifold valves are designed so that they have no direct effect on gauge readings, but serve only to provide for, or cut off, flow of refrigerant through the manifold. During all testing and hook-up operations, the valves are kept in a close position to avoid disturbing the refrigeration system. The valves are opened only to purge the system or refrigerant or to charge it.

INSPECTION

CAUTION: *The compressed refrigerant used in the air conditioning system expands into the atmosphere at a temperature of –21.7°F (–30°C) or lower. This will freeze any surface, including your eyes, that it contacts. In addition, the refrigerant decomposes into a poisonous gas in the presence of a flame. Do not open or disconnect any part of the air conditioning system.*

Sight Glass Check

NOTE: *Most late model vehicles are not equipped with a sight glass. The only way to find out if the system has enough refrigerant is to install a set of test gauges.*

You can safely make a few simple checks to determine if your air conditioning system needs service. The tests work best if the temperature is warm (about 70°F [21.1°C]).

NOTE: *If your vehicle is equipped with an after market air conditioner, the following system check may not apply. You should contact the manufacturer of the unit for instructions on systems checks.*

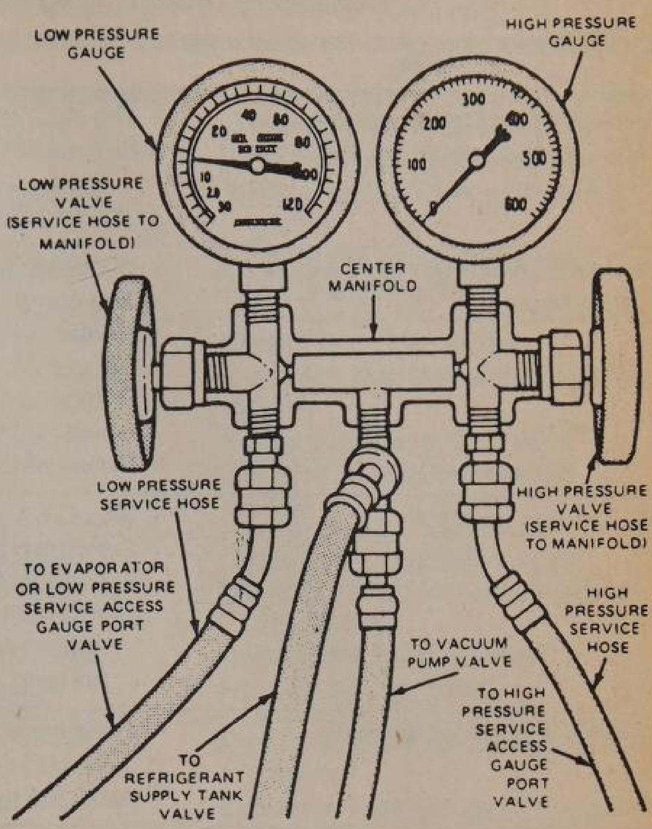
1. Operation of the air conditioning blower at all four speeds with the mode button in any position except OFF and engagement of the compressor clutch would indicate that the electrical circuit are functioning properly. (The blower will not operate in any speed with the mode button in the OFF position.)
2. The same hand felt temperature of the evaporator inlet pipe and the accumulator surface of an operating system would indicate a properly charged system.
3. Operation of the air conditioning control selector (mode) button to distribute air from designed outlets would indicate proper functioning.

NOTE: *If it is determined that the system has a leak, it should be corrected as soon as possible. Leaks may allow moisture to enter and cause a very expensive rust problem. Exercise the air conditioner for a few minutes, every two weeks or so, during the cold months. This avoids the possibility of the compressor seals drying out from lack of lubrication.*

TESTING THE SYSTEM

1. Connect a gauge set.
2. Close (clockwise) both gauge set valves.
3. Mid-position both service valves.
4. Park the vehicle in the shade. Start the engine, set the parking brake, place the transmission in **N** and establish an idle of 1,500 rpm.
5. Run the air conditioning system for full cooling, but NOT in the **MAX** or **COLD** mode.
6. Insert a thermometer into the center air outlet.
7. Use the accompanying performance chart for a specifications reference. If pressures are abnormal, refer to the air conditioner performance chart in this section.

WARNING: *These pressures are the norm for an ambient temperature of 70–80°F (21–27°C). Higher air temperatures along with high humidity will cause higher system pressures. At idle speed and an ambient temperature of 110°F (43°F), the high pressure reading can exceed 300 psi. Under these extreme conditions, you can keep the pressures down by directing a large electric floor fan through the condenser.*



Air conditioning gauge set

DISCHARGING THE SYSTEM

1. Remove the caps from the high and low pressure charging valves in the high and low pressure lines.
2. Turn both manifold gauge set hand valves to the fully closed (clockwise) position.
3. Connect the manifold gauge set.
4. If the gauge set hoses do not have the gauge port actuating pins, install fitting adapters on the manifold gauge set hoses. If the car does not have a service access gauge port valve, connect the gauge set low pressure hose to the evaporator service access gauge port valve. A special adapter may be required to attach the manifold gauge set to the high pressure service access gauge port valve.
5. Place the end of the center hose away from you and the car.
6. Open the low pressure gauge valve slightly and allow the system pressure to bleed off.
7. When the system is just about empty, open the high pressure valve very slowly to avoid losing an excessive amount of refrigerant oil. Allow any remaining refrigerant to escape.

EVACUATING THE SYSTEM

NOTE: *This procedure requires the use of a vacuum pump.*

1. Connect the manifold gauge set.
2. Discharge the system.
3. On 1983 and later models, make sure that the low pressure gauge set hose is connected to the low pressure service gauge port

Troubleshooting Basic Air Conditioning Problems

Problem	Cause	Solution
There's little or no air coming from the vents (and you're sure it's on)	• The A/C fuse is blown • Broken or loose wires or connections • The on/off switch is defective	• Check and/or replace fuse • Check and/or repair connections • Replace switch
The air coming from the vents is not cool enough	• Windows and air vent wings open • The compressor belt is slipping • Heater is on • Condenser is clogged with debris • Refrigerant has escaped through a leak in the system • Receiver/drier is plugged	• Close windows and vent wings • Tighten or replace compressor belt • Shut heater off • Clean the condenser • Check system • Service system
The air has an odor	• Vacuum system is disrupted • Odor producing substances on the evaporator case • Condensation has collected in the bottom of the evaporator housing	• Have the system checked/repaired • Clean the evaporator case • Clean the evaporator housing drains
System is noisy or vibrating	• Compressor belt or mountings loose • Air in the system	• Tighten or replace belt; tighten mounting bolts • Have the system serviced
Sight glass condition		
Constant bubbles, foam or oil streaks	• Undercharged system	• Charge the system
Clear sight glass, but no cold air	• No refrigerant at all	• Check and charge the system
Clear sight glass, but air is cold	• System is OK	
Clouded with milky fluid	• Receiver drier is leaking dessicant	• Have system checked
Large difference in temperature of lines	• System undercharged	• Charge and leak test the system
Compressor noise	• Broken valves • Overcharged • Incorrect oil level • Piston slap • Broken rings • Drive belt pulley bolts are loose	• Replace the valve plate • Discharge, evacuate and install the correct charge • Isolate the compressor and check the oil level. Correct as necessary. • Replace the compressor • Replace the compressor • Tighten with the correct torque specification
Excessive vibration	• Incorrect belt tension • Clutch loose • Overcharged • Pulley is misaligned	• Adjust the belt tension • Tighten the clutch • Discharge, evacuate and install the correct charge • Align the pulley
Condensation dripping in the passenger compartment	• Drain hose plugged or improperly positioned • Insulation removed or improperly installed	• Clean the drain hose and check for proper installation • Replace the insulation on the expansion valve and hoses
Frozen evaporator coil	• Faulty thermostat • Thermostat capillary tube improperly installed • Thermostat not adjusted properly	• Replace the thermostat • Install the capillary tube correctly • Adjust the thermostat
Low side low—high side low	• System refrigerant is low • Expansion valve is restricted	• Evacuate, leak test and charge the system • Replace the expansion valve
Low side high—high side low	• Internal leak in the compressor—worn	• Remove the compressor cylinder head and inspect the compressor. Replace the valve plate assembly if necessary. If the compressor pistons, rings or

Troubleshooting Basic Air Conditioning Problems (cont.)

Problem	Cause	Solution
Low side high—high side low (cont.)		cylinders are excessively worn or scored replace the compressor
	• Cylinder head gasket is leaking	• Install a replacement cylinder head gasket
	• Expansion valve is defective	• Replace the expansion valve
	• Drive belt slipping	• Adjust the belt tension
Low side high—high side high	• Condenser fins obstructed	• Clean the condenser fins
	• Air in the system	• Evacuate, leak test and charge the system
	• Expansion valve is defective	• Replace the expansion valve
	• Loose or worn fan belts	• Adjust or replace the belts as necessary
Low side low—high side high	• Expansion valve is defective	• Replace the expansion valve
	• Restriction in the refrigerant hose	• Check the hose for kinks—replace if necessary
	• Restriction in the receiver/drier	• Replace the receiver/drier
	• Restriction in the condenser	• Replace the condenser
Low side and high side normal (inadequate cooling)	• Air in the system	• Evacuate, leak test and charge the system
	• Moisture in the system	• Evacuate, leak test and charge the system

on the top center of the accumulator/drier assembly and the high pressure hose connected to the high pressure service gauge port on the compressor discharge line.

4. Connect the center service hose to the inlet fitting of the vacuum pump.

5. Turn both gauge set valves to the wide open position.

6. Start the pump and note the low side gauge reading.

7. Operate the pump until the low pressure gauge reads 25–30 inch Hg. Continue running the vacuum pump for 10 minutes more. If you have replaced some component in the system, run the pump for an additional 20–30 minutes.

8. Leak test the system. Close both gauge set valves. Turn off the pump. The needle should remain stationary at the point at which the pump was turned off. If the needle drops to zero rapidly, there is a leak in the system which must be repaired.

LEAK TESTING

Some leak tests can be performed with a soapy water solution. There must be at least a 1/2 lb. charge in the system for a leak to be detected. The most extensive leak tests are performed with either a Halide flame type leak tester or the more preferable electronic leak tester.

In either case, the equipment is expensive, and, the use of a Halide detector can be **extremely** hazardous!

CHARGING THE SYSTEM

CAUTION: *NEVER OPEN THE HIGH PRESSURE SIDE WITH A CAN OF REFRIGERANT CONNECTED TO THE SYSTEM! OPENING THE HIGH PRESSURE SIDE WILL OVER PRESSURIZE THE CAN, CAUSING IT TO EXPLODE!*

1. Start and run the engine until it reaches operating temperature. Then set the air conditioning mode control button on **OFF**.

2. With the R-12 cans inverted, open the R-12 source valve(s) and allow one 14 oz. can of liquid R-12 to flow into the system through the low side service fitting.

3. As soon as one can of R-12 has been added to the system, immediately engage the compressor by setting the air conditioning control button to **NORM** and the blower speed on **HI**, to draw in the remainder of the R-12 charge.

NOTE: *The charging operation can be speeded up by using a large volume fan to pass air over the condenser. If the condenser temperature is maintained below the charging cylinder temperature, R-12 will enter the system more rapidly.*

4. Turn off the R-12 source valve and run engine for 30 seconds to clear the lines and gauges.

5. With the engine running, remove the charging low side hose adapter from the accumulator service fitting. Unscrew rapidly to avoid excess R-12 escape from the system.

CAUTION: *Never remove a gauge line from its adapter when the line is connected to the air conditioning system. Always remove the line adapter from the service fitting to disconnect a line. Do not remove charging hose at the gauge set while attached to the accumulator. This will result in complete discharge of the system due to the depressed Schrader valve in service low side fitting, and may cause personal injury due to escaping R-12.*

6. Replace protective cap on accumulator fitting.
7. Turn engine off.
8. Leak check system with electronic leak detector J-29547 or equivalent.
9. Start engine.
10. With the system fully charged and leak checked, continue to operate the system performance.

CAUTION: *NEVER ALLOW THE HIGH PRESSURE SIDE READING TO EXCEED 240 psi.*

The maximum charge for systems is:
1982–87: 48 oz (3.00 lbs.) [1.36 kg]
1988: 36 oz (2.25 lbs.) [1.02 kg]
1989–90: 56 oz (3.50 lbs.) [1.59 kg].

NOTE: *Remember that the disposable cans are only 14 oz., not 16 oz.*

ADDING REFRIGERANT OIL

Refrigerant oil can be purchased in raw or pressurized cans. The raw oil can be added when the system is discharged and has no pressure or forced in under pressure using a oil injection pump. The can is pressurized with R-12 and has 4 oz. of refrigerant oil per can. The oil is added in the same manner as the refrigerant.

Refrigerant oil must be added after the system has been discharged. The air conditioner system requires a total of **6 fluid ounces** (180ml) of 525 viscosity refrigerant oil ONLY. New oil quantities must be added during component replacement.

With no signs of excessive leakage, add as follows:

1. If the R-4 compressor is removed, the oil in the compressor should be drained, measured and recorded. Added the same amount plus 1 oz. (30ml) to the new compressor.

NOTE: *When installing a new compressor, drain the new compressor and add the amount of oil in step 1. Do not add the amount in step 1 without draining the compressor first because the system will be over filled.*

2. If the evaporator is removed, add 3 oz. (90ml) of oil.
3. If the condenser is removed, add 1 oz. (30ml) of oil.
4. If the accumulator is removed, the oil in it must be drained, measured and recorded. The same amount of new oil must be replaced. If installing a new accumulator, add an extra 2 oz. (60ml) plus the original recording.

With signs of excessive leakage, add oil as follows:

1. If less than 3 oz. (90ml) is drained out of the accumulator, 3 oz. (90ml) of oil should be installed.
2. If more than 3 oz. (90ml) of oil was drained, add that amount.

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.

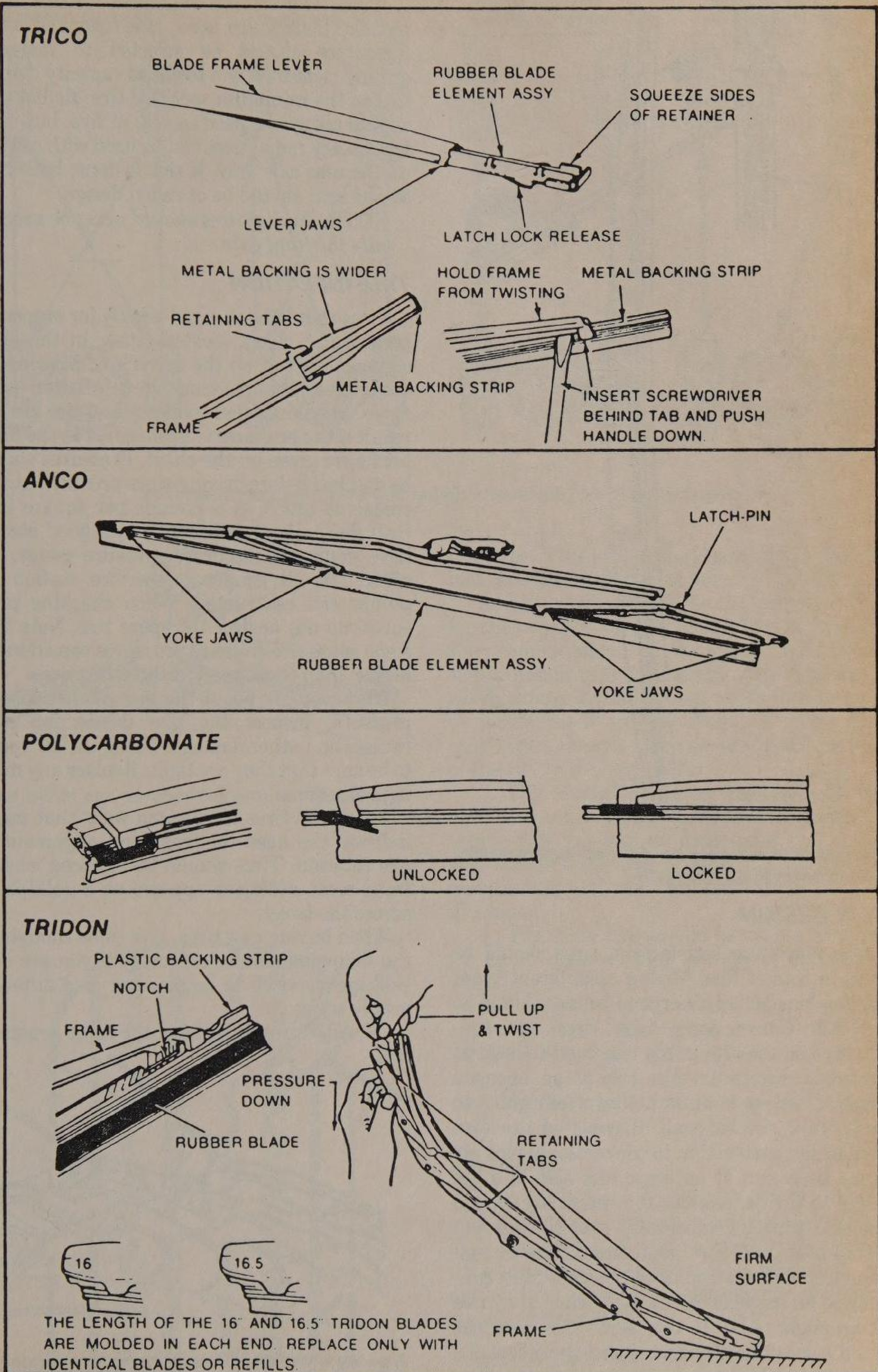
To install the new element, slide it into the housing retaining tabs, lining up the slot in the element with the housing tab and snap the element into place.

Tires and Wheels

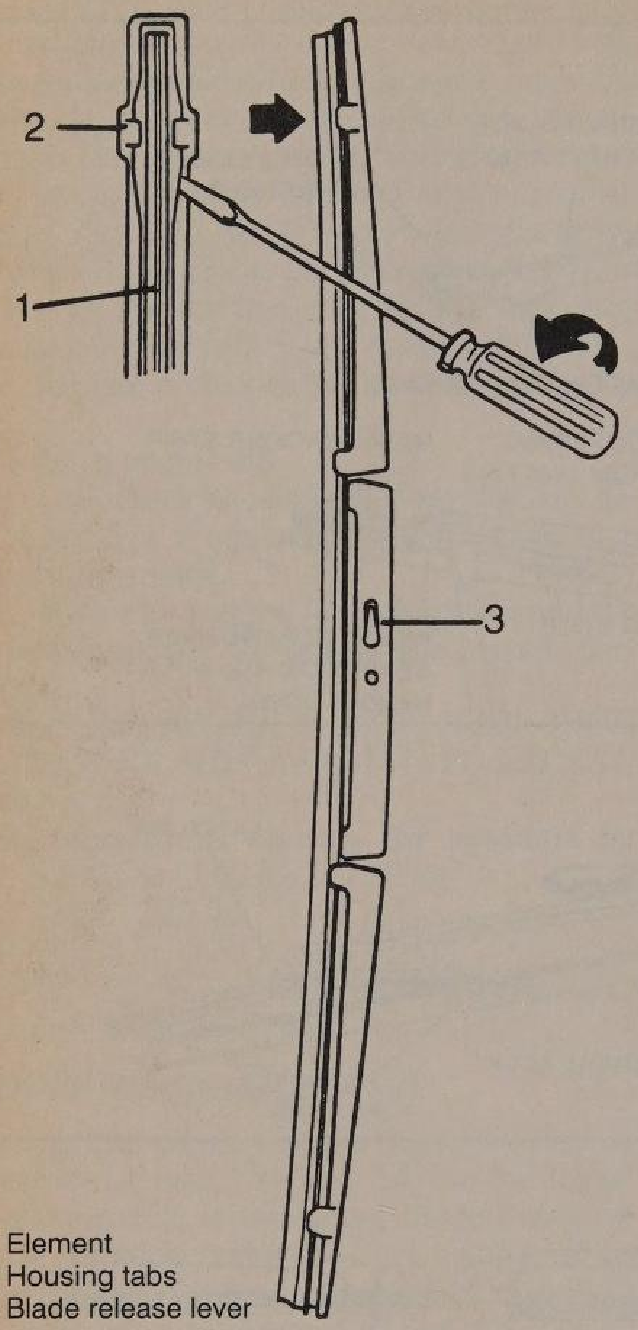
TIRE ROTATION

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

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



Wiper insert replacement



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

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

TIRE DESIGN

For maximum satisfaction, tires should be used in sets of five. Mixing or different types (radial, bias-belted, fiberglass belted) should be avoided. Conventional bias tires are constructed so that the cords run bead-to-bead at an angle. Alternate plies run at an opposite angle. This type of construction gives rigidity to both tread and sidewall. Bias-belted tires are similar in construction to conventional bias ply tires. Belts run at an angle and also at a 90° angle to the bead, as in the radial tire. Tread life is improved considerably over the conventional bias tire. The radial tire differs in construction, but instead of the carcass plies running at an angle of 90° to each other, they run at an angle of 90° to the bead. This gives the tread a great deal of rigidity and the sidewall a great deal of flexibility and accounts for the characteristic bulge associated with radial tires.

Radial tire are recommended for use on all models. If they are used, tire sizes and wheel diameters should be selected to maintain ground clearance and tire load capacity equivalent to the minimum specified tire. Radial tires should always be used in sets of five, but in an emergency radial tires can be used with caution on the rear axle only. If this is done, both tires on the rear should be of radial design.

NOTE: *Radial tires should never be used on only the front axle.*

TIRE INFLATION

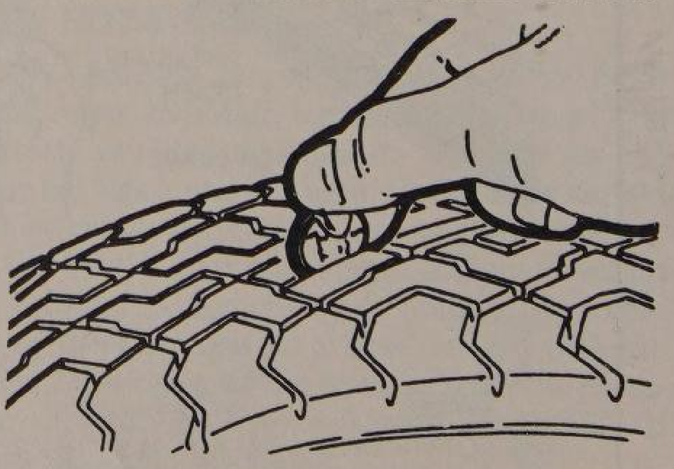
Tires should be checked weekly for proper air pressure. A chart, located either in the glove compartment or on the driver's or passenger's door, gives the recommended inflation pressures. Maximum fuel economy and tire life will result if the pressure is maintained at the highest figure given on the chart. Pressures should be checked before driving since pressure can increase as much as 6 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.

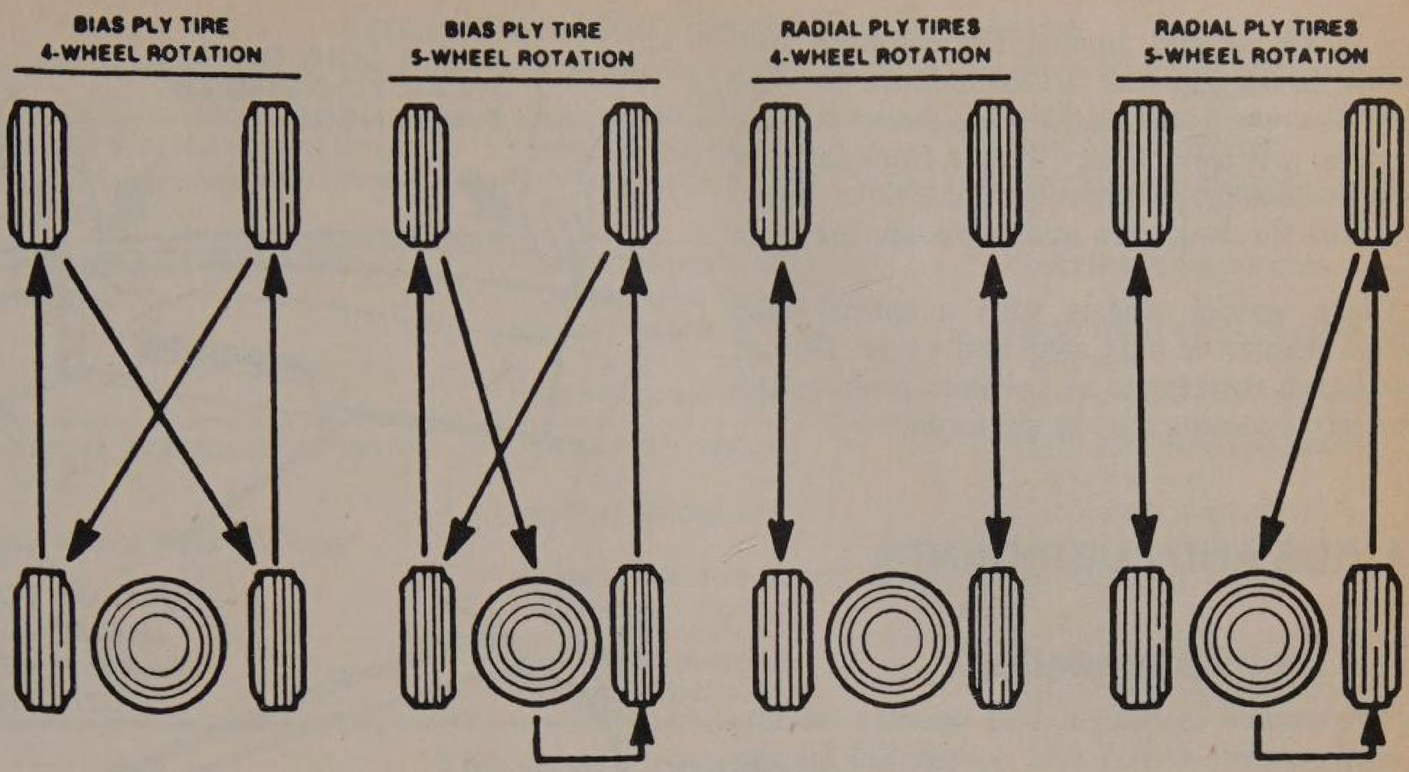
Check the tires for uneven wear that might indicate the need for front end alignment or tire rotation. Tires should be replaced when a tread wear indicator appears as a solid band across the tread.

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:

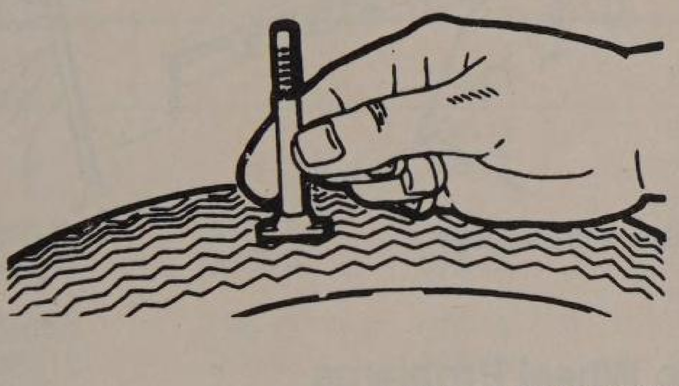
1. All 4 tires must be of the same construc-



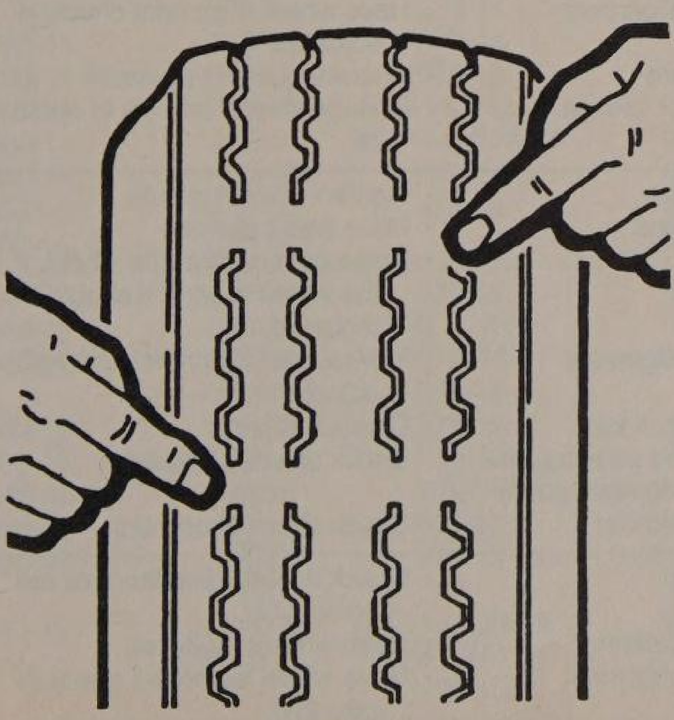
A penny works as well as anything for checking the tire tread depth; when you can see the top of Lincoln's head, its time for a new tire.



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



Tread depth can be checked with an inexpensive gauge



Tread wear indicators will appear when the tires is worn out

tion 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 25mm (1 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.

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).*

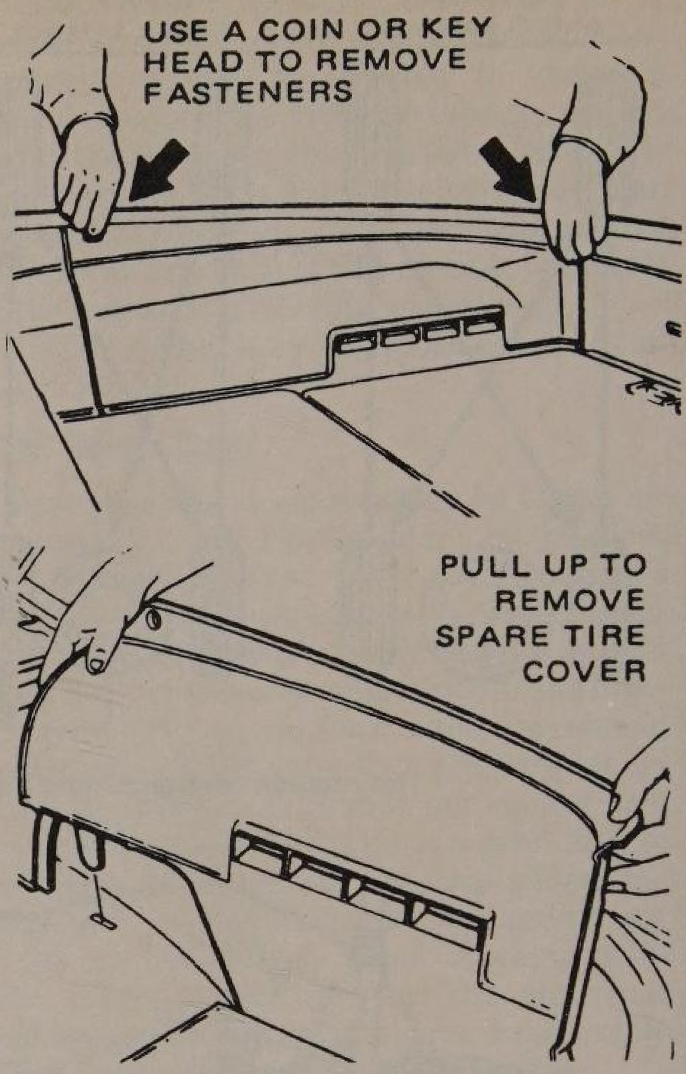
STORAGE

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.

CARE OF SPECIAL WHEELS

An aluminum wheel may become porous and leak air. Locate the leak by inflating the assembly to 40 psi and dipping the assembly into water. Mark the leak areas. Remove the tire from the wheel and scuff the inside rim surface with 80 grit sandpaper. Apply a thick layer of adhesive/sealant part number 1052366 or equivalent to the leak area and allow six hours to dry.

Clean special wheels with a special mag wheel cleaner or mild soap and water. Do not use harsh detergents or solvents because the protective coating may be damaged.



Spare tire storage

FLUIDS AND LUBRICANTS

Fuel Recommendations

The engine is designed to operate on unleaded gasoline ONLY and is essential for the proper 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. However, the 3.8L Turbo, 5.0L and 5.7L high performance engines are recommended to use a fuel with an octane

Troubleshooting Basic Wheel Problems

Problem	Cause	Solution
The car's front end vibrates at high speed	• The wheels are out of balance • Wheels are out of alignment	• Have wheels balanced • Have wheel alignment checked/adjusted
Car pulls to either side	• Wheels are out of alignment • Unequal tire pressure • Different size tires or wheels	• Have wheel alignment checked/adjusted • Check/adjust tire pressure • Change tires or wheels to same size
The car's wheel(s) wobbles	• Loose wheel lug nuts • Wheels out of balance • Damaged wheel • Wheels are out of alignment • Worn or damaged ball joint • Excessive play in the steering linkage (usually due to worn parts) • Defective shock absorber	• Tighten wheel lug nuts • Have tires balanced • Raise car and spin the wheel. If the wheel is bent, it should be replaced • Have wheel alignment checked/adjusted • Check ball joints • Check steering linkage • Check shock absorbers
Tires wear unevenly or prematurely	• Incorrect wheel size • Wheels are out of balance • Wheels are out of alignment	• Check if wheel and tire size are compatible • Have wheels balanced • Have wheel alignment checked/adjusted

Troubleshooting Basic Tire Problems

Problem	Cause	Solution
The car's front end vibrates at high speeds and the steering wheel shakes	• Wheels out of balance • Front end needs aligning	• Have wheels balanced • Have front end alignment checked
The car pulls to one side while cruising	• Unequal tire pressure (car will usually pull to the low side) • Mismatched tires • Front end needs aligning	• Check/adjust tire pressure • Be sure tires are of the same type and size • Have front end alignment checked
Abnormal, excessive or uneven tire wear See "How to Read Tire Wear"	• Infrequent tire rotation • Improper tire pressure • Sudden stops/starts or high speed on curves	• Rotate tires more frequently to equalize wear • Check/adjust pressure • Correct driving habits
Tire squeals	• Improper tire pressure • Front end needs aligning	• Check/adjust tire pressure • Have front end alignment checked

Tire Size Comparison Chart

"Letter" sizes			Inch Sizes	Metric-inch Sizes		
"60 Series"	"70 Series"	"78 Series"	1965–77	"60 Series"	"70 Series"	"80 Series"
			5.50-12, 5.60-12	165/60-12	165/70-12	155-12
		Y78-12	6.00-12			
		W78-13	5.20-13	165/60-13	145/70-13	135-13
		Y78-13	5.60-13	175/60-13	155/70-13	145-13
			6.15-13	185/60-13	165/70-13	155-13, P155/80-13
A60-13	A70-13	A78-13	6.40-13	195/60-13	175/70-13	165-13
B60-13	B70-13	B78-13	6.70-13	205/60-13	185/70-13	175-13
			6.90-13			
C60-13	C70-13	C78-13	7.00-13	215/60-13	195/70-13	185-13
D60-13	D70-13	D78-13	7.25-13			
E60-13	E70-13	E78-13	7.75-13			195-13
			5.20-14	165/60-14	145/70-14	135-14
			5.60-14	175/60-14	155/70-14	145-14
			5.90-14			
A60-14	A70-14	A78-14	6.15-14	185/60-14	165/70-14	155-14
	B70-14	B78-14	6.45-14	195/60-14	175/70-14	165-14
	C70-14	C78-14	6.95-14	205/60-14	185/70-14	175-14
D60-14	D70-14	D78-14				
E60-14	E70-14	E78-14	7.35-14	215/60-14	195/70-14	185-14
F60-14	F70-14	F78-14, F83-14	7.75-14	225/60-14	200/70-14	195-14
G60-14	G70-14	G77-14, G78-14	8.25-14	235/60-14	205/70-14	205-14
H60-14	H70-14	H78-14	8.55-14	245/60-14	215/70-14	215-14
J60-14	J70-14	J78-14	8.85-14	255/60-14	225/70-14	225-14
L60-14	L70-14		9.15-14	265/60-14	235/70-14	
	A70-15	A78-15	5.60-15	185/60-15	165/70-15	155-15
B60-15	B70-15	B78-15	6.35-15	195/60-15	175/70-15	165-15
C60-15	C70-15	C78-15	6.85-15	205/60-15	185/70-15	175-15
	D70-15	D78-15				
E60-15	E70-15	E78-15	7.35-15	215/60-15	195/70-15	185-15
F60-15	F70-15	F78-15	7.75-15	225/60-15	205/70-15	195-15
G60-15	G70-15	G78-15	8.15-15/8.25-15	235/60-15	215/70-15	205-15
H60-15	H70-15	H78-15	8.45-15/8.55-15	245/60-15	225/70-15	215-15
J60-15	J70-15	J78-15	8.85-15/8.90-15	255/60-15	235/70-15	225-15
	K70-15		9.00-15	265/60-15	245/70-15	230-15
L60-15	L70-15	L78-15, L84-15	9.15-15			235-15
	M70-15	M78-15				255-15
		N78-15				

Note: Every size tire is not listed and many size comparisons are approximate, based on load ratings. Wider tires than those supplied new with the vehicle, should always be checked for clearance.

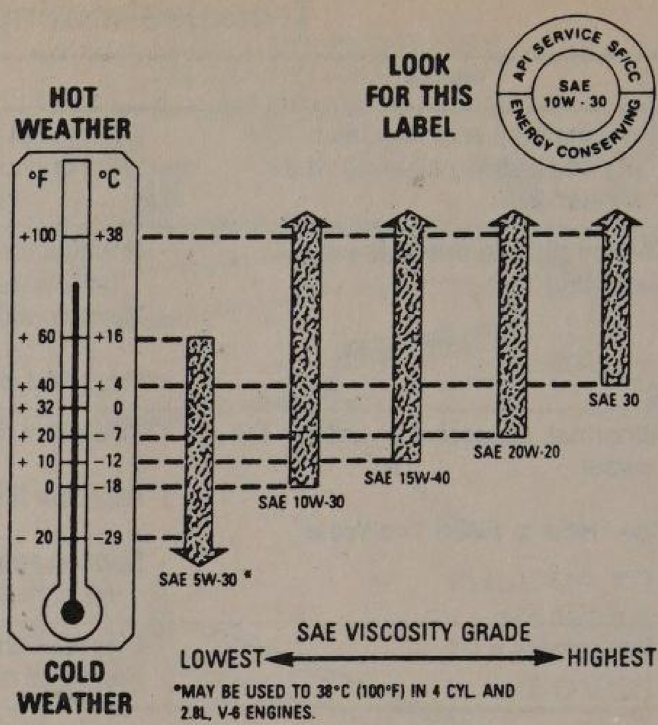
rating of 93 or greater. Using fuels with a lower octane may decrease engine performance, increase emissions and engine wear.

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 "SG", "SG/CC" or "SG/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.



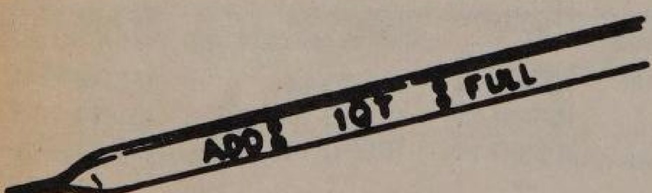
Select the lowest SAE viscosity grade oil for the expected temperature range

OIL LEVEL CHECK

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

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.

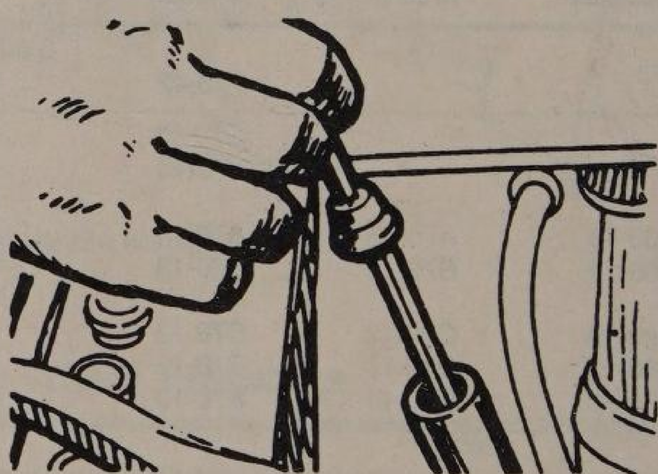


The oil level should be between the "ADD" and "Full" marks on the dipstick

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.

5. Replace the dipstick and check the oil level again after adding any oil. Be careful not to overfill the crankcase. Approximately 1

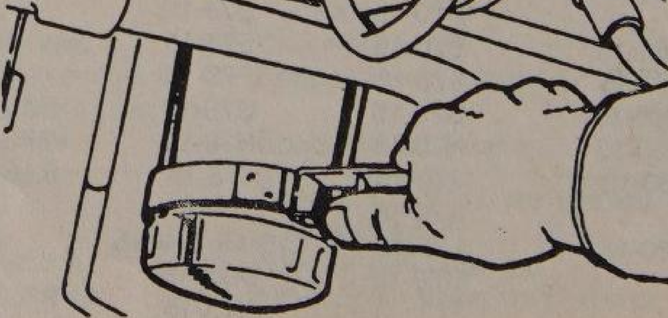


The oil level is checked with the dipstick

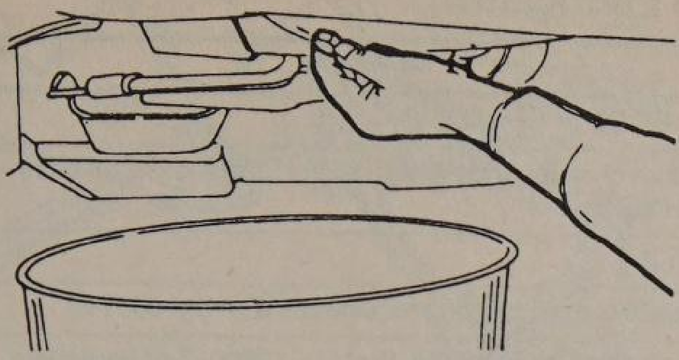
quart of oil will raise the level from the "ADD" mark to the "FULL" mark. Excess oil will generally be consumed at an accelerated rate.

CHANGING OIL AND FILTER

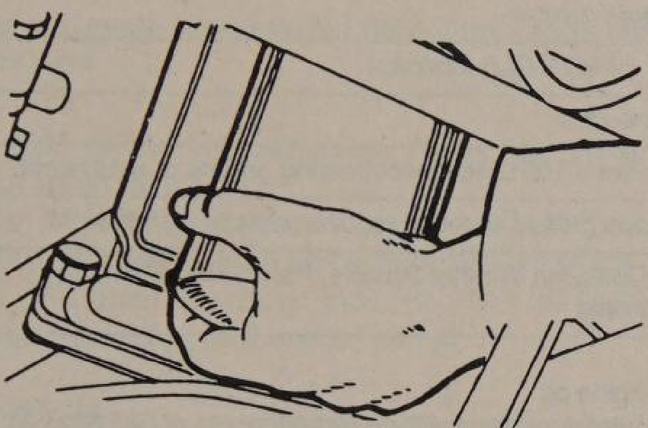
The oil is to be changed every 7500 miles or 12 months, which ever occurs first. Under normal conditions, change the filter at first oil change and then at every other oil change,



Remove the oil filter with a strap wrench



By keeping inward pressure on the plug as you unscrew it, oil will not escape past the threads



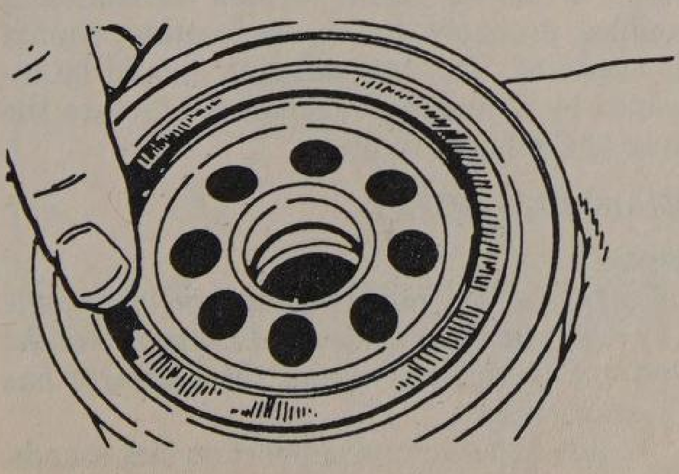
Install the new oil filter by hand

unless 12 months pass between changes. We recommend that the oil filter be changed every time the oil is changed. About a quart of dirty oil remains in the old filter. For a few dollars, it is a small expense for extended engine life.

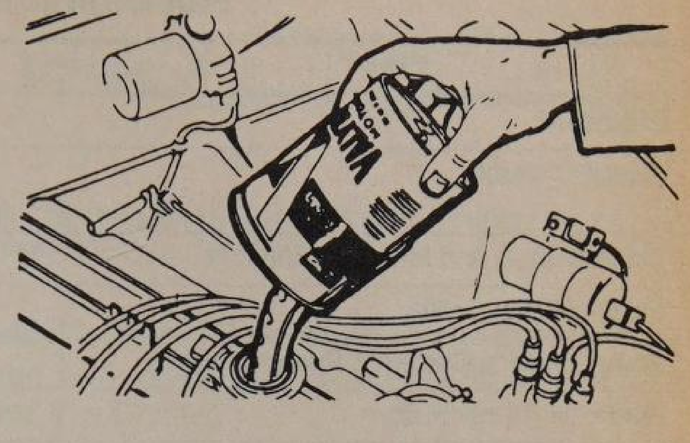
If driving under such conditions, such as : dusty areas, trailer towing, idling for long periods of time, low speed operation, or when operating with temperatures below freezing and driving short distances (under 4 miles), change the oil and filter every 3000 miles or 3 months.

REMOVAL AND INSTALLATION

1. Raise the car and support on jack stands. Remove the oil pan plug and drain oil into a catch pan.



Coat the new oil filter gasket with clean oil



Add oil through the capped opening in he cylinder head cover

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 hand tight. Install the oil pan plug and torque to 20 ft. lbs. (27 Nm).
4. Make sure the plug is tight in the pan. 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 DEXRON®II Automatic Transmission Fluid.

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.

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

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.

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 1 pint of ATF will 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.

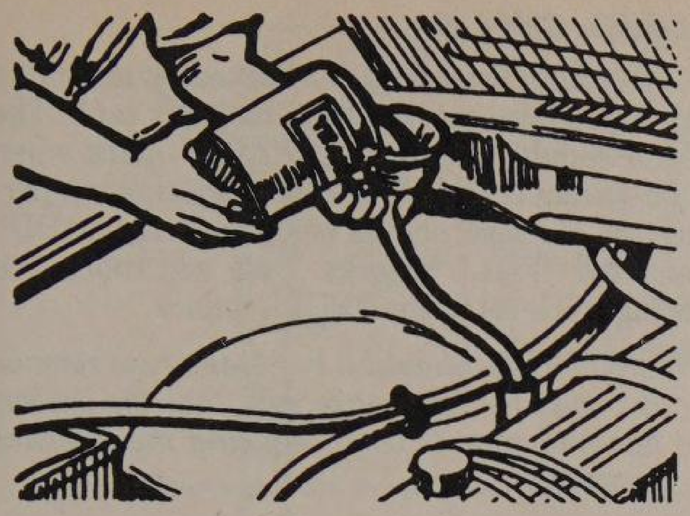
DRAIN AND REFILL

Manual

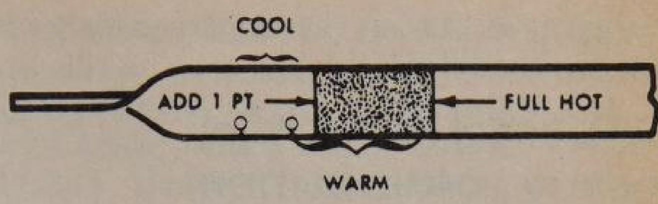
NOTE: *Before removing the oil from the transmission, drive the car to ensure that the oil has been warmed and the sediment has been stirred.*

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



Add automatic transmission fluid through the dipstick tube



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

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 5mm ($^3/_{16}$ 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.

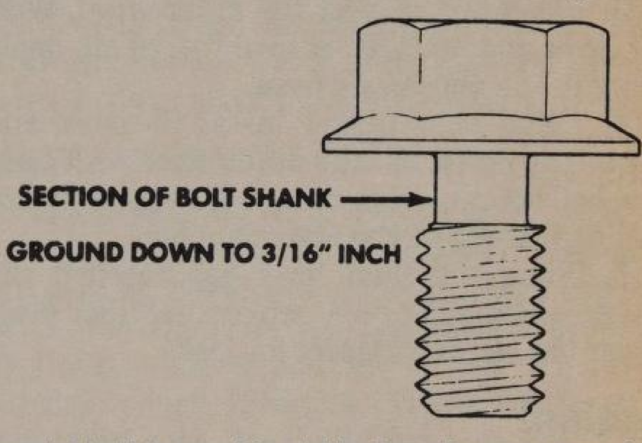
4. Clean the oil pan and screen. Clean the mating surface of the transmission with a scraper. Wash the mating surfaces with solvent to remove the oil film.

5. Install the screen with a new filter and O-ring (coat the O-ring with petroleum jelly).

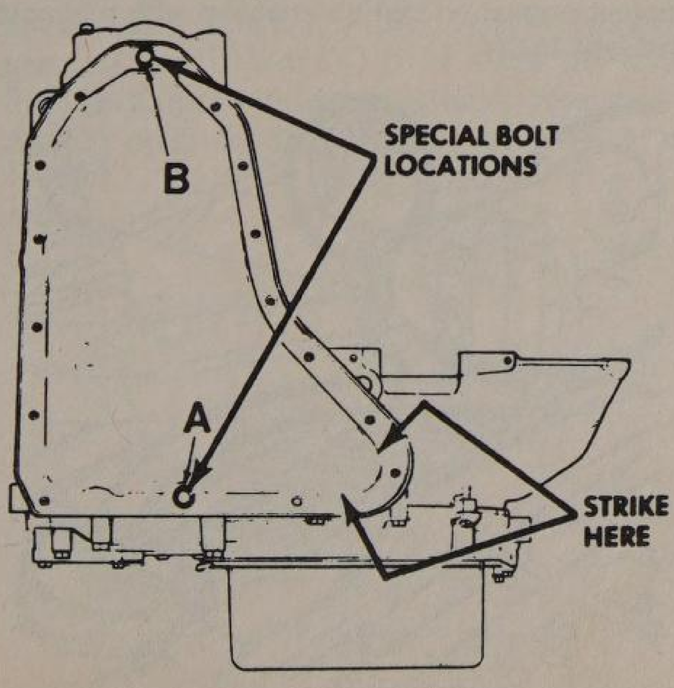
6. Apply R.T.V. sealant to both sides of the new gasket (be sure to seal around bolt holes) and position on the oil pan.

7. Raise the oil pan into position and install the bolts. Torque the bolts and lower the car.

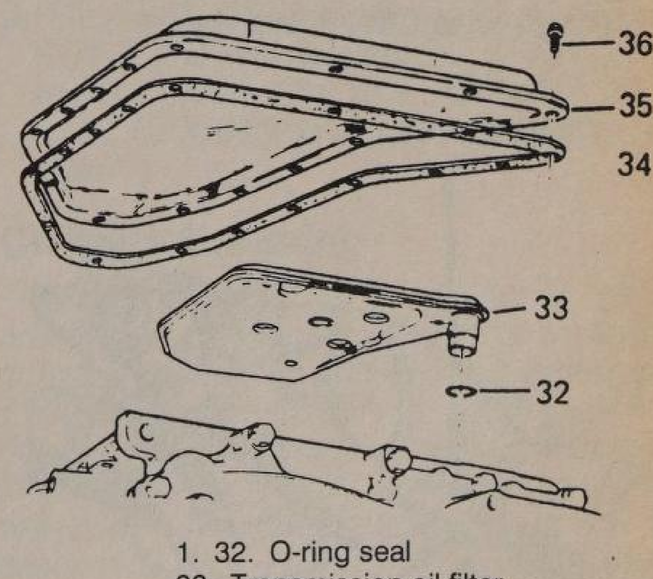
8. Add new transmission fluid through the



Special bolt is used to aid in the oil pan removal



Using special bolts to remove the oil pan



1. 32. O-ring seal
33. Transmission oil filter
34. Pan gasket
35. Oil pan
36. Oil pan bolt

Automatic transmission pan and filter

dipstick tube. Operate the engine and transmission and check for leaks.

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. Use a suction pump to remove the fluid if available.
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.

Remove the filler plug to check the lubricant level in the rear axle

LEVEL CHECK

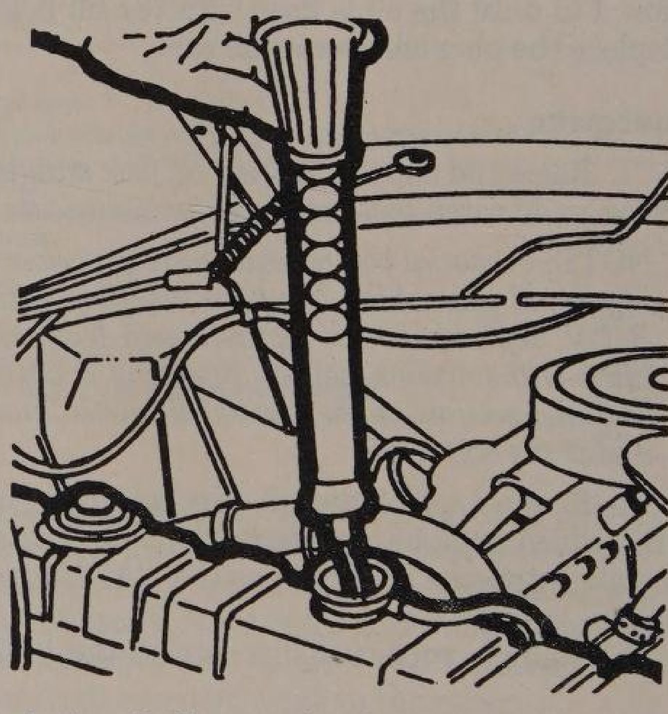
The fluid level may be checked by observing the fluid level marks of the recovery tank. The level should be below the "ADD" mark when the system is cold. At normal operating temperatures, the level should be between the "ADD" and the "FULL" marks. Only add coolant to bring the level to the "FULL" mark.

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

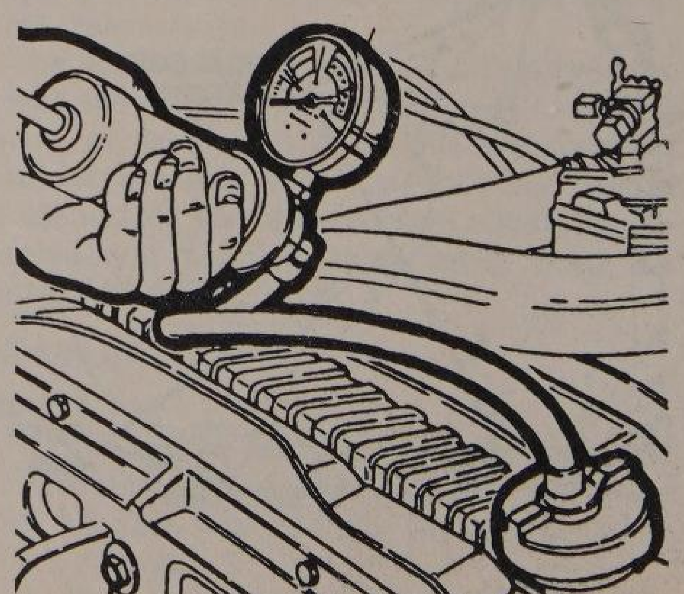
DRAIN, FLUSH AND REFILL

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.

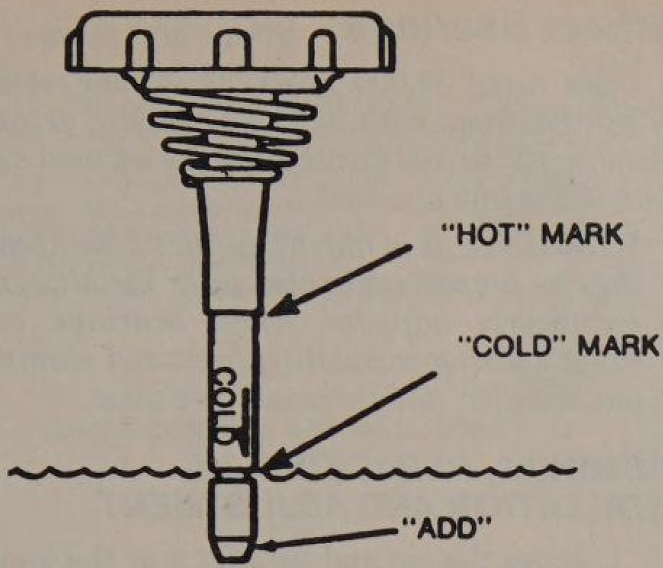
1. Remove the radiator and recovery tank caps. Run the engine until the upper radiator



Coolant protection can be checked with a simple float-type tester



The system should be pressure tested at least once a year



Use the dipstick to check the power steering fluid

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, if so equipped.

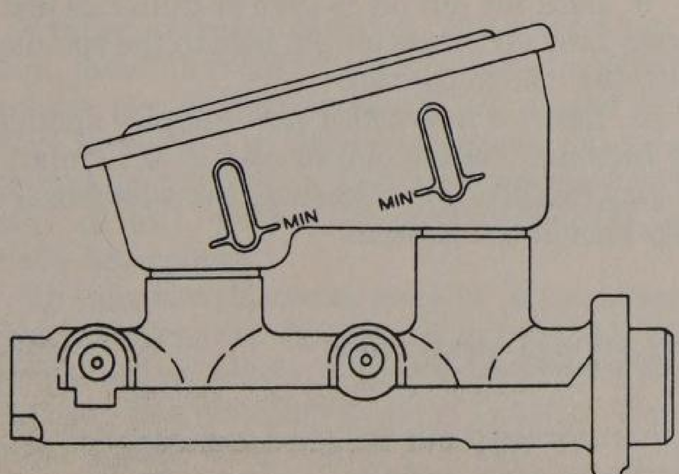
3. Close the drain valves and add water until the system is full. Repeat the draining and filling process several times, until the liquid is nearly colorless.

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 II or DOT-3. DO NOT allow the brake fluid container or master cylinder reservoir to remain open for long periods of time; brake



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

fluid absorbs moisture from the air, reducing its effectiveness and causing corrosion in the lines. General Motors recommends that silicone brake should not be used in the brake system. Damage to the rubber parts may result.

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

Power Steering Pump

FLUID RECOMMENDATION

When filling or replacing the fluid of the power steering pump reservoir, use GM part #1050017 power steering fluid only. Automatic transmission fluid may cause damage to the internal power steering components.

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 not 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. Do not over grease the components because damage may occur to the grease seals.

Body Lubrication

HOOD LATCH AND HINGES

Clean the latch surfaces and apply clean engine oil or all purpose lithium grease to the latch pilot bolts, spring anchor and 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 of 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

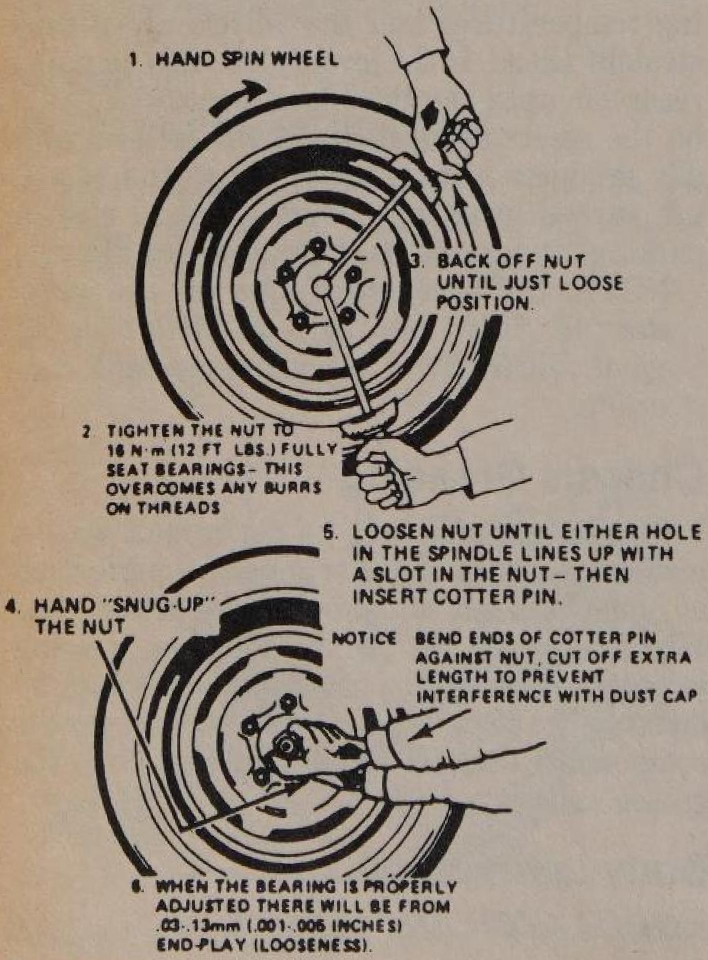
Use chassis grease on the parking brake cable where it contacts the guides, links, levers, and pulleys. The grease should be a water resistant one for durability under the car.

ACCELERATOR LINKAGE

Lubricate the carburetor stud, carburetor lever, throttle body and the accelerator pedal lever at the support inside the car with clean engine oil or silicone spray.

TRANSMISSION SHIFT LINKAGE

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



Front wheel bearing adjustment

Wheel Bearings

Once every 30,000 miles, clean and repack wheel bearings with a wheel bearing grease. Remove any excess grease from the exposed surface of the hub and seal.

WARNING: *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.*

REMOVAL, REPACKING, INSTALLATION AND ADJUSTMENT

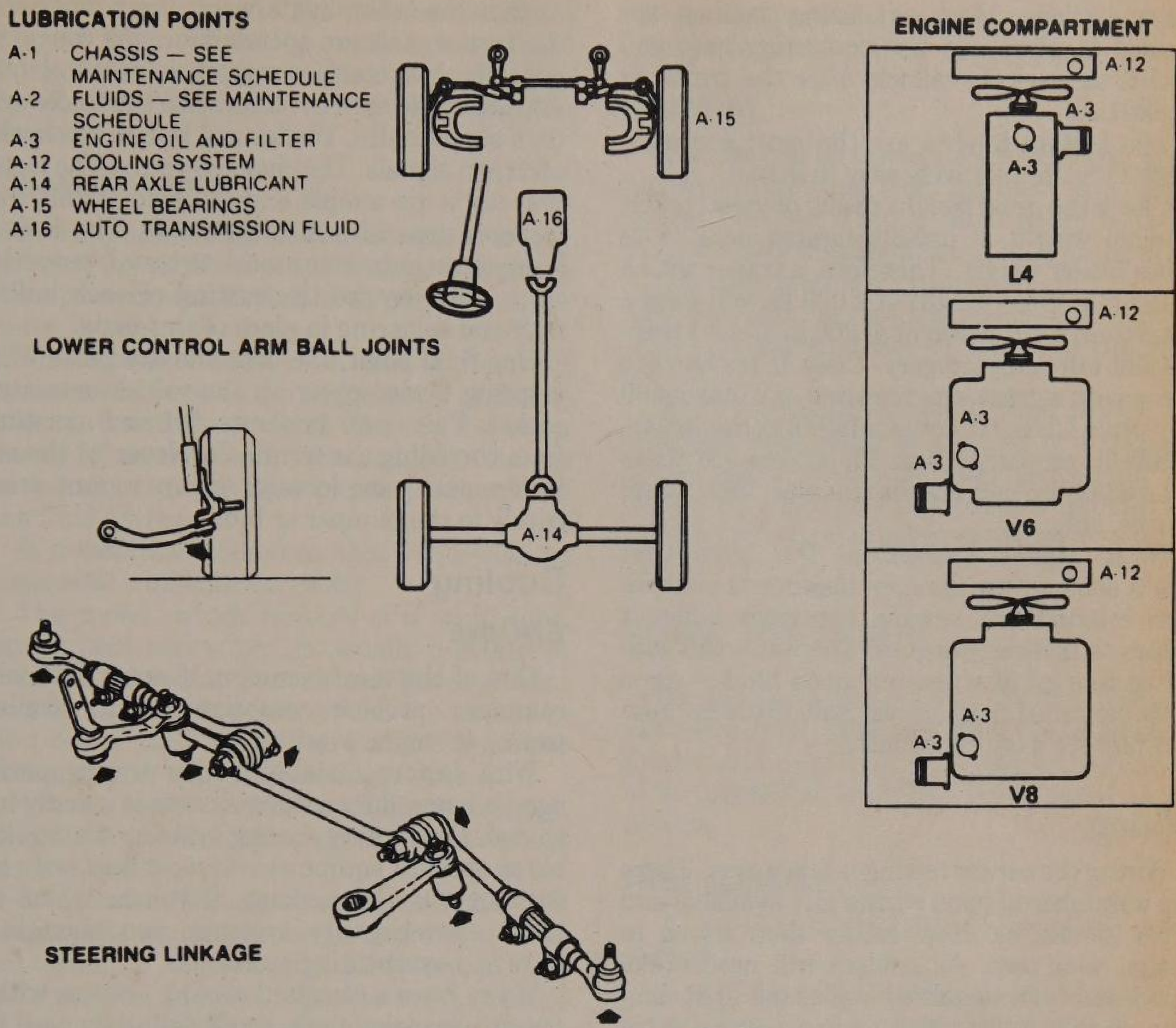
1. Raise the car and support it at the lower arm. Remove the wheel. Remove the brake caliper and support it on a wire.
2. Remove the dust cap, cotter pin, castle nut, thrust washer and outside wheel bearing. Pull the disc/hub assembly from the steering knuckle.
3. Pry out the inner seal and remove the inner bearing.
4. Smear grease inside of hub.
5. Clean the wheel bearings thoroughly with solvent and check their condition before installation. After cleaning, check parts for excessive wear and replace damaged parts.

WARNING: *Do not blow the bearing dry with compressed air as this would allow the bearing to turn without lubrication.*

6. 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.
7. 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.
8. 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.
9. Back the nut off $1/4$ turn or until it is just loose. Line up the cotter pin hole in the spindle with the hole in the nut.
10. Insert a new cotter pin. Endplay should be between 0.001–0.005 in. (0.025–0.127mm). If play exceeds this tolerance, the wheel bearings should be replaced.

TRAILER TOWING

Your Firebird was designed and intended primarily to carry people. Towing a trailer may affect some characteristic of the car, like handling, durability and economy. Proper use of



Lubrication points

the correct equipment are highly recommended for your safety and satisfaction.

Factory trailer towing packages are available on most cars. However, if you are installing a trailer hitch and wiring on your car, there are a few thing that you ought to know.

Trailer Weight

Trailer weight is the first, and most important, factor in determining whether or not your vehicle is suitable for towing the trailer you have in mind. The horsepower-to-weight ratio should be calculated. The basic standard is a ratio of 35:1. That is, 35 pounds of GVW for every horsepower.

To calculate this ratio, multiply you engine's rated horsepower by 35, then subtract the weight of the vehicle, including passengers and luggage. The resulting figure is the ideal maximum trailer weight that you can tow. One point to consider: a numerically higher axle ratio can offset what appears to be a low trailer weight. If the weight of the trailer that you have in mind is somewhat higher than the weight you just calculated, you might consider changing your rear axle ratio to compensate.

Hitch Weight

There are three kinds of hitches: bumper mounted, frame mounted, and load equalizing.

Bumper mounted hitches are those which attach solely to the vehicle's bumper. Many states prohibit towing with this type of hitch, when it attaches to the vehicle's stock bumper, since it subjects the bumper to stresses for which it was not designed. Aftermarket rear step bumpers, designed for trailer towing, are acceptable for use with bumper mounted hitches.

Frame mounted hitches can be of the type which bolts to two or more points on the frame, plus the bumper, or just to several points on the frame. Frame mounted hitches can also be of the tongue type, for Class I towing, or, of the receiver type, for Classes II and III.

Load equalizing hitches are usually used for large trailers. Most equalizing hitches are welded in place and use equalizing bars and chains to level the vehicle after the trailer is hooked up.

The bolt-on hitches are the most common, since they are relatively easy to install.

Check the gross weight rating of your trailer. Tongue weight is usually figured as 10% of gross trailer weight. Therefore, a trailer with a maximum gross weight of 2,000 lb. will have a maximum tongue weight of 200 lb. Class I trailers fall into this category. Class II trailers are those with a gross weight rating of 2,000–3,500 lb., while Class III trailers fall into the 3,500–6,000 lb. category. Class IV trailers are those over 6,000 lb. and are for use with fifth wheel trucks, only.

When you've determined the hitch that you'll need, follow the manufacturer's installation instructions, exactly, especially when it comes to fastener torques. The hitch will subjected to a lot of stress and good hitches come with hardened bolts. Never substitute an inferior bolt for a hardened bolt.

Wiring

Wiring the car for towing is fairly easy. There are a number of good wiring kits available and these should be used, rather than trying to design your own. All trailers will need brake lights and turn signals as well as tail lights and side marker lights. Most states require extra marker lights for overly wide trailers. Also, most states have recently required back-up lights for trailers, and most trailer manufacturers have been building trailers with back-up lights for several years.

Additionally, some Class I, most Class II and just about all Class III trailers will have electric brakes.

Add to this number an accessories wire, to operate trailer internal equipment or to charge the trailer's battery, and you can have as many as seven wires in the harness.

Determine the equipment on your trailer and buy the wiring kit necessary. The kit will contain all the wires needed, plus a plug adapter set which included the female plug, mounted on the bumper or hitch, and the male plug, wired into, or plugged into the trailer harness.

When installing the kit, follow the manufacturer's instructions. The color coding of the wires is standard throughout the industry.

One point to note, some domestic vehicles, and most imported vehicles, have separate turn signals. On most domestic vehicles, the brake lights and rear turn signals operate with the same bulb. For those vehicles with separate turn signals, you can purchase an isolation unit so that the brake lights won't blink whenever the turn signals are operated, or, you can go to your local electronics supply house and buy four diodes to wire in series with the brake and turn signal bulbs. Diodes will isolate the brake and turn signals. The choice is yours. The isolation units are simple and quick to install, but far more expensive than the diodes. The diodes, however, require more work to install properly, since they require the cutting of each bulb's wire and soldering in place of the diode.

One final point, the best kits are those with a spring loaded cover on the vehicle mounted socket. This cover prevents dirt and moisture from corroding the terminals. Never let the vehicle socket hang loosely. Always mount it securely to the bumper or hitch.

Cooling

ENGINE

One of the most common, if not THE most common, problem associated with trailer towing is engine overheating.

With factory installed trailer towing packages, a heavy duty cooling system is usually included. Heavy duty cooling systems are available as optional equipment on most cars, with or without a trailer package. If you have one of these extra-capacity systems, you shouldn't have any overheating problems.

If you have a standard cooling system, without an expansion tank, you'll definitely need to get an aftermarket expansion tank kit, preferably one with at least a 2 quart capacity. These kits are easily installed on the radiator's overflow hose, and come with a pressure cap designed for expansion tanks.

Another helpful accessory is a Flex Fan. These fan are large diameter units are designed to provide more airflow at low speeds, with blades that have deeply cupped surfaces. The blades then flex, or flatten out, at high speed, when less cooling air is needed. These fans are far lighter in weight than stock fans, requiring less horsepower to drive them. Also, they are far quieter than stock fans.

If you do decide to replace your stock fan with a flex fan, note that if your car has a fan clutch, a spacer between the flex fan and water pump hub will be needed.

Aftermarket engine oil coolers are helpful for prolonging engine oil life and reducing overall engine temperatures. Both of these factors increase engine life.

While not absolutely necessary in towing Class I and some Class II trailers, they are recommended for heavier Class II and all Class III towing.

Engine oil cooler systems consist of an

adapter, screwed on in place of the oil filter, a remote filter mounting and a multi-tube, finned heat exchanger, which is mounted in front of the radiator or air conditioning condenser.

TRANSMISSION

An automatic transmission is usually recommended for trailer towing. Modern automatics have proven reliable and, of course, easy to operate, in trailer towing.

The increased load of a trailer, however, causes an increase in the temperature of the automatic transmission fluid. Heat is the worst enemy of an automatic transmission. As the temperature of the fluid increases, the life of the fluid decreases.

It is essential, therefore, that you install an automatic transmission cooler.

The cooler, which consists of a multi-tube, finned heat exchanger, is usually installed in front of the radiator or air conditioning compressor, and hooked inline with the transmission cooler tank inlet line. Follow the cooler manufacturer's installation instructions.

Select a cooler of at least adequate capacity, based upon the combined gross weights of the car and trailer.

Cooler manufacturers recommend that you use an aftermarket cooler in addition to, and not instead of, the present cooling tank in your car's radiator. If you do want to use it in place of the radiator cooling tank, get a cooler at least two sizes larger than normally necessary.

NOTE: *A transmission cooler can, sometimes, cause slow or harsh shifting in the transmission during cold weather, until the fluid has a chance to come up to normal operating temperature. Some coolers can be purchased with or retrofitted with a temperature bypass valve which will allow fluid flow through the cooler only when the fluid has reached operating temperature, or above.*

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 push car bumper does not override your bumper. If your car 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 gear shift in 2nd or 3rd 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 152mm (6 in.) during towing.

JUMP STARTING

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.

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.

Procedure

1. Bring the starting vehicle close (they must not touch) so that the batteries can be reached easily.
2. Turn the ignition OFF and all accessories must be off (except for hazard light, if required).
3. Put both cars in **P** or **N** and set the parking brake.
4. If the terminals on the run down battery are heavily corroded, clean them.
5. Identify the positive and negative posts on both batteries and connect the cables in the order shown.
6. 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

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.

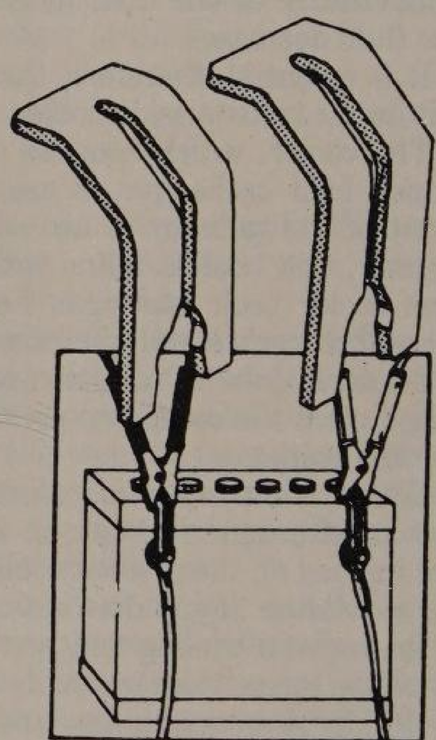
Jump Starting Precautions

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. Do not jump start a frozen battery.
7. Do not allow electrolyte on your skin or clothing.
8. Be sure the electrolyte is not frozen.

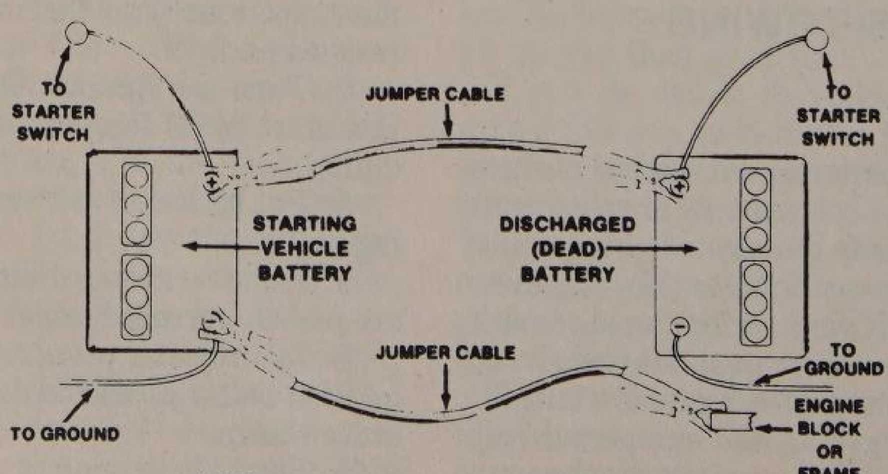
CAUTION: *Make certain that the ignition key, in the vehicle with the dead battery, is in the OFF position. Connecting cables to vehicles with on-board computers will result in computer destruction if the key is not in the OFF position.*

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 oc casionally 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 sure vehicles do not touch

This hook–up for negative ground cars only seconds at a time and let it cool off for 20 seconds in between tries.

7. If it doesn't start in 3 tries, there is something else wrong.

8. Disconnect the cables in the reverse order.

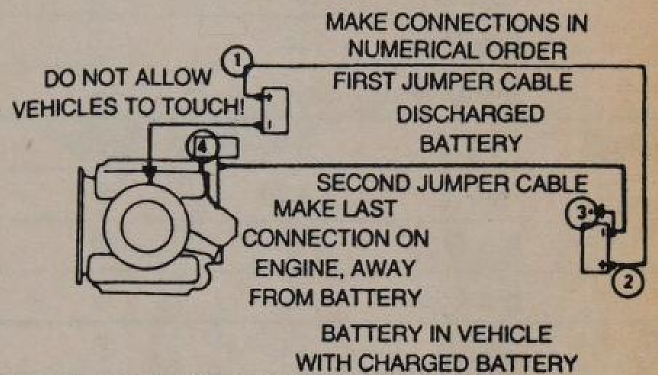
JACKING

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

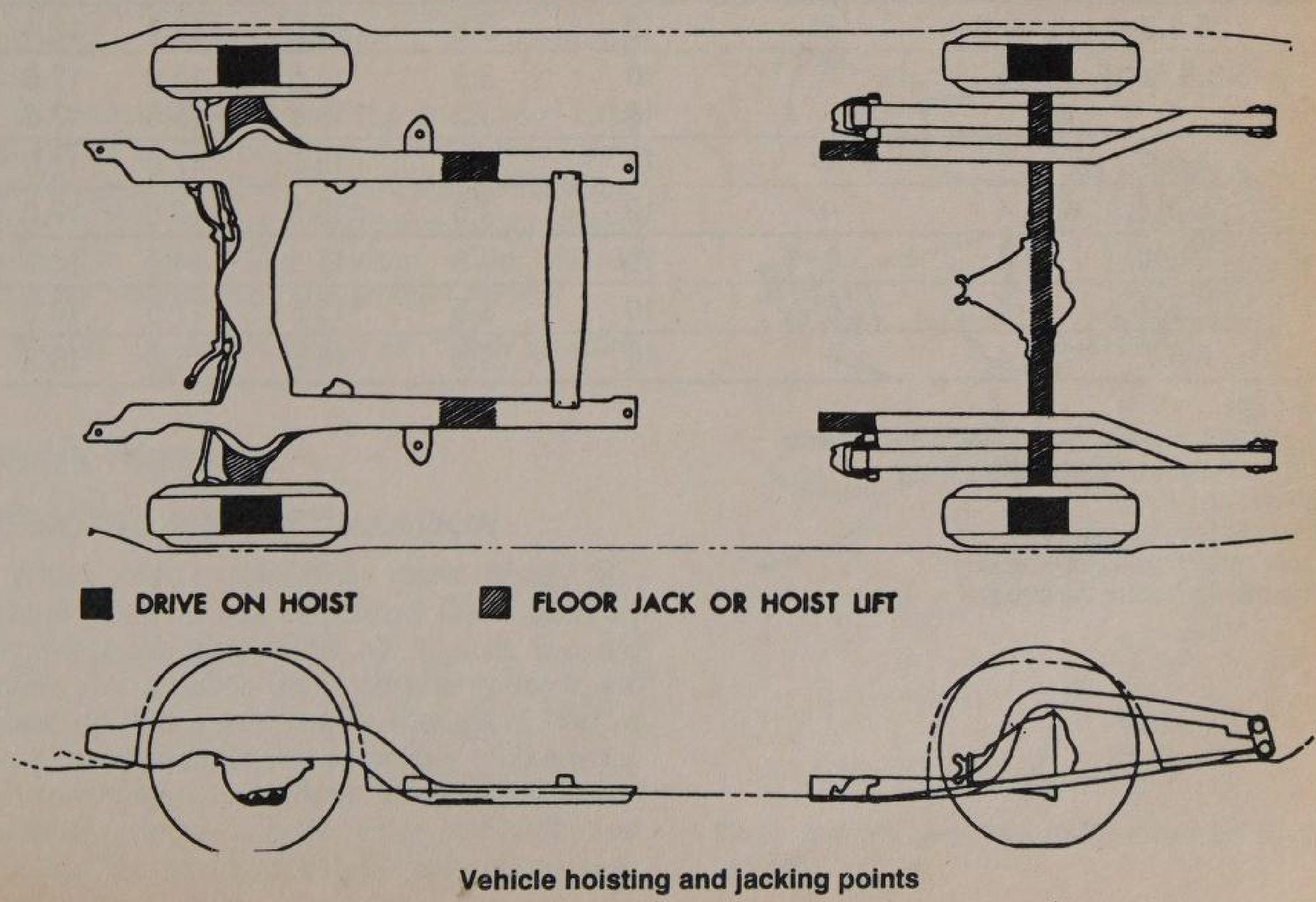
The service operations in this book often require that one end or the other, or both, of the car be raised and safely supported. The ideal method, of course, would be a hydraulic hoist. Since this is beyond both the resource and requirement of the do-it-yourselfer, a small hydraulic, screw or scissors 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.

Alternator bracket location for final battery jumper cable connection



Recommended battery jumper connection sequence



Vehicle hoisting and jacking points

CAPACITIES

Year	Engine No. Cyl. Displacement (Liters)	Engine Crankcase Add 1 qt for New Filter	Transmission Pts to Refill After Draining: Manual	Transmission Pts to Refill After Draining: Automatic ①	Drive Axle (pts)	Gasoline Tank (gals)	Cooling System (qts): With Heater	Cooling System (qts): With A/C
1982	4-2.5	3 ②	3.5	7	3.5	16	8.8	9.1
	6-2.8	4 ②	3.5	7	3.5	16	12.5	12.5
	8-5.0 ③	4	3.5	7	3.5	16	15.0	15.0
	8-5.0 ④	4	—	7	3.5	16	15.0	15.0
1983	4-2.5	3 ②	3.5 ⑤	7	3.5	16	8.8	9.1
	6-2.8	4 ②	⑤	7	3.5	16	12.5	12.5
	8-5.0 ③	4	⑤	7	3.5	16	15.0	15.0
	8-5.0 ④	4	—	7	3.5	16	15.0	15.0
1984–85	4-2.5	3 ②	3.5 ⑤	7	3.5	16	8.8	9.1
	6-2.8	4 ②	⑤	7	3.5	16	12.5	12.5
	8-5.0 ③	4	⑤	7	3.5	16	15.0	15.0
	8-5.0 ④	4	⑤	7	3.5	16	15.0	15.0
1986	4-2.5	3 ②	⑥	10	3.5	16	12.8	13.0
	6-2.8	4 ②	⑥	10	3.5	16	12.5	12.5
	8-5.0	4	⑥	10	3.5	16	17.0	17.0
1987	6-2.8	4 ②	⑥	10	3.5	16	12.4	12.4
	8-5.0	4	⑥	10	3.5	16	17.0	17.0
	8-5.7	4	⑥	10	3.5	16	15.7	15.7
1988	6-2.8	4 ②	⑥	10	3.5	16	12.5	12.5
	8-5.0	4	⑥	10	3.5	16	15.3	15.6
	8-5.7	4	⑥	10	3.5	16	17.0	17.0
1989	6-2.8	4 ②	⑥	10	3.5	15.5	12.4	12.4
	6-3.8 Turbo	5	⑥	10	3.5	15.5	12.0	12.0
				10	3.5	15.5	15.6	17.0
	8-5.0	4	⑥	10	3.5	15.5	17.0	17.0
	8-5.7	4	⑥	10	3.5	15.5	17.0	17.0
1990	6-3.1	4	6	10	3.5	15.5	14.5	14.5
	8-5.0	4	6	10	3.5	15.5	17.5	18.0
	8-5.7	4	6	10	3.5	15.5	16.0	16.3

—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
⑥ 6.6 pints on the 5 speed transmission

Engine Performance and Tune-Up

2

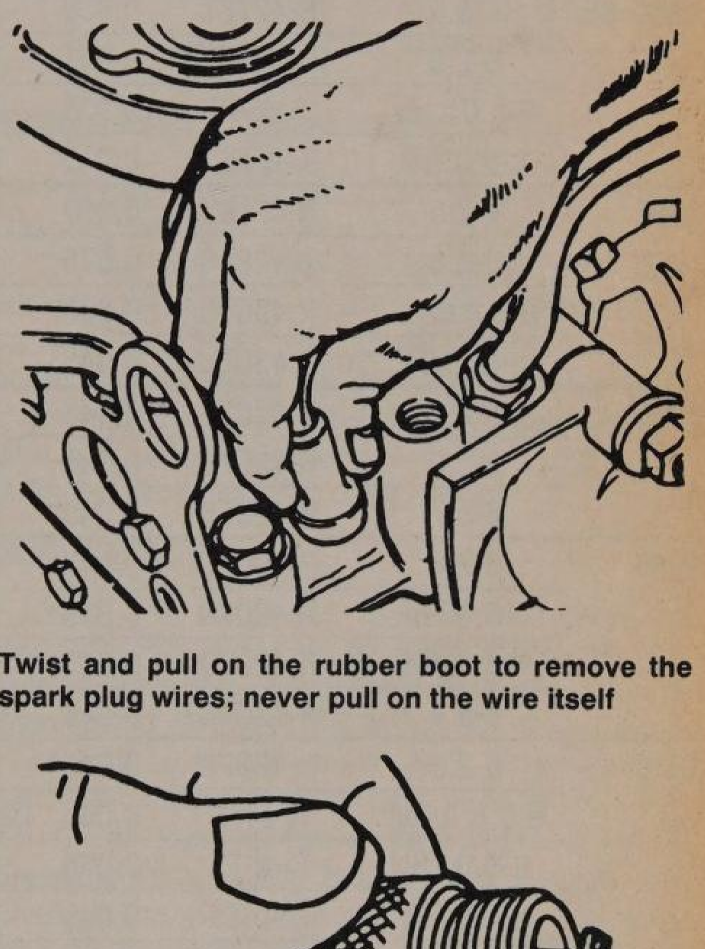
TUNE-UP PROCEDURES

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 Firebird's engine running smoothly and will prevent the annoying breakdowns and poor performance associated with an untuned engine.

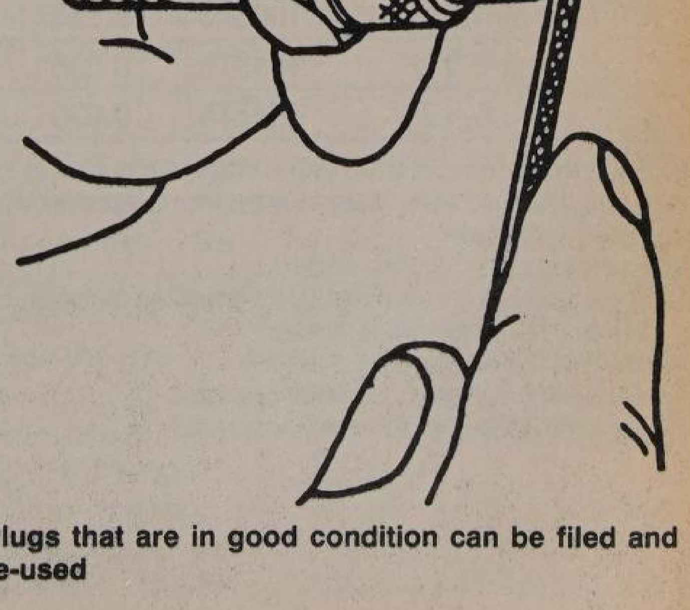
A complete tune-up should be performed every 30,000 miles (48,000 km). This interval should be halved if the car is operated under severe conditions such as trailer towing, prolonged idling, start-and-stop driving, or if starting or running problems are noticed. It is assumed that the routine maintenance 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.

It 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 Firebirds use electronic ignition.*



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



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

Spark Plugs

REMOVAL AND INSTALLATION

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

TUNE-UP SPECIFICATIONS

Year	Engine No. Cyl. Displacement (Liters)	Spark Plugs Type	Spark Plugs Gap (in.)	Distributor	Ignition Timing	Fuel Pump Pressure (psi)	Idle Speed
1982	4-2.5	R-44TSX	0.060	Electronic	①	9–13	①
	6-2.8	R-43TS ③	0.045	Electronic	①	$5^1/_2$–$6^1/_2$	①
	8-5.0	R-45TS	0.045	Electronic	①	$5^1/_2$–$6^1/_2$	①
	8-5.0	R-45TS ②	0.045	Electronic	①	9–13	①
1983	4-2.5	R-44TSX	0.060	Electronic	①	9–13	①
	6-2.8	R-43CTS ④	0.045	Electronic	①	$5^1/_2$–$6^1/_2$	①
	8-5.0	R-45TS	0.045	Electronic	①	$5^1/_2$–$6^1/_2$	①
	8-5.0	R-45TS ②	0.045	Electronic	①	9–13	①
1984–85	4-2.5	R-43TSX	0.060	Electronic	8°	9–13	①
	6-2.8	R-43CTS ④	0.045	Electronic	10°	$5^1/_2$–$6^1/_2$	①
	8-5.0 carb	R-45TS	0.035	Electronic	6°	$5^1/_2$–$6^1/_2$	①
	8-5.0 TBI	R-45TS ②	0.035	Electronic	6°	9–13	①
1986	4-2.5	R-43TSX	0.060	Electronic	8°	9–13	①
	6-2.8	R-42CTS	0.045	Electronic	10°	40–47	①
	8-5.0 carb	R-43CTS	0.035	Electronic	0°	4–6.5	①
	8-5.0 PFI	R-43CTS	0.045	Electronic	6°	40–47	①
1987	6-2.8	R-42CTS	0.045	Electronic	10°	40–47	①
	8-5.0	R-43CTS	0.035	Electronic	0°	4–6.5	①
	8-5.7	R-43CTS	0.045	Electronic	6°	40–47	①
1988	6-2.8	R-42CTS	0.045	Electronic	10°	40–47	①
	8-5.0 TBI	R-42CTS	0.045	Electronic	0°	9–13	①
	8-5.0 PFI	R-42CTS	0.045	Electronic	6°	40–47	①
	8-5.7	R-43CTS	0.045	Electronic	6°	40–47	①
1989	6-2.8	R-42CTS	0.045	Electronic	10°	40–47	①
	6-3.8 Turbo	R-44TS	0.045	Distributorless	—	40–47	①
	8-5.0 TBI	R-45TS	0.035	Electronic	0°	9–13	①
	8-5.0 PFI	R-45TS	0.045	Electronic	6°	40–47	①
	8-5.7 PFI	R-45TS	0.045	Electronic	6°	40–47	①
1990	6-3.1	R-43TSK	0.045	Electronic	①	40–47	①
	8-5.0 TBI	R-45TS	0.035	Electronic	0°	9–13	①
	8-5.0 PFI	R-45TS	0.035	Electronic	6°	40–47	①
	8-5.7	R-45TS	0.035	Electronic	6°	40–47	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.

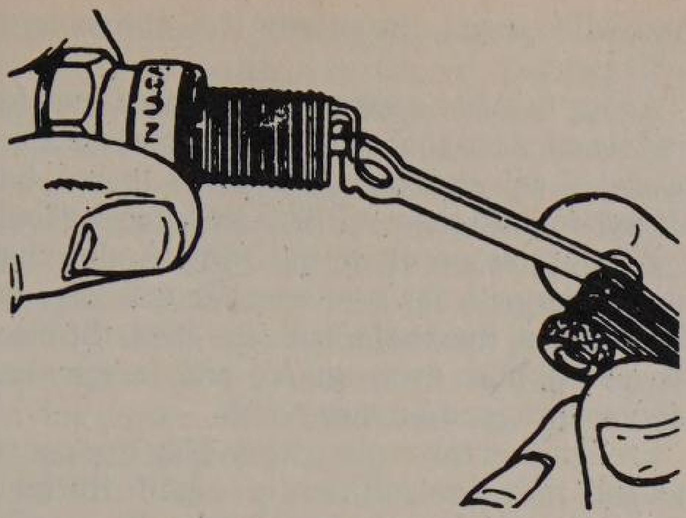
All models use electric ignition systems.

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

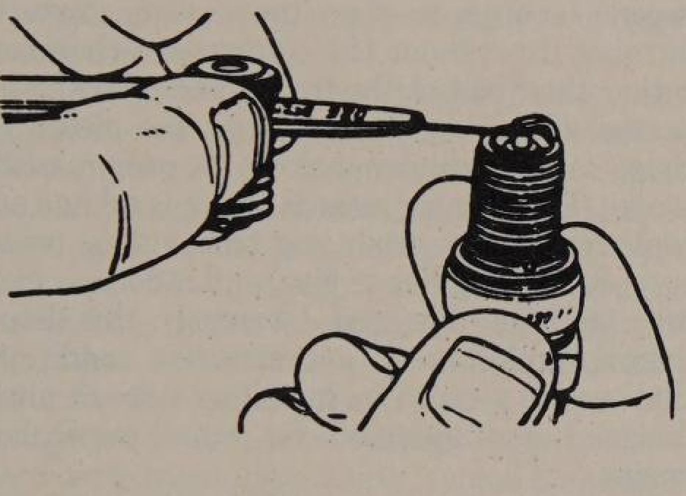
② Use R-44TS if a colder plug is needed

③ Use R-42TS for high performance operation.

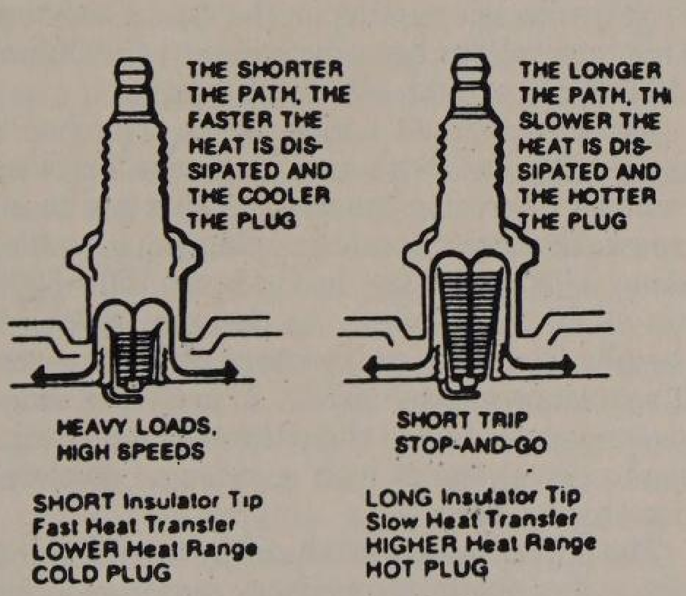
④ Use R-42CTS for high performance operation.



Adjust the electrode gap by bending the side electrode



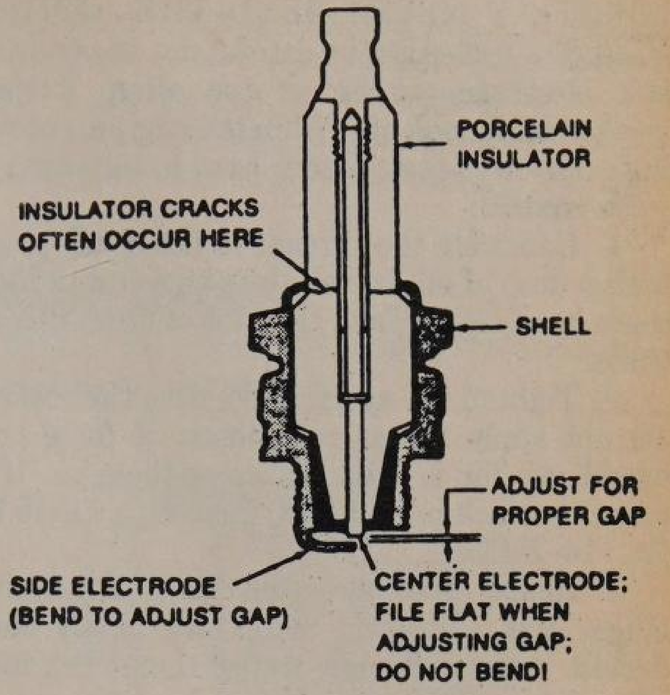
Always use a wire gauge to check the electrode gap



Spark plug heat range

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 re-



Cross section of a spark plug

moved 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.

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 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 gap 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. AB-

SOLUTELY 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.

To install:

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. (14–20 Nm).
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 Firebirds 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 Firebirds.

Spark plug life and efficiency depend upon the condition of the engine and the temperatures 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 16,000 or 19,000 km (10,000 or 12,000 miles) depending on the type of driving. This interval has been increased to 48,000 km (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 0.025mm (0.001 in.) in every 1600–3200 km (1000–2000 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 is not 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.*

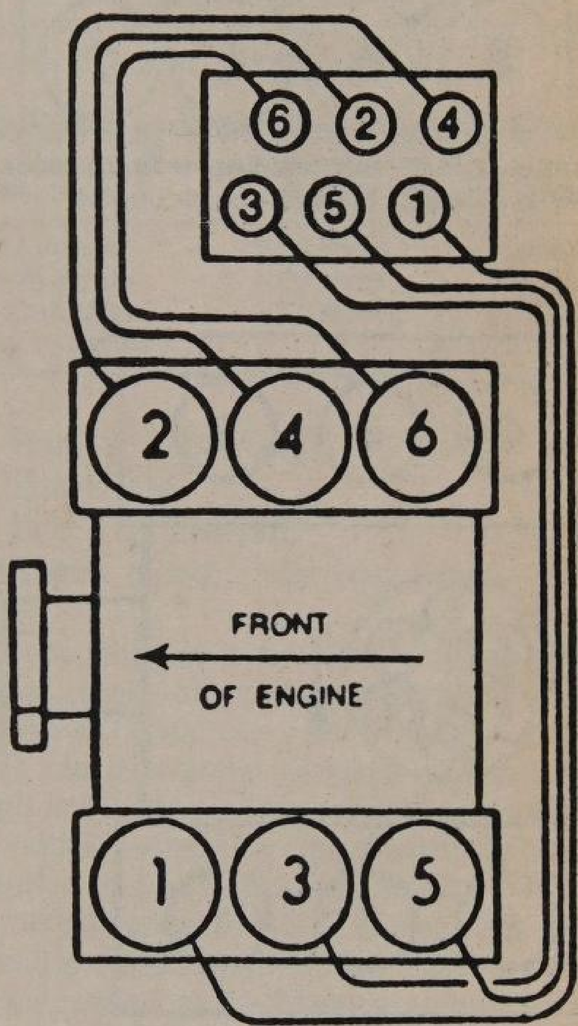
Accelerate your car to the speed where the engine begins to miss and then slow down to the point where the engine smooths out. Run at this speed for a few minutes and then accelerate again to the point of engine miss. With each repetition this engine miss should occur at increasingly higher speeds and 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 Firebird 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.

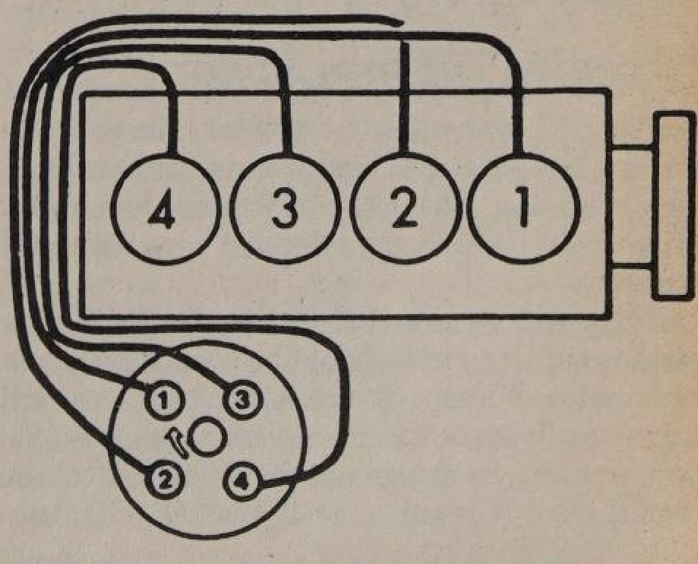
If the car is used for abnormal driving (as in the examples above), or the engine has been modified for higher performance, then a change to a plug of a different heat range may be necessary. For a modified car it is always wise to go to a colder plug as a protection against pre-ignition. It will require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

FIRING ORDERS

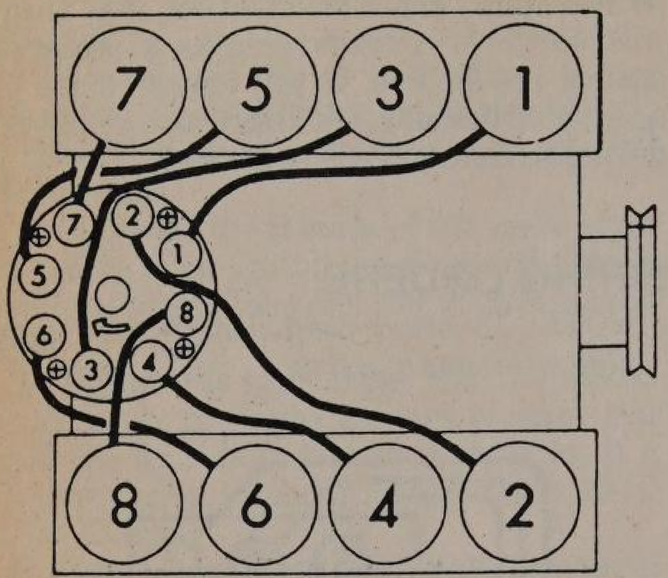
NOTE: *To avoid confusion, replace spark plug wires one at a time.*



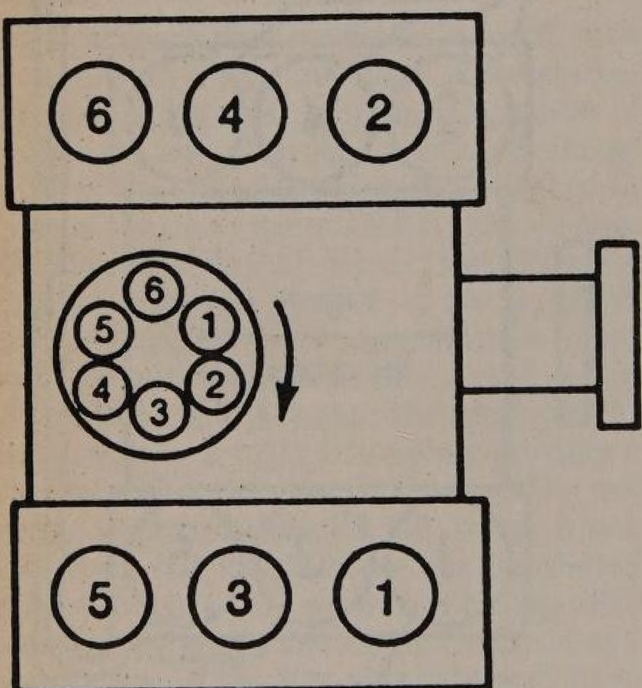
Buick-built V6 with C³I ignition system; Engine firing order 1-6-5-4-3-2



Pontiac-built 4-151 (2.5L) engine; Engine firing order; 1-3-4-2 Distributor rotation; clockwise



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



Chevrolet-built 6–173 (2.8L) engine; Engine firing order; 1-2-3-4-5-6 Distributor rotation; clockwise

Spark Plug Wires

CHECKING AND REPLACING

Every 15,000 miles (24,000 km), 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 (72,000 km) 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 (72,000–96,000 km).

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 30,000Ω (ohms). Generally speaking, however, resistance should not be over 25,000Ω and 30,000Ω 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.

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.

The distributor contains the electronic control module, and the magnetic triggering device. The magnetic pickup 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 pickup coil. When the teeth of the rotating timer align with the teeth of the pole piece, the induced voltage in the pickup 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 pickup 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 pickup 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. I 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:

HEI Plug Wire Resistance Chart

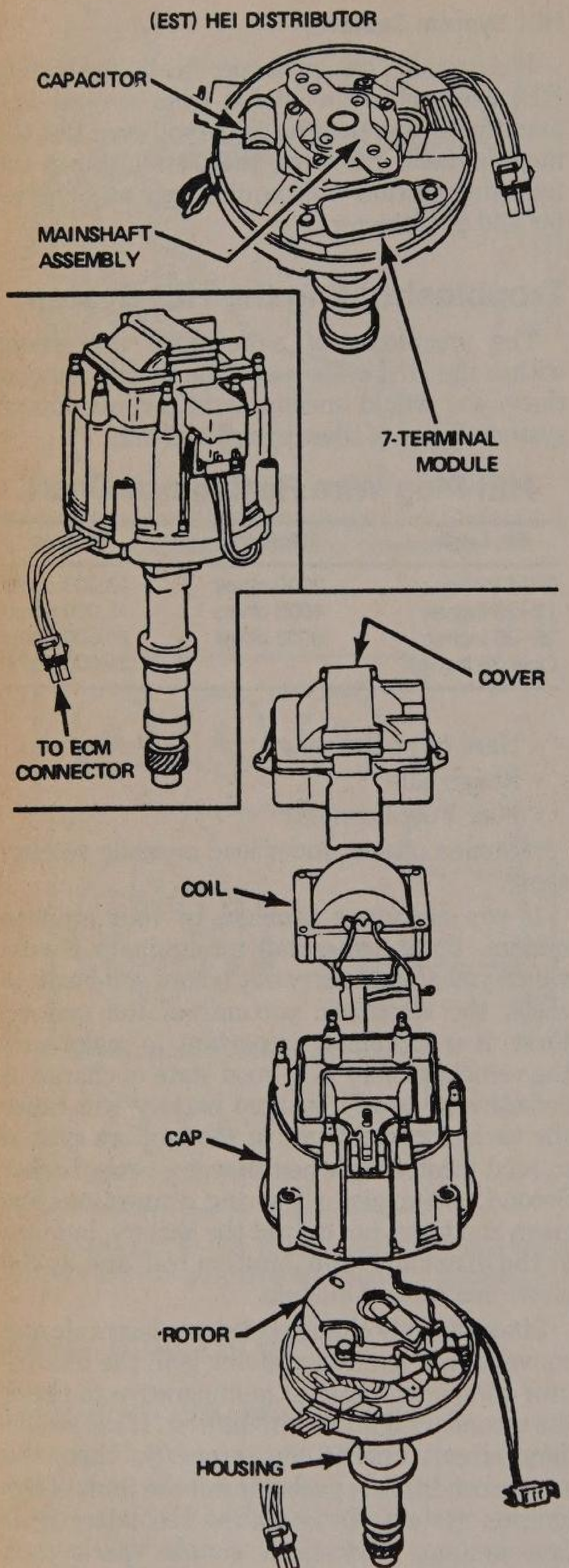
Wire Length	Minimum	Maximum
0–15 inches	3000 ohms	10,000 ohms
15–25 inches	4000 ohms	15,000 ohms
25–35 inches	6000 ohms	20,000 ohms
Over 35 inches		25,000 ohms

- 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 6mm ($^1/_4$ 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



HEI (EST) distributor

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.

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 wire 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.

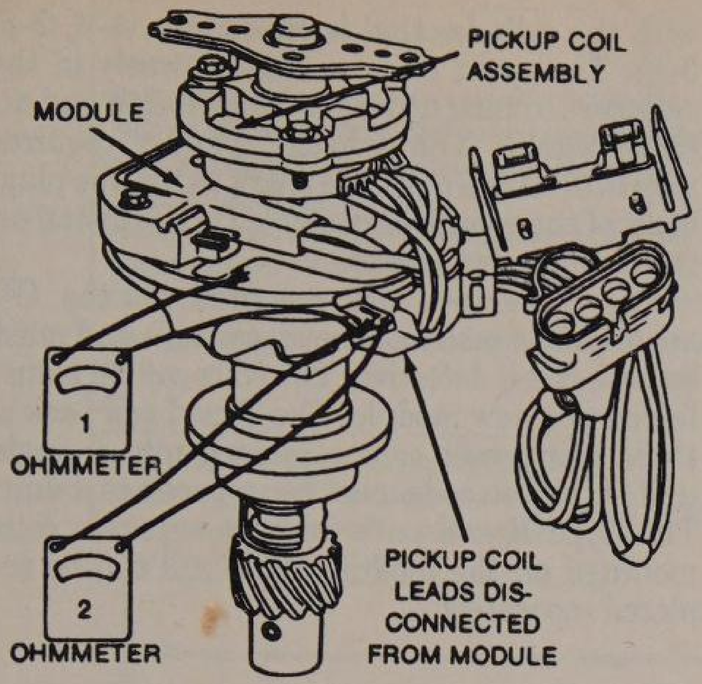
Engine Runs, But Runs Roughly or Cuts Out

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 leads 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.

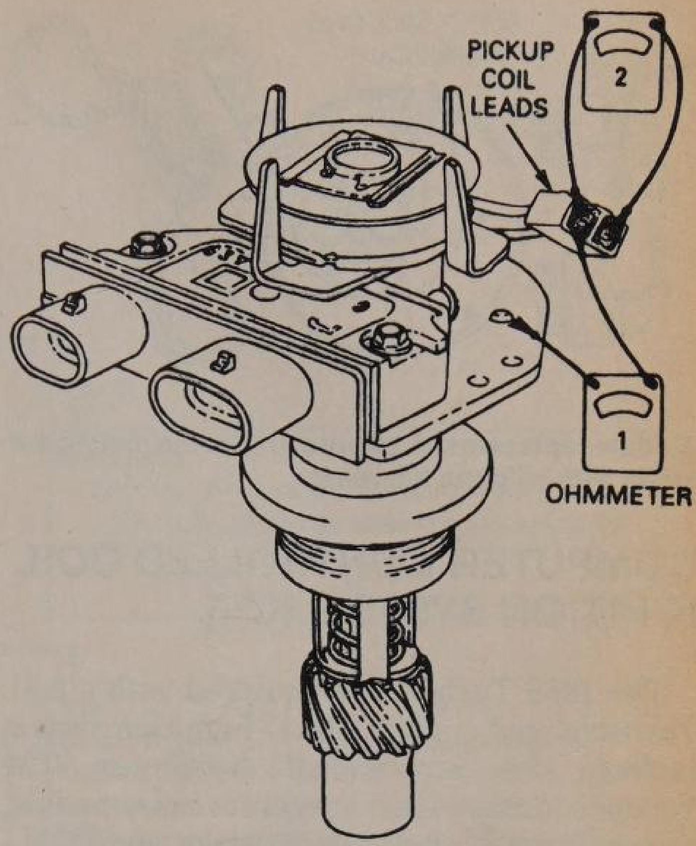
DISTRIBUTOR COMPONENTS TESTING

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.

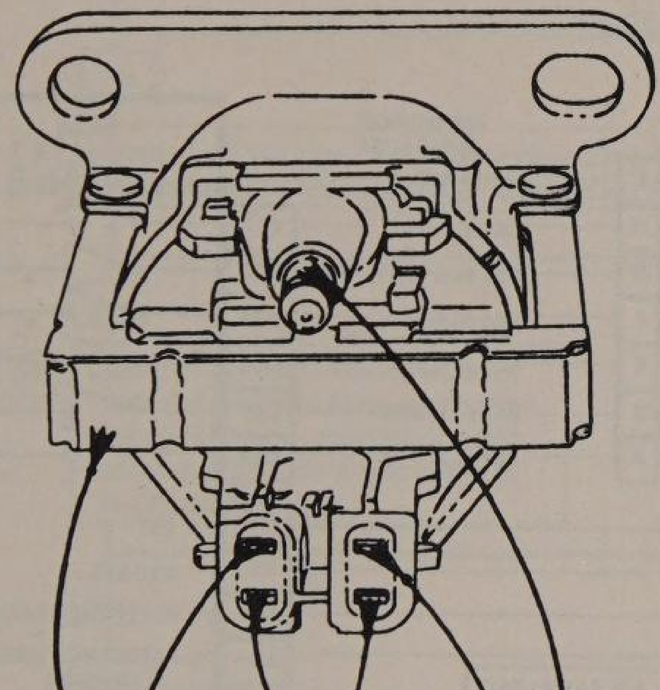
1. Connect an ohmmeter between the **TACH** and **BAT** terminals on the ignition coil. The primary coil resistance should be less than 1Ω.
2. To check the coil secondary resistance, connect an ohmmeter between the high tension terminal and the **BAT** terminal. Note the reading. Connect the ohmmeter between the high tension terminal and the **TACH** terminal. Note the reading. The resistance in both cases should be 6,000–30,000Ω. Be sure to test be-



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



Pickup coil testing – Test 1, should read infinite at all times. Test 2, should read .500–1500 ohms



Remote coil testing – Test 1, high scale,should bread very high (infinite). Test 2, low scale, should read very low or zero. Test 3, high scale, should not read infinite

tween 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.*

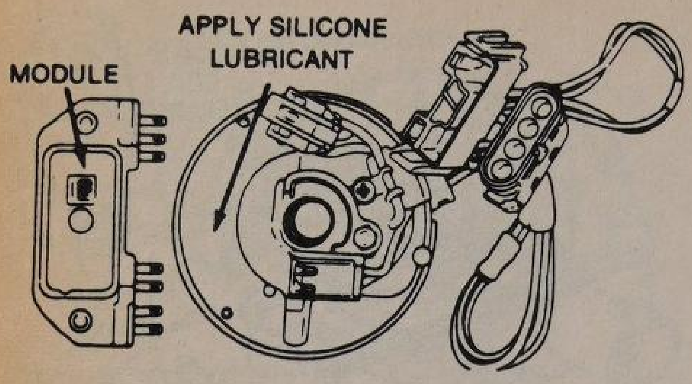
4. To test the pickup coil, first disconnect the white and green module leads. Set the ohmmeter on the high scale and connect it between a ground and either the white or green lead. Any resistance measurement less than infinity (∞) requires replacement of the pickup coil.

5. Pickup coil continuity is tested by connecting the ohmmeter (on low range) between the white and green leads. Normal resistance is 500–1,500Ω. 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 pickup soil 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.

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 Roughly 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.



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

COMPUTER CONTROLLED COIL IGNITION SYSTEM (C^3I)

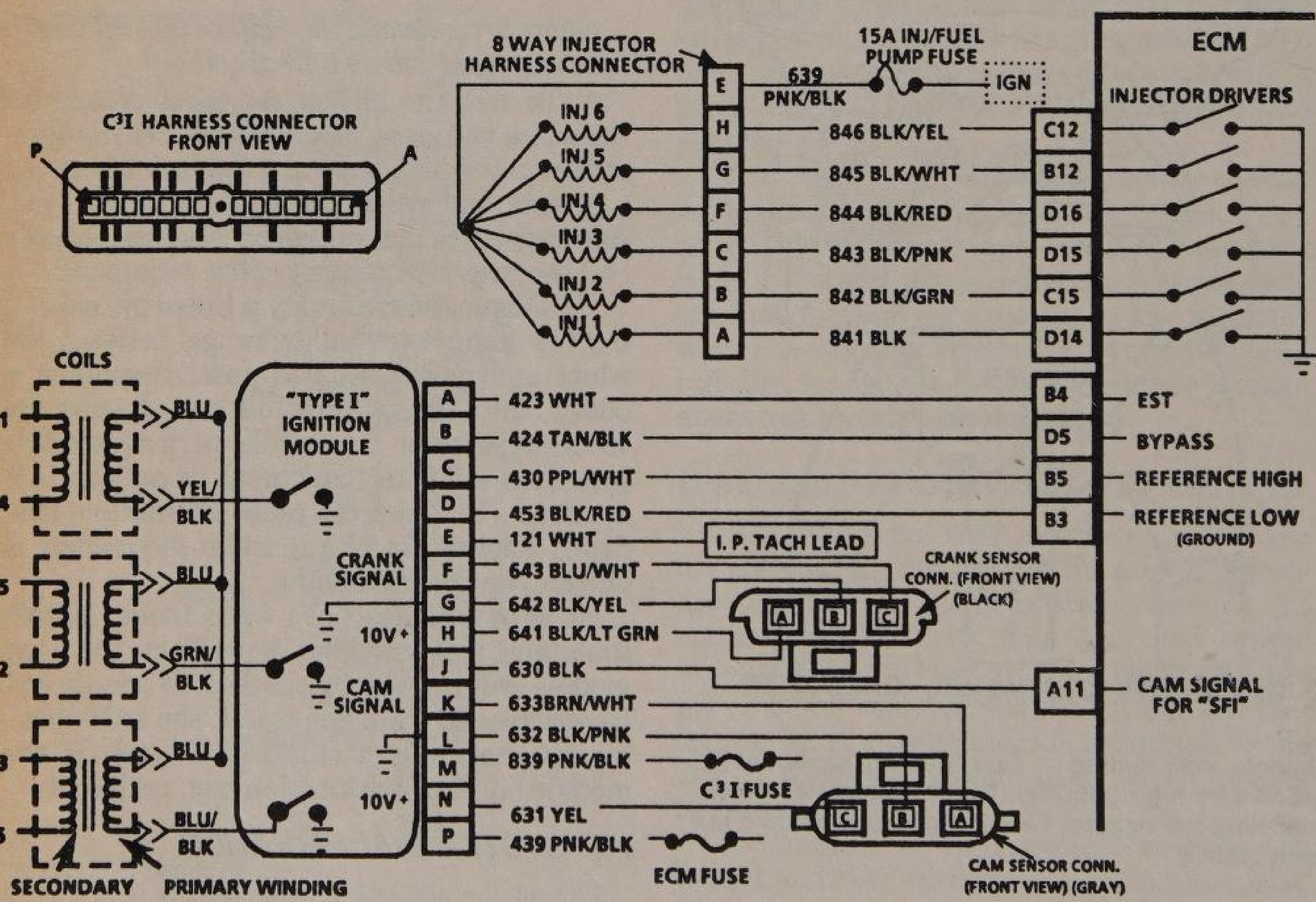
The 1989 Turbo TA is equipped with a 3.8L Turbocharged engine. The C^3I ignition system replaces the conventional distributor. The system consists of three separate coils, module, camshaft sensor, crankshaft sensor and ECM.

The system uses the "Waste Spark" method of spark distribution. Each cylinder is matched with the cylinder that is opposite it (1–4, 2–5, 3–6). The spark occurs simultaneously in the cylinders coming up on the compression and exhaust stroke. The exhaust cylinder requires very little of the available spark to fire the plug. Most of the energy is available for the piston on the compression stroke.

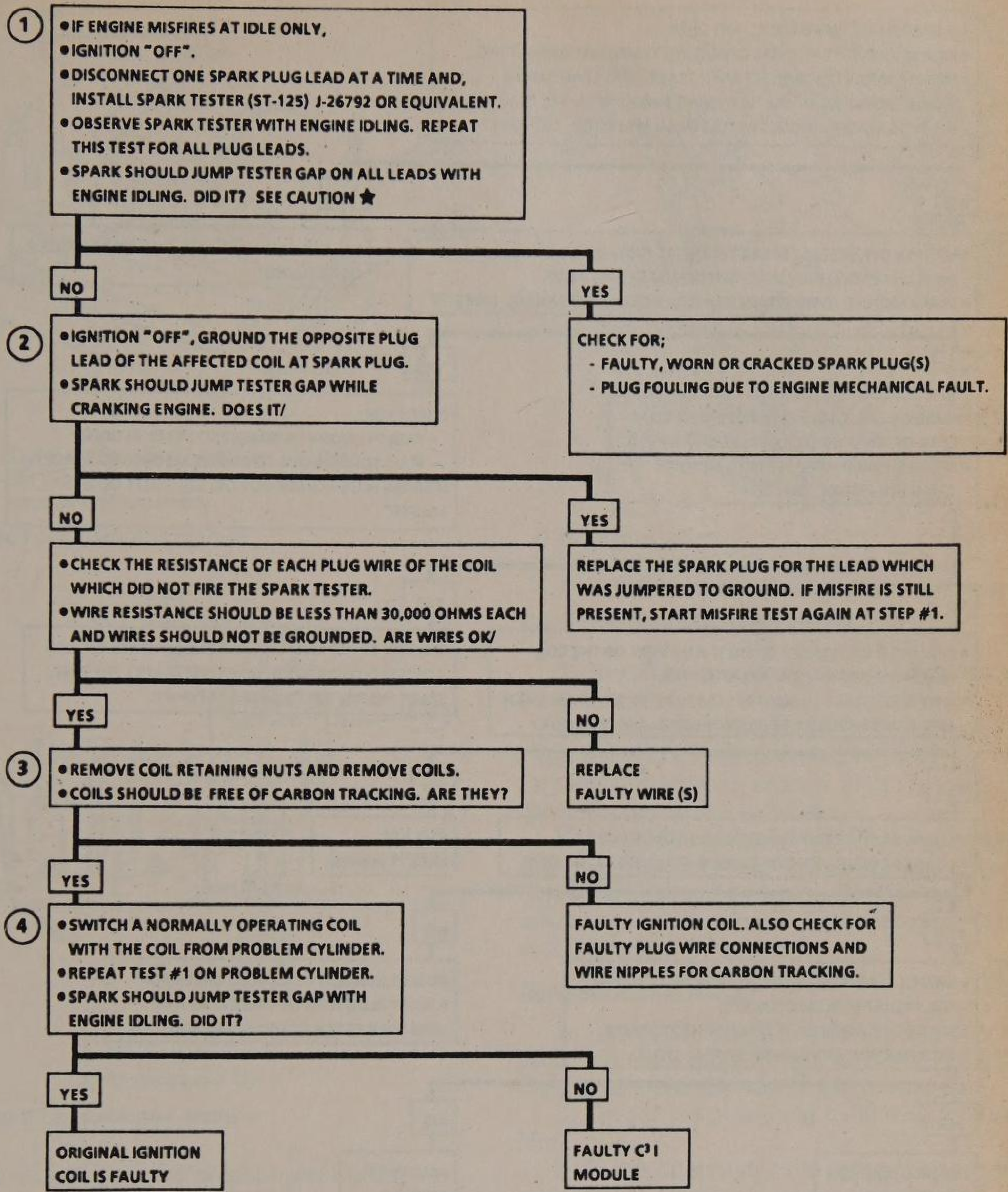
The three coils are mounted on the C^3I module. The module is not repairable and must be replaced if defective. The coils can be transferred to a new module. The Type I coil pack is three twin tower coils combined into a single unit. All three coils must be replaced as a unit. The Type II coil pack is three separate coils mounted on the module. Each coil can be replaced separately.

C^3I SYSTEM DIAGNOSIS

CAUTION: *When handling secondary spark plug leads with the engine running or starting, insulated pliers must be used and care exercised to prevent a possible electrical shock.*



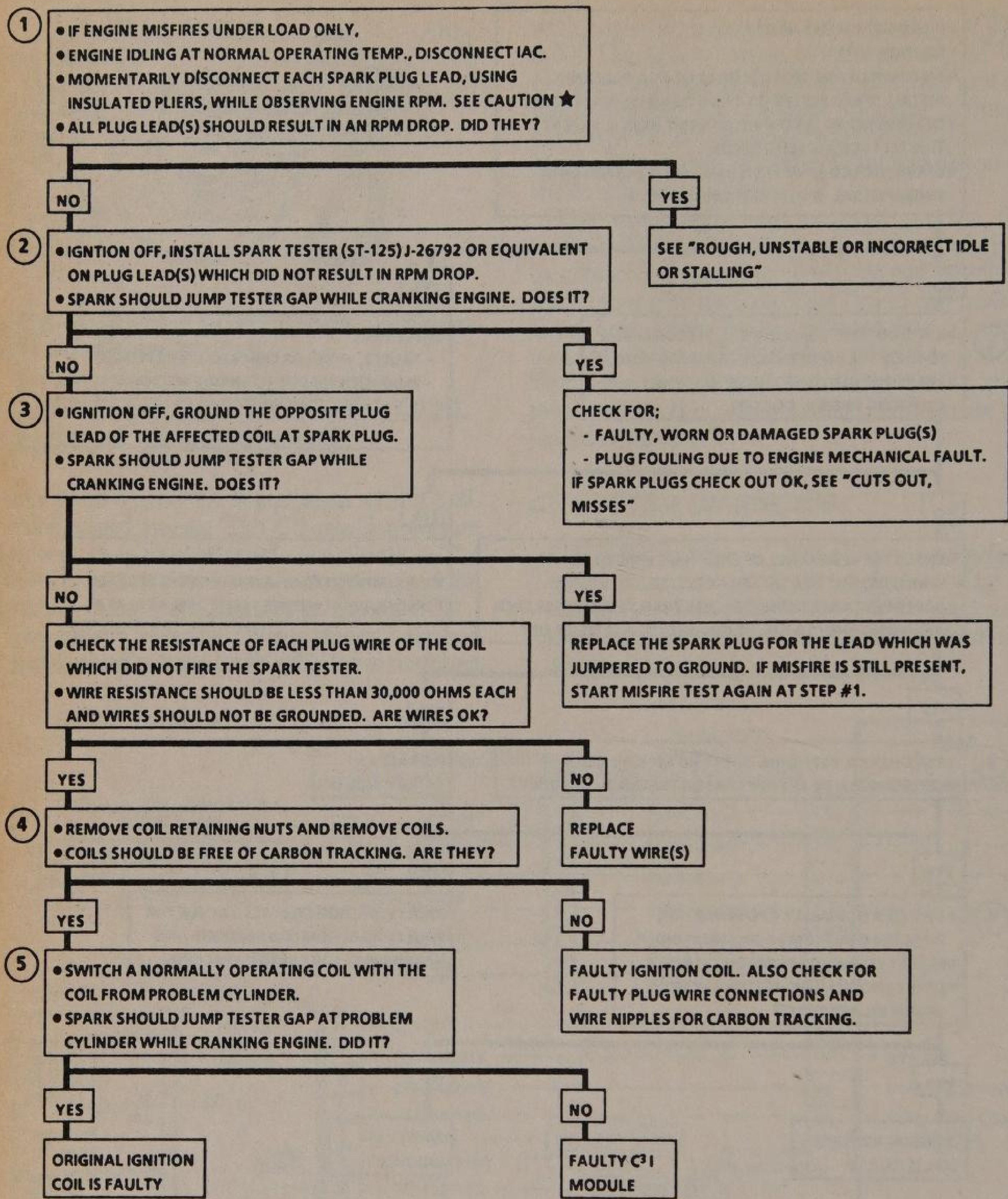
C^3I system wiring



★CAUTION; When handling secondary spark plug leads with engine running, insulated pliers must be used and care exercised to prevent a possible electrical shock.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

Engine misses at idle



★**CAUTION:** When handling secondary spark plug leads with engine running, insulated pliers must be used and care exercised to prevent a possible electrical shock.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

Engine misses under load

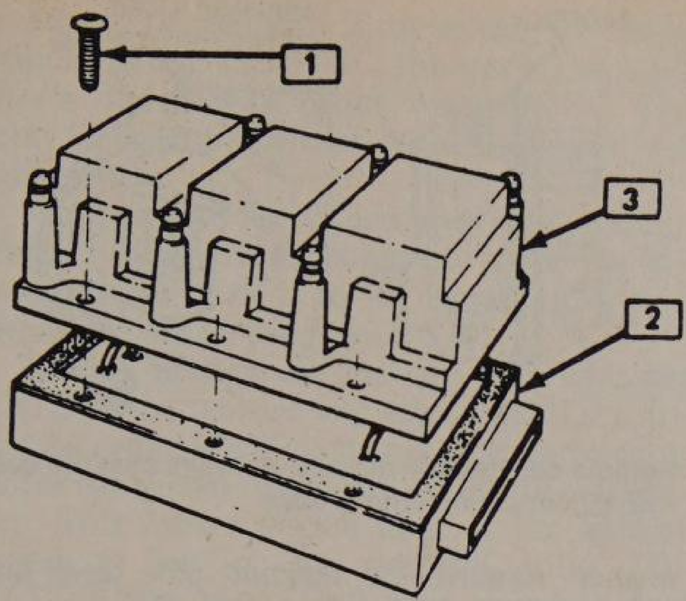
COMPONENT REPLACEMENT

Coil Pack and Module

1. Disconnect the negative (–) battery cable.
2. Label and disconnect the spark plug wires from the coils.
3. Remove the six Torx® screws securing the coil to the module for the Type I unit. Remove the two retaining nuts for each coil for the Type II unit.
4. For the Type I, tilt the coil assembly back and disconnect the coil-to-module connectors.

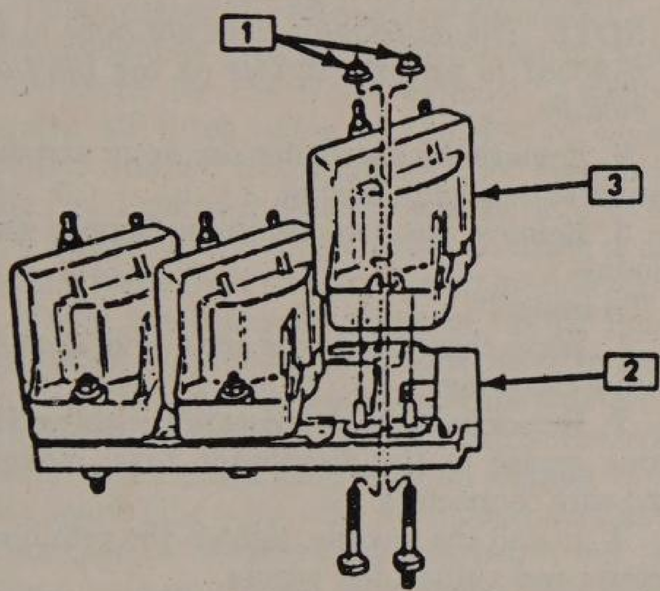
To install:

1. Install the coil assembly and torque the Torx® screws to 27 inch lbs. (3 Nm).
2. Connect the spark plugs and negative bat-



1. Torx® screws (6) 27 inch lbs. (3 Nm)
2. C³I module
3. Ignition coil assembly

Type I coil pack and module



1. Nuts 40 inch lbs. (4.5 Nm)
2. C³I module
3. Ignition coils (3)

Type II coil pack and module

tery cable. Check for proper operation.

Crankshaft Sensor

1. Disconnect the negative (–) battery cable and sensor connector.

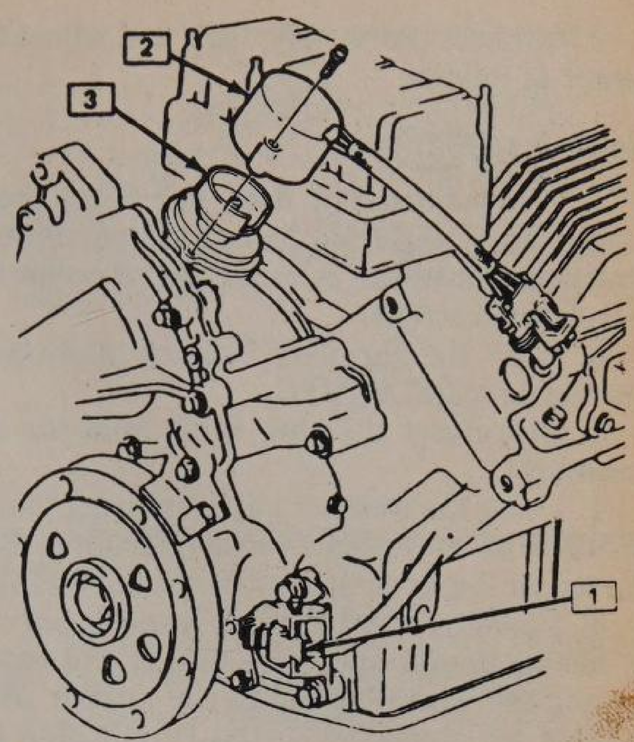
2. Rotate the harmonic balancer until any window in the interrupter is aligned with the crankshaft sensor. Loosen the pinch bolt on the sensor pedestal until the sensor is free to slide in the pedestal.

3. Remove the pedestal-to-engine mounting bolts. Carefully remove the sensor and pedestal as an assembly.

To install:

1. Loosen the pinch bolt on the new sensor until the sensor is free to slide in the pedestal.

2. Make sure the window in the interrupter is still positioned and install the assembly.



1. Crankshaft sensor
2. Camshaft position sensor
3. Camshaft sensor interrupter and shaft assembly

Crankshaft and camshaft sensors

3. Install the mounting bolts and torque to 22 ft. lbs. (30 Nm).

4. Rotate the balancer until the interrupter rings fills the sensor slots and the edge the interrupter window is aligned with the edge of the deflector on the pedestal.

5. Insert special tool J-36179 or equivalent into the gap between the sensor and interrupter. If the gauge will not slide past the sensor on either side of the interrupter. The sensor is out of adjustment.

SENSOR ADJUSTMENT

1. Loosen the pinch bolt on the sensor pedestal and insert adjustment tool J-36179 into the gap between the sensor and interrupter.

2. Torque the pinch bolt to 30 inch lbs. (3.4 Nm).

3. If the interrupter has excessive runout, replace the harmonic balancer.

Camshaft Sensor

NOTE: *If the camshaft sensor needs replacing, the entire drive assembly does not have to be removed from the engine.*

1. Disconnect the negative (–) battery cable and ignition module 14 way connector.

2. Label and disconnect the spark plug wires from the coil pack.

3. Remove the ignition module bracket assembly.

4. Disconnect the three way connector and remove the sensor from the drive assembly.

To install:

1. Position the sensor as removed, connect the wiring and spark plugs.

2. Connect the battery cable and adjust the sensor as follows.

SENSOR ADJUSTMENT

1. This adjustment does not effect spark timing. Remove the No.1 spark plug and rotate the engine until the cylinder comes up on the compression stroke.
2. Mark the harmonic balancer and rotate the engine to 25° A.T.D.C.
3. Disconnect the plug wires from the coil assembly.
4. Using the weather pack removing tool J–28742–A or equivalent, remove terminal **B** of the sensor 3-way connector on the module side.
5. Probe terminal **B** of the 3-way connector by installing a jumper wire into **B** and reconnecting the wire removed to the jumper. Wire **B** must be connected to the circuit plus the jumper wire.
6. Connect a voltmeter between the jumper wire and ground.
7. Key **ON**, engine **OFF**, rotate the camshaft sensor counterclockwise until the sensor switch closes. This is indicated by the voltage reading going from high 5–12 volts to a low voltage 0–2 volts. The low voltage means the switch is closed.
8. Tighten the retaining bolt, install plug wires, remove jumper and check operation.

Distributor Cap (HEI)

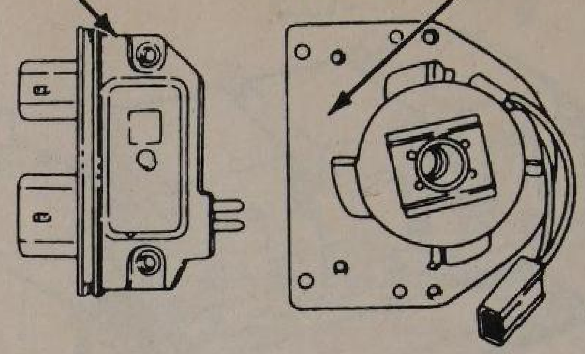
1. Disconnect the ignition switch wire from the distributor cap. Also disconnect the tachometer wire, if so equipped.
2. Release the coil connectors from the cap.
3. Remove the distributor cap by turning the four latches (the L4 distributor has 2 latches) counterclockwise.
4. Remove the cap. Installation 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.
4. Make sure the rotor is positioned in the correct direction and tighten the retaining screws.

Pickup 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 pickup coil.
4. Installation is the reverse of the removal procedure.



Remote coil ignition module—always coat the base with silicone dielectric grease

Module

1. Disconnect the negative (–) battery cable.

NOTE: *The distributor does not have to be removed to perform service on the ignition module.*

2. Remove the distributor cap, rotor and disconnect the module wiring.
3. Remove the two retaining screws and module.

To install:

1. Wipe the distributor base and module with a clean rag.
2. **Important:** apply a coat of Dielectric Silicone grease to the distributor base, module and wire connectors.
3. Install the module, tighten the retaining screws and connect the wiring.
4. Install the distributor rotor, cap and check for proper operation.

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° 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.

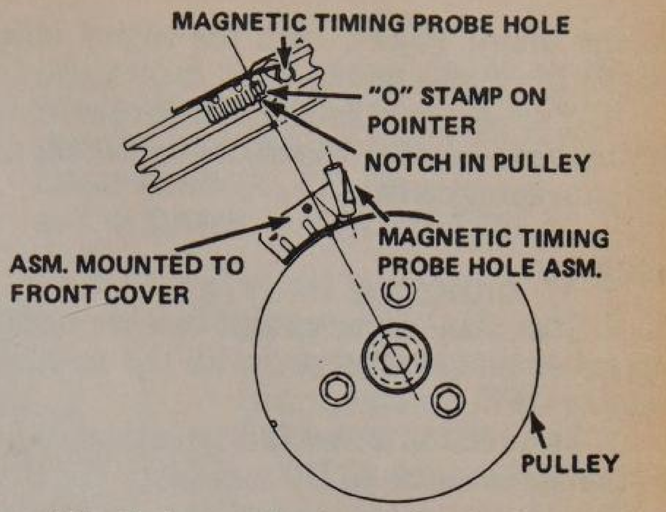
There are two basic types of timing lights available. The first type of light operates from the car's battery. Two alligator clips connect to the battery terminals, while a third wire connects to the spark plug with an adapter or to the spark plug wire with an inductive pickup. This type of light is 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 cross firing or false triggering, which may occur with a conventional light due to the greater voltages produced by HEI.

ADJUSTMENT

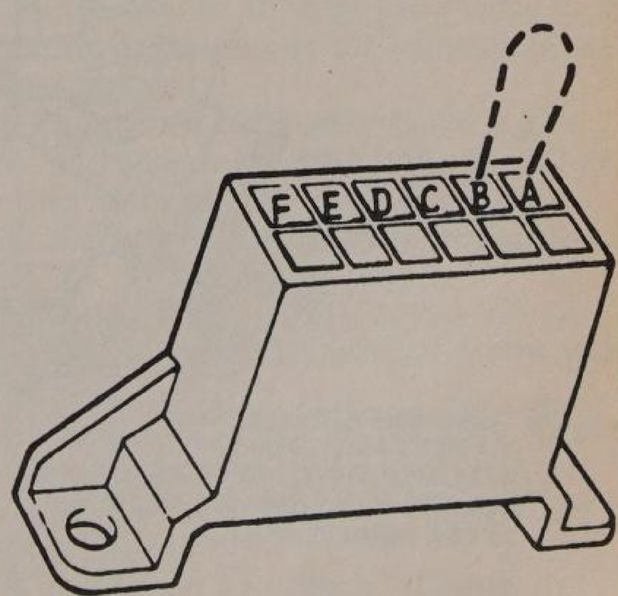
1982–85

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



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

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 pickup lead to the No. 1 spark plug wire; front cylinder of the 4–2.5L engine, front right cylinder of the 6–2.8L and 3.1L engine and front left cylinder of the 6–3.8L, 8–5.0L and 5.7L engine.
5. For 4–2.5L engines, follow emission control sticker instructions. For 6–2.8L and 8–5.0L VIN H engines, disconnect the 4-wire connector at the distributor. For the 8–5.0L VIN S engine, disconnect the Tan/Black wire at the right valve cover to place the EST into the bypass 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



Grounding the diagnostic terminal

at the timing marks. With the engine idling, adjust the timing marks.

9. Turn the engine **OFF** and disconnect the timing light and tachometer. Reconnect the distributor connectors.

1986–90

1. Run the engine until it reaches normal operation temperature and with the air conditioning **OFF**.
2. Ground the **A** and **B** diagnostic terminal of the 12-terminal ALDL (assembly line diagnostic link) located under the instrument panel.
3. Using a timing light connected to the No.1 spark plug, loosen the distributor hold down and turn the distributor to the specified timing. Use the timing specification on the emission control label in the engine compartment. If this label is missing or damaged, refer to the "Tune-up Specification" chart in this chapter.
4. Tighten the distributor hold down clamp and recheck timing.
5. With the engine still running, un-ground the diagnostic terminal.

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

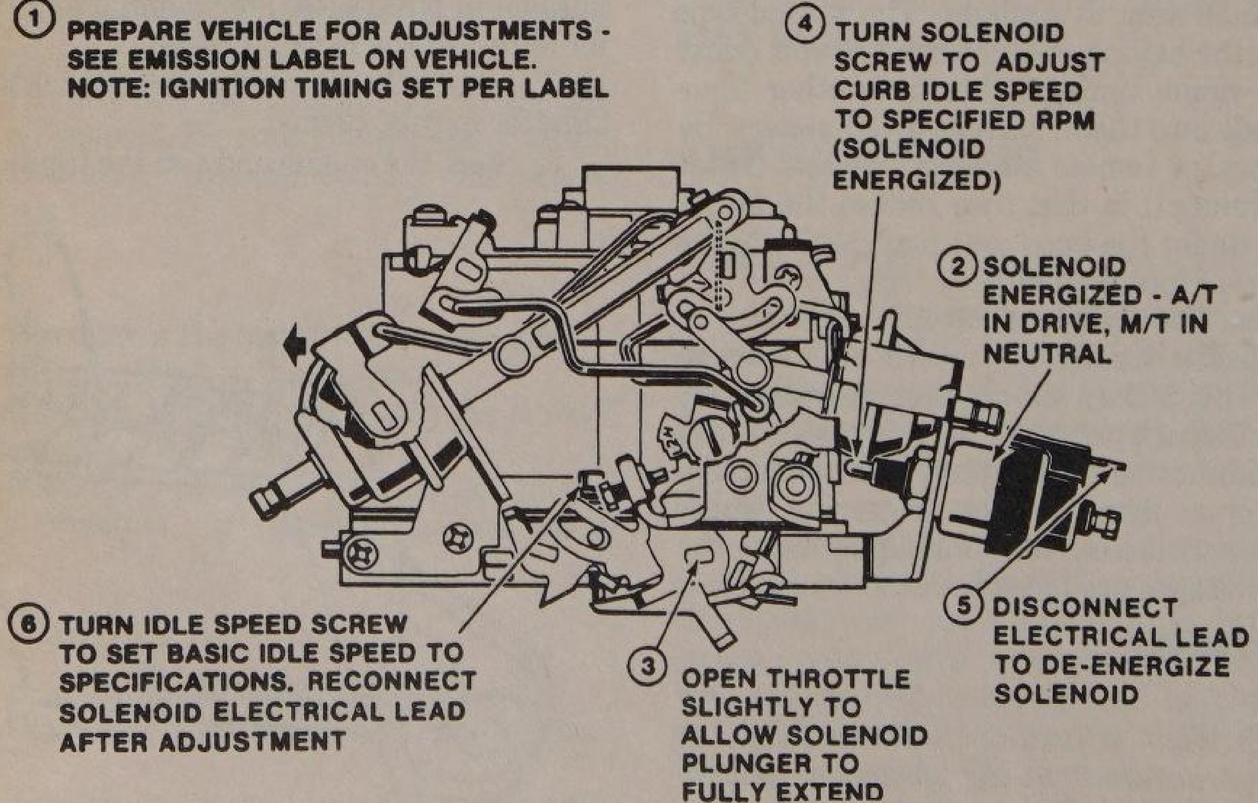
IDLE SPEED

2-bbl Carburetor Without Air Conditioning

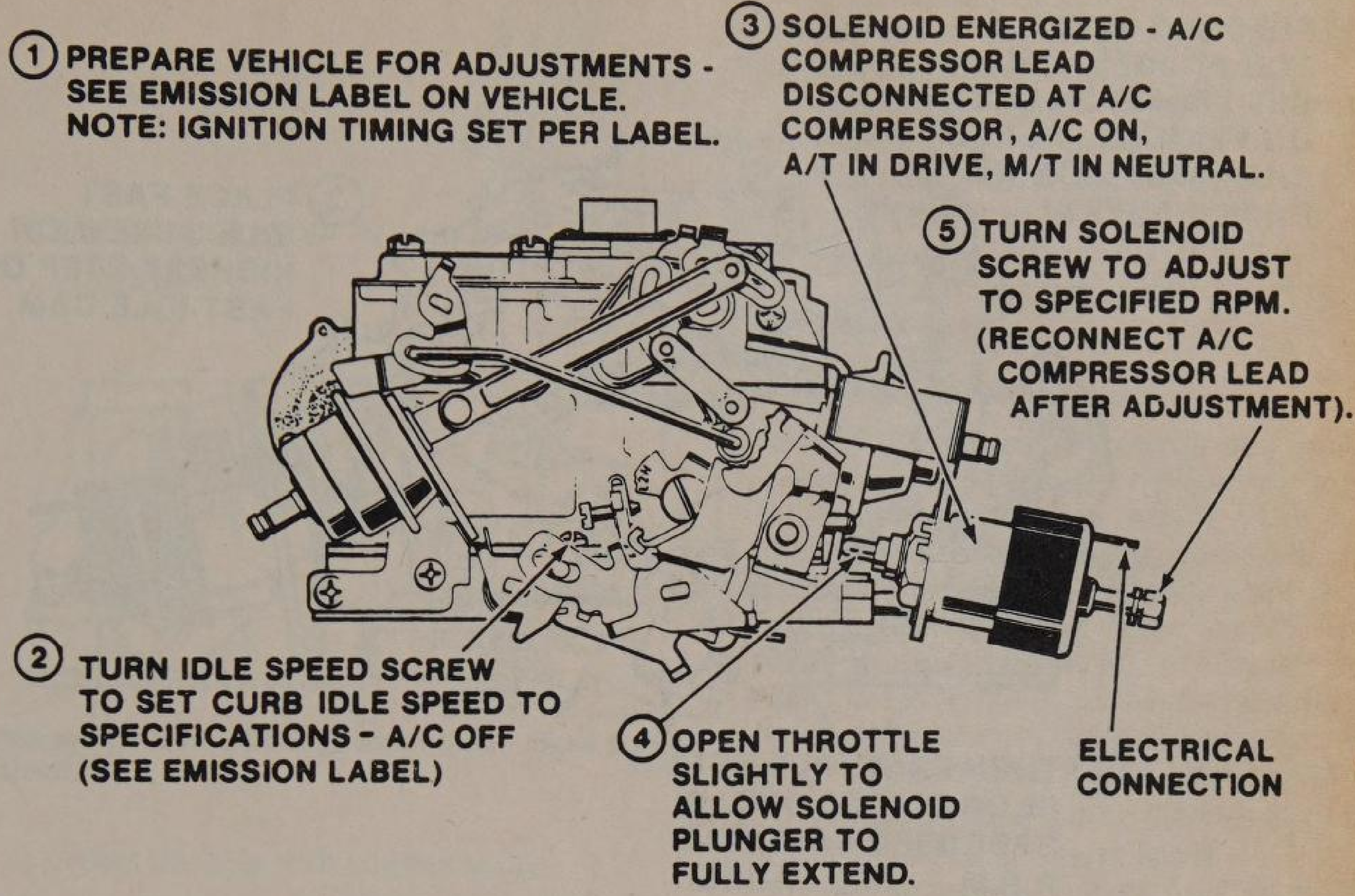
1. Refer to the emission label on the vehicle and prepare the engine for adjustments (set the timing). Set the parking brake. Connect a tachometer to the distributor connector.
2. Place the transmission in **DRIVE** for automatic transmission and **NEUTRAL** for manual transmission; make sure that the 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.

2-bbl Carburetor With Air Conditioning

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 park-



Idle speed adjustment-without A/C



Idle speed adjustment-with A/C

ing brake. Connect a tachometer to the distributor connector.

2. Place the transmission in **DRIVE** for automatic transmission and **NEUTRAL** for manual transmission. Turn the air conditioning **OFF** and set the curb idle speed by turning the idle speed screw.

3. Disconnect the air conditioning lead at the air conditioning 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 air conditioning compressor lead, remove the tachometer and install the air cleaner.

FAST IDLE

2-bbl Carburetor

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

1. Place the transmission in **PARK** or **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.

CURB IDLE

Throttle Body Injection (4–2.5L)

CAUTION: *To prevent the engine from running at high rpm, be sure the ignition is OFF and the vehicle is in PARK before disconnecting the IAC valve.*

1. Use a center punch to start a drill hole over the stop screw. Use a $^{5}/_{32}$ in. (4mm) drill bit to drill through the casting in the hardened plug.

2. Use a punch to drive out the hardened plug.

3. Remove the throttle valve cable to gain access to the minimum air adjustment screw (auto. trans. only).

4. Connect a tachometer to the engine.

5. Disconnect the IAC valve connector at the throttle body.

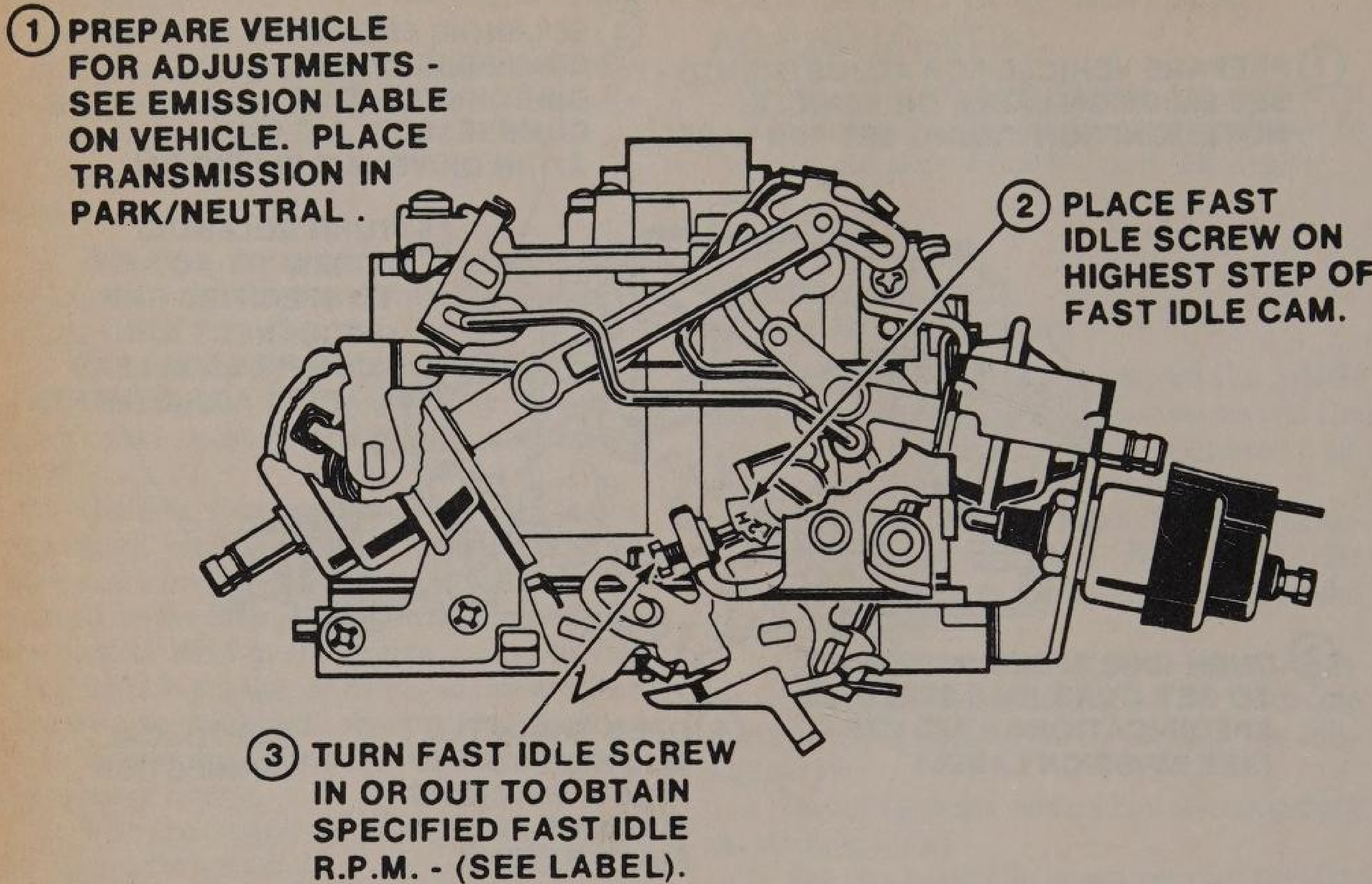
6. Start the engine and allow the rpm to stabilize.

7. Install tool J–33047 in the idle air passage of the throttle body until bottomed and no air leaks exist.

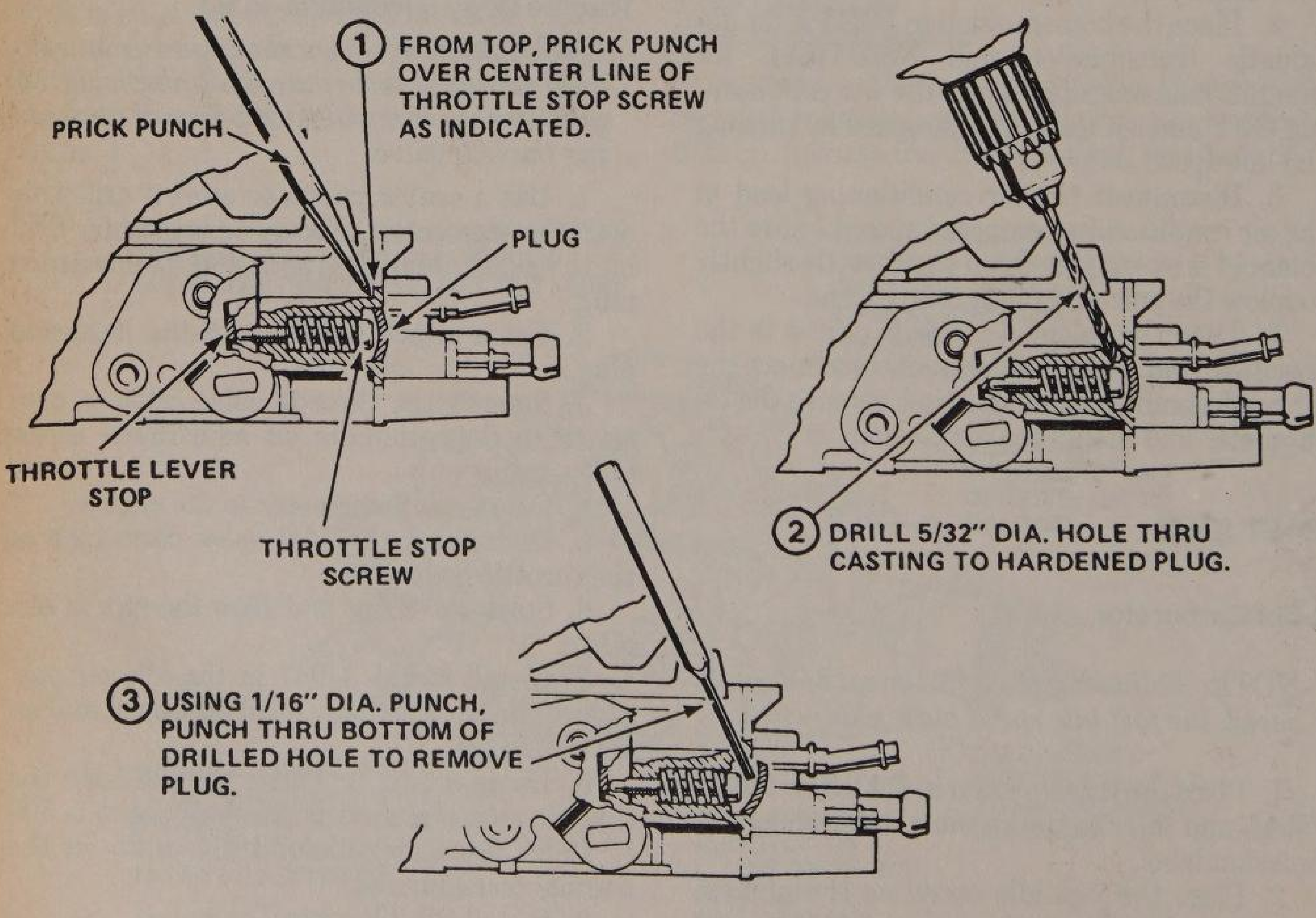
8. Using a No. 20 Torx® bit and turn the throttle stop screw until the engine rpm is 500 ± 25 for the automatic and 775 ± 25 for the manual transmission.

9. Install the TV cable if removed.

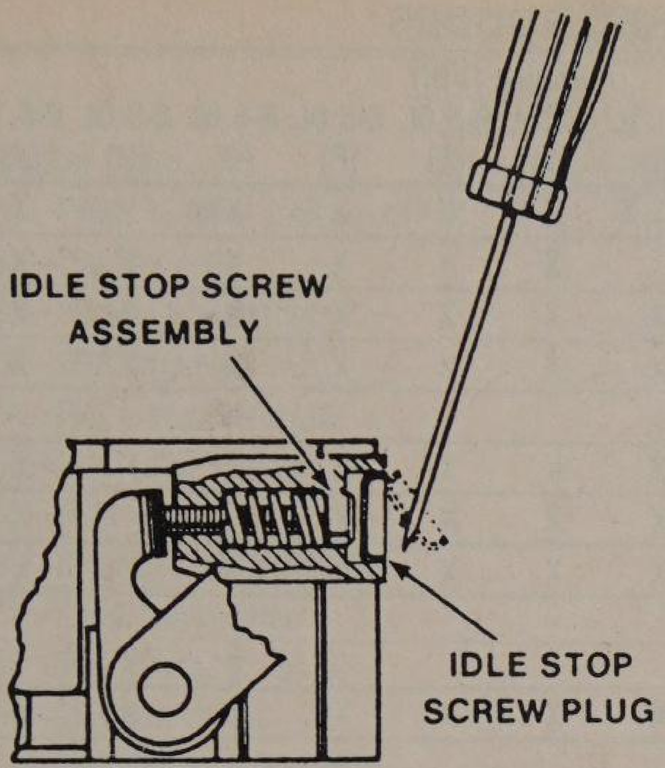
10. Reconnect all disconnected hoses and electrical connectors.



Fast Idle Adjustment Procedure



Removing the throttle stop screw plug—throttle body injection



Removing the throttle stop screw plug—tuned port injection

11. Seal the hole with silicone sealer.

Tuned Port and Sequential Injection

NOTE: *The idle stop screw is used to regulate minimum idle speed and is adjusted at the factory. The screw is covered to discourage unnecessary readjustment.*

1. Pierce the screw plug with an awl and remove it.
2. With the IAC (idle air control) motor located at the throttle body connected, ground the diagnostic link terminals **A** and **B** with a jumper wire.
3. Turn the ignition **ON**, but do not start the engine. Wait 30 seconds.
4. With the ignition **ON**, disconnect the IAC electrical connector.

NOTE: *On the 5.0L and 5.7L engines, disconnect the distributor set-timing connector.*

5. Start the engine and allow it to reach the closed loop.
6. Remove the ground from the diagnostic terminal.
7. Adjust the idle speed to the following specifications if they agree with the specifications on the emission label in the engine compartment. Use the labels specification if it differs from the following.

• 6–2.8L engine, adjust the idle stop screw to 500–550 rpm in DRIVE and 600–650 rpm in NEUTRAL for the manual transmission.

• 6–3.8L Turbo engine, adjust the idle stop screw to 500 ± 50 rpm in DRIVE.

• 8–5.0L and 8–5.7L engines, adjust the idle stop screw to 400 rpm in DRIVE. Adjust the 1988 V8 engines to 425 rpm in DRIVE or NEUTRAL. 8. Turn the ignition switch and reconnect the IAC motor.

1989–90 Tuned Port Injection

NOTE: *Idle adjustment should only be performed when installing a replacement throttle body. The minimum throttle valve position is critical to vehicle performance and component durability. If the throttle valve is adjusted to far open, it will cause the IAC valve pintle to constantly bottom on its seat and result in early failure. If the throttle valve is not open far enough, the vehicle may not start in cold weather or may stall during warn-up*

1. Connect a Scan tool or equivalent to the ALDL under the instrument panel.
2. Back the stop screw out until an air gap between the screw and the throttle lever can be seen.
3. Turn the screw in until it just contacts the throttle lever plus 1½ turns further.
4. Perform the idle lean procedure as follows:

NOTE: *Any time the battery is disconnected, the programmed position of the IAC valve pintle is lost, and replaced with a default value.*

a. Restore battery power.
b. Connect a TECH I scan tool.
c. Select the IAC system and then select the "Idle Learn" in the "Misc Test" mode.
d. Proceed with the idle learn procedure. This should stabilize the idle and update the ECM memory.

5. Place the transmission in the **PARK** position for automatic and **NEUTRAL** for a manual transmission.
6. Start the engine and allow to reach operating temperature.
7. Observe the IAC counts on the Scan tool. The counts should be 10 to 20. If not, repeat the adjustment procedure.

DIAGNOSTIC TROUBLE CODES

	Engine (VIN)									
Trouble Codes	4-2.5L (2)	6-2.8L (1)	6-2.8L (5)	6-3.1L (T)	6-3.8L (7)	8-5.0L (E)	8-5.0L (F)	8-5.0L (G)	8-5.0L (H)	8-5.7L (8)
12—Speed reference pulse	X⑤	X⑤	X⑤	X⑤	X⑤	X⑤	X⑤	X⑤	X⑤	X⑤
13—Oxygen sensor	X	X	X	X	X	X	X	X	X	X
14—CTS (Temp HI)	X	X	X	X	X	X	X	X	X	X
15—CTS (Temp LO)	X	X		X	X	X	X	X	X	X
16—System volts HI										
21—TPS (Volts HI)	X	X	X	X	X	X	X	X	X	X
22—TPS (Volts LO)	X		X	X	X	X	X			X
23—MAT (Temp LO)			X	X	X	X	X			X
23—M/C solenoid (open or ground)		X						X	X	
24—VSS	X	X	X	X	X	X	X	X	X	X
24B—Park/neutral switch										
25—MAT (Temp HI)			X	X	X	X	X			X
26—Quad-driver										
27/28—Gear switch										
28/29—Gear switch										
31—Park/neutral switch										
31—Wastegate overboost					X					
31—Canister purge (Volts HI)										
32—EGR failure		X①	X	X	X	X	X	X①	X①	X
33—MAP (Volts HI/Vac LO)	X			X	X	X				
33—MAF (gm/sec HI)			X				X			X
34—MAP (Volts LO/Vac HI)	X	X②		X	X	X		X②	X②	
34—MAF (gm/sec HI)			X				X			X
35—Idle speed error					X					
35—IAC				X						
36—Close throttle air flow HI										
36—MAF burn-off							X			X
38—Brake switch										
39—TCC										
41—1 X reference		X						X	X	
41—Cylinder select error/ MEM-CAL			X	X			X			X
41—Cam sensor					X					
42—EST	X	X	X	X	X	X	X	X	X	X
43—ESC		X		X	X	X	X	X	X	X
44—Oxygen sensor (lean)	X	X	X	X	X	X	X	X	X	X
45—Oxygen sensor (rich)	X	X	X	X	X	X	X	X	X	X
46—Power steering press switch										
46—VATS				X			X			X
48—Misfire diagnosis										

DIAGNOSTIC TROUBLE CODES

	Engine (VIN)									
Trouble Codes	4-2.5L (2)	6-2.8L (1)	6-2.8L (5)	6-3.1L (T)	6-3.8L (7)	8-5.0L (E)	8-5.0L (F)	8-5.0L (G)	8-5.0L (H)	8-5.7L (8)
51—PROM or MEM-CAL error	X	X	X	X	X	X	X	X	X	X
52—CALPAK error			X	X	X	X	X			
53—System overvoltage			X	X		X ③	X			X
53—EGR (Improper VAC)					X ④			X	X	
54—Fuel pump (Volts LO)			X	X		X	X			X
54—M/C solenoid (Volts HI)		X						X	X	
55—ECM error	X		X			X				
61—Degraded oxygen sensor				X						
62—Trans. gear switch										
63—MAP (Volts HI/Vac LO)										
63—EGR flow check										
64—MAP (Volts LO/Vac HI)										
64—EGR flow check										
65—Fuel injector (LO amps)										
65—EGR flow check										
66—A/C press switch										

X = code applies

Notes:

① Carbureted, baro sensor

② Carbureted, differential pressure sensor

③ 1990 TBI code 53 is VATS circuit

④ 1989 3.8L turbo code 53 is ECM error

⑤ Code 12 will flash three times. If no other codes are stored, code 12 will continue to flash until the diagnostic terminal is disconnected. Refer to text for more information.

Engine and Engine Overhaul

3

UNDERSTANDING THE ENGINE ELECTRICAL SYSTEM

The engine electrical system can be broken down into three separate and distinct systems:

1. Starting
2. Charging
3. Ignition

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 (2V) subsections connected in series so the unit is capable of producing approximately 12V 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 that 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 current 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 solenoid 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 connected 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

Ignition component removal and diagnosis is in Chapter 2.

The Delco-Remy High Energy Ignition (HEI) System is a breakerless, pulse triggered, transistor controlled, inductive discharge ignition system. Early model engines have the coil located in the distributor cap, connecting directly to the rotor. After 1984, most engines have a separately mounted coil.

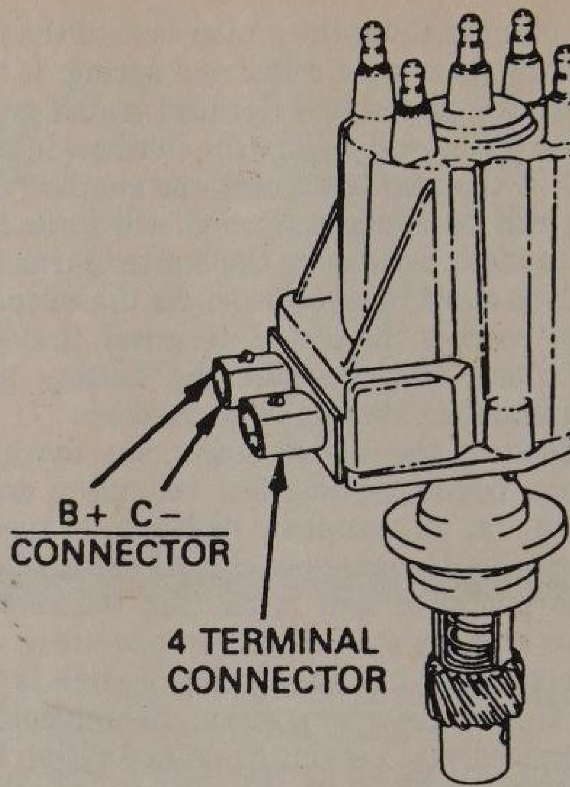
The magnetic pick-up assembly located inside the distributor contains a permanent magnet, a pole piece with internal teeth, and a pick-up coil. When the teeth of the rotating timer core and pole piece align, an induced voltage in the pick-up signals the electronic module to open the coil primary circuit. 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, Firebirds 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) instead of a mechanical vacuum advance. The system 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.

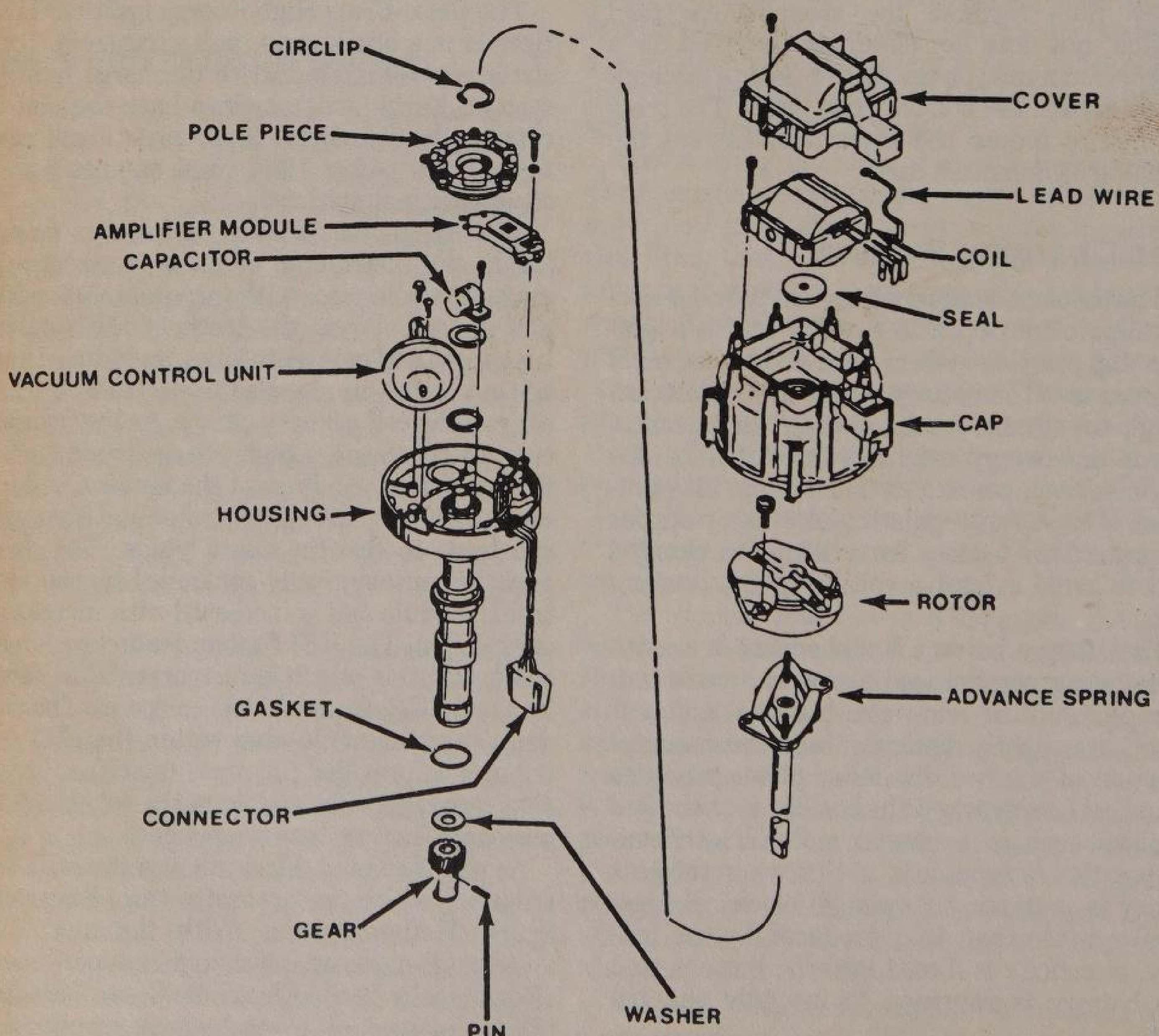
REMOVAL AND INSTALLATION

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. There are 2 retainers for the 2.5L engine.
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



Exploded view of the HEI/EST distributor — remote coil



Exploded view of the HEI distributor

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.

To install:

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.

WARNING: *Do NOT force the distributor into the engine using the hold down clamp. If the distributor does not drop into the engine completely, the oil pump drive is not engaging the distributor shaft. Forcing may cause severe engine damage. Slowly turn the engine by clicking the starter or manually turning the crankshaft until the distributor is fully seated into the engine.*

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 to the specification on the emission label in the engine compartment. Also, refer to the "Ignition Timing" procedures in Chapter 2.
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 (not using the starter). 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.

WARNING: *Do NOT force the distributor into the engine using the hold down clamp. If the distributor does not drop into the engine completely, the oil pump drive is not engaging the distributor shaft. Forcing may cause severe engine damage. Slowly turn the engine by clicking the starter or manually turning the crankshaft until the distributor is fully seated into the engine.*

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 to the specification on the emission label in the engine compartment. Also, refer to the "Ignition Timing" procedures in Chapter 2.

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 consist 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 elec-

ALTERNATOR SPECIFICATIONS

Series	Type	Field Ohms (80°F)	Field Current (80°F) Amps	Volts	Cold Output Amps	RPM	Amps	RPM	Pulley Nut Torque (Ft. lbs.)	(N.m)
12-SI	100	2.4–2.7	4.5–5.0	12	51	2000	81	7000	40–60	54–82
15-SI	100	2.6–3.0	4.0–4.6	12	57	2000	85	5000	40–60	54–82
10-SI	100	2.4–3.0	4.0–5.0	12	30	2000	51	5000	40–60	54–82
27-SI	200	2.4–2.7	4.4–4.9	12	52	2000	72	5000	40–60	54–82
CS-130	100	1.6–2.0	6.0–7.5	12	42	1600	85	6500	40–80	54–108
CS-144	200	2.4–2.7	4.4–4.9	12	52	2000	72	5000	40–80	54–108

trical 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.

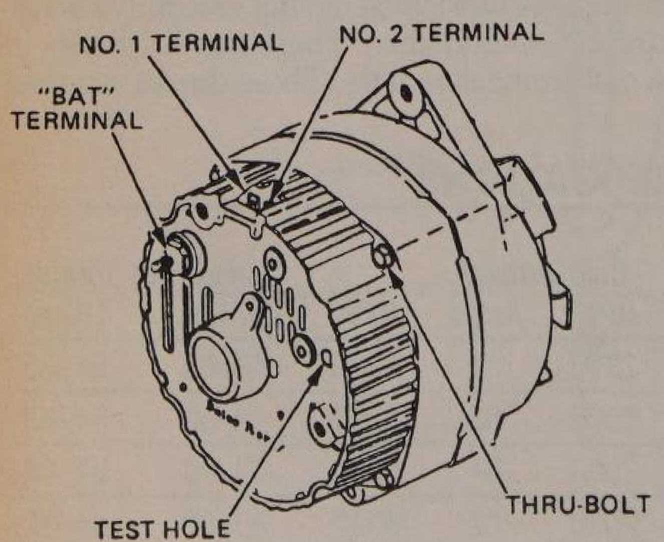
PRECAUTIONS

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

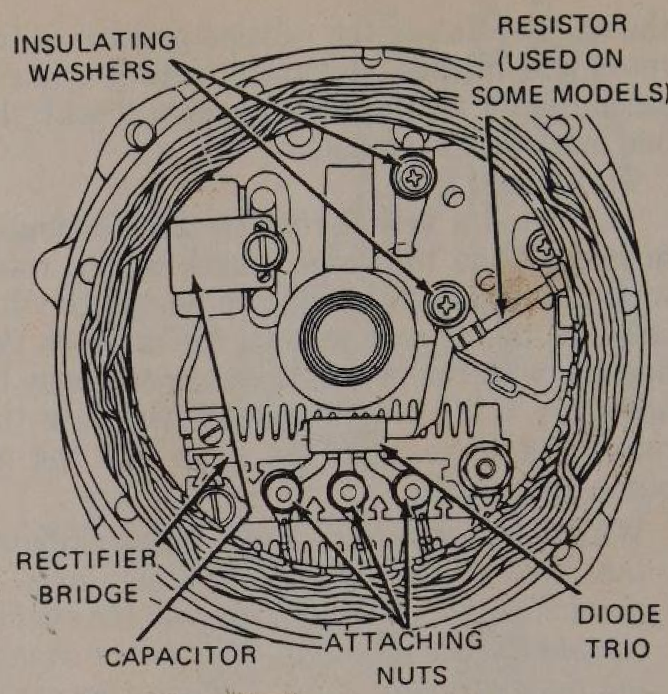
1. When installing a battery, make sure that the positive cable is connected to the positive terminal and the negative to the negative.
2. When jump-starting the car with another battery, make sure that like terminals are connected. This also applies when using a battery charger.
3. Never operate the 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 belts(s). If the engine is equipped with automatic belt tensioner, remove the tension from the belt by installing a 1/2 in. ratchet into the groove and pull. Note the belt routing before removal. Use the "Serpentine Belt Routing" diagrams in Chapter 1.
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 13mm (1/2 in.) of play on the longest run between pulleys.
6. If equipped with a serpentine belt, route the belt around the pulleys, release the tension from the automatic tensioner and install the belt. Make sure the belt is routed properly.



SI series alternator



View of the alternator end frame

Voltage Regulator

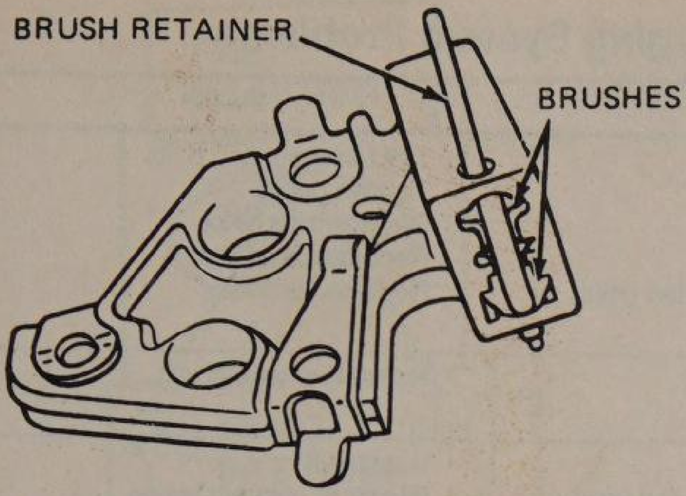
REMOVAL AND INSTALLATION

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

The late model CS-130 and CS-144 are not serviceable. No service parts are available. If the alternator is defective, the complete unit must be replaced.

SI Series

1. Make scribe marks on the end frames to make reassembly easier.
2. Remove the 4 through-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.



Voltage regulator with the brushes depressed

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

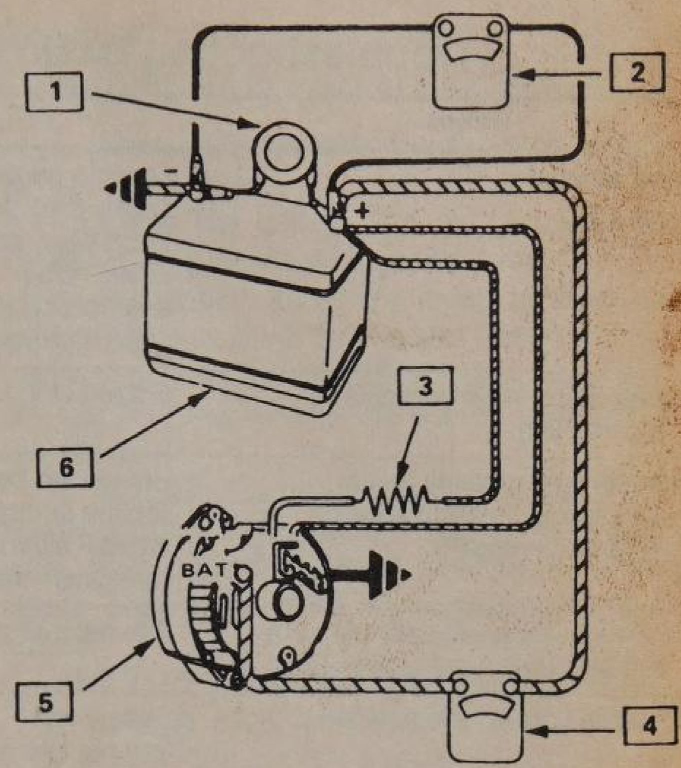
VOLTAGE ADJUSTMENT

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 disassemble.

ALTERNATOR TESTING

Bench Test

1. Remove the alternator from the vehicle and install in a suitable test stand.
2. Make the connections shown in the illustration but leave the carbon pile disconnected. Use a fully charged battery and a 10Ω resistor rated at six watts or more between the alternator No. 1 terminal and the battery.
3. Slowly increase the alternator speed and observe the voltage.
4. If the voltage is uncontrolled with speed and increases above 15.5 volts. test the regulator with an approved regulator tester and check the field winding.
5. If the voltage is below 15.5 volts, connect the carbon pile as shown. Operate the alternator at moderate speed and adjust the carbon pile as required to obtain maximum current output.
6. If the output is within 10 amperes of the rated output as stamped on the alternator frame, the unit is OK.
7. If the output is not within 10 amperes, keep the battery loaded with carbon pile and ground the alternator field.
8. Operate the alternator at moderate



1. Carbon pile
2. Voltmeter
3. Resistor
4. Test ammeter
5. Alternator
6. Battery

Alternator bench test

speed and adjust the carbon pile as required to obtain maximum output.

9. If the output is within 10 amperes of the rated output, test the regulator and field winding.
10. If the output is not within 10 amperes, check the field winding, diode trio, rectifier bridge and stator.

Voltage Regulator Testing

1. Remove the regulator from the alternator.
2. Connect a voltmeter and fast charger to a 12 volt battery.
3. Connect the regulator and test light as shown in the illustration. The test light should be ON.
4. Turn the charger ON and slowly increase the charge rate. Observe the voltmeter, the light should go out at the regulator setting of a minimum of 13.5 volts and maximum of 16.0 volts. Readings may vary with temperature.

Battery

REMOVAL AND INSTALLATION

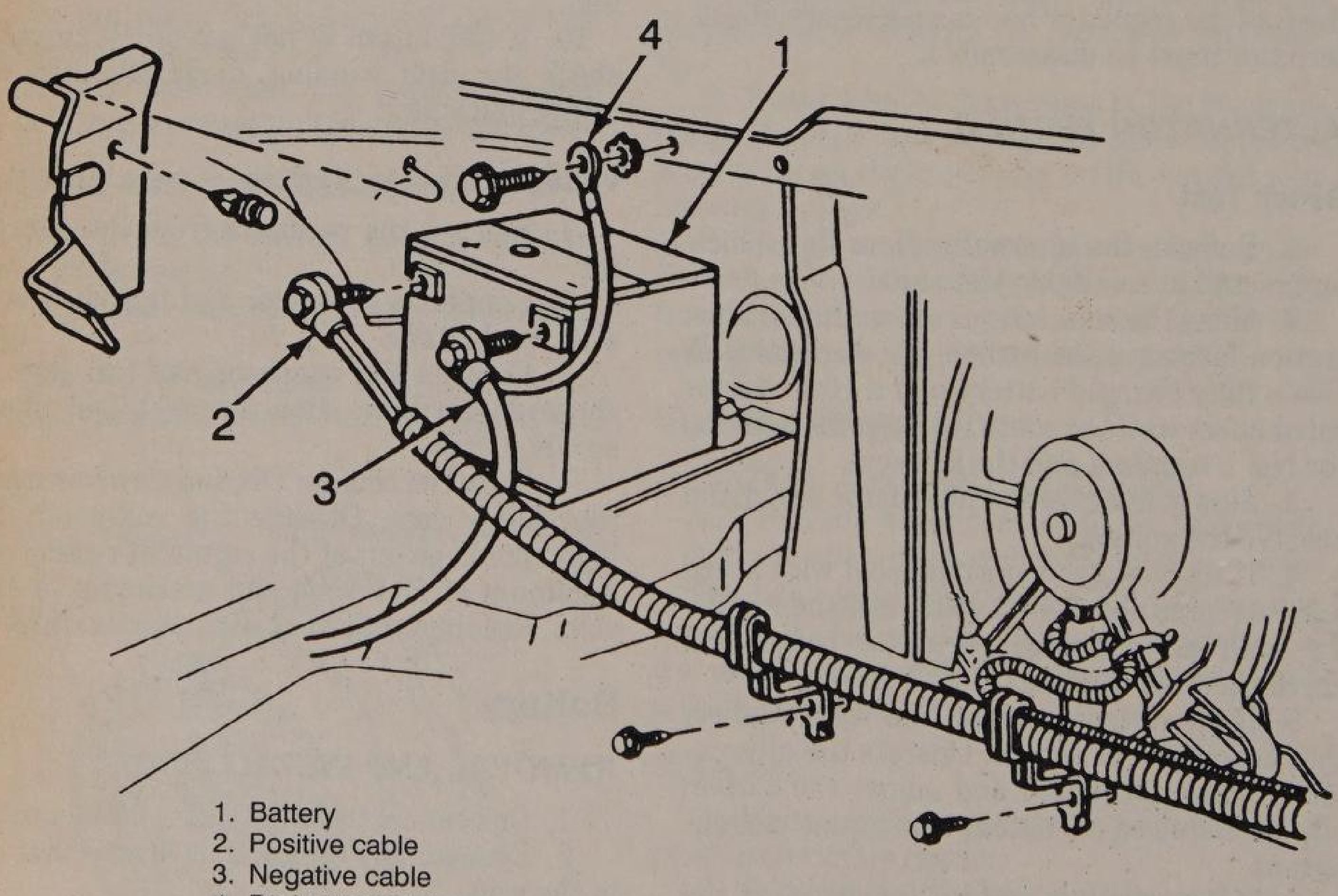
1. Disconnect the negative (–) battery cable.
2. Remove any brackets or braces that are in the way.
3. Disconnect the positive battery cable.
4. Remove the retainer bolt and retainer.
5. Remove the battery using a carrying tool.

To install:

1. Clean the battery, tray and surrounding area with a baking soda and water solution.

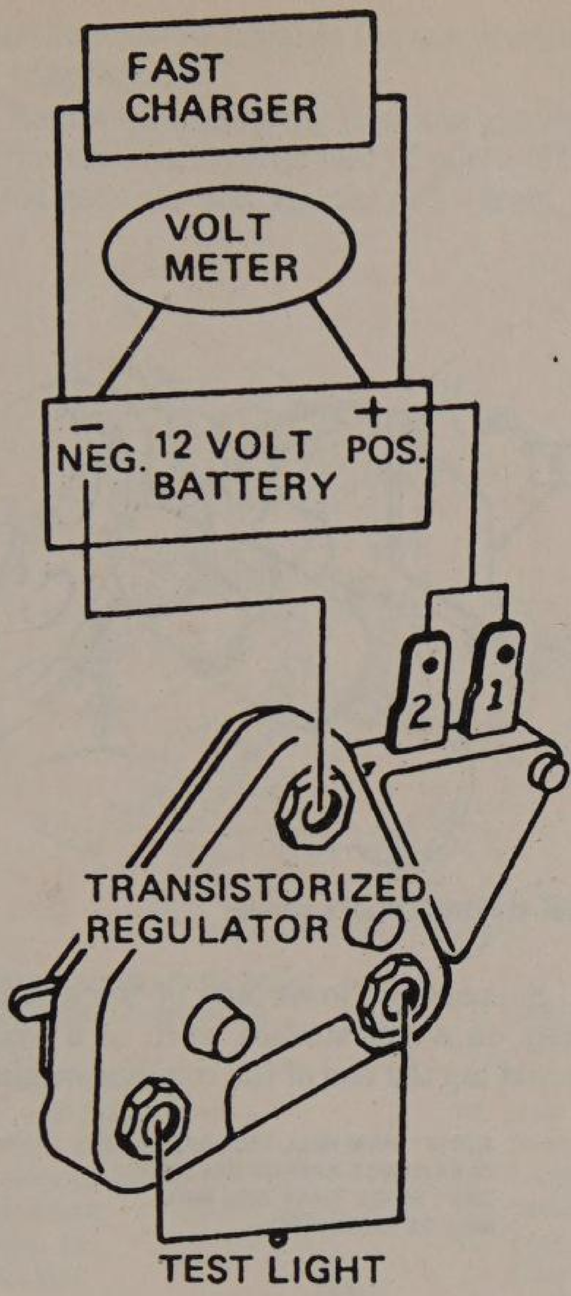
Troubleshooting Basic Charging System Problems

Problem	Cause	Solution
Noisy alternator	• Loose mountings • Loose drive pulley • Worn bearings • Brush noise • Internal circuits shorted (High pitched whine)	• Tighten mounting bolts • Tighten pulley • Replace alternator • Replace alternator • Replace alternator
Squeal when starting engine or accelerating	• Glazed or loose belt	• Replace or adjust belt
Indicator light remains on or ammeter indicates discharge (engine running)	• Broken fan belt • Broken or disconnected wires • Internal alternator problems • Defective voltage regulator	• Install belt • Repair or connect wiring • Replace alternator • Replace voltage regulator
Car light bulbs continually burn out—battery needs water continually	• Alternator/regulator overcharging	• Replace voltage regulator/alternator
Car lights flare on acceleration	• Battery low • Internal alternator/regulator problems	• Charge or replace battery • Replace alternator/regulator
Low voltage output (alternator light flickers continually or ammeter needle wanders)	• Loose or worn belt • Dirty or corroded connections • Internal alternator/regulator problems	• Replace or adjust belt • Clean or replace connections • Replace alternator or regulator



1. Battery
2. Positive cable
3. Negative cable
4. Body ground strap

Battery installation

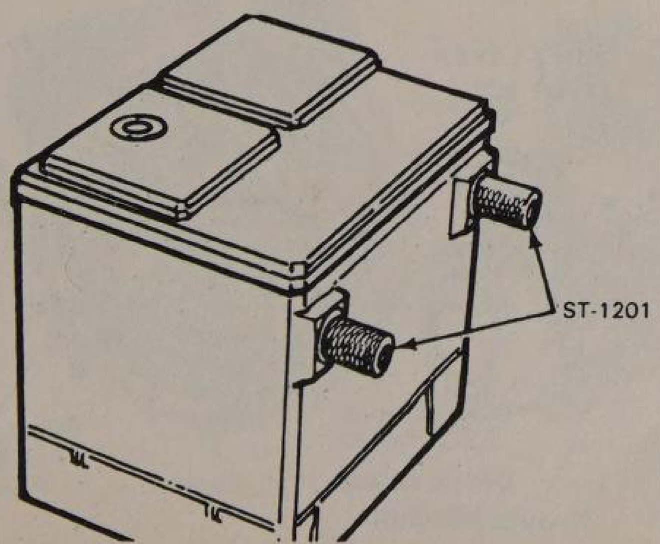


Voltage regulator testing

Paint the rusted areas with corrosion resistant paint.

2. Install the battery and retainers. Torque the retainer bolt to 71 inch lbs. (8 Nm).

3. Connect the positive cable and then the negative. Torque the cable bolts to 106 ft. lbs. (12 Nm).



Battery with carrying tool installed

Starter

REMOVAL AND INSTALLATION

1. **Very Important:** 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:*

a. Loosen the mounting bolt that attaches the support to the corner of the frame.

b. Loosen and remove the mounting bolt that attaches the support to the front crossmember and then swing the support out of the way.

c. 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.

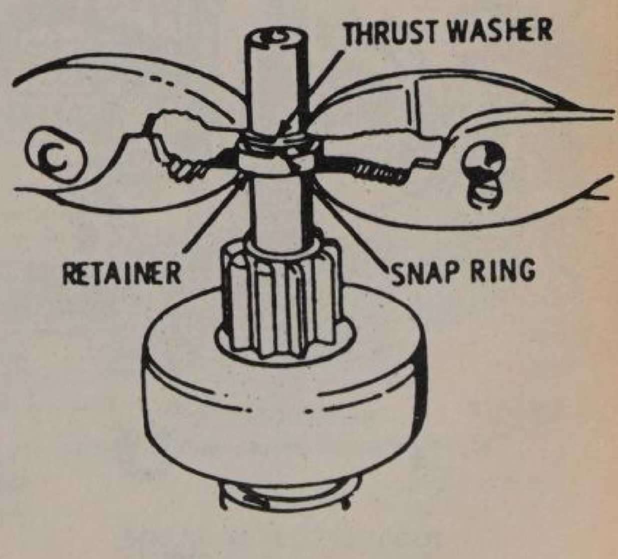
To install:

6. Install the starter. Torque the two mounting bolts to 25–35 ft. lbs. (34–48 Nm).

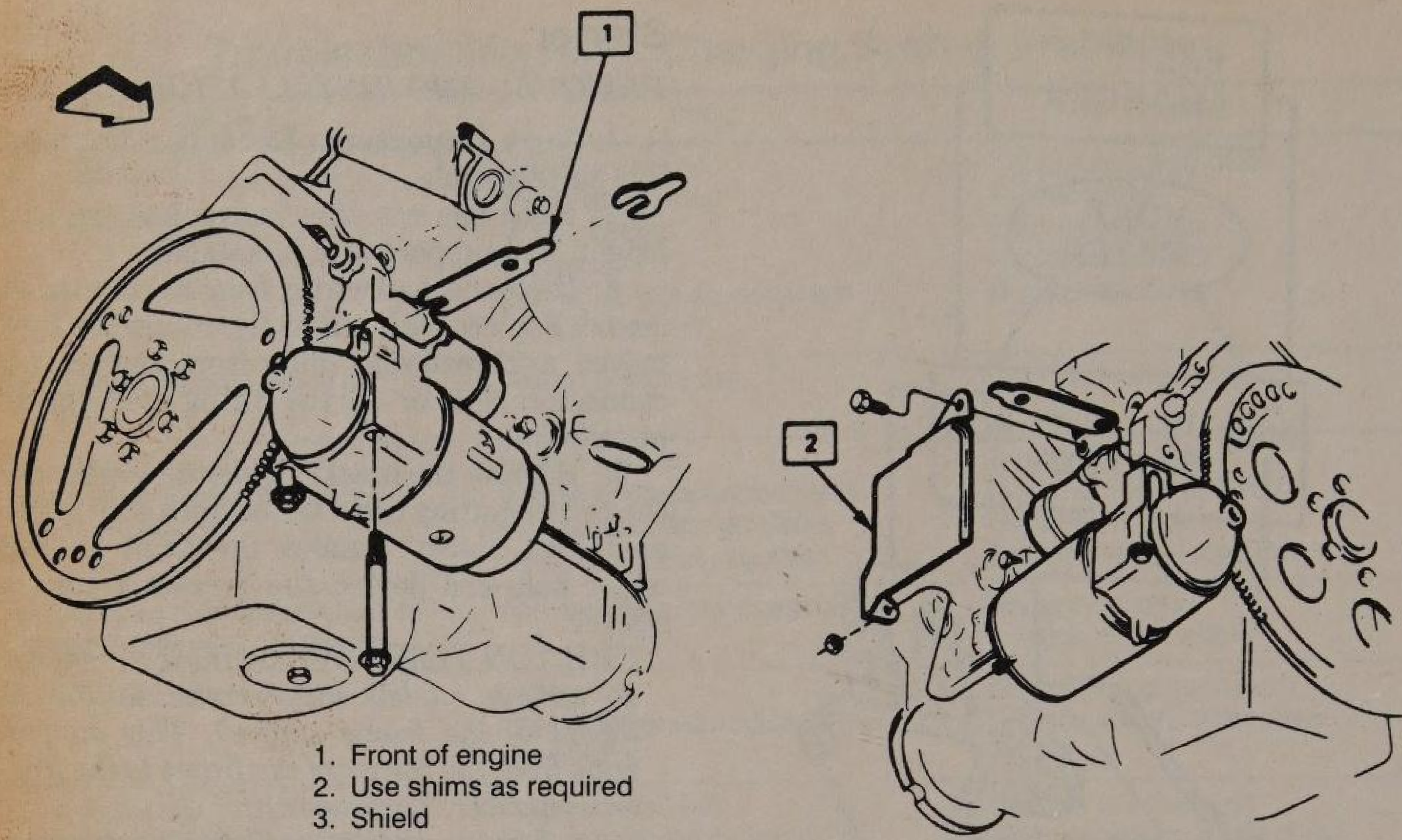
NOTE: *If shims were placed between the starter and engine block, they must be replaced in their original locations.*

7. Install all brackets, shields and hardware that was removed.

8. Connect the wiring to the proper location, start the engine and check performance.



Snap ring installation



1. Front of engine
2. Use shims as required
3. Shield

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

STARTER OVERHAUL

Drive Replacement

1. Disconnect the field coil straps from the solenoid.

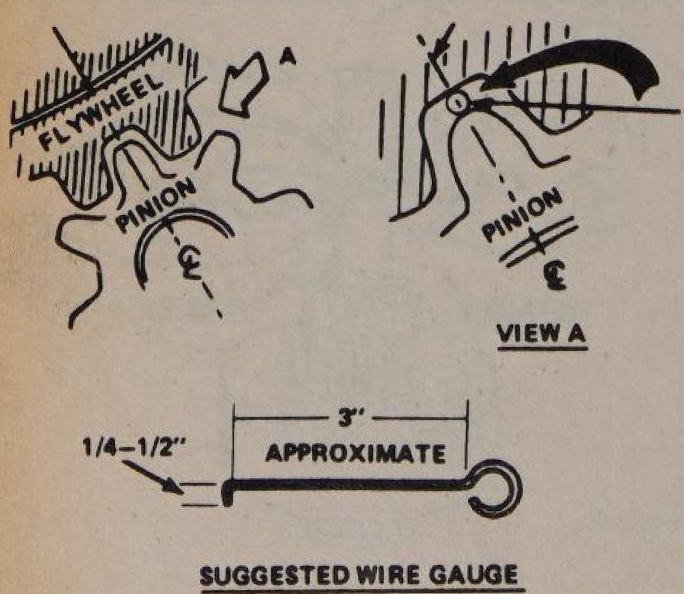
2. Remove the through bolts, and separate commutator end frame, field frame assembly, drive housing, and armature assembly from each other.

3. Slide the two piece thrust collar off the end of the armature shaft.

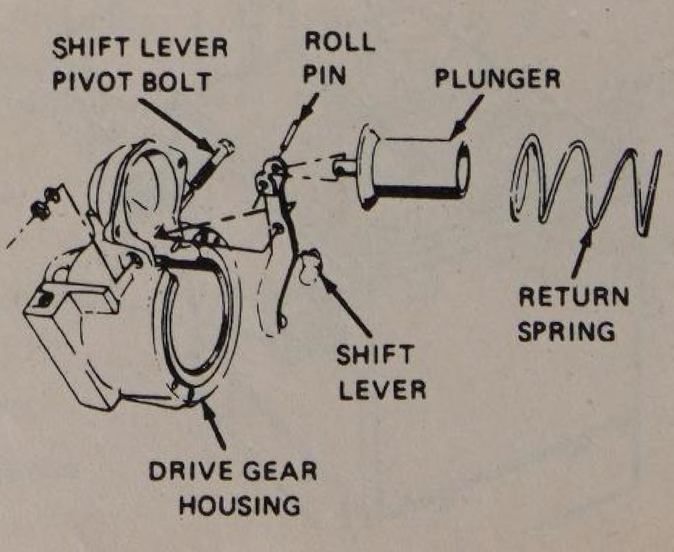
4. Slide a suitably sized metal cylinder, such as a standard 0.5 in. pipe coupling, or an old pinion, onto the shaft so that the end of the coupling or pinion butts up against the edge of the pinion retainer.

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,

Matching starter and flywheel teeth



Flywheel-to-pinion clearance

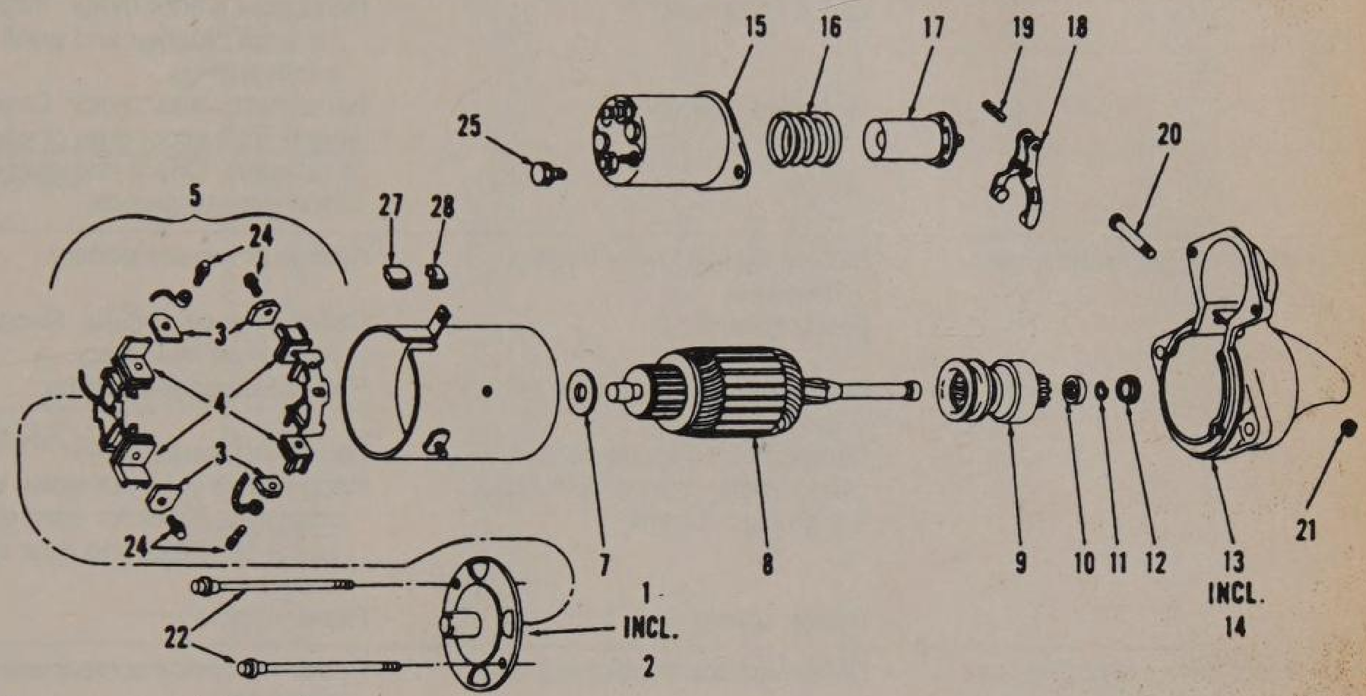


Removing shaft lever and plunger from starter

driving the retainer towards the armature end of the snapring.

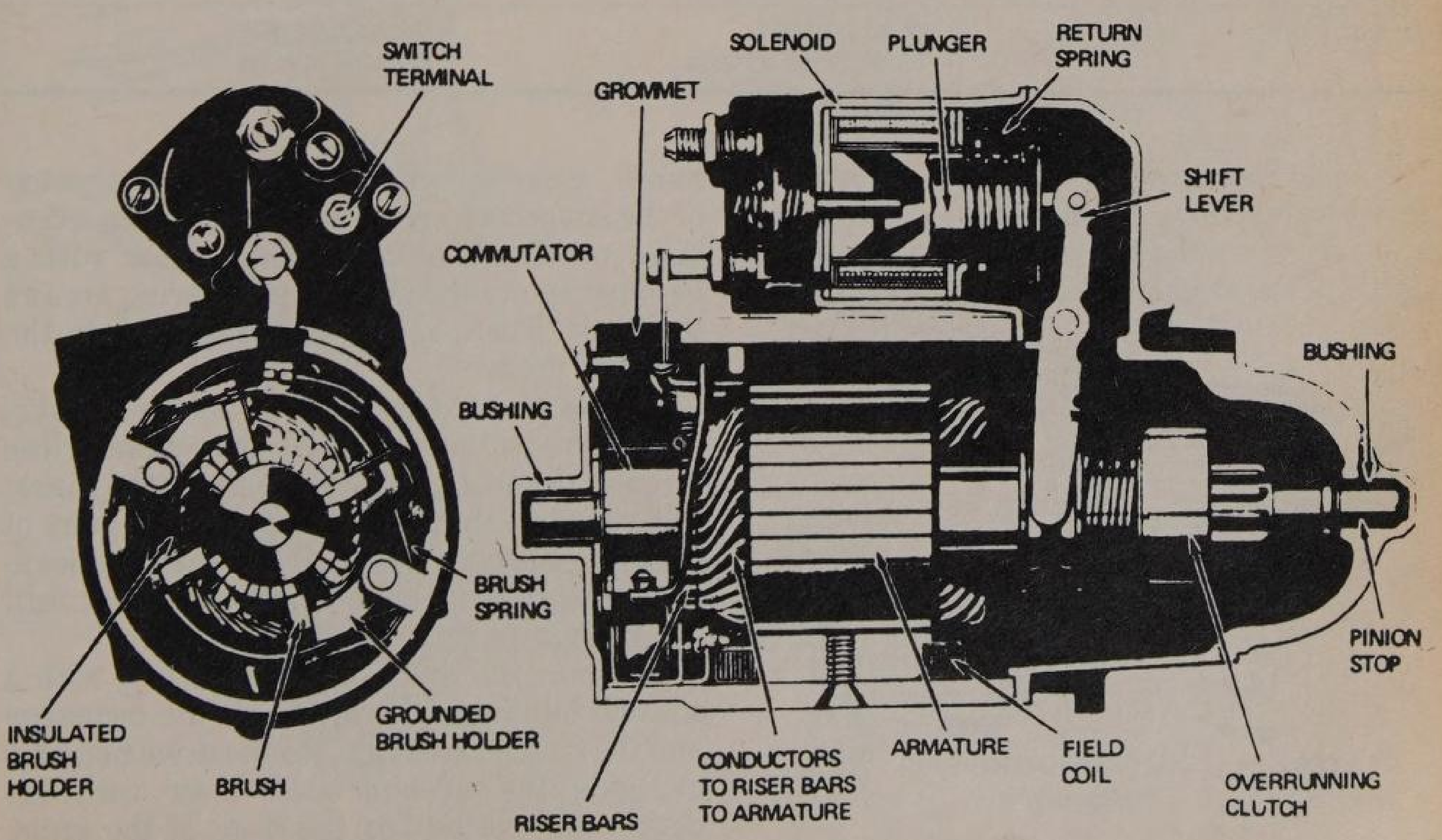
6. Remove the snapring from the groove in the armature shaft with a pair of pliers. Then, slide the retainer and starter drive from the shaft.

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

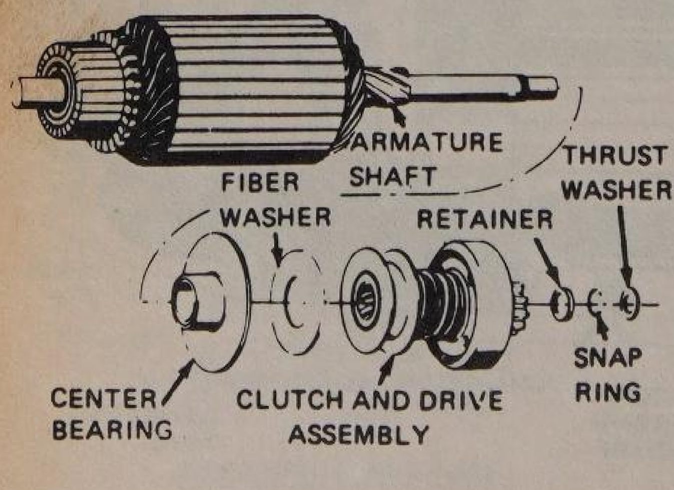


Cross section of a typical starter

Troubleshooting Basic Starting System Problems

Problem	Cause	Solution
Starter motor rotates engine slowly	• Battery charge low or battery defective • Defective circuit between battery and starter motor • Low load current • High load current	• Charge or replace battery • Clean and tighten, or replace cables • Bench-test starter motor. Inspect for worn brushes and weak brush springs. • Bench-test starter motor. Check engine for friction, drag or coolant in cylinders. Check ring gear-to-pinion gear clearance.
Starter motor will not rotate engine	• Battery charge low or battery defective • Faulty solenoid • Damage drive pinion gear or ring gear • Starter motor engagement weak • Starter motor rotates slowly with high load current • Engine seized	• Charge or replace battery • Check solenoid ground. Repair or replace as necessary. • Replace damaged gear(s) • Bench-test starter motor • Inspect drive yoke pull-down and point gap, check for worn end bushings, check ring gear clearance • Repair engine
Starter motor drive will not engage (solenoid known to be good)	• Defective contact point assembly • Inadequate contact point assembly ground • Defective hold-in coil	• Repair or replace contact point assembly • Repair connection at ground screw • Replace field winding assembly
Starter motor drive will not disengage	• Starter motor loose on flywheel housing • Worn drive end busing • Damaged ring gear teeth • Drive yoke return spring broken or missing	• Tighten mounting bolts • Replace bushing • Replace ring gear or driveplate • Replace spring
Starter motor drive disengages prematurely	• Weak drive assembly thrust spring • Hold-in coil defective	• Replace drive mechanism • Replace field winding assembly
Low load current	• Worn brushes • Weak brush springs	• Replace brushes • Replace springs

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



Starter and drive assembly removed

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 snapring. Using two pairs of pliers on opposite sides of the shaft, squeeze the thrust collar and the retainer together until the snapring is forced into the retainer.

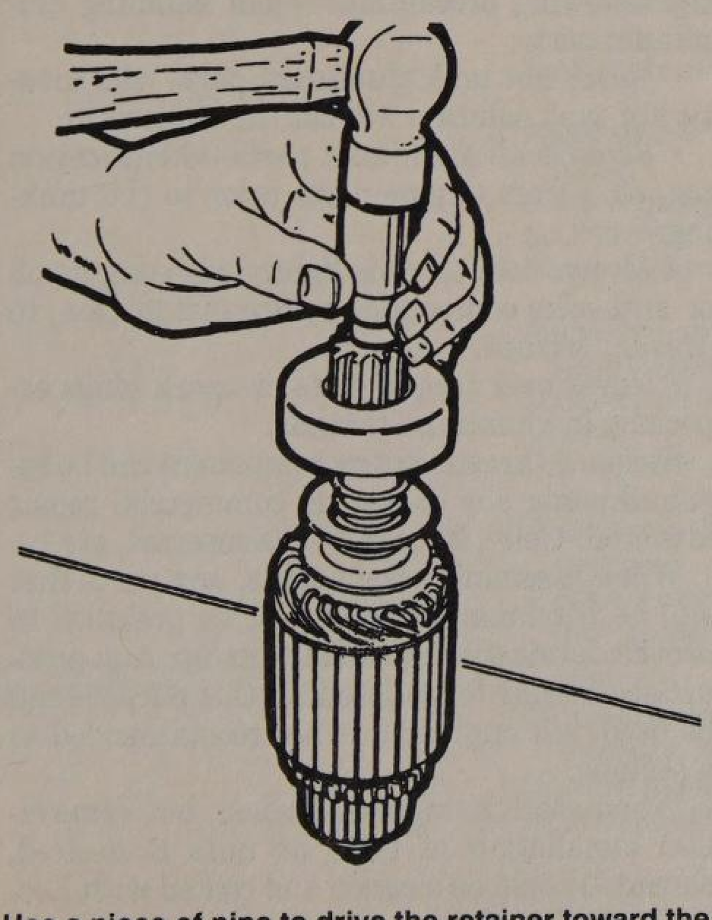
10. Lube the drive housing bushing with a silicone lubricant. Then, install the armature and the clutch assembly into the drive housing, engaging the solenoid shift lever with the clutch, and positioning the front of the armature shaft into the bushing.

11. Apply a sealing compound approved for

STARTER SPECIFICATIONS

Year	No. Cyl. Displacement (Liters) Engine	Type	No Load Test (includes solenoid current) Volts	Min. Amps	Max. Amps	Min. RPM	Max. RPM
1982–85	4–2.5	5MT	12	50	75	6,000	11,900
	6–2.8	5MT	12	50	75	6,000	11,900
	8–5.0	5MT	12	50	75	6,000	11,900
	8–5.0	5MT	12	52	76	6,000	12,000
1986–88	4–2.5	5MT	12	50	75	6,000	11,900
	6–2.8	5MT	12	50	75	6,000	11,900
	8–5.0	5MT	12	50	75	6,000	11,900
	8–5.0 HO	10MT	12	70	110	6,500	10,700
	8–5.7	5MT	12	52	76	6,000	12,000
1989–90	6–2.8	SD200	12	50	75	6,000	11,900
	6–3.1	SD200	12	50	75	6,000	11,900
	6–3.8 Turbo	10MT	12	45	74	8,600	12,900
	8–5.0	SD200	12	50	75	6,000	11,900
	8–5.7	SD300	12	70	110	6,500	10,700

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.



Use a piece of pipe to drive the retainer toward the snapring

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 through-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 counter-clockwise 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.

ENGINE MECHANICAL

Engine Overhaul Tips

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 accept 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.

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, piston 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:

- 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

The 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 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 fluorescent 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 the 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 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 prelube.

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.

Troubleshooting Engine Mechanical Problems

Problem	Cause	Solution
External oil leaks	• Fuel pump gasket broken or improperly seated	• Replace gasket
	• Cylinder head cover RTV sealant broken or improperly seated	• Replace sealant; inspect cylinder head cover sealant flange and cylinder head sealant surface for distortion and cracks
	• Oil filler cap leaking or missing	• Replace cap
	• Oil filter gasket broken or improperly seated	• Replace oil filter
	• Oil pan side gasket broken, improperly seated or opening in RTV sealant	• Replace gasket or repair opening in sealant; inspect oil pan gasket flange for distortion
	• Oil pan front oil seal broken or improperly seated	• Replace seal; inspect timing case cover and oil pan seal flange for distortion
	• Oil pan rear oil seal broken or improperly seated	• Replace seal; inspect oil pan rear oil seal flange; inspect rear main bearing cap for cracks, plugged oil return channels, or distortion in seal groove
	• Timing case cover oil seal broken or improperly seated	• Replace seal
	• Excess oil pressure because of restricted PCV valve	• Replace PCV valve
	• Oil pan drain plug loose or has stripped threads	• Repair as necessary and tighten
	• Rear oil gallery plug loose	• Use appropriate sealant on gallery plug and tighten
	• Rear camshaft plug loose or improperly seated	• Seat camshaft plug or replace and seal, as necessary
	• Distributor base gasket damaged	• Replace gasket
Excessive oil consumption	• Oil level too high	• Drain oil to specified level
	• Oil with wrong viscosity being used	• Replace with specified oil
	• PCV valve stuck closed	• Replace PCV valve
	• Valve stem oil deflectors (or seals) are damaged, missing, or incorrect type	• Replace valve stem oil deflectors
	• Valve stems or valve guides worn	• Measure stem-to-guide clearance and repair as necessary
	• Poorly fitted or missing valve cover baffles	• Replace valve cover
	• Piston rings broken or missing	• Replace broken or missing rings
	• Scuffed piston	• Replace piston
	• Incorrect piston ring gap	• Measure ring gap, repair as necessary
	• Piston rings sticking or excessively loose in grooves	• Measure ring side clearance, repair as necessary
	• Compression rings installed upside down	• Repair as necessary
	• Cylinder walls worn, scored, or glazed	• Repair as necessary
	• Piston ring gaps not properly staggered	• Repair as necessary
	• Excessive main or connecting rod bearing clearance	• Measure bearing clearance, repair as necessary
No oil pressure	• Low oil level	• Add oil to correct level
	• Oil pressure gauge, warning lamp or sending unit inaccurate	• Replace oil pressure gauge or warning lamp
	• Oil pump malfunction	• Replace oil pump
	• Oil pressure relief valve sticking	• Remove and inspect oil pressure relief valve assembly
	• Oil passages on pressure side of pump obstructed	• Inspect oil passages for obstruction

Troubleshooting Engine Mechanical Problems (cont.)

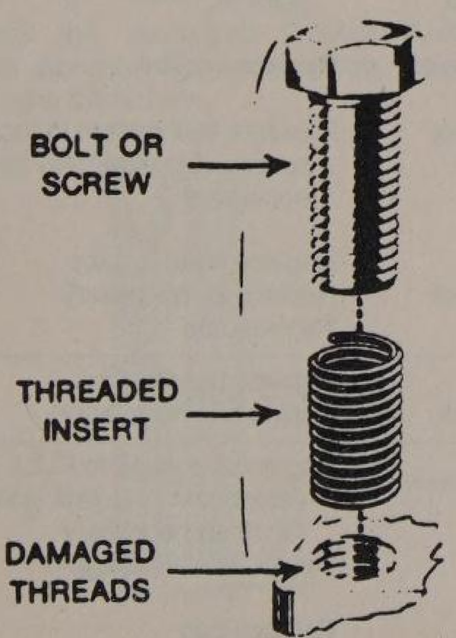
Problem	Cause	Solution
No oil pressure (cont.)	• Oil pickup screen or tube obstructed • Loose oil inlet tube	• Inspect oil pickup for obstruction • Tighten or seal inlet tube
Low oil pressure	• Low oil level • Inaccurate gauge, warning lamp or sending unit • Oil excessively thin because of dilution, poor quality, or improper grade • Excessive oil temperature • Oil pressure relief spring weak or sticking • Oil inlet tube and screen assembly has restriction or air leak • Excessive oil pump clearance • Excessive main, rod, or camshaft bearing clearance	• Add oil to correct level • Replace oil pressure gauge or warning lamp • Drain and refill crankcase with recommended oil • Correct cause of overheating engine • Remove and inspect oil pressure relief valve assembly • Remove and inspect oil inlet tube and screen assembly. (Fill inlet tube with lacquer thinner to locate leaks.) • Measure clearances • Measure bearing clearances, repair as necessary
High oil pressure	• Improper oil viscosity • Oil pressure gauge or sending unit inaccurate • Oil pressure relief valve sticking closed	• Drain and refill crankcase with correct viscosity oil • Replace oil pressure gauge • Remove and inspect oil pressure relief valve assembly
Main bearing noise	• Insufficient oil supply • Main bearing clearance excessive • Bearing insert missing • Crankshaft end play excessive • Improperly tightened main bearing cap bolts • Loose flywheel or drive plate • Loose or damaged vibration damper	• Inspect for low oil level and low oil pressure • Measure main bearing clearance, repair as necessary • Replace missing insert • Measure end play, repair as necessary • Tighten bolts with specified torque • Tighten flywheel or drive plate attaching bolts • Repair as necessary
Connecting rod bearing noise	• Insufficient oil supply • Carbon build-up on piston • Bearing clearance excessive or bearing missing • Crankshaft connecting rod journal out-of-round • Misaligned connecting rod or cap • Connecting rod bolts tightened improperly	• Inspect for low oil level and low oil pressure • Remove carbon from piston crown • Measure clearance, repair as necessary • Measure journal dimensions, repair or replace as necessary • Repair as necessary • Tighten bolts with specified torque
Piston noise	• Piston-to-cylinder wall clearance excessive (scuffed piston) • Cylinder walls excessively tapered or out-of-round • Piston ring broken • Loose or seized piston pin • Connecting rods misaligned • Piston ring side clearance excessively loose or tight • Carbon build-up on piston is excessive	• Measure clearance and examine piston • Measure cylinder wall dimensions, rebore cylinder • Replace all rings on piston • Measure piston-to-pin clearance, repair as necessary • Measure rod alignment, straighten or replace • Measure ring side clearance, repair as necessary • Remove carbon from piston

Troubleshooting Engine Mechanical Problems (cont.)

Problem	Cause	Solution
Valve actuating component noise	• Insufficient oil supply	• Check for: (a) Low oil level (b) Low oil pressure (c) Plugged push rods (d) Wrong hydraulic tappets (e) Restricted oil gallery (f) Excessive tappet to bore clearance
	• Push rods worn or bent	• Replace worn or bent push rods
	• Rocker arms or pivots worn	• Replace worn rocker arms or pivots
	• Foreign objects or chips in hydraulic tappets	• Clean tappets
	• Excessive tappet leak-down	• Replace valve tappet
	• Tappet face worn	• Replace tappet; inspect corresponding cam lobe for wear
	• Broken or cocked valve springs	• Properly seat cocked springs; replace broken springs
	• Stem-to-guide clearance excessive	• Measure stem-to-guide clearance, repair as required
	• Valve bent	• Replace valve
	• Loose rocker arms	• Tighten bolts with specified torque
	• Valve seat runout excessive	• Regrind valve seat/valves
	• Missing valve lock	• Install valve lock
	• Push rod rubbing or contacting cylinder head	• Remove cylinder head and remove obstruction in head
	• Excessive engine oil (four-cylinder engine)	• Correct oil level

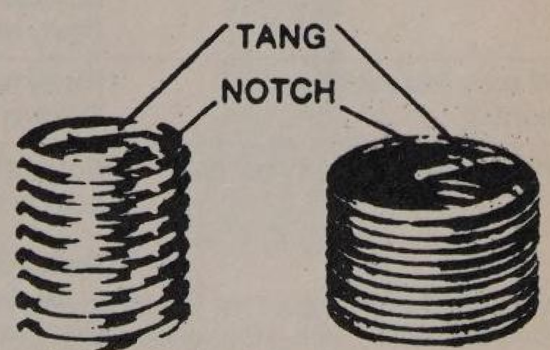
REPAIRING DAMAGED THREADS

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.



Damaged bolt holes can be repaired with thread repair inserts

Two types of thread repair inserts are usually supplied: a standard type for most Inch Coarse, Inch Fine, Metric Course and Metric Fine thread sizes and a spark lug 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.



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

Troubleshooting the Cooling System

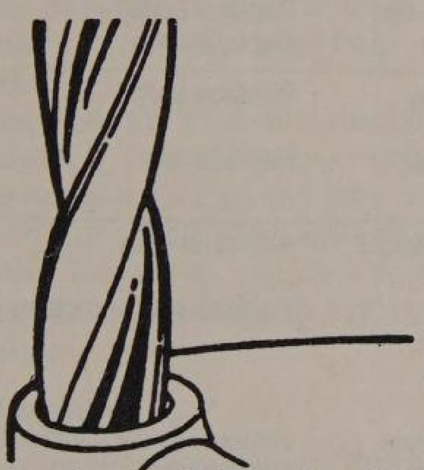
Problem	Cause	Solution
High temperature gauge indication—overheating	• Coolant level low	• Replenish coolant
	• Fan belt loose	• Adjust fan belt tension
	• Radiator hose(s) collapsed	• Replace hose(s)
	• Radiator airflow blocked	• Remove restriction (bug screen, fog lamps, etc.)
	• Faulty radiator cap	• Replace radiator cap
	• Ignition timing incorrect	• Adjust ignition timing
	• Idle speed low	• Adjust idle speed
	• Air trapped in cooling system	• Purge air
	• Heavy traffic driving	• Operate at fast idle in neutral intermittently to cool engine
	• Incorrect cooling system component(s) installed	• Install proper component(s)
	• Faulty thermostat	• Replace thermostat
	• Water pump shaft broken or impeller loose	• Replace water pump
	• Radiator tubes clogged	• Flush radiator
	• Cooling system clogged	• Flush system
	• Casting flash in cooling passages	• Repair or replace as necessary. Flash may be visible by removing cooling system components or removing core plugs.
	• Brakes dragging	• Repair brakes
	• Excessive engine friction	• Repair engine
	• Antifreeze concentration over 68%	• Lower antifreeze concentration percentage
	• Missing air seals	• Replace air seals
	• Faulty gauge or sending unit	• Repair or replace faulty component
	• Loss of coolant flow caused by leakage or foaming	• Repair or replace leaking component, replace coolant
	• Viscous fan drive failed	• Replace unit
Low temperature indication—undercooling	• Thermostat stuck open	• Replace thermostat
	• Faulty gauge or sending unit	• Repair or replace faulty component
Coolant loss—boilover	• Overfilled cooling system	• Reduce coolant level to proper specification
	• Quick shutdown after hard (hot) run	• Allow engine to run at fast idle prior to shutdown
	• Air in system resulting in occasional "burping" of coolant	• Purge system
	• Insufficient antifreeze allowing coolant boiling point to be too low	• Add antifreeze to raise boiling point
	• Antifreeze deteriorated because of age or contamination	• Replace coolant
	• Leaks due to loose hose clamps, loose nuts, bolts, drain plugs, faulty hoses, or defective radiator	• Pressure test system to locate source of leak(s) then repair as necessary
	• Faulty head gasket	• Replace head gasket
	• Cracked head, manifold, or block	• Replace as necessary
	• Faulty radiator cap	• Replace cap
Coolant entry into crankcase or cylinder(s)	• Faulty head gasket	• Replace head gasket
	• Crack in head, manifold or block	• Replace as necessary
Coolant recovery system inoperative	• Coolant level low	• Replenish coolant to FULL mark
	• Leak in system	• Pressure test to isolate leak and repair as necessary
	• Pressure cap not tight or seal missing, or leaking	• Repair as necessary
	• Pressure cap defective	• Replace cap
	• Overflow tube clogged or leaking	• Repair as necessary
	• Recovery bottle vent restricted	• Remove restriction

Troubleshooting the Cooling System (cont.)

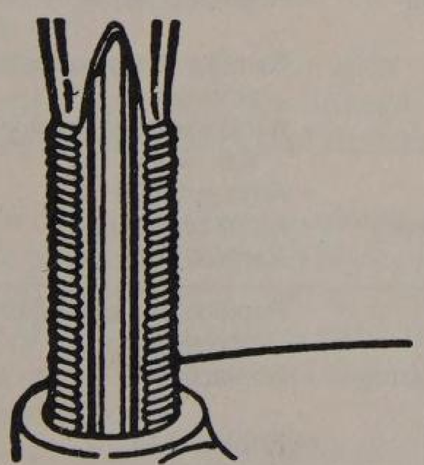
Problem	Cause	Solution
Noise	• Fan contacting shroud • Loose water pump impeller • Glazed fan belt • Loose fan belt • Rough surface on drive pulley • Water pump bearing worn • Belt alignment	• Reposition shroud and inspect engine mounts • Replace pump • Apply silicone or replace belt • Adjust fan belt tension • Replace pulley • Remove belt to isolate. Replace pump. • Check pulley alignment. Repair as necessary.
No coolant flow through heater core	• Restricted return inlet in water pump • Heater hose collapsed or restricted • Restricted heater core • Restricted outlet in thermostat housing • Intake manifold bypass hole in cylinder head restricted • Faulty heater control valve • Intake manifold coolant passage restricted	• Remove restriction • Remove restriction or replace hose • Remove restriction or replace core • Remove flash or restriction • Remove restriction • Replace valve • Remove restriction or replace intake manifold

NOTE: *Immediately after shutdown, the engine enters a condition known as heat soak. This is caused by the cooling system being inoperative while engine temperature is still high. If coolant temperature rises above boiling point, expansion and pressure may push some coolant out of the radiator overflow tube. If this does not occur frequently it is considered normal.*

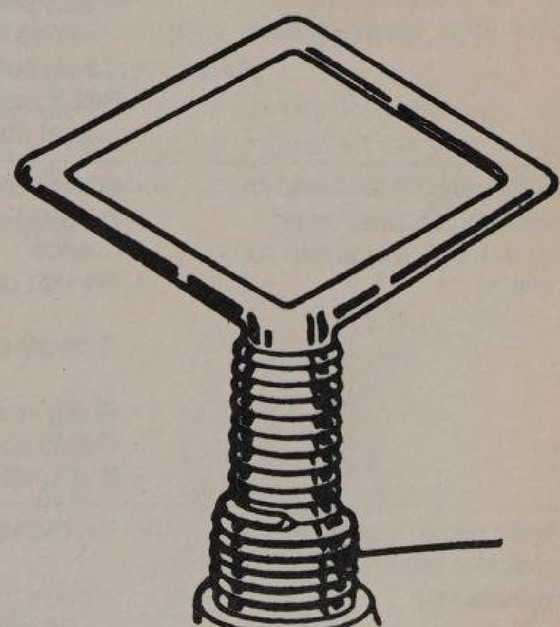
Before effecting a repair to a threaded hole, remove any snapped, broken or damaged bolts or studs. Penetrating oil can be used to free frozen threads. The offending item can be removed with locking pliers or with a screw or stud extractor. After the hole is clear, the thread can be repaired, as shown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



Drill out the damaged threads with specific 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 frequentlyto 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 1/4-1/2 turn below the top surface. After installation break off the tang with a hammer and punch

Troubleshooting the Serpentine Drive Belt

Problem	Cause	Solution
Tension sheeting fabric failure (woven fabric on outside circumference of belt has cracked or separated from body of belt)	• Grooved or backside idler pulley diameters are less than minimum recommended • Tension sheeting contacting (rubbing) stationary object • Excessive heat causing woven fabric to age • Tension sheeting splice has fractured	• Replace pulley(s) not conforming to specification • Correct rubbing condition • Replace belt • Replace belt
Noise (objectional squeal, squeak, or rumble is heard or felt while drive belt is in operation)	• Belt slippage • Bearing noise • Belt misalignment • Belt-to-pulley mismatch • Driven component inducing vibration • System resonant frequency inducing vibration	• Adjust belt • Locate and repair • Align belt/pulley(s) • Install correct belt • Locate defective driven component and repair • Vary belt tension within specifications. Replace belt.
Rib chunking (one or more ribs has separated from belt body)	• Foreign objects imbedded in pulley grooves • Installation damage • Drive loads in excess of design specifications • Insufficient internal belt adhesion	• Remove foreign objects from pulley grooves • Replace belt • Adjust belt tension • Replace belt
Rib or belt wear (belt ribs contact bottom of pulley grooves)	• Pulley(s) misaligned • Mismatch of belt and pulley groove widths • Abrasive environment • Rusted pulley(s) • Sharp or jagged pulley groove tips • Rubber deteriorated	• Align pulley(s) • Replace belt • Replace belt • Clean rust from pulley(s) • Replace pulley • Replace belt
Longitudinal belt cracking (cracks between two ribs)	• Belt has mistracked from pulley groove • Pulley groove tip has worn away rubber-to-tensile member	• Replace belt • Replace belt
Belt slips	• Belt slipping because of insufficient tension • Belt or pulley subjected to substance (belt dressing, oil, ethylene glycol) that has reduced friction • Driven component bearing failure • Belt glazed and hardened from heat and excessive slippage	• Adjust tension • Replace belt and clean pulleys • Replace faulty component bearing • Replace belt
"Groove jumping" (belt does not maintain correct position on pulley, or turns over and/or runs off pulleys)	• Insufficient belt tension • Pulley(s) not within design tolerance • Foreign object(s) in grooves • Excessive belt speed • Pulley misalignment • Belt-to-pulley profile mismatched • Belt cordline is distorted	• Adjust belt tension • Replace pulley(s) • Remove foreign objects from grooves • Avoid excessive engine acceleration • Align pulley(s) • Install correct belt • Replace belt
Belt broken (Note: identify and correct problem before replacement belt is installed)	• Excessive tension • Tensile members damaged during belt installation • Belt turnover • Severe pulley misalignment • Bracket, pulley, or bearing failure	• Replace belt and adjust tension to specification • Replace belt • Replace belt • Align pulley(s) • Replace defective component and belt

Troubleshooting the Serpentine Drive Belt (cont.)

Problem	Cause	Solution
Cord edge failure (tensile member exposed at edges of belt or separated from belt body)	· Excessive tension · Drive pulley misalignment · Belt contacting stationary object · Pulley irregularities · Improper pulley construction · Insufficient adhesion between tensile member and rubber matrix	· Adjust belt tension · Align pulley · Correct as necessary · Replace pulley · Replace pulley · Replace belt and adjust tension to specifications
Sporadic rib cracking (multiple cracks in belt ribs at random intervals)	· Ribbed pulley(s) diameter less than minimum specification · Backside bend flat pulley(s) diameter less than minimum · Excessive heat condition causing rubber to harden · Excessive belt thickness · Belt overcured · Excessive tension	· Replace pulley(s) · Replace pulley(s) · Correct heat condition as necessary · Replace belt · Replace belt · Adjust belt tension

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 war. 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 that 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.

Gasoline Engines

1. Warm up the engine to normal operating temperature.
2. Remove all the spark plugs.
3. Disconnect the high tension lead from the ignition coil.
4. On fully open the throttle either by operating the carburetor throttle linkage by hand or by having an assistant floor the accelerator pedal.
5. Screw the compression gauge into the No. 1 spark plug hole until the fitting is snug.

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

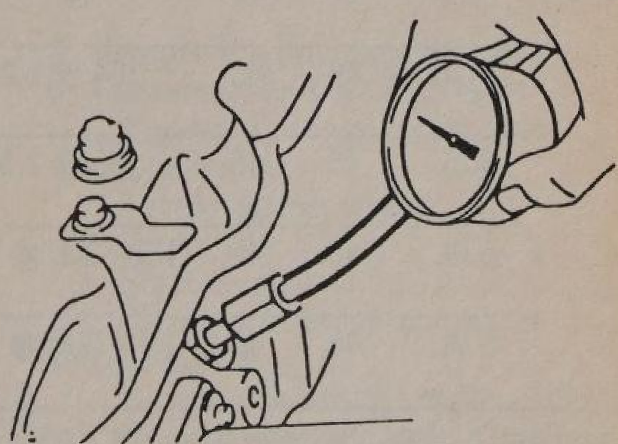
6. Ask an assistant to depress the accelerator pedal fully on both carbureted and fuel injected vehicles. Then, while you read the compression gauge, ask the assistant to crank the engine two or three times in short bursts using the ignition switch.
7. Read the compression gauge at the end of each series of cranks, and record the highest of these readings. Repeat this procedure for each of the engine's cylinders.

A cylinder's compression pressure is usually acceptable if it is not less than 70% of maximum. The difference between any two cylinders should be no more than 12–14 pounds.

NORMAL– Compression builds up quickly and evenly to the specified compression on each cylinder.

PISTON RINGS– Compression low on the first stroke, tends to build up on the following strokes, but does not reach normal. This reading should be tested with the addition of a few shots of engine oil into the cylinder. If the compression increases considerably, the rings are leaking compression.

VALVES– Low on the first stroke, does not tend to build up on following strokes. This reading will stay around the same with a few shots of engine oil.



The screw-in type compression gauge is more accurate

HEAD GASKET– The compression reading is low between two adjacent cylinders. The head gasket between the two cylinders may be blown. If there is the sign of white smoke coming from the exhaust while the engine is running may indicate water leaking into the cylinder.

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 the 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 does not 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.

Engine

REMOVAL AND INSTALLATION

The factory recommended procedure for engine removal is to remove the engine/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.

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
1982–86	2.5L	46	45	122–180 @ 1.25	1.69	0.0010–0.0027	0.0010–0.0027 ①	0.3418–0.3425	0.3418–0.3425
	2.8L	46	45	194 @ 1.18	1.57	0.0010–0.0027	0.0010–0.0027	0.3410–0.3416	0.3410–0.3416
	5.0L	46	45	194–206 @ 1.25	1.72	0.0010–0.0027	0.0010–0.0027	0.3414	0.3414
1987–88	2.8L	46	45	194 @ 1.18	1.57	0.0010–0.0027	0.0010–0.0027	0.3410–0.3416	0.3410–0.3416
	5.0L	46	45	194–206 @ 1.25	1.72	0.0010–0.0027	0.0010–0.0027	0.3414	0.3414
	5.7L	46	45	194–206 @ 1.25	1.72	0.0010–0.0027	0.0010–0.0027	0.3410–0.3416	0.3410–0.3416
1989–90	2.8L	46	45	194 @ 1.18	1.57	0.0010–0.0027	0.0010–0.0027	0.3410–0.3416	0.3410–0.3416
	3.1L	46	45	194 @ 1.20	1.60	0.0010–0.0027	0.0010–0.0027	0.3410–0.3416	0.3410–0.3416
	3.8L	45	45	185 @ 1.34	1.34	0.0015–0.0035	0.0015–0.0035	0.3405–0.3412	0.3405–0.3412
	5.0L	46	45	1.94–206 @ 1.25	1.72	0.0010–0.0027	0.0010–0.0027	0.3410–0.3416	0.3410–0.3416
	5.7L	46	45	1.94–206 @ 1.25	1.72	0.0010–0.0027	0.0010–0.0027	0.3410–0.3416	0.3410–0.3416

① Figure given is measured at the top of the guide; 0.0020–0.0037 is measured at the bottom of the guide.

GENERAL ENGINE SPECIFICATIONS

Year	VIN	No. Cylinder Displacement cu. in. (liter)	Fuel System Type	Net Horsepower @ rpm	Net Torque @ rpm (ft. lbs.)	Bore × Stroke (in.)	Com-pression Ratio	Oil Pressure @ 2000 rpm
1982–84	2	4-151 (2.5)	TBI	90 @ 4000	134 @ 2400	4.000 × 3.000	8.2:1	40
	1	6-173 (2.8)	carb	102 @ 4800	145 @ 2400	3.500 × 3.000	8.5:1	40
	H	8-305 (5.0)	carb	145 @ 4000	240 @ 2400	3.736 × 3.480	8.6:1	40
1985–86	2	4-151 (2.5)	TBI	92 @ 4000	134 @ 2800	4.000 × 3.000	9.0:1	40
	S	6-173 (2.8)	MFI	135 @ 5100	165 @ 3600	3.500 × 3.000	8.9:1	55
	F	8-305 (5.0)	TPI	190 @ 4800	240 @ 3200	3.740 × 3.480	9.5:1	55
	G	8-305 (5.0)	carb	165 @ 4400	250 @ 2000	3.740 × 3.480	9.5:1	55
	H	8-305 (5.0)	carb	150 @ 4000	240 @ 2400	3.740 × 3.480	8.6:1	55
1987	S	6-173 (2.8)	MFI	135 @ 5100	165 @ 3600	3.500 × 3.000	8.9:1	55
	F	8-305 (5.0)	TPI	190 @ 4800	240 @ 3200	3.740 × 3.480	9.3:1	55
	H	8-305 (5.0)	carb	150 @ 4000	240 @ 2400	3.740 × 3.480	8.6:1	55
	8	8-350 (5.7)	TPI	230 @ 4000	300 @ 3200	4.000 × 3.480	9.5:1	55
1988	S	6-173 (2.8)	MFI	135 @ 5100	165 @ 3600	3.500 × 3.000	8.9:1	55
	E	8-305 (5.0)	TBI	150 @ 4000	240 @ 3200	3.736 × 3.480	9.3:1	55
	F	8-305 (5.0)	TPI	190 @ 4800	240 @ 3200	3.736 × 3.480	9.3:1	55
	8	8-350 (5.7)	TPI	230 @ 4000	300 @ 3200	4.000 × 3.480	9.5:1	55
1989	S	6-173 (2.8)	MFI	135 @ 5100	165 @ 3600	3.500 × 3.000	8.9:1	55
	7	6-231 (3.8)	SFI Turbo	235 @ 4400	330 @ 2800	3.800 × 3.400	8.0:1	37
	E	8-305 (5.0)	TBI	150 @ 4000	240 @ 3200	3.736 × 3.480	9.3:1	55
	F	8-305 (5.0)	TPI	190 @ 4800	240 @ 3200	3.736 × 3.480	9.3:1	55
	8	8-350 (5.7)	TPI	230 @ 4000	300 @ 3200	4.000 × 3.480	9.5:1	55
1990	T	6-189 (3.1)	MFI	140 @ 3600	180 @ 3600	3.500 × 3.310	8.9:1	55
	E	8-305 (5.0)	TBI	170 @ 4000	255 @ 2400	3.740 × 3.480	9.3:1	55
	F	8-305 (5.0)	TPI	225 @ 4400	300 @ 4400	3.740 × 3.480	9.3:1	55
	8	8-350 (5.7)	TPI	235 @ 4400	340 @ 3200	4.000 × 3.480	9.5:1	55

■ 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
M.F.I.—Multi-port injection
TPI—Tuned port injection
SFI—Sequential fuel injection

Be absolutely sure to tag any wire or hose before disconnecting it, so that it may be reconnected properly during installation.

All Engines Except 3.8L Turbo

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 or throttle body air intake.
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 or throttle body (as equipped).

CRANKSHAFT AND CONNECTING ROD SPECIFICATIONS

(All measurements are given in inches)

	Engine	Crankshaft				Connecting Rod		
Year	Displacement (Liters)	Main Brg Journal Dia.	Main Brg Oil Clearance	Shaft End-Play	Thrust on No.	Journal Diameter	Oil Clearance	Side Clearance
1982–86	2.5L	2.300	0.0005–0.0022	0.0035–0.0085	5	2.000	0.0005–0.0026	0.006–0.022
	2.8L	2.493–2.494	0.0017–0.0029	0.0019–0.0066	3	1.998–1.999	0.0014–0.0035	0.0060–0.0170
	5.0L	①	②	0.0020–0.0060	5	2.098–2.099	0.0018–0.0039	0.0080–0.0140
1987–88	2.8L	2.493–2.494	0.0017–0.0029	0.0019–0.0066	3	1.998–1.999	0.0014–0.0035	0.0060–0.0170
	5.0L	①	②	0.0020–0.0060	5	2.098–2.099	0.0018–0.0039	0.0080–0.0140
	5.7L	①	②	0.0020–0.0060	5	2.098–2.099	0.0018–0.0039	0.0080–0.0140
1989–90	2.8L	2.493–2.494	0.0017–0.0029	0.0019–0.0066	3	1.998–1.999	0.0014–0.0035	0.0060–0.0170
	3.1L	2.6473–2.6483	0.0012–0.0027	0.0024–0.0083	3	1.9994–1.9983	0.0014–0.0036	0.0140–0.0270
	3.8L Turbo	2.4995	0.0003–0.0018	0.0030–0.0110	2	2.2487–2.2495	0.0005–0.0026	0.0030–0.0150
	5.0L	①	②	0.001–0.007	5	2.089–2.098	0.0013–0.0035	0.0060–0.0140
	5.7L	①	②	0.001–0.007	5	2.089–2.098	0.0013–0.0035	0.0060–0.0140

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

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. Use a wire to attach the compressor out of the way.

9. Remove the power steering pump, leaving the hoses attached to the pump. Set the pump aside using a piece of wire to hold the pump 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

PISTON AND RING SPECIFICATIONS

(All measurements are given in inches)

Year	Engine Displacement	Ring Gap: Top Compression	Ring Gap: Bottom Compression	Ring Gap: Oil Control	Ring Side Clearance: Top Compression	Ring Side Clearance: Bottom Compression	Ring Side Clearance: Oil Control	Piston-to-Bore Clearance (in.)
1982–86	2.5L	0.0100–0.0220	0.0100–0.0270	0.0150–0.0550	0.0015–0.0030	0.0015–0.0030	0.0010–0.0050	0.0017–0.0033 ②
	2.8L	0.0098–0.0196	0.0098–0.0196	0.0020–0.0550	0.0011–0.0027	0.0015–0.0037	0.0078 max.	0.0007–0.0027
	5.0L	0.0100–0.0200	0.0100–0.0250	0.0150–0.0550	0.0012–0.0032	0.0012–0.0032	0.0020–0.0070	0.0007–0.0027 ①
1987–88	2.8L	0.0098–0.0196	0.0098–0.0196	0.0020–0.0550	0.0011–0.0027	0.0015–0.0037	0.0078 max.	0.0170–0.0430
	5.0L	0.0100–0.0200	0.0100–0.0250	0.0150–0.0550	0.0012–0.0032	0.0012–0.0032	0.0020 0.0070	0.0027 max.
	5.7L	0.0100–0.0200	0.0100–0.0250	0.0150–0.0550	0.0012–0.0032	0.0012–0.0032	0.0020–0.0070	0.0027 max.
1989–90	2.8L	0.0098–0.0196	0.0098–0.0196	0.0020–0.0550	0.0011–0.0027	0.0015–0.0037	0.0078 max.	0.0170–0.0430
	3.1L	0.0100–0.0200	0.0100–0.0200	0.0100–0.0300	0.0020–0.0035	0.0020–0.0035	0.0080 max.	0.0012–0.0029
	3.8L Turbo	0.0100–0.0200	0.0100–0.0200	0.0150–0.0550	0.0011–0.0027	0.0015–0.0037	0.0078– max.	③
	5.0L	0.0100–0.0200	0.0100–0.0200	0.0150–0.0550	0.0012–0.0032	0.0012–0.0032	0.0020–0.0070	0.0027 max.
	5.7L	0.0100–0.0200	0.0100–0.0200	0.0150–0.0550	0.0012–0.0032	0.0012–0.0032	0.0020–0.0070	0.0027 max.

① 0.75" below piston pin centerline
② 2.25" from top of cylinder (bore); 1 13/16" from top of piston
③ Top land: .0460–.0560
Skirt top: .0008–.0020
Skirt bottom: .0013–.0035

weight off the front mounts, then remove the front mount through-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.

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	Manifold Exhaust
1982–86	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
1987–88	2.8L	②	34–44	63–83	66–85	45–59	13–25	18–31
	5.0L	68	44	77	70	74	35	20
	5.7L	68	44	77	70	74	35	20
1989–90	2.8L	②	34–44	63–83	66–85	45–59	13–25	18–31
	3.1L	②	39	73	76	52	19	25
	3.8L Turbo	55–62	40	100	219	60	45	37
	5.0L	68	44	77	70	74	35	20
	5.7L	68	44	77	70	74	35	20

① 20–34 for T.B.I. plate bolts

② Coat the threads with sealer. Use a 12 inch clicker type torque wrench and torque to 40 ft. lbs. in sequence. Rotate each bolt an additional 90° (1/4 turn)

CAMSHAFT SPECIFICATIONS

(All measurements in inches)

Year	Engine Displacement (Liters)	Journal Diameter 1	2	3	4	5	Lobe Lift Intake	Lobe Lift Exhaust	Camshaft End Play
1982–86	2.5L	All 1.869					0.398	0.398	0.0015–0.0050
	2.8L	All 1.8976–1.8996					0.235	0.266	0.001–0.004
	5.0L	All 1.8682–1.8692					0.234 ①	0.257 ①	0.004–0.012
1987–88	2.8L	All 1.8676–1.8996					0.262	0.273	0.001–0.004
	5.0L	All 1.8682–1.8992					0.234 ①	0.257 ①	0.004–0.012
	5.7L	All 1.8682–1.8992					0.273	0.282	0.004–0.012
1989–90	2.8L	All 1.8676–1.8996					0.262	0.273	NA
	3.1L	All 1.8678–1.8815					0.262	0.273	NA
	3.8L Turbo	All 1.7850–1.7860					NA	NA	NA
	5.0L	All 1.8682–1.8692					0.269	0.276	0.004–0.012
	5.7L	All 1.8682–1.8692					0.273	0.282	0.004–0.012

① TBI engine .269 intake—.276 exhaust

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 and torque the bolts to 50 ft. lbs. (68 Nm). Align the torque converter and install the bolts for the automatic transmission. Install the clutch assembly and transmission as outlined in Chapter 7.
2. Bolt the engine lifting tool to the engine 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.

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

6. Install the rear mount to cross-member bolts.
7. Lower the vehicle, remove the engine lifting adapter and install the rocker arm covers.
8. On vehicles with manual transmissions, connect the clutch linkage at the cross-shaft.
9. Connect:
   a. Shift linkage at the transmission.
   b. Speedometer cable at the transmission.
   c. Transmission cooler lines, if so equipped.
10. Install the driveshaft to the original position.
11. Refill the crankcase with engine oil.
12. Install the power steering pump and route the hoses.
13. If the car has air conditioning, install the compressor.
14. Connect:
    a. Accelerator linkage at the pedal.
    b. Cruise control and/or transmission cable at the carburetor or throttle body (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.
15. Connect the label wires at:
    a. Emission control components.
    b. Distributor.
    c. Temperature switch.
    d. Alternator.
    e. Starter solenoid.
    f. Oil pressure sending unit.
16. Install the fan blade and pulley.
17. Install the radiator and shroud.
18. Connect the battery cables at the battery.
19. Install the air cleaner or throttle body air intake.
20. Install the hood.

3.8L Turbo (VIN 7)

1. Disconnect the negative (–) battery cable.
2. Scribe marks at the hood hinge mating surfaces and remove the hood with the help of an assistant.

CAUTION: *When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.*

3. Drain the engine coolant and crankcase oil.
4. Remove the air cleaner.
5. Remove the fan blade, pulleys and belt.
6. Remove the air conditioning compressor from the bracket and hang out of the way with a small piece of wire. Do NOT disconnect the refrigerant lines.
7. Remove the radiator heater hoses from the engine.
8. Remove the fan shroud assembly.
9. Remove the power steering pump and hang out of the way. Do not disconnect the fluid hoses.
10. Disconnect the fuel line and negative ground strap from the engine.
11. Disconnect all vacuum hoses from all non-engine mounted components.
12. Disconnect the accelerator, transmission and cruise control cables.
13. Disconnect the engine wiring harnesses.
14. Raise the vehicle and support with jackstands.
15. Remove the crossover pipe from the exhaust manifold.
16. Scribe a mark on the flywheel and converter for installation references. Remove the flywheel cover and torque converter bolts.
17. Remove the wiring from the starter motor.
18. Remove the transmission-to-cylinder

block bolts and support the transmission with a jack.

19. Remove the front motor mount attaching bolts.

20. Install an engine lifting device and remove the engine. With an assistant, guide the engine out of the vehicle making sure all components are disconnected and out of the way.

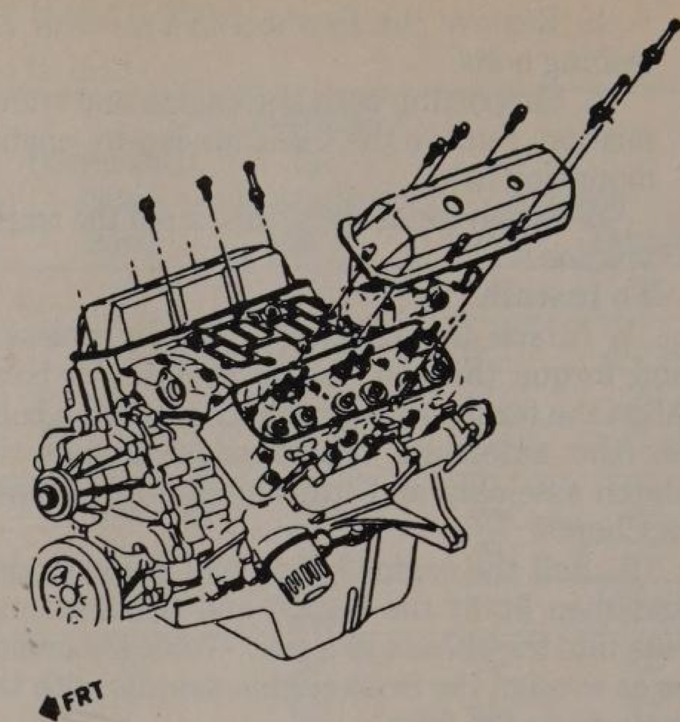
To install:

1. Lower the engine into the vehicle with the help of an assistant.
2. Align the engine-to-transmission and flywheel-to-torque converter.
3. Raise the vehicle and support with jackstands.
4. Install the front motor mount bolts.
5. Install the torque converter bolts and flywheels cover.
6. Connect the starter wiring.
7. Install the crossover pipe-to-manifold.
8. Lower the vehicle.
9. Connect the engine ground strap, alternator and engine wiring harnesses.
10. Connect the accelerator, transmission and cruise control cable.
11. Connect all vacuum hoses that were disconnected.
12. Connect the engine ground strap from the battery.
13. Connect the fuel lines and secure the power steering pump.
14. Install the fan shroud, radiator and connect the coolant hoses.
15. Install the air conditioning compressor to the mounting bracket.
16. Install the fan, pulleys and belt.
17. Add engine oil and coolant.
18. Install the air cleaner and negative battery cable.
19. Install the hood in the same position as removed.
20. Recheck all procedures for completion of repair.
21. Start the engine and check for oil pressure. After engine is performing properly, road test.

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 if causing an obstruction.



Rocker arm cover — V6 and V8

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

To install:

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

1. Apply RTV to the cover and install the retaining bolts.
2. Install the EGR valve.
3. Install the fuel return line if removed.
4. Install the spark plug wires and clips to the valve cover(s). Connect any necessary lines and hoses.
5. Install the PCV Valve.
6. Install the throttle cable on EFI engines.
7. Install the air cleaner.
8. Start the engine and check for oil leaks.

Pushrod Cover

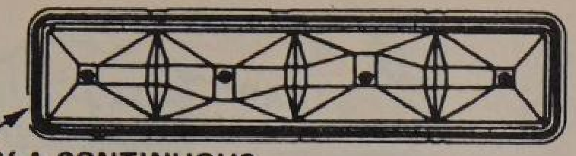
REMOVAL AND INSTALLATION

2.5L L4

1. Disconnect the negative (–) battery cable.
2. Remove the intake manifold as outlined in the "Intake Manifold" procedures in this chapter.

CAUTION: *When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.*

3. Remove the four push rod cover attaching nuts.



Push rod cover RTV application – 2.5L engine

NOTE: *Do not pry on the cover or damage to the sealing surface may result.*

4. To remove the push rod cover, proceed as follows:

a. Unscrew the four nuts from the cover attaching studs, reverse the two nuts so the washers face outward and screw them back onto the inner two studs. Assemble the remaining nuts to the same two inner studs with washers facing inward.

b. Using a small wrench on the inner nut, on each stud, jam the two nuts tightly together. Again using the small wrench, on the inner nut, unscrew the studs until the cover breaks loose.

c. After breaking the cover loose, remove the jammed nuts from each stud. Remove the cover from the studs. Examine the stud and rubber washer assembly and replace if either stud or washer is damaged.

To install:

5. Clean the sealing surfaces on the cover and cylinder block.

6. Apply a continuous $^3/_{16}$ in. (5mm) bead of RTV sealer or equivalent around the push rod cover.

7. Install the cover and torque the bolts to 90 inch lbs. (10 Nm).

8. Install the intake manifold as outlined in the "Intake Manifold" installation procedures in this chapter.

Rocker Arms/Shafts

REMOVAL AND INSTALLATION

Except 3.8L Turbo

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 0.003 and 0.013 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: *4–2.5L engines use bolts instead of studs, 6–2.8L and 3.1L engines use threaded studs, and 8–5.0L engines use press fit studs.*

1. Disconnect the negative (–) battery cable.

2. Remove the rocker arm cover as outlined in this chapter.

3. Remove the rocker arm nuts, balls and rocker arms. Place components in a rack so they can be reinstalled in the same location.

To install:

1. Coat the bearings surfaces with a thin coating of Molykote® or its equivalent.

2. Install the pushrods and make sure the rod is in the lifter seat.

3. Install the rocker arm, balls and nut. Tighten the nut until all lash is eliminated. The camshaft must be on the base circle before tightening.

4. Adjust the valves when the lifter is on the base circle of the camshaft lobe as follows:

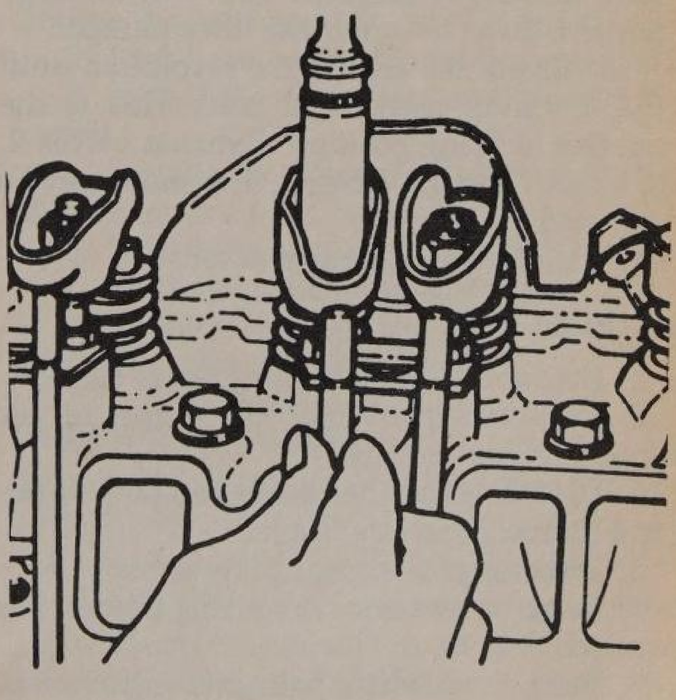
2.5L Engine – Torque the rocker arm bolts to 20 ft. lbs. (27 Nm).

V6 Engine

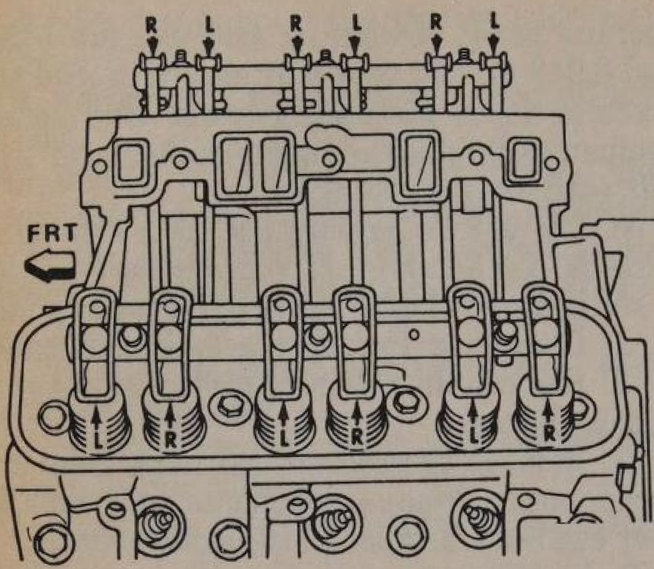
a. Crank engine until the mark on the harmonic balancer lines up with the 0 mark on the tab. The engine must on the number one firing position. When the timing marks start moving to the 0 mark, the number 1 valves should be both closes.

b. With the engine on the number 1 firing position, exhaust valves 1, 2 and 3 and intake valves 1, 5 and 6 may be adjusted.

c. Back out the adjusting nut until lash is



Adjusting rocker arms



Rocker arm positioning -- 3.8L Turbo, each rocker arm is marked with a R or L, used for location

felt at the pushrod. Turn the adjusting nut until all lash is removed and turn an additional 1 1/2 turns to center the lifter plunger.

d. Crank the engine one revolution until the 0 timing mark is aligned. This is the number 4 firing position. Exhaust valves 4, 5 and 6 and intake valves 2, 3 and 4 may be adjusted.

V8 Engine

a. Crank engine until the mark on the harmonic balancer lines up with the 0 mark on the tab. The engine must on the number one firing position. When the timing marks start moving to the 0 mark, the number 1 valves should be both closes.

b. With the engine on the number 1 firing position, exhaust valves 1, 3, 4 and 8, intake valves 1, 2, 5 and 7 may be adjusted.

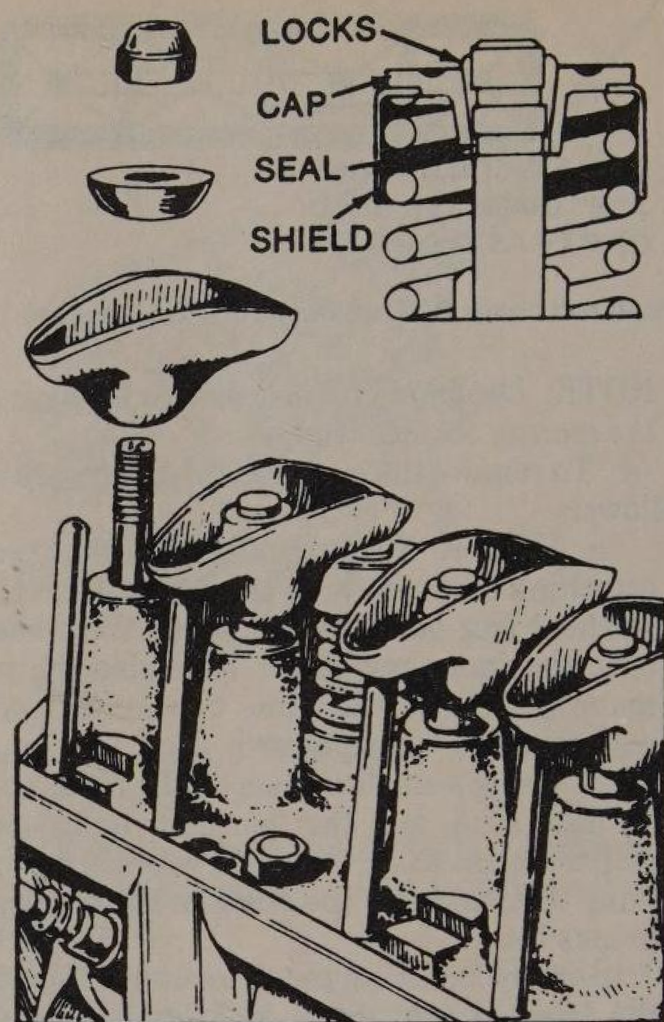
c. Back out the adjusting nut until lash is felt at the pushrod. Turn the adjusting nut until all lash is removed and turn an additional 1 turns to center the lifter plunger.

d. Crank the engine one revolution until the 0 timing mark is aligned. This is the number 6 firing position. Exhaust valves 2, 5, 6 and 7, intake valves 3, 4, 6 and 8 may be adjusted.

5. Install the rocker arm cover.

3.8L Turbo

1. Disconnect the negative battery cable.
2. Remove right side PCV pipe to air cleaner and hot air tube.
3. Disconnect all necessary computer command control hoses and leads.
4. Disconnect the spark plug wires.
5. Remove accessory mounting brackets as required.
6. Remove attaching bolts and valve cover.
7. Remove the rocker arm and shaft assembly from the cylinder head.



Rocker arm components

8. Remove the nylon rocker arm retainers and separate the rocker arms from the rocker shaft.

To install:

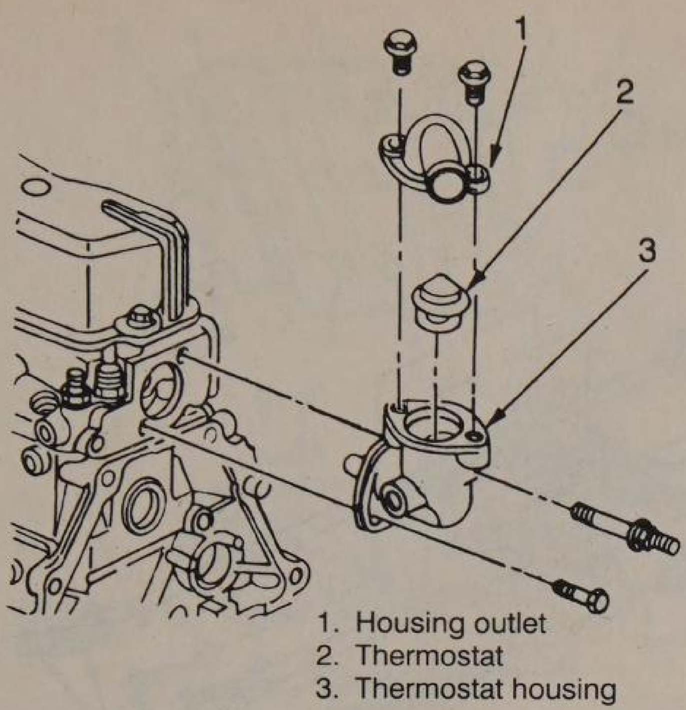
1. Be sure to use new valve cover gaskets, where required.
2. When installing the rocker arms onto the rocker shaft, be sure to position them in the correct sequence. Refer to the illustration and stamped marks on each rocker arm for proper positioning.
3. Use new nylon retainers and install them using a drift of at least 1/2 in. (12.7mm) in diameter.
4. Torque the rocker shaft bolts to 25 ft. lbs. (35 Nm).
5. Install the rocker arm cover.

Thermostat

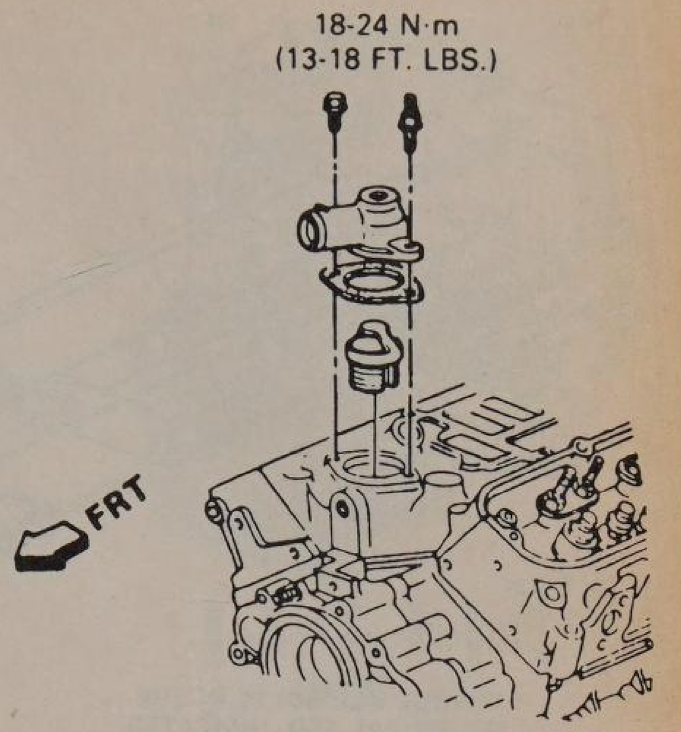
REMOVAL AND INSTALLATION

Carbureted and Throttle Body Engines

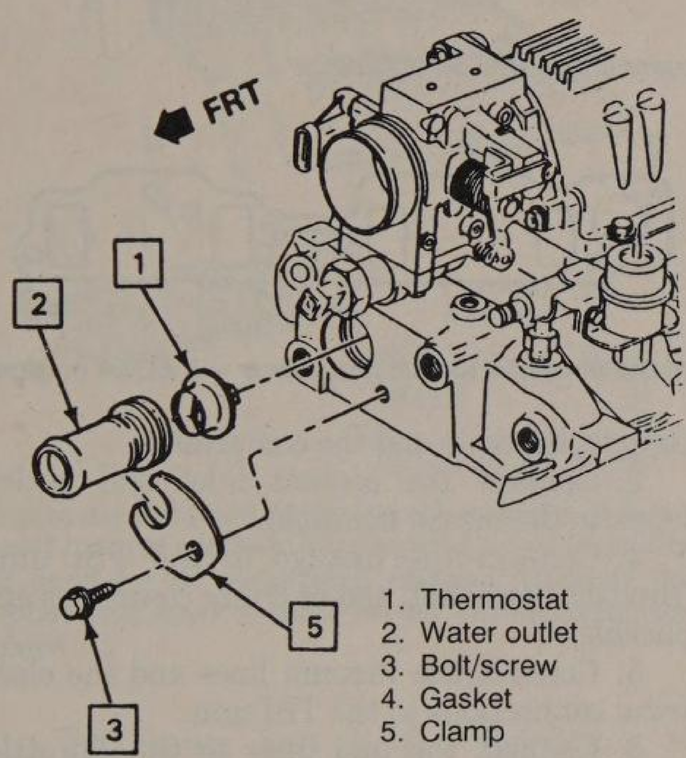
1. Disconnect the negative (–) battery cable. Drain the cooling system to below the thermostat level.
2. It is not necessary to remove the radiator hose from the thermostat housing.
3. Remove the two retaining bolts from the thermostat housing and remove the thermostat.



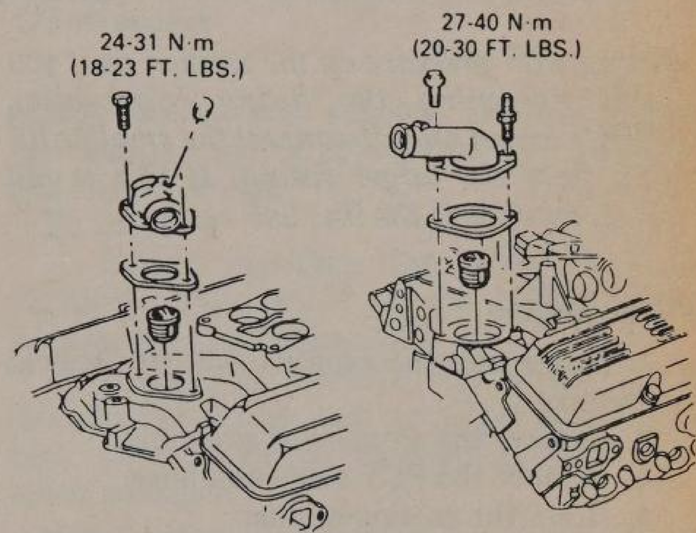
Thermostat and housing — 2.5L engine



Thermostat and housing — 2.8L and 3.1L engine



Thermostat and housing — 3.8L Turbo engine



Thermostat and housing — V8 engines

4. Use a new gasket when replacing the thermostat. Coat the gasket with RTV Sealer.

Tuned Port Injected Engines

1. Disconnect the negative (–) battery cable.
2. Drain the radiator to a level below the thermostat housing.
3. Remove the air cleaner and intake duct.
4. Remove the throttle body and intake plenum outlined in Chapter 5.
5. Remove the fuel pipes and bracket if they obstruct the thermostat.
6. Remove the radiator inlet hose, thermostat housing bolts, thermostat and gasket.

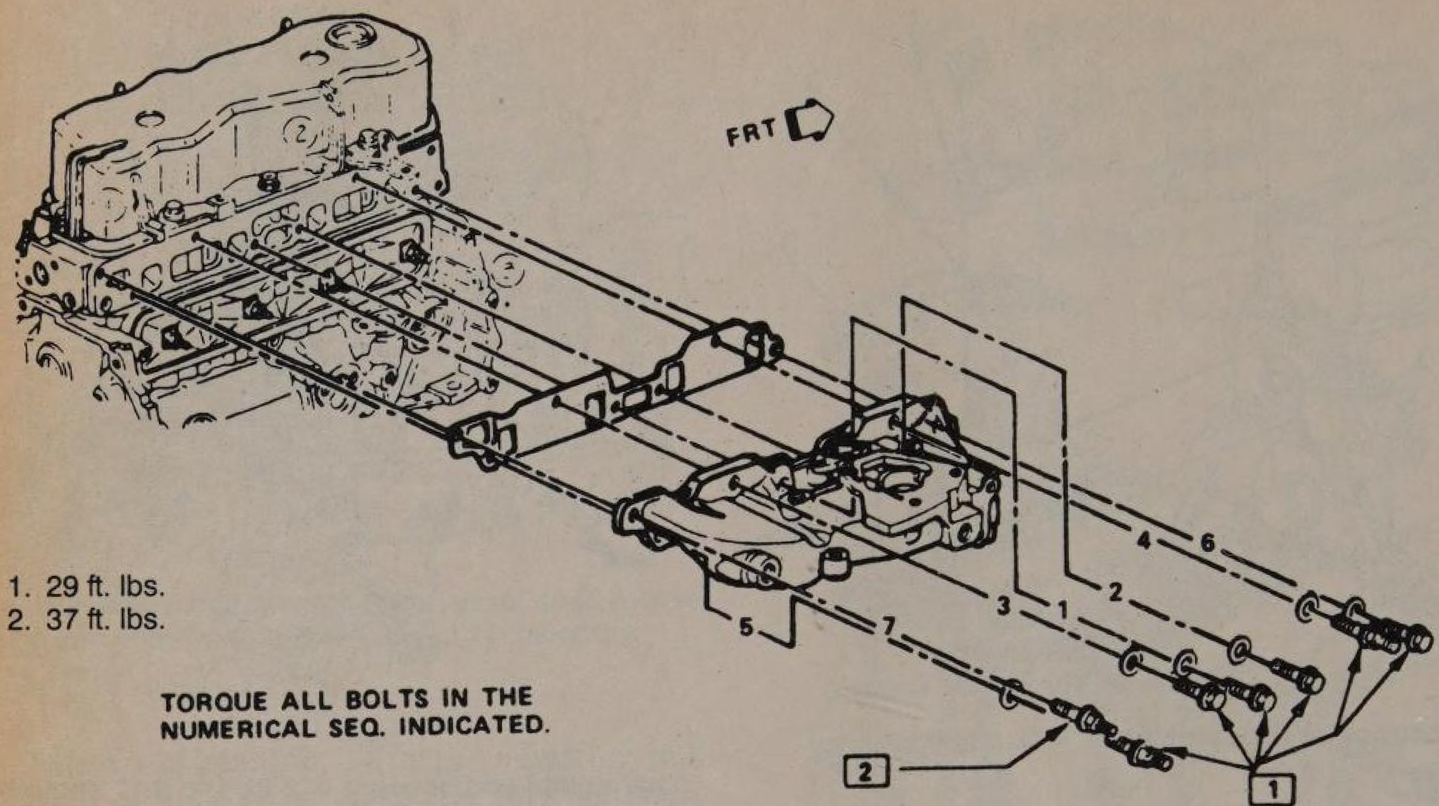
To install:

1. Clean the gasket mating surfaces.
2. Install the new thermostat gasket with RTV sealer, thermostat, housing and bolts. Torque the bolts to 21 ft. lbs. (28 Nm).
3. Install the radiator inlet hose and clamp.
4. Install the fuel pipes and bracket if removed.
5. Install the throttle body and intake plenum outlined in Chapter 5.
6. Install the air cleaner and intake duct.
7. Refill the radiator to the proper level.
8. Connect the negative (–) battery cable, start the engine and check for leaks.

Intake Manifold

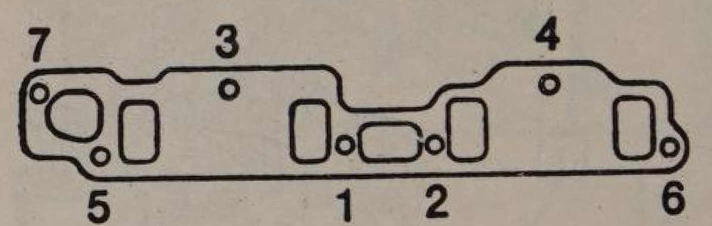
REMOVAL AND INSTALLATION

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*



Intake manifold bolt tightening sequence for the 2.5L engine.

fitting with pressure on the wrench as if you were tightening the fitting (clock-wise), THEN loosen and disconnect the smaller fitting from the larger fitting. If this is not done, damage to the line will result.



Intake manifold torque sequence – 2.5L L4 engine

4-2.5L Engine

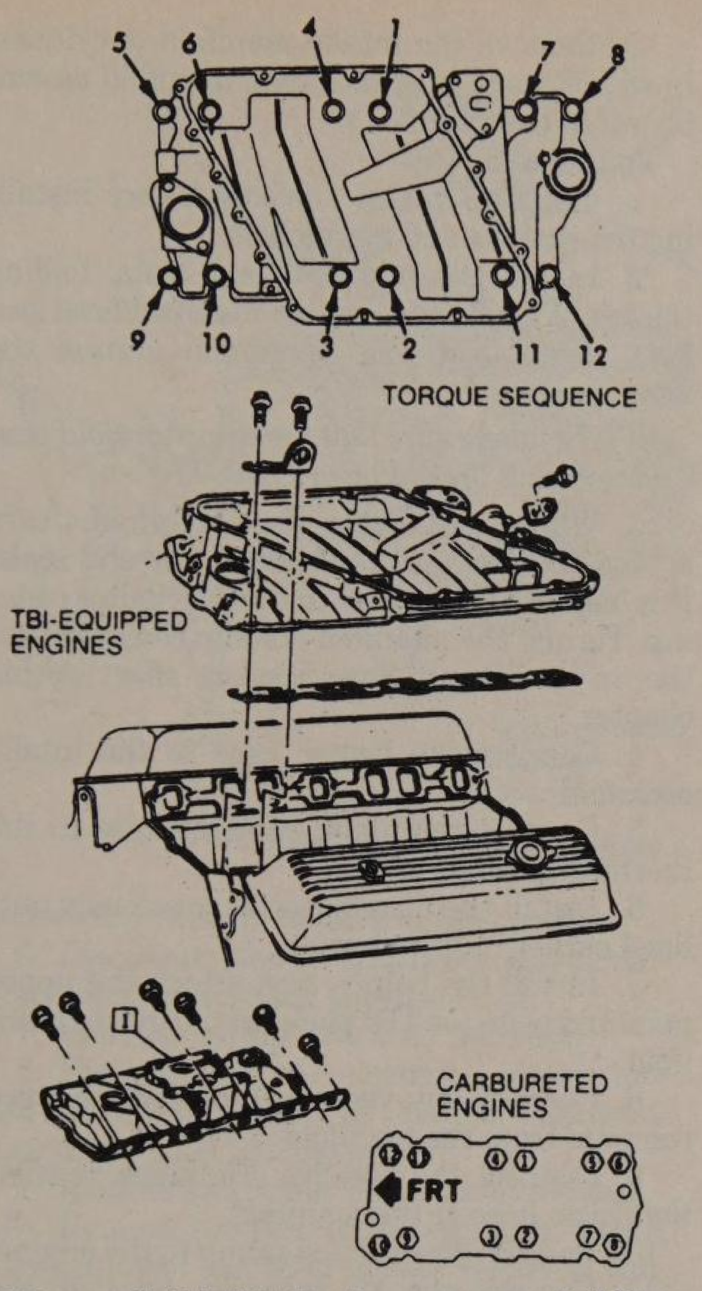
1. Disconnect the negative battery cable at the battery.
2. Remove the air cleaner assembly.
3. Remove the PCV valve and hose.
4. Drain the cooling system.
5. Disconnect the fuel lines from the Throttle Body Injection (TBI) unit.
6. Mark and disconnect the vacuum lines and the electrical connections 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.
10. Remove the manifold attaching bolts and remove the manifold. Clean all gasket surfaces before installation.

To install:

1. Install the manifold and bolts. Be sure to torque all manifold bolts to 29 ft. lbs. (39 Nm) except for #7 which gets torqued to 37 ft. lbs. (50 Nm), following the sequence in the accompanying illustration.
2. Install the air conditioning compressor support brackets and the compressor.
3. Connect the coolant inlet and outlet hoses to the intake manifold.
4. Connect the linkage to the TBI unit (throttle, downshift, and/or cruise control, as applicable).
5. Connect the vacuum lines and the electrical connections to the TBI unit.
6. Connect the fuel lines to the Throttle Body Injection (TBI) unit.
7. Refill the cooling system.
8. Install the PCV valve and hose.
9. Install the air cleaner assembly.
10. Connect the negative battery cable at the battery and check for leaks.

Carbureted V6 and V8 Engines

1. Disconnect the negative (–) battery cable. 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.



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

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.

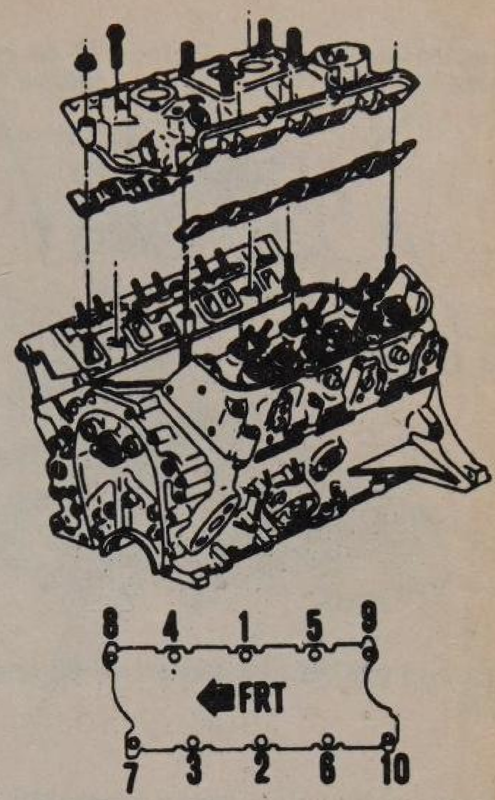
5. Remove the distributor.

6. If applicable, remove the alternator upper bracket. As required, remove the air cleaner bracket, and accelerator bell crank.

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 or throttle body (and mounting studs), water outlet and thermostat (use a new



Intake manifold bolt tightening sequence for the 173-V6 engine

gasket) heater hose adapter, EGR valve (use new gasket) and, if applicable, TVS switch(s) and the choke coil.

To install:

1. Before installing the manifold, thoroughly clean the gasket and seal surfaces of the cylinder heads and manifold.

2. 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.*

3. 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. Torque the manifold bolts to the specification in the Torque Specifications chart in this chapter.

4. 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 "Distributor Removal and Installation" procedure earlier in this chapter.

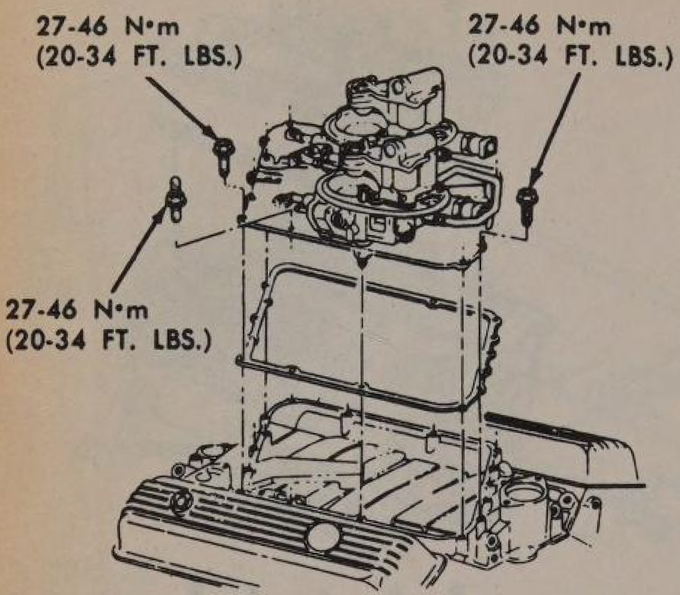
5. If applicable, install the alternator upper bracket and adjust the belt tension.

6. Connect all disconnected components at their original locations.

7. Fill the cooling system, start the engine, check for leads and adjust the ignition timing and carburetor idle speed.

TBI Equipped 8–5.0L Engine

1. Disconnect the negative battery cable at the battery.



TBI plate and gasket installation on V8 engines so equipped

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

To install:

1. Clean all gasket surfaces before installing the gaskets and manifold.
2. Install the manifold end seals, folding the tabs if applicable, and the manifold/head gaskets, using a sealing compound around the water passages.

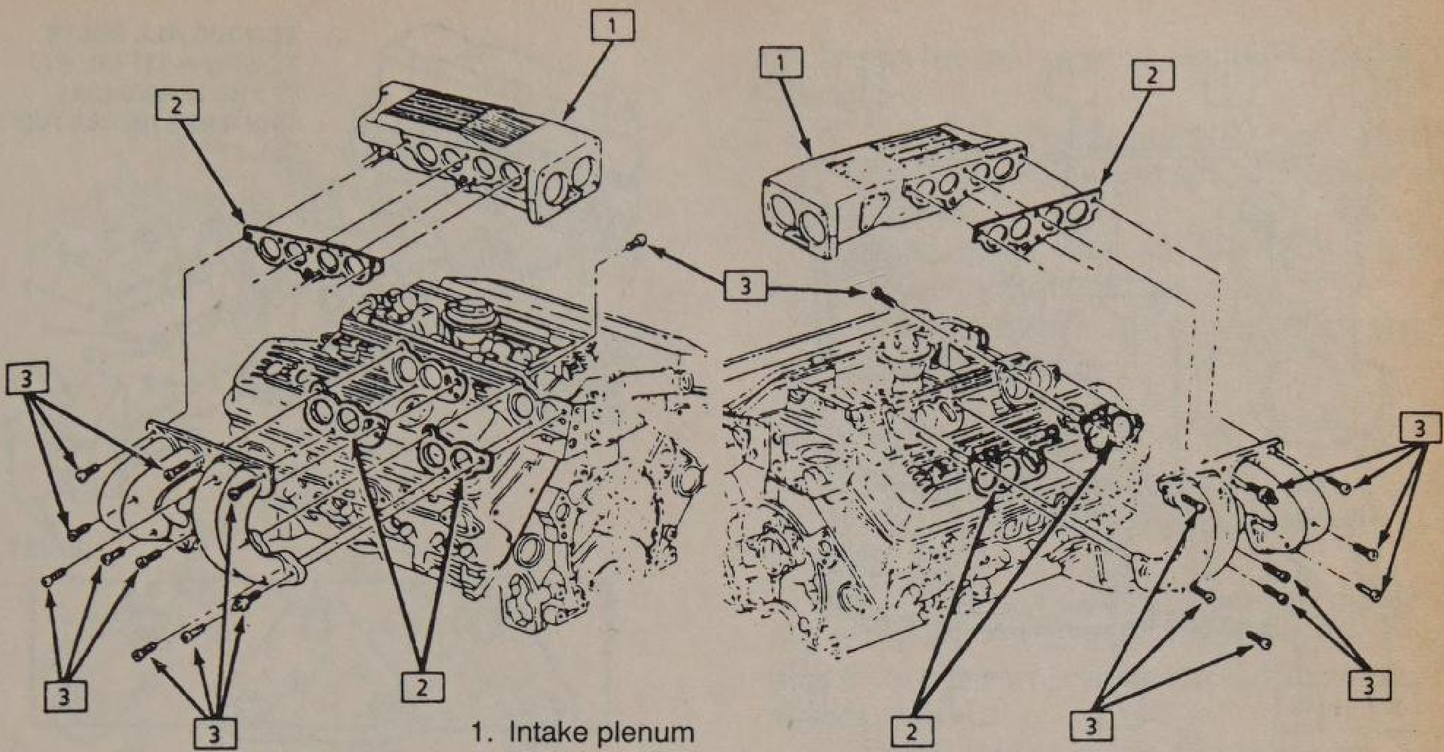
NOTE: *Make sure that the new manifold gaskets match the old ones EXACTLY.*

3. 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. Torque the manifold bolts to the specification in the Torque Specifications chart in this chapter.
4. Connect the heater hose to the intake manifold.
5. Connect the upper radiator hose to the thermostat housing.
6. Install the distributor as previously outlined earlier in this chapter.
7. Install the bolts which attach the upper manifold plate (or TBI plate) to the intake manifold.
8. Connect any vacuum hoses which were removed from the manifold.
9. Connect the positive crankcase ventilation valve hose at the manifold.
10. Bolt the air injection pump to the engine.
11. Connect the air injection hose at the check valve and the air control valve.
12. Connect the accelerator and cruise control cables.
13. Install the power brake booster line.
14. Connect the fuel return line at the rear TBI unit.
15. Connect the wiring from the idle air motors, injectors, and the throttle position sensor (TPS).
16. Install the exhaust gas recirculation (EGR) solenoid.
17. Connect the fuel inlet line at the front Throttle Body Injection (TBI) units.
18. Refill the cooling system.
19. Install the air cleaner assembly.
20. Connect the negative battery cable at the battery. Start the engine and check for leaks.

TPI Equipped V6 and V8 Engines

PLENUM AND RUNNERS (UPPER INTAKE)

1. Disconnect the negative (–) battery cable.
2. Partially drain the cooling system.
3. Remove the throttle, TV and cruise control cables.
4. Remove the cable retainer bracket.
5. Remove the air intake duct and label/dis-



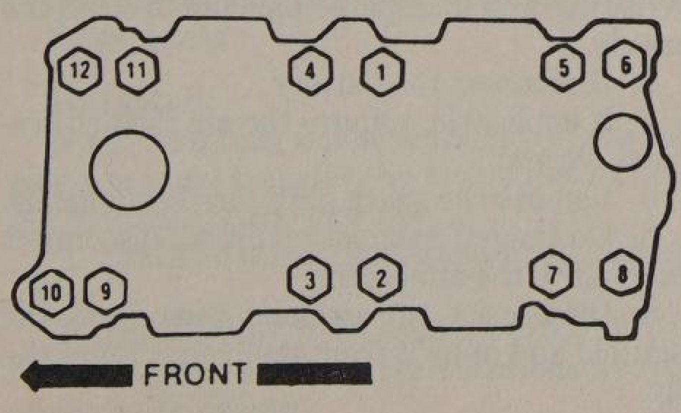
Intake plenum and runners — Tuned Port Injected engines

connect the vacuum hoses from the engine.

6. Disconnect the coolant hoses and electrical connectors from the throttle body.
7. Remove the throttle body assembly.
8. Disconnect the electrical connectors from the injectors. Refer to Chapter 5 for assistance in the Fuel System area.
9. Remove the power brake vacuum hose.
10. Remove the runner-to-plenum bolts, lift and disconnect the MAT sensor electrical connectors. Remove the plenum and gaskets.
11. Remove the left side runner-to-manifold bolts.
12. Remove the PCV valve and hose.
13. Remove the right side runner-to-manifold bolts.
14. Remove the runners and gaskets.

To install:

1. Clean the gasket mating surfaces, install the new gaskets and runners.
2. Torque the bolts to 35 ft. lbs. (34 Nm).



Lower intake manifold torque sequence — V8 engines with TPI

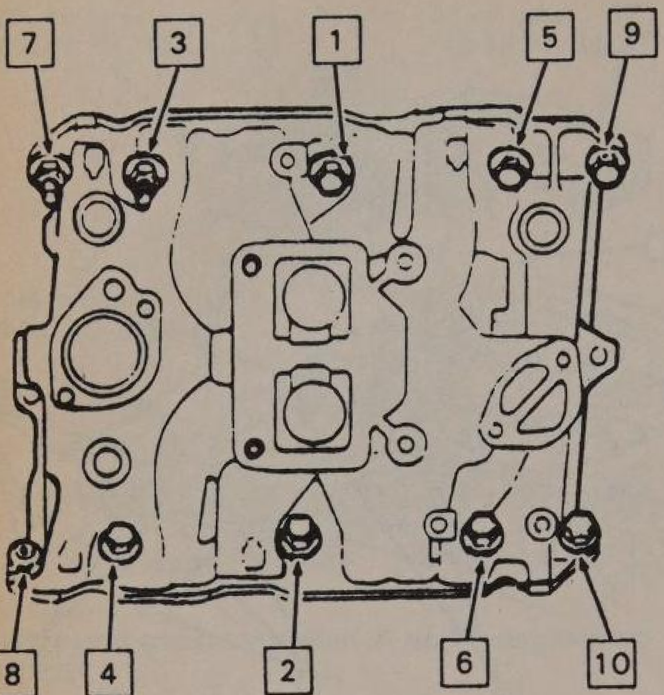
3. Install the EGR solenoid.
4. Support the plenum above the runners and connect the MAT sensor electrical connector, then lower the plenum into position.
5. Start a few bolts to hold the assembly in place.
6. Connect the vacuum hoses and MAP sensor. Install and torque the remaining runner-to-plenum bolts to 25 ft. lbs. (34 Nm).
7. Install the PCV valve, power brake hose, and connect the injector harnesses.
8. Install the throttle body with a new gasket. Torque the bolts to 18 ft. lbs. (24 Nm).
9. Connect all vacuum, coolant and electrical connections.
10. Install the cruise, TV and accelerator cables.
11. Refill the radiator with coolant, connect the negative battery cable and check for leaks.

LOWER INTAKE MANIFOLD

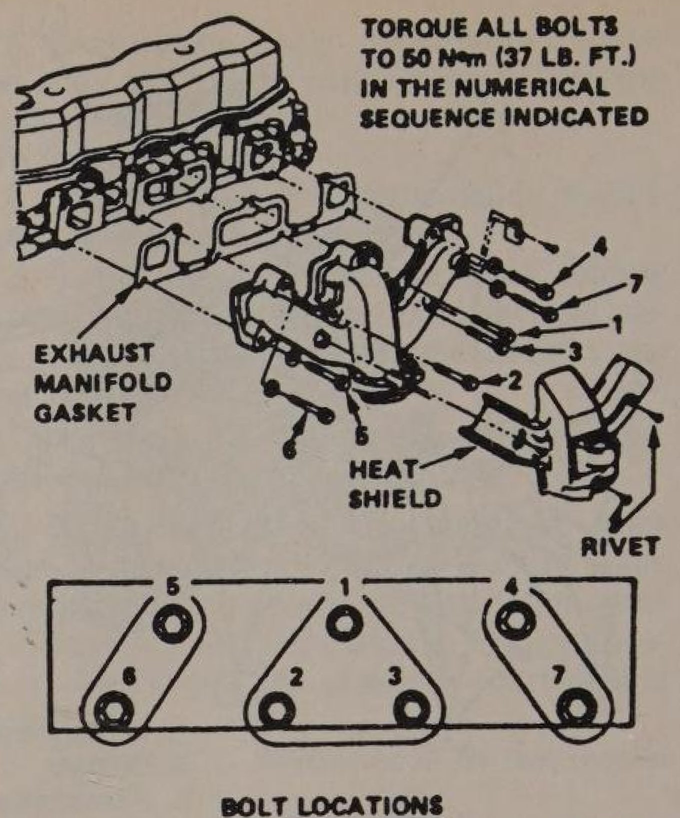
1. Disconnect the negative (–) battery cable.
2. **Important:** mark and label the spark plug wires, distributor, and rotor location. Remove the distributor cap and distributor assembly.
3. Remove the port injection system as outlined in the Upper Intake Manifold section in this chapter.
4. Remove the ignition coil, upper radiator hose and thermostat housing.
5. Remove the EGR valve, switch and pipe.
6. Disconnect the electrical wiring.
7. Remove the manifold bolts, studs, manifold and gaskets.

To install:

1. Clean the gasket and seal surfaces.



Intake manifold torque sequence – 1989 3.8L Turbo engine



Exhaust manifold torque sequence – 2.5L L4 engine

2. Apply a bead of RTV sealer on the front and rear ridges of the cylinder block. Extend the RTV 1/2 in. further up each end of the cylinder head to seal and retain the intake manifold side gaskets.
3. Install the manifold gaskets, manifold and bolts. Torque the bolts to the specifications in the Torque Specifications chart in the beginning of this chapter.
4. Connect all electrical, vacuum and coolant hoses and wires.
5. Install the EGR valve, switch and pipe.
6. Install the thermostat housing and radiator hose.
7. Install the ignition coil.
8. Install the port injection system as outlined in this chapter.
9. Install the distributor, cap and wires as removed. Refer to the Distributor section in this chapter for assistance.
10. Refill the cooling system, connect the negative battery cable and check for leaks.

Exhaust Manifold

REMOVAL AND INSTALLATION

4–2.5L

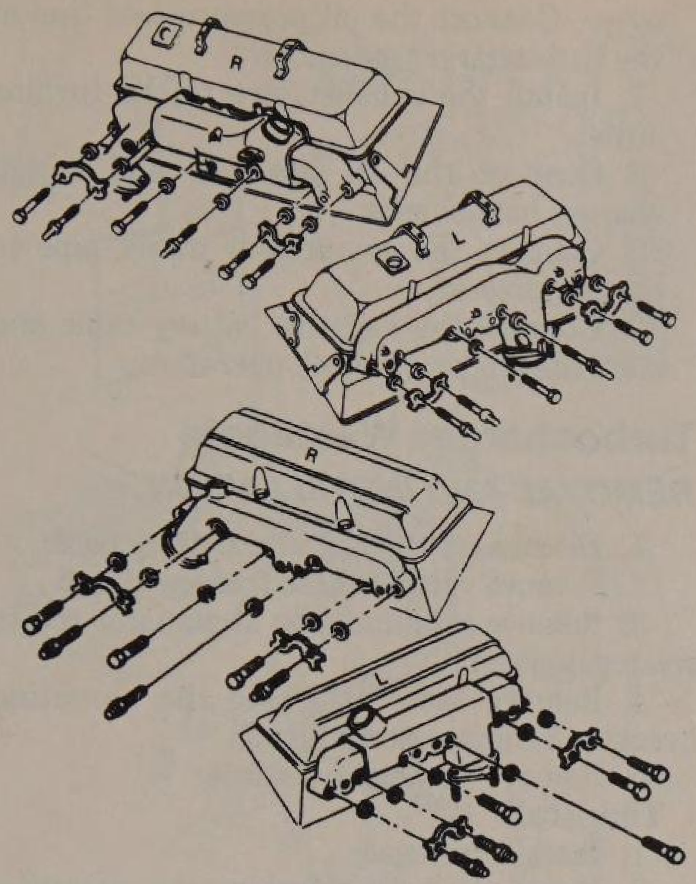
1. Disconnect the negative battery cable at the battery.
2. Remove the air cleaner assembly, being sure to mark any disconnected hoses for proper reinstallation.
3. Remove the E.F.I. preheat tube.
4. Remove the oxygen sensor and disconnect the exhaust pipe from the exhaust manifold.
5. Remove the engine oil level dipstick and tube.
6. Remove the exhaust manifold attaching bolts and remove the manifold.

To install:

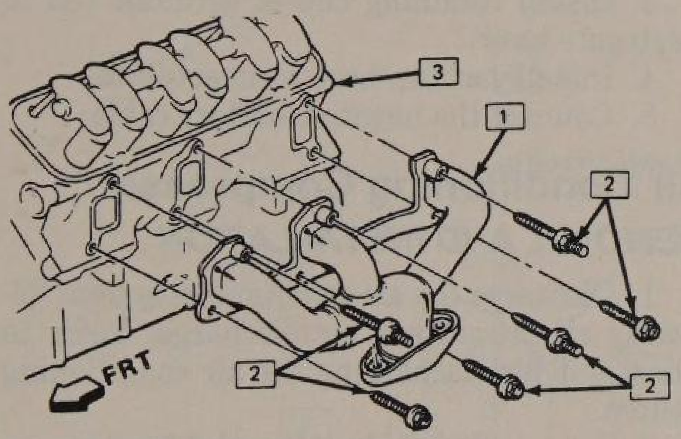
1. Position the exhaust manifold onto the engine and torque the bolts, follow the sequence in the accompanying diagram and tighten each bolt to 37 ft. lbs. (50 Nm).
2. Install the engine oil level dipstick tube and dipstick.
3. Connect the exhaust pipe to the exhaust manifold and install the oxygen sensor.
4. Install the E.F.I. preheat tube.
5. Install the air cleaner assembly and connecting hoses.
6. Connect the negative battery cable at the battery. Start the engine and check for leaks.

V6 and V8 Engines (Except 3.8L Turbo)

1. If equipped with AIR, remove the air injector manifold assembly. The 1/4 in. pipe threads in the manifold are straight threads. Do not use a 1/4 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 lock tabs and remove the end bolts, then the center bolts. Remove the manifold.



Exhaust manifold installation



1. Exhaust manifold
2. Bolt 37 ft. lbs. (50 Nm)
3. Cylinder head

Left exhaust manifold — 3.8L Turbo

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 lock tabs.*

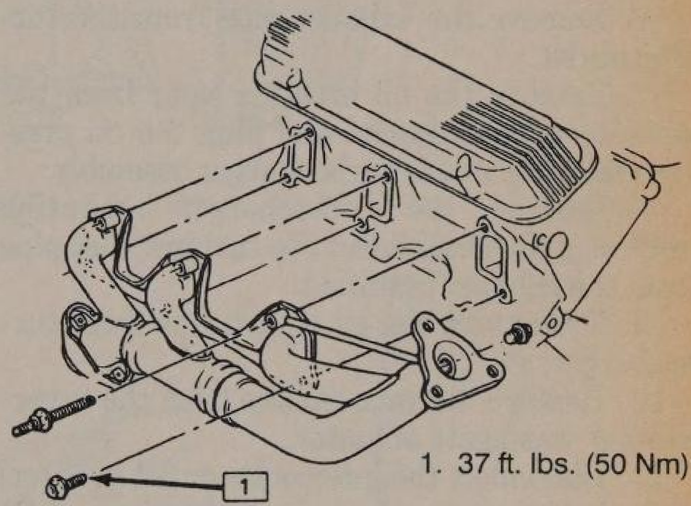
To install:

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

1. Clean all mating surfaces and use new gaskets.
2. Install the new gasket, manifold and bolts. Torque all bolts to specifications from the inside working out.
3. Bend the lock tabs over the bolts.
4. Connect the exhaust pipe to the manifold and torque the bolts to 25 ft. lbs. (34 Nm).
5. On the left exhaust manifold, install the alternator.
6. Install the spark plug wire heat shields.
7. If applicable, install the air cleaner preheater shroud.
8. If equipped with an AIR pump, install the air injector manifold assembly.
9. Connect the battery, start the engine and check for leaks.

3.8L Turbo

1. Disconnect the negative (−) battery cable.
2. Raise the vehicle and support with jackstands.
3. Left side, remove the crossover pipe from the manifold. Right side, remove the exhaust pipe from the turbocharger and disconnect the oxygen sensor.
4. Right side, remove the crossover from the manifold.
5. Lower the vehicle.
6. Remove the manifold bolts and manifold from the cylinder head.



Right exhaust manifold — 3.8L Turbo

To install:

1. Clean all gasket mating surfaces and inspect for cracks.
2. Install the exhaust manifold and torque the bolts to the specification in the Torque Specifications chart in this chapter.
3. Raise the vehicle and support with jackstands.
4. Install the crossover-to-manifold.
5. Lower the vehicle.
6. Right side, connect the oxygen sensor and manifold-to-turbocharger.
7. Connect the negative battery cable, start the engine and check for leaks.

Turbocharger

The turbocharger is basically an air compressor or air pump. It consists of a turbine or hot wheel, a shaft, a compressor or cold wheel, a turbine housing, a compressor housing and a center housing. The center housing contains bearings, a turbine seal assembly and a compressor seal assembly.

Turbochargers are installed on an engine to put more and denser air into the engine's combustion chambers. Because of the increased volume and weight of compressed air, more fuel can be scheduled to produce more horsepower from an engine. The turbocharged version of an engine, when operated above sea level, will also maintain a higher level of power output than the non-turbocharged version.

REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable.
2. Relieve the fuel system pressure.
3. Remove the air inlet hose from the compressor section of the turbocharger.
4. Disconnect the compressor outlet pipe from the compressor.
5. Disconnect the oil breather and turbocharger heat shields.
6. Remove the exhaust pipe from the turbine outlet.
7. Remove the oil breather vent from the valve cover. Disconnect and plug the oil pressure feed line at the turbocharger assembly.
8. Remove the turbocharger mounting bracket nuts. Disconnect the turbine inlet pipe from the exhaust manifold.
9. Disconnect the oil return line from turbocharger.
10. Remove the vacuum line from the turbocharger wastegate actuator.
11. Disconnect the intercooler outlet to throttle body pipe.
12. Remove the turbocharger assembly from the manifold adapter.

NOTE: *Before installing the turbocharger assembly, be sure that it is first charged with oil. Failure to do this may cause damage to the assembly.*

To install:

1. Install the turbocharger assembly to the manifold adapter. Torque the assembly to 20 ft. lbs. (27 Nm)
2. Connect the intercooler outlet to throttle body pipe.
3. Install the vacuum line to the turbocharger wastegate actuator.
4. Install the turbocharger mounting bracket nuts. Connect the turbine inlet pipe to the exhaust manifold.
5. Connect the oil return line to turbocharger.
6. Install the oil breather vent to the valve cover. Connect the oil pressure feed line at the turbocharger assembly.
7. Install the exhaust pipe to the turbine outlet.
8. Connect the oil breather and turbocharger heat shields.
9. Connect the compressor outlet pipe to the compressor.
10. Connect the negative battery cable and start the engine to check operation.

Turbocharger Wastegate

REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable.
2. Remove vacuum hose from actuator.
3. Remove retaining clip at actuator rod to wastegate lever.
4. Remove bolts attaching the mounting bracket to compressor housing.
5. Remove wastegate actuator.

To install:

1. Install wastegate.
2. Install the bolts attaching the mounting bracket to compressor housing.
3. Install retaining clip at actuator rod to wastegate lever.
4. Install vacuum hose from actuator.
5. Connect the negative battery cable.

Air Conditioning Compressor

REMOVAL AND INSTALLATION

1. Discharge the air conditioning system following all precaution for discharge. Refer to Chapter 1 for discharging the air conditioning system.
2. Remove fitting block (coupled hose assembly) bolt at rear of compressor.
3. Remove mounting bracket bolt(s).
4. Remove drive belt (Route lower loop behind crankshaft pulley to gain additional slack if required). Use a $^1/_2$ in. drive ratchet to release the tension on the serpentine drive belts.
5. Remove compressor.

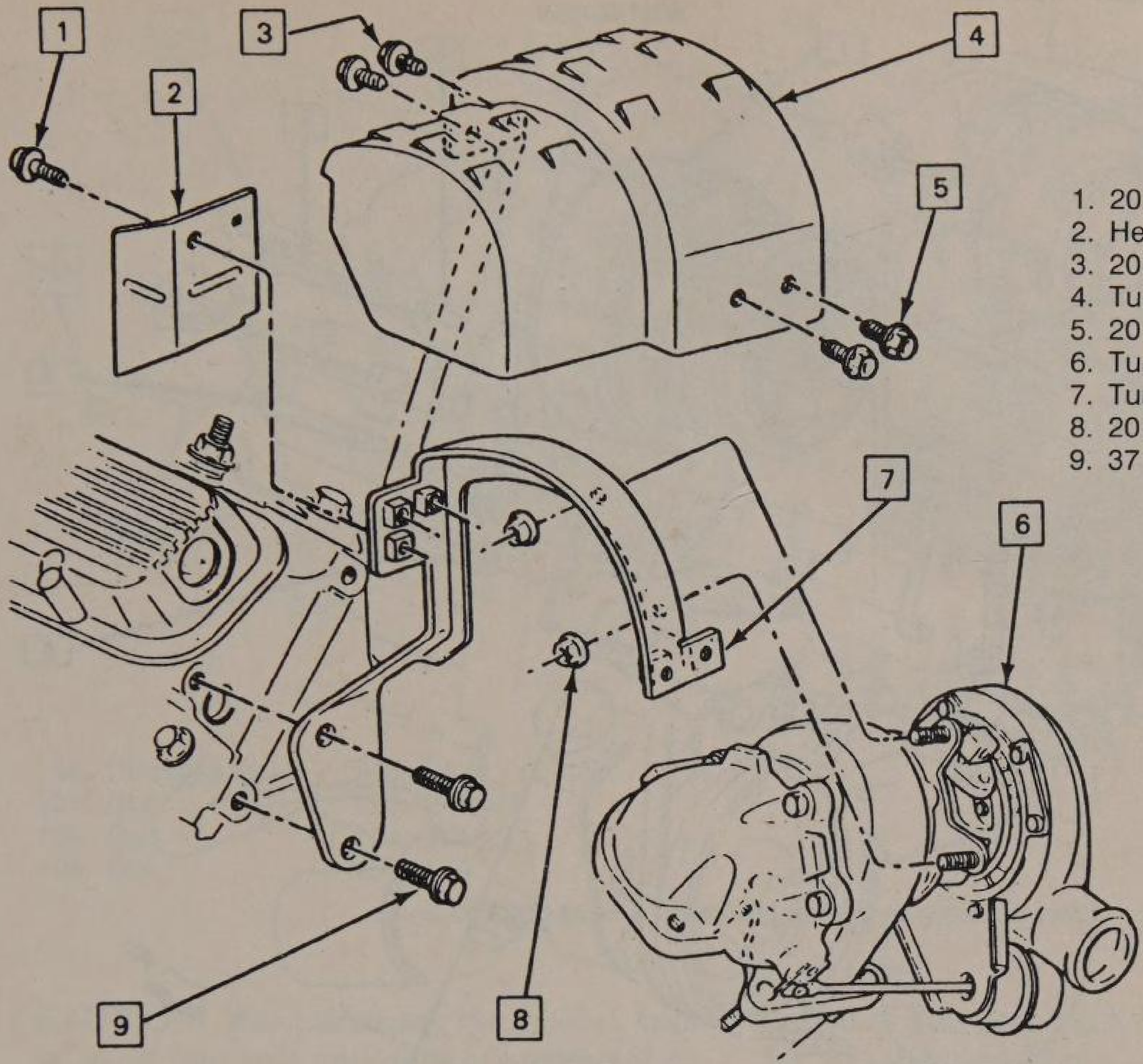
To install:

1. Use new O-rings lubricated with refrigerant oil.
2. Install the compressor.
3. Install the drive belt.
4. Install the mounting bracket and bolts.
5. Install the fitting block bolt at the rear of the compressor.
6. Evacuate and recharge system as outlined in Chapter 1.

Radiator

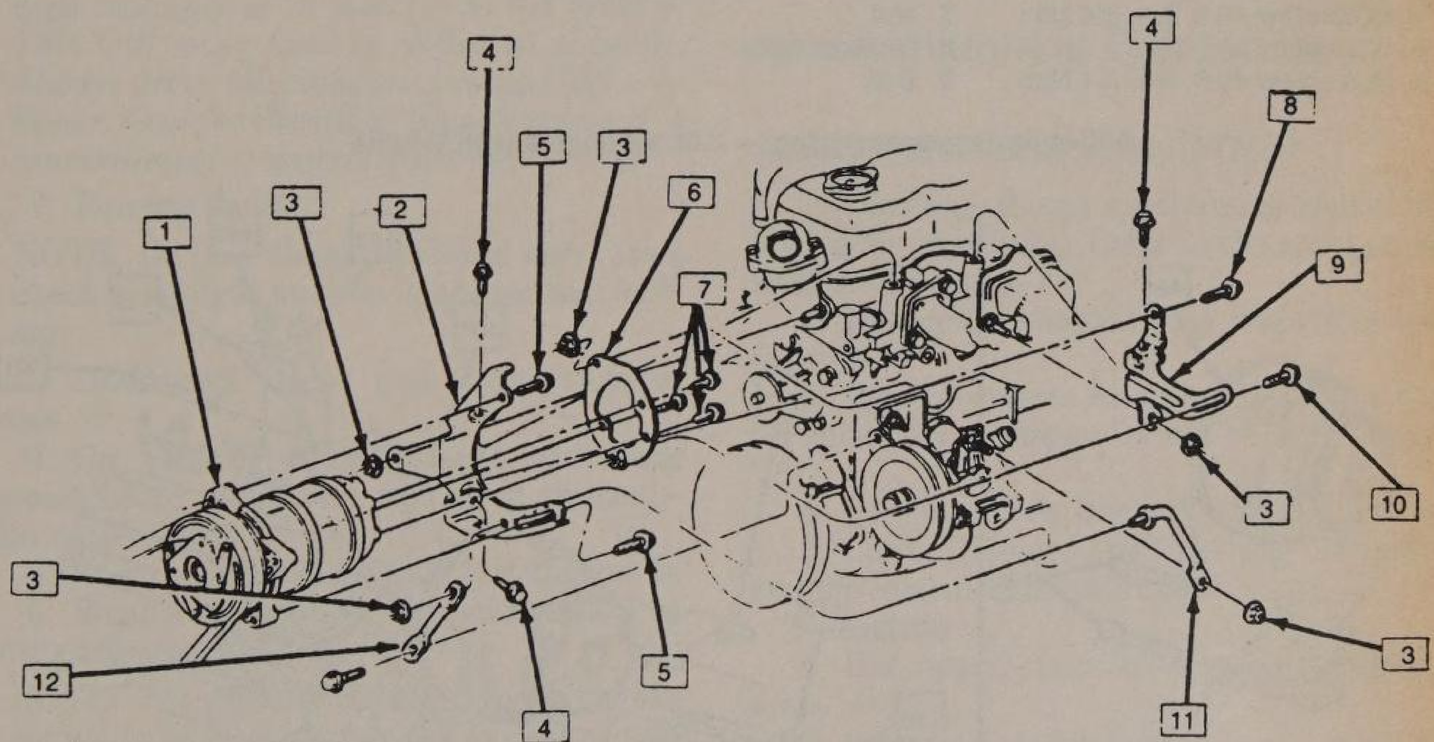
REMOVAL AND INSTALLATION

1. Drain the cooling system.



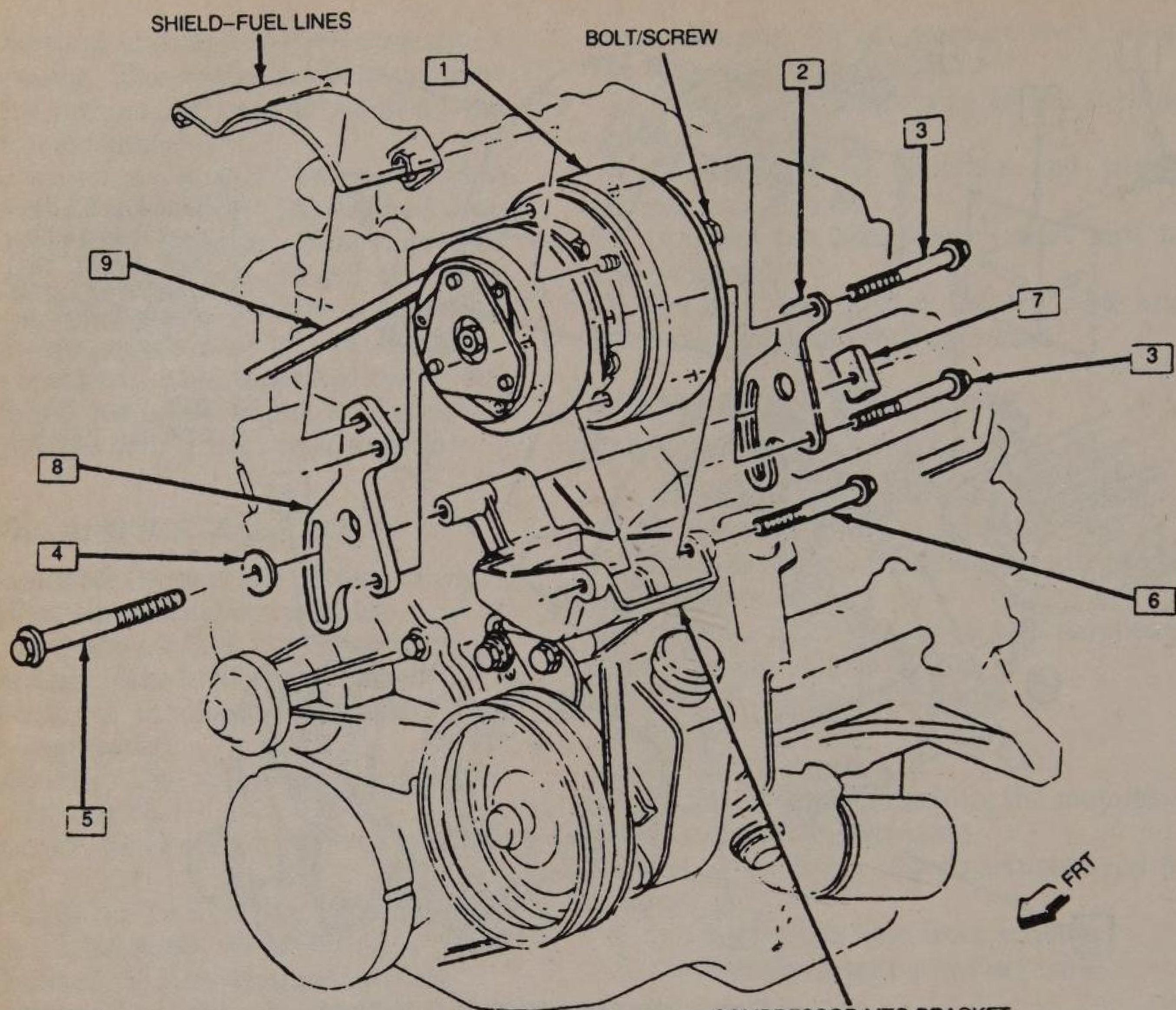
1. 20 ft. lbs. (27 Nm)
2. Heat shield elbow
3. 20 ft. lbs. (27 Nm)
4. Turbo heat shield
5. 20 ft. lbs. (27 Nm)
6. Turbo assembly
7. Turbo mounting bracket
8. 20 ft. lbs. (27 Nm)
9. 37 ft. lbs. (50 Nm)

Turbocharger assembly – 3.8L Turbo



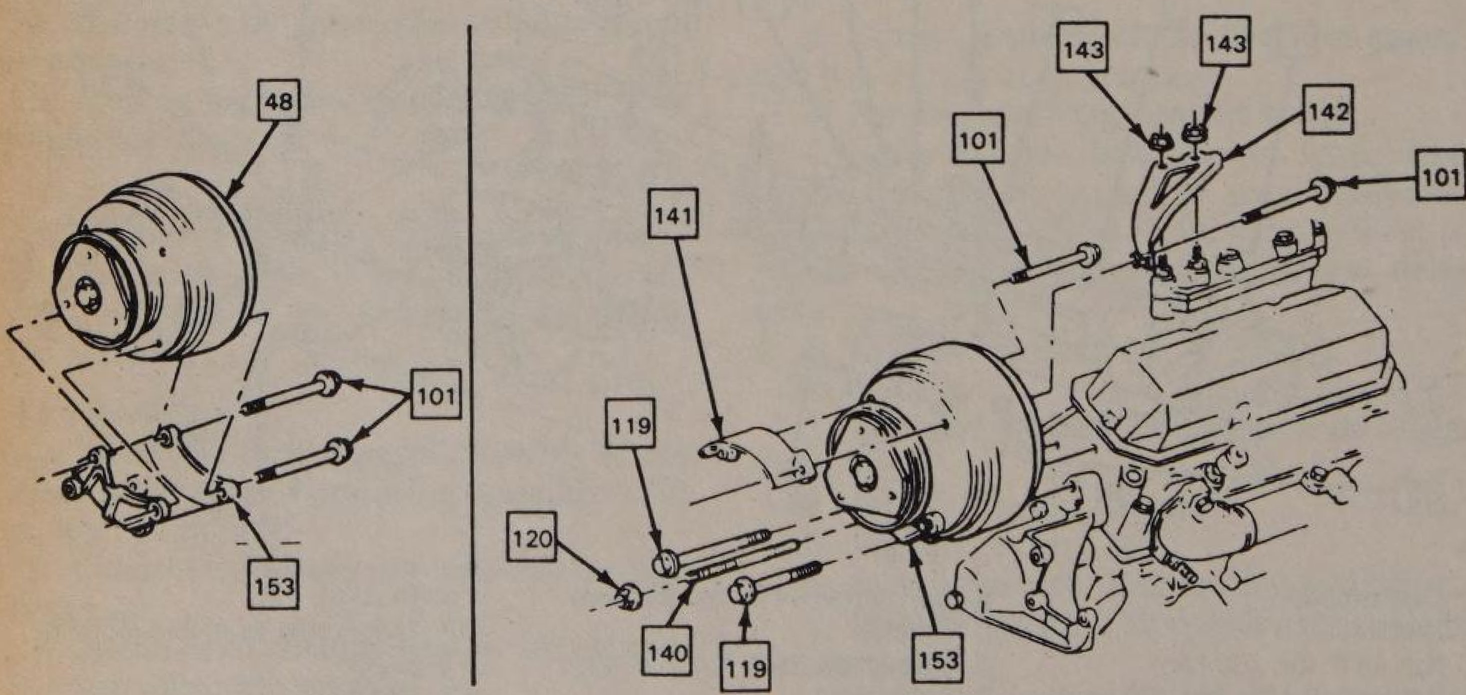
1. Compressor
2. Bracket
3. Nut 44 ft. lbs. (60 Nm)
4. Bolt/screw 44 ft. lbs. (60 Nm)
5. Bolt/screw 44 ft. lbs. (60 Nm)
6. Bracket
7. Bolt/screw 25 ft. lbs. (34 Nm)
8. Bolt/screw
9. Bracket
10. Bolt/screw 44 ft. lbs. (60 Nm)
11. Brace
12. Brace

A/C compressor servicing – 2.5L L4 engine



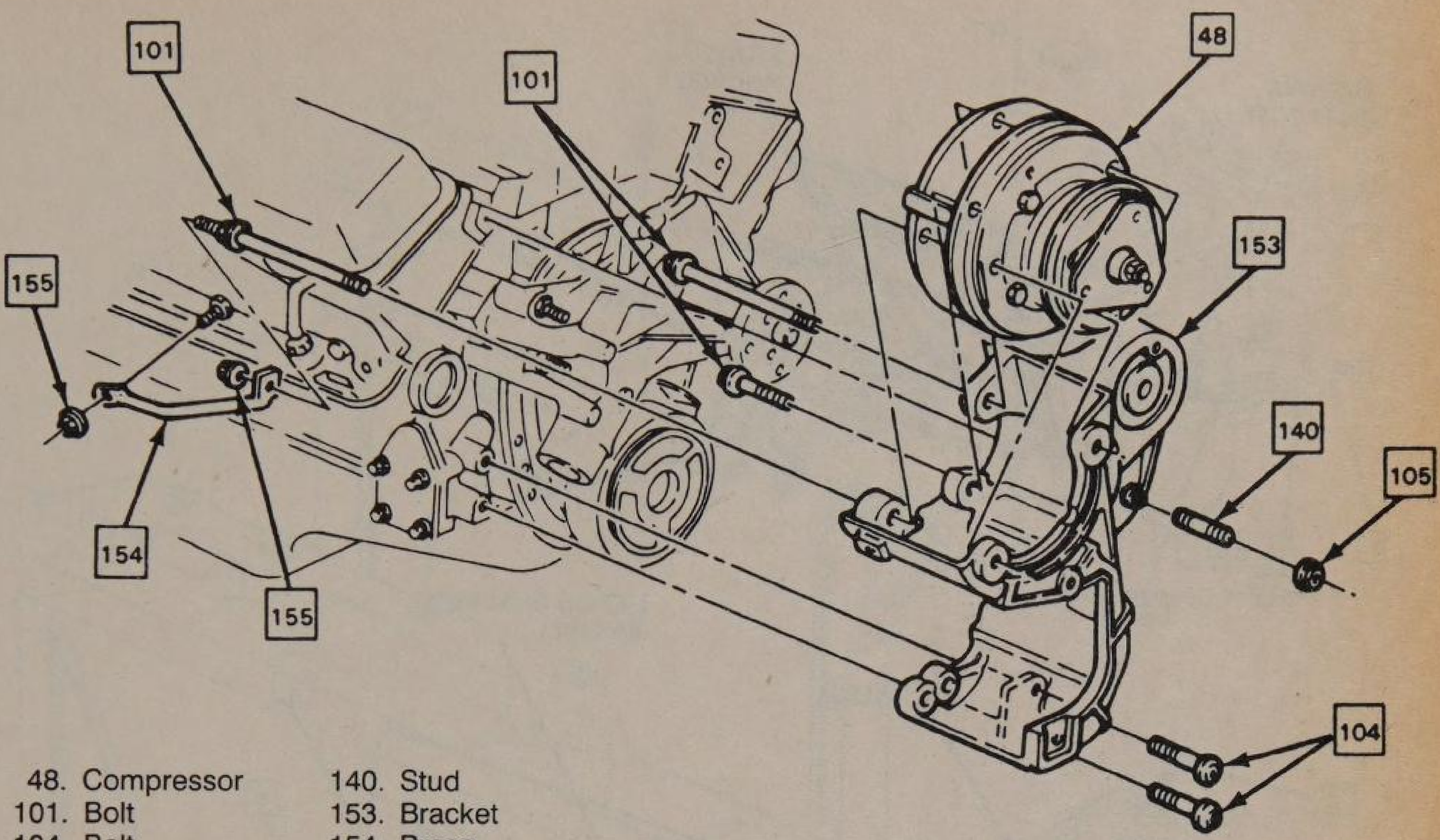
1. Compressor
2. Bracket, right rear
3. Bolt/screw 40 ft. lbs. (54 Nm)
4. Washer
5. Bolt/screw 40 ft. lbs. (54 Nm)
6. Bolt/screw 40 ft. lbs. (54 Nm)
7. Nut
8. Bracket, front
9. Belt

A/C compressor servicing – 2.8L V6 engine with V-belts



48. Compressor
101. Bolt
119. Bolt
120. Nut
140. Stud
141. Shield
142. Brace
143. Nut
153. Bracket

A/C compressor – 2.8L and 3.1L V6 with serpentine belt



48. Compressor
101. Bolt
104. Bolt
105. Nut
140. Stud
153. Bracket
154. Brace
155. Nut

A/C compressor — V8 engines with serpentine belt

CAUTION: *When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.*

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.*

To install:

1. If installing a new radiator, transfer fittings from old radiator to new radiator.
2. Replace radiator assembly by reversing the above steps, checking to assure radiator lower cradles are located properly in radiator recess.
3. 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.

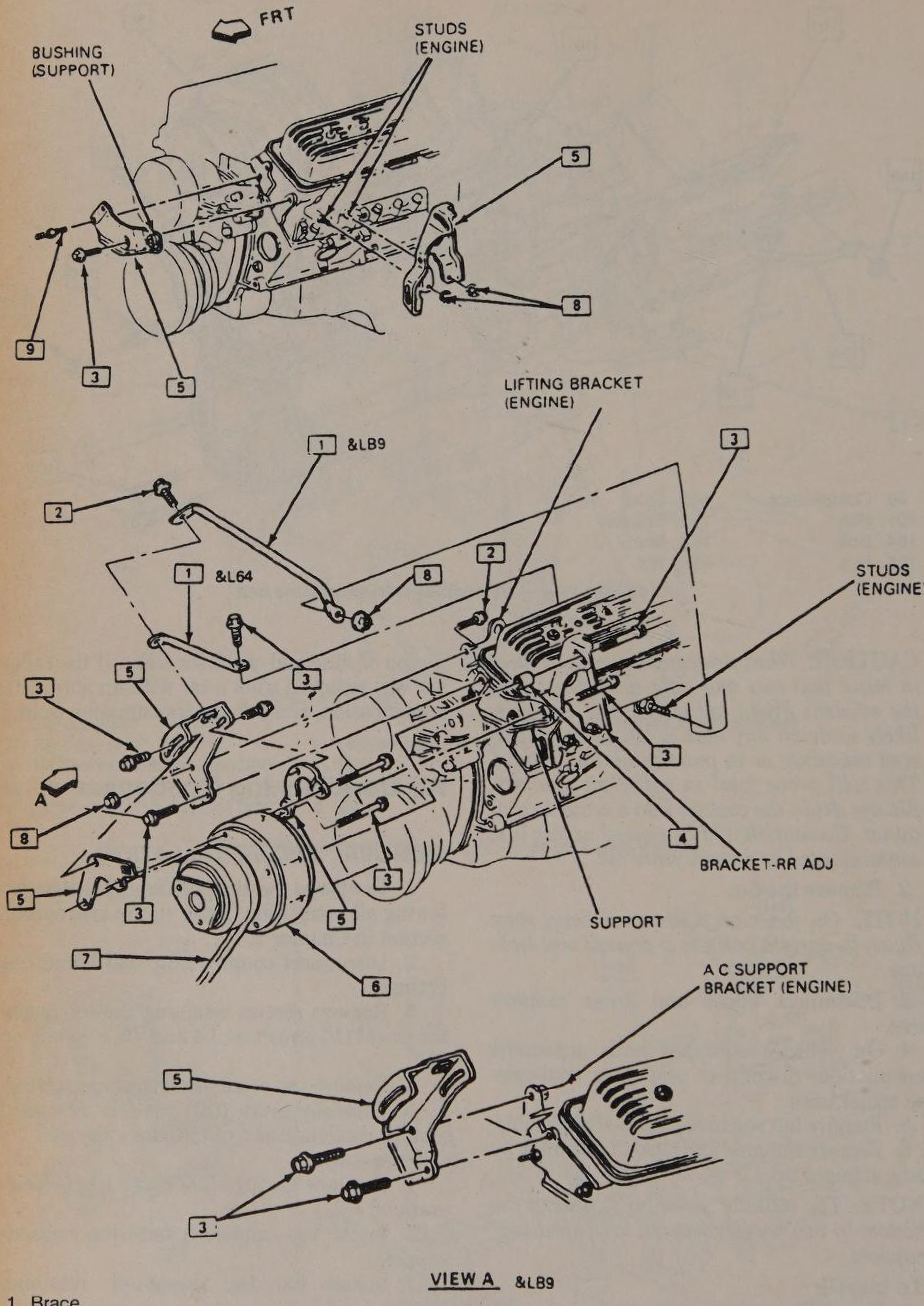
Air Conditioning Condenser

REMOVAL AND INSTALLATION

1. Discharge the air conditioning system following all precaution. Refer to the appropriate section in Chapter 1.
2. Disconnect coupled hose and liquid line fittings.
3. Remove screws retaining the top radiator shield (10 screws on L4 and V6, 8 screws on V8).
4. Remove top condenser retaining screws.
5. Carefully move (tilt) radiator rearward and lift condenser out of radiator support.

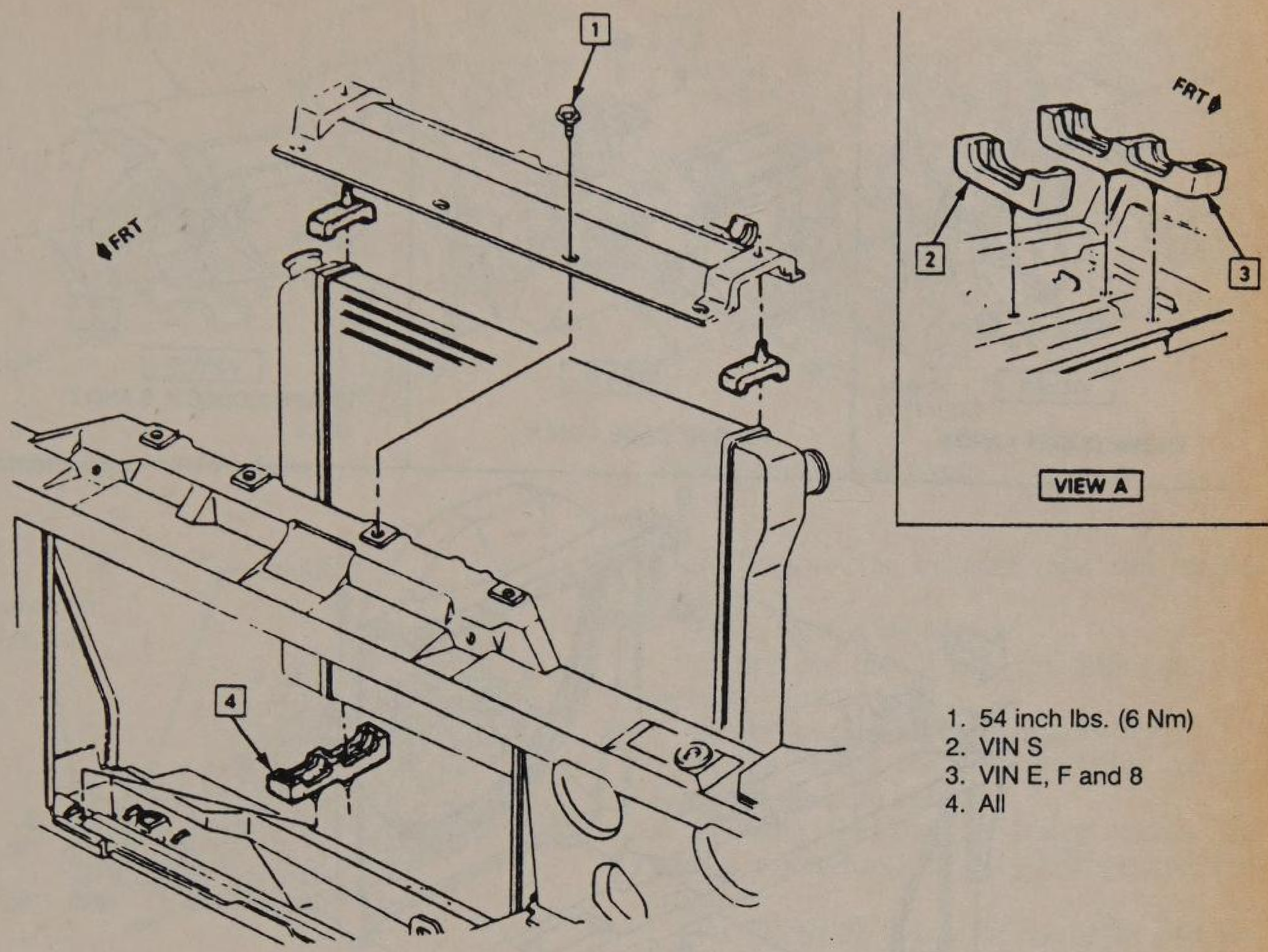
To install:

1. Use new O-rings lubricated with refrigerant oil.
2. Install the condenser onto the radiator support.
3. Install the top condenser retaining screws.
4. Install the screws retaining the top of the radiator shield.
5. Connect the coupled hose and liquid line fittings.
6. Evacuate and recharge system. Test for proper operation as outlined in Chapter 1.



1. Brace
2. Bolt/screw
3. Bolt/screw 29 ft. lbs. (40 Nm)
4. Spacer
5. Bracket
6. Compressor
7. Belt
8. Nut 29 ft. lbs. (40 Nm)
9. Stud 29 ft. lbs. (40 Nm)

A/C compressor servicing — V8 engines with V-belts



1. 54 inch lbs. (6 Nm)
2. VIN S
3. VIN E, F and 8
4. All

Radiator mounting

Water Pump

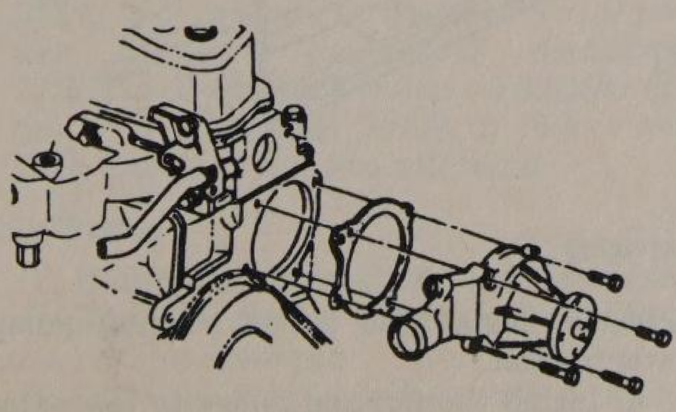
REMOVAL AND INSTALLATION

4-Cylinder

1. Disconnect the negative (–) battery cable. 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.

To install:

1. Coat the new gasket with RTV Sealer. Install the pump and torque the bolts to 15 ft. lbs. (20 Nm).



Water pump – 2.5L engine

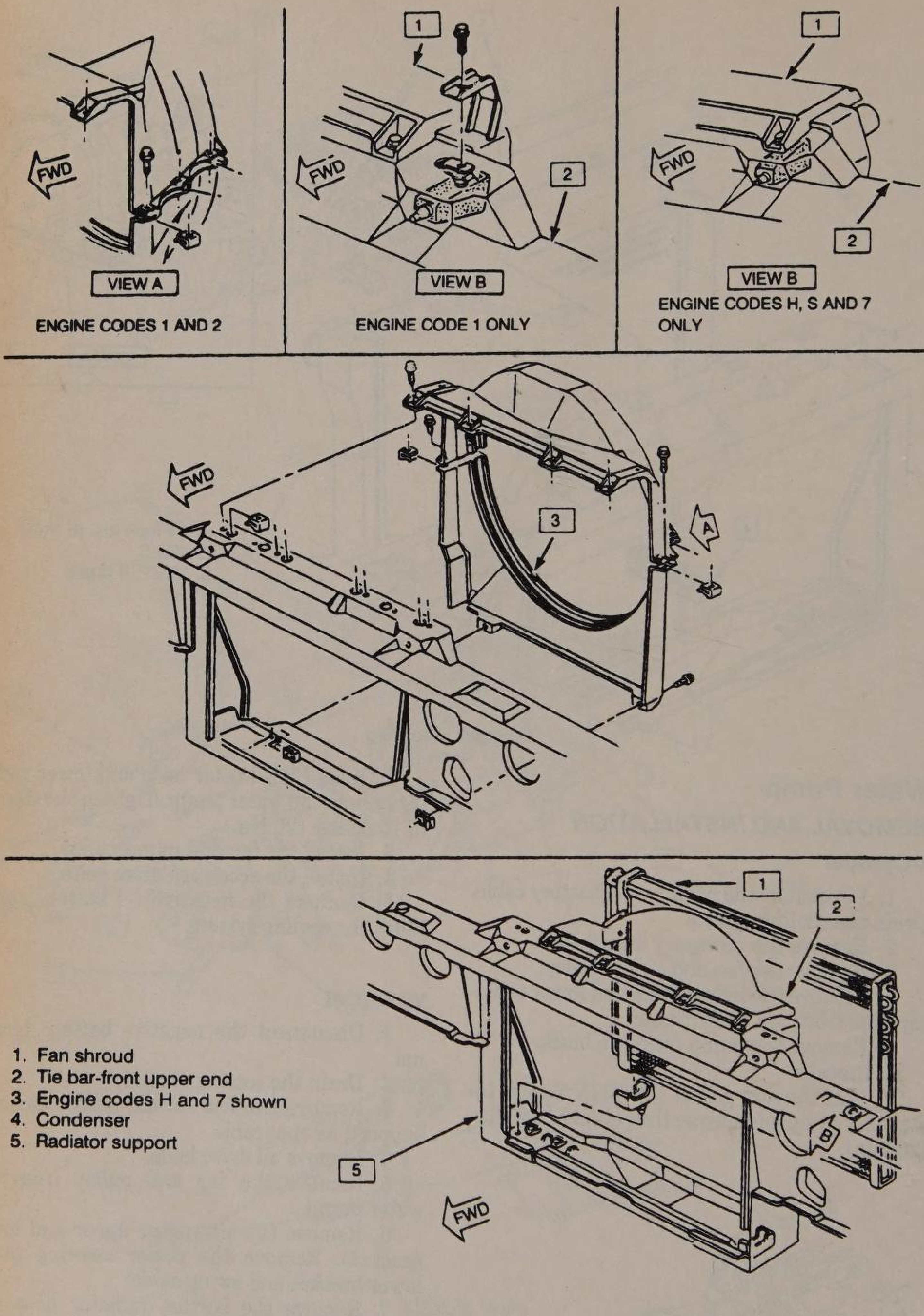
2. Install the heater hose and lower radiator hose to the water pump. Tighten the clamps to 15 ft. lbs. (20 Nm).
3. Install the fan and pump pulley.
4. Install the accessory drive belts.
5. Connect the negative (–) battery cable. Refill the cooling system.

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.

To install:

1. Clean the gasket mating surfaces with solvent and a scraper.
2. Coat the new gasket with RTV Sealer.
3. Install the gasket, pump and bolts.



A/C condenser servicing

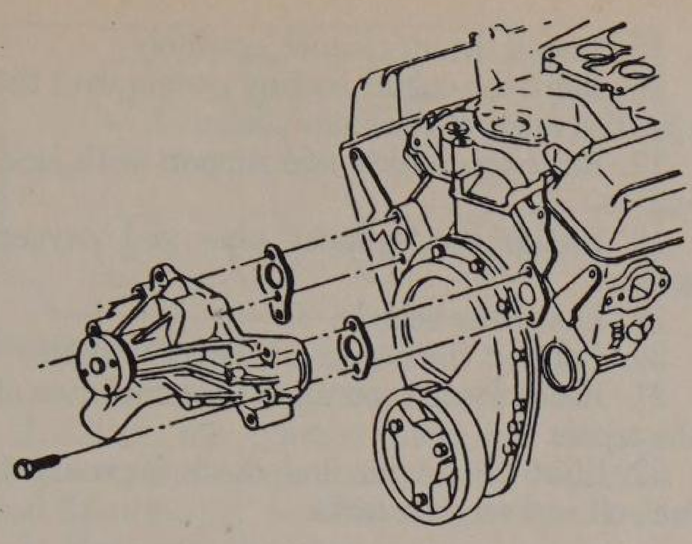
Torque the pump bolts 15–25 ft. lbs. (20–34 Nm).

4. Install the bottom radiator hose and heater hose to the pump.

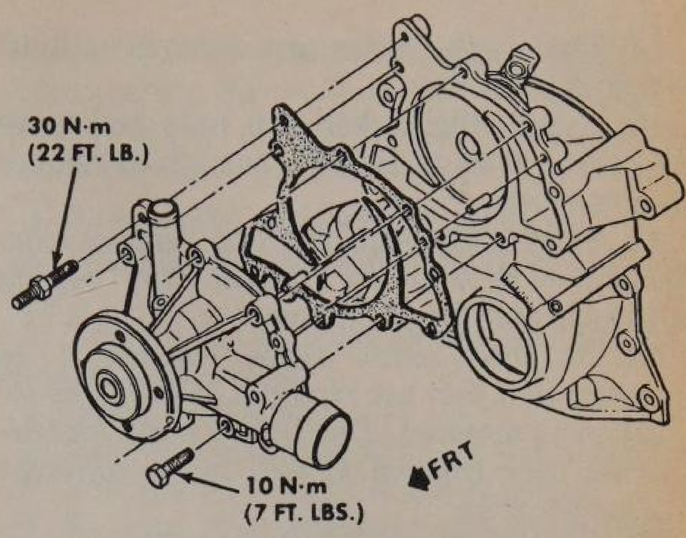
5. Install the alternator upper and lower brackets. Install the power steering pump lower bracket.

6. Install the fan and pulley to the water pump.

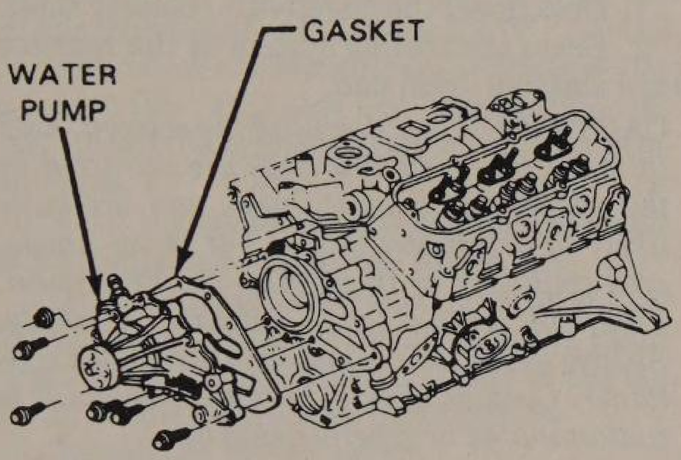
7. Install all drive belts.



Water pump — V8 engines



Water pump — 3.8L Turbo



Water pump — 2.8L and 3.1L engines

8. Install the fan shroud and/or radiator support, as applicable.
9. Refill the cooling system.
10. Connect the negative battery terminal. Start the engine and check for leaks.

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.*

2.5L Engine

1. Disconnect the negative (–) battery cable.
2. Drain the cooling system at the radiator into a suitable drain pan.
3. Raise the vehicle and support it safely with jack stands.
4. Remove the exhaust pipe and oxygen sensor.
5. Lower the vehicle.
6. Remove the oil level indicator tube and auxiliary ground cable.
7. Remove the air cleaner assembly.
8. Disconnect the EFI electrical connections and vacuum hoses.
9. From the throttle body; remove the wiring connectors, throttle linkage and fuel lines.

CAUTION: *To reduce the risk of fire and personal injury, it is necessary to relieve the fuel system pressure before servicing any fuel system component. If this procedure is not performed, fuel may be sprayed out of the connection under pressure. Always keep a dry chemical (Class B) fire extinguisher near the work area.*

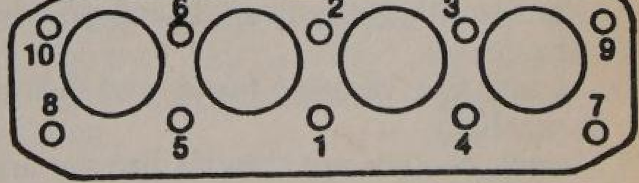
Fuel pressure relief procedures:

a. Remove the fuel pump fuse from the fuse block located in the passenger compartment.

b. Start the engine and run until the engine stops due to the lack of fuel.

c. Crank the engine for 3 seconds to ensure all pressure is relieved.

10. Remove the heater hose from the intake manifold.
11. Remove the wiring connectors from the manifold and cylinder head.
12. Remove the vacuum hoses, serpentine belt and alternator bracket.
13. Remove the radiator hoses.



Torquing sequence for the 2.5L L4 engine

14. Remove the rocker arm cover as outlined in this chapter.

15. Loosen the rocker arm nuts and move the rocker arms to the side enough to remove the push rods.

16. Mark each push rod and remove from the engine. Refer to the "Rocker Arm" section in this chapter for assistance.

NOTE: *Mark each valve component to ensure that they are replaced in the same location as removed. This is very important because each component will follow different wear patterns.*

17. Remove the cylinder head bolts.

18. Tap the sides of the cylinder head with a plastic hammer to dislodge the gasket. Remove the cylinder head with the intake and exhaust manifold still attached.

19. If the cylinder head has to be serviced or replaced, remove the intake manifold, exhaust manifold and remaining hardware.

To install:

1. Before installing, clean the gasket surfaces of the head and block with solvent and a gasket scraper.

2. Check the cylinder head for warpage using a straight edge. Refer to the "Cylinder Head Resurfacing" procedures in this section.

3. Make sure the retaining bolt threads and the cylinder block threads are clean since dirt could affect bolt torque.

4. Match up the old head gasket with the new one to ensure the holes are EXACT. Install a new gasket over the dowel pins in the cylinder block.

5. Install the cylinder head in place over the dowel pins.

6. Coat the cylinder head bolt threads with sealing compound and install finger tight.

7. Torque the cylinder head bolts gradually in the sequence shown in the illustration. Refer to the "Torque Specifications" chart in the beginning of this chapter for instructions.

8. Install the push rods, rocker arms and nuts (or bolts) in the same location as removed. Torque the nuts (or bolts) to 24 ft. lbs. (32 Nm).

9. Install the rocker arm cover as outlined in the "Rocker Arm Cover" removal and installation procedures in this chapter.

10. Install the radiator hoses, alternator bracket and serpentine belt.

11. Connect all intake manifold and cylinder head wiring.

12. Install the vacuum hoses and heater hose at manifold.

13. Install the wiring, throttle linkage and fuel lines to the throttle body assembly.

14. Install the oil level indicator tube-to-exhaust manifold.

15. Install the air cleaner assembly.

16. Refill the engine cooling system with the specified amount of engine coolant.

17. Raise the vehicle and support with jackstands.

18. Install the exhaust pipe and oxygen sensor.

19. Lower the vehicle.

20. Connect the negative (–) battery cable.

21. Recheck each operation for completion of the repair.

22. Start the engine and check for coolant, fuel, oil and vacuum leaks.

2.8L and 3.1L V6

LEFT

1. Disconnect the negative (–) battery cable.

2. Drain the cooling system at the radiator into a suitable drain pan.

CAUTION: *When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.*

3. Remove the air cleaner assembly.

4. Remove the rocker arm cover as outlined in that section in this chapter.

5. Remove the intake plenum and manifold as outlined in those sections in this chapter.

6. Remove the exhaust crossover pipe and front exhaust manifold.

7. Remove the oil level indicator and spark plug wires from the front head.

8. Loosen the rocker arm nuts and move to the side or remove.

9. Mark each push rod and remove from the engine. Refer to the "Rocker Arm" section in this chapter for assistance. The intake push rods are marked (orange) and the exhaust push rods are marked (blue).

NOTE: *Mark each valve component to ensure that they are replaced in the same location as removed. This is very important because each component will follow different wear patterns.*

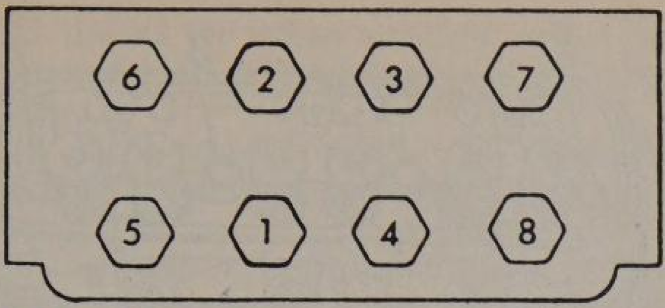
10. Remove the cylinder head bolts.

11. Tap the sides of the cylinder head with a plastic hammer to dislodge the gasket. Remove the cylinder.

12. If the cylinder head has to be serviced or replaced, remove all remaining hardware.

To install:

1. Before installing, clean the gasket surfaces of the head and block with solvent and a gasket scraper.



Valve guide cleaner

2. Check the cylinder head for warpage using a straight edge. Refer to the "Cylinder Head Resurfacing" procedures in this section.
3. Make sure the retaining bolt threads and the cylinder block threads are clean since dirt could affect bolt torque.
4. Match up the old head gasket with the new one to ensure the holes are EXACT. Install a new gasket over the dowel pins in the cylinder block with the "This Side Up" mark facing UP.
5. Install the cylinder head in place over the dowel pins.
6. Coat the cylinder head bolt threads with sealing compound and install finger tight.
7. Torque the cylinder head bolts gradually in the sequence shown in the illustration. Refer to the "Torque Specifications" chart in the beginning of this chapter for instructions.
8. Install the intake gasket.
9. Install the valve mechanisms and rocker arms over the valves. Adjust the valves as outlined in the Rocker Arm section of this chapter.
10. Install the intake manifold and plenum as outlined in the appropriate section in this chapter.
11. Install the rocker arm covers as outlined in the appropriate section in this chapter.
12. Install the oil level indicator and front exhaust manifold.
13. Install the exhaust crossover pipe and oxygen sensor (if removed).
14. Install the air cleaner assembly.
15. Refill the engine cooling system with the specified amount of engine coolant.
16. Connect the negative (–) battery cable.
17. Recheck each operation for completion of the repair.
18. Start the engine and check for coolant, fuel, oil and vacuum leaks.

RIGHT

1. Disconnect the negative (–) battery cable.
2. Drain the cooling system at the radiator into a suitable drain pan.

CAUTION: *When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.*

3. Remove the air cleaner assembly.
4. Raise the vehicle and support with jackstands.
5. Remove the exhaust crossover pipe and rear exhaust manifold.
6. Lower the vehicle.
7. Remove the torque struts at the engine.
8. Remove the coolant recovery bottle.
9. Remove the exhaust crossover heat shield and crossover from the rear manifold.
10. Remove rear exhaust manifold.
11. Remove the spark plug wires from the rear head.
12. Remove the rocker arm cover as outlined in that section in this chapter.
13. Remove the intake plenum and manifold as outlined in those sections in this chapter.
14. Loosen the rocker arm nuts and move to the side or remove.
15. Mark each push rod and remove from the engine. Refer to the "Rocker Arm" section in this chapter for assistance. The intake push rods are marked (orange) and the exhaust push rods are marked (blue).

NOTE: *Mark each valve component to ensure that they are replaced in the same location as removed. This is very important because each component will follow different wear patterns.*

16. Remove the cylinder head bolts.
17. Tap the sides of the cylinder head with a plastic hammer to dislodge the gasket. Remove the cylinder.
18. If the cylinder head has to be serviced or replaced, remove all remaining hardware.

To install:

1. Before installing, clean the gasket surfaces of the head and block with solvent and a gasket scraper.
2. Check the cylinder head for warpage using a straight edge. Refer to the "Cylinder Head Resurfacing" procedures in this section.
3. Make sure the retaining bolt threads and the cylinder block threads are clean since dirt could affect bolt torque.
4. Match up the old head gasket with the new one to ensure the holes are EXACT. Install a new gasket over the dowel pins in the cylinder block with the "This Side Up" mark facing UP.
5. Install the cylinder head in place over the dowel pins.
6. Coat the cylinder head bolt threads with sealing compound and install finger tight.
7. Torque the cylinder head bolts gradually in the sequence shown in the illustration. Refer

to the "Torque Specifications" chart in the beginning of this chapter for instructions.

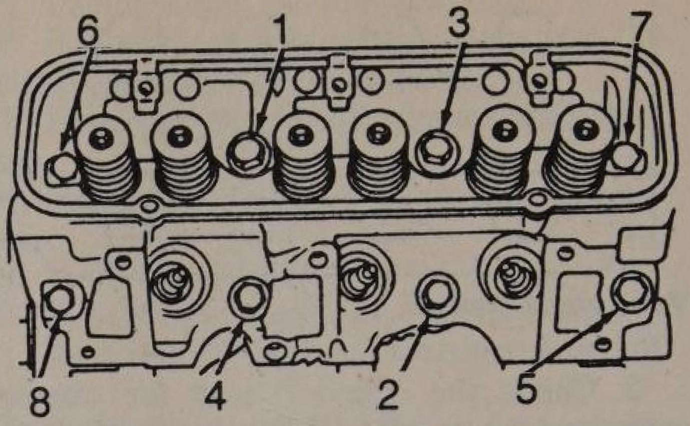
8. Install the intake gasket.
9. Install the valve mechanisms and rocker arms over the valves. Adjust the rocker arms as outlined in the Rocker Arm section of this chapter.
10. Install the intake manifold and plenum as outlined in the appropriate section in this chapter.
11. Install the rocker arm covers as outlined in the appropriate section in this chapter.
12. Install the spark plug wires and rear exhaust manifold.
13. Install the exhaust crossover pipe, oxygen sensor (if removed) and crossover heat shield.
14. Refill the engine cooling system with the specified amount of engine coolant.
15. Raise the vehicle and support with jackstands.
16. Install the exhaust pipe at the crossover and lower the vehicle.
17. Connect the negative (–) battery cable.
18. Recheck each operation for completion of the repair.
19. Start the engine and check for coolant, fuel, oil and vacuum leaks.

3.8L Turbo

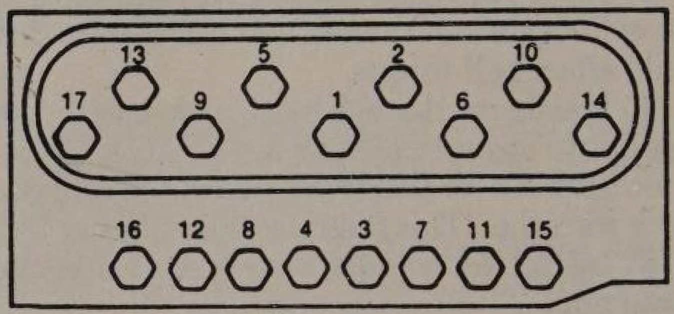
1. Disconnect the negative (–) battery cable and drain the cooling system.

CAUTION: *When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.*

2. Remove the accessory drive belts.
3. Right cylinder head: remove the air conditioning compressor and hang to the side with a piece of wire. Do NOT disconnect the refrigerant lines. Remove the alternator and mounting brackets.
4. Left cylinder head: remove the oil level indicator, power steering pump and mounting brackets with the hoses connected and hang to the side.
5. Label and disconnect the spark plug wires.
6. Remove the exhaust pipe-to-manifold bolts.
7. Remove the intake manifold and rocker arm covers as outlined in this chapter.
8. Label and remove the rocker arm shafts and pushrods. Label and mark the engine parts so they are installed into their original location.



Torquing sequence for the 3.8L Turbo engine



Tightening sequence for the 5.0L engine cylinder head

9. Remove the cylinder head bolts and cylinder head. Tap the side of the head with a plastic hammer to dislodge the gasket. Do NOT try to pry off with a screwdriver between the mating surfaces.

To install:

1. Before installing, clean the gasket surfaces of the head and block with solvent and a gasket scraper.
2. Check the cylinder head for warpage using a straight edge. Refer to the "Cylinder Head Resurfacing" procedures in this section.
3. Make sure the retaining bolt threads and the cylinder block threads are clean since dirt could affect bolt torque.
4. Match up the old head gasket with the new one to ensure the holes are EXACT. Install a new gasket over the dowel pins in the cylinder block with the "This Side Up" mark facing UP.
5. Install the cylinder head in place over the dowel pins.
6. Coat the cylinder head bolt threads with sealing compound and install finger tight.
7. Torque the cylinder head bolts gradually in the sequence shown in the illustration.
8. Torque all head bolts in sequence, in three steps. Step 1: torque all bolts to 25 ft. lbs. (34 Nm). Step 2: torque the bolts an additional $^{1}/_{4}$ (90°) turn. Step 3: torque all bolts in sequence an additional $^{1}/_{4}$ (90°) turn.
9. Install the exhaust manifold bolts.
10. Install the pushrods and rocker arm shafts. Torque the rocker shaft bolts to 43 ft. lbs. (58 Nm).

11. Install the intake manifold, rocker arm cover and spark plug wires as outlined in this chapter.
12. Right cylinder head: install alternator, mounting bracket and air conditioning compressor.
13. Left cylinder head: install the power steering pump, mounting bracket and oil level indicator.
14. Install the belts and connect the negative battery cable.
15. Refill the cooling system, start the engine and check for leaks.

5.0L and 5.7L Engines

1. Disconnect the battery cables at the battery.
2. Drain the engine block of coolant.
3. Remove the intake manifold as previously described in this chapter. 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).

To install:

1. Before installing, clean the gasket surfaces of the head and block with solvent and a gasket scraper.
2. Check the cylinder head for warpage using a straight edge. Refer to the "Cylinder Head Resurfacing" procedures in this section.
3. Make sure the retaining bolt threads and the cylinder block threads are clean since dirt could affect bolt torque.
4. Match up the old head gasket with the new one to ensure the holes are EXACT. Install a new gasket over the dowel pins in the cylinder block with the "This Side Up" mark facing UP.
5. Install the cylinder head in place over the dowel pins.
6. Coat the cylinder head bolt threads with sealing compound and install finger tight.
7. Torque the cylinder head bolts gradually in the sequence shown in the illustration. Refer to the Torque Specifications chart in this chapter for torque values.
8. Install the exhaust and intake manifolds as previously outlined.
9. Adjust the valves as described in the Rocker Arm section in this chapter.
10. Install the rocker arm covers.
11. Refill the engine with coolant, start the engine and check for leaks.

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.

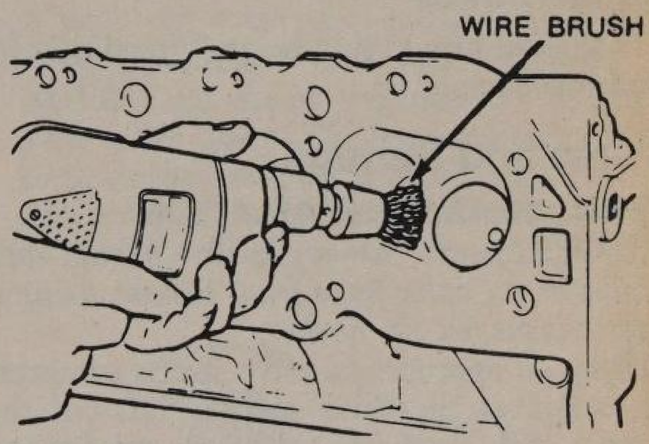
NOTE: *Be sure that the deposits are actually removed, rather than burnished.*

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.

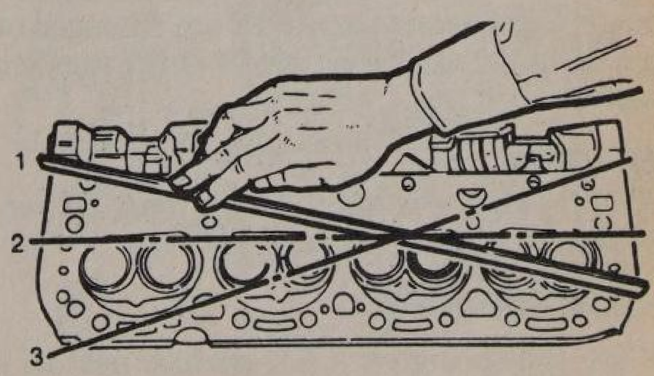
WARNING: *Aluminum cylinder head can not be hot-tanked in the same solution that is used for cast iron. Make sure the machine shop knows if the cylinder heads are aluminum.*

Place a straight-edge across the gasket surface of the cylinder head. Using feeler gauges, determine the clearance at the center of the straight-edge. If warpage exceeds 0.08mm (0.003 in.) in a 152mm (6 in.) span, or 0.15mm (0.006 in.) over the total length, the cylinder head must be resurfaced.

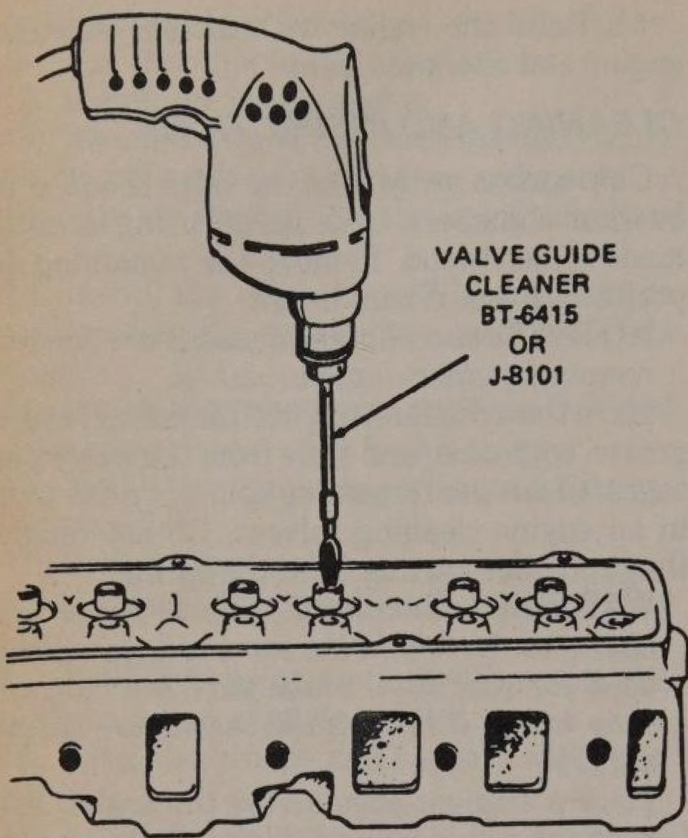
NOTE: *If warpage exceeds the manufacturer's maximum tolerance for material removal, the cylinder head must be replaced.*



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



Check the cylinder head for warpage



Valve guide cleaner

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.

RESURFACING

This procedure should be performed only by a machine shop.

Valves and Springs

REMOVAL AND INSTALLATION

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

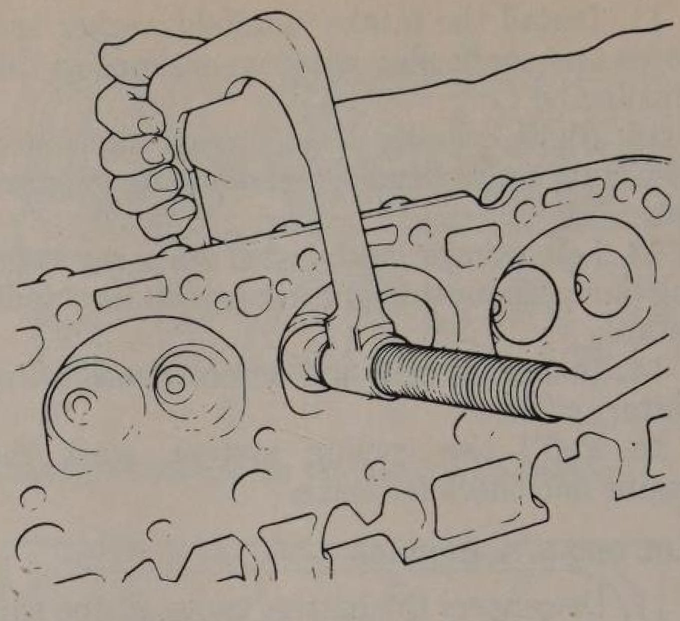
Using an appropriate valve spring compressor, compress the valve springs. Lift out the keepers with needle nosed pliers, release the compressor, and remove the valve, spring, and spring retainer. Clean the valve stem with lacquer thinner or a similar solvent to remove any gum and varnish. Clean the valve 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.

REFACING

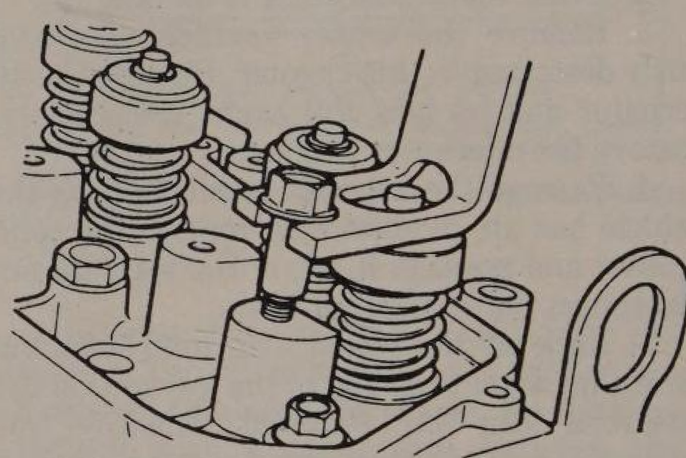
NOTE: *This procedure should only be performed by a qualified machine shop.*

CHECK SPRINGS

Place the spring on a flat surface nest 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 1.5mm ($^1\!/_{16}$ in.), or, if distortion exceeds 1.5mm ($^1\!/_{16}$ in.), replace the spring.



Compressing valve spring – typical



Compressing valve springs

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.

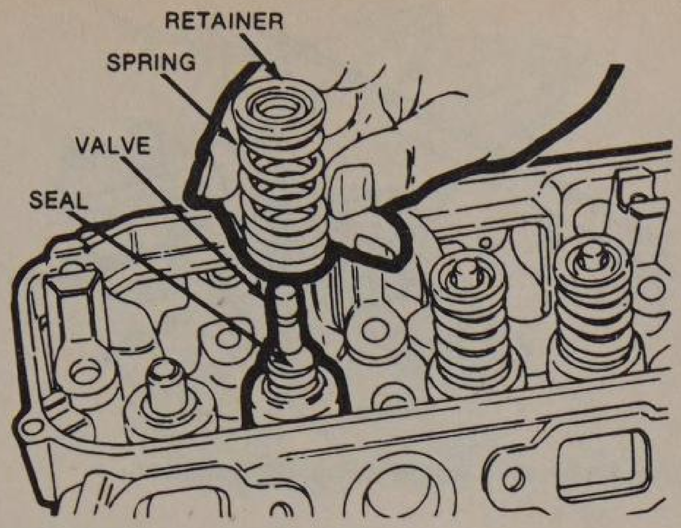
Valve Guides

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.*

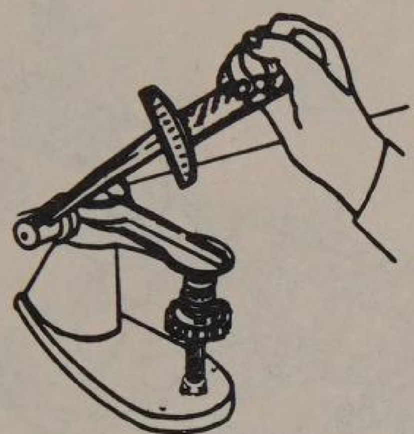
KNURLING

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.



Install valve stem seals



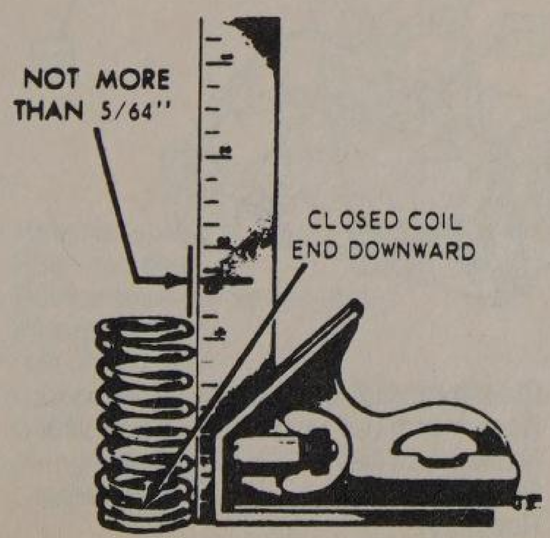
Check the valve spring test pressure

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



Check the valve spring free length and squareness

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 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.

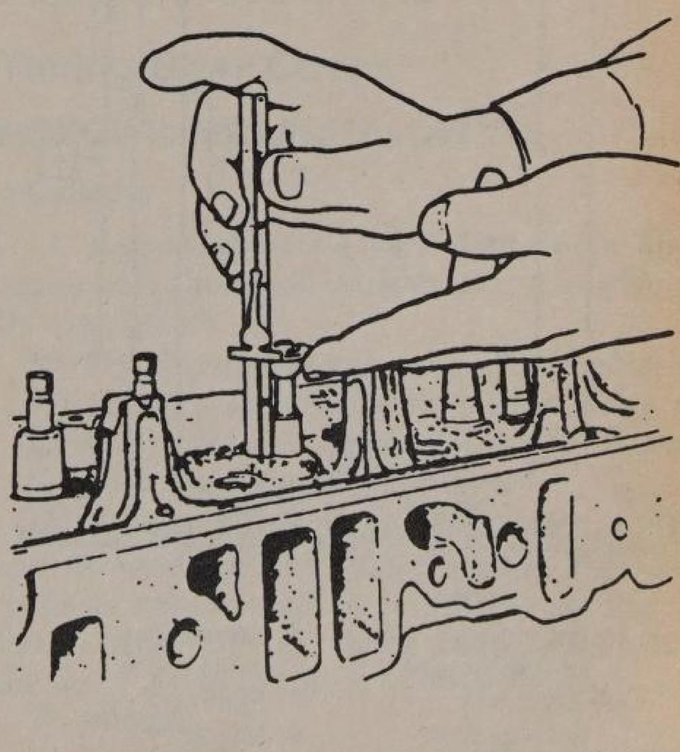
NOTE: *Valve lapping can also be done by fastening a suction cup to a piece of drill rod in a hand "eggbeater" type drill. Proceed as above, using the drill as a lapping tool. Due to the higher speeds involved when using the hand drill, care must be exercised to avoid grooving the seat. Lift the tool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

Valve Lifters

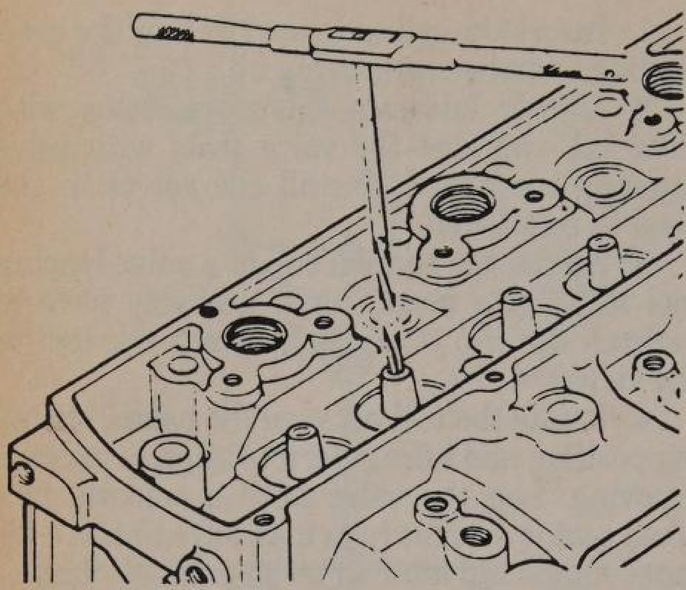
REMOVAL AND INSTALLATION

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

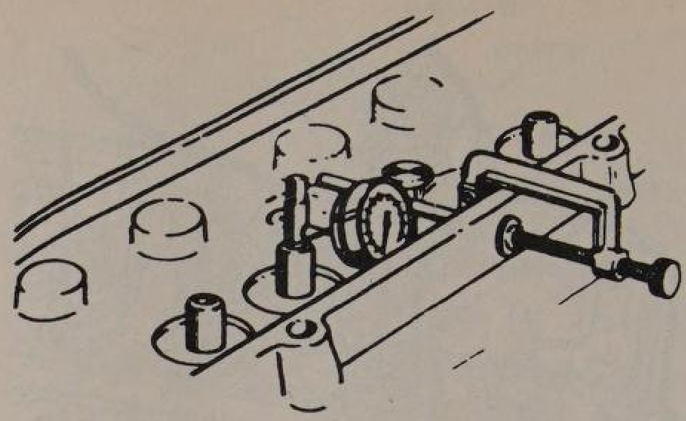
NOTE: *Late model engines are equipped with roller lifters. The basic assembly is the same as the conventional lifter except for the cam roller to prevent the lifters from rotating in the lifter bore. Remove the lifter retainer*



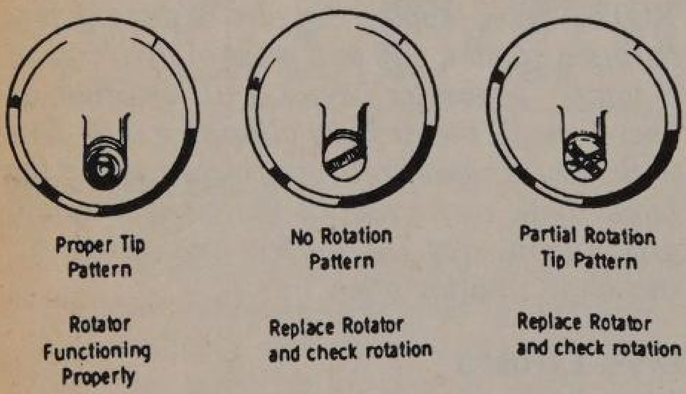
Checking valve spring installed height



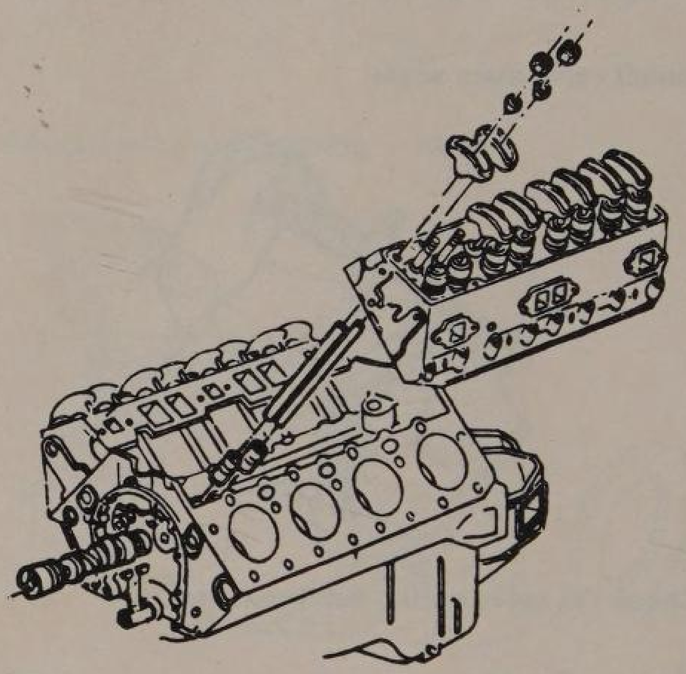
Reaming valve guides



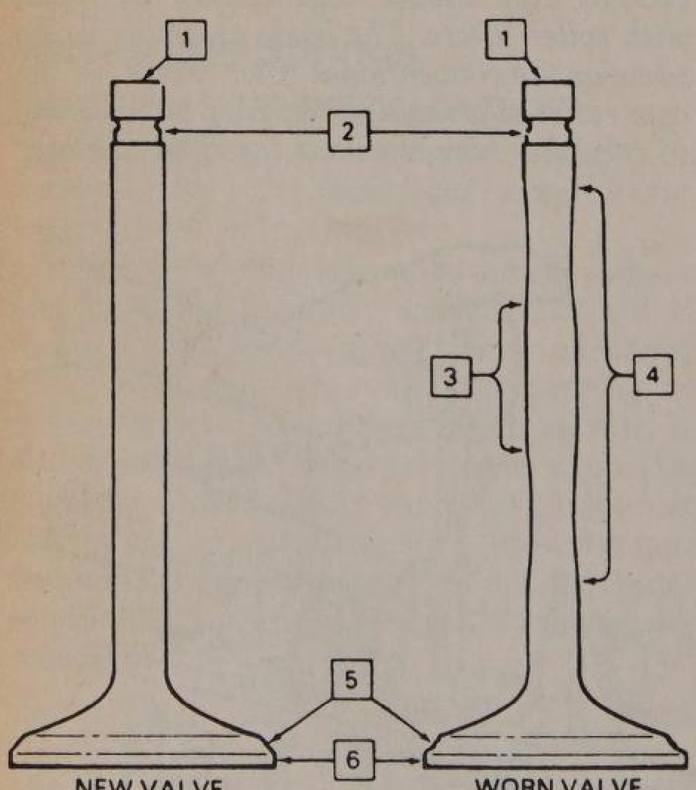
Checking valve guide with dial indicator



Checking damaged valve tips

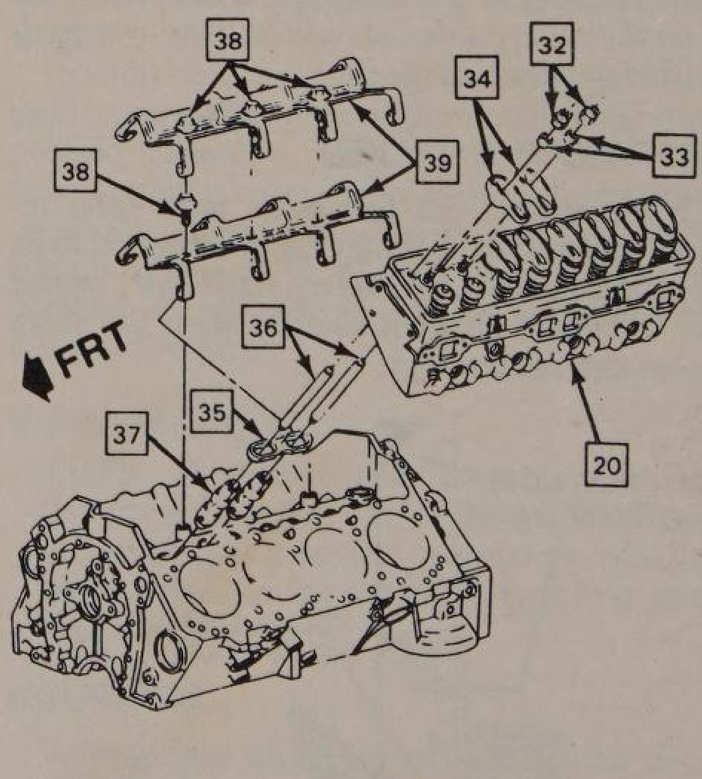


View of V8 valve lifters



1. Valve tip
2. keeper groove
3. Stem least worn section
4. Stem most worn section
5. Face
6. Margin

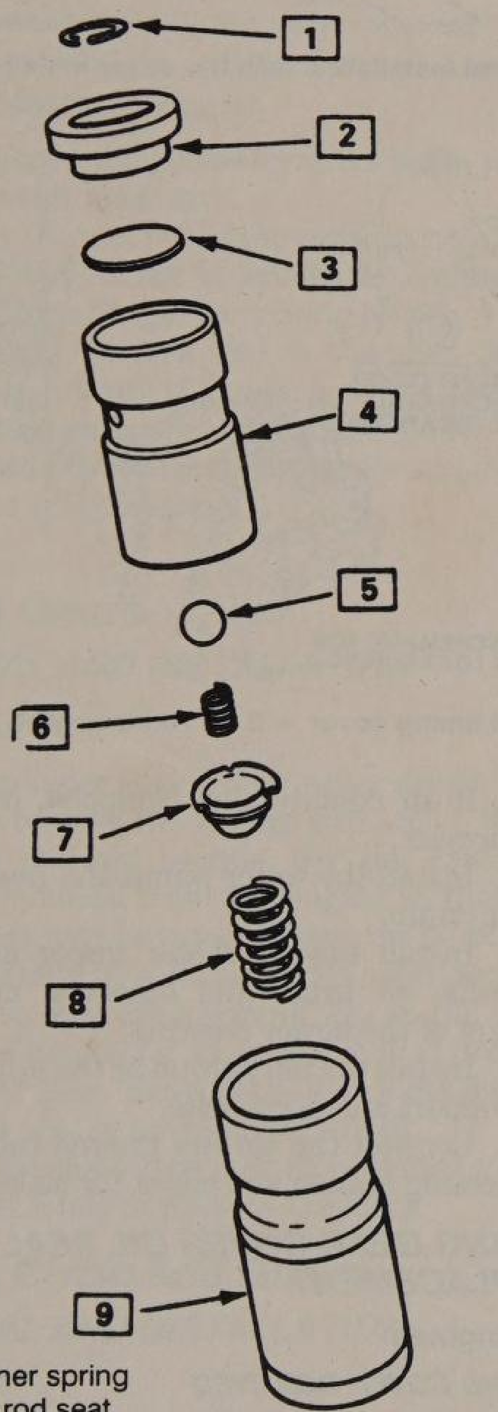
Valve wear indication



20. Cylinder head
32. Rocker arm nut
33. Rocker arm ball
34. Rocker arm
35. Restrictor
36. Pushrod
37. Valve lifter
38. Bolt
39. Retainer

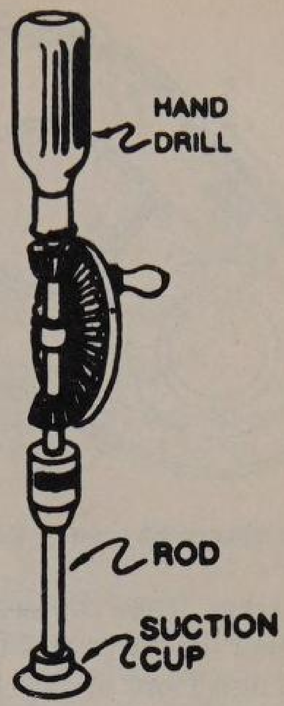
Roller valve lifter — late model engines

Lapping the valves by hand



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



Home made valve iapping tool

and restrictor before removing the lifter assembly.

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 3mm (1/8 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 and pushrods into the engine in their original position.

5. Install the rocker arms and adjust the valves. Install the lifter retainer and restrictors if equipped with roller lifters.

Timing Gear Cover

REMOVAL AND INSTALLATION

4-Cylinder

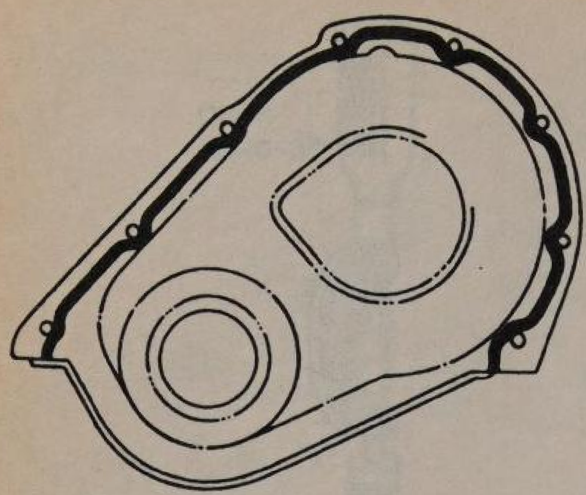
1. Remove the drive belts. Remove the hub center bolt, then slide the hub and pulleys from the crankshaft.

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.

To install:

3. Remove the front cover and clean any por-



Apply sealer to darkened area — 2.5L L4 engine

tion 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. Install the cover and align with a front cover centering tool. Torque the cover bolts to 90 inch lbs. (10 Nm).

V6 and V8

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. Do NOT disconnect fluid lines.

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 air conditioning equipped, remove the compressor and move aside. Remove the compressor mounting bracket. Move the compressor out of the way without disconnecting the refrigerant lines.

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

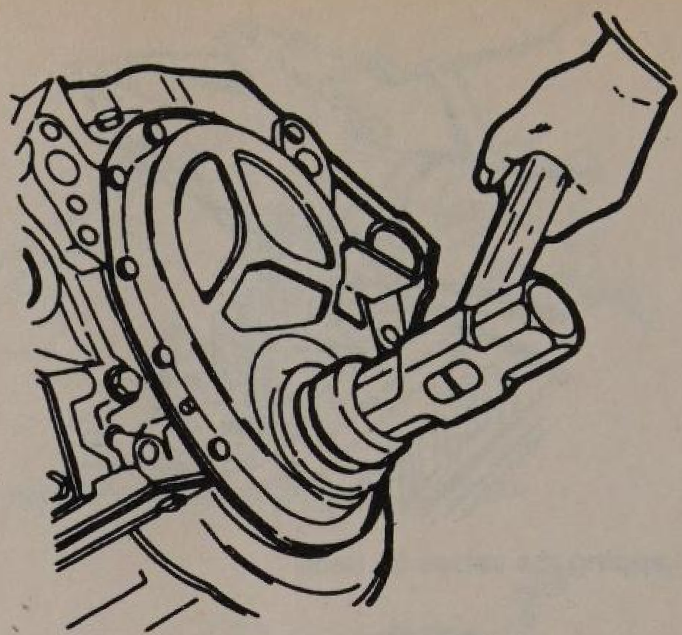
7. Remove the timing gear cover bolts and the timing gear cover.

To install:

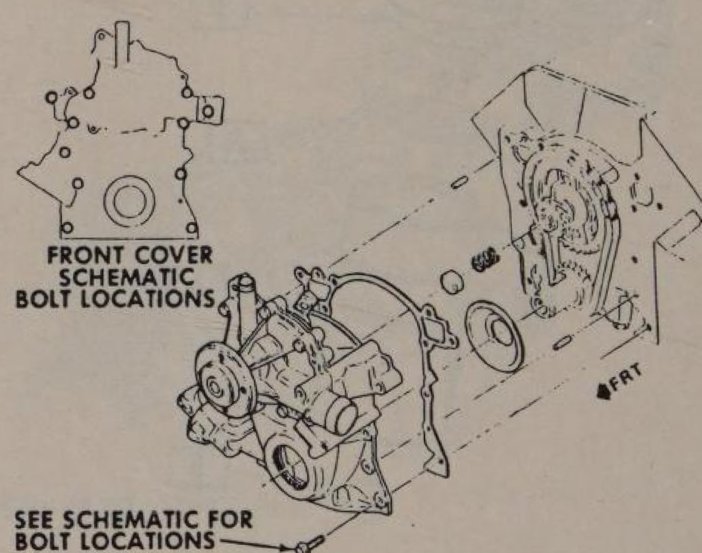
NOTE: *With the timing gear cover removed, use a large screwdriver to pry the oil seal from the cover. To install the new oil seal, lubricate it with engine oil and drive it into place.*

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

2. Install the damper pulley and retaining bolt. Torque to specifications.



Oil seal installation with the cover installed



Front timing cover — 3.8L Turbo engine

3. If air conditioning equipped, install the compressor.

4. Install the water pump and hoses to the water pump.

5. Install the alternator upper and lower brackets, air brace and brackets, and lower bracket of the power steering.

6. Install the fan shroud or the upper radiator support and drive belts.

7. Connect the battery ground cable. Refill the cooling system and check for leaks.

TIMING GEAR COVER OIL SEAL REPLACEMENT

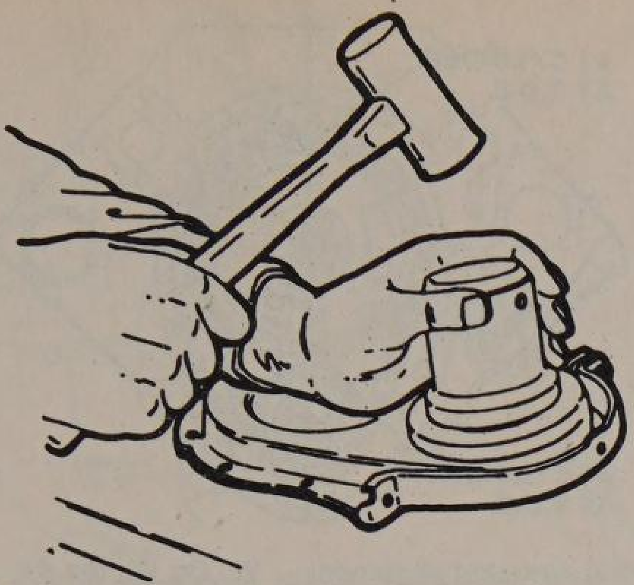
All Engines

TIMING COVER REMOVED

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

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.



Oil seal installation with the cover removed

TIMING COVER INSTALLED

1. Remove the accessory drive belts, pulley and harmonic balancer.

2. Pry the seal out of the cover using a large prybar. Be careful not to damage the sealing surface on the crankshaft or timing cover.

3. Install the new seal so the open end of the seal is toward the engine. Drive the seal into position with a seal installer J-35468.

4. Install the harmonic balancer and torque the bolt to specifications.

Timing Gears

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 Chain and Gears

REMOVAL AND INSTALLATION

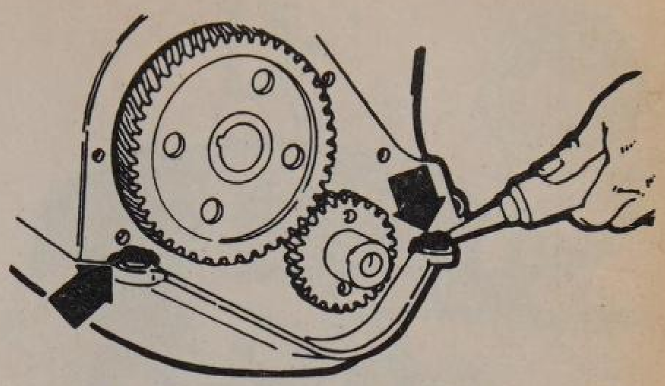
V6 and V8

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 as follows:

a. All engines, place the No. 1 piston at TDC with the marks on the camshaft sprocket at 6 o'clock and the crankshaft sprocket at 12 o'clock.

b. Make sure the No. 1 cylinder is on the compression stroke with both valves closed.



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

2. Remove the bolts holding the camshaft sprocket to the camshaft. Pull the camshaft sprocket forward. Remove the thrust button and spring on the 3.8L engine.

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. Remove the crankshaft gear using a gear puller. Make sure the keyway does not fall into the oil pan.

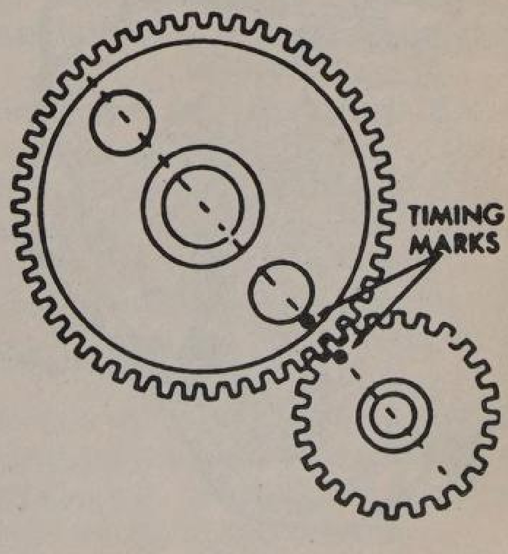
To install:

1. Install the crankshaft gear about $^1/_2$ in. from the crankshaft stop.

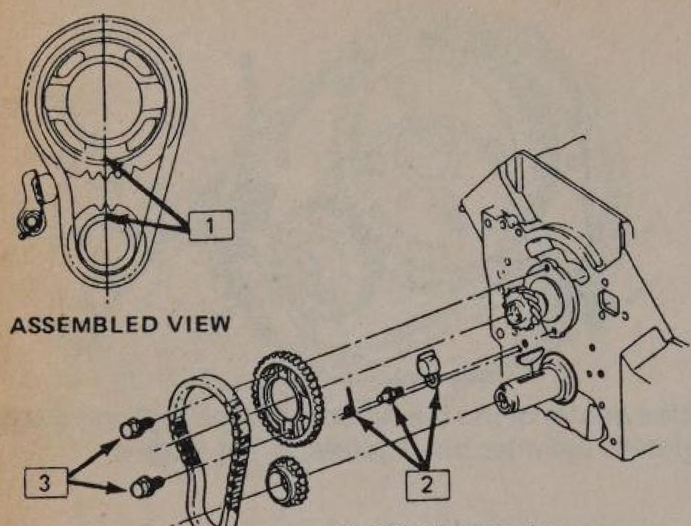
2. Position the chain onto the cam gear and slide the chain and cam gear onto the crank gear and camshaft, keeping the timing marks aligned at all times.

3. Install the camshaft gear retaining bolts and tighten. Install the thrust button and spring for the 3.8L engine.

4. Turn the crankshaft over two revolutions with the crankshaft bolt to check to see if the timing marks are perfectly aligned. If not, remove the cam gear and realign.

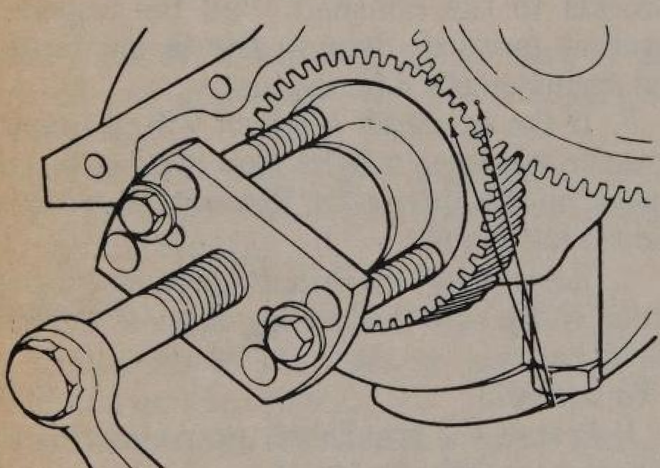


Timing gear alignment inline 4 cylinder



1. Timing marks
2. Damper assembly
3. 31 ft. lbs. (42 Nm)

Timing chain and gear alignment — 3.8L Turbo engine

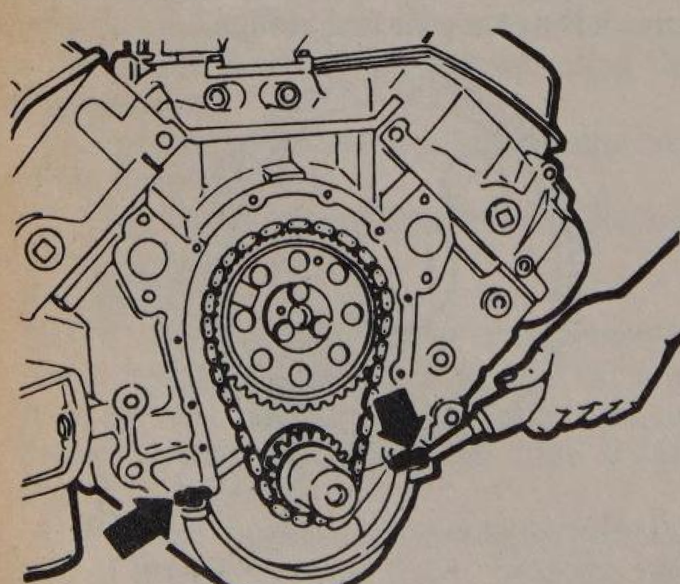


The inline 4-cylinder crankshaft gear is removed with a gear plier

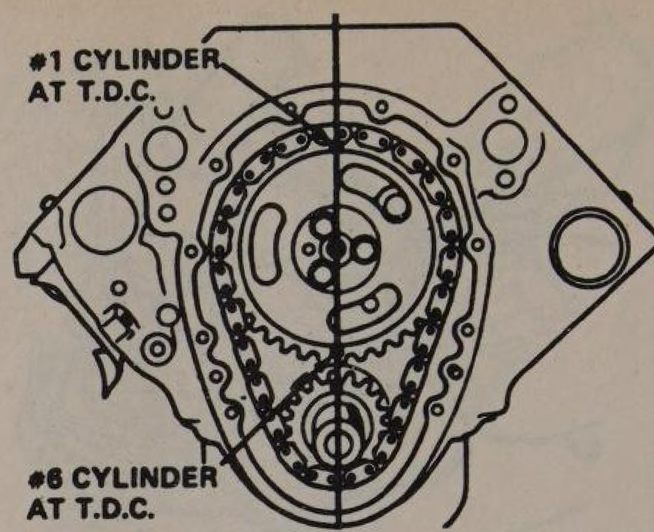
Crankshaft Sprocket

REMOVAL AND INSTALLATION

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



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



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

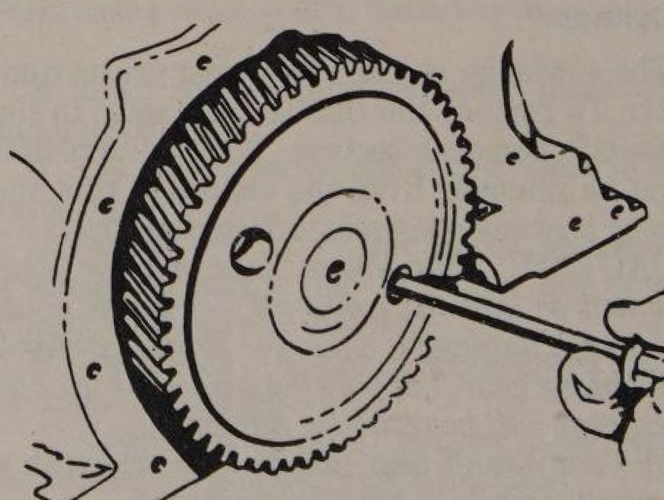
2. Using a wheel puller, remove the crankshaft sprocket.
3. To install, pay attention to the position of the woodruff key. Slide the sprocket onto the crankshaft. Install the oil slinger.

Camshaft and Bearings

REMOVAL AND INSTALLATION

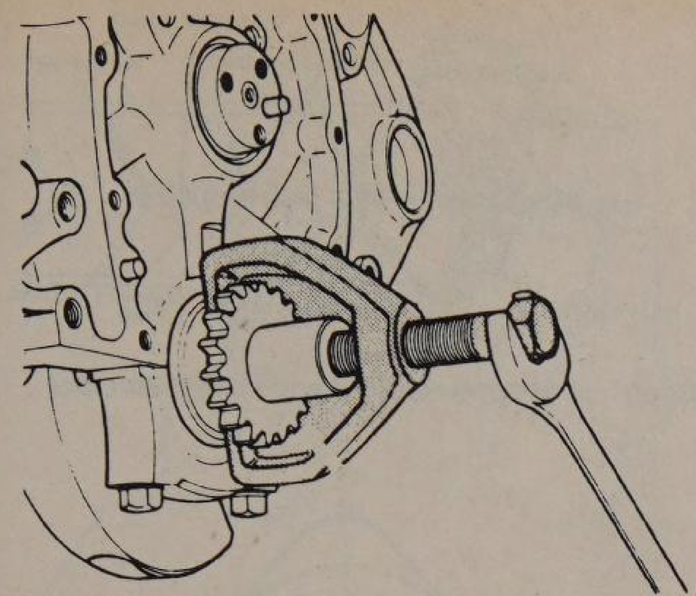
4-Cylinder

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.



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

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



V6 and V8 crankshaft sprocket removal

pump pulley. Remove the valve cover. Loosen the rocker arms and pivot them, then remove the push rods.

3. Remove the oil pump driveshaft and gear assembly. Remove the spark plugs.

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

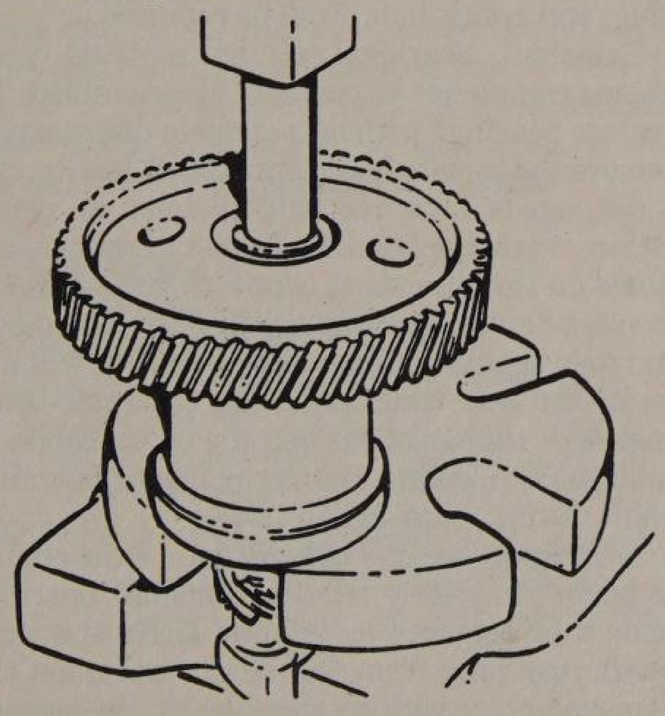
5. Remove the valve lifters. Refer to the Timing Gear Cover Removal and Installation section in this chapter and remove the timing gear cover.

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

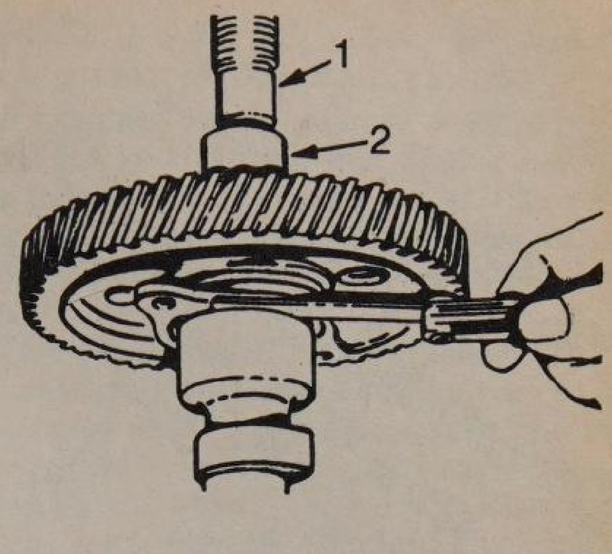
7. Pull the camshaft and gear assembly out through the front of the engine block.

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.



Pressing the timing gear from the camshaft — 4 cylinder



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

CAUTION: *When removing the timing gear from the camshaft, the thrust plate must be positioned so that the woodruff key does not damage it.*

To install:

1. To install the timing gear to the camshaft, press the assembly together and measure the end clearance which should be 0.038–0.127mm (0.0015-0.0050 in.) between the thrust plate and the camshaft.

NOTE: *If the clearance is less that 0.038mm (0.0015 in.), replace the space ring; if more that 0.127mm (0.0050 in.), replace the thrust ring.*

2. 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.

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

4. Install the valve lifters. Refer to the Timing Gear Cover Removal and Installation section in this chapter and install the timing gear cover.

5. Install the oil pump driveshaft and gear assembly. Install the spark plugs.

6. Install the distributor to the original position.

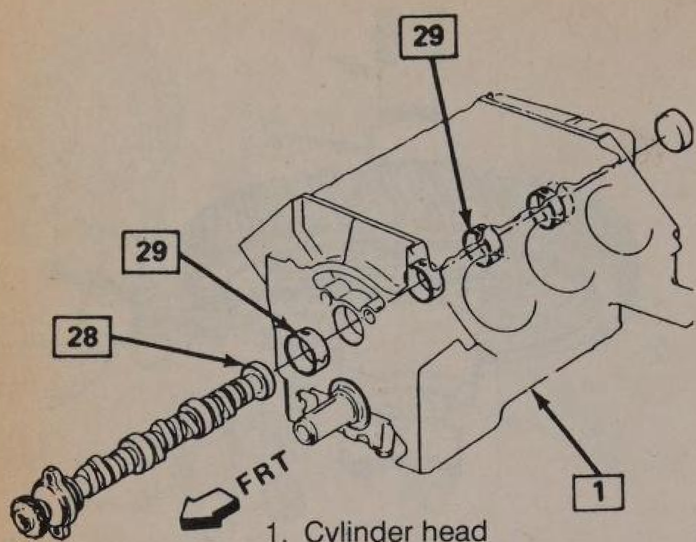
7. Install the fan, drive belts and water pump pulley. Install the pushrods, rocker arms and tighten the rocker arms to 20 ft. lbs. (27 Nm). Install the valve cover.

8. Install the radiator and shroud if removed. Refill the crankcase and the radiator.

V6 and V8

1. Disconnect the negative (–) battery cable. 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 sec-



1. Cylinder head
28. Camshaft
29. Camshaft bearing

Camshaft and bearings — 3.8L Turbo, V6 and V8 engines similar

tions 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.

NOTE: *Remove the roller lifter retainer and restrictors on engines equipped with hydraulic roller lifters.*

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

5. Use long bolts threaded into the camshaft gear holes to help slide the camshaft toward the front of the engine (be careful not to damage the camshaft bearings).

To install:

1. Lubricate bearings, lobes and journals with Assembly Lube or equivalent before installing.

2. Install the timing chain and gears as outlined in the Timing Chain and Sprocket Removal and Installation section in this chapter.

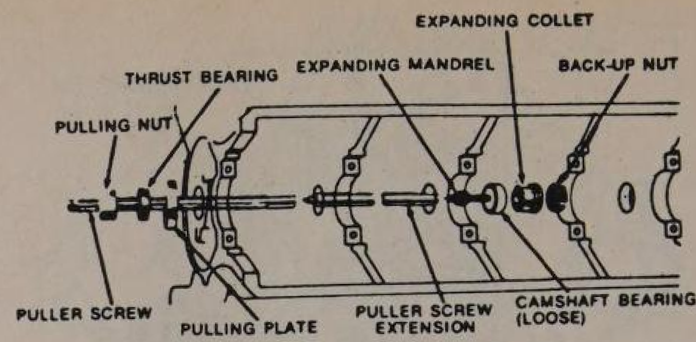
3. Install the distributor to the original position. Install the fuel pump and fuel pump push rod, if so equipped.

4. Install the lifters, pushrods and rocker arms. Adjust the valve as outlined in this chapter under Rocker Arm Removal and Installation. Install the intake manifold and valve covers.

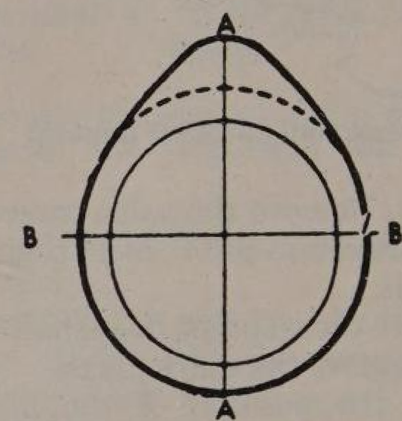
5. Install the timing gear, chain and cover.

6. Connect the negative (–) battery cable. Install the radiator by referring to the Radiator Removal and Installation section in this chapter.

7. Refill the cooling system and check for leaks.



Camshaft bearing removal and installation tool



Camshaft lobe measurement

CAMSHAFT BEARING REMOVAL AND INSTALLATION

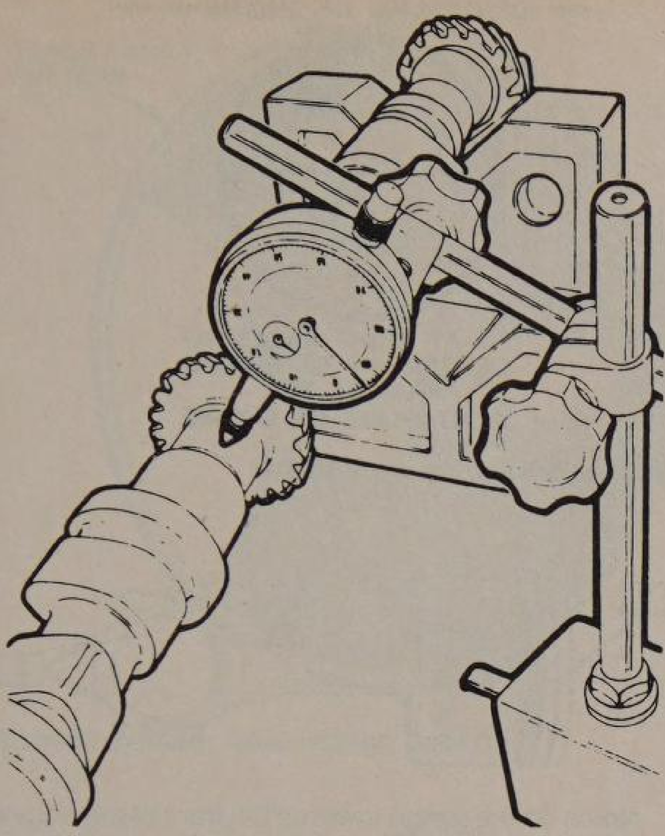
NOTE: *It is recommended that the engine be removed from the vehicle before attempting this procedure. The camshaft, lifters, flywheel and the expansion plug (at the rear of the camshaft) must be removed. Drive the expansion plug out from the inside of the engine block.*

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, install rubber fuel hoses on the 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. Use rubber bands and the oil pan bolts to hold the connecting rods away from the crankshaft during removal.

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



Check the camshaft for straightness

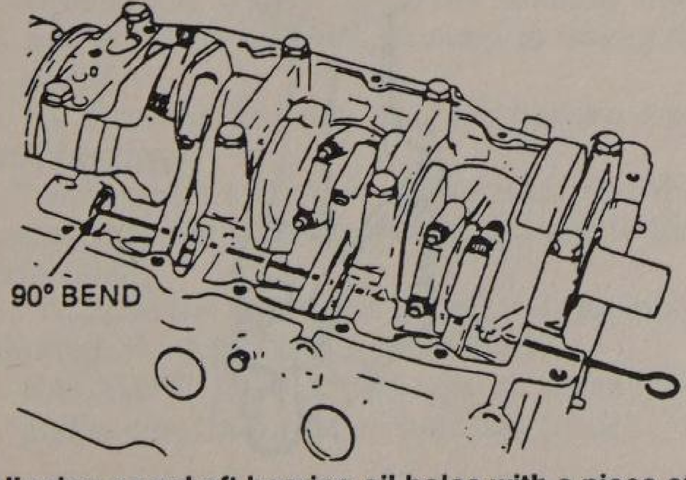
bearings, leaving the front and rear for last. To remove front and rear bearings, reverse position of the tool, so as to pull the bearings in toward the center of the block. Leave the tool in this position, pilot the new front and rear bearings on the installer, and pull them into position: Return the 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.



Aligning camshaft bearing oil holes with a piece of wire bent at a 90° angle. The holes MUST be in alignment

NOTE: *If a journal is worn, there is a good change that the bearings 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 0.025mm (0.001 in.) 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

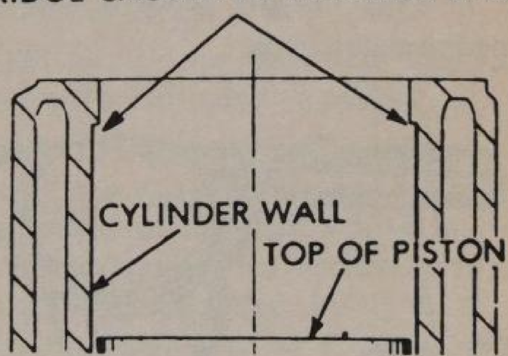
REMOVAL

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

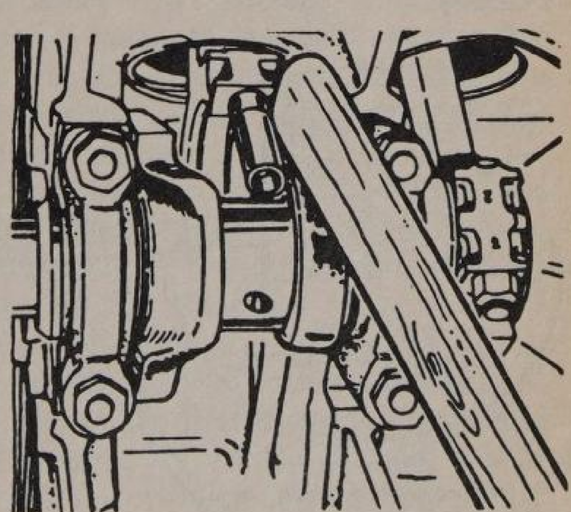
Cylinder bore ridge

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

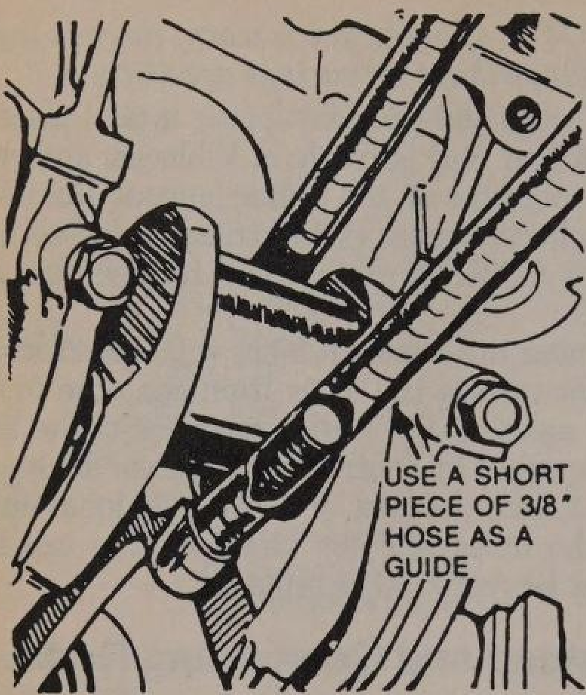
1. Remove the cylinder head(s), intake manifold, exhaust manifold, oil pan, and oil pump as outlined in this chapter.



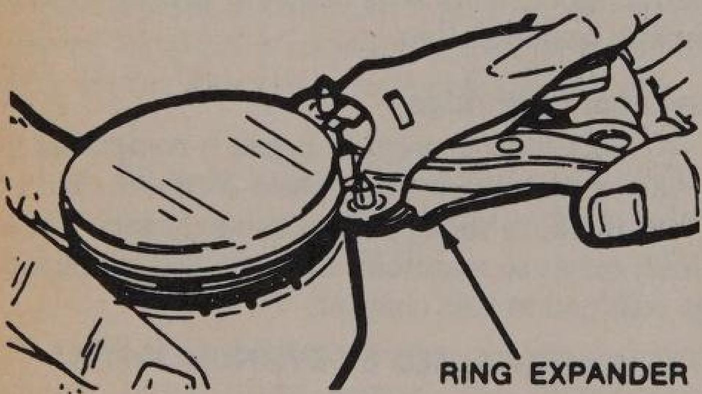
Cylinder bore ridge



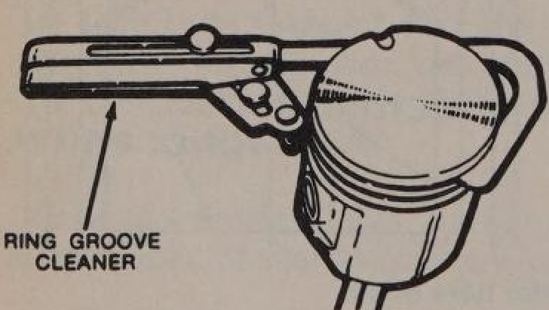
Push the piston out with a hammer handle



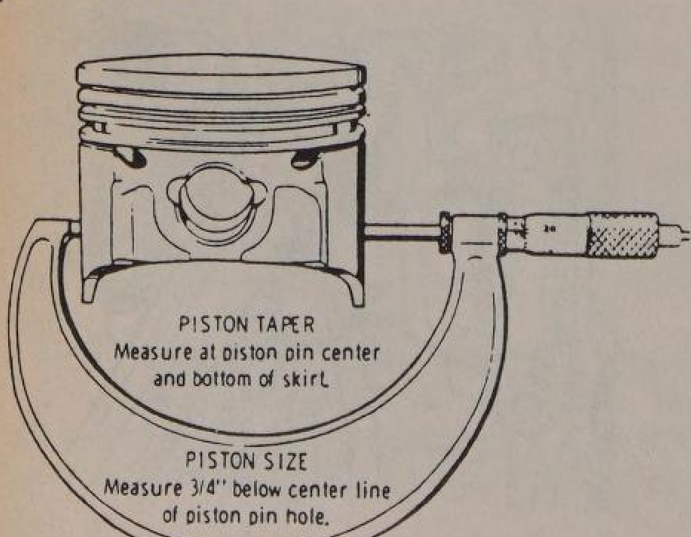
Use lengths of vacuum hose or rubber tubing to protect the crankshaft journals and cylinder walls during piston installation



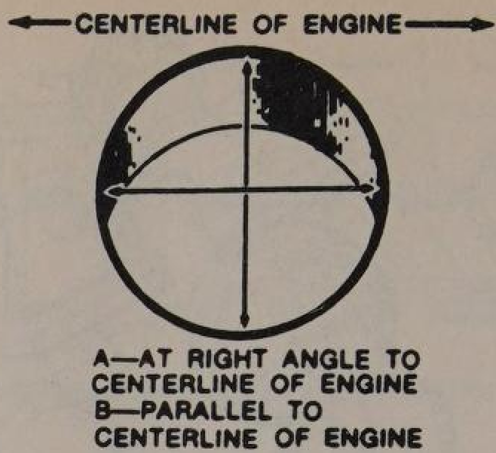
Removing the piston rings



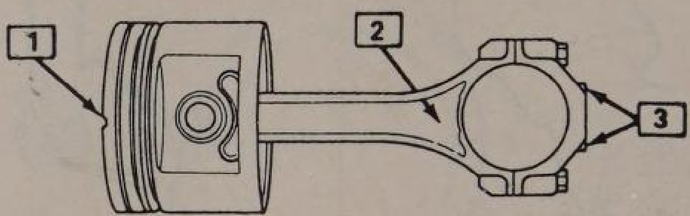
Cleaning the piston ring grooves using a ring groove cleaner



Piston skirt measurement

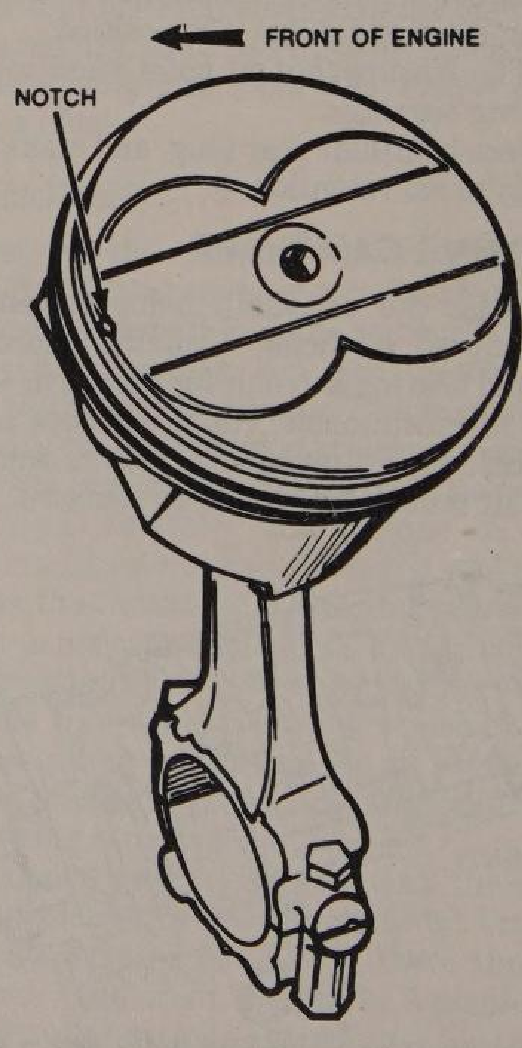


Cylinder bore measuring points

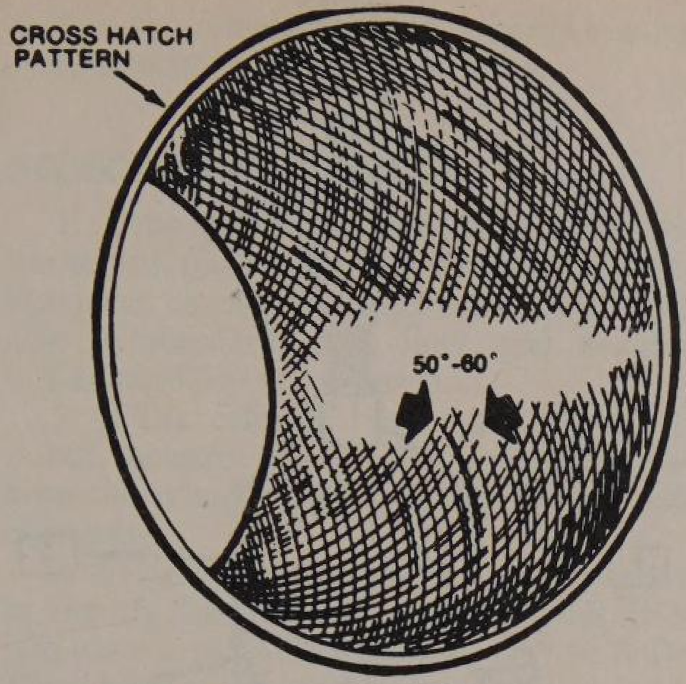


1. Notch on the piston towards the front of the engine
2. Left bank: No. 1, 3 and 5, two bosses on the rod towards rear of engine
3. Chamfered corners on the rod cap towards front of engine
2. Right bank: No. 2, 4 and 6, two bosses on the rod towards front of engine
3. Chamfered corners on the rod cap towards rear of engine

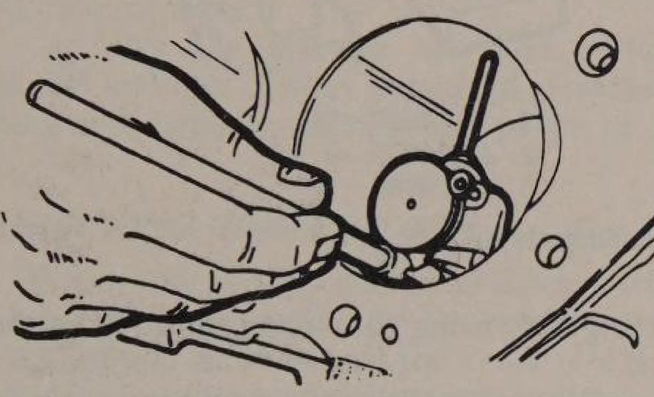
Piston positioning references — 3.8L Turbo engine



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



Correct cylinder bore honing pattern



Measuring the cylinder bore with a dial gauge

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.

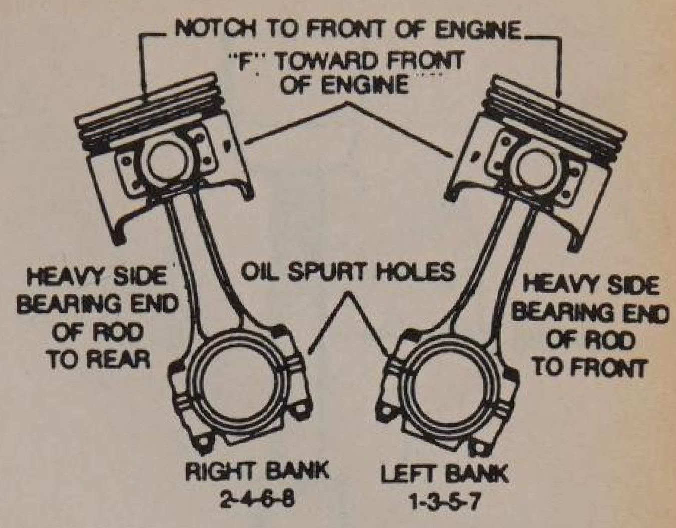
4. Install a section of rubber hose over the connecting rod bolts to prevent damage to the crankshaft.

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



Small block V8 piston-to-rod relationship

CLEANING AND INSPECTING

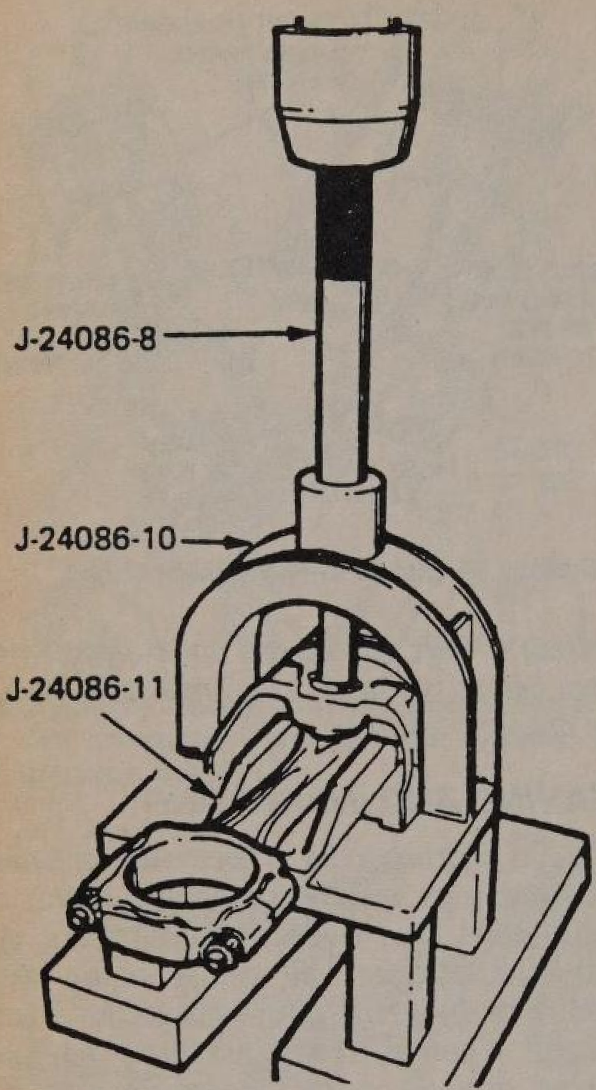
A piston ring expander is necessary for removing piston rings without damaging them; any other method (screwdriver blades, pliers, etc.) usually results in the rings being bent, scratched or distorted, or the piston itself being damaged. When the rings are removed, clean the ring grooves using an appropriate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

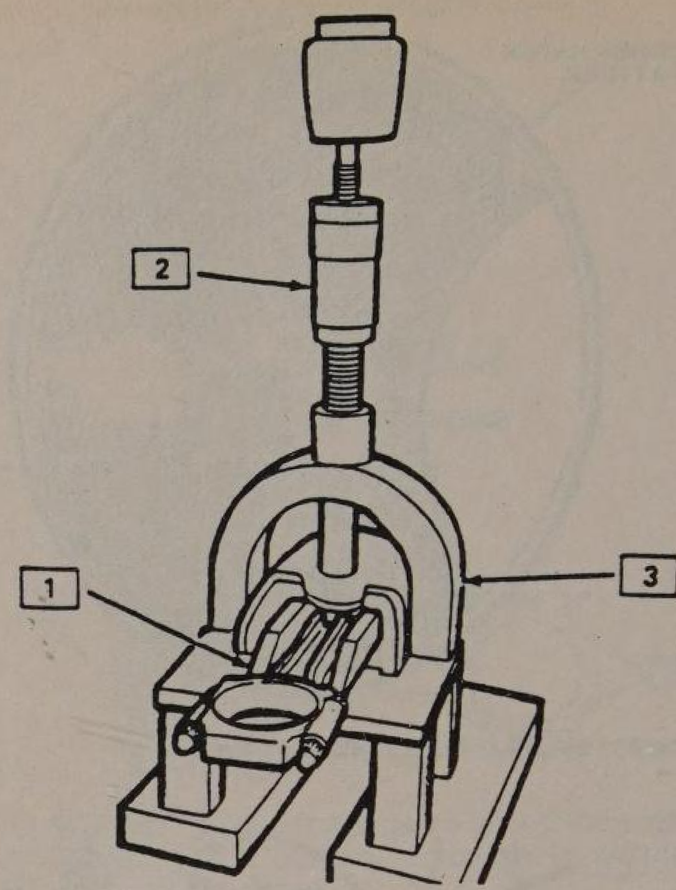
Inspect the pistons for scuffing, scoring, cracks, pitting, or excessive ring groove wear. If these are evident, the piston must be replaced.

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, 64mm ($2^1/2$ 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 between 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 0.127mm (0.005 in.) or more or is out-of-round 0.076mm (0.003 in.) or more, it is advisable to rebore for the smallest possible oversize piston and rings.



Removing piston pin



1. J–24086–11
2. J–24086–9
3. J–24086–16

Installing piston pin

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.*

PISTON PIN REMOVAL AND INSTALLATION

Use care at all times when handling and servicing connecting rods and pistons. To prevent possible damage to these units, do not clamp the rod or piston in a vise since they may become distorted. Do not allow the pistons to strike against one another, against hard objects or bench surfaces, since distortion of the piston contour or nicks in the soft aluminum material may result.

1. Remove the piston rings using a suitable piston ring remover.
2. Install the guide bushing of the piston pin removing and installing tool.
3. Install the piston and connecting rod assembly on a support, and place the assembly in an arbor press. Press the pin out of the connecting rod, using the appropriate piston pin tool.
4. When installing the new piston, apply clean engine oil to the pin and press in with a piston pin installing tool. Make sure the connecting rod moves freely without binding after pin is installed. If not, reaming the pin hole may have to be performed.

MEASURING THE OLD PISTONS

Check used piston-to-cylinder bore clearance as follows:

1. Measure the cylinder bore diameter with a telescope gauge.
2. Measure the piston diameter. When measuring the pistons for size or taper, measurements must be made with the piston pin removed.
3. Subtract the piston diameter from the cylinder bore diameter to determine piston-to-bore clearance.
4. Compare the piston-to-bore clearances obtained with those clearances recommended in the "Piston and Connecting Rod" chart in the beginning of this chapter. Determine if the piston-to-bore clearance is in the acceptable range.
5. When measuring taper, the largest reading must be at the bottom of the skirt.
6. If the measurement is not within specifi-

cations, the cylinders should be bored and new oversize pistons should be installed.

SELECTING NEW PISTONS

1. If the used piston is not acceptable, check the service piston size and determine if a new piston can be selected. (Service pistons are available in standard, high limit and standard 0.254mm (0.010 in.) oversize.).

2. If the cylinder bore must be reconditioned, measure the new piston diameter, then hone the cylinder bore to obtain the preferred clearance.

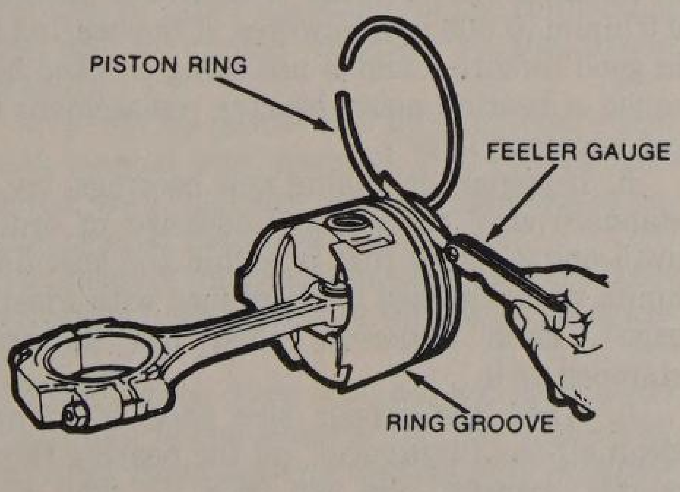
3. Select a new piston and mark the piston to identify the cylinder for which it was fitted. (On some cars, oversize pistons may be found. These pistons will be 0.254mm (0.010 in.) oversize). After market piston manufactures supply oversized pistons 0.030 in., 0.040 in., and 0.060 in. in most cases.

4. After the cylinder has been reconditioned and new pistons purchased, remeasure bore and piston to ensure proper piston fit.

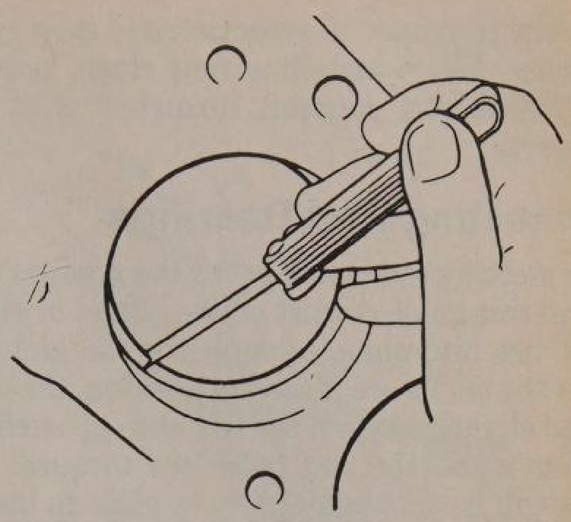
CHECKING RING END GAP

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 50mm (2 in.) of cylinder wall are coated. Using an inverted piston, press the rings approximately 25mm (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.



Check the piston ring side clearance



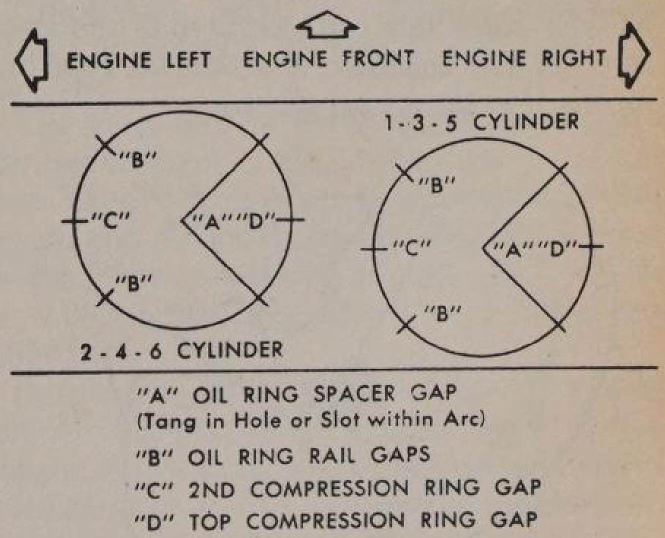
Check the piston ring end gap

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



Locating the 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.

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.

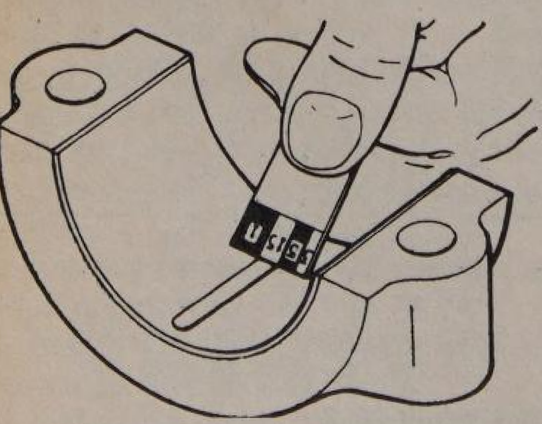
CAUTION: *Under no circumstances should the rod end or cap be filed to adjust the bearing clearance, nor should shims of any kind be used.*

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.

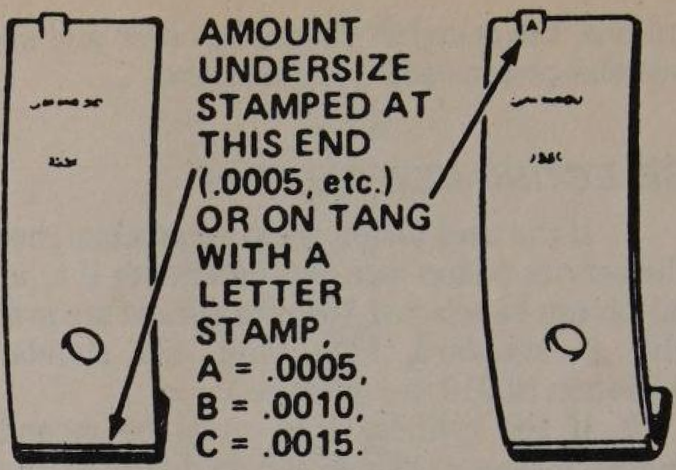
NOTE: *If journals are deeply scored or ridged the crankshaft must be replaced, as regrinding will reduce the durability of the crankshaft*

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.*



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

Replacement bearings are available in standard size, and in undersizes for reground 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 0.025–0.080mm (0.001–0.003 in.).

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.
2. 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.
3. 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 hundreths of a millimeter (thousandths of an inch).
4. Check the specifications chart in this chapter for the desired clearance. It is advisable to install a new bearing if clearance exceeds 0.076mm (0.003 in.); however, if the bearing is in good condition and is not being checked because of bearing noise, bearing replacement is not necessary.
5. 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.
6. 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*

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

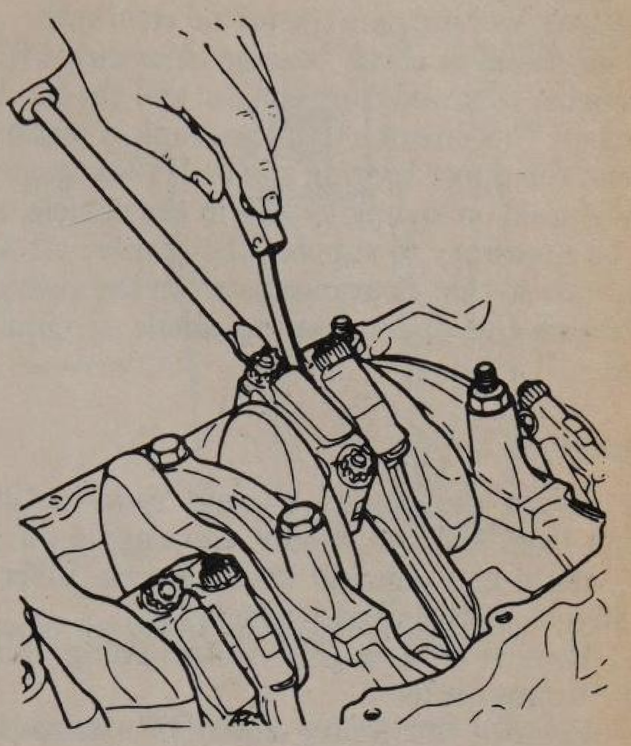
move the connecting rod back and forth freely on the crank journal as allowed by the specified connecting rod end clearance. If the rod cannot be moved, either the rod bearing is too far undersize or the rod is misaligned.

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 snaprings 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.
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(es).
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.

NOTE: *When more than one rod and piston assembly is being installed, the connecting rod cap attaching nut 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 assemblies.*



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

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.

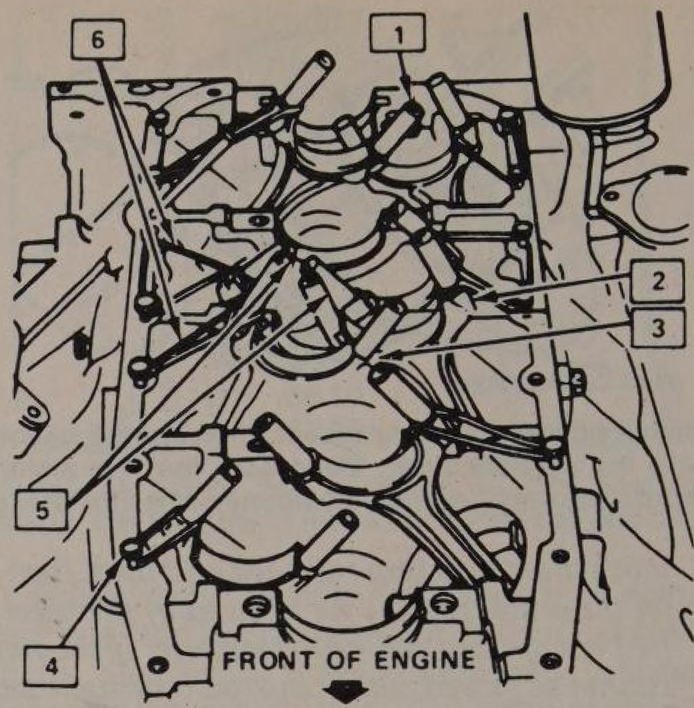
It is easiest to check bearing clearance with the engine removed from the car and the block inverted. This ensures that the crank is resting against the upper bearing shells. If Plastigage® is to be used on an engine still in the vehicle, it will be necessary to support the crankshaft at both ends so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

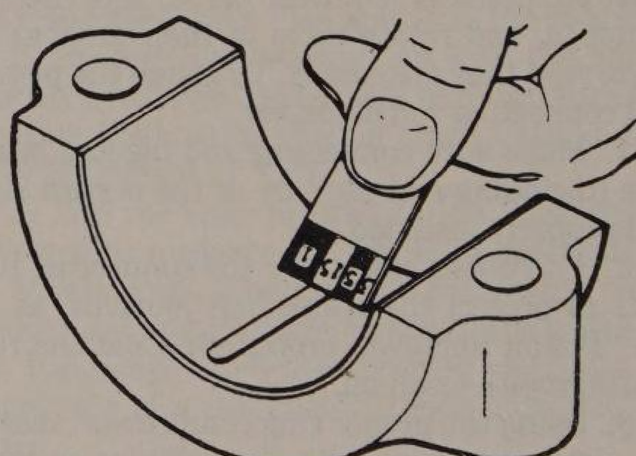
MAIN BEARING INSPECTION

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.



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



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

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®.

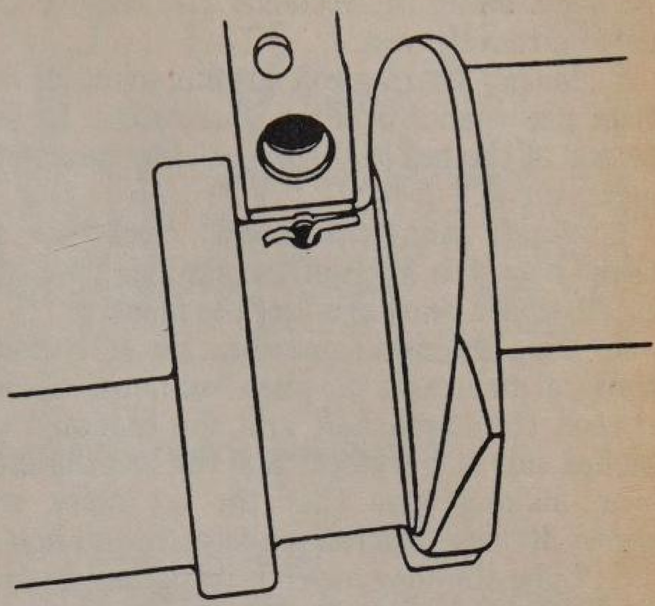
NOTE: *Crankshaft bearing caps and bearing shells should NEVER be filed flush with the cap-to-block mating surface to adjust for wear in the old bearings. Always install new bearings.*

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.*

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, 0.001 in. or 0.002 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.



Removing upper crankshaft bearing

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®.

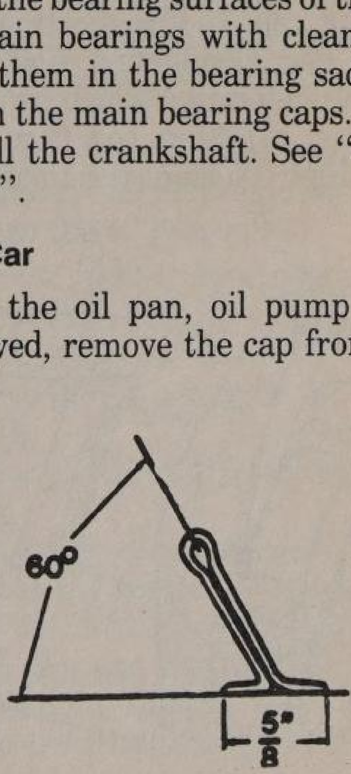
MAIN BEARING REPLACEMENT

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 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



Fabricate a roll-out pin as illustrated, if necessary

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 (un-notched) 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

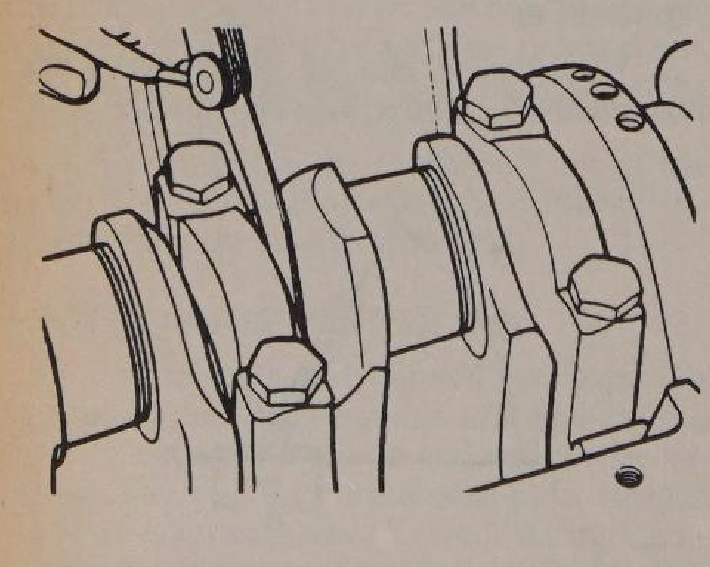
NOTE: *Regrinding rod and/or main bearing journals should be performed by a qualified machine shop.*

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.



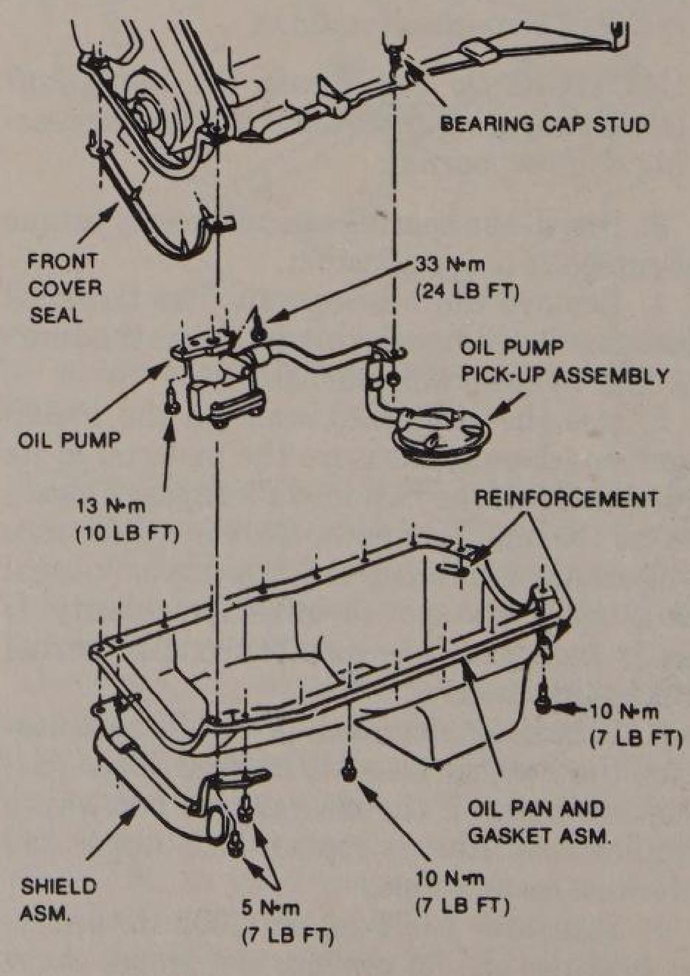
Torque the caps to specifications.

Oil Pan

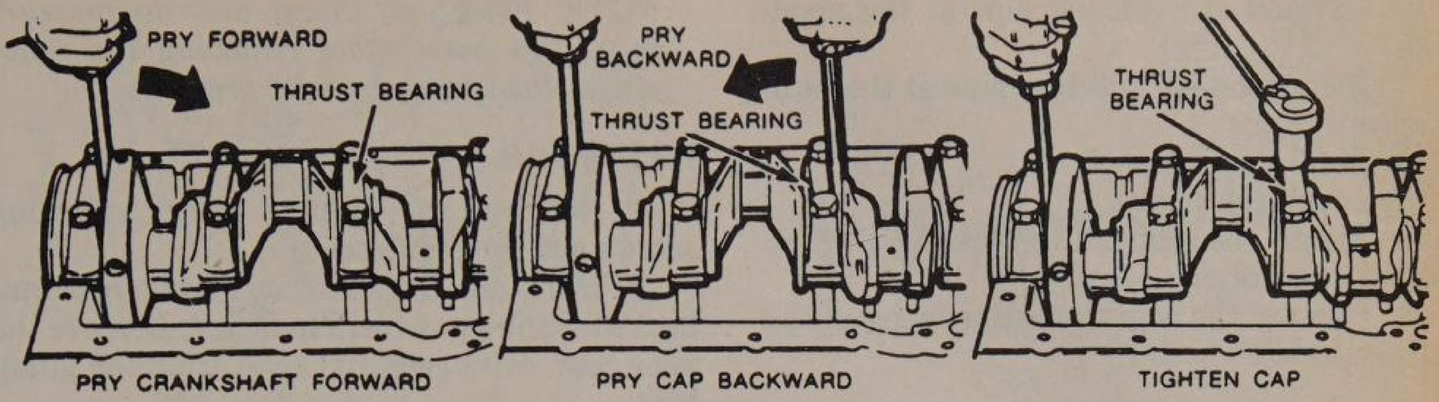
REMOVAL AND INSTALLATION

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.



Four cylinder oil pan and pump installation details

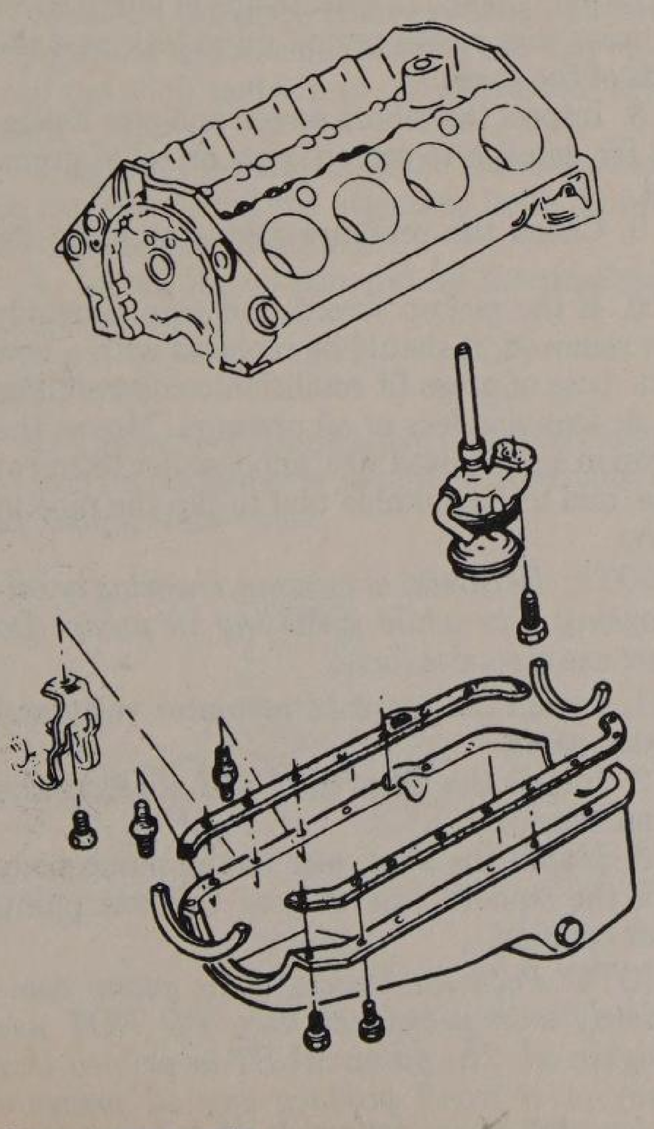


Align the thrust bearing as illustrated. Torque the caps to specifications.

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.

To install:

1. Clean all old RTV from the mating surfaces
2. 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.
3. Install the front gasket.
4. Install the side gaskets, using grease as a retainer. Apply a small amount of RTV where the side gaskets meet the front gasket.



Oil pan components

5. 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.*

6. Torque the oil pan bolts to 90 inch lbs. (10 Nm).

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.

To install:

1. Remove all old RTV from the oil pan and engine block.
2. Run a 3mm ($^1/_8$ in.) head of RTV around the oil pan sealing surface. Remember to keep the RTV on the INSIDE of the bolt holes.
3. Install the pan and torque the bolts to 72–130 inch lbs. (8–14 Nm).
4. Install the front engine mount through-bolts.
5. Install the starter bolts and brace.
6. Install the catalytic converter hanger

bolts. Connect the exhaust pipe at the manifold.

7. Install the air injection pipe at the catalytic convertor.

8. Refill the engine oil.

9. Lower the vehicle.

10. Install the distributor cap and the fan shroud assembly.

11. Connect the negative battery cable at the battery and air cleaner.

Oil Pump

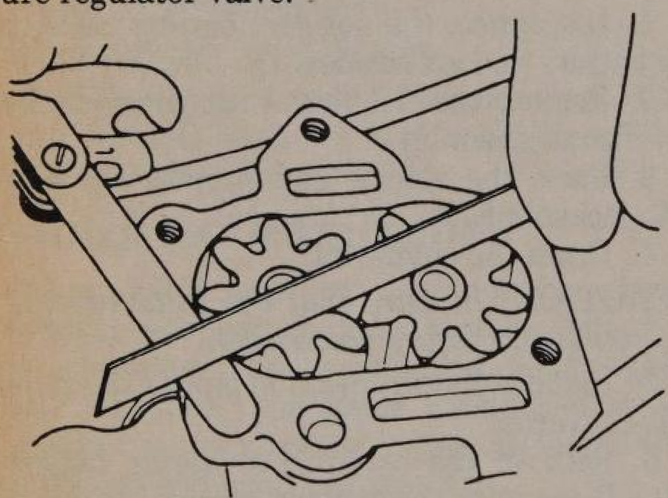
REMOVAL

Except 3.8L Turbo

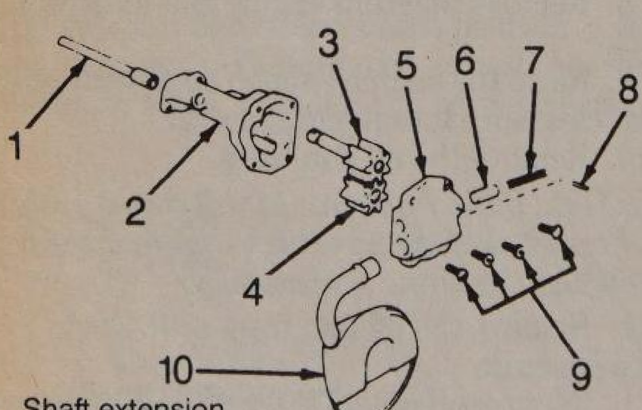
1. Drain and remove the oil pan.

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.



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



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

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.

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.

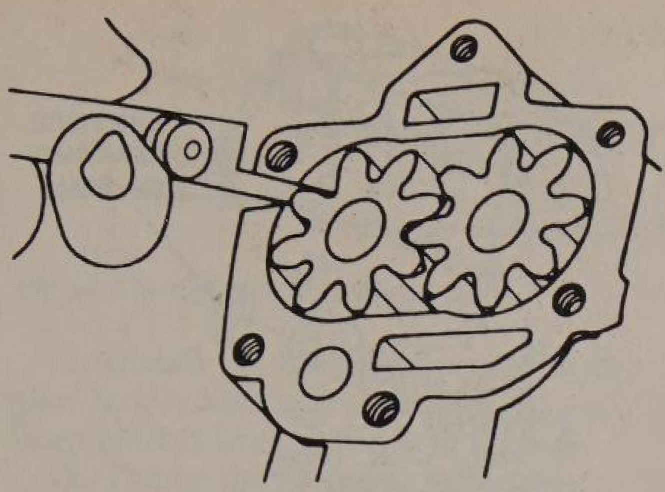
NOTE: *Be careful of twisting, shearing or collapsing pipe while installing in pump. Do not use excessive force.*

11. Install the pressure regulator valve and related parts.

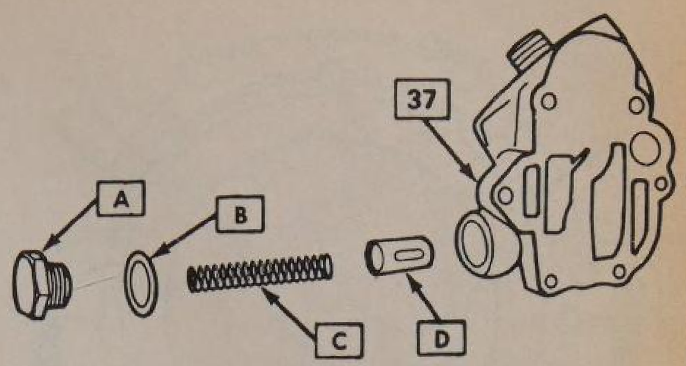
12. Install the drive gear and shaft in the pump body.

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.*



Removing the lower half of the rear main oil seal



Oil pump assembly – 3.8L Turbo engine

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.

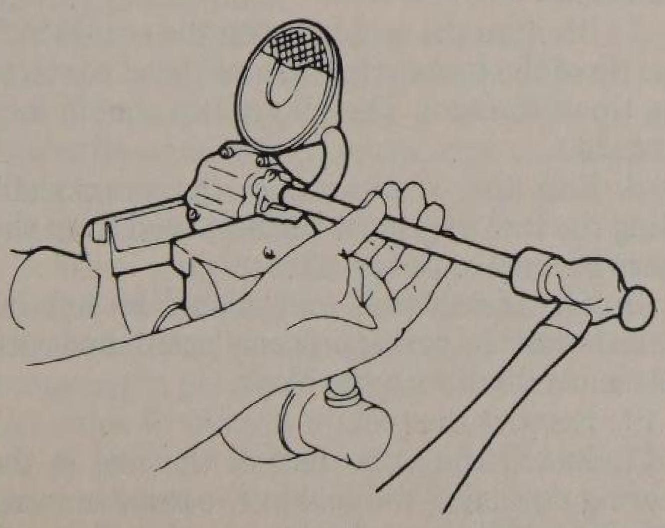
3. Install the pump onto the rear main bearing cap and install the attaching bolts. Torque the bolts to specifications.

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

3.8L Turbo

1. Disconnect the negative (–) battery cable.

2. The oil pump is mounted externally on the timing chain cover.



Install the oil pump screen by tapping lightly

3. Remove the oil filter.

4. Remove the pump cover-to-timing chain cover bolts.

5. Remove the pump cover, drive and driven gears.

6. Remove the oil pressure relief valve cap, spring and valve if necessary.

To install:

1. Clean all parts in solvent and blow dry with compressed air.

2. Lubricate the pressure relief valve with oil and install. Install the spring, gasket and valve cap.

NOTE: *The next step is important because the pump may lose its prime when the engine is started after the oil pump has been disturbed.*

3. Pack the gear pockets with petroleum jelly and install the drive, driven and pump cover.

4. Torque the cover bolts to 141 inch lbs. (16 Nm).

5. Install the oil filter full of engine oil.

6. Connect the negative battery cable.

7. Start the engine and check the oil pressure light or gauge. The oil pressure should be present in a few seconds. If not, stop the engine and restart the engine for a few seconds. The oil pressure should be present. If not, remove the oil pump and check for a potential problem.

Rear Main Oil Seal

REMOVAL AND INSTALLATION

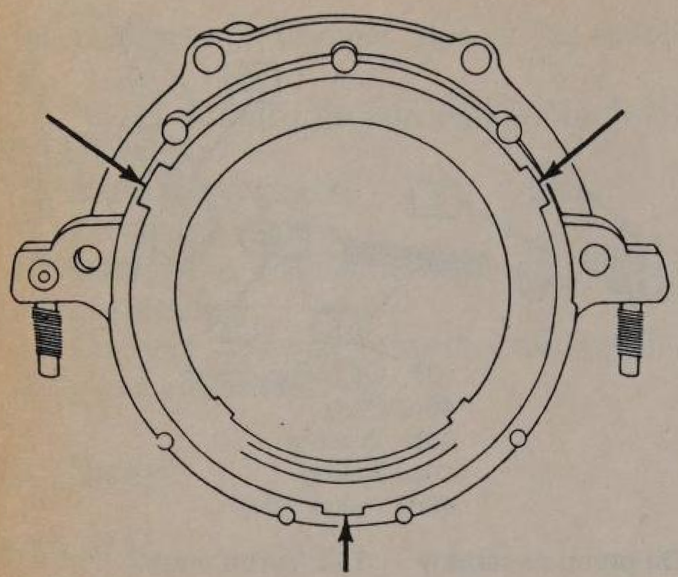
2.5L L4
1985-90 2.8L and 3.1L V6
1986-90 V8

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

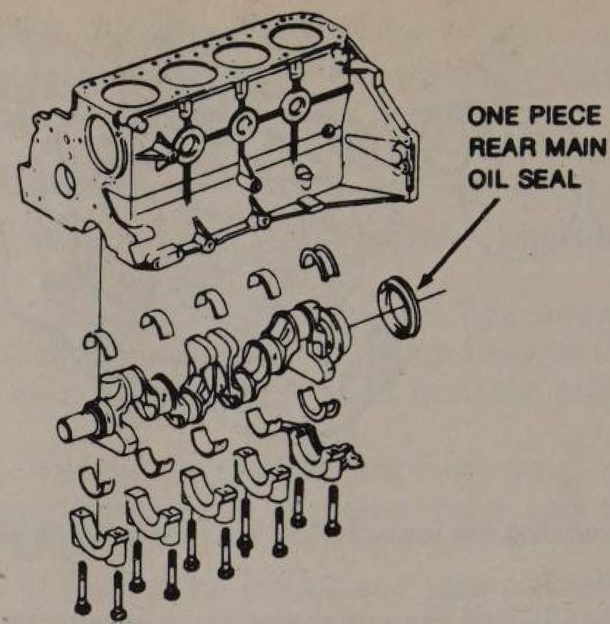
1. Jack up your vehicle and support it with jackstands.

2. Remove the transmission and flywheel.

3. If equipped with a manual transmission



One piece rear main seal – use prybar in slots to remove



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

remove the clutch, pressure plate and flywheel.

4. With a suitable tool remove the seal.

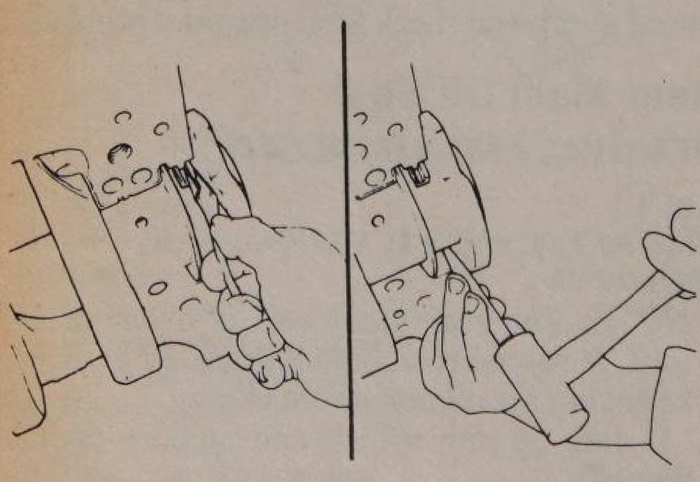
To install:

1. Coat the seal with engine oil for easy installation.
2. Drive the new seal into the retainer using a seal installer J–35621 or equivalent. Make sure the seal is completely seated in the retainer before going any further.
3. Install the flywheel and transmission.

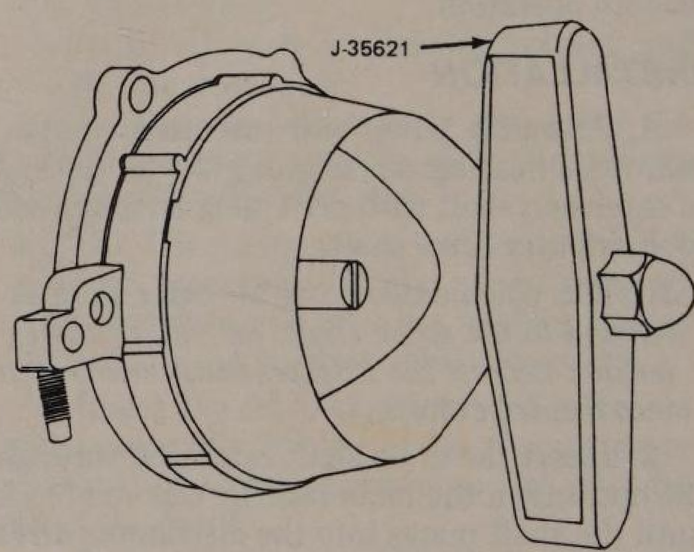
Early Model V6
All V8 3.8L V6 Turbo

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



Rear main seal – removing upper half with crankshaft installed

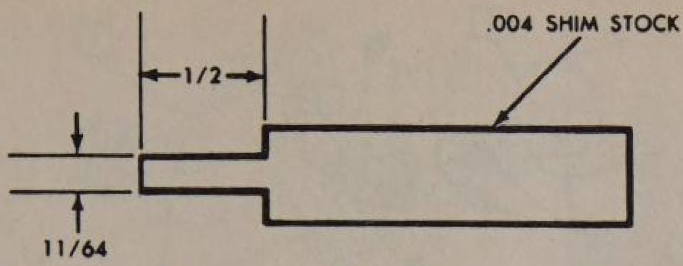


One piece rear seal installation with tool

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

To install:

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.
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.



Oil seal installation tool dimensions

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. Install the oil pump, oil pan and refill the engine with oil.

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 found in the beginning of this chapter. Tighten bolts in crisscross pattern.

EXHAUST SYSTEM

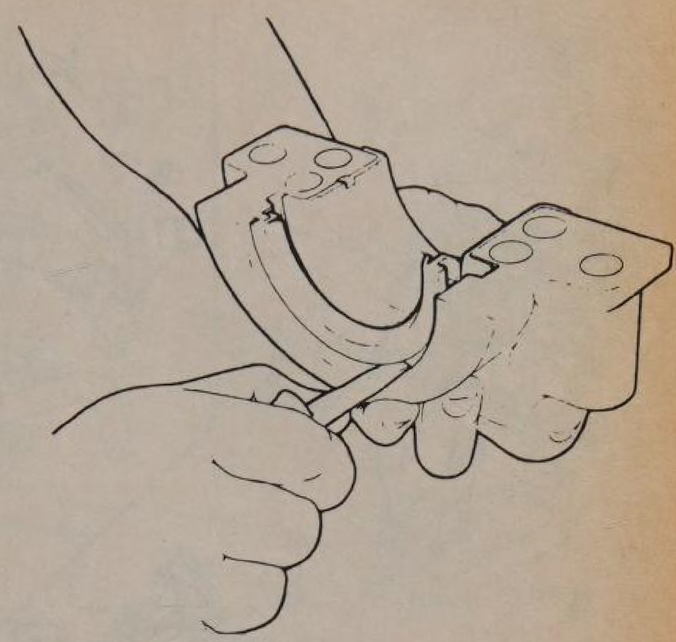
Safety Precautions

For a number of reasons, exhaust system work can be the most dangerous type of work you can do on your car. Always observe the following precautions:

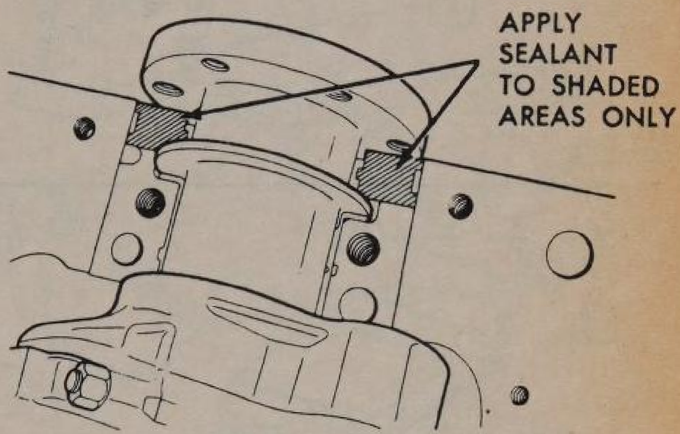
• Support the car extra securely. Not only will you often be working directly under it, but you'll frequently be using a lot of force, say, heavy hammer blows, to dislodge rusted parts. This can cause a car that's improperly supported to shift and possibly fall.

• Wear goggles. Exhaust system parts are always rusty. Metal chips can be dislodged, even when you're only turning rusted bolts. Attempting to pry pipes apart with a chisel makes the chips fly even more frequently.

• If you're using a cutting torch, keep it a great distance from either the fuel tank or lines. Stop what you're doing and feel the temperature of the fuel bearing pipes on the tank frequently. Even slight heat can expand and/or vaporize fuel, resulting in accumulated vapor, or even a liquid leak, near your torch.



Rear main seal – removing lower half



Sealing upper and lower main seal halves

• Watch where your hammer blows fall and make sure you hit squarely. You could easily tap a brake or fuel line when you hit an exhaust system part with a glancing blow. Inspect all lines and hoses in the area where you've been working.

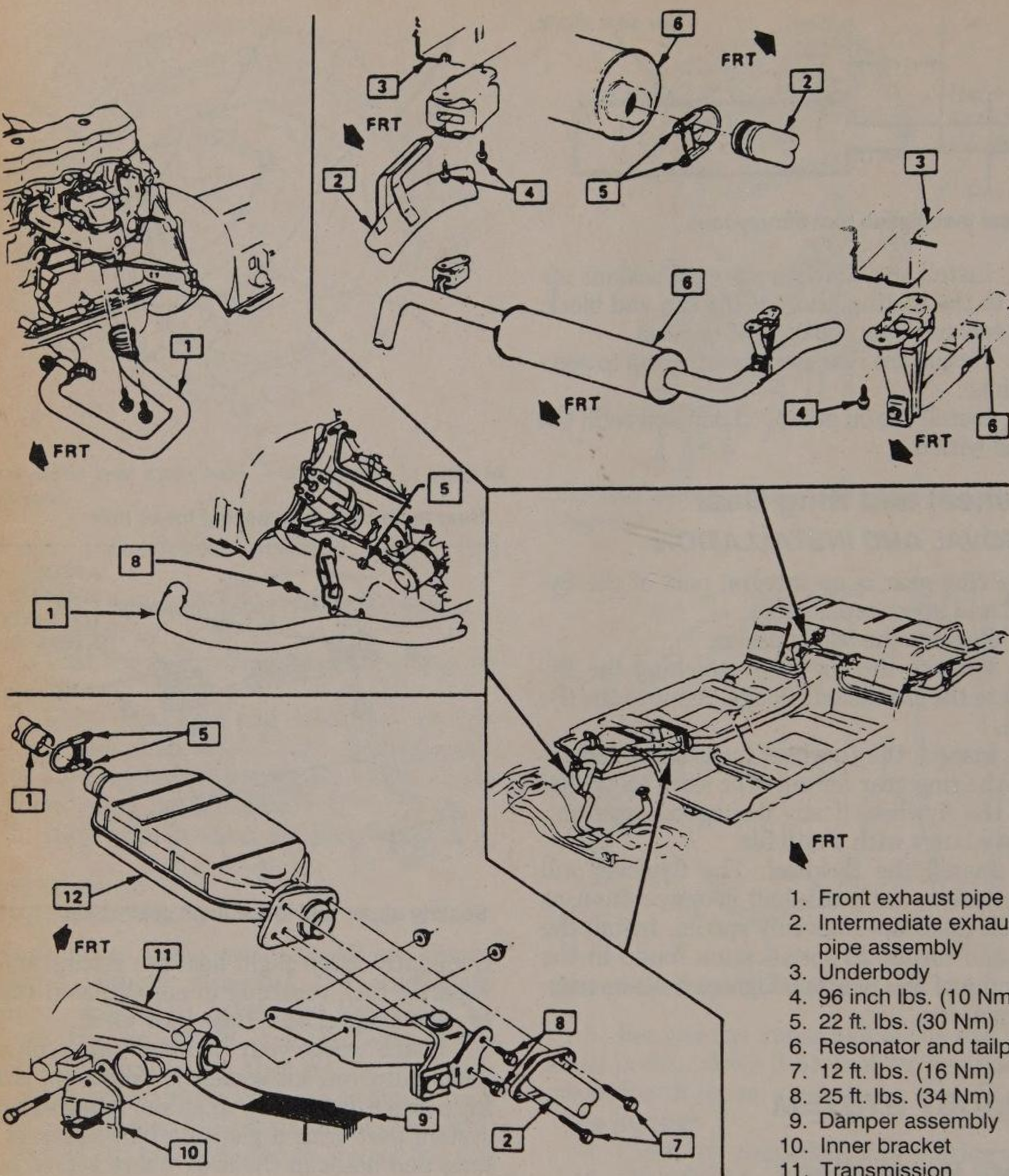
Special Tools

A number of special exhaust system tools can be rented from auto supply houses or local stores that rent special equipment. A common one is a tail pipe expander, designed to enable you to join pipes of identical diameter.

It may also be quite helpful to use solvents designed to loosen rusted bolts or flanges. Soaking rusted parts the night before you do the job can speed the work of freeing rusted parts considerably. Remember that these solvents are often flammable. Apply only to parts after they are cool!

Checking

Check complete exhaust system and nearby body areas and trunk lid for broken, damaged,



1. Front exhaust pipe
2. Intermediate exhaust pipe assembly
3. Underbody
4. 96 inch lbs. (10 Nm)
5. 22 ft. lbs. (30 Nm)
6. Resonator and tailpipe
7. 12 ft. lbs. (16 Nm)
8. 25 ft. lbs. (34 Nm)
9. Damper assembly
10. Inner bracket
11. Transmission
12. Converter assembly

Exhaust system — 2.5L engine

missing or mispositioned parts, open seams, holes, loose connections or other deterioration which could permit exhaust fumes to seep into the trunk or passenger compartment. Dust or water in the trunk may be an indication of a problem in one of these areas. Any defects should be corrected immediately. To help insure continued integrity, the exhaust system pipe rearward of the muffler must be replaced whenever a new muffler is installed.

Exhaust Pipe

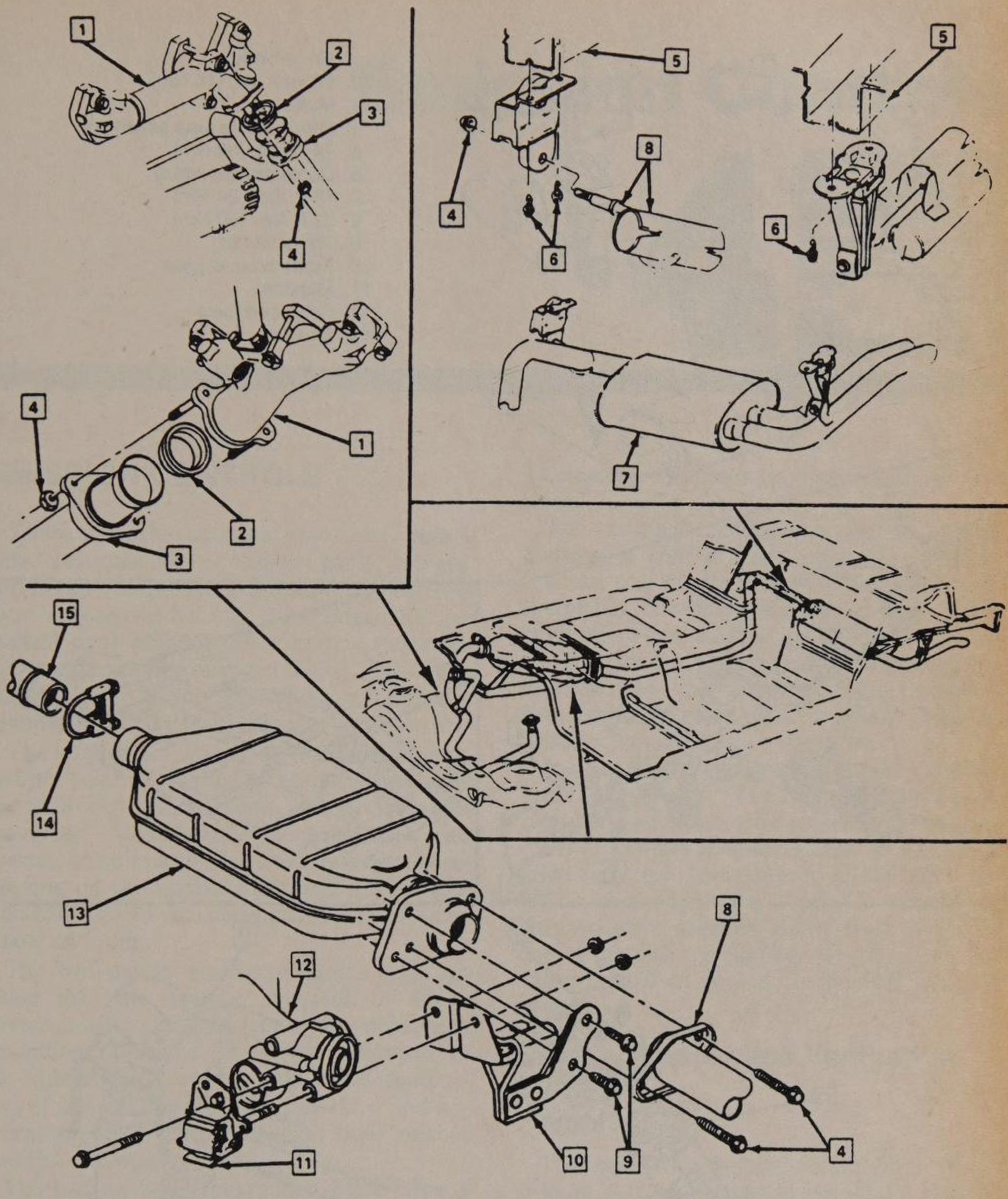
The exhaust manifold-to-crossover pipe connections are of the ball type, which eliminates the need for gaskets.

Muffler

The mufflers are a tri-flow design. Some muffler installations have a slot in the inlet and/or outlet pipe which indexes to a key (tab) welded on the exhaust and/or tail pipe to help maintain alignment.

Resonator

A resonator is used on some series exhaust systems. It allows the use of mufflers with less back pressure and provides for optimum tuning characteristics of the exhaust system.



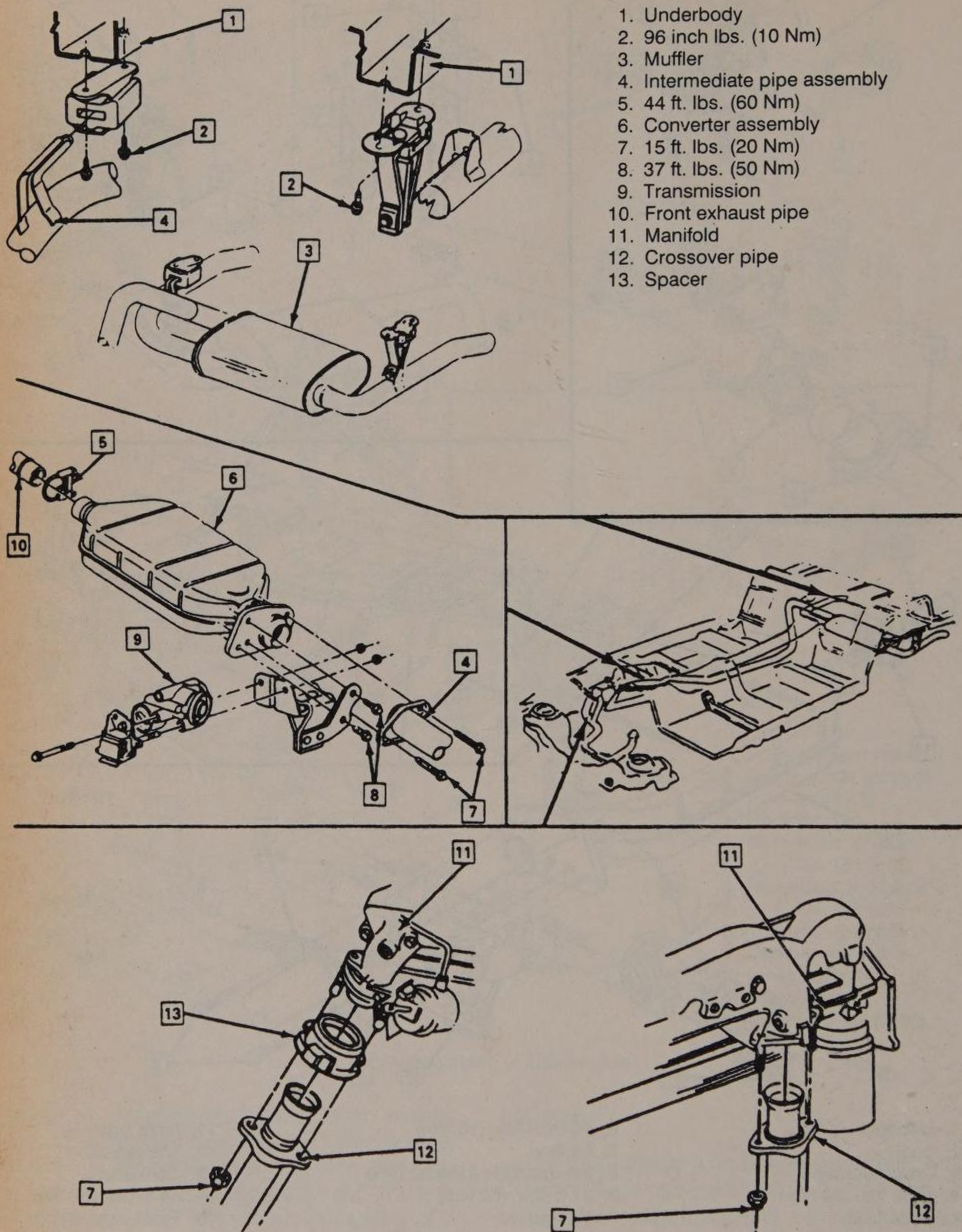
1. Manifold
2. Seal
3. Crossover pipe
4. 15 ft. lbs. (20 Nm)
5. Underbody
6. 96 inch lbs. (10 Nm)
7. Muffler
8. Intermediate exhaust pipe
9. 37 ft. lbs. (50 Nm)
10. Hanger
11. Inner bracket
12. Transmission
13. Converter
14. 44 ft. lbs. (60 Nm)
15. Front exhaust pipe

Exhaust system – V6 engine

Catalytic Converter

The catalytic converter is an emission control device added to the exhaust system to reduce pollutants from the exhaust gas stream.

Periodic maintenance of the exhaust system is not required, however, if the car is raised for other service, it is advisable to check the general condition of the catalytic converter, pipes and mufflers.



1. Underbody
2. 96 inch lbs. (10 Nm)
3. Muffler
4. Intermediate pipe assembly
5. 44 ft. lbs. (60 Nm)
6. Converter assembly
7. 15 ft. lbs. (20 Nm)
8. 37 ft. lbs. (50 Nm)
9. Transmission
10. Front exhaust pipe
11. Manifold
12. Crossover pipe
13. Spacer

Exhaust system — V8 engine

Emission Controls

4

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: unburned hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx). The equipment that is used to limit these pollutants is commonly called emission control equipment.

The engines are equipped with an air pump system, positive crankcase ventilation, exhaust gas recirculation, electronic ignition, catalytic converter, thermostatically controlled air cleaner, or an evaporative emissions system depending on the model. Electronic engine controls are used on various engines, depending on model and year.

The belt driven air pump injects clean air either into the exhaust manifold, or downstream into the catalytic converter, depending on engine conditions. The oxygen contained in the injected air, supports continued combustion of the hot carbon monoxide (CO) and hydrocarbon (HC) gases, reducing their release into the atmosphere.

The back pressure modulated EGR valve is mounted next to the carburetor or upper intake manifold for fuel injected engines. Vacuum applied to the EGR diaphragm raises the pintle valve from its seat, allowing hot exhaust gases to be drawn into the intake manifold with the intake charge. The exhaust gases reduce peak combustion temperature; lower temperatures reduce the formation of oxides of nitrogen (NOx).

The dual brick catalytic converter is mounted in the exhaust system, ahead of the muffler. Catalytic converters use noble metals (platinum, palladium, and rhodium) and great heat – 1200°F (650°C) – to catalytically oxidize HC and CO gases into H_2O and CO_2. The Thermactor system is used as a fresh air (and therefore, oxygen) supply.

The thermostatically controlled air cleaner housing is able to draw fresh air from two sources: cool air from outside the car (behind the grille), or warm air obtained from a heat stove encircling the exhaust manifold. A warm air supply is desirable during cold engine operation. Because it promotes better atomization of the air/fuel mixture, while cool air promotes better combustion in a hot engine.

Instead of venting gasoline vapors from the carburetor float bowl or fuel tank into the atmosphere, an evaporative emission system captures the vapors and stores them in a charcoal filled canister, located ahead of the left front wheel arch. When the engine is running, a purge control solenoid allows fresh air to be drawn through the canister. The fresh air and vapors are then routed to the fuel injection system.

Positive Crankcase Ventilation System

OPERATION

The positive crankcase ventilation (PVC) 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.

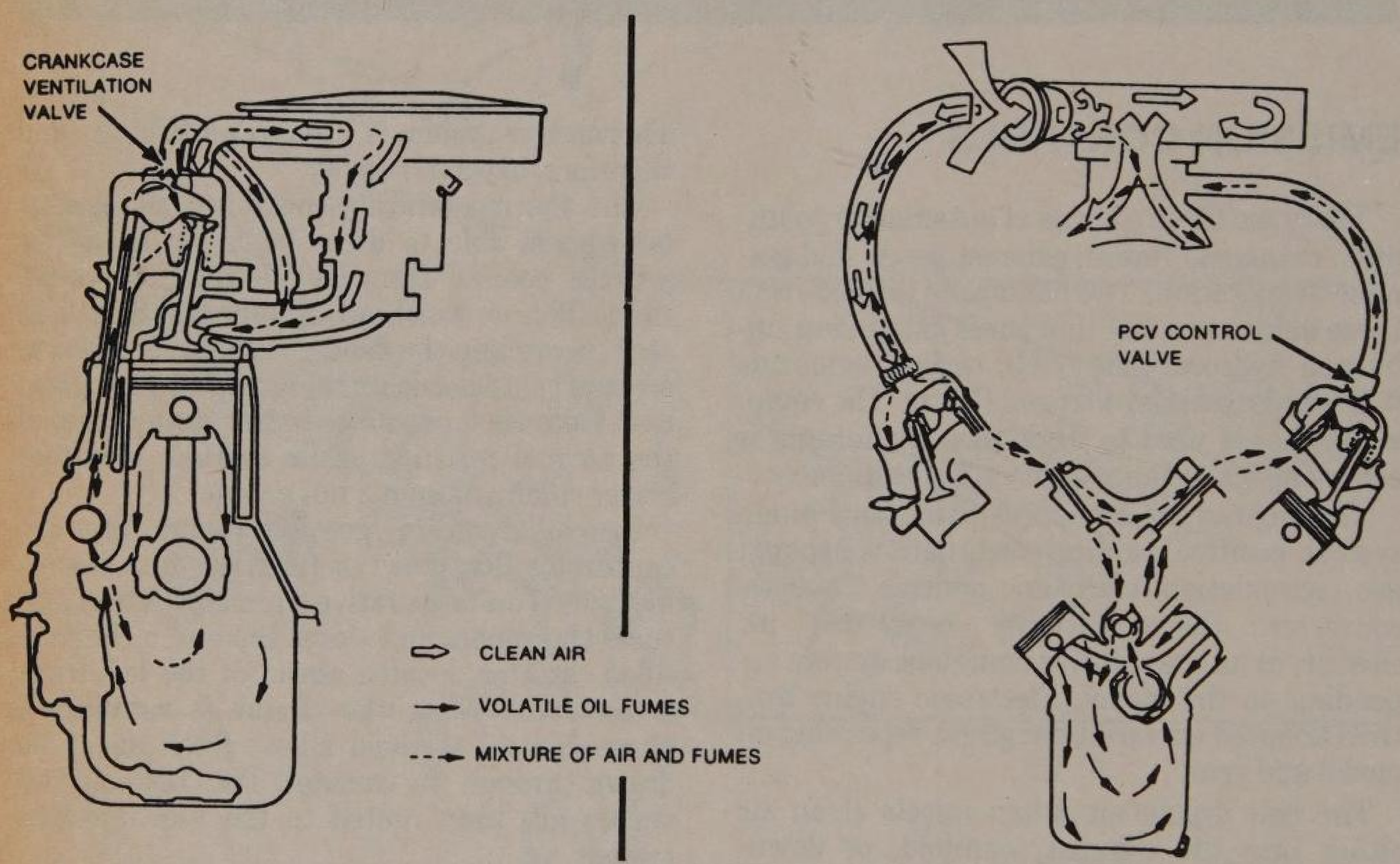
The most critical component in the system is the PCV valve. This valve controls the amount of gases which are recycled into the combustion chamber. At low engine speeds, the valve is partially closed, limiting the flow of gases into the intake manifold. As engine speed increases, the valve opens to admit 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

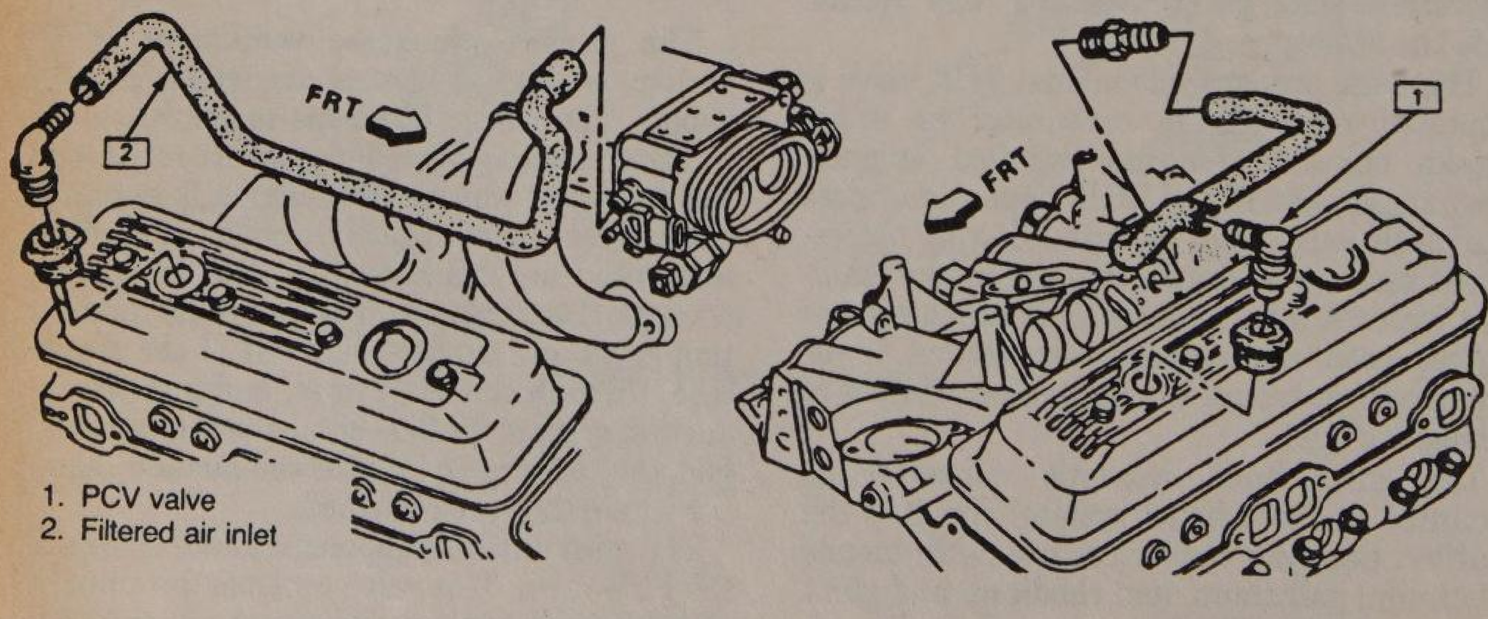
Inspect the PCV system hose and connections at each tune-up and replace any deteriorated hoses. Check the PCV valve at every tune-up and replace it at 48,000 km (30,000 mile) intervals.

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.



Typical PCV flow



Positive crankcase ventilation system — 8–5.7L TPI engine

4. Shut off the engine. Shake the valve and listen for the rattle. If valve does not 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.

SERVICE

Evidence of fuel loss or fuel vapor odor can be caused by the following:

1. Liquid fuel leaking from the fuel lines or throttle body.
2. Inoperative purge valve.
3. Disconnected or damaged vapor and control lines.
4. Air cleaner or cleaner gasket improperly seated.

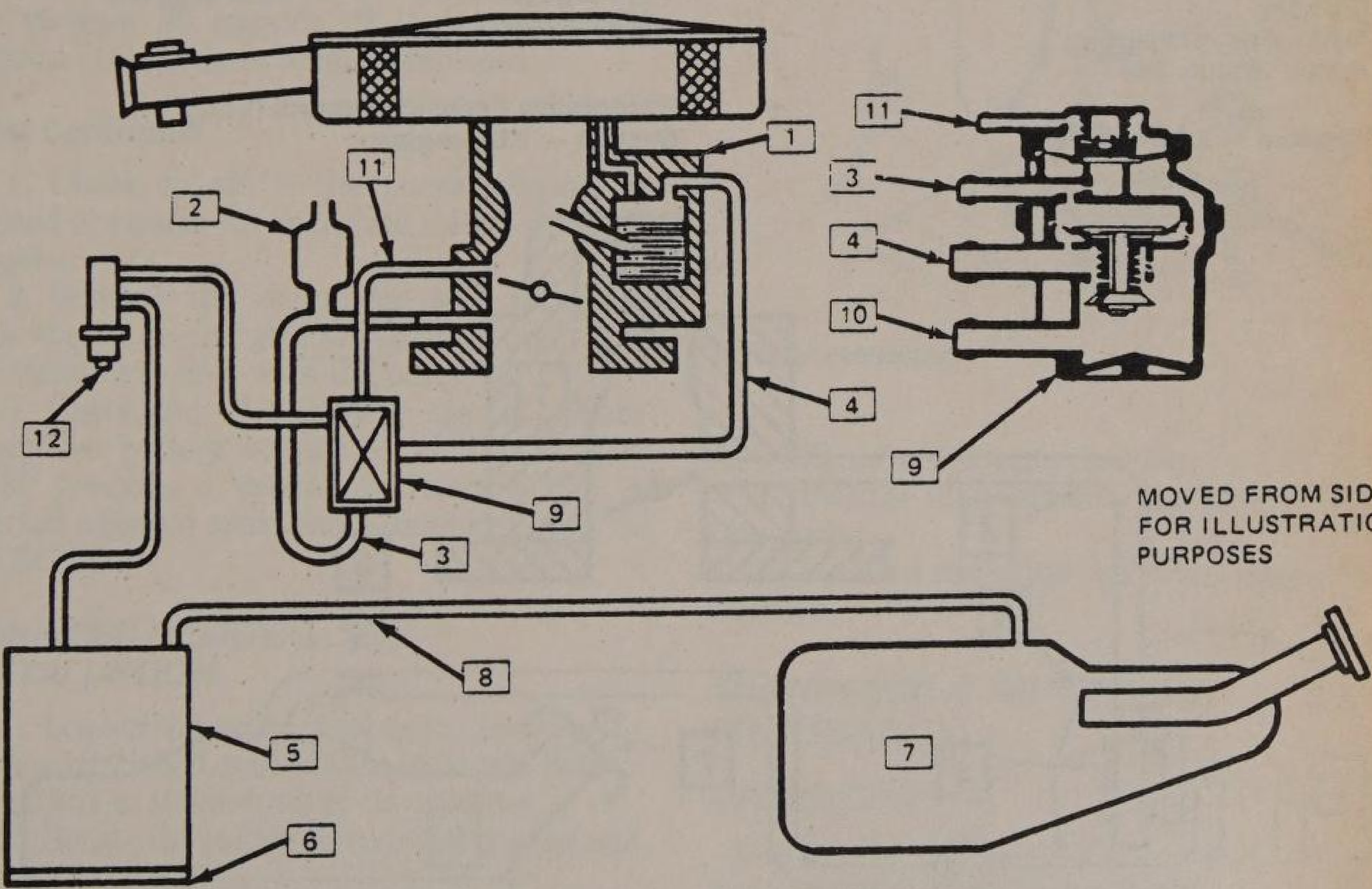
Poor idle, stalling or poor drive ability can be caused by the following:

1. Inoperative purge valve.
2. Damaged canister.
3. Hoses split, cracked, damaged or connected improperly.
4. Fault in the ECM circuit. ECM controlled purge solenoid.

TESTING

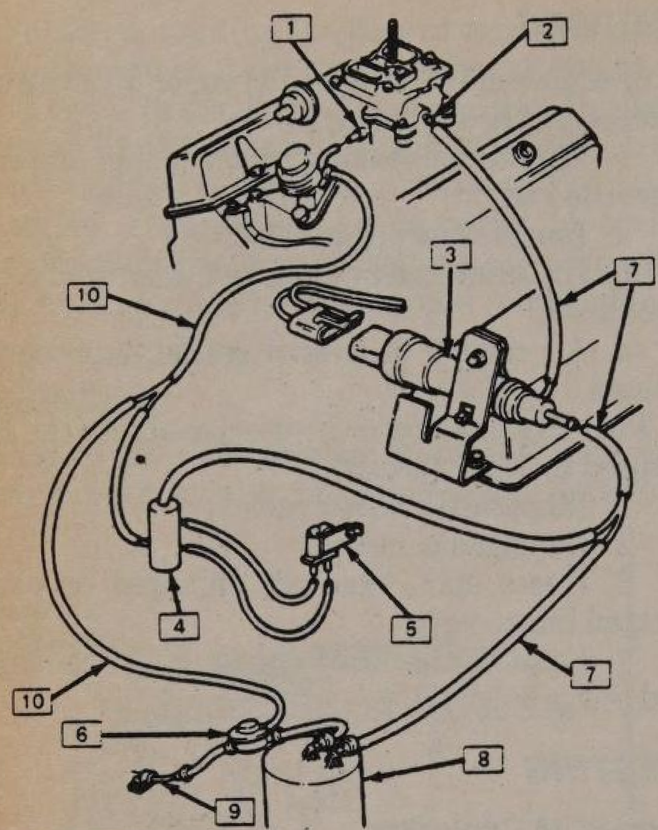
Non-ECM Controlled

1. Visually check the canister for cracks or damage, replace canister.
2. If fuel is leaking from the bottom of the canister, replace canister and check for proper hose routing.



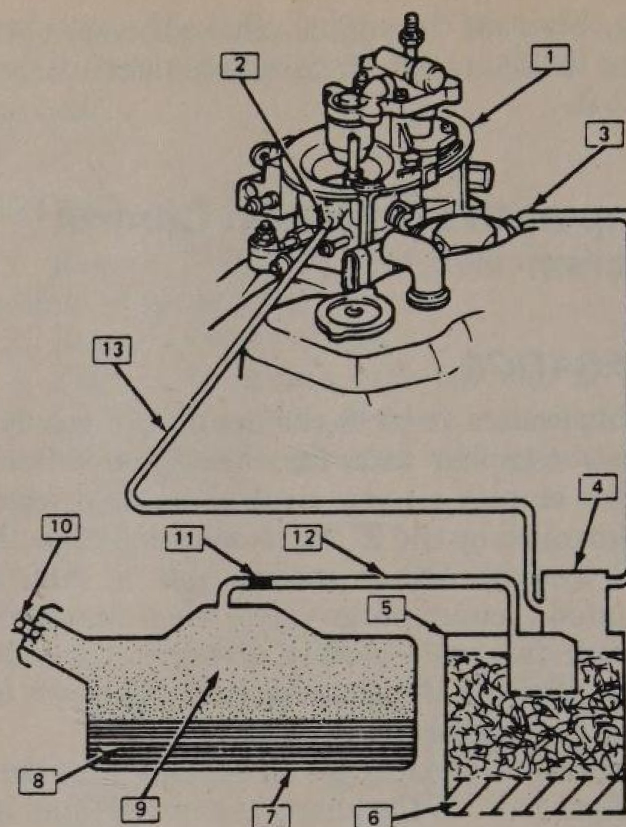
1. Carburetor
2. PCV valve
3. Manifold vacuum from PCV
4. Carburetor bowl tube
5. Vapor storage canister
6. Purge air
7. Fuel tank
8. Fuel tank vent pipe
9. Canister control valve
10. Canister tube
11. Tube control vacuum
12. T.V.S. switch

Evaporative Emission Control System (EECS) – 5.0L engine



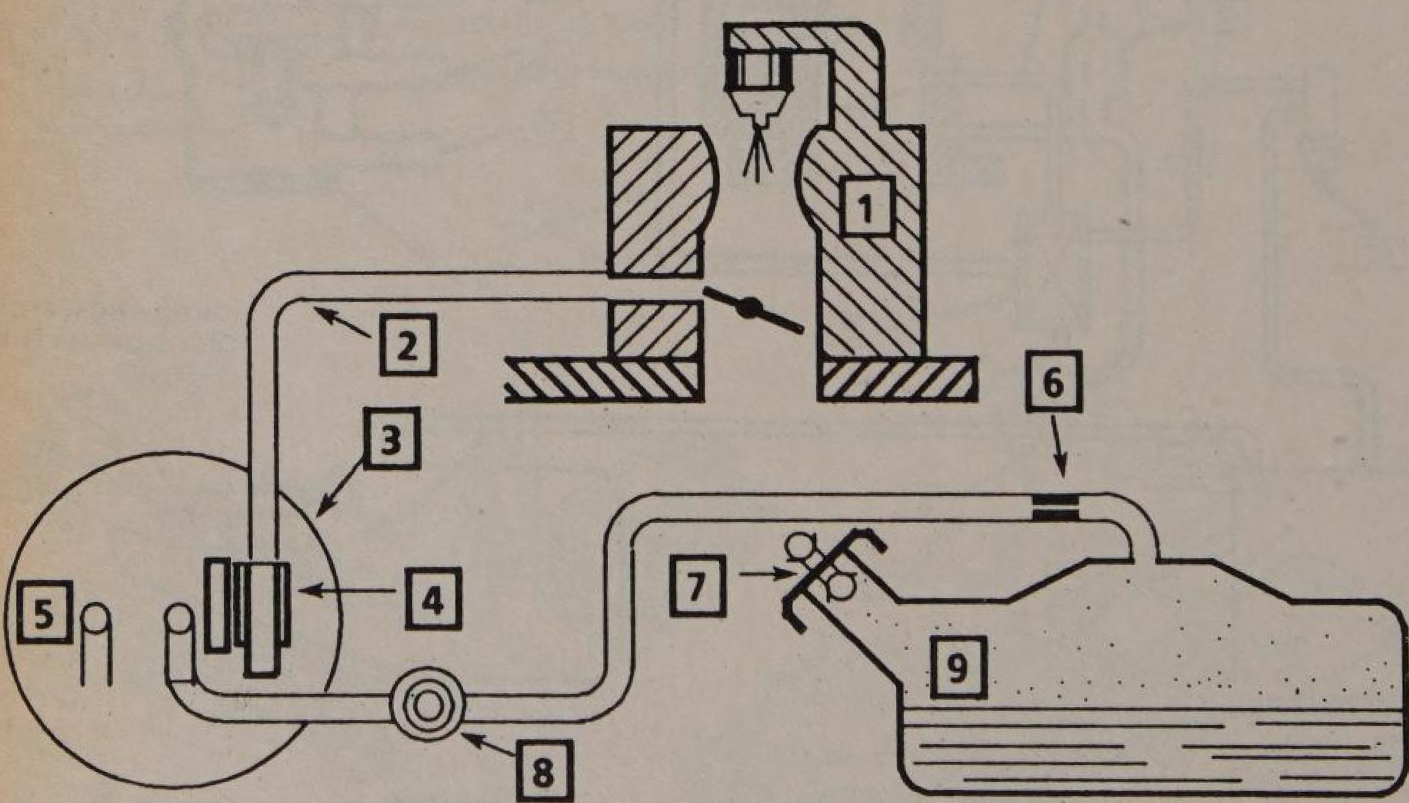
1. Port "B" ported vacuum
2. Port "F" bowl vent
3. Fuel bowl vent solenoid
4. Fuel vapor connector
5. Fuel vapor purge solenoid
6. Tank pressure control valve
7. Vent/purge hose
8. Canister
9. Tank vapor vent pipe
10. Ported vacuum line

EEC System – 2.8L engine



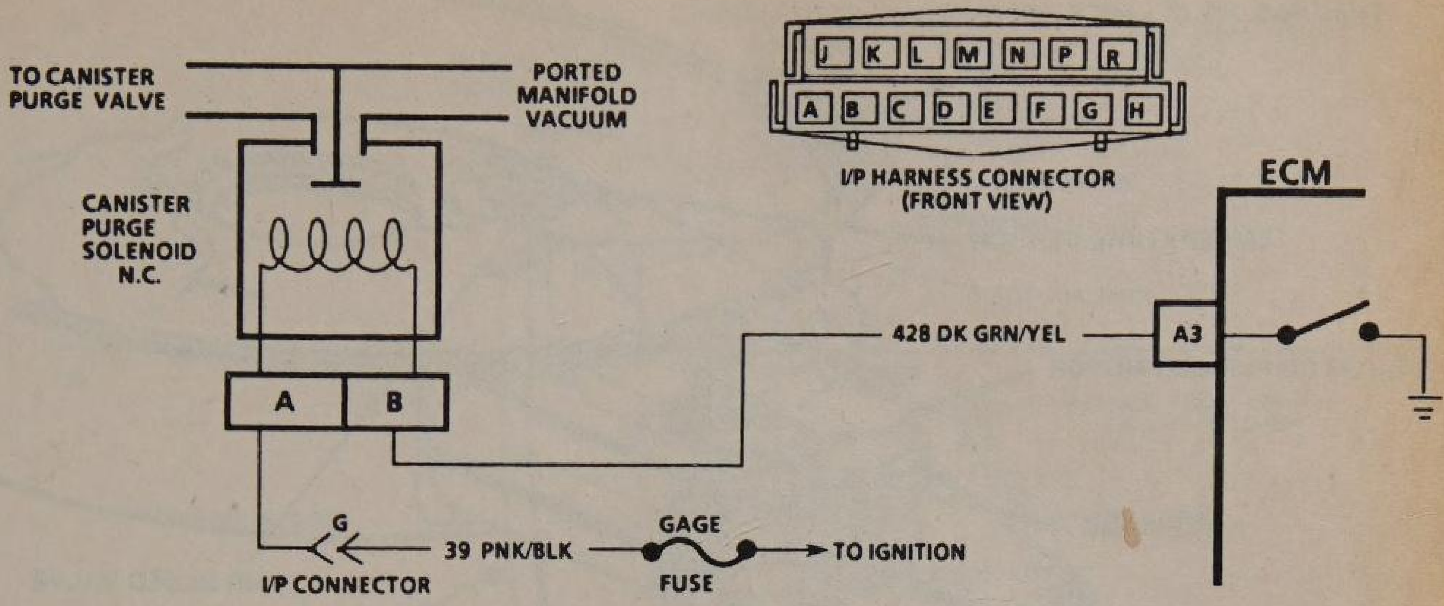
1. TBI
2. Canister purge port
3. Vacuum signal
4. Purge valve
5. Vapor storage canister
6. Purge air
7. Fuel tank
8. Fuel
9. Vapor
10. Pressure-vacuum relief gas cap
11. Vent restrictor
12. Fuel tank vent
13. Purge line

Evaporative Emission Control (EEC) System – 2.5L engine



1. TBI unit
2. Purge line
3. Vapor canister
4. Canister purge solenoid
5. Air inlet
6. Vapor restrictor
7. Pressure/vacuum relief vented fuel filler cap
8. Tank pressure control valve
9. Fuel tank

Evaporative emission control system – late model TPI and TBI engines



ECM controlled EEC system

3. Check the filter at the bottom of the canister. If dirty, replace the filter.

4. Functional test the purge valve by installing a piece of hose to the lower tube of the valve and attempt to blow through it. Little or no air should pass into the canister.

5. Connect a vacuum pump and apply 15 Hg (51 kPa) of vacuum to the upper control valve tube. The diaphragm should hold vacuum for at least 20 seconds. If it does not hold vacuum, the canister must be replaced.

ECM Controlled

1. Check to see if the purge solenoid is opened or closed. An energized solenoid should be open.

2. Ground the diagnostic test terminal. This should de-energize the solenoid and allow the vacuum to drop with the purge ON.

3. Check for a complete circuit. There should be battery voltage on circuit 39. The ECM provides a ground on circuit 428. A shorted solenoid could cause an open circuit in the ECM.

CANISTER REMOVAL AND INSTALLATION

1. Loosen the screw holding the canister retaining bracket. Later models have two retaining screws at the bottom of the canister.

2. Rotate the canister retaining bracket and remove the canister.

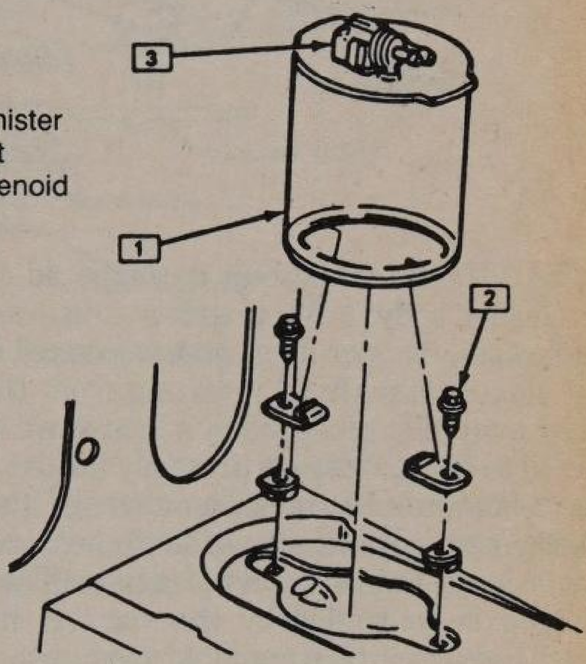
3. Tag and disconnect the hoses and wiring leading from the canister.

4. Installation is in the reverse order of removal.

FILTER REPLACEMENT

NOTE: *Some later model canisters do not have replaceable filters.*

1. Canister
2. Bolt
3. Solenoid



Canister assembly

1. Remove the vapor canister.

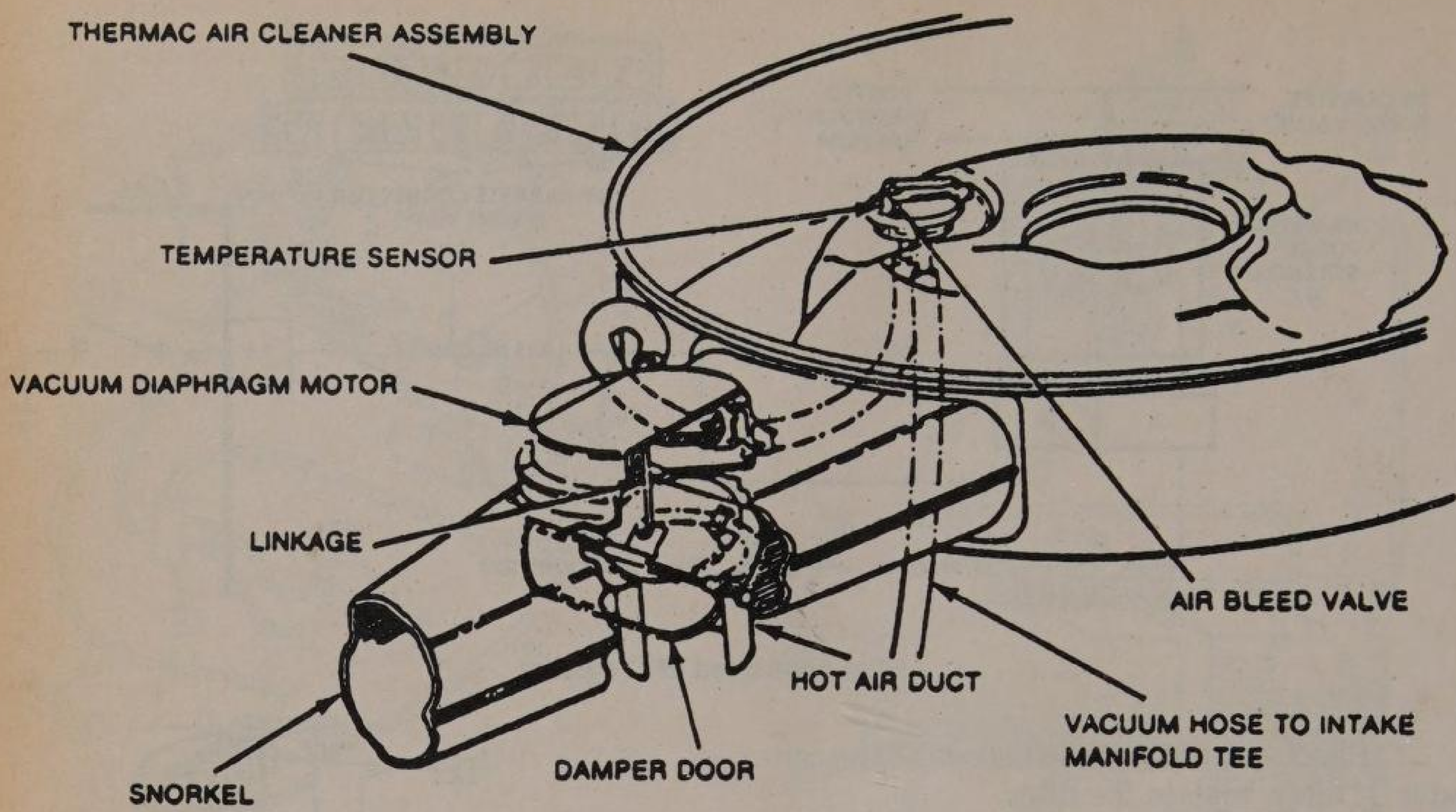
2. Pull the filter out from the bottom of the canister.

3. Install a new filter and then replace the canister.

Thermostatic Air Cleaner (THERMAC)

OPERATION

Carbureted and throttle body injected 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.



Typical THERMAC air cleaner

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 motor, 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 would be open to admit outside air.
3. Apply at least 7 in. Hg of vacuum to the damper diaphragm unit. The door should close. If it does not 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 does not 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 3mm ($^1/_8$ in.) 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 2.8mm ($^7/_{64}$ in.) 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.*

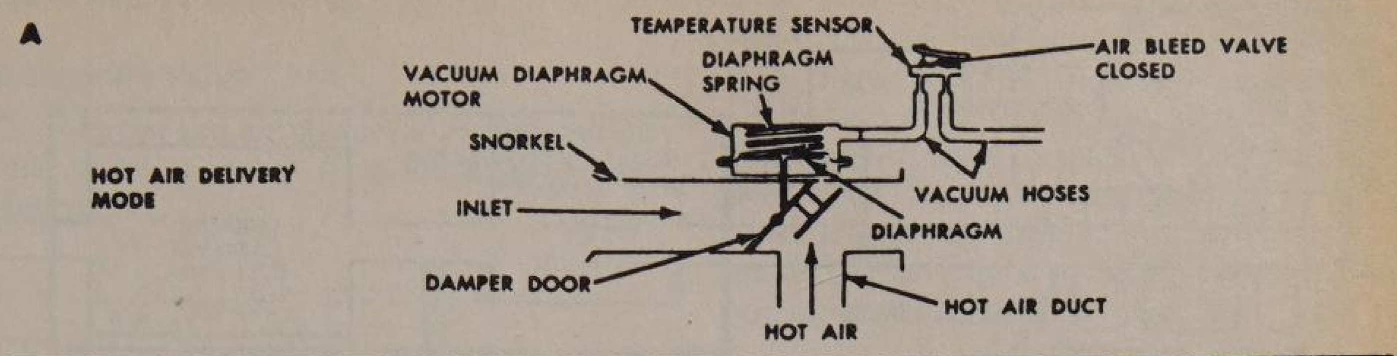
Temperature Sensor

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

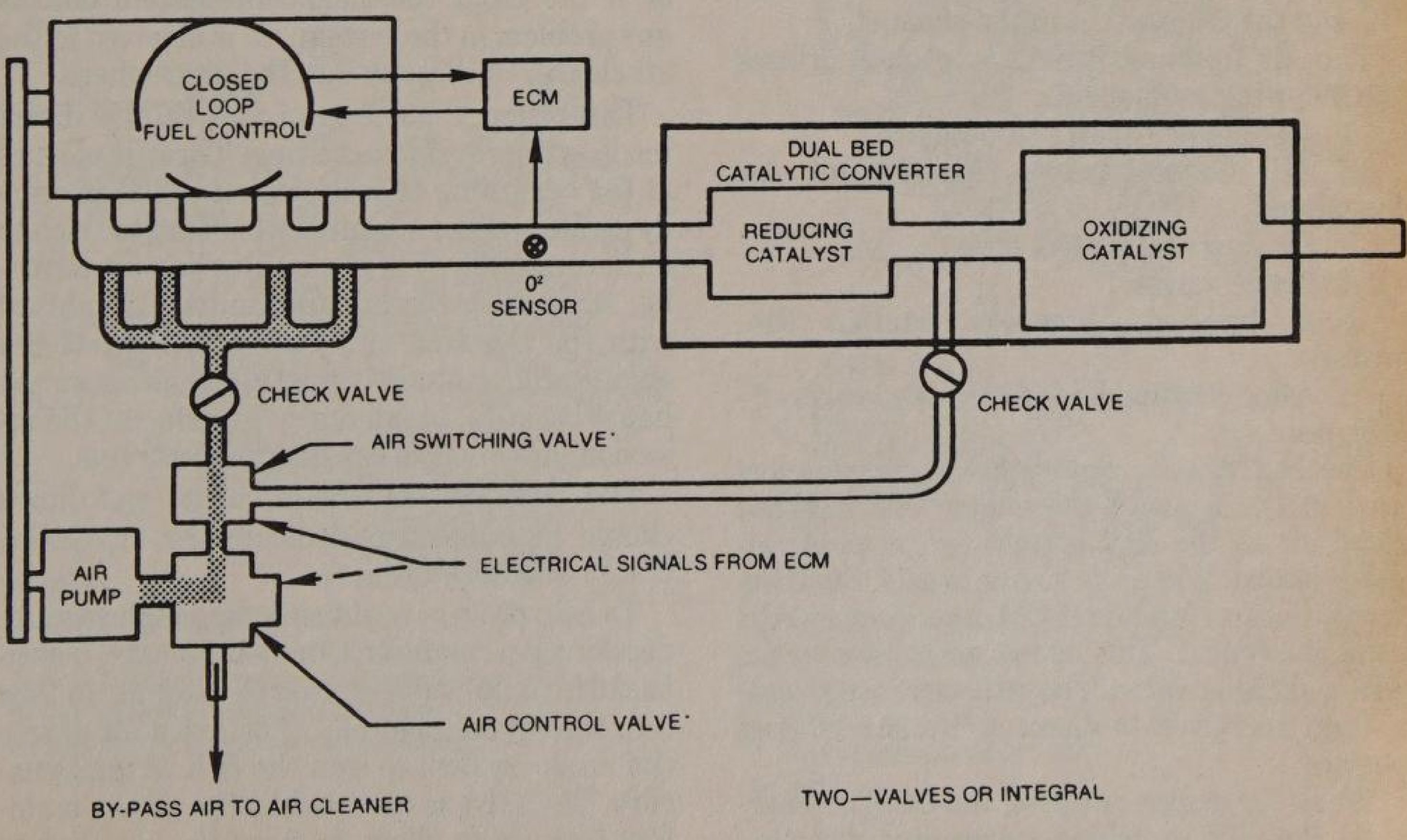
OPERATION

The AIR management system, is used to provide additional oxygen to continue the combus-

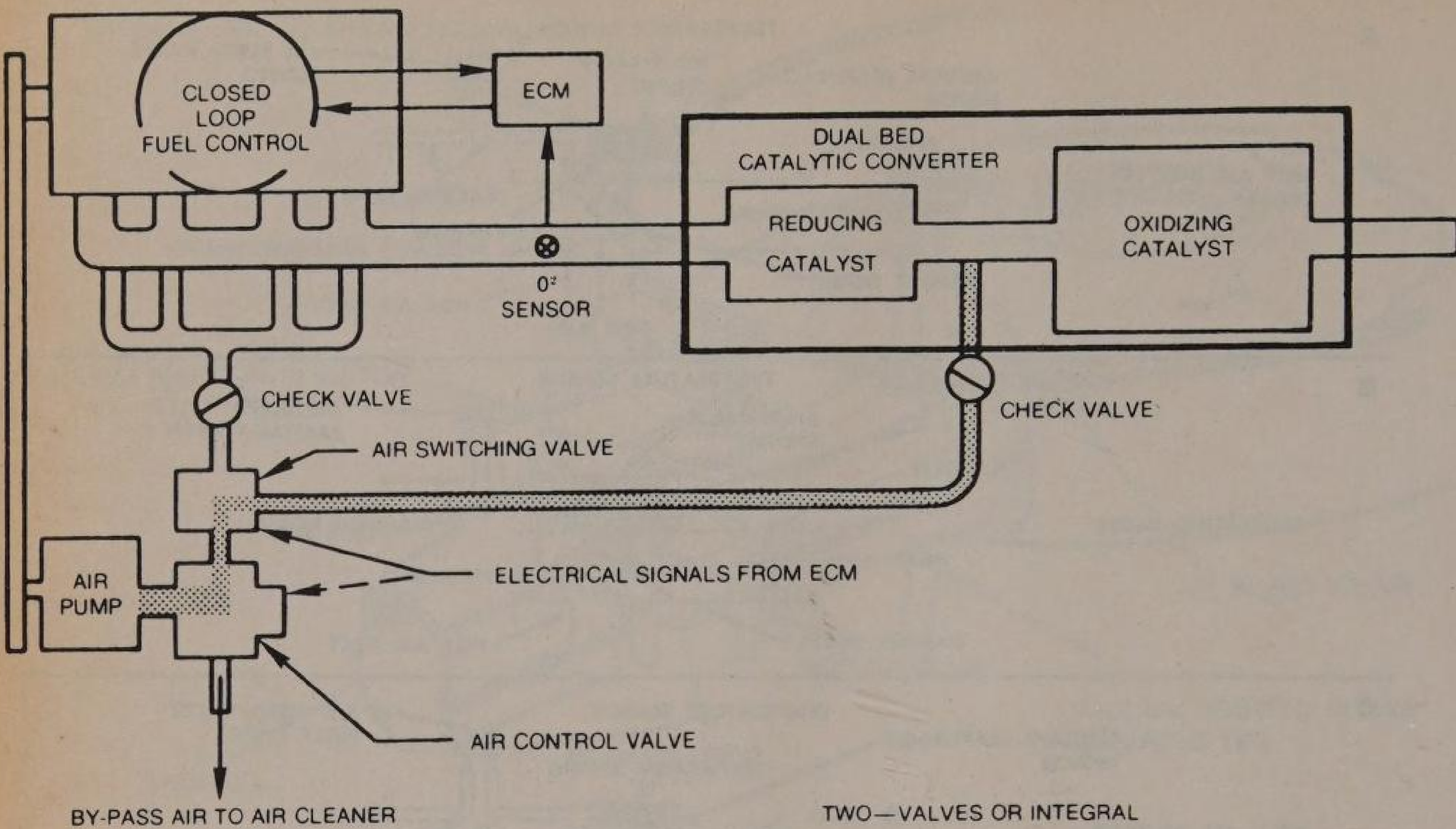


Schematic of the vacuum motor operation

tion 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,



Air Injection Reaction System – Cold Engine



Air Injection Reaction System — Warm Engine

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:

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 - 6–2.8L 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 de-energizes 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 NOx.

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.

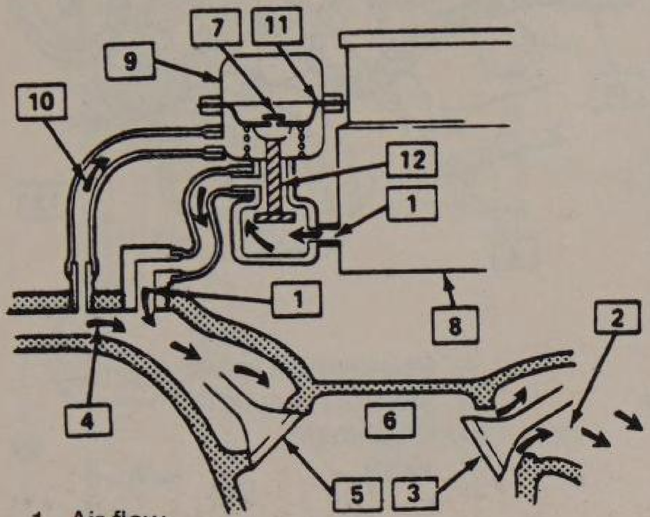
The AIR system check valves and hoses should be checked periodically for any leaks, cracks or deterioration.

To help prevent backfire during high vacuum deceleration conditions, on 6–2.8L 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

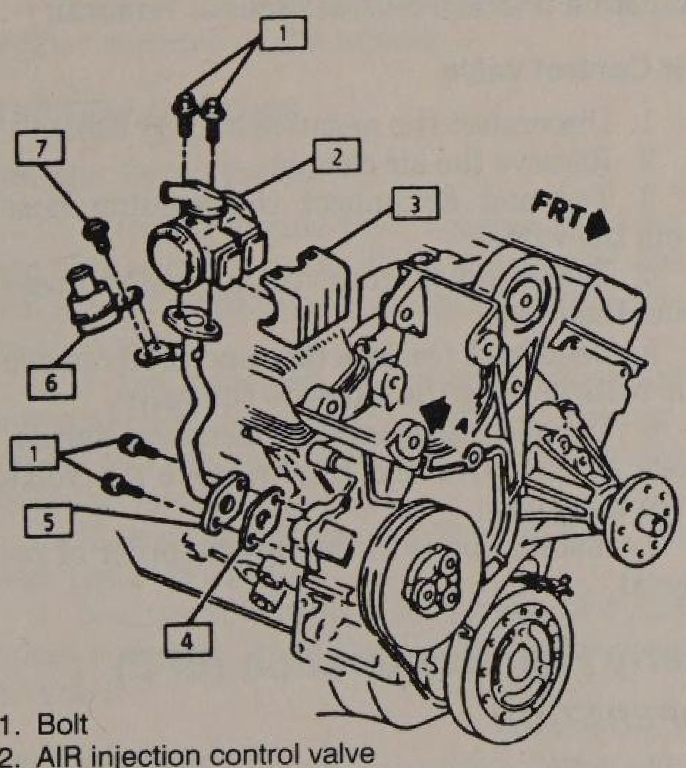
Anti-Backfire Valve

1. Remove the air cleaner and plug the air cleaner vacuum source. Connect a tachometer to the engine.



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 — 6-2.8L ONLY



1. Bolt
2. AIR injection control valve
3. AIR injection control valve cover
4. AIR injection control valve adapter gasket
5. AIR injection control valve pipe
6. AIR injection control valve silencer
7. Screw

AIR pump control valve — V8 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 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).

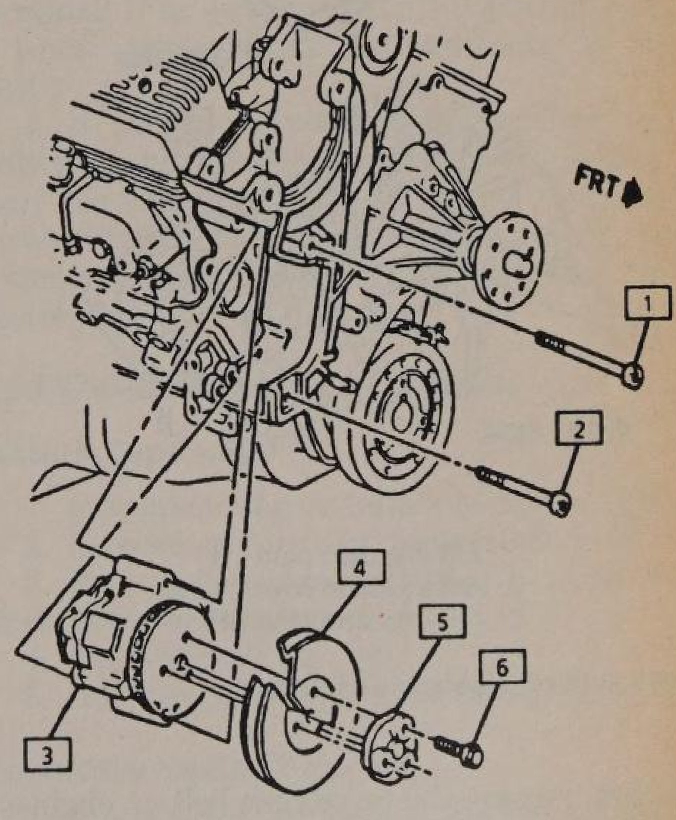
2. Then, suck through the valve. If air flows in one direction, the valve is operative. If not, replace the control valve.

REMOVAL AND INSTALLATION

Air Pump

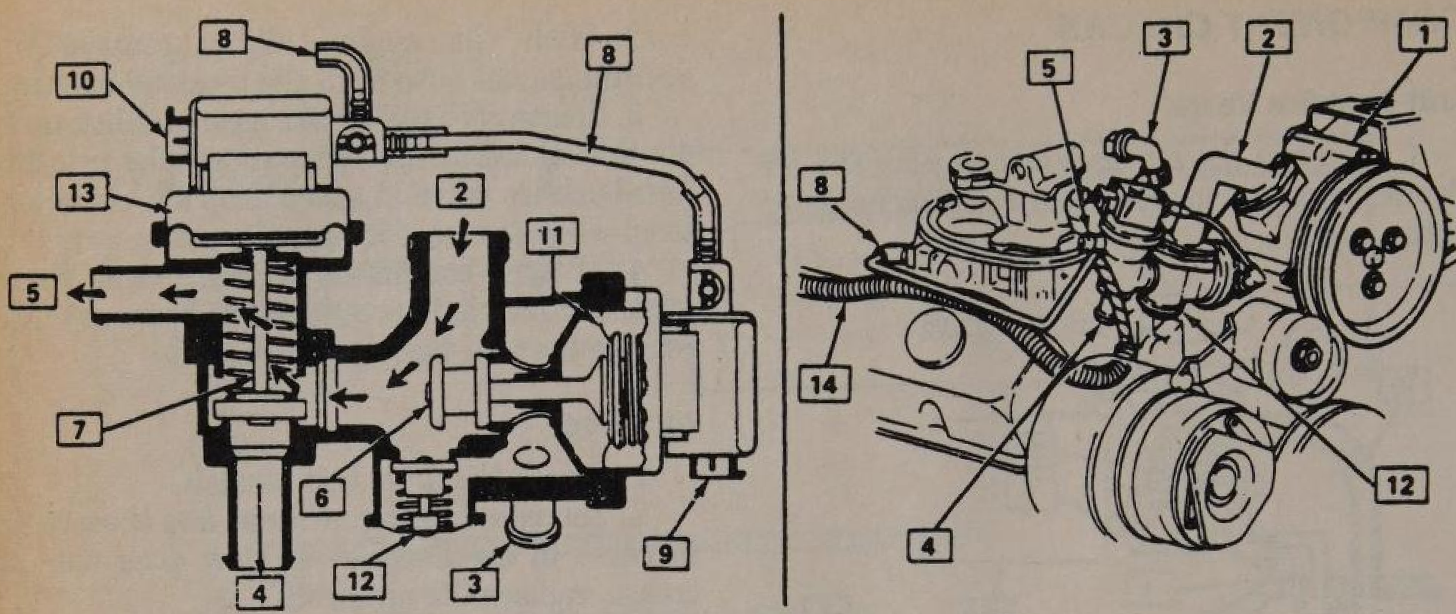
1. Remove the AIR control valves and/or adapter at the pump.

2. Loosen the air pump adjustment bolt and remove the drive belt. Using a $^{1}/_{2}$ in.



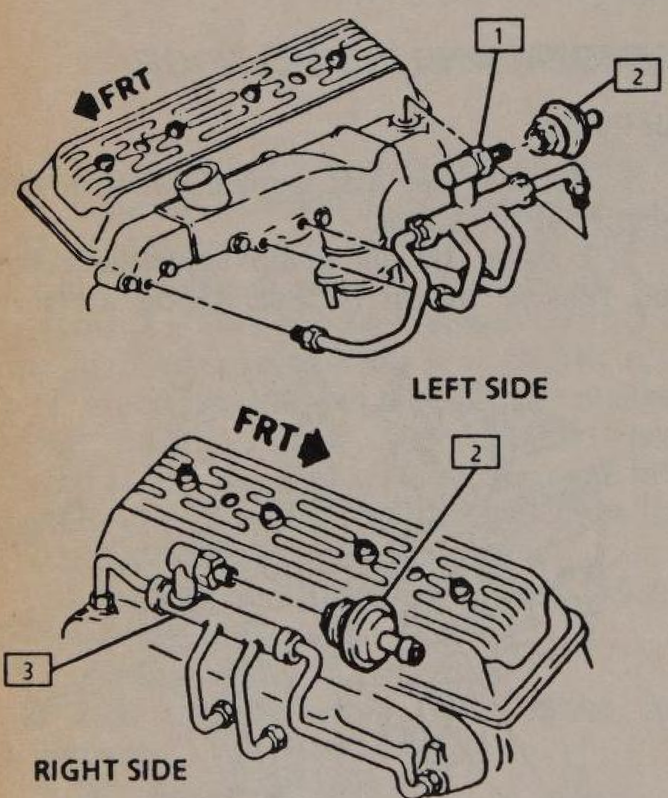
1. AIR pump upper bolt
2. AIR pump lower bolt
3. AIR injection pump
4. AIR pump pulley
5. AIR pump pulley spacer
6. Bolt

AIR pump mounting — V8 engines



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

Air Injection Reaction System Control Valve



1. AIR injection pipe LH
2. AIR injection check valve
3. AIR injection pipe RH

AIR injection pipe and check valve

ratchet, remove the serpentine belt on engines equipped with a single serpentine 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, except self-adjusting serpentine belt.

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. Use anti-seize component on the injection pipe threads to aid in future removal. Installation is in the reverse order of removal.

Air Control Valve

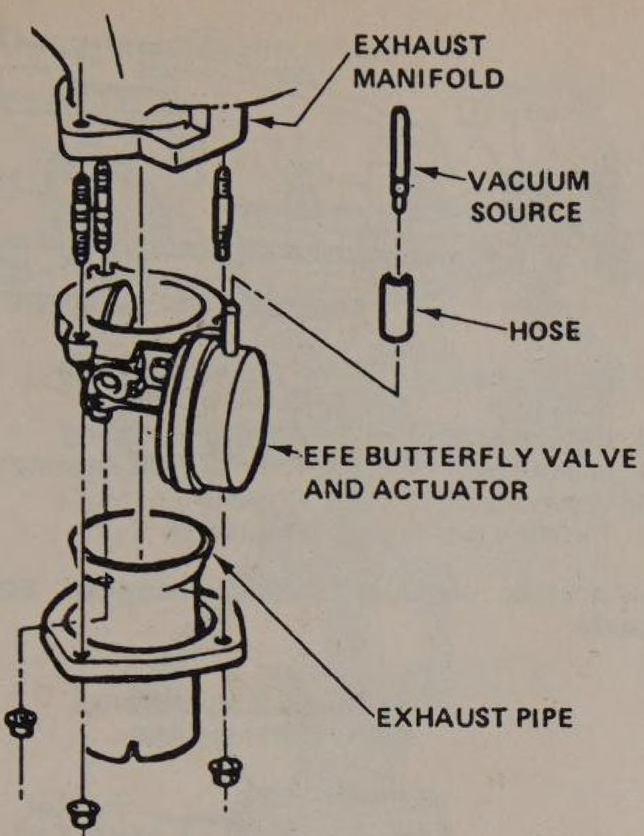
1. Disconnect the negative battery cable.
2. Remove the air cleaner.
3. Tag and disconnect the vacuum hose from the valve.
4. Tag and disconnect the air outlet hoses from the valve.
5. Bend back the lock tabs and then remove the bolts holding the elbow to the valve.
6. Tag and disconnect any electrical connections at the valve and then remove the valve from the elbow.
7. Installation is in the reverse order of removal.

Early Fuel Evaporation (EFE)

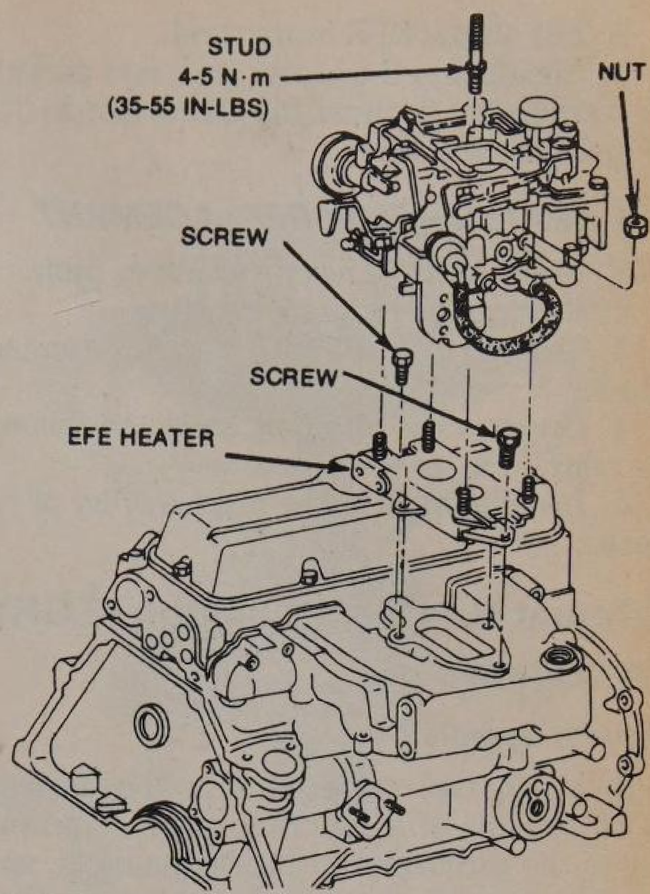
OPERATION

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



Air Injection Reaction System Control Valve



EFE Heater grid

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 systems is OK; if power exists, replace the heater switch.

REMOVAL AND INSTALLATION

Vacuum Type

1. Disconnect the vacuum hose at the EFE.
2. Remove exhaust pipe to manifold nuts.
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 in Chapter 5.

5. Lift off the EFE heater grid.
6. Installation the heater grid, new gaskets and carburetor. Tighten the carburetor to 35–55 inch lbs. (4–5 Nm).

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

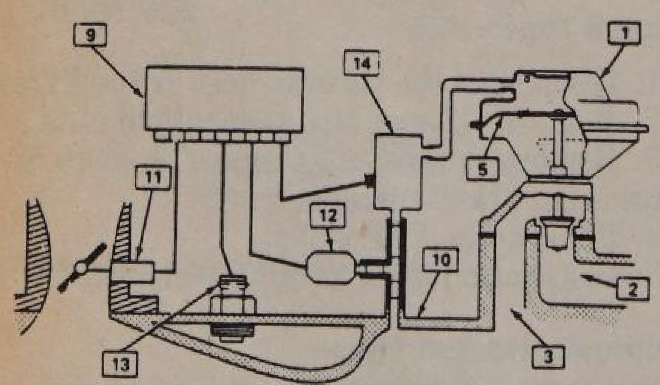
Vacuum Operated

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 NOx. 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 Backpressure 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.

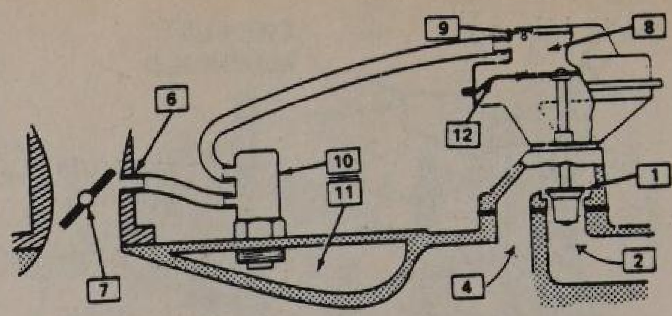
Ported Valve

In the Ported system, the amount of exhaust gas admitted into the intake manifold depends



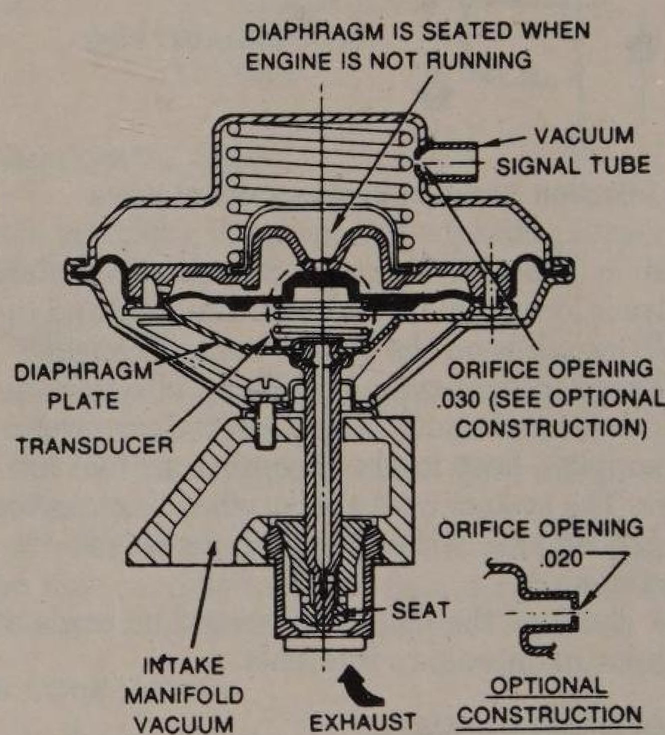
1. EGR valve
2. Exhaust gas
3. Intake air
5. Diaphragm
9. Electronic control module
10. Manifold vacuum
12. Manifold pressure sensor
13. Coolant temperature sensor
14. EGR control solenoid

Electronic controlled EGR system



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



Cross section of a negative backpressure EGR valve

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 amount of vacuum inside the vacuum chamber during operation. When the valve receives sufficient exhaust backpressure through the

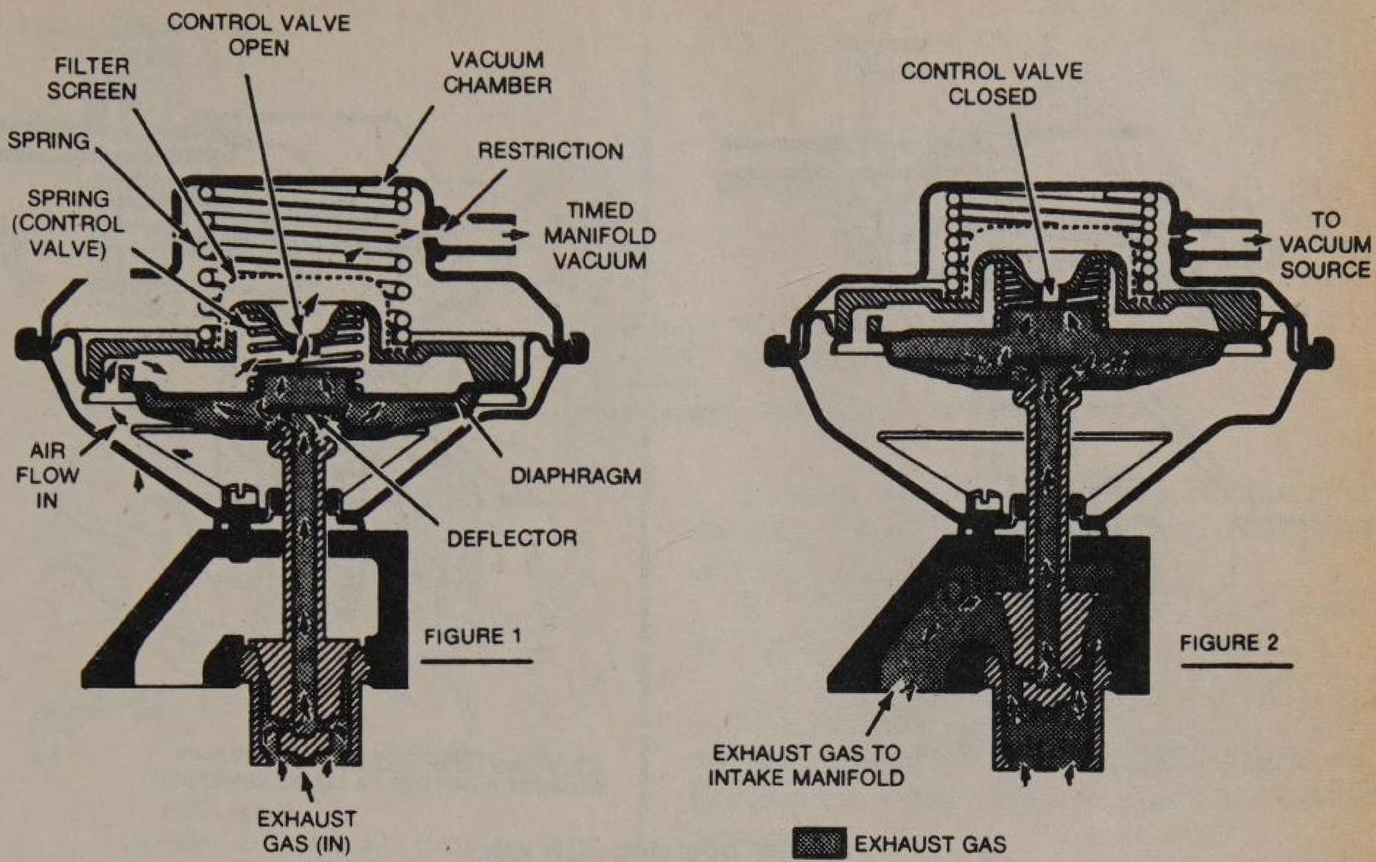


FIGURE 1

FIGURE 2

Positive Backpressure EGR Valve

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.

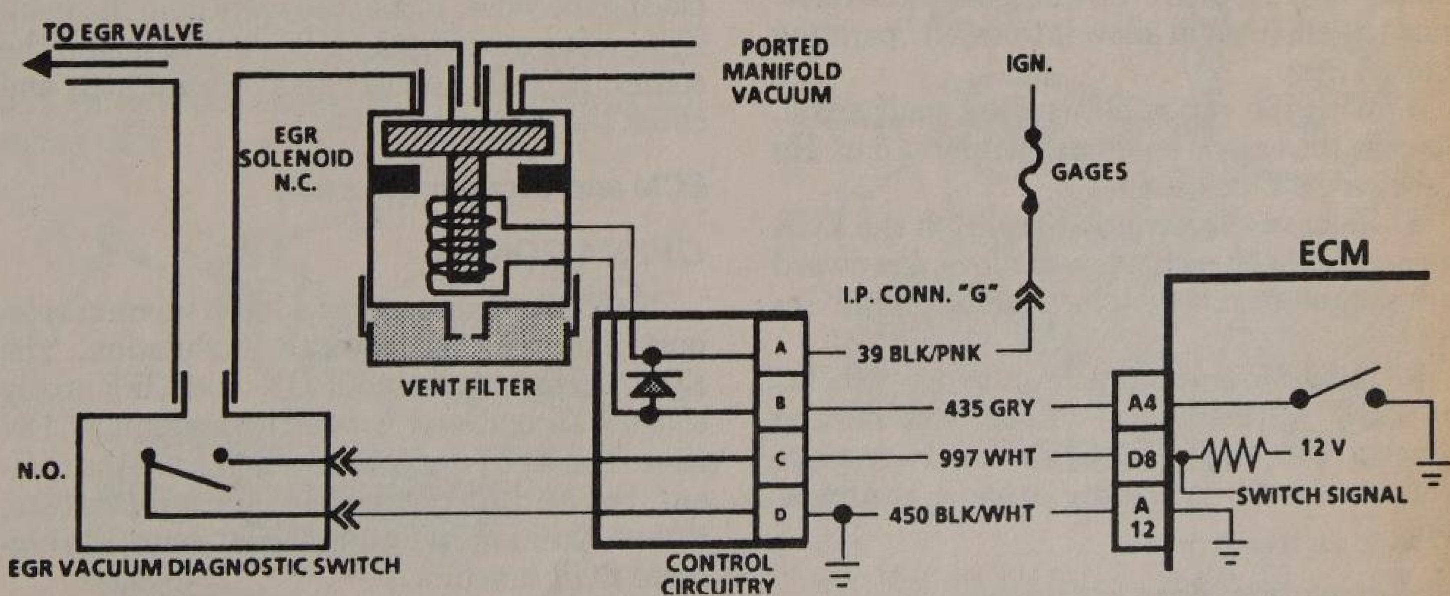
At certain manifold pressures, the EGR valve will open. When the manifold vacuum combines with the negative exhaust backpressure, the bleed hole opens and the EGR valve closes.

NOTE: *This valve will open when vacuum is applied and the engine is not running.*

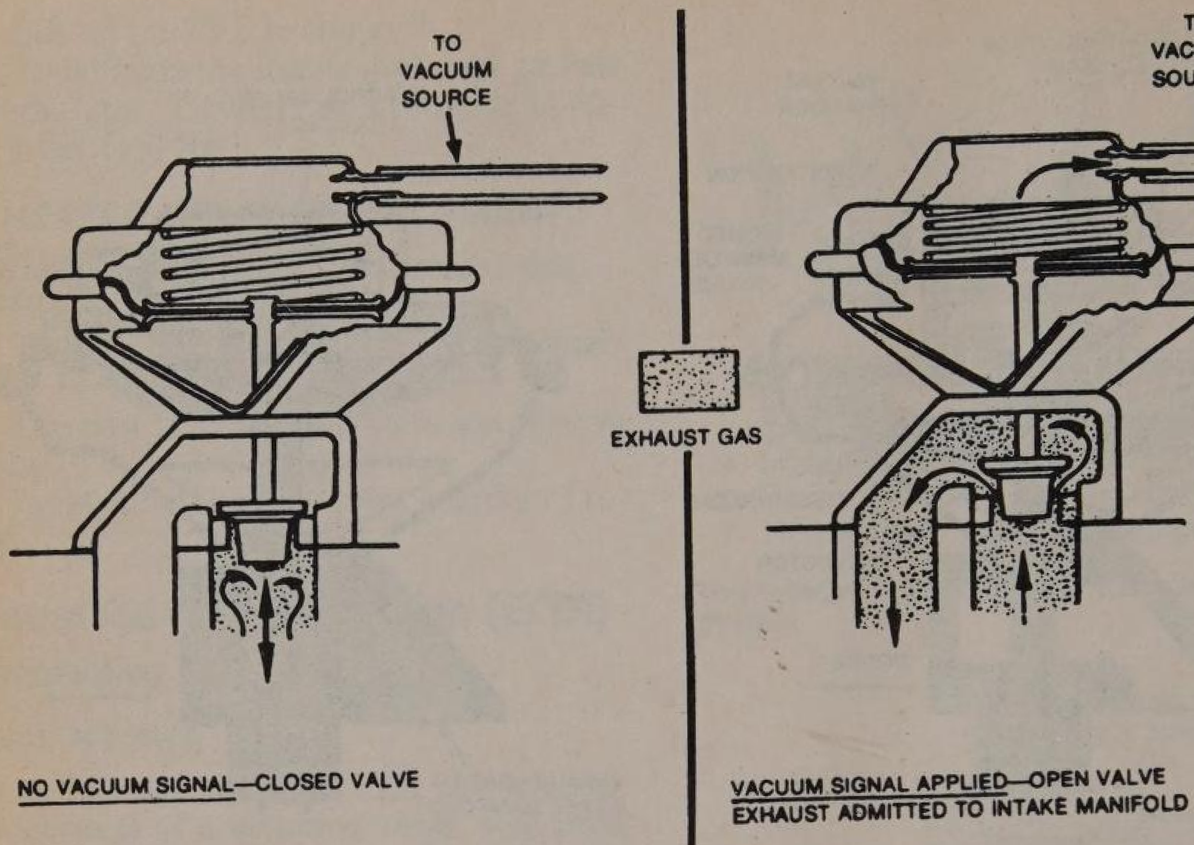
Optional Controls

THERMOSTATIC VACUUM SWITCH (TVS)

The switch is sometimes used in combination with the EGR valve to close off vacuum during cold operation.



ECM and vacuum operated EGR valve schematic



Vacuum operated EGR valve

VACUUM/SOLENOID CONTROL

Some systems use a coolant temperature switch, throttle position switch and pressure sensor with the 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 does not move freely, the valve should be replaced. The use of a mirror will aid the inspection process.

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 does not 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 does not change, check the EGR passages in the intake manifold for blockage.

REMOVAL AND INSTALLATION

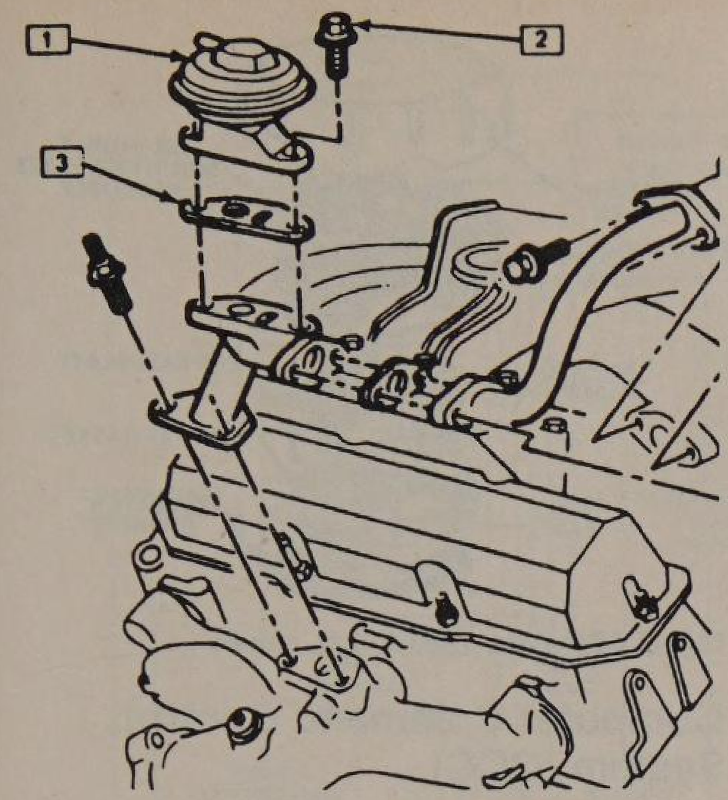
1. Disconnect the vacuum hose.
2. Remove the bolts or nuts holding the EGR valve to the engine.
3. Remove the valve.
4. Clean the mounting surfaces before replacing the valve. Install the valve onto the manifold, using a new gasket. Be sure to install the spacer, if used. Connect the vacuum hose and check the valve operation.

ECM and Vacuum Operated

OPERATIONS

The EGR vacuum control has a vacuum solenoid that uses pulse width modulation. The ECM turns the solenoid ON and OFF many times a second and varies the amount of ON time. The ECM uses information from the coolant temperature, manifold air temperature, throttle position and park/neutral sensors to regulate EGR function.

The ECM operates a solenoid to control the EGR valve. The solenoid is normally closed. By providing a ground path, the ECM energizes the solenoid and then allows vacuum to pass to



1. EGR valve
2. Bolts 23 ft. lbs. (31 Nm)
3. Gasket

EGR valve 6–2.8L engine

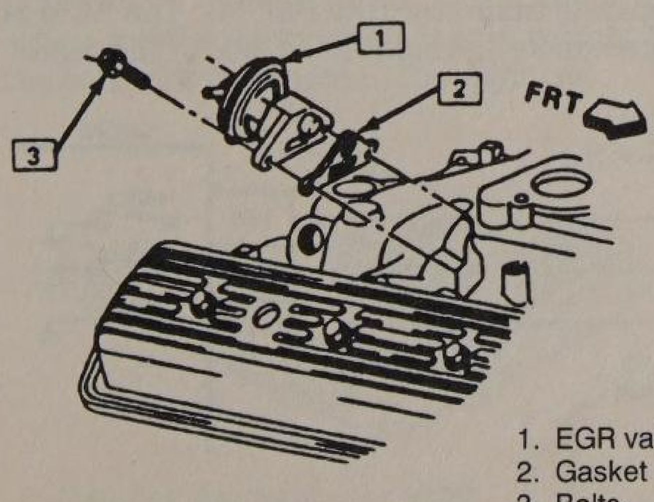
the EGR valve. A code 32 indicates an EGR circuit malfunction when hocked up to diagnostic equipment.

SYSTEM CHECKS

1. Ground the ALDL (assembly line diagnostic link) A and B terminals to put the ECM into the diagnostic mode. The EGR solenoid should be energized and allow vacuum to be applied to the valve and vacuum should hold.

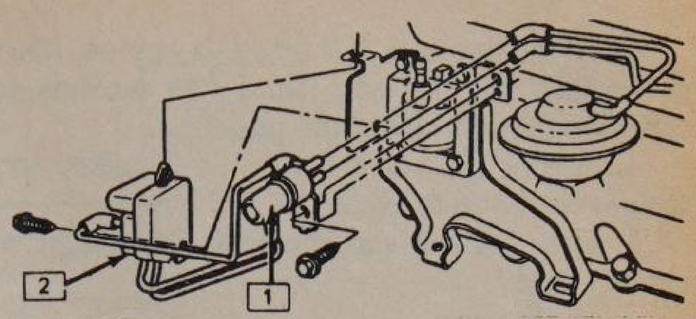
2. When the ALDL is ungrounded, the vacuum to the EGR valve should bleed off through the vent in the EGR solenoid. No bleed off may indicate a problem. This test will indicate if the electrical control is at fault or if the connector or solenoid is at fault.

3. The system uses a negative backpressure EGR valve which should hold vacuum with the engine OFF.



1. EGR valve
2. Gasket
3. Bolts

EGR valve 8–5.0L TBI engine



1. EGR control solenoid
2. EGR diagnostic vacuum switch

EGR control solenoid 6–2.8L engine

4. When the engine is started, exhaust backpressure should cause the vacuum to bleed off and the valve should fully close.

5. AT 2000 rpm, there should be at least 7 in. Hg (25 kPa) of vacuum at the valve.

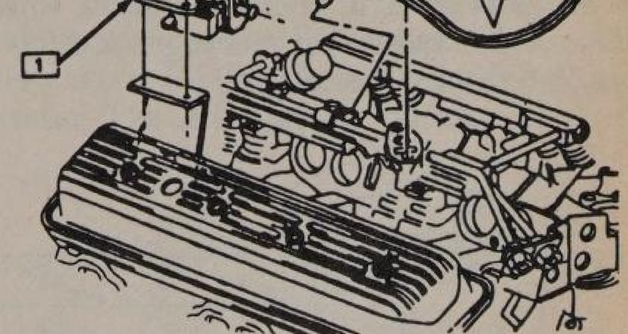
6. If the EGR valve operates properly, but an EGR problem still exists, the passages in the exhaust or intake manifolds may be obstructed. Remove the valve and clean deposits from the passages.

REMOVAL AND INSTALLATION

1. Disconnect the negative (–) battery cable.
2. Remove the air cleaner.
3. Remove the EGR valve vacuum hose, bolts and valve from the engine.

To install:

1. With a wire brush, buff the exhaust deposits from the mounting surfaces and around the valve.
2. Remove deposits from the valve inlet and outlet with a scraper.



1. EGR solenoid
2. Coil
3. Bolt 16 ft. lbs. (21 Nm)
4. EGR valve
5. Bolts
6. EGR diagnostic temp. switch 105 inch lbs. (12 Nm)

EGR valve and solenoid 8 –5.0L and 8–5.7L TPI engines

3. If the deposits fall into the engine, start the engine for no more than two seconds to blow the deposits from the passages.
4. Install the valve with a new gasket and torque the bolts to 16 ft. lbs. (22 Nm).
5. Connect the vacuum hose and negative battery cable.

Digitally Operated

OPERATION

The 1990 3.1L V6 engine is equipped with a digital EGR valve. The valve is designed to accurately supply exhaust gas to the engine independent of manifold vacuum. The valve regulates the flow of exhaust gas into the intake manifold through three orifices. The three orifices increment in size and produce seven combinations. When the solenoid is energized, the armature with the attached shaft and swivel pintle is lifted, opening the orifice. The EGR valve is usually open under warn engine operation above idle speed.

The ECM uses information from the coolant temperature, throttle position and manifold absolute pressure sensors.

An engine code 32 indicates an EGR circuit problem with diagnostic equipment installed.

SYSTEM CHECKS

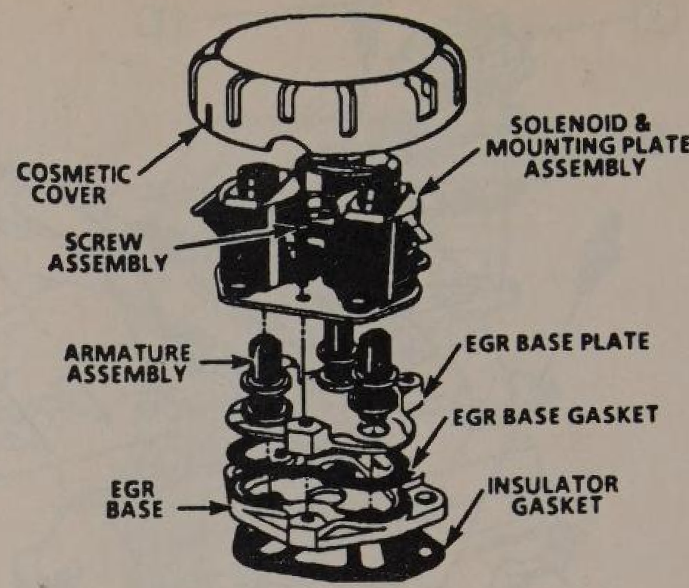
Too much EGR flow at idle, cruise or cold operation may produce the following condition.

- Engine stops after cold start
- Engine stops at idle after deceleration
- Vehicle surges during cruise
- Rough idle

Too little or no EGR flow allows combustion temperatures to get too high and may produce the following condition.

- Spark knock (detonation)
- Engine overheating
- Emission test failure

NOTE: *If the digital EGR valve shows signs of excessive heat, a melted condition. Check the exhaust system for blockage (possibly a plugged catalytic converter).*



Digital EGR valve 1990 6–3.1L engine

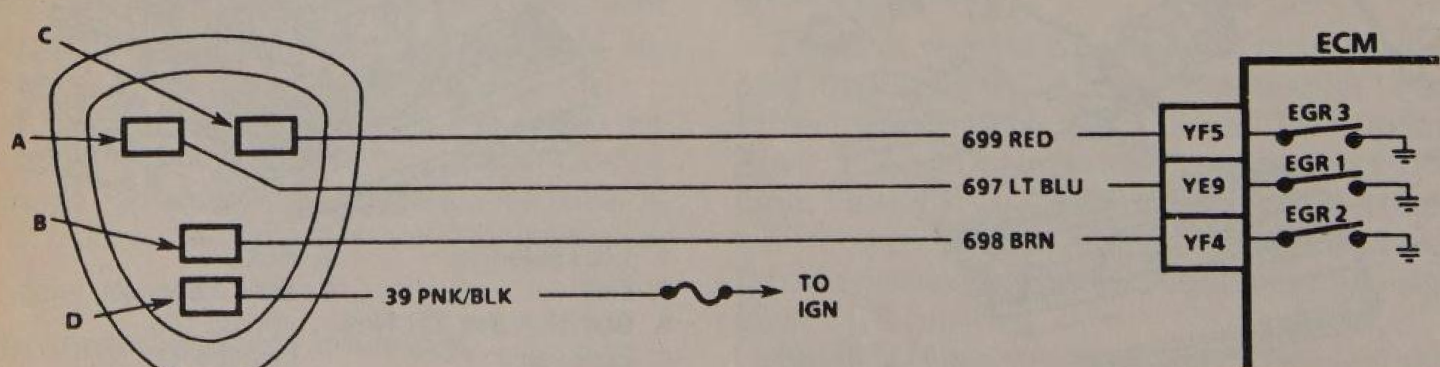
Computer Command Control System (CCC)

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 NOx.

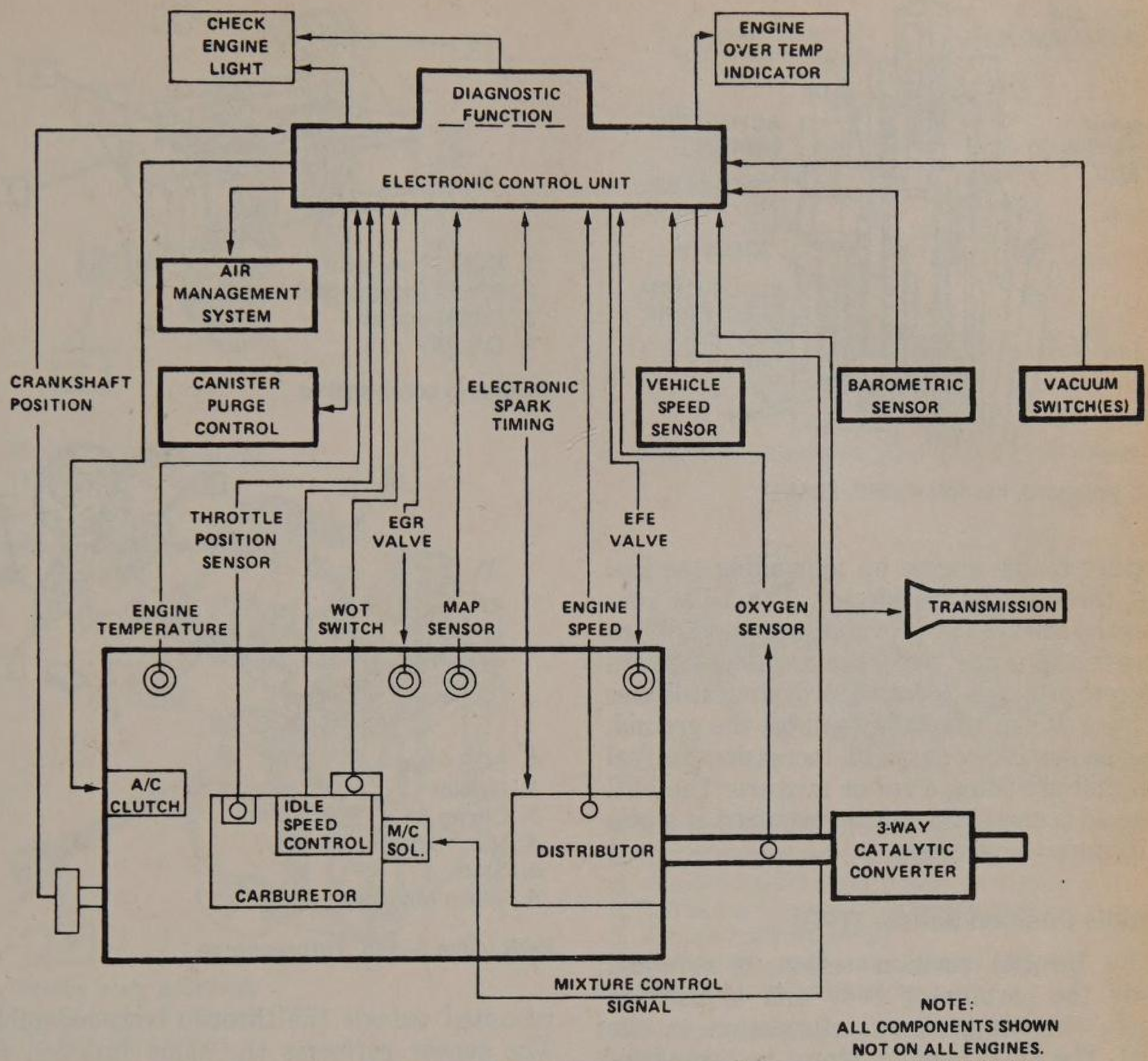
OPERATION

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.



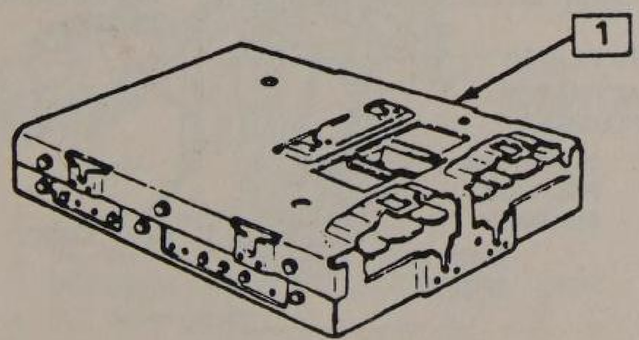
Digital EGR valve schematic



Computer Control Command schematic

Prom

To allow the Controller to be used in many different vehicles, a device called a Calibrator of 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.



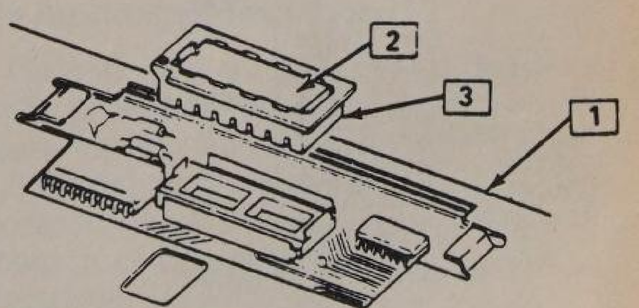
1. Electronic control module (ECM)

Electronic Control Module (ECM)

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.*

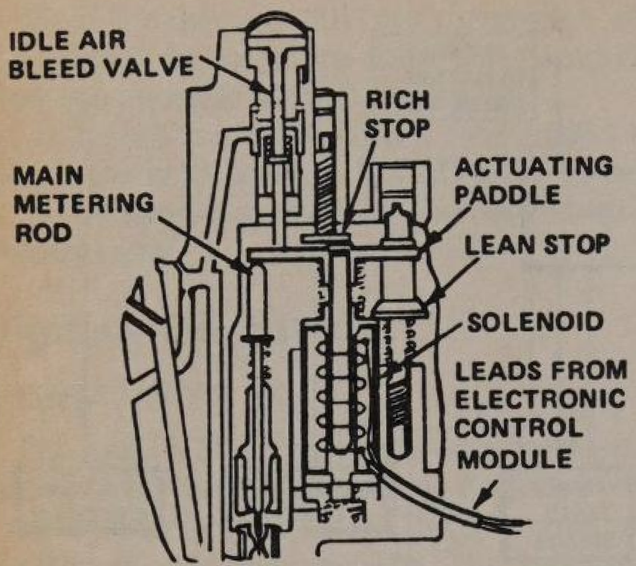
Mixture Control Solenoid (M/C)

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

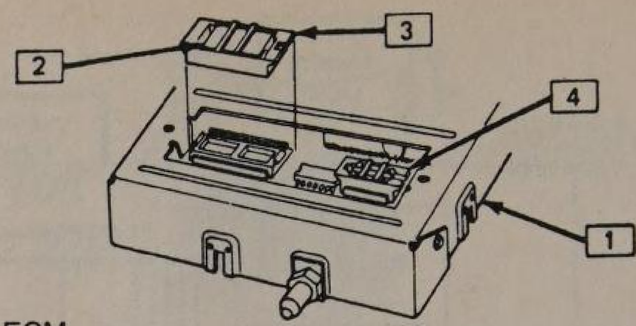


1. ECM
2. Prom (engine calibrator)
3. Prom carrier

Programmable Read Only Memory (PROM)



M/C solenoid, models E2ME, E4ME



1. ECM
2. PROM (engine calibrator)
3. PROM carrier
4. CALPAK

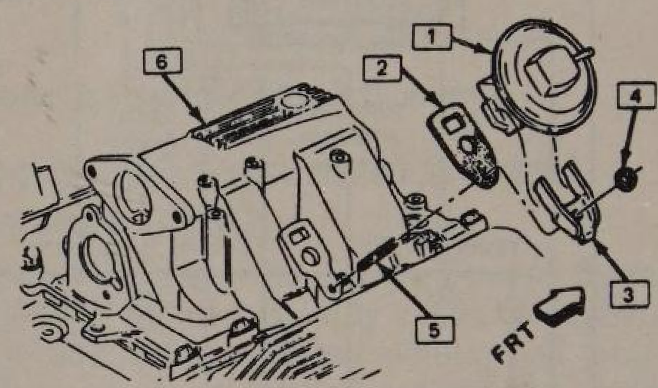
ECM and components

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 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 inside 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.

The throttle position sensor (TPS) is



1. EGR valve
2. Gasket
3. Clamp
4. Nut, 15 ft. lbs. (20 Nm)
5. Stud
6. Intake manifold

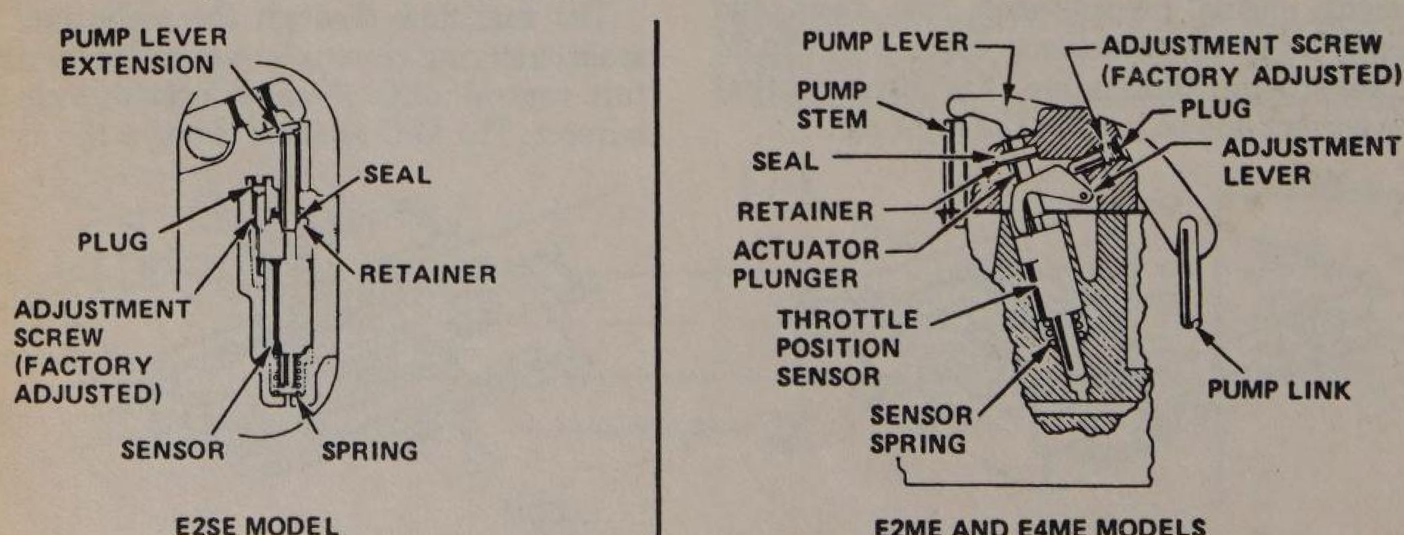
EGR valve 6–3.8L Turbo engine

mounted outside the throttle body assembly. The sensor performs the same function for both the carbureted and fuel injected models.

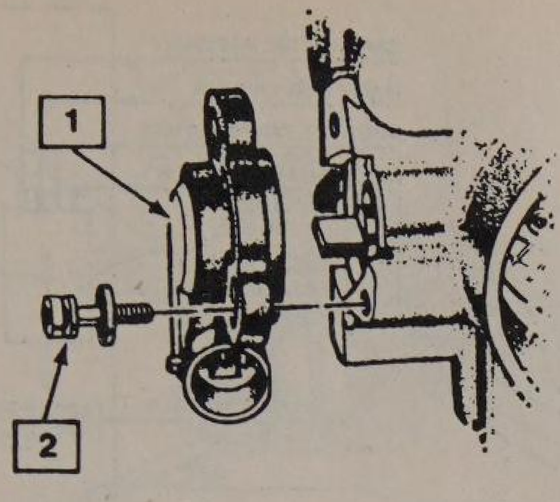
Idle Speed Control (ISC)

CARBURETED

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

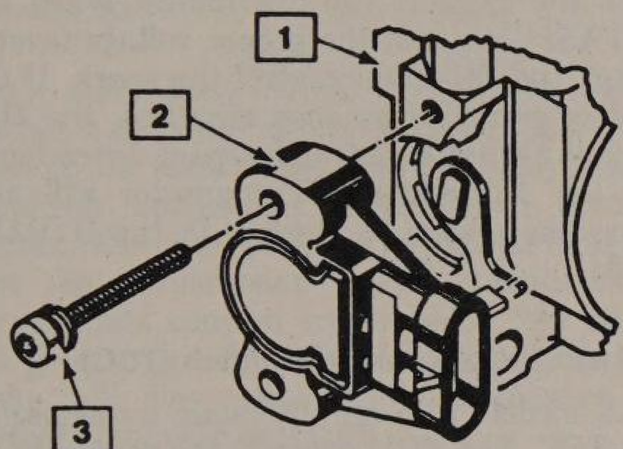


Throttle Position Sensor (TPS)



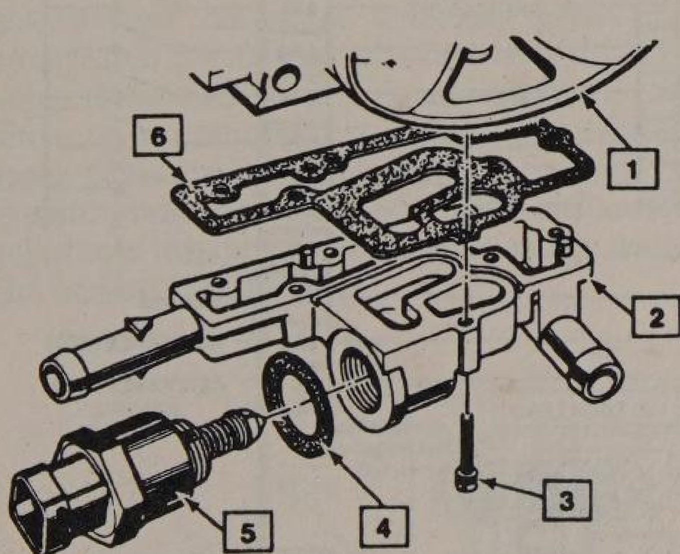
1. Throttle position sensor
2. TPS attaching screw

Throttle position sensor V6 TPI



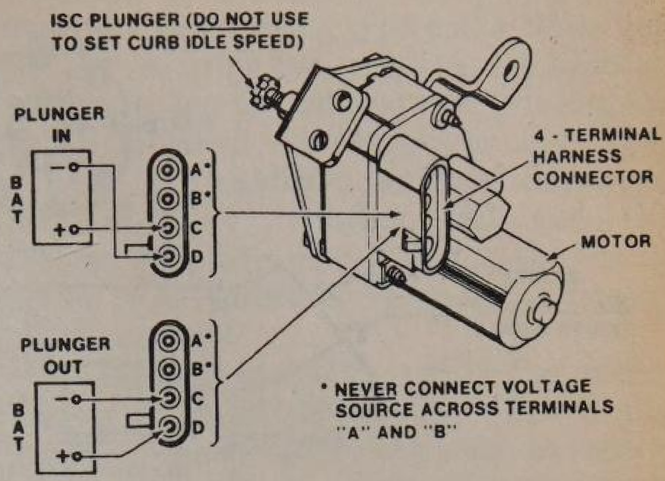
1. Throttle body assembly
2. Throttle position sensor (TPS)
3. TPS attaching screw

Throttle position sensor V8 engine

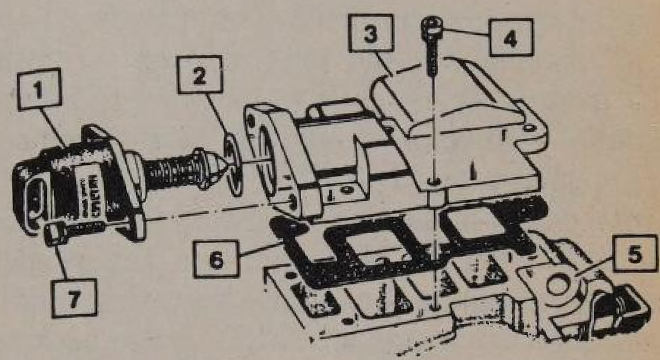


1. Throttle body assembly
2. IAC coolant cover
3. IAC cover assembly to throttle body screw
4. IAC valve gasket
5. Idle air control valve
6. IAC coolant cover to throttle body gasket

Idle air control valve V8 fuel injected engines



Idle speed control E4ME and E4MC carburetors



1. Idle air control (IAC) valve assembly
2. Idle air control valve O-ring
3. Idle air/vacuum signal housing assembly
4. Idle air/vacuum signal assembly screw
5. Throttle body assembly
6. Idle air/vacuum signal assembly gasket
7. Idle air control valve screw

Idle air control valve 6–3.1L; 6–2.8L uses the screw-in IAC valve

assembly mounted on the carburetor which moves the throttle lever so as to open or close the throttle blades.

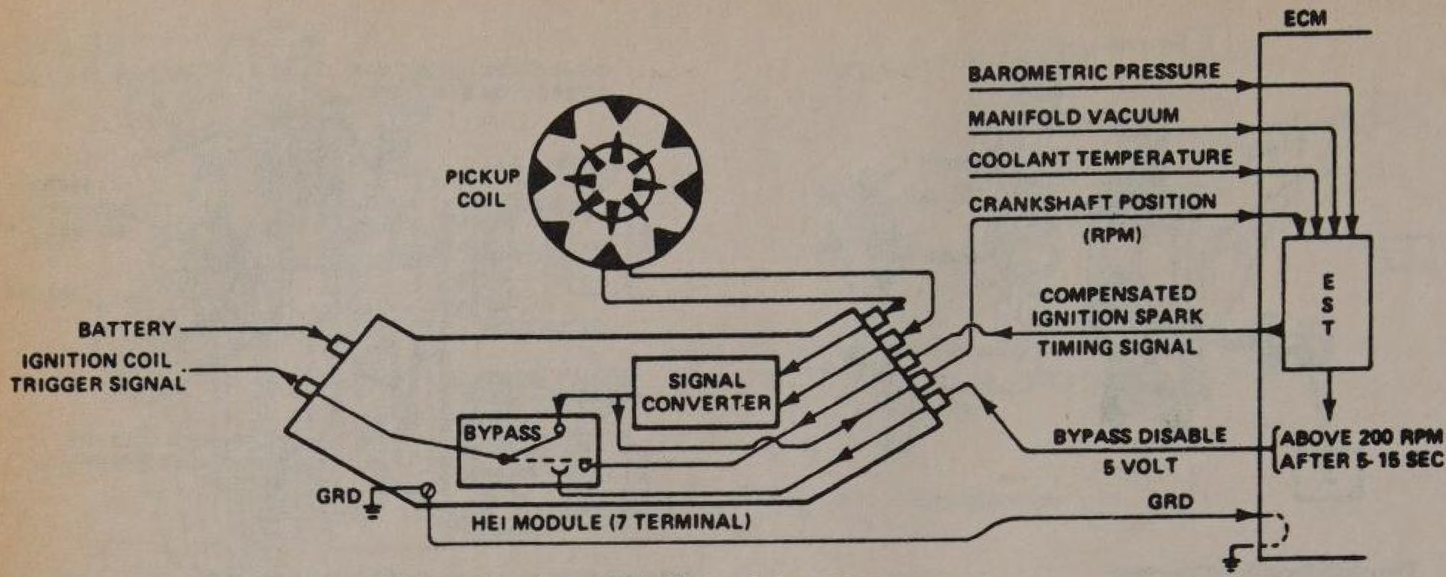
The whole operation is controlled by the ECM. The ECM monitors engine load to determine the proper idle speed. To prevent stalling, it monitors the air conditioning compressor switch, the transmission, the park/neutral switch and the ISC throttle switch. The ECM processes all this information and then uses it to control the ISC motor which in turn will vary the idle speed as necessary.

Idle Air Control (IAC) Valve

The IAC valve controls the engine idle speed, while preventing stalls due to changes in engine load for fuel injected engines. The valve is mounted on the throttle body and controls bypass air around the throttle valve. The pintle moves in and out to control the amount of air around the throttle plate.

Electronic Spark Timing (EST)

All models use EST. The EST distributor (except 3.8L Turbo), as described in an earlier



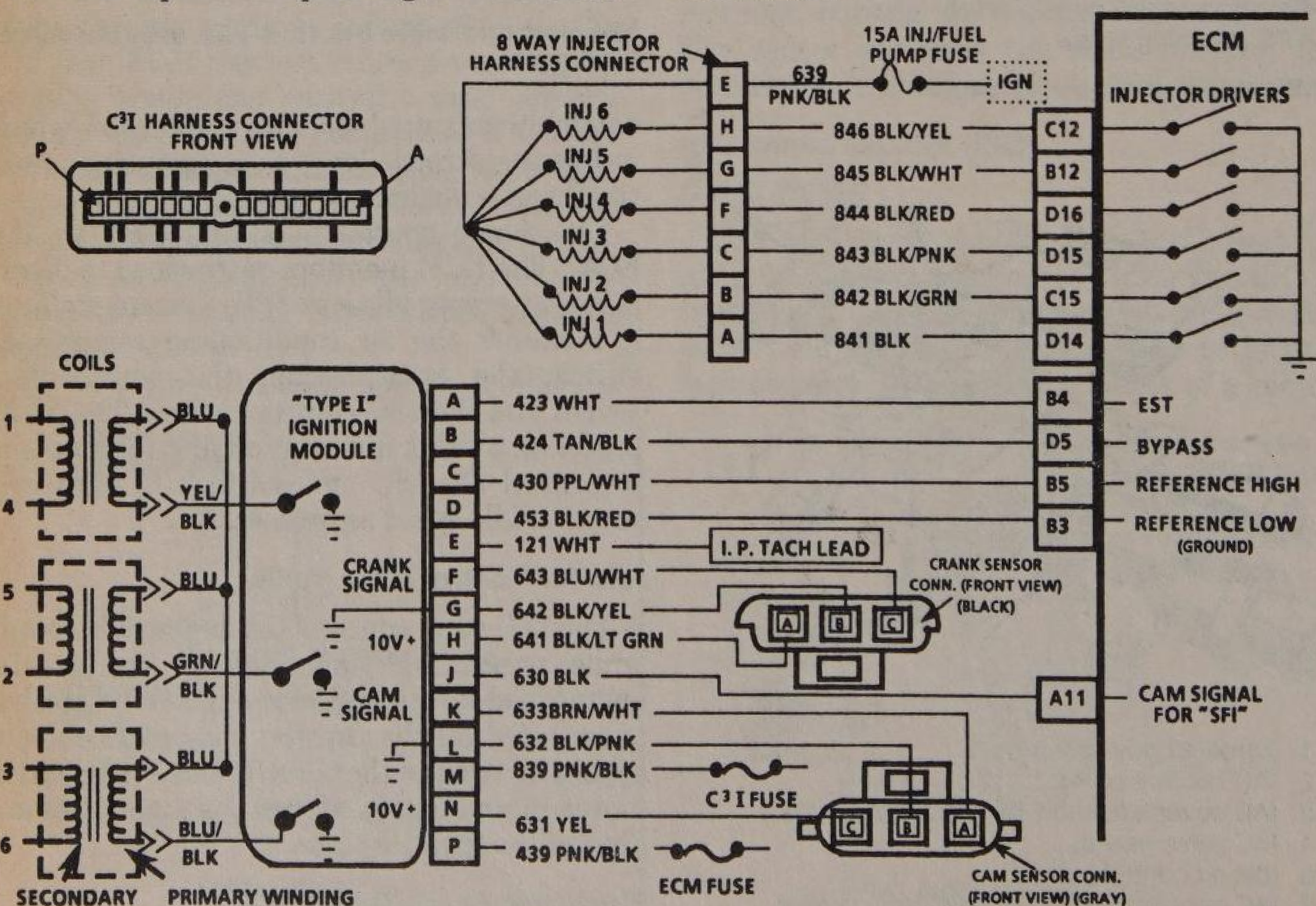
A schematic view of the EST circuitry

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.

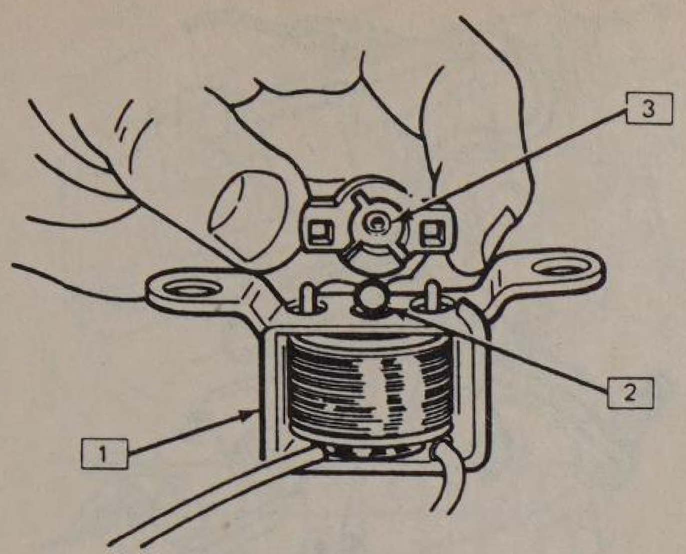
Under most normal operating conditions, the ECM will control the spark advance. However, under certain operating conditions such as cranking or when setting base timing, the distributor is capable of operating without ECM control. This condition is called BYPASS and is determined by the BYPASS lead which 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 connector 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 transmis-



Electronic spark timing 6–3.8L Turbo with C³I ignition



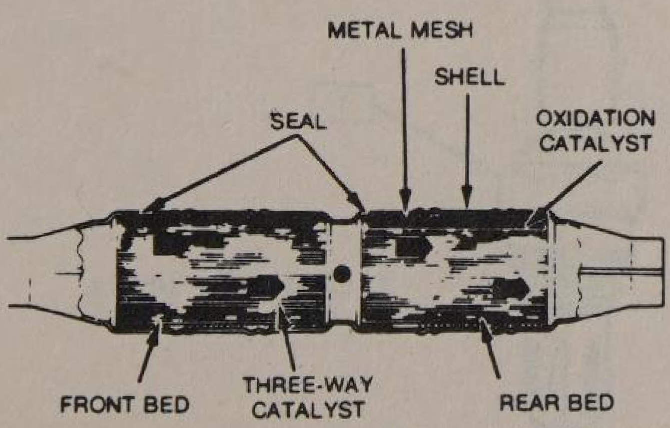
1. TCC solenoid
2. Check ball
3. Check ball seat

Torque converter clutch (TCC) solenoid located in the valve body

sion's valve body. 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.



Cutaway view of the typical three-way catalytic converter

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 or reducing NOx emissions. Thus, the three-way catalytic converter.

The three-way converter, unlike the oxidizing type, is capable of reducing HC, CO and NOx 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 NOx calls for the removal of oxygen. In actuality, the three-way 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.

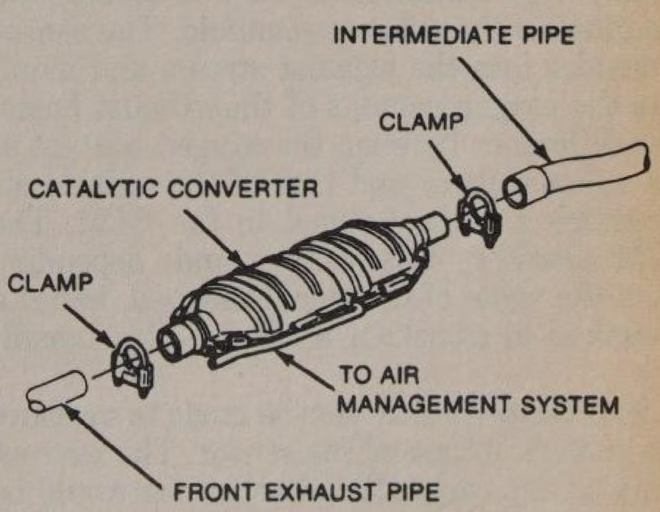
There are no service procedures required for the catalytic converter, although the converter body should be inspected occasionally for damage.

PRECAUTIONS

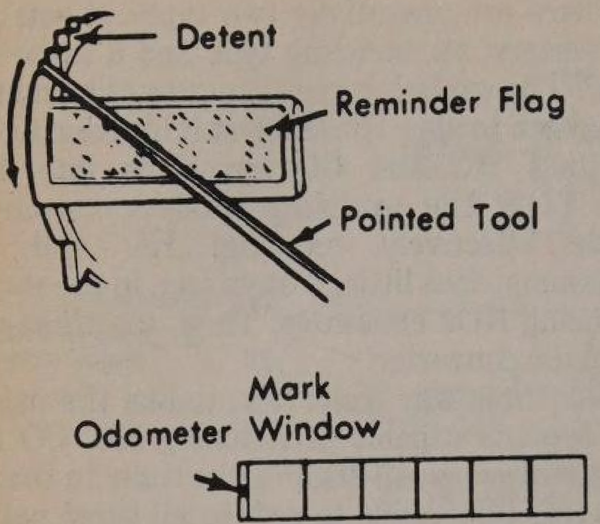
1. Use only unleaded fuel.
2. Avoid prolonged idling; the engine should run no longer than 20 min. at curb idle and no longer than 10 min. at fast idle.
3. Do not disconnect any of the spark plug leads while the engine is running.
4. Make engine compression checks as quickly as possible.

CATALYST TESTING

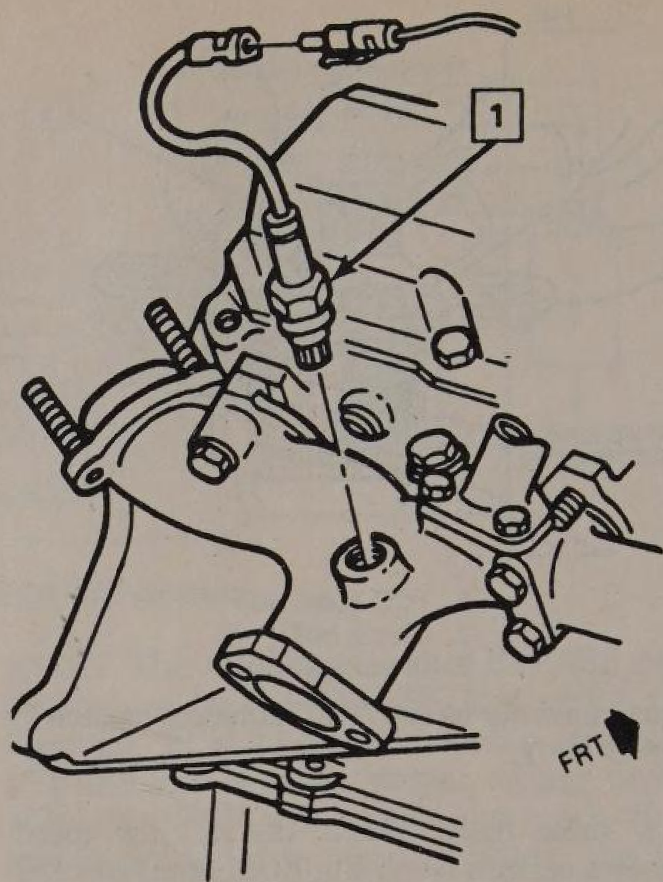
At the present time there is no known way to reliably test catalytic converter operation in the field. The only reliable test is a 12 hour and 40



The catalytic converter is upstream of the muffler



Resetting the emission odometer flag



1. Oxygen (O_2) sensor

Oxygen sensor 6–3.1L engine, all engines similar

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.

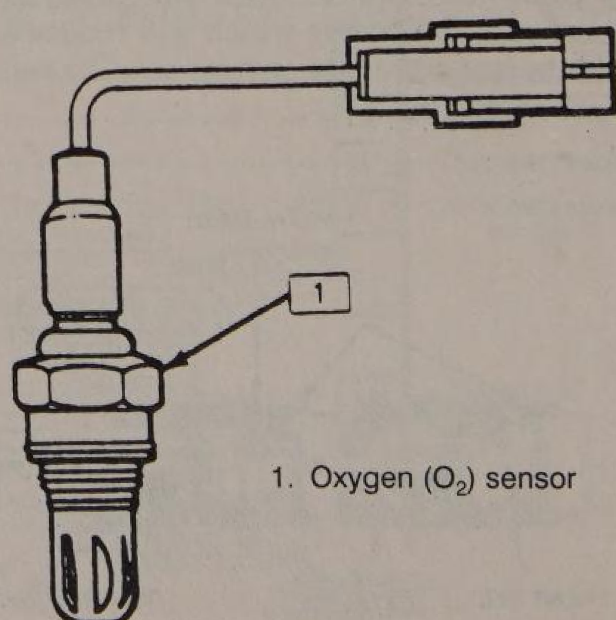
Oxygen Sensor

An oxygen sensor is used on all models and mounted in the exhaust manifold. The sensor protrudes into the exhaust stream and monitors the oxygen content of the exhaust hoses. 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.

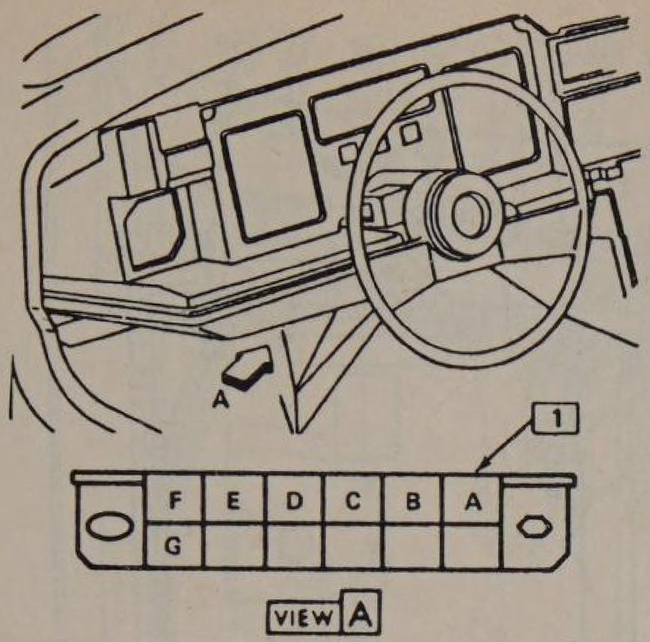
A "sensor" flag on the instrument panel indicates when the oxygen sensor must be replaced.

> 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.*



1. Oxygen (O_2) sensor

Oxygen sensor



1. ALCL Connector
A. Ground
B. Diagnostic "Test Terminal"
C. A.I.R.
E. Serial data
F. T.C.C.
G. Fuel pump

The ECM diagnostic terminal—ALDL is the same—the terminal is located under the steering column

REMOVAL AND INSTALLATION

The oxygen sensor must be replaced every 48,000 km (30,000 miles). The sensor may be difficult to remove when the engine temperature is blow 120°F (48°C). Excessive removal force may damage the threads in the exhaust manifold or pipe; follow the removal procedure carefully.

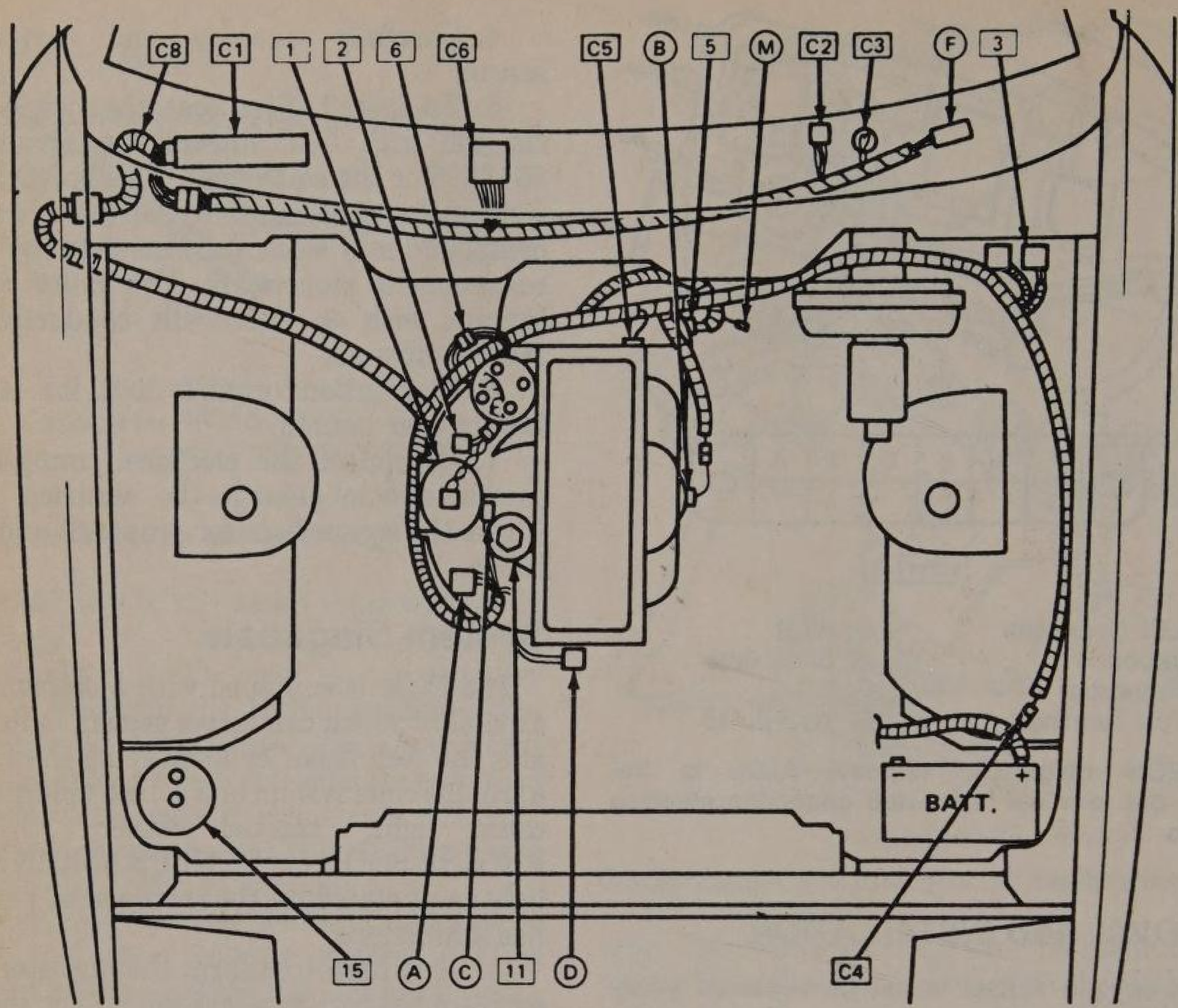
1. Locate the oxygen sensor. It protrudes from the center of the exhaust manifold at the front of the engine compartment (it looks somewhat like a spark plug).
2. Disconnect the electrical connector from the oxygen sensor.
3. Spray a commercial solvent onto the sensor threads and allow it to soak in for at least five minutes.
4. Carefully unscrew and remove the sensor.
5. To install, first coat the new sensor's threads with GM 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 over tighten.
7. Reconnect the electrical connector. Be careful not to damage the electrical pigtail. Check the sensor boot for proper fit and installation.

System Diagnosis

The ECM is equipped with a self-diagnostic capability which can detect system failures and aids the technician by identifying the fault via a trouble code system and a dash mounted indicator light, marked either "SERVICE ENGINE SOON" or "CHECK ENGINE". The light is mounted on the instrument panel and has 2 functions:

1. It is used to inform the operator that a problem has occurred and the vehicle should be taken in for service as soon as reasonably possible.
2. It is used by the technician to read out stored trouble codes in order to localize malfunction areas during the diagnosis and repair phases.

As a bulb and system check, the light will come on with the ignition key in the **ON** position and the engine not operating. When the engine is started, the light will turn off. If the light does not turn off, the self diagnostic system has detected a problem in the system. If the problem goes away, the light will go out, in most cases after 10 second, but a trouble code will be set in the ECM's memory.



"F" SERIES
2.5L (151 CID) L4 RPO: LR8 V.I.N. CODE: R

COMPUTER SYSTEM

- C1 Electronic Control Module (ECM)
- C2 ALCL Connector
- C3 "CHECK ENGINE" Light
- C4 System Power
- C5 System Ground
- C6 Fuse Panel
- C8 Computer Control Harness

AIR/FUEL SYSTEM

- 1 Throttle Body Injection
- 2 Idle Air Control
- 3 Fuel Pump Relay

TRANSMISSION CONVERTER CLUTCH CONTROL SYSTEM

- 5 Trans. Conv. Clutch Connector

IGNITION SYSTEM

- 6 Electronic Spark Timing Connector

EXHAUST GAS RECIRCULATION CONTROL SYSTEM

- 11 Exhaust Gas Recirculation Valve

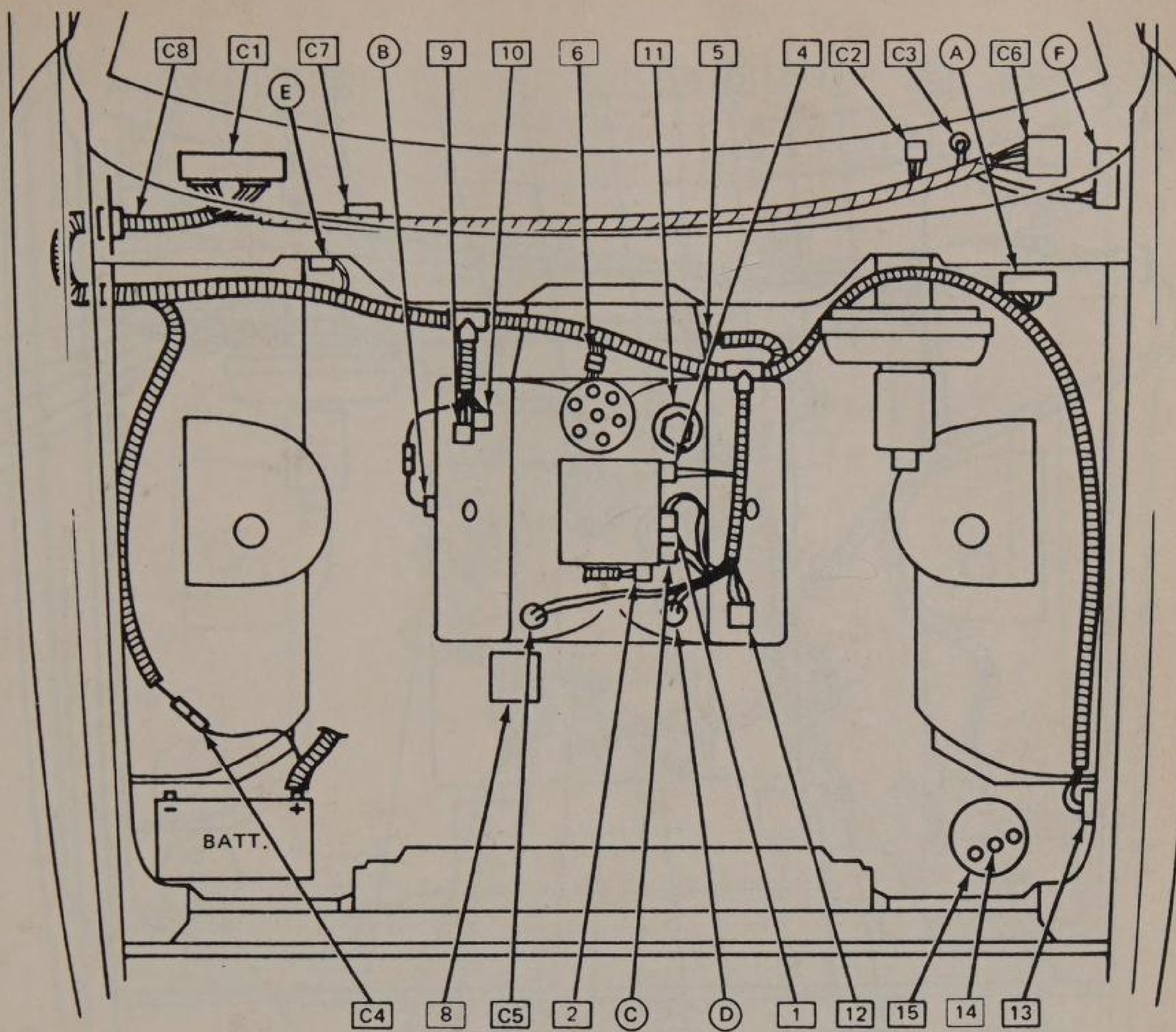
FUEL VAPOR CONTROL SYSTEM

- 15 Vapor Canister

SENSORS/SWITCHES

- A Manifold Pressure Sensor
- B Exhaust Oxygen Sensor
- C Throttle Position Sensor
- D Coolant Sensor
- F Vehicle Speed Sensor
- M Fuel Pump Test Connector

Component location—1982–84 2.5L TBI



"F" SERIES

2.8L (173 CID) V6   RPO: LC1/LL1 H.O.   V.I.N. CODE: 1/L

COMPUTER SYSTEM

- C1 Electronic Control Module (ECM)
- C2 ALCL Connector
- C3 "CHECK ENGINE" Light
- C4 System Power
- C5 System Ground
- C6 Fuse Panel
- C7 Lamp Driver
- C8 Computer Control Harness

AIR/FUEL SYSTEM

- 1 Mixture Control
- 2 Idle Speed Solenoid
- 4 Heated Grid EFE

TRANSMISSION CONVERTER CLUTCH CONTROL SYSTEM

- 5 Trans. Conv. Clutch Connector

IGNITION SYSTEM

- 6 Electronic Spark Timing Connector

AIR INJECTION SYSTEM

- 8 Air Injection Pump
- 9 Air Control Solenoid Valve (Divert)
- 10 Air Switching Solenoid Valve

EXHAUST GAS RECIRCULATION CONTROL SYSTEM

- 11 Exhaust Gas Recirculation Valve
- 12 Exhaust Gas Recirculation Solenoid Valve

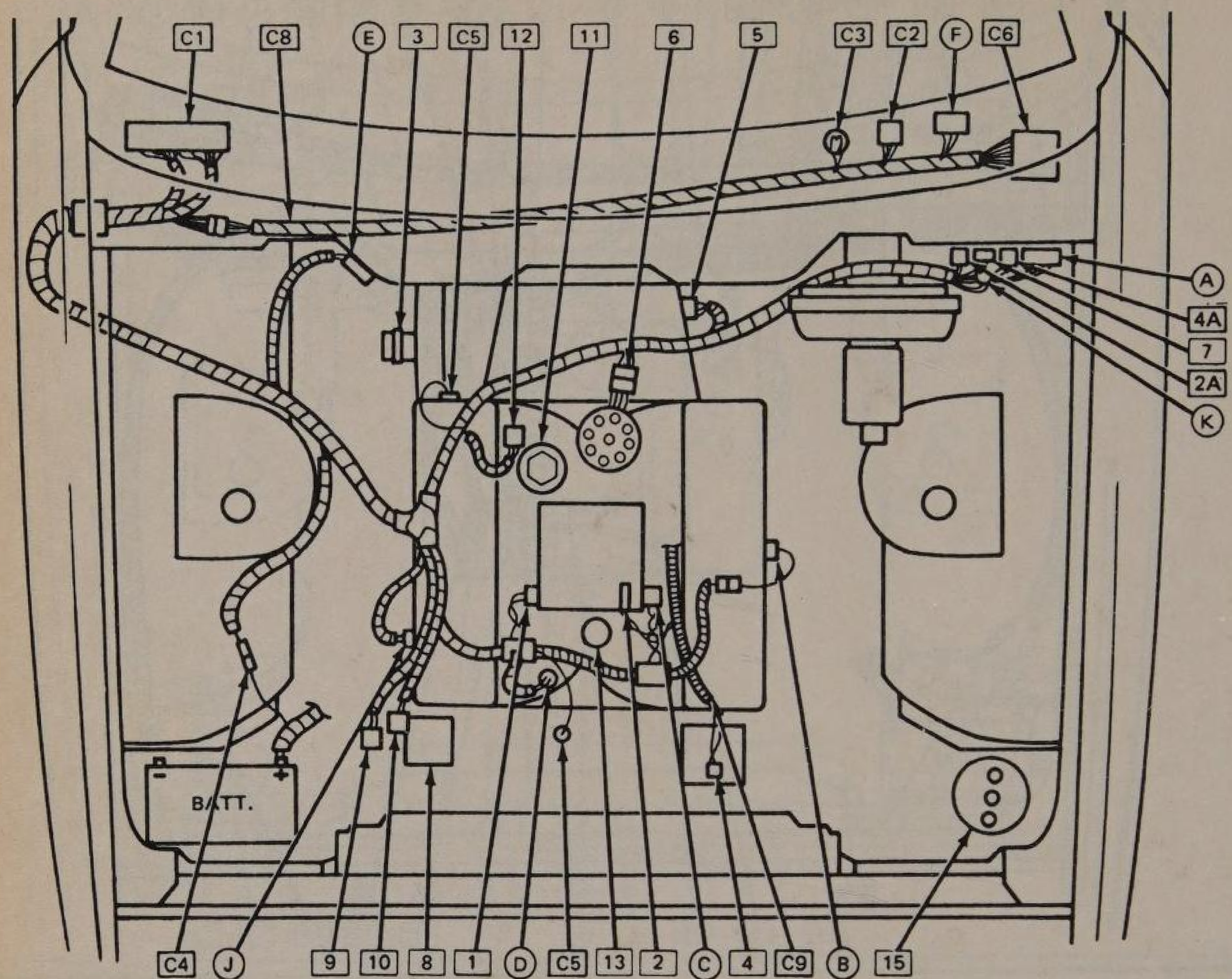
FUEL VAPOR CONTROL SYSTEM

- 13 Canister Purge Solenoid Valve
- 14 From Fuel Tank
- 15 Vapor Canister

SENSORS/SWITCHES

- A Differential Pressure Sensor
- B Exhaust Oxygen Sensor
- C Throttle Position Sensor
- D Coolant Sensor
- E Barometric Pressure Sensor
- F Vehicle Speed Sensor

Component location — 1982–84 2.8L carburetor



"F" SERIES
5.0L (305 CID) V8 RPO: LG4/L69 V.I.N. CODE: H/G

COMPUTER SYSTEM

- C1 Electronic Control Module (ECM)
- C2 ALCL Connector
- C3 "CHECK ENGINE" Light
- C4 Code Memory Power
- C5 System Ground
- C6 Fuse Panel
- C8 Computer Control Harness
- C9 Engine Harness

AIR/FUEL SYSTEM

- 1 Mixture Control
- 2 Idle Speed Solenoid
- 2A Throttle Kicker Control
- 3 EFE Valve
- 4 A/C Clutch Control
- 4A Engine Fan Relay

TRANSMISSION CONVERTER CLUTCH CONTROL SYSTEM

- 5 Trans. Conv. Clutch Connector

IGNITION SYSTEM

- 6 Electronic Spark Timing Connector
- 7 Electronic Spark Control (ESC) L69 Only

AIR INJECTION SYSTEM

- 8 Air Injection Pump
- 9 Air Control Solenoid Valve
- 10 Air Switching Solenoid Valve

EXHAUST GAS RECIRCULATION CONTROL SYSTEM

- 11 Exhaust Gas Recirculation Valve
- 12 Exhaust Gas Recirculation Solenoid Valve

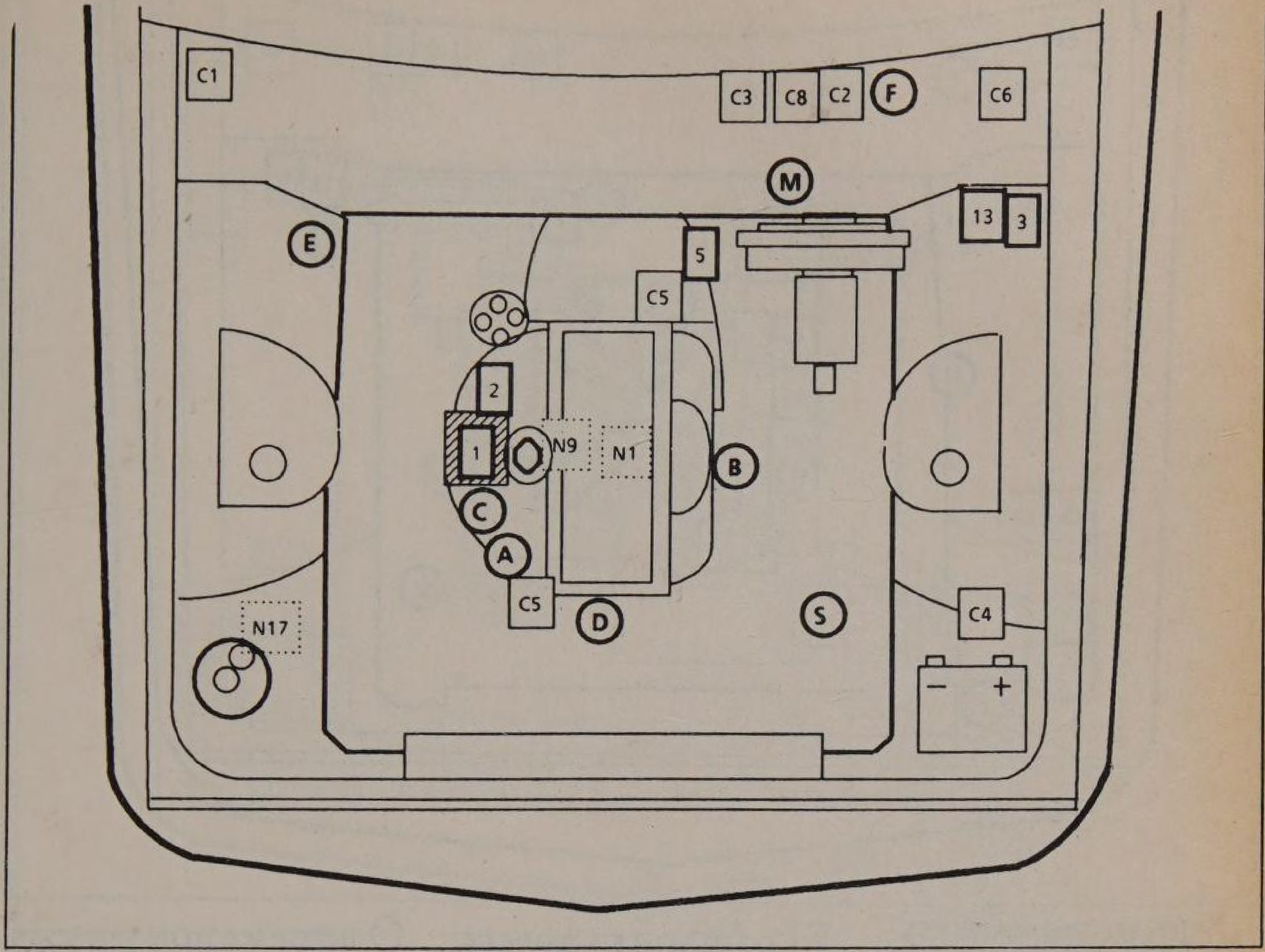
FUEL VAPOR CONTROL SYSTEM

- 13 Canister Purge Valve
- 15 Vapor Canister

SENSORS/SWITCHES

- A Differential Pressure Sensor
- B Exhaust Oxygen Sensor
- C Throttle Position Sensor
- D Coolant Sensor
- E Barometric Pressure Sensor
- F Vehicle Speed Sensor
- J ESC Sensor (Knock) L69 Only
- K Hood Louver Vacuum Switch

Component location—1982–84 5.0L carburetor



☐ COMPUTER HARNESS

- C1 Electronic Control Module (ECM)
- C2 ALCL diagnostic connector
- C3 "SERVICE ENGINE SOON" light
- C4 ECM power
- C5 ECM harness ground
- C6 Fuse panel
- C8 Fuel pump test (ALCL "G")

☐ CONTROLLED DEVICES

- 1 Fuel injector solenoid
- 2 Idle air control valve
- 3 Fuel pump relay
- 5 Trans. Conv. Clutch connector
- 13 A/C compressor relay
- Exhaust Gas Recirculation valve

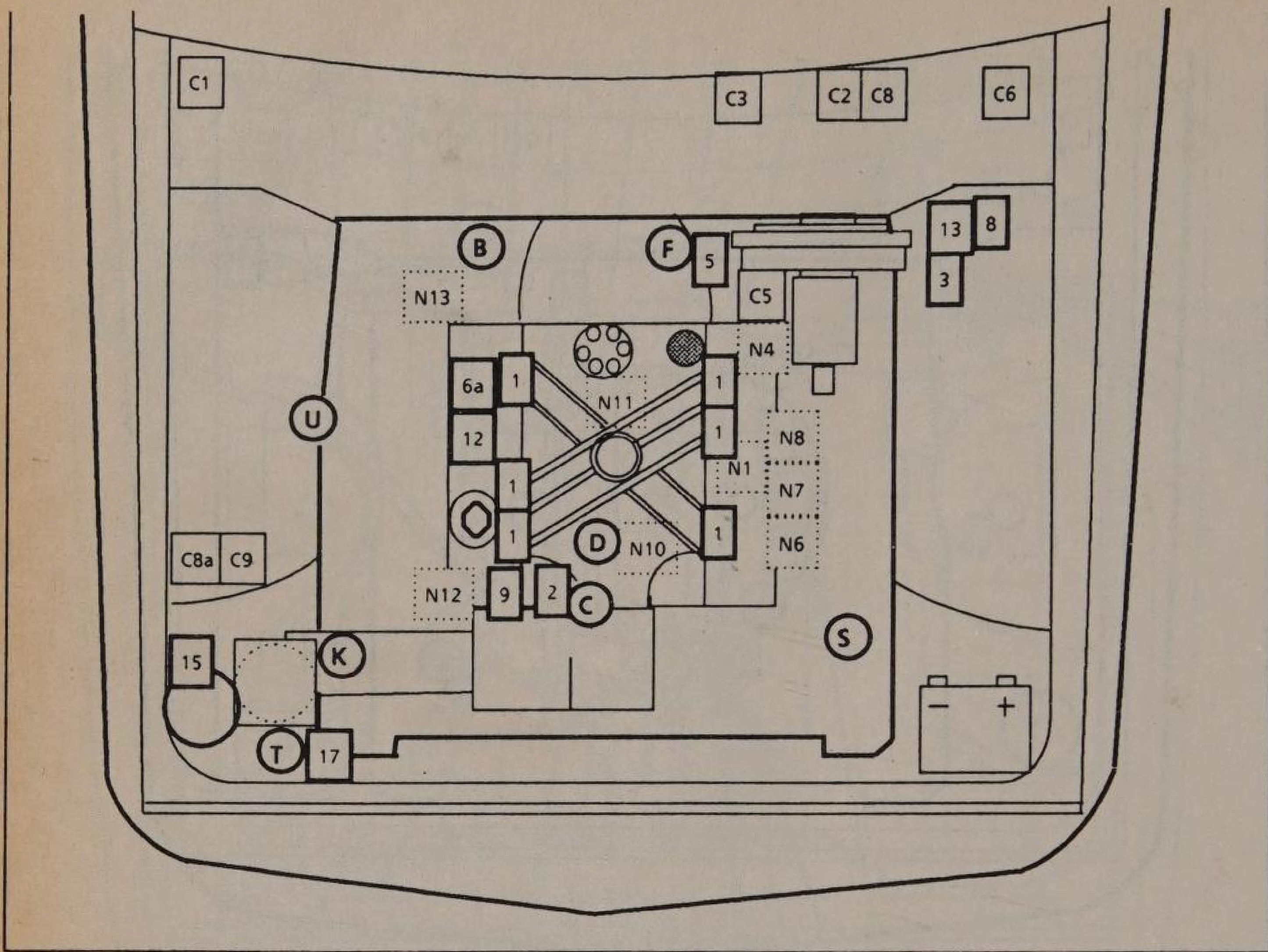
○ INFORMATION SENSORS

- A Manifold differential pressure
- B Exhaust oxygen
- C Throttle position
- D Coolant temperature
- F Vehicle speed
- M P/N switch / neutral start
- S Power steering switch

NOT ECM CONNECTED

- N1 Crankcase vent valve (PCV)
- N9 Exhaust Gas Recirculation valve
- N17 Fuel vapor canister

Component location – 1985–86 2.5L TBI



COMPUTER HARNESS

C1 Electronic Control Module (ECM)
C2 ALCL diagnostic connector
C3 "SERVICE ENGINE SOON" light
C5 ECM harness ground
C6 Fuse panel
C8 Fuel pump test connector (ALCL"G")
C8a Fuel pump/ECM fuse
C9 MAF Fuse

NOT ECM CONNECTED

N1 Crankcase vent (PCV) valve
N4 Engine temp. switch(telltale)
N4 Engine temp. sensor(gage)
N6 Oil press. switch (telltale)
N7 Oil press. sensor (gage)
N8 Oil press. swich (fuel pump)
N10 Cold start fuel injection switch
N11 Cold start valve
N12 Deceleration Valve
N13 Fan override switch

CONTROLLED DEVICES

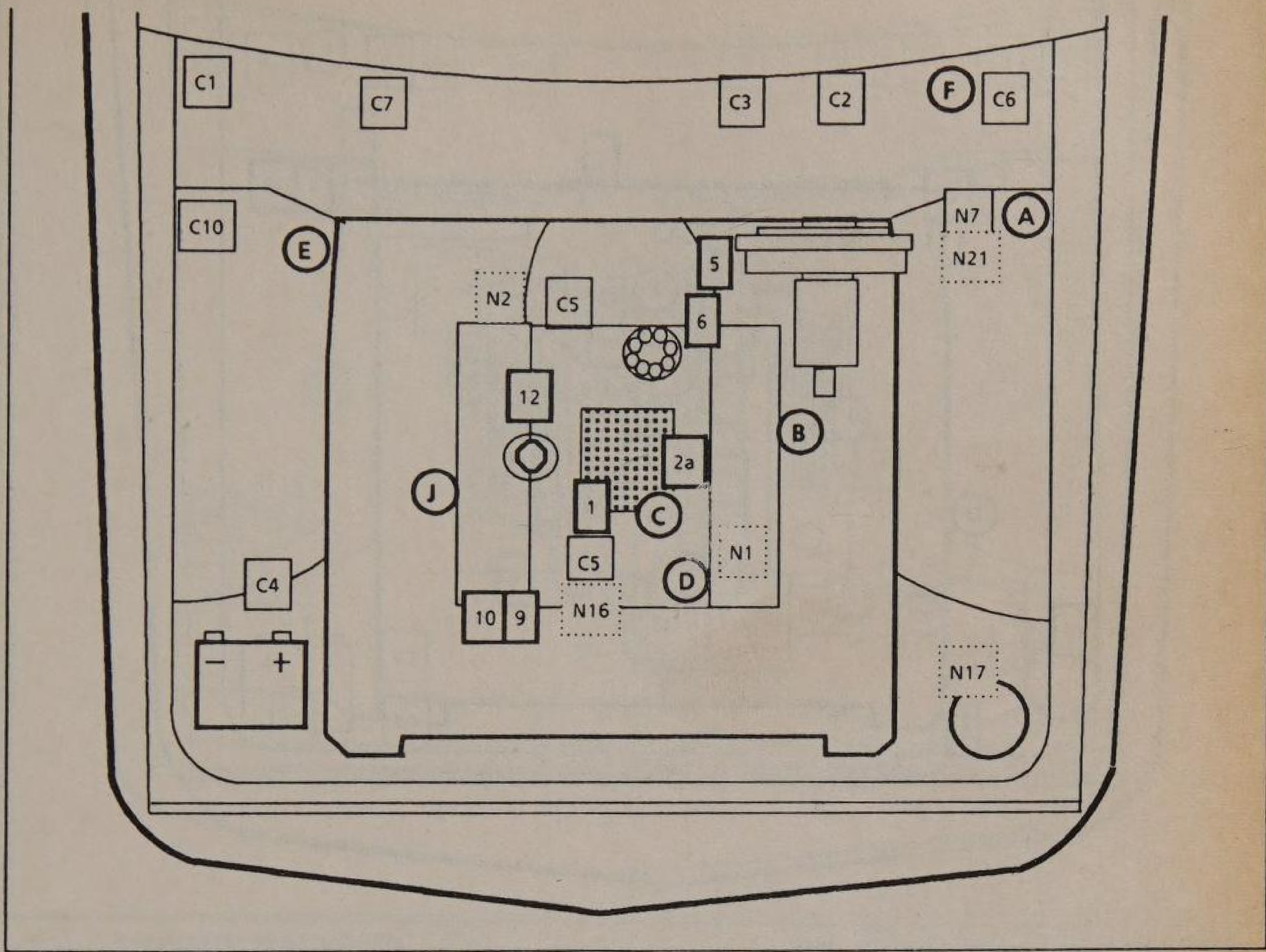
1 Fuel injector
2 Idle air control motor
3 Fuel pump relay
5 Trans. Conv. Clutch connector
6a Remote ignition coil
8 Engine coolant fan relay
9 Air injection control valve (M.T. only)
12 Exhaust Gas Recirculation solenoid
13 A/C compressor relay
15 Fuel vapor canister solenoid
17 Mass air flow sensor relay

Exhaust Gas Recirculation valve

INFORMATION SENSORS

B Exhaust oxygen
C Throttle position
D Coolant temperature
F Vehicle speed
K Mass Air Flow
S Power steering pressure switch
T Manifold Air Temperature
U A/C pressure fan switch

Component location – 1985–87 2.8L TPI



☐ COMPUTER HARNESS

- C1 Electronic Control Module (ECM)
- C2 ALCL diagnostic connector
- C3 "SERVICE ENGINE SOON" light
- C4 ECM power
- C5 ECM harness ground (2)
- C6 Fuse panel
- C7 "C. E." lamp driver
- C10 M/C dwell connector

NOT ECM CONNECTED

- N1 Crankcase vent (PCV) valve
- N2 Intake manifold warming (EFE)
- N16 Fuel vapor canister valve
- N17 Fuel vapor canister
- N21 Engine fan relay

☐ CONTROLLED DEVICES

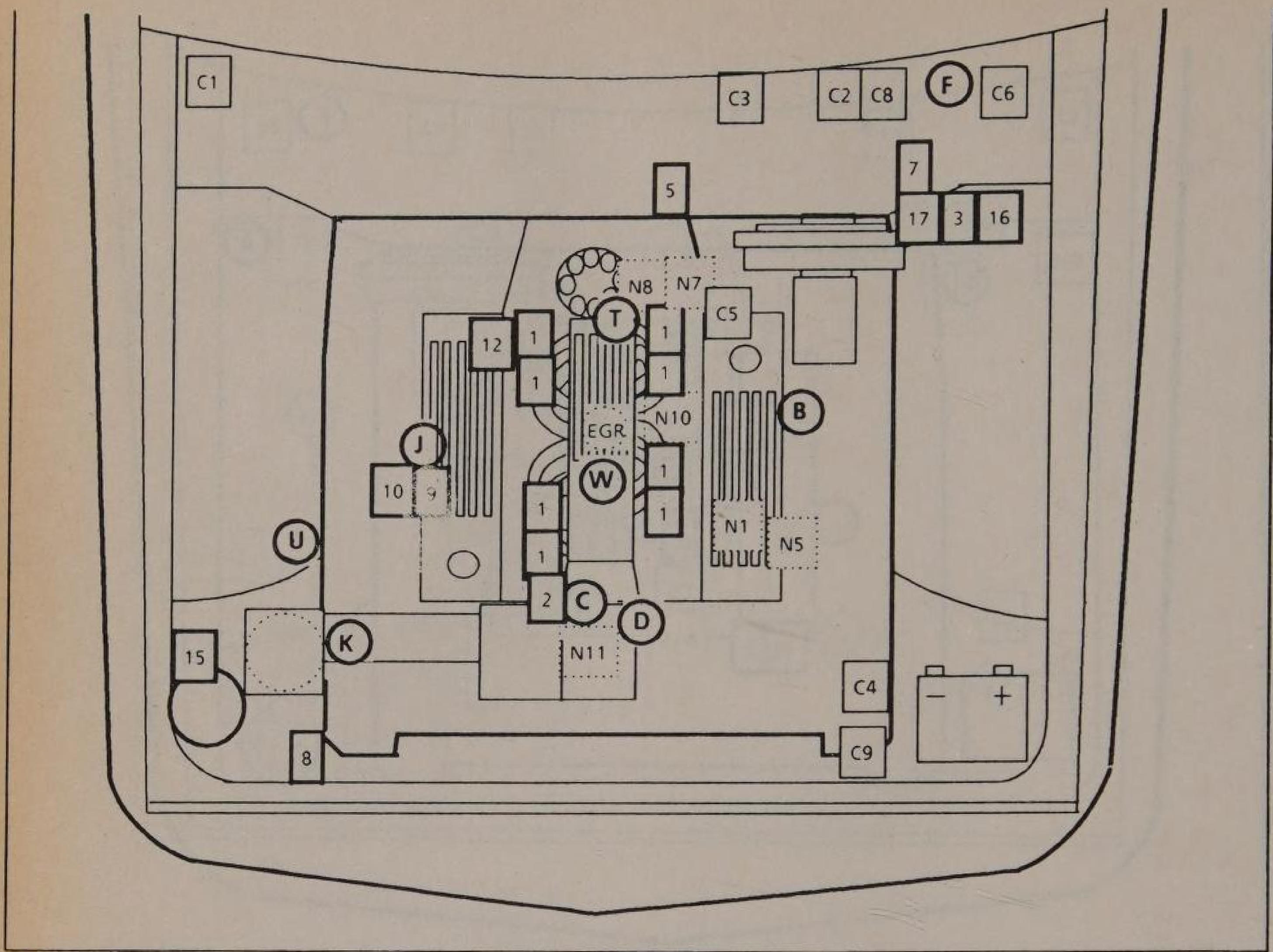
- 1 Mixture control solenoid
- 2a Electric throttle kicker (idle solenoid)
- 5 Trans. Conv. Clutch connector
- 6 Electronic Spark Timing Connector
- 7 Electronic Spark Control module
- 9 Air injection divert valve
- 10 Air injection switching valve
- 12 Exhaust Gas Recirc. solenoid (PWM)

Exhaust Gas Recirculation valve

O INFORMATION SENSORS

- A Differential Pressure (VAC)
- B Exhaust oxygen
- C Throttle position
- D Coolant temperature
- E Barometric pressure
- F Vehicle speed
- J ESC knock

Component location—1985–87 5.0L carbureted



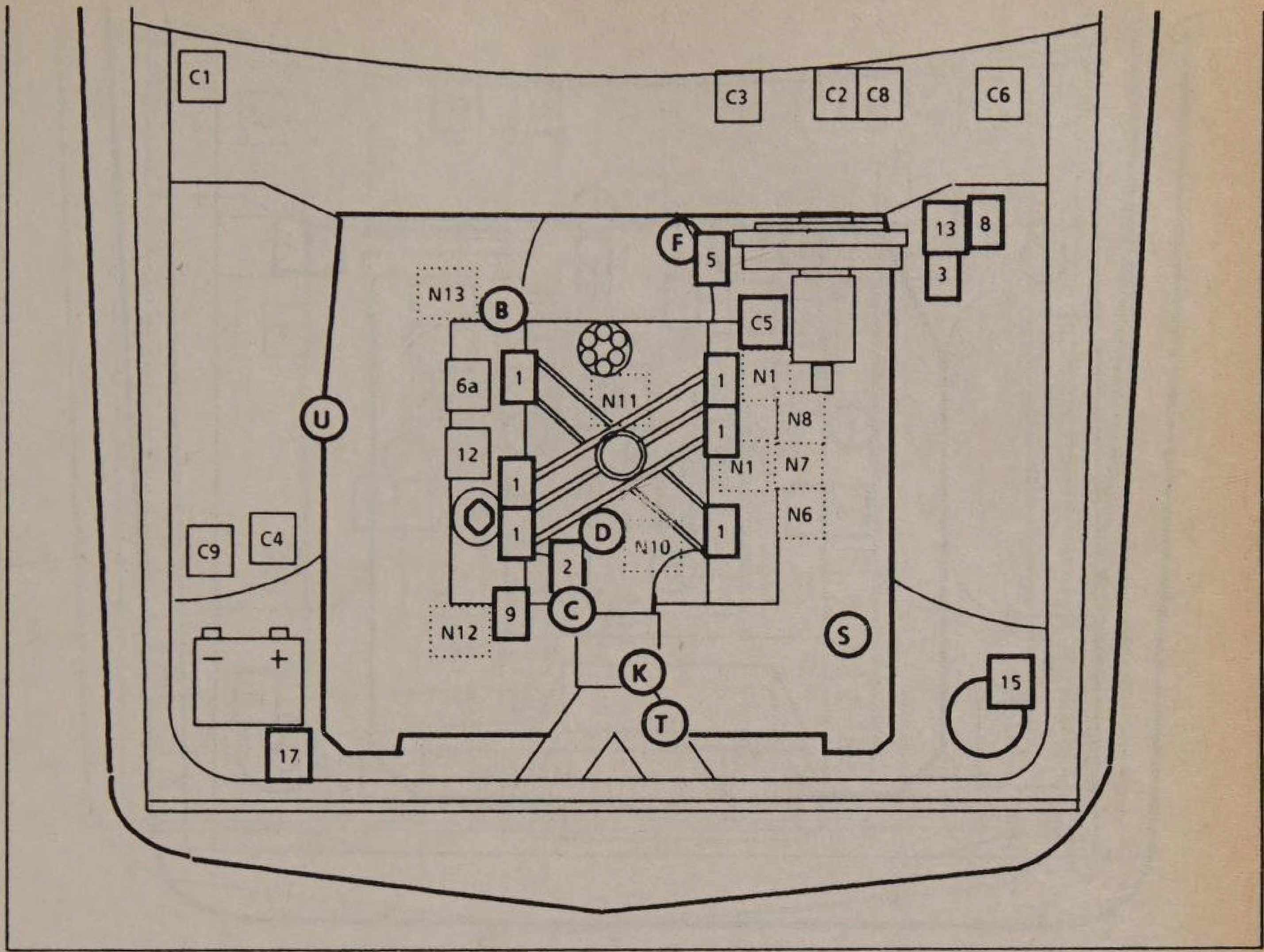
□ COMPUTER HARNESS
- C1 Electronic Control Module (ECM)
- C2 ALCL diagnostic connector
- C3 "SERVICE ENGINE SOON" light
- C4 ECM power
- C5 ECM harness ground
- C6 Fuse panel
- C8 Fuel pump test connector (ALCL "G")
- C9 Fuel pump/ECM fuse

⬚ NOT ECM CONNECTED
- N1 Crankcase vent valve (PCV)
- N5 Engine temp. sensor (gage.overheat)
- N7 Oil pressure sensor (gage)
- N8 Oil pressure switch (fuel pump)
- N10 Cold start valve
- N11 Cold start fuel injection switch

□ CONTROLLED DEVICES
- 1 Fuel injector
- 2 Idle air control motor
- 3 Fuel pump relay
- 5 Trans. Converter Clutch connector
- 7 Electronic Spark Control module
- 8 Engine cooling fan relay
- 9 Air injection divert valve
- 10 Air injection switching valve
- 12 Exh. Gas Recirc. vacuum solenoid
- 15 Fuel vapor canister solenoid
- 16 MAF sensor power relay
- 17 MAF sensor burn-off relay

○ INFORMATION SENSORS
- B Exhaust oxygen
- C Throttle position
- D Coolant temperature
- F Vehicle speed
- J ESC knock
- K Mass Air Flow
- T Manifold Air Temperature
- U A/C pressure fan switch
- W EGR temp. diagnostic switch

Component location—1986 5.0L TPI



☐ COMPUTER HARNESS

C1 Electronic Control Module (ECM)
C2 ALDL diagnostic connector
C3 "SERVICE ENGINE SOON" light
C4 ECM power/fuel pump fuse
C5 ECM harness ground
C6 Fuse panel
C8 Fuel pump test connector (ALDL "G")
C9 MAF fuse

NOT ECM CONNECTED

N1 Crankcase vent valve (PCV)
N4 Engine temp. switch (telltale)
N5 Engine temp. sensor (gage)
N6 Oil press. switch (telltale)
N7 Oil press. sensor (gage)
N8 Oil press. swich (fuel pump)
N10 Cold start fuel injection switch
N11 Cold start valve
N12 Deceleration Valve (M/T only)
N13 Fan Override Switch

☐ CONTROLLED DEVICES

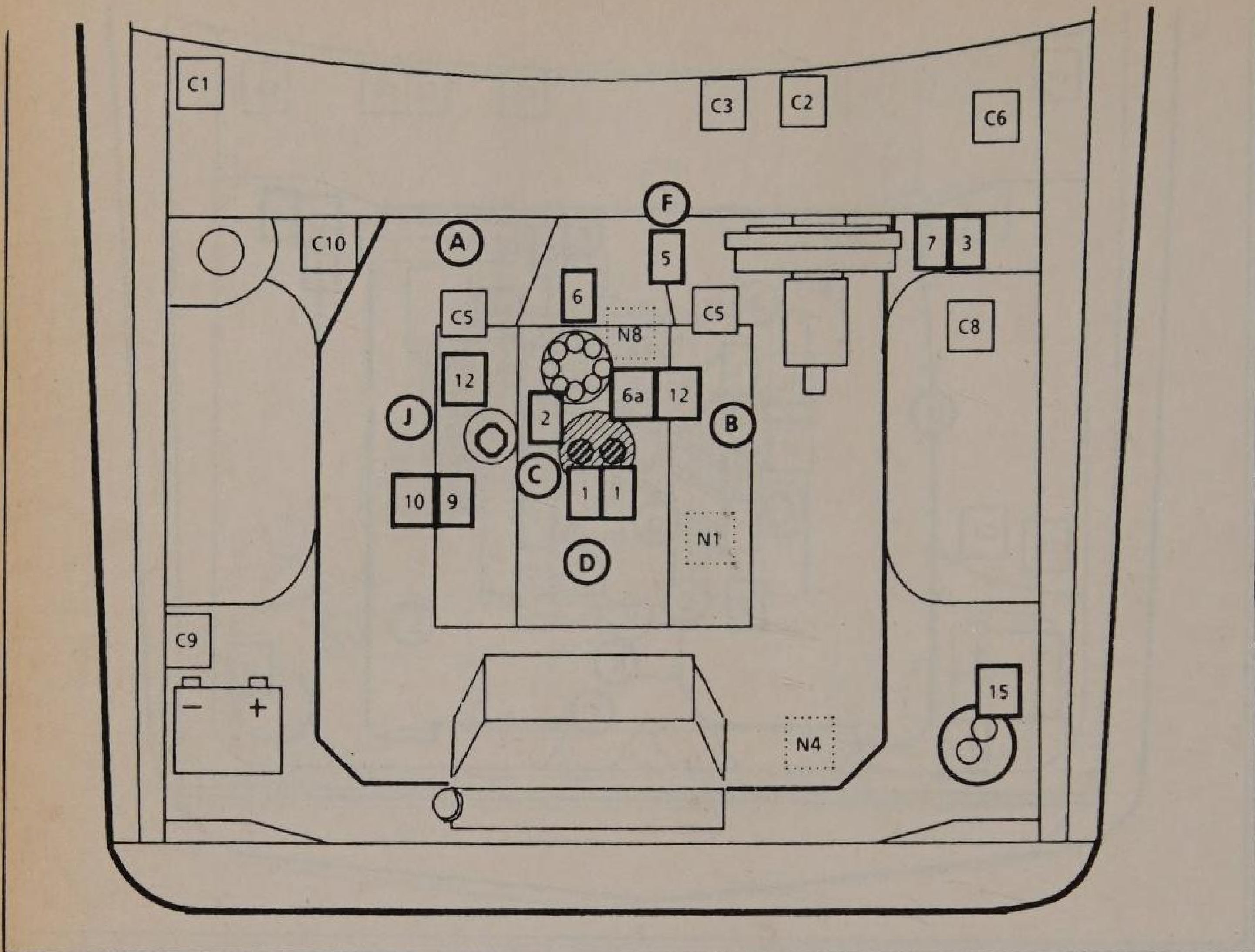
1 Fuel injector
2 Idle air control motor
3 Fuel pump relay
5 Trans. Conv. Clutch connector
6a Remote ignition coil
8 Engine coolant fan relay
9 Air control solenoid (M.T. only)
12 Exhaust Gas Recirculation solenoid
13 A/C compressor relay
15 Fuel vapor canister solenoid
17 Mass air flow sensor relay

Exhaust Gas Recirculation valve

○ INFORMATION SENSORS

B Exhaust oxygen
C Throttle position
D Coolant temperature
F Vehicle speed
K Mass Air Flow
S Power steering pressure switch
T Manifold Air Temperature
U A/C pressure fan switch

Component location – 1988–89 2.8L TPI



COMPUTER HARNESS

C1 Electronic Control Module
C2 ALDL diagnostic connector
C3 "SERVICE ENGINE SOON" light
C5 ECM harness grounds
C6 Fuse panel
C8 Fuel pump test connector
C9 Fuel pump fuse & ECM power
C10 Set timing connector

NOT ECM CONNECTED

N1 Crankcase vent valve (PCV)
N4 P/S Switch
N8 Oil pressure switch

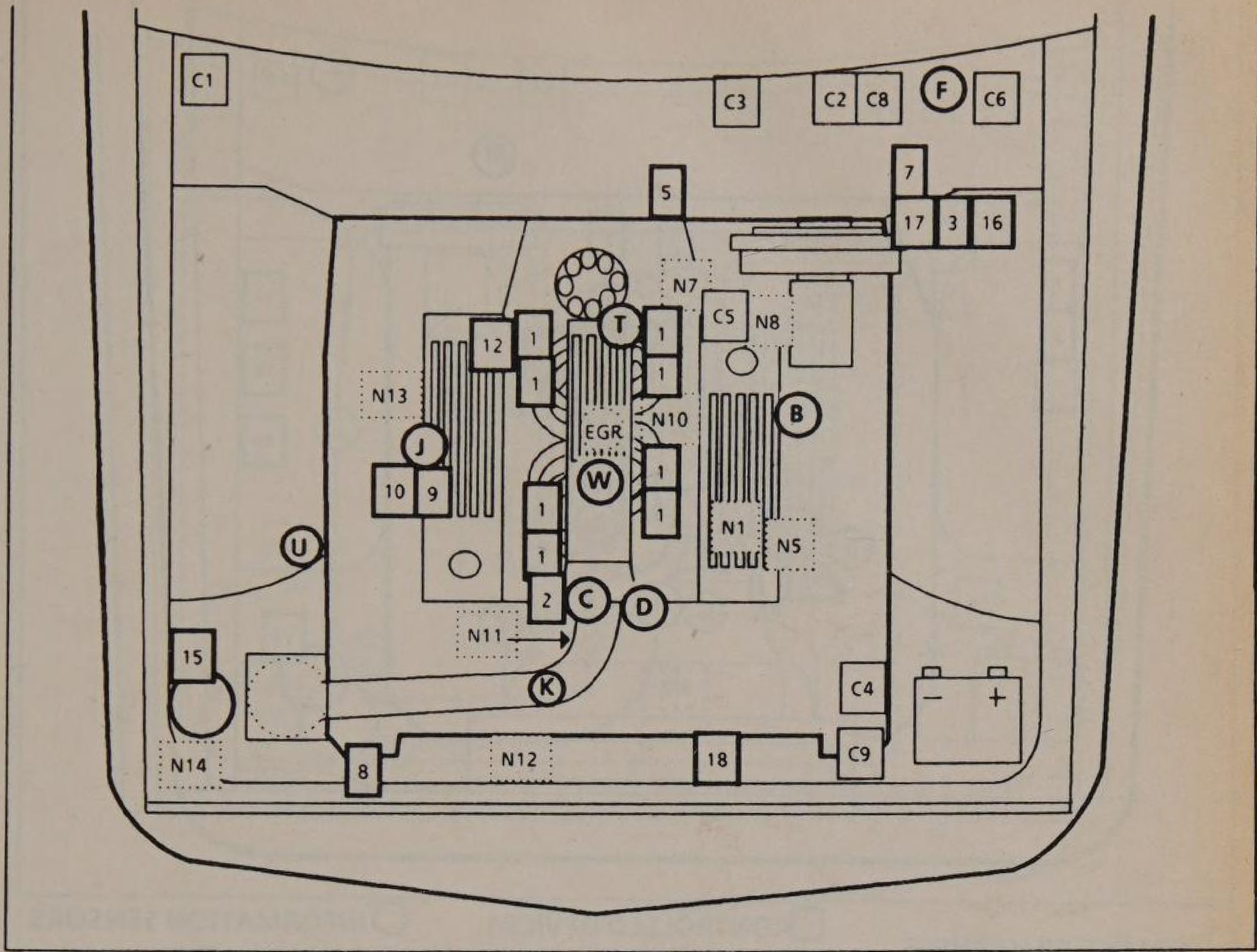
CONTROLLED DEVICES

1 Fuel injectors
2 Idle air control motor
3 Fuel pump relay
5 Trans. Conv. Clutch connector
6 EST distributor
6a Remote ignition coil
7 Electronic Spark Control module
9 Air injection port solenoid
10 Air injection converter solenoid
12 Exh. Gas Recirc. vacuum solenoid
15 Fuel vapor canister solenoid
Exhaust Gas Recirculation valve

INFORMATION SENSORS

A Manifold Absolute Pressure
B Exhaust oxygen
C Throttle position
D Coolant temperature
F Vehicle speed
J ESC knock
MAT (on air cleaner)

Component location – 1988–90 5.0L TBI



COMPUTER HARNESS

C1 Electronic Control Module (ECM)
C2 ALDL diagnostic connector
C3 "SERVICE ENGINE SOON" light
C4 ECM power
C5 ECM harness ground
C6 Fuse panel
C8 Fuel pump test connector (ALDL "G")
C9 Fuel pump/ECM fuse

NOT ECM CONNECTED

N1 Crankcase vent valve (PCV)
N5 Engine temp. sensor (gage overheat)
N7 Oil pressure sensor (gage)
N8 Oil pressure switch (fuel pump)
N10 Cold start valve
N11 Cold start fuel injection switch
N12 Secondary cooling fan
N13 Cooling fan temperature switch
N14 Secondary cooling fan relay

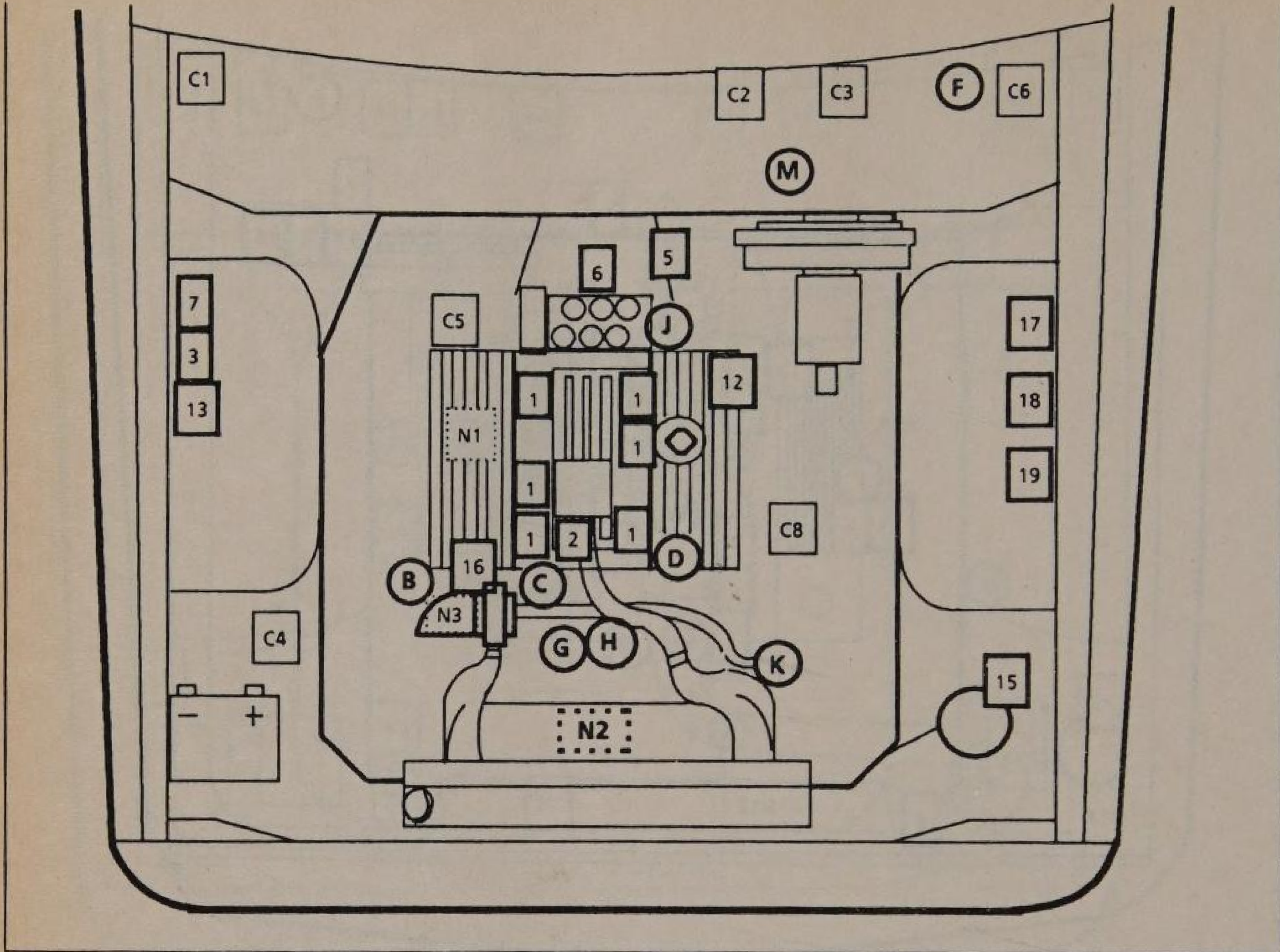
CONTROLLED DEVICES

1 Fuel injector
2 Idle air control motor
3 Fuel pump relay
5 Trans. Converter Clutch connector
7 Electronic Spark Control module
8 Primary cooling fan relay
9 Air injection converter/divert solenoid
10 Air injection port solenoid
12 EGR vacuum solenoid
15 Fuel vapor canister solenoid
16 MAF sensor power relay
17 MAF sensor burn-off relay
18 Primary cooling fan

INFORMATION SENSORS

B Exhaust oxygen
C Throttle position
D Coolant temperature
F Vehicle speed
J ESC knock
K Mass Air Flow
T Manifold Air Temperature
U A/C pressure fan switch
W EGR temp. diagnostic switch

Component location – 1987–89 5.0L and 5.7L TPI



COMPUTER HARNESS

- C1 Electronic Control Module (ECM)
- C2 ALDL diagnostic connector
- C3 "SERVICE ENGINE SOON" light
- C4 ECM power
- C5 ECM harness ground
- C6 Fuse panel
- C8 Fuel pump test connector

NOT ECM CONNECTED

- N1 Crankcase vent valve (PCV)
- N2 Inner Cooler
- N3 Turbo Charger

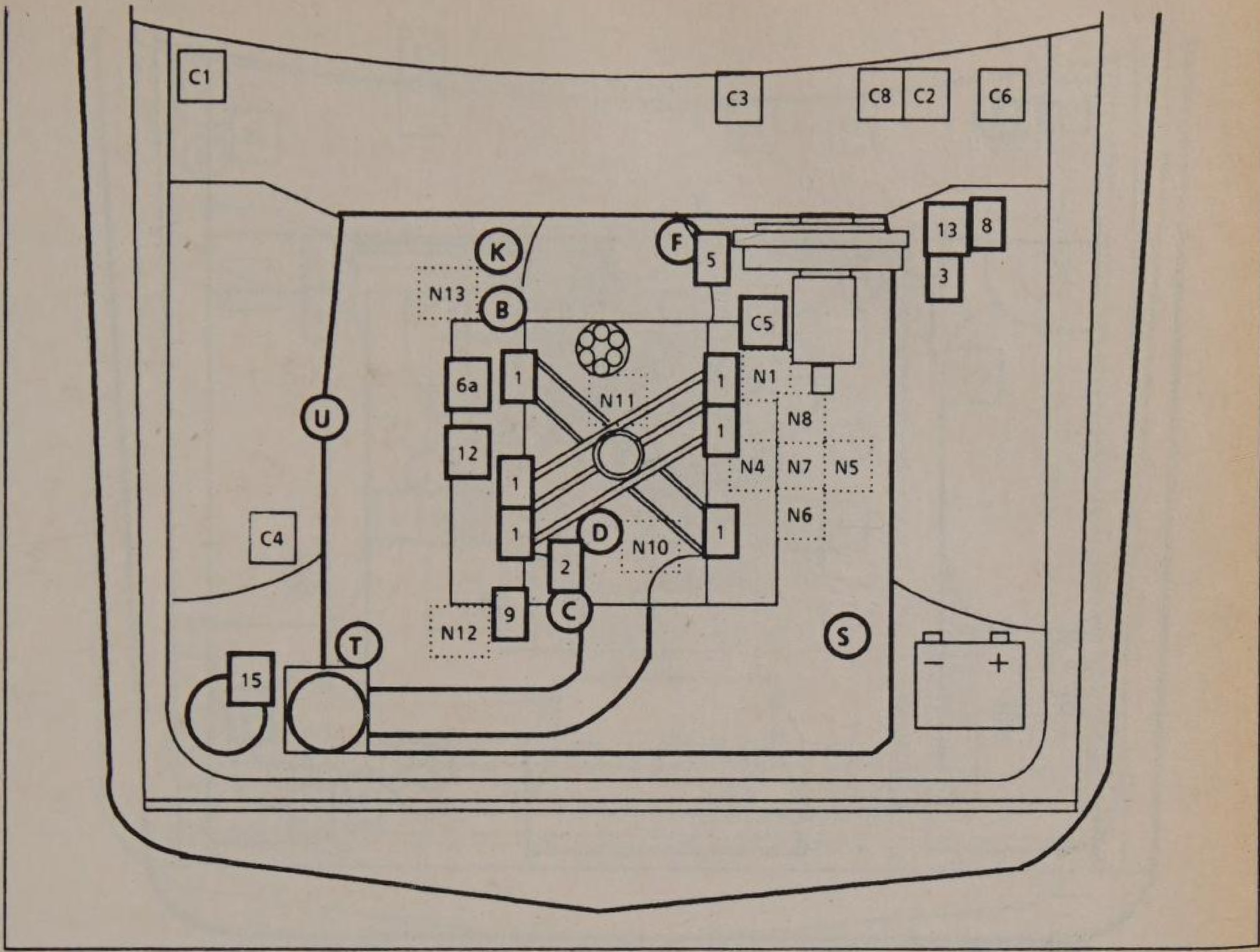
CONTROLLED DEVICES

- 1 Fuel injector
- 2 Idle air control motor (IAC)
- 3 Fuel pump relay
- 5 Trans. Converter Clutch connector (TCC)
- 6 Comp. Controlled Coil Ignition (C^3I)
- 7 Electronic Spark Control module (ESC)
- 12 Exh. Gas Recirc. vacuum solenoid
- 13 A/C compressor relay
- 15 Fuel vapor canister solenoid
- 16 Wastegate solenoid
- Exhaust Gas Recirculation valve
- 17 Delay Relay (Coolant Fan)
- 18 HiSpeed Relay (Coolant Fan)
- 19 Lo Speed Relay (Coolant Fan)

INFORMATION SENSORS

- B Exhaust oxygen (O_2)
- C Throttle position (TPS)
- Coolant temperature
- Vehicle speed (VSS)
- G Camshaft position (C^3I)
- H Crkshft pos. Reference/RPM (C^3I)
- J ESC knock sensor
- K Mass Air Flow
- M P/N switch

Component location – 1989 3.8L Turbo SFI



□ **COMPUTER HARNESS**

C1 Electronic Control Module (ECM)
C2 ALDL diagnostic connector
C3 "SERVICE ENGINE SOON" light
C4 ECM power/fuel pump fuse
C5 ECM harness ground
C6 Fuse panel
C8 Fuel pump test connector (ALDL "G")

NOT ECM CONNECTED

⬚ Crankcase vent valve (PCV)
N4 Engine temp. switch (telltale)
N5 Engine temp. sensor (gage)
N6 Oil press. switch (telltale)
N7 Oil press. sensor (gage)
N8 Oil press. swich (fuel pump)
N10 Cold start fuel injection switch
N11 Cold start valve
N12 Deceleration Valve (M/T only)
N13 Fan Override Switch

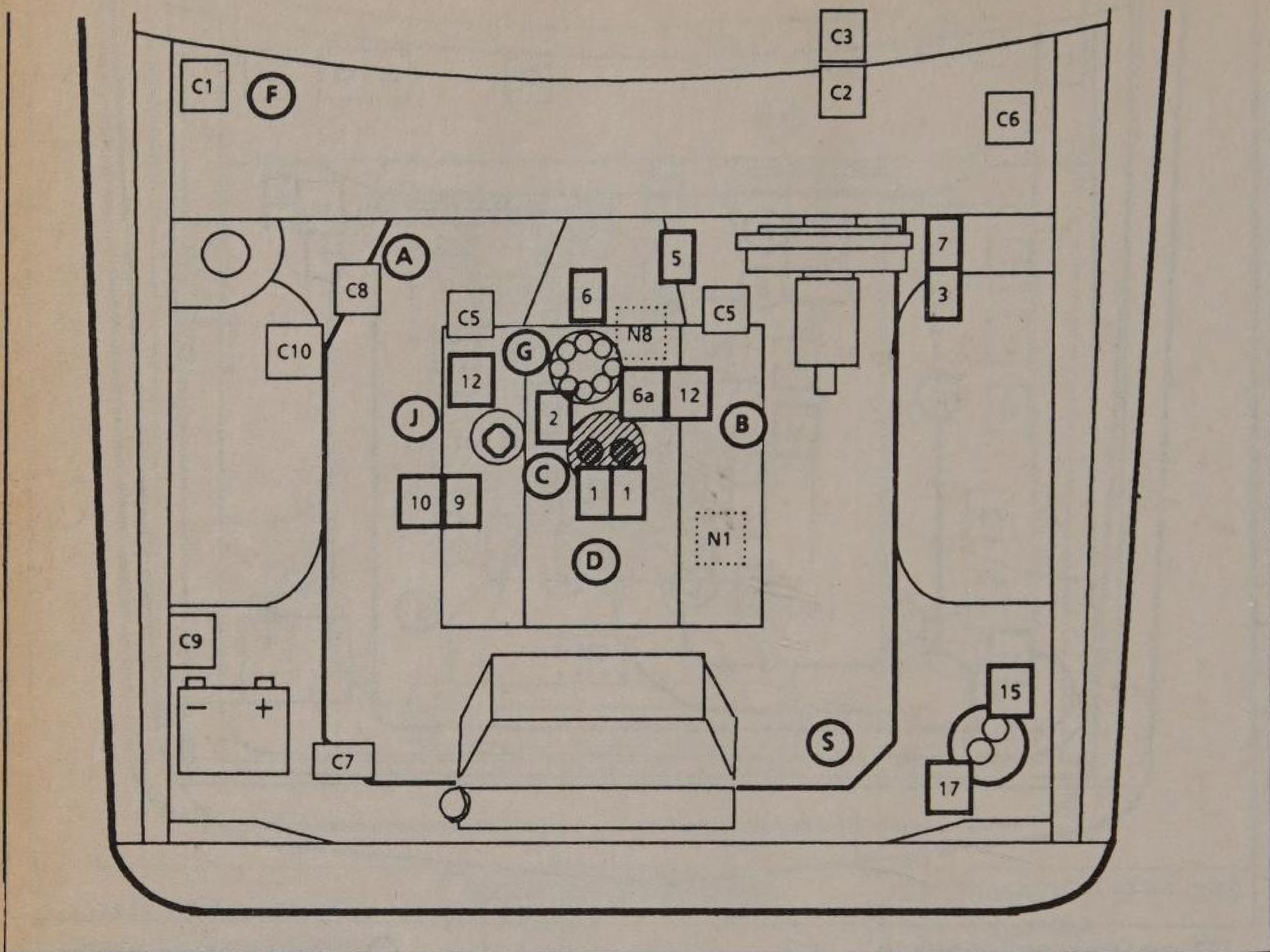
□ **CONTROLLED DEVICES**

1 Fuel injector
2 Idle air control motor
3 Fuel pump relay
5 Trans. Conv. Clutch connector
6a Remote ignition coil
8 Engine coolant fan relay
9 Air control solenoid (M.T. only)
12 Exhaust Gas Recirculation valve
13 A/C compressor relay
15 Fuel vapor canister solenoid

○ **INFORMATION SENSORS**

B Exhaust oxygen sensor
C Throttle position sensor
D Coolant Temperature sensor
F Vehicle speed sensor
K Manifold absolute pressure sensor
S Power steering pressure switch
T Manifold Air Temperature sensor
U A/C pressure fan switch

Component location – 1990 3.1L TPI



COMPUTER HARNESS

C1 Electronic Control Module (ECM)
C2 ALDL diagnostic connector
C3 "SERVICE ENGINE SOON" light
C5 ECM harness grounds
C6 Fuse panel
C7 Battery junction block
C8 Fuel pump test connector
C9 Fuel pump/ECM fuse
C10 Set timing connector

NOT ECM CONNECTED

N1 Crankcase vent valve (PCV)
N8 Oil pressure switch

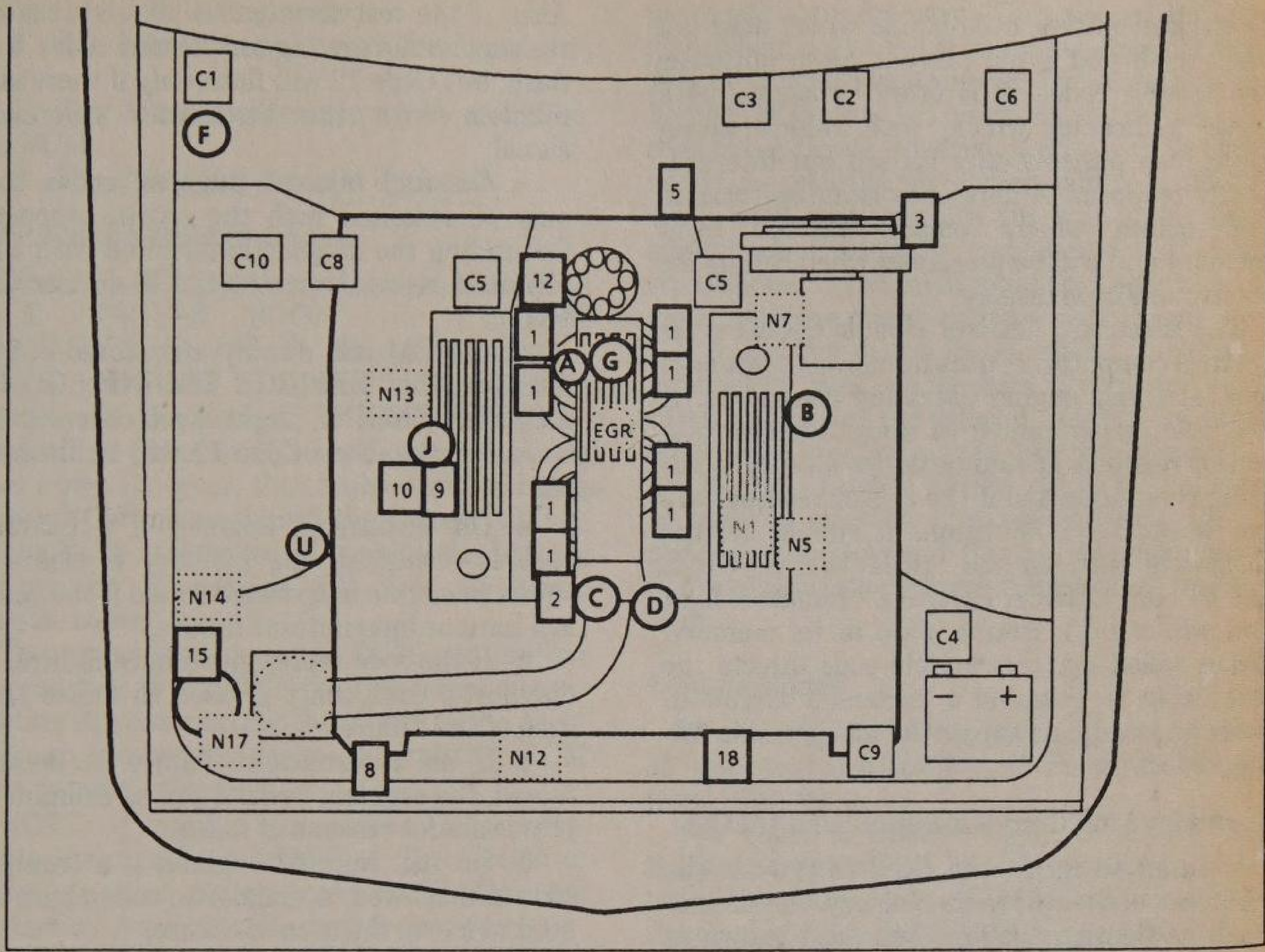
CONTROLLED DEVICES

1 Fuel injector
2 Idle air control motor
3 Fuel pump relay
5 Torque converter clutch connector
6 EST distributor
6a Remote ignition coil
7 Electronic spark control module
9 AIR port solenoid
10 AIR converter solenoid
12 EGR solenoid
15 Fuel vapor canister solenoid
17 Fuel vapor canister
Exhaust Gas Recirculation valve

INFORMATION SENSORS

A Manifold absolute pressure
B Exhaust oxygen
C Throttle position
D Coolant temperature
F Vehicle speed (buffer)
G MAT (in air cleaner)
J ESC knock
S Power steering pressure switch

Component location – 1990 5.0L TBI



☐ COMPUTER HARNESS

C1 Electronic Control Module (ECM)
C2 ALDL diagnostic connector
C3 "SERVICE ENGINE SOON" light
C4 Power Feed Connectors
C5 ECM harness grounds
C6 Fuse panel
C8 Fuel pump test connector
C9 Fuel pump/ECM fuse
C10 Set timing connector

⬚ NOT ECM CONNECTED

N1 Crankcase vent valve (PCV)
N5 Engine temp. sensor (gage overheat)
N7 Oil pressure sensor (gage) and switch (fuel pump)
N12 Secondary cooling fan
N13 Cooling fan temperature switch
N14 Secondary cooling fan relay
N17 Fuel Vapor Canistor

☐ CONTROLLED DEVICES

1 Fuel injector
2 Idle air control motor
3 Fuel pump relay
5 Torque converter clutch connector
8 Primary cooling fan relay
9 AIR port solenoid
10 AIR converter solenoid
12 EGR solenoid
14 Fuel vapor canister
15 Fuel vapor canister solenoid
18 Primary cooling fan

○ INFORMATION SENSORS

A Manifold Absolute Pressure
B Exhaust oxygen
C Throttle position
D Coolant temperature
F Vehicle speed (buffer)
G Manifold air temperature
J ESC knock sensor
U Fan control switch (A/C Pressure)

Component location—1990 5.0L and 5.7L TPI

Intermittent or Hard Trouble Codes

An intermittent code is one which does not reset itself and is not present when initiating the trouble codes. It is often be caused by a loose connection which, with vehicle movement, can possibly cure its self but intermittently reappear. A hard code is an operational malfunction which remains in the ECM memory and will be presented when calling for the trouble code display.

The Electronic Control Module (ECM) is actually a computer. It uses numerous sensors to look at many engine operating conditions. It has been programmed to know what certain sensor readings should be under most all operating conditions and if the sensor readings are not what the ECM thinks it should be, the ECM will turn on the "SERVICE ENGINE SOON" or "CHECK ENGINE" indicator light and will store a trouble code in its memory. When called up, the trouble code directs the technician to examine a particular circuit in order to locate and repair the trouble code setting defect.

Assembly Line Communication Link (ALCL)

In order to access the ECM to provide the trouble codes stored in its memory, the Assembly Line Communication Link (also known as the Assembly Line Diagnostic Link or ALDL) is used.

NOTE: *This connector is utilized at the assembly plant to insure the engine is operating properly before the vehicle is shipped.*

Terminal **B** of the diagnostic connector is the diagnostic terminal and it can be connected to terminal **A**, or ground, to enter the diagnostic mode, or the field service mode on fuel injection models.

ENTERING DIAGNOSTIC MODE

If the diagnostic terminal is grounded with the ignition in the **ON** position and the engine stopped, the system will enter the diagnostic mode. In this mode, the ECM will accomplish the following:

1. The ECM will display a Code 12 by flashing the "SERVICE ENGINE SOON" or "CHECK ENGINE" light, which indicates the system is working. A Code 12 consists of one flash, followed by a short pause, then 2 flashes in quick succession.
   a. This code will be flashed 3 times. If no other codes are stored, Code 12 will continue to flash until the diagnostic terminal is disconnected from the ground circuit.
   b. On a carbureted engine, the engine should not be started with the diagnostic terminal grounded, because it may continue to flash a Code 12 with the engine running. Also, if the test terminal is grounded after the engine is running any stored codes will flash, but Code 12 will flash only if there is a problem with the distributor reference signal.
   c. On fuel injected engines, codes can only be obtained with the engine stopped. Grounding the diagnostic terminal with the engine running activates the Field Service Mode.
2. The ECM will display any stored codes by flashing the "SERVICE ENGINE SOON" or "CHECK ENGINE" light. Each code will be flashed 3 times, then Code 12 will be flashed again.
   a. On carbureted engines, if a trouble code is displayed, the memory is cleared, then the engine is operated to see if the code is a hard or intermittent failure.
   b. If the code represents a hard failure, a diagnostic code chart is used to locate the area of the failure.
   c. If an intermittent failure is determined, the problem circuits can be examined physically for reasons of failure.
   d. On fuel injected engines, if a trouble code is displayed, a diagnostic code chart is used to locate the area of failure.
3. The ECM will energize all controlled relays and solenoids that are involved in the current engine operation.
   a. On carbureted engines, the ISC motor, if equipped, will move back and forth and the mixture control solenoid will be pulsed for 25 seconds or until the engine is started, which ever occurs first.
   b. On fuel injected engines, the IAC valve is moved back and forth or is fully extended, depending upon the engine family.

Field Service Mode

FUEL INJECTION MODELS

If the diagnostic terminal is grounded with the engine operating, the system will enter the Field Service Mode. In this mode, the "SERVICE ENGINE SOON" or "CHECK ENGINE" indicator light will show whether the system is in open or closed loop operation.

When in the open loop mode, the indicator light will flash $2^1/_2$ times per second.

When in the closed loop mode, the indicator light will flash once every second. Also, in closed loop, the light will stay out most of the time if the system is too lean. The light will stay on most of the time is the system is too rich. In either case, the Field Service Mode Check, which is part of the diagnostic circuit check, will direct the technician to the fault area.

While in the Field Service Mode, the ECM will be in the following mode:

1. The distributor will have a fixed spark advance.
2. New trouble codes cannot be stored in the ECM.
3. The closed loop timer is bypassed.

Clearing the Trouble Codes

When the ECM sets a trouble code, the "SERVICE ENGINE SOON" or "CHECK ENGINE" light will be illuminated and a trouble code will be stored in the ECM's memory. If the problem is intermittent, the light will go out after 10 seconds when the fault goes away, however, the trouble code will stay in the ECM memory until the battery voltage to the ECM is removed. Removing the battery voltage for 10 seconds will clear all stored trouble codes.

To prevent damage to the ECM, the ignition key must be in the **OFF** position when disconnecting or reconnecting the power to the ECM through the battery cable, ECM pigtail, ECM fuse, jumper cables, etc.

NOTE: *If possible, clear codes by disconnecting the pigtail or ECM fuse. Disconnecting the negative battery cable will clear the memory from other on-board computers systems, such as pre-set radio, seat control, etc.*

All trouble codes should be cleared after repairs have been accomplished. In some cases, such as through a diagnostic routine, the codes may have to be cleared first to allow the ECM to set a trouble code during the test, should a malfunction be present.

NOTE: *The ECM has a learning ability to perform after the battery power has been disconnected to it. A change may be noted in the vehicle's performance. To teach the vehicle, make sure the engine is at normal operating temperature and drive it at part throttle, at moderate acceleration and idle conditions, until normal performance returns.*

ALDL Scan Tools

The ALDL connector, located under the dash, has a variety of information available on terminals **E** and **M** (depending upon the engine used). There are several tools on the market, called Scan units for reading the available information.

The use of the Scan tools do not make the diagnostics unnecessary. They do not tell exactly where a problem is in a given circuit. However, with an understanding of what each position on the instrument measures and the knowledge of the circuit involved, the tool can be very useful in getting information which could be more time consuming to get with outer test equipment. It must be emphasized that each type scanner instrument must be used in accordance with the manufacturers instructions.

If a problem seems to be related to certain parameters, they can be checked with the Scan tool while driving the vehicles. If there does not seem to be any correlation between the problem and any specific circuit, the Scan tool can be checked on each position, watching for a period of time to see if there is any change in the readings that indicate intermittent operations.

Trouble Codes

The Diagnostic Trouble Code chart contains all the trouble codes for all Firebird models from 1982–90.

The chart is labeled with the engine (in liters) and the engine VIN designation at the top of the chart. Along the side of the chart are the trouble codes and the abbreviated function. Within the chart are all the applicable body series letter designation. If a particular code applies the all the body series that is equipped with the listed engine, then the word "ALL" will appear in block.

The abbreviation for the chart functions are as follows:

A/C – Air Conditioning
CTS – Coolant Temperature Sensor
ECM – Electronic Control Module
EGR – Exhaust Gas Recirculation
ESC – Electronic Spark Control
EST – Electronic Spark Timing
IAC – Idle Air Control
M/C SOL – Mixture Control Solenoid
MAF – Mass Air Flow sensor
MAP – Manifold Absolute Pressure
MAT – Manifold Air Temperature sensor
TCC – Torque Converter Clutch
TPS – Throttle Position Sensor
VAC – Vacuum
VATS – Vehicle Anti-Theft System
VSS – Vehicle Speed Sensor

DIAGNOSTIC TROUBLE CODES

Trouble Codes	Engine (VIN) 4-2.5L (2)	6-2.8L (1)	6-2.8L (5)	6-3.1L (T)	6-3.8L (7)	8-5.0L (E)	8-5.0L (F)	8-5.0L (G)	8-5.0L (H)	8-5.7L (8)
12—Speed reference pulse	X ⑤	X ⑤	X ⑤	X ⑤	X ⑤	X ⑤	X ⑤	X ⑤	X ⑤	X ⑤
13—Oxygen sensor	X	X	X	X	X	X	X	X	X	X
14—CTS (Temp HI)	X	X	X	X	X	X	X	X	X	X
15—CTS (Temp LO)	X	X		X	X	X	X	X	X	X
16—System volts HI										
21—TPS (Volts HI)	X	X	X	X	X	X	X	X	X	X
22—TPS (Volts LO)	X		X	X	X	X	X			X
23—MAT (Temp LO)			X	X	X	X	X			X
23—M/C solenoid (open or ground)		X						X	X	
24—VSS	X	X	X	X	X	X	X	X	X	X
24B—Park/neutral switch										
25—MAT (Temp HI)			X	X	X	X	X			X
26—Quad-driver										
27/28—Gear switch										
28/29—Gear switch										
31—Park/neutral switch										
31—Wastegate overboost					X					
31—Canister purge (Volts HI)										
32—EGR failure		X ①	X	X	X	X	X	X ①	X ①	X
33—MAP (Volts HI/Vac LO)	X			X	X	X				
33—MAF (gm/sec HI)			X				X			X
34—MAP (Volts LO/Vac HI)	X	X ②		X	X	X		X ②	X ②	
34—MAF (gm/sec HI)			X				X			X
35—Idle speed error					X					
35—IAC				X						
36—Close throttle air flow HI										
36—MAF burn-off							X			X
38—Brake switch										
39—TCC										
41—1 X reference		X						X	X	
41—Cylinder select error/ MEM-CAL			X	X			X			X
41—Cam sensor					X					
42—EST	X	X	X	X	X	X	X	X	X	X
43—ESC		X		X	X	X	X	X	X	X
44—Oxygen sensor (lean)	X	X	X	X	X	X	X	X	X	X
45—Oxygen sensor (rich)	X	X	X	X	X	X	X	X	X	X
46—Power steering press switch										
46—VATS				X			X			X
48—Misfire diagnosis										

DIAGNOSTIC TROUBLE CODES

Trouble Codes	Engine (VIN) 4-2.5L (2)	6-2.8L (1)	6-2.8L (5)	6-3.1L (T)	6-3.8L (7)	8-5.0L (E)	8-5.0L (F)	8-5.0L (G)	8-5.0L (H)	8-5.7L (8)
51—PROM or MEM-CAL error	X	X	X	X	X	X	X	X	X	X
52—CALPAK error			X	X	X	X	X			
53—System overvoltage			X	X		X ③	X			X
53—EGR (Improper VAC)					X ④			X	X	
54—Fuel pump (Volts LO)			X	X		X	X			X
54—M/C solenoid (Volts HI)		X						X	X	
55—ECM error	X		X			X				
61—Degraded oxygen sensor				X						
62—Trans. gear switch										
63—MAP (Volts HI/Vac LO)										
63—EGR flow check										
64—MAP (Volts LO/Vac HI)										
64—EGR flow check										
65—Fuel injector (LO amps)										
65—EGR flow check										
66—A/C press switch										

X = code applies

Notes:

① Carbureted, baro sensor

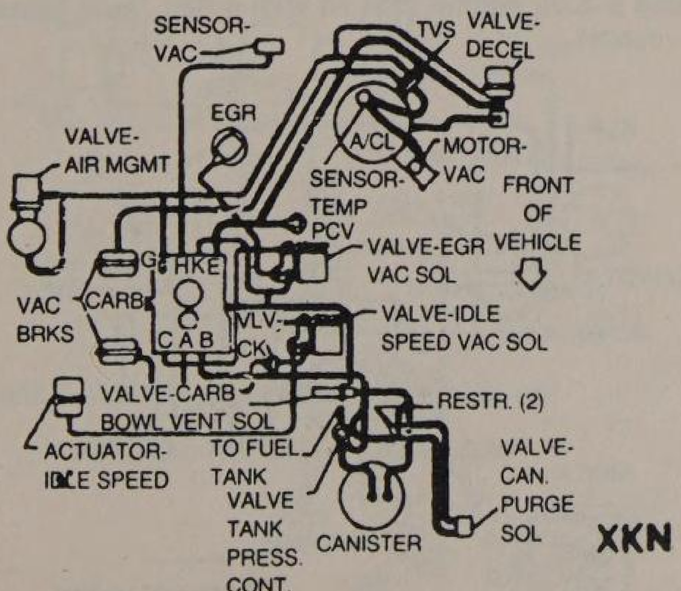
② Carbureted, differential pressure sensor

③ 1990 TBI code 53 is VATS circuit

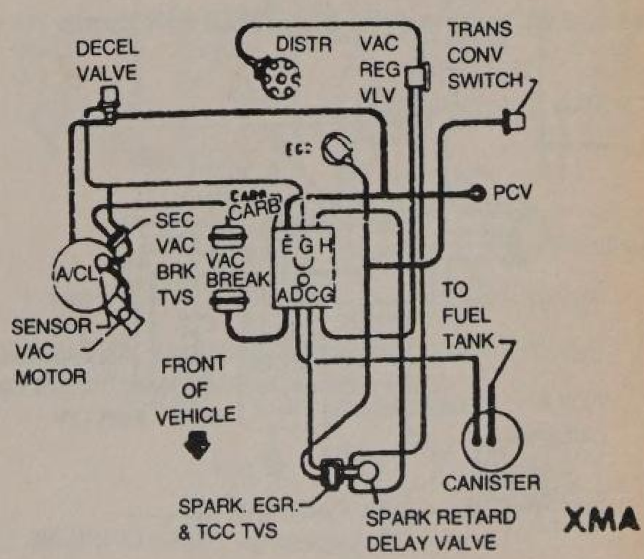
④ 1989 3.8L turbo code 53 is ECM error

⑤ Code 12 will flash three times. If no other codes are stored, code 12 will continue to flash until the diagnostic terminal is disconnected. Refer to text for more information.

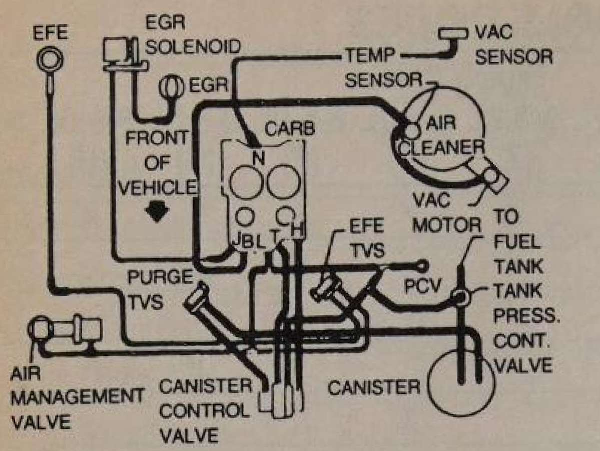
Vacuum Diagrams



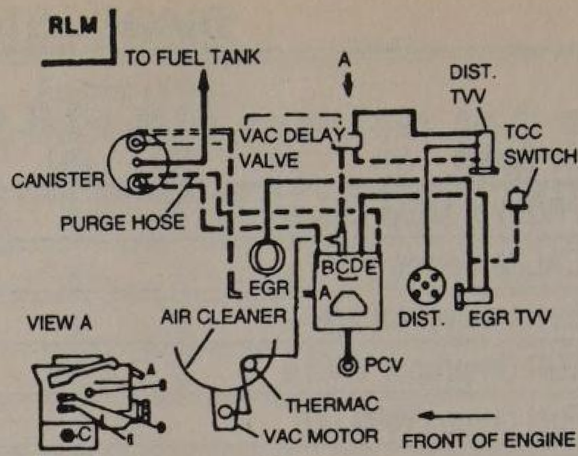
19846–2.8L engine (VIN L) with 2 BBL, manual and auto trans



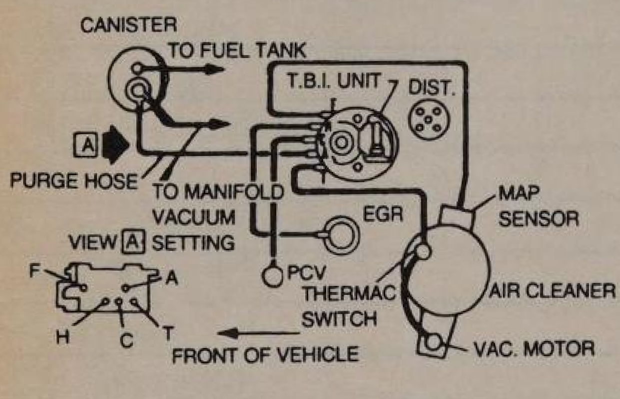
19846–2.8L engine (VIN L) with 2 BBL, automatic trans – export and Canada



1983 8–5.0L (VIN H) with 2-BBL carb, manual and automatic trans.

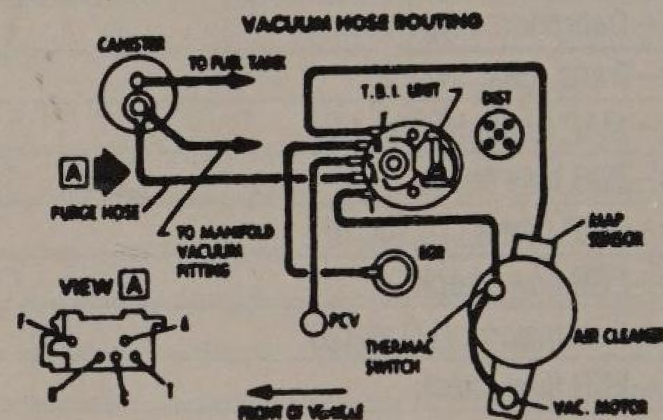


1982 4–2.5L engine with automatic trans. and no A/C

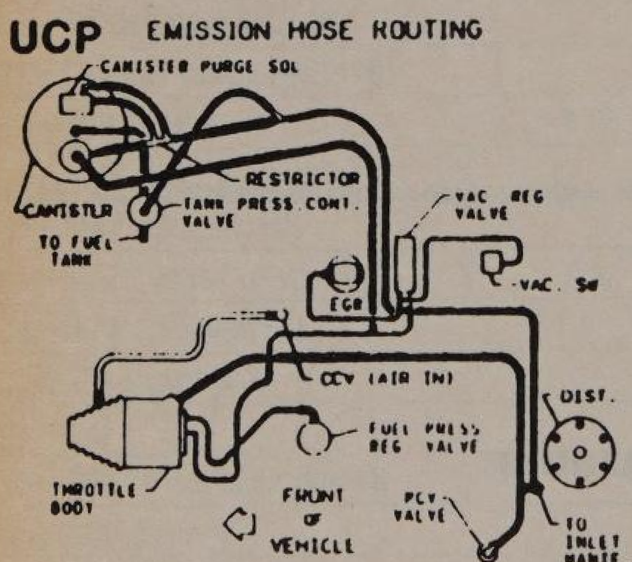


FAH

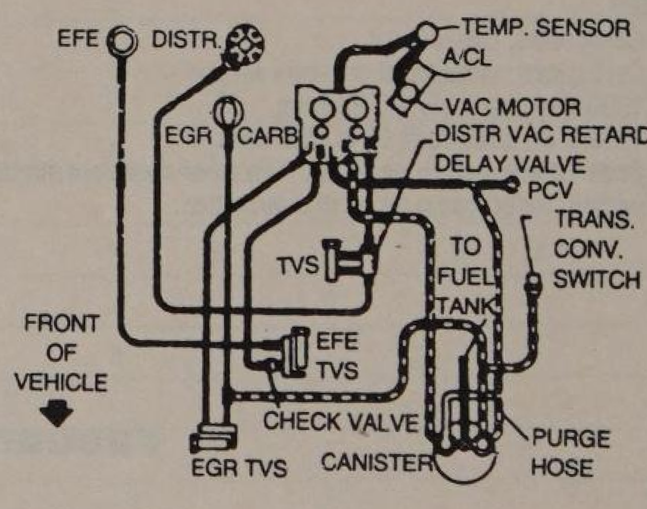
1984 4–2.5L (VIN 2) with manual and auto trans



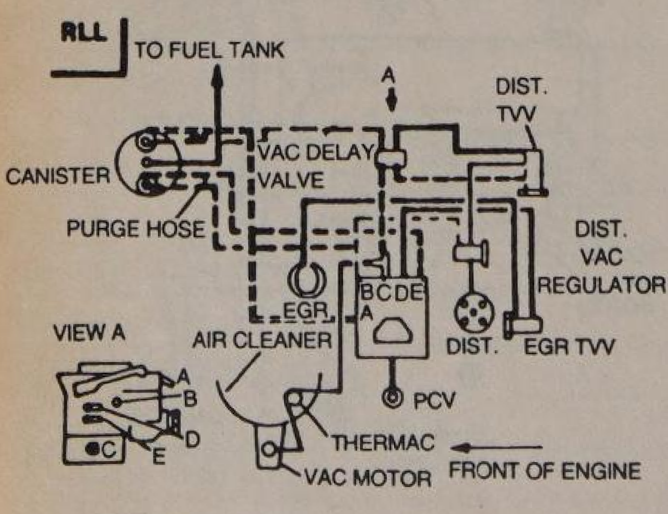
1985 4–2.5L engine (VIN 2) – federal and Calif.



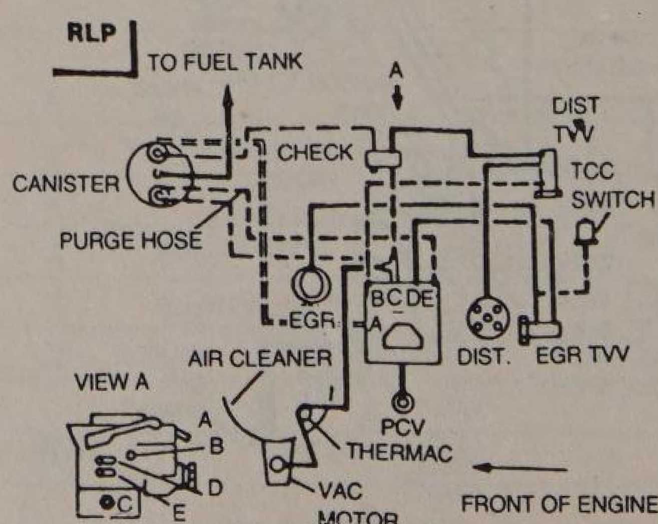
1985 6–2.8L engine (VIN S) without AIR pump



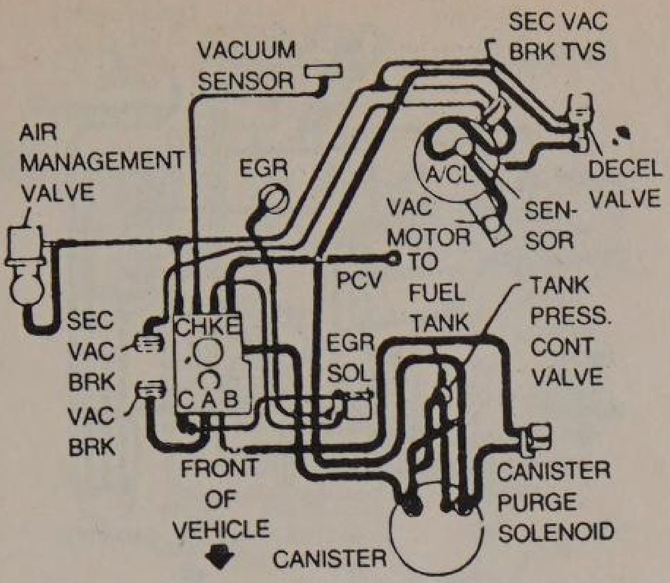
1984 8–5.0L engine (VIN H) with 4 BBL, auto trans – export



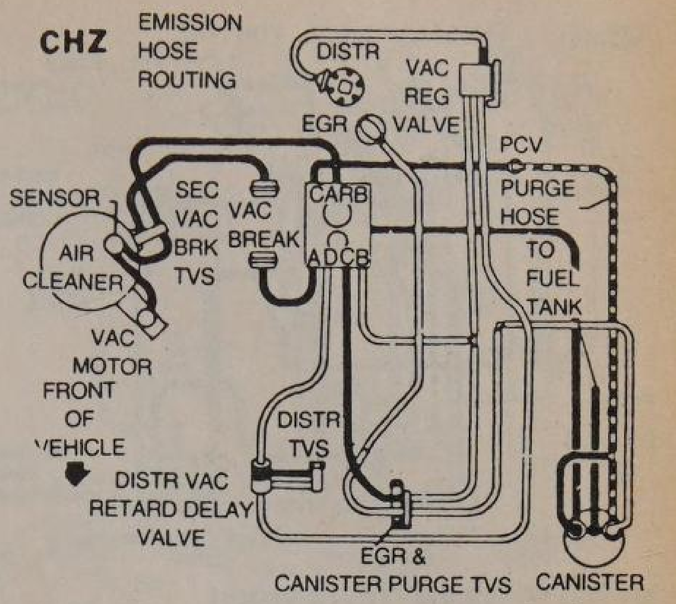
1982 4–2.5L engine with manual trans. and no A/C



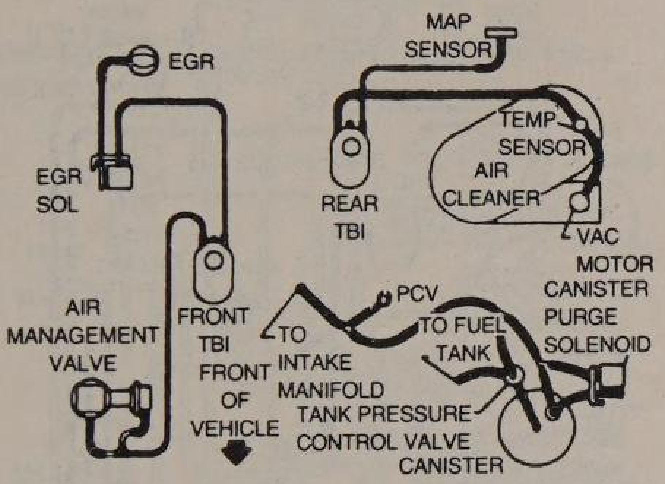
1982 4–2.5L engine with air conditioning



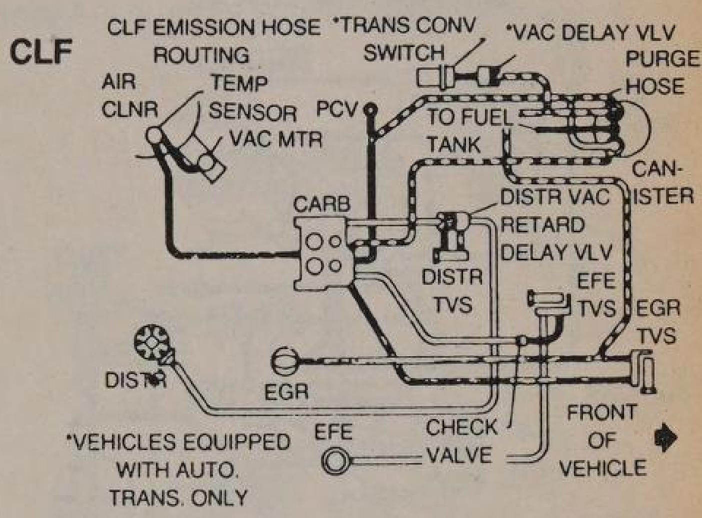
1983 6–2.8L engine, all



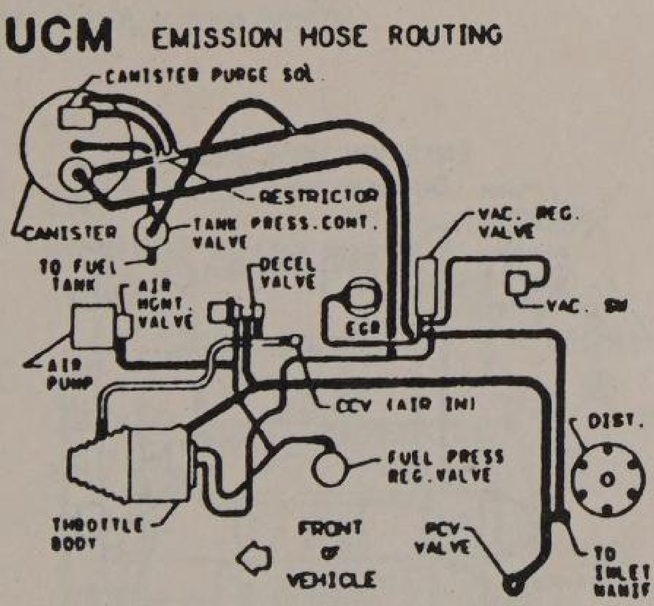
1982 6–2.8L engine with manual transmission



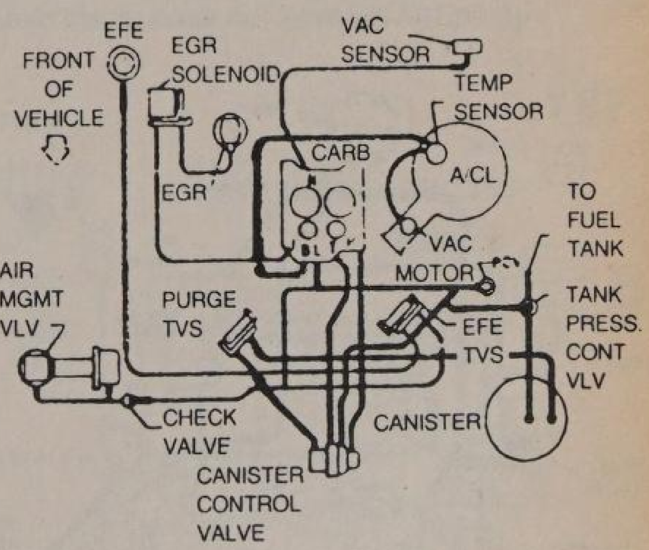
1983 8–5.0L (VIN 7) with TBI and automatic transmission



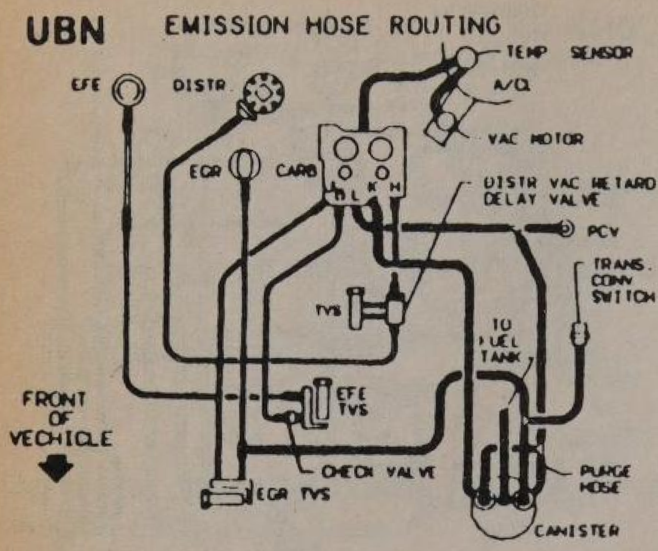
1982 8–5.0L engine with automatic transmission



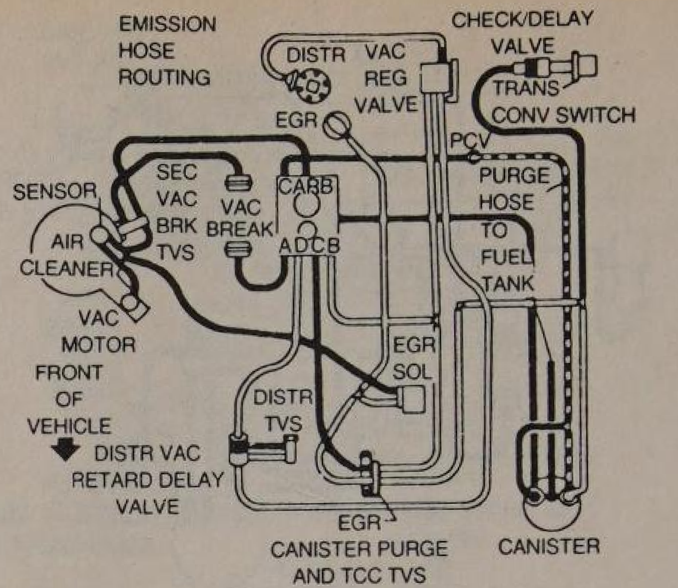
1985 6–2.8L engine (VIN S) manual trans



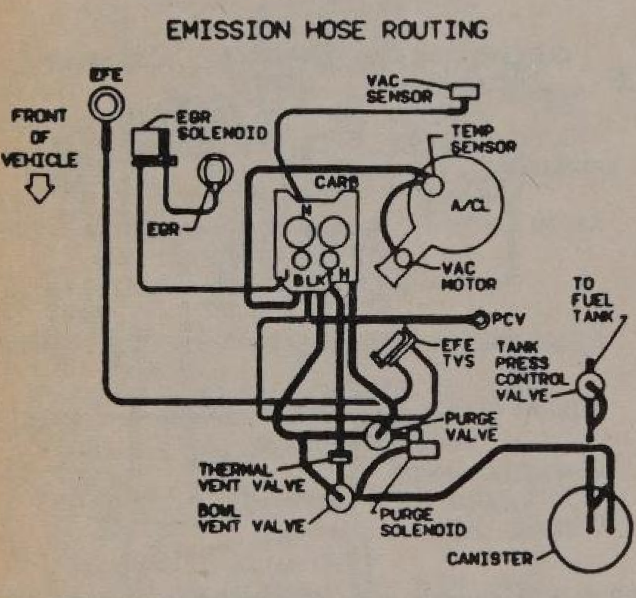
1984 8–5.0L engine (VIN H) with 4 BBL, manual and auto trans — federal and Calif.



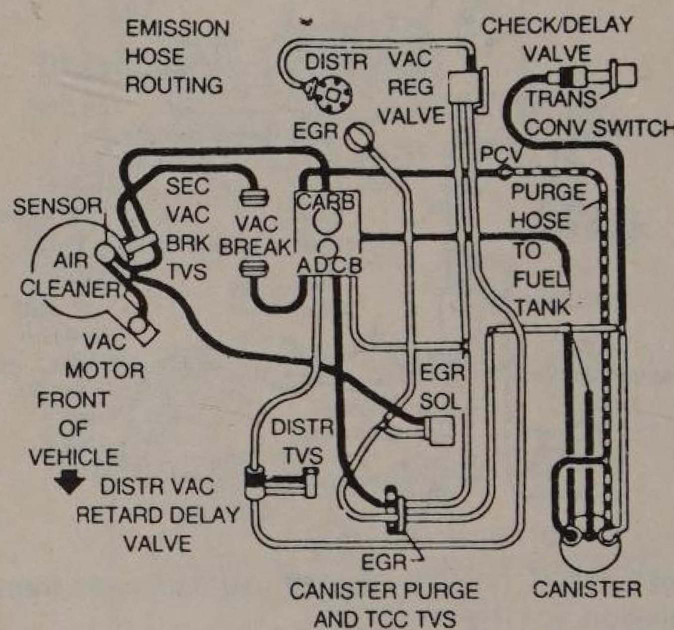
1985 8–5.0L engine (VIN H) export



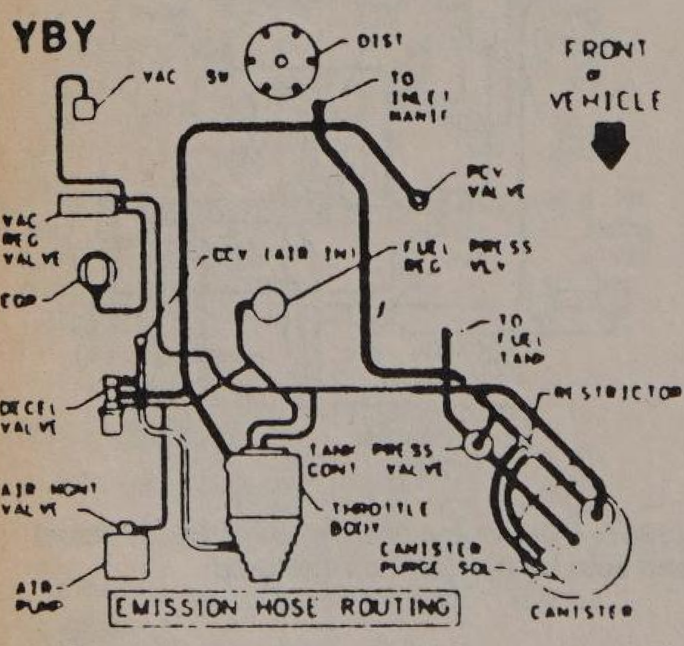
1982 6–2.8L engine with automatic transmission



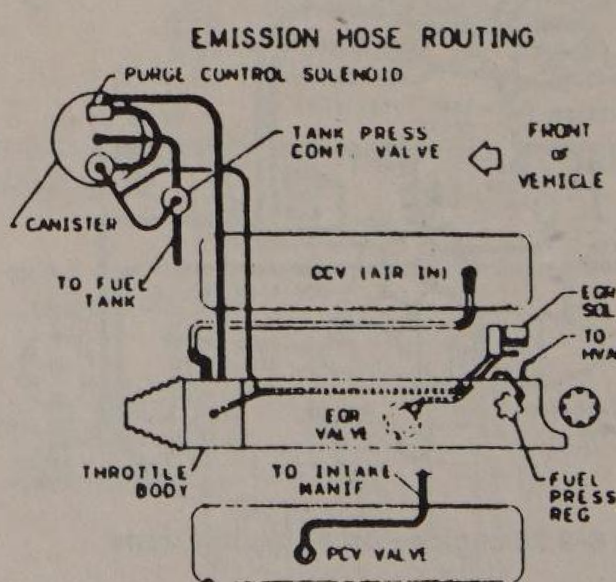
1987–88 8–5.0L engine (VIN H)



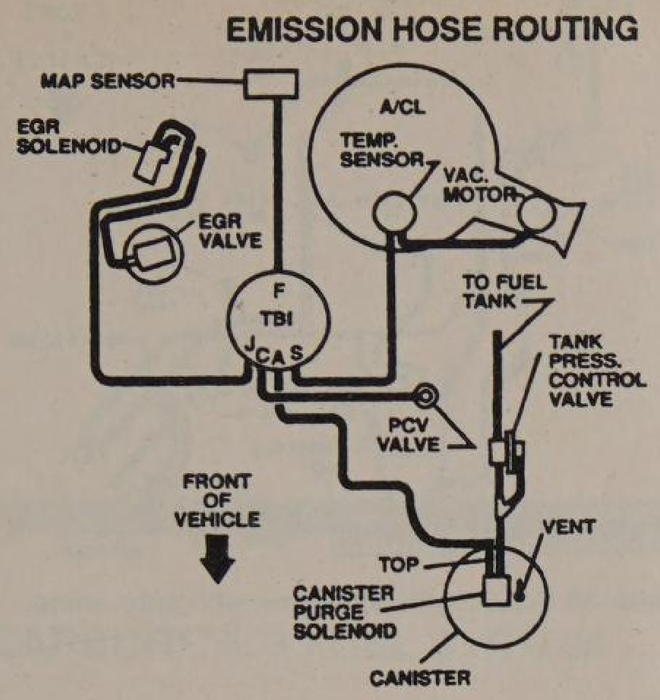
1982 6–2.8L engine with automatic transmission



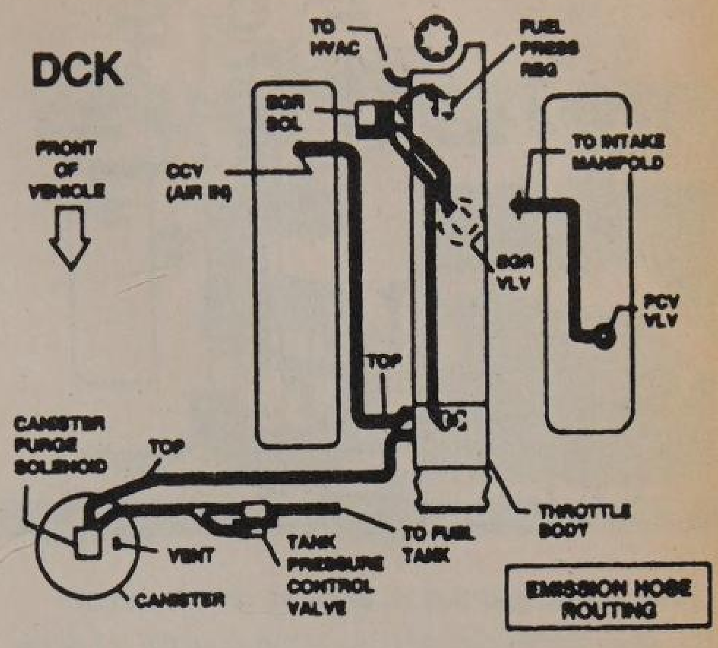
1986 4–2.5L engine (VIN 2) — federal and Calif.



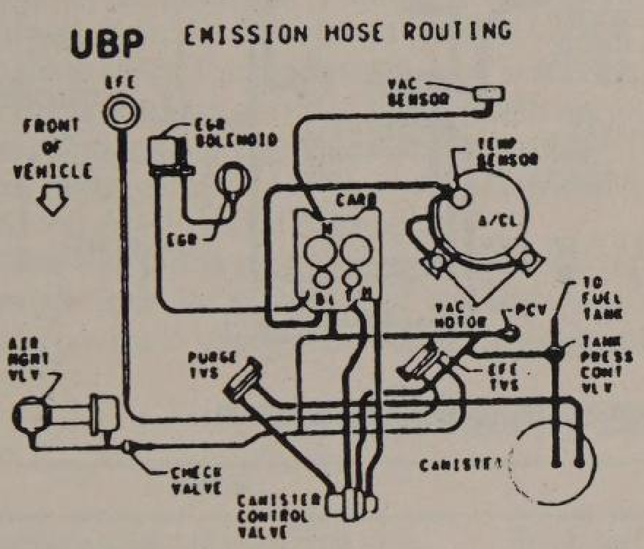
1985–86 8–5.0L engine (VIN F)



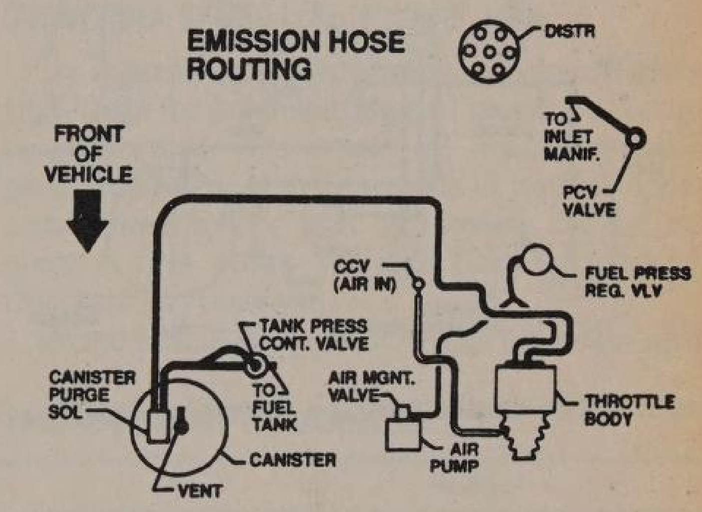
1988–90 8–5.0L engine (VIN E) with auto trans.



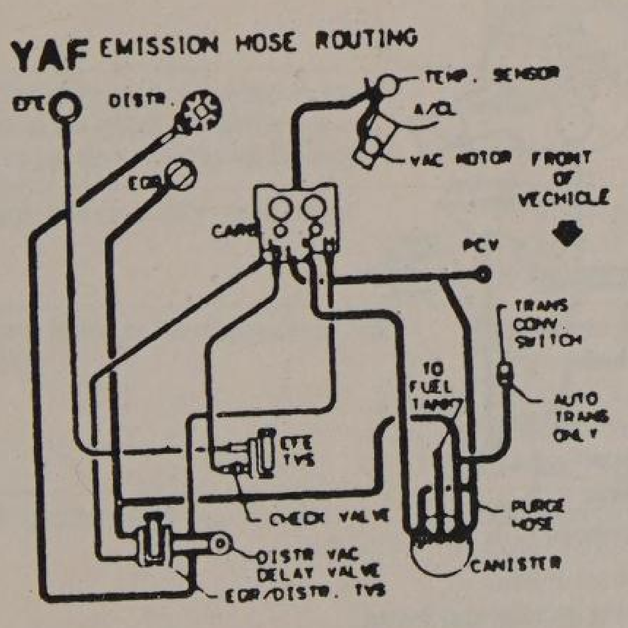
1989 8–5.0L and 8–5.7L engines (VIN F and 8)



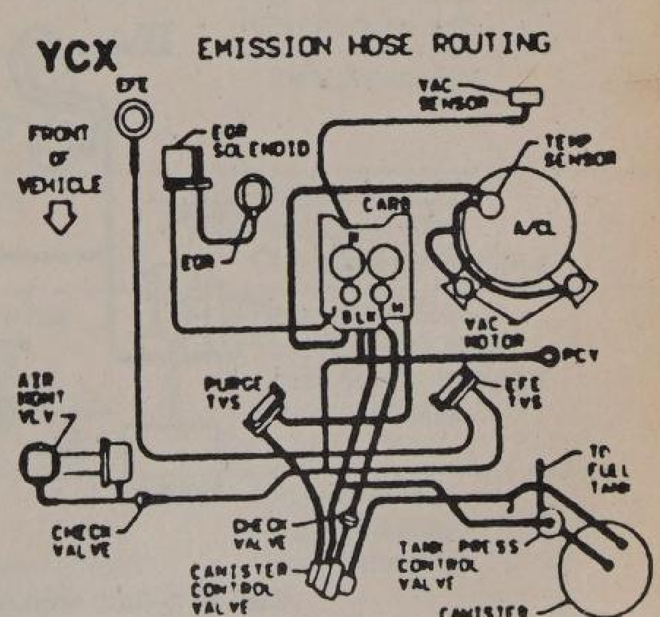
1985 8–5.0L engine (VIN G)



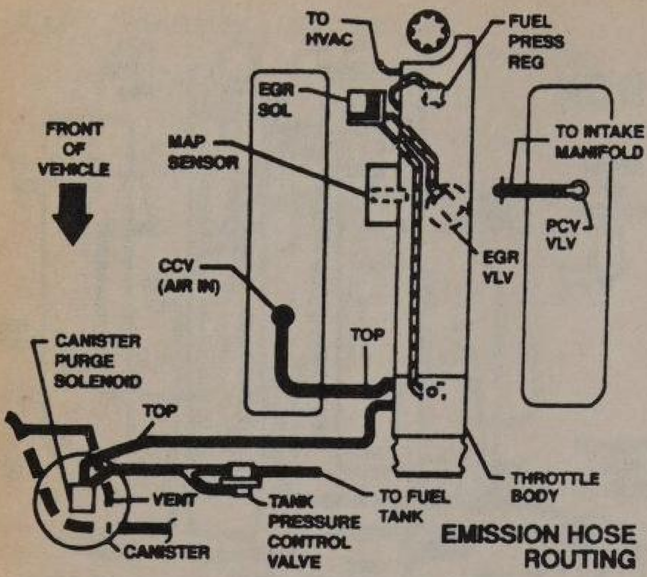
1990 6–3.1L engine (VIN T) with manual trans — automatic trans. does not have an AIR pump



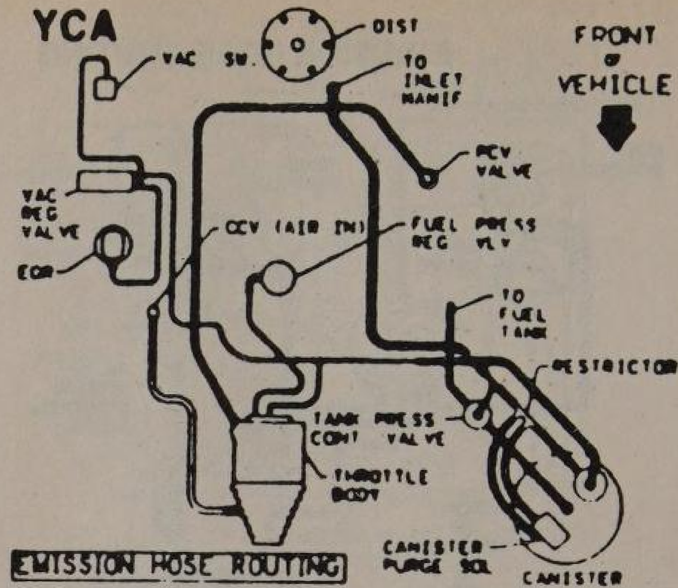
1986 8–5.0L engine (VIN H) — Canada



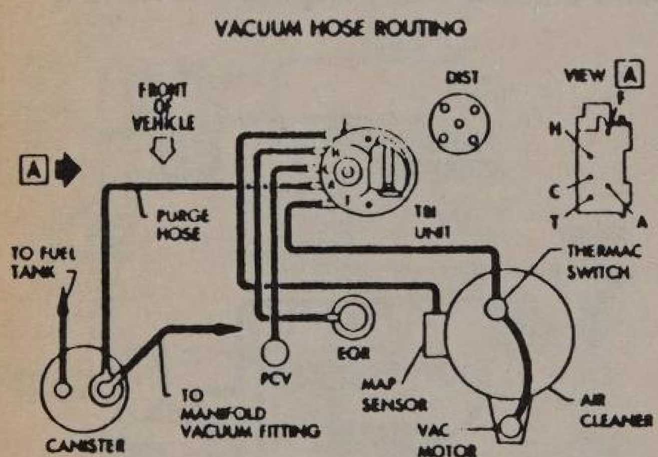
1986 8–5.0L engine (VIN G)



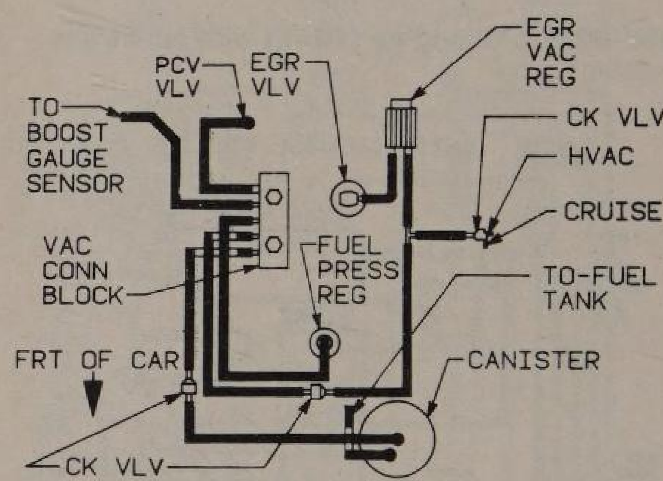
1990 8–5.0L and 8–5.7L engines (VIN F and 8)



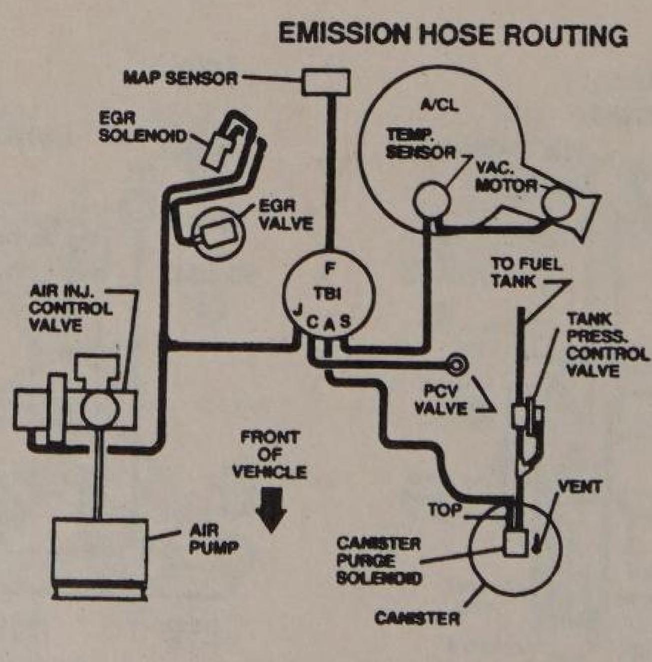
1986–89 6–2.8L (VIN S) engine with auto. trans.



1986 4–2.5L engine (VIN 2) – federal and Calif.



1989 6–3.8L Turbo engine (VIN 7)



1988–90 8–5.0L engine (VIN E) with manual trans.

Fuel System

5

CARBURETED 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.

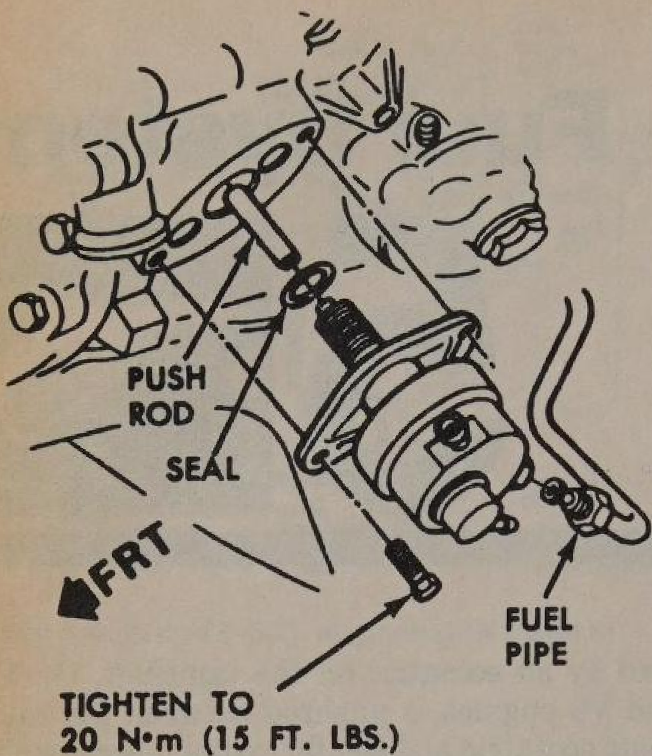
TESTING THE FUEL PUMP

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.

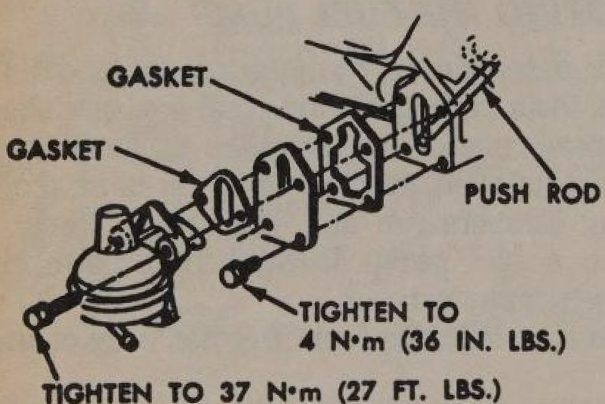
Be sure that the fuel filter has been changed

Troubleshooting Basic Fuel System Problems

Problem	Cause	Solution
Engine cranks, but won't start (or is hard to start) when cold	• Empty fuel tank • Incorrect starting procedure • Defective fuel pump • No fuel in carburetor • Clogged fuel filter • Engine flooded • Defective choke	• Check for fuel in tank • Follow correct procedure • Check pump output • Check for fuel in the carburetor • Replace fuel filter • Wait 15 minutes; try again • Check choke plate
Engine cranks, but is hard to start (or does not start) when hot—(presence of fuel is assumed)	• Defective choke	• Check choke plate
Rough idle or engine runs rough	• Dirt or moisture in fuel • Clogged air filter • Faulty fuel pump	• Replace fuel filter • Replace air filter • Check fuel pump output
Engine stalls or hesitates on acceleration	• Dirt or moisture in the fuel • Dirty carburetor • Defective fuel pump • Incorrect float level, defective accelerator pump	• Replace fuel filter • Clean the carburetor • Check fuel pump output • Check carburetor
Poor gas mileage	• Clogged air filter • Dirty carburetor • Defective choke, faulty carburetor adjustment	• Replace air filter • Clean carburetor • Check carburetor
Engine is flooded (won't start accompanied by smell of raw fuel)	• Improperly adjusted choke or carburetor	• Wait 15 minutes and try again, without pumping gas pedal • If it won't start, check carburetor



V8 fuel pump



V6 fuel pump

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 5.5–6.5 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 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 filling, always use 2 wrenches to avoid damaging the pump.*

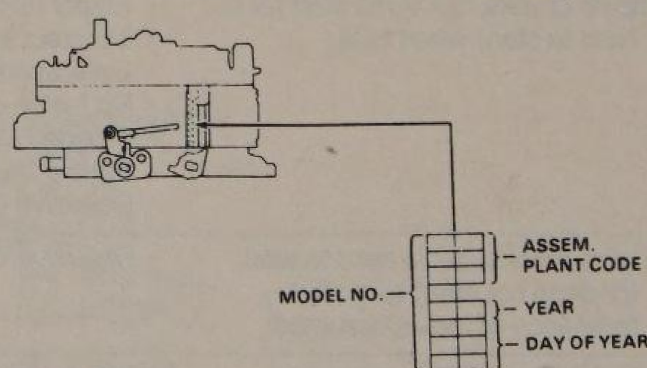
1. Disconnect the fuel intake and outlet lines at the pump and plug the pump intake line.
2. Remove the two pump mounting bolts and lock washers; remove the pump and its gasket.
3. If the rocker arm pushrod is to be removed from V8, remove the two adapter bolts and lock washers and remove the adapter 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.

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



The carburetor identification number is stamped on the float bowl

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.

OVERHAUL

NOTE: *Because of their intricate nature E2SE, E4ME and E4MC carburetors should be serviced only by a qualified mechanic.*

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 disassemble 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 purchases 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 over-tighten 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.

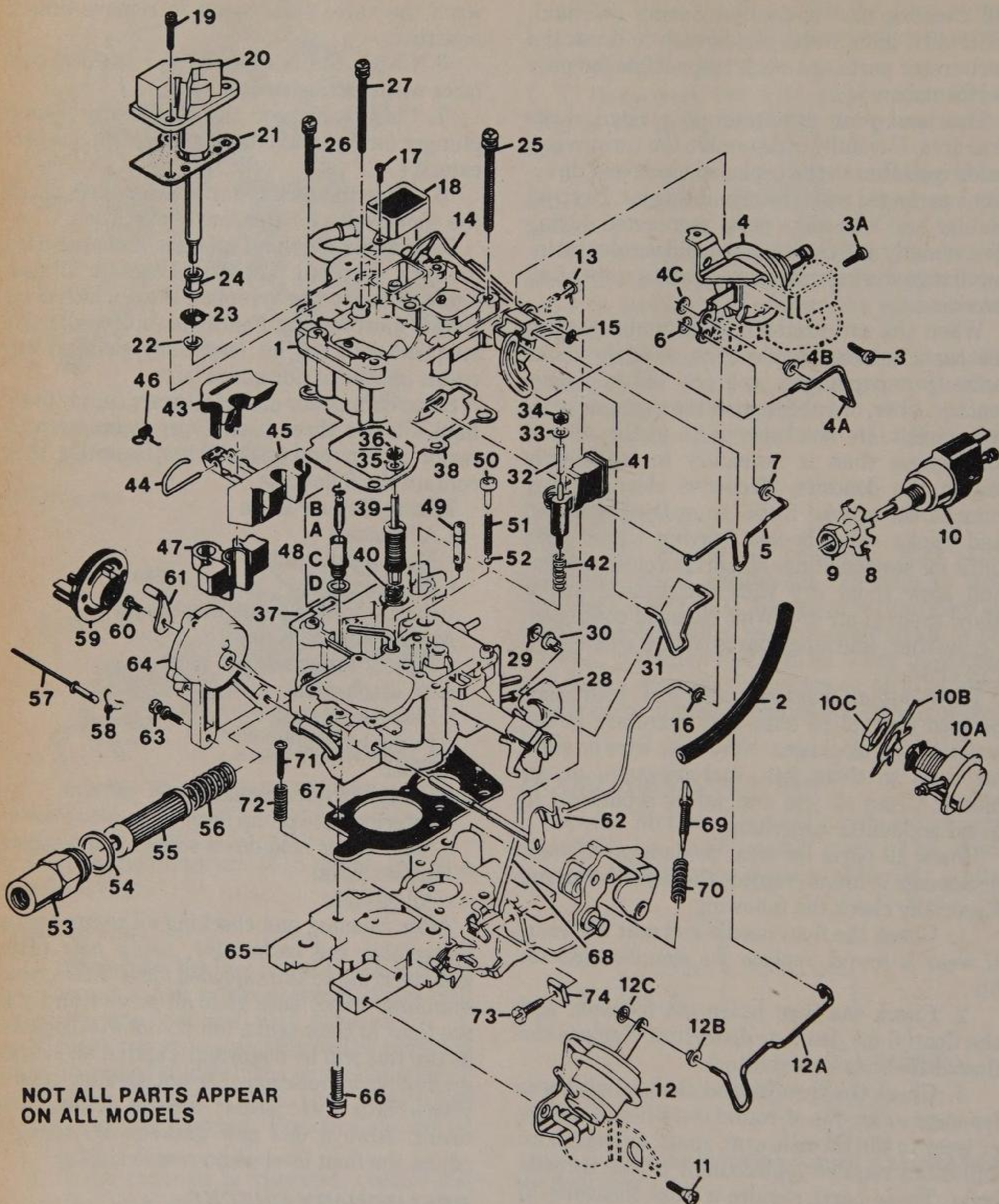
PRELIMINARY CHECKS

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.



E2SE 2 BBL carburetor — exploded view

AIR HORN PARTS

1. AIR HORN ASSEMBLY
17. SCREW-VENT STACK ATTACHING
18. VENT STACK
19. SCREW ASSEMBLY-M/C SOLENOID ATTACHING
20. MIXTURE CONTROL (M/C) SOLENOID
21. GASKET-SOLENOID TO AIR HORN
22. RETAINER-M/C SOLENOID SEAL
23. SEAL-SOLENOID TO FLOAT BOWL
24. SPACER-M/C SOLENOID
25. SCREW ASSEMBLY-AIR HORN TO FLOAT BOWL (LARGE)
26. SCREW ASSEMBLY-AIR HORN TO FLOAT BOWL (SHORT)
27. SCREW ASSEMBLY-AIR HORN TO FLOAT BOWL (LONG)
32. PLUNGER-TPS ACTUATOR
33. RETAINER-TPS PLUNGER SEAL
34. SEAL-THROTTLE POSITION SENSOR (TPS) PLUNGER
35. RETAINER-PUMP STEM SEAL
36. SEAL-PUMP STEM
38. GASKET-AIR HORN TO FLOAT BOWL

CHOKE PARTS

2. HOSE-PRIMARY SIDE VACUUM BREAK
3. SCREW-PRIMARY SIDE VACUUM BREAK ATTACHING
3A SCREW ASSEMBLY-PRIMARY SIDE VACUUM BREAK ATTACHING
4. VACUUM BREAK ASSEMBLY-PRIMARY SIDE
4A LINK-PRIMARY SIDE VACUUM BREAK
4B BUSHING-PRIMARY SIDE VACUUM BREAK LINK
4C RETAINER-PRIMARY SIDE VACUUM BREAK LINK
5. LINK-AIR VALVE
6. RETAINER-AIR VALVE LINK
7. BUSHING-AIR VALVE LINK
11. SCREW-SECONDARY SIDE VACUUM BREAK ATTACHING
12. VACUUM BREAK ASSEMBLY-SECONDARY SIDE
12A LINK-SECONDARY SIDE VACUUM BREAK
12B BUSHING-SECONDARY SIDE VACUUM BREAK LINK
12C RETAINER-SECONDARY SIDE VACUUM BREAK LINK
15. RETAINER-INTERMEDIATE CHOKE SHAFT LINK
16. BUSHING-INTERMEDIATE CHOKE SHAFT LINK
29. RETAINER-FAST IDLE CAM LINK
30. BUSHING-FAST IDLE CAM LINK
31. LINK-FAST IDLE CAM
57. RIVET-CHOKE COVER ATTACHING
58. RETAINER-CHOKE COVER
59. ELECTRIC CHOKE COVER & STAT ASSEMBLY
60. SCREW-CHOKE STAT LEVER ATTACHING
61. LEVER-CHOKE STAT
62. INTERMEDIATE CHOKE SHAFT, LEVER, AND LINK ASSEMBLY
63. SCREW ASSEMBLY-CHOKE HOUSING ATTACHING
64. CHOKE HOUSING

FLOAT BOWL PARTS

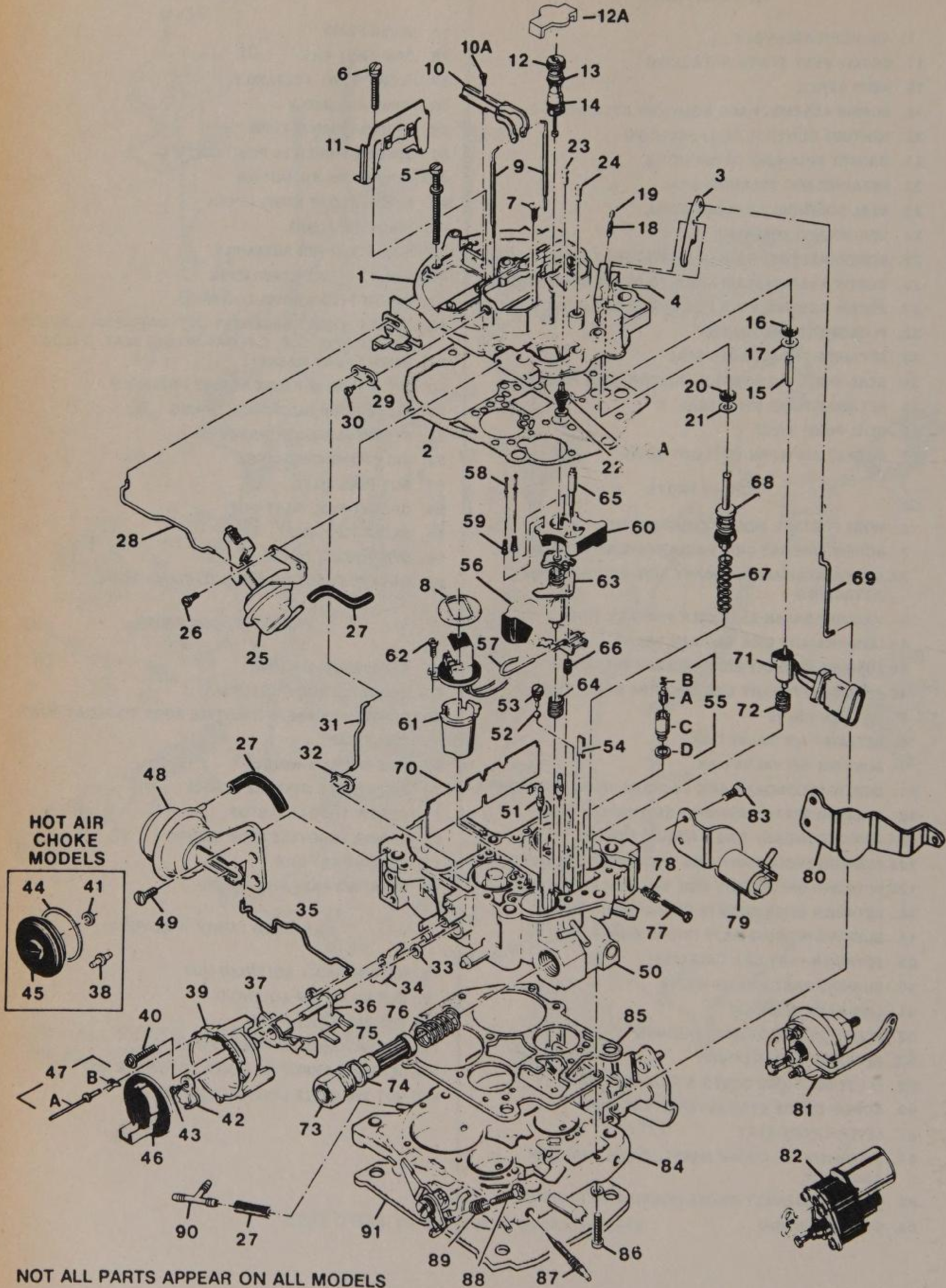
14. LEVER-PUMP
28. CAM-FAST IDLE
37. FLOAT BOWL ASSEMBLY
39. PUMP ASSEMBLY
40. SPRING-PUMP RETURN
41. SENSOR-THROTTLE POSITION (TPS)
42. SPRING-TPS ADJUSTING
43. INSERT-FLOAT BOWL-UPPER
44. HINGE PIN-FLOAT
45. FLOAT & LEVER ASSEMBLY
46. SPRING-FLOAT STABILIZING
47. INSERT-FLOAT BOWL-LOWER
48. NEEDLE & SEAT ASSEMBLY (A-FLOAT NEEDLE, B-FLOAT NEEDLE PULL CLIP, C-FLOAT NEEDLE SEAT, D-FLOAT NEEDLE SEAT GASKET)
49. JET & LEAN MIXTURE NEEDLE ASSEMBLY
50. GUIDE-PUMP DISCHARGE SPRING
51. SPRING-PUMP DISCHARGE
52. BALL-PUMP DISCHARGE
53. NUT-FUEL INLET
54. GASKET-FUEL INLET NUT
55. FILTER-FUEL INLET
56. SPRING-FUEL FILTER
67. GASKET-THROTTLE BODY TO FLOAT BOWL

THROTTLE BODY PARTS

13. RETAINER-PUMP LINK
65. THROTTLE BODY ASSEMBLY
66. SCREW ASSEMBLY-THROTTLE BODY TO FLOAT BOWL
68. LINK-PUMP
69. IDLE MIXTURE NEEDLE
70. SPRING-IDLE MIXTURE NEEDLE
71. SCREW-THROTTLE STOP
72. SPRING-THROTTLE STOP SCREW
73. SCREW-FAST IDLE
74. RETAINER-FAST IDLE SCREW

IDLE SPEED CONTROL DEVICES

8. RETAINER-IDLE SOLENOID NUT
9. NUT-IDLE STOP SOLENOID
10. SOLENOID-IDLE STOP
10A ACTUATOR-THROTTLE LEVER
10B RETAINER-THROTTLE LEVER ACTUATOR NUT
10C NUT-THROTTLE LEVER ACTUATOR



E4ME and E4MC 4 BBL carburetor — exploded view

AIR HORN PARTS

No. Part Name (Not all parts appear on all models.)

1. Air Horn Assembly
2. Gasket - Air Horn
3. Lever - Pump Actuating (Not Removable)
4. Roll Pin - Pump Lever Hinge
5. Screw - Air Horn, Long (2)
6. Screw - Air Horn, Short
7. Screw - Air Horn, Countersunk (2)
8. Gasket - Solenoid Connector to Air Horn
9. Metering Rod - Secondary (2)
10. Holder - Secondary Metering Rod
10a. Screw - Secondary Metering Rod Holder
11. Baffle - Secondary Air
12. Valve - Idle Air Bleed
12a. Cover - Idle Air Bleed Valve
13. "O" Ring (Thick) - Idle Air Bleed Valve
14. "O" Ring (Thin) - Idle Air Bleed Valve
15. Plunger - Throttle Position Sensor (TPS) Actuator
16. Seal - TPS Plunger
17. Retainer - TPS Seal
18. Screw - TPS Adjusting
19. Plug - TPS Adjusting Screw
20. Seal - Pump Plunger
21. Retainer - Pump Seal
22. Screw - Solenoid Plunger Stop (Rich Stop)
22a. Spring - Rich Authority Adjusting
23. Solenoid Plunger Stop Screw (Rich Stop)
24. Plug - Solenoid Adjusting Screw (Lean Mixture)

CHOKE PARTS

No. Part Name (Not all parts appear on all models.)

25. Vacuum Break & Bracket Assembly - Primary (Front)
26. Screw - Vacuum Break Attaching (2)
27. Hose - Vacuum Break
28. Rod - Air Valve
29. Lever - Choke (Upper)
30. Screw - Choke Lever
31. Rod - Choke
32. Lever - Intermediate Choke (Lower)
33. Seal - Intermediate Choke Shaft
34. Lever - Secondary Throttle Lockout
35. Link - Secondary Vacuum Break (Rear)
36. Intermediate Choke Shaft & Lever Assembly
37. Cam - Fast Idle
38. Seal - Choke Housing to Bowl (Hot Air Choke)
39. Choke Housing
40. Screw - Choke Housing to Bowl
41. Seal - Intermediate Choke Shaft (Hot Air Choke)
42. Lever - Choke Coil
43. Screw - Choke Coil Lever
44. Gasket - Stat Cover (Hot Air Choke)
45. Stat Cover & Coil Assembly (Hot Air Choke)
46. Stat Cover & Coil Assembly - Electric Choke
47. Kit - Choke Cover Retainer (A - Rivet, B - Retainer)
48. Vacuum Break & Bracket Assembly - Secondary (Rear)
49. Screw - Vacuum Break Attaching (2)

FLOAT BOWL PARTS

No. Part Name (Not all parts appear on all models.)

50. Float Bowl Assembly
51. Primary Metering Jet Assembly
52. Ball - Pump Discharge
53. Retainer - Pump Discharge Ball
54. Baffle - Pump Well
55. Needle & Seat Assembly (A - Float Needle, B - Pull Chip, C - Needle Seat, D - Seat Gasket)
56. Float & Lever Assembly
57. Hinge Pin - Float Assembly
58. Rod - Primary Metering
59. Spring - Primary Meting Rod (2)
60. Insert - Float Bowl
61. Insert - Aneroid Cavity
62. Screw - Solenoid Connector Attaching
63. Mixture Control (M/C) Solenoid & Plunger Assembly
64. Spring - SOlenoid Tension
65. Screw - Solenoid Adjusting (Lean Mixture)
66. Spring - Solenoid Adjusting Screw
67. Spring - Pump Return
68. Pump Assembly
69. Link - Pump
70. Baffle - Secondary Bores
71. Throttle Position Sensor (TPS)
72. Spring - TPS Tension
73. Filter Nut - Fuel Inlet
74. Gasket - Filter Nut
75. Filter - Fuel Inlet
76. Spring, Fuel Filter
77. Screw - Idle Stop
78. Spring - Idle Stop Screw
79. Idle Stop Solenoid & Bracket Assembly
80. Bracket - Throttle Return Spring
81. Idle Load Compensator & Bracket Assembly
82. Idle Speed Control & Bracket Assembly
83. Screw - Bracket Attaching

THROTTLE BODY PARTS

No. Part Name (Not all parts appear on all models.)

84. Throttle Body Assembly
85. Gasket - Throttle Body
86. Screw - Throttle Body
87. Idle Mixture Needle & Spring Assembly
88. Screw - Fast Idle Adjusting
89. Spring - Fast Idle Screw
90. Tee - Vacuum Hose
91. Gasket - Flange

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.

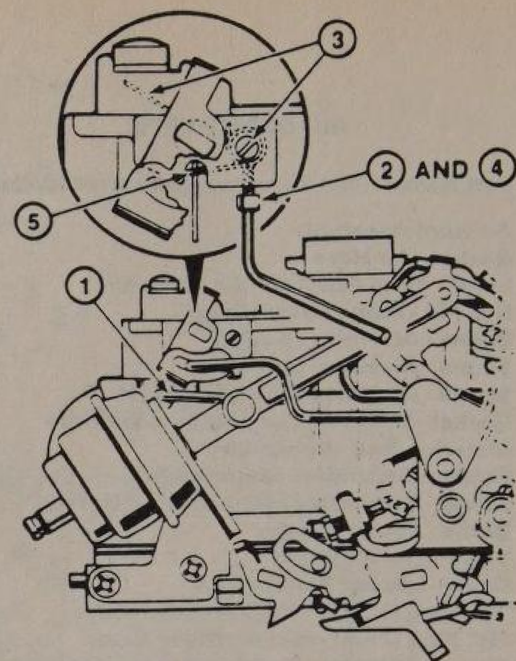
Rochester E2SE

REMOVAL AND INSTALLATION

1. Remove the aid 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.

To install:

1. Install the gaskets, carburetor and attaching bolts. Torque the bolts to 13 ft. lbs. (18 Nm).
2. If equipped, connect the cruise control linkage.
3. Connect the downshift cable, if equipped with an automatic transmission.



1. If necessary, remove intermediate choke rod, to gain access to lock screw
2. Loosen lock screw using $^3/_{32}$ in. 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

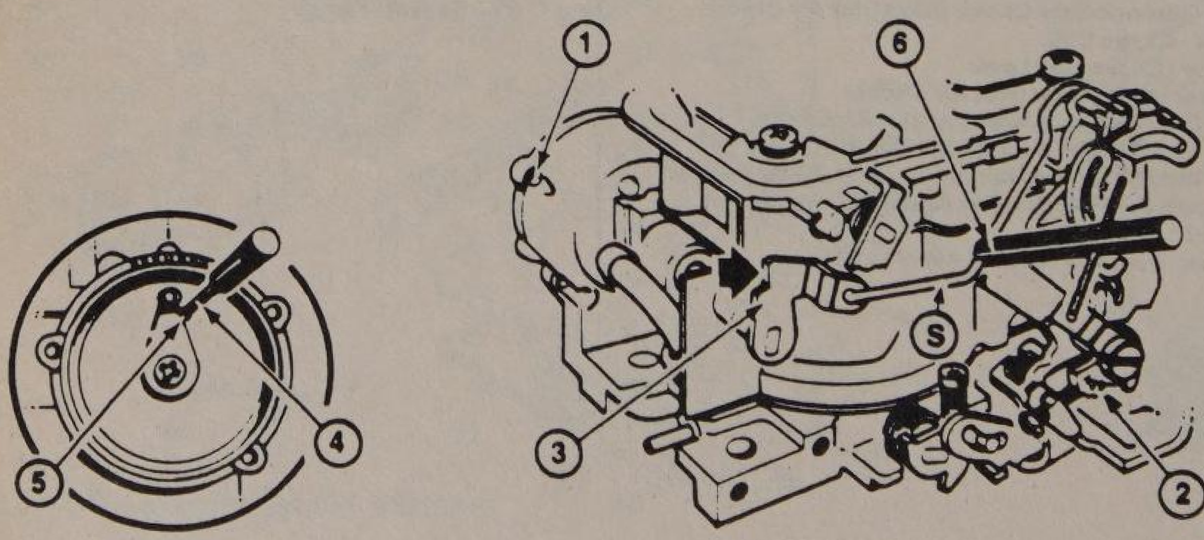
Air Valve Spring Adjustment — E2SE

4. Connect the accelerator linkage.
5. Connect the electrical connectors.
6. Connect the fuel tube and the vacuum lines.
7. Install the aid cleaner and gasket.

ADJUSTMENTS

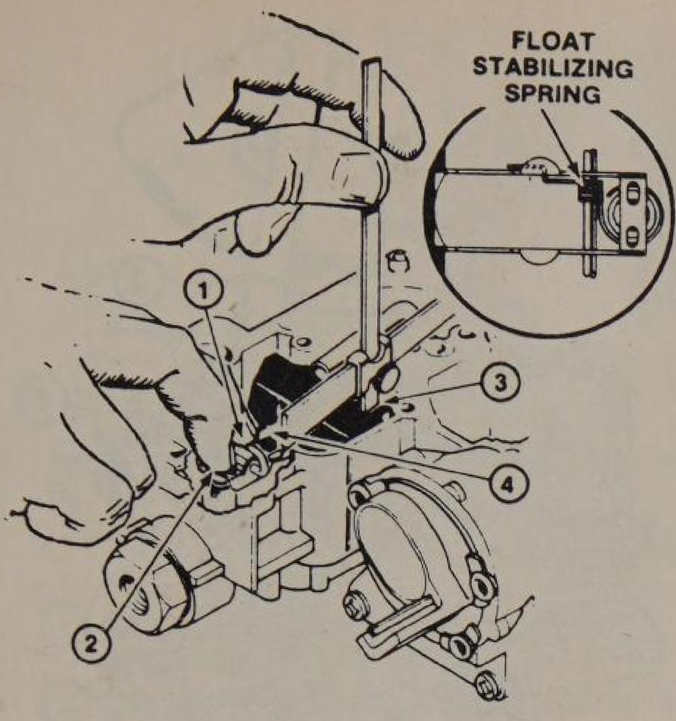
Throttle Linkage Adjustment

No adjustment of the throttle cable can be made.



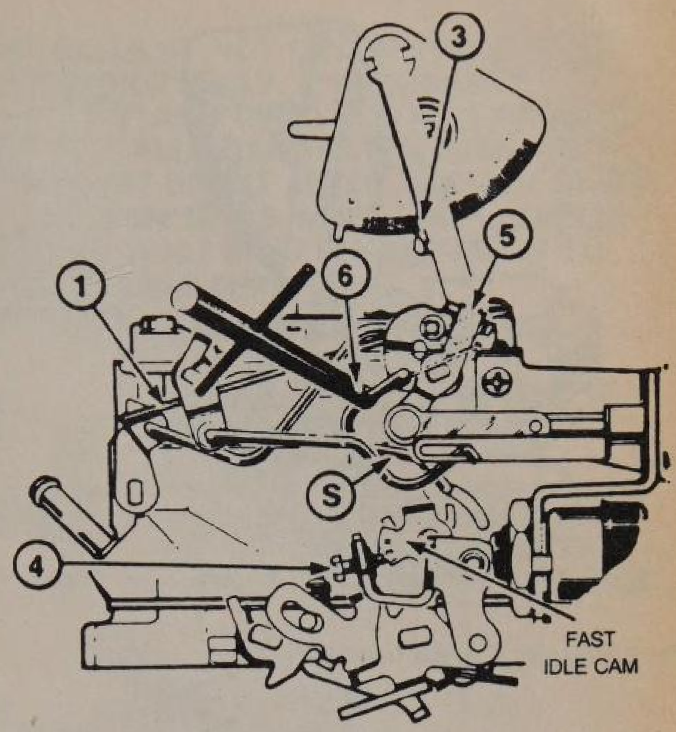
1. If riveted, drill out and remove rivets. Remove choke cover and coil assembly
2. Place fast idle screw on high step of fast idle cam
3. Push on intermediate choke lever until choke valve is closed
4. Insert 0.085 in. plug gage in hole
5. Edge of lever should just contact side of gage
6. Support at "S" and bend intermediate choke rod to adjust

Choke Lever Adjustment — E2SE



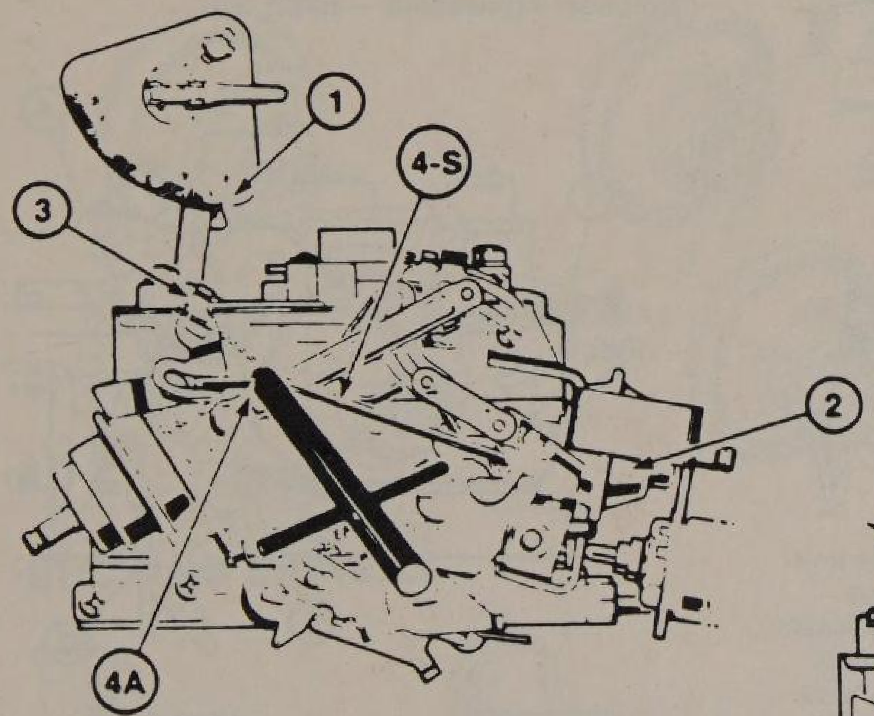
1. Hold retainer in place
2. Push float down lightly against needle
3. Gauge at large toe of float, at point farthest from float hinge
4. Remove float and bend float arm up or down to adjust (Some models have float stabilizer spring; use care in removing.)
5. Visually check float alignment

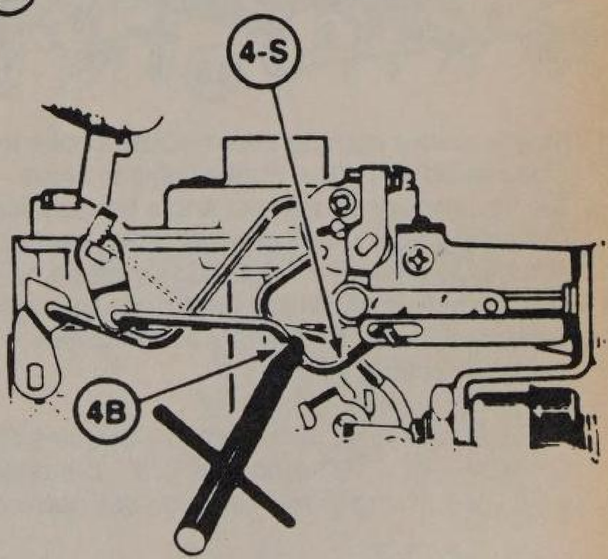
Float Level Adjustment – E2SE



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

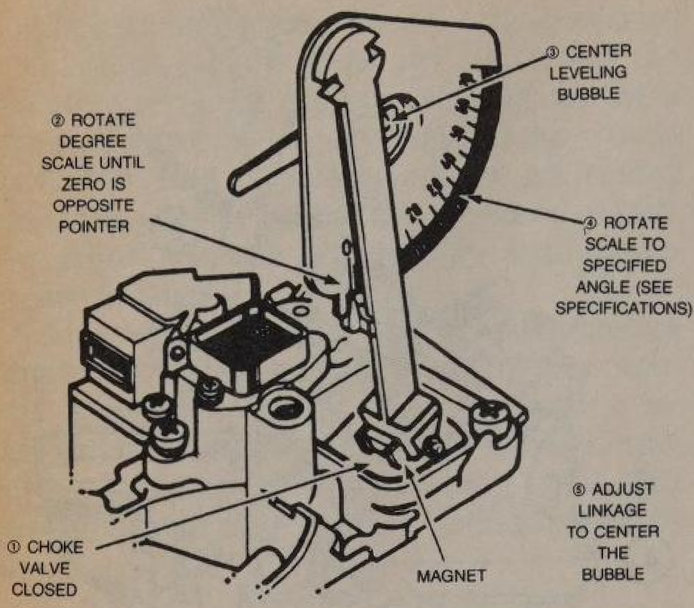
Choke Rod Fast Idle Cam Adjustment – E2SE



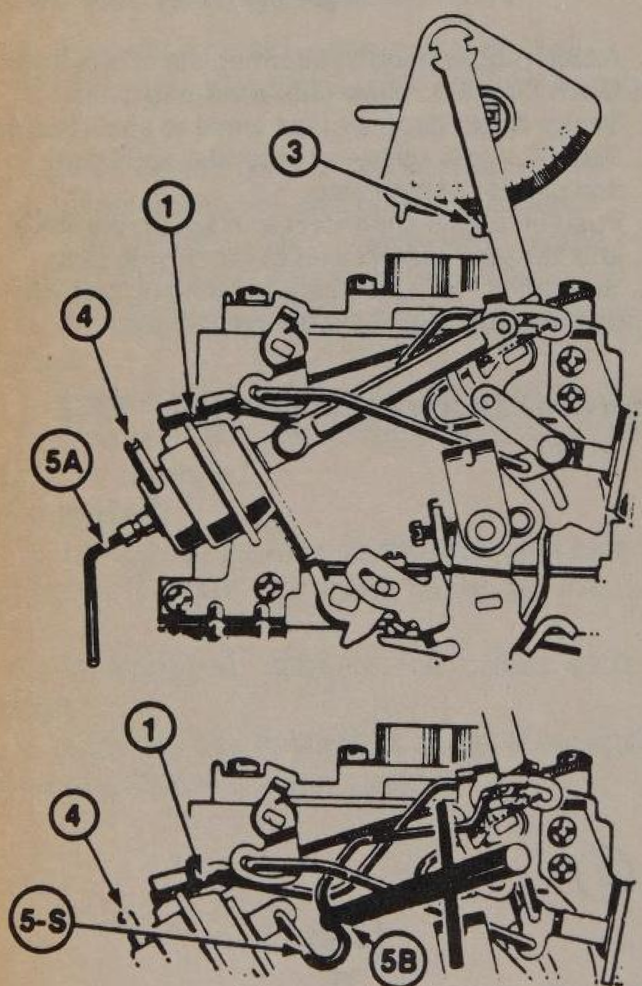


1. Set up angle gage on air valve and set angle to specifications
2. Use vacuum source, at least 18 in. Hg, to seat vacuum break plunger
3. Rotate air valve in the direction of open air valve by applying light pressure to air valve lever
4. To adjust, support at "4-S" and bend air valve rod ("A" or "B") until bubble is centered

Air Valve Rod Adjustment – E2SE

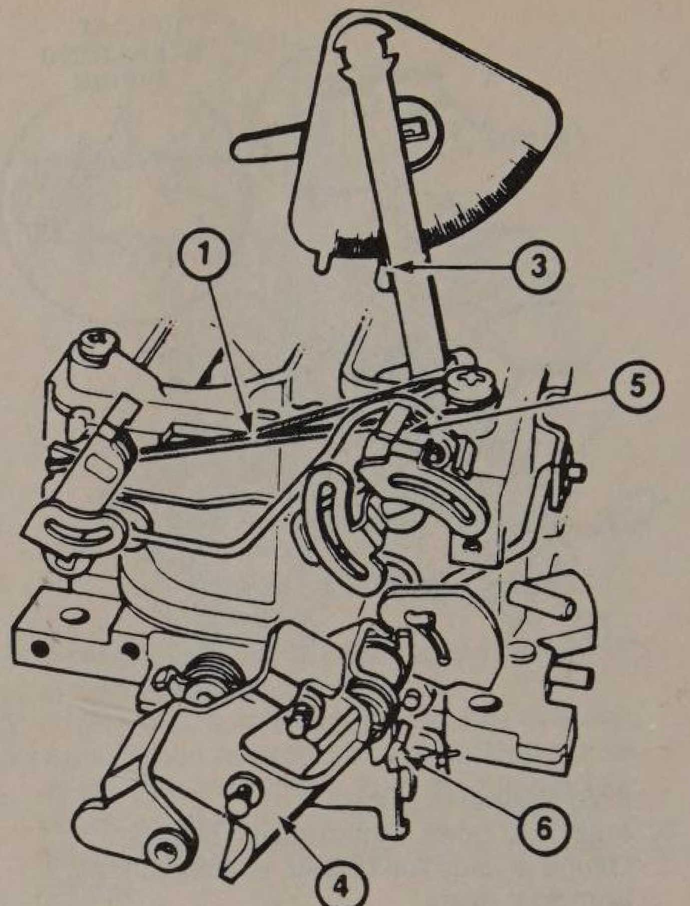


Choke Angle Gauge Installation



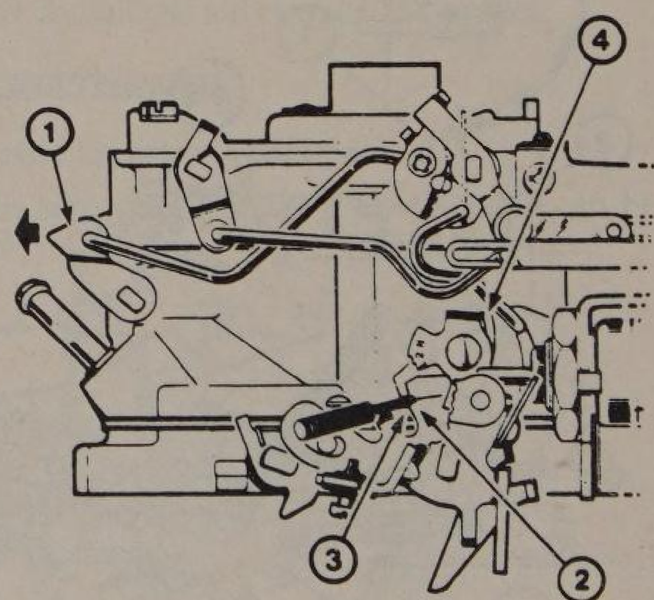
1. Attach rubber band to intermediate choke lever
2. Open throttle to allow choke valve to close
3. Set up angle gage and set angle to specification
4. Retract vacuum break plunger using vacuum source, at least 18 in. Hg. Plug air bleed holes where applicable. Where applicable, plunger stem must be extended fully to compress plunger bucking spring.
5. To center bubble, either:
   A.Adjust with 1/8 in. hex wrench (vacuums till applied)— or —B.Support at "5-S", bend side from vacuum break rod (vacuum still applied)

Secondary vacuum break adjustment — E2SE



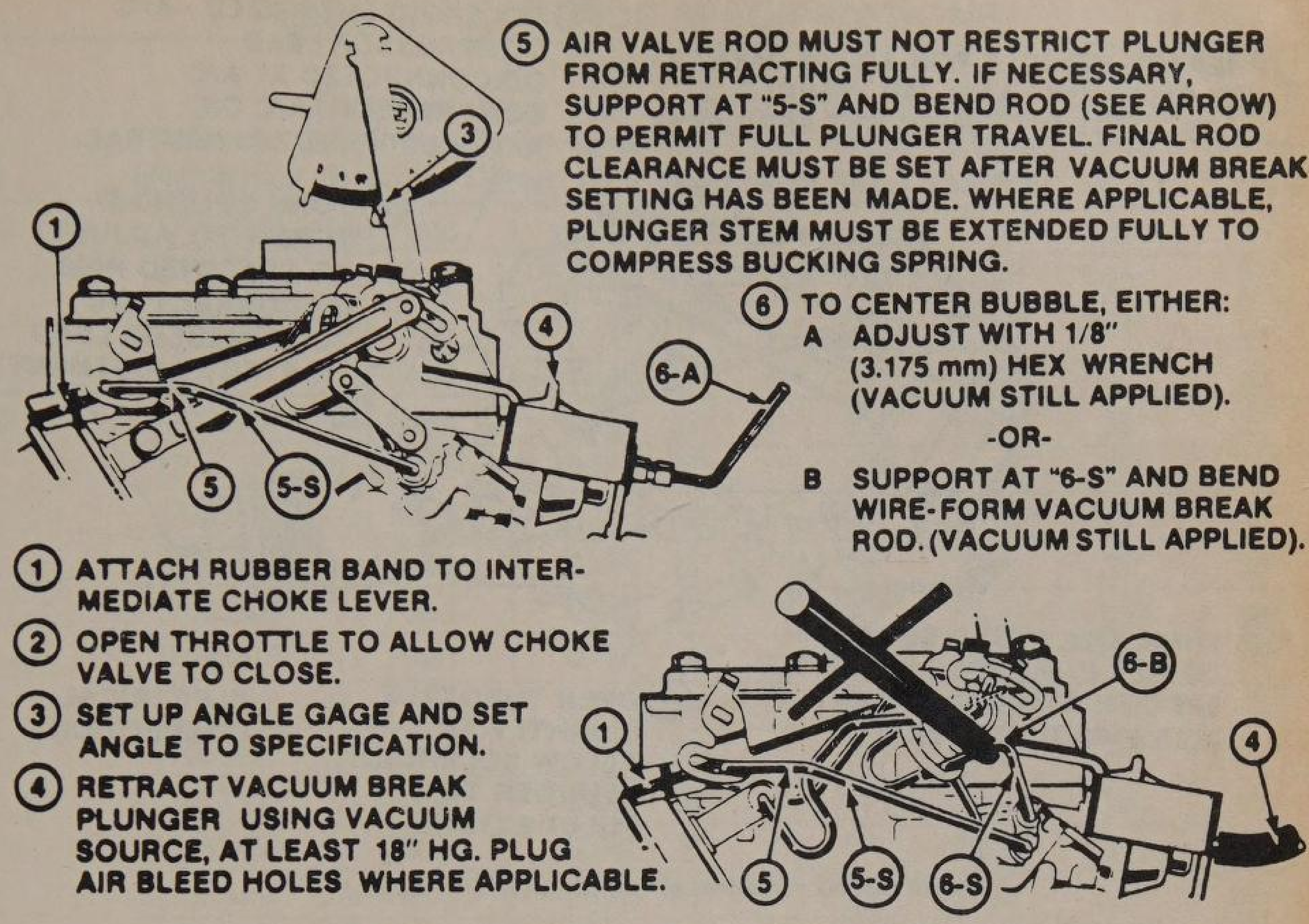
1. Attach rubber band to intermediate choke lever
2. Open throttle to allow choke valve to close
3. Set up angle gage and set angle to specifications
4. Hold throttle lever in wide open position
5. Push on choke shaft lever to open choke valve and to make contact with black closing tang
6. Adjust by bending tang until bubble is centered

Unloader Adjustment — E2SE

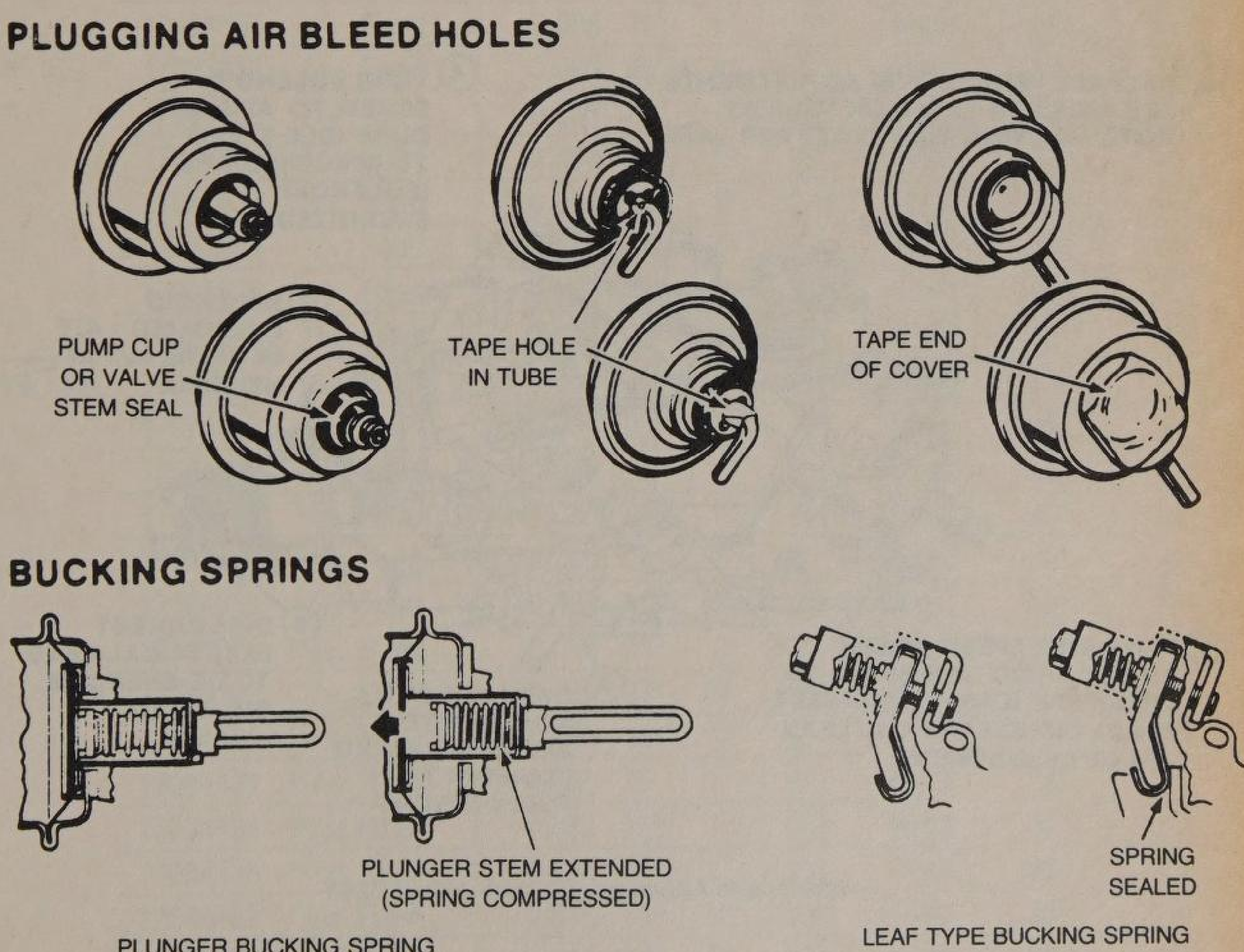


1. Hold choke valve wide open by pushing down on intermediate choke lever
2. Open throttle lever until end of secondary actuating lever is opposite toe of lockout lever
3. Gage clearance — dimension should be 0.025 in.
4. If necessary to adjust, bend lockout lever gag contacting fast idle cam

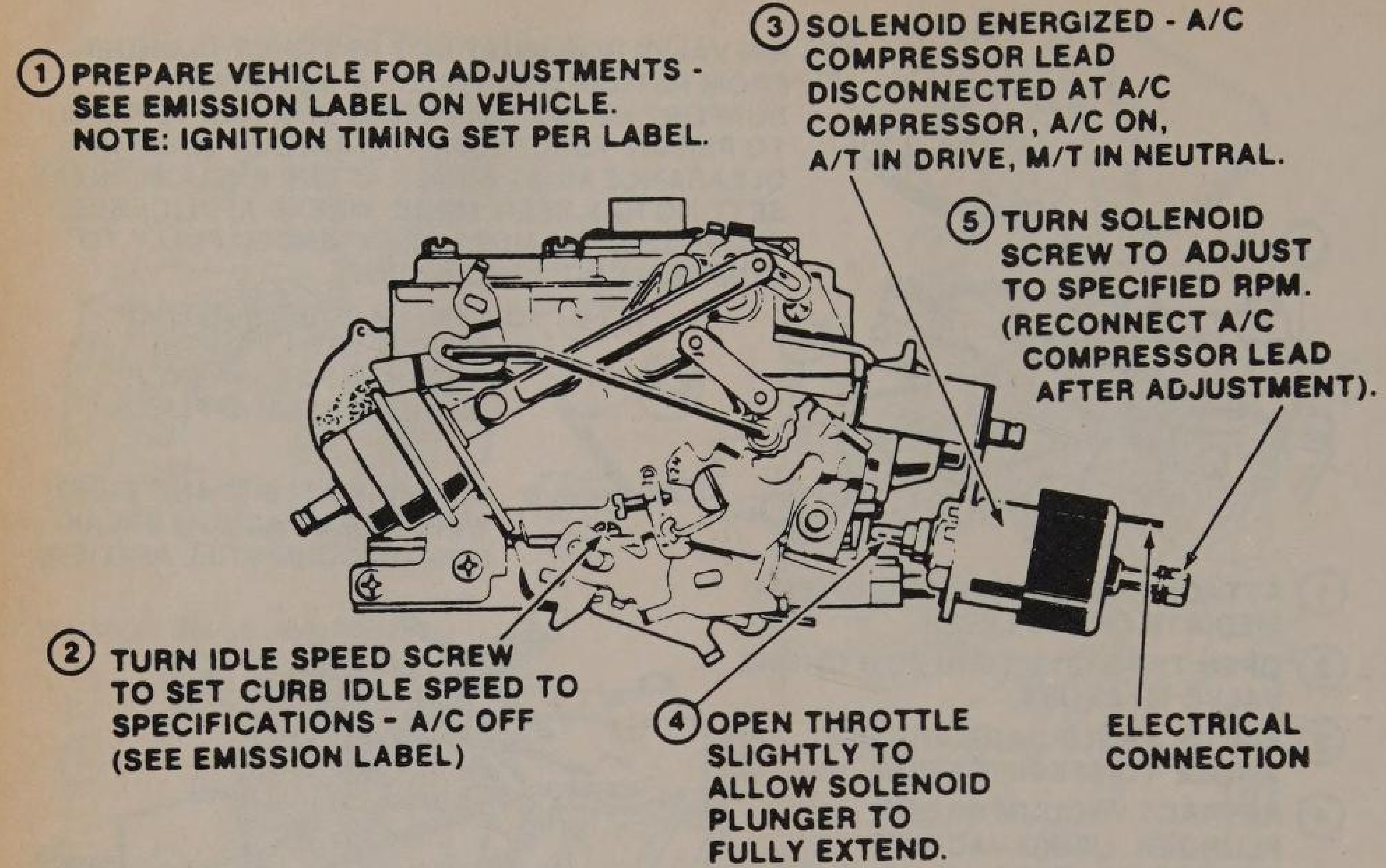
Secondary Lockout Adjustment — E2SE



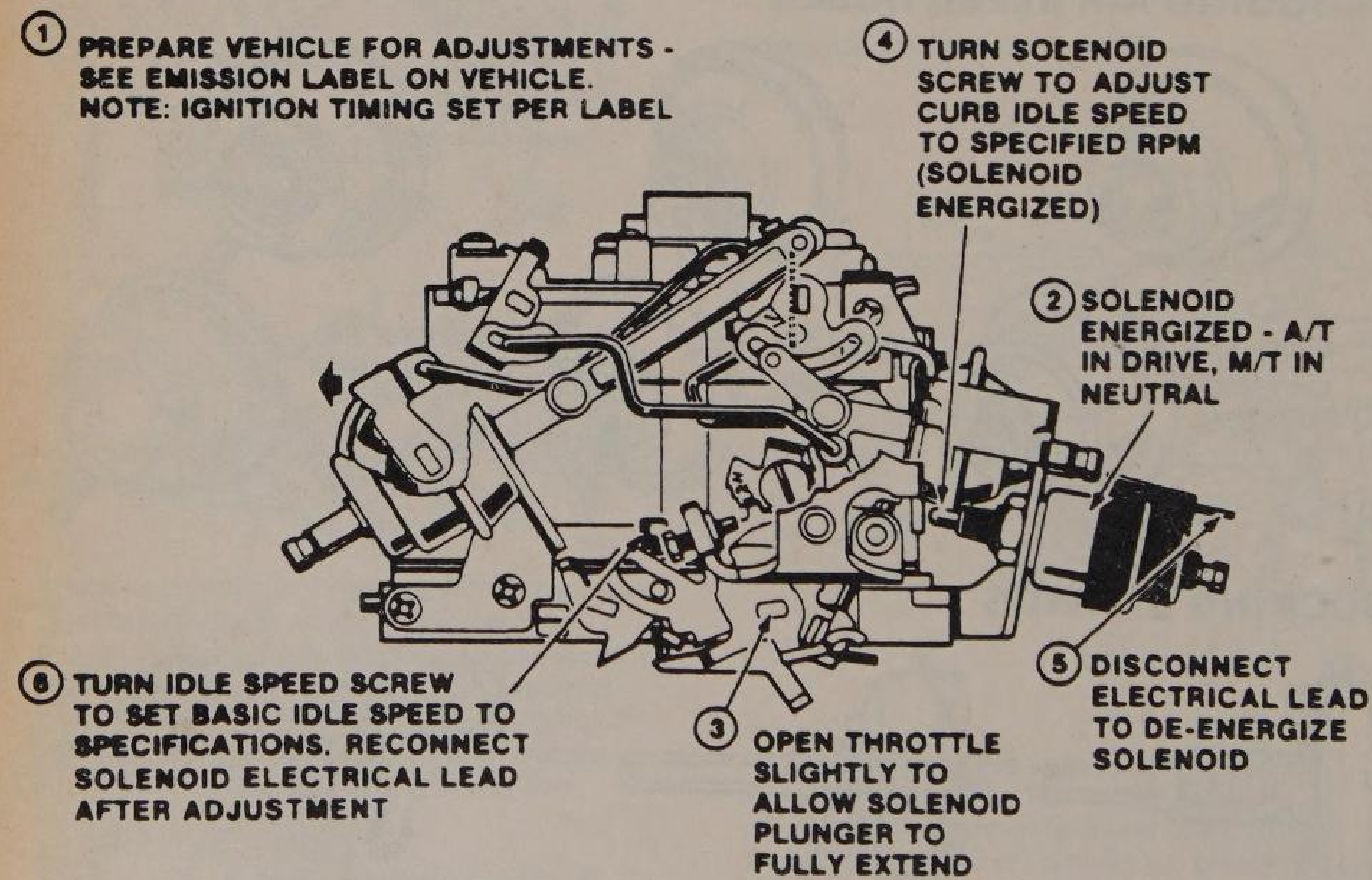
Primary vacuum break adjustment — E2SE



Vacuum Break Adjustment Information



Idle Speed Adjustment — without A/C — E2SE



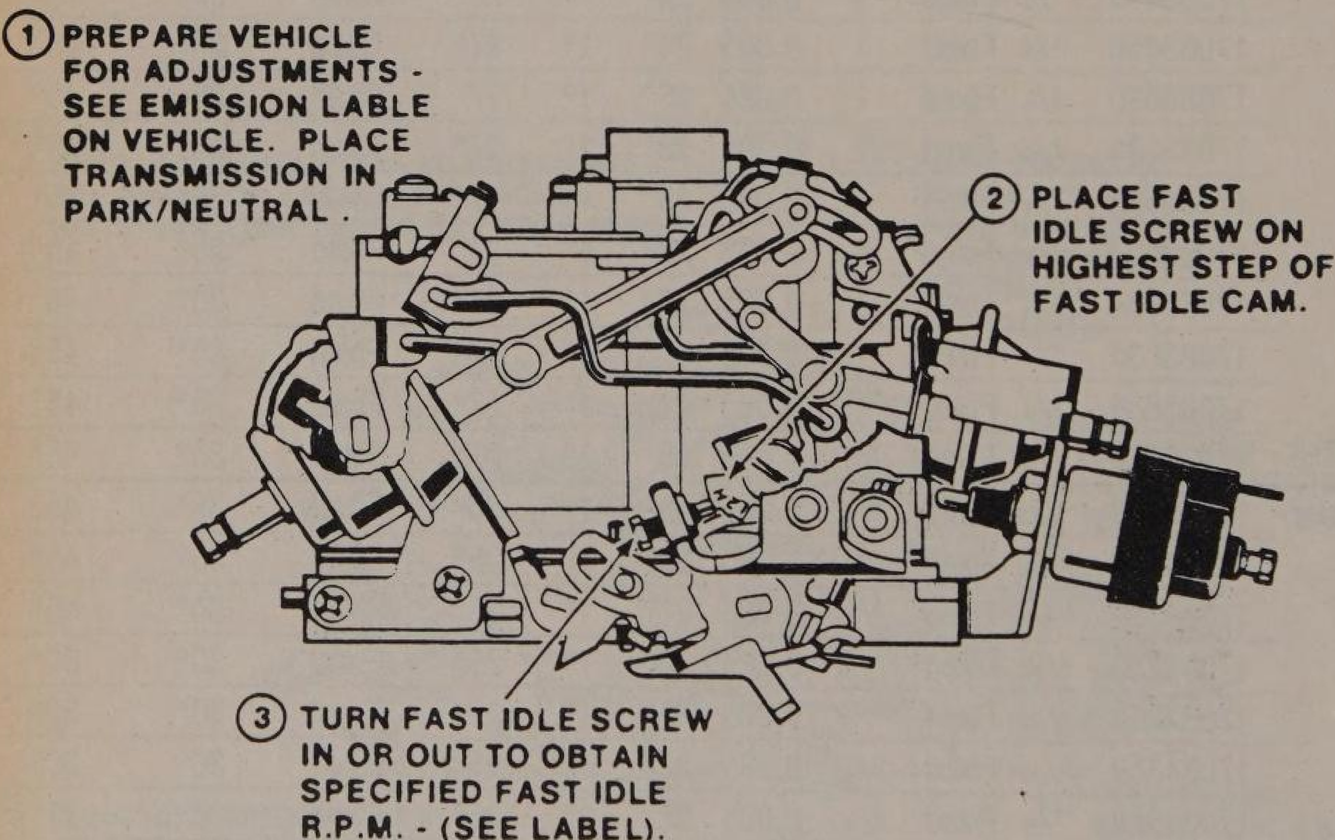
Idle Speed Adjustment — with A/C — E2SE

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 Settling (notches)	Secondary Vacuum Break (deg.)	Choke Unloader (deg.)
1982	17082390	13/32	Fixed	1	0.085	17°	1°	26°	Fixed	34°	35°
	17082391	13/32	Fixed	1	0.085	25°	1°	29°	Fixed	35°	35°
	17082490	13/32	Fixed	1	0.085	17°	1°	26°	Fixed	34°	35°
	17082491	13/32	Fixed	1	0.085	25°	1°	29°	Fixed	35°	35°
1983	17083356	13/32	Fixed	1	0.085	22°	1°	25°	Fixed	35°	30°
	17083357	13/32	Fixed	1	0.085	22°	1°	25°	Fixed	35°	30°
	17083358	13/32	Fixed	1	0.085	22°	1°	25°	Fixed	35°	30°
	17083359	13/32	Fixed	1	0.085	22°	1°	25°	Fixed	35°	30°
	17083368	1/8	Fixed	1	0.085	22°	1°	25°	Fixed	35°	30°
	17083370	1/8	Fixed	1	0.085	22°	1°	25°	Fixed	35°	30°
	17083450	1/8	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083451	1/8	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083452	1/8	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083453	1/8	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083454	1/8	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083455	1/8	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083456	1/8	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083630	1/4	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083631	1/4	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083632	1/4	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083633	1/4	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083634	1/4	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083635	1/4	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083636	1/4	Fixed	1	0.085	28°	1°	27°	Fixed	35°	45°
	17083650	1/8	Fixed	1/2	0.085	28°	1°	27°	Fixed	35°	45°
1984 & Later	17072683	9/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17074812	9/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17084356	9/32	Fixed	3/4	0.085	22°	1°	25°	Fixed	30°	45°
	17084357	9/32	Fixed	3/4	0.085	22°	1°	25°	Fixed	30°	30°
	17084358	9/32	Fixed	3/4	0.085	22°	1°	25°	Fixed	30°	30°
	17084359	9/32	Fixed	3/4	0.085	22°	1°	25°	Fixed	30°	30°
	17084368	1/8	Fixed	3/4	0.085	22°	1°	25°	Fixed	30°	30°
	17084370	1/8	Fixed	3/4	0.085	22°	1°	25°	Fixed	30°	30°
	17084430	11/32	Fixed	1	0.085	15°	1°	26°	Fixed	38°	42°
	17084431	11/32	Fixed	1	0.085	15°	1°	26°	Fixed	38°	42°
	17084434	11/32	Fixed	1	0.085	15°	1°	26°	Fixed	38°	42°
	17084435	11/32	Fixed	1	0.085	15°	1°	26°	Fixed	38°	42°
	17084452	5/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17084453	5/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17084455	5/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°

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 Settling (notches)	Secondary Vacuum Break (deg.)	Choke Unloader (deg.)
1984 & Later	17084456	5/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17084458	5/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17084532	5/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17084534	5/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17084535	5/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17084537	5/32	Fixed	1/2	0.085	28°		25°	Fixed	35°	45°
	17084538	5/32	Fixed	1/2	0.085	28°		25°	Fixed	35°	45°
	17084540	5/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17084542	1/8	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17084632	9/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17084633	9/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17084635	9/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°
	17084636	9/32	Fixed	1/2	0.085	28°	1°	25°	Fixed	35°	45°



Fast Idle Adjustment — E2SE

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.

To install:

1. Install the attaching bolts and carburetor.
2. Connect the fuel line at the carburetor inlet.
3. Connect all of the necessary vacuum lines.
4. If equipped, install the cruise control.
5. Connect the transmission detent cable.
6. Connect the accelerator linkage.
7. Connect the battery and install the air cleaner.

ADJUSTMENTS

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.

Pump Adjustment

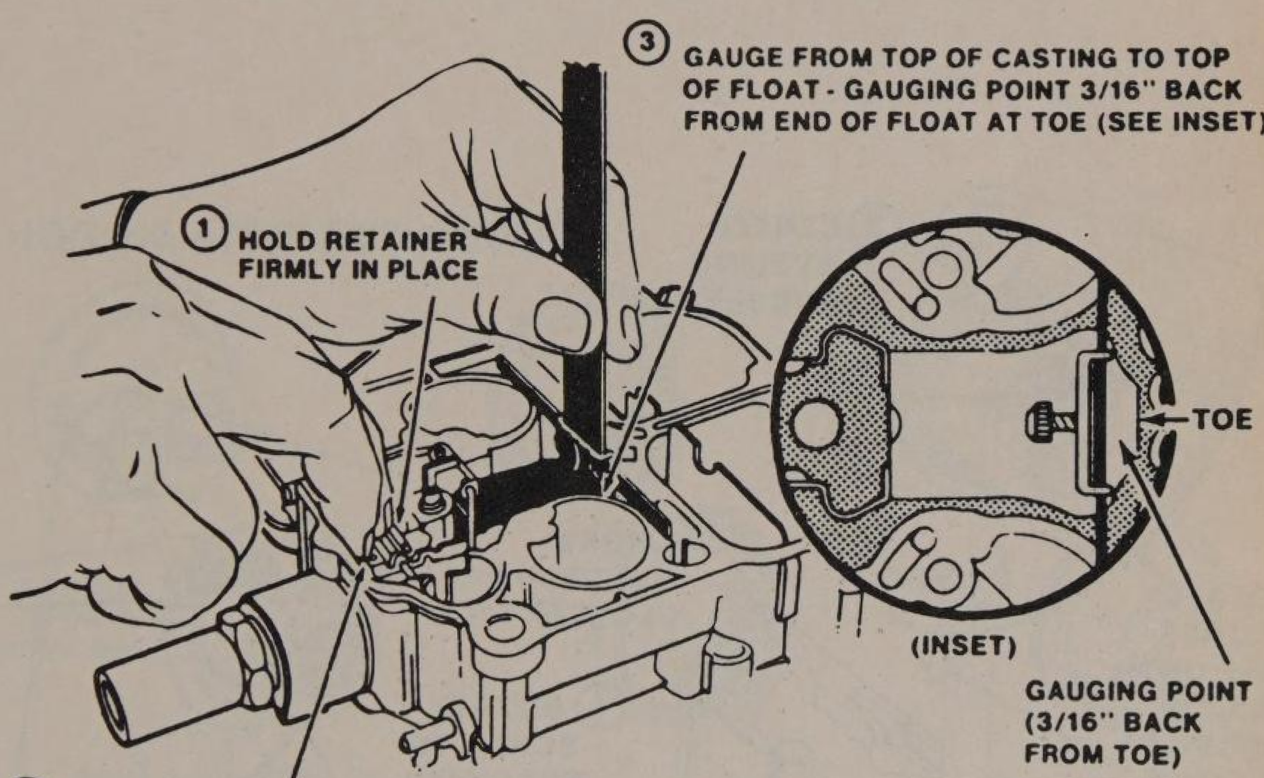
E4ME and E4MC carburetors have a non-adjustable pump lever. No adjustments are necessary or possible.

Fast Idle Adjustment

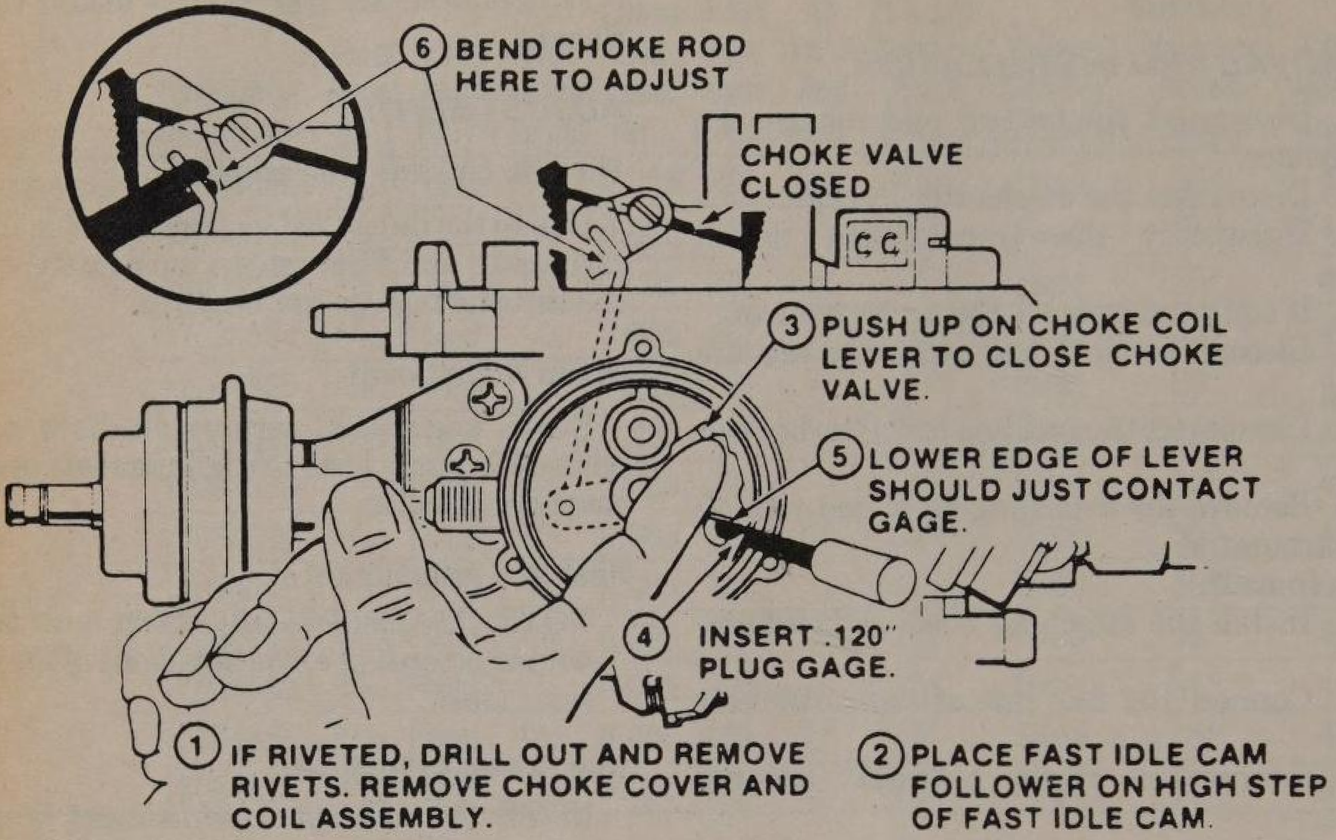
NOTE: *The fast idle adjustment must be performed according to the directions of the emissions label.*

Idle Speed Adjustment

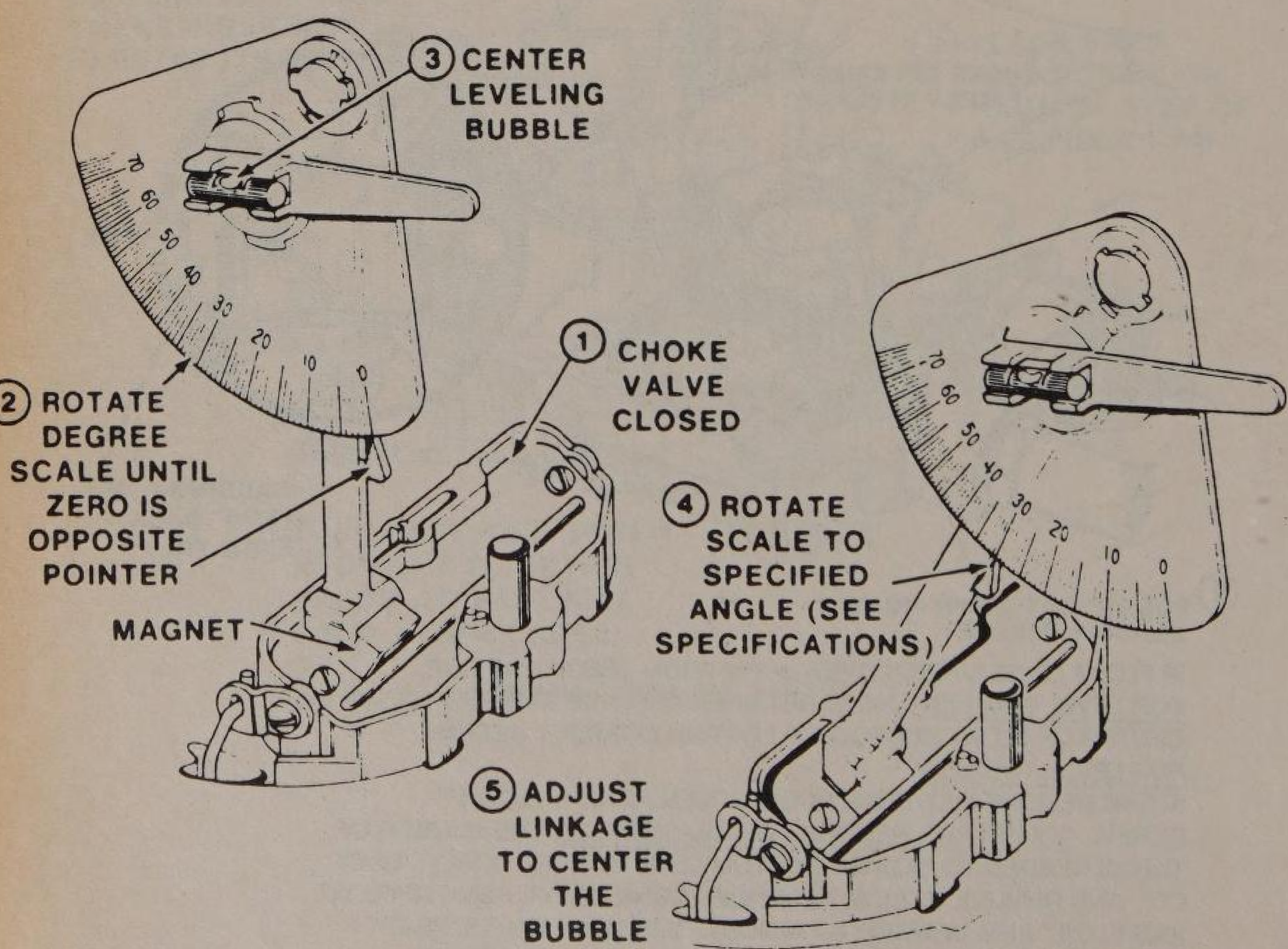
NOTE: *No idle speed adjustment is necessary, for the idle speed is controlled by the ECM.*



Float Level Adjustment — E4ME/E4MC



Choke Lever Adjustment — E4ME/E4MC



Choke Valve Angle Gauge

(1) ATTACH RUBBER BAND TO GREEN TANG OF INTERMEDIATE CHOKE SHAFT

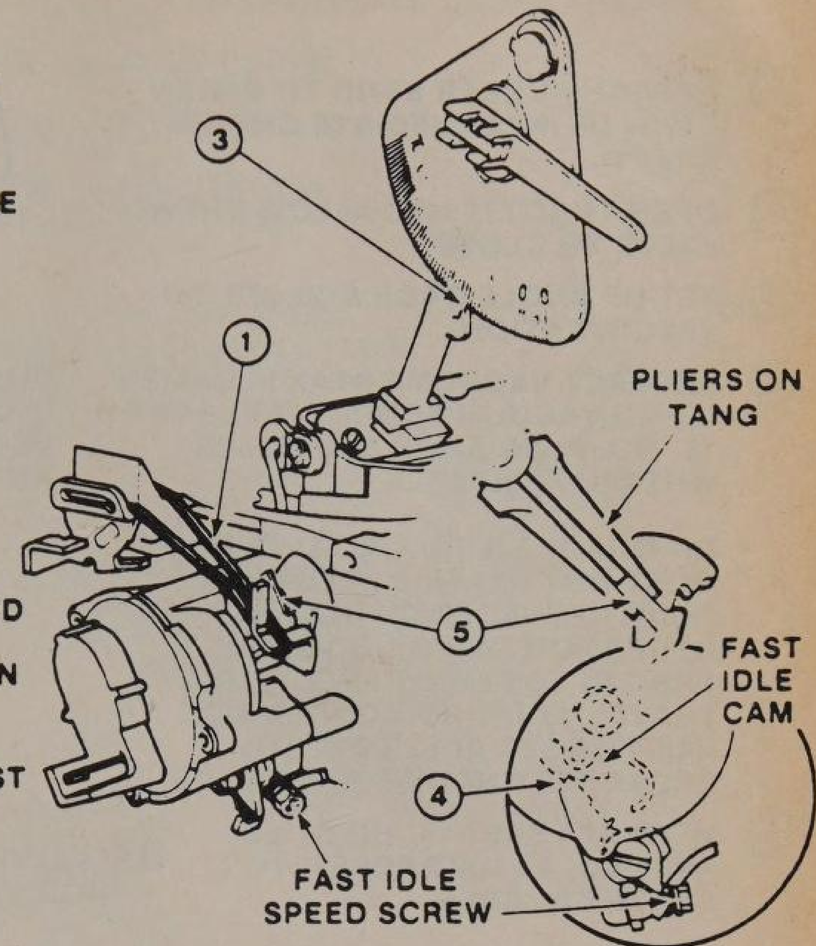
(2) OPEN THROTTLE TO ALLOW CHOKE VALVE TO CLOSE

(3) SET UP ANGLE GAGE AND SET ANGLE TO SPECIFICATIONS

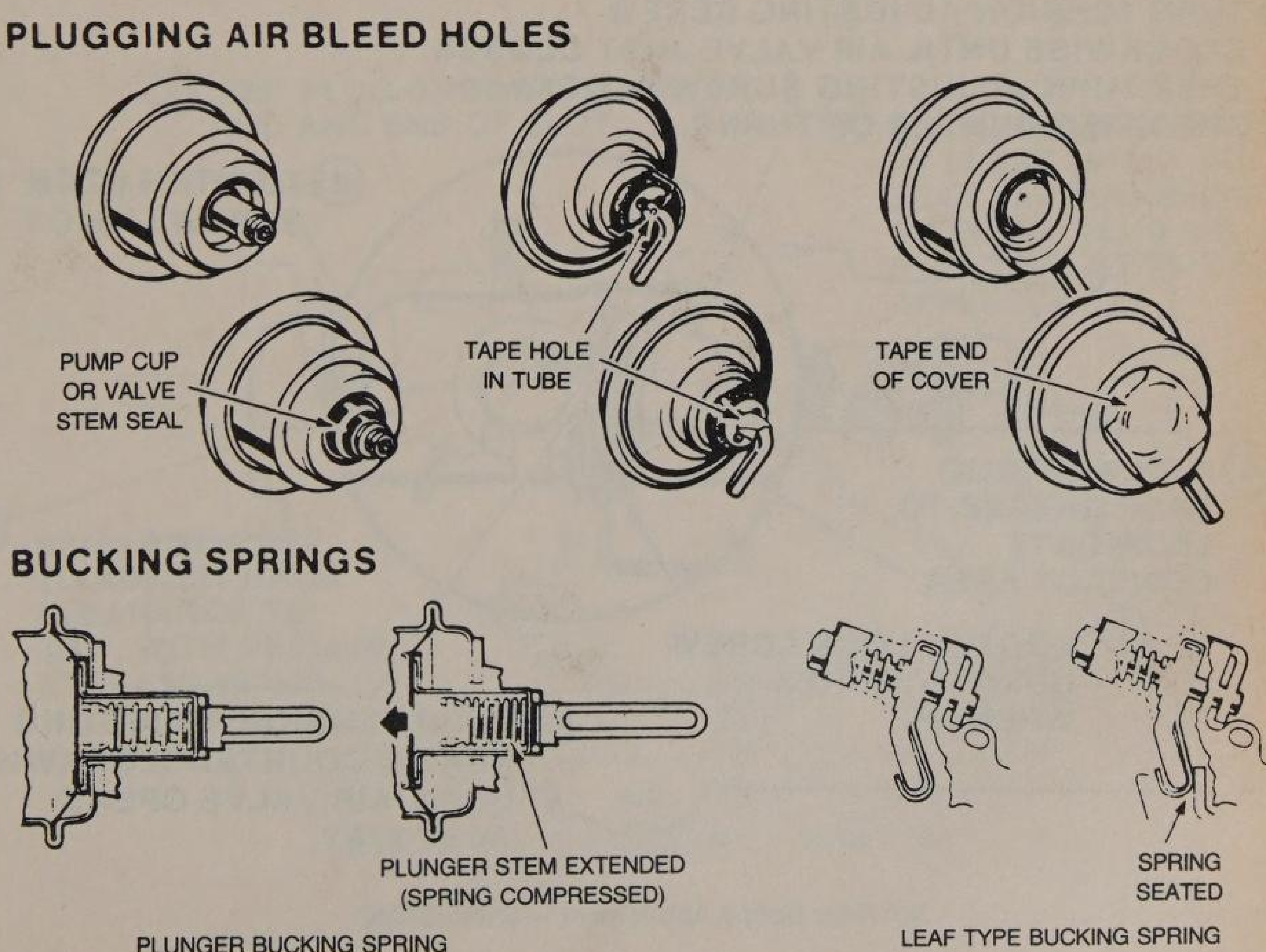
(4) PLACE CAM FOLLOWER ON SECOND STEP OF CAM, AGAINST RISE OF HIGH STEP. IF CAM FOLLOWER DOES NOT CONTACT CAM, TURN IN FAST IDLE SPEED SCREW ADDITIONAL TURN(S).

NOTICE: FINAL FAST IDLE SPEED ADJUSTMENT MUST BE PERFORMED ACCORDING TO UNDER-HOOD EMISSION CONTROL INFORMATION LABEL.

(5) ADJUST BY BENDING TANG OF FAST IDLE CAM UNTIL BUBBLE IS CENTERED.



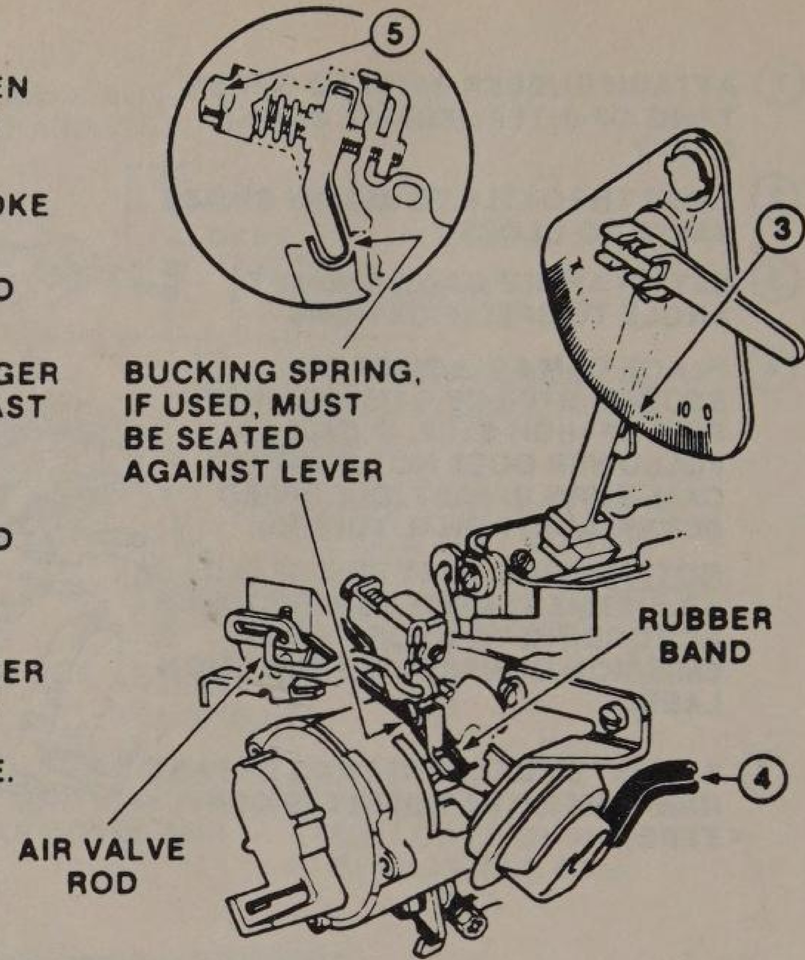
Choke Rod-Fast Idle Cam Adjustment — E4ME/E4MC



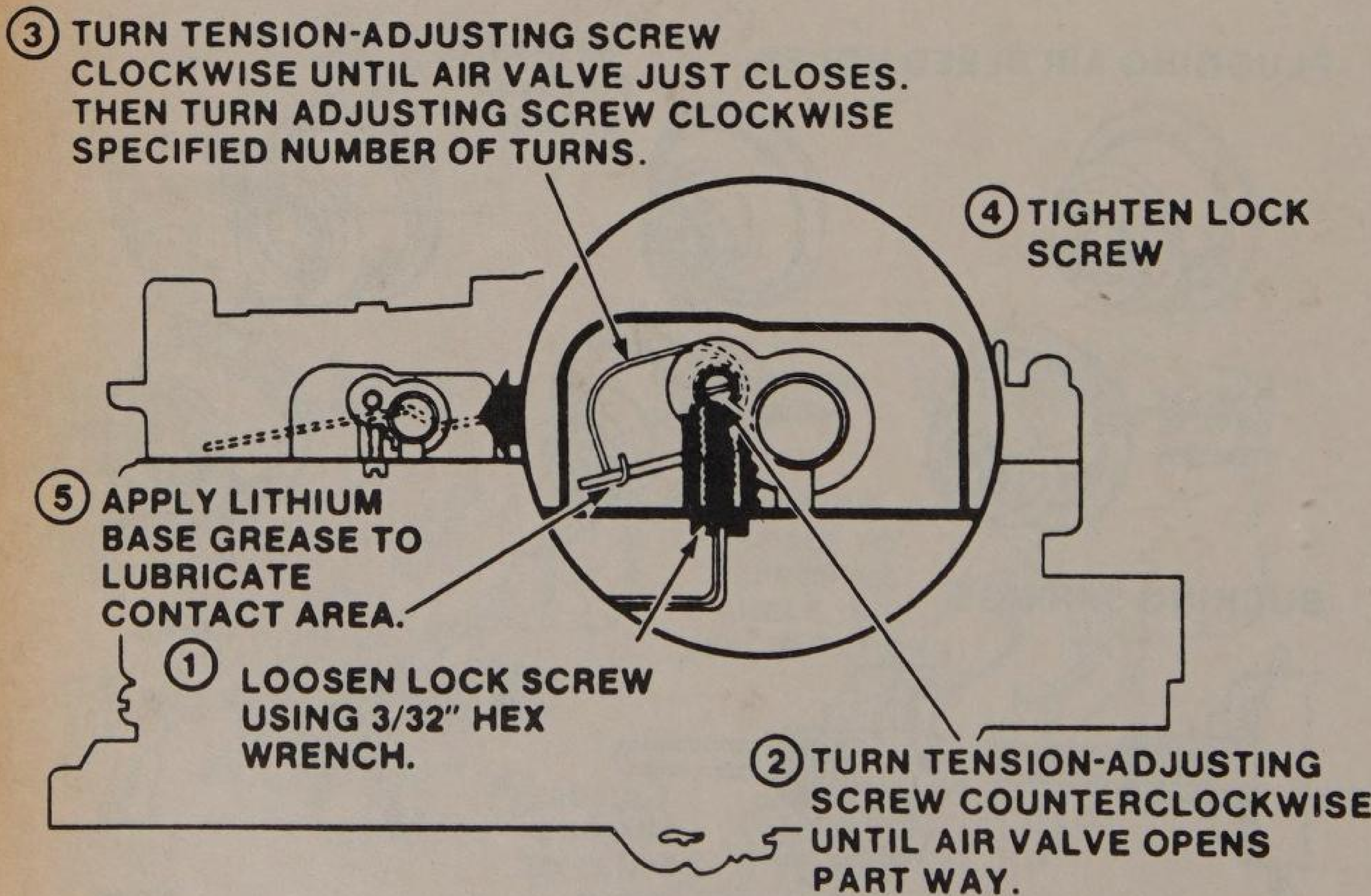
Vacuum Break Information (Adjustment)

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 TO SPECIFICATION
4. RETRACT VACUUM BREAK PLUNGER USING VACUUM SOURCE, AT LEAST 18″ HG. PLUG AIR BLEED HOLES WHERE APPLICABLE

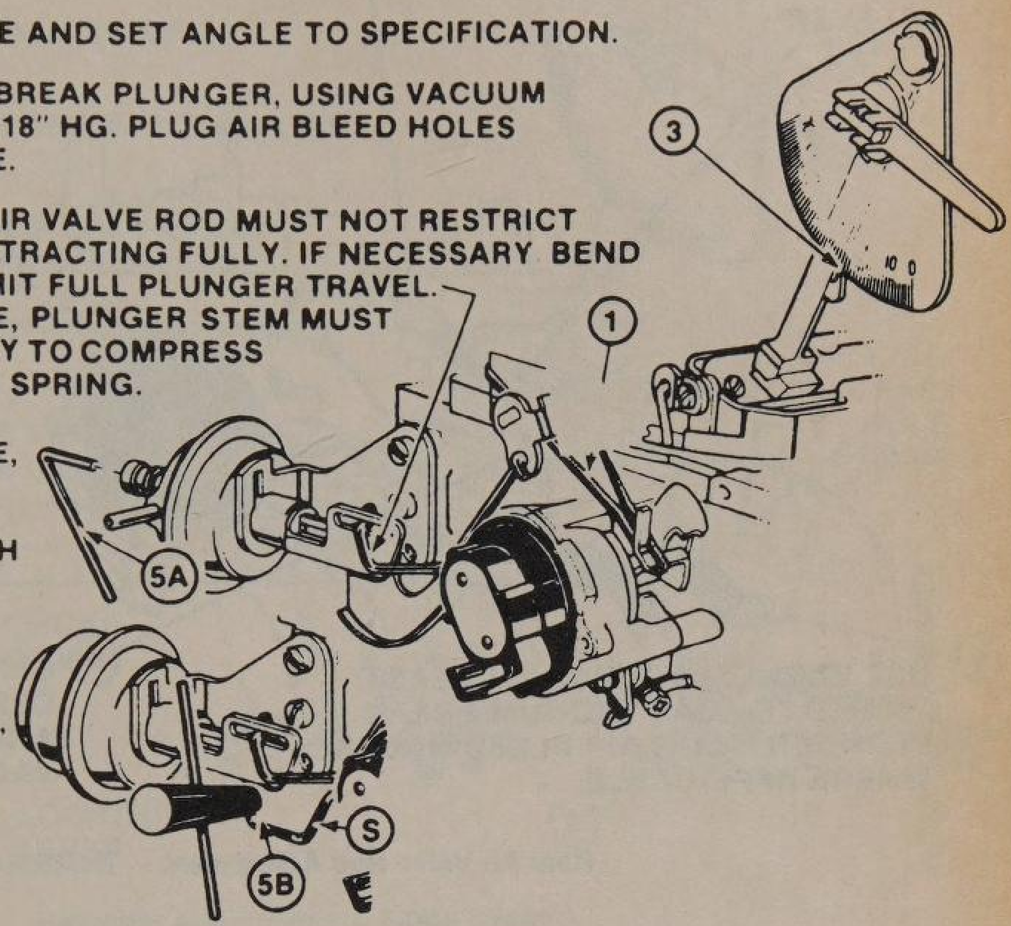
   ON QUADRAJETS, AIR VALVE ROD MUST NOT RESTRICT PLUNGER FROM RETRACTING FULLY. IF NECESSARY, BEND ROD (SEE ARROW) TO PERMIT FULL PLUNGER TRAVEL. FINAL ROD CLEARANCE MUST BE SET AFTER VACUUM BREAK SETTING HAS BEEN MADE.
5. WITH AT LEAST 18″ HG STILL APPLIED, ADJUST SCREW TO CENTER BUBBLE



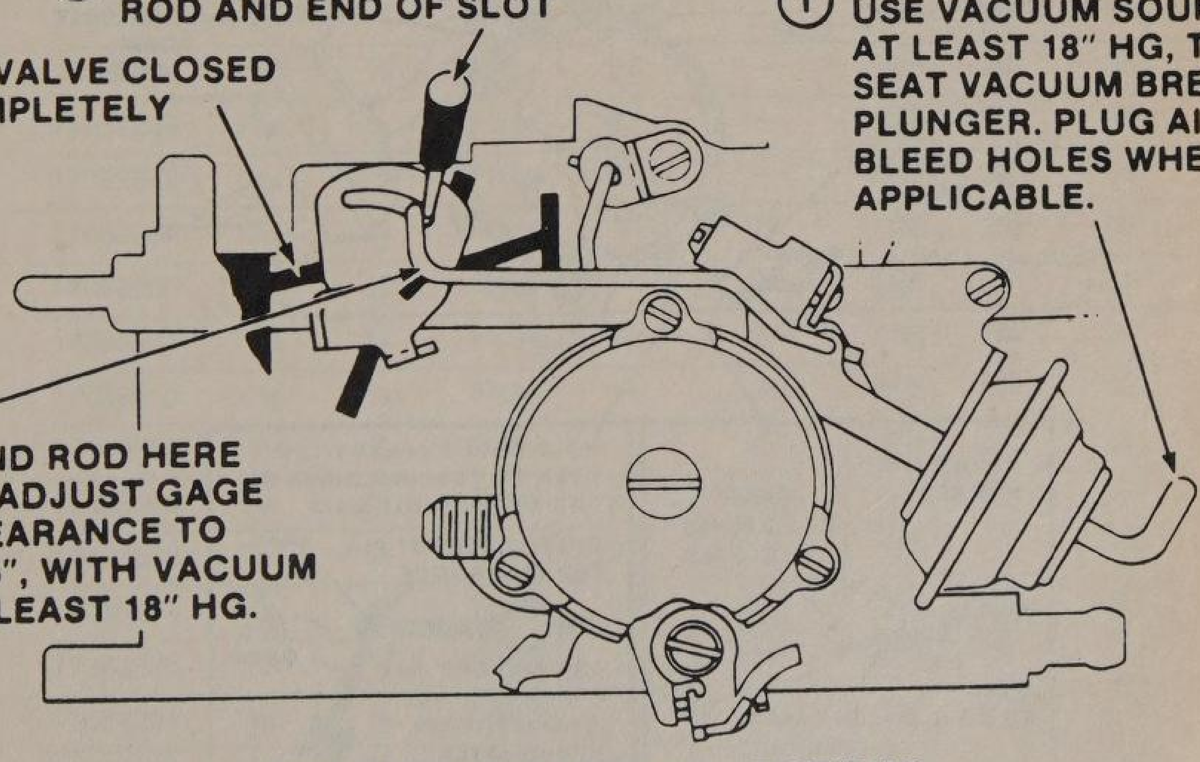
Front Vacuum Break Adjustment — E4ME/E4MC



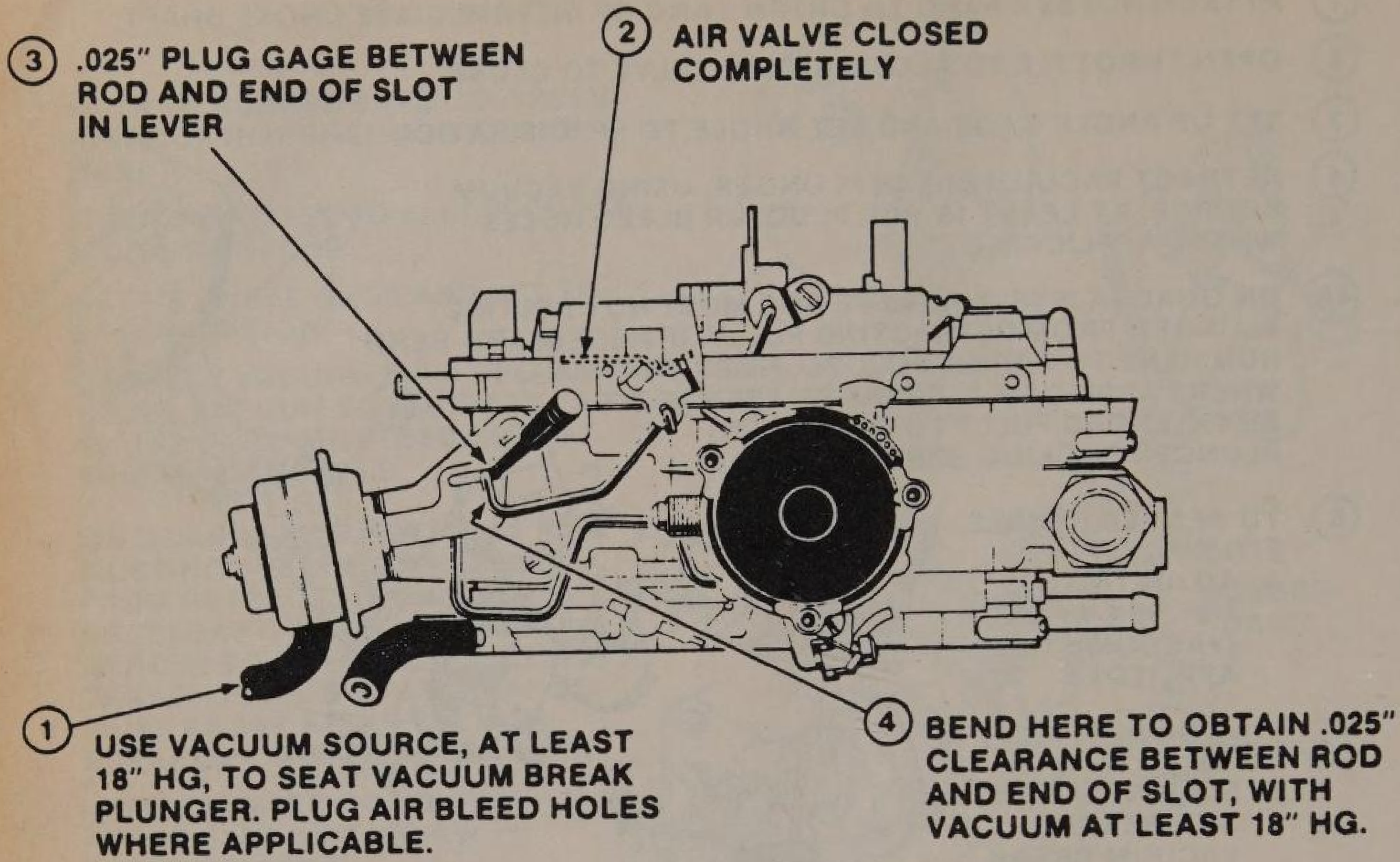
Air Valve Spring Adjustment — E4ME/E4MC



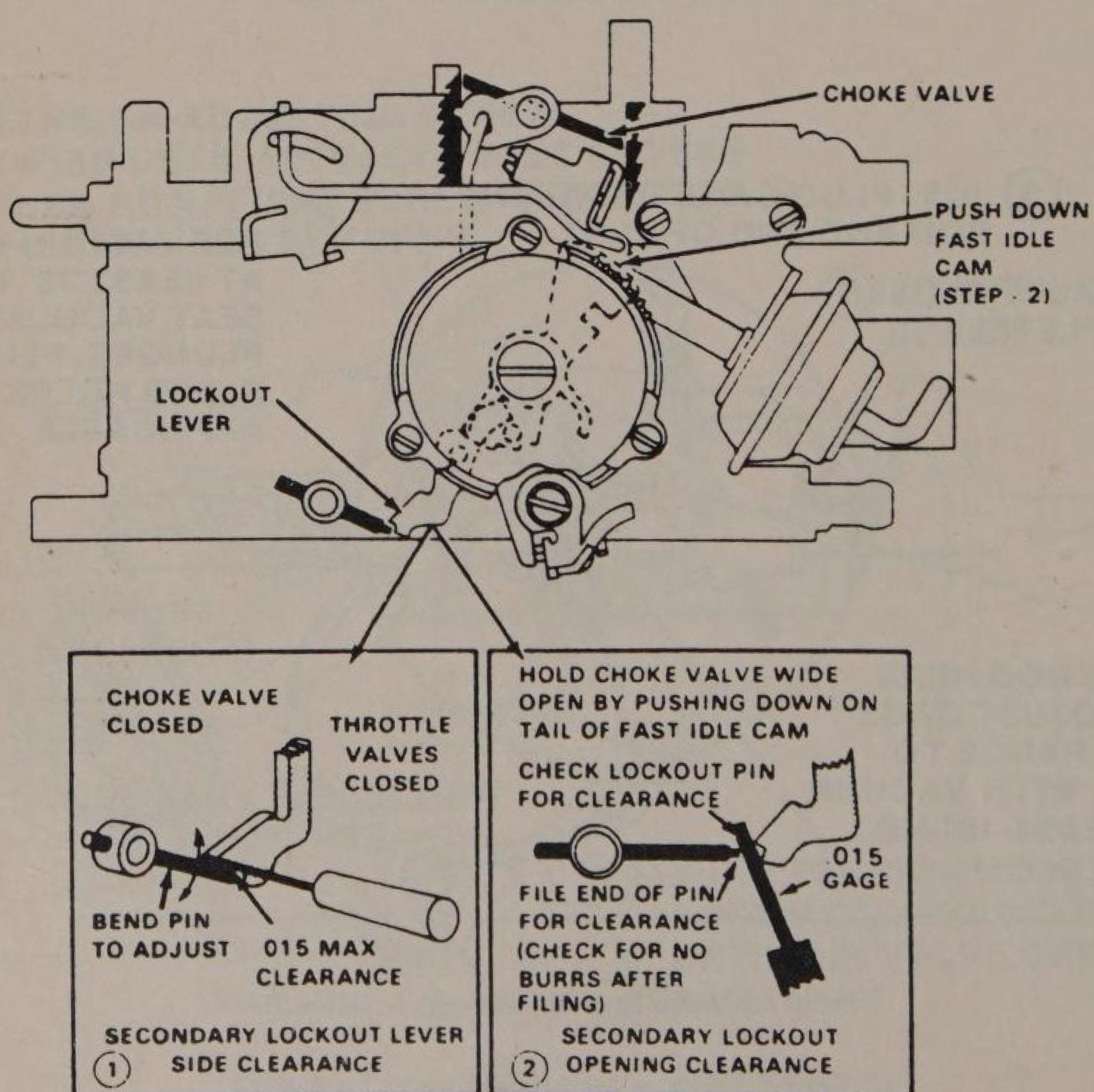
Rear vacuum break adjustment – E4ME/E4MC



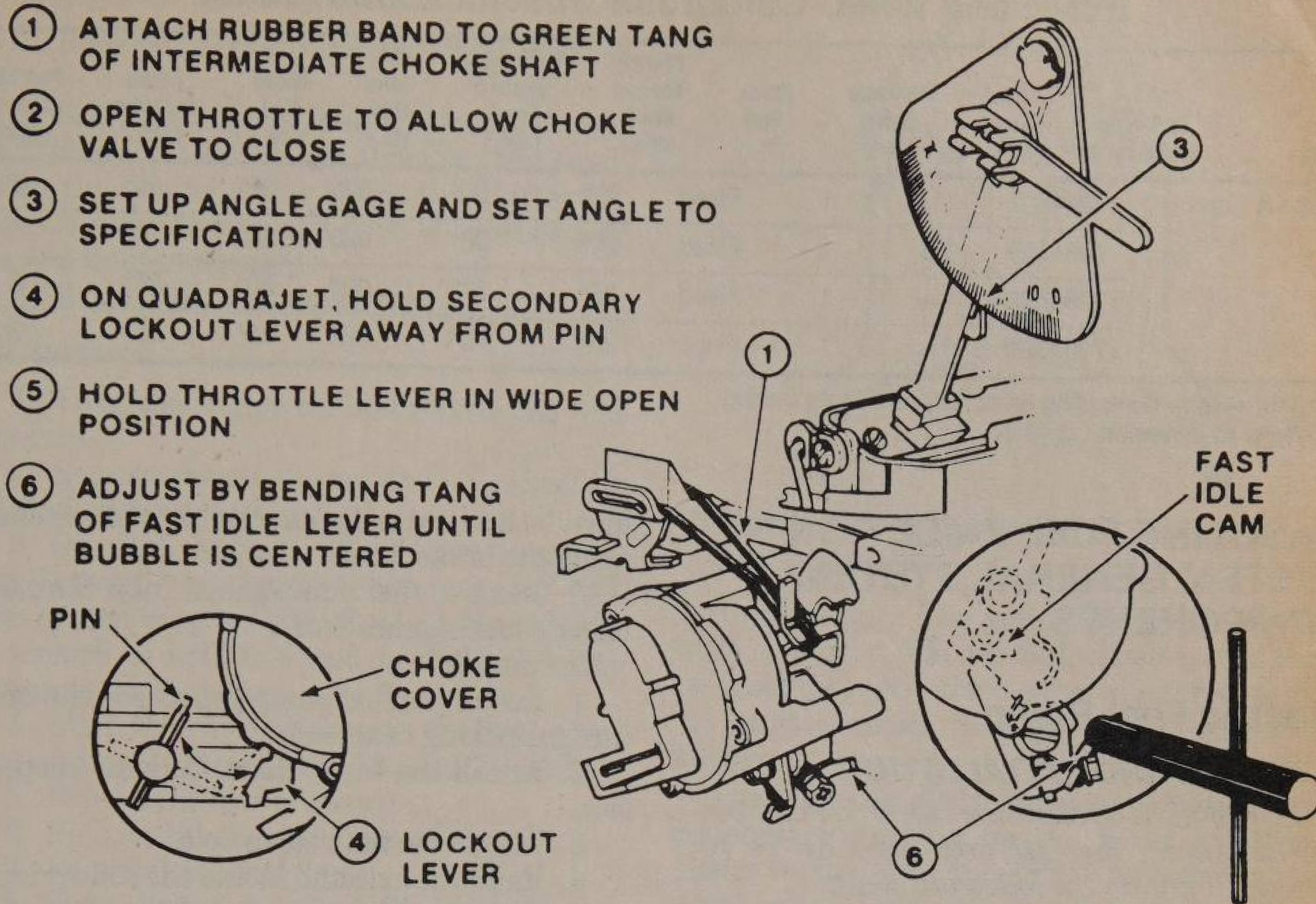
Front Air Valve Rod Adjustment – E4ME/E4MC



Rear Air Valve Rod Adjustment — E4ME/E4MC



Secondary Lockout Adjustment — E4ME/E4MC



Unloader Adjustment – E4ME/E4MC

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

E4ME and E4MC Carburetor Specifications (cont.)

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)
1984 & Later	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

GASOLINE FUEL INJECTION SYSTEM GENERAL SYSTEM COMPONENTS

Electric Fuel Pump

REMOVAL AND INSTALLATION

CAUTION: *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 using an approved suction pump.
6. Jack up your vehicle and support it with jackstands.
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.
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 using a locking cam tool.

To install:

1. Install the fuel pump/gauge into the tank using a locking cam tool.
2. Install the tank. Raise the rear suspension.
3. Install the tank strap bolts.
4. Raise the axle and install the coil springs.
5. Connect the lower end of the shock absorbers.
6. Install the fuel pipe retaining bracket on the left side.
7. Connect all fuel lines.
8. Connect the fuel pump/gauge connector.
9. Install the rear suspension track bar and its brace.
10. Install the filler neck shield.
11. Install the heat shield.
12. Connect the exhaust system.
13. Lower the vehicle.
14. Start the engine and check operation.

TESTING

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.

NOTE: *The idle pressure will vary somewhat depending on barometric pressure. Check for a drop in pressure indicating regulator control, rather than specific values.*

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 3 seconds to make sure all pressure in the fuel lines is released.
3. Replace the fuel pump fuse.

TBI Systems

1. Turn the engine off and relieve the fuel pressure.
2. Remove the air cleaner and plug the THERMAC vacuum port on TBI.
3. On 2.5L engine, install fuel pressure gage between the throttle body unit and fuel filter by removing the steel fuel line. Use a back-up wrench to hold fuel nut on the TBI when removing the fuel line.
4. Start the car and observe the fuel pressure reading. It should be 9–13 psi (62–90 kPa).
5. Relieve the fuel pressure.
6. Remove the fuel pressure gauge.
7. Reinstall the fuel line.
8. Start the car and check for fuel leaks.
9. Remove plug covering THERMAC vacuum port on the TBI and install the air cleaner.

Port Fuel Injection System

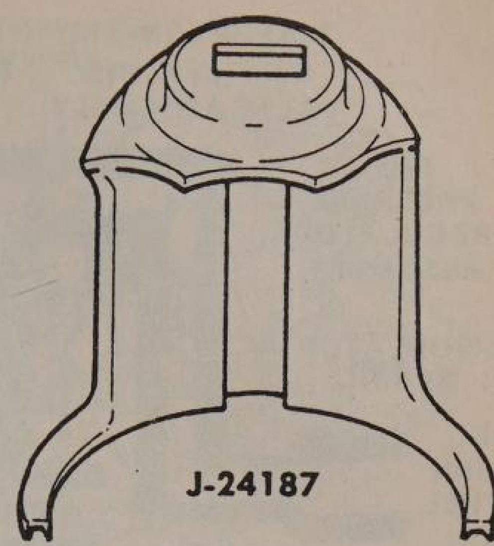
1. Turn the engine off and relieve the fuel pressure.
2. Connect a fuel pressure gauge to the fuel pressure test connector port on the fuel rail.
3. Turn the ignition ON for at least 10 seconds and observe the fuel pressure reading. It should be 40–47 psi (280–325 kPa).
4. Turn the ignition OFF and relieve fuel pressure.
5. Remove the fuel pressure gauge.
6. Check for leaks.

THROTTLE BODY INJECTION (TBI)

Throttle Body Injection (TBI)

The Model 300 Throttle Body Injection (TBI) System is used on all 2.5L (VIN 2) engines. The Model 220 Throttle Body Injection system is used on the 5.0L (VIN E) engines. The assembly is centrally located on the intake manifold in the same fashion as a carburetor. Its function is to supply an air/fuel mixture to the in take manifold, which is controlled by the ECM.

The assembly is simple. It consists of two casting assemblies: a throttle body and a fuel me-



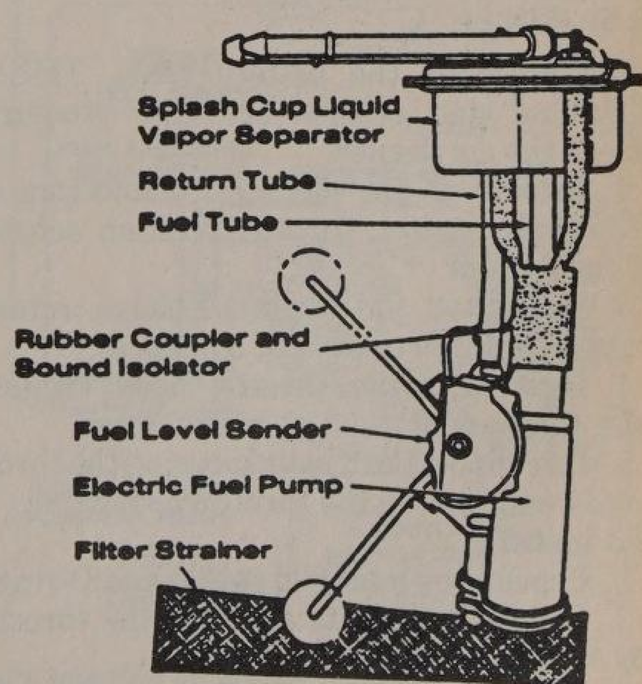
Fuel pump locking cam tool

tering assembly. The assembly contains a pressure regulator, idle air control valve, electrical solenoid that activates the fuel injector(s), throttle position sensor, fuel inlet and a fuel return fitting.

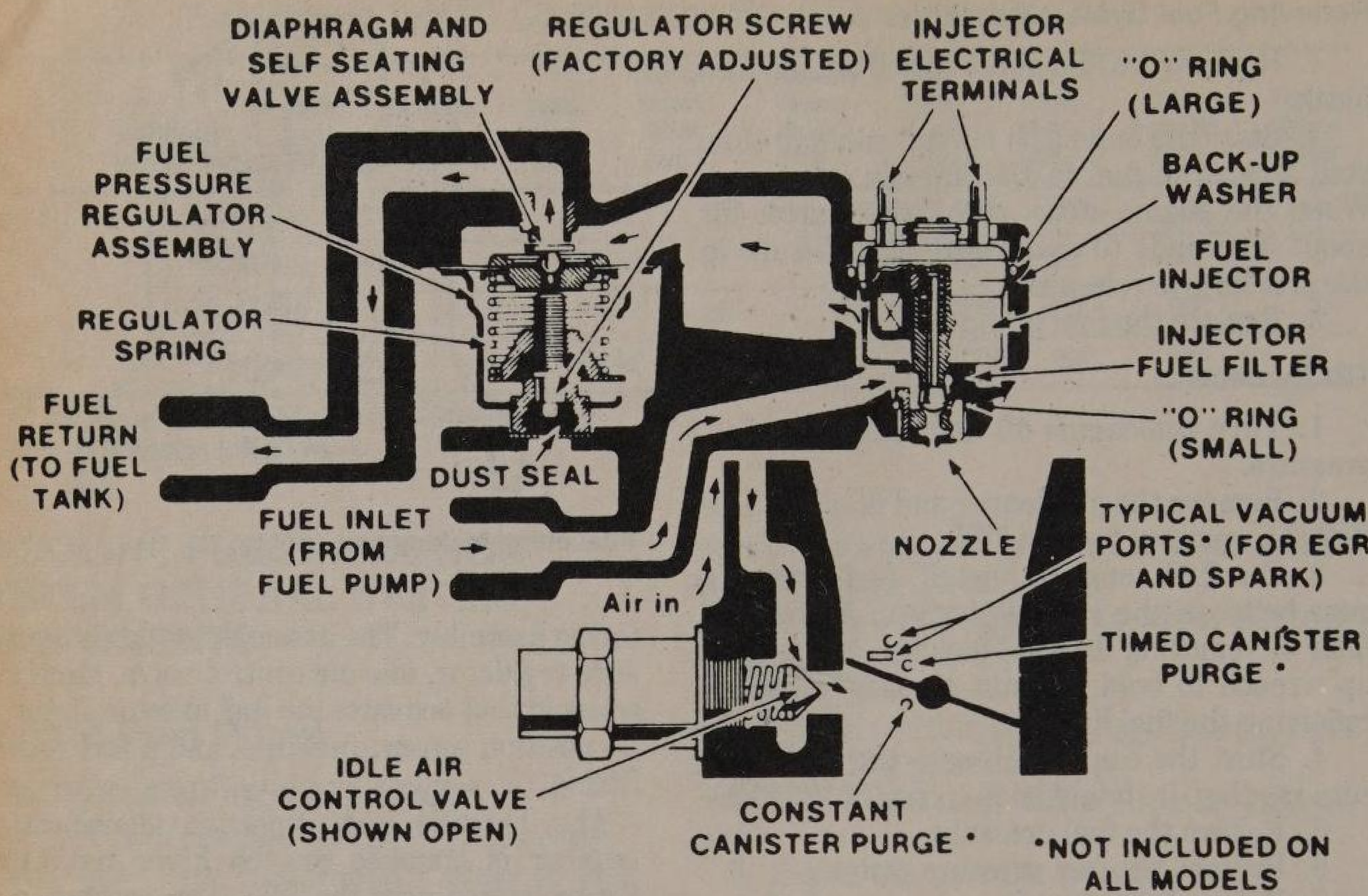
The Throttle Body Injection identification number is stamped on the lower mounting flange located near the TPS. The number is in alphabetical code and should be noted before servicing the unit.

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 drive ability.

Trouble diagnosis of the injection system is nearly impossible for the novice mechanic to per-



TBI fuel pump



Fuel Metering Schematic — TBI

form, because of the interaction between the injection, emissions, and ignition systems; 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).

Throttle Body

REMOVAL AND INSTALLATION

4–2.5L (VIN 2)

1. Disconnect the battery cable, THERMAC hose and release the fuel pressure. 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.

To install:

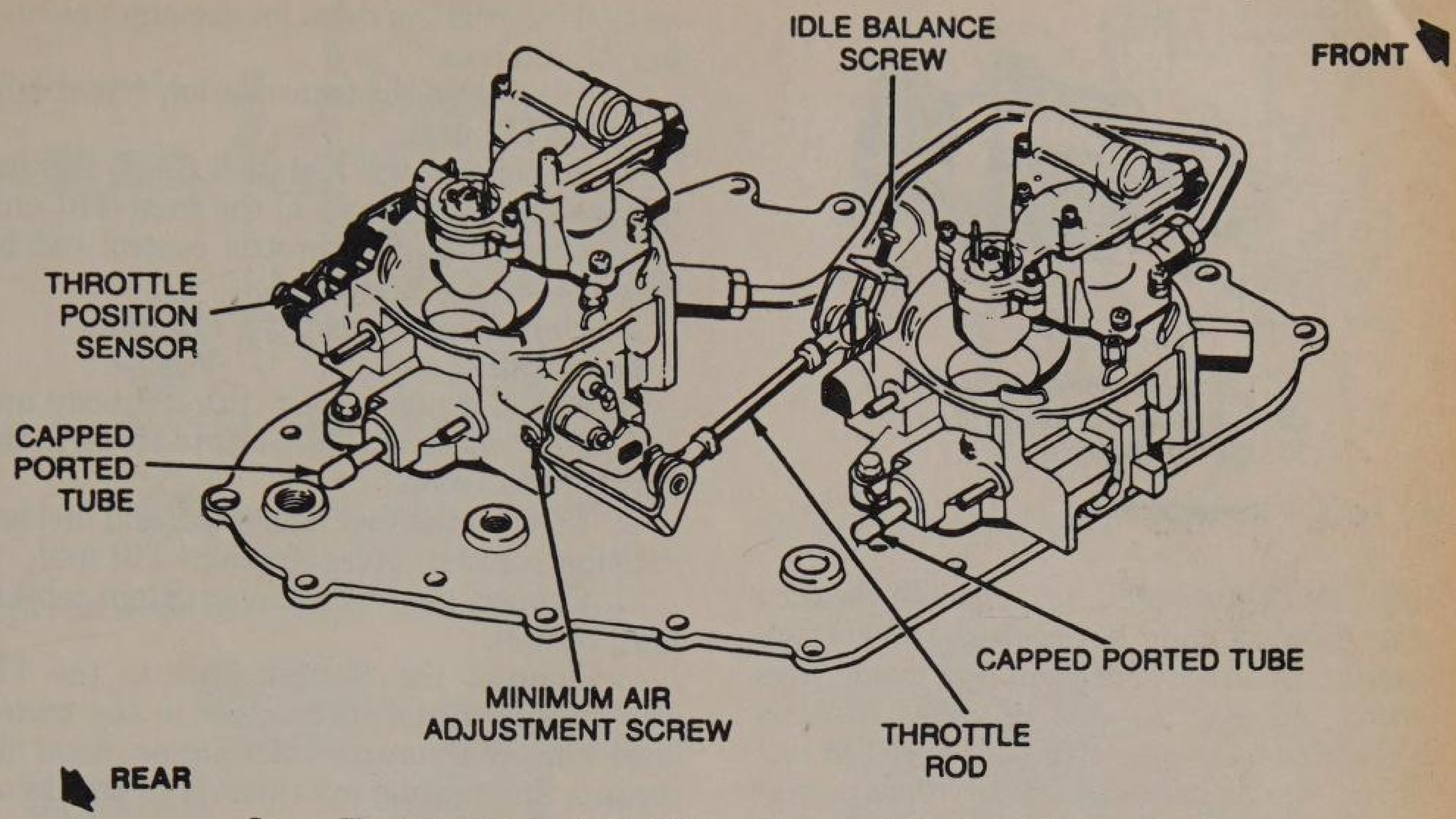
1. Replace the manifold gasket and O-rings.
2. Install the 3 bolts securing the throttle body to the manifold.
3. Connect the throttle body vacuum hoses, fuel supply and fuel return lines.
4. Connect the throttle linkage, return spring, and cruise control (if equipped).
5. Connect the electrical connectors at the idle air control, throttle position sensor, and the injector.
6. Connect the battery cable, THERMAC hose and install the air cleaner.

8–5.0L (VIN E)

1. Disconnect the negative (–) battery cable.
2. Relieve the fuel pressure as outlined in this Chapter.
3. Remove the air cleaner and extension.
4. Disconnect the IAC, TPS and injector harnesses.
5. Disconnect the throttle, transmission and cruise control cables.
6. Disconnect all vacuum hoses.
7. Using a backup wrench and flare nut wrench, disconnect the fuel inlet and return hoses.
8. Remove the three TBI bolts and unit from the manifold. Stuff the manifold opening with a shop towel to prevent dirt from entering the engine.

To install:

1. Clean the gasket mating surfaces with a scraper and solvent.
2. Install a new gasket, TBI assembly and bolts. Torque the bolts to 16 ft. lbs. (22 Nm).
3. Connect all vacuum lines, cables and electrical connectors. Make sure the throttle plates



Cross-Fire Injection System (CFI) — Twin throttle Body Injectors (TBI)

are not held open by stuck cables or misrouted wires.

4. Connect the fuel lines using a backup and flare nut wrench. Connect the negative battery cable.

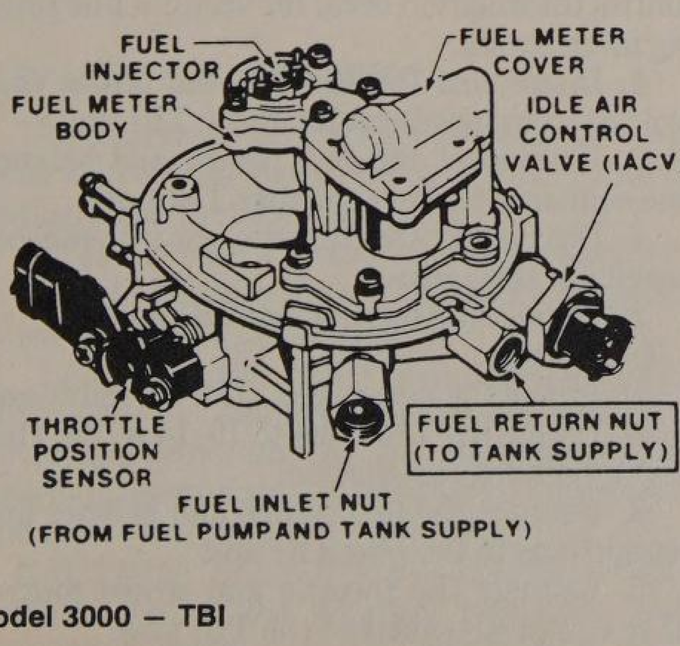
5. Turn the ignition switch ON (engine stopped) for two seconds, then turn OFF for five seconds. Check for fuel leaks.

6. Install the air cleaner and extension.

7. Reset the IAC valve pintle by depressing the accelerator slowly, start and run the engine for 3 seconds, turn the ignition OFF for ten seconds, restart the engine and check for proper idle operation.

TESTING AND ADJUSTMENT (TBI)

NOTE: *To perform these adjustments, refer to the section on Cross-Fire Injection (CFI) later in this Chapter.*



Model 3000 — TBI

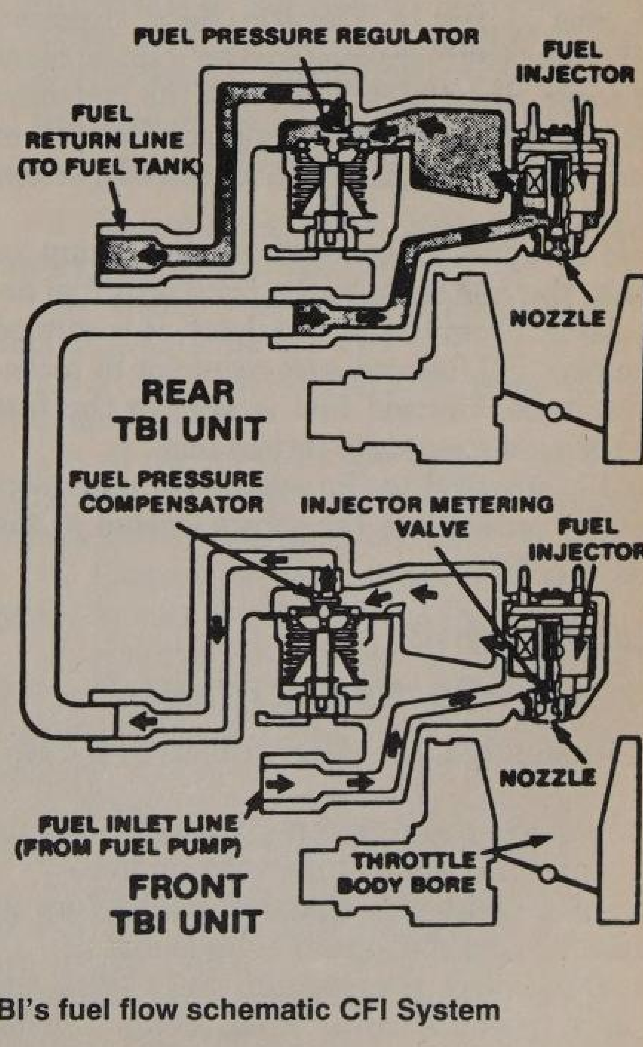
Idle Air Control Assembly (IAC)

REMOVAL AND INSTALLATION

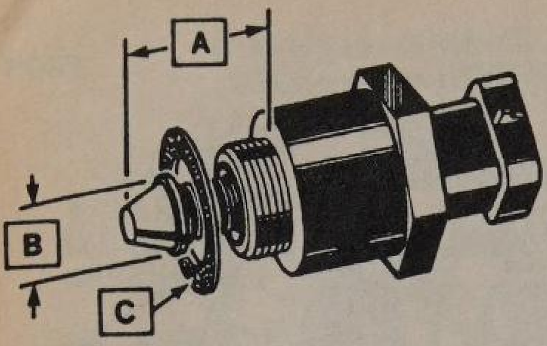
1. Remove the air cleaner.

2. Disconnect the electrical connection from the idle air control assembly.

3. Using a $1^3/_4$ or $1^1/_4$ in. wrench, remove the IAC from the throttle body.



TBI's fuel flow schematic CFI System



A. Distance of pintle extension
B. Diameter and shape of pintle
C. IAC valve gasket

IAC valve – threaded type

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 32mm (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. (17 Nm).

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.

Front TBI Unit

REMOVAL AND INSTALLATION

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.

To install:

1. Install a new gasket, throttle body unit and bolts. Torque the TBI bolts to 10–14 ft. lbs. during installation.
2. Connect the fuel inlet (feed) and fuel balance line connections at the front TBI unit.
3. Connect the transmission detent cable to the TBI unit.
4. Connect the vacuum lines to the TBI unit. During installation, refer to the underhood emission control information decal for vacuum line routing information or the decals at the end of Chapter 4.
5. Connect the electrical connectors at the injector and the idle air control motor.
6. Install the air cleaner assembly, noting the connection points of the vacuum lines.
7. Connect the battery cables at the battery.

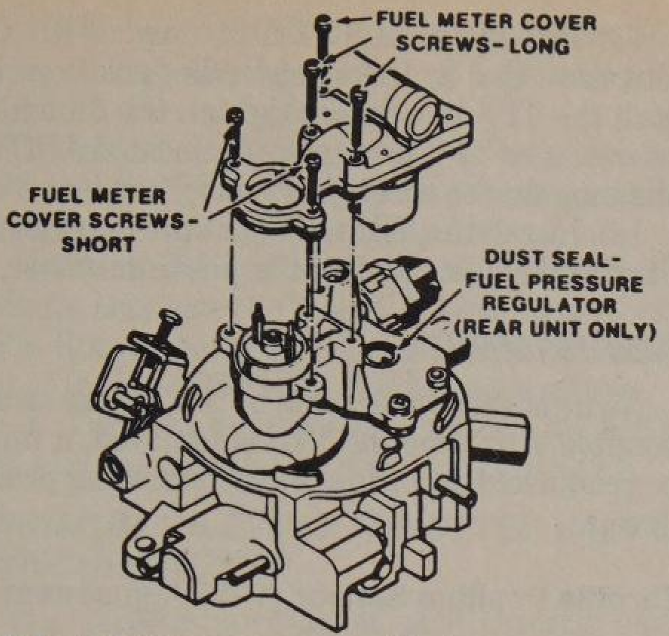
Rear TBI Unit

REMOVAL AND INSTALLATION

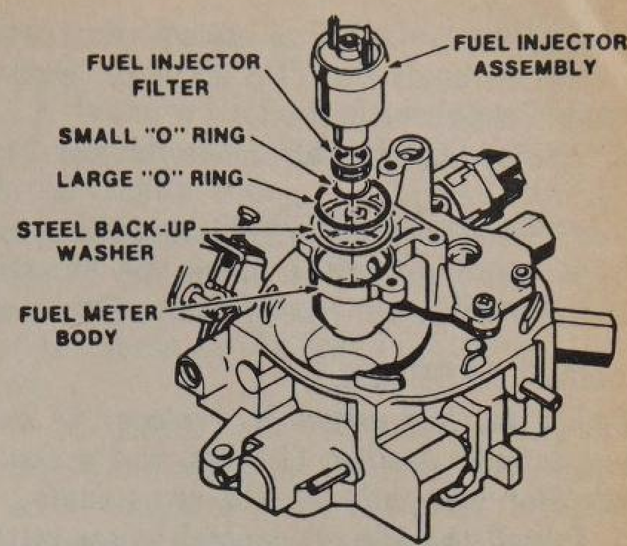
1. Disconnect the battery cables at the battery.
2. Remove the air cleaner assembly, noting the connection points of the vacuum lines.
3. Disconnect the electrical connectors at the injector, idle air control motor, and throttle position sensor.
4. Disconnect the vacuum lines from the TBI unit, noting 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.

To install:

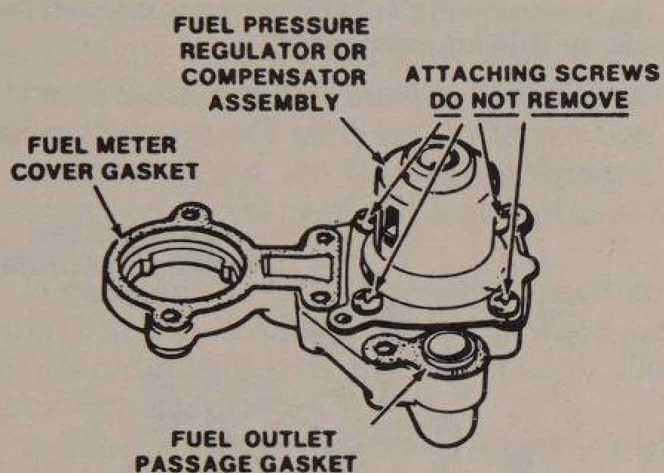
1. Install the new gasket, TBI assembly and bolts. Torque the TBI bolts to 10–14 ft. lbs. (14–19 Nm) during installation.
2. Connect the fuel return and balance line connections to the rear TBI unit.
3. Connect the throttle and cruise control (if so equipped) cables at the TBI unit.
4. Connect the vacuum lines to the TBI



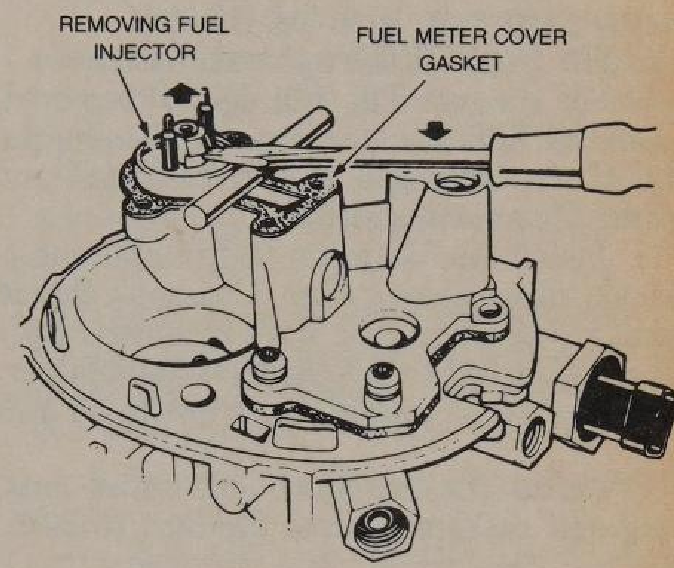
TBI Fuel meter cover screws (five)



Fuel Injector Installation



Bottom view of the fuel meter cover assembly — do not remove the four screws indicated



Removing the fuel injector

unit, noting the connection points. During installation, refer to the underhood emission control information decal or the end of Chapter 4 for vacuum line routing information.

5. Connect the electrical connectors at the injector, idle air control motor, and throttle position sensor.

6. Install the air cleaner assembly, noting the connection points of the vacuum lines.

7. Connect the battery cables at the battery.

TBI UNIT DISASSEMBLY

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 one at a time. The parts are similar but can not be interchanged.*

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.*

WARNING: *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.

3a. Using a screwdriver and rod, lift the fuel injector from the TBI.

3b. Use a twisting motion when removing the fuel injector.

3c. 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 throttler body assembly (three screws).

8. For the rear TBI unit only: Remove the throttle position sensor (TPS) from the throt-

tle 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.*

TBI UNIT 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. (17 Nm).

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 22 ft. 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

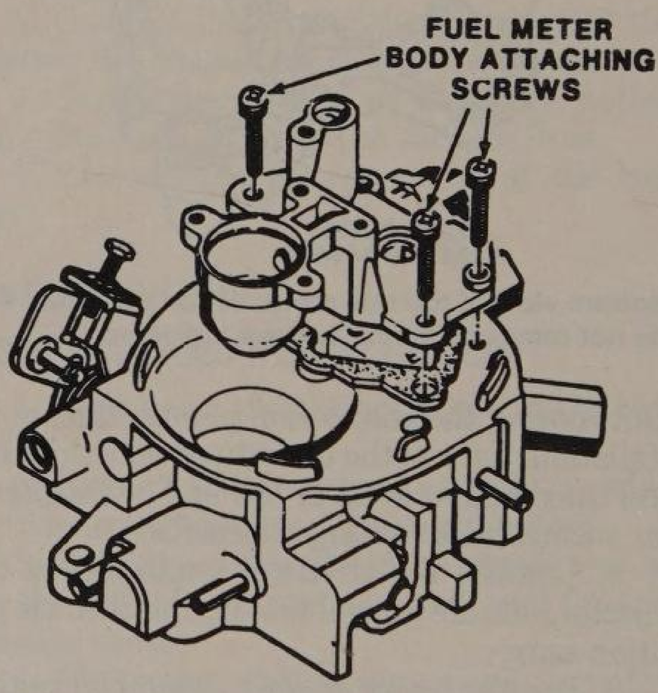
No internal adjustments of the TBI units are possible. Any time the TPS is removed, it must be readjusted according to the following procedure.

Throttle Position Sensor (TPS) Adjustment

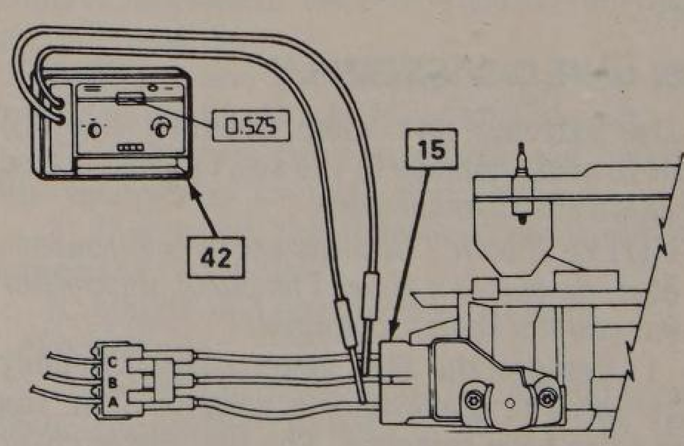
HORIZONTAL MOUNT 2.5L

An accurate digital voltmeter is needed to perform this adjustment.

WARNING: *A loose TPS can cause intermittent bursts of fuel from the injector and an unstable idle.*



Fuel meter body attaching screws



15. TPS
42. Digital volt/ohmmeter

Horizontal mount TPS 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 0.450–1.250 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.

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 13mm ($^1/_2$ in.) of mercury as read on the vacuum gauge, or 152mm (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.

   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 13mm ($^1/_2$ in.) of mercury on the vacuum gauge, or 152mm (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.

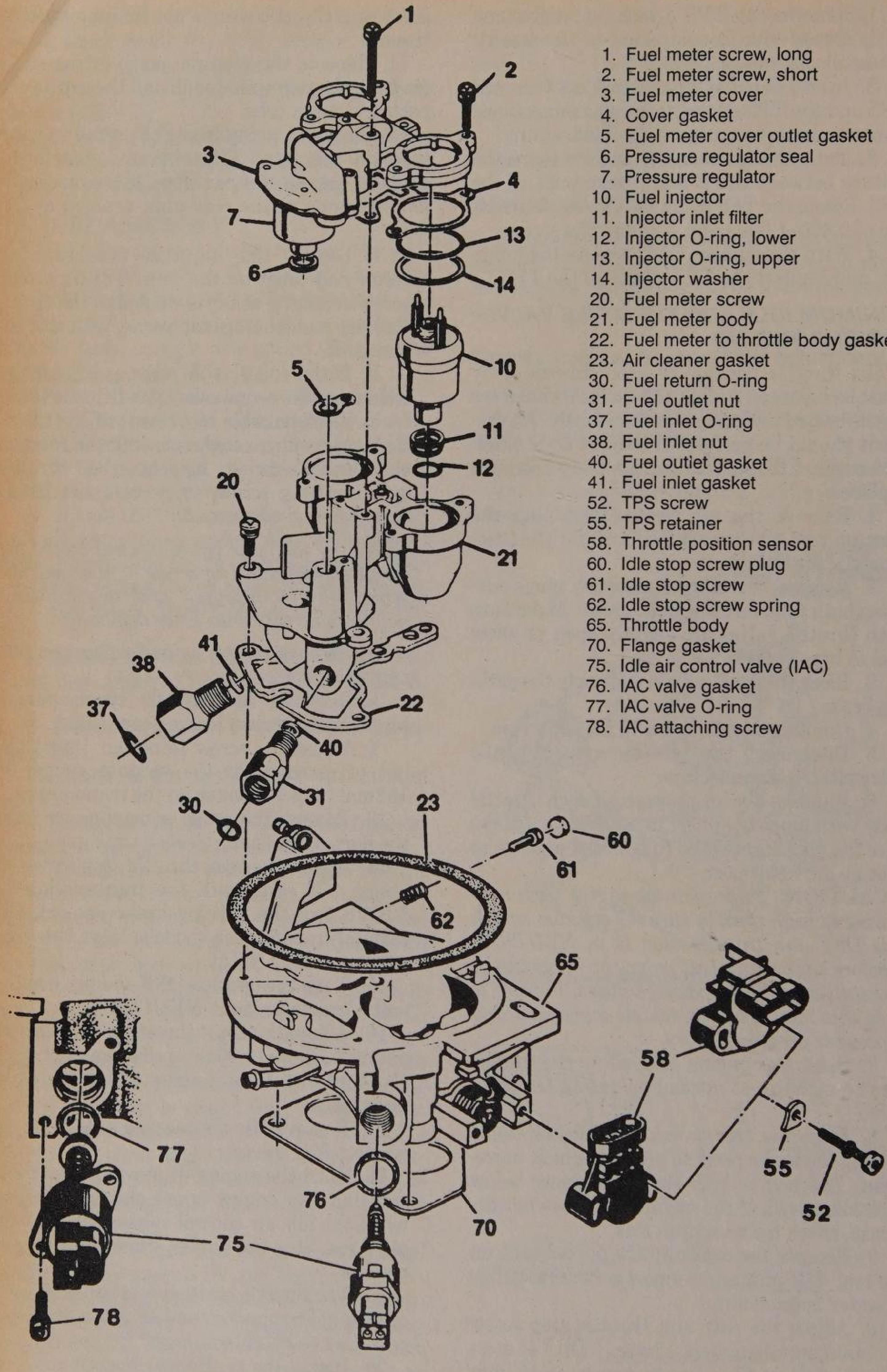
16. Adjust the front throttle stop screw to obtain 0.13mm (0.005 in.) clearance between the front throttle stop screw and the throttle lever tang.

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.

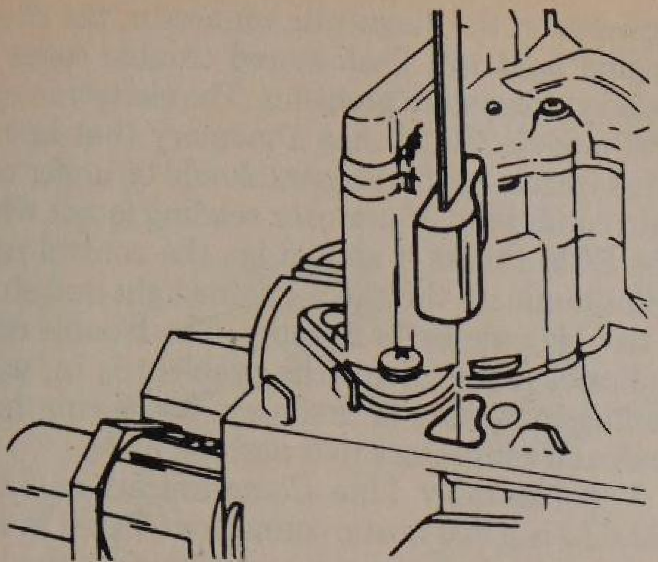
19. The throttle position sensor (TPS) voltage should be checked and adjusted, if necessary. See "TPS Adjustment" for procedures.

20. Install the air cleaner gasket, connect the vacuum line to the TBI unit and install the air cleaner.

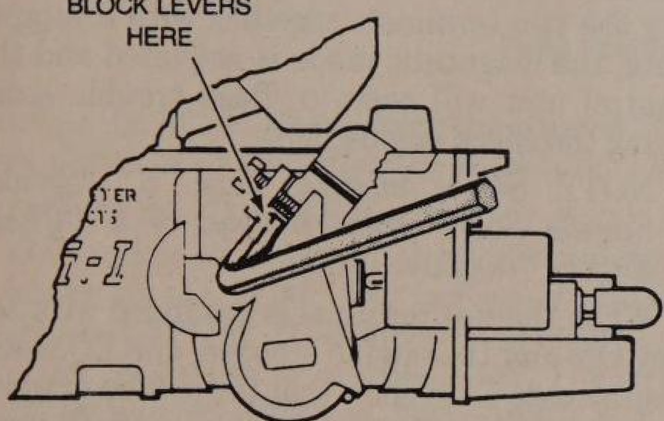


1. Fuel meter screw, long
2. Fuel meter screw, short
3. Fuel meter cover
4. Cover gasket
5. Fuel meter cover outlet gasket
6. Pressure regulator seal
7. Pressure regulator
10. Fuel injector
11. Injector inlet filter
12. Injector O-ring, lower
13. Injector O-ring, upper
14. Injector washer
20. Fuel meter screw
21. Fuel meter body
22. Fuel meter to throttle body gasket
23. Air cleaner gasket
30. Fuel return O-ring
31. Fuel outlet nut
37. Fuel inlet O-ring
38. Fuel inlet nut
40. Fuel outlet gasket
41. Fuel inlet gasket
52. TPS screw
55. TPS retainer
58. Throttle position sensor
60. Idle stop screw plug
61. Idle stop screw
62. Idle stop screw spring
65. Throttle body
70. Flange gasket
75. Idle air control valve (IAC)
76. IAC valve gasket
77. IAC valve O-ring
78. IAC attaching screw

Model 220 TBI unit — 5.0L (VIN E) engine



Plug the idle passages of each throttle body as shown



Block throttle lever movement as shown

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 1987–90 5.7L engine is equipped with the TPI system identical to the 5.0L engine. The 1989 3.8L Turbo is equipped with a Sequential Fuel Injection (SFI) system. The system is basically the same as the TPI system.

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.

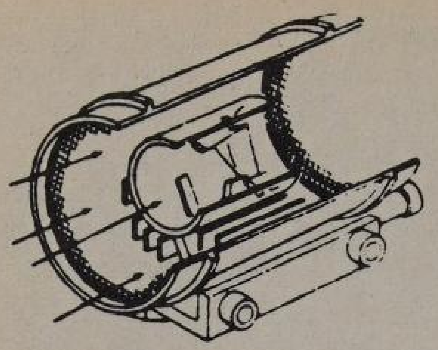
The systems consist of a large front mounted air cleaner, a mass air flow sensor (TPI uses a burn off filament), a cast throttle body assembly (TPI has dual throttle blades), a large cast plenum (TPI uses individual tuned runners) and dual (TPI) or single (MFI) fuel rail assemblies with computer controlled injectors.

The tuned runners (TPI) are designed to provide excellent throttle responses throughout the driving range. Their configuration enables large volumes of high pressure air to be present at each intake valve, resulting in improved cylinder charging and operation efficiency.

All systems use Bosch injectors, one at each intake port, rather than the single injector for each barrel 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 simultaneously.

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 temperature of the film at 75°F (24°C) 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



Section view of Air Mass Flow Sensor

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 0.4 volts); as the throttle valve opens, the output increases to a maximum 5 volts at wide open throttle (WOT). The TPS can be mis-adjusted 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 occurred 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.

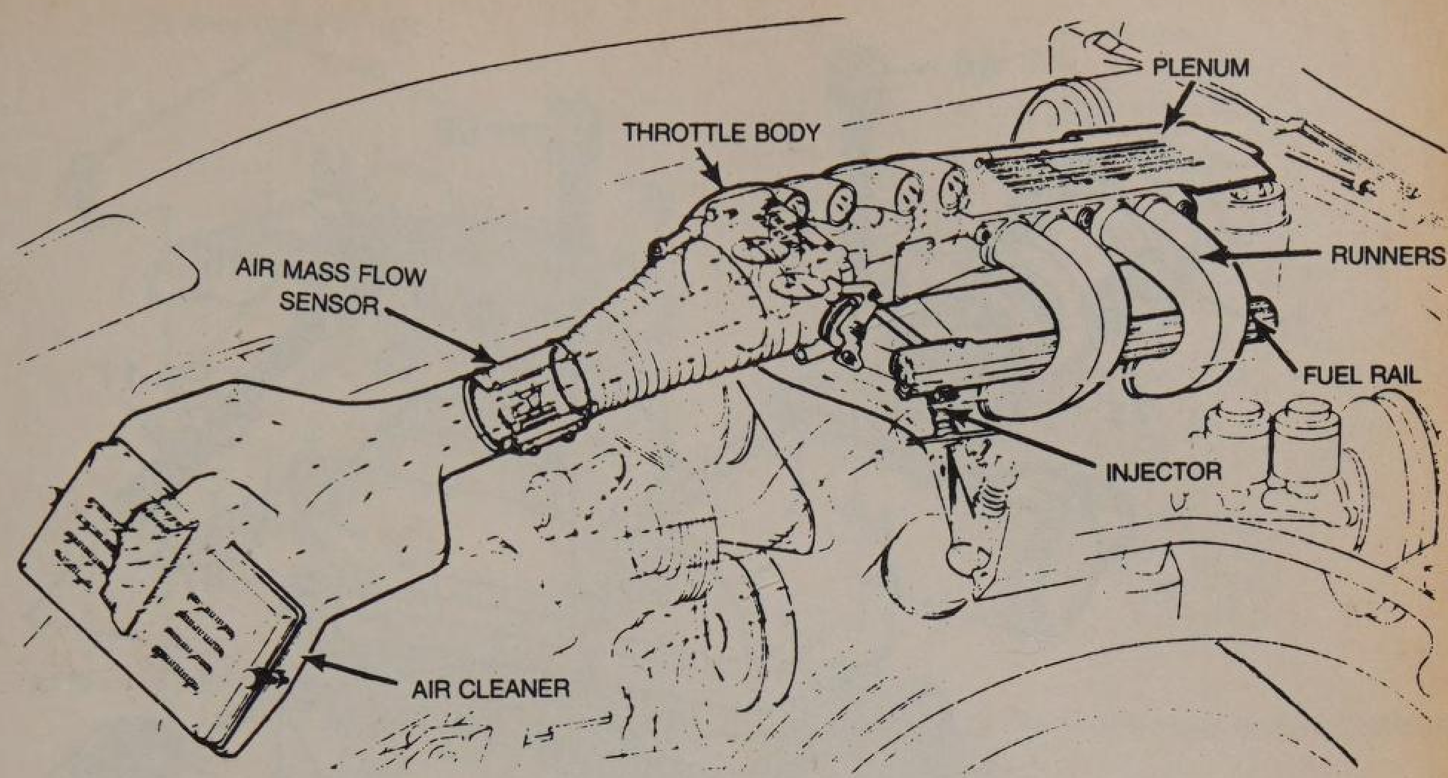
NOTE: *Some models have a "Service Engine Soon" light instead of a "Check Engine" display.*

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 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 $2^1/_2$ 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 drive ability 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 discon-



Tune Port Injection (TPI) System

necting 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.*

Throttle Body

REMOVAL AND INSTALLATION

1. Disconnect the negative (–) battery cable and drain the radiator.
2. Remove the air inlet duct and disconnect the IAC and TPS electrical connectors.
3. Label and disconnect the vacuum and coolant lines.
4. Disconnect the throttle, TV and cruise control cables.
5. Remove the throttle body attaching bolts and throttle body.

To install:

1. Install the throttle body and attaching bolts. Torque the bolts to 18 ft. lbs. (25 Nm). Always use a new gasket.
2. Connect the throttle, TV and cruise control cables.
3. Connect the vacuum and coolant lines.
4. Install the air inlet duct and connect the IAC and TPS electrical connectors.
5. Connect the negative (–) battery cable and refill the radiator.

Plenum

REMOVAL AND INSTALLATION

6–2.8L and 6–3.1L ENGINE

1. Release the fuel system pressure as outlined earlier in this Chapter. 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.

To install:

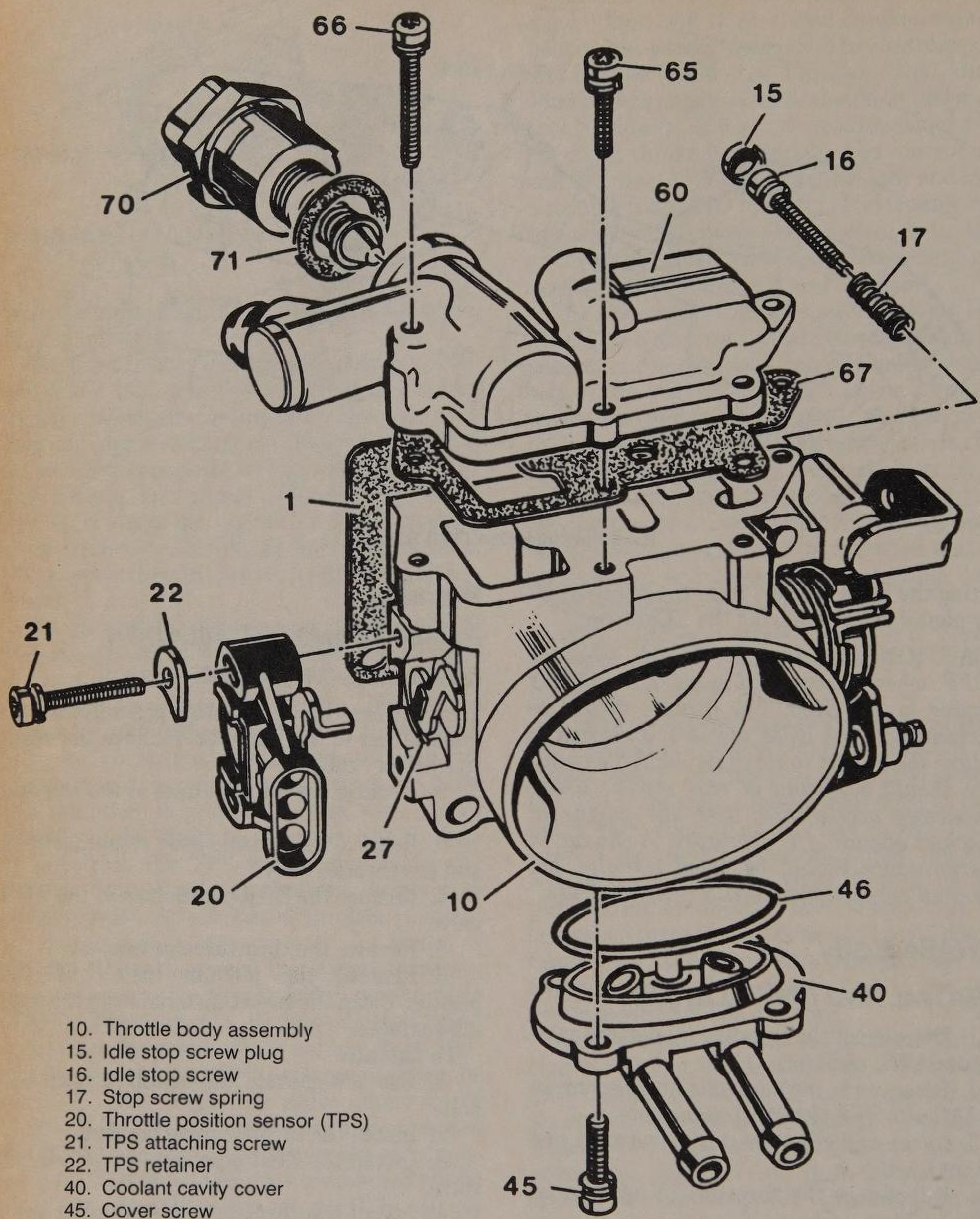
1. Use new gaskets and install plenum and bolts.
2. Install the throttle cable bracket.
3. Install the EGR pipe bolts and the EGR valve.
4. Install the throttle body retaining bolts and the throttle body. Torque the bolts to 18 ft. lbs. (25 Nm).
5. Install the air inlet duct at the throttle body.
6. Connect the negative battery cable and check operation and leaks.

6–3.8L Turbo Engine

Refer to the "Intake Manifold" section in Chapter 3 for information.

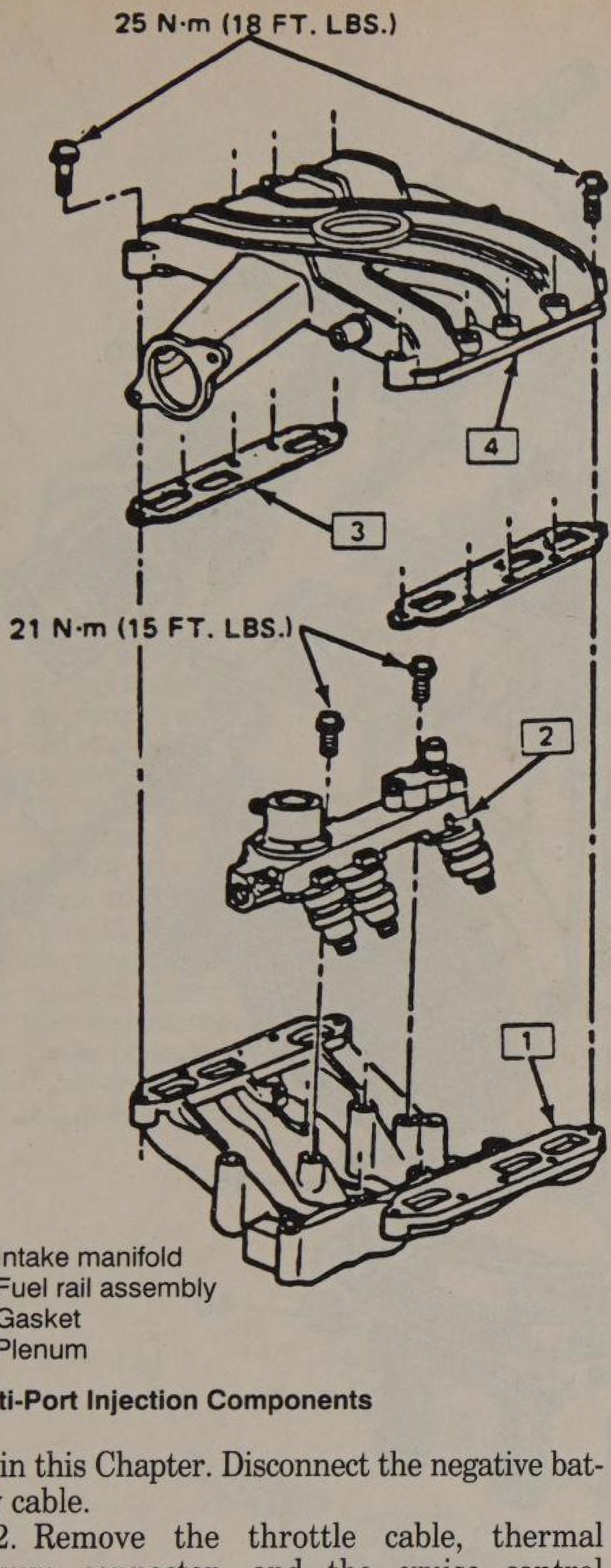
8–5.0L and 8–5.7L Engine

1. Release the fuel pressure as outlined ear-



10. Throttle body assembly
15. Idle stop screw plug
16. Idle stop screw
17. Stop screw spring
20. Throttle position sensor (TPS)
21. TPS attaching screw
22. TPS retainer
40. Coolant cavity cover
45. Cover screw
46. Cover O-ring
60. Idle air/vacuum signal housing
65. Idle air/vacuum signal assembly screw
66. Idle air/vacuum signal assembly screw
67. Idle air/vacuum assembly gasket
70. Idle air control valve (IAC)
71. IAC valve gasket

Throttle body assembly – 2.8L V6 engine



1. Intake manifold
2. Fuel rail assembly
3. Gasket
4. Plenum

Multi-Port Injection Components

lier in this Chapter. Disconnect 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.

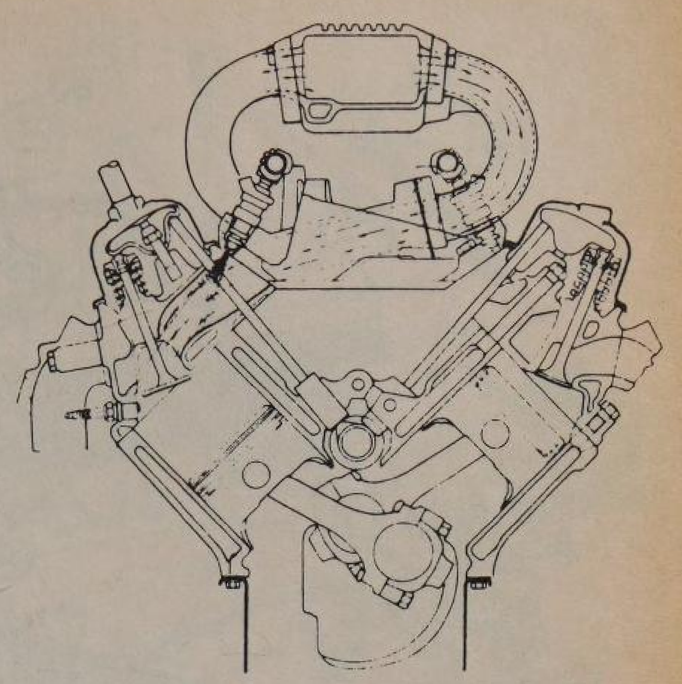
5. Remove the throttle body bolts and the throttle body.

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.

To install:

1. Install the right runners, the plenum retaining bolts and the plenum. Always use new gaskets. Install the left runners and torque the bolts to 25 ft. lbs. (34 Nm).



Cross section view of Tuned Port Injection Systems

2. Install the brake booster pipe, vacuum hose and the canister control valve fresh air pipe.

3. Install the throttle body bolts and the throttle body.

4. Install the Throttle Position Sensor (TPS) and the Idle Air Control (IAC) connectors.

5. Install the cable retaining bracket.

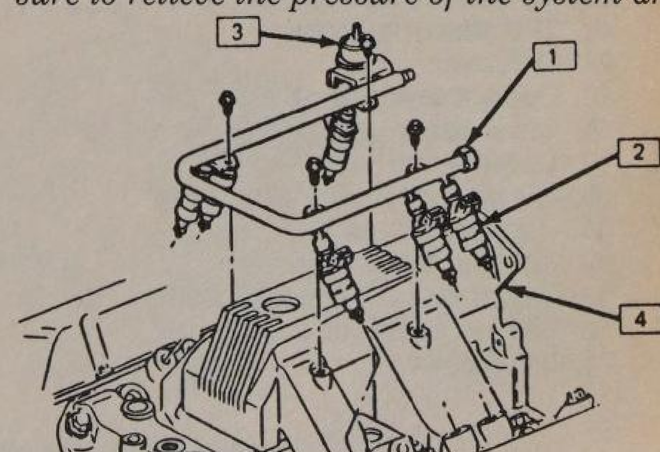
6. Install the throttle cable, thermal vacuum connector, and the cruise control cable, if equipped.

7. Connect the negative battery cable, refill the cooling system and check engine operation.

Fuel Rail and Pressure Regulator Assembly

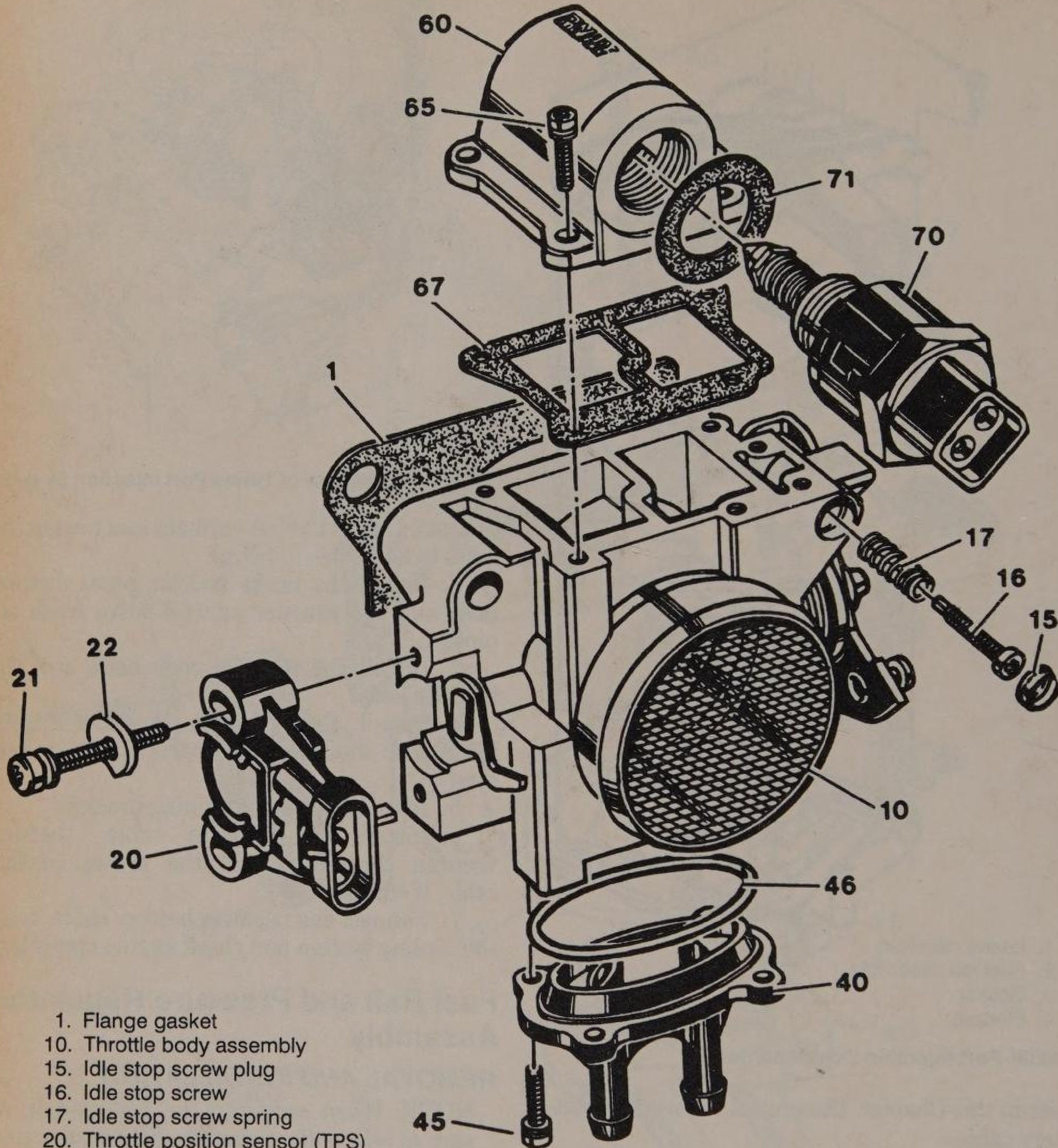
REMOVAL AND INSTALLATION

NOTE: *When servicing the fuel system, be sure to relieve the pressure of the system and*



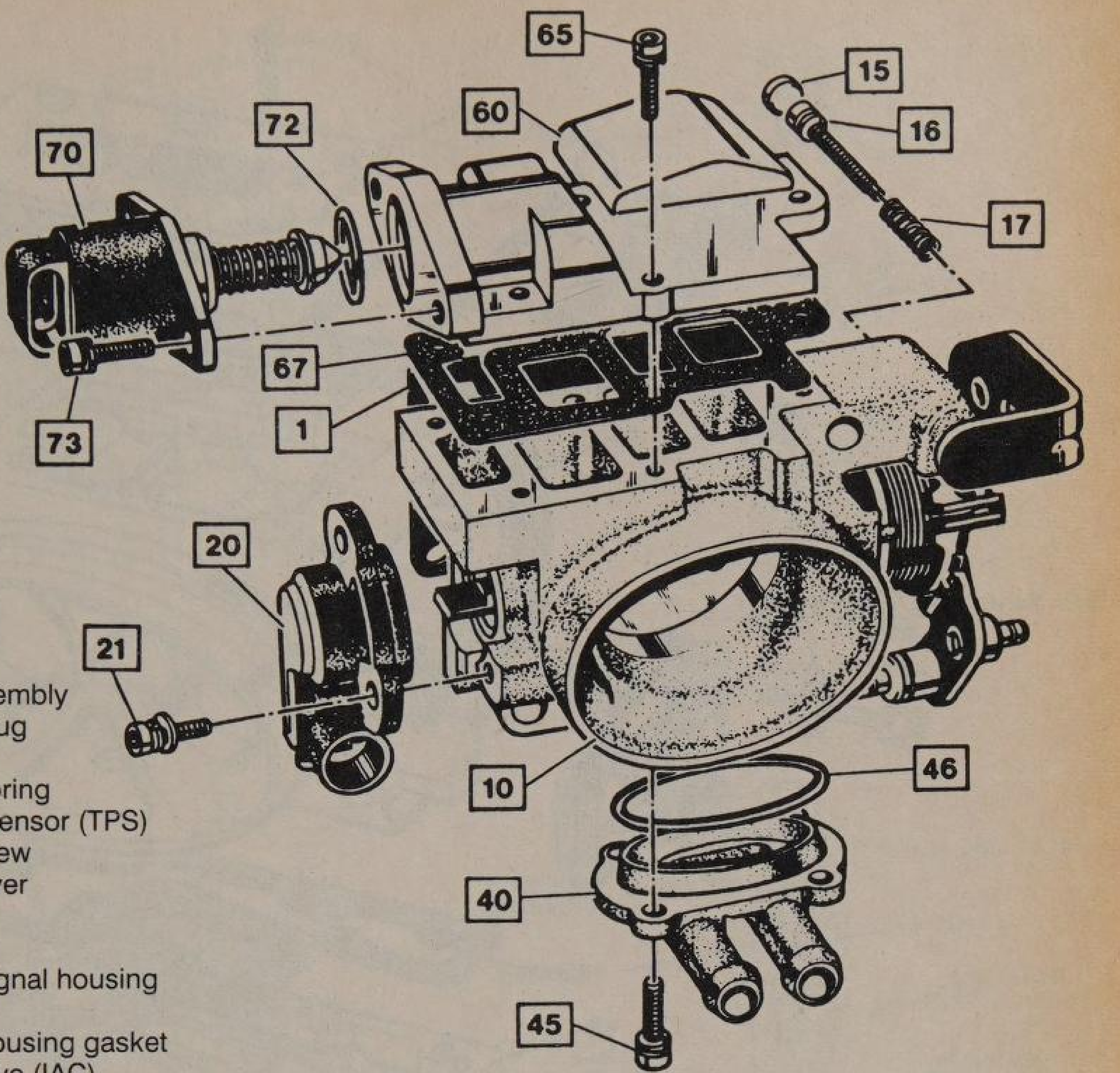
1. Fuel rail assembly
2. Injector
3. Pressure regulator
4. Intake manifold

Fuel rail and pressure regulator — 3.8L Turbo V6 engine



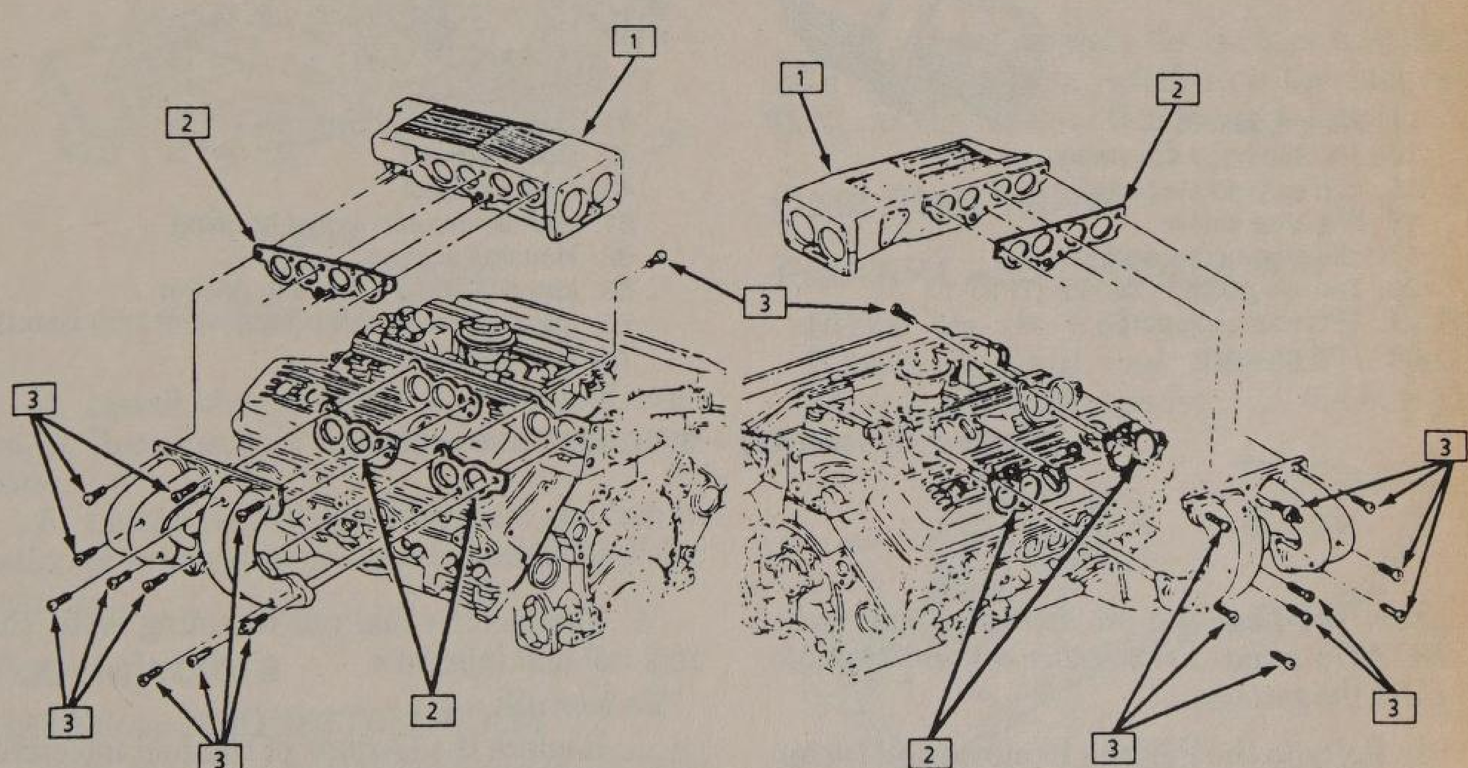
1. Flange gasket
10. Throttle body assembly
15. Idle stop screw plug
16. Idle stop screw
17. Idle stop screw spring
20. Throttle position sensor (TPS)
21. TPS attaching screw
27. TPS lever
40. Coolant cavity cover
45. Cover screw
46. Cover O-ring
60. Idle air/vacuum signal housing
65. Housing screws
66. Housing screws, long
67. Idle air/vacuum housing gasket
70. Idle air control valve (IAC)
71. IAC gasket

Throttle body assembly — 3.8L Turbo V6 engine



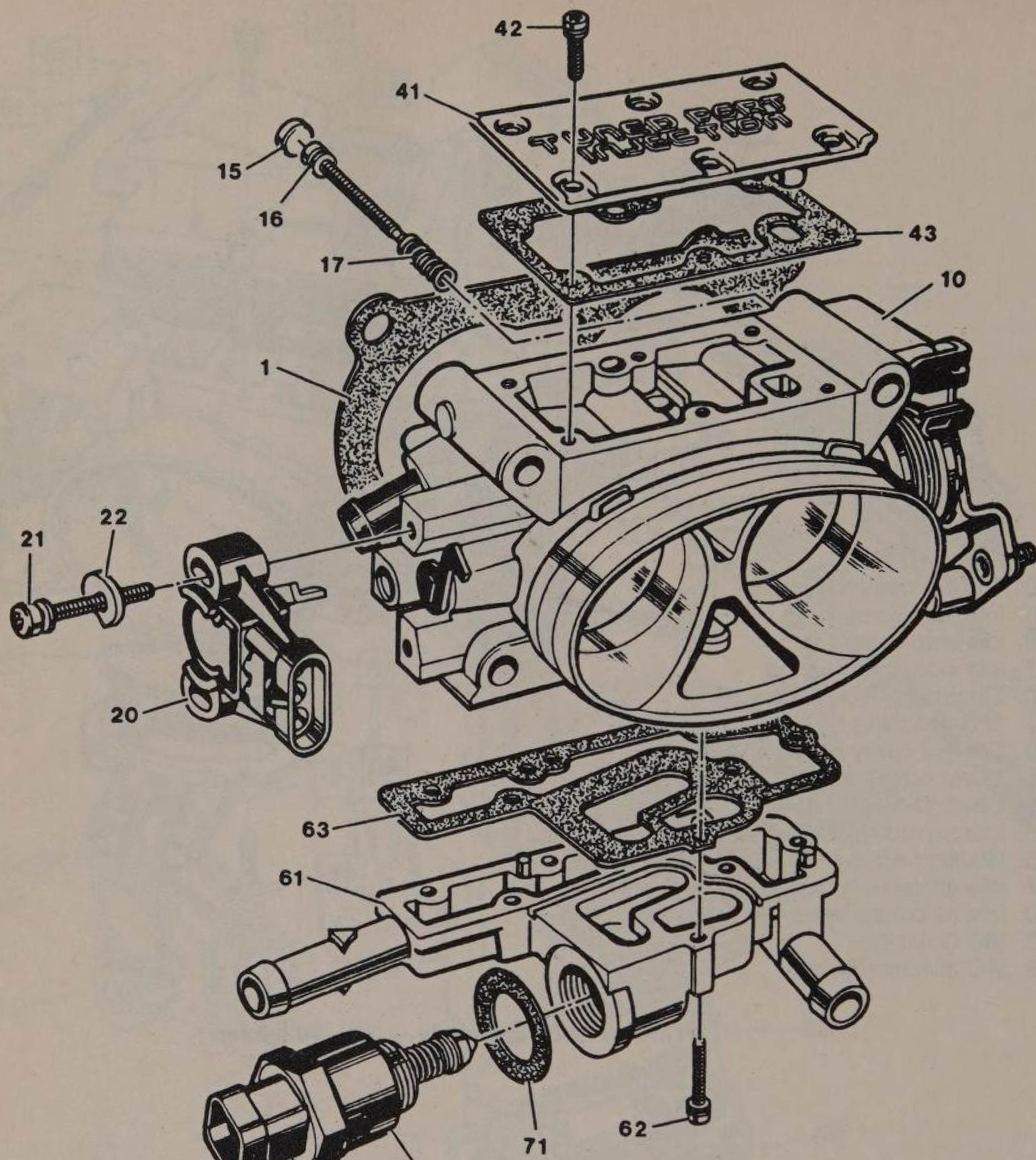
1. Flange gasket
10. Throttle body assembly
15. Idle stop screw plug
16. Idle stop screw
17. Idle stop screw spring
20. Throttle position sensor (TPS)
21. TPS attaching screw
40. Coolant cavity cover
45. Cover screw
46. Cover O-ring
60. Idle air/vacuum signal housing
65. Housing screws
67. Idle air/vacuum housing gasket
70. Idle air control valve (IAC)
72. IAC O-ring
73. IAC attaching screw

Throttle body assembly — 3.1L V6 engine



1. Intake plenum
2. Gaskets
3. Plenum/runners attaching bolts

Intake plenum and runners — 5.0L and 5.7L V8 engine



1. Flange gasket
10. Throttle body assembly
15. Idle stop screw plug
16. Idle stop screw
17. Idle stop screw spring
20. Throttle position sensor (TPS)
21. TPS attaching screw
22. TPS retainer
41. Coolant cavity cover
42. Cover screw
43. Cover gasket
61. Idle air/vacuum signal housing
62. Housing screws
63. Idle air/vacuum housing gasket
70. Idle air control valve (IAC)
71. IAC gasket

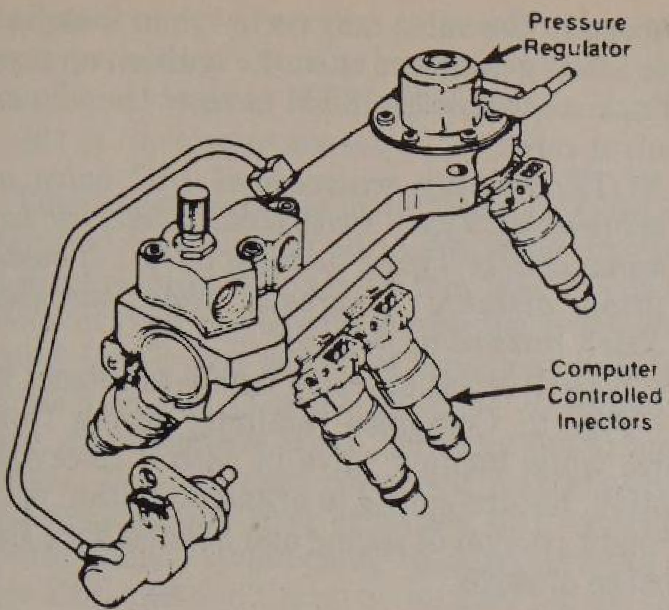
Throttle body assembly — 5.0L and 5.7L V8 engines

drain the fuel into an approved container. DO NOT allow dirt or other contaminants to enter the system.

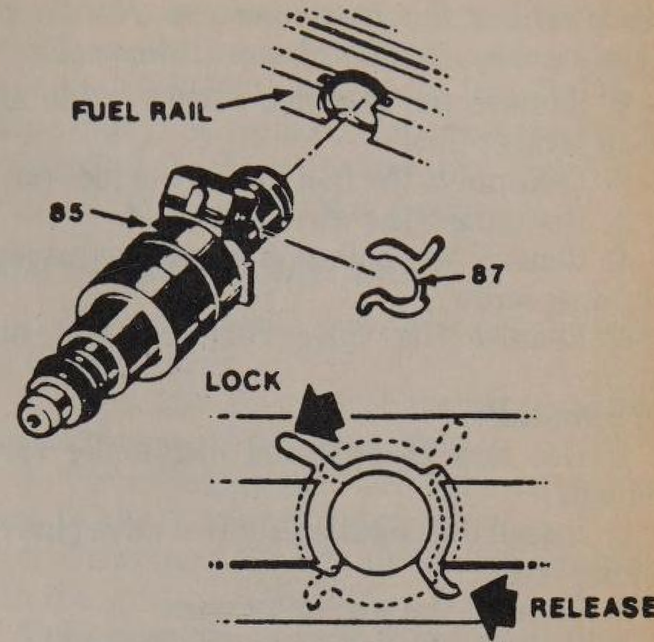
1. Refer to the Plenum Removal and Installation procedures in this section and remove the plenum.
2. Remove the fuel lines and the cold start valve. Remove the injector harness connectors.
3. On the 2.8L engine, remove the vacuum line at the pressure regulator.
4. Remove the fuel rail retaining bolts, the fuel rail and injectors.

To install:

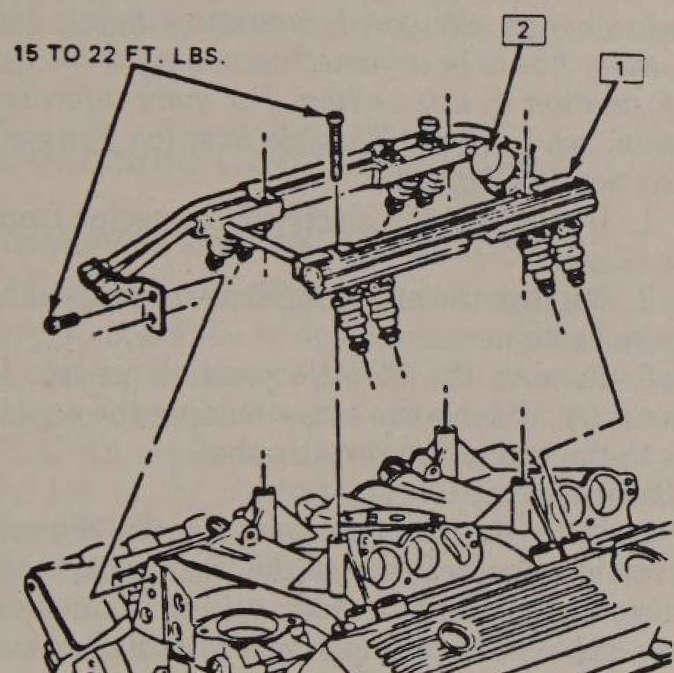
1. Replace the O-rings of the fuel injectors, coat the O-rings with engine oil and install into the fuel rail.
2. Turn the ignition "ON" and "OFF" several times and inspect for leaks.
3. On the 2.8L engine, install the vacuum line at the pressure regulator.



Multi-Port Fuel Injection Fuel Rail



Removing fuel injector from the fuel rail



1. Fuel rail
2. Pressure regulator

Tuned Port Injection Fuel Rail

4. Install the fuel lines and the cold start valve. Reconnect the injector harness connectors.

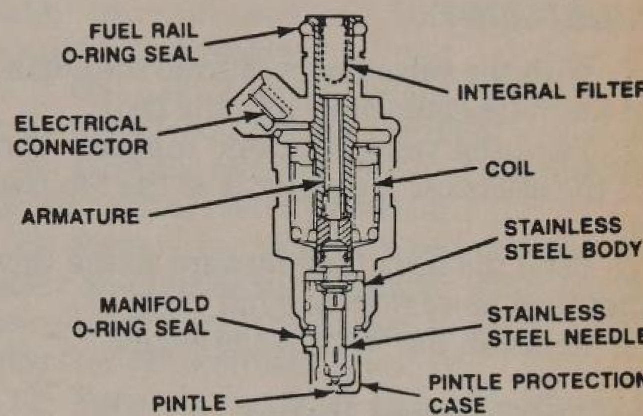
5. Refer to the Plenum Removal and Installation procedures in this section and install the plenum.

Fuel Injectors

REMOVAL AND INSTALLATION

1. Refer to 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.



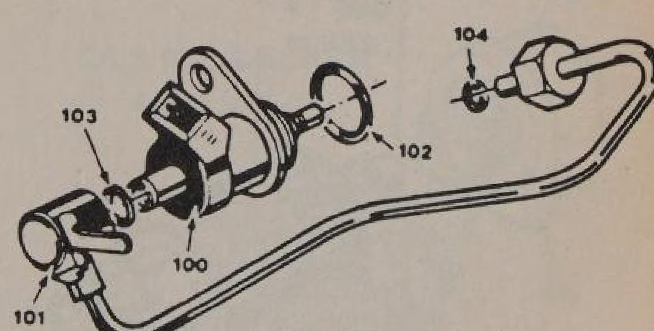
Sectional view of Fuel Injector

3. To install, replace the O-rings, coat them with engine oil and install into the fuel rail. Lock the clip into position for each injector.

Cold Start Valve

REMOVAL AND INSTALLATION

NOTE: *On the 2.8L engine, refer to the Plenum Removal and Installation procedures in this section and remove the Plenum.*



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

Also remove the distributor cap. Not all engines are equipped with a cold start valve.

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.

To install:

1. Use new O-rings and install the valve and bolt.
2. Install the pollution control valve pipe retaining screw.
3. Connect the wiring harness.
4. Connect the fuel line at the fuel rail.
5. Connect the negative battery cable and brake booster hose.

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.

Idle Air Control Valve

REMOVAL AND INSTALLATION

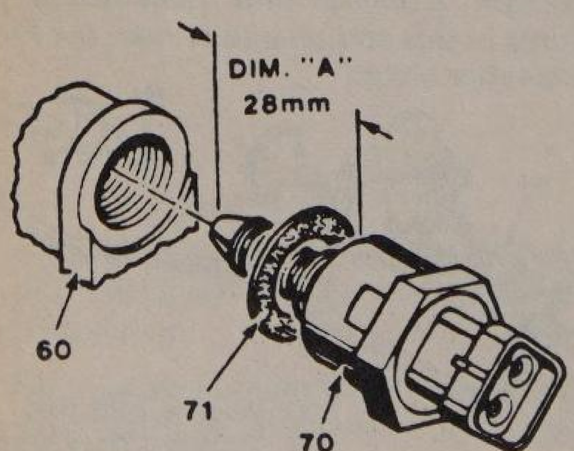
1. Remove electrical connector from idle air control valve.
2. Remove the idle air control valve.

To install:

1. Before installing the idle air control valve, measure the distance that the valve is extended. Measurement should be made from the motor housing to the end of the cone. The distance should not exceed 28.5mm ($1^1/_8$ in.), 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.



60. Idle air/vacuum signal housing
70. Idle air control valve (IAC)
71. IAC gasket

Idle Air Control Valve Assembly

Throttle Position Sensor

REMOVAL AND INSTALLATION

NOTE: *The 1987 and later TPS units do not have to be adjusted when installed. If the sensor has elongated mounting holes, the sensor has to be adjusted according to the information in this section. For more information, refer to the "Throttle Position Sensor" section in Chapter 4.*

1. Disconnect the electrical connector from the sensor.
2. Remove the attaching screws, lock washers and retainers.
3. Remove the throttle position sensor. If necessary, remove the screw holding the actuator to the end of the throttle shaft.

To install:

1. 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.
2. Install the retainers, screws and lock washers using a thread locking compound. DO NOT tighten the screws until the throttle position switch is adjusted.
3. Install three jumper wires between the throttle position switch and the harness connector.
4. 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.
5. Tighten the mounting screws, then recheck the reading to insure that the adjustment hasn't changed.
6. Turn ignition OFF, remove jumper wires, then reconnect harness to throttle position switch.

Oxygen Sensor

REMOVAL AND INSTALLATION

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°F (48°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.

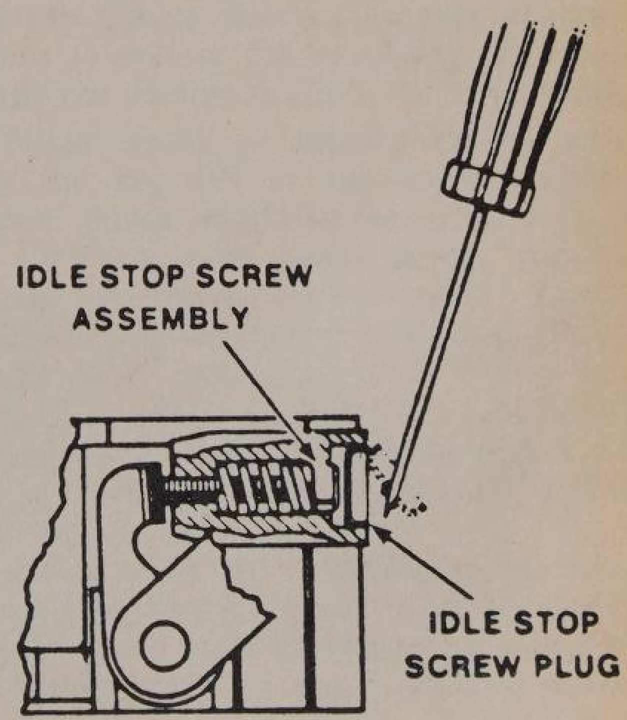
Electronic Control Module

REMOVAL AND INSTALLATION

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 CLAPAK 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 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.

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".
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 0.50–0.60 volt for the 2.8L engine or 0.475–0.615 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.



Removing the Idle Stop Screw Plug

FUEL TANK

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.
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.

To install:

1. Use new O-ring in the fuel tank. Install the fuel tank.
2. Install the tank strap bolts.
3. Lower the axle and install the coil springs.
4. Connect the lower end of the shock absorbers.
5. Install the brake line clip to the bracket. Install the fuel pipe retaining bracket on the left side.
6. Connect all fuel lines.
7. Connect the fuel pump/gauge connector.
8. Install the rear suspension track bar and its brace.
9. Install the filler neck shield.
10. Install the heat shield.
11. Connect the exhaust system.
12. Lower the vehicle.
13. Fill the fuel tank and check for leaks.

Chassis Electrical

6

UNDERSTANDING AND TROUBLESHOOTING ELECTRICAL SYSTEMS

At the rate which both import and domestic manufacturers are incorporating electronic control systems into their production lines, it won't be long before every new vehicle is equipped with one or more on-board computer. These electronic components (with no moving parts) should theoretically last the life of the vehicle, provided nothing external happens to damage the circuits or memory chips.

While it is true that electronic components should never wear out, in the real world malfunctions do occur. It is also true that any computer-based system is extremely sensitive to electrical voltages and cannot tolerate careless or haphazard testing or service procedures. An inexperienced individual can literally do major damage looking for a minor problem by using the wrong kind of test equipment or connecting test leads or connectors with the ignition switch **ON**. When selecting test equipment, make sure the manufacturers instructions state that the tester is compatible with whatever type of electronic control system is being serviced. Read all instructions carefully and double check all test points before installing probes or making any test connections.

The following section outlines basic diagnosis techniques for dealing with computerized automotive control systems. Along with a general explanation of the various types of test equipment available to aid in servicing modern electronic automotive systems, basic repair techniques for wiring harnesses and connectors is given. Read the basic information before attempting any repairs or testing on any computerized system, to provide the background of information necessary to avoid the most common and obvious mistakes that can cost both time and money. Although the replacement and testing procedures are simple in themselves, the systems are not, and unless one has a thorough understanding of all components and their function within a particular computerized control system, the logical test sequence these systems demand cannot be followed. Minor malfunctions can make a big difference, so it is important to know how each component affects the operation of the overall electronic system to find the ultimate cause of a problem without replacing good components unnecessarily. It is not enough to use the correct test equipment; the test equipment must be used correctly.

Safety Precautions

CAUTION: *Whenever working on or around any computer based microprocessor control system, always observe these general precautions to prevent the possibility of personal injury or damage to electronic components.*

• Never install or remove battery cables with the key ON or the engine running. Jumper cables should be connected with the key OFF to avoid power surges that can damage electronic control units. Engines equipped with computer controlled systems should avoid both giving and getting jump starts due to the possibility of serious damage to components from arcing in the engine compartment when connections are made with the ignition ON.

• Always remove the battery cables before charging the battery. Never use a high output charger on an installed battery or attempt to use any type of "hot shot" (24 volt) starting aid.

• Exercise care when inserting test probes into connectors to insure good connections without damaging the connector or spreading the pins. Always probe connectors from the rear (wire) side, NOT the pin side, to avoid accidental shorting of terminals during test procedures.

• Never remove or attach wiring harness connectors with the ignition switch ON, especially to an electronic control unit.

• Do not drop any components during service procedures and never apply 12 volts directly to any component (like a solenoid or relay) unless instructed specifically to do so. Some component electrical windings are designed to safely handle only 4 or 5 volts and can be destroyed in seconds if 12 volts are applied directly to the connector.

• Remove the electronic control unit if the vehicle is to be placed in an environment where temperatures exceed approximately 176°F (80°C), such as a paint spray booth or when arc or gas welding near the control unit location in the car.

ORGANIZED TROUBLESHOOTING

When diagnosing a specific problem, organized troubleshooting is a must. The complexity of a modern automobile demands that you approach any problem in a logical, organized manner. There are certain troubleshooting techniques that are standard:

1. Establish when the problem occurs. Does the problem appear only under certain conditions? Were there any noises, odors, or other unusual symptoms?
2. Isolate the problem area. To do this, make some simple tests and observations; then eliminate the systems that are working properly. Check for obvious problems such as broken wires, dirty connections or split or disconnected vacuum hoses. Always check the obvious before assuming something complicated is the cause.
3. Test for problems systematically to determine the cause once the problem area is isolated. Are all the components functioning properly? Is there power going to electrical switches and motors? Is there vacuum at vacuum switches and/or actuators? Is there a mechanical problem such as bent linkage or loose mounting screws? Doing careful, systematic checks will often turn up most causes on the first inspection without wasting time checking components that have little or no relationship to the problem.
4. Test all repairs after the work is done to make sure that the problem is fixed. Some causes can be traced to more than one component, so a careful verification of repair work is important to pick up additional malfunctions that may cause a problem to reappear or a different problem to arise. A blown fuse, for example, is a simple problem that may require more than another fuse to repair. If you don't look for a problem that caused a fuse to blow, for example, a shorted wire may go undetected.

Experience has shown that most problems tend to be the result of a fairly simple and obvious cause, such as loose or corroded connectors or air leaks in the intake system; making careful inspection of components during testing essential to quick and accurate troubleshooting. Special, hand held computerized testers designed specifically for diagnosing the system are available from a variety of aftermarket sources, as well as from the vehicle manufacturer, but care should be taken that any test equipment being used is designed to diagncse that particular computer controlled system accurately without damaging the control unit (ECM) or components being tested.

NOTE: *Pinpointing the exact cause of trouble in an electrical system can sometimes only be accomplished by the use of special test equipment. The following describes commonly used test equipment and explains how to put it to best use in diagnosis. In addition to the information covered below, the manufacturer's instructions booklet provided with the tester should be read and clearly understood before attempting any test procedures.*

TEST EQUIPMENT

Jumper Wires

Jumper wires are simple, yet extremely valuable, pieces of test equipment. Jumper wires are merely wires that are used to bypass sections of a circuit. The simplest type of jumper wire is merely a length of multi-strand wire with an alligator clip at each end. Jumper wires are usually fabricated from lengths of standard automotive wire and whatever type of connector (alligator clip, spade connector or pin connector) that is required for the particular vehicle being tested. The well equipped tool box will have several different styles of jumper wires in several different lengths. Some jumper wires are made with three or more terminals coming from a common splice for special purpose testing. In cramped, hard-to-reach areas it is advisable to have insulated boots over the jumper wire terminals in order to prevent accidental grounding, sparks, and possible fire, especially when testing fuel system components.

Jumper wires are used primarily to locate open electrical circuits, on either the ground (–) side of the circuit or on the hot (+) side. If an electrical component fails to operate, connect the jumper wire between the component and a good ground. If the component operates only with the jumper installed, the ground circuit is open. If the ground circuit is good, but the component does not operate, the circuit between the power feed and component is open. You can sometimes connect the jumper wire directly from the battery to the hot terminal of the component, but first make sure the component uses 12 volts in operation. Some electrical components, such as fuel injectors, are designed to operate on about 4 volts and running 12 volts directly to the injector terminals can burn out the wiring. By inserting an in-line fuse holder between a set of test leads, a fused jumper wire can be used for bypassing open circuits. Use a 5 amp fuse to provide protection against voltage spikes. When in doubt, use a voltmeter to check the voltage input to the component and measure how much voltage is being applied normally. By moving the jumper wire successively back from the lamp toward the power source, you can isolate the area of the circuit where the open is located. When the component stops functioning, or the power is cut off, the open is in the segment of wire between the jumper and the point previously tested.

CAUTION: *Never use jumpers made from wire that is of lighter gauge than used in the circuit under test. If the jumper wire is of too small gauge, it may overheat and possibly melt. Never use jumpers to bypass high resistance loads in a circuit. Bypassing resistances, in effect, creates a short circuit which may, in turn, cause damage and fire. Never use a jumper for anything other than temporary bypassing of components in a circuit.*

12 Volt Test Light

The 12 volt test light is used to check circuits and components while electrical current is flowing through them. It is used for voltage and ground tests. Twelve volt test lights come in different styles but all have three main parts; a ground clip, a probe, and a light. The most commonly used 12 volt test lights have pick-type probes. To use a 12 volt test light, connect the ground clip to a good ground and probe wherever necessary with the pick. The pick should be sharp so that it can penetrate wire insulation to make contact with the wire, without making a large hole in the insulation. The wraparound light is handy in hard to reach areas or where it is difficult to support a wire to push a probe pick into it. To use the wrap around light, hook the wire to probed with the hook and pull the trigger. A small pick will be forced through the wire insulation into the wire core.

CAUTION: *Do not use a test light to probe electronic ignition spark plug or coil wires. Never use a pick-type test light to probe wiring on computer controlled systems unless specifically instructed to do so. Any wire insulation that is pierced by the test light probe should be taped and sealed with silicone after testing.*

Like the jumper wire, the 12 volt test light is used to isolate opens in circuits. But, whereas the jumper wire is used to bypass the open to operate the load, the 12 volt test light is used to locate the presence of voltage in a circuit. If the test light glows, you know that there is power up to that point; if the 12 volt test light does not glow when its probe is inserted into the wire or connector, you know that there is an open circuit (no power). Move the test light in successive steps back toward the power source until the light in the handle does glow. When it does glow, the open is between the probe and point previously probed.

NOTE: *The test light does not detect that 12 volts (or any particular amount of voltage) is present; it only detects that some voltage is present. It is advisable before using the test light to touch its terminals across the battery posts to make sure the light is operating properly.*

Self-Powered Test Light

The self-powered test light usually contains a 1.5 volt penlight battery. One type of self-powered test light is similar in design to the 12 volt test light. This type has both the battery and the light in the handle and pick-type probe tip. The second type has the light toward the open tip, so that the light illuminates the contact point. The self-powered test light is dual purpose piece of test equipment. It can be used to test for either open or short circuits when power is isolated from the circuit (continuity test). A powered test light should not be used on any computer controlled system or component unless specifically instructed to do so. Many engine sensors can be destroyed by even this small amount of voltage applied directly to the terminals.

Open Circuit Testing

To use the self-powered test light to check for open circuits, first isolate the circuit from the vehicle's 12 volt power source by disconnecting the battery or wiring harness connector. Connect the test light ground clip to a good ground and probe sections of the circuit sequentially with the test light. (start from either end of the circuit). If the light is out, the open is between the probe and the circuit ground. If the light is on, the open is between the probe and end of the circuit toward the power source.

Short Circuit Testing

By isolating the circuit both from power and from ground, and using a self-powered test light, you can check for shorts to ground in the circuit. Isolate the circuit from power and ground. Connect the test light ground clip to a good ground and probe any easy-to-reach test point in the circuit. If the light comes on, there is a short somewhere in the circuit. To isolate the short, probe a test point at either end of the isolated circuit (the light should be on). Leave the test light probe connected and open connectors, switches, remove parts, etc., sequentially, until the light goes out. When the light goes out, the short is between the last circuit component opened and the previous circuit opened.

NOTE: *The 1.5 volt battery in the test light does not provide much current. A weak battery may not provide enough power to illuminate the test light even when a complete circuit is made (especially if there are high resistances in the circuit). Always make sure that the test battery is strong. To check the battery, briefly touch the ground clip to the probe; if the light glows brightly the battery is strong enough for testing. Never use a self-powered test light to perform checks for opens or shorts when power is applied to the electrical system under test. The 12 volt vehicle power will quickly burn out the 1.5 volt light bulb in the test light.*

Voltmeter

A voltmeter is used to measure voltage at any point in a circuit, or to measure the voltage drop across any part of a circuit. It can also be used to check continuity in a wire or circuit by indicating current flow from one end to the other. Voltmeters usually have various scales on the meter dial and a selector switch to allow the selection of different voltages. The voltmeter has a positive and a negative lead. To avoid damage to the meter, always connect the negative lead to the negative (–) side of circuit (to ground or nearest the ground side of the circuit) and connect the positive lead to the positive (+) side of the circuit (to the power source or the nearest power source). Note that the negative voltmeter lead will always be black and that the positive voltmeter will always be some color other than black (usually red). Depending on how the voltmeter is connected into the circuit, it has several uses.

A voltmeter can be connected either in parallel or in series with a circuit and it has a very high resistance to current flow. When connected in parallel, only a small amount of current will flow through the voltmeter current path; the rest will flow through the normal circuit current path and the circuit will work normally. When the voltmeter is connected in series with a circuit, only a small amount of current can flow through the circuit. The circuit will not work properly, but the voltmeter reading will show if the circuit is complete or not.

Available Voltage Measurement

Set the voltmeter selector switch to the 20V position and connect the meter negative lead to the negative post of the battery. Connect the positive meter lead to the positive post of the battery and turn the ignition switch ON to provide a load. Read the voltage on the meter or digital display. A well charged battery should register over 12 volts. If the meter reads below 11.5 volts, the battery power may be insufficient to operate the electrical system properly. This test determines voltage available from the battery and should be the first step in any electrical trouble diagnosis procedure. Many electrical problems, especially on computer controlled systems, can be caused by a low state of charge in the battery. Excessive corrosion at the battery cable terminals can cause a poor contact that will prevent proper charging and full battery current flow.

Normal battery voltage is 12 volts when fully charged. When the battery is supplying current to one or more circuits it is said to be "under load". When everything is off the electrical system is under a "no-load" condition. A fully charged battery may show about 12.5 volts at no load; will drop to 12 volts under medium load; and will drop even lower under heavy load. If the battery is partially discharged the voltage decrease under heavy load may be excessive, even though the battery shows 12 volts or more at no load. When allowed to discharge further, the battery's available voltage under load will decrease more severely. For this reason, it is important that the battery be fully charged during all testing procedures to avoid errors in diagnosis and incorrect test results.

Voltage Drop

When current flows through a resistance, the voltage beyond the resistance is reduced (the larger the current, the greater the reduction in voltage). When no current is flowing, there is no voltage drop because there is no current flow. All points in the circuit which are connected to the power source are at the same voltage as the power source. The total voltage drop always equals the total source voltage. In a long circuit with many connectors, a series of small, unwanted voltage drops due to corrosion at the connectors can add up to a total loss of voltage which impairs the operation of the normal loads in the circuit.

INDIRECT COMPUTATION OF VOLTAGE DROPS

1. Set the voltmeter selector switch to the 20 volt position.
2. Connect the meter negative lead to a good ground.
3. Probe all resistances in the circuit with the positive meter lead.
4. Operate the circuit in all modes and observe the voltage readings.

DIRECT MEASUREMENT OF VOLTAGE DROPS

1. Set the voltmeter switch to the 20 volt position.
2. Connect the voltmeter negative lead to the ground side of the resistance load to be measured.
3. Connect the positive lead to the positive side of the resistance or load to be measured.
4. Read the voltage drop directly on the 20 volt scale.

Too high a voltage indicates too high a resistance. If, for example, a blower motor runs too slowly, you can determine if there is too high a resistance in the resistor pack. By taking voltage drop readings in all parts of the circuit, you can isolate the problem. Too low a voltage drop indicates too low a resistance. If, for example, a blower motor runs too fast in the MED and/or LOW position, the problem can be isolated in the resistor pack by taking voltage drop readings in all parts of the circuit to locate a possibly shorted resistor. The maximum allowable voltage drop under load is critical, especially if there is more than one high resistance problem in a circuit because all voltage drops are cumulative. A small drop is normal due to the resistance of the conductors.

HIGH RESISTANCE TESTING

1. Set the voltmeter selector switch to the 4 volt position.
2. Connect the voltmeter positive lead to the positive post of the battery.
3. Turn on the headlights and heater blower to provide a load.
4. Probe various points in the circuit with the negative voltmeter lead.
5. Read the voltage drop on the 4 volt scale. Some average maximum allowable voltage drops are:

FUSE PANEL: 7 volts
IGNITION SWITCH: 5 volts
HEADLIGHT SWITCH: 7 volts
IGNITION COIL (+): 5 volts
ANY OTHER LOAD: 1.3 volts

NOTE: *Voltage drops are all measured while a load is operating; without current flow, there will be no voltage drop.*

Ohmmeter

The ohmmeter is designed to read resistance in ohms () in a circuit or component. Although there are several different styles of ohmmeters, all will usually have a selector switch which permits the measurement of different ranges of resistance (usually the selector switch allows the multiplication of the meter reading by 10, 100, 1,000, and 10,000). A calibration knob allows the meter to be set at zero for accurate measurement. Since all ohmmeters are powered by an internal battery (usually 9 volts), the ohmmeter can be used as a self-powered test light. When the ohmmeter is connected, current from the ohmmeter flows through the circuit or component being tested. Since the ohmmeter's internal resistance and voltage are known values, the amount of current flow through the meter depends on the resistance of the circuit or component being tested.

The ohmmeter can be used to perform continuity test for opens or shorts (either by observation of the meter needle or as a self-powered test light), and to read actual resistance in a circuit. It should be noted that the ohmmeter is used to check the resistance of a component or wire while there is no voltage applied to the circuit. Current flow from an outside voltage source (such as the vehicle battery) can damage the ohmmeter, so the circuit or component should be isolated from the vehicle electrical system before any testing is done. Since the ohmmeter uses its own voltage source, either lead can be connected to any test point.

NOTE: *When checking diodes or other solid state components, the ohmmeter leads can only be connected one way in order to measure current flow in a single direction. Make sure the positive (+) and negative (–) terminal connections are as described in the test procedures to verify the one-way diode operation.*

In using the meter for making continuity checks, do not be concerned with the actual resistance readings. Zero resistance, or any resistance readings, indicate continuity in the circuit. Infinite resistance indicates an open in the circuit. A high resistance reading where there should be none indicates a problem in the circuit. Checks for short circuits are made in the same manner as checks for open circuits except that the circuit must be isolated from both power and normal ground. Infinite resistance indicates no continuity to ground, while zero resistance indicates a dead short to ground.

RESISTANCE MEASUREMENT

The batteries in an ohmmeter will weaken with age and temperature, so the ohmmeter must be calibrated or "zeroed" before taking measurements. To zero the meter, place the selector switch in its lowest range and touch the two ohmmeter leads together. Turn the calibration knob until the meter needle is exactly on zero.

NOTE: *All analog (needle) type ohmmeters must be zeroed before use, but some digital ohmmeter models are automatically calibrated when the switch is turned on. Self-calibrating digital ohmmeters do not have an adjusting knob, but its a good idea to check for a zero readout before use by touching the leads together. All computer controlled systems require the use of a digital ohmmeter with at least 10M (megohms) impedance for testing. Before any test procedures are attempted, make sure the ohmmeter used is compatible with the electrical system or damage to the on-board computer could result.*

To measure resistance, first isolate the circuit from the vehicle power source by disconnecting the battery cables or the harness connector. Make sure the key is OFF when disconnecting any components or the battery. Where necessary, also isolate at least one side of the circuit to be checked to avoid reading parallel resistances. Parallel circuit resistances will always give a lower reading than the actual resistance of either of the branches. When measuring the resistance of parallel circuits, the total resistance will always be lower than the smallest resistance in the circuit. Connect the meter leads to both sides of the circuit (wire or component) and read the actual measured ohms on the meter scale. Make sure the selector switch is set to the proper ohm scale for the circuit being tested to avoid misreading the ohmmeter test value.

WARNING: *Never use an ohmmeter with power applied to the circuit. Like the self-powered test light, the ohmmeter is designed to operate on its own power supply. The normal 12 volt automotive electrical system current could damage the meter!*

Ammeters

An ammeter measures the amount of current flowing through a circuit in units called amperes or amps. Amperes are units of electron flow which indicate how fast the electrons are flowing through the circuit. Since Ohms Law dictates that current flow in a circuit is equal to the circuit voltage divided by the total circuit resistance, increasing voltage also increases the current level (amps). Likewise, any decrease in resistance will increase the amount of amps in a circuit. At normal operating voltage, most circuits have a characteristic amount of amperes, called "current draw" which can be measured using an ammeter. By referring to a specified current draw rating, measuring the amperes, and comparing the two values, one can determine what is happening within the circuit to aid in diagnosis. An open circuit, for example, will not allow any current to flow so the ammeter reading will be zero. More current flows through a heavily loaded circuit or when the charging system is operating.

An ammeter is always connected in series with the circuit being tested. All of the current that normally flows through the circuit must also flow through the ammeter; if there is any other path for the current to follow, the ammeter reading will not be accurate. The ammeter itself has very little resistance to current flow and therefore will not affect the circuit, but it will measure current draw only when the circuit is closed and electricity is flowing. Excessive current draw can blow fuses and drain the battery, while a reduced current draw can cause motors to run slowly, lights to dim and other components to not operate properly. The ammeter can help diagnose these conditions by locating the cause of the high or low reading.

Multimeters

Different combinations of test meters can be built into a single unit designed for specific tests. Some of the more common combination test devices are known as Volt/Amp testers, Tach/Dwell meters, or Digital Multimeters. The Volt/Amp tester is used for charging system, starting system or battery tests and consists of a voltmeter, an ammeter and a variable resistance carbon pile. The voltmeter will usually have at least two ranges for use with 6, 12 and 24 volt systems. The ammeter also has more than one range for testing various levels of battery loads and starter current draw and the carbon pile can be adjusted to offer different amounts of resistance. The Volt/Amp tester has heavy leads to carry large amounts of current and many later models have an inductive ammeter pickup that clamps around the wire to simplify test connections. On some models, the ammeter also has a zero-center scale to allow testing of charging and starting systems without switching leads or polarity. A digital multimeter is a voltmeter, ammeter and ohmmeter combined in an instrument which gives a digital readout. These are often used when testing solid state circuits because of their high input impedance (usually 10 megohms or more).

The tach/dwell meter combines a tachometer and a dwell (cam angle) meter and is a specialized kind of voltmeter. The tachometer scale is marked to show engine speed in rpm and the dwell scale is marked to show degrees of distributor shaft rotation. In most electronic ignition systems, dwell is determined by the control unit, but the dwell meter can also be used to check the duty cycle (operation) of some electronic engine control systems. Some tach/dwell meters are powered by an internal battery, while others take their power from the car battery in use. The battery powered testers usually require calibration much like an ohmmeter before testing.

Special Test Equipment

A variety of diagnostic tools are available to help troubleshoot and repair computerized engine control systems. The most sophisticated of these devices are the console type engine analyzers that usually occupy a garage service bay, but there are several types of aftermarket electronic testers available that will allow quick circuit tests of the engine control system by plugging directly into a special connector located in the engine compartment or under the dashboard. Several tool and equipment manufacturers offer simple, hand held testers that measure various circuit voltage levels on command to check all system components for proper operation. Although these testers usually cost about $300–500, consider that the average computer control unit (or ECM) can cost just as much and the money saved by not replacing perfectly good sensors or components in an attempt to correct a problem could justify the purchase price of a special diagnostic tester the first time it's used.

These computerized testers can allow quick and easy test measurements while the engine is operating or while the car is being driven. In addition, the on-board computer memory can be read to access any stored trouble codes; in effect allowing the computer to tell you where it hurts and aid trouble diagnosis by pinpointing exactly which circuit or component is malfunctioning. In the same manner, repairs can be tested to make sure the problem has been corrected. The biggest advantage these special testers have is their relatively easy hookups that minimize or eliminate the chances of making the wrong connections and getting false voltage readings or damaging the computer accidentally.

NOTE: *It should be remembered that these testers check voltage levels in circuits; they don't detect mechanical problems or failed components if the circuit voltage falls within the preprogrammed limits stored in the tester PROM unit. Also, most of the hand held testers are designed to work only on one or two systems made by a specific manufacturer.*

A variety of aftermarket testers are available to help diagnose different computerized control systems. Owatonna Tool Company (OTC), for example, markets a device called the OTC Monitor which plugs directly into the assembly line diagnostic link (ALDL). The OTC tester makes diagnosis a simple matter of pressing the correct buttons and, by changing the internal PROM or inserting a different diagnosis cartridge, it will work on any model from full size to subcompact, over a wide range of years. An adapter is supplied with the tester to allow connection to all types of ALDL links, regardless of the number of pin terminals used. By inserting an updated PROM into the OTC tester, it can be easily updated to diagnose any new modifications of computerized control systems.

Wiring Harnesses

The average automobile contains about $^1/_2$ mile of wiring, with hundreds of individual connections. To protect the many wires from damage and to keep them from becoming a confusing tangle, they are organized into bundles, enclosed in plastic or taped together and called wire harnesses. Different wiring harnesses serve different parts of the vehicle. Individual wires are color coded to help trace them through a harness where sections are hidden from view.

A loose or corroded connection or a replacement wire that is too small for the circuit will add extra resistance and an additional voltage drop to the circuit. A ten percent voltage drop can result in slow or erratic motor operation, for example, even though the circuit is complete. Automotive wiring or circuit conductors can be in any one of three forms:

1. Single strand wire
2. Multi-strand wire
3. Printed circuitry

Single strand wire has a solid metal core and is usually used inside such components as alternators, motors, relays and other devices. Multi-strand wire has a core made of many small strands of wire twisted together into a single conductor. Most of the wiring in an automotive electrical system is made up of multi-strand wire, either as a single conductor or grouped together in a harness. All wiring is color coded on the insulator, either as a solid color or as a colored wire with an identification stripe. A printed circuit is a thin film of copper or other conductor that is printed on an insulator backing. Occasionally, a printed circuit is sandwiched between two sheets of plastic for more protection and flexibility. A complete printed circuit, consisting of conductors, insulating material and connectors for lamps or other components is called a printed circuit board. Printed circuitry is used in place of individual wires or harnesses in places where space is limited, such as behind instrument panels.

Wire Gauge

Since computer controlled automotive electrical systems are very sensitive to changes in resistance, the selection of properly sized wires is critical when systems are repaired. The wire gauge number is an expression of the cross section area of the conductor. The most common system for expressing wire size is the American Wire Gauge (AWG) system.

Wire cross section area is measured in circular mils. A mil is $^1/_{1000}$ in. (0.001 in.); a circular mil is the area of a circle one mil in diameter. For example, a conductor $^1/_4$ in. in diameter is 0.250 in. or 250 mils. The circular mil cross section area of the wire is 250 squared (250^2)or 62,500 circular mils. Imported car models usually use metric wire gauge designations, which is simply the cross section area of the conductor in square millimeters (mm^2).

Gauge numbers are assigned to conductors of various cross section areas. As gauge number increases, area decreases and the conductor becomes smaller. A 5 gauge conductor is smaller than a 1 gauge conductor and a 10 gauge is smaller than a 5 gauge. As the cross section area of a conductor decreases, resistance increases and so does the gauge number. A conductor with a higher gauge number will carry less current than a conductor with a lower gauge number.

NOTE: *Gauge wire size refers to the size of the conductor, not the size of the complete wire. It is possible to have two wires of the same gauge with different diameters because one may have thicker insulation than the other.*

12 volt automotive electrical systems generally use 10, 12, 14, 16 and 18 gauge wire. Main power distribution circuits and larger accessories usually use 10 and 12 gauge wire. Battery cables are usually 4 or 6 gauge, although 1 and 2 gauge wires are occasionally used. Wire length must also be considered when making repairs to a circuit. As conductor length increases, so does resistance. An 18 gauge wire, for example, can carry a 10 amp load for 10 feet without excessive voltage drop; however if a 15 foot wire is required for the same 10 amp load, it must be a 16 gauge wire.

An electrical schematic shows the electrical current paths when a circuit is operating properly. It is essential to understand how a circuit works before trying to figure out why it does not. Schematics break the entire electrical system down into individual circuits and show only one particular circuit. In a schematic, no attempt is made to represent wiring and components as they physically appear on the vehicle; switches and other components are shown as simply as possible. Face views of harness connectors show the cavity or terminal locations in all multi-pin connectors to help locate test points.

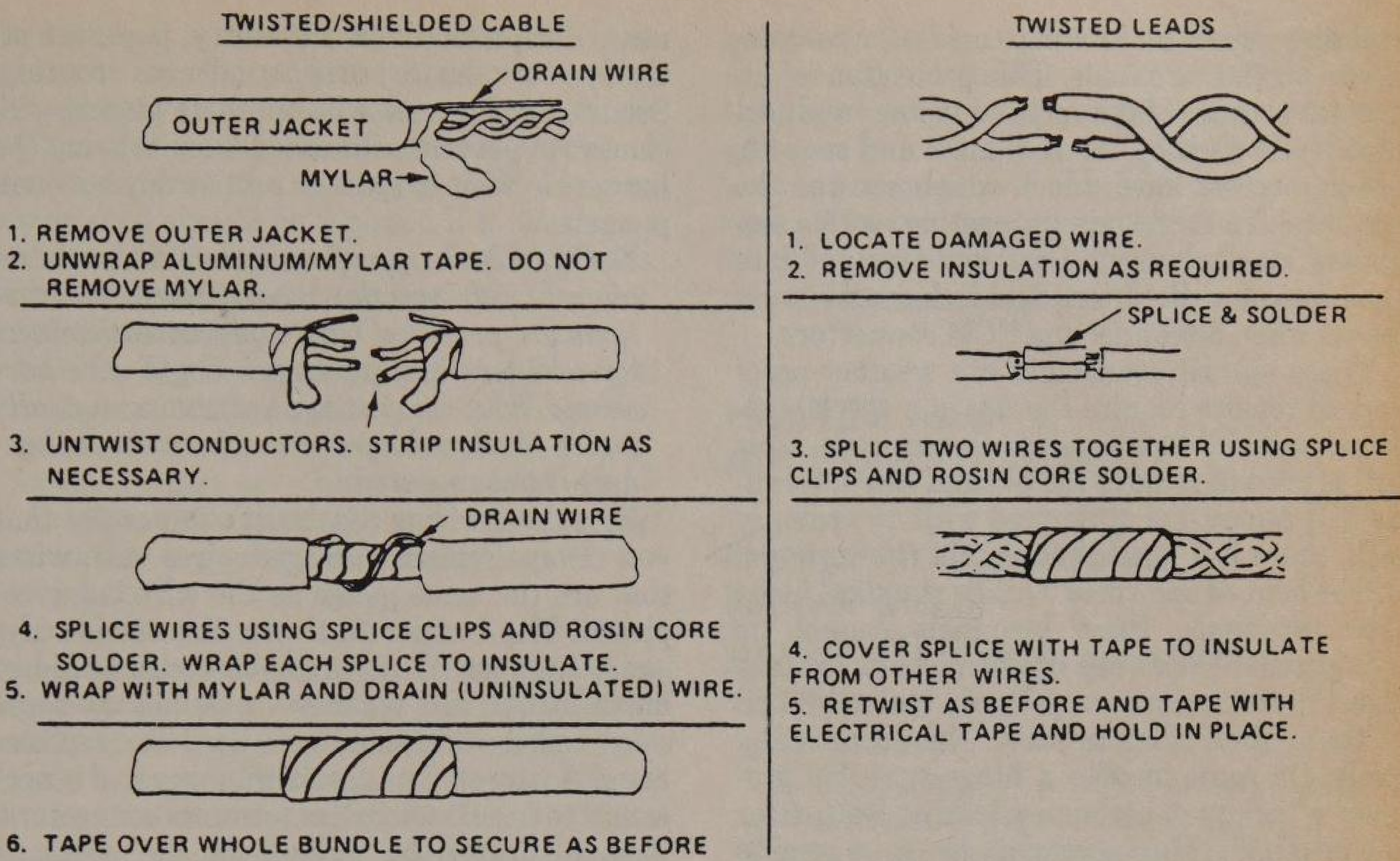
If you need to backprobe a connector while it is on the component, the order of the terminals must be mentally reversed. The wire color code can help in this situation, as well as a keyway, lock tab or other reference mark.

NOTE: *Wiring diagrams are not included in this book. As trucks have become more complex and available with longer option lists, wiring diagrams have grown in size and complexity. It has become almost impossible to provide a readable reproduction of a wiring diagram in a book this size. Information on ordering wiring diagrams from the vehicle manufacturer can be found in the owner's manual.*

WIRING REPAIR

Soldering is a quick, efficient method of joining metals permanently. Everyone who has the occasion to make wiring repairs should know how to solder. Electrical connections that are soldered are far less likely to come apart and will conduct electricity much better than connections that are only "pig-tailed" together. The most popular (and preferred) method of soldering is with an electrical soldering gun. Soldering irons are available in many sizes and wattage ratings. Irons with higher wattage ratings deliver higher temperatures and recover lost heat faster. A small soldering iron rated for no more than 50 watts is recommended, especially on electrical systems where excess heat can damage the components being soldered.

There are three ingredients necessary for successful soldering; proper flux, good solder and sufficient heat. A soldering flux is necessary to clean the metal of tarnish, prepare it for soldering and to enable the solder to spread into tiny crevices. When soldering, always use a resin flux or resin core solder which is non-corrosive and will not attract moisture once the job is finished. Other types of flux (acid core) will leave a residue that will attract moisture and cause the wires to corrode. Tin is a unique metal with a low melting point. In a molten state, it dissolves and alloys easily with many metals. Solder is made by mixing tin with lead. The most common proportions are 40/60, 50/50 and 60/40, with the percentage of tin listed first. Low priced solders usually contain less tin, making them very difficult for a beginner to use because more heat is required to melt the



Wiring repair

solder. A common solder is 40/60 which is well suited for all-around general use, but 60/40 melts easier, has more tin for a better joint and is preferred for electrical work.

Soldering Techniques

Successful soldering requires that the metals to be joined be heated to a temperature that will melt the solder, usually 360–460°F (182–238°C). Contrary to popular belief, the purpose of the soldering iron is not to melt the solder itself, but to heat the parts being soldered to a temperature high enough to melt the solder when it is touched to the work. Melting flux-cored solder on the soldering iron will usually destroy the effectiveness of the flux.

NOTE: *Soldering tips are made of copper for good heat conductivity, but must be "tinned" regularly for quick transference of heat to the project and to prevent the solder from sticking to the iron. To "tin" the iron, simply heat it and touch the flux-cored solder to the tip; the solder will flow over the hot tip. Wipe the excess off with a clean rag, but be careful as the iron will be hot.*

After some use, the tip may become pitted. If so, simply dress the tip smooth with a smooth file and "tin" the tip again. An old saying holds that "metals well cleaned are half soldered." Flux-cored solder will remove oxides but rust, bits of insulation and oil or grease must be removed with a wire brush or emery cloth. For maximum strength in soldered parts, the joint must start off clean and tight. Weak joints will result in gaps too wide for the solder to bridge.

If a separate soldering flux is used, it should be brushed or swabbed on only those areas that are to be soldered. Most solders contain a core of flux and separate fluxing is unnecessary. Hold the work to be soldered firmly. It is best to solder on a wooden board, because a metal vise will only rob the piece to be soldered of heat and make it difficult to melt the solder. Hold the soldering tip with the broadest face against the work to be soldered. Apply solder under the tip close to the work, using enough solder to give a heavy film between the iron and the piece being soldered, while moving slowly and making sure the solder melts properly. Keep the work level or the solder will run to the lowest part and favor the thicker parts, because these require more heat to melt the solder. If the soldering tip overheats (the solder coating on the face of the tip burns up), it should be retinned. Once the soldering is completed, let the soldered joint stand until cool. Tape and seal all soldered wire splices after the repair has cooled.

Wire Harness and Connectors

The on-board computer (ECM) wire harness electrically connects the control unit to the various solenoids, switches and sensors used by the control system. Most connectors in the engine compartment or otherwise exposed to the elements are protected against moisture and dirt which could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels used by the computer and sensors. All connectors have a lock which secures the male and female terminals together, with a secondary lock holding the seal and terminal into the connector. Both terminal locks must be released when disconnecting ECM connectors.

These special connectors are weather-proof and all repairs require the use of a special terminal and the tool required to service it. This tool is used to remove the pin and sleeve terminals. If removal is attempted with an ordinary pick, there is a good chance that the terminal will be bent or deformed. Unlike standard blade type terminals, these terminals cannot be straightened once they are bent. Make certain that the connectors are properly seated and all of the sealing rings in place when connecting leads. On some models, a hinge-type flap provides a backup or secondary locking feature for the terminals. Most secondary locks are used to improve the connector reliability by retaining the terminals if the small terminal lock tangs are not positioned properly.

Molded-on connectors require complete replacement of the connection. This means splicing a new connector assembly into the harness. All splices in on-board computer systems should be soldered to insure proper contact. Use care when probing the connections or replacing terminals in them as it is possible to short between opposite terminals. If this happens to the wrong terminal pair, it is possible to damage certain components. Always use jumper wires between connectors for circuit checking and never probe through weatherproof seals.

Open circuits are often difficult to locate by sight because corrosion or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may correct the open circuit condition. This should always be considered when an open circuit or a failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections. When using a circuit tester for diagnosis, always probe connections from the wire side. Be careful not to damage sealed connectors with test probes.

All wiring harnesses should be replaced with identical parts, using the same gauge wire and connectors. When signal wires are spliced into a harness, use wire with high temperature insulation only. With the low voltage and current levels found in the system, it is important that the best possible connection at all wire splices be made by soldering the splices together. It is seldom necessary to replace a complete harness. If replacement is necessary, pay close attention to insure proper harness routing. Secure the harness with suitable plastic wire clamps to prevent vibrations from causing the harness to wear in spots or contact any hot components.

NOTE: *Weatherproof connectors cannot be replaced with standard connectors. Instructions are provided with replacement connector and terminal packages. Some wire harnesses have mounting indicators (usually pieces of colored tape) to mark where the harness is to be secured.*

In making wiring repairs, it's important that you always replace damaged wires with wires that are the same gauge as the wire being replaced. The heavier the wire, the smaller the gauge number. Wires are color-coded to aid in identification and whenever possible the same color coded wire should be used for replacement. A wire stripping and crimping tool is necessary to install solderless terminal connectors. Test all crimps by pulling on the wires; it should not be possible to pull the wires out of a good crimp.

Wires which are open, exposed or otherwise damaged are repaired by simple splicing. Where possible, if the wiring harness is accessible and the damaged place in the wire can be located, it is best to open the harness and check for all possible damage. In an inaccessible harness, the wire must be bypassed with a new insert, usually taped to the outside of the old harness.

When replacing fusible links, be sure to use fusible link wire, NOT ordinary automotive wire. Make sure the fusible segment is of the same gauge and construction as the one being replaced and double the stripped end when crimping the terminal connector for a good contact. The melted (open) fusible link segment of the wiring harness should be cut off as close to the harness as possible, then a new segment spliced in as described. In the case of a damaged fusible link that feeds two harness wires, the harness connections should be replaced with two fusible link wires so that each circuit will have its own separate protection.

NOTE: *Most of the problems caused in the wiring harness are due to bad ground connections. Always check all vehicle ground connections for corrosion or looseness before performing any power feed checks to eliminate the chance of a bad ground affecting the circuit.*

Repairing Hard Shell Connectors

Unlike molded connectors, the terminal contacts in hard shell connectors can be replaced. Weatherproof hard-shell connectors with the leads molded into the shell have non-replaceable terminal ends. Replacement usually involves the use of a special terminal removal tool that depress the locking tangs (barbs) on the connector terminal and allow the connector to be removed from the rear of the shell. The connector shell should be replaced if it shows any evidence of burning, melting, cracks, or breaks. Replace individual terminals that are burnt, corroded, distorted or loose.

NOTE: *The insulation crimp must be tight to prevent the insulation from sliding back on the wire when the wire is pulled. The insulation must be visibly compressed under the crimp tabs, and the ends of the crimp should be turned in for a firm grip on the insulation.*

The wire crimp must be made with all wire strands inside the crimp. The terminal must be fully compressed on the wire strands with the ends of the crimp tabs turned in to make a firm grip on the wire. Check all connections with an ohmmeter to insure a good contact. There should be no measurable resistance between the wire and the terminal when connected.

Mechanical Test Equipment

Vacuum Gauge

Most gauges are graduated in inches of mercury (in.Hg), although a device called a manometer reads vacuum in inches of water (in. H_2O). The normal vacuum reading usually varies between 18 and 22 in.Hg at sea level. To test engine vacuum, the vacuum gauge must be connected to a source of manifold vacuum. Many engines have a plug in the intake manifold which can be removed and replaced with an adapter fitting. Connect the vacuum gauge to the fitting with a suitable rubber hose or, if no manifold plug is available, connect the vacuum gauge to any device using manifold vacuum, such as EGR valves, etc. The vacuum gauge can be used to determine if enough vacuum is reaching a component to allow its actuation.

Hand Vacuum Pump

Small, hand-held vacuum pumps come in a variety of designs. Most have a built-in vacuum gauge and allow the component to be tested without removing it from the vehicle. Operate the pump lever or plunger to apply the correct amount of vacuum required for the test specified in the diagnosis routines. The level of vacuum in inches of Mercury (in.Hg) is indicated on the pump gauge. For some testing, an additional vacuum gauge may be necessary.

Intake manifold vacuum is used to operate various systems and devices on late model vehicles. To correctly diagnose and solve problems in vacuum control systems, a vacuum source is necessary for testing. In some cases, vacuum can be taken from the intake manifold when the engine is running, but vacuum is normally provided by a hand vacuum pump. These hand vacuum pumps have a built-in vacuum gauge that allow testing while the device is still attached to the component. For some tests, an additional vacuum gauge may be necessary.

HEATER AND AIR CONDITIONING

Heater/Air Conditioner Blower Motor

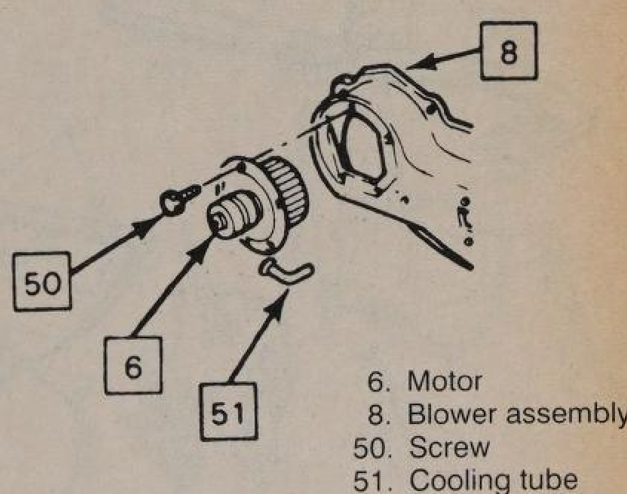
REMOVAL AND INSTALLATION

NOTE: *Refer to Chapter 1 for discharging, evacuating and recharging the A/C system.*

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.

To install:

1. Position the blower motor into place and install the retaining screws.
2. Install the blower motor cooling tube.
3. Connect all the electrical connections.
4. Connect the negative battery cable.



Blower motor assembly

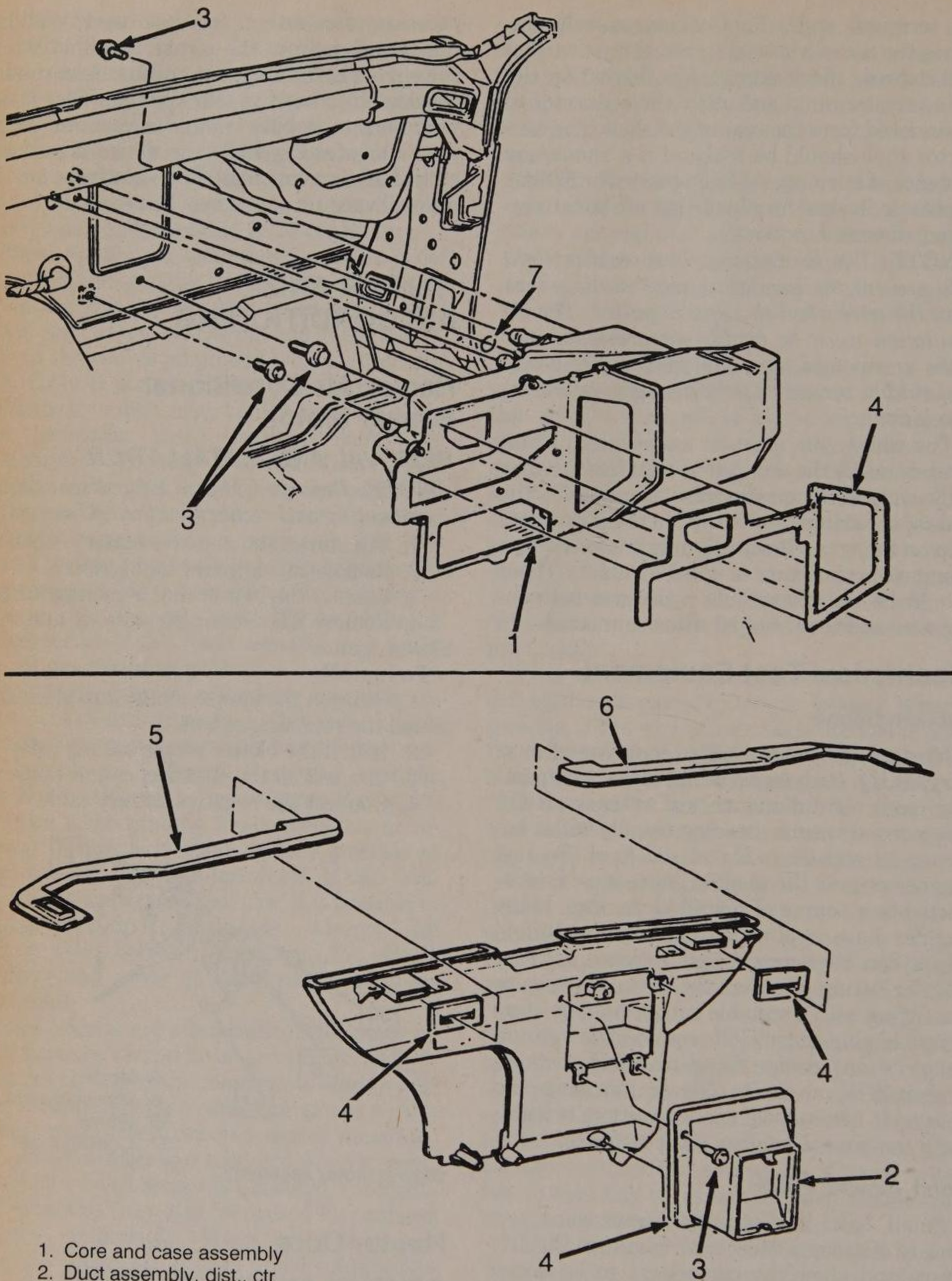
Heater Core

REMOVAL AND INSTALLATION

1982–86

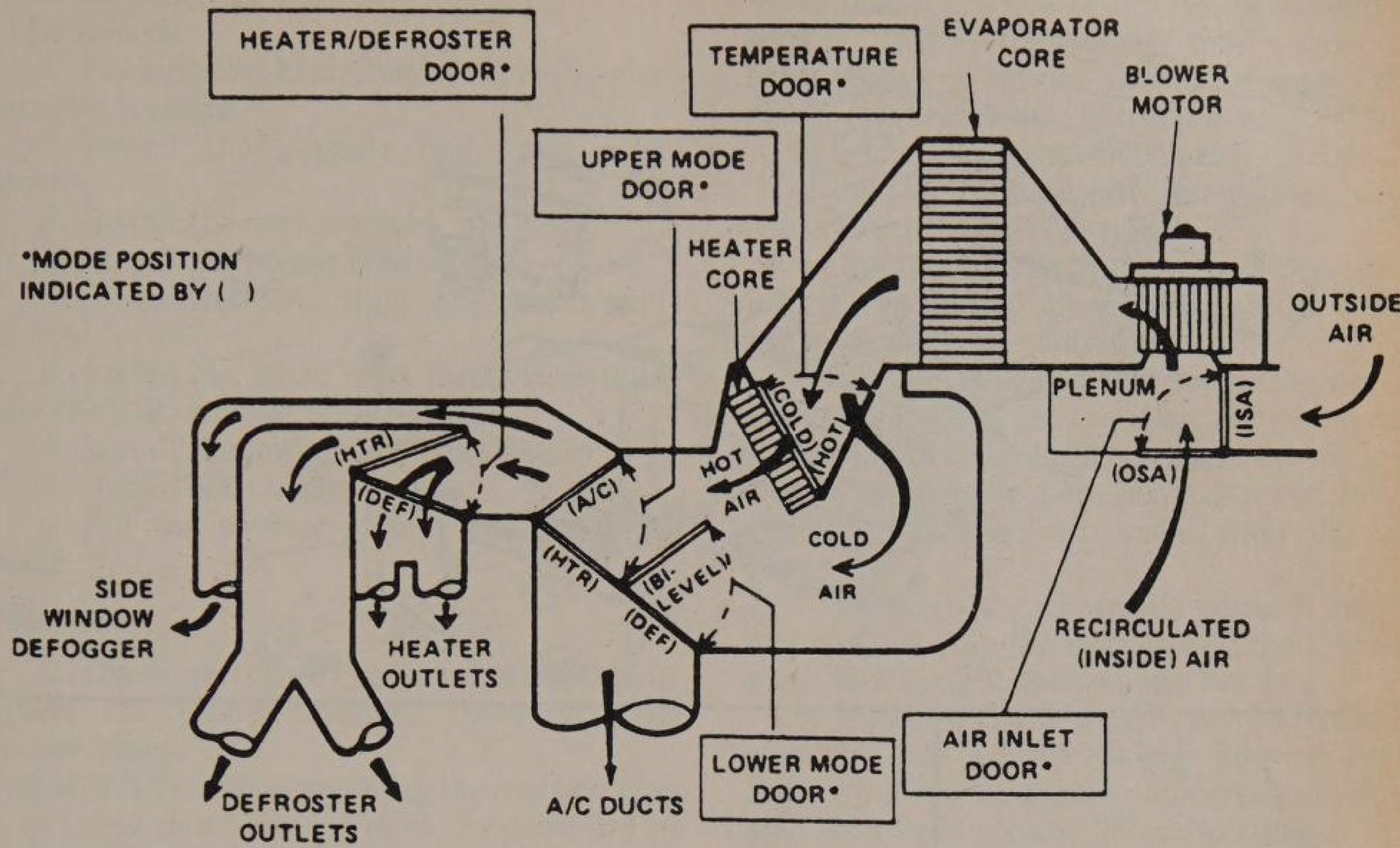
1. Drain the cooling system.

CAUTION: *When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable con-*

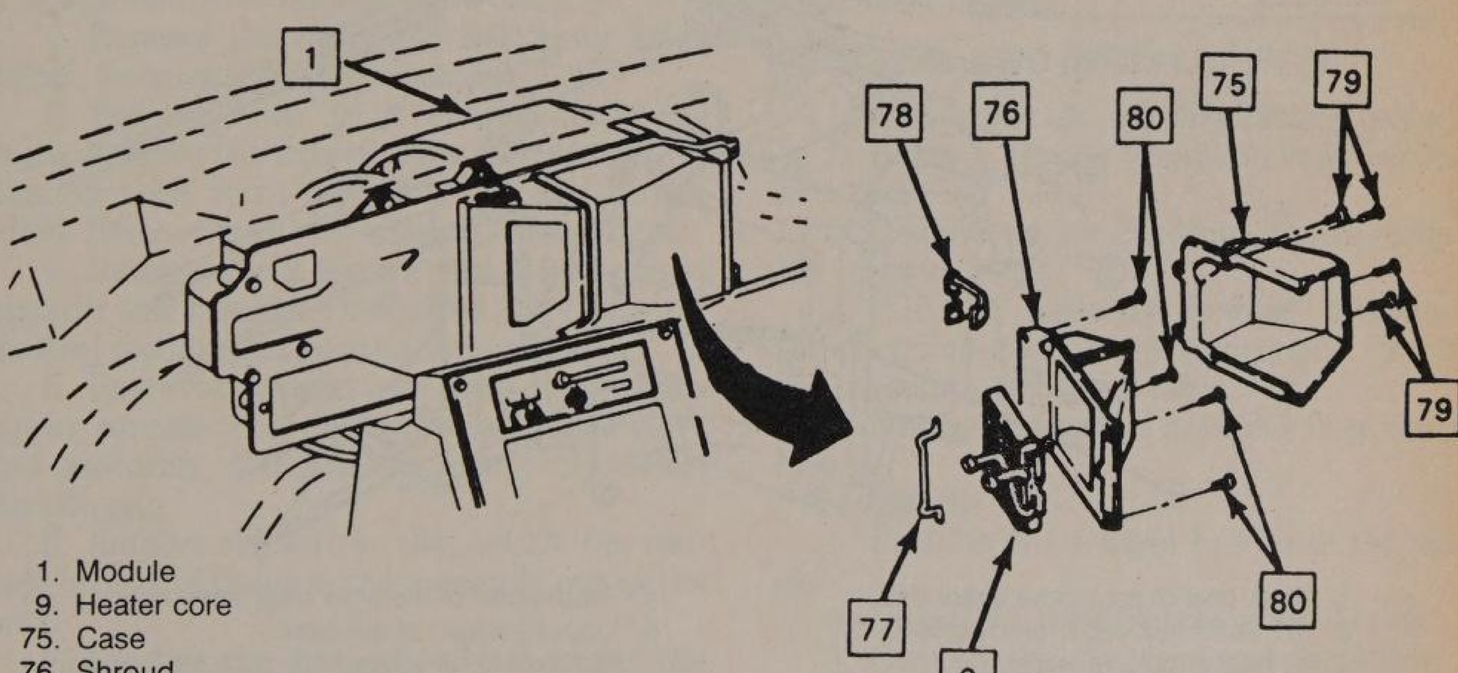


1. Core and case assembly
2. Duct assembly, dist., ctr
3. Bolt/screw
4. Seal
5. Duct – side window defrost L.H.
6. Duct – side window defrost R.H.
7. Stud, part of case assembly

Heater controller and mode cables

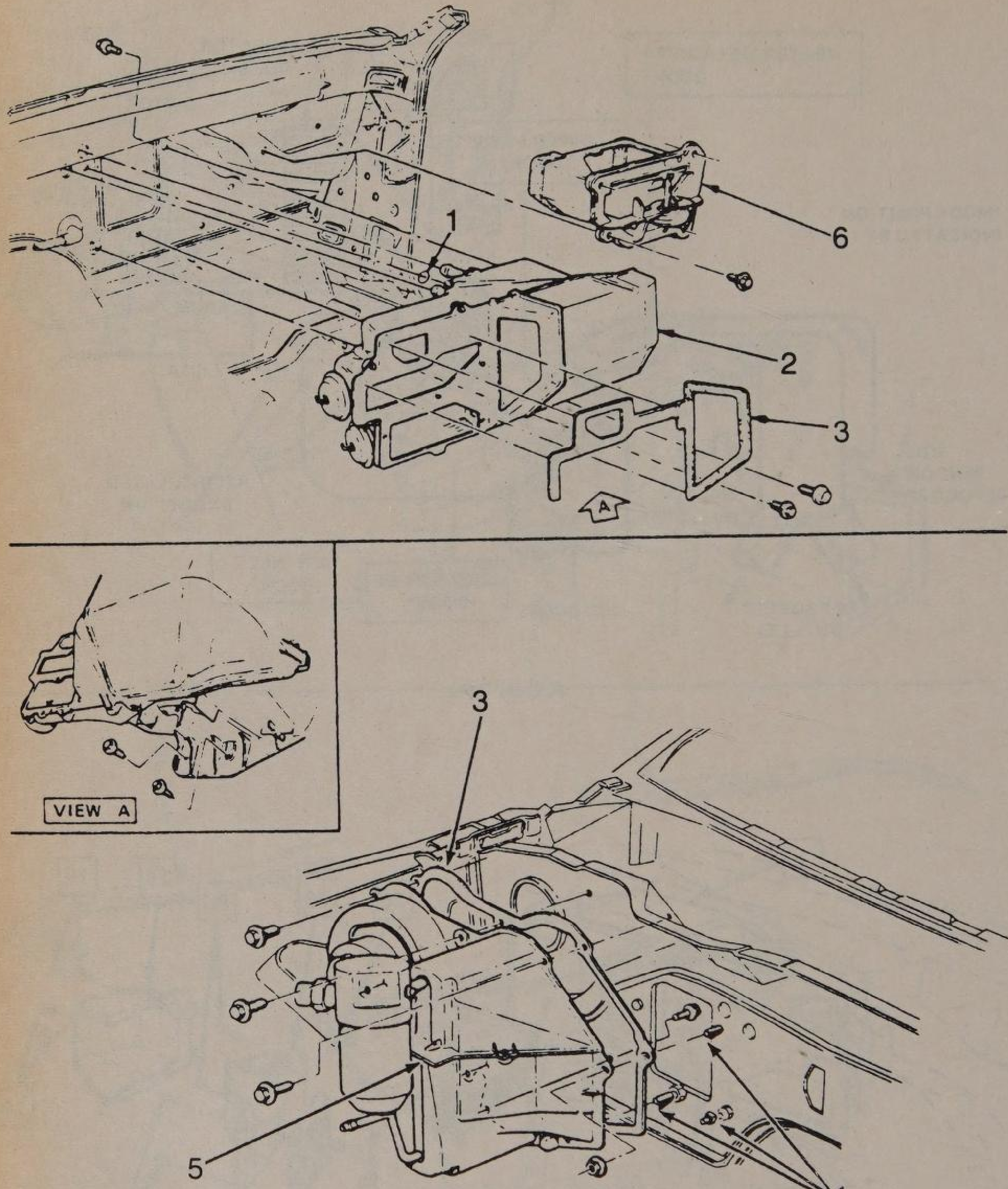


A/C air flow



1. Module
9. Heater core
75. Case
76. Shroud
77. Strap
78. Clamp
79. Screw
80. Screw

Heater core removal



1. Stud, part of core case assembly
2. RH section of case removable for heater core replacement
3. Gasket
4. Studs, part of the core case assembly
5. Upper section of the case removable for evaporator core replacement
6. Air inlet assembly

A/C module and case servicing

tainer. Coolant should be reused unless it is contaminated or several years old.

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.

To install:

1. Position the heater core and baffle plate into the housing.
2. Install the support plate and baffle screws.
3. Install the case cover.
4. Install the heater case screws.
5. Install the lower right instrument panel to cowl screw.
6. Install the lower right instrument panel and the ESC module if necessary.
7. Install the lower right hush panel.
8. Install both heater hoses.
9. Fill the cooling system and check for leaks.

1987–90

1. Disconnect the negative battery cable. Drain the cooling system. Disconnect the heater hoses.

CAUTION: *When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.*

2. Remove the right and left lower hush panel. Remove the upper dash pad.
3. Remove both front speaker retaining nuts. Remove the side window defrost duct retaining nuts, front carrier braces and carrier shelf. Remove both side window defrost ducts.
4. Remove the 2 screws securing the right speaker and bracket. Disconnect the electronic control module and position it to the side.
5. Remove the radio trim plate. Remove the upper console trim. Remove the console glove box assembly. Remove the emergency brake handle grip.
6. Remove the screws that secure the console body and position the assembly out of the way.
7. Remove the trim plate from under the steering column. Remove the steering column retaining nuts and lower the column.
8. Remove the nuts and screws that retain the instrument panel carrier.
9. Move the instrument panel carrier back to gain access to the heater core and the heater core upper bolt.
10. Remove the screws that secure the heater core housing cover. Remove the screws that secure the heater core and shroud. Remove the heater core from the shroud assembly.

To install:

1. Install the heater core to the shroud assembly. Install the screws that secure the heater core and shroud. Install the screws that secure the heater core housing cover.
2. Install the instrument panel carrier.
3. Install the nuts and screws that retain the instrument panel carrier.
4. Install the trim plate to under the steering column. Install the steering column retaining nuts and lower the column.
5. Install the screws that secure the console body and position the assembly out of the way.
6. Install the emergency brake handle grip. Install the console glove box assembly. Install the upper console trim. Install the radio trim plate.
7. Connect the electronic control module and position it to the side. Install the 2 screws securing the right speaker and bracket.
8. Install both side window defrost ducts. Install the side window defrost duct retaining nuts, front carrier braces and carrier shelf. Install both front speaker retaining nuts.
9. Install the upper dash pad. Install the right and left lower hush panel.
10. Connect the heater hoses. Connect the negative battery cable. Fill the cooling system and check for leaks.

Control Head

REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable.
2. Remove the air condition/radio console trim plate.
3. Remove the air condition control retaining screws.
4. Pull the assembly forward, disconnect the electrical and vacuum connections. Remove the temperature control cable.
5. Remove the control assembly from the vehicle.

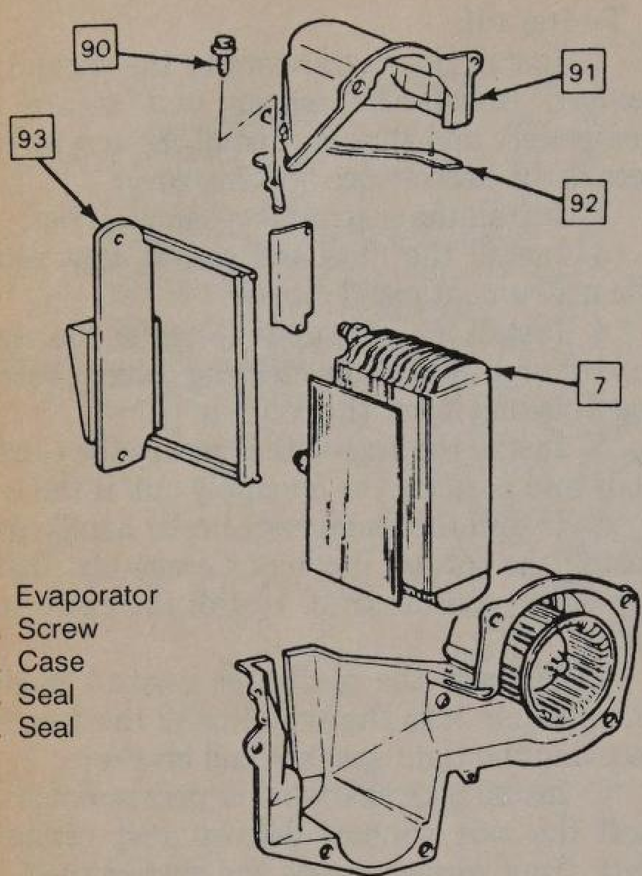
To install:

1. Position the control head into the vehicle.
2. Install the temperature control cable.
3. Connect the electrical and vacuum connections and push the assembly rearward.
4. Install the air condition control retaining screws.
5. Install the air condition/radio console trim plate.
6. Connect the negative battery cable.

Evaporator Core

REMOVAL AND INSTALLATION

1. Discharge the A/C system. Refer to Chapter 1 for discharging.



7. Evaporator
90. Screw
91. Case
92. Seal
93. Seal

Evaporator core

2. Remove the accumulator.

3. Remove the 2 screws and remove the high blower relay terminal

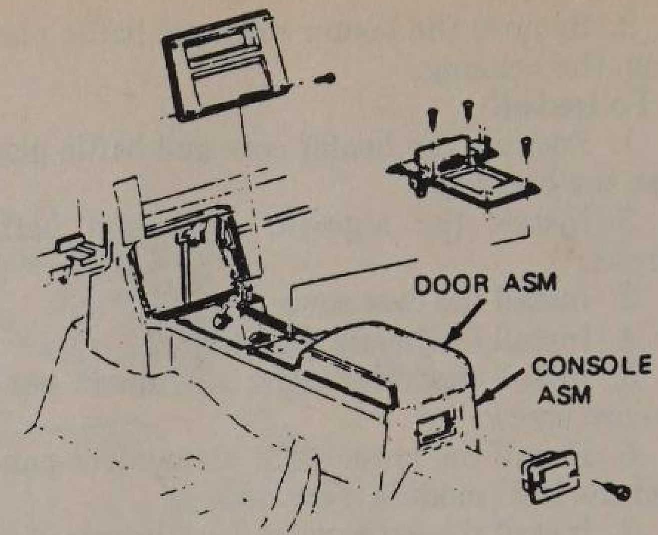
4. Remove the upper case screws.

5. Relocate the wiring harness and remove the dipstick (if equipped).

6. Disconnect the liquid line fitting.

7. Remove the upper case and lift the evaporator core out of the case (retain the foam wedge).

To install:



Console, radio and A/C/heater control trim servicing

1. Position the evaporator core into place with the foam wedge and install the upper case.

2. Connect the liquid line fitting.

3. Install the dipstick (if equipped) and position the wiring harness to the original place.

4. Install the high blower relay terminal and secure it with the 2 screws.

5. Install the accumulator.

6. Evacuate and charge the system. Check for leaks.

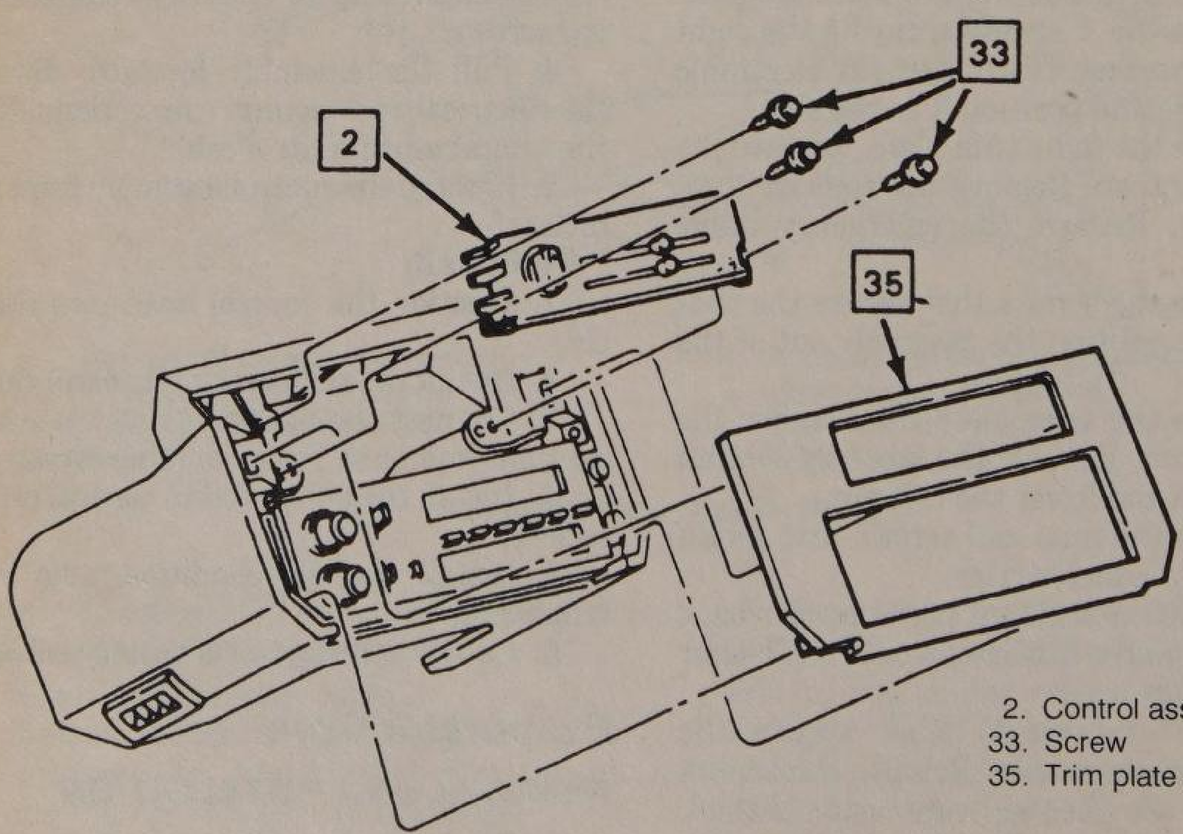
RADIO

REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable.

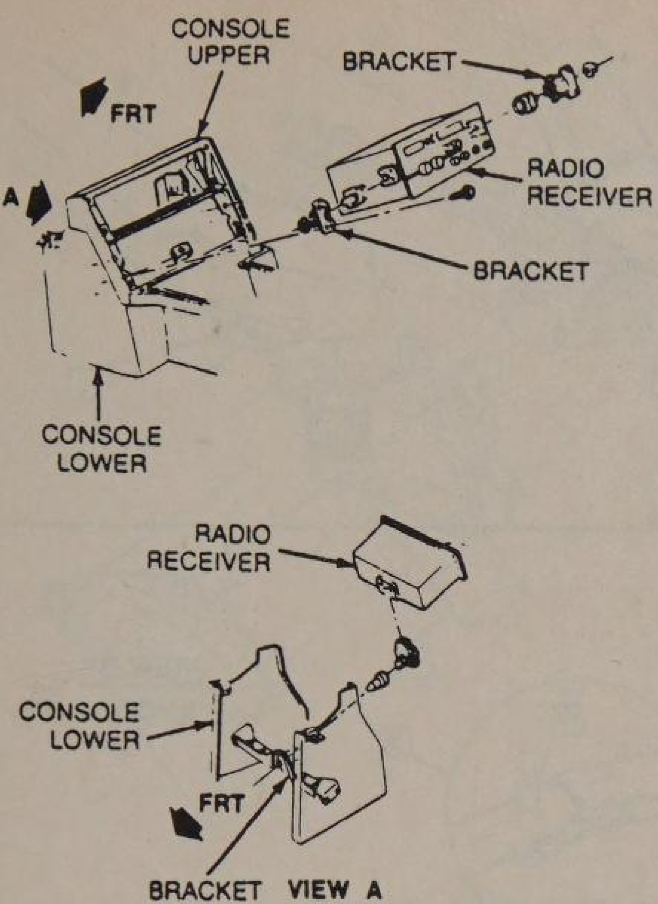
2. Remove the console bezel screws.

3. Remove the radio to console attaching screws.



2. Control assembly
33. Screw
35. Trim plate

Control assembly removal



Radio servicing

4. Remove the radio and disconnect the electrical connector.

5. To install, connect the electrical connector.

6. Install the radio to console attaching screws.

7. Install the console bezel screws.

8. Connect the negative battery cable.

NOTE: *Always connect the speakers before applying power to the radio as radio damage may result.*

WINDSHIELD WIPERS

Blade and Arm

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 retainer 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. J-8966 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.

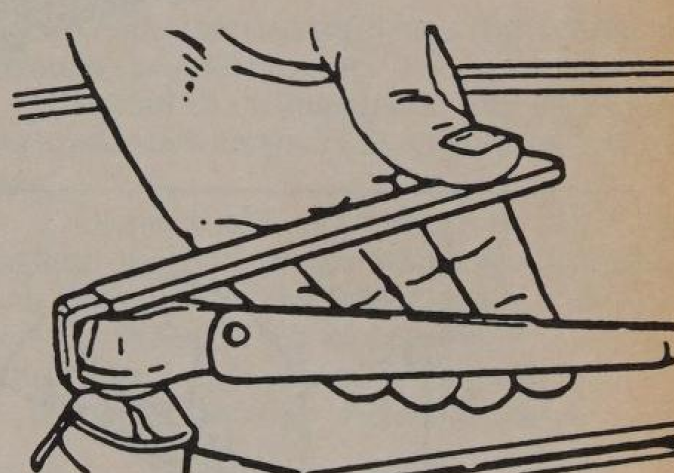
Windshield Wiper Motor

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.



Remove the wire arm with the special tool

4. Remove the three motor attaching screws, and remove the motor, guiding the crank arm through the hole.

To install:

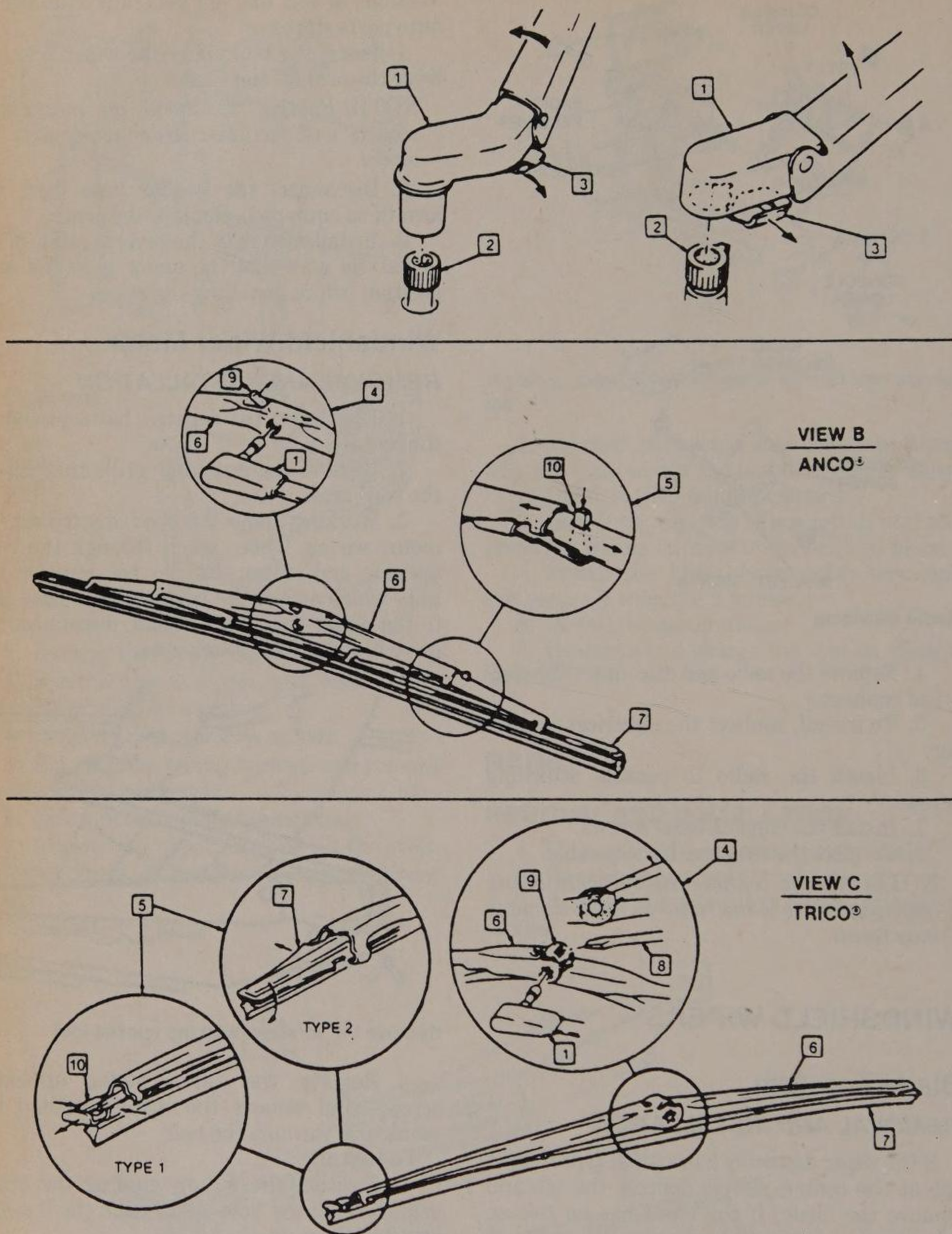
1. Position the motor, guiding the crank arm through the hole, and install the 3 motor attaching screws.

2. Connect the drive link to the crank arm and connect the motor wiring.

NOTE: *The motor must be in the park position before assembling the crank arm to the transmission drive link(s).*

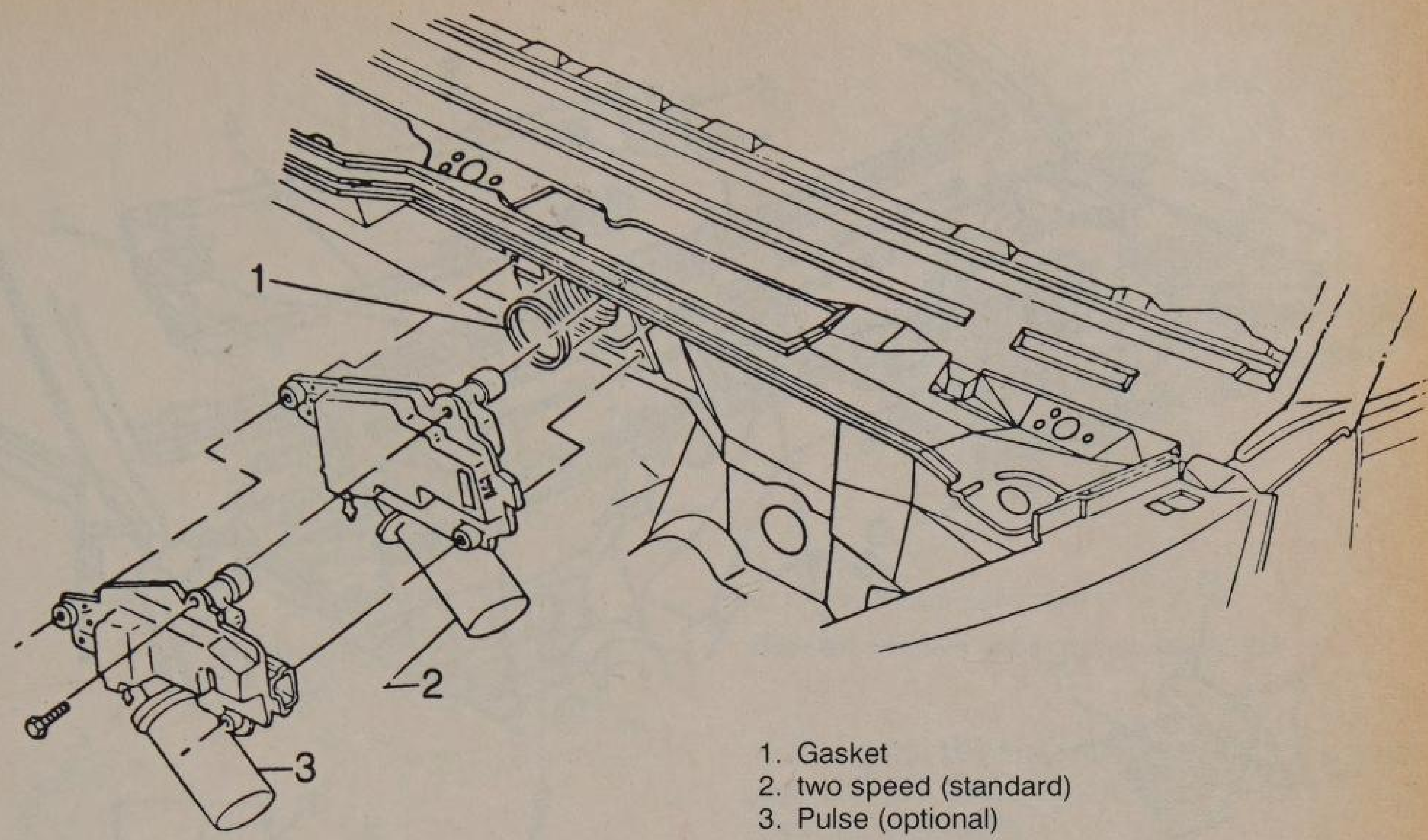
3. Install the screen or grille that covers the cowl area.

4. Connect the negative battery cable at the battery.



1. Wiper arm
2. Transmission shaft
3. Wiper arm retaining latch
4. Wiper blade removal
5. Wiper insert removal
6. Wiper blade assembly
7. Wiper insert
8. Screwdriver
9. Blade retainer
10. Insert retainer

Wiper arm, blade and insert



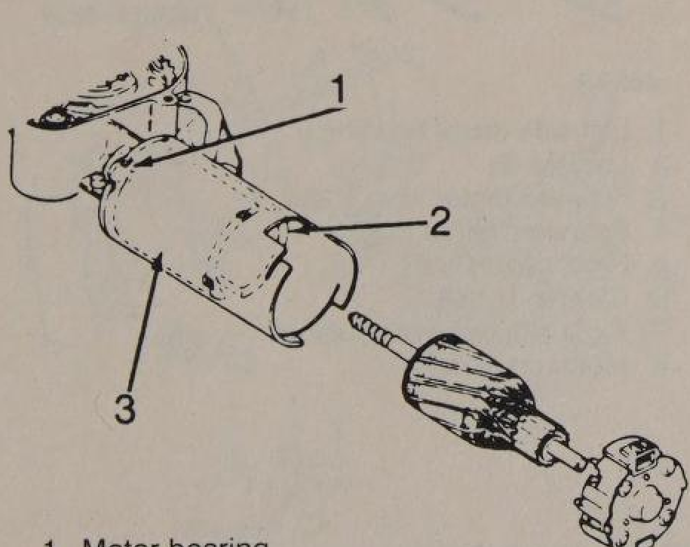
1. Gasket
2. two speed (standard)
3. Pulse (optional)

Wiper motor installation (1982–1982 Similar)

Wiper Linkage

REMOVAL AND INSTALLATION

1. Remove the wiper arms and blades. Remove the cowl screen or grille.
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.



1. Motor bearing
2. Be careful not to chip magnets
3. Magnets

Armature installation (1984 and Later)

To install:

1. Guide the transmissions and linkage in through the cowl opening.
2. Install the transmission-to-body attaching screws to both the right and left sides of the car.
3. Connect the drive link to the arm. Tighten the nuts which attach the transmission drive link to the motor crank arm. Connect the wiring to the wiper motor.
4. Install the cowl screen or grille.
5. Install the wiper arms and blades.

Washer Pump

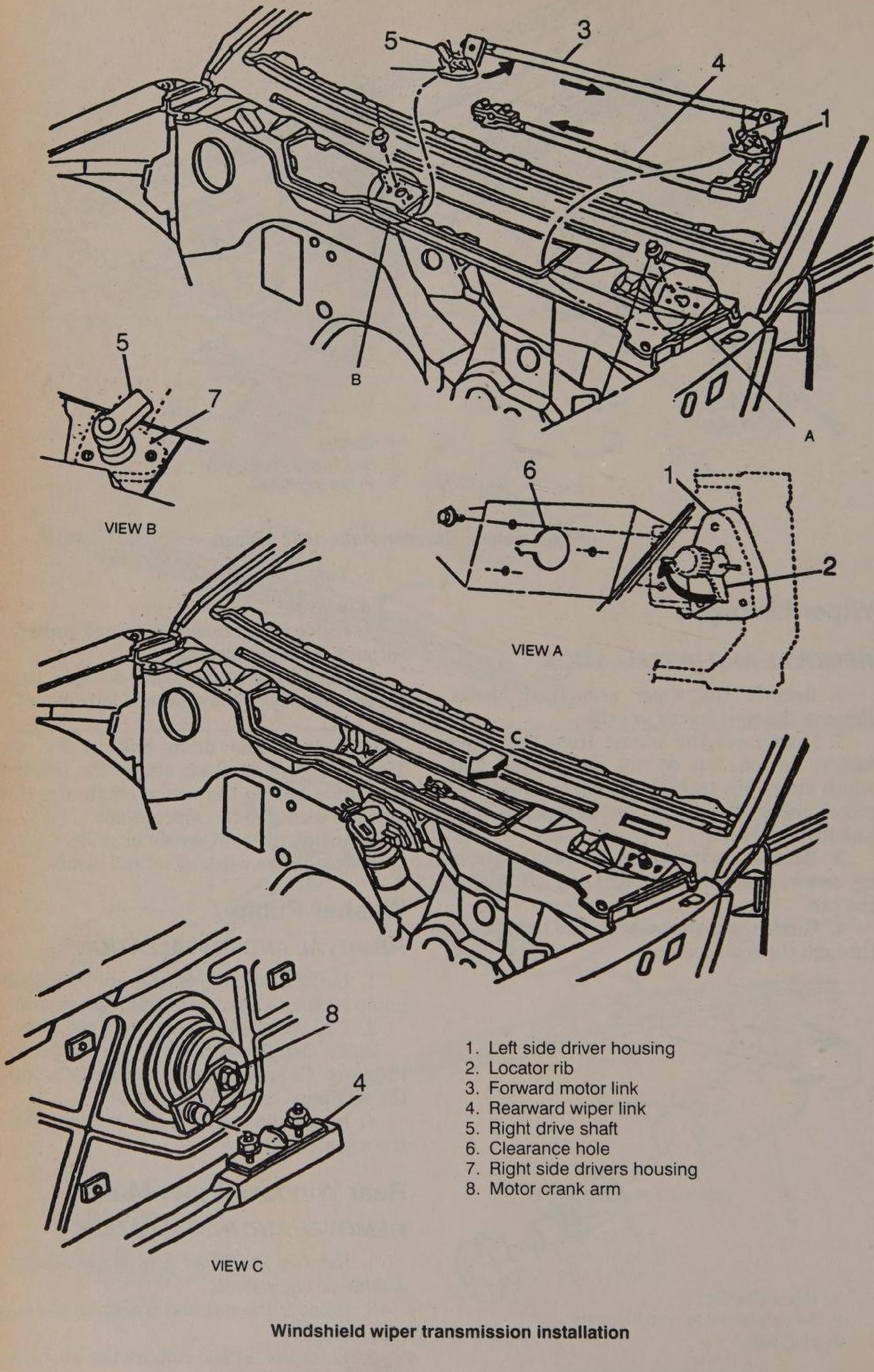
REMOVAL AND INSTALLATION

1. Using a suitable pry bar, lift the washer pump retainer clip on the wiper motor cover.
2. Pull the washer pump from the cover.
3. To install, position the washer pump to the cover. Be sure to push the washer pump all the way into the female socket.
4. Install the washer pump retainer clip on the wiper motor cover.

Rear Window Wiper Motor

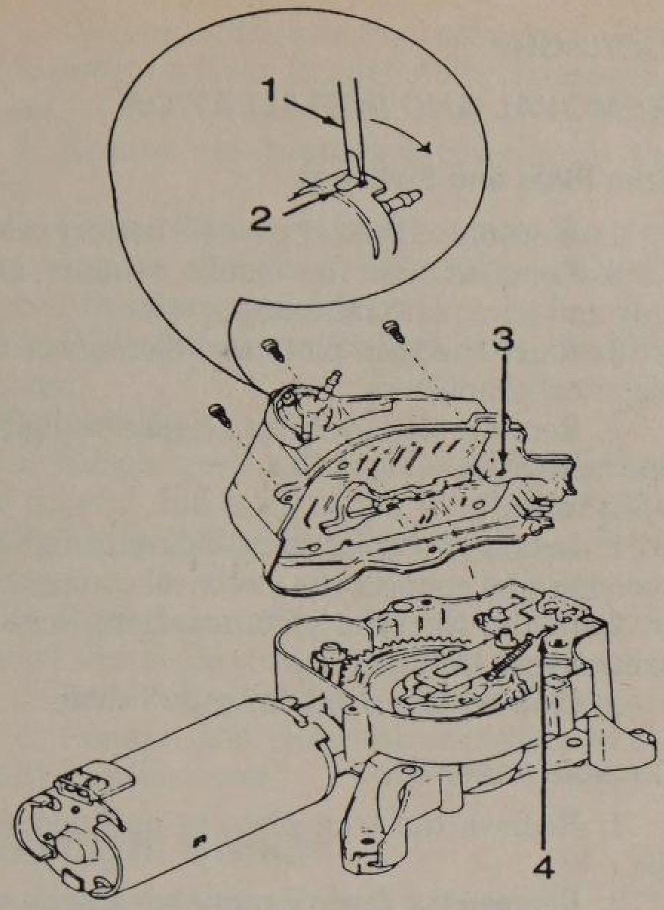
REMOVAL AND INSTALLATION

1. Remove the wiper arm blade using tool J–8966 or equivalent.
2. Remove the nut and spacer on the wiper motor shaft.
3. Raise the lid and remove the lift window trim panel.



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 drivers 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 (1984 and Later)

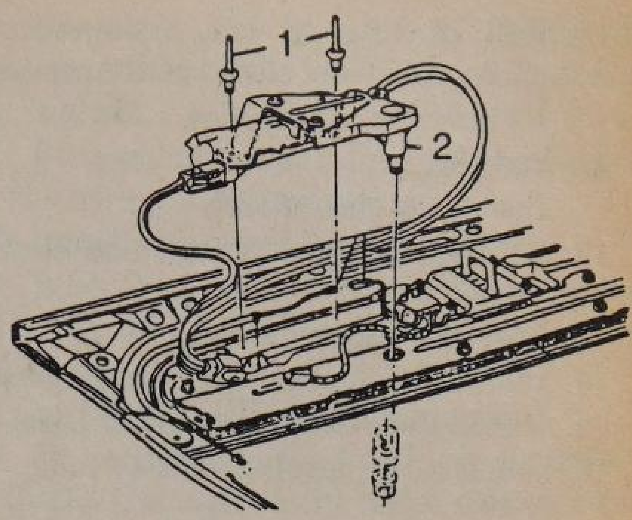
4. Disconnect the electrical connectors to the wiper motor.

5. Remove the rivets holding the motor support to the lift window panel and remove the assembly from the car.

6. To remove the motor, remove the screws retaining wiper motor to motor support.

To install:

1. Position the motor onto the motor support and install the screws.



1. Rivets
2. Wiper motor assembly

Rear lift window wiper motor assembly

2. Install the motor support with the motor onto the lift window panel and secure it with rivets or nuts/bolts.

3. Connect the electrical connectors to the wiper motor.

4. Install the lift window trim panel and lower the lid.

5. Install the nut and spacer on the wiper motor shaft.

6. Install the wiper arm blade.

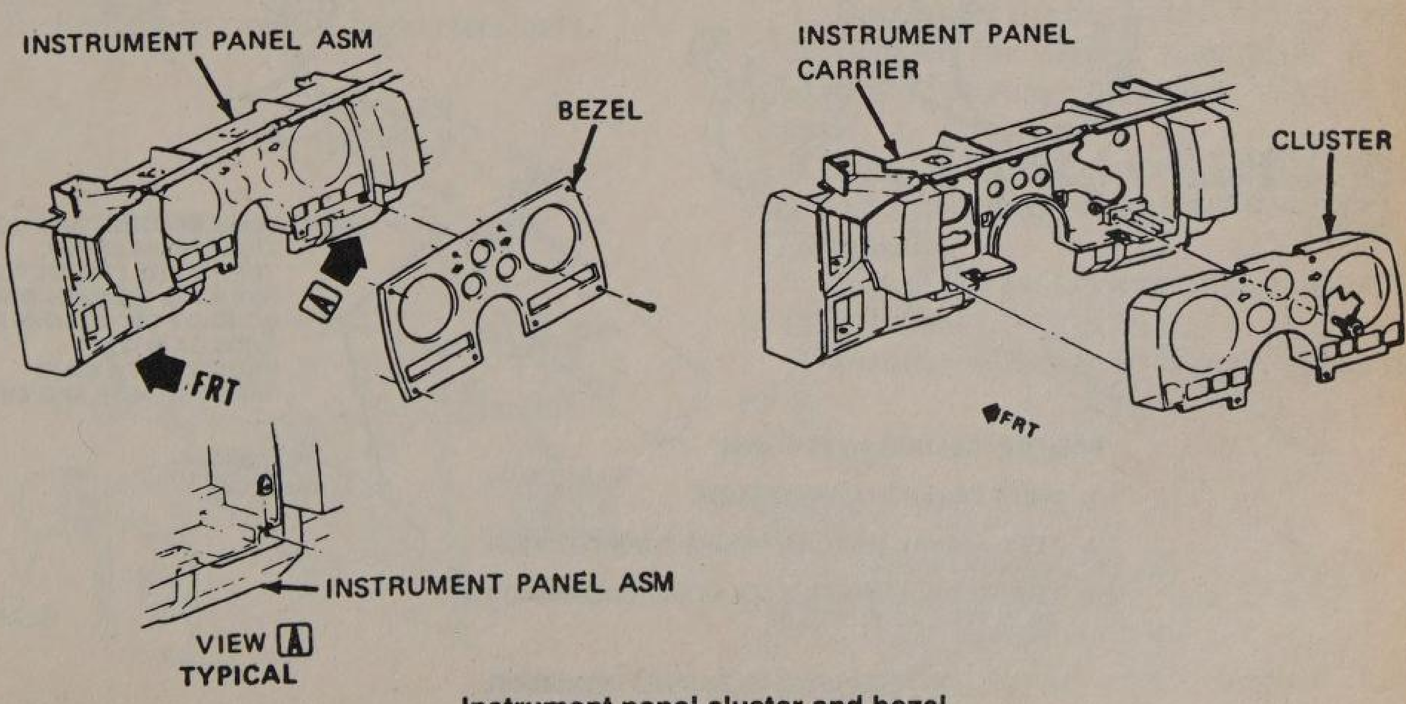
INSTRUMENTS AND SWITCHES

Instrument Cluster

REMOVAL AND INSTALLATION

Sport Coupe Model

1. Disconnect the negative battery cable.
2. Remove the instrument cluster bezel.
3. Remove the cluster attachment screws.

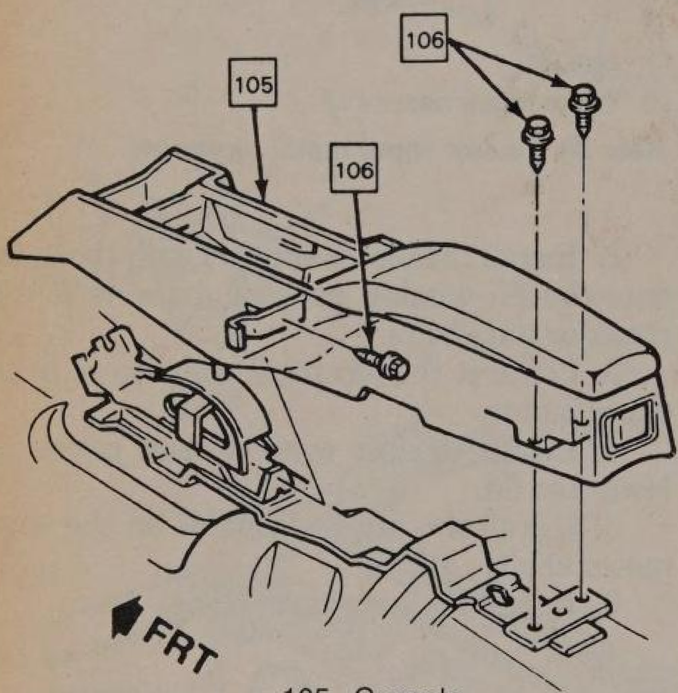


Instrument panel cluster and bezel

4. Pull the cluster out. Disconnect the speedometer cable and electrical connections.
5. Remove the cluster lens.

To install:

1. Install the cluster lens.
2. Connect the speedometer and electrical connections.
3. Push the cluster in.
4. Install the cluster attachment screws.
5. Install the instrument cluster bezel.
6. Connect the negative battery cable.



105. Console
196. Screw

Console assembly

Console

REMOVAL AND INSTALLATION

Trim Plate and Switches

1. Disconnect the negative (–) battery cable.
2. Remove the shifter handle, retainer, ashtray and trim plate retaining screws.
3. Raise the trim plate and disconnect the electrical connectors.
4. Remove the switches, cigarette lighter and trim plate.

To install:

1. Install the trim plate, cigarette lighter, switches and connect the electrical connectors.
2. Install the trim plate attaching screws, ashtray and shift handle.
3. Connect the negative battery cable.

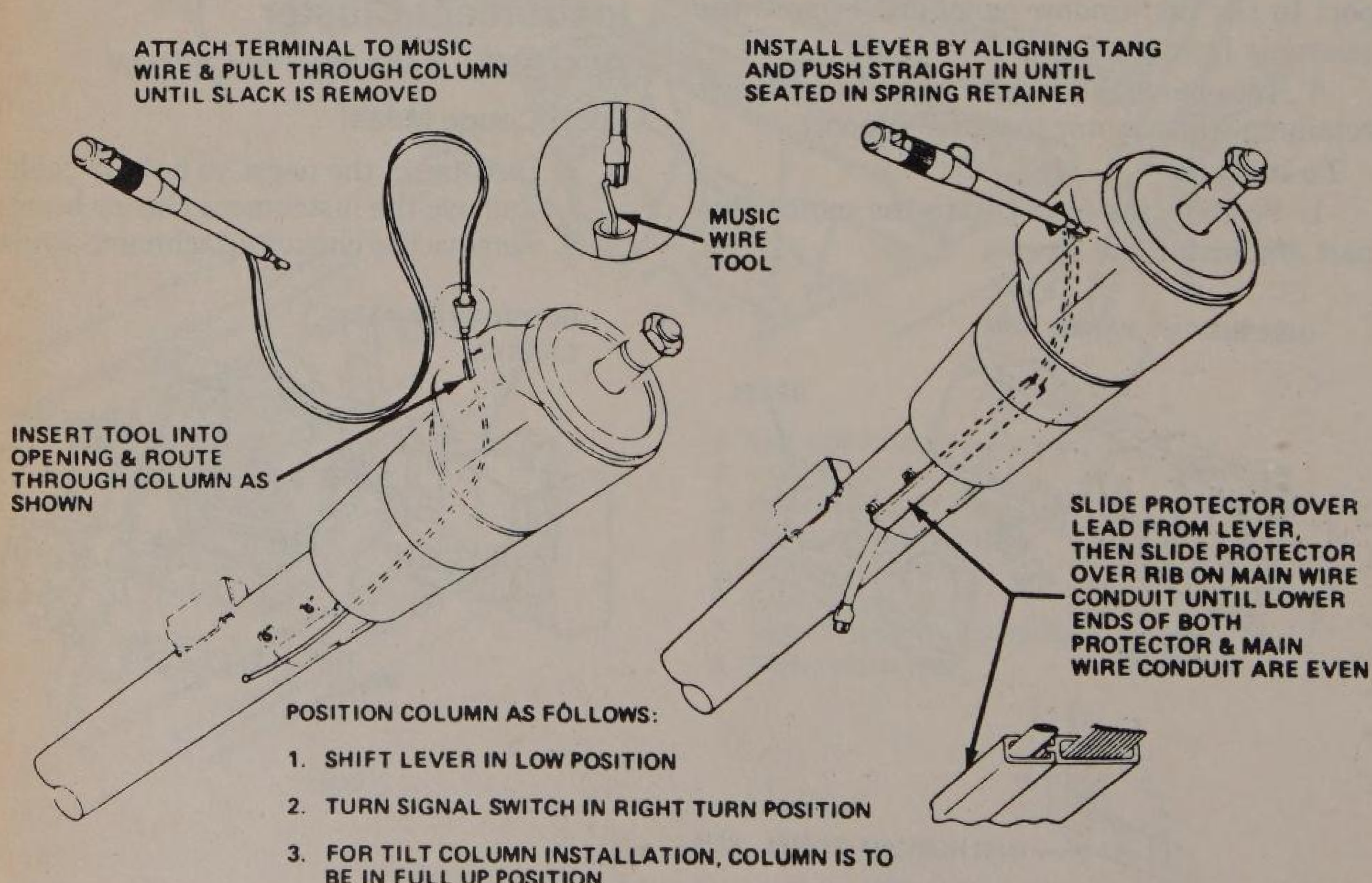
Console Assembly

1. Remove the trim plate as outlined earlier.
2. Remove the console retaining screws and console.
3. Install the console and torque the retaining bolts to 23 inch lbs. (2.6 Nm).

Windshield Wiper Switch

REMOVAL AND INSTALLATION

NOTE: *The wiper switch is part of the multi-function lever, located on the steering wheel column.*



Multi-Function Lever Installation

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.

To install:

1. 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.

2. Push the control lever into the spring loaded socket (be sure to align the tang).

3. Install the protective cover to the wire.

4. Connect the electrical connector of the multi-function lever.

Headlight Switch

REMOVAL AND INSTALLATION

Early Models

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.

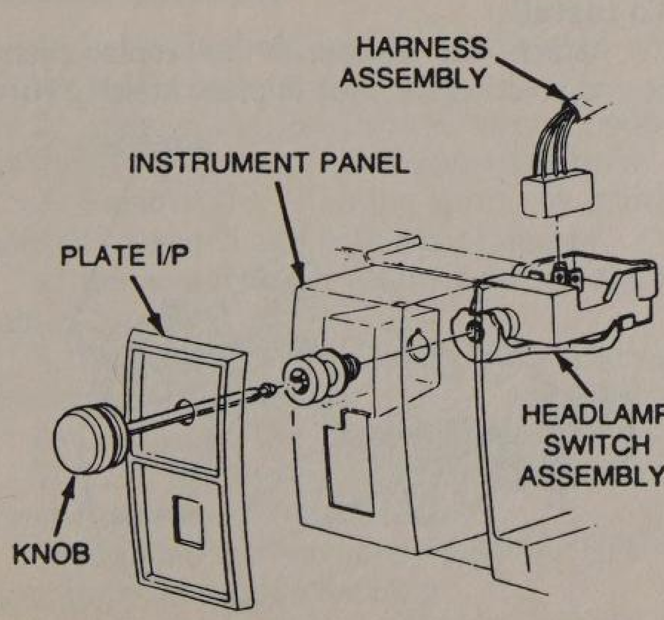
4. Remove the instrument panel pad.

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 headlight 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).



Headlight switch assembly

9. Disconnect the wiring from the switch and remove the switch.

To install:

1. Position the switch into place and connect the wiring to the switch.

2. Install the switch bezel (retainer).

3. Push the headlight switch knob into the switch. (It may be necessary to depress the knob release button.

4. Install the radio speaker bracket.

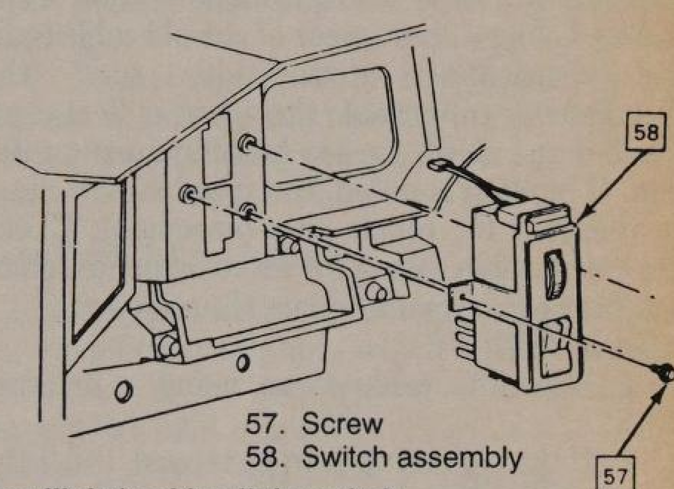
5. On models equipped with air conditioning, install the instrument panel cluster bezel and the cluster.

6. Install the instrument panel pad.

7. Install the screws which are under the lip of the instrument panel pad.

8. Install the four screws from inside the defroster duct (instrument panel pad securing screws).

9. Connect the negative battery cable at the battery.



Headlight/parking light switch

Late Models

1. Disconnect the negative (–) battery cable.

2. Remove the cluster trim plate as outlined in the Instrument Cluster section in this Chapter.

3. Remove the switch screws, electrical connector and switch assembly.

To install:

1. Install the switch and torque the screws to 13 inch lbs. (1.5 Nm).

2. Install the cluster trim plate and battery cable.

Clock

The clock is an integral part of the radio assembly. If the clock is effective, the radio has to removed and serviced. Refer to "Radio" removal and installation procedures in this Chapter for information.

Speedometer Cable

REMOVAL AND INSTALLATION

Mechanical Cable

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 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:

1. Wipe the cable clean using a lint-free cloth.
2. If the old casing is to be reused, flush the casing with petroleum spirits and blow dry with compressed air.
3. Lubricate the speedometer cable with an appropriate lubricant, being sure to cover the lower $^{2}/_{3}$ of the cable.
4. Insert the cable into the casing, then connect the cable and casing assembly to the speedometer.
5. Install the cluster and install the 6 instrument cluster attaching screws.
6. Install the instrument cluster bezel.
7. On models without cruise control, connect the speedometer cable strap at the power brake booster. On models with power brakes, connect the speedometer cable at the cruise control transducer.
8. Connect the negative battery cable at the battery.

Electronic Speedometer Sensor

The electronic speedometer does not use a cable. An electronic signal is sent to the speedometer by a vehicle speed sensor located in the transmission. The sensor is mounted in the extension housing of the transmission. To remove, disconnect the electrical connector, remove the bolt/retainer and sensor.

LIGHTING

Headlights

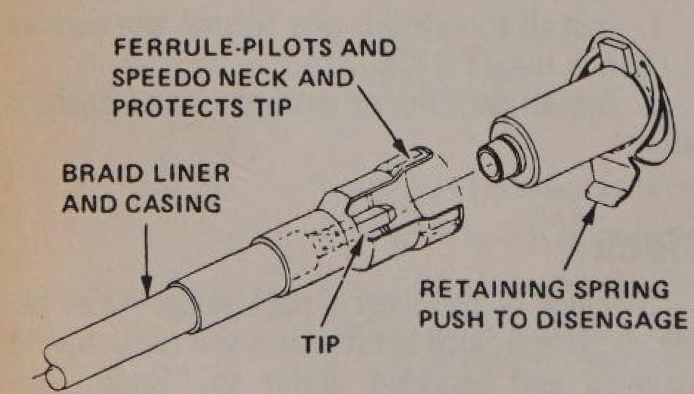
REMOVAL AND INSTALLATION

CAUTION: *Halogen bulbs contain a gas under pressure. Handling a bulb improperly could cause it to shatter into flying glass fragments. To help avoid personal injury: turn off the light switch and allow the bulb to cool, always wear eye protection, handle the bulb only by its base and avoid touching the glass, do not scratch the bulb and place the old bulb in the new bulb's carton and dispose of properly.*

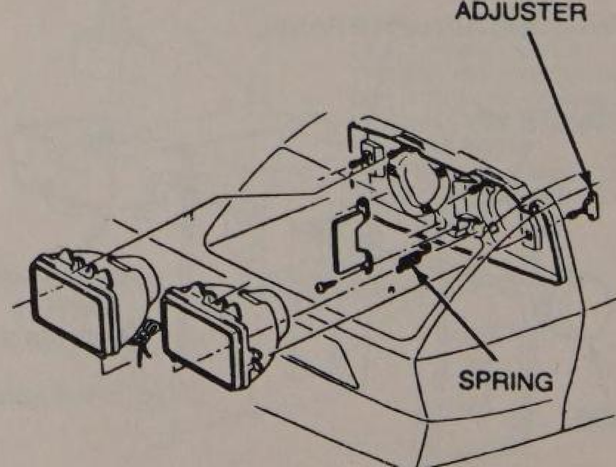
1. Remove headlight bezel retaining screws and remove bezel.
2. Disengage spring from the retaining ring with a cotter pin removal tool and remove two attaching screws.
3. Remove retaining ring, disconnect sealed beam unit at wiring connector and remove the unit.

To install:

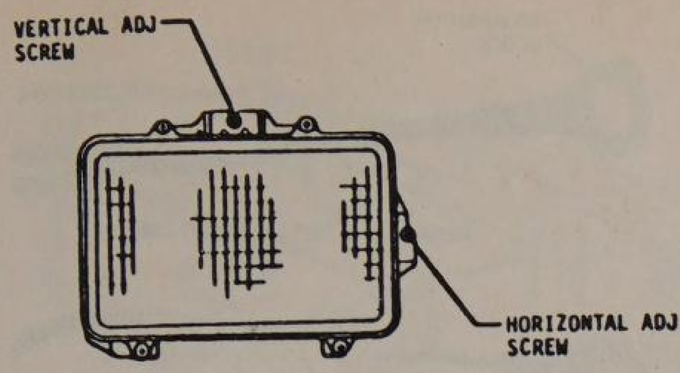
1. Attach the connector to replacement unit and position the unit in place making sure



Speedometer cable-to-instrument cluster removal



Headlamp and bezel



Headlight switch

the number molded into the lens face is at the top.

NOTE: *In the dual headlight installation the inboard unit (No. 1) takes a double connector plug, the outboard unit (No. 2) takes a triple connector plug.*

2. Position retaining ring into place and install the retaining ring attaching screws and spring.
3. Check operation of unit and install the headlight bezel.

ALIGNMENT

Horizontal and vertical aiming of each sealed beam headlight is done by two adjusting screws which move the mounting ring in the body against the tension of a coil spring. When using mechanical aimers, follow the manufacturer's instructions.

CONCEALED HEADLIGHT SERVICING

Manual Opening

Should an electrical failure occur in the headlight circuit, they may be raised manually by opening the hood and rotating the knob on the actuator in a counterclockwise direction until the headlights are fully open. The lights may be lowered by rotating in a clockwise direction.

Actuator Assembly

1. Raise the headlight by turning the knob on the motor counterclockwise.
2. Remove the four screws at each side of the bezel (light cover) and remove the bezel.
3. Remove the retaining spring by using a hooked tool such as a cotter pin remover.
4. Remove the four retainer screws and retainer.
5. Remove the headlight by rotating toward the center of the vehicle.
6. Disconnect the electrical connector.
7. Turn the knob on the headlight motor to lower the assembly about halfway.
8. Remove the two lower assembly bolts by reaching through the opening.
9. Remove the two upper bolts and disconnect the motor electrical connector. Remove the assembly from the vehicle.

To install:

1. Install the assembly and connect the electrical connector.
2. Install the two upper and lower bolts.
3. Raise the assembly, connect the light connector and install the headlight.
4. Install the retainer and screws.
5. Install the bezel and screws.
6. Install the retaining spring and lower the assembly.
7. Adjust the headlights.

Signal and Marker Lights

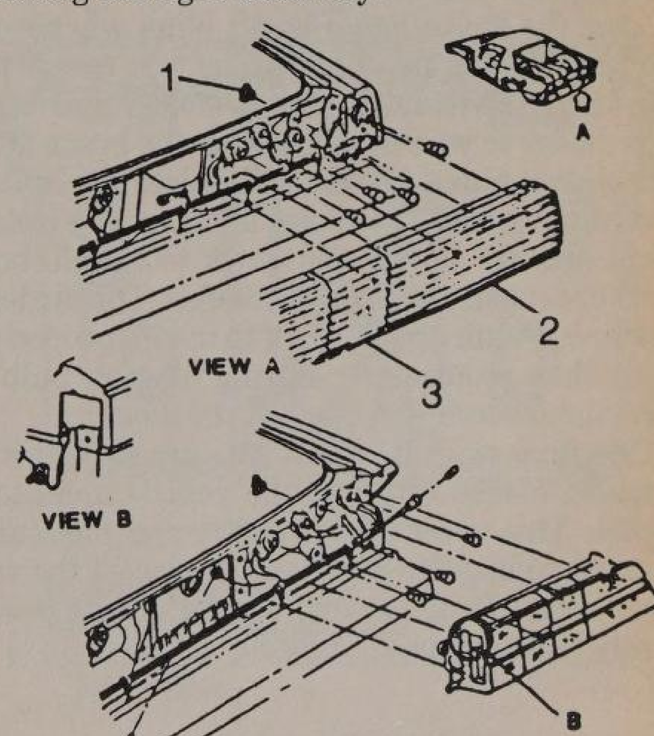
REMOVAL AND INSTALLATION

Front Park/Turn and All Side Marker Lights

1. Reach around to the back side of the light assembly and unlock the bulb holder/wiring harness by grasping the bulb holder/wiring harness and turning it counterclockwise approximately 1/4 turn.
2. Remove the bulb holder/wiring harness assembly.
3. To install, insert the bulb holder/wiring harness assembly into the light assembly and locking the holder by turning it 1/4 turn clockwise.

Rear Park/Turn Lights

The tail light bulbs can be replaced by removing the plastic wing nuts which retain the light assemblies to the rear end panel and then removing the light assembly.



1. Attaching nut
2. Lamp assembly
3. Filler assembly

Rear exterior tail assembly servicing

TRAILER WIRING

Wiring the car for towing is fairly easy. There are a number of good wiring kits available and these should be used, rather than trying to design your own. All trailers will need brake lights and turn signals as well as tail lights and side marker lights. Most states require extra marker lights for overly wide trailers. Also, most states have recently required back-up lights for trailers, and most trailer manufacturers have been building trailers with back-up lights for several years.

Additionally, some Class I, most Class II and just about all Class III trailers will have electric brakes.

Add to this number an accessories wire, to operate trailer internal equipment or to charge the trailer's battery, and you can have as many as seven wires in the harness.

Determine the equipment on your trailer and buy the wiring kit necessary. The kit will contain all the wires needed, plus a plug adapter set which included the female plug, mounted on the bumper or hitch, and the male plug, wired into, or plugged into the trailer harness.

When installing the kit, follow the manufacturer's instructions. The color coding of the wires is standard throughout the industry.

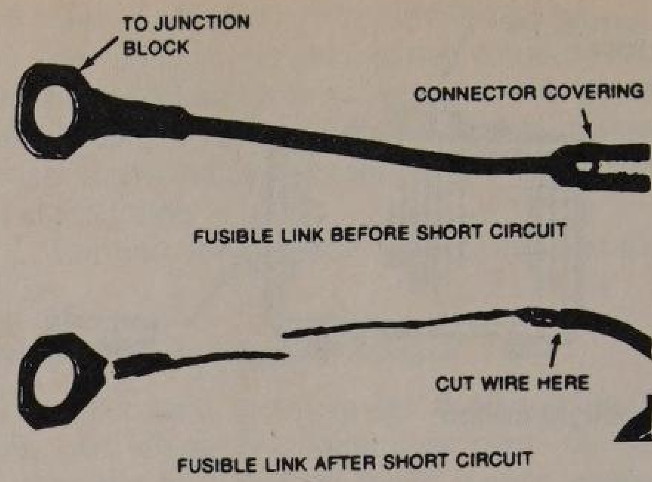
One point to note: some domestic vehicles, and most imported vehicles, have separate turn signals. On most domestic vehicles, the brake lights and rear turn signals operate with the same bulb. For those vehicles with separate turn signals, you can purchase an isolation unit so that the brake lights won't blink whenever the turn signals are operated, or, you can go to your local electronics supply house and buy four diodes to wire in series with the brake and turn signal bulbs. Diodes will isolate the brake and turn signals. The choice is yours. The isolation units are simple and quick to install, but far more expensive than the diodes. The diodes, however, require more work to install properly, since they require the cutting of each bulb's wire and soldering in place of the diode.

One final point, the best kits are those with a spring loaded cover on the vehicle mounted socket. This cover prevents dirt and moisture from corroding the terminals. Never let the vehicle socket hang loosely; always mount it securely to the bumper or hitch.

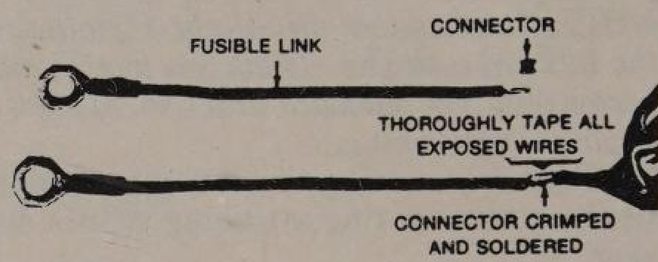
CIRCUIT PROTECTION

Fusible Links

In addition to circuit breakers and fuses, the wiring harness incorporates fusible links to pro-



Fusible links before and after a short circuit



New fusible links are spliced to the wire

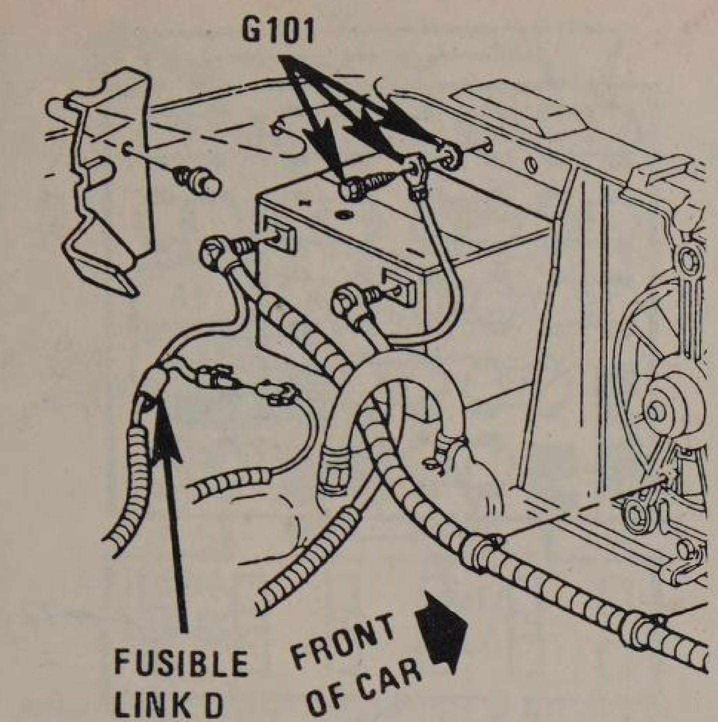
tect the wiring. Links are used rather than a fuse, in wiring circuits that are not normally fused, such as the ignition circuit. Firebird fusible links are color coded red in the charging and load circuits to match the color coding of the circuits they protect. Each link is four gauges smaller than 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.

REPLACEMENT

1. Determine the circuit that is damaged.
2. Disconnect the negative battery terminal.



Fusible link D – located at battery

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 $^1/_2$ in. on each end.

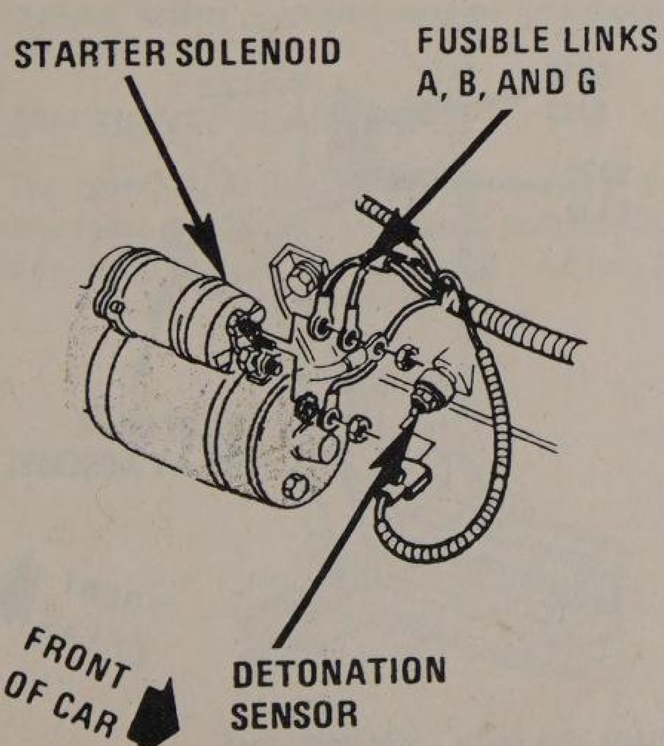
6. Connect the fusible link and crimp the butt connectors making sure that the wires are secure.

7. Solder each connection with resin core solder, and wrap the connections with plastic electrical tape.

8. Reinstall the wire in the harness.

• Fusible Link A – located at starter solenoid, main power, rust

• Fusible Link B – located at starter solenoid, ignition switch, rust



Fusible link A, B and G – located at the starter motor

• Fusible Link D – located at near battery, coolant fan, rust

• Fusible Link E – located at junction block, coolant fan, rust

• Fusible Link G – located at starter solenoid, alternator, rust

• Fusible Link J – located at junction block, alternator, rust

9. Connect the negative battery terminal and test the system for proper operation.

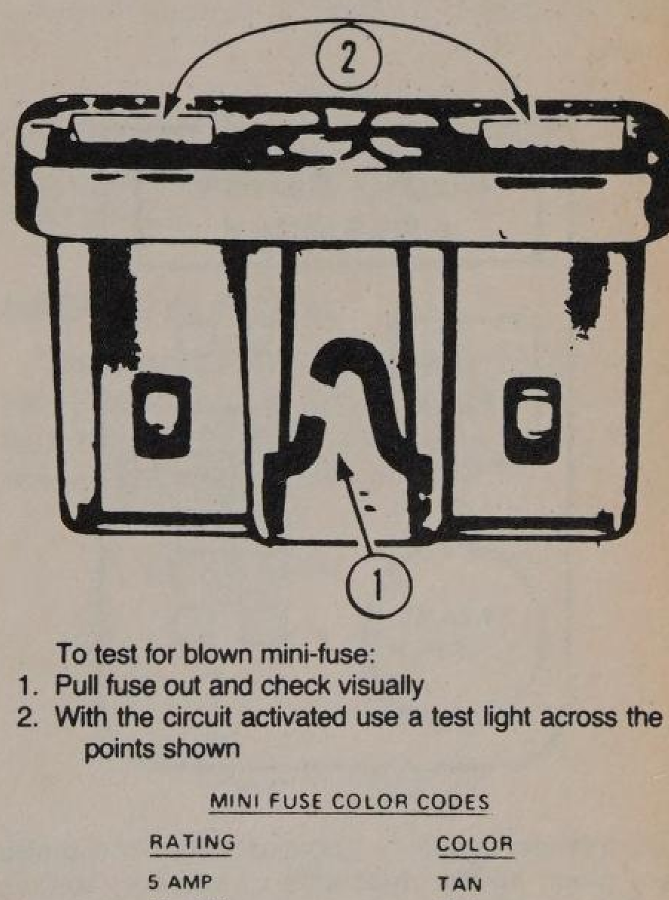
Circuit Breakers

Various circuit breakers are located under the instrument panel. In order to gain access to these components, it may be necessary to first remove the under dash padding. Most of the circuit breakers are located in the convenience center or the fuse panel. The rear hatch and windshield wiper motors have internal circuit breakers built-in. These circuit breakers cannot be serviced separately.

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.

Each fuse block uses miniature fuses which are designed for increased circuit protection and greater reliability. The compact fuse is a

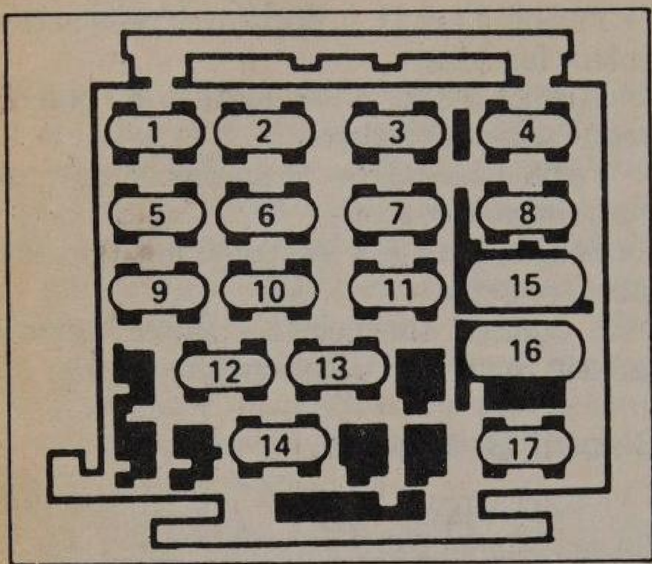


To test for blown mini-fuse:
1. Pull fuse out and check visually
2. With the circuit activated use a test light across the points shown

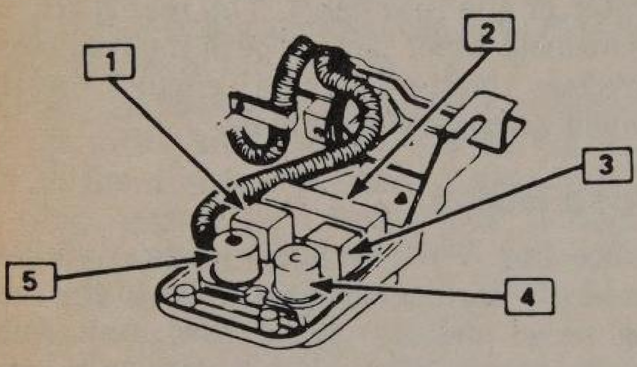
MINI FUSE COLOR CODES

RATING	COLOR
5 AMP	TAN
10 AMP	RED
20 AMP	YELLOW
25 AMP	WHITE

Blown fuse

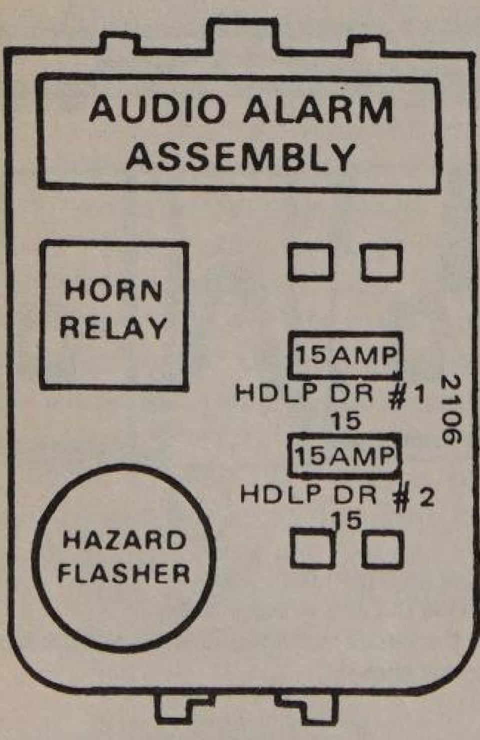


Fuse block — 1982–89

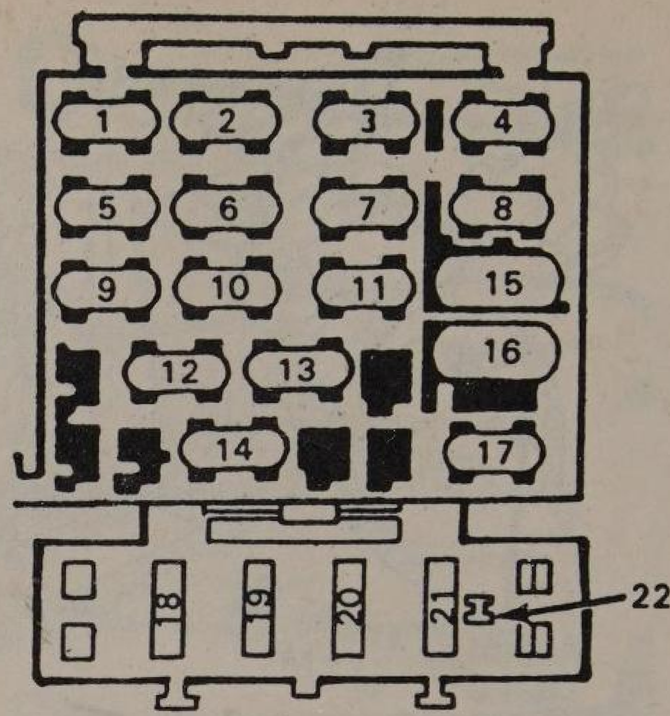


1. Horn relay
2. Seat belt — ignition key-headlamp buzzer
3. Choke relay (vacant w/EFI)
4. Hazard flasher
5. Signal flasher

Convenience center and components



Convenience center — located under the instrument panel on the right side of steering column. The two headlight door fuses are located in the convenience center



Fuse block — 1989–90

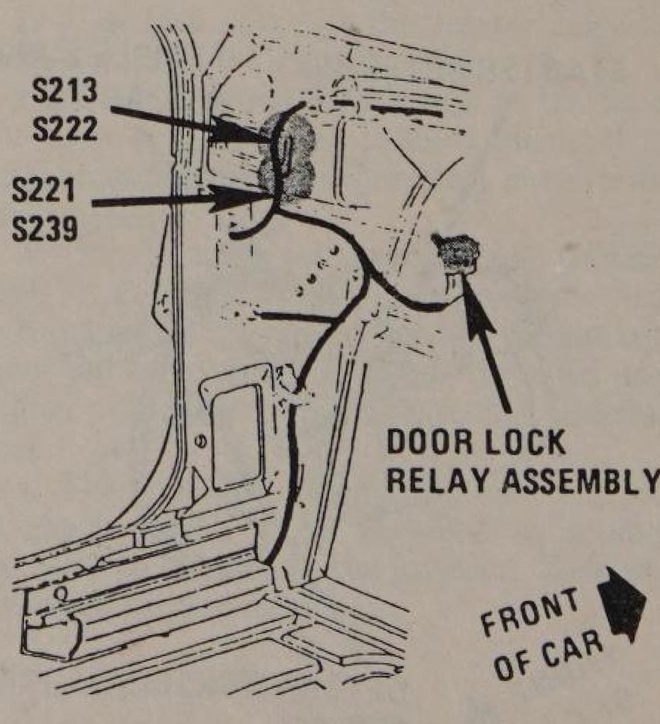
blade terminal design which allows fingertip removal and replacement.

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.

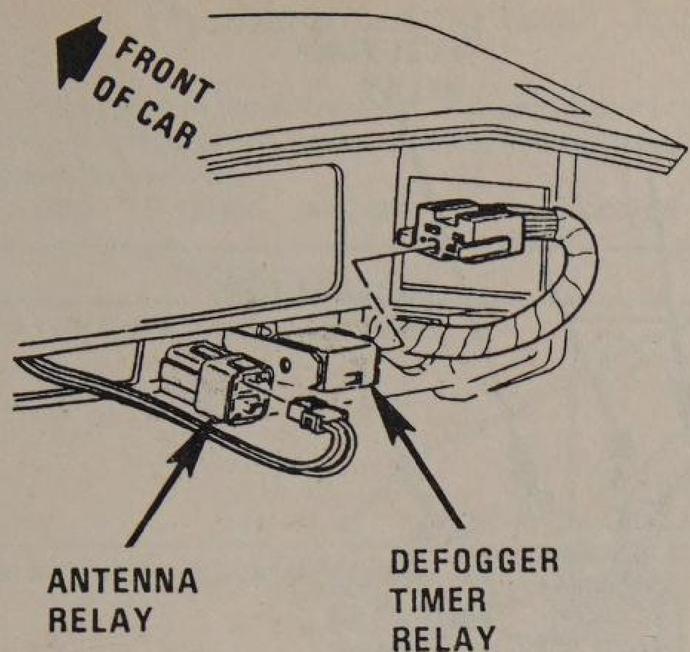
A blown fuse can easily be checked by visual inspection or by continuity testing.

Buzzers, Relays, and Flashers

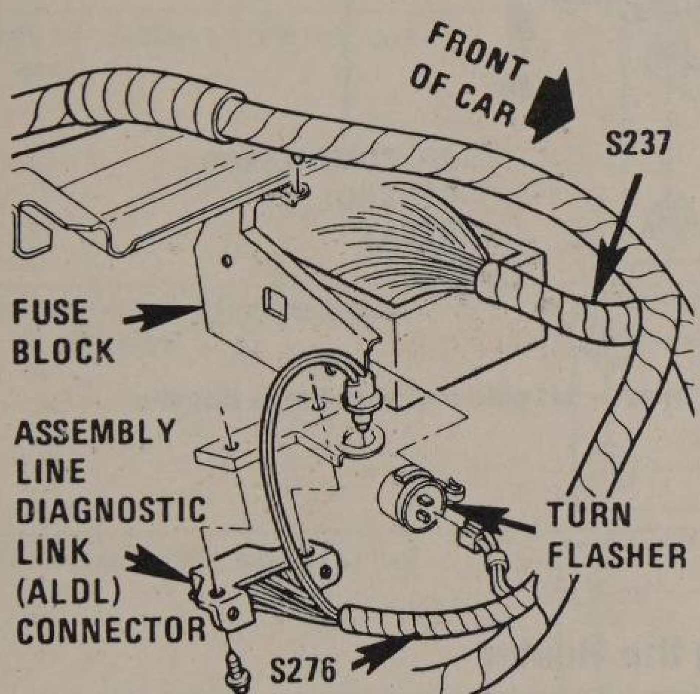
The electrical protection devices are located in the convenience center, which is a swing down unit located under the instrument panel. All units are serviced by plug-in replacements.



Door lock relay — LH door post



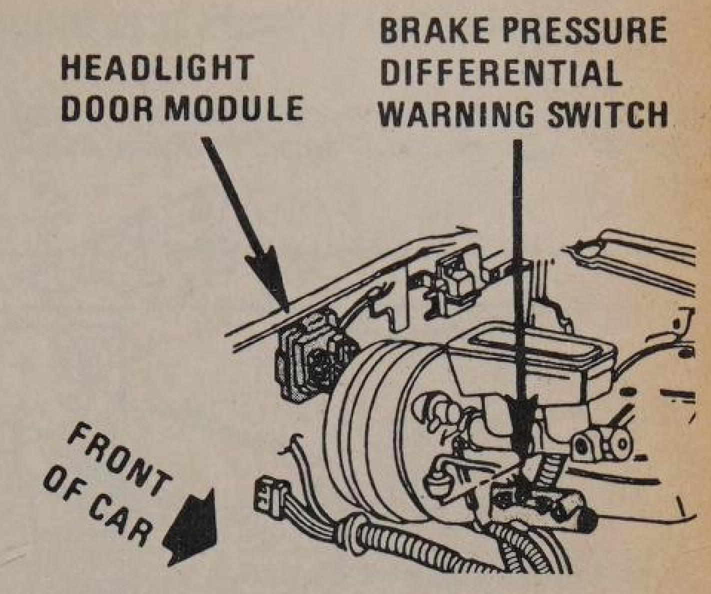
Antenna and rear defogger relay — RH side of instrument panel



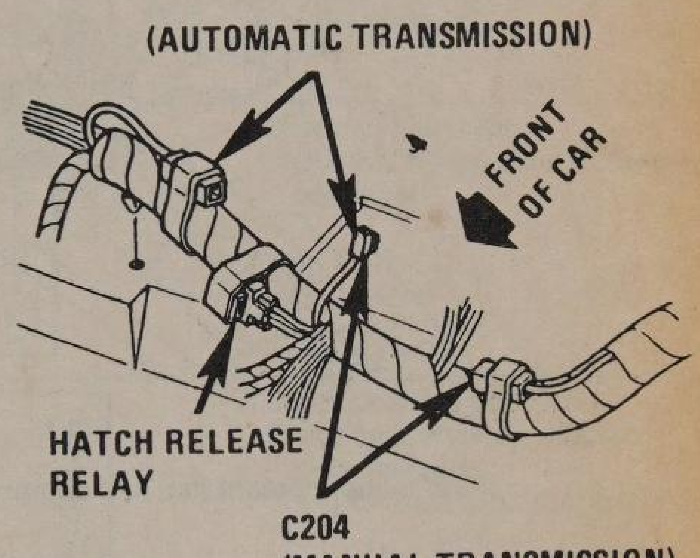
Turn signal flasher — located near the fuse block — late model

TURN SIGNAL FLASHER

The turn signal flasher is located inside the convenience center for early model vehicles and beside the fuse block for late model vehicles . In



Headlight door module — behind brake power booster

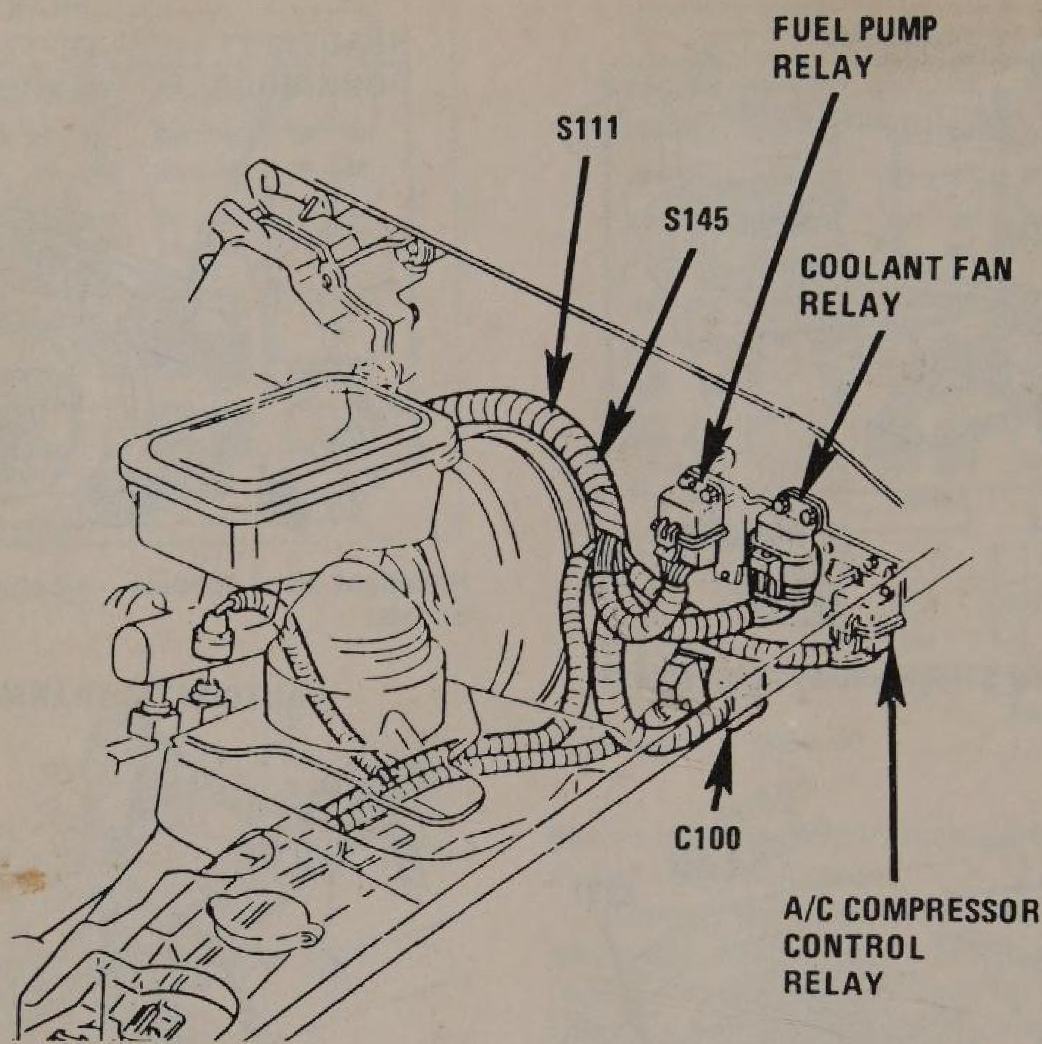


Hatch release relay — RH side of instrument panel

order to gain access to the turn signal flasher, it may be necessary to first remove the under dash padding.

HAZARD FLASHER

The hazard flasher is located inside the convenience center. In order to gain access to the turn signal flasher, it may be necessary to first remove the under dash padding.



Fuel pump, coolant fan, A/C compressor relay — LH side of power brake booster

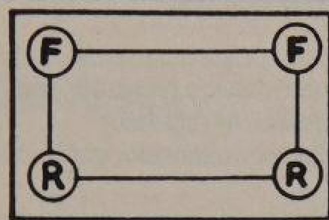
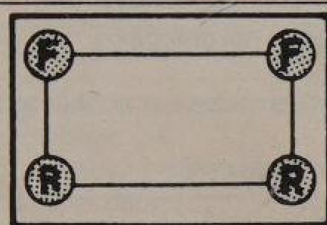
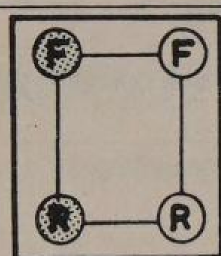
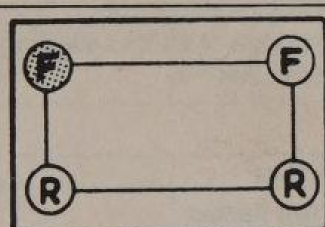
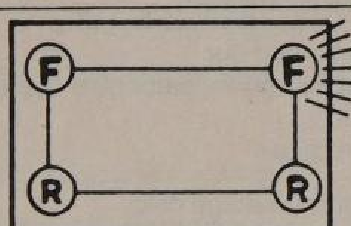
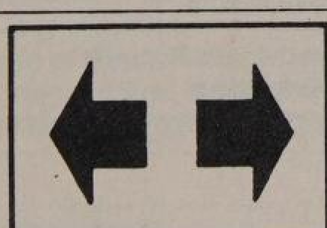
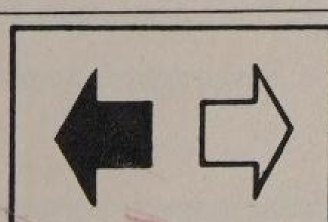
Troubleshooting the Heater

Problem	Cause	Solution
Blower motor will not turn at any speed	• Blown fuse • Loose connection • Defective ground • Faulty switch • Faulty motor • Faulty resistor	• Replace fuse • Inspect and tighten • Clean and tighten • Replace switch • Replace motor • Replace resistor
Blower motor turns at one speed only	• Faulty switch • Faulty resistor	• Replace switch • Replace resistor
Blower motor turns but does not circulate air	• Intake blocked • Fan not secured to the motor shaft	• Clean intake • Tighten security
Heater will not heat	• Coolant does not reach proper temperature • Heater core blocked internally • Heater core air-bound • Blend-air door not in proper position	• Check and replace thermostat if necessary • Flush or replace core if necessary • Purge air from core • Adjust cable
Heater will not defrost	• Control cable adjustment incorrect • Defroster hose damaged	• Adjust control cable • Replace defroster hose

Troubleshooting Basic Turn Signal and Flasher Problems

Most problems in the turn signals or flasher system can be reduced to defective flashers or bulbs, which are easily replaced. Occasionally, problems in the turn signals are traced to the switch in the steering column, which will require professional service.

F = Front R = Rear • = Lights off o = Lights on

Problem		Solution
Turn signals light, but do not flash		• Replace the flasher
No turn signals light on either side		• Check the fuse. Replace if defective. • Check the flasher by substitution • Check for open circuit, short circuit or poor ground
Both turn signals on one side don't work		• Check for bad bulbs • Check for bad ground in both housings
One turn signal light on one side doesn't work		• Check and/or replace bulb • Check for corrosion in socket. Clean contacts. • Check for poor ground at socket
Turn signal flashes too fast or too slow		• 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 slow. A standard bulb was probably installed in place of a heavy-duty bulb. • Check for 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 1 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 2 indicators: Check the bulbs on the same side Check the indicator light bulb Check the flasher by substitution

Troubleshooting Basic Lighting Problems

Problem	Cause	Solution
Lights		
One or more lights don't work, but others do	• Defective bulb(s) • Blown fuse(s) • Dirty fuse clips or light sockets • Poor ground circuit	• Replace bulb(s) • Replace fuse(s) • Clean connections • Run ground wire from light socket housing to car frame
Lights burn out quickly	• Incorrect voltage regulator setting or defective regulator • Poor battery/alternator connections	• Replace voltage regulator • Check battery/alternator connections
Lights go dim	• Low/discharged battery • Alternator not charging • Corroded sockets or connections • Low voltage output	• Check battery • Check drive belt tension; repair or replace alternator • Clean bulb and socket contacts and connections • Replace voltage regulator
Lights flicker	• Loose connection • Poor ground • Circuit breaker operating (short circuit)	• Tighten all connections • Run ground wire from light housing to car frame • Check connections and look for bare wires
Lights "flare"—Some flare is normal on acceleration—if excessive, see "Lights Burn Out Quickly"	• High voltage setting	• Replace voltage regulator
Lights glare—approaching drivers are blinded	• Lights adjusted too high • Rear springs or shocks sagging • Rear tires soft	• Have headlights aimed • Check rear springs/shocks • Check/correct rear tire pressure
Turn Signals		
Turn signals don't work in either direction	• Blown fuse • Defective flasher • Loose connection	• Replace fuse • Replace flasher • Check/tighten all connections
Right (or left) turn signal only won't work	• Bulb burned out • Right (or left) indicator bulb burned out • Short circuit	• Replace bulb • Check/replace indicator bulb • Check/repair wiring
Flasher rate too slow or too fast	• Incorrect wattage bulb • Incorrect flasher	• Flasher bulb • Replace flasher (use a variable load flasher if you pull a trailer)
Indicator lights do not flash (burn steadily)	• Burned out bulb • Defective flasher	• Replace bulb • Replace flasher
Indicator lights do not light at all	• Burned out indicator bulb • Defective flasher	• Replace indicator bulb • Replace flasher

Troubleshooting Basic Dash Gauge Problems

Problem	Cause	Solution
Coolant Temperature Gauge		
Gauge reads erratically or not at all	• Loose or dirty connections • Defective sending unit • Defective gauge	• Clean/tighten connections • Bi-metal gauge: remove the wire from the sending unit. Ground the wire for an instant. If the gauge registers, replace the sending unit. • 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	• Connections reversed on gauge • Ammeter is OK • Loose connections or faulty wiring • Defective gauge	• Reinstall connections • Nothing • Check/correct wiring • Replace gauge
Oil Pressure Gauge		
Gauge does not register or is inaccurate	• On mechanical gauge, Bourdon tube may be bent or kinked • Low oil pressure • Defective gauge • Defective wiring • Defective sending unit	• Check tube for kinks or bends preventing oil from reaching the gauge • Remove sending unit. Idle the engine briefly. If no oil flows from sending unit hole, problem is in engine. • 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. • Check the wiring to the gauge. If it's OK and the gauge doesn't register when grounded, replace the gauge. • If the wiring is OK and the gauge functions when grounded, replace the sending unit
All Gauges		
All gauges do not operate	• Blown fuse • Defective instrument regulator	• Replace fuse • Replace instrument voltage regulator
All gauges read low or erratically	• Defective or dirty instrument voltage regulator	• Clean contacts or replace
All gauges pegged	• Loss of ground between instrument voltage regulator and car • Defective instrument regulator	• Check ground • Replace regulator
Warning Lights		
Light(s) do not come on when ignition is ON, but engine is not started	• Defective bulb • Defective wire • Defective sending unit	• Replace bulb • Check wire from light to 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	• Problem in individual system • Defective sending unit	• Check system • Check sending unit (see above)

Troubleshooting Basic Windshield Wiper Problems

Problem	Cause	Solution
Electric Wipers		
Wipers do not operate— Wiper motor heats up or hums	• Internal motor defect • Bent or damaged linkage • Arms improperly installed on linking pivots	• Replace motor • Repair or replace linkage • Position linkage in park and reinstall wiper arms
Wipers do not operate— No current to motor	• Fuse or circuit breaker blown • Loose, open or broken wiring • Defective switch • Defective or corroded terminals • No ground circuit for motor or switch	• Replace fuse or circuit breaker • Repair wiring and connections • Replace switch • Replace or clean terminals • Repair ground circuits
Wipers do not operate— Motor runs	• Linkage disconnected or broken	• Connect wiper linkage or replace broken linkage
Vacuum Wipers		
Wipers do not operate	• Control switch or cable inoperative • Loss of engine vacuum to wiper motor (broken hoses, low engine vacuum, defective vacuum/fuel pump) • Linkage broken or disconnected • Defective wiper motor	• Repair or replace switch or cable • Check vacuum lines, engine vacuum and fuel pump • Repair linkage • Replace wiper motor
Wipers stop on engine acceleration	• Leaking vacuum hoses • Dry windshield • Oversize wiper blades • Defective vacuum/fuel pump	• Repair or replace hoses • Wet windshield with washers • Replace with proper size wiper blades • Replace pump

Drive Train 7

MANUAL TRANSMISSION

Understanding the Manual Transmission

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 vehicle, 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. 4-speed or 5-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.

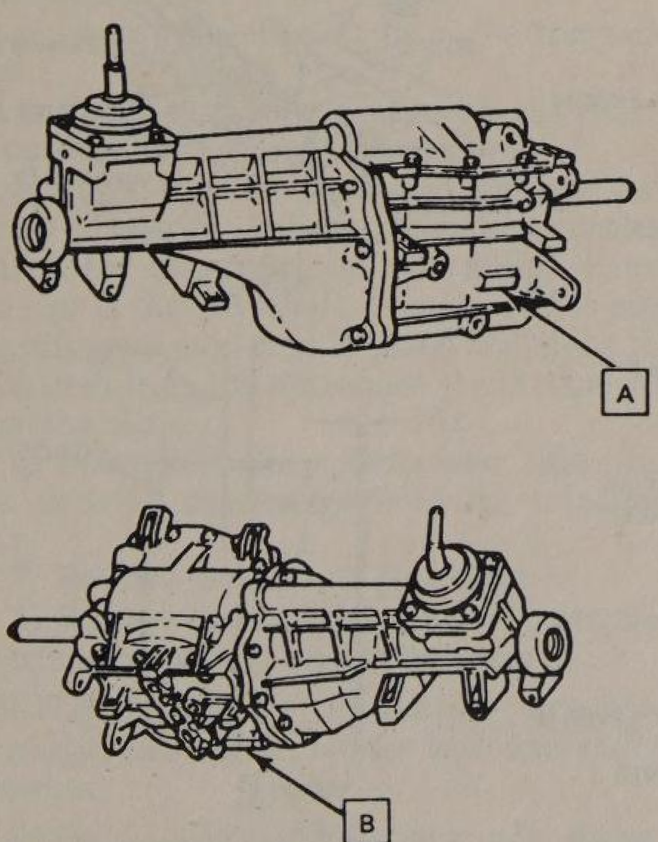
All 1984 and later clutches use a hydraulic system in place of a mechanical linkage. If the clutch fails to release, fill the clutch master cylinder with fluid to the proper level and pump

Troubleshooting the Manual Transmission

Problem	Cause	Solution
Transmission shifts hard	• Clutch adjustment incorrect	• Adjust clutch
	• Clutch linkage or cable binding	• Lubricate or repair as necessary
	• Shift rail binding	• Check for mispositioned selector arm roll pin, loose cover bolts, worn shift rail bores, worn shift rail, distorted oil seal, or extension housing not aligned with case. Repair as necessary.
	• Internal bind in transmission caused by shift forks, selector plates, or synchronizer assemblies	• Remove, dissemble and inspect transmission. Replace worn or damaged components as necessary.
	• Clutch housing misalignment	• Check runout at rear face of clutch housing
	• Incorrect lubricant	• Drain and refill transmission
	• Block rings and/or cone seats worn	• Blocking ring to gear clutch tooth face clearance must be 0.030 inch or greater. If clearance is correct it may still be necessary to inspect blocking rings and cone seats for excessive wear. Repair as necessary.
Gear clash when shifting from one gear to another	• Clutch adjustment incorrect	• Adjust clutch
	• Clutch linkage or cable binding	• Lubricate or repair as necessary
	• Clutch housing misalignment	• Check runout at rear of clutch housing
	• Lubricant level low or incorrect lubricant	• Drain and refill transmission and check for lubricant leaks if level was low. Repair as necessary.
	• Gearshift components, or synchronizer assemblies worn or damaged	• Remove, disassemble and inspect transmission. Replace worn or damaged components as necessary.
Transmission noisy	• Lubricant level low or incorrect lubricant	• Drain and refill transmission. If lubricant level was low, check for leaks and repair as necessary.
	• Clutch housing-to-engine, or transmission-to-clutch housing bolts loose	• Check and correct bolt torque as necessary
	• Dirt, chips, foreign material in transmission	• Drain, flush, and refill transmission
	• Gearshift mechanism, transmission gears, or bearing components worn or damaged	• Remove, disassemble and inspect transmission. Replace worn or damaged components as necessary.
	• Clutch housing misalignment	• Check runout at rear face of clutch housing
Jumps out of gear	• Clutch housing misalignment	• Check runout at rear face of clutch housing
	• Gearshift lever loose	• Check lever for worn fork. Tighten loose attaching bolts.
	• Offset lever nylon insert worn or lever attaching nut loose	• Remove gearshift lever and check for loose offset lever nut or worn insert. Repair or replace as necessary.
	• Gearshift mechanism, shift forks, selector plates, interlock plate, selector arm, shift rail, detent plugs, springs or shift cover worn or damaged	• Remove, disassemble and inspect transmission cover assembly. Replace worn or damaged components as necessary.
	• Clutch shaft or roller bearings worn or damaged	• Replace clutch shaft or roller bearings as necessary

Troubleshooting the Manual Transmission

Problem	Cause	Solution
Jumps out of gear (cont.)	• Gear teeth worn or tapered, synchronizer assemblies worn or damaged, excessive end play caused by worn thrust washers or output shaft gears	• Remove, disassemble, and inspect transmission. Replace worn or damaged components as necessary.
	• Pilot bushing worn	• Replace pilot bushing
Will not shift into one gear	• Gearshift selector plates, interlock plate, or selector arm, worn, damaged, or incorrectly assembled	• Remove, disassemble, and inspect transmission cover assembly. Repair or replace components as necessary.
	• Shift rail detent plunger worn, spring broken, or plug loose	• Tighten plug or replace worn or damaged components as necessary
	• Gearshift lever worn or damaged	• Replace gearshift lever
	• Synchronizer sleeves or hubs, damaged or worn	• Remove, disassemble and inspect transmission. Replace worn or damaged components.
Locked in one gear—cannot be shifted out	• Shift rail(s) worn or broken, shifter fork bent, setscrew loose, center detent plug missing or worn	• Inspect and replace worn or damaged parts
	• Broken gear teeth on countershaft gear, clutch shaft, or reverse idler gear	• Inspect and replace damaged part
	Gearshift lever broken or worn, shift mechanism in cover incorrectly assembled or broken, worn damaged gear train components	• Disassemble transmission. Replace damaged parts or assemble correctly.



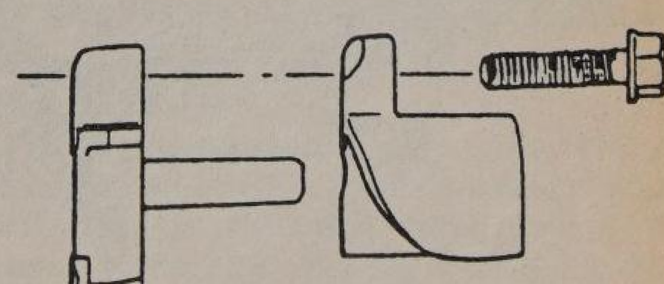
A. VIN derivative location
B. VIN derivative optional location

Transmission identification—late model 5-speed 77mm manual transmission

the clutch pedal to fill the system with fluid. 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.

Identification

The Firebird uses the Borg Warner 77mm 4 and 5 speed transmissions with all engines. Manual transmissions are identified by the number of forward gears and the measured distance between the centerlines of the mainshaft and the countergear.



Transmission identification—early model 4 and 5-speed 77mm manual transmission

Adjustments

LINKAGE

1982–84

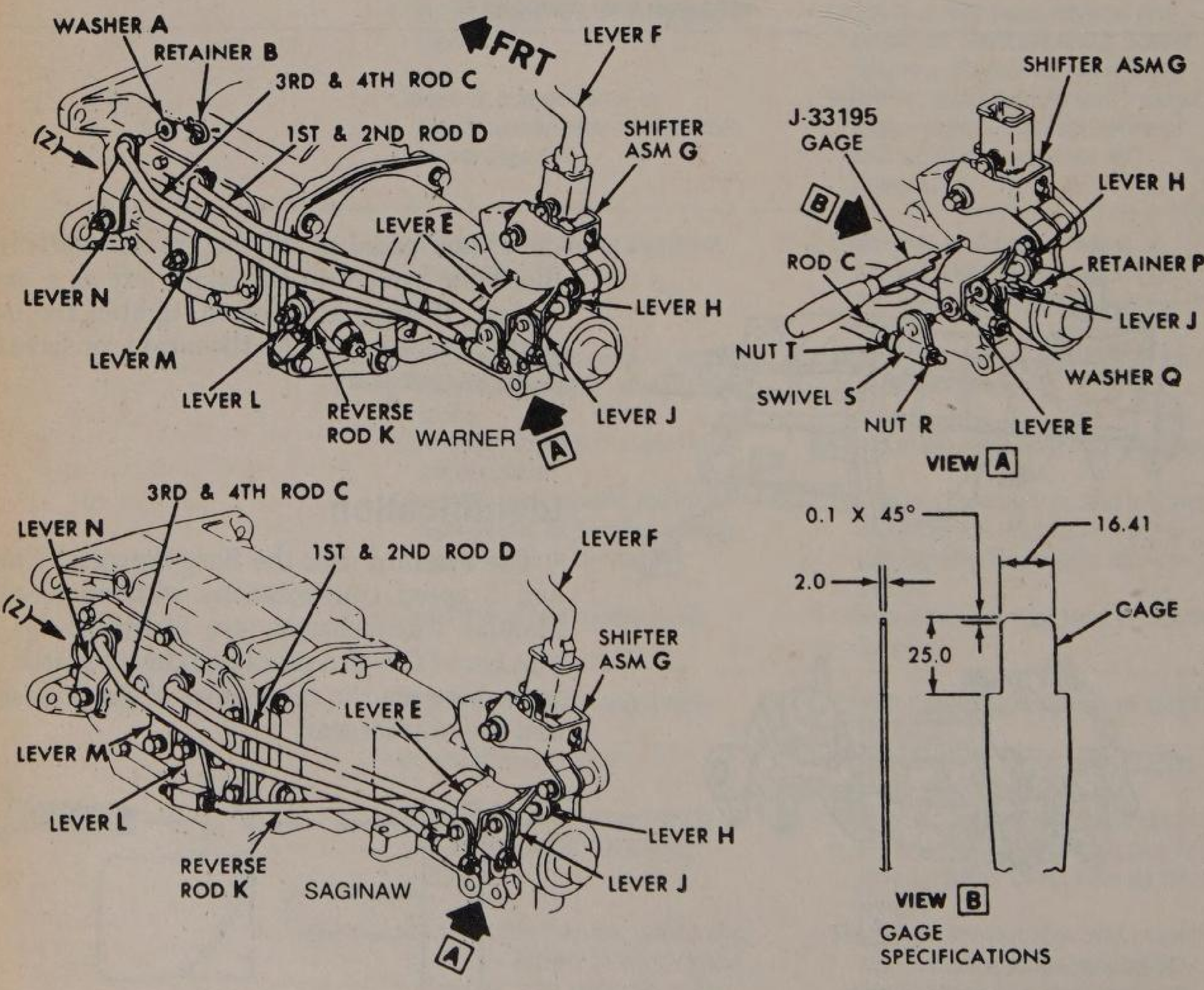
NOTE: *All terms used in the following procedure match those which are used in the accompanying illustration. No linkage adjustment is possible on the 1984–90 4- and 5-speed transmissions.*

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. (34 Nm).
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.

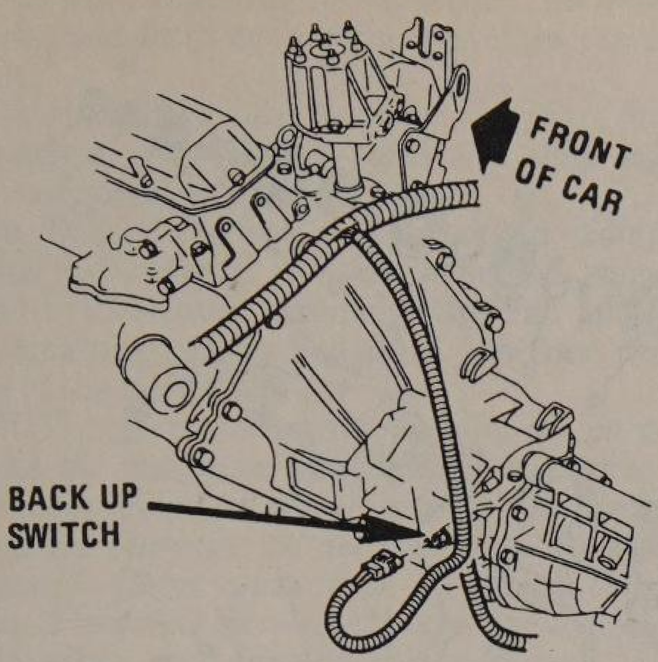
Back-up Light Switch

REMOVAL AND INSTALLATION

1. Disconnect the negative (–) battery cable.
2. Raise the vehicle and support with jackstands.
3. Disconnect the switch electrical connector.
4. Remove the switch from the transmission.
5. Install the switch and torque to 20 ft. lbs. (27 Nm).



Transmission shift linkage adjustment



Backup light switch – manual transmission

6. Reconnect the connector, lower the vehicle and connect the battery cable.

Transmission

REMOVAL AND INSTALLATION

NOTE: *On 5-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 support attaching bolts from the transmission.

NOTE: *To remove the shifter assembly, remove the console, shifter boot and shifter control.*

9. On 4-speed transmissions only, 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.

To install:

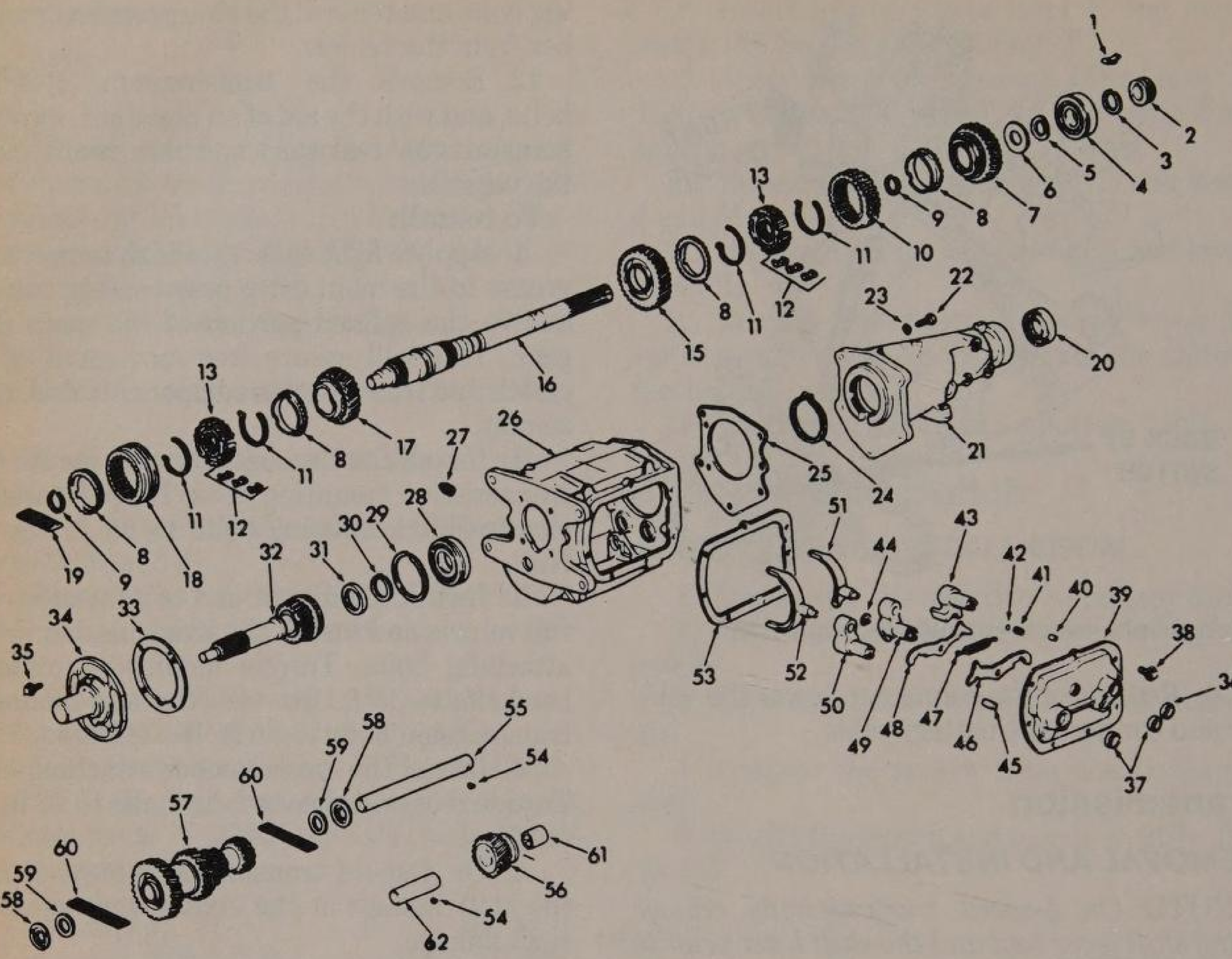
1. Apply a light coating of high temperature grease to the main drive gear bearing retainer and to the splined portion of the main drive gear. This will assure free movement of the clutch and transmission components during assembly.
2. Install the transmission and secure with transmission mounting bolts. Torque transmission-to-clutch housing bolts to 55 ft. lbs. (75 Nm).
3. Install the mount and crossmember into the vehicle and install the transmission mount attaching bolts. Torque mount-to-crossmember bolts to 35 ft. lbs. (48 Nm) and mount-to-transmission bolts to 35 ft. lbs. (48 Nm).
4. Install the crossmember attaching bolts. Torque crossmember-to-body bolts to 35 ft. lbs. (48 Nm).
5. On 4-speed transmissions only, connect the shift linkage at the shifter and adjust the shift linkage.
6. Install the transmission shifter support attaching bolts to the transmission. Torque shifter bracket-to-extension housing to 25 ft. lbs. (34 Nm).
7. Install the exhaust pipe brace.
8. Connect the speedometer cable and the electrical connectors to the transmission.
9. Install the driveshaft into the transmission. Then, align the marks on the driveshaft and the rear axle pinion flange. Bolt the rear universal joint straps.
10. Install the torque arm into the vehicle.
11. Fill the transmission with lubricant. Then install the filler plug and torque to 15 ft. lbs. (20 Nm).
12. Lower the vehicle.
13. Connect the negative battery cable at the battery.

76mm Overhaul

TRANSMISSION CASE DISASSEMBLY

1. Drain the lubricant. Remove the side cover and the shift forks.
2. Remove the clutch gear bearing retainer. Remove the bearing-to-gear stem snapring and pull out on the clutch gear until a small pry bar can be inserted between the bearing, the large snapring and case to pry the bearing off.

NOTE: *The clutch gear bearing is a slip fit on the gear and in the case. Removal of the*



1. Clip
2. Speedometer drive gear
3. Snapring
4. Mainshaft rear bearing
5. Wave washer
6. Wave washer
7. 1st gear
8. Blocker ring
9. Retaining ring
10. Synchronizer
11. Spring
12. Synchronizer key
13. Synchronizer hub
15. 2nd gear
16. Mainshaft
17. 3rd gear
18. Synchronizer assembly
19. Mainshaft bearing rollers
20. Extension housing oil seal
21. Extension housing
22. Bolt
23. Washer
24. Rear bearing ring
25. Gasket
26. Case assembly
27. Drain plug
28. Bearing assembly
29. Retainer ring
30. Locator ring
31. Seal
32. Main drive gear
33. Gasket
34. Retainer assembly
35. Bolt
36. Shifter shaft seal
37. Shifter shaft seal
38. Bolt
39. Cover
40. Dowel pin
41. Spring
42. Bearing
43. Shaft
44. Retainer
45. Pin
46. Cam
47. Spring
48. Cam
49. Shaft assembly
50. Shaft
51. Fork
52. Fork
53. Gasket
54. Woodruff key
55. Countershaft
56. Gear assembly
57. Countershaft gear
58. Gear thrust washer
59. Bearing thrust washer
60. Countershaft rollers
61. Extension bushing
62. Reverse idle shaft

Exploded view of the 76mm 4-speed transmission

bearing will provide clearance for the clutch gear and the mainshaft removal.

3. Remove the extension housing bolts, then remove the clutch gear, the mainshaft and the extension as an assembly.

4. Spread the snapring which holds the mainshaft rear bearing and remove the extension case.

5. Using a dummy shaft, drive the countershaft and its woodruff key out through the rear of the case. Remove the countergear assembly and the bearings.

6. Using a long drift, drive the Reverse idler shaft and the woodruff key through the rear of the case.

7. Expand and remove the 3rd/4th speed sliding clutch hub snapring from the mainshaft. Remove the clutch assembly, the 3rd gear blocking ring and the 3rd speed gear from the front of the mainshaft.

8. Press in the speedometer gear retaining clip and slide the gear off the mainshaft. Remove the rear bearing snapring from the mainshaft.

9. Using an arbor press, support the 1st gear on press plates, then press the 1st gear,

the thrust washer, the spring washer, the rear bearing and snapring from the rear of the mainshaft.

CAUTION: *Be sure to center the gear, the washers, the bearings and the snapring when pressing the rear bearing.*

10. Expand and remove the 1st/2nd sliding clutch hub snapring from the mainshaft, then remove the clutch assembly, the 2nd speed blocking ring and the 2nd speed gear from the rear of the mainshaft.

NOTE: *After thoroughly cleaning the parts and the transmission case, inspect and replace the damaged or worn parts. When checking the bearings, do not spin them at high speeds. Clean and rotate the bearings by hand to detect the roughness or unevenness. Spinning can damage the balls and the races.*

TRANSMISSION CASE ASSEMBLY

1. Grease both inside ends of the countergear. Install a dummy shaft into the countergear, then load a row of roller bearings (27) and thrust washers at each end of the countergear.
2. Position the countergear assembly into the case through the rear opening. Place a tanged thrust washer at each end of the countergear.
3. Install the countergear shaft and woodruff key from the rear of the case.

NOTE: *Make sure that the shaft engages both thrust washers and that the tangs align with their notches in the case.*

4. Install the Reverse idler gear, the shaft and the woodruff key. Install the extension-to-rear bearing snapring. Assemble the extension housing over the rear of the mainshaft and onto the rear bearing.
5. Install the 14 mainshaft pilot bearings into the clutch opening and the 4th speed blocking ring onto the clutching surface of the clutch gear (with the clutching teeth facing the gear).
6. Assemble the clutch gear, the pilot bearings and the 4th speed blocking ring unit over the front of the mainshaft. Do not assemble the bearing to the gear at this point.

CAUTION: *Be sure that the blocking ring notches align with the 3rd/4th synchronizer assembly keys.*

7. Install the extension-to-case gasket and secure it with grease. Install the clutch gear, the mainshaft and the extension housing as an assembly. Install the extension-to-case bolts (apply sealer to the bottom bolt) and torque to 45 ft. lbs. (61 Nm).
8. Install the outer snapring on the front bearing and place the bearing over the stem of the clutch gear and into the case bore.
9. Install the snapring to the clutch gear stem. Install the clutch gear bearing retainer and the gasket, with the retainer oil return hole at the bottom.
10. Place the synchronizer sleeves into the Neutral positions and install the cover, the gasket and the fork assemblies to the case; be sure the forks align with the synchronizer sleeve grooves. Torque the cover bolts to 22 ft. lbs. (30 Nm).

MAINSHAFT ASSEMBLY

Install the following parts with the front of the mainshaft facing up:

1. Install the 3rd speed gear with the clutching teeth up; the rear face of the gear will abut with the mainshaft flange.
2. Install a blocking ring (with the clutching teeth down) over the 3rd speed gear synchronizing surface.

NOTE: *The four blocking rings are the same.*

3. Press the 3rd/4th synchronizer assembly (with the fork slot down) onto the mainshaft splines until it bottoms.

CAUTION: *The blocking ring notches must align with the synchronizer assembly keys.*

4. Install the synchronizer hub-to-mainshaft snapring; both synchronizer snaprings are the same.

Install the following parts with the rear of the mainshaft facing up:

5. Install the 2nd speed gear with the clutching teeth up; the front face of the gear will abut with the flange on the mainshaft.
6. Install a blocking ring (with the clutching teeth down) over the 2nd speed gear synchronizing surface.
7. Press the 1st/2nd synchronizer assembly (with the fork slot down) onto the mainshaft.

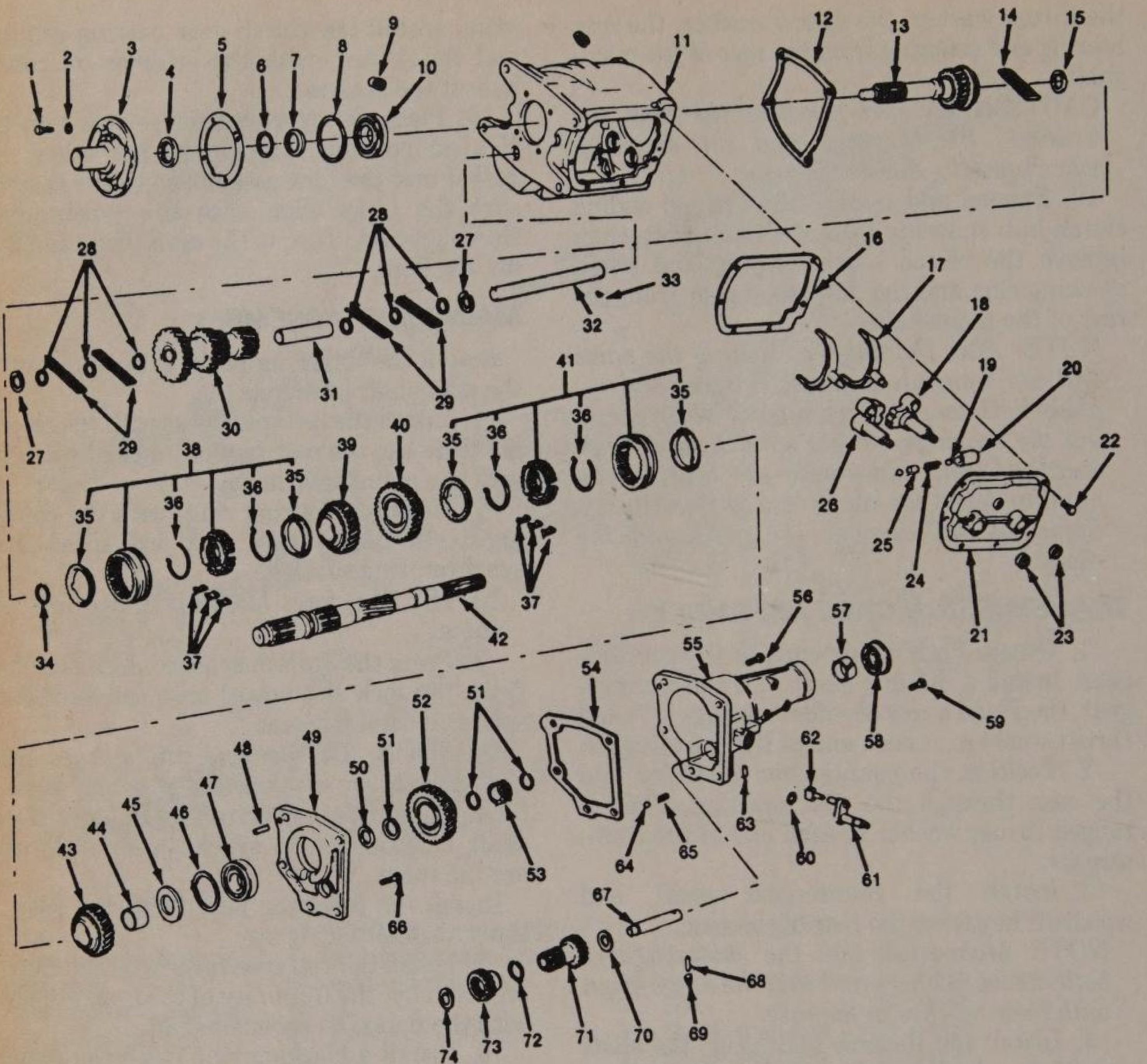
CAUTION: *The blocking ring notches must align with the synchronizer assembly keys.*

8. Install the synchronizer hub-to-mainshaft snapring.
9. Install a blocking ring with the notches down so they align with the 1st/2nd synchronizer assembly keys.
10. Install the 1st gear with the clutching teeth down. Install the 1st gear thrust washer and the spring washer.
11. Press the rear ball bearing (with the slot down) onto the mainshaft. Install the snapring. Install the speedometer gear and clip.

83mm Overhaul

TRANSMISSION CASE DISASSEMBLY

1. Thoroughly clean the exterior of the case.
2. Remove the 7 Overdrive unit-to-Reverse housing bolts and separate the two units.



1. Bolt
2. Lock washer
3. Bearing retainer
4. Seal
5. Gasket
6. Snapring
7. Ring
8. Snapring
9. Drain plug
10. Bearing
11. Transmission case
12. Front gasket
13. Clutch gear
14. Roller
15. Spacer
16. Side gasket
17. 1st, 2nd, 3rd and 4th fork
18. 1st/2nd shaft assembly
19. Balls
20. Interlock sleeve
21. Transmission cover
22. Bolt
23. Shifter shaft seal
24. Rev. lever spring
25. Interlock pin
26. 3rd/4th shaft assembly
27. Washer
28. Countershaft bearing washer
29. Roller
30. Countershaft gear
31. Spacer
32. Countershaft
33. Key ($^1/_8$ in. × $^5/_8$ in.)
34. Clutch hub retaining ring
35. Blocker ring
36. Synchronizer spring
37. Shifting key
38. 3rd/4th synchronizer
39. 3rd gear
40. 2nd gear
41. 1st/2nd synchronizer
42. Transmission mainshaft
43. 1st gear
44. 1st gear sleeve
45. 1st gear thrust washer
46. Snapring
47. Mainshaft rear bearing
48. Pin
49. Retainer assembly
50. Ring
51. Retainer ring
52. Reverse gear
53. Speedometer drive gear
54. Gasket
55. Extension housing
56. Bolt
57. Extension bushing
58. Extension seal
59. Bolt
60. Shift shaft oil seal
61. Reverse shift shaft
62. Reverse fork
63. Lock pin
64. Lever poppet spring
65. Ball
66. Bolt
67. Shaft
68. Pin
69. Plug
70. Rev. idler gear washer
71. Reverse idler gear
72. Front ring
73. Rev. idler gear, front
74. Washer

Exploded view of the 83mm 4-speed transmission

3. Remove the drain plug from the lower right side of the case and drain the lubricant.

4. Shift the transmission into 2nd gear, then remove the shift cover bolts, the cover, the gasket and both shift forks.

5. Remove the backup switch from the Reverse housing.

6. Rotate the Reverse shifter shaft, then remove the shift fork and gear from the mainshaft.

7. Remove the lock pin from the Reverse shift lever boss and pull the shaft from the housing.

8. Remove the drive gear bearing retainer bolts, the retainer and the gasket from the front of the case.

9. Remove the front bearing snapring, the selective fit snapring and the spacer washer.

10. Using tool No. J–6654–01 and J–8433–1, pull the drive gear bearing from the case.

11. Remove the six Reverse housing-to-case bolts. Using a small drift and a hammer, tap the reverse housing locating pin into the case.

12. Rotate the Reverse housing on the mainshaft until the Reverse idler gear shaft hole in the housing aligns with the countergear shaft.

13. Using tool No. J–24658 or a dummy shaft, drive the countergear shaft rearward out of the gear and through the Reverse housing. The countergear will drop to the bottom of the case allowing clearance for the removal of the mainshaft.

14. Remove the mainshaft with the Reverse housing and the drive gear from the case.

15. Remove the front Reverse idler gear and thrust washer from the case.

16. Remove the countergear and the two tanged thrust washers from the case. Check the bottom of the case for loose pilot bearings. Remove the Reverse housing locating pin and any other loose components.

TRANSMISSION CASE ASSEMBLY

1. Place the transmission case on its side with the shift cover opening toward the assembler. Position the countergear tanged washers in place, using a heavy grease to retain them.

NOTE: *Be sure the tangs are in the notches of the thrust face.*

2. Position the countergear assembly in the bottom of the case.

3. Install the front Reverse idler gear (teeth facing forward) and the thrust washer in the case; use a heavy grease to hold the thrust washer in position.

4. Using heavy grease, install the 16 roller bearings and the washer into the main drive gear. Mate the main drive gear with the mainshaft assembly. Position the 3rd/4th synchronizer sliding sleeve forward.

NOTE: *This will provide clearance for installation as well as hold the assembly together.*

5. Position a new Reverse housing to the case gasket on the rear of the case.

6. Install the mainshaft and drive gear assembly into the case.

7. Place the bearing snapring on the front main bearing. Using tool No. J–5590 or a hollow tube, position the front main bearing into the case opening and tap into place. Install the spacer washer and the snapring to secure the main drive bearing.

8. Raise the countergear in the case, aligning the holes in the case with the center of the gear. With the thrust washers in place, slide the countershaft through the rear of the case. Install the woodruff key and tap the shaft into the case, until it is flush with the rear face of the case.

9. Align the Reverse housing and the gasket to the case. Install the locating pin for the Reverse housing and tap the pin in until it is flush with the housing.

10. Install the 6 Reverse housing-to-case bolts.

11. Install the Reverse shift shaft and the O-ring into the housing, then the retaining pin.

12. Install the Reverse gear and the shift fork. Slide the gear and the fork forward on the mainshaft until the shift fork and the shifter shaft can be indexed into position.

13. Position the drive gear bearing retainer and the gasket to the front of the case. Apply sealant to the bolts.

14. Install the rear Reverse idler gear. Align the splines on the rear gear with the front gear and slide together.

15. Assemble the overdrive unit to the Reverse housing. Guide the idler shaft on the O/D unit into the idler gears and align the splines on the mainshaft with the splines in the input sun gear. Slide the units together and install the retaining bolts.

16. Slide the 1–2 synchronizer forward into the 2nd gear. Install the shift forks into the grooves of the synchronizers. Place the side cover with a gasket on the transmission. Guide the shift forks into the cover and install the bolts.

17. Check the operation of the transmission by manually shifting the transmission into all gears.

MAINSHAFT DISASSEMBLY

1. Using snapring pliers, remove the 3–4 synchronizer assembly retaining ring from front of the mainshaft, then slide the washer, the synchronizer assembly and the synchronizer ring 3rd speed gear from the mainshaft.

2. Spread the rear bearing retainer

snapring and slide the retainer from the mainshaft.

3. Remove the rear bearing-to-mainshaft snapring.

4. Support the mainshaft under the 2nd gear and press the mainshaft from the rear bearing, the 1st gear and sleeve, the 1–2 synchronizer assembly and the 2nd gear.

MAINSHAFT ASSEMBLY

1. At the rear of mainshaft, assemble the 2nd speed gear with the hub of the gear facing the rear of the shaft.

2. Install the 1st–2nd synchronizer assembly (sliding the synchronizer sleeve taper toward the rear, the hub to the front) on the mainshaft together with a synchronizer ring on both sides of the synchronizer assemblies.

3. Position the 1st gear sleeve on the shaft and press the sleeve onto the mainshaft until the 2nd gear, the synchronizer assembly and the sleeve bottom against the shoulder of the mainshaft.

4. Install the 1st speed gear (with the hub facing the front) and support the inner race, then press the rear bearing onto the mainshaft with the snapring groove toward the front of the case.

5. Install the spacer and the new snapring (thickest one that will fit) in the mainshaft behind the rear bearing.

6. Install the 3rd speed gear (the hub to the front of the case) and the 3rd speed gear synchronizing ring (with the notches to the front of the case).

7. Install the 3rd/4th speed gear synchronizer assembly (hub and sliding sleeve) with the taper facing the front.

NOTE: *Make sure that the keys in hub correspond to the notches in the 3rd speed gear synchronizing ring.*

8. Install the new snapring (the thickest that will fit) in the groove of the mainshaft in front of the 3rd/4th speed synchronizer assembly.

9. Install the rear bearing retainer (Reverse housing) over the end of the mainshaft. Spread the snapring to drop around the rear bearing, then release the snapring when it aligns with the groove in the rear bearing.

COUNTERGEAR DISASSEMBLY

1. Remove the dummy shaft or the tool No. J–24658 from the countergear.

2. Tip the countergear on end and let the six spacers, the 112 rollers and the roller sleeve slide out of the gear.

COUNTERGEAR ASSEMBLY

1. Install the roller spacer in the countergear (if removed).

2. Insert a dummy shaft or the loading tool No. J–24658 into the countergear.

3. Using heavy grease to retain the rollers, install the spacer, the 28 rollers, a spacer, the 28 rollers and a spacer in either end of the countergear. Repeat the procedure in the other end of the countergear.

CHECKING COUNTERGEAR ENDPLAY

1. Rest the transmission case on its side with the side cover opening toward the assembler. Put the countergear tanged thrust washers in place, retaining them with heavy grease.

NOTE: *Make sure the tangs are resting in the notches of the case.*

2. Set the countergear in place in the bottom of the case.

3. Position the case to rest on its front face.

4. Lubricate and insert the countershaft (pushing the loading tool No. J–24658 out through the front of the case) until woodruff key slot is in its installed position (do not install key).

5. Attach a dial indicator and check end play of the countergear. If the end play is greater than 0.025 in., a new thrust washer must be installed.

SYNCHRONIZER KEYS AND SPRINGS REPLACEMENT

The synchronizer hubs and the sliding sleeves are a selected assembly and should be kept together as originally assembled, but the keys and the two springs may be replaced if worn or broken.

1. If the relation of the hub and the sleeve are not already marked, mark for assembly purposes.

2. Push the hub from the sliding sleeve, the keys will fall free and the springs may be easily removed.

3. Place the springs in position (one on each side of hub) so the keys are engaged by both springs.

NOTE: *Place the keys in position and while holding them in place, slide the sleeve onto the hub, aligning the marks made before disassembly.*

DRIVE GEAR BEARING RETAINER OIL SEAL REPLACEMENT

1. Pry out the old seal.

2. Using a new seal, drive it into the retainer using tool No. J–23096 until it bottoms

in bore. Lubricate the I.D. of the seal with transmission lubricant.

REVERSE SHIFTER SHAFT AND/OR SEAL REPLACEMENT

1. With the Reverse housing removed from case, the Reverse shifter shaft lock pin will already be removed.
2. Carefully drive shifter shaft into the Reverse housing allowing the ball detent to drop into the case. Remove the shaft and the ball detent spring. Remove the O-ring seal from the shaft.
3. Place the ball detent spring into the detent spring hole and start the Reverse shifter shaft into the hole in the boss.
4. Place the detent ball on the spring and while holding the ball down, push the shifter shaft into place and turn until the ball drops into place in the detent on the shaft detent plate.
5. Install the O-ring seal on the shaft.
6. Install the shift fork. Do not drive the shifter shaft lock pin into place until the Reverse housing has been installed on the case.

REVERSE IDLER SHAFT REPLACEMENT

1. Place a small punch into the front cover hole of the overdrive unit and drive the pin into the shaft until the shaft can be pulled from front cover.
2. Insert a new idler shaft into cover until the hole in the shaft aligns with the hole in the boss.
3. Insert the roll pin into the boss opening and drive the pin into the cover until the shaft is securely locked in place.

SIDE COVER ASSEMBLY

Although the service of the side cover is covered here, the transmission does not have to be removed to perform these operations. To remove the side cover in the vehicle, simply drain the transmission, disconnect the electrical leads at the side cover switches, disconnect the 1st/2nd and the 3rd/4th linkage, then remove the attaching bolts.

1. Remove the outer shifter lever nuts and the lockwasher, then pull the levers from the shafts.
2. Carefully push the shifter shafts into the cover, allowing the detent balls to fall free, then remove both shifter shafts.
3. Remove the interlock sleeve, the interlock pin and the poppet spring.
4. Replace the necessary parts and the assembly by reversing the Steps 1–3.

OVERDRIVE UNIT DISASSEMBLY

Cleanliness is an important factor in the overhaul procedures. Before attempting any disassembly operation, the exterior of the transmission should be thoroughly cleaned to prevent the possibility of dirt entering the internal mechanism. During the inspection and the reassembly, the parts should be thoroughly cleaned with cleaning fluid and then air dried. Wiping cloths or rags should not be used to dry parts. Do not use solvents on neoprene seals, composition faced clutch plates or thrust washers. All oil passages should be blown out and checked to make sure that they are not obstructed. The small passages should be checked with a tag wire.

1. Remove the fill plug and drain the oil from the case.
2. Remove the retaining bolt and the bracket from the speedometer sensor and the driven gear. Remove the sensor and the gear.
3. Remove the three $^1/_8$ in. pipe plugs from the rear of the unit.
4. Using tool No. J–34681, install the pressure plate bolts until they are flush with the case. Turn the bolts two additional turns, by rotating each bolt one turn at a time.

   NOTE: *This sequence must be followed in order to prevent the pressure plate from cocking and causing damage to the unit.*
5. Remove the 4 adapter plate-to-case Allen® head bolts.
6. Using a plastic hammer and a small pry bar, remove the adapter plate. Tap the adapter plate to separate it from the case.

   NOTE: *Do not pry between the case and the adapter plate, damage to the sealing surfaces could occur.*
7. Bolt the overdrive unit to tool No. J–34162. Mount the holding fixture to the base plate tool No. J–3389–20.
8. Remove the large snapring from the O/D unit forward of the accumulator piston.

   CAUTION: *If pressure is felt at the snapring, do not remove it. Check to insure that the pressure plate bolts are installed. If the bolts are installed, tighten each bolt (one additional turn) until the pressure is relieved. The pressure plate is under a 1200 lb. spring load. If the bolts are not installed, personal injury could occur.*
9. Remove the piston/accumulator assembly. Using an Allen® wrench, pry the assembly up evenly by lifting under the flange. Do not pry at or near the seal surface.
10. Remove the carrier and the bearing assembly (includes the input sun and pinion gears) as an assembly.
11. Remove the finger pressure plate.
12. Remove the overdrive clutches, (4) composition, (4) steel and (1) clutch stop plate.
13. Remove the direct clutch plates, (5) com-

position, (5) steel and (1) steel bearing plate. Measure each selective clutch plate in the direct clutch pack and record the readings.

NOTE: *The selective clutch plates are used to control the clutch pack clearance. When replacing the clutch plates, replace each selective clutch plate with one of the same size.*

14. Inspect the overdrive and the direct clutch plates as follows:

a. Compositioned Plates—Dry the plates and inspect for pitting, flaking wear, glazing, cracking, charring and chips or metal particles embedded in lining. If a plate shows any of the above conditions, replacement is required.

b. Steel Plates—Wipe the plates dry and check for discoloration. If the surface is smooth and even color, reuse the plate. If severe heat spot discoloration or surface scuffing is indicated, the plate must be replaced.

15. Remove the thrust washer and the bearing from the output sun gear; the thrust washer may stick to the input sun gear hub.

16. Remove pump housing Allen® head bolts by rotating the hub to gain access to the bolts.

17. Remove the output shaft assembly (the output sun gear, the sprag clutch, the clutch hub, the gerotor pump and the speedometer drive gear).

18. Remove the pressure plate and the springs by positioning tool No. J–21420–2 on the pressure plate (with the bolt from tool No. J–23327) through the center of the plate. Next position tool No. J–23327 on the rear of the case and install the retaining nut. Remove the three retaining bolts and the tool No. J–34681, from the rear of the case. Loosen the retaining nut on the tool No. J–23327 bolt to relieve the spring pressure.

19. Remove the cooler valve assembly by loosening the nuts on the tube and then the valve-to-case bolts.

20. Remove the 12 oil pan bolts and then pry the pan from the case.

21. Remove the oil filter and the tube from the valve body.

22. Disconnect the throttle valve cable from the lever, then remove the cable retaining bolt and the cable assembly.

23. Remove the throttle valve lever bolt and the lever from the valve body.

24. Remove the remaining valve body bolts and the valve body with the spacer plate.

NOTE: *There are two check balls, one on each side of the spacer plate. One ball is located in the case and the other is spring loaded in the valve body.*

OVERDRIVE UNIT ASSEMBLY

1. Install the pressure plate springs into the transmission case pockets.

2. Place the pressure plate on top of the springs and seat the springs into the pockets of pressure plate.

3. Position the plate tool No. J–21420–2 on top of the pressure plate with the bolt from tool No. J–23327 through the center of the plate. Next, position tool No. J–23327 on the rear of the case and install the retaining nut. Tighten the nut until the pressure plate is drawn approximately $^1/_8$ in. below the step for the overdrive clutch plates. Install the three pressure plate bolts (J–34681). Remove the tools No. J–21420–2 and J–23327 from the case.

4. Install the output shaft assembly into the case. Install the pump bolts and torque.

NOTE: *Be sure the O-rings are positioned properly on pump cover before installing the output shaft assembly.*

5. Install the thrust bearing on the output sun gear.

6. Install the tanged direct clutch thrust washer with the tabs facing pressure plate.

7. Install the direct clutch thrust bearing and the thrust washer.

NOTE: *The thrust washer will have a tooth missing from its outer edge. The side of the thrust washer with the circular grind pattern must face the thrust bearing. The side with the grind pattern can be identified by the notch ground into the tooth.*

8. Install one composition clutch disc and then a selective clutch plate.

NOTE: *The selective clutch plates come in five sizes (0.080–0.120 in.) and is used to control the clutch pack clearance; a 0.050–0.070 in. clearance must be maintained in the direct clutch pack. Excessive or insufficient amount of clutch travel will cause failure to the clutch plates and discs.*

9. Alternate the remaining clutch discs and plates until all five plates and discs are installed.

10. Install the lower half of the carrier assembly onto the direct clutch pack; index the carrier until all of the clutch plates are engaged.

11. Install the steel overdrive stop clutch plate and then alternate with a disc and a plate until the four plates and disc are installed.

12. Install the finger pressure plate.

13. Install the carrier thrust plate with tabs facing the sprag clutch.

14. Install the two pinion gears with the index mark on the gears facing inward or to-

wards each other. Install the other two pinion gears with the index mark 90° from the first two gears.

15. Install the output sun thrust washer into the rear of the input sun gear; use petroleum jelly to retain the thrust washer to the input sun gear.

16. Install the input sun gear.

NOTE: *If the input sun gear spreads the pinion gears when installing, the pinion gears are not indexed properly.*

17. Install the selective thrust washer with the washer oil grooves facing the input sun gear.

18. Install the thrust bearing on the input sun gear.

19. Install the carrier thrust washer to the cover; use petroleum to retain the thrust washer to the cover.

20. Install the four pinion gear thrust washers onto the carrier cover; use petroleum to retain washers to the cover.

21. Install the carrier cover, the four new nuts and torque.

NOTE: *If the pinion gears are not indexed properly, the four cover bolt holes will not align with the lower half of the carrier bolts.*

22. Measure the end play for the overdrive unit as follows:

a. Place the straight edge tool No. J–34673 across the face of the overdrive unit. Using the Depth Micrometer tool No. J–34672, measure the distance from the bearing to the top of the bar. Next, using tool No. J–34673 and a 0–1 micrometer, measure the thickness of the bar and subtract this from the reading of the depth micrometer tool No. J–34672 and record this reading.

b. Place the straight edge tool No. J–34673 across the rear of the adapter plate. Using the Depth Micrometer tool No. J–34672, measure the distance from the top of the bar to the adapter plate mounting surface and record the reading.

c. Next, measure the distance from the top of the bar to the bearing seat in the adapter plate and record the reading.

d. Subtract the reading of Step (c) from Step (b) and record the difference.

e. Next, subtract the difference of step (d) from step (a). The difference will be the end play, it should be 0.003–0.003 in.

NOTE: *If the results of your measurements are not within the specifications, it will be necessary to remove the carrier cover and change the input sun selective thrust washer. The selective thrust washers are available in eight sizes, in 0.005 in. increments, ranging from 0.123–0.158 in.*

23. Install the accumulator and the piston assembly; coat the lips of the seals with clean Dexron® II automatic transmission fluid before installing.

24. Install the large snapring at the front of the overdrive unit.

25. Place the a new seal on the tool No. J–34523 and install it at the front side of the adapter plate.

26. Place seal protector tool No. J–34621 on the input sun gear and install the adapter plate. Apply a light coating of RTV Sealant No. 1052366 around the heads of the adapter plate bolts. Install the adapter plate bolts and torque.

27. Remove the seal protector.

28. Remove the first 1/8 in. pipe plug from the left side of the overdrive unit. Install the air line fitting tool No. J–34742 into the plug hole and torque.

29. Measure the clutch pack clearance as follows:

a. Loosen the pressure plate bolts (J–34681) evenly until the spring pressure is released.

b. Assemble the Dial Indicator tool No. J–8001 to the rear of the overdrive unit.

c. Apply a minimum of 100 psi to the air line fitting tool No. J–34742 and read the dial indicator, it should be between 0.050–0.070 in.

NOTE: *If the reading does not fall within the specification, it will be necessary to disassemble the overdrive unit to change the direct clutch selective clutch plates. The selective clutch plates are available in five sizes, they are in 0.010 in. increments ranging from 0.080–0.120 in. If the clutch pack clearance is within specification, remove the clutch pack retaining bolts (J–34681).*

30. Coat the three 1/8 in. pipe plugs with anti-seize compound, then install and torque the plugs.

31. Remove the air line adapter tool No. J–34742. Coat the plug with anti-seize compound, then install and torque the plug.

32. Install the speedometer gear and the sensor.

33. Using tool No. J–21426, install a new output seal; coat the lip of the seal with Dexron® II transmission fluid.

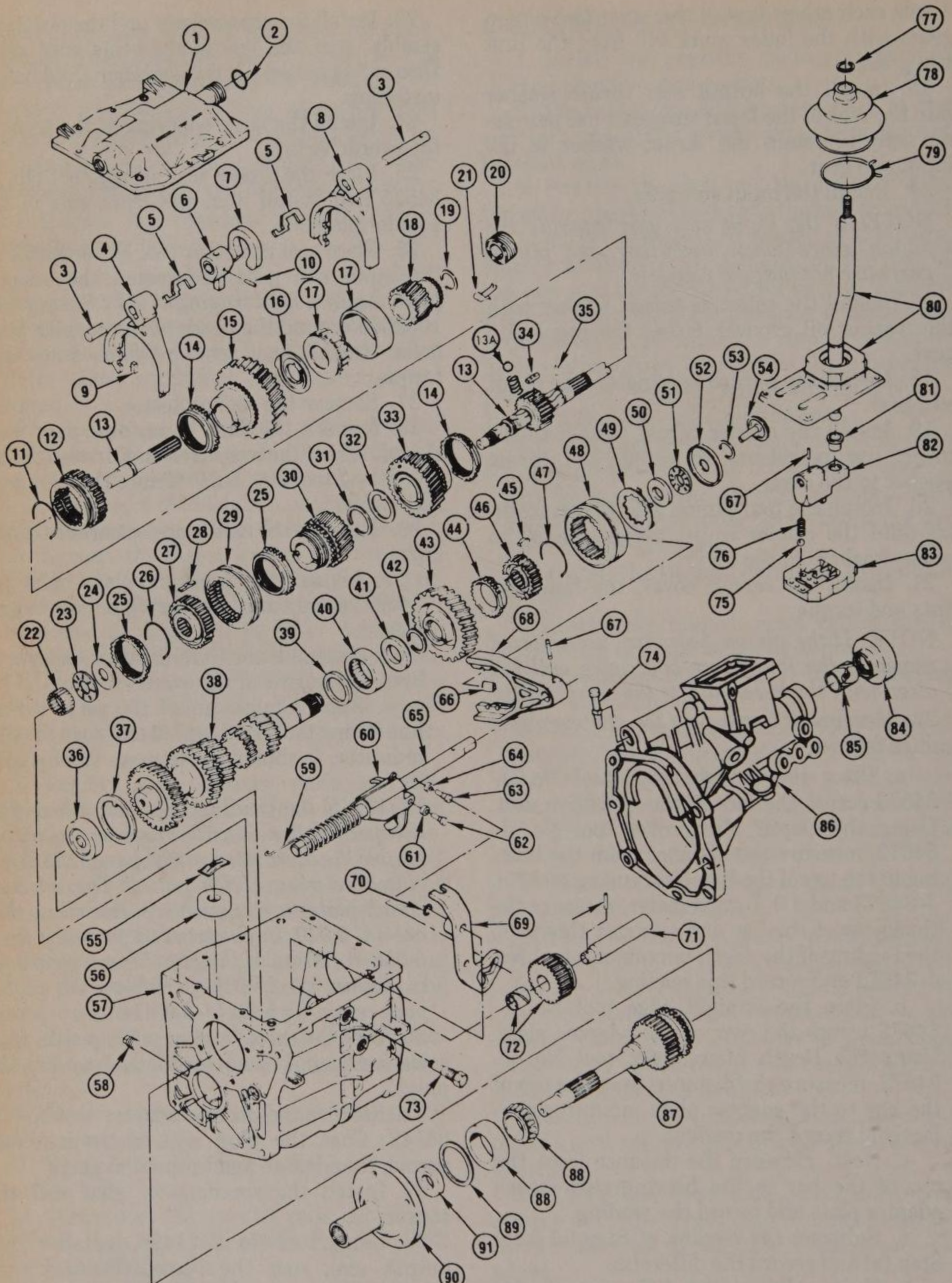
34. Install the valve body as follows:

a. Install the check ball into the case.

b. Position the gaskets, one on each side of the separator plate and position the separator plate on the valve body.

c. Position the valve to the case, then install and torque the bolts.

d. Install the throttle valve cable, the retaining clip and the bolt, then torque bolt.



Exploded view of the 77mm 5-speed transmission

e. Install the throttle valve lever and torque bolt, then connect throttle valve cable to the lever.

f. Install the Throttle Setting Gage tool No. J-34671-1 into the throttle valve cable bore on the side of the case. Set the throttle valve cable hook onto the high step of the gauge. Place the valve body cam stop as close to the lever as possible, then install and torque the bolt.

g. Set the throttle valve cable hook onto the lower step of the gauge. Place the tool

1. Transmission cover
2. O-ring seal
3. Shift shaft
4. 3rd/4th shift fork
5. Fork plate
6. Selector control arm
7. Select interlock plate
8. 1st/2nd shift fork
9. Shift fork insert
10. Roll pin
11. Synchronizer spring
12. Reverse sliding gear
13. Output shaft
13a. Anti-rattle spring/ball
14. 1st/2nd blocker ring
15. 1st gear
16. 1st gear thrust washer
17. Rear bearing
18. 5th speed driven gear
19. Snapring
20. Speedometer drive gear
21. Drive gear clip
22. Mainshaft bearing
23. Mainshaft needle bearing
24. Mainshaft bearing race
25. 3rd/4th synchronizer ring
26. 3rd/4th synchronizer ring
27. 3rd/4th synchronizer hub
28. 3rd/4th synchronizer key
29. 3rd/4th synchronizer sleeve
30. 3rd gear
31. Snapring
32. 2nd gear thrust washer
33. 2nd gear
34. 1st/2nd synchronizer key
35. 1st gear thrust washer retainer
36. Center gear bearing
37. Center bearing washer
38. Counter gear
39. Counter gear front spacer
40. Counter gear bearing
41. Counter gear rear spacer
42. Snapring
43. 5th gear
44. 5th synchronizer ring
45. 5th synchronizer key
46. 5th synchronizer hub
47. 5th synchronizer spring
48. 5th synchronizer sleeve
49. 5th synchronizer key retainer
50. 5th synchronizer bearing front race
51. 5th synchronizer needle bearing
52. 5th synchronizer bearing rear race
53. Snapring
54. Oiling funnel
55. Magnet nut
56. Magnet
57. Transmission case
58. Fill/drain plug
59. Reverse lock spring
60. Reverse shift fork
61. Fork roller

No. J-34671-2 between the piston and the solenoid bracket, then adjust the throttle valve lever screw/bolt until the bolt makes contact with the cam stop.

35. Install the pickup tube and the oil filter on the valve body.

36. Apply a bead of RTV Sealant No. 1052366 or equivalent to the oil pan flange and assemble it wet. Install the magnet in the oil pan. The bead of RTV should be applied around the inside of the bolt holes. Install the pan bolts and torque.

37. Assemble the Overdrive unit to the Reverse housing. Guide the idler shaft on the adapter plate into the idler gears and align the mainshaft splines with the input sun gear splines. Slide the units together, then install the bolts and torque the bolts.

77mm Overhaul

TRANSMISSION CASE DISASSEMBLY

NOTE: *Many special tools and an arbor press are required to properly disassemble and assemble this transmission. Read the entire procedure carefully before starting the job.*

1. Remove the transmission from the vehicle as outlined in the appropriate car section, then drain the lubricant from the transmission.

2. Using a pin punch and a hammer, carefully the offset lever-to-shift rail roll pin.

3. Remove the extension housing-to-case bolts. Remove the housing and offset lever as an assembly.

CAUTION: *DO NOT attempt to remove the housing with the offset lever in place.*

4. Remove the detent ball and the spring from the offset lever, then the roll pin from the extension housing or offset lever.

5. Remove the plastic funnel, the thrust bearing race and thrust bearing from the rear of the countershaft.

NOTE: *The funnel and race may be found inside the extension.*

6. Remove the cover-to-case bolts and lift the cover assembly off of the case.

NOTE: *Two of the cover bolts are alignment type dowel bolts. Mark the location of these bolts so that they may be reinstalled in their original locations.*

7. Place a wooden block under the 5th gear shift fork and drive the roll pin from the fork. The wood must be used to prevent damage to the shift rail.

8. Remove the following items from the rear of the countershaft.

a. The 5th gear synchronizer snapring.
b. The shift fork.
c. The 5th gear synchronizer sleeve.
d. The blocking ring.
e. The 5th speed drive gear.

9. Remove the 5th gear synchronizer springs and the inserts from the sleeve and the hub. Mark the sleeve and the hub so that they may be properly reassembled.

10. Remove the snapring from the 5th speed driven gear. Using the Kent-Moore puller tool No. J-25215, remove the driven gear.

11. Mark the front bearing cap and the case, so that the cap may be reinstalled in its proper position, then remove the front bearing cap.

12. Remove the front bearing race and the end play shim(s) from the bearing cap. Using a

small pry bar, carefully pry the oil seal from the cap.

13. Rotate the clutch shaft until the flat surface on the main drive gear faces the countershaft, then remove the clutch shaft and the main gear unit from the case.

NOTE: *The clutch shaft bearing is pressed on; an arbor press must be used to replace the bearing if the bearing is rough.*

14. Remove the mainshaft rear bearing race and tilt the shaft upward, then remove the output shaft assembly from the case.

15. Unhook the over center spring from the front of the case.

16. Remove the Reverse lever C-clip.

17. Rotate the 5th/Reverse shift rail clockwise, to disengage it from the Reverse lever, then remove the rail from the rear of the case.

18. Remove the Reverse lever and the fork assembly from the case.

19. Drive the roll pin from the forward end of the Reverse idler shaft, then remove the Reverse idler shaft, the rubber O-ring and the gear from the case.

20. Remove the gear countershaft snapring and the spacer.

21. Insert a brass drift through the main drive gear opening in the front of the case, so that it contacts the countershaft gear assembly. Using an arbor press (positioned at the other end of the drift), carefully press the countershaft gear rearward (just enough) to remove the countershaft rear bearing.

NOTE: *During the assembly, note that the bearing identification numbers should face outward.*

22. Move the countershaft assembly rearward, tilt it upward, then remove the assembly from the case. Mark the position of the front countershaft thrust washer (so that it may be reinstalled properly), then remove the washer from the case.

23. Remove the countershaft rear bearing spacer.

24. Drive the roll pin from the front of the Reverse idler shaft, then remove the shaft and the gear from the case.

NOTE: *Mark the position of the gear, so that it may be reinstalled properly.*

25. Using an arbor press, remove the countershaft front bearing from the case.

26. Remove the clutch shaft front bearing.

27. Using a flat drift and a hammer, carefully tap out the rear extension and the adapter housing seal.

TRANSMISSION CASE ASSEMBLY

NOTE: *If a replacement fastener is used, be sure that it matches the original EXACTLY. Many metric fasteners are used in this transmission.*

1. Apply a coat of Loctite® 601 to the outer cage of the front countershaft bearing, then press the bearing into its bore until it is flush with the case.

2. Apply a coat of petroleum jelly to the tabbed countershaft thrust washer, then install the washer so that its tab engages the corresponding depression in the case.

3. Tip the case on end and install the countershaft into the front bearing bore.

4. Install the countershaft rear bearing spacer and coat the rear countershaft bearing with petroleum jelly. Using the Kent-Moore installer tool No. J-29895 and the sleeve protector tool No. J–33032, install the rear countershaft bearing.

NOTE: *When properly installed, the rear bearing will extend $^1/_8$ in. beyond the case surface.*

5. Position the Reverse idler gear into the case (with the shift lever groove facing rearward) and install the Reverse idler shaft from the rear of the case.

6. Install the shaft retaining pin.

7. Install the mainshaft assembly and the rear mainshaft bearing race into the case.

8. Using an arbor press, install the clutch shaft/main gear bearing (if removed).

9. Coat the main drive gear roller bearings with petroleum jelly and install them into the rear of the clutch shaft/main gear unit.

10. Install the thrust bearing and the race into the rear of the clutch shaft/main gear unit.

11. Install the 4th gear blocking ring onto the mainshaft.

12. Install the clutch shaft/main gear unit into the case, engaging the 3rd/4th synchronizer blocking ring.

13. Evenly and carefully tap a new front bearing cap seal into place.

14. Install the front bearing race into the front bearing cap; do not install the front bearing cap shims.

15. Temporarily install the front bearing cap, without sealant.

16. Install the following:

   a. The 5th/Reverse lever.
   b. The pivot bolt.
   c. The C-clip retainer.

NOTE: *Coat the pivot bolt threads with non hardening sealant (RTV is preferred). Also, be sure to engage the Reverse lever fork in the Reverse idler gear.*

17. Install the countershaft rear bearing spacer and the snapring.
18. Install the 5th speed gear onto the mainshaft.
19. Install the 5th/Reverse rail through the rear case opening and into the 5th/Reverse lever, then rotate the rail to engage it with the lever.
20. Position the 5th speed synchronizer assembly on the 5th speed shift fork, then slide the assembly onto the countershaft and the 5th/Reverse rail.

NOTE: *The 5th/Reverse rail roll pin hole must be aligned with the hole of the 5th speed shift fork.*

21. Support the 5th speed shift fork rail and the fork with a block of wood, then drive the roll pin into place.
22. Install the:
   a. Thrust race against the 5th speed synchronizer hub, then retain with the snapring.
   b. Needle type thrust bearing against the thrust race on the countershaft (coat the bearing and the race with petroleum jelly).
   c. Lipped thrust race over the needle type thrust bearing.
   d. Plastic funnel into the hole in the end of the countershaft gear.
23. Temporarily install the extension/adapter housing and the bolts.
24. Turn the case on end. Mount a dial indicator on the extension/adapter housing, so that the indicator needle contacts the end of the mainshaft, then zero the indicator needle.
25. Pull upward on the mainshaft to remove the end play, then read the indicator and record the reading.
26. Select a shim pack which measures 0.001–0.005 in. thicker than the end play reading obtained during Step
25. 27. Position the case horizontally. Remove the front bearing cap and the bearing race, then install the shim pack. Reinstall the bearing race.
28. Apply a 1/8 in. bead of RTV sealer on the front bearing cap-to-case mating surface. Align the case and the cap matchmarks. Install the bearing cap and torque the bolts to 15 ft. lbs. (20 Nm).
29. Recheck the end play; no play should be evident.
30. Remove the extension and adapter housing, then carefully drive a new housing seal into place.
31. Move the shift forks of the cover and the synchronizer sleeves to their Neutral positions.
32. Apply a 1/8 in. bead of RTV sealer to the cover-to-case mating surface. While aligning the shift forks with the synchronizer sleeves, carefully lower the cover assembly into case.
33. Center the cover and to engage the Reverse relay lever, then install the alignment type (dowel) cover attaching bolts. Install the remaining cover bolts and torque to 120 inch lbs. (14 Nm).

NOTE: *The offset lever-to-shift rail roll pin hole must be positioned vertically; if not, repeat Steps 31, 32 and 33.*

34. Apply a 1/8 in. bead of RTV sealer to the extension/adapter housing-to-case mating surface and install the housing over the mainshaft.

NOTE: *The shift rail must be positioned so that it just enters the shift cover opening.*

35. Install the detent spring into the offset lever and place the steel ball into the Neutral guide plate detent. Apply pressure on the steel ball with the detent spring and the offset lever, then slide the offset lever on the shift rail and seat the extension/adapter against the case.
36. Install the extension/adapter housing bolts and torque to 25 ft. lbs. (34 Nm).
37. Install the roll pin into the offset lever and the shift rail.
38. Install the damper sleeve in the offset lever. Coat the back up lamp switch threads with RTV sealant, then install the switch into the case and torque to 15 ft. lbs. (20 Nm).

MAINSHAFT DISASSEMBLY

1. Remove the thrust bearing and the washer from the front of the mainshaft.
2. Scribe matchmarks on the 3rd/4th synchronizer hub and the sleeve to indicate their relationship for proper reassembly.
3. Remove the 3rd/4th synchronizer blocking ring, the sleeve and hub from the mainshaft as an assembly. Mark the positions of these items, so that they may be properly reassembled.
4. Remove the snapring, the tabbed thrust washer and the 2nd gear from the mainshaft.
5. Using an arbor press and the puller tool, remove the 5th speed gear from the mainshaft.
6. Slide the rear mainshaft bearing off of the mainshaft.
7. Remove the 1st gear thrust washer, the roll pin, the 1st speed gear and the blocking ring.
8. Scribe matchmarks on the 1st/2nd synchronizer hub and the sleeve for reassembly purposes.
9. Remove the insert spring and the inserts from the 1st/Reverse sliding gear, then the gear from the mainshaft.

CAUTION: *Do not attempt to remove the 1st/2nd/Reverse hub from the mainshaft as these* *parts are machined as a matched set from the factory.*

MAINSHAFT ASSEMBLY

1. Lubricate the mainshaft and the gear bores with a liberal coating of transmission lubricant.
2. Align and install the 1st/2nd synchronizer sleeve on the mainshaft, using the matchmarks made during disassembly.
3. If removed, install the synchronizer inserts and the springs into the 1st/2nd synchronizer sleeve.

NOTE: *The tanged end of each spring should be positioned on the same insert but that the open face of each spring should be opposite the other.*

4. Install the blocking ring and the 2nd speed gear onto the mainshaft.
5. Install the tabbed thrust washer and the 2nd speed gear snapring onto the mainshaft.

NOTE: *Be sure that the washer tab is fully seated into the mainshaft notch.*

6. Install the blocking ring and the 1st speed gear onto the mainshaft.
7. Carefully drive the 1st gear roll pin into place, then install the 1st gear thrust washer.
8. Slide the mainshaft rear bearing onto the mainshaft.
9. Using an arbor press and the special tools, press the 5th speed gear onto the mainshaft.
10. Install the 3rd speed gear, the 3rd/4th synchronizer assembly and the thrust bearing onto the mainshaft; the synchronizer hub offset must face forward.

COVER DISASSEMBLY

1. Place the selector arm plates and the shift rail in the Neutral position (centered).
2. Rotate the shift rail counterclockwise until the selector arm disengages from the selector arm plates. The selector arm roll pin will now be accessible.
3. Using a $^3/_{16}$ in. pin punch and a hammer, carefully drive out the selector arm roll pin, then remove the shift rail.
4. Remove the shift forks, the selector arm plates, the selector arm, the roll pin and the interlock plate.
5. Remove the nylon inserts and the selector arm plates from the shift forks. Mark the positions of the inserts and the plates so they may be properly reinstalled.

COVER ASSEMBLY

1. Attach the nylon inserts to the shift forks and install the selector arm plates into the shift forks.
2. If removed, apply sealer to the edges of the shift rail plug, then carefully tap the plug into place.
3. Coat the shift rail and the rail bores with petroleum jelly, then slide the rail into the cover until the end is flush with the inside edge of the cover.
4. With the offset of the 1st/2nd shift fork facing the rear of the cover, install the fork into the cover and push the shift rail through the fork.

NOTE: *The the 1st/2nd fork is the larger of the two forks.*

5. Place the selector arm and the C-shaped interlock plate into the cover, then insert the shift rail through the arm.

NOTE: *The widest part of the interlock plate must face away from the cover and the selector arm roll pin hole must face downward, toward the rear of the cover.*

6. With the offset of the 3rd/4th shift fork facing the rear of the cover, install the fork into the cover. The 3rd/4th shift fork selector arm plate must be positioned under the 1st/2nd arm plate. Push the shift rail completely forward, through the 3rd/4th fork and into the cover bore.
7. Rotate the shift rail so that the forward selector arm plate faces away from but parallel to the cover.
8. After aligning the holes, install the selector arm-to-shift rail roll pin.

NOTE: *To prevent the roll pin from contacting the selector arm plates when shifting, the roll pin must be installed flush with the surface of the selector arm.*

9. Install the O-ring into the groove of the shift rail oil seal.
10. Installation of the shift rail oil seal should be performed as follows:
    a. Install the Kent-Moore tool No. J–26628–2 over the threaded end of the shift rail.
    b. Lubricate the lip of the oil seal with petroleum jelly.
    c. Slide the seal over the protector tool and onto the shift rail.
    d. Using the Kent–Moore seal installer tool No. J–26628–1, seat the seal in the cover.

CLEANING AND INSPECTION

The parts (except the nylon or plastic) should be thoroughly cleaned in cleaning solvent. The nylon or plastic parts, which are to be reused should just be wiped clean with a cloth. The assembled roller bearings should be dried with compressed air.

CAUTION: *Do not spin the bearings with the compressed air as they could shatter and* *cause personal injury. The individual bearing rollers, washers and thrust bearings should be allowed to air dry after cleaning, though they may be wiped with a clean cloth.*

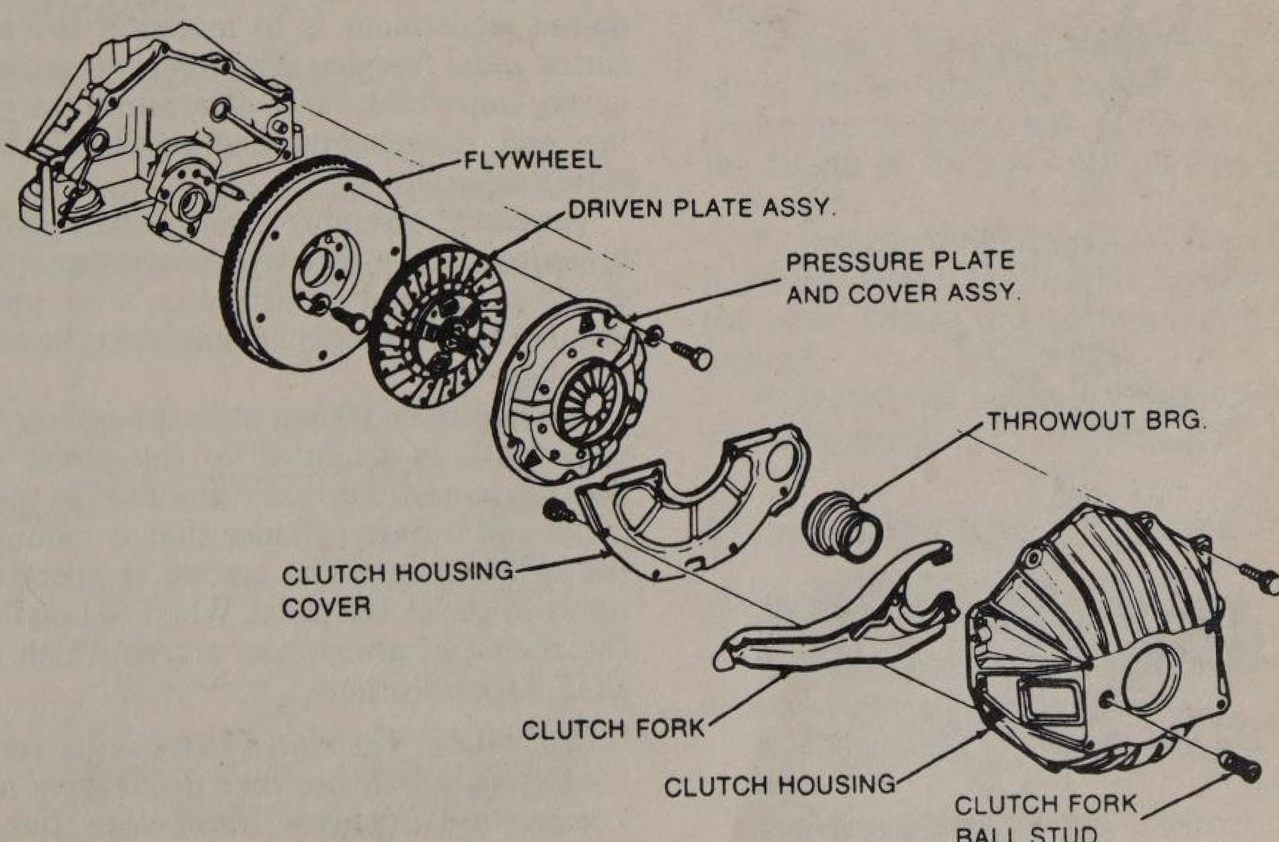
Inspect the parts for excessive wear and/or damage such as scoring, cracks, nicks or rough edges; replace the defective parts. To check the condition of the assembled bearings, first clean and dry them, then coat the bearings with light engine oil. Slowly spin the bearings by hand and check for any signs of roughness. If the bearing does not feel perfectly smooth, it should be replaced.

CLUTCH

Understanding the Clutch

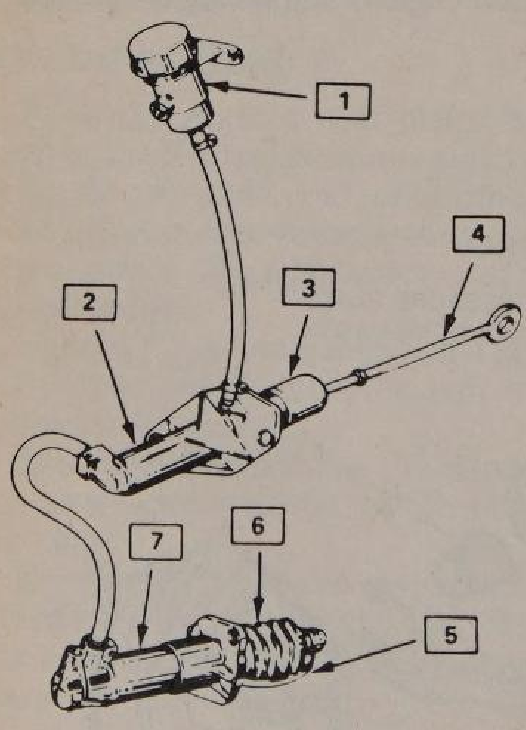
The purpose of the clutch is to disconnect and connect engine power from the transmission. A car at rest requires a lot of engine torque to get all that weight moving. An internal combustion engine does not develop a high starting torque (unlike steam engines), so it must be allowed to operate without any load until it builds up enough torque to move the car. Torque increases with engine rpm. The clutch allows the engine to build up torque by physically disconnecting the engine from the transmission, relieving the engine of any load or resistance. The transfer of engine power to the transmission (the load) must be smooth and gradual; if it were not, drive line components would wear out or break quickly. This gradual power transfer is made possible by gradually releasing the clutch pedal. The clutch disc and pressure plate are the connecting link between the engine and transmission. When the clutch pedal is released, the disc and plate contact each other (clutch engagement), physically joining the engine and transmission. When the pedal is pushed in, the disc and plate separate (the clutch is disengaged), disconnecting the engine from the transmission.

The clutch assembly consists of the flywheel, the clutch disc, the clutch pressure plate, the throwout bearing and fork, the actuating linkage and the pedal. The flywheel and clutch pressure plate (driving members) are connected to the engine crankshaft and rotate with it. The clutch disc is located between the flywheel and pressure plate, and splined to the transmission shaft. A driving member is one that is attached to the engine and transfers engine power to a driven member (clutch disc) on the transmission shaft. A driving member (pressure plate) rotates (drives) a driven member (clutch disc) on contact and, in so doing, turns the transmission shaft. There is a circular diaphragm spring within the pressure plate cover (transmission side). In a relaxed state (when the clutch pedal is fully released), this spring is convex; that is, it is dished outward toward the transmission. Pushing in the clutch pedal actuates an attached linkage rod. Connected to the other end of this rod is the throwout bearing fork. The throwout bearing is attached to the fork. When the clutch pedal is depressed, the clutch linkage pushes the fork and bearing forward to contact the diaphragm spring of the pressure plate. The outer edges of the spring are secured to the



Exploded view of the clutch and flywheel assembly

pressure plate and are pivoted on rings so that when the center of the spring is compressed by the throwout bearing, the outer edges bow outward and, by so doing, pull the pressure plate in the same direction – away from the clutch disc. This action separates the disc from the plate, disengaging the clutch and allowing the transmission to be shifted into another gear. A coil type clutch return spring attached to the clutch pedal arm permits full release of the pedal. Releasing the pedal pulls the throwout bearing away from the diaphragm spring resulting in a reversal of spring position. As bearing pressure is gradually released from the spring center, the outer edges of the spring bow outward, pushing the pressure plate into closer contact with the clutch disc. As the disc and plate move closer together, friction between the two increases and slippage is reduced until, when full spring pressure is applied (by fully releasing the pedal), The speed of the disc and plate are the same. This stops all slipping, creating a direct connection between the plate and disc which results in the transfer of power from the engine to the transmission. The clutch disc is now rotating with the pressure plate at engine speed and, because it is splined to the transmission shaft, the shaft now turns at the same engine speed. Understanding clutch operation can be rather difficult at first; if you're still confused after reading this, consider the following analogy. The action of the diaphragm spring can be compared to that of an oil can bottom. The bottom of an oil can is shaped very much like the clutch diaphragm spring and pushing



1. Fluid reservoir
2. Clutch master cylinder
3. Boot
4. Pushrod
5. Shipping strap
6. Boot
7. Clutch slave cylinder

Hydraulic clutch system

in on the can bottom and then releasing it produces a similar effect. As mentioned earlier, the clutch pedal return spring permits full release of the pedal and reduces linkage slack due to wear. As the linkage wears, clutch pedal free-travel will increase and free-travel will decrease as the clutch wears. Free-travel is actually throwout bearing lash.

The diaphragm spring type clutches used are available in two different designs: flat diaphragm springs or bent spring. The bent fingers are bent back to create a centrifugal boost ensuring quick re-engagement at higher engine speeds. This design enables pressure plate load to increase as the clutch disc wears and makes low pedal effort possible even with a heavy duty clutch. The throwout bearing used with the bent finger design is $1^1/_4$ in. long and is shorter than the bearing used with the flat finger design. These bearings are not interchangeable. If the longer bearing is used with the bent finger clutch, free-pedal travel will not exist. This results in clutch slippage and rapid wear.

The transmission varies the gear ratio between the engine and rear wheels. It can be shifted to change engine speed as driving conditions and loads change. The transmission allows disengaging and reversing power from the engine to the wheels.

Application

All 1982–83 vehicles use a mechanical (non-hydraulic) clutch; 1984 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 reservoir 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.

CAUTION: *The clutch driven disc contains asbestos, which has been determined to be a cancer causing agent. Never clean clutch surfaces with compressed air! Avoid inhaling any dust from any clutch surface! When clean-*

Troubleshooting Basic Clutch Problems

Problem	Cause
Excessive clutch noise	Throwout bearing noises are more audible at the lower end of pedal travel. The usual causes are: • Riding the clutch • Too little pedal free-play • Lack of bearing lubrication A bad clutch shaft pilot bearing will make a high pitched squeal, when the clutch is disengaged and the transmission is in gear or within the first 2" of pedal travel. The bearing must be replaced. Noise from the clutch linkage is a clicking or snapping that can be heard or felt as the pedal is moved completely up or down. This usually requires lubrication. Transmitted engine noises are amplified by the clutch housing and heard in the passenger compartment. They are usually the result of insufficient pedal free-play and can be changed by manipulating the clutch pedal.
Clutch slips (the car does not move as it should when the clutch is engaged)	This is usually most noticeable when pulling away from a standing start. A severe test is to start the engine, apply the brakes, shift into high gear and SLOWLY release the clutch pedal. A healthy clutch will stall the engine. If it slips it may be due to: • A worn pressure plate or clutch plate • Oil soaked clutch plate • Insufficient pedal free-play
Clutch drags or fails to release	The clutch disc and some transmission gears spin briefly after clutch disengagement. Under normal conditions in average temperatures, 3 seconds is maximum spin-time. Failure to release properly can be caused by: • Too light transmission lubricant or low lubricant level • Improperly adjusted clutch linkage
Low clutch life	Low clutch life is usually a result of poor driving habits or heavy duty use. Riding the clutch, pulling heavy loads, holding the car on a grade with the clutch instead of the brakes and rapid clutch engagement all contribute to low clutch life.

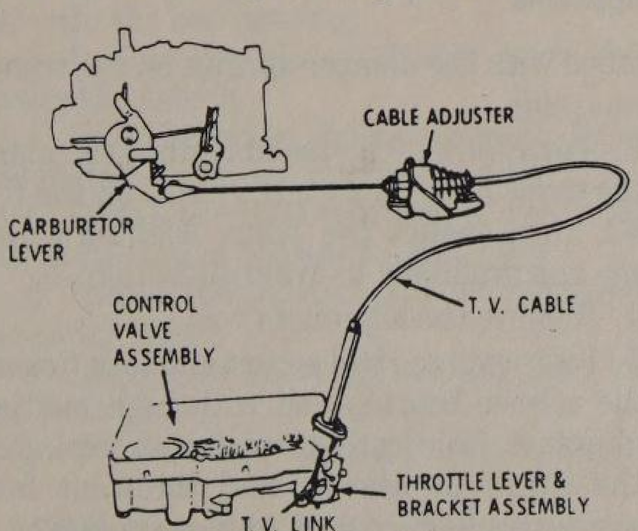
ing clutch surfaces, use a commercially available brake cleaning fluid.

Adjustments

FREE-PLAY ADJUSTMENT

Non-Hydraulic

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.

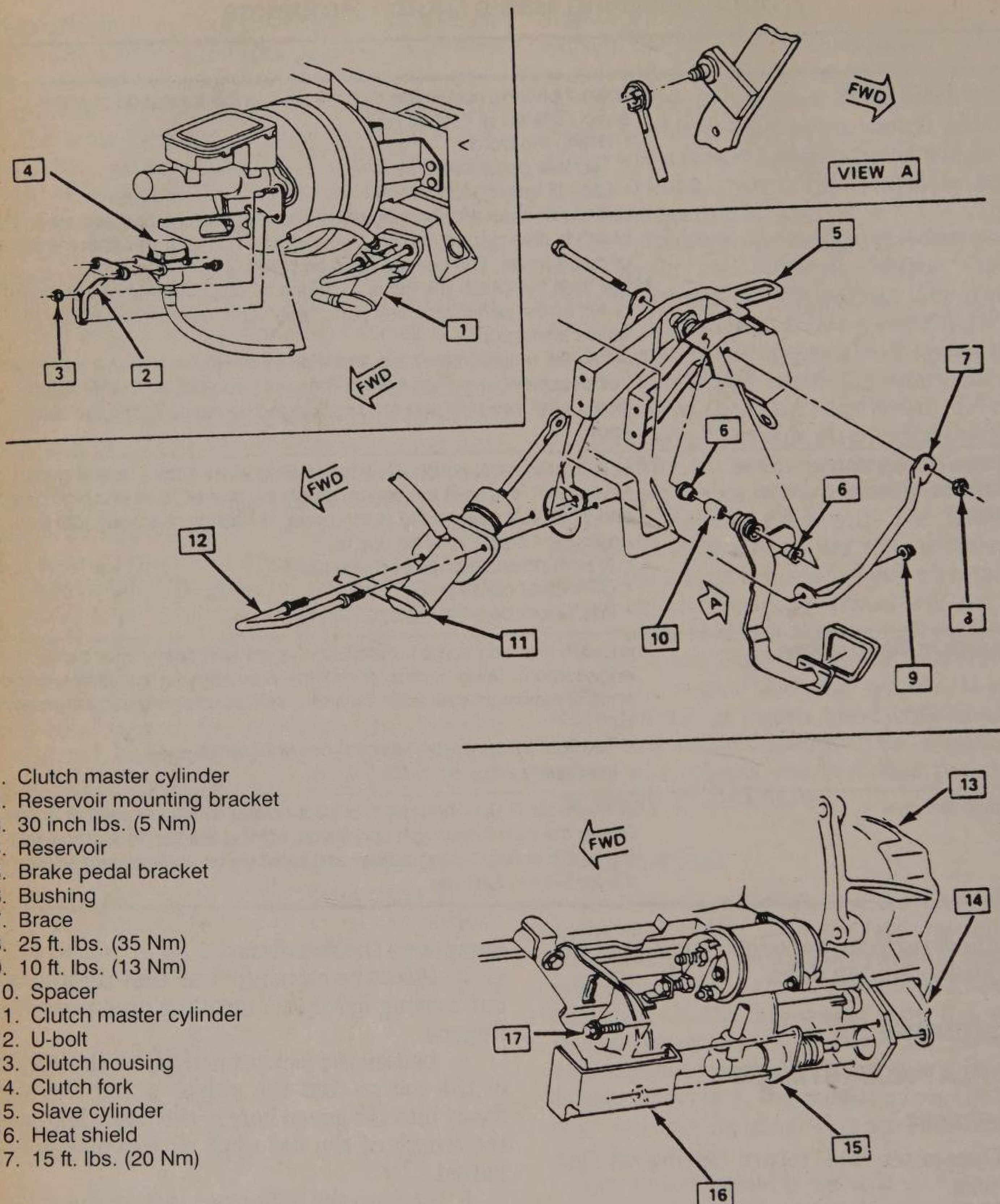


Clutch pedal free travel

Driven Disc and Pressure Plate

REMOVAL AND INSTALLATION

1. Support engine and remove the transmission (as outlined in this section).
2. Disconnect the clutch fork push rod and spring.
3. Remove the flywheel housing.
4. Slide the clutch fork from the ball stud and remove the fork from the dust boot. The



1. Clutch master cylinder
2. Reservoir mounting bracket
3. 30 inch lbs. (5 Nm)
4. Reservoir
5. Brake pedal bracket
6. Bushing
7. Brace
8. 25 ft. lbs. (35 Nm)
9. 10 ft. lbs. (13 Nm)
10. Spacer
11. Clutch master cylinder
12. U-bolt
13. Clutch housing
14. Clutch fork
15. Slave cylinder
16. Heat shield
17. 15 ft. lbs. (20 Nm)

Clutch system and components

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.

To install:

1. Clean the pressure plate and flywheel face.

2. Support the clutch disc and pressure plate with an alignment tool. The driven disc is installed with the damper springs on the transmission side.

3. 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.

4. Remove the alignment tool.

5. 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.

6. 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.

7. Connect the fork push rod and spring. Lubricate the spring and pushrod ends.

8. Adjust the shift linkage and clutch pedal free-play, if non-hydraulic.

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 14mm. 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 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.

To install:

1. Place the hydraulic system into the engine compartment.
2. Raise the vehicle. Install the slave cylinder onto the bell housing.
3. Install the slave cylinder heat shield. Lower the vehicle.
4. Pull the brake master cylinder forward and install the clutch master cylinder.
5. Install the fluid reservoir to the bracket. Install the brake booster to cowl nuts.
6. Install the master cylinder push rod to the clutch pedal.
7. Install the steering column trim cover and hush panel.
8. Connect the negative battery cable.

NOTE: *Overhaul of the cylinders is not possible; it is serviced by replacement ONLY.*

AUTOMATIC TRANSMISSION

Understanding Automatic Transmissions

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.

THE TORQUE CONVERTER

The torque converter replaces the conventional clutch. It has three functions:

1. It allows the engine to idle with the vehicle at a standstill, even with the transmission in gear.
2. It allows the transmission to shift from range to range smoothly, without requiring that the driver close the throttle during the shift.
3. It multiplies engine torque to an increasing extent as vehicle speed drops and throttle opening is increased. This has the effect of making the transmission more responsive and reduces the amount of shifting required.

The torque converter is a metal case which is shaped like a sphere that has been flattened on opposite sides. It is bolted to the rear end of the engine's crankshaft. Generally, the entire metal case rotates at engine speed and serves as the engine's flywheel.

The case contains three sets of blades. One set is attached directly to the case. This set forms the torus or pump. Another set is directly connected to the output shaft, and forms the turbine. The third set is mounted on a hub which, in turn, is mounted on a stationary shaft through a one-way clutch. This third set is known as the stator.

A pump, which is driven by the converter hub at engine speed, keeps the torque converter full of transmission fluid at all times.

Fluid flows continuously through the unit to provide cooling.

Under low speed acceleration, the torque converter functions as follows:

The torus is turning faster than the turbine. It picks up fluid at the center of the converter and, through centrifugal force, slings it outward. Since the outer edge of the converter moves faster than the portions at the center, the fluid picks up speed.

The fluid then enters the outer edge of the turbine blades. It then travels back toward the center of the converter case along the turbine blades. In impinging upon the turbine blades, the fluid loses the energy picked up in the torus.

If the fluid were now to immediately be returned directly into the torus, both halves of the converter would have to turn at approximately the same speed at all times, and torque input and output would both be the same.

In flowing through the torus and turbine, the fluid picks up two types of flow, or flow in two separate directions. It flows through the turbine blades, and it spins with the engine. The stator, whose blades are stationary when the vehicle is being accelerated at low speeds, converts one type of flow into another. Instead of allowing the fluid to flow straight back into the torus, the stator's curved blades turn the fluid almost 90° toward the direction of rotation of the engine. Thus the fluid does not flow as fast toward the torus, but is already spinning when the torus picks it up. This has the effect of allowing the torus to turn much faster than the turbine. This difference in speed may be compared to the difference in speed between the smaller and larger gears in any gear train. The result is that engine power output is higher, and engine torque is multiplied.

As the speed of the turbine increases, the fluid spins faster and faster in the direction of engine rotation. As a result, the ability of the stator to redirect the fluid flow is reduced. Under cruising conditions, the stator is eventually forced to rotate on its one-way clutch in the direction of engine rotation. Under these conditions, the torque converter begins to behave almost like a solid shaft, with the torus and turbine speeds being almost equal.

THE PLANETARY GEARBOX

The ability of the torque converter to multiply engine torque is limited. Also, the unit tends to be more efficient when the turbine is rotating at relatively high speeds. Therefore, a planetary gearbox is used to carry the power output of the turbine to the driveshaft.

Planetary gears function very similarly to conventional transmission gears. However, their construction is different in that three elements make up one gear system, and, in that all three elements are different from one another. The three elements are: an outer gear that is shaped like a hoop, with teeth cut into the inner surface; a sun gear, mounted on a shaft and located at the very center of the outer gear; and a set of three planet gears, held by pins in a ring-like planet carrier, meshing with both the sun gear and the outer gear. Either the outer gear or the sun gear may be held stationary, providing more than one possible torque multiplication factor for each set of gears. Also, if all three gears are forced to rotate at the same speed, the gearset forms, in effect, a solid shaft.

Most modern automatics use the planetary gears to provide either a single reduction ratio of about 1.8:1, or two reduction gears: a low of about 2.5:1, and an intermediate of about 1.5:1. Bands and clutches are used to hold various portions of the gearsets to the transmission case or to the shaft on which they are mounted. Shifting is accomplished, then, by changing the portion of each planetary gearset which is held to the transmission case or to the shaft.

THE SERVOS AND ACCUMULATORS

The servos are hydraulic pistons and cylinders. They resemble the hydraulic actuators used on many familiar machines, such as bulldozers. Hydraulic fluid enters the cylinder, under pressure, and forces the piston to move to engage the band or clutches.

The accumulators are used to cushion the engagement of the servos. The transmission fluid must pass through the accumulator on the way to the servo. The accumulator housing contains a thin piston which is sprung away from the discharge passage of the accumulator. When fluid passes through the accumulator on the way to the servo, it must move the piston against spring pressure, and this action smooths out the action of the servo.

THE HYDRAULIC CONTROL SYSTEM

The hydraulic pressure used to operate the servos comes from the main transmission oil pump. This fluid is channeled to the various servos through the shift valves. There is generally a manual shift valve which is operated by the transmission selector lever and an automatic shift valve for each automatic upshift the transmission provides: i.e., 2-speed automatics have a low/high shift valve, while 3-speeds have a 1–2 valve, and a 2–3 valve.

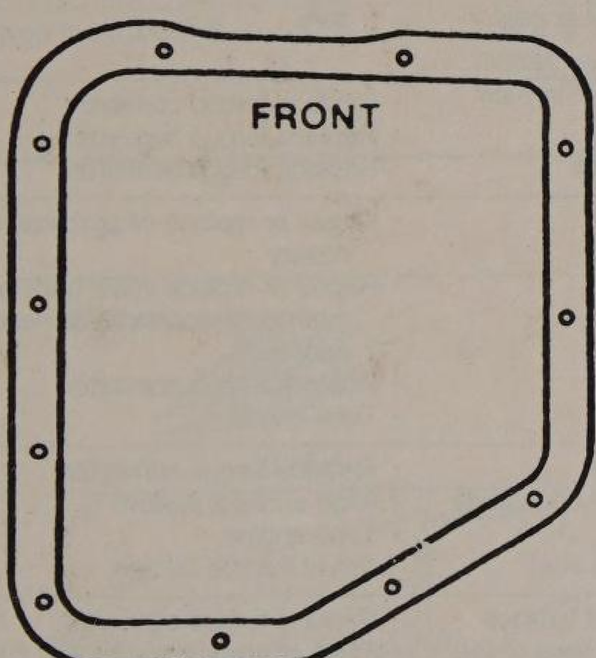
There are two pressures which effect the operation of these valves. One is the governor pressure which is affected by vehicle speed. The other is the modulator pressure which is affected by intake manifold vacuum or throttle position. Governor pressure rises with an increase in vehicle speed, and modulator pressure rises as the throttle is opened wider. By responding to these two pressures, the shift valves cause the upshift points to be delayed with increased throttle opening to make the best use of the engine's power output.

Most transmissions also make use of an auxiliary circuit for downshifting. This circuit may be actuated by the throttle linkage or the vacuum line which actuates the modulator, or by a cable or solenoid. It applies pressure to a special downshift surface on the shift valve or valves.

The transmission modulator also governs the line pressure, used to actuate the servos. In this way, the clutches and bands will be actuated with a force matching the torque output of the engine.

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

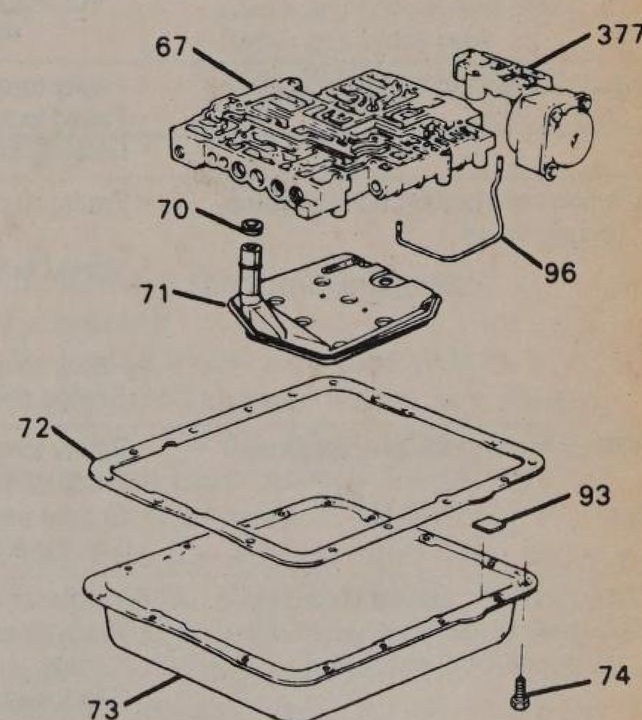
Fluid Pan

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 transmission 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.

Turbo hydra-Matic 700-R4 Gasket



67.Control body valve assembly
70. Filter seal
71. Oil filter assembly
72. Oil pan gasket
73. Oil pan
74. Pan hex bolt and washer
93. Magnet
96. Auxiliary accumulator valve tube
377.Auxiliary accumulator valve body

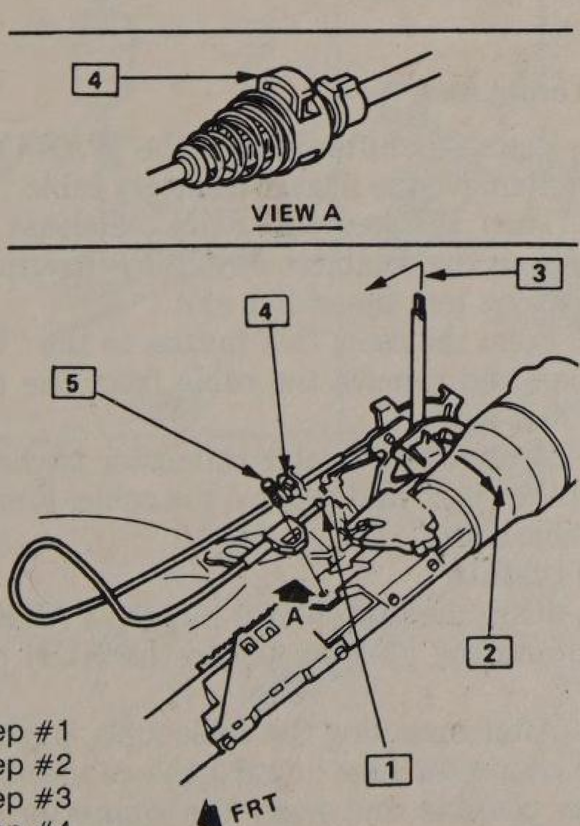
Fluid pan and filter

Lockup Torque Converter Service Diagnosis

Problem	Cause	Solution
No lockup	• Faulty oil pump • Sticking governor valve • Valve body malfunction (a) Stuck switch valve (b) Stuck lockup valve (c) Stuck fail-safe valve • Failed locking clutch • Leaking turbine hub seal • Faulty input shaft or seal ring	• Replace oil pump • Repair or replace as necessary • Repair or replace valve body or its internal components as necessary • Replace torque converter • Replace torque converter • Repair or replace as necessary
Will not unlock	• Sticking governor valve • Valve body malfunction (a) Stuck switch valve (b) Stuck lockup valve (c) Stuck fail-safe valve	• Repair or replace as necessary • Repair or replace valve body or its internal components as necessary
Stays locked up at too low a speed in direct	• Sticking governor valve • Valve body malfunction (a) Stuck switch valve (b) Stuck lockup valve (c) Stuck fail-safe valve	• Repair or replace as necessary • Repair or replace valve body or its internal components as necessary
Locks up or drags in low or second	• Faulty oil pump • Valve body malfunction (a) Stuck switch valve (b) Stuck fail-safe valve	• Replace oil pump • Repair or replace valve body or its internal components as necessary
Sluggish or stalls in reverse	• Faulty oil pump • Plugged cooler, cooler lines or fittings • Valve body malfunction (a) Stuck switch valve (b) Faulty input shaft or seal ring	• Replace oil pump as necessary • Flush or replace cooler and flush lines and fittings • Repair or replace valve body or its internal components as necessary
Loud chatter during lockup engagement (cold)	• Faulty torque converter • Failed locking clutch • Leaking turbine hub seal	• Replace torque converter • Replace torque converter • Replace torque converter
Vibration or shudder during lockup engagement	• Faulty oil pump • Valve body malfunction • Faulty torque converter • Engine needs tune-up	• Repair or replace oil pump as necessary • Repair or replace valve body or its internal components as necessary • Replace torque converter • Tune engine
Vibration after lockup engagement	• Faulty torque converter • Exhaust system strikes underbody • Engine needs tune-up • Throttle linkage misadjusted	• Replace torque converter • Align exhaust system • Tune engine • Adjust throttle linkage
Vibration when revved in neutral Overheating: oil blows out of dip stick tube or pump seal	• Torque converter out of balance • Plugged cooler, cooler lines or fittings • Stuck switch valve	• Replace torque converter • Flush or replace cooler and flush lines and fittings • Repair switch valve in valve body or replace valve body
Shudder after lockup engagement	• Faulty oil pump • Plugged cooler, cooler lines or fittings • Valve body malfunction • Faulty torque converter • Fail locking clutch • Exhaust system strikes underbody • Engine needs tune-up • Throttle linkage misadjusted	• Replace oil pump • Flush or replace cooler and flush lines and fittings • Repair or replace valve body or its internal components as necessary • Replace torque converter • Replace torque converter • Align exhaust system • Tune engine • Adjust throttle linkage

Troubleshooting Basic Automatic Transmission Problems

Problem	Cause	Solution
Fluid leakage	• Defective pan gasket	• Replace gasket or tighten pan bolts
	• Loose filler tube	• Tighten tube nut
	• Loose extension housing to transmission case	• Tighten bolts
	• Converter housing area leakage	• Have transmission checked professionally
Fluid flows out the oil filler tube	• High fluid level	• Check and correct fluid level
	• Breather vent clogged	• Open breather vent
	• Clogged oil filter or screen	• Replace filter or clean screen (change fluid also)
	• Internal fluid leakage	• Have transmission checked professionally
Transmission overheats (this is usually accompanied by a strong burned odor to the fluid)	• Low fluid level	• Check and correct fluid level
	• Fluid cooler lines clogged	• Drain and refill transmission. If this doesn't cure the problem, have cooler lines cleared or replaced.
	• Heavy pulling or hauling with insufficient cooling	• Install a transmission oil cooler
	• Faulty oil pump, internal slippage	• Have transmission checked professionally
Buzzing or whining noise	• Low fluid level	• Check and correct fluid level
	• Defective torque converter, scored gears	• Have transmission checked professionally
No forward or reverse gears or slippage in one or more gears	• Low fluid level	• Check and correct fluid level
	• Defective vacuum or linkage controls, internal clutch or band failure	• Have unit checked professionally
Delayed or erratic shift	• Low fluid level	• Check and correct fluid level
	• Broken vacuum lines	• Repair or replace lines
	• Internal malfunction	• Have transmission checked professionally



1. Step #1
2. Step #2
3. Step #3
4. Step #4
5. 4 Nm

Park lock cable assembly (1982-83)

5. Remove the filter and gasket.

To install:

1. Install a new filter and gasket.
2. Reinstall the pan with a new gasket.
3. Lower the car. Add Dexron® II automatic transmission fluid through the fill tube.
4. 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 1/4 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.

Adjustments

BAND

There are no band adjustments possible or required for the Turbo Hydra-Matic 200 or 700-R4 transmissions.

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)	• The level is too high (gear train is churning oil) • 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

PARK LOCK CABLE REMOVAL AND INSTALLATION

1982–83

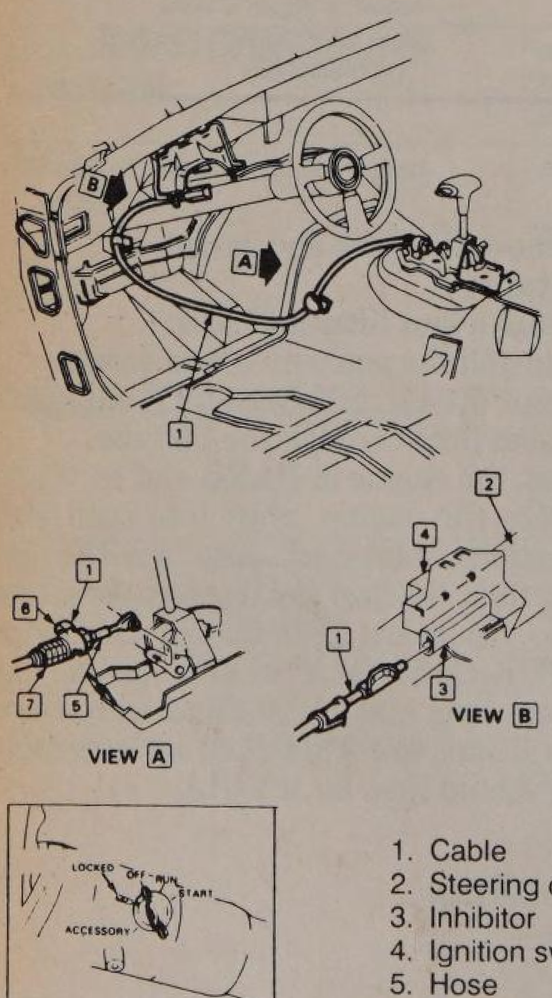
1. Remove the console and steering column covers. Remove cable retaining screw from the steering column slider and disconnect the cable.

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.



1. Cable
2. Steering column
3. Inhibitor
4. Ignition switch
5. Hose
6. Cable lock
7. Connector

Park Lock Cable Assembly (1984 and Later)

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.

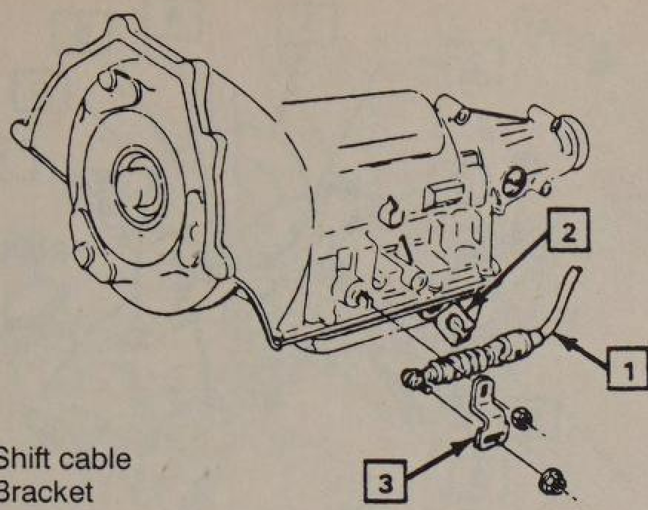
4. Depress the 2 cable connector latches at the shifter base and remove the cable. Remove the cable clips.

To install:

1. Place the shifter lever into the **PARK** position and the ignition key to the **RUN** position.

2. After installing the cable ends, push the cable connector nose toward the connector as far as possible and push the connector lock button down.

3. Complete the installation by reversing the removal procedure.



1. Shift cable
2. Bracket
3. Lever

Shift Cable Assembly at Transmission

PARK LOCK CABLE ADJUSTMENT

NOTE: *The adjustment procedures are covered under the Park Lock Cable Removal and Installation procedures.*

SHIFT CONTROL CABLE

1. Place the control lever in **N**.
2. Raise the car and support it with jackstands.
3. Loosen the cable attachment a the shift lever.
4. Rotate the shift lever clockwise to the park detent and then back to neutral.
5. Tighten cable attachment to 11 ft. lbs. (15 Nm).

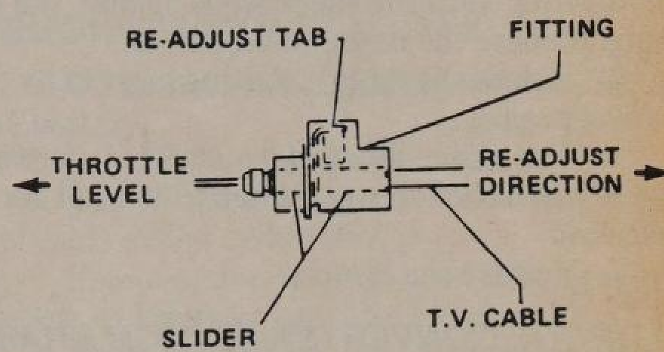
NOTE: *The lever must be held out of* **P** when torquing the nut.

SHIFT LINKAGE

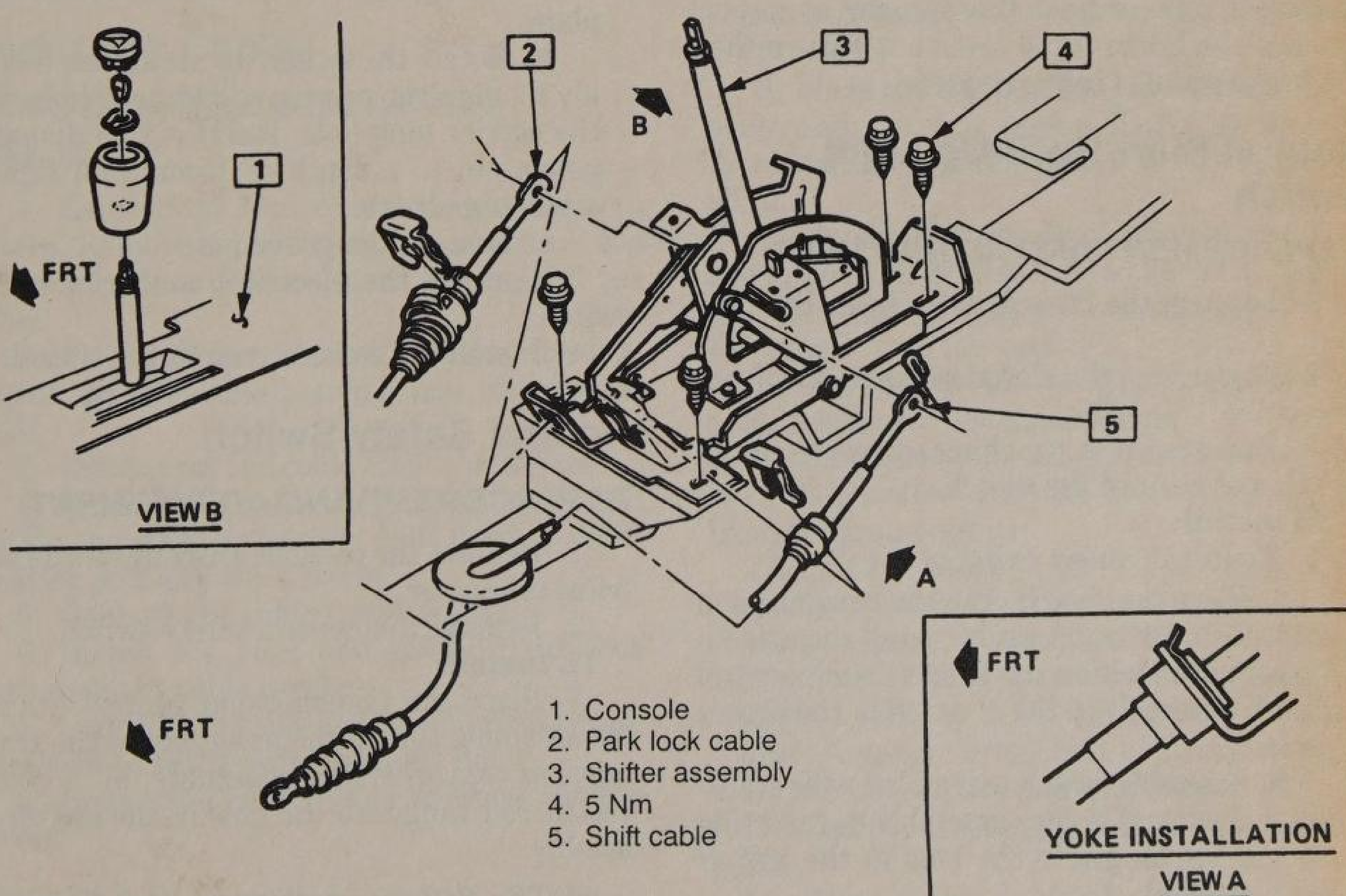
1. Place the manual shaft of the transmission in **N**. Place the console shift lever in **N**.
2. Install the cable in the slot of the shift lever. Adjust the cable so that the pin has free movement.
3. Install and tighten the nut to the pin.

THROTTLE VALVE CABLE

1. After installation of the cable to the transmission, engine bracket, and the cable actuating lever, check to assure that the cable slider is in the zero or fully re-adjusted position.
2. If cable slider is not in the zero or fully

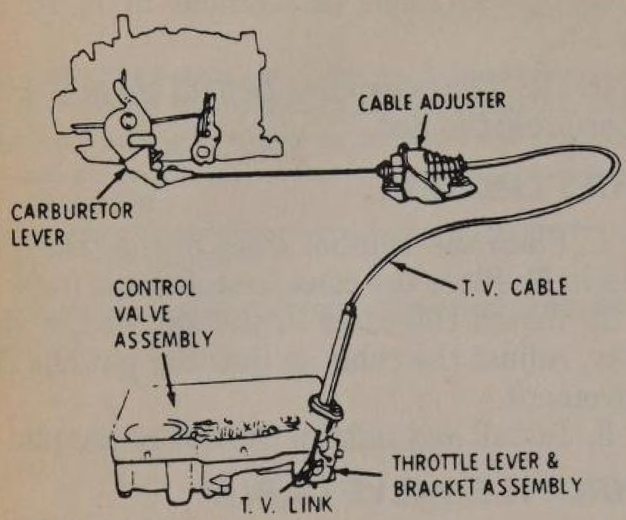


Throttle Valve Cable Adjuster Sleeve

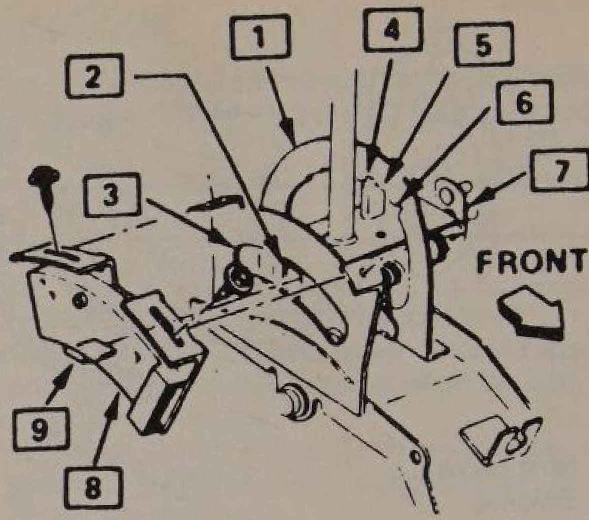


1. Console
2. Park lock cable
3. Shifter assembly
4. 5 Nm
5. Shift cable

Shift cable assembly at console



Throttle Valve Cable Adjuster



1. Detent plate
2. Tang hole
3. Tang slot
4. Neutral notch
5. R
6. P
7. Transmission control shifter
8. Neutral start and backup light switch
9. Carrier tang

Neutral start/backup light switch

re-adjusted, depress and hold the medal re-adjust tab. Move the slider back through the fitting in the direction away from the cable actuating lever until the slider stops against the fitting. Release the metal re-adjust tab.

3. Rotate the cable actuating lever to its full travel position.
4. The slider must move (ratchet) forward lever when the lever is rotated to the full travel position.
5. Release the lever.

TORQUE CONVERTER CLUTCH BRAKE SWITCH

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 brake pedal lever but ensure that the brake pedal is fully released.

Neutral Start/Back-Up Light Switch

REPLACEMENT AND ADJUSTMENT

1. Remove the console trim from the console.
2. Disconnect the electrical connector from the switch.
3. Remove the 2 attaching screws from the switch and remove the switch.

To install:

1. To install a new switch:
   a. Place the switch onto the transmission control shifter and loosely install the attaching screws. Position the transmission control shifter assembly in the N notch in the detent plate.
   b. Assemble switch assembly to the transmission control shifter assembly by inserting the carrier tang into the hole in the shifter lever assembly.
   c. Install the attaching screws and tighten.
   d. Move the transmission control shifter assembly out of **N** position. This will shear the switch internal plastic pin.
2. To install the original switch:
   a. Place the switch onto the transmission control shifter and loosely install the attaching screws. Position the transmission control shifter assembly in the N notch in the detent plate.
   b. Rotate the switch on the shifter assembly to align the service adjustment hole with the carrier tang hole. Insert a 2.34 diameter gauge pin to a depth of 15mm and tighten attaching screws.
   c. Remove the gauge pin.
3. Connect the electrical connector to the switch.
4. Install the console trim to the console.

Neutral Safety Switch

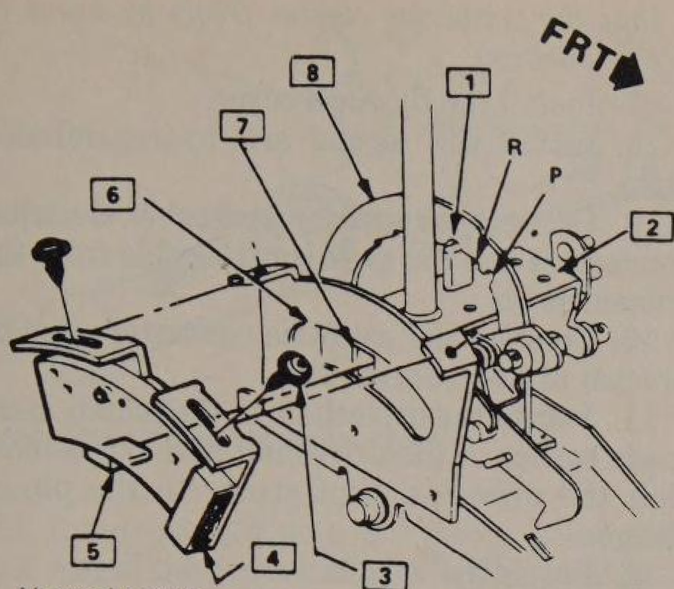
REPLACEMENT AND ADJUSTMENT

1. Remove the console. Disconnect the electrical connector.
2. Remove the neutral safety switch.

To install:

1. Place the transmission control lever in **N.** 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 6mm pin gauge into alignment hole. If the switch is new, it will have a plastic shear pin already installed.*



1. Neutral notch
2. Transmission control shifter
3. 2 Nm (1.5 ft. lbs.) bolt screw
4. Switch assembly
5. Carrier tang
6. Tang slot
7. Tang hole
8. Detent plate

Neutral Safety Switch Assembly

2. Install the mounting screws. Move the shifting lever to shear the plastic alignment pin. If the switch is used, remove the alignment pin.
3. Connect the electrical connector to the switch.
4. Install the console.
5. Check to see if the engine will start in **N** and **P**.

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.
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 **P**. Rotate the steering column shift bowl to the **P** position and lock the column.
5. Connect the cable to the shifter.
6. Install the yoke and push in the lock button on the cable bracket.
7. Connect the cable and install cable retaining screw to the steering column slider.
8. Install the console and steering column covers.

1984–88

1. Place the shifter lever in the **P** 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 **P** 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.
7. Complete the installation by reversing the removal procedure.

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 converter 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 converter and the flywheel so that these parts may be reassembled in the same relationship.

12. Remove the torque converter-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 throttle valve cable and oil cooler lines from the transmission.

16. Support the engine using GM 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, throttle valve cable, or the shift control cable. Also, keep the rear of the transmission lower than the front to avoid the possibility of the torque converter disengaging from the transmission.

To install:

1. Position the transmission and converter into place.

2. Install the transmission-to-engine mounting bolts.

3. Connect the throttle valve cable and oil cooler lines to the transmission.

4. Install the transmission crossmember and secure with bolts.

5. Install the transmission mount bolt.

6. Match mark the torque converter to flywheel. Install the torque converter-to-flywheel attaching bolts.

NOTE: *Before installing the converter-to-flywheel bolts, be sure that the weld nuts on the converter are flush with the flywheel, and that the converter rotates freely by hand in this position.*

7. Install the flywheel cover.

8. Install the torque arm-to-transmission bolts.

9. Connect the speedometer cable, electrical connectors and the shift control cable from the transmission.

10. Connect the catalytic converter support bracket at the transmission.

11. Install the driveshaft to the match mark made earlier to the driveshaft and axle pinion. Bolt the universal joint straps to the pinion flange.

12. Lower the vehicle.

13. Install the dipstick tube using a new dipstick tube O-ring and secure with the bolt. Install the transmission oil dipstick.

14. Connect the throttle valve (TV) control cable at the carburetor.

15. Install the air cleaner assembly.

16. Connect the negative battery cable at the battery.

DRIVELINE

Driveshaft and U-Joints

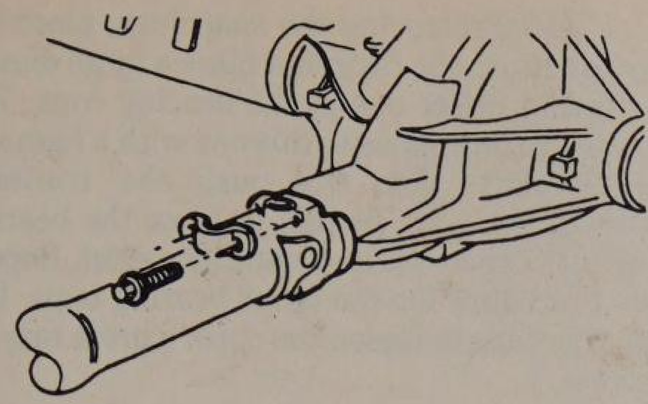
The driveshaft (propeller shaft) is a long steel tube that transmits engine power from the transmission to the rear axle assembly. It is connected to, and revolves with, the transmission output shaft (remember, the transmission shaft is connected to and revolves with the engine crankshaft) whenever the transmission is put into gear. With the transmission in neu-

Troubleshooting Basic Driveshaft and Rear Axle Problems

When abnormal vibrations or noises are detected in the driveshaft area, this chart can be used to help diagnose possible causes. Remember that other components such as wheels, tires, rear axle and suspension can also produce similar conditions.

BASIC DRIVESHAFT PROBLEMS

Problem	Cause	Solution
Shudder as car accelerates from stop or low speed	• Loose U-joint • Defective center bearing	• Replace U-joint • Replace center bearing
Loud clunk in driveshaft when shifting gears	• Worn U-joints	• Replace U-joints
Roughness or vibration at any speed	• Out-of-balance, bent or dented driveshaft • Worn U-joints • U-joint clamp bolts loose	• Balance or replace driveshaft • Replace U-joints • Tighten U-joint clamp bolts
Squeaking noise at low speeds	• Lack of U-joint lubrication	• Lubricate U-joint; if problem persists, replace U-joint
Knock or clicking noise	• U-joint or driveshaft hitting frame tunnel • Worn CV joint	• Correct overloaded condition • Replace CV joint



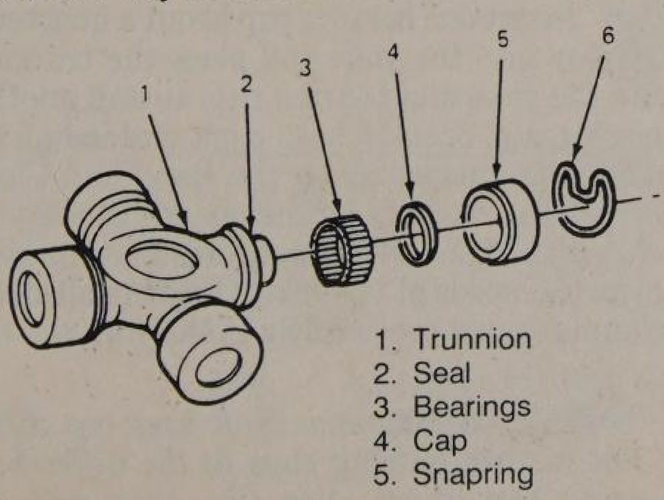
Strap-type retainer on drive shaft

tral, 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.

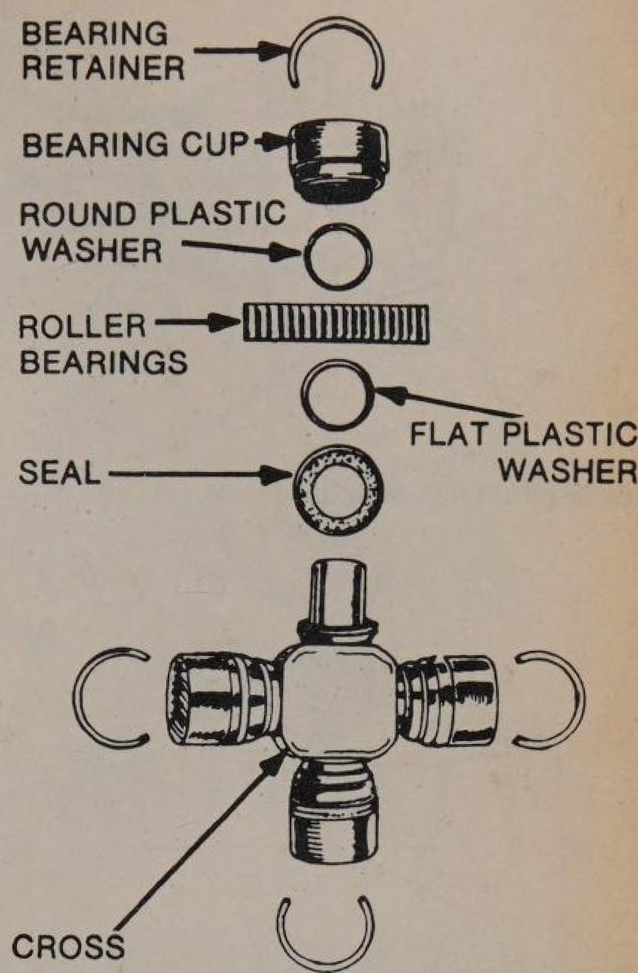
A slip joint is coupled to the front of the driveshaft by a universal joint. This U-joint allows the yoke (slip joint) to move up and down with the car. The yoke is a cylinder containing splines that slide over the meshes with the splines on the transmission output shaft. When the rear axle moves up 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 Firebird U-joint is secured to the yoke in one of two ways. Dana and Cleveland shafts use



Driveshaft trunnion (Dana)



Driveshaft trunnion (Saginaw)

a conventional snapring to hold each bearing cup in the yoke. The snapring 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 snapring. 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.

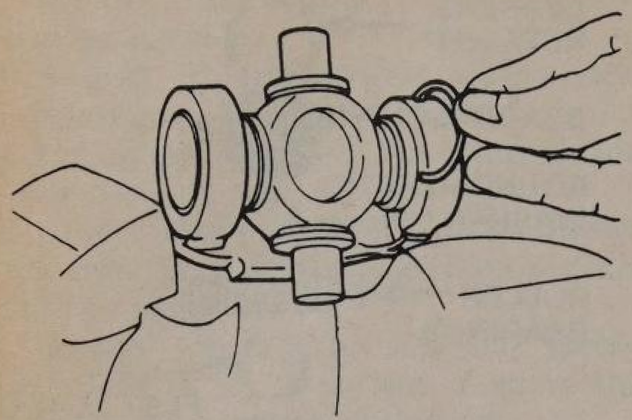
Replacement kits include new bearing cups and conventional snaprings to replace the original nylon rings. These replacement rings must go inboard of the yoke in contrast to outboard mounting of the Dana and Cleveland designs. Previous service to the Saginaw U-joints can be recognized by the presence of snaprings 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. Firebird U-joints require no periodic maintenance and therefore have no lubrication fittings.

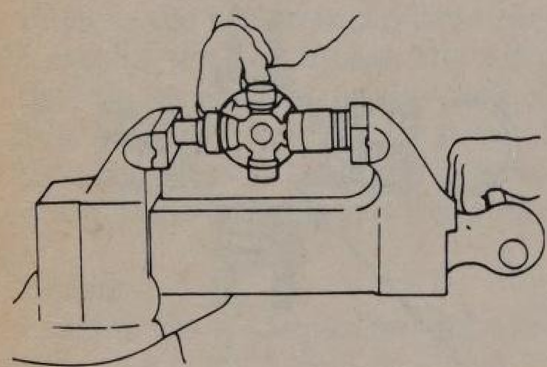
Driveshaft

REMOVAL AND INSTALLATION

1. Raise the vehicle and safely support it on



Installing trunnion snap ring



Installing U-joint trunnion seal

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.*

To install:

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 snaprings from the ends of the bearing cup.

2. After removing the snaprings, 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 snaprings of the Dana and Cleveland designs. 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 snapring. 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 snaprings to replace the original nylon rings.*

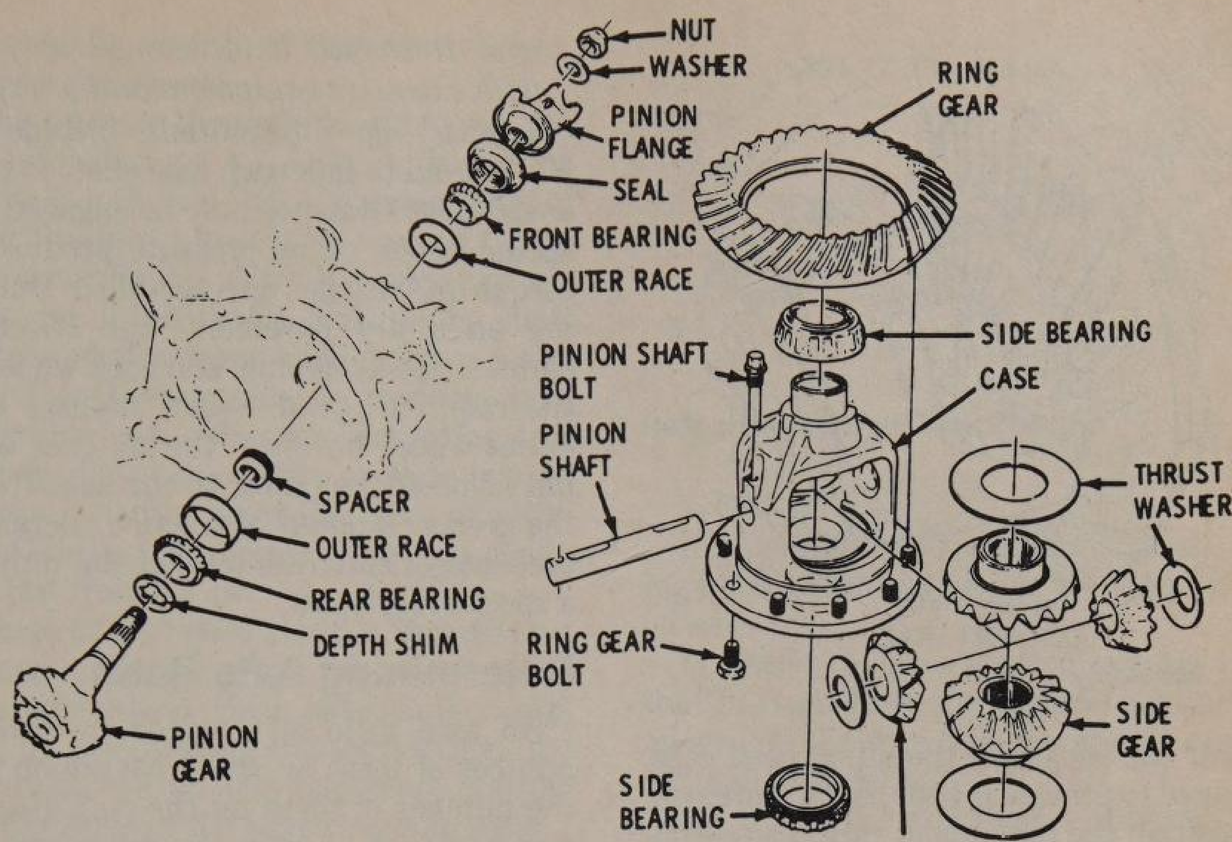
3. Thoroughly clean the entire U-joint assembly with solvent. Inspect for excessive wear in the yoke bores and on the four ends of the trunnion. The needle bearings should not be scored, broken, or loose in their cups. Bearing cups may suffer slight distortion during removal and should be replaced.

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 snaprings. Snaprings 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.*



Exploded view of the rear axle

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.

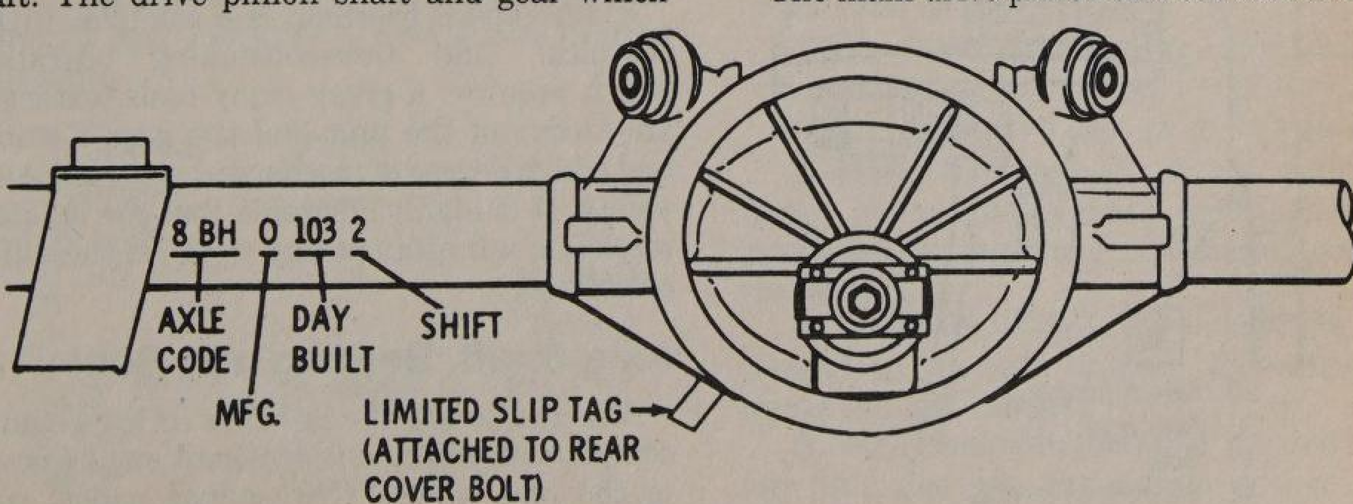
Understanding Drive Axles

The drive axle is a special type of transmission that reduces the speed of the drive from the engine and transmission and divides the power to the wheels. Power enters the axle from the driveshaft via the companion flange. The flange is mounted on the drive pinion shaft. The drive pinion shaft and gear which carry the power into the differential turn at engine speed. The gear on the end of the pinion shaft drives a large ring gear the axis of rotation of which is 90 degrees away from the of the pinion. The pinion and gear reduce the gear ratio of the axle, and change the direction of rotation to turn the axle shafts which drive both wheels. The axle gear ratio is found by dividing the number of pinion gear teeth into the number of ring gear teeth.

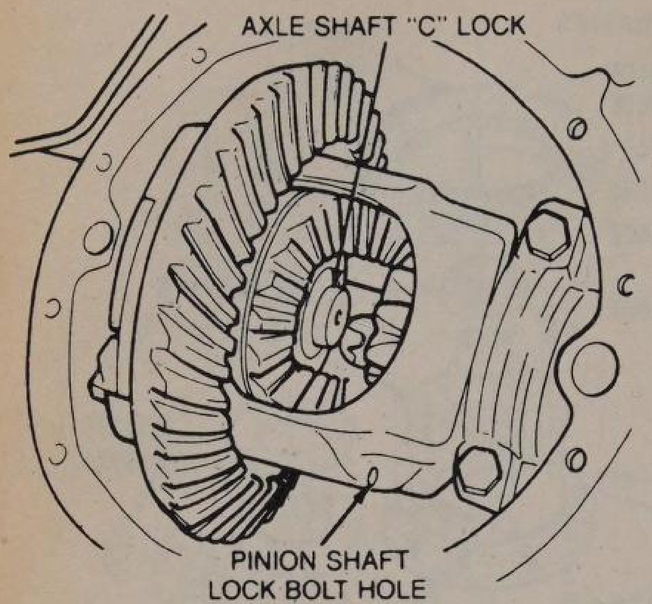
The ring gear drives the differential case. The case provides the two mounting points for the ends of a pinion shaft on which are mounted two pinion gears. The pinion gears drive the two side gears, one of which is located on the inner end of each axle shaft.

By driving the axle shafts through the arrangement, the differential allows the outer drive wheel to turn faster than the inner drive wheel in a turn.

The main drive pinion and the side bearings,



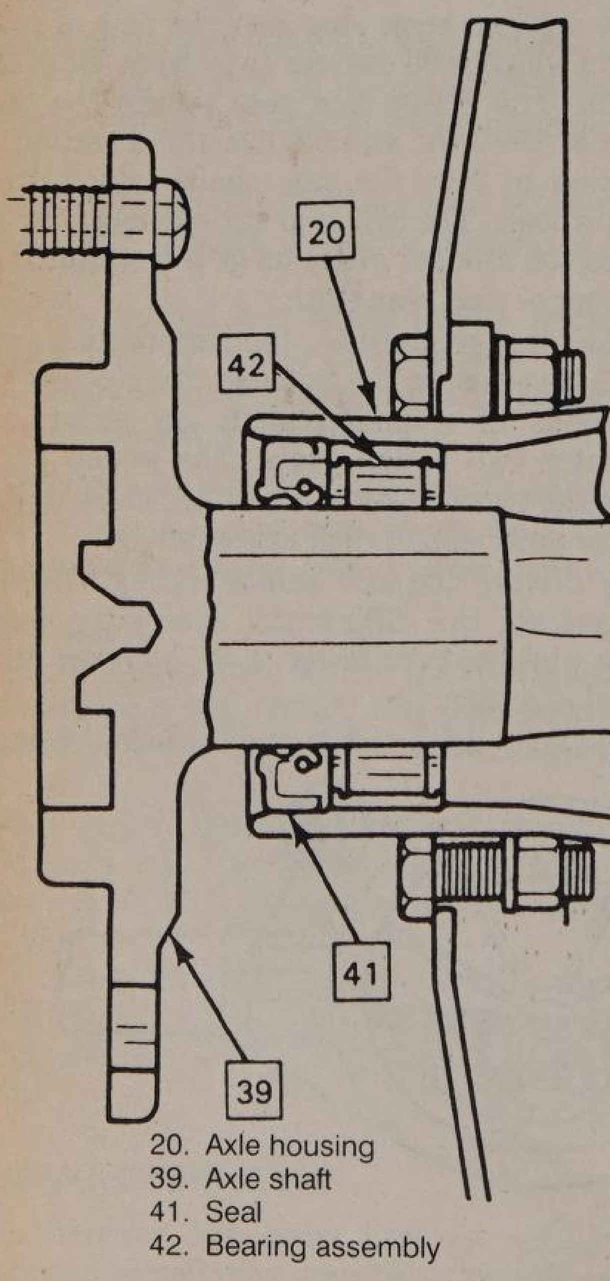
Rear Axle Identification Code



Rear Axle Assembly

which bear the weight of the differential case, are shimmed to provide proper bearing preload, and to position the pinion and ring gears properly.

WARNING: *The proper adjustment of the relationship of the ring and pinion gears is critical. It should be attempted only by those with extensive equipment and/or experience.*



Axle housing components

Limited-slip differentials include clutches which tend to link each axle shaft to the differential case. Clutches may be engaged either by spring action or by pressure produced by the torque on the axles during a turn. During turning on a dry pavement, the effects of the clutches are overcome, and each wheel turns at the required speed. When slippage occurs at either wheel, however, the clutches will transmit some of the power to the wheel which has the greater amount of traction. Because of the presence of clutches, limited-slip units require a special lubricant.

Determining 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.

Differential Overhaul

A differential overhaul is a complex, highly technical, and time-consuming operation, which requires a great many tools, extensive knowledge of the unit and the way it works, and a high degree of mechanical experience and ability. It is highly advisable that the amateur mechanic not attempt any work on the differential unit.

Axle Shaft, Bearing and Seal

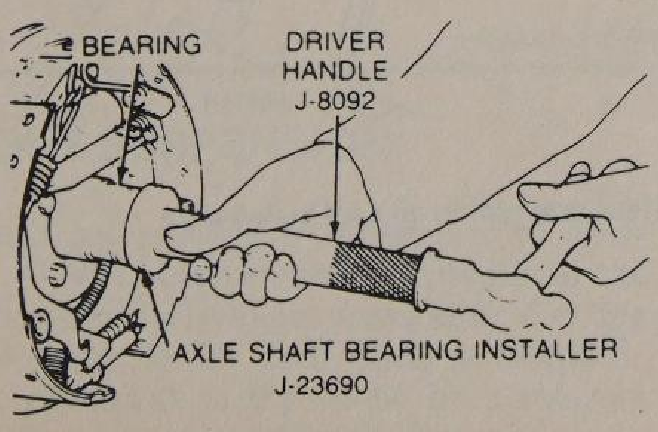
Axle shafts are the last link in the chain of components working to transmit engine power to the rear wheels. The splined end of each shaft meshes with the internal splines of each differential side gear. As the side gears turn, so do the axle shafts, and, since they are also connected, so do the wheels.

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.

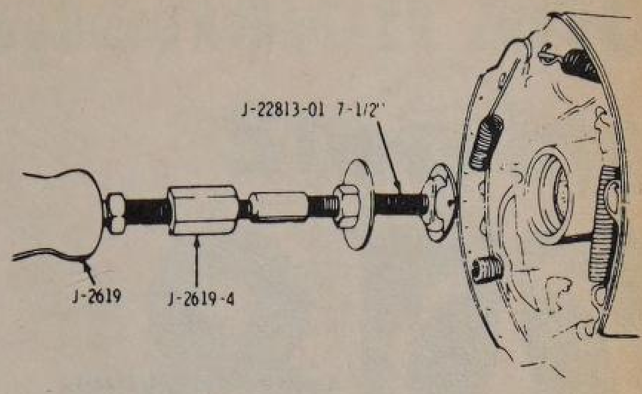
The wheel end of each shaft is flanged and pressed into it are five wheel lug bolts serving to hold on the wheel. Each axle shaft is supported by an axle bearing (wheel bearing) and oil seal located within the axle shaft housing just to the outside of the brake backing plate.

REMOVAL AND INSTALLATION

1. Raise the vehicle and remove the wheels and brake drums.
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 lubricant and lubricate a new wheel bearing with same.



Installing the Rear Axle Bearing



Removing the Rear Axle Bearing

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.

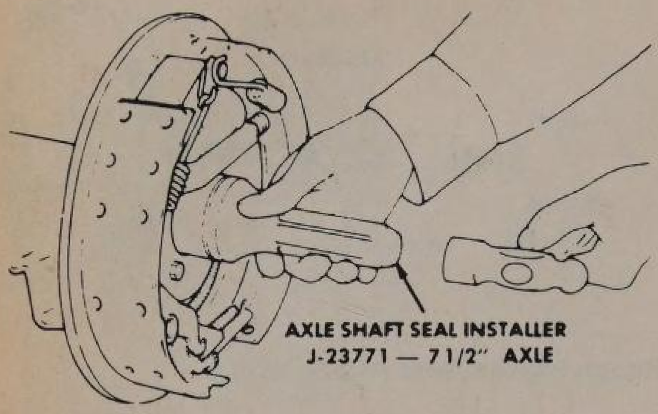
Pinion Seal

REMOVAL AND INSTALLATION

1. Mark the driveshaft and the pinion companion flange so that they can be reassembled in the same position.
2. Disconnect the driveshaft from the pinion companion flange and support the propeller shaft up in the body tunnel by wiring it to the exhaust pipe.

NOTE: *If the joint bearing caps are not retained by a retainer strap, use a piece of tape to hold the bearing caps on their trunnions.*

3. Mark the position of the companion flange, pinion shaft and nut, so that the proper pinion bearing preload can be maintained upon reassembly.
4. Using Tool J-8614-10 to hold the pinion companion flange, remove the companion flange nut and washer.
5. With a suitable container in place to hold any fluid that may drain from thee rear axle, remove the pinion companion flange with Tool J-8614-10.



Installing the Rear Axle Seal

6. Remove the seal by driving it out with a blunt chisel.

WARNING: *Be careful not to damage the carrier.*

7. Examine the pinion companion flange for any nicks or damage. If so, replace it.

8. Examine the pinion seal bore in the carrier and remove any burrs.

9. Using Tool J–23911, install a new seal.

10. Apply Special Seal Lubricant, No. 1050169 or equivalent to the O.D. of the pinion flange and sealing lip of the new seal.

11. Install the pinion companion flange and nut and tighten the nut $\frac{1}{16}$ in. beyond the alignment marks.

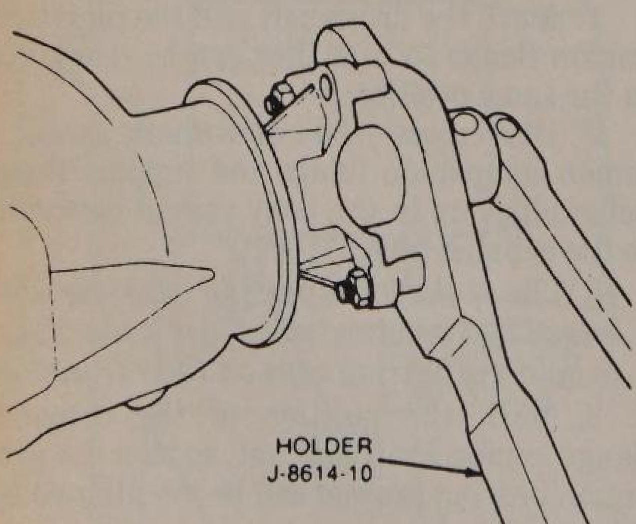
Axle Housing

REMOVAL AND INSTALLATION

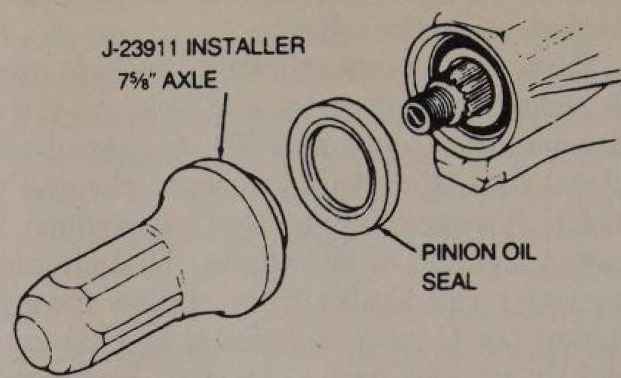
1. Raise the vehicle and support it safely. Be sure that the rear axle assembly is supported safely.

2. Disconnect shock absorbers from axle. Remove the wheel assemblies.

3. Mark driveshaft and pinion flange, then disconnect driveshaft and support out of the way.



Rear axle pinion nut removal and installation



Rear axle pinion oil seal installation

4. Remove brake line junction block bolt at axle housing. If necessary, disconnect the brake lines at the junction block.

5. Disconnect the upper control arms from the axle housing.

6. Lower the rear axle assembly. Remove the springs.

7. Continue lowering the rear axle assembly and remove it from the vehicle.

To install:

1. Position the rear axle assembly into place and install the springs.

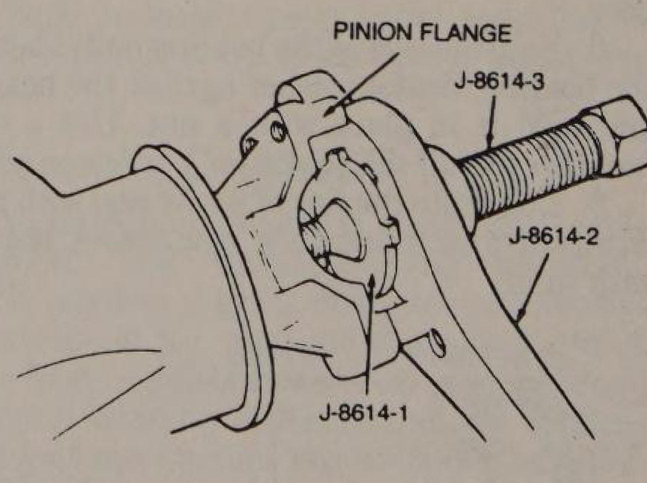
2. Connect the upper control arms to the axle housing.

3. Install the brake line junction block bolt at the axle housing. Connect any brake lines that were disconnected.

4. Install the driveshaft to the match marks made earlier and secure the driveshaft.

5. Connect the shock absorbers to the axle and install the wheel assemblies.

6. Lower the vehicle and replace any lost rear axle fluid.



Rear axle pinion oil seal installation

Suspension and Steering

8

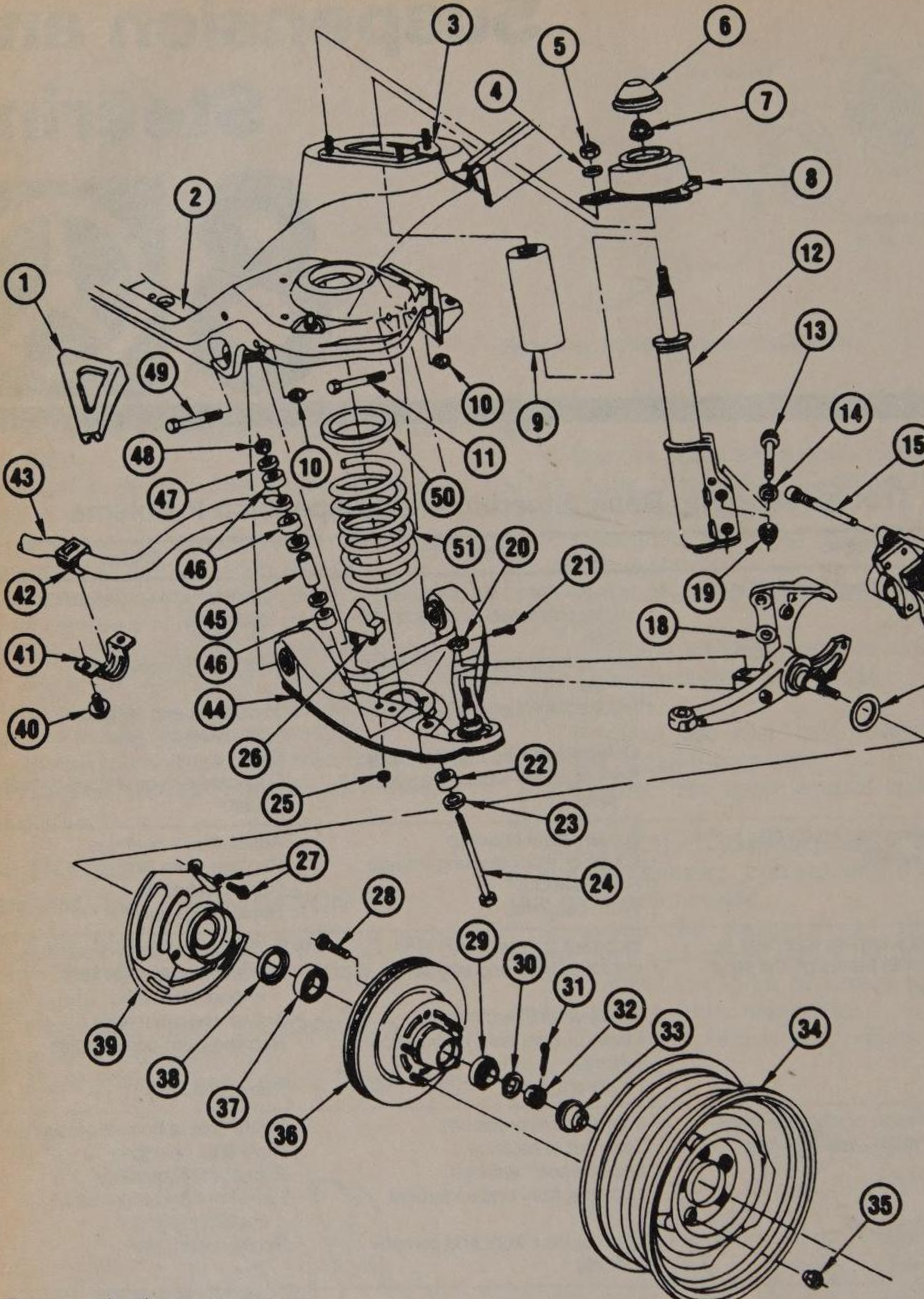
Troubleshooting Basic Steering and Suspension Problems

Problem	Cause	Solution
Hard steering (steering wheel is hard to turn)	• Low or uneven tire pressure • Loose power steering pump drive belt • Low or incorrect power steering fluid • Incorrect front end alignment • Defective power steering pump • Bent or poorly lubricated front end parts	• Inflate tires to correct pressure • Adjust belt • Add fluid as necessary • Have front end alignment checked/adjusted • Check pump • Lubricate and/or replace defective parts
Loose steering (too much play in the steering wheel)	• Loose wheel bearings • Loose or worn steering linkage • Faulty shocks • Worn ball joints	• Adjust wheel bearings • Replace worn parts • Replace shocks • Replace ball joints
Car veers or wanders (car pulls to one side with hands off the steering wheel)	• Incorrect tire pressure • Improper front end alignment • Loose wheel bearings • Loose or bent front end components • Faulty shocks	• Inflate tires to correct pressure • Have front end alignment checked/adjusted • Adjust wheel bearings • Replace worn components • Replace shocks
Wheel oscillation or vibration transmitted through steering wheel	• Improper tire pressures • Tires out of balance • Loose wheel bearings • Improper front end alignment • Worn or bent front end components	• Inflate tires to correct pressure • Have tires balanced • Adjust wheel bearings • Have front end alignment checked/adjusted • Replace worn parts
Uneven tire wear	• Incorrect tire pressure • Front end out of alignment • Tires out of balance	• Inflate tires to correct pressure • Have front end alignment checked/adjusted • Have tires balanced

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 pro-



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

vided 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.

Coil Springs

REMOVAL AND INSTALLATION

1. Raise the front of the vehicle and support it on jackstands.
2. Remove the road wheel(s).
3. Disconnect the stabilizer link from the lower control arm.
4. If the steering gear hinders removal procedures, detach 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.

To install:

1. 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.
2. Connect the lower control arm from the steering knuckle at the ball joint. Connect the lower control arm from the crossmember at the pivot bolts and install the coil spring.
3. Connect the tie rod to the steering knuckle.
4. Attach the steering gear unit.
5. Connect the stabilizer link to the lower control arm.
6. Install the wheel(s).
7. Lower the vehicle.

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:

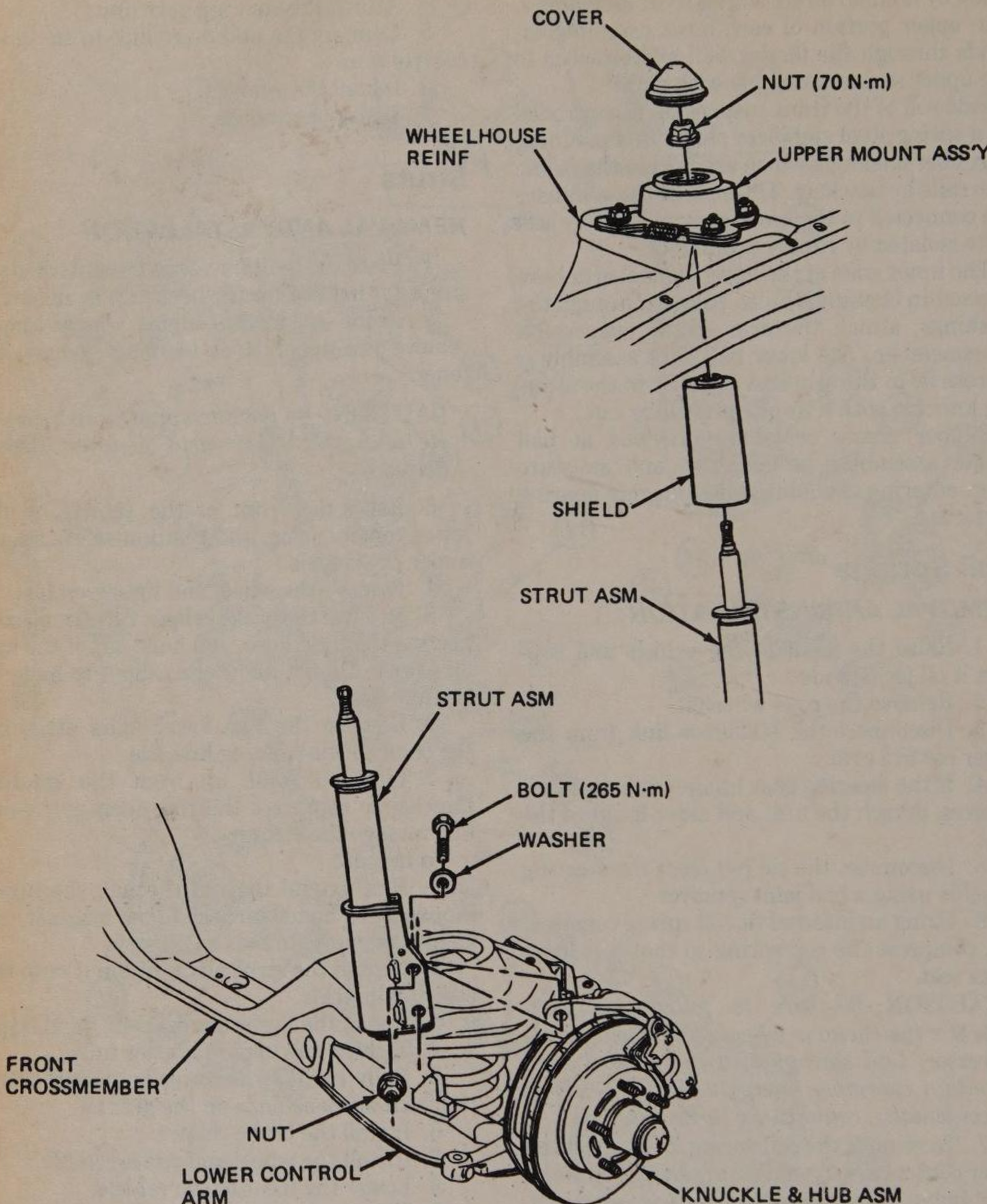
1. Half extend the rod through the upper mount, then hand start the upper fastener, engaging as many threads as possible.
2. Extend the strut and position it onto the steering knuckle.
3. Install the lower mount bolts hand tight.
4. Tighten the upper fastener fully.
5. Fully tighten the lower bolts only when the front suspension is on the ground.
6. Install the brake caliper
7. Install the wheel and tire assembly.
8. Lower the front of the vehicle.
9. From inside the engine compartment, install the upper strut to upper mount fastener.

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.



Remove or 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.*

Lower Ball Joint

INSPECTION

NOTE: *Before performing this inspection, make sure the wheel bearings are adjusted correctly and that the control arm bushings are in good condition.*

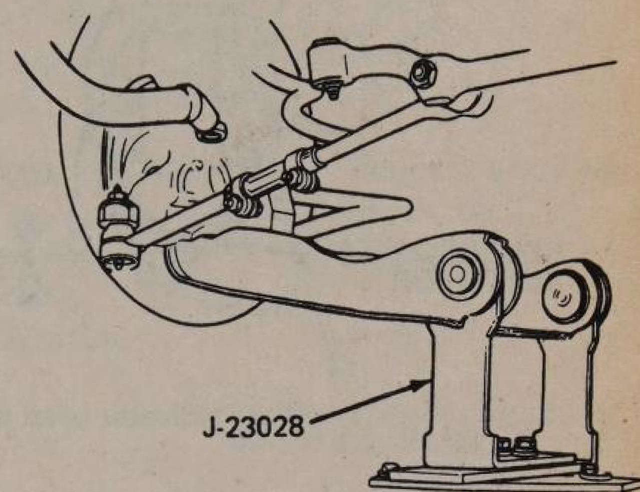
1. Jack the car up under the front lower control arm at the spring seat.
2. Raise the car until there is 1–2 in. of clearance under the wheel.

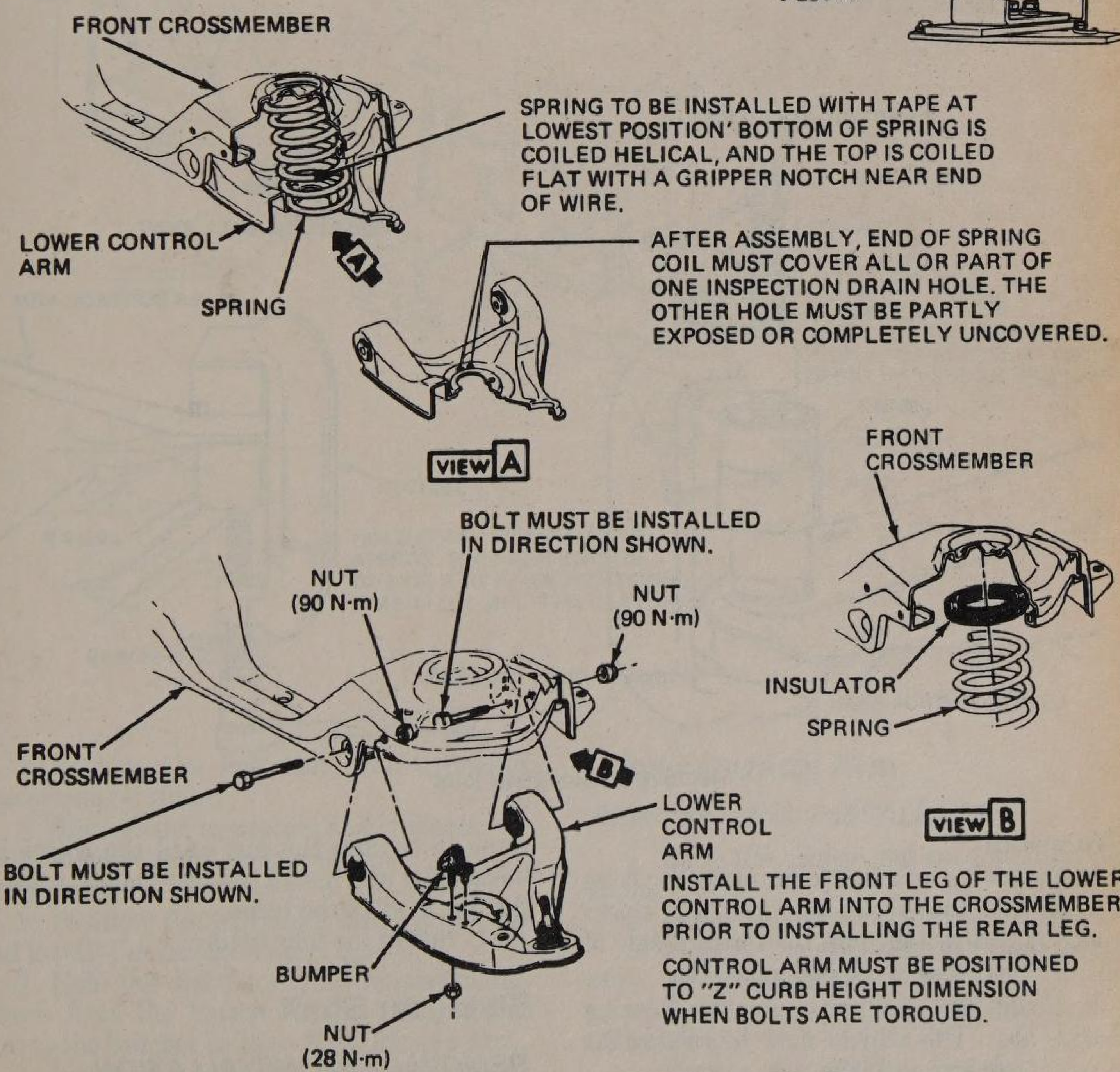
3. Insert a bar under the wheel and pry upward. If the wheel raises more than 1/8 in., the ball joints are worn. Determine if the lower ball joint is worn by visual inspection while prying on the wheel.

REMOVAL AND INSTALLATION

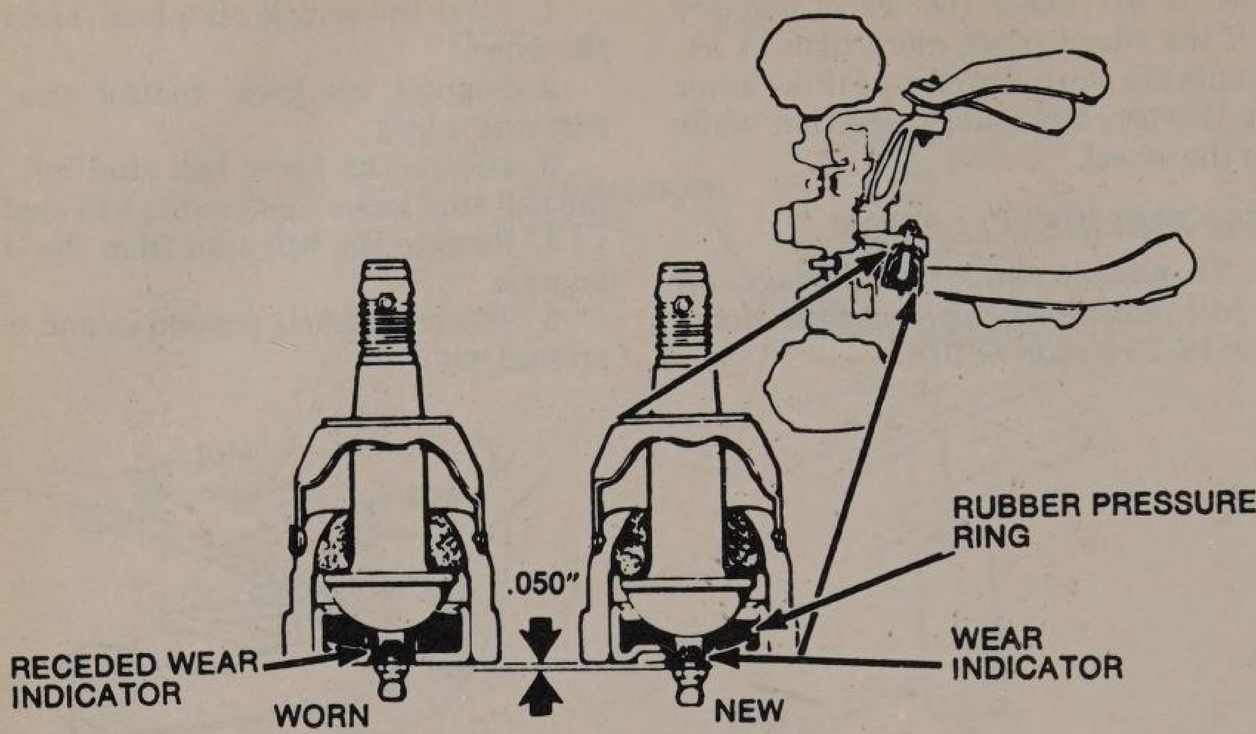
NOTE: *To prevent component damage, an on-car ball joint press, such as Kent-Moore tool J-9519-23 should be used.*

1. Raise the vehicle on a hoist and remove the wheel.
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.

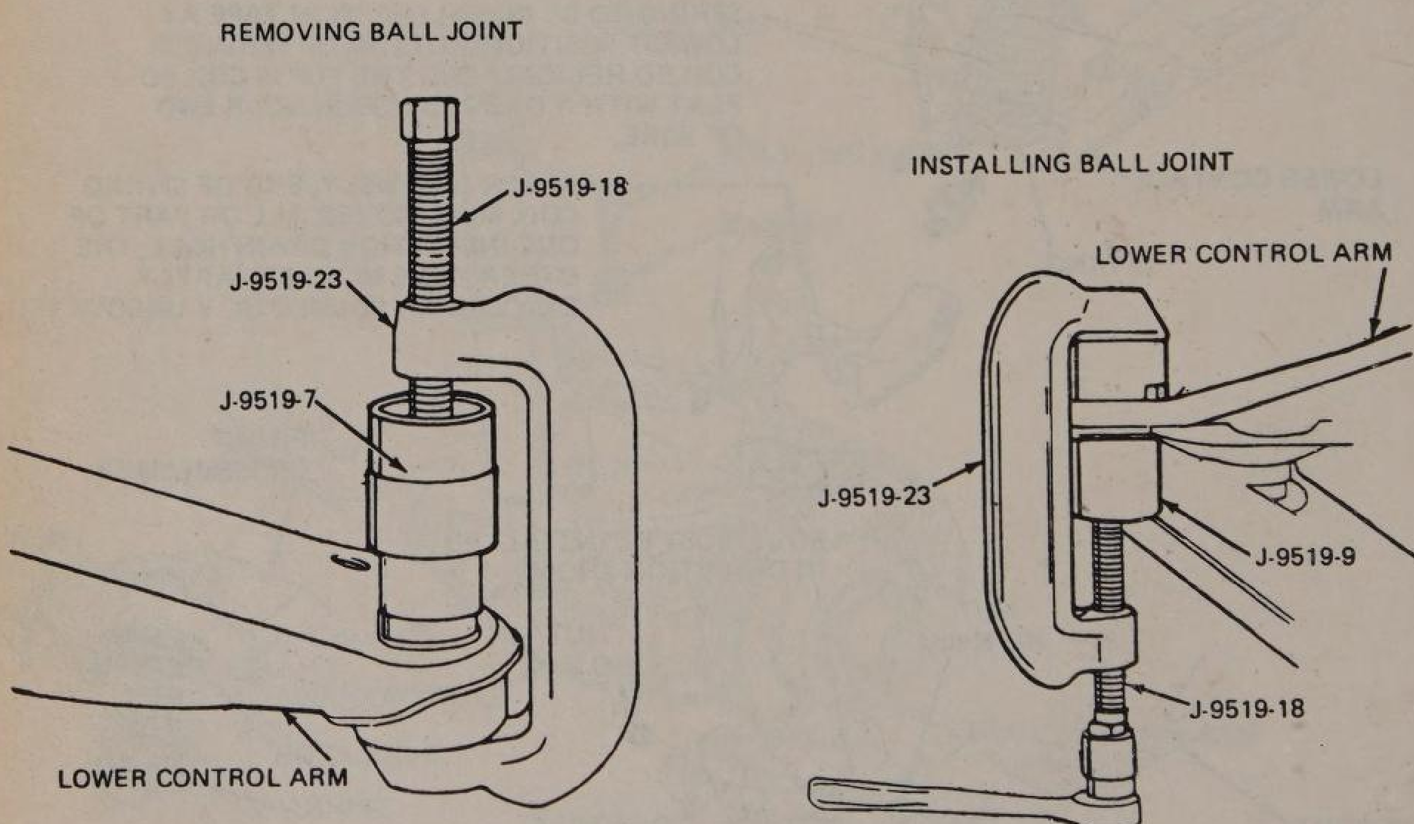




Remove or install coil spring/lower control arm



Wear indicator used on the lower ball joints — all models



Remove or install ball joint

To install:

1. 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.

2. Install the ball stud in the steering knuckle boss. This may be done by raising the lower control arm with the jack.

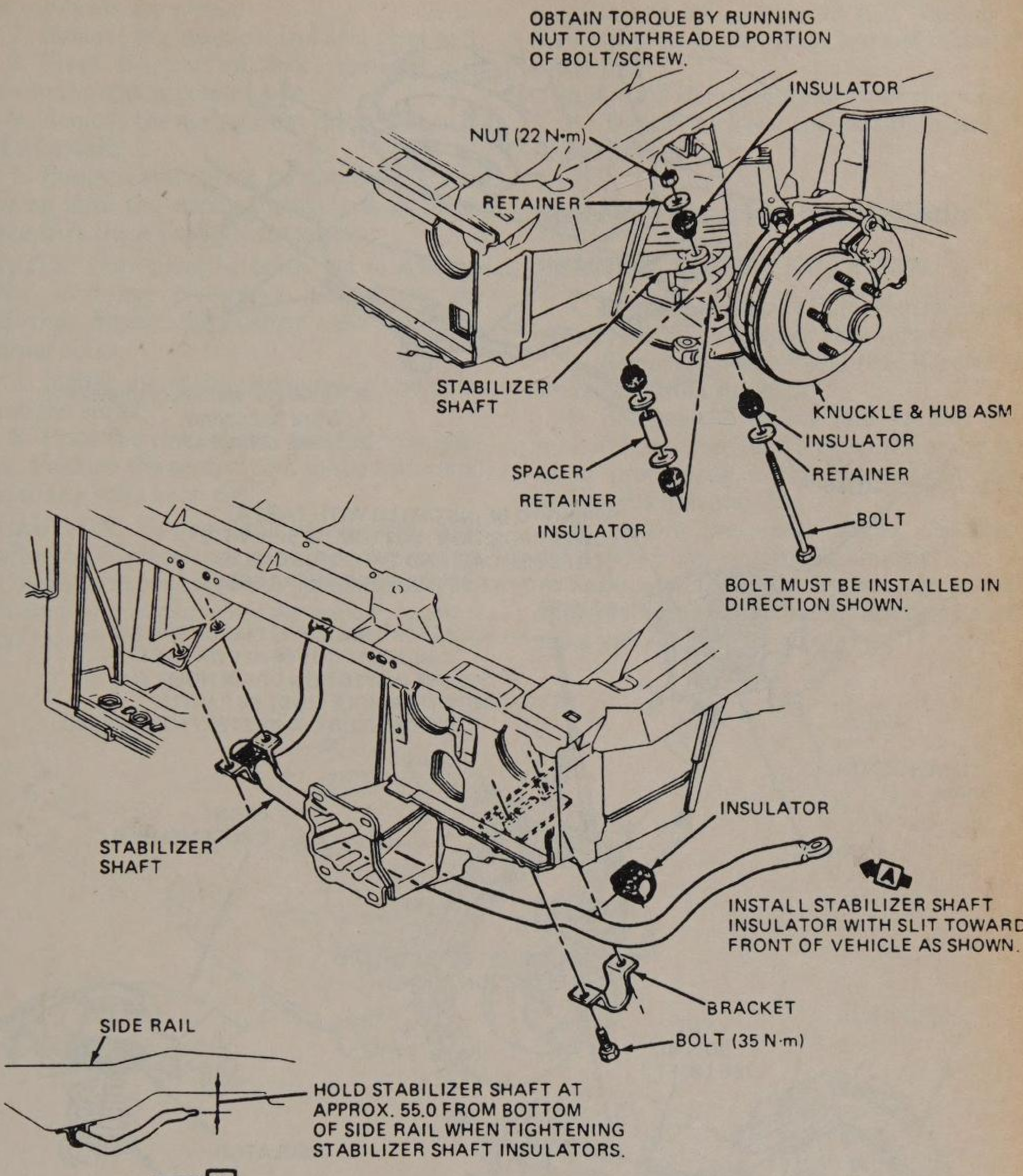
3. Install the nut on the ball stud, tightening to 77 ft. lbs. (105 Nm) on all models. Continue to tighten the nut until the cotter pin holes align and install the pin. Do not back off the nut to align the holes.

4. Install the lube fitting.

Stabilizer Shaft

REMOVAL AND INSTALLATION

1. Raise the car and support the car on jackstands.



Stabilizer shaft assembly

2. Remove the link bolt, nut, grommet, spacer and retainers.
3. Remove the insulators and brackets.
4. Remove the stabilizer shaft.

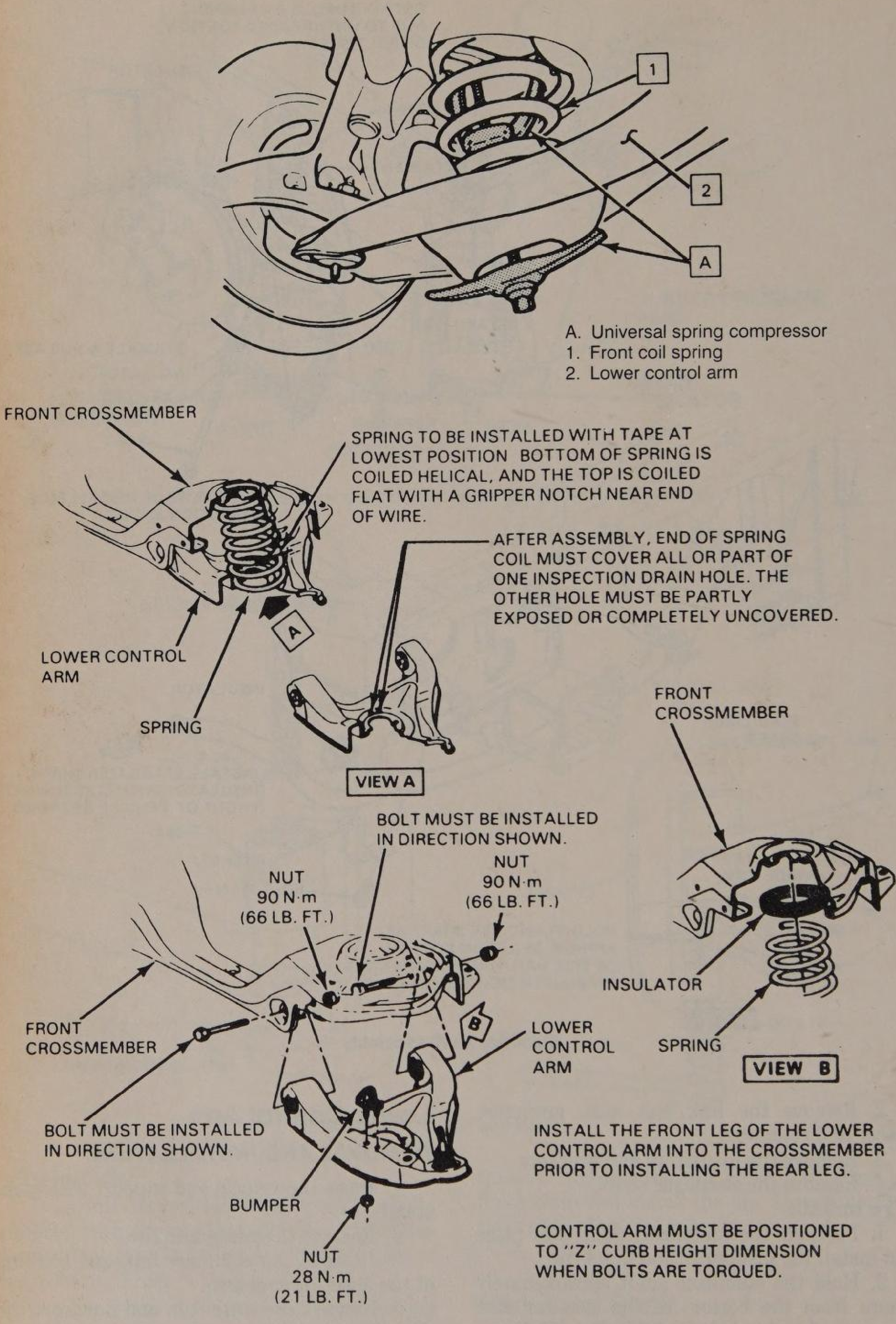
To install:

1. Position the stabilizer shaft into place and install the insulators and brackets.
2. Hold the stabilizer shaft approximately 55mm from the bottom of the side rail and torque the bracket bolts to 37 ft. lbs. (50 Nm).
3. Install the bolt, nut, grommets, spacer and retainers.
4. Lower the car.

Lower Control Arm

REMOVAL AND INSTALLATION

1. Raise the vehicle and support with jackstands.
2. Remove the wheel and tire.
3. Remove the stabilizer link and bushing at the lower control arm.
4. Remove the cotter pin and nut from the tie rod end.
5. Remove the steering knuckle from the tie rod ball joint stud using a ball joint separator J–24292–B.



Compressing and installing the coil spring

6. Install a universal spring compressor and compress the spring.

7. Remove the lower control arm pivot bolt.

8. Pivot the control arm rearward and remove the spring compressor.

9. Remove the spring from the vehicle.

To install:

1. Position the spring on the control arm making sure the spring insulator is in place. Make sure the is properly installed.

NOTE: *Care must be taken not to damage the corrosion protection coating on the spring. Repair the coating with corrosion proof paint.*

2. Install the spring compressor and compress the spring.

3. Pivot the control arm forward into position. Position the control arm to the frame and install the bolts hand tight.

CAUTION: *Torque the control arm bolts after the suspension is resting on the spring. Control arm bushings may be damaged if the bolts are tightened while the vehicle weight is off the springs.*

4. Install the stabilizer linkage, steering knuckle and ball joint stud nut. Torque the stud nut to 83 ft. lbs. (113 Nm) and install the cotter pin.

5. Install the wheels and lower the vehicle.

6. Torque the lower control arm bolts to 66 ft. lbs. (90 Nm).

Steering Knuckle and Spindle

REMOVAL AND INSTALLATION

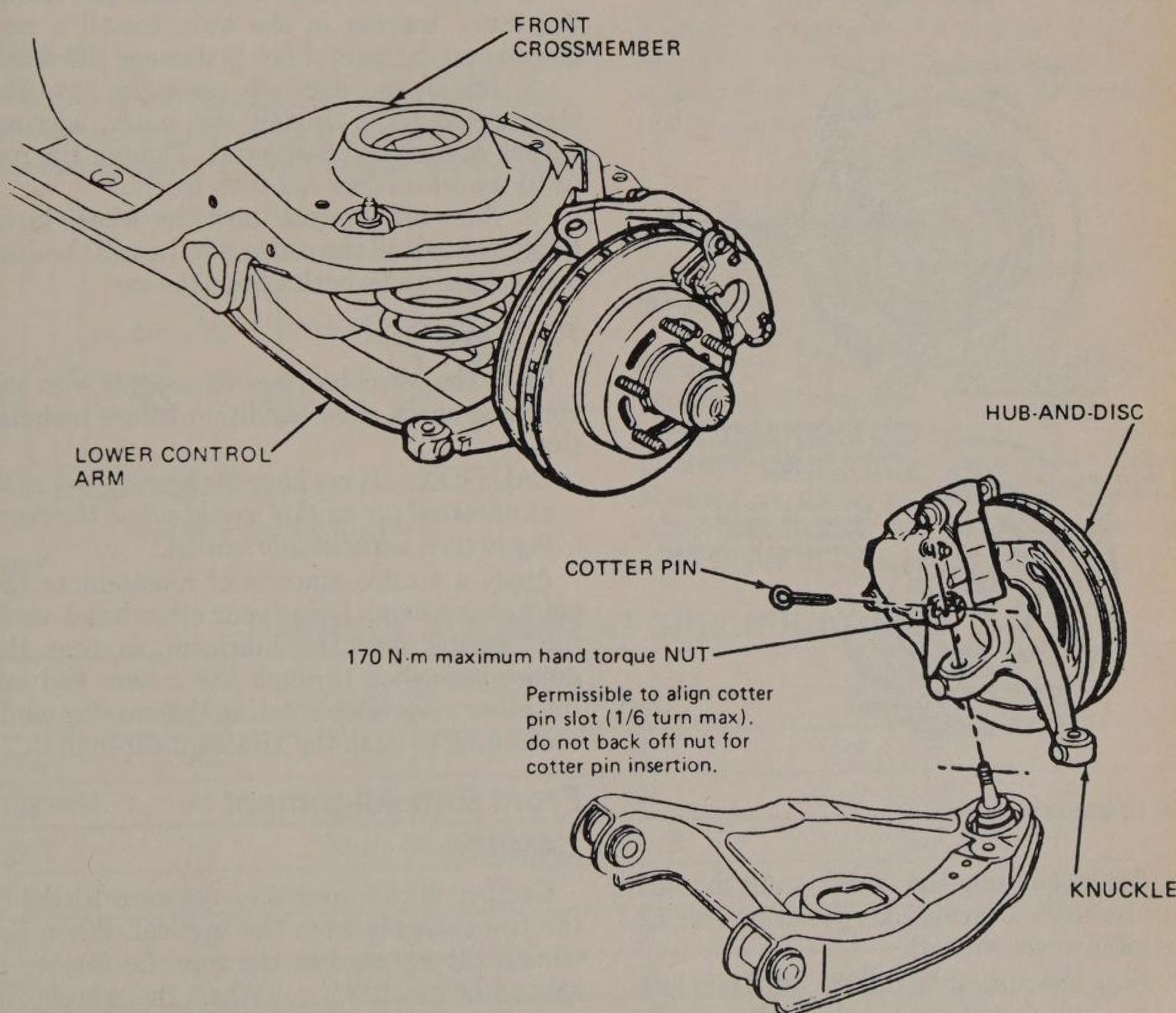
1. Siphon some brake fluid from the master cylinder. Raise and support the vehicle.

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.



Steering knuckle assembly

6. Remove the 2 bolts securing the strut to the steering knuckle and remove the steering knuckle.

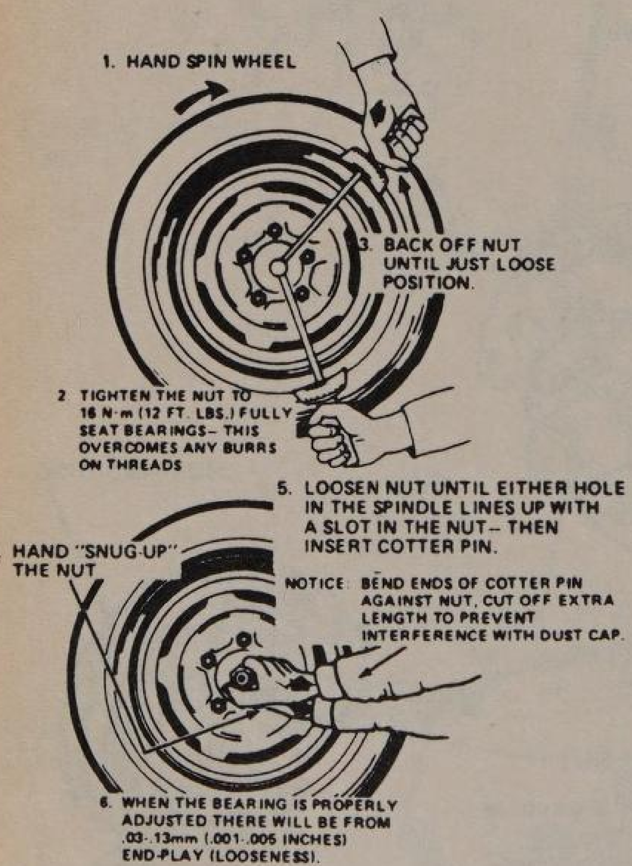
To install:

1. Place the steering knuckle into position and install the 2 bolts securing the strut to the steering knuckle.
2. Support the lower control arm and connect the ball joint to the steering knuckle.
3. Connect the tie rod to the steering knuckle. Install the splash shield.
4. Install the caliper.
5. Install the brake hose from the strut. Install the wheel and tire.
6. Lower the vehicle and refill the master cylinder with brake fluid.

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.



Wheel bearing adjustment

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 1/4 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 0.03–0.13mm. 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 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.

To install:

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.

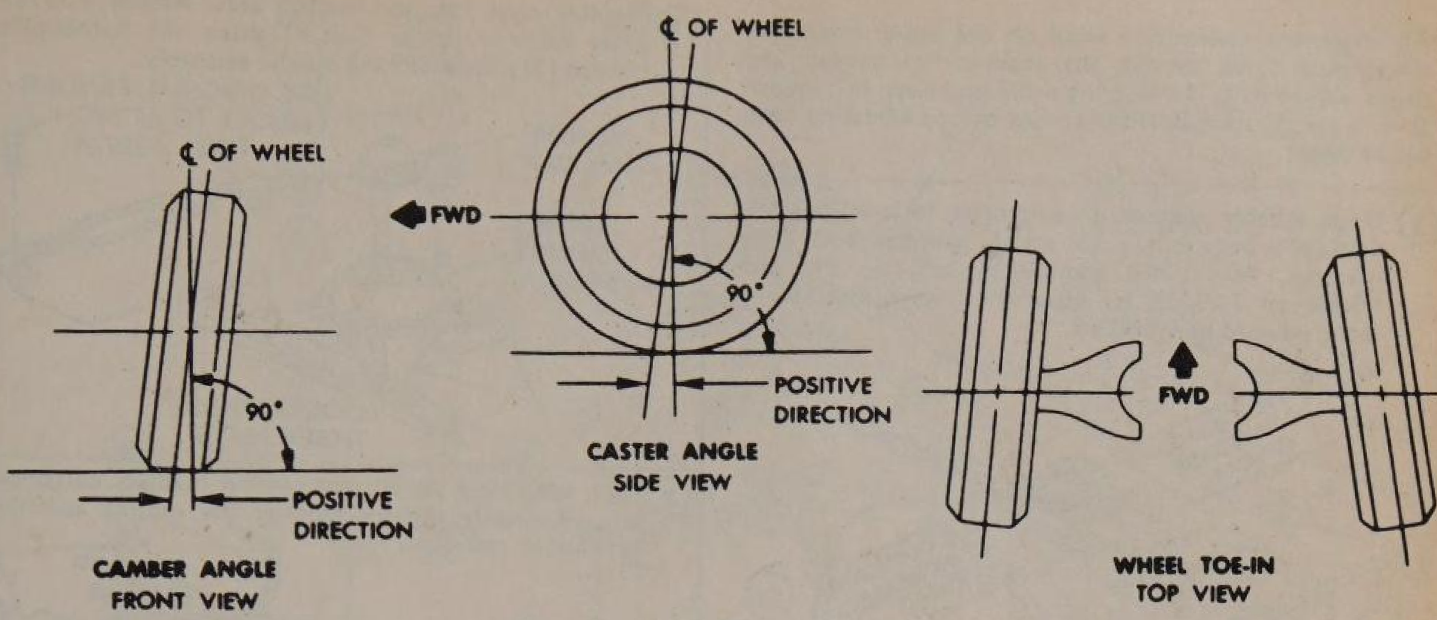
CAUTION: *Do not blow the bearing dry with compressed air as this would allow the bearing to turn without lubrication.*

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.

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.



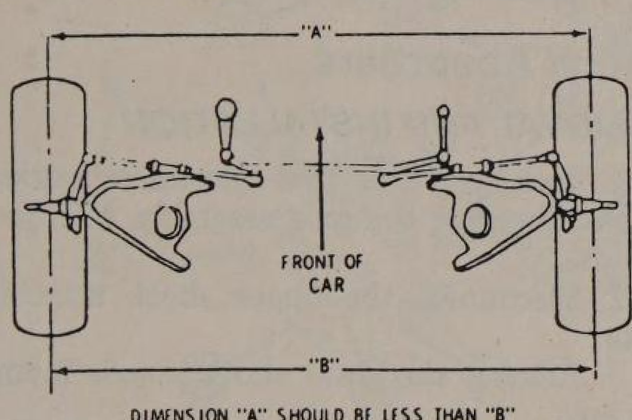
Caster, camber, toe-in

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.)



Toe-in

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.

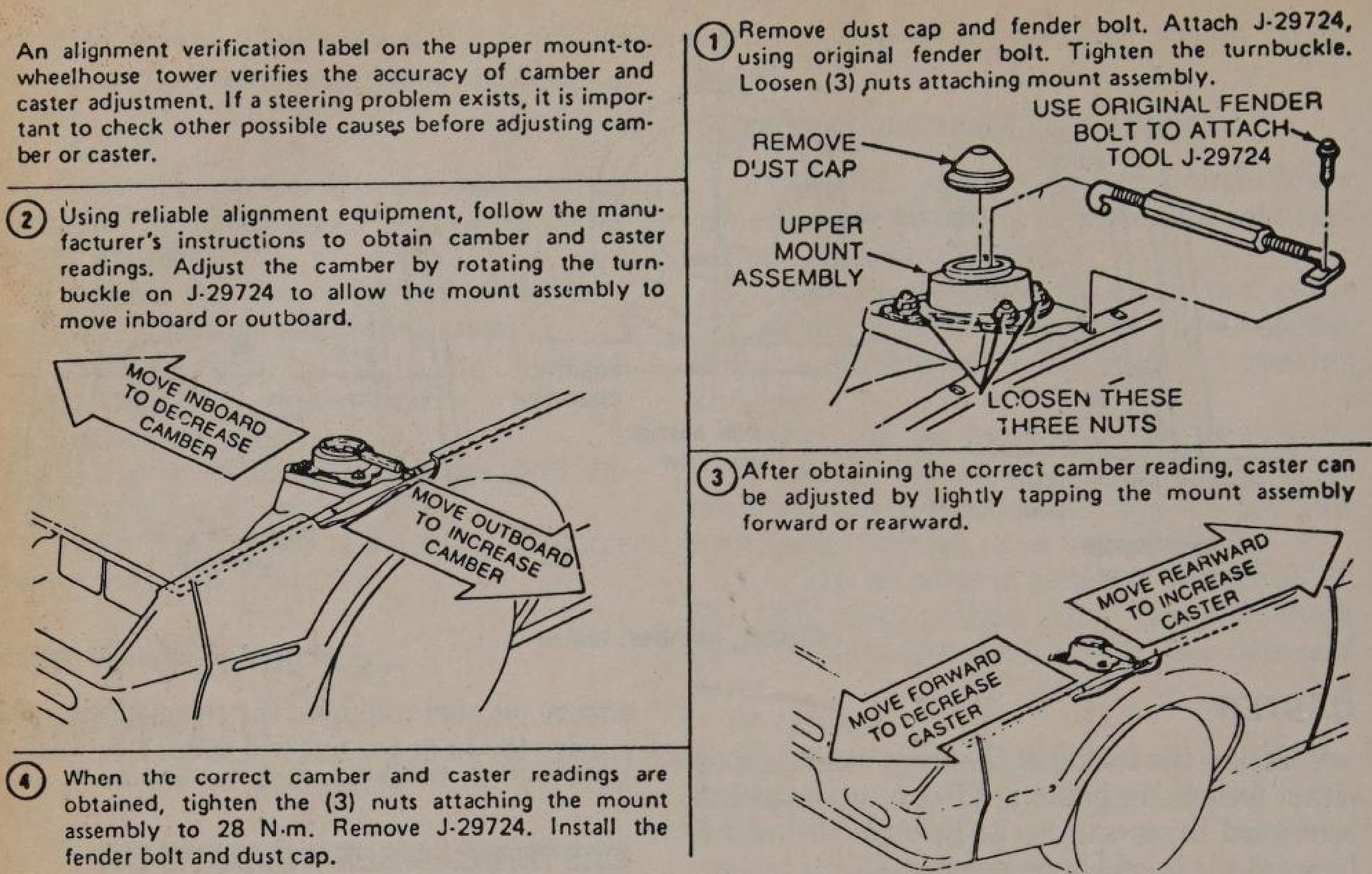
TOE-IN ADJUSTMENT

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.

WHEEL ALIGNMENT SPECIFICATIONS

Years	Models	Caster (deg.) Range	Caster (deg.) Pref.	Camber (deg.) Range	Camber (deg.) Pref.	Toe-in (in.)
1982	All	$2^1/_2$P–$3^1/_2$P	3P	$^1/_2$P–$1^1/_2$P	1P	$^1/_{16}$P
1983–84	All	2P–4P	3P	$^3/_{16}$P–$1^3/_{16}$P	1P	$^1/_{16}$P
1985	All	$2^5/_{16}$P–$3^5/_{16}$P	$2^{13}/_{16}$P	$^1/_2$P–$1^1/_2$P	1P	$^1/_{16}$P
1986	All	3P–4P	$3^1/_2$P	$^1/_2$P–$1^1/_2$P	1P	$^1/_{16}$P
1987	All	$4^1/_2$P–$5^1/_2$P	5P	$^1/_2$–$1^1/_2$P	1P	$^3/_{64}$P
1988	All	$4^1/_2$P–$5^1/_2$P	5P	$^1/_2$N–$^1/_2$P	0	$^3/_{64}$P
1989–90	All	$4^5/_{16}$P–$5^5/_{16}$P	5P	$^1/_2$N–$^1/_2$P	0	$^3/_{64}$P

N Negative
P Positive



Caster and camber adjustment

REAR SUSPENSION

Coil 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.

NOTE: *On vehicles equipped with a 4–cylinder 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.

To install:

1. Install the coil spring by positioning the spring into place with the axle lowered.
2. On vehicles equipped with 4–cylinder engines, install the drive shaft.
3. Raise the axle and install the lower shock absorber bolts.
4. Connect the track bar to the axle.
5. Connect the brake hose attaching brackets, if removed.
6. Remove the support from the rear axle.
7. Lower the vehicle.

Shock Absorbers

REMOVAL AND INSTALLATION

1. Jack up the car to a convenient working height. Support the axle assembly with jackstands.
2. Disconnect the upper shock attaching nuts.
3. Remove the lower shock to axle mounting bolt.
4. Remove the shock absorber.

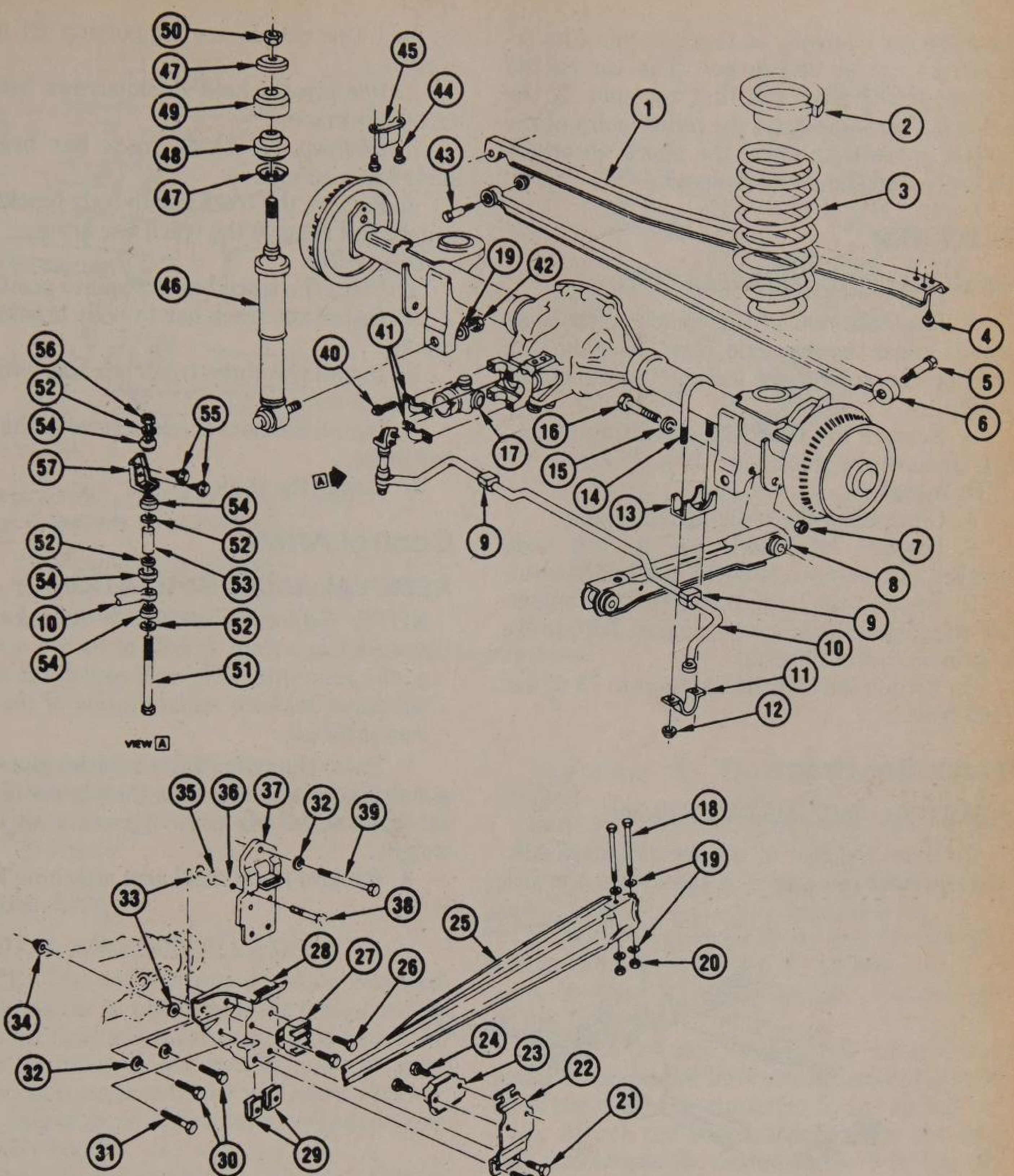
To install:

1. Position the shock into place.
2. Install the lower shock to axle mounting bolt. Torque to 70 ft. lbs. (95 Nm).
3. Connect the upper shock attaching nuts. Torque the upper nuts to 13 ft. lbs. (17 Nm).
4. Lower the car.

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



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. Push-nut
36. Spacer
37. Bracket
38. Bolt
39. Bolt (M10 × 1.5 × 10)
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 (M6 × 1.25 × 180)
52. Washer
53. Spacer
54. grommet
55. Screw (M10 × 1.5 × 32)
56. Nut (M8 × 1.25) (No.2)
57. Bracket

Coil spring rear suspension

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.

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:

1. Clean all of the track bar fasteners.
2. Position the track bar in the body bracket and loosely install the bolt and the nut.
3. Position the track bar to the axle assembly and install the bolt and the nut. Torque the bolt to 59 ft. lbs. (80 Nm).
4. Torque the body bracket nut to 78 ft. lbs. (105 Nm).

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.

To install:

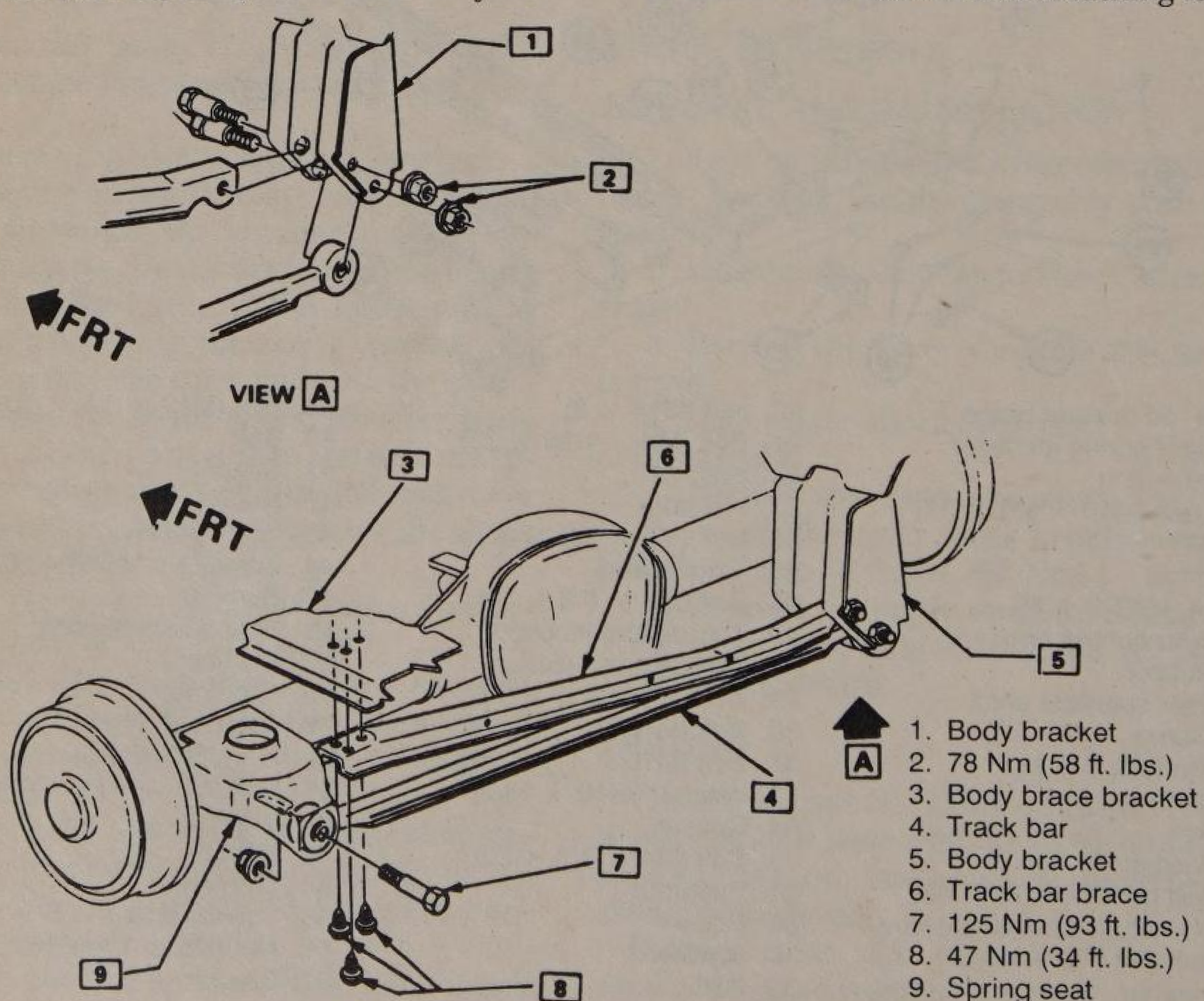
1. Place the track bar brace into position.
2. Install the track bar-to-body bracket fasteners.
3. Install the three track bar brace-to-body brace screws.
4. Install the heat shield screws to the track bar brace.
5. Lower the vehicle.

Control Arms

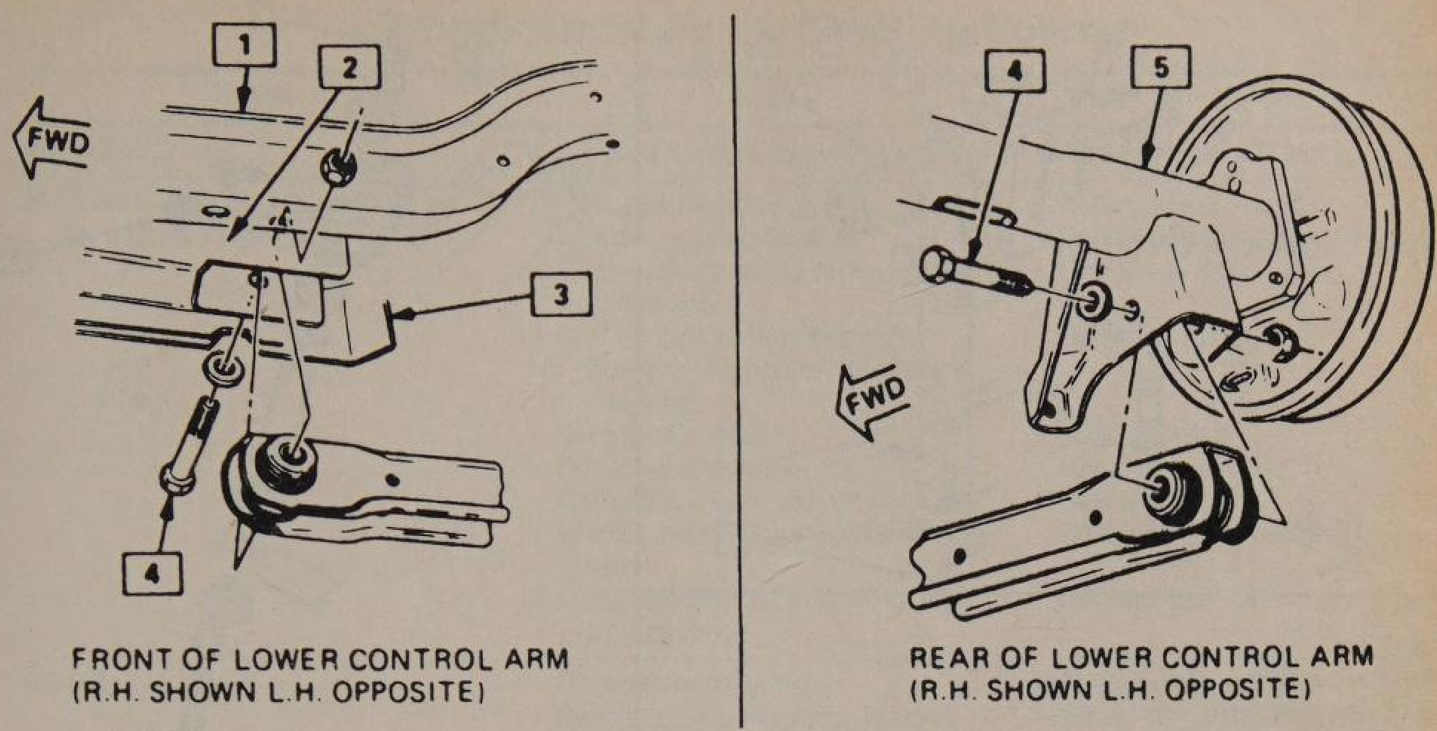
REMOVAL AND INSTALLATION

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. 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 fasten-



Track bar and track bar brace



1. Underbody pan assembly
2. Lower control arm body bracket
3. Underbody rocker panel sheet metal
4. 85 ft. lbs. (115 Nm)
5. Axle assembly

Rear lower control arms

ers, then remove the control arm.

3. Installation is a simple matter of bolting the arm into place. Torque the fasteners to 68 ft. lbs. (90 Nm).

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. 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 overstress 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.

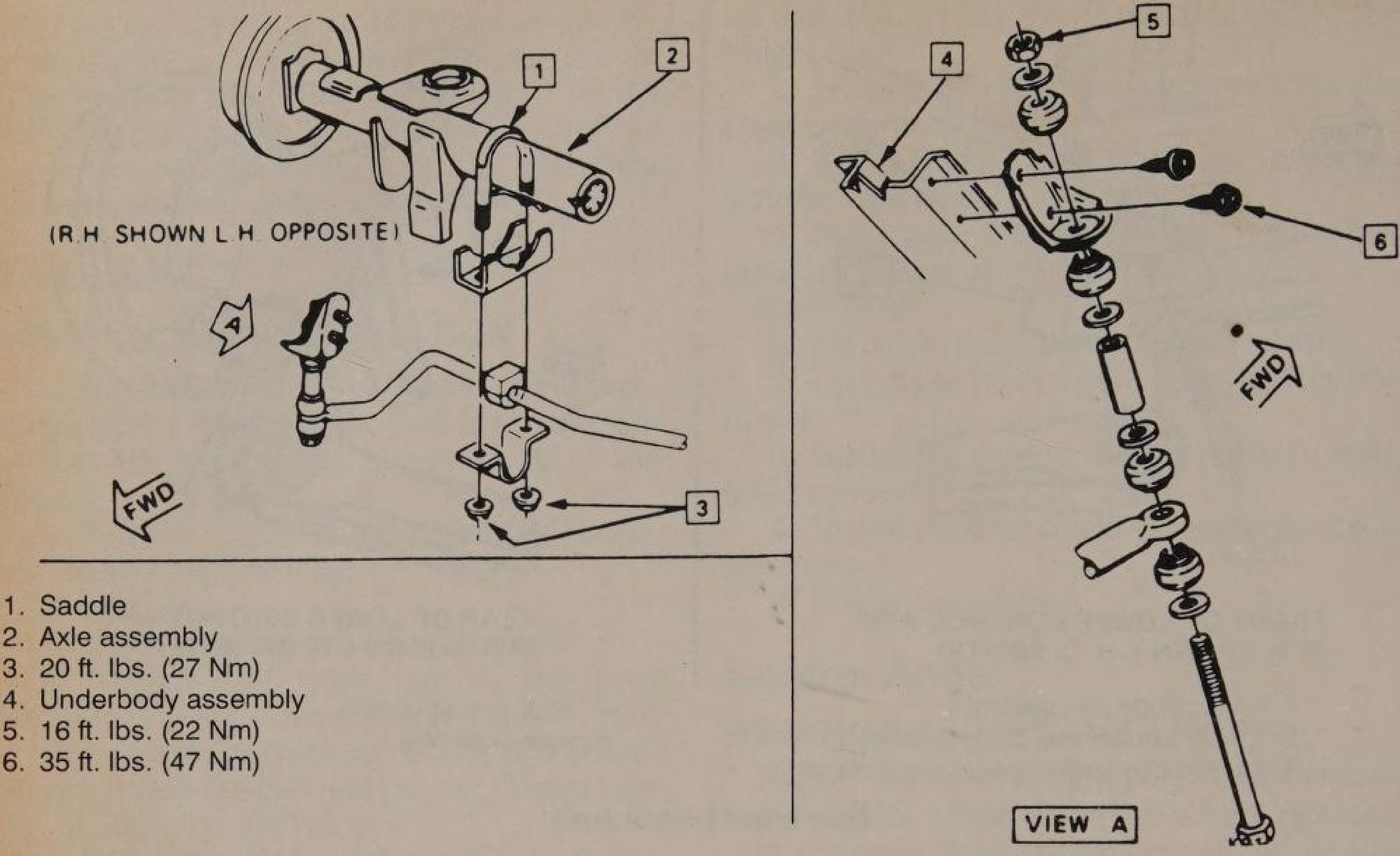
To install:

1. Place the torque arm in position and loosely install the rear torque arm bolts.
2. Install the front torque arm bracket and torque the nuts to 31 ft. lbs. (42 Nm).
3. Torque the rear torque arm nuts to 100 ft. lbs. (135 Nm).
4. Place the rear springs and insulators in position, then raise the rear axle assembly until all of the weight is supported by the spring.
5. Attach the shock absorbers to the rear axle and torque the fasteners to 70 ft. lbs. (95 Nm).
6. Clean and reinstall the track bar mounting bolt at the axle. Torque the bolt to 59 ft. lbs. (80 Nm).
7. Clean and reinstall the track bar-to-body brace nut. Torque the nut to 78 ft. lbs. (105 Nm).
8. Install the brake line clip to the underbody.
9. On 4–cylinder models, reinstall the driveshaft.
10. Lower the vehicle.

Rear Stabilizer Shaft

REMOVAL AND INSTALLATION

1. Raise the vehicle and support with jackstands.
2. Disconnect the saddle-to-axle U-bolts.



Rear stabilizer shaft

3. Remove the frame-to-stabilizer bolts and bushings. Remove the shaft from the vehicle.

To install:

1. Install the shaft and hand tighten the frame and axle hardware.
2. Torque the saddle-to-axle U-bolts to 20 ft. lbs. (27 Nm).
3. Torque the frame-to-stabilizer bolts to 16 ft. lbs. (22 Nm).
4. Lower the vehicle and check operation.

Rear Wheel Alignment

There is no provision for periodic rear wheel alignment. If the rear wheels are out of alignment, have a qualified alignment technician inspect and repair the problem.

STEERING

Steering Wheel

REMOVAL AND INSTALLATION

Non-Air Bag

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.*

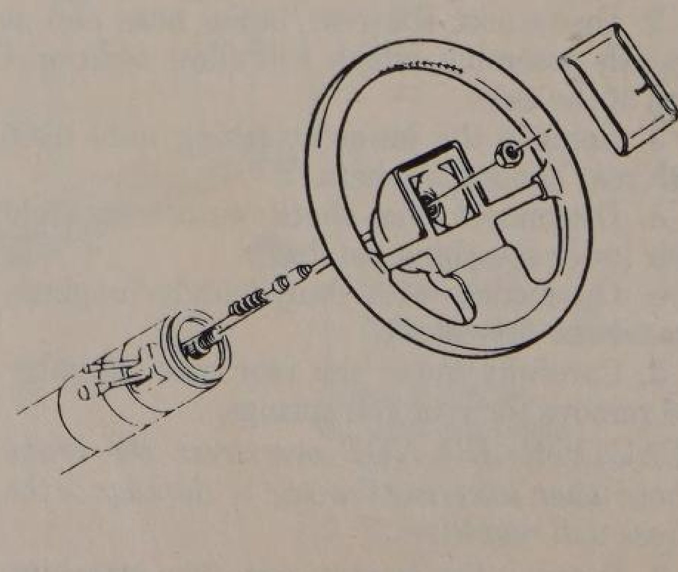
1. Remove the trim retaining screws from behind the wheel. On wheels with a center cap, pull off the cap.
2. Lift the trim off and pull the horn wires from the turn signal canceling cam.

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 snapring. Remove the steering wheel nut.
4. Mark the wheel-to-shaft relationship, and then remove the wheel with a puller.

To install:

1. Install the wheel on the shaft aligning the previously made marks. Tighten the nut to 30 ft. lbs. (41 Nm).



Steering wheel and hub assembly

Troubleshooting the Steering Column

Problem	Cause	Solution
Will not lock	• Lockbolt spring broken or defective	• Replace lock bolt spring
High effort (required to turn ignition key and lock cylinder)	• Lock cylinder defective • Ignition switch defective • Rack preload spring broken or deformed • Burr on lock sector, lock rack, housing, support or remote rod coupling • Bent sector shaft • Defective lock rack • Remote rod bent, deformed • Ignition switch mounting bracket bent • Distorted coupling slot in lock rack (tilt column)	• Replace lock cylinder • Replace ignition switch • Replace preload spring • Remove burr • Replace shaft • Replace lock rack • Replace rod • Straighten or replace • Replace lock rack
Will stick in "start"	• Remote rod deformed • Ignition switch mounting bracket bent	• Straighten or replace • Straighten or replace
Key cannot be removed in "off-lock"	• Ignition switch is not adjusted correctly • Defective lock cylinder	• Adjust switch • Replace lock cylinder
Lock cylinder can be removed without depressing retainer	• Lock cylinder with defective retainer • Burr over retainer slot in housing cover or on cylinder retainer	• Replace lock cylinder • Remove burr
High effort on lock cylinder between "off" and "off-lock"	• Distorted lock rack • Burr on tang of shift gate (automatic column) • Gearshift linkage not adjusted	• Replace lock rack • Remove burr • Adjust linkage
Noise in column	• One click when in "off-lock" position and the steering wheel is moved (all except automatic column) • Coupling bolts not tightened • Lack of grease on bearings or bearing surfaces • Upper shaft bearing worn or broken • Lower shaft bearing worn or broken • Column not correctly aligned • Coupling pulled apart • Broken coupling lower joint • Steering shaft snap ring not seated • Shroud loose on shift bowl. Housing loose on jacket—will be noticed with ignition in "off-lock" and when torque is applied to steering wheel.	• Normal—lock bolt is seating • Tighten pinch bolts • Lubricate with chassis grease • Replace bearing assembly • Replace bearing. Check shaft and replace if scored. • Align column • Replace coupling • Repair or replace joint and align column • Replace ring. Check for proper seating in groove. • Position shroud over lugs on shift bowl. Tighten mounting screws.
High steering shaft effort	• Column misaligned • Defective upper or lower bearing • Tight steering shaft universal joint • Flash on I.D. of shift tube at plastic joint (tilt column only) • Upper or lower bearing seized	• Align column • Replace as required • Repair or replace • Replace shift tube • Replace bearings
Lash in mounted column assembly	• Column mounting bracket bolts loose • Broken weld nuts on column jacket • Column capsule bracket sheared	• Tighten bolts • Replace column jacket • Replace bracket assembly

Troubleshooting the Steering Column (cont.)

Problem	Cause	Solution
Lash in mounted column assembly (cont.)	• Column bracket to column jacket mounting bolts loose • Loose lock shoes in housing (tilt column only) • Loose pivot pins (tilt column only) • Loose lock shoe pin (tilt column only) • Loose support screws (tilt column only)	• Tighten to specified torque • Replace shoes • Replace pivot pins and support • Replace pin and housing • Tighten screws
Housing loose (tilt column only)	• Excessive clearance between holes in support or housing and pivot pin diameters • Housing support-screws loose	• Replace pivot pins and support • Tighten screws
Steering wheel loose—every other tilt position (tilt column only)	• Loose fit between lock shoe and lock shoe pivot pin	• Replace lock shoes and pivot pin
Steering column not locking in any tilt position (tilt column only)	• Lock shoe seized on pivot pin • Lock shoe grooves have burrs or are filled with foreign material • Lock shoe springs weak or broken	• Replace lock shoes and pin • Clean or replace lock shoes • Replace springs
Noise when tilting column (tilt column only)	• Upper tilt bumpers worn • Tilt spring rubbing in housing	• Replace tilt bumper • Lubricate with chassis grease
One click when in "off-lock" position and the steering wheel is moved	• Seating of lock bolt	• None. Click is normal characteristic sound produced by lock bolt as it seats.
High shift effort (automatic and tilt column only)	• Column not correctly aligned • Lower bearing not aligned correctly • Lack of grease on seal or lower bearing areas	• Align column • Assemble correctly • Lubricate with chassis grease
Improper transmission shifting—automatic and tilt column only	• Sheared shift tube joint • Improper transmission gearshift linkage adjustment • Loose lower shift lever	• Replace shift tube • Adjust linkage • Replace shift tube

Troubleshooting the Ignition Switch

Problem	Cause	Solution
Ignition switch electrically inoperative	• Loose or defective switch connector • Feed wire open (fusible link) • Defective ignition switch	• Tighten or replace connector • Repair or replace • Replace ignition switch
Engine will not crank	• Ignition switch not adjusted properly	• Adjust switch
Ignition switch wil not actuate mechanically	• Defective ignition switch • Defective lock sector • Defective remote rod	• Replace switch • Replace lock sector • Replace remote rod
Ignition switch cannot be adjusted correctly	• Remote rod deformed	• Repair, straighten or replace

Troubleshooting the Turn Signal Switch

Problem	Cause	Solution
Turn signal will not cancel	• Loose switch mounting screws • Switch or anchor bosses broken • Broken, missing or out of position detent, or cancelling spring	• Tighten screws • Replace switch • Reposition springs or replace switch as required
Turn signal difficult to operate	• Turn signal lever loose • Switch yoke broken or distorted • Loose or misplaced springs • Foreign parts and/or materials in switch • Switch mounted loosely	• Tighten mounting screws • Replace switch • Reposition springs or replace switch • Remove foreign parts and/or material • Tighten mounting screws
Turn signal will not indicate lane change	• Broken lane change pressure pad or spring hanger • Broken, missing or misplaced lane change spring • Jammed wires	• Replace switch • Replace or reposition as required • Loosen mounting screws, reposition wires and retighten screws
Turn signal will not stay in turn position	• Foreign material or loose parts impeding movement of switch yoke • Defective switch	• Remove material and/or parts • Replace switch
Hazard switch cannot be pulled out	• Foreign material between hazard support cancelling leg and yoke	• Remove foreign material. No foreign material impeding function of hazard switch—replace turn signal switch.
No turn signal lights	• Inoperative turn signal flasher • Defective or blown fuse • Loose chassis to column harness connector • Disconnect column to chassis connector. Connect new switch to chassis and operate switch by hand. If vehicle lights now operate normally, signal switch is inoperative • If vehicle lights do not operate, check chassis wiring for opens, grounds, etc.	• Replace turn signal flasher • Replace fuse • Connect securely • Replace signal switch • Repair chassis wiring as required
Instrument panel turn indicator lights on but not flashing	• Burned out or damaged front or rear turn signal bulb • If vehicle lights do not operate, check light sockets for high resistance connections, the chassis wiring for opens, grounds, etc. • Inoperative flasher • Loose chassis to column harness connection • Inoperative turn signal switch • To determine if turn signal switch is defective, substitute new switch into circuit and operate switch by hand. If the vehicle's lights operate normally, signal switch is inoperative.	• Replace bulb • Repair chassis wiring as required • Replace flasher • Connect securely • Replace turn signal switch • Replace turn signal switch
Stop light not on when turn indicated	• Loose column to chassis connection • Disconnect column to chassis connector. Connect new switch into system without removing old.	• Connect securely • Replace signal switch

Troubleshooting the Turn Signal Switch (cont.)

Problem	Cause	Solution
Stop light not on when turn indicated (cont.)	Operate switch by hand. If brake lights work with switch in the turn position, signal switch is defective. • If brake lights do not work, check connector to stop light sockets for grounds, opens, etc.	 • Repair connector to stop light circuits using service manual as guide
Turn indicator panel lights not flashing	• Burned out bulbs • High resistance to ground at bulb socket • Opens, ground in wiring harness from front turn signal bulb socket to indicator lights	• Replace bulbs • Replace socket • Locate and repair as required
Turn signal lights flash very slowly	• High resistance ground at light sockets • Incorrect capacity turn signal flasher or bulb • If flashing rate is still extremely slow, check chassis wiring harness from the connector to light sockets for high resistance • Loose chassis to column harness connection • Disconnect column to chassis connector. Connect new switch into system without removing old. Operate switch by hand. If flashing occurs at normal rate, the signal switch is defective.	• Repair high resistance grounds at light sockets • Replace turn signal flasher or bulb • Locate and repair as required • Connect securely • Replace turn signal switch
Hazard signal lights will not flash—turn signal functions normally	• Blow fuse • Inoperative hazard warning flasher • Loose chassis-to-column harness connection • Disconnect column to chassis connector. Connect new switch into system without removing old. Depress the hazard warning lights. If they now work normally, turn signal switch is defective. • If lights do not flash, check wiring harness "K" lead for open between hazard flasher and connector. If open, fuse block is defective	• Replace fuse • Replace hazard warning flasher in fuse panel • Conect securely • Replace turn signal switch • Repair or replace brown wire or connector as required

Troubleshooting the Manual Steering Gear

Problem	Cause	Solution
Hard or erratic steering	• Incorrect tire pressure	• Inflate tires to recommended pressures
	• Insufficient or incorrect lubrication	• Lubricate as required (refer to Maintenance Section)
	• Suspension, or steering linkage parts damaged or misaligned	• Repair or replace parts as necessary
	• Improper front wheel alignment	• Adjust incorrect wheel alignment angles
	• Incorrect steering gear adjustment	• Adjust steering gear
	• Sagging springs	• Replace springs
Play or looseness in steering	• Steering wheel loose	• Inspect shaft spines and repair as necessary. Tighten attaching nut and stake in place.
	• Steering linkage or attaching parts loose or worn	• Tighten, adjust, or replace faulty components
	• Pitman arm loose	• Inspect shaft splines and repair as necessary. Tighten attaching nut and stake in place
	• Steering gear attaching bolts loose	• Tighten bolts
	• Loose or worn wheel bearings	• Adjust or replace bearings
	• Steering gear adjustment incorrect or parts badly worn	• Adjust gear or replace defective parts
Wheel shimmy or tramp	• Improper tire pressure	• Inflate tires to recommended pressures
	• Wheels, tires, or brake rotors out-of-balance or out-of-round	• Inspect and replace or balance parts
	• Inoperative, worn, or loose shock absorbers or mounting parts	• Repair or replace shocks or mountings
	• Loose or worn steering or suspension parts	• Tighten or replace as necessary
	• Loose or worn wheel bearings	• Adjust or replace bearings
	• Incorrect steering gear adjustments	• Adjust steering gear
	• Incorrect front wheel alignment	• Correct front wheel alignment
Tire wear	• Improper tire pressure	• Inflate tires to recommended pressures
	• Failure to rotate tires	• Rotate tires
	• Brakes grabbing	• Adjust or repair brakes
	• Incorrect front wheel alignment	• Align incorrect angles
	• Broken or damaged steering and suspension parts	• Repair or replace defective parts
	• Wheel runout	• Replace faulty wheel
	• Excessive speed on turns	• Make driver aware of conditions
Vehicle leads to one side	• Improper tire pressures	• Inflate tires to recommended pressures
	• Front tires with uneven tread depth, wear pattern, or different cord design (i.e., one bias ply and one belted or radial tire on front wheels)	• Install tires of same cord construction and reasonably even tread depth, design, and wear pattern
	• Incorrect front wheel alignment	• Align incorrect angles
	• Brakes dragging	• Adjust or repair brakes
	• Pulling due to uneven tire construction	• Replace faulty tire

Troubleshooting the Power Steering Gear

Problem	Cause	Solution
Hissing noise in steering gear	• There is some noise in all power steering systems. One of the most common is a hissing sound most evident at standstill parking. There is no relationship between this noise and performance of the steering. Hiss may be expected when steering wheel is at end of travel or when slowly turning at standstill.	• Slight hiss is normal and in no way affects steering. Do not replace valve unless hiss is extremely objectionable. A replacement valve will also exhibit slight noise and is not always a cure. Investigate clearance around flexible coupling rivets. Be sure steering shaft and gear are aligned so flexible coupling rotates in a flat plane and is not distorted as shaft rotates. Any metal-to-metal contacts through flexible coupling will transmit valve hiss into passenger compartment through the steering column.
Rattle or chuckle noise in steering gear	• Gear loose on frame	• Check gear-to-frame mounting screws. Tighten screws to 88 N·m (65 foot pounds) torque.
	• Steering linkage looseness	• Check linkage pivot points for wear. Replace if necessary.
	• Pressure hose touching other parts of car	• Adjust hose position. Do not bend tubing by hand.
	• Loose pitman shaft over center adjustment **NOTE:** A slight rattle may occur on turns because of increased clearance off the "high point." This is normal and clearance must not be reduced below specified limits to eliminate this slight rattle.	• Adjust to specifications
	• Loose pitman arm	• Tighten pitman arm nut to specifications
Squawk noise in steering gear when turning or recovering from a turn	• Damper O-ring on valve spool cut	• Replace damper O-ring
Poor return of steering wheel to center	• Tires not properly inflated	• Inflate to specified pressure
	• Lack of lubrication in linkage and ball joints	• Lube linkage and ball joints
	• Lower coupling flange rubbing against steering gear adjuster plug	• Loosen pinch bolt and assemble properly
	• Steering gear to column misalignment	• Align steering column
	• Improper front wheel alignment	• Check and adjust as necessary
	• Steering linkage binding	• Replace pivots
	• Ball joints binding	• Replace ball joints
	• Steering wheel rubbing against housing	• Align housing
	• Tight or frozen steering shaft bearings	• Replace bearings
	• Sticking or plugged valve spool	• Remove and clean or replace valve
	• Steering gear adjustments over specifications	• Check adjustment with gear out of car. Adjust as required.
	• Kink in return hose	• Replace hose
Car leads to one side or the other (keep in mind road condition and wind. Test car in both directions on flat road)	• Front end misaligned	• Adjust to specifications
	• Unbalanced steering gear valve **NOTE:** If this is cause, steering effort will be very light in direction of lead and normal or heavier in opposite direction	• Replace valve

Troubleshooting the Power Steering Gear (cont.)

Problem	Cause	Solution
Momentary increase in effort when turning wheel fast to right or left	• Low oil level • Pump belt slipping • High internal leakage	• Add power steering fluid as required • Tighten or replace belt • Check pump pressure. (See pressure test)
Steering wheel surges or jerks when turning with engine running especially during parking	• Low oil level • Loose pump belt • Steering linkage hitting engine oil pan at full turn • Insufficient pump pressure • Pump flow control valve sticking	• Fill as required • Adjust tension to specification • Correct clearance • Check pump pressure. (See pressure test). Replace relief valve if defective. • Inspect for varnish or damage, replace if necessary
Excessive wheel kickback or loose steering	• Air in system • Steering gear loose on frame • Steering linkage joints worn enough to be loose • Worn poppet valve • Loose thrust bearing preload adjustment • Excessive overcenter lash	• Add oil to pump reservoir and bleed by operating steering. Check hose connectors for proper torque and adjust as required. • Tighten attaching screws to specified torque • Replace loose pivots • Replace poppet valve • Adjust to specification with gear out of vehicle • Adjust to specification with gear out of car
Hard steering or lack of assist	• Loose pump belt • Low oil level **NOTE:** Low oil level will also result in excessive pump noise • Steering gear to column misalignment • Lower coupling flange rubbing against steering gear adjuster plug • Tires not properly inflated	• Adjust belt tension to specification • Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage. Tighten loose connectors. • Align steering column • Loosen pinch bolt and assemble properly • Inflate to recommended pressure
Foamy milky power steering fluid, low fluid level and possible low pressure	• Air in the fluid, and loss of fluid due to internal pump leakage causing overflow	• Check for leak and correct. Bleed system. Extremely cold temperatures will cause system aeriation should the oil level be low. If oil level is correct and pump still foams, remove pump from vehicle and separate reservoir from housing. Check welsh plug and housing for cracks. If plug is loose or housing is cracked, replace housing.
Low pressure due to steering pump	• Flow control valve stuck or inoperative • Pressure plate not flat against cam ring	• Remove burrs or dirt or replace. Flush system. • Correct
Low pressure due to steering gear	• Pressure loss in cylinder due to worn piston ring or badly worn housing bore • Leakage at valve rings, valve body-to-worm seal	• Remove gear from car for disassembly and inspection of ring and housing bore • Remove gear from car for disassembly and replace seals

Troubleshooting the Power Steering Pump

Problem	Cause	Solution
Chirp noise in steering pump	• Loose belt	• Adjust belt tension to specification
Belt squeal (particularly noticeable at full wheel travel and stand still parking)	• Loose belt	• Adjust belt tension to specification
Growl noise in steering pump	• Excessive back pressure in hoses or steering gear caused by restriction	• Locate restriction and correct. Replace part if necessary.
Growl noise in steering pump (particularly noticeable at stand still parking)	• Scored pressure plates, thrust plate or rotor • Extreme wear of cam ring	• Replace parts and flush system • Replace parts
Groan noise in steering pump	• Low oil level • Air in the oil. Poor pressure hose connection.	• Fill reservoir to proper level • Tighten connector to specified torque. Bleed system by operating steering from right to left—full turn.
Rattle noise in steering pump	• Vanes not installed properly • Vanes sticking in rotor slots	• Install properly • Free up by removing burrs, varnish, or dirt
Swish noise in steering pump	• Defective flow control valve	• Replace part
Whine noise in steering pump	• Pump shaft bearing scored	• Replace housing and shaft. Flush system.
Hard steering or lack of assist	• Loose pump belt • Low oil level in reservoir **NOTE:** Low oil level will also result in excessive pump noise • Steering gear to column misalignment • Lower coupling flange rubbing against steering gear adjuster plug • Tires not properly inflated	• Adjust belt tension to specification • Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage. Tighten loose connectors. • Align steering column • Loosen pinch bolt and assemble properly • Inflate to recommended pressure
Foaming milky power steering fluid, low fluid level and possible low pressure	• Air in the fluid, and loss of fluid due to internal pump leakage causing overflow	• Check for leaks and correct. Bleed system. Extremely cold temperatures will cause system aeriation should the oil level be low. If oil level is correct and pump still foams, remove pump from vehicle and separate reservoir from body. Check welsh plug and body for cracks. If plug is loose or body is cracked, replace body.
Low pump pressure	• Flow control valve stuck or inoperative • Pressure plate not flat against cam ring	• Remove burrs or dirt or replace. Flush system. • Correct
Momentary increase in effort when turning wheel fast to right or left	• Low oil level in pump • Pump belt slipping • High internal leakage	• Add power steering fluid as required • Tighten or replace belt • Check pump pressure. (See pressure test)
Steering wheel surges or jerks when turning with engine running especially during parking	• Low oil level • Loose pump belt • Steering linkage hitting engine oil pan at full turn • Insufficient pump pressure	• Fill as required • Adjust tension to specification • Correct clearance • Check pump pressure. (See pressure test). Replace flow control valve if defective.

Troubleshooting the Power Steering Pump (cont.)

Problem	Cause	Solution
Steering wheel surges or jerks when turning with engine running especially during parking (cont.)	• Sticking flow control valve	• Inspect for varnish or damage, replace if necessary
Excessive wheel kickback or loose steering	• Air in system	• Add oil to pump reservoir and bleed by operating steering. Check hose connectors for proper torque and adjust as required.
Low pump pressure	• Extreme wear of cam ring • Scored pressure plate, thrust plate, or rotor • Vanes not installed properly • Vanes sticking in rotor slots • Cracked or broken thrust or pressure plate	• Replace parts. Flush system. • Replace parts. Flush system. • Install properly • Freeup by removing burrs, varnish, or dirt • Replace part

2. Insert the horn wires into the canceling cam.

3. Install the center trim and reconnect the battery cable.

Air Bag System

CAUTION: *On vehicles equipped with an air bag, the negative battery cable must be disconnected, before working on the system. Failure to do so may result in deployment of the air bag and possible personal injury.*

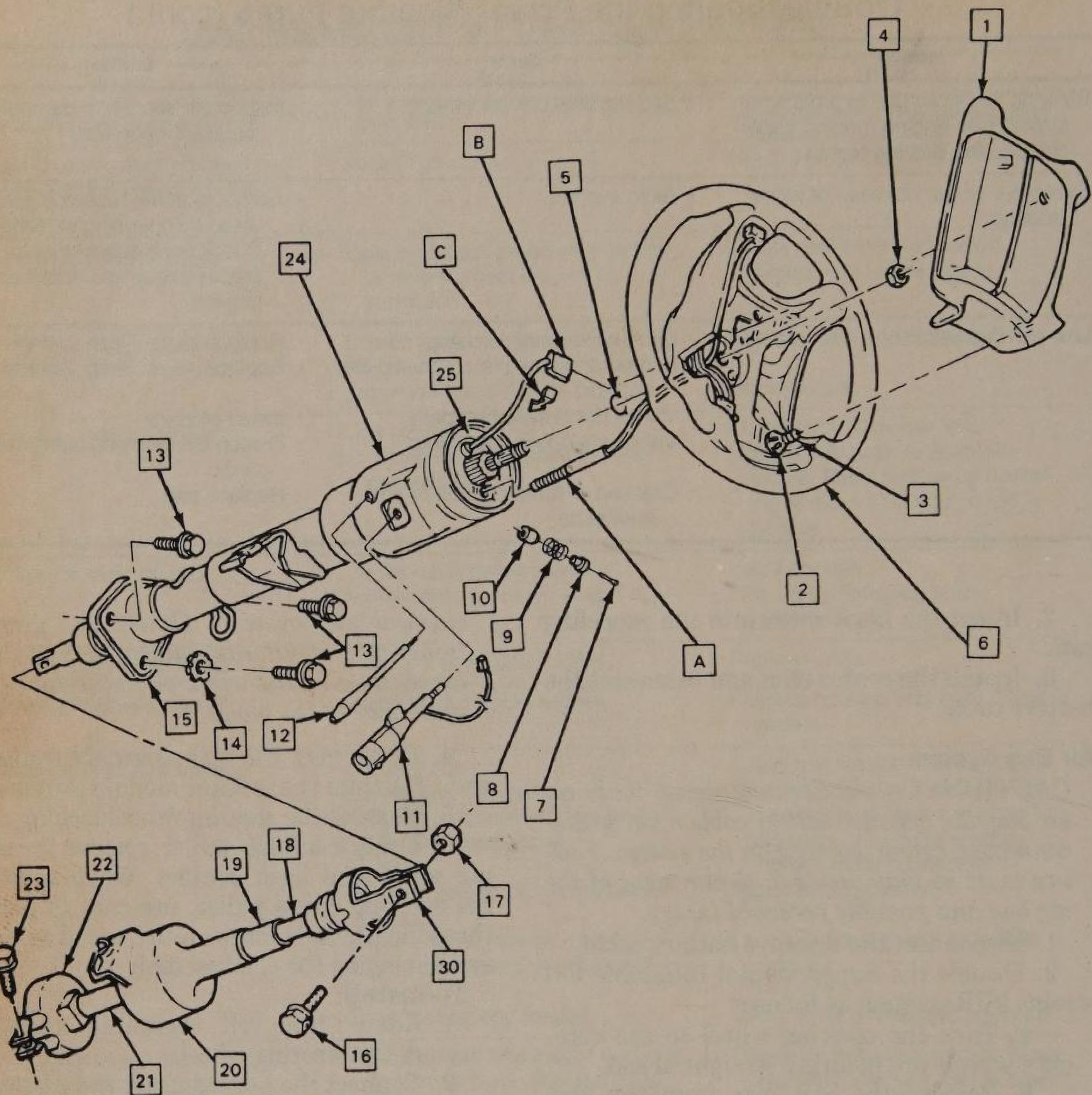
1. Disconnect the negative battery cable.
2. Disable the Supplemental Inflatable Restraint (SIR) system as follows:
   a. Turn the steering wheel so the vehicle's wheels are pointing straight ahead.
   b. Remove the SIR fuse from the fuse block.
   c. Remove the left sound insulator by removing the nut from the stud and gently prying the insulator from the knee bolster.
   d. Disconnect the Connector Position Assurance (CPA) and yellow 2-way SIR harness connector at the base of the steering column.
3. Loosen the screws and locknuts from the back of the steering wheel using a suitable Torx® driver or equivalent until the inflator module can be released from the steering wheel. Remove the inflator module from the steering wheel.

CAUTION: *When carrying a live inflator module, make sure the bag and trim cover are pointed away from the body. In case of an accidental deployment, the bag will then deploy with minimal chance of injury. When placing a live inflator module on a bench or other surface, always face the bag and trim cover up, away from the surface. This is necessary so a free space is provided to allow the air bag to expand in the unlikely event of accidental deployment. Otherwise, personal injury may result. Also, never carry the inflator module by the wires or connector on the underside of the module.*

4. Disconnect the coil assembly connector and CPA from the inflator module terminal.
5. Remove the steering wheel locking nut.
6. Using a suitable puller, remove the steering wheel and horn contact. When attaching the steering wheel puller, use care to prevent threading the side screws into the coil assembly and damaging the coil assembly.

To install:

1. Route the coil assembly connector through the steering wheel.
2. Connect the horn contact and install the steering wheel. When installing the steering wheel, align the block tooth on the steering wheel with the block tooth on the steering shaft within 1 female serration.
3. Install the steering wheel locking nut. Tighten the nut to 31 ft. lbs. (42 Nm).
4. Connect the coil assembly connector and CPA to the inflator module terminal.
5. Install the inflator module. Make sure the wiring is not exposed or trapped between the inflator module and the steering wheel. Tighten the inflator module screws to 25 inch lbs. (2.8 Nm).
6. Connect the negative battery cable.
7. Enable the SIR system as follows:
   a. Connect the yellow 2-way SIR harness connector to the base of the steering column and CPA.
   b. Install the left sound insulator.
   c. Install the SIR fuse in the fuse block.
   d. Turn the ignition switch to **RUN** and verify that the inflatable restraint indicator flashes 7–9 times and then turns OFF. If the



A. Horn connector
B. Coil-to-inflator connector
C. Connector positive assurance
1. Inflator module
2. Locknut
3. Screw
4. Nut
5. Retaining ring
6. Steering wheel
7. Screw
8. Hazard warning button
9. Spring
10. Hazard warning knob
11. Multi-function lever
12. Tilt lever
13. Bolt
14. Washer
15. Bracket
16. Bolt
17. Nut
18. Upper intermediate shaft
19. Seal
20. Coupling shield
21. Lower intermediate shaft
22. Flexible coupling
23. Bolt
24. Steering column
25. Coil assembly
30. Pot joint coupling

Steering wheel – air bag system

indicator does not respond as stated, a problem within the SIR system is indicated.

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.

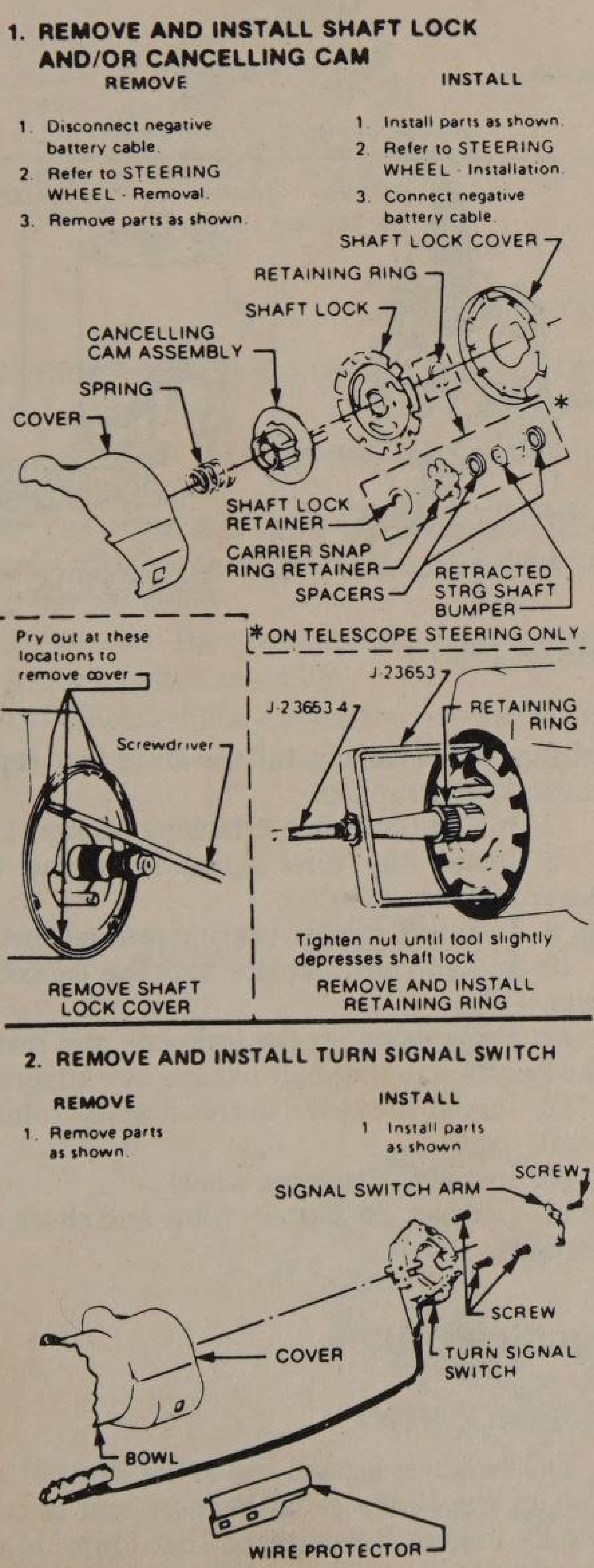
3. Position the U-shaped lockplate compressing tool on the end of the steering shaft and compress the lock plate by turning the shaft nut clockwise. Pry the wire snapring out of the shaft groove.

4. Remove the tool and lift the lockplate off the shaft.

5. Remove the canceling 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.



Turn signal switch assembly

8. Remove the three switch mounting screws. Remove the switch by pulling it straight up while guiding the wiring harness cover through the column.

To install:

1. 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.

2. Install the switch mounting screws and the connector on the mast jacket bracket. Install the column-to-dash trim plate.

3. Install the flasher knob and the turn signal lever.

4. With the turn signal lever in neutral and the flasher knob out, slide the upper bearing preload spring, and canceling cam assembly onto the shaft.

5. Position the lock plate on the shaft and press it down until a new snapring can be inserted in the shaft groove. Always use a new snapring when assembling.

6. 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 snapring from the shaft.

5. Remove the lockplate and the canceling cam.

6. Remove the upper bearing preload spring.

7. Remove the turn signal lever and the hazard flasher knob.

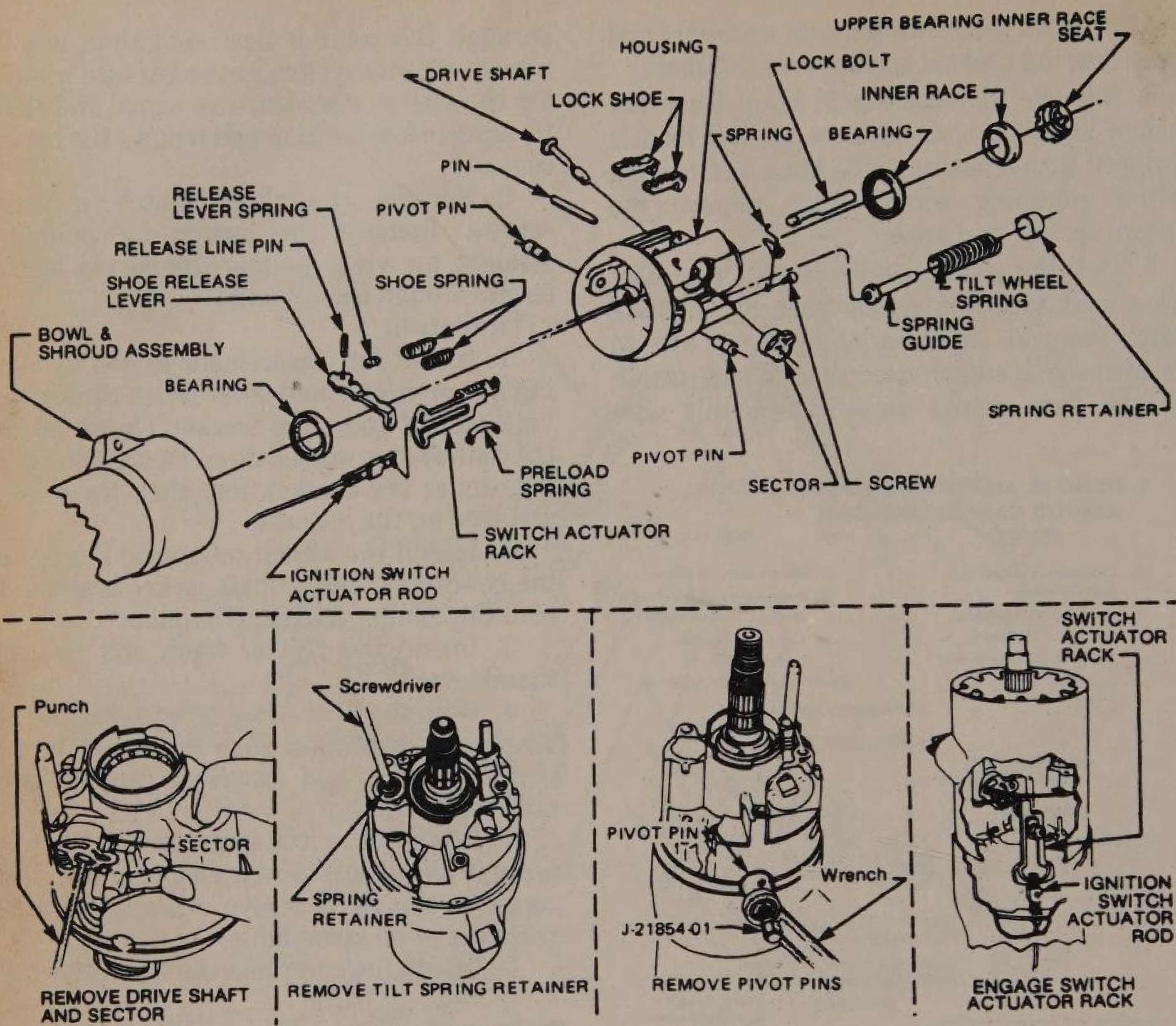
8. Lift up on the tilt lever and position the housing in its central position.

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 in-



Tilt steering column assembly

dicator 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.

To install:

1. Carefully install the turn signal switch and wiring into the column.

2. Remove the tape from the turn signal wires.

3. Install the wire protector and, while holding the column in position, install the two nuts to the column support bracket.

4. Connect the clip to the link and tighten the screw that holds the shift indicator needle.

5. Install the four bolts which secure the bracket assembly to the jacket.

6. Connect the turn signal connector to the wiring harness and install the lower trim cap to the instrument panel.

7. Install the switch attaching screws.

8. Install the turn signal lever and the hazard flasher knob.

9. Install the upper bearing preload spring.

10. Install the lockplate and the canceling cam.

11. Press down on the lockplate and install the snapring to the shaft using a new snapring.

12. Install the cover to the steering column shaft.

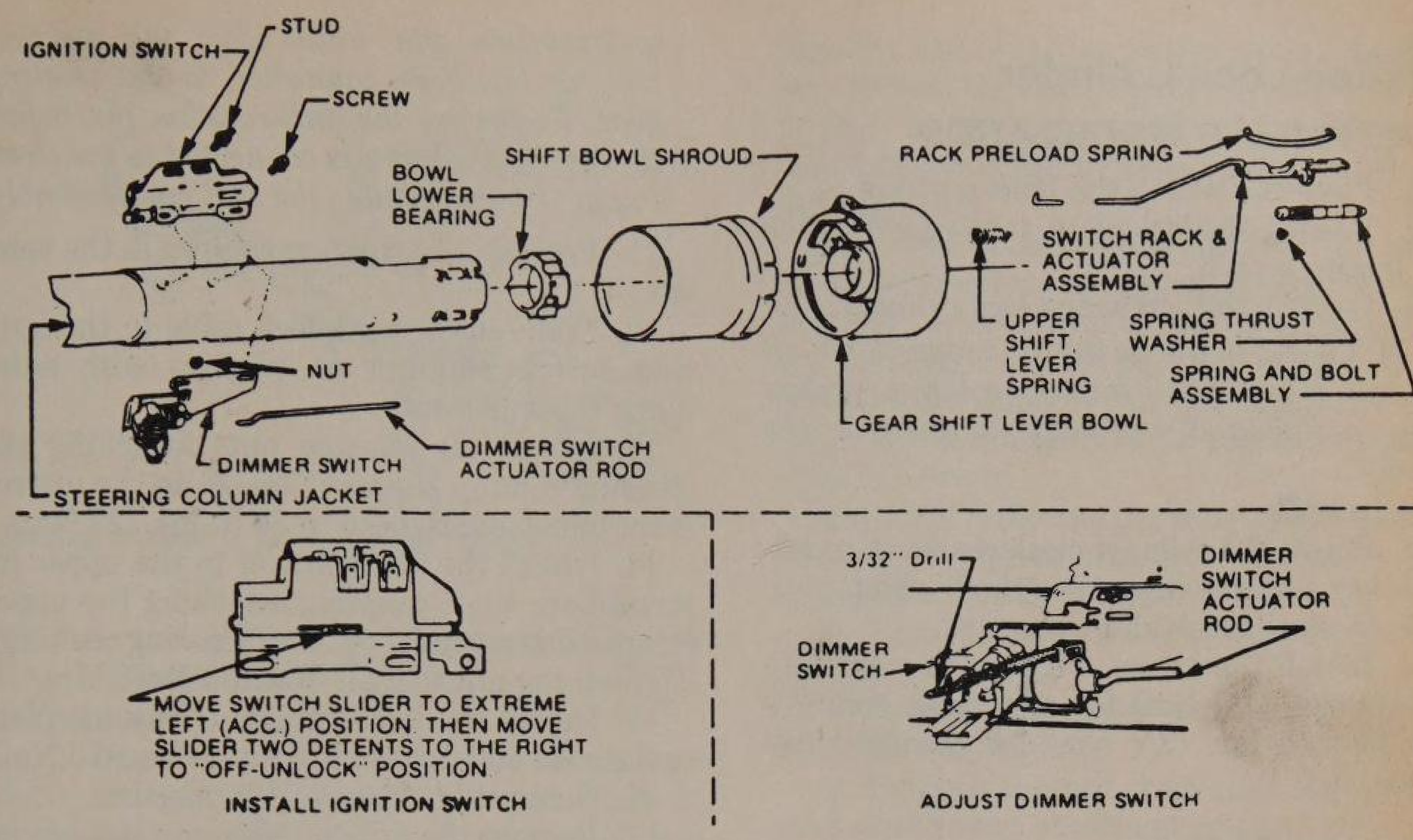
13. Install the steering wheel.

14. Connect the battery cable and check operation.

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



Ignition switch assembly

lock cylinder engages the toothed upper end of the rod.

1. Lower the steering column; be sure to properly support it.

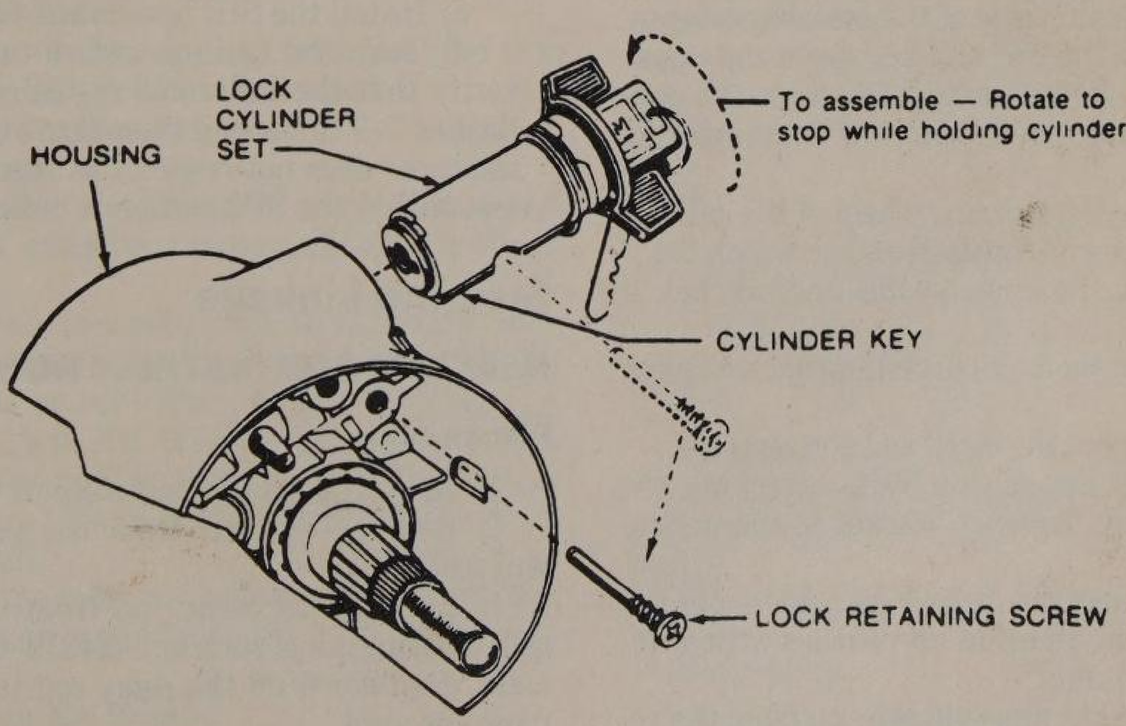
2. Put the switch in the **Off-Unlocked** position. **Off-Unlocked** position is two detents from the top.

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 specified screws since overlength screws could impair the collapsibility of the column.

6. Reinstall the steering column.



Ignition lock cylinder replacement

Ignition Lock Cylinder

REMOVAL AND INSTALLATION

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.*

To install:

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 inch lbs. (1.3 Nm) for adjustable columns and 25 inch lbs. (2.7 Nm) for standard columns.

Steering Column

REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable.
2. On 1990–91 vehicles, disable the Supplemental Inflatable Restraint (SIR) system as follows:
   a. Turn the steering wheel so the vehicle's wheels are pointing straight ahead.
   b. Remove the SIR fuse from the fuse block.
   c. Remove the left sound insulator by removing the nut from the stud and gently prying the insulator from the knee bolster.
   d. Disconnect the Connector Position Assurance (CPA) and yellow 2-way SIR harness connector at the base of the steering column.
3. Remove the nut and bolt from the upper intermediate shaft coupling. Separate the coupling from the lower end of the steering column.
4. Remove the steering wheel, if the column is to be replaced or repaired on the bench.
5. Remove the knee bolster and bracket, if equipped.
6. Remove the bolts attaching the toe plate to the cowl.
7. Disconnect the electrical connectors.
8. Remove the capsule nuts attaching the steering column support bracket to the instrument panel.
9. Disconnect the park lock cable from the ignition switch inhibitor, on vehicles with automatic transmission.
10. Remove the steering column from the vehicle.

To install:

NOTE: *If a service replacement steering column is being installed, do not remove the anti-rotation pin until after the steering column has been connected to the steering gear. Removing the anti-rotation pin before the steering column is connected to the steering gear may damage the SIR coil assembly.*

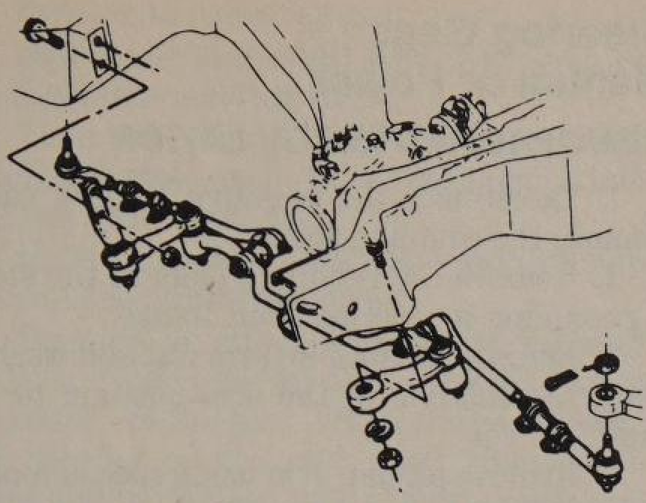
11. Position the steering column in the vehicle.
12. Connect the park lock cable to the ignition switch inhibitor on vehicles with automatic transmission.
13. Install the capsule nuts attaching the steering column support bracket to the instrument panel and tighten to 20 ft. lbs. (27 Nm).
14. Install the nut and bolt to the upper intermediate shaft coupling attaching the upper intermediate shaft to the steering column. Tighten the nut to 44 ft. lbs. (60 Nm).
15. Install the bolts attaching the toe plate to the cowl and tighten to 58 inch lbs. (6.5 Nm).
16. Connect the electrical connectors.
17. Remove the anti-rotation pin if a service replacement steering column is being installed.
18. Install the knee bolster and bracket, if equipped.
19. Install the sound insulator panel.
20. If a service replacement steering column is being installed, remove the locking nut, remove the coil assembly shipping cover and disengage the connector from the cover.
21. Install the steering wheel.
22. Connect the negative battery cable.
23. Enable the SIR system as follows:
   a. Connect the yellow 2-way SIR harness connector to the base of the steering column and CPA.
   b. Install the left sound insulator.
   c. Install the SIR fuse in the fuse block.
   d. Turn the ignition switch to **RUN** and verify that the inflatable restraint indicator flashes 7–9 times and then turns OFF. If the indicator does not respond as stated, a problem within the SIR system is indicated.

Steering Linkage

REMOVAL AND INSTALLATION

Pitman Arm

1. Raise the vehicle and support securely.
2. Remove the nut from the pitman arm ball stud.
3. Remove the relay rod from the pitman arm by using a tool such as J–24319–01 or equivalent. Pull down on the relay rod to remove it from the stud.
4. Remove the pitman arm nut from the pitman shaft and mark the relation of the arm position to the shaft.
5. Remove the pitman arm with tool J–


Steering linkage — typical of all models

5504 or tool J–6632 or equivalent. DO NOT HAMMER ON THE PULLER.

To install:

1. Position the pitman arm on the pitman shaft, lining up the marks made upon removal.
2. Position the relay rod on the pitman arm. Use J–29193 or J–29194 or equivalent to seat the tapers. A torque of 15 ft. lbs. (20 Nm) is required. With the tapers seated, remove the tool, then install a prevailing torque nut, and tighten to 35 ft. lbs. (48 Nm).
3. Set the relay rod height. Torque the idler arm-to-frame mounting bolts to 61 ft. lbs. (83 Nm).
4. Lower the vehicle.

Idler Arm

1. Raise the vehicle and support securely.
2. Remove the idler arm to frame nuts, washers, and bolts.
3. Remove the nut from the idler arm to relay rod ball stud.
4. Remove the relay rod from the idler arm by using J–24319–01 or equivalent.
5. Remove the idler arm.

To install:

1. Position the idler arm on the frame and LOOSELY install the mounting bolts, washers and nuts.
2. Install the relay rod to the idler arm, making certain seal is on the stud. Use J–29193 or J–29194 or equivalent to seat the tapers. A torque of 15 ft. lbs. (20 Nm) is required. With the tapers seated, remove the tool, then install a prevailing torque nut, and tighten to 35 ft. lbs. (48 Nm).
3. Set the relay rod height. Torque the idler arm-to-frame mounting bolts to 61 ft. lbs. (83 Nm).
4. Lower the vehicle.

Relay Rod

During production, the installed position of the relay rod is carefully controlled to assure that the rod is at the proper height. Both the left end and the right end of the relay rod must be held at the same height. The side-to-side height is controlled by adjusting the position of the idler arm

Whenever disconnecting the relay rod assembly, it is important to first scribe the position of the idler arm-to-frame, and to reinstall the idler arm in the same position. Be sure to prevent the idler support from turning in the bushing, since that motion could result in improper relay rod height.

Whenever replacing the relay rod, or the idler arm, or the pitman arm, it is mandatory to establish the correct height.

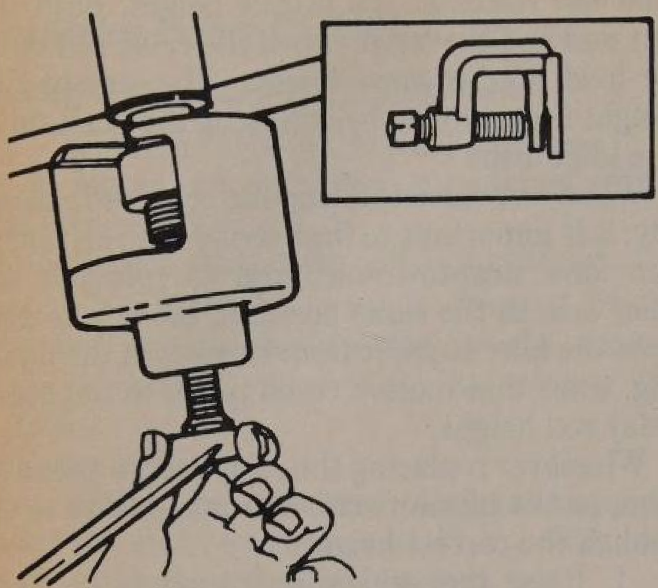
1. Raise the vehicle and support on jackstands.
2. Remove the inner ends of the tie rods from the relay rod.
3. Remove the nut from the relay rod ball stud attachment at pitman arm.
4. Detach the relay rod from the pitman arm by using tool such as J–24319–01 or equivalent. Shift the steering linkage as required to free the pitman arm from the relay rod.
5. Remove the nut from the idler arm and remove the relay rod from the idler arm.

To install:

1. Install the relay rod to idler arm, making certain idler stud seal is in place. Use J–29193 or J–29194 or equivalent to seat the tapers. A torque of 15 ft. lbs. (20 Nm) is required. With the tapers seated, remove the tool, then install a prevailing torque nut, and tighten to 35 ft. lbs. (48 Nm).
2. Raise the end of the rod and install on the pitman arm. Use J–29193 or J–29194 or equivalent to seat the tapers. A torque of 15 ft. lbs. (20 Nm) is required. With the tapers seated, remove the tool, then install a prevailing torque nut, and tighten to 35 ft. lbs. (48 Nm).
3. Install the tie rod ends to the relay rod. Lubricate the tie rod ends.
4. Install the damper, if equipped.
5. Set the relay rod height. Torque the idler arm-to-frame mounting bolts to 61 ft. lbs. (83 Nm).
6. Lower the vehicle.
7. Check and, if necessary, have a qualified alignment technician adjust the front end alignment.

Tie Rod Ends

1. Raise the vehicle and support securely.
2. Remove the cotter pins from the ball studs and remove the castellated nuts.
3. Remove the outer ball stud by using the ball stud puller. If necessary, pull downward on



Using a tie rod puller

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.

To install:

1. 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.

2. 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.

3. 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° upward (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.

4. Install ball stud nuts and torque to 35 ft. lbs. (48 Nm). Then tighten (do not loosen) further as required to align cotter pin holes in studs and nuts. Install new cotter pins.

5. Lubricate new tie rod ends and lower the vehicle.

NOTE: *The Do-it-Yourself mechanic should not attempt to perform any wheel alignment procedures. Expensive alignment tools are needed and would not be cost efficient to purchase these tools. The wheel alignment should be performed by a certified alignment technician using the proper alignment tools.*

Steering Gear Manual 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.

NOTE: *On vehicles with power steering, remove the fluid hoses and cap them to prevent foreign material from entering the system.*

To install:

1. Position the steering box and secure with the steering box-to-frame bolts.

2. Install the pitman arm to the match marks made earlier.

3. Install the pitman arm nut and washer.

4. Install the retaining bolts at the steering coupling to steering shaft flange.

5. Install the coupling shield.

6. Connect the negative battery cable.

ADJUSTMENT

Worm Bearing Preload

1. Disconnect the negative battery cable.

2. Remove the steering gear.

3. Rotate the stub shaft back and forth to drain the power steering fluid.

4. Remove the adjuster plug nut.

5. Turn the adjuster plug in (clockwise) using a suitable spanner wrench until the adjuster plug and thrust bearing are firmly bottomed in the housing. Tighten the adjuster plug to 20 ft. lbs. (27 Nm).

6. Place an index mark on the housing even with 1 of the holes in the adjuster plug.

7. Measure back counterclockwise $1/2$ inch (13mm) and place a second mark on the housing.

8. Turn the adjuster plug counterclockwise until the hole in the adjuster plug is aligned with the second mark on the housing.

9. Install the adjuster plug nut and using a suitable punch in a notch, tighten securely. Hold the adjuster plug to maintain alignment of the marks.

10. Install the steering gear and connect the negative battery cable.

Pitman Shaft Over-center

1. Disconnect the negative battery cable.

2. Remove the steering gear.

3. Rotate the stub shaft back and forth to drain the power steering fluid.

4. Turn the pitman shaft adjuster screw counterclockwise until fully extended, then turn back 1 full turn.

5. Rotate the stub shaft from stop to stop and count the number of turns.

6. Starting at either stop, turn the stub shaft back $^1/_2$ the total number of turns. This is the "center" of the gear. When the gear is centered, the flat on the stub shaft should face upward and be parallel with the side cover and the master spline on the pitman shaft should be in line with the adjuster screw.

7. Rotate the stub shaft 45° each side of the center using a suitable torque wrench with the handle in the vertical position. Record the worm bearing preload measured on or near the center.

8. Adjust the over-center drag torque by loosening the adjuster locknut and turning the pitman shaft adjuster screw clockwise until the correct drag torque is obtained: Add 6–10 inch lbs. (0.7–1.1 Nm) torque to the previously measured worm bearing preload torque. Tighten the adjuster locknut to 20 ft. lbs. (27 Nm). Prevent the adjuster screw from turning while tightening the adjuster screw locknut.

9. Install the steering gear and connect the negative battery cable.

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.

3. Loosen the retaining bolts and any braces, and remove the pump.

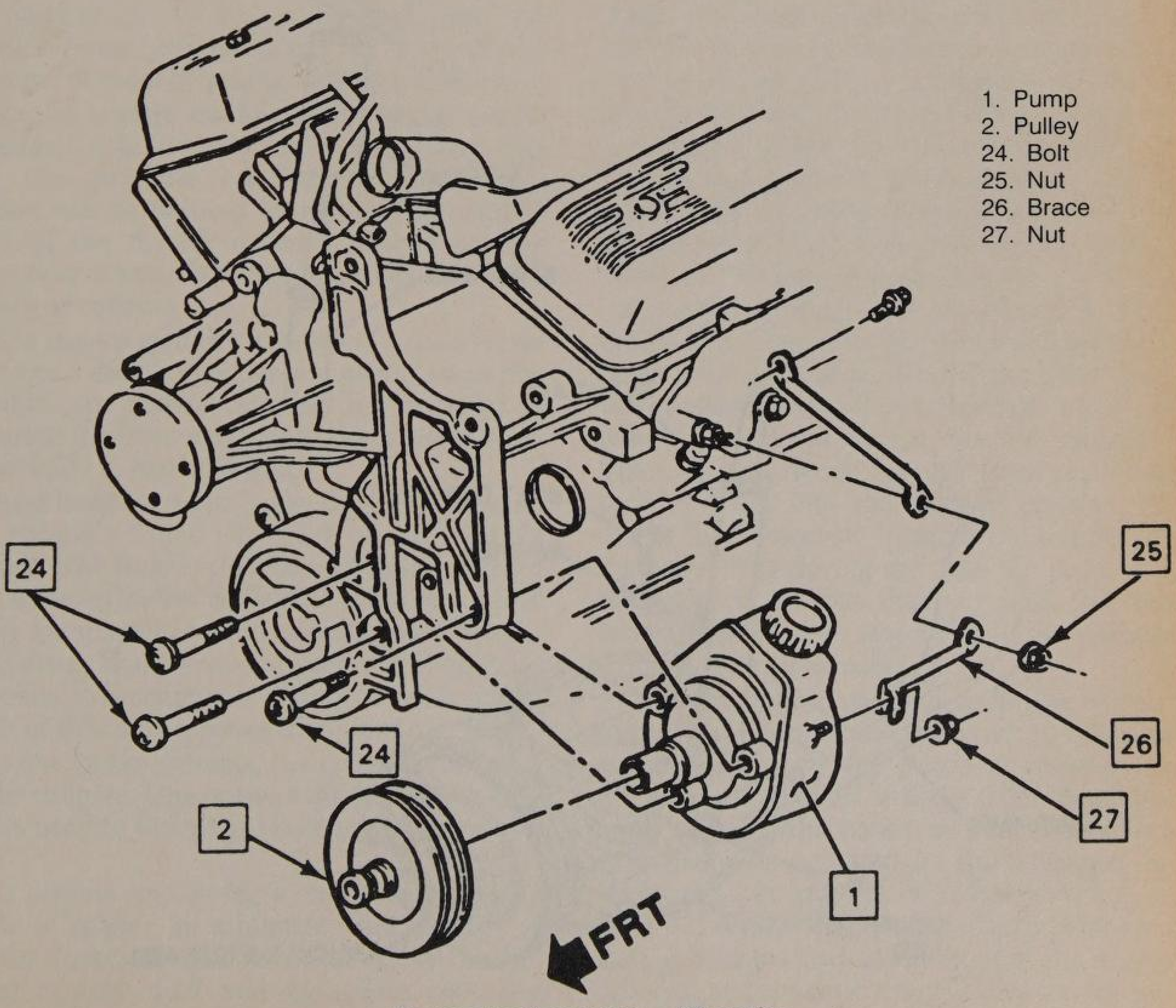
To install:

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.



Power steering pump — V8 engine

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.

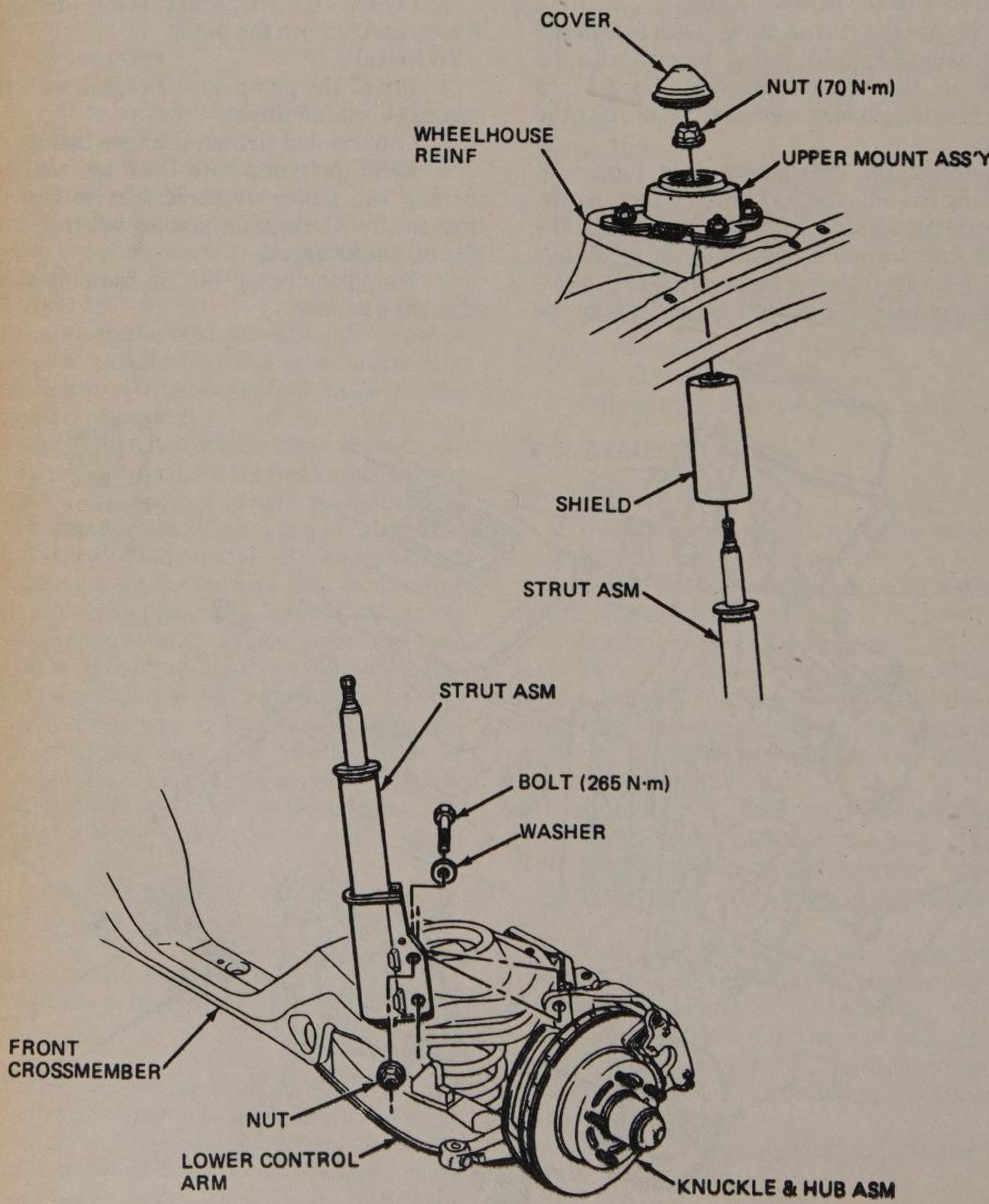
7. Start the engine and increase the engine speed to about 1500 rpm.

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.



Remove or install strut

Brakes 9

BASIC OPERATING PRINCIPLES

Hydraulic systems are used to actuate the brakes of all automobiles. The system transports the power required to force the frictional surfaces of the braking system together from the pedal to the individual brake units at each wheel. A hydraulic system is used for two reasons.

First, fluid under pressure can be carried to all parts of an automobile by small pipes and flexible hoses without taking up a significant amount of room or posing routing problems.

Second, a great mechanical advantage can be given to the brake pedal end of the system, and the foot pressure required to actuate the brakes can be reduced by making the surface area of the master cylinder pistons smaller than that of any of the pistons in the wheel cylinders or calipers.

The master cylinder consists of a fluid reservoir and a double cylinder and piston assembly. Double type master cylinders are designed to separate the front and rear braking systems hydraulically in case of a leak.

Steel lines carry the brake fluid to a point on the vehicle's frame near each of the vehicle's wheels. The fluid is then carried to the calipers and wheel cylinders by flexible tubes in order to allow for suspension and steering movements.

In drum brake systems, each wheel cylinder contains two pistons, one at either end, which push outward in opposite directions.

In disc brake systems, the cylinders are part of the calipers. One or two cylinder in each caliper is used to force the brake pads against the disc.

All pistons employ some type of seal, usually made of rubber, to minimize fluid leakage. A rubber dust boot seals the outer end of the cylinder against dust and dirt. The boot fits around the outer end of the piston on disc brake calipers, and around the brake actuating rod on wheel cylinders.

The hydraulic system operates as follows: When at rest, the entire system, from the piston(s) in the master cylinder to those in the wheel cylinders or calipers, is full of brake fluid. Upon application of the brake pedal, fluid trapped in front of the master cylinder piston(s) is forced through the lines to the wheel cylinders. Here, it forces the pistons outward, in the case of drum brakes, and inward toward the disc, in the case of disc brakes. The motion of the pistons is opposed by return springs mounted outside the cylinders in drum brakes, and by spring seals, in disc brakes.

Upon release of the brake pedal, a spring located inside the master cylinder immediately returns the master cylinder pistons to the normal position. The pistons contain check valves and the master cylinder has compensating ports drilled in it. These are uncovered as the pistons reach their normal position. The piston check valves allow fluid to flow toward the wheel cylinders or calipers as the pistons withdraw. Then, as the return springs force the brake pads or shoes into the released position, the excess fluid reservoir through the compensating ports. It is during the time the pedal is in the released position that any fluid that has leaked out of the system will be replaced through the compensating ports.

Dual circuit master cylinders employ two pistons, located one behind the other, in the same cylinder. The primary piston is actuated directly by mechanical linkage from the brake pedal through the power booster. The secondary piston is actuated by fluid trapped between the two pistons. If a leak develops in front of the secondary piston, it moves forward until it bottoms against the front of the master cylinder, and the fluid trapped between the pistons will operate the rear brakes. If the rear brakes develop a leak, the primary piston will move forward until direct contact with the secondary piston takes place, and it will force the secondary piston to actuate the front brakes. In either case, the brake pedal moves farther when the brakes are applied, and less braking power is available.

All dual circuit systems use a switch to warn the driver when only half of the brake system is operational. This switch is located in a valve body which is mounted on the firewall or the frame below the master cylinder. A hydraulic piston receives pressure from both circuits, each circuit's pressure being applied to one end of the piston. When the pressures are in balance, the piston remains stationary. When one circuit has a leak, however, the greater pressure in that circuit during application of the brakes will push the piston to one side, closing the switch and activating the brake warning light.

In disc brake systems, this valve body also contains a metering valve and, in some cases, a proportioning valve. The metering valve keeps pressure from traveling to the disc brakes on the front wheels until the brake shoes on the rear wheels have contacted the drums, ensuring that the front brakes will never be used alone. The proportioning valve controls the pressure to the rear brakes to lessen the chance of rear wheel lock-up during very hard braking.

Warning lights may be tested by depressing the brake pedal and holding it while opening one of the wheel cylinder bleeder screws. If this does not cause the light to go on, substitute a new lamp, make continuity checks, and, finally, replace the switch as necessary.

The hydraulic system may be checked for leaks by applying pressure to the pedal gradually and steadily. If the pedal sinks very slowly to the floor, the system has a leak. This is not to be confused with a springy or spongy feel due to the compression of air within the lines. If the system leaks, there will be a gradual change in the position of the pedal with a constant pressure.

Check for leaks along all lines and at wheel cylinders. If no external leaks are apparent, the problem is inside the master cylinder.

Disc Brakes

BASIC OPERATING PRINCIPLES

Instead of the traditional expanding brakes that press outward against a circular drum, disc brake systems utilize a disc (rotor) with brake pads positioned on either side of it. Braking effect is achieved in a manner similar to the way you would squeeze a spinning phonograph record between your fingers. The disc (rotor) is a casting with cooling fins between the two braking surfaces. This enables air to circulate between the braking surfaces making them less sensitive to heat buildup and more resistant to fade. Dirt and water do not affect braking action since contaminants are thrown off by the centrifugal action of the rotor or scraped off the by the pads. Also, the equal clamping action of the two brake pads tends to ensure uniform, straight line stops. Disc brakes are inherently self-adjusting.

There are three general types of disc brake:

1. A fixed caliper.
2. A floating caliper.
3. A sliding caliper.

The fixed caliper design uses two pistons mounted on either side of the rotor (in each side of the caliper). The caliper is mounted rigidly and does not move.

The sliding and floating designs are quite similar. In fact, these two types are often lumped together. In both designs, the pad on the inside of the rotor is moved into contact with the rotor by hydraulic force. The caliper, which is not held in a fixed position, moves slightly, bringing the outside pad into contact with the rotor. There are various methods of attaching floating calipers. Some pivot at the bottom or top, and some slide on mounting bolts. In any event, the end result is the same.

All the cars covered in this book employ the sliding caliper design.

Drum Brakes

BASIC OPERATING PRINCIPLES

Drum brakes employ two brake shoes mounted on a stationary backing plate. These shoes are positioned inside a circular drum which rotates with the wheel assembly. The shoes are held in place by springs. This allows them to slide toward the drums (when they are applied) while keeping the linings and drums in alignment. The shoes are actuated by a wheel cylinder which is mounted at the top of the backing plate. When the brakes are applied, hydraulic pressure forces the wheel cylinder's actuating links outward. Since these links bear directly against the top of the brake shoes, the tops of the shoes are then forced against the inner side of the drum. This action forces the bottoms of the two shoes to contact the brake drum by rotating the entire assembly slightly (known as servo action). When pressure within the wheel cylinder is relaxed, return springs pull the shoes back away from the drum.

Most modern drum brakes are designed to self-adjust themselves during application when the vehicle is moving in reverse. This motion causes both shoes to rotate very slightly with the drum, rocking an adjusting lever, thereby causing rotation of the adjusting screw.

Power Boosters

Power brakes operate just as non-power brake systems except in the actuation of the master cylinder pistons. A vacuum diaphragm is located on the front of the master cylinder and assists the driver in applying the brakes, reducing both the effort and travel he must put into moving the brake pedal.

The vacuum diaphragm housing is connected to the intake manifold by a vacuum hose. A check valve is placed at the point where the hose enters the diaphragm housing, so that during periods of low manifold vacuum brake assist vacuum will not be lost.

Depressing the brake pedal closes off the vacuum source and allows atmospheric pressure to enter on one side of the diaphragm. This causes the master cylinder pistons to move and apply the brakes. When the brake pedal is released, vacuum is applied to both sides of the diaphragm, and return springs return the diaphragm and master cylinder pistons to the released position. If the vacuum fails, the brake pedal rod will butt against the end of the master cylinder actuating rod, and direct mechanical application will occur as the pedal is depressed.

The hydraulic and mechanical problems that apply to conventional brake systems also apply to power brakes, and should be checked for if the tests below do not reveal the problem.

Test for a system vacuum leak as described below:

1. Operate the engine at idle without touching the brake pedal for at least one minute.
2. Turn off the engine, and wait one minute.
3. Test for the presence of assist vacuum by depressing the brake pedal and releasing it several times. Light application will produce less and less pedal travel, if vacuum was present. If there is no vacuum, air is leaking into the system somewhere.

Test for system operation as follows:

1. Pump the brake pedal (with engine off) until the supply vacuum is entirely gone.
2. Put a light, steady pressure on the pedal.
3. Start the engine, and operate it at idle. If the system is operating, the brake pedal should fall toward the floor if constant pressure is maintained on the pedal.

Power brake systems may be tested for hydraulic leaks just as ordinary systems are tested.

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 $\frac{1}{32}$ in.

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.

Troubleshooting the Brake System

Problem	Cause	Solution
Low brake pedal (excessive pedal travel required for braking action.)	• Excessive clearance between rear linings and drums caused by inoperative automatic adjusters	• Make 10 to 15 alternate forward and reverse brake stops to adjust brakes. If brake pedal does not come up, repair or replace adjuster parts as necessary.
	• Worn rear brakelining	• Inspect and replace lining if worn beyond minimum thickness specification
	• Bent, distorted brakeshoes, front or rear	• Replace brakeshoes in axle sets
	• Air in hydraulic system	• Remove air from system. Refer to Brake Bleeding.
Low brake pedal (pedal may go to floor with steady pressure applied.)	• Fluid leak in hydraulic system	• Fill master cylinder to fill line; have helper apply brakes and check calipers, wheel cylinders, differential valve tubes, hoses and fittings for leaks. Repair or replace as necessary.
	• Air in hydraulic system	• Remove air from system. Refer to Brake Bleeding.
	• Incorrect or non-recommended brake fluid (fluid evaporates at below normal temp).	• Flush hydraulic system with clean brake fluid. Refill with correct-type fluid.
	• Master cylinder piston seals worn, or master cylinder bore is scored, worn or corroded	• Repair or replace master cylinder
Low brake pedal (pedal goes to floor on first application—o.k. on subsequent applications.)	• Disc brake pads sticking on abutment surfaces of anchor plate. Caused by a build-up of dirt, rust, or corrosion on abutment surfaces	• Clean abutment surfaces
Fading brake pedal (pedal height decreases with steady pressure applied.)	• Fluid leak in hydraulic system	• Fill master cylinder reservoirs to fill mark, have helper apply brakes, check calipers, wheel cylinders, differential valve, tubes, hoses, and fittings for fluid leaks. Repair or replace parts as necessary.
	• Master cylinder piston seals worn, or master cylinder bore is scored, worn or corroded	• Repair or replace master cylinder
Decreasing brake pedal travel (pedal travel required for braking action decreases and may be accompanied by a hard pedal.)	• Caliper or wheel cylinder pistons sticking or seized	• Repair or replace the calipers, or wheel cylinders
	• Master cylinder compensator ports blocked (preventing fluid return to reservoirs) or pistons sticking or seized in master cylinder bore	• Repair or replace the master cylinder
	• Power brake unit binding internally	• Test unit according to the following procedure: (a) Shift transmission into neutral and start engine (b) Increase engine speed to 1500 rpm, close throttle and fully depress brake pedal (c) Slow release brake pedal and stop engine (d) Have helper remove vacuum check valve and hose from power unit. Observe for backward movement of brake pedal. (e) If the pedal moves backward, the power unit has an internal bind—replace power unit

Troubleshooting the Brake System (cont.)

Problem	Cause	Solution
Spongy brake pedal (pedal has abnormally soft, springy, spongy feel when depressed.)	• Air in hydraulic system	• Remove air from system. Refer to Brake Bleeding.
	• Brakeshoes bent or distorted	• Replace brakeshoes
	• Brakelining not yet seated with drums and rotors	• Burnish brakes
	• Rear drum brakes not properly adjusted	• Adjust brakes
Hard brake pedal (excessive pedal pressure required to stop vehicle. May be accompanied by brake fade.)	• Loose or leaking power brake unit vacuum hose	• Tighten connections or replace leaking hose
	• Incorrect or poor quality brakelining	• Replace with lining in axle sets
	• Bent, broken, distorted brakeshoes	• Replace brakeshoes
	• Calipers binding or dragging on mounting pins. Rear brakeshoes dragging on support plate.	• Replace mounting pins and bushings. Clean rust or burrs from rear brake support plate ledges and lubricate ledges with molydisulfide grease. **NOTE:** If ledges are deeply grooved or scored, do not attempt to sand or grind them smooth—replace support plate.
	• Caliper, wheel cylinder, or master cylinder pistons sticking or seized	• Repair or replace parts as necessary
	• Power brake unit vacuum check valve malfunction	• Test valve according to the following procedure: (a) Start engine, increase engine speed to 1500 rpm, close throttle and immediately stop engine (b) Wait at least 90 seconds then depress brake pedal (c) If brakes are not vacuum assisted for 2 or more applications, check valve is faulty
	• Power brake unit has internal bind	• Test unit according to the following procedure: (a) With engine stopped, apply brakes several times to exhaust all vacuum in system (b) Shift transmission into neutral, depress brake pedal and start engine (c) If pedal height decreases with foot pressure and less pressure is required to hold pedal in applied position, power unit vacuum system is operating normally. Test power unit. If power unit exhibits a bind condition, replace the power unit.
	• Master cylinder compensator ports (at bottom of reservoirs) blocked by dirt, scale, rust, or have small burrs (blocked ports prevent fluid return to reservoirs).	• Repair or replace master cylinder **CAUTION:** Do not attempt to clean blocked ports with wire, pencils, or similar implements. Use compressed air only.
	• Brake hoses, tubes, fittings clogged or restricted	• Use compressed air to check or unclog parts. Replace any damaged parts.
	• Brake fluid contaminated with improper fluids (motor oil, transmission fluid, causing rubber components to swell and stick in bores	• Replace all rubber components, combination valve and hoses. Flush entire brake system with DOT 3 brake fluid or equivalent.
	• Low engine vacuum	• Adjust or repair engine

Troubleshooting the Brake System (cont.)

Problem	Cause	Solution
Grabbing brakes (severe reaction to brake pedal pressure.)	• Brakelining(s) contaminated by grease or brake fluid	• Determine and correct cause of contamination and replace brakeshoes in axle sets
	• Parking brake cables incorrectly adjusted or seized	• Adjust cables. Replace seized cables.
	• Incorrect brakelining or lining loose on brakeshoes	• Replace brakeshoes in axle sets
	• Caliper anchor plate bolts loose	• Tighten bolts
	• Rear brakeshoes binding on support plate ledges	• Clean and lubricate ledges. Replace support plate(s) if ledges are deeply grooved. Do not attempt to smooth ledges by grinding.
	• Incorrect or missing power brake reaction disc	• Install correct disc
	• Rear brake support plates loose	• Tighten mounting bolts
Dragging brakes (slow or incomplete release of brakes)	• Brake pedal binding at pivot	• Loosen and lubricate
	• Power brake unit has internal bind	• Inspect for internal bind. Replace unit if internal bind exists.
	• Parking brake cables incorrrectly adjusted or seized	• Adjust cables. Replace seized cables.
	• Rear brakeshoe return springs weak or broken	• Replace return springs. Replace brakeshoe if necessary in axle sets.
	• Automatic adjusters malfunctioning	• Repair or replace adjuster parts as required
	• Caliper, wheel cylinder or master cylinder pistons sticking or seized	• Repair or replace parts as necessary
	• Master cylinder compensating ports blocked (fluid does not return to reservoirs).	• Use compressed air to clear ports. Do not use wire, pencils, or similar objects to open blocked ports.
Vehicle moves to one side when brakes are applied	• Incorrect front tire pressure	• Inflate to recommended cold (reduced load) inflation pressure
	• Worn or damaged wheel bearings	• Replace worn or damaged bearings
	• Brakelining on one side contaminated	• Determine and correct cause of contamination and replace brakelining in axle sets
	• Brakeshoes on one side bent, distorted, or lining loose on shoe	• Replace brakeshoes in axle sets
	• Support plate bent or loose on one side	• Tighten or replace support plate
	• Brakelining not yet seated with drums or rotors	• Burnish brakelining
	• Caliper anchor plate loose on one side	• Tighten anchor plate bolts
	• Caliper piston sticking or seized	• Repair or replace caliper
	• Brakelinings water soaked	• Drive vehicle with brakes lightly applied to dry linings
	• Loose suspension component attaching or mounting bolts	• Tighten suspension bolts. Replace worn suspension components.
	• Brake combination valve failure	• Replace combination valve
Chatter or shudder when brakes are applied (pedal pulsation and roughness may also occur.)	• Brakeshoes distorted, bent, contaminated, or worn	• Replace brakeshoes in axle sets
	• Caliper anchor plate or support plate loose	• Tighten mounting bolts
	• Excessive thickness variation of rotor(s)	• Refinish or replace rotors in axle sets
Noisy brakes (squealing, clicking, scraping sound when brakes are applied.)	• Bent, broken, distorted brakeshoes	• Replace brakeshoes in axle sets
	• Excessive rust on outer edge of rotor braking surface	• Remove rust

Troubleshooting the Brake System (cont.)

Problem	Cause	Solution
Noisy brakes (squealing, clicking, scraping sound when brakes are applied.) (cont.)	• Brakelining worn out—shoes contacting drum of rotor	• Replace brakeshoes and lining in axle sets. Refinish or replace drums or rotors.
	• Broken or loose holdown or return springs	• Replace parts as necessary
	• Rough or dry drum brake support plate ledges	• Lubricate support plate ledges
	• Cracked, grooved, or scored rotor(s) or drum(s)	• Replace rotor(s) or drum(s). Replace brakeshoes and lining in axle sets if necessary.
	• Incorrect brakelining and/or shoes (front or rear).	• Install specified shoe and lining assemblies
Pulsating brake pedal	• Out of round drums or excessive lateral runout in disc brake rotor(s)	• Refinish or replace drums, re-index rotors or replace

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.

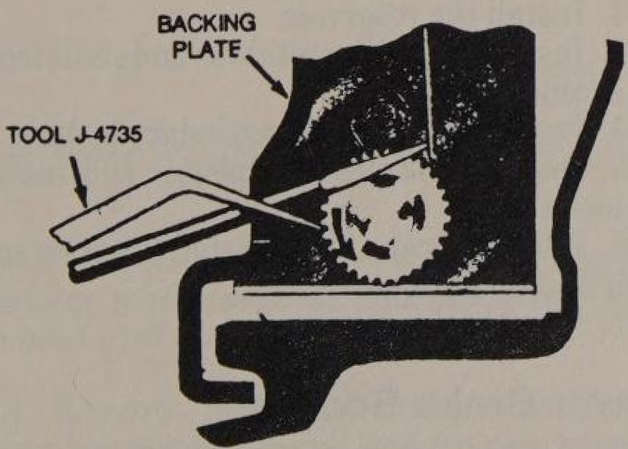
1. Use a punch to knock out the lanced area in the brake backing plate. If this is done with the drum installed on the car, the drum must then be removed to clean out all metal pieces. After adjustments are complete, obtain a hole cover to prevent entry of dirt and water into the brakes.

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 be turned by hand. The drag should be equal at all the wheel.

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.



Adjusting rear drum brakes using brake adjusting spoon

Brake Light Switch

REMOVAL AND INSTALLATION

1. Disconnect the wiring harness from the brake light switch.

2. Remove the switch.

3. **To install,** depress the braked pedal, insert the switch into the tubular clip until the switch body seats on the clip. Clicks should be heard as the threaded portion of the switch are pushed through the clip toward the brake pedal.

4. Pull the brake pedal fully rearward (towards the driver) against the pedal stop, until the click sounds can no longer be heard. The switch will be moved in the tubular clip providing adjustment.

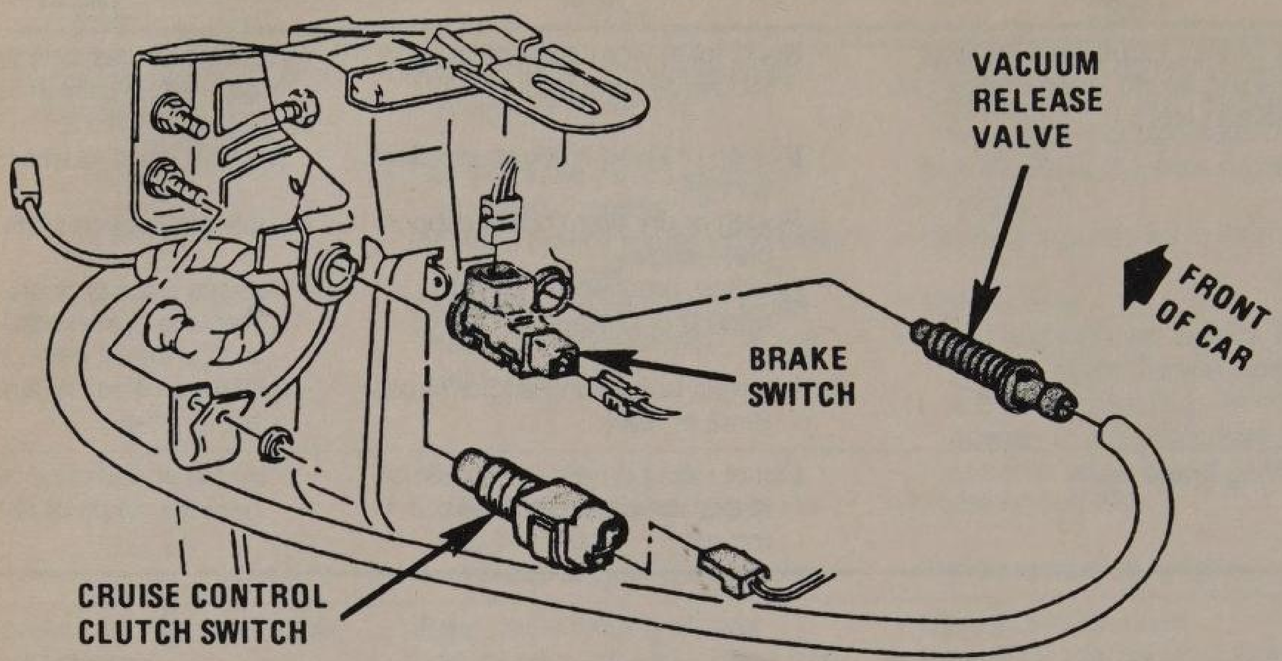
5. Release the brake pedal, and then repeat Step 4, to assure that no click sound remains.

6. Connect the wiring harness to the brake light switch.

Master Cylinder

REMOVAL AND INSTALLATION

1. Disconnect hydraulic lines at master cylinder.



Brake light switch—mounted above brake pedal

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.

To install:

1. Install nuts and lockwashers. Torque nuts to 22–30 ft. lbs. (30–45 Nm).

2. Install hydraulic lines then check brake pedal free play.

3. 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 between a rebuilding kit and a rebuilt part usually makes it more economical, in terms of time and work, to buy the rebuilt part.

Disassembly

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.

Assembly

10. Reassemble, using new seals and grommets. Lubricate all parts with brake fluid.

11. Install the reservoir grommets.

12. Install the reservoir.

13. Install the spring retainer and seals from the secondary piston.

14. Install primary and secondary piston.

15. Depress the primary piston and install the lock ring.

16. Fill with brake fluid. Install the reservoir cover and diaphragm.

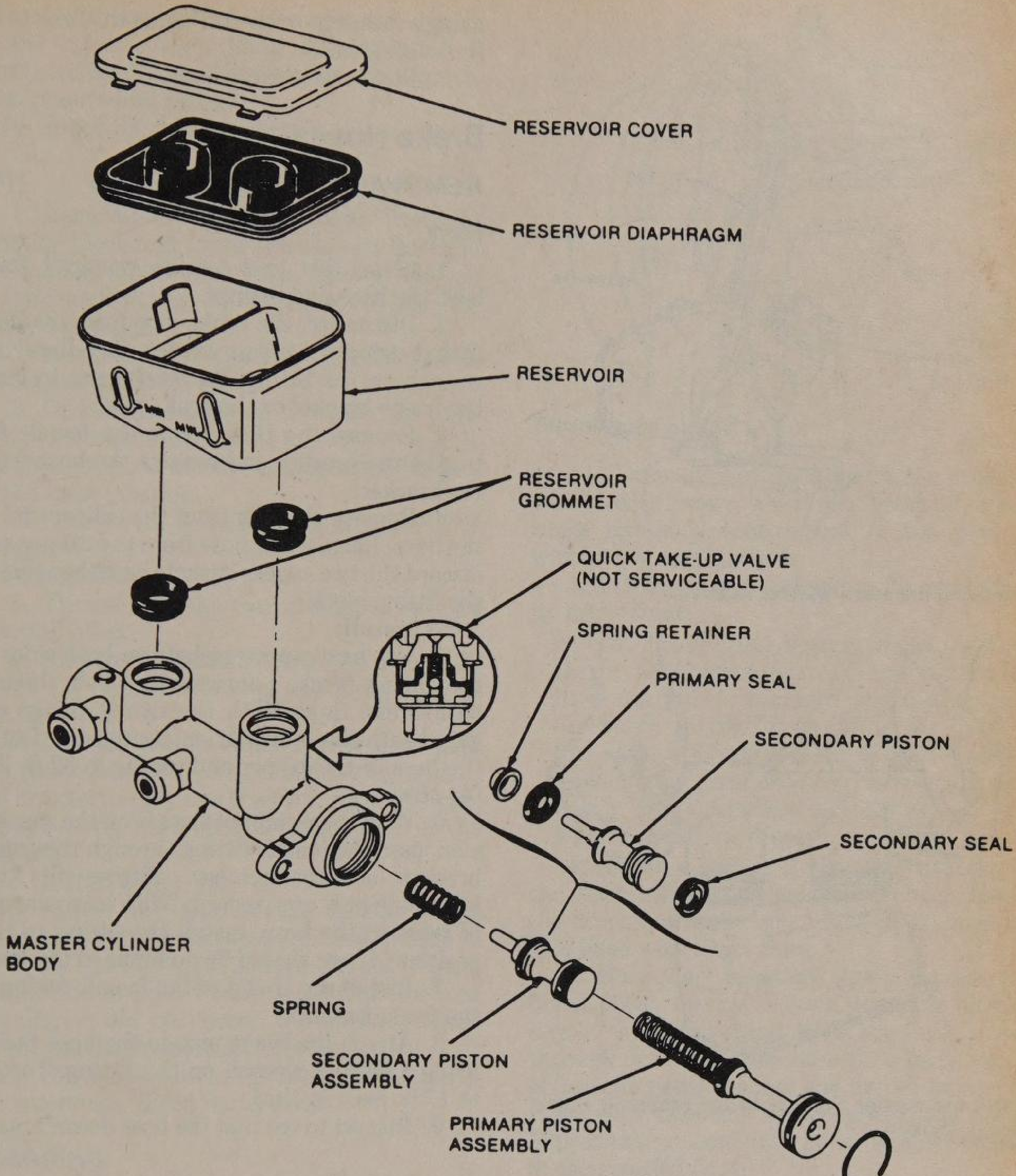
17. Bleed brake system.

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.



Quick take-up master cylinder assembly

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.*

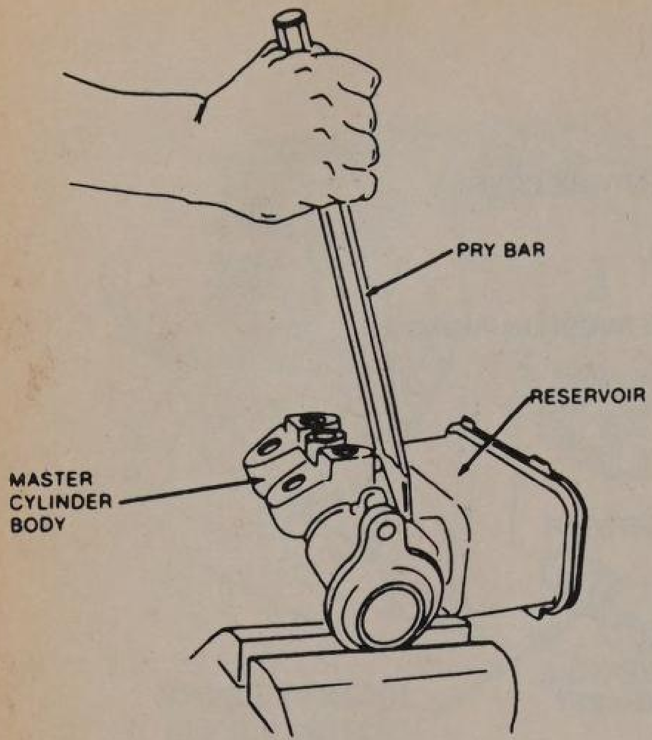
4. Remove nuts and lockwashers that secure booster to firewall and remove booster from engine compartment.
5. Install the booster and torque the nuts to 20 ft. lbs. (27 Nm). Install the brake master cylinder. Make sure to check operation of stop lights. Allow engine vacuum to build before applying brakes.

Combination Valve

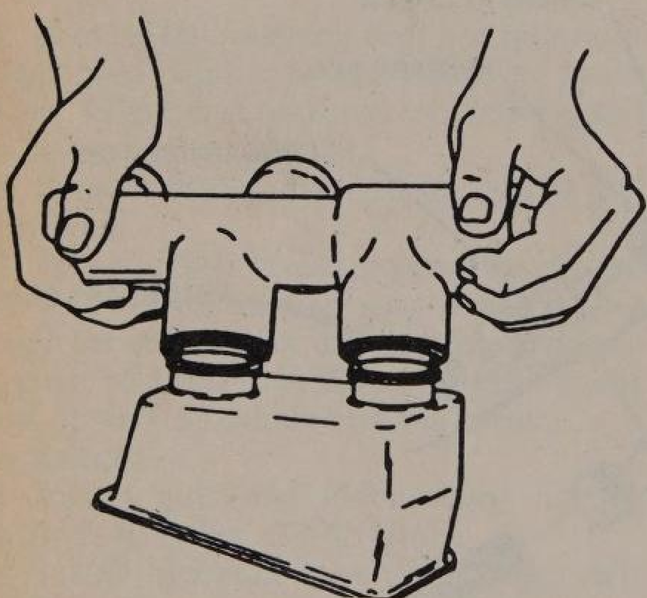
REMOVAL AND INSTALLATION

NOTE: *This valve is not repairable and only serviced as a complete assembly. The valve is mounted under the master cylinder assembly.*

1. Disconnect the hydraulic lines from the valve using flare nut wrenches. Plug the lines to prevent fluid loss and dirt contamination.
2. Disconnect the electrical connection.
3. Remove the valve.
4. **To install**, position the valve.
5. Connect the electrical connection.
6. Connect the hydraulic lines to the valve



Removing the mast cylinder reservoir



Install the master cylinder to the reservoir with a rocking motion

using a flare nut wrench. Torque the lines to 15 ft. lbs. (20 Nm).

7. Bleed the brake system.

Brake Hoses

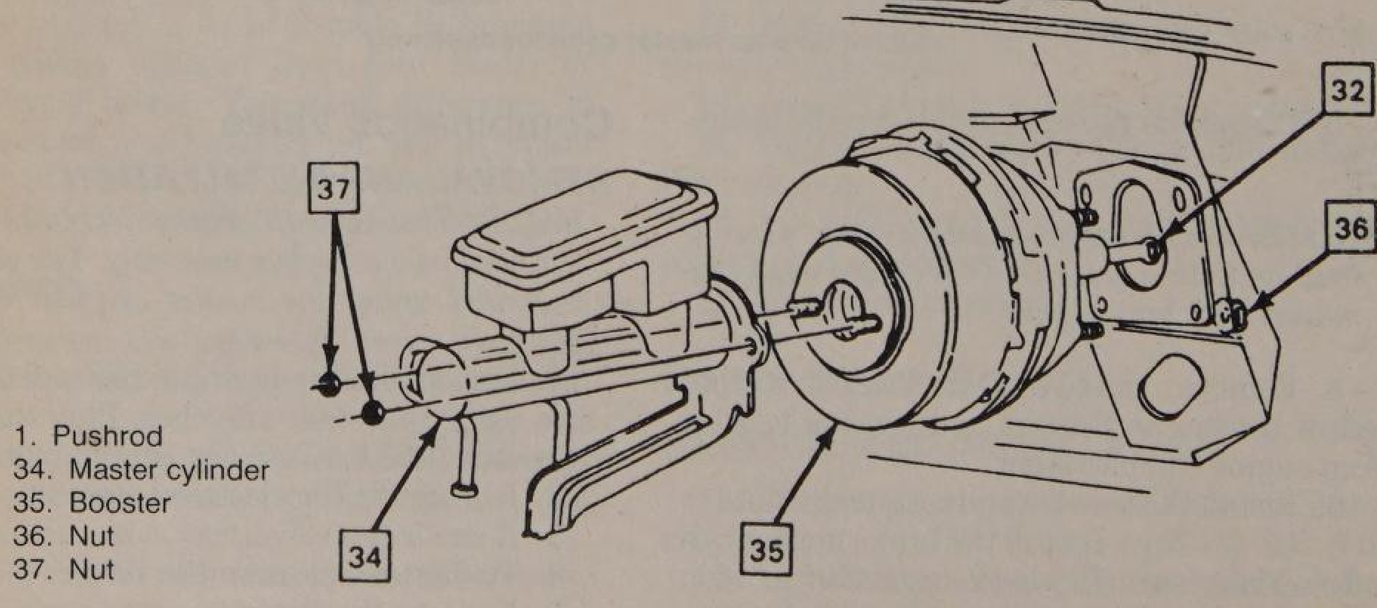
REMOVAL AND INSTALLATION

Front

1. Clean dirt and foreign material from both the hose and fittings.
2. Disconnect the brake pipe from the hose fitting using a backup wrench and flare nut wrench on the fitting. Be careful not to bend the frame bracket or the brake pipe.
3. Remove the U-clip from the female fitting at the bracket and remove the hose from the bracket.
4. Remove the bolt from the caliper end of the hose. Remove the hose from the caliper and discard the two copper gaskets on either side of the fitting block.

To install:

5. Use new copper gaskets on both sides of the fitting block. Lubricate the bolt threads with brake fluid. With the fitting flange engaged with the caliper orientation ledge, fasten the hose to the caliper and torque to 32 ft. lbs. (44 Nm).
6. With the weight of the car on the suspension, pass the female fitting through the frame bracket of crossmember. Fitting fits the bracket in only one position. With least amount of twist in the hose, install the fitting in this position. There should be no kinks in the hose.
7. Install the U-clip to the female fitting at the frame bracket.
8. Attach the brake pipe to the hose fitting using a backup wrench on the fitting. Torque to 17 ft. lbs. (24 Nm).
9. Inspect to see that the hose doesn't make



Power brake booster mounting

contact with any part of the suspension. Check in the extreme right hand and extreme left hand turn conditions. If the hose makes any contact, remove and correct.

10. Bleed the brake system.

Rear

1. Remove the two brake pipes from the junction block and , with the use of a flare nut wrench and a backup wrench, remove the hose at the female fitting. Be careful not to bend the bracket or pipes.
2. Remove the U-clip and take the female fitting out of the bracket.
3. Observe the position at which the junction block is mounted to the axle. When installing the new hose, be sure this junction block is in the same position.
4. Remove the bolt attaching junction block to axle.

To install:

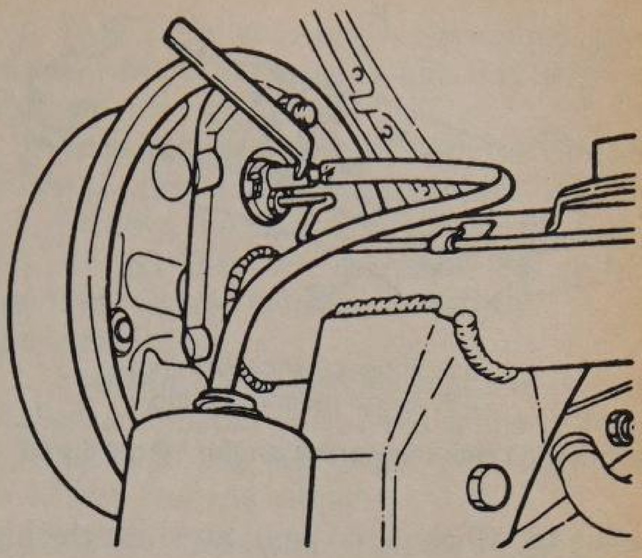
5. Thread both the rear axle pipes into the junction block.
6. Bolt the junction block to the axle to 20 ft. lbs. (27 Nm). Torque the rear pipes to 17 ft. lbs. (24 Nm).
7. Pass the female end of the hose through the frame bracket. The female fitting will fit the bracket in only one position; without twisting the hose, position the female end in the bracket.
8. Install the U-clip.
9. Attach the pipe to the female fitting using a backup wrench on the fitting, torque to 17 ft. lbs. (24 Nm) again be careful not to bend the bracket or pipe. Check to see that the hose installation did not loosen the frame bracket. Re-torque the bracket, if necessary.
10. Fill and maintain the brake fluid level in the reservoirs. Bleed the 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, 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.



Bleeding the brakes

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.*

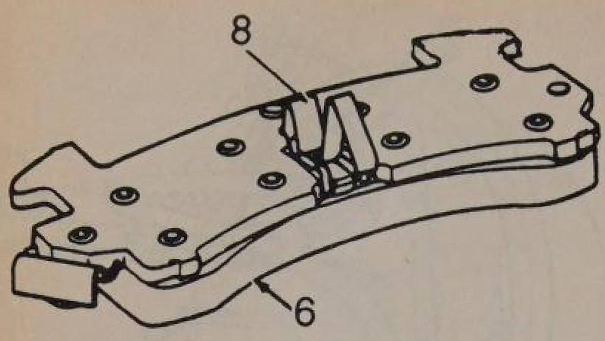
4. Attach a length of clear vinyl tubing to the bleeder screw on the wheel cylinder. Insert the other end of the tube into a clear, clean jar half filled with brake fluid.
5. Have your assistant slowly depress the brake pedal. As this is done, open the bleeder screw $^3/_4$ of a turn and allow the fluid 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.
7. 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

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



6. Inboard shoe & lining
8. Shoe retainer spring

Install the retaining spring on the inboard pad

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. (0.76mm) 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

Single Piston

CAUTION: *Brake pads contain asbestos, which has been determined to be a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces, use a commercially available brake cleaning fluid.*

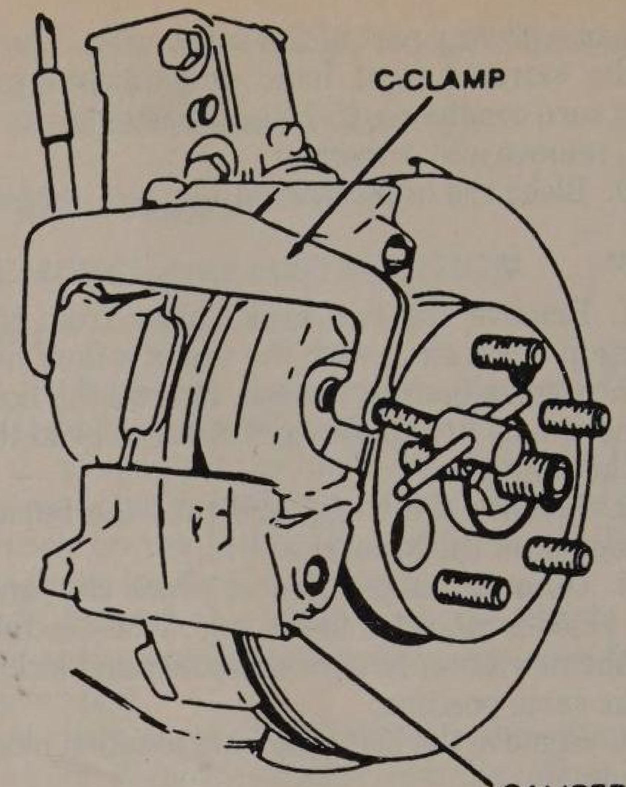
1. Siphon $^2/_3$ of the brake fluid from the master cylinder reservoir. Loosen the wheel lug nuts and raise the car. Remove the wheel.
2. Position a C-clamp across the caliper and press on the pads. Tighten it until the caliper piston bottoms in its bore.

NOTE: *If you haven't removed some brake fluid from the master cylinder, it may overflow when the piston is retracted.*

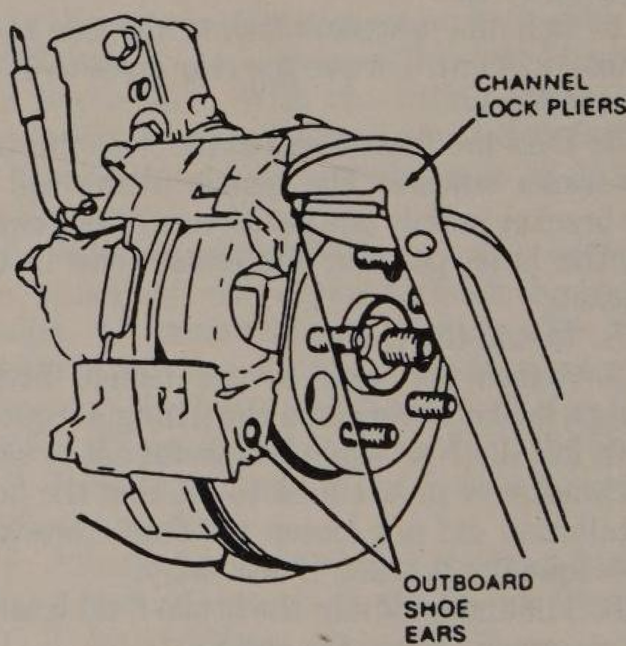
3. Remove the C-clamp.
4. Remove the allen head caliper mounting bolts. Inspect the bolts for corrosion and replace as necessary.
5. Remove the caliper from the steering knuckle and suspend it from the body of the car with a length of wire. Do not allow the caliper to hang by its hose.
6. Remove the pad retaining springs and remove the pads from the caliper.
7. Remove the plastic sleeves and the rubber bushings from the mounting bolt holes.

To install:

1. Obtain a pad replacement kit. Lubricate and install the new sleeves and bushings with a light coat of silicone grease.



Install a C-clamp to retract the brake pads



Bend the outboard pad ears into place with a large pair of slipjoint pliers

2. Install the retainer spring on the inboard pad.

NOTE: *A new spring should be included in the pad replacement kit.*

3. Install the new inboard pad into the caliper with the wear sensor at the leading of the shoe during forward wheel rotation.
4. Install the outboard pad into the caliper.
5. Use a large pair of slip joint pliers to bend the outer pad ears down over the caliper.
6. Install the caliper onto the steering knuckle. Tighten the mounting bolts to 21–35 ft. lbs. (28–47 Nm.). Install the wheel and lower the car. Fill the master cylinder to its proper level with a good quality brake fluid.

Dual Piston

CAUTION: *Some brake pads contain asbestos, which has been determined to be a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces, use a commercially available brake cleaning fluid.*

1. Remove the caliper assembly.
2. Position a C-clamp over the caliper housing and the center of the inboard disc brake pad. Compress the C-clamp until the pistons are bottomed.
3. Remove the disc brake pads.

To install:

4. Clean all residue from the mounting bracket and caliper pad contact surfaces.
5. Install the disc brake pads. The outboard disc brake pad with insulator is installed in the caliper housing. The inboard brake pad with wear sensor is pressed into the caliper pistons. Push the pads in firmly until they are flush and fully seated in the caliper housing.
6. Install the caliper and bleed the brake system.

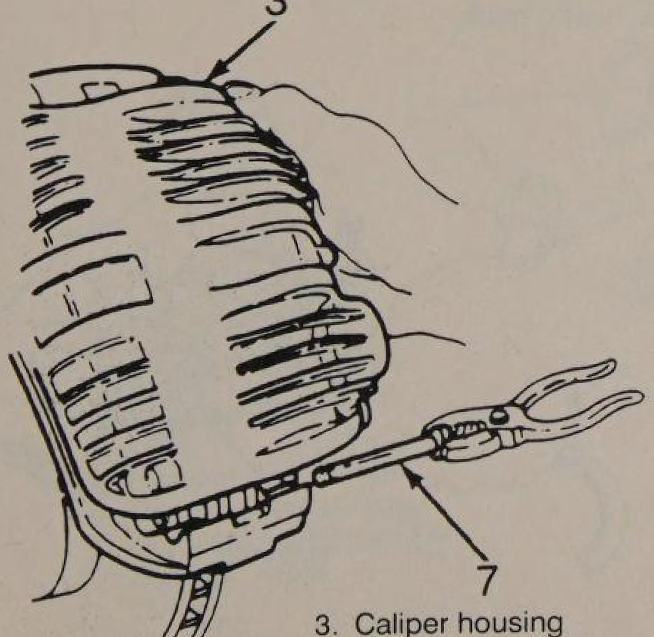
Brake Caliper

REMOVAL AND INSTALLATION

Single Piston

CAUTION: *Brake pads contain asbestos, which has been determined to be a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces, use a commercially available brake cleaning fluid.*

1. Remove $^{2}/_{3}$ of the brake fluid from the master cylinder. Raise the vehicle and remove the wheel.



3. Caliper housing
7. Retainer pin

Removing caliper retaining pin

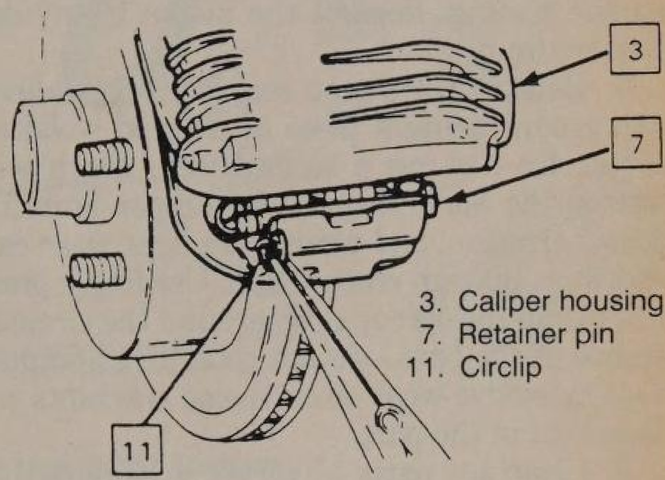
2. Place a C-clamp across the caliper, positioned on the brake pads. Tighten it until the piston is forced into its bore.
3. Remove the C-clamp. Remove the bolt holding the brake hose to the caliper.
4. Remove the allen head caliper mounting bolts. Inspect them for corrosion and replace them if necessary. Remove the caliper.

To install:

1. Position the caliper with the brake pad installed and install allen head caliper mounting bolts. Mounting bolt torque is 21–35 ft. lbs. (28–47 Nm.) for the caliper.

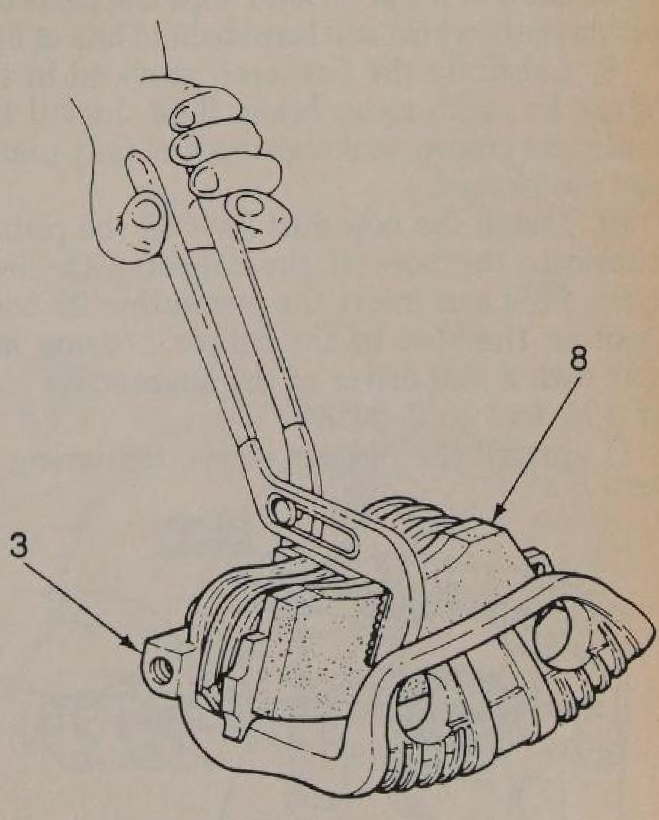
CAUTION: *Before moving the vehicle, pump the brakes several times to set the brake pad against the rotor*

2. Install the C-clamp. Install the bolt holding the brake hose to the caliper and tighten to 18–30 ft. lbs. (24–40 Nm.).



3. Caliper housing
7. Retainer pin
11. Circlip

Removing caliper clip



3. Caliper housing
8. Inboard pad assembly

Compressing caliper pistons

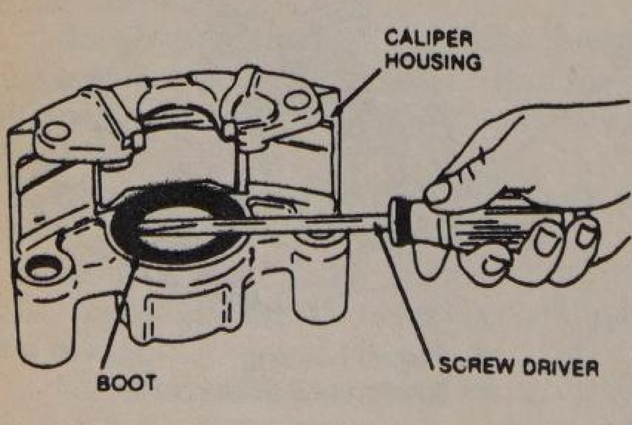
3. Fill the master cylinder with brake fluid.
4. Install the wheels and lower the vehicle.

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 east 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 corcus cloth around the circumference of the bore—do not slide it in and out. More extensive wear or corrosion warrants replacement of the part.
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 inch lbs. (9–16 Nm.). Do not overtighten.
12. Install the pads, install the caliper, and bleed the brakes.



Remove the piston boot with an awl

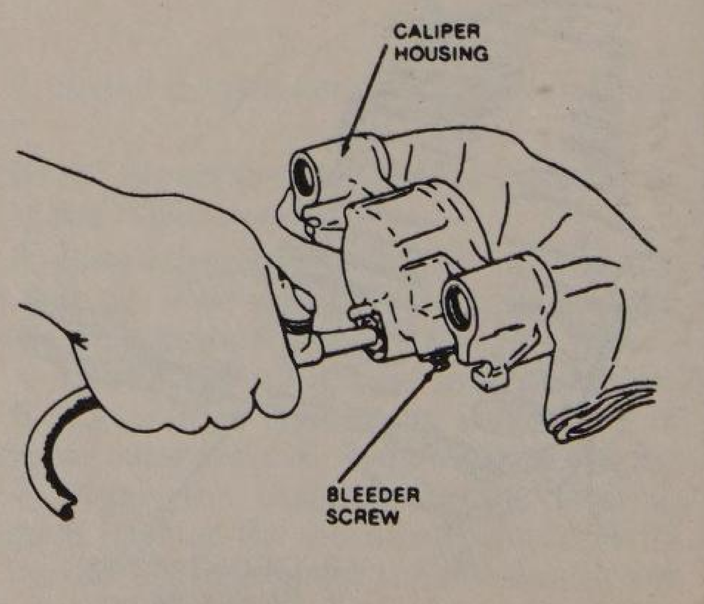
Double Piston

CAUTION: *Some brake pads contain asbestos, which has been determined to be a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces, use a commercially available brake cleaning fluid.*

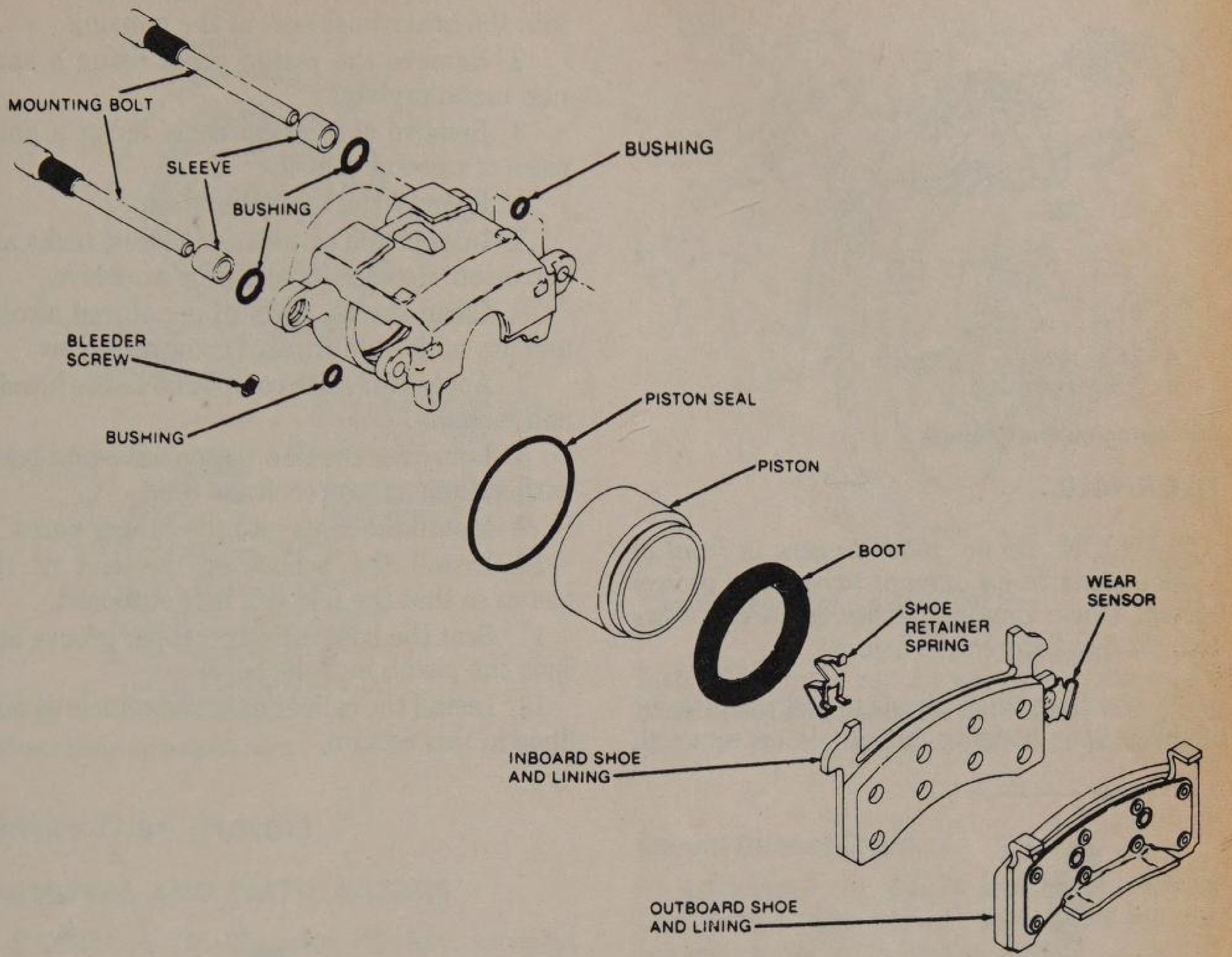
1. Remove $^{2}/_{3}$ of the brake fluid from the master cylinder.
2. Raise and support the vehicle safely.
3. Remove the wheel and tire assembly.
4. Remove the bolt, inlet fitting and 2 washers from the caliper housing. Plug the openings in the caliper housing and inlet fittings.
5. Remove the circlip and retainer pin.
6. Remove the caliper housing from the rotor and mounting bracket.

To install:

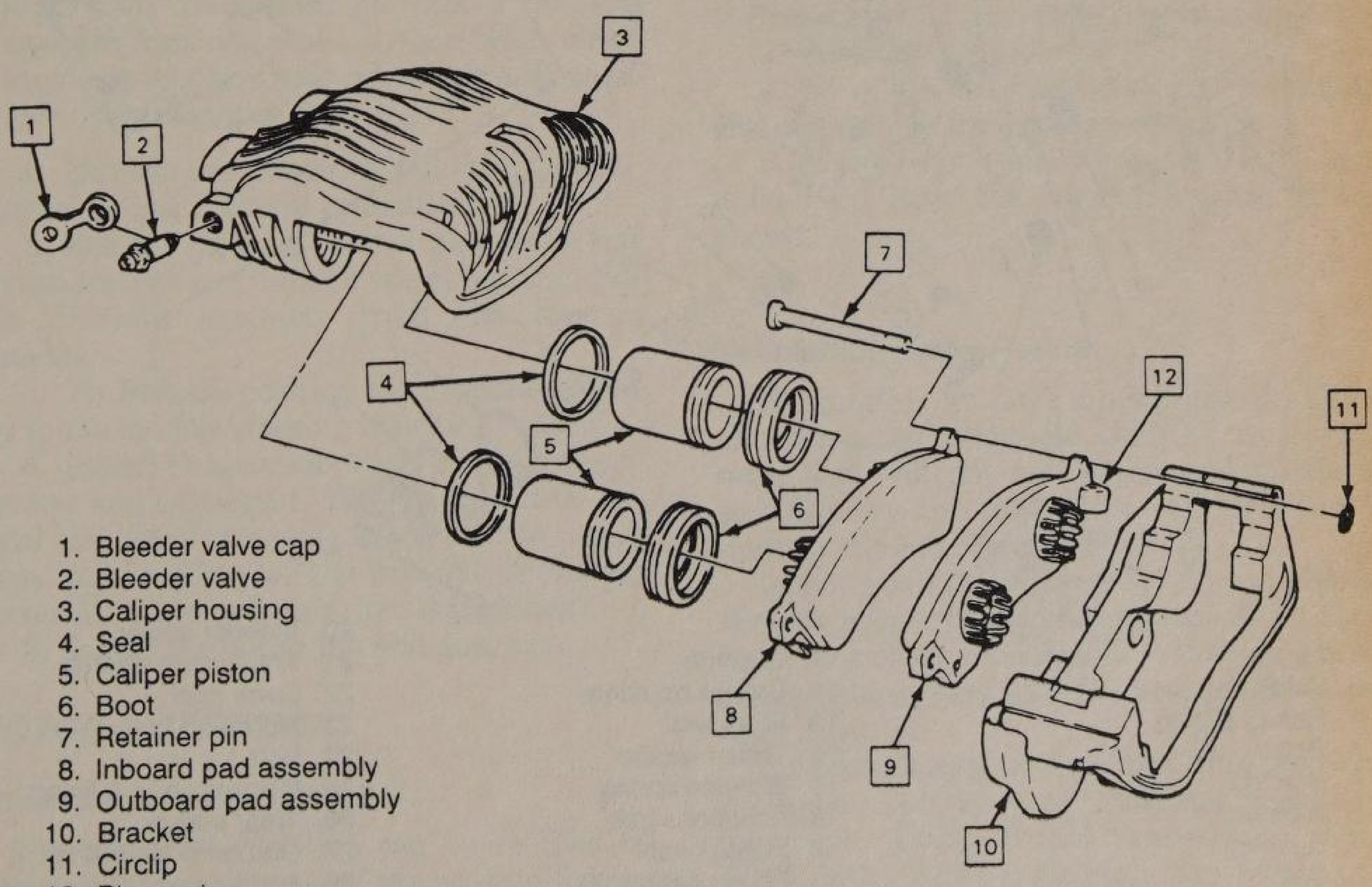
7. Check the inlet fitting bolt for blockage and clear or replace as necessary.
8. Install the caliper housing over the rotor and onto the mounting bracket. Make sure the guiding surfaces on the inboard and outboard disc brake pads and mounting bracket are seated correctly.
9. Press the caliper housing down to compress the bias springs and slide a new retainer pin into position and install a new circlip.
10. Install the inlet fitting, bolt and 2 new washers. Tighten the bolt to 30 ft. lbs. (40 Nm).
11. Bleed the brakes.
12. Install the wheel and tire assembly and lower the vehicle.
13. With the engine running, pump the brake pedal slowly and firmly 3 times to seat the brake pads.



Use air pressure to remove the piston from the bore

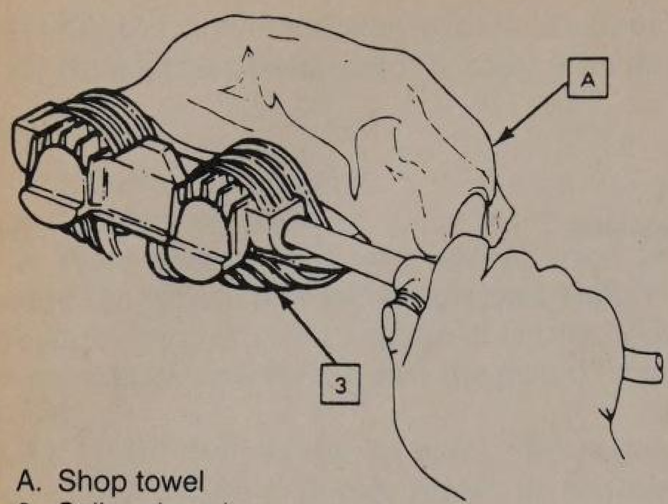


Exploded View of the front Disc Brake Caliper



1. Bleeder valve cap
2. Bleeder valve
3. Caliper housing
4. Seal
5. Caliper piston
6. Boot
7. Retainer pin
8. Inboard pad assembly
9. Outboard pad assembly
10. Bracket
11. Circlip
12. Bias spring

Double piston front caliper



A. Shop towel
3. Caliper housing

Removing caliper pistons

OVERHAUL

CAUTION: *Do not place fingers in front of the pistons in an attempt to catch or protect them whem applying compressed air. This could result in serious injury.*

1. Use clean shop towels to pad the interior of the caliper housing during piston removal. Remove the pistons by directing compressed air into the brake hose port of the housing.

2. Remove the piston boots using a small non-metal prybar.

3. Remove the piston seals using a small piece of wood or plastic.

4. Remove the bleeder and cap.

5. Inspect the pistons for scores, nicks and corrosion. Replace if damage is excessive.

6. Clean the all parts in denatured alcohol and dry with unlubricated compressed air.

7. Apply anti-seize compound to the bleeder and install.

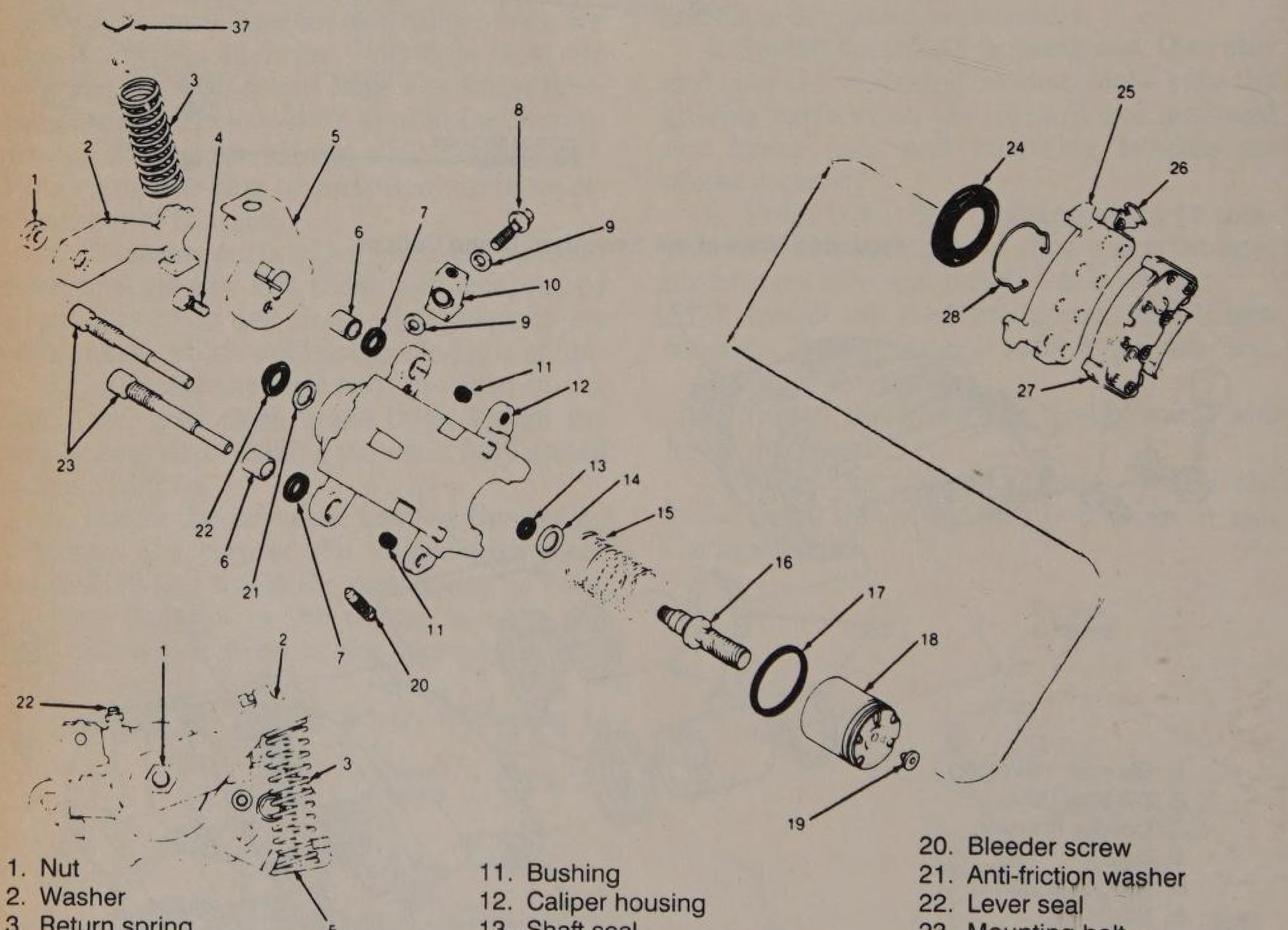
8. Lubricate the new piston seals and bores with silicone grease or brake fluid.

9. Install the seals into the caliper bores.

10. Install the boot over the end of the piston so that the fold will face outboard.

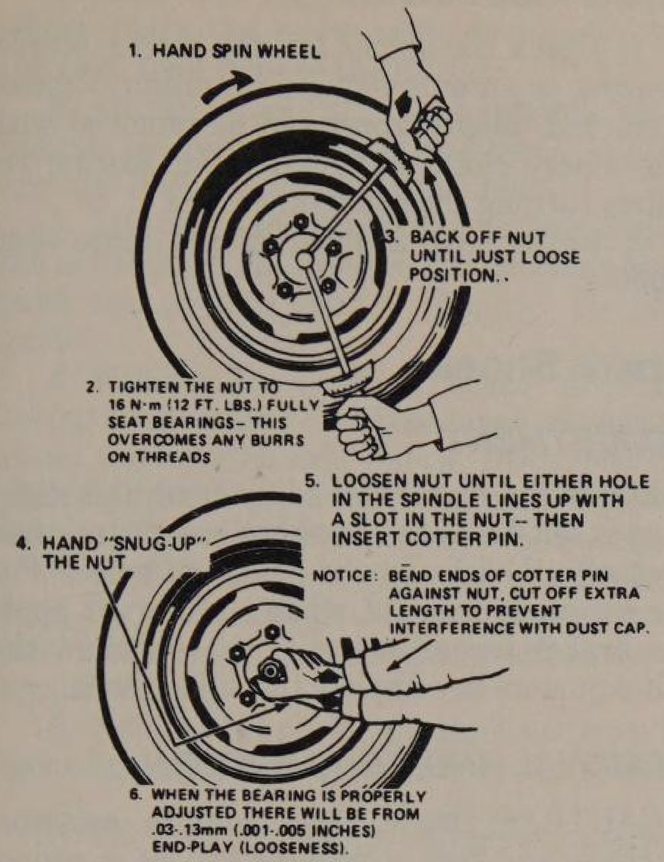
11. Seat the boot into the caliper groove and slide the piston into the bore.

12. Install the caliper onto the vehicle as outlined in this section.



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. Bolt
25. Inboard shoe & lining
26. Wear sensor
27. Outboard shoe & lining
28. Shoe dampening spring
37. Damper

Rear caliper exploded view



Wheel bearing adjustment

Brake Disc (Rotor)

REMOVAL AND INSTALLATION

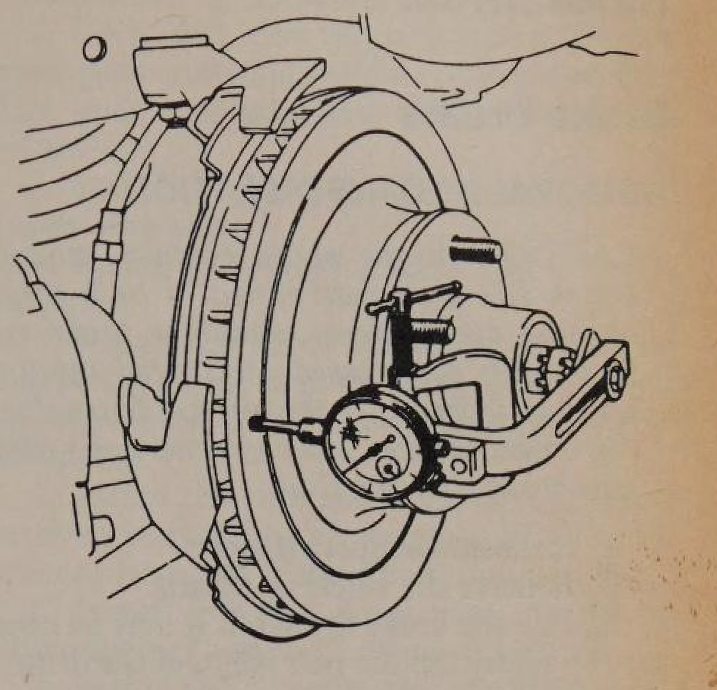
CAUTION: *Brake pads contain asbestos, which has been determined to be a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces, use a commercially available brake cleaning fluid.*

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**, position the disc/hub assembly to the spindle/steering knuckle.
4. Install the outside wheel bearing, thrust washer and castle nut. Tighten the castle nut until the bearing is snug. Back off the nut $^{1}/_{4}$ turn. Refer to Chapter 1 or 8 for Wheel Bearing Removal and Installation, and Adjustment.
5. Install the cotter pin and dust cap.

ROTOR INSPECTION

Thickness Variation Check

The thickness variation can be checked by measuring the thickness of the rotor at four or more points. All of the measurements must be made at the same distance from the edge of the rotor. A rotor the varies by more than 0.0005 inch (0.013mm) can cause a pulsation in the brake pedal. If these measurement are excessive, the rotor should be refinished or replaced.



Check the out with a dial indicator

Lateral Runout Check

1. Remove the caliper and hang from the body with a piece of wire. Install two inverted lug nuts to retain the rotor.
2. Install a dial indicator to the steering knuckle so that the indicator button contacts the rotor about 1 inch from the rotor edge.
3. Zero the dial indicator.
4. Move the rotor one complete revolution and observe the total indicated runout.
5. If the rotor runout exceeds 0.0015 inch (0.040mm) have the rotor refinished or replaced.

Refinishing Brake Rotors

All brake rotors have a minimum thickness dimension cast onto them. Do NOT use a brake rotor that will not meet minimum thickness specifications in the "Brake Specifications" chart at the end of this chapter.

Accurate control of rotor tolerances is necessary for proper brake performance and safety. Machining of the rotor should be done by a qualified machine shop with the proper machining equipment.

The optimum speed for refinishing the rotor surface is a spindle speed of 200 rpm. Crossfeed for rough cutting should range from 0.010–0.006 inch (0.254–0.152mm) per revolution. The finish cuts should be made at crossfeeds no greater than 0.002 inch (0.051mm) per revolution.

REAR DRUM BRAKES

Brake Drums

REMOVAL AND INSTALLATION

CAUTION: *Brake shoes contain asbestos, which has been determined to be a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces, use a commercially available brake cleaning fluid.*

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.

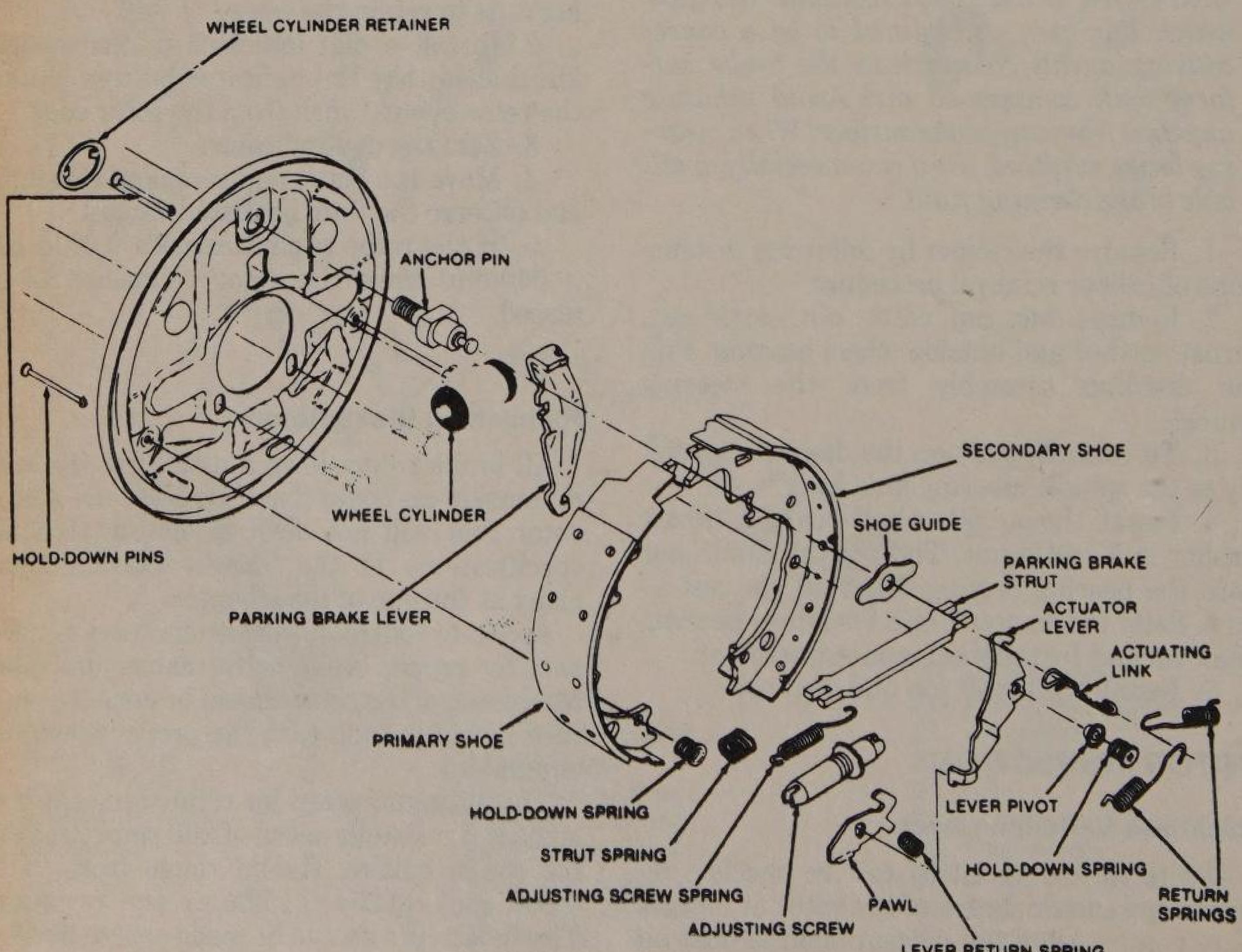
Brake Shoes

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

CAUTION: *Brake shoes contain asbestos, which has been determined to be a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces, use a commercially available brake cleaning fluid.*



Exploded View of the Rear Brake Drum

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 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.*

To install:

1. Clean dirt from all parts and wirebrush raised pads on backing plate. Lubricate backing plate pads and adjusting screw with brake grease.

2. Install the parking brake lever to the secondary shoe slot.

3. Install the adjusting screw and spring to the shoes.

4. Install the shoes. Connect the parking brake cable to the primary shoe and the parking brake lever. Install the parking brake strut and spring.

5. Install the shoe guide. Install the actuator lever, pawl and return spring. Lift up on the actuator lever and install the actuating link.

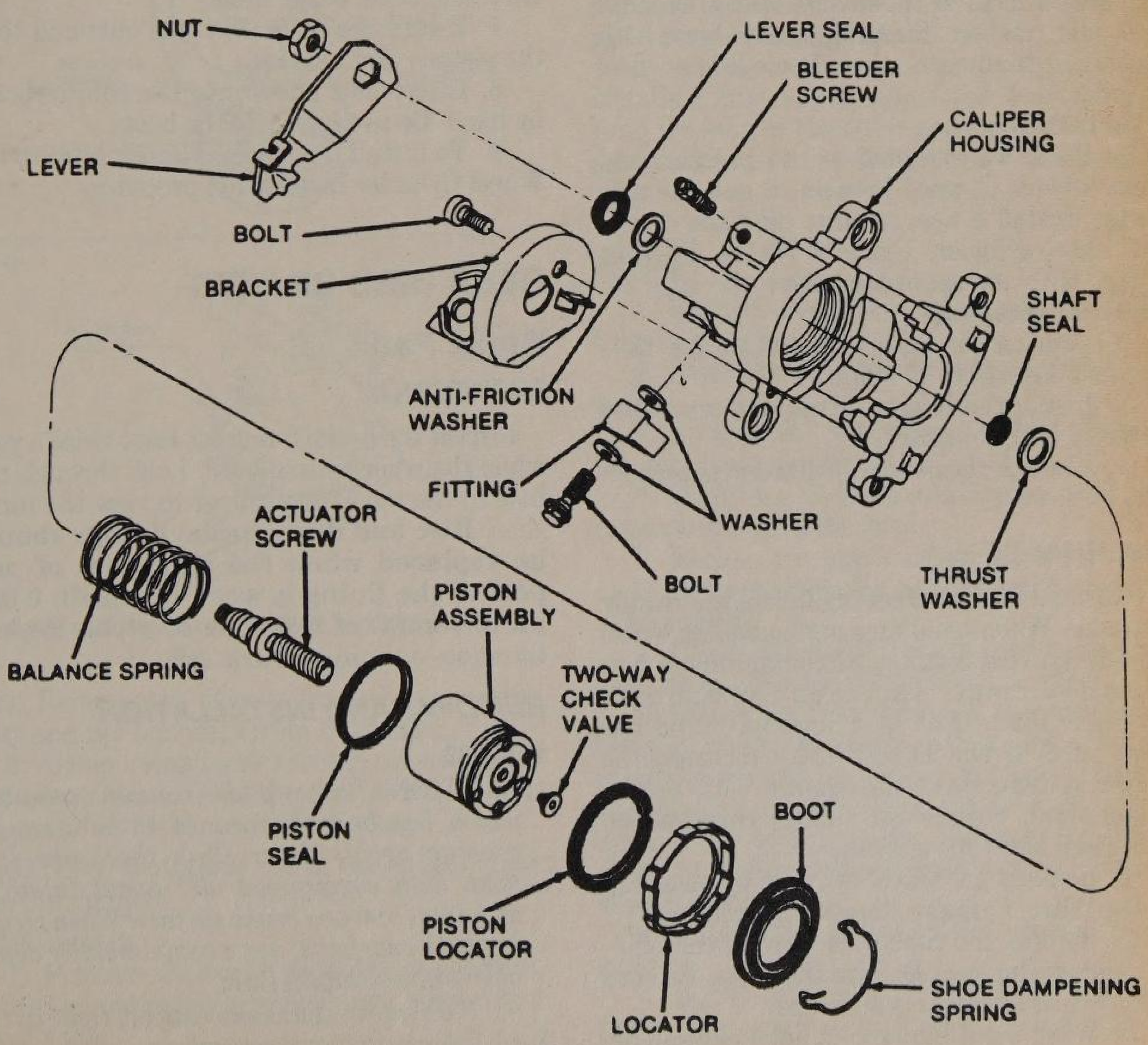
6. Install the hold down pins. Install the return springs and the hold down springs.

7. Install the wheel to the marks made on the drum and the axle and adjust the brakes.

8. Lower the car.

INSPECTION

Inspect the brake linings at least twice a year



Rear caliper overhaul

when the wheels are moved. Look through the hole in the top of the caliper to view the inner shoe. **Disc and drum brake linings should be replaced when the thickness of any part of the lining is worn to within 0.030 in. (0.76mm) of the shoe or rivet.** Replace the shoes or linings in axle sets.

Wheel Cylinders

REMOVAL AND INSTALLATION

CAUTION: *Brake shoes contain asbestos, which has been determined to be a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces, use a commercially available brake cleaning fluid.*

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 ($^1/_8$ in. diameter.), 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.

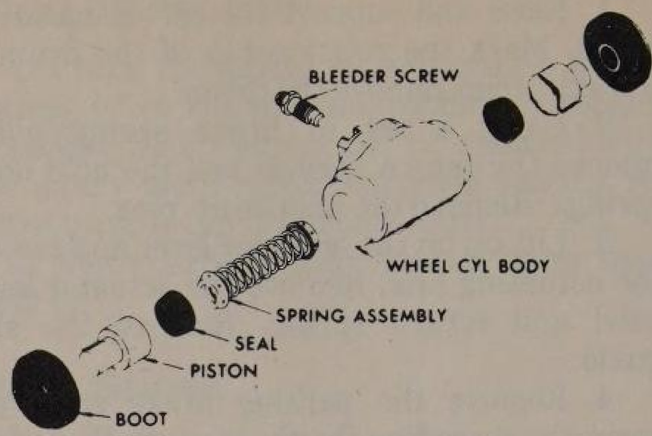
To install:

1. 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 $1^1/_8$ in. 12-point socket with an extension, drive the new retainer into position.
2. Connect the inlet tube and torque 120–280 inch lbs. (13.6–20 Nm).
3. Install the brakes, drum and wheels as outlined in this chapter.
4. Bleed the brakes as outlined in this chapter.

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.
3. Wash the cylinder and metal parts in denatured alcohol or clean brake fluid.



Exploded view of a typical wheel cylinder

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.

REAR DISC BRAKES

Brake Pads

INSPECTION

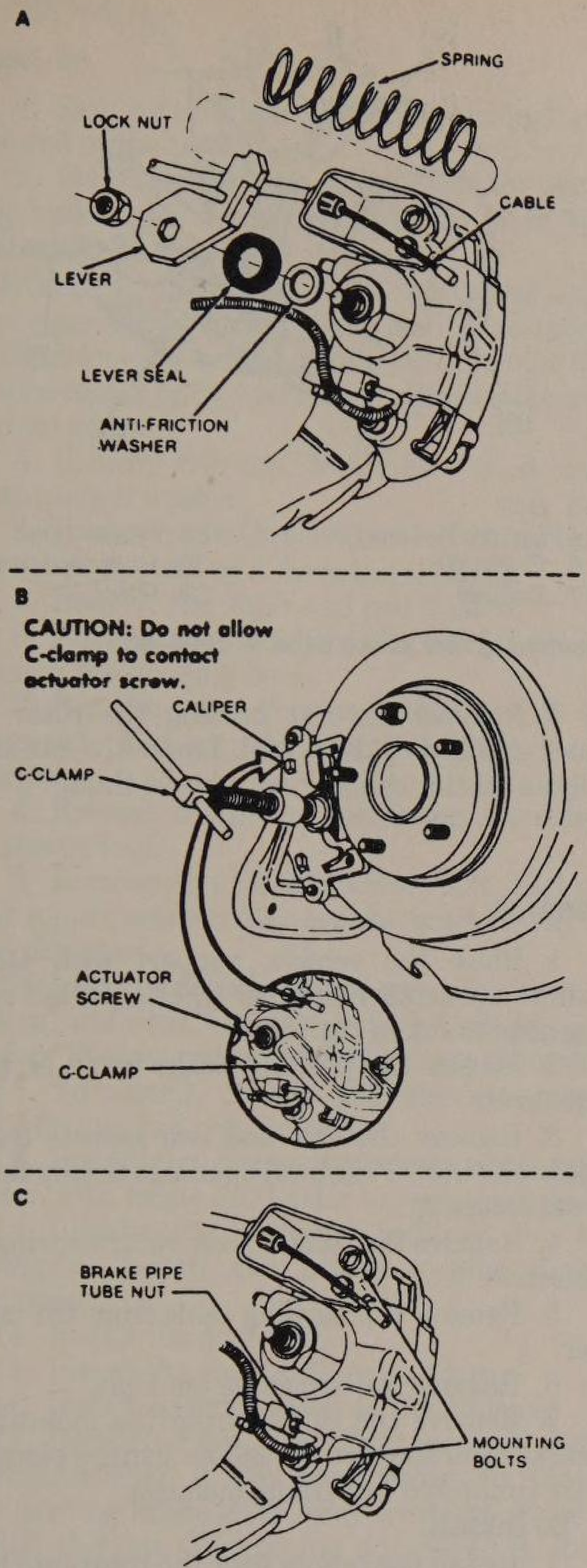
Inspect the brake linings at least twice a year when the wheels are moved. Look through the hole in the top of the caliper to view the inner shoe. **Disc and drum brake linings should be replaced when the thickness of any part of the lining is worn to within 0.030 in. (0.76mm) of the shoe or rivet.** Replace the shoes or linings in axle sets.

REMOVAL AND INSTALLATION

1982–88

CAUTION: *Brake pads contain asbestos, which has been determined to be a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces, use a commercially available brake cleaning fluid.*

1. To remove the brake caliper, refer to the Rear Caliper Removal procedure.
2. Remove the brake pads from the cali-



Remove and install rear caliper — 1982–88

pers. Remove the sleeves from the mounting bolts and the bushings from the caliper.

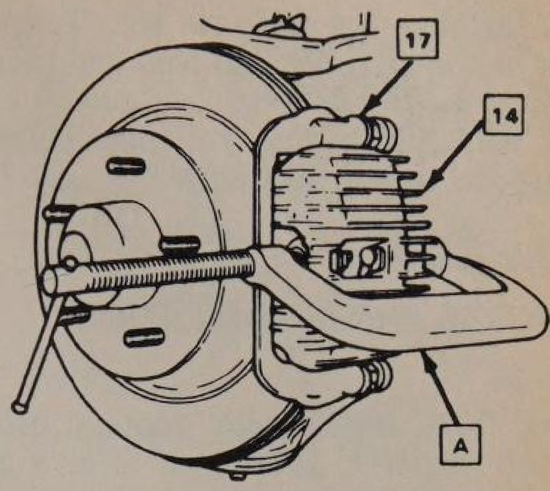
3. Using a small screwdriver, remove the 2-way check valve from the end of the piston. Clean and check the valve for leakage.

NOTE: *If leakage is noted, the caliper must be overhauled.*

To install:

1. Position the brake pads into the caliper. Lubricate and install new bushings, sleeves and check valve.

2. When installing the inner brake pad,



A. C–clamp
14. Caliper housing
17. Bracket

Compressing caliper piston with C-clamp — 1989–90

make sure that the D-shaped tab of the pad engages with the D-shaped notch of the piston.

3. 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 the ends of the dampening spring and snap the pad into position against the piston.

4. 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.

1989–90

1. Remove two thirds of the brake fluid from the master cylinder.

2. Raise the vehicle and support with jackstands.

3. Remove the rear wheels and install two lug nuts to retain the rotor.

4. Position a C-clamp and tighten until the piston bottoms in the bore.

5. Remove the upper caliper guide pin bolt.

6. Remove the brake pads from the bracket.

To install:

1. Clean all residue from the pad guide surfaces on the mounting bracket and caliper.

2. Install the new pads on the mounting bracket. The outboard pad is installed with the insulator toward the caliper housing. The inboard pad is installed with the wear indicator nearest the caliper piston. The wear indicator must be in the trailing position with forward wheel rotation.

3. Rotate the caliper to the original position.

4. Install the springs onto the pads so that the spring does not stick through the hole in the housing.

5. Install a new guide pin bolt. Torque the upper bolt to 26 ft. lbs. (35 Nm) and the lower bolt to 16 ft. lbs. (22 Nm).

6. With the engine running, pump the brake pedal to seat the linings.

Brake Caliper

REMOVAL AND INSTALLATION

1982–88

CAUTION: *Brake pads contain asbestos, which has been determined to be a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces, use a commercially available brake cleaning fluid.*

1. Remove 2/3 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.*

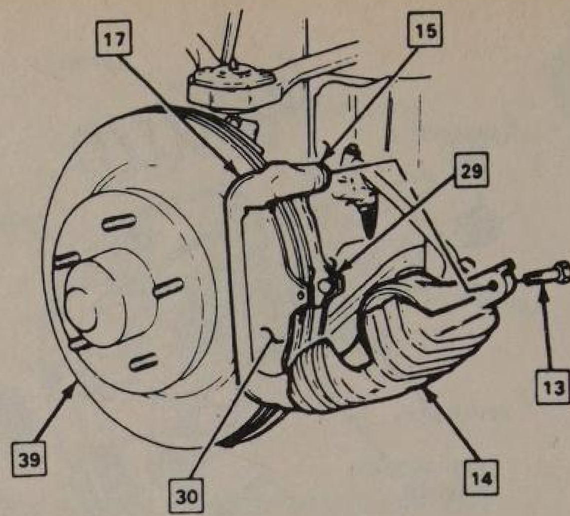
6. Remove the mounting bolts using a 3/8 in. allen head socket. Remove the caliper and inspect the mounting bolts for corrosion. If necessary, replace the mounting bolts.

To install:

1. Place the caliper onto the rotor and install the mounting bolts. Torque the mounting bolts to 30–45 ft. lbs. (40.7–61 Nm).

2. 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. lbs. (40.7–54.2 Nm), then rotate the lever back against the stop on the caliper.

3. 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.



13. Bolt
14. Caliper housing
15. Guide pin
17. Bracket
29. Inboard pad
30. Outboard pad
39. Rotor

Removing rear brake pads — 1989–90

4. Remove the nut holding the rotor in place and install the wheel. Lower the car and fill the master cylinder with brake fluid.

1989–90

1. Raise the vehicle, support with jackstands and remove the rear wheels. Install two lug nuts to retain the rotor.

2. Loosen the parking brake cable at the equalizer.

3. Remove the bolt and two gaskets from the brake hose. Plug both openings to stop fluid from escaping.

4. Remove the caliper lever return spring if defective.

5. Remove the parking cable from the caliper.

6. Remove the two guide pin bolts.

7. Remove the caliper from the mounting bracket and support the caliper using a piece of wire connected to a frame member.

To install:

1. Install the caliper over the rotor into the mounting bracket.

2. Install the guide pin bolts and torque the upper bolt to 26 ft. lbs. (35 Nm) and the lower bolt to 16 ft. lbs. (22 Nm).

3. Install the parking cable and return spring if removed.

4. Install the brake hose with two new gaskets and torque the bolt to 30 ft. lbs. (40 Nm).

5. Adjust the parking cable at the equalizer.

6. Bleed the brake system as outlined in this chapter.

7. Install the rear wheels and torque the lug nuts to 100 ft. lbs. (136 Nm).

8. Pump the brake pedal, lower the vehicle and road test.

OVERHAUL

1982–88

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.*

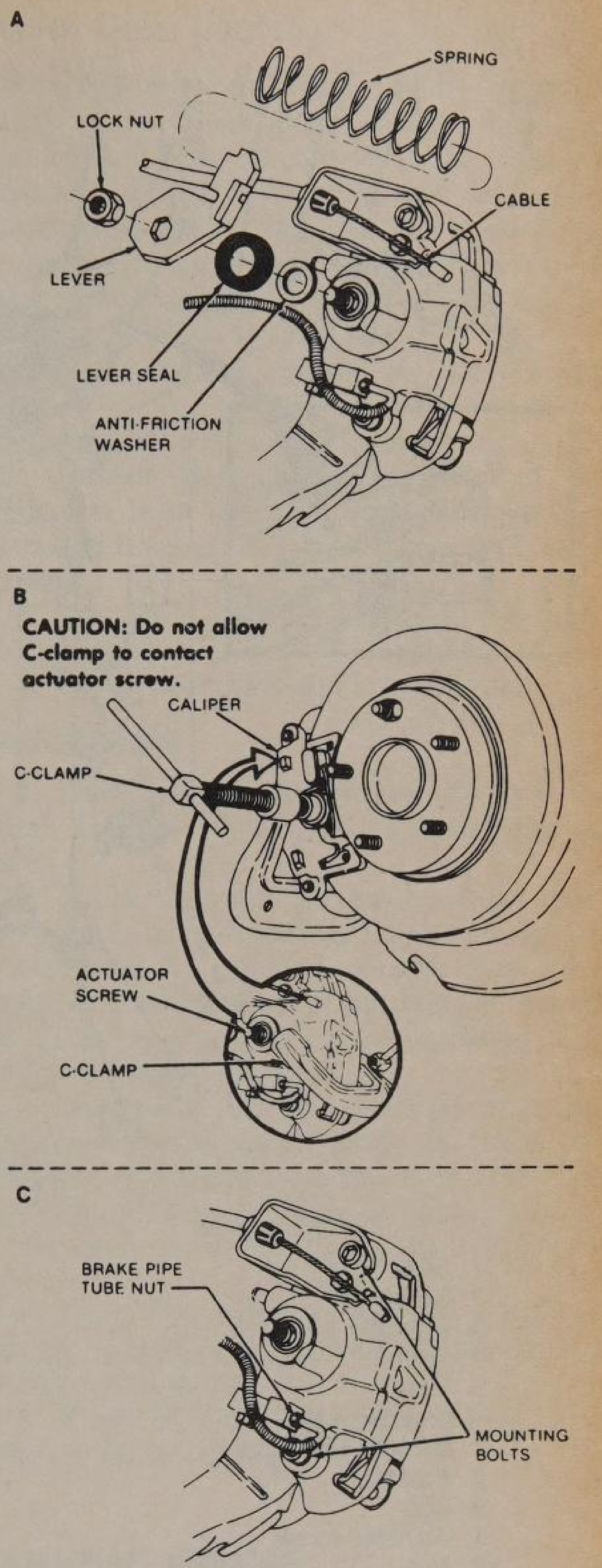
3. Remove the nut, lever, lever seal, and anti-friction washer.
4. Press on the threaded end of the actuator screw to remove it from the housing.
5. Remove the shaft seal and washer.
6. Remove the dust boot. Be careful not to scratch the housing bore.
7. Remove the locator retainer if so equipped. Remove 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. To install, replace the bleeder screw, bolt, fitting, and copper washer.
12. Install the piston. Lubricate seals and piston with brake fluid prior to reinstallation.
13. Install the locator retainer if so equipped. Install the piston locator if so equipped.
14. Install the dust boot.
15. Install the shaft seal and washer.
16. Install actuator screw to the housing.
17. Install the nut, lever, lever seal, and anti-friction washer. It may be necessary to rotate the parking brake lever away from the stop to install the nut. Torque the nut 30–40 ft. lbs. (41–54 Nm) and rotate the lever back to the stop.
18. Install the shoe dampening spring to the end of the piston.

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.*

1989–90

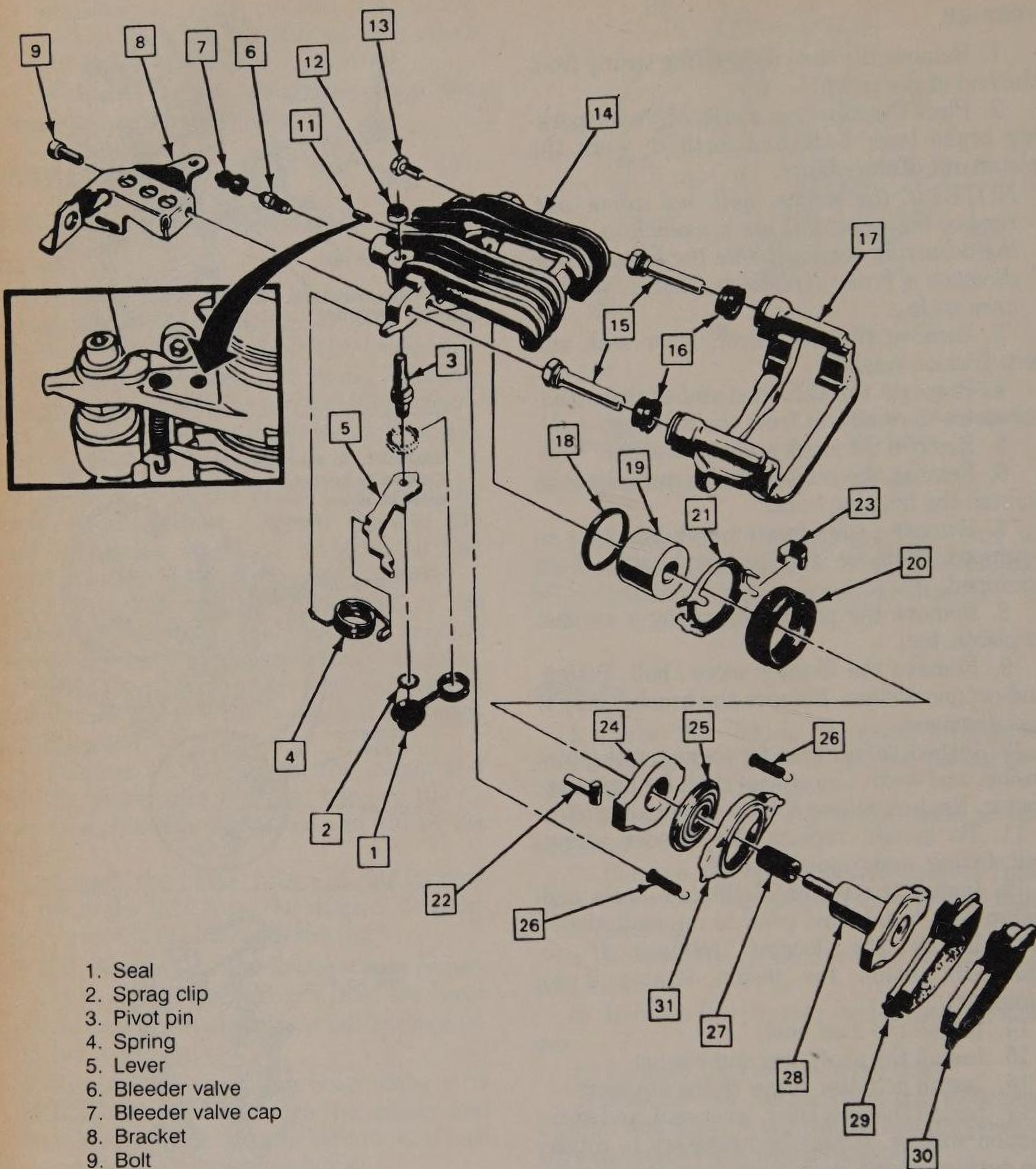
DISASSEMBLY

1. Remove the caliper from the vehicle as outlined in this section.



Remove and install rear caliper

2. Remove the two collar return springs from the actuating collar.
3. Remove the actuating collar with the assembled parts. Pull the collar out of the housing with the assembled parts.
4. Remove the clamp rod and compliance bushing from the actuating collar.
5. Remove the two boot retainers, boots and pushrods from the actuating collar. Bend back the retainer tabs and take apart.
6. Remove the preload spring from the retainer.
7. Use shop towels to pad the inside of the caliper housing during piston removal. Remove



1. Seal
2. Sprag clip
3. Pivot pin
4. Spring
5. Lever
6. Bleeder valve
7. Bleeder valve cap
8. Bracket
9. Bolt
11. Adjuster screw
12. Nut
13. Bolt
14. Caliper housing
15. Guide pin
16. Boot
17. Bracket
18. Seal
19. Piston
20. Boot
21. Retainer
22. Pushrod
23. Preload spring
24. Actuating collar
25. Boot
26. Return spring
27. Bushing
28. Clamp rod
29. Inboard pad
30. Outboard pad
31. Retainer

Rear caliper exploded view — 1989–90

the caliper pistons by directing compressed air into the brake hose inlet.

8. Inspect the bores and pistons for scores, corrosion and damage.

9. .Using a wood or plastic tool, remove the piston seals.

10. Remove the bleeder cap and valve.

11. Remove the caliper lever pivot pin seal, sprag clip, spring and lever from the pivot pin.

12. Remove the adjuster screw from the housing.

13. Remove the two guide pins and boots from the mounting bracket.

ASSEMBLY

1. Clean all parts not included in the repair kit in denatured alcohol and dry with unlubricated compressed air.

2. Lubricate the new piston seal and caliper bore with silicone grease of clean brake fluid.

3. Install the new piston seals into the groove.

4. Install the piston into the bore by pushing down to the bottom of the bore by hand.

5. Install the pushrod, new boots and retainers to the actuating collar. Lubricate the collar with the grease provided in the repair kit, clamp the retainers against the actuating collar and bend the tabs on the retainer to hold the assembly together.

6. Preload spring into the boot retainers.

7. Clamp the rod to the actuating collar boot.

8. Install a new compliance bushing to the clamp rod. Lubricate the outside of the bushing with lubricant.

9. Install the bleeder valve and cap.

10. Install the pivot pin and new nut into the caliper housing. Torque the nut to 16 ft. lbs. (22 Nm).

11. Lubricate the parking lever and pivot pin with lubricant.

12. Install the pivot pin seal, parking lever, sprag clip and spring in that order. The teeth of the clip must face away from the lever.

13. Install the two collar return springs to the retainer.

14. Install the adjuster screw until the actuating collar is about parallel to the piston bore face of the caliper housing.

15. Install the new guide pin boots and pins. Lubricate the pins, slide the boots on the guide pins and fill the boots with grease.

16. Install the caliper, install wheels, lower the vehicle, bleed brakes, pump brakes and check operation.

Brake Disc (Rotor)

REMOVAL AND INSTALLATION

CAUTION: *Brake pads contain asbestos, which has been determined to be a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces, use a commercially available brake cleaning fluid.*

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. Remove the caliper mounting bracket on 1989–90 rear disc brake systems.

3. To install, place the rotor onto the spindle and install caliper.

4. Install the wheel and lower the car.

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 0.0005 in. (0.013mm). 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 0.004 in. (0.10mm).

5. If any of these conditions are not met, reface or replace the rotor.

PARKING BRAKE

Cables

REMOVAL AND INSTALLATION

Front Cable

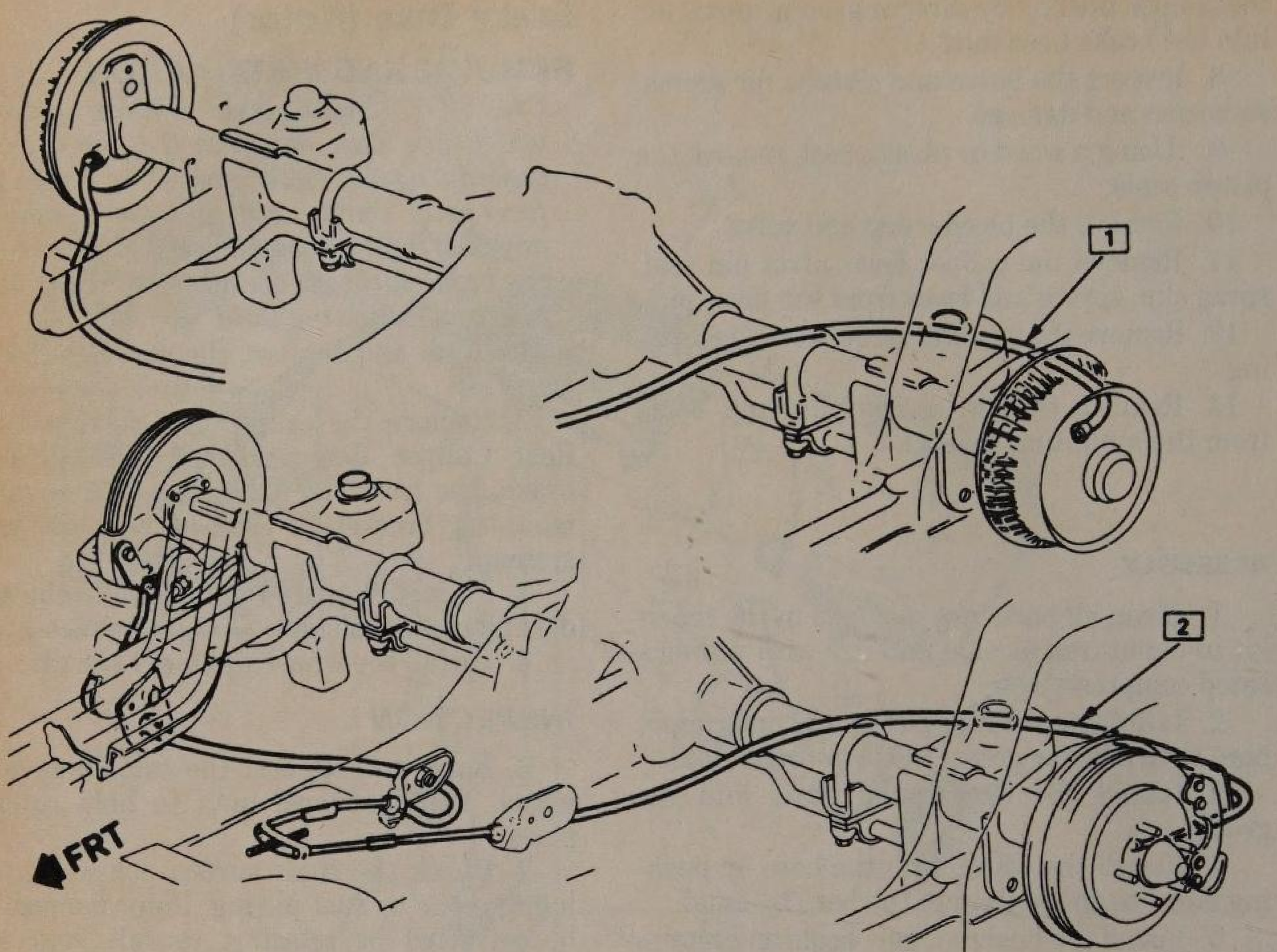
1. Raise the car and support it with jackstands.

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



1. Rear cable drum brakes
2. Rear cable disc brakes

Parking brake rear cables (rear drum and rear disc)

access to the cable retainer at the hand lever.

6. Remove the cable retainer pin, cable retainer, then the cable.

To install:

1. Position the cable retainer pin, cable retainer, then the cable.
2. Install the upper console cover and lower console rear screws. Raise the car and support it with jackstands.
3. Install the spring retainer clip from the bracket.
4. Install the adjusting nut at the equalizer.
5. Adjust the parking brake. Lower the car.

Rear Cable

DRUM BRAKES

CAUTION: *Brake shoes contain asbestos, which has been determined to be a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces, use a commercially available brake cleaning fluid.*

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.

To install:

1. Engage the cable at the brake shoe operating lever.
2. Bend the retainer fingers.
3. Install the wheel assembly and brake drum.
4. Engage the rear cable at the connector.
5. Adjust the parking brake by the adjusting nut at the equalizer.
6. Lower the car.

DISC BRAKES

CAUTION: *Brake pads contain asbestos, which has been determined to be a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces, use a commercially available brake cleaning fluid.*

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. Pull on the caliper parking brake apply lever to engage the cable to the tang.
6. Engage the cable at the connector.
7. Adjust the parking brake cable by the adjusting nut at the equalizer.
8. Apply the parking brake 3 times with heavy pressure and repeat adjustment.
9. Lower the car.

ADJUSTMENT

Models With Rear Drum Brakes

1. Depress the parking brake lever exactly two ratchet clicks.
2. Raise the rear of the vehicle and support safely with jackstands.
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.

BRAKE SPECIFICATIONS

Years	Model	Master Cyl. Bore	Brake Disc Original Thickness	Brake Disc Minimum Thickness	Brake Disc Maximum Run-out	Brake Drum Orig. Inside Dia.	Brake Drum Max. Wear Limit	Brake Drum Maximum Machine O/S	Wheel Cyl. or Caliper Bore Front	Wheel Cyl. or Caliper Bore Rear
1982	(1)	0.945	0.980	0.965	0.005	9.50	9.59	9.56	2.50	0.748
	(2)	1.000	0.980	0.965	0.005	—	—	—	2.50	1.890
1983	(1)	0.945	0.980	0.965	0.005	9.50	9.59	9.56	2.50	0.748
	(2)	1.000	0.980	0.965	0.005	—	—	—	2.50	1.890
1984	(1)	0.945	0.980	0.965	0.005	9.50	9.59	9.56	2.50	0.748
	(2)	1.000	0.980	0.965	0.005	—	—	—	2.50	1.890
1985	(1)	0.945	0.980	0.965	0.005	9.50	9.59	9.56	2.50	0.748
	(2)	1.000	0.980	0.965	0.005	—	—	—	2.50	1.890
1986	(1)	0.945	1.043	0.980	0.005	9.50	9.59	9.56	2.50	0.750
	(2)	1.000	1.042	0.986	0.005	—	—	—	2.50	1.870
1987	(1)	0.945	1.043	0.980	0.005	9.50	9.59	9.56	2.50	0.750
	(2)	1.000	1.042	0.986	0.005	—	—	—	2.50	1.870
1988–90	(1)	0.945	1.043	0.980	0.005	9.50	9.59	9.56	2.50	0.750
	(2)	1.000	1.042	0.986	0.005	—	—	—	2.50	1.870

(1) Equipped with rear drum brakes
(2) Equipped with rear disc brakes

Body

10

EXTERIOR

Doors

REMOVAL AND INSTALLATION

1. On doors that are equipped with power operated components, do the following:
   a. Remove the door trim panel and inner panel water deflector.
   b. Disconnect the wire harness from all components in the door.
   c. Remove the rubber conduit from the door, then remove the wire harness from the door through the conduit access hole.
2. Tape the area (on the door pillar and body pillar) above the lower hinge with cloth backed body tape.

CAUTION: *Before performing the following step, cover the spring with a shop cloth or rag to prevent the spring from flying and possibly causing personal injury or damage.*

3. Insert a long, flat-blade prybar under the pivot point of the hold-open link and over the top of the spring. The prybar should be positioned so as not to apply pressure to the hold-open link. Cover the spring with a shop cloth or rag and lift the screwdriver to disengage the spring. The spring can also be removed by using tool J–28625, J–36604 (or equivalent) door hinge spring compressor tool. The tool is stamped right side and left side. The tool stamped left side is used to service the right hand hinge spring and vise-a-versa for the tool stamped right side.

NOTE: *Cover all painted areas with heavy cloth and tape to protect the surface from damage. Always use an assistant when removing body parts to protect painted surfaces and reduce the chance of personal injury.*

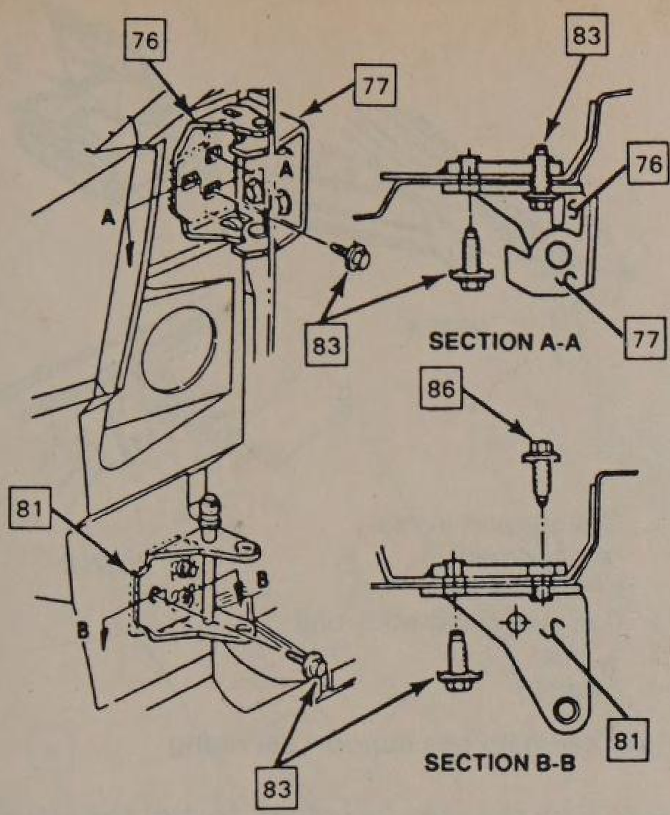
4. With the aid of a helper to support the door, remove the lower hinge pin using a soft-headed hammer and locking type pliers. The helper can aid the hinge pin removal by raising and lowering the rear of the door.
5. Insert a bolt into the hole of the lower hinge to maintain the door attachment during upper hinge removal.
6. Using a 13mm socket, remove the upper hinge bolts from the pillar. Remove the bolt from the lower hinge and remove the door from the body.

To install:

1. Replace the hinge pin clip.
2. With the aid of a helper, position the door and insert the bolt in the hole of the lower hinge.
3. Bolt the upper hinge to the body. The lower hinge pin is installed with the pointed end down.
4. Remove the screw from the lower hinge and install the lower hinge pin. The use of tool J–28625 or equivalent is recommended for installing the hinge spring.

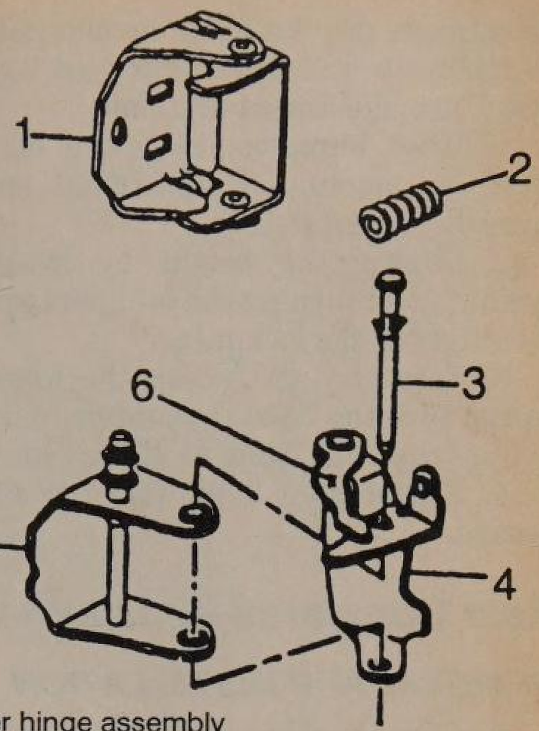
NOTE: *If the spring is installed before installing the lower hinge pin, damage to the hinge bushings may result.*

5. If the spring was removed using a screwdriver, install the spring as follows:
   a. Place the spring in tool J–28625 or equivalent.
   b. Place the tool and spring in a bench vise.
   c. Compress the tool in the vise and install the bolt until the spring is fully compressed.
   d. Remove the tool (with the compressed spring) from the vise and install in the proper position in the door lower hinge. A slot in one jaw fits over the hold-open link. The hole on the other jaw fits over the bubble.
   e. Remove the bolt from the tool to install the spring.
   f. Remove the tool from the door hinge



76. Upper body hinge strap
77. Upper door hinge strap
81. Lower body hinge strap
83. Bolt
86. Bolt

Door hinge-to-body strap



1. Upper hinge assembly
2. Spring
3. Lower hinge pin
4. Door side hinge strap
5. Body side hinge strap
6. Hold open link

Door hinge assembly

(tool will fall out in three pieces). Cycle the door to check the spring operation.

6. Remove the tape from the door and the body pillars.

7. On doors with power operated components:

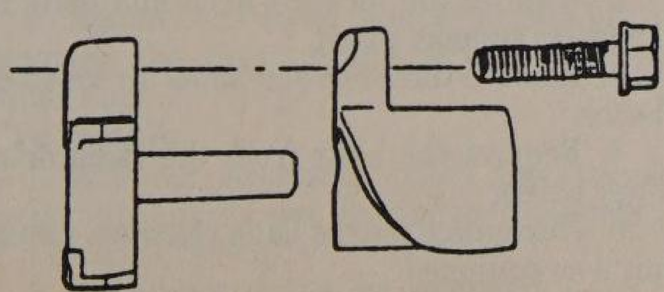
a. Install the wire harness to the door through the conduit access hole, then install the rubber conduit to the door.

b. Connect wire harness to all components in the door.

c. Install the inner panel water deflector and door trim panel.

ADJUSTMENT

The door hinges are made of steel and are welded to the door and bolted to the body hinge pillars. No adjustment provisions are used in this type system. The upper hinge is a one piece type. The lower hinge is made up of a door side and body side strap with a removable pin. All service hinge straps have holes to permit bolt-on installation. No service welding is required when replacing door hinge straps.



Door hinge spring compressor tool

Hood

REMOVAL AND INSTALLATION

1. Open the hood and mark the position of the hood hinge assembly-to-hood by a scribe, caulk or paint.

NOTE: *Cover all painted areas with heavy cloth and tape to protect the surface from damage. Always use an assistant when removing body parts to protect painted surfaces and reduce the chance of personal injury.*

2. Remove the hood attaching bolts that are towards the front of the hood.

3. Slowly loosen the remaining hood attaching bolts.

4. With the aid of a helper, remove the bolts and remove the hood. Place the hood on a protected surface.

To install:

1. Position the hood over the hood hinge assembly with the aid of a helper and install the hood attaching bolts finger tight.

2. Align the hood to the match marks made earlier and tighten the hood attaching bolts. Torque the bolts to 20 ft. lbs. (27 Nm).

3. Close the hood and check align.

ADJUSTMENT

Slotted holes are provided at all hood hinge attaching points for proper adjustment. Vertical adjustment may be made by adjusting rubber bumpers up and down. For best appearance, make one adjustment at a time.

1. Hood bumpers: close the hood, determine the amount of adjustment needed and open the hood.
2. Change the height by loosening the locknuts and turning the bumpers up or down, then tighten the locknuts.
3. Fore and aft: loosen the hinge-to-hood bolts, move the hood forward or rearward and tighten the hinge bolts to 97 inch lbs. (11 Nm).
4. Repeat step 3 on the opposite side if needed.

Rear Compartment Lift Window

REMOVAL AND INSTALLATION

1. Prop the lid open and place a protective covering along the edges of the rear compartment opening to prevent any damage to the painted surfaces.
2. Use a 13mm socket to remove the nuts holding the glass to the hinge.

CAUTION: *Do not attempt to remove or loosen the gas support assembly attachments with the lid in any position other than fully open as personal injury may result.*

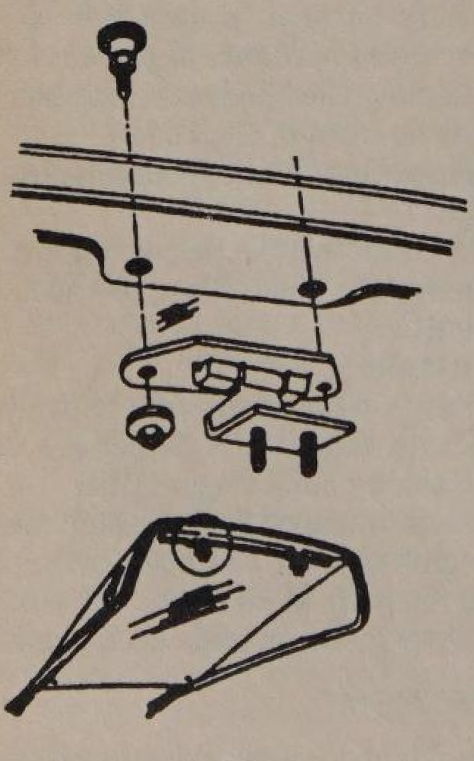
3. While a helper supports the glass, disengage the gas supports from the lift window assembly and disconnect the harness connector for the electric grid defogger, if equipped.
4. With the aid of a helper, remove the lift window assembly from the body and place it on a protected surface.

To install:

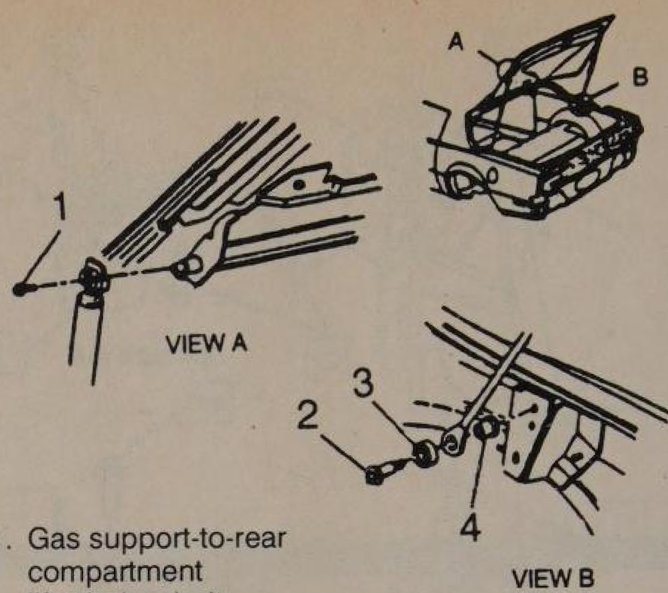
1. Position the lift window assembly to the body with the aid of a helper. Install the attaching bolts and torque to 11 ft. lbs. (16 Nm).

CAUTION: *Do not overtighten the glass-to-hinge bolts as it could cause the glass to break and possible personal injury. Always wear safety glasses during this operation.*

2. Connect the harness connector for the electric grid defogger, if equipped, and connect the gas supports to the lift window assembly.
3. Lower the lid and check alignment.



Rear hatch lid hinge servicing



1. Gas support-to-rear compartment lift window bolt
2. Gas support-to-body bolt
3. Spacer
4. Bushing

Rear hatch lid gas support servicing

ADJUSTMENT

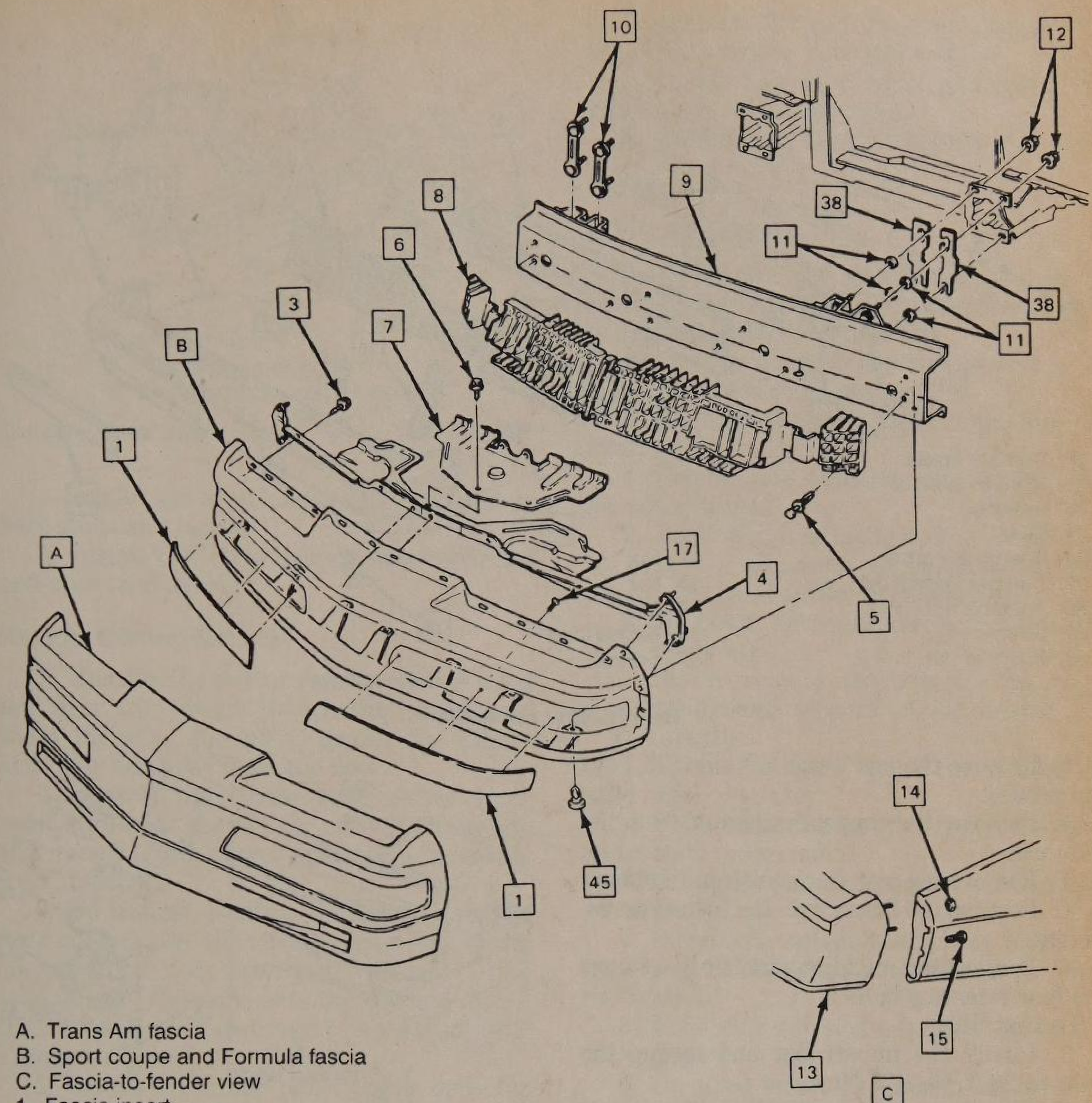
The rear compartment lift window assembly height, fore and aft and side adjustments are controlled at the hinge-to-body location. This area of the body has oversize hinge attaching holes in addition to the hinge-to-body spacers. Adjustments at the hinge location must be made with the gas supports disengaged. Additional height adjustment can also be made at the lower panel by adjusting the rubber bumpers. Bolts holding hinge-to-body should be tightened to 15–20 ft. lbs. (20–28 Nm).

Bumpers

REMOVAL AND INSTALLATION

Front Bumper Fascia

1. Disconnect the negative (–) battery cable.
2. Remove the forward horn and bolts for the fascia support panel.
3. Remove the front end panel air lower deflector.
4. Remove the bolts from the radiator air lower baffle.
5. Disconnect the fog lamp electrical connector, if so equipped.
6. Remove the retainers from the bumper impact bar.



A. Trans Am fascia
B. Sport coupe and Formula fascia
C. Fascia-to-fender view
1. Fascia insert
3. Bolt
4. Fascia reinforcement panel
5. Rivets
6. Bolt
7. Fascia support panel
8. Energy absorber
9. Bumper impact bar
10. Stud plate
11. Push-on nut
12. Nut
13. Bumper fascia
14. Nut
15. Screw
17. Screw
38. Shim
45. Retainer

Front bumper assembly

7. Remove the front bumper fascia-to-fender attaching nuts and screws.

8. With an assistant, remove the bumper fascia.

9. Remove the metal bumper impact bar by removing the four impact bar-to-energy absorber nuts.

To install:

1. With an assistant, install the bumper fascia, nuts and screws. Torque the retainers to 97 inch lbs. (11 Nm).

2. Install the impact bar retainers.

3. Install the lower air baffle bolts and torque to 20 inch lbs. (2.25 Nm).

4. Connect the fog lamps and install the front end panel lower air deflector.

5. Install the fascia support panel and bolts. Torque the bolts to 97 inch lbs. (11 Nm).

6. Install the forward horns and connect the negative battery cable.

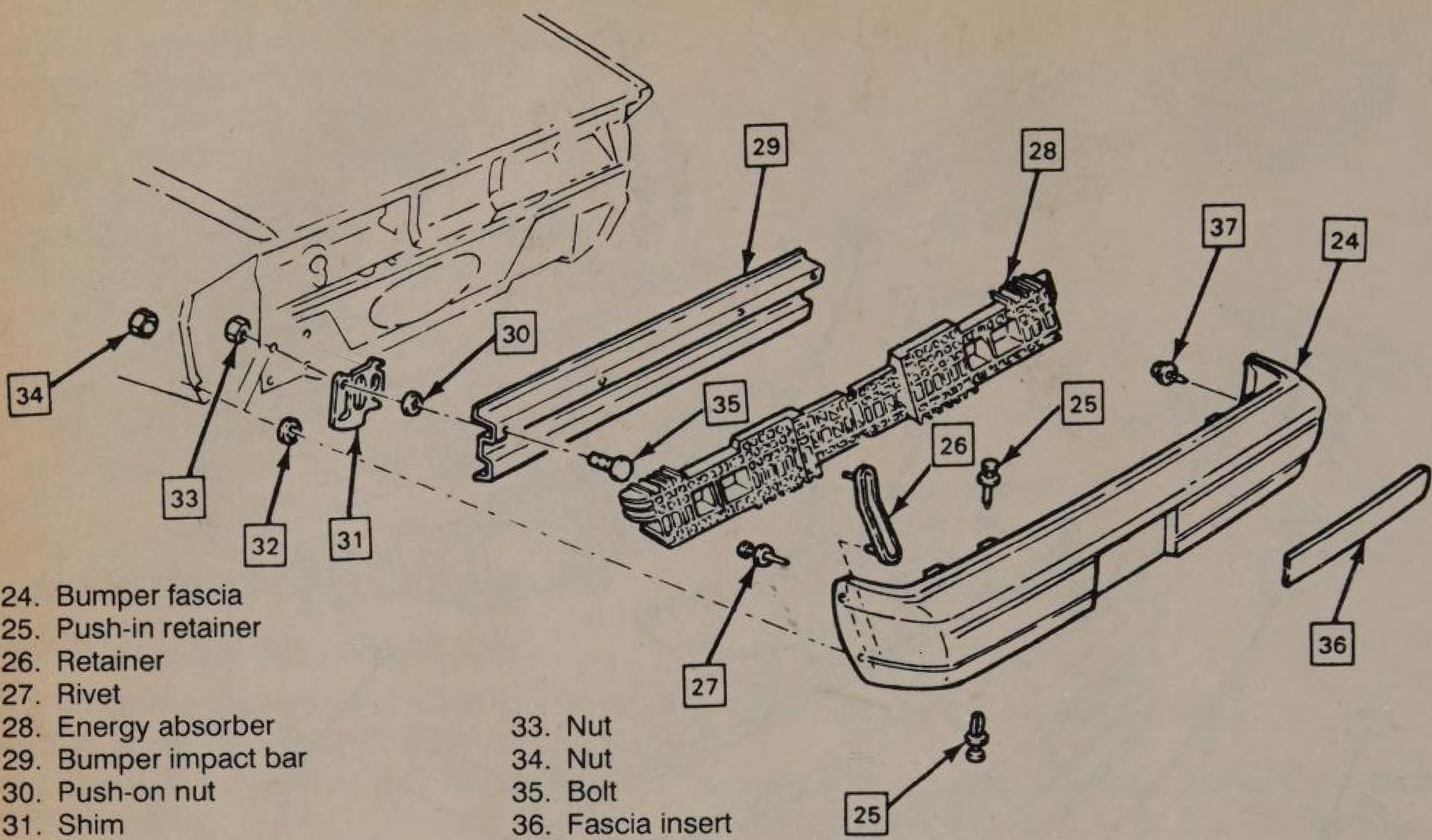
Rear Bumper

1. Disconnect the negative (–) battery cable.

2. Open the rear lid window and remove the rear center trim panel.

3. Remove the right and left rear quarter trim panels.

4. Remove the spare tire assembly.



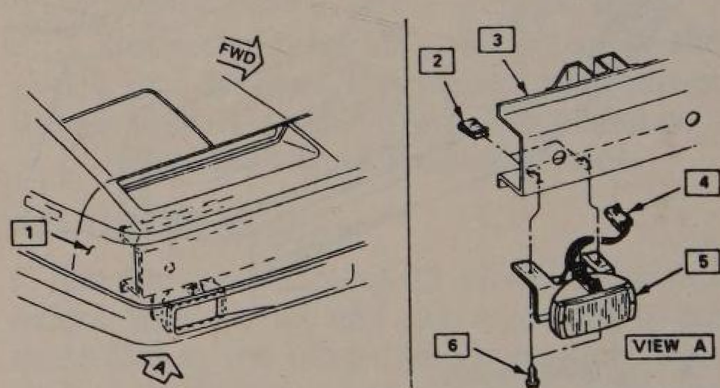
24. Bumper fascia
25. Push-in retainer
26. Retainer
27. Rivet
28. Energy absorber
29. Bumper impact bar
30. Push-on nut
31. Shim
32. Push-on nut
33. Nut
34. Nut
35. Bolt
36. Fascia insert
37. Screw

Rear bumper assembly

5. Remove the right and left side tail light assemblies.
6. Remove the bumper fascia nuts from the retainers.
7. Remove the rear fascia push-in retainers.
8. Remove the fascia with the help of an assistant.
9. Remove the metal impact bar by remove the four retaining bolts.

To install:

1. Install the impact bar and torque the bolts to 20 ft. lbs. (27 Nm).
2. With an assistant, install the fascia and push-in retainers.
3. Install the rear fascia nuts and torque to 52 inch lbs. (6 Nm).
4. Install the tail lights, spare tire and interior trim panels.



1. Front end fascia
2. Nut
3. Front impact fascia
4. To fog light connector and forward lamp harness
5. Fog light assembly
6. Bolt/screw

Fog light assembly

Fog Lights

REMOVAL AND INSTALLATION

1. Disconnect the negative (–) battery cable.
2. Remove the six screws holding the filler panel under the front fascia and filler panel.
3. Disconnect the electrical connector and two retaining bolts.
4. Remove the fog lamp assembly by lowering through the filler panel opening.

To install:

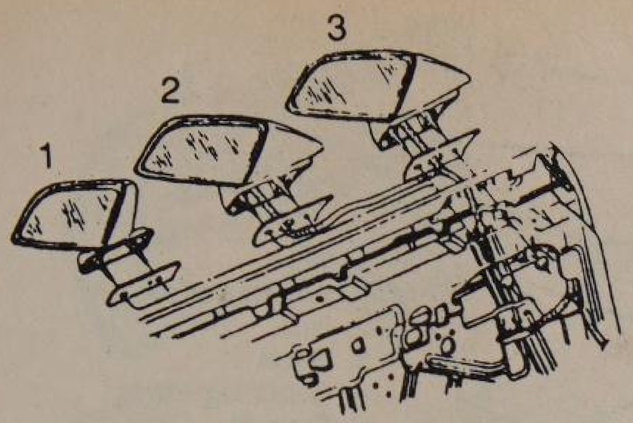
1. Install the lamp assembly and retaining bolt.
2. Connect the electrical connector.
3. Install the filler panel and screws.

Outside Mirrors

REMOVAL AND INSTALLATION

Standard Mirrors

1. Remove the door trim panel and detach inner panel water deflector enough to gain access to the mirror retainer nuts.
2. Remove the attaching nuts from the mirror base studs and remove the mirror assembly from the door.
3. **To install,** position the mirror onto the door making sure the mirror gasket is properly aligned on the door outer panel.



1. Manual mirror
2. Remote control mirror
3. Electric remote control mirror

Outside mirror assemblies

4. Install the attaching nuts to the mirror base studs and tighten.
5. Install the inner panel water deflector and door trim panel.

Remote Control Mirrors

1. Remove the mirror remote control bezel and door trim panel. Detach the inner panel water deflector enough to expose the mirror and cable assembly from the door.
2. Remove the mirror base-to-door outer panel stud nuts, remove the cable from the clip and remove the mirror and cable assembly from the door.
3. **To install,** position the mirror onto the door making sure the mirror gasket is properly aligned on the door outer panel.
4. Install the cable onto the clip and install the mirror base-to-door outer panel stud nuts. Torque to 72 inch lbs. (8 Nm).
5. Install the inner panel water deflector and door trim panel.
6. Install the mirror remote control bezel.

Power Operated Mirrors

1. Disconnect the negative battery terminal and, from the door trim panel side, remove the remote control mirror bezel, release and remove the door panel.
2. Disconnect wire harness connection from the remote mirror electrical switch.
3. Peel back water deflector enough to detach the harness from the retaining tabs in the door.
4. Remove the mirror base-to-door stud nuts and lift mirror housing and harness assembly from the door.

To install:

1. Feed the mirror harness through the door along with the mirror assembly. Install the mirror base-to-door stud nuts and tighten.
2. Connect the mirror wire harness and install the water deflector.
3. Connect the wire harness connection to the remote mirror electrical switch.
4. Install the door panel and install the remote control mirror bezel.
5. Connect the negative battery terminal.

Antenna

REPLACEMENT

1. Disconnect the antenna coaxial at the radio. (It may be necessary to remove the radio to gain access to the connector.
2. Connect a length of string or wire to the antenna coaxial radio connector.
3. On fixed antennas, remove the antenna mast.
4. Remove the antenna nut and bezel on top of the fender.
5. Remove the antenna bolt(s) to bracket. (It may be necessary to partially or fully remove the front fender to gain access.)
6. On power antennas, disconnect the electrical connector.
7. Slowly remove the antenna assembly, pulling the coaxial with the string or wire.

To install:

1. Tie the string or wire to the antenna coaxial radio connector.
2. From inside the car, slowly pull the coaxial through to the radio.
3. On power antennas, connect the electrical connector.
4. Install the antenna attaching bolt(s) to the bracket. (If the fender was removed, install the fender.)
5. Install the antenna nut and bezel on top of the fender.
6. On fixed antennas, install the antenna mast.
7. Connect the antenna coaxial to the radio. (Install the radio if it was removed).

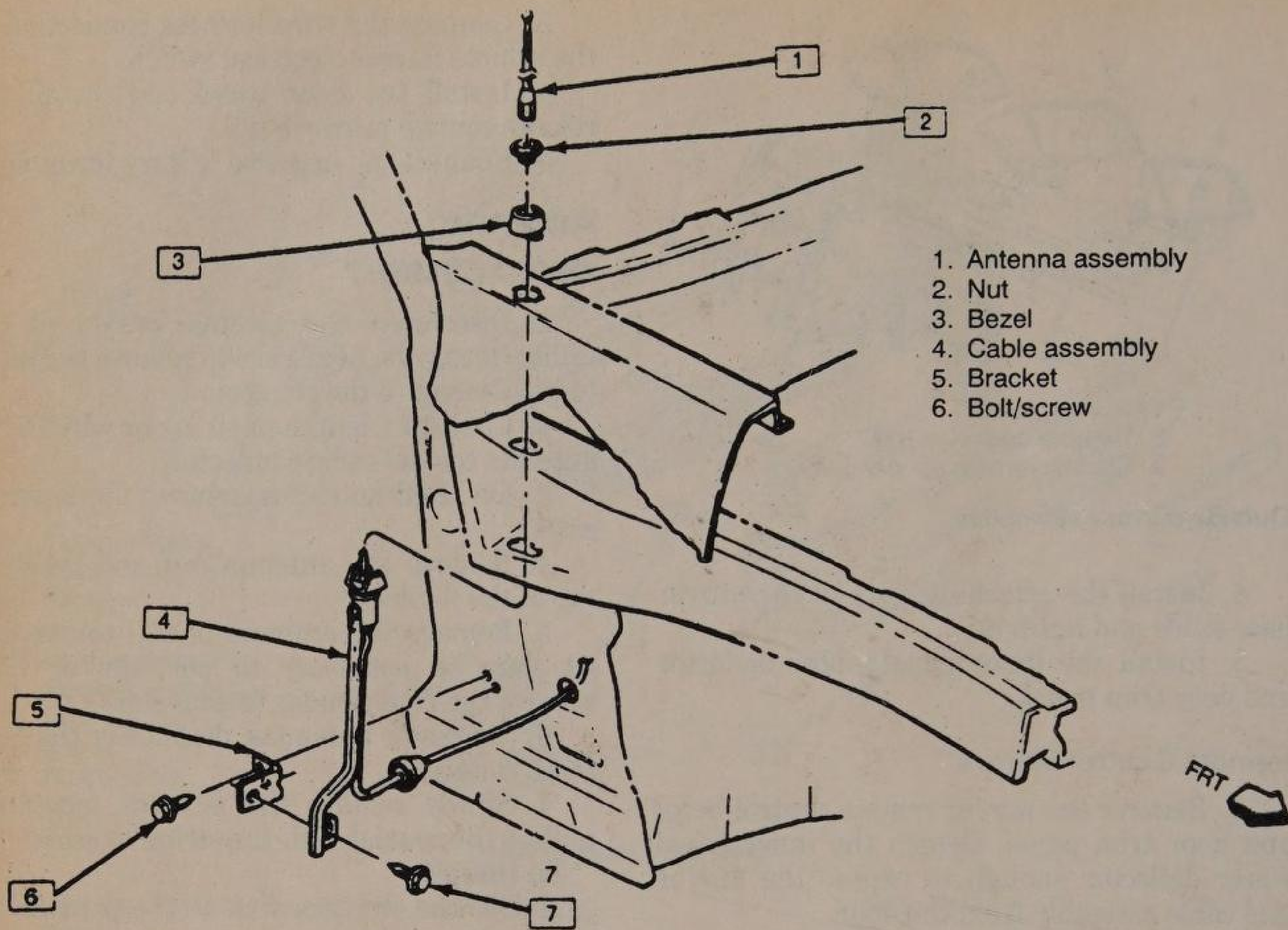
INTERIOR

Door Panels

REMOVAL AND INSTALLATION

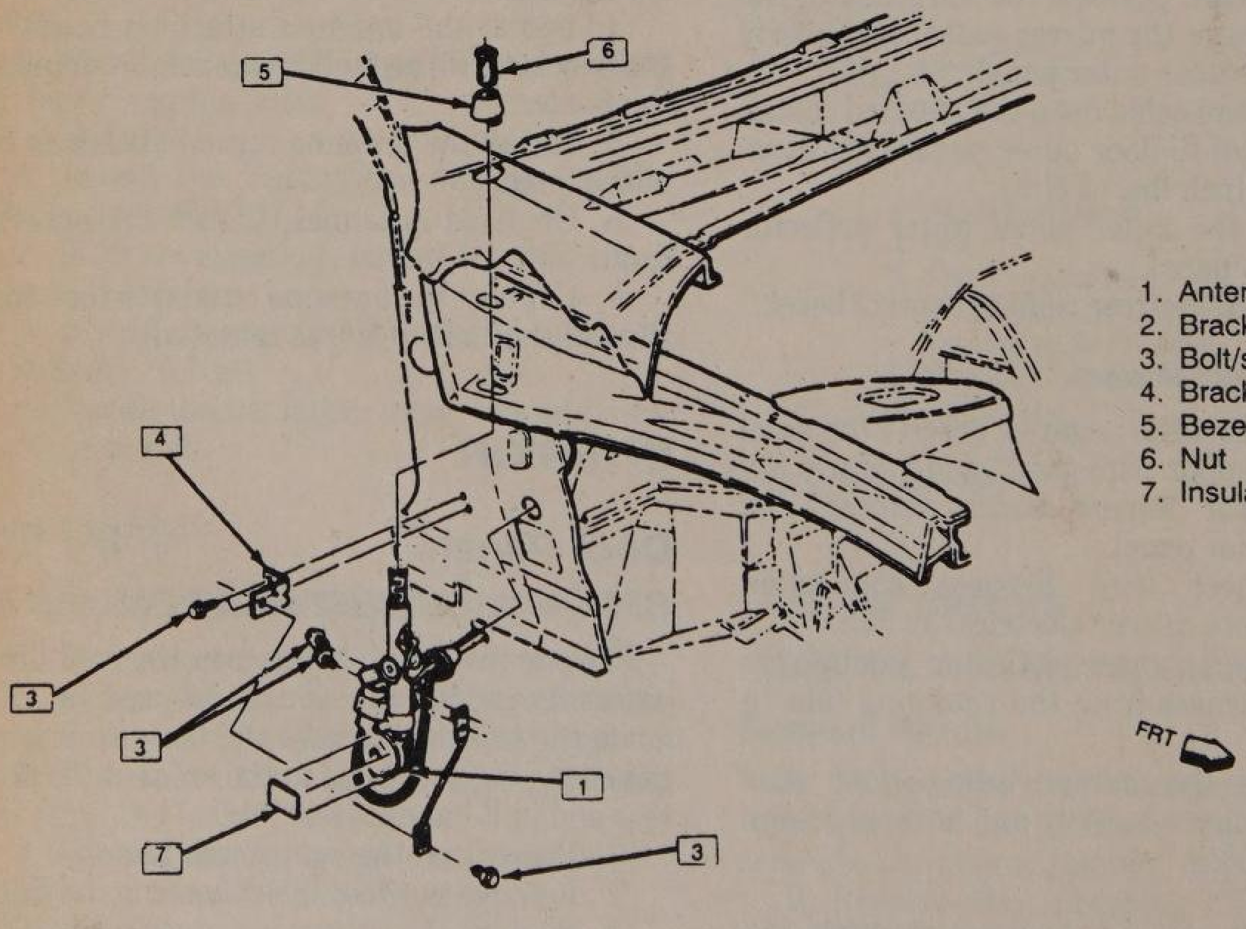
The one-piece trim hangs over the door inner panel across the top and is secured by clips down the sides and across the bottom. It is retained by screws located in the areas of the armrest and pull handle assembly.

1. Remove all the door inside handles.
2. Remove the door inside locking rod knob.
3. Remove the screws inserted through the door armrest and pull the handle assembly into the door inner panel or armrest hanger support bracket.
4. On models with remote control mirror as-



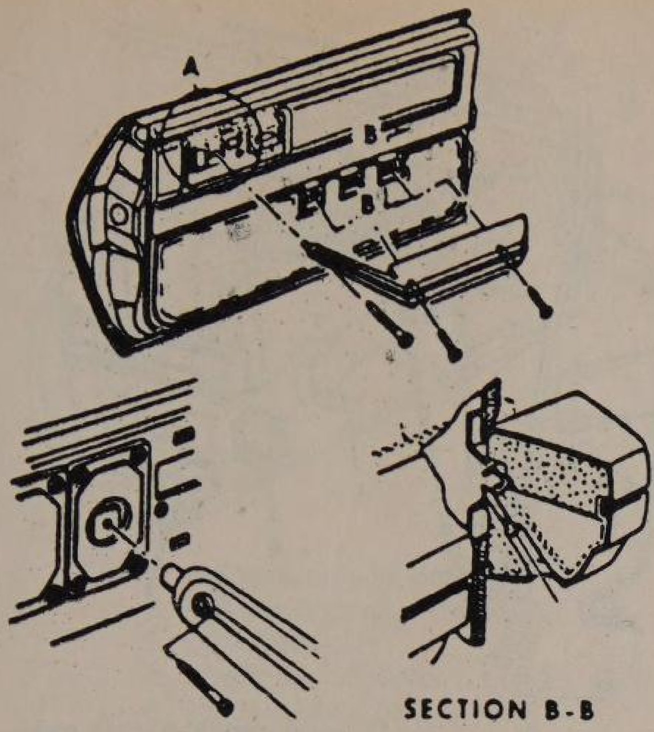
1. Antenna assembly
2. Nut
3. Bezel
4. Cable assembly
5. Bracket
6. Bolt/screw

Fixed mast antenna servicing



1. Antenna assembly
2. Bracket
3. Bolt/screw
4. Bracket
5. Bezel
6. Nut
7. Insulator

Power antenna servicing



Door armrest and pull handle attachment

semblies, remove the control plate from the bezel on the trim pad and remove the control from the plate.

5. On models with power door lock controls located in the door trim panel, disconnect the wire harnesses at the switch assemblies.

6. Remove the remote control handle bezel screws.

7. Remove the screws used to hold the armrest to the inner panel.

8. Remove the screws and plastic retainers from the perimeter of the door trim panel using tool BT–7323A or equivalent and a screwdriver. To remove the trim panel, push the trim upward and outboard to disengage from the door inner panel at the beltline.

9. On models with a water deflector held in place by fasteners, use tool BT–7323A or equivalent to remove the fasteners and water deflector.

To install:

1. Install the water deflector, locate the fasteners in the holes in the door inner panel and press in place. Replace all tape which may have been applied to assist in holding the water deflector in place.

2. Before installing the door trim panel, make certain that all the trim retainers are installed securely to the panel and are not damaged. Where required, replace damaged retainers. Start the retainer flange into $^1/_4$ in. (6mm) cutout attachment hole in the trim panel, rotate the retainer until the flange is engaged fully.

3. Connect all electrical components where present.

4. To install the door trim panel, locate the top of the assembly over the upper flange of the door inner panel, inserting the door handle through the handle slot in the panel and press down on the trim panel to engage the upper retaining clips.

5. Position the trim panel to the door inner panel so the trim retainers are aligned with the attaching holes in the panel and tap the retainers into the holes with the palm of hand or a clean rubber mallet.

6. Install the screws used to hold the armrest to the inner panel.

7. Install the remote control handle bezel screws.

8. On models with power door lock controls located in the door trim panel, connect the wire harnesses at the switch assemblies.

9. On models with remote control mirror assemblies, install the control to the plate. Install the control plate to the bezel on the trim pad.

10. Install the handle assembly and install the screws inserted through the door armrest.

11. Install the door inside locking rod knob.

12. Install all the door inside handles.

Door Locks

REMOVAL AND INSTALLATION

1. Raise the door window. Remove the door trim panel and detach the inner panel water deflector enough to expose the access hole.

2. Disengage the lock cylinder to the lock rod at the cylinder.

CAUTION: *If removing the lock cylinder retainer by hand, wear gloves to prevent personal injury.*

3. With a suitable prybar or similar tool, slide the lock cylinder retainer forward until it disengages. Retainer can also be removed by hand by grasping anti-theft shield at the top of the retainer and rotating until disengaged. Remove the lock cylinder from the door.

To install:

1. Lubricate the cylinder with the proper lubricant.

2. Position the cylinder into place and rotate it until the cylinder engages. Install the cylinder retainer.

3. Engage the lock cylinder to lock rod at the cylinder.

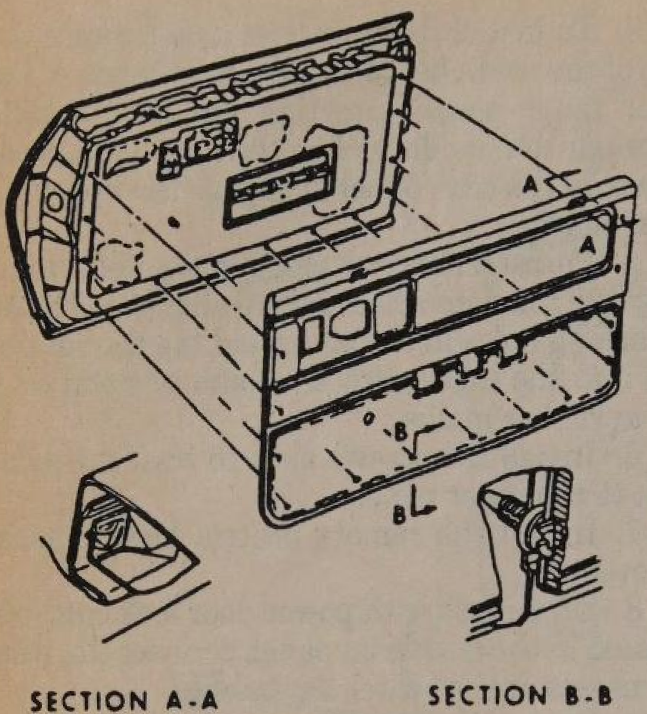
4. Install the inner panel water deflector and door trim panel.

Door Window

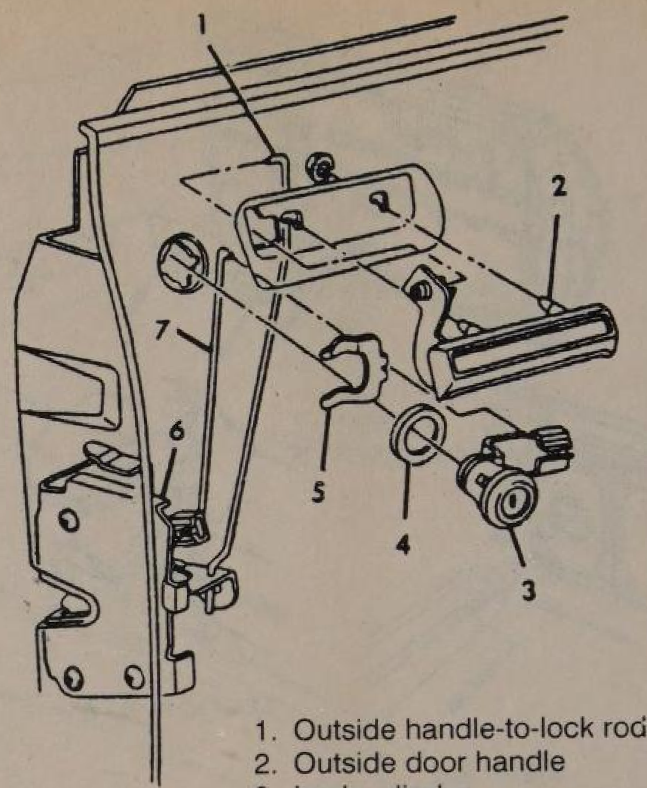
REMOVAL AND INSTALLATION

1. Remove the door trim panel and the inner panel water deflector.

2. Raise the window to half-up position.

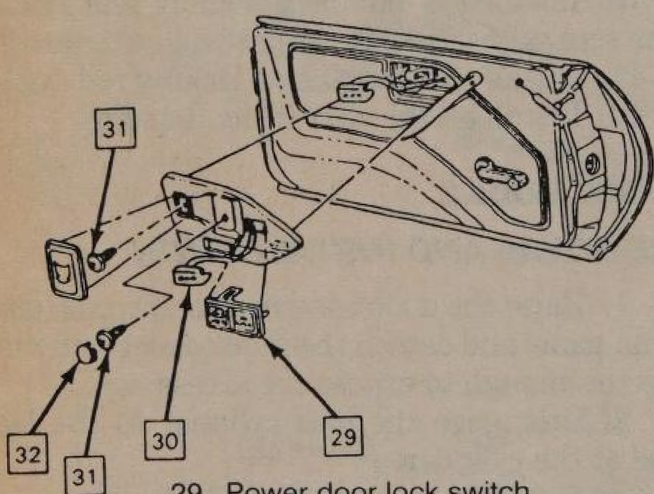


Door trim panel servicing



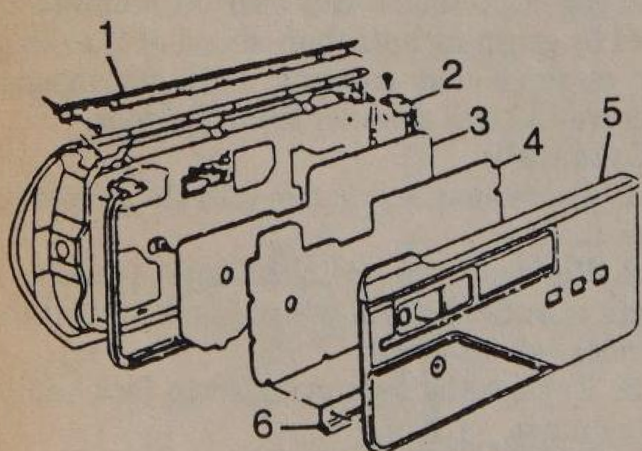
1. Outside handle-to-lock rod
2. Outside door handle
3. Lock cylinder
4. Lock cylinder gasket
5. Lock cylinder retainer
6. Door lock assembly
7. Lock cylinder-to-lock rod

Door locking system (exterior)



29. Power door lock switch
30. Connector
31. Screw
32. Cover

Inside door lock switch and cover



1. Outer belt sealing strip
2. Door weatherstrip
3. Water deflector
4. Insulator pad
5. Door trim panel
6. Lower sealing strip

Door sealing components

3. Punch out the center pins of the glass to sash channel attaching rivets.

4. Remove the rear guide channel through the rear access hole.

5. Remove the up stop.

6. Using a $^1/_4$ in. (6mm) drill bit, drill out the attaching rivets on sash channel.

7. Raise the glass to remove from the sash channel and remove the glass from the door.

To install:

1. Remove the drilled out rivets and shavings from the door.

2. Check the rivet bushings and retainers on the glass for damage. If necessary, remove the bushings using a flat-bladed tool covered with a cloth body tape. Install by snapping rivet retainer into the bushing.

3. Lower the glass into the door and position on the sash channel so the holes in the sash line up with the holes in the bushings and retainers.

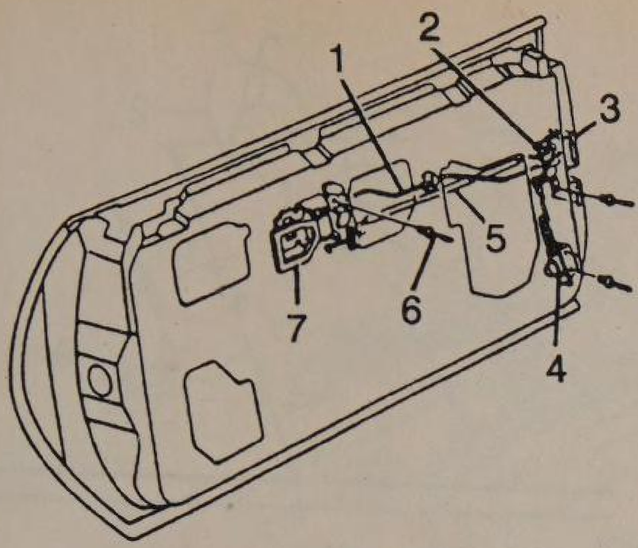
4. Using rivet tool J–29022 or equivalent, install $^1/_4$ in. peel type rivet (part No. 20184399 or equivalent) to retain the glass to sash channel.

5. Install the rear guide channel.

6. Install the front up stop to support on the inner panel.

7. Before installing the trim parts, check the window operation for performance and fit to roof rail weatherstrip.

8. Install the inner panel water deflector and the door trim panel.



1. Inside handle-to-lock rod
2. Bell crank (power locks only)
3. Lock assembly
4. Power lock actuator
5. Inside locking rod
6. Rivet
7. Inside handle

Door locking system (interior)

Window Regulator and Regulator Motor

REMOVAL AND INSTALLATION

1. Remove the door trim panel and inner panel water deflector.

2. Raise the window to half-up position and hold in place by inserting a rubber wedge door stops at the front and rear of the window between window and inner panel.

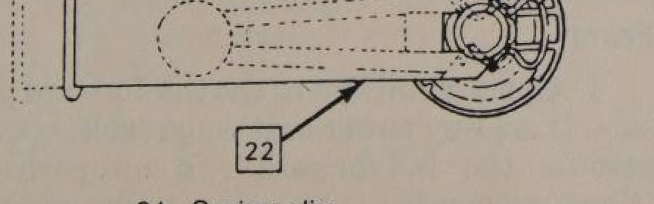
3. Remove the rear guide channel and inner panel cam channel.

4. Punch out the center pins of the regulator rivets; then drill out the rivets using a $^1/_4$ in. (6mm) drill bit.

5. Move the regulator rearward and disconnect wire harness from the motor (if equipped). Disengage the roller on the regulator lift arm from glass sash channel.

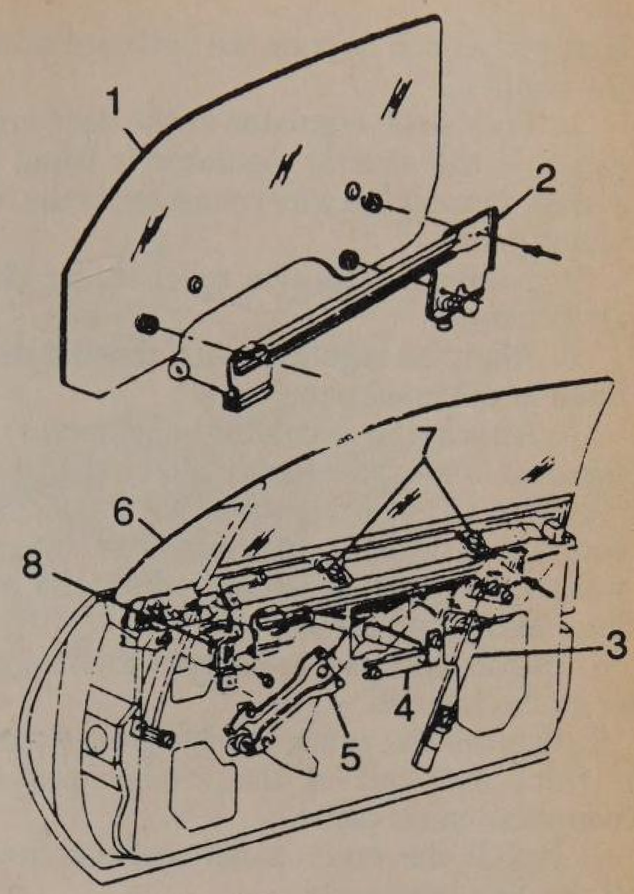
6. Remove the regulator through the rear access hole.

CAUTION: *If electric motor removal from the regulator is required, the sector gear must be locked in position. The regulator lift arm is under tension from the counterbalance spring and could cause personal injury if the sector gear is not locked in position.*



21. Spring clip
22. Window regulator handle

Window regulator handle removal



1. Door glass
2. Lower sash panel
3. Rear guide channel
4. Inner guide channel
5. Window regulator
6. Filler assembly
7. Guide stabilizer
8. Support—front up stop

Door glass and operating hardware

7. Drill a hole through the regulator sector gear and backplate and install a bolt and nut to lock the sector gear in position.

8. Using a $^3/_{16}$ in. drill bit, drill out the motor attaching rivets and remove the motor from the regulator.

To install:

1. To install the motor to the regulator, use a rivet tool J–29022 or equivalent, and install $^3/_{16}$ inch rivets or $^3/_{16}$ inch nuts and bolts. Remove bolt and nut used to secure the sector gear in position.

2. Place the regulator through the rear access hole into the door inner panel. If electric regulator is being installed, connect the wire connector to motor prior to installing the regulator to the inner panel.

3. Locate the lift arm roller into the glass sash channel.

4. Using rivet tool J–29022 or equivalent, rivet regulator to the inner panel of the door using $^1/_4$ in. × $^1/_2$ in. aluminum peel type rivets (part No. 9436175 or equivalent). If rivet tool is not available, use the following nut and bolt method:

a. Install U-clips on the regulator at the attaching locations. Be sure to install the clips with clinch nuts on the outboard side of the regulator.

b. Locate the regulator in the door inner panel. If the electric regulator is being installed, connect the wire connector to the regulator motor.

c. Locate the lift arm roller in the glass sash channel.

d. Align the regulator with clinch nuts to holes in the inner panel.

e. Attach the regulator (and motor) to the door inner panel with M6.0 × 1 × 13 ($^1/_4$-20 × $^1/_2$ in.) screws (part No. 9419723 or equivalent) into $^1/_4$ in. nuts with integral washers. Tighten the screw to 90–125 inch lbs. (10–14 Nm) torque.

5. Install the inner panel cam channel and rear guide channel.

6. Remove the rubber wedge door stops at the front and rear of the window between window and inner panel.

7. Install the inner panel water deflector and the door trim panel.

Inside Rear View Mirror

INSTALLATION

The rear view mirror is attached to a support which is secured to the windshield glass. This support is installed by the glass supplier using a plastic-polyvinyl butyl adhesive.

Service replacement windshield glass has the mirror support bonded to the glass assembly. To install a detached mirror support or install a new part, the following items are needed:

• Part No. 1052369, Loctite® Minute-Bond Adhesive 312 two component pack or equivalent

• Original mirror support (prepared per Steps 4 and 5 of the installation procedure) or replacement rear view mirror support

• Wax marking pencil or crayon

• Rubbing alcohol

• Clean paper towels

• Fine grit emery cloth or sandpaper (No. 320 or No. 360)

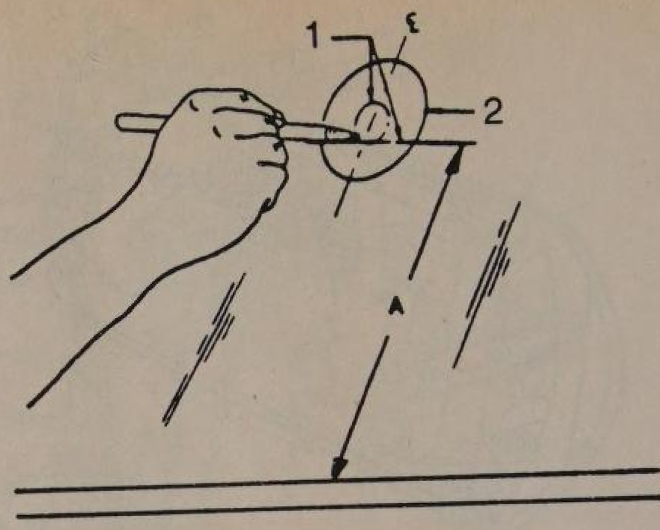
• Clean toothpick

• Six-lobed socket bit.

1. Determine the rear view mirror support position on the windshield. Support is to be located at the center of the glass 27$^1/_8$ in. (68.8cm) from the base of the glass to the base of the support.

2. Mark the location on the outside of the glass with wax pencil or crayon. also make a larger diameter circle around the mirror support circle on the outside of the glass surface.

3. On the inside of the glass surface, clean the large circle with a paper towel and domestic scouring cleanser, glass cleaning solution or pol-



1. Locating circle and base of support line on outside glass surface
2. Circle on outside glass surface indicates area to be cleaned

Locating and marking bonded rear view mirror support on the glass

ishing compound. Rub until the area is completely clean and dry. When dry, clean the area with an alcohol saturated paper towel to remove any traces of scouring powder of cleaning solution from this area.

4. With a piece of fine grit (No. 320 or No. 360) emery cloth or sandpaper, sand the bonding surface of the new rear view mirror support or factory installed support. If original rear view mirror support is to be reused, all traces of the factory installed adhesive must be removed prior to reinstallation.

5. Wipe the sanded mirror support with a clean paper towel saturated with alcohol and allow it to dry.

6. Follow the directions on the manufacturer's kit to prepare the rear view mirror support prior to installation on the glass.

7. Properly position the support to its premarked location, with rounded end pointed upward, press the support against the glass for 30–60 seconds, exerting steady pressure against the glass. After five minutes, any excess adhesive may be removed with an alcohol moistened paper towel or glass cleaning solution.

8. Install the mirror.

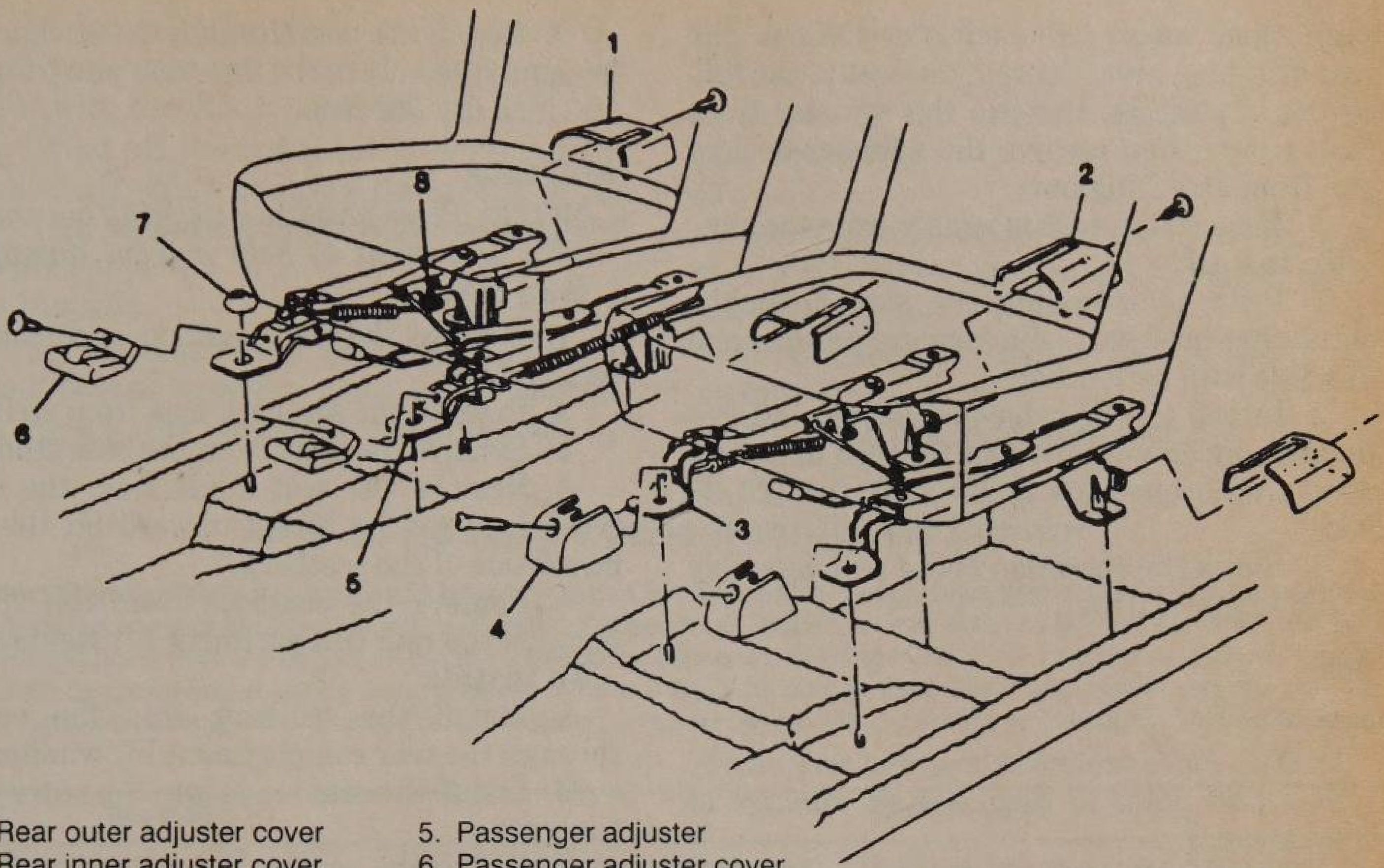
Seats

REMOVAL AND INSTALLATION

Front

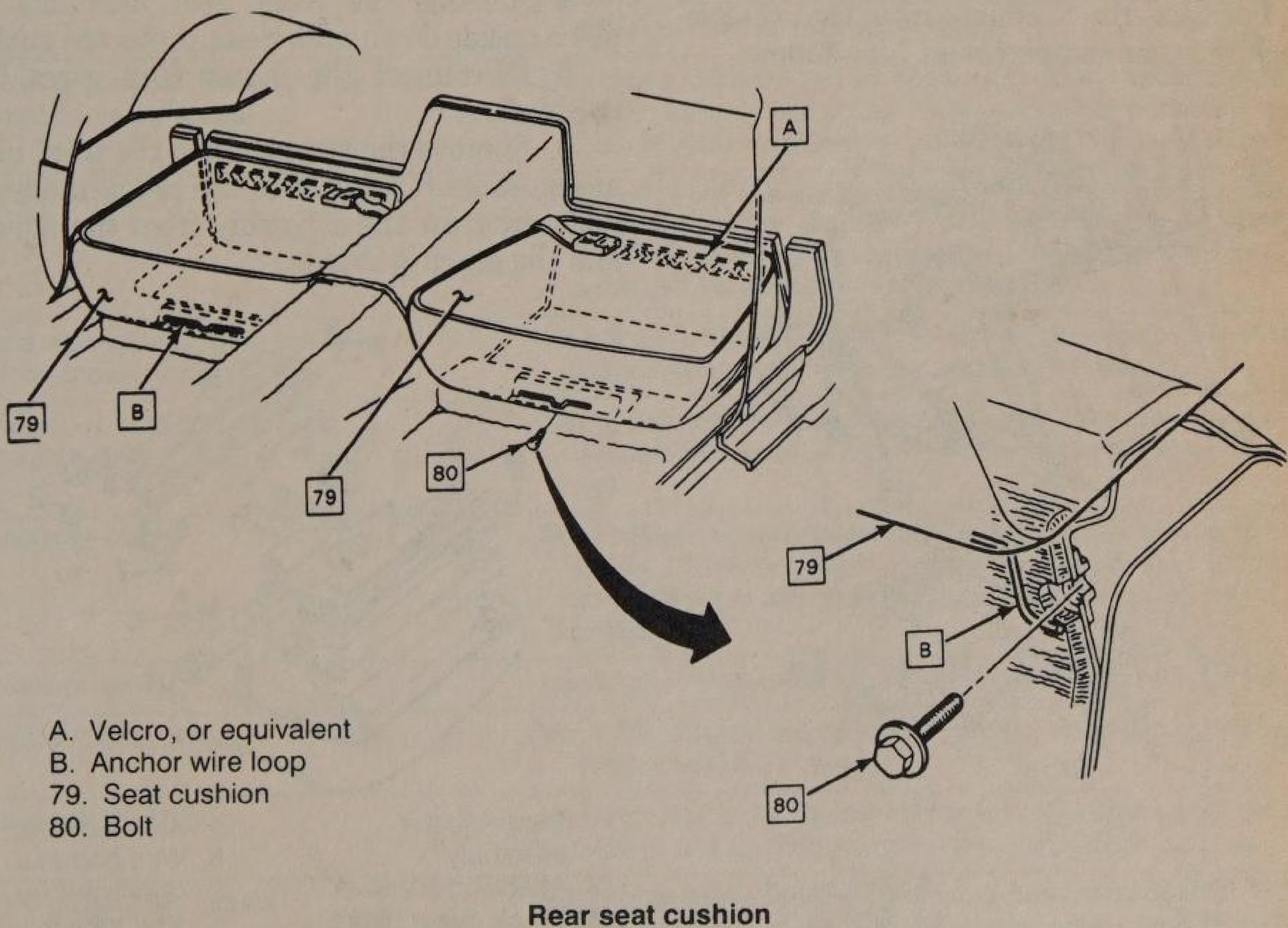
1. Operate the seat to the full-forward position. If six-way power seat is operable, operate seat to the full-forward and up positions. Where necessary to gain access to the adjuster-to-floor pan attaching nuts, remove the adjuster rear foot covers and/or carpet retainers.

2. Remove the track covers where neces-



1. Rear outer adjuster cover
2. Rear inner adjuster cover
3. Driver adjuster
4. Driver adjuster cover
5. Passenger adjuster
6. Passenger adjuster cover
7. Nut
8. Auxiliary locking wire

Seat-to-floor pan components and servicing for manual seats



A. Velcro, or equivalent
B. Anchor wire loop
79. Seat cushion
80. Bolt

Rear seat cushion

sary; then remove the adjuster-to-floor pan rear attaching nuts. Operate the seat to the full-rearward position. Remove the adjuster front foot covers; then remove the adjuster-to-floor pan front attaching nuts.

3. Remove the seat assembly from the car.

To install:

1. Prior to installing the seat assembly, check that both seat adjusters are parallel and in phase with each other.

2. Install the adjuster-to-floor pan attaching nuts by moving the seat forward and rearward and torque nuts to 15–21 ft. lbs. (20–28 Nm).

3. Check the operation of the seat assembly to full limits of travel.

Rear

CUSHION

NOTE: *Place protective covering over nearby trim and paint to help prevent damage to these areas.*

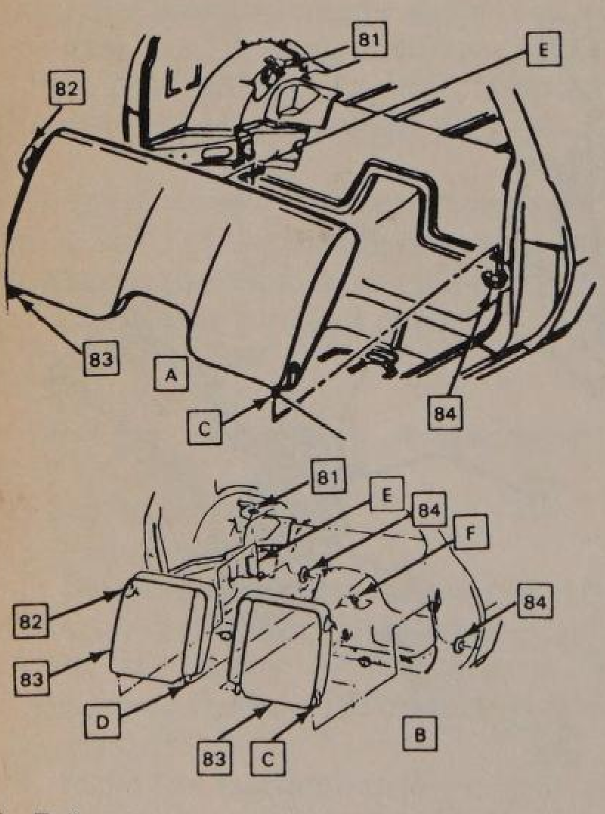
1. Remove the bolt and seat cushion by pulling upward and forward.

2. Remove the rear seat cushion through the rear compartment lift window, being careful not to damage the painted surfaces.

3. If necessary, remove the protective shield.

To install:

1. Position the cushion into the vehicle through the rear compartment lift window.



A. Full seat
B. Split seat
C. Seat stud
D. Inner pivot support
E. Outer pivot support
F. Floor stud
81. Striker
82. Seatback lock
83. Seatback
84. Nut

Rear seatback

2. Install the bolt through the anchor wire loop into the hole in the floor apn and torque to 106 inch lbs. (12 Nm).

SEATBACK

NOTE: *Place protective covering over nearby trim and paint to help prevent damage to these areas.*

1. Remove the seat cushion and shoulder strap guide.

2. Rmeove the seatback lock from striker.

3. Remove the nuts from the seat studs.

4. Remove the seat studs from the outer pivot supports by lifting upward on the outboard side of the seatback.

5. Remove the seatback from the vehicle through the rear compartment lift window.

To install:

1. Install the seatback into the vehicle through the rear compartment lift window.

2. Install the seat studs into the outer pivot supports.

3. Install the seatback lock to the striker. Torque the nuts to 20 ft. lbs. (27 Nm).

4. Install the seat cushion and shoulder strap guide.

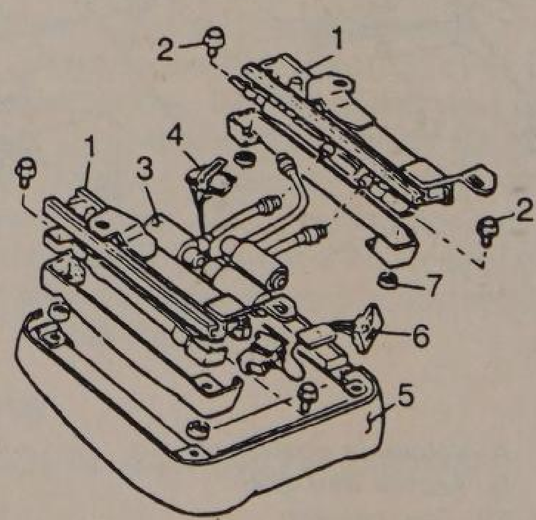
Power Seat Motor

REMOVAL AND INSTALLATION

1. Remove the front seat assembly and place upside down on a clean protected surface.

2. Disconnect the motor feed wires from the motors.

3. Remove the nut securing the front of the motor support bracket to the inboard adjuster and withdraw the assembly from the adjuster and the gearnut drives.



1. Seat adjuster assembly
2. Attaching screw
3. Three motor direct drive
4. Wiring harness connector
5. Seat cushion
6. Wire harness connector to seat switch
7. Adjuster-to-seat spacer

Six-way power seat components

4. Disconnect the drive cables from the motors and complete removal of the support bracket with the motor attached.

5. Grind off the peened over end(s) of the grommet assembly securing the motor to the support and separate the motor(s) as required from the support.

To install:

1. Before installation, drill out the top end of the grommet assembly using a $^3/_{16}$ in. drill.

2. Install the grommet assembly to the motor support bracket and secure the motor to the grommet using $^3/_{16}$ in. rivet.

3. Install the support bracket with the motor attached and connect the drive cables to the motors.

4. Install the support bracket nuts securing the front of the motor support bracket to the inboard adjuster.

5. Connect the motor feed wires to the motors.

6. Install the front seat assembly.

How to Remove Stains from Fabric Interior

For best results, spots and stains should be removed as soon as possible. Never use gasoline, lacquer thinner, acetone, nail polish remover or bleach. Use a 3′ x 3″ piece of cheesecloth. Squeeze most of the liquid from the fabric and wipe the stained fabric from the outside of the stain toward the center with a lifting motion. Turn the cheesecloth as soon as one side becomes soiled. When using water to remove a stain, be sure to wash the entire section after the spot has been removed to avoid water stains. Encrusted spots can be broken up with a dull knife and vacuumed before removing the stain.

Type of Stain	How to Remove It
Surface spots	Brush the spots out with a small hand brush or use a commercial preparation such as K2R to lift the stain.
Mildew	Clean around the mildew with warm suds. Rinse in cold water and soak the mildew area in a solution of 1 part table salt and 2 parts water. Wash with upholstery cleaner.
Water stains	Water stains in fabric materials can be removed with a solution made from 1 cup of table salt dissolved in 1 quart of water. Vigorously scrub the solution into the stain and rinse with clear water. Water stains in nylon or other synthetic fabrics should be removed with a commercial type spot remover.
Chewing gum, tar, crayons, shoe polish (greasy stains)	Do not use a cleaner that will soften gum or tar. Harden the deposit with an ice cube and scrape away as much as possible with a dull knife. Moisten the remainder with cleaning fluid and scrub clean.
Ice cream, candy	Most candy has a sugar base and can be removed with a cloth wrung out in warm water. Oily candy, after cleaning with warm water, should be cleaned with upholstery cleaner. Rinse with warm water and clean the remainder with cleaning fluid.
Wine, alcohol, egg, milk, soft drink (non-greasy stains)	Do not use soap. Scrub the stain with a cloth wrung out in warm water. Remove the remainder with cleaning fluid.
Grease, oil, lipstick, butter and related stains	Use a spot remover to avoid leaving a ring. Work from the outisde of the stain to the center and dry with a clean cloth when the spot is gone.
Headliners (cloth)	Mix a solution of warm water and foam upholstery cleaner to give thick suds. Use only foam—liquid may streak or spot. Clean the entire headliner in one operation using a circular motion with a natural sponge.
Headliner (vinyl)	Use a vinyl cleaner with a sponge and wipe clean with a dry cloth.
Seats and door panels	Mix 1 pint upholstery cleaner in 1 gallon of water. Do not soak the fabric around the buttons.
Leather or vinyl fabric	Use a multi-purpose cleaner full strength and a stiff brush. Let stand 2 minutes and scrub thoroughly. Wipe with a clean, soft rag.
Nylon or synthetic fabrics	For normal stains, use the same procedures you would for washing cloth upholstery. If the fabric is extremely dirty, use a multi-purpose cleaner full strength with a stiff scrub brush. Scrub thoroughly in all directions and wipe with a cotton towel or soft rag.

Mechanic's Data

11

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
.164	Cubic inches	Liters	61.02
16.39	Cubic inches	Cubic cms.	.061
28.32	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			
6.45	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
1.356	Ft. lbs.	Newton-meters	.737
.113	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
1.609	Mph	Km/h	.621
.425	Mpg	Km/L	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	28	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

Drill Sizes In Decimal Equivalents

Inch	Decimal	Wire	mm
1/64	.0156		.39
	.0157		.4
	.0160	78	
	.0165		.42
	.0173		.44
	.0177		.45
	.0180	77	
	.0181		.46
	.0189		.48
	.0197		.5
	.0200	76	
	.0210	75	
	.0217		.55
	.0225	74	
	.0236		.6
	.0240	73	
	.0250	72	
	.0256		.65
	.0260	71	
	.0276		.7
	.0280	70	
	.0292	69	
	.0295		.75
	.0310	68	
1/32	.0312		.79
	.0315		.8
	.0320	67	
	.0330	66	
	.0335		.85
	.0350	65	
	.0354		.9
	.0360	64	
	.0370	63	
	.0374		.95
	.0380	62	
	.0390	61	
	.0394		1.0
	.0400	60	
	.0410	59	
	.0413		1.05
	.0420	58	
	.0430	57	
	.0433		1.1
	.0453		1.15
	.0465	56	
3/64	.0469		1.19
	.0472		1.2
	.0492		1.25
	.0512		1.3
	.0520	55	
	.0531		1.35
	.0550	54	
	.0551		1.4
	.0571		1.45
	.0591		1.5
	.0595	53	
	.0610		1.55
1/16	.0625		1.59
	.0630		1.6
	.0635	52	
	.0650		1.65
	.0669		1.7
	.0670	51	
	.0689		1.75
	.0700	50	
	.0709		1.8
	.0728		1.85

Inch	Decimal	Wire	mm
	.0730	49	
	.0748		1.9
	.0760	48	
	.0768		1.95
5/64	.0781		1.98
	.0785	47	
	.0787		2.0
	.0807		2.05
	.0810	46	
	.0820	45	
	.0827		2.1
	.0846		2.15
	.0860	44	
	.0866		2.2
	.0886		2.25
	.0890	43	
	.0906		2.3
	.0925		2.35
	.0935	42	
3/32	.0938		2.38
	.0945		2.4
	.0960	41	
	.0965		2.45
	.0980	40	
	.0981		2.5
	.0995	39	
	.1015	38	
	.1024		2.6
	.1040	37	
	.1063		2.7
	.1065	36	
	.1083		2.75
7/64	.1094		2.77
	.1100	35	
	.1102		2.8
	.1110	34	
	.1130	33	
	.1142		2.9
	.1160	32	
	.1181		3.0
	.1200	31	
	.1220		3.1
1/8	.1250		3.17
	.1260		3.2
	.1280		3.25
	.1285	30	
	.1299		3.3
	.1339		3.4
	.1360	29	
	.1378		3.5
	.1405	28	
9/64	.1406		3.57
	.1417		3.6
	.1440	27	
	.1457		3.7
	.1470	26	
	.1476		3.75
	.1495	25	
	.1496		3.8
	.1520	24	
	.1535		3.9
	.1540	23	
5/32	.1562		3.96
	.1570	22	
	.1575		4.0
	.1590	21	
	.1610	20	

Inch	Decimal	Wire & Letter	mm
	.1614		4.1
	.1654		4.2
	.1660	19	
	.1673		4.25
	.1693		4.3
	.1695	18	
11/64	.1719		4.36
	.1730	17	
	.1732		4.4
	.1770	16	
	.1772		4.5
	.1800	15	
	.1811		4.6
	.1820	14	
	.1850	13	
	.1850		4.7
	.1870		4.75
3/16	.1875		4.76
	.1890		4.8
	.1890	12	
	.1910	11	
	.1929		4.9
	.1935	10	
	.1960	9	
	.1969		5.0
	.1990	8	
	.2008		5.1
	.2010	7	
13/64	.2031		5.16
	.2040	6	
	.2047		5.2
	.2055	5	
	.2067		5.25
	.2087		5.3
	.2090	4	
	.2126		5.4
	.2130	3	
	.2165		5.5
7/32	2188		5.55
	.2205		5.6
	.2210	2	
	.2244		5.7
	.2264		5.75
	.2280	1	
	.2283		5.8
	.2323		5.9
	.2340	A	
15/64	.2344		5.95
	.2362		6.0
	.2380	B	
	.2402		6.1
	.2420	C	
	.2441		6.2
	.2460	D	
	.2461		6.25
	.2480		6.3
1/4	.2500	E	6.35
	.2520		6.
	.2559		6.5
	.2570	F	
	.2598		6.6
	.2610	G	
	.2638		6.7
17/64	.2656		6.74
	.2657		6.75
	.2660	H	
	.2677		6.8

Inch	Decimal	Letter	mm
	.2717		6.9
	.2720	I	
	.2756		7.0
	.2770	J	
	.2795		7.1
	.2810	K	
9/32	.2812		7.14
	.2835		7.2
	.2854		7.25
	.2874		7.3
	.2900	L	
	.2913		7.4
	.2950	M	
	.2953		7.5
19/64	.2969		7.54
	.2992		7.6
	.3020	N	
	.3031		7.7
	.3051		7.75
	.3071		7.8
	.3110		7.9
5/16	.3125		7.93
	.3150		8.0
	.3160	O	
	.3189		8.1
	.3228		8.2
	.3230	P	
	.3248		8.25
	.3268		8.3
21/64	.3281		8.33
	.3307		8.4
	.3320	Q	
	.3346		8.5
	.3386		8.6
	.3390	R	
	.3425		8.7
11/32	.3438		8.73
	.3445		8.75
	.3465		8.8
	.3480	S	
	.3504		8.9
	.3543		9.0
	.3580	T	
	.3583		9.1
23/64	.3594		9.12
	.3622		9.2
	.3642		9.25
	.3661		9.3
	.3680	U	
	.3701		9.4
	.3740		9.5
3/8	.3750		9.52
	.3770	V	
	.3780		9.6
	.3819		9.7
	.3839		9.75
	.3858		9.8
	.3860	W	
	.3898		9.9
25/64	.3906		9.92
	.3937		10.0
	.3970	X	
	.4040	Y	
13/32	.4062		10.31
	.4130	Z	
	.4134		10.5
27/64	.4219		10.71

Inch	Decimal	mm
	.4331	11.0
7/16	.4375	11.11
	.4528	11.5
29/64	.4531	11.51
15/32	.4688	11.90
	.4724	12.0
31/64	.4844	12.30
	.4921	12.5
1/2	.5000	12.70
	.5118	13.0
33/64	.5156	13.09
17/32	.5312	13.49
	.5315	13.5
35/64	.5469	13.89
	.5512	14.0
9/16	.5625	14.28
	.5709	14.5
37/64	.5781	14.68
	.5906	15.0
19/32	.5938	15.08
39/64	.6094	15.47
	.6102	15.5
5/8	.6250	15.87
	.6299	16.0
41/64	.6406	16.27
	.6496	16.5
21/32	.6562	16.66
	.6693	17.0
43/64	.6719	17.06
11/16	.6875	17.46
	.6890	17.5
45/64	.7031	17.85
	.7087	18.0
23/32	.7188	18.25
	.7283	18.5
47/64	.7344	18.65
	.7480	19.0
3/4	.7500	19.05
49/64	.7656	19.44
	.7677	19.5
25/32	.7812	19.84
	.7874	20.0
51/64	.7969	20.24
	.8071	20.5
13/16	.8125	20.63
	.8268	21.0
53/64	.8281	21.03
27/32	.8438	21.43
	.8465	21.5
55/64	.8594	21.82
	.8661	22.0
7/8	.8750	22.22
	.8858	22.5
57/64	.8906	22.62
	.9055	23.0
29/32	.9062	23.01
59/64	.9219	23.41
	.9252	23.5
15/16	.9375	23.81
	.9449	24.0
61/64	.9531	24.2
	.9646	24.5
31/64	.9688	24.6
	.9843	25.0
63/64	.9844	25.0
1	1.0000	25.4

AIR/FUEL RATIO: The ratio of air to gasoline by weight in the fuel mixture drawn into the engine.

AIR INJECTION: One method of reducing harmful exhaust emissions by injecting air into each of the exhaust ports of an engine. The fresh air entering the hot exhaust manifold causes any remaining fuel to be burned before it can exit the tailpipe.

ALTERNATOR: A device used for converting mechanical energy into electrical energy.

AMMETER: An instrument, calibrated in amperes, used to measure the flow of an electrical current in a circuit. Ammeters are always connected in series with the circuit being tested.

AMPERE: The rate of flow of electrical current present when one volt of electrical pressure is applied against one ohm of electrical resistance.

ANALOG COMPUTER: Any microprocessor that uses similar (analogous) electrical signals to make its calculations.

ARMATURE: A laminated, soft iron core wrapped by a wire that converts electrical energy to mechanical energy as in a motor or relay. When rotated in a magnetic field, it changes mechanical energy into electrical energy as in a generator.

ATMOSPHERIC PRESSURE: The pressure on the Earth's surface caused by the weight of the air in the atmosphere. At sea level, this pressure is 14.7 psi at 32°F (101 kPa at 0°C).

ATOMIZATION: The breaking down of a liquid into a fine mist that can be suspended in air.

AXIAL PLAY: Movement parallel to a shaft or bearing bore.

BACKFIRE: The sudden combustion of gases in the intake or exhaust system that results in a loud explosion.

BACKLASH: The clearance or play between two parts, such as meshed gears.

BACKPRESSURE: Restrictions in the exhaust system that slow the exit of exhaust gases from the combustion chamber.

BAKELITE: A heat resistant, plastic insulator material commonly used in printed circuit boards and transistorized components.

BALL BEARING: A bearing made up of hardened inner and outer races between which hardened steel balls roll.

BALLAST RESISTOR: A resistor in the primary ignition circuit that lowers voltage after the engine is started to reduce wear on ignition components.

BEARING: A friction reducing, supportive device usually located between a stationary part and a moving part.

BIMETAL TEMPERATURE SENSOR: Any sensor or switch made of two dissimilar types of metal that bend when heated or cooled due to the different expansion rates of the alloys. These types of sensors usually function as an on/off switch.

BLOWBY: Combustion gases, composed of water vapor and unburned fuel, that leak past the piston rings into the crankcase during normal engine operation. These gases are removed by the PCV system to prevent the buildup of harmful acids in the crankcase.

BRAKE PAD: A brake shoe and lining assembly used with disc brakes.

BRAKE SHOE: The backing for the brake lining. The term is, however, usually applied to the assembly of the brake backing and lining.

BUSHING: A liner, usually removable, for a bearing; an anti-friction liner used in place of a bearing.

BYPASS: System used to bypass ballast resistor during engine cranking to increase voltage supplied to the coil.

CALIPER: A hydraulically activated device in a disc brake system, which is mounted straddling the brake rotor (disc). The caliper contains at least one piston and two brake pads. Hydraulic pressure on the piston(s) forces the pads against the rotor.

CAMSHAFT: A shaft in the engine on which are the lobes (cams) which operate the valves. The camshaft is driven by the crankshaft, via a belt, chain or gears, at one half the crankshaft speed.

CAPACITOR: A device which stores an electrical charge.

CARBON MONOXIDE (CO): A colorless, odorless gas given off as a normal byproduct of combustion. It is poisonous and extremely dangerous in confined areas, building up slowly to toxic levels without warning if adequate ventilation is not available.

CARBURETOR: A device, usually mounted on the intake manifold of an engine, which mixes the air and fuel in the proper proportion to allow even combustion.

CATALYTIC CONVERTER: A device installed in the exhaust system, like a muffler, that converts harmful byproducts of combustion into carbon dioxide and water vapor by means of a heat-producing chemical reaction.

CENTRIFUGAL ADVANCE: A mechanical method of advancing the spark timing by using fly weights in the distributor that react to centrifugal force generated by the distributor shaft rotation.

CHECK VALVE: Any one-way valve installed to permit the flow of air, fuel or vacuum in one direction only.

CHOKE: A device, usually a movable valve, placed in the intake path of a carburetor to restrict the flow of air.

CIRCUIT: Any unbroken path through which an electrical current can flow. Also used to describe fuel flow in some instances.

CIRCUIT BREAKER: A switch which protects an electrical circuit from overload by opening the circuit when the current flow exceeds a predetermined level. Some circuit breakers must be reset manually, while most reset automatically

COIL (IGNITION): A transformer in the ignition circuit which steps up the voltage provided to the spark plugs.

COMBINATION MANIFOLD: An assembly which includes both the intake and exhaust manifolds in one casting.

COMBINATION VALVE: A device used in some fuel systems that routes fuel vapors to a charcoal storage canister instead of venting them into the atmosphere. The valve relieves fuel tank pressure and allows fresh air into the tank as the fuel level drops to prevent a vapor lock situation.

COMPRESSION RATIO: The comparison of the total volume of the cylinder and combustion chamber with the piston at BDC and the piston at TDC.

CONDENSER: 1. An electrical device which acts to store an electrical charge, preventing voltage surges.

2. A radiator-like device in the air conditioning system in which refrigerant gas condenses into a liquid, giving off heat.

CONDUCTOR: Any material through which an electrical current can be transmitted easily.

CONTINUITY: Continuous or complete circuit. Can be checked with an ohmmeter.

COUNTERSHAFT: An intermediate shaft which is rotated by a mainshaft and transmits, in turn, that rotation to a working part.

CRANKCASE: The lower part of an engine in which the crankshaft and related parts operate.

CRANKSHAFT: The main driving shaft of an engine which receives reciprocating motion from the pistons and converts it to rotary motion.

CYLINDER: In an engine, the round hole in the engine block in which the piston(s) ride.

CYLINDER BLOCK: The main structural member of an engine in which is found the cylinders, crankshaft and other principal parts.

CYLINDER HEAD: The detachable portion of the engine, fastened, usually, to the top of the cylinder block, containing all or most of the combustion chambers. On overhead valve engines, it contains the valves and their operating parts. On overhead cam engines, it contains the camshaft as well.

DEAD CENTER: The extreme top or bottom of the piston stroke.

DETONATION: An unwanted explosion of the air/fuel mixture in the combustion chamber caused by excess heat and compression, advanced timing, or an overly lean mixture. Also referred to as "ping".

DIAPHRAGM: A thin, flexible wall separating two cavities, such as in a vacuum advance unit.

DIESELING: A condition in which hot spots in the combustion chamber cause the engine to run on after the key is turned off.

DIFFERENTIAL: A geared assembly which allows the transmission of motion between drive axles, giving one axle the ability to turn faster than the other.

DIODE: An electrical device that will allow current to flow in one direction only.

DISC BRAKE: A hydraulic braking assembly consisting of a brake disc, or rotor, mounted on an axle, and a caliper assembly containing, usually two brake pads which are activated by hydraulic pressure. The pads are forced against the sides of the disc, creating friction which slows the vehicle.

DISTRIBUTOR: A mechanically driven device on an engine which is responsible for electrically firing the spark plug at a predetermined point of the piston stroke.

DOWEL PIN: A pin, inserted in mating holes in two different parts allowing those parts to maintain a fixed relationship.

DRUM BRAKE: A braking system which consists of two brake shoes and one or two wheel cylinders, mounted on a fixed backing plate, and a brake drum, mounted on an axle, which revolves around the assembly. Hydraulic action applied to the wheel cylinders forces the shoes outward against the drum, creating friction, slowing the vehicle.

DWELL: The rate, measured in degrees of shaft rotation, at which an electrical circuit cycles on and off.

ELECTRONIC CONTROL UNIT (ECU): Ignition module, amplifier or igniter. See Module for definition.

ELECTRONIC IGNITION: A system in which the timing and firing of the spark plugs is controlled by an electronic control unit, usually called a module. These systems have no points or condenser.

ENDPLAY: The measured amount of axial movement in a shaft.

ENGINE: A device that converts heat into mechanical energy.

EXHAUST MANIFOLD: A set of cast passages or pipes which conduct exhaust gases from the engine.

FEELER GAUGE: A blade, usually metal, of precisely predetermined thickness, used to measure the clearance between two parts. These blades usually are available in sets of assorted thicknesses.

F-HEAD: An engine configuration in which the intake valves are in the cylinder head, while the camshaft and exhaust valves are located in the cylinder block. The camshaft operates the intake valves via lifters and pushrods, while it operates the exhaust valves directly.

FIRING ORDER: The order in which combustion occurs in the cylinders of an engine. Also the order in which spark is distributed to the plugs by the distributor.

FLATHEAD: An engine configuration in which the camshaft and all the valves are located in the cylinder block.

FLOODING: The presence of too much fuel in the intake manifold and combustion chamber which prevents the air/fuel mixture from firing, thereby causing a no-start situation.

FLYWHEEL: A disc shaped part bolted to the rear end of the crankshaft. Around the outer perimeter is affixed the ring gear. The starter drive engages the ring gear, turning the flywheel, which rotates the crankshaft, imparting the initial starting motion to the engine.

FOOT POUND (ft.lb. or sometimes, ft. lbs.): The amount of energy or work needed to raise an item weighing one pound, a distance of one foot.

FUSE: A protective device in a circuit which prevents circuit overload by breaking the circuit when a specific amperage is present. The device is constructed around a strip or wire of a lower amperage rating than the circuit it is designed to protect. When an amperage higher than that stamped on the fuse is present in the circuit, the strip or wire melts, opening the circuit.

GEAR RATIO: The ratio between the number of teeth on meshing gears.

GENERATOR: A device which converts mechanical energy into electrical energy.

HEAT RANGE: The measure of a spark plug's ability to dissipate heat from its firing end. The higher the heat range, the hotter the plug fires.

HUB: The center part of a wheel or gear.

HYDROCARBON (HC): Any chemical compound made up of hydrogen and carbon. A major pollutant formed by the engine as a byproduct of combustion.

HYDROMETER: An instrument used to measure the specific gravity of a solution.

INCH POUND (in.lb. or sometimes, in. lbs.): One twelfth of a foot pound.

INDUCTION: A means of transferring electrical energy in the form of a magnetic field. Principle used in the ignition coil to increase voltage.

INJECTION PUMP: A device, usually mechanically operated, which meters and delivers fuel under pressure to the fuel injector.

INJECTOR: A device which receives metered fuel under relatively low pressure and is activated to inject the fuel into the engine under relatively high pressure at a predetermined time.

INPUT SHAFT: The shaft to which torque is applied, usually carrying the driving gear or gears.

INTAKE MANIFOLD: A casting of passages or pipes used to conduct air or a fuel/air mixture to the cylinders.

JOURNAL: The bearing surface within which a shaft operates.

KEY: A small block usually fitted in a notch between a shaft and a hub to prevent slippage of the two parts.

MANIFOLD: A casting of passages or set of pipes which connect the cylinders to an inlet or outlet source.

MANIFOLD VACUUM: Low pressure in an engine intake manifold formed just below the throttle plates. Manifold vacuum is highest at idle and drops under acceleration.

MASTER CYLINDER: The primary fluid pressurizing device in a hydraulic system. In automotive use, it is found in brake and hydraulic clutch systems and is pedal activated, either directly or, in a power brake system, through the power booster.

MODULE: Electronic control unit, amplifier or igniter of solid state or integrated design which controls the current flow in the ignition primary circuit based on input from the pick-up coil. When the module opens the primary circuit, the high secondary voltage is induced in the coil.

NEEDLE BEARING: A bearing which consists of a number (usually a large number) of long, thin rollers.

OHM:(Ω) The unit used to measure the resistance of conductor to electrical flow. One ohm is the amount of resistance that limits current flow to one ampere in a circuit with one volt of pressure.

OHMMETER: An instrument used for measuring the resistance, in ohms, in an electrical circuit.

OUTPUT SHAFT: The shaft which transmits torque from a device, such as a transmission.

OVERDRIVE: A gear assembly which produces more shaft revolutions than that transmitted to it.

OVERHEAD CAMSHAFT (OHC): An engine configuration in which the camshaft is mounted on top of the cylinder head and operates the valves either directly or by means of rocker arms.

OVERHEAD VALVE (OHV): An engine configuration in which all of the valves are located in the cylinder head and the camshaft is located in the cylinder block. The camshaft operates the valves via lifters and pushrods.

OXIDES OF NITROGEN (NOx): Chemical compounds of nitrogen produced as a byproduct of combustion. They combine with hydrocarbons to produce smog.

OXYGEN SENSOR: Used with the feedback system to sense the presence of oxygen in the exhaust gas and signal the computer which can reference the voltage signal to an air/fuel ratio.

PINION: The smaller of two meshing gears.

PISTON RING: An open ended ring which fits into a groove on the outer diameter of the piston. Its chief function is to form a seal between the piston and cylinder wall. Most automotive pistons have three rings: two for compression sealing; one for oil sealing.

PRELOAD: A predetermined load placed on a bearing during assembly or by adjustment.

PRIMARY CIRCUIT: Is the low voltage side of the ignition system which consists of the ignition switch, ballast resistor or resistance wire, bypass, coil, electronic control unit and pick-up coil as well as the connecting wires and harnesses.

PRESS FIT: The mating of two parts under pressure, due to the inner diameter of one being smaller than the outer diameter of the other, or vice versa; an interference fit.

RACE: The surface on the inner or outer ring of a bearing on which the balls, needles or rollers move.

REGULATOR: A device which maintains the amperage and/or voltage levels of a circuit at predetermined values.

RELAY: A switch which automatically opens and/or closes a circuit.

RESISTANCE: The opposition to the flow of current through a circuit or electrical device, and is measured in ohms. Resistance is equal to the voltage divided by the amperage.

RESISTOR: A device, usually made of wire, which offers a preset amount of resistance in an electrical circuit.

RING GEAR: The name given to a ring-shaped gear attached to a differential case,or affixed to a flywheel or as part a planetary gear set.

ROLLER BEARING: A bearing made up of hardened inner and outer races between which hardened steel rollers move.

ROTOR: 1. The disc-shaped part of a disc brake assembly, upon which the brake pads bear; also called, brake disc.
2. The device mounted atop the distributor shaft, which passes current to the distributor cap tower contacts.

SECONDARY CIRCUIT: The high voltage side of the ignition system, usually above 20,000 volts. The secondary includes the ignition coil, coil wire, distributor cap and rotor, spark plug wires and spark plugs.

SENDING UNIT: A mechanical, electrical, hydraulic or electromagnetic device which transmits information to a gauge.

SENSOR: Any device designed to measure engine operating conditions or ambient pressures and temperatures. Usually electronic in nature and designed to send a voltage signal to an on-board computer, some sensors may operate as a simple on/off switch or they may provide a variable voltage signal (like a potentiometer) as conditions or measured parameters change.

SHIM: Spacers of precise, predetermined thickness used between parts to establish a proper working relationship.

SLAVE CYLINDER: In automotive use, a device in the hydraulic clutch system which is activated by hydraulic force, disengaging the clutch.

SOLENOID: A coil used to produce a magnetic field, the effect of which is to produce work.

SPARK PLUG: A device screwed into the combustion chamber of a spark ignition engine. The basic construction is a conductive core inside of a ceramic insulator, mounted in an outer conductive base. An electrical charge from the spark plug wire travels along the conductive core and jumps a preset air gap to a grounding point or points at the end of the conductive base. The resultant spark ignites the fuel/air mixture in the combustion chamber.

SPLINES: Ridges machined or cast onto the outer diameter of a shaft or inner diameter of a bore to enable parts to mate without rotation.

TACHOMETER: A device used to measure the rotary speed of an engine, shaft, gear, etc., usually in rotations per minute.

THERMOSTAT: A valve, located in the cooling system of an engine, which is closed when cold and opens gradually in response to engine heating, controlling the temperature of the coolant and rate of coolant flow.

TOP DEAD CENTER (TDC): The point at which the piston reaches the top of its travel on the compression stroke.

TORQUE: The twisting force applied to an object.

TORQUE CONVERTER: A turbine used to transmit power from a driving member to a driven member via hydraulic action, providing changes in drive ratio and torque. In automotive use, it links the driveplate at the rear of the engine to the automatic transmission.

TRANSDUCER: A device used to change a force into an electrical signal.

TRANSISTOR: A semi-conductor component which can be actuated by a small voltage to perform an electrical switching function.

TUNE-UP: A regular maintenance function, usually associated with the replacement and adjustment of parts and components in the electrical and fuel systems of a vehicle for the purpose of attaining optimum performance.

TURBOCHARGER: An exhaust driven pump which compresses intake air and forces it into the combustion chambers at higher than atmospheric pressures. The increased air pressure allows more fuel to be burned and results in increased horsepower being produced.

VACUUM ADVANCE: A device which advances the ignition timing in response to increased engine vacuum.

VACUUM GAUGE: An instrument used to measure the presence of vacuum in a chamber.

VALVE: A device which control the pressure, direction of flow or rate of flow of a liquid or gas.

VALVE CLEARANCE: The measured gap between the end of the valve stem and the rocker arm, cam lobe or follower that activates the valve.

VISCOSITY: The rating of a liquid's internal resistance to flow.

VOLTMETER: An instrument used for measuring electrical force in units called volts. Voltmeters are always connected parallel with the circuit being tested.

WHEEL CYLINDER: Found in the automotive drum brake assembly, it is a device, actuated by hydraulic pressure, which, through internal pistons, pushes the brake shoes outward against the drums.

A: Ampere

AC: Alternating current

A/C: Air conditioning

A-h: Amper hour

AT: Automatic transmission

ATDC: After top dead center

μA: Microampere

bbl: Barrel

BDC: Bottom dead center

bhp: Brake horsepower

BTDC: Before top dead center

BTU: British thermal unit

C: Celsius (Centigrade)

CCA: Cold cranking amps

cd: Candela

cm^2: Square centimeter

cm^3, cc: Cubic centimeter

CO: Carbon monoxide

CO_2: Carbon dioxide

cu.in., in^3: Cubic inch

CV: Constant velocity

Cyl.: Cylinder

DC: Direct current

ECM: Electronic control module

EFE: Early fuel evaporation

EFI: Electronic fuel injection

EGR: Exhaust gas recirculation

Exh.: Exhaust

F: Farenheit

F: Farad

pF: Picofarad

μF: Microfarad

FI: Fuel injection

ft.lb., ft. lb., ft. lbs.: foot pound(s)

gal: Gallon

g: Gram

HC: Hydrocarbon

HEI: High energy ignition

HO: High output

hp: Horsepower

Hyd: Hydraulic

Hz: Hertz

ID: Inside diameter

in.lb; in. lbs.; in. lbs.: inch pound(s)

Int: Intake

K: Kelvin

kg: Kilogram

kHz: Kilohertz

km: Kilometer

km/h: Kilometers per hour

kΩ: Kilohm

kPa: Kilopascal

kV: Kilovolt

kW: Kilowatt

l: Liter

l/s: Liters per second

m: Meter

mA: Milliampere

mg: Milligram

mHz: Megahertz

mm: Millimeter

mm^2: Square millimeter

m^3: Cubic meter

MΩ: Megohm

m/s: Meters per second

MT: Manual transmission

mV: Millivolt

μm: Micrometer

N: Newton

N–m: Newton meter

NOx: Nitrous oxide

OD: Outside diameter

OHC: Over head camshaft

OHV: Over head valve

Ω: Ohm

PCV: Positive crankcase ventilation

psi: Pounds per square inch

pts: Pints

qts: Quarts

rpm: Rotations per minute

rps: Rotations per second

R–12: refrigerant gas (Freon)

SAE: Society of Automotive Engineers

SO_2: Sulfur dioxide

T: Ton

t: Megagram

TBI: Throttle Body Injection

TPS: Throttle Position Sensor

V: 1. Volt; 2. Venturi

μV: Microvolt

W: Watt

∞: Infinity

<: Less than

>: Greater than

A

B

F

G

H

I

J

K

L

M

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ISBN 0-8019-8060-7

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