ENGINE OPERATIONS

NOTE
The material in this student reference book contains information for the following STST specialities:
• ENGINE PERFORMANCE
• ENGINE REPAIR

Ford Parts and Service Division
Technical Training

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles, as well as the personal safety of the individual doing the work. This manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from instructions provided in this manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

As you read through the procedures, you will come across NOTES, CAUTIONS, AND WARNINGS. Each one is there for a specific purpose. NOTES give you added information that will help you to complete a particular procedure. CAUTIONS are given to prevent you from making an error that could damage the vehicle. WARNINGS remind you to be especially careful in those areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow when you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK unless instructed otherwise for a specific service operation. If you have a manual transmission, it should be in REVERSE (engine OFF) or NEUTRAL (engine ON) unless instructed otherwise for a specific service operation.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from moving parts when the engine is running, especially the fan and belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on the vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle. Tie long hair securely behind your head.
- Keep hands and other objects clear of the radiator fan blades. Electric cooling fans can start to operate at any time by an increase in underhood temperatures, even though the ignition is in the OFF position. Therefore, care should be taken to ensure that the electric cooling fan is completely disconnected when working under the hood.

The recommendations and suggestions contained in this manual are made to assist the dealer in improving his dealership parts and/or service department operations. These recommendations and suggestions do not supersede or override the provisions of the Warranty and Policy Manual or the Shop Manual and in any cases where there may be a conflict, the provisions of the Warranty and Policy Manual or the Shop Manual shall govern.

The descriptions, testing procedures, and specifications in this handbook were in effect at the time the handbook was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications, design, or testing procedures without notice and without incurring obligation. Any reference to brand names in this manual is intended merely as an example of the types of tools, lubricants, materials, etc. recommended for use. Equivalents, if available, may be used. The right is reserved to make changes at any time without notice.

WARNING: Many brake linings contain asbestos fibers. When working on brake components, avoid breathing the dust. Breathing the asbestos dust can cause asbestosis and cancer.

Breathing asbestos dust is harmful to your health.

Dust and dirt present on car wheel brake and clutch assemblies may contain asbestos fibers that are hazardous to your health when made airborne by cleaning with compressed air or by dry brushing.

Wheel brake assemblies and clutch facings should be cleaned using a vacuum cleaner recommended for use with asbestos fibers. Dust and dirt should be disposed of in a manner that prevents dust exposure, such as sealed bags. The bag must be labelled per OSHA instructions and the trash hauler notified as to the contents of the bag.

If a vacuum bag suitable for asbestos is not available, cleaning should be done wet. If dust generation is still possible, technicians should wear government approved toxic dust purifying respirators.

OSHA requires areas where asbestos dust generation is possible to be isolated and posted with warning signs. Only technicians concerned with performing brake or clutch service should be present in the area.

Produced and Coordinated by
Joseph C. Barney, Jr.
Technical Training
Ford Parts and Service Division

Raymond Johnson

WHAT YOU SHOULD KNOW ABOUT TECHNICIAN SPECIALTY TRAINING

The Key — SPECIALTY...

STST changes the approach to training by specifically identifying and tailoring training according to your chosen specialty.

Ford Parts and Service Division will offer a series of courses tailored for your specialty. Courses will be scheduled at your District Service Training Center.

When you have completed this group of courses, you will be recognized as the specialist technician that you are!

The Path — A NEW CURRICULUM...

To support STST, a new curriculum is being prepared to provide you with more thorough, job-related training. Courses are designed with more depth, more hands-on training, more skills testing and more shop time — just like the EEC-IV and the Automatic Transmission classes now offered.

The Bottom Line — CUSTOMER SATISFACTION...

STST courses are designed to enable technicians to diagnose and repair customer's vehicles the first time with knowledge of the system and confidence in the repair.

This spells the best satisfied customers in the world!

BE A PART OF IT...SEE THE NEXT PAGE FOR THE STST CURRICULUM.

Course Requirements By Service Specialty

STST Curriculum	Service Specialties								
	Engine Performance 31	Engine Repair 32	Suspension & Steering 33	Electrical Systems 34	Climate Control 35	Manual Trans-mission and Drive Train 36	Automatic Transmis-sion and Drive Train 37	Brakes 38	Pre-Delivery 39
Electrical Systems (5 days)†	X[1]	O	O	X	X[1]	O	X	X[1]	O
Gas Engine Operations (4 days)†	X	X							
Electronic Engine Control (5 days)†	X								
Advanced Engine Performance (2 days)†	X								
Diesel Engine Operations (4 days)†	O[2]	X[2]							
Engine Repair (4 days)	O	X							
Suspension (2 days)†			X						
Steering (2 days)†			X						
Brake Systems (2 days)†								X	
Climate Control Systems (3 days)†					X				
Manual Transmission (2 days)						X			
Rear Axle & Driveshaft (1 day)						X			
NVH (1 day)†			X			X			
Automatic Transmission Rear-wheel Drive (5 days)†							X		
Automatic Transmission Front-wheel Drive (5 days)†							X		
Automatic Transmission Advanced Diagnostics (2 days)							X		
Pre-Delivery (1 day)†									X

O = Optional, but recommended
†Courses available for training in 1989
[1]Prerequisite course
[2]Ford Dealers

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SHO ENGINE CONTROLS

INTRODUCTION

This training reference book contains information about the 1989 Gasoline and Diesel Engines, Emission Controls and Related Systems for cars and light trucks manufactured by Ford Motor Company. This year the book contains both car and truck new model information. The new model information will be separated into two books. This book pertains to technicians with Engine Operations specialties, as well as those with Engine Controls specialties (3.0L SHO Engine only). The remaining Engine Controls information can be found in the Engine Controls technicians reference book, Order No. 0901-057. In this operations book, car engines will precede truck engines. The only exception is the 3.0L Super High Output (SHO) engine. This engine will be covered in its entirety following truck engines. This advanced service information is designed to help you service new model cars and trucks with confidence and maintain Ford customer satisfaction.

Read the entire book, paying particular attention to items that affect your repair area. Remember, however, that these training books only highlight key changes. For complete details on service procedures and diagnostic techniques, refer to Ford Shop Manuals, Technical Service Bulletins and related service publications.

The first section in the book will contain GENERAL INFORMATION that pertains to significant highlights. The remaining sections are divided by engine displacement. Refer to the applicable shop manual for further information and service procedures.

OBJECTIVES

After studying this technician's reference book, you should be able to:

- Describe each domestic and import engine for the 1989 model year.
- Summarize the engine and related system changes for 1989.
- Know which changes will affect your specific area of repair.
- Identify and explain new systems and components.
- Reference new EEC service codes that have been added to the 1989 model year.

GENERAL INFORMATION

ENGINE EMISSION APPLICATION CHART – CAR

Car Engine	Vehicle Application	Catalyst(s)		Fuel System Type	Electronic Eng Ctrl	EGR System	Secondary Air System	Ignition System	Idle Speed Control
		Type	Location						
1.3L	Festiva	TWC	UB	2V	EEC	EEGR	PA	UIC	TK
1.3L	Festiva	TWC	UB	EFI	EEC	None	None	UIC	BPA
1.6L	Tracer	TWC	UB	EFI	EEC	None	None	UIC	BPA
1.9L	Escort	TWC	Close Mount	CFI	EEC-IV	PFE	None	TFI-IV	DCM
1.9L	Escort GT	TWC COC	DBUB	EFI	EEC-IV	BVT	Dual PA	TFI-IV	BPA
2.2L	Probe	TWC	UB	EFI	EEC	BVT	None	UIC	BPA
2.2L Turbo	Probe GT	TWC	UB	EFI	EEC	EEGR	None	ESA	BPA
2.3L OHC	Mustang	TWC	TB UB	EFI	EEC-IV	EEGR	None	TFI-IV	BPA
2.3L OHC Turbo	XR4Ti	TWC	UB	EFI	EEC-IV	Ported	None	TFI-IV	BPA
2.3L HSC	Tempo/Topaz	TWC COC	DBUB	EFI	EEC-IV	PFE	PA	TFI-IV	BPA
2.3L HSO	Tempo/Topaz	TWC COC	DBUB	EFI	EEC-IV	PFE	PA	TFI-IV	BPA
2.5L HSC	Taurus	TWC COC	DBUB	CFI	EEC-IV	EEGR	PA	TFI-IV	DCM
2.9L	Scorpio	TWC	UB	EFI	EEC-IV	EEGR	CT (MT) None (AT)	TFI-IV	BPA
3.0L SHO	Taurus	(2) TWC TWC	TB UB	SEFI	EEC-IV	PFE	None	DIS	BPA
3.0L	Taurus/Sable	TWC	UE	EFI	EEC-IV	None Calif-PFE	None	TFI-IV	BPA
3.8L	Thunderbird/Cougar (RWD)	(2) TWC TWC	TB UB	SEFI	EEC-IV	PFE	None	TFI-IV	BPA
	Continental (FWD)	(2) TWC TWC	TB UB	SEFI	EEC-IV	PFE	None	TFI-IV	BPA
	Taurus/Sable (FWD)	(2) TWC TWC	TB UB	SEFI	EEC-IV	PFE	None	TFI-IV	BPA
3.8L S/C	Thunderbird/Cougar (RWD)	(2) TWC TWC	TB UB	SEFI	EEC-IV	PFE	None	DIS	BPA
5.0L	Ford/Mercury Town Car	(2) TWC (2) COC	TB UB	SEFI	EEC-IV	EEGR	MTA	TFI-IV	BPA
5.0L HO	Mustang/Mark VII	(2) TWC (2) COC	TB UB	SEFI	EEC-IV	EEGR	MTA	TFI-IV	BPA
5.8L	Ford Mercury (Canada) Ford Police	(2) TWC COC	DBUB	7200-VV FBC, Ford	MCU	IBP	MTA	UIC	TSP

ABBREVIATIONS:

AM (1), AM (2) = Air Management (1), (2)
BPA = Bypass Air
BVT = Back Pressure Variable Transducer
CFI = Central Fuel Injection
COC = Conventional Oxidation Catalyst
CT = Conventional Thermactor
DBUB = Dual Brick Underbody
DCM = D.C. Motor
DIS = Distributorless Ignition System
DP = Dual Plug
DS = Dura-Spark II
EEC = Electronic Engine Control
EEC-IV = Electronic Engine Control System-IV
EEGR = Electronic EGR Valve (Sonic)
EFI = Electronic Fuel Injection
EGR = Exhaust Gas Recirculation
ESA = Electronic Spark Advance
HO = High Output
HSC = High Swirl Combustion
IBP = Integral Back Pressure
MA = Mass Air
MCU = Microprocessor Control Unit
Mfg = Manufacturer
MTA = Managed Thermactor Air
OHC = Overhead Cam
PA = Pulse Air
PFE = Pressure Feedback Electronic EGR
PSIN = Pressure Sensitive Injector Nozzle
REDOX = Reduction-Oxidation
SEFI = Sequential EFI
TB = Toe Board
TFI = Thick Film Ignition
TK = Throttle Kicker
TSP = Throttle Solenoid Positioner
TWC = Three-Way Catalyst
UB = Underbody
UE = Under Engine
UIC = Universal Ignition Control
V = Venturi
VV = Variable Venturi

GENERAL INFORMATION

ENGINE APPLICATION CHART

1989 CARLINE ENGINE APPLICATION	1.3L 2V	1.3L EFI	1.6L EFI	1.9L CFI	1.9L EFI	2.2L EFI	2.2L EFI TURBO	2.3L OHC EFI	2.3L EFI TURBO	2.3L HSC	2.3L HSO	2.5L HSC CFI	2.9L EFI	3.0L EFI	3.0L SEFI SHO	3.8L SEFI FWD	3.8L SEFI RWD	3.8L SEFI S/C	5.0L SEFI	5.0L SEFI HO	5.8L 7200-VV
FESTIVA	X	X																			
TRACER			X																		
ESCORT				X	X																
PROBE						X	X														
XR4Ti									X												
TAURUS/SABLE												X_1		X	X_1	X					
SCORPIO													X								
TEMPO/TOPAZ										X	X										
MUSTANG								X												X	
THUNDERBIRD/ COUGAR																	X	X			
MARK VII																				X	
CROWN VICTORIA/ GRAND MARQUIS																			X		
POLICE AND CANADA (CROWN VICTORIA)																					X
CONTINENTAL																X					
TOWN CAR																			X		

X_1 = TAURUS ONLY

GENERAL INFORMATION

ENGINE EMISSION APPLICATION CHART – TRUCK

Truck Engine	Vehicle Application	Catalyst(s) Type	Catalyst(s) Location	Fuel System Type	Electronic Eng Ctrl	EGR System	Secondary Air System	Ignition System	Idle Speed Control
2.3L OHC	Ranger	TWC TWC	DBUB	EFI	EECIV	EEGR	None	DIS	BPA
2.9L	Ranger/Bronco II	TWC TWC	(2) SBUB	EFI	EEC-IV	None	None	TFI-IV	BPA
3.0L	Aerostar	TWC TWC	(2) SBUB	EFI	EEC-IV	None	None	TFI-IV	BPA
4.9L	E-Series/F-Series Bronco	TWC (2) COC	UB #1 UB #2	EFI	EEC-IV	EGR	MTA/ AM1, AM2	TFI-IV	BPA
5.0L	E-Series/F-Series Bronco	TWC (2) COC	UB #1 UB #2	EFI	EEC-IV	EGR	MTA/ AM1, AM2	TFI-IV	BPA
5.8L	E-Series/F-Series Bronco	TWC (2) COC	UB #1 UB #2	EFI	EEC-IV	EGR	MTA/ AM3, AM2	TFI-IV	BPA
Truck Over 8500 GVW									
4.9L	E-Series/F-Series	TWC COC	UB #1 UB #2	EFI	EEC-IV	EGR	MTA/ AM1, AM2	TFI-IV	BPA
5.8L	E-Series/F-Series	REDOX	UB	EFI	EEC-IV	EGR	MTA/ AM1, AM2	TFI-IV	BPA
7.3L	E-Series/F-Series	None	None	PSIN	None	None	None	None	None
7.5L	E-Series/F-Series	REDOX	UB	EFI	EEC-IV	EGR	MTA	TFI-IV	BPA

ABBREVIATIONS:

AM (1), AM (2) = Air Management (1), (2)
BPA = Bypass Air
BVT = Back Pressure Variable Transducer
CFI = Central Fuel Injection
COC = Conventional Oxidation Catalyst
CT = Conventional Thermactor
DBUB = Dual Brick Underbody
DCM = D.C. Motor
DIS = Distributorless Ignition System
DP = Dual Plug
DS = Dura-Spark II
EEC = Electronic Engine Control
EEC-IV = Electronic Engine Control System-IV
EEGR = Electronic EGR Valve (Sonic)
EFI = Electronic Fuel Injection
EGR = Exhaust Gas Recirculation
ESA = Electronic Spark Advance
HO = High Output
HSC = High Swirl Combustion
IBP = Integral Back Pressure
MA = Mass Air
MCU = Microprocessor Control Unit
Mfg = Manufacturer
MTA = Managed Thermactor Air
OHC = Overhead Cam
PA = Pulse Air
PFE = Pressure Feedback Electronic EGR
PSIN = Pressure Sensitive Injector Nozzle
REDOX = Reduction-Oxidation
SBUB = Single Brick Underbody
SEFI = Sequential EFI
TB = Toe Board
TFI = Thick Film Ignition
TK = Throttle Kicker
TSP = Throttle Solenoid Positioner
TWC = Three-Way Catalyst
UB = Underbody
UE = Under Engine
UIC = Universal Ignition Control
V = Venturi
VV = Variable Venturi

ENGINE APPLICATION CHART

1989 TRUCKLINE ENGINE APPLICATION	2.3L OHC EFI DP	2.9L EFI	3.0L EFI	4.9L EFI	5.0L EFI	5.8L EFI	7.3L DIESEL	7.5L EFI
RANGER	X							
RANGER/BRONCO II		X						
AEROSTAR			X					
E-SERIES/F-SERIES				X	X	X	X	X
BRONCO				X	X	X_1		

X_1 = UNDER 8500 GVW

GENERAL INFORMATION

DISTRIBUTORLESS IGNITION SYSTEM (DIS)

- This is a brief description of the DIS system. It is covered in greater detail in the New Model Engine Controls technicians reference book, Order No. 0901-057. This information is an overview of DIS components and basic operation.
- All but three Ford and Lincoln-Mercury gasoline engines are equipped with the conventional TFI-IV (Thick Film Ignition) module or universal design distributor. Three engines are equipped with the new distributorless ignition system (DIS). They are the 2.3L Dual Plug (DP) Ranger, 3.0L Super High Output (SHO), and the 3.8L Supercharged (S/C) engines. As the name implies, it is distributorless, with no rotor or distributor cap. The new system includes two familiar sensors: the Profile Ignition Pickup (PIP) sensor and the Cylinder Identification sensor (CID).

Profile Ignition Pickup Sensor (PIP)

- The DIS PIP sensor is operationally the same as the TFI-IV PIP. The DIS PIP sensor is different in appearance and location. It is driven by the crankshaft and sets base timing for the DIS module and the ECA.

Cylinder Identification Sensor (CID)

- The CID sensor supplies cylinder #1 identification to the DIS Module for correct firing order on start up for the 2.3L EFI engine.

On the 3.0L SHO and the 3.8L S/C SEFI engines, the CID sensor supplies the ECA with cylinder #1 identification. On the 3.0L SHO and 3.8L S/C it is driven by the camshaft, while the 2.3L DP is crankshaft driven.

DIS Operation

- PIP and CID sensors are Hall Effect devices receiving information from specially designed rotary vane cups or cutters. The electrical signals are produced from vanes passing by the sensors. The Hall Effect sensor switches between detecting a vane or a window from a rotating cup. This alternating action produces a signal which is then interpreted by both the DIS Module and the ECA (refer to Figures 1 and 2).
- The DIS Module then controls coil firing from ECA commands similar to the way the TFI-IV module does. The ECA controls dwell (spark advance and retard) depending on the operating conditions and demands placed on the engine.
- The DIS system features other major design improvements. The coils and the spark towers are one solid state unit which takes the place of the distributor cap, rotor, and single coil.
- There is one coil for every two cylinders. Each coil fires two spark plugs at the same time. The plugs are paired so that as one plug fires during the compression stroke, the other fires during the exhaust stroke and vice-versa. The spark in the exhaust stroke is wasted, but very little of the coil energy is lost.

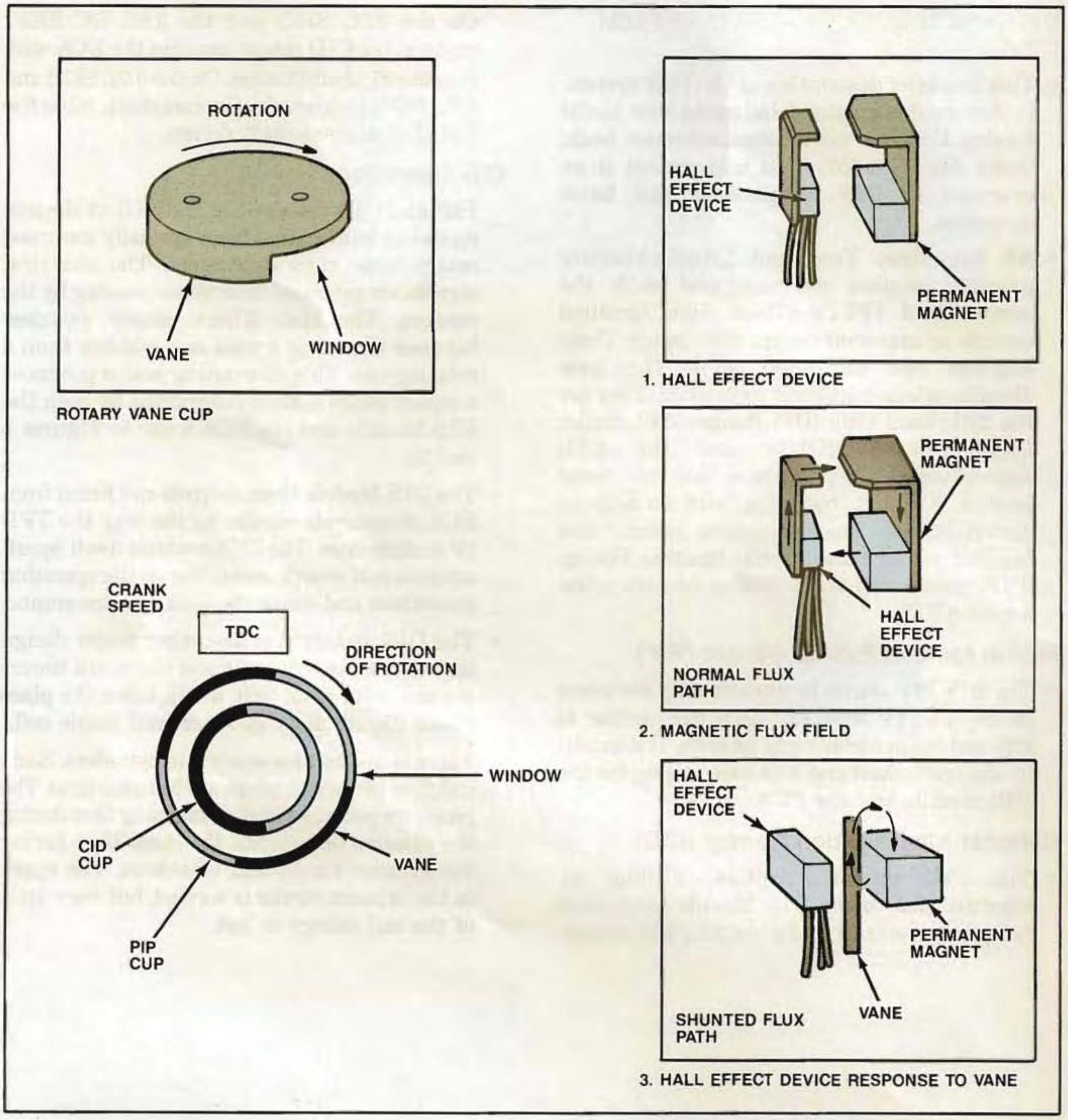


Figure 1. 2.3L Dual Plug Hall Effect Device and Cups

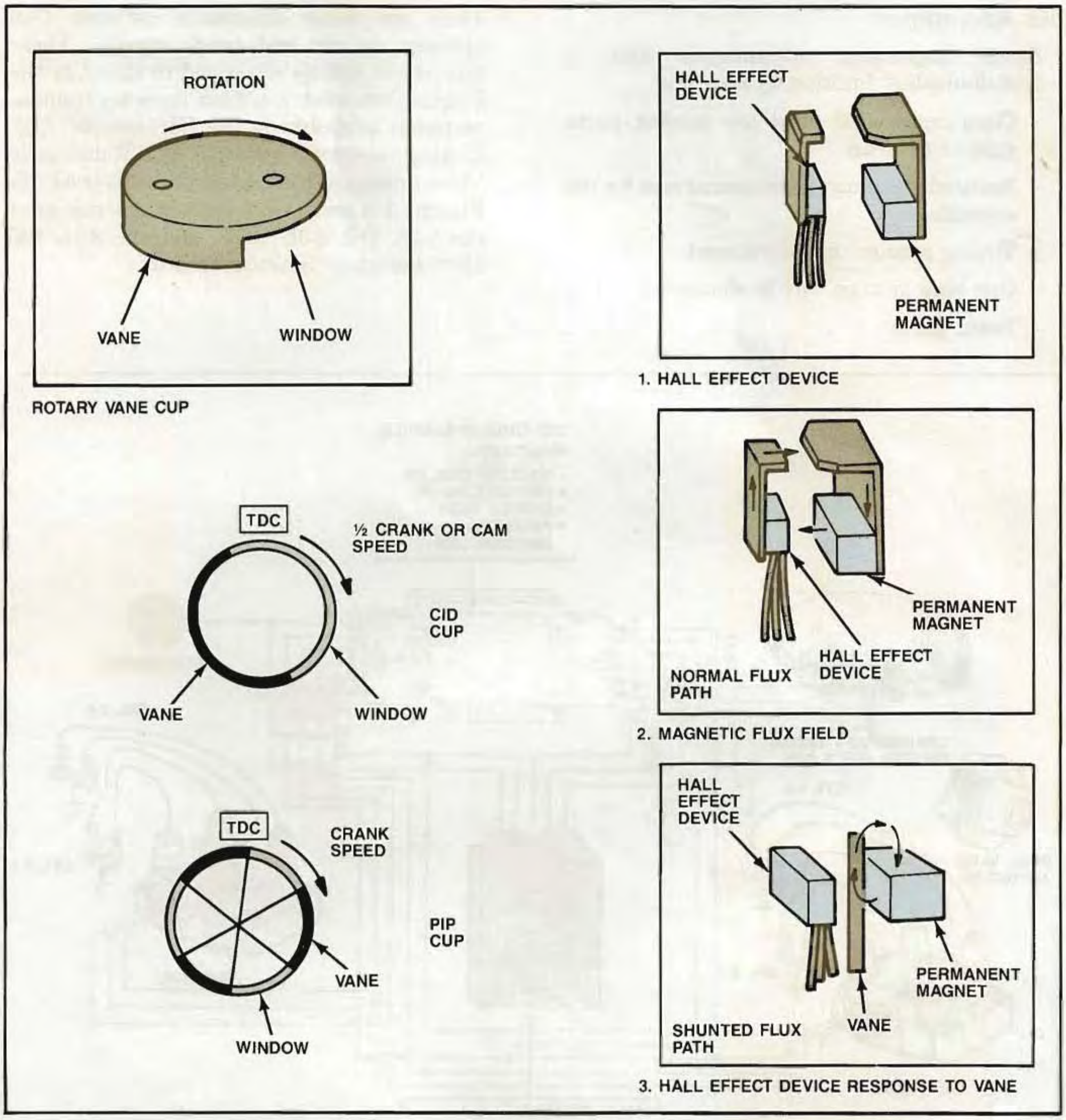


Figure 2. 3.0L SHO and 3.8L S/C Hall Effect Device and Cups

DIS Advantages

- Some important advantages with a Distributorless Ignition System are:
  - Completely solid state (no moving parts subject to wear)
  - Reduced repair and maintenance cost for the consumer
  - Timing requires no adjustment
  - One high voltage wire is eliminated
  - Fewer parts
- There are some differences between DIS systems on car and truck engines. These differences will be discussed in detail in the Engine Controls book. Also, there are training materials available on the DIS system, DIS Components and Operation and Technician's Video Reference Guide, Order No. 2105-003-PCB. Figures 3, 4 and 5 show system schematics of the 2.3L DP, 3.0L SHO, and the 3.8L S/C Distributorless Ignition System.

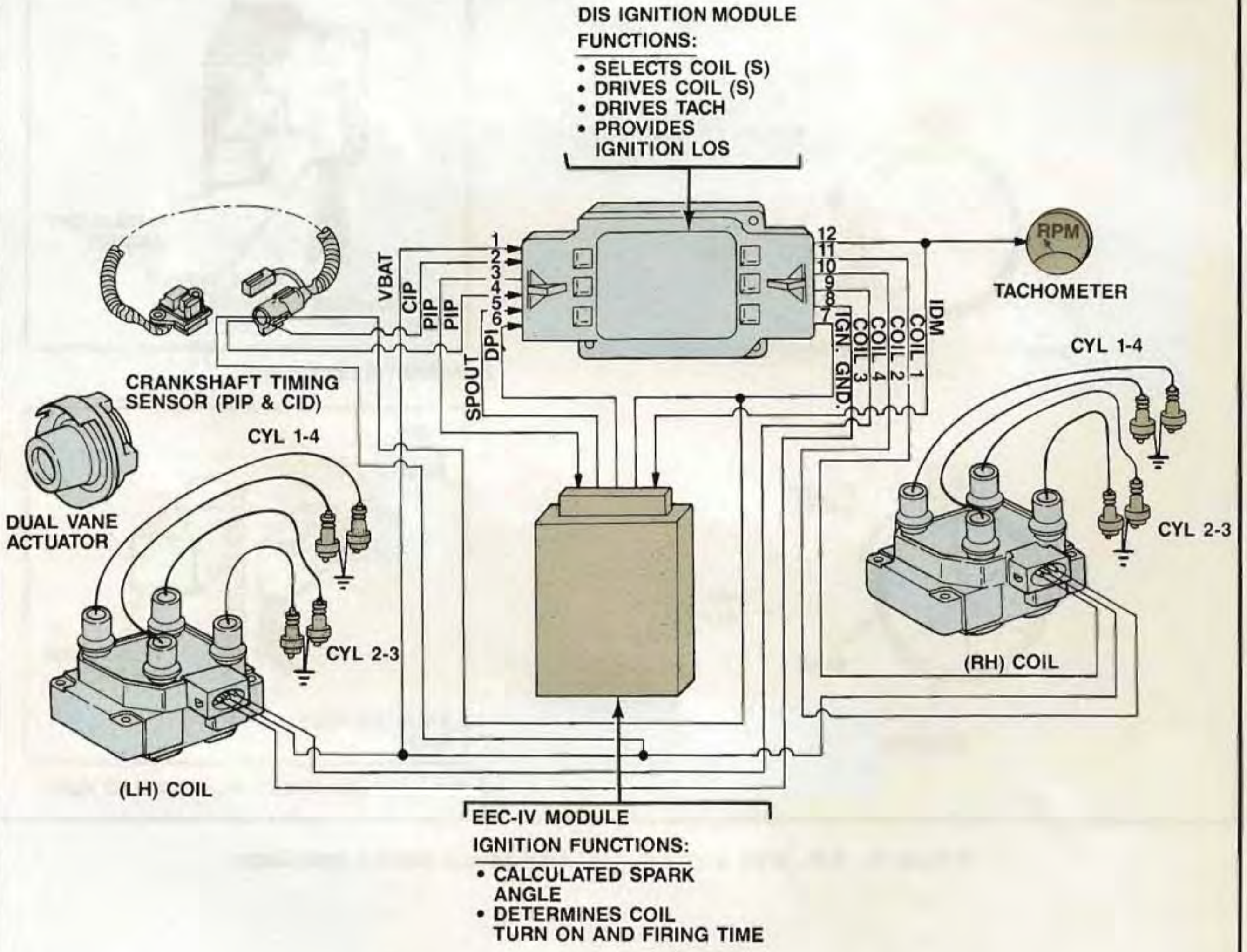


Figure 3. 2.3L Dual Plug Distributorless Ignition System (DIS)

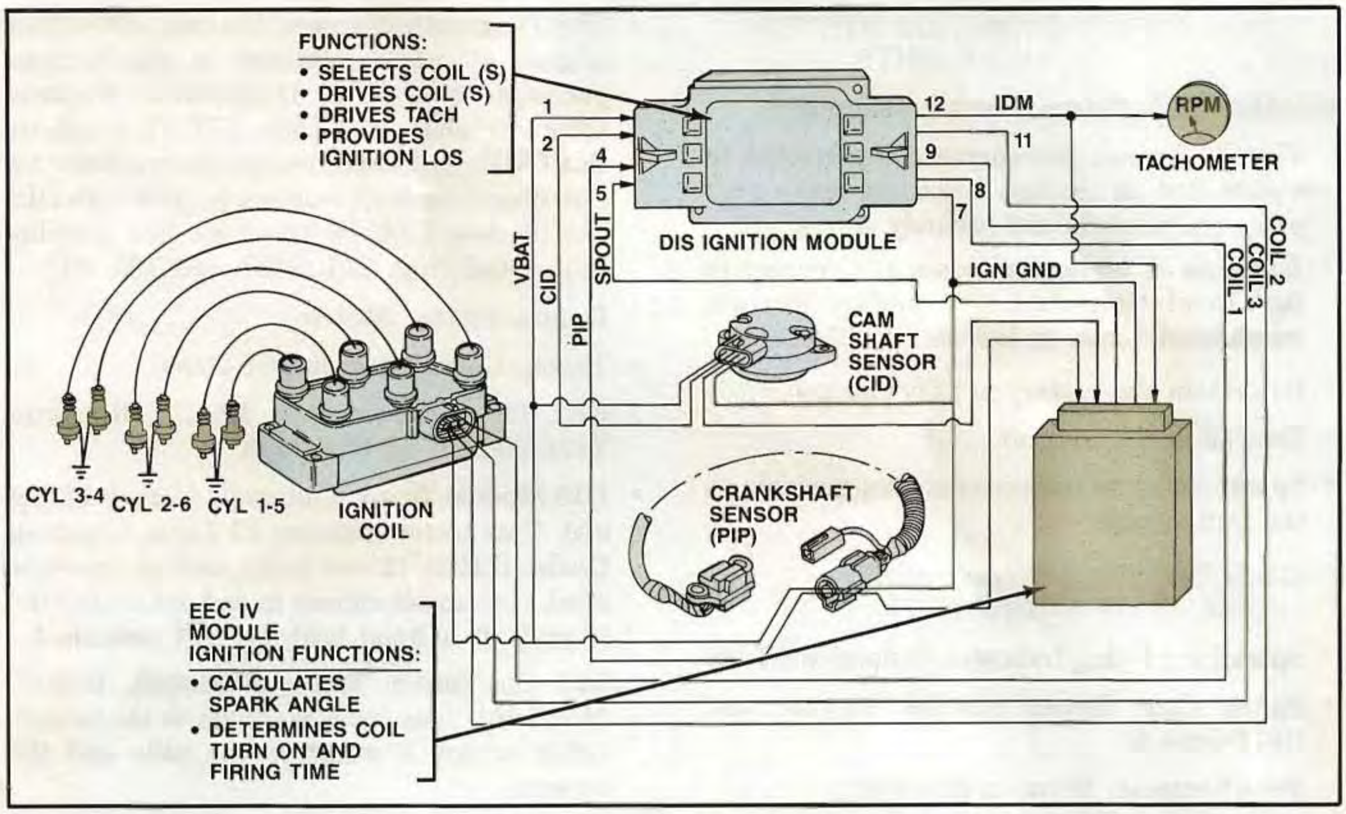


Figure 4. 3.0L SHO Distributorless Ignition System (DIS)

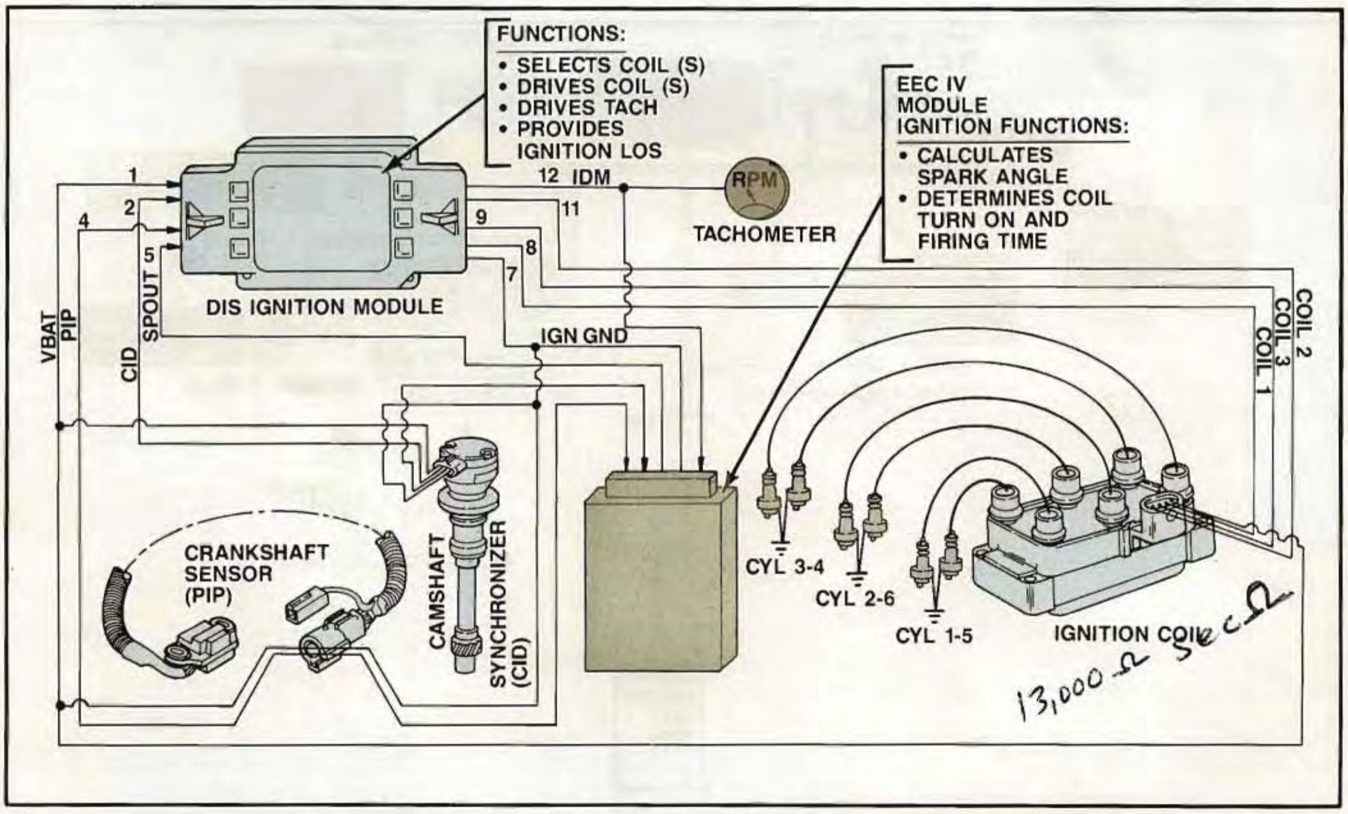


Figure 5. 3.8L Supercharged Distributorless Ignition (DIS)

DISTRIBUTORLESS IGNITION SYSTEM (DIS) DIAGNOSTIC HIGHLIGHTS

REMEMBER, Before Starting Diagnosis:

- Visually inspect the engine compartment to ensure that all vacuum hoses and spark plug wires are properly and securely connected.
- Examine all wiring harnesses and connectors for insulation damage, and/or burned, overheated, loose, or broken conditions.
- Be certain the battery is fully charged.
- Turn all accessories off.
- Spark timing adjustments are not possible on the DIS system.

OBTAIN THE FOLLOWING TEST EQUIPMENT OR EQUIVALENT

- Spark Plug Firing Indicator, Champion CT-436
- Spark Gap Tester, special service tool D81P-6666-A
- Volt-ohmmeter, Rotunda 014-00407
- 12 Volt Test Lamp
- DIS Diagnostic Harness, Rotunda 007-00044 (Figure 6). Also contained in this harness package is a DIS Diagnostic Harness schematic along with three EEC-IV Breakout Box Overlays. These Overlays are necessary for DIS diagnosis. Each engine equipped with DIS has its own EEC-IV Breakout Box Overlay (2.3L Dual Plug, 3.0L SHO, and 3.8L S/C).
- Remote Starter Switch
- Timing Light, Rotunda 059-00006
- EEC-IV Breakout Box, Rotunda T83L-50-EEC-IV (Figure 6).
- DIS Module Tester (Optional), Hickok Model 600. This tester contains 12 Light Emitting Diodes (LED), 12 test jacks, and an interface label. It monitors signals in and out of the DIS Module. It is hand held and self contained.
- DIS Coil/Sensor Tester (Optional), Hickok Model 601. This tester is similar to the module tester except it monitors the coils and the sensors.

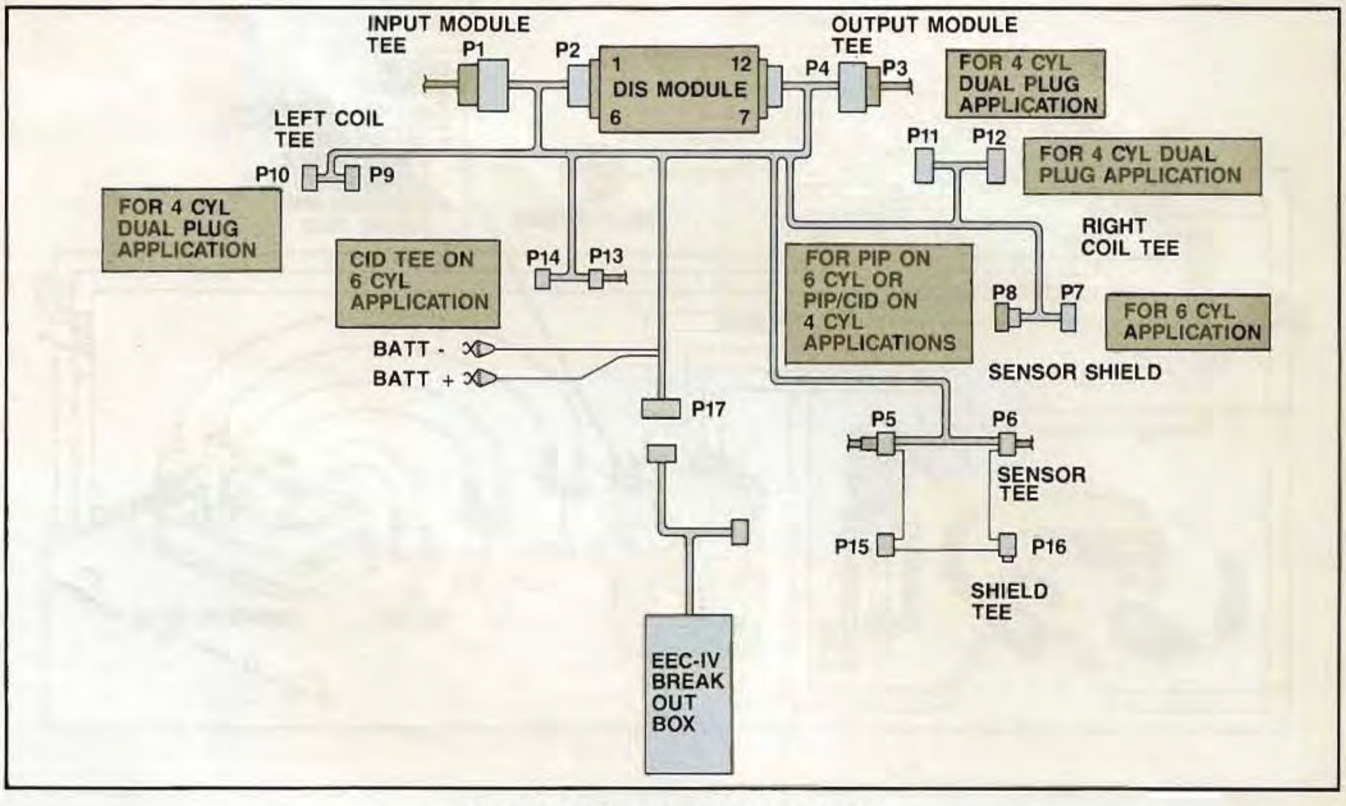


Figure 6. DIS Diagnostic Harness

CYLINDER BALANCE TEST

- The Cylinder Balance Test has been improved and can only be performed on SEFI equipped engines. The purpose of this test is to assist the technician in finding a weak or noncontributing cylinder. The test is entered by depressing and releasing the throttle within two minutes after the engine running Self-Test Code(s) have been output.
- Once the test is entered, the engine is allowed to stabilize (constant idle). Next, injector number 8 (or 6, depending on the engine being tested) is shut off and tested. Injector 8 (or 6) is turned on again and the process is repeated for each injector down to injector 1.
- The RPM drops for each cylinder are then checked to see if they all fall within a certain percentage. If all the cylinders fall within specifications, then a "Code 90" is output indicating that all cylinders pass the test. If a specific cylinder does not fall within specifications, codes will be issued for that cylinder.
- The test can be repeated a second time if the throttle is depressed and released within two minutes of the last code output. Again, RPM drops for each cylinder are checked against each other; this time by a smaller percentage of RPM drop than the first test run. The purpose of the smaller percentage check on the second test is to determine how weak the problem cylinder is. For example, if the injector is shut off and there is little or no RPM drop by the engine then the cylinder is weak or noncontributing. The problem cylinder from the first test may pass the second test indicating that it is weaker than the rest of the cylinders. If the problem cylinder fails the second test it can be checked one more time by again a lesser RPM percentage.
- For the third test you must depress and release the throttle within two minutes of the last Code Output. If the cylinder that failed test one and test two passes test three, then it is considered very weak. If the cylinder fails all three tests it is considered to be a noncontributing cylinder.
- This improved cylinder balance test also allows for normal aging characteristics of engine components to ensure an accurate test on new and older SEFI engines.
- Codes associated with the Cylinder Balance test for SEFI engines are as follows:

Code	Fault	Description
10 KOER	Detects a problem in cylinder No. 1.	Cylinder 1 is weak or a noncontributing cylinder.
20 KOER	Detects a problem in cylinder No. 2.	Cylinder 2 is weak or a noncontributing cylinder.
30 KOER	Detects a problem in cylinder No. 3.	Cylinder 3 is weak or a noncontributing cylinder.
40 KOER	Detects a problem in cylinder No. 4.	Cylinder 4 is weak or a noncontributing cylinder.
50 KOER	Detects a problem in cylinder No. 5.	Cylinder 5 is weak or a noncontributing cylinder.
60 KOER	Detects a problem in cylinder No. 6.	Cylinder 6 is weak or a noncontributing cylinder.
70 KOER	Detects a problem in cylinder No. 7.	Cylinder 7 is weak or a noncontributing cylinder.

Code	Fault	Description
80 KOER	Detects a problem in cylinder No. 8.	Cylinder 8 is weak or a noncontributing cylinder.
77 KOER	Operator error.	A step was performed wrong in the cylinder balance test. When the cylinder balance is being performed the throttle must stay constant. This also pertains to the dynamic response test.
90 KOER	No fault.	All cylinders pass the test.

Note: KOER = Key On Engine Running

IDLE SPEED CONTROL IN 1989

In 1989, all Air Bypass Valves have an integral diode that replaces a diode formerly located in the engine harness. It is important that only new Air Bypass Valves with the integral diode be used on "89" vehicles which have the diode deleted from the harness. The new Bypass Valves can be identified by the new Part No. E9** -9F715- **. These new Bypass Valves can be used on earlier model engines which contain the diode in the harness without problems. However, if the engine does not have the diode in either the harness or the Bypass Valve, it is very possible that the vehicle will experience driveability problems.

NOTE: The above information does not pertain to Festiva, Tracer, Probe, XR4Ti or Scorpio vehicles.

MALFUNCTION INDICATOR LIGHT (MIL) OR "CHECK ENGINE" LIGHT

- MIL is mandatory on all Ford California vehicles and optional for the 49 states and Canada for 1989.
- The MIL is intended to alert the driver of certain malfunctions in the engine control system.
- If such a fault occurs, the EEC-IV processor will substitute a value(s) for the failing circuit and continue operating. This process is called Failure Mode Effects Management (FMEM). In some cases this action may result in a slight change in driveability.
- How the "MIL or Check Engine" Light operates:

System OK

The light will remain on with the key on and the engine off. Once the vehicle is started, the MIL/Check Engine Light will go out.

System Not OK

If the MIL/Check Engine Light should remain on after the vehicle is started, run Quick Test and service any codes. If the self-test has a pass code, and the Check Engine Light is always on, go to Quick Test Step 7.0, Diagnosis By Symptom (Volume H).

If the vehicle is a no start, run Quick Test to Step 3.0. If Key On Engine Off Self-Test has pass codes, go to Pinpoint Test Step "A1" (Volume H).

If the Check Engine Light never comes on, go to Quick Test Step 7.0, Diagnostic By Symptom (Volume H).

- When in Self-Test, the MIL/Check Engine Light will also flash the service codes.

NOTE: For vehicles such as Festiva, Tracer, Probe, and Scorpio, the Electronic Engine Controls are referred to as EEC and not EEC-IV. Volume H contains no information on these four vehicles. All information on these vehicles is in their designated Shop Manuals.

CAR ENGINES

3.0L SHO ENGINE

INTRODUCTION

The 1989 SHO engine (Fig. 55) is a high performance V6. Its initial vehicle application will be in the Taurus SHO and will be available only with a manual transaxle. The engine has aluminum cylinder heads, a DOHC (Dual Overhead Camshaft) design along with 4 valves per cylinder and shim type valve adjusters. The block is a new cast iron 60 degree V type design.

Left and right bank intake camshafts are driven by a timing belt at the front of the engine. The intake camshafts drive the exhaust camshafts on the rear of the engine through timing chains.

The SHO engine utilizes Ford's new Distributorless Ignition System (DIS), with triple pack coils. The three-driver DIS ignition module is mounted on the front of the engine on the intake manifold surge tank connector. The platinum spark plugs are centrally mounted in the hemispheric combustion chambers and are the 14mm type with a 0.42 - 0.46 inch gap and a 60,000 mile life.

The air intake system is a unique design and is one of the most prominent features of the engine with two surge tank chambers, one for each bank of cylinders. From the intake manifold surge tank there are two runners going to each cylinder, a primary runner and a secondary runner. The primary runner conducts air to the cylinder whenever the engine is running. The secondary runner is opened by a vacuum operated intake air control valve when engine speeds are in excess of approximately 4000 rpm. This improves low- and mid- range torque and fuel efficiency.

The SHO engine is unique in many ways and contains features which set it apart from other engines that have been utilized by Ford Motor Company. Let us look into these special features and point out all important details related to service and maintenance.

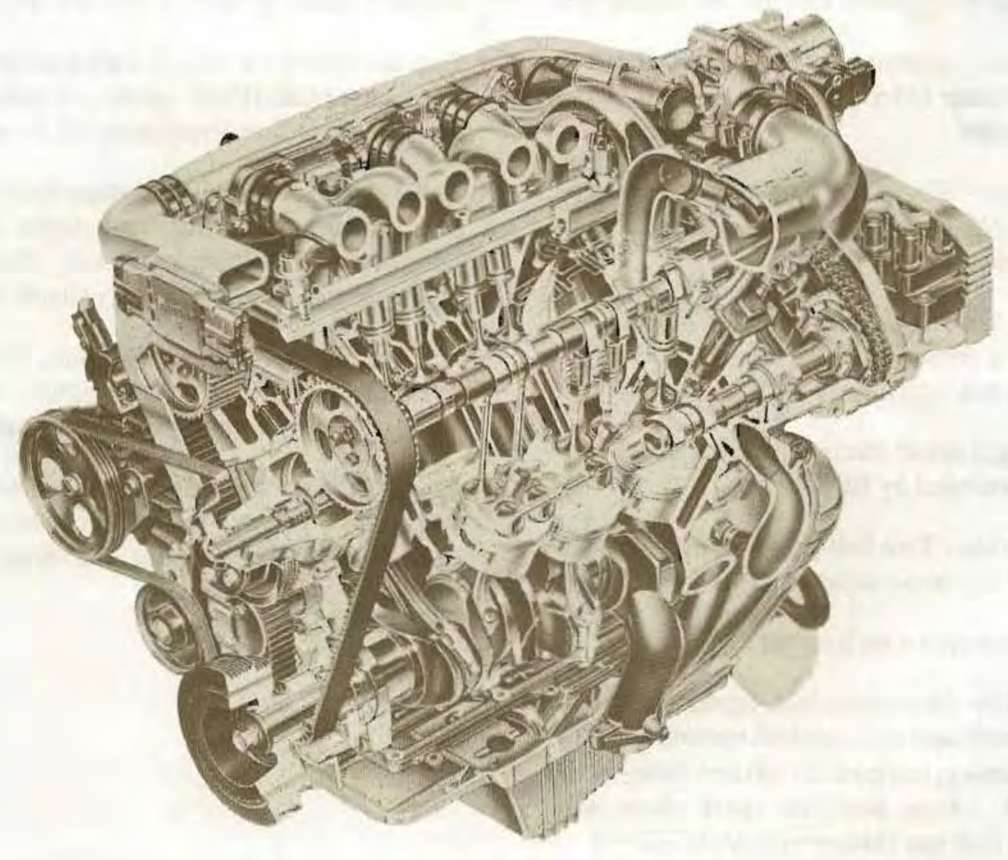


Figure 55. 1989 SHO Engine

SPECIFICATIONS

Type	6-Cylinder 60° V-Block Design	Fuel Injection (electro-mechanical)	EFI (Six port-mounted injectors)
Displacement	3.0L (182 CID)	Main Bearings	4
Horsepower @ rpm	220 @ 6000 rpm (SAE Net)	Fuel	Premium Unleaded
Torque (ft./lbs.) @ rpm	200 @ 4800 rpm (SAE Net)	Exhaust	Dual Catalyst
Compression Ratio	9.8:1	Firing Order	1-4-2-5-3-6
Bore & Stroke	89mm x 80mm (3.5 inch x 3.1 inch)	Oil Fill	4.2L (4.5 quarts) without filter 4.7L (5.0 quarts) with filter
Valve Train	DOHC, 4 Valves per cylinder		
Engine Control	EEC-IV	Engine Weight	(220 kg) 485 lbs.

NOTE: All engine fasteners are metric.

SPECIAL FEATURES

- Engine Block - New design cast iron 60 degree V-6
- Cylinder Head - Aluminum head with DOHC, 4 valves per cylinder (24 valves total) and two intake ports per cylinder
- Fuel Induction - Six intake port-mounted electro-mechanical fuel injectors supplied by an in-tank high pressure pump
- Lubrication - Trochoidal gear oil pump mounted on crankshaft, oil cooler mounted on block, die cast aluminum oil pan with low oil level sensor
- Cooling - single speed electro-drive fan (14.2 inch diameter) (controlled by EEC-IV)
- Accessory Drive - Two belt poly-vee drive system ''jackscrew'' automatic adjustments
- Starter - High output 4-inch starter
- Ignition - New Distributorless Ignition System (DIS) with crankshaft and camshaft sensors to determine spark timing, triple pack coils and three-driver DIS module, 14mm platinum spark plugs with 0.042-0.046 inch gap (Motorcraft AGSP32P+)
- Engine Control System - Ford EEC-IV
- Exhaust Emissions - Dual catalyst system, Pressure Feedback EGR (PFE) system (California only), Positive Crankcase Ventilation (PCV) system
- Valve Train - Belt and chain drive DOHC, 4 valves per cylinder with shim type valve adjustment, ''Bucket'' type mechanical lifters, 35mm diameter intake valves, 30mm diameter exhaust valves
- Crankshaft - 60 degree offset pins, 80mm stroke, five fully machined counterweights. Thrust bearings are 4 pieces, placed on main journal No. 3
- Air Induction - Unique primary and secondary intake runner design, vacuum operated Intake Air Control (IAC) valve opens and closes secondary runner

ENGINE OPERATION

The following section covers the general engine operation along with information concerning components, special service techniques and special tools.

AIR INTAKE SYSTEM

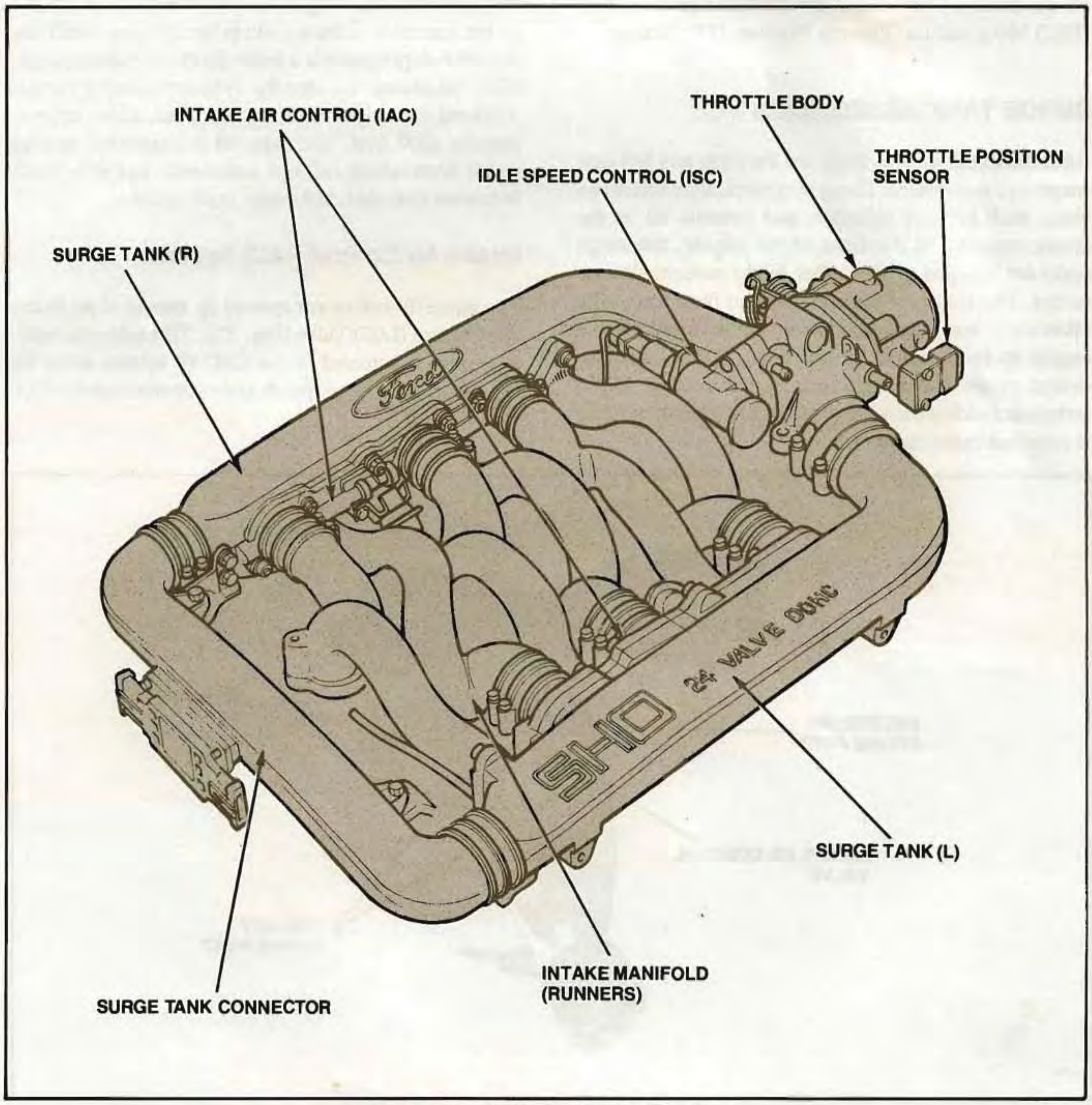


Figure 56. Air Intake Control System

AIR INTAKE SYSTEM

DESCRIPTION

The air intake system (Fig. 56) is the most noticeable and visually impressive engine system that is immediately visible upon opening the hood. The primary feature of the air intake system is the dual surge tank/dual runner design. The surge tanks are fed air by a single throttle body that faces toward the left side of the vehicle. Two EEC-IV controlled components are mounted on the throttle body. These are the Idle Speed Control (ISC) Valve and the Throttle Position (TP) Sensor.

SURGE TANK ASSEMBLIES

Attached to the throttle body are the right and left side surge tank assemblies. These surge tank assemblies run along each bank of cylinders and conduct air to the intake runners. At the front of the engine, the surge tanks are attached to each other by the surge tank connector. The length of the plenums and their large size allows the maximum volume of air required by the engine to be available at any time. In addition, the design of the surge tank reduces the amount of air turbulence so that a smooth flow and even amount of air is admitted to the runners.

Intake Runners

Each cylinder has two intake ports, one for each valve. The surge tank assemblies attach to the intake ports by means of individual runners. These runners have two designations, primary and secondary. The primary runner is long and comes from the surge tank on the opposite side of the engine. The primary runner has no obstructions or throttling mechanisms. The secondary runner is short and originates from the surge tank that is on the same side of the engine as the cylinder. Built into the secondary runner is a butterfly throttle that opens to allow additional air into the cylinders during periods when maximum performance is desired, above approximately 4000 rpm. The extra air is channeled through an air horn which reduces turbulence and effectively improves low- and mid-range performance.

Intake Air Control (IAC) System

The butterfly valves are opened by means of an Intake Air Control (IAC) Valve (Fig. 57). This solenoid-operated valve is actuated by the EEC-IV system when the engine accelerates to speeds above approximately 4000 rpm (Fig. 58).

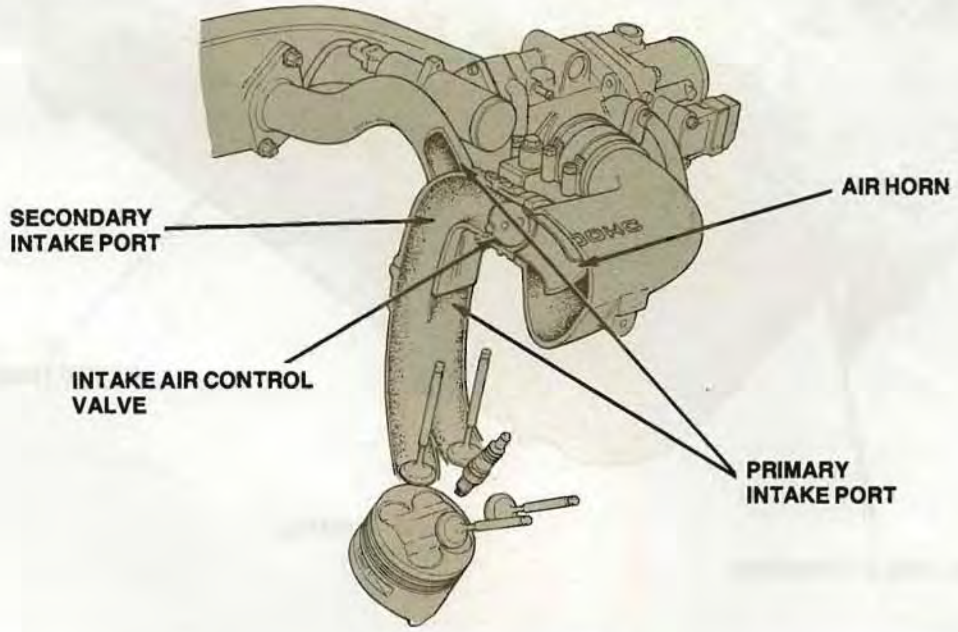


Figure 57. Intake Air Control (IAC) Valve

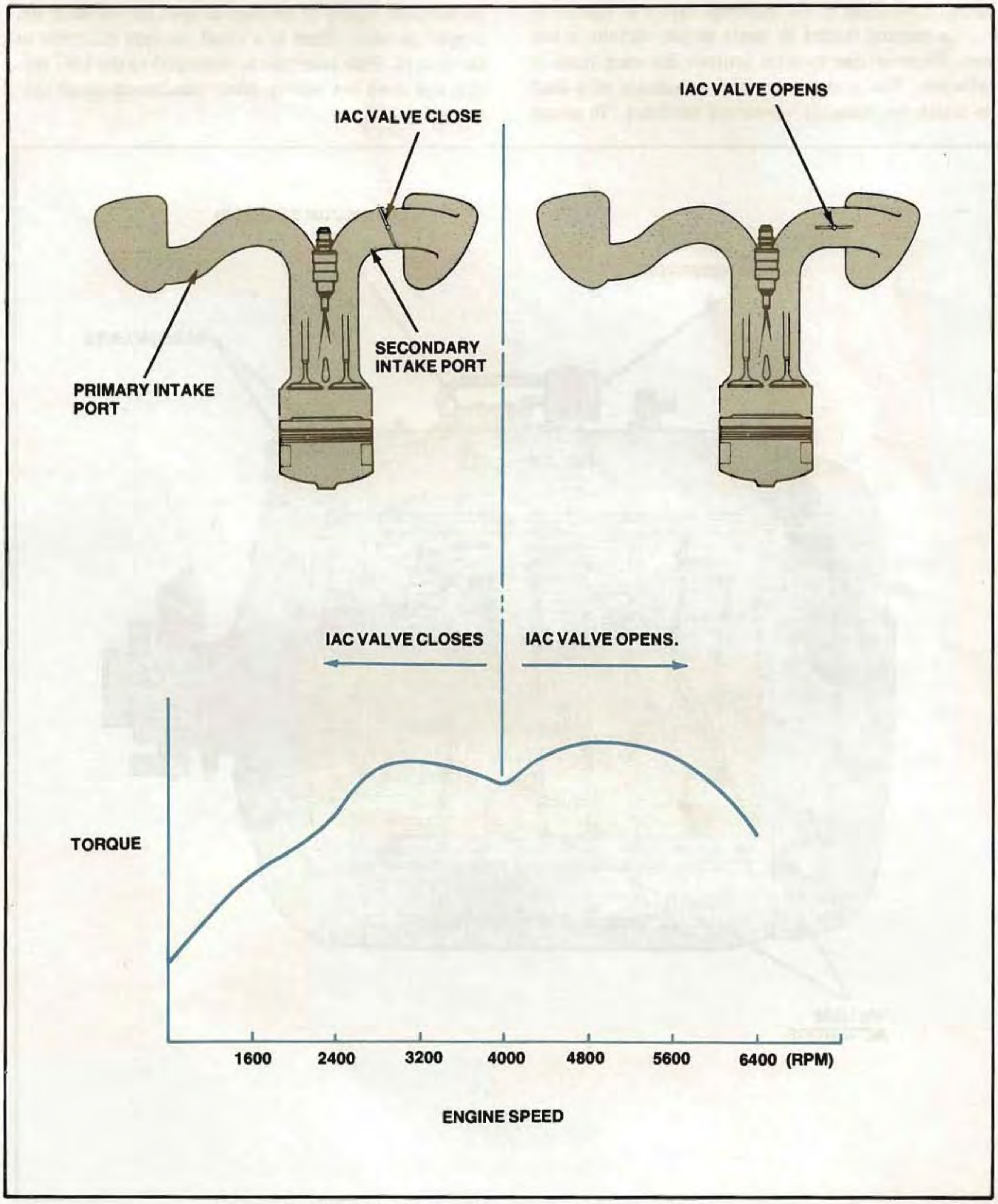


Figure 58. IAC Valve Opening and Closing Points

Actual movement of the butterfly valves is caused by engine vacuum routed by hoses to two vacuum actuators. There is one vacuum actuator for each bank of cylinders. The acutators control movement of a shaft on which the butterfly valves are mounted. To assure an adequate supply of vacuum to open the valves at the proper moment, there is a small vacuum reservoir in the system. This reservoir is dedicated to the IAC system and does not supply other vacuum-operated systems (Fig. 59).

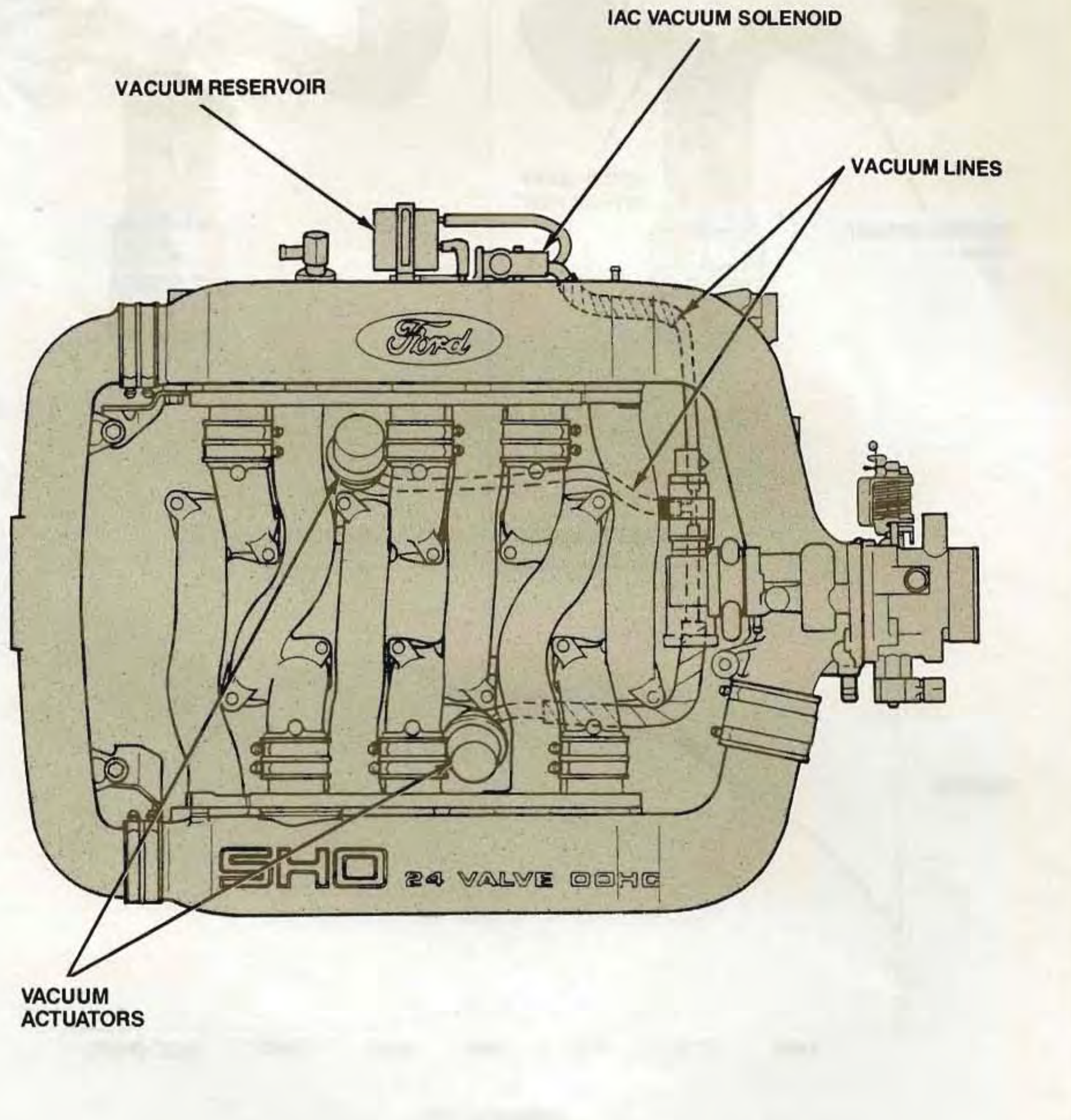


Figure 59. IAC Vacuum Motors and Reservoir

AIR INTAKE SYSTEM

The following exploded view shows all of the components included on the engine's air intake system (Fig. 60). During service on this system that involves disassembly and assembly, make sure that all seals and gaskets are replaced and that fastener tightening is done with a torque wrench.

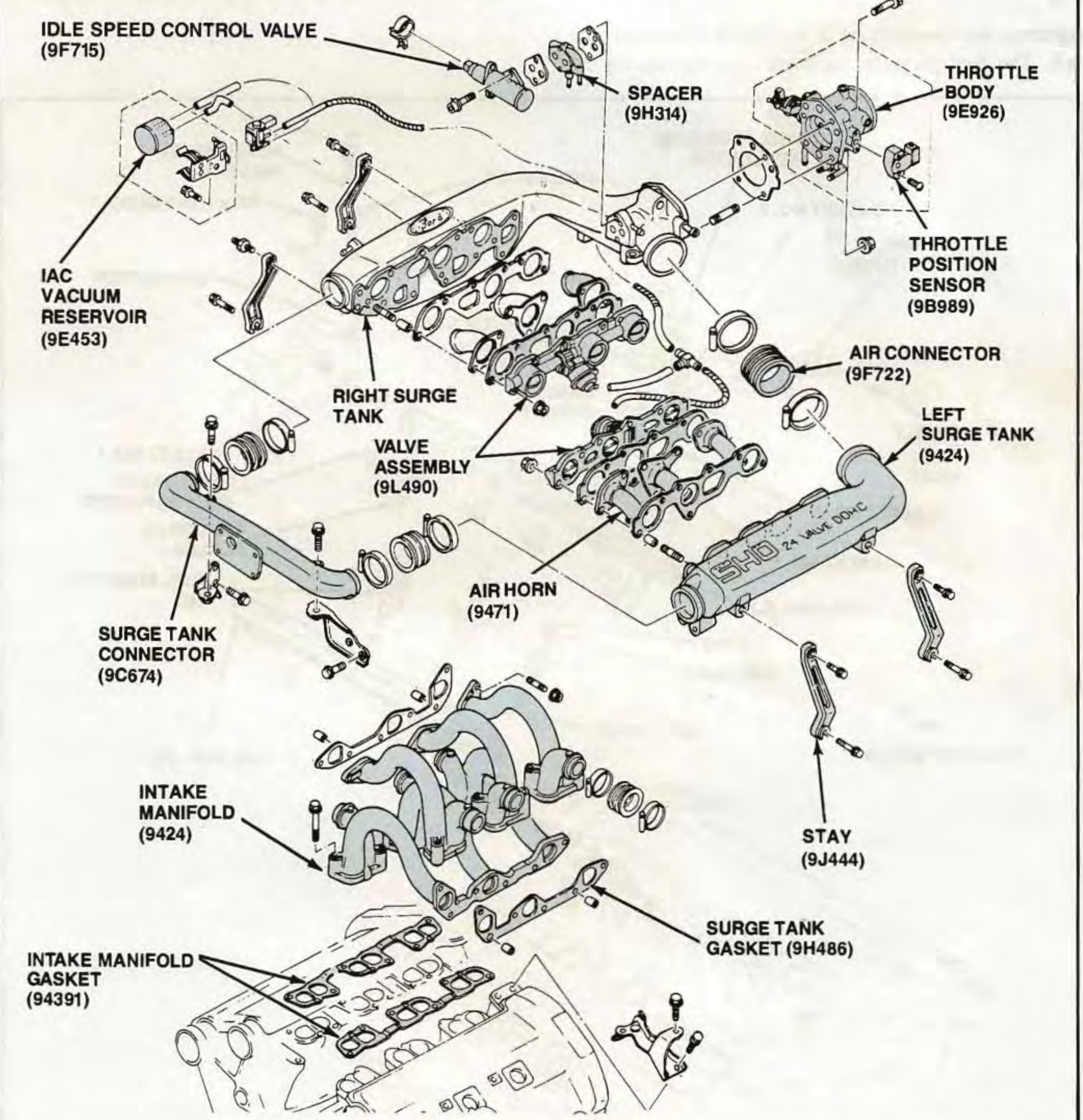


Figure 60. Air Intake System

DESCRIPTION

The SHO engine is equipped with multi-port Sequential Electronic Fuel Injection (SEFI) (Fig. 61). Fuel is injected through six electro-mechanical fuel injectors that are flow matched to provide uniform fuel delivery. Injector pulse width is controlled by the ECA based on input sensor information.

Injectors are mounted on a machined aluminum fuel rail. The fuel pressure regulator also mounts on the fuel rail. In addition to the fuel pressure regulator there is a fuel pressure damper. The purpose of the damper is to reduce pressure pulsations in the fuel line caused by the pumping action of the electric fuel pump. By damping the pressure pulsations, a uniform pressure is available to the fuel injectors. Fuel pressure should be between 230-270 kPa (33-39 psi) with the engine off and the ignition switch in the ON position.

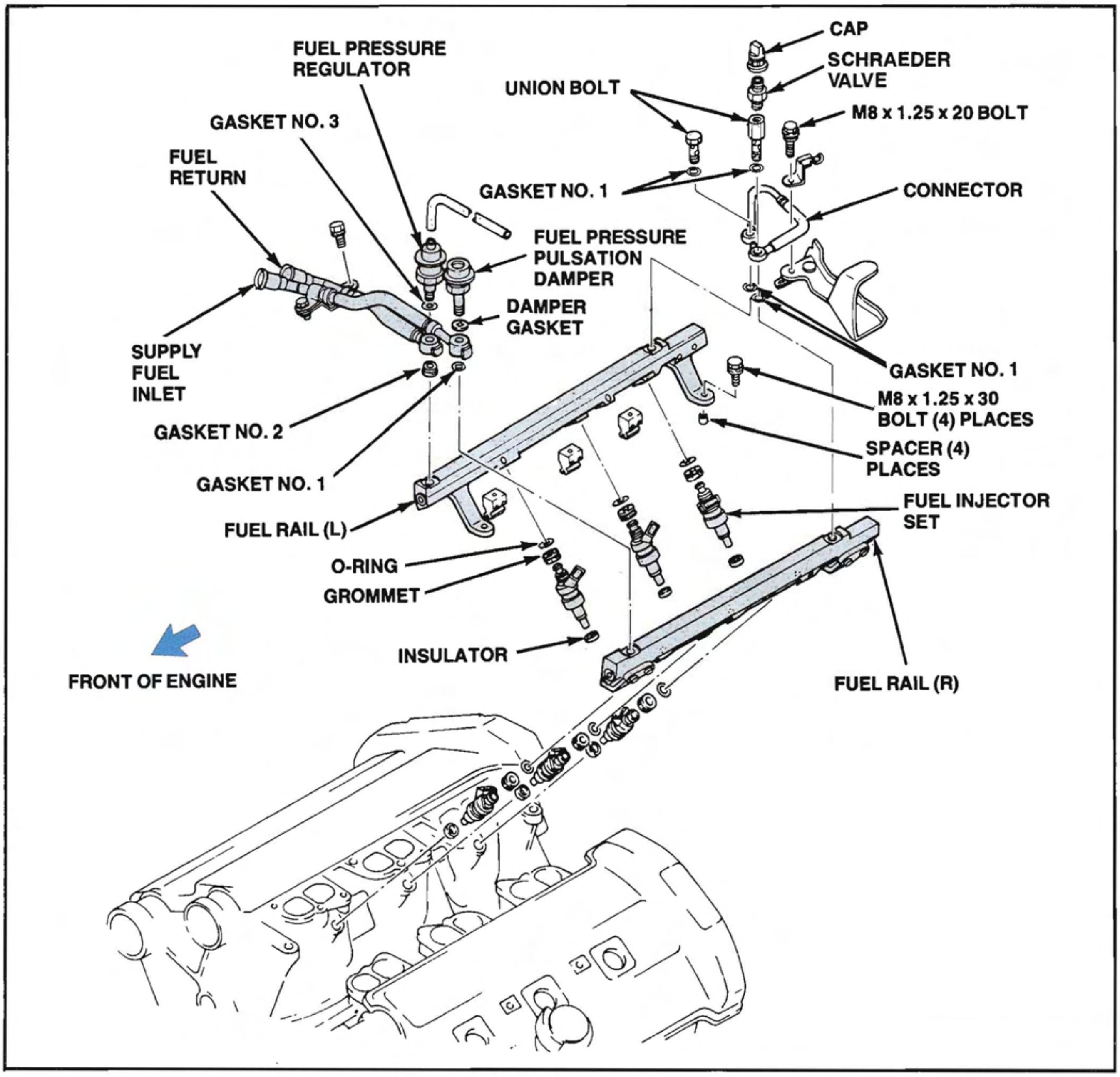


Figure 61. Engine Fuel System

VEHICLE FUEL SYSTEM

The vehicle fuel system is typical of other Taurus models. The fuel pump is electric and is mounted in the fuel tank. Also, an inertia switch is used. The inertia switch is mounted in the trunk on the inner rear wheel housing on the left side.

ENGINE FUEL SYSTEM SERVICE HIGHLIGHTS

CAUTION: Always use new gaskets when assembling fuel system components to avoid fuel leakage.

The primary service highlight on the fuel system involves the assembly procedure used on the fuel rails and the installation of the fuel injectors. During installation and assembly, the positioning of the injector seals and gaskets is very important to prevent leaks and ensure engine performance. The gaskets and seals are shown in Figure 61. Note that some gaskets are identified as Gaskets 1, 2 or 3. These gaskets must be properly installed, in the correct position. They are different sizes and are made of different materials.

Assembly Procedures

Left Side Fuel Rail Subassembly

Install the fuel pressure regulator with fuel line gasket No. 3, fuel return line, and fuel line gasket No. 2 to the left side fuel rail subassembly (Fig. 62). Tighten the fuel pressure regulator to 25-34 N·m (18-25 lb-ft).

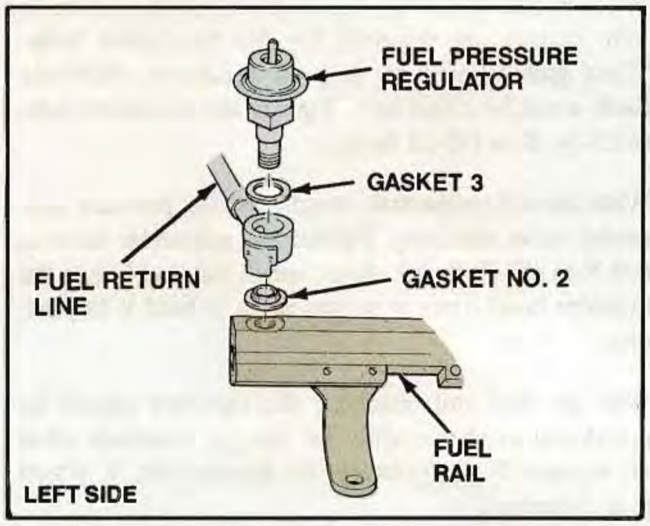


Figure 62. Left Side Fuel Rail Subassembly

Right Side Fuel Rail Subassembly

Install the fuel pressure damper assembly with the fuel pressure damper gasket, fuel line feed, and fuel pipe gasket No. 1 to the right side fuel rail subassembly (Fig. 63). Tighten the fuel pressure damper to 25-34 N·m (18-25 lb-ft).

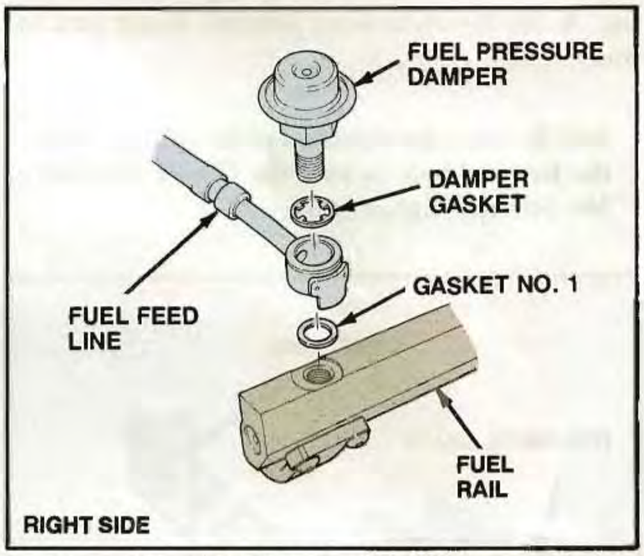


Figure 63. Right Side Fuel Rail Subassembly

To assist in identifying the fuel system gaskets, refer to the following chart (Fig. 64).

GASKET IDENTIFICATION

Description	O.D.	I.D.	Thickness	Remarks
Fuel Line Gasket 1	0.63 in (16 mm)	0.47 in (12 mm)	0.04 in (1.0 mm)	Copper
Fuel Line Gasket 2	0.75 in (19 mm)	0.49 in (12.4 mm)	0.13 in (3.2 mm)	I.D. is rubber-coated.
Fuel Line Gasket 3	0.87 in (22 mm)	0.57 in (14.5 mm)	0.04 in (1.0 mm)	Copper

Figure 64. Gasket Identification

Injector Installation

Prior to installing a fuel injector (Fig. 65) into the fuel rail check the O-rings for deterioration and replace them if necessary. Also check the inlet end of the fuel injector for burrs, cracks or foreign materials. Apply a thin coat of light grade oil (Ford Specification ESE-M2C39 or equivalent) to the O-ring to prevent binding. As the injector is being installed, turn it back and forth slightly.

NOTE: Align the direction of the injector with the fuel rail hole so that the O-ring does not bite into the edge or tear.

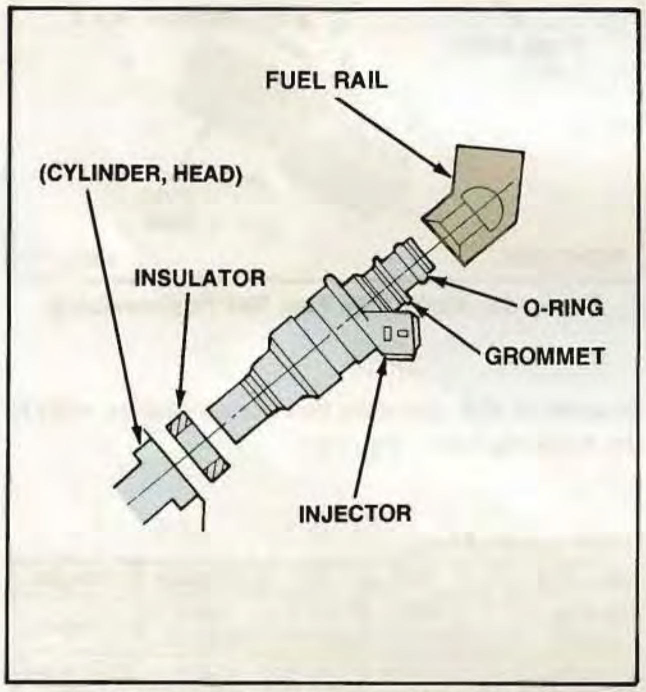


Figure 65. Fuel Injector Installation

Installation of the fuel rails to the cylinder head should begin with left rail. During installation, install the three insulators for the injector into the holes of each cylinder head. Place two spacers for the fuel rail on each cylinder head prior to installation.

Installation of the intake air connector stay requires three bolts (Fig. 66). One for the right side and two for the left side. Tighten these bolts to 16-23 N·m (12-17 lb-ft).

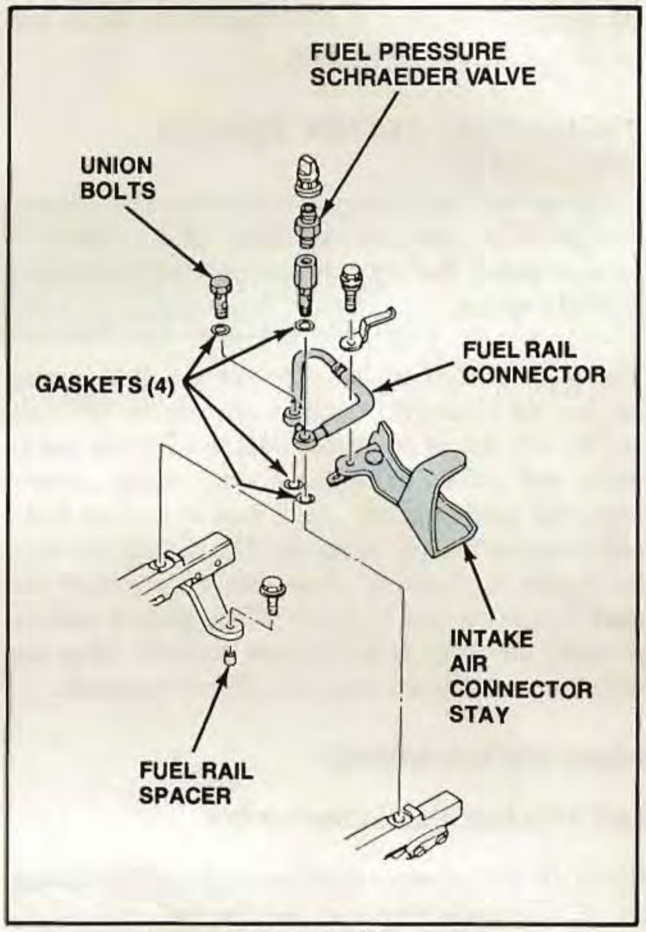


Figure 66. Fuel Rail Connector

When attaching the fuel rail connector to the fuel rails, four gaskets are required for the two union bolts. These gaskets must be in good condition, otherwise there could be a fuel leak. Tighten the two union bolts to 25-34 N·m (18-25 lb-ft).

With the rail connected, install the fuel pressure schraeder valve assembly. Tighten the schraeder valve to 6-9 N·m (52-78 lb-in). Also, attach the fuel line to the cylinder head cover with two bolts to hold it in position.

With the fuel rail attached, the injectors should be positioned as shown with the injector terminals all at 40 degrees (Fig. 67) except for injector No. 4, which is at 0 degrees.

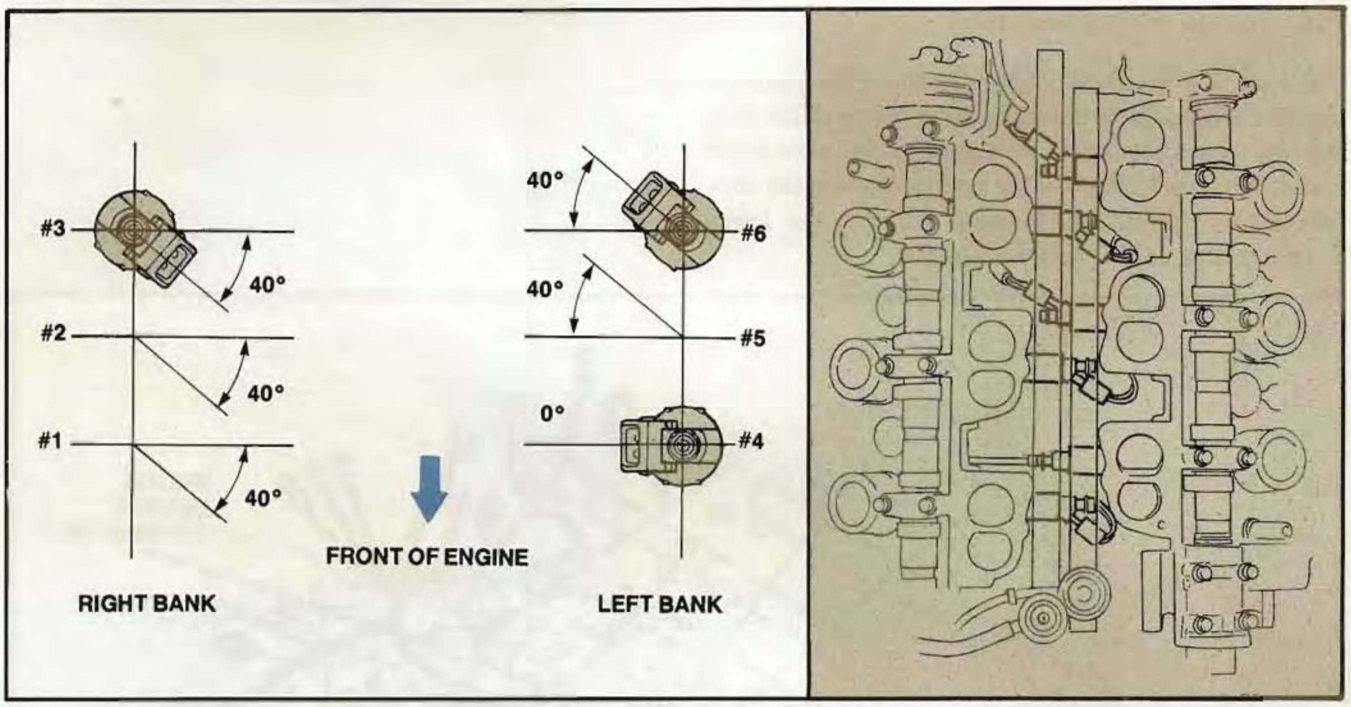


Figure 67. Fuel Injector Positioning

NOTE: Connect injector connectors with care to match injector numbers with the wire harness identification numbers.

After installation of the fuel pipe subassembly, the bolts holding it to the right cylinder head cover should be tightened to 6.3-9.4 N·m (4.6-6.9 lb-ft).

NOTE: If the right hand cylinder head cover is not installed at this time, rotate the fuel pipe subassembly counterclockwise so that it does not interfere with installation of the head cover.

Installation of the fuel rail dampers (Fig. 68) begins by first coating them with soapy water to allow them to slide into position. They should be installed between the right and left fuel rail subassembly pointing at the white painted marking on the right fuel rail subassembly.

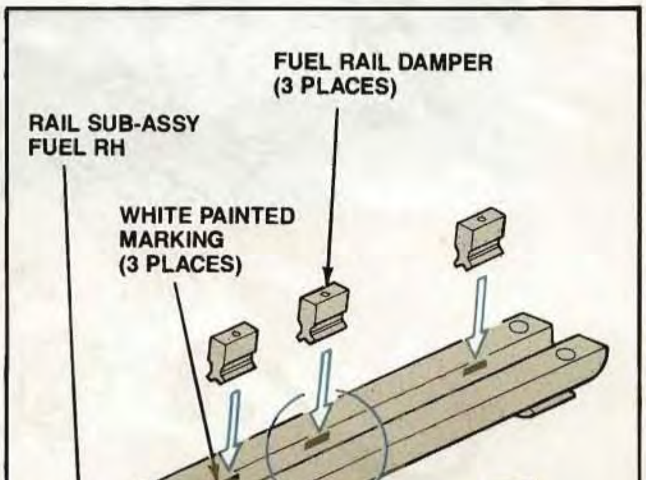


Figure 68. Installing Fuel Rail Dampers

Fuel Charge Wiring Assembly

The following illustration (Fig. 69) shows the primary engine harness. Note the installation points of the fuel injector connectors. Also note the eye-type connector end of the wire harness. This screws into the top surface of the cylinder block between cylinders No. 1 and 2, functioning as the electrical ground.

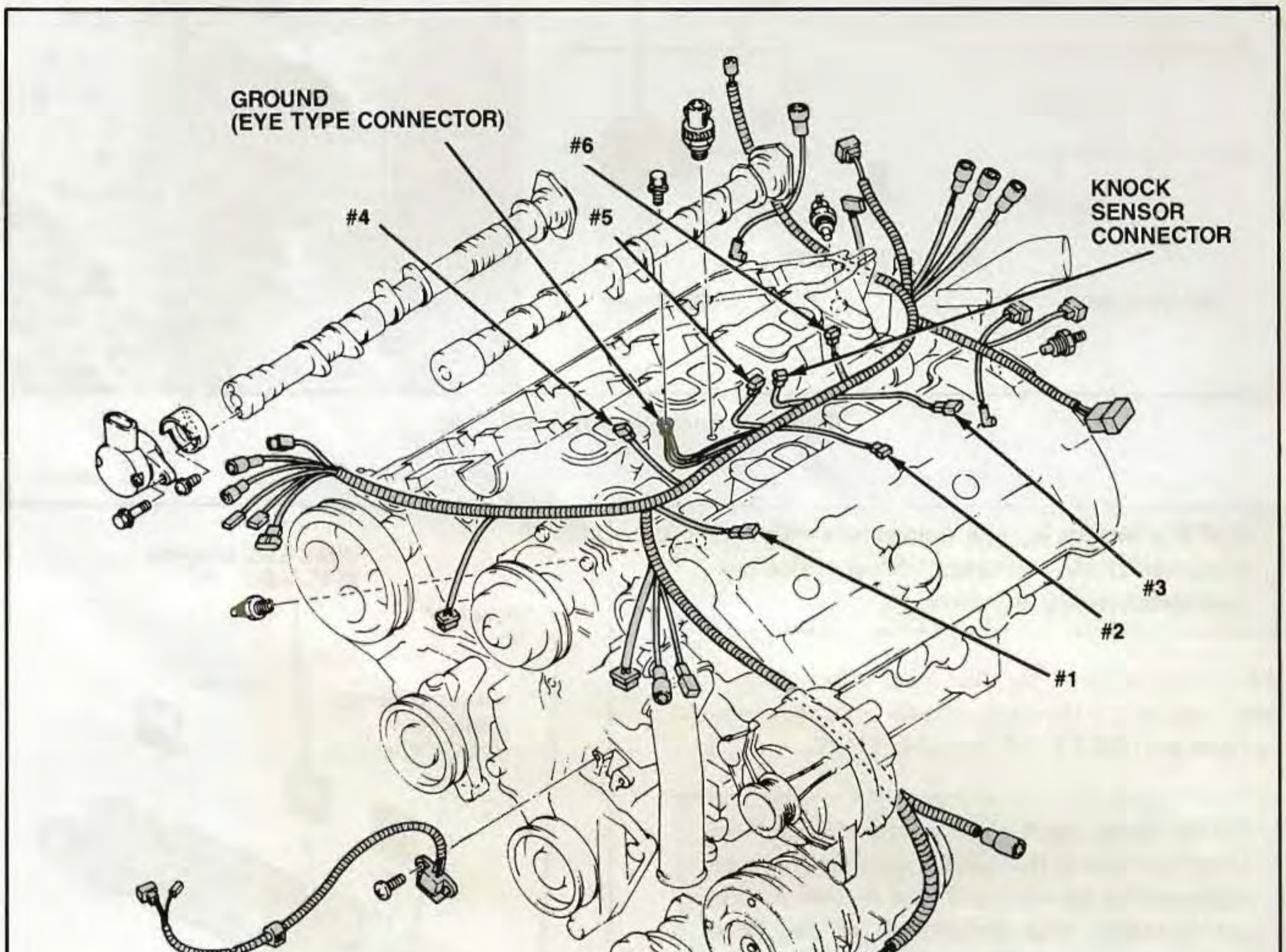


Figure 69. Fuel Injector Wiring

LUBRICATION SYSTEM

The lubrication system of the SHO engine is designed to provide optimum oil flow through the entire operating range (Fig. 70). The heart of the system is a positive displacement trochoidal gear driven oil pump that is mounted on the front of the engine and is driven by the crankshaft. The oil pump contains an integral pressure relief valve that relieves pressure at 4+0.4 kg/cm2 (56.88 ± 5.68 psi). The oil pump is capable of operating at an extremely high capacity from idle through the maximum rpm limit. Note the following chart (Fig. 71). It shows the oil pump capacity and pressure at high and low rpm's.

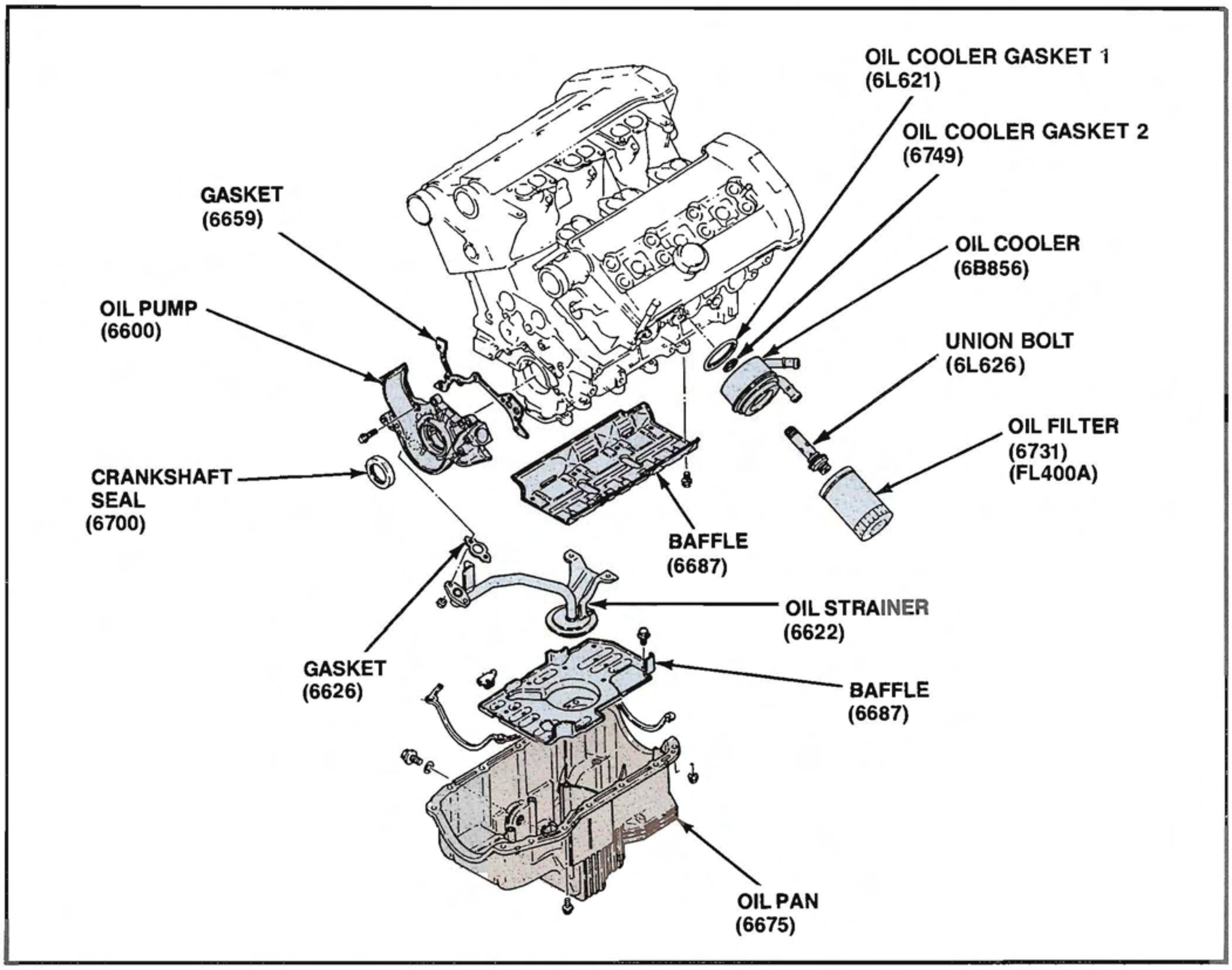


Figure 70. Lubrication System

	Engine rpm	600	6,400	4,000
Capacity	l/min (gpm)	min. 3 (.8)	min. 46 (12.15)	
Pressure	kg/cm² (psi)	1.5 (21.33)	3 (42.66)	
Pressure Relief Valve Opening Pressure	kg/cm² (psi)			4±0.4 (56.88 ± 5.68)

Figure 71. Oil Pump Capacity Chart

OIL FLOW

Oil flow through the engine is as follows (Fig. 72):

1. Oil is drawn into the oil pump through the strainer in the sump.
2. Oil is pumped to the filter assembly on the side of the block.
3. Oil leaves the filter and enters an oil cooler.
4. Oil enters the main oil gallery where it is distributed to the crankshaft main journals.
5. From the main journals, oil is routed through passages in the crankshaft to the rod bearings. From the rod bearings oil is routed through a passage in the connecting rod to the piston pin and then to the cylinder walls.
6. Crankshaft main journals Nos. 2 and 3 are cross-drilled to feed the connecting rods. Journal No. 2 feeds connecting rods Nos. 2 and 4. Journal No. 3 feeds connecting rods Nos. 3 and 5. The main gallery has two supply oil passages drilled through the block and cylinder head. The passage from journal No. 2 feeds oil to the left cylinder head. The passage from journal No. 3 feeds oil to the right cylinder head.
7. In the cylinder head, oil is provided to the cam timing chain tensioner, camshaft journals and to the cam lobes, lifters and valve stems.

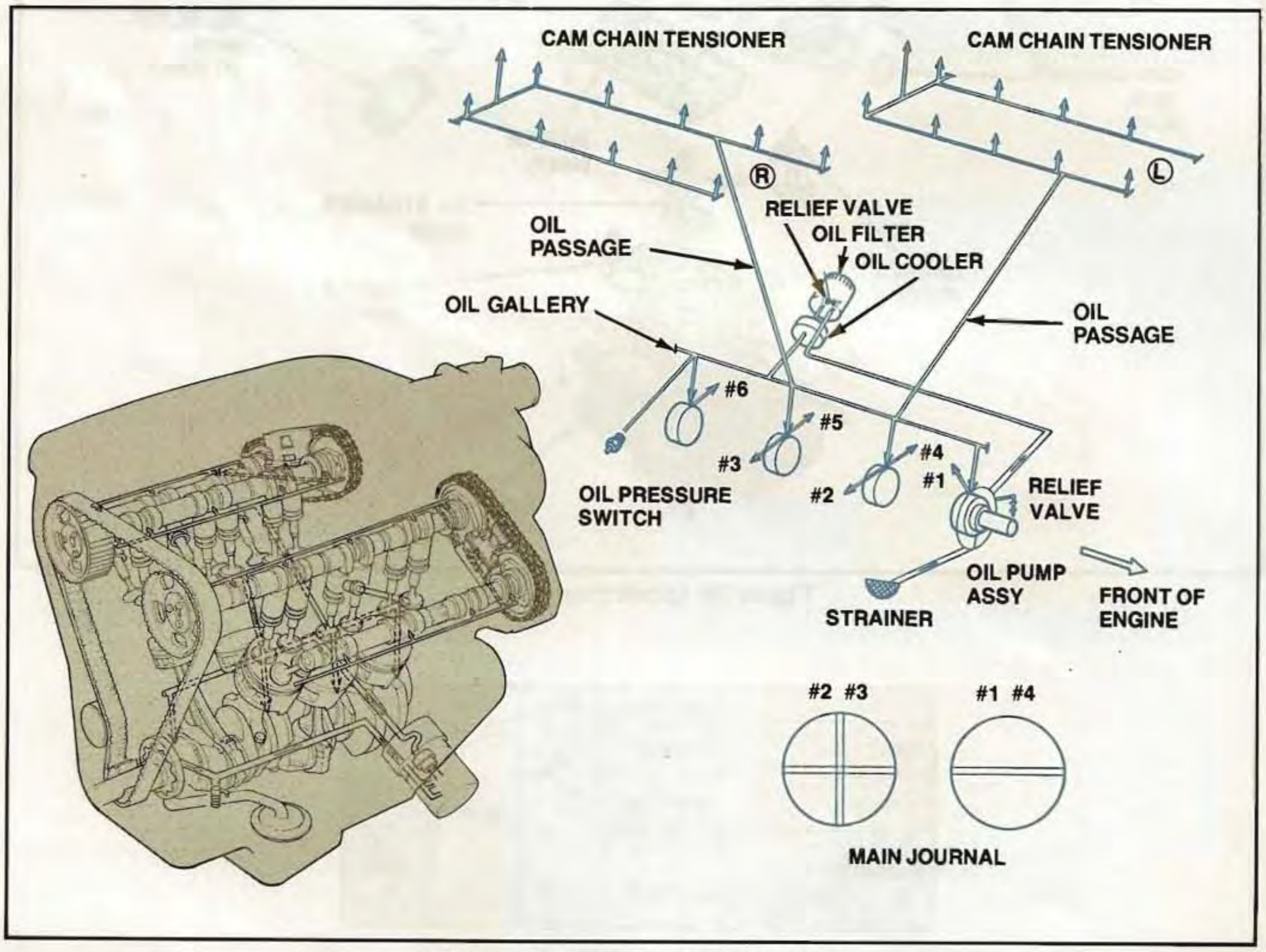


Figure 72. Lubrication System Flow

LUBRICATION SYSTEM

A schematic of the oil flow path can be seen in the block diagram (Fig. 73).

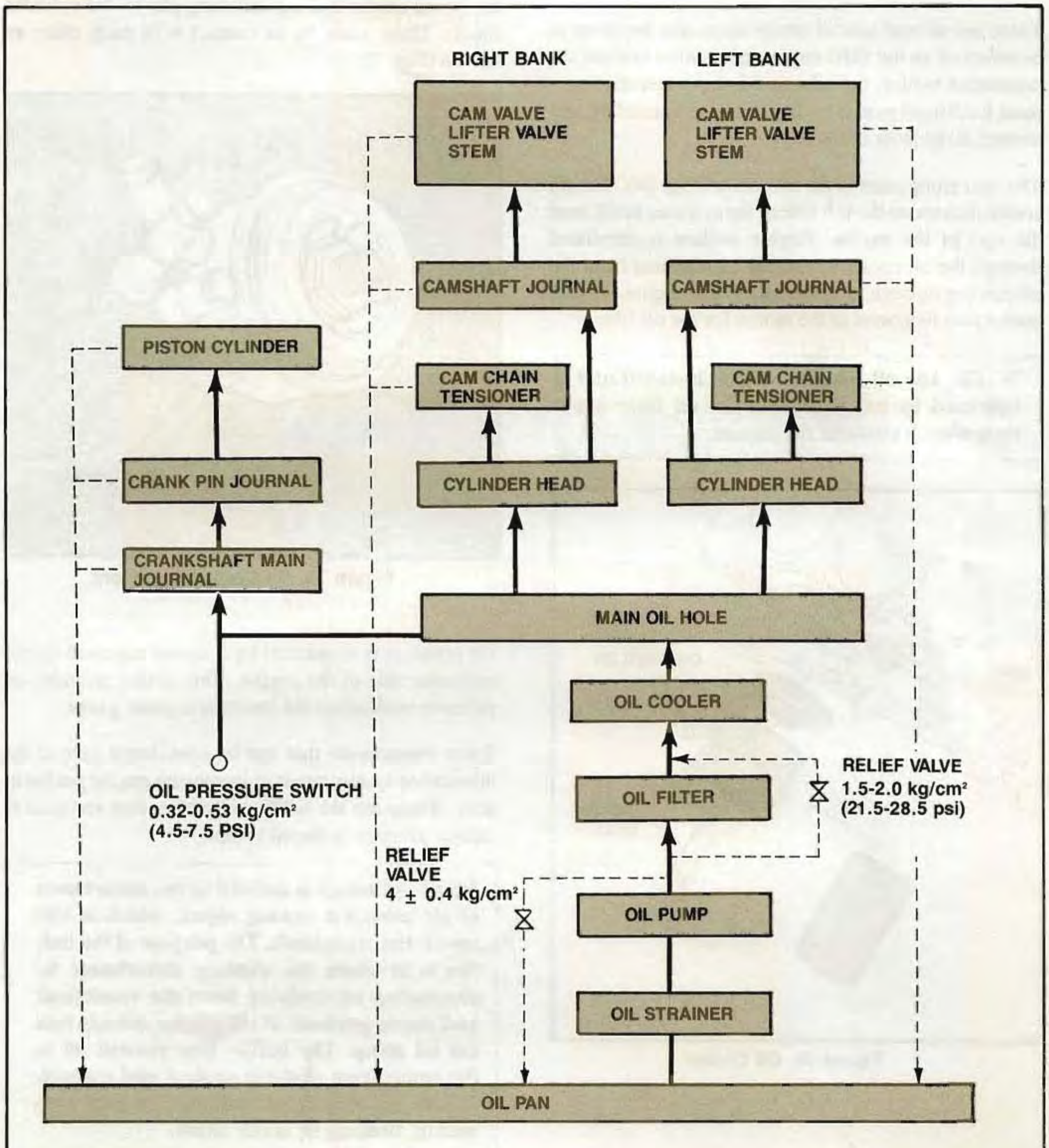


Figure 73. Lubrication System Block Diagram

LUBRICATION SYSTEM MAJOR COMPONENTS

There are several special components and locations to be aware of on the SHO engine lubrication system. As mentioned earlier, the oil pump is a positive displacement trochoidal gear type driven by the crankshaft and located at the front of the engine.

The next component is the oil cooler (Fig. 74). The oil cooler mounts on the left side of the cylinder block near the rear of the engine. Engine coolant is circulated through the oil cooler to remove excess heat from the oil passing through it on the way to the engine. The oil cooler also functions as the mount for the oil filter.

NOTE: The oil filter should be installed and tightened by hand. Tighten the oil filter 3/4 turn after it contacts the mount.

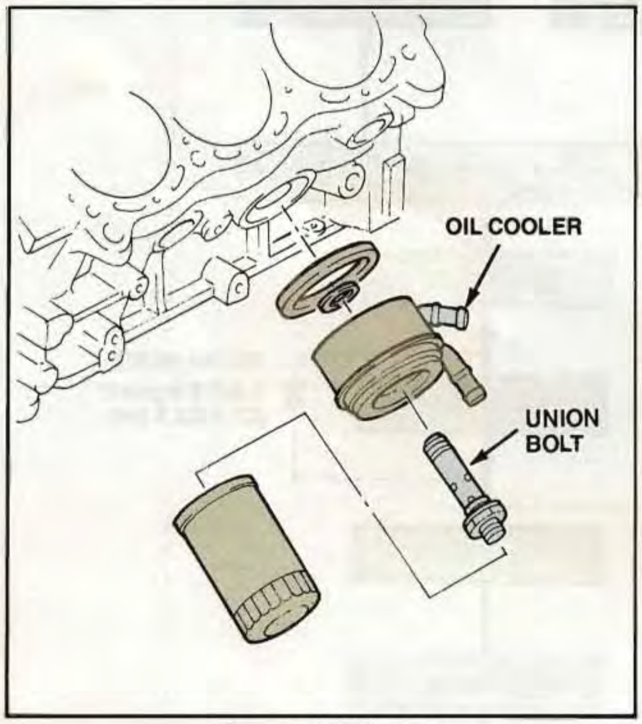


Figure 74. Oil Cooler

The oil cooler must be properly positioned on the cylinder block. This is accomplished with an alignment stay on the oil cooler and a positioning pin on the cylinder block. These must be in contact with each other as shown (Fig. 75).

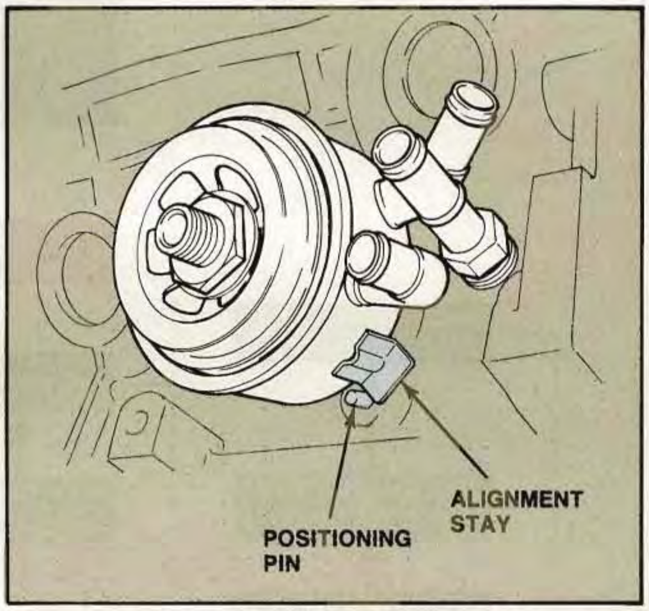


Figure 75. Oil Cooler Alignment

Oil pressure is monitored by a sensor mounted on the right rear side of the engine. This sensor provides oil pressure readings to the instrument panel gauge.

Some components that can be considered part of the lubrication system assist in increasing engine performance. These are the baffle assemblies that are used to reduce windage in the oil sump.

NOTE: Windage is defined as the disturbance of air around a moving object, which in this case is the crankshaft. The purpose of the baffles is to lessen the windage disturbance by channeling oil draining from the crankshaft and upper portions of the engine quickly into the oil sump. The baffles also prevent oil in the sump from sloshing around and contacting the rotating crankshaft during hard cornering, braking or acceleration.

There are two baffles. The first is bolted to the main cap beam that attaches to the main caps (Fig. 76). The second is attached to the oil pan (Fig. 77).

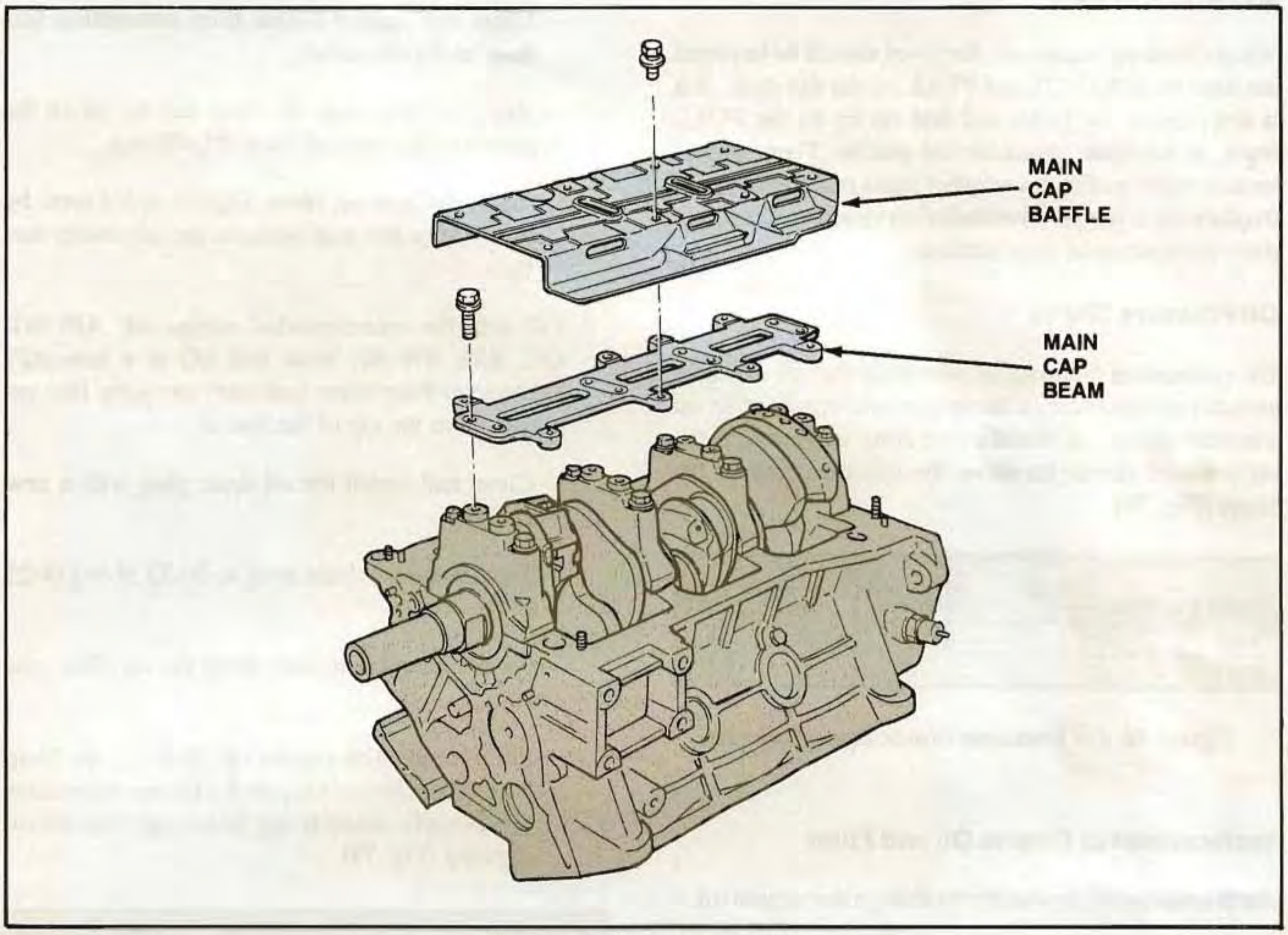


Figure 76. Main Cap Baffle

NOTE: The purpose of the crankshaft bearing cap beam is to provide a rigid support for the lower part of the engine. This extra support reduces vibration and engine noise.

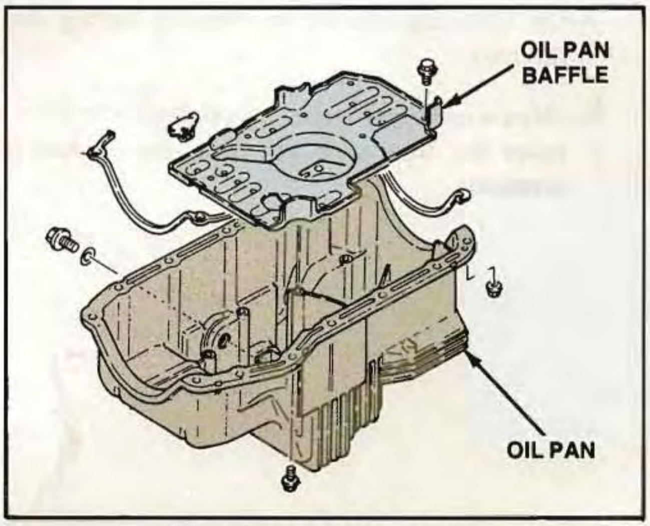


Figure 77. Oil Pan Baffle

LUBRICATION SYSTEM SERVICE HIGHLIGHTS

General Service

When checking engine oil, the level should be between the lines of ADD 1 QT and FULL on the dip stick. If it is low, check for leaks and add oil up to the FULL mark. In addition, check the oil quality. There should be no evidence of water or other signs of deterioration. Replace oil at the recommended service intervals, or if there is evidence of deterioration.

Oil Pressure Check

Oil pressure is checked by removing the oil pressure switch right rear side of the engine and installing an oil pressure gauge. At normal operating temperature the oil pressure should be above the specifications on the chart (Fig. 78).

	More than		
Standard Oil Pressure:	kg/cm²	psi	kPa
At idle	0.9	12.8	88
2500 rpm	2.0	28.4	196

Figure 78. Oil Pressure Check Specifications

Replacement of Engine Oil and Filter

Use the following procedure to change the engine oil.

1. Drain engine oil.

   — Oil filler cap should be removed during the draining.

   — Place a container under the oil drain plug. Remove the drain plug and drain the oil into a container.

2. Replace the oil filter.

   — Using an oil filter wrench, remove the oil filter.

   — Clean and inspect the oil filter installation surface on the oil cooler.

   — Apply a light coat of clean engine oil to the gasket of the new oil filter (FL400-A).

   — Install the new oil filter. Tighten it 3/4 turn, by hand, after the seal contacts the oil cooler surface.

3. Fill with the recommended engine oil, API SG/CC, SAE 5W-30. Note that SG is a new API (American Petroleum Institute) category that replaces SF as the top of the line oil.

   — Clean and install the oil drain plug with a new gasket.

   — Tighten the oil drain plug to 20-33 N·m (14-25 lb-ft).

   — Clean any contaminants from the oil filler tube neck.

   — Fill with the new engine oil. Refer to the Shop Manual or Owner's Guide for the recommended oil viscosity. Refer to the following chart for oil capacity (Fig. 79).

Oil Capacity	Qts	Liters	Imp·qts
Without oil filter change	4.5	3.2	3.7
With oil filter change	5.0	4.7	4.2
Dry fill	6.0	5.8	5.1

Figure 79. Oil Fill Specifications

   — Install the oil filler cap.

   — Start the engine and check for leaks.

   — Recheck engine oil level and add if necessary.

Oil Pump Service

The special tools to be aware of for use in servicing the lubrication system are included in the Front Crank Seal/Gear/Damper set, T89P-6701 (Fig. 80). They are used to remove the crankshaft gear to gain access to the oil pump (T89P-6701-A), and also to press the front crankshaft oil seal into the oil pump housing (T89P-6701-B).

If extensive engine repair is required, it is recommended that the oil pump be disassembled, cleaned and inspected. Note that individual components at the oil pump are not serviceable. If any part of the oil pump requires replacement, replace the complete pump assembly.

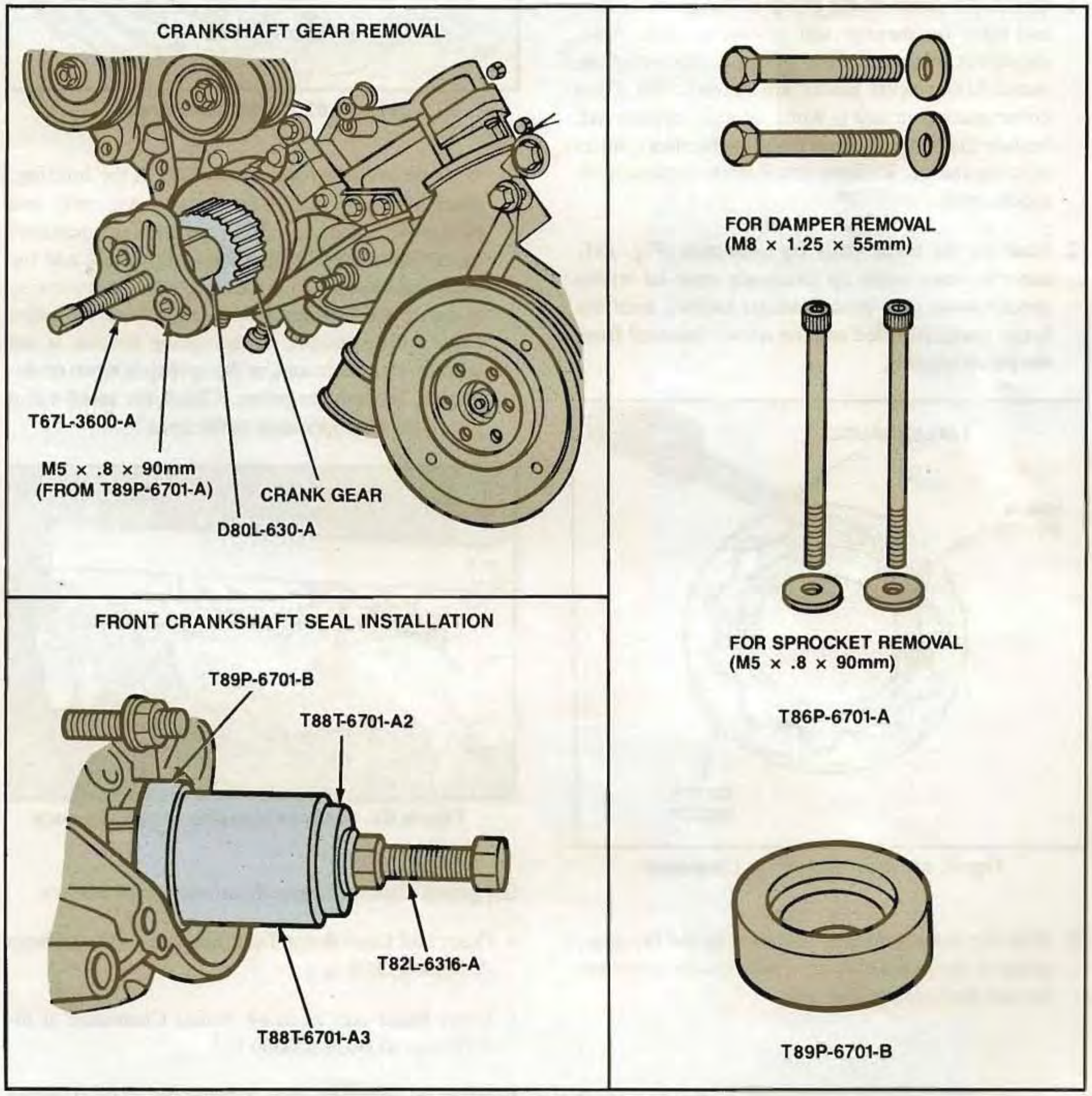


Figure 80. Oil Pump Special Tools

Cleaning

Wash all parts in solvent and dry them thoroughly with compressed air. Use a brush to clean the inside of the pump housing and pressure relief valve chamber. Make sure that all dirt and metal particles are removed.

Inspection

1. Check the inside of the pump housing, outer race and rotor for damage and excessive wear. Also, check the mating surface of the pump cover for wear. Minor scuff marks are normal, but if the cover mating surface is worn, scored, or grooved, replace the pump. Inspect the rotor for nicks, burrs or score marks. Remove small imperfections with crocus cloth.

2. Measure the inner rotor tip clearance (Fig. 81). Inner to outer rotor tip clearance must be within specification (see specifications below) with the feeler gauge inserted and the rotors removed from the pump housing.

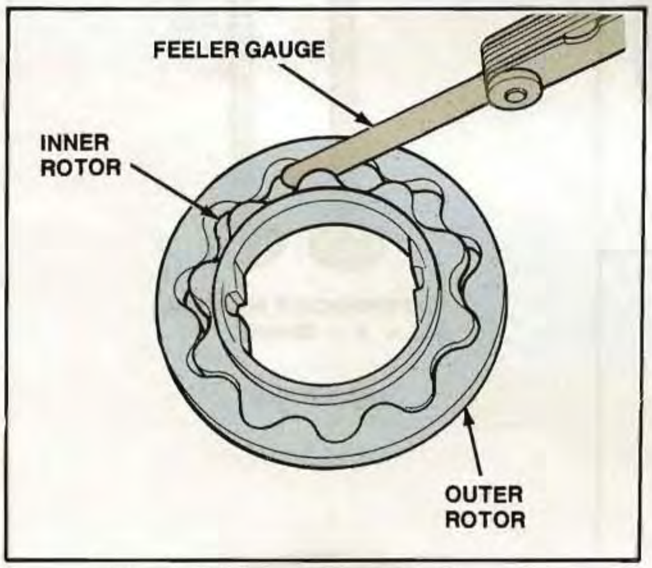


Figure 81. Inner Rotor Tip Clearance

3. With the rotor assembly installed in the housing, measure the radial clearance between the outer rotor and the housing (Fig. 82).

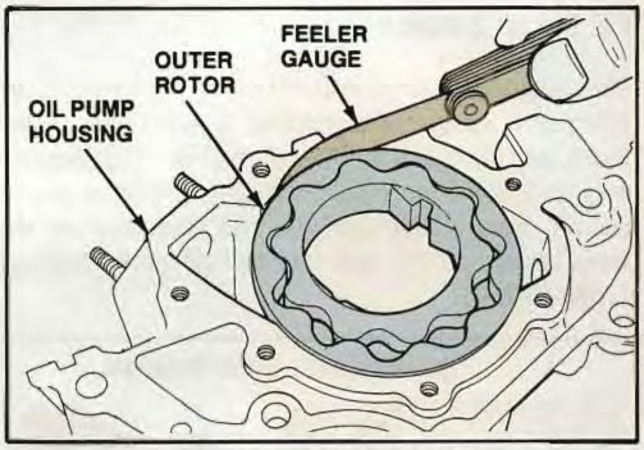


Figure 82. Radial Clearance

4. With the rotor assembly installed in the housing, place a straightedge over the rotor assembly and the housing (Fig. 83). Measure the side clearance (rotor end play) between the straightedge and the rotor and outer race. Inspect the relief valve spring to see if it is collapsed or worn. Check the relief valve spring tension. If the spring tension is not with specification and/or the spring is worn or damaged, replace the pump. Check the relief valve piston for free operation in the bore.

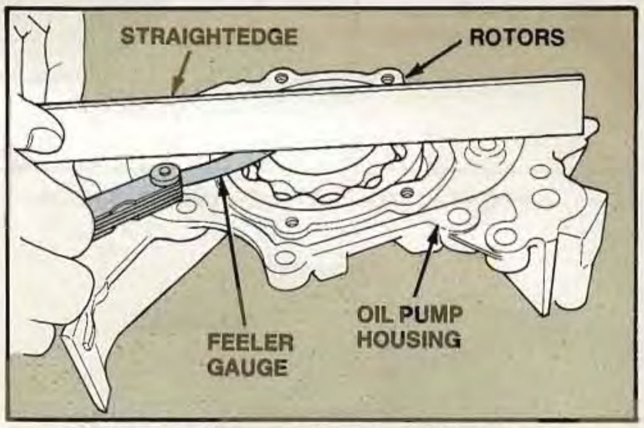


Figure 83. Rotor to Housing Side Clearance

Oil pump clearance specifications are as follows:

- Outer and Inner Rotor Tip Clearance: 0.06-0.18mm (0.0024-0.0071 in.)
- Outer Rotor and Housing Radial Clearance: 0.10-0.175mm (0.0039-0.0069 in.)
- Rotor to Housing Side Clearance: 0.03-0.09mm (0.0012-0.0035 in.)

Lubrication System Component Installation Highlights

Other important features to be aware of during service include installation of the baffle and crankshaft bearing cap beam, oil pump and rear oil seal carrier, oil strainer, and also the oil pan and oil level sensor.

Baffle and Beam Installation

During installation of the baffle and beam, be aware of the directional arrow on the crankshaft bearing cap beam and the torque specifications for the attaching screws (Fig. 84). Also, note that one of the oil pan baffle screws must be tightened with the oil strainer in place.

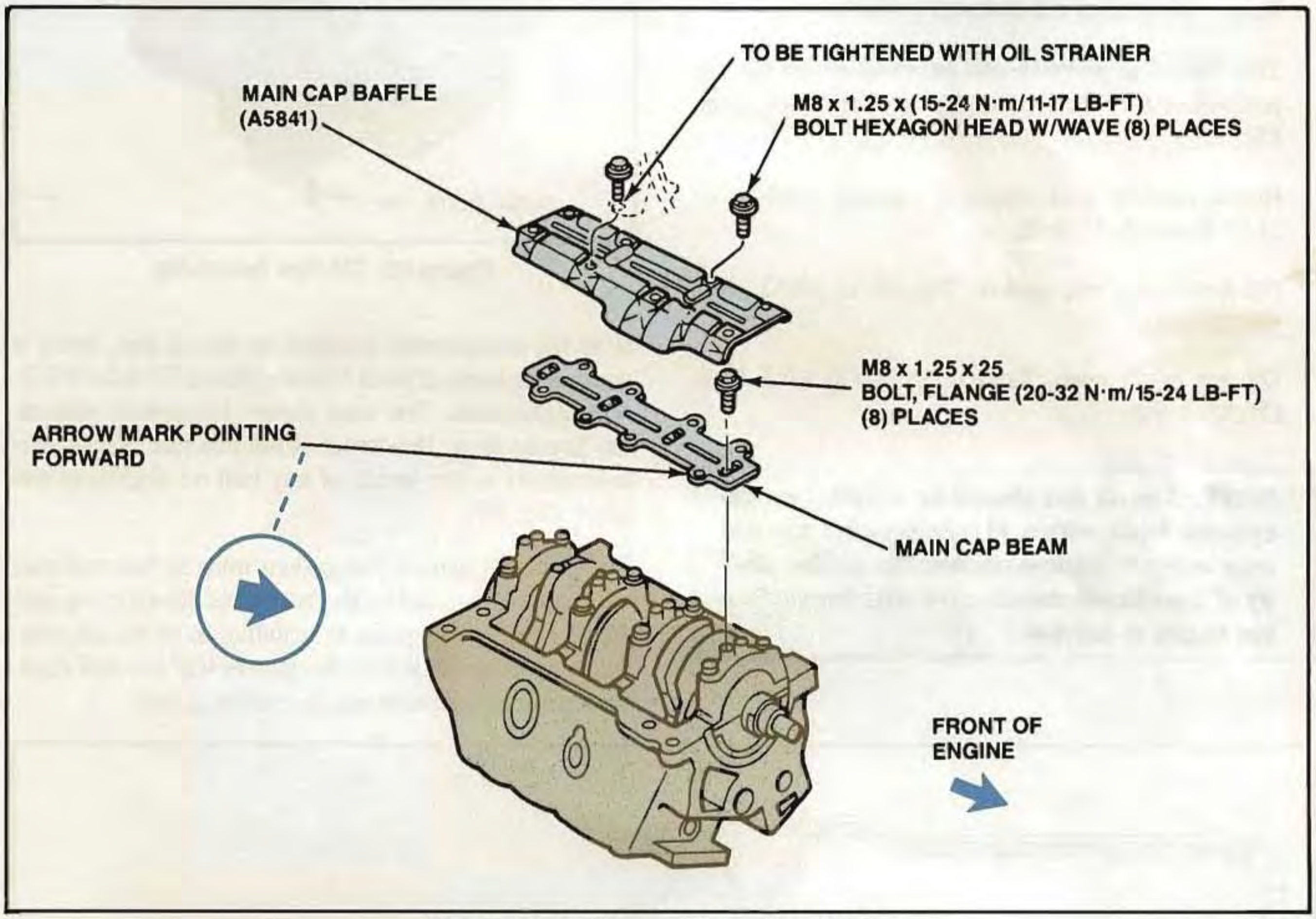


Figure 84. Baffle and Beam Installation

Oil Strainer and Oil Pan Installation

Prior to installing the oil strainer, position a new oil strainer gasket on the oil pump. Install the oil strainer attaching nuts and bolts and tighten them to specification.

— Nuts - 7.5-10 N·m (65-91 lb-in)

— Bolts - 16-23 N·m (12-17 lb-ft)

- The following parts should be installed on the oil pan before it is attached to the cylinder block (Fig. 85):
- Engine low oil level sensor and gasket. Tighten to 21-33 N·m (15-25 lb-ft).
- Oil drain plug and gasket. Tighten to 20-33 N·m (14-25 lb-ft).
- Oil pan baffle plate. Tighten bolts to 6.5-9.5 N·m (56-82 lb-in).

> **NOTE: The oil pan should be installed on the cylinder block within 10 minutes after the silicone sealer is applied because the sealing ability of the silicone deteriorates after the surface has begun to harden.**

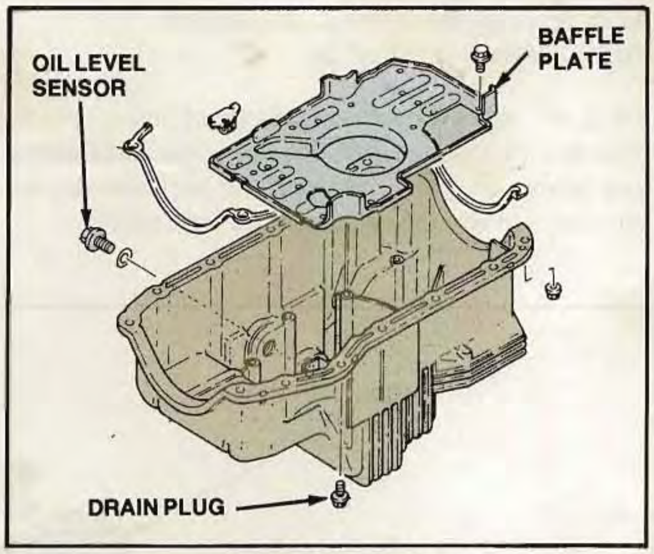


Figure 85. Oil Pan Assembly

With the components installed on the oil pan, apply a continuous bead of Ford Silicone Sealer E3AZ-19562-A or equivalent. The bead should be applied without any breaks along the center of the pan rail. Apply silicone sealer to the inside of any bolt or alignment pin holes (Fig. 86).

The front and rear oil pan gaskets must be inserted into the grooves provided on the bottom of the oil pump and the oil seal carrier prior to installation of the oil pan. Inserting the gaskets into the groove will prevent them from protruding and possibly causing a leak.

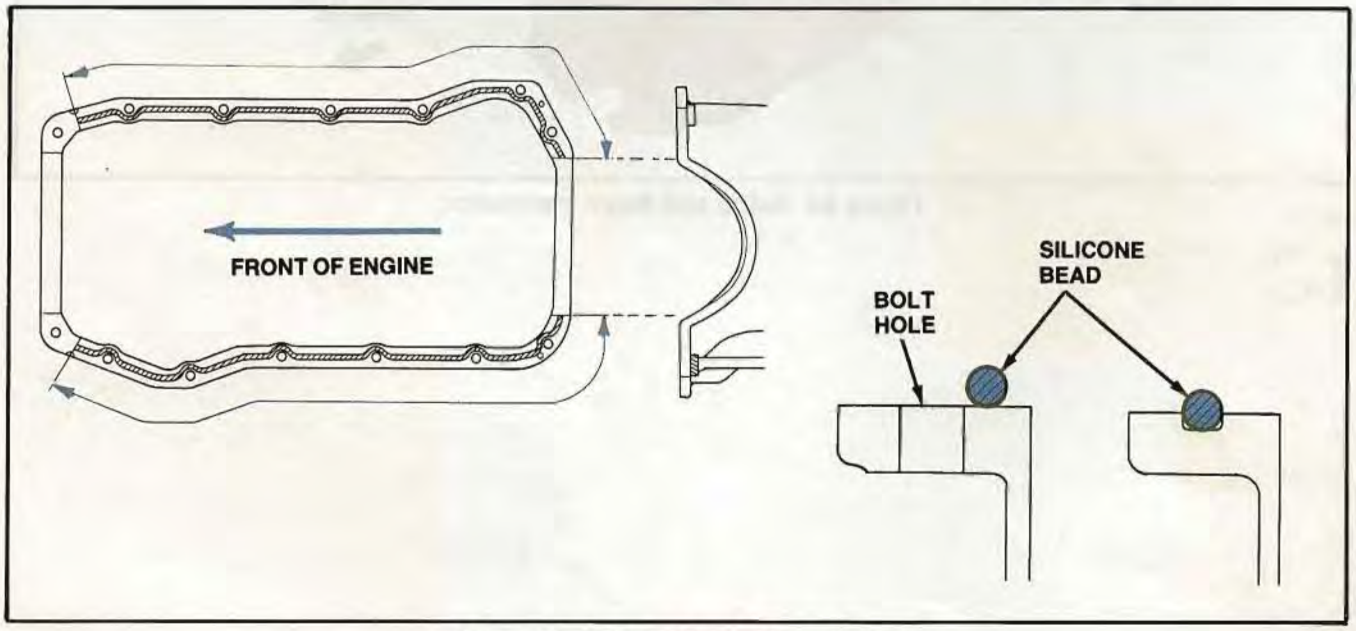


Figure 86. Oil Pan Sealer Installation

Install the oil pan on the cylinder block (Fig. 87). Install the attaching bolts and nuts. Note that there is a harness clamp for the oil level sensor lead that is held in position by an oil pan bolt.

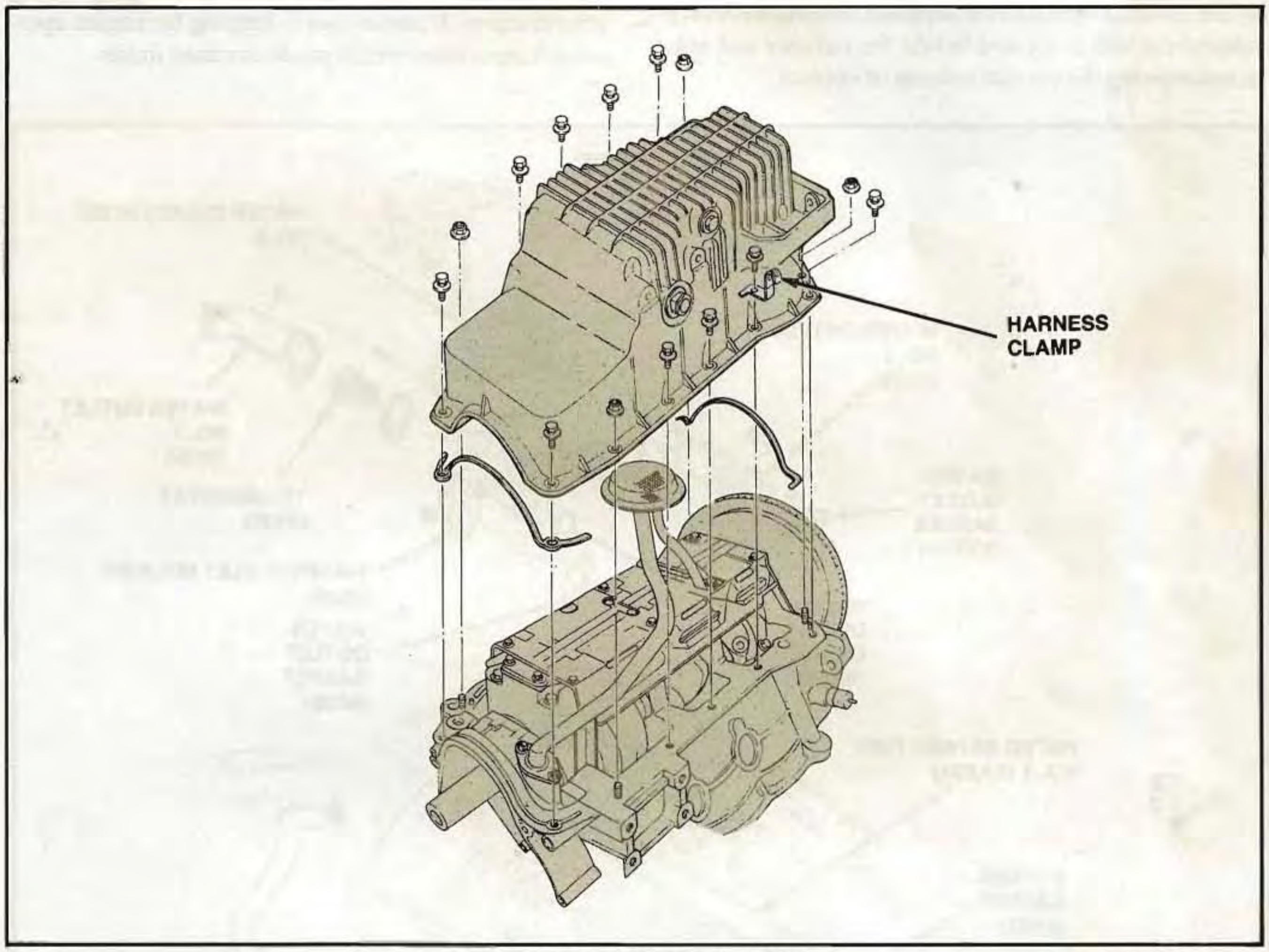


Figure 87. Oil Pan Installation

Tighten the oil pan attaching bolts and nuts in the sequence shown (Fig. 88). Tightening specifications for the oil pan fasteners are 16-23 N·m (12-17 lb-ft).

Install the oil cooler and two gaskets to the cylinder block. Make sure that the oil cooler is properly positioned as mentioned earlier. Tighten the oil cooler union bolt to the cylinder block to specifications, 39-49 N·m (29-36 lb-ft).

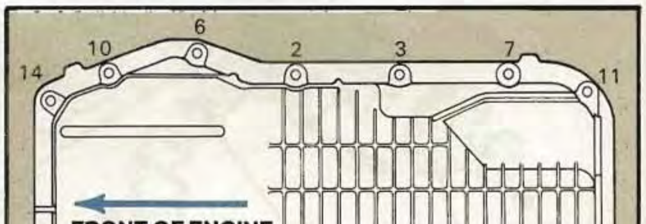


Figure 88. Tightening Sequence

SYSTEM DESCRIPTION

The cooling system (Fig. 89) includes a radiator, water circulating pump and a cooling fan which is activated by the integrated relay control module. Also included in the cooling system is a separate coolant recovery reservoir which is located beside the radiator and aids in maintaining the correct volume of coolant.

The water pump is of a conventional design and is driven by the accessory drive belt. A thermostat is in the water outlet connection housing at the opposite end of the engine. The thermostat ensures rapid engine warm-up, restricting coolant flow at lower operating temperatures. It also assists in keeping the engine operating temperature within predetermined limits.

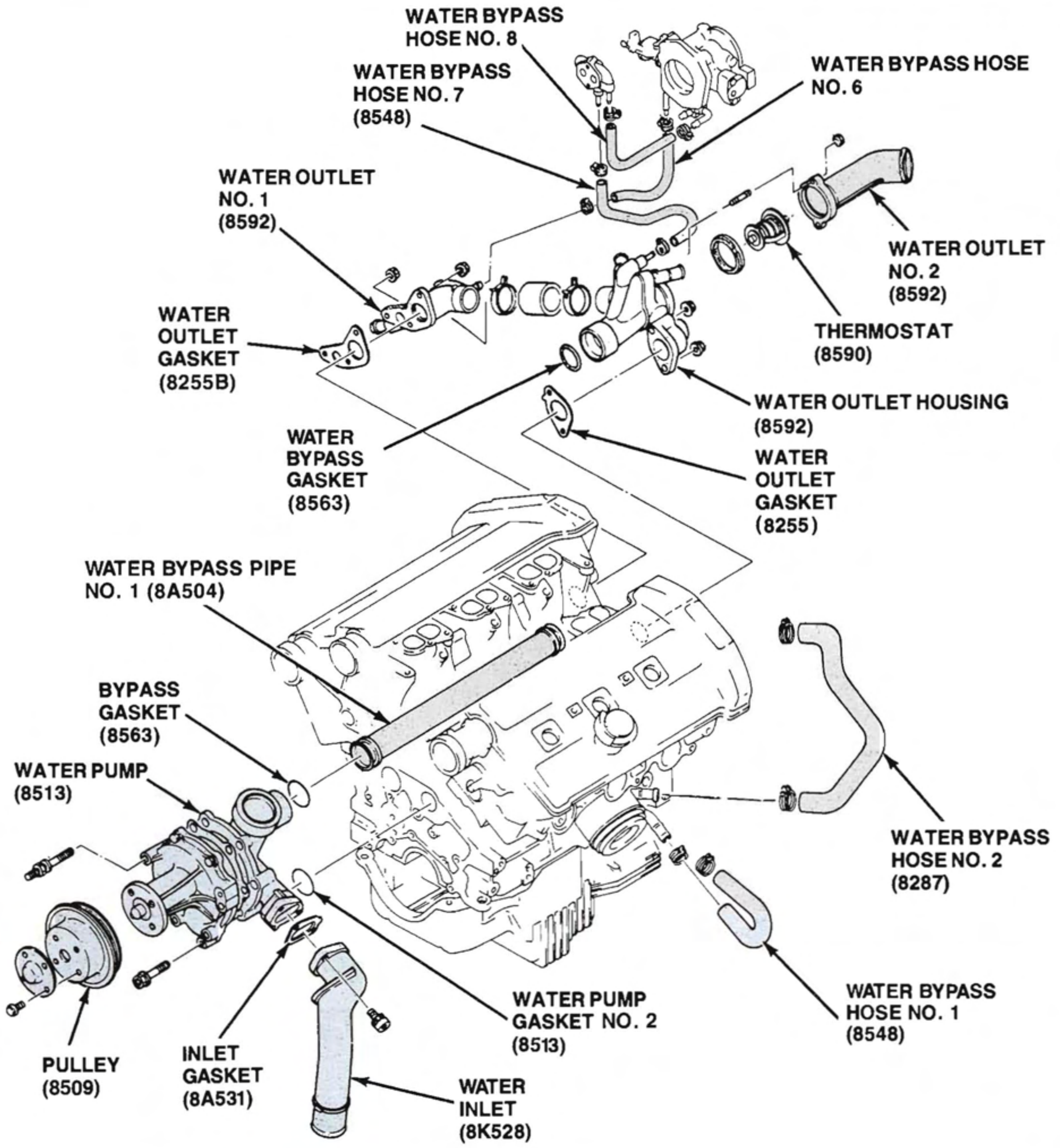


Figure 89. Cooling System

COOLING SYSTEM

The coolant normally contains a 50/50 mix of water and permanent coolant/antifreeze fluid such as Ford Cooling System Fluid E2FZ-19549-AA or equivalent (cooling system fluid must meet Ford Specification ESE-M97B44-A). Note that the addition of more water than recommended will raise the freezing protection temperature and weaken the corrosion inhibitors. Refer to the Shop Manual specifications for the cooling system capacity.

NOTE: The cooling system must be maintained with the correct concentration and type of antifreeze to prevent corrosion damage.

The electric radiator cooling fan motor is mounted behind the radiator. The integrated relay control module actuates the fan when the coolant reaches a specified temperature, and/or when the air conditioning clutch is activated, if so equipped.

WARNING: THE ENGINE ELECTRIC COOLING FAN MAY COME ON AT ANY TIME WITHOUT WARNING EVEN IF THE ENGINE IS NOT RUNNING.

COOLING SYSTEM OPERATING PRINCIPLES

Coolant flow through the system is determined by coolant temperature (Fig. 90). When the coolant is cold, the thermostat is in the closed position and the coolant flow is restricted to the cylinder block, heads, intake manifold and heater. As the temperature increases, the thermostat opens, allowing a portion of the coolant to pass into the radiator. The coolant flows through the radiator tubes and is cooled by air passing over the cooling fins assisted by the cooling fan. Coolant is then circulated from the radiator outlet tank through the water pump and into the cylinder block to complete the circuit.

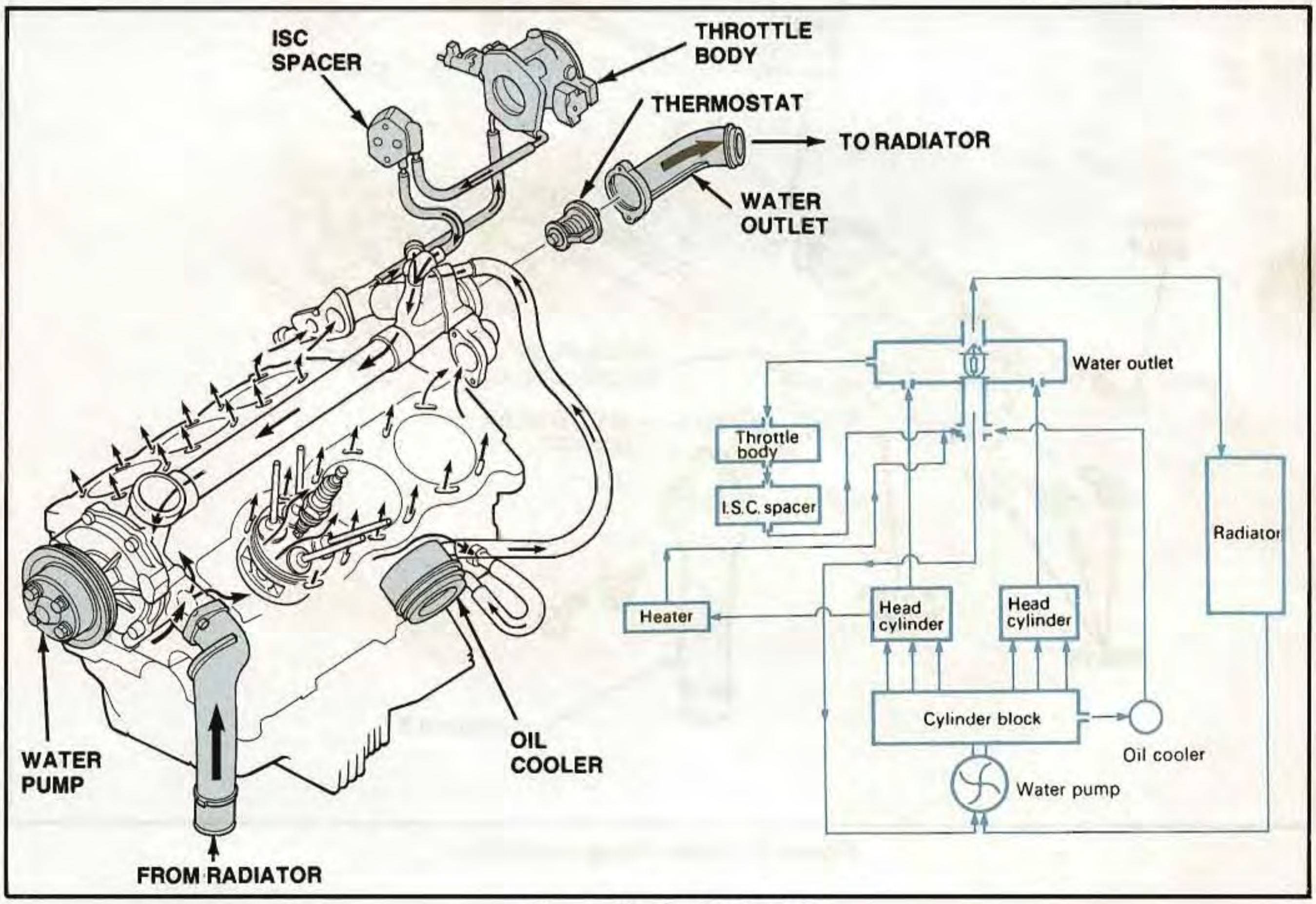


Figure 90. Coolant Flow

The coolant expands as the temperature and pressure rise in the system. When the limiting system working pressure is reached, the pressure relief valve in the radiator cap is lifted from its seat and allows coolant to flow through the radiator filler neck and the overflow hose into the coolant recovery tank. The radiator filler cap has a rubber seal on the underside to prevent leakage.

When system temperature and pressure drop, the coolant contracts in volume and the pressure in the radiator is reduced, resulting in a partial vacuum. The coolant in the recovery tank then flows back into the radiator through the vacuum relief valve in the radiator filler cap.

The integrated relay control module activates the cooling fan motor when the coolant reaches a specified temperature, and/or when the engine reaches a specified temperature. On vehicles equipped with air conditioning, the cooling fan motor is activated whenever the air conditioning clutch is engaged.

COOLING SYSTEM SERVICE

Water Pump Installation

Install the water inlet and water inlet gasket to the water pump (Fig. 91). Tighten these bolts to 8.5-13 N·m (6-9.5 lb-ft).

Install the water pump and water pump gasket 2 with the bolts and stud bolt on the cylinder block. Tighten the two bolts to 16-23 N·m (12-17 lb-ft).

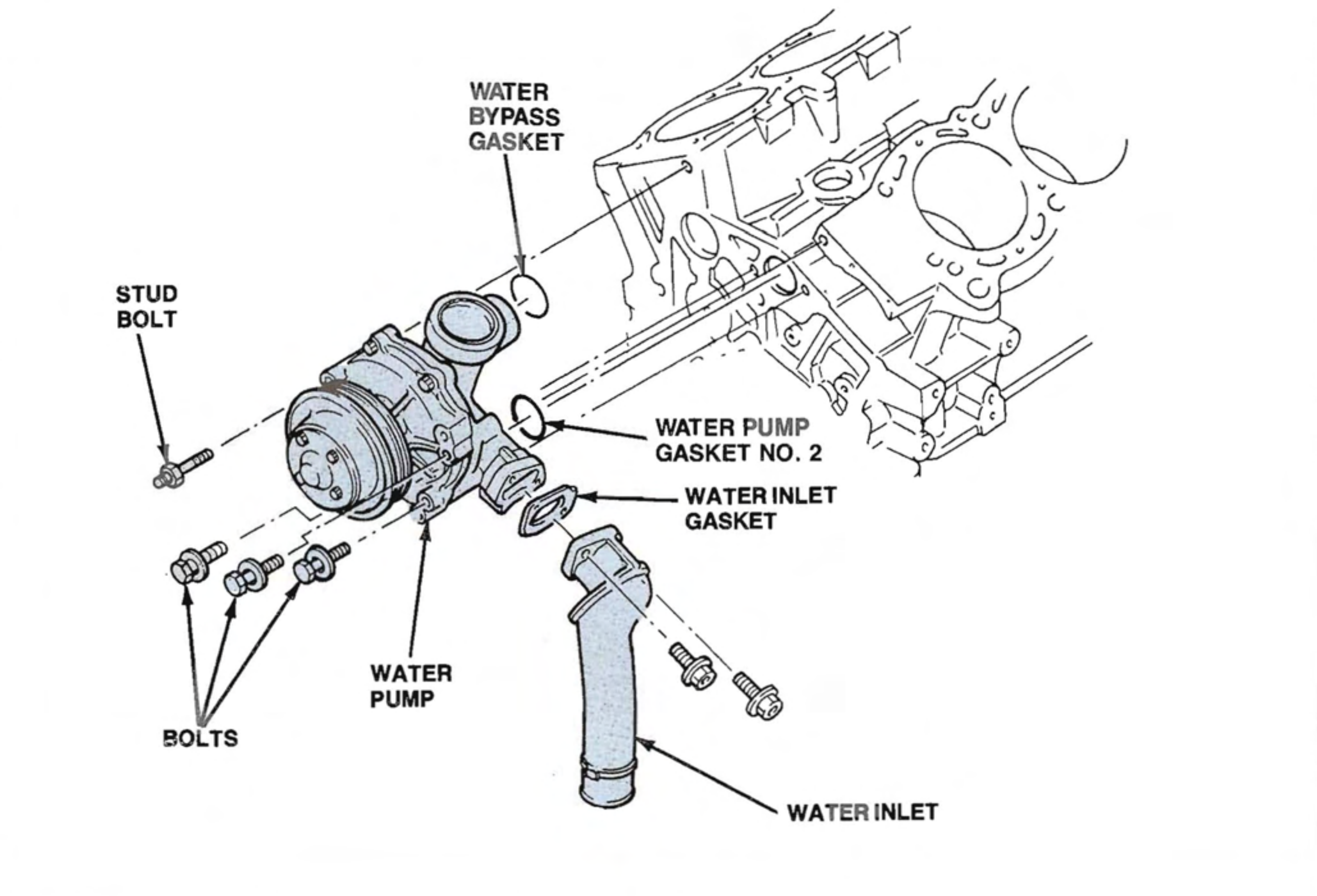


Figure 91. Water Pump Installation

Water Outlet Housing Installation

Prior to installation, the water outlet housing must be subassembled.

1. Install the engine coolant temperature sensor to the water outlet housing and tighten to 17-24 N·m (12-18 lb-ft) (Fig. 92).
2. Install the engine electronic coolant temperature sensor to water outlet No. 1 and tighten it to 17-24 N·m (12-18 lb-ft).

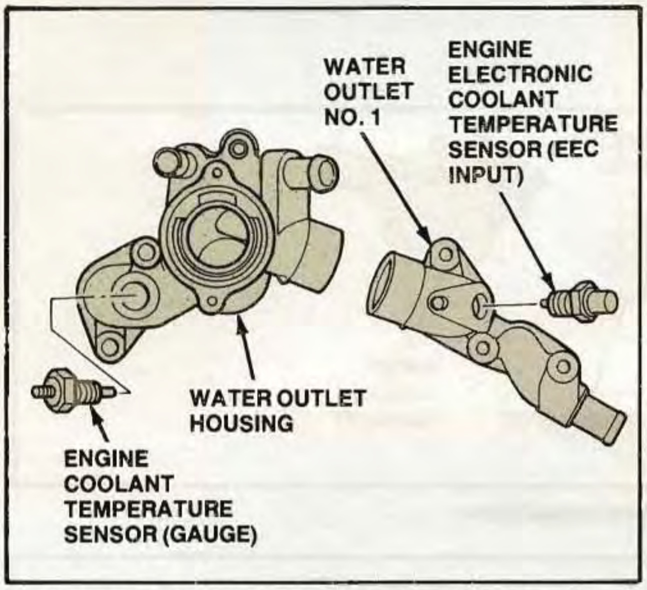


Figure 92. Water Outlet Housing Subassembly

3. Subassemble the water outlet housing and water outlet No. 1 with the coolant hose and two clamps (Fig. 93).
   - Insert the hose to the water outlet housing and clamp it.
   - Insert the hose on the water outlet housing to water outlet No. 1.
   - Coat the water bypass pipe No. 1 gasket with soapy water or similar liquid.

NOTE: Do not use engine oil as the lubricant.

   - Insert the water bypass pipe No. 1 into the water outlet housing.

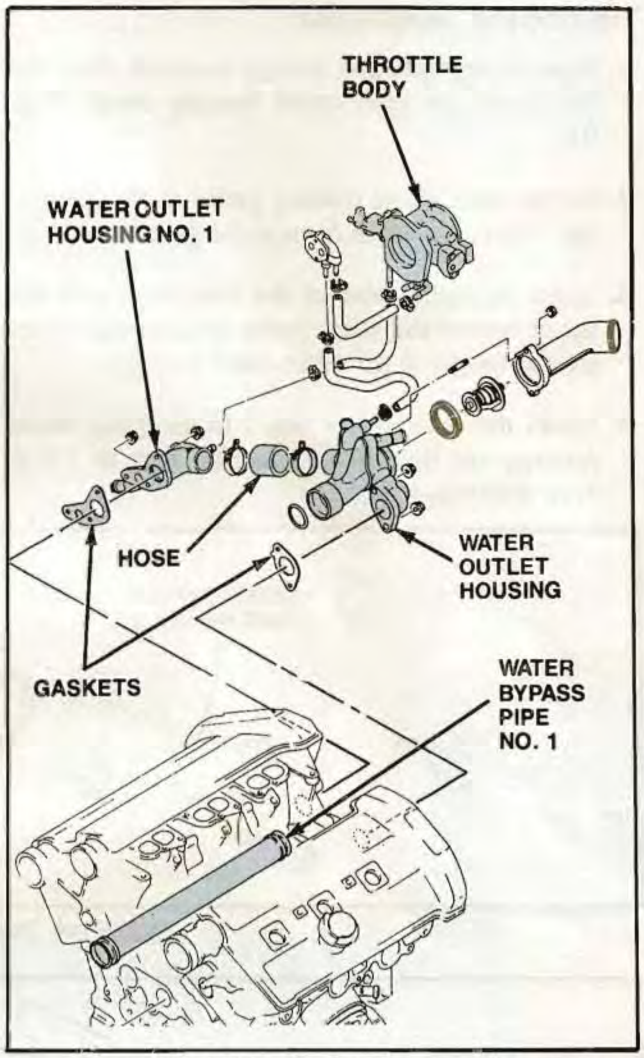


Figure 93. Water Outlet Housing Assembly

NOTE: Be careful not to damage the gasket of the water bypass pipe No. 1.

4. Install the subassembled water outlet housing.
   - Place the gasket on each cylinder head.
   - Install the subassembled water outlet housing and tighten the attaching nuts to 16-23 N·m (12-17 lb-ft).
   - As the water outlet housing is installed, insert the water bypass pipe into the water pump, taking care not to damage the gasket.
   - Clamp the hose at water outlet No. 1.

Thermostat Installation

1. Remove any dust and foreign materials from the outside of the water outlet housing flange (Fig. 94).
2. Fit the water outlet housing gasket to the thermostat. Take care not to damage the gasket.
3. Align the jiggle valve of the thermostat with the upper bolt of the water outlet housing and insert the thermostat in the water outlet housing.
4. Install the water outlet No. 2 to the water outlet housing and tighten the attaching nuts to 7.5-10 N·m (65-91 lb-in).

Hose Installation

Hoses should be installed as indicated (Fig. 95). Note that the heater hose (water bypass hoses 6 and 7 which act as the throttle body warmer) must be subassembled on the throttle body. Therefore, when installing the intake system on the cylinder heads, insert the hoses to the water outlet housing. Also, when water bypass hose No. 2 from the oil cooler is clamped to the ignition coil mount, take care not to break the resin coating on the clamp.

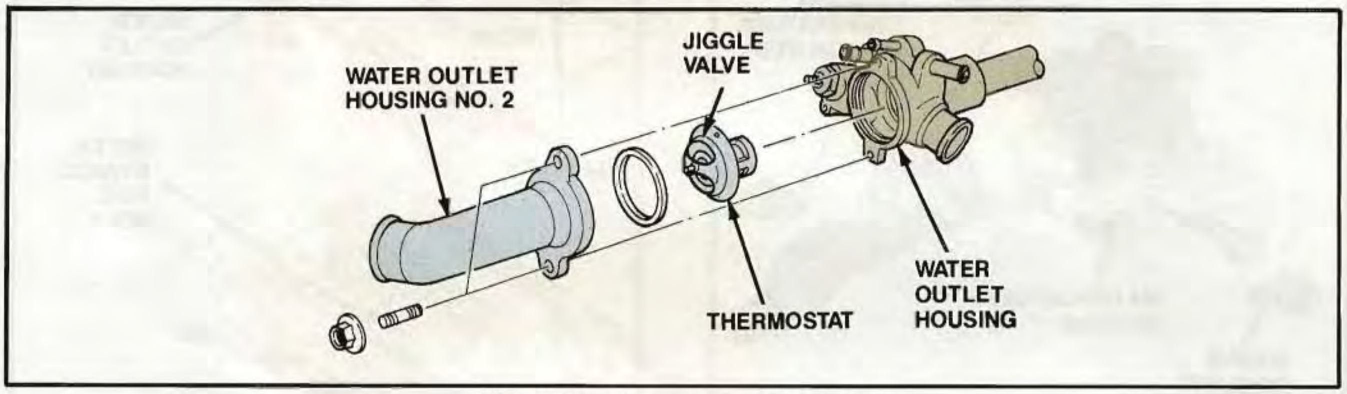


Figure 94. Thermostat Installation

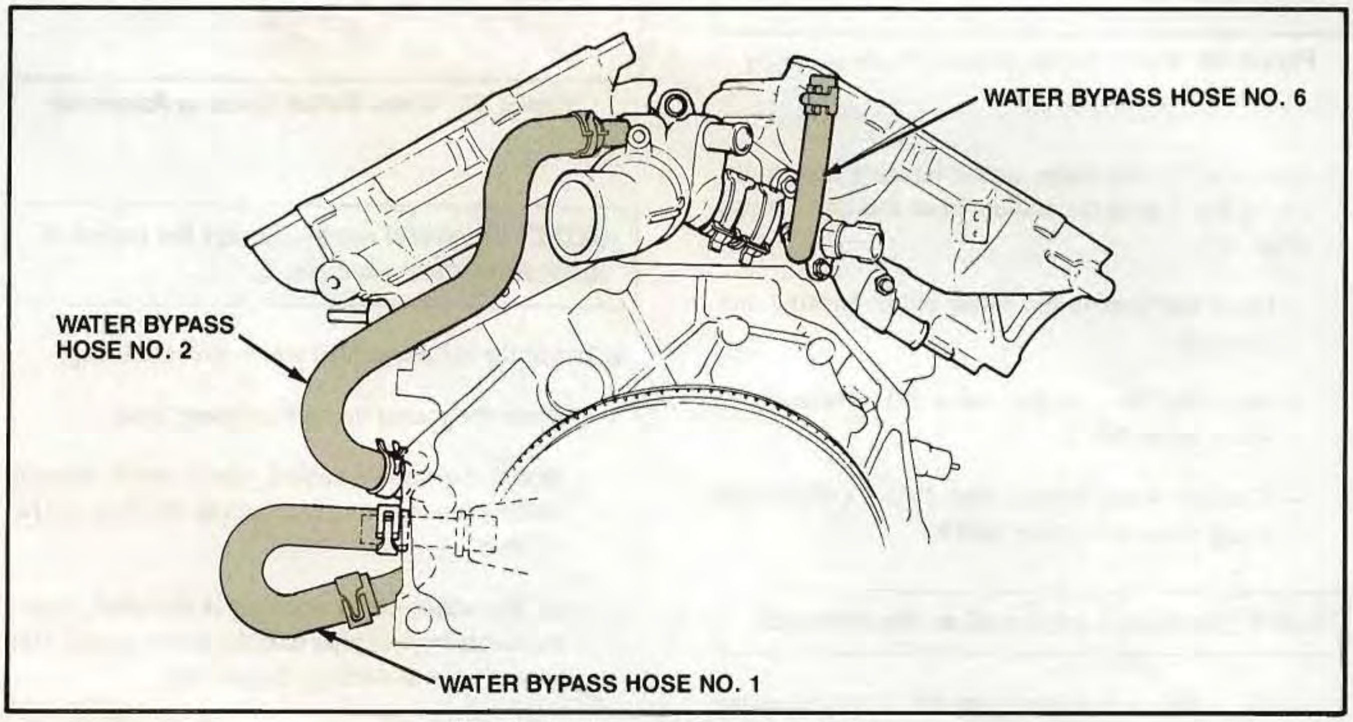


Figure 95. Bypass Hose Installation

CYLINDER BLOCK SERVICE

This section details the information required to properly service the cylinder block components including the crankshaft, crankshaft bearings, main caps, pistons, connecting rods and the flywheel.

CRANKSHAFT, MAIN AND THRUST BEARINGS

The main bearing used in the SHO engine are steel-backed copper lead with a tin overlay. The upper bearings are grooved. The lower bearings are plain. The main caps are made of ductile cast iron and are retained with 11mm diameter main cap bolts and stud bolts. The crankshaft is a forged carbon steel design with five fully machined counterweights.

Note the location of the major components (Fig. 96). The main bearing caps are numbered and should be assembled with the ID numbers pointing toward the front of the engine. The caps are identified by the numbers 1 through 4 from front to rear.

It is important to be aware of the different style main bearings. Style 1 bearings are placed on the outer main journals 1 and 4. They are slightly wider than the style 2 bearings that are used on the inner main journals 2 and 3.

The thrust bearings are placed on either side of main journal 3. Note that the lower thrust bearings are tabbed.

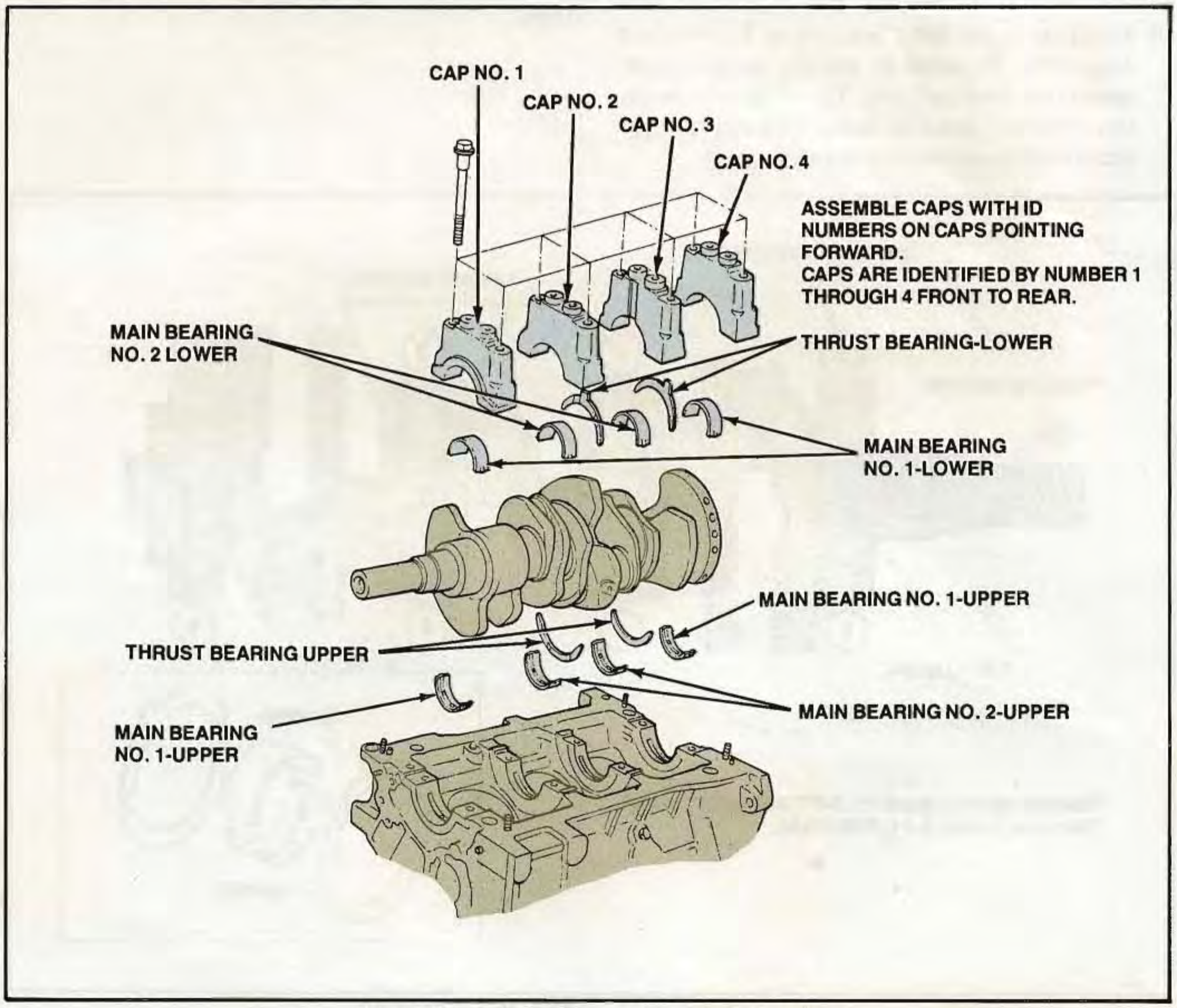


Figure 96. Main and Thrust Bearing Location

Main and Thrust Bearing Assembly

To assemble the crankshaft into the cylinder block with the main and thrust bearings properly positioned, use the following procedure:

1. Install the upper main bearings into the cylinder block. Note that the grooved main bearing halves are used in the block.
2. Oil all the upper bearing surfaces with clean engine oil.
3. Place the crankshaft into the block carefully to avoid damaging the journal surfaces or the bearings.
4. Install the upper thrust bearings on the front and rear of No. 3 journal by pushing the crankshaft toward the front and rear. The oil groove on the thrust bearing should be facing the crankshaft. No selective fit is provided for thrust bearings.
5. Oil all journals and install bearing caps Nos. 1 through 4. Lower thrust bearings are installed on bearing cap No. 3 with the bearing grooves toward the crankshaft.
6. Apply a coat of oil to the bearing cap bolts and tighten them in the proper sequence (Fig. 97) in two steps. Tighten bearing caps in the following manner:
   - First Step: 49-69 N·m (36-51 lb-ft)
   - Second Step: 78-88 N·m (58-65 lb-ft)

After assembly, confirm that the crankshaft can rotate smoothly and that thrust end play is within specifications.

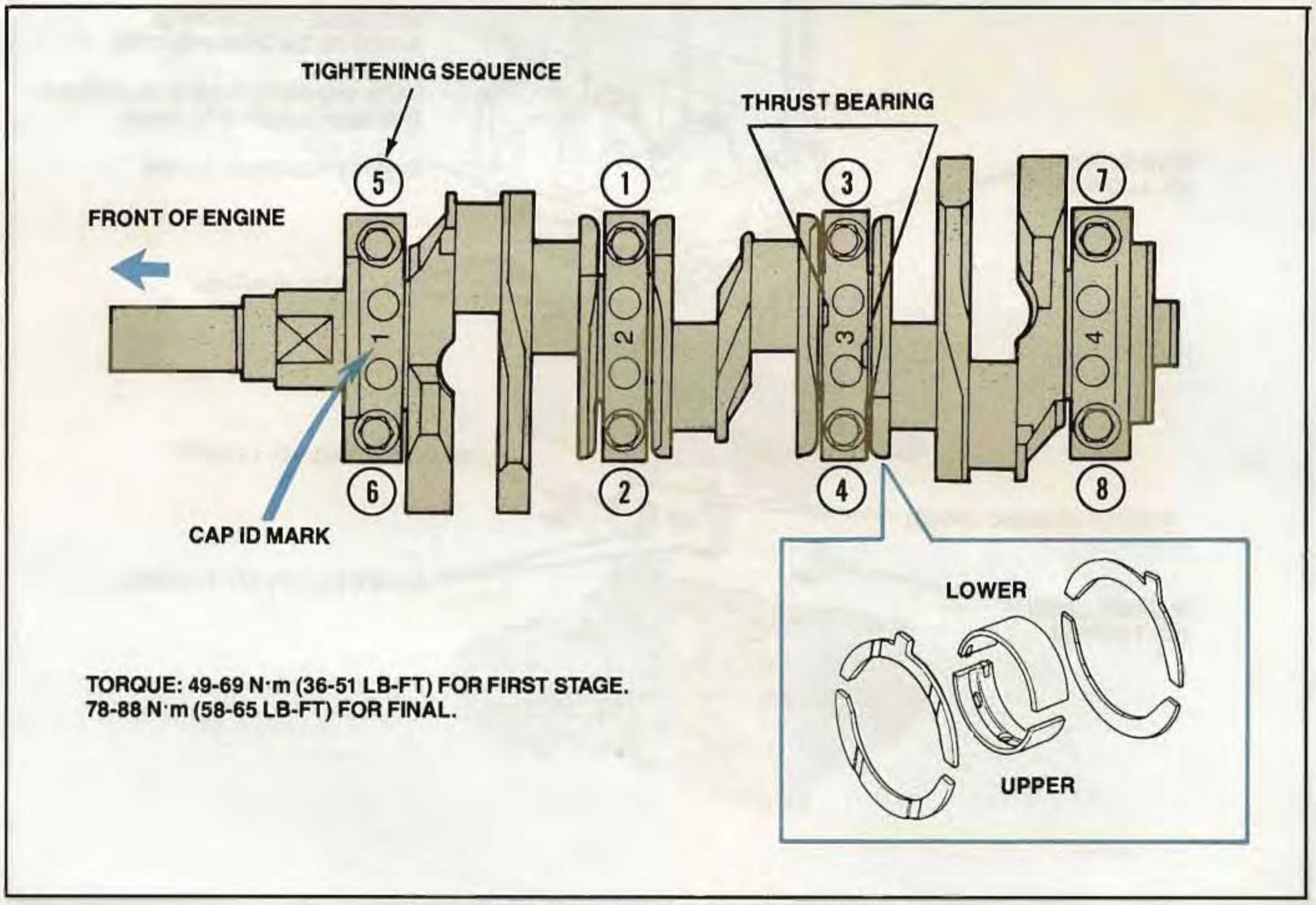


Figure 97. Bearing and Main Cap Installation

Piston and Connecting Rod

The pistons used in the SHO engine are of a cast aluminum design with valve reliefs cut for each of the valves. Connecting rods are made of forged steel. Identification of the pistons is as follows (Fig. 98):

- Pistons have directional arrows which must point to the front of the engine.
- There are indicators that show which side goes toward the exhaust side of the engine.
- There are indicators which show if the piston is used on the right or left bank.

Piston compression rings should be positioned as indicated with the chamfered edge on the inside top. The "R" marking should also be on the top of the ring. On the connecting rod the "KOA" mark should point to the front as should the hash mark on the rod bearing cap. Also note that there is a letter mark on the rod and cap that assures that the cap is correctly installed on the rod.

NOTE: The "KOA" designation is a manufacturing number. It should only be used as a directional reference by Ford Technicians. It is used on other components, in addition to the rod caps.

A special point to note is that connecting rods are not numbered from the factory. They are stamped by weight and size. To assure the connecting rods and their respective caps go back in the same cylinder they should be marked prior to disassembly.

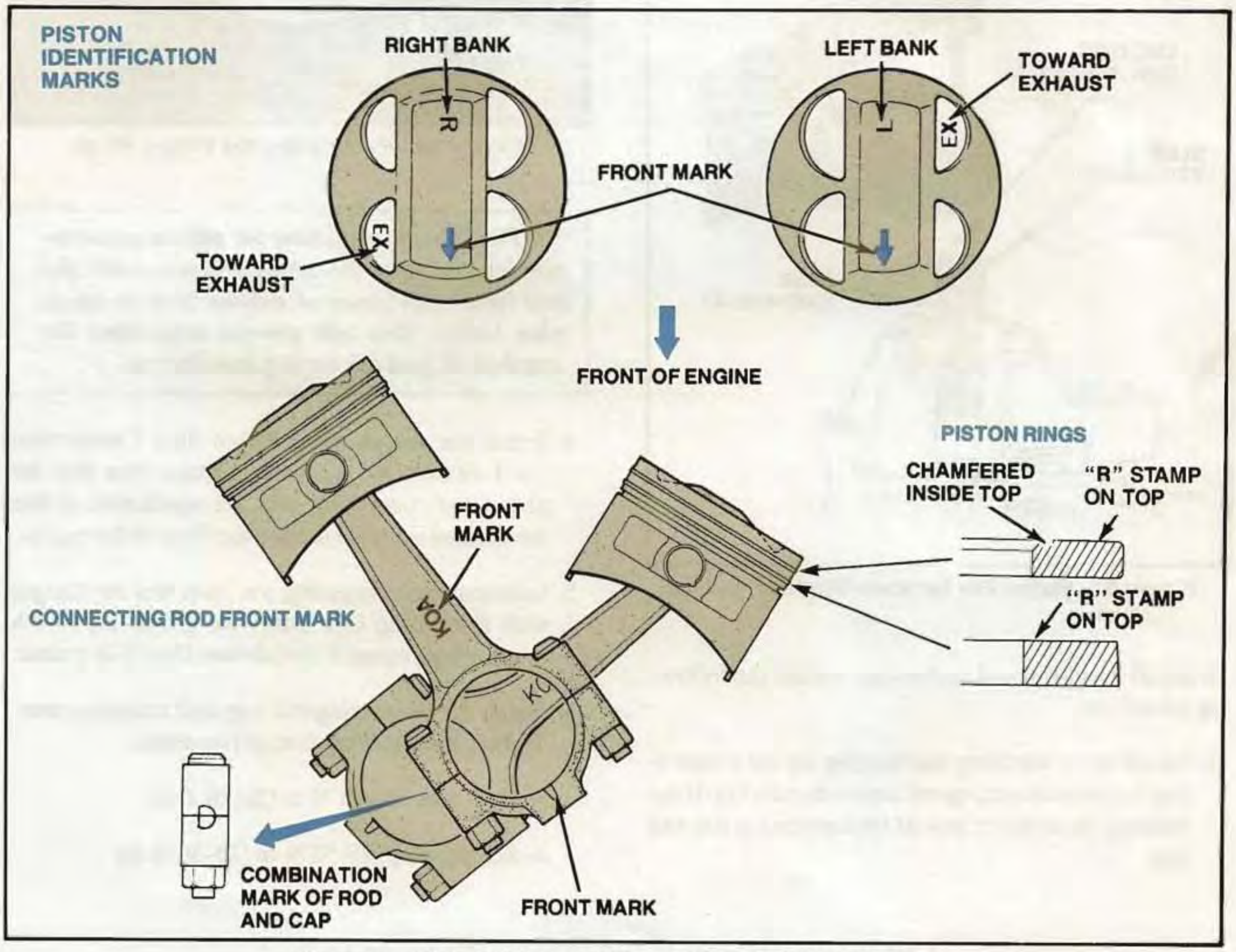


Figure 98. Piston, Ring and Connecting Rod Identification

Piston and Connecting Rod Assembly Procedures

If during engine service it is necessary to install a new piston, it is necessary to remove and install the piston pin from the connecting rod and piston using the Piston Pin Remover/Replacer D89P-6135-A or equivalent (Fig. 99). Be sure to follow the procedure outlined in the Shop Manual.

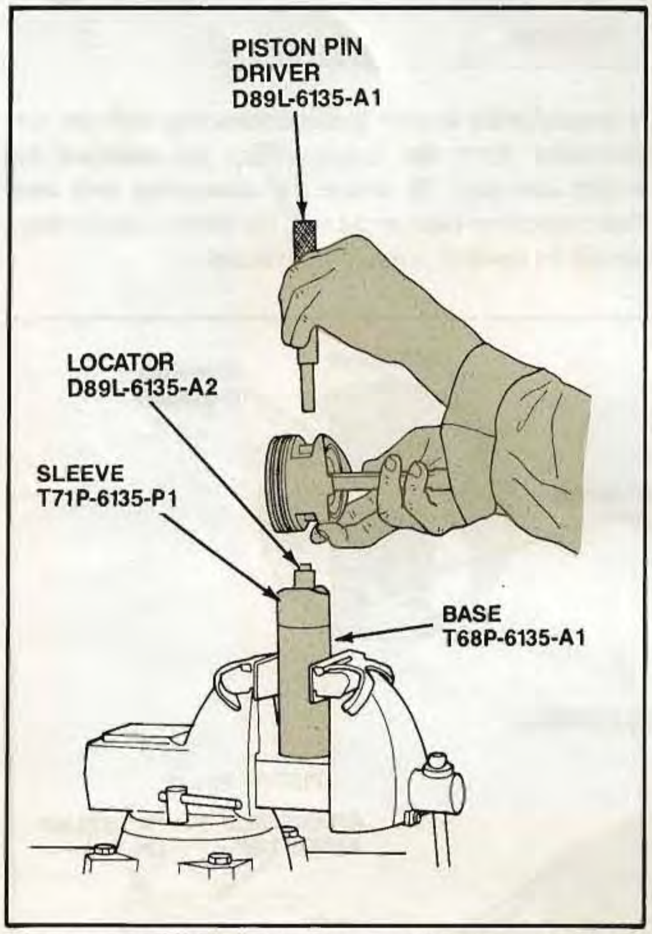


Figure 99. Piston Pin Remover/Replacer In Use

To install the piston and connecting rod use the following procedure:

1. Install the connecting rod bearing on the connecting rod and connecting rod cap so that the lug of the bearing fits in the groove of the connecting rod and cap.
2. Apply a light coat of engine oil on the piston, piston rings, piston pin, connecting rod bearing and the inside of the cylinder bore.
3. Position the piston ring gaps around the piston as shown (Fig. 100).

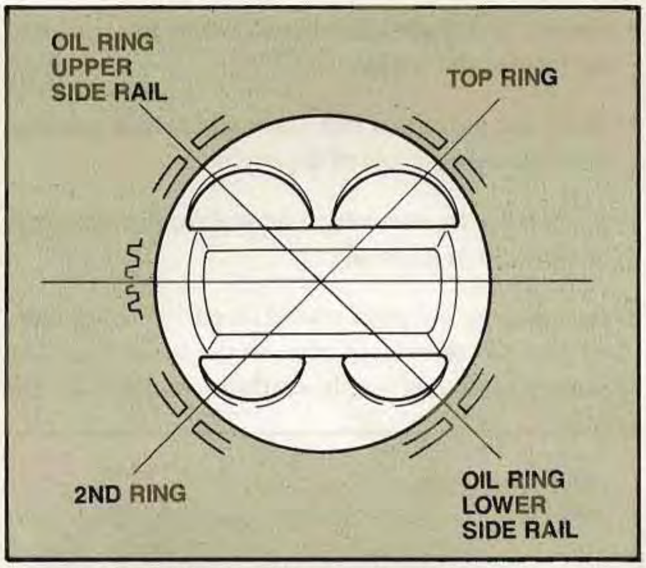


Figure 100. Positioning the Piston Rings

> **NOTE: Prior to installing the pistons and connecting rods into the cylinder block, cover the rod bolts with pieces of rubber hose or spark plug boots. This will prevent scratching the crankshaft journal during installation.**

4. Install the pistons using Piston Ring Compressor D81L-6002-C or equivalent. Make sure that the piston and connecting rods are positioned so that the marked sides are toward the front of the engine.
5. Lubricate the connecting rod bolts and nut flanges with Ford Long Life Lubricant C1AZ-19590-BA or other equivalent Molybdenum Disulfide grease.
6. Install the connecting rod cap and attaching nuts. Tighten the attaching nuts in two steps:

   — First Step: 30-35 N·m (22-26 lb-ft)

   — Second Step: 45-50 N·m (33-36 lb-ft)

7. Check connecting rod side clearance as outlined in the Shop Manual.

8. Install the crankshaft bearing cap beam on the caps. The directional arrow on the beam must point to the front of the engine (Fig. 101). Tighten the fasteners to 21-32 N·m (15-24 lb-ft).

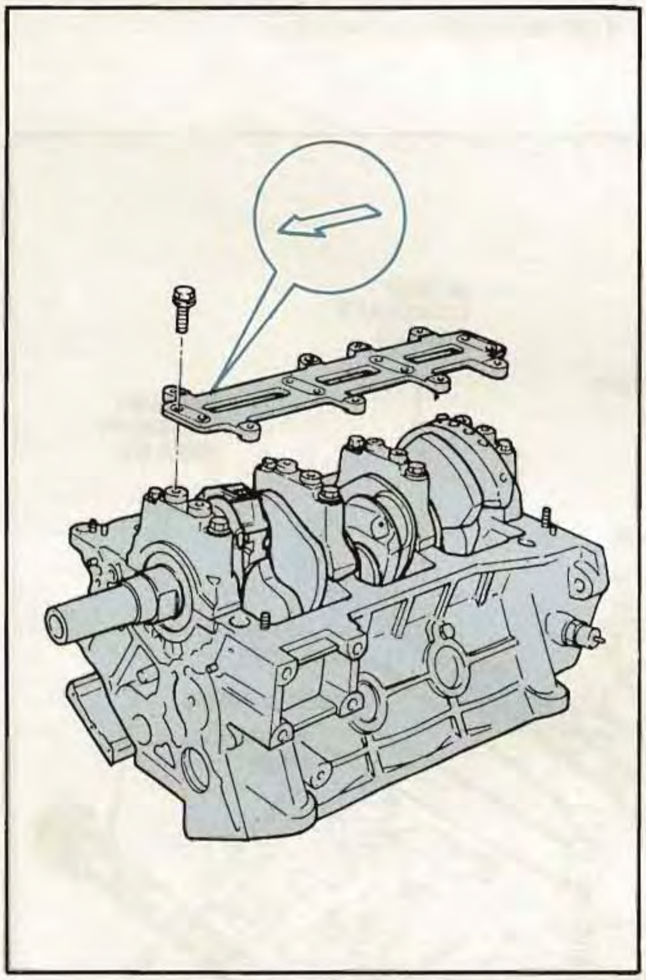


Figure 101. Installing the Crankshaft Bearing Cap Beam

Flywheel Installation

Flywheel installation requires the following procedure:

1. Clean the crankshaft bolt holes and contacting surface with a clean solvent. Check the flywheel surface and bolt holes for dirt and burrs.

2. Install the flywheel on the crankshaft.

3. Attach Flywheel Holding Tool T74P-6375-A or equivalent to prevent the flywheel from rotating during the tightening procedure.

4. Install new flywheel bolts. Coat the flywheel bolt threads with Ford Dry Film Lubricant E2SZ-19553-A or an equivalent Molybdenum Disulfide lubricant.

NOTE: Do not reuse flywheel bolts. Always install new bolts.

5. Install and uniformly tighten the eight flywheel bolts in the sequence shown in two stages (Fig. 102):

   — Stage 1: 39-59 N·m (29-43 lb-ft)

   — Stage 2: 69-78 N·m (51-58 lb-ft)

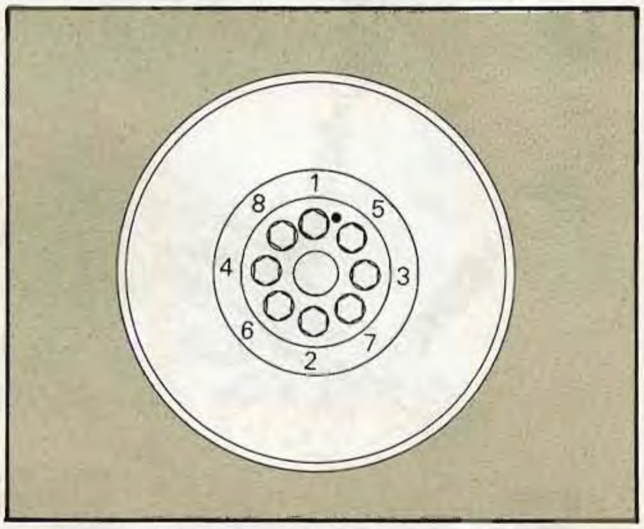


Figure 102. Flywheel Bolt Tightening Sequence

6. Wipe out surplus oil around bolts and any oil that is present on the flywheel surface contacting the clutch disc.

CYLINDER HEAD AND VALVE TRAIN

The primary features of the cylinder heads (Fig. 103) and valve train (Fig. 104) are the Dual Overhead Camshaft (DOHC) and 4 valves per cylinder design. Other features include:

- Cylinder head is made of cast aluminum.
- Valves are actuated by "bucket" type shim adjustable lifters.
- Valve adjustment is accomplished with shims.
- Left and right bank intake camshafts are driven by a timing belt.
- Left and right bank exhaust camshafts are driven by the intake camshafts through timing chains.
- Head bolts are designed to be used for the entire life of the engine. There is no stretch criteria to check for if the bolts are being reused.

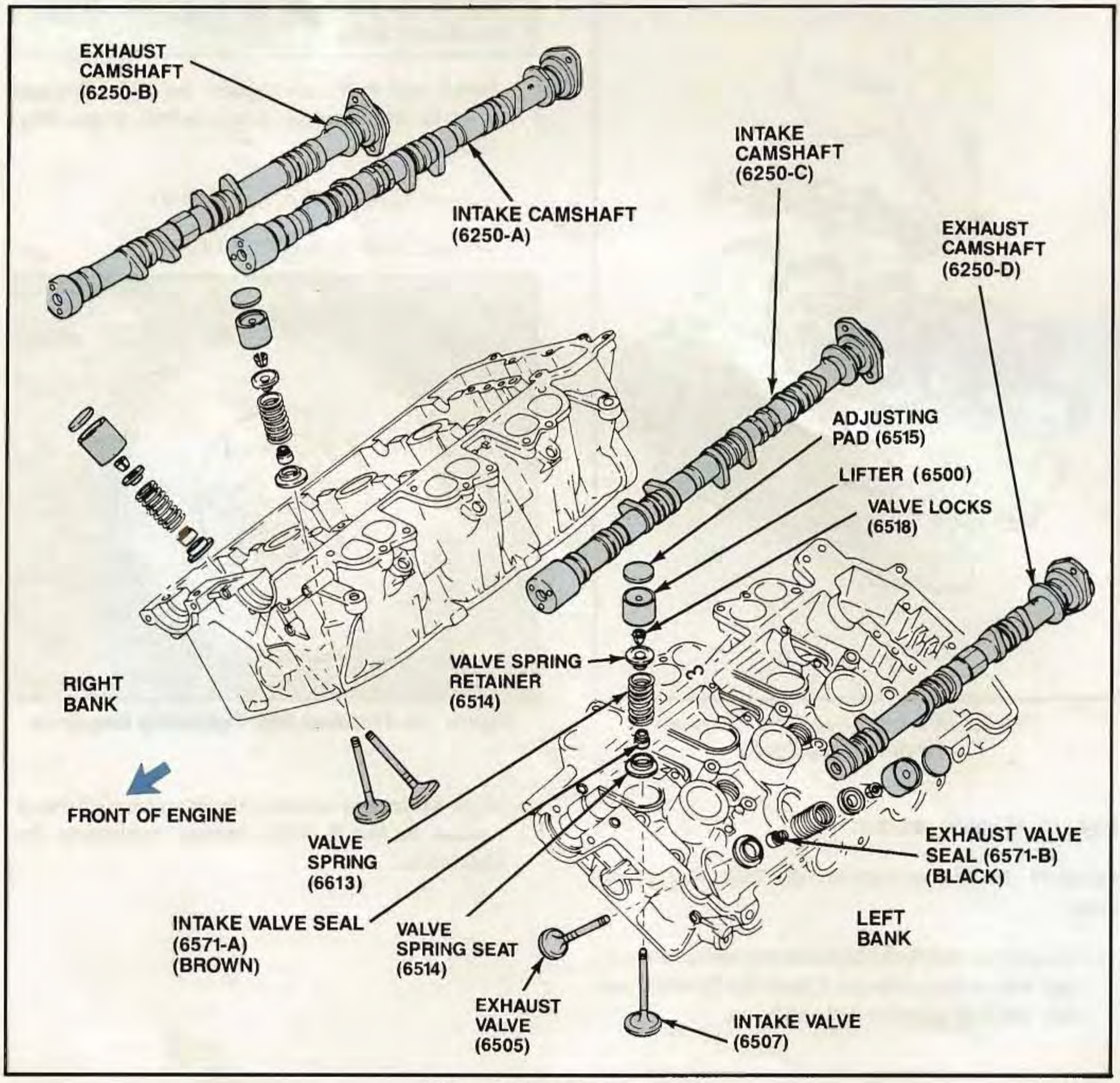


Figure 103. Cylinder Head

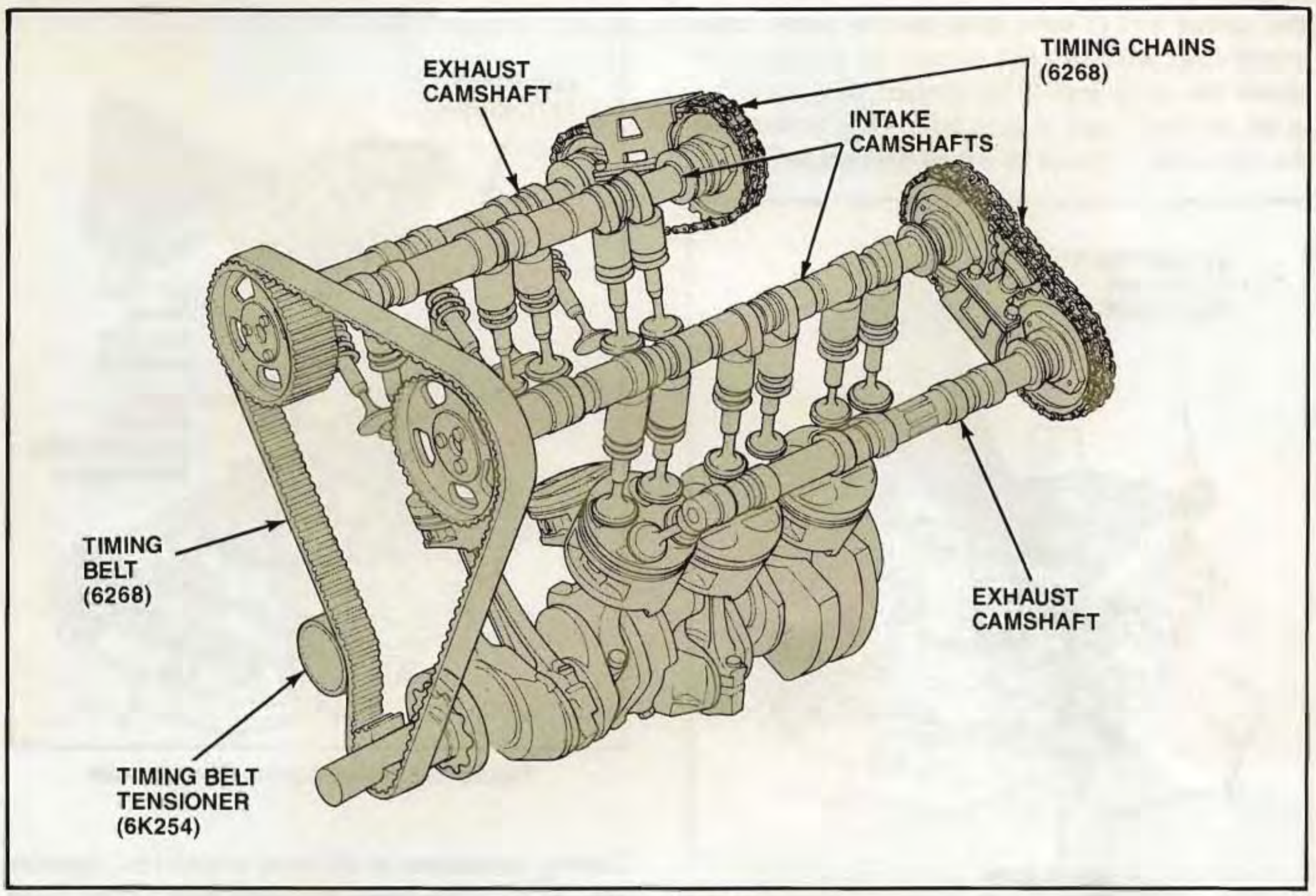


Figure 104. Valve Train

CYLINDER HEAD AND VALVE TRAIN ASSEMBLY FEATURES

Cylinder head and valve train assembly techniques are critical to proper engine operation. This section examines the procedures that must be performed during assembly, including timing. These procedures must be precisely executed for the engine to perform to its maximum potential.

Valve Assembly Service

Valve Seals

Two special tools are required for servicing the valve stem seals. The first is Valve Stem Seal Remover T89P-6510-D (Fig. 105). This tool is used in conjunction with Slide Hammer T79L-100-B and slides beneath the seal, allowing it to be pulled off the end of the valve guide.

Figure 105. Valve Stem Oil Seal Remover

The second tool is Valve Stem Seal Replacer T89P-6510-C (Fig. 106). This tool fits over the valve seal and allows the valve seal to be pressed over the valve guide, by hand, until it seats fully. Prior to installing the valve seal, it should be coated with engine oil.

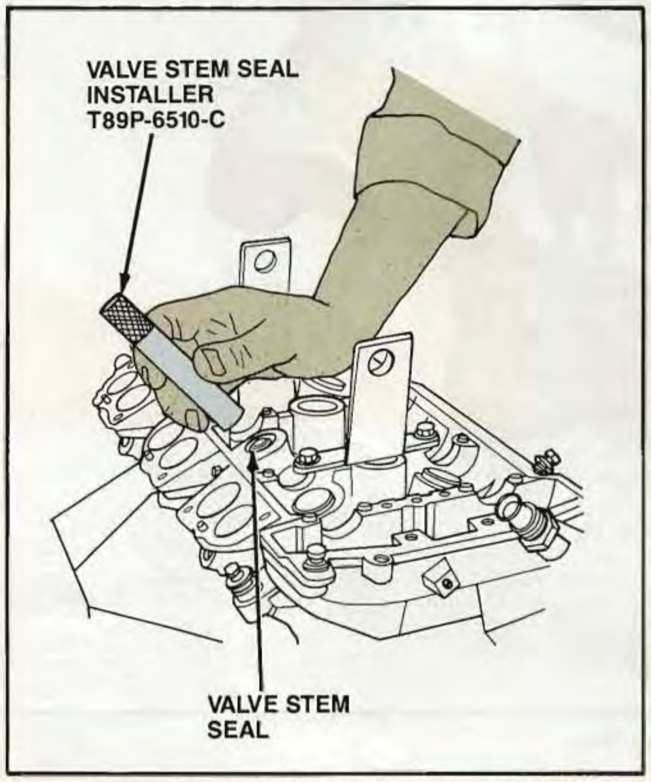


Figure 106. Valve Stem Seal Installation

During installation, take care not to allow the seal to be inclined on the valve guide. It must be fully seated. *Also, be careful not to confuse the valve seals. They are color coded. Brown seals go on the intake valves, black seals go on the exhaust valves.*

Valve, Valve Spring and Valve Guide Service

Valve springs should be removed and installed utilizing Valve Spring Compressor T89P-6565-A (Fig. 107).

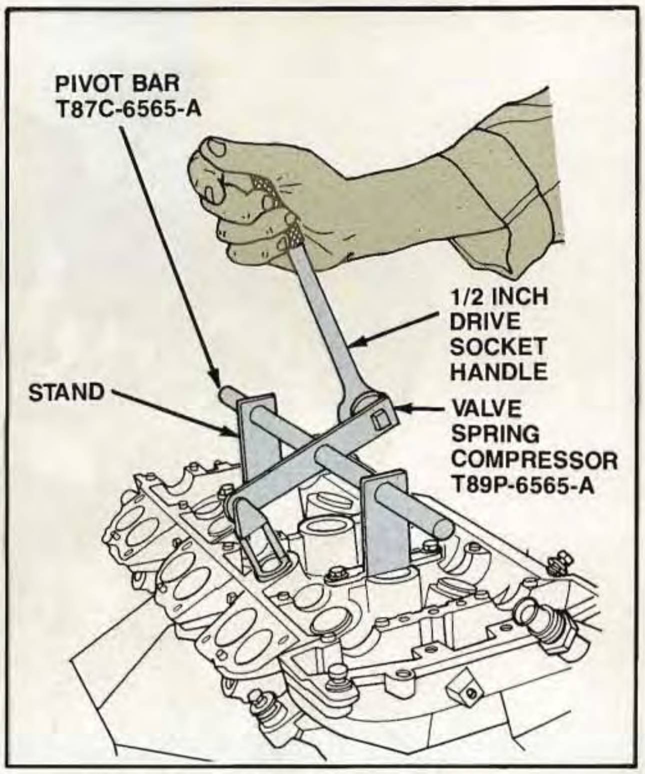


Figure 107. Valve Spring Compressor

During installation of the valve assemblies, lubricate the valves, valve stems and valve guides using clean engine oil. *During installation of the valve springs, make sure that the end of the springs with the wide pitch (painted yellow) is facing upward (Fig. 108).*

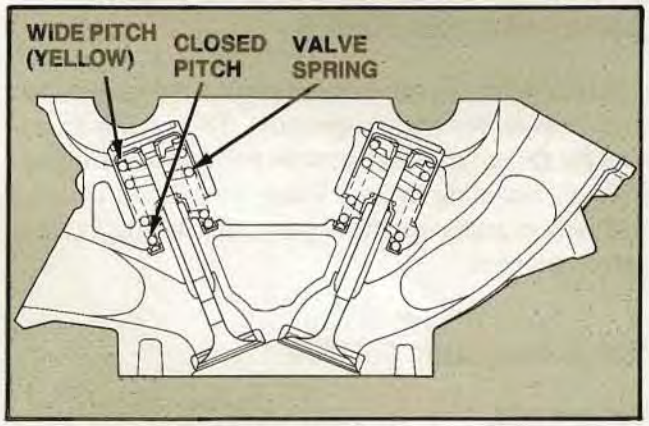


Figure 108. Valve Assembly Installed

The valve lifters should be installed in the cylinder head prior to the camshafts. Use the following procedure to install the lifters:

— Lubricate the lifters, lifter bores and valve tips with clean engine oil prior to installation.

— Install the lifter on the valve stem tip.

— Check that the lifter rotates smoothly in the bore.

— Place the adjusting pad on the lifter with the numbers down. This prevents them from wearing off.

A special point to note is that the valve guides in this engine are serviceable. Valve guides are removed using Valve Guide Remover T89P-6510-A (Fig. 109). Installation of the valve guide is accomplished using the same tool along with Valve Guide Replacer Adapter T89P-6510-B.

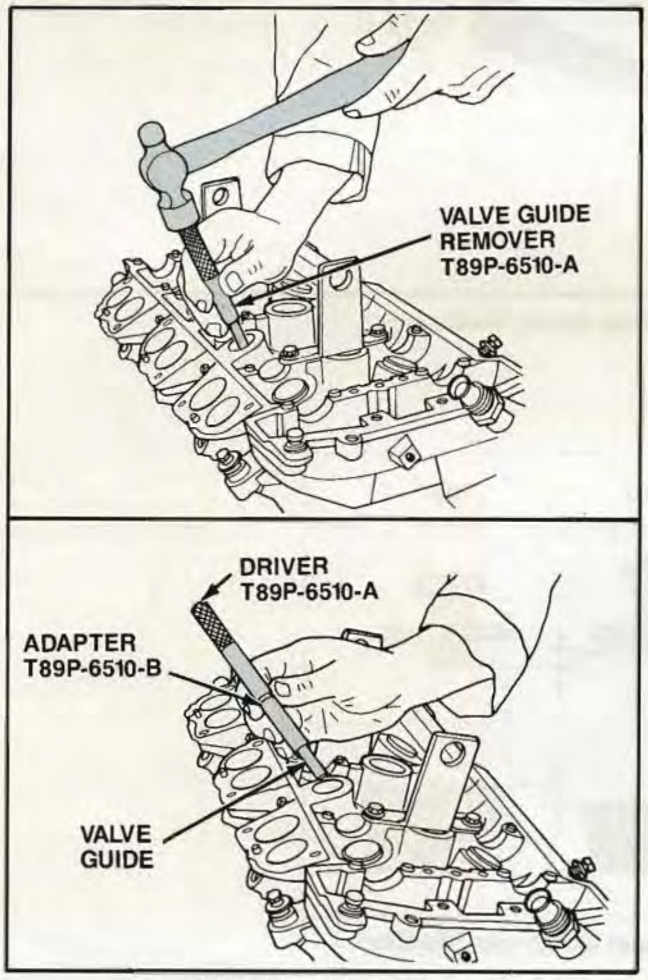


Figure 109. Valve Guide Remover and Replacer Adapter

Camshaft, Timing Chain and Chain Tensioner Installation

Proper installation of the camshaft, timing chain and chain tensioner are critical and must be performed precisely using the following procedures:

1. Install the chain sprockets to the camshafts (Fig. 110).
   - Place the sprockets on the camshafts with the timing mark outward.
   - Align the timing mark of the sprocket with that of the camshaft.
   - Tighten the two bolts by hand, then tighten to 14-18 N·m (10-13 lb-ft).

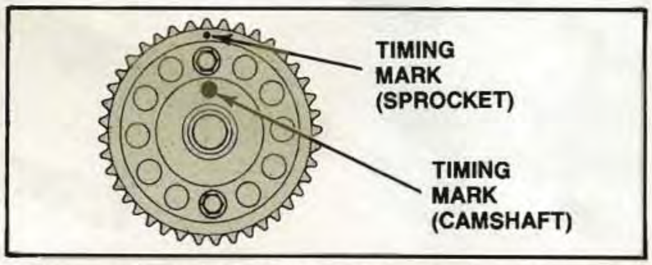


Figure 110. Installing Chain Sprocket to Camshaft

2. Install the right side chain and chain tensioner (Fig. 111). Note that the right side chain tensioner forces down against the chain while the left tensioner forces up (Fig. 112). The tensioners can be identified by their appearance. *Note the height difference in the tensioners and the chain guides (Fig. 113).*
   - Align white chain plate with the sprocket timing mark and install the chain.

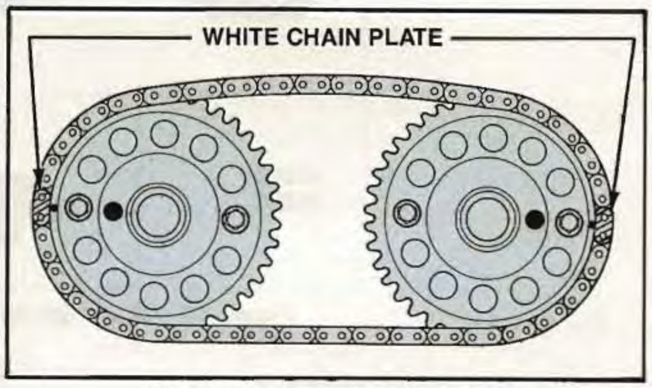


Figure 111. Installing the Chain

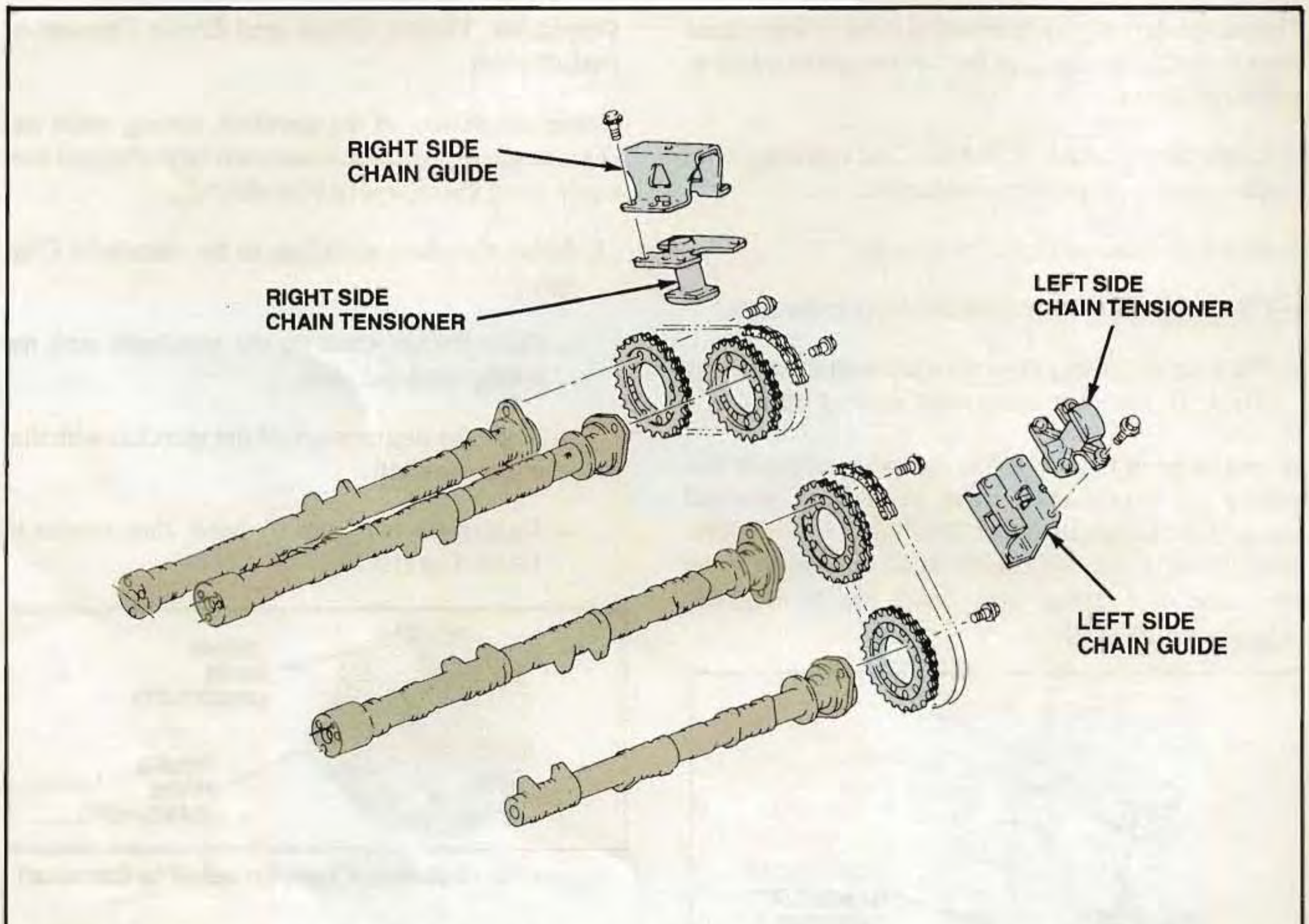


Figure 112. Right and Left Side Chain Tensioners

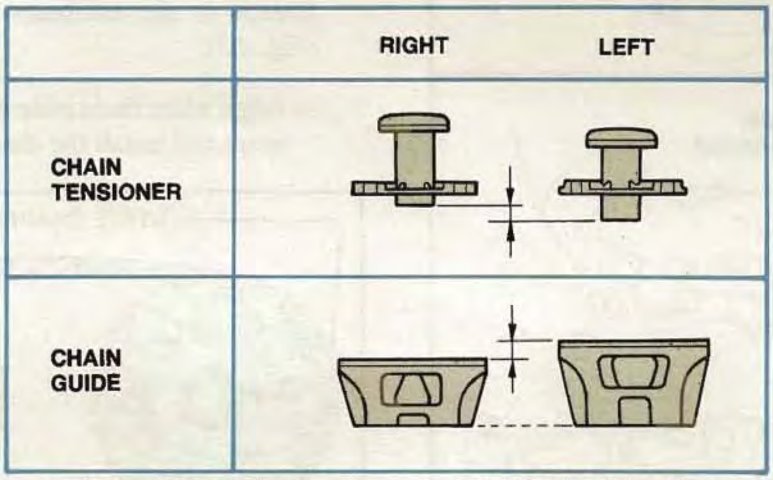


Figure 113. Chain Tensioner and Guide Identification

— Rotate the camshafts approximately 60 degrees counterclockwise.

— Place the chain tensioner between the two sprockets (Fig. 114).

— Place the two camshafts with the chain and chain tensioner on the right side cylinder head.

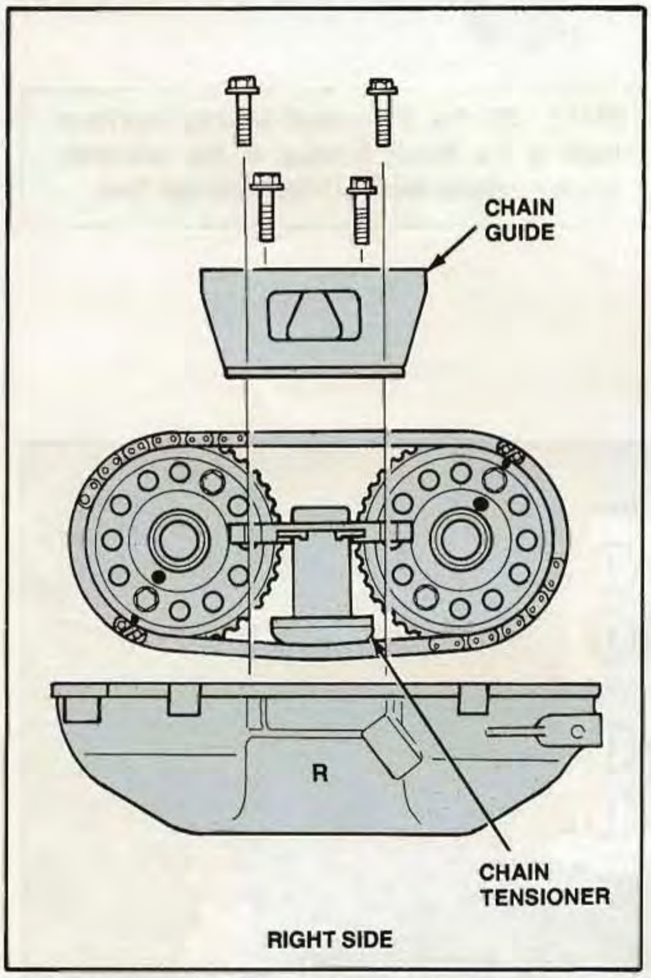


Figure 114. Right Side Chain Tensioner Installed

3. Install the right hand camshaft bearing caps.

— Apply a coat of engine oil on the camshaft journals.

— Install Nos. 2 through 5 camshaft bearing caps and tighten the attaching bolts temporarily.

NOTE: There are directional arrow marks on the camshaft bearing caps. These arrow marks should point to the front of the engine.

— Install the camshaft oil seals using the Camshaft Seal Protector and the Camshaft Seal Expander T89P-6256-B and Camshaft Seal Replacer T89P-6256-A (Fig. 115).

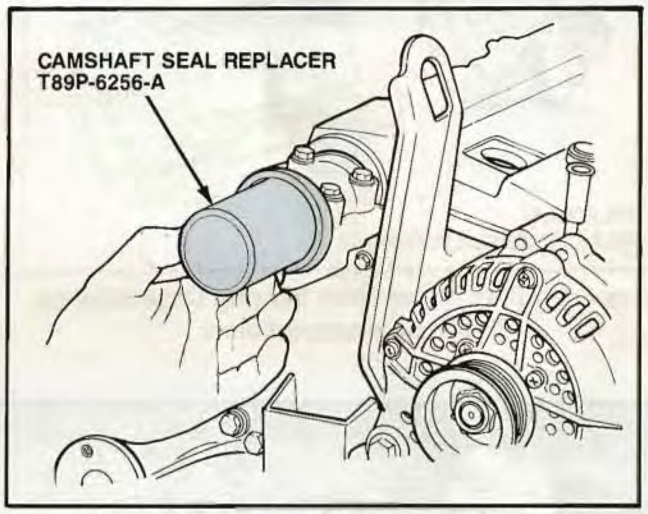


Figure 115. Camshaft Seal Expander and Camshaft Seal Replacer In Use

— Apply Ford Silicone Gasket and Sealant E3AZ-19562-A or equivalent to the cylinder head and the oil seal shoulder as shown (Fig. 116).

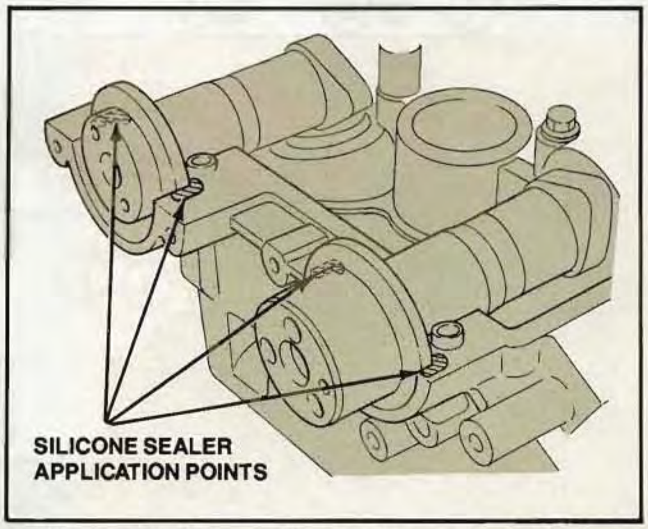


Figure 116. Silicone Sealer Application Points

— Apply a thin bead, approximately 2.5mm (1/10 in.) thick, of Ford Silicone Sealer E3AZ-19562-A or equivalent to the No. 1 bearing caps (Fig. 117).

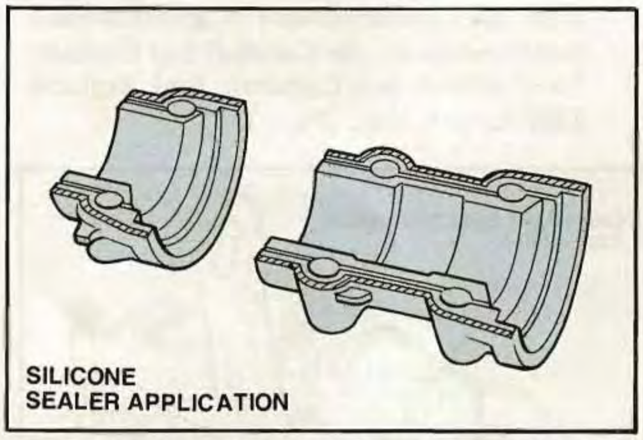


Figure 117. No. 1 Camshaft Bearing Caps Silicone Sealer Application Points

— Install and tighten the No. 1 camshaft bearing caps while holding the oil seal in position with Camshaft Seal Replacer T89P-6256-A.

— Tighten the bearing cap attaching bolts in two steps in the sequence indicated. On the first step, tighten the bolts to 11 N·m (8 lb-ft). On the second step tighten the bolts to a final torque specification of 16-22 N·m (12-16 lb-ft) (Fig. 118).

NOTE: The No. 5 camshaft bearing cap functions as the thrust bearing of the camshaft. Always tighten the No. 5 bearing cap first.

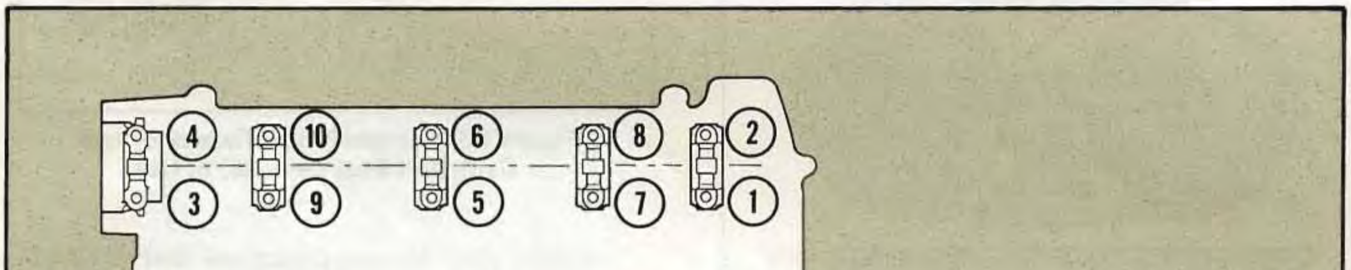


Figure 118. Camshaft Bearing Torque Sequence

— Position the right side chain guide and chain tensioner on the cylinder head and tighten the retaining bolts to 15-19 N·m (11-14 lb-ft).

— Rotate the camshaft approximately 60 degrees clockwise, then check the alignment of the timing mark of the chain and sprockets.

4. Install the left side chain and chain tensioner using the same techniques that were used on the right side (Fig. 119).

NOTE: Location of the left side chain tensioner and guide are opposite those of the right side.

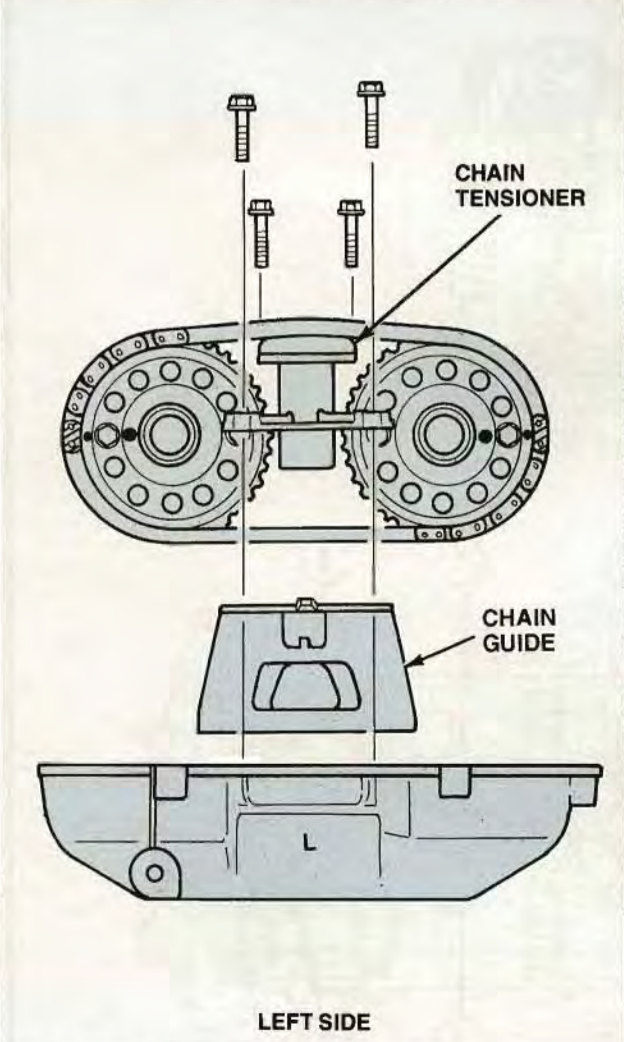


Figure 119. Left Side Chain Tensioner, Guide and Timing Chain

5. Install the camshaft bearing caps on the left side using the same procedures as for the right cylinder head.

NOTE: Install the left side bearing caps while compressing the chain tensioner by hand to avoid damaging the bearing caps.

6. Using a plastic hammer, lightly tap the valve stem tip to ensure a proper fit.

CYLINDER HEAD AND GASKET INSTALLATION

The SHO engine utilizes a composite cylinder head gasket (Fig. 120) that has a steel core and steel firing ring seal. A common gasket is used for both the right and left sides. The gasket is positioned by two alignment dowels.

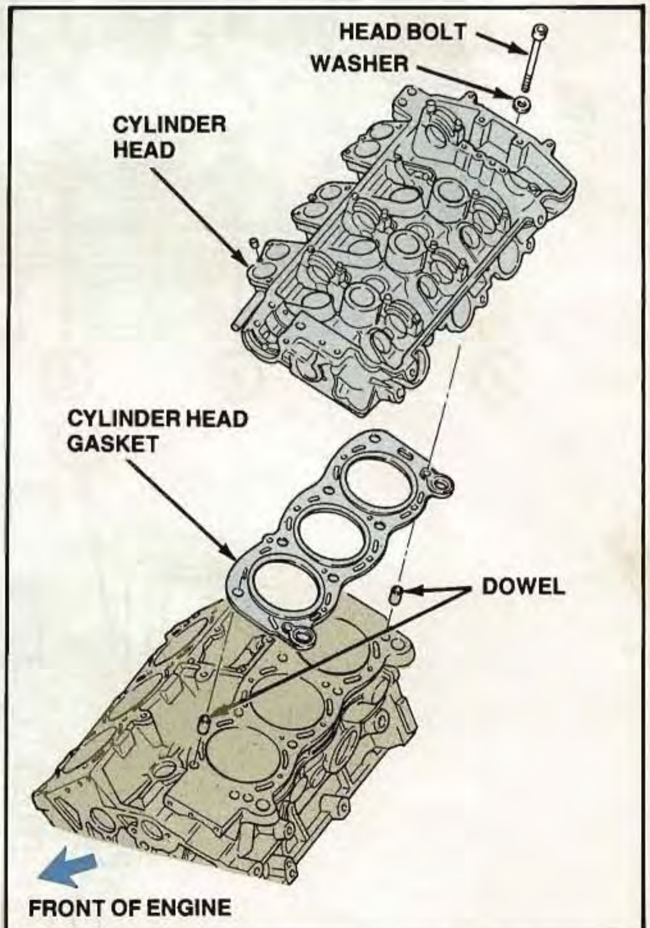


Figure 120. Cylinder Head Gasket

Cylinder Head Installation Procedures

The following procedures must be followed when installing the cylinder head to assure proper cylinder sealing:

1. Completely remove all foreign materials or oil from the upper surface of the cylinder block and lower surface of the cylinder head.
2. Place the head gasket and cylinder head on the cylinder block. Use the dowel pins to align both the gasket and head.
3. Apply a light coat of engine oil on the threads and under the head on the cylinder head bolts.
4. Install the cylinder head bolts and washers and tighten them in two steps (Fig. 121):

— First to 49-69 N·m (36-51 lb-ft)

— Second to 83-93 N·m (61-69 lb-ft).

NOTE: During cylinder head service and installation the intake ports should be taped closed to prevent parts or foreign materials from falling in.

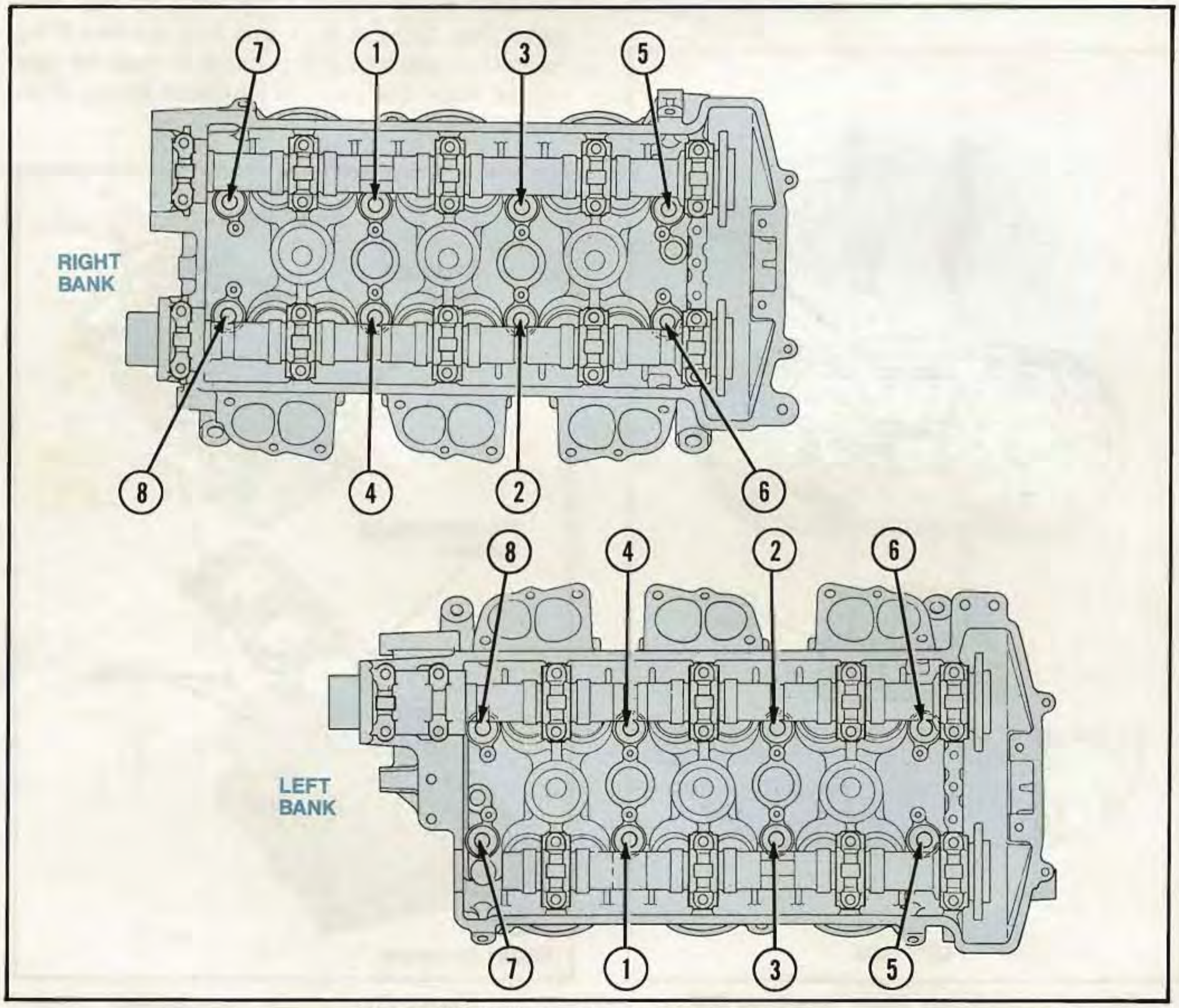


Figure 121. Cylinder Head Torque Sequence

CRANKSHAFT PULLEY, CAMSHAFT PULLEY, CRANKSHAFT DAMPER AND TIMING BELT INSTALLATION

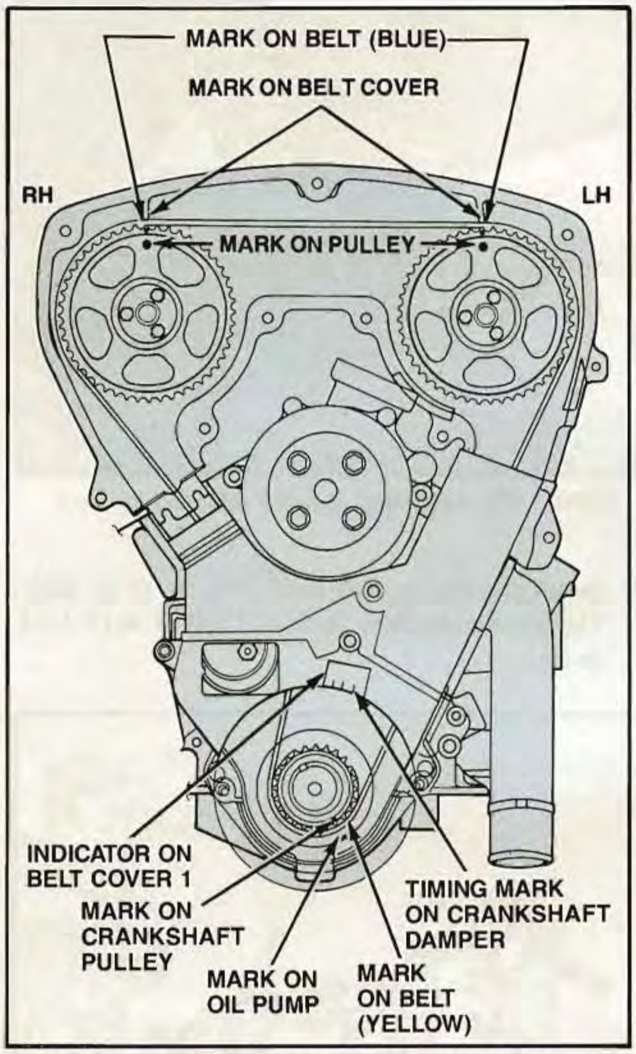


Figure 122. Timing Belt Components (Marks When No. 1 Cylinder is at T.D.C. on Compression Stroke)

The crankshaft sprocket, camshaft sprocket, crankshaft damper and timing belt must be installed so that the timing marks are aligned as shown when the No. 1 piston is at TDC (Fig. 122).

Prior to installation of the timing belt there are certain procedures that must be followed to assure the belt is not damaged. They are:

- Do not bend tightly, twist or turn the belt inside out.
- Do not allow the belt to come into contact with oil, gasoline, water or steam.
- Keep the belt in a cool and dark room for long term storage.
- Do not hit or squeeze the belt with a hammer or screwdriver during removal or installation.
- While handling the belt on a pulley, do not tighten or loosen the pulley set bolts without holding the shaft with a wrench or special jig. This prevents timing from being altered. Note that there are special tools available for this engine to hold the camshafts and the crankshaft. These will be discussed in this section.

NOTE: If a timing belt is removed for service it can be reused. The maintenance interval on timing belts is 96,000 km (60,000 miles).

Install the components using the following procedures:

1. Install the timing belt idler subassembly (Fig. 123).

   — Install the stud bolt on the cylinder block.

   — Install the idler subassembly with the torsion spring onto the stud bolt on the cylinder block. Install the nut and washer and tighten the nut slightly.

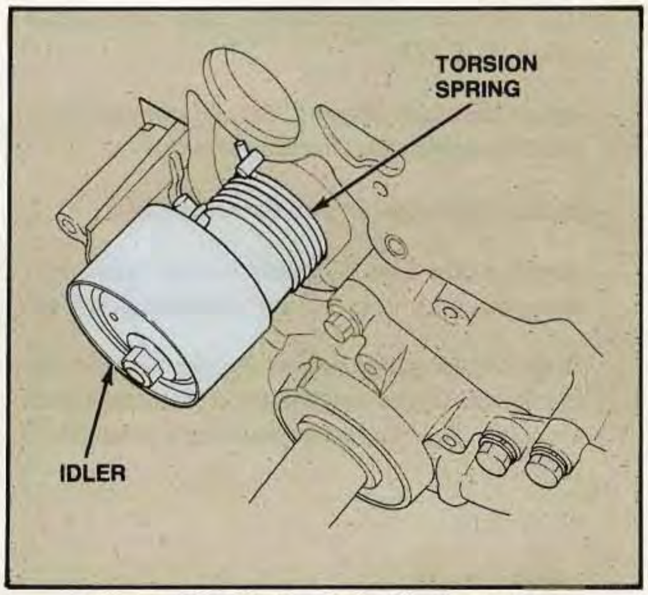


Figure 123. Timing Belt Idler Installation

— Insert a 6mm hex wrench into the idler screw while holding the idler with a wrench or socket. Rotate the idler fully clockwise to apply pressure on the spring and tighten the nut (Fig. 124).

NOTE: Make sure that the spring is placed properly on the pins of the idler and cylinder block so that when it is released it will apply pressure on the timing belt.

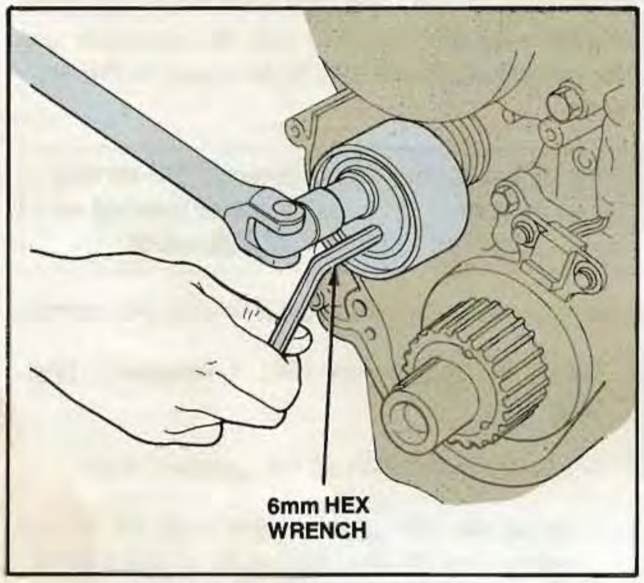


Figure 124. Tightening the Idler

2. Install the crankshaft sensor and crankshaft sprocket (Fig. 125).

   — Attach the crank sensor to the oil pump and temporarily tighten the attaching screws.

   — Install the straight key on the crankshaft.

   — Apply a thin film of grease on the crankshaft then push the crankshaft sprocket into position.

   — With a feeler gauge, adjust the gap between the crankshaft sensor and shutter on the crankshaft sprocket. The clearance should be 0.8mm (0.03 in.).

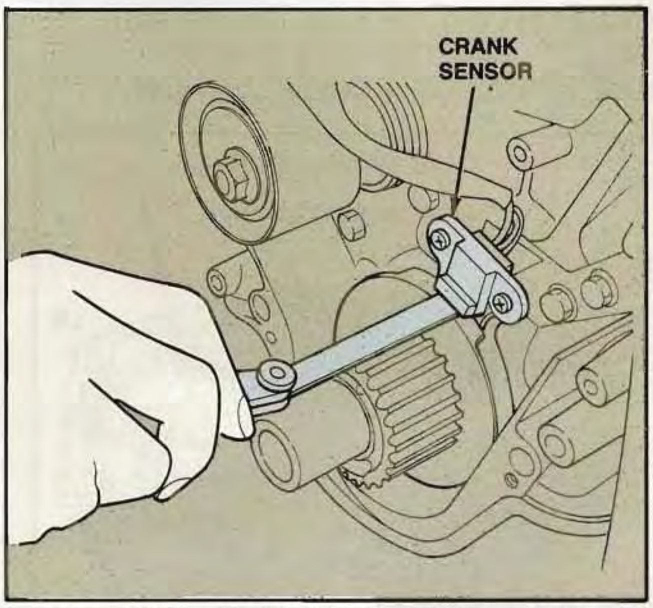


Figure 125. Adjusting Crankshaft Sensor Gap

3. Install the timing belt cover No. 5 (Fig. 126). Tighten the attaching bolts to 7.1-11 N·m (5.2-7.8 lb-ft).

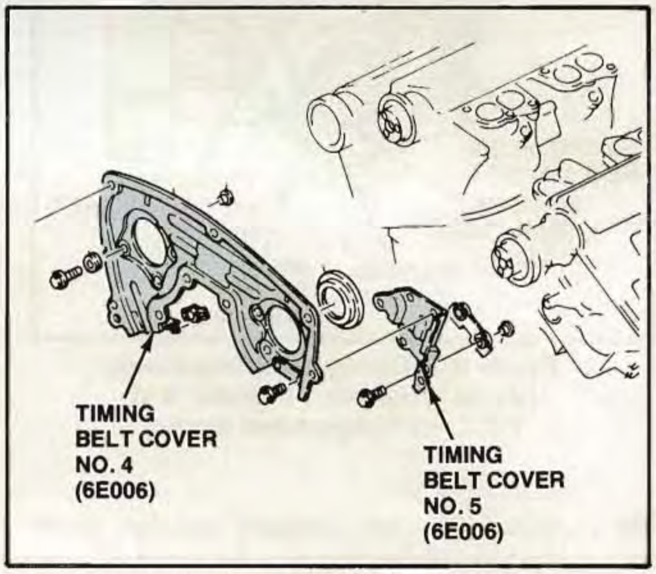


Figure 126. Installing Timing Belt Covers Nos. 4 and 5

4. Install timing belt cover No. 4. Tighten attaching bolts to 7.1-11 N·m (5.2-7.8 lb-ft).

5. Install the timing belt with the "KOA" mark toward the cylinder head (Fig. 127). Temporarily install the timing belt on the crankshaft pulley and tensioner.

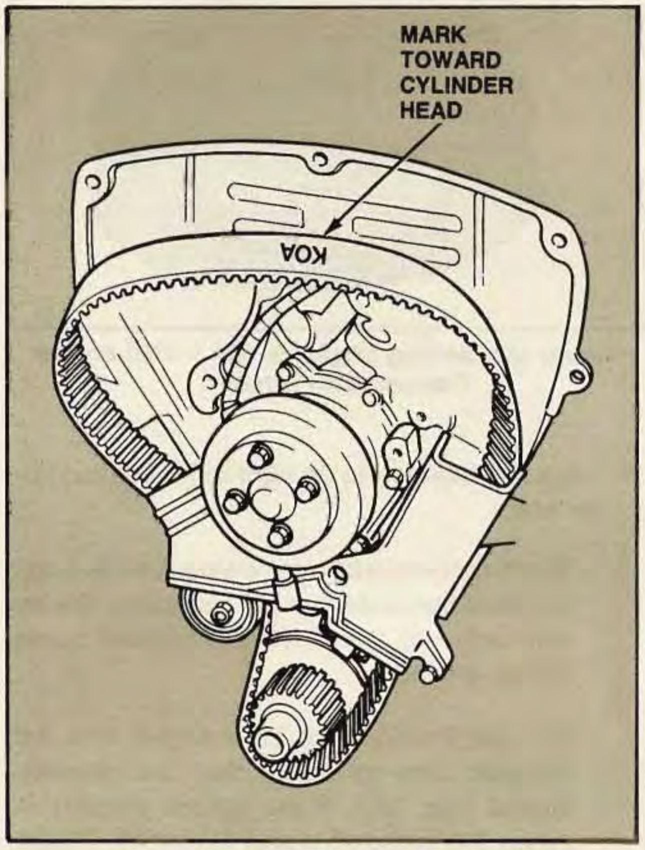


Figure 127. Installing the Timing Belt

6. Install timing belt covers 2 and 1 (Fig. 128).

— While holding the timing belt, place timing belt cover No. 2 onto the engine. Tighten the attaching bolts to 8.8 N·m (5.8 lb-ft).

— Set the crankshaft sensor wire seal into the groove of belt cover No. 2.

— Install the timing belt guide. The cup side should face outward.

— Place belt cover No. 1 with its gasket on the engine and tighten the four attaching bolts to 8.8 N·m (5.8 lb-ft).

— Remove the timing belt.

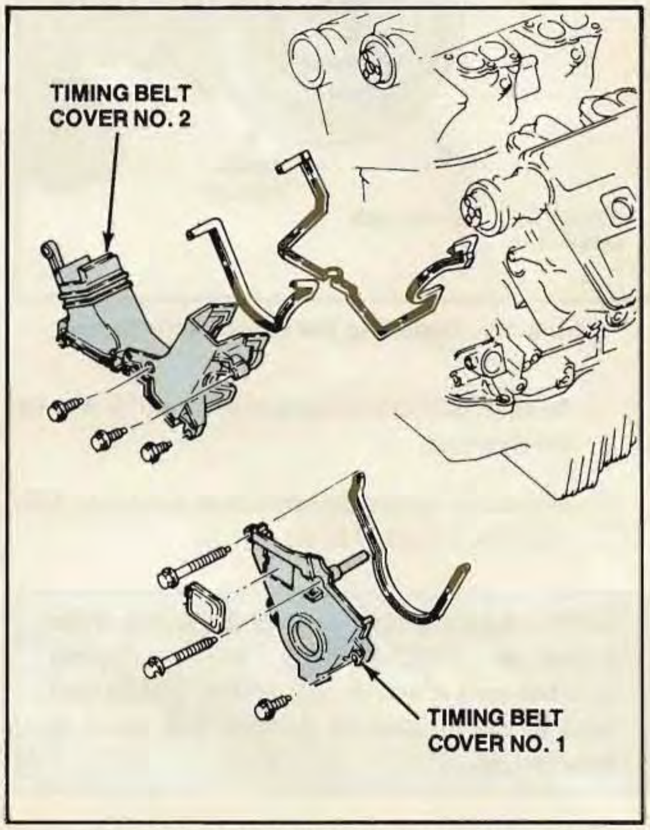


Figure 128. Installing Timing Belt Covers Nos. 1 and 2

7. Install the crankshaft damper (Fig. 129).

   — Align the key groove of the pulley with the key and position the gear.

   — Using Crankshaft Seal Installer Aligner T88T-6701-A with forcing screw from T82L-6316-A, press the crank damper onto the crankshaft.

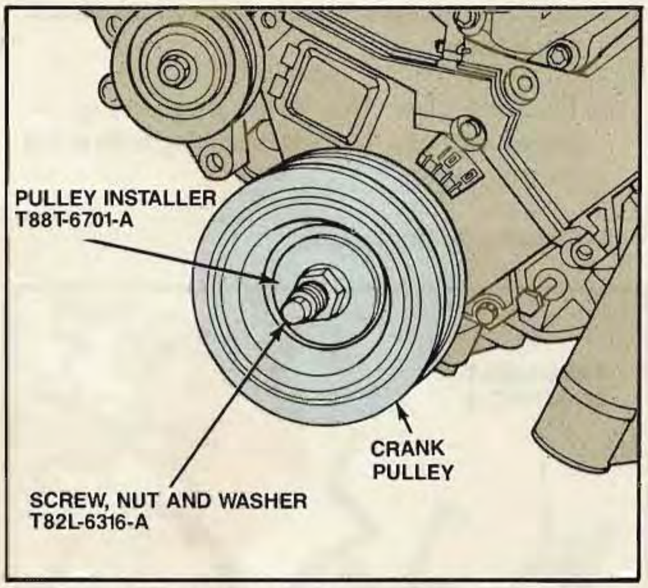


Figure 129. Installing the Crankshaft Damper

   — Install flywheel holding tool T74P-6375-A to fix the flywheel.

   — Install and tighten the crankshaft damper to 152-172 N·m (112-127 lb-ft).

NOTE: Apply a light coat of Ford Dry Film Lubricant E2SZ-19553-A (or equivalent molybdenum disulfide oil) to the thread and head of the crankshaft damper bolt prior to installation.

8. Set No. 1 cylinder at TDC on the compression stroke. To do this, rotate the crankshaft and align the white timing mark on the crankshaft pulley with the zero mark on the timing belt cover No. 1 (Fig. 130). This is approximately 60 degrees from the 12 o'clock position.

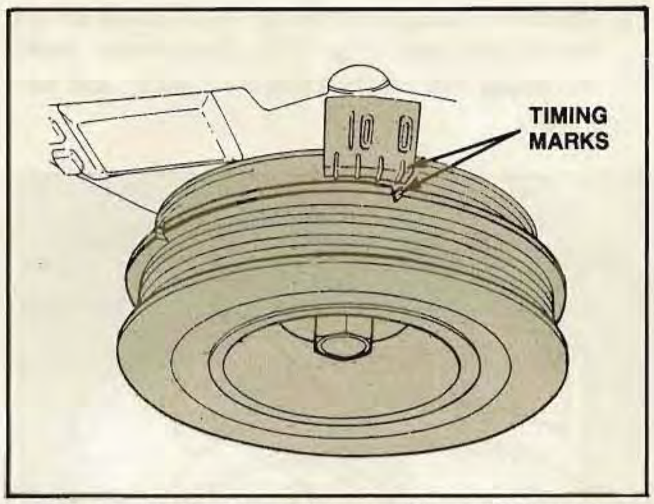


Figure 130. Setting Engine to No. 1 TDC on the Compression Stroke

9. Align the camshafts in the right and left side cylinder heads.

   — Rotate the camshafts using a wrench on the octagon flats machined into the camshafts. Set the camshafts with their "KOA" embossed marks facing upward.

   — Set Cam Position Tool T89P-6256-C over the camshaft flats to assure they are properly aligned (Fig. 131). If the tool fits properly it means that camshaft timing is correct. This is essential to proper engine operation.

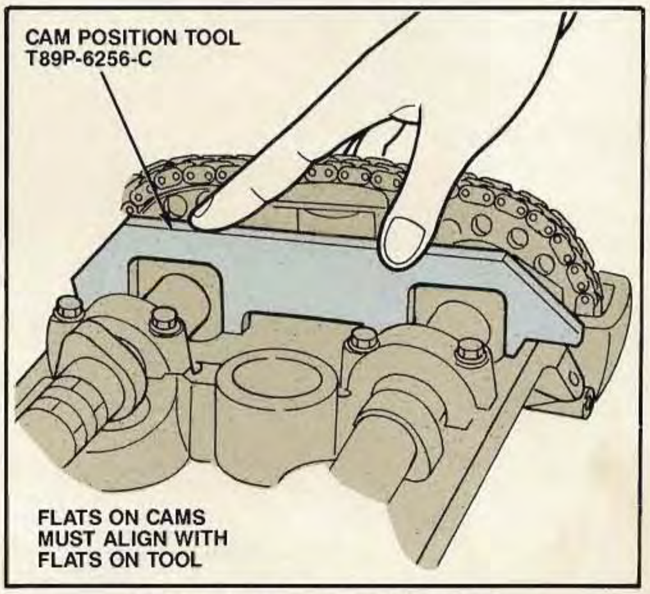


Figure 131. Cam Position Tool

— If the camshafts are properly aligned the timing marks on the cam sprockets will be positioned as shown (Fig. 132).

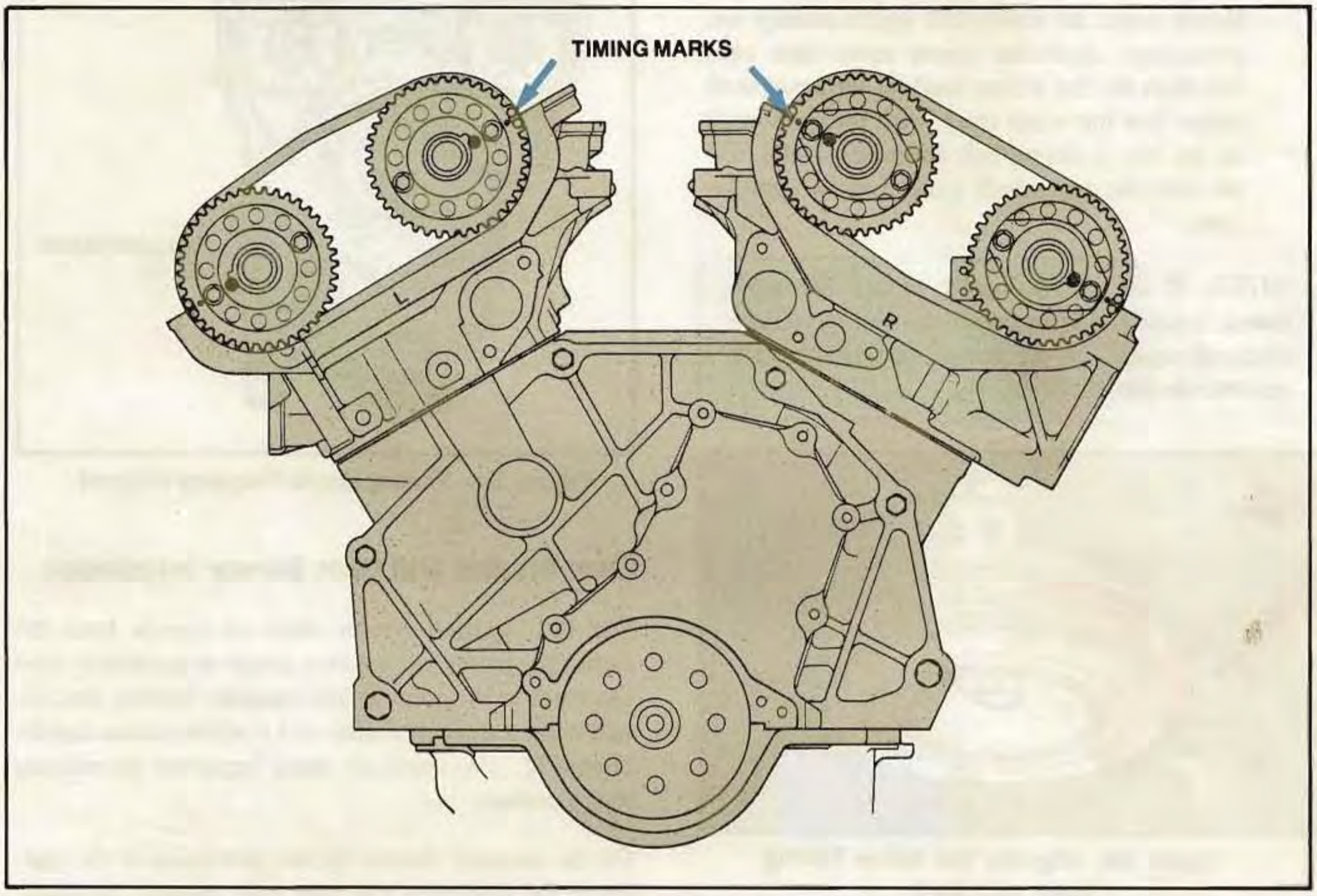


Figure 132. Timing Marks Properly Aligned

10. Install timing belt and camshaft pulleys (Fig. 133).

    — Set Cam Position Tool T89P-6256-C on the right side camshafts.

    — While giving belt tension at other side of tensioner, align timing mark on pulley and belt cover 4, then install left camshaft pulley with belt on camshaft 3, then install right camshaft pulley.

    — Insert dowel pin.

    — Tighten up camshaft pulley and washer with 3 flange bolts per each cylinder while holding at the octagonal portion of the camshaft with an adjustable wrench. Tighten bolts to 21-25 N·m (15-18 lb-ft).

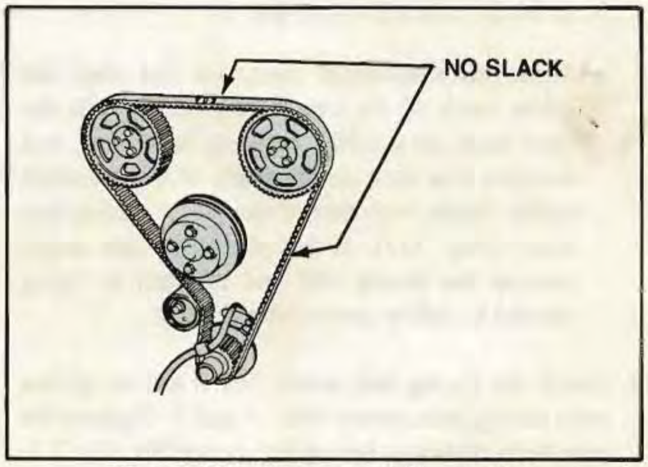


Figure 133. Timing Belt Tensioning

11. Apply tension to the timing belt.

    — Loosen the tensioner nut and allow the tensioner to move against the timing belt.

    — Slowly rotate the crankshaft approximately two revolutions clockwise (never more than two) and align the the yellow mark of the crankshaft pulley (not the white one), with the zero mark on the No. 1 timing belt cover (Fig. 134). Do not turn the crankshaft more than two revolutions.

NOTE: If the yellow mark passes the zero mark, rotate the crankshaft less than two revolutions again. Never rotate the crankshaft counterclockwise.

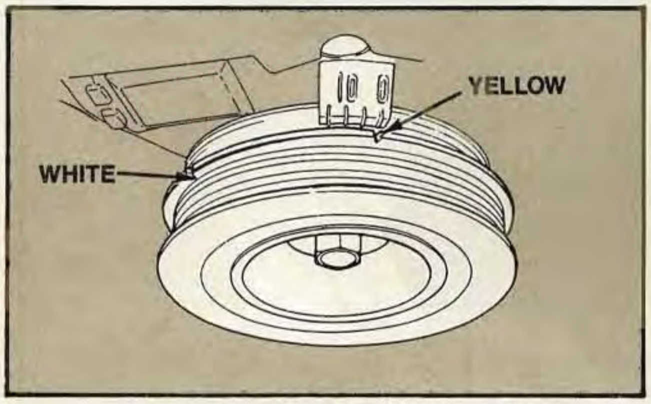


Figure 134. Aligning the Yellow Timing Mark with Zero

    — Tighten the timing belt tensioner attaching nut to 34-50 N·m (25-37 lb-ft).

    — Rotate the crankshaft clockwise and align the white mark of the crankshaft pulley with the zero mark on the No. 1 timing belt cover, and confirm that each timing mark of the camshaft pulley aligns with that of the No. 4 timing belt cover (Fig. 135). If the marks do not align, remove the timing belt and reinstall it, being careful to follow procedures exactly.

12. Install the timing belt cover No. 3 and its gasket onto timing belt covers Nos. 4 and 5. Tighten the nine bolts retaining timing belt cover No. 3 to 7.1-11 N·m (5.2-7.8 lb-ft).

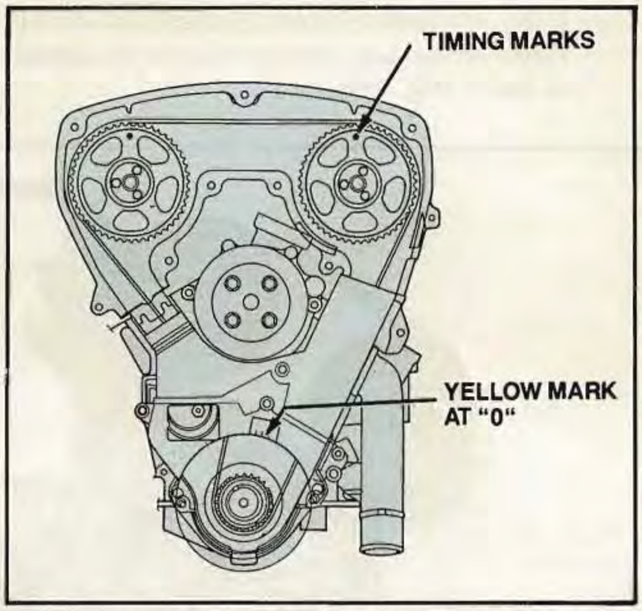


Figure 135. Timing Marks Properly Aligned

Cam Shutter and Cam Sensor Installation

The DIS ignition system relies on signals from the camshaft shutter and position sensor to accurately time the spark to the combustion chamber. During installation of the camshaft shutter and position sensor assemblies (Fig. 136) there are some important procedures to remember.

On the camshaft shutter, set the protrusion of the shutter in the cavity on the right side exhaust camshaft. Tighten the camshaft shutter bolts (2) to 1.5-2.5 N·m (13-22 lb-in)

Install the camshaft position sensor assembly to the right side cylinder head. Tighten the two bolts retaining the position sensor to 7.1-11 N·m (5.2-7.8 lb-ft).

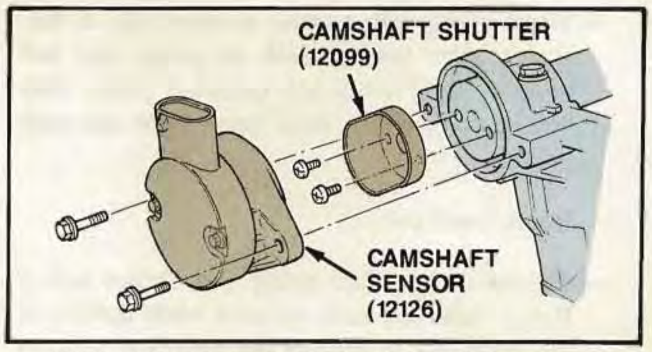


Figure 136. Camshaft Shutter and Camshaft Position Sensor

VALVE CLEARANCE ADJUSTMENT

The following description provides only the valve adjustment procedure. Refer to the Shop Manual for the complete procedure, including information on what components have to be removed, order of removal, etc. Valve adjustment on the SHO engine is accomplished with shims, or adjusting pads as they are typically referred to.

NOTE: Inspect and adjust the valve clearance when the engine is cold.

Prior to measuring clearance it is important to position the cam lobe upward, away from the pad so that the base circle of the camshaft is facing the pad area (Fig. 137). Valve clearance, when cold, should be as follows:

Intake: 0.15-0.25mm (0.006-0.010 in.) Exhaust: 0.25-0.35mm (0.010-0.014 in.)

Record any measurement which is out of specification.

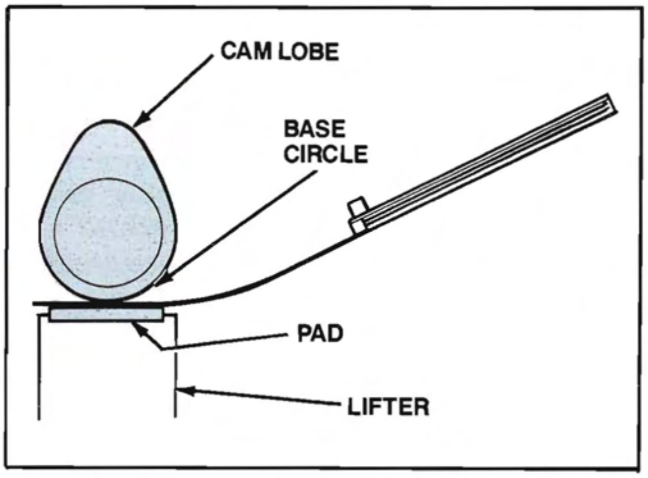


Figure 137. Measuring Valve Clearance

Valve Adjustment Procedure

1. Turn the crankshaft to position the cam lobe upward, away from the adjusting pad.
2. Position the notch of the valve lifter toward the spark plug (Fig. 138).

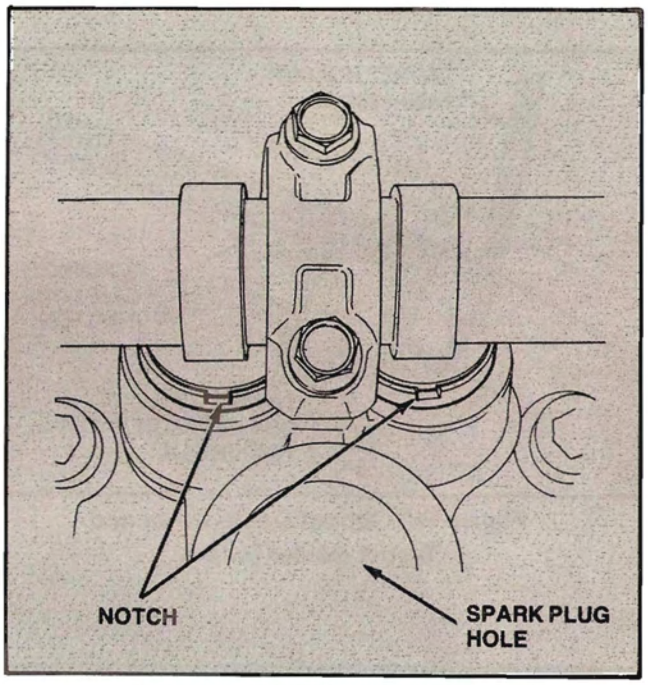


Figure 138. Positioning the Notch

3. Insert Tappet Compressor T89P-6500-A from the spark plug side and press down the lifter (Fig. 139).

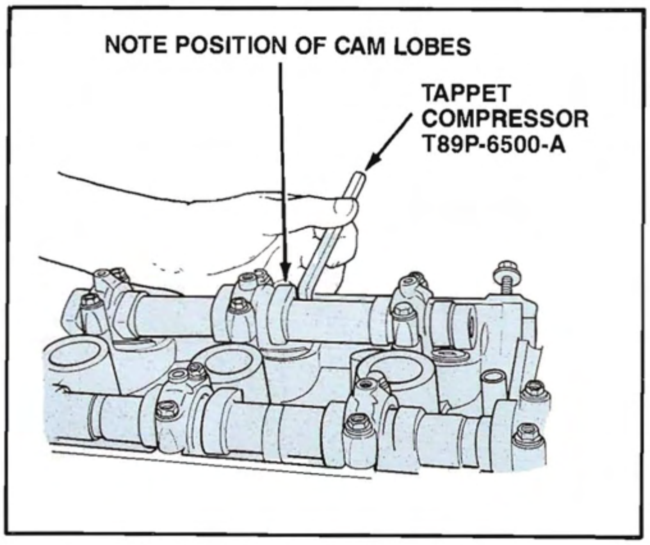


Figure 139. Tappet Compressor

4. Place Tappet Holder T89P-6500-B between the camshaft and edge of the valve lifter, then remove the Tappet Compressor (Fig. 140).

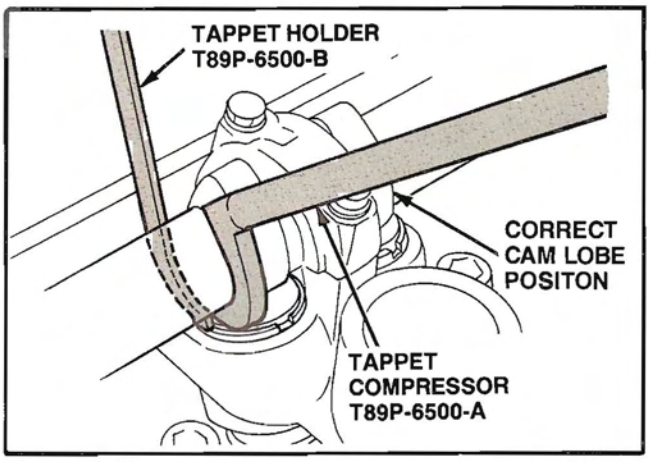


Figure 140. Tappet Compressor and Tappet Holder In Use

NOTE: The Tappet Holder must be positioned so that it is pushing only against the edge of the lifter (Fig. 141). If the tool contacts the adjusting pad it cannot be removed.

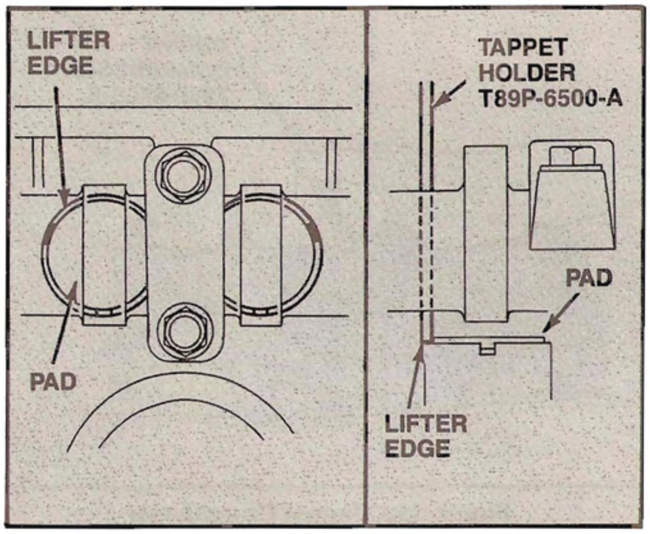


Figure 141. Tappet Holder Properly Positioned

5. Using O-ring pick T71P-19703-C, or equivalent, pry the adjusting pad out of the valve lifter (Fig. 142).

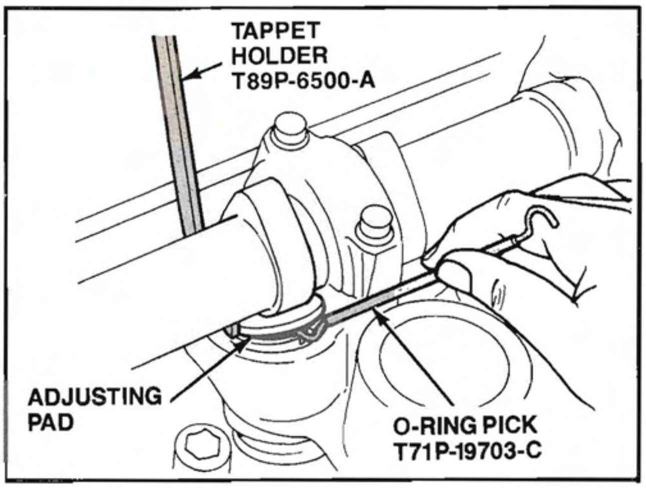


Figure 142. Removing Adjusting Pad

NOTE: Adjusting Pad sizes are metric.

6. Determine the replacement pad size by using the following formula:

INTAKE: N = T+A - 0.20mm (0.008 in.)
EXHAUST: N = T+A - 0.30mm (0.012 in.)

T: Thickness of Pad Used A: Valve Clearance Measured N: Thickness of New Pad

NOTE: There are 52 sizes of adjusting pads available from 2.00 to 3.25mm (0.0787 to 0.1280 in.) in 0.025mm (0.001 in.) increments. If numbers have been worn off, use a micrometer to measure pad thickness.

7. Install a new adjusting pad on the valve lifter.

NOTE: Pad thickness is stamped on the pad (Fig. 143). Install new pads with numbers down, against the lifter. This will prevent the numbers from being worn off the pad.

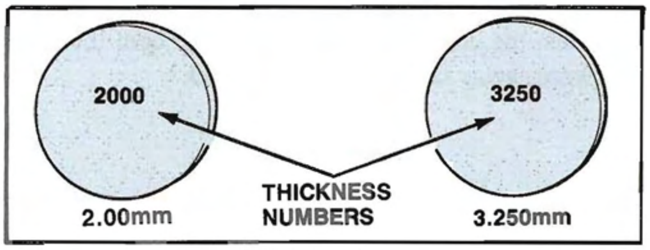


Figure 143. Adjusting Pad Thickness Numbering

8. Insert Tappet Compressor T89P-6500-A from the spark plug side, press down the lifter and remove Tappet Holder T89P-6500-B.

9. Remove the Tappet Compressor.

10. Check valve clearance.

11. Repeat Steps 1 through 10 for each valve to be adjusted.

Cylinder Head Cover Installation

The cylinder head covers (Fig. 144) must be installed according to recommended procedures to prevent oil leakage or damage to spark plug wires.

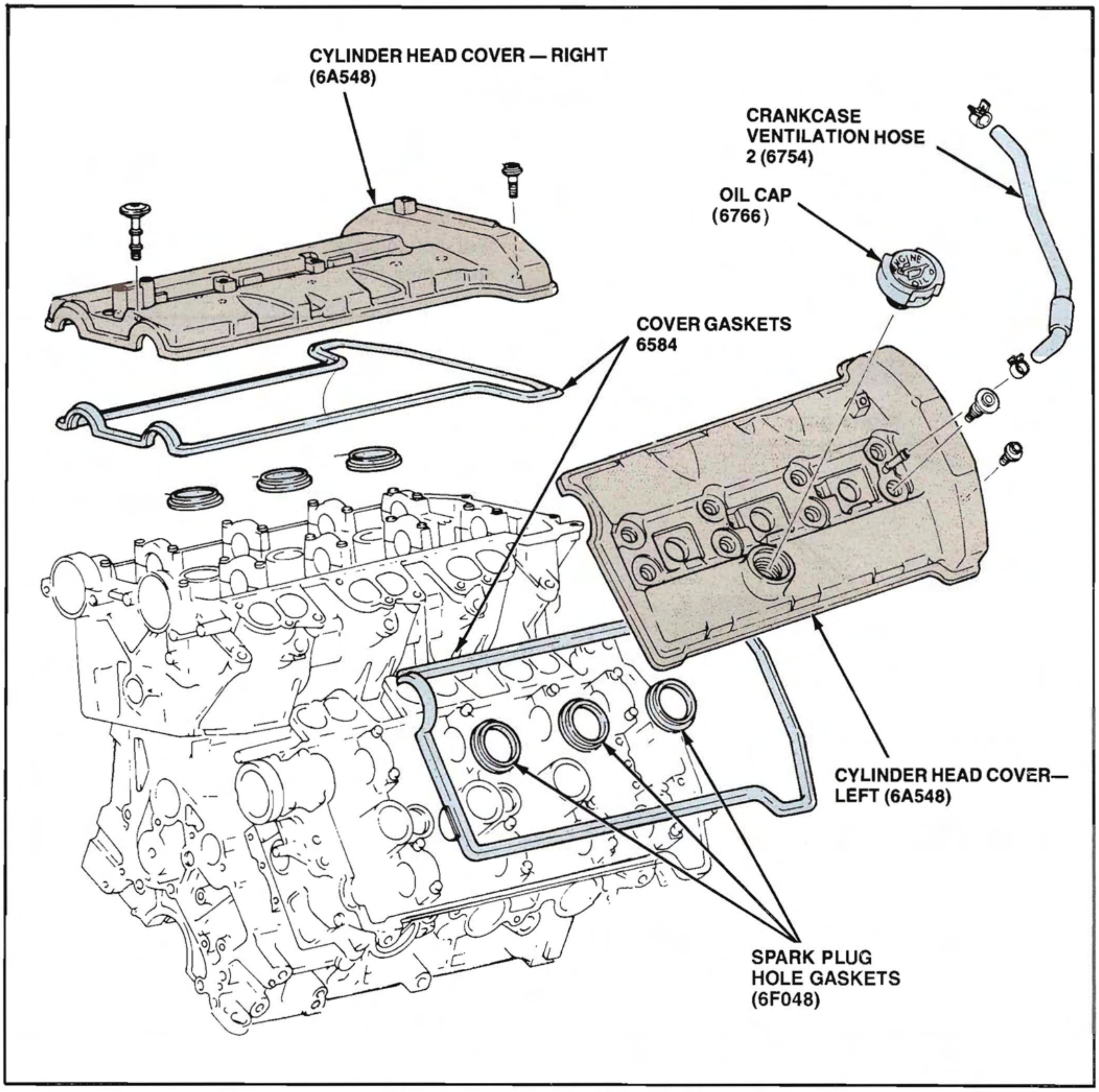


Figure 144. Cylinder Head Covers

1. Remove any oil or foreign materials from the cylinder head cover gasket groove and the cylinder head cover.

2. Apply Silicone Sealer E3AZ-19562-A at four points on both the right and left side cylinder heads (Fig. 145).

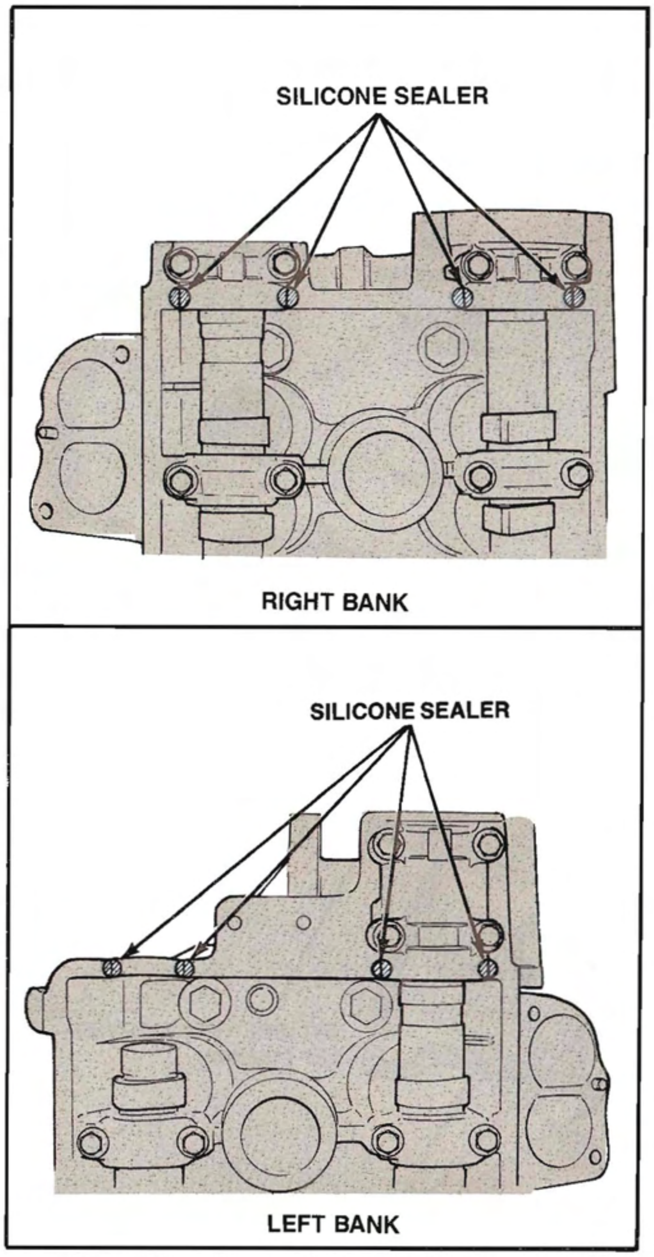


Figure 145. Silicone Sealer Application Points

3. Install the cylinder head cover gasket and three plug hole gaskets to each cylinder head cover.

4. Install and tighten each cylinder head cover with the eight retaining bolts and two seal bolts. Tighten retaining bolts to 10-16 N·m (7-12 lb-ft). Tighten seal bolts to 8-12 N·m (6-9 lb-ft)

NOTE: If the fuel pipe subassembly is already installed, be careful not to damage the fuel pipe subassembly while installing the cylinder head cover.

5. Install the crankcase ventilation hose 2 onto the left cylinder head cover with its white paint mark toward the pipe (Fig. 146). Make sure that the clip holding the hose is moved to a position where it will not interfere with, or cause damage to the spark plug wire.

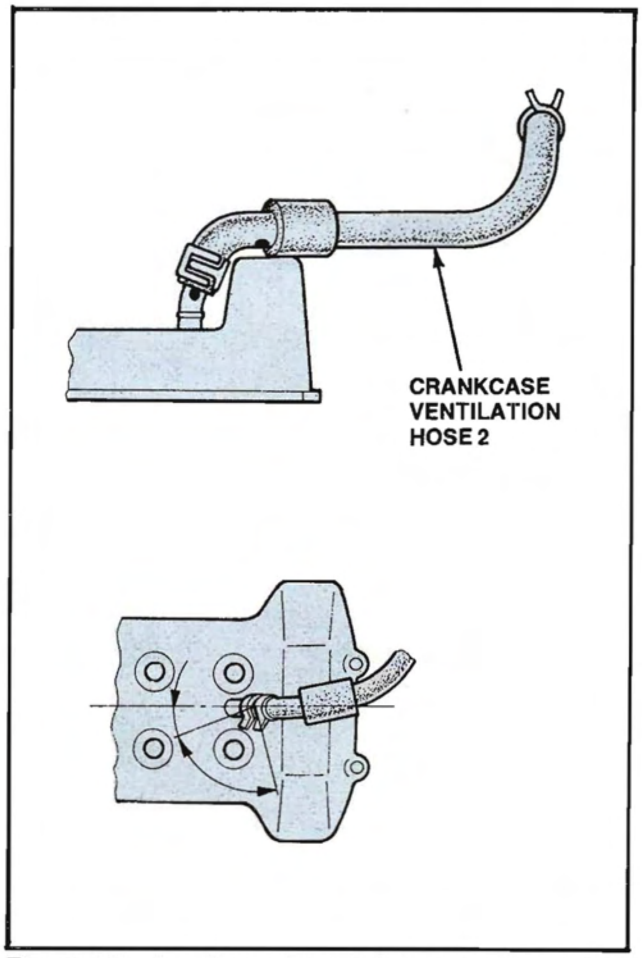


Figure 146. Crankcase Ventilation Hose Installation

ENGINE ACCESSORY DRIVES

The 3.0L SHO engine accessory drive features two poly-vee rib belts, each tensioned by a "Jack Screw" bolt (Fig. 147). The first belt is a six-rib type that drives the alternator and air conditioner compressor. The idler pulley provides the means to tension the belt and provide increased belt wrap for the crankshaft drive pulley and alternator. The second belt is a four-rib type that drives the water pump and power steering. Note that power steering is standard on all Taurus SHO vehicles.

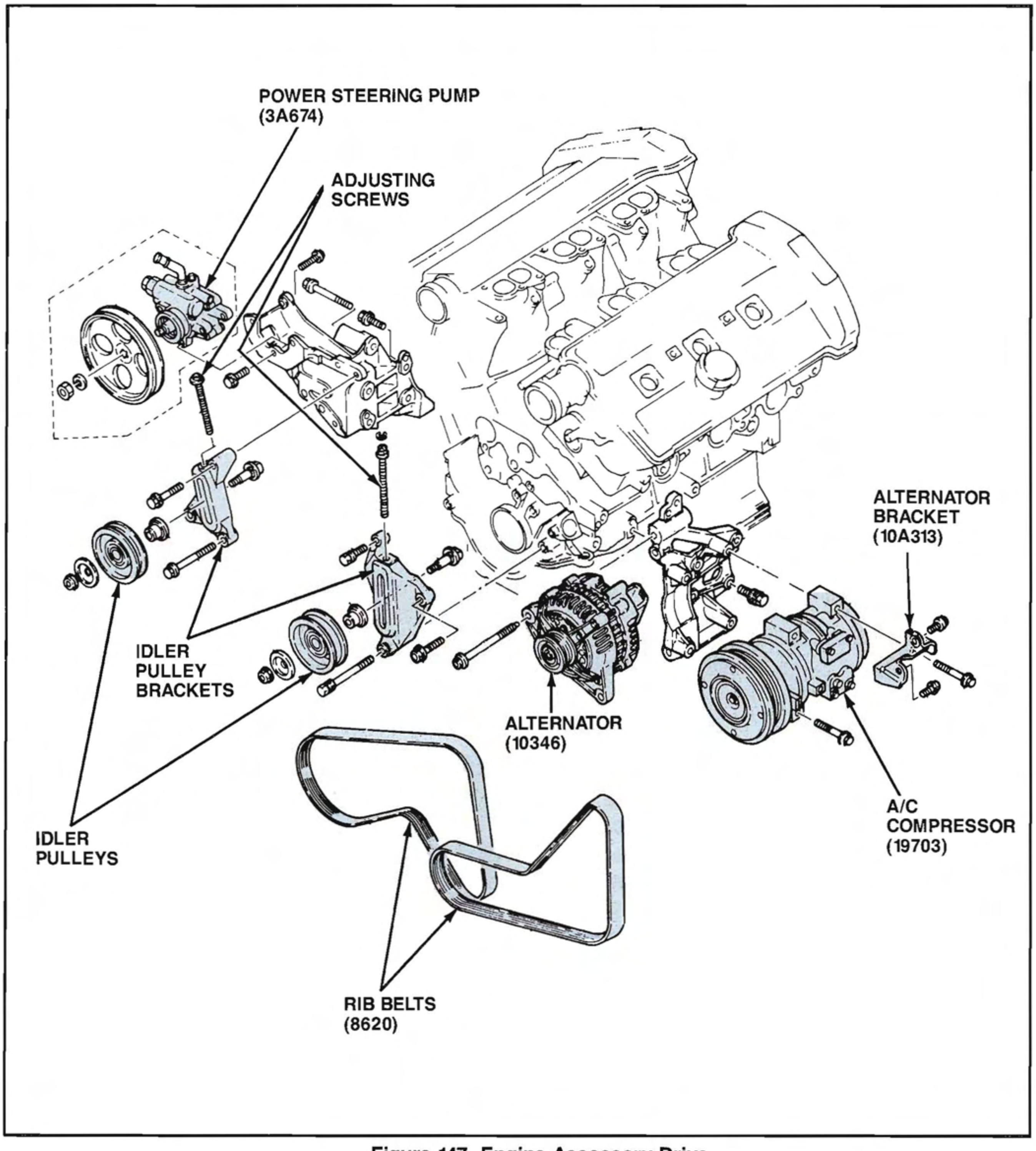


Figure 147. Engine Accessory Drive

ENGINE ACCESSORY DRIVES

Fully assembled, the accessory drive should match this depiction (Fig. 148).

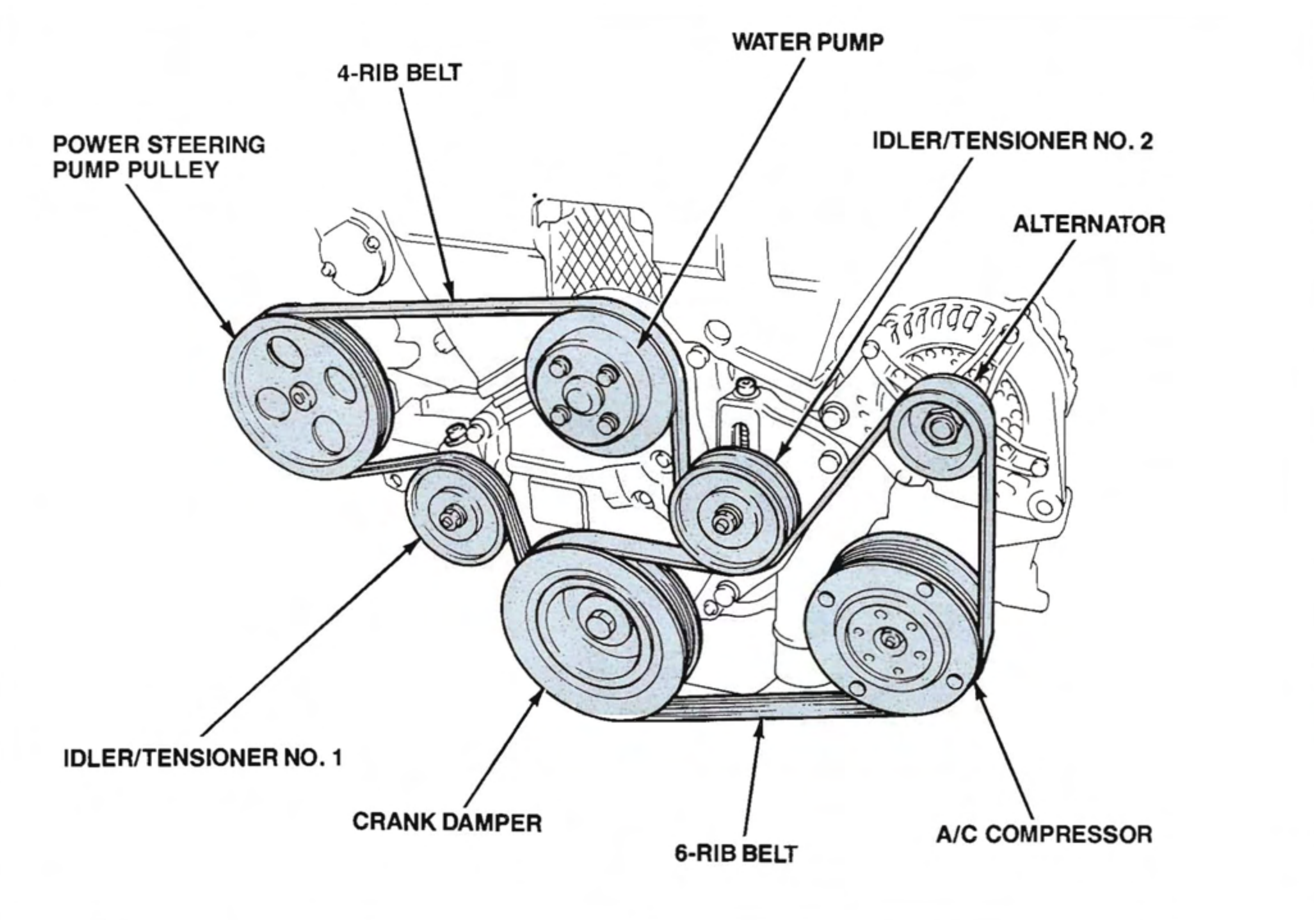


Figure 148. Engine Accessory Drive Assembled

Belt tension is very important to the proper operation of the driven components and also to the life of the drive belt. The following specifications for the drive belts should be maintained at all times (Fig. 149). Note that the values indicated for belt tension are determined using Rotunda Belt Tension Gauge 021-00061. Tension can be measured at any span between the pulleys and/or the idler. Another point to be aware of is that the idler pulley bolt should not be adjusted when the idler pulley nut is tightened.

BELT TENSION SPECIFICATIONS

Engine	Belt Type		New Installation		Used Belt Reset		Allowable Minimum	
			N	Lbs	N	Lbs	N	Lbs
3.0L SHO Engine	6-Rib	Air Conditioning Alternator	980-1180	220-265	660-850	148-192	535	120
	4-Rib	Power Steering Water Pump	690-880	154-198	500-700	112-157	357	80

Figure 149. Belt Tension Specifications

ACCESSORY INSTALLATIONS

Power Steering Pump Installation

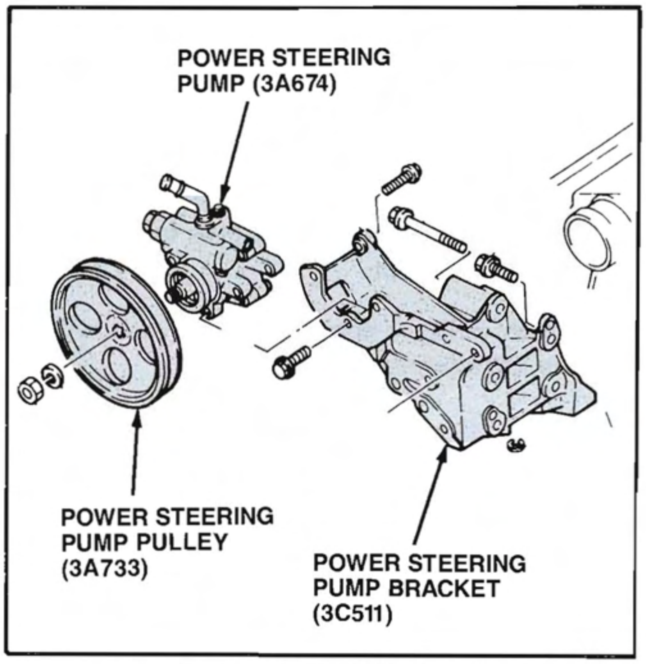


Figure 150. Power Steering Pump

1. Install the power steering pump bracket to the cylinder block and tighten the five retaining bolts to 36-55 N·m (27-41 lb-ft) (Fig. 150).

2. Install the power steering pump and tighten the four retaining bolts to 21-32 N·m (15-24 lb-ft).

3. Install the power steering pump pulley and tighten the attaching spring washer and nut to 54-68 N·m. (40-50 lb-ft) using strap wrench D85L-6000-A.

A/C Compressor and Alternator Installation

1. Install the A/C compressor bracket to the cylinder block and tighten the four retaining bolts to 36-55 N·m (27-41 lb-ft) (Fig. 151).

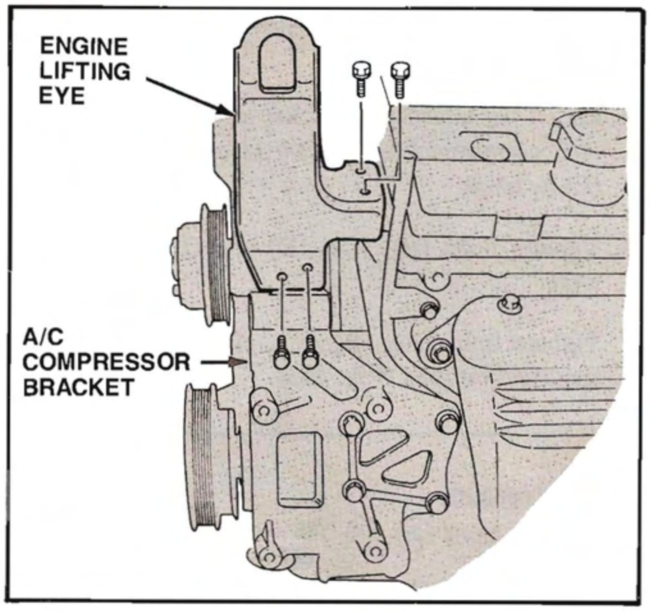


Figure 151. A/C Compressor Bracket

2. Install engine lifting eye 2 to the A/C compressor bracket and left cylinder head. Tighten the two bolts to 16-23 N·m (11-17 lb-ft).

NOTE: Lifting eye 2 must be installed before the alternator.

3. Install the A/C compressor to bracket and temporarily tighten with the two bolts (A) (Fig. 152).

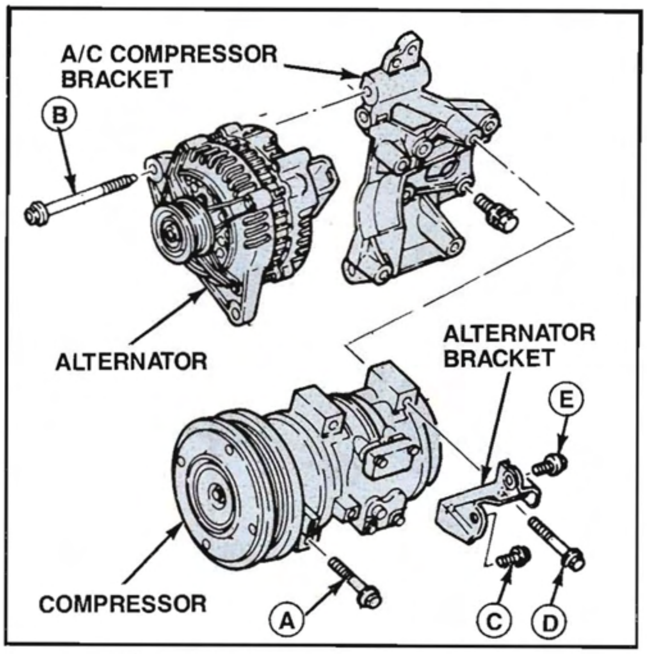


Figure 152. Alternator Installation

4. Install the alternator on the bracket and tighten bolt (B) by hand.

5. Install the alternator bracket to the alternator and A/C compressor and screw in bolts (C), (D) and (E) by hand.

6. Tighten bolts (B), (C), (D) and (E) so they are snug.

7. Tighten bolts (A), (B), (C), (D) and (E) to their specified torques (Fig. 153).

TORQUE:

BOLT Ⓐ, Ⓓ	:36 — 55 N·m (27 — 41 Lb-ft)
BOLT Ⓑ	:48 — 72 N·m (35 — 53 Lb-ft)
BOLT Ⓒ, Ⓔ	:34 — 50 N·m (25 — 37 Lb-ft)

Figure 153. Bolt Torques for A/C Compressor and Alternator Mounting

Idler Pulley Subassembly 1 Installation

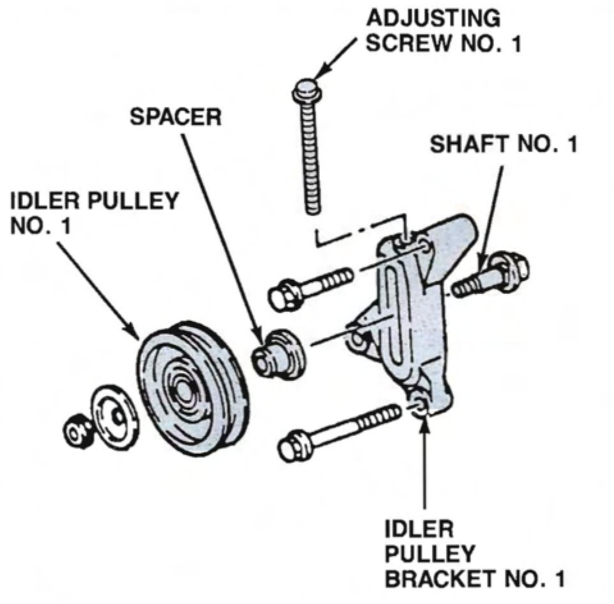


Figure 154. Idler Pulley Subassembly 1 Installation

1. Install idler pulley shaft 1 to the idler pulley bracket 1 and screw belt adjusting screw 1 into the pulley shaft (Fig. 154).

2. Install the idler pulley bracket to the power steering pump bracket and cylinder block with three retaining bolts. Tighten the bolts to 16-23 N·m (12-17 lb-ft).

3. Install the idler pulley spacer, idler pulley subassembly 1 and the idler pulley plate to shaft 1 and tighten the lock nut.

4. Set idler pulley 1 downward as far as it will go using belt adjusting screw 1.

Idler Pulley Subassembly 2 Installation

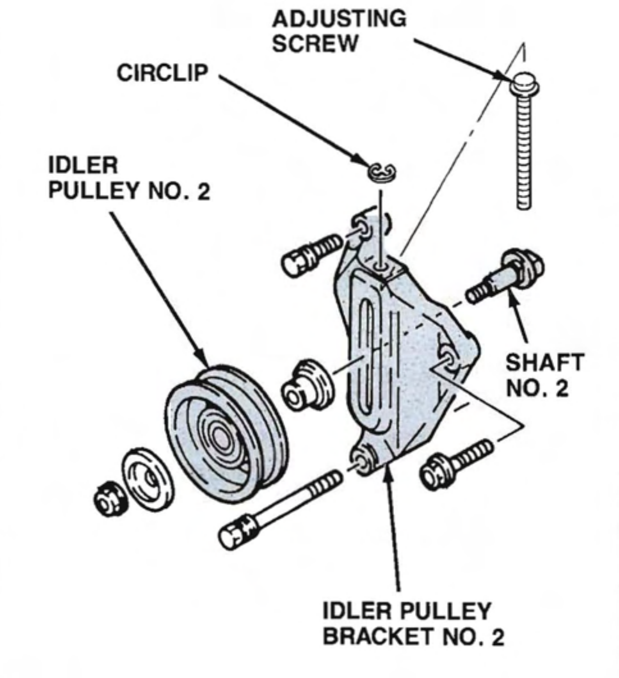


Figure 155. Idler Pulley Subassembly 2 Installation

1. Install idler pulley shaft 2 with adjusting screw 2 to idler pulley bracket 2 and install the circlip to adjusting screw 2 (Fig. 155).

2. Install idler pulley bracket 2 to the water pump, a/c compressor and cylinder block. Tighten the 3 bolts as specified (Fig. 156).

TORQUE:		
	TO A/C BRACKET	:36 — 55 N·m (27 — 41 Lb-ft).
	TO WATER PUMP	:15 — 23 N·m (11 — 17 Lb-ft).
	TO CYLINDER BLOCK	:15 — 23 N·m (11 — 17 Lb-ft).

Figure 156. Bolt Torques For Idler Pulley Subassembly 2

3. Install the idler pulley spacer, idler pulley subassembly 2 and idler pulley plate to shaft 2 and tighten the lock nut.

4. Set idler pulley 2 upward as far as it will go using belt adjusting screw 2.

V-Ribbed Belt Installation

1. Install V-ribbed belt on pulleys and idler.

2. Check that the ribs and grooves of the V-ribbed belt and pulleys match in place (Fig. 157)

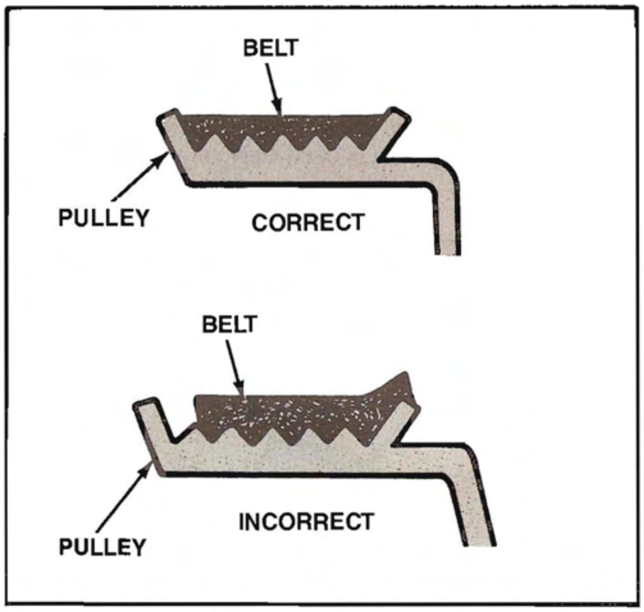


Figure 157. V-Ribbed Belt Installation

3. Adjust the idler pulley bolt and set belt tension at the specified values.

> **NOTE:**
>
> - **Do not adjust the belt adjusting screw when the nut is tightened.**
> - **Turning the wrench to the right tightens the belt. Turning left loosens the belt.**

4. Tighten the idler pulley nuts to specification, 34-50 N·m (25-37 lb-ft).

5. Rotate crankshaft one revolution and check belt tension.

EXHAUST SYSTEM

The SHO engine utilizes high performance tubular type exhaust manifolds to allow for maximum exhaust flow (Fig. 158). The exhaust manifolds feed into dual catalytic converters. Note that the Exhaust Gas Recirculation (EGR) System is used only on vehicles sold in California.

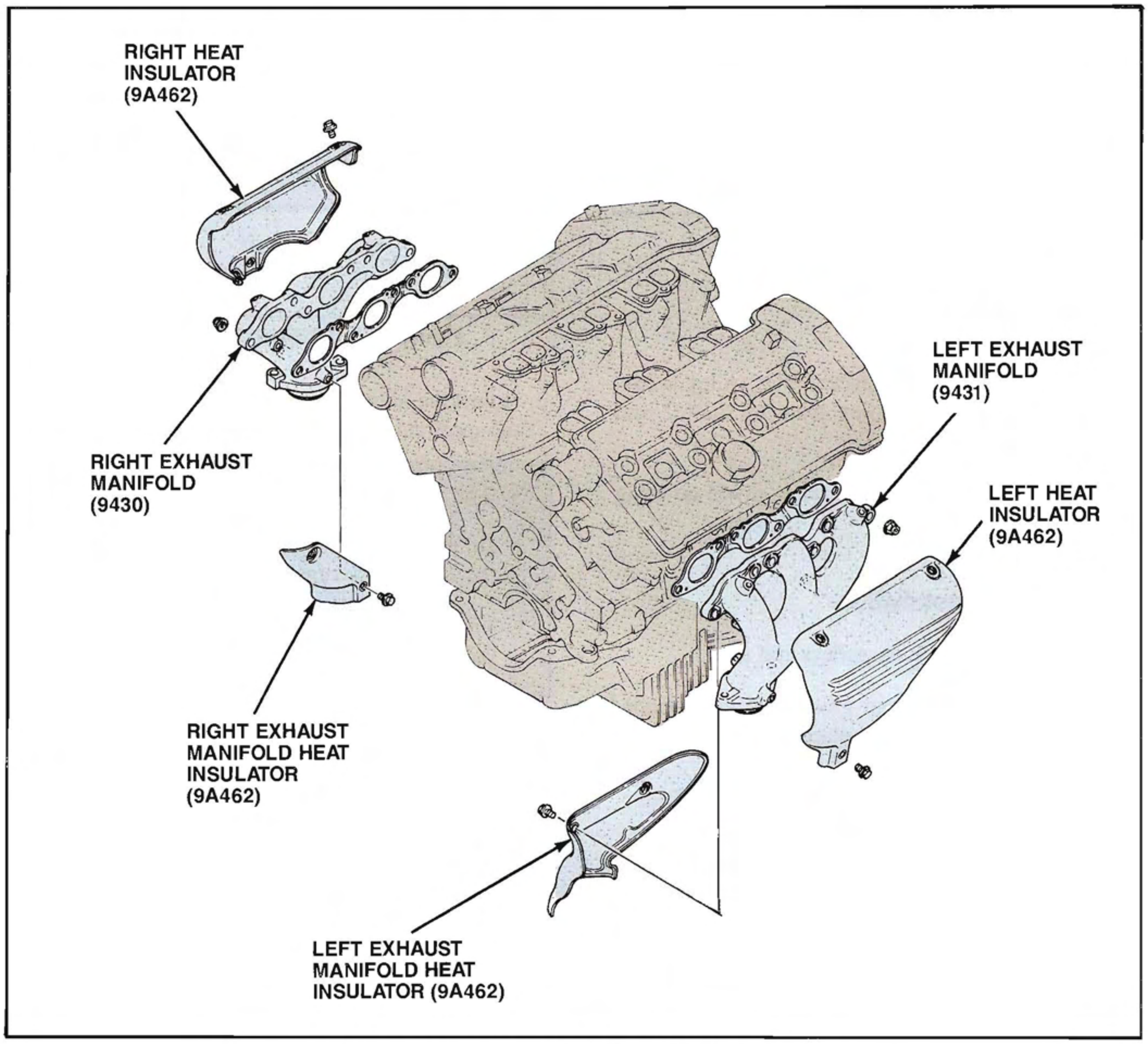


Figure 158. Engine Exhaust System Components

COMPONENT INSTALLATIONS

Right Side Exhaust Manifold Installation

1. Install the exhaust manifold heat insulator to the right exhaust manifold and tighten the two retaining bolts to 16-23 N·m (12-17 lb-ft).
2. Place the exhaust manifold gasket and exhaust manifold on the right cylinder head. Tighten the six retaining nuts to 35-51 N·m (26-38 lb-ft).
3. Install the exhaust manifold heat insulator to the right exhaust manifold and tighten the three retaining screws to 16-23 N·m (12-17 lb-ft).

Left Side Exhaust Manifold Installation

1. Install the exhaust manifold heat insulator to the left exhaust manifold and tighten the two retaining bolts to 16-23 N·m (12-17 lb-ft).
2. Place the exhaust manifold gasket and exhaust manifold on the left cylinder head. Tighten the six retaining nuts to 35-51 N·m (26-38 lb-ft).
3. Install the exhaust manifold heat insulator to the left exhaust manifold and tighten the three retaining screws to 16-23 N·m (12-17 lb-ft).

EGR System Installation (California Only)

1. Install the gasket and EGR tube assembly to the left exhaust manifold and tighten the two retaining bolts to 16-23 N·m (12-17 lb-ft) (Fig. 159).

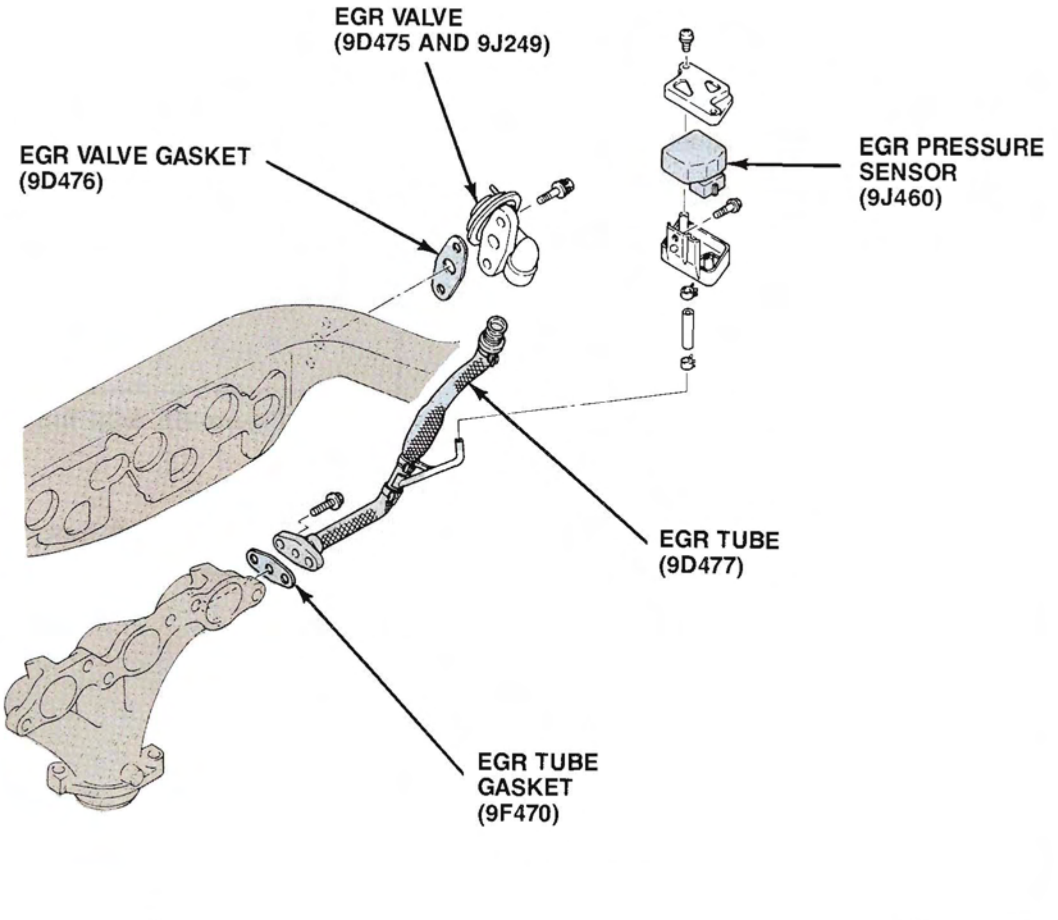


Figure 159. EGR System Components

2. Install the EGR pressure sensor (Fig. 160).

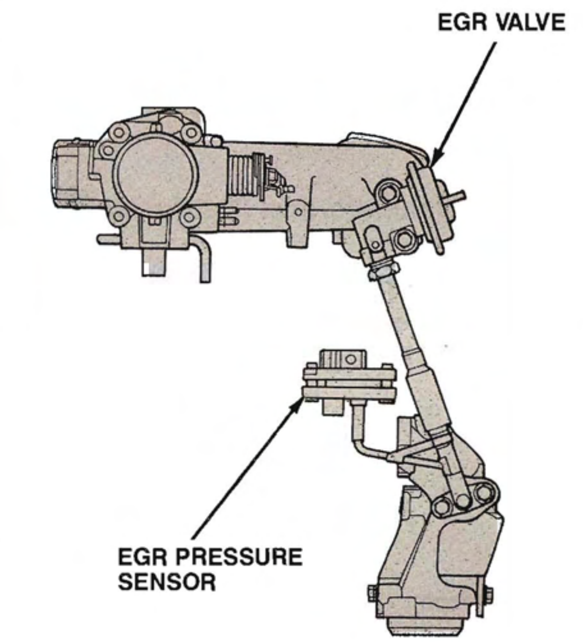


Figure 160. EGR Pressure Sensor Installation

— Position the EGR pressure sensor and cover on the bracket, then tighten the attaching screws to 3.0-4.5 N·m (26-39 lb-in).

— Install rubber hose to the EGR sensor nozzle with the retaining clip.

— First install the hose end to the EGR tube subassembly with the clip. Install the bracket to the rear end of the right cylinder head and tighten the attaching bolt to 6.5 - 9.5 N·m (56-82 lb-in).

3. Install the gasket and EGR valve to the right surge tank and tighten the attaching bolts to 16-23 N·m (12-17 lb-ft).

4. Connect the EGR tube with the EGR valve and tighten the nut to 25-34 N·m (18-25 lb-ft) (Fig. 161).

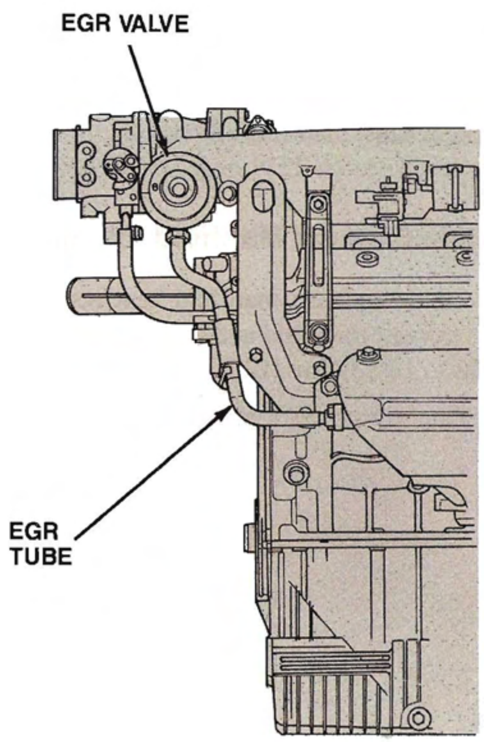


Figure 161. EGR Tube Installation

5. Connect the vacuum hose from the EVR (Electronic Vacuum Regulator) to the EGR valve.

This section contains the installation of engine electrical components and engine wiring.

INSTALLATION TECHNIQUES

Installation of Ignition Module

When installing the DIS ignition module on the surge tank connector there should be an application of a heat transfer compound between the module and connector as shown (Fig. 162). Apply Ford Thermo-Grease ESFM 99E123-A or equivalent at nine spots (total amount applied should be about 0.5-0.75 grams).

NOTE: The absolute amount of heat transfer compound applied at each spot is not important, however, each spot should be coated equally.

Install the ignition module to the surge tank connector with four bolts and tighten them to 2-3 N·m (17-26 lb-in).

Ignition Coil Installation

1. Install the ignition coil stay to the left cylinder head and tighten the three retaining bolts to 28-42 N·m (21-31 lb-ft).
2. Place the ignition coil and capacitor on the ignition coil stay and tighten the four retaining bolts to 4.5-7.0 N·m (3.3-5.1 lb-ft).

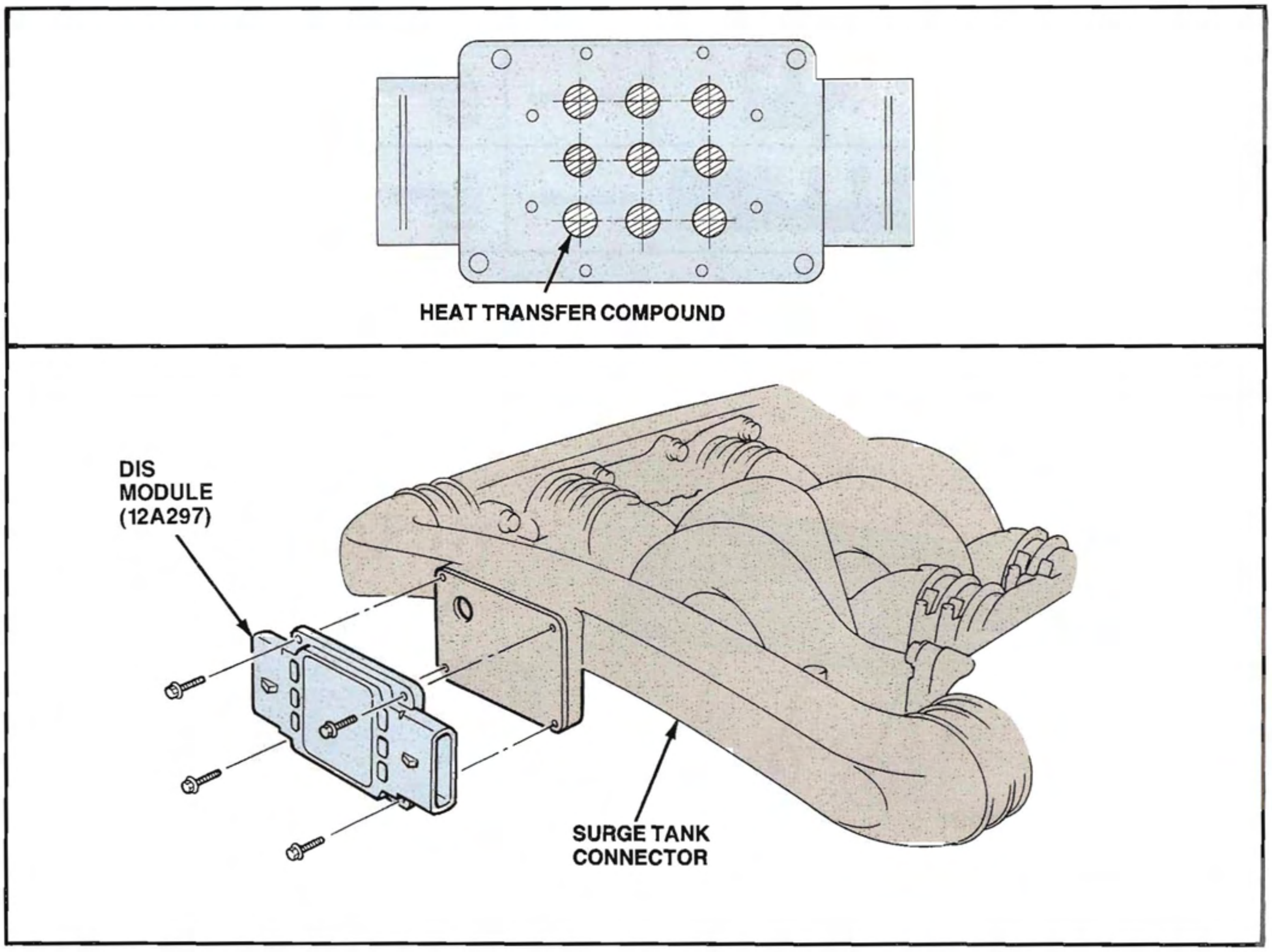


Figure 162. Application Points of Heat Transfer Compound

Spark Plug Wire Installation

Spark plug wire routing is important to assure that plug wires do not come into contact with moving components or become chafed. There are six different styles of spark plug wire clamps used on the SHO engine (Fig. 163). These are positioned at different points on the right and left side cylinder heads to route the spark plug wires (Fig. 164).

	SHAPE	PART NAME	LOCATION OF INSTALLATION
①		CLAMP, WIRE 1	*1 CYLINDER HEAD COVER
②		CLAMP, WIRE 2	*2 CYLINDER HEAD COVER LEFT
③		CLAMP, WIRE 3	*3 CYLINDER HEAD COVER RIGHT SURGE TANK RIGHT
④		CLAMP, WIRE 4	*4
⑤		CLAMP, WIRE 5	*5 CYLINDER HEAD COVER RIGHT
⑥		CLAMP, WIRE 6	*6 CYLINDER HEAD COVER RIGHT

Figure 163. Spark Plug Wire Clamps

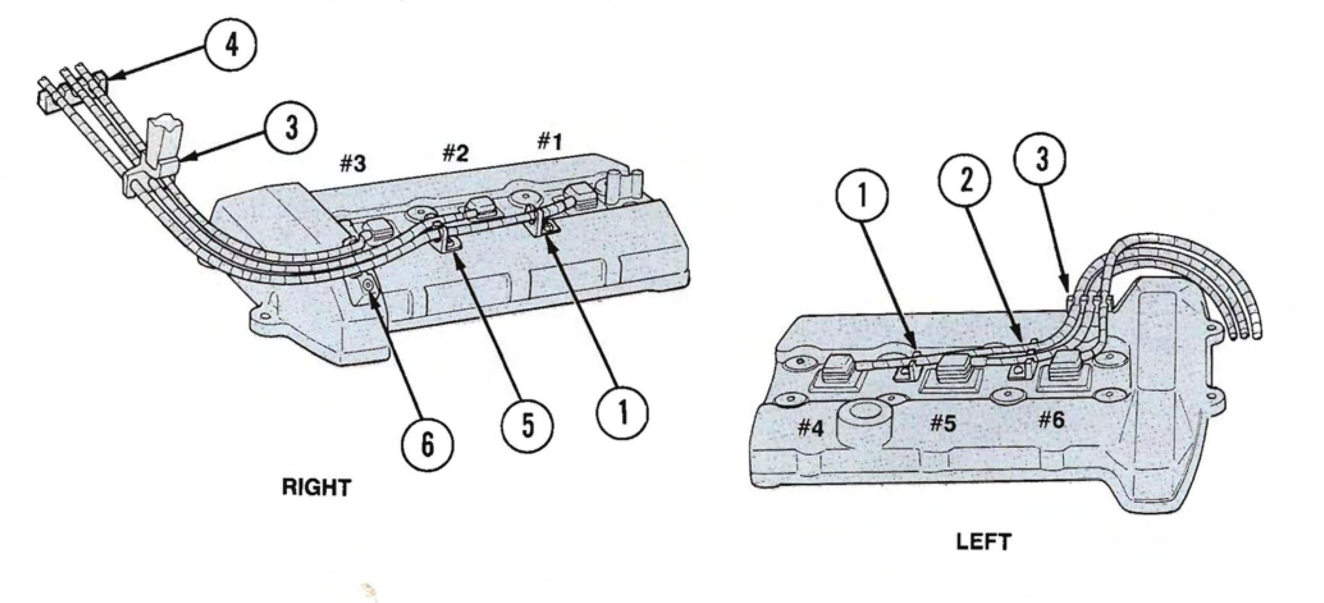


Figure 164. Clamp Positions

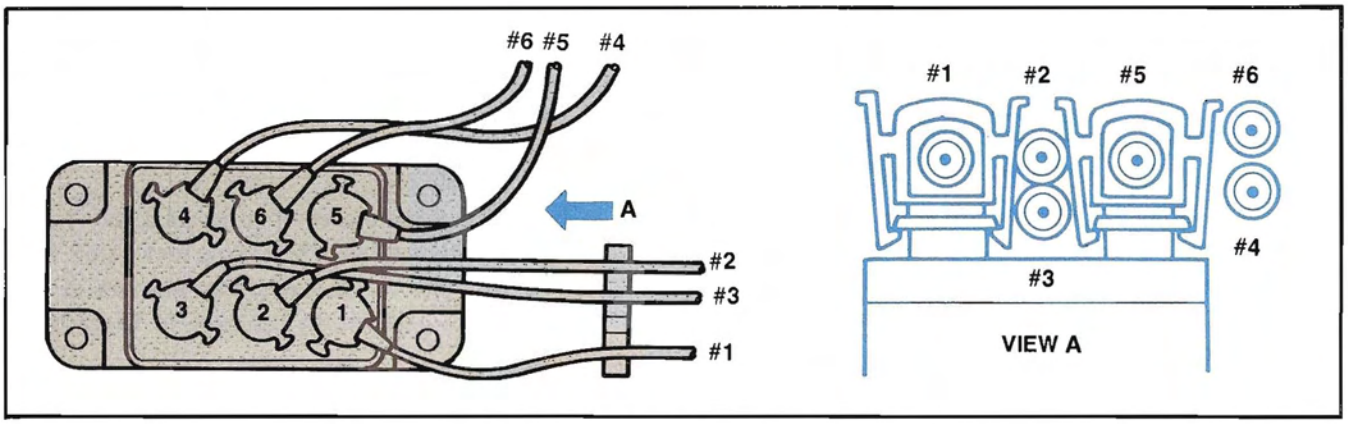


Figure 165. Spark Plug Wire Routing

Install the spark plug wires using the following procedure:

1. Install wire clamps 1 through 6 on the cylinder head covers and right side surge tank.
2. Place the spark plug wires in the clamps.
3. Push down the spark plug wire caps at the ignition coil until a click is heard indicating that it is seated.
4. Push down the spark plug wire cap at each spark plug until no clearance exists between the cylinder head cover and the spark plug wire cap.
5. Adjust the spark plug wire routing (Fig. 165).

Intake System Assembly Installation

The intake system should be installed, fully assembled onto the top of the engine using the following procedures.

1. Connect the water bypass hoses to the throttle body (Fig. 166).

   — Connect water bypass hose 6 to the throttle body from water outlet No. 1.

   — Connect water bypass hose 7 to the throttle air bypass valve spacer. Bypass hose 7 originates from the water outlet housing.

   — Connect water bypass hose 8 to the throttle body and throttle air bypass valve spacer.

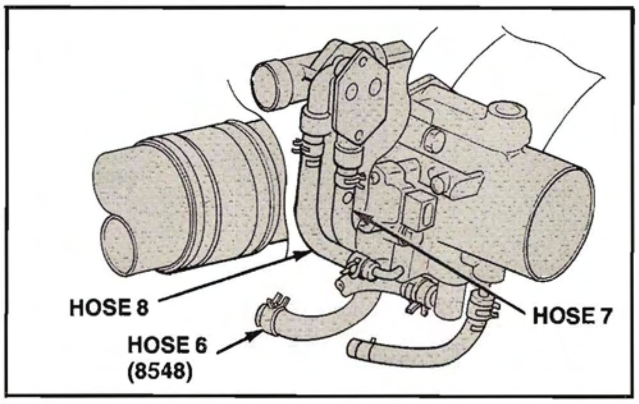


Figure 166. Water Bypass Hoses

NOTE: Water bypass hoses 6, 7 and 8 have white markings on the end of the hoses. This white marking has to be faced to the rear of the engine.

2. Install the air intake system assembly

NOTE: The intake manifold gasket is reusable.

   — Place the intake manifold gasket on each cylinder head.

   — Install the intake system assembly on both cylinder heads, aligning with the three dowel pins per each cylinder head.

   — Tighten the 12 flange bolts to 15-23 N·m (11-17 lb-ft).

   — Tighten the right side surge tank and intake air connector bolt to 15-23 N·m (11-17 lb-ft).

   — Connect the water bypass hoses.

3. Install surge tank stays 1 and 2 (Fig. 167). Note the differences between the stays.

NOTE: The slit portion of the surge tank stay has to be downward (toward the cylinder head). The stud bolt location is on the engine right front side and surge tank upper side. Four bolts with wave and plane washers are used to attach the stays to the cylinder head lower side.

— Install surge tank stay 2 at the right front side and tighten with the stud bolt at the upper side and bolt with the wave and plane washers on the lower side. Tighten the fasteners to 15-23 N·m (11-17 lb-ft).

— Install the three pieces of surge tank stay 1 and tighten with the flange bolt at the upper side, and bolt with the wave and plane washers at the lower side. Tighten the fasteners to 15-23 N·m (11-17 lb-ft).

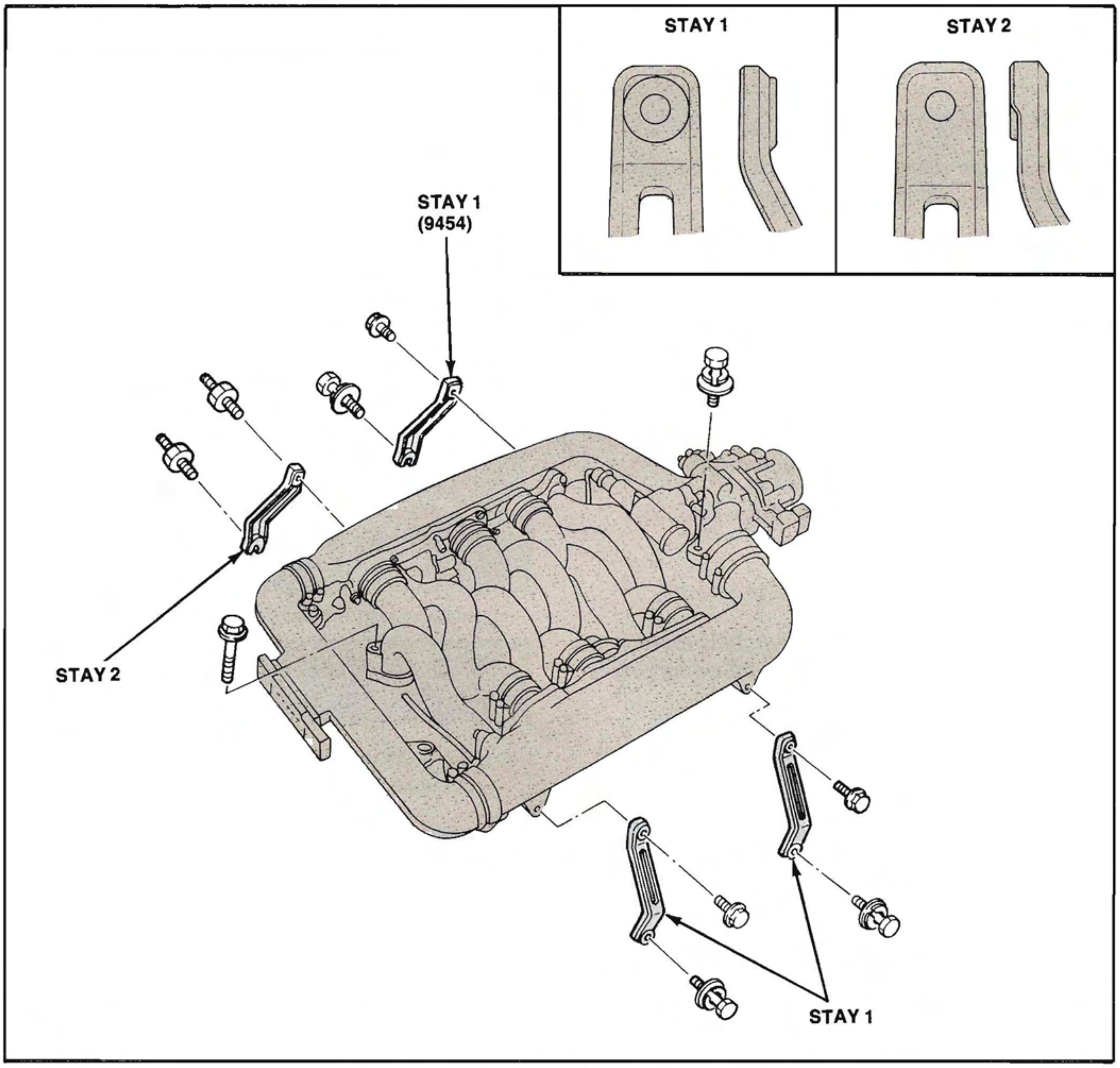


Figure 167. Surge Tank Stay Installation

ENGINE CONTROLS

INTRODUCTION

The Engine Control of the 3.0L SHO engine is the EEC-IV system therefore this section will not go into great detail on EEC-IV diagnostics. The section will cover emission systems used on the 3.0L SHO engine, adjustments, and information concerning the Distributorless Ignition System (DIS) which is used on the SHO engine.

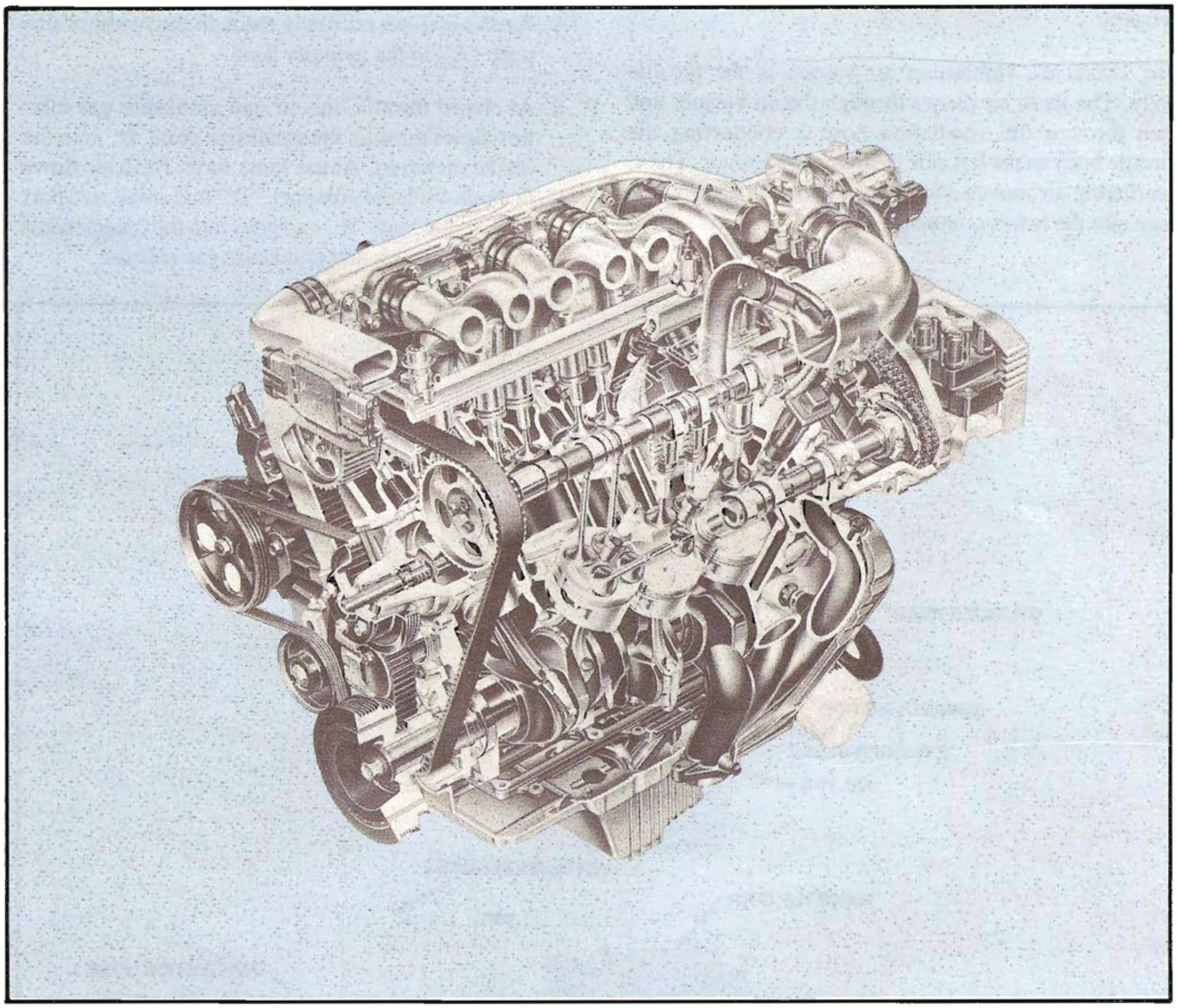


Figure 168. SHO Engine

POSITIVE CRANKCASE VENTILATION

The crankcase emission control system is a closed ventilation system that is designed to prevent crankcase fumes or combustion gases (blow-by) from escaping to the atmosphere (Fig. 169).

The crankcase control system controls these fumes or vapors by directing them back into the intake manifold where they are consumed in the normal combustion process.

The crankcase ventilating air source is the throttle body. The fresh air passes through the air cleaner and then through the ventilation hose 2 connecting the throttle body to the left side cylinder head cover. Then, ventilating air moves down through the oil return passage into the lower crankcase.

The air and crankcase gas mixture flows from the crankcase through the oil separator and ventilation hose 1 to the throttle body and intake manifold.

There are three outlet ports for the air and crankcase mixture, and one for fresh air in the throttle body. Under the following various throttle positions, the air and crankcase gas mixture flows differently through the outlet ports in the throttle body.

1. Fresh air flows normally through the medium size port "A" to the cylinder head.
2. At closed throttle, the air and crankcase gas mixture flows through the small size port "B" into the intake manifold. At the same time, fresh air flows through the large size port "D" and small size port "C" to the port "B" and goes into the intake manifold with the air and crankcase gas mixture.

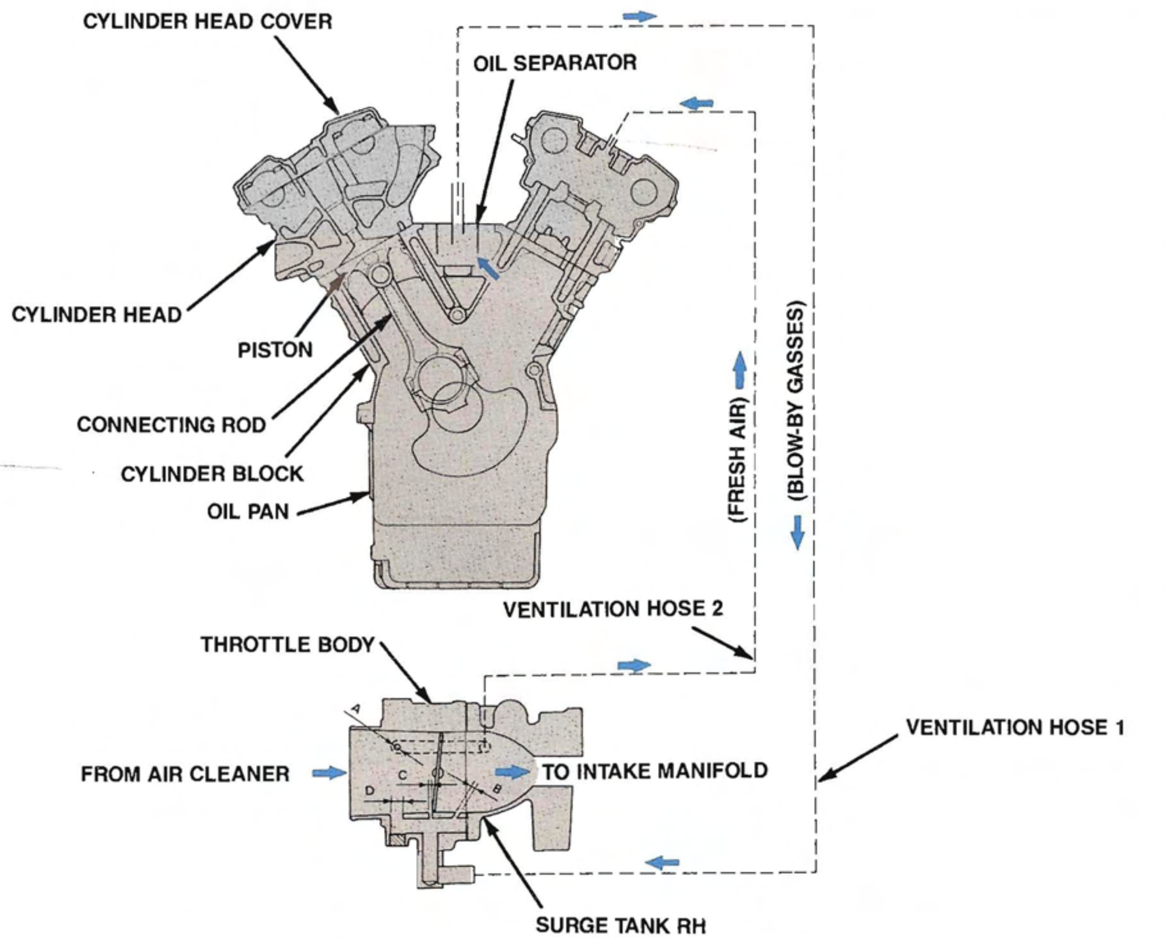


Figure 169. Positive Crankcase Ventilation System

3. At partial open throttle position, the air and crankcase gas mixture flows through ports "B" and "C" into the intake manifold. At the same time, fresh air flows through port "D" to ports "B" and "C" and goes into the intake manifold with the air and crankcase gas mixture.

4. At wide-open throttle position, the air and crankcase gas mixture flows through ports "B", "C" and "D" into the intake manifold. Meanwhile, under the particular condition when the amount of crankcase gas is excessive, the crankcase gas flows also through port "A" into the intake manifold from the left hand cylinder head.

The crankcase ventilation process goes on continuously while the engine is running. The operation at different phases can be seen in the following illustration (Fig. 170).

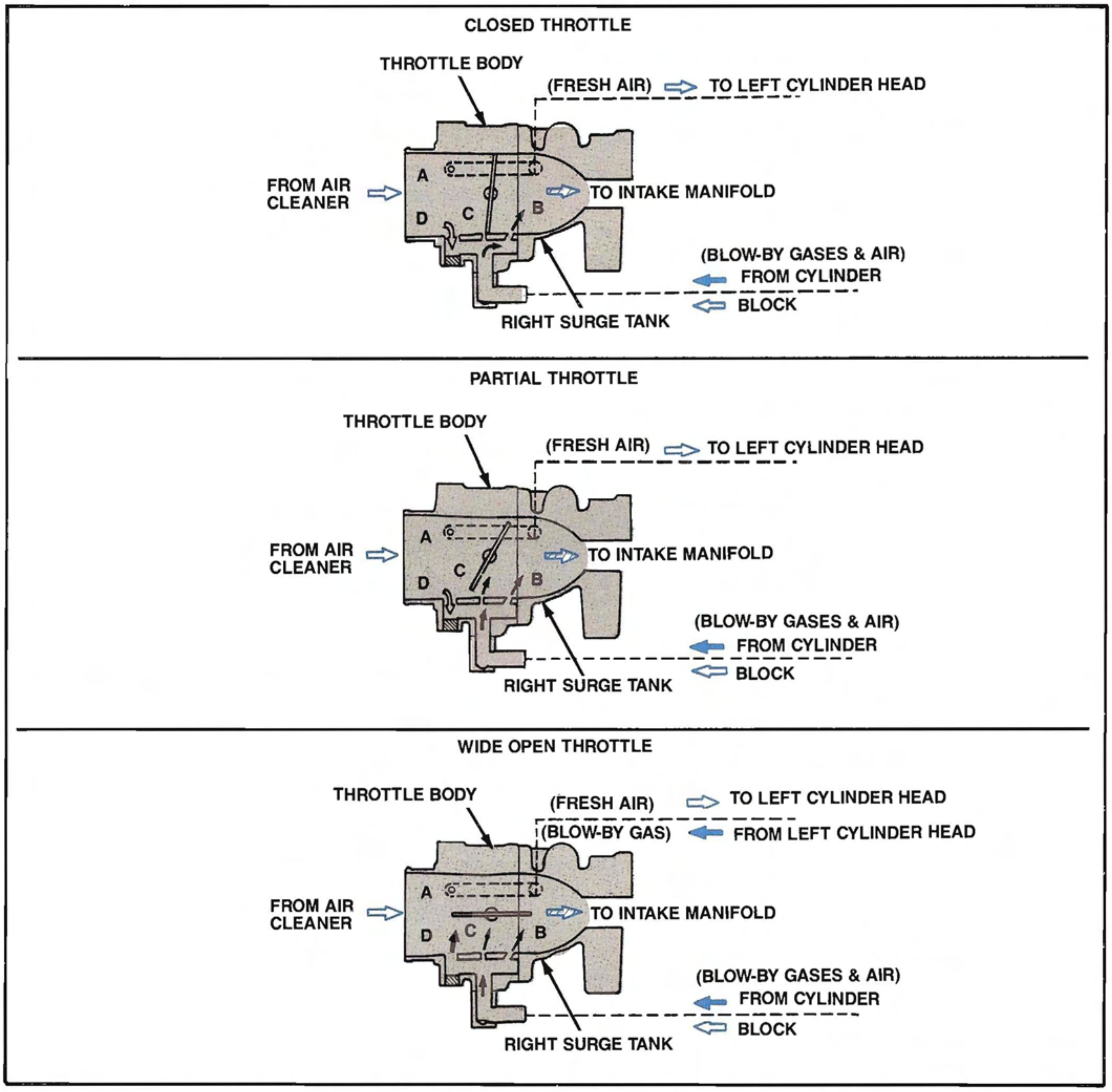


Figure 170. Crankcase Emission System Operating Phases

NON-ELECTRONICALLY CONTROLLED SYSTEMS

EXHAUST SYSTEM CATALYST

The SHO Taurus is equipped with two single brick three way catalyst (TWC) converters, one for each bank of cylinders (Fig. 171).

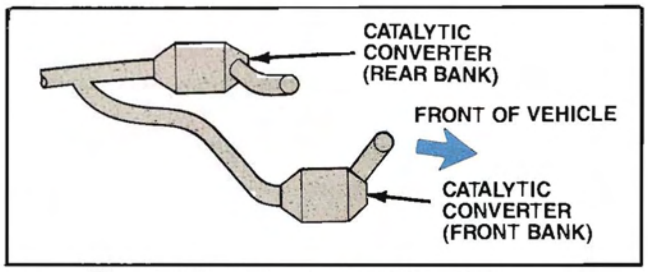


Figure 171. Exhaust System Catalyst

ELECTRONICALLY CONTROLLED SYSTEMS

The EGR, fuel and ignition systems are the primary systems that are electronically controlled on the SHO Taurus. Major components that are in the engine compartment are shown in the following illustration (Fig. 172).

NOTE: Components in this illustration are not all visible. The arrows indicate their general location.

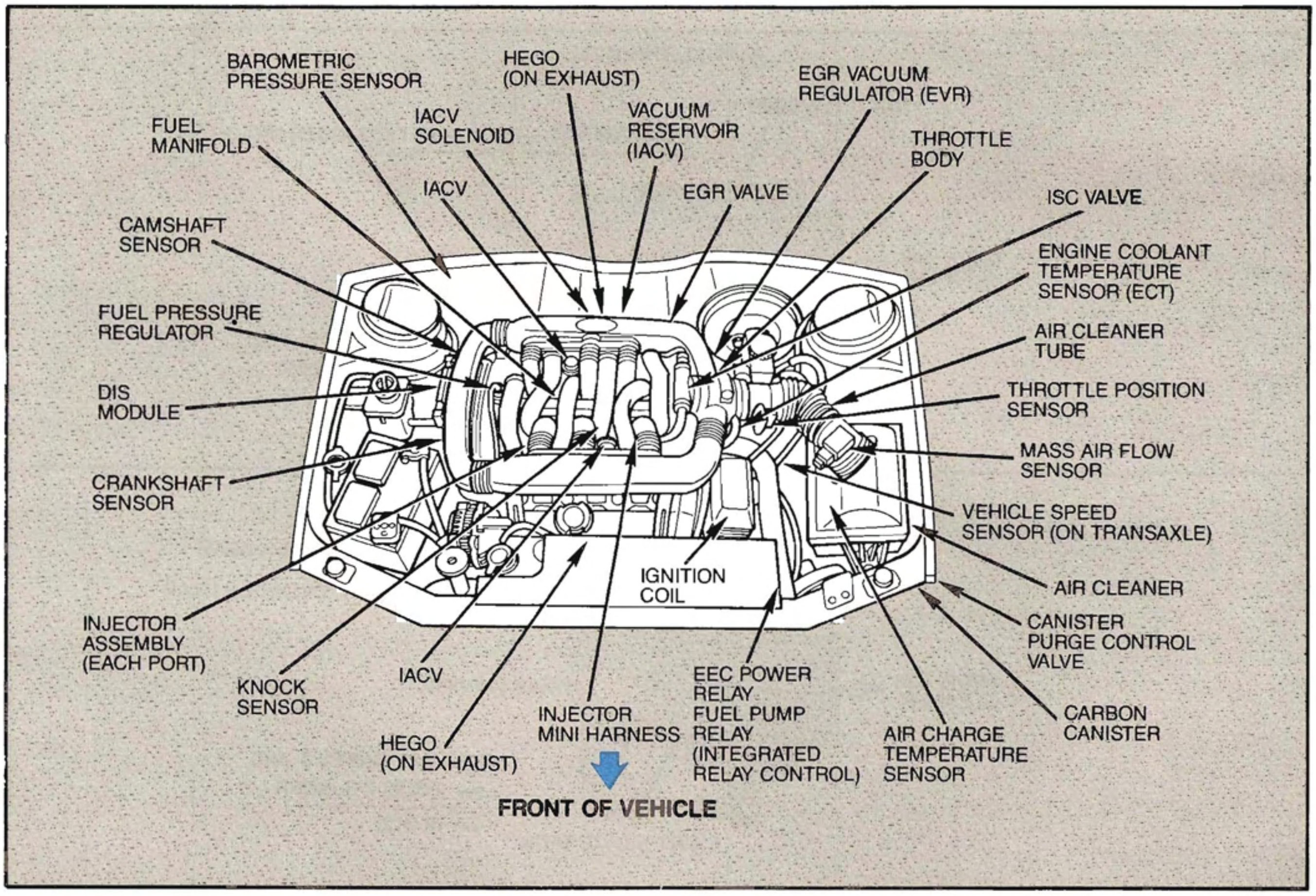


Figure 172. Major Engine Sensors and Output Devices

The primary control of the systems is through the EEC-IV processor (ECA). This computer-controlled device monitors the input of several different sensors and then controls outputs to maintain the correct air/fuel mixture and spark advance for the best engine performance and emissions. The inputs and outputs of the EEC-IV processor can be seen in the following illustration (Fig. 173).

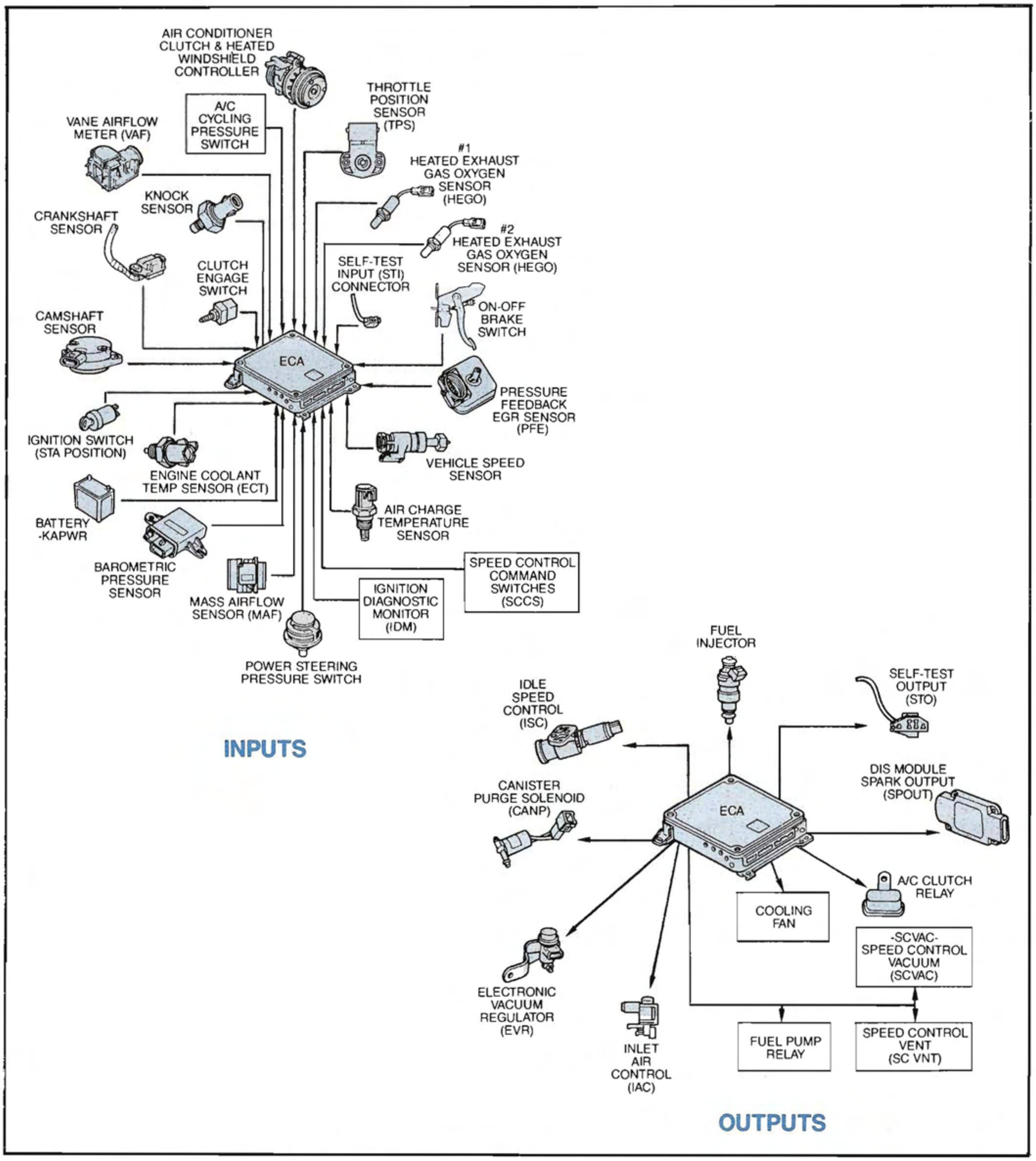


Figure 173. EEC-IV Processor (ECA) Inputs and Outputs

EGR SYSTEM

The EGR system (Fig. 174) used on the SHO engine is currently used only on vehicles produced for the California market. The EGR system is the PFE (Pressure Feedback Electronic) type. It is controlled by the ECA.

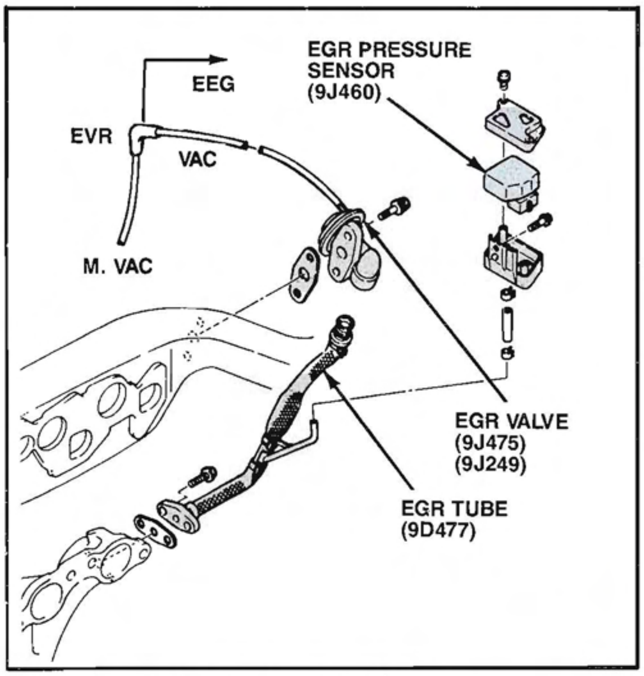


Figure 174. EGR System

In addition to the ECA, the system has three main components:

- EGR Valve (Fig. 175)
- Pressure Sensor (Fig. 176)
- Electronic Vacuum Regulator (Fig. 177)

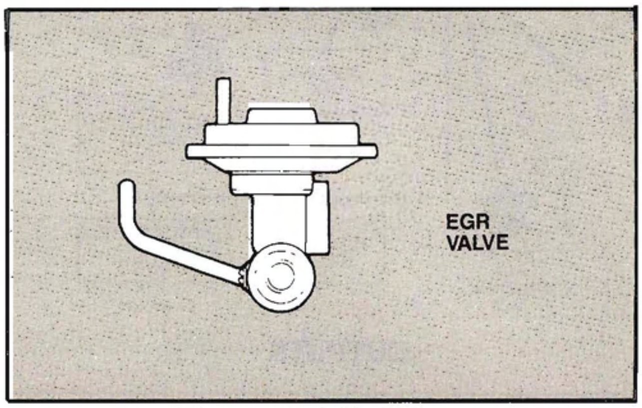


Figure 175. EGR Valve

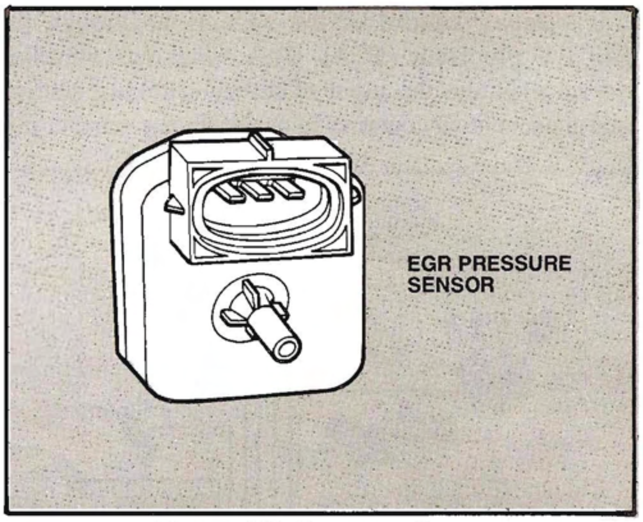


Figure 176. Pressure Sensor

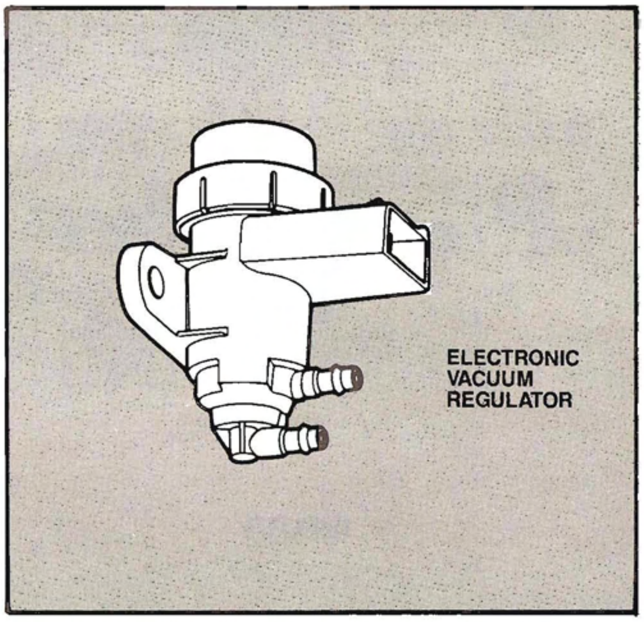


Figure 177. Electronic Vacuum Regulator

The EGR valve is a vacuum operated pintle type common to most EGR systems. The pressure feedback sensor is a ceramic capacitive type that converts exhaust system pressure or vacuum into an analog electrical input signal (.2 - 4.75 volts D.C.) to the ECA. A high signal output indicates minimum or no EGR flow. Engine running at idle (all system working) a PFE output of 3.25 volts + .25 volts D.C. will be indicated. The electronic vacuum regulator is an electrically operated valve used to control the amount of vacuum applied to the EGR valve diaphragm.

The system functions in the following manner (Fig. 178):

The ECA monitors pintle position of the EGR valve and varies the amount exhaust gas recirculation according to engine operating conditions.

Control of the amount of exhaust gas recirculation by the processor is accomplished with the EGR vacuum regulator (EVR). This device applies or bleeds off vacuum according to instructions received from the processor.

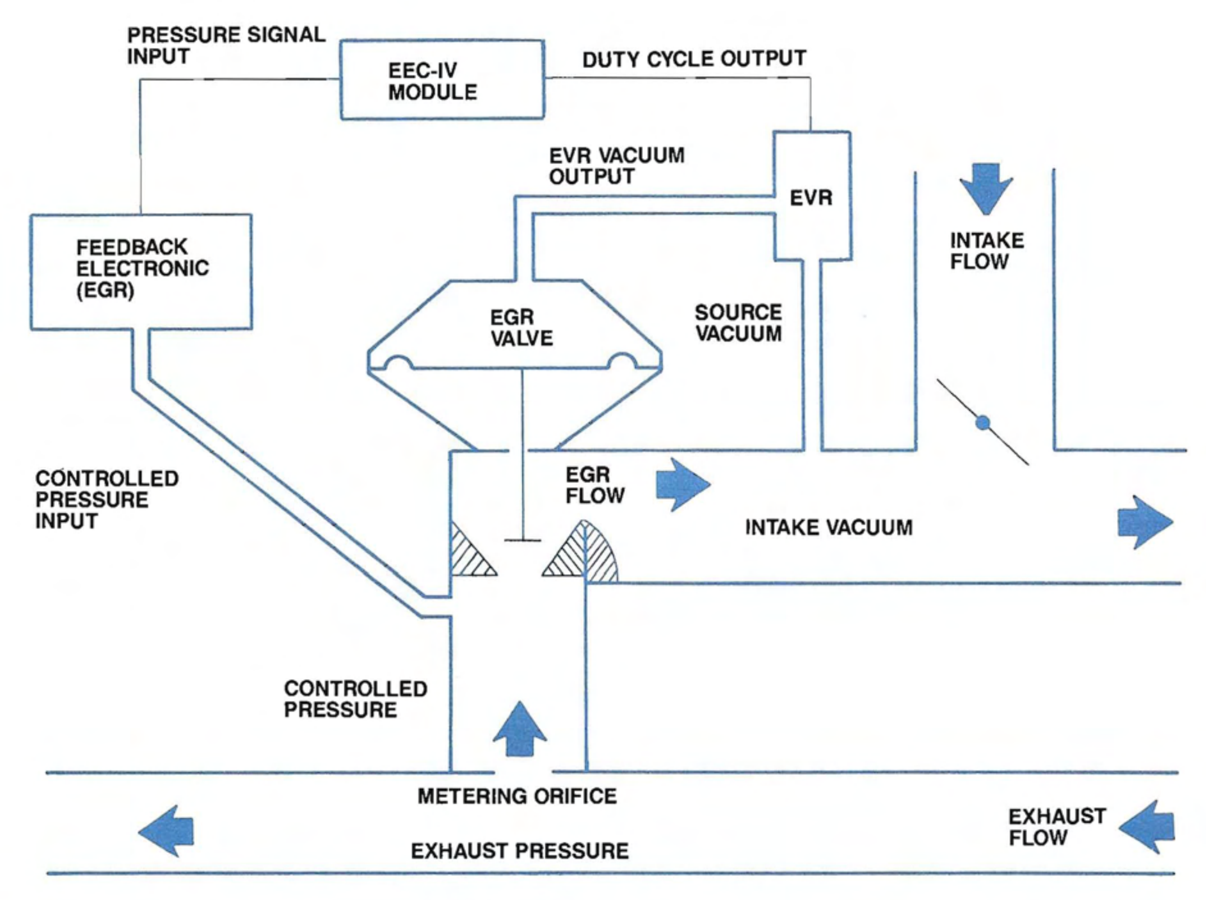


Figure 178. EGR System Operation

FUEL SYSTEM

The fuel system is the Sequential Electronic Fuel Injection (SEFI) system. It is classified as a multi-point, pulse time, mass airflow fuel injection system. Fuel is metered into the intake air stream in accordance with engine demand via individual fuel injectors mounted on the cylinder head intake ports.

An on-board vehicle EEC-IV processor accepts inputs from various engine sensors to compute the required fuel flow rate necessary to maintain a prescribed air/fuel ratio throughout the entire engine operating range. The computer then outputs a command to the fuel injectors to meter the appropriate quantity of fuel.

System Description

The SEFI system can be subdivided into four distinct categories:

- Fuel delivery
- Air induction
- Input Sensors
- Electronic Control Unit

The fuel delivery subsystem consists of a high-pressure electric fuel pump to deliver fuel from the fuel tank, a 20 micron fuel filter to remove particulate contaminants from the fuel, a fuel charging manifold assembly and various solid and flexible fuel lines.

The fuel charging manifold assembly incorporates a single electrically-actuated fuel injector centrally located above each pair of the engine's intake valves. The injectors, when energized, spray a predetermined quantity of fuel into the air stream. Each injector is energized sequentially every two crankshaft revolutions.

Fuel pressure pulsations are reduced by a fuel pressure damper prior to entry into the fuel rail. A constant pressure drop is maintained across the injector nozzles by the fuel pressure regulator. The regulator is connected in series with the fuel injectors and positioned downstream from them. Excess fuel supplied by the pump, but not required by the engine, passes through the regulator and returns to the fuel tank via a fuel return line. The period of time that the injectors are energized (injector ''on time'' - ie., the pulse width) is controlled by the vehicle's EEC-IV processor. Air entering the engine is measured by a mass airflow meter located right after the air cleaner. This airflow information and input from various other engine sensors are used to compute the required fuel flow rate necessary to maintain a prescribed air/fuel ratio for the given engine operation. The computer determines the needed injector pulse width and outputs a command to the injector to meter the appropriate quantity of fuel.

Component Descriptions

The major components of the Fuel Charging Manifold are discussed in this section.

Fuel Injectors

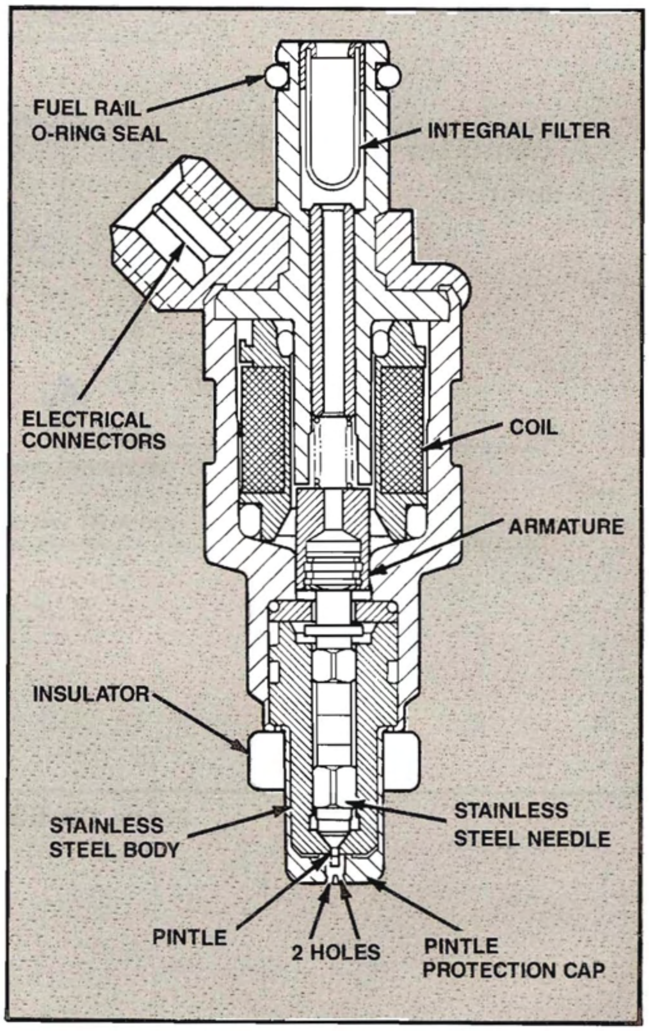


Figure 179. Fuel Injector

The Fuel Injector Nozzles (Fig. 179) are electro-mechanical devices which both meter and atomize fuel delivered to the engine. The injectors are mounted on the cylinder head intake ports and are positioned so that their tips are directing fuel just before the engine intake valves. The injector body consists of a solenoid actuated pintle and needle valve assembly. An electrical control signal from the EEC-IV processor activates the solenoid causing the pintle to move inward off the seat and fuel to flow. Because the injector flow orifice is fixed and the fuel pressure drop across the injector tip is constant, fuel flow to the engine is regulated by how long the solenoid is energized. Atomization is obtained by contouring the pintle at the point where the fuel ejects.

NOTE: The fuel injectors are Nippondenso single pintle-2 hole injectors.Orientation is controlled by the wiring harness length and position between the intake runners.

Fuel Pressure Damper

The Fuel Pressure Damper is attached to the fuel supply manifold assembly (fuel rails upstream of the fuel injectors) to reduce fuel pressure pulsation.

Fuel Pressure Regulator

The Fuel Pressure Regulator (Fig. 180) is attached to the fuel supply manifold assembly downstream of the fuel injectors. It regulates the pressure supply to the injectors.The regulator is a diaphragm operated relief valve in which one side of the diaphragm senses fuel pressure and the other side is subjected to intake manifold pressure. The nominal fuel pressure is established by a spring preload applied to the diaphragm. Referencing one side of the diaphragm to manifold pressure maintains a constant pressure drop across the injectors. Fuel in excess of that used by the engine passes through the regulator and returns to the fuel tank.

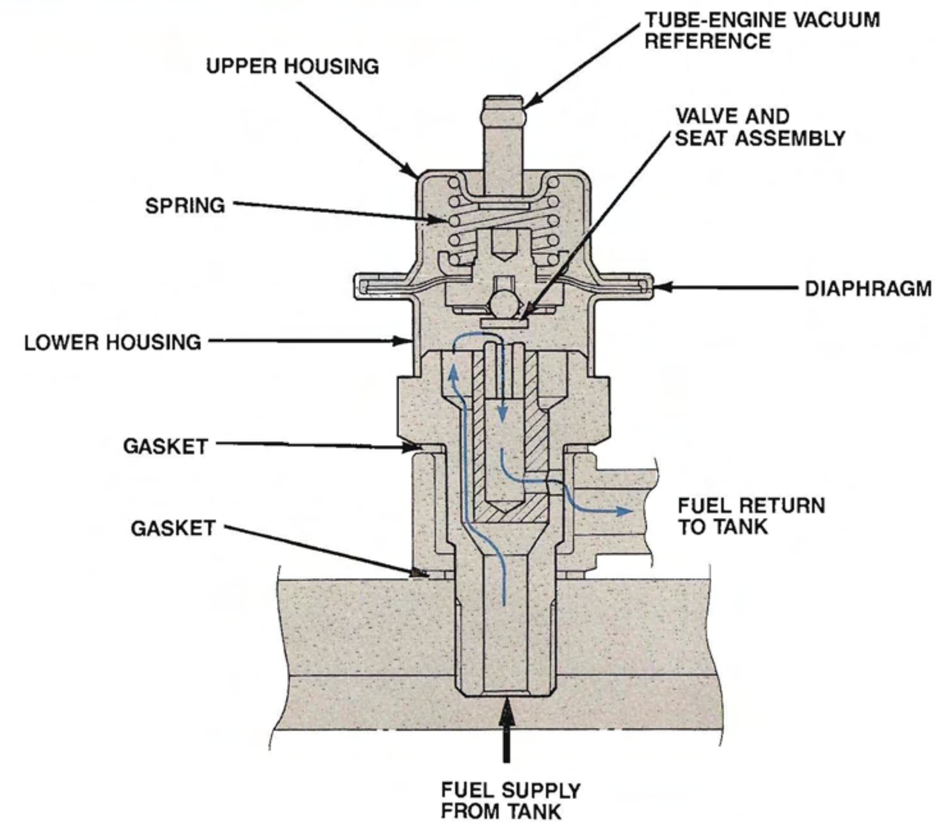


Figure 180. Fuel Pressure Regulator

Mass Airflow Meter

The Mass Airflow Meter (Fig. 181) monitors airflow to the engine. The device contains a hotwire which is attached to a bypass passage. The hotwire produces an output voltage. To obtain the optimum air/fuel ratio at various conditions, the air temperature sensor and barometric pressure sensor are used. The air temperature sensor has a thermistor-type sensing element. This sensor continuously monitors the temperature of the airflow through the mass airflow sensor. The resistance of the thermistor changes in response to changes in airflow temperature. Meanwhile, the barometric sensor has a silicon capacitive sensing element and continuously monitors the barometric pressure. The information is supplied to the EEC-IV processor which in turn adjusts the fuel flow to obtain the optimum air/fuel ratio.

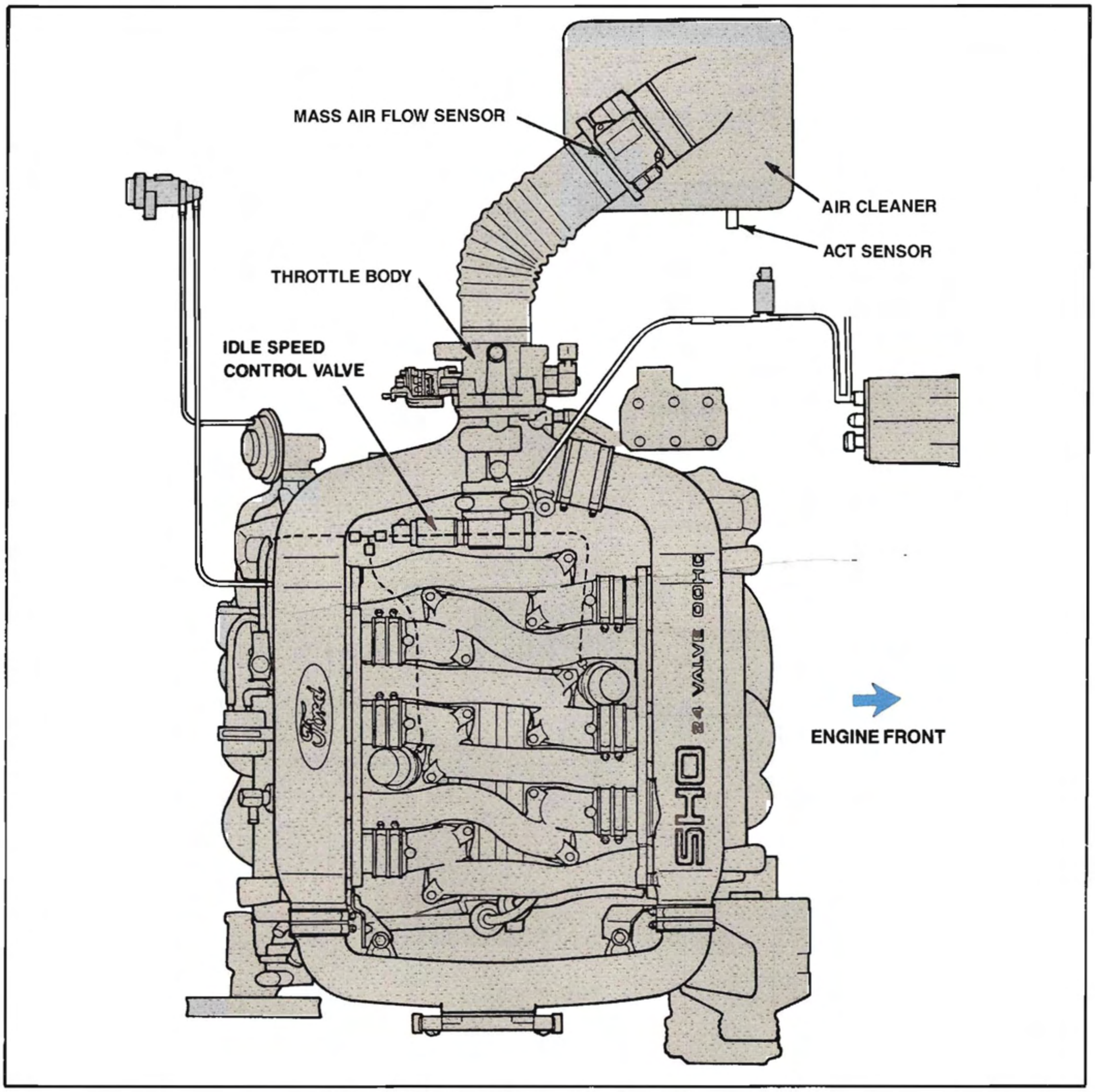


Figure 181. Air Inlet System Major Components

Idle Speed Control (ISC) Valve

The Idle Speed Control (ISC) Valve assembly is an electro-mechanical device controlled by the EEC-IV processor. It incorporates a linear actuator which positions a variable area metering valve. In response to commands from the EEC-IV processor the air bypass valve controls airflow at both warm and cold idle.

Throttle Body Assembly

The Throttle Body Assembly controls airflow to the engine via a single butterfly valve. The throttle position is controlled by linkage. The body is a single piece aluminum die casting. It has a bore with an air bypass channel around the throttle valve. Some other features of the throttle body assembly include:

- An adjustment screw to set the throttle valve at a minimum idle airflow position with a disconnected air bypass valve.
- A throttle body-mounted throttle position sensor.
- A PCV fresh air source upstream of the throttle valve.
- Two PCV orifices for air and crankcase vapors upstream of the throttle valve.
- One PCV orifice for air and crankcase vapors downstream of the throttle valve.

Fuel Supply Manifold Assembly (Fuel Rail Assembly)

The Fuel Supply Manifold Assembly (Fig. 182) is the component that delivers high-pressure fuel from the vehicle fuel supply line to the fuel injectors. The assembly consists of two fuel rails with a connector, mounting flange for the fuel pressure damper and fuel pressure regulator. There is also a Schraeder valve for diagnostic tests and field service fuel system pressure bleed-down.

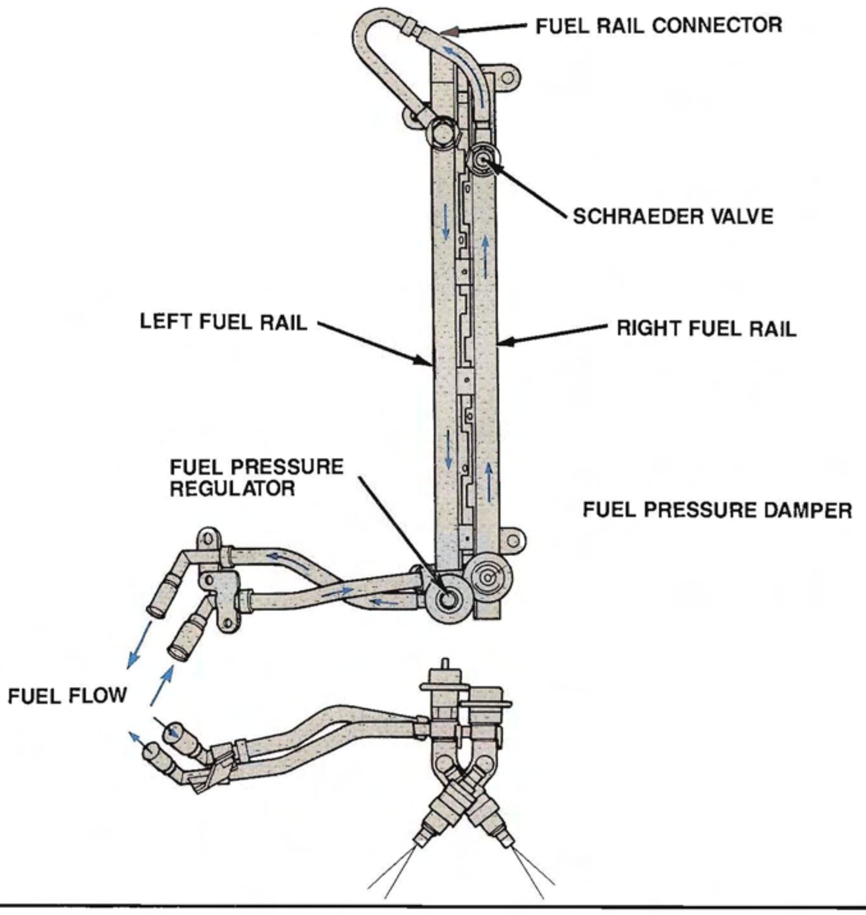


Figure 182. Fuel Supply Manifold Assembly

Air Intake Manifold

The 3.0L SHO uses a unique Air Intake Manifold (Fig. 183) that has the following features:

- Duel surge tanks.
- Two different length runners per cylinder. The primary runner (long) is always open to airflow. The secondary runner (short) is controlled by a vacuum operated IAC valve and opens at high engine rpm.
- Each secondary port has a funnel upstream of the IAC valve inside the surge tanks.
- There is a surge tank connector between the two surge tanks.

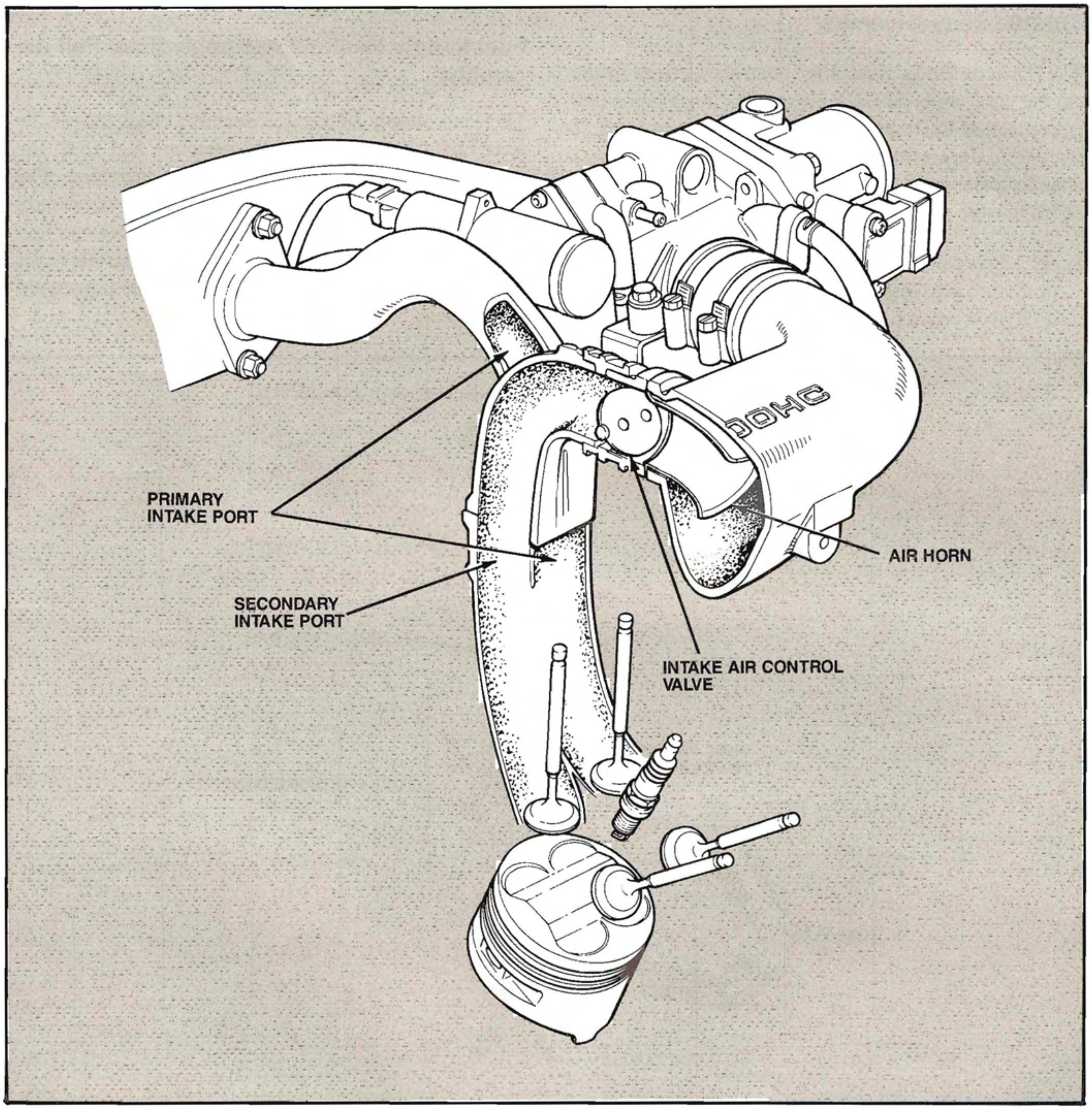


Figure 183. Air Intake Manifold

Fuel System Checks and Adjustments

Fuel system checks and adjustments include the fuel pressure check and the base idle adjustment.

Fuel Pressure Check

Use the following procedure to check fuel pressure:

1. Prepare the vehicle for the fuel pressure test.

   — Check battery voltage. It should be at least 12 volts.

   — Remove the cap from the Schraeder valve (Fig. 184).

   — Install the fuel pressure gauge to the Schraeder valve.

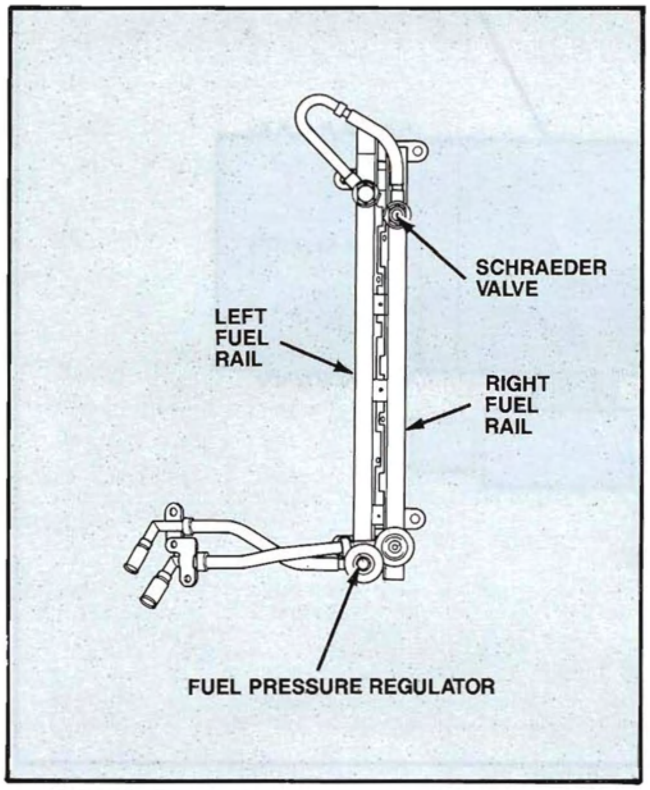


Figure 184. Schraeder Valve

2. Check the fuel pressure.

   — Turn the ignition switch to the ON position.

NOTE: Do not start the engine.

   — Measure the fuel pressure. Gauge readings should be between 2.15-2.85 kg/cm^2 (31-41 psi).

If fuel pressure is high, replace the fuel pressure regulator. If pressure is low, check the following parts.

- Fuel hoses and connections
- Fuel pump
- Fuel filter
- Fuel pressure regulator

   — Start the engine.

   — Remove the vacuum line at the pressure regulator.

   — Measure the fuel pressure at idle. The fuel pressure should be 1.50-2.2 kg/cm^2 (22-32 psi).

   — Install the vacuum line to the pressure regulator.

   — Measure the pressure at idle. The fuel pressure should be 2.00-2.36 kg/cm^2 (28.5-33.5 psi).

If pressure is not as specified, check the vacuum line and the fuel pressure regulator.

   — Stop the engine. Check that the fuel pressure remains at or above 1.5 kg/cm^2 (21 psi) for five minutes after the engine is turned off.

If pressure is not as specified, check the fuel pump, fuel pressure regulator and/or injectors.

Base Idle Adjustment

Idle speed is typically controlled by the EEC-IV processor. However, it is necessary to determine a minimum base idle through a mechanical adjustment. This adjustment takes place at the throttle body using the following procedure (Fig. 185).

1. Remove the Idle Speed Control (ISC) valve connector.
2. Remove the canister purge hose A.
3. Remove the PCV hose B and plug the hose.
4. Connect pipe A to pipe B. Set orifice in the hose. 1/8"
5. Remove the shorting plug for the spark output (SPOUT).
6. Adjust idle rpm to 800±30 rpm.

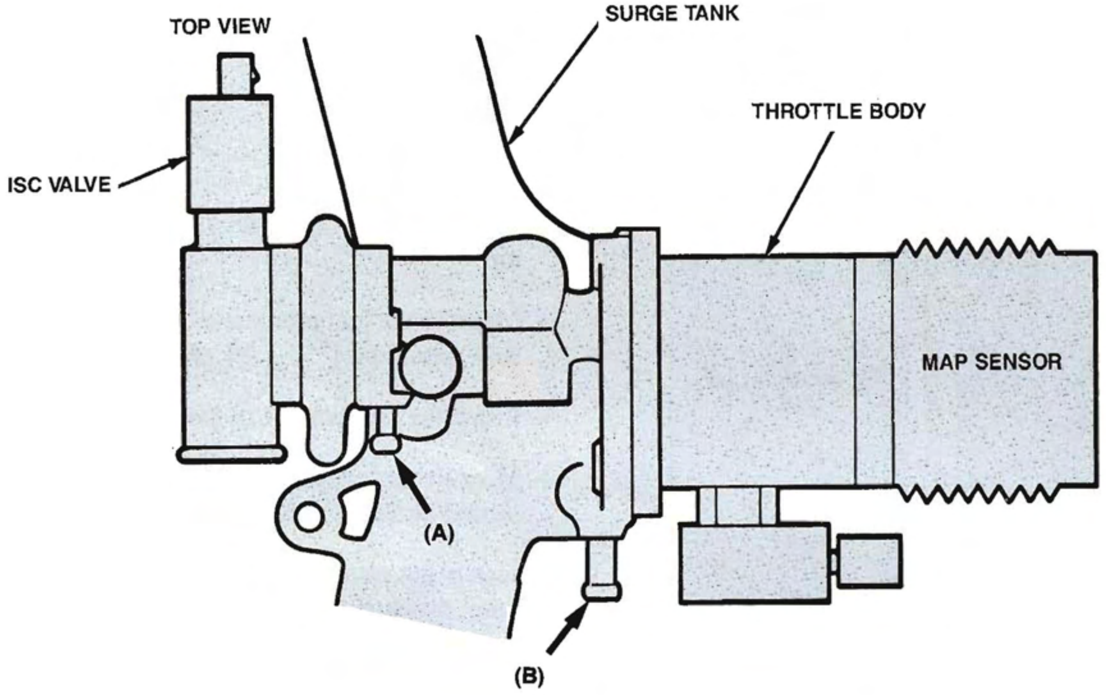
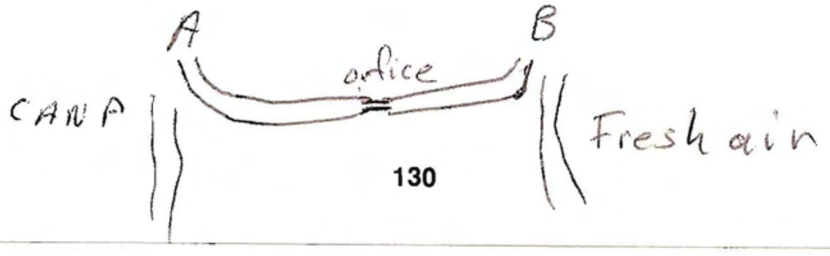


Figure 185. Base Idle Adjustment



DISTRIBUTORLESS IGNITION SYSTEM (DIS)

The Distributorless Ignition System (DIS) is a new feature that is used on selected 1989 models. The DIS system used on the 3.0L SHO is similar to that used on the supercharged 3.0L used in the Thunderbird Super Coupe and Mercury Cougar XR7.

System Description

The Ford DIS (Fig. 186) consists of a crankshaft Hall sensor (Profile Ignition Pickup [PIP]) (Fig. 187), a camshaft Hall sensor (Cylinder Identification) (Fig. 188), a six-tower DIS coil (Fig. 189), a DIS module (Fig. 190), the spark angle portion of the EEC-IV processor and related wiring.

This ignition system eliminates the distributor by using multiple coils. Each coil fires two spark plugs at the same time. The plugs are paired so that as one fires at the beginning of the compression stroke, the other fires at the end of the exhaust stroke. The next time the coil is fired, the plug that was on exhaust will be on compression and the one that was on compression will be on exhaust. The spark in the exhaust cylinder is called "wasted" spark, however very little of the coil energy is lost. Three coils are mounted together in a "coil pack." The coil pack has three coil wires, one for each coil.

The crankshaft sensor is a digital output Hall device (PIP) that responds to a rotating metallic vane cup mounted on the crankshaft timing belt pulley. The vane cup has three equally spaced vanes which produce three PIP output pulses for every crankshaft revolution. The resulting PIP output is a 50% duty cycle signal which provides base timing information.

The camshaft sensor is also a digital output Hall device (CID) which is mounted at the end of the rear camshaft (No. 1 exhaust). The vane cup has one vane and is driven by the camshaft. This differs from the 3.8L S/C application which has the camshaft sensor mounted in the normal distributor location. The CID signal is also a 50% duty cycle signal and is required to identify cylinder #1 for ignition coil and fuel synchronization. The CID signal is high (Vbatt) for half of the camshaft revolution (180 degrees) and low for the other half.

The EEC-IV processor determines spark angle using the PIP signal to establish base timing. SPOUT is sent from the EEC-IV processor to the DIS module and serves two purposes; the trailing edge controls the dwell time, and the leading edge fires the coil. This feature is called Computer Controlled Dwell (CCD).

The Ignition Diagnostic Monitor (IDM) signal is an output from the DIS module that provides diagnostic information concerning the ignition system to the EEC-IV processor for self-test. This signal is also used to drive the vehicle tachometer.

The Failure Mode Effects Management (FMEM) system attempts to keep the vehicle drivable in spite of certain EEC system and/or DIS system failures. If the DIS module does not receive the SPOUT signal from the EEC-IV it will fire the coils directly from the PIP input. This results in a fixed spark angle of 10 degrees BTDC and fixed dwell (no CCD). If the CID circuit fails and an attempt to start the engine is made, the DIS module will randomly select one of the three coils to fire. If hard starting results, turning the key off and cranking again will result in another coil selection attempt. Several attempts may be needed until the proper coil is selected, allowing the vehicle to be started and driven until repairs can be made.

NOTE: Initial timing is preset at 10 BTDC and is not adjustable.

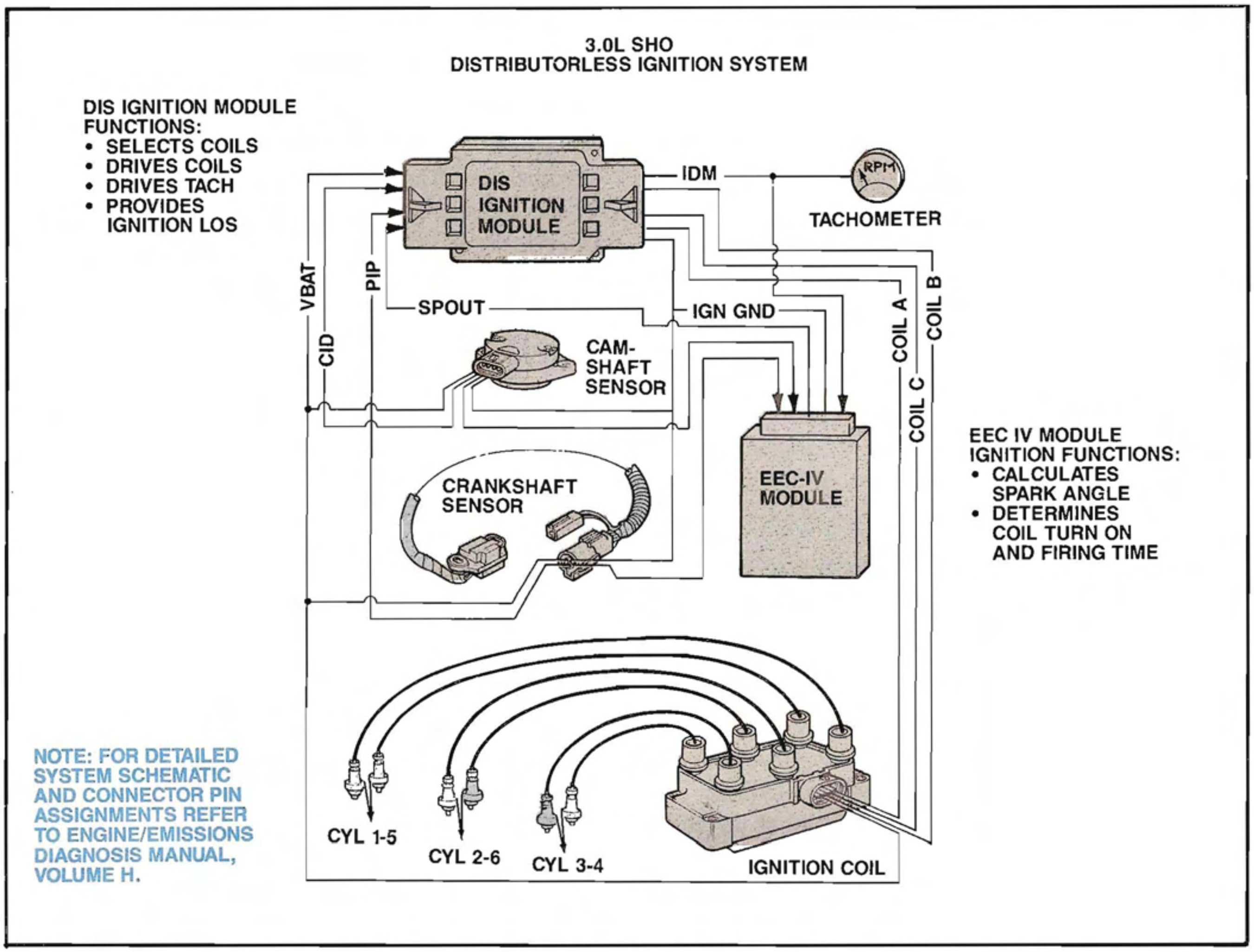


Figure 186. DIS System

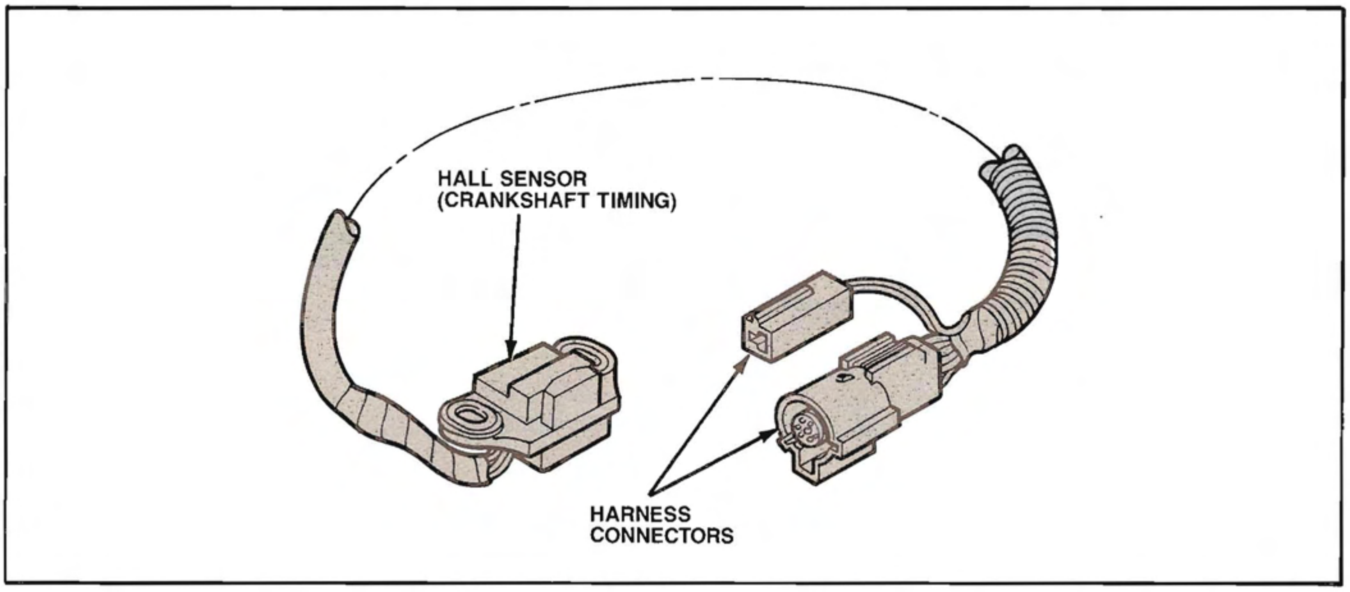


Figure 187. Crankshaft PIP Hall Sensor

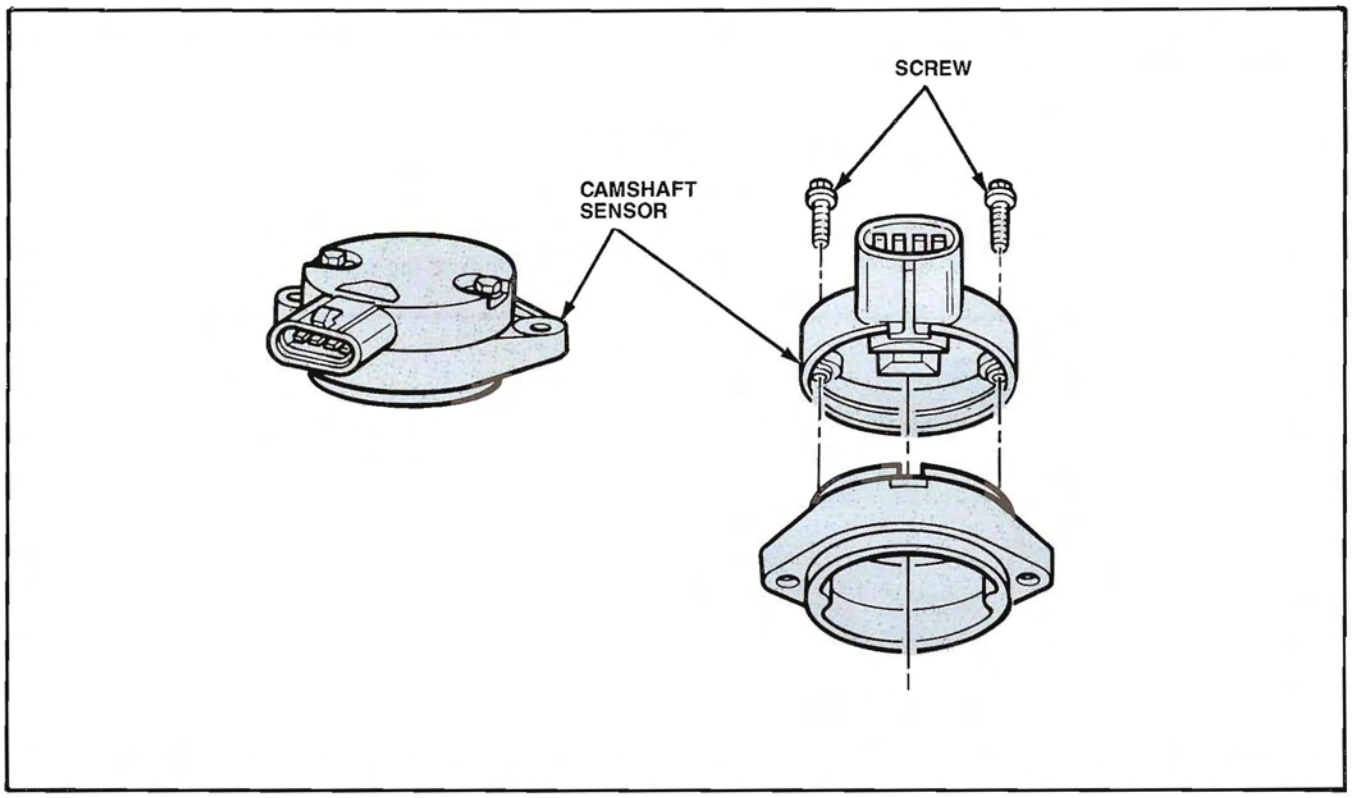


Figure 188. Camshaft Hall Sensor

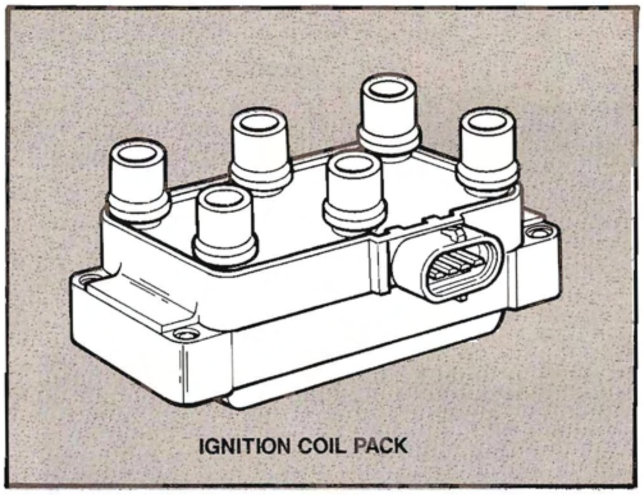


Figure 189. Ignition Coil

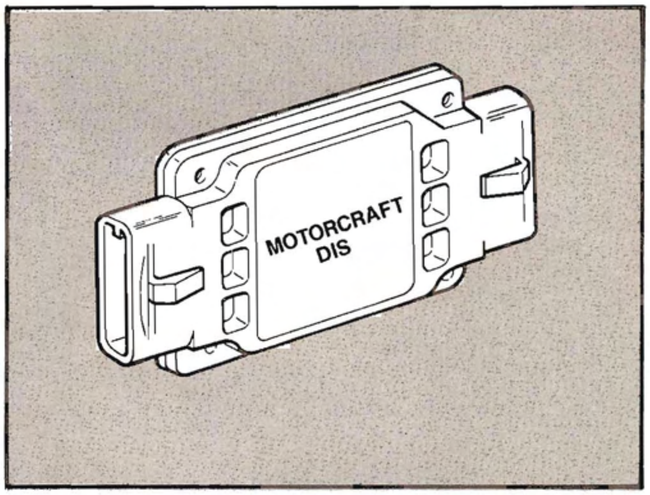


Figure 190. DIS Module

Sensor Description

The primary sensors used in the DIS are the camshaft and crankshaft sensors (Fig. 191). Both of these sensors are digital Hall devices that provide a voltage signal to the DIS module. The cam sensor is located on the right end of the cylinder head that faces the rear of the engine compartment. A rotary vane cup (or wheel) made of ferrous metal is used to trigger the Hall effect switch located in the sensor (Fig. 192). The camshaft cup has one tooth and is driven by the camshaft. The signal from the camshaft sensor has one positive going edge once every two crank revolutions (one cam revolution). The crankshaft cup has three teeth and the crankshaft sensor generates three positive (PIP) edges every revolution of the crankshaft.

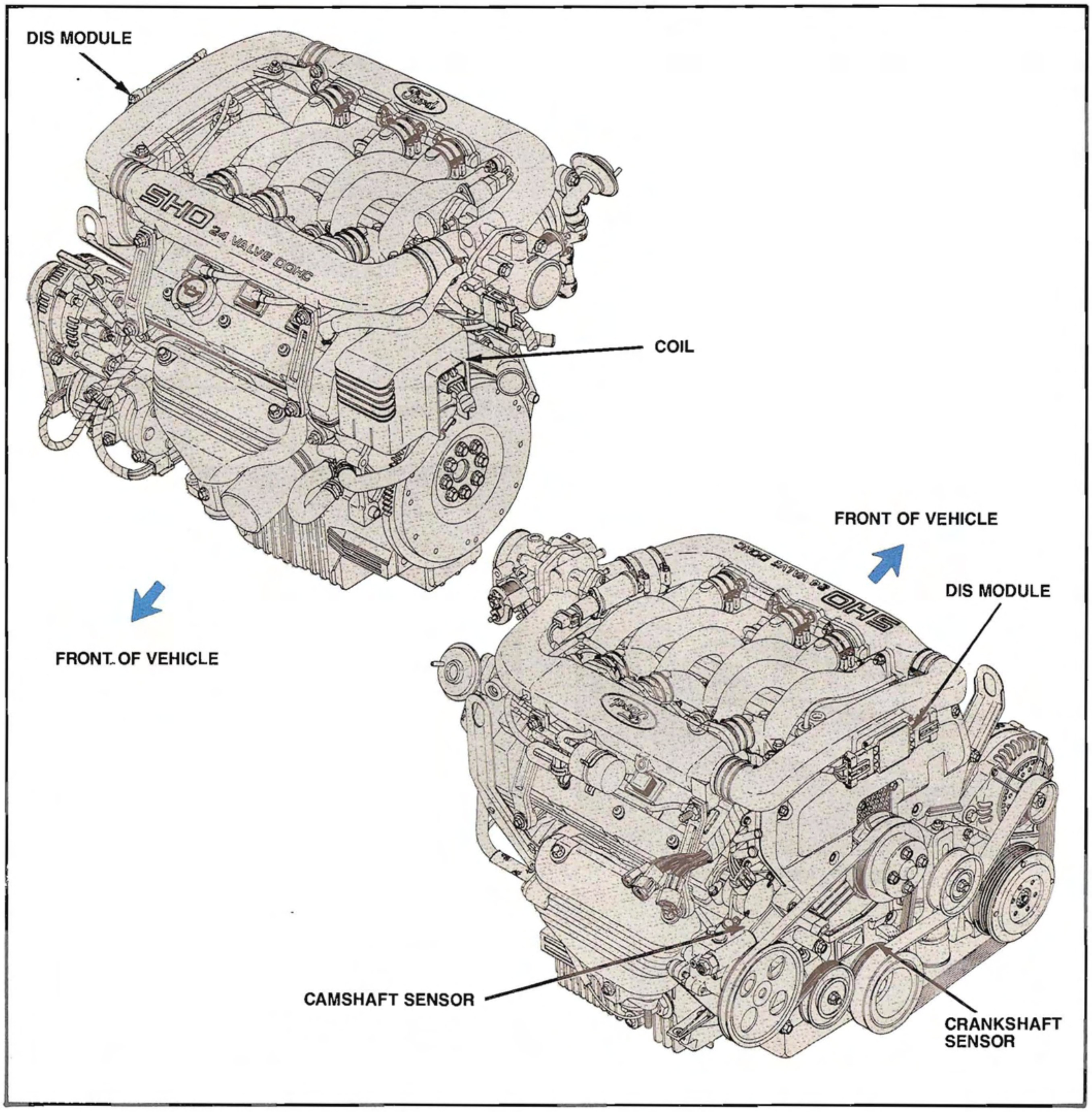


Figure 191. Camshaft and Crankshaft Sensors

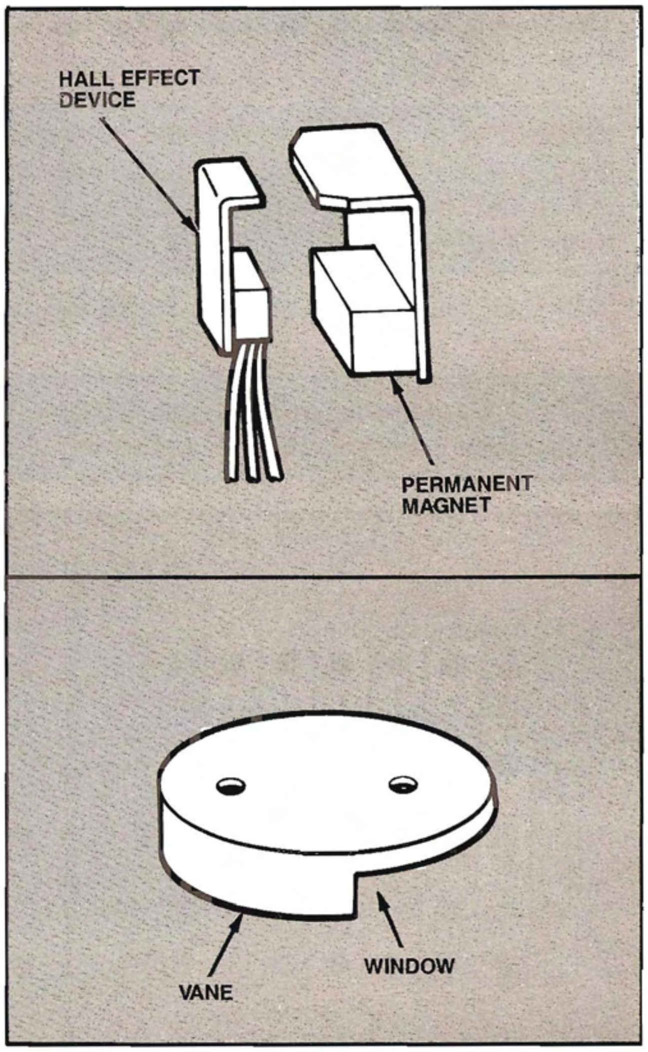


Figure 192. Rotary Vane Cup

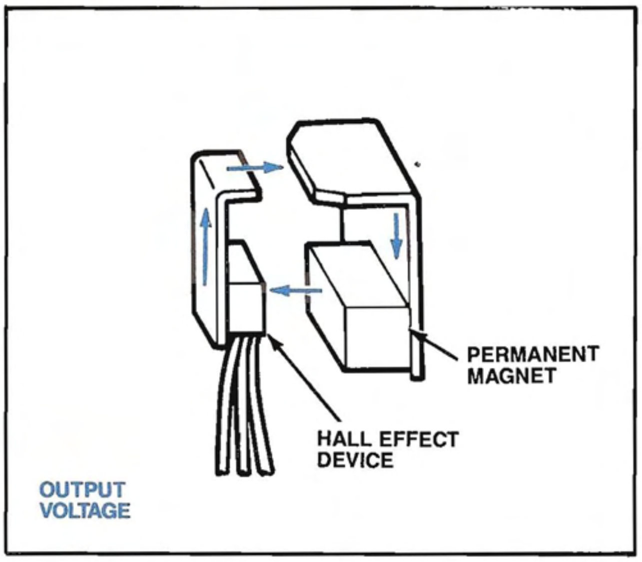


Figure 193. Low Voltage Signal

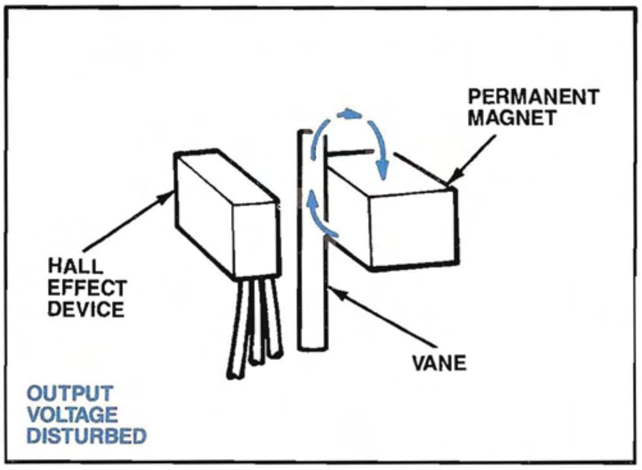


Figure 194. High Voltage Signal

When the window of the vane cup is between the magnet and the Hall effect device and back to the magnet (Fig. 193), the output signal will be low (0 volts). However, when the vane tooth moves into the gap between the Hall effect device and the magnet, the flux lines are shunted through the vane and back to the magnet (Fig. 194) and the output will change from a low to a high (V BATT) signal.

System Diagnostics

The following information discusses the procedures used to check the DIS. The system is capable of displaying different codes to indicate a problem (Fig. 195).

CODE	DESCRIPTION
45	COIL PACK "A" CIRCUIT FAILURE
46	COIL PACK "B" CIRCUIT FAILURE
47	SPARK LOCATION ERROR*
48	COIL PACK "C" CIRCUIT FAILURE*
49	DEFAULT SPARK ERROR*

*THESE CODES ARE ALSO USED IN THE SPECIAL SPEED CONTROL SYSTEM SELF-TEST.

Figure 195. Code Chart

Preliminary Checks

1. Visually inspect the engine compartment to ensure all vacuum hoses and spark plug wires are properly and securely connected.
2. Examine all wiring harnesses and connectors for insulation damage, burned, overheated, loose or broken conditions.
3. Be certain the battery is fully charged.
4. Make sure that all accessories and electrical load devices are turned off during diagnosis.

Equipment

To properly perform the diagnostic procedure on the DIS, the following equipment is necessary:

- DIS Diagnostic Cable (Hickok HK-100-306 or equivalent)
- Spark Tester, Neon Bulb Type (Champion CT-436 or equivalent)
- Spark Tester, Gap Type (D81P-6666-A or equivalent)
- Volt/Ohm Meter (Rotunda 014-00407 or equivalent)
- .14-Volt Test Lamp
- Remote Starter Switch
- Timing Light (Rotunda 014-00407 or equivalent)
- EEC-IV Breakout Box (Rotunda T83L-50-EEC-IV or equivalent)

NOTE: A DIS overlay is required for the breakout box to correctly identify the different pins (Fig. 196).

- DIS Lite Box (Hickock 506 or equivalent)

NOTE: The DIS Lite Box connects to the EEC Breakout Box TEE and provides a visual indication of DIS signal status.

- DIS Module Tester (NU-DI Model 600 or equivalent)

NOTE: This tester contains 12 LEDs, 12 test jacks and an interface cable. It monitors signals in and out of the DIS module. It is hand-held and self-contained.

- DIS Coil/Sensor Tester (NU-DI Model 601 or equivalent)

NOTE: This tester is similar to the Module Tester except it monitors the coils and sensors.

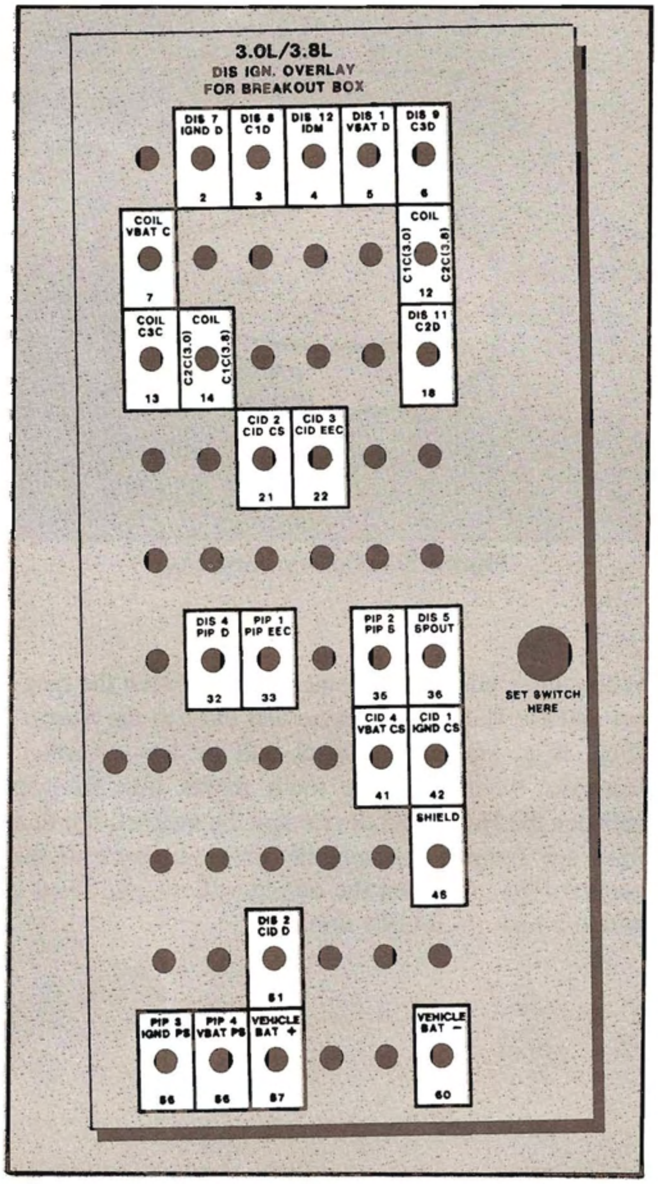


Figure 196. Breakout Box Overlay For 3.0L SHO

DIS Cable Attachment

The DIS cable and related testers should be hooked up as shown (Fig. 197).

The following are some important points to be aware of when making tests on the DIS:

- When making measurements on a wiring harness, both a visual inspection and a continuity test should be performed.
- Spark timing adjustments cannot be made.
- When making voltage checks and a reference to ground is made, use either the negative battery lead or cast iron on the engine. V BATT means the positive battery cable at the battery.

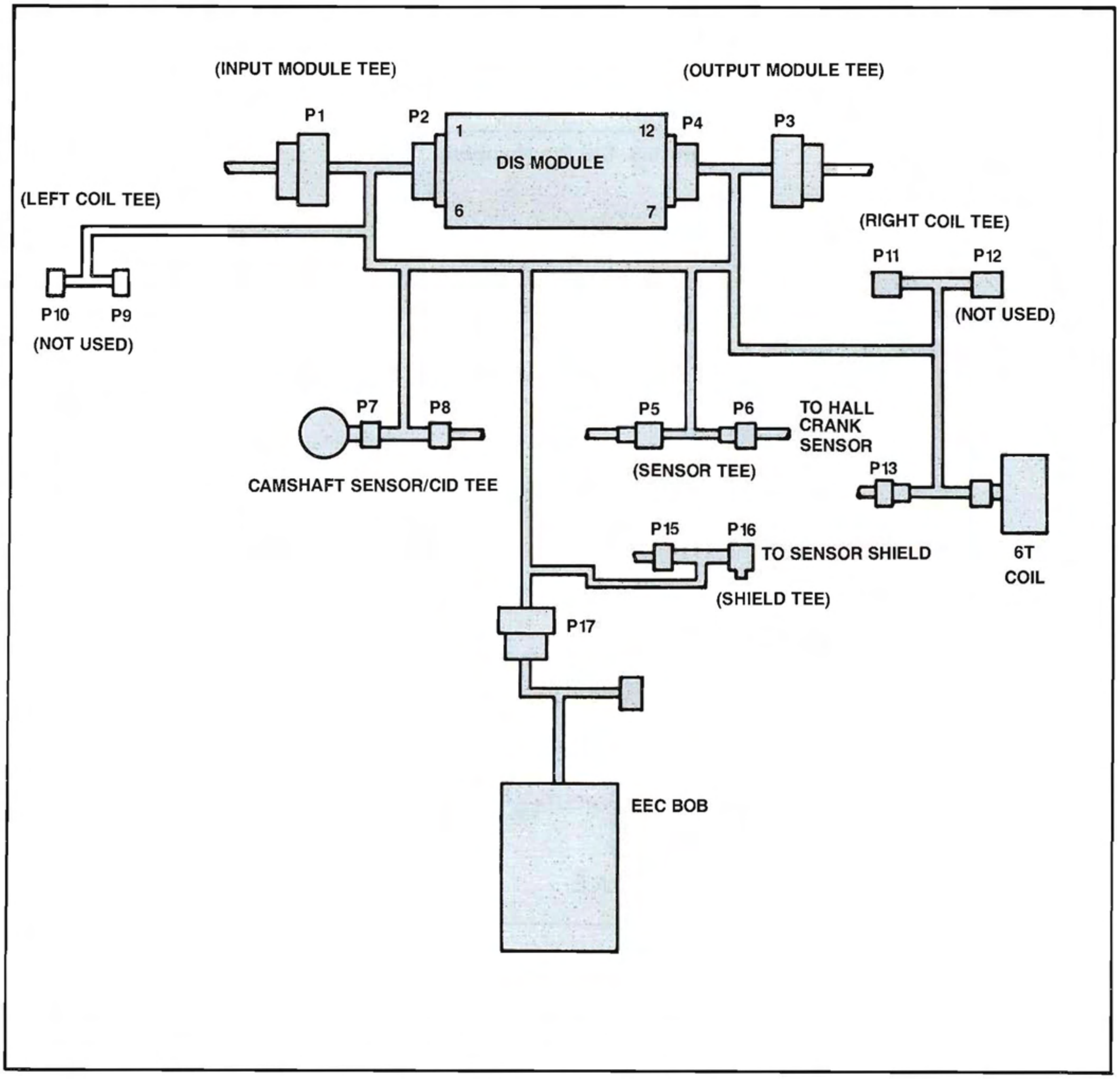


Figure 197. DIS Cable Attachment

Some other important points to be aware of when diagnosing the DIS are the DIS module pin numbers (Fig. 198).

Wiring for the DIS is as shown (Fig. 199).

*NOTE PIN 7 (IGN GND) IS CONNECTED INTERNALLY TO THE BOTTOM DIS MODULE MOUNTING HOLES.

PIN #	
1	VBAT
2	CID
3	
4	PIP IN
5	SPOUT
6	
7	IGND
8	COIL 1
9	COIL 3
10	
11	COIL 2
12	IDM

Figure 198. DIS Pin Numbers

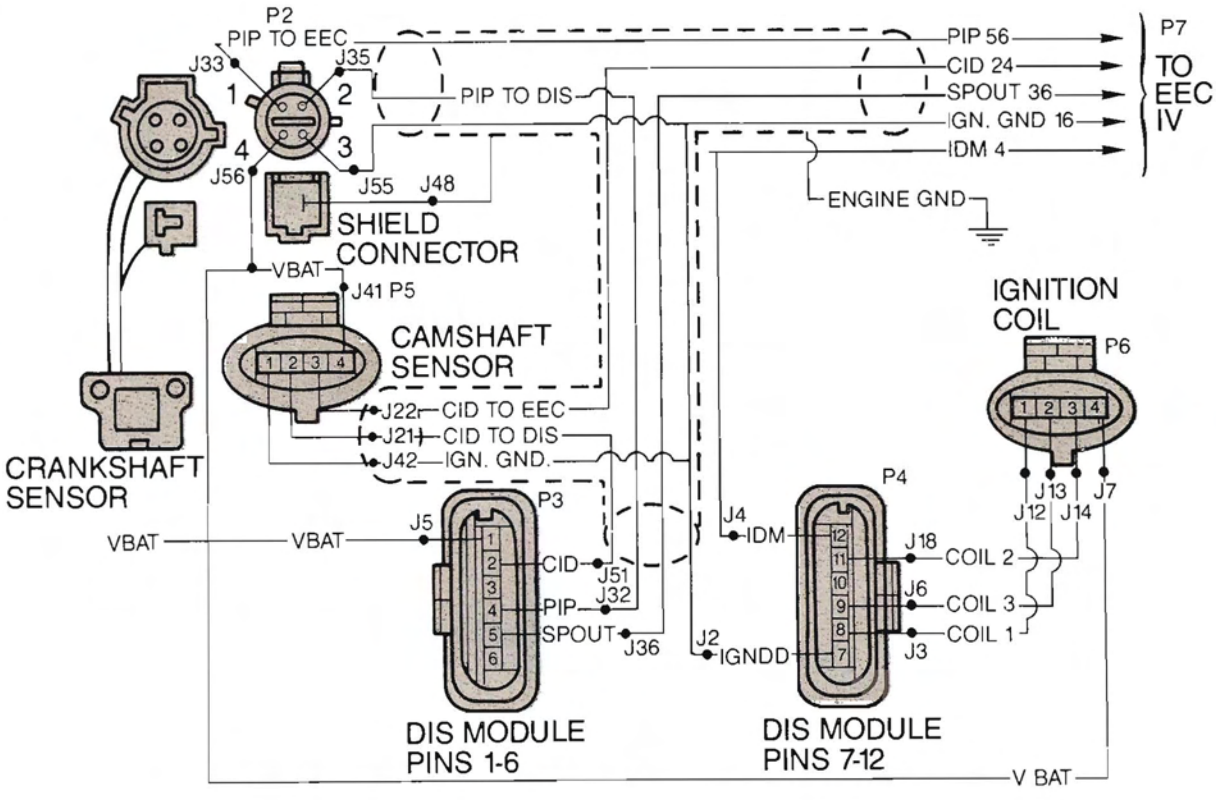


Figure 199. DIS Wiring Diagram

DIS Diagnostics

Diagnosis of improper operating conditions should not begin with the DIS section. Instead, electronic diagnostics should begin with the EEC system first. The tests outlined for the DIS are dependent on results from tests conducted on the EEC system.

Should it be necessary to diagnose the DIS, use the following charts. Begin with Steps as shown in the service index.

SERVICE INDEX

If timing light will not trigger	start at	TEST 1, Step 7.
If cranking is not smooth and regular	start at	TEST 1, Step 6.
If no start and fuel ok.	start at	TEST 1, Step 7.
If no start and no fuel.	start at	TEST 1, Step 13.
If continuous service code 18 (Spout fault)	start at	TEST 3, Step 15.
If continuous service code 45, 46, or 48 (Coil 1, Coil 2 or Coil 3 failure), lack of power and engine noise.	start at	TEST 2, Step 1.
If continuous service code 49 (10 degree spark angle all the time)	start at	TEST 3, Step 15.

System Function | 3.0 SHO, 3.8 SC | Test 1

TEST STEP	RESULT ▶	ACTION TO TAKE
STEP 1		
• Is the spark angle 10° BTDC (±3°) with the SPOUT jumper disconnected?	Yes ▶	GO to **Step 2**.
	No ▶	GO to **Step 3**.
STEP 2		
• Is the spark angle 30° BTDC (±3°) with SPOUT jumper connected, during self-test?	Yes ▶	GO to **Step 4**.
	No ▶	REPLACE DIS module.
STEP 3		
• Inspect the vane cups located on the back of the crankshaft (refer to Group 26). Are the cups bent or damaged?	Yes ▶	REPLACE or SERVICE.
	No ▶	REPLACE crank sensor.
STEP 4		
• Is cranking smooth and regular (does not backfire or pause)?	Yes ▶	GO to **Step 7**.
	No ▶	GO to **Step 5**.
STEP 5		
• Is there continuous spark at all plug wires (use neon spark tester)?	Yes ▶	GO to **Step 6**.
	No ▶	GO to **Step 8**.
STEP 6		
• Install the DIS diagnostic cable and EEC breakout box. Measure the voltage between J51 (CIDD) and J2 (IGNDD) while cranking the engine in very short bursts. Are two voltages, 0 and + VBAT observed during crank or 6.4 VDC (± 1 VDC) if engine runs?	Yes ▶	REPLACE DIS module.
	No ▶	GO to **Test 3, Step 1**.

System Function (Cont'd.)

3.0 SHO, 3.8 SC | **Test 1**

TEST STEP	RESULT	ACTION TO TAKE
STEP 7		
• Is there continuous spark at all plug wires (use neon spark tester)?	Yes ▶	GO to **Step 11**.
	No ▶	GO to **Step 8**.
STEP 8		
• Using the air gap spark tester at the coil verify that there is good quality (blue) spark at all coil towers.	Yes ▶	GO to **Test 2, Step 1**.
	No ▶	GO to **Step 9**.
STEP 9		
• Is the resistance of the plug wires less than 30K ohms?	Yes ▶	GO to **Step 10**.
	No ▶	REPLACE damaged wires.
STEP 10		
• Inspect the plugs. Are they OK?	Yes ▶	GO to **Test 2, Step 1**.
	No ▶	REPLACE damaged plugs.
STEP 11		
• Is the resistance of the plug wires less than 30K ohms?	Yes ▶	GO to **Step 12**.
	No ▶	REPLACE damaged wires.
STEP 12		
• Inspect the plugs. Are they OK?	Yes ▶	Ignition OK. GO to **Section 2**.
	No ▶	REPLACE damaged plugs.

System Function (Cont'd.)

3.0 SHO, 3.8 SC | **Test 1**

TEST STEP	RESULT	ACTION TO TAKE
STEP 13		
• Install DIS Diagnostic Cable and EEC Breakout Box. Measure the voltage between J22 (CIDEEC) and the negative terminal of the battery while cranking the engine in very short bursts. Are two voltages 0 and VBAT observed or 6.5 (± 1 VDC) if engine runs ?	Yes ▶	CID Sensor OK. GO to **Section 2**.
	No ▶	GO to **Step 14**.
STEP 14		
• Is the resistance between J42 (IGNDCS) and the negative of the battery less than 5 ohms key off ?	Yes ▶	GO to **Step 15**.
	No ▶	IGNDCS fault. SERVICE circuit (Figure 2).
STEP 15		
• Is the voltage between J41 (VBATC) and J55 (IGNDC) more than 11 VDC key on ?	Yes ▶	REPLACE CID Sensor.
	No ▶	GO to **Step 16**.
STEP 16		
• Remove the CID Sensor from the sensor TEE. Repeat Step 15. OK now?	Yes ▶	REPLACE CID Sensor.
	No ▶	VBATCS fault. SERVICE harness.
STEP 17		
• Install the DIS Diagnostic Cable and EEC Breakout Box. Measure the voltage between J33 (PIPEEC) and the negative terminal of the battery while cranking the engine in very short bursts. Are two voltages observed 0 and VBAT or 6.5 (±1 VDC)?	Yes ▶	PIP Sensor OK. GO to **Section 2**.
	No ▶	GO to **Step 18**.
STEP 18		
• Is the resistance between J55 (IGNDC) and the negative terminal of the battery less than 5 ohms ?	Yes ▶	GO to **Step 19**.
	No ▶	IGNDC fault. SERVICE IGNDC circuit.

System Function (Cont'd.)

3.0 SHO, 3.8 SC | **Test 1**

TEST STEP	RESULT ▶	ACTION TO TAKE
STEP 19		
• Is the voltage between J56 (VBATC) and J55 (IGNDC) more than 11 VDC key on ?	Yes ▶	REPLACE PIP Sensor.
	No ▶	GO to **Step 20.**
STEP 20		
• Remove the PIP Sensor from the Crank Sensor TEE. Repeat Step 19. OK now ?	Yes ▶	Place PIP Sensor.
	No ▶	VBAT fault. SERVICE harness.

DIS Module, Harness and Coil

3.0 SHO, 3.8 SC

Test 2

TEST STEP	RESULT	ACTION TO TAKE
STEP 1		
• Install the DIS diagnostic cable and EEC Breakout Box. Is there continuous spark at any coil wire?	Yes	GO to **Step 6**.
	No	GO to **Step 2**.
STEP 2		
• Is the voltage between J5 (VBATD) and the negative terminal of the battery more than 11 VDC with the key on?	Yes	GO to **Step 3**.
	No	GO to **Step 31**.
STEP 3		
• Is the resistance between J2 (IGNDD) and the negative terminal of the battery less than 5 ohms key off?	Yes	GO to **Step 4**.
	No	IGNDD open, SERVICE harness.
STEP 4		
• Measure the voltage between J32 (PIPD) and J2 (IGNDD) while cranking the engine in very short bursts. Are two voltages 0 and VBAT observed during crank or 6.5 VDC (±1 VDC) if engine runs?	Yes	GO to **Step 5**.
	No	GO to **Test 3, Step 8**.
STEP 5		
• Measure the voltage between J51 (CIDD) and J2 (IGNDD) while cranking the engine in very short bursts. Are two voltage levels, 0 and VBAT observed during crank or 6.5 VDC (±1VDC) if engine runs?	Yes	GO to **Step 6**.
	No	GO to **Test 3, Step 1**.
STEP 6		
• Connect the test light between J14 (C1C) if 3.0 or J12 (C1C) if 3.8 and J5 (VBATD). Crank the engine. Does the light blink continuously?	Yes	GO to **Step 7**.
	No	GO to **Step 10**.
STEP 7		
• Move the lead from J12 or J14 to J13 (C3C). Crank the engine. Does the light blink continuously?	Yes	GO to **Step 8**.
	No	GO to **Step 15**.

DIS Module, Harness and Coil (Cont'd.)

3.0 SHO, 3.8 SC

Test 2

TEST STEP	RESULT	ACTION TO TAKE
STEP 8		
• Move the lead from J13 (C3C) to J12 (C2C) if 3.0 or J14 (C2C) if 3.8. Crank the engine. Does the light blink continuously?	Yes ▶	GO to **Step 9**.
	No ▶	GO to **Step 20**.
STEP 9		
• Is the voltage between J7 (VBATC) and J2 (IGNDD) more than 11 VDC?	Yes ▶	REPLACE coil.
	No ▶	Coil VBAT is damaged. SERVICE harness.
STEP 10		
• For 3.0L, move the lead from J14 to J3 (C1D). • For 3.8L, move the lead from J12 to J3 (C1D). Does the light blink continuously?	Yes ▶	C1C is open. SERVICE.
	No ▶	GO to **Step 11**.
STEP 11		
• Remove the coil from the coil TEE. Crank the engine. Does the light blink continuously?	Yes ▶	REPLACE the coil.
	No ▶	GO to **Step 12**.
STEP 12		
• For 3.0L, measure resistance between J14 (C1C) and J3 (CID). • For 3.8L, measure resistance between J12 (C1C) and J3 (CID). • Is the resistance less than 5 ohms?	Yes ▶	GO to **Step 13**.
	No ▶	C1 is open. SERVICE harness.
STEP 13		
• Disconnect the DIS module from the module output TEE. Is the resistance between J18 (CID) and J2 (IGNDD) more than 10K ohms key off?	Yes ▶	GO to **Step 14**.
	No ▶	C1 is shorted to ground. SERVICE harness.
STEP 14		
• Is the resistance between J18 (CID) and J5 (VBATD) more than 10K ohms key off?	Yes ▶	REPLACE DIS module.
	No ▶	C1 is shorted to VBAT.

DIS Module, Harness and Coil (Cont'd.)

3.0 SHO, 3.8 SC — Test 2

TEST STEP	RESULT ▶	ACTION TO TAKE
STEP 15		
• Move the lead from J13 (C3C) to J6 (C3D). Crank the engine. Does the light blink continuously?	Yes ▶	C3 is open. SERVICE harness.
	No ▶	GO to **Step 16**.
STEP 16		
• Remove the coil from the coil TEE. Crank the engine. Does the light blink continuously?	Yes ▶	REPLACE coil.
	No ▶	GO to **Step 17**.
STEP 17		
• Is the resistance between J13 (C3C) and J6 (C3D) less than 5 ohms, key off?	Yes ▶	GO to **Step 18**.
	No ▶	C3 is open. SERVICE harness.
STEP 18		
• Disconnect the DIS module from the module output TEE. Is the resistance between J6 (C3D) and J2 (IGNDD) more than 10K ohms, key off?	Yes ▶	GO to **Step 19**.
	No ▶	C2 is shorted to GND. SERVICE harness.
STEP 19		
• Is the resistance between J13 (C3C) and J5 (VBATD) more than 10K ohms, key off?	Yes ▶	REPLACE DIS module.
	No ▶	C2 is shorted to VBAT.
STEP 20		
• For 3.0L, move the lead from J12 to J18 (C2D). For 3.8L, move the lead from J14 to J18 (C2D). Crank the engine. Does the light blink continuously?	Yes ▶	C2 is open. SERVICE harness.
	No ▶	GO to **Step 21**.
STEP 21		
• Remove the coil from the coil TEE. Crank the engine. Does the light blink continuously?	Yes ▶	REPLACE coil.
	No ▶	GO to **Step 22**.

DIS Module, Harness and Coil (Cont'd.)

3.0 SHO, 3.8 SC | **Test 2**

TEST STEP	RESULT ▶	ACTION TO TAKE
STEP 22		
• For 3.0L, measure the resistance between J3 (CID) and J14 (C1C). • For 3.8L, measure the resistance between J3 (CID) and J12 (C1C). • Is the resistance less than 5 ohms?	Yes ▶ No ▶	GO to Step **23**. C1 is open. SERVICE harness.
STEP 23		
• Disconnect the module from the module output TEE. Is the resistance between J3 (C1D) and J2 (IGNDD) more than 10K ohms, key off?	Yes ▶ No ▶	GO to Step **24**. C1 is shorted to GND. SERVICE harness.
STEP 24		
• Is the resistance between J3 (C1D) and J5 (VBATD) more than 10K ohms, key off?	Yes ▶ No ▶	REPLACE DIS module. C1 is shorted to VBAT. SERVICE harness.

DIS Module, Harness and Sensors

3.0 SHO, 3.8 SC | **Test 3**

TEST STEP	RESULT	ACTION TO TAKE
STEP 1		
• Disconnect the module from the DIS input TEE. Measure the voltage between J51 (CIDD) and J2 (IGNDD) while cranking the engine in very short bursts. Are two voltages 0 and +VBAT observed during crank or 6.5 VDC (±1 VDC) if the engine runs?	Yes ▶	REPLACE DIS module.
	No ▶	GO to **Step 2**.
STEP 2		
• Is the voltage between J21 (CIDS) and J2 0 and +VBAT while cranking or 6.5 VDC (±1 VDC) if the engine runs?	Yes ▶	CID is open. SERVICE harness.
	No ▶	GO to **Step 3**.
STEP 3		
• Is the voltage between J41 (VBATCS) and J2 (IGNDD) more than 11 VDC key on?	Yes ▶	GO to **Step 4**.
	No ▶	VBATCS fault. SERVICE harness.
STEP 4		
• Is the resistance between J42 (IGND CS) and J2 (IGNDD) less than 5 ohms, key off?	Yes ▶	GO to **Step 5**.
	No ▶	IGND is open. SERVICE IGND circuit.
STEP 5		
• Is the resistance between J21 (CIDS) and J5l (CIDD) less than 5 ohms?	Yes ▶	GO to **Step 6**.
	No ▶	CID is open. SERVICE harness.
STEP 6		
• Disconnect the CID sensor from the CID TEE. • Is the resistance between J51 (CIDD) and J2 (IGNDD) more than 10K ohms key off?	Yes ▶	GO to **Step 7**.
	No ▶	CID is shorted to GND. SERVICE harness.

DIS Module, Harness and Sensors (Cont'd.)

3.0 SHO, 3.8 SC | **Test 3**

TEST STEP	RESULT	ACTION TO TAKE
STEP 7		
• Is the resistance between J51 and J5 (VBATD) more than 10K ohms key off?	Yes ▶	REPLACE CID sensor.
	No ▶	CID is shorted to VBAT.
STEP 8		
• Is the voltage between J35 (PIPS) and J2 (IGNDD) 0 and +VBAT while cranking the engine in very short bursts?	Yes ▶	PIP is open. SERVICE harness.
	No ▶	GO to **Step 9**.
STEP 9		
• Is the resistance between J35 (PIPS) and J32 (PIPD) less than 5 ohms key off?	Yes ▶	GO to **Step 10**.
	No ▶	PIP is open. SERVICE harness.
STEP 10		
• Disconnect the DIS module from the DIS input TEE. Repeat Step 8. OK now?	Yes ▶	REPLACE DIS module.
	No ▶	GO to **Step 11**.
STEP 11		
• Is the voltage between J56 (VBATS) and J2 (IGNDD) more than 11 VDC with the key on?	Yes ▶	GO to **Step 12**.
	No ▶	GO to **Step 13**.
STEP 12		
• Is the resistance between J55 (IGNDPS) and the negative terminal of the battery less than 5 ohms key off?	Yes ▶	GO to **Step 13**.
	No ▶	SERVICE harness.
STEP 13		
• Disconnect the crank sensor from the crank sensor TEE. Repeat Step 11. OK now?	Yes ▶	REPLACE crank sensor.
	No ▶	VBAT to crank sensor damaged. SERVICE harness.

DIS Module, Harness and Sensors (Cont'd.)

3.0 SHO, 3.8 SC — **Test 3**

TEST STEP	RESULT	ACTION TO TAKE
STEP 14		
• Was a continuous service code of 18 observed during self-test?	Yes ▶	REPLACE DIS module.
	No ▶	GO to **Section 14**.
STEP 15		
• Is SPOUT continuous code 18 or 49 percent?	Yes ▶	REPLACE DIS module.
	No ▶	GO to **Section 14**.

MAINTENANCE SCHEDULES

MAINTENANCE SCHEDULE A

Follow Maintenance Schedule A if the vehicle is FREQUENTLY driven in one or more of the following conditions:

- Short trips of less than 16 km (10 miles) when outside temperatures remain below freezing.
- Operating during hot weather in stop and go ''rush hour'' traffic.
- Towing a trailer, using a camper or car-top carrier.
- Operating in severe dust conditions.
- Extensive idling, such as police, taxi or door-to-door delivery service.

1989 FIELD SERVICE MAINTENANCE SCHEDULE "A" — PASSENGER CAR

SERVICE INTERVALS Perform at the months or distances shown, whichever comes first. Miles x 1000	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
Kilometers x 1000	4.8	9.6	14.4	19.2	24.0	28.8	33.6	38.4	43.2	48.0	52.8	57.6	62.4	67.2	72.0	76.8	82.0	86.9	91.7	96.6
EMISSION CONTROL SERVICE																				
Change Engine Oil and Oil Filter Every 3 Months OR	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Replace Spark Plugs: — Standard (Non-Turbo)										X										X
— Platinum Type 3.0L & 3.8L Supercharged																				X
— Turbocharged					(X)					X					(X)					X
Inspect Accessory Drive Belt(s)										X										X
Replace Air Cleaner Filter (1)										X										X
Replace Crankcase Filter (1)										X										X
Clean/Check Choke Linkage - 5.8L Engine										X										X
Replace Engine Coolant, Every 36 Months OR										X										X
Check Engine Coolant Protection, Hoses and Clamps	ANNUALLY																			
Replace PCV Valve - 5.0L Engine					(X)					(X)					(X)					X
Replace Cam Belt and Adjust Valve Lash - 3.0L SHO Engine																				X

(1) If operating in severe dust, ask your dealer for proper replacement intervals.
(2) If your vehicle accumulates 5,000 miles (8,000 kilometers) or more per month or is used in CONTINUOUS stop-and-go service, change every 30.000 miles (48,000 kilometers) — not necessary for severe dust, short trips or extensive idling.
X All items with an "X" code are required to be performed in all states.
(X) This item not required to be performed. However, Ford recommends that you also perform maintenance on items designated by an "(X)" in order to achieve best vehicle operation. Failure to perform this recommended maintenance will not invalidate the vehicle emissions warranty or manufacturer recall liability.

MAINTENANCE SCHEDULE B

Follow Maintenance Schedule B if, generally the vehicle is driven on a daily basis for longer than 16 km (10 miles) and NONE OF THE DRIVING CONDITIONS SHOWN FOR SCHEDULE A APPLY TO THE VEHICLE.

1989 FIELD SERVICE MAINTENANCE SCHEDULE "B" — PASSENGER CAR

SERVICE INTERVALS Perform at the months or distances shown, whichever comes first.	Miles x 1000	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0
	Kilometers x 1000	12	24	36	48	60	72	84	96
EMISSION CONTROL SERVICE									
Turbocharged Engine Change Engine Oil and Oil Filter		EVERY 5,000 MILES (8,000 km) OR 6 MONTHS, WHICHEVER COMES FIRST							
Change Spark Plugs			(X)		X		(X)		X
3.8L Supercharged Engine Change Engine Oil and Oil Filter when indicated by the Vehicle Maintenance Monitor, but do not go beyond		EVERY 5,000 MILES (8,000 km) OR 6 MONTHS, WHICHEVER COMES FIRST							
3.8L Engine with Vehicle Maintenance Monitor Change Engine Oil and Oil Filter when indicated by the Vehicle Maintenance Monitor, but do not go beyond		EVERY 7,500 MILES (12,000 km) OR 6 MONTHS, WHICHEVER COMES FIRST							
All Engines except Turbocharged and Supercharged Change Engine Oil and Oil Filter Every 6 Months OR		X	X	X	X	X	X	X	X
Replace Spark Plugs - Standard					X				X
-Platinum Type 3.0L & 3.8L Supercharged									X
Inspect Accessory Drive Belt(s)					X				X
Replace Crankcase Filter (1)					X				X
Replace Air Cleaner Filter (1)					X				X
Check/Clean Choke Linkage - 5.8L Engine					X				X
Replace Engine Coolant Every 36 Months OR					X				X
Check Engine Coolant Protection, Hoses and Clamps		ANNUALLY							
Replace PCV Valve - 5.0L Engine			(X)		(X)		(X)		X
Replace Cam Belt and Check/Adjust Valve Lash - 3.0L SHO Engine									X

(1) If operating in severe dust, ask your dealer for proper replacement intervals.
X All items with an "X" code are required to be performed in all states.
(X) This item is not required to be performed. However, Ford recommends that you also perform maintenance on items designated by an "(X)" in order to achieve best vehicle operation. Failure to perform this recommended maintenance will not invalidate the vehicle emissions warranty or manufacturer recall liability.

3.0L SHO ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS	
DISPLACEMENT	3.0L
NUMBER OF CYLINDERS	6
BORE AND STROKE	
Bore	89.00mm (3.5039 in)
Stroke	80.00mm (3.1496 in)
FIRING ORDER	1-4-2-5-3-6
OIL PRESSURE (HOT, Idling)	Min 12.8 PSI
DRIVE BELT TENSION	SEE CHART

CYLINDER HEAD AND VALVE TRAIN	
COMBUSTION CHAMBER VOLUME (cc)	47.0-48.0
VALVE GUIDE BORE DIAMETER	
Intake and Exhaust	6.000-6.018 mm (0.2362-0.2369 in.)
VALVE SEATS	
Width — Intake	1.0-1.4mm (0.039-0.055 in.)
— Exhaust	1.0-1.4mm (0.039-0.055 in.)
Angle	45°
Width Limit	1.5mm (0.06 in.)
GASKET SURFACE FLATNESS	0.2mm (0.008 in.)
VALVE STEM TO GUIDE CLEARANCE	
Intake	0.025-0.058mm (0.0010-0.0023 in.)
Exhaust	0.030-0.063mm (0.0012-0.0025 in.)
VALVE HEAD DIAMETER (GAGE)	
Intake	35mm (1.38 in.)
Exhaust	30mm (1.18 in.)
MARGIN THICKNESS LIMIT	0.5mm (0.02 in.)
VALVE FACE ANGLE	45.5°
VALVE STEM DIAMETER (STD.)	
Intake	5.960-5.975mm (0.2346-0.2352 in.)
Exhaust	5.955-5.970mm (0.2344-0.2350 in.)
VALVE SPRINGS	
Compression Pressure (Kg [Lb] @ Spec. Length)	
Maximum Load	537.4 N (120.8 lbs.) @ 30.2mm (1.19 in.)
Set Load	188.3 N (42.3 lbs.) @ 38.7mm (1.52 in.)
Free Length (Approximate)	44.82mm (1.76 in.)
Service Limit	10% Force Loss @ Specified Height
VALVE LIFTER	
Diameter (Std.)	31.970-31.994mm (1.2587-1.2596 in.)
Clearance to Bore	0.024-0.036mm (0.0009-0.0014 in.)
Service Limit	0.07mm (0.003 in.)
VALVE CLEARANCE	
Intake	0.15-0.25mm (0.006-0.010 in.)
Exhaust	0.25-0.35mm (0.010-0.014 in.)
CAMSHAFT BORE INSIDE DIAMETER	
All	31.000-31.025mm (1.2205-12215 in.)

CAMSHAFT	
LOBE LIFT	
Intake	8.5mm (0.335 in.)
Exhaust	8.0mm (0.315 in.)
LOBE HEIGHT	
Intake	41.81-41.91mm (1.6461-1.650 in.)
Limit	41.80mm (1.6457 in.)
Exhaust	41.31-41.41mm (1.6264-1.6303 in.)
Limit	41.30mm (1.6260 in.)
END PLAY	
Service Limit	0.30mm (0.012 in.)
JOURNAL TO BEARING CLEARANCE	0.025-0.066mm (0.0010-0.0026 in.)
JOURNAL DIAMETER	
All	30.959-30.975mm (1.2189-1.2195 in.)

CYLINDER BLOCK	
HEAD GASKET SURFACE FLATNESS	0.05mm (0.002 in.)
CYLINDER BORE	
Diameter	89.000-89.030mm (3.5039-3.5051 in.)
Surface Finish (RMS) micrometers	TBD
Out-of-Round Limit	0.01mm (0.0004 in.)
Out-of-Round Service Limit	0.02mm (0.0008 in.)
Taper Service Limit	0.02mm (0.0008 in.)
MAIN BEARING BORE DIAMETER	68.000mm (2.677 in.)

CRANKSHAFT AND FLYWHEEL	
MAIN BEARING JOURNAL	
DIAMETER	63.976-64.000mm (2.5187-2.5197 in.)
Out-of-Round Limit	0.02mm (0.0008 in.)
Taper Limit	0.02mm (0.0008 in.) TOTAL
Journal Runout Limit	0.06mm (0.0024 in.)
THRUST BEARING	
Thickness	2.227-2.277mm (0.0877-0.0896 in.)
CONNECTING ROD JOURNAL	
Diameter	51.976-52.000mm (2.0463-2.0472 in.)
Out-of-Round Limit	0.02mm (0.0008 in.) MAX
Taper Limit	0.02mm (0.0008 in.) TOTAL

FLYWHEEL RING GEAR LATERAL RUNOUT (T.I.R.)	
CRANKSHAFT END PLAY	0.021-0.221mm (0.0008-0.0087 in.)
CONNECTING ROD BEARINGS	
Clearance to Crankshaft	
Desired	0.024-0.056mm (0.0009-0.0022 in.)
Allowable	0.08mm (0.0031 in.)
Bearing Wall Thickness (Std.)	1.484-1.496mm (0.0584-0.0589 in.)
MAIN BEARINGS	
Clearance to Crankshaft	
Desired	0.028-0.056mm (0.0011-0.0022 in.)
Allowable	0.08mm (0.0031 in.)
Bearing Wall Thickness (Std.)	1.981-1.998mm (0.0780-0.0787 in.)

CONNECTING ROD, PISTON AND RINGS	
CONNECTING ROD	
Piston Pin Bore Diameter	21.005-21.017mm (0.8270-0.8274 in.)
Crankshaft Bearing Bore Diameter	55.000-55.016mm (2.1653-2.1660 in.)
Length (Center-to-Center)	146.75-146.85mm (5.778-5.781 in.)
ALIGNMENT (BORE-TO-BORE MAX. DIFF.)	
Twist	0.15 per 100mm (0.0015 per in.)
Bend	0.05 per 100mm (0.0005 per in.)
SIDE CLEARANCE (ASSEMBLED TO CRANK)	
Standard	0.16-0.312mm (0.0063-0.0123 in.)
Service Limit	0.35mm MAX. (0.0138 in. MAX.)

PISTON	
Diameter	
Coded (STD.)	88.960-88.990mm (3.5023-3.5035 in.)
Coded (O/S: 0.25)	TBDmm (TBD in.)
Coded (O/S: 0.50)	TBDmm (TBD in.)
PISTON-TO-BORE CLEARANCE	0.030-0.050mm (0.0012-0.0020 in.)
Service Limit	0.080mm MAX.
RING GROOVE WIDTH	
Compression (Top)	1.21-1.23mm (0.0476-0.0484 in.)
Compression (Bottom)	1.505-1.525mm (0.0593-0.0600 in.)
Oil	2.81-2.83mm (0.1106-0.1114 in.)
PISTON PIN	
Length	61.9-62.0mm (2.437-2.441 in.)
Diameter	20.997-21.009mm (0.8267-0.8271 in.)
PIN TO PISTON CLEARANCE	−0.005- +0.001mm (−0.00020- +0.00004 in.)
PIN TO ROD CLEARANCE	0.005-0.011mm (0.00020-0.00043 in.)
PISTON PIN INSTALLING TEMPERATURE	70-80°C (158-176°F)

3.0L SHO ENGINE SPECIFICATIONS

PISTON — Continued

PISTON RINGS
- Ring Width
  - Compression (Top) .... 1.17-1.19mm (0.0461-0.0469 in.)
  - Compression (Bottom) .... 1.47-1.49mm (0.0579-0.587 in.)
- Ring Gap
  - Compression (Top) (In Gauge) .... 0.30-0.45mm (0.012-0.018 in.)
  - Compression (Bottom) (In Gauge) .... 0.30-0.45mm (0.012-0.018 in.)
- Oil Ring (Steel Rail) (In Gauge) .... 0.20-0.50mm (0.008-0.020 in.)
- Side Clearance
  - 1st Ring .... 0.02-0.06mm (0.0008-0.0024 in.)
  - 2nd Ring .... 0.015-0.055mm (0.0006-0.0022 in.)
  - Oil Ring .... 0.06-0.15mm (0.0024-0.0059 in.)

LUBRICATION SYSTEM

OIL PUMP
- Relief Valve Spring Tension
  - (Force @ Length) .... 6.05 N/mm (34.5 lb./in.)
- Relief Valve to Bore Clearance .... 0.052-0.088mm (0.0020-0.0035 in.)
- Outer and Inner Rotor
  - Tip Clearance .... 0.06-0.18mm (0.0024-0.0071 in.)
  - Rotor to Housing Side Clearance .... 0.03-0.09mm (0.0012-0.0035 in.)
  - Outer Rotor to Housing Radial Clearance .... 0.10-0.175mm (0.0039-0.0069 in.)
  - Inner Rotor Shaft to Housing Clearance .... 0.03-0.095mm (0.0012-0.0037 in.)

OIL CAPACITY
- Passenger Car: 5.0 qt. with filter change.

BELT TENSION ALLOWABLE LIMITS

	Specifications		Allowable Minimum
	New Belt (1) Installation Tension	Use Belt (2) Reset Tension	Cold Belt (2) (3) Audit Check
6 Rib	100-120 kg (220-265 lbs.)	67-87 kg (148-192 lbs.)	N.A.
4 Rib	70-90 kg (154-198 lbs.)	51-71 kg (112-157 lbs.)	

(1)New belt installed and tensioned/engine not rotated.
(2)Used belt is any belt that has rotated on an engine.
(3)Cold belt (i.e., 3-hour soak; 0 warm-up).

3.0L SHO ENGINE TORQUE SPECIFICATIONS

Description	Thread Size	N·m	Lb-Ft	kg·cm	
1. CYLINDER BLOCK					
Crankshaft Bearing Cap	M11 x 1.5	78-88	58-65	800-900	*(1)
Crankshaft Bearing Cap Beam to Crankshaft Bearing Cap	M8 x 1.25	21-32	15-24	210-330	
Ventilation Case	M6 x 1.0	6.5-9.5	56-82 Lb-In	65-95	
Oil Level Indicator Tube	M6 x 1.0	6.5-9.5	56-82 Lb-In	65-95	
Oil Seal Carrier	M6 x 1.0	6.5-9.5	56-82 Lb-In	65-95	
Oil Pressure Switch	NPTF 1/4 - 18	12-16	8.5-12	120-160	
Knock Sensor	M10 x 1.5	29-39	22-29	300-400	
Water Jacket Drain Plug	PT 1/4	16-24	12-17	160-240	
Oil Main Hole Plug	PT 1/4	24-35	17-26	240-360	
Oil Cooler Water Pipe	PT 1/2	39-59	29-43	400-600	
2. CRANKSHAFT					
Flywheel	M10 x 1.0	69-78	51-58	700-800	**(2)
Crankshaft Damper Pulley	M14 x 1.5	152-172	112-127	1550-1750	**
Connecting Rod to Connecting Rod Cap	M9 x 1.0	45-49	33-36	460-500	**(3)
3. LUBRICATION SYSTEM					
Oil Pump to Cylinder Block	M8 x 1.25	16-23	12-17	160-230	
Crankshaft Bearing Cap Beam to Oil Pan Baffle Plate No. 1	M8 x 1.25	16-23	12-17	160-230	
Oil Pan to Cylinder Block	M8 x 1.25	16-23	12-17	160-230	
Low Oil Level Sensor to Oil Pan	M20 x 1.5	21-33	15-25	210-340	
Oil Drain Plug to Oil Pan	M14 x 1.5	20-33	14-25	200-340	
Oil Pan Baffle Plate No. 2 to Oil Pan	M6 x 1.0	6.5-9.5	56-82 Lb-In	65-95	
Oil Strainer to Oil Pump	M6 x 1.0	7.5-10	66-89 Lb-In	75-108	
Oil Cooler Union Bolt to Cylinder Block	M20 x 1.5	39-49	29-36	400-500	
Oil Filter	3/4-16 UNF	(4)	(4)	(4)	
4. COOLING SYSTEM					
Water Pump to Cylinder Block	M8 x 1.25	15-23	11-17	156-234	
Water Pump Pulley to Water Pump	M8 x 1.25	15-23	11-17	156-234	
Water Pump Body to Water Pump Cover	M6 x 1.0	6.3-9.4	4.6-6.9	64-96	
Water Inlet to Water Pump	M6 x 1.0	8.3-13	6.1-9.4	85-130	
Water Outlet Housing to Cylinder Head (L)	M8 x 1.25	15-23	11-17	156-234	
Water Outlet No. 1 to Cylinder Head (R)	M8 x 1.25	15-23	11-17	156-234	
Water Outlet No. 2 to Water Outlet Housing	M6 x 1.0	7.1-11	5.2-7.8	72-108	
Water Temperature Indicator Sender to Water Outlet No. 1	NPTF 3/8-18	16-24	12-18	166-249	
Engine Electronic Coolant Temperature Sensor to Water Outlet Housing	NPTF 8/8-18	16-24	12-18	166-249	
5. CYLINDER HEAD					
Camshaft Cap to Cylinder Head	M7 x 1.0	16-22	12-16	160-220	
Cylinder Head to Cylinder Block	M11 x 1.5	83-93	61-69	850-950	*(5)
Cylinder Head Cover to Cylinder Head	M6 x 1.0	9.8-16	7.2-12	100-160	
Timing Chain Sprocket to Camshaft, 1-4	M7 x 1.0	14-18	10-13	140-180	
Timing Chain Guide (R) to Timing Chain Tensioner (R) to Cylinder Head (R)	M7 x 1.0	15-19	11-14	150-190	
Timing Chain Tensioner (L) to Timing Chain Guide (L) to Cylinder Head (L)	M7 x 1.0	15-19	11-14	150-190	

(1)Tighten in 2 steps 49-69 N·m (36-51 Lb-Ft), 78-83 N·m (58-65 Lb-Ft).
(2)Tighten in 2 steps 39-59 N·m (29-43 Lb-Ft), 69-78 N·m (51-58 Lb-Ft).
(3)Tighten in 2 steps 30-35 N·m (22-26 Lb-Ft), 45-50 N·m (33-36 Lb-Ft).
(4)Advance 3/4 turn after gasket contacts surface.
(5)Tighten in 2 steps 49-69 N·m (36-51 Lb-Ft), 83-93 N·m (61-69 Lb-Ft).
NOTE: *Coat with engine oil.
**Coat with Molybdenum paste.

3.0L SHO ENGINE TORQUE SPECIFICATIONS

Description	Thread Size	N·m	Lb-Ft	kg·cm	
6. FUEL SYSTEM					
Fuel Rail to Cylinder Head	M8 x 1.25	16-23	12-17	160-230	
Fuel Pressure Relief Valve to Union Bolt	NPTF 1/8-27	6-9	52-78 Lb-In	60-90	
Fuel Rail Connector to Fuel Rail (R and L)	M12 x 1.25	25-34	18-25	250-350	
Fuel Pressure Damper to Fuel Rail (R)	M12 x 1.25	25-34	18-25	250-350	
Fuel Pressure Regulator to Fuel Rail (L)	M12 x 1.25	25-34	18-25	250-350	
Clamp. Fuel Rail Connector to Intake Air Connector Stay	M6 x 1.0	6.5-9.5	56-82 Lb-In	65-95	
Fuel Pipe to Cylinder Head Cover	M6 x 1.0	6.5-9.5	56-82 Lb-In	65-95	
7. TIMING BELT					
Camshaft to Camshaft Timing Pulley	M7 x 1.0	21-25	15-18	210-250	
Timing Belt Idler Pulley Locknut	M10 x 1.5	34-50	25-37	350-510	
Timing Belt Idler Stud	M10 x 1.5	15-26	11-20	150-270	
8. AIR INTAKE SYSTEM					
Throttle Body to Surge Tank (R)	M8 x 1.25	16-23	12-17	160-230	
Throttle Air Bypass Valve to Surge Tank (R)	M6 x 1.0	7.5-10	66-89 Lb-In	75-105	
Intake Air Surge Tank (R and L) to Intake Manifold	M8 x 1.25	16-23	12-17	160-230	
Intake Manifold to Cylinder Head	M8 x 1.25	16-23	12-17	160-230	
Intake Air Control Valve to Intake Air Surge Tank (R and L)	M8 x 1.25	16-23	12-17	160-230	
Vacuum Switching Valve Assembly to Intake Air Surge Tank (R)	M8 x 1.25	16-23	12-17	160-230	
Surge Tank Stay to Cylinder Head (R and L)	M8 x 1.25	16-23	12-17	160-230	
Surge Tank Stay to Intake Air Surge Tank (R and L)	M8 x 1.25	16-23	12-17	160-230	
Surge Tank Connector to Surge Tank Connector Stay (R and L)	M8 x 1.25	16-23	12-17	160-230	
Intake Air Surge Tank (R) to Intake Air Connector Stay	M8 x 1.25	16-23	12-17	160-230	
Intake Air Connector Stay to Cylinder Head (R and L)	M8 x 1.25	16-23	12-17	160-230	
Brake Booster Union to Surge Tank (R)	NPTF 3/8-18	16-24	12-17	160-240	(5)
9. EXHAUST SYSTEM					
Exhaust Manifold to Cylinder Head	M10 x 1.25	35-51	26-38	360-520	
Exhaust Manifold to Exhaust Manifold Insulator	M8 x 1.25	16-23	12-17	160-230	
EGR Valve to Intake Air Surge Tank (R)	M8 x 1.25	16-23	12-17	160-230	
EGR Tube to Exhaust Manifold (R)	M8 x 1.25	16-23	12-17	160-230	
EGR Valve to EGR Valve Plug	M3.5 x 0.6	1.5-2.5	14-21 Lb-In	16-24	
EGR Valve to EGR Tube	M22 x 1.5	25-34	18-25	250-350	
PFE Sensor Bracket to Cylinder Head (R)	M6 x 1.0	6.5-9.5	56-82 Lb-In	65-95	
PFE Sensor Bracket to Bracket Cover	M5 x 0.8	3.0-4.5	26-39 Lb-In	30-45	

(5)Coat with Loctite No. 270

3.0L SHO ENGINE TORQUE SPECIFICATIONS

Description	Thread Size	N·m	Lb-Ft	kg·cm	
10. ACCESSORIES					
P/S Pump Bracket to Cylinder Block	M10 x 1.5	36-55	27-41	370-560	
P/S Pump to P/S Pump Bracket	M8 x 1.25	21-32	15-24	210-330	
P/S Pump Pulley to P/S Pump	M12 x 1.25	54-68	40-50	550-690	
A/C Compressor Bracket to Cylinder Block	M10 x 1.5	36-55	27-41	370-560	
A/C Compressor Bracket to Alternator Bracket	M10 x 1.5	36-55	27-41	370-560	
A/C Compressor to A/C Compressor Bracket	M10 x 1.5	36-55	27-41	370-560	
Alternator to Alternator Bracket	M10 x 1.5	34-50	25-37	350-510	
Alternator to A/C Compressor Bracket	M10 x 1.5	48-72	35-53	490-730	
Idler Pulley Nut	M10 x 1.5	34-50	25-37	350-510	
Idler Pulley Bracket 1 (R) to Cylinder Block	M8 x 1.25	16-23	12-17	160-230	
Idler Pulley Bracket 1 (R) to P/S Pump Bracket	M8 x 1.25	16-23	11-17	160-230	
Idler Pulley Bracket 2 (L) to A/C Bracket	M8 x 1.25	36-55	27-41	370-560	
Idler Pulley Bracket 2 (L) to Water Pump	M8 x 1.25	16-23	11-17	160-230	
Idler Pulley Bracket 2 (L) to Cylinder Block	M8 x 1.25	16-23	11-17	160-230	
11. IGNITION SYSTEM					
Spark Plug to Cylinder Head	M14 x 1.25	22-27	16-20	220-280	(6)
Ignition Coil to Ignition Coil Stay	M5 x 0.8	4.5-7.0	39-61 Lb-In	45-70	
Ignition Coil Stay to Cylinder Head (L)	M10 x 1.5	28-42	21-31	290-430	
Crank Sensor to Oil Pump	M4 x 0.7	1.5-2.5	13-22 Lb-In	15-25	
Camshaft Sensor to Cylinder Head (R)	M6 x 1.0	7.5-10	66-89 Lb-In	75-105	
Camshaft Shutter to Camshaft Right EXT.	M4 x 0.7	2.5-2.5	13-22 Lb-In	15-25	
Ignition Module to Surge Tank Connector	M4 x 0.7	2.0-3.0	17-26 Lb-In	20-30	
Crankshaft Shutter to Crankshaft Timing Pulley	M3 x 0.5	1.0-1.5	9-13 Lb-In	10-15	
Spark Plug Wire Clamp to Cylinder Head Cover	M5 x 0.8	3.0-4.5	26-39 Lb-In	30-45	
12. OTHERS					
Engine Lifting Eye No. 1, 2 to Cylinder Head	M8 x 1.25	16-23	11-17	160-230	
Engine Lifting Eye No. 2 to A/C Compressor Bracket	M8 x 1.25	16-23	11-17	160-230	

(6)Seal Washer Type Spark Plug

SPECIAL SERVICE TOOLS

ESSENTIAL SPECIAL TOOLS

Number	Tool
T89P-6701-A	Screw & Washer Set
T89P-6701-B	Front Crank Seal Installer
T89P-6701-C	Rear Seal Replacer Screw Set
T89P-6565-A	Valve Spring Compressor Set
T89P-6256-A	Cam Seal Replacer
T89P-6256-B	Cam Seal Expander
T89P-6256-C	Cam Position Tool
T89P-6510-A	Valve Guide Remover
T89P-6510-B	Valve Guide Replacer Adaptor
T89P-6510-C	Valve Stem Seal Replacer
T89P-6510-D	Valve Stem Seal Remover
T89P-6500-A	Tappet Compressor
T89P-6500-B	Tappet Holder

DESIRED SPECIAL TOOLS

Number	Tool
D89L-6135-A	Piston Pin Remover/Replacer
D89L-6001-A	Engine Lifting Bracket

WE SUPPORT VOLUNTARY TECHNICIAN CERTIFICATION

September, 1988 Litho in U.S.A. ORDER NO. 2112-003