

1991 Ford Festiva Service Manual

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INSTRUMENT PANEL

1991 ACCESSORIES & SAFETY EQUIPMENT Ford Motor Co. Switches & Instrument Panels - Standard

DESCRIPTION & OPERATION

Instrument panel on Capri contains a speedometer, tachometer, fuel, water temperature, oil pressure and voltmeter gauges. A boost gauge is incorporated into the tachometer on turbo models. Instrument panel is equipped with indicator/warning lights for charging system, air bag, manual shift, seat belt, turn signals, high beam and brakes. A CHECK ENGINE light, located on instrument panel, illuminates if a computerized engine control fault occurs with engine running.

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CAUTION: On models with Supplemental Restraint System (SRS), observe safety precautions. The air bag system is powered directly from the battery and back-up power supply. Before any repairs are performed, disconnect and shield battery ground cable. Disconnect the back-up power supply BEFORE servicing ANY air bag component. Use caution when working near steering column. Air bag could accidentally deploy at any time.

TROUBLE SHOOTING

NOTE: Ensure continuity exists between chassis ground and Black wire of instrument panel connector, especially if fault exists in multiple gauge circuits. See appropriate chassis wiring diagram in the WIRING DIAGRAMS Section.

FUEL GAUGE

Fuel Gauge Always Reads Empty

If fuel gauge always reads empty, check these items:

- Check fuel gauge for open or damaged wires.
- Check for open ground at fuel gauge sending unit.
- Check for defective fuel sending unit.
- Check for defective fuel gauge.
- Check for defective instrument panel voltage regulator (Festiva).
- Check for blown 10-amp METER fuse in fuse panel.
- Check for open in Black/Yellow power feed wire from fuse panel instrument panel.
- Check for fuel tank float full of fuel (sunk).

Fuel Gauge Always Reads Full

If fuel gauge always reads full, check these items:

- Check for fuel gauge Yellow wire shorted to ground.
- Check for defective fuel sending unit.
- Check for defective fuel gauge.
- Check for defective instrument panel voltage regulator (Festiva).

Fuel Gauge Inaccurate

If fuel gauge is inaccurate, check these items:

- Check for faulty (loose or corroded) wire connections.
- Check for defective fuel sending unit.
- Check for defective instrument panel voltage regulator (Festiva).

TEMPERATURE GAUGE

Temperature Gauge Always Reads Cold

If temperature gauge always reads cold, check these items:

- Check temperature gauge for open wire.
- Check for defective temperature sender.
- Check for defective temperature gauge.
- Check for defective instrument panel voltage regulator (Festiva).
- Check for blown 10-amp METER fuse in fuse panel.
- Check for open in Black/Yellow power feed wire from fuse panel to instrument panel.

Temperature Gauge Always Reads Hot

If temperature gauge always reads hot, check these items:

- Check for temperature gauge wire shorted to ground.
- Check for defective temperature sender.
- Check for defective temperature gauge.
- Check for defective instrument panel voltage regulator (Festiva).

Temperature Gauge Inaccurate

If temperature gauge is inaccurate, check these items:

- Check for faulty (loose or corroded) wire connections.
- Check for defective temperature sender.
- Check for defective instrument panel voltage regulator (Festiva).

SPEEDOMETER

Speedometer Does Not Operate

If speedometer does not operate, check these items:

- Check for broken speedometer drive cable.
- Check for broken drive gear in transmission.
- Check for defective speedometer head.

Speedometer Needle Bounces

If speedometer needle bounces, check these items:

- Check for binding speedometer drive cable.
- Check for missing teeth on drive gear in transmission.
- Check for defective speedometer head.

Speedometer Does Not Indicate Correct Vehicle Speed

If speedometer does not indicate correct vehicle speed, check these items:

- Check for incorrect size tires.
- Check for improper tire inflation.
- Check for defective speedometer head.

TACHOMETER (CAPRI)

Tachometer Does Not Work, But All Other Gauges Work Properly

-If tachometer does not work, but all other gauges function properly, check these items:

- Check for defective tachometer.
- Check for open Yellow/Black tachometer signal wire from ignition coil to instrument panel.
- Check for faulty Black ground wire to instrument panel.

Tachometer & All Gauges Do Not Function

If tachometer and all other gauges do not function properly, check these items:

- Check for blown 10-amp METER fuse in fuse panel.
- Check for open in Black/Yellow wire to fuse panel to instrument panel and Black/White wire from ignition switch to fuse panel

Tachometer Reading Low

If tachometer reading is lower than normal, check these items:

- Check for defective tachometer.
- Check for faulty Black ground wire at instrument panel.

TURBO BOOST GAUGE (CAPRI)

Turbo Boost Gauge Always Reads Low

If turbo boost gauge always reads low, check these items:

- Check boost gauge for open or damaged wires.
- Check for defective boost sensing unit.
- Check for defective boost gauge.
- Check for blown 10-amp METER fuse in fuse panel.
- Check for loose or corroded connections.

Turbo Boost Gauge Always Reads High

If turbo boost gauge always reads high, check these items:

- Check for damaged White/Black signal wire.
- Check for defective boost sensing unit.
- Check for defective boost gauge.

Turbo Boost Gauge Inaccurate

If turbo boost gauge is inaccurate, check these items:

- Check for loose or corroded connections.
- Check for defective boost sensing unit.
- Check for defective boost gauge.

TESTING

FUEL GAUGE SENDING UNIT

NOTE: Inspect fuel tank for distortion or damage. If distorted or damaged, repair or replace tank before testing.

Capri

Remove rear seat cushion. Disconnect fuel pump/fuel gauge sending unit electrical connector at access cover. Turn ignition on. Fuel gauge should read empty. Using a jumper wire, connect Yellow fuel gauge wire of vehicle harness connector to ground. Fuel gauge should read full. If fuel gauge operates as specified, replace fuel gauge sending unit.

Festiva

Remove fuel gauge sending unit from tank. See [FUEL SENDING UNIT](#) under REMOVAL & INSTALLATION. Connect an ohmmeter and check sending unit resistance as indicated in [FUEL GAUGE SENDING UNIT RESISTANCE \(FESTIVA\)](#) table. Replace sending unit if resistance is drastically different than specification.

FUEL GAUGE SENDING UNIT RESISTANCE (FESTIVA)

Float Position	Ohms
Full Position (Up)	Approximately 7
Half-Full Position (Middle)	Approximately 33
Empty Position (Down)	Approximately 95

OIL PRESSURE GAUGE (CAPRI)

1. Remove electrical connector from oil pressure sending unit located on right side of engine block. Turn ignition switch on. Oil pressure gauge should read low. Install a jumper wire between Yellow/Red wire of oil pressure sending unit vehicle harness connector and ground. Oil pressure gauge should read high.
2. If oil pressure gauge operates as specified, replace sending unit. If gauge does not operate as specified, check instrument panel power and ground circuits.

OIL PRESSURE WARNING LIGHT (FESTIVA)

Light Stays On With Engine Running

1. Turn ignition on (DO NOT start engine). Disconnect Yellow/Red wire from oil pressure switch connector. Light should go off.
2. If light stays on, repair short in Yellow/Red wire between oil indicator light and oil pressure switch. Reconnect wire to switch. Light should be on with ignition on. If light does not go off when engine is started, check switch or engine for low oil pressure.

Oil Light Will Not Go On With Ignition On

1. Ground Yellow/Red wire at instrument panel connector. If light goes on, repair Yellow/Red wire between oil pressure switch and indicator light or replace defective oil pressure switch.
2. If light does not illuminate, check bulb or check instrument panel ground circuit.

TEMPERATURE GAUGE (CAPRI)

1. Remove electrical connector from temperature sending unit located at front of cylinder head. Connect one lead of Gauge System Tester (021-00055) to connector and other tester lead to ground. Set tester to 18 ohms, turn ignition switch on and observe temperature gauge. Gauge should read 250°F.
2. Turn tester to 60 ohms. Gauge should read 175°F. Turn tester to 223 ohms. Gauge should read 100°F. If all readings are within twice the needle width of correct reading, gauge is functioning properly. If readings are not as specified, replace gauge.

TEMPERATURE GAUGE (FESTIVA)

See TROUBLE SHOOTING for possible service areas.

TEMPERATURE SENDING UNIT (CAPRI)

Remove sending unit from engine and place in container of water. Heat water to 176°F (80°C). Measure resistance between sending unit connector and case. Resistance should be 49.3-57.7 ohms. If resistance is not as specified, replace sending unit.

TURBO BOOST GAUGE & SENSOR (CAPRI)

- 1. Disconnect 3-pin boost sensor electrical connected located on right side of firewall. Turn ignition on. Measure voltage between Yellow/Green and Black wires. Voltage should be greater than 10 volts. Turn ignition off. If voltage is greater than 10 volts, go to next step. If voltage is 10 volts or less, repair Yellow/Green or Black wires as necessary.
- 2. Remove instrument panel. See [INSTRUMENT PANEL](#) under REMOVAL & INSTALLATION. Disconnect instrument panel 8-pin connector. With boost sensor disconnected, measure resistance through White/Black between instrument panel and boost sensor harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair or replace White/Black wire.
- 3. With 8-pin instrument panel connector disconnected, ground White/Black at boost gauge. Boost gauge should read low. Apply 12 volts to White/Black wire at boost gauge. Boost gauge should read high. If boost gauge operates as specified, go to next step. If boost gauge does not operate as specified, replace boost gauge.
- 4. Reconnect instrument panel connectors (if removed). With ignition on and boost sensor disconnected, install jumper wire between Yellow/Green and White/Black wires of boost sensor vehicle harness connector. Boost gauge should read high. If boost gauge reads high, replace boost sensor. If boost gauge does not read high, go to [TROUBLE SHOOTING](#) for other possible causes.

REMOVAL & INSTALLATION

INSTRUMENT PANEL

Removal & Installation (Capri)

- 1. Disconnect negative battery cable. Pull storage compartment from heater/radio bezel. Pull outward and remove trim covers located on both sides of steering column. Remove retaining screws and carefully pull instrument panel bezel partially away from dash. Disconnect electrical connectors from clock and switches in bezel. Remove instrument panel bezel.
- 2. Disconnect speedometer cable from transaxle. Remove instrument panel retaining screws and slide instrument panel outward. Press lock tab and release speedometer cable from instrument panel. Remove electrical connectors from rear of instrument panel. Remove instrument panel. To install instrument panel, reverse removal procedure.

Removal & Installation (Festiva)

- 1. Disconnect negative battery cable. Remove upper and lower steering column covers. Remove screws from panel bezel and remove bezel. Disconnect rear wiper switch and rear defogger switch wiring harness connectors (if equipped).
- 2. Remove instrument panel-to-dash screws. Pull panel from dash. Reach behind panel and release speedometer drive cable lock tab. Lift lock tabs and disconnect 2 electrical connectors from rear of panel. Remove panel. To install instrument panel, reverse removal procedure.

INDICATOR LIGHTS

Removal & Installation

Remove instrument panel for access to indicator light bulbs. See [INSTRUMENT PANEL](#) under REMOVAL & INSTALLATION. To remove bulb, rotate bulb counterclockwise to disengage locking tabs. When tabs release, pull bulb from printed circuit board. To install bulb, reverse removal procedure. Install instrument panel and test lights.

SPEEDOMETER R & I

NOTE: Federal law requires that a label stating the odometer has been repaired or replaced be affixed to any vehicle that has its odometer repaired, replaced or set to zero.

Removal & Installation (Capri)

Remove negative battery cable. Remove instrument panel. See [INSTRUMENT PANEL](#) under REMOVAL & INSTALLATION. Disassemble instrument panel and remove speedometer/tachometer/boost gauge assembly from instrument panel. To install, apply a 3/16" (4.6 mm) ball of Silicone Damping Grease (D7AZ-19A331-A) into drive hole of speedometer head. Reverse removal procedure to complete installation.

Removal & Installation (Festiva)

Remove negative battery cable. Remove instrument panel. See [INSTRUMENT PANEL](#) under REMOVAL & INSTALLATION. Disassemble instrument panel and remove speedometer head assembly from instrument panel. Speedometer is a separate module and can be removed independently from gauges. To install, reverse removal procedure.

SPEED SENSOR

On vehicles equipped with speed control, a speed sensor is mounted in speedometer head assembly. If replacement is necessary, speedometer head assembly must be replaced. See [SPEEDOMETER R & I](#) under REMOVAL & INSTALLATION.

FUEL GAUGE

Removal & Installation

Remove instrument panel. See [INSTRUMENT PANEL](#) under REMOVAL & INSTALLATION. Disassemble panel and remove fuel gauge. To install gauge, reverse removal procedure. On Capri, the fuel/volt gauge must be replaced as an assembly.

FUEL SENDING UNIT

Removal & Installation

- 1. For Festiva, remove rear seat. For Capri, remove rear seat cushion. On Festiva, remove carpet hold-down pins and lift carpet for access to sending unit access plate. On all models, remove access plate screws.

- 2. Lift access plate and disconnect sending unit wiring. To relieve fuel pressure, start engine and run it until engine stalls. Turn ignition off. Disconnect and plug fuel lines at sending unit. Remove sending unit attaching screws. Remove sending unit. To install, reverse removal procedure.

TACHOMETER

CAUTION: Tachometer is calibrated at factory. Rough handling could disturb calibration.

Removal & Installation

Remove instrument panel. See [INSTRUMENT PANEL](#) under REMOVAL & INSTALLATION. Disassemble panel and remove tachometer. To install tachometer, reverse removal procedure. On Capri, the tachometer/speedometer/boost gauge assembly must be replaced as an assembly.

TEMPERATURE GAUGE

Removal & Installation

Remove instrument panel. See [INSTRUMENT PANEL](#) under REMOVAL & INSTALLATION. Disassemble panel and remove temperature gauge. To install gauge, reverse removal procedure. On Capri, the temperature/oil pressure gauge assembly must be replaced as an assembly.

TEMPERATURE SENDING UNIT

Removal

Disconnect sending unit wire, located on side of block below thermostat housing (Festiva) or cylinder head (Capri). Remove radiator cap to relieve cooling system pressure. Position drain pan below sending unit. Remove temperature sending unit.

Installation

To install, apply Pipe Sealant With Teflon (D8AZ-19554-A) to threads of sending unit. Reverse removal procedure to complete installation. Fill cooling system to proper level. Start engine and check for coolant leaks at sending unit.

WIRING DIAGRAMS

NOTE: Refer to the appropriate **WIRING DIAGRAMS** article in the **WIRING DIAGRAMS** section.

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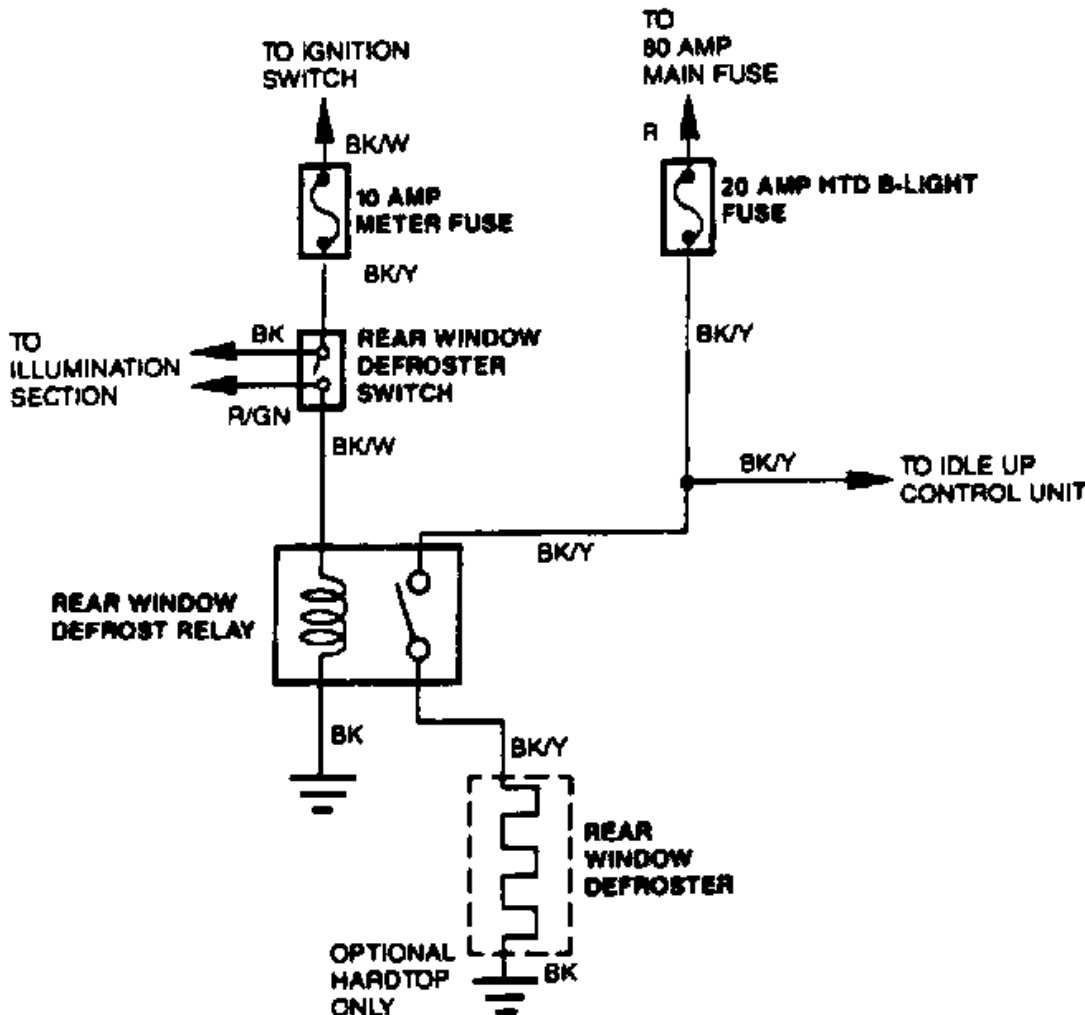
DEFOGGER - REAR WINDOW

1991 ACCESSORIES & SAFETY EQUIPMENT Rear Window Defoggers - Rear Window

DESCRIPTION & OPERATION

The rear window defogger consists of an electrical grid on rear window glass. The rear window defogger switch is located in the instrument cluster bezel. On Capri, the switch is a push type and includes a small indicator light in the switch to indicate when rear defogger is on. On Festiva, the switch is a rocker type and includes a small indicator light in instrument cluster to indicate when rear defogger is on.

On Capri, the defogger circuit includes a 10-amp METER fuse which receives battery power from ignition switch and a 20-amp HTD B-LIGHT fuse which has battery power at all times. The wire from the METER fuse goes to the rear defogger switch and then to the relay. The wire from the HTD B-LIGHT fuse goes to the rear defogger relay and then to the grid. See [Fig. 1](#) .



[Fig. 1: Rear Window Defogger Wiring Diagram \(Capri\)](#)
Courtesy of FORD MOTOR CO.

On Festiva, the defogger circuit includes a 15-amp DEFOG fuse which receives battery power from ignition switch. The wire from the fuse goes to the rear defogger switch and then to the grid. The defogger circuit does not contain a relay. See [Fig. 2](#) .

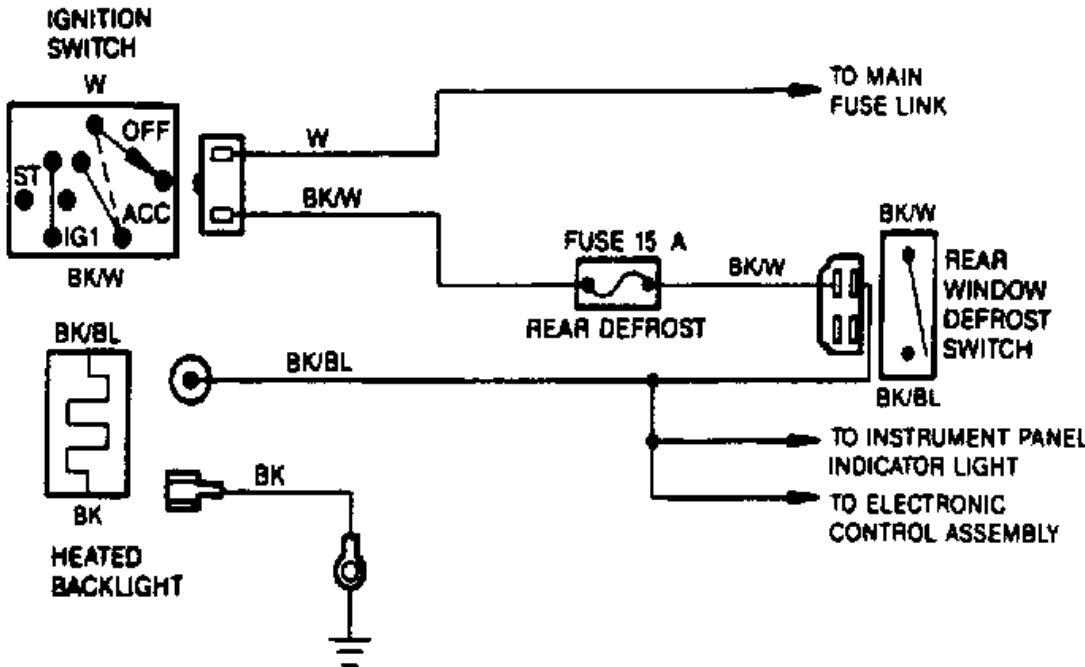


Fig. 2: Rear Window Defogger Wiring Diagram (Festiva)
Courtesy of FORD MOTOR CO.

TROUBLE SHOOTING

DEFOGGER DOES NOT OPERATE

Blown fuse(s) or poor contact. Defogger switch defective. Defogger relay defective. Poor connections. Broken wire. Defective grid filament.

INDICATOR LIGHT DOES NOT WORK BUT DEFOGGER DOES WORK

Open circuit from rear defogger switch to instrument panel (Festiva). Defective light bulb. Defective flexible circuit on instrument cluster.

TESTING

SYSTEM TESTING

1. Ensure all in-line fuses or circuit breakers are okay. Turn ignition and control switches to ON position. Glass should feel warm after a few minutes.
2. If glass is not warm, use a test light or voltmeter to check for battery voltage at grid feed wire. If voltage is not correct, check wiring harness, control switch and flexible circuit on instrument cluster. See FILAMENT TESTING.

REAR DEFOGGER SWITCH TESTING

Capri

Remove rear defogger switch. Using an ohmmeter, ensure continuity exists between terminals listed in table at specified switch positions. If switch does not test as specified, replace rear defogger switch. See REAR DEFOGGER SWITCH CONTINUITY (CAPRI) table.

NOTE: On Capri, if indicator light is not working, replace switch.

REAR DEFOGGER SWITCH CONTINUITY (CAPRI)

Terminal	Position	Continuity
BLK/YEL - BLK/WHT	Off	No
BLK/YEL - BLK/WHT	On	Yes

Festiva

Remove rear defogger switch. Using an ohmmeter, ensure continuity exists between terminals listed in table at specified switch positions. If switch does not test as specified, replace rear defogger switch. See REAR DEFOGGER SWITCH CONTINUITY (FESTIVA) table. See [Fig. 3](#).

REAR DEFOGGER SWITCH CONTINUITY (FESTIVA)

Terminal	Position	Continuity
BLK/WHT - BLK/BLU	Off	No
BLK/WHT - BLK/BLU	On	Yes
RED/GRN - BLK	Off	No
RED/GRN - BLK	On	Yes

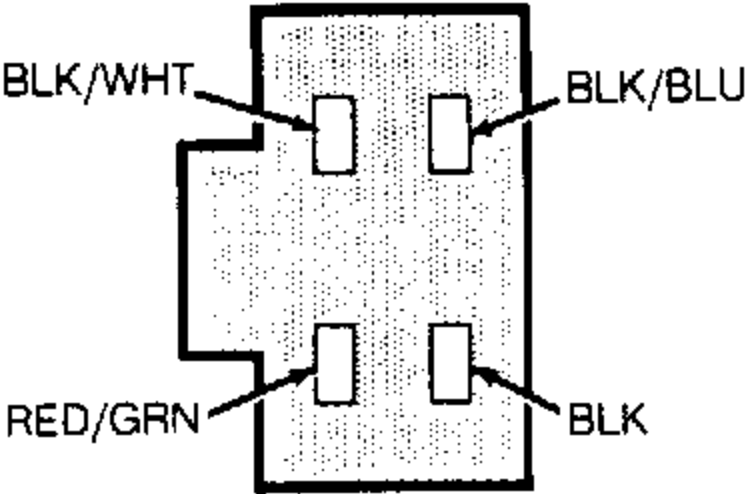


Fig. 3: Identifying Rear Defogger Switch Terminals (Festiva)
Courtesy of FORD MOTOR CO.

REAR DEFOGGER RELAY TESTING

Unplug rear window defroster relay. Relay is located in left rear corner of luggage compartment. Apply battery voltage and ground to

Black/White and Black wire terminals of relay. Check continuity of relay across 2 Black/Yellow wire terminals of relay. Continuity should exist when relay is energized. When relay is de-energized, continuity should not exist.

FILAMENT TESTING

- 1. To locate breaks in grid wire filaments, attach a voltmeter to middle portion of each filament. Attach other meter probe to vertical section of window grid.
- 2. If a grid is broken, meter will register either zero volt or battery voltage, depending on if grid is broken between or outside test leads. If wire is not broken, meter will register about one half of battery voltage. To locate break, move probe along wire until meter needle moves abruptly.

REMOVAL & INSTALLATION

REAR DEFOGGER SWITCH

Removal & Installation (Capri)

- 1. Disconnect negative battery cable. Pull out center storage compartment. Remove 2 nuts, 2 lower screws, and heater/radio bezel. Pull outward and remove 2 trim covers, one located on each side of steering column.
- 2. Remove instrument panel bezel retaining screws and pull instrument bezel from dash. Disconnect electrical connector from rear defogger switch. Depress tangs on both sides of switch and remove switch. To install, reverse removal procedure.

Removal & Installation (Festiva)

Disconnect negative battery cable. Remove steering column covers. Remove screws securing instrument panel bezel to instrument panel. Pull instrument bezel away from instrument panel. Disconnect electrical connectors from switches in bezel. Compress rear defogger switch lock tabs and remove switch from bezel. To install, reverse removal procedure.

WIRING DIAGRAMS

See appropriate chassis wiring diagram in the WIRING DIAGRAMS Section.

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1990-92 ACCESSORIES & EQUIPMENT

Power Mirrors - Festiva

DESCRIPTION & OPERATION

The power outside rearview mirrors are an aerodynamic sail-mount design. See [Fig. 1](#) . The mirror base is secured to the lower front corner of the window frame. The screws attaching the base to the door and the wiring connector are concealed behind a trim cover which is also attached to the window frame.

The power outside rearview mirrors are operated by a switch located to the left of the steering column just below the air discharge register. See [Fig. 1](#) . The switch housing actually contains two separate switch assemblies. The outer perimeter switch controls the up/down and the inboard/outboard position of the mirrors. The center toggle switch determines which mirror is connected to the perimeter switch. When the toggle is positioned to the left mirror, the left mirror will respond to the perimeter switch. The right mirror responds when the toggle is positioned to the right.

Each mirror contains two electric motors -- one for tilting the mirror up or down and another for moving the mirror inboard or outboard. See [Fig. 1](#) . Each motor drives a gear train that includes a worm gear, a reduction gearset, and a threaded attaching lug. Rotation of the gear train threads the attaching lug in or out of the final gear in the train. As the lug moves in the gear, it pushes or pulls the mirror into a new position. A spring clip installed over the lug allows it to ratchet when it reaches the end of its travel.

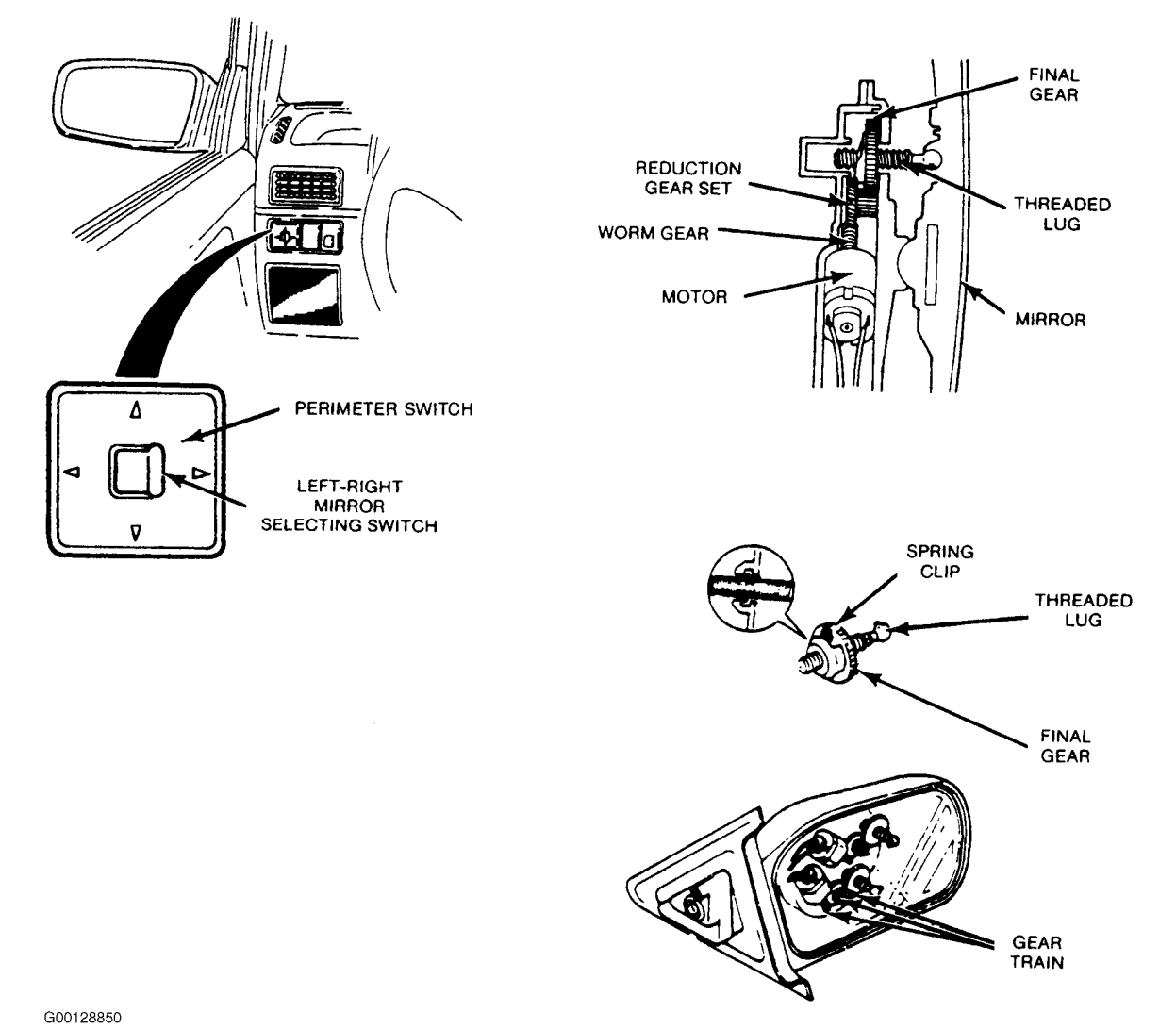


Fig. 1: Identifying Power Rear View Mirror Components
Courtesy of FORD MOTOR CO.

COMPONENT LOCATIONS

Component	Location
Fuse Panel	Left Side Of Instrument Panel, Left Of Steering Column. See .
Ground G201	Far Left Side Of Instrument Panel, Above Kick Panel. See .



Courtesy of FORD MOTOR CO.



Courtesy of FORD MOTOR CO.

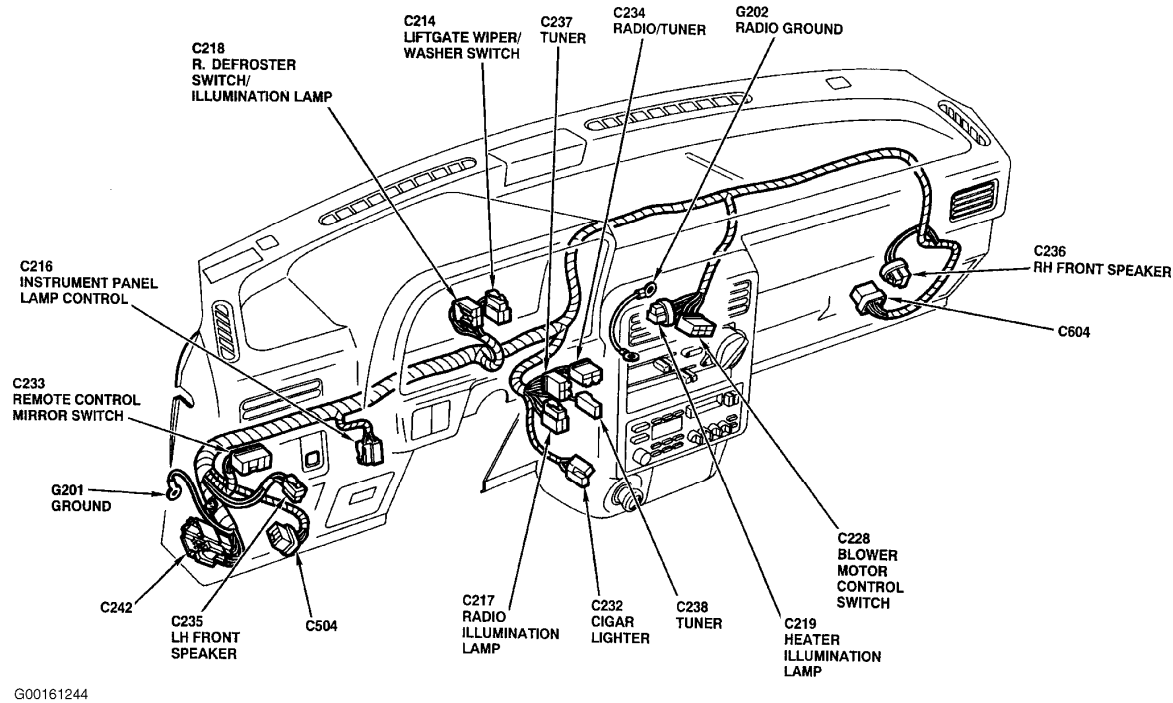


Fig. 4: Locating Ground G201
Courtesy of FORD MOTOR CO.

SYSTEM TESTS

POWER REAR VIEW MIRROR

RM1: Check Remote Control Mirror

Check the operation of the remote control mirrors in all switch positions. If remote control mirror not working at all, go to next step. If one or more, but not all, switches not working, go to **RM7: Check Remote Control Mirror Switch** .

RM2: Check Related Systems

Check the radio and cigar lighter. Do they work? If yes, go to step **RM5: Check Remote Control Mirror Supply** . If no, go to next step.

RM3: Check Cigar Fuse

NOTE: If the fuse blows again, check for shorts to ground in the Blue/Yellow wires. Repair the Blue/Yellow wires as needed.

Check the 15 amp CIGAR fuse. Is fuse OK? If yes, go to next step. If no, replace the 15 amp CIGAR fuse.

RM4: Check ACC Supply

Ignition switch in the ACC position. Check for 12 volts on the Blue/Red wire wire at the ignition switch. See **Fig. 5** Is there 12 volts? If yes, repair the Blue/Red wire between the CIGAR fuse and ignition switch. If no, repair or replace the ignition switch, White wire from the ignition switch to the main fuse box, or the MAIN fuse as required.

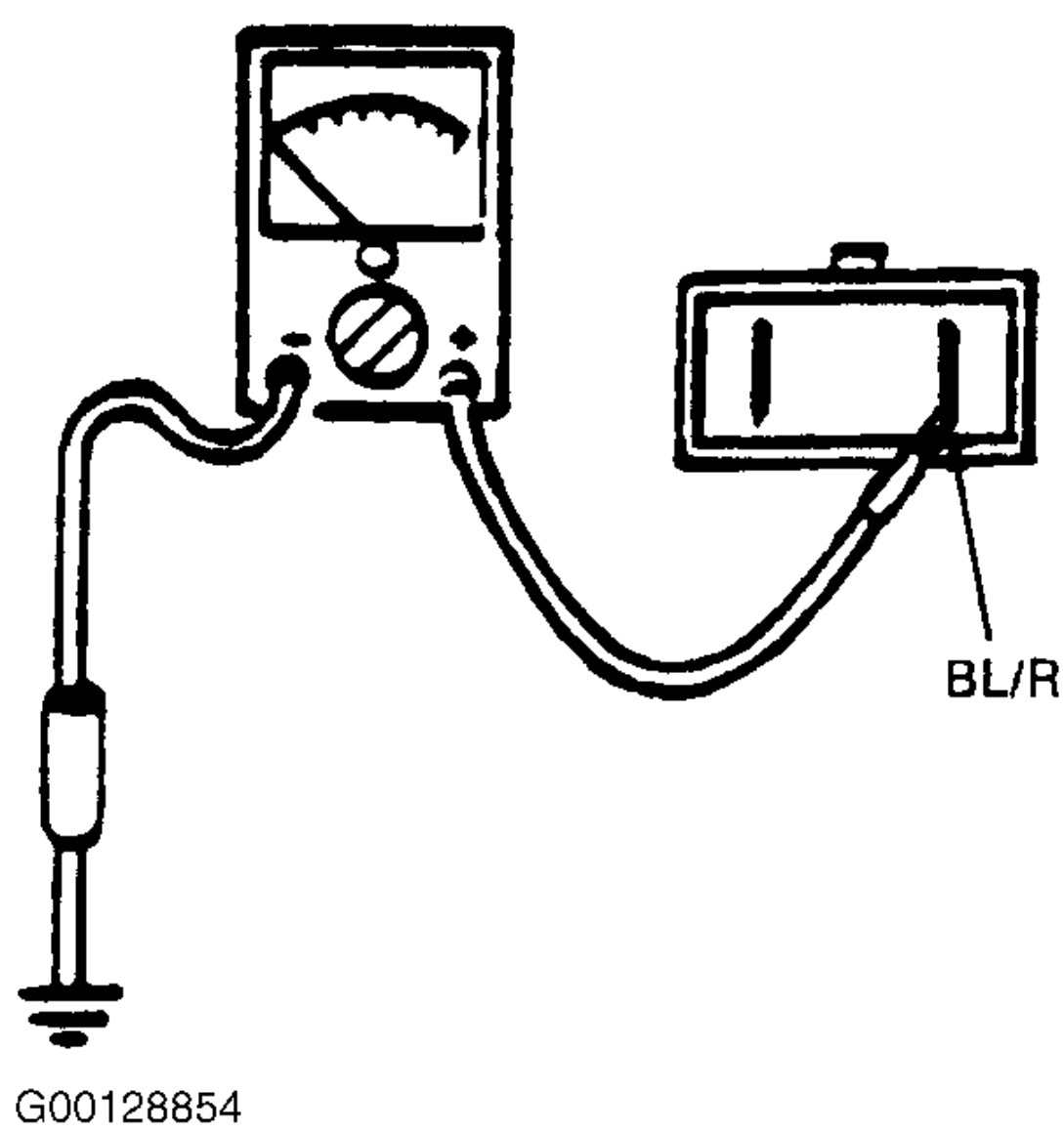


Fig. 5: Checking ACC Supply
Courtesy of FORD MOTOR CO.

RM5: Check Remote Control Mirror Supply

Check for 12 volts on the Blue/Yellow wire at the remote control mirror switch. See [Fig. 6](#) . Is there 12 volts? If yes, see [RM6: Check Remote Control Mirror Ground](#) . If no, repair the Blue/Yellow wire between the CIGAR fuse and remote control mirror switch.

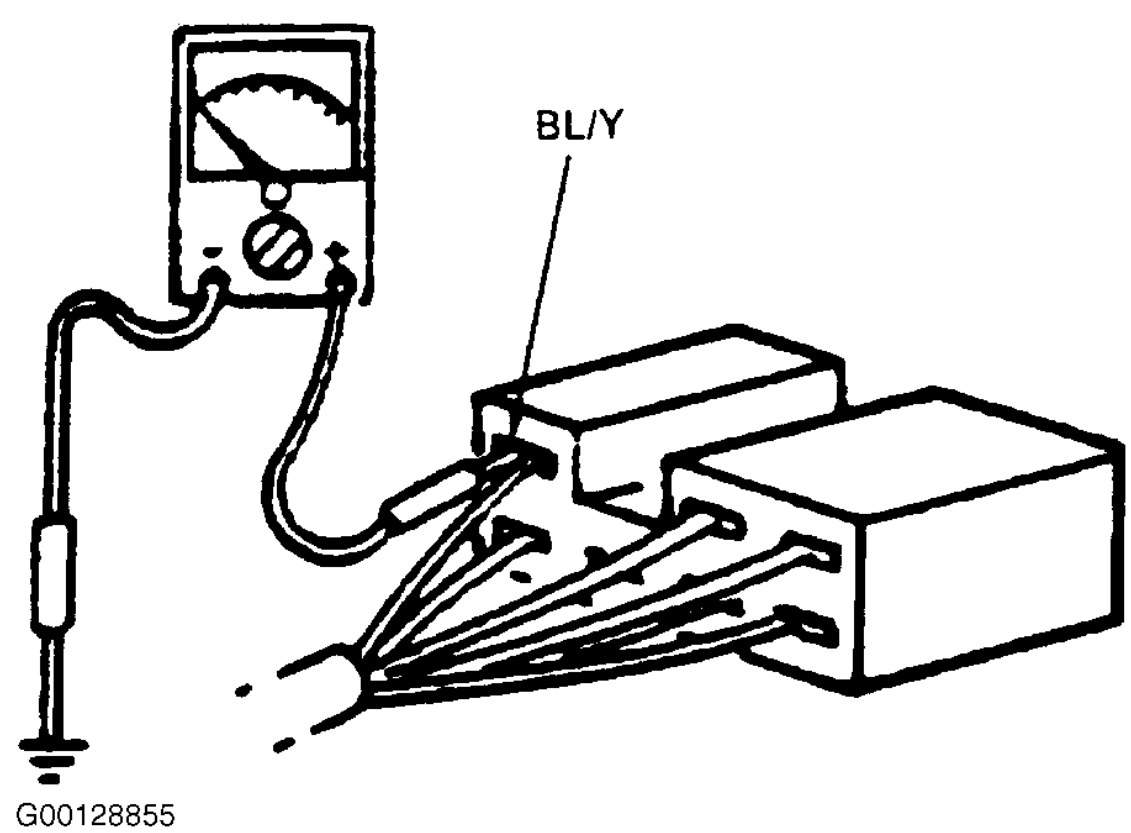


Fig. 6: Checking Remote Control Mirror Power Supply
Courtesy of FORD MOTOR CO.

RM6: Check Remote Control Mirror Ground

Check for continuity between ground and the Black wire at the remote control mirror switch. Is there continuity? If yes, replace the remote

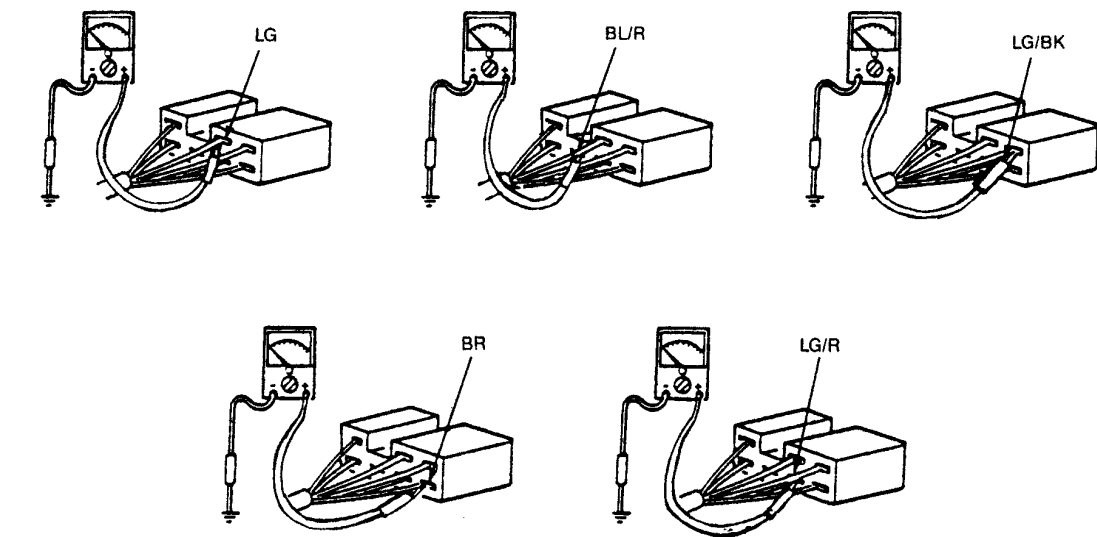
control mirror switch. See [REMOTE MIRROR SWITCH](#) under REMOVAL & INSTALLATION. If no, repair the Black wire between the remote control mirror switch and ground.

RM7: Check Remote Control Mirror Switch

Access the remote control mirror switch. Check for voltages at the remote control mirror switch as shown. See [Fig. 7](#) . Do all the switch positions check out OK? If yes, see [RM8: Check Wire Power](#) . If no, replace the remote control mirror switch. See [REMOTE MIRROR SWITCH](#) under REMOVAL & INSTALLATION.

NOTE: Voltage readings from 11V to 13V OK for 12V, and 0V to 1V OK for 0V. When switch is in resting position, 0V should be on all wires.

SWITCH POSITION		LG/BK	LG	LG/R	BR	BL/R
Left Mirror	Up	0	X	X	0	12
	Down	12	X	X	12	0
	Left	12	X	X	0	12
	Right	0	X	X	12	0
Right Mirror	Up	X	0	0	X	12
	Down	X	12	12	X	0
	Left	X	12	0	X	12
	Right	X	0	12	X	0



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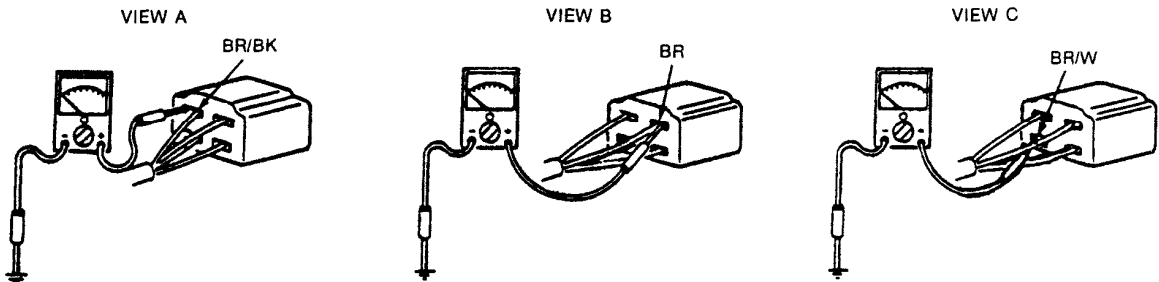
[Fig. 7: Identifying Remote Control Mirror Switch Terminals & Switch Positions](#)
Courtesy of FORD MOTOR CO.

RM8: Check Wire Power

Check for voltages at the remote control mirror motors as shown. See [Fig. 8](#) . Do all the switch positions check out OK? If yes, replace the remote control mirror in question. See [POWER REAR VIEW MIRROR](#) under REMOVAL & INSTALLATION. If no, repair the wire(s) in question from the mirror(s) to the mirror switch.

NOTE: Voltage readings from 11V to 13V OK for 12V, and 0V to 1V OK for 0V.

SWITCH POSITION		BR/BK	BR/W	BR
Left or Right Mirror	Up	0	0	12
	Down	12	12	0
	Left	12	0	12
	Right	0	12	0



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[Fig. 8: Checking Power Mirror Switch Voltage](#)
Courtesy of FORD MOTOR CO.

REMOVAL & INSTALLATION

POWER REAR VIEW MIRROR

Removal

1. Remove the interior trim cover attaching screw and trim cover. See [Fig. 9](#) .

2. Disconnect the wiring at the mirror.
3. Remove the attaching screws and the mirror.
4. Remove the seal from the mirror. See [Fig. 9](#).

Installation

To install, reverse the removal procedure.

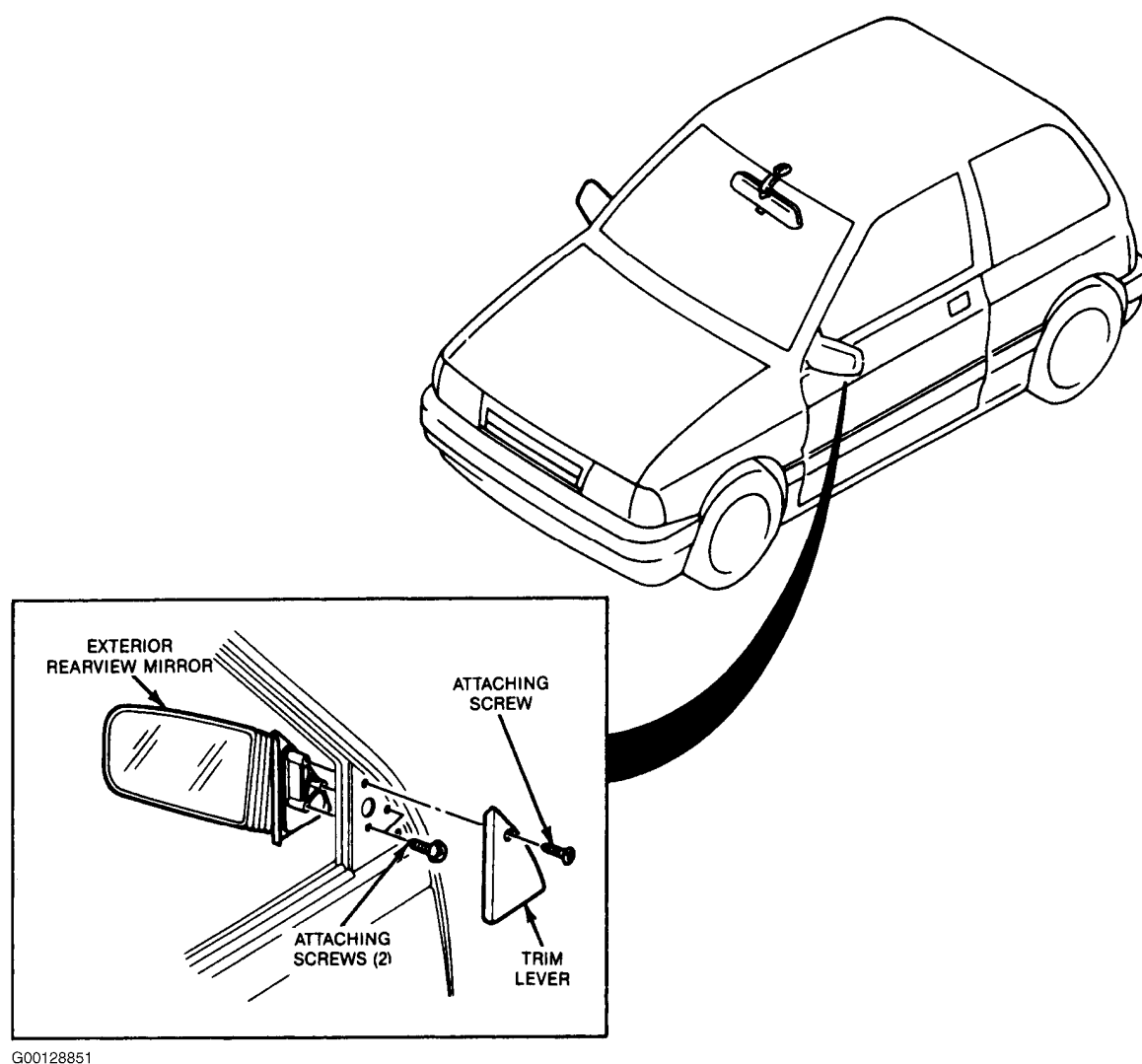


Fig. 9: Removing & Installing Power Rear View Mirror
Courtesy of FORD MOTOR CO.

REMOTE MIRROR SWITCH

Removal

1. Remove the left radio speaker grille by carefully prying it up with a screwdriver.
2. Remove the four speaker attaching screws and the radio speaker. See [Fig. 10](#).
3. Using a screwdriver, pry at the bottom of the switch casing to loosen the remote mirror switch. See [Fig. 11](#). To prevent marring the instrument panel, place a pad or clean rag between the blade and the instrument panel.
4. Reach through the speaker opening and disconnect the electrical connector.
5. Remove the remote mirror switch.

Installation

To install, reverse the removal procedure.

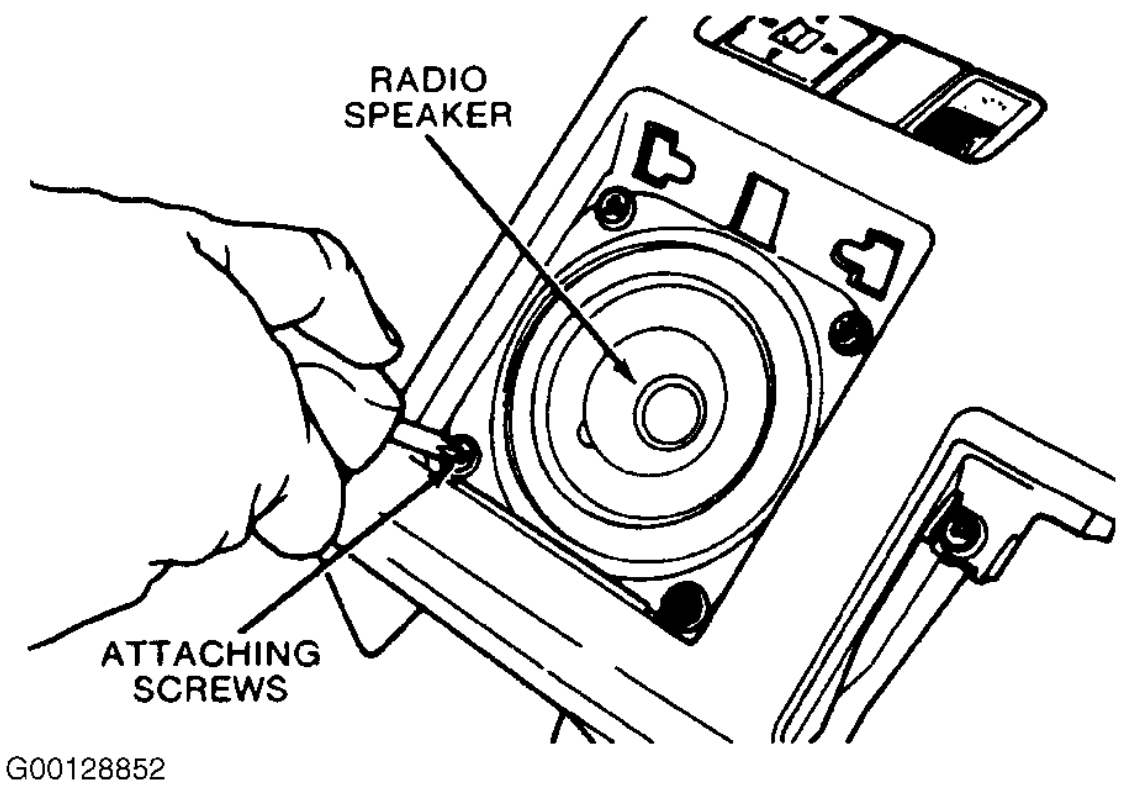


Fig. 10: Identifying Radio Speaker Attaching Screws
Courtesy of FORD MOTOR CO.

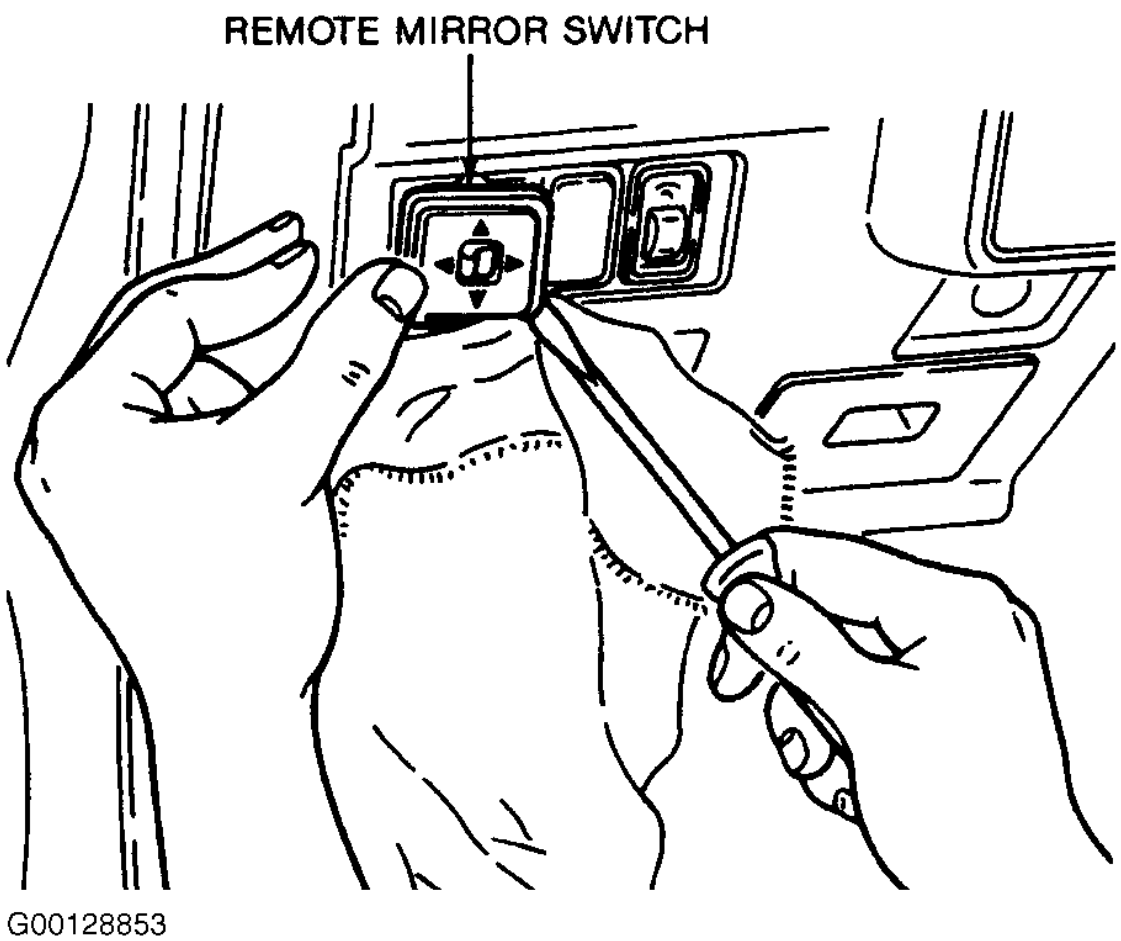


Fig. 11: Removing Remote Mirror Switch
Courtesy of FORD MOTOR CO.

WIRING DIAGRAMS

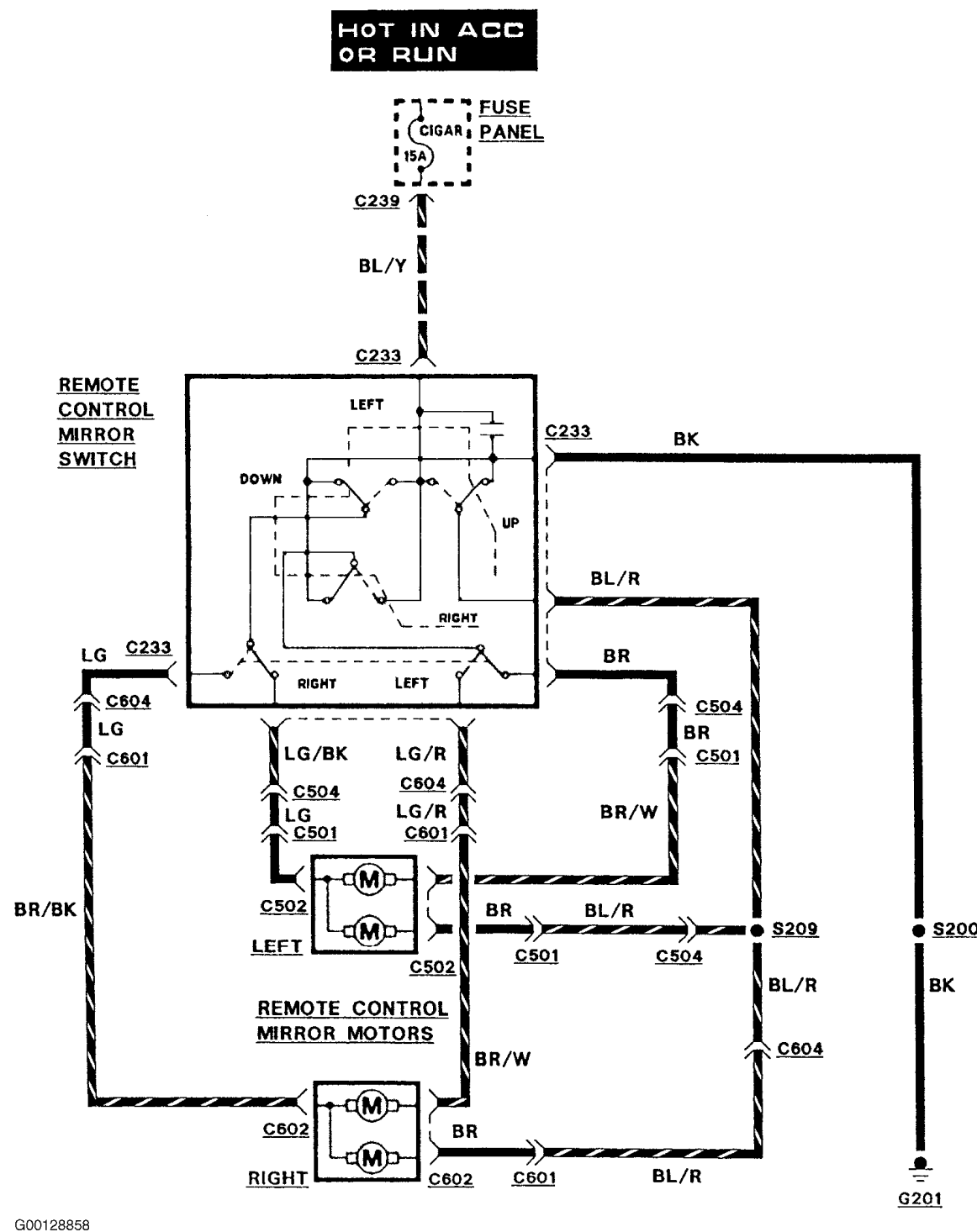


Fig. 12: Power Mirror Wiring Diagram
Courtesy of FORD MOTOR CO.

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STEERING COLUMN SWITCHES

1991 ACCESSORIES & SAFETY EQUIPMENT Ford Motor Co. Steering Column Switches

DESCRIPTION & OPERATION

CAUTION: On Capri models with Supplemental Restraint System (SRS), observe safety precautions. The air bag system is powered directly from the battery and back-up power supply. Before any repairs are performed, disconnect and shield battery ground cable. Disconnect the back-up power supply and wait at least 15 minutes BEFORE servicing ANY air bag component. Use caution when working near steering column. Air bag could accidentally deploy at any time.

DISABLING AIR BAG SYSTEM

NOTE: The following disabling sequence is ONLY for component replacement purposes.

To disable SRS, disconnect battery cable. Unplug back-up power supply 3-way harness connector. System is now disabled. Back-up power supply is mounted to inside of instrument panel, left of glove box opening. Glove box door must be opened past its stops and lowered toward floor to access back-up power supply.

ACTIVATING AIR BAG SYSTEM

To activate SRS, reconnect back-up power supply connector and negative battery cable. From passenger's side of vehicle, turn ignition switch to RUN position. System is now activated. Check AIR BAG light to ensure system is functioning properly.

TESTING

HAZARD WARNING SWITCH & TURN SIGNAL SWITCH

Capri

- 1. Remove steering column covers to access turn signal/hazard switch connectors. Turn ignition on. Using a 12-volt test light, ensure battery voltage is present at Green/Red and Green/Yellow wires at turn signal/hazard switch connectors. If battery voltage is not present, check METER and HAZARD fuses. Also check hazard and turn signal flasher units and replace as necessary.
- 2. If battery voltage is present at Green/Red and Green/Yellow wires, place turn signal switch in RIGHT position. Check both Green/White wires at switch connector. Test light should flash on and off in constant cycles.
- 3. Place turn signal switch in LEFT position. Check both Green/Black wires at switch connector. Test light should flash on and off in constant cycles. If turn signal/hazard switch does not function as specified, replace switch.

Festiva

- 1. Remove steering column covers to access turn signal/hazard switch connectors. Turn ignition on. Using a 12-volt test light, ensure battery voltage is present at White/Black and Black/Yellow wires at hazard and turn signal switch connectors. If battery voltage is not present, check METER and HAZARD fuses.
- 2. If battery voltage is present at White/Black and Black/Yellow wires, place turn signal/hazard switch in RIGHT position. Check Green/Black wire at switch connector. Test light should flash on and off in constant cycles.
- 3. Place turn signal/hazard switch in LEFT position. Check Green/White wire at switch connector. Test light should flash on and off in constant cycles. If turn signal/hazard switch does not function as specified, replace switch.

HEADLIGHT SWITCH

Capri

- 1. Remove instrument panel bezel to access switch connector. See HEADLIGHT SWITCH under REMOVAL & INSTALLATION. Disconnect switch electrical connector. Measure voltage between Red and Red/White wires of headlight switch vehicle harness and ground. If battery voltage is present, go to next step. If battery voltage is not present, check HEAD and MAIN fuses and Red and Red/White wires between switch and fuse block.
- 2. Press headlight switch to first position. Using a self powered test light or ohmmeter, check continuity between switch terminals which correspond to Red and Red/Green wires of vehicle harness connector. Continuity should not exist. If continuity exists, replace switch.
- 3. Press headlight switch to second position. Check continuity between switch terminals which correspond with the Red and Red/Green wires of vehicle harness connector. Continuity should exist. If switch does not function as described, replace headlight switch. If switch functions as described but headlights do not work, go to next step.
- 4. Remove steering column covers to access Flash-To-Pass switch connector. Using a 12-volt test light or voltmeter, place switch in position indicated in table and check voltage between indicated wire terminals and ground. See FLASH-TO-PASS SWITCH TEST (CAPRI) table. If switch does not function as indicated, replace switch.

FLASH-TO-PASS SWITCH TEST (CAPRI)

Switch Position	Wire Color	Voltage
Off		
Headlights Off	RED	Battery
"	All other wires	0
Headlights On	RED, RED/GRN, RED/BLK	Battery
"	All other wires	0
On		

Headlights Off	RED, RED/WHT	Battery
"	All other wires	0
Headlights On	RED, RED/GRN, RED/WHT	Battery
"	All other wires	0

Festiva

Disconnect headlight switch. Using an ohmmeter, place switch in position indicated in table and check continuity between switch terminals that correspond to wire colors listed. See HEADLIGHT SWITCH CONTINUITY TEST (FESTIVA) table. If switch does not function indicated, replace switch.

HEADLIGHT SWITCH CONTINUITY TEST (FESTIVA)

Switch Position	Wire Color	Continuity
Flash	RED/BLK to BLK	Yes
Low	WHT to RED/BLK	Yes
High	WHT to RED/WHT	Yes
1	RED/YEL to BLK	Yes
2	RED/BLK to BLK	Yes
Off	BLK to All	No

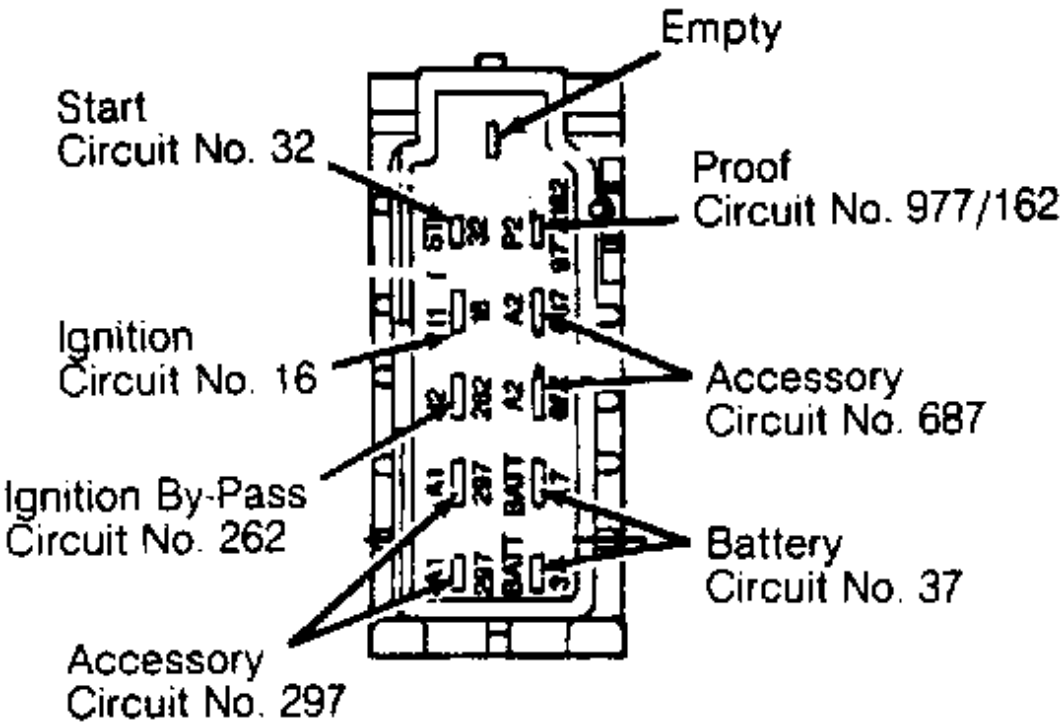
IGNITION SWITCH

Capri

Remove lower steering column cover to gain access to ignition switch electrical connector. Connect a self-powered test light or ohmmeter between blade terminals indicated in table. See IGNITION SWITCH CONTINUITY (CAPRI) table. Continuity should not exist between any blade terminal and chassis ground in any switch position except proof circuit (162/997) in START position. See [Fig. 1](#) .

IGNITION SWITCH CONTINUITY (CAPRI)

Switch Position	Continuity Should Exist Only Between
ACC	37, 297
LOCK	No Continuity
OFF	No Continuity
RUN	37, 16, 687, 297
START	977, 162 (Chassis Ground), 37, 32, 262
NOTE: Circuit pairs 37, 687 and 297 are connected together inside ignition switch.	



[Fig. 1: Identifying Ignition Switch Terminals \(Capri\)](#)
Courtesy of FORD MOTOR CO.

Festiva

Remove lower steering column cover to gain access to ignition switch electrical connector. Using a self-powered test light or ohmmeter, ensure continuity exists between terminals listed in table at specified switch positions. If switch does not test as specified, replace ignition switch. See IGNITION SWITCH CONTINUITY (FESTIVA) table. See [Fig. 2](#) .

IGNITION SWITCH CONTINUITY (FESTIVA)

Terminal	Position	Continuity
----------	----------	------------

"A" (WHT) - "E" (BLU/RED)	OFF	No
"	ACC	Yes
"	ON	Yes
"	START	No
"A" (WHT) - "D" (BLK/RED)	OFF	No
"	ACC	No
"	ON	Yes
"	START	No
"A" (WHT) - "C" (BLK/WHT)	OFF	No
"	ACC	No
"	ON	Yes
"	START	Yes
"A" (WHT) - "B" (BLK/BLU)	OFF	No
"	ACC	No
"	ON	No
"	START	Yes

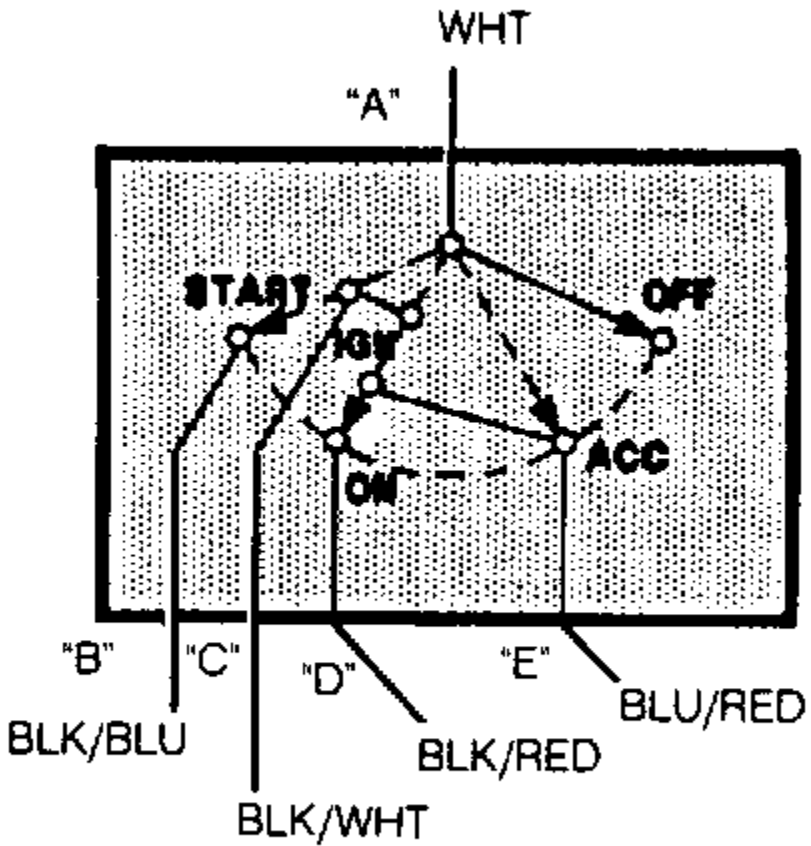


Fig. 2: Identifying Ignition Switch Terminals (Festiva)
Courtesy of FORD MOTOR CO.

WIPER SWITCH

For testing information on wiper switch, see appropriate WIPER/WASHER SYSTEMS article in the ACCESSORIES/SAFETY EQUIP Section.

REMOVAL & INSTALLATION

STEERING WHEEL & HORN PAD

CAUTION: On Capri models with Supplemental Restraint System (SRS), observe safety precautions. The air bag system is powered directly from the battery and back-up power supply. Before any repairs are performed, disconnect and shield battery ground cable. Disconnect the back-up power supply and wait at least 15 minutes BEFORE servicing ANY air bag component. Use caution when working near steering column. Air bag could accidentally deploy at any time.

Removal (Capri)

1. Disable SRS. See SAFETY PRECAUTIONS. Ensure front wheels are in straight-ahead position. From rear of steering wheel, remove 4 retaining nuts and washers securing air bag module to steering wheel. Disconnect air bag module-to-clockspring connector.
2. Remove air bag module and place out of the way, with pad facing upward. Disconnect horn and speed control wire harness connectors (if equipped) from steering wheel. Scribe reference mark on steering shaft and steering wheel hub for reassembly. Loosen steering wheel retaining bolt 4-6 turns.

CAUTION: When removing steering wheel, DO NOT use a knock-off type steering wheel puller, or strike the steering wheel or shaft with a hammer. A sudden impact could damage bearing, or collapse the

steering column.

3. Position Steering Wheel Remover (T67L-3600-A) on steering wheel. Tighten bolt on remover until steering wheel is loose. Remove steering wheel puller, steering wheel retaining bolt, and steering wheel.

CAUTION: Remove steering wheel carefully to avoid damaging clockspring wiring, air bag module connector, or accidentally turning clockspring. After steering wheel removal, tape clockspring in position to prevent damage and keep it from being turned accidentally.

Installation

1. Ensure front wheels are in straight-ahead position. Route clockspring wiring harness through steering wheel opening. Position steering wheel on steering shaft and align reference marks.
2. Ensure clockspring wire is not pinched when positioning steering wheel. Install new steering wheel retaining bolt and tighten to specification. See TORQUE SPECIFICATIONS table at end of article. Connect horn and speed control wiring connectors (if equipped) to steering wheel.
3. Connect air bag module-to-clockspring connector. Install air bag module. Tighten air bag module retaining nuts to specification. Activate SRS. See SAFETY PRECAUTIONS. Check AIR BAG light to ensure system is functioning properly.

Removal (Festiva)

From back of steering wheel, remove 2 screws securing horn pad. Disconnect horn wire from horn pad and remove pad. Remove steering wheel nut. Scribe reference mark on steering shaft and steering wheel hub for reassembly. Using Steering Wheel Puller (T67L-3600-A), remove steering wheel.

Installation

Position steering wheel on steering shaft and align reference marks. Be sure cutouts in rear cover engage turn signal canceling cam. To complete installation, reverse removal procedure.

COMBINATION SWITCH

Removal (Capri)

1. Disconnect negative battery cable. Remove lower steering column cover. Remove center access panel and trim cover under steering column. Remove left side defroster connector tube. Remove steering column upper retaining bolts. Column will pivot downward and rest on instrument panel brace.

CAUTION: Ensure that no wiring is pinched beneath steering column when lowered.

2. Remove 2 switch retaining screws and remove switch. Grasp switch and lever and pull lever out of switch. Disconnect switch electrical connectors and remove switch.

Installation

Align key with slot and install lever in switch assembly. Position switch on steering column and install retaining screws. To complete installation, reverse removal procedure.

Removal (Festiva)

1. Disconnect negative battery cable. Remove steering wheel. See STEERING WHEEL & HORN PAD under REMOVAL & INSTALLATION. Remove 4 screws from upper half of lower steering column cover and remove cover. Remove upper steering column cover. Remove 5 clips from lower half of lower steering column cover and remove cover.
2. Release wiring harness clip and unplug 4 harness connectors from back of combination switch. From below steering column, loosen band clamp securing switch hub to steering column jacket. Pull switch assembly from steering column.

Installation

Slide combination switch assembly onto steering column. Make sure switch assembly is seated and level against end of column jacket. To complete installation, reverse removal procedure.

HEADLIGHT SWITCH

Removal & Installation (Capri)

1. Headlight off/on switch is located on left side of instrument panel bezel. Disconnect negative battery cable. Pull out center storage compartment. Remove 2 upper screws, 2 lower screws and heater/radio bezel. Pull outward and remove trim covers located on both sides of steering column.
2. Remove retaining screws and carefully pull instrument panel bezel partially away from dash. Disconnect electrical connector from headlight switch. Depress tangs on both sides of switch and remove switch from bezel. To install, reverse removal procedure.

IGNITION SWITCH & LOCK CYLINDER

Removal (Capri)

1. Disconnect negative battery cable. Remove lower steering column cover. Remove center access panel and trim cover under steering column. Remove left side defroster connector tube. Remove steering column upper retaining bolts. Column will pivot downward and rest on instrument panel brace.

CAUTION: Ensure that no wiring is pinched beneath steering column when it is lowered.

2.
- With ignition key inserted in lock assembly, rotate tumbler while pushing release pin with a .125" (3.17 mm) drift punch. Pull tumbler assembly out of housing. Remove upper column cover. Remove column lock shield. Disconnect ignition switch electrical connector. Remove switch retaining screws and remove switch.

Installation

Position ignition switch on column lock assembly. Make sure actuator pin of lock assembly fits into slot in ignition switch. To complete installation, reverse removal procedure.

Removal & Installation (Festiva)

1.
- Disconnect negative battery cable. Remove 4 screws from upper half of lower steering column cover and remove cover. Remove upper steering column cover. Remove 5 clips from lower half of lower steering column cover and remove cover.
2.
- Remove 4 steering column shield nuts and remove shield. Remove 2 shield bracket bolts and remove bracket. Remove air discharge duct from below steering column. Remove steering column attaching nuts then lower steering column mounting bracket.
3.
- Remove tie strap securing key warning buzzer switch wires. Remove ignition switch attaching screw. Pull switch loose from switch housing. Remove switch harness from routing clip and disconnect electrical connectors. Remove switch. To install, reverse removal procedure.

TURN SIGNAL SWITCH

See COMBINATION SWITCH under REMOVAL & INSTALLATION.

WIPER SWITCH

Removal & Installation (Capri)

Remove center trim panel and lower steering column cover. Disconnect wiper switch electrical connector and pull wiring from routing clip. Firmly grasp switch and lever and pull out to remove. To install, reverse removal procedure.

Removal & installation (Festiva)

See COMBINATION SWITCH under REMOVAL & INSTALLATION.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Capri	
Column Lock Shield Screw & Nut	11-14 (15-19)
Ignition Lock Housing Bolt	12-13 (16-18)
Steering Wheel Bolt	23-33 (31-45)
Upper Column Retaining Bolts	17-23 (23-31)
Festiva	
Steering Wheel Nut	29-36 (39-49)
Upper Column Retaining Bolts	23-34 (31-46)
INCH Lbs. (N.m)	
Capri	
Ignition Switch Screw	50-70 (5.6-7.9)
Capri & Festiva	
Air Bag Module-To-Steering Wheel Nuts	35-53 (4-6)

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WIPER/WASHER SYSTEM

1991 ACCESSORIES & SAFETY EQUIPMENT Ford Motor Co. Wiper/Washer Systems

DESCRIPTION & OPERATION

Capri and Festiva vehicles are equipped with a 2-speed wiper motor with an optional intermittent system. The Festiva rear wiper uses a single speed wiper motor. Washer systems for both front and rear washers use pumps mounted near fluid reservoirs.

ADJUSTMENTS

WIPER ARM ADJUSTMENT

Remove wiper arm and blade assemblies from pivot shafts. Turn wiper switch on and allow wiper motor to cycle 2 to 3 times. Turn wiper switch off to place pivot shafts in park position. Reinstall wiper arm and blade assemblies with tips of wiper blades at specified distance from lower edge of windshield. See [WIPER BLADE ADJUSTMENT SPECIFICATIONS](#) table. Tighten wiper arm retaining nut to 89-124 INCH Lbs. (10-14 N.m).

WIPER BLADE ADJUSTMENT SPECIFICATIONS

Application	In. (mm)
Capri	
Driver Side	1.0 (25)
Passenger Side	1.26 (32)
Festiva	
Both Sides	1.0 (25)
Rear	(1) 3.15 (80)
(1) From left edge of liftgate window.	

TESTING

FRONT WIPER MOTOR TEST

Capri

1. Check WIPER fuse in interior fuse block and replace if necessary. Perform [FRONT INTERVAL WIPE MODULE TEST](#) . If wiper/washer switch and interval module are operating properly, disconnect wiper motor connector. Turn ignition on and place wiper/washer switch in HIGH position. Measure voltage at Blue/Red and Blue wires at wiper motor vehicle harness connector.
2. If battery voltage is not present, check Blue/Red or Blue wire for open circuit. If battery voltage is present at Blue/Red and Blue wires, check Black ground wire at wiper motor vehicle harness connector for an open circuit and repair as necessary. If Black ground wire is okay, replace wiper motor.

Festiva

1. Place wiper in any position other than park. Remove WIPER fuse. Disconnect wiper motor electrical connector. Using an ohmmeter, check for continuity to ground at motor case. Continuity should exist. If continuity does not exist, replace or repair wiper motor ground strap or wire.
2. Check for continuity to ground at Blue/Black terminal of wiper motor. Continuity should exist. If continuity does not exist, replace wiper motor.

FRONT INTERVAL WIPE MODULE TEST

Capri

1. Check WIPER fuse in interior fuse block and replace if necessary. Perform [FRONT WIPER/WASHER SWITCH TEST](#) . Access interval wipe module connector. Interval wipe module is located below instrument panel near console. Ensure wiper switch is in OFF position. Turn ignition on and measure voltage at Blue/White and Blue/Black wires of module connector. Battery voltage should not be present. Turn wiper switch to LOW position. Measure voltage at Blue/White and Blue/Black wires of module connector. Battery voltage should be present.
2. Turn wiper switch to HIGH position. Measure voltage at Blue/White, Blue/Black and Blue/Red wires of module connector. Battery voltage should be present. Turn wiper switch to INT position. Measure voltage at Blue/White and Blue/Black wires of module connector. Battery voltage should be present during each cycle. If module does not perform as specified, replace module.

Festiva

Information is not available from manufacturer.

FRONT WIPER/WASHER SWITCH TEST

Capri

Remove lower steering column cover to gain access to wiper switch electrical connector. Using an ohmmeter, ensure continuity exists between terminals listed in table at specified switch positions. If switch does not test as specified, replace wiper/washer switch. See [FRONT WIPER/WASHER SWITCH CONTINUITY \(CAPRI\)](#) table. See [Fig. 1](#) .

FRONT WIPER/WASHER SWITCH CONTINUITY (CAPRI)

Terminal	Position	Continuity

BLU - BLU/ORG	Pull washer lever	Yes
"	Release washer lever	No
BLU - BRN/WHT	Int	Yes
"	All other positions	No
BLU - GRN	Lo	Yes
"	High	Yes
"	All other positions	No
BLU - BLU/RED	High	Yes
"	All other positions	No
ORG - YEL/RED	Rotate INT control knob	(1)
(1) Ohmmeter will indicate a smoothly increasing resistance from 420-880 ohms (minimum) to 7-13 k/ohms (maximum).		

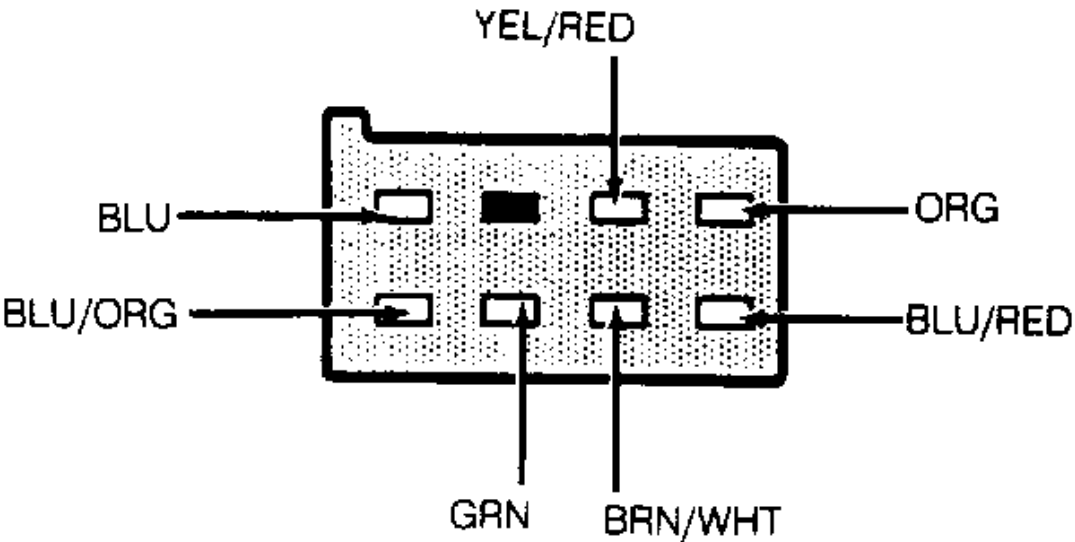


Fig. 1: Identifying Front Wiper/Washer Switch Terminals (Capri)
Courtesy of FORD MOTOR CO.

Festiva

Remove lower steering column cover to gain access to wiper switch electrical connector. Using an ohmmeter, ensure continuity exists between terminals listed in table at specified switch positions. If switch does not test as specified, replace wiper/washer switch. See **FRONT WIPER/WASHER SWITCH CONTINUITY (FESTIVA)** table. See [Fig. 2](#) .

FRONT WIPER/WASHER SWITCH CONTINUITY (FESTIVA)

Terminal	Position	Continuity
BLK - BLK/WHT	Off	No
"	Low	Yes
"	High	No
BLK - BLU/RED	Off	No
"	Low	No
"	High	Yes
BLK - BLU/ORG	Washer Off	No
"	Washer On	Yes

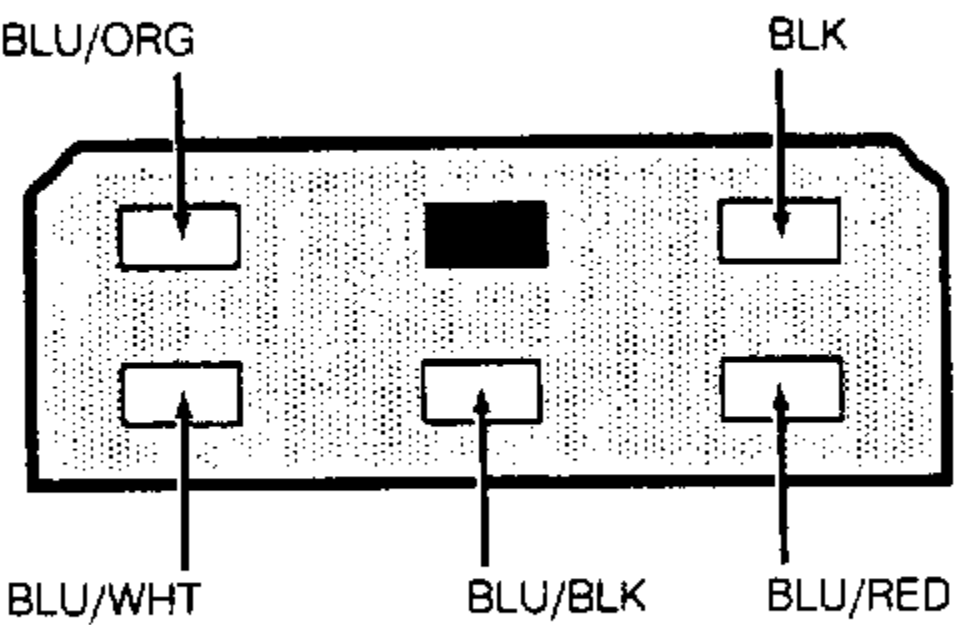


Fig. 2: Identifying Front Wiper/Washer Switch Terminals (Festiva)
Courtesy of FORD MOTOR CO.

FRONT WASHER MOTOR TEST

Remove washer fluid reservoir. Remove washer motor from reservoir. Connect fused jumper wire between washer motor terminal that corresponds with Blue/Orange wire (Capri) or Blue wire (Festiva) and battery positive terminal. Connect other washer motor terminal to ground. Washer motor should run smoothly. If washer motor does not run smoothly or does not run, replace motor.

REAR WIPER MOTOR TEST

Festiva

- 1. Place wiper in any position other than park. Disconnect wiper motor electrical connector. Using an ohmmeter, check for continuity to ground at motor case. Continuity should exist. If continuity does not exist, repair wiper motor housing ground wire.
- 2. Check for continuity to ground at Blue terminal of wiper motor. Continuity should exist. If continuity does not exist, replace wiper motor.

REAR WIPER/WASHER SWITCH TEST

Festiva

Remove rear wiper/wash switch. Using a self-powered test light or an ohmmeter, ensure continuity exists between terminals listed in table at specified switch positions. If switch does not test as specified, replace wiper/washer switch. See [Fig. 3](#) . Also, refer to the [REAR WIPER/WASHER SWITCH CONTINUITY \(FESTIVA\)](#) table.

REAR WIPER/WASHER SWITCH CONTINUITY (FESTIVA)

Terminal	Position	Continuity
BLU - BLK	Off	No
"	On	Yes
GRN/BLK - BLK	Off	No
"	On	Yes

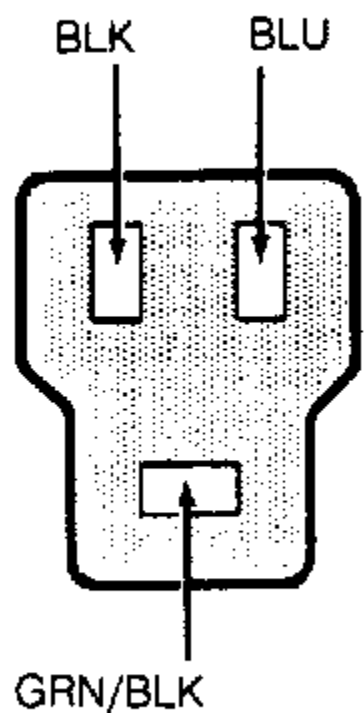


Fig. 3: Identifying Rear Wiper/Washer Switch Terminals (Festiva)
Courtesy of FORD MOTOR CO.

REAR WASHER MOTOR TEST

See FRONT WASHER MOTOR TEST under TESTING.

REMOVAL & INSTALLATION

FRONT WIPER MOTOR

Removal

Disconnect negative battery cable. On Capri, gently pry linkage off ball socket at wiper motor arm. On Festiva, remove access plate then gently pry linkage off ball socket at wiper motor arm. On all models, disconnect wiper motor electrical connector. Remove 4 mounting bolts and rubber insulators and remove wiper motor.

NOTE: **Disconnect linkage from wiper motor arm ball socket NOT by removing nut and wiper motor arm. This will eliminate the need to retime wiper motor and linkage. Replacement motors are supplied with arm attached. Manufacturer does not give procedure for timing motor arm to wiper park position.**

Installation

Position wiper motor on firewall. Install 4 rubber insulators and mounting screws and tighten to 62-89 INCH lbs. (7-10 N.m). Reverse removal procedure to complete installation. Check wipers for proper operation.

FRONT WIPER/WASHER SWITCH

Removal & Installation (Capri)

Remove center trim panel and access cover under steering column. Remove 2 screws and remove lower steering column shroud. Disconnect wiper/washer switch electrical connector and pull wiring from routing clip. Firmly grasp switch and lever and remove from mounting. To install, reverse removal procedure.

Removal & Installation (Festiva)

1. Disconnect negative battery cable. From back of steering wheel, remove 2 screws securing horn pad. Disconnect horn wire from horn pad and remove pad. Remove steering wheel nut. Scribe reference mark on steering shaft and steering wheel hub for reassembly. Using Steering Wheel Puller (T67L-3600-A), remove steering wheel.
2. Remove 4 screws from upper half of lower steering column cover. Remove cover. Remove upper steering column cover. Remove 5 clips from lower half of lower steering column cover. Remove cover.
3. Release wiring harness clip and unplug 4 harness connectors from back of combination switch. From below steering column, loosen band clamp securing switch hub to steering column jacket. Pull switch assembly from steering column.
4. To install, slide combination switch assembly onto steering column. Make sure switch assembly is seated and level against end of column jacket. To complete installation, reverse removal procedure.

FRONT WASHER MOTOR & RESERVOIR

Removal & Installation (Capri)

Drain reservoir if necessary. Remove 2 bolts securing reservoir to inner finder. Disconnect electrical connector from washer pump motor.

Disconnect fluid lines and remove reservoir. To install, reverse removal procedure.

Removal & Installation (Festiva)

1. Disconnect negative battery cable. Remove washer reservoir filler neck attaching bolt. Remove coolant expansion reservoir. Disconnect washer pump electrical connector. Remove left front splash shield.
2. Disconnect washer pump fluid lines and detach lines from reservoir clips. Remove reservoir attaching nuts and bolt. Detach washer reservoir from filler neck and remove reservoir. To install, reverse removal procedure.

REAR WIPER MOTOR

Removal & Installation (Festiva)

Remove rear wiper arm and blade assembly. Remove boot from outer bushing attaching nut. Remove outer bushing attaching nut and remove outer bushing. Remove liftgate trim panel. Disconnect wiper motor electrical connector. Remove 4 wiper motor mounting bolts and remove motor. To install, reverse removal procedure.

REAR WIPER/WASHER SWITCH

Removal & Installation (Festiva)

Disconnect negative battery cable. Remove steering column covers. Remove screws securing instrument panel bezel to instrument panel. Pull instrument bezel away from instrument panel. Disconnect electrical connectors from switches in bezel. Compress wiper/washer switch lock tabs and remove switch from bezel. To install, reverse removal procedure.

REAR WASHER MOTOR & RESERVOIR

Removal & Installation (Festiva)

Open liftgate and detach reservoir cap. Remove rear quarter trim panel. Remove reservoir mounting bolts. Disconnect electrical connector from washer pump. Disconnect fluid lines. Remove reservoir. To install, reverse removal procedure.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	INCH Lbs. (N.m)
Front Wiper Arm Retaining Nut	89-124 (10-14)
Front Wiper Motor Mounting Bolts	62-89 (7-10)
Rear Outer Bushing Retaining Nut	27-44 (3-5)
Rear Wiper Arm Nut	53-62 (6-7)
Rear Wiper Motor Mounting Bolts	71-97 (8-11)

WIRING DIAGRAMS

See appropriate chassis wiring diagram in the WIRING DIAGRAMS Section.

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BRAKE SYSTEM

1991-92 BRAKES Disc & Drum

DESCRIPTION & OPERATION

On Capri, vehicle braking is provided by front and rear disc brakes. Front and rear brakes are a full-floating, single piston design. The rear caliper houses a self-adjusting parking brake.

On Festiva, vehicle braking is provided by front disc brakes and rear drum brakes. Rear brakes are a standard non-servo, self-energizing design. Front brakes are a full-floating, single piston design with caliper attached to steering knuckle.

BLEEDING BRAKE SYSTEM

BLEEDING PROCEDURES

Manual Bleeding

1. Exhaust vacuum from power brake unit by depressing brake pedal several times. Fill master cylinder with clean brake fluid. Install clear vinyl bleeder hose onto first bleeder valve to be serviced. See BRAKE LINE BLEEDING SEQUENCE table. Place other end of hose in clean transparent container.
2. Partially fill container with clean brake fluid. Open the bleeder valve 3/4 turn. Slowly depress brake pedal through its full travel. Close bleeder valve and release pedal. Pump pedal several times to push air toward wheel cylinders. Repeat procedure until flow of brake fluid is clear and shows no signs of air bubbles. Proceed to next bleeder valve in sequence and repeat procedure.

BRAKE LINE BLEEDING SEQUENCE

Application	Sequence
Capri	RR, LF, LR & RF
Festiva	RR, LR, RF & LF

NOTE: Check fluid level in master cylinder frequently during the bleeding sequence.

Pressure Bleeding

1. Exhaust vacuum from power brake unit by depressing brake pedal several times. Fill master cylinder with clean brake fluid. With pressure bleeder at least 1/2 full, connect pressure bleeder to master cylinder using appropriate adaptor.
2. Install clear vinyl bleeder hose onto first bleeder valve to be serviced. See BRAKE LINE BLEEDING SEQUENCE table. Place other end of hose in clean transparent container. Partially fill container with clean brake fluid. Open bleeder valve 1-2 turns. Allow fluid to run until flow of fluid is clear and shows no signs of air bubbles. Proceed to next bleeder valve in sequence and repeat procedure. Remove pressure bleeder and fill master cylinder with clean brake fluid.

ADJUSTMENTS

BRAKE PEDAL HEIGHT (FESTIVA)

1. Block wheels to prevent vehicle from rolling. Start engine and place transmission in Neutral. Fully release parking brake. Move carpet and insulation away from firewall and brake pedal. Measure distance horizontally between upper center of brake pedal pad and firewall. Distance should be 8.03-8.23" (204-209 mm).
2. If pedal height is incorrect, inspect pedal assembly for missing, worn or damaged bushings or for loose attaching bolts. Ensure firewall is not distorted and pedal is not bent. If pedal height is still not within specifications, check brake pedal, booster or master cylinder for correct and/or correctly installed parts

BRAKE PEDAL FREE PLAY (FESTIVA)

Pump brake pedal several to bleed vacuum from power brake booster. Gently depress brake pedal by hand and measure and measure play before resistance is felt. Free play should be .16-.28" (4-7 mm). If free play is not within specifications, adjust brake pedal push rod.

BRAKE PEDAL FLOOR CLEARANCE

Capri

1. Move carpet and insulation away from floor board and brake pedal. With engine running and using Brake Pedal Effort Gauge (021-00001), apply 132 lbs. (59.9 kg) of force to brake pedal. Measure distance from upper surface of brake pedal pad to floor board. If distance is less than 3.27" (83 mm), inspect pedal assembly for missing, worn or damaged bushings or for loose attaching bolts.
2. Verify that floor board is not distorted and pedal is not bent. If pedal height is still not within specifications, check brake pedal, booster or master cylinder for correct and/or correctly installed parts. Check for air in hydraulic system.

Festiva

Move carpet and insulation away from floor board and brake pedal. Using Brake Pedal Effort Gauge (021-00001) or equivalent, apply 132 lbs. (59.9 kg) of force to brake pedal. Measure distance from upper surface of brake pedal pad to floor board. If distance is less than 2.68" (68 mm), check for air in hydraulic system, faulty automatic adjusters or excessive shoe clearance.

POWER BRAKE UNIT PUSH ROD

Capri

Power brake push rod length is not adjustable.

Festiva

Remove master cylinder. See MASTER BRAKE CYLINDER under REMOVAL & INSTALLATION. Place Adjustment Gauge (T87C-2500-A) on master cylinder. Loosen set screw on gauge and place plunger against master cylinder. See [Fig. 1](#) . Invert gauge and position on power booster. Check clearance between gauge and power booster. Adjust push rod until clearance is zero.

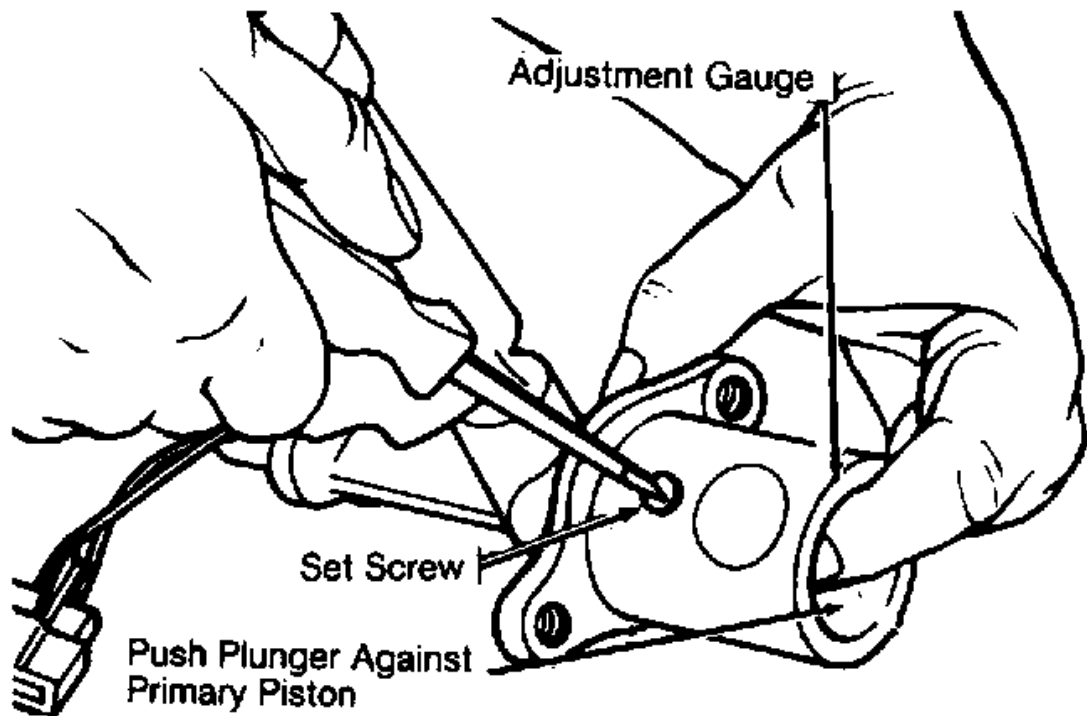


Fig. 1: Measuring Brake Booster Push Rod Length (Festiva)
Courtesy of FORD MOTOR CO.

PARKING/EMERGENCY BRAKE

Capri

1. Ensure parking brake lever is released. Remove parking brake console. Loosen parking brake cable lock nut. Loosen or tighten adjusting nut so parking brake begins to apply when lever is pulled up 5 notches and is fully applied at 7-11 notches.
2. Using Spring Scale (T74P-3504-Y), check force required to apply parking brake. A properly operating system will require 44 lb. (97 kg) of force to fully apply parking brakes. Tighten lock nut. Ensure brake warning light operates when parking brake lever is raised.

Festiva

1. Ensure parking brake lever is released. Remove parking brake console insert. Remove locking clip from cable adjuster nut. Raise and support rear of vehicle. Tighten parking brake adjuster until slight drag is felt when rotating wheels.
2. Loosen adjuster in small increments until drag is eliminated. As parking brake lever is lifted, parking brake should lock rear wheels in 11-16 notches. Ensure brake warning light operates when parking brake lever is raised.

REAR BRAKE SHOES

Festiva

1. Raise and support vehicle. Release parking brake. Unstake and remove axle lock nut. Remove brake drum. Insert screwdriver between adjusting plate and quadrant. See [Fig. 2](#) . Twist screwdriver to disengage teeth.
2. Push quadrant adjusting lever toward backing plate. Install brake drum and NEW axle lock nut. Adjust wheel bearings and secure nut by crimping. See REAR AXLE BEARINGS. Operate brake pedal a few times to reset adjuster. Adjust parking brake (if necessary). See PARKING/EMERGENCY BRAKE.

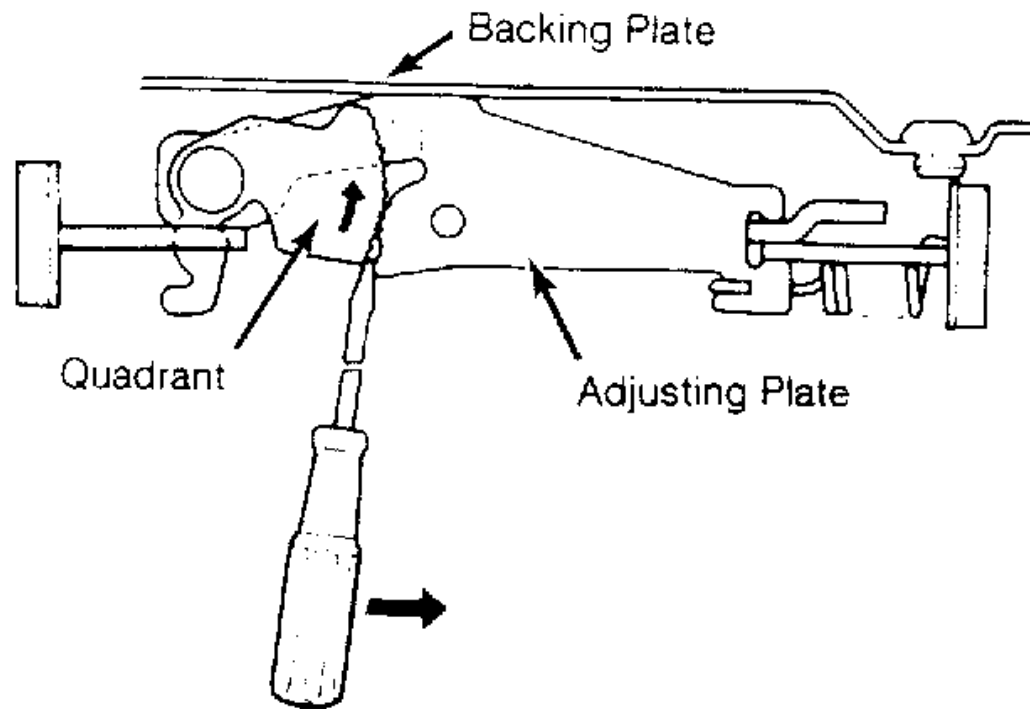


Fig. 2: Moving Quadrant on Drum Brake Adjuster (Festiva)
 Courtesy of FORD MOTOR CO.

FRONT AXLE BEARINGS

Front bearing preload is adjusted during bearing replacement by changing preload spacer. See FRONT WHEEL BEARINGS under REMOVAL & INSTALLATION.

REAR AXLE BEARINGS

NOTE: Axle lock nut on right side has left-hand threads. Always install NEW lock nut when removed.

With bearings installed, tighten NEW lock nut to 18-22 ft. lbs. (24-30 N.m) while rotating wheel. Slightly loosen lock nut so it can be turned by hand. Install a lug nut into axle hub. Attach an inch-pound torque wrench to lug nut at 12 o'clock position. Measure bearing preload. Tighten lock nut until bearing preload, including seal drag, is 3.5-6.2 INCH lbs. (.4-.7 N.m). Stake NEW lock nut into notch on spindle.

TESTING

POWER BRAKE UNIT

NOTE: Inspect all vacuum hoses for holes, collapsed areas and secure connections. Ensure all unused vacuum ports are capped.

Functional Test

1. Check master cylinder fluid level and hydraulic system for leaks. Place transaxle in Neutral or Park, turn ignition off and apply parking brake. Pump brake pedal several times to eliminate vacuum from system, and hold pedal in depressed position.
2. Start and idle engine. If vacuum system is functioning properly, pedal moves downward under constant foot pressure. If no pedal motion is felt, vacuum booster is not functioning properly. Go to next step.
3. Run engine for at least one minute and turn ignition off. Depress brake pedal several times. Booster is okay if pedal stroke is long at first and becomes shorter with each stroke. If stroke does not shorten, check for a damaged, restricted or improperly connected check valve vacuum hose. Repair and recheck. Go to next step.
4. Restart engine. Depress and hold pedal down. Turn ignition off and wait 30 seconds. Booster is okay if pedal height remains unchanged. If pedal height changes, check for a damaged, restricted or improperly connected check valve or vacuum hose. Go to next step.
5. Connect a pressure gauge to master cylinder output line. Connect a vacuum gauge to booster and a pedal depression force gauge to brake pedal. Bleed air from pressure gauge. Start engine. When vacuum gauge reads 19.7 in. Hg, turn ignition off. Watch vacuum gauge for 15 seconds. Booster is okay if vacuum gauge reads 18.7-19.7 in. Hg. If vacuum gauge reads less than 18.7 in. Hg, proceed to next step.
6. Restart engine. Apply and hold 44 lbs. (196 N) force to brake pedal. When vacuum gauge reading reaches 19.7 in. Hg, turn ignition off. Watch vacuum gauge for 15 seconds. Booster is okay if vacuum gauge reads 18.7-19.7 in. Hg. If vacuum gauge reads less than 18.7 in. Hg, proceed to next step.
7. With engine stopped and vacuum gauge at zero, check pressure gauge. Apply 44 lbs. (196 N) force to brake pedal and check pressure gauge. Booster is okay if pressure gauge reads 256 psi (18 kg/cm²).
8. Remove pedal force and start engine. When vacuum gauge reaches 19.7 in. Hg, apply 44 lbs. (196 N) force to pedal. Booster is okay if pressure gauge read 768 psi (54 kg/cm²).

Diagnosis

If booster does not function properly, see [Fig. 3](#) .

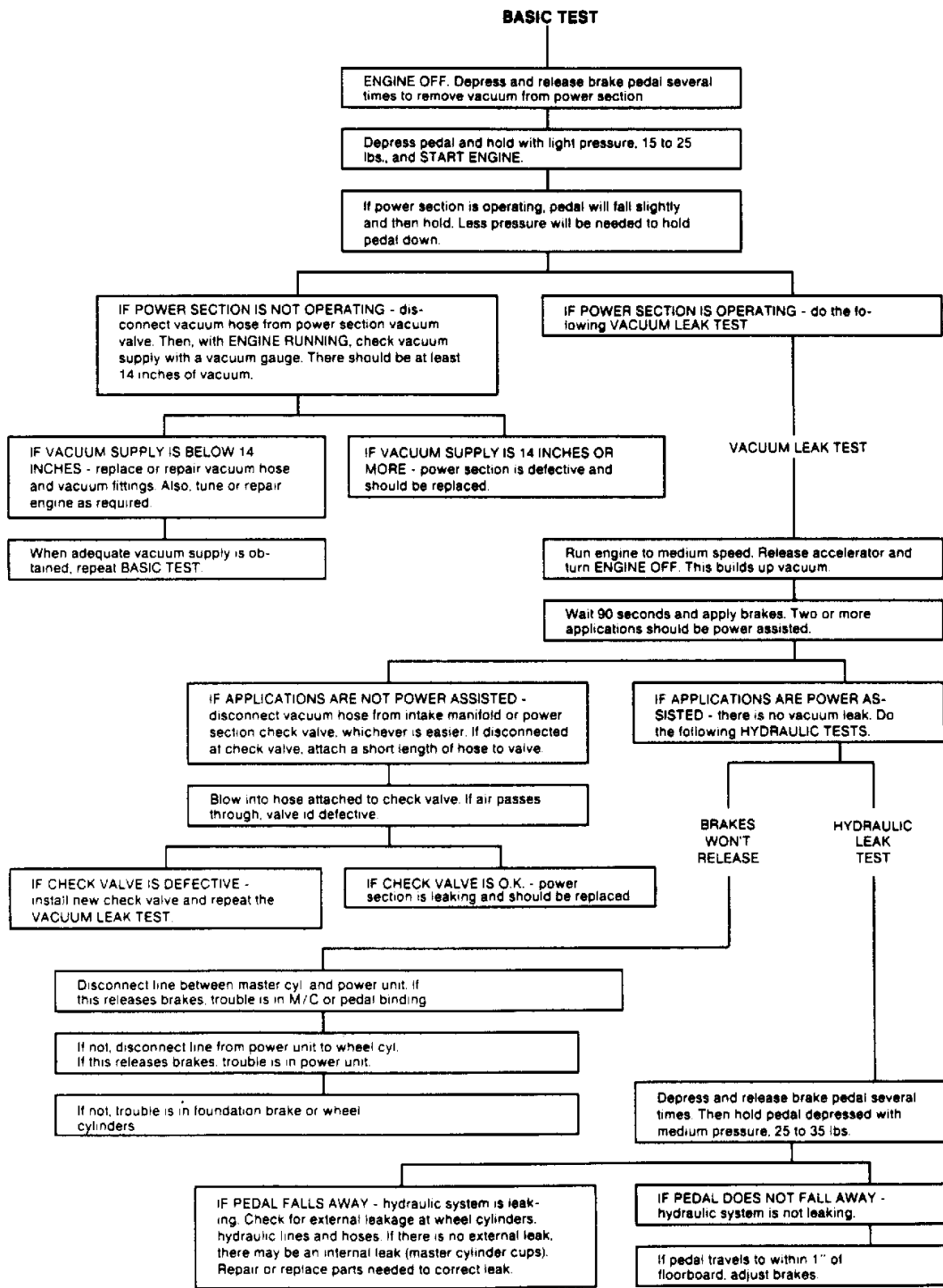


Fig. 3: Power Brake Unit Troubleshooting

CHECK VALVE

NOTE: On Festiva, check valve is pressed into hose. An arrow on hose indicates direction of vacuum flow.

On Capri, check valve is located on power brake unit. On Festiva, check valve is located in vacuum hose connecting power booster to intake manifold. Disconnect check valve vacuum hose from manifold. Alternately apply vacuum and pressure to hose. Ensure air flows only toward engine. If pressure by-passes check valve or if check valve blocks vacuum, replace hose and check valve.

REMOVAL & INSTALLATION

FRONT BRAKE CALIPER & PADS

Removal & Installation (Capri)

1. Raise and support front of vehicle. Remove wheels. Using needle-nose pliers, remove brake pad pin retainer spring. Remove brake pad pins. Remove brake pads and shims. Mark shims so they can be reinstalled in their original position. DO NOT discard shims from inner brake pad.
2. Remove flex hose-to-caliper banjo bolt. Remove caliper retaining bolts and caliper. To install, reverse removal procedure. Ensure brake pad shims are installed behind inner brake pad.

Removal & Installation (Festiva)

1. Raise and support front of vehicle. Remove wheels. Remove brake pad pin retainer clip. Remove brake pad pins and anti-rattle spring. Remove brake pads and shims. Mark shims so they can be reinstalled in their original position. DO NOT discard shims from inner brake pad.
2. To install, reverse removal procedure. Ensure brake pad shims are installed behind inner brake pad.

FRONT BRAKE ROTOR & HUB

NOTE: Front knuckle, disc brake rotor and hub are removed as an assembly.

Removal

1. Raise and support front of vehicle. Remove wheel. Unstake axle shaft lock nut tab. Apply brakes (to lock hub) and remove drive shaft

lock nut. Discard axle lock nut. Separate tie rod end from knuckle.

2. Disconnect brake hose from strut (if necessary). Remove brake caliper assembly from knuckle and wire out of way. Remove nuts and bolts holding ball joint and strut to knuckle assembly.
3. Remove knuckle assembly from ball joint and drive shaft. If binding occurs, use a dual-jawed puller to force knuckle/hub/rotor assembly off drive axle shaft.

NOTE: **Hub and rotor are a matched and balanced assembly. Before removing rotor, locate paint or etch mark indicating proper hub-to-rotor alignment. If marks are not present, mark hub and rotor for assembly alignment. Failure to properly align hub and rotor can result in an imbalance condition.**

4. Using a puller, separate knuckle from wheel hub. Retain original outer bearing preload spacer to maintain bearing preload setting. If replacing bearing, change spacer to maintain proper bearing preload (if necessary). See FRONT WHEEL BEARINGS under REMOVAL & INSTALLATION. Scribe match marks between hub and rotor assembly. Remove rotor-to-hub bolts. Separate hub from rotor.

Installation

Align marks and install rotor on hub. Press knuckle and preload spacer into wheel hub assembly. To complete installation, reverse removal procedure. Tighten axle shaft lock nut to 117-175 ft. lbs. (159-237 N.m).

REAR BRAKE CALIPER & PADS

Removal (Capri)

1. Raise and support vehicle. Remove tire and wheel assembly. Using needle-nose pliers, remove parking brake return spring. Loosen parking brake cable housing adjusting nut. Remove cable housing from bracket on lower control arm. Loosen parking brake cable bracket-to-caliper attaching bolt. Remove parking brake cable from caliper.
2. Remove lower caliper retaining bolt. Pivot caliper upward on upper caliper guide pin. Remove brake pad retaining spring, pads and shims. If replacing rear brake pads only, reverse removal procedure to install. If removing caliper, proceed to next step.
3. Remove attaching clip from brake flex hose. Remove flex hose banjo bolt from caliper and discard copper washers. Remove lower caliper retaining bolt. Using a cold chisel, remove upper caliper guide pin dust cap. Using an Allen wrench, remove upper caliper guide pin. Lift caliper off rotor.

Installation

1. To install, fit brake pads and shims into caliper anchor plate. Remove upper guide pin and lower guide pin bushing from caliper. Remove guide pin and guide pin bushing dust boots. Lubricate upper guide pin and lower guide pin bushing with Disc Brake Caliper Slide Grease (D7AZ-19590-A).
2. To complete installation, reverse removal procedure. To fit caliper over new brake pads, it may be necessary to rotate caliper piston into caliper bore. Use NEW copper washers on flex hose. Bleed brakes, and then pump brake pedal several times to seat pads.

REAR BRAKE ROTOR

Removal & Installation (Capri)

See REAR WHEEL BEARINGS under REMOVAL & INSTALLATION.

REAR BRAKE SHOES

Removal & Installation (Festiva)

Remove brake drum. Remove hold-down springs. Remove return springs. Remove self adjuster. See [Fig. 8](#) . To install, reverse removal procedure. Apply brake grease to all shoe contact points. See REAR BRAKE SHOES under ADJUSTMENTS.

REAR WHEEL CYLINDER

Removal & Installation (Festiva)

Remove rear brake shoes. Disconnect brake line from wheel cylinder. Remove wheel cylinder. To install, reverse removal procedure. Bleed brake system.

MASTER BRAKE CYLINDER

Removal

Disconnect low fluid level sensor wiring (if equipped). Drain some brake fluid from reservoir. Disconnect brake lines from master cylinder. Cap lines and master cylinder ports. Remove attaching nuts and master cylinder.

Installation

To install, reverse removal procedure. Fill master cylinder to proper level and bleed hydraulic system (if necessary).

POWER BRAKE UNIT

Removal & Installation

Remove master cylinder. Disconnect vacuum line. Remove clevis pin at brake pedal. Remove power brake unit. To install, reverse removal procedure.

FRONT WHEEL BEARINGS

Removal

Remove rotor and hub assembly from steering knuckle. Separate rotor, knuckle and hub. See FRONT BRAKE ROTOR & HUB under REMOVAL & INSTALLATION. Press outer bearing from hub using Bearing Splitter (D84L-1123-A) and Shaft Protector (D80L-625-2). Remove and discard outer grease seal. Pry inner wheel bearing grease seal from steering knuckle using a large screwdriver. Discard seal. Remove inner bearing.

Bearing Preload

1. Use Spacer Selector Set (T87C-1104-B) to check and adjust preload. Install spacer selector into steering knuckle and clamp tool in vise where shock absorber mounts, before installing hub/rotor assembly into steering knuckle. See [Fig. 4](#) .

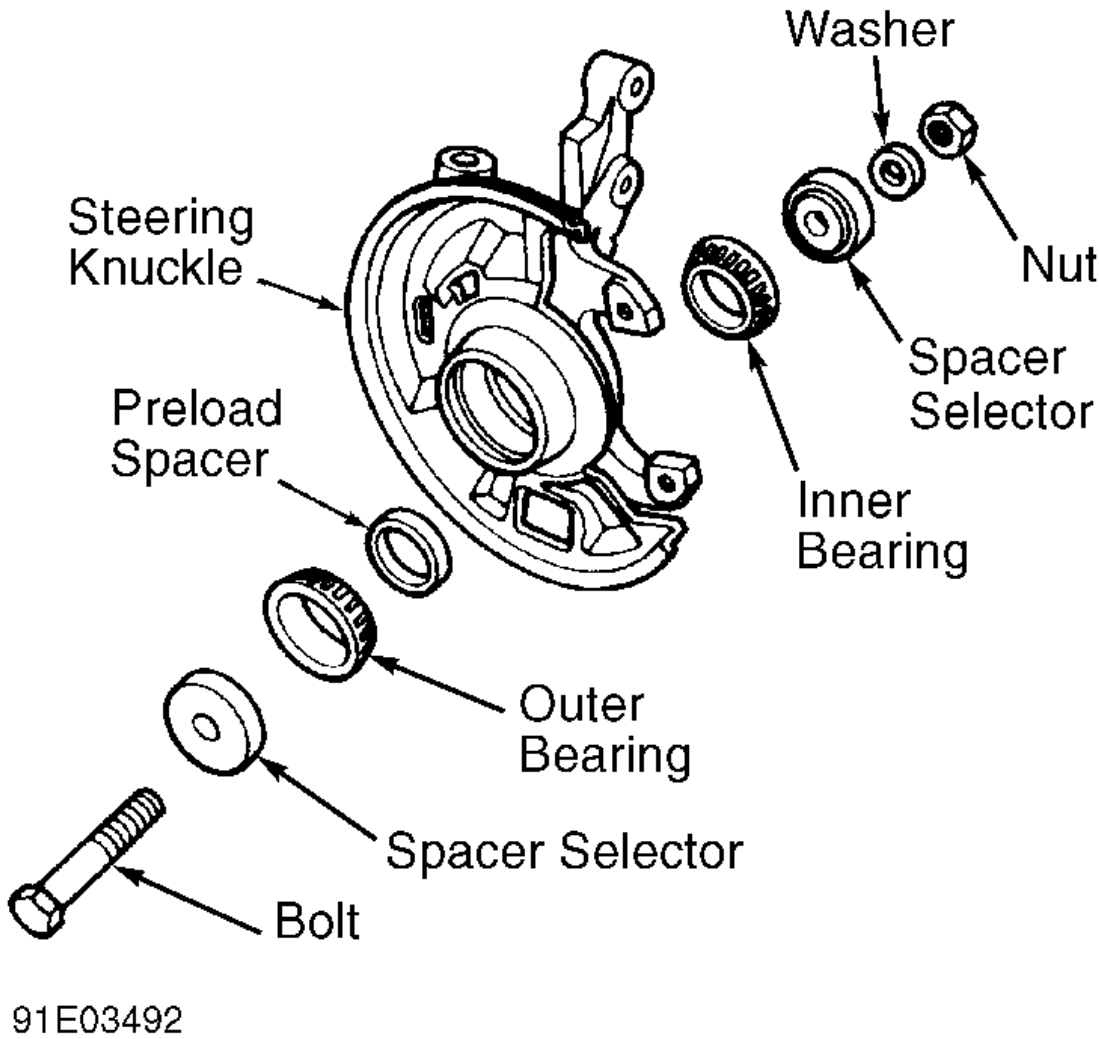


Fig. 4: Installing Preload Spacer Selector Set
Courtesy of FORD MOTOR CO.

2. Tighten center bolt from spacer selector set, in increments, to 36, 72, 108 and finally 145 ft. lbs. (49, 98, 147 and 196 N.m). Each time center bolt is tightened, seat bearings by rotating hub by hand. Using an inch-pound torque wrench, measure torque required to turn center bolt. Ensure torque reading is taken just as wrench starts to rotate.
3. Preload spacer thickness is correct if torque wrench indicates 2.2-16 INCH lbs. (.25-1.8 N.m). If measurement indicates less than 2.2 INCH lbs. (.25 N.m), a thinner spacer must be installed. If measurement indicates more than 16 INCH lbs. (1.8 N.m), a thicker spacer must be installed.
4. Bearing spacers are available in various thicknesses. See PRELOAD SPACER AVAILABILITY table. Changing spacer thickness one number changes bearing preload 1.8-3.5 INCH lbs. (.2-.4 N.m). Ensure correct spacer is installed and preload is within specification. Remove preload spacer selector set.

PRELOAD SPACER AVAILABILITY

Stamped Mark On Spacer	In. (mm)
1	0.2474 (6.285)
2	0.2490 (6.325)
3	0.2506 (6.365)
4	0.2522 (6.405)
5	0.2537 (6.445)
6	0.2553 (6.485)
7	0.2569 (6.525)
8	0.2585 (6.565)
9	0.2600 (6.605)
10	0.2616 (6.645)
11	0.2632 (6.685)
12	0.2648 (6.725)
13	0.2663 (6.765)
14	0.2679 (6.805)
15	0.2695 (6.845)
16	0.2711 (6.885)

17	0.2726 (6.925)
18	0.2742 (6.965)
19	0.2758 (7.005)
20	0.2774 (7.045)
21	0.2789 (7.085)

Installation

1. Lubricate bearings with appropriate wheel bearing grease. Place inner bearing into steering knuckle. Install new inner bearing grease seal, and drive seal into place using appropriate seal installer.
2. Place original outer wheel bearing preload spacer (or spacer selected during preload inspection process) into steering knuckle bore. Place outer wheel bearing into steering knuckle bore.
3. Liberally lubricate lip of NEW outer grease seal with appropriate lubricant. Drive seal into steering knuckle bore. Install brake rotor on hub axle hub. Tighten bolts to 33-40 ft. lbs. (45-54 N.m). Position rotor/hub assembly into steering knuckle, and press assembly into place using adapter from spacer selector set. To complete installation, reverse removal procedure.

REAR WHEEL BEARINGS

Removal & Installation

1. Raise and support rear axle. Remove wheel. Remove wheel bearing dust cap. On Capri, remove rear brake caliper. See REAR BRAKE CALIPER & PADS under REMOVAL & INSTALLATION. On all models, carefully unstake rear axle lock nut using a chisel. DO NOT damage threads on axle spindle. Remove and discard axle nut.
2. On Capri, remove rotor/hub assembly. On Festiva, remove brake drum/hub assembly. On all models, DO NOT allow outer wheel bearing to fall out of hub. Remove inner bearing grease seal. Remove inner bearing. To install rear bearings, reverse removal procedure. Adjust rear wheel bearings. See REAR AXLE BEARINGS under ADJUSTMENTS.

OVERHAUL

NOTE: See Fig. 5 -12 for exploded views of brake assemblies and components.

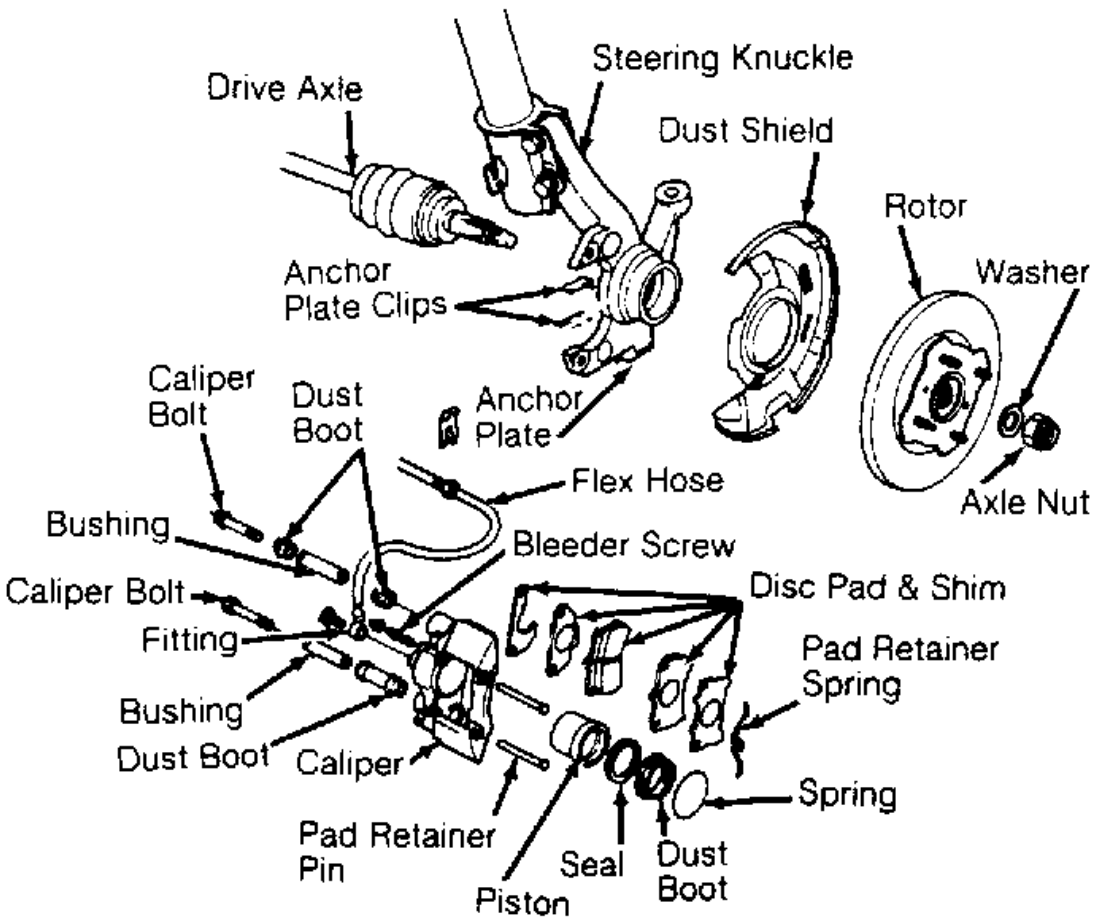


Fig. 5: Exploded View of Front Brake Assembly (Capri)
Courtesy of FORD MOTOR CO.

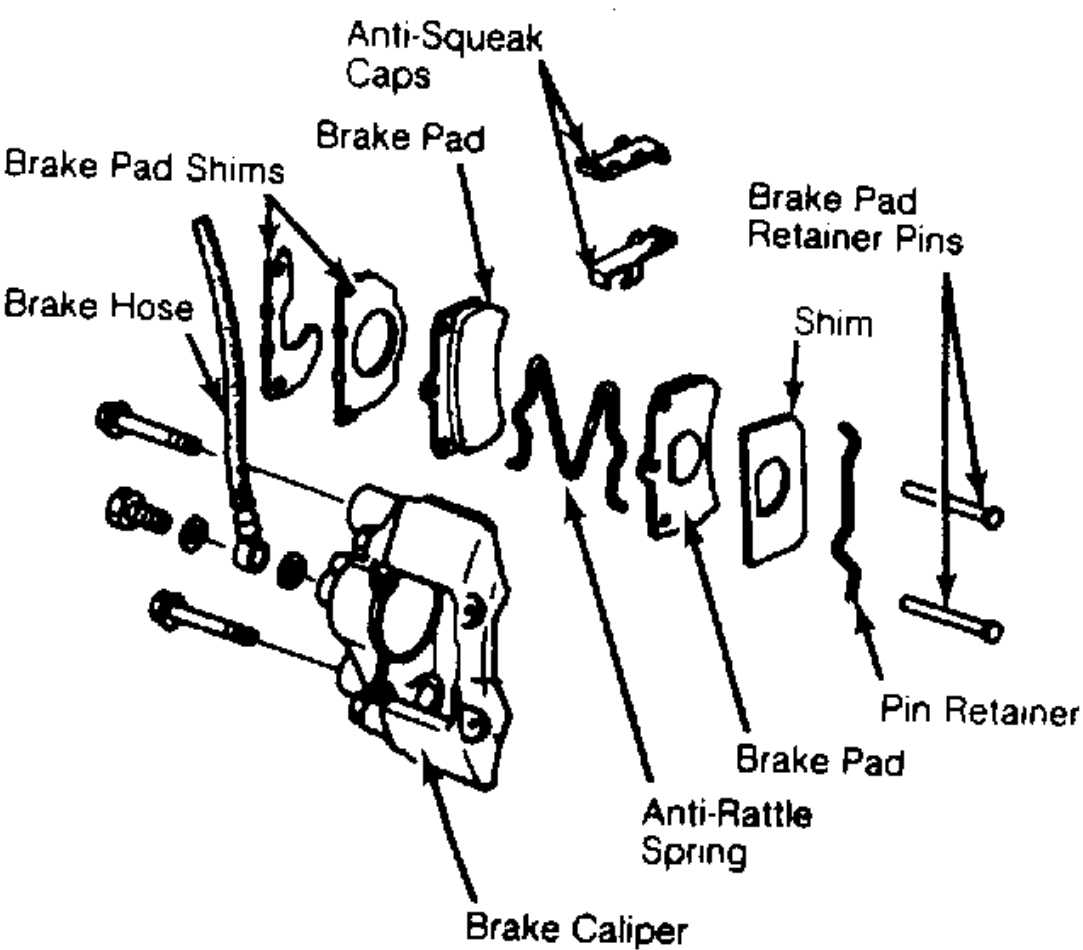


Fig. 6: Exploded View of Front Brake Assembly (Festiva)
Courtesy of FORD MOTOR CO.

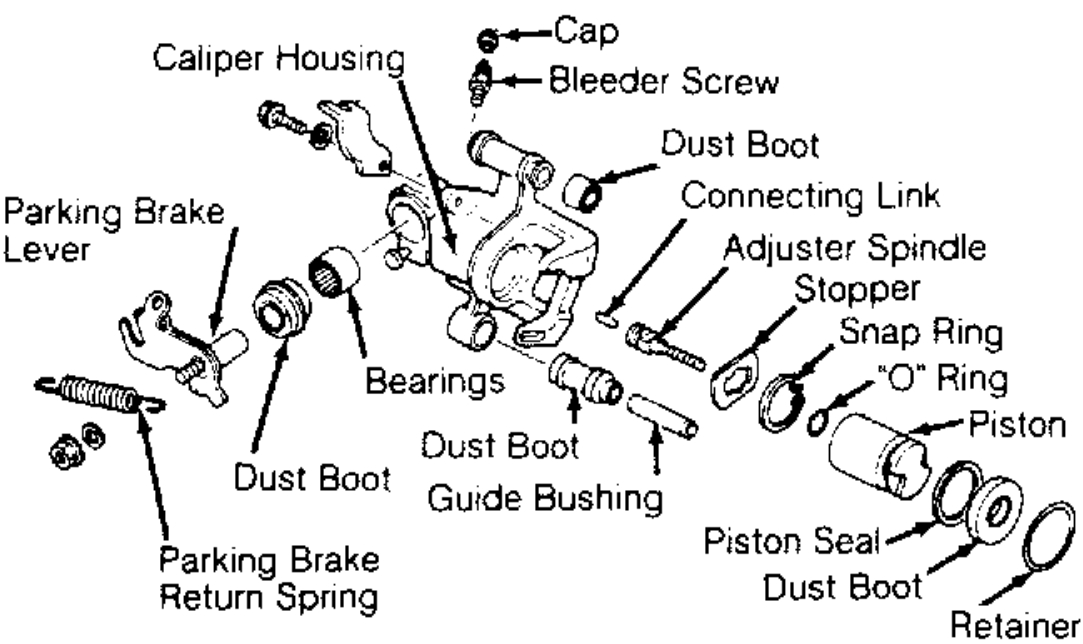


Fig. 7: Exploded View of Rear Brake Caliper (Capri)
Courtesy of FORD MOTOR CO.

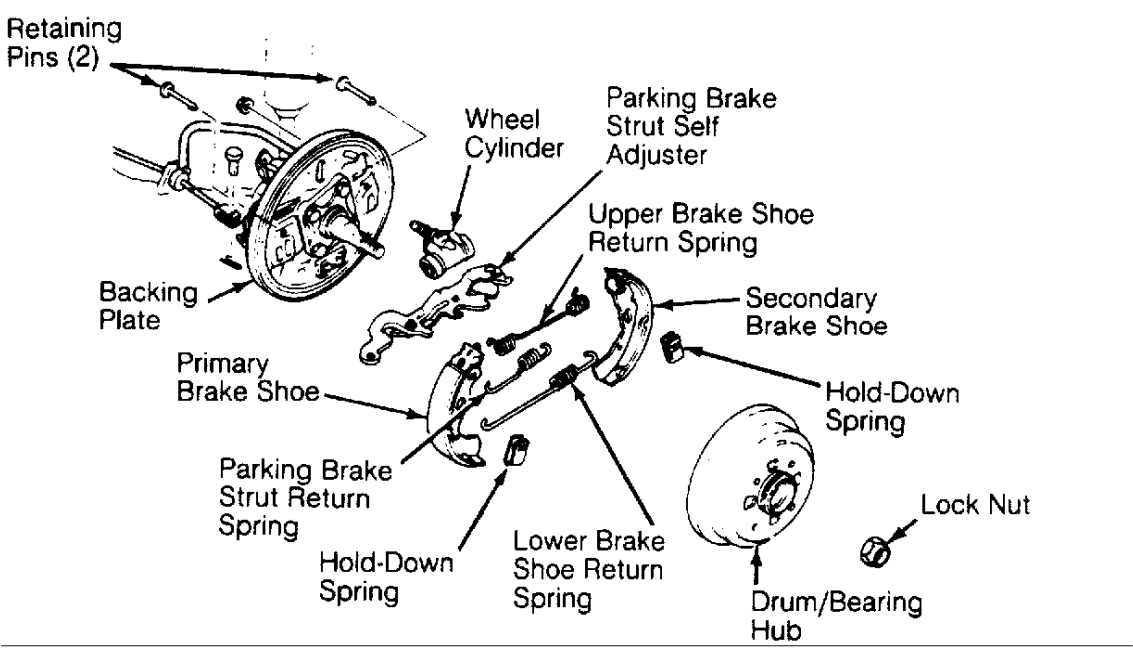


Fig. 8: Exploded View of Rear Brake Assembly (Festiva)
Courtesy of FORD MOTOR CO.

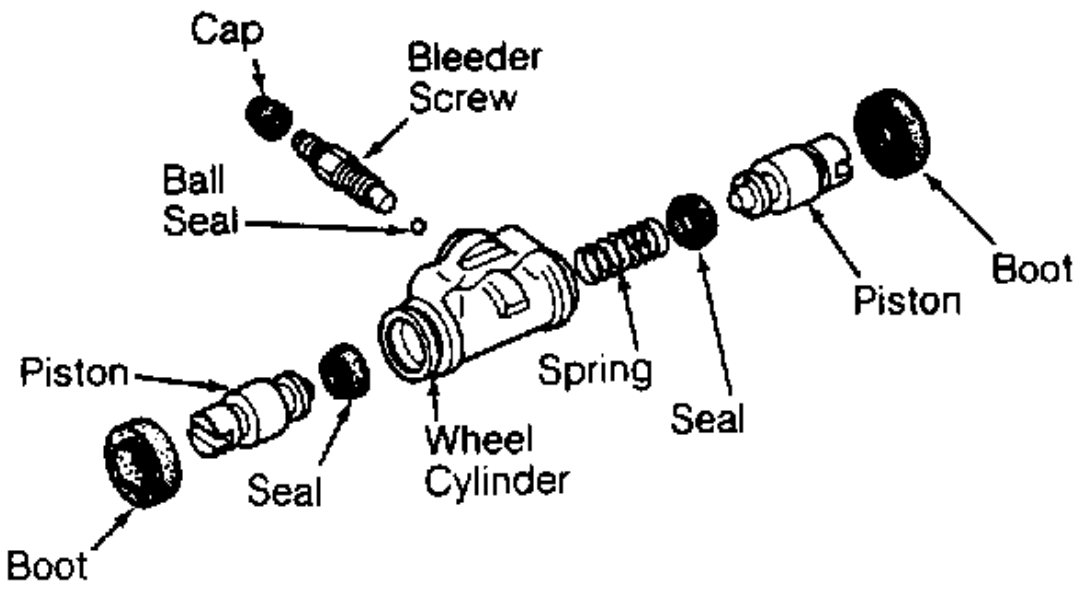


Fig. 9: Exploded View of Rear Wheel Cylinder (Festiva)
Courtesy of FORD MOTOR CO.

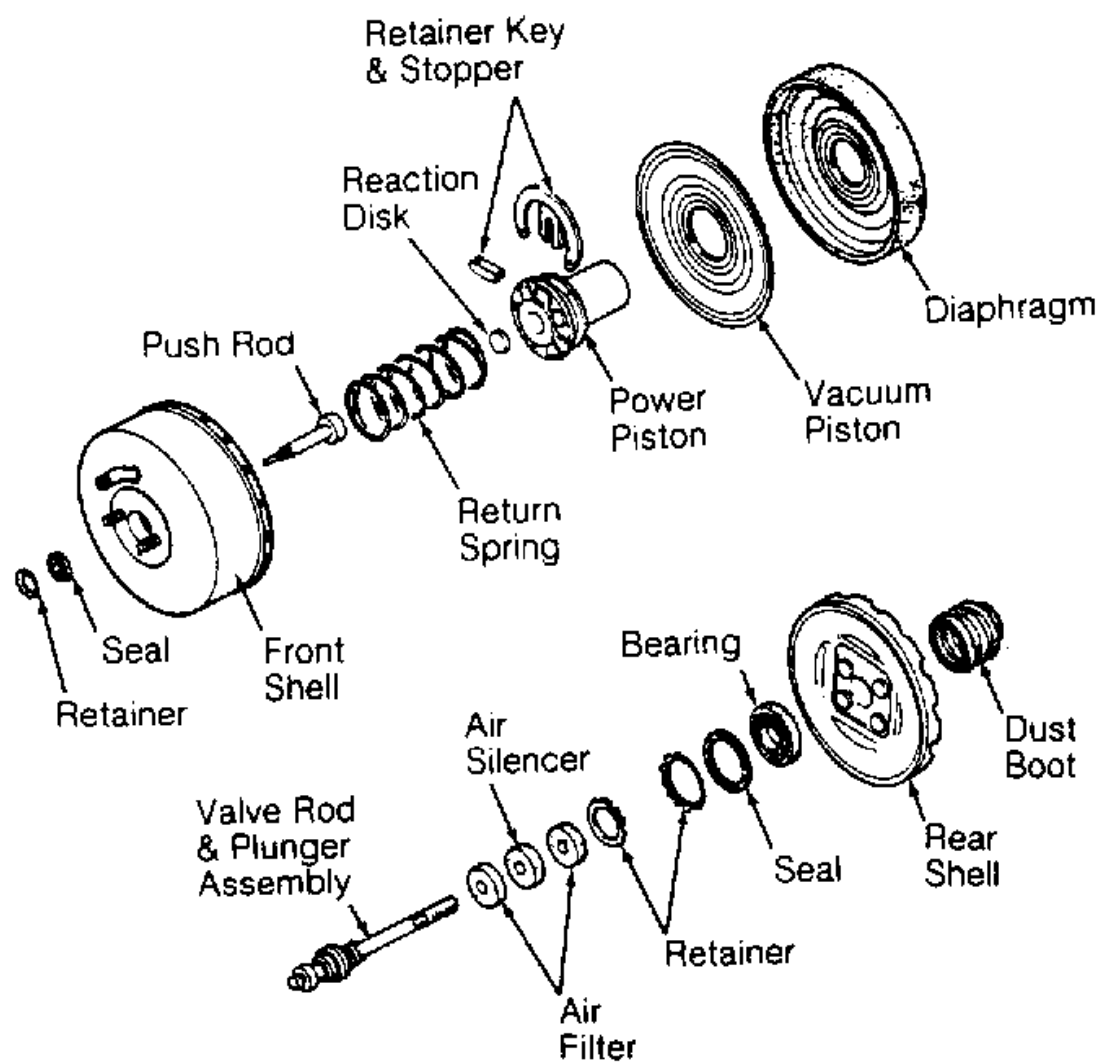


Fig. 10: Exploded View of Power Brake Booster (Festiva)
Courtesy of FORD MOTOR CO.

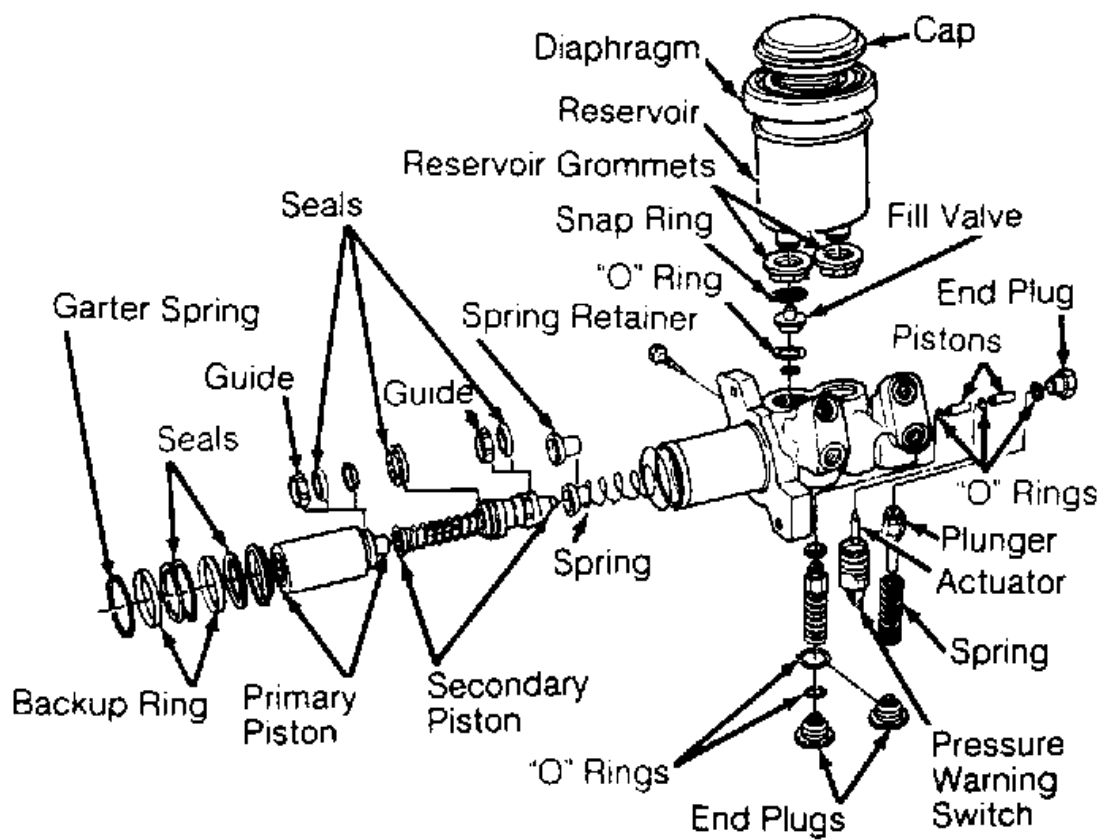


Fig. 11: Exploded View of Master Cylinder (Capri)
Courtesy of FORD MOTOR CO.

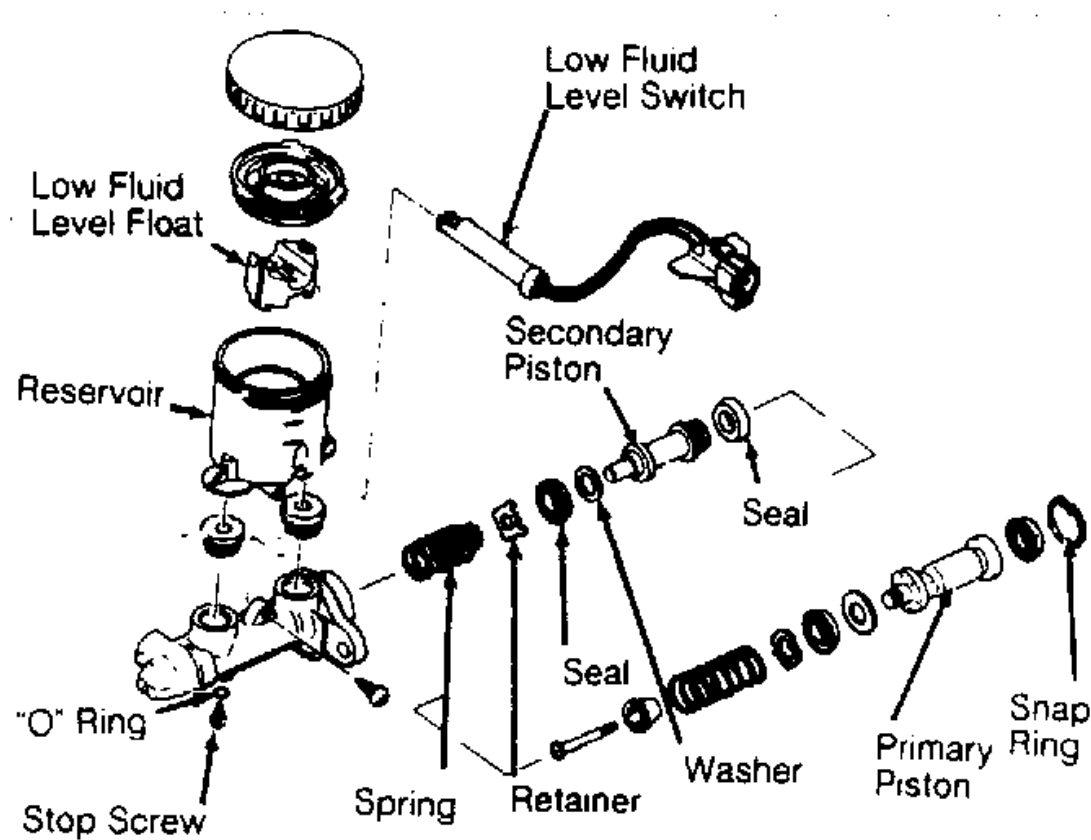


Fig. 12: Exploded View of Master Cylinder (Festiva)
Courtesy of FORD MOTOR CO.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS	
Application	Ft. Lbs. (N.m)
Backing Plate/Spindle Bolts (Rear)	32-45 (43-61)
Brake Hose to Caliper	16-22 (22-30)
Caliper Guide/Mounting Bolt	29-36 (39-49)
Caliper Banjo Bolt	16-21 (22-29)
Front Drive Axle Nut	117-175 (159-237)
Hub-To-Rotor Bolt	33-40 (45-54)
Power Booster Mounting Nuts	
Capri	14-19 (19-26)
Festiva	12-17 (16-23)
Rear Axle Nut	(1)
Rear Strut/Spindle (Capri-Rear)	69-86 (93-117)
Rotor-To-Hub Bolts	33-40 (44-54)
Steering Knuckle-To-Control Arm	32-40 (43-54)
Steering Knuckle-To-Strut	69-86 (93-117)
Steering Knuckle-To-Tie Rod	21-33 (29-44)
Wheel Lug Nut	65-87 (88-118)
INCH Lbs. (N.m)	
Master Cylinder-To-Booster Nut	89-142 (10-16)
Wheel Cylinder Mounting Bolt	89-106 (10-12)
(1) See REAR AXLE BEARINGS under ADJUSTMENTS.	

DISC BRAKE SPECIFICATIONS

DISC BRAKE SPECIFICATIONS	
Application	In. (mm)
Capri	
Lateral Runout	.004 (.1)
Parallelism	.004 (.1)
Original Thickness	
Front	.71 (18)
Rear	.39 (10)
Minimum Refinish Thickness	
Front	.660 (16.762)
Rear	.384 (9.762)
Discard Thickness	
Front	.63 (16)
Rear	.35 (9)

Minimum Brake Pad Thickness	.12 (3)
Master Cylinder Diameter	.811 (20.6)
Festiva	
Lateral Runout	.004 (.1)
Parallelism	.004 (.1)
Original Thickness	.5 (13)
Minimum Refinish Thickness	.46 (11.762)
Discard Thickness	.43 (11)
Minimum Brake Pad Thickness	.12 (3)
Minimum Brake Pad Thickness (1992)	.16 (4)

DRUM BRAKE SPECIFICATIONS

DRUM BRAKE SPECIFICATIONS

Application	In. (mm)
Drum Diameter	
Original	6.69 (170)
Maximum Refinish Diameter	6.75 (171.5)
Minimum Lining Thickness	.04 (1.0)

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AXLE SHAFTS - FRONT

1988-93 Drive Axles - FWD Axle Shafts

DESCRIPTION & OPERATION

Axle shafts transfer power from transaxle to driving wheels. All axle shafts consist of a shaft with a flexible Constant Velocity (CV) joint at each end. Inner CV joint is coupled to transaxle by splines. Outer CV joint is splined to hub assembly and secured by axle shaft nut.

Three different types of axle shaft CV joints are used: Double Offset Joint (DOJ) or Rzeppa type, Birfield Joint (BJ) and the Tripot Joint (TJ).

CV joint boots protect CV joints by maintaining proper lubrication and preventing contaminants from entering joint. Boots must be replaced when signs of leakage or cracks are present. Inner CV joint may be disassembled and serviced. Outer CV joint boot may be replaced, but outer Birfield CV joint must NOT be disassembled. It must be replaced as an assembly, if faulty.

To prevent torsional vibration and torque steer on turbocharged Capri vehicles, an intermediate shaft and conventional axle shaft are used on the right side. Both shafts are of similar length and are supported by a bearing, which is attached to engine.

CV JOINT IDENTIFICATION

Application	Joint Type
Outer Joint	Birfield (BJ)
Inner Joint	
Automatic Transaxle	Tripot (TJ)
Manual Transaxle	Rzeppa (DOJ)

TROUBLE SHOOTING

NOTE: See TROUBLE SHOOTING - BASIC PROCEDURES article in GENERAL INFORMATION.

REMOVAL, DISASSEMBLY, REASSEMBLY & INSTALLATION

FWD AXLE SHAFTS

Removal

1. Raise and support vehicle. Remove lower underbody splash shields. Drain transaxle fluid. Remove front wheels and loosen axle shaft lock nut. On Capri, remove stabilizer bar-to-control arm attaching nuts, bolt, washers and bushings. On Festiva, remove stabilizer bar attaching nuts and bracket. On all models, remove joint clamp bolt from lower control arm. Pry downward and separate steering knuckle from ball joint, taking care not to damage ball joint dust boot.
2. On Capri turbo, remove bolts securing intermediate shaft bearing bracket to engine. On all models, slowly pry axle shaft from transaxle using a flat-tip screwdriver or pry bar. Axle is held into transaxle by a circlip fitted to the end of the axle. Remove axle shaft from wheel hub. If difficult to remove, use axle puller to remove axle from drive hub. Remove axle shaft from transaxle. Plug transaxle openings with Plugs (T87C-7025-C). Remove axle shaft assembly from vehicle. See [Fig. 1](#) .

CAUTION: Damage to CV joint will occur if a hammer is used to separate half-shaft from wheel hub.

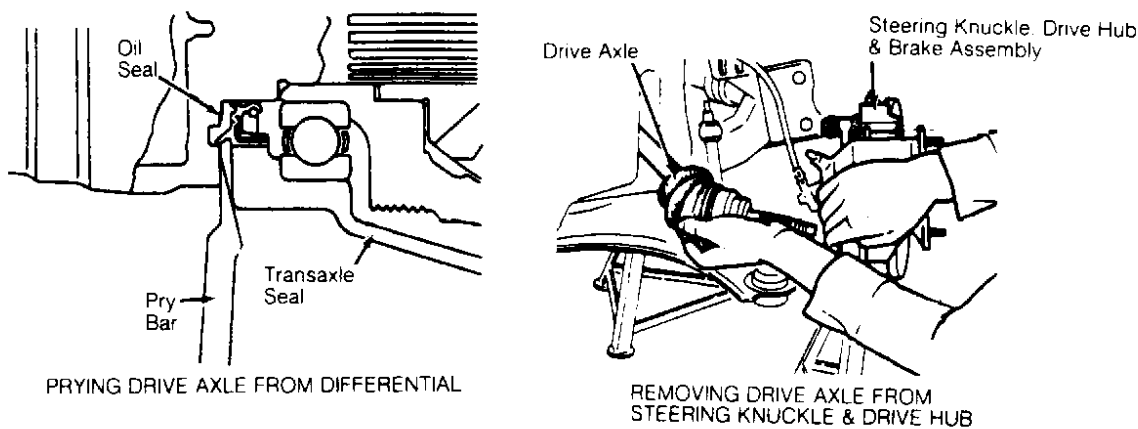


Fig. 1: Removing & Installing Axle Shafts
Courtesy of FORD MOTOR CO.

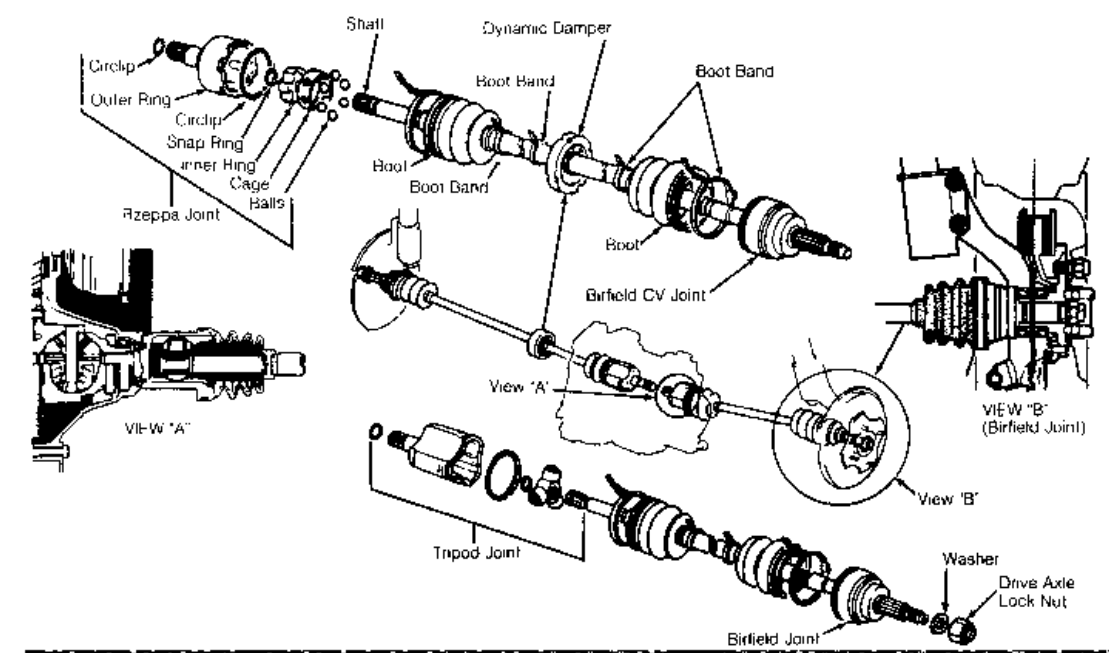


Fig. 2: Exploded View Of Axle Shafts & CV Joints
Courtesy of FORD MOTOR CO.

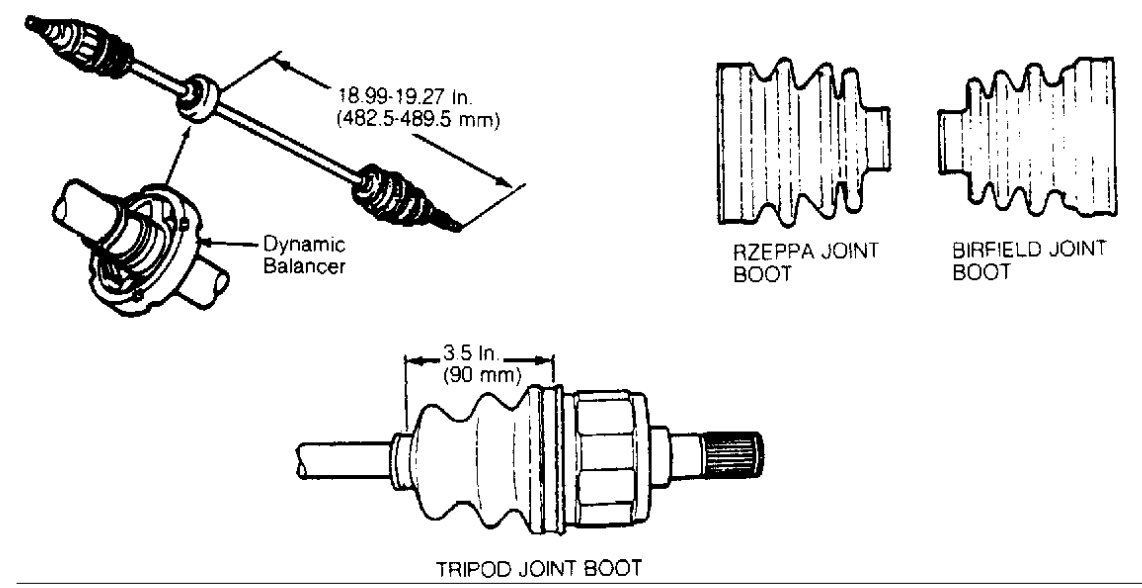


Fig. 3: Measuring & Identifying Axle Shafts & CV Boots
Courtesy of FORD MOTOR CO.

Disassembly (Rzeppa/DOJ Type)

- 1. Label and remove CV joint boot. Mark alignment of axle shaft to outer race of CV joint. Remove circlip and outer bearing race housing. Mark alignment of inner race to shaft. Remove inner snap ring. Remove cage assembly. See Fig. 2 .
- 2. Pry ball bearings from bearing cage. Mark alignment of bearing cage to inner race. Rotate inner race about 30 degrees and remove from cage assembly. If necessary, remove remaining boot.

NOTE: Check old grease for contamination by rubbing between two fingers. Any gritty feeling indicates contaminated CV joint. If joint is contaminated disassemble, clean, and inspect thoroughly.

Reassembly (Rzeppa/DOJ Type)

- 1. Apply Grease (E43Z-19590-A) to all areas of CV joint during reassembly. Reverse disassembly procedure for reassembly, noting alignment marks made during disassembly. Ensure chamfer on bearing cage faces snap ring. Lubricate outer race housing with 1.4-2.1 ounces (40-60 g) of grease.
- 2. Install right side dynamic damper at a distance of 18.99-19.27" (482.5-489.5 mm) from outboard end of axle shaft. Installed length of CV boot should be 3.5" (90 mm). See Fig. 3 .

Disassembly (Tripot Type)

Remove boot clamp and boot. Paint an alignment mark of axle shaft to outer race of CV joint. Remove circlip and outer bearing race housing. Mark alignment of inner race to shaft. Remove snap ring and remove tripot assembly using a soft brass drift and hammer. See Fig. 2 .

Reassembly (Tripot Type)

Apply Grease (E43Z-19590-A) to all areas of CV joint during reassembly. Reverse removal procedure, noting alignment marks made during disassembly. Ensure chamfer on bearing cage faces snap ring. Lubricate outer race housing with 3.5 ounces (100 g) of grease. Installed length of CV boot should be 3.5" (90 mm).

NOTE: Always install NEW cotter pin, washer and suspension lock nuts.

Installation (All)

1.

To install axle shaft, reverse removal procedure. Always install a NEW retaining circlip. Check seals at both ends of axle shaft. If necessary, replace seals prior to installation. Lubricate transaxle seal lip with transaxle oil. See [Fig. 1](#) .
2.

After installing axle shaft into transaxle, pull axle shaft outward by hand to ensure proper engagement of retaining circlip and snap ring. Install axle shaft into wheel hub. Align suspension alignment marks and tighten nuts.

INTERMEDIATE SHAFT

Removal

Intermediate shaft and axle shaft are removed as an assembly. See [FWD AXLE SHAFTS](#) under REMOVAL, DISASSEMBLY, REASSEMBLY & INSTALLATION.

Disassembly

Separate intermediate shaft from axle shaft. Remove circlip from intermediate shaft and press off bearing and bracket assembly. See [Fig. 4](#) . Press bearing out of bracket. Inspect bracket for damage or wear and replace if necessary.

Reassembly

Press NEW bearing into bracket and install NEW seals. Install bearing and bracket assembly onto intermediate shaft. Install NEW circlip. Assemble intermediate shaft to axle shaft.

Installation

Intermediate shaft and axle shaft are installed as an assembly. See [FWD AXLE SHAFTS](#) under REMOVAL, DISASSEMBLY, REASSEMBLY & INSTALLATION.

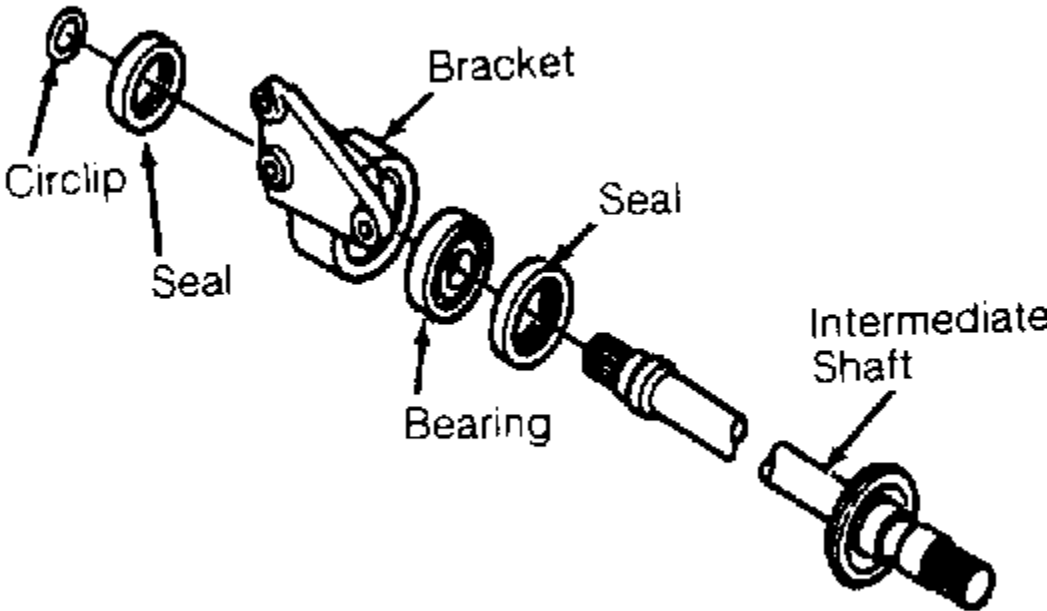


Fig. 4: Exploded View Of Intermediate Shaft
Courtesy of FORD MOTOR CO.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Axle Nut (1)	116-173 (157-235)
Ball Joint Pinch Bolt	32-40 (43-54)
Steering Knuckle-To-Strut Bolt	69-86 (93-117)
Caliper Retaining Bolt	29-36 (39-49)
Stabilizer Bar Bracket Nut	40-50 (54-68)
Stabilizer Link Bolt	9-13 (12-18)
Tie Rod End Nut	21-32 (29-44)
Wheel Lug Nuts	66-89 (90-120)
(1) Ensure locking flange on nut is staked into axle slot.	

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ALTERNATOR & REGULATOR

1991 ELECTRICAL Alternators & Regulators

DESCRIPTION

Mitsubishi alternator is a 50-amp, conventional 3-phase, self-rectifying type unit, containing 6 diodes (3 main diodes and a smaller diode trio) and a case-mounted Integrated Circuit (IC) regulator. A charge indicator light in the instrument panel indicates charging system malfunctions. See [Fig. 1](#) .

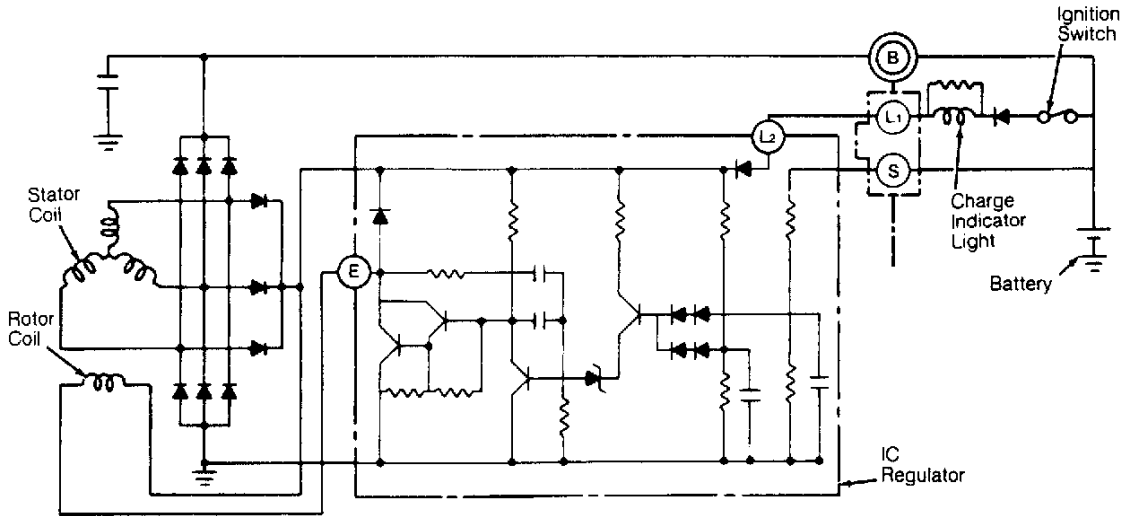


Fig. 1: Charging System Wiring Schematic
Courtesy of FORD MOTOR CO.

ADJUSTMENTS

BELT TENSION

BELT ADJUSTMENTS [\(1\)](#)

Application	New Belt	Used Belt
A/C & P/S Belts	110-125 (50-57)	92-110 (42-50)
Alt. Belt	110-130 (50-60)	95-110 (43-50)
(1) Tension in Lbs. (Kg) Using Strand Tension Gauge		

ON-VEHICLE TESTING

NOTE: Before testing, check alternator wiring harness connections, drive belt tension and battery voltage. Ensure battery cables and engine ground cable are clean and tight. Wait at least 30 seconds after starting engine before measuring voltage.

ALTERNATOR OUTPUT

CAUTION: DO NOT start engine with "L" and "S" terminal connectors disconnected from alternator. DO NOT allow "L" terminal to contact ground while engine is running. See [Fig. 2](#) .

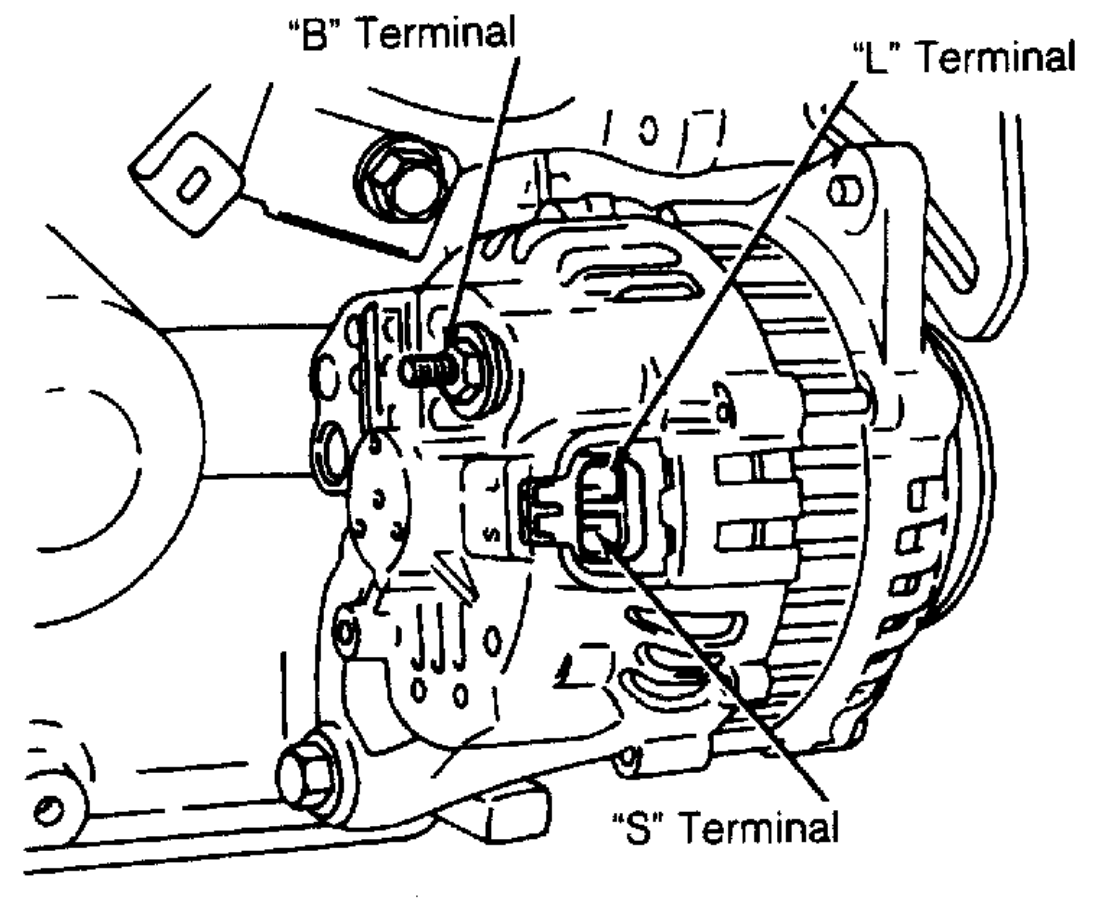


Fig. 2: Identifying Alternator Test Terminals

Courtesy of FORD MOTOR CO.

1. Turn ignition switch to OFF position. Connect positive voltmeter lead wire to alternator "B" terminal and negative wire to ground. See [Fig. 2](#) . Ensure voltmeter indicates battery voltage. If voltmeter indicates zero volts, an open circuit exists in wire between "B" terminal and battery positive terminal.
2. Remove voltmeter. Disconnect negative battery cable. Remove output lead from alternator terminal "B". Connect a 100-amp ammeter in series between "B" terminal and disconnected output lead. Connect positive lead of ammeter to "B" terminal and negative lead to disconnected output wire.
3. Connect voltmeter in parallel between alternator "B" terminal and battery positive terminal. Connect positive lead wire of voltmeter to "B" terminal and negative lead wire to positive terminal of battery. Reconnect negative battery cable.
4. Install tachometer (if necessary) to monitor engine RPM. Start engine. Turn all lights and accessories on and depress brake pedal to load system. Increase engine speed to 2500-3000 RPM. Ensure alternator output is at least 35 amps.
5. Observe voltmeter reading. If voltmeter indicates .2 volt and amperage output is at least 35 amps, system is okay. If voltage drop is greater than .2 volt, wiring is defective between alternator "B" terminal and battery positive terminal.
6. Allow engine to idle. Turn off all accessories to remove load from system. Disconnect voltmeter. Connect negative lead of voltmeter to ground. Using positive lead of voltmeter, backprobe "S" terminal connector at rear of alternator. See [Fig. 2](#) .
7. Increase engine speed to 2500-3000 RPM. With no load on system, ammeter should read 5 amps or more. Battery voltage with no load at indicated speed should be 14.1-14.7 volts. If amperage output is less than indicated with or without load and no external faults exist in alternator circuit, overhaul or replace alternator.

BENCH TESTING

Rotor

Check continuity across rotor slip rings. If no continuity exists, replace rotor. Check continuity between individual slip rings and rotor core/shaft. If continuity exists, rotor coil or slip ring is grounded. Replace rotor.

Stator

Ensure no continuity exists between stator coil leads and stator core. Check continuity between leads of stator coil. If continuity does not exist, replace stator.

Brushes

Inspect brushes. Replace brushes if worn to wear line (leading edge of small square cast into brush). Use a spring pressure gauge to push each NEW brush into its holder until .079" (2 mm) projects from holder. Spring force should be 10.6-15.6 oz. (.3-.4 kg). If spring force is not within specification, replace brush spring.

Rectifier

1. Using an ohmmeter, check for continuity between positive side of diode leads and heat sink. If no continuity exists from any positive diode lead to heat sink, replace rectifier assembly.
2. Reverse ohmmeter leads, and check for continuity between negative side of diodes and heat sink. If continuity exists from any negative diode lead to heat sink, replace rectifier assembly.
3. Check diode trio (smaller diodes between main diode leads) for continuity in both directions. Continuity should exist in one direction only. If any diode shows continuity in both directions or does not show continuity in either direction, replace diode trio.

TROUBLE SHOOTING

NOTE: See TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

OVERHAUL

NOTE: For exploded view of alternator, see [Fig. 3](#) .

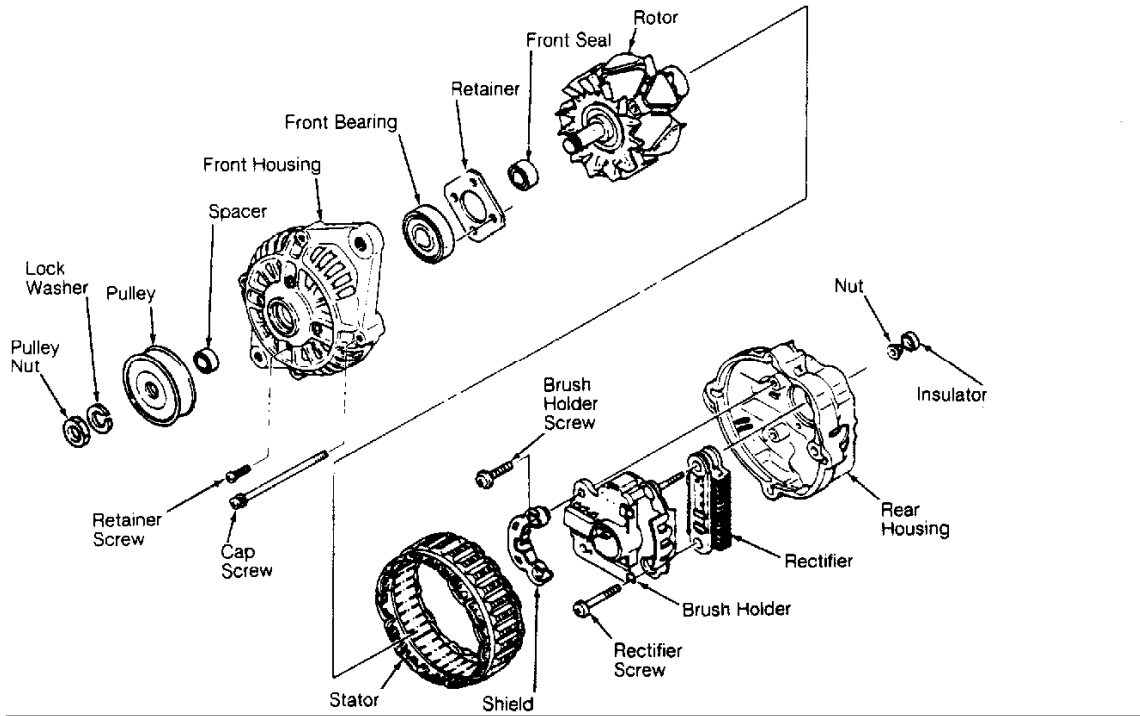


Fig. 3: Exploded View of Mitsubishi Alternator
Courtesy of FORD MOTOR CO.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Alternator Adjustment Bolt	14-18 (19-25)
Alternator Mount Bolt	27-38 (37-52)
Idler Pulley Attaching Nut	23-34 (31-46)
Power Steering Pump Adjustment Lock Nut	27-38 (37-52)
Power Steering Pump Mounting Bolt	27-40 (37-54)

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ELECTRICAL COMPONENT LOCATOR

1991-92 ELECTRICAL COMPONENT LOCATION Ford Motor Co. Electrical Components

BUZZERS, RELAYS & TIMERS

BUZZERS, RELAYS & TIMERS LOCATION

Component	Location
A/C Clutch Relay (1991)	On right front of engine bay, near power steering pump.
A/C Relay	On left front corner of engine bay, left of cooling fan. See Fig. 1 & Fig. 2
A/C Wide Open Throttle (WAC) Relay	On left front corner of engine bay, left of cooling fan. See Fig. 1 & Fig. 2 .
Cooling Fan Relay	On left front fender panel, near headlight. See Fig. 1 & Fig. 2 .
Condenser Fan Relay	On left front of engine bay, left of cooling fan. See Fig. 1 & Fig. 2 .
Daytime Running Light (DRL) Relay (Canada) (1992)	On left front corner of engine bay, near headlight. See Fig. 1 .
Fuel Pump Relay	Behind left side of dash, near ECA.
Headlight Relay	Behind left headlight. See Fig. 1 .
Horn Relay	Under left side of dash. See Fig. 3 .
Main Relay	In left front corner of engine bay, near battery.
Parking Light Relay	On right front corner of engine bay. See Fig. 1 .
Turn Signal/Flasher Relay	Under left side of dash, behind ECA. See Fig. 3 .

CIRCUIT PROTECTION DEVICES

CIRCUIT PROTECTION DEVICES LOCATION

Component	Location
A/C In-Line Fuse	On left side of heater case.
Condenser Fan In-Line Fuse	On right side of steering column.
Fuse Panel	Behind access panel, to left of steering column.
Fusible Links	On left front strut tower. See Fig. 1 .

CONTROL UNITS

CONTROL UNITS LOCATION

Component	Location
Electronic Control Assembly (ECA)	Behind left side of dash, left of steering column.
Passive Restraint Module	Under driver's seat.

SENDING UNITS & SENSORS

SENDING UNITS & SENSORS LOCATION

Component	Location
Airflow Meter	On right front corner of engine bay. See Fig. 1 .
Coolant Temperature Sending Unit	Below thermostat housing.
Crankshaft Position Sensor	Inside distributor. See Fig. 1 .
EGR Temperature Sensor (1991)	In exhaust manifold, near EGR valve.
Engine Coolant Temperature (ECT) Sensor	On top of engine, near injector No. 1.
Fuel Gauge Sending Unit (1992)	In fuel tank.
Throttle Position Sensor (TPS)	On left side of throttle body. See Fig. 1 .

MOTORS

MOTORS LOCATION

Component	Location
Blower Motor	Under center of dash, behind radio.
Windshield Washer Motors:	
Front (1991)	On right front fender panel, bottom of washer reservoir.
Front (1992)	On left front corner of engine bay, in front of battery.
Rear	On body panel, behind right rear quarter panel.
Windshield Wiper Motor	

Front	On left rear corner of engine bay, on firewall. See Fig. 1 .
Rear	In liftgate, behind trim panel.

SOLENOIDS & SOLENOID VALVES

SOLENOIDS & SOLENOID VALVES LOCATION

Component	Location
Canister Purge Solenoid	On center of firewall, to right of wiper motor. See Fig. 1 .
Idle-Up Speed Control (ISC) Solenoid	On left rear of engine, left of injector No. 4.
Kickdown Solenoid Valve (A/T)	On lower right front corner of transaxle. See Fig. 1 .

SWITCHES

SWITCHES LOCATION

Component	Location
A/C Pressure Switch	On A/C line, near right front strut tower. See Fig. 1 .
A/C Thermostatic Switch (1992)	On bottom of evaporator housing, below glove box.
Back-Up Light Switch	Mounted on transaxle. See Fig. 1 .
Brake Fluid Level Switch	On brake fluid reservoir.
Brake On-Off Switch (1992)	On bracket, above brake pedal.
Clutch Interlock Switch	On bracket, above clutch pedal.
Cooling Fan Switch	In thermostat housing. See Fig. 1 .
Inertia Switch	In left rear quarter panel.
Kickdown Switch (A/T)	Mounted on accelerator pedal.
Neutral Safety Switch	On right rear side of transaxle.
Oil Pressure Switch	On rear center of engine block.
Parking Brake Switch	On base of parking brake lever.
Passive Restraint Limit Switch	At top of left & right "A" pillar.
Power Steering Pressure Switch	Mounted on power steering pump assembly.
Seat Belt Switch (1991)	On driver's seat belt buckle.
Stoplight Switch	On brake pedal lever.
Wide Open Throttle A/C Cut-Off (WAC) Switch (1991)	On left corner of engine bay, left of cooling fan.

MISCELLANEOUS

MISCELLANEOUS LOCATION

Component	Location
Blower Resistor	Near blower motor.
RPM Test Connector	On left rear of engine bay, next to ignition module. See Fig. 1 .

COMPONENT LOCATION GRAPHICS

NOTE: Figures may show multiple component locations. Refer to appropriate table for proper figure references.

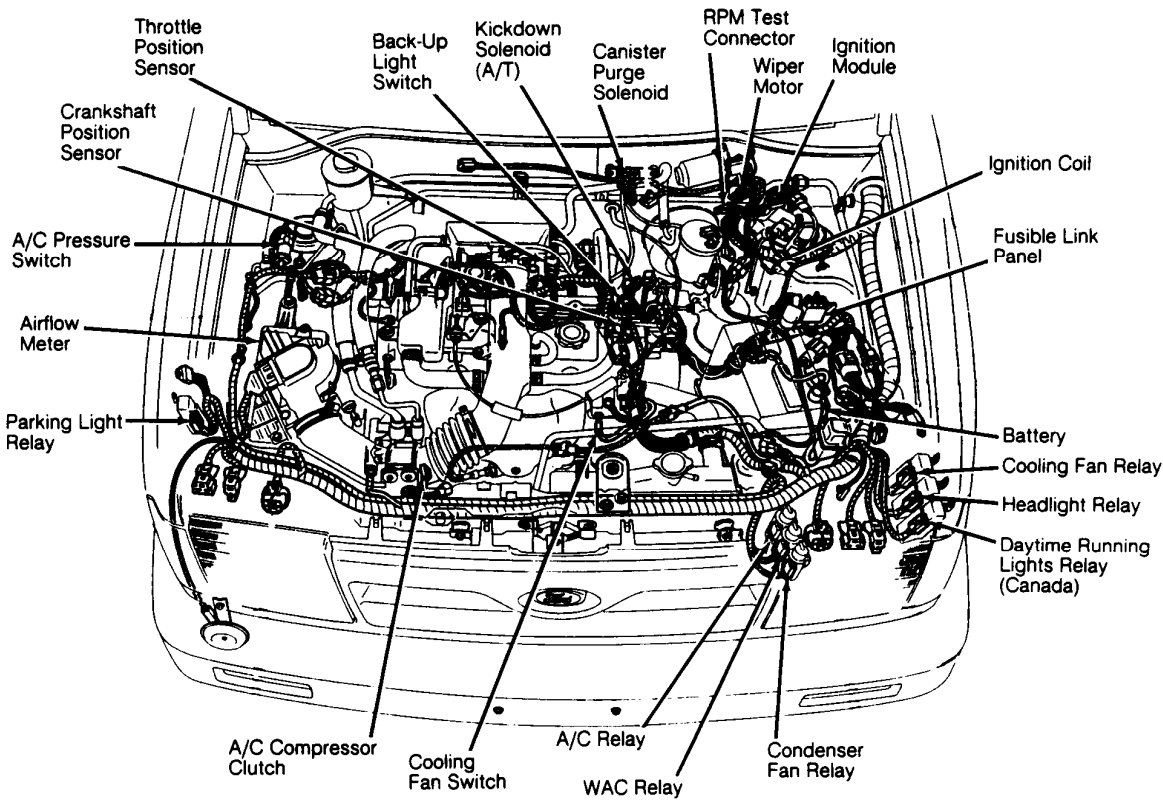


Fig. 1: Component Locations (1 Of 3)

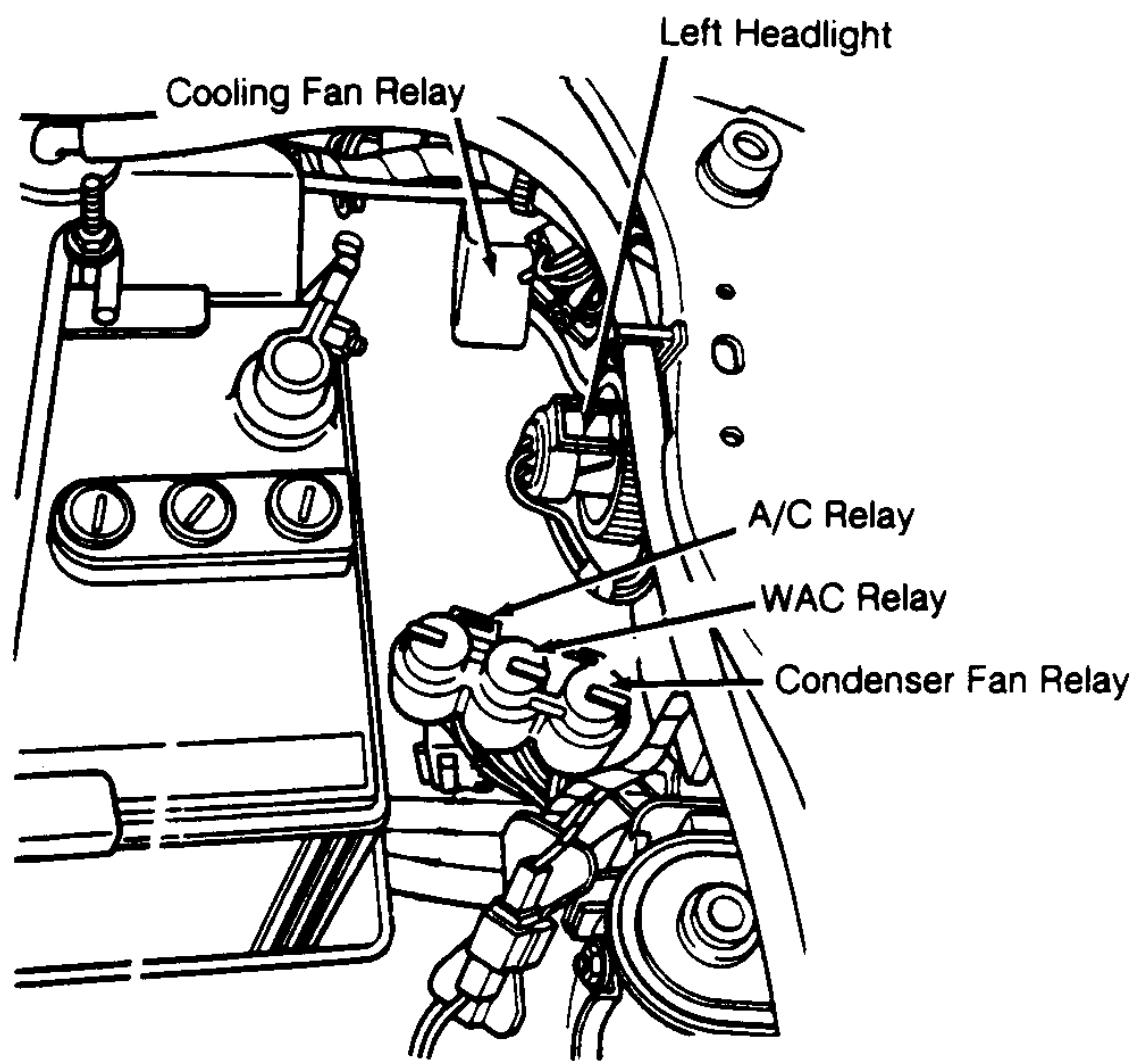


Fig. 2: Component Locations (2 Of 3)

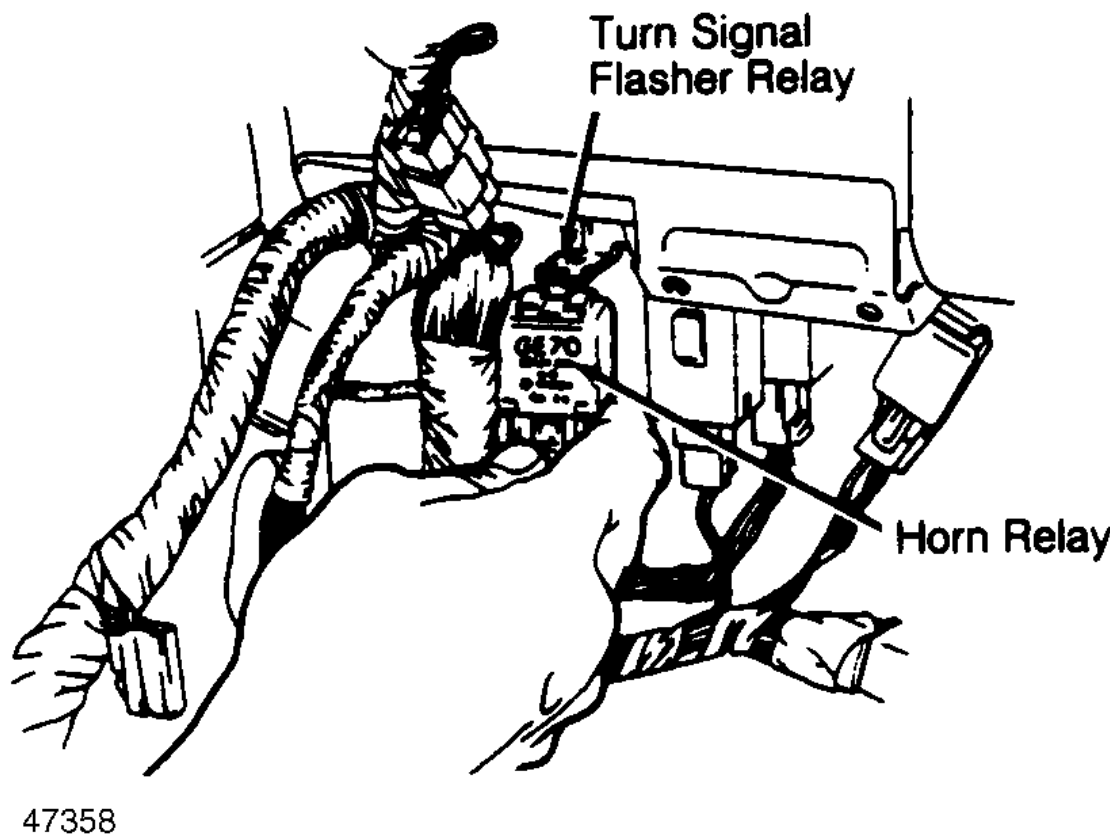


Fig. 3: Component Locations (3 Of 3)

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FUSES & CIRCUIT BREAKERS

Fuses & Circuit Breakers 1988-93 Festiva

FUSES & FUSIBLE LINKS

FUSE PANEL & FUSIBLE LINK BLOCK LOCATIONS

The vehicle has a fuse block with fusible links and a fuse panel with circuit fuses. The fuse panel is located behind the instrument panel, left of the steering column. The fuse block is located under the hood.

FUSE PANEL IDENTIFICATION

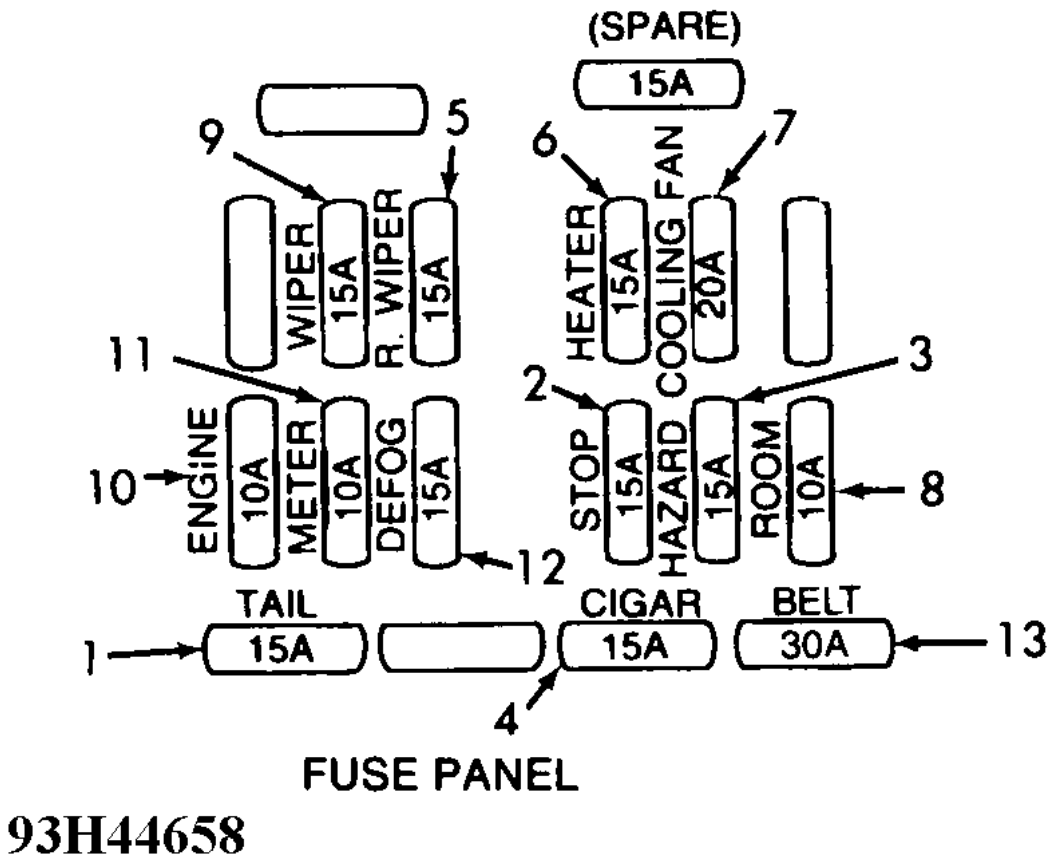


Fig. 1: Fuse Panel Identification
Courtesy of FORD MOTOR CO.

Fuse & Circuit Breaker Identification

- 1 - 15 Amp License Plate Light, Rear Side Marker Light, Front Parking Lights, Cluster and Tail Lights
- 2 - 15 Amp Horn, Brakelights, High-Mount Brakelight
- 3 - 15 Amp (1988-89) Safety Belt Warning, Turn & Hazard Warning Flasher Lights, Radio, Trunk Light, Ignition Key Reminder Buzzer
- 3 - 15 Amp (1990-93) Safety Belt Warning, Turn & Hazard Warning Flasher Lights, Ignition Key Reminder Buzzer
- 4 - 15 Amp Audio System, Cigarette Lighter, Remote Control Mirror
- 5 - 15 Amp Rear Wiper/Washer, Daytime Running Light System (Canada)
- 6 - 15 Amp Heater & Air Conditioner
- 7 - 20 Amp Heater & Air Conditioner, Cooling Fan System
- 8 - 10 Amp (1988-89) Interior Courtesy Lights 10 Amp (1990-93) Radio, Interior Courtesy Lights, Luggage Compartment Light
- 9 - 15 Amp (1988-89) Front Wiper/Washer
- 9 - 15 Amp (1990-93) Front Wiper/Washer, Shift-Lock System (ATX), Engine Control System
- 10 - 10 Amp Charging System, Emission Control System
- 11 - 10 Amp (1988-90) Safety Belt Warning, Turn & Hazard Warning Flasher Lights, Back-Up Lights, Instrument Cluster, Warning Lights,
- 11 - 10 Amp (1991-93) Safety Belt Warning, Turn & Hazard Warning Flasher Lights, Back-Up Lights, Instrument Cluster, Warning Lights, Shift-Lock System
- 12 - 15 Amp Rear Window Defroster
- 13 - Not Used (1988-89) Spare
- 13 - 30 Amp (1990-93) Passive Restraint System (Automatic Seat Belt)

In-Line Fuse Identification

- 15 Amp (1990-93) Condenser Fan Motor (A/T Models Only)
- 10 Amp (1990-93) A/C System (located on left side of heater case)

FUSIBLE LINK BLOCK IDENTIFICATION

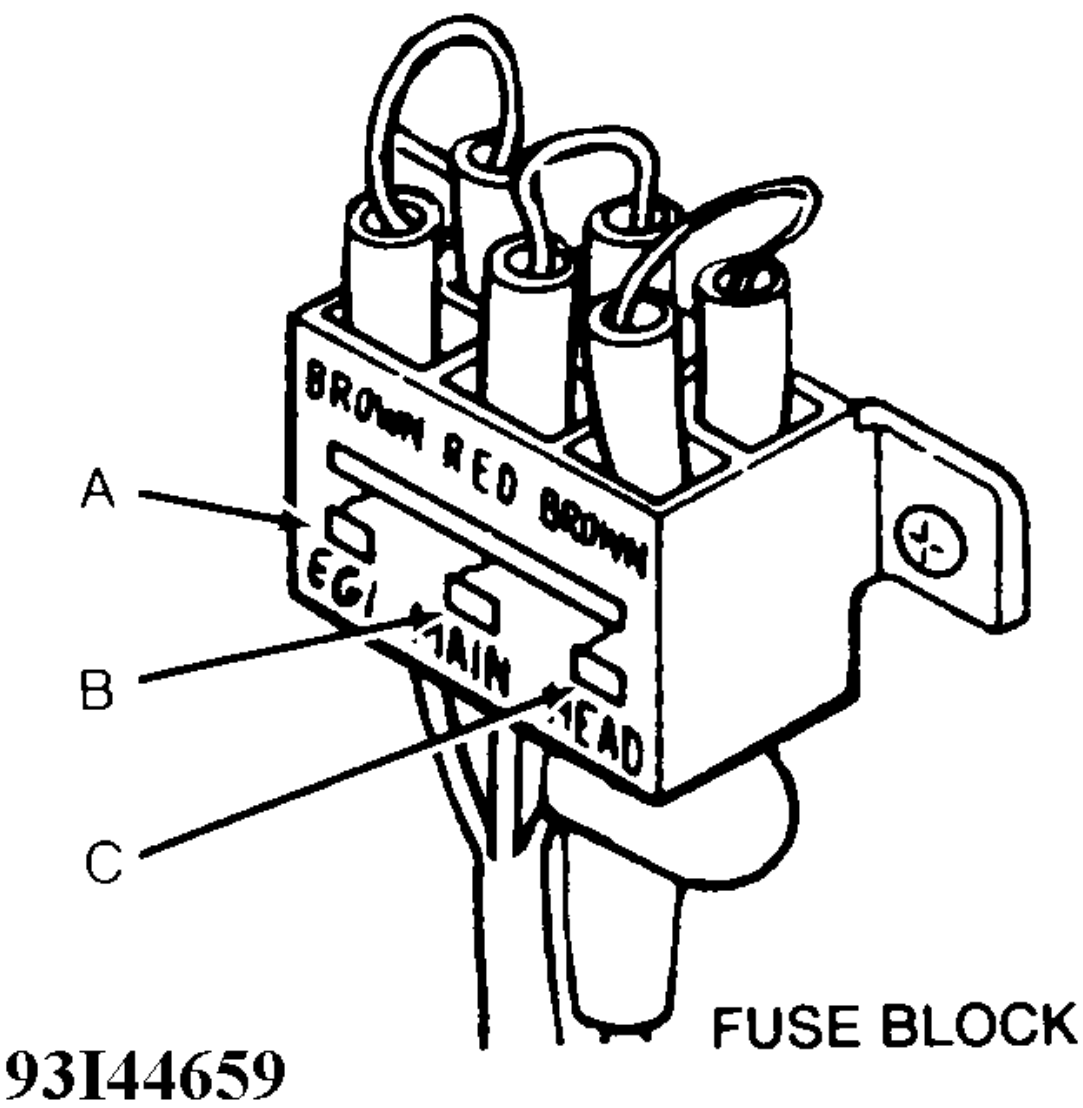


Fig. 2: Underhood Fusible Link Block Identification
Courtesy of FORD MOTOR CO.

Fusible Link Identification

- A - Brown (PTC) (1988-89 Carburetor) EFE Carburetor Heater
- A - Brown (EGI) (1989-93 EFI) EFI System (1989-92), EGI-EFI System (1993)
- B - Red (Main) Back-Up, Interior & Parking Lights, Brakelights, Taillights, Horn, Luggage Compartment Light, Turn Signal & Hazard Flasher Lights, Cluster & Warning Lights, Radio, Cigarette Lighter, Charging & Emission Control Systems, Wiper/Washer Systems, A/C-Heater System, Cooling Fan System, Rear Window Defroster, Ignition & Starting Systems, Shift Lock System, Remote Control Mirror, Ignition Key Reminder, Passive Restraint System (1990-93)
- C - Brown (Head) Headlights, Daytime Running Lights, Starting & Charging System

BATTERY SPECIFICATIONS

CAUTION: When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See [COMPUTER RELEARN PROCEDURES](#) article in the GENERAL INFORMATION section.

All 1988-92 models use a BX-35 battery. The 1993 Festiva uses a 50D 20L standard battery.

CAUTIONS & WARNINGS

BATTERY WARNING

WARNING: When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See [COMPUTER RELEARN PROCEDURES](#) article in GENERAL INFORMATION section.

REPLACING BLOWN FUSES

Before replacing a blown fuse, remove ignition key, turn off all lights and accessories to avoid damaging the electrical system. Be sure to use fuse with the correct indicated amperage rating. The use of an incorrect amperage rating fuse may result in a dangerous electrical system overload.

BRAKE PAD WEAR INDICATOR

Indicator will cause a squealing or scraping noise, warning that brake pads need replacement.

CATALYTIC CONVERTER

Continued operation of vehicle with a severe malfunction could cause converter to overheat, resulting in possible damage to converter and vehicle.

Any modification to the exhaust system on turbo models, which reduces exhaust backpressure, will lead to lean fuel mixtures and excessive spark advance. This could cause serious engine damage.

ELECTROSTATIC DISCHARGE SENSITIVE (ESD) PARTS

WARNING: Many solid state electrical components can be damaged by static electricity (ESD). Some will display a warning label, but many will not. Discharge personal static electricity by touching a metal ground point on the vehicle prior to servicing any ESD sensitive component.

ENGINE OIL

CAUTION: Never use non-detergent or straight mineral oil.

FUEL PUMP SHUTOFF SWITCH

This switch stops flow of fuel to engine after a collision. The impact does not have to be great for switch to be triggered. Switch must be reset after collision. Switch is located under left rear speaker in luggage compartment. Press button to reset switch.

FUEL SYSTEM SERVICE

WARNING: Relieve fuel system pressure prior to servicing any fuel system component (fuel injection models).

HALOGEN BULBS

WARNING: Halogen bulbs contain pressurized gas which may explode if overheated. DO NOT touch glass portion of bulb with bare hands. Eye protection should be worn when handling or working around halogen bulbs.

PASSIVE RESTRAINTS

CAUTION: Before operating vehicle, securely fasten passive shoulder restraints to the emergency release buckles. The buckle fits in only one way. Ensure to position it properly.

RADIATOR CAP

CAUTION: Always disconnect the fan motor when working near the radiator fan. The fan is temperature controlled and could start at any time even when the ignition key is in the OFF position. DO NOT loosen or remove radiator cap when cooling system is hot.

RADIATOR FAN

WARNING: Keep hands away from radiator fan. Fan is controlled by a thermostatic switch which may come on or run for up to 15 minutes even after engine is turned off.

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STARTER

1991 ELECTRICAL Starters

DESCRIPTION

The Nippondenso direct drive starter is a conventional 12-volt, 4-pole, brush-type starter. The integral solenoid is attached to the drive housing. When starter is energized, starter solenoid causes the starter pinion to engage with the flywheel ring gear. The overrunning clutch pinion drive is mounted directly on armature shaft drive end.

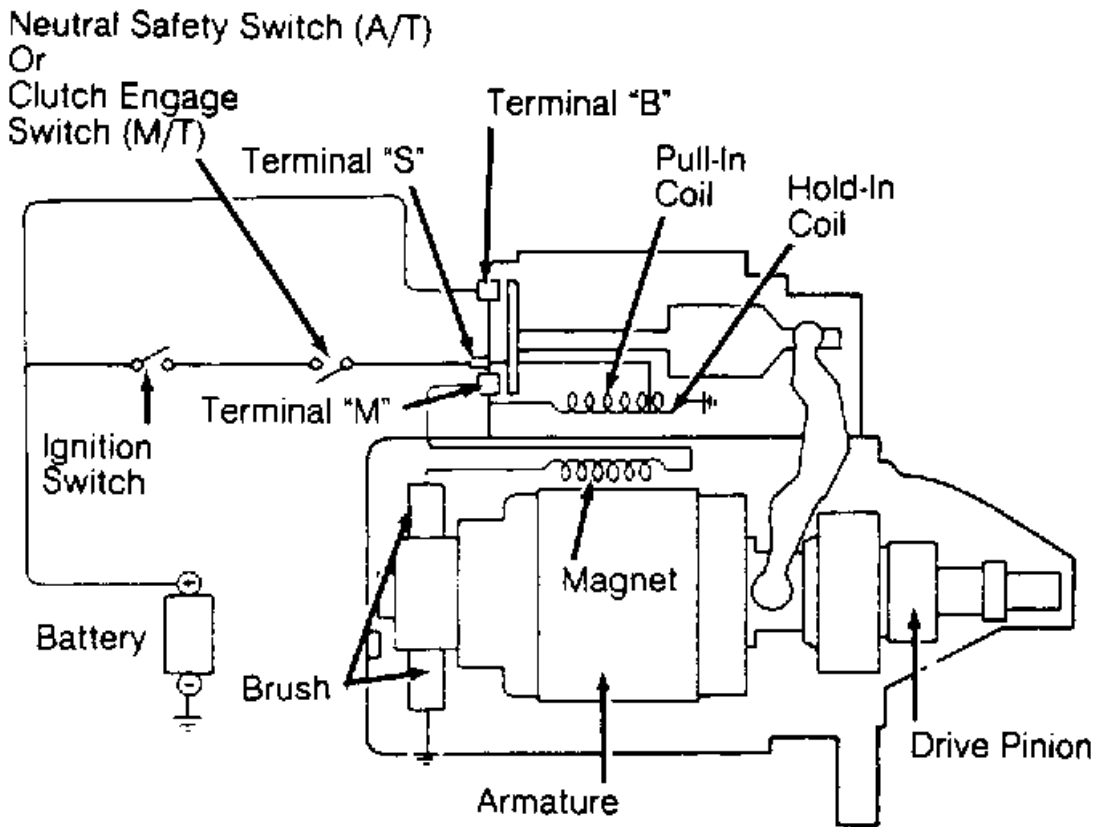


Fig. 1: Starter System Schematic
Courtesy of FORD MOTOR CO.

TROUBLE SHOOTING

ENGINE CRANKS SLOWLY

Undercharged battery. Loose or corroded cable connections. Bad starter.

ENGINE WILL NOT CRANK

Undercharged battery. Bad ignition switch. Bad clutch engage switch (M/T) or neutral safety switch (A/T). Loose or corroded cable connections. Bad starter. Faulty circuit grounds.

STARTER SPINS & ENGINE DOES NOT CRANK

Bad starter. Bad flywheel ring gear and/or starter drive pinion.

ENGINE STARTS WITH CLUTCH ENGAGED (M/T)

Bad clutch engage switch. Adjust or replace.

ENGINE STARTS IN GEAR (A/T)

Bad neutral safety switch. Adjust or replace.

ON-VEHICLE TESTING

PRELIMINARY TEST

Ensure battery is fully charged and has load tested okay. If starter will not crank engine with fully charged battery, proceed with the following test.

1. Using a digital voltmeter, connect positive voltmeter lead to starter solenoid terminal "S", and negative lead to starter housing. See [Fig. 1](#).
2. Turn ignition switch to START position, and observe voltmeter reading. If voltage at terminal "S" is greater than 8 volts, starter or circuit malfunction is indicated. See [VOLTAGE DROP TEST](#) and STARTER GROUND CIRCUIT TEST under ON-VEHICLE TESTING.

3. If voltage is not present or is less than 8 volts at starter solenoid terminal "S", malfunction in circuit to terminal "S" is indicated. Proceed to the following tests.

IGNITION SWITCH TEST

1. Locate ignition switch connector under dash. Using a 12-volt test light or voltmeter, ensure voltage is present on Black/Yellow wire when ignition switch is turned to RUN or ON position. This will verify proper operation of ignition switch.
2. If there is no voltage on Black/Yellow wire, the problem is either ignition switch or circuit between battery and ignition switch.

CLUTCH ENGAGE SWITCH (M/T) TEST

Unplug clutch engage switch from main wiring harness. Using an ohmmeter, check for continuity across switch terminals. Continuity should exist when switch plunger is pushed in and should not exist when switch plunger is released. If clutch engage switch does not operate as specified, replace switch.

NEUTRAL SAFETY SWITCH (A/T) TEST

Unplug neutral safety switch from main wiring harness. Using an ohmmeter, check for continuity across switch terminals "A" and "B". See [Fig. 2](#). Place transmission shift selector in Park or Neutral position. Continuity should exist between terminals "A" and "B". Continuity should not exist in any other transmission shift selector positions. If switch does not operate as specified, replace switch.

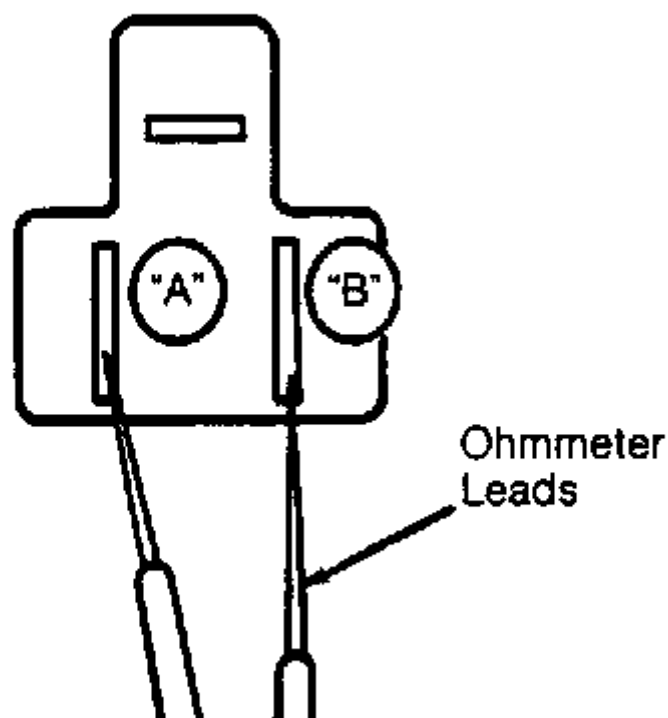


Fig. 2: Identifying Neutral Safety Switch Terminals

Courtesy of FORD MOTOR CO.

VOLTAGE DROP TEST

NOTE: Make all voltmeter connections at component terminal rather than at cable or wire end.

1. Disconnect and ground coil wire from distributor cap to prevent engine from starting. Connect remote starter switch between starter solenoid terminal "S" and battery positive terminal. See [Fig. 3](#).
2. Using a digital voltmeter set on low scale, connect positive voltmeter lead to battery positive terminal. Connect negative lead to starter solenoid terminal "M". See [Fig. 3](#).
3. Engage remote starter switch. Observe and record voltmeter reading. Voltmeter reading should be less than .5 volt. If voltage at terminal "M" is greater than .5 volt, move negative voltmeter lead to solenoid terminal "B", and repeat test.
4. If voltage at terminal "B" is less than .5 volt, inspect solenoid cable connections and solenoid contacts for problem.
5. Clean solenoid terminals "B", "M" and "S", and repeat steps 1) through 4). If voltmeter still reads greater than .5 volt at terminal "M" and less than .5 volt at terminal "B", solenoid contacts are bad.
6. If voltmeter reads greater than .5 volt at terminal "B", clean cables and connections at solenoid. If voltmeter still reads greater than .5 volt, check for poor positive battery cable connection or bad cable. Repair or replace as necessary.
7. To locate excessive voltage drop, move negative voltmeter lead toward battery, and check each connection point. When high voltmeter reading is no longer present, last connection point is bad.

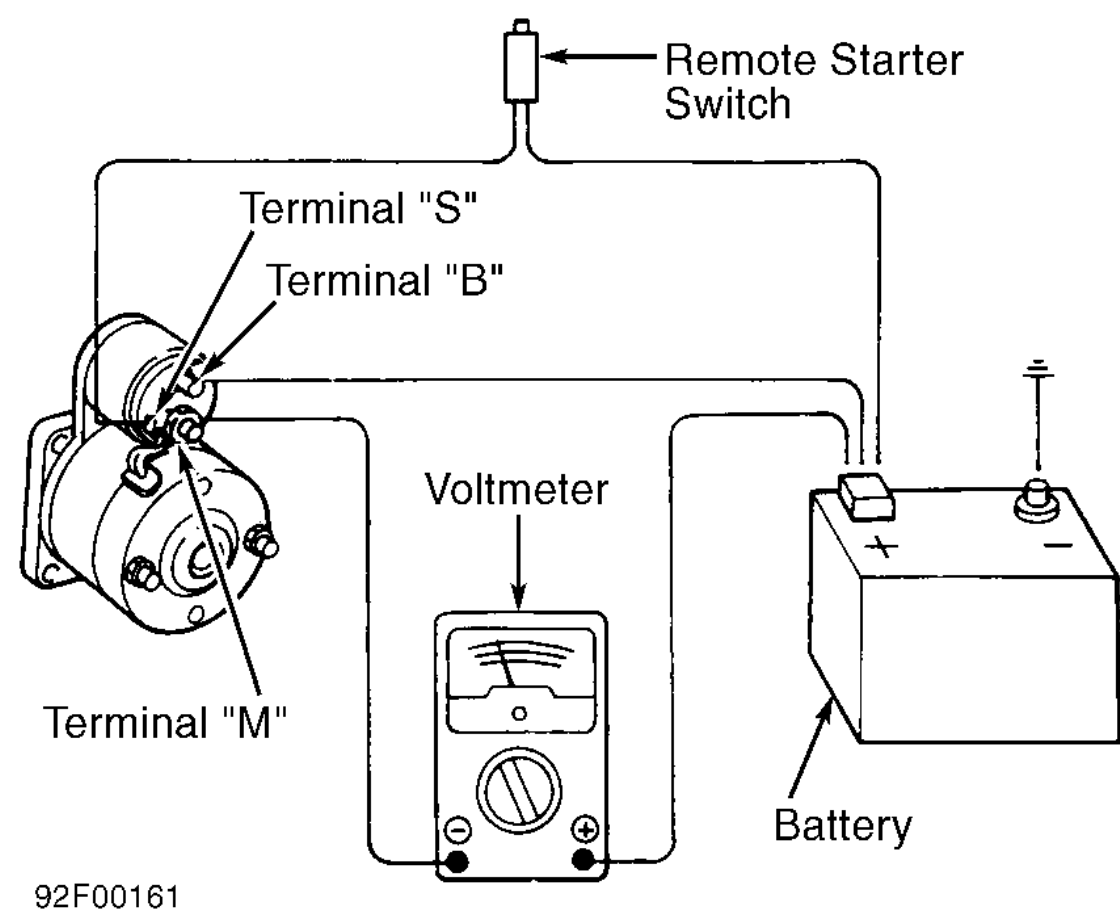


Fig. 3: Testing Voltage Drop
Courtesy of FORD MOTOR CO.

STARTER GROUND CIRCUIT TEST

- NOTE:** Make all voltmeter connections at component terminal rather than at cable or wire end.
1. Disconnect and ground coil wire from distributor cap to prevent engine from starting. Connect remote starter switch between starter solenoid terminal "S" and battery positive terminal. See [Fig. 1](#) .
 2. Using a digital voltmeter set on low scale, connect positive voltmeter to starter motor housing. Ensure connection point is clean and free of rust and grease. Connect negative voltmeter lead to negative battery terminal.
 3. Engage remote starter switch and crank engine. Observe and record voltmeter reading. Voltmeter should read .2 volt or less. If voltage drop is greater than .2 volt, clean negative battery cable connections at battery and body connections. Retest to ensure problem has been corrected.
 4. If voltage drop is still excessive, replace negative battery cable(s) as necessary. If battery cables test okay, and starter still cranks slowly or not at all, remove and repair starter motor.

BENCH TESTING

STARTER NO-LOAD TEST

Remove starter. Place starter on bench. Connect a fully charged 12-volt battery, voltmeter, ammeter and remote starter switch to starter. See [Fig. 4](#) . Engage remote starter switch. Starter should rotate smoothly. Ensure voltage and amperage draw is less than maximum specification at 5000 RPM minimum. See NO-LOAD TEST SPECIFICATIONS table. If voltage and/or amperage is higher than specifications, disassemble starter and determine cause.

NO-LOAD TEST SPECIFICATIONS

Application	Maximum Amps	Volts
Capri & Festiva	60	11.5

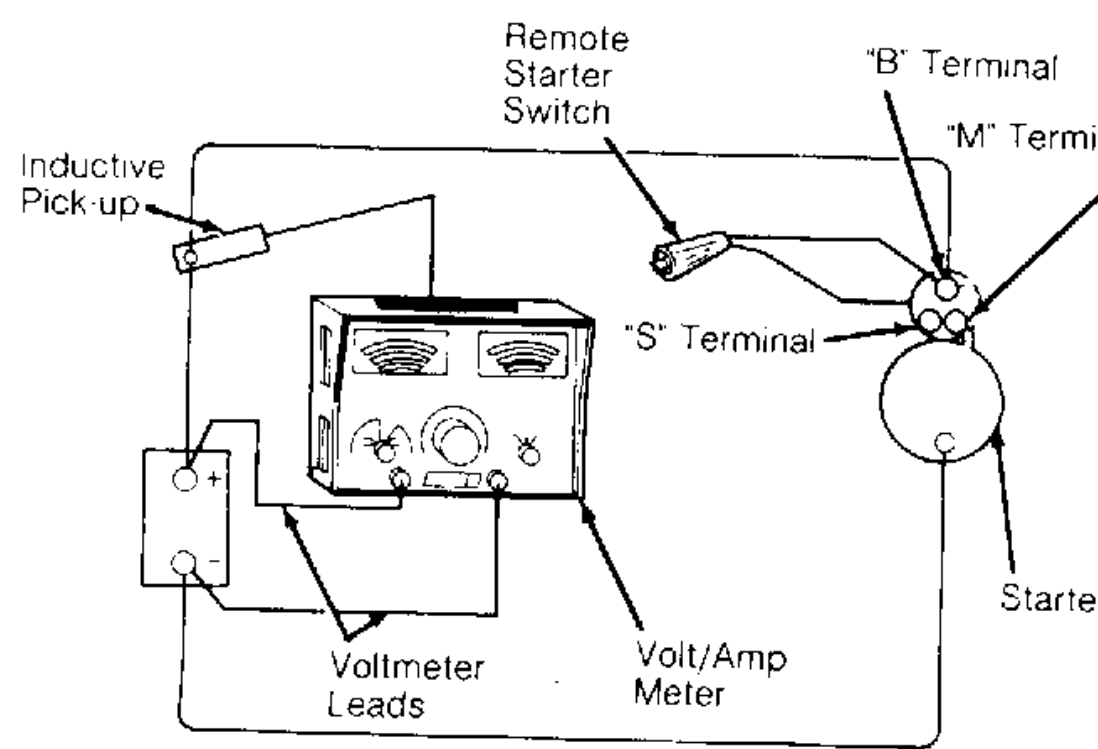


Fig. 4: Starter No-Load Test
Courtesy of FORD MOTOR CO.

PINION GAP ADJUSTMENT TEST

1. Disconnect field lead from terminal "M" of solenoid to prevent starter from turning. See [Fig. 5](#) . Connect jumper wire from a 12-volt battery positive terminal to terminal "S" of solenoid. Connect another jumper wire from negative battery terminal to terminal "M" of solenoid.
2. Solenoid should energize when battery is connected, kicking out drive pinion. With drive pinion extended, measure pinion gap between drive pinion and collar. Gap should be .020-.080" (.5-2.0 mm). See [Fig. 5](#) .

NOTE: **DO NOT engage solenoid for more than 10 seconds. If test must be repeated, wait at least 3 minutes between tests to allow solenoid to cool.**

3. Add or subtract shims between solenoid and end housing to achieve proper pinion depth gap. Install field lead to terminal "M" of solenoid. Install nut and tighten to 70-106 INCH lbs. (8-12 N.m).

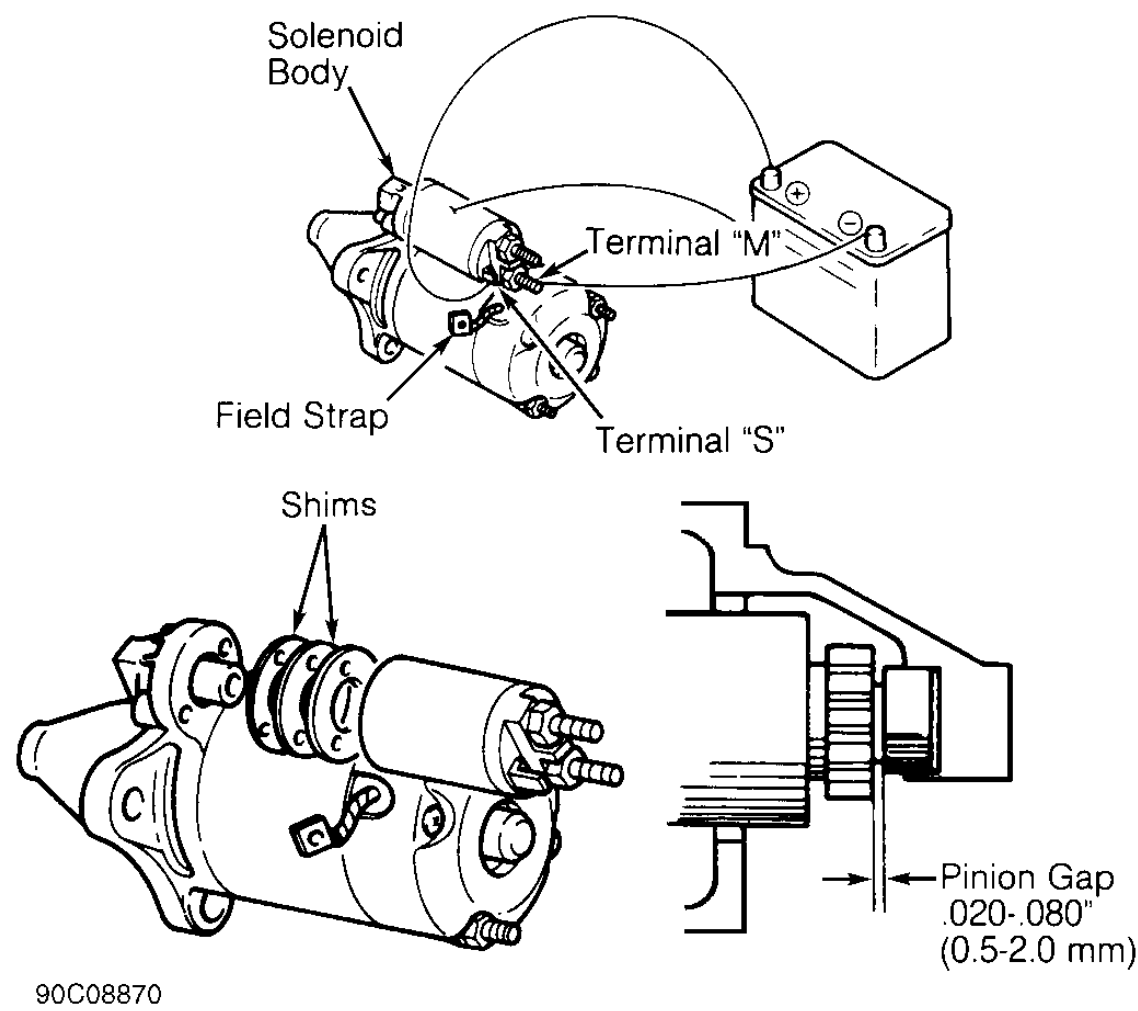


Fig. 5: Measuring Pinion Gap
Courtesy of FORD MOTOR CO.

SOLENOID TEST

Disconnect wiring and cables from solenoid. Using an ohmmeter, check for continuity between terminal "M" and body of starter solenoid. See [Fig. 1](#) . Continuity should exist. If continuity does not exist, replace solenoid.

ARMATURE TEST

1.

Place armature in growler. Turn on growler and hold a piece of hacksaw blade over armature. Slowly rotate armature. If hacksaw blade is attracted to core or if it vibrates, replace armature.
2.

Remove armature from growler. Using an ohmmeter, check continuity between commutator and core. If continuity exists, replace armature. Check continuity between commutator and shaft. If continuity exists, replace armature.
3.

Check continuity between each commutator segment. If an open exists between any 2 segments, replace armature.

COMMUTATOR TEST

1.

Clean surface of commutator and polish with No. 400 grit sandpaper (if required). If surface is scored, out of round or pitted, turn commutator on a lathe.
2.

Maximum commutator runout and minimum diameter of commutator must not exceed specification after turning. See [STARTER MOTOR SPECIFICATIONS](#) table.
3.

Commutator mica undercut depth should be .02-.03" (.5-.8 mm). If undercut depth is not within specification, undercut with a hacksaw blade to standard depth.

BRUSH & SPRING TEST

1.

Connect ohmmeter between positive brush holder and negative brush holder. If ohmmeter indicates continuity, brush holder assembly is shorted and must be replaced.
2.

Check brush length. See [STARTER MOTOR SPECIFICATIONS](#) table. If brush length is less than specification, replace brushes.
3.

Check spring tension. Spring tension should be 2.0-4.3 Lbs. (8.8-19.1 N.m). Ensure brushes move freely in holders.

FIELD COIL TEST

1.

Connect ohmmeter between field lead and soldered portion of brush lead. If continuity does not exist, repair or replace field coil.
2.

Check field coil for shorts to ground by connecting ohmmeter between field lead and starter housing. If continuity exists, repair or replace field coil.

OVERHAUL

NOTE: For exploded view of starter assembly, see [Fig. 6](#) .

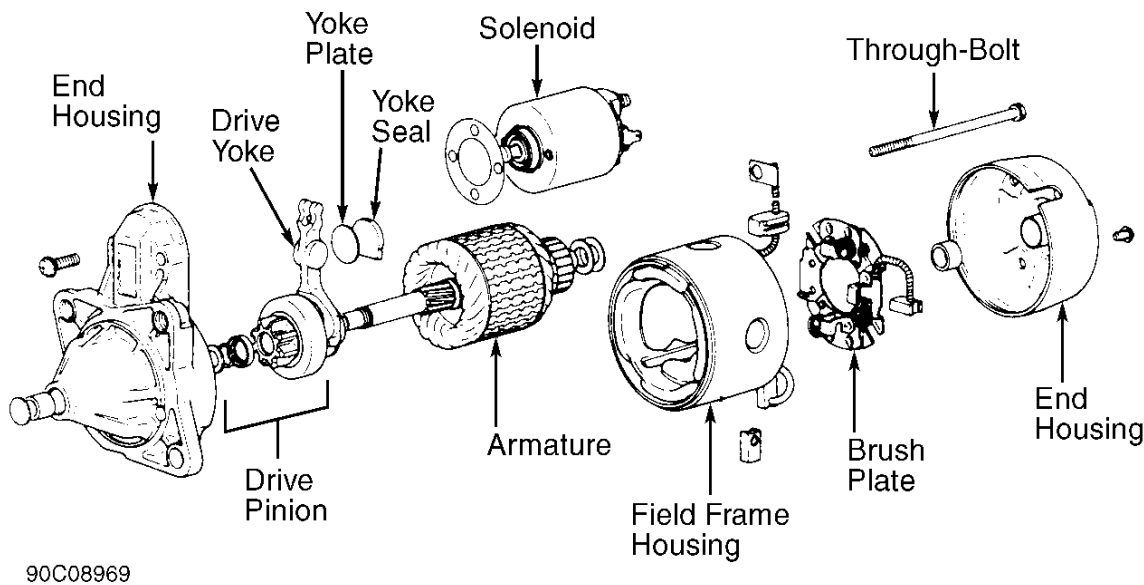


Fig. 6: Exploded View of Starter Motor Assembly
Courtesy of FORD MOTOR CO.

STARTER MOTOR SPECIFICATIONS

STARTER MOTOR SPECIFICATIONS	
Application	Specification
Brush Length	
Minimum	.45" (11.5 mm)
New	.67" (17 mm)
Brush Spring Force	2.0-4.3 Lbs. (8.8-19.1 N.m)
Commutator	
Runout	.002" (.05 mm)
Minimum Diameter	1.22" (31.0 mm)
Segment Depth	.02-.03" (.5-.8 mm)
Pinion Gap	.020-.080" (0.5-2.0

	mm)
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TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Starter Motor Mounting Bolts	23-34 (31-46)
	INCH Lbs. (N.m)
Solenoid Retaining Screws	36-67 (4.1-7.5)
Through Bolts	55-75 (6-8)
Terminal Nuts	71-106 (8-12)

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1991 System Wiring Diagrams

Ford - Festiva

COOLING FAN

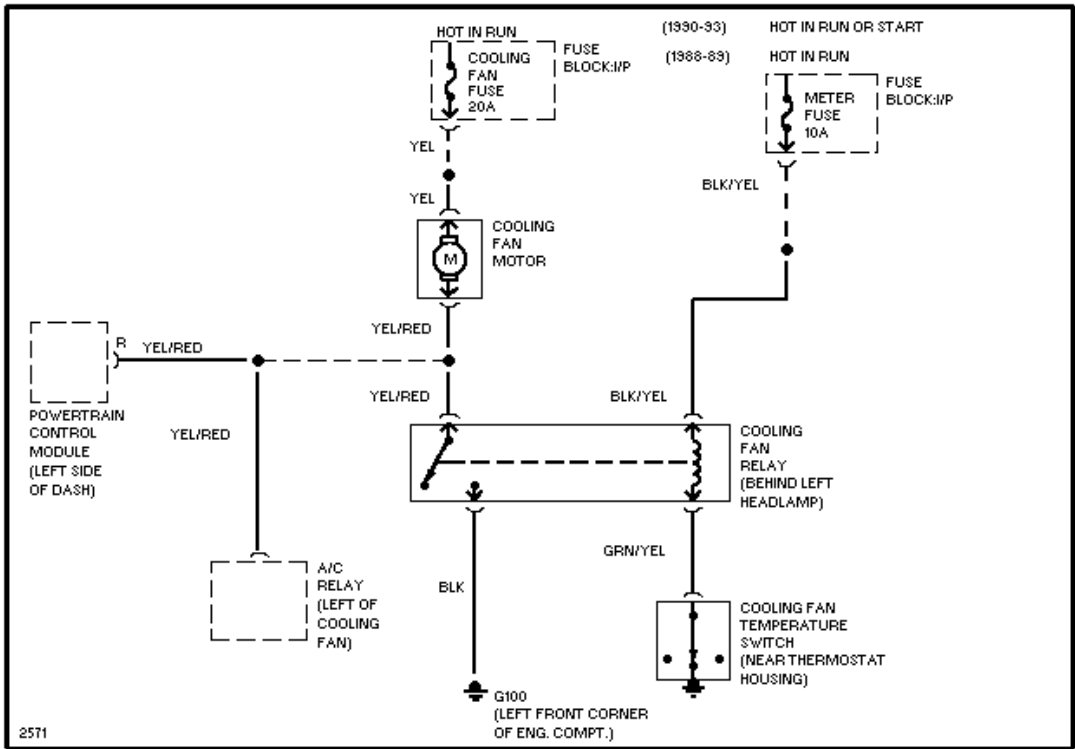


Fig. 1: Cooling Fan Circuit

DEFOGGERS

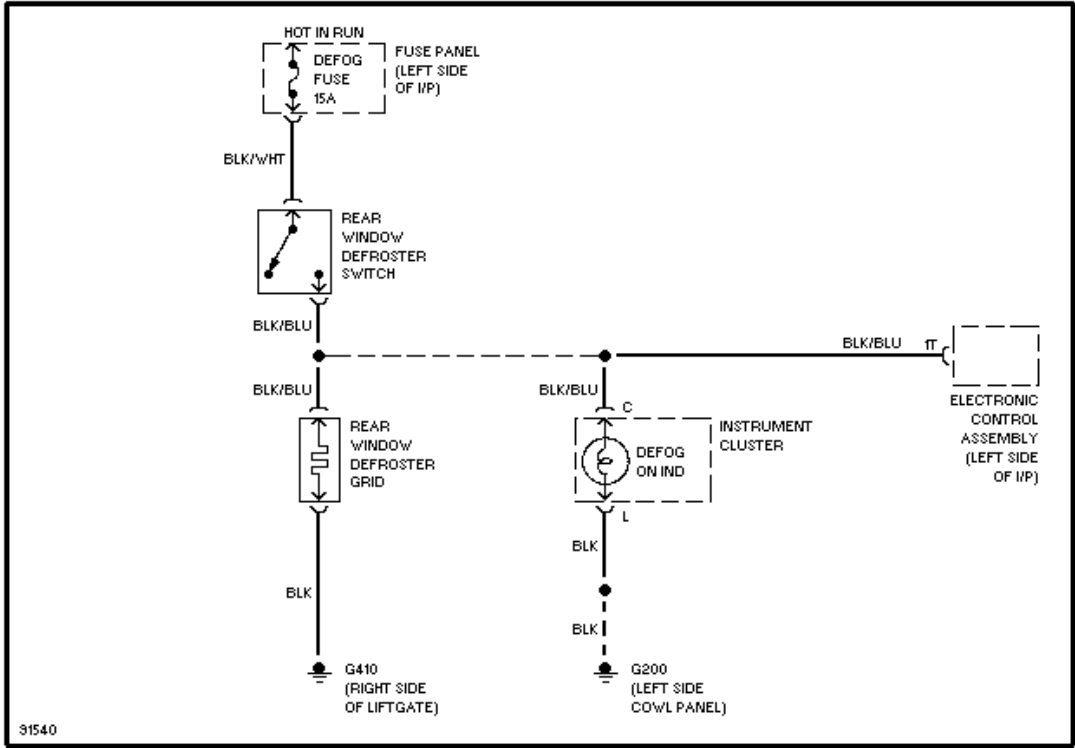


Fig. 2: Defogger Circuit

HORN

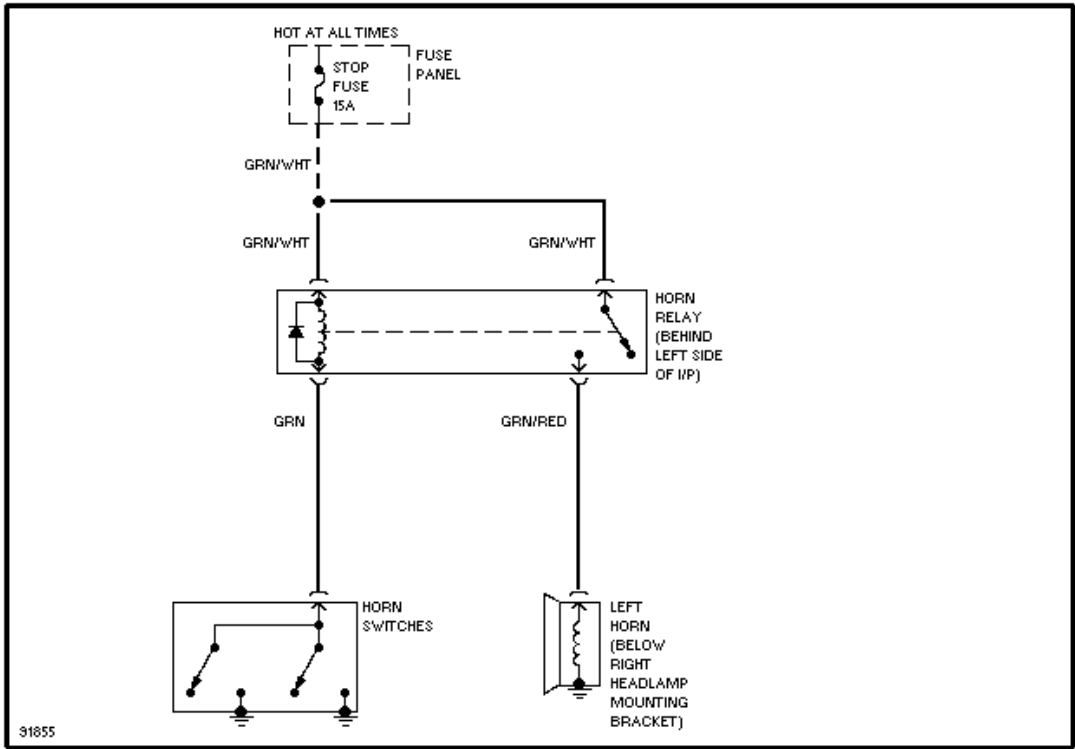


Fig. 3: Horn Circuit

POWER MIRRORS

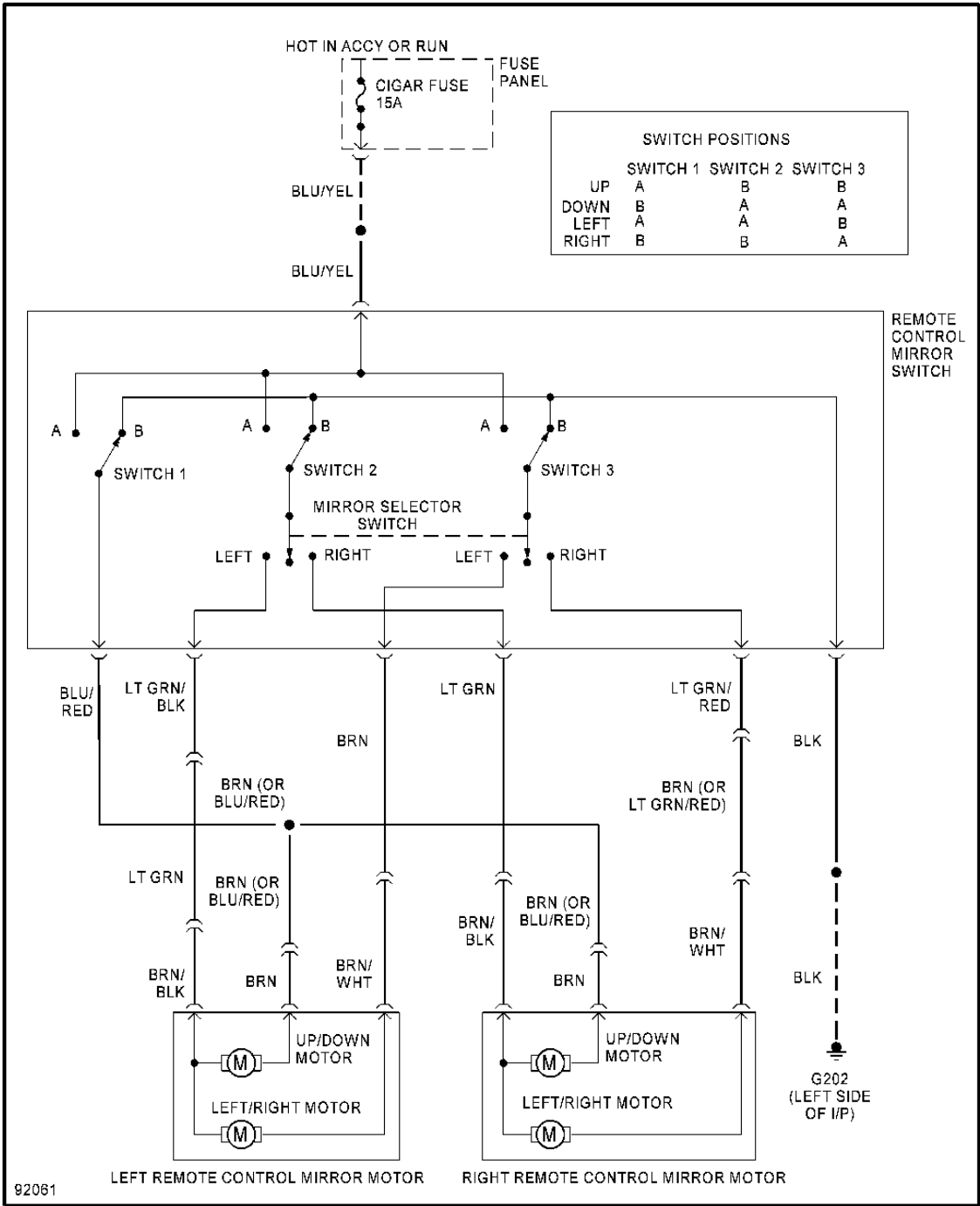


Fig. 4: Power Mirror Circuit

RADIO

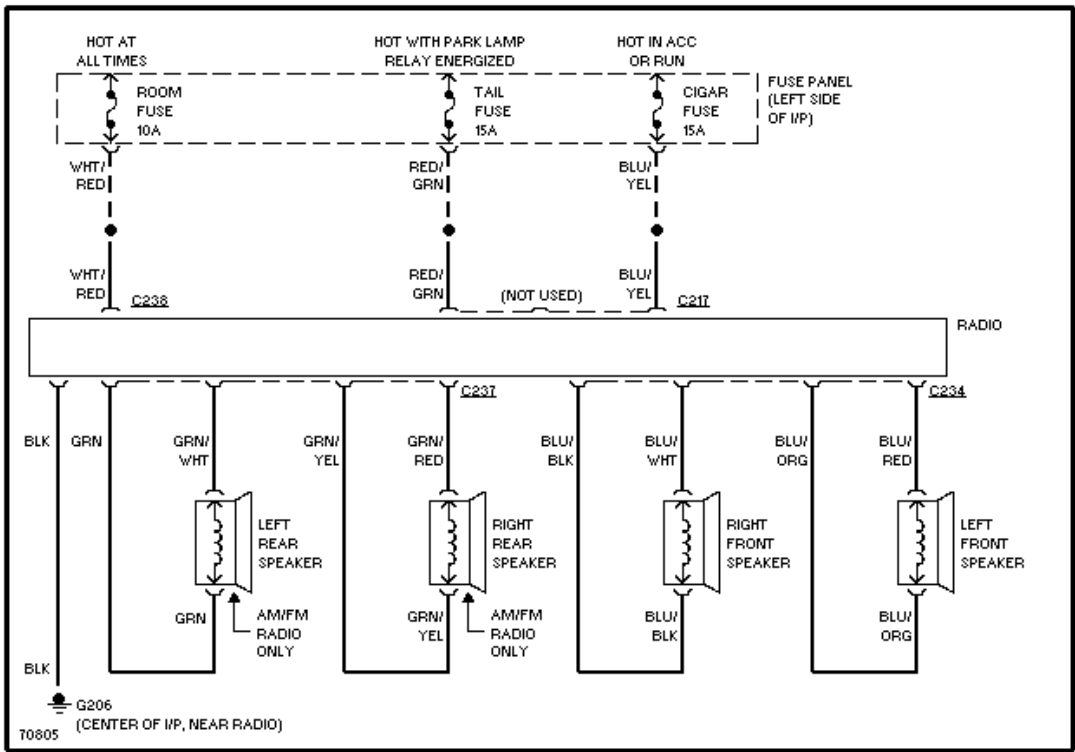


Fig. 5: Radio Circuits

STARTING/CHARGING

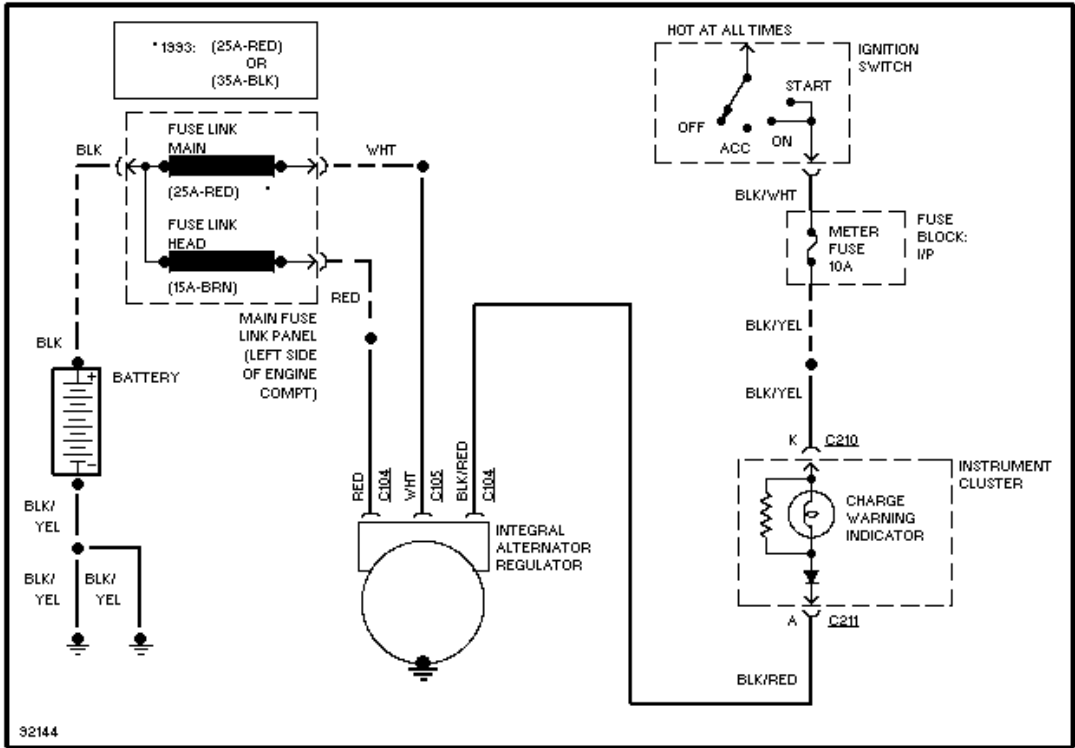


Fig. 6: Charging Circuit

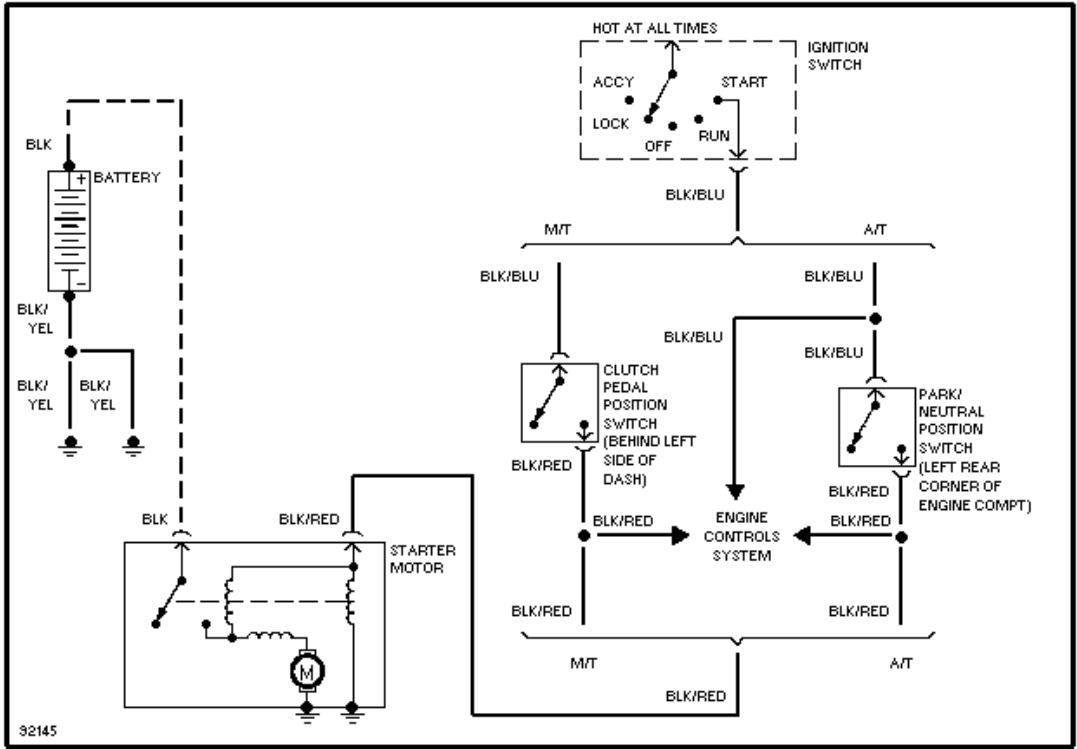


Fig. 7: Starting Circuit

WIPER/WASHER

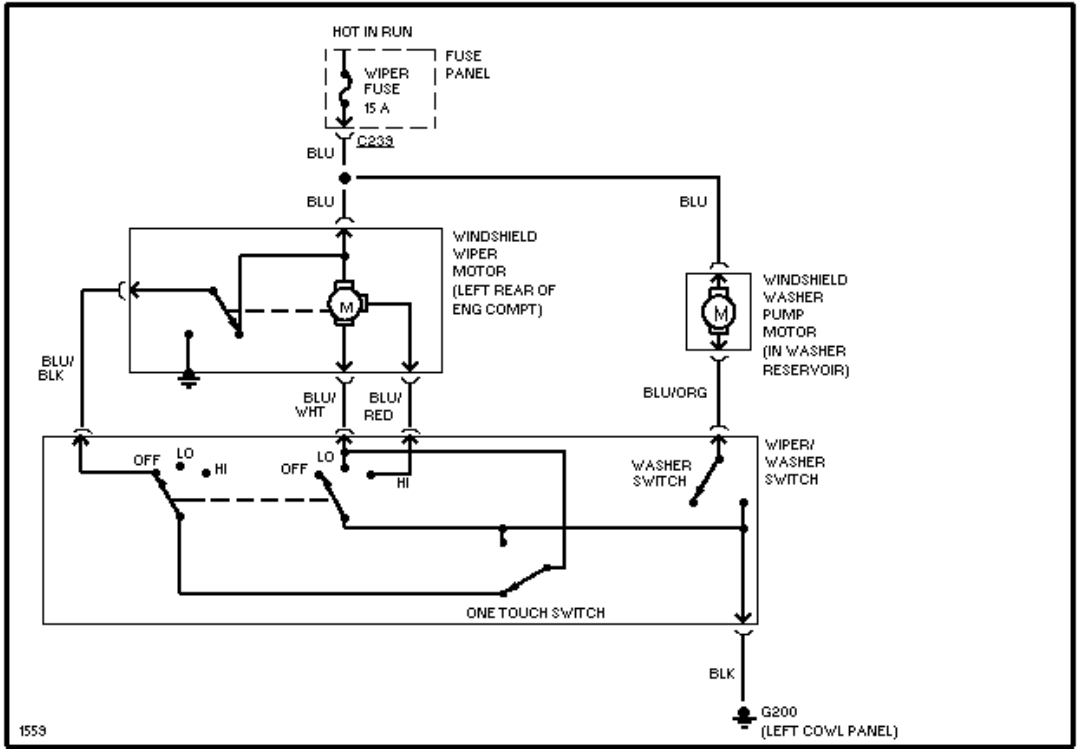


Fig. 8: Front Wiper/Washer Circuit

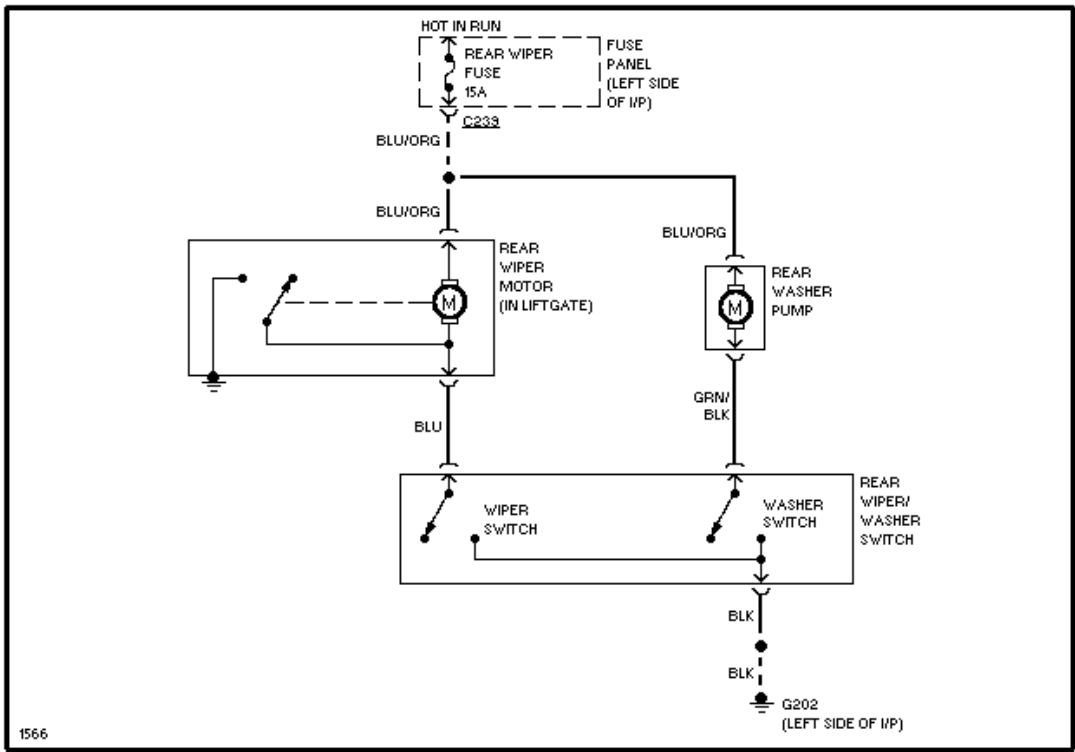


Fig. 9: Rear Wiper/Washer Circuit

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GENERAL INFORMATION

Using Mitchell1's Wiring Diagrams

INTRODUCTION

Mitchell1(R) obtains wiring diagrams and technical service bulletins, containing wiring diagram changes, from the domestic and import manufacturers. These are checked for accuracy and are all redrawn into a consistent format for easy use. All system wiring diagrams are available in color format and may be viewed and or printed in color or black and white, depending on your program settings and available printer hardware.

In the past, when cars were simpler, diagrams were simpler. All components were connected by wires, and diagrams seldom exceeded 4 pages in length. Today, some wiring diagrams require more than 16 pages. It would be impractical to expect a service technician to trace a wire from page 1 across every page to page 16.

Removing some of the wiring maze reduces eyestrain and time wasted searching across several pages. Today, the majority of Mitchell1(R) diagrams follow a much improved format, which permits space for internal switch details, and component and ground locations.

Components shown with a dashed line instead of a solid line indicate not all circuits are shown in this particular diagram (circuits shown in system diagrams are typically applicable to that system only). The remaining circuits connected to that component will be shown in the appropriate system that they apply to.

Today, the wiring diagram necessary to support a given repair procedure is included within that article or a link is provided to the appropriate SYSTEM WIRING DIAGRAM article. For example, the wiring diagram for a Ford EEC-IV system may be included in ENGINE PERFORMANCE and WIRING DIAGRAMS articles for Ford Motor Co. The wiring diagram for a cruise control system may be included in ACCESSORIES & EQUIPMENT section for the specific vehicle manufacturer, and the wiring diagram for an anti-lock brake system may be included in BRAKES and WIRING DIAGRAMS for the specific manufacturer.

WIRING DIAGRAMS contains all wiring diagrams not included in STARTING & CHARGING SYSTEMS and ACCESSORIES & EQUIPMENT. This includes: Data Link Connectors, Ground Distribution, Power Distribution, Engine Performance, Electric Cooling Fans, Anti-Lock Brakes, Electronic Suspension and Electronic Steering wiring diagrams. The Data Link Connectors wiring diagrams show the circuits by which the various on-board computers exchange information, and the diagnostic connectors used for diagnosis and their location. The Ground Distribution wiring diagrams show all vehicle ground points, their location, and the components common to those ground points. The Power Distribution wiring diagrams show the power feed circuits and the components common to those power feeds.

Wiring diagrams used to support the information in ACCESSORIES & EQUIPMENT are drawn in a "top-down" format. The diagrams are drawn with the power source at the top of the diagram and the ground point at the bottom of the diagram. Component locations are identified on the wiring diagrams. Any wires that do not connect directly to a component are identified on the diagram to indicate where they go.

WIRING DIAGRAM COLOR ABBREVIATIONS

COLOR ABBREVIATIONS

Color	Normal	Optional
Black	BLK	BK
Blue	BLU	BU
Brown	BRN	BN
Clear	CLR	CR
Dark Blue	DK BLU	DK BU
Dark Green	DK GRN	DK GN
Green	GRN	GN
Gray	GRY	GY
Light Blue	LT BLU	LT BU
Light Green	LT GRN	LT GN
Orange	ORG	OG
Pink	PNK	PK
Purple	PPL	PL
Red	RED	RD
Tan	TAN	TN
Violet	VIO	VI
White	WHT	WT
Yellow	YEL	YL

WIRING DIAGRAM SYMBOLS

NOTE: Standard wiring symbols are used on all wiring diagrams. The list below will help clarify any symbols that are not easily understood at a glance. Most components are labeled “Motor”, “Switch” or “Relay” in addition to being drawn with the standard symbol.

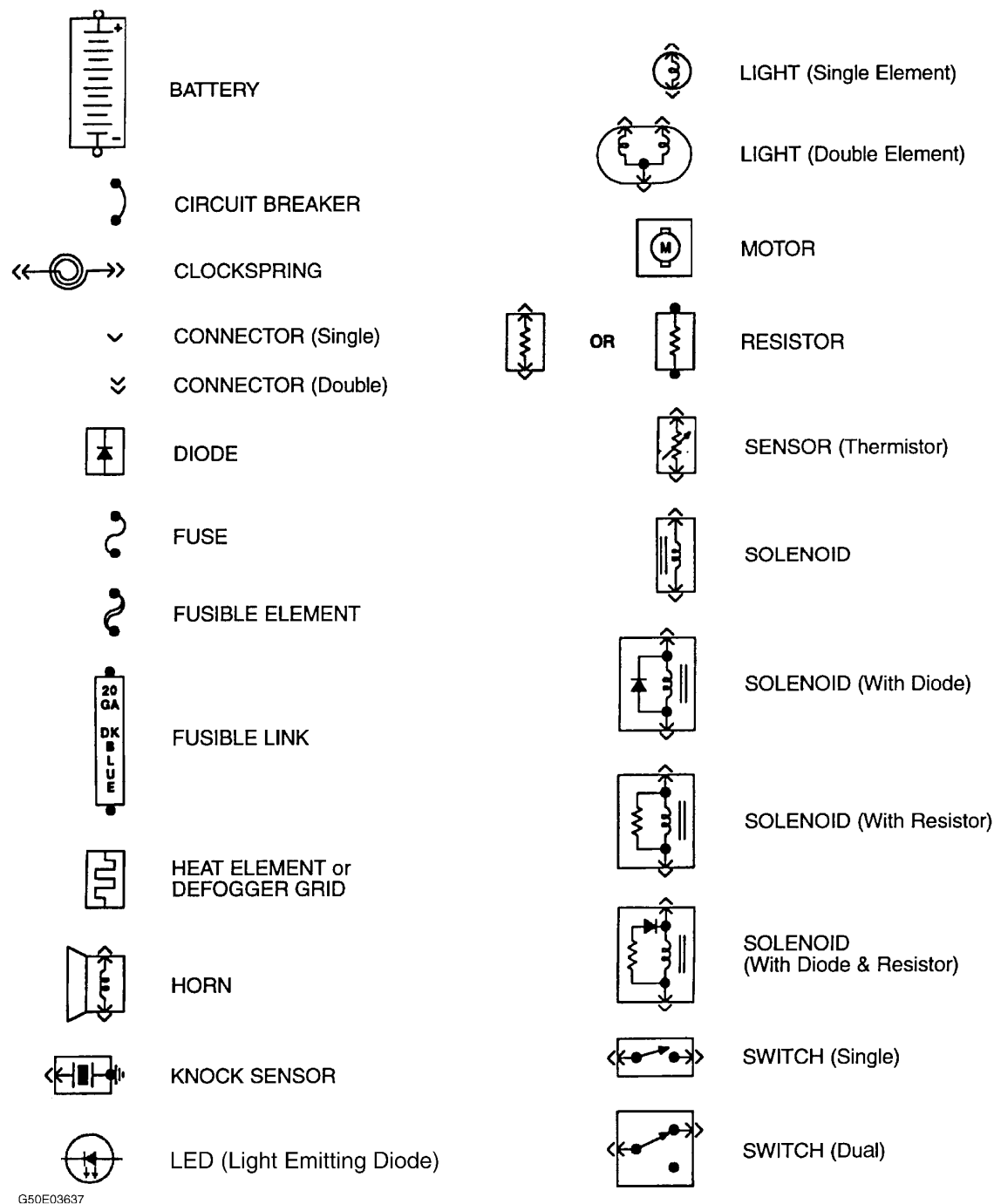


Fig. 1: Identifying Standard Wiring Diagram Symbols

WIRING DIAGRAM GROUND NUMBER LOCATIONS

NOTE: The following illustration depicts standardized ground numbers and locations to be used in conjunction with Mitchell1's (R) wiring diagrams applying to 2001 and prior model years only. See [Fig. 2](#) . Wiring diagrams applying to newer model years depict manufacturer-specified ground numbers and locations. Do not utilize the illustration with 2002 and newer model year wiring diagrams.

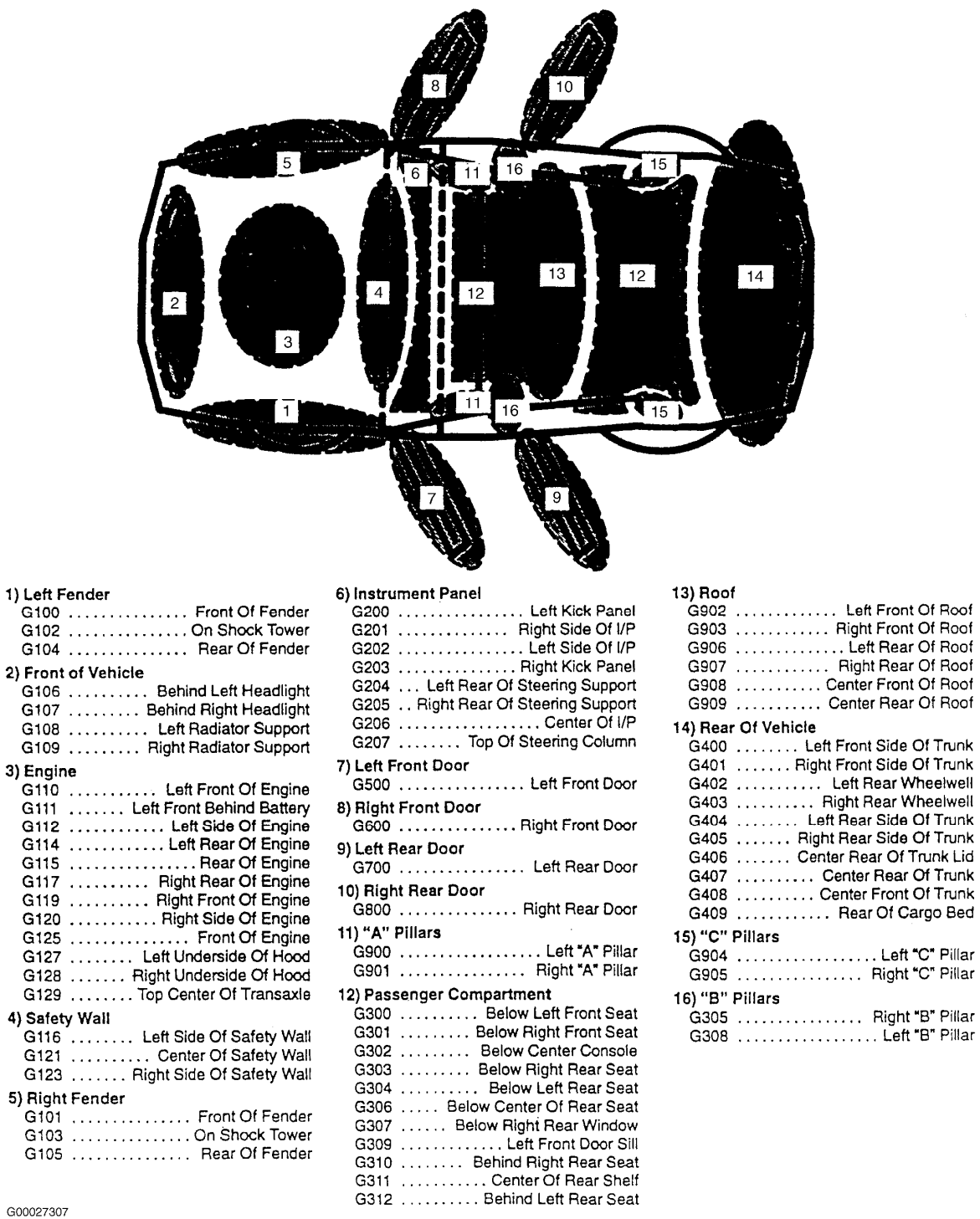


Fig. 2: Ground Numbers & Locations (2001 & Prior Model Years)

WIRING DIAGRAM COMPONENT LOCATIONS

When trying to locate a component in a wiring diagram and you don't know the specific system where it is located, use this handy component locator to find the system wiring diagram in which the component is located. Then, go to that system and locate the component within the wiring diagram.

For example, if you don't know the specific system in which the ignition switch is located, look up ignition switch in the wiring diagram component location tables and go to the appropriate wiring diagram(s) which contain either full or partial views of the ignition switch. The full view of the ignition switch is located in Power Distribution.

The first listing for the component will be the full or most complete view of the component. Additional listings will be partial views of the component. Not all components are used on all models.

All components will have a partial view in Ground Distribution and Power Distribution. Data Link Connectors show connecting circuits between modules. Alternate names for components may be listed in wiring diagram component locations tables.

WIRING DIAGRAM COMPONENT LOCATIONS

Component	Wiring Diagram
ABS Electronic Control Unit	Anti-Lock Brakes; Data Link Connectors
ABS Hydraulic Unit	Anti-Lock Brakes
Acceleration Sensor	Anti-Lock Brakes
Accessory Delay Relay	Power Windows
A/C Compressor Clutch Relay	Engine Performance
A/C Sensor	Engine Performance
A/C Pressure Switch	Engine Performance
Adaptive Lamp Control Module	Exterior Lights
Air Bag(s)	Air Bag Restraint System
Air Bag Module	Air Bag Restraint System
Air Bag Sensor(s)	Air Bag Restraint System
Air Injection Pump Relay	Engine Performance
Air Temperature Sensor	Overhead Console
Alternator (Generator)	Generators & Regulators
Anti-Theft Control Module	Anti-Theft System; Starters

Autolamp Control Relay	Headlight Systems; Daytime Running Lights
Automatic Shutdown (ASD) Relay	Engine Performance; Generators & Regulators
Autostick Switch	Engine Performance
Auxiliary Battery Relay	Generators & Regulators
Back-Up Lights	Back-Up Lights; Exterior Lights
Barometric (BARO) Pressure Sensor	Engine Performance
Battery	Power Distribution
Battery Temperature Sensor	Engine Performance
Body Control Module	Body Control Computer; Anti-Theft System; Daytime Running Lights; Engine Performance; Headlight Systems; Warning Systems
Boost Control Solenoid	Engine Performance
Boost Sensor	Engine Performance
Brake Fluid Level Switch	Analog Instrument Panels
Brake On/Off (BOO) Switch	Cruise Control Systems; Engine Performance; Shift Interlock Systems
Buzzer Module	Warning Systems
Camshaft Position (CMP) Sensor	Engine Performance
Central Control Module	Anti-Theft System
Clockspring	Air Bag Restraint System; Cruise Control Systems; Steering Column Switches
Clutch Pedal Position Switch	Starters
Clutch Start Switch	Starters
Combination Meter	Analog Instrument Panels
Constant Control Relay Module (CCRM)	Engine Performance; Electric Cooling Fans
Convenience Center	Power Distribution; Illumination/Interior Lights
Convertible Top Motor	Power Convertible Top
Convertible Top Switch	Power Convertible Top
Crankshaft Position (CKP) Sensor	Engine Performance
Cruise Control Module	Cruise Control Systems
Cruise Control Switch	Cruise Control Systems
Condenser Fan Relay(s)	Electric Cooling Fans
Data Link Connector (DLC)	Engine Performance
Daytime Running Lights Module	Daytime Running Lights; Exterior Lights
Defogger Relay	Rear Window Defogger
Diagnostic Energy Reserve Module (DERM)	Air Bag Restraint System
Discriminating Sensor (Air Bag)	Air Bag Restraint System
Distributor	Engine Performance
Door Lock Actuators	Power Door Locks; Remote Keyless Entry
Door Lock Relay(s)	Power Door Locks
Electrochromic Mirror	Power Mirrors
Electronic Level Control (ELC) Height Sensor	Electronic Suspension
Electronic Level Control (ELC) Module	Electronic Suspension
Engine Coolant Temperature (ECT) Sending Unit	Analog Instrument Panels
Engine Coolant Temperature (ECT) Sensor	Engine Performance
Engine Control Module	Engine Performance; Generators & Regulators; Starters
ETACS ECU	Warning Systems; Power Windows; Remote Keyless Entry
Evaporative (EVAP) Emissions Canister	Engine Performance
EVAP Canister Purge Solenoid	Engine Performance
EVAP Canister Vent Solenoid	Engine Performance
Exhaust Gas Recirculation (EGR) Valve	Engine Performance
Fuel Tank Vacuum Sensor	Engine Performance
Fog Lights	Headlight Systems; Daytime Running Lights
Fog Light Relay	Headlight Systems; Daytime Running Lights
Fuel Door Release Solenoid	Power Fuel Door Release
Fuel Gauge Sending Unit	Analog Instrument Panels
Fuel Injectors	Engine Performance
Fuel Pump	Engine Performance
Fuel Pump Relay	Engine Performance; Power Distribution
Fuse/Relay Block	Power Distribution
Fusible Links	Power Distribution; Generators & Regulators; Starters
Generator	Generators & Regulators; Engine Performance; Power Distribution
Generic Electronic Module (GEM)	Body Control Modules; Electronic Suspension
Glow Plug Relay	Engine Performance
Glow Plugs	Engine Performance
Grounds	Ground Distribution
Headlight Door Module	Headlight Doors
Headlight Relay	Headlight Systems; Daytime Running Lights
Headlights	Headlight Systems; Daytime Running Lights
Heated Oxygen Sensor(s) (HO2S)	Engine Performance
Heated Windshield Control Module	Heated Windshields

Height Sensor	Electronic Suspension
Horns	Steering Column Switches
Horn Relay	Steering Column Switches
Idle Air Control (IAC) Motor/Valve	Engine Performance
Ignition Coil(s)	Engine Performance
Ignition Key Lock Cylinder	Anti-Theft System
Ignition Module	Engine Performance
Ignition Switch	Power Distribution; Engine Performance; Generators & Regulators; Starters
Illuminated Entry Module	Illumination/Interior Lights
Illumination Lights	Illumination/Interior Lights
Impact Sensor	Air Bag Restraint System
Inertia Fuel Shutoff Switch	Engine Performance
Inhibit Relay	Starters
Instrument Cluster	Analog Instrument Panels
Intake Air Temperature (IAT) Sensor	Engine Performance
Interior Lights	Illumination/Interior Lights
Interlock Switch	Starters
Junction Block	Power Distribution
Keyless Entry Receiver	Remote Keyless Entry
Key Reminder Switch	Starters
Knock Sensor	Engine Performance
Lamp Control Module	Exterior Lights
License Plate Lamp	Exterior Lights
Lighting Control Module	Lighting Control Modules; Anti-Theft System; Daytime Running Lights; Headlight Systems
Lower Relay	Power Convertible Top
Malfunction Indicator Light (MIL)	Engine Performance; Instrument Panels
Manifold Absolute Pressure (MAP) Sensor	Engine Performance
Mass Airflow (MAF) Sensor	Engine Performance
Mega Fuse	Generators & Regulators
Memory Seat/Mirror Module	Memory Systems
Mirror Defogger	Rear Window Defogger
Moon Roof Motor	Power Moon Roof
Moon Roof Relay	Power Moon Roof
Multi-Function Control Module	Warning Systems
Neutral Safety Switch	Starters
Oil Level Switch	Engine Performance
Oil Pressure Switch/Sending Unit	Analog Instrument Panels; Engine Performance
Overhead Console	Overhead Console
Oxygen Sensor(s) (O2S)	Engine Performance
Parking Brake Switch	Analog Instrument Panels
Park Lights	Exterior Lights
Park/Neutral Position Switch	Starters; Engine Performance; Anti-Theft System; Body Control Module
Perimeter Lighting Control Relay	Exterior Lights
Power Amplifier	Power Antennas
Power Antenna Module	Power Antennas
Power Antenna Motor	Power Antennas
Power Distribution Center	Power Distribution; Generators & Regulators; Starters
Power Door Lock Motors	Power Door Locks
Power Mirror Motors	Power Mirrors; Memory Systems
Power Sliding Door Controller	Power Sliding Side Door
Power Seat Motors	Power Seats; Memory Systems
Power Steering Pressure Switch	Engine Performance
Power Top Motor	Power Convertible Top
Power Top Relay(s)	Power Convertible Top
Powertrain Control Module	Engine Performance; Analog Instrument Panels; Cruise Control Systems; Data Link Connectors; Generators & Regulators; Starters
Power Window Motors	Power Windows
Power Window Relay(s)	Power Windows
Radiator Fan Motor(s)	Electric Cooling Fans
Radiator Fan Relay(s)	Engine Performance; Electric Cooling Fans;
Rainsense Module	Wiper/Washer Systems
Raise Relay	Power Convertible Top
Remote Anti-Theft Personality (RAP) Module	Anti-Theft System; Starters; Warning Systems
Seat Belt Pretensioners	Air Bag Restraint System
Seat Belt Retractor Solenoid	Passive Restraints
Seat Belt Switch	Air Bag Restraint System; Passive Restraints
Shift Interlock Solenoid	Shift Interlock Systems

Shift Lock Actuator	Shift Interlock Systems
Side Marker Lights	Exterior Lights
SIR Coil Assembly (Clockspring)	Air Bag Restraint System
Slip Ring (Clockspring)	Air Bag Restraint System; Steering Column Switches
SRS Control Module	Air Bag Restraint System
Starter Motor	Starters
Starter Interrupt Relay	Starters
Starter Solenoid	Starters
Starter Relay	Starters
Steering Wheel Position Sensor	Anti-Lock Brakes
Stoplights	Exterior Lights
Stoplight Switch	Engine Performance; Cruise Control Systems; Anti-Lock Brakes
Sun Roof ECU	Power Sun Roof
Sun Roof Motor	Power Sun Roof
Sun Roof Position Sensor	Power Sun Roof
Taillights	Exterior Lights
Throttle Position (TP) Sensor	Engine Performance
Torque Converter Clutch Solenoid/Switch	Engine Performance
Traction Control Switch	Anti-Lock Brakes
Trailer Tow Connector	Exterior Lights
Trailer Tow Relay	Exterior Lights
Transmission/Transaxle	Engine Performance
Transmission Control Module (TCM)	Engine Performance; Starters
Transmission Range Sensor	Starters; Back-Up Lights; Engine Performance
Transmission Range Switch	Back-Up Lights; Engine Performance; Anti-Theft System
Turn Signal Flasher	Exterior Lights
Turn Signal Lights	Exterior Lights
Twilight Sentinel Switch	Headlight Systems; Daytime Running Lights
Vapor Canister Leak Detection Pump	Engine Performance
Vehicle Control Module (VCM)	Engine Performance
Vehicle Dynamic Module	Electronic Suspension
Vehicle Speed Control Servo	Cruise Control Systems
Vehicle Speed Sensor	Data Link Connectors; Analog Instrument Panels; Cruise Control Systems; Electronic Suspension
Voltage Regulator	Generators & Regulators
Water-In-Fuel Sensor	Engine Performance; Analog Instrument Panels
Wheel Speed Sensors	Anti-Lock Brakes
Window Timer Module	Power Convertible Top
Windshield Intermittent Wiper Relay	Wiper/Washer Systems
Windshield Washer Motor	Wiper/Washer Systems
Wiper Motor	Wiper/Washer Systems

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WIRING DIAGRAMS

1991 WIRING DIAGRAMS Ford Motor Co.

IDENTIFICATION

COMPONENT LOCATION MENU

COMPONENT LOCATIONS

Component	Figure No. (Location)
A/C RELAY	3 (B 8)
A/T SELECT LIGHT	3 (E 8)
ALTERNATOR	1 (C 3)
BACK-UP LIGHT SWITCH	5 (D 19)
BATTERY	1 (A 2)
BLOWER SWITCH	3 (C 9)
BRAKE WARNING SWITCH	1 (C 2)
CIG LTR	4 (E 14)
CLUTCH INTERLOCK SWITCH (M/T)	1 (B 2)
CONDENSER FAN (A/T)	3 (C 8)
COOLANT FAN MOTOR	1 (D 3)
COOLANT FAN RELAY	1 (D 3)
DEFOG SWITCH	5 (C 16)
DIR/HAZARD SWITCH	4 (B-C 12)
ELECT CONTROL ASSY (ECA)	2 (A 4-7)
FRONT WASHER MOTOR	1 (E 3)
FRONT WIPER MOTOR	1 (E 3)
FRONT WIPER/WASHER SWITCH	5 (A 16)
FUEL PUMP INERTIA SWITCH	2 (D 4)
FUEL PUMP RELAY	2 (C 4)
FUSE BLOCK	3 (D-E 9-10)
HEADLIGHT RELAY	4 (D 14)
HORN RELAY	3 (E 11)
HORN SWITCH	4 (E 15)
IGNITION COIL	2 (E 5)
IGNITION KEY REMINDER SWITCH	4 (E 13)
IGNITION SWITCH	3 (C-D 11)
INSTRUMENT CLUSTER	4 (A-E 15)
INSTRUMENT PANEL LIGHT CONTROL	4 (D-E 12)
INTERIOR LIGHT SWITCH	4 (E 14)
LIGHT SWITCH	4 (C-D 12)
MAIN FUSE PANEL	1 (A 3)
MAIN RELAY	2 (D 5)
NEUTRAL SAFETY SWITCH (A/T)	1 (B 2)
PARKING LIGHT RELAY	4 (C 14)
PASSIVE RESTRAINT CONTROL MODULE	3 (A 11)
REAR WASHER MOTOR	5 (D 17)
REAR WIPER/WASHER SWITCH	5 (E 16)
SHIFT LOCK SERVO ASSY	4 (A 12)
STARTER	1 (B 3)
STOP LIGHT SWITCH	5 (D 19)
TIMER/BUZZER UNIT	4 (E 12)
TRUNK LIGHT	5 (B 16)
WAC RELAY	3 (B 8)

WIRING DIAGRAMS

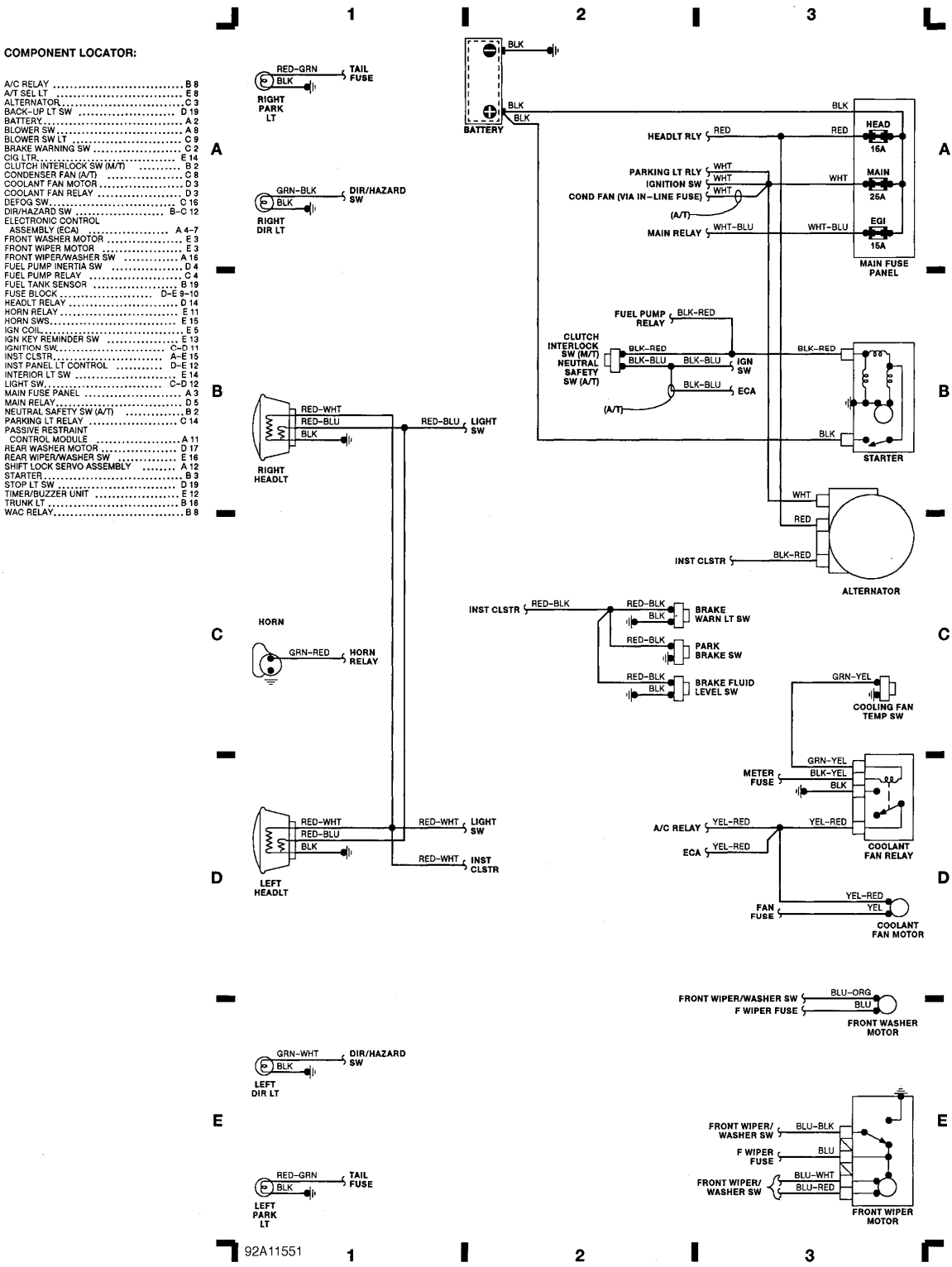


Fig. 1: Engine Compartment & Headlights (Grid 1-3)



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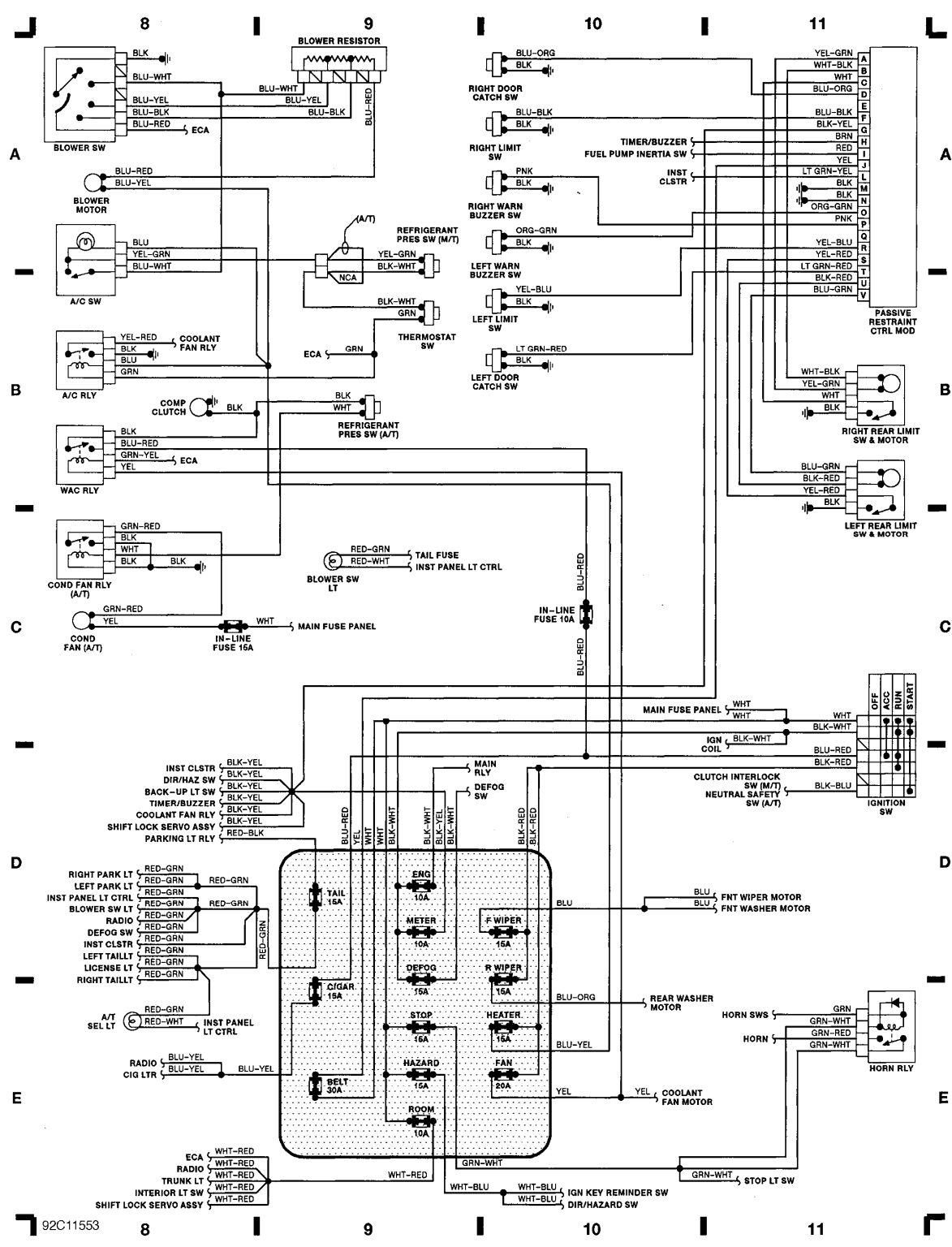


Fig. 3: A/C & Heat, Fuse Block, Passive Restraint,Ign (Grid 8-11)

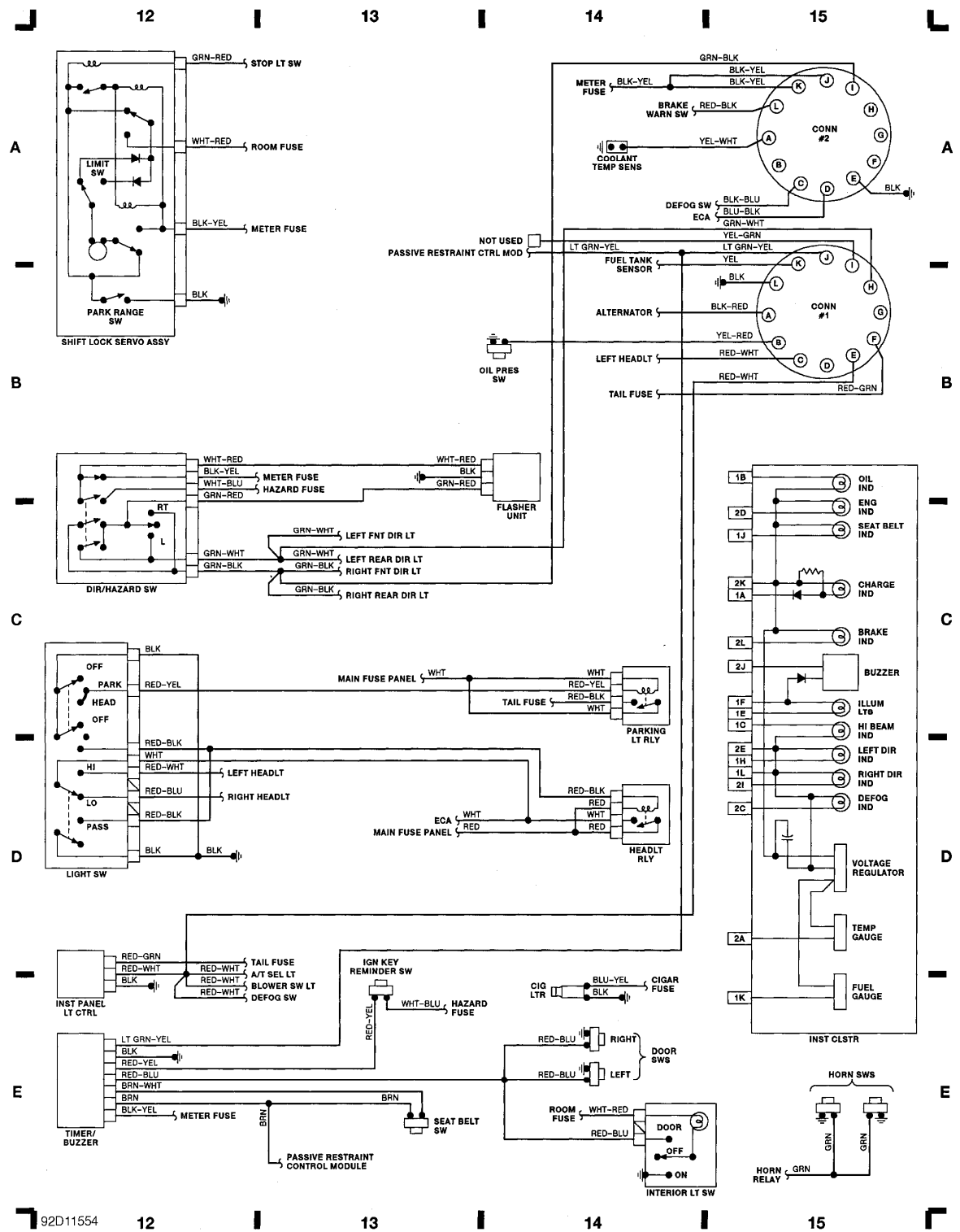


Fig. 4: Intr Cluster, Shift Lock Servo (Grid 12-15)

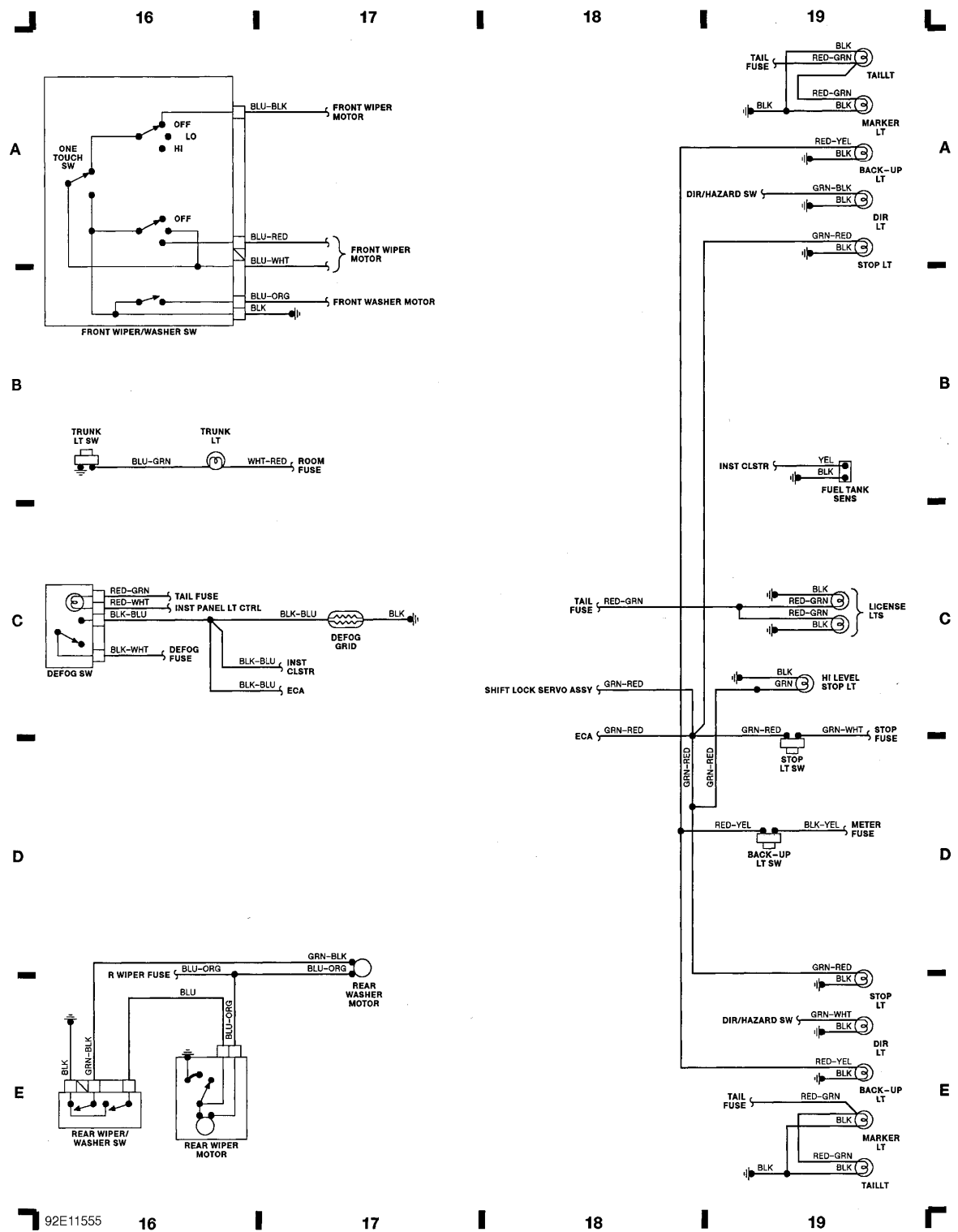


Fig. 5: Pwr Mirror, Wiper/Washer, Defog Sw, Taillights (Grid 16-19)

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DRIVE BELT ROUTING

1991-92 ENGINE COOLING BELT ROUTING

BELT ADJUSTMENT

Tensioners may be used to automatically adjust belt tension to specification. Check belt for fraying. If fraying exists, ensure both belt and tensioner are properly aligned. See [Fig. 1](#) . Tensioners may contain a belt-wear indicator. See [Fig. 2](#) . If tensioner reaches travel limit, as indicated by marks on tensioner, replace belt. Ensure serpentine belts are properly installed. See [Fig. 3 -Fig. 7](#) . On models without tensioners, ensure belt tension is within specification. See BELT ADJUSTMENT SPECIFICATIONS table.

BELT TENSION ADJUSTMENT SPECIFICATIONS [\(1\)](#)

Application	New Belt	(2) Used Belt
Continental	(3)	(3)
Cougar & Thunderbird	(3)	(3)
Crown Victoria & Grand Marquis		
5.0L & 5.8L		
1/4" "V" Belt	70 (32)	50 (23)
6 Rib Belt	170 (77)	150 (68)
Escort & Tracer		
1.8L	(4) (5)	(4) (5)
1.9L	(3)	(3)
Mark VII	(3)	(3)
Mustang	(3)	(3)
Probe		
2.2L & 2.2L Turbo		
Alternator	(4) (6)	(4) (6)
A/C	90 (41)	90 (41)
Sable & Taurus		
2.5L	(3)	(3)
3.0L (7)		
Alternator	140-160 (63-67)	110-130 (50-59)
P/S & A/C	(3)	(3)
3.0L SHO		
A/C & Alt.	220-265	(100-120) 148-192 (67-87)
P/S & W/P	154-198 (70-90)	112-157 (51-71)
3.8L	(3)	(3)
Tempo & Topaz		
2.3L		
Alternator	150-170 (68-77)	130-150 (59-68)
W/P	150-90 (23-41)	40-60 (18-27)
Town Car	(3)	(3)
(1) Tension is measured in Lbs. (kg) using tension gauge. (2) Used belt is a belt in operation for at least 10 minutes. (3) Belt tension is automatically adjusted by tensioner. (4) Manufacturer lists only belt deflection with 22 lbs. applied on belt. (5) Belt deflection on new belt is .31-.35" (7.9-8.9 mm) or .35-.39" (8.9-9.9 mm) on used belt. (6) Belt deflection on new belt is .24-.31" (6.1-7.9 mm) or .27-.35" (6.9-8.9 mm) on used belt. (7) Specification is for models without belt tensioner.		

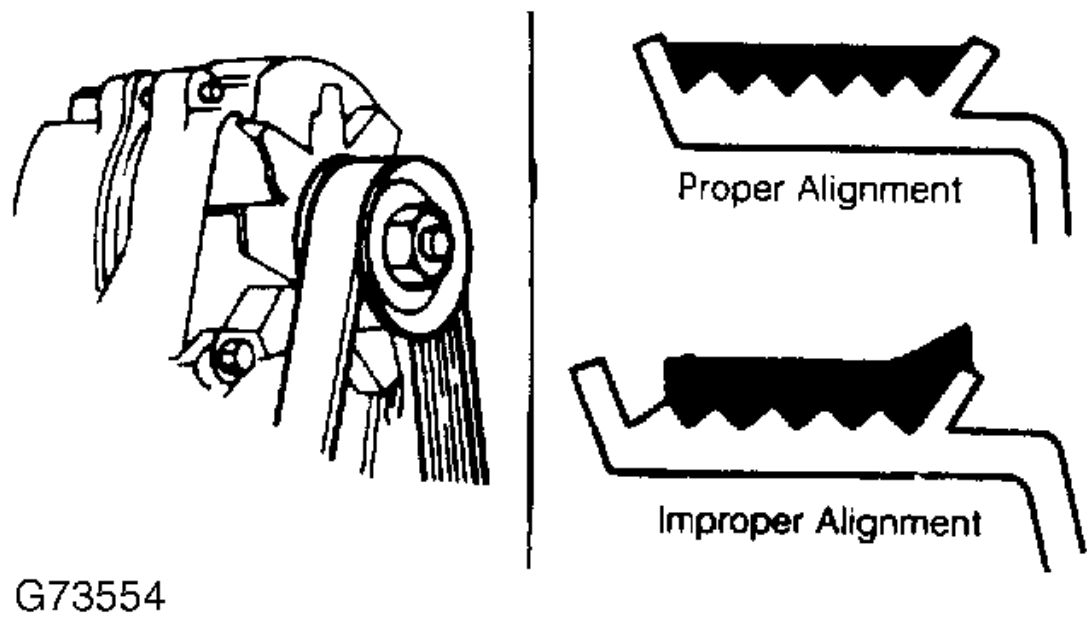
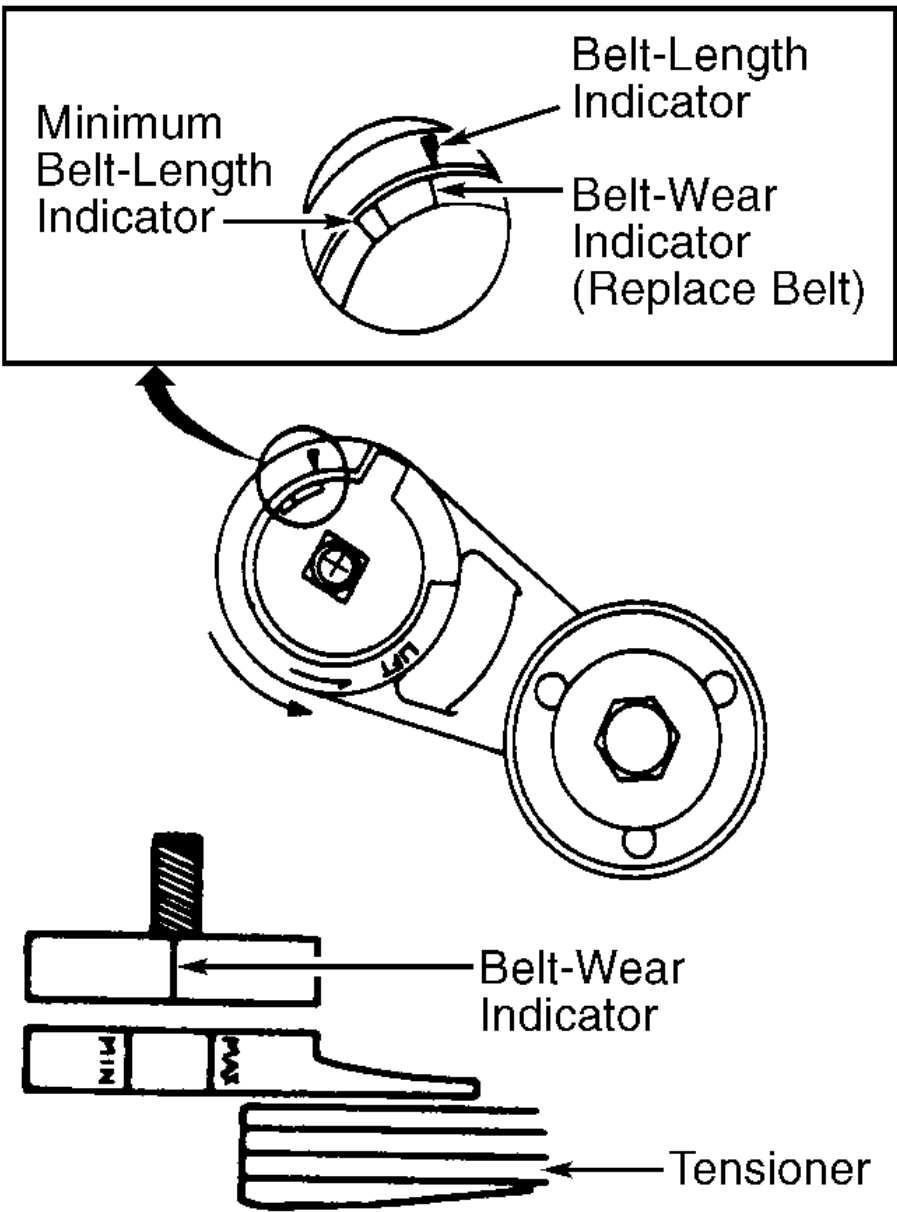


Fig. 1: Aligning Serpentine Belts
Courtesy of FORD MOTOR CO.



NOTE: The wear indicator mark inspection is done with engine off.

Fig. 2: Locating Tensioner Wear Indicator
Courtesy of FORD MOTOR CO.

BELT ROUTING

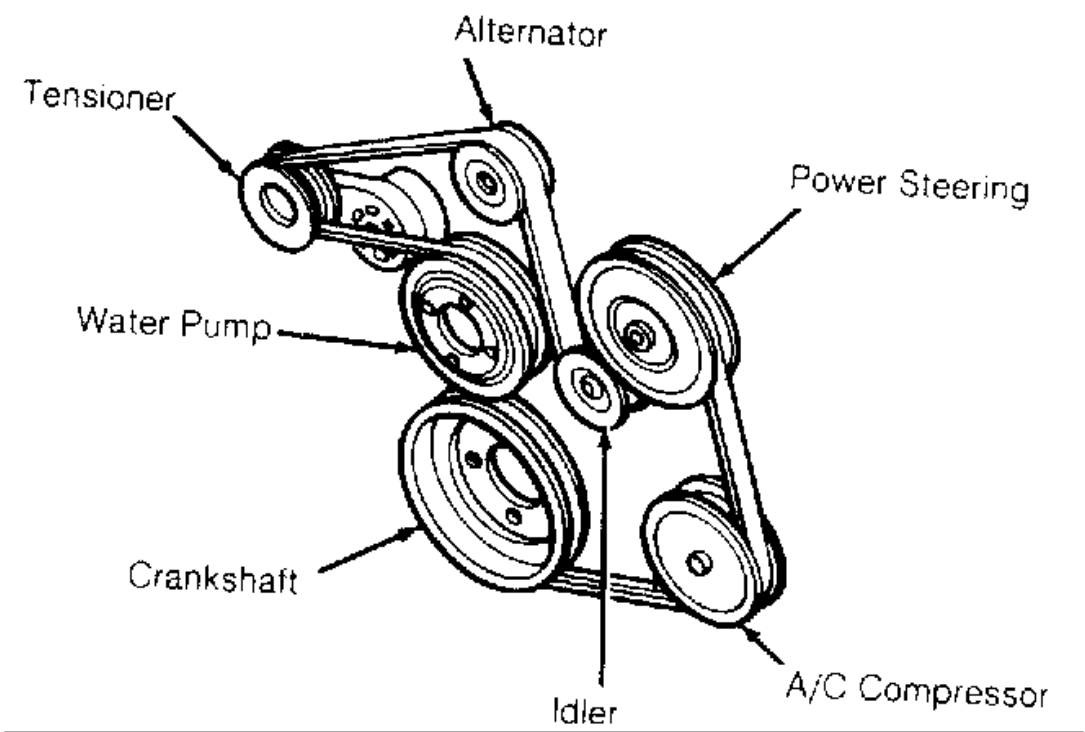


Fig. 3: Serpentine Belt Routing (Continental 3.8L)
Courtesy of FORD MOTOR CO.

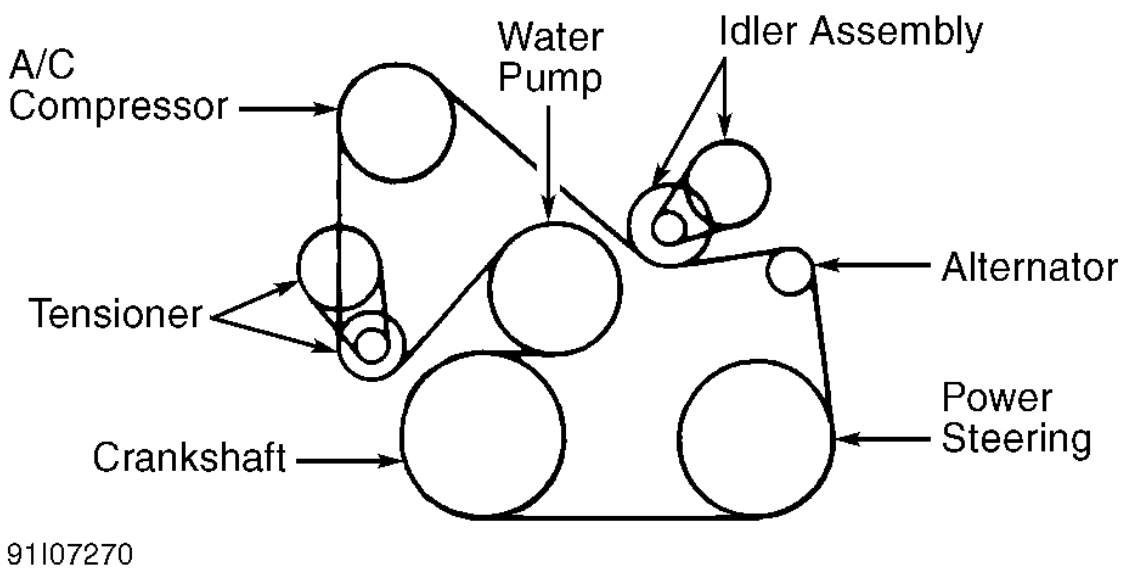


Fig. 4: Serpentine Belt Routing (Cougar 5.0L & Thunderbird 3.8L)
Courtesy of FORD MOTOR CO.

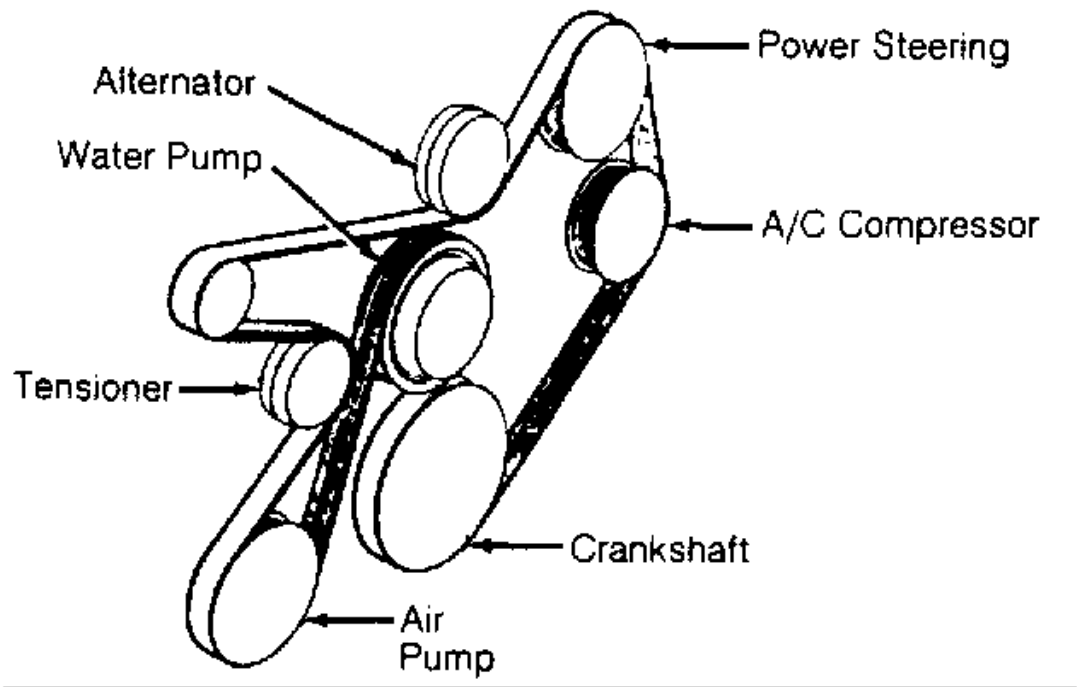


Fig. 5: Serpentine Belt Routing (Cougar 5.0L & Thunderbird 5.0L)
Courtesy of FORD MOTOR CO.

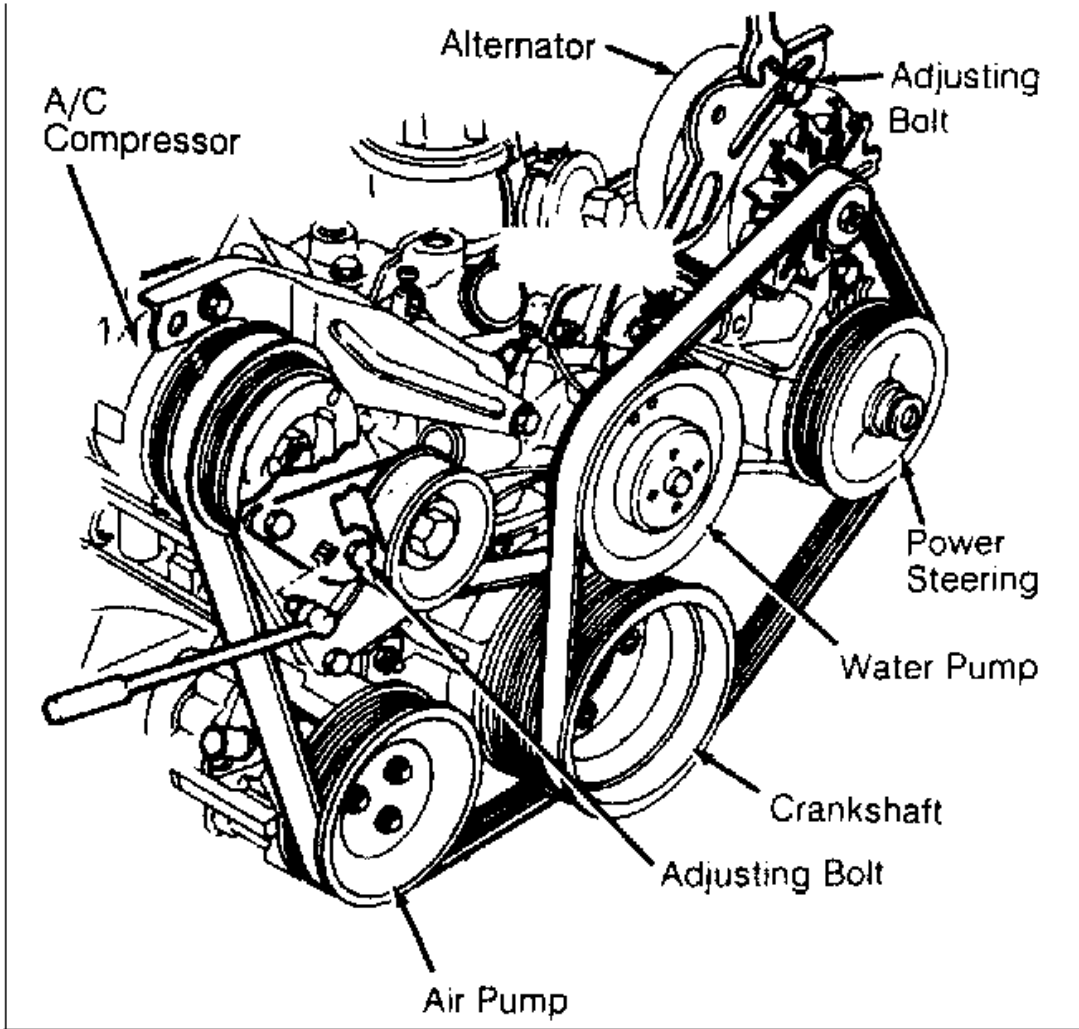


Fig. 6: Serpentine Belt Routing (Crown Victoria & Grand Marquis)
Courtesy of FORD MOTOR CO.

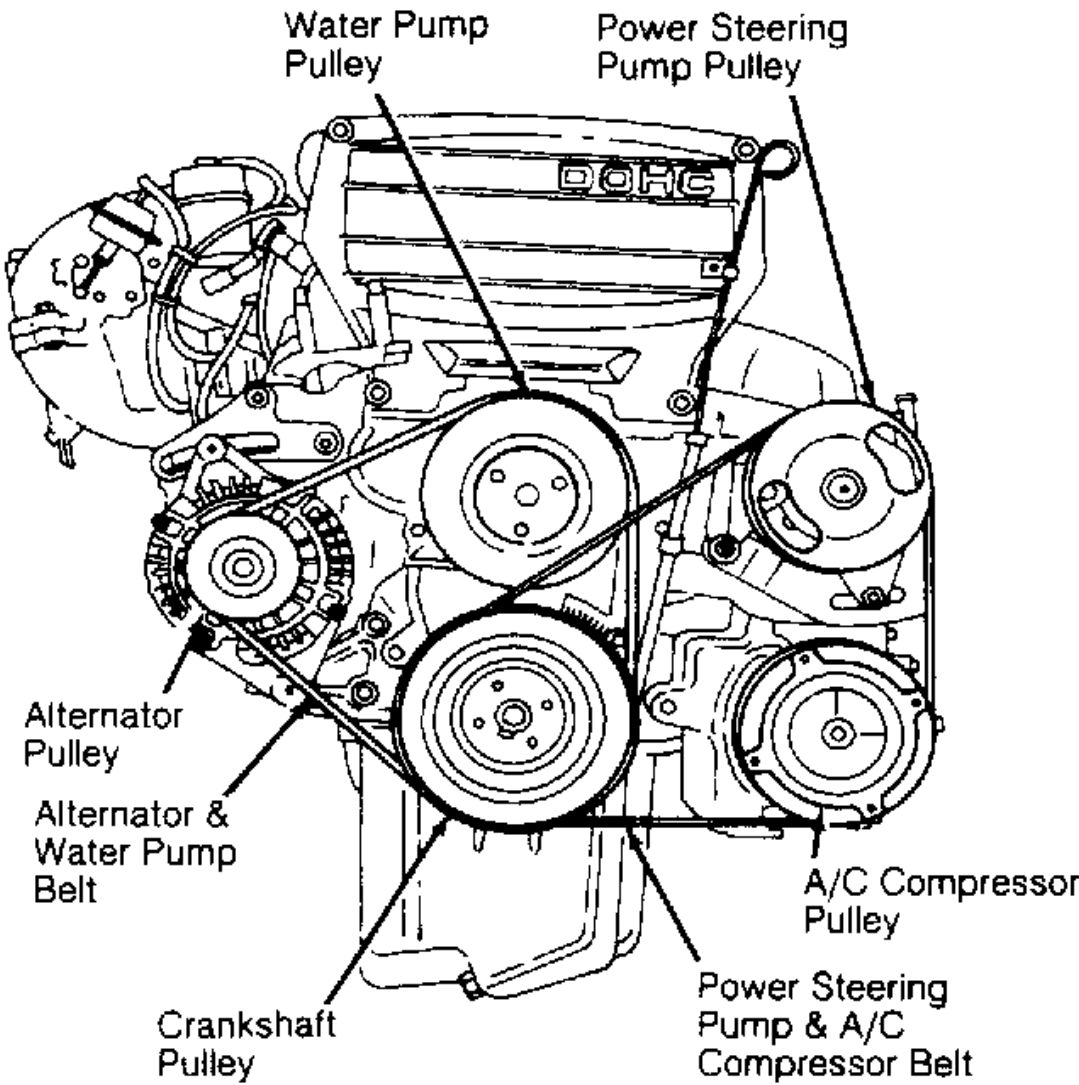


Fig. 7: Serpentine Belt Routing (Escort & Tracer 1.8L)
Courtesy of FORD MOTOR CO.

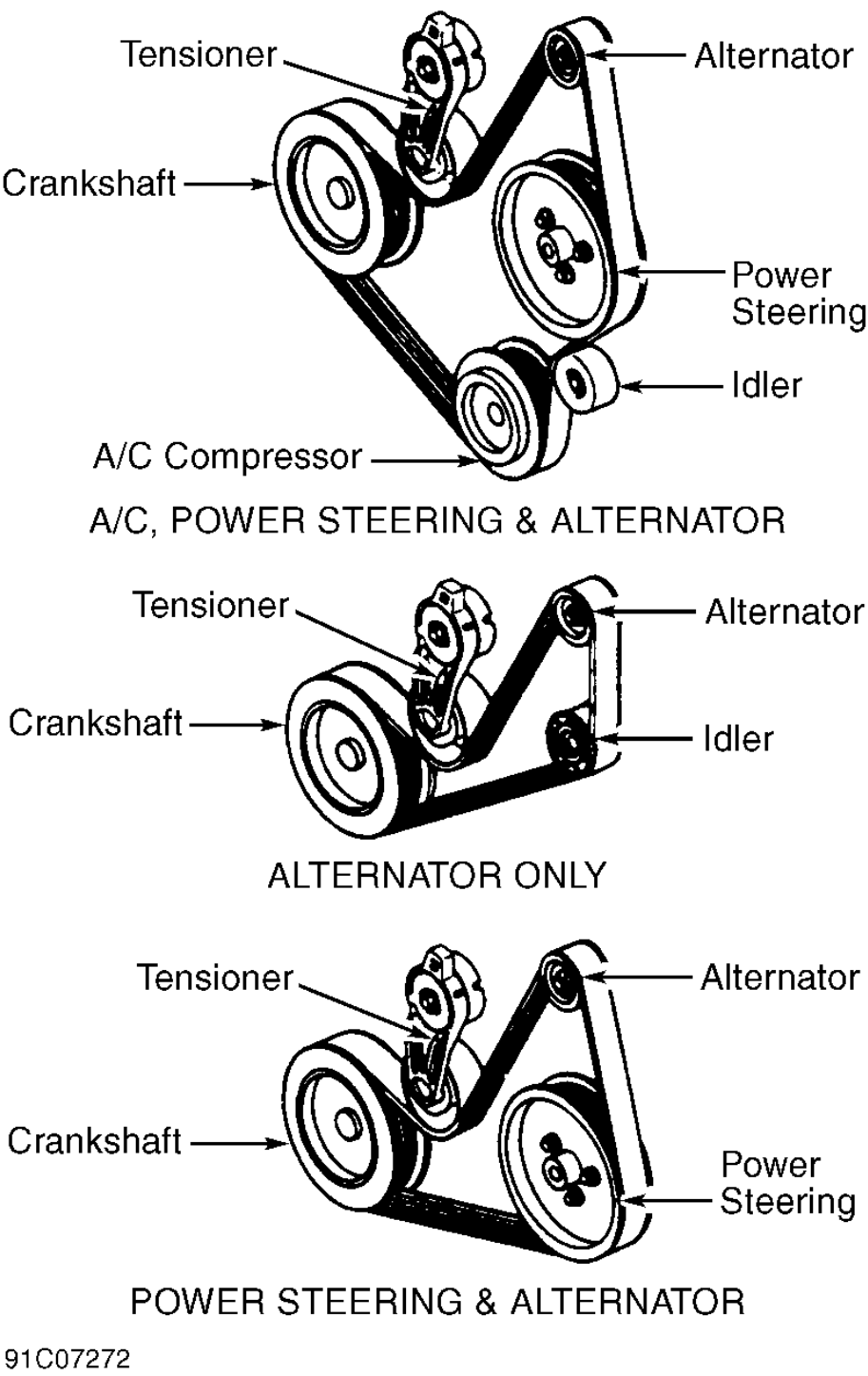


Fig. 8: Serpentine Belt Routing (Escort 1.9L & Tracer 1.9L)
Courtesy of FORD MOTOR CO.

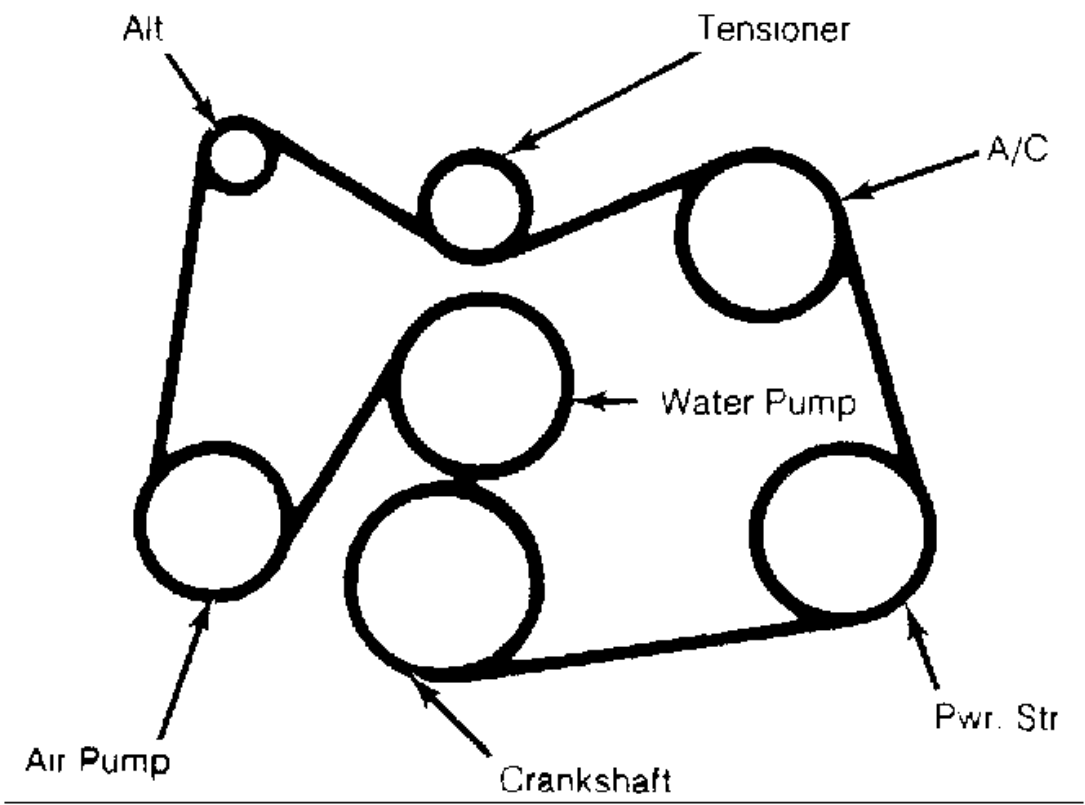


Fig. 9: Serpentine Belt Routing (Mark VII)
Courtesy of FORD MOTOR CO.

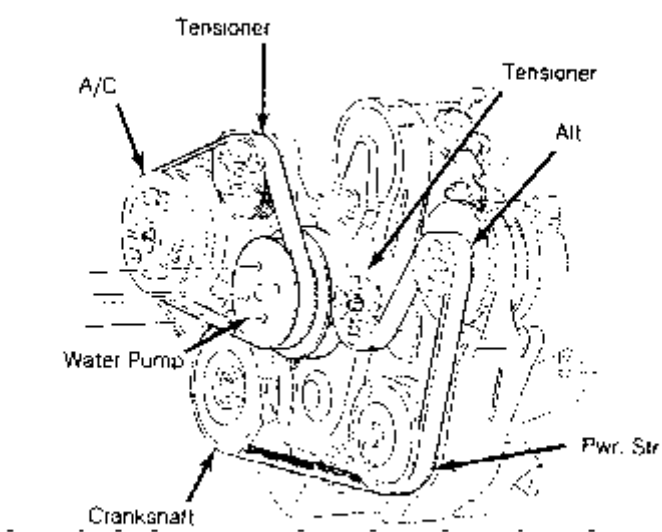


Fig. 10: Serpentine Belt Routing (Mustang 2.3L with A/C)
Courtesy of FORD MOTOR CO.

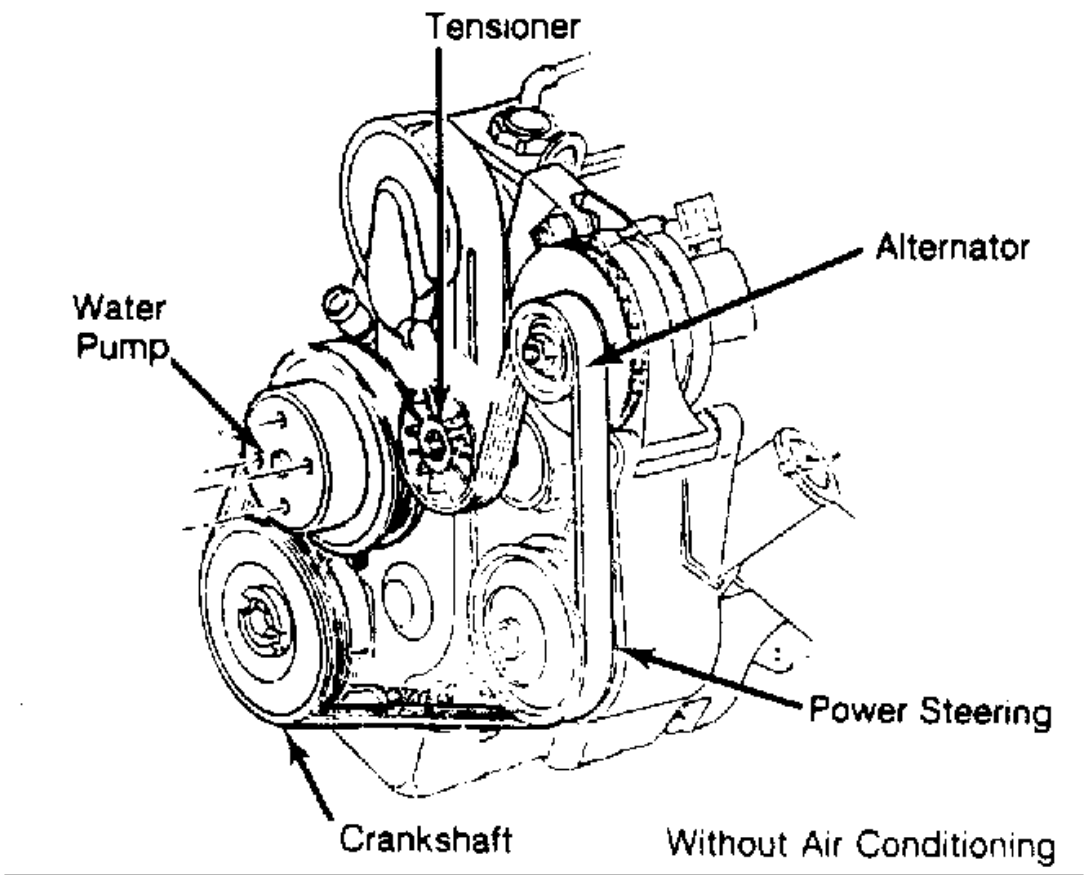


Fig. 11: Serpentine Belt Routing (Mustang 2.3L without A/C)
Courtesy of FORD MOTOR CO.

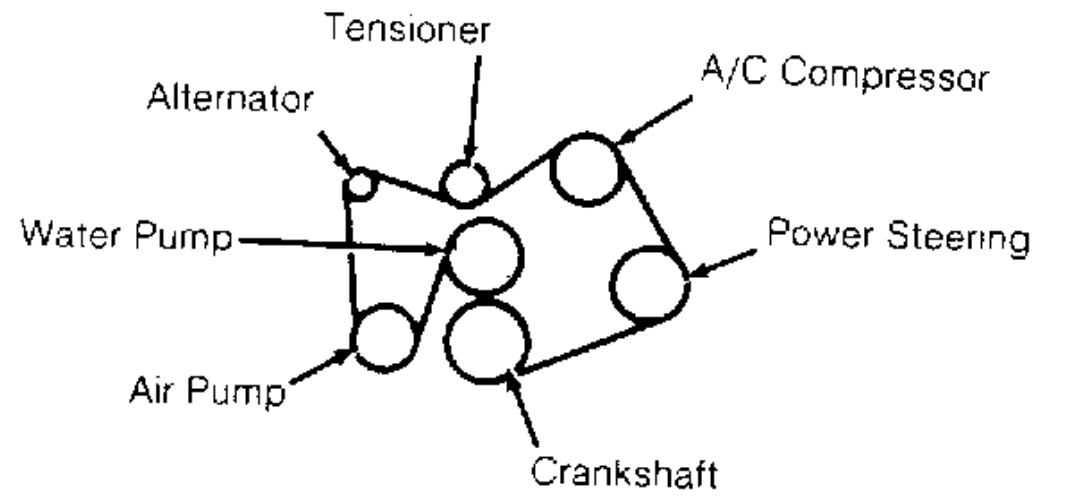


Fig. 12: Serpentine Belt Routing (Mustang 5.0L with A/C)
Courtesy of FORD MOTOR CO.

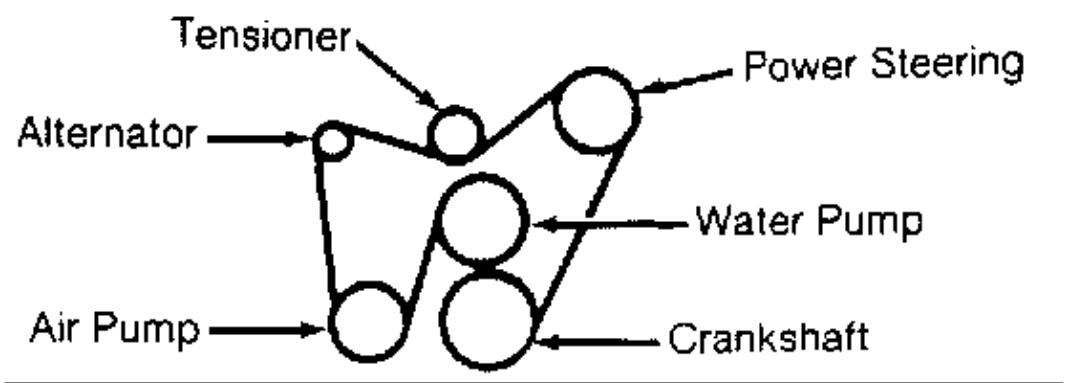


Fig. 13: Serpentine Belt Routing (Mustang 5.0L without A/C)
Courtesy of FORD MOTOR CO.

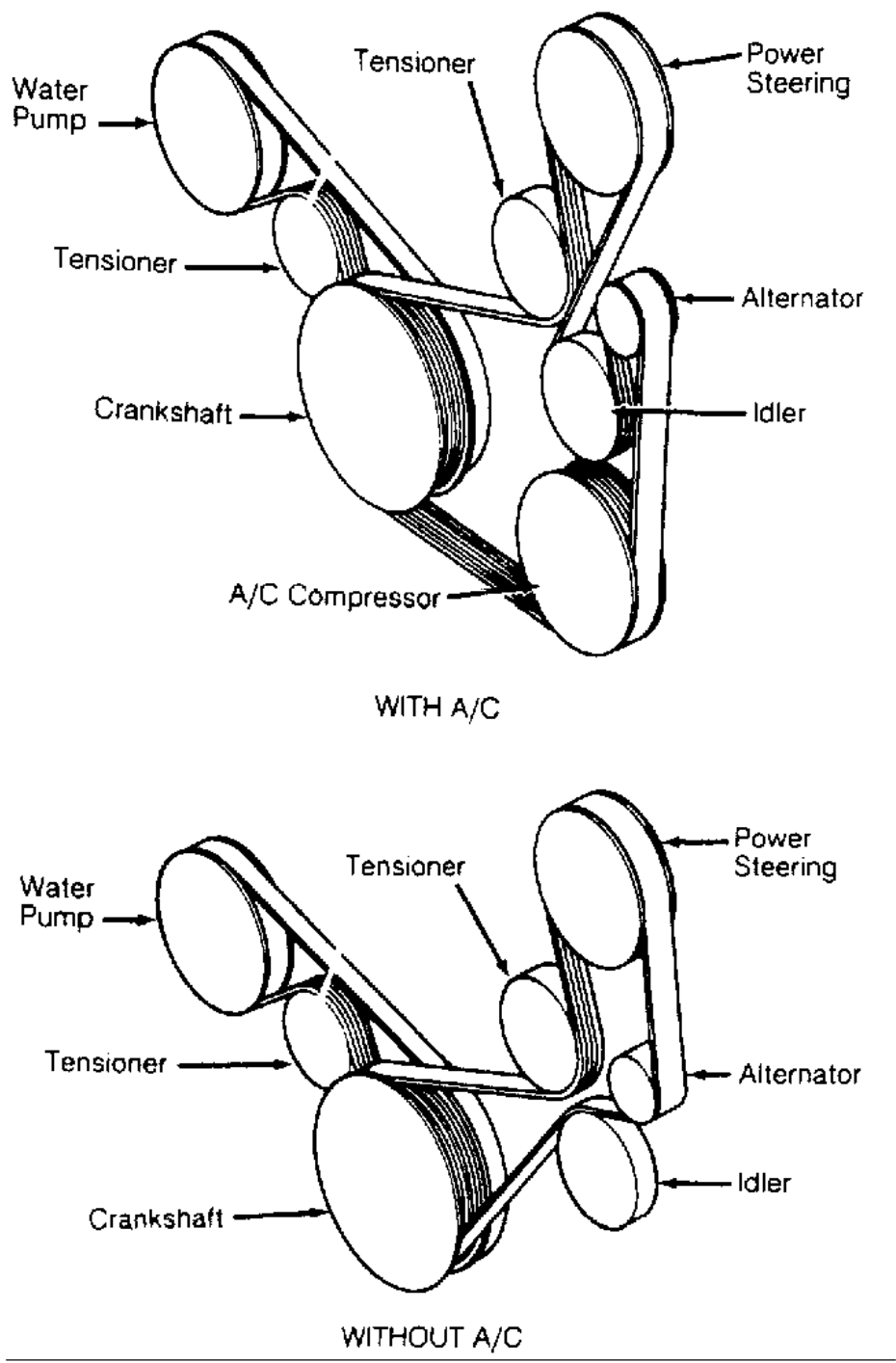


Fig. 14: Serpentine Belt Routing (Probe 3.0L)
Courtesy of FORD MOTOR CO.

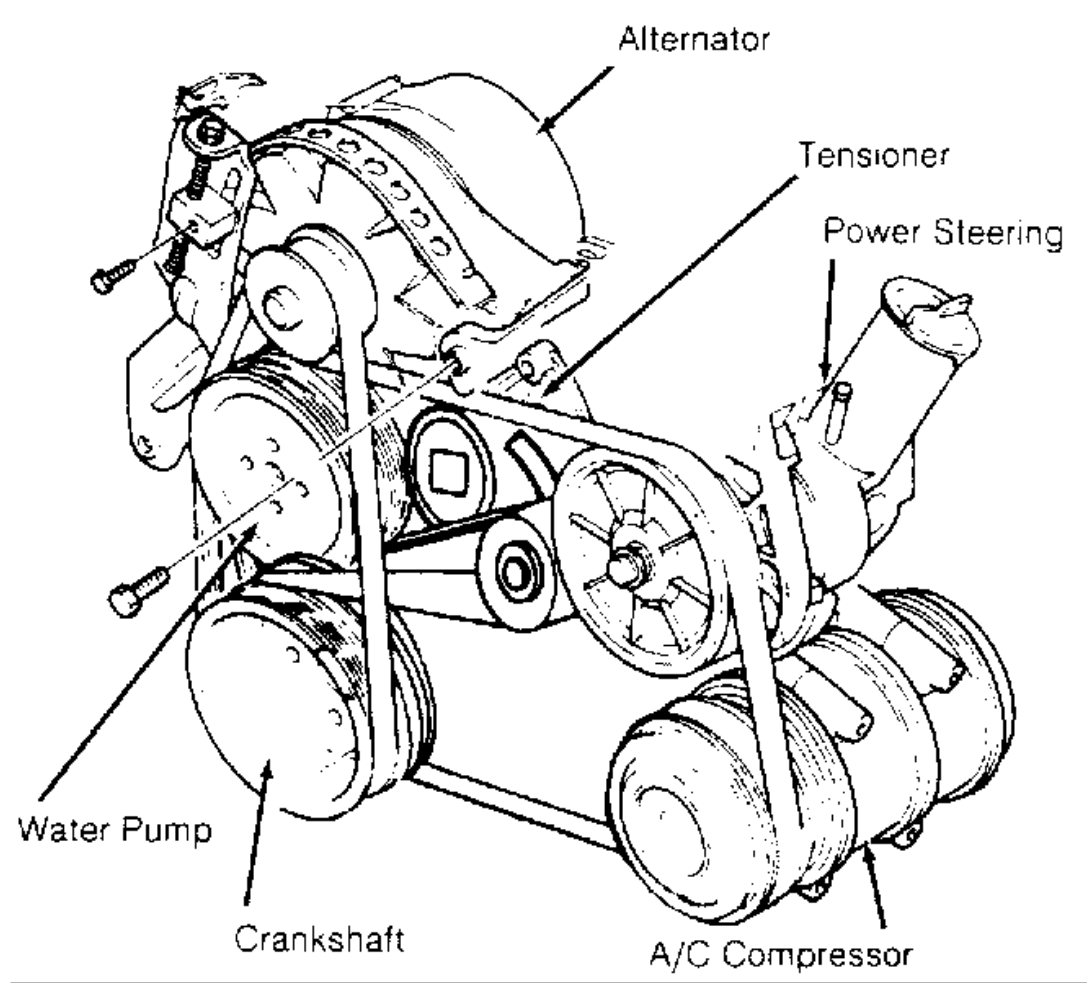
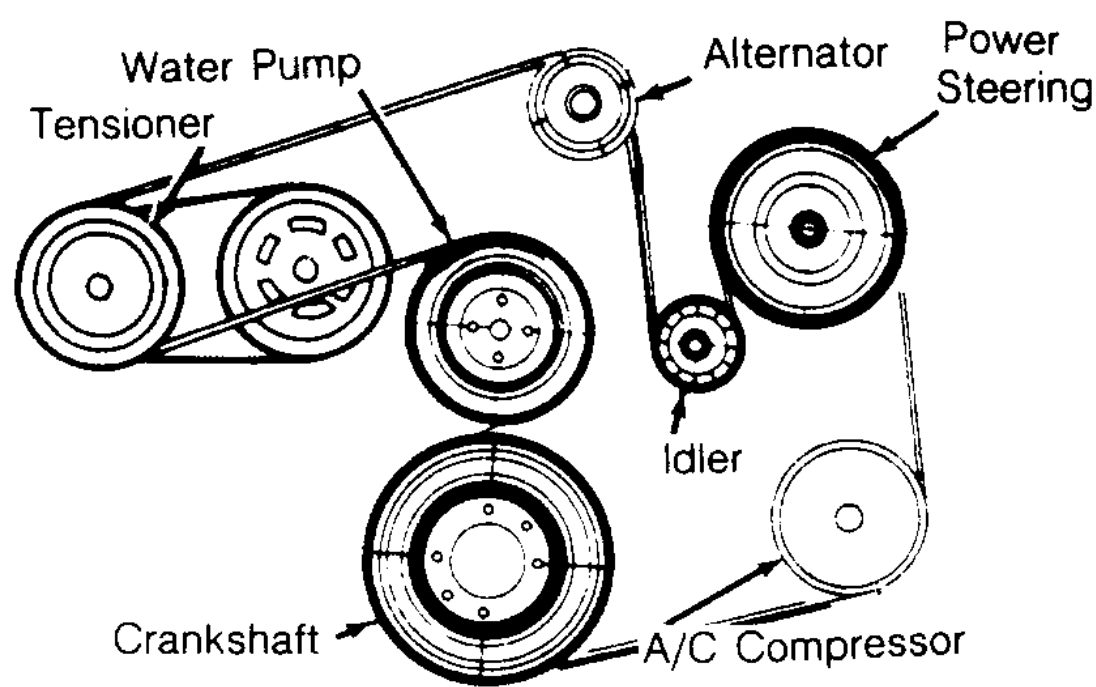


Fig. 15: Serpentine Belt Routing (Sable 3.0L & Taurus 3.0L)
Courtesy of FORD MOTOR CO.



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Fig. 16: Serpentine Belt Routing (Sable 3.8L & Taurus 3.8L)
Courtesy of FORD MOTOR CO.

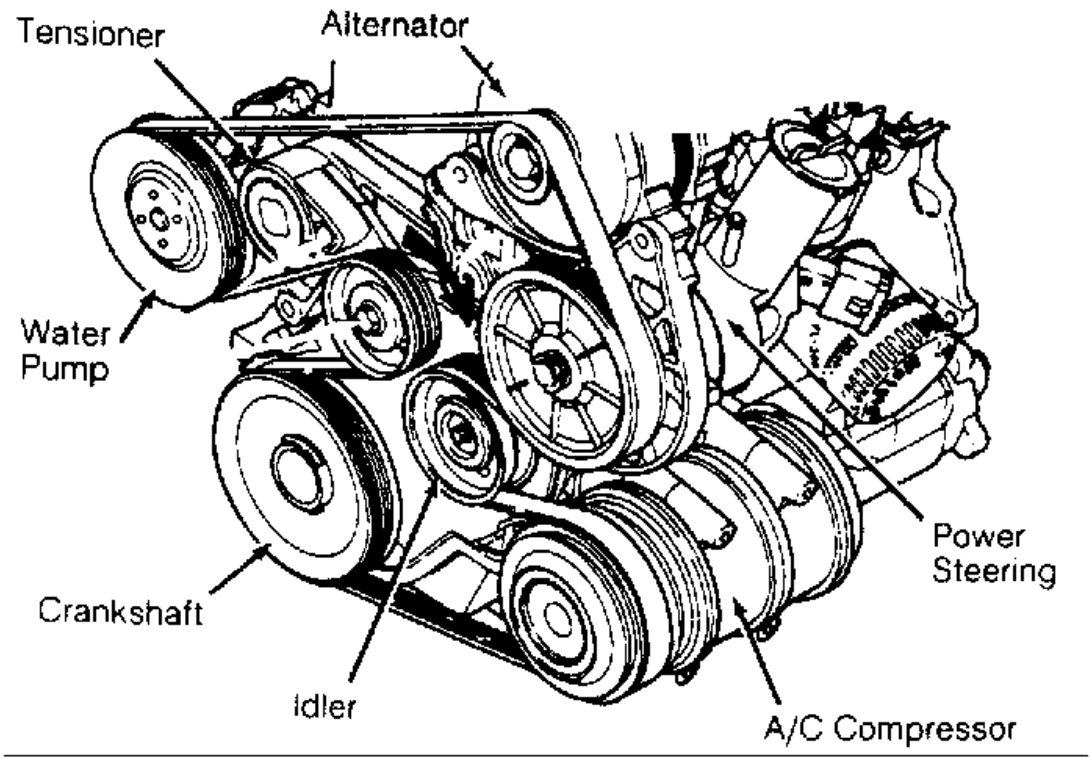


Fig. 17: Serpentine Belt Routing (Taurus 2.5L)
Courtesy of FORD MOTOR CO.

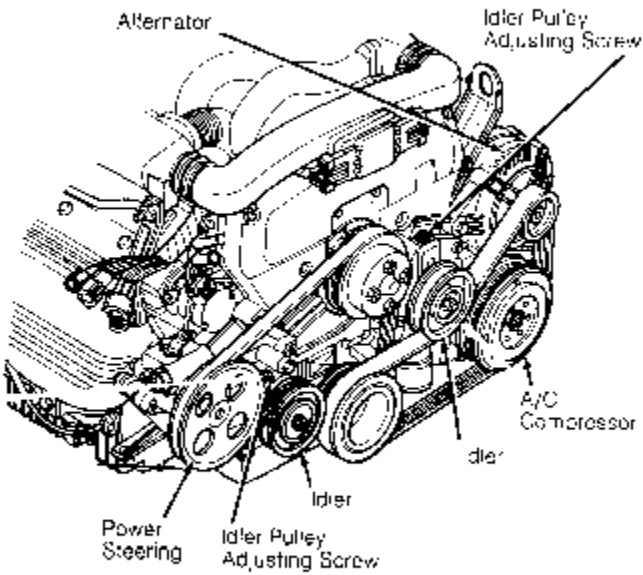
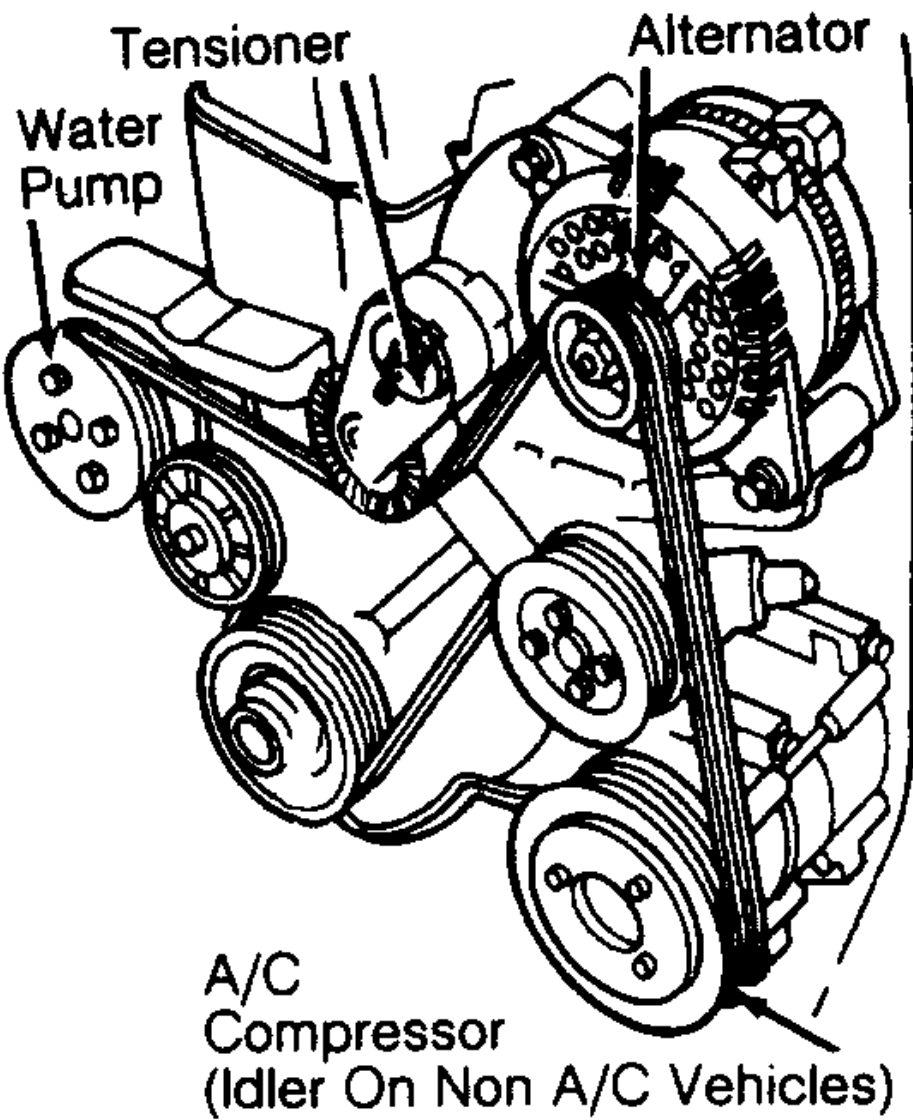


Fig. 18: Serpentine Belt Routing (Taurus 3.0L SHO)
Courtesy of FORD MOTOR CO.

NOTE: Fig. 19 has been revised as per TSB #93-26-11 dated December 22, 1993.



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Fig. 19: Serpentine Belt Routing (Tempo 2.3L & Topaz 2.3L)
Courtesy of FORD MOTOR CO.

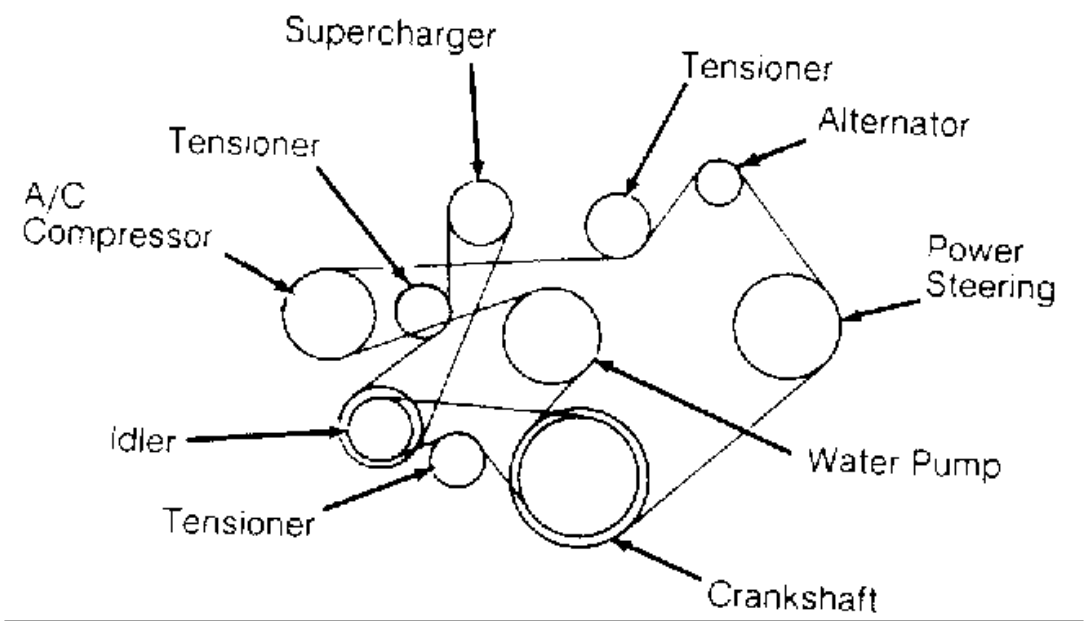


Fig. 20: Serpentine Belt Routing (Thunderbird 3.8L SC)
Courtesy of FORD MOTOR CO.

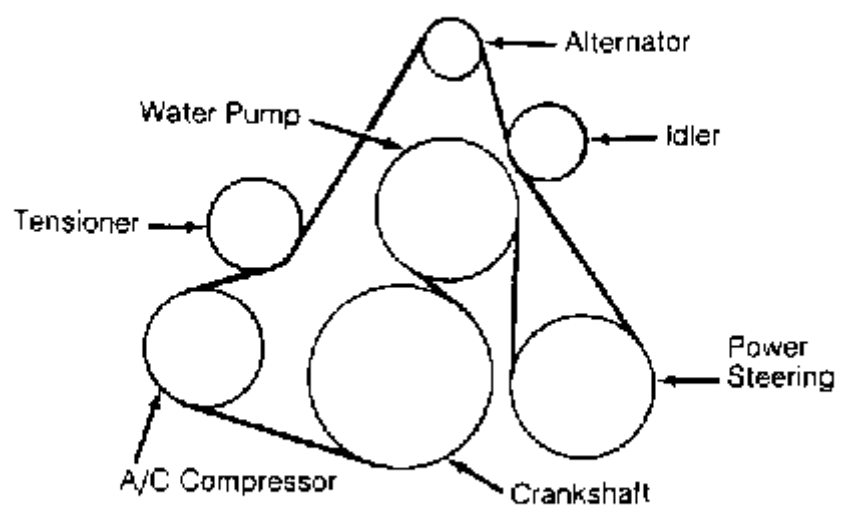


Fig. 21: Serpentine Belt Routing (Town Car 4.6L)
Courtesy of FORD MOTOR CO.

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ENGINE COOLING FAN

1990-92 ENGINE COOLING Ford Motor Co. Engine Cooling Fans

DESCRIPTION

Power for cooling fan is provided by the 20-amp COOLING fuse (Capri) or C-FAN fuse (Festiva). Cooling fan is activated when ground is supplied for fan motor. On Festiva, ground can be supplied by fuel system ECA (located under the left side of dash), A/C cooling fan relay (if equipped) or cooling fan relay. See [Fig. 1](#) . On all models, when cooling fan is energized, relay contacts are open; when cooling fan is NOT energized, relay contacts are closed, providing ground through closed contacts to activate cooling fan. See [Fig. 2](#) .

Cooling fan relay is energized when coolant temperature switch is closed. This occurs when coolant temperature is less than 212°F (100°C) for Capri or 207°F (97°C) for Festiva. At temperatures greater than 212°F (100°C) for Capri or 207°F (97°C) for Festiva, coolant temperature switch opens and cooling fan relay is de-energized, closing relay contacts and energizing cooling fan.

When ECA senses A/C request, it energizes A/C cooling fan relay by providing a ground for relay windings on ECA pin 1Q. Power for the A/C cooling fan relay is provided by the HEATER fuse. On Capri, when A/C cooling fan relay is energized, it opens the power circuit for the cooling fan relay. On Festiva, when A/C cooling fan relay is energized, it provides an alternate path to ground for cooling fan motor. ECA also provides an alternate path to ground (at ECA pin 1R) for cooling fan motor based on input from coolant temperature sensor to ECA pin 2Q.

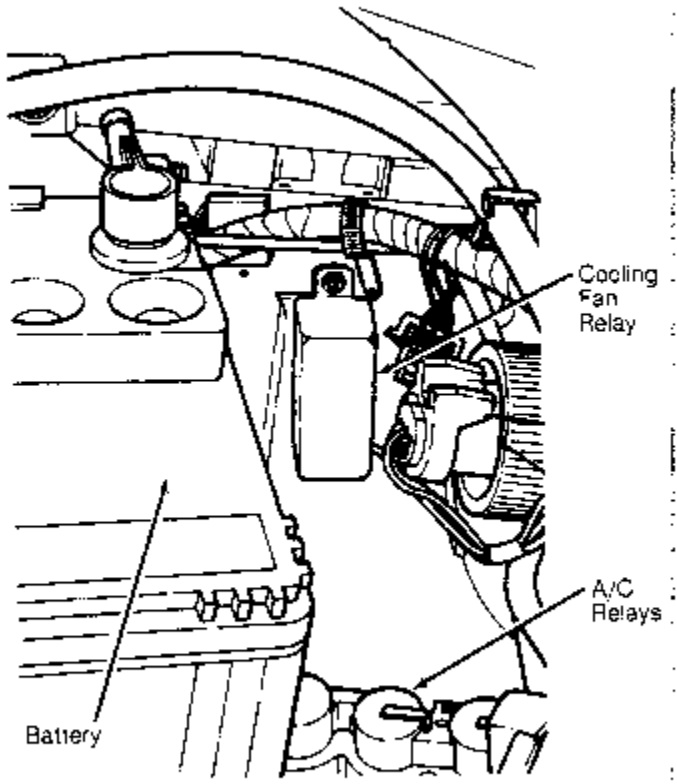


Fig. 1: Locating Cooling Fan & A/C Relays
Courtesy of FORD MOTOR CO.

TROUBLE SHOOTING

COOLING FAN DOES NOT OPERATE OR OPERATES ERRATICALLY

If cooling fan does not run at any time, or operates erratically, check the following items to help locate fault.

- Check power fuse.
- Check cooling fan relay.
- Check coolant temperature switch.
- Check cooling fan wiring harness.
- Check cooling fan motor.
- Check A/C cooling fan relay.

COOLING FAN RUNS CONTINUOUSLY

If cooling fan runs continuously, check the following items to help locate fault.

- Check cooling fan relay.
- Check coolant temperature switch.
- Check cooling fan wiring harness.
- Check cooling fan motor.
- Check A/C cooling fan relay.

COOLING FAN DOES NOT RUN WITH A/C ON

If cooling fan does not run with A/C on, check the following items to help isolate fault.

- Check A/C cooling fan relay.
- Check cooling fan wiring harness.

TESTING

VOLTAGE SUPPLY TEST

Disconnect cooling fan motor connector. Turn ignition on. Check for voltage at Yellow wire terminal of connector. If voltage is NOT present, check for blown 20-amp COOLING fuse (Capri) or C-FAN fuse (Festiva) or open in Yellow wire between cooling fan and fuse.

Disconnect cooling fan relay connector. Cooling fan relay is located in the left front corner of engine compartment. Turn ignition on. Check for voltage at Yellow (Capri) or Black/Yellow (Festiva) wire terminal of connector. If voltage is NOT present, check for blown 30-amp HEATER fuse on Capri or 10-amp METER fuse on Festiva or open in Black/Yellow wire between cooling fan relay and fuse.

Disconnect A/C cooling fan relay connector. On Capri, A/C relay is located in the left rear corner of the engine compartment, on firewall. On Festiva, A/C relay is located in the left front corner of engine compartment, under a triple relay cover. Relay may be identified by wire colors to relay connector. See [Fig. 2](#) and [Fig. 3](#) . Turn ignition on. Check for voltage at Blue wire terminal of connector. If voltage is NOT present, check for blown 15-amp HEATER fuse or open in Blue wire between A/C cooling fan relay and fuse.

GROUND CIRCUIT TEST

Turn ignition off. Unplug connectors from cooling fan and A/C cooling fan relays. Check for continuity between ground and Black wire terminal of relay connectors. If continuity is NOT present, repair Black ground wire.

FAN MOTOR TEST

Disconnect fan motor wire connector. Apply ground and battery voltage to motor connector. Fan should run. If fan does not run, replace cooling fan motor.

COOLING FAN RELAY TEST

Unplug cooling fan relay connector. Apply battery voltage and ground to Yellow and Green/Red (Capri) or Black/Yellow and Green/Yellow (Festiva) wire terminals of relay. Check continuity of relay across Yellow/Green (Capri) or Yellow/Red and Black (Festiva) wire connector terminals. Ensure continuity is NOT present while relay is energized. When relay is de-energized, continuity should exist.

A/C COOLING FAN RELAY TEST

Unplug A/C relay connector. Apply battery voltage and ground to Blue and White (Capri) or Blue and Green (Festiva) wire terminals of relay. Check continuity of relay across Blue and Red (Capri) or Yellow/Red and Black (Festiva) wire connector terminals. On Capri, ensure continuity does NOT exist while relay is energized. On Festiva, ensure continuity exists while relay is energized. On Capri, when relay is de-energized continuity should exist. On Festiva, when relay is de-energized, continuity should NOT exist.

COOLANT TEMPERATURE SWITCH TEST

Disconnect connector from coolant temperature switch located in thermostat housing. With coolant temperature less than 200°F (93°C) for Capri or 194°F (90°C) for Festiva, check continuity between ground and coolant temperature switch. Ensure continuity exists. Start engine and allow coolant temperature to reach 200°F (93°C) for Capri or 207°F (97°C) for Festiva. Check continuity between ground and coolant temperature switch terminal. Continuity should NOT be present. If switch does not test as indicated, replace switch.

HARNESS & CIRCUIT CHECK TEST

Turn ignition off. Disconnect harness connectors of the following components: ECA, cooling fan motor, coolant temperature switch, cooling fan relay and A/C cooling fan relay. Using an ohmmeter, check for continuity on the related harness leads of each connector. See [Fig. 2](#) and [Fig. 3](#) .

WIRING DIAGRAMS

For further detail, see appropriate chassis wiring diagram in the WIRING DIAGRAMS article in the WIRING DIAGRAMS section.

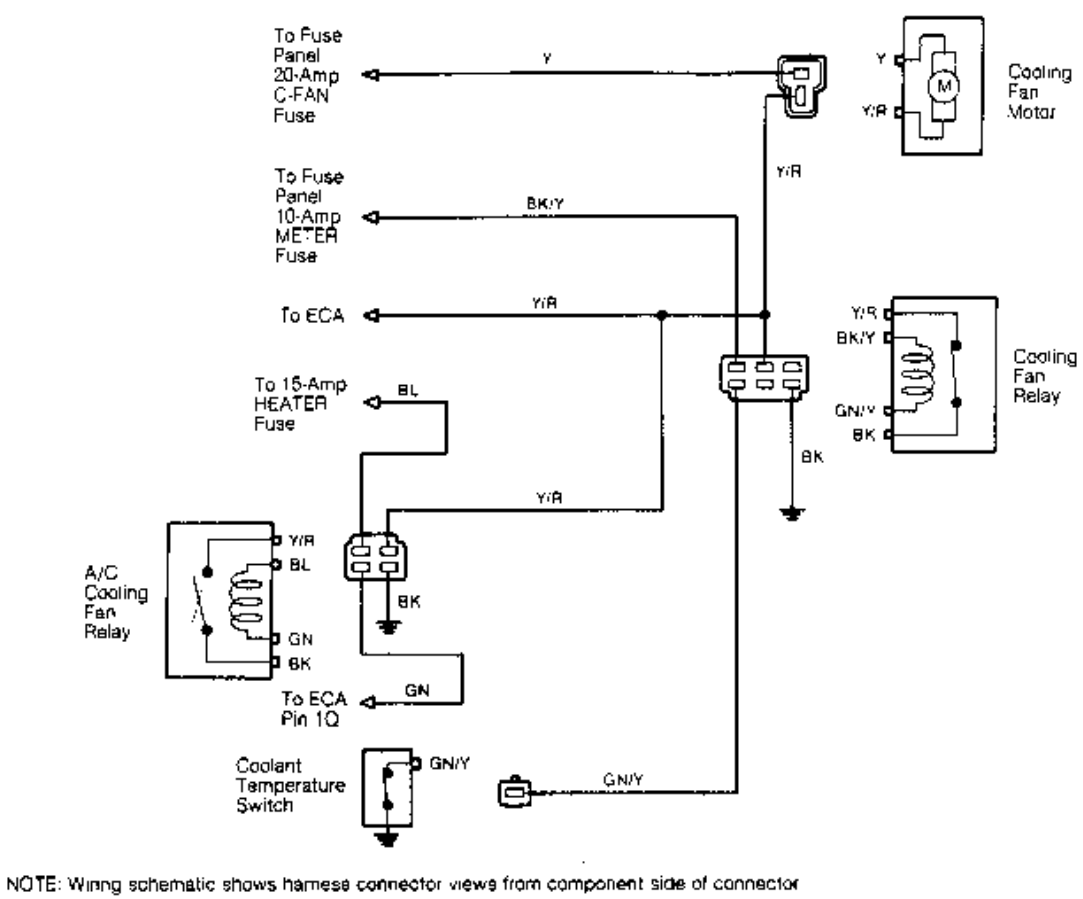


Fig. 2: Electric Cooling Fan Wiring Schematic (Festiva)
Courtesy of FORD MOTOR CO.

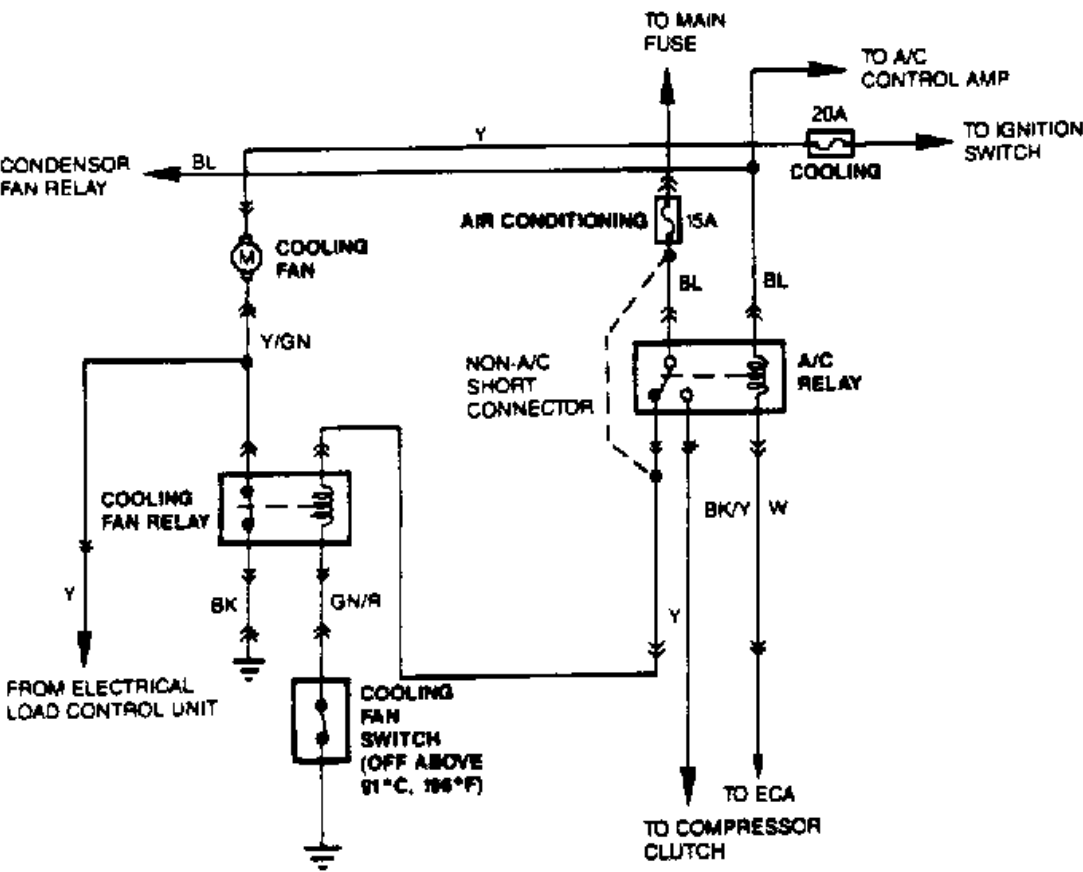


Fig. 3: Electric Cooling Fan Wiring Schematic (Capri)
Courtesy of FORD MOTOR CO.

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1990-92 ENGINE COOLING

Cooling System Specifications - Festiva

BELT ADJUSTMENT TABLE

BELT TENSION ADJUSTMENT SPECIFICATIONS [\(1\)](#)

Application	New Belt Lbs. (Kg)	Used Belt Lbs. (Kg)
A/C Belt	110-125 (50-57)	92-110 (42-50)
Alt. Belt	110-130 (50-60)	95-110 (43-50)
Power Steering	110-130 (50-60)	95-110 (43-50)
(1) Measure tension with strand tension gauge.		

COOLING SYSTEM SPECS TABLE

COOLING SYSTEM SPECIFICATIONS

Application	Specification
Coolant Replacement Interval	Every 36 Months
Coolant Capacity	5.3 Qts. (5.0L)
Pressure Cap	11-15 psi
Thermostat Opens (1)	
Main Valve	188-193°F (86.5-89.5°C)
Sub-Valve	182-188°F (83.5-86.5°C)
(1) Dual stage thermostat.	

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DRIVE BELT ROUTING

1991-92 ENGINE COOLING BELT ROUTING

BELT ADJUSTMENT

Tensioners may be used to automatically adjust belt tension to specification. Check belt for fraying. If fraying exists, ensure both belt and tensioner are properly aligned. See [Fig. 1](#) . Tensioners may contain a belt-wear indicator. See [Fig. 2](#) . If tensioner reaches travel limit, as indicated by marks on tensioner, replace belt. Ensure serpentine belts are properly installed. See [Fig. 3 -Fig. 7](#) . On models without tensioners, ensure belt tension is within specification. See BELT ADJUSTMENT SPECIFICATIONS table.

BELT TENSION ADJUSTMENT SPECIFICATIONS [\(1\)](#)

Application	New Belt	(2) Used Belt
Continental	(3)	(3)
Cougar & Thunderbird	(3)	(3)
Crown Victoria & Grand Marquis		
5.0L & 5.8L		
1/4" "V" Belt	70 (32)	50 (23)
6 Rib Belt	170 (77)	150 (68)
Escort & Tracer		
1.8L	(4) (5)	(4) (5)
1.9L	(3)	(3)
Mark VII	(3)	(3)
Mustang	(3)	(3)
Probe		
2.2L & 2.2L Turbo		
Alternator	(4) (6)	(4) (6)
A/C	90 (41)	90 (41)
Sable & Taurus		
2.5L	(3)	(3)
3.0L (7)		
Alternator	140-160 (63-67)	110-130 (50-59)
P/S & A/C	(3)	(3)
3.0L SHO		
A/C & Alt.	220-265	(100-120) 148-192 (67-87)
P/S & W/P	154-198 (70-90)	112-157 (51-71)
3.8L	(3)	(3)
Tempo & Topaz		
2.3L		
Alternator	150-170 (68-77)	130-150 (59-68)
W/P	150-90 (23-41)	40-60 (18-27)
Town Car	(3)	(3)
(1) Tension is measured in Lbs. (kg) using tension gauge. (2) Used belt is a belt in operation for at least 10 minutes. (3) Belt tension is automatically adjusted by tensioner. (4) Manufacturer lists only belt deflection with 22 lbs. applied on belt. (5) Belt deflection on new belt is .31-.35" (7.9-8.9 mm) or .35-.39" (8.9-9.9 mm) on used belt. (6) Belt deflection on new belt is .24-.31" (6.1-7.9 mm) or .27-.35" (6.9-8.9 mm) on used belt. (7) Specification is for models without belt tensioner.		

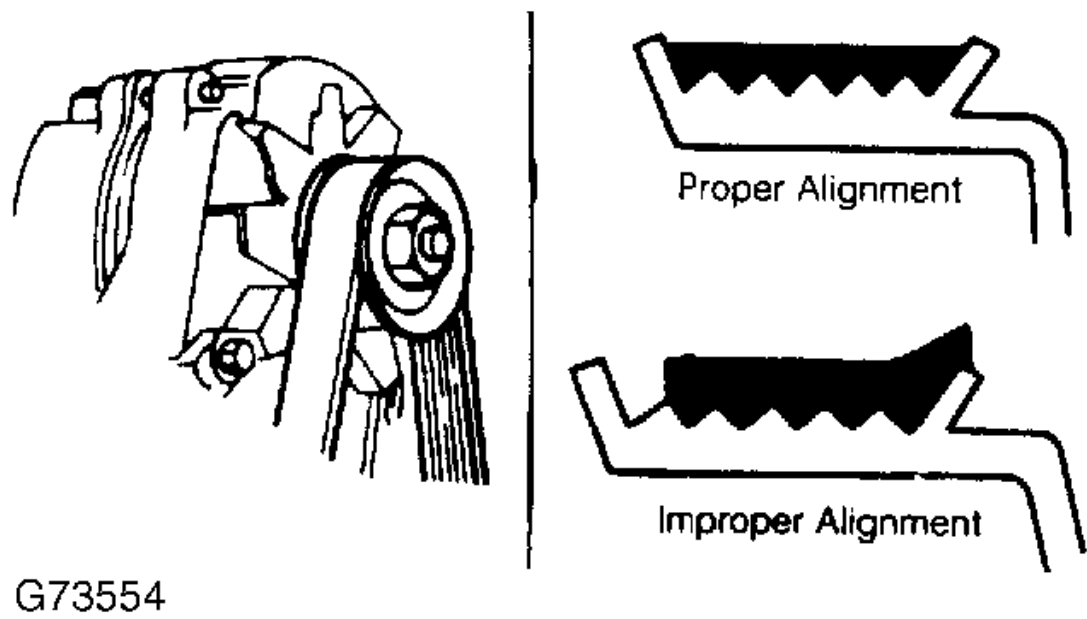
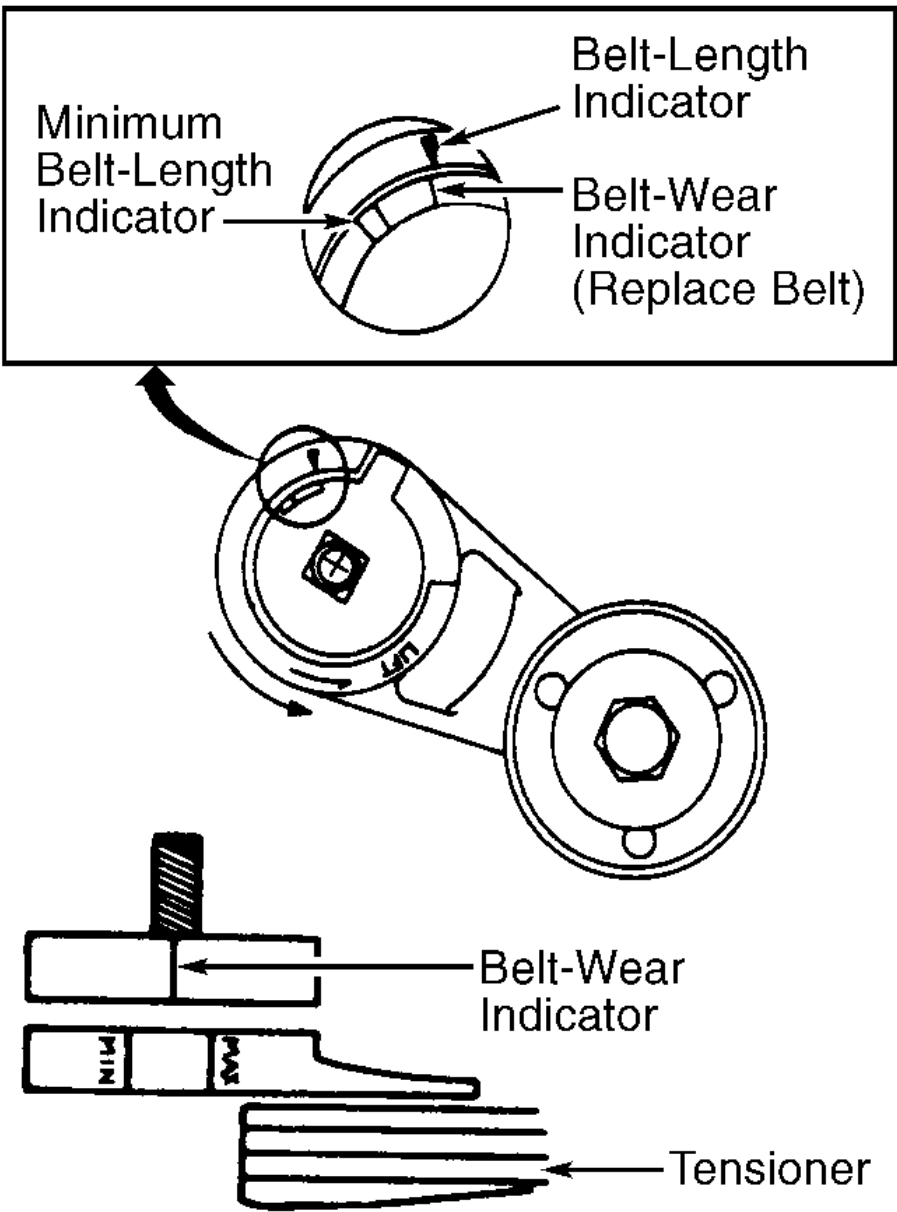


Fig. 1: Aligning Serpentine Belts
Courtesy of FORD MOTOR CO.



NOTE: The wear indicator mark inspection is done with engine off.

Fig. 2: Locating Tensioner Wear Indicator
Courtesy of FORD MOTOR CO.

BELT ROUTING

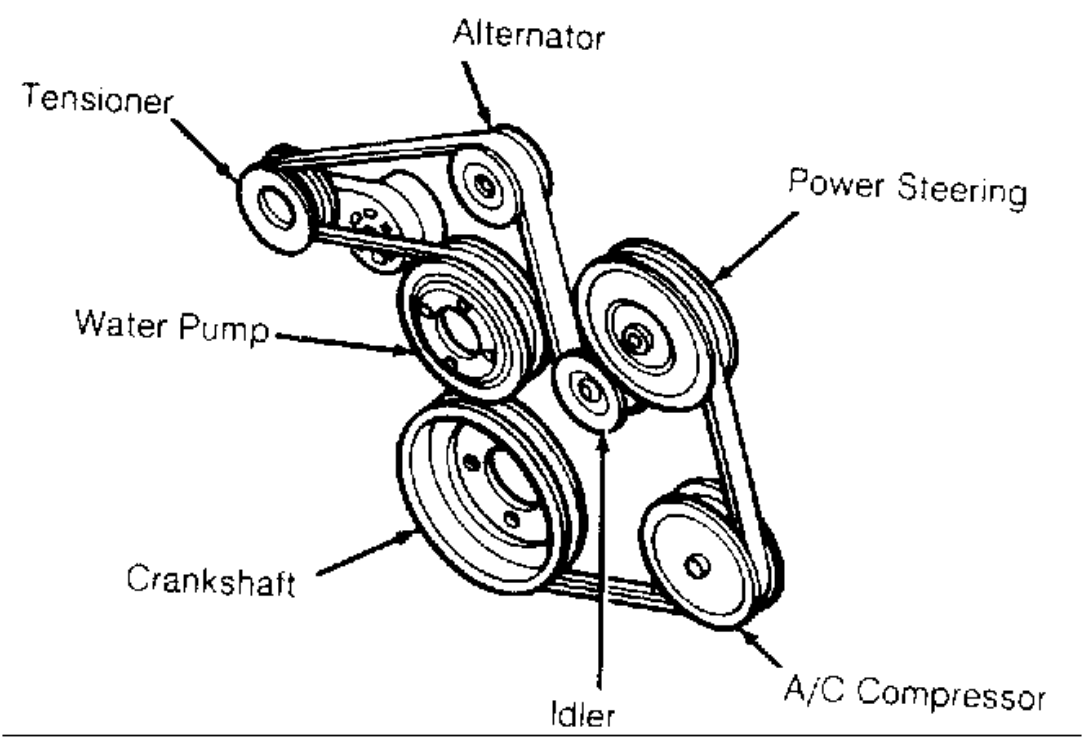


Fig. 3: Serpentine Belt Routing (Continental 3.8L)
Courtesy of FORD MOTOR CO.

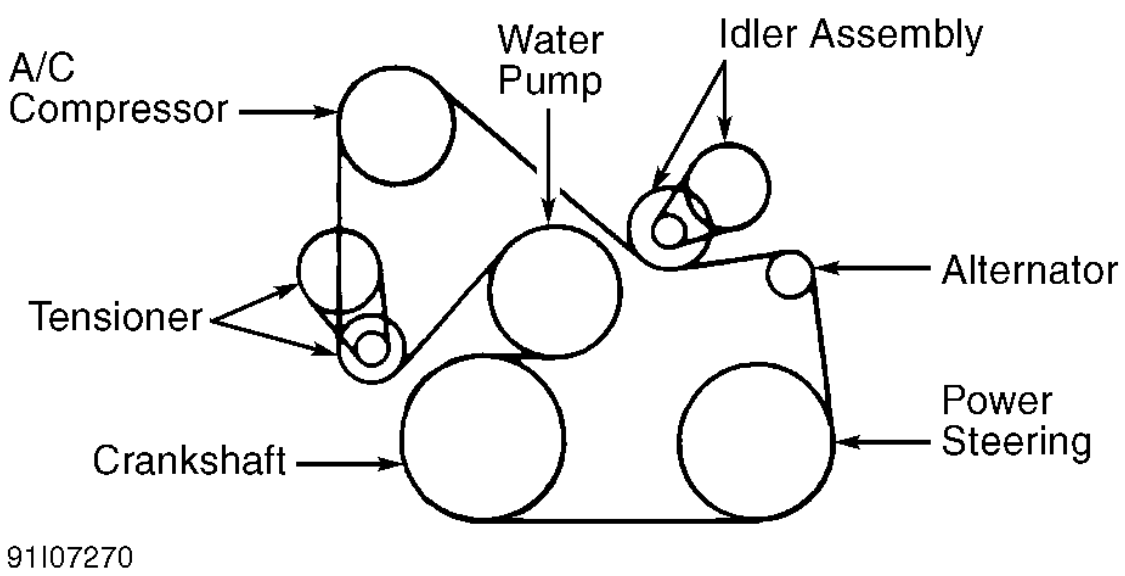


Fig. 4: Serpentine Belt Routing (Cougar 5.0L & Thunderbird 3.8L)
Courtesy of FORD MOTOR CO.

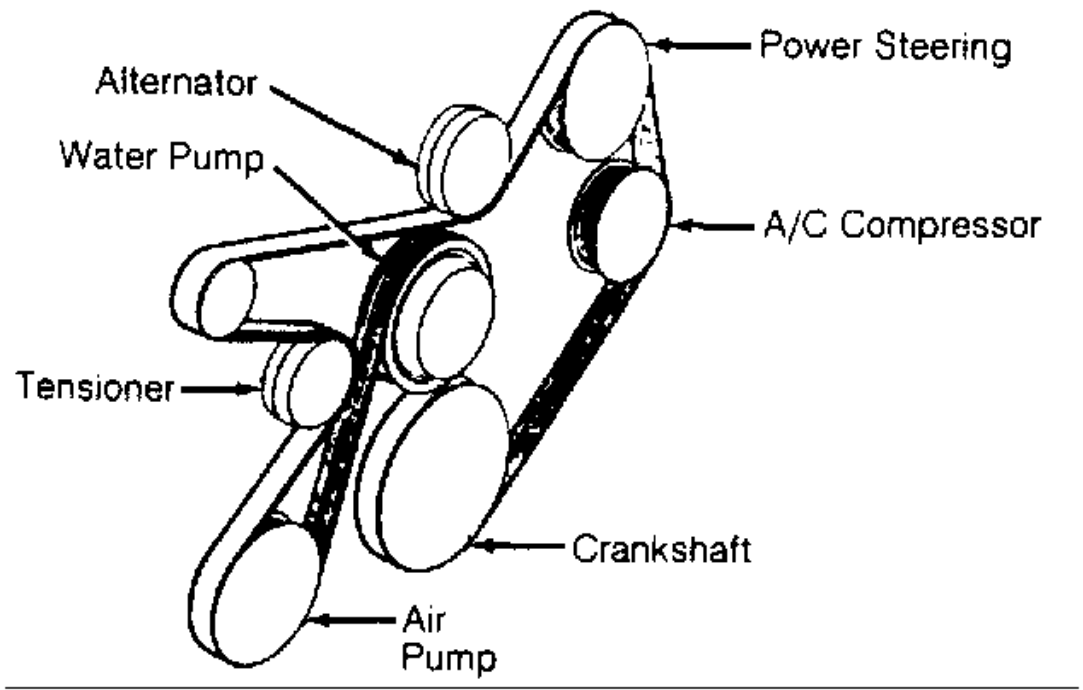


Fig. 5: Serpentine Belt Routing (Cougar 5.0L & Thunderbird 5.0L)
Courtesy of FORD MOTOR CO.

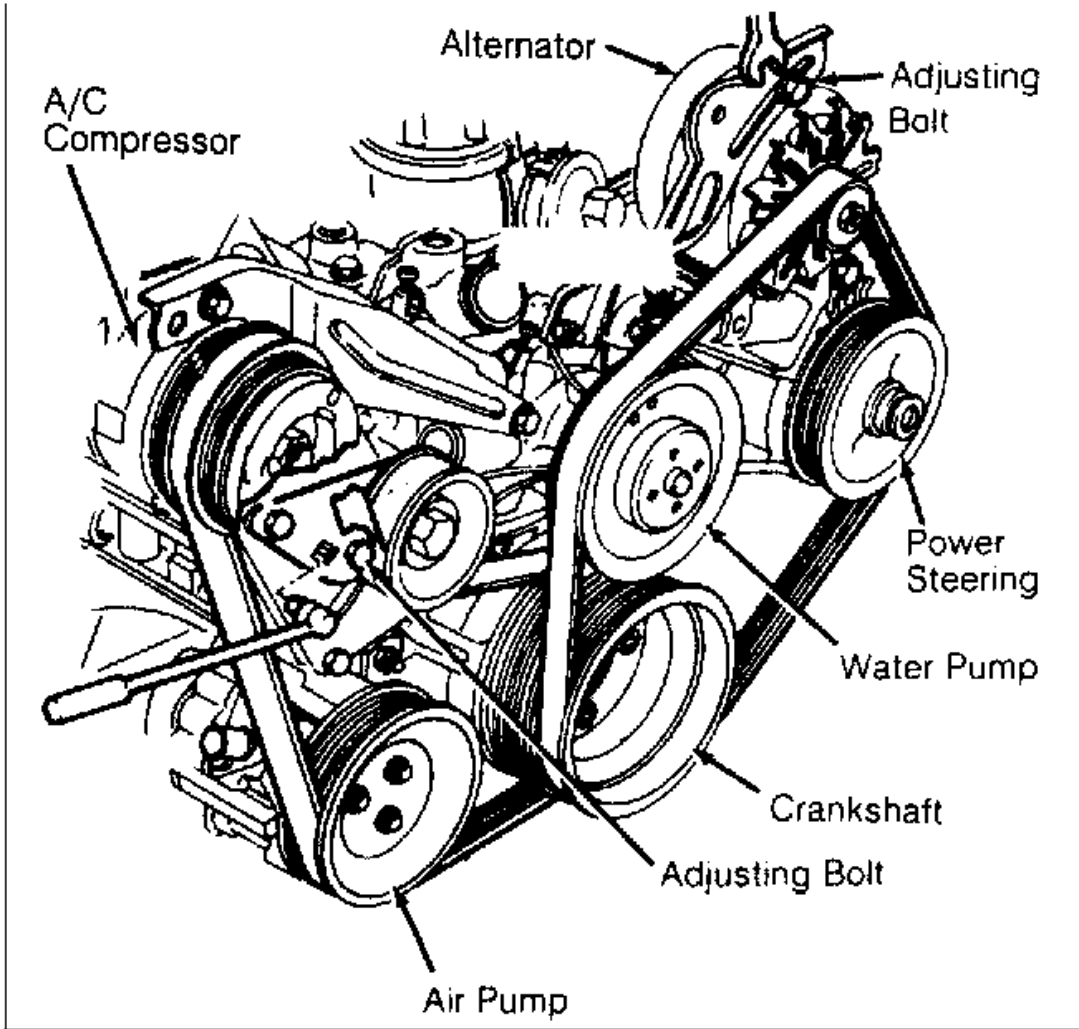


Fig. 6: Serpentine Belt Routing (Crown Victoria & Grand Marquis)
Courtesy of FORD MOTOR CO.

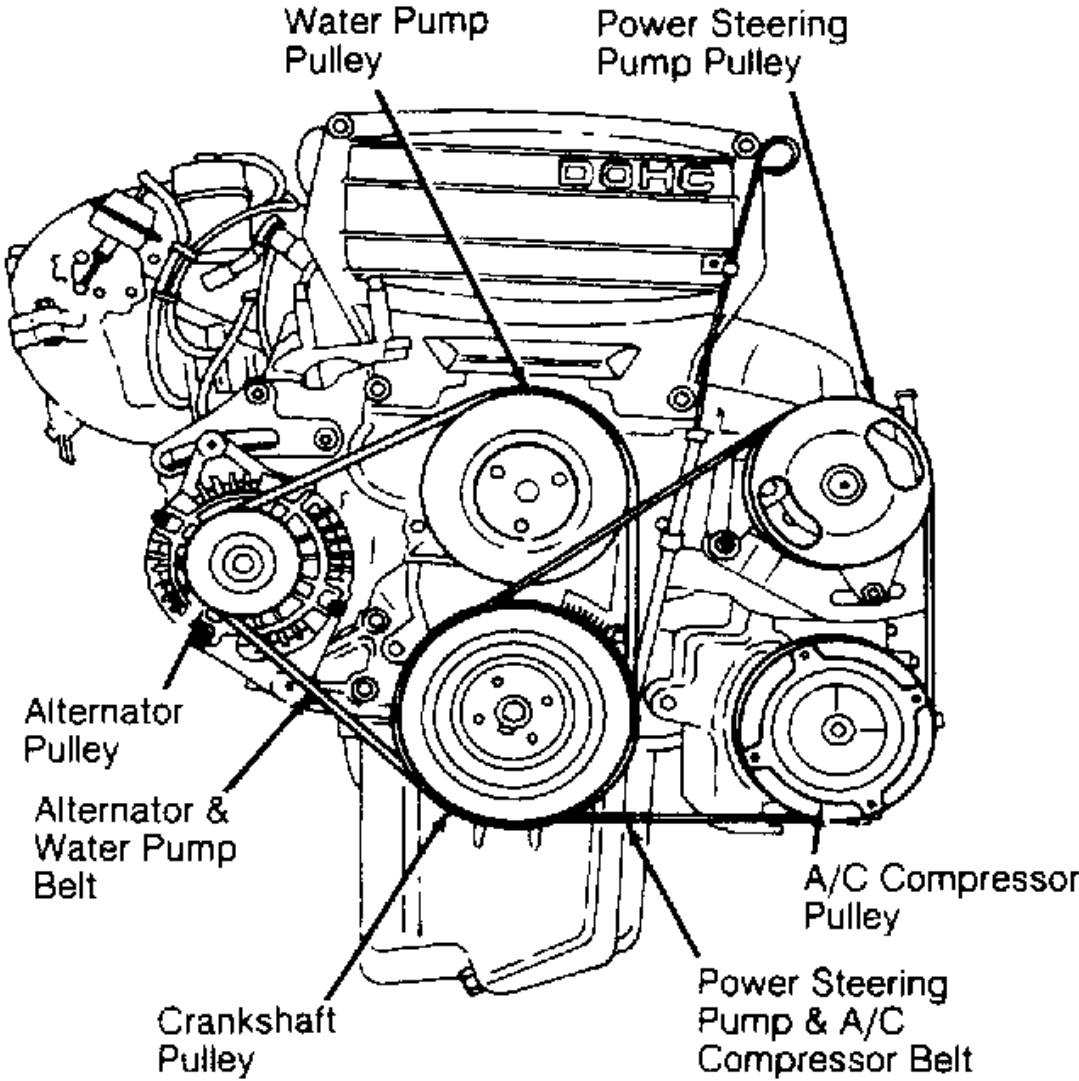


Fig. 7: Serpentine Belt Routing (Escort & Tracer 1.8L)
Courtesy of FORD MOTOR CO.

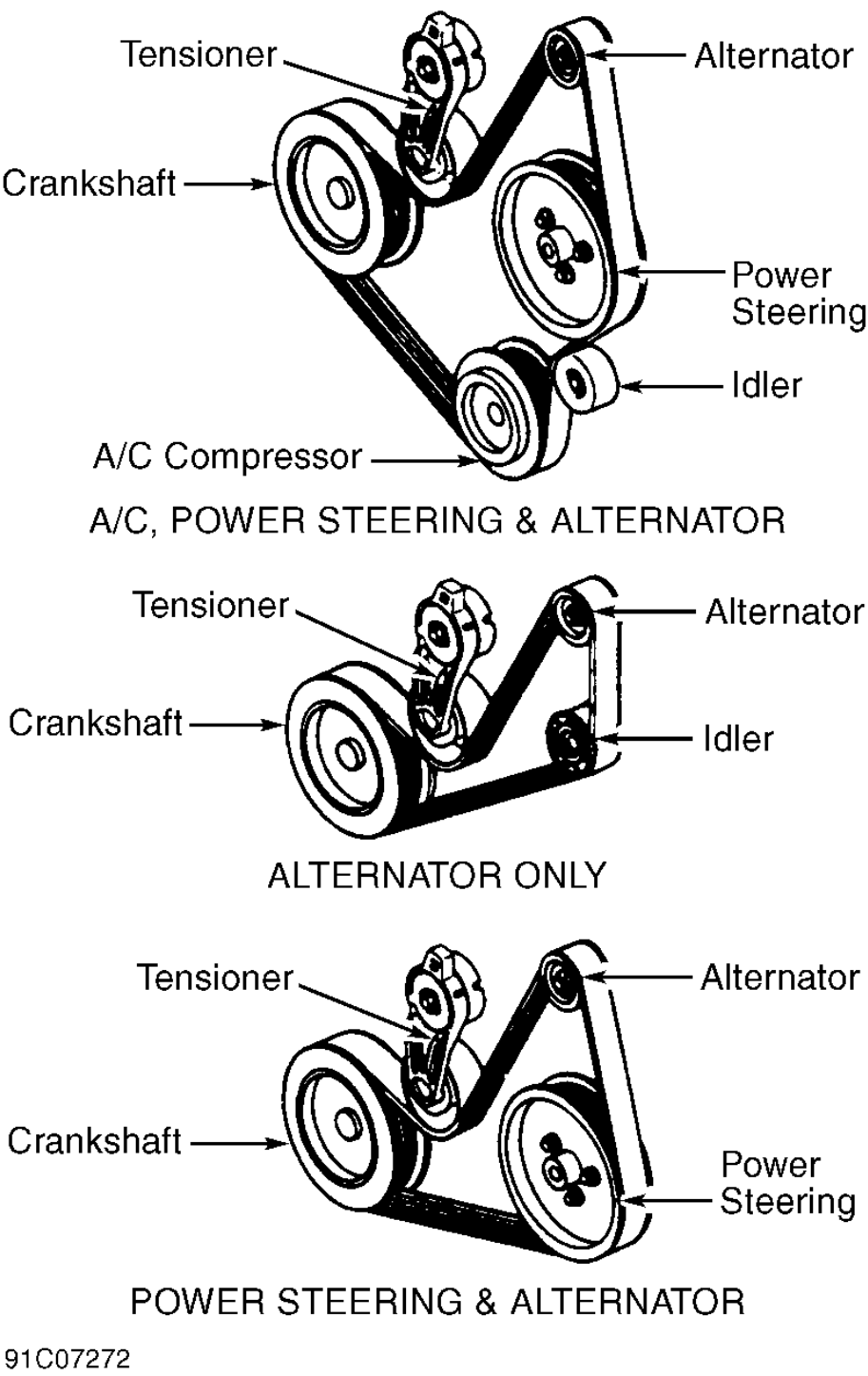


Fig. 8: Serpentine Belt Routing (Escort 1.9L & Tracer 1.9L)
Courtesy of FORD MOTOR CO.

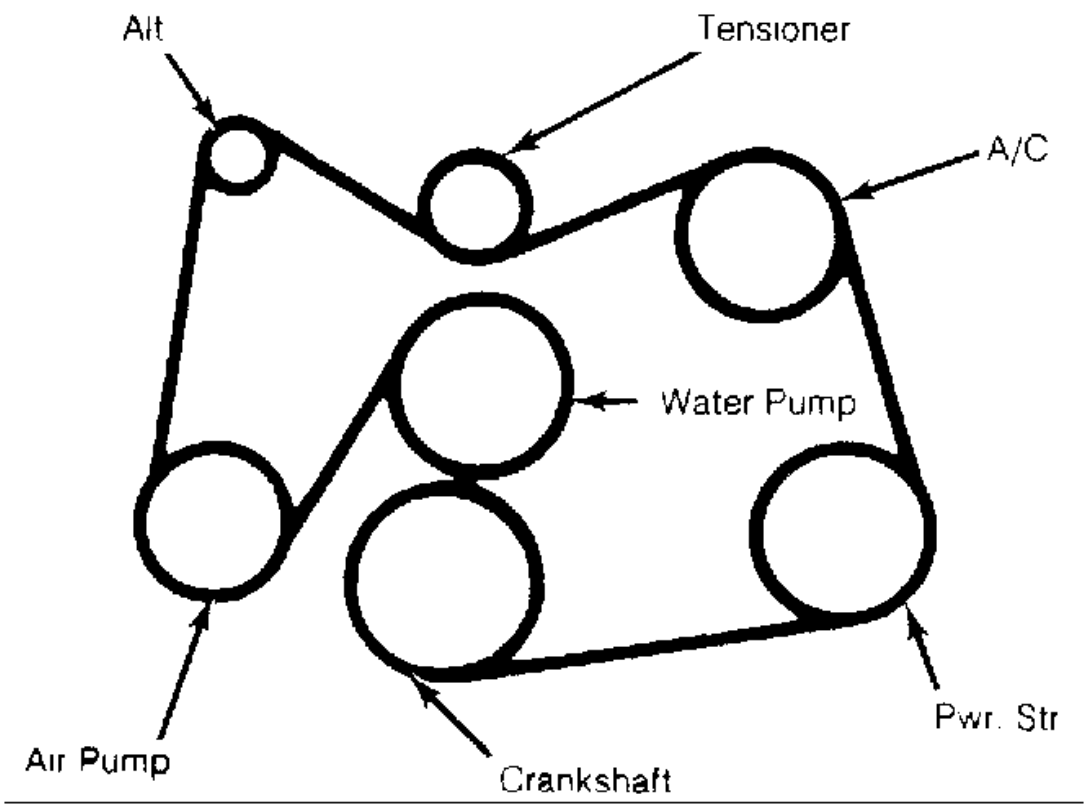


Fig. 9: Serpentine Belt Routing (Mark VII)
Courtesy of FORD MOTOR CO.

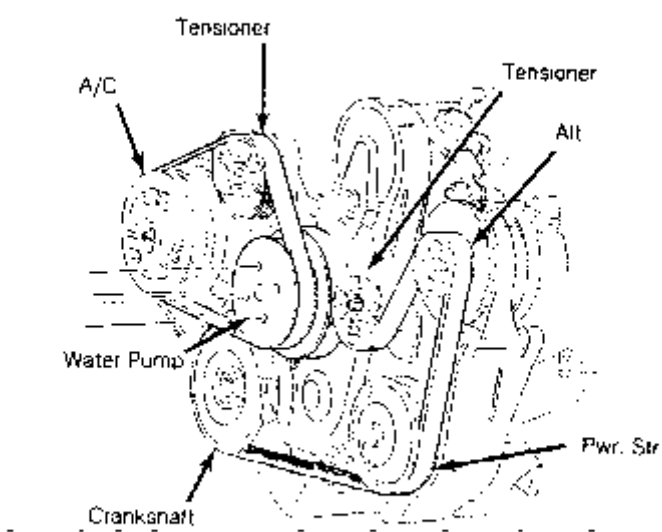


Fig. 10: Serpentine Belt Routing (Mustang 2.3L with A/C)
Courtesy of FORD MOTOR CO.

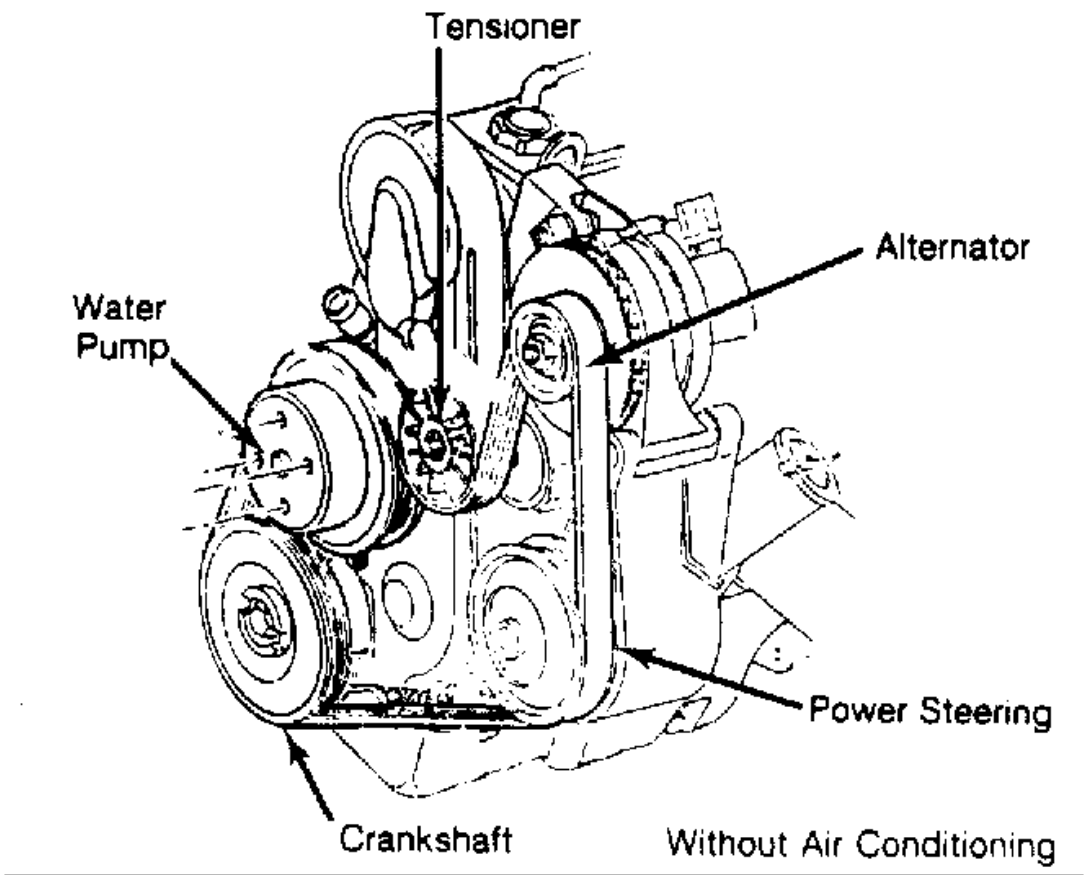


Fig. 11: Serpentine Belt Routing (Mustang 2.3L without A/C)
Courtesy of FORD MOTOR CO.

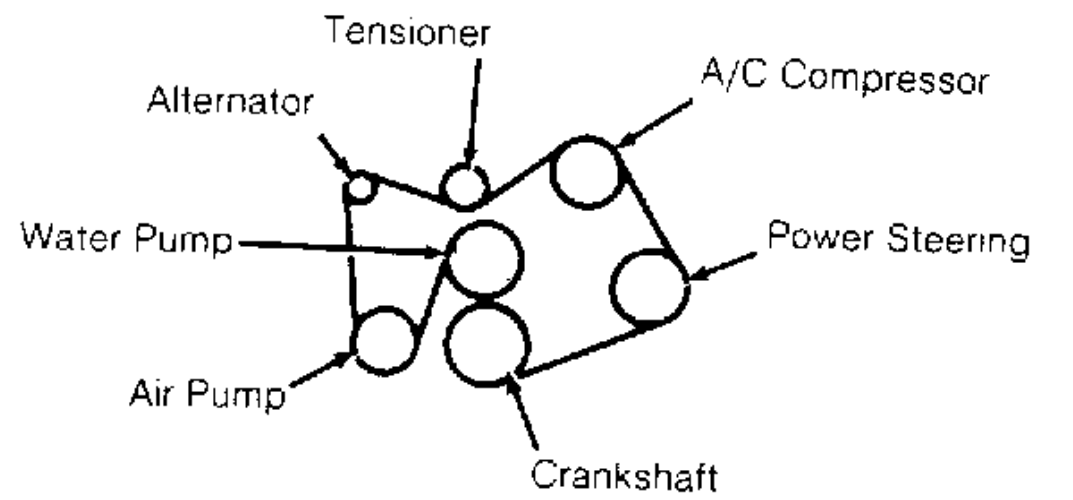


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Courtesy of FORD MOTOR CO.

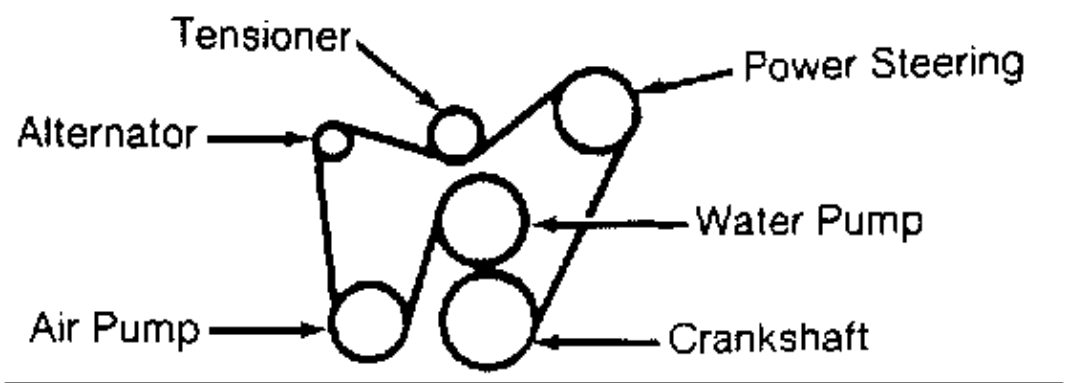


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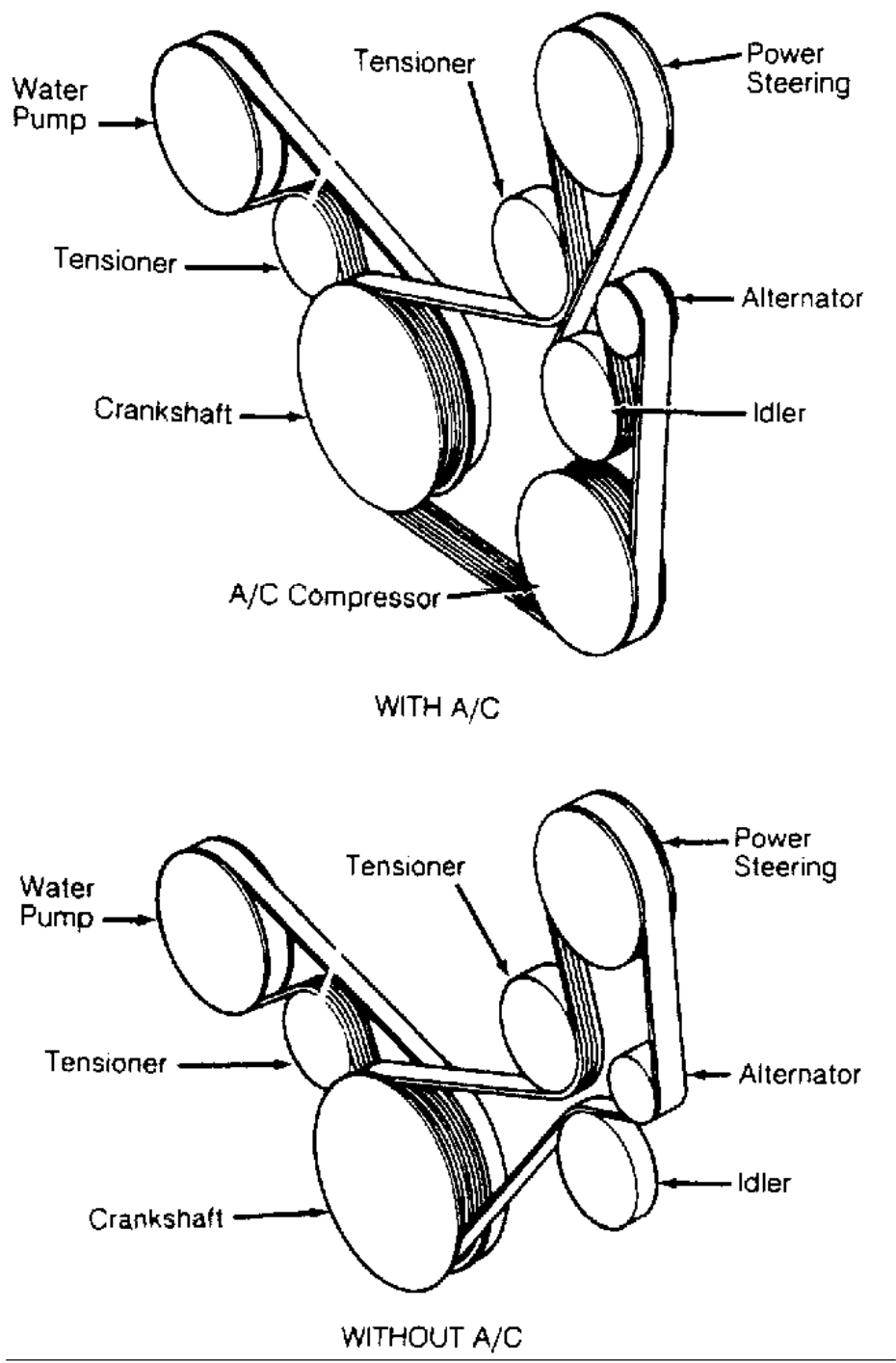


Fig. 14: Serpentine Belt Routing (Probe 3.0L)
Courtesy of FORD MOTOR CO.

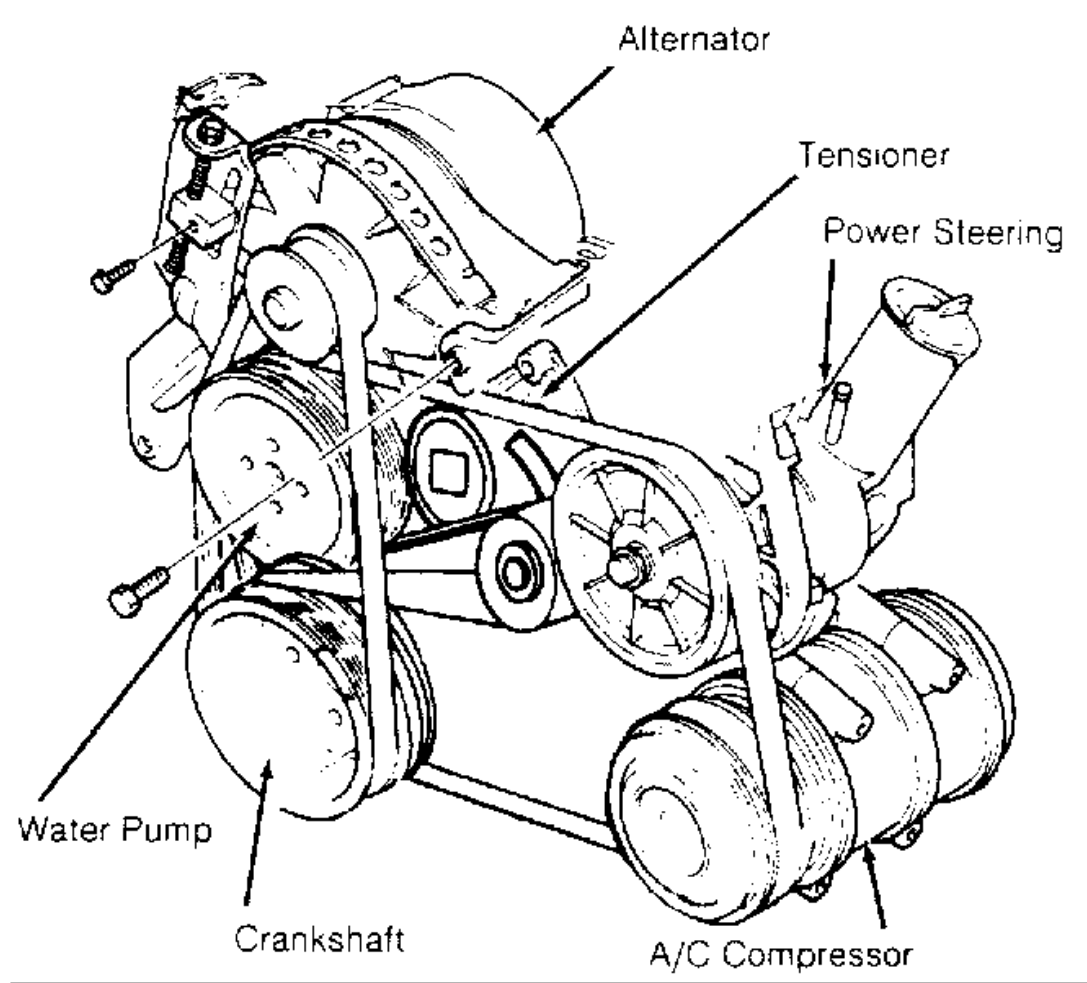
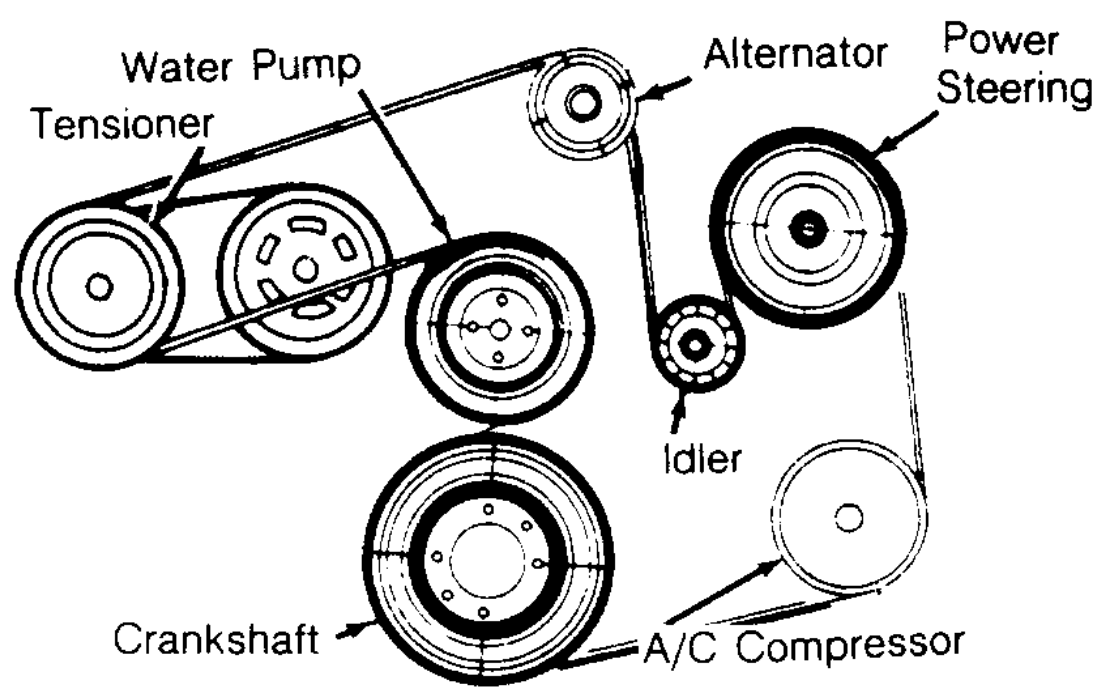


Fig. 15: Serpentine Belt Routing (Sable 3.0L & Taurus 3.0L)
Courtesy of FORD MOTOR CO.



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Fig. 16: Serpentine Belt Routing (Sable 3.8L & Taurus 3.8L)
Courtesy of FORD MOTOR CO.

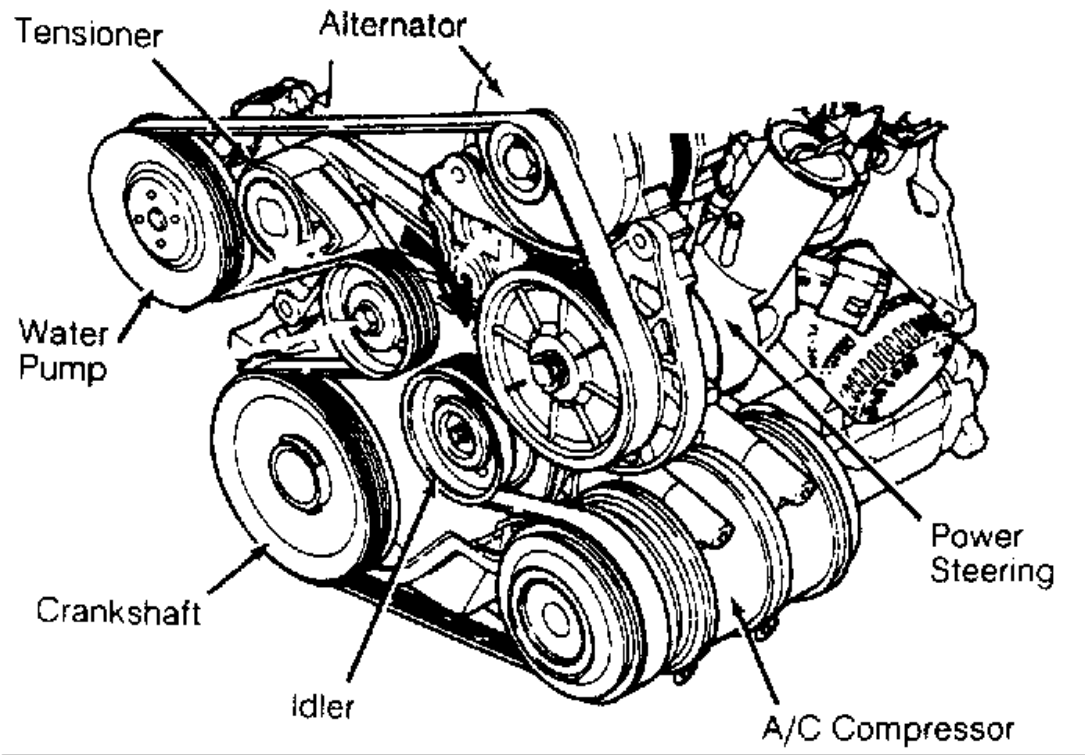


Fig. 17: Serpentine Belt Routing (Taurus 2.5L)
Courtesy of FORD MOTOR CO.

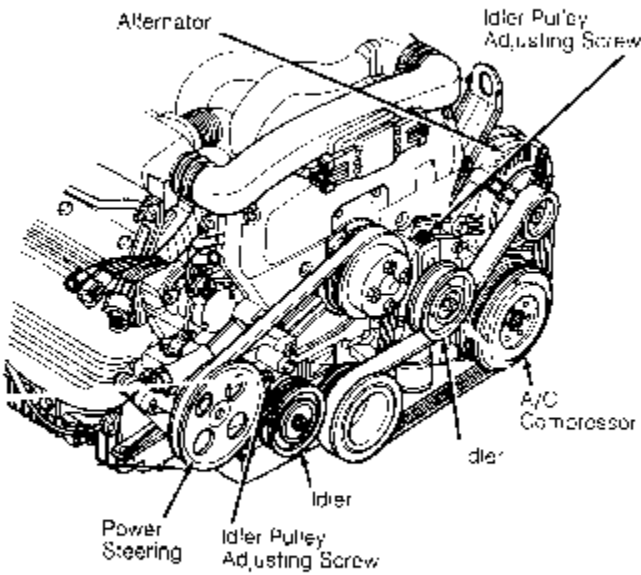
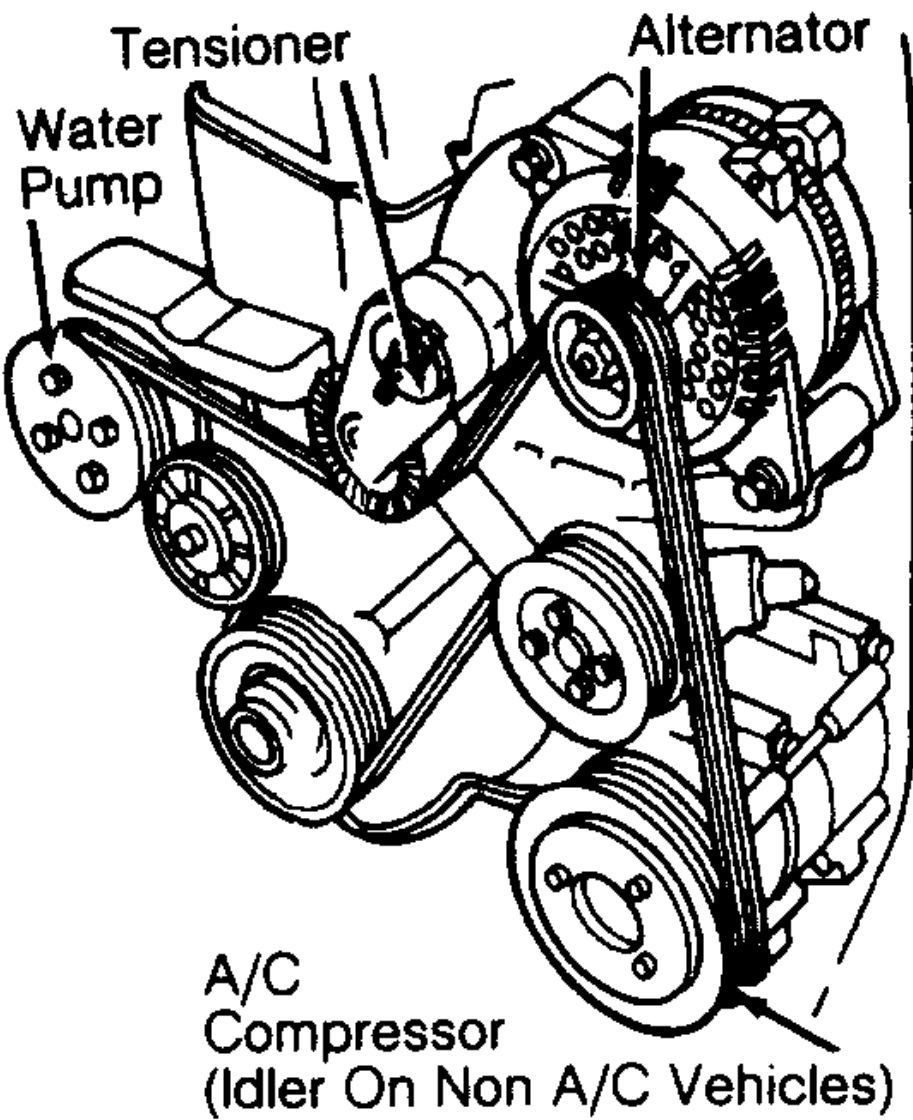


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Courtesy of FORD MOTOR CO.

NOTE: **Fig. 19** has been revised as per TSB #93-26-11 dated December 22, 1993.



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Courtesy of FORD MOTOR CO.

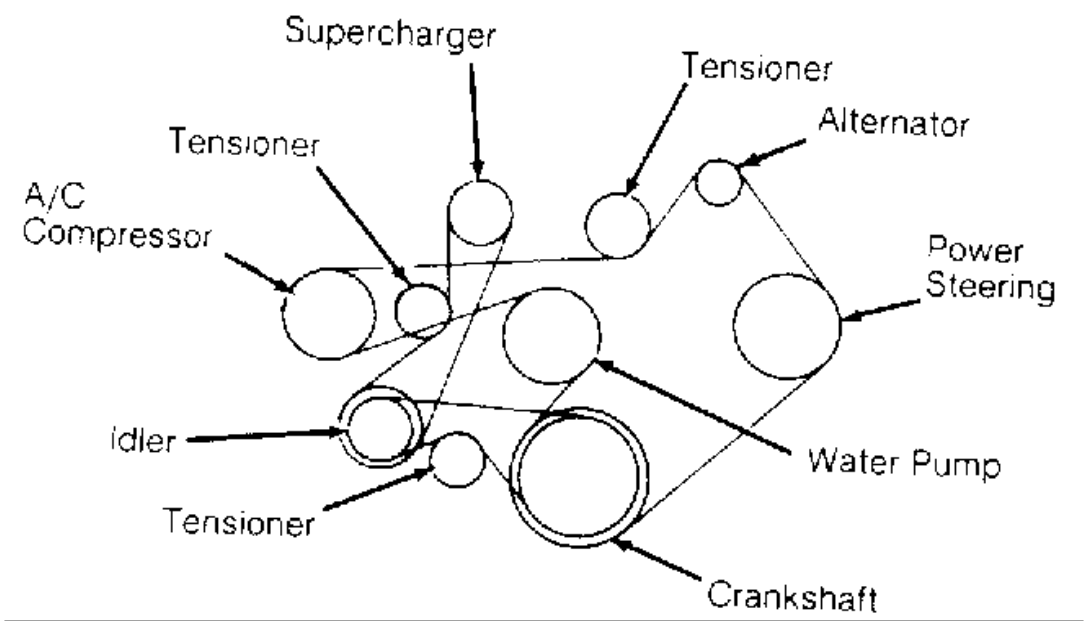


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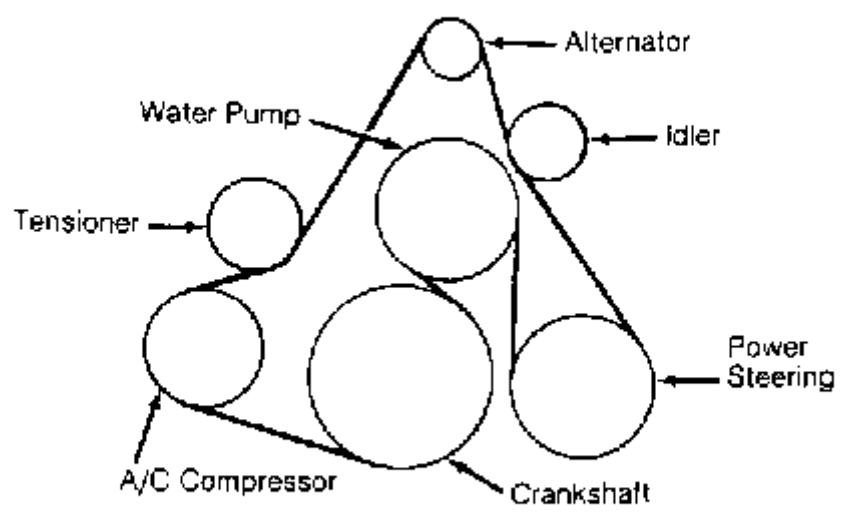


Fig. 21: Serpentine Belt Routing (Town Car 4.6L)
Courtesy of FORD MOTOR CO.

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ENGINE OVERHAUL

1991-92 FORD MOTOR CO. ENGINES 1.3L & 1.6L 4-Cylinder

ENGINE IDENTIFICATION

NOTE: For engine repair procedures not covered in this article, see [ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION](#) article in the GENERAL INFORMATION section.

Engine can be identified by Vehicle Identification Number (VIN) on metal tab attached to instrument panel. Tab is close to windshield on driver's side and is visible through windshield. VIN has 17 characters. The 8th character identifies engine.

ENGINE IDENTIFICATION CODES

Application	VIN Code
Festiva	
1.3L SOHC PFI	H
Capri	
1.6L DOHC PFI	Z
1.6L DOHC PFI TURBO	6

ADJUSTMENTS

VALVE ARRANGEMENT

Firewall Side

Intake valves.

Radiator Side

Exhaust valves.

VALVE CLEARANCE ADJUSTMENT

Hydraulic lifters are used. Adjustment is NOT possible nor necessary.

REMOVAL & INSTALLATION

FUEL PRESSURE RELEASE

Remove rear seat. Remove fuel pump access panel. Disconnect fuel pump electrical connector. Start engine and allow to idle until engine dies.

ENGINE

NOTE: When removing engine mounts, mark and note location and position to ensure proper installation. Engine and transaxle are removed as an assembly.

Removal (1.3L)

1. Remove battery and battery tray. Index hood-to-hinge and remove hood. Drain coolant. Drain engine oil and transaxle fluid. Disconnect vane airflow meter connector, vane airflow meter and hose.
2. Remove oil dipstick, cooling fan and radiator assembly. Disconnect accelerator cable from mounting bracket and throttle lever. Disconnect speedometer cable at transaxle. Mark and disconnect fuel lines at fuel pump. Plug fuel lines. Remove heater hoses. Remove brake booster vacuum hose. Disconnect transaxle vacuum hose.
3. Remove charcoal canister hoses from engine. Disconnect engine wiring harness. Remove alternator and brackets. Remove engine ground strap. Raise vehicle and remove catalytic converter.
4. Disconnect A/C compressor without removing hoses, and set compressor aside. Disconnect distributor wiring at coil. On automatic transaxle models, remove shift lever-to-manual shaft assembly nut. Remove shift cable from transaxle. Loosen front wheel bolts. Raise vehicle and remove wheel assemblies.
5. Remove stabilizer mounting nuts and brackets. Remove lower arm clamp bolts and nuts. Pull lower arms downward, separating lower arms from knuckles. Separate halfshafts and install Differential Plugs (T87C-7025-C) between differential side gears. See FWD AXLE SHAFTS article in DRIVE AXLES Section.
6. On manual transaxle vehicles, disconnect clutch control cable and shift control cable rod. Remove stabilizer bar from transaxle. Remove catalytic converter inlet pipe. Support engine assembly with hoist. Remove rear crossmember mount bolts. Remove front and rear engine mount nuts.
7. Remove crossmember. Lower vehicle and attach engine lift hooks. Remove right engine mount bolt. Remove engine/transaxle assembly. Remove gusset plates. Remove starter and flywheel cover. Remove torque converter bolts on automatic transaxle. Remove engine-to-transaxle bolts. Separate transaxle from engine.

Installation (1.3L)

1. Install transaxle to engine in reverse order of removal. Attach hoist to engine/transaxle assembly and position in vehicle. Support engine in chassis and install engine mount bolts. Raise vehicle and install front engine mount nut. Tighten nuts to specification. See [TORQUE SPECIFICATIONS](#) table at end of article.
2. Position crossmember onto mounts and chassis. Tighten rear nut. Install mount-to-crossmember nuts and tighten. Remove differential plugs and install halfshafts. To complete installation, reverse removal procedure. Tighten all bolts/nuts to specifications. Fill all fluid

levels to proper level.

Removal (1.6L & 1.6L Turbo)

1. Relieve fuel pressure and discharge air conditioning system (if equipped). See [FUEL PRESSURE RELEASE](#) under REMOVAL & INSTALLATION. Disconnect and remove battery, battery tray and battery tray support bracket.
2. Release wiring harness retaining straps from battery support tray. Disconnect windshield washer supply hose between fluid reservoir and hood. Mark hinge locations and remove hood.
3. Disconnect intake air tube and wiring to ignition coil and vane airflow meter. Remove air cleaner/vane airflow meter assembly. Remove air cleaner assembly support brackets. Disconnect intercooler hoses from turbocharger (if equipped).
4. Drain engine coolant and remove radiator. Disconnect accelerator cable, and remove retaining bracket from cam cover. Position cable to one side.
5. Disconnect and plug fuel lines at fuel filter and pressure regulator. Disconnect power brake booster manifold vacuum hose from manifold. Disconnect heater hoses at heater core tubes. Label and remove vacuum hoses located at throttle body.
6. For manual transaxle turbocharged vehicles, disconnect clutch cable and remove support bracket and cable from transmission. On non-turbo vehicles, disconnect clutch slave hydraulic line. For automatic transaxle, remove transaxle cooler lines.
7. Disconnect starter wiring at starter. Remove harness from locating strap on bracket. Disconnect alternator wiring. Disconnect wiring from engine coolant sensors located on rear of engine block. Remove ground connection at bracket on thermostat cover. Disconnect O2 sensor wire, main wiring harness connector, TPS connector (turbocharged only), knock sensor connector, distributor wiring and transaxle wiring. Disconnect ground wire and strap at front of engine, and reinstall lifting eye.
8. Remove engine oil dipstick and retaining clip. Remove power steering pump from mounting bracket. Remove power steering pump mounting bracket. With hoses attached, position pump aside. Remove upper air conditioning compressor retaining bolts (if equipped).
9. Raise vehicle on hoist. Drain engine oil and cooling system. On vehicles with air conditioning, remove lower air conditioning compressor mounting bolts, and position compressor out of way.

CAUTION: **DO NOT allow compressor to hang by hoses. Tie up compressor with mechanic's wire.**

10. Remove front wheels and tires. Remove front ball joints-to-steering knuckles retaining bolts. Remove splash guards. Drain transmission oil and remove half shafts from differential. Remove front exhaust pipe bracket located on lower side of engine. Disconnect front exhaust pipe from exhaust manifold, or turbocharger (if equipped).
11. Remove frame support bar-to-engine support bolt. Loosen right control arm bolt and, pivot support bar downward. Disengage rubber exhaust hangers located directly behind catalytic converter. Allow exhaust system to hang down 6 inches, and support system with mechanic's wire. Unbolt shift linkage and stabilizer bar at transaxle. Remove nuts from front and rear engine mounts, and lower vehicle.
12. Attach chains onto lift eyes at ends of cylinder head, and support engine with hoist. Remove RH engine mount through bolt. Raise engine off mounts and slightly pivot engine/transaxle assembly. Disconnect oil pressure sensor and route starter/alternator wiring harness from engine. Carefully lift engine/transaxle assembly, turn assembly while raising to clear brake master cylinder, shift linkage universal joint, radiator support and air conditioning lines (if equipped).
13. Remove intake manifold support bracket. Remove gusset plate(s) (if equipped). Remove starter. Remove transaxle-to-engine retaining bolts. Identify bolts to ensure correct installation. Separate transaxle from engine. On manual transaxle, remove pressure plate, clutch disc and flywheel. On automatic transaxle, remove flexplate.

Installation (1.6L & 1.6L Turbo)

1. Install transaxle to engine in reverse order of removal. Attach hoist to engine/transaxle assembly and position assembly in vehicle. Before engine contacts mounts, route starter, alternator and oil pressure sensor wiring, and connect oil pressure sensor. Lower engine until front mount seats on crossmember. Install through bolt on RH engine mount. **DO NOT** tighten bolt.
2. Remove hoist. Raise vehicle and support with jackstands. Align rear engine mount to crossmember, and install retaining nuts to front and rear engine mounts. Tighten nuts to specification. See [TORQUE SPECIFICATIONS](#) table at end of article.
3. On manual transaxles, connect shift coupling and stabilizer. Tighten to specification. On automatic transaxles, connect shift linkage and oil cooler lines. Tighten linkage retaining bolt, shift cable pivot and oil cooler hose clamps to specification. Connect front exhaust pipe to manifold (or turbocharger). Install exhaust pipe to support bracket. Tighten bolts to specification. Tighten manifold (or turbocharger) to specification. Attach rubber exhaust hangers. Position cross brace. Tighten retaining nut and bolt and right control arm front bolt.
4. Install drive axles. Install ball joint retaining bolts and tighten to specification. Mount A/C Compressor to engine (if equipped). Tighten lower retaining bolts to specification. Install splash guards. Install tire and wheel assemblies. Tighten retaining nuts to specification.
5. Lower vehicle. Install upper A/C compressor retaining bolts (if equipped). Tighten bolts to specification. Tighten RH engine mount through bolt to specification. Connect alternator wiring.
6. Position power steering pump bracket on stud. Lower pump into engine compartment. Install power steering pump bracket retaining bolts and nut. Tighten to specification. Install power steering pump and belt. Tighten adjustment nut and pivot bolt to specification.
7. Install engine oil dipstick and retaining clip. Install ground strap and ground wire to cylinder head. Install clutch cable (if equipped). Connect clutch hydraulic line if equipped with manual transaxle or naturally aspirated. Connect transmission electrical connectors. Connect fuel lines to fuel filter and pressure regulator. Install intake air tube to throttle body.
8. Install intercooler hoses on turbocharged models. Install air cleaner assembly brackets. Install air cleaner assembly with airflow meter attached. Install intake air tube. Install coil and airflow meter connectors. Connect coolant crankcase and air bypass hoses. Install vacuum hoses as noted in disassembly.
9. Connect accelerator cable. Install retaining bracket. Install power brake booster hose. Remove speedometer cable from transaxle. Fill transaxle to specification. See CAPACITIES in SERVICE & ADJUSTMENT SPECIFICATIONS article. Install speedometer cable. Connect speedometer cable connector. Fill engine oil to capacity.
10. Install radiator/fan assembly. Tighten bracket retaining bolts to specification. Connect coolant hoses and fan electrical connector. Fill coolant to specification.
11. Install hood and connect washer hose. Install battery tray support, battery tray, battery and battery hold-down. Connect battery terminal. Evacuate and charge air conditioning system (if equipped). Road test vehicle and inspect for leaks.

INTAKE MANIFOLD

Removal (1.3L)

Disconnect negative battery cable. Drain cooling system. Remove air cleaner. Remove intake manifold bracket. Disconnect throttle cable. Mark and disconnect vacuum hoses, fuel hoses and wiring. Remove intake manifold bolts. Remove intake manifold and gasket.

Installation (1.3L)

Clean all gasket mating surfaces. Ensure surface is free of burrs, scratches and cracks. Replace all gaskets. Position gasket and manifold to cylinder head. Install bolts and tighten to specification. To complete installation, reverse removal procedure.

Removal (1.6L)

1. Disconnect negative battery terminal. Relieve fuel pressure. See [FUEL PRESSURE RELEASE](#) under REMOVAL & INSTALLATION. Drain cooling system. Disconnect intercooler tube and/or air intake tube. Disconnect air by-pass hoses. Disconnect main engine harness electrical connection and TPS connector. Disconnect vacuum hoses from throttle body.
2. Disconnect fuel lines from fuel filter and pressure regulator. Disconnect throttle cable. Disconnect hoses from By-pass Air Control valve (BAC). Remove BAC valve retaining nut and bolt. Remove intake manifold retaining nuts and bolts from support bracket and cylinder head. Remove intake manifold and throttle body assembly.

Installation (1.6L)

1. Install new intake manifold gasket, ensuring coolant passage openings align with openings in cylinder head and manifold. Install intake manifold. Tighten retaining nut and bolts and support bracket bolts to specification. See [TORQUE SPECIFICATIONS](#) table at end of article.
2. Install BAC valve and connect air hoses. Connect throttle cable. Connect fuel lines to fuel filters and pressure regulator. Connect main engine harness connector and TPS connector. Connect vacuum lines to throttle body. Install intake air tube. Connect intercooler tube and/or intake air tube. Connect air by-pass hoses. Fill cooling system. Connect negative battery terminal. Start engine and check for fluid leaks and correct operation.

EXHAUST MANIFOLD

Removal (1.3L)

1. Raise vehicle. Remove catalytic converter inlet pipe at exhaust manifold. Remove pulse air tube nuts at inlet pipe. Remove inlet pipe support bracket bolts. Lower vehicle. Remove air intake duct. Remove exhaust manifold heat shroud bolts and remove shroud.
2. Disconnect oxygen sensor connector. Remove exhaust manifold nuts and remove exhaust manifold. Remove gasket from inlet pipe and cylinder head.

Installation

Position new gasket on cylinder head and inlet pipe. Install exhaust manifold and nuts. Tighten nuts to specification. See, at end of article, [TORQUE SPECIFICATIONS](#) table. To complete installation, reverse removal procedure. Tighten all bolts and nuts to specification.

Removal (1.6L Non-Turbo)

Remove intake air tube. Remove front exhaust pipe to exhaust manifold retaining nuts. Remove exhaust support bracket (if equipped). Remove heat shield. Disconnect O2 sensor electrical connector. Remove exhaust manifold.

Installation (1.6L Non-Turbo)

Install exhaust manifold gaskets. Install heavier gasket first. Install exhaust manifold and tighten retaining nuts to specification. See [TORQUE SPECIFICATIONS](#) table at end of article. Connect O2 sensor electrical connector. Install manifold heat shield. Install intake air tube. Connect front exhaust pipe to intake manifold and tighten retaining nuts to specification. Install exhaust support bracket, if removed, and tighten engine mount bolt to specification. Start engine and check for leaks.

Removal (1.6L Turbo)

1. Disconnect negative battery cable. Drain cooling system. Remove throttle body air intake tube. Disconnect intercooler hose from turbocharger assembly and position both intercooler hoses out of the way. Remove O2 sensor connector from its retaining clip, and disconnect O2 sensor. Remove lower heat shield and then upper heat shield. Remove turbocharger side heat shield.

NOTE: **Feed O2 sensor wire and guide through upper heat shield.**

2. Remove power steering pump (leave hoses attached) and lay aside. Disconnect lower radiator hose from water pump. Position power steering pump to access mounting bracket retaining bolts and nut. Remove both bolts and one nut, and remove bracket from engine. Remove 2 screws retaining air cleaner duct tube, loosen clamp at turbocharger and position duct tube out of the way. Disconnect coolant return hose at turbocharger. Remove bolt and brass sealing washers from oil supply line at engine block.
3. Raise vehicle. Remove retaining nuts and washers from exhaust pipe flange. Remove 2 bolts retaining exhaust hangers to engine block. Slide off two rubber exhaust hangers at catalytic converter. Pull exhaust pipe downward and to LH side of vehicle. Disconnect oil return hose at turbocharger. Disconnect coolant return hose at turbocharger. Remove 2 retaining bolts from turbocharger support bracket. Remove 2 bolts retaining coolant by-pass tube outlet to water pump. Lower vehicle.
4. Loosen retaining clamp bolt on coolant by-pass tube at rear of cylinder head. Remove 11 retaining nuts from exhaust manifold. Pull coolant by-pass tube bracket from exhaust stud, and position tube out of way. Grasp manifold, pull off studs and move assembly slightly to RH side of engine compartment to clear cooling fan, and remove assembly from vehicle.
5. Working on bench, remove 4 nuts retaining turbocharger to exhaust manifold, separate assembly and discard gasket.

NOTE: **When reinstalling turbocharger, thoroughly remove all gaskets and sealant. Use new gaskets. Add .85 oz. (25 cc) of engine oil in the oil passage of the turbocharger.**

Installation (1.6L Turbo)

1. Position new gasket on exhaust manifold, and install turbocharger onto studs. Install 4 retaining nuts and tighten to specification. See [TORQUE SPECIFICATIONS](#) table at end of article.

NOTE: Turbocharger-to-exhaust manifold mounting nuts are of special quality. Ensure correct nuts are used.

2. Remove oil supply line from turbocharger. Position new (2-piece) exhaust gasket on cylinder head with heavy gasket installed first. Carefully position turbocharger assembly in engine compartment and slide exhaust manifold on studs. Position heater tube bracket onto exhaust stud. Install 11 retaining nuts onto exhaust manifold and tighten to specification. See [TORQUE SPECIFICATIONS](#) table at end of article. Tighten heater tube clamp bolt securely.
3. Raise vehicle. Position new gasket and install 2 retaining bolts on heater tube outlet. Install 2 retaining bolts into turbocharger support bracket and tighten bolts to specification.
4. Connect coolant return hose. Connect oil return hose and secure with clamp. Position exhaust pipe onto turbocharger, and start nuts and washers. Install 2 retaining bolts on exhaust hanger at engine. Slide on 2 rubber exhaust hangers at catalytic converter. Tighten exhaust pipe retaining nuts to specification. Lower vehicle.
5. Install retaining bolt and brass washers on oil supply line, carefully position oil line into vehicle and hand-start bolt into engine block. Connect and finger tighten oil line to turbocharger. Tighten oil line bolt and oil supply line on turbocharger to specification.

NOTE: Ensure one brass washer is positioned on each side of oil line fitting.

6. Connect coolant supply hose. Position air cleaner duct tube on turbocharger and tighten clamp. Install 2 screws retaining air cleaner duct tube. Position power steering pump bracket on engine, and install 2 retaining bolts and one retaining nut. Tighten to specification. Position power steering pump on mounting bracket, and install though bolt and adjuster. Connect lower radiator hose. Install power steering belt. Position upper heat shield and install 2 retaining bolts finger tight.

NOTE: Feed O2 sensor wire through upper heat shield. Install wire retainer under LH bolt.

7. Position lower heat shield and install three retaining bolts finger tight. Tighten all heat shield bolts to specification. Connect O2 sensor and install connector into its retaining clip. See [TORQUE SPECIFICATIONS](#) table at end of article. Position intercooler hose on turbocharger and secure with clamp. Install throttle body air intake tube. Connect negative battery cable. Refill cooling system.

NOTE: If turbocharger was replaced: Disconnect ignition coil, crank engine for 20 seconds, connect ignition coil, start engine and run at idle for 30 seconds and check for leaks.

CYLINDER HEAD

Removal (1.3L)

1. Disconnect battery ground cable. Mark and disconnect fuel lines at fuel pump. Remove accessory belts, water pump pulley, crankshaft pulley, timing belt covers, timing belt tensioner, timing belt, valve cover and exhaust and intake manifolds. Drain cooling system.

NOTE: If original timing belt is being reused, mark direction of rotation for installation reference.

2. Mark and remove electrical connectors and vacuum hoses. Remove spark plug wires from spark plugs, and remove spark plugs. Remove distributor cap. Disconnect vacuum hoses and distributor wiring.
3. Index distributor-to-mount position and remove hold-down bolt. Remove distributor assembly. Remove engine ground strap. Remove front and rear engine lifting hooks. Remove upper radiator hose, by-pass hose and bracket.
4. Remove bolts retaining rocker arm shaft. Remove rocker arm assemblies. Remove cylinder head bolts. Remove head and gasket.

Inspection (1.3L)

1. Thoroughly clean and check gasket mating surface of cylinder head and block. Check cylinder for cracks, nicks, burrs or damage. Using a straightedge and feeler gauge, check warpage over entire gasket area. Ensure cylinder head and/or block warpage does not exceed .006" (.15 mm).
2. If warpage exceeds .006" (.15 mm), machine cylinder head and/or block gasket surface. Maximum machining allowed is .008" (.20 mm). If more machining is required, replace block and/or cylinder head.

Installation (1.3L)

1. Place new head gasket properly on block. Carefully place cylinder head in position on block. Install head bolts. Tighten bolts in sequence and in 2 steps. See [Fig. 1](#) .
2. While tightening rocker arm shaft, slide shaft springs away from retaining bolt to prevent pinching springs. Tighten rocker arm shaft bolts in sequence and to specification. See [Fig. 5](#) . To complete installation, reverse removal procedure. Tighten all bolts/nuts to specification. Fill all fluids to proper levels.

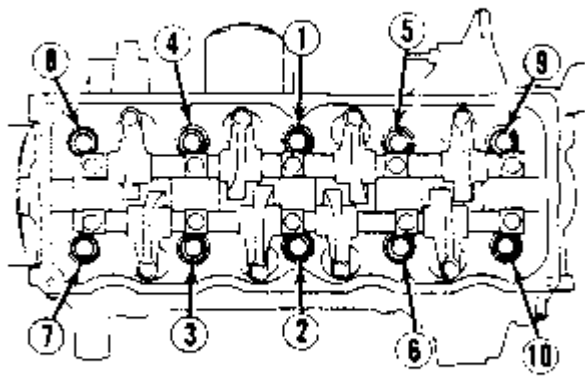


Fig. 1: Installing Cylinder Head Bolts (1.3L)
Courtesy of FORD MOTOR CO.

Removal (1.6L)

1. Release fuel pressure. Drain cooling system. Disconnect negative battery terminal. Remove intake air tube from throttle body. Disconnect air by-pass hoses. Remove spark plug wires and retainers. Remove intake air tube from air cleaner assembly. Disconnect coolant hose from thermostat cover. Disconnect vacuum hoses and coolant hoses from throttle body and intake manifold.
2. Disconnect throttle cable and remove retaining brackets and cable. Disconnect fuel lines at fuel filter and pressure regulator. Disconnect main harness connector. Disconnect O2 sensor connector and remove ground connection retaining screw at bracket. Disconnect intercooler tubes from turbocharger (if equipped). Remove ground wire and strap retaining bolts at front sides of cylinder head.
3. Remove timing belt covers and timing belt. On turbocharged vehicles, remove exhaust manifold and turbocharger as an assembly. On non-turbocharged vehicles, disconnect front exhaust pipe from exhaust manifold. Remove intake manifold support upper retaining bolts.
4. Remove cam cover. Remove cylinder head and intake manifold as an assembly. Separate intake manifold from cylinder head (if required).

Installation (1.6L)

1. Position new (2-piece) exhaust gasket on cylinder head with heavy gasket installed first. Install exhaust manifold to head. Install intake manifold to head using new gasket. Tighten all manifold nuts to specification. See **TORQUE SPECIFICATIONS** table at end of article.

NOTE: Ensure coolant passage openings in gasket align with manifold and cylinder head.

2. Ensure gasket surfaces of head and block are clean of old gasket and sealant. Place new head gasket on cylinder block. Carefully, place cylinder head on block. Tighten cylinder head in sequence and in two stages to correct specification. See **Fig. 2** .

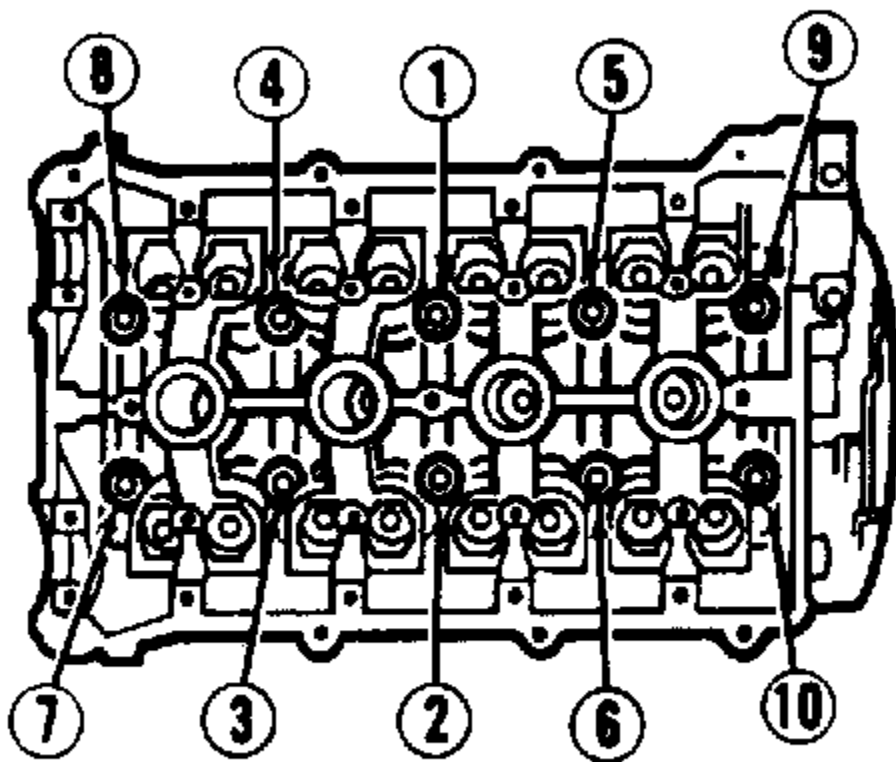


Fig. 2: Installing Cylinder Head Bolts (1.6L)
Courtesy of FORD MOTOR CO.

3. Install intake manifold support upper retaining bolts and tighten to specification. See **TORQUE SPECIFICATIONS** table at end of

article. Install timing belt and covers. Install cam cover. On non-turbo engines, connect front exhaust pipe to exhaust manifold. Tighten nuts to specification.

4. On turbocharged engines, install exhaust manifold and turbocharger assembly. Install ground wire and strap to cylinder head with retaining bolts. Connect intercooler tubes (if equipped). Connect O2 sensor connector, and install ground wires to bracket on cylinder head with retaining screw. Connect main engine harness connector. Connect fuel lines to fuel filter and pressure regulator. Install throttle cable and retaining brackets.
5. Install coolant hoses and vacuum lines to intake manifold and throttle body. Install coolant hose to thermostat cover. Install intake air tube to air cleaner. Install spark plug wires and retainers. Install intake air tube to throttle body, and connect by-pass hoses. Fill cooling system. Connect negative battery terminal. Start engine, check for leaks and system operation.

TIMING BELT COVER

Removal & Installation (1.3L)

Remove accessory belts. Remove water pump pulley. Remove crankshaft damper. Remove bolts retaining upper and lower cover halves to engine front. Remove both covers. To install, reverse removal procedure.

Removal & Installation (1.6L)

Raise vehicle on hoist. Remove RF tire and wheel assembly. Remove RF splash guard. Lower vehicle. Remove spark plugs and set camshaft timing to TDC No. 1 cylinder. Remove oil dipstick. Remove water pump pulley. Remove crankshaft pulley, damper and baffle plate. Remove upper timing belt cover. Remove center and lower timing belt covers. To install, reverse removal procedure.

TIMING BELT

NOTE: Always rotate engine in direction of normal operation. Rotating crankshaft backwards may cause belt to jump timing.

Removal (1.3L)

Remove accessory belts, water pump pulley, crankshaft damper and upper and lower timing belt covers. Mark timing belt direction of rotation for installation reference. Remove timing belt tensioner pulley bolt. Remove tensioner pulley, spring and spring cover. Remove timing belt.

Installation (1.3L)

1. Ensure timing belt and sprockets are clean and not worn or damaged. Align crankshaft and camshaft timing marks. See [Fig. 3](#) . No. 1 cylinder must be at TDC of compression stroke.
2. Position belt on camshaft sprocket. Install timing belt tensioner spring, spring cover and pulley. Tighten tensioner pulley bolt to specification. See [TORQUE SPECIFICATIONS](#) table at end of article. To complete installation, reverse removal procedure. Tighten all bolts and nuts to specification.

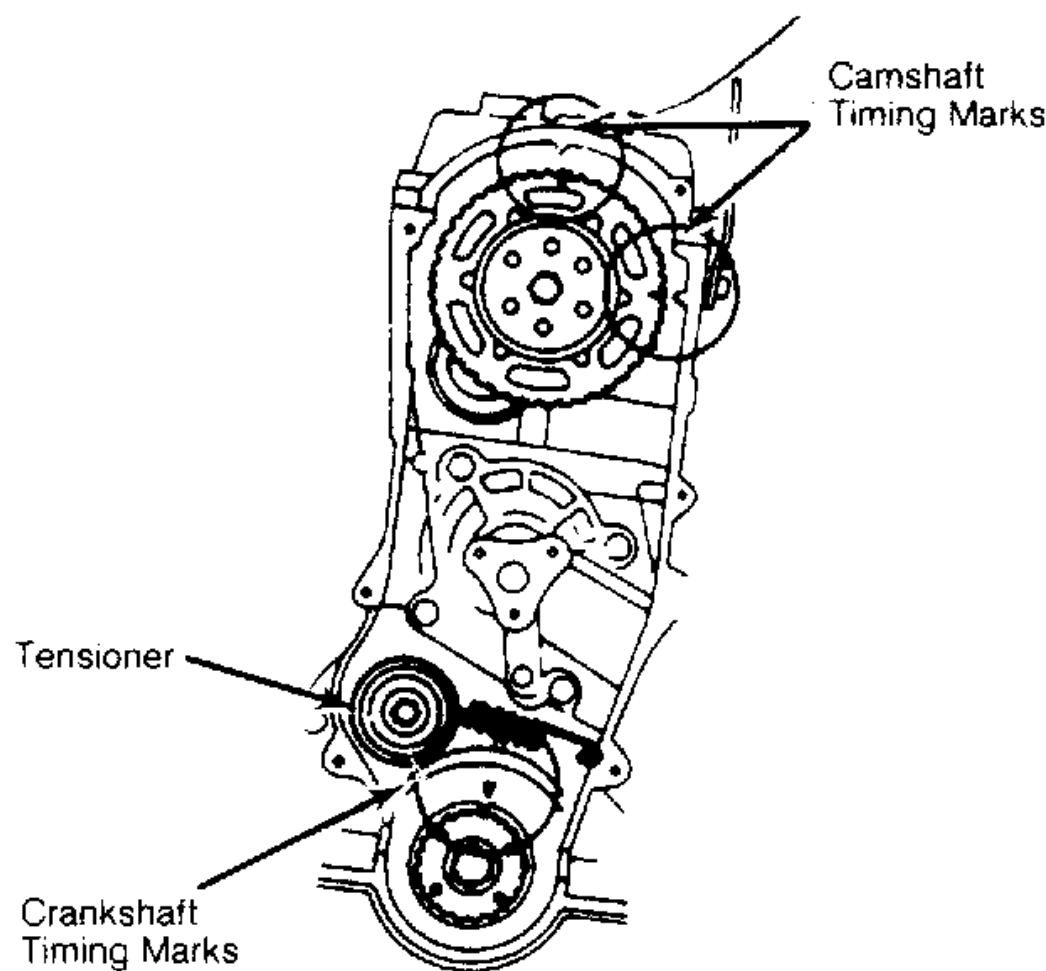


Fig. 3: Aligning Camshaft & Crankshaft Timing Marks (1.3L)

Courtesy of FORD MOTOR CO.

Removal (1.6L)

Remove timing belt covers, See TIMING BELT COVER procedure to remove timing belt from this engine.

Installation (1.6L)

1. Ensure timing belt and sprockets are clean and not worn or damaged. Ensure timing marks are properly positioned on camshafts and crankshaft. Intake cam should have letter "I" aligned with arrow on belt cover. Exhaust cam should have letter "E" aligned with arrow on belt cover. Crankshaft key should align with arrow. See [Fig. 4](#) .
2. Tighten tension pulley with tension spring fully extended. Install timing belt. Keep tension on opposite side of tensioner as tight as possible. Ensure rotation mark on belt is correct.
3. Turn crankshaft 2 full turns. Check alignment of timing marks. If any mark is not aligned, remove timing belt and reset timing. Loosen tension pulley retaining bolt allowing tension spring to tighten belt. Tighten tension pulley to specification and rotate engine 2 full turns. Verify timing mark alignment.
4. Measure timing belt tension between camshaft pulleys. Belt deflection should be 0.33-0.45" (8.5-11.5 mm). If incorrect, loosen tension pulley and repeat procedure. If correct tension cannot be achieved, replace tension spring.
5. Install lower, center and upper timing belt covers, and tighten bolts to specification. See [TORQUE SPECIFICATIONS](#) table at end of article. Install RH engine mount. Lower engine. Tighten retaining nuts to specification. Install crankshaft pulley, damper and baffle. Tighten baffle and damper screws and pulley retaining bolts to specification. Install water pump pulley and tighten retaining bolts to specification.
6. Install alternator and power steering belts. Install oil dipstick. Raise vehicle and install splash guard and RF wheel and tire assembly. Lower vehicle, install spark plugs and start engine. Inspect for leaks and check operation.

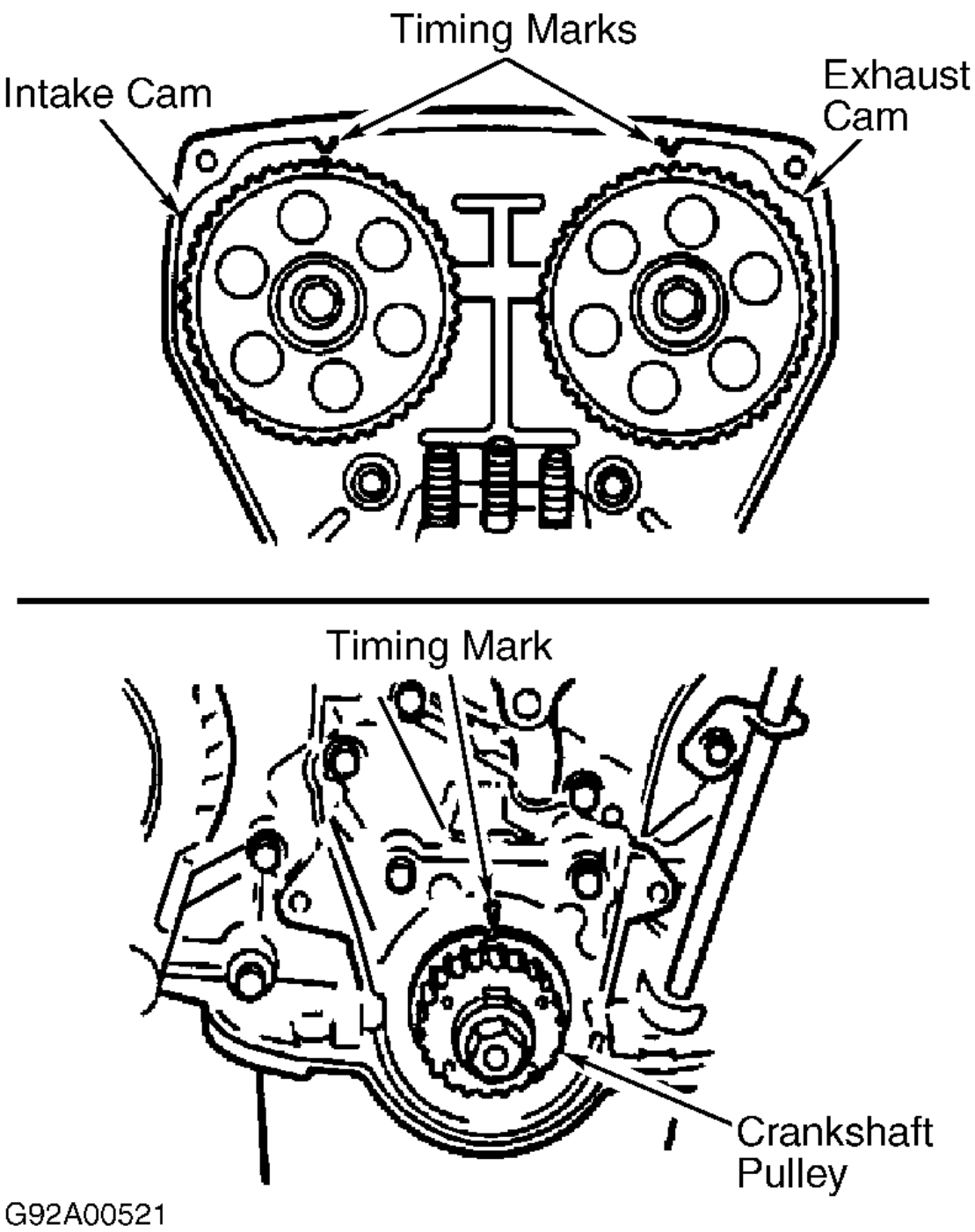


Fig. 4: Aligning Camshaft & Crankshaft Timing Marks (1.6L)
Courtesy of FORD MOTOR CO.

FRONT COVER & OIL SEAL

Removal & Installation

Front cover is the housing for the oil pump. See OIL PUMP under ENGINE OILING.

CAMSHAFT

Removal (1.3L)

Remove cylinder head. Remove rocker arm assemblies if not previously removed. Carefully remove camshaft thrust plate. Remove camshaft

front oil seal. Carefully slide camshaft out front of cylinder head. **DO NOT** damage bearing bores.

Inspection (1.3L)

1. Check cylinder head for warpage. See INSPECTION under **CYLINDER HEAD** under REMOVAL & INSTALLATION. Measure camshaft lobes across their maximum dimensions. Inspect for scoring and wear. Replace camshaft if not within specification. See, in this article, **CAMSHAFT LOBE SPECIFICATIONS** table.

- NOTE:** For additional camshaft specifications, see, in this article, **CAMSHAFT SPECIFICATIONS** table under ENGINE SPECIFICATIONS at end of this article.
- NOTE:** Camshaft bearings are NOT replaceable. If not within specification, replace cylinder head and/or camshaft.

2. Measure camshaft bearing journals and cylinder head bores. See **Fig. 6** and **Fig. 7** . Subtract camshaft bearing journal O.D. from cylinder head bore I.D. to obtain oil clearance. If clearance is not within specification, replace head and/or camshaft. See, in this article, **CAMSHAFT SPECIFICATIONS** table under ENGINE SPECIFICATIONS tables.

Installation (1.3L)

1. Oil camshaft and insert carefully. Install thrust plate. Install camshaft front oil seal. Install rocker arm shaft assemblies to original location. Ensure oil holes in rocker arm shaft face downward.
2. While tightening rocker arm shaft, slide shaft springs away from retaining bolt to prevent pinching spring. Tighten rocker arm shaft bolts in sequence and to specification. See **Fig. 5** . See **TORQUE SPECIFICATIONS** table at end of article. To complete installation, reverse removal procedure. Tighten all bolts and nuts to specification.

CAMSHAFT LOBE SPECIFICATIONS

Application	Standard Height: In. (mm)	Wear Limit: In. (mm)
1.3L	1.4332-1.4371 (36.403-36.503)	1.4273 (36.253)
1.6L	1.6098 (40.888)	1.5944 (40.498)

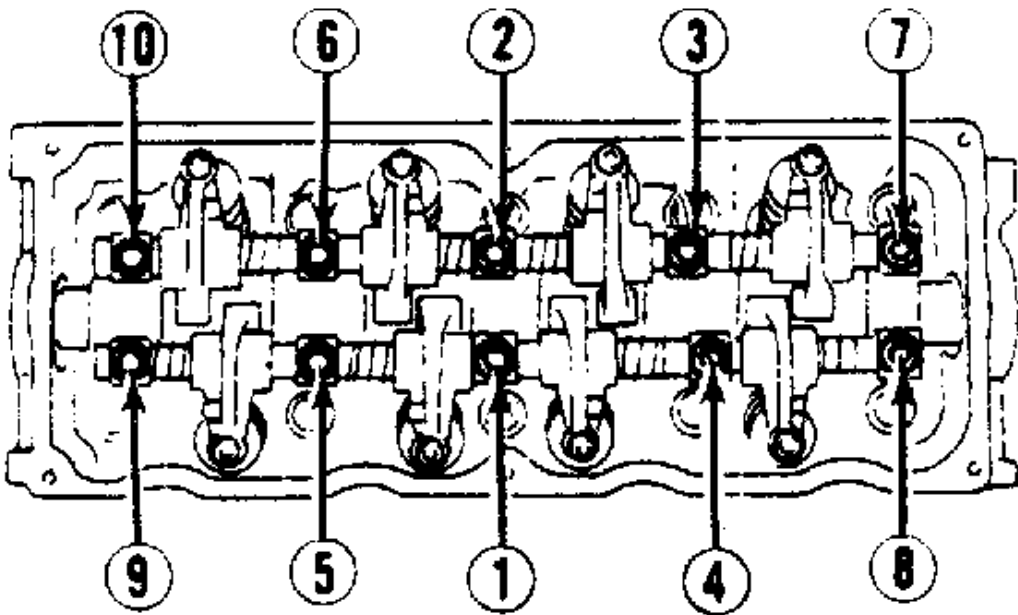


Fig. 5: Rocker Arm Shaft Tightening Sequence (1.3L)
Courtesy of FORD MOTOR CO.

Removal (1.6L)

1. Disconnect battery ground terminal. Disconnect air by-pass hoses, and remove intake air tube. Disconnect throttle cable, and remove retaining brackets. Remove cam cover. Remove timing belt.
2. Hold camshaft with wrench while removing pulley retaining bolt. Remove camshaft pulley(s). Remove seal plate. Remove camshaft seal using Seal Remover (T78P-3504-N). If removing intake cam, remove distributor.
3. Note numerical and directional markings on camshaft bearing caps for installation. Remove bearing cap retaining bolts alternately and gradually to prevent overstressing camshaft. Remove camshaft.

Inspection (1.6L)

1. Check cylinder head for warpage (if removed). See INSPECTION in **CYLINDER HEAD** . Measure camshaft lobes across their maximum dimensions. Inspect for scoring and wear. Replace camshaft if not within specification. See **CAMSHAFT LOBE SPECIFICATIONS** table.

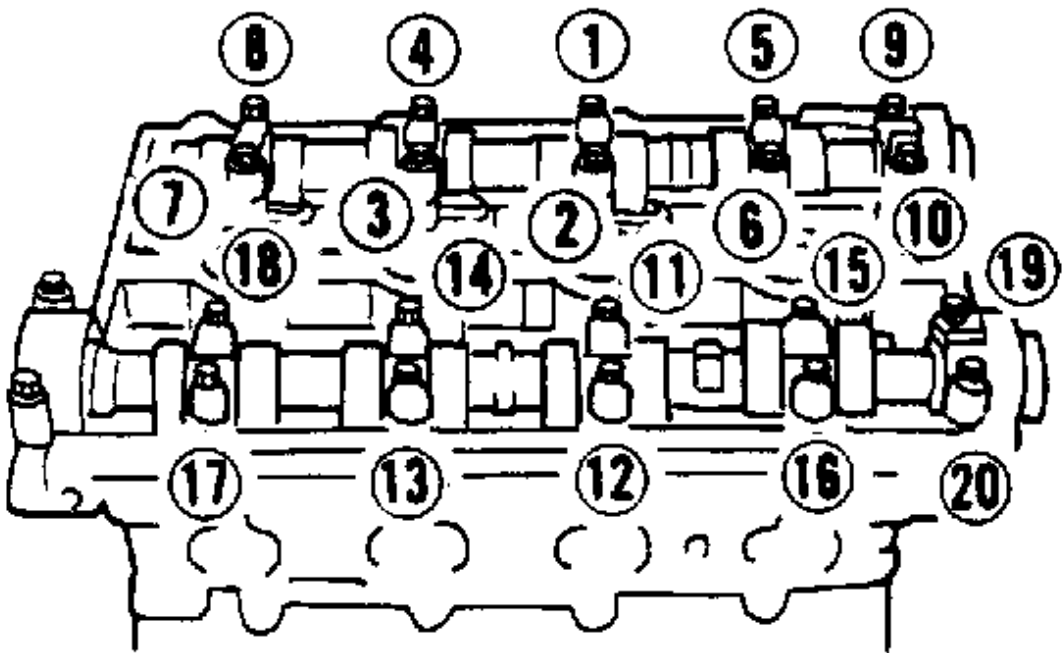
- NOTE:** For additional camshaft specifications, see **CAMSHAFT SPECIFICATIONS** table under ENGINE SPECIFICATIONS at end of this article.
- NOTE:** Camshaft bearings are NOT replaceable. If not within specification, replace cylinder head and/or

camshaft.

- 2. Measure camshaft bearing journals and cylinder head bores (with bearing caps in place and torqued to specification). See [Fig. 7](#) . Subtract camshaft bearing journal O.D. from cylinder head bore I.D. to obtain oil clearance. If clearance is not within specification, replace head and/or camshaft. See [CAMSHAFT SPECIFICATIONS](#) table under ENGINE SPECIFICATIONS at end of article.

Installation (1.6L)

- 1. Lubricate camshaft bearings with engine oil. Position camshaft(s) in cylinder head. Ensure all tappets are in place. Install intake cam with the "I" mark straight up and exhaust cam with the "E" mark straight up. Install bearing caps according to numbers and arrows. Arrows point to front of engine. Tighten retaining bolts gradually and in sequence to specification See [Fig. 6](#) . See, at end of this article, [TORQUE SPECIFICATIONS](#) table.
- 2. Install distributor (if removed). Install camshaft seal using Seal Protector (T90P-6256-AH) and Seal Installer (T90P-6256-BH). Install seal plate and tighten retaining screws to specification. Install camshaft pulley to specification and tighten retaining bolt to specification.
- 3. Install timing belt. Install cam cover. Install throttle cable and retaining brackets. Install intake air tube and connect air by-pass hoses. Connect battery ground terminal. Start engine and check for leaks and proper operation.



[Fig. 6: Cam Bearing Cap Tightening Sequence \(1.6L\)](#)
Courtesy of FORD MOTOR CO.

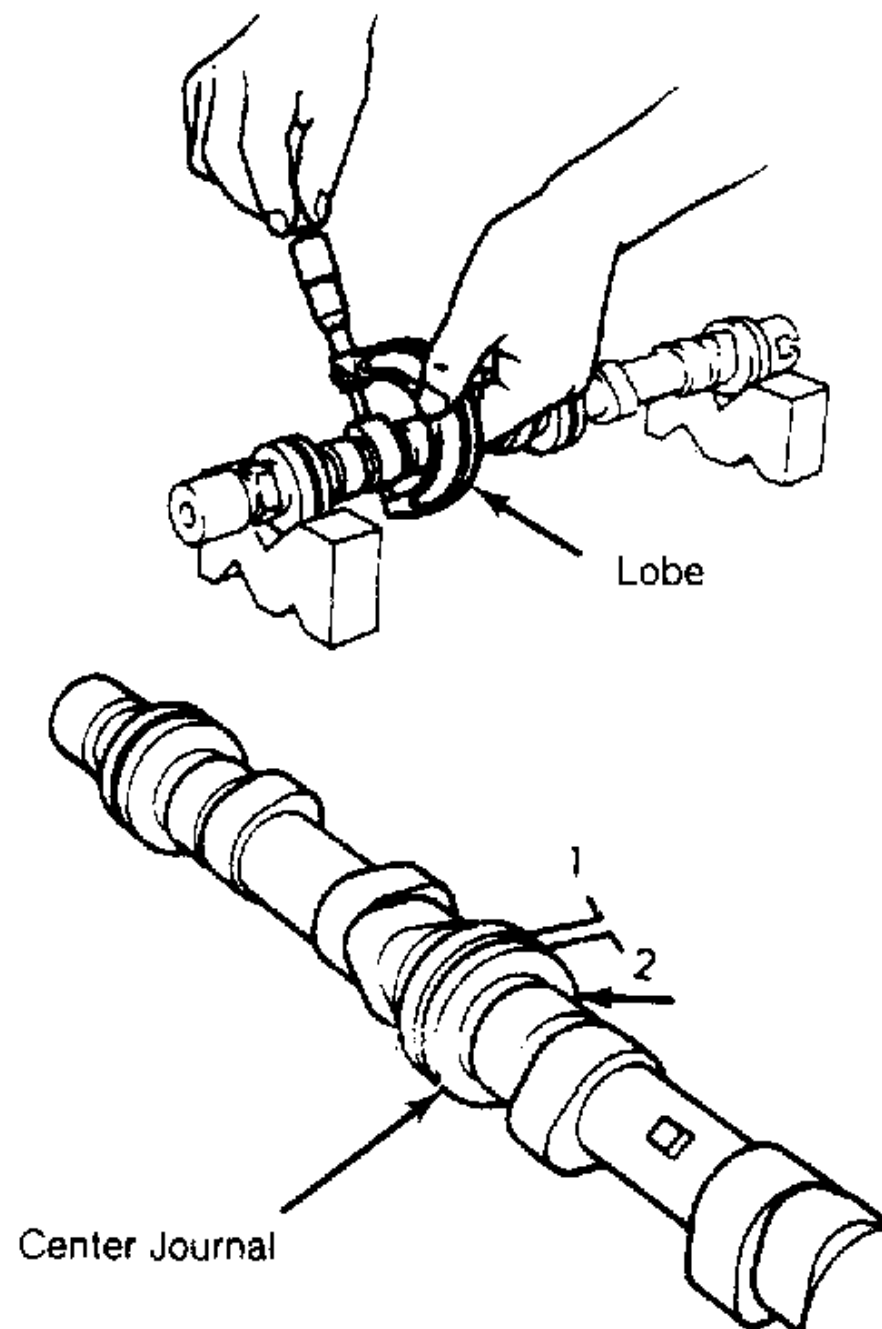


Fig. 7: Measuring Camshaft (1.3L Shown; 1.6L Similar)
 Courtesy of FORD MOTOR CO.

CAMSHAFT END PLAY

1. Measure camshaft end play with thrust plate in position. Install dial indicator to front of head, with pointer on camshaft center. Pry camshaft fully rear, and zero dial indicator.
2. Pry camshaft fully forward and note dial indicator reading. Standard end play is .002-.007" (.05-.18 mm) with a limit of .008" (.20 mm). If end play exceeds specification on 1.3L engines, replace thrust plate and recheck end play. If end play is exceeded on 1.6L engines, replace camshaft and/or cylinder head.

CAMSHAFT OIL SEAL

See [CAMSHAFT](#) .

REAR MAIN BEARING OIL SEAL

Removal (1.3L)

Remove transaxle. See TRANSMISSION REMOVAL & INSTALLATION article in TRANSMISSION SERVICING. Remove flywheel or flexplate. Remove rear engine plate (if equipped). Remove rear main bearing oil seal retainer and press out rear main bearing oil seal.

Installation (1.3L)

Clean seal surface in retainer. Lubricate oil seal inside and outside. Install seal retainer on engine. Install seal in retainer with hollow side of seal facing engine. Using Rear Main Seal Installer (T87C-6701-A), install rear main bearing oil seal. To complete installation, reverse removal procedure.

Removal (1.6L)

Remove transaxle. See TRANSMISSION REMOVAL & INSTALLATION article in TRANSMISSION SERVICING. Remove clutch cover and disc (if equipped). Remove flywheel or flexplate. Remove rear seal using Seal Remover (T78P-3504-N).

Installation (1.6L)

Lubricate oil seal lip with engine oil. Using Rear Main Seal Installer (T87C-6701-A) and Screw Set (T90P-6701-AH), install rear main

bearing oil seal. To complete installation, reverse removal procedure.

WATER PUMP

Removal & Installation (1.3L)

Remove timing belt. Drain cooling system. Remove lower radiator hose and heater return hose from water pump. Remove water pump retaining bolts and water pump. Clean gasket mounting surface and replace gasket. To install, reverse removal procedure.

Removal (1.6L)

1. Remove timing belt. See [TIMING BELT](#) . Drain cooling system. Remove timing belt tensioner and idler pulleys. Remove oil dipstick bracket retaining bolt.
2. Remove power steering pump from retaining bracket, leaving hoses attached. Remove power steering bracket and position power steering pump to one side. Remove water pump outlet. Remove water pump retaining bolts and water pump.

NOTE: **Raise engine slightly with floor jack, if required, to gain clearance for water pump removal.**

Installation (1.6L)

1. Clean all gasket surfaces. Transfer rubber belt cover seal to new water pump (if required). Position water pump with new gasket and install retaining bolts. Install pump outlet with new gasket and "O" ring. See [TORQUE SPECIFICATIONS](#) table at end of article.
2. Install oil dipstick retaining bolt. Install timing belt tensioner and idler pulleys. Install power steering pump bracket. Install power steering pump. Tighten all bolts and nuts to specification. See [TORQUE SPECIFICATIONS](#) table at end of article.
3. Install timing belt. Fill cooling system. Start engine and check for leaks and proper system function.

OIL PAN

Removal (1.3L)

Disconnect battery ground cable. Raise vehicle and drain engine oil. Remove flywheel housing dust cover. Remove oil pan retaining bolts, nuts and stiffeners. Rotate crankshaft while removing oil pan. Remove baffle plate from oil pan. Clean gasket mating surfaces thoroughly.

Installation (1.3L)

Ensure gasket surfaces are clean. Apply oil resistant sealer to front and rear engine covers and across joint line of cylinder block.

Removal (1.6L)

1. Raise vehicle and drain engine oil. Remove frame brace retaining bolt. Loosen RH "A" arm front bolt, and pivot brace downward. Disconnect front exhaust pipe from exhaust manifold (or turbocharger). Remove exhaust pipe bracket retaining bolts. Loosen rubber exhaust hangers at catalytic converter.
2. Allow exhaust to hang supported by mechanic's wire. Disconnect turbocharger oil return hose (if equipped). Remove oil pan retaining bolts. Carefully pry oil pan loose from cylinder block.

CAUTION: **DO NOT force a pry tool between cylinder block and oil pan.**

Installation (1.6L)

1. Clean pan and block gasket surfaces. Apply Gasket Sealant (E3AZ-19562-A) to new front and rear pan seals. Install seals to cylinder block. Apply Gasket Sealant (E3AZ-19562-A) to oil pan gasket surface. See [Fig. 8](#) . Install oil pan and tighten pan retaining bolts to specification. See [TORQUE SPECIFICATIONS](#) table at end of article.
2. Connect turbocharger oil return hose (if equipped). Install rubber exhaust hanger to brackets. Install new gasket and connect front exhaust pipe to exhaust manifold (or turbocharger). Install front exhaust pipe bracket. Tighten nuts and bolts to specification.
3. Pivot frame brace into position. Tighten retaining bolt to crossmember and RH "A" arm front retaining bolt to specification. Lower vehicle, fill with oil and start engine. Check for oil leaks and system operation.

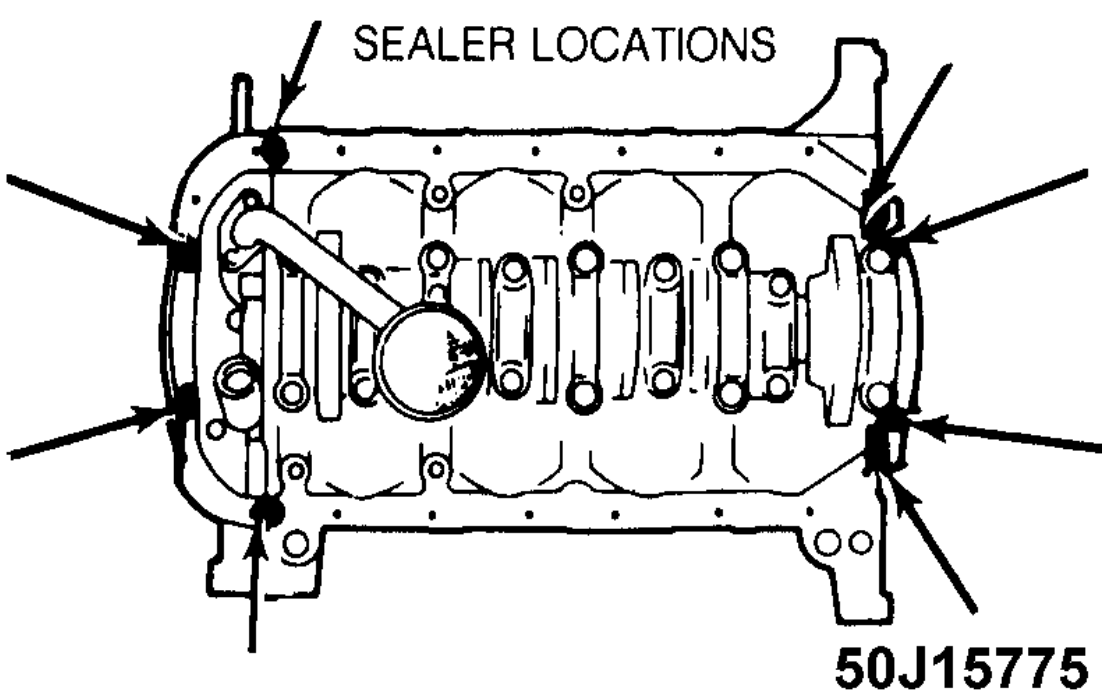


Fig. 8: Identifying Oil Pan Sealing Points
Courtesy of FORD MOTOR CO.

OVERHAUL

VALVE SPRINGS

Measure valve springs squareness and free length. Replace spring if either measurement is out of specification. See, at end of article, [VALVES & VALVE SPRINGS](#) table in ENGINE SPECIFICATIONS.

VALVE STEM INSTALLED HEIGHT

Measure protruding length of each valve stem. See VALVE STEM INSTALLED HEIGHT table. If length is at service limit, use valve spring shims to bring measurement within range of acceptable limit. If length is greater than service limit, replace valve seat or cylinder head.

VALVE STEM INSTALLED HEIGHT

Application	In. (mm)
1.3L	
New	1.520-1.539 (38.6-39.1)
Acceptable Limit	1.539-1.579 (39.2-40.1)
Service Limit	1.579 (40.1)
1.6L	
New	1.713-1.732
Acceptable Limit	1.7732-1.772 (44-45)
Service Limit	1.772 (45)

NOTE: For additional valve specifications, see, at end of this article, [VALVES & VALVE SPRINGS](#) table under ENGINE SPECIFICATIONS.

VALVE GUIDES

Remove cylinder head, camshaft(s) and valves. Check valve stem-to-guide oil clearance. If clearance exceeds specification, replace valve guides and/or valves. See [CYLINDER HEAD](#) table under ENGINE SPECIFICATIONS at end of this article.

ROCKER ARM SHAFT ASSEMBLY (1.3L)

Remove valve cover. Keep components in order of removal to ensure reassembly to original position. Remove rocker arm shaft retaining bolts and rocker arm shaft assembly. To install, reverse removal procedure.

VALVE LASH ADJUSTERS (1.3L)

Warm engine to normal operating temperature. Remove valve cover. Inspect hydraulic lash adjuster operation by pushing each rocker arm down by hand. If rocker arm moves downward, replace hydraulic lash adjuster. Adjustment on valve lash adjusters is NOT possible or necessary.

CAM SHAFT(S) (1.6L)

Remove cam cover. Remove camshaft(s). Keep components in order of removal to ensure reassembly to original position. To install, reverse removal procedure.

VALVE LASH ADJUSTERS (1.6L)

Inspect friction surfaces for wear and damage. Hold bucket body (each adjuster) and press between thumb and forefinger. If plunger moves,

replace hydraulic lash adjuster. Adjustment on valve lash adjusters is NOT possible or necessary.

PISTON & ROD ASSEMBLY

1. Remove cylinder head assembly. Remove oil pan. Mark connecting rod caps for reassembly reference. Remove rod nuts. Remove lower rod cap and bearing. Tap piston out top of cylinder block. **DO NOT** scratch crank journal or cylinder walls during removal.
2. Repeat procedure for remaining pistons. Keep removed parts in order to ensure installation to original position. Position piston assembly in correct cylinder bore. Align piston mark "F" (1.3L), or notch (1.6L) located at piston pin bore area, and connecting rod oil groove toward engine front. To complete installation, reverse removal procedure. Tighten all bolts and nuts to specification. See [TORQUE SPECIFICATIONS](#) table at end of article.

FITTING PISTONS

1. With piston assembly removed, remove piston rings and clean piston. Measure piston outer diameter in thrust direction, below oil ring groove. Diameter is 2.793-2.794" (70.954-70.974 mm) for 1.3L engines and 3.0690-3.0698 (77.954-77.974) for 1.6L engines.
2. Place piston upside down in cylinder from which it was removed. Using a feeler gauge, measure clearance between piston and cylinder bore. If clearance is not within specification, bore cylinder and replace piston as necessary. See [CYLINDER BLOCK](#) table in ENGINE SPECIFICATIONS at end of article.

PISTON RINGS

Install rings on piston. Ensure marked side of rings are in proper position. Set ends of rings to proper position. See [Fig. 9](#) .

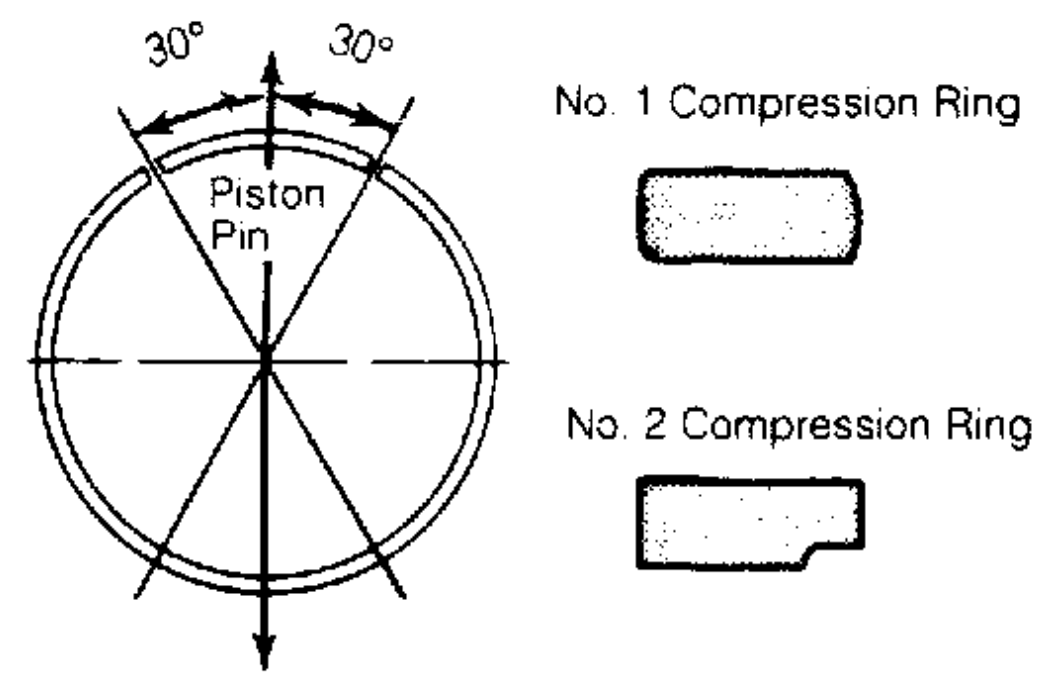


Fig. 9: Positioning Piston Rings
Courtesy of FORD MOTOR CO.

PISTON PIN REPLACEMENT

1. With piston removed and cleaned, mark piston-to-rod to ensure proper reassembly. Using Piston Pin Remover/Installer Set (D81L-6135-A for 1.3L or D90P-6135-AH for 1.6L), place piston and rod assembly in press.
2. Apply pressure and press piston pin from piston assembly. Keep all removed components together for reassembly. Remove piston and rod from press and inspect.
3. Using a micrometer, measure piston pin O.D. in several areas. Measure piston pin I.D. Measure I.D. of piston pin bore and rod pin bore. Replace components if not within specifications. See, at end of article, [PISTONS PINS & RINGS](#) table in ENGINE SPECIFICATIONS
4. If measurements of rod, piston and pin are within specification, reassemble using piston pin assembly set. Ensure piston-to-rod position is proper, with connecting rod oil groove on side of piston marked "F" or by a notch. Lubricate pin with engine oil before reassembly. With piston assembly reassembled, rod should fall by its own weight with piston held horizontally. Repeat procedure for remaining pistons.

NOTE: Installation press pressure for piston pins is 1100-3300 lbs. (500-1500 Kg)

Rod Bearings Check rod bearing for abnormal wear. Check crankshaft journal. Check rod bearing-to-crankshaft clearance with Plastigage. Machine or replace as necessary. See, at end of article, [CRANKSHAFT MAIN & CONNECTING ROD BEARINGS](#) table under ENGINE SPECIFICATIONS.

CRANKSHAFT & MAIN BEARINGS

1. Drain oil and remove oil pan. Ensure main bearing caps are marked for installation to original location and position.

NOTE: If replacing bearing inserts with engine in vehicle, remove one bearing at a time for measurement

or replacement.

2. Remove main bearing cap bolts. Remove cap and lower bearing insert. Use bearing remover or fabricated cotter key to remove upper bearing insert. Insert bearing remover in journal lubrication hole. Rotate crankshaft in normal direction of operation only. Repeat procedure for remaining main bearings.
3. Check bearings for abnormal wear. Check crankshaft for grooves, scratches and pitting. Using Plastigage method, check clearance of main bearing-to-crankshaft. Always keep at least 2 bearings and caps tight during clearance check. See, at end of article, [CRANKSHAFT MAIN & CONNECTING ROD BEARINGS](#) table under ENGINE SPECIFICATIONS.
4. Lubricate and install new bearings in cap and block. Match bearing tangs with notch in cap and block. Position cap in its proper location and position. Install cap bolts and tighten to specification. See [TORQUE SPECIFICATIONS](#) table at end of article. Repeat procedure for remaining main bearings.

CRANKSHAFT END PLAY

Check crankshaft end play with dial indicator. End play should be .0031-.0111" (.08-.282 mm). Service limit is .012" (.30 mm). If end play is not within specification, replace thrust bearings as necessary.

CYLINDER BLOCK

1. Using straightedge and feeler gauge, check entire cylinder head surface of cylinder block. Ensure warpage does not exceed .006" (.15 mm). If warpage exceeds specification, cylinder block surface can be machined a maximum of .008" (.20 mm).
2. Replace cylinder block if it needs to be machined more than .008" (.20 mm). Check cylinder bore for wear, out-of-round, taper and piston fit. See [CYLINDER BORE SPECIFICATIONS](#) table. Oversize pistons are available in .010" and .020" (.25 mm and .50 mm).

CYLINDER BORE SPECIFICATIONS

Application	In. (mm)
Cylinder Diameter	
Standard Bore	
1.3L	2.7953-2.7960 (71.000-71.019)
1.6L	3.0709-3.0716 (78.000-78.019)
Maximum Bore	
1.3L	2.8020 (71.17)
1.6L	3.0905-3.0913 (78.500-78.519)
Maximum Out-Of-Round & Taper	.0007 (.019)
Piston-To-Bore Clearance	.006 (.15)

LUBRICATION

ENGINE OILING SYSTEM

Oiling system is force-feed type and uses a full-flow oil filter. Oil is retrieved from oil pan by oil pump pick-up tube and distributed to oil filter. Oil is then filtered and routed throughout engine.

Crankcase Capacity

1.3 L crankcase capacity is 3.2 qts. (3.0 L) without filter change and 3.6 qts. (3.4 L) with filter change. For 1.6 L vehicles, capacity is 3.2 qts (3.2 L) without filter and 3.72 qts. (3.5 L) with filter.

Normal Oil Pressure (Hot)

Normal oil pressure is 50-64 psi (3.5-4.5 kg/cm²) at 3000 RPM.

Pressure Regulator Valve

Pressure regulator valve is located in oil pump body and is nonadjustable.

OIL PUMP

Removal

Remove oil pan, pick-up tube and screen, timing belt and crankshaft sprocket. Remove front engine cover bolts and remove front cover. Remove bolts retaining pump cover to back side of front cover housing.

2) Remove pump cover and inner and outer gears. Pry out front seal from front cover. Remove cotter pin. Remove pressure regulator retainer, spring and valve.

OIL PUMP SPECIFICATIONS

Application	In. (mm)
Inner Gear-To-Outer Gear	
1.3L	.008 (.20)
1.6L	.0008-.0063 (.02-.16)
Outer Gear-To-Housing	
1.3L	.009 (.22)
1.6L	.0035-.0071 (.09-.18)
End Play	
1.3L	.006 (.14)

1.6L	.0012-.0043 (.03-.11)
------	-----------------------

Installation

1. Install pressure regulator valve, spring, retainer and new cotter pin. Press a new seal in front cover housing. Install outer and inner gears in housing. Install pump cover. Coat bolts with Loctite and tighten to specification. See [TORQUE SPECIFICATIONS](#) table at end of article.
2. Install new gasket and install front cover housing. Install new gasket and install pick-up tube and screen. Tighten all bolts/nuts to specification. To complete installation, reverse removal procedure.

ENGINE COOLING

NOTE: Refer to [WATER PUMP](#) under REMOVAL & INSTALLATION in this article.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
"A" Arm Front Bolt	72-86 (97-117)
A/C Compressor Bolt	29-40 (39-54)
Camshaft Sprocket Bolt	36-45 (49-61)
Connecting Rod Nut	
Step 1	11-13 (15-18)
Step 2	
1.3L	22-25 (30-34)
1.6L	35-38 (47-52)
Crankshaft Pulley Bolts	9-13 (12-17)
Crankshaft Sprocket Bolt	80-87 (108-118)
Crossmember-To-Body Bolt	
1.3L	47-66 (64-89)
1.6L	27-37 (35-50)
Cylinder Head Bolt	
Step 1	35-40 (48-54)
Step 2	56-60 (76-81)
Exhaust Manifold-To-Cylinder Head	
1.3L	12-17 (16-23)
1.6L	29-42 (39-57)
Exhaust Pipe-To-Manifold	29-42 (39-57)
Exhaust Pipe-To-Support Bracket	32-45 (43-61)
Flywheel Bolt	71-76 (96-103)
Front Cover Housing Bolt (1.3L)	14-19 (19-26)
Front Engine Mount Nut	32-38 (43-52)
Heater Tube	32-45 (43-61)
Intake Manifold-To-Cylinder Head	
1.3L	14-20 (19-27)
1.6L	47-66 (64-89)
Main Bearing Cap Bolts	40-44 (54-59)
O2 Sensor	27-33 (37-45)
Oil Pump Cover Bolt (1.6L)	14-18 (19-25)
P/S Pump Bracket (Nut & Bolt)	35-49 (47-66)
P/S Adjusting Nut	27-38 (37-52)
P/S Pivot Bolt	23-34 (31-46)
Pulse Air Tube Nut	23-34 (31-46)
Rear Engine Mount Nut	
1.3L	21-34 (28-46)
1.6L	47-66 (64-89)
Rocker Arm Shaft Bolts	16-21 (22-28)
Side Engine Mount Nuts	
1.3L	29-40 (39-54)
1.6L	
RH	49-67 (67-91)
LH	33-48 (45-65)
Spark Plug	11-17 (15-23)
Thermostat Housing Bolt	14-22 (19-30)
Timing Belt Tensioner Adjusting Bolt	14-19 (19-26)
Turbo Oil Supply Tube	
Engine Block Side	12-18 (16-24)
Banjo Side	1 106-159 (12-18)
Turbo-To-Manifold	29-42 (39-57)
Water Outlet Bolt	14-22 (19-30)
Water Pump Pulley Bolts (1.3L)	36-45 (49-61)

Water Pump-To-Block	14-19 (19-26)
Wheels	66-89 (90-120)
INCH Lbs. (N.m)	
Camshaft Bearing Cap Bolt	97-124 (11-14)
Camshaft Cover	71-97 (8-11)
Camshaft Thrust Plate Bolt	71-106 (8-12)
Front Cover Housing Bolt (1.6L)	71-97 (8-11)
Oil Pan Bolt	
1.3L	71-80 (8-9)
1.6L	71-97 (8-11)
Oil Pressure Sender	106-159 (12-18)
Oil Pump Cover Bolt (1.3L)	89-133 (10-15)
Pickup Tube-To-Oil Pump Bolt	71-97 (8-11)
Radiator Fan Bracket	71-97 (8-11)
Rear Engine Plate Bolt	71-97 (8-11)
Temperature Sender	44-89 (5-10)
Timing Belt Cover Bolt	71-97 (8-11)
Valve Cover Bolt	44-79 (5-9)
Water Pump Pulley Bolts (1.6L)	71-97 (8-11)
(1) This specification is INCH Lbs.	

ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS

Application	Specification
Displacement	
1.3L	80.8 Cu. In. (1.3L)
1.6L	97.4 Cu. In. (1.6L)
Bore	
1.3L	2.80" (71.0 mm)
1.6L	3.07" (78 mm)
Stroke (1.3L & 1.6L)	3.29" (83.6 mm)
Compression Ratio	
1.3L	9.7:1
1.6L	N/A
Fuel System	PFI
HP@RPM	
1.3L	58 @ 5000
1.6L	
(Non-Turbo)	100 @ 5750
(Turbo)	132 @ 6000
Torque Ft. Lbs.@RPM	
1.3L	73 @ 3000
1.6L	
(Non-Turbo)	95 @ 5500
(Turbo)	136 @ 3000

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS

Application	In. (mm)
Crankshaft	
End Play	.0031-.0111 (.080-.282)
Runout (Maximum)	.002 (.05)
Main Bearings	
Journal Diameter	1.9661-1.9668 (49.938-49.956)
Journal Out-Of-Round	.002 (.05)
Journal Taper	.002 (.05)
Oil Clearance	.0009-.0017 (.024-.042)
Connecting Rod Bearings	
Journal Diameter	
1.3L	1.5724-1.5731 (39.939-39.957)
1.6L	1.7693-1.7699 (44.940-44.956)
Journal Out-Of-Round	.002 (.05)
Journal Taper	.002 (.05)

Oil Clearance	.0011-.0027 (.028-.068)
---------------	-------------------------

CONNECTING RODS

CONNECTING RODS

Application	In. (mm)
Bore Diameter	
Pin Bore	
1.3L	.7854-.7859 (19.948-19.961)
1.6L	.7875-.7880 (20.003-20.014)
Crankpin Bore	1.8897-1.8904 (48.000-48.016)
Center-To-Center Length	5.230-5.234 (132.85-132.95)
Maximum Bend & Twist (1)	
1.3L	.0016 (.04)
1.6L	.0078 (.198)
Side Play	.012 (.30)
(1) Per 3.94" (100 mm) of length.	

PISTONS, PINS & RINGS

PISTONS PINS & RINGS

Application	In. (mm)
Piston	
Clearance (Max.)	.006 (.15)
Diameter	
1.3L	2.793-2.794 (70.954-70.974)
1.6L	3.0690-3.0698 (77.954-77.974)
Pins	
Outside Diameter	
1.3L	.7864-.7866 (19.974-19.980)
1.6L	.7869-.7871 (19.987-19.993)
Inside Diameter	.524 (13.309)
Pin-To-Piston Fit	
1.3L	.0003-.0005 (.0076-.0127)
1.6L	.0004-.0012 (.0100-.0260)
Rod Fit	(1) 0-.0012 (0-.030)
Rings	
No. 1	
End Gap	.006-.012 (.15-.30)
Side Clearance	.001-.003 (.03-.07)
No. 2	
End Gap	.006-.012 (.15-.30)
Side Clearance	.001-.003 (.03-.07)
No. 3 (Oil)	
End Gap	.008-.028 (.20-.70)
Side Clearance	
1.3L	.039 (1.0)
1.6L	.001-.003 (.03-.07)
(1) This is a negative clearance (interference fit).	

CYLINDER BLOCK

CYLINDER BLOCK

Application	In. (mm)
Cylinder Bore	
Standard Diameter	
1.3L	2.7953-2.7961 (71.00-71.02)
1.6L	3.0709-3.0716 (78.000-78.019)
Maximum Taper	.0007 (.018)
Maximum Out-Of-Round	.0007 (.018)
Maximum Deck Warpage	.006 (.15)

VALVES & VALVE SPRINGS

VALVES & VALVE SPRINGS

Application	In. (mm)
Intake Valves	
Face Angle	45°

Head Diameter	
1.3L	N/A
1.6L	1.217-1.224 (30.90-31.10)
Minimum Margin	
.020 (.50)	
Stem Diameter	
1.3L	.2744-.2750 (6.970-6.985)
1.6L	.2350-.2356 (5.970-5.985)
Exhaust Valves	
Face Angle	45°
Head Diameter	
1.3L	N/A
1.6L	1.028-1.035 (26.1-26.3)
Minimum Margin	
1.3L	.039 (1.0)
1.6L	.020 (.5)
Stem Diameter	
1.3L	.2742-.2748 (6.965-6.980)
1.6L	.2348-.2354 (5.965-5.980)
Valve Springs	
Free Length	
1.3L	1.717 (43.6)
1.6L	1.858 (47.2)
Out-Of-Square	
1.3L	.059 (1.50)
1.6L	.063 (1.60)

CYLINDER HEAD

CYLINDER HEAD

Application	In. (mm)
Maximum Warpage	.006 (.15)
Valve Seats	
Intake Valve	
Seat Angle	45°
Seat Width	
1.3L	.043-.067 (1.10-1.70)
1.6L	.030-.055 (.80-1.40)
Maximum Seat Runout	
.0016 (.04)	
Exhaust Valve	
Seat Angle	45°
Seat Width	
1.3L	.043-.067 (1.10-1.70)
1.6L	.030-.055 (.80-1.40)
Maximum Seat Runout	
.0016 (.04)	
Valve Guides	
Intake Valve	
Valve Guide I.D.	
1.3L	.276-.277 (7.01-7.03)
1.6L	.2366-.2374 (6.01-6.03)
Valve Stem-To-Guide	
Oil Clearance	
1.3L	Maximum Service Limit .008 (.20)
1.6L	.0010-.0024 (.025-.060)
Exhaust Valve	
Valve Guide I.D.	
1.3L	.276-.277 (7.01-7.03)
1.6L	.2366-.2374 (6.01-6.03)
Valve Stem-To-Guide	
Oil Clearance	
1.3L	Maximum Service Limit .008 (.20)
1.6L	.0012-.0026 (.300-.650)

CAMSHAFT SPECIFICATIONS

CAMSHAFT SPECIFICATIONS

Application	In. (mm)
End Play	(1) .002-.007 (.05-.18)
Journal Diameter	

1.3L	
No. 1 & 3	1.7102-1.7109 (43.440-43.456)
No. 2	1.7091-1.7100 (43.410-43.435)
1.6L (All Journals)	1.0213-1.0222 (25.940-25.965)
Journal Runout	.002 (.05)
Lobe Height	
1.3L	(2) 1.4332-1.4371 (36.403-36.503)
1.6L	(3) 1.6098 (40.888)
Oil Clearance	
1.3L	
No. 1 & 3 Journals	(4) .0014-.0033 (.035-.085)
No. 2 Journal	(4) .0026-.0045 (.065-.115)
1.6L (All Journals)	(4) .0014-.0033 (.035-.085)
(1) End play limit is .008" (.20 mm). (2) Wear limit is 1.4272" (36.253 mm) (3) Wear limit is 1.5940" (40.489) (4) Maximum clearance is .0059" (.150 mm)	

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Article GUID: A00048707

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STARTER

1991 ELECTRICAL Starters

DESCRIPTION

The Nippondenso direct drive starter is a conventional 12-volt, 4-pole, brush-type starter. The integral solenoid is attached to the drive housing. When starter is energized, starter solenoid causes the starter pinion to engage with the flywheel ring gear. The overrunning clutch pinion drive is mounted directly on armature shaft drive end.

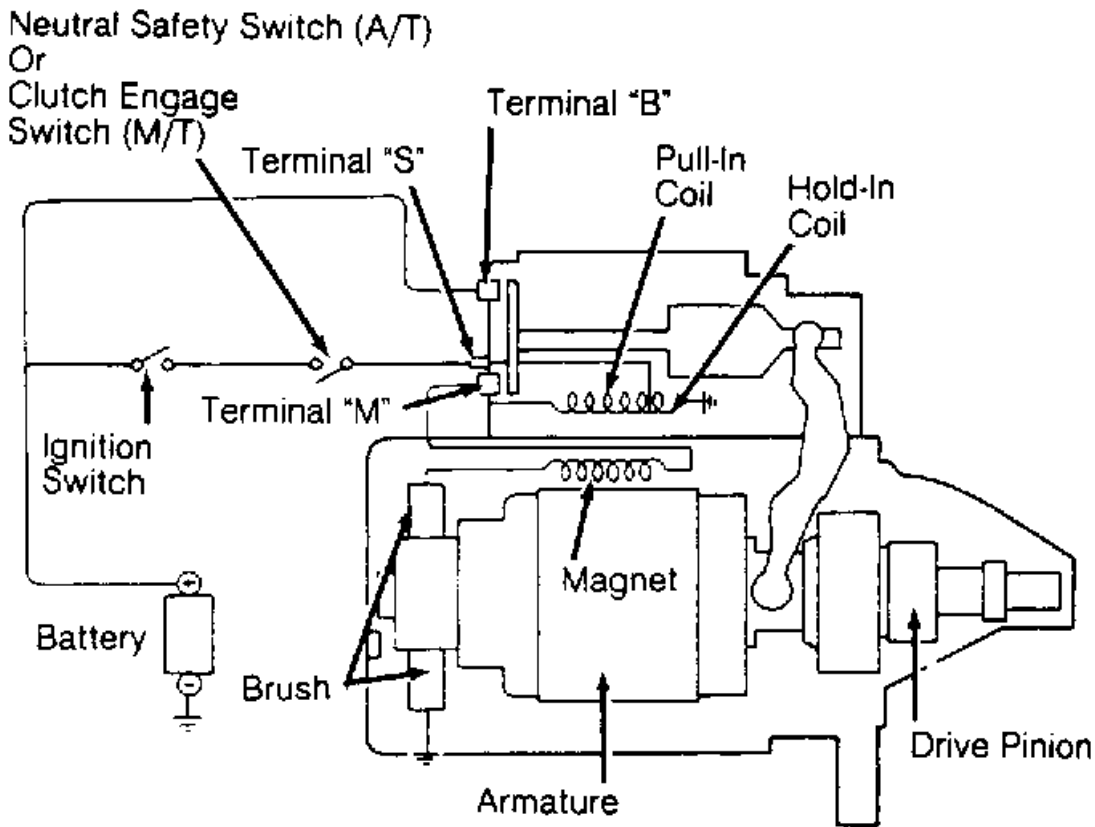


Fig. 1: Starter System Schematic
Courtesy of FORD MOTOR CO.

TROUBLE SHOOTING

ENGINE CRANKS SLOWLY

Undercharged battery. Loose or corroded cable connections. Bad starter.

ENGINE WILL NOT CRANK

Undercharged battery. Bad ignition switch. Bad clutch engage switch (M/T) or neutral safety switch (A/T). Loose or corroded cable connections. Bad starter. Faulty circuit grounds.

STARTER SPINS & ENGINE DOES NOT CRANK

Bad starter. Bad flywheel ring gear and/or starter drive pinion.

ENGINE STARTS WITH CLUTCH ENGAGED (M/T)

Bad clutch engage switch. Adjust or replace.

ENGINE STARTS IN GEAR (A/T)

Bad neutral safety switch. Adjust or replace.

ON-VEHICLE TESTING

PRELIMINARY TEST

Ensure battery is fully charged and has load tested okay. If starter will not crank engine with fully charged battery, proceed with the following test.

- Using a digital voltmeter, connect positive voltmeter lead to starter solenoid terminal "S", and negative lead to starter housing. See [Fig. 1](#).
- Turn ignition switch to START position, and observe voltmeter reading. If voltage at terminal "S" is greater than 8 volts, starter or circuit malfunction is indicated. See [VOLTAGE DROP TEST](#) and STARTER GROUND CIRCUIT TEST under ON-VEHICLE TESTING.

3. If voltage is not present or is less than 8 volts at starter solenoid terminal "S", malfunction in circuit to terminal "S" is indicated. Proceed to the following tests.

IGNITION SWITCH TEST

1. Locate ignition switch connector under dash. Using a 12-volt test light or voltmeter, ensure voltage is present on Black/Yellow wire when ignition switch is turned to RUN or ON position. This will verify proper operation of ignition switch.
2. If there is no voltage on Black/Yellow wire, the problem is either ignition switch or circuit between battery and ignition switch.

CLUTCH ENGAGE SWITCH (M/T) TEST

Unplug clutch engage switch from main wiring harness. Using an ohmmeter, check for continuity across switch terminals. Continuity should exist when switch plunger is pushed in and should not exist when switch plunger is released. If clutch engage switch does not operate as specified, replace switch.

NEUTRAL SAFETY SWITCH (A/T) TEST

Unplug neutral safety switch from main wiring harness. Using an ohmmeter, check for continuity across switch terminals "A" and "B". See [Fig. 2](#). Place transmission shift selector in Park or Neutral position. Continuity should exist between terminals "A" and "B". Continuity should not exist in any other transmission shift selector positions. If switch does not operate as specified, replace switch.

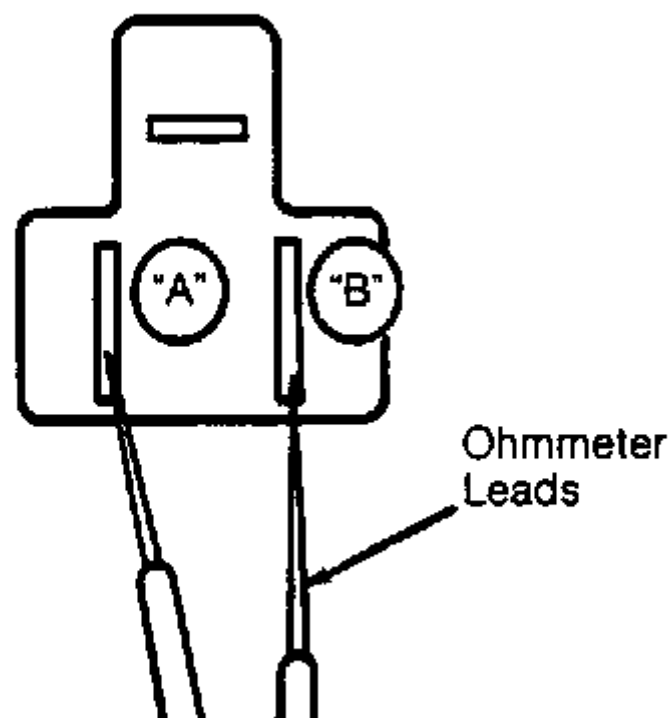


Fig. 2: Identifying Neutral Safety Switch Terminals

Courtesy of FORD MOTOR CO.

VOLTAGE DROP TEST

NOTE: Make all voltmeter connections at component terminal rather than at cable or wire end.

1. Disconnect and ground coil wire from distributor cap to prevent engine from starting. Connect remote starter switch between starter solenoid terminal "S" and battery positive terminal. See [Fig. 3](#).
2. Using a digital voltmeter set on low scale, connect positive voltmeter lead to battery positive terminal. Connect negative lead to starter solenoid terminal "M". See [Fig. 3](#).
3. Engage remote starter switch. Observe and record voltmeter reading. Voltmeter reading should be less than .5 volt. If voltage at terminal "M" is greater than .5 volt, move negative voltmeter lead to solenoid terminal "B", and repeat test.
4. If voltage at terminal "B" is less than .5 volt, inspect solenoid cable connections and solenoid contacts for problem.
5. Clean solenoid terminals "B", "M" and "S", and repeat steps 1) through 4). If voltmeter still reads greater than .5 volt at terminal "M" and less than .5 volt at terminal "B", solenoid contacts are bad.
6. If voltmeter reads greater than .5 volt at terminal "B", clean cables and connections at solenoid. If voltmeter still reads greater than .5 volt, check for poor positive battery cable connection or bad cable. Repair or replace as necessary.
7. To locate excessive voltage drop, move negative voltmeter lead toward battery, and check each connection point. When high voltmeter reading is no longer present, last connection point is bad.

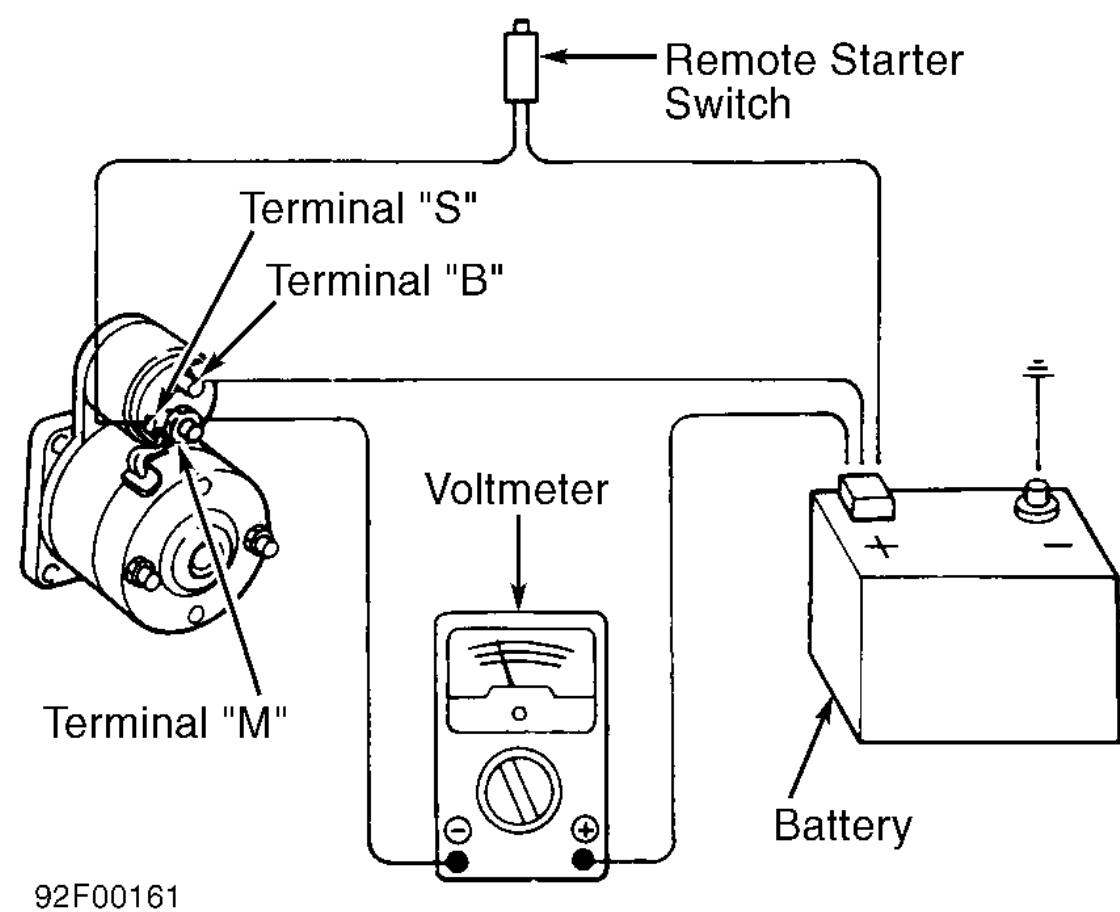


Fig. 3: Testing Voltage Drop
Courtesy of FORD MOTOR CO.

STARTER GROUND CIRCUIT TEST

- NOTE:** Make all voltmeter connections at component terminal rather than at cable or wire end.
1. Disconnect and ground coil wire from distributor cap to prevent engine from starting. Connect remote starter switch between starter solenoid terminal "S" and battery positive terminal. See [Fig. 1](#) .
 2. Using a digital voltmeter set on low scale, connect positive voltmeter to starter motor housing. Ensure connection point is clean and free of rust and grease. Connect negative voltmeter lead to negative battery terminal.
 3. Engage remote starter switch and crank engine. Observe and record voltmeter reading. Voltmeter should read .2 volt or less. If voltage drop is greater than .2 volt, clean negative battery cable connections at battery and body connections. Retest to ensure problem has been corrected.
 4. If voltage drop is still excessive, replace negative battery cable(s) as necessary. If battery cables test okay, and starter still cranks slowly or not at all, remove and repair starter motor.

BENCH TESTING

STARTER NO-LOAD TEST

Remove starter. Place starter on bench. Connect a fully charged 12-volt battery, voltmeter, ammeter and remote starter switch to starter. See [Fig. 4](#) . Engage remote starter switch. Starter should rotate smoothly. Ensure voltage and amperage draw is less than maximum specification at 5000 RPM minimum. See NO-LOAD TEST SPECIFICATIONS table. If voltage and/or amperage is higher than specifications, disassemble starter and determine cause.

NO-LOAD TEST SPECIFICATIONS

Application	Maximum Amps	Volts
Capri & Festiva	60	11.5

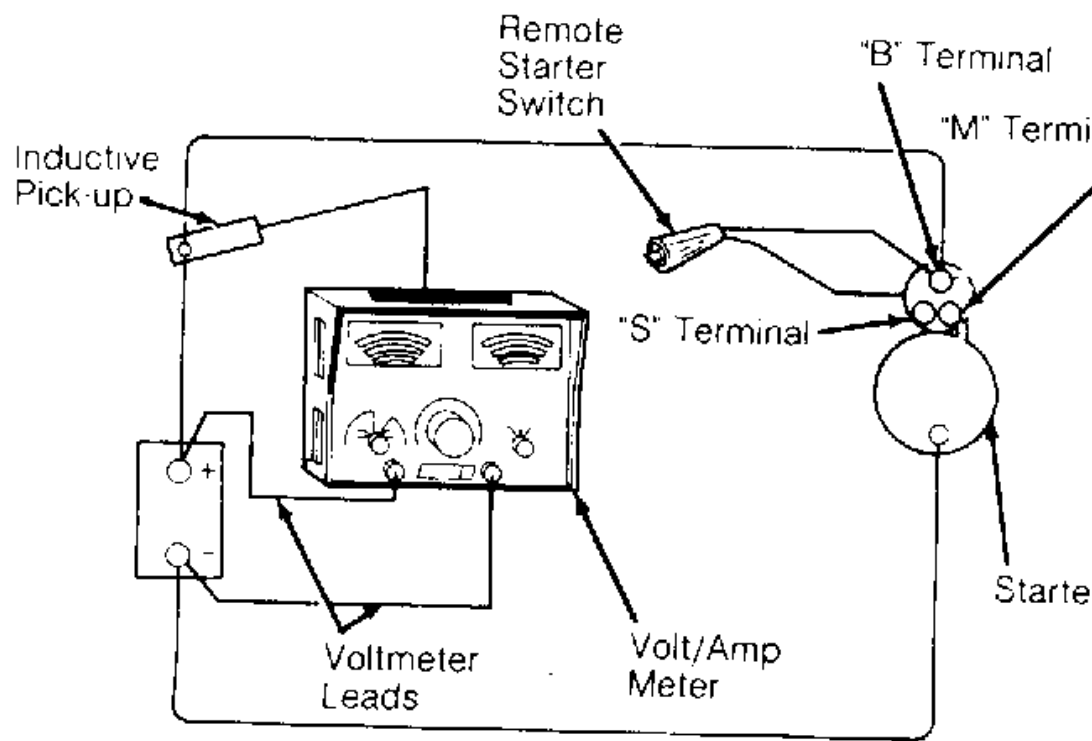


Fig. 4: Starter No-Load Test
Courtesy of FORD MOTOR CO.

PINION GAP ADJUSTMENT TEST

1. Disconnect field lead from terminal "M" of solenoid to prevent starter from turning. See [Fig. 5](#) . Connect jumper wire from a 12-volt battery positive terminal to terminal "S" of solenoid. Connect another jumper wire from negative battery terminal to terminal "M" of solenoid.
2. Solenoid should energize when battery is connected, kicking out drive pinion. With drive pinion extended, measure pinion gap between drive pinion and collar. Gap should be .020-.080" (.5-2.0 mm). See [Fig. 5](#) .

NOTE: **DO NOT engage solenoid for more than 10 seconds. If test must be repeated, wait at least 3 minutes between tests to allow solenoid to cool.**

3. Add or subtract shims between solenoid and end housing to achieve proper pinion depth gap. Install field lead to terminal "M" of solenoid. Install nut and tighten to 70-106 INCH lbs. (8-12 N.m).

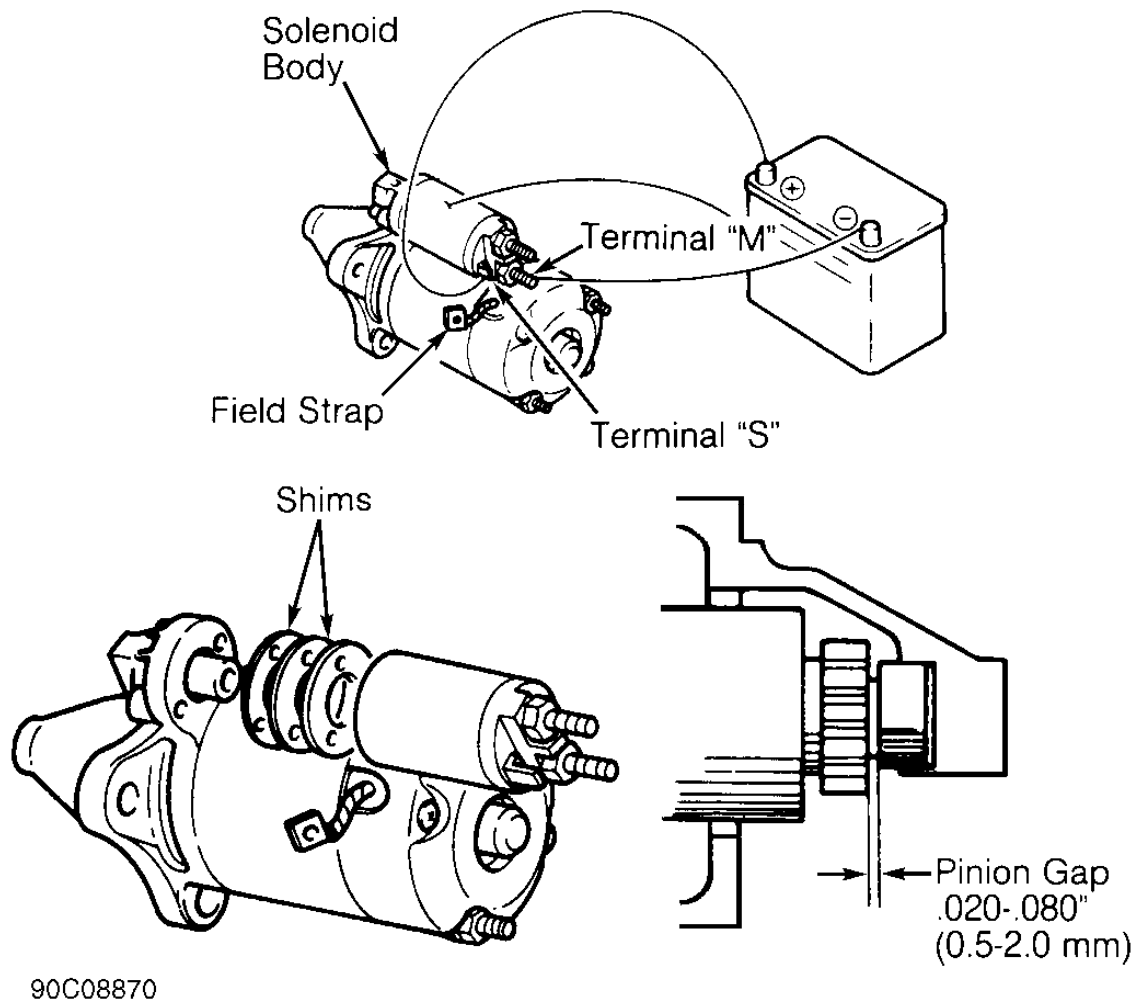


Fig. 5: Measuring Pinion Gap
Courtesy of FORD MOTOR CO.

SOLENOID TEST

Disconnect wiring and cables from solenoid. Using an ohmmeter, check for continuity between terminal "M" and body of starter solenoid. See [Fig. 1](#) . Continuity should exist. If continuity does not exist, replace solenoid.

ARMATURE TEST

1.

Place armature in growler. Turn on growler and hold a piece of hacksaw blade over armature. Slowly rotate armature. If hacksaw blade is attracted to core or if it vibrates, replace armature.
2.

Remove armature from growler. Using an ohmmeter, check continuity between commutator and core. If continuity exists, replace armature. Check continuity between commutator and shaft. If continuity exists, replace armature.
3.

Check continuity between each commutator segment. If an open exists between any 2 segments, replace armature.

COMMUTATOR TEST

1.

Clean surface of commutator and polish with No. 400 grit sandpaper (if required). If surface is scored, out of round or pitted, turn commutator on a lathe.
2.

Maximum commutator runout and minimum diameter of commutator must not exceed specification after turning. See [STARTER MOTOR SPECIFICATIONS](#) table.
3.

Commutator mica undercut depth should be .02-.03" (.5-.8 mm). If undercut depth is not within specification, undercut with a hacksaw blade to standard depth.

BRUSH & SPRING TEST

1.

Connect ohmmeter between positive brush holder and negative brush holder. If ohmmeter indicates continuity, brush holder assembly is shorted and must be replaced.
2.

Check brush length. See [STARTER MOTOR SPECIFICATIONS](#) table. If brush length is less than specification, replace brushes.
3.

Check spring tension. Spring tension should be 2.0-4.3 Lbs. (8.8-19.1 N.m). Ensure brushes move freely in holders.

FIELD COIL TEST

1.

Connect ohmmeter between field lead and soldered portion of brush lead. If continuity does not exist, repair or replace field coil.
2.

Check field coil for shorts to ground by connecting ohmmeter between field lead and starter housing. If continuity exists, repair or replace field coil.

OVERHAUL

NOTE: For exploded view of starter assembly, see [Fig. 6](#) .

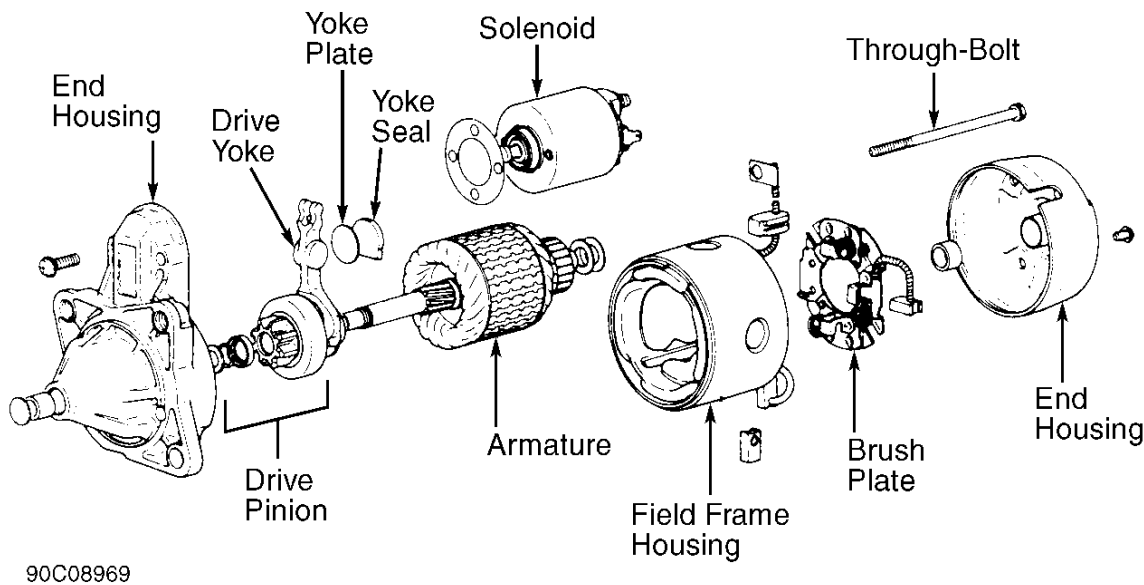


Fig. 6: Exploded View of Starter Motor Assembly
Courtesy of FORD MOTOR CO.

STARTER MOTOR SPECIFICATIONS

STARTER MOTOR SPECIFICATIONS

Application	Specification
Brush Length	
Minimum	.45" (11.5 mm)
New	.67" (17 mm)
Brush Spring Force	2.0-4.3 Lbs. (8.8-19.1 N.m)
Commutator	
Runout	.002" (.05 mm)
Minimum Diameter	1.22" (31.0 mm)
Segment Depth	.02-.03" (.5-.8 mm)
Pinion Gap	.020-.080" (0.5-2.0

	mm)
--	-----

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Starter Motor Mounting Bolts	23-34 (31-46)
	INCH Lbs. (N.m)
Solenoid Retaining Screws	36-67 (4.1-7.5)
Through Bolts	55-75 (6-8)
Terminal Nuts	71-106 (8-12)

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FORD

1.3L 4-Cylinder

MANUFACTURER'S SUGGESTED SCHEDULED MAINTENANCE

For Aspire, the manufacturer recommends the belt be replaced every 60,000 miles on Federal vehicles, and 105,000 miles on California vehicles. For Festiva, the manufacturer recommends the belt be replaced every 60,000 miles.

REMOVAL & INSTALLATION

TIMING BELT

Removal

1. Disconnect negative battery cable. Remove accessory belts. Remove water pump pulley. Remove right inner fender panel to gain access to crankshaft pulley. See [Fig. 1](#) . Remove outer crankshaft pulley attaching bolts, then outer stiffener and spacer. Remove inner pulley and baffle plate. Remove bolts retaining upper and lower cover halves to engine front. Remove both covers. See [Fig. 2](#) .

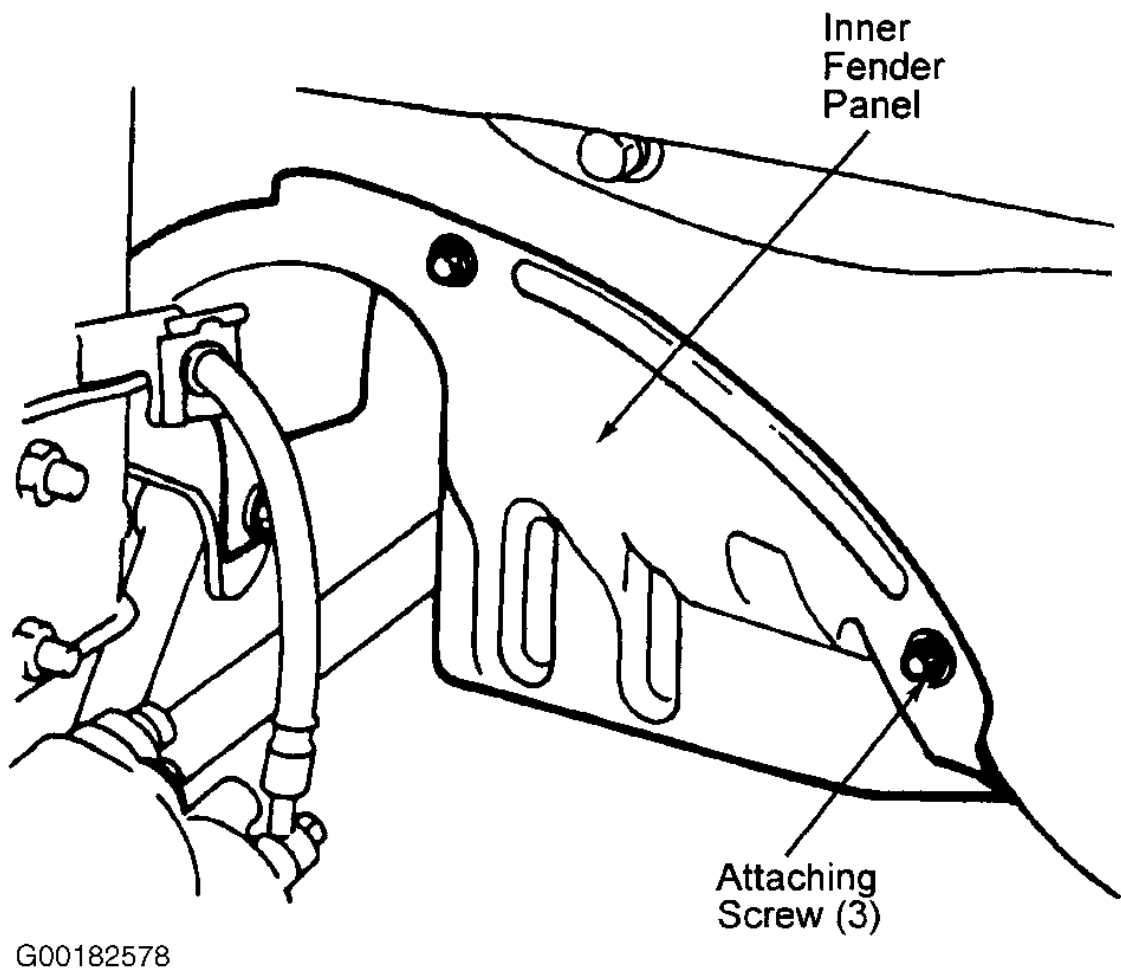
NOTE: Always rotate engine in direction of normal operation. Rotating crankshaft backwards may cause belt to jump timing.

2. Mark timing belt direction of rotation for installation reference. Remove timing belt tensioner pulley bolt. Remove tensioner pulley, spring, and spring cover. Remove timing belt.

CAUTION: Never twist, turn inside out, or bend timing belt. Keep belt away from grease and oil.

Installation

1. Ensure timing belt and sprockets are clean, and not worn or damaged. Align crankshaft and camshaft timing marks. See [Fig. 3](#) . Position belt onto sprockets in original running direction.
2. Install timing belt tensioner spring, spring cover, and pulley. To complete installation, reverse removal procedure. Tighten all bolts and nuts to specification. See [TORQUE SPECIFICATIONS](#) . Adjust drive belts to proper tension.



[Fig. 1: Removing Right Inner Fender Panel](#)
Courtesy of FORD MOTOR CO.

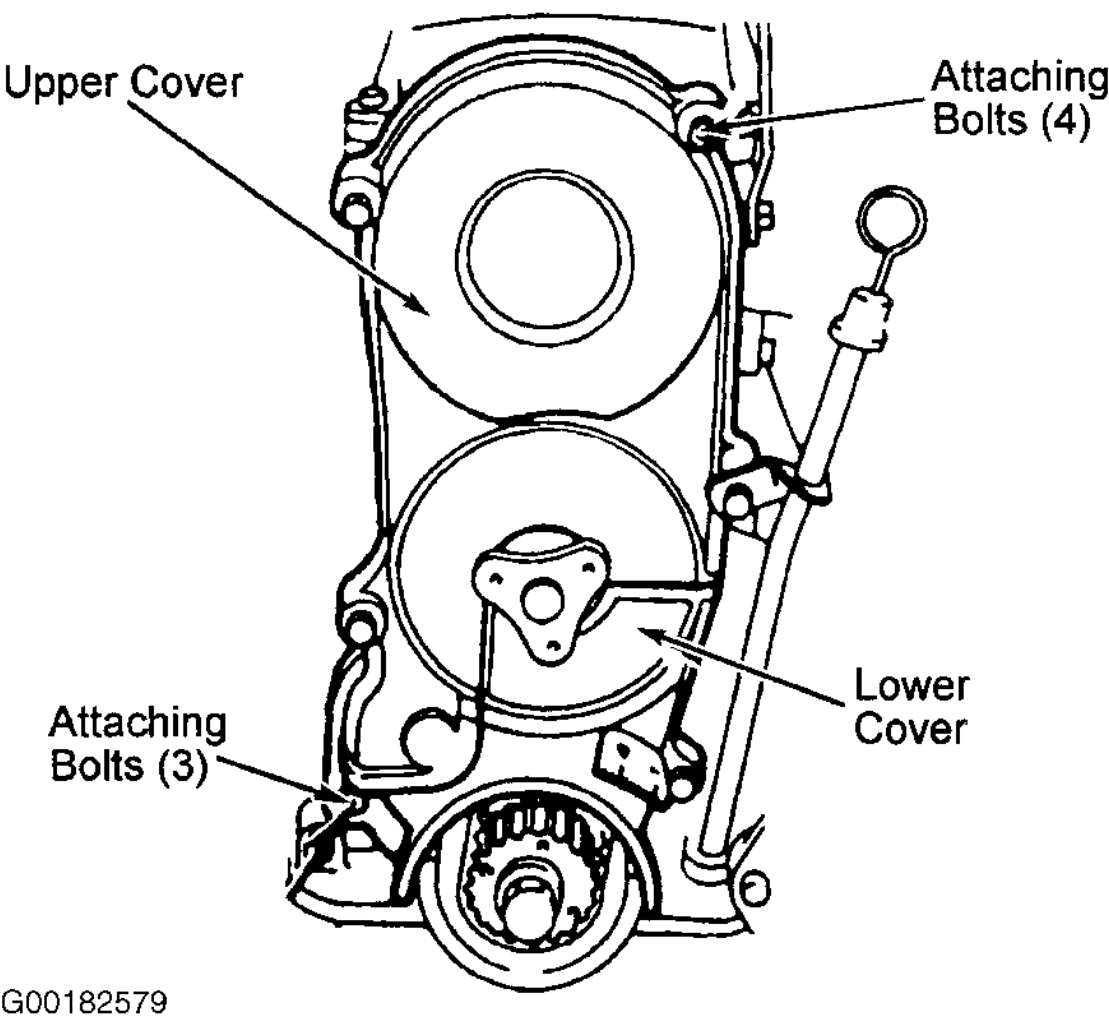


Fig. 2: Locating Timing Belt Upper & Lower Covers
Courtesy of FORD MOTOR CO.

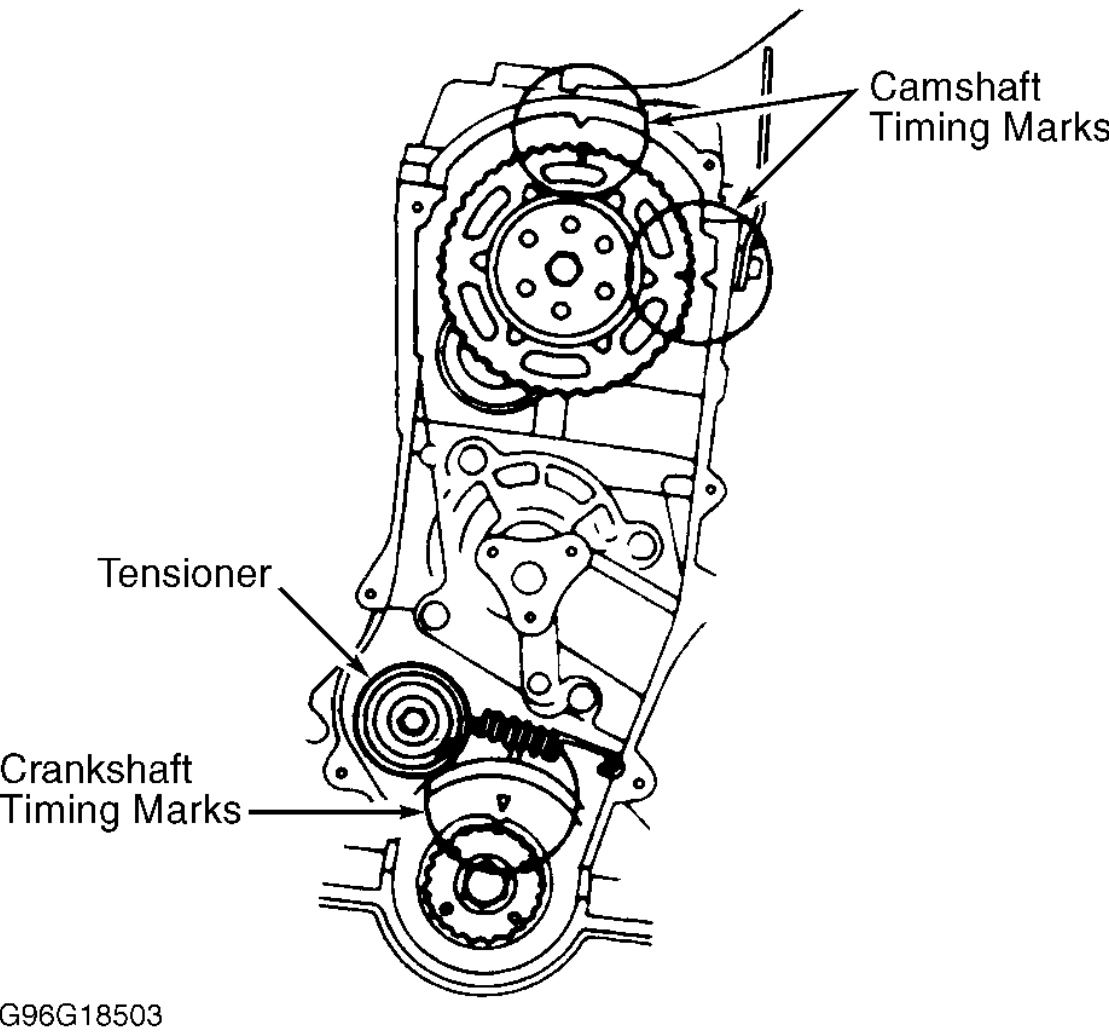


Fig. 3: Aligning Timing Marks
Courtesy of FORD MOTOR CO.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS	
Application	Ft. Lbs. (N.m)
A/C Compressor Bolt	29-40 (39-54)
Camshaft Pulley Bolt	9-13 (12-17)
Camshaft Sprocket Bolt	36-45 (49-61)

Crankshaft Pulley Bolts	10-13 (12-17)
Crankshaft Sprocket Bolt	80-87 (108-118)
Power Steering Adjuster Nut	27-38 (37-52)
Timing Belt Tensioner Adjuster Bolt	14-19 (19-26)
Water Pump Pulley Bolts	36-45 (49-61)
INCH Lbs. (N.m)	
Camshaft Cover	71-97 (8-11)
Timing Belt Cover Bolt	71-97 (8-11)
Valve Cover Bolt	44-79 (5-9)

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D - ADJUSTMENTS

1991 ENGINE PERFORMANCE Ford/Mercury - On-Vehicle Adjustments

ADJUSTMENTS

ENGINE MECHANICAL

Before beginning any on-vehicle adjustments to fuel or ignition systems, ensure engine mechanical condition is okay.

VALVE CLEARANCE

NOTE: All models are equipped with hydraulic lash adjusters. No adjustments are required.

IGNITION TIMING

CAPRI

1. Place automatic transmission in Park or manual transmission in Neutral. Disconnect and plug hoses attached to vacuum diaphragm assembly on distributor. Connect tachometer and timing light. Turn off all electrical loads.
2. Start engine, and warm it to operating temperature. Ensure idle speed is set to specification, adjusting if necessary. See [IDLE SPEED & MIXTURE](#) . Determine initial timing. See [IGNITION TIMING](#) table. If base timing is not correct, loosen distributor mounting bolts and rotate distributor until marks align. Tighten bolts to 14-18 ft. lbs. (19-25 N.m).
3. Increase engine RPM while observing timing light. Verify ignition timing advances. For Turbo models, go to step 5). For non-Turbo models, continue with step 4).
4. On non-Turbo models, apply 16 in. Hg vacuum to chamber "A". Verify timing advances by 26-30 degrees. Remove vacuum source from chamber "A". Apply 8 in. Hg vacuum to chamber "B" while observing timing. Verify timing advances by 3-7 degrees. Stop engine, and remove test equipment.
5. On Turbo models, apply 20 in. Hg vacuum to advance diaphragm. Verify timing advances by 13-17 degrees. Disconnect vacuum source. Apply 8 psi (.6 kg/cm²) pressure to advance diaphragm. Verify timing retards by 3-7 degrees. Stop engine, and remove test equipment.

FESTIVA

1. Place manual transmission in Neutral or automatic transmission in Park. Turn all accessories off. Locate one-wire STI (Black) connector near master cylinder. Using a jumper wire, connect STI terminal to ground. See [Fig. 1](#) . Connect timing light and tachometer.

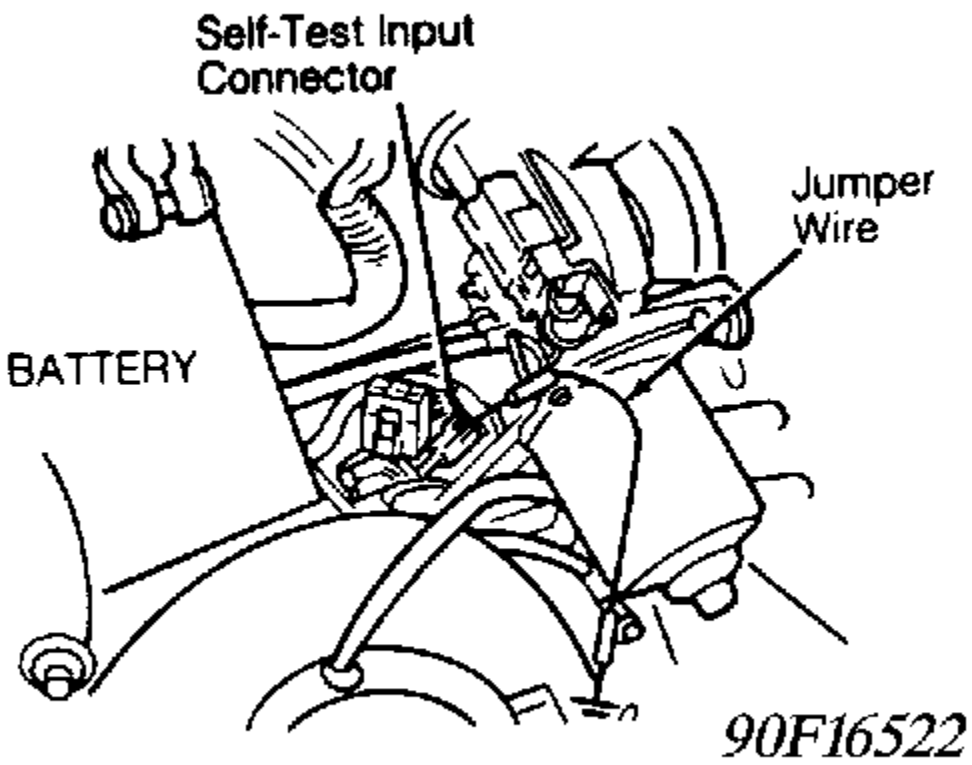


Fig. 1: Locating Self-Test Input (STI) Connector
Courtesy of FORD MOTOR CO.

2. Start engine, and warm to operating temperature. Ensure idle speed is set to specification, adjusting if necessary. See [IDLE SPEED & MIXTURE](#) .
3. Check initial timing. White timing mark should align with white mark on crankshaft pulley. If marks do not align, loosen distributor mounting bolts and rotate distributor until marks align. Tighten bolts to 14-18 ft. lbs. (19-25 N.m).
4. Remove jumper wire. Increase engine RPM, and verify ignition timing advances beyond initial setting. Stop engine, and remove test equipment.

IGNITION TIMING

Application	Auto. Trans.	Man. Trans.
1.3L	9-11 @ 850	9-11 @ 700
1.6L Non-Turbo	1-3 @ 850	0-4 @ 850
1.6L Turbo	10-14 @ 850	0-4 @ 850

IDLE SPEED & MIXTURE

IDLE MIXTURE

NOTE: Idle mixture is controlled by ECA and is not adjustable.

IDLE SPEED

- Turn off all accessories. Place automatic transmission in Park or manual transmission in Neutral. Set parking brake. Connect tachometer to engine. Warm engine to normal operating temperature. Connect a jumper wire between single-wire STI test connector (Green on Capri; Black on Festiva) and ground. See [Fig. 1](#) .
 - Locate idle speed control by-pass air (ISC-BPA) valve on intake manifold. Remove cap, and adjust idle speed to specification by turning idle air adjust screw on ISC-BPA valve. See [Fig. 2](#) . Remove jumper wire.

IDLE RPM

Application	Auto. Trans.	Man. Trans.
1.3L	830-870	680-720
1.6L	800-900	800-900

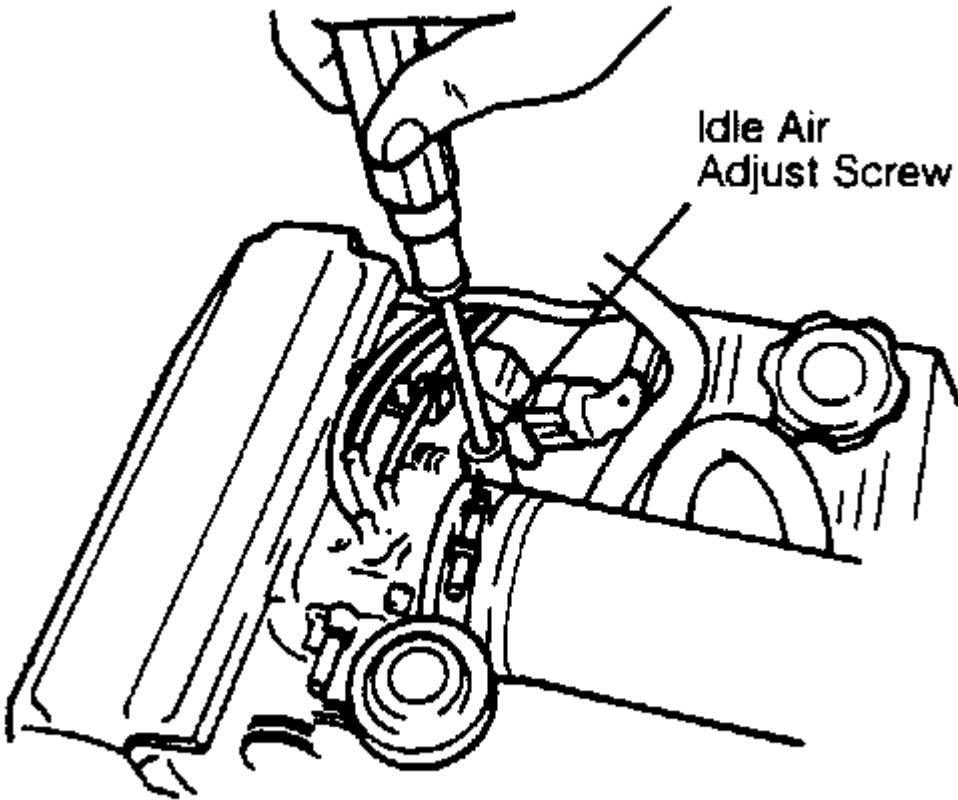


Fig. 2: Locating Idle Air Adjust Screw
 Courtesy of FORD MOTOR CO.

THROTTLE POSITION SWITCH (TP)

CAPRI

Throttle position sensor is preset at factory. No adjustment is required.

FESTIVA

- Ensure idle speed and ignition timing are adjusted to specification. Stop engine. Disconnect negative battery cable.

- CAUTION:** DO NOT tamper with throttle stop screw at throttle lever. Doing so may result in damage to throttle body.

 - Unplug TP connector at throttle body. Insert appropriate feeler gauge between throttle stop screw and stop lever. Check for continuity between specified terminals on TP connector. See TP ADJUSTMENT table.
 - To adjust, loosen TP attaching screws. Connect ohmmeter between terminals IDL and TL. See [Fig. 3](#) . Insert a .020" (.5 mm) feeler gauge between throttle stop screw and stop lever.
 - Rotate TP until ohmmeter indicates continuity. Insert a .028" (.7 mm) thickness gauge between stop screw and stop lever. Ohmmeter should indicate no continuity. If ohmmeter indicates continuity, repeat adjustment procedure.

TP ADJUSTMENT

Test Condition ⁽¹⁾	Cont. Between IDL-TL	Cont. Between PSW-TL
.02" (.5 mm)	Yes	No
.03" (.7 mm)	No	No
Wide Open Throttle	No	Yes
(1) Insert specified feeler gauge between throttle adjustment screw and stop lever.		

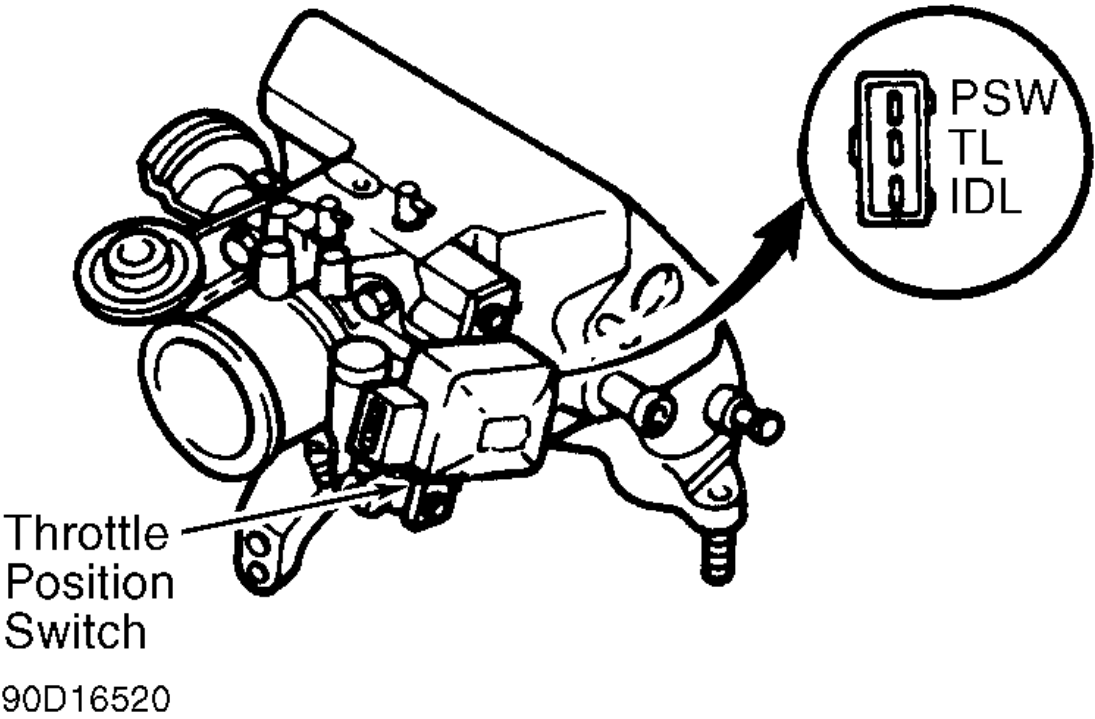


Fig. 3: Throttle Position Switch Connector Terminal ID. (Festiva)
Courtesy of FORD MOTOR CO.

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A - ENGINE/VIN ID

1991 ENGINE PERFORMANCE Ford/Mercury - Introduction

APPLICATION

MODEL COVERAGE

Model	Body Code	Eng. Type ⁽¹⁾	Eng. ID	Fuel Sys.	Ign. Sys.
Capri	01	1.6L	Z	PFI	Magnetic
Capri	01	1.6L Turbo	6 ⁽²⁾	PFI	Magnetic
Festiva	05, 06, 07	1.3L	H	PFI	Magnetic
(1) See vehicle engine code label affixed to timing belt cover, See Fig. 1 .					
(2) XR2 model W/intercooled turbo.					

VIN DEFINITION

Numbers preceding the explanations in the legend below refer to the sequence of characters as listed on VIN identification label.

SAMPLE VIN

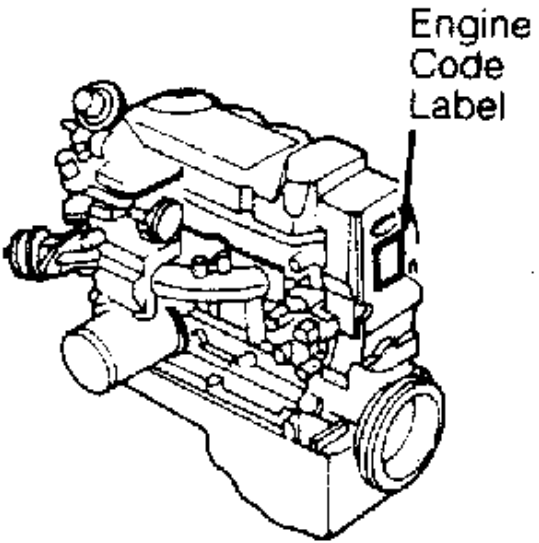
Digit #: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17.

(VIN) K N J P T O 6 H 9 L 6 1 0 0 0 0 .

VIN Definition

- 1-3 - Indicates Nation of Origin.
- 4 - Indicates Restraint System.
- 5 - Indicates Carline Code.
- 6-7 - Indicates Body Type.
- **8 - Indicates Engine Type.**
- 9 - Indicates Check Digit.
- **10 - Indicates Model Year.**
- 11 - Indicates Assembly Plant.
- 12-17 - Vehicle Serial Number.

ENGINE CODE LOCATION



1.3L FESTIVA

Fig. 1: Engine Code Location
Courtesy of FORD MOTOR CO.

MODEL YEAR VIN CODE APPLICATION

VIN Code	Model Year
L	1990
M	1991

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EMISSION CONTROL APPLICATIONS

Emission Applications - Ford Motor Co. - Imports (1968-97)

EMISSION APPLICATIONS

1968-97 FORD MOTOR CO. - IMPORTS

Year, Model, Engine & Fuel System	(1) Emission Control Systems & Devices
1968-69	
Cortina 1.6L Carb.	PCV, AIS
1970	
Capri & Cortina (Except GT) 1.6L Carb.	PCV, ACL, (2) EVAP, SPK, EVAP-VC, SPK-DDD, DCLV
Cortina GT 1.6L Carb.	PCV, (2) EVAP, AIS, EVAP-VC
1971	
Capri 1.6L Carb.	PCV, ACL, EVAP, SPK, EVAP-VC, SPK-DDD, DCLV
Pantera 5.8L V8 Carb.	PCV, EVAP, SPK, EVAP-VC, SPK-DDD
1972	
Capri 1.6L Calif. Carb.	PCV, ACL, EVAP, SPK, EVAP-VC, SPK-DDD, SPK-TCS, DCLV
1.6L Fed. Carb.	PCV, ACL, EVAP, SPK, EVAP-VC, SPK-DDD, DCLV
2.0L Calif. Carb.	PCV, ACL, EVAP, SPK, EVAP-VC, SPK-DDD, DCLV
2.0L Fed. Carb.	PCV, ACL, EVAP, SPK, EVAP-VC, SPK-DDD, DCLV
2.6L Carb.	PCV, ACL, EVAP, SPK, EVAP-VC, SPK-DDD, DCLV
Courier 1.8L Calif. Carb.	PCV, EVAP, AIS, EVAP-VC, CRV
Fed. Carb.	PCV, EVAP, SPK, EVAP-VC, SPK-DPD
Pantera 5.8L V8 Carb.	PCV, EVAP, SPK, EVAP-VC, SPK-DDD
1973	
Capri 2.0L Calif. Carb.	PCV, ACL, EVAP, SPK, EVAP-VC, SPK-DDD, DCLV
2.0L Fed. Carb.	PCV, ACL, EVAP, SPK, EVAP-VC, SPK-DDD, SPK-TCS, DCLV
2.6L A/T Carb.	PCV, ACL, EVAP, SPK, EVAP-VC, SPK-DDD
2.6L M/T Carb.	PCV, ACL, EVAP, SPK, EVAP-VC, SPK-DDD, SPK-TCS, DCLV
Courier 1.8L Calif. Carb.	PCV, EVAP, AIS, EVAP-VC, CRV
Fed. Carb.	PCV, EVAP, SPK, EVAP-VC, SPK-DPD, CRV
Pantera 5.8L V8 Carb.	PCV, EVAP, SPK, EVAP-VC, SPK-DDD
1974	
Capri 2.0L Carb.	PCV, ACL, EVAP, EGR, AIS, EVAP-VC, DCLV
2.8L Carb.	PCV, ACL, EVAP, (3) EGR, (2) AIS, EVAP-VC, DCLV
Courier 1.8L Carb.	PCV, EVAP, AIS, EVAP-VC, CRV
Pantera 5.8L V8 Carb.	PCV, ACL, EVAP, SPK, EVAP-VC, SPK-DDD
1975	
Capri II 2.3L Carb.	PCV, ACL, EVAP, (2) OC, (2) FR, EGR, (3) SPK, AIS, EVAP-VC, SPK-DV, DCLV
2.8L Carb.	PCV, ACL, EVAP, OC, FR, EGR, (2) SPK, AIS, EFE, EVAP-VC, (4) SPK-CSSA, SPK-DDD, EFE-HCV, (5) DCLV
Courier 1.8L Carb.	PCV, EVAP, AP, EVAP-VC, CRV
1976	

Capri II 2.3L Carb.	PCV, ACL, EVAP, (2) OC, (2) FR, EGR, (12) SPK, AIS, EVAP-VC, (12)SPK-DV, DCLV
2.8L Carb.	PCV, ACL, EVAP, OC, FR, EGR, (10) SPK, AIS, EFE, EVAP-VC, (13) SPK-CSSA, SPK-DDD, (10)SPK-DV, EFE-HCV, (4) DCLV
Courier 1.8L Carb.	PCV, ACL, EVAP, (12) OC, (12) FR, (14) EGR, AIS, EVAP-VC, (13) CRV, (11) TR
1977	
Capri II 2.3L & 2.8L Carb.	PCV, ACL, EVAP, (6) OC, (6) FR, EGR, SPK, AIS, EFE, EVAP-VC, SPK-CSSA, SPK-DDD, EFE-HCV, DCLV
Courier 1.8L Carb	PCV, ACL, EVAP, (2) OC, (2) FR, EGR, SPK, AIS, EVAP-VC, SPK-DV, DCLV, (2) TOS
1978	
Capri II 2.3L & 2.8L Carb.	PCV, ACL, EVAP, (7) OC, (7) FR, EGR, SPK, AIS, EFE, EVAP-VC, SPK-CSSA, SPK-DDD, EFE-HCV, DCLV
Courier 1.8L Carb.	PCV, ACL, EVAP, (2) OC, (2) FR, EGR, SPK, AIS, EVAP-VC, SPK-DV, AIS-ACV, DCS
2.3L Carb.	PCV, EVAP, (2) OC, (2) FR, EGR, SPK, EVAP-VC
1979	
Courier 2.0L & 2.3L Carb.	PCV, ACL, EVAP, OC, FR, EGR, SPK, (2) AP, (4) PAIR, EVAP-VC, (8) SPK-ITCS, DCS
Fiesta 1.6L Carb.	PCV, ACL, EVAP, OC, FR, EGR, AIS, EVAP-VC
1980	
Courier 2.0L & 2.3L Carb.	PCV, ACL, EVAP, OC, FR, EGR, (8) SPK, (2) AP, (4) PAIR, EVAP-VC, DCS
Fiesta 1.6L Carb.	PCV, ACL, EVAP, OC, FR, EGR, AP, EVAP-VC
1981	
Courier 2.0L & 2.3L Carb.	PCV, ACL, EVAP, OC, FR, EGR, (9) SPK, AP, (4) PAIR, EVAP-VC, (8) SPK-DV, DCS
1982	
Courier 2.0L & 2.3L Carb.	PCV, ACL, EVAP, OC, FR, EGR, SPK, AIS, EVAP-VC, DCS
1985-86	
Merkur XR4Ti 2.3L MFI	PCV, EVAP, TWC, FR, EGR, O2S, CEC, MIL, EVAP-VC, EGR-C
1987	
Merkur XR4Ti 2.3L MFI	PCV, EVAP, TWC, FR, EGR, O2S, CEC, MIL, EVAP-VC
1988	
Festiva 1.3L Carb.	PCV, ACL, EVAP, OC, FR, EGR, AIS, O2S, CEC, (2) MIL, EVAP-VC
Merkur Scorpio 2.9L V6 MFI	PCV, EVAP, TWC, FR, EGR, (10) AIS, O2S, CEC, MIL, EVAP-VC
Merkur XR4Ti 2.3L MFI	PCV, EVAP, TWC, FR, EGR, O2S, CEC, MIL, EVAP-VC
Tracer 1.6L MFI	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCV, EVAP-VSV, VA
1989	
Festiva 1.3L 2-Bbl.	PCV, ACL, EVAP, OC, FR, EGR, PAIR, O2S, CEC, EFE, MIL, EVAP-VC, EGR-PS, PAIR-ACV
Festiva 1.3L MFI	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCV, VA
Merkur Scorpio 2.9L V6 MFI	

	PCV, EVAP, TWC, FR, EGR, (10) AP, O2S, CEC, MIL, EVAP-VC
Merkur XR4Ti 2.3L MFI	PCV, EVAP, TWC, FR, EGR, O2S, CEC, MIL, EVAP-VC
Tracer 1.6L MFI	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCV, EVAP-VSV, VA
1990	
Tracer 1.8L MFI	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCV, SPK-CC
Festiva 1.3L MFI	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCV, SPK-CC
1991	
Capri 1.6L MFI Non-Turbo & Turbo	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL
Tracer 1.8L MFI	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCV, SPK-CC
1.9L MFI	PCV, ACL, EVAP, TWC, FR, (15) EGR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-PVS, EGR-SOL, SPK-CC
Festiva 1.3L MFI	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC
1992	
Capri 1.6L MFI Non-Turbo & Turbo	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCS, EVAP-CPCV
Tracer 1.8L 4-Cyl. MFI	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCS, SPK-CC
1.9L 4-Cyl. MFI-MAF	PCV, EVAP, TWC, FR, (15) EGR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCS, EGR-SOL, SPK-CC
Festiva 1.3L MFI	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-CPCS, EVAP-CPCV, SPK-CC
1993	
Capri 1.6L MFI Non-Turbo & Turbo	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCS, EVAP-CPCV
Tracer 1.8L 4-Cyl. MFI	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCS, SPK-CC
1.9L 4-Cyl. MFI-MAF	PCV, EVAP, TWC, FR, (15) EGR, SPK, HO2S, CEC, MIL, EVAP-VC, EVAP-CPCS, EGR-SOL, SPK-CC
Festiva 1.3L MFI	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCS, EVAP-CPCV, SPK-CC
1994	
Aspire 1.3L SFI	PCV, EVAP, TWC, FR, EGR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCS, EVAP-CPCV, EGR-SOL, SPK-CC
Capri 1.6L MFI Non-Turbo & Turbo	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCS, EVAP-CPCV, SPK-CC
Tracer 1.8L 4-Cyl. SFI	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCS, SPK-CC
1.9L 4-Cyl. SFI-MAF	PCV, EVAP, TWC, FR, (15) EGR, SPK, HO2S, CEC, MIL, EVAP-VC, EVAP-CPCS, EGR-SOL, SPK-CC
1995	
Aspire 1.3L SFI	PCV, EVAP, TWC, FR, EGR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCS, EVAP-CPCV, EGR-SOL, SPK-CC
Tracer 1.8L 4-Cyl. SFI	PCV, EVAP, TWC, FR, SPK, O2S, CEC, MIL, EVAP-VC, EVAP-CPCS, SPK-CC
1.9L 4-Cyl. SFI-MAF	PCV, EVAP, TWC, FR, (15) EGR, SPK, HO2S, CEC, MIL, EVAP-VC, EVAP-CPCS, EGR-SOL, SPK-CC
1996	
Aspire 1.3L SFI	PCV, EVAP, TWC, FR, EGR, SPK, HO2S, CEC, MIL, EVAP-CPCS, EVAP-VC, EGR-CVS
1997	
Aspire 1.3L SFI	PCV, EVAP, TWC, FR, EGR, SPK, HO2S, CEC, MIL, EVAP-CKV, EVAP-CPCS, EVAP-VC, EGRB, EGR-

	CS, EGR-PS, SPK-CC
(1) For quick reference, major emission control systems and devices are listed in bold type; components and other related devices are listed in light type.	
(2) California only.	
(3) A/T only.	
(4) Federal only.	
(5) M/T only.	
(6) 2.8L & California 2.3L.	
(7) Except Federal models.	
(8) 2.0L only.	
(9) 2.3L California only.	
(10) M/T only.	
(11) California with M/T.	
(12) Some models.	
(13) Federal with M/T.	
(14) M/T models with engine family VBT.	
(15) Electronically controlled.	

ABBREVIATIONS

ACL

Air Cleaner (Thermostatic Air Cleaner)

AIS

Air Injection System

AIS-ACV

AIS Air Control Valve

AIS-AMV

AIS Air Management Valve

AIS-ASS

AIS Air Switching Solenoid

AIS-ASV

AIS Air Switching Valve

AIS-BPV

AIS By-Pass Valve

AIS-CKV

AIS Check Valve

AIS-CV

AIS Combination Valve

AIS-DV

AIS Diverter Valve

AIS-RV

AIS Relief Valve

AIS-SOL

AIS Solenoid

AIS-SV

AIS Solenoid Valve

AIS-VCV

AIS Vacuum Control Valve

AIS-VSV

AIS Vacuum Switching Valve

AIS-VT

AIS Vacuum Tank

AIS-VCV

AIS Vacuum Control Valve

AIS-VSV

AIS Vacuum Switching Valve

AP

Air Pump Injection System

AP-ACV

AP Air Control Valve

AP-AMV

AP Air Management Valve

AP-BPV

AP By-Pass Valve

AP-CKV

AP Check Valve

AP-CS

AP Control Solenoid

BP/EGR

Backpressure EGR System

BP/EGR-BPS

BP/EGR Backpressure Sensor

BP/EGR-BPT

BP/EGR Backpressure Transducer

BP/EGR-BPV

BP/EGR Backpressure Valve

BP/EGR-BS

BP/EGR Bleed Solenoid

BP/EGR-BVSV

BP/EGR Bimetallic Vacuum Switching Valve

BP/EGR-C

BP/EGR Controller

BP/EGR-CLR

BP/EGR Cooler

BP/EGR-CS

BP/EGR Control Solenoid

CEC

Computerized Engine Controls

DOHC

Dual Overhead Cam

DPFE

Differential Pressure Feedback EGR Valve

EAIR

Electric Air Injection System

EAIR DV

Electric Air Injection System Diverter Valve

ECM

Electronic Control Module

ECU

Electronic Control Unit

EGR

Exhaust Gas Recirculation

EVRS

EGR Vacuum Regulator Solenoid

EVAP

Fuel Evaporative System

EVAP-AAC

EVAP Auxiliary Air Control

EVAP-BPSV

EVAP By-Pass Solenoid Valve

EVAP-BVSV

EVAP Bimetallic Vacuum Switching Valve

EVAP-CAV

EVAP Canister Air Valve

EVAP-CCV

EVAP Control Canister Close Valve

EVAP-CCVSV

EVAP Control Canister Vent Shut Valve

EVAP-CCVVS

EVAP Closed Canister Valve Vacuum Switching Valve

EVAP-CDCV

EVAP Canister Drain Cut Valve

EVAP-CKV

EVAP Check Valve

EVAP-CPCS

EVAP Canister Purge Control Solenoid

EVAP-CPCV

EVAP Canister Purge Control Valve

EVAP-CPRV

EVAP Canister Purge Regulator Valve

EVAP-CPSV

EVAP Canister Vent Shut Valve

EVAP-CPT

EVAP Canister Purge Timer

EVAP-CPTVS

EVAP Canister Purge Thermal Vacuum Switch

EVAP-CPV

EVAP Canister Vent Valve

EVAP-CPVCSV

EVAP Canister Purge Volume Control

EVAP-CPVDV

EVAP Canister Purge Vacuum Delay Valve

EVAP-CS

EVAP Control Solenoid

EVAP-CSPS

EVAP Control System Pressure Sensor

EVAP-ORVR

Evaporative On-Board Refueling Vapor Recovery System

EVAP-ORVRFTVRV

EVAP-ORVR Fuel Tank Vapor Recirculation

EVAP-OVCV

EVAP Outer Vent Control Valve

EVAP-OWV

EVAP One-Way Valve

EVAP-PCSV

EVAP Purge Cut-Off Solenoid Valve

EVAP-PFS

EVAP Purge Flow Sensor

EVAP-PFSVVS

EVAP Purge Flow Switching Valve Vacuum Switching Valve

EVAP-PRRV

EVAP Pressure Relief Rollover Valve

EVAP-VC

EVAP Vapor Canister

FF

Flexible Fuel

FLV

Fill Limit Valve

FR

Fill Pipe Restrictor

FVV

Fuel Vapor Valve

HO2S

Heated Oxygen Sensor

MFI

Multiport Fuel Injection

MFI-MAF

MFI Mass Airflow Sensor

MIL

Malfunction Indicator Light

OC

Oxidation Catalytic Converter

OHC

Overhead Cam

ORVR

On-Board Refueling Vapor Recovery

ORVR-COV

ORVR Cut-Off Valve

ORVR-CV

ORVR Control Valve

ORVR-FMV

ORVR Flow Management Valve

ORVR-FTVCV

ORVR Fuel Tank Vapor Control Valve

ORVR-FTVRV

ORVR Fuel Tank Vapor Recirculation Valve

ORVR-LV

ORVR Leveling Valve

ORVR-OCKV

ORVR Overfill Check Valve

ORVR-RCV

ORVR Refueling Control Valve

ORVR-VCV

ORVR Vapor Cut Valve

ORVR-VRV

ORVR Vapor Recirculating Valve

ORVR-VSV

ORVR Vent Shut Valve

ORVR-VV

ORVR Vent Valve

OVCV

Outer Vent Control Valve

O2S

Oxygen Sensor

PAIR

Pulsed Secondary Air Injection

PCV

Positive Crankcase Ventilation

SFI

Sequential Multiport Fuel Injection

SFI-MAF

SFI Mass Airflow Sensor

SPK

Spark Controls

SPK-AVM

SPK Advance Vacuum Modulator

SPK-BVSV

SPK Bimetal Vacuum Switching Valve

SPK-CC

SPK Computer Controlled

SPK-CKV

SPK Check Valve

TWC

Three-Way Catalytic Converter

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J - PIN VOLTAGE CHARTS

1991 ENGINE PERFORMANCE Ford/Mercury Pin Voltage Charts

INTRODUCTION

Pin voltage charts are supplied to reduce diagnostic time. Checking pin voltages at the Electronic Control Assembly (ECA) determines whether it is receiving and transmitting proper voltage signals. Charts may also help determine if ECA wiring harness is shorted or opened.

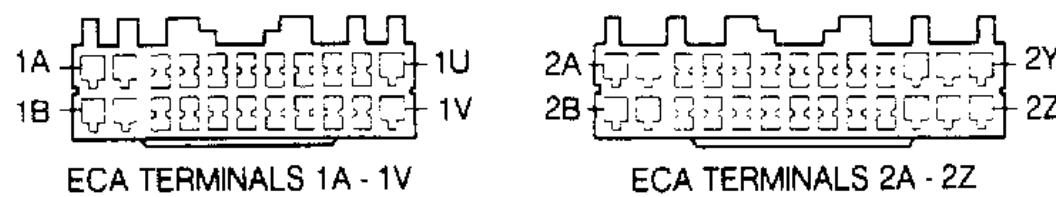


Fig. 1: Identifying ECA Connector Terminals (Festiva)
Courtesy of FORD MOTOR CO.

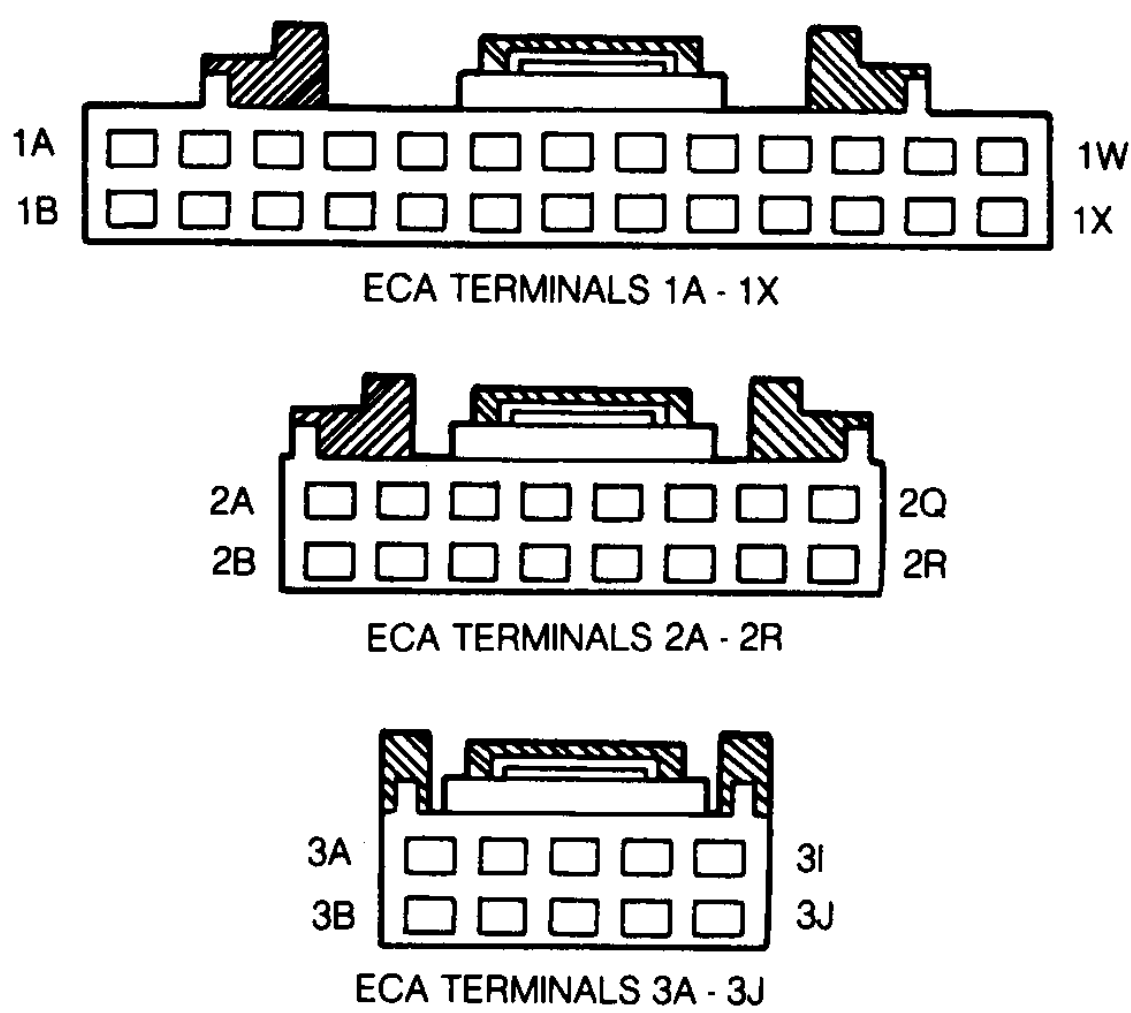


Fig. 2: Identifying ECA Connector Terminals (Capri)
Courtesy of FORD MOTOR CO.

- NOTE:** Unless stated otherwise in testing procedures, perform all voltage tests using a Digital Volt-Ohmmeter (DVOM) with a minimum 10-megohm input impedance. Voltage readings may vary slightly due to battery condition or charging rate.
- NOTE:** For additional pin voltage information, see appropriate trouble code information in G - TESTS W/ CODES article in the ENGINE PERFORMANCE Section.

SENSORS	ECA PIN #	REF. PIN #	KOEO	UNITS	HOT IDLE	30 MPH	55 MPH	UNITS
VAF	2O	PWRGND	4.0	DCV	3.0	1.5	1.2	DCV
VAT	2P	PWRGND	3.0	DCV	3.0	3.0	3.3	DCV
ECT	2Q	PWRGND	0.36	DCV	0.36	0.46	0.50	DCV
WOT	2L	PWRGND	5.0	DCV	5.0	5.0	5.0	DCV
IDL	1N	PWRGND	0	DCV	0	14	14	DCV
CPS	2E	PWRGND	N/A	RPM	730-800	1350-1400	2350-2400	RPM
HLDT	1U	PWRGND	0	DCV	0	0	0	DCV
BLMT ¹	1S	PWRGND	12	DCV	14	14	14	DCV
EGO	2N	PWRGND	N/A	DCV	0.2-0.75	1	1	DCV
BOO	1O	PWRGND	0	DCV	0	0	0	DCV
ACS	1Q	PWRGND	12 ²	DCV	14 ²	14 ²	14 ²	DCV
PSPS	1P	PWRGND	12	DCV	14	14	14	DCV
FAN	1R	PWRGND	12	DCV	14	14	14	DCV
NGS/CES	1V	PWRGND	0	DCV	0	14 ³	14 ³	DCV
ACTUATORS								
BANK 1	2U	PWRGND	N/A	mSEC	2.8-3.1	3.2	3-4	mSEC
BANK 2	2V	PWRGND	N/A	mSEC	2.8-3.1	3.2	3-4	mSEC
STO/MIL	1F/1E	PWRGND	.6/1.5	DCV	12/12	12/12	12/12	DCV
WAC	1J	PWRGND	12	DCV	12	12	12	DCV
ISC	2W	PWRGND	7.45	DCV	10.5	10.8	10.6	DCV
SPOUT	1G	PWRGND	N/A	RPM	730-800	1350-1400	2350-2400	RPM
CANP	2X	PWRGND	12	DCV	12	10-11	12-14	DCV

Reference values shown may vary approximately plus or minus 20% depending on operating conditions and other factors.

- ¹ - Blower Off

² - Air Conditioning On/Blower On

³ - In Gear

ACS: A/C Cycling Switch

BLMT: Blower Motor (Heat/Ventilation System)

BOO: Brake On/Off Switch

CANP: Canister Purge Solenoid

CES: Clutch Engage Switch

CPS: Crankshaft Position Sensor

ECT: Engine Coolant Temperature Sensor

EGO: Heated Exhaust Gas Oxygen Sensor

FAN: Engine Cooling Fan

HLDT: Headlight Switch

IDL: Idle Switch

ISC: Idle Speed Control

MIL: Malfunction Indicator Light

NGS: Neutral Gear Switch

PSPS: Power Steering Pressure Switch

SPOUT: Spark Output Signal

STO: Self Test Output Circuit

VAF: Vane Air Flow Sensor Or Circuit

VAT: Vane Air Temperature

WAC: WOT A/C Cut-Off Switch Or Circuit

WOT: Wide Open Throttle Switch

Fig. 3: Checking ECA Pin Voltages (Festiva)
Courtesy of FORD MOTOR CO.

NON-TURBO	SENSORS	SIG PIN #	REF. PIN #	KOEO	UNITS	HOT IDLE	30 MPH	55 MPH	UNITS
	TP	2G	SIGRTN	0.5	DCV	0.5	0.6	0.8	DCV
	VAF	2E	SIGRTN	1.8	DCV	6.7	8	8.2	DCV
	ECT	2I	SIGRTN	0.5	DCV	0.4	0.5	0.5	DCV
	BP	2H	SIGRTN	3.9	DCV	3.9	3.9	3.8	DCV
	VAT	2J	PWRGND	2.4	DCV	3	3	3	DCV
	IDL	1E	PWRGND	0	DCV	0	12.6	12.4	DCV
	NGS/CES	1G	PWRGND	12	DCV	14	14	14	DCV
	BOO	1J	PWRGND	0	DCV	0	0	0	DCV
	PSPS	1K	PWRGND	12	DCV	14	14	14	DCV
	IDM	1M	PWRGND	N/A	RPM	850-1050	2650-2700	3125-3175	RPM
	EGO	2D	PWRGND	0	DCV	0.8	0.5	0.6	DCV
	ACTUATORS								
	BANK 1	3E	PWRGND	N/A	mSEC	3.9	5.8	7.1	mSEC
	BANK 2	3C	PWRGND	N/A	mSEC	3.9	5.9	7.1	mSEC
	CANP	2P	PWRGND	12	DCV	14.3	1.1	1.1	DCV
	ISC	2Q	PWRGND	7	DCV	10	9.7	9.8	DCV
	PRC	2K	PWRGND	12	DCV	14	14.3	14	DCV
	STO	1B	PWRGND	0.7	DCV	14	14	13.8	DCV
	MIL	1A	PWRGND	1.6	DCV	13.2	14	13.8	DCV
TURBO	SENSORS	SIG PIN #	REF. PIN #	KOEO	UNITS	HOT IDLE	30 MPH	55 MPH	UNITS
	TP	2G	SIGRTN	0.4	DCV	0.36	0.5	0.67	DCV
	VAF	2E	SIGRTN	2	DCV	5.5	7.4	8.1	DCV
	ECT	2I	SIGRTN	0.5	DCV	0.4	0.5	0.5	DCV
	BP	2H	SIGRTN	3.9	DCV	3.8	3.8	3.8	DCV
	VAT	2J	PWRGND	2.2	DCV	2.3	2.6	2.7	DCV
	IDL	1E	PWRGND	0	DCV	0	13.9	13.9	DCV
	NGS/CES	1G	PWRGND	12	DCV	14	14	14	DCV
	BOO	0	PWRGND	0	DCV	0	0	0	DCV
	PSPS	1K	PWRGND	12	DCV	13.6	13.7	13.7	DCV
	KCU	2M	PWRGND	12	DCV	12	12	12	DCV
	IDM	1M	PWRGND	N/A	RPM	800-900	2640-2680	3120-3160	RPM
	EGO	2D	PWRGND	0	DCV	0	0.5	0.5	DCV
	ACTUATORS								
	BANK 1	3E	PWRGND	N/A	mSEC	3.4	3.5	4.3	mSEC
	BANK 2	3C	PWRGND	N/A	mSEC	3.4	3.5	3.5	mSEC
	CANP	2P	PWRGND	12	DCV	14.3	1.1	1.1	
	ISC	2Q	PWRGND	7.5	DCV	7.6	9.4	9.6	DCV
	PRC	2K	PWRGND	12	DCV	14	14	14	DCV
	STO	1B	PWRGND	0.71	DCV	13.5	13.5	13.5	DCV
	MIL	1A	PWRGND	1.6	DCV	13.6	13.7	13.6	DCV
Reference values shown may vary approximately plus or minus 20% depending on operating conditions and other factors.									
BOO: Brake On/Off Switch					KCU: Knock Control Unit Or Circuit				
BP: Barometric Pressure Sensor Or Circuit					MIL: Malfunction Indicator Light				
CANP: Canister Purge Solenoid					NGS: Neutral Gear Switch				
CES: Clutch Engage Switch					PRC: Fuel Pressure Regulator Control				
ECT: Engine Coolant Temperature Sensor					PSPS: Power Steering Pressure Switch				
EGO: Heated Exhaust Gas Oxygen Sensor					STO: Self Test Output Circuit				
IDL: Idle Switch					TP: Throttle Position Sensor Or Circuit				
IDM: Ignition Diagnostics Monitor					VAF: Vane Air Flow Sensor Or Circuit				
ISC: Idle Speed Control					VAT: Vane Air Temperature				

Fig. 4: Checking ECA Pin Voltages (Capri)
Courtesy of FORD MOTOR CO.

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N - REMOVE/INSTALL/OVERHAUL

1991 ENGINE PERFORMANCE Ford/Mercury Removal, Overhaul & Installation

INTRODUCTION

Removal, overhaul and installation procedures are covered in this article. If component removal and installation is primarily an unbolt and bolt-on procedure, only a torque specification may be furnished.

IGNITION SYSTEM

DISTRIBUTOR

Removal

Disconnect negative battery cable. On Capri, disconnect vacuum hose from vacuum control unit. Disconnect coil wire from distributor cap. Remove screws and distributor cap. Disconnect electrical connectors. Mark position of distributor housing to cylinder head for reassembly. Remove distributor mounting bolts and distributor.

Installation

To install, reverse removal procedure. Install new "O" ring if damaged or worn. Insert distributor and rotate until offset drive tangs engage camshaft slots. See [Fig. 1](#) , [Fig. 2](#) or [Fig. 3](#) . Check and adjust timing as required.

NOTE: On Festiva, DO NOT disassemble distributor. Entire unit is serviceable only by complete replacement.

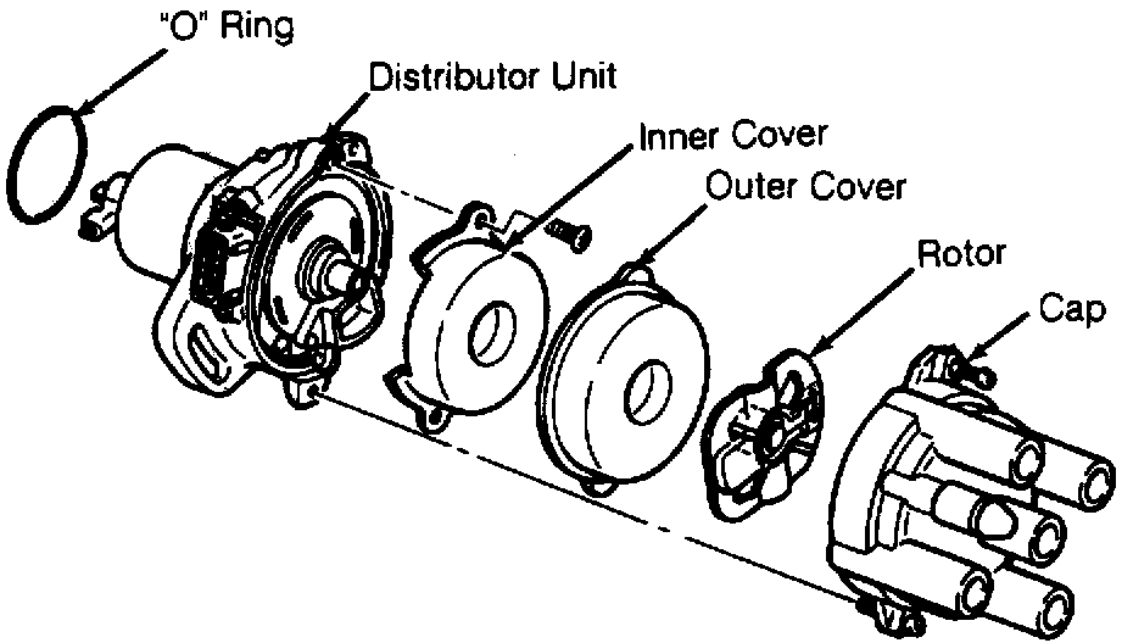


Fig. 1: Exploded View of Distributor Assembly (Festiva)
Courtesy of FORD MOTOR CO.

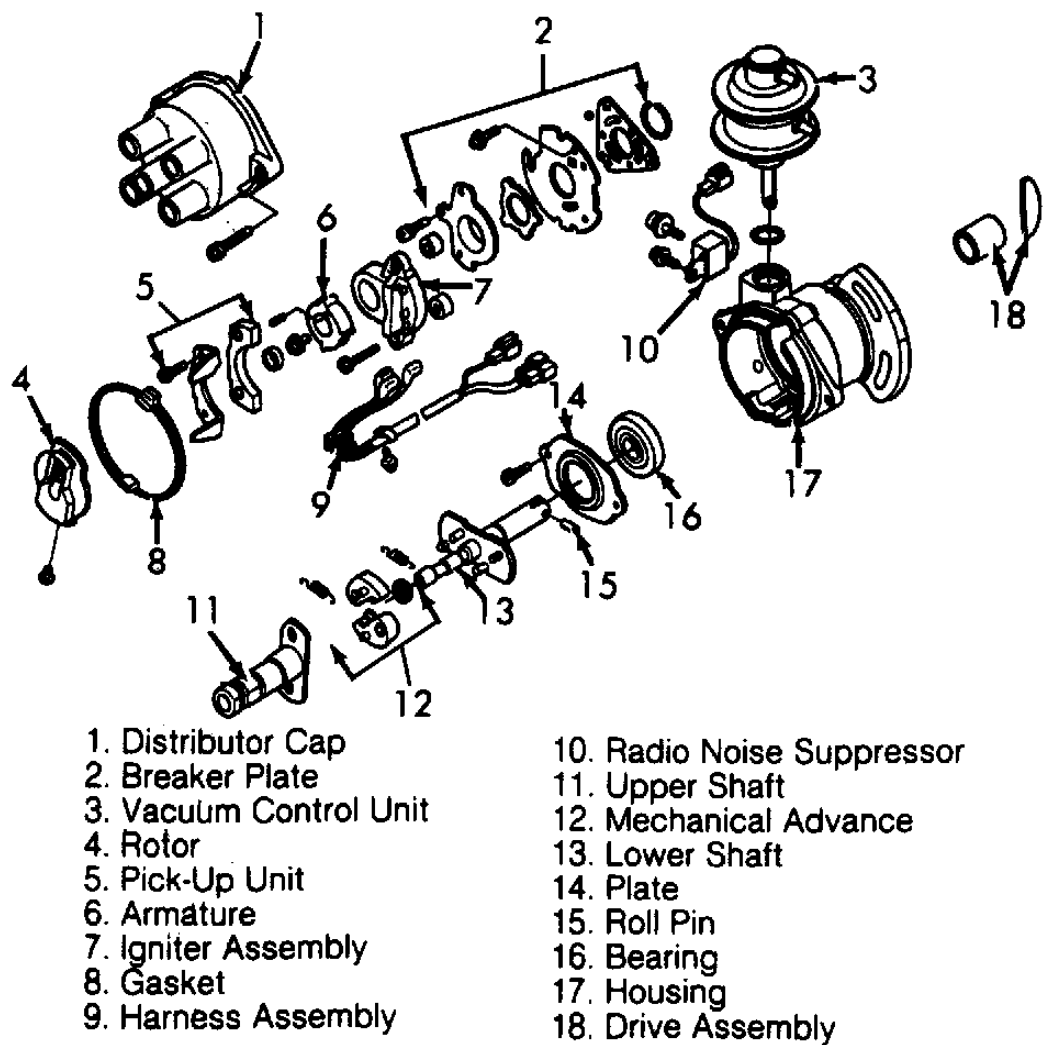


Fig. 2: Exploded View of Distributor Assembly (Capri Non-Turbo)
Courtesy of FORD MOTOR CO.

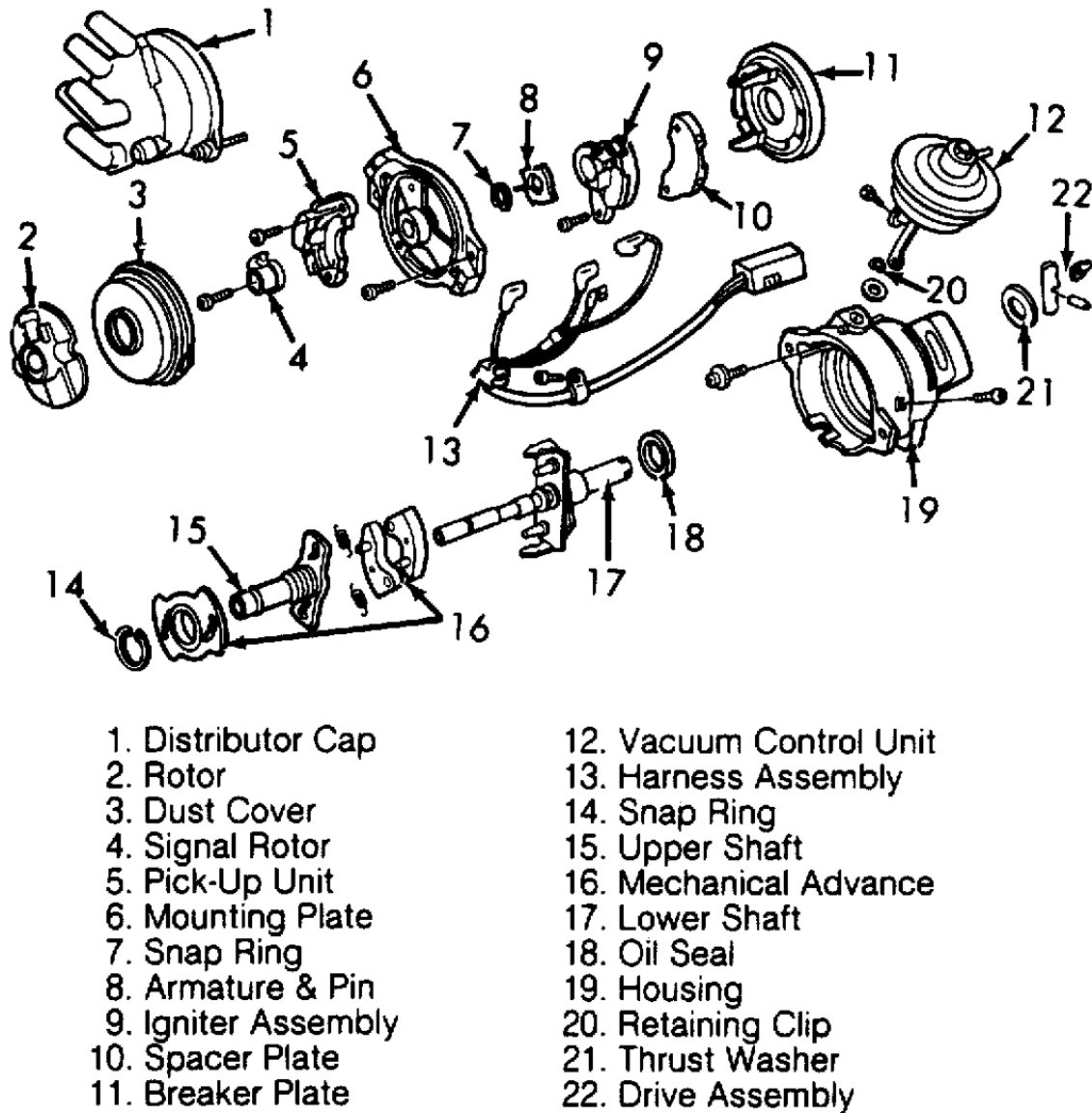


Fig. 3: Exploded View of Distributor Assembly (Capri Turbo)
Courtesy of FORD MOTOR CO.

ELECTRONIC CONTROL ASSEMBLY (ECA)

REMOVAL & INSTALLATION

Disconnect negative battery cable. On Festiva, from under instrument panel, remove heater duct. On Capri, disengage push-pin retainers by pulling back on front edges of both center carpet panels. Remove carpet panel retaining screws and panels. Disconnect ECA wire harness connector. Remove ECA bolts and ECA. To install, reverse removal procedure. On Festiva, ensure mounting clip is inserted into bulkhead recess.

FUEL SYSTEM

FUEL SYSTEM PRESSURE RELEASE

Remove rear seat assembly. With engine running, disconnect fuel pump connector. Run engine until it stalls to relieve fuel line pressure.

FUEL INJECTORS

WARNING: ALWAYS relieve fuel pressure before disconnecting any fuel injection-related component. DO NOT allow fuel to contact engine or electrical components.

Removal

Relieve fuel system pressure. On Capri, remove throttle body. On Festiva, remove intake plenum. See INTAKE PLENUM. Remove fuel inlet and fuel return line from fuel rail. Remove electrical connectors from injectors. Remove pressure regulator. See Fig. 4 . Remove fuel rail attaching bolts and fuel rail. Remove fuel injectors.

Installation

Install NEW "O" rings on fuel injectors and lubricate with gasoline. Install fuel injectors into cylinder head. Install fuel rail onto fuel injectors. Install fuel rail attaching bolts. To complete installation, reverse removal procedure. Check system for leaks.

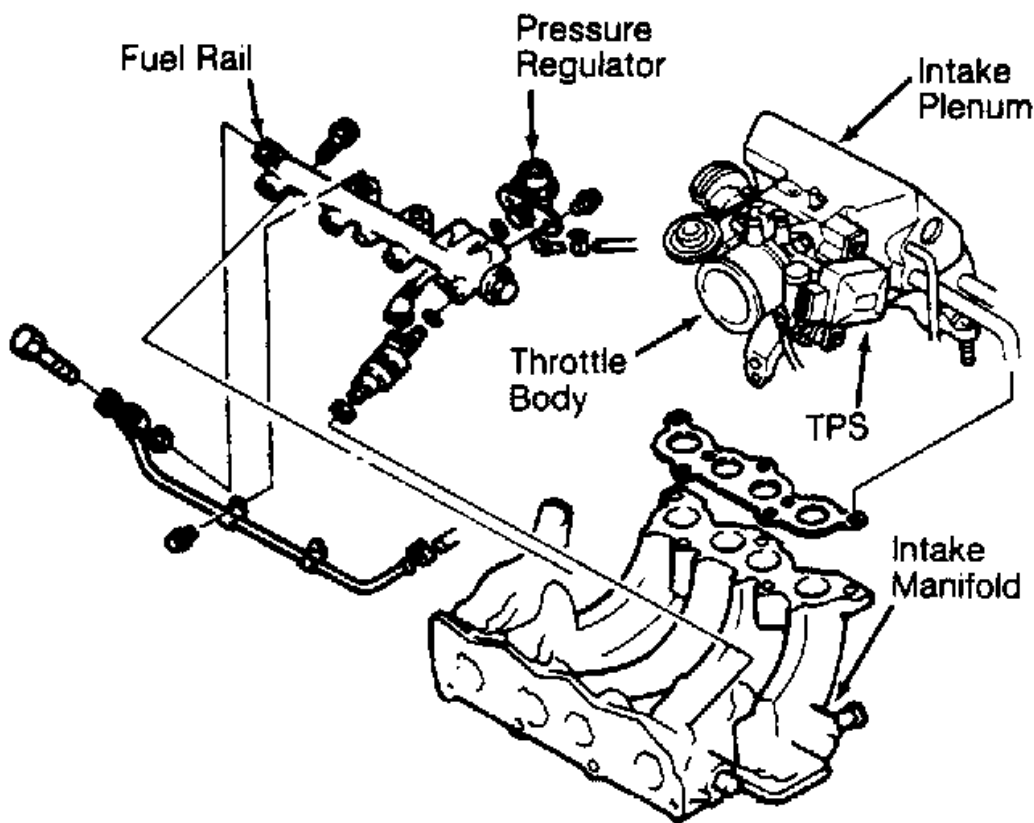


Fig. 4: Exploded View of Fuel Control System
Courtesy of FORD MOTOR CO.

FUEL PUMP

WARNING: ALWAYS relieve fuel pressure before disconnecting any fuel-related component. DO NOT allow fuel to contact engine or electrical components.

Removal

Remove fuel tank sending unit. Remove fuel filter from pump. Remove fuel pump wires from sending unit. Remove retaining clamp screw and clamp. Remove rubber retaining band (if equipped). Remove fuel pump from sending unit.

Installation

To install, reverse removal procedure. Check system for leaks.

INTAKE PLENUM

Removal

Drain radiator and remove negative battery cable. Disconnect throttle cable. Remove air duct from throttle body. Disconnect throttle position sensor/switch connector. Mark all coolant and vacuum hoses for reassembly reference and remove from throttle body. See [Fig. 4](#) . Remove intake plenum bolts and remove intake plenum and gasket.

NOTE: **To prevent dust and dirt from entering intake manifold ports, cover ports with clean cloth after removing intake plenum.**

Installation

To install, reverse removal procedure. Use NEW intake plenum-to-intake manifold gasket. Tighten bolts to specification, see [TORQUE SPECIFICATIONS](#) at end of article.

OXYGEN (O2) SENSOR

WARNING: **DO NOT remove oxygen sensor when engine is hot.**

Removal & Installation

Disconnect negative battery cable. Disconnect wire harness connector, and remove oxygen sensor. If exhaust sensor is difficult to remove, use rust penetrant to avoid possible damage to exhaust threads. If new sensor is not pre-coated with anti-seize, apply anti-seize compound to sensor threads. DO NOT remove anti-seize from sensor. To install, tighten sensor and attach wire harness connector.

THROTTLE BODY

NOTE: **Clean throttle body exterior before removal.**

Removal & Installation

Drain radiator and remove negative battery cable. Remove resonance chamber. Disconnect throttle cable. Remove air duct. Mark all coolant and vacuum hoses for reassembly reference and remove from throttle body. Disconnect throttle position sensor/switch connector. Remove throttle body nuts and bolts. Remove throttle body and gasket. To install, reverse removal procedure using NEW throttle body-to-intake plenum gasket.

THROTTLE POSITION SENSOR/SWITCH

Removal & Installation

Disconnect negative battery cable. Disconnect throttle position sensor/switch connector. Remove attaching bolts. Remove sensor/switch from throttle body. To install, reverse removal procedure.

TURBOCHARGER

Removal

1. Drain radiator and remove negative battery cable. Remove throttle body air intake tube. Disconnect intercooler hose from turbocharger assembly. Disconnect O2 sensor. Remove lower heat shield retaining bolts and lower heat shield from turbocharger. Remove upper heat shield retaining bolts and upper heat shield from exhaust manifold.
2. Slide O2 sensor wire and guide through upper heat shield. Remove side heat shield retaining bolts from turbocharger, and remove side heat shield. Remove power steering belt. Remove power steering pump through bolt and adjuster nuts and bolts. Disconnect lower radiator hose from water pump.
3. Pull pump from bracket, and position pump to access mounting bracket retaining nut and bolts. Remove mounting bracket-to-engine nut and bolts and remove bracket. Remove air cleaner duct retaining screws. Loosen clamp at turbocharger and move duct tube out of way. Disconnect coolant supply hose at turbocharger.
4. Remove bolt and sealing washers attaching oil supply line at engine block. Raise vehicle on hoist. Remove nuts and washers from exhaust pipe flange. Remove bolts attaching exhaust hanger to engine block. Slide rubber exhaust hangers from catalytic converter. Pull exhaust pipe downward and to left side of vehicle. Disconnect oil return hose from turbocharger. Disconnect coolant return hose from turbocharger.
5. Remove turbocharger support bracket retaining bolts. Remove coolant by-pass tube outlet-to-water pump bolts. Lower vehicle. Loosen retaining clamp bolt on coolant by-pass tube at rear of cylinder head. Remove 11 retaining nuts from exhaust manifold. Position coolant by-pass tube out of way after pulling bracket from exhaust stud.
6. Remove exhaust manifold by pulling off studs and moving assembly towards right side of engine compartment, clearing cooling fan. With assembly removed from vehicle, remove turbocharger-to-exhaust manifold nuts. Separate assembly and discard gasket.

CAUTION: **Before installing turbocharger, put .8 oz. (25 ml) engine oil into turbocharger oil inlet.**

Installation

1. Install NEW gasket on exhaust manifold and install turbocharger onto studs. Install turbocharger-to-exhaust manifold nuts. Remove oil supply line from turbocharger. Install NEW exhaust gasket on cylinder head. Install turbocharger and exhaust manifold assembly onto studs. Install coolant by-pass tube bracket onto exhaust stud. Install 11 retaining nuts onto exhaust manifold.
2. Securely tighten heater tube clamp bolt. Raise vehicle. Install coolant by-pass tube outlet-to-water pump bolts. Install turbocharger support bracket retaining bolts. Connect coolant return hose to turbocharger. Connect oil return hose to turbocharger. Install exhaust pipe onto turbocharger, and hand tighten nuts and washers. Install bolts attaching exhaust hanger to engine block.
3. Slide rubber exhaust hangers onto catalytic converter. Tighten exhaust pipe nuts and washers. Lower vehicle. Install bolt and sealing washers attaching oil supply line at engine block. Install oil supply line onto turbocharger. To complete installation, reverse removal procedure. Tighten bolts and nuts to specification, see [TORQUE SPECIFICATIONS](#) at end of article.

VANE AIRFLOW (VAF) METER

Removal

1.

Disconnect negative battery cable. On Capri, disconnect primary and secondary wires from coil. On Festiva, disconnect VAF wire harness connector. Remove air duct.
2.

On Capri, remove retaining bolt and ground wire from air cleaner cover. Remove air cleaner cover bolts and air cleaner cover. From inside of air cleaner cover, remove VAF meter retaining nuts. On Festiva, remove attaching bolt and 4 nuts. Remove vane airflow meter.

Installation

To install, reverse removal procedure. Position new gasket over VAF mounting studs. Tighten bolts and nuts to specification, see [TORQUE SPECIFICATIONS](#) at end of article.

NOTE: For all on-vehicle adjustments not covered in this article, see **ADJUSTMENTS** article in the **ENGINE PERFORMANCE** Section.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Coolant By-Pass Tube Outlet-To-Water Pump Bolts	14-19 (19-26)
Distributor Mounting Bolts	14-19 (19-26)
Exhaust Manifold Retaining Nuts	29-42 (39-57)
Exhaust Pipe Nuts	18-25 (24-34)
Fuel Line-To-Fuel Filter Bolt	18-25 (24-34)
Fuel Pressure Regulator Nut	(1)
Fuel Rail Retaining Bolt	14-19 (19-26)
Heat Shield Bolts	14-19 (19-26)
Intake Plenum Bolts/Nuts	11-16 (15-22)
Oil Supply Line-To-Turbocharger Bolt	12-17 (16-23)
Oxygen Sensor	(1)
Power Steering Pump Bracket-To-Engine Bolts/Nut	35-48 (47-65)
Throttle Body Bolt/Nuts	12-17 (16-23)
Turbocharger Support Bracket Bolts	32-45 (43-61)
Turbocharger-To-Exhaust Manifold Nuts	20-25 (27-34)
INCH Lbs. (N.m)	
Barometric Pressure (BP) Sensor Nut	54-84 (6-9)
MAP Sensor Nuts	54-84 (6-9)
Oil Supply Line-To-Engine Block Bolt	104-156 (12-18)
Vane Airflow Meter Nuts	110-152 (12-18)
(1) Information not available from manufacturer.	

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K - SENSOR RANGE CHARTS

1991 ENGINE PERFORMANCE Ford Motor Co. Sensor Operating Range Charts

INTRODUCTION

Sensor operating range information can help determine if a sensor is out of calibration. An out-of-calibration sensor may not set a trouble code, but it may cause driveability problems.

NOTE: Unless stated otherwise in test procedure, perform all voltage tests using a Digital Volt-Ohmmeter (DVOM) with a minimum 10-megohm input impedance.

BAROMETRIC PRESSURE SENSOR OUTPUT VOLTAGE

Vacuum In. Hg.	(1) Volts
0	3.84
5	3.36
10	2.66
15	1.93
20	1.26
25	.58
(1) Voltage may vary by plus or minus 15 percent.	

ENGINE COOLANT TEMPERATURE SENSOR RESISTANCE

Temperature °F (°C)	Ohms
-4 (-20)	14,600-17,800
68 (20)	2200-2700
104 (40)	1000-1300
140 (60)	500-650
176 (80)	290-350

IGNITION DIAGNOSTIC MONITOR VOLTAGE

RPM (1)	Volts
500	1.103
1000	1.257
1500	1.542
2000	1.768
2500	2.06
3000	2.15
3500	2.26
4000	2.50
4500	2.47
5000	2.40
(1) Revolutions per minute.	

THROTTLE POSITION SENSOR RESISTANCE (1)

Throttle Opening	(2) Ohms
1/8	989
1/4	1104
3/8	1278
1/2	1462
5/8	1480
3/4	1459
7/8	1144
Fully Open	1072
(1) Capri only. Festiva uses throttle position switch.	
(2) Resistance may vary by plus or minus 15 percent.	

VANE AIRFLOW METER VOLTAGE

Door Opening	(1) Volts (Capri)	(1) Volts (Festiva)
Fully Closed	(2)	.5-1.5
1/8	3.24	.59
1/4	5.60	1.19
3/8	5.62	1.78
1/2	5.83	2.38
5/8	6.02	2.97
3/4	6.57	3.56
7/8	7.46	4.16
Fully Open	7.87	4.5-5.0

- (1) Voltage may vary by plus or minus 15 percent.
- (2) Voltage specification is not available.

VANE AIR TEMPERATURE RESISTANCE [\(1\)](#)

Temperature °F (°C)	Ohms
-4 (-20)	15,000
32 (0)	5200
68 (20)	2500
104 (40)	1100
140 (60)	600
176 (80)	300
(1) Resistance may vary by plus or minus 15 percent.	

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1991 ENGINE PERFORMANCE

Fuel Pressure Specifications

FUEL SYSTEMS

FUEL PRESSURE

1991 FUEL PRESSURE SPECIFICATIONS (EEC-IV - CARS)

Engine	KOER psi (kg/cm ²)	KOEO psi (kg/cm ²)
2.3L HSC EFI SEFI	45-60 (3.2-4.2)	50-60 (3.5-4.2)
3.0L SHO SEFI	28-33 (2.0-2.3)	30-45 (2.1-3.2)
3.8L SC SEFI	30-40 (2.1-2.8)	35-40 (2.5-2.8)
All Others	30-45 (2.1-3.2)	35-40 (2.5-2.8)

1991 FUEL PRESSURE SPECIFICATIONS (EEC-IV - TRUCKS)

Engine	KOER psi (kg/cm ²)	KOEO psi (kg/cm ²)
4.9L EFI	45-60 (3.2-4.2)	50-60 (3.5-4.2)
All Others	30-45 (2.1-3.2)	35-45 (2.5-3.2)

1991 FUEL PRESSURE SPECIFICATIONS (EEC - CARS)

Engine	KOER psi (kg/cm ²)	KOEO psi (kg/cm ²)
1.3L	25-31 (1.8-2.2)	64-85 (4.5-6.0)
1.6L	28-31 (2.0-2.2)	64-85 (4.5-6.0)
1.8L	(1)	64-85 (4.5-6.0)
2.2L	27-33 (1.9-2.3)	64-85 (4.5-6.0)
2.2L Turbo	27-33 (1.9-2.3)	64-85 (4.5-6.0)
(1) Fuel pressure should be 30-37 psi (2.1-2.6 kg/cm²) with engine running and vacuum hose connected to fuel pressure regulator. Fuel pressure should be 38-45 psi (2.7-3.2 kg/cm²) with engine running and vacuum hose disconnected to fuel pressure regulator.		

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C - SPECIFICATIONS

1991 ENGINE PERFORMANCE Ford/Mercury - Service & Adjustment Specifications

INTRODUCTION

Use this article to quickly find specifications related to servicing and on-vehicle adjustments. This is a quick-reference article to use when you are familiar with an adjustment procedure and only need a specification.

CAPACITIES

BATTERY SPECIFICATIONS

Application	Amp Hr. Rating
1.3L & 1.6L	50

FLUID CAPACITIES

Application	Qts. (L)
Crankcase (Includes Filter)	3.6 (3.4)
Cooling System (Includes Heater)	5.3 (5.0)
Manual Transaxle (Mercon)	2.6 (2.5)
Automatic Transaxle (Mercon)	6.0 (5.7)

FLUID CAPACITIES

Application	Qts. (L)
Crankcase (Includes Filter)	
Non-Turbo	3.5 (3.3)
Turbo	3.7 (3.5)
Cooling System (Includes Heater)	
Non-Turbo	5.3 (5.0)
Turbo	6.3 (6.0)
Manual Transaxle (Mercon)	3.4 (3.2)
Automatic Transaxle (Mercon)	6.0 (5.7)

QUICK-SERVICE

SERVICE INTERVALS & SPECIFICATIONS

REPLACEMENT INTERVALS

Component	Interval (Miles)
Air Filter	30,000
Camshaft Timing Belt	60,000
Coolant	30,000
Oil & Filter	3000
Spark Plugs	30,000

BELT ADJUSTMENTS [\(1\)](#)

Application	New Belt	Used Belt
A/C Belt	110-125 (50-57)	92-110 (42-50)
Alternator Belt	110-132 (50-60)	95-110 (43-50)
(1) Tension in Lbs. (Kg) Using Strand Tension Gauge		

BELT ADJUSTMENTS [\(1\)](#)

Application	New Belt	Used Belt
A/C Belt	110-132 (50-60)	110-132 (50-60)
Alternator Belt	110-132 (50-60)	110-132 (50-60)
(1) Tension in Lbs. (Kg) Using Strand Tension Gauge.		

MECHANICAL CHECKS

ENGINE COMPRESSION

Check engine compression at specified cranking speed with engine at normal operating temperature, all spark plugs removed and throttle wide open.

COMPRESSION SPECIFICATIONS

Application	Specification
Compression Ratio	
1.3L	9.7:1
1.6L	(1)
Compression Pressure	(2)

- (1) Information is not available.
- (2) Lowest cylinder compression reading should not be less than 75 percent of highest cylinder compression reading.

VALVE CLEARANCE

NOTE: All models are equipped with hydraulic lash adjusters. No adjustments are required.

IGNITION SYSTEM

IGNITION COIL

IGNITION COIL RESISTANCE

Application	Primary (Ohms)	Secondary (Ohms)
1.3L & 1.6L	0.8-1.6	6000-30,000

CRANKSHAFT POSITION SENSOR

CRANKSHAFT POSITION SENSOR RESISTANCE

Application	Ohms
1.3L	(1) 210-250
1.6L	(2)
(1) Measured between CPS (Yellow/Blue) and GND terminal.	
(2) Capri is equipped with Cylinder Identification (CID) sensor. Resistance is not specified.	

HIGH TENSION WIRE RESISTANCE

HIGH TENSION WIRE RESISTANCE

Application	Ohms
Coil Wire & Spark Plug Wires	4000-6000 per foot

SPARK PLUGS

SPARK PLUG TYPE

Application	Motorcraft
1.3L	AGS32C
1.6L	
Non-Turbo	AGSP32C
Turbo	AGS32C

SPARK PLUG SPECIFICATIONS

Application	Gap: In.- (mm)	Torque: Ft.-Lbs./(N.m)
1.3L & 1.6L	.039-.043 (1.0-1.1)	10-17 (14-23)

FIRING ORDER & TIMING MARKS

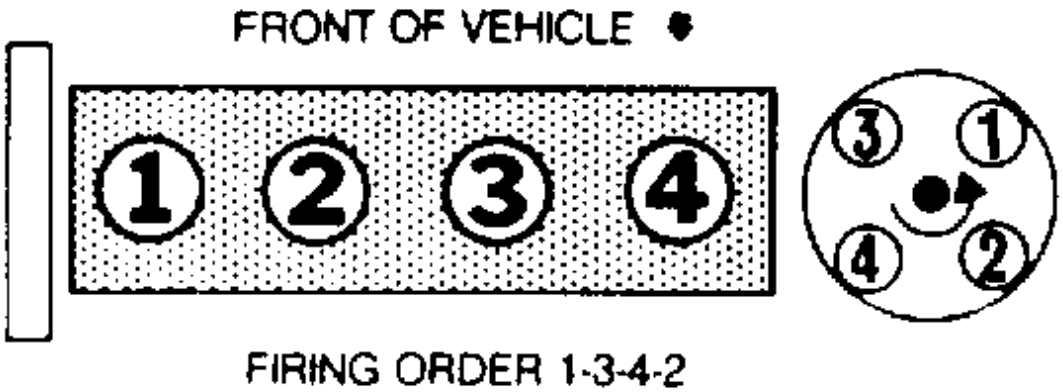


Fig. 1: Firing Order & Distributor Rotation

IGNITION TIMING

Application	Auto. Trans.	Man. Trans.
1.3L	9-11 @ 850	9-11 @ 700
1.6L Non-Turbo	1-3 @ 850	0-4 @ 850
1.6L Turbo	10-14 @ 850	0-4 @ 850

FUEL SYSTEM

FUEL PUMP

NOTE: For fuel pressure specifications, see [FUEL PRESSURE SPECIFICATIONS](#) article.

NOTE: Fuel pump performance is a measurement of fuel pressure and volume availability, not regulated fuel pressure.

FUEL PUMP PERFORMANCE

Application	Pressure -psi kg/cm ²)	Min. Vol. in 10 sec. oz. (CC)
1.3L	(1)	7.4 (220)
1.6L	(1)	5.5 (167)
(1) For fuel pressure specifications, see FUEL PRESSURE SPECIFICATIONS article.		

INJECTOR RESISTANCE

FUEL INJECTOR RESISTANCE

Application	Ohms
1.3L & 1.6L	12-16

IDLE SPEED

IDLE SPEED [\(1\)](#)

Application	Auto. Trans.	Man. Trans.
1.3L	830-870	680-720
1.6L	800-900	800-900
(1) With jumper wire connected between single-wire STI terminal and ground.		

THROTTLE POSITION SWITCH (TPS)

NOTE: Capri is equipped with throttle position sensor. No adjustment is required.

TPS ADJUSTMENT

Test Condition (1)	Cont. Between IDL-TL	Cont. Between PSW-TL
.02" (.5 mm)	Yes	No
.03" (.7 mm)	No	No
Wide Open Throttle	No	Yes
(1) Insert specified feeler gauge between throttle adjustment screw and stop lever.		

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F - BASIC TESTING

1991-92 ENGINE PERFORMANCE Ford Motor Co. Basic Diagnostic Procedures

INTRODUCTION

The following diagnostic steps help prevent overlooking simple problems and begin diagnosis for a no-start condition.

The first step in diagnosing any driveability problem is to verify the complaint. Test drive the vehicle under the conditions in which the problem reportedly occurred.

Before entering self-diagnostics, perform a careful and complete visual inspection. Most engine control problems result from mechanical breakdowns, poor electrical connections or damaged/misrouted vacuum hoses. Before condemning the computerized system, perform each test listed in this article.

NOTE: Unless stated otherwise in test procedure, perform all voltage tests with a Digital Volt-Ohmmeter (DVOM) with a minimum 10-megohm input impedance.

PRELIMINARY INSPECTION & ADJUSTMENTS

VISUAL INSPECTION

Perform a visual inspection of all electrical wiring. Look for chafed, stretched, cut or pinched wiring. Ensure electrical connections fit tightly and are not corroded. Ensure vacuum hoses are properly routed and are not cut or pinched. If necessary, see VACUUM DIAGRAMS article in the ENGINE PERFORMANCE Section to verify routing and connections. Inspect air induction system for possible vacuum leaks.

MECHANICAL INSPECTION

Compression

Engine mechanical condition can be checked using a compression gauge, vacuum gauge or engine analyzer. See engine analyzer instruction manual for specific instructions. Lowest compression reading must be not less than 75 percent of highest reading.

CAUTION: DO NOT use ignition switch during compression tests on fuel injected vehicles. Fuel injectors are triggered by ignition switch during cranking mode. Use a remote starter to crank engine to prevent fire hazard and catalytic converter and engine oiling system contamination.

Exhaust System Backpressure

Exhaust system can be checked with a vacuum gauge or a 0-5 psi pressure gauge. If a pressure gauge is used, remove O2 sensor. Connect gauge to O2 sensor port. Start engine, and run at 2500 RPM. If exhaust system backpressure is more than 2 psi, exhaust system or catalytic converter is plugged.

If a vacuum gauge is used, connect it to intake manifold vacuum. Start engine. Observe vacuum gauge. Open throttle part way and hold steady. If vacuum gauge drops slowly after stabilizing, check exhaust system for a restriction.

FUEL PRESSURE

WARNING: ALWAYS relieve fuel pressure before disconnecting any fuel injection system component. DO NOT allow fuel to contact engine or electrical components.

NOTE: For 1991 fuel pressure specifications, see [FUEL PRESSURE SPECIFICATIONS](#) article. For 1992 fuel pressure specifications, see [FUEL PRESSURE SPECIFICATIONS](#) article.

Fuel Pressure Release

Start engine (if possible), and unplug VAF meter connector. When engine stalls, turn ignition off and reconnect VAF meter wiring. Using shop towel, cover fitting to absorb leakage when opening fuel system.

Fuel Pressure Check

1. Connect fuel pressure gauge between fuel filter and fuel rail. Open main valve, and close drain valve. Locate fuel pump check connector in engine compartment, near left strut. Connect jumper wire between fuel pump test terminals (Black and Green/White wires on Capri or Black and Green/Red wires on Festiva).
2. Turn ignition on to activate fuel pump. If pump does not run, check fuel pump circuit. If possible, start engine. Measure and record fuel pressure. For fuel pressure specifications, see [FUEL PRESSURE SPECIFICATIONS](#) article. Disconnect vacuum from pressure regulator. Turn engine off. Wait 5 minutes and ensure residual pressure is at least 21 psi (1.5 kg/cm²).
3. Operate fuel pump by reconnecting jumper wire at fuel pump check connector. Check fuel pump performance. Pinch hose between pressure gauge and fuel filter. Do not hold longer than necessary to check pressure.For fuel pressure specifications, see [FUEL PRESSURE SPECIFICATIONS](#) article. If pump does not meet specifications, check fuel pump circuit, fuel pump, fuel tank and fuel filter or replace fuel pump.

FUEL PUMP PERFORMANCE

Application	Pressure psi (kg/cm ²)	Min. Vol. in 10 sec. Ozs. (cc)
Capri	(1)	5.5 (167)
Festiva	(1)	7.4 (220)

(1) For 1991 fuel pressure specifications, see [FUEL PRESSURE SPECIFICATIONS](#) article. For 1992 fuel pressure specifications, see [FUEL PRESSURE SPECIFICATIONS](#) article.

Fuel Pump Circuit

- 1. Turn ignition on. Connect jumper wire between fuel pump test connector terminals. See [Fig. 1](#) or [Fig. 2](#) . Turn ignition on to activate fuel pump.
- 2. Listen for fuel pump sound. If there is no sound, check main fuse, inertia switch (located at left rear shock tower), fuel pump relay, fuel pump and all electrical connections.

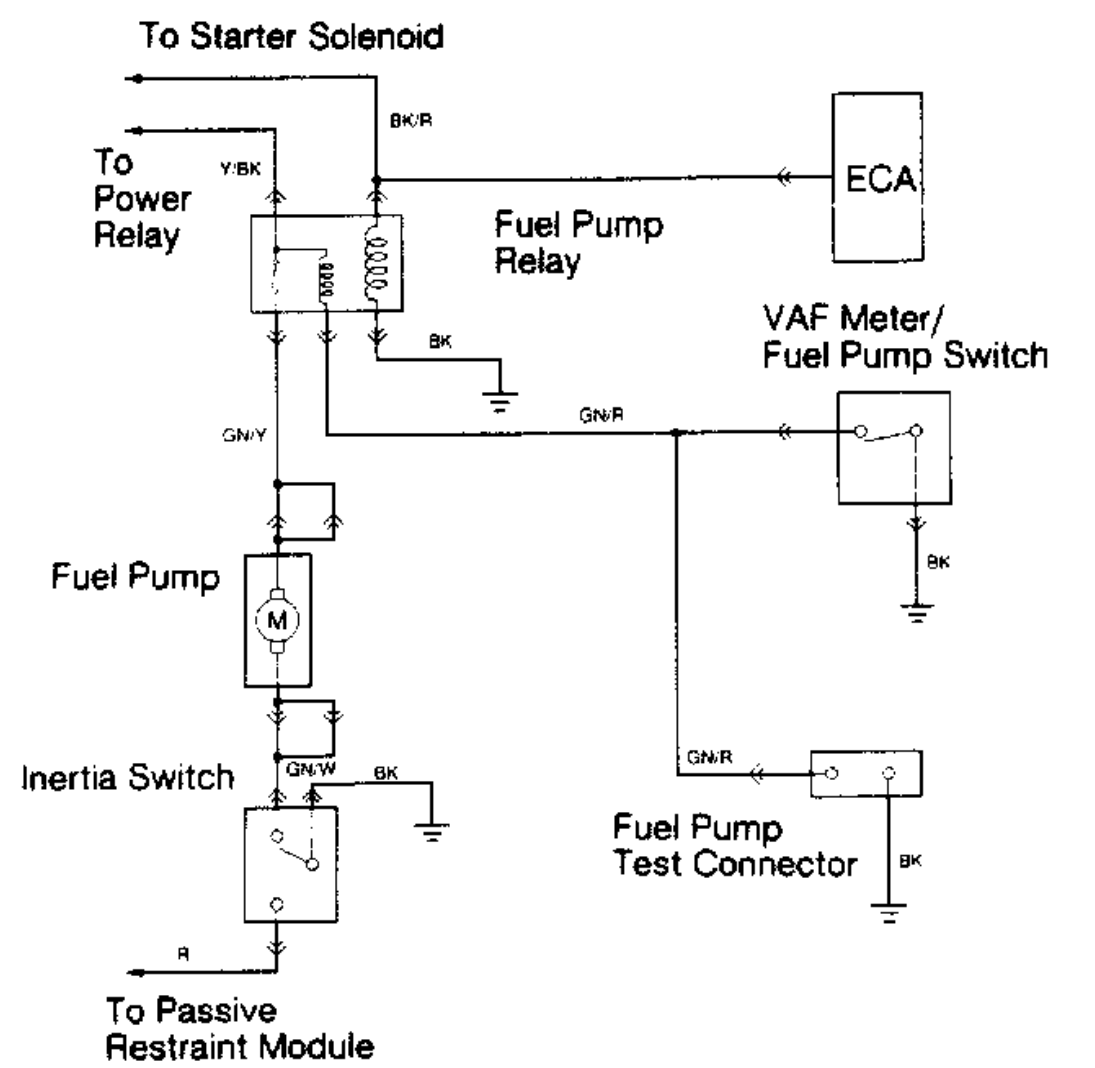


Fig. 1: Festiva Fuel System Electrical Schematic
Courtesy of FORD MOTOR CO.

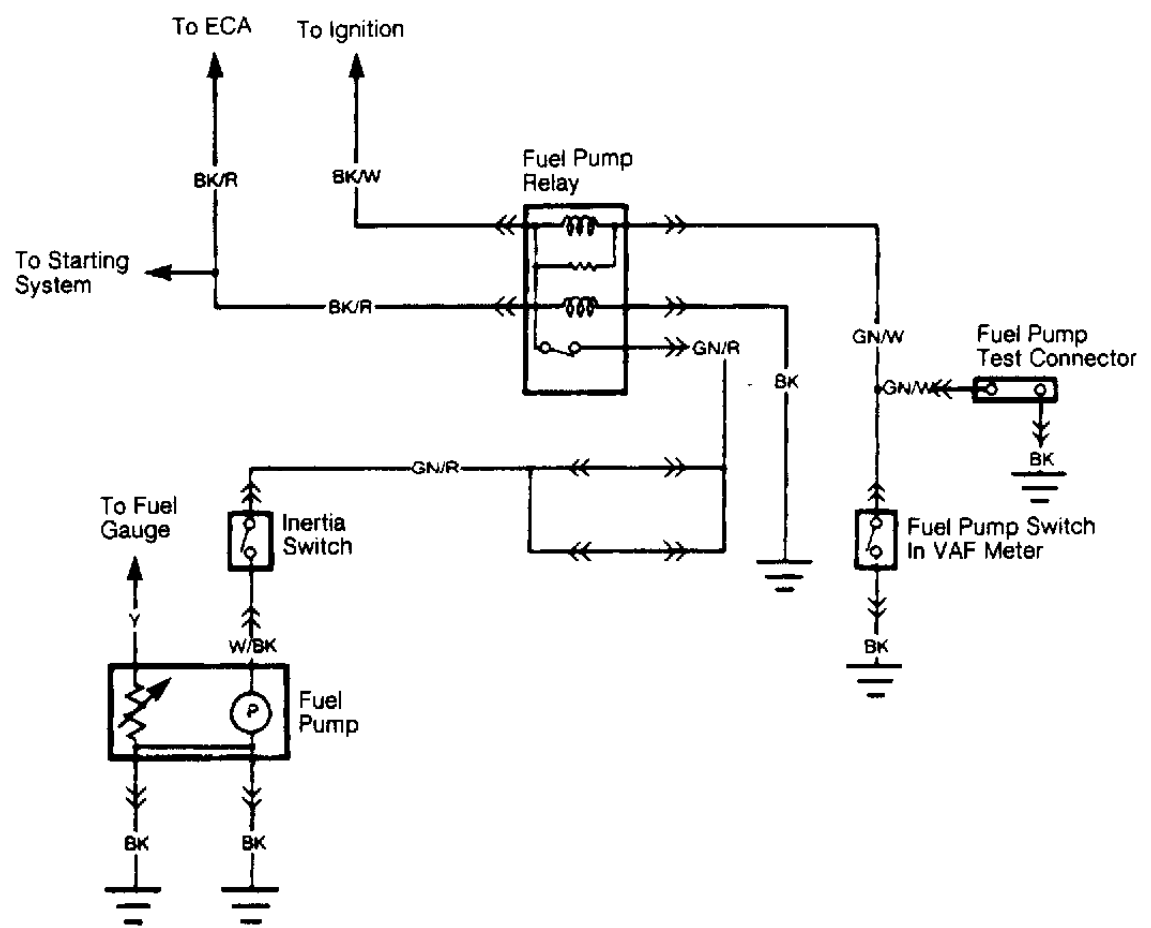


Fig. 2: Capri Fuel System Electrical Schematic
Courtesy of FORD MOTOR CO.

Fuel Pump Relay

Remove fuel pump relay (located near heater duct under carpet). Apply positive 12 volts to relay terminals "A" and "B" together. See [Fig. 3](#) . Measure voltage between terminal "C" and ground, while individually grounding terminals "D" and "E". Ensure voltage is as specified. See [FUEL PUMP RELAY SPECIFICATIONS](#) table. If voltage is not as specified, replace relay.

FUEL PUMP RELAY SPECIFICATIONS

Terminal "D"	Terminal "E"	Terminal "C" Voltage
Open	Open	Less than one
Grounded	Open	Less than 10
Open	Grounded	Greater than 10
Grounded	Grounded	Greater than 10

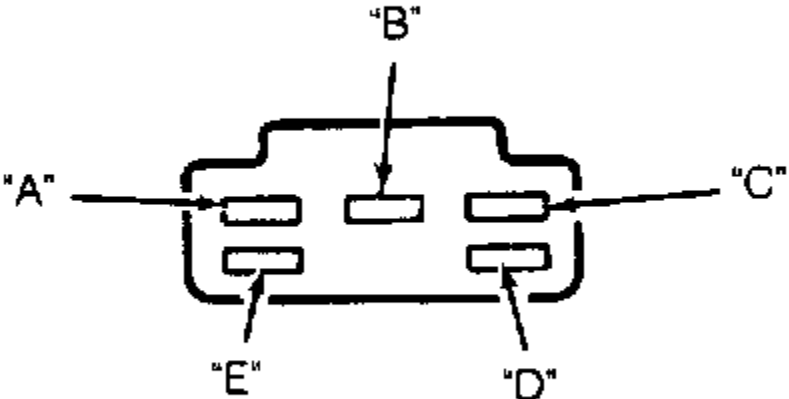


Fig. 3: Identifying Fuel Pump Relay Terminals
Courtesy of FORD MOTOR CO.

IGNITION CHECKS

Firing Order

Inspect spark plug wiring routing. Ensure firing order is 1-3-4-2.

Spark

1. Crank engine. Check for a strong Blue spark at each spark plug wire by using a high output spark tester. Ensure resistance of each spark plug wire is 4000-6000 ohms per foot.
2. Disconnect and inspect all related ignition system connectors and harness. Clean or repair as necessary, and recheck spark. If still no spark, go to [IGNITION COIL POWER SOURCE](#) .

Ignition Coil Power Source

Disconnect primary wires at ignition coil. Turn ignition on. Measure voltage between Black/White wire on harness connector and ground. If voltage is not greater than 10 volts, check battery feed, ignition switch and fusible links. If voltage is greater than 10 volts, go to [IGNITION COIL RESISTANCE](#) .

Ignition Coil Resistance

Measure resistance between primary terminals of coil. Measure resistance between positive primary terminal and coil tower. See [IGNITION COIL RESISTANCE](#) table. Verify resistance between coil case and primary positive terminal is infinite. Replace coil if resistance measurements are not within specifications.

IGNITION COIL RESISTANCE

Application	Primary (Ohms)	Secondary (Ohms)
1.3L & 1.6L	0.8-1.6	6000-30,000

IDLE SPEED & IGNITION TIMING

Ensure idle speed and ignition timing are set to specification. For adjustment procedures, see ON-VEHICLE ADJUSTMENTS article.

SUMMARY

If no faults were found while performing BASIC TESTING , proceed to TESTS W/CODES article in the ENGINE PERFORMANCE Section. If no hard codes are found in self-diagnostics, proceed to TESTS W/O CODES article in the ENGINE PERFORMANCE Section for diagnosis by symptom (i.e., ROUGH IDLE, NO START, etc.) or intermittent diagnostic procedures.

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P - EGR FUNCTION TESTING

1989-95 ENGINE PERFORMANCE Ford Motor Co. EGR Function Testing

TESTING

EGR VALVE

1989 Merkur & 1991-95 Escort/Tracer 1.9L (Ported EGR Valve)

1. Check vacuum lines for correct routing. Ensure no vacuum is available to EGR valve with engine idling. Disconnect idle air by-pass valve connector.
2. Disconnect vacuum hose at EGR valve and plug hose end. Connect a vacuum pump to EGR valve. Start engine. Apply 5-10 in. Hg to vacuum hose. If idle becomes unstable or engine stalls, EGR valve is functioning properly.
3. Reconnect idle air by-pass connector. Connect a vacuum pump to EGR vacuum supply hose. Ensure engine is at normal operating temperature. Increase engine speed 1500-2000 RPM. Vacuum gauge should read more than 5 in. Hg. If system operates as indicated, system is functioning properly.

1988-89 Festiva & Tracer (Ported EGR Valve)

1. Ensure engine is at normal operating temperature. Check vacuum lines for correct routing. Ensure no vacuum is available to EGR valve with engine idling. Start engine. Place finger against EGR diaphragm. Increase engine RPM. Diaphragm should move.
2. Remove EGR vacuum supply hose from EGR valve and plug hose end. Connect a vacuum pump to EGR valve. With engine idling, apply 6 in. Hg to EGR valve. If vacuum holds and idle becomes unstable or engine stalls, EGR valve is functioning properly.

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I - SYSTEM/COMPONENT TESTS

1991 ENGINE PERFORMANCE Ford Motor Co. - Ford/Mercury System & Component Testing

INTRODUCTION

Before testing separate components or systems, perform procedures in BASIC TESTING article in the ENGINE PERFORMANCE Section. Since many computer-controlled and monitored components set a trouble code if they malfunction, also perform procedures in TESTS W/CODES article in the ENGINE PERFORMANCE Section.

NOTE: **Testing individual components does not isolate shorts or opens. Perform all voltage tests with a Digital Volt-Ohmmeter (DVOM) with a minimum 10-megohm input impedance, unless stated otherwise in test procedure. Use ohmmeter and Breakout Box (BOB) (007-00033) to isolate wiring harness shorts or opens.**

AIR INDUCTION SYSTEMS

TURBOCHARGERS

Wastegate Actuator

Disconnect air hose from wastegate actuator. Apply 7.0-8.6 psi (.5-.6 kg/cm²) regulated air pressure to wastegate inlet fitting. Replace turbocharger if wastegate actuator rod does not move.

COMPUTERIZED ENGINE CONTROLS

ELECTRONIC CONTROL ASSEMBLY (ECA)

Ground Circuits

Turn ignition off. Connect BOB, leaving ECA disconnected. Measure resistance between each specified BOB pin and ground. See ECA GROUND CIRCUIT RESISTANCE table. Repair indicated ECA ground circuit if resistance is greater than 5 ohms.

ECA GROUND CIRCUIT RESISTANCE

ECA Pin	BOB Pin	Wire Color
1.3L		
2A	39,40,44	Black
2B	20	Black
2C	16	Black
2D	46,49	Black
2J ⁽²⁾	⁽³⁾ 6	⁽³⁾ White/Red
2J ⁽⁴⁾	6	Black
1.6L		
2R	49	Black
3A ⁽¹⁾	⁽¹⁾ 20	Black
3G ⁽¹⁾	⁽¹⁾ 40	Black
(1) Turbo only. (2) A/T models only. (3) No continuity on A/T models. (4) M/T models only.		

Power Circuits

Turn ignition off. Connect BOB, leaving ECA disconnected. Turn ignition on. Repair indicated ECA power circuit if battery voltage does not appear on specified BOB pin. See [ECA POWER CIRCUITS RESISTANCE](#) .

ECA POWER CIRCUIT RESISTANCE

ECA Pin	BOB Pin	Wire Color
1.3L: 1A	1	White/Red
1.6L: 3J	1	Black/Red

ENGINE SENSORS & SWITCHES

Check each component and all related wiring for any looseness or damage. Make all resistance and voltage measurements using Breakout Box (BOB) unless specified otherwise.

BAROMETRIC PRESSURE SENSOR (1.3L)

This unit is incorporated into the ECA, and cannot be checked or serviced separately. If a Code 14 is set and cannot be cleared, replace the ECA.

BAROMETRIC PRESSURE (BP) SENSOR (1.6L)

Connect BOB. Remove dust cover from BP sensor, located on passenger side cowl. Turn ignition on. Connect vacuum pump to BP sensor. Measure voltage between pins BP and SIGRTN on BOB while applying vacuum to BP sensor. See [BAROMETRIC PRESSURE SENSOR OUTPUT VOLTAGE](#) . Replace BP sensor if voltage is not as specified.

BAROMETRIC PRESSURE SENSOR OUTPUT VOLTAGE

Vacuum In. Hg.	(1) Voltage
0	3.84
5	3.36
10	2.66
15	1.93
20	1.26
25	.58
(1) Voltage may vary by plus or minus 15 percent.	

BRAKE ON-OFF (BOO) SWITCH

Unplug connector from BOO switch at brake pedal. Connect ohmmeter to switch terminals. With pedal released, ohmmeter should indicate no continuity. Ohmmeter should indicate continuity with pedal depressed.

CLUTCH ENGAGE SWITCH (CES)

Unplug connector from CES switch at clutch pedal. Connect ohmmeter to switch terminals. With pedal released, ohmmeter should indicate continuity. Ohmmeter should indicate no continuity with pedal depressed.

CRANKSHAFT POSITION SENSOR (CPS) (1.3L)

Unplug 3-wire connector from distributor. Measure resistance between CPS terminal on distributor (Yellow/Blue wire) and ground. Replace CPS if resistance is not 210-250 ohms.

CYLINDER IDENTIFICATION (CID) SENSOR (1.6L)

Turn ignition off. Connect BOB, leaving ECA connected. Turn ignition on, but DO NOT start engine. Measure voltage at BOB pin No. 34 (Yellow wire). Volt- meter should indicate less than one volt or more than 10 volts. Start engine and run at idle. Voltmeter should indicate 3-5 volts. Replace CID sensor if voltage is not as specified.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

1. Remove ECT sensor. ECT sensor is threaded into top of lower intake manifold on 1.3L, and on underside of intake manifold on 1.6L. Place ECT sensor and thermometer into container of coolant.
2. Connect ohmmeter to coolant temperature sensor terminals. Cool or heat container. Note resistance at specified temperatures. See [ENGINE COOLANT TEMPERATURE SENSOR RESISTANCE](#) . Replace ECT sensor if resistance is not within specification.

ENGINE COOLANT TEMPERATURE SENSOR RESISTANCE

Temperature °F (°C)	Ohms
-4 (-20)	14,600-17,800
68 (20)	2200-2700
104 (40)	1000-1300
140 (60)	500-650
176 (80)	290-350

EXHAUST GAS OXYGEN (EGO) SENSOR

With engine at normal operating temperature, unplug connector from EGO in exhaust manifold. Measure voltage between EGO sensor terminal and ground. Voltage should increase with increasing engine speed and decrease with decreasing engine speed. Voltage at idle should fluctuate within a range of .2-.8 volt.

NOTE: A steady voltage higher than .55 volt indicates a continuously rich condition. A steady voltage lower than .55 volt indicates a continuously lean condition.

IDLE SWITCH (1.6L)

Unplug connector from throttle position sensor on throttle body. Connect ohmmeter to switch terminals IDL and ground (Green/Orange and Blue/Yellow wires on mating connector). Resistance must be less than 5 ohms with throttle in idle position, and more than 10,000 ohms with throttle pedal depressed.

KNOCK SENSOR (1.6L TURBO)

Disconnect vacuum hose at distributor. Connect timing light. Start engine and record ignition timing. Tap intake plenum with a plastic mallet. Knock sensor is okay if timing retards. If timing does not retard, check associated circuitry and components. See [TIMING CONTROL SYSTEMS](#) under IGNITION SYSTEM.

NEUTRAL GEAR SWITCH (M/T)

1. Unplug connector near transmission. Place transmission in Neutral. Resistance across switch should be infinite.
2. Place transmission in any other gear. Resistance across switch should be zero ohms. If necessary, replace switch.

POWER STEERING PRESSURE SWITCH

1. Start engine and run it at idle. Remove connector from switch. Connect ohmmeter to switch terminals. Turn steering wheel from side to side while observing ohmmeter.
2. Replace power steering switch if continuity does not exist with front wheels turned, or if continuity exists with wheels straight ahead.

THROTTLE POSITION SENSOR (1.6L)

Unplug connector from sensor. Connect ohmmeter to sensor terminals TP and SIGRTN (Orange and Blue/Yellow wires on mating connector). Measure resistance at each throttle opening specified in [THROTTLE POSITION SENSOR RESISTANCE](#) . Replace sensor if resistance is not within specification.

THROTTLE POSITION SENSOR RESISTANCE

Throttle Opening	(1) Ohms
1/8	989
1/4	1104
3/8	1278
1/2	1462
5/8	1480
3/4	1459
7/8	1144
Fully Open	1072
(1) Resistance may vary by plus or minus 15 percent.	

THROTTLE POSITION SWITCH (1.3L)

1. Ensure idle speed and ignition timing are adjusted to specification. Stop engine. Disconnect negative battery cable.

CAUTION: DO NOT tamper with throttle stop screw at throttle lever. Doing so may result in damage to the throttle body.

2. Unplug TPS connector at throttle body. Insert appropriate feeler gauge between throttle stop screw and stop lever. Check for continuity between specified terminals on TPS connector. See ON-VEHICLE ADJUSTMENTS article and TPS CONTINUITY table.

TPS CONTINUITY

Test Condition (1)	Cont. Between IDL-TL	Cont. Between PSW-TL
.02" (.5 mm)	Yes	No
.03" (.7 mm)	No	No
Wide Open Throttle	No	Yes
(1) Insert specified feeler gauge between throttle adjustment screw and stop lever.		

VANE AIRFLOW (VAF) METER

1. Check all wiring, harnesses, connectors and components for evidence of damage, overheating, shorting or looseness. If any defect exists, repair as necessary.
2. Inspect vane airflow meter for damage and ensure measuring plate moves smoothly. Install BOB. Turn ignition on. Measure voltage between BOB test pins VAF and ground on 1.3L, or between VAF and SIGRTN on 1.6L. Voltage measurements must be as specified in [VANE AIRFLOW METER VOLTAGE](#) .

VANE AIRFLOW METER VOLTAGE

Door Opening	(1) Volts: 1.3L	(1) Volts: 1.6L
Fully Closed	.5-1.5	(2) *
1/8	.59	3.24
1/4	1.19	5.60
3/8	1.78	5.62
1/2	2.38	5.83
5/8	2.97	6.02
3/4	3.56	6.57
7/8	4.16	7.48
Fully Open	4.5-5.0	7.87
(1) Voltage may vary by plus or minus 15 percent.		
(2) Voltage not specified.		

VANE AIR TEMPERATURE (VAT) SENSOR

1. Unplug connector from VAF meter. On 1.3L, connect ohmmeter to terminals VAT and ground (Green/Black and Black wires on mating connector). On 1.6L, connect ohmmeter to VAF meter terminals VAT and SIGRTN (Brown and Blue/Yellow wires on mating connector).
2. Measure intake air temperature. Measure resistance between specified terminals. See [VANE AIR TEMPERATURE RESISTANCE](#) . Replace VAF if resistance is not as specified.

VANE AIR TEMPERATURE RESISTANCE [\(1\)](#)

°F (°C)	Ohms
-4 (-20)	15,000
32 (0)	5200
68 (20)	2500
104 (40)	100
140 (60)	600
176 (80)	300
(1) Resistance may vary by plus or minus 15 percent	

WIDE OPEN THROTTLE SWITCH (1.3L)

This switch is part of the throttle position switch. See THROTTLE POSITION SWITCH (1.3L).

MODULES, RELAYS & SOLENOIDS

MODULES

Ignition Module

See [IGNITION SYSTEM](#) .

RELAYS

A/C Clutch Relay

See [MISCELLANEOUS CONTROLS](#) .

Cooling Fan Relay

See [MISCELLANEOUS CONTROLS](#) .

SOLENOIDS

Canister Purge Solenoid

See [FUEL EVAPORATION](#) .

Fuel Pressure Regulator Control Solenoid

See [FUEL DELIVERY](#) under FUEL SYSTEM.

Idle Speed Control (ISC) Solenoid

This solenoid is part of the Idle Speed Control By-Pass Air (ISC-BPA) valve. See [IDLE CONTROL SYSTEM](#) under FUEL SYSTEM.

FUEL SYSTEM

NOTE: For fuel pressure specifications, see [FUEL PRESSURE SPECIFICATIONS](#) article.

FUEL DELIVERY

Fuel Pressure Regulator

1. Measure fuel pressure. See FUEL PRESSURE in BASIC TESTING article in the ENGINE PERFORMANCE Section. Stop engine. With fuel pressure tester still installed, measure fuel pressure after 5 minutes. If fuel pressure is greater than 21 psi (1.5 kg/cm²) after 5 minutes, go to step 2). Replace fuel pressure regulator if fuel pressure does not remain higher than 21 psi (1.5 kg/cm²).
2. Remove fuel pressure regulator. Inspect "O" ring, gasket and mounting surfaces for defects. Connect vacuum tester to fuel return tube, and apply 20 in. Hg vacuum. Replace fuel pressure regulator if vacuum drops by more than 10 in. Hg in 10 seconds. Reinstall fuel pressure regulator.
3. Again measure fuel pressure. If regulated fuel pressure is higher than specification, check for engine vacuum leaks, damage to fuel pressure regulator housing or a restricted fuel return line. Replace fuel pressure regulator if no problems are found.

Fuel Pressure Regulator Control Solenoid (1.6L)

1. Locate PRESSURE CONTROL (PRC) solenoid on cowl panel next to canister purge solenoid. Unplug PRC connector. Remove both vacuum lines. Plug one vacuum port and apply vacuum to remaining port. Replace PRC solenoid if it does not hold vacuum.
2. Connect 12-volt power to PRC terminals. If vacuum drops to zero, PRC solenoid is okay. Replace PRC solenoid if vacuum does not drop to zero.

FUEL CONTROL

Fuel Injectors

1. Using stethoscope, listen for normal clicking sound at each injector during idle and acceleration. If clicking sound is not heard, remove electrical connector from injector.
2. Using ohmmeter, measure resistance between injector terminals. See [FUEL INJECTOR RESISTANCE](#) table. Replace injector if

resistance is not within specifications. If injector resistance is okay, check for 12 volts at each injector connector. Repair or replace connector as necessary.

FUEL INJECTOR RESISTANCE

Application	Ohms
1.3L & 1.6L	12-16

IDLE CONTROL SYSTEM

Idle Speed Control By-pass Air (ISC-BPA) Valve

1. Remove ISC-BPA valve from engine. Connect a hose from a hot water tap to coolant inlet nipple on ISC-BPA valve. Blow through valve air port. Note resistance to airflow.
2. Supply hot water at 130°F (56°C) minimum to ISC-BPA valve and allow time for valve to respond. Blow through valve again. If resistance to airflow does not increase when valve is hot, replace ISC-BPA valve.
3. Apply 12 volts to solenoid terminals. If solenoid does not click, replace ISC-BPA valve.

IGNITION SYSTEM

NOTE: For basic ignition checks, see BASIC TESTING article in the ENGINE PERFORMANCE Section.

PICK-UP COIL

Check continuity of pick-up coil. If continuity exists, replace igniter unit. If continuity does not exist, replace pick-up coil.

TIMING CONTROL SYSTEMS

Advance Components (1.3L)

Ignition timing advance is controlled by the ECA.

Advance Components (1.6L Non-Turbo)

Ignition advance is controlled by a centrifugal advance mechanism within the distributor, and by a vacuum advance mechanism. If centrifugal advance is not within specification, service the distributor. Replace the vacuum advance mechanism if vacuum advance is not within specification. See [IGNITION TIMING](#) . Also see IGNITION TIMING in ADJUSTMENTS article in the ENGINE PERFORMANCE Section.

IGNITION TIMING

Application	Auto. Trans.	Man. Trans.
1.6L Non-Turbo	1-3 @ 850	0-4 @ 850
1.6L Turbo	10-14 @ 850	0-4 @ 850

Retard Components (1.6L Turbo)

Positive pressure to the vacuum advance cylinder on the distributor retards ignition timing. The ECA also retards ignition timing when it receives a signal from a Knock Sensor (KS), Knock Control Unit (KC) and related circuitry.

1. Disconnect and plug hoses at distributor. Connect timing light and start engine. Record ignition timing. Tap intake plenum with plastic mallet while observing ignition timing. If timing retards, knock control circuitry is okay. If timing does not retard, go to step 2).
2. Unplug KC sensor service connector near ECA. Tap intake plenum with plastic mallet while observing ignition timing. If ignition timing retards, go to step 3). If timing does not retard, go to step 4).
3. Reconnect KC service connector. Tap intake plenum with plastic mallet while observing ignition timing. If ignition timing retards, replace knock controller. If ignition timing does not retard, go to step 4).
4. Unplug KC service connector near ECA. Temporarily install a known good KS. Tap intake plenum with plastic mallet while observing ignition timing. If ignition timing retards, replace KS. If ignition timing does not retard, go to step 5).
5. Turn ignition off. Connect BOB. Ensure VPWR and ground wires to KC are okay. Check all KC wiring for shorts or opens. If wiring is okay, replace KC.

EMISSION SYSTEMS & SUB-SYSTEMS

FUEL EVAPORATION

Canister Purge Solenoid

1. Disconnect vacuum hoses from solenoid. See [Fig. 1](#) . Blow through port "A". Ensure no air exhausts from port "B".
2. Disconnect 2-wire connector from solenoid. Connect 12 volts to one terminal and ground the other terminal of solenoid. Blow air though port "A". Ensure air exhausts through port "B".

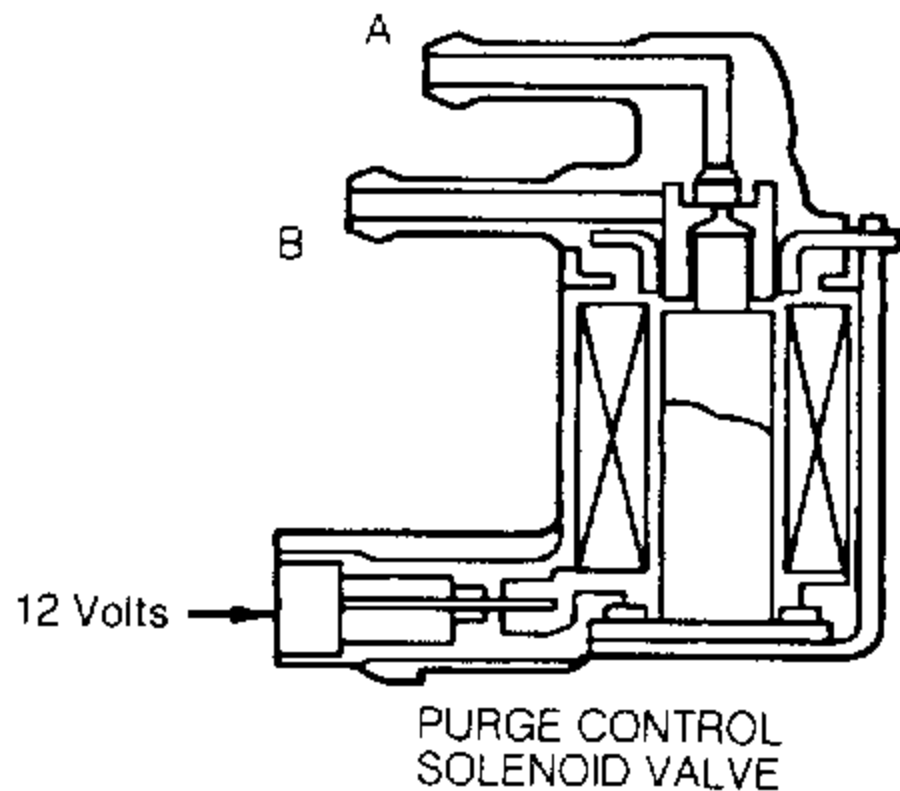


Fig. 1: Testing Canister Purge Solenoid
Courtesy of FORD MOTOR CO.

Carbon Canister

- 1. Start and run engine until it is at operating temperature. Stop engine. Remove carbon canister. Carbon canister on 1.3L is located under brake booster. Carbon canister is located in right side of engine compartment near cowl panel on 1.6L.
- 2. Inspect carbon canister for presence of liquid fuel, as evidenced by odor or weight. Blow into air vent and ensure air exits from fuel vapor inlet. Replace carbon canister if it contains fuel, or if air does not pass freely through it.

POSITIVE CRANKCASE VENTILATION (PCV)

- 1. Remove PCV valve from valve cover and disconnect it from PCV hose. Shake valve vigorously to ensure plunger is free to move. Replace PCV valve if plunger is not free.
- 2. Idle engine until it is warm. Remove fresh air hose at inlet end. Plug nipple immediately to prevent stalling. Verify presence of vacuum at inlet end of hose. If vacuum is not present, replace PCV valve or service hoses or loose oil dipstick.

THROTTLE CONTROLS

Dashpot

Disconnect PCV valve. Remove resonance chamber. Push dashpot rod in and then release it. Replace dashpot if rod does not go in slowly and return quickly.

MISCELLANEOUS CONTROLS

NOTE: Although some of the controlled devices listed here are not technically engine performance components, they can affect driveability if they malfunction.

A/C CLUTCH

A/C Clutch Relay

Remove relay from its socket near left headlight, in front of battery. Connect ohmmeter to contact terminals (Blue/Red and Black/White wires on mating connector). Ohmmeter should indicate continuity. Supply 12 volts to remaining terminals (Green/Yellow and Yellow wires on mating connector). Ohmmeter should indicate no continuity.

COOLING FAN

Cooling Fan

Unplug connector from cooling fan. Apply 12 volts to one terminal of fan connector. Ground remaining fan connector terminal. Replace fan if it does not run.

Cooling Fan Control Relay

Remove relay from its socket near left headlight. Connect ohmmeter to contact terminals. Wire colors are Yellow/Red and Black on mating connector on Festiva; Yellow/Green and Black on Capri. Ohmmeter should indicate continuity. Supply 12 volts to remaining 2 relay terminals. Ohmmeter should indicate no continuity.

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G - TESTS W/CODES

1991-92 ENGINE PERFORMANCE Ford Motor Co. Self-Diagnostics

INTRODUCTION

If no faults were found while performing BASIC TESTING , proceed with self-diagnostics. If no fault codes or only pass codes are present after entering self-diagnostics, proceed to TESTS W/O CODES article in the ENGINE PERFORMANCE Section for diagnosis by symptom (i.e., ROUGH IDLE, NO START, etc.).

This article uses many abbreviations for devices, signal names, and wire colors. See [SELF-DIAGNOSTICS ABBREVIATIONS](#) table. Abbreviations for wire colors used in individual PINPOINT TEST diagrams are as follows:

- BLK - Black
- BLU - Blue
- BRN - Brown
- GRN - Green
- LT GRN - Light Green
- ORG - Orange
- PNK - Pink
- RED - Red
- WHT - White
- YEL - Yellow

SELF-DIAGNOSTICS ABBREVIATIONS

Application	Abbreviation
Analog Volt/Ohmmeter	VOM
Barometric Pressure Sensor	BP
Breakout Box	BOB
Canister Purge Control Solenoid	CANP
CHECK ENGINE Light	MIL
Crankshaft Position Sensor	CPS
Cylinder Identification Sensor	CID
Electronic Control Assembly	ECA
Electronic Engine Control	EEC
Engine Coolant Temperature Sensor	ECT
Exhaust Gas Oxygen Sensor	EGO
Idle Speed Control	ISC
Ignition Diagnostic Monitor	IDM
Keep Alive Power	KAPWR
Key On Engine Off	KOEO
Key On Engine Running	KOER
Knock Control	KC
Power & Ground Connections	PGC
Fuel Pressure Regulator Control Solenoid	PRC
Reference Voltage & Signal Return	VREF
Self-Test Input	STI
Self-Test Output	STO
Signal Return	SIGRTN
Solenoid Controlled By Ground	SCG
Switch Monitor Lamp	SML
Switch To Ground	STG
Switch To Power	STP
Throttle Position Sensor	TP
Vane Airflow Meter	VAF
Vane Air Temperature Sensor	VAT
Vehicle Power	VPWR
Vehicle Speed Sensor	VSS

SELF-DIAGNOSTIC SYSTEM

Hard Failures

Hard failures cause CHECK ENGINE light (MIL) to come on and remain on until problem is repaired. If MIL comes on and remains on (light may flash) during vehicle operation, cause of malfunction must be determined using diagnostic (code) charts. If a sensor fails, ECA will use a substitute value in its calculations to permit continued engine operation. In this condition (limp-in mode), vehicle will run but driveability will not be optimum.

Intermittent Failures

Intermittent failures may cause MIL to flicker or come on and go off after intermittent defect goes away. Corresponding trouble code, however, will be retained in ECA memory. If related defect does not reoccur within a certain time frame, related trouble code will be erased from ECA

memory. Intermittent failures may be caused by a sensor, connector, or wiring. See INTERMITTENTS in TESTS W/O CODES article in the ENGINE PERFORMANCE Section.

VISUAL CHECK & VEHICLE PREPARATION

Before connecting any equipment to diagnose EEC system, perform following preparatory procedures:

- Verify condition of air cleaner and air ducts.
- Check all vacuum hoses for leaks, restrictions, or improper routing.
- Check EEC system wiring harness electrical connections for corrosion, bent or broken pins, loose wires or terminals, or improper routing.
- Check ECA, sensors, and actuators for physical damage.
- Check engine oil and coolant level.
- Perform all necessary safety precautions to prevent personal injury or vehicle damage.
- Set parking brake. Place shift lever in Park for automatic transmissions, or Neutral for manual transmissions. DO NOT move shift lever during test unless specifically directed.
- Turn off all lights and accessories. Ensure vehicle doors are closed when measuring voltage or resistance.
- Start engine. Run at idle until upper radiator hose is hot and pressurized and engine is off fast idle. Check for leaks around exhaust manifold, exhaust gas oxygen sensor, and vacuum hose connections.
- Turn ignition off. Service items as required. Go to [EQUIPMENT HOOK-UP](#) .

EQUIPMENT HOOK-UP

VOM

1. Turn ignition off. Connect a jumper wire from STI connector to ground. Refer to [SELF-TEST CONNECTOR LOCATION](#) and [SELF-TEST CONNECTOR WIRE COLORS](#) tables. See [Fig. 1](#) .
2. Connect VOM between STO terminal and engine ground. Set VOM to measure 0-20 volts DC.

CHECK ENGINE Light (MIL)

Connect a jumper wire between STI connector and ground.

SUPER STAR II Tester

Turn ignition off. Connect adapter cable leads to diagnostic tester. Connect service adapter cables to vehicle self-test connectors. Ground adapter cable.

SELF-TEST CONNECTOR LOCATION

Application	Location
1.3L	Left Rear Corner Of Engine Compartment
1.6L	Right Rear Corner Of Engine Compartment

SELF-TEST CONNECTOR WIRE COLORS

Circuit	Wire Color
1.3L	
SML	Blue/Green
STI	Yellow/Green
STO	Yellow/White
1.6L	
SML	Black/Blue
STI	Yellow
STO	Green/Black

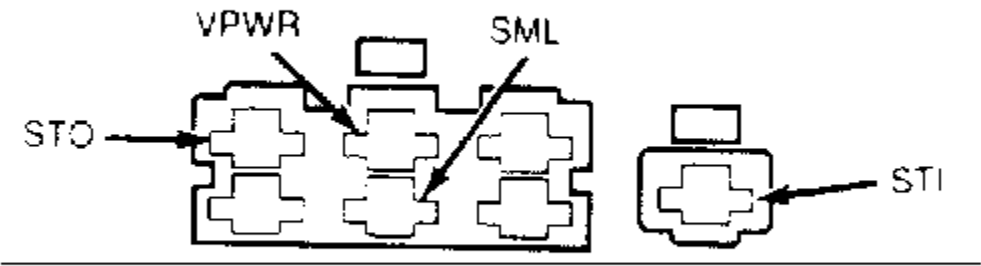


Fig. 1: Self-Test Connector Terminal ID
Courtesy of FORD MOTOR CO.

RETRIEVING CODES

Reading Service Codes

Engine control system communicates malfunctions to technician through service codes. These service codes are 2-digit numbers representing a particular defect. Service codes are transmitted through STO connector.

Service codes are displayed as timed pulses, and may be read with a VOM or Super Star II tester. VOM displays codes by needle sweeps. See [Fig. 2](#) .

Turn ignition off. Ensure all procedures of [EQUIPMENT HOOK-UP](#) have been followed. Engine should be at normal operating temperature.

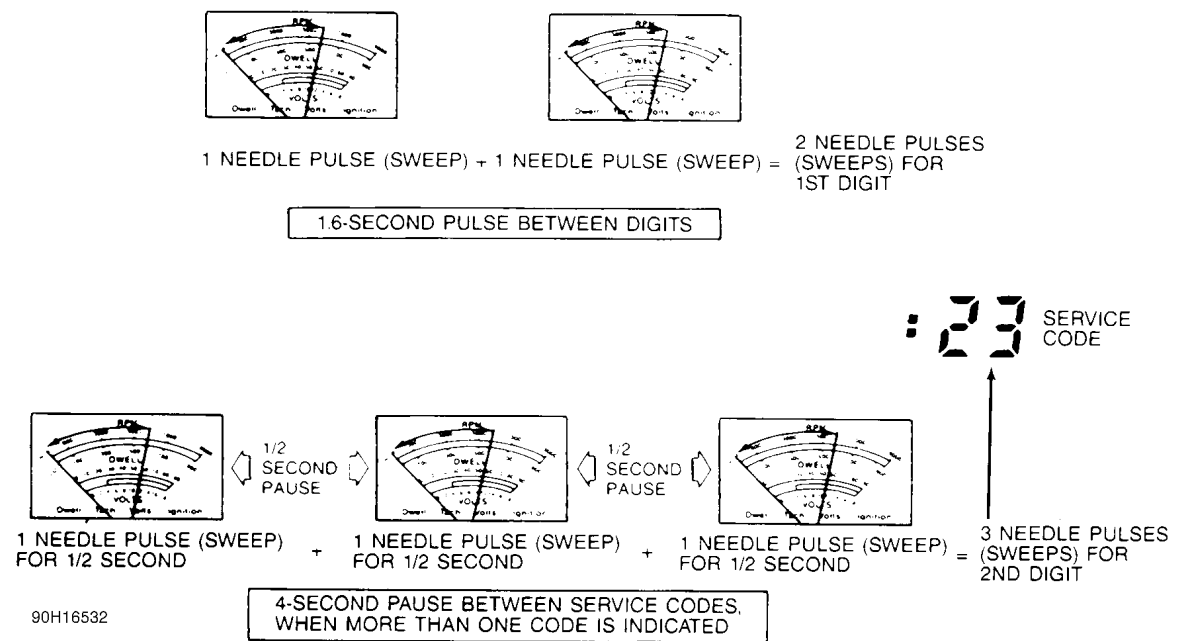


Fig. 2: Reading Service Codes With VOM
Courtesy of FORD MOTOR CO.

VOM

Disconnect and reconnect jumper wire from STI terminal to ground. Turn ignition on. Record displayed codes. Erase codes, and repeat test procedure to verify all codes are currently valid. See [ERASING CODES & RETESTING](#) . Service only those codes which appear during retest. Refer to [TROUBLE CODE DEFINITION](#) table to find appropriate pinpoint test.

MIL

Turn ignition on. Connect a jumper wire between STI connector and ground. Observe MIL, and record pulses to determine codes stored.

NOTE: If MIL flashes continuously prior to connecting test equipment, go to [PINPOINT TEST STI](#) .

SUPER STAR II Tester

Set center button to TEST position. Turn ignition on. Turn tester on. When activated, tester should display 888 for 2 seconds. Release and reset center TEST button. After all codes are displayed, release center button. All codes in tester memory may now be reviewed.

ERASING CODES & RETESTING

Erasing codes and retesting will give an indication of whether codes are hard or intermittent defects. Hard codes reset immediately and will be displayed during retest.

Disconnect negative battery cable. Press brake pedal for 5-10 seconds. Turn off VOM or Super Star II tester. Reconnect battery. Perform tests under [RETRIEVING CODES](#) to again display and record codes.

TROUBLE CODE DEFINITION

TROUBLE CODE DEFINITION

Service Code	Fault	Circuit & Pinpoint Test
01	Ignition Diagnostic Monitor	IDM
02 (1)	Crankshaft Position Sensor	CPS
03 (2)	Cylinder Identification Sensor	CID
06 (2)	Vehicle Speed Sensor	VSS
08	Vane Airflow Meter	VAF
09	Engine Coolant Temperature Sensor	ECT
10	Vane Air Temperature Sensor	VAT
12 (2)	Throttle Position Sensor	TP
14	Barometric Pressure Sensor	BP
15	Exhaust Gas Oxygen Sensor	EGO
17	Exhaust Gas Oxygen Sensor	EGO
25 (2)	Fuel Pressure Regulator Control Solenoid	PRC
26	Canister Purge Control Solenoid	CANP
34	Idle Speed Control	ISC
Codes Not Listed	Power & Ground Connections	PGC

- (1) Festiva only.
- (2) Capri only.

CLEARING CODES

Clearing Codes Procedure

Disconnect negative battery cable. Press brake pedal for 5-10 seconds. Turn off VOM or Super Star II tester. Reconnect battery.

ECA LOCATION

ECA is located on center console behind kick panel on Capri, and under instrument panel on driver side of Festiva.

QUICK TESTS

KEY ON, ENGINE OFF (KOEO) SELF-TEST

NOTE: DO NOT move throttle during KOEO self-test.

KOEO

1. This is a test of electronic engine control system, conducted with power (voltage) applied and engine not running. Activate self-test, and record all codes displayed.
2. Erase codes, and repeat self-test. Diagnose only codes occurring during repeat self-test. See [TROUBLE CODE DEFINITION](#) table. If no codes are present, proceed to [KEY ON, ENGINE RUNNING \(KOER\) SELF-TEST](#) .

KEY ON, ENGINE RUNNING (KOER) SELF-TEST

NOTE: It is necessary to clear codes in memory before performing this test. DO NOT move throttle during test.

KOER

1. Deactivate self-test. Start and run engine at 2000 RPM for 2 minutes to warm up EGO sensor. Turn off engine and wait 10 seconds.
2. Restart engine, and activate self-test. Record all service codes displayed. See [TROUBLE CODE DEFINITION](#) table. If no codes are present, proceed to [SWITCH MONITOR TEST](#) .

SWITCH MONITOR TEST

NOTE: All switches must be tested individually. Allowing a switch to remain on while testing another will lead to false test results.

This test procedure checks input signals received by ECA from individual switches. Use following procedure to perform switch monitor test:

- Turn engine off and allow it to cool.

• Ensure all accessories are turned off.

• Deactivate self-test.

• Ensure transmission is in Neutral or Park.

• Turn ignition on.

SUPER STAR II Tester

Connect Super Star II tester adapter cable. Turn on tester. Latch center button. Operate each switch listed in [SWITCH MONITOR TEST](#) table. Note output of LED on adapter cable as each switch operates. Record test results.

VOM

1. Ground STI connector. Connect VOM positive lead to SML terminal on self-test connector. Connect negative lead to ground. See [Fig. 1](#) .
2. Operate each switch listed in [SWITCH MONITOR TEST](#) table. Note output on VOM as each switch is operated. Go to specified PINPOINT TEST if any switch does not meet specification.

NOTE: DO NOT move throttle, clutch, or transmission lever unless so directed.

SWITCH MONITOR TEST

Switch	VOM Indication/Condition	1 Pinpoint Test
A/C Switch	Less Than 1.5 Volts; A/C & Blower Switch On	STG
Blower Motor Switch	Less Than 1.5 Volts; Switch Set To "2" Or Higher	STG
Brake On/Off Switch	Less Than 1.5 Volts; Brake Pedal Partially Pressed	STP
Clutch Engage/Neutral Gear Switch 2	Less Than 1.5 Volts; In Gear, Clutch Released	STG
Coolant Temperature Switch	Less Than 1.5 Volts; Cooling Fan On	STP
Defrost Switch	Less Than 1.5 Volts; Defrost Switch On	STP
Headlight Switch	Less Than 1.5 Volts; Headlight Switch On	STP
Idle Switch	Less Than 1.5 Volts; Accelerator Pedal Pressed	STG

Manual Lever Position Switch	Less Than 1.5 Volts; Transaxle In Park Or Neutral	STP
Wide Open Throttle Switch	Less Than 1.5 Volts; Accelerator Pedal Fully Pressed	STG
(1) Proceed to PINPOINT TEST indicated if Super Star II tester/VOM indication is incorrect.		
(2) Not applicable to vehicles with A/T.		

WIGGLE TEST

Checking Circuitry

1. Visually inspect suspected sensor, switch, or solenoid. Enter WIGGLE TEST if using Super Star II tester. If using VOM, connect it to STO terminal on self-test connector, and ground STI self-test connector terminal. Lightly tap sensor, switch, or solenoid.
2. Push and pull on suspected sensor, switch, or solenoid connector, but DO NOT unplug it. Test and wiggle harness vigorously, working in small sections, from suspected device toward dash panel, and from dash panel to ECA.
3. If VOM or Super Star II tester does not display a positive indication of an intermittent defect, carefully disconnect suspected device. Remove terminals from connector.
4. Inspect terminals at both ends for corrosion, bad crimps, or improperly seated terminals. Reconnect after inspection. Unplug harness from ECA.
5. Inspect ECA and harness connector terminals for corrosion, bad crimps, or improperly seated terminals. If VOM does not indicate any intermittent defect, reconnect wiring and erase codes.

PINPOINT TESTS

NOTE: Following tests and illustrations are courtesy of Ford Motor Co. Complete EEC system wiring diagrams may be found in WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

HOW TO USE PINPOINT TESTS

NOTE: Check all wiring, harnesses, connectors, and components for damage, overheating, shorting, or looseness. If any defect is found, repair as necessary before proceeding to any PINPOINT TEST.

1. DO NOT perform any PINPOINT TEST unless directed by a QUICK TESTS procedure. Ensure all non-EEC related defects are corrected. Follow each test step in order until defect is found. DO NOT replace any part unless so directed. When more than one service code exists, start with first code displayed.
2. PINPOINT TESTS require ensuring electrical circuits are okay before replacing sensors or any other components. Always test circuits for continuity between sensor and ECA. Test all circuits for shorts to power, opens, or shorts to ground. VREF and VPWR circuits should be tested with KOEO or as specified in PINPOINT TESTS.
3. DO NOT measure voltage or resistance at ECA, or connect any test light unless specified in testing procedure. DO NOT pierce wiring. Isolate both ends of a circuit and turn key off whenever checking for shorts or continuity, unless otherwise specified.
4. Disconnect solenoids and switches before checking circuit continuity or energizing solenoids.
5. An open is defined as any resistance greater than 10,000 ohms, unless otherwise specified.
6. To help diagnose circuits to ECA, turn ignition off and disconnect ECA harness. Connect BOB between ECA and ECA harness to perform circuit and pinpoint tests.

PINPOINT TEST IDM - IGNITION DIAGNOSTIC MONITOR

NOTE: Enter this test only when Code 01 is displayed during QUICK TESTS procedure or when directed here from another PINPOINT TEST.

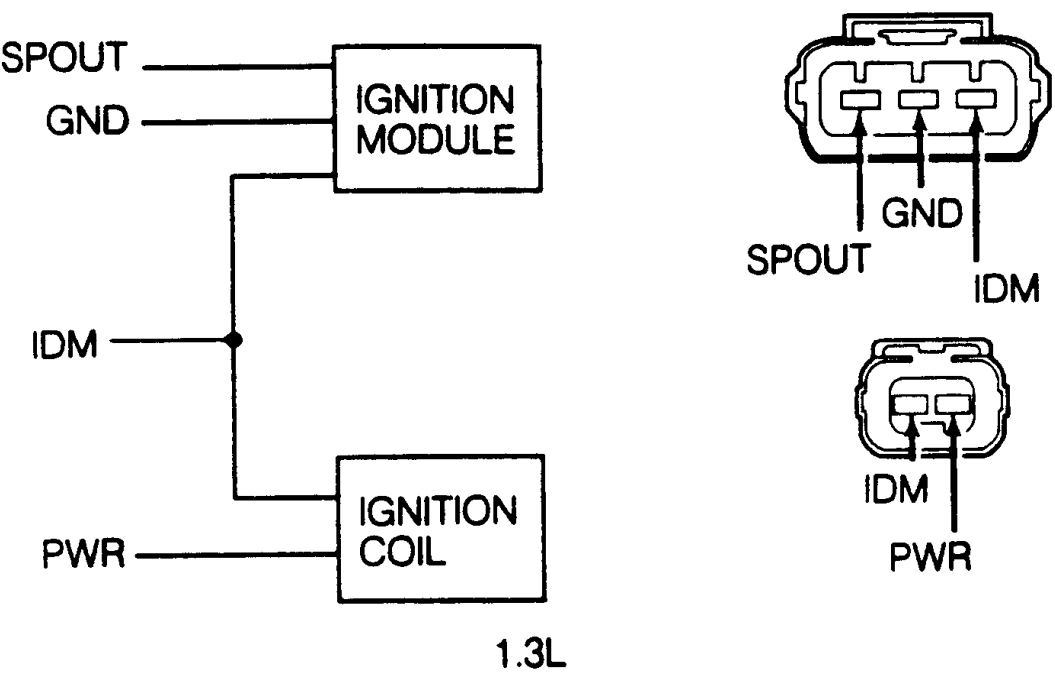


Fig. 3: Identifying IDM Circuit & Connector

IDM CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
---------	---------	---------	------------

1.3L			
GND	2A	39, 40, 44, 60	BLK
IDM	(1)	(1)	YEL/GRN
PWR	(1)	(1)	BLK/WHT
SPOUT	1G	36	BLU/ORG
1.6L			
IDM	1M	6	YEL/BLU
PWR	*****	*****	BLK/WHT
(1) ECA and BOB pins not specified.			

- 1.3L
1. Connect spark tester between coil secondary wire and ground. Crank engine several times, leaving ignition on between cranking periods. If continuous sparks jump tester gap, go to next step. If continuous sparks do not jump tester gap, go to step 3).
 2. With ignition off, connect BOB, leaving ECA disconnected. Connect test light between test pins IDM and VPWR. Crank engine several times. If test light flashes each time engine cranks, IDM circuit is okay. Return to QUICK TESTS if directed here from there. If test light does not flash, repair IDM wire between ECA and coil.
 3. Unplug connector from ignition coil. Connect test light between coil IDM wire and PWR wire. Crank engine several times, leaving ignition on between cranking periods. If test light flashes continuously, go to next step. If test light does not flash continuously, go to step 6).
 4. Turn ignition on. Measure voltage between coil harness PWR wire and ground. If voltage is greater than 10 volts, replace coil. If voltage is less than 10 volts, repair wire between ignition switch and coil.
 5. Connect test light between PWR and ground terminals at coil harness connector. Turn ignition on. If test light glows, replace coil. If test light does not glow, repair ground wire to coil.
 6. Unplug connector from ignition module. Connect jumper wire between SPOUT wire on ignition module harness connector and mating terminal on ignition module. Connect another jumper wire between ignition module GND wire and mating connector. Leave IDM wire disconnected. Connect test light between IDM terminal on ignition module and PWR wire. Crank engine several times, leaving ignition on between cranking periods. If test light flashes each time engine cranks, repair wire between ignition module IDM wire and coil. If test light does not flash, go to next step.
 7. Turn ignition off. Unplug ignition module connector. Turn ignition on. Measure voltage between ignition module PWR wire and ground. Turn ignition on. If voltage is not more than 10 volts, repair PWR wire from ignition switch. If voltage is more than 10 volts, go to next step.
 8. Turn ignition off. Unplug ignition module connector. Turn ignition on. Connect test light between ignition coil PWR wire and ignition module GND wire. Turn ignition on. If test light glows, go to step 10). If test light does not glow, go to next step.
 9. Turn ignition off. Unplug ignition module connector. Connect test light between ignition coil PWR wire and ignition module SPOUT wire. Crank engine. If test light flashes, check ignition module SPOUT wire for short to ground; if no short exists, replace ignition module. If test light does not flash, go to next step.
 10. Turn ignition off. Unplug ignition module connector. Install BOB, leaving ECA disconnected. Check SPOUT wire for continuity between BOB test pin and ignition module. If continuity exists, check SPOUT wire for shorts to any other wire. If no short exists, replace ECA. If continuity does not exist, repair SPOUT wire to ECA.

- 1.6L
1. Connect spark tester between coil secondary wire and ground. Crank engine several times, leaving ignition on between cranking periods. If continuous sparks do not jump tester gap, go to step 3). If continuous sparks jump tester gap, go to next step.
 2. Turn ignition off. Connect BOB. Leave ECA disconnected. Connect test light between test BOB pins IDM and VPWR. Crank engine several times. If test light flashes each time engine cranks, IDM circuit is okay. Return to QUICK TESTS if directed here from there. If test light does not flash, repair IDM wire between ECA and coil.
 3. Unplug connector from ignition coil. Connect test light between coil IDM wire and PWR wire. Crank engine several times, leaving ignition on between cranking periods. If test light does not flash continuously, go to step 6). If test light flashes continuously, go to next step.
 4. Turn ignition on. Measure voltage between coil harness PWR wire and ground. If voltage is greater than 10 volts, replace coil. If voltage is less than 10 volts, repair wire between ignition switch and coil.
 5. Connect test light between PWR and ground terminals at coil harness connector. Turn ignition on. If test light glows, replace coil. If test light does not glow, repair ground wire to coil.
 6. Unplug connector from ignition module. Connect a jumper wire between PWR wire on ignition module harness connector and mating terminal on ignition module. Leave IDM wire disconnected. Connect test light between IDM terminal on ignition module and PWR wire. Crank engine several times, leaving ignition on between cranking periods. If test light flashes each time engine cranks, repair wire between ignition module IDM wire and coil. If test light does not flash. go to next step.
 7. Unplug connector from ignition module. Measure voltage between ignition module PWR wire and ground. If voltage is not higher than 10 volts, repair PWR wire from ignition switch. If voltage is higher than 10 volts, go to next step.
 8. Turn ignition off. Unplug ignition module connector. Turn ignition on. Connect test light between ignition module PWR wire and ignition module GND wire. Turn ignition on. If test light glows, replace ignition module. If test light does not glow, repair ignition module ground wire.

PINPOINT TEST CPS - CRANKSHAFT POSITION SENSOR

NOTE: Enter this test only when Code 02 is displayed during QUICK TESTS procedure or when directed here from another PINPOINT TEST.

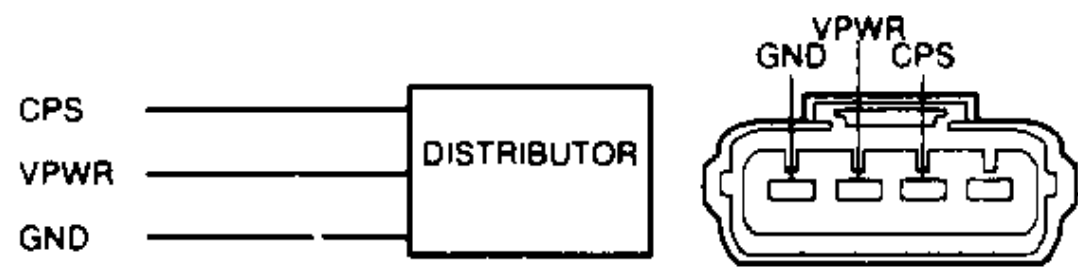


Fig. 4: Identifying CPS Circuit & Connector

CPS CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
CPS	2E	56	YEL/BLU
GND	2A	39, 40, 44, 60	BLK
GND	2B	20	BLK
GND	2C	16	BLK
VPWR	1B	37, 57	YEL/BLK

1. Turn ignition off. Install BOB. Leave ECA disconnected. Unplug distributor connector. Measure resistance of CPS, VPWR, and GND wires between ECA and distributor. If all resistances are not less than 5 ohms, repair wire in question. If all resistances are less than 5 ohms, go to next step.
2. Turn ignition off. Unplug distributor connector. Turn ignition on. Measure voltage between distributor VPWR and GND wires. If voltage is more than 10 volts, replace CPS sensor. If voltage is not more than 10 volts, repair distributor GND wire.

PINPOINT TEST CID - CYLINDER IDENTIFICATION SENSOR

NOTE: Enter this test only when Code 03 is displayed during QUICK TESTS procedure or when directed here from another PINPOINT TEST.

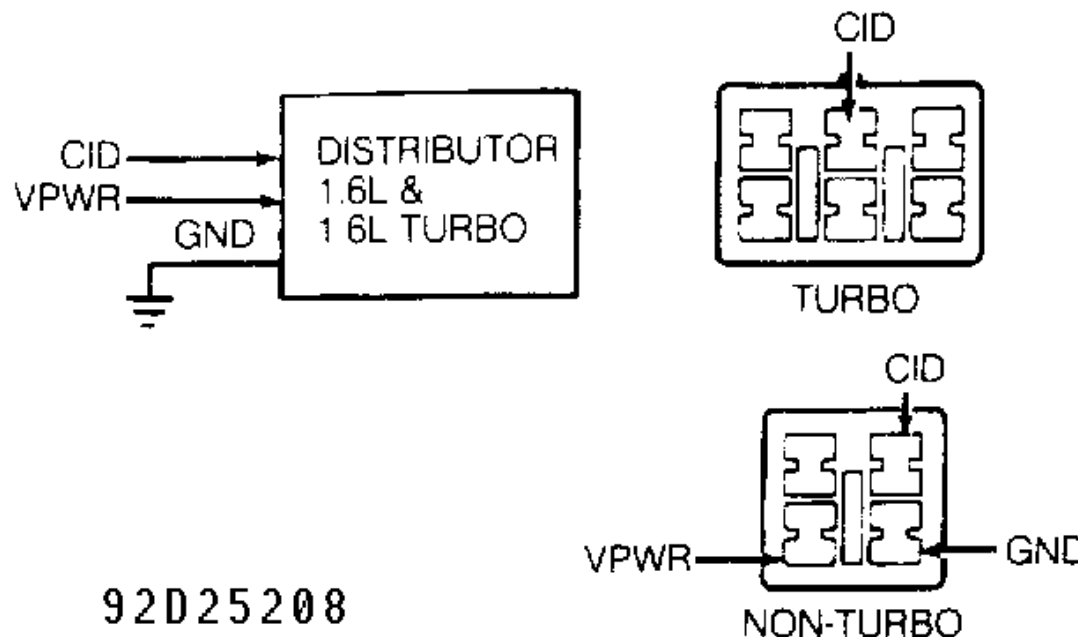


Fig. 5: Identifying CID Circuit & Connectors

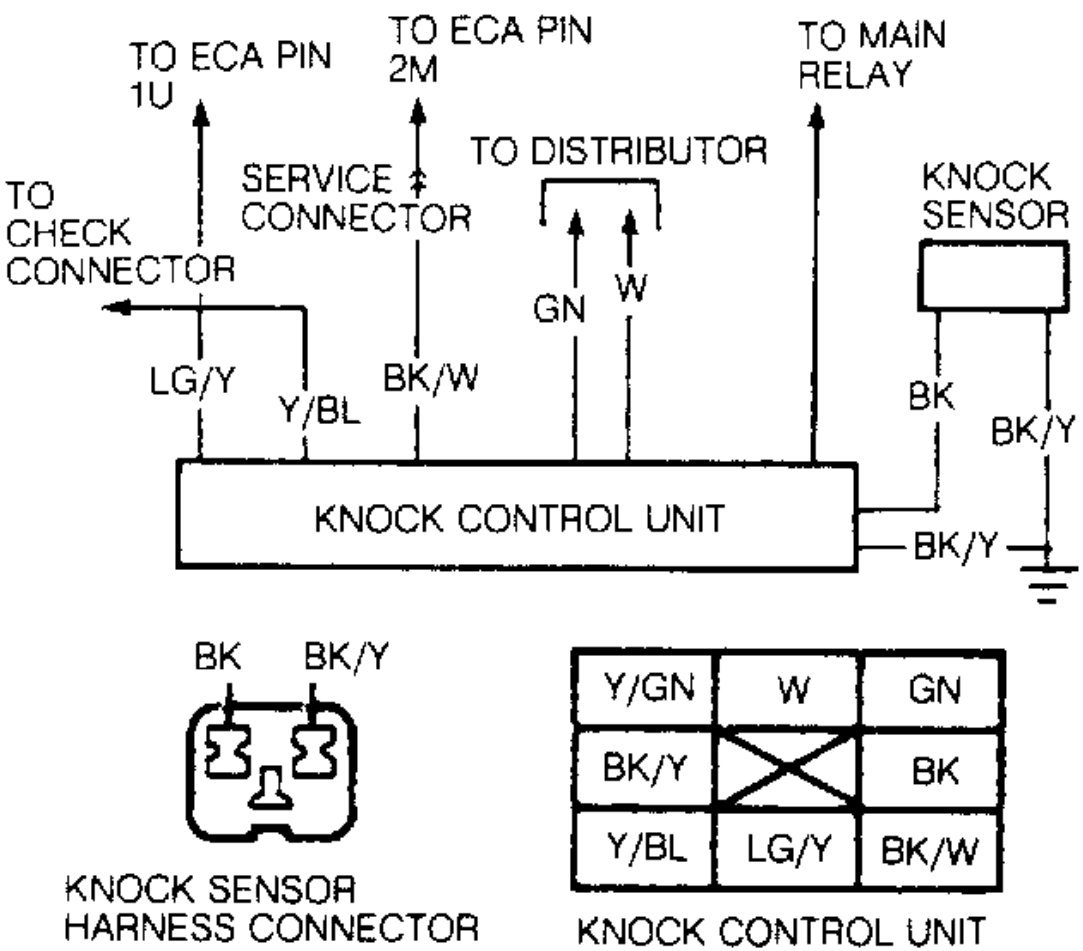
CID CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
CID	1N	34	YEL

1. Turn ignition off. Install BOB, leaving ECA disconnected. Unplug distributor connector. Measure resistance between BOB pin No. 34 and CID terminal on distributor harness connector. Repair Yellow wire between ECA and distributor if resistance is greater than 5 ohms. If resistance is less than 5 ohms, go to next step.
2. Turn ignition on. Measure voltage between distributor VPWR and GND wires. If voltage is greater than 10 volts, replace CID sensor. If voltage is not greater than 10 volts, repair distributor GND wire.

PINPOINT TEST KC - KNOCK CONTROL

NOTE: Enter this test only when directed here from QUICK TESTS.



92A25205

Fig. 6: Identifying KC Circuit & Connectors

1. Disconnect and plug vacuum hose at distributor. Connect timing light. Start engine. Unplug knock control service connector, located near ECA. If timing retards, service knock sensor and/or knock sensor wiring. If timing does not retard, go to next step.
2. Determine and record ignition timing setting. Tap intake plenum with plastic mallet. If timing does not retard, go to step 4). If timing retards, go to next step.
3. Reconnect knock control service connector, located near ECA. Determine and record ignition timing setting. Tap intake plenum with plastic mallet. If timing does not retard, knock control unit is okay; go to next step. If timing retards, replace knock control unit.
4. Turn ignition off. Unplug knock control service connector, located near ECA. Install a known good knock sensor. Start engine. Tap intake plenum with plastic mallet. If timing retards, replace knock sensor. If timing does not retard, go to next step.
5. Check VPWR and GND (Yellow/Green and Black/Yellow wires respectively) to knock control unit for shorts or open circuits. Service wires as necessary. If wires are okay, replace knock control unit.

PINPOINT TEST VSS - VEHICLE SPEED SENSOR

NOTE: Enter this test only when Code 06 is displayed during QUICK TESTS procedure or when directed here from another PINPOINT TEST.

VSS Circuit & Connector Identification

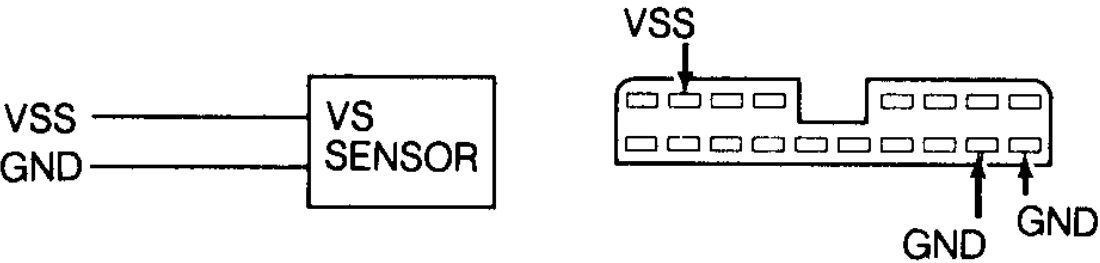


Fig. 7: Identifying VSS Circuit & Connectors

VSS CIRCUIT PIN IDENTIFICATION

Circuit	4EAT Pin	Wire Color
GND	1J	BLK
VSS	1P	GRN/RED

1. **Install 4EAT Tester** Leave 4EAT module disconnected. Disconnect speedometer cable at transaxle. Measure resistance between BOB VSS and GND test pins. Rotate speedometer cable. If resistance drops to less than 5 ohms 4 times for each revolution of speedometer cable, VSS is okay. Return to QUICK TESTS if sent here from there; otherwise, replace 4EAT module. If resistance does not drop as

specified, go to next step.

2. Unplug VSS connector at instrument cluster. Measure resistance between VSS and GND terminals on instrument cluster. Rotate speedometer cable. If resistance drops to less than 5 ohms 4 times for each revolution of speedometer cable, repair VSS signal wire to 4EAT. If resistance does not drop as specified, replace speedometer assembly.

PINPOINT TEST VAF - VANE AIRFLOW METER

NOTE: Enter this test only when a Code 08 is displayed during QUICK TESTS procedure, or when directed here from another PINPOINT TEST. To avoid unnecessary diagnostic time, check for unmetered air leaks between VAF meter and throttle body. This test is intended to diagnose only VAF and VREF circuits.

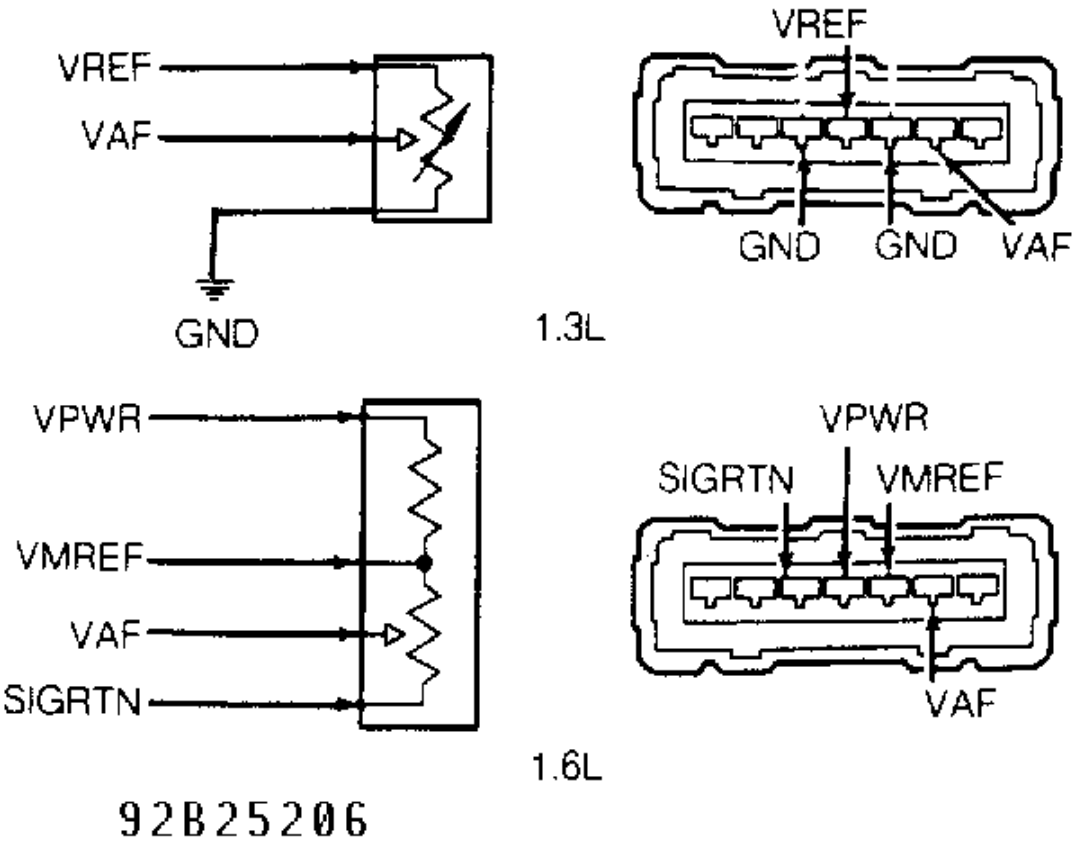


Fig. 8: Identifying VAF Meter Circuits

VAF CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
1.3L			
GND	2A	45	BLK
VAF	2O	25	WHT
VREF	2D	46, 49	BLK
1.6L			
SIGRTN	2C	46	BLK/YEL
VAF	2E	43	LT GRN/BLK
VMREF	2B	18	LT GRN/RED
VPWR	3I	37	YEL/GRN

1.3L

1. Turn ignition off. Install BOB. Turn on ignition. Measure voltage between VAF and ground pins while moving vane in VAF meter. Voltage should vary smoothly between .5-1.5 volts with door open, and 4.5-5.0 with door closed. If voltage is as specified, VAF meter is okay; return to QUICK TESTS if sent here from there. If not sent here from QUICK TESTS, replace ECA. If voltage is not as specified, go to next step.
2. Remove connector from VAF meter. Using jumper wires, connect VREF and ground terminals on VAF connector to corresponding terminals on VAF meter. Turn ignition on. Measure voltage between VAF terminal on VAF meter and ground terminal while moving vane in VAF meter. Voltage should vary smoothly between .5-1.5 volts with door open, and 4.5-5.0 with door closed. If voltage is correct, repair VAF circuit between ECA and VAF meter. If voltage is not as specified, go to next step.
3. Turn ignition off. Unplug VAF meter connector. Turn ignition on. Measure voltage between VREF and ground wires. If voltage is 4.5-5.5 volts, replace VAF meter. If voltage is not 4.5-5.5 volts, go to PINPOINT TEST VREF.

1.6L

1. Turn ignition off. Install BOB. Turn ignition on. Measure voltage between VAF and SIGRTN pins while moving vane in VAF meter. Voltage should be as specified in VAF METER VOLTAGE table. If voltage is not as specified, go to step 3). If voltage is as specified, go to next step.
2. Measure voltage between VMREF and SIGRTN test pins. If voltage is 7-9 volts, circuit is okay; return to QUICK TESTS if sent here from there. If not sent here from QUICK TESTS, replace ECA. If voltage is not as specified, repair VMREF wire to VAF.
3. Unplug connector from VAF meter. Using jumper wires, connect VPWR, VMREF, and SIGRTN terminals on VAF connector to corresponding terminals on VAF meter. Leave VAF wire disconnected. Measure voltage between VAF and SIGRTN pins on harness

connector while moving vane in VAF meter. Voltage should be as specified in **VAF METER VOLTAGE** table. If voltage is okay, repair VAF wire to ECA. If voltage is not okay, go to next step.

VAF METER VOLTAGE

Door Position	Volts
1/8 Open	3.24
1/4 Open	5.60
3/8 Open	5.62
1/2 Open	5.83
5/8 Open	6.02
3/4 Open	6.57
7/8 Open	7.46
Full Open	7.87

4. Unplug connector from VAF. Using jumper wires, connect VPWR and SIGRTN terminals on VAF connector to corresponding terminals on VAF meter. Leave VAF and VMREF wires disconnected. Measure voltage between VAF terminal at VAF meter, and SIGRTN pin at harness connector while moving vane in VAF meter. Voltage should be as specified in **VAF METER VOLTAGE** table. If voltage is okay, repair VMREF wire to ECA. If voltage is not okay, go to next step.
5. Unplug connector from VAF meter. Turn ignition on. Measure voltage between SIGRTN and VPWR wire. If voltage is more than 10 volts, replace VAF meter. If voltage is not more than 10 volts, go to next step.
6. Unplug VAF meter connector. Turn ignition on. Measure voltage between VAF meter VPWR wire and ground. If voltage is more than 10 volts, repair VAF wire to ECA. If voltage is not more than 10 volts, go to PINPOINT TEST VPWR.

PINPOINT TEST ECT - ENGINE COOLANT TEMPERATURE SENSOR

NOTE: Enter this test only when a Code 09 is displayed during QUICK TESTS procedure or when directed here from another PINPOINT TEST. To prevent unnecessary diagnosis, inspect coolant level, oil level, cooling fan, thermostat, and airflow to radiator before testing.

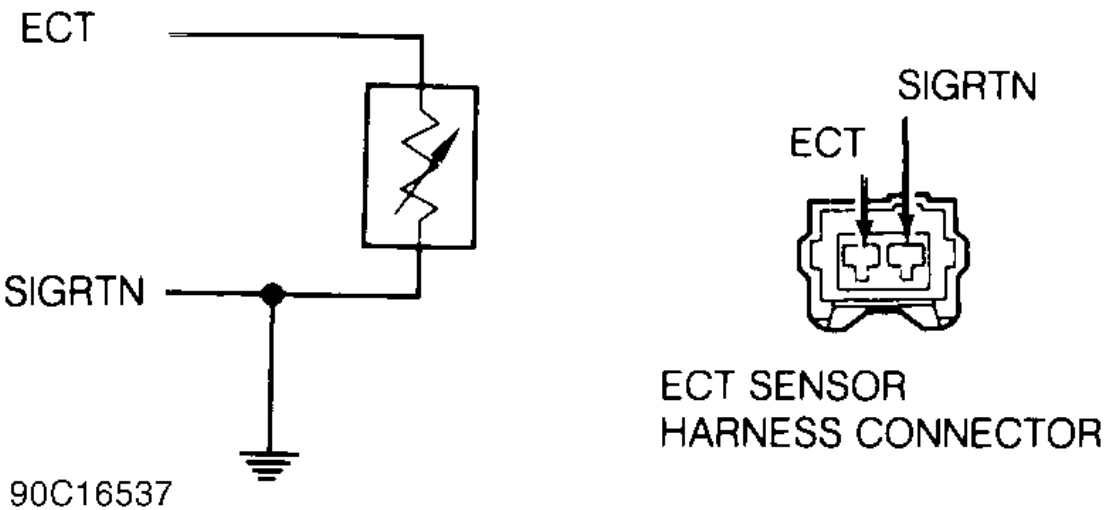


Fig. 9: Identifying ECT Sensor Circuits

ECT CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
1.3L			
ECT	2Q	7	RED/BLU
GND	(1)	(1)	BLK
1.6L			
ECT	2I	7	BLU/RED
SIGRTN	2C	46	BLU/YEL
(1) Not specified.			

1.3L

1. Turn ignition off. Install BOB. Leave ECA disconnected. Unplug ECT connector. Check for continuity between ECT test pin and ECT terminal (Red/Blue wire) on ECT harness connector. If continuity does not exist, repair ECT wire between ECA and ECT sensor. If continuity exists, go to next step.
2. Unplug ECT sensor. Check for continuity between Black wire at ECT sensor and ground. If continuity does not exist, repair Black wire between ECT sensor and ground. If continuity exists, go to next step.
3. Reconnect ECA. Measure resistance between BOB ECT test pin and ground pin. If resistance is 500-1000 ohms, replace ECA. If resistance is not 500-1000 ohms, replace ECT sensor.

1.6L

1. Turn ignition off. Install BOB. Leave ECA disconnected. Unplug ECT connector. Check for continuity between ECT test pin and ECT terminal (Blue/Red wire) on ECT harness connector. If continuity does not exist, repair ECT wire between ECA and ECT sensor. If

continuity exists, go to next step.

2. Install BOB. Connect ECT. Warm engine to normal operating temperature. Measure resistance between ECT test pin and SIGRTN pins. If resistance is 500-1000 ohms, replace ECA. If resistance is not 500-1000 ohms, replace ECT sensor.

PINPOINT TEST VAT - VANE AIR TEMPERATURE SENSOR

NOTE: Enter this test only when a Code 10 is displayed during QUICK TESTS procedure or when directed here from another PINPOINT TEST. Ambient temperature must be higher than 50°F (10°C) for this test.

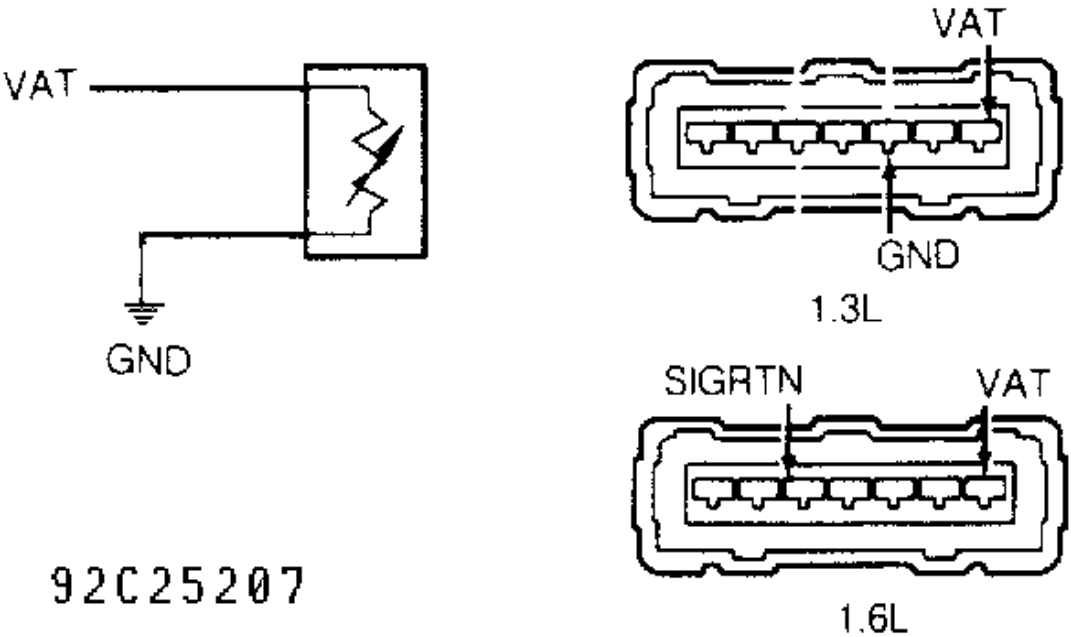


Fig. 10: Identifying VAT Circuits

VAT CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
1.3L			
GND	2A	46, 49	BLK
VAT	2P	45	GRN/BLK
1.6L			
SIGRTN	2C	46,49	BLU/YEL
VAT	2J	25	BRN/YEL

1. Turn ignition off. Ensure engine is at operating temperature. With ignition off, install BOB. Turn ignition on. Measure temperature near VAT sensor. Measure voltage between VAT and SIGRTN test pins. Compare voltage to specifications shown in VAT SENSOR VOLTAGE table. If voltage is within specification, VAT circuit is okay. If voltage is not within specification, go to next step.

VAT SENSOR VOLTAGE

Temperature °F (°C)	(1) Volts
20 (-6)	3.64
30 (-1)	3.36
40 (4)	3.05
44 (7)	2.79
50 (10)	2.29
60 (16)	2.61
70 (21)	2.35
80 (27)	2.05
90 (32)	1.76
100 (38)	1.57
(1) Values may vary by 15 percent.	

2. Turn ignition off. Disconnect ECA. Measure resistance between VAT and SIGRTN test pins. Measure temperature near VAF meter. Compare resistance to specifications shown in VAT SENSOR RESISTANCE table. If resistance is within specification, go to next step. If resistance is not within specification, go to step 4).
3. Unplug VAF sensor connector. Measure resistance between VAT test pin and all other test pins. If any resistance is less than 5 ohms, repair VAT wire from ECA to VAF meter. If all measurements are greater than 5 ohms, replace ECA.
4. Turn ignition off. Unplug VAF meter connector. Monitor temperature near VAT sensor. Measure resistance between VAF meter VAT and SIGRTN terminals. Compare resistance to specifications shown in VAT SENSOR RESISTANCE table while heating VAT sensor . If resistance is within specification, repair VAT and/or SIGRTN wires from VAF to ECA. If resistance is not within specification, replace VAF meter.

VAT SENSOR RESISTANCE

--	--

Temperature °F (°C)	Ohms
-4 (-23)	15,000
32 (0)	5210
68 (20)	2500
104 (40)	1100
140 (60)	600
176 (80)	300

PINPOINT TEST TP - THROTTLE POSITION SENSOR

NOTE: Enter this test only when a Code 12 is displayed during QUICK TESTS procedure or when directed here from another PINPOINT TEST.

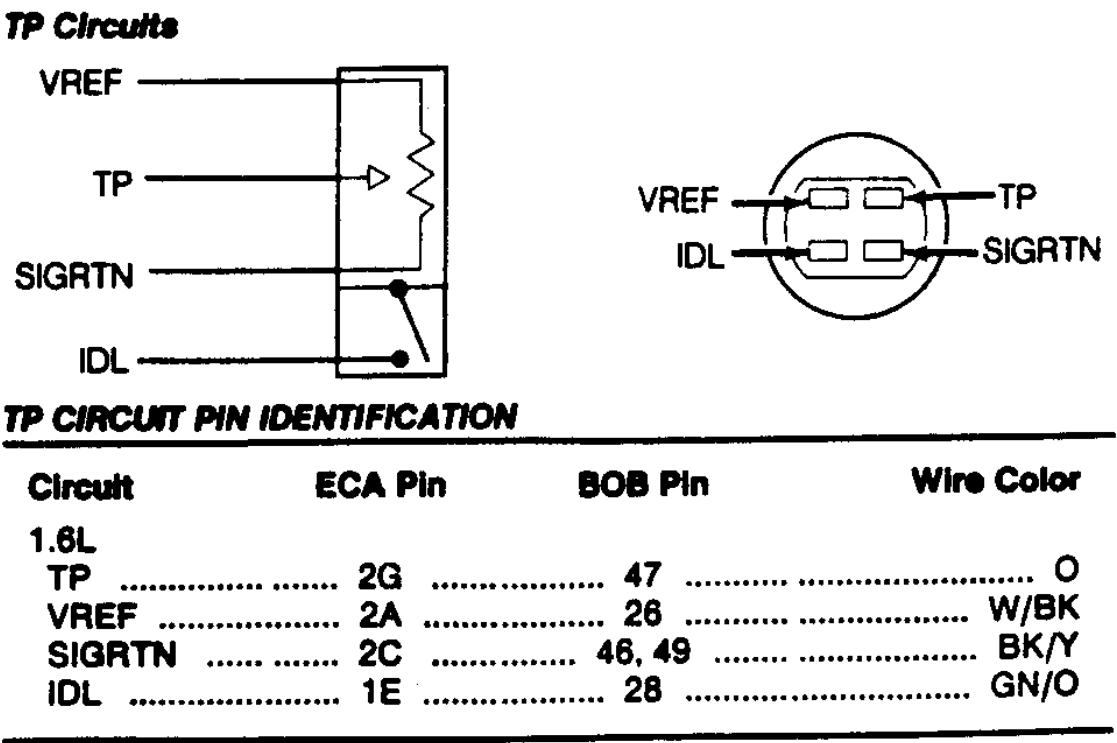


Fig. 11: Identifying TP Circuits

TP CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
1.6L			
IDL	1E	28	GRN/ORG
SIGRTN	2C	46, 49	BLK/YEL
TP	2G	47	ORG
VREF	2A	26	WHT/BLK

1.6L

1.
- Turn ignition off. Install BOB. Turn ignition on. Measure voltage between BOB test pins TP and SIGRTN while opening throttle. Compare voltage to specification in [TP SENSOR OUTPUT VOLTAGE](#) table. Go to next step if output voltage is not within specification.

TP SENSOR OUTPUT VOLTAGE

Throttle Opening	⁽¹⁾ Voltage
1/8	1.00
1/4	1.60
3/8	2.37
1/2	2.74
5/8	3.15
3/4	3.43
7/8	3.60
(1) Voltage may vary by 15 percent.	

2.
- Turn ignition off. Unplug TP sensor connector at throttle body. Using jumper wires, connect VREF and SIGRTN wires on harness

- connector to corresponding terminals on TP sensor connector. Turn ignition on. Measure voltage between TP and SIGRTN terminals on TP sensor while opening throttle. Compare voltage to specification in [TP SENSOR OUTPUT VOLTAGE](#) table. If voltage is within specification, repair TP wire to ECA. Go to next step if voltage is not within specification.
- Turn ignition off. Unplug TP harness connector. Turn ignition on. Measure voltage between VREF and SIGRTN wires on TP harness connect-or. If voltage is 4-5 volts, replace TP sensor. If voltage is not 4.5-5.5 volts, go to next step.
 - Measure voltage between VREF wire on TP harness connector and ground. If voltage is 4-5 volts, adjust or replace throttle position sensor. If voltage is not 4-5 volts, go to [PINPOINT TEST VREF](#) .

PINPOINT TEST BP - BAROMETRIC PRESSURE SENSOR

NOTE: Enter this procedure only when a Code 14 is displayed during QUICK TESTS procedure or when directed here from another PINPOINT TEST. To prevent unnecessary replacement of components, note following non-EEC items may be at fault: unusually high or low atmospheric pressure, blocked vacuum lines, or basic mechanical engine components.

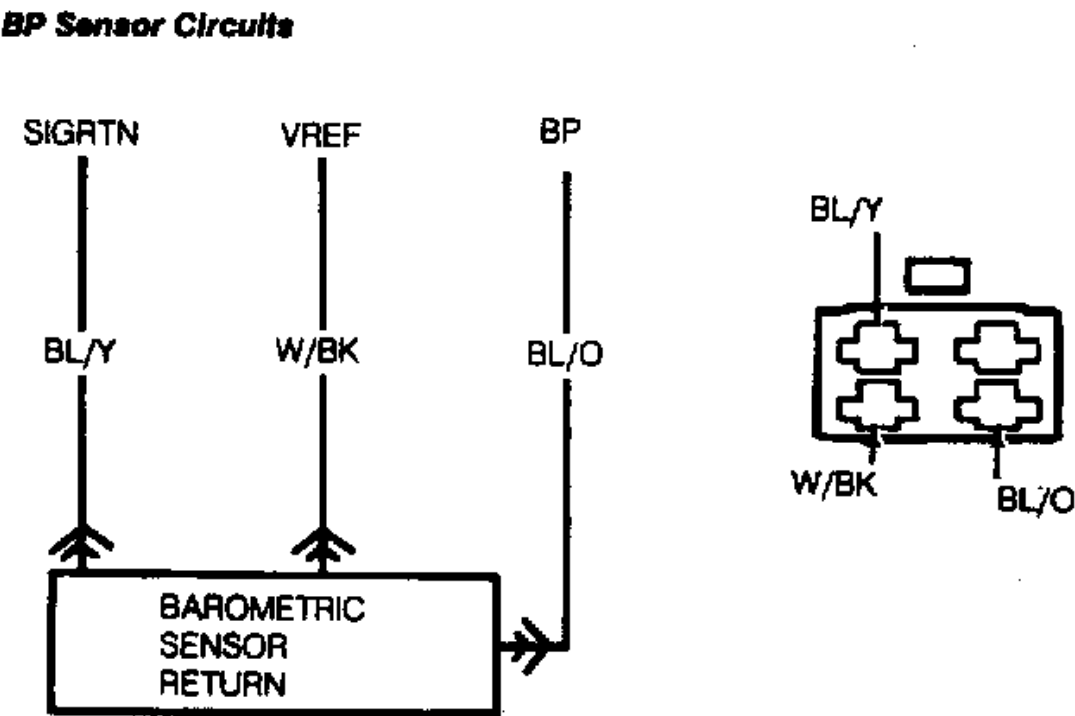


Fig. 12: Identifying BP Sensor Circuits

- 1.3L**
- BP sensor is incorporated into ECA; it cannot be checked or serviced separately. If Code 14 is set and cannot be cleared, replace ECA.
- 1.6L**
- Turn ignition off. Connect BOB. Remove dust cover from BP sensor, located on passenger side cowl. Turn ignition on. Connect vacuum pump to BP sensor. Measure voltage between pins BP and SIGRTN on BOB while applying vacuum to BP sensor. See [BAROMETRIC PRESSURE SENSOR OUTPUT VOLTAGE](#) table. Replace BP sensor if voltage is not as specified.

BAROMETRIC PRESSURE SENSOR OUTPUT VOLTAGE

Vacuum (In. Hg.)	(1) Voltage
0	3.84
5	3.36
10	2.66
15	1.93
20	1.26
25	.58
(1) Voltage may vary by 15 percent.	

PINPOINT TEST EGO - EXHAUST GAS OXYGEN SENSOR

NOTE: Enter this test only when a Code 15 (lean) or Code 17 (rich) is displayed during QUICK TESTS procedure.

EGO CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
EGO			
1.3L	2N	29	BLU
1.6L	2D	29	BLK

- Warm engine to operating temperature, and let idle. Unplug EGO sensor. Measure voltage between EGO sensor connector (sensor side)

and ground. With engine at idle, voltage should fluctuate between 0.2-0.8 volt.

2. Increase and decrease engine speed while reading voltmeter. When engine speed is decreasing, voltage should decrease. When engine speed is increasing, voltage should increase. If voltage is within specification, go to next step. If voltage is not within specification, replace EGO sensor.
3. With ignition off, install BOB. Leave ECA disconnected. Unplug EGO sensor connector. Measure continuity between EGO test pin and EGO sensor connector wire. If continuity exists, EGO circuit is okay; return to QUICK TESTS if sent here from there. If not sent here from QUICK TESTS, replace ECA. If voltage is not as specified, repair VMREF wire to VAF. If continuity does not exist, service EGO sensor wire to ECA.

PINPOINT TEST PRC - FUEL PRESSURE REGULATOR CONTROL SOLENOID

NOTE: Enter this test only when a Code 25 is displayed during QUICK TESTS procedure or when directed here from another PINPOINT TEST.

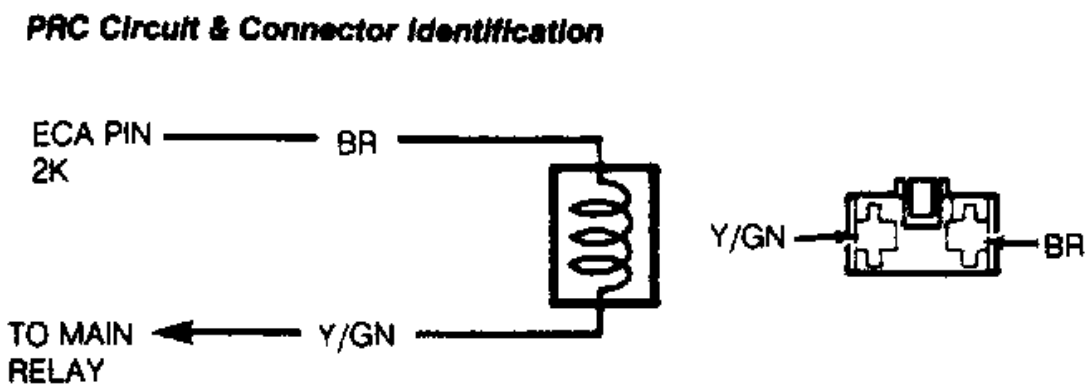


Fig. 13: Identifying PRC Circuit & Connector

PRC CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
PRC (1.6L)	2K	31	BRN

1. Locate Fuel Pressure Control (PRC) solenoid on cowl panel, next to canister purge solenoid. Unplug PRC solenoid connector. Remove both vacuum lines. Plug vacuum port from engine vacuum source. Apply vacuum to remaining port. Replace PRC solenoid if it does not hold vacuum.
2. Turn ignition off. Connect BOB. Leave ECA disconnected. Reconnect wiring to PRC solenoid. Turn ignition on. Apply vacuum to PRC solenoid. Connect jumper wire between PRC test pin on BOB and ground. If vacuum drops to zero, PRC solenoid function is okay. Return to QUICK TESTS if sent here from there. If vacuum does not drop to zero, go to next step.
3. Turn ignition off. Unplug PRC solenoid connector. Turn ignition on. Measure voltage between VPWR wire on harness connector and ground. If voltage is not higher than 10 volts, repair VPWR wire to main relay. If voltage is higher than 10 volts, go to next step.
4. Turn ignition off. Unplug PRC solenoid connector. Turn ignition on. Measure voltage between solenoid connector VPWR wire and solenoid connector SIG wire. Connect jumper wire between PRC test pin on BOB and ground. If voltage is higher than 10 volts only when solenoid is activated, replace solenoid. If voltage is not higher than 10 volts only when solenoid is activated, go to next step.
5. Turn ignition off. Connect BOB. Leave ECA disconnected. Unplug solenoid connector. Measure resistance between SIG test pin and solenoid connector SIG wire. If resistance is not less than 5 ohms, repair SIG wire to ECA. If resistance is less than 5 ohms, go to next step.
6. Turn ignition off. Connect BOB. Leave ECA disconnected. Unplug solenoid connector. Measure resistance between SIG test pin and all other test pins. If resistance between SIG PRC test pin and any other pin is less than 5 ohms, repair PRC wire to ECA. If resistance between PRC test pin and any other pin is greater than 10,000 ohms, replace ECA.

PINPOINT TEST CANP - CANISTER PURGE CONTROL SOLENOID

NOTE: Enter this test only when a Code 26 is displayed during QUICK TESTS procedure or when directed here from another PINPOINT TEST.

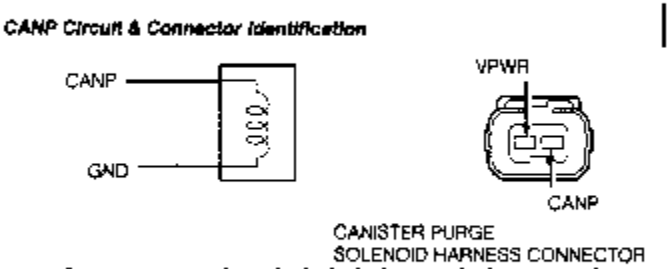


Fig. 14: Identifying CANP Circuit & Connector

CANP CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
CANP			
1.3L	2X	31	RED
1.6L	2P	32	YEL

1. Turn ignition off. Install BOB. Leave ECA disconnected. Turn ignition on. Remove canister purge hose from intake manifold, and apply vacuum. Connect a jumper wire between CANP test terminal and ground. If vacuum releases, solenoid is okay. If vacuum does not release, go to next step.
2. Locate CANP solenoid near center of cowl panel. Unplug solenoid connector. Apply vacuum to port from engine vacuum source. Replace CANP solenoid if it does not hold vacuum.
3. Connect BOB. Leave ECA disconnected. Reconnect wiring to CANP solenoid. Turn ignition on. Apply vacuum to CANP solenoid. Connect jumper wire between CANP test pin on BOB and ground. If vacuum drops to zero, solenoid function is okay. Return to QUICK TESTS if sent here from there. If vacuum does not drop to zero, go to next step.
4. Turn ignition off. Unplug CANP solenoid connector. Turn ignition on. Measure voltage between VPWR wire on harness connector and ground. If voltage is not higher than 10 volts, repair VPWR wire to main relay. If voltage is higher than 10 volts, go to next step.
5. Turn ignition off. Unplug CANP solenoid connector. Turn ignition on. Measure voltage between solenoid connector VPWR wire and solenoid connector SIG wire. Connect jumper wire between CANP test pin on BOB and ground. If voltage is higher than 10 volts only when solenoid is activated, replace solenoid. If voltage is not higher than 10 volts only when solenoid is activated, go to next step.
6. Turn ignition off. Connect BOB. Leave ECA disconnected. Unplug CANP solenoid connector. Measure resistance between SIG test pin and solenoid connector SIG wire. If resistance is not less than 5 ohms, repair SIG wire to ECA. If resistance is less than 5 ohms, go to next step.
7. Turn ignition off. Connect BOB. Leave ECA disconnected. Unplug solenoid connector. Measure resistance between SIG test pin and all other test pins. If resistance between SIG PRC test pin and any other pin is less than 5 ohms, repair CANP wire to ECA. If resistance between CANP test pin and all other pins is greater than 10,000 ohms, replace ECA.

PINPOINT TEST ISC - IDLE SPEED CONTROL

NOTE: Enter this test only when a Code 34 is displayed during QUICK TESTS procedure or when directed here from another PINPOINT TEST.

ISC Circuit & Connector Identification

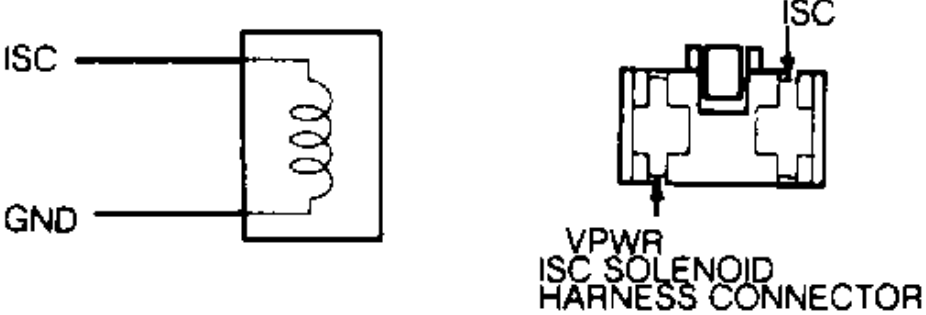


Fig. 15: Identifying ISC Circuit & Connector

ISC CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
ISC			
1.3L	2W	41	RED/BLK
1.6L	2Q	41	GRN

1. Install BOB, leaving ECA disconnected. Turn ignition on. Connect a jumper between BOB test pin No. 41 and ground. Listen for clicking sound from solenoid, mounted on throttle body. If clicking sound occurs, ISC solenoid is okay; return to QUICK TESTS if sent here from there. If no clicking sound occurs, go to next step.
2. Unplug ISC solenoid connector. With ignition on, measure voltage between VPWR wire and ground. If voltage is less than 10 volts, repair VPWR wire to main relay. Go to next step if voltage is not less than 10 volts.
3. Measure voltage between ISC solenoid VPWR wire and solenoid connector SIG wire while cranking engine. Replace solenoid if voltage is more than 10 volts only when engine is cranking. If okay, go to next step.
4. With BOB installed and ECA disconnected, unplug ISC solenoid connector. Check for continuity between BOB SIG test pin and ISC connector SIG wire. If resistance is not less than 5 ohms, repair ISC wire between solenoid and ECA. If okay, go to next step.
5. With BOB installed and ECA disconnected, measure resistance between BOB SIG test pin and all other test pins. If resistance is less than 5 ohms, repair short in SIC wire to ECA. If resistance is not less than 5 ohms, replace ECA.

PINPOINT TEST STI - SELF-TEST INPUT

NOTE: Enter this test only when sent here from QUICK TESTS.

STI CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
STI			
1.3L	1K	48	YEL/GRN
1.6L	1W	48	YEL

1. Turn ignition off. Install BOB. Leave ECA disconnected. Connect test light between STI test pin on BOB and 12-volt source. If test light comes on, go to [PINPOINT TEST STO](#) . If light does not come on, go to next step.
2. Leave test light connected. Ground STI connector. If test light does not come on, repair open circuit between STI connector and ECA.

PINPOINT TEST STO - SELF-TEST OUTPUT

NOTE: Enter this test only when codes cannot be retrieved or when directed by PINPOINT TEST STI.

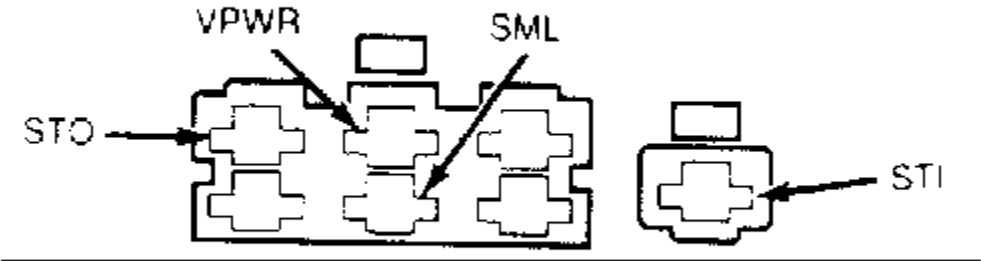


Fig. 16: Identifying STI & STO Circuit & Connector

STO CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
STO			
1.3L	1F	17	YEL/WHT
1.6L	1B	17	GRN/BLK

1. Turn ignition off. Install BOB. Leave ECA disconnected. Measure resistance between STO test pin and STO terminal of self-test connector. If resistance is greater than 5 ohms, repair circuit between ECA and self-test connector. If resistance is less than 5 ohms, go to next step.
2. Measure resistance between STO test pin and all other test pins. If resistance between STO test pin and any other test pin is less than 5 ohms, repair short in STO wire to diagnostic connector. If resistance is greater than 5 ohms, go to [PINPOINT TEST PGC](#) .

PINPOINT TEST PGC - POWER & GROUND CONNECTIONS

NOTE: Enter this test only when directed here from QUICK TESTS or another PINPOINT TEST.

PGC CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
1.3L			
GND	2A	39, 40, 44, 60	BLK
GND	2B	20	BLK
GND	2C	16	BLK
GND	2D	46, 49	BLK
KAPWR	1A	1	(1) WHT/RED
MT/AT (2)	2J	6	BLK
1.6L			
GND	2R	49	BLK
GND	3A	20	BLK
GND	3G	40	BLK
KAPWR	3J	1	(1) BLU/RED
(1) Battery voltage.			
(2) Manual transmission only.			

1. Turn ignition off. Install BOB, leaving ECA disconnected. Turn ignition on. Measure voltage at BOB pin in question. Compare voltage to specification in [PGC CIRCUIT PIN IDENTIFICATION](#) table. If voltage is not to specification, repair wire in question.
2. Measure resistance between ground and BOB pin in question. If any measurement is greater than 5 ohms, repair associated wire to ground. If resistance is less than 5 ohms, return to [PINPOINT TEST VREF](#) if sent here from there, and replace ECA. If not sent here from PINPOINT TEST VREF, return to diagnostic routine.

PINPOINT TEST STG - SWITCH TO GROUND

NOTE: Enter this test only when directed here from QUICK TESTS or another PINPOINT TEST.

STG CIRCUIT PIN IDENTIFICATION

Switch	ECA Pin	BOB Pin	Wire Color
1.3L			
ACS	1Q	10	BLU/RED
BLMT	1S	23	GRN
IDL	1N	18	YEL/BLK
NGS/CES (1)	1V	43	BLU/WHT
PSPS	1P	19	PNK
WOT	2L	27	YEL
1.6L			
BPS (2)	2L	12	LT GRN/BLK
IDL	1E	18	GRN/ORG
NGS/CES (1)	1G	8	RED/BLU
PSPS	1K	19	GRN/RED
(1) Manual transmission only.			
(2) Turbo only.			

NOTE: For 1.3L, blower motor resistor must be disconnected, HEATER fuse must be removed, and blower motor switch must be in position "1" when testing ACS signal.

1. Turn ignition off. Install BOB, leaving ECA disconnected. Measure resistance between switch BOB test pin and ground. Cycle switch. If resistance is greater than 10,000 ohms with switch open and less than 5 ohms when switch is closed, switch is okay; go to step 4). If resistance is not greater than 10,000 ohms with switch open, or greater than 5 ohms when switch is closed, go to next step.
2. Turn ignition off. Disconnect switch. Connect ohmmeter between switch terminals on 2-pin switches, or between ground and switch ECA terminal on multi-pin or one-pin switches. Cycle switch. If resistance is not greater than 10,000 ohms with switch open, or is greater than 5 ohms when switch is closed, replace switch. If resistance is greater than 10,000 ohms with switch open and less than 5 ohms when switch is closed, switch is okay; go to next step.
3. Turn ignition off. Install BOB, leaving ECA disconnected. Measure resistance between BOB pin for suspected switch and BOB pins 26, 37, 57, and 60. If any measurement is less than 10,000, repair shorted wire in question. If all measurements are greater than 10,000 ohms, go to next step.
4. Turn ignition off. Install BOB, leaving ECA disconnected. Measure resistance between BOB pin for suspected switch and switch connector. If resistance is greater than 5 ohms, repair wire in question. If sent here from SWITCH MONITOR TEST in QUICK TESTS, replace ECA; otherwise, return to QUICK TESTS.

PINPOINT TEST STP - SWITCH TO POWER

NOTE: Enter this test only when directed here from QUICK TESTS.

STP CIRCUIT PIN IDENTIFICATION

Switch	ECA Pin	BOB Pin	Wire Color
1.3L			
ACS	1Q	10	GRN
BOO	1O	2	GRN/RED
DEF	1T	30	BLK/BLU
Fan	1R	22	YEL/RED
HLDT	1U	28	WHT
VST	1C	5	BLK/RED
1.6L			
BOO	1J	3	WHT/GRN
VST	3B	5	BLK/RED

1. Turn ignition off. Install BOB, leaving ECA disconnected. Turn ignition on. Cycle switch in question. Measure voltage between switch BOB test pin and ground. If voltage changes from less than 4 volts to more than 10 volts, switch is okay. If sent here from SWITCH MONITOR TEST in QUICK TESTS, replace ECA. If sent here from elsewhere in QUICK TESTS, return to QUICK TESTS. If voltage is not as specified, go to next step.
2. Turn ignition on. Measure voltage at switch in question on wire to ECA. Cycle switch. If voltage changes from less than 4 volts to more than 10 volts, repair wire from switch to ECA. If voltage does not change from less than 4 volts to more than 10 volts, go to next step.
3. Turn ignition on. Install BOB, leaving ECA disconnected. Measure resistance between BOB test pin for switch in question and ground and between BOB test pin and BOB pins 37, 57, and 26. If resistance is greater than 10,000 ohms for all measurements, go to next step. If resistance is not greater than 10,000 ohms for all measurements, repair wire to switch.
4. Disconnect switch. Measure resistance between switch terminals. Cycle switch. If resistance is less than 5 ohms with switch closed and greater than 10,000 ohms with switch open, switch is okay. If sent here from SWITCH MONITOR TEST in QUICK TESTS, return to QUICK TESTS. If sent here from elsewhere in QUICK TESTS, replace ECA. If resistance is not as specified, replace switch.

PINPOINT TEST VPWR - VEHICLE POWER

NOTE: Enter this test only when directed here from another PINPOINT TEST. To prevent replacement of good components, note following non-EEC components may be faulty: ignition switch, alternator, battery cables, ground straps, or voltage regulator. This test is intended to diagnose only ECA, wiring harness circuits, and battery voltage.

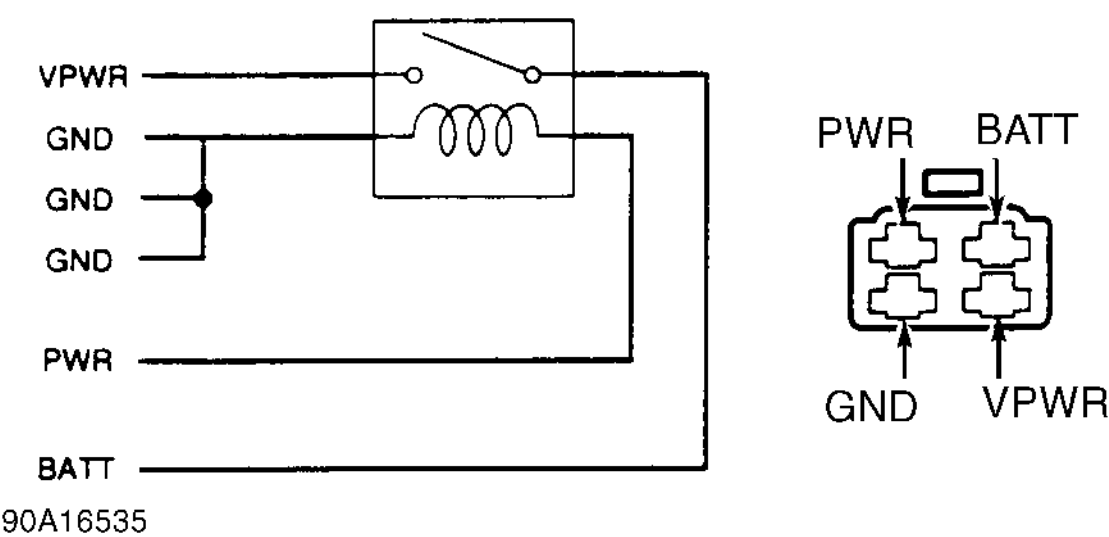


Fig. 17: Identifying VPWR Circuit & Connector

VPWR CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
1.3L			
GND	2A	39, 40, 44, 60	BLK
GND	2B	20	BLK
GND	2C	16	BLK
VPWR	1B	37, 57	YEL/BLK
1.6L			
GND	2R	49	BLK
GND	3A	20	BLK
GND	3G	40	BLK
VPWR	3I	37	YEL/GRN

1. Turn ignition off. Install BOB, leaving ECA disconnected. Turn ignition on. Measure voltage between VPWR test pin and battery ground. If voltage is not greater than 10 volts, go to step 3). If voltage is greater than 10 volts, go to next step.
2. Measure voltage between VPWR test pin and GROUND test pin. If voltage is greater than 10 volts, go to next step. Repeat measurement for each ECA ground wire. If all voltages are greater than 10 volts, go to [PINPOINT TEST VREF](#) . If all voltages are not greater than 10 volts, repair ECA ground wire in question.
3. Turn ignition off. Locate main power relay. On Capri, relay is located on left side of engine compartment. On Festiva, relay is located at left front of engine compartment. Disconnect main power relay 4-wire connector. Using jumper wires, connect BATT, PWR, and GND terminals of relay to corresponding trammels on connector. Leave VPWR wire disconnected.
4. Turn ignition on. Measure voltage between main power relay VPWR terminal (where VPWR wire was) and ground. If voltage is more than 10 volts, repair VPWR circuit between main power relay and ECA. If voltage is not more than 10 volts, go to next step.
5. Unplug main relay connector. Measure voltage between harness connector BATT wire and ground. If voltage is not greater than 10 volts, repair BATT wire from battery to harness connector. If voltage is greater than 10 volts, go to next step.
6. Unplug main relay connector. Measure voltage between harness connector PWR wire and ground. If voltage is not greater than 10 volts, repair PWR wire from ignition switch to harness connector. If voltage is greater than 10 volts, go to next step.
7. Measure voltage between main power relay BATT wire and main power relay GROUND wire. If voltage is less than 10 volts, repair main power relay ground wire. If voltage is not less than 10 volts, ground circuit is okay; replace main power relay.

PINPOINT TEST VREF - REFERENCE VOLTAGE & SIGNAL RETURN

NOTE: Enter this test only when directed from another PINPOINT TEST.

REFERENCE VOLTAGE & SIGNAL RETURN

NOTE: Enter this test only when directed from another PINPOINT TEST.

Reference Voltage Circuit & Connector Identification

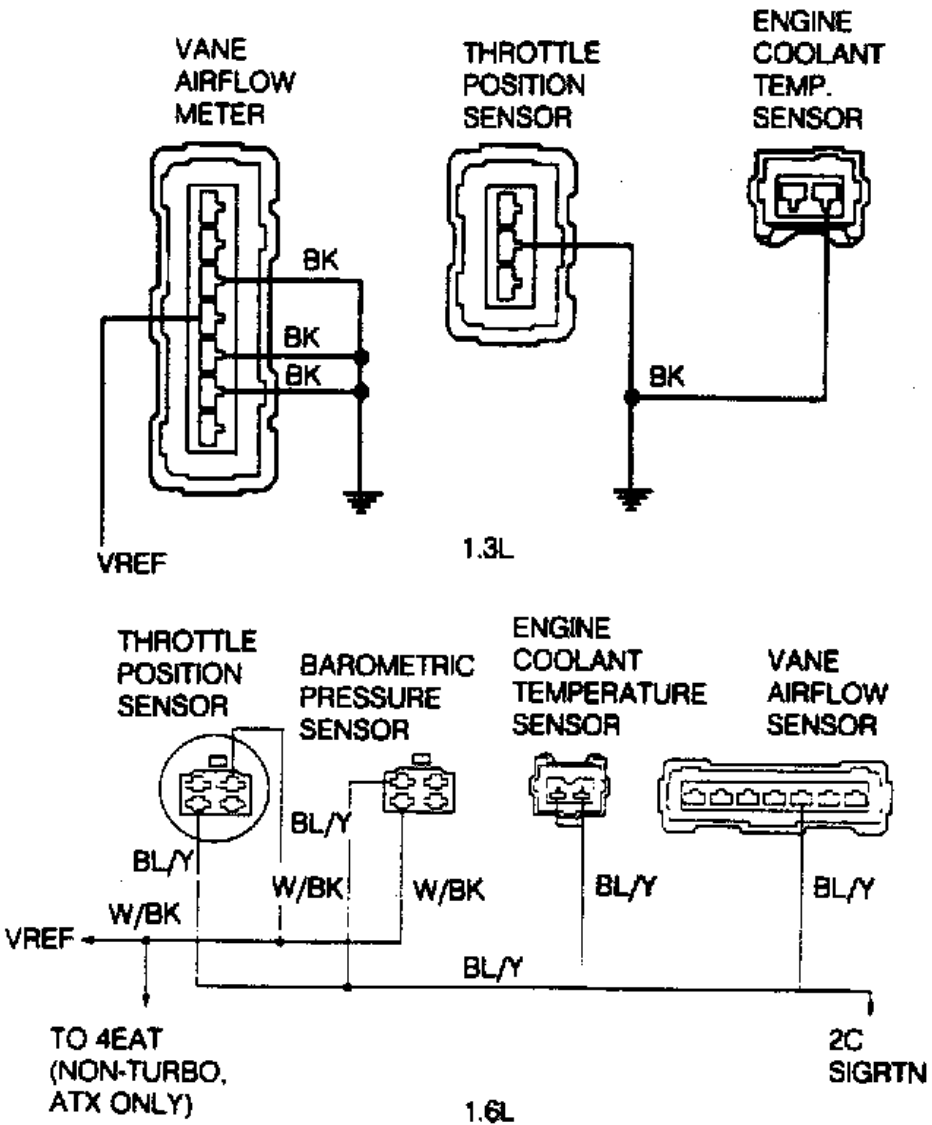


Fig. 18: Identifying VREF Circuit & Connector

VREF CIRCUIT PIN IDENTIFICATION

Circuit	ECA Pin	BOB Pin	Wire Color
1.3L			
SIGRTN	2D	46, 49	BLK
VREF	2K	26	WHT/BLK
1.6L			
SIGRTN	2C	46	BLU/YEL
VREF	2A	26	WHT/BLK

- On 1.3L, go to next step. On 1.6L, turn ignition on. Measure voltage between throttle position switch VREF and SIGRTN wires. See [VREF CIRCUIT PIN IDENTIFICATION](#) table. If voltage is 10-12 volts, repair short to voltage. If voltage is zero volts, go to next step.
- Turn ignition on. On 1.3L, measure voltage between Black and White-Black wires at VAF sensor. On 1.6L, measure voltage between White-Black and Blue/Yellow wires at BP sensor. If voltage is 4-5 volts, VREF circuit is okay. If voltage is zero volts, go to next step. If voltage is 10-12 volts, repair short to voltage.
- Turn ignition off. Install BOB. Install 4EAT tester (if vehicle is equipped with 4EAT transaxle). Unplug connector from VAF, TP, and BP sensors as applicable to vehicle. Measure resistance between VREF terminals on ECA and 4EAT module. Also measure resistance between ECA VREF terminal and TP, BP, and VAF VREF harness connector terminals. If any measurement is greater than 5 ohms, repair wire in question. If resistance is less than 5 ohms for all measurements, go to next step.
- Turn ignition off. Disconnect 4EAT module (if equipped). Unplug connector from VAF, TP, and BP sensors as applicable to vehicle. Measure resistance between ECA VREF pin on BOB and ground. If resistance is not greater than 10,000 ohms, repair short in VREF circuit. If resistance is greater than 10,000 ohms, go to next step.
- Turn ignition off. Disconnect ECA. Unplug connector from VAF, TP, and BP sensors as applicable to vehicle. Measure resistance between ECA SIGRTN, 4EAT, and all SIGRTN pins on BOB. If any measurement is greater than 5 ohms, repair wire in question. If resistance is less than 5 ohms for all measurements, go to next step.
- Turn ignition off. Install BOB. Connect ECA. Connect 4EAT module (if equipped). Turn ignition on. Measure voltage at ECA SIGRTN test pin on BOB. If voltage is 0-1 volt, go to [PINPOINT TEST PGC](#) . If voltage is not 0-1 volt, repair short to voltage on SIGRTN circuit.

SUMMARY

If no hard codes, or only pass codes, are present, and driveability symptoms or intermittent codes still exist, proceed to TESTS W/O CODES article in the ENGINE PERFORMANCE Section for diagnosis by symptom (i.e., ROUGH IDLE, NO START, etc.) or intermittent diagnostic procedures.

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H - TESTS W/O CODES

1991-92 ENGINE PERFORMANCE Ford Motor Co. Trouble Shooting - No Codes

INTRODUCTION

Before diagnosing symptoms or intermittent faults, perform steps in BASIC TESTING and TESTS W/CODES articles in the ENGINE PERFORMANCE Section. Use this article to diagnose driveability problems existing when a hard fault code is not present or vehicle is not equipped with a self-diagnostic system.

NOTE: **Some driveability problems may have been corrected by manufacturer with a revised computer calibration chip or computer control unit. Check with manufacturer for latest chip or computer application.**

Symptom checks can direct the technician to malfunctioning component(s) for further diagnosis. A symptom should lead to a specific component, system test or adjustment.

Use intermittent test procedures to locate driveability problems which DO NOT occur when the vehicle is being tested. These test procedures should also be used if a soft (intermittent) trouble code was present but no problem was found during self-diagnostic testing.

NOTE: **For specific testing procedures, see SYSTEM/COMPONENT TESTS article in the ENGINE PERFORMANCE Section. For specifications, see ADJUSTMENTS or SPECIFICATIONS article in the ENGINE PERFORMANCE Section.**

SYMPTOMS

SYMPTOM DIAGNOSIS

Symptom checks cannot be used properly unless problem occurs while vehicle is being tested. To reduce diagnostic time, ensure steps in BASIC TESTING and TESTS W/CODES articles in the ENGINE PERFORMANCE Section were performed before diagnosing a symptom. These symptoms are available for diagnosis.

- Backfire through induction or exhaust.
- Dieseling (run-on).
- Lack of power.
- Spark knock (pinging).
- Stalls/quits.
- Stumble/hesitation during acceleration.
- Misses/surges.
- Idle is fast/slow return to idle.
- Idle is rough.
- Engine speeds up.
- Cranks normally/no start.
- Cranks normally/slow to start.
- Poor fuel economy.
- Exhaust smoke/odor.
- Fuel odor/leaks.
- Fails emission test.

BACKFIRE THROUGH INDUCTION OR EXHAUST

- Check vane airflow meter.
- Check idle speed control solenoid.

DIESELING (RUN-ON)

- Check idle speed control solenoid.

LACK OF POWER

- Check vane airflow meter.
- Check throttle position switch.
- Check heated exhaust gas oxygen sensor.
- Check A/C switch.
- Check wide open throttle A/C (WAC) relay.

SPARK KNOCK (PINGING)

- Verify ignition timing is correct.
- Check vane airflow meter.

STALLS/QUITS

- Check vane airflow meter.
- Check idle speed control solenoid.
- Check pressure regulator control solenoid.
- Check heated exhaust gas oxygen sensor.
- Check engine coolant temperature sensor.
- Check A/C load control solenoid.

STUMBLE/HESITATION DURING ACCELERATION

- Check throttle position switch.
- Check vane airflow meter.
- Check canister purge solenoid.
- Check heated exhaust gas oxygen sensor.
- Check wide open throttle A/C (WAC) relay.
- Check A/C thermostatic switch.

MISSES/SURGES

- Check exhaust gas oxygen sensor.
- Check throttle position switch.
- Check vane airflow meter.
- Check wide open throttle vacuum switch.
- Check A/C load control solenoid.
- Check engine coolant temperature sensor.

IDLE IS FAST/SLOW RETURN TO IDLE

- Check idle speed control solenoid.
- Check by-pass air control valve.
- Check engine coolant temperature sensor.
- Check A/C load control solenoid.

IDLE IS ROUGH

- Check idle speed control solenoid.
- Check A/C load control solenoid.
- Check by-pass air control valve.
- Check throttle position switch.
- Check vane airflow meter.
- Check vane air temperature sensor.
- Check canister purge solenoid.
- Check engine cooling fan.
- Check headlight switch.
- Check blower control switch.
- Check A/C thermostatic switch.
- Check neutral safety switch.
- Check neutral gear switch or clutch engage switch.
- Check heated exhaust gas oxygen sensor.

ENGINE SPEEDS UP

- Check idle speed control solenoid.
- Check heated exhaust gas oxygen sensor.
- Check by-pass air control valve.

CRANKS NORMALLY/NO START

- Verify secondary ignition spark is present.
- Verify fuel pressure is within specification.
- Check vane airflow meter.
- Check engine coolant temperature sensor.

CRANKS NORMALLY/SLOW TO START

- Check ignition module.
- Check engine coolant temperature sensor.
- Check vane airflow meter.
- Check evaporative emission control components.

POOR FUEL ECONOMY

- Verify intake air is not restricted.
- Verify fuel pressure is within specification.
- Check ignition module.
- Check canister purge solenoid.
- Check vane air temperature sensor.
- Check vane airflow meter.
- Check heated exhaust gas oxygen sensor.

EXHAUST SMOKE/ODOR

- Check vane air temperature sensor.
- Check vane airflow meter.
- Check exhaust gas oxygen sensor.

FUEL ODOR/LEAKS

- Check evaporative emission control components.
- Check rollover vent valve.
- Check by-pass air control valve.

FAILS EMISSION TEST

- Check canister purge solenoid.
- Check pressure regulator control solenoid.
- Check heated exhaust gas oxygen sensor.
- Check by-pass air control valve.

INTERMITTENTS

INTERMITTENT PROBLEM DIAGNOSIS

Intermittent fault testing requires duplicating circuit or component failure to identify problem. These procedures may lead to computer setting a fault code (on some systems) which may help in diagnosis.

If problem vehicle does not produce fault codes, monitor voltage or resistance values using a DVOM while attempting to reproduce conditions causing intermittent fault. A status change on DVOM indicates a fault has been located.

Use a DVOM to pinpoint faults. When monitoring voltage, ensure ignition switch is in ON position or engine is running. Ensure ignition switch is in OFF position or negative battery cable is disconnected when monitoring circuit resistance. Status changes on DVOM during test procedures indicate area of fault.

TEST PROCEDURES

INTERMITTENT SIMULATION

To reproduce conditions creating an intermittent fault, use following methods:

- Lightly vibrate component.
- Heat component.
- Wiggle or bend wiring harness.
- Spray component with water.
- Remove/apply vacuum source.

Monitor circuit/component voltage or resistance while simulating intermittent. If engine is running, monitor for self-diagnostic codes. Use test results to identify a faulty component or circuit.

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E - THEORY/OPERATION

1991 ENGINE PERFORMANCE Ford/Mercury Theory & Operation

INTRODUCTION

This article covers basic description and operation of engine performance-related systems and components. Read this article before attempting to diagnose systems with which you are not completely familiar.

COMPUTERIZED ENGINE CONTROLS

An electronic Control Assembly (ECA) receives and processes signals from various sensors and switches. See [Fig. 1](#) . It then generates signals which control ignition timing, fuel injection functions and various emission control devices. The ECA has system diagnostic capabilities and will store trouble codes for use by service technicians.

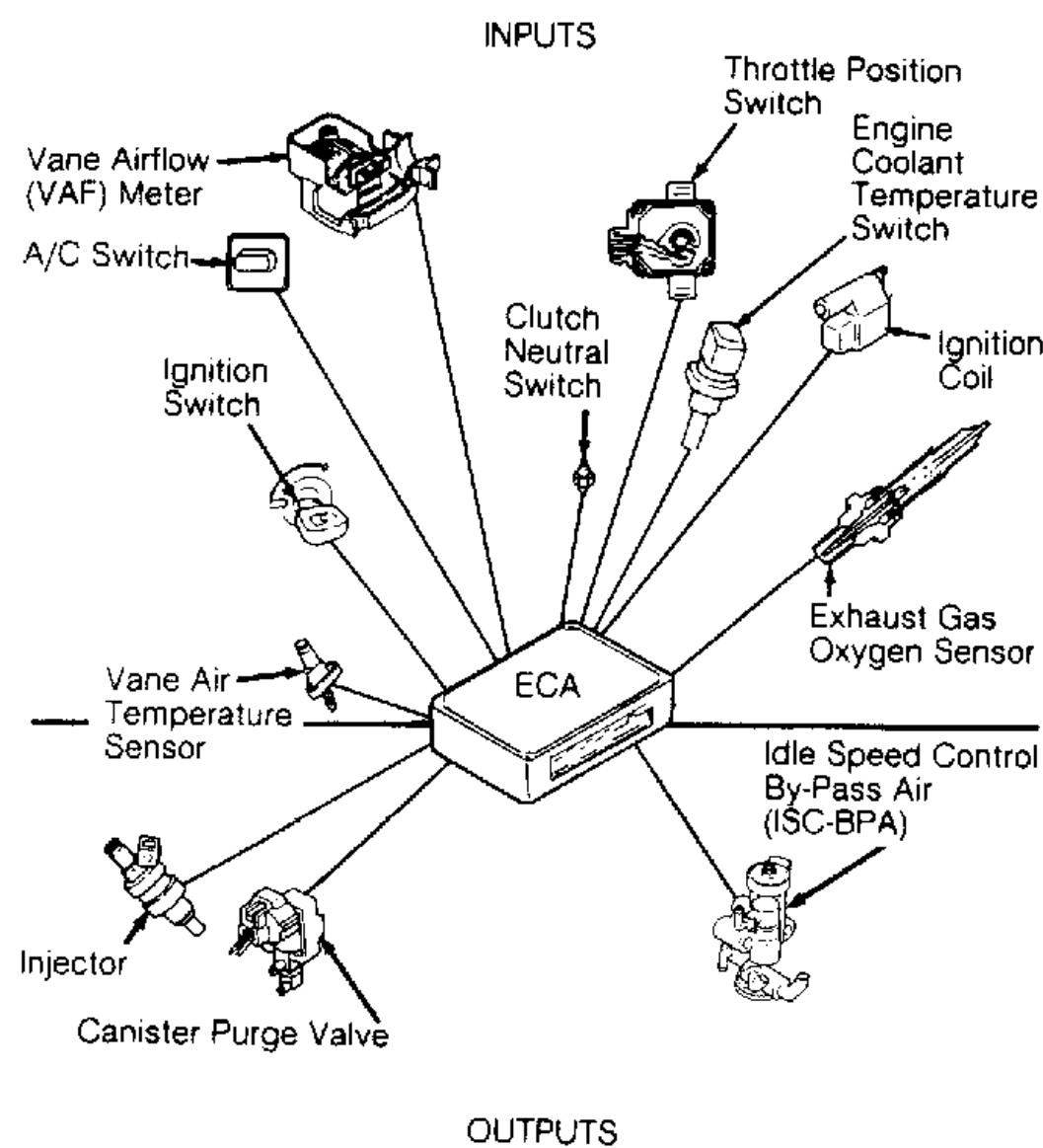


Fig. 1: Identifying Input Devices & Output Signals (Not All Shown)
Courtesy of FORD MOTOR CO.

ELECTRONIC CONTROL ASSEMBLY (ECA)

The ECA is located under the instrument panel on the driver side. It receives and processes data from sensors, switches and other components. The ECA generates output signals to control fuel injection, spark timing, other engine functions and emission systems.

NOTE: Components are grouped into 2 categories. The first category is CEC INPUT DEVICES, which control or produce voltage signals monitored by the control unit. The second category is CEC OUTPUT SIGNALS, which are components controlled by the control unit.

CEC INPUT DEVICES

Vehicles are equipped with different combinations of input devices. Not all devices are used on all models. To determine input device usage of a specific model, see appropriate wiring diagram in WIRING DIAGRAMS article. The available input devices include the following:

BAROMETRIC PRESSURE SENSOR (BP)

This device senses changes in barometric pressure. The ECA uses this information in calculating fuel metering, ignition timing and idle speed. On Festiva, BP is incorporated into the ECA. On Capri, BP is located on the passenger-side cowl.

BRAKE ON-OFF (BOO) SWITCH

This switch, located at the brake pedal, senses brake operation. The ECA uses this information in calculating fuel metering.

CLUTCH ENGAGE SWITCH (CES)

This switch is located on the manual transaxle and informs the ECA of transmission operating conditions. The ECA uses this data for idle speed control and canister purge valve operation.

CRANKSHAFT POSITION SENSOR (CPS) (FESTIVA)

This sensor is located in the distributor and sends engine RPM and crankshaft position data to the ECA. The ECA uses this data in calculating fuel metering, ignition timing, idle speed control and canister purge valve operation.

CYLINDER IDENTIFICATION SENSOR (CID) (CAPRI)

This sensor is located in the distributor and provides crankshaft position data to the ECA. The ECA uses this data in calculating fuel metering and ignition timing.

ELECTRICAL LOAD SWITCHES

Blower control, cooling fan, rear window defroster, air conditioning and headlight switches all send signals to the ECA. The ECA uses these signals for idle speed control.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

This sensor is located in the intake manifold and sends coolant temperature data to the ECA. The ECA uses this data in calculating fuel metering, idle speed control and canister purge valve operation.

EXHAUST GAS OXYGEN (EGO) SENSOR

This sensor is located in the exhaust manifold and senses oxygen concentration in the exhaust gas. The ECA uses this data in calculating fuel metering, idle speed control and canister purge valve operation.

NEUTRAL SAFETY SWITCH (A/T)

This switch is located on the automatic transaxle and sends a signal to the ECA whenever the transaxle is in Neutral or Park ranges. The ECA uses this signal in calculating fuel metering, idle speed control and canister purge valve operation.

POWER STEERING PRESSURE SWITCH (PSPS)

This switch is located on the power steering pump and sends data about power steering operation to the ECA. The ECA uses this data for idle speed control.

THROTTLE POSITION SENSOR (TP)

This device is located on the throttle body and contains 2 switches. The Wide Open Throttle (WOT) Switch sends a signal to the ECA when throttle valve opening is more than 70 degrees. The ECA uses this signal in calculating fuel metering.

The Idle Switch (IDL) sends a signal to the ECA when throttle valve opening is less than 1.5 degrees. The ECA uses this signal for idle speed control and canister purge valve operation.

VANE AIRFLOW (VAF) METER

This sensor is located in the air cleaner housing and sends intake airflow data to the ECA. The ECA uses this data in calculating fuel metering.

VANE AIR TEMPERATURE (VAT) SENSOR

This sensor is located inside the vane airflow sensor and senses intake air temperature. The ECA uses this data in calculating fuel metering, idle speed control and canister purge valve operation.

CEC OUTPUT SIGNALS

NOTE: Vehicles are equipped with different combinations of computer-controlled components. Not all components listed below are used on every vehicle. For theory and operation of each output component, refer to indicated system.

CANISTER PURGE (CANP) SOLENOID

See EMISSION SYSTEMS.

CHECK ENGINE LIGHT

See SELF-DIAGNOSTIC SYSTEM.

FUEL INJECTORS

See FUEL CONTROL.

IDLE SPEED CONTROL BY-PASS AIR (ISC-BPA) VALVE

See IDLE SPEED.

FUEL DELIVERY SYSTEM

Major components of the fuel delivery system are an electric fuel pump, fuel supply and return lines, a pressure regulator, fuel rail and fuel injectors. See Fig. 2 or Fig. 3 .

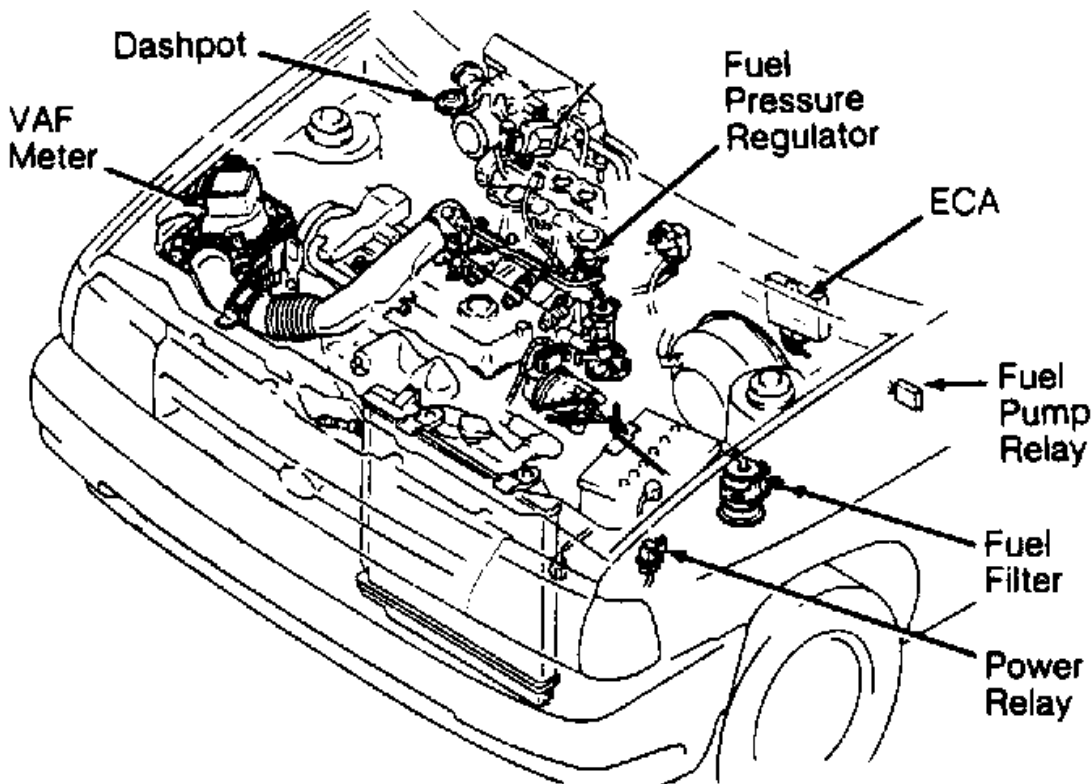


Fig. 2: Locating Fuel Delivery System Components (Festiva)
Courtesy of FORD MOTOR CO.

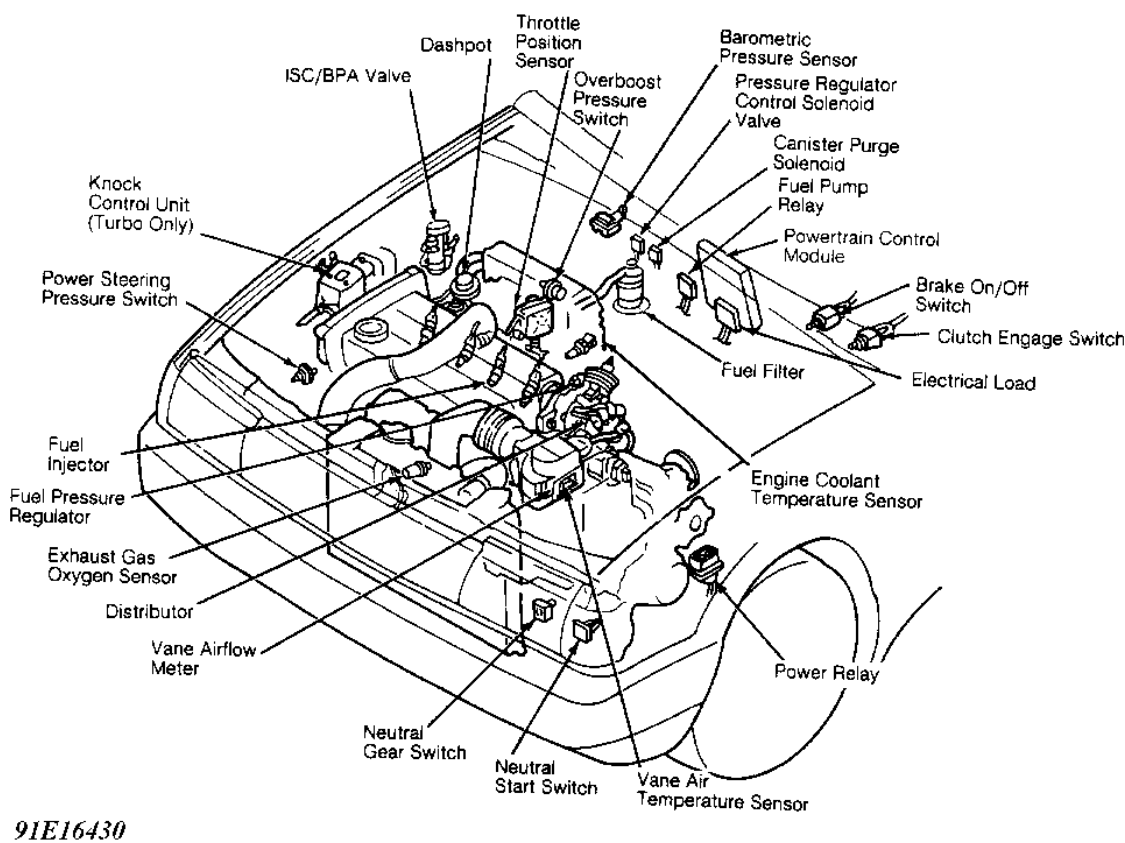


Fig. 3: Locating Fuel Delivery System Components (Capri)
Courtesy of FORD MOTOR CO.

FUEL PUMP

The fuel pump, located inside the fuel tank, includes a check valve at the outlet and a filter element at the inlet. A pressure relief valve limits maximum fuel outlet pressure.

FUEL PUMP RELAY

This relay prevents fuel pump operation unless the engine is cranking or when a signal from the VAF confirms the engine is running. See Fig. 4 . Internal circuitry holds the relay contacts closed during momentary loss of the VAF signal during rapid deceleration. The fuel pump relay is

located under the center of the instrument panel, between the panel and the floor.

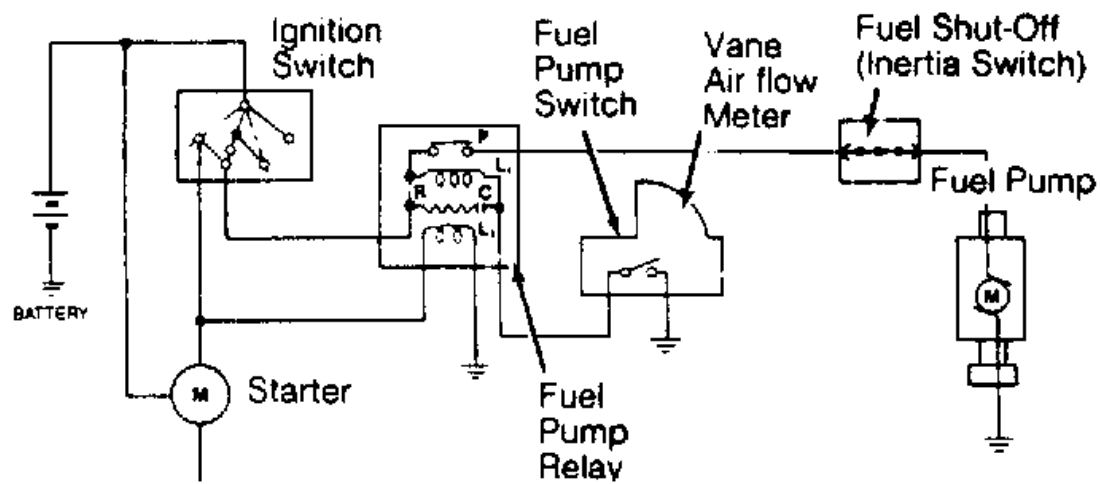


Fig. 4: Electric Fuel Pump System Schematic
Courtesy of FORD MOTOR CO.

FUEL PRESSURE REGULATOR

The fuel pressure regulator is located at the fuel return end of the fuel rail and maintains fuel pressure within the fuel rail at a constant 36.3 psi (2.54 kg/cm²) higher than intake manifold pressure.

FUEL PRESSURE REGULATOR CONTROL SOLENOID (PRC) (CAPRI)

This device closes the vacuum supply to the fuel pressure regulator on hot starts, thus increasing fuel pressure within the fuel rail and preventing fuel percolation which could cause hard starts during hot conditions. The PRC is located on the cowl panel, next to the canister purge solenoid.

FUEL PUMP SHUT-OFF (INERTIA) SWITCH

The fuel pump shut-off switch is connected in series with the fuel pump and prevents fuel pump operation in the event of major collision or vehicle rollover. A reset button is provided to reset the switch after it has been triggered. See [Fig. 5](#).

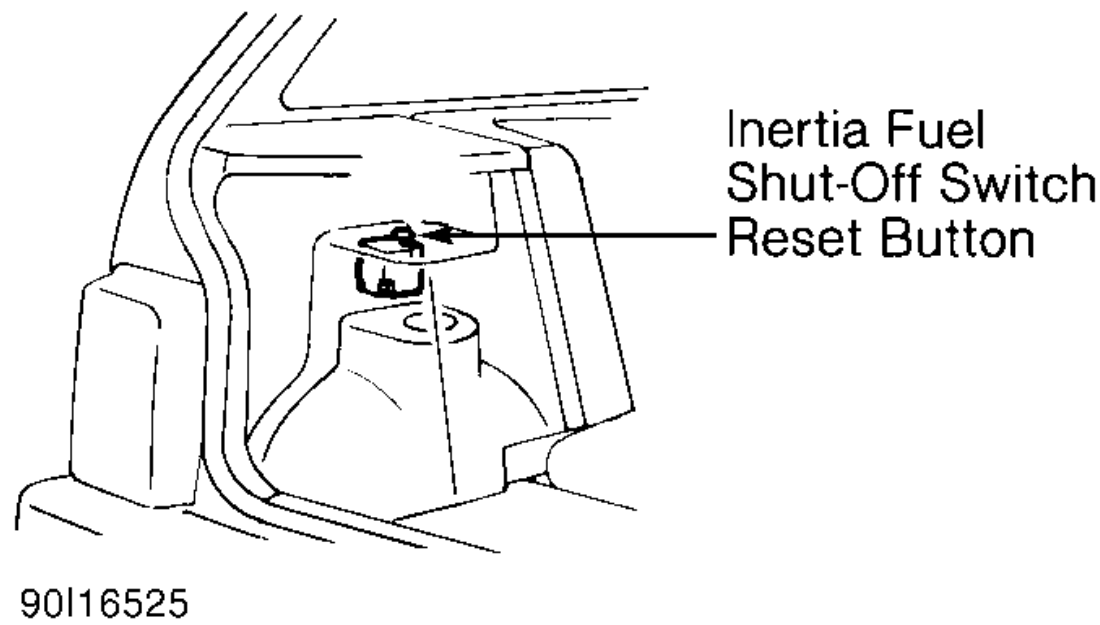


Fig. 5: Locating Inertia Switch Reset Button
Courtesy of FORD MOTOR CO.

FUEL CONTROL SYSTEM

ELECTRONIC FUEL INJECTION (EFI)

The ECA receives a signal from the CPS (Festiva) or CID (Capri) for basic fuel injector timing. Signals to the ECA from other sensors and switches affect injector on-time. The amount of fuel injected is determined by the duration of the electronic pulse sent to the fuel injector from the ECA.

Between idle and 5000 RPM, fuel is supplied by providing one injection per crankshaft rotation (2 injections per cycle) to all cylinders. There is one injection per 2 crankshaft rotations when engine speed exceeds 5000 RPM. When engine speed exceeds 6400 RPM, fuel injectors are shut off to prevent engine damage.

IDLE SPEED

While the engine is cold, the Idle Speed Control By-Pass Air (ISC-BPA) Valve increases idle speed to warm the engine quickly. At engine temperatures less than 140°F (60°C), the valve is open. As the engine warms, the valve begins to close. The valve is fully closed at engine temperatures higher than 140°F (60°C). Idle speed is also affected by various switches, sensors and load on the engine.

ELECTRONIC IGNITION SYSTEM

CAPRI

A pick-up coil within the distributor sends a signal to a Distributor-Mounted Ignition Module With Vacuum Advance (DMIVA) within the distributor. The DMIVA then sends a signal which fires the coil. When the coil fires, the distributor directs high voltage current to the spark plugs. The DMIVA system operates independently of the ECA.

FESTIVA

A pick-up coil within the distributor sends a signal to a transistorized ignition module on the coil bracket. A timing signal also goes from the ECA to the ignition module. The ignition module then sends a signal which fires the coil. When the coil fires, the distributor directs high voltage current to the spark plugs.

IGNITION TIMING CONTROL SYSTEM

CAPRI

Spark timing is controlled by vacuum and centrifugal advance mechanisms and by a signal from the ECA. The ECA does not affect ignition timing on turbo models. On turbo models, a knock sensor and control unit retard ignition timing when knock occurs.

FESTIVA

The ECA generates a spark timing signal from data received from the BP, CPS and VAF. This signal goes to the ignition module. The ignition module then sends a signal to fire the coil.

HIGH ALTITUDE SPARK ADVANCE CORRECTION

A barometric pressure sensor is incorporated into the ECA on Festiva and is a separate component on Capri. At high altitudes, the ECA sends a signal to the ignition module to advance ignition timing. This feature is not used on turbo models.

KNOCK SENSOR (CAPRI)

A Knock Sensor (KS) generates a signal when knock occurs. A control unit processes this signal and then sends it to the ignition module to retard spark timing. The KS is located in the engine block, near the oil pressure switch. This device is only used on 1.6L turbo engines.

KNOCK CONTROL UNIT (CAPRI)

The Knock Control Unit filters normal engine vibration signals from the KS, then sends a signal to the ignition module to retard spark timing. This unit, used only on 1.6L turbo engines, is located on right side of engine compartment.

EMISSION SYSTEMS

DECELERATION SYSTEM (DASHPOT)

The deceleration control system closes the throttle plate gradually during deceleration. The dashpot prevents engine stalling on deceleration and provides a smooth transition from deceleration to sudden acceleration.

EVAPORATIVE SYSTEM

CARBON CANISTER

The carbon canister stores vapors from the fuel tank until they are purged and burned in the engine. On Festiva, carbon canister is located under the brake booster. On Capri, carbon canister is located on the right side of the engine compartment near the cowl panel.

CANISTER PURGE SOLENOID

This component is connected between the carbon canister and intake manifold. When the ECA sends a signal to the solenoid to open, fuel vapors in the carbon canister are drawn into the engine.

CANISTER PURGE VALVE

This valve opens to purge vapors from the carbon canister into the engine intake system. The valve is part of the canister purge solenoid.

ROLLOVER VENT VALVE

This valve, located in front of the fuel tank, blocks the vapor line in case of vehicle rollover.

This valve, located in front of the fuel tank, blocks the vapor line in case of vehicle rollover.

CATALYTIC CONVERTER

The catalytic converter is in the exhaust system, between the exhaust manifold and the muffler. It converts certain pollutants in the exhaust

gases into harmless substances.

PCV VALVE

The Positive Crankcase Ventilation (PCV) valve, located in the valve cover, controls the flow of blow-by gas from the crankcase to the intake manifold.

SELF-DIAGNOSTIC SYSTEM

NOTE: For additional information and operating procedures for the self-diagnostic system, refer to TESTS W/CODES article in the ENGINE PERFORMANCE Section.

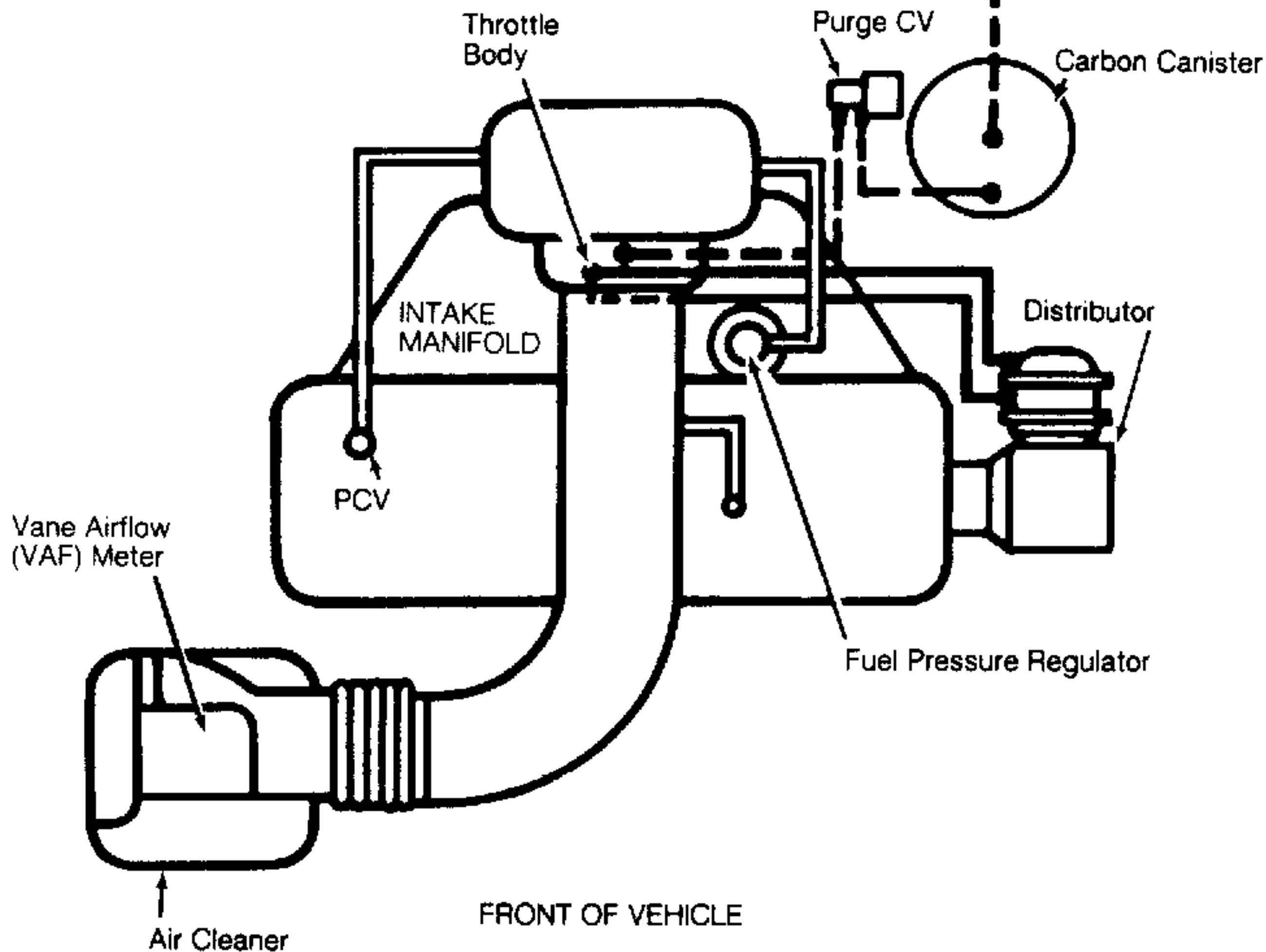
The ECA monitors its inputs and outputs. When it detects a malfunction, it sets a code in the ECA and sends a signal to the CHECK ENGINE warning light. The light remains on until the malfunction is repaired. Trouble codes may be accessed at the Self-Test Output (STO) and Self-Test Input (STI) connectors, near the battery.

If a sensor fails, the ECA will use a substitute value in its calculations to permit continued engine operation. In this condition, the vehicle will run, but driveability may be poor. Intermittent failures may result in the CHECK ENGINE warning light flickering or going out after the fault goes away. The corresponding trouble code, however, will be stored in the ECA. If fault does not recur, the related code will be erased from ECA memory.

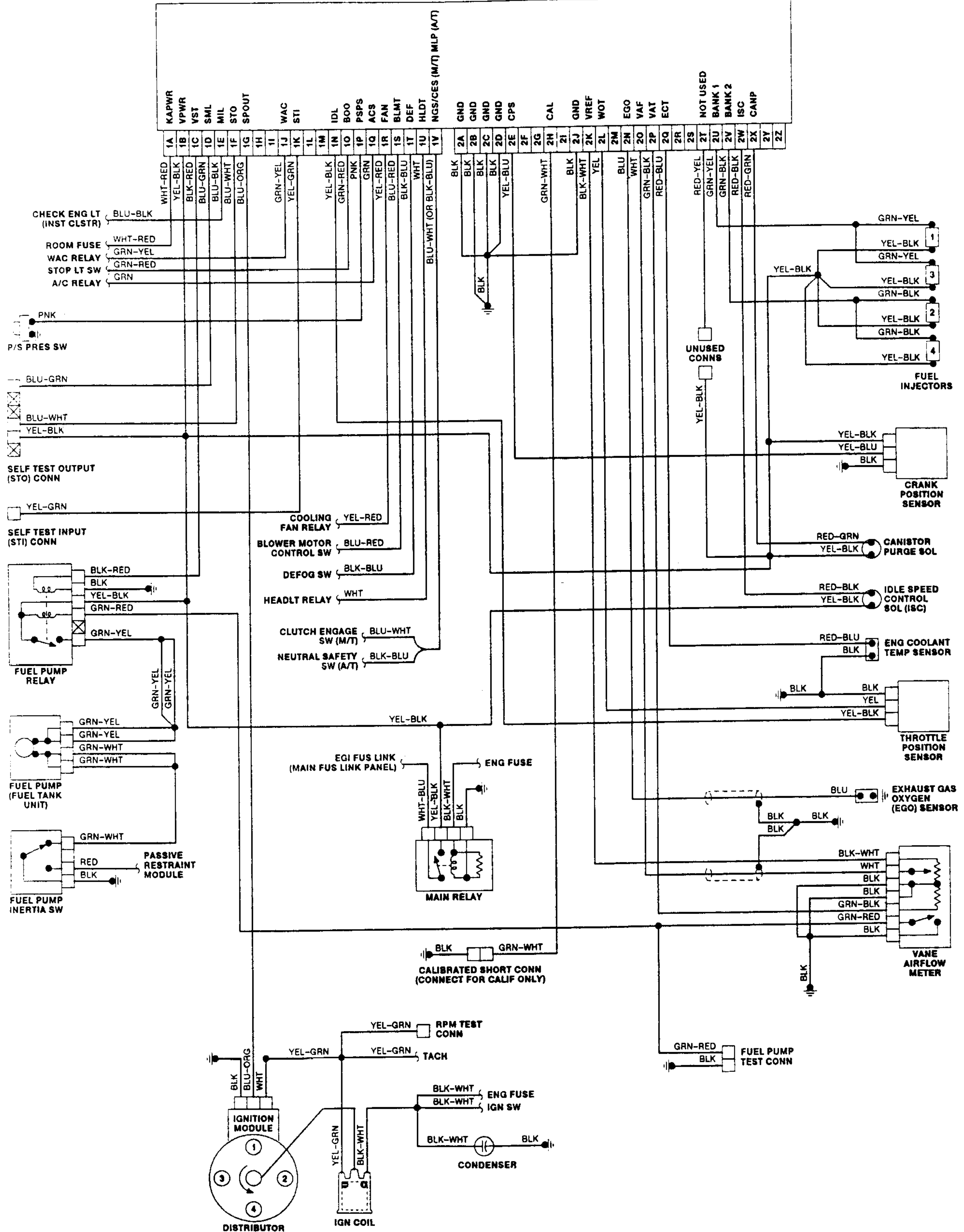
CHECK ENGINE LIGHT

Hard failures cause the CHECK ENGINE warning light to come on and remain on until the malfunction is repaired. If the warning light comes on and stays on during vehicle operation, determine and correct the cause of the malfunction.

From Fuel Tank →



ELECTRONIC CONTROL ASSEMBLY (ECA) 1.3L



[Back To Article](#)

GENERAL INFORMATION

Commonly Used Abbreviations

* PLEASE READ THIS FIRST *

NOTE: This article is intended for general information purposes only. This information may not apply to all makes and models. Not all abbreviations are covered as manufacturers add new ones every day.

"A"

A

Amperes

ABS

Anti-Lock Brakes

ABRS

Air Bag Restraint System

AC

Alternating Current

A/C

Air Conditioning

ACCS

A/C Cycling Switch

ACCUM

Accumulator

ACCY

Accessory

ACT

Air Charge Temperature Sensor

ADJ

Adjust or Adjustable

ADV

Advance

AFS

Airflow Sensor

AI

Air Injection

AIR or A.I.R.

Air Injection Reactor

AIS

Air Injection System

Alt.

Alternator or Altitude

Amp./amp/amps

Ampere

ASCS

Air Suction Control Solenoid

ASD

Auto Shutdown

ASDM

Air Bag System Diagnostic Module

ASV

Air Suction Valve

A/T

Automatic Transmission/Transaxle

ATC

Automatic Temperature Control

ATDC

After Top Dead Center

ATF

Automatic Transmission Fluid

ATS

Air Temperature Sensor

Aux.

Auxiliary

Avg.

Average

AXOD

Automatic Transaxle Overdrive (Ford Models Only)

"B"

BAC

By-Pass Air Control

BAP

Barometric Absolute Pressure Sensor

BARO

Barometric

Batt.

Battery

Bbl.

Barrel (Example: 4-Bbl.)

BCM

Body Control Module

BHP

Brake Horsepower

BMAP

Barometric and Manifold Absolute Pressure Sensor

BOO

Brake On-Off Switch

B/P

Backpressure

BPS

Barometric Pressure Sensor

BPT

Backpressure Transducer

BTDC

Before Top Dead Center

BTU

British Thermal Unit

BVSV

Bimetallic Vacuum Switching Valve

"C"

° C

Celsius (Degrees)

Calif.

California

CANP

Canister Purge

CARB

California Air Resources Board

CAT

Catalytic Converter

CB

Circuit Breaker

CBD

Closed Bowl Distributor

cc

cubic centimeter

CCC

Computer Command Control

CCD

Computer Controlled Dwell

CCOT

Cycling Clutch Orifice Tube

CCW

Counterclockwise

CDI

Capacitor Discharge Ignition

CEC

Computerized Engine Control

CID

Cubic Inch Displacement

cm

Centimeter

CMP

Camshaft Position Sensor

CO

Carbon Monoxide

CO₂

Carbon Dioxide

Cont.

Continued

CONV

Convertible

CP

Canister Purge

CKP

Crankshaft Position Sensor

CTS

Coolant Temperature Sensor

Cu. In.

Cubic Inch

CVC

Constant Vacuum Control

CV

Check Valve or Constant Velocity

CW

Clockwise

CYL or Cyl.

Cylinder

C³ I

Computer Controlled Coil Ignition

C⁴

Computer Controlled Catalytic Converter

"D"

"D"

	Drive
DC	
	Direct Current Or Discharge
DDD	
	Dual Diaphragm Distributor
Def.	
	Defrost
Defog.	
	Defogger
DERM	
	Diagnostic Energy Reserve Module
DFI	
	Digital Fuel Injection
Diag.	
	Diagnostic
DTC	
	Diagnostic Trouble Code
DIC	
	Driver Information Center
DIS	
	Distributorless Ignition System
DIST	
	Distribution
DLC	
	Data Link Connector
DOHC	
	Double Overhead Cam
DOT	
	Department of Transportation
DRB-II	
	Diagnostic Readout Box
DVOM	
	Digital Volt-Ohmmeter
"E"	
EACV	
	Electric Air Control Valve
EATX	
	Electronic Automatic Transaxle
EBCM	
	Electronic Brake Control Module

EBL	
Electronic Back Light	
ECM	
Engine Control Module	
ECT	
Engine Coolant Temperature Sensor	
EDIS	
Electronic Distributorless Ignition System	
EEC	
Electronic Engine Control	
EECS	
Evaporative Emission Control System	
EEPROM	
Electronically Erasable PROM	
EFE	
Early Fuel Evaporation	
EGO	
Exhaust Gas Oxygen Sensor	
EGR	
Exhaust Gas Recirculation	
ESA	
Electronic Spark Advance	
ESC	
Electronic Spark Control	
EST	
Electronic Spark Timing	
EVAP	
Fuel Evaporative System	
EVIC	
Electronic Vehicle Information Center	
EVP	
EGR Valve Position Sensor	
Exc.	
Except	
"F"	
° F	
Fahrenheit (Degrees)	
F/B	
Fuse Block	
Fed.	

Federal

FI

Fuel Injection

FICU

Fuel Injection Control Unit

FIPL

Fuel Injector Pump Lever

FPR-VSV

Fuel Pressure Regulator Vacuum Switching Valve

Ft. Lbs.

Foot Pounds

FWD

Front Wheel Drive

"G"

g

grams

Gals.

gallons

GND or GRND

Ground

"H"

HAC

High Altitude Compensation

HC

Hydrocarbons

H/D

Heavy Duty

HO2S

Heated Exhaust Gas Oxygen Sensor

Hg

Mercury

Hgt.

Height

HLDT

Headlight

HO

High Output

HO2S

Heated Oxygen Sensor

HP

	High Performance
HSC	
	High Swirl Combustion
HSO	
	High Specific Output
HTR	
	Heater
Hz	
	Hertz (Cycles Per Second)
"I"	
IAC	
	Idle Air Control
IACV	
	Idle Air Control Valve
IAT	
	Intake Air Temperature
IC	
	Integrated Circuit
ID	
	Identification
I.D.	
	Inside Diameter
Ign.	
	Ignition
IMRC	
	Intake Manifold Runner Control
In.	
	Inches
INCH Lbs.	
	Inch Pounds
in. Hg	
	Inches of Mercury
Inj.	
	Injector
IP	
	Instrument Panel
ISC	
	Idle Speed Control
IVSV	
	Idle Vacuum Switching Valve

"J"

J/B

Junction Block

"K"

KAPWR

Keep Alive Power

k/ohms

kilo-ohms (1000 ohms)

kg

Kilograms (weight)

kg/cm²

Kilograms Per Square Centimeter

KM/H

Kilometers Per Hour

KOEO

Key On, Engine Off

KOER

Key On, Engine Running

KS

Knock Sensor

kW

Kilowatt

kV

Kilovolt

"L"

L

Liter

lbs. (Lbs. when used in table)

Pounds

LCD

Liquid Crystal Display

L/D

Light Duty

LDP

Leak Detection Pump (Part of EVAP system.)

LED

Light Emitting Diode

LH

Left Hand

"M"

mA	
	Milliamps
MA or MAF	
	Mass Airflow
MAFS	
	Mass Airflow Sensor
MAP	
	Manifold Absolute Pressure
MAT	
	Manifold Air Temperature
Mem.	
	Memory
MEM-CAL	
	Memory Calibration Chip
mfd.	
	Microfarads
MFI	
	Multiport Fuel Injection
MIL	
	Malfunction Indicator Light
MPI	
	Multi-Point (Fuel) Injection
mm	
	Millimeters
MPH	
	Miles Per Hour
mV	
	Millivolts
"N"	
NA	
	Not Available
NGS	
	New Generation Star
N.m	
	Newton Meter
No.	
	Number
Nos.	
	Numbers
NOx	

Oxides of Nitrogen

"O"

O₂

Oxygen

OBD

On-Board Diagnostics

OC

Oxidation Catalyst

OD

Overdrive

O.D.

Outside Diameter

OHC

Overhead Camshaft

O/S

Oversize

oz.

Ounce

ozs.

Ounces

"P"

"P"

Park

P/C

Printed Circuit

PCM

Powertrain Control Module

PCS

Purge Control Solenoid

PC-SOL

Purge Control Solenoid

PCV

Positive Crankcase Ventilation

PFI

Port Fuel Injection

PGM-FI

Programmed Fuel Injection

PID

Parameter Identification

PIP

Profile Ignition Pick-up

PNP

Park Neutral Position Switch

P/N

Park/Neutral

PRNDL

Park Reverse Neutral Drive Low

PROM

Programmable Read-Only Memory

psi

Pounds Per Square Inch

P/S

Power Steering

PSPS

Power Steering Pressure Switch

PTC

Positive Temperature Coefficient

PTO

Power Take-Off

Pts.

Pints

Pwr.

Power

"Q"

Qts.

Quarts

"R"

RABS

Rear Anti-Lock Brake System

RECIRC

Recirculation

RH

Right Hand

RPM

Revolutions Per Minute

RWAL

Rear Wheel Anti-Lock Brake

RWD

Rear Wheel Drive

"S"

SBC

Single Bed Converter

SBEC

Single Board Engine Controller

SES

Service Engine Soon

SFI

Sequential (Port) Fuel Injection

SIL

Shift Indicator Light

SIR

Supplemental Inflatable Restraint

SOHC

Single Overhead Cam

SOL or Sol.

Solenoid

SPFI

Sequential Port Fuel Injection

SPK

Spark Control

SPOUT

Spark Output

SRI

Service Reminder Indicator

SRS

Supplemental Restraint System (Air Bag)

STAR

Self-Test Automatic Readout

STO

Self-Test Output

SUB-O₂

Sub Oxygen Sensor

Sw.

Switch

Sys.

System

"T"

TAB

Thermactor Air By-Pass

TAC

Throttle Actuator Module

TAD

Thermactor Air Diverter

TBC

Body Control Module

TBI

Throttle Body Injection

TCC

Torque Converter Clutch

TDC

Top Dead Center

Temp.

Temperature

TFI

Thick Film Ignition

THERMAC

Thermostatic Air Cleaner

TPM

Tire Pressure Monitor

TPMS

Tire Pressure Monitor System

TPS

Throttle Position Sensor/Switch

TS

Temperature Sensor

TV

Therموالve

TWC

Three-Way Catalyst

"V"

V

Valve

Vac.

Vacuum

VAF

Vane Airflow

VAPS

Variable Assist Power Steering

VCC

Viscous Converter Clutch

VCRM

Variable Control Relay Module

VIN

Vehicle Identification Number

VM

Vacuum Modulator

Volt.

Voltage

VOM

Volt-Ohmmeter (Analog)

VRV

Vacuum Regulator Valve

VSS

Vehicle Speed Sensor

VSV

Vacuum Switching Valve

"W"

W/

With

W/O

Without

WAC

Wide Open Throttle A/C Switch

WOT

Wide Open Throttle

[Back To Article](#)

GENERAL INFORMATION

Trouble Shooting - Basic Procedures

* PLEASE READ THIS FIRST *

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to **SUBJECT**, **DIAGNOSTIC**, or **TESTING** articles available in the section(s) you are accessing.

ACCESSORIES & ELECTRICAL

CHARGING SYSTEM TROUBLE SHOOTING

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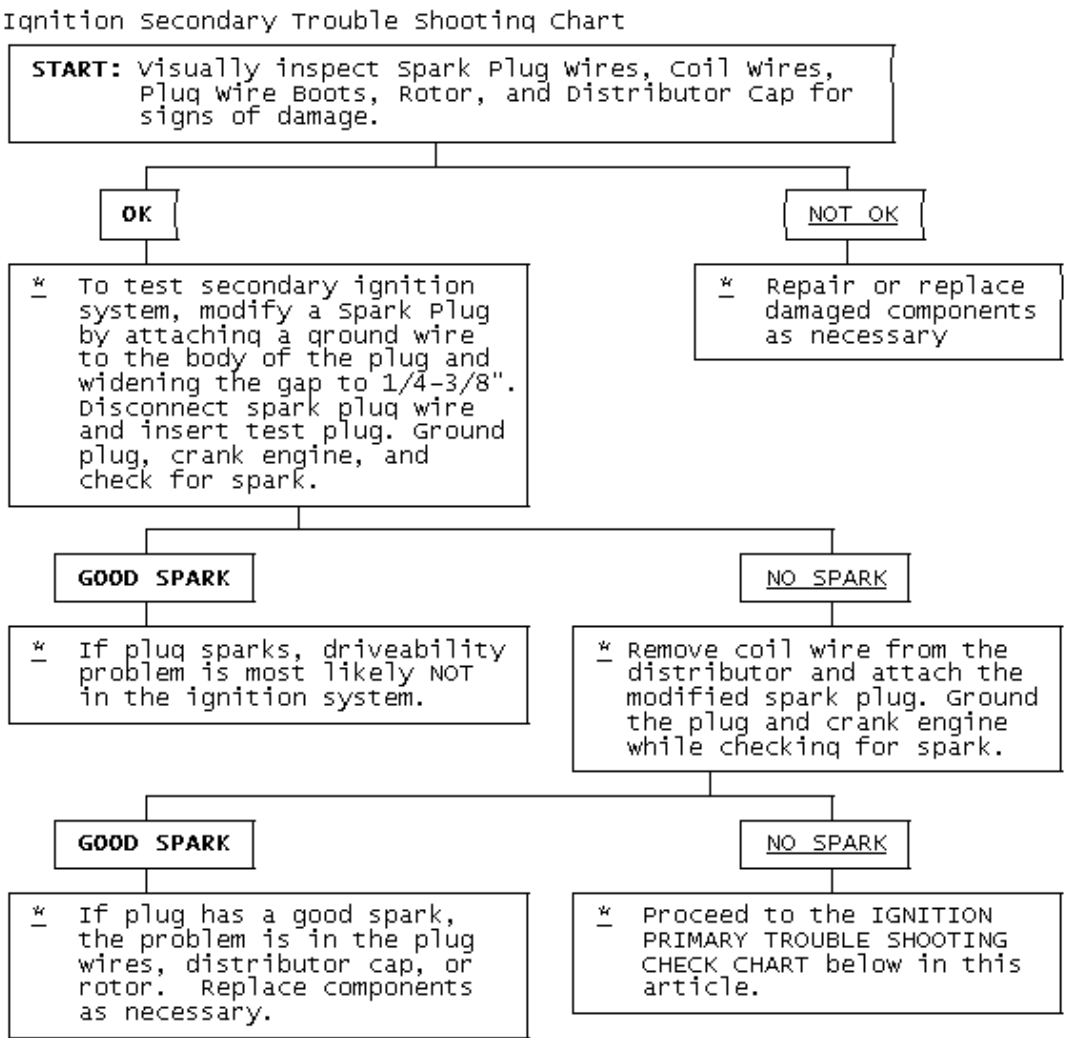
BASIC CHARGING SYSTEM TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Vehicle Will Not Start	
Dead battery	Check battery cells, alternator belt tension and alternator output
Loose or corroded battery connections	Check all charging system connections
Ignition circuit or switch malfunction	Check and replace as necessary
Alternator Light Stays On With Engine Running	
Loose or worn alternator drive belt	Check alternator drive tension and condition, See Belt Adjustment in TUNE-UP article in the TUNE-UP section
Loose alternator wiring connections	Check all charging system connections
Short in alternator light wiring	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Defective alternator stator or diodes	See Bench Tests in ALTERNATOR article
Defective regulator	See Regulator Check in ALTERNATOR article
Alternator Light Stays Off With Ignition Switch ON	
Blown fuse	See WIRING DIAGRAMS
Defective alternator	See Testing in ALTERNATOR article
Defective indicator light bulb or socket	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Alternator Light Stays OFF With Ignition Switch ON	
Short in alternator wiring	See On-Vehicle Tests in ALTERNATOR article
Defective rectifier bridge	See Bench Tests in ALTERNATOR article
Lights or Fuses Burn Out Frequently	
Defective alternator wiring	See On-Vehicle Tests in ALTERNATOR article
Defective regulator	See Regulator Check in ALTERNATOR article
Defective battery	Check and replace as necessary
Ammeter Gauge Shows Discharge	
Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in TUNE-UP article in the TUNE-UP section
Defective wiring	Check all wires and wire

	connections
Defective alternator or regulator	See Bench Tests and On-Vehicle Tests in ALTERNATOR article
Defective ammeter, or improper ammeter wiring connection	See Testing in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Noisy Alternator	
Loose drive pulley	Tighten drive pulley attaching nut
Loose mounting bolts	Tighten all alternator mounting bolts
Worn or dirty bearings	See Bearing Replacement ALTERNATOR article
Defective diodes or stator	See Bench Test in ALTERNATOR article
Battery Does Stay Charged	
Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in appropriate TUNE-UP article in the TUNE-UP section
Loose or corroded battery connections	Check all charging system connections
Loose alternator connections	Check all charging system connections
Defective alternator or battery	See On-Vehicle Tests and Bench Tests in ALTERNATOR article
Add-on electrical accessories exceeding alternator capacity	Install larger alternator
Battery Overcharged-Uses Too Much Water	
Defective battery	Check alternator output and repair as necessary
Defective alternator	See On-Vehicle Test and Bench Tests in ALTERNATOR article
Excessive alternator voltage	Check alternator output and repair as necessary

IGNITION SYSTEM TROUBLE SHOOTING

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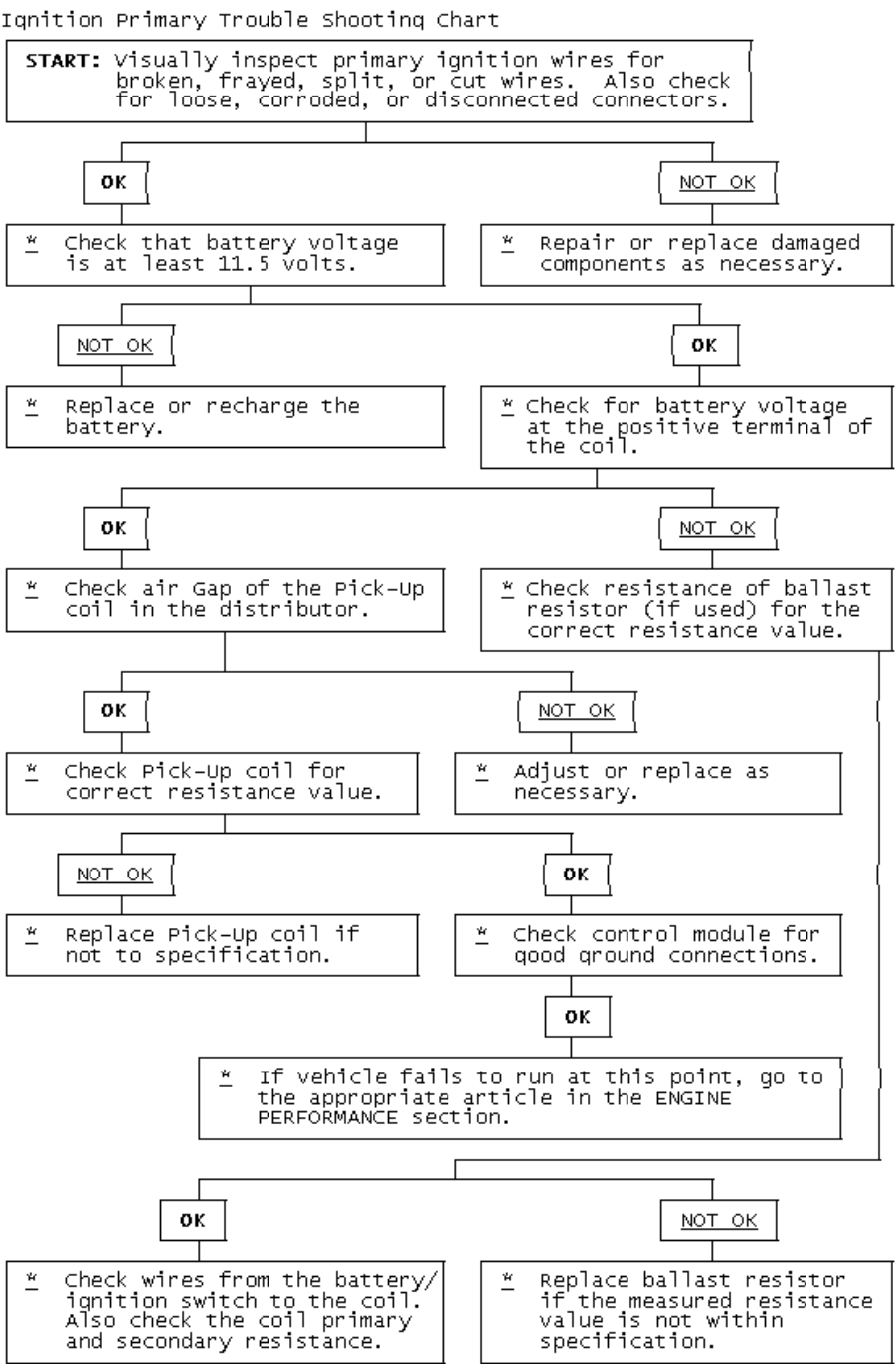


Fig. 2: Ignition Primary Trouble Shooting Chart

STARTER TROUBLE SHOOTING

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BASIC STARTER TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	
Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter
Ignition switch faulty or misadjusted	Adjust or replace ignition switch
Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
Starter relay or starter defective	See Testing in STARTER article
Open solenoid pull-in wire	Testing in STARTER article
Starter Does Not Operate and Headlights Dim	
Weak battery or dead cell	Charge or replace battery as necessary
Loose or corroded battery connections	Check that battery connections are clean and tight
Internal ground in starter windings	See Testing in STARTER article
Grounded starter fields	See Testing in STARTERS
Armature rubbing on pole	See STARTER article shoes
Starter Turns but Engine Does Not Rotate	
Starter clutch slipping	See STARTER article

Broken clutch housing	See STARTER article
Pinion shaft rusted or dry	See STARTER article
Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	
Faulty overrunning clutch	See STARTER article
Broken clutch housing	See STARTER article
Broken flywheel teeth	Replace flywheel and check for starter pinion gear damage
Armature shaft sheared or reduction gear teeth stripped	See STARTER article
Weak battery	Charge or replace battery as necessary
Faulty solenoid	See On-Vehicle Tests in STARTER article
Poor grounds	Check all ground connections for tight and clean connections
Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	
Battery weak or defective	Charge or replace battery as necessary
Engine overheated	See ENGINE COOLING SYSTEM article
Engine oil too heavy	Check that proper viscosity oil is used
Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
Current draw too low or too high	See Bench Tests in STARTER article
Bent armature, loose pole shoes screws or worn bearing	See STARTER article
Burned solenoid contacts	Replace solenoid
Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	
Engine timing too far advanced	See Ignition Timing in TUNE-UP article
Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
Broken starter clutch	See STARTER article
Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
Weak drive assembly thrust spring	See STARTER article
Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	
Defective point assembly	See Testing in STARTER article
Poor point assembly ground	See Testing in STARTER article
Defective pull-in coil	Replace starter solenoid
Starter Relay Does Not Close	
Dead battery	Charge or replace battery as necessary
Faulty wiring	Check all wiring and connections leading to relay
Neutral safety switch faulty	Replace neutral safety switch
Starter relay faulty	Replace starter relay
Starter Drive Will Not Disengage	
Starter motor loose on mountings	Tighten starter attach bolts
Worn drive end bushing	See STARTER article
Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
Drive yolk return spring broken or missing	Replace return spring
Faulty ignition switch	Replace ignition switch
Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
Starter clutch not disengaging	Replace starter clutch
Ignition starter switch	Replace ignition switch contacts sticking
Starter Relay Operates but Solenoid Does Not	
Faulty solenoid switch, switch connections or relay	Check all wiring between relay and solenoid or replace relay or solenoid as necessary

Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	
Weak battery	Charge or replace battery as necessary
Solenoid contacts corroded	Clean contacts or replace solenoid
Faulty wiring	Check all wiring leading to solenoid
Broken connections inside switch cover	Repair connections or replace solenoid
Open hold-in wire	solenoid
Low Current Draw	
Worn brushes or weak brush springs	Replace brushes or brush springs as necessary
High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	
Distance too great between starter pinion and flywheel	Align starter or check that correct starter and flywheel are being used
High Pitched Whine After Engine Fires With Key released. Engine Fires and Cranks Normally	
Distance too small between starter pinion and flywheel	Flywheel runout contributes to the intermittent nature

AIR CONDITIONING & HEAT

AIR CONDITIONING TROUBLE SHOOTING

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BASIC AIR CONDITIONING TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Compressor Not Working	Compressor clutch circuit open.
.....	Compressor clutch coil inoperative.
.....	Poor clutch ground connection.
.....	Fan belts loose.
.....	Thermostatic switch inoperative.
.....	Thermostatic switch not adjusted.
.....	Ambient temperature switch open.
.....	Superheat fuse blown.
Excessive Noise or Vibration	Missing or loose mounting bolts.
.....	Bad idler pulley bearings.
.....	Fan belts not tightened correctly.
.....	Compressor clutch contacting body.
.....	Excessive system pressure.
.....	Compressor oil level low.
.....	Damaged clutch bearings.
.....	Damaged reed valves.
.....	Damaged compressor.
Insufficient or No Cooling; Compressor Working	Expansion valve inoperative.
.....	Heater control valve stuck open.
.....	Low system pressure.
.....	Blocked condenser fins.
.....	Blocked evaporator fins.
.....	Vacuum system leak.
.....	Vacuum motors inoperative.
.....	Control cables improperly adjusted.
.....	Restricted air inlet.
.....	Mode doors binding.
.....	Blower motor inoperative.
.....	Temperature above system capacity.

HEATER SYSTEM TROUBLE SHOOTING

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BASIC HEATER SYSTEM TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Insufficient, Erratic, or No Heat	Low Coolant Level
.....	Incorrect thermostat.
.....	Restricted coolant flow through core.
.....	Heater hoses plugged.
.....	Misadjusted control cable.
.....	Sticking heater control valve.
.....	Vacuum hose leaking.
.....	Vacuum hose blocked.
.....	Vacuum motors inoperative.
.....	Blocked air inlet.
.....	Inoperative heater blower motor.
.....	Oil residue on heater core fins.
.....	Dirt on heater core fins.
Too Much Heat	Improperly adjusted cables.
.....	Sticking heater control valve.
.....	No vacuum to heater control valve.
.....	Temperature door stuck open.
Air Flow Changes During Acceleration	Vacuum system leak.
.....	Bad check valve or reservoir.
Air From Defroster At All Times	Vacuum system leak.
.....	Improperly adjusted control cables.
.....	Inoperative vacuum motor.
Blower Does Not Operate Correctly	Blown fuse.
.....	Blower motor windings open.
.....	Resistors burned out.
.....	Motor ground connection loose.
.....	Wiring harness connections loose.
.....	Blower motor switch inoperative.
.....	Blower relay inoperative.
.....	Fan binding or foreign object in housing.
.....	Fan blades broken or bent.

BRAKES

BRAKE SYSTEM TROUBLE SHOOTING

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to **SUBJECT**, **DIAGNOSTIC**, or **TESTING** articles available in the section(s) you are accessing.

BRAKE SYSTEM TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Brakes Pull Left or Right	
Incorrect tire pressure	Inflate tires to proper pressure
Front end out of alignment	See WHEEL ALIGNMENT
Mismatched tires	Check tires sizes
Restricted brake lines or hoses	Check hose routing
Loose or malfunctioning caliper	See DISC BRAKES or BRAKE SYSTEM
Bent shoe or oily linings	See DRUM BRAKES or BRAKE SYSTEM
Malfunctioning rear brakes	See DRUM, DISC BRAKES or BRAKE SYSTEM
Loose suspension parts	See SUSPENSION
Noises Without Brakes Applied	
Front linings worn out	Replace linings
Dust or oil on drums or rotors	See DRUM, DISC BRAKES or BRAKE SYSTEM
Noises With Brakes Applied	
Insulator on outboard shoe damaged	See DISC BRAKES or BRAKE SYSTEM
Incorrect pads or linings	Replace pads or linings
Brake Rough, Chatters or Pulsates	
Excessive lateral runout	Check rotor runout
Parallelism not to specifications	Reface or replace rotor
Wheel bearings not adjusted	See SUSPENSION
Rear drums out-of-round	Reface or replace drums
Disc pad reversed, steel against rotor	Remove and reinstall pad
Excessive Pedal Effort	

Malfunctioning power unit	See POWER BRAKES or BRAKE SYSTEM
Partial system failure	Check fluid and pipes
Worn disc pad or lining	Replace pad or lining
Caliper piston stuck or sluggish	See DISC BRAKES or BRAKE SYSTEM
Master cylinder piston stuck	See MASTER CYLINDERS or BRAKE SYSTEM
Brake fade due to incorrect pads for linings	Replace pads or linings
Linings or pads glazed	Replace pads or linings
Worn drums	Reface or replace drums
Excessive Pedal Travel	
Partial brake system failure	Check fluid and pipes
Insufficient fluid in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
Air trapped in system	See BRAKE BLEEDING or BRAKE SYSTEM
Rear brakes not adjusted	See Adjustments in DRUM BRAKES or BRAKE SYSTEM
Bent shoe or lining	See DRUM BRAKES or BRAKE SYSTEM
Plugged master cylinder cap	See MASTER CYLINDERS or BRAKE SYSTEM
Improper brake fluid	Replace brake fluid
Pedal Travel Decreasing	
Compensating port plugged	See MASTER CYLINDERS or BRAKE SYSTEM
Swollen cup in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
Master cylinder piston not returning	See MASTER CYLINDERS or BRAKE SYSTEM
Weak shoe retracting springs	See DRUM BRAKES BRAKE SYSTEM
Wheel cylinder piston sticking	See DRUM BRAKES or BRAKE SYSTEM
Dragging Brakes	
Master cylinder pistons not returning	See MASTER CYLINDERS BRAKE SYSTEM
Restricted brake lines or hoses	Check line routing
Incorrect parking brake adjustment	See DRUM BRAKES BRAKE SYSTEM
Parking Brake cables frozen	See DRUM BRAKES BRAKE SYSTEM
Incorrect installation of inboard disc pad	Remove and replace correctly
Power booster output rod too long	See POWER BRAKE UNITS BRAKE SYSTEM
Brake pedal not returning freely	See DISC, DRUM BRAKES BRAKE SYSTEM
Brakes Grab or Uneven Braking Action	
Malfunction of combination valve	See CONTROL VALVE or BRAKE SYSTEM
Malfunction of power brake unit	See POWER BRAKE UNITS or BRAKE SYSTEM
Binding brake pedal	See DISC, DRUM BRAKES or BRAKE SYSTEM
Pulsation or Roughness	
Uneven pad wear caused by caliper	See DISC BRAKES or BRAKE SYSTEM
Uneven rotor wear	See DISC BRAKES or BRAKE SYSTEM
Drums out-of-round	Reface or replace drums

ENGINE MECHANICAL

COOLING SYSTEM TROUBLE SHOOTING

NOTE:

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COOLING SYSTEM TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
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Overheating	
Coolant Leak	Fill/Pressure Test System
A/C Condenser Fins Clogged	Remove/Clean Condenser
Radiator Fins Clogged	Remove/Clean Radiator
Thermostat Stuck Closed	Replace Thermostat
Clogged Cooling System Passages	Clean/Flush Cooling System
Water Pump Malfunction	Replace Water Pump
Fan Clutch Malfunction	Replace Fan Clutch
Retarded Ignition Timing	Reset Ignition Timing
Cooling Fan Malfunction	Test Cooling Fan/Circuit
Cooling Fan Motor Malfunction	Test Fan Motor
Cooling Fan Relay Malfunction	Test Fan Relay
Faulty Radiator Cap	Replace Radiator Cap
Broken/Slipping Fan Belt	Replace Fan Belt
Restricted Exhaust	Repair Exhaust System
Corrosion	
Impurities In Coolant	Clean/Flush System
Coolant Leakage	
Damaged hose	Replace Hose
Leaky Water Pump	Replace Water Pump
Damaged Radiator Seam	Replace/Repair Radiator
Leaky Thermostat Cover	Replace Thermostat Cover
Cylinder Head Problem	Check Head/Head Gasket
Leaky Freeze Plugs	Replace Freeze Plugs
Recovery System Inoperative	
Loose and/or Defective Radiator Cap	Replace Radiator Cap
Overflow Tube Clogged and/or Leaking	Repair Tube
Recovery Bottle Vent Restricted	Clean Vent
No Heater Core Flow	
Collapsed Heater Hose	Replace Heater Hose
Plugged Heater Core	Clean/Replace Heater Core
Faulty Heater Valve	Replace Heater Valve

GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING

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BASIC GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Lopes At Idle	
Intake manifold-to-head leaks	Replace manifold gasket, See ENGINES
Blown head gasket	Replace head gasket, See ENGINES
Worn timing gears, chain or sprocket	Replace gears, chain or sprocket
Worn camshaft lobes	Replace camshaft, See ENGINES
Overheated engine	Check cooling system, See COOLING
Blocked crankcase vent valve	Remove restriction
Leaking EGR valve	Repair leak and/or replace valve
Faulty fuel pump	Replace fuel pump
Engine Has Low Power	
Leaking fuel pump	Repair leak and/or replace fuel pump
Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
Sticking valves or weak valve springs	Check valve train components, See ENGINES
Incorrect valve timing	Reset valve timing, See ENGINES
Worn camshaft lobes	Replace camshaft, See ENGINES
Blown head gasket	Replace head gasket. See ENGINES.
Clutch slipping	Adjust pedal and/or replace components, See ENGINES

Engine overheating	Check cooling system, See COOLING
Auto. Trans. pressure regulator valve faulty	Replace pressure regulator valve
Auto. Trans. fluid level too low	Add fluid as necessary
Improper vacuum diverter valve operation	Replace vacuum diverter valve
Vacuum leaks	Inspect vacuum system and repair as required
Leaking piston rings	Replace piston rings, See ENGINES
Faulty High Speed Operation	
Low fuel pump volume	Replace fuel pump
Leaking valves or worn	Replace valves and/or springs, See ENGINES
Incorrect valve timing	Reset valve timing, See ENGINES
Intake manifold restricted	Remove restriction
Worn distributor shaft	Replace distributor
Faulty Acceleration	
Improper fuel pump stroke	Remove pump and reset pump stroke
Incorrect ignition timing	Reset ignition timing, See TUNE-UP
Leaking valves	Replace valves, See ENGINES
Worn fuel pump diaphragm or piston	Replace diaphragm or piston
Intake Backfire	
Improper ignition timing	Reset ignition timing, See TUNE-UP
Faulty accelerator pump discharge	Replace accelerator pump
Improper choke operation	Check choke and adjust as required
Defective EGR valve	Replace EGR valve
Fuel mixture too lean	Reset air/fuel mixture, See TUNE-UP
Choke valve initial clearance too large	Reset choke valve initial clearance
Exhaust Backfire	
Vacuum leak	Inspect and repair vacuum system
Faulty vacuum diverter valve	Replace vacuum diverter valve
Faulty choke operation	Check choke and adjust as required
Exhaust system leak	repair exhaust system leak
Engine Detonation	
Ignition timing too far advanced	Reset ignition timing, See TUNE-UP
Faulty ignition system	Check ignition timing, See TUNE-UP
Spark plugs loose or faulty	Retighten or replace plugs
Fuel delivery system clogged	Inspect lines, pump and filter for clog
EGR valve inoperative	Replace EGR valve
PCV system inoperative	Inspect and/or replace hoses or valve
Vacuum leaks	Check vacuum system and repair leaks
Excessive combustion chamber deposits	Remove built-up deposits
Leaking, sticking or broken valves	Inspect and/or replace valves
External Oil Leakage	
Fuel pump improperly seated or worn gasket	Remove pump, replace gasket and seat properly
Oil pan gasket broken or pan bent	Straighten pan and replace gasket
Timing chain cover gasket broken	Replace timing chain cover gasket
Rear main oil seal worn	Replace rear main oil seal
Oil pan drain plug not seated properly	Remove and reinstall drain plug
Camshaft bearing drain hole blocked	Remove restriction
Oil pressure sending switch leaking	Remove and reinstall sending switch
Excessive Oil Consumption	
Worn valve stems or guides	Replace stems or guides, See

	ENGINES
Valve "O" ring seals damaged	Replace "O" ring seals, See ENGINES
Plugged oil drain back holes	Remove restrictions
Improper PCV valve operation	Replace PCV valve
Engine oil level too high	Remove excess oil
Engine oil too thin	Replace thicker oil
Valve stem oil deflectors damaged	Replace oil deflectors
Incorrect piston rings	Replace piston rings, See ENGINES
Piston ring gaps not staggered	Reinstall piston rings, See ENGINES
Insufficient piston ring tension	Replace rings, See ENGINES
Piston ring grooves or oil return	slots clogged Replace piston rings, See ENGINES
Piston rings sticking in grooves	Replace piston rings, See ENGINES
Piston ring grooves excessively worn	Replace piston and rings, See ENGINES
Compression rings installed upside down	Replace compression rings correctly, See ENGINES
Worn or scored cylinder walls	Rebore cylinders or replace block
Mismatched oil ring expander and rail	Replace oil ring expander and rail, See ENGINES
Intake gasket dowels too long	Replace intake gasket dowels
Excessive main or connecting rod bearing clearance	Replace main or connecting rod bearings, See ENGINES
No Oil Pressure	
Low oil level	Add oil to proper level
Oil pressure sender or gauge broken	Replace sender or gauge
Oil pump malfunction	Remove and overhaul oil pump, See ENGINES
Oil pressure relief valve sticking	Remove and reinstall valve
Oil pump passages blocked	Overhaul oil pump, See ENGINES
Oil pickup screen or tube blocked	Remove restriction
Loose oil inlet tube	Tighten oil inlet tube
Loose camshaft bearings	Replace camshaft bearings, See ENGINES
Internal leakage at oil passages	Replace block or cylinder head
Low Oil Pressure	
Low engine oil level	Add oil to proper level
Engine oil too thin	Remove and replace with thicker oil
Excessive oil pump clearance	Reduce oil pump clearance, See ENGINES
Oil pickup tube or screen blocked	Remove restrictions
Main, rod or cam bearing clearance excessive	Replace bearing to reduce clearance, See ENGINES
High Oil Pressure	
Improper grade of oil	Replace with proper oil
Oil pressure relief valve stuck closed	Eliminate binding
Oil pressure sender or gauge faulty	Replace sender or gauge
Noisy Main Bearings	
Inadequate oil supply	Check oil delivery to main bearings
Excessive main bearing clearance	Replace main bearings, See ENGINES
Excessive crankshaft end play	Replace crankshaft, See ENGINES
Loose flywheel or torque converter	Tighten attaching bolts
Loose or damaged vibration damper	Tighten or replace vibration damper
Crankshaft journals out-of-round	Re-grind crankshaft journals
Excessive belt tension	Loosen belt tension
Noisy Connecting Rods	
Excessive bearing clearance or missing bearing	Replace bearing, See ENGINES
Crankshaft rod journal out-of-round	Re-grind crankshaft journal
Misaligned connecting rod or cap	Remove rod or cap and realign
Incorrectly tightened rod bolts	Remove and re-tighten rod

	bolts
Noisy Pistons and Rings	
Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
Bore tapered or out-of-round	Rebore block
Piston ring broken	Replace piston rings, See ENGINES
Piston pin loose or seized	Replace piston pin, See ENGINES
Connecting rods misaligned	Realign connecting rods
Ring side clearance too loose or tight	Replace with larger or smaller rings
Carbon build-up on piston	Remove carbon
Noisy Valve Train	
Worn or bent push rods	Replace push rods, See ENGINES
Worn rocker arms or bridged pivots	Replace push rods, See ENGINES
Dirt or chips in valve lifters	Remove lifters and remove dirt/chips
Excessive valve lifter leak-down	Replace valve lifters, See ENGINES
Valve lifter face worn	Replace valve lifters, See ENGINES
Broken or cocked valve springs	Replace or reposition springs
Too much valve stem-to-guide clearance	Replace valve guides, See ENGINES
Valve bent	Replace valve, See ENGINES
Loose rocker arms	Retighten rocker arms, See ENGINES
Excessive valve seat run-out	Reface valve seats, See ENGINES
Missing valve lock	Install new valve lock
Excessively worn camshaft lobes	Replace camshaft, See ENGINES
Plugged valve lifter oil holes	Eliminate restriction or replace lifter
Faulty valve lifter check ball	Replace lifter check ball, See ENGINES
Rocker arm nut installed upside down	Remove and reinstall correctly
Valve lifter incorrect for engine	Remove and replace valve lifters
Faulty push rod seat or lifter plunger	Replace plunger or push rod
Noisy Valves	
Improper valve lash	Re-adjust valve lash, See ENGINES
Worn or dirty valve lifters	Clean and/or replace lifters
Worn valve guides	Replace valve guides, See ENGINES
Excessive valve seat or face run-out	Reface seats or valve face
Worn camshaft lobes	Replace camshaft, See ENGINES
Loose rocker arm studs	Re-tighten rocker arm studs, See ENGINES
Bent push rods	Replace push rods, See ENGINES
Broken valve springs	Replace valve springs, See ENGINES
Burned,Sticking or Broken Valves	
Weak valve springs or warped valves	Replace valves and/or springs, See ENGINES
Improper lifter clearance	Re-adjust clearance or replace lifters
Worn guides or improper guide clearance	Replace valve guides, See ENGINES
Out-of-round valve seats or improper seat width	Re-grind valve seats
Gum deposits on valve stems, seats or guide	Remove deposits
Improper spark timing	Re-adjust spark timing
Broken Pistons/Rings	
Undersize pistons	Replace with larger pistons, See ENGINES
Wrong piston rings	Replace with correct rings, See ENGINES
Out-of-round cylinder bore	Re-bore cylinder bore

Improper connecting rod alignment	Remove and realign connecting rods
Excessively worn ring grooves	Replace pistons, See ENGINES
Improperly assembled piston pins	Re-assemble pin-to-piston, See ENGINES
Insufficient ring gap clearance	Install new rings, See ENGINES
Engine overheating	Check cooling system
Incorrect ignition timing	Re-adjust ignition timing, See TUNE-UP
Excessive Exhaust Noise	
Leaks at manifold to head, or to pipe	Replace manifold or pipe gasket
Exhaust manifold cracked or broken	Replace exhaust manifold, See ENGINES

ENGINE PERFORMANCE

CARBURETOR TROUBLE SHOOTING:

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BASIC COLD START SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Choke not closing	Check choke operation, see FUEL SYSTEMS
Choke linkage bent	Check linkage, see FUEL SYSTEM
Engine Starts, Then Dies	
Choke vacuum kick setting too wide	Check setting and adjust see, FUEL SYSTEMS
Fast idle RPM too low	Reset RPM to specification, see TUNE-UP
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEMS
Vacuum leak	Inspect vacuum system for leaks
Low fuel pump outlet	Repair or replace pump, see FUEL SYSTEMS
Low carburetor fuel level	Check float setting see FUEL SYSTEM
Engine Quits Under Load	
Choke vacuum kick setting incorrect	Reset vacuum kick setting,see FUEL SYSTEMS
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEM
Incorrect hot fast idle speed RPM	Reset fast idle RPM, see TUNE-UP
Engine Starts, Runs Up, Then Idles, Slowly With Black Smoke	
Choke vacuum kick set too narrow	Reset vacuum kick, see FUEL SYSTEMS
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEMS
Hot fast idle RPM too low	Reset fast idle RPM, see TUNE-UP

BASIC HOT START SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Engine flooded	Allow fuel to evaporate

BASIC COLD ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Stalls in Gear	
Choke vacuum kick setting incorrect	Reset choke vacuum kick, see FUEL SYSTEMS
Fast idle RPM incorrect	Reset fast idle RPM, see TUNE-UP
Fast idle cam index incorrect	Reset fast idle cam see FUEL

	SYSTEMS
Acceleration Sag or Stall	
Defective choke control switch	Replace choke control switch
Choke vacuum kick setting incorrect	Reset choke vacuum kick see, FUEL SYSTEMS
Float level incorrect (too low)	Adjust float level, FUEL SYSTEMS
Accelerator pump defective	Repair or replace pump see FUEL SYSTEMS
Secondary throttles not closed	Inspect lockout adjustment, see FUEL SYSTEMS
Sag or Stall After Warmup	
Defective choke control switch	Replace choke control switch, see FUEL SYSTEMS
Defective accelerator pump	Replace pump, see FUEL SYSTEMS
Float level incorrect (too low)	Adjust float level, see FUEL SYSTEMS
Backfiring & Black Smoke	
Plugged heat crossover system	Remove restriction

BASIC WARM ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Hesitation With Small Amount of Gas Pedal Movement	
Vacuum leak	Inspect vacuum lines
Accelerator pump weak or inoperable	Replace pump, see FUEL SYSTEMS
Float level setting too low	Reset float level, see,FUEL SYSTEMS
Metering rods sticking or binding	Inspect and/or replace rods, see FUEL SYSTEMS
Carburetor idle or transfer system plugged	Inspect system and remove restriction
Frozen or binding heated air inlet	Inspect heated air door for binding
Hesitation With Heavy Gas Pedal Movement	
Defective accelerator pump	Replace pump, see FUEL SYSTEMS
Metering rod carrier sticking or binding	Remove restriction
Large vacuum leak	Inspect vacuum system and repair leak
Float level setting too low	Reset float level, see FUEL SYSTEMS
Defective fuel pump, lines or filter	Inspect pump, lines and filter
Air door setting incorrect	Adjust air door setting, see FUEL

DIESEL ENGINE TROUBLE SHOOTING

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NOTE: Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

BASIC DIESEL ENGINE TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Crank	
Bad battery connections or dead batteries	Check connections and/or replace batteries
Bad starter connections or bad starter	Check connections and/or replace starter
Engine Cranks Slowly, Won't Start	
Bad battery connections or dead batteries	Check connections and/or replace batteries
Engine oil too heavy	Replace engine oil
Engine Cranks Normally, But Will Not Start	
Glow plugs not functioning	Check glow plug system, see FUEL SYSTEMS
Glow plug control not functioning	Check controller, see FUEL SYSTEMS

Fuel not injected into cylinders	Check fuel injectors, see FUEL SYSTEMS
No fuel to injection pump	Check fuel delivery system
Fuel filter blocked	Replace fuel filter
Fuel tank filter blocked	Replace fuel tank filter
Fuel pump not operating	Check pump operation and/or replace pump
Fuel return system blocked	Inspect system and remove restriction
No voltage to fuel solenoid	Check solenoid and connections
Incorrect or contaminated fuel	Replace fuel
Incorrect injection pump timing	Re-adjust pump timing, see FUEL SYSTEMS
Low compression	Check valves, pistons, rings, see ENGINES
Injection pump malfunction	Inspect and/or replace injection pump
Engine Starts, Won't Idle	
Incorrect slow idle adjustment	Reset idle adjustment, see TUNE-UP
Fast idle solenoid malfunctioning	Check solenoid and connections
Fuel return system blocked	Check system and remove restrictions
Glow plugs go off too soon	See glow plug diagnosis in FUEL SYSTEMS
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
No fuel to injection pump	Check fuel delivery system
Incorrect or contaminated fuel	Replace fuel
Low compression	Check valves, piston, rings, see ENGINES
Injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
Fuel solenoid closes in RUN position	Check solenoid and connections
Engines Starts/Idles Rough W/out Smoke or Noise	
Incorrect slow idle adjustment	Reset slow idle, see TUNE-UP
Injection line fuel leaks	Check lines and connections
Fuel return system blocked	Check lines and connections
Air in fuel system	Bleed air from system
Incorrect or contaminated fuel	Replace fuel
Injector nozzle malfunction	Check nozzles, see FUEL SYSTEMS
Engines Starts and Idles Rough W/out Smoke or Noise, But Clears After Warm-Up	
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
Engine not fully broken in	Put more miles on engine
Air in system	Bleed air from system
Injector nozzle malfunction	Check nozzles, see FUEL SYSTEMS
Engine Idles Correctly, Misfires Above Idle	
Blocked fuel filter	Replace fuel filter
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
Incorrect or contaminated fuel	Replace fuel
Engine Won't Return To Idle	
Fast idle adjustment incorrect	Reset fast idle, see TUNE-UP
Internal injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
External linkage binding	Check linkage and remove binding
Fuel Leaks On Ground	
Loose or broken fuel line	Check lines and connections
Internal injection pump seal leak	Replace injection pump, see FUEL SYSTEMS
Cylinder Knocking Noise	
Injector nozzles sticking open	Test injectors, see FUEL SYSTEMS
Very low nozzle opening pressure	Test injectors and/or replace
Loss of Engine Power	
Restricted air intake	Remove restriction

EGR valve malfunction	Replace EGR valve
Blocked or damaged exhaust system	Remove restriction and/or replace components
Blocked fuel tank filter	Replace filter
Restricted fuel filter	Remove restriction and/or replace filter
Block vent in gas cap	Remove restriction and/or replace cap
Tank-to-injection pump fuel supply blocked	Check fuel lines and connections
Blocked fuel return system	Remove restriction
Incorrect or contaminated fuel	Replace fuel
Blocked injector nozzles	Check nozzle for blockage, see FUEL SYSTEMS
Low compression	Check valves, rings, pistons, see ENGINES
Loud Engine Noise With Black Smoke	
Basic timing incorrect	Reset timing, see FUEL SYSTEMS
EGR valve malfunction	Replace EGR valve
Internal injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
Incorrect injector pump housing pressure	Check pressure, see FUEL SYSTEMS
Engine Overheating	
Cooling system leaks	Check cooling system and repair leaks
Belt slipping or damaged	Check tension and/or replace belt
Thermostat stuck closed	Remove and replace thermostat, see ENGINE COOLING
Head gasket leaking	Replace head gasket
Oil Light on at Idle	
Low oil pump pressure	Check oil pump operation, see ENGINES
Oil cooler or line restricted	Remove restriction and/or replace cooler
Engine Won't Shut Off	
Injector pump fuel solenoid does not return fuel valve to OFF position	Remove and check solenoid and replace if needed

VACUUM PUMP DIAGNOSIS

CONDITION & POSSIBLE CAUSE	CORRECTION
Excessive Noise	
Loose pump-to-drive assembly screws	Tighten screws
Loose tube on pump assembly	Tighten tube
Valves not functioning properly	Replace valves
Oil Leakage	
Loose end plug	Tighten end plug
Bad seal crimp	Remove and re-crimp seal

FUEL INJECTION TROUBLE SHOOTING

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BASIC FUEL INJECTION TROUBLE SHOOTING CHART

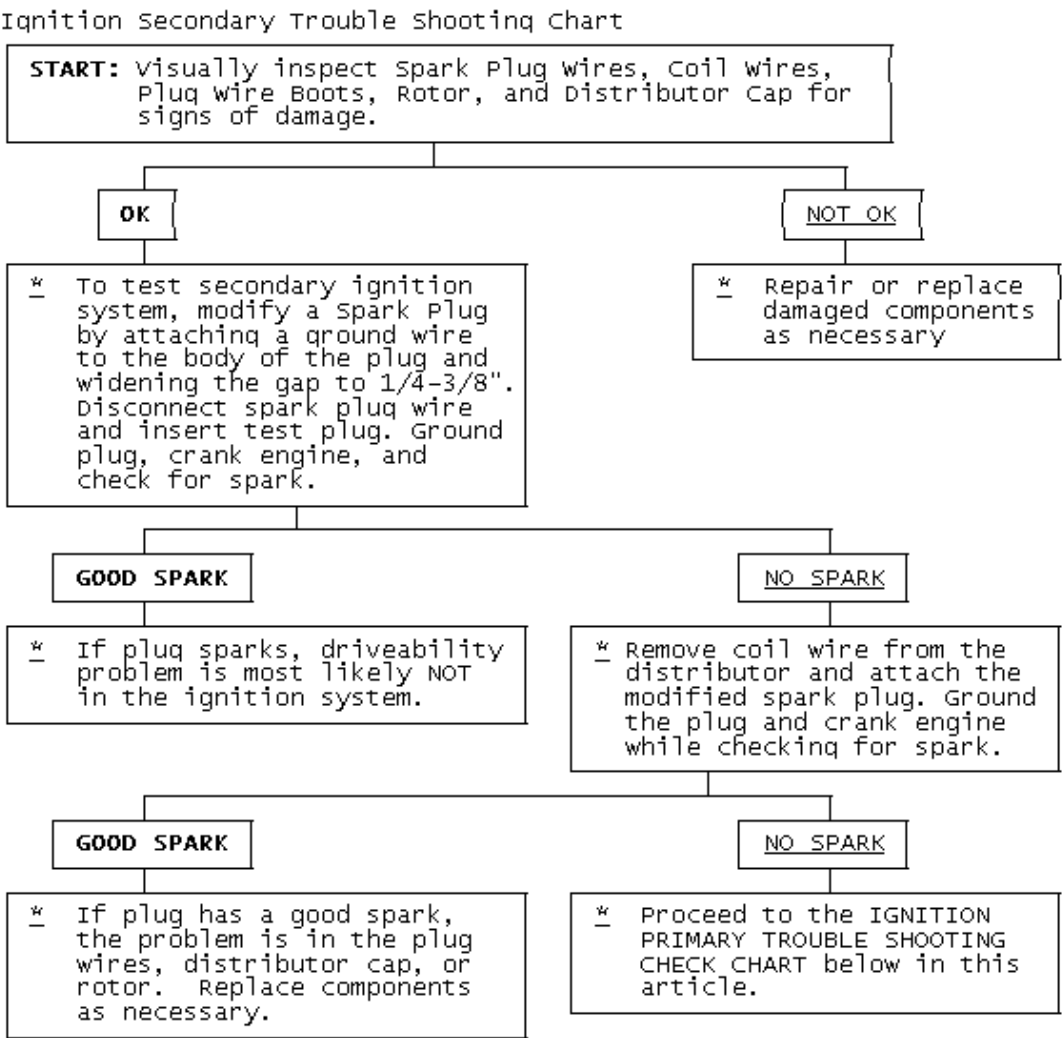
CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start (Crankes Normally)	
Cold start valve inoperative	Test valve and circuit
Poor connection;vacuum or wiring	Check vacuum and electrical connections
Contaminated fuel	Test fuel for water or alcohol
Defective fuel pump relay or circuit	Test relay and wiring
Battery too low	Charge and test battery
Low fuel pressure	Test pressure regulator and fuel pump, check for restricted lines and filters
No distributor reference pulses	Repair ignition system as necessary

Open coolant temperature sensor circuit	Test sensor and wiring
Shorted W.O.T. switch in T.P.S.	Disconnect W.O.T. switch, engine should start
Defective ECM	Replace ECM
Fuel tank residual pressure valve leaks	Test for fuel pressure drop after shut down
Hard Starting	
Disconnected hot air tube to air cleaner	Reconnect tube and test control valve
Defective Idle Air Control (IAC) valve	Test valve operation and circuit
Shorted, open or misadjusted T.P.S.	Test and adjust or replace T.P.S.
EGR valve open	Test EGR valve and control circuit
Poor Oxygen sensor signal	Test for shorted or circuit
Incorrect mixture from PCV system	Test PCV for flow, check sealing of oil filter cap
Poor High Speed Operation	
Low fuel pump volume	Faulty pump or restricted fuel lines or filters
Poor MAP sensor signal	Test MAP sensor, vacuum hose and wiring
Poor Oxygen sensor signal	Test for shorted or open sensor or circuit
Open coolant temperature sensor circuit	Test sensor and wiring
Faulty ignition operation	Check wires for cracks or poor con- nections, test secondary voltage with oscilloscope
Contaminated fuel	Test fuel for water or alcohol
Intermittent ECM ground	Test ECM ground connection for resistance
Restricted air cleaner	Replace air cleaner
Restricted exhaust system	Test for exhaust manifold back pressure
Poor MAF sensor signal	Check leakage between sensor and manifold
Poor VSS signal	If tester for ALCL hook-up is available check that VSS reading matches speedometer
Ping or Knock on Acceleration	
Poor Knock sensor signal	Test for shorted or open sensor or circuit
Poor Baro sensor signal	Test for shorted or open sensor or circuit
Improper ignition timing	See VEHICLE EMISSION CONTROL LABEL (where applicable)
Check for engine overheating problems	Low coolant, loose belts or electric cooling fan inoperative

NOTE: For additional electronic fuel injection trouble shooting information, see the appropriate article in the **ENGINE PERFORMANCE** section (not all vehicles have Computer Engine Control articles). Information is provided there for diagnosing fuel system problems on vehicles with electronic fuel injection.

IGNITION SYSTEM TROUBLE SHOOTING

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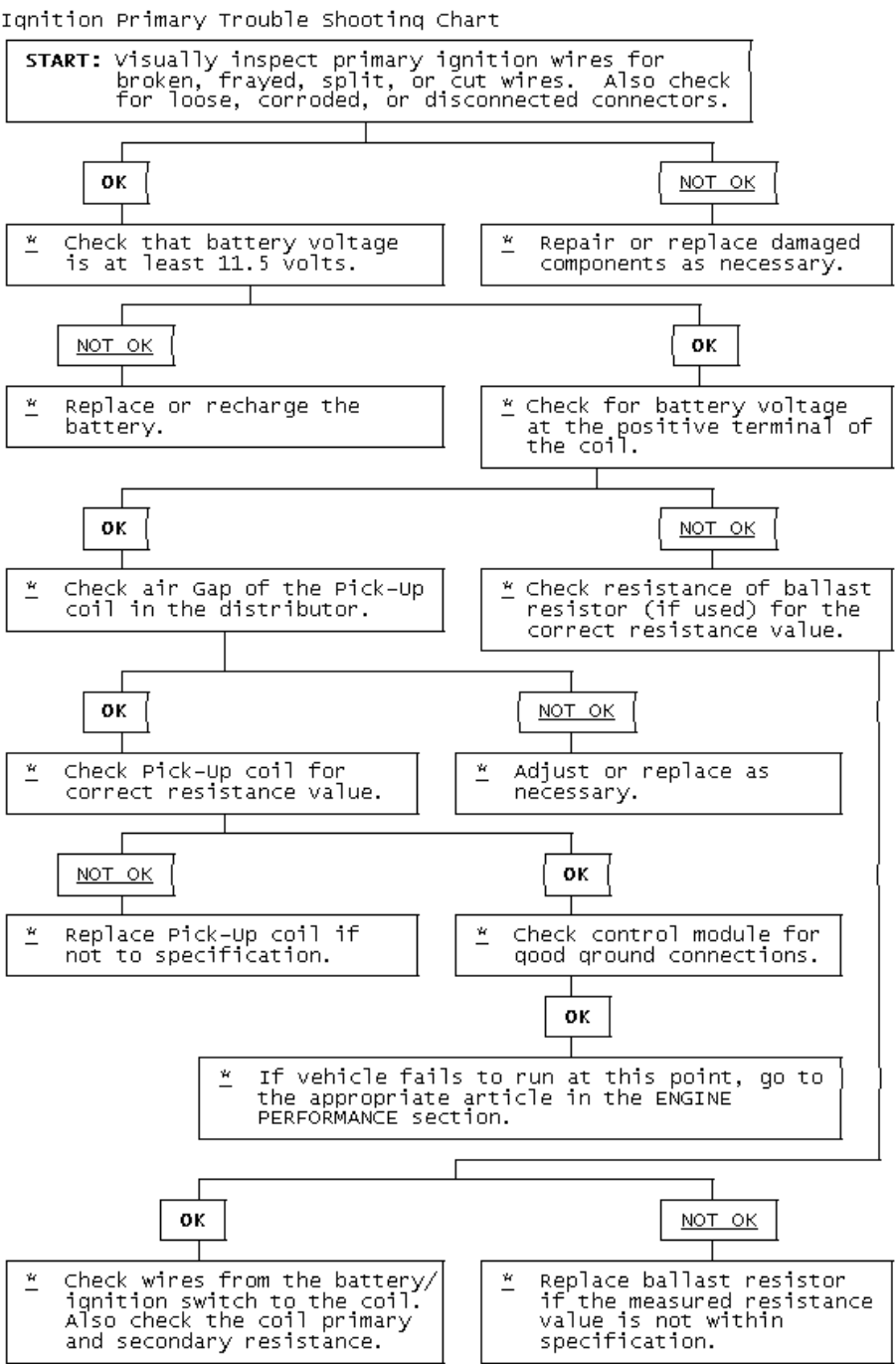


Fig. 4: Ignition Primary Trouble Shooting Chart

STARTER TROUBLE SHOOTING

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BASIC STARTER TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	
Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter
Ignition switch faulty or misadjusted	Adjust or replace ignition switch
Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
Starter relay or starter defective	See Testing in STARTER article
Open solenoid pull-in wire	See Testing in STARTER article
Starter Does Not Operate and Headlights Dim	
Weak battery or dead cell	Charge or replace battery as necessary
Loose or corroded battery connections	Check that battery connections are clean and tight
Internal ground in starter windings	See Testing in STARTER article
Grounded starter fields	See Testing in STARTERS
Armature rubbing on pole shoes	See STARTER article

Starter Turns but Engine Does Not Rotate	
Starter clutch slipping	See STARTER article
Broken clutch housing	See STARTER article
Pinion shaft rusted or dry	See STARTER article
Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	
Faulty overrunning clutch	See STARTER article
Broken clutch housing	See STARTER article
Broken flywheel teeth	Replace flywheel and check for starter pinion gear damage
Armature shaft sheared or reduction gear teeth stripped	See STARTER article
Weak battery	Charge or replace battery as necessary
Faulty solenoid	See On-Vehicle Tests in STARTER article
Poor grounds	Check all ground connections for tight and clean connections
Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	
Battery weak or defective	Charge or replace battery as necessary
Engine overheated	See ENGINE COOLING SYSTEM article
Engine oil too heavy	Check that proper viscosity oil is used
Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
Current draw too low or too high	See Bench Tests in STARTER article
Bent armature, loose pole shoes screws or worn bearings	See STARTER article
Burned solenoid contacts	Replace solenoid
Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	
Engine timing too far advanced	See Ignition Timing in TUNE-UP article
Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
Broken starter clutch	See STARTER article
Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
Weak drive assembly thrust spring	See STARTER article
Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	
Defective point assembly	See Testing in STARTER article
Poor point assembly ground	See Testing in STARTER article
Defective pull-in coil	Replace starter solenoid
Starter Relay Does Not Close	
Dead battery	Charge or replace battery as necessary
Faulty wiring	Check all wiring and connections leading to relay
Neutral safety switch faulty	Replace neutral safety switch
Starter relay faulty	Replace starter relay
Starter Drive Will Not Disengage	
Starter motor loose on mountings	Tighten starter attach bolts
Worn drive end bushing	See STARTER article
Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
Drive yolk return spring broken or missing	Replace return spring
Faulty ignition switch	Replace ignition switch
Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
Starter clutch not disengaging	Replace starter clutch
Ignition starter switch contacts sticking	Replace ignition switch
Starter Relay Operates but Solenoid Does Not	

Faulty solenoid switch, switch connections or relay	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	
Weak battery	Charge or replace battery as necessary
Solenoid contacts corroded	Clean contacts or replace solenoid
Faulty wiring	Check all wiring leading to solenoid
Broken connections inside switch cover	Repair connections or replace solenoid
Open hold-in wire	Replace solenoid
Low Current Draw	
Worn brushes or weak	Replace brushes or brush springs as necessary
High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	
Distance too great between starter pinion and flywheel	Align starter or check that correct starter and flywheel are being used
High Pitched Whine After Engine Fires With Key released. Engine Fires and Cranks Normally	
Distance too small between starter pinion and flywheel	Flywheel runout contributes to the intermittent nature

TUNE-UP TROUBLE SHOOTING - GAS ENGINE VEHICLES

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BASIC SPARK PLUG TROUBLE SHOOTING CHARTS

CONDITION & POSSIBLE CAUSE	CORRECTION
Normal Spark Plug Condition	
Light Tan or Gray deposits	No Action
Electrode not burned or fouled	No Action
Gap tolerance not changed	No Action
Cold Fouling or Carbon Deposits	
Overrich air/fuel mixture	Adjust air/fuel mixture, see ENGINE PERFORMANCE section
Faulty choke	Replace choke assembly, see ENGINE PERFORMANCE section
Clogged air filter	Clean and/or replace air filter
Incorrect idle speed or dirty carburetor	Reset idle speed and/ or clean carburetor
Faulty ignition wires	Replace ignition wiring
Prolonged operation at idle	Shut engine off during long idle
Sticking valves or worn valve guide seals	Check valve train
Wet Fouling or Oil Deposits	
Worn rings and pistons	Install new rings and pistons
Excessive cylinder wear	Rebore or replace block
Excessive valve guide clearance	Worn or loose bearing
Gap Bridged	
Deposits in combustion chamber becoming fused to electrode	Clean combustion chamber of deposits
Blistered Electrode	
Engine overheating	Check cooling system
Wrong type of fuel	Replace with correct fuel
Loose spark plugs	Retighten spark plugs
Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Pre-Ignition or Melted Electrodes	
Incorrect type of fuel	Replace with correct fuel
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Burned valves	Replace valves
Engine Overheating	Check cooling system
Wrong type of spark plug, too hot	Replace with correct spark

	plug, see ENGINE PERFORMANCE
Chipped Insulators	
Severe detonation	Check for over-advanced timing or combustion
Improper gapping procedure	Re-gap spark plugs
Rust Colored Deposits	
Additives in unleaded fuel	Try different fuel brand
Water In Combustion Chamber	
Blown head gasket or cracked head	Repair or replace head or head gasket

NOTE: Before diagnosing an electronic ignition system, ensure that all wiring is connected properly between distributor, wiring connector and spark plugs. Ignition problem will show up either as: Engine Will Not Start or Engine Runs Rough.

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Open circuit between distributor and bulkhead connector	Repair circuit
Open circuit between bulkhead connector and ignition switch	Repair circuit
Open circuit between ignition switch and starter solenoid	Repair circuit
Engine Runs Rough	
Fuel lines leaking or clogged	Tighten fitting, remove restriction
Initial timing incorrect	Reset ignition timing see ENGINE PERFORMANCE
Centrifugal advance malfunction	Repair distributor advance
Defective spark plugs or wiring	Replace plugs or plug wiring
Component Failure	
Spark arc-over on cap, rotor or coil	Replace cap, rotor or or coil
Defective pick-up coil	Replace pick-up coil
Defective ignition coil	Replace ignition coil
Defective vacuum unit	Replace vacuum unit
Defective control module	Replace control module

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS - USING OSCILLOSCOPE PATTERNS

CONDITION & POSSIBLE CAUSE	CORRECTION
Firing Voltage Lines are the Same, but Abnormally High	
Retarded ignition timing	Reset ignition timing, see ENGINE PERFORMANCE section
Fuel mixture too lean	Readjust carburetor, see ENGINE PERFORMANCE
High resistance in coil wire	Replace coil wire
Corrosion in coil tower terminal	Clean and/or replace coil
Corrosion in distributor coil terminal	Clean and/or replace distributor cap
Firing Voltage Lines are the Same but Abnormally Low	
Fuel mixture too rich	Readjust carburetor, see ENGINE PERFORMANCE
Breaks in coil wire causing arcing	Replace coil wire
Cracked coil tower causing arcing	Replace coil
Low coil output	Replace coil
Low engine compression	Determine cause and repair
One or More, But Not All Firing Voltage Lines are Higher Than Others	
Carburetor idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
EGR valve stuck open	Clean and/or replace valve
High resistance in spark plug wires	Replace spark plug wires
Cracked or broken spark plug insulator	Replace spark plugs
Intake vacuum leak	Repair leak
Defective spark plugs	Replace spark plugs
Corroded spark plug terminals	Replace spark plugs
One or More, But Not All Firing Voltage Lines Are Lower Than Others	
Curb idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
Breaks in plug wires	Replace plug wires causing arcing
Cracked coil tower causing arcing	Replace coil
Low compression	Determine cause and repair
Defective spark plugs	Replace spark plugs

Corroded spark plugs	Replace spark plugs
Cylinders Not Firing	
Cracked distributor cap terminals	Replace distributor cap
Shorted spark plug wire	Determine cause and repair
Mechanical problem in engine	Determine cause and repair
Defective spark plugs	Replace spark plugs
Spark plugs fouled	Replace spark plugs

BASIC DRIVEABILITY PROBLEMS TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Hard Starting	
Binding carburetor linkage	Eliminate binding
Binding choke linkage	Eliminate binding
Binding choke piston	Eliminate binding
Restricted choke vacuum	Check vacuum lines for blockage
Worn or dirty needle valve and seat	Clean carburetor, see ENGINE PERFORMANCE
Float sticking	Readjust or replace float see the ENGINE PERFORMANCE section
Incorrect choke adjustment	Reset choke adjustment see ENGINE PERFORMANCE
Defective coil	Replace coil
Improper spark plug gap	Regap spark plugs
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Detonation	
Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Defective spark plugs	Replace spark plugs
Fuel lines clogged	Clean fuel lines
EGR system malfunction	Check and repair EGR system
PCV system malfunction	Repair PCV system
Vacuum leaks	Check and repair vacuum system
Loose fan belts	Tighten or replace fan belts, see ENGINE PERFORMANCE
Restricted airflow	Remove restriction
Vacuum advance malfunction	Check distributor operation
Dieseling	
Binding carburetor linkage	Eliminate binding
Binding throttle linkage	Eliminate blinding
Binding choke linkage or fast idle cam	Eliminate binding
Defective idle solenoid	Replace idle solenoid see ENGINE PERFORMANCE
Improper base idle speed	Reset idle speed, see see ENGINE PERFORMANCE
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Incorrect idle mixture setting	Reset idle mixture, see ENGINE PERFORMANCE
Faulty Acceleration	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Engine cold and choke too lean	Adjust choke and allow engine to warm-up
Defective spark plugs	Replace spark plugs
Defective coil	Replace coil
Faulty Low Speed Operation	
Clogged idle transfer slots	Clean idle transfer slots, see FUEL
Restricted idle air bleeds and passages	Disassemble and clean carburetor, see FUEL
Clogged air cleaner	Replace air filter
Defective spark plugs	Replace spark plugs
Defective ignition wires	Replace ignition wire see ENGINE PERFORMANCE
Defective distributor cap	Replace distributor cap
Faulty High Speed Operation	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE

Defective distributor centrifugal advance	Replace advance mechanism
Defective distributor vacuum advance	Replace advance unit
Incorrect spark plugs or plug gap	Check gap and/or replace spark plugs
Faulty choke operation	Check choke and repair as required
Clogged vacuum passages	Remove restrictions
Improper size or clogged main jet	Check jet size and clean, see FUEL
Restricted air cleaner	Check filter and replace as necessary
Defective distributor cap, rotor or coil	Replace cap, rotor or coil
Misfire at All Speeds	
Defective spark plugs	Replace spark plugs
Defective spark plug wires	Replace spark plug wires
Defective distributor cap, rotor, or coil	Replace cap, rotor, or coil
Cracked or broken vacuum hoses	Replace vacuum hoses
Vacuum leaks	Repair vacuum leaks
Fuel lines clogged	Remove restriction
Hesitation	
Cracked or broken vacuum	Replace vacuum hoses hoses
Vacuum leaks	Repair Vacuum leaks
Binding carburetor linkage	Eliminate binding
Binding throttle linkage	Eliminate binding
Binding choke linkage or fast idle cam	Eliminate binding
Improper float setting	Readjust float setting, see FUEL
Cracked or broken ignition wires	Replace ignition wires
Rough Idle, Missing or Stalling	
Incorrect curb idle or fast idle speed	Reset idle speed, see see ENGINE PERFORMANCE
Incorrect basic timing	Reset ignition timing see ENGINE PERFORMANCE
Improper idle mixture adjustment	Reset idle mixture, see ENGINE PERFORMANCE
Improper feedback system operation	Check feedback system see ENGINE PERFORMANCE
Incorrect spark plug gap	Reset spark plug gap, see ENGINE PERFORMANCE
Moisture in ignition components	Dry components
Loose or broken ignition wires	Replace ignition wires
Damaged distributor cap or or rotor	Replace distributor cap or rotor
Faulty ignition coil	Replace ignition coil
Fuel filter clogged or worn	Replace fuel filter
Damaged idle mixture screw	Replace idle mixture screw, see FUEL
Improper fast idle cam adjustment	Reset fast idle cam adjustment, see TUNE- see ENGINE PERFORMANCE
Improper EGR valve operation	Replace EGR valve
Faulty PCV valve air flow	Replace PCV valve
Choke binding or improper choke setting	Reset choke or eliminate binding
Vacuum leak	Repair vacuum leak
Improper float bowl fuel level	Reset float adjustment, see FUEL
Clogged air bleed or idle passages	Clean carburetor passages, see FUEL
Clogged or worn air cleaner filter	Replace air filter
Faulty choke vacuum diaphragm	Replace diaphragm, see ENGINE PERFORMANCE
Exhaust manifold heat valve inoperative	Replace heat valve
Improper distributor spark advance	Check distributor operation
Leaking valves or valve components	Check and repair valvetrain
Improper carburetor mounting	Remove and remount carburetor
Excessive play in distributor shaft	Replace distributor
Loose or corroded wiring connections	Repair or replace as required
Engine Surges	
Improper PCV valve airflow	Replace PCV valve
Vacuum leaks	Repair vacuum leaks

Clogged air bleeds	Remove restriction
EGR valve malfunction	Replace EGR valve
Restricted air cleaner filter	Replace air filter
Cracked or broken vacuum hoses	Replace vacuum hoses
Cracked or broken ignition wires	Replace ignition wires
Vacuum advance malfunction	Check unit and replace as necessary
Defective or fouled spark plugs	Replace spark plugs
Ping or Spark Knock	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Distributor centrifugal or vacuum advance malfunction	Check operation and replace as necessary
Carburetor setting too lean	Readjust mixture setting, see ENGINE PERFORMANCE
Vacuum leak	Eliminate vacuum leak
EGR valve malfunction	Replace EGR valve
Poor Gasoline Mileage	
Cracked or broken vacuum	Replace vacuum hoses hoses
Vacuum leaks	Repair vacuum leaks
Defective ignition wires	Replace wires
Incorrect choke setting	Readjust setting, see ENGINE PERFORMANCE
Defective vacuum advance	Replace vacuum advance
Defective spark plugs	Replace spark plugs
Binding carburetor power piston	Eliminate binding
Dirt in carburetor jets	Clean and/or replace jets
Incorrect float adjustment	Readjust float setting, see FUEL
Defective power valve	Replace power valve, see ENGINE PERFORMANCE
Incorrect idle speed	Readjust idle speed
Engine Stalls	
Improper float level	Readjust float level
Leaking needle valve and seat	Replace needle valve and seat
Vacuum leaks	Eliminate vacuum leaks

VACUUM PUMP - DIESEL TROUBLE SHOOTING

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NOTE: Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

VACUUM PUMP (DIESEL) TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Excessive Noise	
Loose pump-to-drive assembly screws	Tighten screws
Loose tube on pump assembly	Tighten tube
Valves not functioning properly	Replace valves
Oil Leakage	
Loose end plug	Tighten end plug
Bad seal crimp	Remove and re-crimp seal

MANUAL TRANSMISSION

MANUAL TRANSMISSION TROUBLE SHOOTING

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MANUAL TRANSMISSION/TRANSAXLE TROUBLE SHOOTING

Condition	Possible Cause
Noisy In Forward Gears	Low gear oil level, Loose bell housing bolts, Worn bearings or gears
Clunk On Deceleration (FWD Only)	Loose engine mounts, Worn inboard CV joints, Worn differential pinion shaft, Side gear hub counterbore in case worn oversize

Gear Clash When Shifting Forward Gears	Clutch Out Of Adjustment, Shift linkage damaged or out of adjustment, Gears or synchronizers damaged, Low gear oil level
Transmission Noisy When Moving (RWD Only) Quiet In Neutral With Clutch Engaged	Worn rear outputshaft bearing
Gear Rattle	Worn bearings, Wrong gear oil, Low gear oil, Worn gears
Steady Ticking At Idle (Increases With RPM)	Broken tooth on gear
Gear Clash When Shifting Forward Gears	Worn or broken synchronizers
Loud Whine In Reverse	Normal condition (1)
Noise When Stepping On Clutch	Bad release bearing, Worn pilot bearing
Ticking Or Screeching As Clutch Is Engaged	Faulty release bearing, Uneven pressure plate fingers
Click Or Snap When Clutch Is Engaged	Worn clutch fork, Worn or broken front bearing retainer
Transmission Shifts Hard	Clutch not releasing, Shift mechanism binding, Clutch installed backwards
Will Not Shift Into One Gear, Shifts Into All Others	Bent shift fork, Worn detent balls
Locked Into Gear, Cannot Shift	Clutch adjustment, Worn detent balls
Transmission Jumps Out Of Gear	Pilot bearing worn, Bent shift fork, Worn gear teeth or face, Excessive gear train end play, Worn synchronizers, Missing detent ball spring, Shift mechanism worn or out of adjustment, Engine or transmission mount bolts loose or out of adjustment, Transmission not aligned
Shift Lever Rattle	Worn shift lever or detents, Worn shift forks, Worn synchronizers sleeve
Shift Lever Hops Under Acceleration	Worn engine or transmission mounts
(1) Most units use spur cut gears in reverse and are noisy	

POWERTRAIN

CLUTCH TROUBLE SHOOTING

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BASIC CLUTCH TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Chattering or Grabbing	
Incorrect clutch adjustment	Adjust clutch
Oil, grease or glaze on facings	Disassemble and clean or replace
Loose "U" joint flange	See DRIVE AXLES article
Worn input shaft spline	Replace input shaft
Binding pressure plate	Replace pressure plate
Binding release lever	See CLUTCH article
Binding clutch disc hub	Replace clutch disc
Unequal pressure plate contact	Replace worn/misaligned components
Loose/bent clutch disc	Replace clutch disc
Incorrect transmission alignment	Realign transmission
Worn pressure plate, disc or flywheel	Replace damaged components
Broken or weak pressure springs	Replace pressure plate
Sticking clutch pedal	Lubricate clutch pedal & linkage
Incorrect clutch disc facing	Replace clutch disc
Engine loose in chassis	Tighten all mounting bolts
Failure to Release	
Oil or grease on clutch facings	Clean or replace clutch clutch disc
Incorrect release lever or pedal adjustment	See CLUTCH article
Worn or broken clutch facings	Replace clutch disc
Bent clutch disc or pressure plate	Replace damaged components
Clutch disc hub binding on input shaft	Clean or replace clutch disc and/or input shaft
Binding pilot bearing	Replace pilot bearing
Sticking release bearing sleeve	Replace release bearing and/or sleeve
Binding clutch cable	See CLUTCH article
Defective clutch master	Replace master cylinder
Defective clutch slave	Replace slave cylinder
Air in hydraulic system	Bleed hydraulic system
Rattling	
Weak or broken release lever spring	Replace spring and check alignment
Damaged pressure plate	Replace pressure plate

Broken clutch return spring	Replace return spring
Worn splines on clutch disc or input shaft	Replace clutch disc and/or input shaft
Worn clutch release bearing	Replace release bearing
Dry or worn pilot bearing	Lubricate or replace pilot bearing
Unequal release lever contact	Align or replace release lever
Incorrect pedal free play	Adjust free play
Warped or damaged clutch disc	Replace damaged components
Slipping	
Pressure springs worn or	Release pressure plate
Oily, greasy or worn facings	Clean or replace clutch disc
Incorrect clutch alignment	Realign clutch assembly
Warped clutch disc or pressure plate	Replace damaged components
Binding release levers or clutch pedal	Lubricate and/or replace release components
Squeaking	
Worn or damaged release	Replace release bearing
Dry or worn pilot or release bearing	Lubricate or replace assembly
Pilot bearing turning in crankshaft	Replace pilot bearing and/or crankshaft
Worn input shaft bearing	Replace bearing and seal
Incorrect transmission alignment	Realign transmission
Dry release fork between pivot	Lubricate release fork and pivot
Heavy and/or Stiff Pedal	
Sticking release bearing sleeve	Replace release bearing and/or sleeve
Dry or binding clutch pedal hub	Lubricate and align components
Floor mat interference with pedal	Lay mat flat in proper area
Dry or binding ball/fork pivots	Lubricate and align components
Faulty clutch cable	Replace clutch cable
Noisy Clutch Pedal	
Faulty interlock switch	Replace interlock switch
Self-adjuster ratchet noise	Lubricate or replace self-adjuster
Speed control interlock switch	Lubricate or replace interlock switch
Clutch Pedal Sticks Down	
Binding clutch cable	See CLUTCH article
Springs weak in pressure plate	Replace pressure plate
Binding in clutch linkage	Lubricate and free linkage
Noisy	
Dry release bearing	Lubricate or replace release bearing
Dry or worn pilot bearing	Lubricate or replace bearing
Worn input shaft bearing	Replace bearing
Transmission Click	
Weak springs in pressure	Replace pressure plate plate
Release fork loose on ball stud	Replace release fork and/or ball stud
Oil on clutch disc damper	Replace clutch disc
Broken spring in slave cylinder	Replace slave cylinder

DRIVE AXLE - NOISE DIAGNOSIS

Unrelated Noises

Some driveline trouble symptoms are also common to the engine, transmission, wheel bearings, tires, and other parts of the vehicle. Ensure cause of trouble actually is in the drive axle before adjusting, repairing, or replacing any of its parts.

Non-Drive Axle Noises

A few conditions can sound just like drive axle noise and have to be considered in pre-diagnosis. The 4 most common noises are exhaust, tires, CV/universal joints and wheel trim rings.

In certain conditions, the pitch of the exhaust gases may e gear whine. At other times, it may be mistaken for a wheel bearing rumble.

Tires, especially radial and snow, can have a high-pitched tread whine or roar, similar to gear noise. Also, some non-standard tires with an unusual tread construction may emit a roar or whine.

Defective CV/universal joints may cause clicking noises or excessive driveline play that can be improperly diagnosed as drive axle problems.

Trim and moldings also can cause a whistling or whining noise. Ensure none of these components are causing the noise before disassembling the drive axle.

Gear Noise

A "howling" or "whining" noise from the ring and pinion gear can be caused by an improper gear pattern, gear damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.

Before disassembling axle to diagnose and correct gear ke sure that tires, exhaust, and vehicle trim have been checked as possible causes.

Chuckle

This is a particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 40 MPH and usually can be heard until vehicle comes to a complete stop. The frequency varies with the speed of the vehicle.

A chuckle that occurs on the driving phase is usually caused ive clearance due to differential gear wear, or by a damaged tooth on the coast side of the pinion or ring gear. Even a very small tooth nick or a ridge on the edge of a gear tooth is enough the cause the noise.

This condition can be corrected simply by cleaning the gear tooth nick or ridge with a small grinding wheel. If either gear is damaged or scored badly, the gear set must be replaced. If metal has broken loose, the carrier and housing must be cleaned to remove particles that could cause damage.

Knock

This is very similar to a chuckle, though it may be louder, and occur on acceleration or deceleration. Knock can be caused by a gear tooth that is damaged on the drive side of the ring and pinion gears. Ring gear bolts that are hitting the carrier casting can cause knock. Knock can also be due to excessive end play in the axle shafts.

Clunk

Clunk is a metallic noise heard when an automatic transmission is engaged in Reverse or Drive, or when throttle is applied or released. It is caused by backlash somewhere in the driveline, but not necessarily in the axle. To determine whether driveline clunk is caused by the axle, check the total axle backlash as follows:

1. Raise vehicle on a frame or twinpost hoist so that drive wheels are free. Clamp a bar between axle companion flange and a part of the frame or body so that flange cannot move.
2. On conventional drive axles, lock the left wheel to keep it from turning. On all models, turn the right wheel slowly until it is felt to be in Drive condition. Hold a chalk marker on side of tire about 12" from center of wheel. Turn wheel in the opposite direction until it is again felt to be in Drive condition.
3. Measure the length of the chalk mark, which is the total axle backlash. If backlash is one inch or less, drive axle is not the source of clunk noise.

Bearing Whine

Bearing whine is a high-pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings. Pinion bearings operate at drive shaft speed. Roller wheel bearings may whine in a similar manner if they run completely dry of lubricant. Bearing noise will occur at all driving speeds. This distinguishes it from gear whine, which usually comes and goes as speed changes.

Bearing Rumble

Bearing rumble sounds like marbles being tumbled. It is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about 1/3 of drive shaft speed.

Chatter On Turns

This is a condition where the entire front or rear of vehicle vibrates when vehicle is moving. The vibration is plainly felt as well as heard. Extra differential thrust washers installed during axle repair can cause a condition of partial lock-up that creates this chatter.

Axle Shaft Noise

Axle shaft noise is similar to gear noise and pinion bearing whine. Axle shaft bearing noise will normally distinguish itself from gear noise by occurring in all driving modes (Drive, cruise, coast and float), and will persist with transmission in Neutral while vehicle is moving at problem speed.

If vehicle displays this noise condition, remove suspect parts, replace wheel seals and install a new set of bearings. Re-evaluate vehicle for noise before removing any internal components.

Vibration

Vibration is a high-frequency trembling, shaking or grinding condition (felt or heard) that may be constant or variable in level and can occur during the total operating speed range of the vehicle.

The types of vibrations that can be felt in the vehicle can d into 3 main groups:

- Vibrations of various unbalanced rotating parts of the vehicle.
- Resonance vibrations of the body and frame structures caused by rotating of unbalanced parts.
- Tip-in moans of resonance vibrations from stressed engine or exhaust system mounts or driveline flexing modes.

DRIVE AXLE - RWD TROUBLE SHOOTING

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DRIVE AXLE (RWD) TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Knocking or Clunking	
Differential Side Gear Clearance	Check Clearance
Worn Pinion Shaft	Replace Pinion Shaft
Axle Shaft End Play	Check End Play
Missing Gear Teeth	Check Differential/Replace Gear
Wrong Axle Backlash	Check Backlash
Misaligned Driveline	Realign Driveline
Clinking During Engagement	
Side Gear Clearance	Check Clearance
Ring and Pinion Backlash	Check Backlash
Worn/Loose Pinion Shaft	Replace Shaft/Bearing
Bad "U" Joint	Replace "U" Joint
Sticking Slip Yoke	Lube Slip Yoke
Broken Rear Axle Mount	Replace Mount
Loose Drive Shaft Flange	Check Flange
Click/Chatter On Turns	
Differential Side Gear Clearance	Check Clearance
Wrong Turn On Plates (1)	Replace Clutch Plates
Wrong Differential Lubricant (1)	Change Lubricant
Knock Or Click	
Flat Spot on Rear Wheel Bearing	Replace Wheel Bearing
Low Vibration At All Speeds	
Faulty Wheel Bearing	Replace Wheel Bearing
Faulty "U" Joint	Replace "U" Joint
Faulty Drive Shaft	Balance Drive Shaft
Faulty Companion Flange	Replace Flange
Faulty Slip Yoke Flange	Replace Flange
(1) Limited slip differential only.	

FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING

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BASIC FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Grease Leaks	CV boot torn or cracked
Clicking Noise on Cornering	Damaged outer CV
Clunk Noise on Acceleration	Damaged inner CV
Vibration or Shudder on Acceleration	Sticking, damaged or worn CV Misalignment or spring height

STEERING & SUSPENSION

MANUAL STEERING GEAR TROUBLE SHOOTING

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BASIC MANUAL STEERING GEAR TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise in Rack and Pinion	
Rack and pinion mounting bracket loose	Tighten all mounting bolts
Lack of/or incorrect lubricant	Correct as necessary
Steering gear mounting bolts loose	Tighten all mounting bolts
Excessive Play	
Front wheel bearing improperly adjusted	See FRONT SUSPENSION article
Loose or worn steering linkage	See STEERING LINKAGE article
Loose or worn steering gear shift	See MANUAL STEERING GEAR article
Steering arm loose on gear shaft	See MANUAL STEERING GEAR article
Steering gear housing bolts loose	Tighten all mounting bolts

Steering gear adjustment too loose	See MANUAL STEERING GEAR article
Steering arms loose on knuckles	Tighten and check steering linkage
Rack and pinion mounting loose	Tighten all mounting bolts
Rack and pinion out of adjustment	See adjustment in STEERING article
Tie rod end loose	Tighten and check steering linkage
Excessive Pitman shaft-to-ball nut lash	Repair as necessary
Poor Returnability	
Lack of lubricant in ball joint or linkage	Lubricate and service systems
Binding in linkage or ball joints	See STEERING LINKAGE and SUSPENSION article
Improper front end alignment	See WHEEL ALIGNMENT article
Improper tire pressure	Inflate to proper pressure
Tie rod binding	Inflate to proper pressure
Shaft seal rubbing shaft	See STEERING COLUMN article
Excessive Vertical Motion	
Improper tire pressure	Inflate to proper pressure
Tires, wheels or rotors out of balance	Balance tires then check wheels and rotors
Worn or faulty shock absorbers	Check and replace if necessary
Loose tie rod ends or steering	Tighten or replace if necessary
Loose or worn wheel bearings	See SUSPENSION article
Steering Pulls to One Side	
Improper tire pressure	Inflate to proper pressure
Front tires are different sizes	Rotate or replace if necessary
Wheel bearings not adjusted properly	See FRONT SUSPENSION article
Bent or broken suspension components	See FRONT SUSPENSION article
Improper wheel alignment	See WHEEL ALIGNMENT article
Brakes dragging	See BRAKES article
Instability	
Low or uneven tire pressure	Inflate to proper pressure
Loose or worn wheel bearings	See FRONT SUSPENSION article
Loose or worn idler arm bushing	See FRONT SUSPENSION article
Loose or worn strut bushings	See FRONT SUSPENSION article
Incorrect front wheel alignment	See WHEEL ALIGNMENT article
Steering gear not centered	See MANUAL STEERING GEARS article
Springs or shock	Check and replace if necessary
Improper cross shaft	See MANUAL STEERING GEARS article

POWER STEERING TROUBLE SHOOTING

NOTE:

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BASIC POWER STEERING TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise	
Pressure hoses touching engine parts	Adjust to proper clearance
Loose Pitman shaft	Adjust or replace if necessary
Tie rods ends or Pitman arm loose	Tighten and check system
Rack and pinion mounts loose	Tighten all mounting bolts
Free play in worm gear	See POWER STEERING GEAR article
Loose sector shaft or thrust bearing adjustment	See POWER STEERING GEAR
Free play in pot coupling	See STEERING COLUMN article

Worn shaft serrations	See STEERING COLUMN article
Growl in Steering Pump	
Excessive pressure in hoses	Restricted hoses, see POWER STEERING GEAR article
Scored pressure plates	See POWER STEERING GEAR article
Scored thrust plates or rotor	See POWER STEERING GEAR article
Extreme wear of cam ring	See POWER STEERING GEAR article
Rattle in Steering Pump	
Vanes not installed	See POWER STEERING PUMP article
Vanes sticking in rotor	See POWER STEERING PUMP article
Swish noise in Pump	
Defective flow control valve	See POWER STEERING PUMP article
Groan in Steering Pump	
Air in fluid	See POWER STEERING PUMP article
Poor pressure hose connection	Tighten and check, replace if necessary
Squawk When Turning	
Damper "O" ring on valve spool cut	See POWER STEERING PUMP article
Moan or Whine in Pump	
Pump shaft bearing scored	Replace bearing and fluid
Air in fluid or fluid level low	See POWER STEERING PUMP article
Hose or column grounded	Check and replace if necessary
Cover "O" ring missing or damaged	See POWER STEERING PUMP article
Valve cover baffle missing or damaged	See POWER STEERING PUMP article
Interference of components in pump	See POWER STEERING PUMP article
Loose or poor bracket alignment	Correct or replace if necessary
Hissing When Parking	
Internal leakage in steering gear	Check valved assembly first
Chirp in Steering Pump	
Loose or worn power steering belt	Adjust or replace if necessary
Buzzing When Not Steering	
Noisy pump	See POWER STEERING PUMP article
Free play in steering shaft bearing	See STEERING COLUMN article
Bearing loose on shaft serrations	See STEERING COLUMN article
Clicking Noise in Pump	
Pump slippers too long	See POWER STEERING PUMP article
Broken slipper springs	See POWER STEERING PUMP article
Excessive wear or nicked rotors	See POWER STEERING PUMP article
Damaged cam contour	See POWER STEERING PUMP article
Poor Return of Wheel	
Wheel rubbing against turn signal	See STEERING COLUMN SWITCHES article
Flange rubbing steering gear adjuster	See STEERING COLUMN article
Tight or frozen steering shaft bearing	See STEERING COLUMN article
Steering gear out of adjustment	See POWER STEERING GEAR article
Sticking or plugged spool valve	See POWER STEERING PUMP article
Improper front end alignment	See WHEEL ALIGNMENT article
Wheel bearings worn or loose	See FRONT SUSPENSION article

Ties rods or ball joints binding	Check and replace if necessary
Intermediate shaft joints binding	See STEERING COLUMN article
Kinked pressure hoses	Correct or replace if necessary
Loose housing head spanner nut	See POWER STEERING GEAR article
Damaged valve lever	See POWER STEERING GEAR article
Sector shaft adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
Worm thrust bearing adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
Reaction ring sticking in cylinder	See POWER STEERING GEAR article
Reaction ring sticking in housing head	See POWER STEERING GEAR article
Steering pump internal leakage	See POWER STEERING PUMP article
Steering gear-to-column misalignment	See STEERING COLUMN article
Lack of lubrication in linkage	Service front suspension
Lack of lubrication in ball joints	Service front suspension
Increased Effort When Turning Wheel Fast Foaming, Milky Power Steering Fluid, Low Fluid Level or Low Pressure	
High internal pump leakage	See POWER STEERING PUMP article
Power steering pump belt slipping	Adjust or replace if necessary
Low fluid level	Check and fill to proper level
Engine idle speed to low	Adjust to correct setting
Air in pump fluid system	See POWER STEERING PUMP article
Pump output low	See POWER STEERING PUMP article
Steering gear malfunctioning	See POWER STEERING GEAR article
Wheel Surges or Jerks	
Low fluid level	Check and fill to proper level
Loose fan belt	Adjust or replace if necessary
Insufficient pump pressure	See POWER STEERING PUMP article
Sticky flow control valve	See POWER STEERING PUMP article
Linkage hitting oil pan at full turn	Replace bent components
Kick Back or Free Play	
Air in pump fluid system	See POWER STEERING PUMP article
Worn poppet valve in steering gear	See POWER STEERING PUMP article
Excessive over center lash	See POWER STEERING GEAR article
Thrust bearing out of adjustment	See POWER STEERING GEAR article
Free play in pot coupling	See POWER STEERING PUMP article
Steering gear coupling loose on shaft	See POWER STEERING PUMP article
Steering disc mounting bolts loose	Tighten or replace if necessary
Coupling loose on worm shaft	Tighten or replace if necessary
Improper sector shaft adjustment	See POWER STEERING GEAR article
Excessive worm piston side play	See POWER STEERING GEAR article
Damaged valve lever	See POWER STEERING GEAR article
Universal joint loose	Tighten or replace if necessary
Defective rotary valve	See POWER STEERING GEAR article
No Power When Parking	
Sticking flow control valve	See POWER STEERING PUMP article
Insufficient pump pressure output	See POWER STEERING PUMP article
Excessive internal pump leakage	See POWER STEERING

	PUMP article
Excessive internal gear leakage	See POWER STEERING PUMP article
Flange rubs against gear adjust plug	See STEERING COLUMN article
Loose pump belt	Adjust or replace if necessary
Low fluid level	Check and add proper amount of fluid
Engine idle too low	Adjust to correct setting
Steering gear-to-column misaligned	See STEERING COLUMN article
No Power, Left Turn	
Left turn reaction seal "O" ring worn	See POWER STEERING GEAR article
Left turn reaction seal damaged/missing	See POWER STEERING GEAR article
Cylinder head "O" ring damaged	See POWER STEERING PUMP article
No Power, Right Turns	
Column pot coupling bottomed	See STEERING COLUMN article
Right turn reaction seal "O" ring worn	See POWER STEERING GEAR article
Right turn reaction seal damaged	See POWER STEERING GEAR article
Internal leakage through piston end plug	See POWER STEERING GEAR article
Internal leakage through side plugs	See POWER STEERING GEAR article
Lack of Effort in Turning	
Left and/or right reaction seal sticking in cylinder head	Replace, see POWER STEERING GEAR article
Wanders to One Side	
Front end alignment incorrect	See WHEEL ALIGNMENT article
Unbalanced steering gear valve	See POWER STEERING GEAR article
Low Pressure Due to Steering Pump	
Flow control valve stuck or inoperative	See POWER STEERING PUMP article
Pressure plate not flat against cam ring	See POWER STEERING PUMP article
Extreme wear of cam ring	Replace and check adjustments
Scored plate, thrust plate or rotor	See POWER STEERING PUMP article
Vanes not installed properly	See POWER STEERING PUMP article
Vanes sticking in rotor slots	See POWER STEERING PUMP article
Cracked/broken thrust or pressure plate	See POWER STEERING PUMP article

STEERING COLUMN TROUBLE SHOOTING

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BASIC STEERING COLUMN TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Noise in Steering	
Coupling pulled apart	See STEERING COLUMNS article
Column not correctly aligned	See STEERING COLUMNS article
Broken lower joint	Replace joint
Horn contact ring not	See STEERING COLUMN article
Bearing not lubricated	See STEERING COLUMN article
Shaft snap ring not properly seated	Reseat or replace snap ring
Plastic spherical joint not lubricated	See STEERING COLUMN

	article
Shroud or housing loose	Tighten holding screws
Lock plate retaining ring not seated	See STEERING COLUMN article
Loose sight shield	Tighten holding screws
High Steering Shaft Effort	
Column assembly misaligned	See STEERING COLUMN article
Improperly installed dust shield	Adjust or replace
Tight steering universal joint	See STEERING COLUMN article
High Shift Effort	
Column is out of alignment	See STEERING COLUMN article
Improperly installed dust shield	Adjust or replace
Seals or bearings not lubricated	See STEERING COLUMNS article
Mounting bracket screws too long	Replace with new shorter screws
Burrs on shift tube	Remove burrs or replace tube
Lower bowl bearing assembled wrong	See STEERING COLUMN article
Shift tube bent or broken	Replace as necessary
Improper adjustment of shift levers	See STEERING COLUMN article
Improper Trans. Shifting	
Sheared shift tube joint	Replace as necessary
Sheared lower shaft lever	Replace as necessary
Improper shift lever adjustment	See STEERING COLUMN article
Improper gate plate adjustment	See STEERING COLUMN article
Excess Play in Column	
Instrument panel bracket bolts loose	Tighten bolts and check bracket
Broken weld nut on jacket	See STEERING COLUMN article
Instrument bracket capsule sheared	See STEERING COLUMN article
Column bracket/jacket bolts loose	Tighten bolts and check bracket
Steering Locks in Gear	
Release lever mechanism	See STEERING COLUMN article

SUSPENSION TROUBLE SHOOTING

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BASIC SUSPENSION TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Front End Noise	
Loose or worn wheel	See Wheel Bearing Adjustment in SUSPENSION
Worn shocks or shock mountings	Replace struts or strut mountings
Worn struts or strut mountings	Replace struts or strut mountings
Loose or worn lower control arm	See SUSPENSION
Loose steering gear-to-frame bolts	See STEERING
Worn control arm bushings	See SUSPENSION
Ball joints not lubricated	Lubricate ball joints & see Ball Joint Checking in SUSPENSION
Front Wheel Shake, Shimmy, or Vibration	
Tires or wheels out of balance	Check tire balance
Incorrect wheel alignment	See WHEEL ALIGNMENT
Drive shaft unbalanced	Check drive shaft balance
Loose or worn wheel bearings	See WHEEL ALIGNMENT
Loose or worn tie rod ends	See SUSPENSION

Worn upper ball joints	See Ball Joint Checking in SUSPENSION
Worn shock absorbers	Replace shock absorbers
Worn strut bushings	Replace strut bushings
Car Pulls to One Side	
Mismatched or uneven tires	Check tire condition
Broken or sagging springs	See SUSPENSION
Loose or worn strut bushings	See SUSPENSION
Improper wheel alignment	See WHEEL ALIGNMENT
Improper rear axle alignment	Check rear axle alignment
Power steering gear unbalanced	See STEERING
Front brakes dragging	See BRAKES
Abnormal Tire Wear	
Unbalanced tires	Check tire balance & rotation
Sagging or broken springs	See SUSPENSION
Incorrect front end alignment	See WHEEL ALIGNMENT
Faulty shock absorbers	Replace chock absorbers
Scuffed Tires	
Toe-In incorrect	See WHEEL ALIGNMENT
Suspension arm bent or twisted	See appropriate SUSPENSION article
Springs Bottom or Sag	
Bent or broken springs	See SUSPENSION
Leaking or worn shock absorbers	Replace shock absorbers
Frame misalignment	Check frame for damage
Spring Noises	
Loose "U" Bolts	See SUSPENSION
Loose or worn bushings	See SUSPENSION
Worn or missing interliners	See SUSPENSION
Shock Absorber Noise	
Loose shock mountings	Check & tighten mountings
Worn bushings	Replace bushings
Air in system	Bleed air from system
Undercoating on shocks	Remove undercoating
Car Leans or Sways on Corners	
Loose stabilizer bar	See SUSPENSION
Faulty shocks or mountings	Replace shocks or mountings
Broken or sagging springs	See SUSPENSION
Shock Absorbers Leaking	
Worn seals or reservoir tube crimped	See SUSPENSION
Broken Springs	
Loose "U" bolts	See SUSPENSION
Inoperative shock absorbers	Replace shock absorbers

WHEEL ALIGNMENT TROUBLE SHOOTING

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BASIC WHEEL ALIGNMENT TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Premature Tire Wear	
Improper tire inflation	Check tire pressure
Front alignment out of tolerance	See ALIGNMENT SPECS in WHEEL ALIGNMENT section
Suspension components worn	See SUSPENSION section
Steering system components worn	See STEERING section
Improper standing height	See WHEEL ALIGNMENT
Uneven or sagging springs	See SUSPENSION section
Bent wheel	See WHEEL ALIGNMENT
Improper torsion bar adjustment	See SUSPENSION section
Loose or worn wheel bearings	See WHEEL BEARING ADJ. in SUSPENSION section
Worn or defective shock	Replace shock absorbers
Tires out of balance	Check tire balance
Pulls to One Side	
Improper tire inflation	Check tire pressure
Brake dragging	See BRAKE section

Mismatched tires	See WHEEL ALIGNMENT
Broken or sagging spring	See SUSPENSION section
Broken torsion bar	See SUSPENSION section
Power steering valve not centered	See STEERING section
Front alignment out of tolerance	See WHEEL ALIGNMENT section
Defective wheel bearing	See WHEEL BEARINGS in SUSPENSION section
Uneven sway bar links	See SUSPENSION section
Frame bent	Check for frame damage
Steering system bushing worn	See STEERING section
Hard Steering	
Idler arm bushing too tight	See STEERING LINKAGE in STEERING section
Ball joint tight or seized	See SUSPENSION section
Steering linkage too tight	See STEERING LINKAGE in STEERING section
Power steering fluid low	Add proper amount of fluid
Power steering drive belt loose	See STEERING section
Power steering pump defective	See STEERING section
Steering gear out of adjustment	See STEERING section
Incorrect wheel alignment	See WHEEL ALIGNMENT
Damaged steering gear	See STEERING section
Damaged suspension	See SUSPENSION section
Bent steering knuckle or supports	See SUSPENSION section
Vehicle "Wanders"	
Strut rod or control arm bushing worn	See SUSPENSION section
Loose or worn wheel bearings	See WHEEL BEARINGS in SUSPENSION section
Improper tire inflation	Check tire pressure
Stabilizer bar missing or defective	See SUSPENSION section
Wheel alignment out of tolerance	See Adjustment in WHEEL ALIGNMENT section
Broken spring	See SUSPENSION section
Defective shock absorber	Replace shock absorbers
Worn steering & suspension components	See SUSPENSION section
Front End Shimmy	
Tire out of balance/round	Check tire balance
Excessive wheel runout	See WHEEL ALIGNMENT
Insufficient or improper caster	See WHEEL ALIGNMENT section
Worn suspension or steering components	See SUSPENSION section
Defective shock absorbers	Replace shock absorber
Wheel bearings worn or loose	See WHEEL BEARING ADJ. in SUSPENSION section
Power steering reaction Bracket loose	See STEERING section
Steering gear box (rack) mounting loose	See STEERING section
Steering gear adjustment loose	See STEERING section
Worn spherical joints	See SUSPENSION section
Toe-In Not Adjustable	
Lower control arm bent	See SUSPENSION section
Frame bent	Check frame for damage
Camber Not Adjustable	
Control arm bent	See SUSPENSION section
Frame bent	Check frame for damage
Hub & bearing not seated properly	See SUSPENSION section

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GENERAL INFORMATION

TROUBLE SHOOTING

* PLEASE READ THIS FIRST *

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ENGINE PERFORMANCE

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TUNE-UP TROUBLE SHOOTING

Problem & Possible Cause	Action
Carbon Fouled Plugs	
Clogged Air Filter	Replace Air Filter
Incorrect Idle Speed	Reset Idle Speed
Faulty Ignition Wiring	Replace Ignition Wiring
Sticky Valves/Worn Valve Seal	Check Valve Train
Fuel Injection Operation	Check Fuel Injection
Wet/Oil Fouled Plugs	
Worn Rings/Pistons	Overhaul/Replace Engine
Excessive Cylinder Wear	Overhaul/Replace Engine
Plug Gap Bridged	
Combustion Chamber Carbon Deposits	Clean Combustion Chamber
Blistered Electrode	
Engine Overheating	Check Cooling System
Loose Spark Plugs	Clean/Torque Plugs
Over-Advanced Timing	Reset Timing
Wrong Plug Heat Range	Install Correct Plug
Melted Electrodes	
Incorrect Timing	Reset Timing
Burned Valves	Replace Valves
Engine Overheating	Check Cooling System
Wrong Plug Heat Range	Install Correct Plug
Engine Won't Start	
Loose Connections	Check Connections
No Power	Check Fuses/Battery
Loose/Worn Timing Belt/Chain/Gears	Check Belt/Chain/Gears
Engine Runs Rough	
Leaky/Clogged Fuel Injectors	Repair Fuel Injectors
Leaky/Clogged Fuel Lines	Repair Fuel Lines
Clogged Fuel Filter	Replace Fuel Filter
Incorrect Timing	Reset Timing/Check Advance
Faulty Plugs/Wires	Replace Plugs/Wires
Uneven Compression	Overhaul/Replace Engine
Poor Acceleration	
Incorrect Ignition Timing	Reset Timing
Leaky Valves	Check Compression
Component Failure	
Spark Arcing	Replace Faulty Part
Defective Pick-Up Coil	Replace Pick-Up Coil
Defective Ignition Coil	Replace Ignition Coil
Defective Control Unit	Replace Control Unit
Ignition Diagnosis By Scope Pattern	
All Firing Lines Abnormally High	
Retarded Ignition Timing	Reset Ignition Timing
Lean Air/Fuel Mixture	Adjust Fuel Mixture
High Secondary Resistance	Repair Secondary Ignition
All Firing Lines Abnormally Low	
Rich Air/Fuel Mixture	Adjust Air/Fuel Mixture
Arcing Coil Wire	Replace Coil Wire
Cracked Coil	Replace Coil
Low Coil Output	Replace Coil
Low Compression	Check/Repair Engine

Several High Firing Lines	
Fuel Mixture Unbalanced	Check Fuel System
EGR Valve Stuck Open	Clean/Replace EGR Valve
High Plug Wire Resistance	Replace Plug Wire
Cracked/Broken Plugs	Replace Plugs
Intake Vacuum Leak	Repair Leak
Several Low Firing Lines	
Fuel Mixture Unbalanced	Adjust Fuel Mixture
Plug Wires Arcing	Replace Plug Wires
Cracked Coil Arcing	Replace Coil
Uneven Compression	Check/Repair Engine
Faulty Spark Plugs	Replace Plugs
Cylinders Not Firing	
Cracked Distributor Cap	Replace Cap
Shorted Plug Wires	Replace Plug Wires
Mechanical Engine Fault	Check/Repair Engine
Spark Plugs Fouled	Replace Plugs
Carbon Track in Distributor Cap	Replace Cap
Hard Starting	
Defective Ignition Coil(s)	Replace Coil(s)
Fouled Spark Plugs	Replace Plugs
Incorrect Timing	Reset Ignition Timing

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FUEL INJECTION TROUBLE SHOOTING

Problem & Possible Cause	Action
Cold Start Valve Inoperative	Test Cold Start Valve
Poor Vacuum/Electrical Connection	Repair Connections
Contaminated Fuel	Test Fuel for Water/Alcohol
Bad Fuel Pump Relay/Circuit	Test Relay/Wiring
Battery Voltage Low	Charge/Test Battery
Low Fuel Pressure	Test Press. Regulator/Pump
No Distributor Reference Pulse	Repair Ignition System
Coolant Temp. Sensor Defective	Test Temp. Sensor/Circuit
No Power To Injectors	Check Injector Fuse/Relay
Hard Starting	
Defective Idle Air Control (IAC)	Test IAC and Circuit
EGR Valve Open	Test EGR Valve/Control Circuit
Restricted Fuel Lines	Inspect/Replace Fuel Lines
Poor MAP Sensor Signal	Test MAP Sensor/Circuit
Engine Stalls During Parking Maneuver	Check P.S. Press. Switch
Rough Idle	
Dirty Fuel Injectors	Clean/Replace Injectors
Poor MAP Sensor Signal	Test MAP Sensor/Circuit
Intermittent Fuel Injector Operation	Check Harness Connectors
Erratic Vehicle Speed Sensor Inputs	Harness Too Close to Plug Wires
Poor O ₂ Sensor Signal	Test O ₂ Sensor/Circuit
Faulty PCV System	Check PCV Valve and Hoses
Poor Acceleration	
Weak Fuel Pump	Replace Fuel Pump
Dirty Fuel Injectors	Clean/Replace Injectors
Excessive Intake Valve Deposits	Clean Intake System
Poor High Speed Operation	
Low Fuel Pump Volume	Faulty Fuel Pump/Filter
Poor MAP Sensor Signal	Test Speed Sensor/Circuit
Acceleration Ping/Knock	
Faulty EGR System	Check EGR Valve and Hoses
Poor Knock Sensor Signal	Test Knock Sensor/Circuit
Poor Baro Sensor Signal	Test Baro Sensor/Circuit
Improper Ignition Timing	Adjust Timing
Engine Overheating	Check Cooling System
Poor Quality Fuel	Use Different Fuel
Carbon Build-Up	Decarbon Engine

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GENERAL INFORMATION

Computer Relearn Procedures

COMPUTER RELEARN PROCEDURES

Vehicles equipped with engine or transmission computers may require a relearn procedure after vehicle battery is disconnected. Many vehicle computers memorize and store vehicle operation patterns for optimum driveability and performance. When vehicle battery is disconnected, this memory is lost. The computer will use default data until new data from each key start is stored. As computer memorizes vehicle operation for each new key start, driveability is restored. Vehicle computers may memorize vehicles operation patterns for 40 of more key starts.

Customers often complain of driveability problems during relearn stage because vehicle acts differently then before being serviced. Depending on type and make of vehicle and how it is equipped, the following complaints (driveability problems) may exist:

- Harsh Or Poor Shift Quality
- Rough Or Unstable Idle
- Hesitation Or Stumble
- Rich Or Lean Running
- Poor Fuel Mileage

These symptoms and complaints should disappear after a number of drive cycles have been memorized. To reduce the possibility of complaints, after any service which requires battery power to be disconnected, vehicle should be road tested.

GENERIC COMPUTER RELEARN PROCEDURES

Some manufacturers identify a specific relearn procedure which will help establish suitable driveability during relearn stage. These procedures are especially important if vehicle is equipped with and electronically controlled automatic transmission or transaxle. Always complete procedure before returning vehicle to customer. The following general procedures are to be used if driveability problems are encountered after power loss or battery has been disconnected. These procedures may provide an aid in eliminating these problems.

Automatic Transmission

- Set parking brake, start engine in "P" or "N" position. Warm-up vehicle to normal operating temperature or until cooling fan cycles.
- Allow vehicle to idle for one minute in "N" position. Select "D" and allow engine to idle for one minute.
- Accelerate at normal throttle position (20-50%) until vehicle shifts into top gear.
- Cruise at light to medium throttle.
- Decelerate to a stop, allowing vehicle to downshift, and use brakes normally.
- Process may be repeated as necessary.

Manual Transmission

- Place transmission in Neutral position.
- Ensure emergency brake has been set and all accessories are turned off.
- Start engine and bring to normal operating temperature.
- Allow vehicle to idle in Neutral for one minute.
- Initial relearn is complete, and process will be completed during normal driving.

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GENERAL INFORMATION

Drive Axle Noise Diagnosis

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UNRELATED NOISES

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Some driveline trouble symptoms are also common to the engine, transmission, wheel bearings, tires and other parts of the vehicle. Make sure that cause of trouble actually is in the drive axle before adjusting, repairing, or replacing any parts.

NON-DRIVE AXLE NOISES

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A few conditions can sound just like drive axle noise and have to be considered in pre-diagnosis. The 4 most common noises are exhaust, tires, CV/universal joints and trim moldings.

In certain conditions, the pitch of exhaust gases may sound like gear whine. At other times, it may be mistaken for a wheel bearing rumble.

Tires, especially radial and snow tires, can have a high-pitched tread whine or roar, similar to gear noise. Also, some non-standard tires with an unusual tread construction may emit a roar or whine.

Defective CV/universal joints may cause clicking noises or excessive driveline play that can be improperly diagnosed as drive axle problems.

Trim and moldings can also cause a whistling or whining noise. Ensure that none of these components are causing the noise before disassembling the drive axle.

GEAR NOISE

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

A "howling" or "whining" noise from the ring and pinion gear can be caused by an improper gear pattern, gear damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.

Before disassembling axle to diagnose and correct gear noise, make sure that tires, exhaust, and vehicle trim have been checked as possible causes.

CHUCKLE

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

This is a particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 40 MPH and usually can be heard until vehicle comes to a complete stop. The frequency varies with the speed of the vehicle.

A chuckle that occurs on the driving phase is usually caused by excessive clearance due to differential gear wear, or by a damaged tooth on the coast side of the pinion or ring gear. Even a very small tooth nick or a ridge on the edge of a gear tooth is enough to cause the noise.

This condition can be corrected simply by cleaning the gear tooth nick or ridge with a small grinding wheel. If either gear is damaged or scored badly, the gear set must be replaced. If metal has broken loose, the carrier and housing must be cleaned to remove particles that could cause damage.

KNOCK

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

This is very similar to a chuckle, though it may be louder, and occur on acceleration of deceleration. Knock can be caused by a gear tooth that is damaged on the drive side of the ring and pinion gears. Ring gear bolts that are hitting the carrier casting can cause knock. Knock can also be due to excessive end play in the axle shafts.

CLUNK

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

Clunk is a metallic noise heard when an automatic transmission is engaged in Reverse or Drive, or when throttle is applied or released. It is caused by backlash somewhere in the driveline, but not necessarily in the axle. To determine whether driveline clunk is caused by the axle, check the total axle backlash as follows:

1. Raise vehicle on a frame or twinpost hoist so that drive wheels are free. Clamp a bar between axle companion flange and a part of the frame or body so that flange cannot move.
2. On conventional drive axles, lock the left wheel to keep it from turning. On all models, turn the right wheel slowly until it is felt to be in drive condition. Hold a chalk marker on side of tire about 12" from center of wheel. Turn wheel in the opposite direction until it is again felt to be in drive condition.
3. Measure the length of the chalk mark, which is the total axle backlash. If backlash is one inch or less, clunk will not be eliminated by overhauling drive axle.

BEARING WHINE

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

Bearing whine is a high-pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings. Pinion bearings operate at driveshaft speed. Roller wheel bearings may whine in a similar manner if they run completely dry of lubricant. Bearing noise will occur at all driving speeds. This distinguishes it from gear whine, which usually comes and goes as speed changes.

BEARING RUMBLE

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

Bearing rumble sounds like marbles being tumbled. It is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about 1/3 of driveshaft speed.

CHATTER ON TURNS

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

This is a condition where the whole front or rear vibrates when vehicle is moving. The vibration is easily felt and heard. Extra differential thrust washers installed during axle repair can cause a condition of partial lock-up that creates the chatter.

AXLE SHAFT NOISE

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

Axle shaft noise is similar to gear noise and pinion bearing whine. Axle shaft bearing noise will normally distinguish itself from gear noise by occurring in all driving modes. Noise will persist with transmission in neutral while vehicle is moving at problem speed.

If vehicle displays this noise condition, remove suspect axle shafts and replace axle bearings. Re-evaluate vehicle for noise before removing any internal components.

VIBRATION

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

Vibration is a high-frequency trembling, shaking or grinding condition (felt or heard) that may be constant or variable in level and con occur during the total operating speed range of the vehicle.

The types of vibrations that can be felt in the vehicle can be divided into 3 main groups:

- Vibrations of various unbalanced rotating parts of the vehicle.
- Resonance vibrations of the body and frame structures caused by rotating of unbalance parts.
- Tip-in moans of resonance vibrations from stressed engine or exhaust system mounts or driveline flexing modes.

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GENERAL INFORMATION

Gear Tooth Contact Patterns

* PLEASE READ THIS FIRST *

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

INSPECTION

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

Wipe lubricant from internal parts. Rotate gears and inspect for wear or damage. Mount dial indicator to housing and check backlash at several points around ring gear. Backlash must be within specification at all points. If no defects are found, check gear tooth pattern contact.

NOTE: Drive pattern should be well centered on ring gear teeth. Coast pattern should be centered, but may be slightly toward toe of ring gear teeth.

GEAR TOOTH CONTACT PATTERN

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

1. Paint ring gear teeth with marking compound. Wrap cloth or rope around drive pinion flange to act as brake. Rotate gear until clear contact pattern is obtained.
2. Contact pattern will indicate whether correct pinion bearing mounting shim has been installed and if drive gear backlash has been set properly. Backlash between drive gear pinion must be maintained within specified limits until correct tooth pattern is obtained.

ADJUSTMENTS

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

GEAR BACKLASH & PINION SHIM CHANGES

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

1. With no change in backlash, moving pinion further from ring gear moves drive pattern toward heel and top of tooth, and moves coast pattern toward toe and top of tooth.
2. With no change in backlash, moving pinion closer to ring gear moves drive pattern toward toe and bottom of tooth, and moves coast pattern toward heel and bottom of tooth.
3. With no change in pinion shim thickness, an increase in backlash moves ring gear further from pinion. Both drive and coast patterns move toward heel and top of tooth.
4. With no change in pinion shim thickness, a decrease in backlash moves ring gear closer to pinion gear. Both drive and coast patterns move toward toe and bottom of tooth.

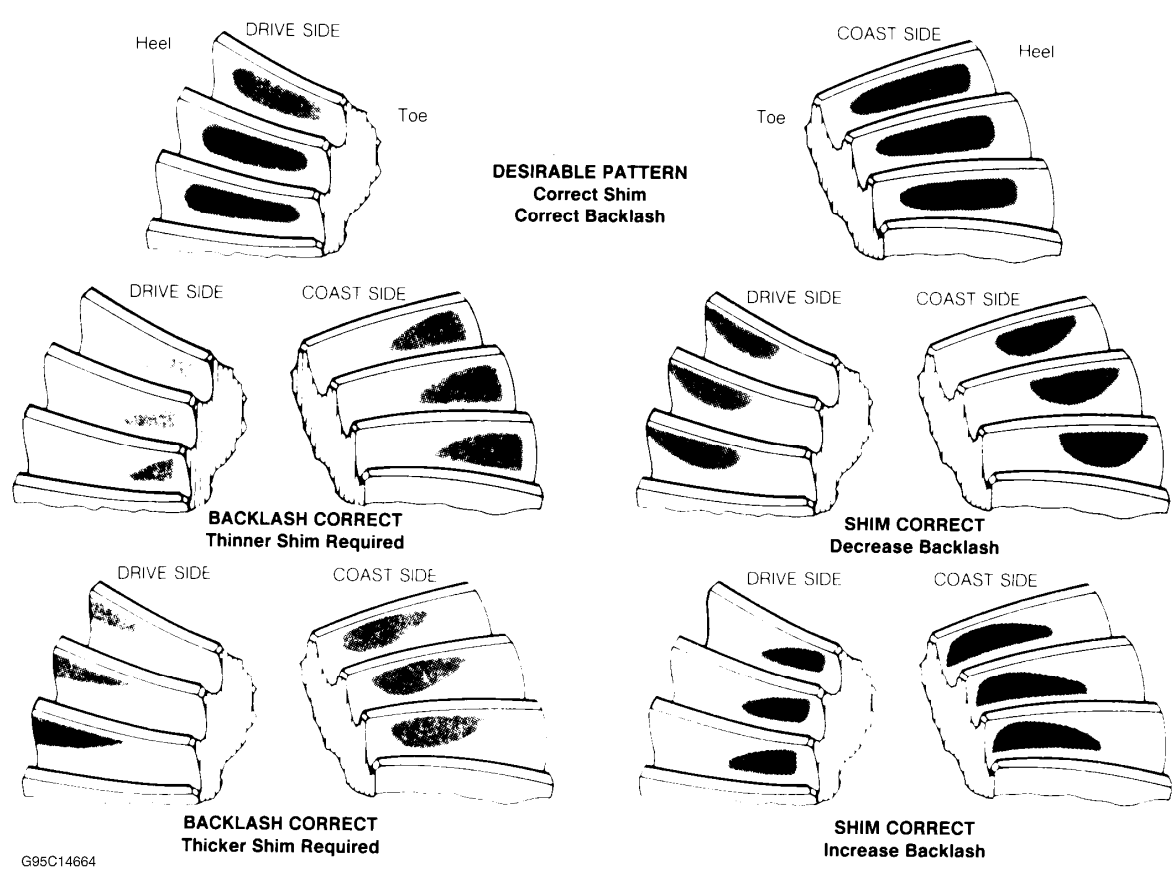


Fig. 1: Drive Axle Gear Tooth Patterns

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GENERAL INFORMATION

Clutch Trouble Shooting

* PLEASE READ THIS FIRST *

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

ALL MODELS

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

CLUTCH TROUBLE SHOOTING

Problem & Possible Cause	Action
Clutch Chatters/Grabs	
Incorrect Pedal Adjustment	Adjust Free Play
Worn Input Shaft Spline	Replace Input Shaft
Binding Pressure Plate	Replace Pressure Plate
Binding Throw-Out Lever	Check Throw-Out Lever, Check Throw-Out Bearing, Check Bearing Retainer
Uneven Pressure Plate Contact With Flywheel	Align/Replace Worn Parts
Transmission Misaligned	Align Transmission
Worn Pressure Plate	Replace Clutch Assembly
Oil-Saturated Disc	Replace Clutch Assembly, Repair Oil Leak
Loose Engine Mounts	Replace Engine Mounts
Clutch Pedal Sticks Down	
Clutch Cable Binding	Replace Clutch Cable
Weak Pressure Plate Springs	Replace Clutch Assembly
Binding Clutch Linkage	Lubricate Linkage
Broken Clutch Pedal Return Spring	Replace Return Spring
Clutch Will Not Release	
Oil-Saturated Disc	Replace Clutch Assembly, Repair Oil Leak
Defective Disc Face	Replace Clutch Assembly
Disc Sticking on Input Shaft Splines	Replace Disc/Input Shaft
Binding Pilot Bearing	Replace Pilot Bearing
Faulty Clutch Master Cylinder	Replace Master Cylinder
Faulty Clutch Slave Cylinder	Replace Slave Cylinder
Blown Clutch Hose	Replace Hose
Sticky Throw-Out Bearing Sleeve	Clean/Lube Sleeve
Clutch Cable Binding	Replace Clutch Cable
Broken/Loose Bellhousing	Check Bellhousing
Rattling/Squeaking	
Broken Throw-Out Lever Return Spring	Replace Return Spring
Faulty Throw-Out Bearing	Replace Throw-Out Bearing
Faulty Clutch Disc	Replace Clutch Disc
Faulty Pilot Bearing	Replace Pilot Bearing
Worn Throw-Out Bearing	Replace Throw-Out Bearing
Dry Bearing Retainer Slide For Throw-Out Bearing Sleeve	Lubricate Slide
Slipping	
Faulty Pressure Plate	Replace Clutch Assembly
Worn Clutch Disc	Replace Clutch Assembly
Incorrect Alignment	Realign Clutch Assembly
Faulty Clutch Slave Cylinder	Replace Slave Cylinder
No Pedal Pressure	
Leaky Hydraulic System	Check Clutch Master Cylinder, Check Clutch Slave Cylinder
Check Clutch Hose	
Broken Clutch Cable	Replace Clutch Cable
Faulty Throw-Out Lever	Replace Throw-Out Lever
Broken Clutch Linkage	Repair Clutch Linkage

Noisy Clutch Pedal	
Faulty Safety Switch	Check/Replace Switch
Noisy Self-Adj. Ratchet	Replace Ratchet
Dry Throw-Out Bearing	Replace Throw-Out Bearing
Dry Pilot Bearing	Replace Pilot Bearing
Worn Input Shaft	Replace Input Shaft

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GENERAL INFORMATION

Electrostatic Discharge (ESD) Warning - Basic Information

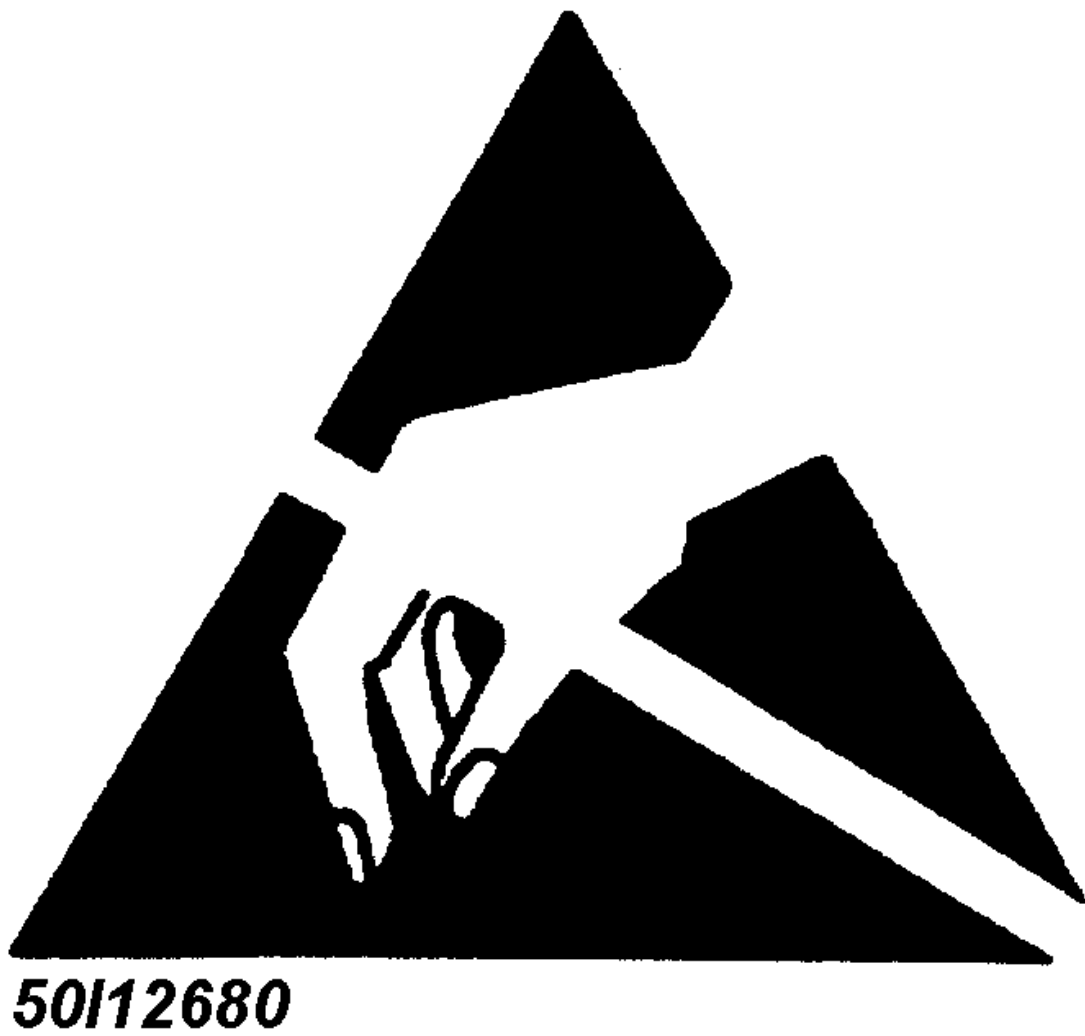
*** PLEASE READ THIS FIRST ***

NOTE: This article is intended for general information purposes only. Contents are generic in nature and all information may or may not apply to all vehicles.

INTRODUCTION

NOTE: This article is intended for general information purposes only. Contents are generic in nature and all information may or may not apply to all vehicles.

All Electrostatic Discharge (ESD) sensitive components contain solid state circuits (transistors, diodes, semiconductors) that may become damaged when contacted with an electrostatic charge. The following information applies to all ESD sensitive devices. The ESD symbol shown in Fig. [Fig. 1](#) may be used on schematics to indicate which components are ESD sensitive. See [Fig. 1](#). Although different manufactures may display different symbols to represent ESD sensitive devices, the handling and measuring precautions and procedures are the same.



[Fig. 1: Sample ESD Symbol](#)

HANDLING STATIC-SENSITIVE CIRCUITS/DEVICES

NOTE: This article is intended for general information purposes only. Contents are generic in nature and all information may or may not apply to all vehicles.

When handling an electronic part that is ESD sensitive, the technician should follow these guidelines to reduce any possible electrostatic charge build-up on the technician's body and the electronic part.

1. Always touch a known good ground source before handling the part. This should be repeated while handling the part and more frequently after sitting down from a standing position, sliding across the seat or walking a distance.
2. Avoid touching electrical terminals of the part, unless instructed by a diagnostic procedure.
3. DO NOT open the package of a new part until it is time to install the part.
4. Before removing the part from its package, ground the package to a known good ground source.

CHECKING STATIC-SENSITIVE CIRCUITS/DEVICES

NOTE: This article is intended for general information purposes only. Contents are generic in nature and all information may or may not apply to all vehicles.

1. Solid State circuits in electronic devices are shown greatly simplified in schematics. See [Fig. 2](#). Due to the simplification of the

electronic devices on the schematic, resistance measurements could be misleading or could lead to an electrostatic discharge. Always follow the recommended diagnostic procedure.

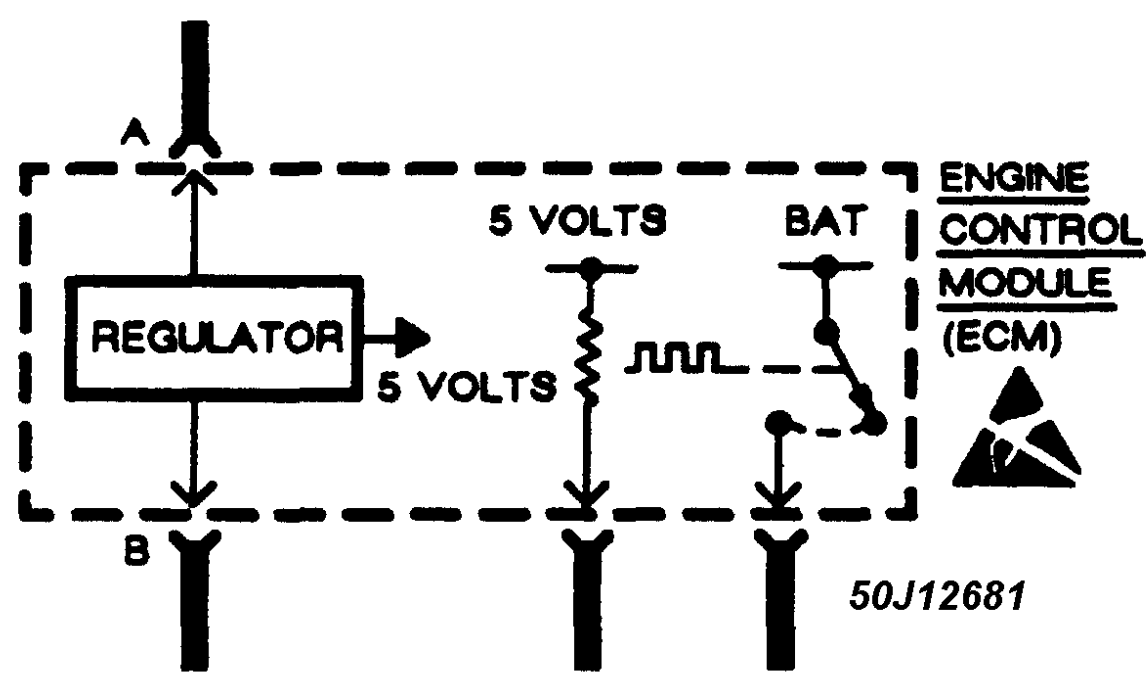


Fig. 2: Sample Schematic Showing Typical ESD Sensitive Device

- 2. Only measure resistance at the terminals of the devices when instructed by the recommended diagnostic procedure.
- 3. When using a voltmeter, be sure to connect the ground lead first.

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EMISSION CONTROL VISUAL INSPECTION PROCEDURES

1983-93 GENERAL INFORMATION Emission Control Visual Inspection Procedures

EMISSION CONTROL LABELS

This article is provided for general information only. Not all information applies to all makes and models. For more complete information, see appropriate article(s) in the ENGINE PERFORMANCE Section.

The vehicle manufacturer's emission control label, also known as the underhood tune-up label or Vehicle's Underhood Emission Control System (VECI) label, is located in the engine compartment. Information regarding year model of vehicle, engine size, number of cylinders, emission equipment or type, engine tune-up specifications, whether vehicle was manufactured for sale in California or is a Federal vehicle, vacuum hose routing schematic, etc., can be found on this label. See [Fig. 1](#) .

In addition to the VECI label, some emission control inspection and maintenance programs may require an additional label to be affixed to the vehicle in special circumstances. For example, in California, a Bureau Of Automotive Repair (BAR) engine label may be affixed to the left door post. A BAR engine label is only used when the vehicle has an engine change, approved modification or is a Specially Constructed (SPCN) or an acceptable Gray market vehicle. Check your state's emission control inspection and maintenance laws to determine if a similar label is used.

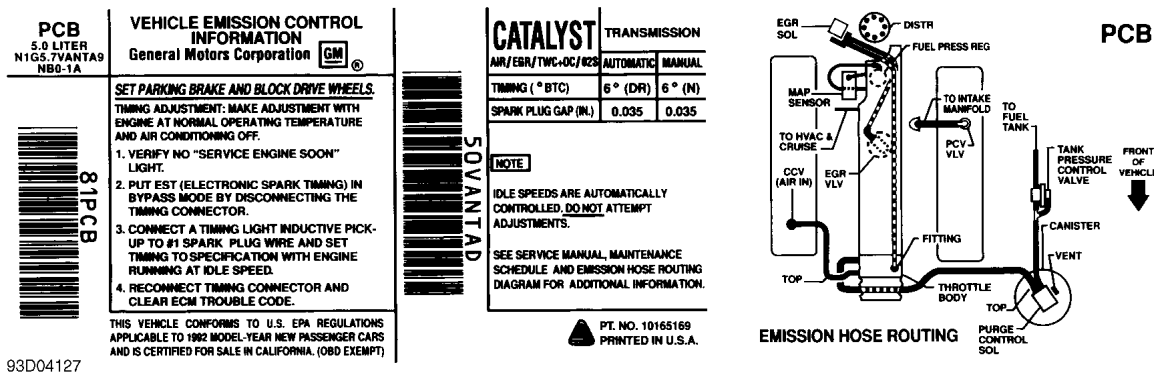


Fig. 1: Typical Emission Control Label
Courtesy of GENERAL MOTORS CORP.

FORD CALIBRATION LABELS

Ford Motor Co. uses an emission calibration label in addition to the emission control label. The emission calibration label is located on either the engine valve cover, the driver-side door or the left door post pillar.

The calibration label identifies the engine year, calibration design and design revision level. These numbers are also used to identify service parts and engine specifications that make up the emission system designed for the vehicle. See [Fig. 2](#) , [Fig. 3](#) , [Fig. 5](#) and [Fig. 6](#) .

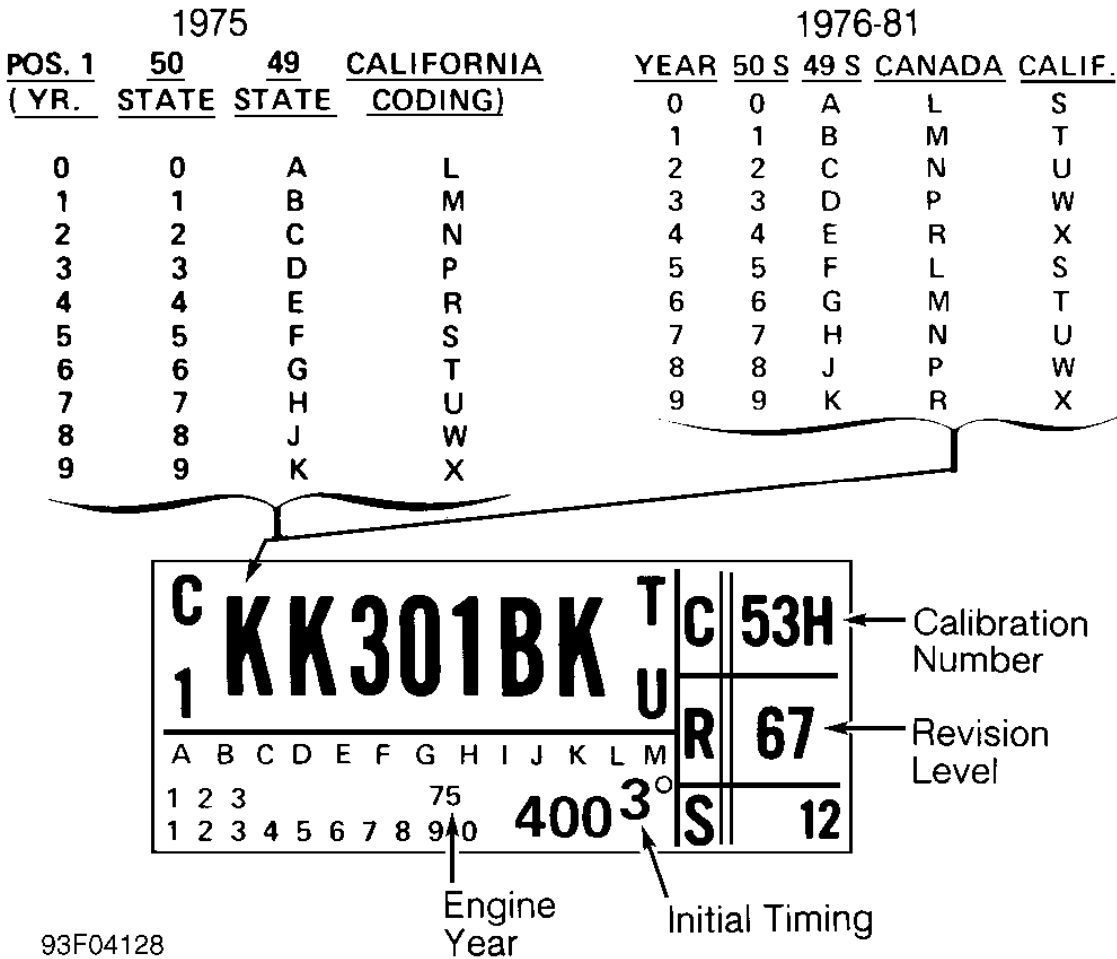
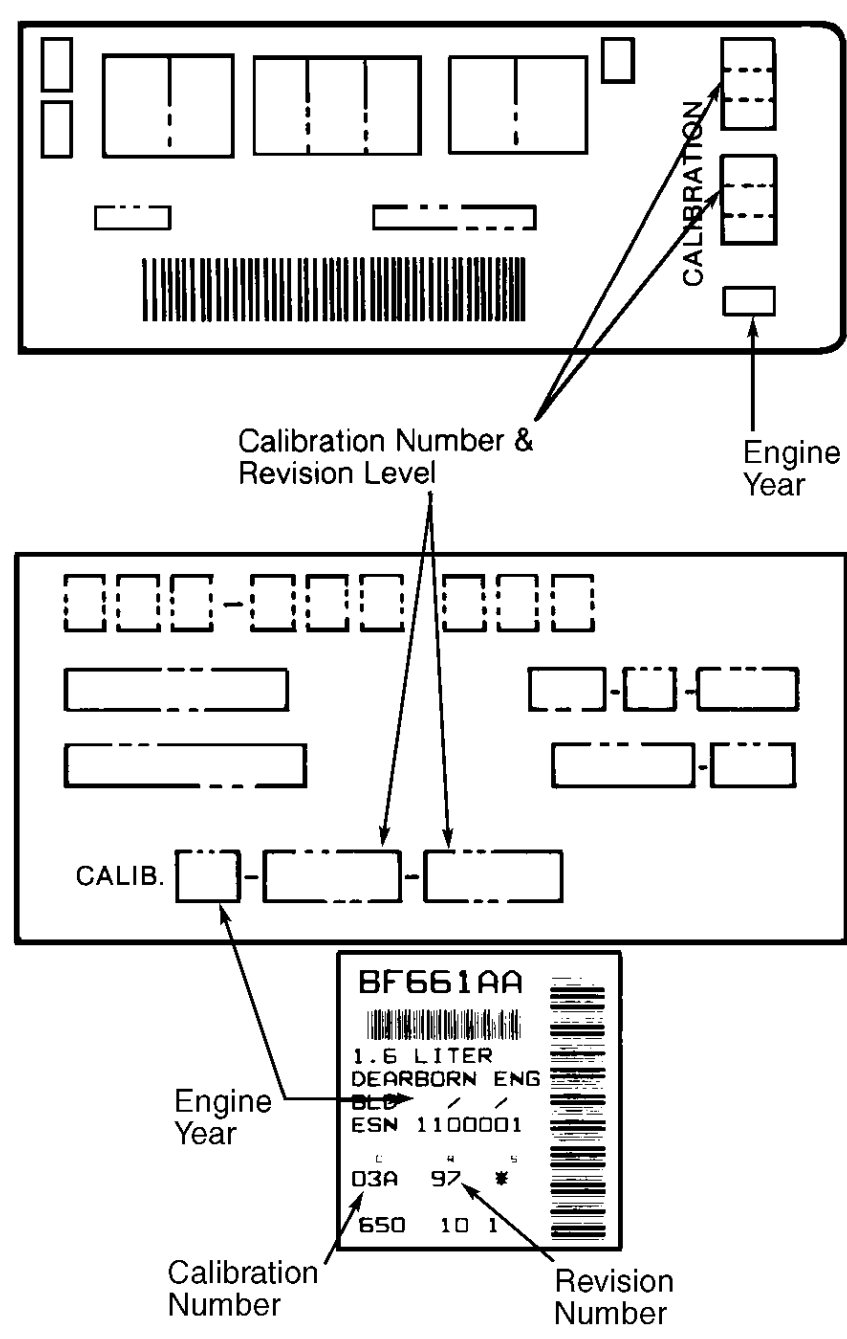


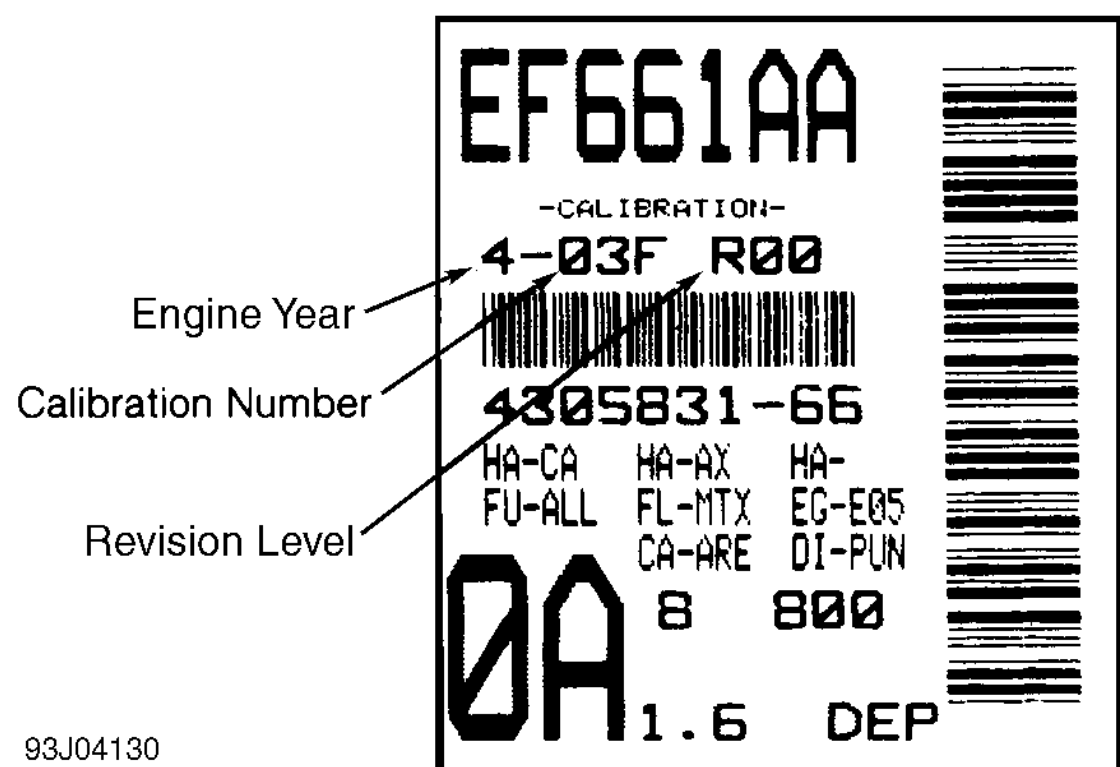
Fig. 2: Identifying Vehicle Calibration Label (1975-81 Ford Models)
Courtesy of FORD MOTOR CO.



NOTE: SIZE AND DESIGN OF CALIBRATION LABEL VARIES DEPENDING ON ENGINE DISPLACEMENT

93H04129

Fig. 3: Identifying Vehicle Calibration Label (1982-83 Ford Models)
Courtesy of FORD MOTOR CO.



93J04130

Fig. 4: Identifying Vehicle Calibration Label (1984-88 Ford Models)
Courtesy of FORD MOTOR CO.

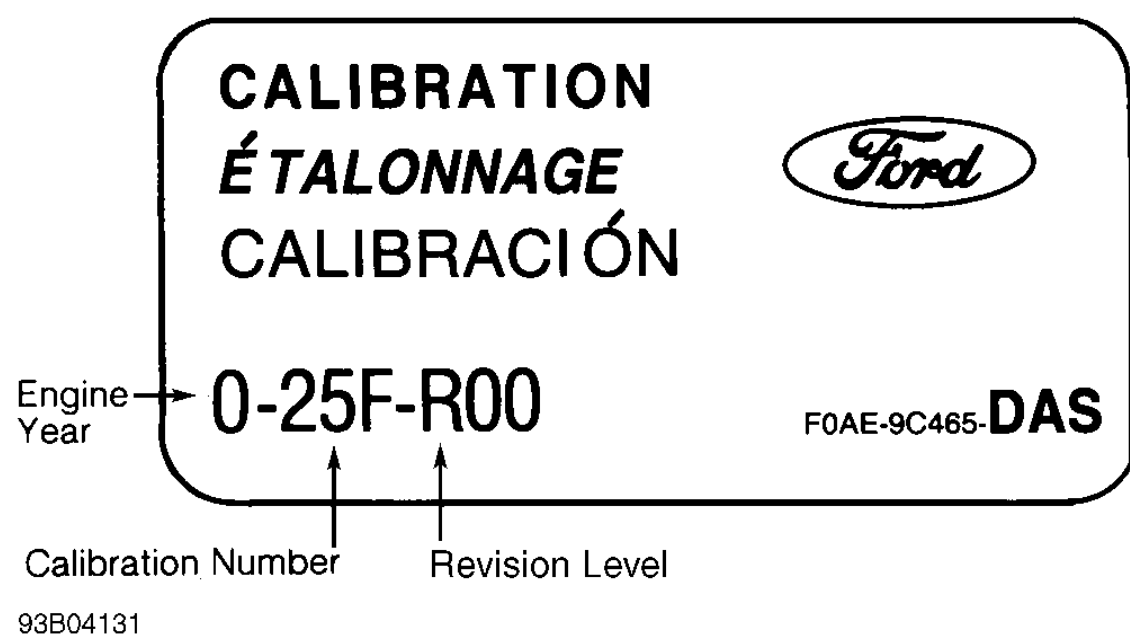


Fig. 5: Identifying Vehicle Calibration Label (1989-93 Ford Models)
Courtesy of FORD MOTOR CO.

EMISSION CONTROL VISUAL INSPECTION

NOTE: The following emission control visual inspection procedures should be used as a guide only. When performing a visual inspection, always follow your state's recommended inspection procedures.

A visual inspection is made to determine if any required emission control devices are missing, modified or disconnected. Missing, modified or disconnected systems must be made fully operational before a vehicle can be certified.

POSITIVE CRANKCASE VENTILATION (PCV)

PCV controls the flow of crankcase fumes into the intake manifold while preventing gases and flames from traveling in the opposite direction. PCV is either an open or closed system. See [Fig. 4](#) .

Ensure PCV system is installed as required. Verify valve, required hoses, connections, flame arresters, etc., are present, routed properly and in serviceable condition.

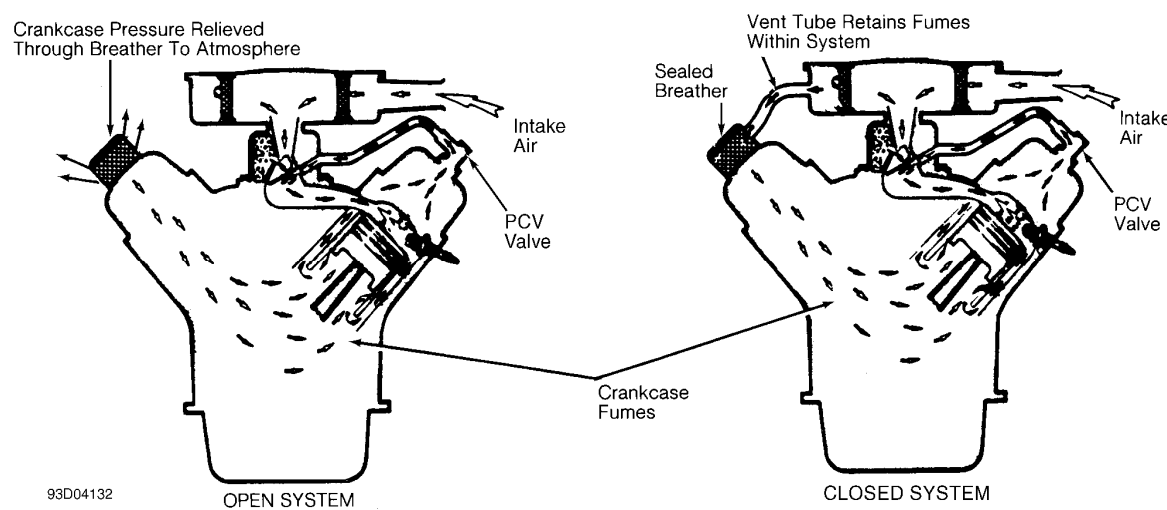


Fig. 6: Typical Open & Closed Type PCV System

THERMOSTATIC AIR CLEANER (TAC)

The TAC supplies warm air to air intake during cold engine operation. This system is active during cold engine warm-up only. Under all other operating conditions, air cleaner function is the same as any non-thermostatic unit.

Ensure required exhaust shroud, hot air duct, vacuum hoses and air cleaner components are present and installed properly. See [Fig. 7](#) . Ensure any required thermostatic vacuum switches are in place and vacuum hoses are installed and in serviceable condition. Also ensure air cleaner lid is installed right side up. Check for oversized air filter elements and for additional holes in the air cleaner housing.

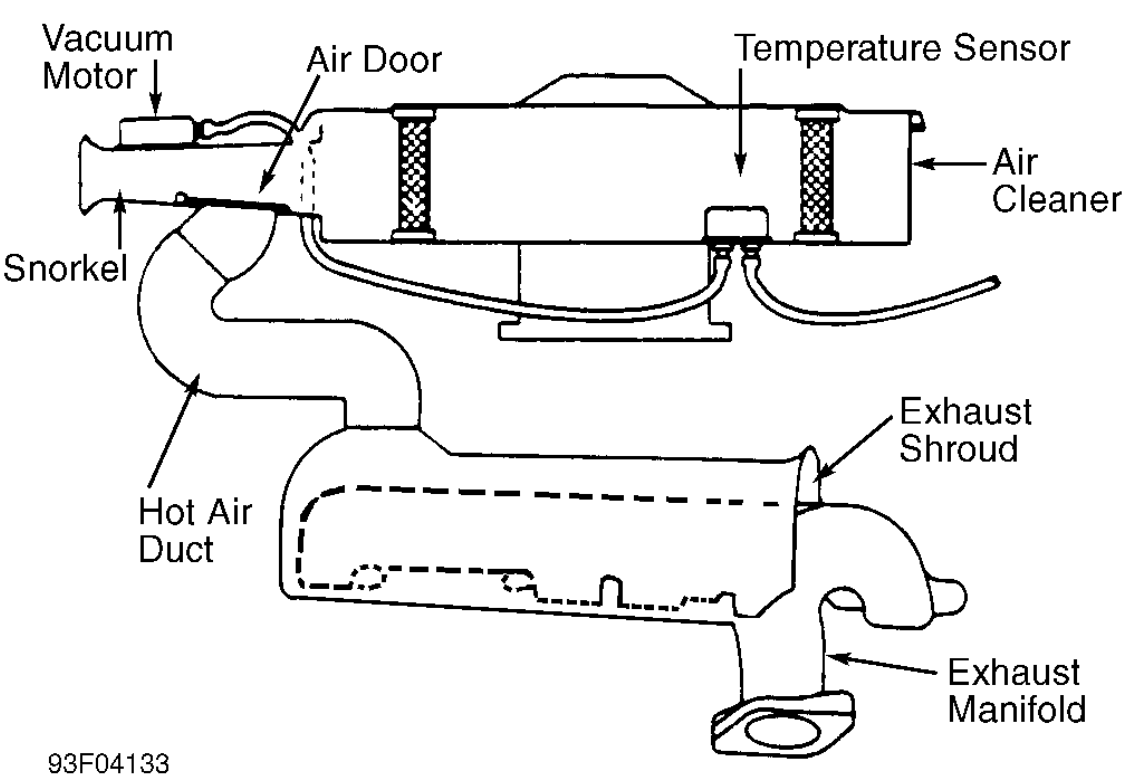


Fig. 7: Typical Thermostatic Air Cleaner System

FUEL EVAPORATIVE SYSTEM (EVAP)

The EVAP system allows for proper fuel system ventilation while preventing fuel vapors from reaching the atmosphere. This means that vapors must be caught and stored while the engine is off, which is when most fuel evaporation occurs. When the engine is started, these fuel vapors can be removed from storage and burned. In most systems, storage is provided by an activated charcoal (or carbon) canister. See [Fig. 8](#) . On a few early systems, charcoal canisters are not used. Instead, fuel vapors are vented into the PCV system and stored inside the crankcase.

The main components of a fuel evaporation system are a sealed fuel tank, a liquid-vapor separator and vent lines to a vapor-storing canister filled with activated charcoal. The filler cap is normally not vented to the atmosphere, but is fitted with a valve to allow both pressure and vacuum relief.

Although a few variations do exist between manufacturers, basic operation is the same for all systems. Check for presence of vapor storage canister or crankcase storage connections when required. Ensure required hoses, solenoids, etc., are present and connected properly. Check for proper type fuel tank cap. Check for any non-OEM or auxiliary fuel tanks for compliance and the required number of evaporation canisters.

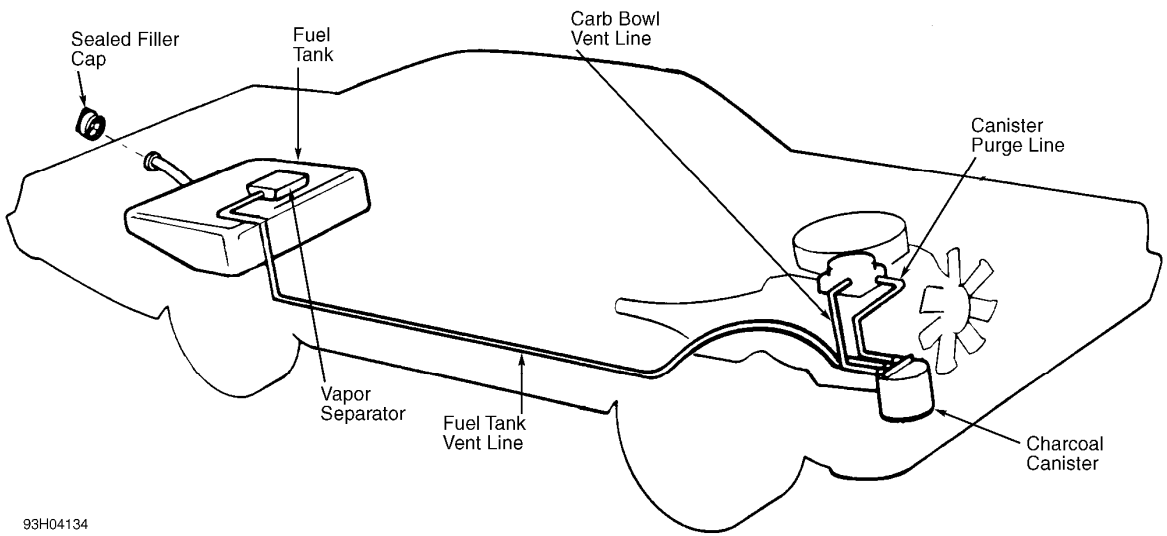


Fig. 8: Typical Fuel Evaporative System

CATALYTIC CONVERTERS

Oxidation Catalyst (OC)

This type of converter is the most common. It may use pellets or monolith medium, depending upon application. See [Fig. 9](#) . Platinum and palladium (or platinum alone) are used as catalyst in this type of converter.

Visually check for presence of catalytic converter(s). Check for external damage such as severe dents, removed or damaged heat shields, etc. Also check for pellets or pieces of converter in the tailpipe.

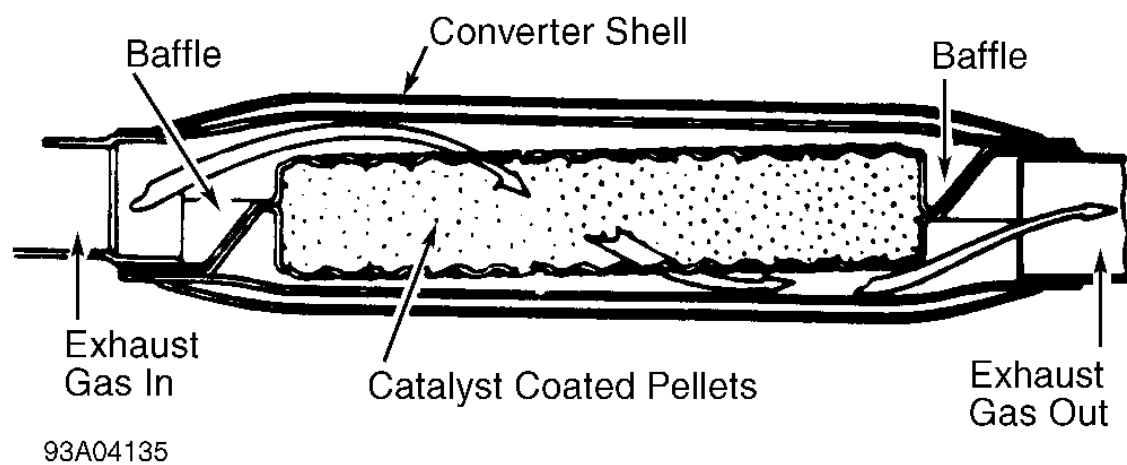


Fig. 9: Typical Oxidation Catalytic Converter (Pellet Type) Shown; Typical Three-Way Catalytic Converter Is Similar
Courtesy of GENERAL MOTORS CORP.

Three-Way Catalyst (TWC)

This type of converter is nearly identical to a conventional converter with the exception of the catalyst. See [Fig. 9](#) . The TWC converter uses rhodium, with or without platinum, as its catalyst. Rhodium helps reduce NOx emissions, as well as HC and CO.

Visually check for presence of catalytic converter(s). Also check for presence of any required air supply system for the oxidizing section of the converter. Check for external damage such as severe dents, removed or damaged heat shields, etc. Check for pellets or pieces of converter in the tailpipe.

Three-Way Catalyst + Oxidation Catalyst (TWC + OC)

This system contains a TWC converter and an OC converter in a common housing, separated by a small air space. See [Fig. 10](#) . The 2 catalysts are referred to as catalyst beds. Exhaust gases pass through the TWC first. The TWC bed performs the same function as it would as a separate device, reducing all 3 emissions. As exhaust gases leave the bed, they pass through the air space and into the second (OC) converter catalyst bed.

Visually check for presence of catalytic converter(s). Check for external damage such as severe dents, removed or damaged heat shields, etc. Check for pellets or pieces of converter in the tailpipe.

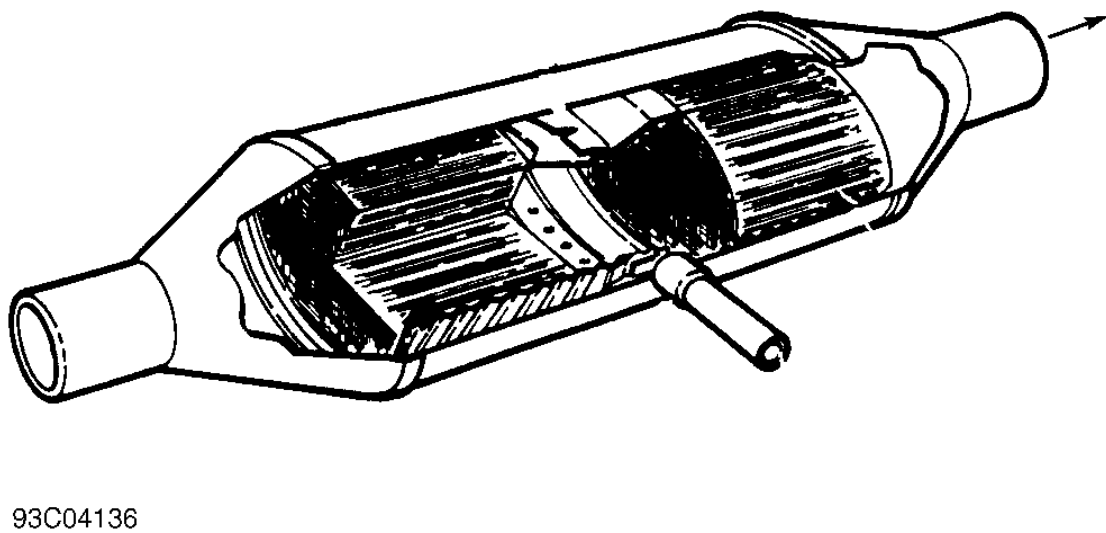


Fig. 10: Typical Three-Way + Oxidation Catalytic Converter
Courtesy of GENERAL MOTORS CORP.

FILL PIPE RESTRICTOR (FR)

A fuel tank fill pipe restrictor is used to prohibit the introduction of leaded fuel into the fuel tank. Unleaded gasoline pump dispensers have a smaller diameter nozzle to fit fuel tank of vehicle requiring the use of unleaded fuel (vehicles equipped with catalytic converter).

Visually inspect fill pipe restrictor(s) for tampering, i.e., restrictor is oversize or the flapper is non-functional. If vehicle is equipped with an auxiliary fuel tank, ensure auxiliary fuel tank is also equipped with a fill pipe restrictor.

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

Single Diaphragm EGR Valve

This type uses a single diaphragm connected to the valve by a shaft. Diaphragm is spring-loaded to keep valve closed in the absence of vacuum. As throttle valves open and engine speed increases, vacuum is applied to the EGR vacuum diaphragm, opening the EGR valve. This vacuum signal comes from a ported vacuum source. Variations in the vacuum signal control the amount of exhaust gas that is recirculated. See [Fig. 11](#) .

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches,

etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.

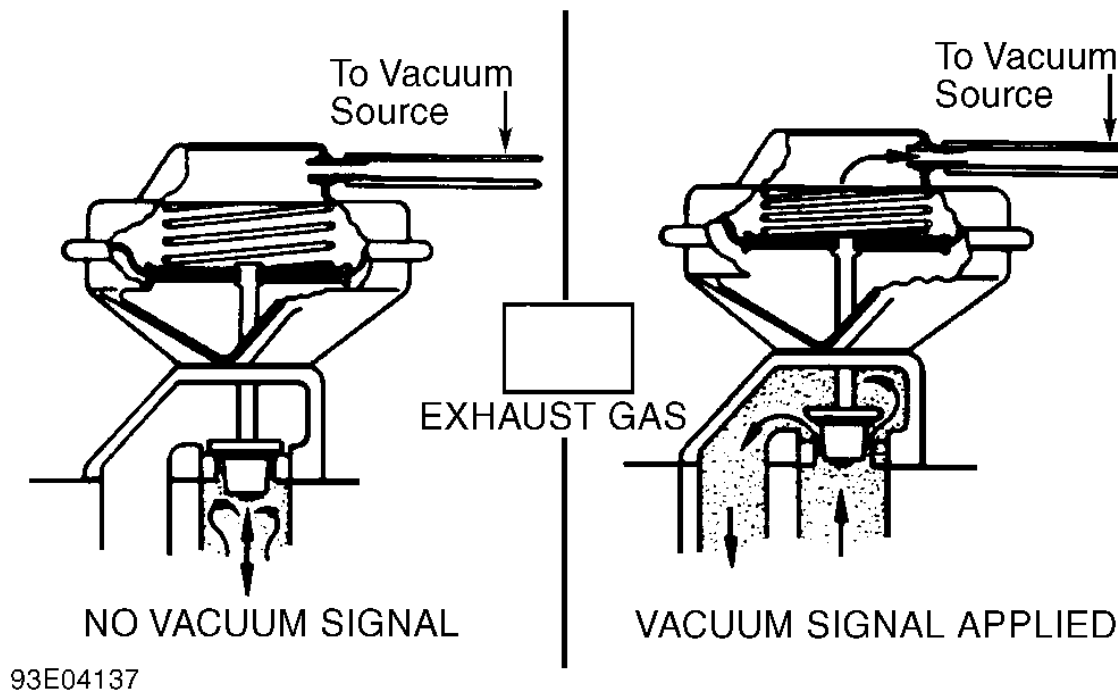


Fig. 11: Typical Single Diaphragm EGR Valve
Courtesy of GENERAL MOTORS CORP.

Dual Diaphragm EGR Valve

This type uses 2 diaphragms with different effective areas and 2 vacuum sources. Although similar to the single diaphragm type, the second diaphragm is added below the upper diaphragm and is rigidly attached to the valve seat. See [Fig. 13](#) . These diaphragms form a vacuum chamber which is connected to manifold vacuum.

During highway cruising when manifold vacuum is high in the center chamber, manifold vacuum tends to pull the valve closed. However, the vacuum signal applied to the top side of the upper diaphragm overcomes the downward spring force and the manifold vacuum pull, due to the diaphragm's larger piston. This regulates the amount of EGR.

When manifold vacuum is low during acceleration, the higher vacuum signal opens the valve, permitting more EGR. When manifold vacuum is high during highway cruising, the valve is only partially opened, reducing the amount of EGR.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.

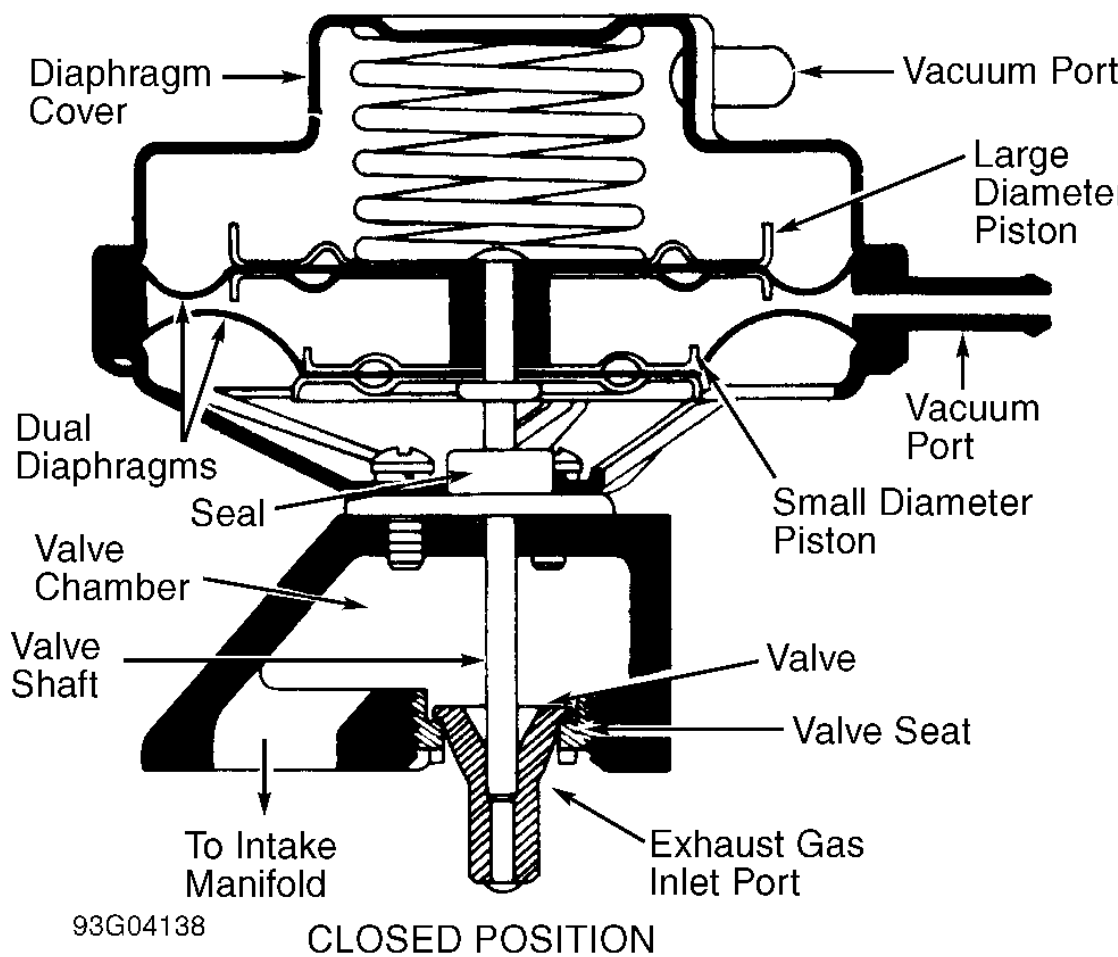


Fig. 12: Typical Dual Diaphragm EGR Valve
Courtesy of GENERAL MOTORS CORP.

Positive Backpressure EGR (BP/EGR) Valve

This type uses both engine vacuum and exhaust backpressure to control the amount of EGR. It provides more recirculation during heavy engine loads than the single diaphragm EGR valve.

A small diaphragm-controlled valve inside EGR valve acts as a pressure regulator. The control valve gets an exhaust backpressure signal through the hollow valve shaft. This exhaust backpressure exerts a force on bottom of control valve diaphragm. The diaphragm plate contains 6 bleed holes to bleed air into the vacuum chamber when backpressure valve is in open position. See [Fig. 12](#) .

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.

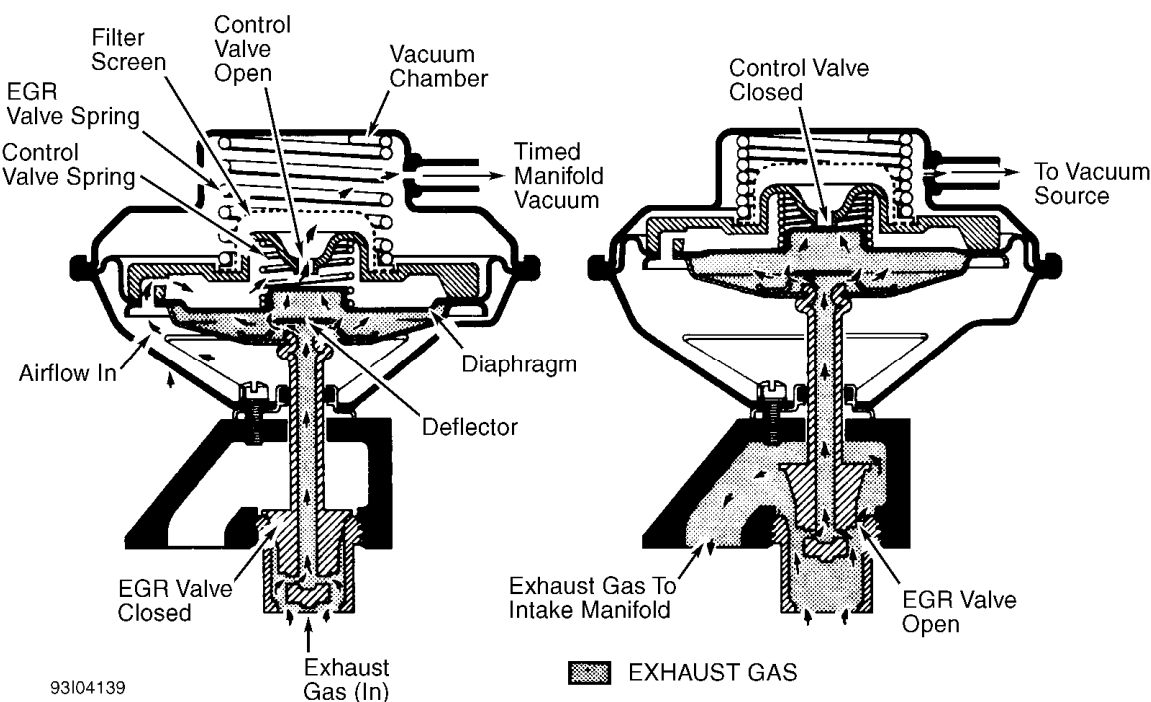


Fig. 13: Typical Positive Backpressure EGR Valve
Courtesy of GENERAL MOTORS CORP.

Negative Backpressure EGR (BP/EGR) Valve

This type has the same function as the positive BP/EGR valve except valve is designed to open with a negative exhaust backpressure. The control valve spring in the transducer is placed on the bottom side of the diaphragm. See [Fig. 14](#) .

When ported vacuum is applied to the main vacuum chamber, partially opening the valve, the vacuum signal from the manifold side (reduced by exhaust backpressure) is transmitted to the hollow stem of the valve. See [Fig. 14](#) . This enables the signal to act on the diaphragm, providing a specific flow. Thus, the EGR flow is a constant percentage of engine airflow.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.

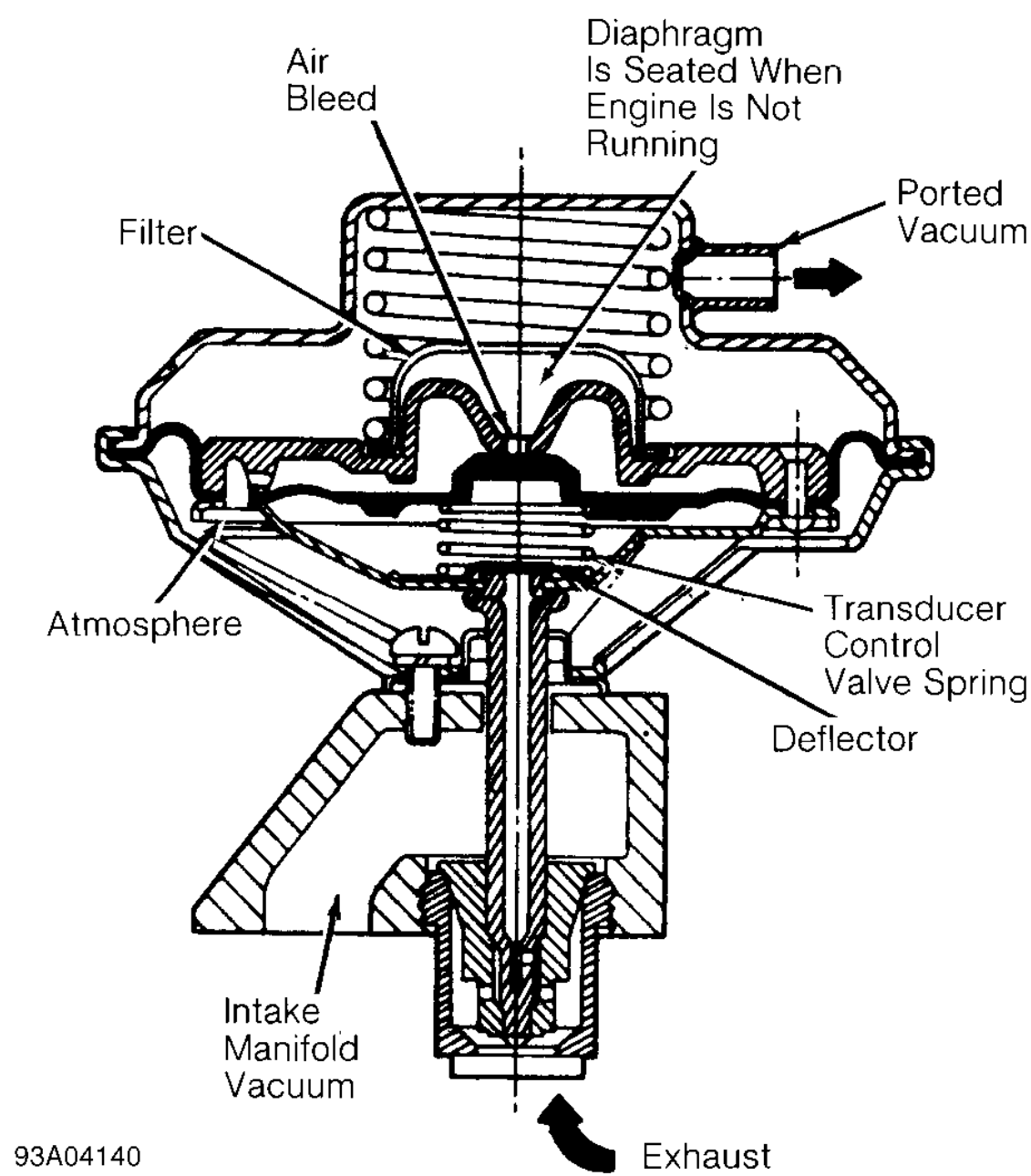


Fig. 14: Typical Negative Backpressure EGR Valve
Courtesy of GENERAL MOTORS CORP.

Digital EGR Valve

The digital EGR valve operates independently of engine manifold vacuum. This valve controls EGR flow through 3 orifices. These 3 orifices are opened and closed by electric solenoids. The solenoids are, in turn, controlled by the Electronic Control Module (ECM). When a solenoid is energized, the armature with attached shaft and swivel pintle is lifted, opening the orifice. See [Fig. 15](#).

The ECM uses inputs from the Coolant Temperature Sensor (CTS), Throttle Position Sensor (TPS) and Mass Airflow (MAF) sensors to control the EGR orifices to make 7 different combinations for precise EGR flow control. At idle, the EGR valve allows a very small amount of exhaust gas to enter the intake manifold. This EGR valve normally operates above idle speed during warm engine operation.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged. Ensure electrical connector to EGR valve is not disconnected.

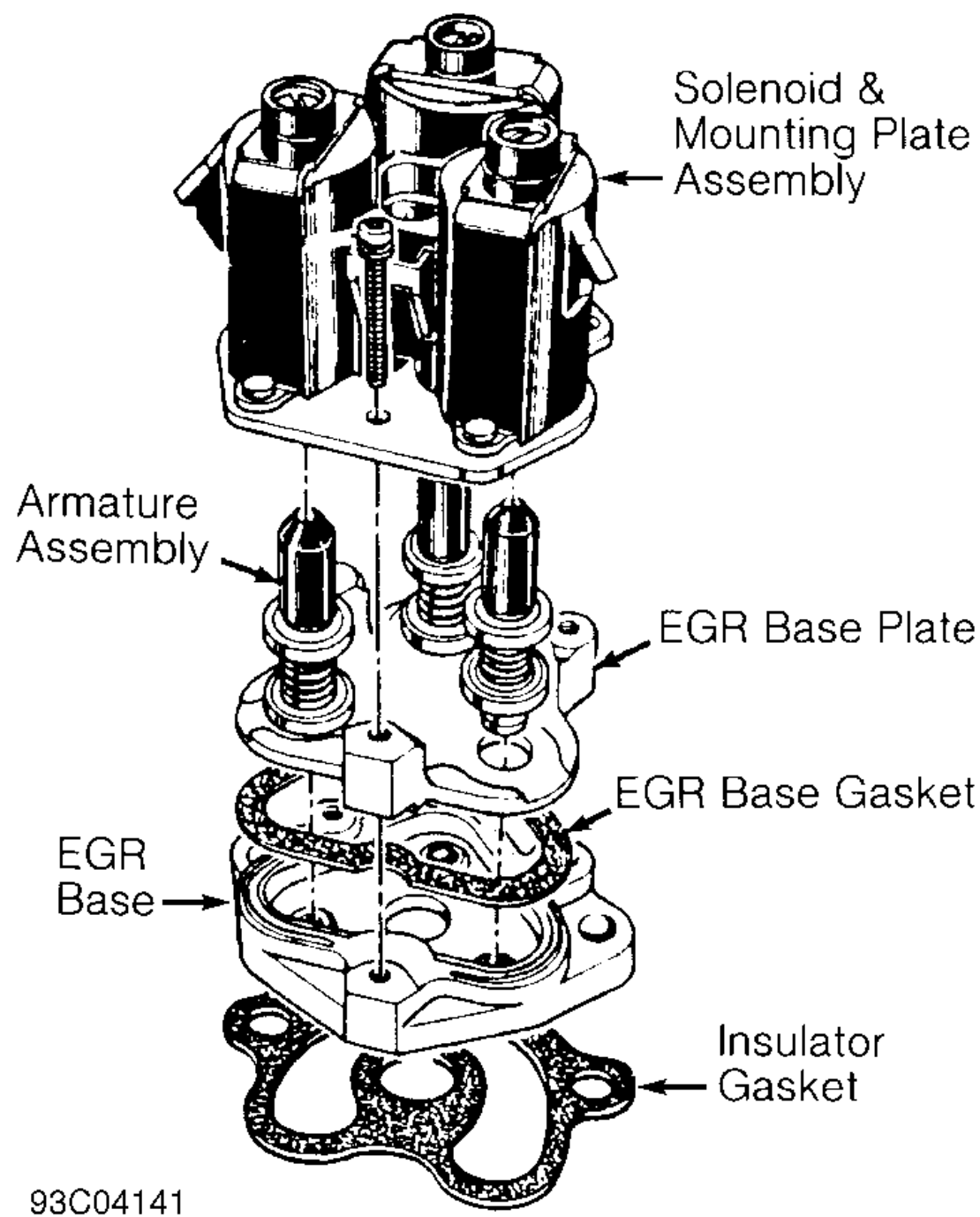


Fig. 15: Typical Digital EGR Valve
Courtesy of GENERAL MOTORS CORP.

Integrated Electronic EGR Valve

This type functions similar to a ported EGR valve with a remote vacuum regulator. The internal solenoid is normally open, which causes the vacuum signal to be vented off to the atmosphere when EGR is not controlled by the Electronic Control Module (ECM). The solenoid valve opens and closes the vacuum signal, controlling the amount of vacuum applied to the diaphragm. See [Fig. 16](#) .

The electronic EGR valve contains a voltage regulator, which converts ECM signal and regulates current to the solenoid. The ECM controls EGR flow with a pulse width modulated signal based on airflow, TPS and RPM. This system also contains a pintle position sensor, which works similarly to a TPS sensor. As EGR flow is increased, the sensor output increases.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure electrical connector to EGR valve is not disconnected.

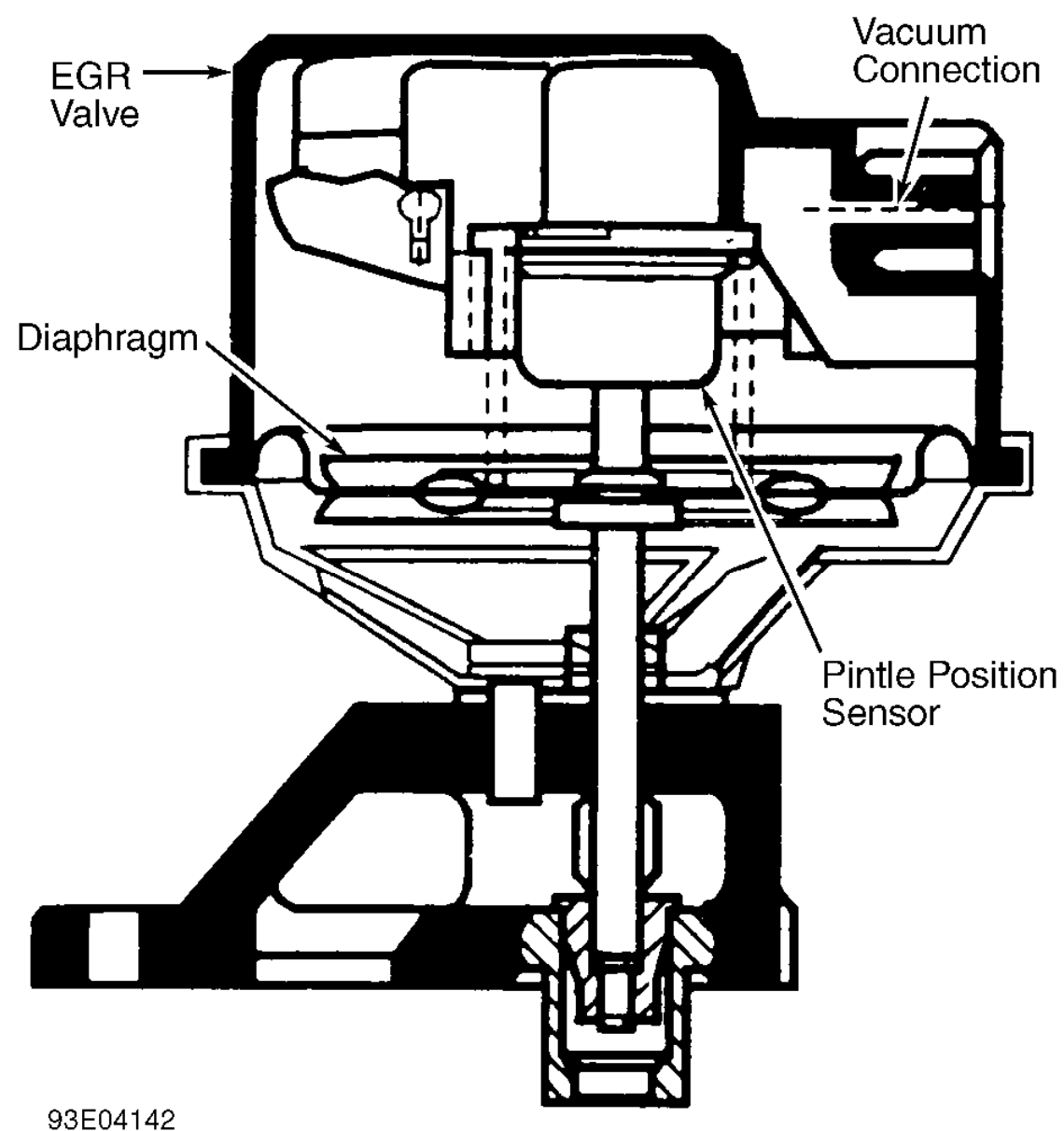


Fig. 16: Cutaway View Of Typical Integrated Electronic EGR Valve
 Courtesy of GENERAL MOTORS CORP.

SPARK CONTROLS (SPK)

Spark control systems are designed to ensure the air/fuel mixture is ignited at the best possible moment to provide optimum efficiency and power and cleaner emissions.

Ensure vacuum hoses to the distributor, carburetor, spark delay valves, thermal vacuum switches, etc., are in place and routed properly. On Computerized Engine Controls (CEC), check for presence of required sensors (O₂, MAP, CTS, TPS, etc.). Ensure they have not been tampered with or modified.

Check for visible modification or replacement of the feedback carburetor, fuel injection unit or injector(s) with a non-feedback carburetor or fuel injection system. Check for modified emission-related components unacceptable for use on pollution-controlled vehicles.

AIR INJECTION SYSTEM (AIS)

Air Pump Injection System (AP)

The air pump is a belt-driven vane type pump, mounted to engine in combination with other accessories. The air pump itself consists of the pump housing, an inner air cavity, a rotor and a vane assembly. As the vanes turn in the housing, filtered air is drawn in through the intake port and pushed out through the exhaust port. See [Fig. 17](#).

Check for missing or disconnected belt, check valve(s), diverter valve(s), air distribution manifolds, etc. Check air injection system for proper hose routing.

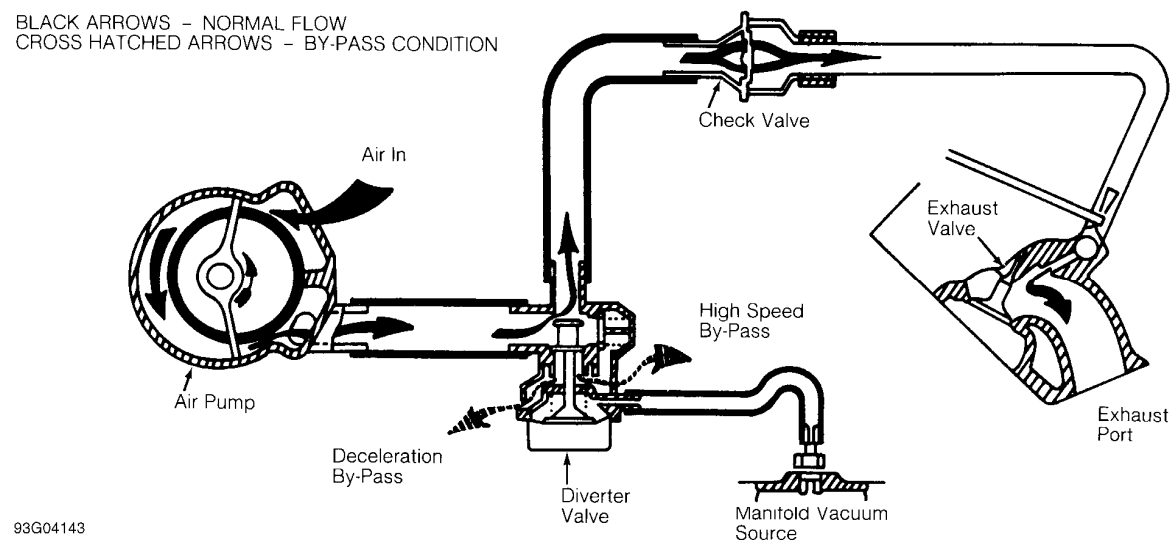


Fig. 17: Typical Air Pump Injection System
Courtesy of GENERAL MOTORS CORP.

Pulsed Secondary Air Injection (PAIR) System

PAIR eliminates the need for an air pump and most of the associated hardware. Most systems consists of air delivery pipe(s), pulse valve(s) and check valve(s). The check valve prevents exhaust gases from entering the air injection system. See [Fig. 18](#) .

Ensure required check valve(s), diverter valve(s), air distribution manifolds, etc., are present. Check air injection system for proper hose routing.

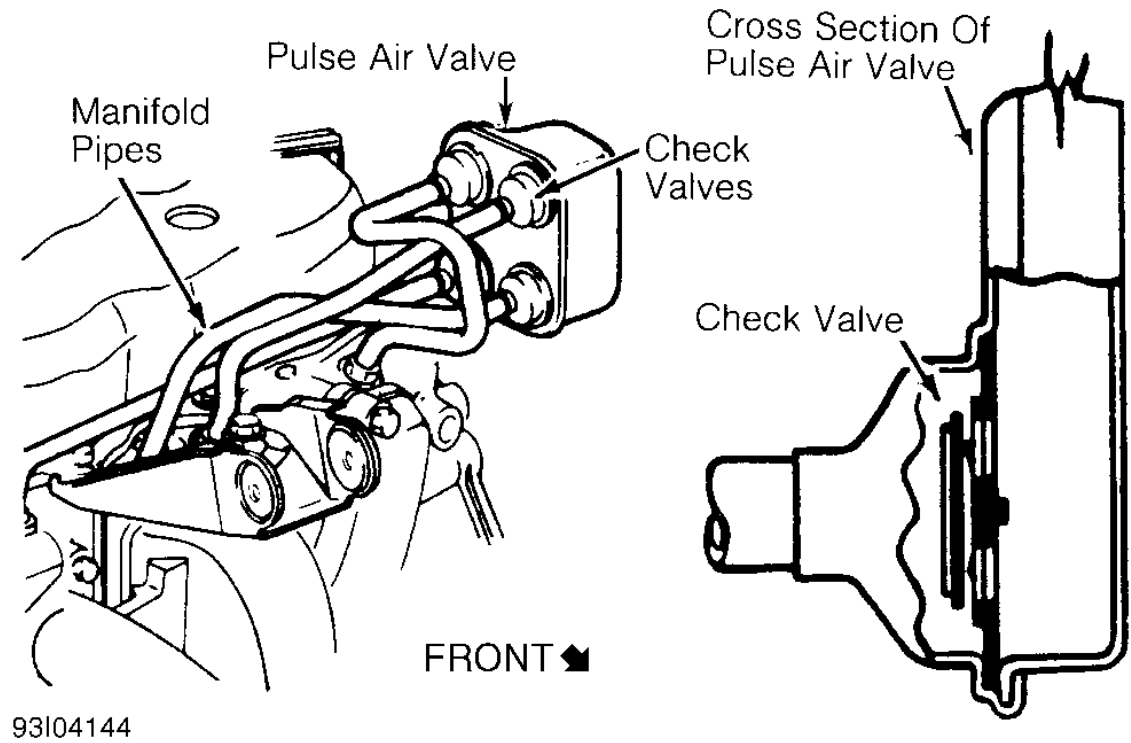


Fig. 18: Typical Pulsed Secondary Air Injection System
Courtesy of GENERAL MOTORS CORP.

OXYGEN SENSOR (O2)

The O2 sensor is mounted in the exhaust system where it monitors oxygen content of exhaust gases. Some vehicles may use 2 O2 sensors. The O2 sensor produces a voltage signal which is proportional to exhaust gas oxygen concentration (0-3%) compared to outside oxygen (20-21%). This voltage signal is low (about .1 volt) when a lean mixture is present and high (1.0 volt) when a rich mixture is present.

As ECM compensates for a lean or rich condition, this voltage signal constantly fluctuates between high and low, crossing a reference voltage supplied by the ECM on the O2 signal line. This is referred to as cross counts. A problem in the O2 sensor circuit should set a related trouble code.

COMPUTERIZED ENGINE CONTROLS (CEC)

The CEC system monitors and controls a variety of engine/vehicle functions. The CEC system is primarily an emission control system designed to maintain a 14.7:1 air/fuel ratio under most operating conditions. When the ideal air/fuel ratio is maintained, the catalytic converter can control oxides of nitrogen (NOx), hydrocarbon (HC) and carbon monoxide (CO) emissions.

The CEC system consists of the following sub-systems: Electronic Control Module (ECM), input devices (sensors and switches) and output signals.

EARLY FUEL EVAPORATION (EFE)

The EFE valve is actuated by either a vacuum actuator or a bimetal spring (heat-riser type). The EFE valve is closed when engine is cold. The closed valve restricts exhaust gas flow from the exhaust manifold. This forces part of the exhaust gas to flow up through a passage below the

carburetor. As the exhaust gas quickly warms the intake mixture, distribution is improved. This results in better cold engine driveability, shorter choke periods and lower emissions.

Ensure EFE valve in exhaust manifold is not frozen or rusted in a fixed position. On vacuum-actuated EFE system, check EFE thermal vacuum valve and check valve(s). Also check for proper vacuum hose routing. See [Fig. 19](#) .

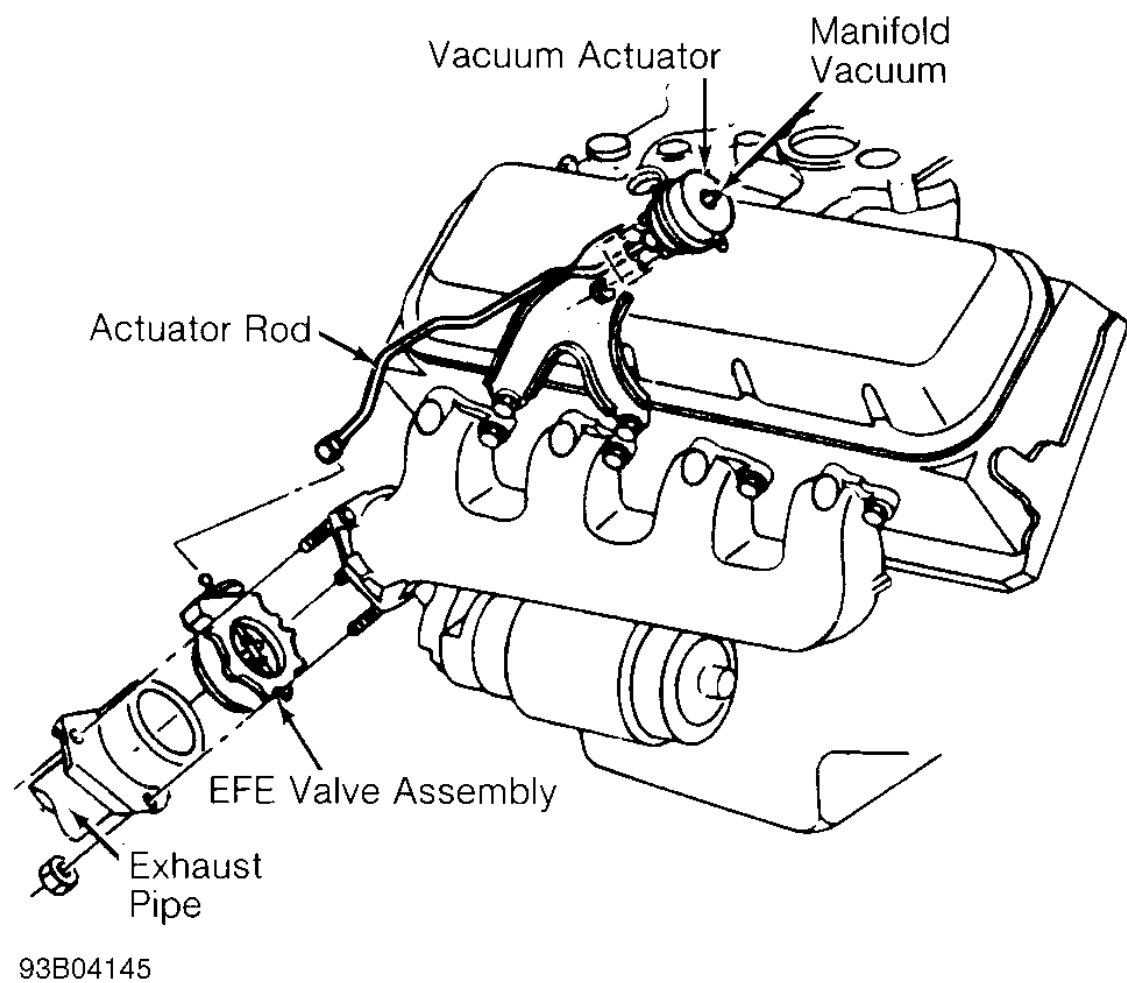


Fig. 19: Typical Vacuum-Actuated EFE System
Courtesy of GENERAL MOTORS CORP.

EMISSION MAINTENANCE REMINDER LIGHT (EMR)

If equipped, the EMR light (some models may use a reminder flag) reminds vehicle operator that an emission system maintenance is required. This indicator is activated after a predetermined time/mileage.

When performing a smog check inspection, ensure EMR indicator is not activated. On models using an EMR light, light should glow when ignition switch is turned to ON position and should turn off when engine is running.

If an EMR flag is present or an EMR light stays on with engine running, fail vehicle and service or replace applicable emission-related components. To reset an EMR indicator, refer to appropriate MAINTENANCE REMINDER LIGHTS article in GENERAL INFORMATION.

MALFUNCTION INDICATOR LIGHT (MIL)

The Malfunction Indicator Light (MIL) is used to alert vehicle operator that the computerized engine control system has detected a malfunction (when it stays on all the time with engine running). On some models, the MIL may also be used to display trouble codes.

As a bulb and system check, malfunction indicator light will glow when ignition switch is turned to ON position and engine is not running. When engine is started, light should go out.

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GENERAL INFORMATION

Engine Performance Diagnostic Routine Outline

* PLEASE READ THIS FIRST *

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

WHERE DOES DRIVEABILITY DIAGNOSIS START?

PERFORM BASIC INSPECTION

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

1. Verify Customer Complaint
2. Perform Visual Inspection (See **Basic Diagnostic Procedures**)
3. Test Engine Sub-Systems (See **Basic Diagnostic Procedures**)
 - Mechanical Condition (Compression)
 - Ignition Output
 - Fuel Delivery
4. Check Air Induction System For Leaks
5. Check & Adjust Basic Engine Settings(See **On-Vehicle Adjustments**)
 - Ignition Timing
 - Idle Speed

CHECK FOR TROUBLE CODES

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

1. Check for Diagnostic Trouble Codes (DTCs).(See **Self-Diagnostics**)
2. Repair cause of DTCs.
3. Clear PCM memory and repeat self-test.

DIAGNOSE SYMPTOM

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

1. If no self-diagnostics available, or no trouble codes present, identify symptom.
2. See trouble shooting procedure to identify problem. (See **Trouble Shooting - No Codes**)

TEST SYSTEM

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

1. Perform required tests. (See **Systems & Component Testing**)
2. Verify complaint is repaired.

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GENERAL INFORMATION

Engine Performance Safety Precautions

- Always refer to Emission Decal in engine compartment before servicing vehicle. If manual and decal differ, always use decal specifications.
- Do not allow or create a condition of misfire in more than one cylinder for an extended period of time. Damage to converter may occur due to loading converter with unburned air/fuel mixture.
- Always turn ignition off and disconnect negative battery cable BEFORE disconnecting or connecting computer or other electrical components.
- DO NOT drop or shock electrical components such as computer, airflow meter, etc.
- DO NOT use fuel system cleaning compounds that are not recommended by the manufacturer. Damage to gaskets, diaphragm materials and catalytic converter may result.
- Before performing a compression test or cranking engine using a remote starter switch, disconnect coil wire from distributor and secure it to a good engine ground, or disable ignition.
- Before disconnecting any fuel system component, ensure fuel system pressure is released.
- Use a shop towel to absorb any spilled fuel to prevent fire.
- DO NOT create sparks or have an open flame near battery.
- If any fuel system components such as hoses or clamps are replaced, ensure they are replaced with components designed for fuel system use.
- Always reassemble throttle body components with new gaskets, "O" rings and seals.
- If equipped with an inertia switch, DO NOT reset switch until fuel system has been inspected for leaks.
- Wear safety goggles when drilling or grinding.
- Wear proper clothing which protects against chemicals and other hazards.

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Article GUID: A00002342

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GENERAL INFORMATION

How To Use The Engine Performance Section - 1989 & Newer Models

* PLEASE READ THIS FIRST *

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

HOW TO USE THE ENGINE PERFORMANCE SECTION

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

Congratulations, you have purchased the most advanced automotive repair and service information available. This information can help you, as a professional automotive technician, to maintain top vehicle performance, and correct driveability problems on today's high-tech vehicles.

For your convenience and ease in use, all of our engine performance service and repair information is consistently organized by manufacturer, using a progressive diagnostic/workflow approach. Due to the differences in how each manufacturer approaches diagnosis and repair, once started and inside of an article, that manufacturer may drive the workflow in a direction other than what is outlined here.

The progressive diagnostic/workflow of our data is as follows:

- APPLICATION to identify vehicle and system usage.
- EMISSION APPLICATION to identify emission system usage.
- SPECIFICATIONS to quickly find an engine performance service specification.
- ADJUSTMENTS to perform engine performance related routine adjustments.
- THEORY & OPERATION to familiarize yourself with new systems and technologies.
- BASIC DIAGNOSTIC PROCEDURES located under TESTING & DIAGNOSTICS, also referred to as BASIC TESTING, is used for performing a basic vehicle inspection and is also the starting point for diagnosis of a "no-start" condition.
- SELF-DIAGNOSTICS located under TESTING & DIAGNOSTICS, also referred to as TESTS W/CODES, is where manufacturer specific procedures for retrieving, identifying and diagnosing DTCs (trouble codes) retained in a control modules memory are located.
- TROUBLE SHOOTING - NO CODES located under TESTING & DIAGNOSTICS, also referred to as TESTS W/O CODES, is where an engine performance problem that does not set a DTC can be potentially isolated through either a SYMPTOM or INTERMITTENTS duplication procedure.
- SYSTEM & COMPONENT TESTING located under TESTING & DIAGNOSTICS, also referred to as SYSTEM/COMPONENT TESTS, once directed to this article, specific system and component tests can be performed to help isolate faulty component/system prior to replacement.
- PIN VOLTAGE CHARTS provide supplemental information to help determine correct control module input and output signals. Pin charts may also be referred to as PID charts by some manufacturers.
- SENSOR RANGE CHARTS help determine if a sensor is out of calibration. In some cases an out-of-calibration sensor will not set a DTC (trouble code), resulting in difficult to diagnose driveability symptoms.
- VACUUM DIAGRAMS help determine correct routing of vacuum hoses when reinstalling components or performing emission inspections.
- REMOVE, OVERHAUL & INSTALL provides procedures necessary for removing and installing engine performance related components.
- WIRING DIAGRAMS can be used to identify circuits, terminals, wire colors and components referenced in testing procedures. NEW COLOR WIRING DIAGRAMS (system diagrams) provide an easy method of identifying and tracing circuits.

APPLICATION

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

INTRODUCTION/ENGINE/VIN ID

Here you will find out how to identify an engine by its Vehicle Identification Number (VIN). The manufacturer's MODEL COVERAGE chart lists each model and engine option, the fuel system, ignition system and engine code. Engine serial number locations are also shown here, as well as the VIN code breakdown. Using model lookup in conjunction with VIN and engine ID will identify application information necessary for servicing vehicle and ordering parts.

EMISSION APPLICATIONS

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

EMISSION APPLICATION TABLES

Here you will find a chart listing what emission control devices apply to each model. This can be helpful when performing government-required emissions inspections. For quick reference, major emission systems and devices are listed in bold type in the emission table. Sub components are listed in light type.

SPECIFICATIONS

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

SERVICE & ADJUSTMENT SPECIFICATIONS

If you want a specification quickly, this is the place to look. Instead of hunting through a long article, we've separated out the important specifications and arranged them into easy-to-use tables in a centralized location. You can find valuable information like spark plug wire resistance, valve clearance, timing, firing orders, etc.

ADJUSTMENT

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

ON-VEHICLE ADJUSTMENTS

The ON-VEHICLE ADJUSTMENTS article contains the type of information that was previously thought of as TUNE-UP information. Procedures for checking and adjusting valves, base ignition timing and idle speed are found in this section. Use this section in conjunction with SERVICE & ADJUSTMENT SPECIFICATIONS for performing routine maintenance. Also, if you have a driveability problem, ensure all on-vehicle adjustments are within specification before attempting further diagnosis.

THEORY & OPERATION

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

This article covers basic THEORY & OPERATION of engine performance-related systems and components. Before diagnosing vehicles or new systems with which you are not completely familiar, read this article.

TESTING & DIAGNOSTICS

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

BASIC DIAGNOSTIC PROCEDURES/BASIC TESTING

The procedures listed in this article can help you avoid skipping a simple step early, like checking base timing, which could be costly in both time and money later. This is also a potential starting point for diagnosis of a "no-start" condition. If all systems check out okay here, proceed to SELF-DIAGNOSTICS/TESTS W/CODES or TROUBLE SHOOTING - NO CODES/TESTS W/O CODES article.

SELF-DIAGNOSTICS/TESTS W/CODES

Use this information to retrieve and interpret Diagnostic Trouble Codes (DTCs) accessed from the vehicle's self-diagnostic system. Once information is retrieved, manufacturer diagnostic procedures are given to help pinpoint and repair computer system/component faults. Also included are steps for clearing trouble codes once these faults are repaired. If there is a driveability symptom with no trouble codes set, proceed to TROUBLE SHOOTING - NO CODES/TESTS W/O CODES article.

TROUBLE SHOOTING - NO CODES/TESTS W/O CODES

This is where to go when you have a problem that does not set a trouble code. It can help determine cause of problem using driveability symptoms and intermittent testing procedures. Procedures in this information should lead you to a specific component or system test.

SYSTEM & COMPONENT TESTING

Here you will find various tests for engine performance systems and their components, such as air induction (turbochargers and superchargers), fuel control, ignition control and emission systems.

PIN VOLTAGE CHARTS

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

These are supplied (when available from manufacturer) to quicken the diagnostic process. By checking pin voltages at the Powertrain Control Module (PCM), you can determine if the PCM is receiving and/or transmitting proper voltage signals. Pin charts may also be referred to as PID charts by some manufacturers.

SENSOR RANGE CHARTS

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

SENSOR OPERATING RANGE CHARTS

These are supplied (when available from manufacturer) to determine if a sensor is out of calibration. An out-of-calibration sensor may not set a trouble code, but it may cause driveability problems.

VACUUM DIAGRAMS

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

Here we give you underhood views or schematics of vacuum-hose routing which can help you find incorrectly routed hoses. Remember, a vacuum leak or incorrectly routed vacuum hose on computer-controlled vehicle can cause many driveability problems.

REMOVAL, OVERHAUL & INSTALLATION

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

After you've diagnosed the problem, this is where to go for the nuts-and-bolts of the job. Here you'll find procedures and specifications for removing, overhauling (if available) and installing components.

WIRING DIAGRAMS - ENGINE PERFORMANCE

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

NOTE: System Wiring diagrams for have been enhanced to include **COLORS**. This will enable you to more easily trace a circuit from its source to its destination, without losing your circuit due to parallel or intersecting lines. Using these diagrams, you can easily identify and trace component circuits, to help locate shorts and opens in circuits. These diagrams can also help you understand how individual circuits function within a system.

2002 & EARLIER

On 2002 and earlier models, once **ENGINE PERFORMANCE** is selected as the service category, the expanded menu will display a **WIRING DIAGRAMS - ENGINE PERFORMANCE** heading. Once the wiring diagrams article is selected, select the engine performance wiring diagrams for your lookup model.

2003 & LATER

On models newer than 2002, we have moved all wiring diagrams under a centralized first level model-specific lookup titled **WIRING DIAGRAMS-ALL**. When selected, **SYSTEM WIRING DIAGRAMS** article will display in the center panel. This article contains all available wiring diagrams related to the selected vehicle. These same wiring diagrams can also be found under the **ELECTRICAL/WIRING DIAGRAMS** heading.

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GENERAL INFORMATION

Parasitic Load Explanation & Test Procedures

* PLEASE READ THIS FIRST *

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

GENERAL INFORMATION

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

The term Parasitic Load refers to electrical devices that continue to use or draw current after the ignition switch is turned to OFF position. This small amount of continuous battery draw is expressed in milliamps (mA). On Chrysler vehicles, a typical Parasitic Load should be no more than 30 milliamps (0.030 amps). On Ford Motor Co. and General Motors vehicles produced after 1980, a typical Parasitic Load should be no more than 50 milliamps (0.050 amps).

Vehicles produced since 1980 have memory devices that draw current with ignition off for as long as 20 minutes before shutting down the Parasitic Drain. When Parasitic Load exceeds normal specifications, the vehicle may exhibit dead battery and no-start condition.

Follow test procedure for checking Parasitic Loads to completion. A brief overview of a suggested test procedure is included along with some typical Parasitic Load specifications. Refer to GENERAL MOTORS PARASITIC LOAD TABLE chart.

TESTING FOR PARASITIC LOAD

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

CAUTION: Always turn ignition off when connecting or disconnecting battery cables, battery chargers or jumper cables. DO NOT turn test switch to OFF position (which causes current to run through ammeter or vehicle electrical system).

NOTE: Memory functions of various accessories must be reset after the battery is reconnected.

The battery circuit must be opened to connect test switch (shunt) and ammeter into the circuit. When a battery cable is removed, timer circuits within the vehicle computer are interrupted and immediately begin to discharge. If in doubt about the condition of the ammeter fuse, test it with an ohmmeter prior to beginning test. An open fuse will show the same reading (00.00) as no parasitic drain. Begin test sequence with the meter installed and on the 10-amp scale. Select lower scale to read parasitic draw.

CHRYSLER IGNITION OFF DRAW (IOD) TEST

To test for excessive IOD, verify that all electrical accessories are OFF. Turn off all lights, remove ignition key, and close all doors and decklid. If the vehicle is equipped with electronic accessories (illuminated entry, automatic load leveler, body computer, or high line radio), allow the system to automatically shut off (time out), up to 3 minutes.

1. Raise the hood and disconnect both battery cables, negative first.

CAUTION: IOD greater than 3 amps may damage millampmeter.

2. Reconnect the negative cable and connect a typical 12-volt test light (low wattage bulb) between the positive cable clamp and the positive battery post. Remove the engine compartment lamp bulb. If the test light does not light, proceed to step [3](#). If the test light does light, proceed to step, [4](#). The test light will indicate IOD greater than 3 amps. After higher amperage IOD has been corrected, proceed to step [3](#).
3. ith 12-volt test light still connected (not lit), connect an ammeter (milliampere scale) between the positive cable clamp and the positive battery post, disconnect test light, refer to instructions provided with ammeter being used. A reading of 30 milliamperes or less indicates normal electrical draw. If ammeter reads more than 30 milliamperes, excessive IOD must be corrected.
4. Locate the fuse panel and remove fuses or circuit breakers one at a time, and observe ammeter after each fuse or circuit breaker is removed. If test light goes out and the reading drops below 30 milliamperes when a certain fuse or circuit breaker is removed, that circuit may have a defect.
5. If IOD is detected after all fuses and circuit breakers have been removed, disconnect the 60-way connector at the Single Module Engine Control (SMEC), located outboard of the battery.
6. If excessive IOD is detected after all fused circuits and SMEC have been verified, disconnect the B+ terminal from the alternator. If reading drops below 30 milliamperes, reinstall all fuses and circuit breakers, reconnect B+ terminal at alternator, reconnect battery, and perform alternator diagnostics.
7. Install engine compartment lamp bulb.

TEST PROCEDURE USING TEST SWITCH

1. Turn ignition off. Remove negative battery terminal cable. Install Disconnect Tool (J-38758) test switch male end to negative battery cable. Turn test switch knob to OFF position (current through meter). Install negative battery cable to the female end of test switch.

2.

Turn test switch knob to ON position (current through switch). Road test vehicle with vehicle accessories on (radio, air conditioner, etc). After road test, turn ignition switch to LOCKED position and remove key. Connect ammeter terminals to test switch terminals. See [Fig. 1](#). Select 10-amp scale.
3.

Turn off all electrical accessories. Turn off interior lights, underhood lamp, trunk light, illuminated entry, etc. To avoid damaging ammeter or obtaining a false meter reading, all accessories must be off before turning test switch knob to OFF position.
4.

Turn test switch knob to OFF position to allow current to flow through ammeter. If meter reads wrong polarity, turn test switch to ON position and reverse leads. Turn test switch to OFF position. Observe current reading. If reading is less than 2 amps, turn test switch to ON position to keep electrical circuits powered-up.
5.

Select low amp scale. Switch lead to the correct meter position. Turn test switch to OFF position and compare results to normal current draw. See [GENERAL MOTORS PARASITIC LOAD TABLE \(MILLIAMPS\)](#). If current draw is unusually high for the vehicle's overall electrical system, remove system fuses one at a time until current draw returns to normal.
6.

Turn test switch to ON position each time door is opened or fuse is removed. Turn switch to OFF position to read current draw value through meter. When the cause of excessive current drain has been located and repaired, remove test switch and reconnect negative battery cable to the negative battery terminal.

INTERMITTENT PARASITIC LOAD PROBLEMS

Intermittent parasitic load can occur because of a memory device that does not power down with ignition off. With an intermittent parasitic load, battery draw can be greater than 1.0 amp.

To find an intermittent problem requires that an ammeter and Disconnect Tool (J-38758) test switch be connected and left in the circuit. See [Fig. 1](#). Road test vehicle. After road test, turn ignition off and remove key.

Monitor the milliamps scale for 15-20 minutes after ignition is turned off. This allows monitoring memory devices to determine if they time out and stop drawing memory current. The test switch is needed to protect ammeter when the vehicle is started.

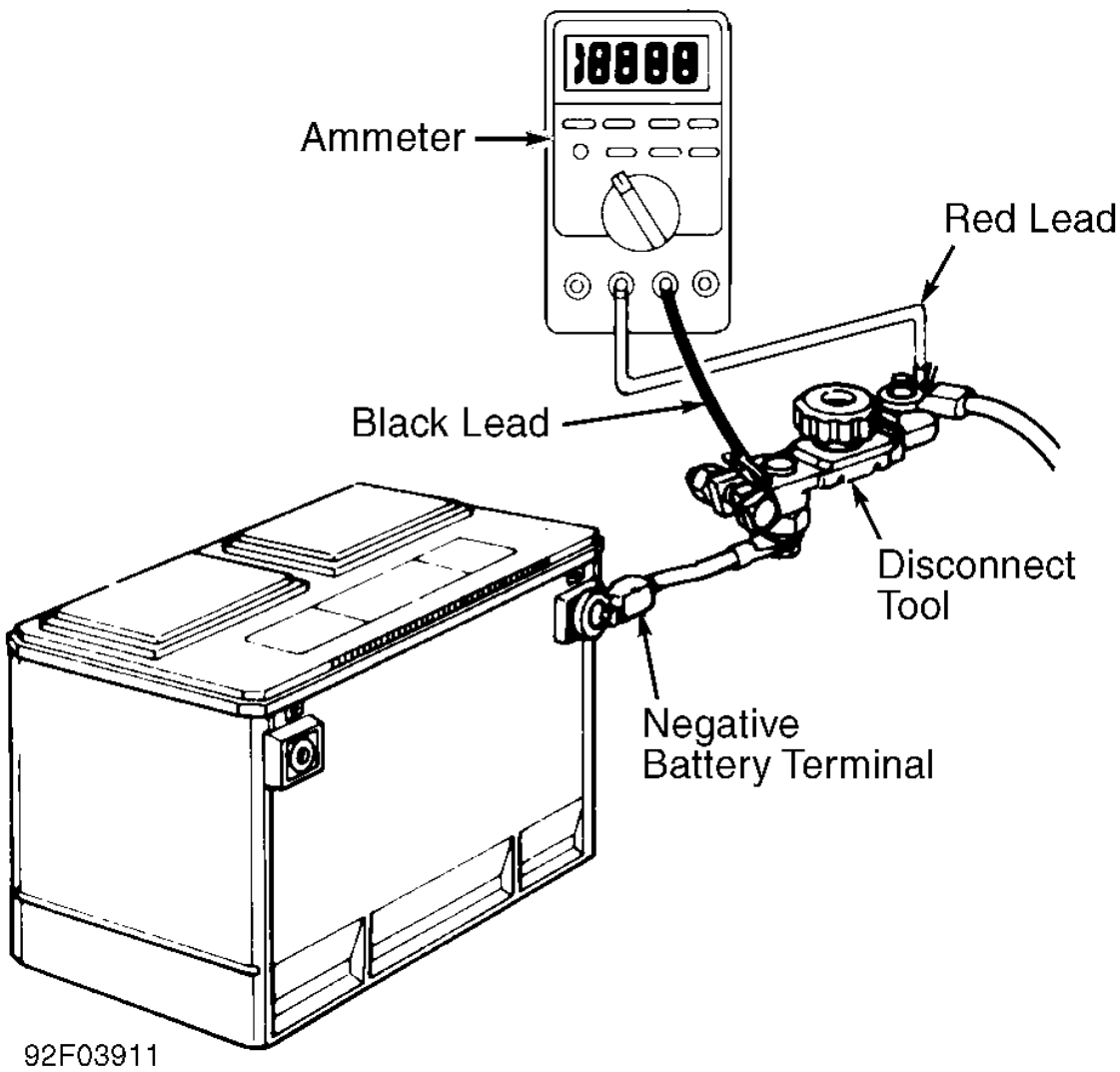


Fig. 1: Connecting Kent-Moore Disconnect Tool (J-38758)
Courtesy of GENERAL MOTORS CORP.

GENERAL MOTORS PARASITIC LOAD

Component	Normal Draw	Maximum Draw	Time-Out (Minutes)
Anti-Theft System	0.4	1.0	.....
Auto Door Lock	1.0	1.0	.....
Body Control Module	3.6	12.4	20
Central Processing System	1.6	2.7	20
Electronic Control Module	5.6	10.0	.....
Electronic Level Control	2.0	3.3	20
Heated Windshield Module	0.3	0.4	.....
HVAC Power Module	1.0	1.0	.....
Illuminated Entry	1.0	1.0	1
Light Control Module	0.5	1.0	.....
Oil Level Module	0.1	0.1	.....

Multi-Function Chime	1.0	1.0	.....
Pass Key Decoder Module	0.75	1.0	.....
Power Control Module	5.0	7.0	.....
Retained Accessory Power	3.8	3.8	.....
Radio	7.0	8.0	15
Twilight Sentinel Module	1.0	1.0	.....
Voltage Regulator	1.4	2.0	.....

DIODE CHECK & SOLENOID TEST

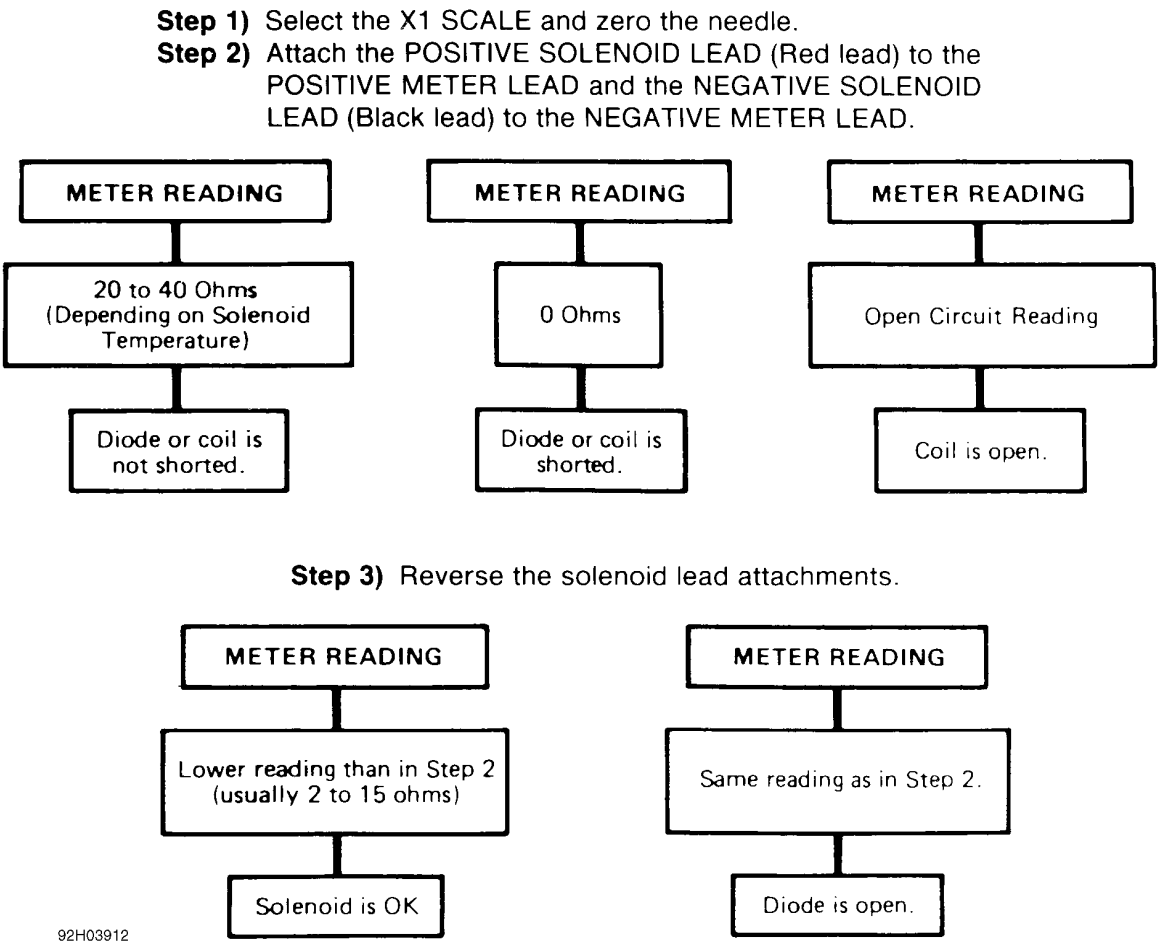


Fig. 2: Diode Check & Solenoid Test
Courtesy of GENERAL MOTORS CORP.

QUAD DRIVER TEST

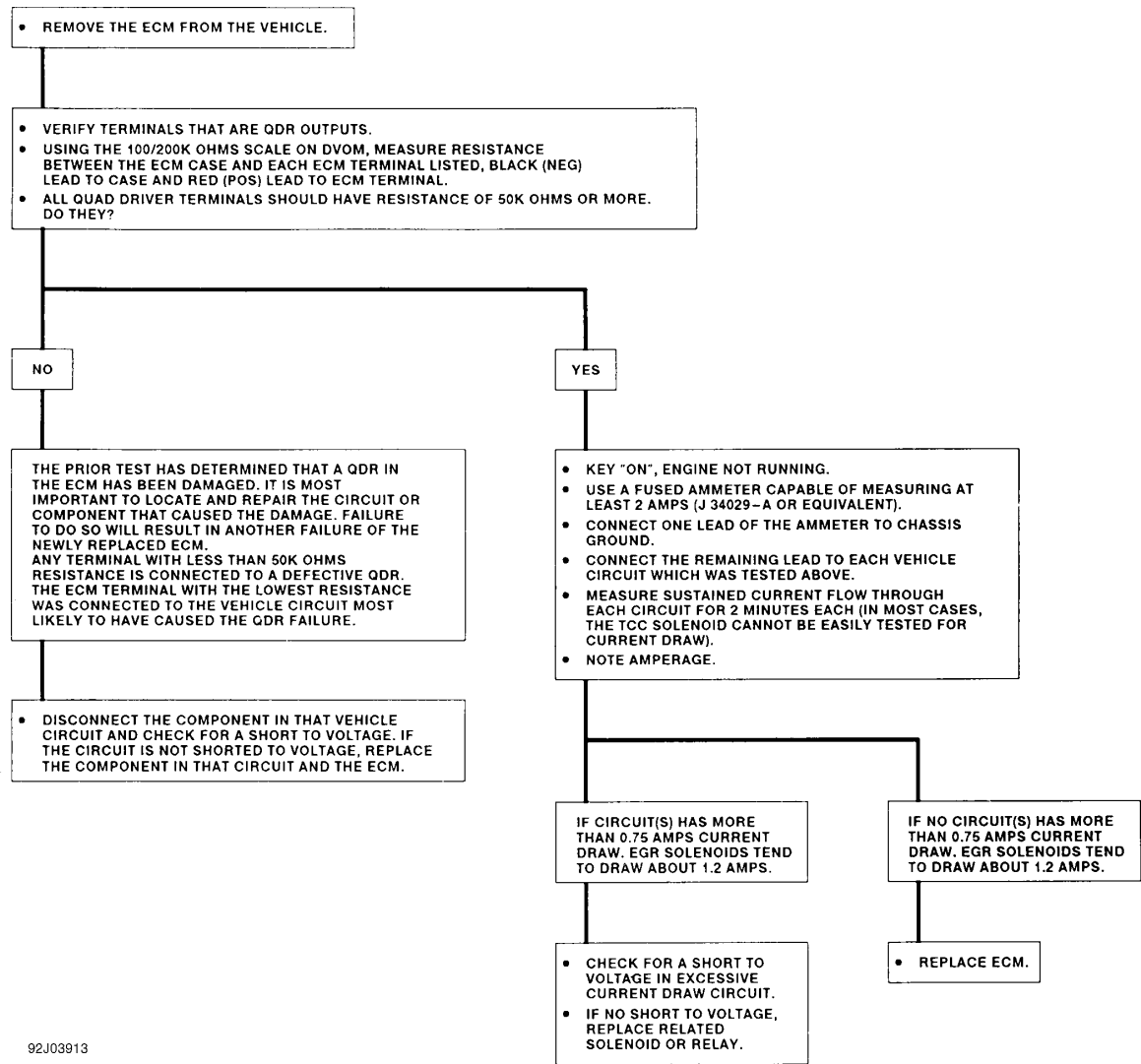


Fig. 3: Quad Driver Test
Courtesy of GENERAL MOTORS CORP.

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GENERAL INFORMATION

Waveforms - Injector Pattern Tutorial

*** PLEASE READ THIS FIRST ***

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

PURPOSE OF THIS ARTICLE

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

Learning how to interpret injector drive patterns from a Lab Scope can be like learning ignition patterns all over again. This article exists to ease you into becoming a skilled injector pattern interpreter.

You will learn:

- How a DVOM and noid light fall short of a lab scope.
- The two types of injector driver circuits, voltage controlled & current controlled.
- The two ways injector circuits can be wired, constant ground/switched power & constant power/switched ground.
- The two different pattern types you can use to diagnose with, voltage & current.
- All the valuable details injector patterns can reveal.

SCOPE OF THIS ARTICLE

This is NOT a manufacturer specific article. All different types of systems are covered here, regardless of the specific year/make/model/engine.

The reason for such broad coverage is because there are only a few basic ways to operate a solenoid-type injector. By understanding the fundamental principles, you will understand all the major points of injector patterns you encounter. Of course there are minor differences in each specific system, but that is where a waveform library helps out.

If this is confusing, consider a secondary ignition pattern. Even though there are many different implementations, each still has a primary voltage turn-on, firing line, spark line, etc.

If specific waveforms are available in On Demand for the engine and vehicle you are working on, you will find them in the Engine Performance section under the Engine Performance category.

IS A LAB SCOPE NECESSARY?

INTRODUCTION

You probably have several tools at your disposal to diagnose injector circuits. But you might have questioned "Is a lab scope necessary to do a thorough job, or will a set of noid lights and a multifunction DVOM do just as well?"

In the following text, we are going to look at what noid lights and DVOMs do best, do not do very well, and when they can mislead you. As you might suspect, the lab scope, with its ability to look inside an active circuit, comes to the rescue by answering for the deficiencies of these other tools.

OVERVIEW OF NOID LIGHT

The noid light is an excellent "quick and dirty" tool. It can usually be hooked to a fuel injector harness fast and the flashing light is easy to understand. It is a dependable way to identify a no-pulse situation.

However, a noid light can be very deceptive in two cases:

- If the wrong one is used for the circuit being tested. Beware: Just because a connector on a noid light fits the harness does not mean it is the right one.
- If an injector driver is weak or a minor voltage drop is present.

Use the Right Noid Light

In the following text we will look at what can happen if the wrong noid light is used, why there are different types of noid lights (besides differences with connectors), how to identify the types of noid lights, and how to know the right type to use.

First, let's discuss what can happen if the incorrect type of noid light is used. You might see:

- A dimly flashing light when it should be normal.
- A normal flashing light when it should be dim.

A noid light will flash dim if used on a lower voltage circuit than it was designed for. A normally operating circuit would appear underpowered, which could be misinterpreted as the cause of a fuel starvation problem.

Here are the two circuit types that could cause this problem:

- Circuits with external injector resistors. Used predominately on some Asian & European systems, they are used to reduce the available voltage to an injector in order to limit the current flow. This lower voltage can cause a dim flash on a noid light designed for full voltage.
- Circuits with current controlled injector drivers (e.g. "Peak and Hold"). Basically, this type of driver allows a quick burst of voltage/current to flow and then throttles it back significantly for the remainder of the pulse width duration. If a noid light was designed for the other type of driver (voltage controlled, e.g. "Saturated"), it will appear dim because it is expecting full voltage/current to flow for the entire duration of the pulse width.

Let's move to the other situation where a noid light flashes normally when it should be dim. This could occur if a more sensitive noid light is used on a higher voltage/ampereage circuit that was weakened enough to cause problems (but not outright broken). A circuit with an actual problem would thus appear normal.

Let's look at why. A noid light does not come close to consuming as much amperage as an injector solenoid. If there is a partial driver failure or a minor voltage drop in the injector circuit, there can be adequate amperage to fully operate the noid light BUT NOT ENOUGH TO OPERATE THE INJECTOR.

If this is not clear, picture a battery with a lot of corrosion on the terminals. Say there is enough corrosion that the starter motor will not operate; it only clicks. Now imagine turning on the headlights (with the ignition in the RUN position). You find they light normally and are fully bright. This is the same idea as noid light: There is a problem, but enough amp flow exists to operate the headlights ("noid light"), but not the starter motor ("injector").

How do you identify and avoid all these situations? By using the correct type of noid light. This requires that you understanding the types of injector circuits that your noid lights are designed for. There are three. They are:

- Systems with a voltage controlled injector driver. Another way to say it: The noid light is designed for a circuit with a "high" resistance injector (generally 12 ohms or above).
- Systems with a current controlled injector driver. Another way to say it: The noid light is designed for a circuit with a low resistance injector (generally less than 12 ohms) without an external injector resistor.
- Systems with a voltage controlled injector driver and an external injector resistor. Another way of saying it: The noid light is designed for a circuit with a low resistance injector (generally less than 12 ohms) and an external injector resistor.

NOTE: Some noid lights can meet both the second and third categories simultaneously.

If you are not sure which type of circuit your noid light is designed for, plug it into a known good car and check out the results. If it flashes normally during cranking, determine the circuit type by finding out injector resistance and if an external injector resistor is used. You now know enough to identify the type of injector circuit. Label the noid light appropriately.

Next time you need to use a noid light for diagnosis, determine what type of injector circuit you are dealing with and select the appropriate noid light.

Of course, if you suspect a no-pulse condition you could plug in any one whose connector fit without fear of misdiagnosis. This is because it is unimportant if the flashing light is dim or bright. It is only important that it flashes.

In any cases of doubt regarding the use of a noid light, a lab scope will overcome all inherent weaknesses.

OVERVIEW OF DVOM

A DVOM is typically used to check injector resistance and available voltage at the injector. Some techs also use it check injector on-time either with a built-in feature or by using the dwell/duty function.

There are situations where the DVOM performs these checks dependably, and other situations where it can deceive you. It is important to be aware of these strengths and weaknesses. We will cover the topics above in the following text.

Checking Injector Resistance

If a short in an injector coil winding is constant, an ohmmeter will accurately identify the lower resistance. The same is true with an open winding. Unfortunately, an intermittent short is an exception. A faulty injector with an intermittent short will show "good" if the ohmmeter cannot force the short to occur during testing.

Alcohol in fuel typically causes an intermittent short, happening only when the injector coil is hot and loaded by a current high enough to jump the air gap between two bare windings or to break down any oxides that may have formed between them.

When you measure resistance with an ohmmeter, you are only applying a small current of a few milliamps. This is nowhere near enough to load the coil sufficiently to detect most problems. As a result, most resistance checks identify intermittently shorted injectors as being normal.

There are two methods to get around this limitation. The first is to purchase an tool that checks injector coil windings under full load. The Kent-Moore J-39021 is such a tool, though there are others. The Kent-Moore costs around \$240 at the time of this writing and works on many different manufacturer's systems.

The second method is to use a lab scope. Remember, a lab scope allows you to see the regular operation of a circuit in real time. If an injector is having an short or intermittent short, the lab scope will show it.

Checking Available Voltage At the Injector

Verifying a fuel injector has the proper voltage to operate correctly is good diagnostic technique. Finding an open circuit on the feed circuit like a broken wire or connector is an accurate check with a DVOM. Unfortunately, finding an intermittent or excessive resistance problem with a DVOM is unreliable.

Let's explore this drawback. Remember that a voltage drop due to excessive resistance will only occur when a circuit is operating? Since the injector circuit is only operating for a few milliseconds at a time, a DVOM will only see a potential fault for a few milliseconds. The remaining 90+% of the time the unloaded injector circuit will show normal battery voltage.

Since DVOMs update their display roughly two to five times a second, all measurements in between are averaged. Because a potential voltage drop is visible for such a small amount of time, it gets "averaged out", causing you to miss it.

Only a DVOM that has a "min-max" function that checks EVERY MILLISECOND will catch this fault consistently (if used in that mode). The Fluke 87 among others has this capability.

A "min-max" DVOM with a lower frequency of checking (100 millisecond) can miss the fault because it will probably check when the injector is not on. This is especially true with current controlled driver circuits. The Fluke 88, among others fall into this category.

Outside of using a Fluke 87 (or equivalent) in the 1 mS "min-max" mode, the only way to catch a voltage drop fault is with a lab scope. You will be able to see a voltage drop as it happens.

One final note. It is important to be aware that an injector circuit with a solenoid resistor will always show a voltage drop when the circuit is energized. This is somewhat obvious and normal; it is a designed-in voltage drop. What can be unexpected is what we already covered--a voltage drop disappears when the circuit is unloaded. The unloaded injector circuit will show normal battery voltage at the injector. Remember this and do not get confused.

Checking Injector On-Time With Built-In Function

Several DVOMs have a feature that allows them to measure injector on-time (mS pulse width). While they are accurate and fast to hookup, they have three limitations you should be aware of:

- They only work on voltage controlled injector drivers (e.g "Saturated Switch"), NOT on current controlled injector drivers (e.g "Peak & Hold").
- A few unusual conditions can cause inaccurate readings.
- Varying engine speeds can result in inaccurate readings.

Regarding the first limitation, DVOMs need a well-defined injector pulse in order to determine when the injector turns ON and OFF. Voltage controlled drivers provide this because of their simple switch-like operation. They completely close the circuit for the entire duration of the pulse. This is easy for the DVOM to interpret.

The other type of driver, the current controlled type, start off well by completely closing the circuit (until the injector pintle opens), but then they throttle back the voltage/current for the duration of the pulse. The DVOM understands the beginning of the pulse but it cannot figure out the throttling action. In other words, it cannot distinguish the throttling from an open circuit (de-energized) condition.

Yet current controlled injectors will still yield a millisecond on-time reading on these DVOMs. You will find it is also always the same, regardless of the operating conditions. This is because it is only measuring the initial completely-closed circuit on-time, which always takes the same amount of time (to lift the injector pintle off its seat). So even though you get a reading, it is useless.

The second limitation is that a few erratic conditions can cause inaccurate readings. This is because of a DVOM's slow display rate; roughly two to five times a second. As we covered earlier, measurements in between display updates get averaged. So conditions like skipped injector pulses or intermittent long/short injector pulses tend to get "averaged out", which will cause you to miss important details.

The last limitation is that varying engine speeds can result in inaccurate readings. This is caused by the quickly shifting injector on-time as the engine load varies, or the RPM moves from a state of acceleration to stabilization, or similar situations. It too is caused by the averaging of all measurements in between DVOM display periods. You can avoid this by checking on-time when there are no RPM or load changes.

A lab scope allows you to overcome each one of these limitations.

Checking Injector On-Time With Dwell Or Duty

If no tool is available to directly measure injector millisecond on-time measurement, some techs use a simple DVOM dwell or duty cycle functions as a replacement.

While this is an approach of last resort, it does provide benefits. We will discuss the strengths and weaknesses in a moment, but first we will look at how a duty cycle meter and dwell meter work.

How A Duty Cycle Meter and Dwell Meter Work

All readings are obtained by comparing how long something has been OFF to how long it has been ON in a fixed time period. A dwell meter and duty cycle meter actually come up with the same answers using different scales. You can convert freely between them. See [**RELATIONSHIP BETWEEN DWELL & DUTY CYCLE READINGS TABLE**](#).

The DVOM display updates roughly one time a second, although some DVOMs can be a little faster or slower. All measurements during this update period are tallied inside the DVOM as ON time or OFF time, and then the total ratio is displayed as either a percentage (duty cycle) or degrees (dwell meter).

For example, let's say a DVOM had an update rate of exactly 1 second (1000 milliseconds). Let's also say that it has been measuring/tallying an injector circuit that had been ON a total of 250 mS out of the 1000 mS. That is a ratio of one-quarter, which would be displayed as 25% duty cycle or 15° dwell (six-cylinder scale). Note that most duty cycle meters can reverse the readings by selecting the positive or negative slope to trigger on. If this reading were reversed, a duty cycle meter would display 75%.

Strengths of Dwell/Duty Meter

The obvious strength of a dwell/duty meter is that you can compare injector on-time against a known-good reading. This is the only practical way to use a dwell/duty meter, but requires you to have known-good values to compare against.

Another strength is that you can roughly convert injector mS on-time into dwell reading with some computations.

A final strength is that because the meter averages everything together it does not miss anything (though this is also a severe weakness that we will look at later). If an injector has a fault where it occasionally skips a pulse, the meter registers it and the reading changes accordingly.

Let's go back to figuring out dwell/duty readings by using injector on-time specification. This is not generally practical, but we will cover it for completeness. You NEED to know three things:

- Injector mS on-time specification.
- Engine RPM when specification is valid.
- How many times the injectors fire per crankshaft revolution.

The first two are self-explanatory. The last one may require some research into whether it is a bank-fire type that injects every 360° of crankshaft rotation, a bank-fire that injects every 720°, or an SFI that injects every 720°. Many manufacturers do not release this data so you may have to figure it out yourself with a frequency meter.

Here are the four complete steps to convert millisecond on-time:

1. Determine the injector pulse width and RPM it was obtained at. Let's say the specification is for one millisecond of on-time at a hot idle of 600 RPM.
2. Determine injector firing method for the complete 4 stroke cycle. Let's say this is a 360° bank-fired, meaning an injector fires each and every crankshaft revolution.
3. Determine how many times the injector will fire at the specified engine speed (600 RPM) in a fixed time period. We will use 100 milliseconds because it is easy to use. Six hundred crankshaft Revolutions Per Minute (RPM) divided by 60 seconds equals 10 revolutions per second. Multiplying 10 times .100 yields one; the crankshaft turns one time in 100 milliseconds. With exactly one crankshaft rotation in 100 milliseconds, we know that the injector fires exactly one time.
4. Determine the ratio of injector on-time vs. off-time in the fixed time period, then figure duty cycle and/or dwell. The injector fires one time for a total of one millisecond in any given 100 millisecond period. One hundred minus one equals 99. We have a 99% duty cycle. If we wanted to know the dwell (on 6 cylinder scale), multiple 99% times .6; this equals 59.4° dwell.

Weaknesses of Dwell/Duty Meter

The weaknesses are significant. First, there is no one-to-one correspondence to actual mS on-time. No manufacturer releases dwell/duty data, and it is time-consuming to convert the mS on-time readings. Besides, there can be a large degree of error because the conversion forces you to assume that the injector(s) are always firing at the same rate for the same period of time. This can be a dangerous assumption.

Second, all level of detail is lost in the averaging process. This is the primary weakness. You cannot see the details you need to make a confident diagnosis.

Here is one example. Imagine a vehicle that has a faulty injector driver that occasionally skips an injector pulse. Every skipped pulse means that that cylinder does not fire, thus unburned O2 gets pushed into the exhaust and passes the O2 sensor. The O2 sensor indicates lean, so the computer fattens up the mixture to compensate for the supposed "lean" condition.

A connected dwell/duty meter would see the fattened pulse width but would also see the skipped pulses. It would tally both and likely come back with a reading that indicated the "pulse width" was within specification because the rich mixture and missing pulses offset each other.

This situation is not a far-fetched scenario. Some early GM 3800 engines were suffering from exactly this. The point is that a lack of detail could cause misdiagnosis.

As you might have guessed, a lab scope would not miss this.

RELATIONSHIP BETWEEN DWELL & DUTY CYCLE READINGS

Dwell Meter ⁽²⁾	Duty Cycle Meter
1°	1%
15°	25%
30°	50%
45°	75%
60°	100%
(1) These are just some examples for your understanding. It is okay to fill in the gaps.	
(2) Dwell meter on the six-cylinder scale.	

THE TWO TYPES OF INJECTOR DRIVERS

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

OVERVIEW

There are two types of transistor driver circuits used to operate electric fuel injectors: voltage controlled and current controlled. The voltage controlled type is sometimes called a "saturated switch" driver, while the current controlled type is sometimes known as a "peak and hold" driver.

The basic difference between the two is the total resistance of the injector circuit. Roughly speaking, if a particular leg in an injector circuit has total resistance of 12 or more ohms, a voltage control driver is used. If less than 12 ohms, a current control driver is used.

It is a question of what is going to do the job of limiting the current flow in the injector circuit; the inherent "high" resistance in the injector circuit, or the transistor driver. Without some form of control, the current flow through the injector would cause the solenoid coil to overheat and result in a damaged injector.

VOLTAGE CONTROLLED CIRCUIT ("SATURATED SWITCH")

The voltage controlled driver inside the computer operates much like a simple switch because it does not need to worry about limiting current flow. Recall, this driver typically requires injector circuits with a total leg resistance of 12 or more ohms.

The driver is either ON, closing/completing the circuit (eliminating the voltage-drop), or OFF, opening the circuit (causing a total voltage drop).

Some manufacturers call it a "saturated switch" driver. This is because when switched ON, the driver allows the magnetic field in the injector to build to saturation. This is the same "saturation" property that you are familiar with for an ignition coil.

There are two ways "high" resistance can be built into an injector circuit to limit current flow. One method uses an external solenoid resistor and a low resistance injector, while the other uses a high resistance injector without the solenoid resistor. See the left side of Fig. [Fig. 1](#).

In terms of injection opening time, the external resistor voltage controlled circuit is somewhat faster than the voltage controlled high resistance injector circuit. The trend, however, seems to be moving toward use of this latter type of circuit due to its lower cost and reliability. The ECU can compensate for slower opening times by increasing injector pulse width accordingly.

NOTE: Never apply battery voltage directly across a low resistance injector. This will cause injector damage from solenoid coil overheating.

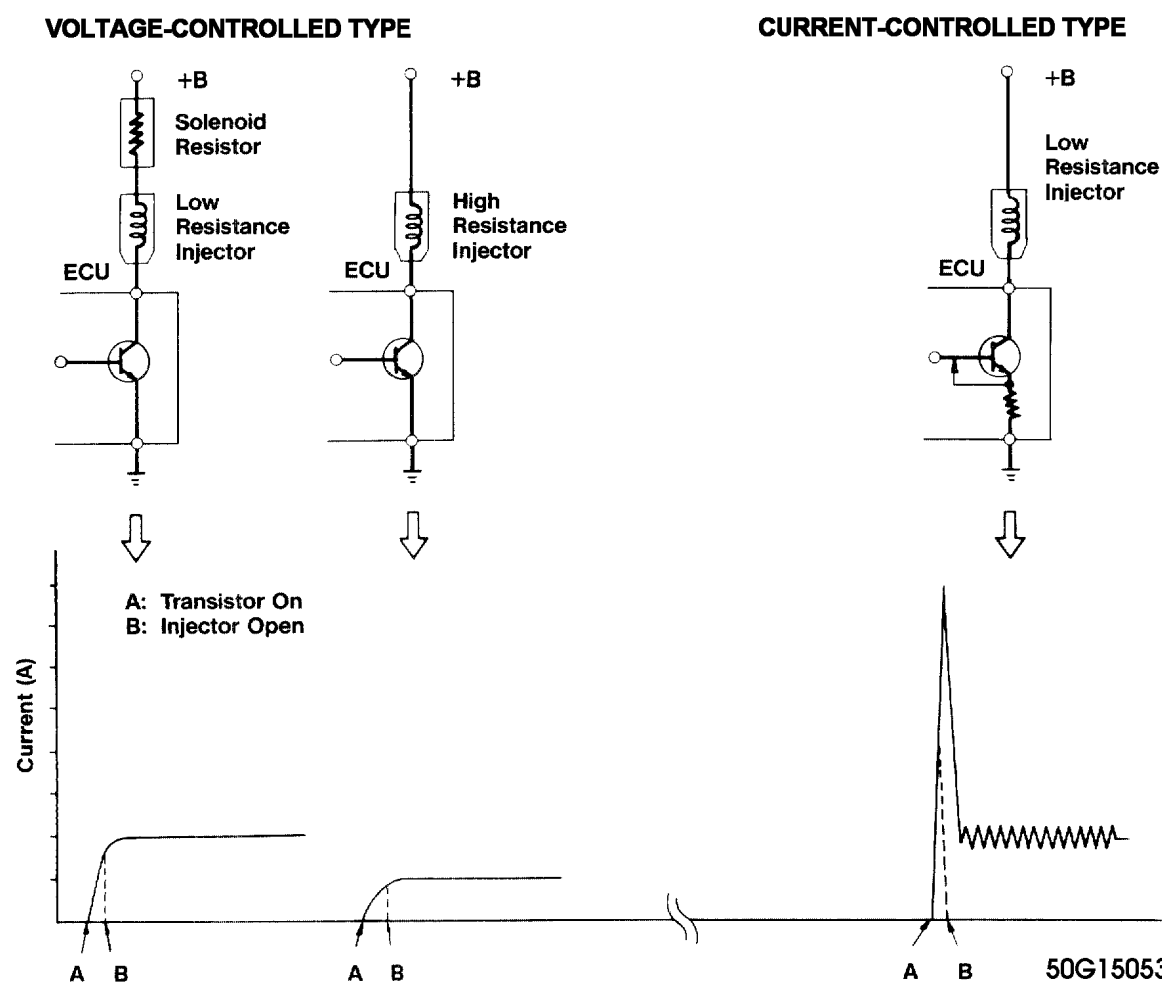


Fig. 1: Injector Driver Types - Current and Voltage

CURRENT CONTROLLED CIRCUIT ("PEAK & HOLD")

The current controlled driver inside the computer is more complex than a voltage controlled driver because as the name implies, it has to limit current flow in addition to its ON-OFF switching function. Recall, this driver typically requires injector circuits with a total leg resistance of less than 12 ohms.

Once the driver is turned ON, it will not limit current flow until enough time has passed for the injector pintle to open. This period is preset by the particular manufacturer/system based on the amount of current flow needed to open their injector. This is typically between two and six amps. Some manufacturers refer to this as the "peak" time, referring to the fact that current flow is allowed to "peak" (to open the injector).

Once the injector pintle is open, the amp flow is considerably reduced for the rest of the pulse duration to protect the injector from overheating. This is okay because very little amperage is needed to hold the injector open, typically in the area of one amp or less. Some manufacturers refer to this as the "hold" time, meaning that just enough current is allowed through the circuit to "hold" the already-open injector open.

There are a couple methods of reducing the current. The most common trims back the available voltage for the circuit, similar to turning down a light at home with a dimmer.

The other method involves repeatedly cycling the circuit ON-OFF. It does this so fast that the magnetic field never collapses and the pintle stays open, but the current is still significantly reduced. See the right side of Fig. [Fig. 1](#) for an illustration.

The advantage to the current controlled driver circuit is the short time period from when the driver transistor goes ON to when the injector actually opens. This is a function of the speed with which current flow reaches its peak due to the low circuit resistance. Also, the injector closes faster when the driver turns OFF because of the lower holding current.

NOTE: Never apply battery voltage directly across a low resistance injector. This will cause injector damage from solenoid coil overheating.

THE TWO WAYS INJECTOR CIRCUITS ARE WIRED

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

Like other circuits, injector circuits can be wired in one of two fundamental directions. The first method is to steadily power the injectors and have the computer driver switch the ground side of the circuit. Conversely, the injectors can be steadily grounded while the driver switches the power side of the circuit.

There is no performance benefit to either method. Voltage controlled and current controlled drivers have been successfully implemented both ways.

However, 95% percent of the systems are wired so the driver controls the ground side of the circuit. Only a handful of systems use the drivers on the power side of the circuit. Some examples of the latter are the 1970's Cadillac EFI system, early Jeep 4.0 EFI (Renix system), and Chrysler 1984-87 TBI.

INTERPRETING INJECTOR WAVEFORMS

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

INTERPRETING A VOLTAGE CONTROLLED PATTERN

NOTE: Voltage controlled drivers are also known as **"Saturated Switch"** drivers. They typically require injector circuits with a total leg resistance of 12 ohms or more.

NOTE: This example is based on a constant power/switched ground circuit.

- See [Fig. 2](#) for pattern that the following text describes.

Point "A" is where system voltage is supplied to the injector. A good hot run voltage is usually 13.5 or more volts. This point, commonly known as open circuit voltage, is critical because the injector will not get sufficient current saturation if there is a voltage shortfall. To obtain a good look at this precise point, you will need to shift your Lab Scope to five volts per division.

You will find that some systems have slight voltage fluctuations here. This can occur if the injector feed wire is also used to power up other cycling components, like the ignition coil(s). Slight voltage fluctuations are normal and are no reason for concern. Major voltage fluctuations are a different story, however. Major voltage shifts on the injector feed line will create injector performance problems. Look for excessive resistance problems in the feed circuit if you see big shifts and repair as necessary.

Note that circuits with external injector resistors will not be any different because the resistor does not affect open circuit voltage.

Point "B" is where the driver completes the circuit to ground. This point of the waveform should be a clean square point straight down with no rounded edges. It is during this period that current saturation of the injector windings is taking place and the driver is heavily stressed. Weak drivers will distort this vertical line.

Point "C" represents the voltage drop across the injector windings. Point "C" should come very close to the ground reference point, but not quite touch. This is because the driver has a small amount of inherent resistance. Any significant offset from ground is an indication of a resistance problem on the ground circuit that needs repaired. You might miss this fault if you do not use the negative battery post for your Lab Scope hook-up, so it is **HIGHLY** recommended that you use the battery as your hook-up.

The points between "B" and "D" represent the time in milliseconds that the injector is being energized or held open. This line at Point "C" should remain flat. Any distortion or upward bend indicates a ground problem, short problem, or a weak driver. Alert readers will catch that this is exactly opposite of the current controlled type drivers (explained in the next section), because they bend upwards at this point.

How come the difference? Because of the total circuit resistance. Voltage controlled driver circuits have a high resistance of 12+ ohms that slows the building of the magnetic field in the injector. Hence, no counter voltage is built up and the line remains flat.

On the other hand, the current controlled driver circuit has low resistance which allows for a rapid magnetic field build-up. This causes a slight inductive rise (created by the effects of counter voltage) and hence, the upward bend. You should not see that here with voltage controlled circuits.

Point "D" represents the electrical condition of the injector windings. The height of this voltage spike (inductive kick) is proportional to the number of windings and the current flow through them. The more current flow and greater number of windings, the more potential for a greater inductive kick. The opposite is also true. The less current flow or fewer windings means less inductive kick. Typically you should see a minimum 35 volts at the top of Point "D".

If you do see approximately 35 volts, it is because a zener diode is used with the driver to clamp the voltage. Make sure the beginning top of the spike is squared off, indicating the zener dumped the remainder of the spike. If it is not squared, that indicates the spike is not strong enough to make the zener fully dump, meaning the injector has a weak winding.

If a zener diode is not used in the computer, the spike from a good injector will be 60 or more volts.

Point "E" brings us to a very interesting section. As you can see, the voltage dissipates back to supply value after the peak of the inductive kick. Notice the slight hump? This is actually the mechanical injector pintle closing. Recall that moving an iron core through a magnetic field will create a voltage surge. The pintle is the iron core here.

This pintle hump at Point "E" should occur near the end of the downward slope, and not afterwards. If it does occur after the slope has ended and the voltage has stabilized, it is because the pintle is slightly sticking because of a faulty injector

If you see more than one hump it is because of a distorted pintle or seat. This faulty condition is known as "pintle float".

It is important to realize that it takes a good digital storage oscilloscope or analog lab scope to see this pintle hump clearly. Unfortunately, it cannot always be seen.

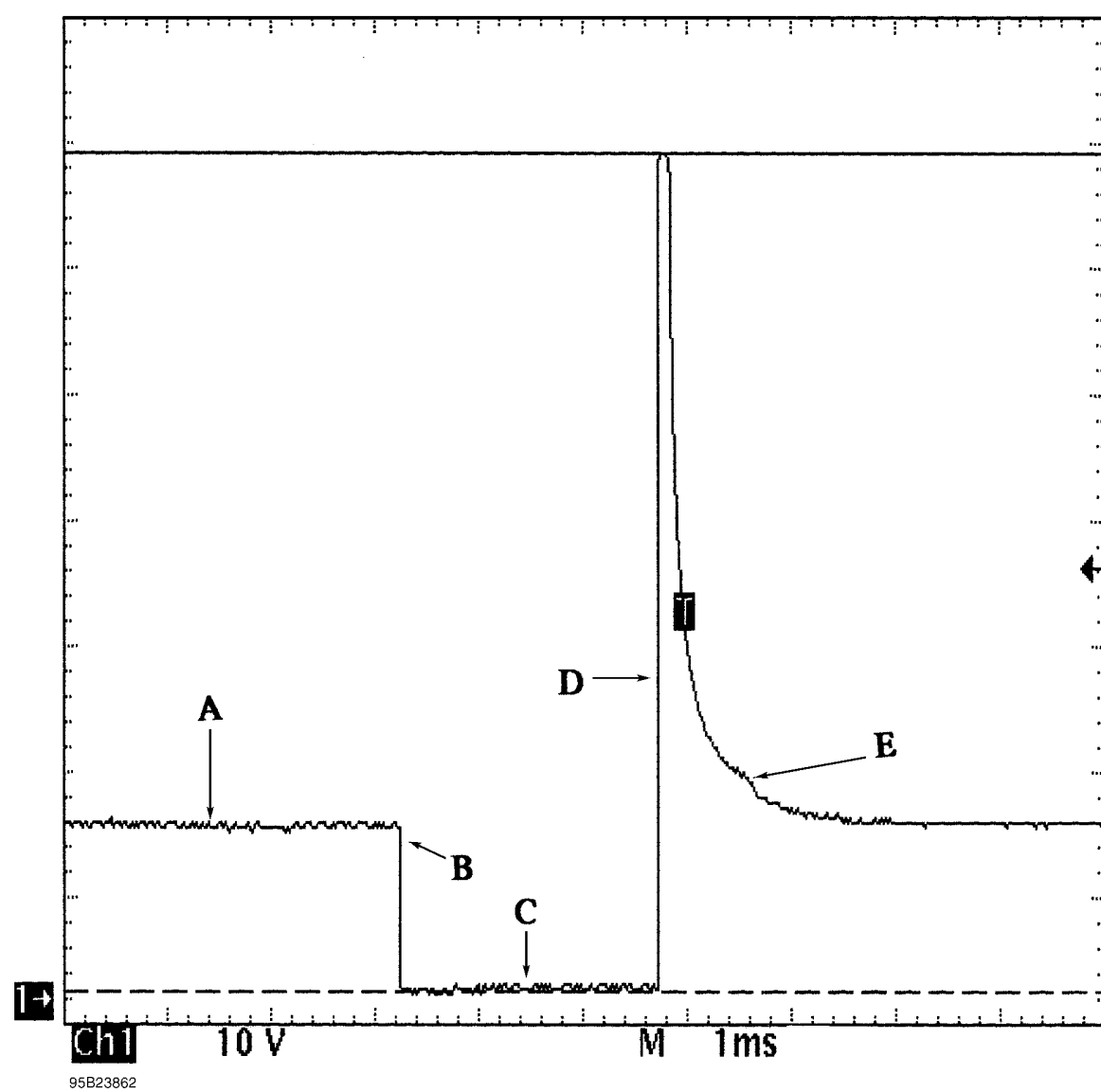


Fig. 2: Identifying Voltage Controlled Type Injector Pattern

INTERPRETING A CURRENT CONTROLLED PATTERN

NOTE: Current controlled drivers are also known as "Peak and Hold" drivers. They typically require injector circuits with a total leg resistance with less than 12 ohm.

NOTE: This example is based on a constant power/switched ground circuit.

- See Fig. 3 for pattern that the following text describes.

Point "A" is where system voltage is supplied to the injector. A good hot run voltage is usually 13.5 or more volts. This point, commonly known as open circuit voltage, is critical because the injector will not get sufficient current saturation if there is a voltage shortfall. To obtain a good look at this precise point, you will need to shift your Lab Scope to five volts per division.

You will find that some systems have slight voltage fluctuations here. This could occur if the injector feed wire is also used to power up other cycling components, like the ignition coil(s). Slight voltage fluctuations are normal and are no reason for concern. Major voltage fluctuations are a different story, however. Major voltage shifts on the injector feed line will create injector performance problems. Look for excessive resistance problems in the feed circuit if you see big shifts and repair as necessary.

Point "B" is where the driver completes the circuit to ground. This point of the waveform should be a clean square point straight down with no rounded edges. It is during this period that current saturation of the injector windings is taking place and the driver is heavily stressed. Weak drivers will distort this vertical line.

Point "C" represents the voltage drop across the injector windings. Point "C" should come very close to the ground reference point, but not quite touch. This is because the driver has a small amount of inherent resistance. Any significant offset from ground is an indication of a resistance problem on the ground circuit that needs repaired. You might miss this fault if you do not use the negative battery post for your Lab Scope hook-up, so it is HIGHLY recommended that you use the battery as your hook-up.

Right after Point "C", something interesting happens. Notice the trace starts a normal upward bend. This slight inductive rise is created by the effects of counter voltage and is normal. This is because the low circuit resistance allowed a fast build-up of the magnetic field, which in turn created the counter voltage.

Point "D" is the start of the current limiting, also known as the "Hold" time. Before this point, the driver had allowed the current to free-flow ("Peak") just to get the injector pintle open. By the time point "D" occurs, the injector pintle has already opened and the computer has just significantly throttled the current back. It does this by only allowing a few volts through to maintain the minimum current required to keep the pintle open.

The height of the voltage spike seen at the top of Point "D" represents the electrical condition of the injector windings. The height of this voltage spike (inductive kick) is proportional to the number of windings and the current flow through them. The more current flow and greater

number of windings, the more potential for a greater inductive kick. The opposite is also true. The less current flow or fewer windings means less inductive kick. Typically you should see a minimum 35 volts.

If you see approximately 35 volts, it is because a zener diode is used with the driver to clamp the voltage. Make sure the beginning top of the spike is squared off, indicating the zener dumped the remainder of the spike. If it is not squared, that indicates the spike is not strong enough to make the zener fully dump, meaning there is a problem with a weak injector winding.

If a zener diode is not used in the computer, the spike from a good injector will be 60 or more volts.

At Point "E", notice that the trace is now just a few volts below system voltage and the injector is in the current limiting, or the "Hold" part of the pattern. This line will either remain flat and stable as shown here, or will cycle up and down rapidly. Both are normal methods to limit current flow. Any distortion may indicate shorted windings.

Point "F" is the actual turn-off point of the driver (and injector). To measure the millisecond on-time of the injector, measure between points "C" and "F". Note that we used cursors to do it for us; they are measuring a 2.56 mS on-time.

The top of Point "F" (second inductive kick) is created by the collapsing magnetic field caused by the final turn-off of the driver. This spike should be like the spike on top of point "D".

Point "G" shows a slight hump. This is actually the mechanical injector pintle closing. Recall that moving an iron core through a magnetic field will create a voltage surge. The pintle is the iron core here.

This pintle hump at Point "E" should occur near the end of the downward slope, and not afterwards. If it does occur after the slope has ended and the voltage has stabilized, it is because the pintle is slightly sticking. Some older Nissan TBI systems suffered from this.

If you see more than one hump it is because of a distorted pintle or seat. This faulty condition is known as "pintle float".

It is important to realize that it takes a good digital storage oscilloscope or analog lab scope to see this pintle hump clearly. Unfortunately, it cannot always be seen.

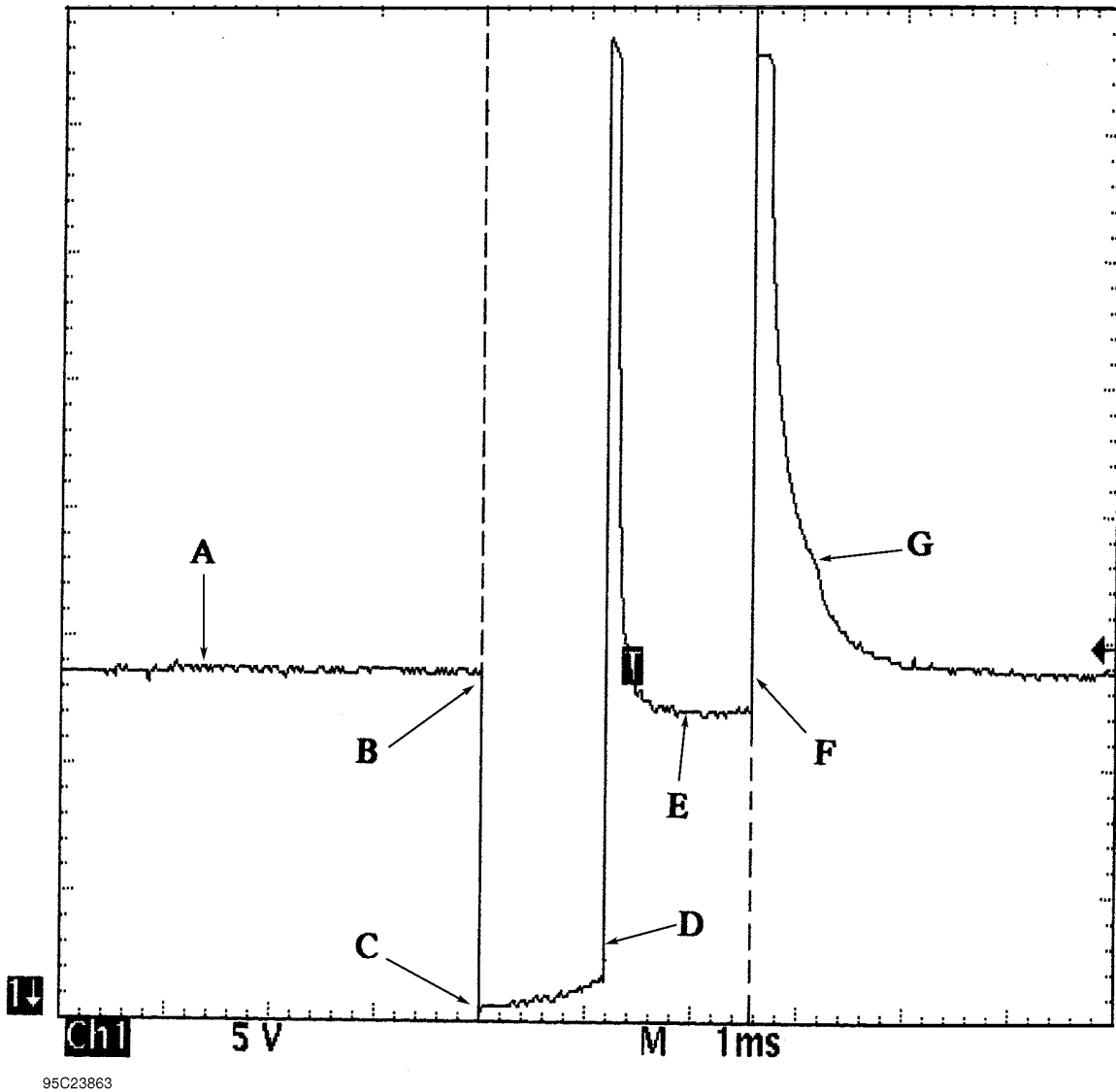


Fig. 3: Identifying Current Controlled Type Injector Pattern

CURRENT WAVEFORM SAMPLES

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

EXAMPLE #1 - VOLTAGE CONTROLLED DRIVER

The waveform pattern shown in Fig. Fig. 4 indicate a normal current waveform from a Ford 3.0L V6 VIN [U] engine. This voltage controlled type circuit pulses the injectors in groups of three injectors. Injectors No. 1, 3, and 5 are pulsed together and cylinders 2, 4, and 6 are pulsed together. The specification for an acceptable bank resistance is 4.4 ohms. Using Ohm's Law and assuming a hot run voltage of 14 volts, we determine that the bank would draw a current of 3.2 amps.

However this is not the case because as the injector windings become saturated, counter voltage is created which impedes the current flow.

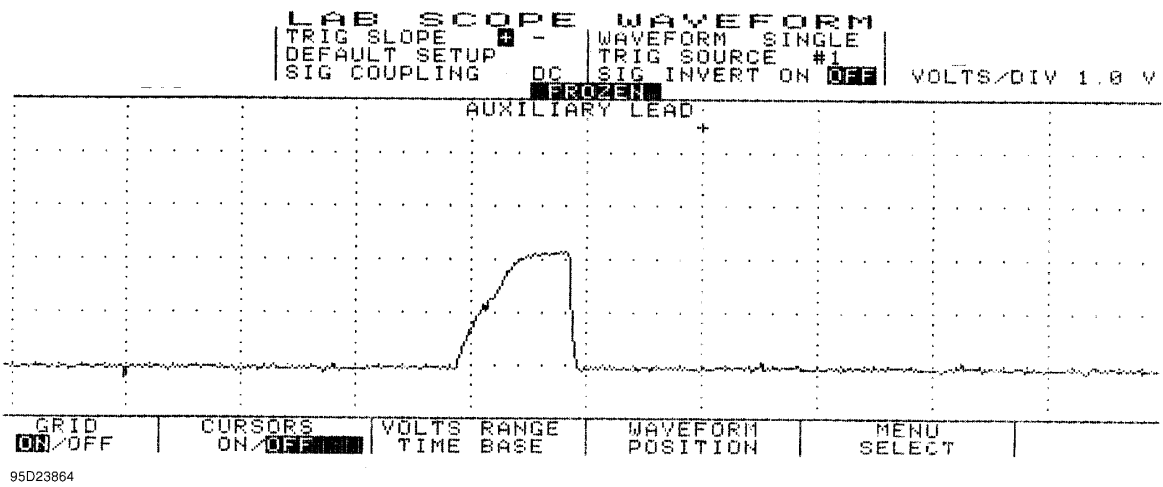
This, coupled with the inherent resistance of the driver's transistor, impedes the current flow even more. So, what is a known good value for a dynamic current draw on a voltage controlled bank of injectors? The waveform pattern shown below indicates a good parallel injector current flow of 2 amps. See [Fig. 4](#).

Note that if just one injector has a resistance problem and partially shorts, the entire parallel bank that it belongs to will draw more current. This can damage the injector driver.

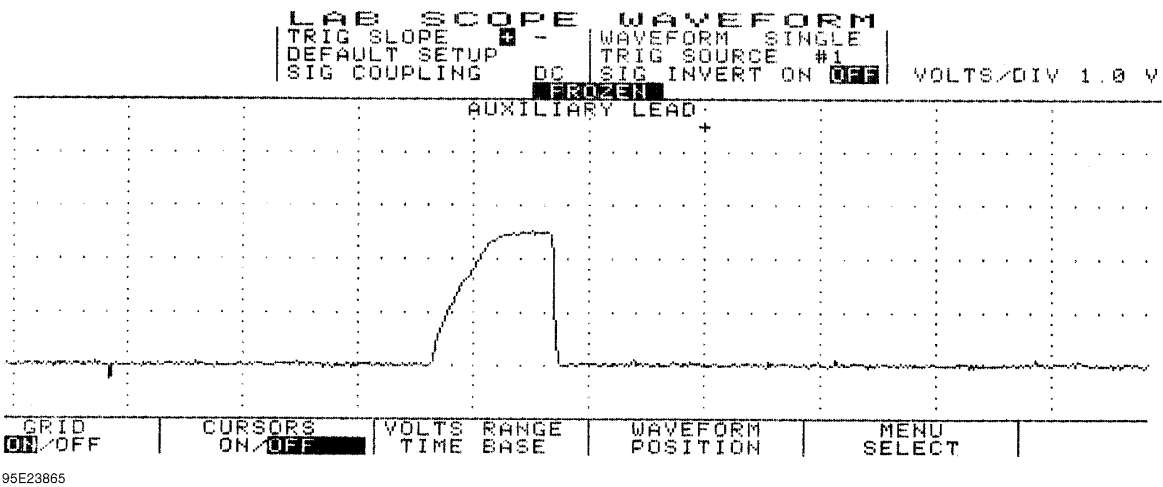
The waveform pattern in Fig. [Fig. 5](#) indicates this type of problem with too much current flow. This is on other bank of injectors of the same vehicle; the even side. Notice the Lab Scope is set on a one amp per division scale. As you can see, the current is at an unacceptable 2.5 amps.

It is easy to find out which individual injector is at fault. All you need to do is inductively clamp onto each individual injector and compare them. To obtain a known-good value to compare against, we used the good bank to capture the waveform in Fig. [Fig. 6](#). Notice that it limits current flow to 750 milliamps.

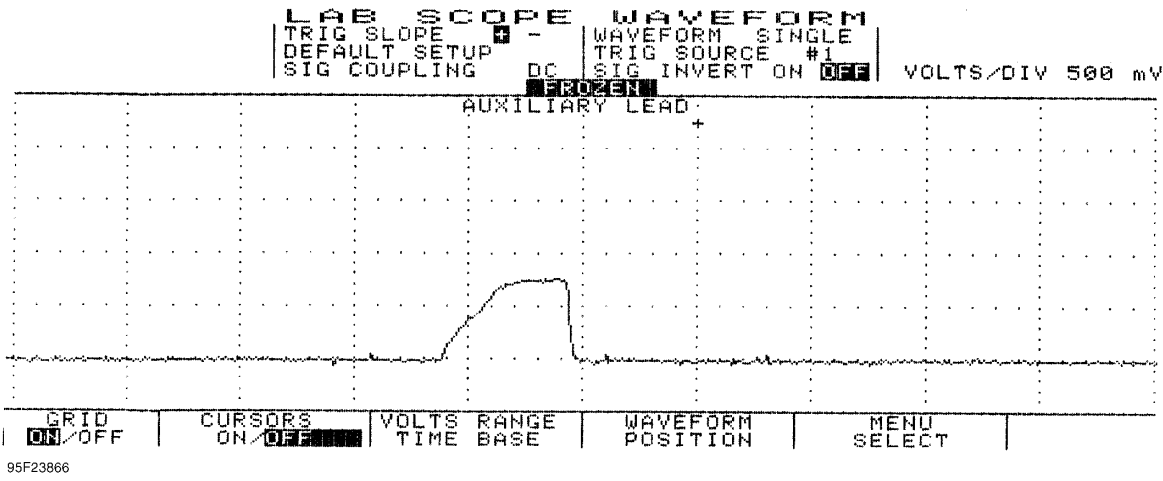
The waveform shown in Fig. [Fig. 7](#) illustrates the problem injector we found. This waveform indicates an unacceptable current draw of just over one amp as compared to the 750 milliamp draw of the known-good injector. A subsequent check with a DVOM found 8.2 ohms, which is under the 12 ohm specification.



[Fig. 4: Injector Bank w/Normal Current Flow - Current Pattern](#)



[Fig. 5: Injector Bank w/Excessive Current Flow - Current Pattern](#)



[Fig. 6: Single Injector w/Normal Current Flow - Current Pattern](#)

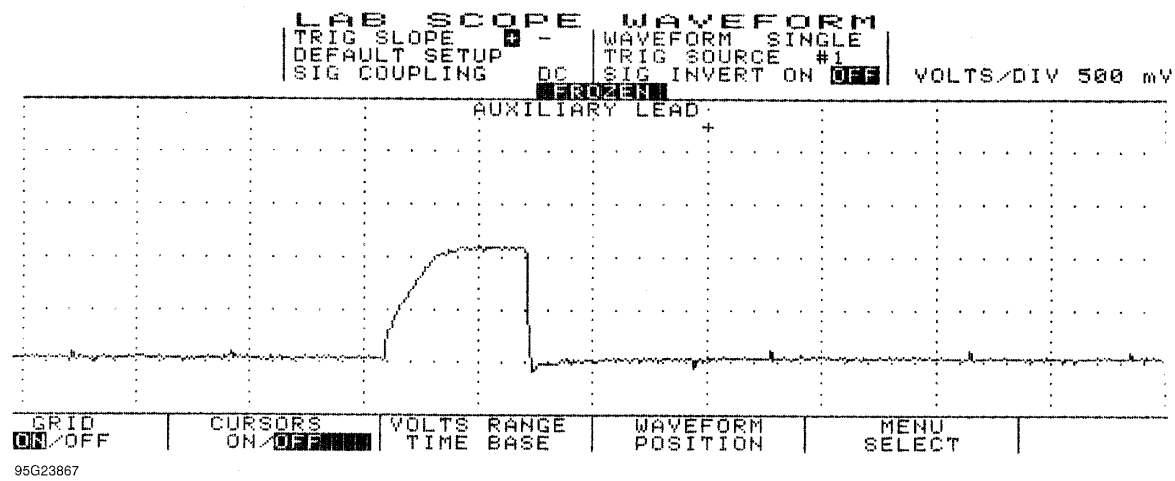


Fig. 7: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #2 - VOLTAGE CONTROLLED DRIVER

This time we will look at a GM 3.1L V6 VIN [T]. Fig. Fig. 8 shows the 1, 3, 5 (odd) injector bank with the current waveform indicating about a 2.6 amp draw at idle. This pattern, taken from a known good vehicle, correctly stays at or below the maximum 2.6 amps current range. Ideally, the current for each bank should be very close in comparison.

Notice the small dimple on the current flow's rising edge. This is the actual injector opening or what engineers refer to as the "set point." For good idle quality, the set point should be uniform between the banks.

When discussing Ohm's Law as it pertains to this parallel circuit, consider that each injector has specified resistance of 12.2 ohms. Since all three injectors are in parallel the total resistance of this parallel circuit drops to 4.1 ohms. Fourteen volts divided by four ohms would pull a maximum of 3.4 amps on this bank of injectors. However, as we discussed in EXAMPLE #1 above, other factors knock this value down to roughly the 2.6 amp neighborhood.

Now we are going to take a look at the even bank of injectors; injectors 2, 4, and 6. See Fig. 9. Notice this bank peaked at 1.7 amps at idle as compared to the 2.6 amps peak of the odd bank (Fig. Fig. 8). Current flow between even and odd injectors banks is not uniform, yet it is not causing a driveability problem. That is because it is still under the maximum amperage we figured out earlier. But be aware this vehicle could develop a problem if the amperage flow increases any more.

Checking the resistance of this even injector group with a DVOM yielded 6.2 ohms, while the odd injector group in the previous example read 4.1 ohms.

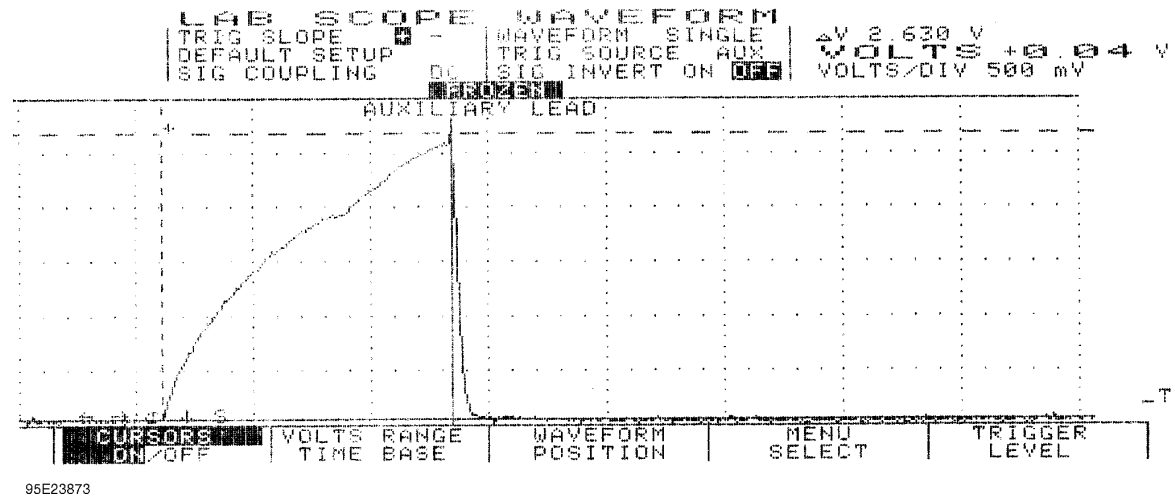


Fig. 8: Injector Odd Bank w/Normal Current Flow - Current Pattern

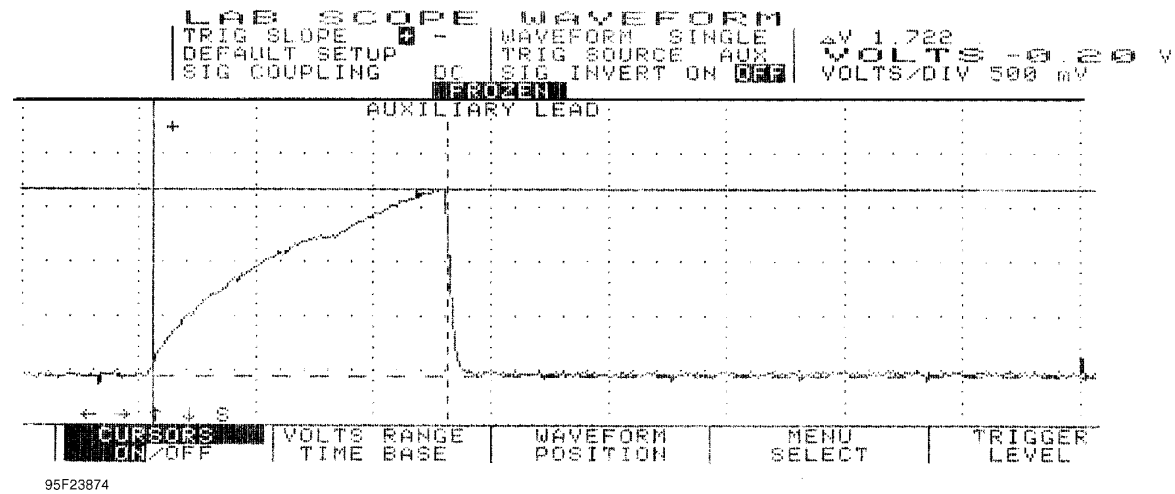


Fig. 9: Injector Even Bank w/Normal Current Flow - Current Pattern

EXAMPLE #3 - VOLTAGE CONTROLLED DRIVER

Example #3 is of a Ford 5.0L V8 SEFI. Fig. Fig. 10 shows a waveform of an individual injector at idle with the Lab Scope set on 200

milliamps per division. Notice the dimple in the rising edge. This dimple indicates the actual opening of the injector (set point) occurred at 400 milliamps and current peaked at 750 milliamps. This is a good specification for this engine.

The next waveform pattern in Fig. [Fig. 11](#) shows an abnormality with another injector. With the Lab Scope set on 500 milliamps per division, you can see that the current waveform indicates a 1200 milliamp draw. This is a faulty injector.

Abnormally low resistance injectors create excessive current draw, causing rough idle, and possible computer driver damage.

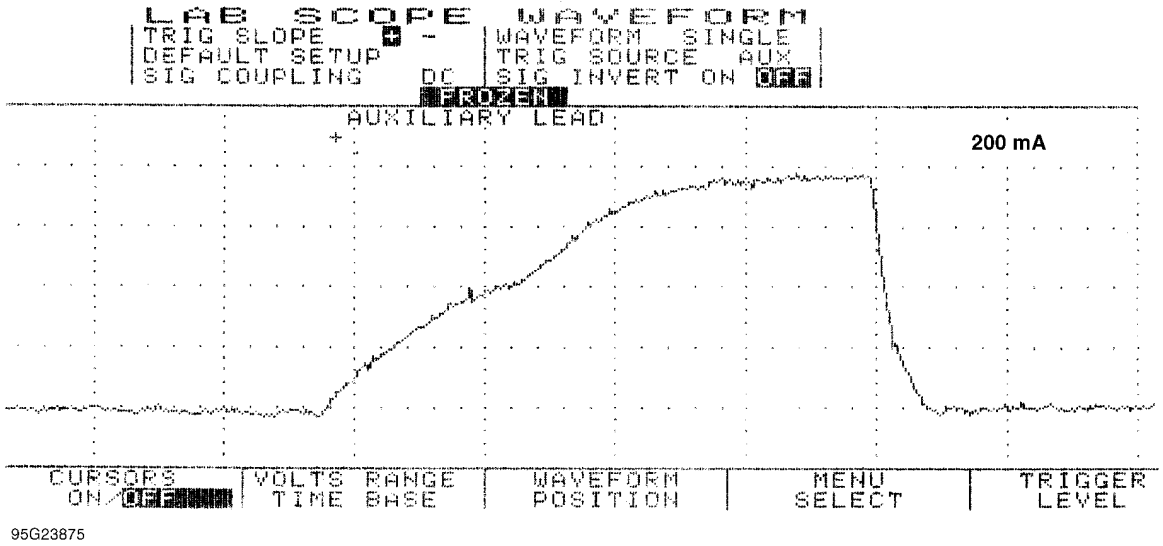


Fig. 10: Single Injector w/Normal Current Flow - Current Pattern

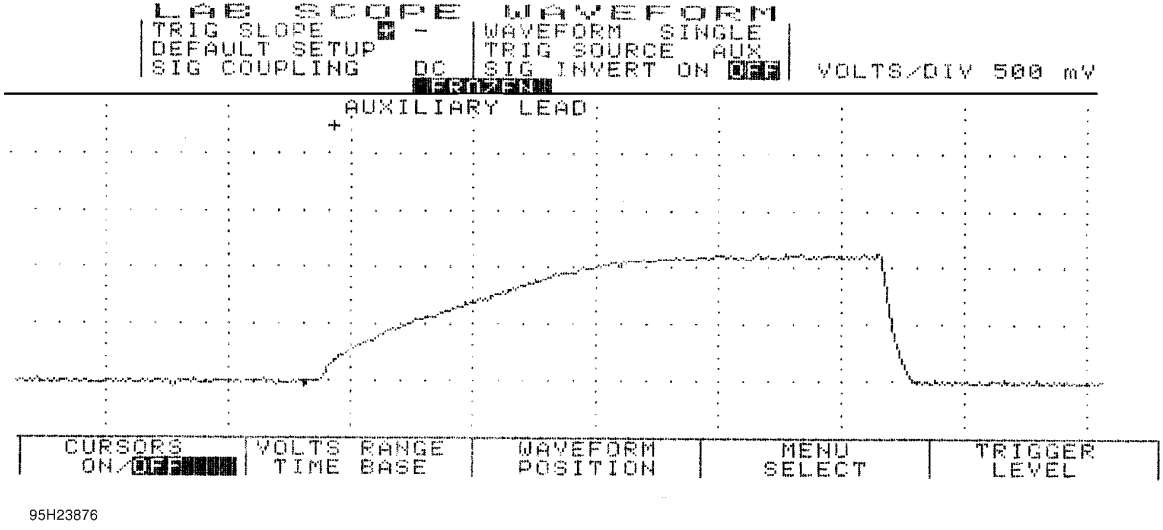


Fig. 11: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #4 - CURRENT CONTROLLED DRIVER

Example #4 is of a Ford 4.6L SEFI VIN [W]. See [Fig. 12](#) for the known-good waveform pattern. This Ford system is different from the one above in [EXAMPLE #3](#) as it peaks at 900 milliamps and the actual opening of the injector (set point) is just below 600 milliamps.

This is offered as a comparison against the Ford pattern listed above, as they are both Ford SEFI injectors but with different operating ranges. The point is that you should not make any broad assumptions for any manufacturer.

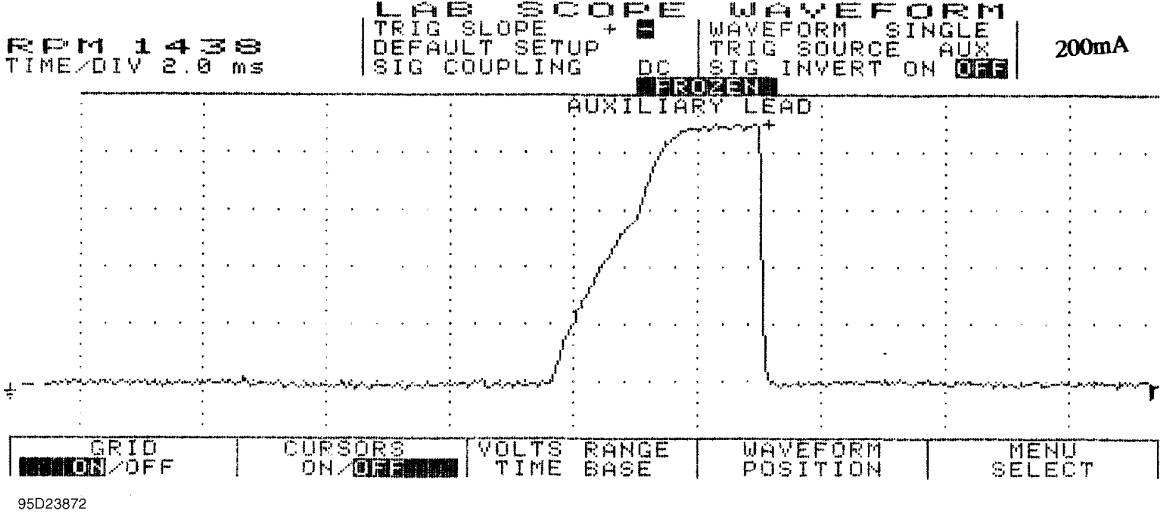


Fig. 12: Single Injector w/Normal Current Flow - Current Pattern

EXAMPLE #5 - CURRENT CONTROLLED DRIVER

The known-good waveform in Fig. [Fig. 13](#) is from a Chrysler 3.0L V6 PFI VIN [3]. It is a perfect example of the peak and hold theory. The waveform shows a 1-amp per division current flow, ramping to 4 amps and then decreasing to 1-amp to hold the injector open.

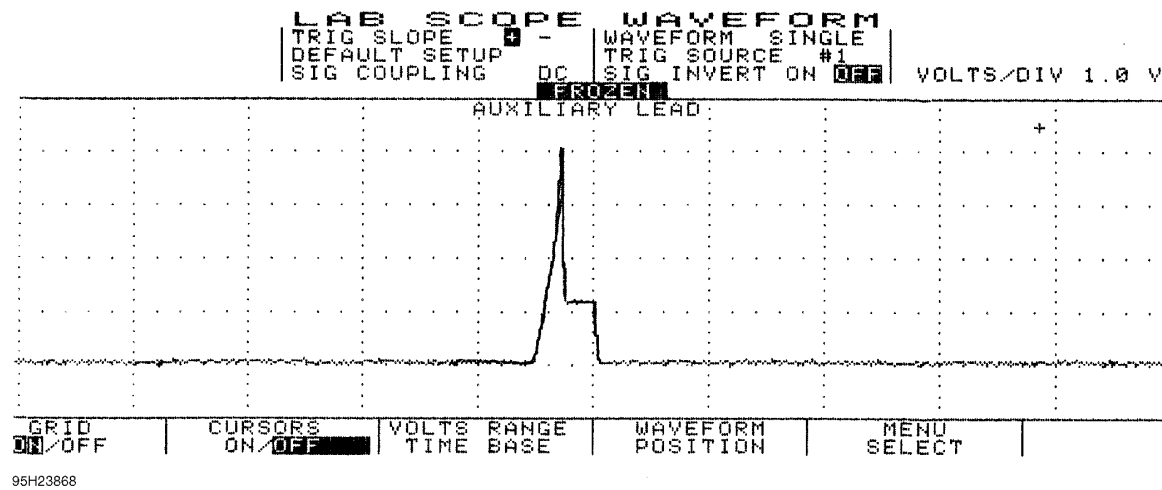


Fig. 13: Injector Bank w/Normal Current Flow - Current Pattern

EXAMPLE #6 - CURRENT CONTROLLED DRIVER

This next known-good waveform is from a Ford 5.0L V8 CFI VIN [F]. See Fig. 14. The pattern, which is set on a 250 milliamps scale, indicates a 1.25 amp peak draw and a hold at 350 milliamps.

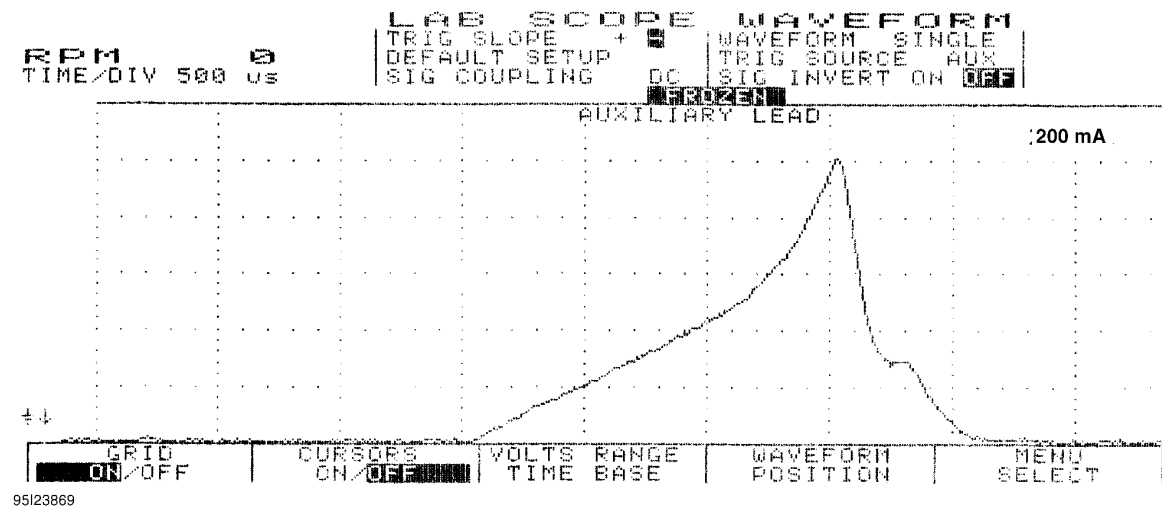


Fig. 14: Single Injector w/Normal Current Flow - Current Pattern

EXAMPLE #7 - CURRENT CONTROLLED DRIVER

The known-good current controlled type waveform in Fig. Fig. 15 is from a GM 2.0L TBI VIN [1]. With the lab scope set at 2 amps per division, notice that this system peaks at 4 amps and holds at 1 amp.

The next waveform is from the same type of engine, except that it shows a faulty injector. See Fig. 16. Notice that the current went to almost 5 amps and stayed at 1 amp during the hold pattern. Excessive amounts of current flow from bad injectors are a common source of intermittent computer shutdown. Using a current waveform pattern is the most accurate method of pinpointing this problem.

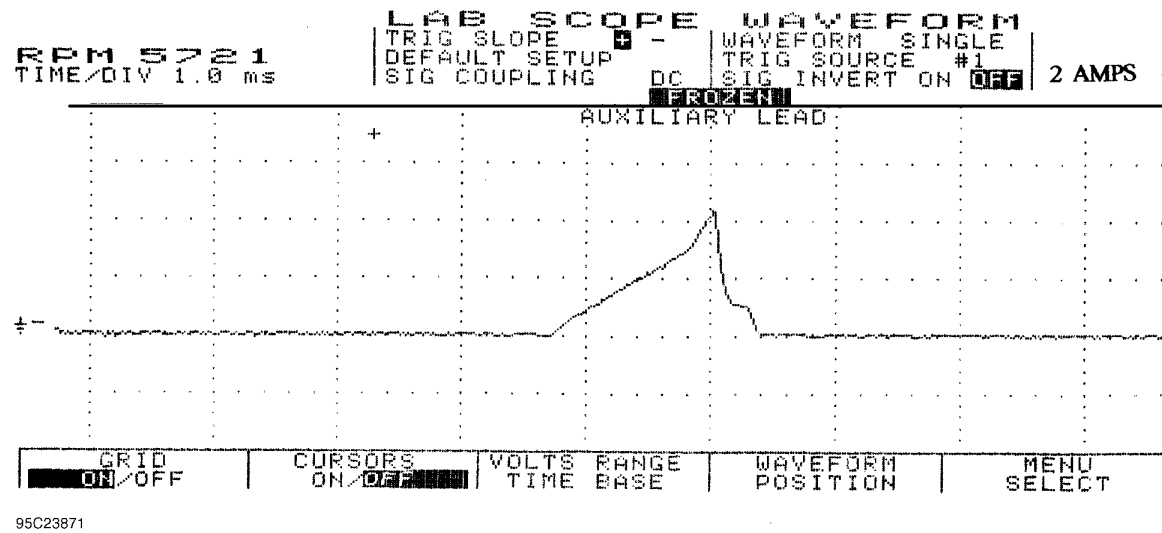


Fig. 15: Single Injector w/Normal Current Flow - Current Pattern

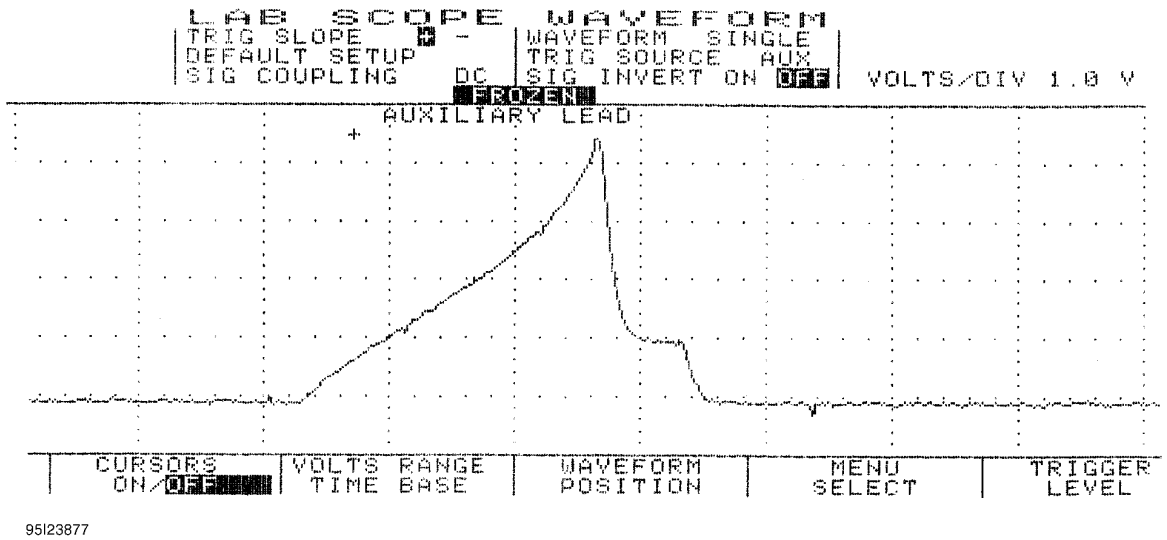


Fig. 16: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #8 - CURRENT CONTROLLED DRIVER

This known-good CPI system waveform from a GM 4.3L V6 CPI VIN [W] peaks at 4 amps and holds at 1-amp. See Fig. 17 for waveform.

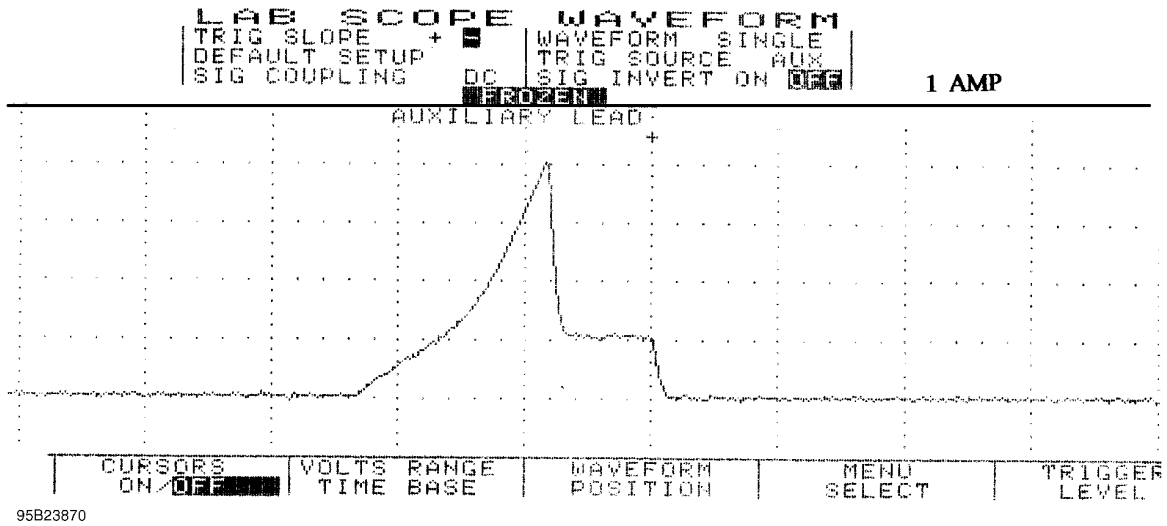


Fig. 17: Single Injector w/Normal Current Flow - Current Pattern

VOLTAGE WAVEFORM SAMPLES

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

EXAMPLE #1 - VOLTAGE CONTROLLED DRIVER

These two known-good waveform patterns are from a Ford 4.6L V8 VIN [W]. Fig. Fig. 18 illustrates the 64 volt inductive kick on this engine, indicating no clamping is occurring. The second pattern, Fig. Fig. 19, was taken during hot idle, closed loop, and no load.

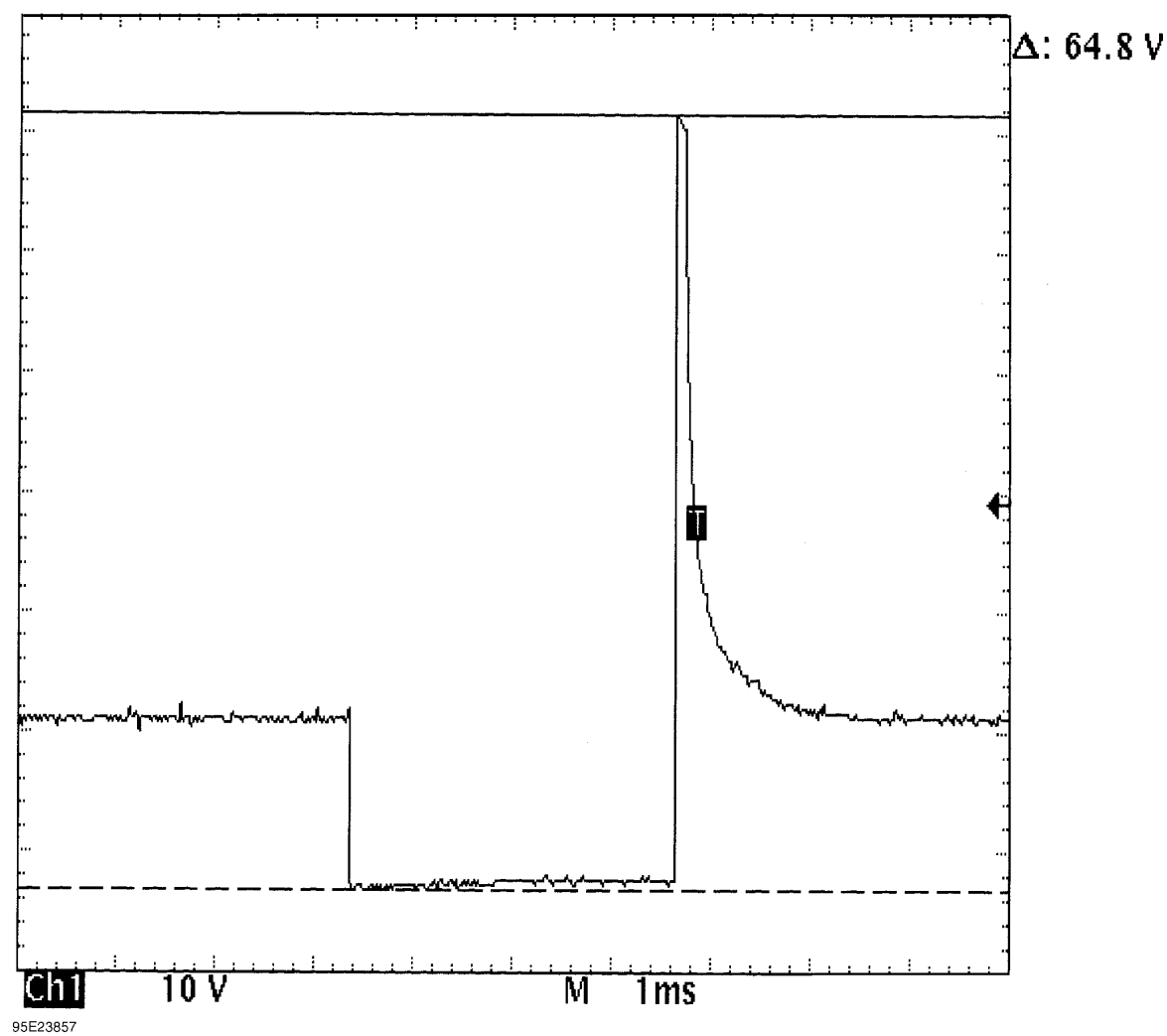


Fig. 18: Injector Bank - Known Good - Voltage Pattern

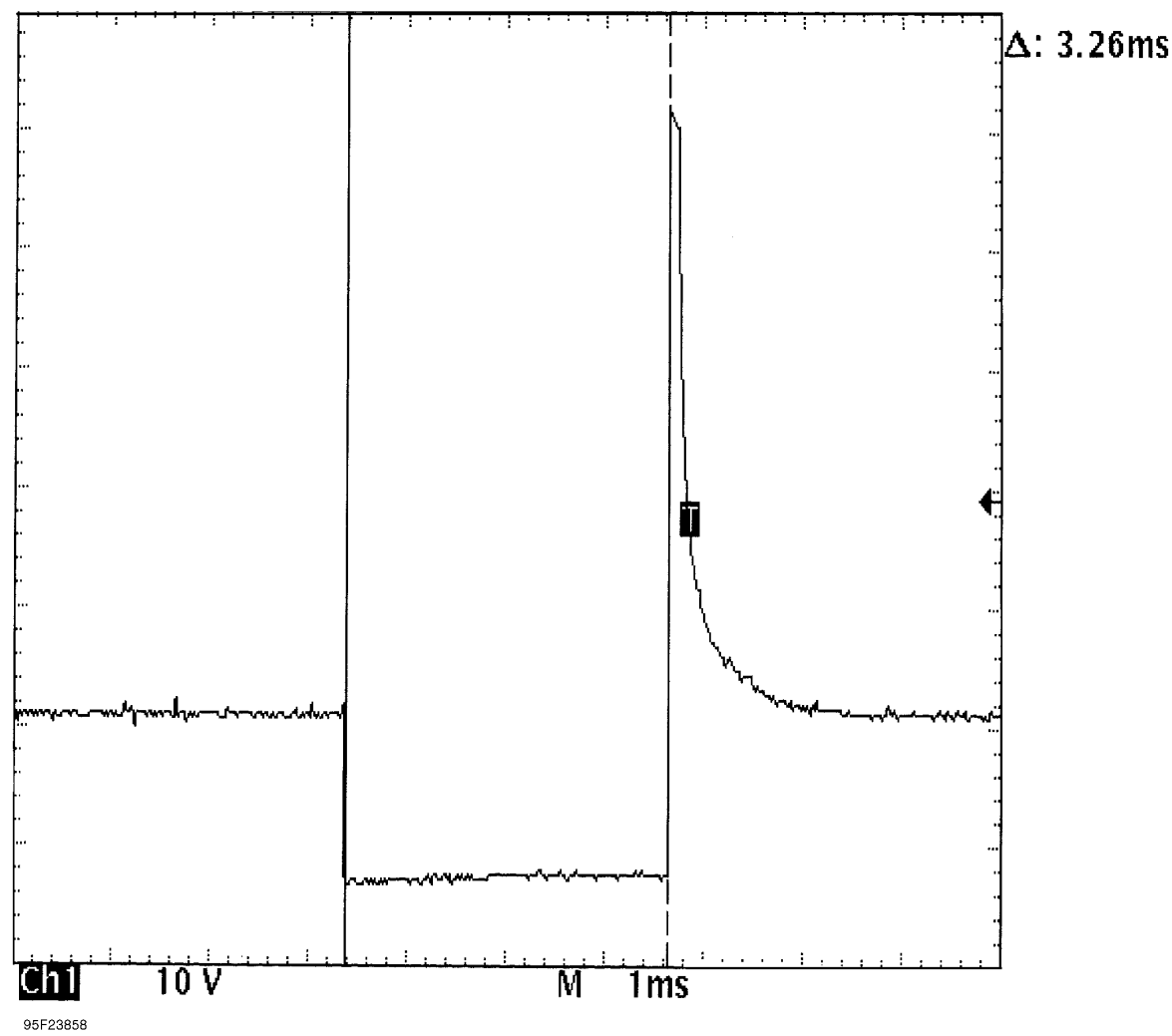


Fig. 19: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #2 - VOLTAGE CONTROLLED DRIVER

The known-good waveform pattern in Fig. Fig. 20 is from a GM 3.8L V6 PFI VIN [3]. It was taken during hot idle, closed loop and no load.

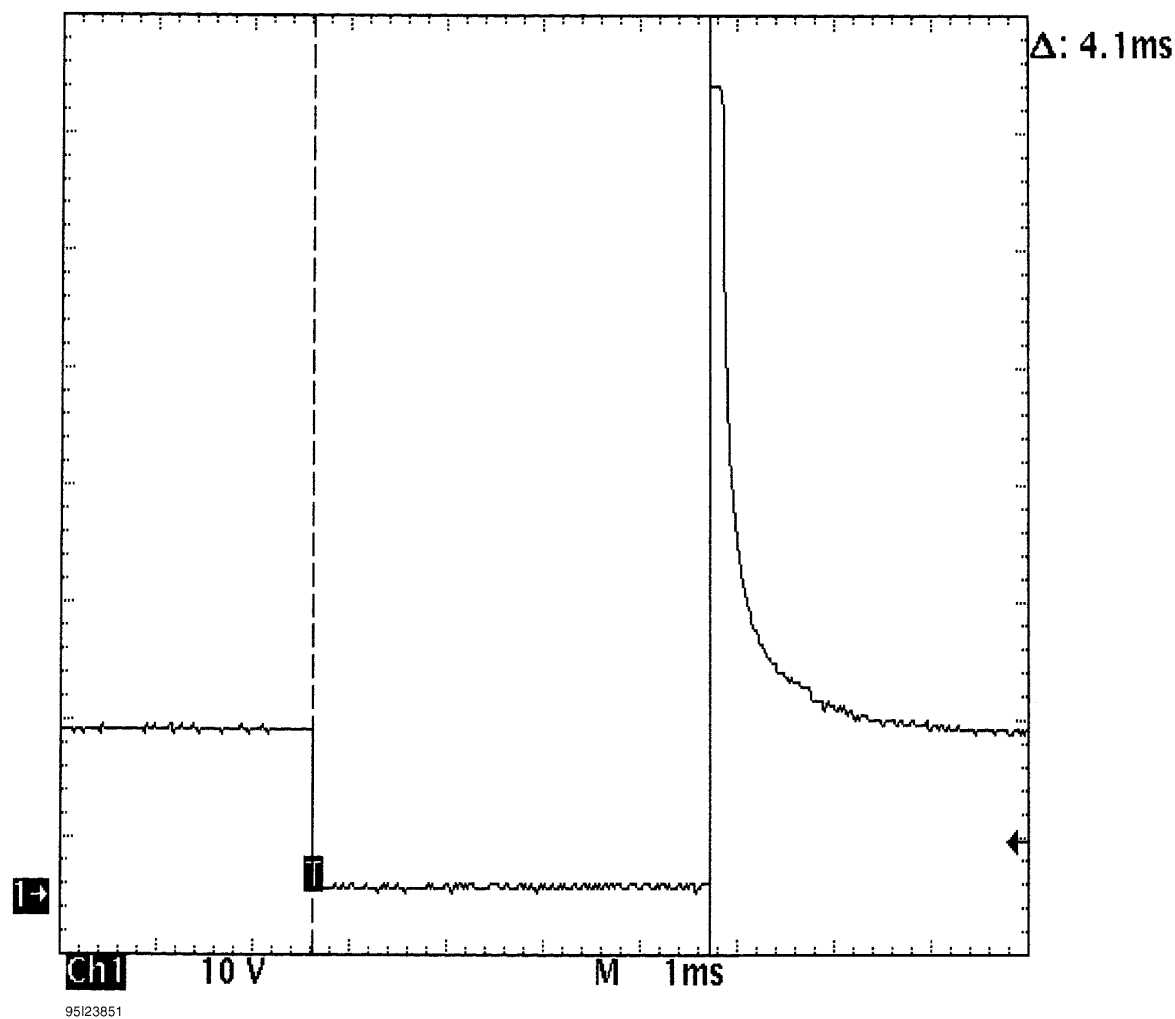


Fig. 20: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #3 - VOLTAGE CONTROLLED DRIVER

This known-good waveform pattern, Fig. Fig. 21, is from a GM 5.0L V8 TPI VIN [F]. It was taken during hot idle, closed loop and no load.

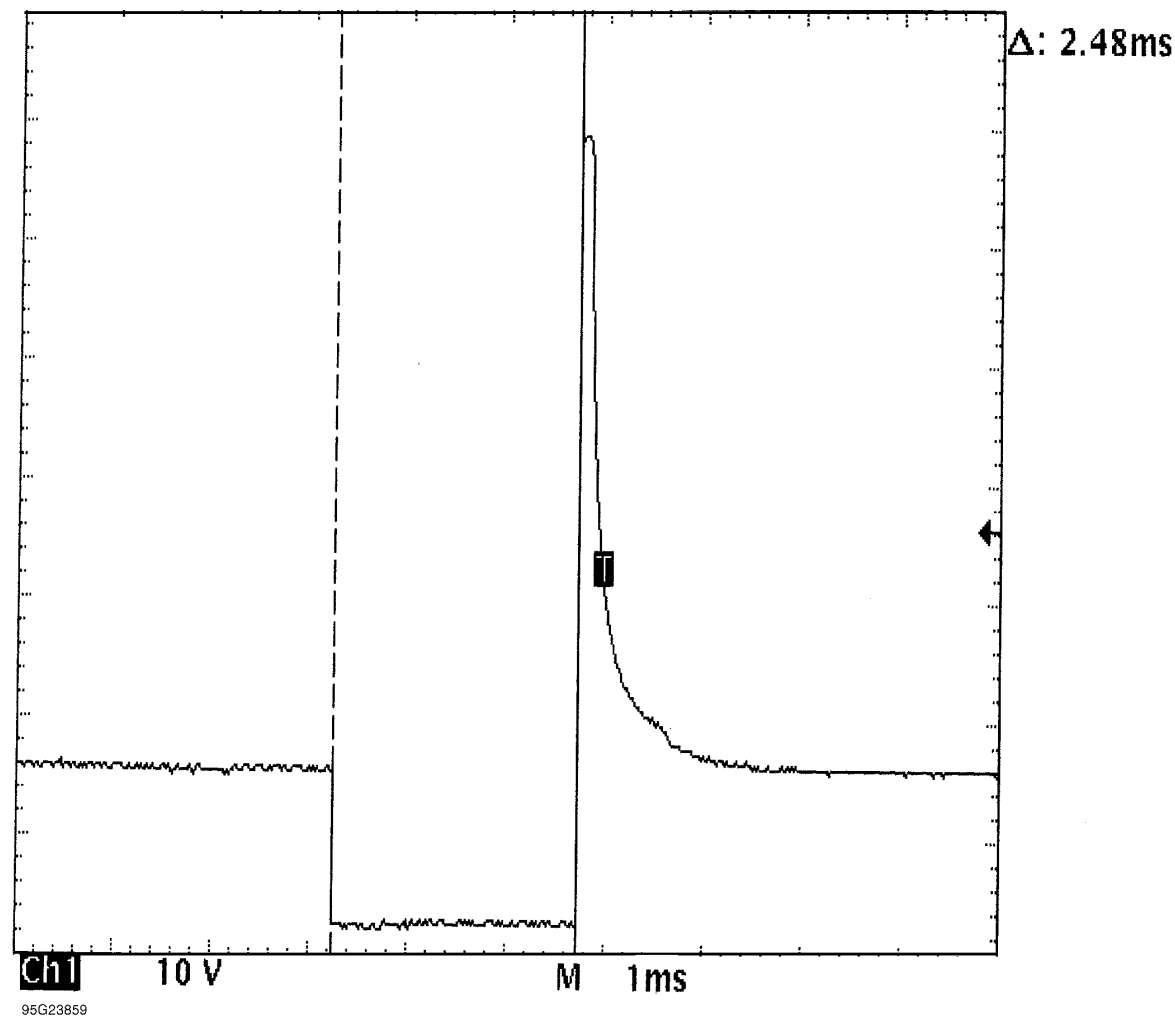


Fig. 21: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #4 - CURRENT CONTROLLED DRIVER

From 1984 to 1987, Chrysler used this type injector drive on their TBI-equipped engines. See Fig. 22 for a known-good pattern. Instead of the ground side controlling the injector, Chrysler permanently grounds out the injector and switches the power feed side. Most systems do not work this way.

These injectors peak at 6 amps of current flow and hold at 1 amp.

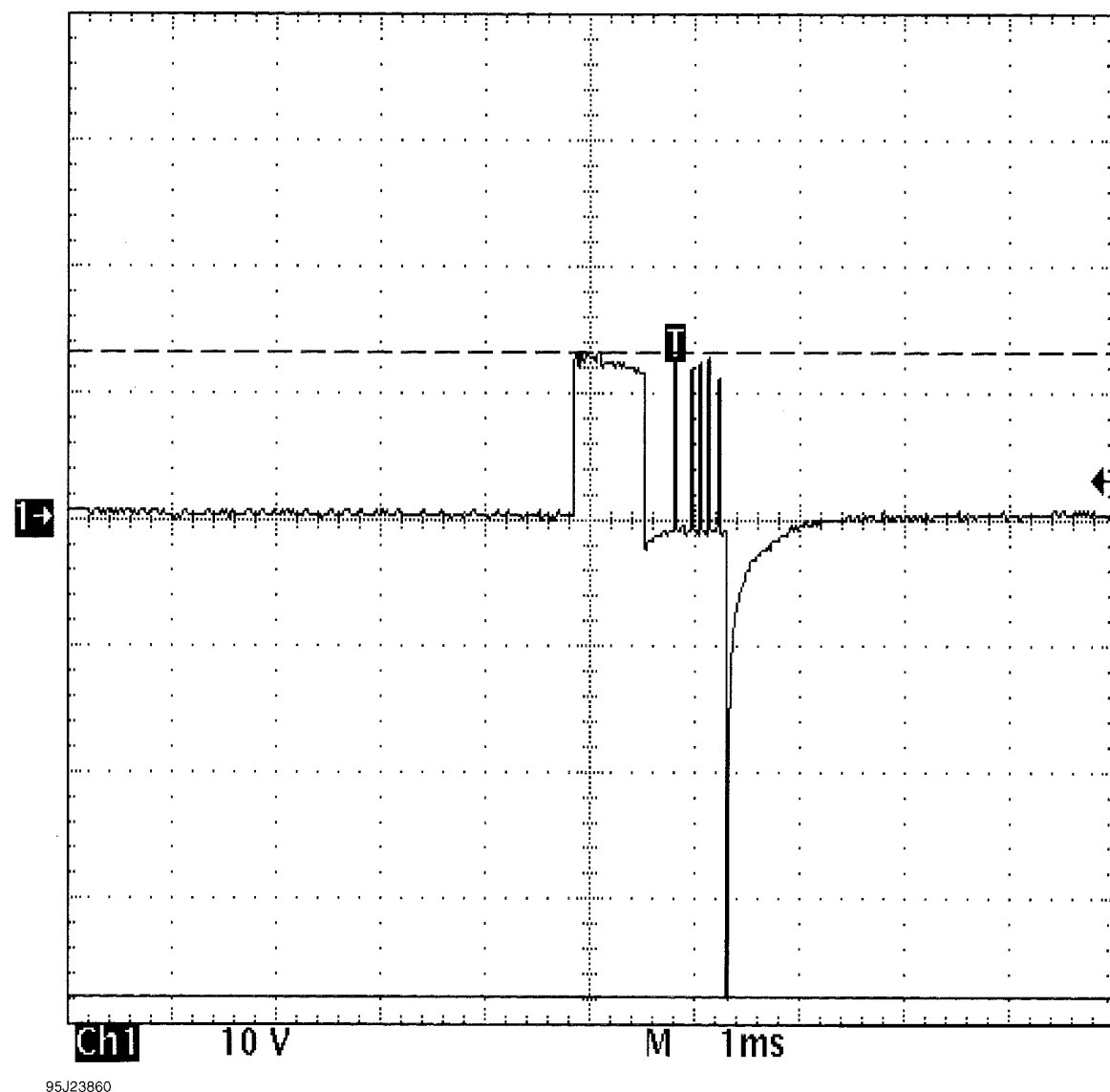


Fig. 22: Single Injector - Known Good - Voltage Pattern

EXAMPLE #5 - CURRENT CONTROLLED DRIVER

These two known-good waveform patterns are from a Chrysler 3.0L V6 VIN [3]. The first waveform, Fig. Fig. 23, is a dual trace pattern that illustrates how Chrysler uses the rising edge of the engine speed signal to trigger the injectors. The second waveform, Fig. Fig. 24, was taken during hot idle, closed loop, and no load.

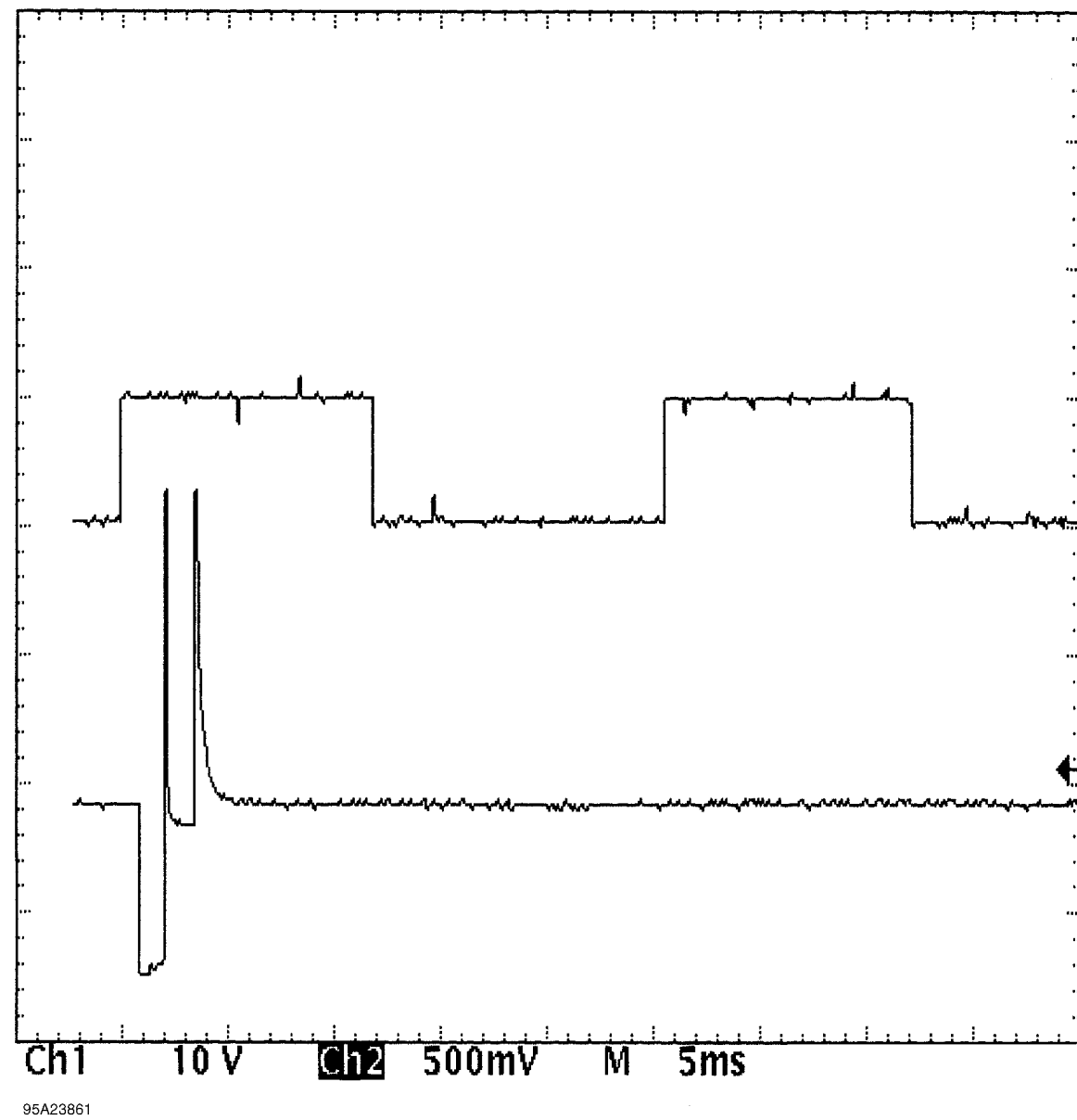


Fig. 23: Injector Bank - Known Good - Voltage Pattern

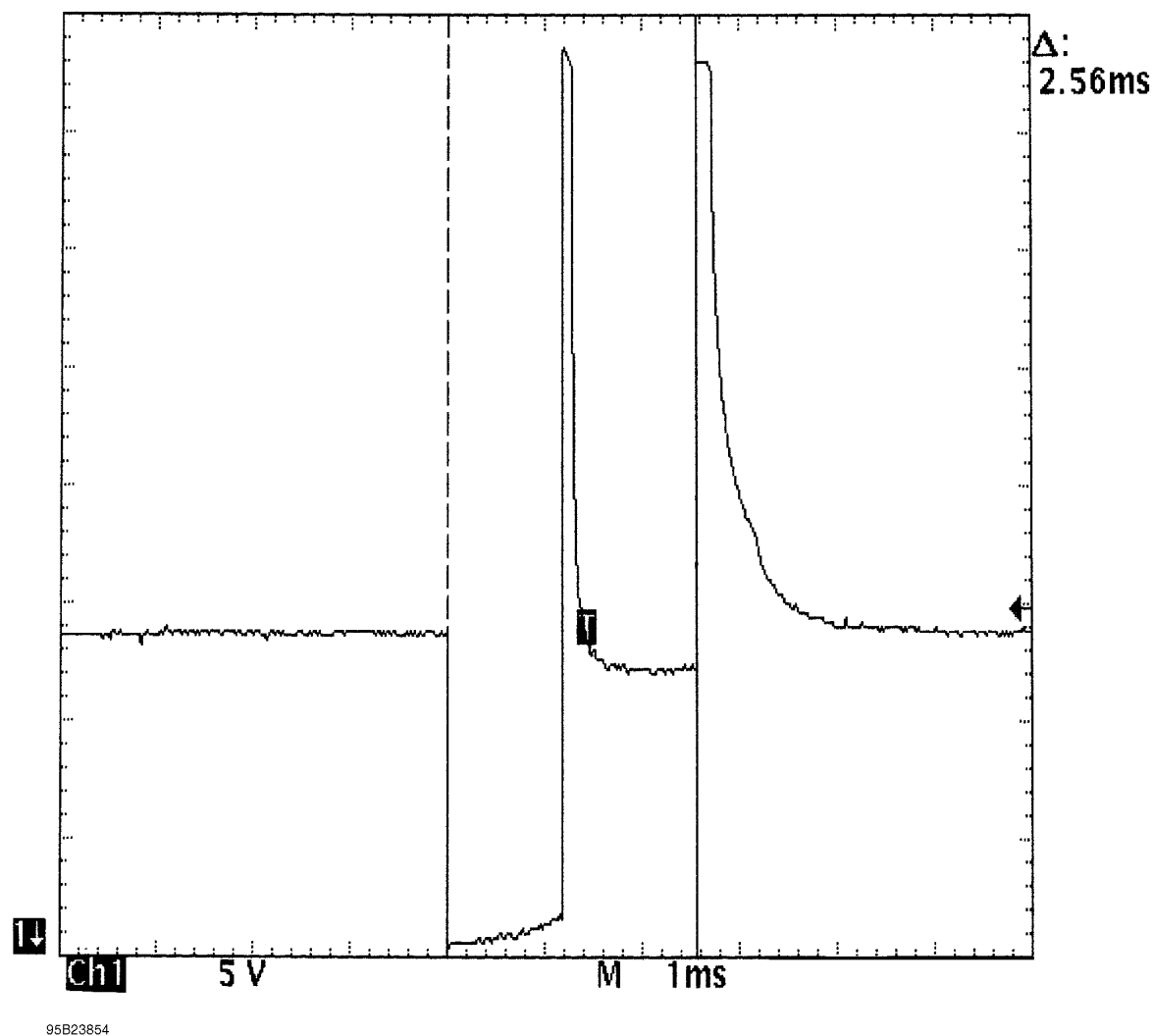


Fig. 24: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #6 - CURRENT CONTROLLED DRIVER

This known-good pattern from a Ford 3.0L V6 PFI VIN [U] illustrates that a zener diode inside the computer is used to clamp the injector's inductive kick to 35-volts on this system. See Fig. 25.

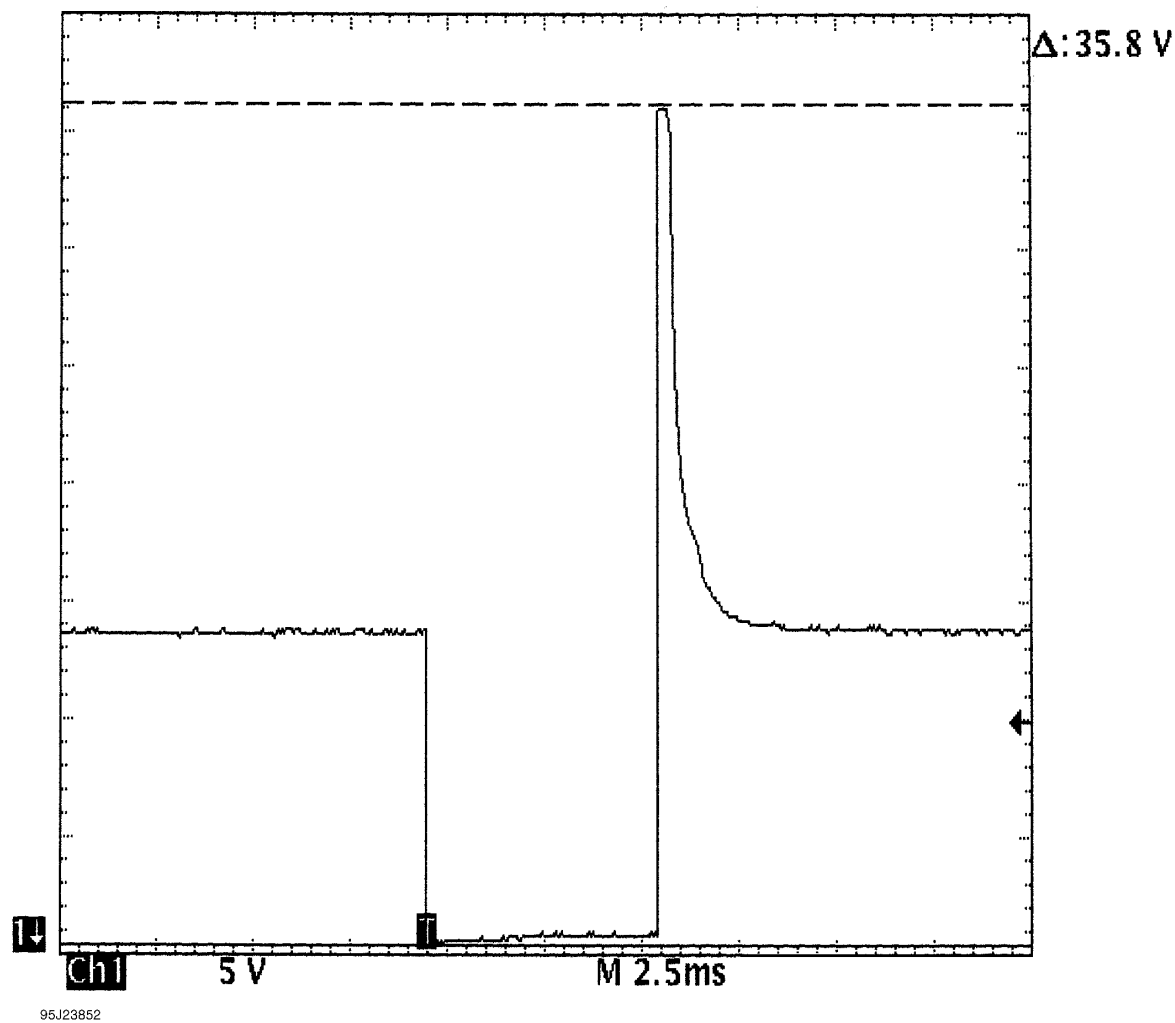


Fig. 25: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #7 - CURRENT CONTROLLED DRIVER

This known-good waveform from a Ford 5.0L V8 CFI VIN [F] was taken during hot idle, closed loop, and no load. See Fig. 26.

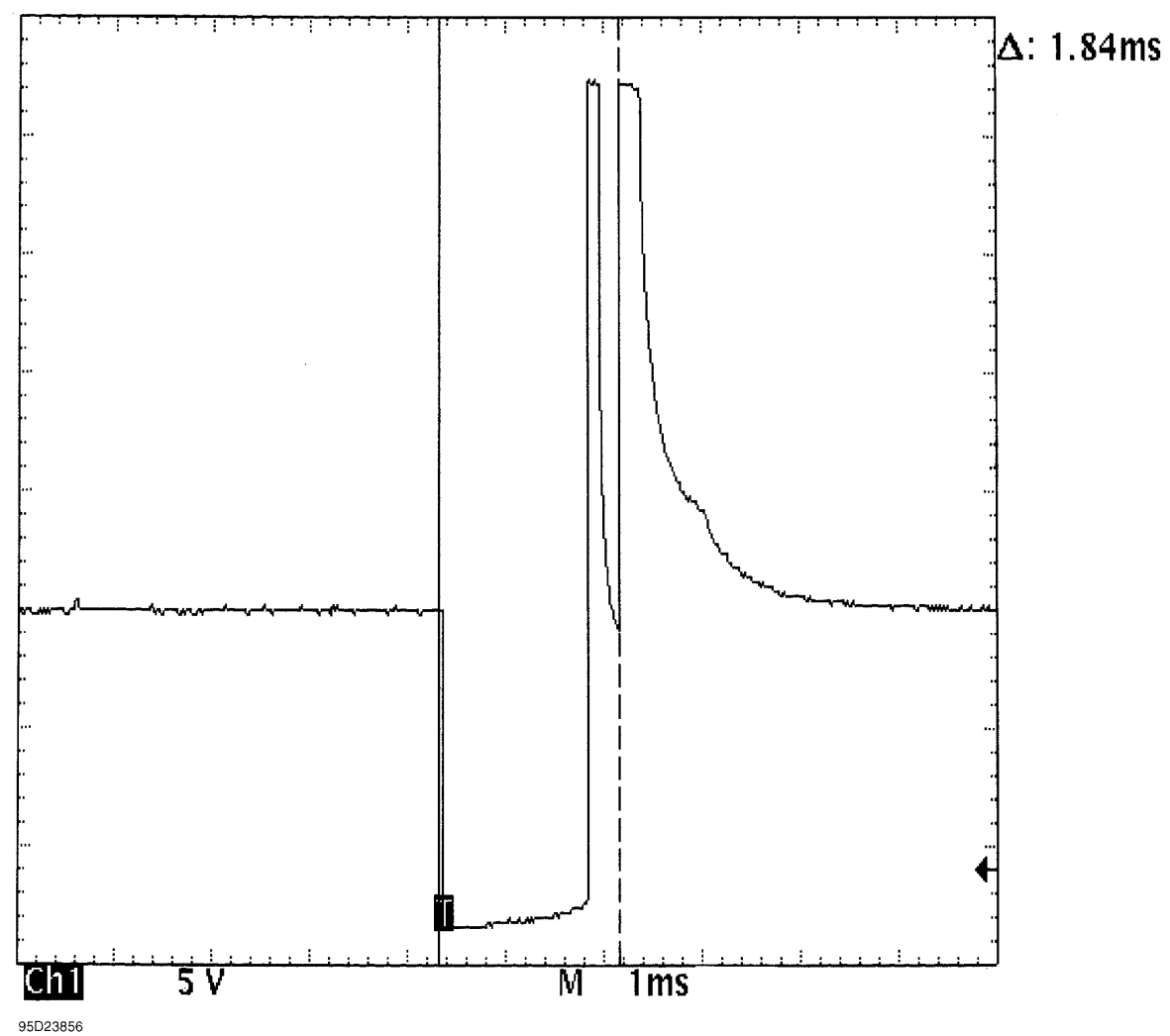


Fig. 26: Single Injector - Known Good - Voltage Pattern

EXAMPLE #8 - CURRENT CONTROLLED DRIVER

These two known-good waveform patterns are from a GM 2.0L In-Line 4 VIN [1]. Fig. Fig. 27 illustrates the 78 volt inductive spike that indicates a zener diode is not used. The second waveform, Fig. Fig. 28, was taken during hot idle, closed loop, and no load.

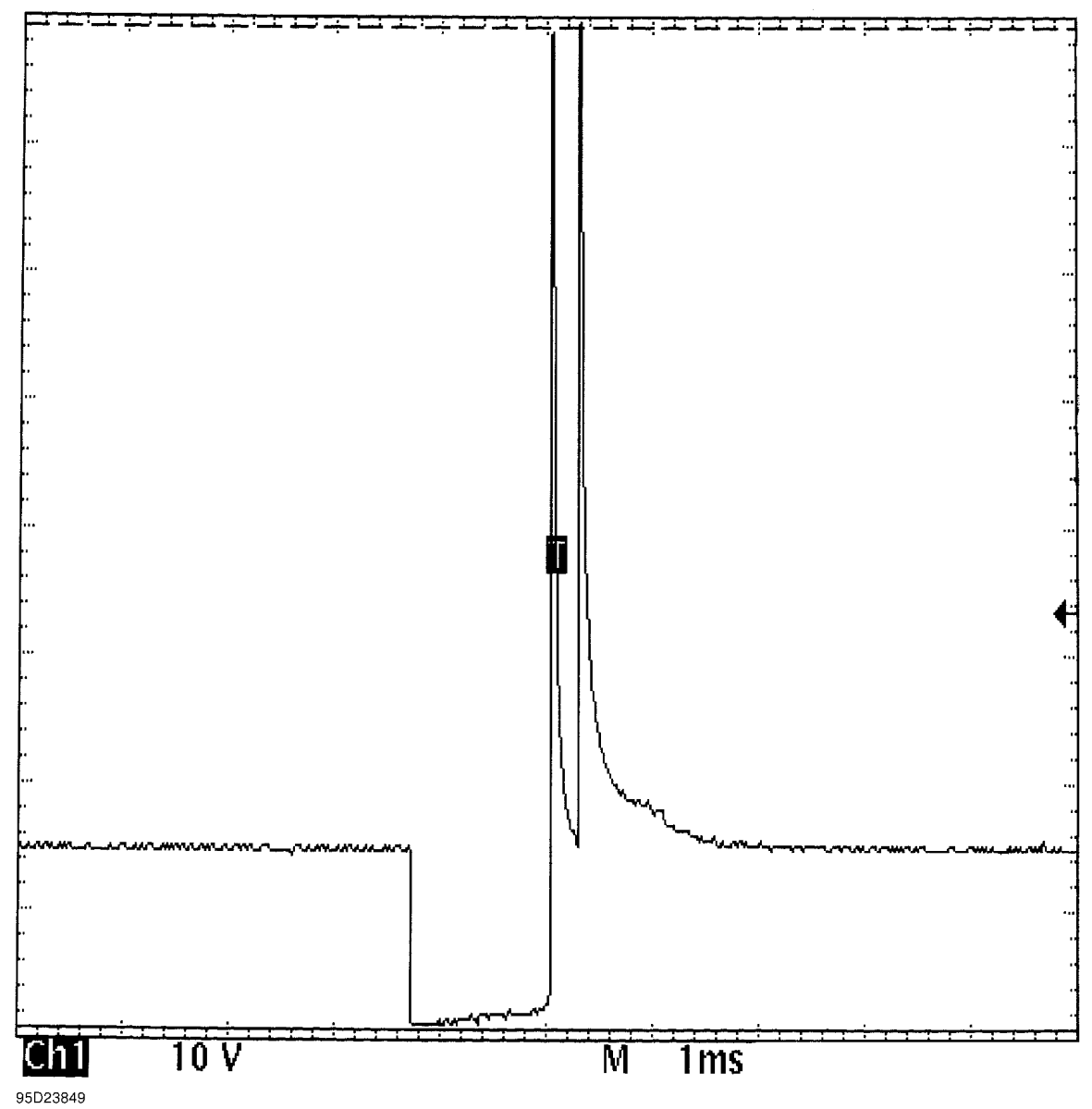


Fig. 27: Single Injector - Known Good - Voltage Pattern

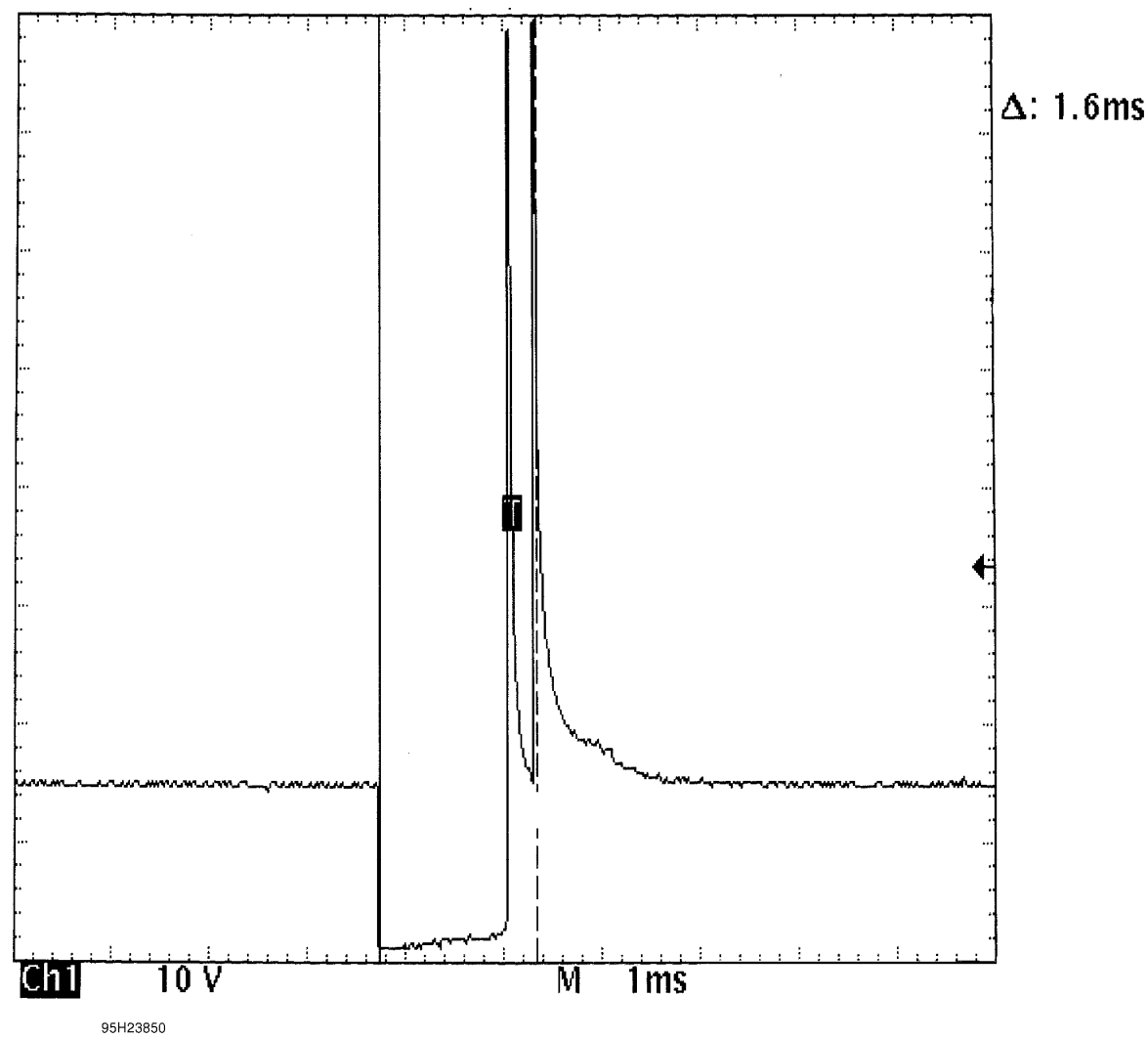


Fig. 28: Single Injector - Known Good - Voltage Pattern

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Article GUID: A00010328

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GENERAL INFORMATION

Wheel Alignment Theory & Operation

* PLEASE READ THIS FIRST *

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

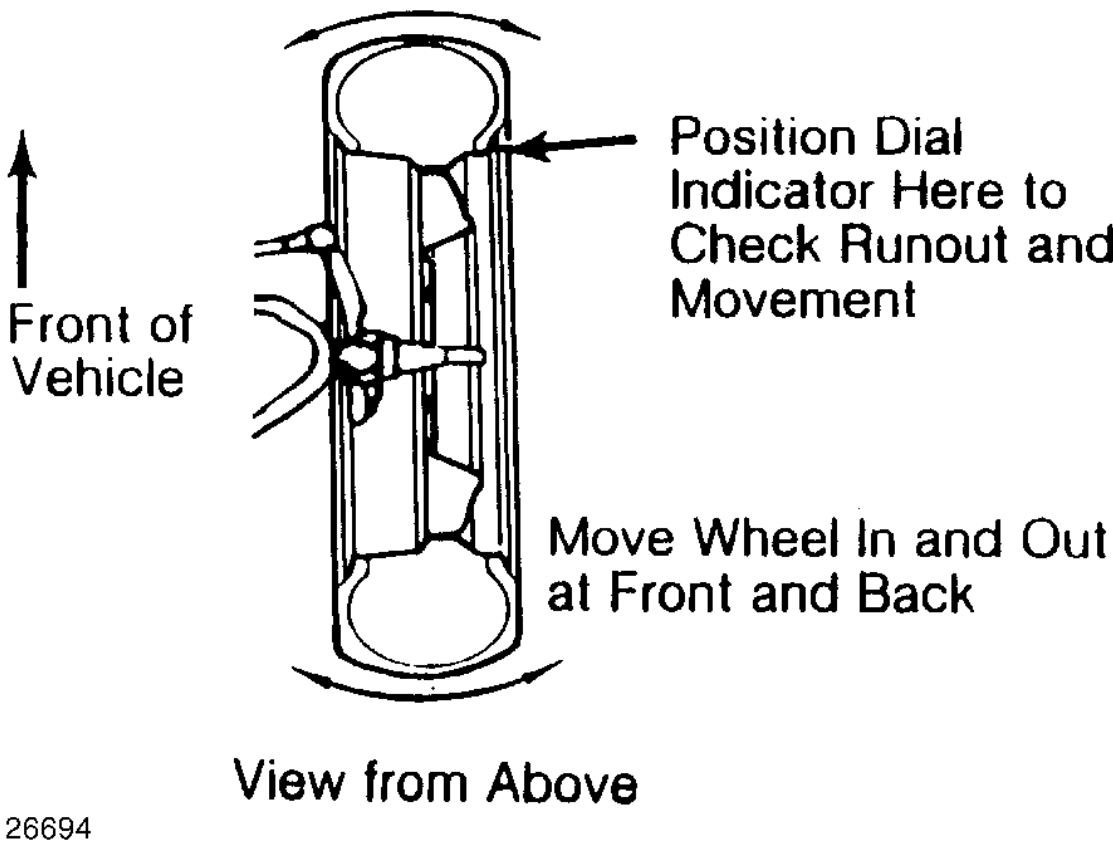
PRE-ALIGNMENT INSTRUCTIONS

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

GENERAL ALIGNMENT CHECKS

Before adjusting wheel alignment, check the following:

- Each axle uses tires of same construction and tread style, equal in tread wear and overall diameter. Verify that radial and axial runout is not excessive. Inflation should be at manufacturer's specifications.
- Steering linkage and suspension must not have excessive play. Check for wear in tie rod ends and ball joints. Springs must not be sagging. Control arm and strut rod bushings must not have excessive play. See [Fig. 1](#).



[Fig. 1: Checking Steering Linkage](#)

- Vehicle must be on level floor with full fuel tank, no passenger load, spare tire in place and no load in trunk. Bounce front and rear end of vehicle several times. Confirm vehicle is at normal riding height.
- Steering wheel must be centered with wheels in straight ahead position. If required, shorten one tie rod adjusting sleeve and lengthen opposite sleeve (equal amount of turns). See [Fig. 2](#).
- Wheel bearings should have the correct preload and lug nuts must be tightened to manufacturer's specifications. Adjust camber, caster and toe-in using this sequence. Follow instructions of the alignment equipment manufacturer.

CAUTION: DO NOT attempt to correct alignment by straightening parts. Damaged parts **MUST** be replaced.

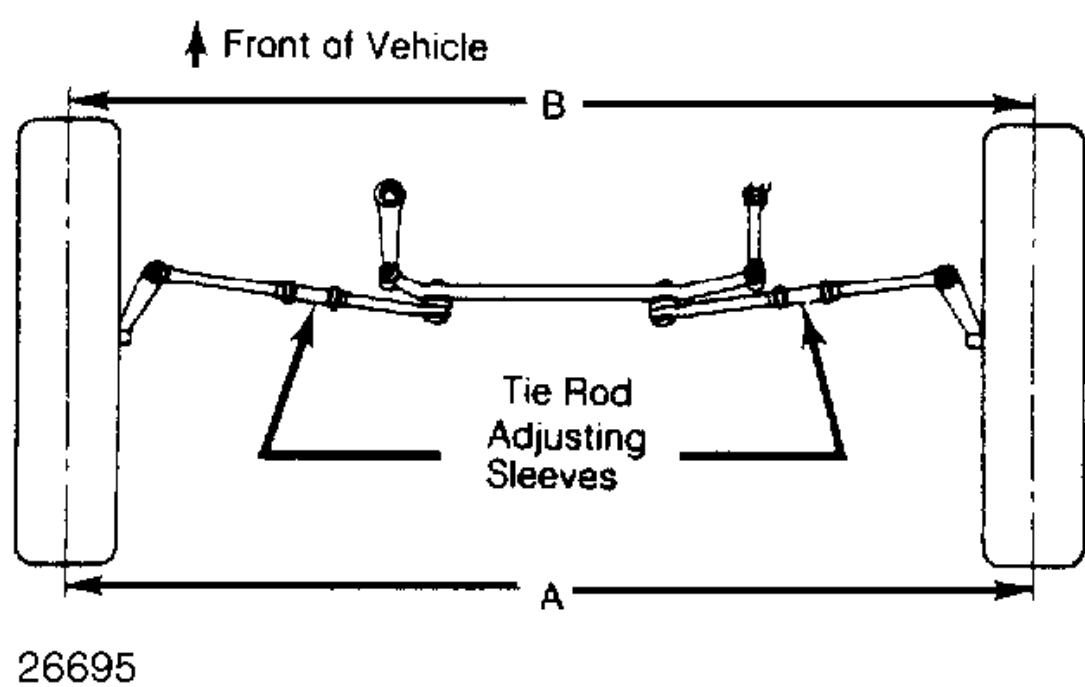


Fig. 2: Adjusting Tie Rod Sleeves (Top View)

ADJUSTMENTS

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

CAMBER

- 1. Camber is the tilting of the wheel, outward at either top or bottom, as viewed from front of vehicle. See Fig. 3.
- 2. When wheels tilts outward at the top (from centerline of vehicle), camber is positive. When wheels tilt inward at top, camber is negative. Amount of tilt is measured in degrees from vertical.

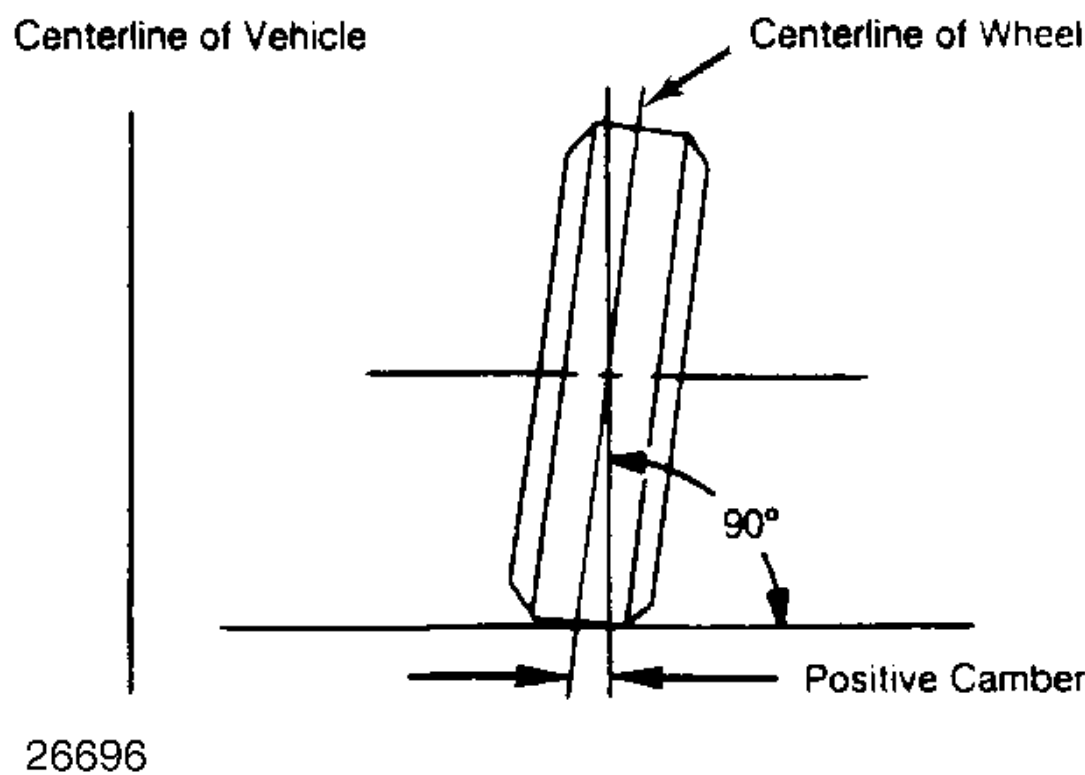


Fig. 3: Determining Camber Angle

CASTER

- 1. Caster is tilting of front steering axis either forward or backward from vertical, as viewed from side of vehicle. See Fig. 4.
- 2. When axis is tilted backward from vertical, caster is positive. This creates a trailing action on front wheels. When axis is tilted forward, caster is negative, causing a leading action on front wheels.

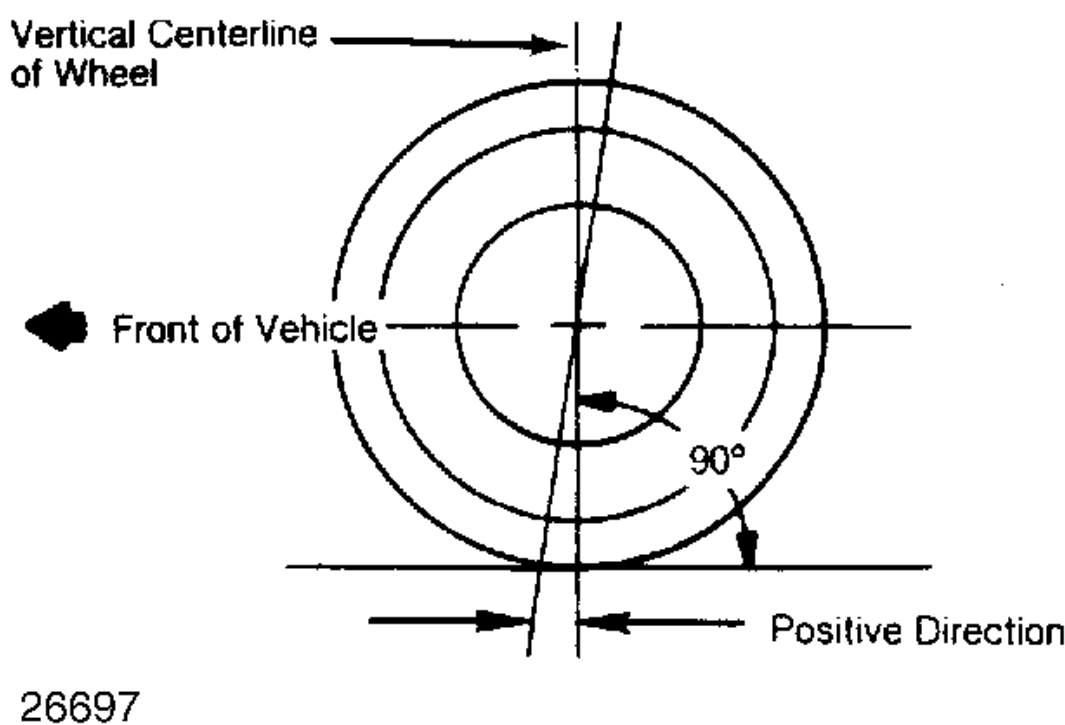


Fig. 4: Determining Caster Angle

TOE-IN ADJUSTMENT

Toe-in is the width measured at the rear of the tires subtracted by the width measured at the front of the tires at about spindle height. A positive figure would indicate toe-in and a negative figure would indicate toe-out. If the distance between the front and rear of the tires is the same, toe measurement would be zero. To adjust:

- 1) Measure toe-in with front wheels in straight ahead position and steering wheel centered. To adjust toe-in, loosen clamps and turn adjusting sleeve or adjustable end on right and left tie rods. See Fig. 2 and Fig. 5 .
- 2) Turn equally and in opposite directions to maintain steering wheel in centered position. Face of tie rod end must be parallel with machined surface of steering rod end to prevent binding.
- 3) When tightening clamps, make certain that clamp bolts are positioned so there will be no interference with other parts throughout the entire travel of linkage.

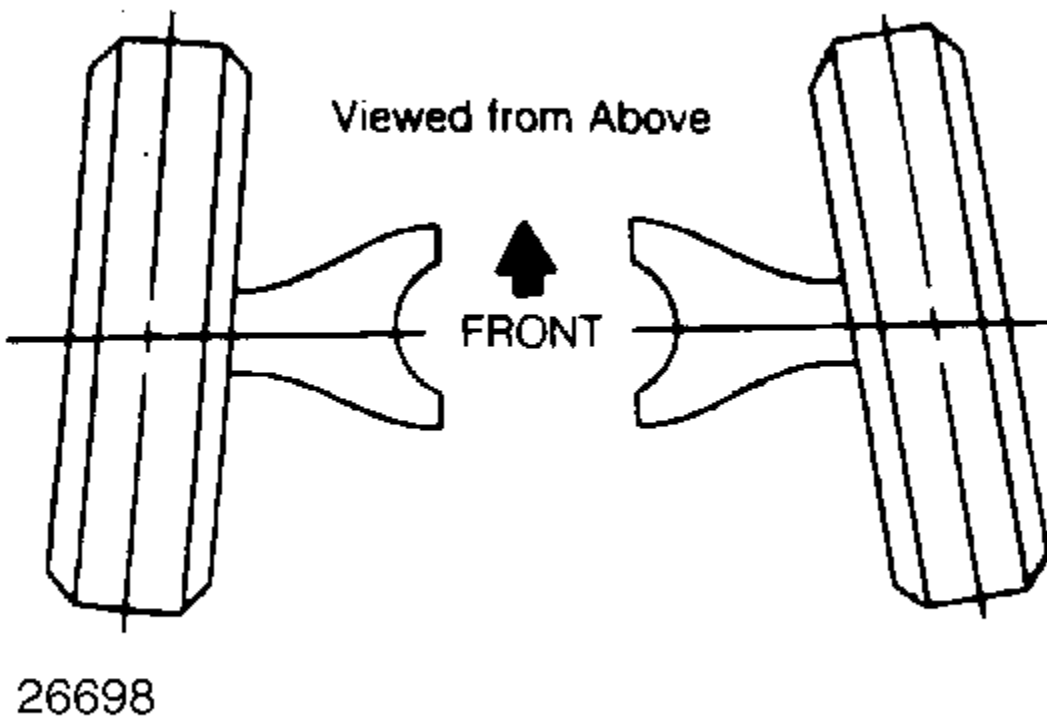


Fig. 5: Wheel Toe-In (Dimension A Less Dimension B)

TOE-OUT ON TURNS

1. Toe-out on turns (turning radius) is a check for bent or damaged parts, and not a service adjustment. With caster, camber, and toe-in properly adjusted, check toe-out with weight of vehicle on wheels.
2. Use a full floating turntable under each wheel, repeating test with each wheel positioned for right and left turns. Incorrect toe-out generally indicates a bent steering arm. Replace arm, if necessary, and recheck wheel alignment.

STEERING AXIS INCLINATION

1. Steering axis inclination is a check for bent or damaged parts, and not a service adjustment. Vehicle must be level and camber should be properly adjusted. See [Fig. 6](#).
2. If camber cannot be brought within limits and steering axis inclination is correct, steering knuckle is bent. If camber and steering axis inclination are both incorrect by approximately the same amount, the upper and lower control arms are bent.

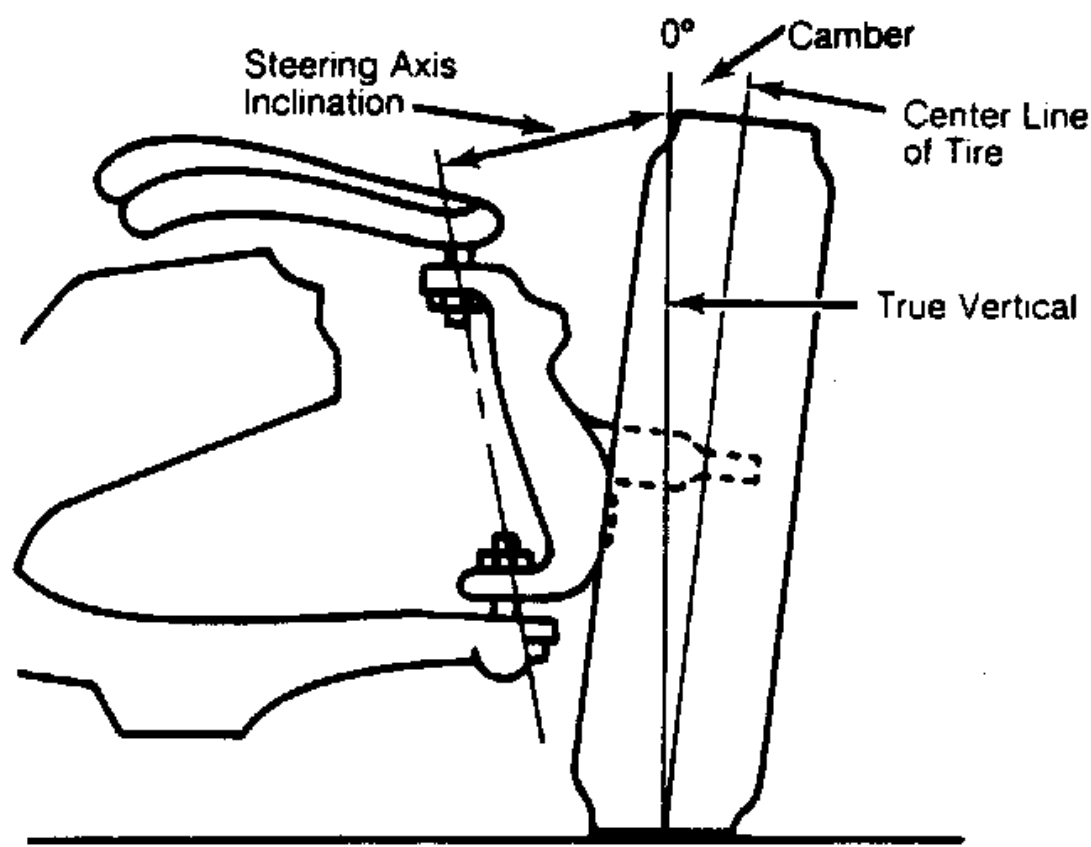


Fig. 6: Checking Steering Axis Inclination

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GENERAL INFORMATION

Manual Transmission Trouble Shooting

* PLEASE READ THIS FIRST *

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

INTRODUCTION

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

There are many times when the transmission is incorrectly blamed for shifting problems or noises that are actually caused by other reasons. Shift difficulties are frequently caused by conditions outside of the transmission or transaxle. Typical conditions include: shift linkage, shift cables, alignment of engine to transmission, worn engine mounts or clutch problems. Drive train noises may come from many sources such as tires, road surfaces, wheel bearings, differentials, engine or exhaust system. Repairing or overhauling transmission will not cure these problems.

No manufacturer makes a perfectly quiet transmission. Gear rollover noise is present in most constant mesh transmissions and will tend to disappear when the clutch is disengaged or transmission is placed in gear. If clutch is properly adjusted, clutch release bearing noise will disappear when release bearing is moved enough to slide release bearing away from pressure plate.

Trouble shooting can be helped by driving vehicle on a smooth level road to help eliminate tire and body noise. Note whether noise occurs on acceleration, coasting, deceleration or steady driving conditions. Some problems may only occur when transmission is either hot or cold. Gear lubricant that is too thick can cause hard shifting on cold mornings before engine is warm and vehicle has been driven.

MANUAL TRANSMISSION/TRANSAXLE TROUBLE SHOOTING

Condition	Possible Cause
Noisy In Forward Gears	Low Gear Oil Level, Loose Bellhousing Bolts, Worn Bearings Or Gears
Clunk On Deceleration (FWD Only)	Loose Engine Mounts, Worn Inboard CV Joints, Worn Differential Pinion Shaft, Oversized Side Gear Hub Counterbore in Case
Gear Clash When Shifting Forward Gears	Clutch Out Of Alignment, Shift Linkage Damaged Or Out Of Adjustment, Gears Or Synchronizers Damaged, Low Gear Oil Level
Transmission Noisy When Moving (RWD Only); Quiet In Neutral With Clutch Engaged	Worn Rear Output Shaft Bearing
Gear Rattle	Worn Bearings, Worn Gear Oil, Low Gear Oil, Worn Gears
Steady Ticking At Idle (Increases With RPM)	Broken Tooth On A Gear
Gear Clash When Shifting Forward Gears	Worn Or Broken Synchronizers, Faulty Clutch
Loud Whine In Reverse	Normal Condition ⁽¹⁾
Noise When Stepping On Clutch	Faulty Release Bearing, Worn Pilot Bearing
Ticking Or Screeching As Clutch Is Engaged	Faulty Release Bearing, Uneven Pressure Plate Fingers
Click Or Snap When Clutch Is Engaged	Worn Clutch Fork, Worn Pivot Ball, Worn Or Broken Front Bearing Retainer
Transmission Shifts Hard	Clutch Not Releasing, Incorrect Gear Oil, Shift Mechanism Binding, Clutch Installed Backward
Will Not Shift Into One Gear, Shifts Into All Others	Bent Shift Fork, Worn Detent Balls
Locked Into Gear, Cannot Shift	Clutch Adjustment, Worn Detent Balls
Transmission Jumps Out Of Gear	Pilot Bearing Worn, Bent Shift Fork, Worn Gear Teeth Or Face, Excessive Gear Train End Play, Worn Synchronizers, Missing Detent Ball Spring, Shift Mechanism Worn Or Out Of Adjustment, Engine Or Transmission Mount Bolts Loose, Transmission Not Aligned
Shift Lever Rattle	Worn Detents Or Shift Lever, Worn Shift Fork, Worn Synchronizer Sleeves
Shift Lever Hops Under Acceleration	Worn Engine Or Transmission Mounts
(1) Most units use spur cut gears in Reverse and are naturally noisy.	

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1991 GENERAL SERVICING

A/C Compressor Refrigerant Oil Checking

ISOLATING COMPRESSOR

NOTE: Only compressors with stem-type service valves can be isolated.

1. Connect service gauge set to the compressor service valves and open compressor valves slightly (turn in clockwise). Start engine and operate air conditioning. Slowly turn compressor suction valve clockwise toward closed (front-seated) position.
2. When suction pressure is reduced to zero or less, turn off engine and compressor and quickly turn suction valve stem in to full front-seated position. Suction pressure should be slightly above zero. Turn discharge valve into front-seated position.
3. To check oil level, slowly open compressor crankcase plug to relieve any remaining pressure. After oil level is corrected, cap service gauge ports on both valves. Back-seat suction service valve to allow refrigerant to enter compressor. Open discharge valve halfway.
4. Loosen discharge service valve cap, allowing refrigerant pressure to force air out of compressor. Back-seat service valve and tighten cap. Compressor is now ready for operation.

REFRIGERANT OIL

Only new, pure, moisture-free refrigerant oil should be used in the air conditioning system. This oil is highly refined and dehydrated to a point where moisture content is less than 10 parts per million. The oil container must be tightly closed at all times when not in use, or moisture will be absorbed into the refrigerant oil from the air.

SERVICING PRECAUTIONS

NOTE: Recent findings by the EPA indicate that refrigerant is harmful to the earth's protective Ozone layer. When discharging refrigerant, DO NOT allow refrigerant to enter the atmosphere. If available, use refrigerant recovery/recycle systems when discharging system. Always follow manufacturer's instructions.

DISCHARGING SYSTEM PRECAUTIONS

If compressor has stem-type service valves, it can be isolated and removed without discharging entire system. See ISOLATING COMPRESSOR at the beginning of this article. Otherwise, discharge system completely before loosening any fittings.

DISCONNECTING LINES & FITTINGS TEST

After system is discharged, carefully clean area around all fittings to be opened. Always use 2 wrenches when tightening or loosening fittings to avoid twisting or distorting lines. Cap or plug all openings as soon as lines are removed. DO NOT remove caps until immediately before connections are made. This will keep entry of air and moisture to a minimum.

CONNECTING LINES AND FITTINGS

A new gasket or "O" ring should be used in all instances when connecting lines or fittings. Dip "O" ring in new refrigerant oil and ensure it is not twisted during installation. Always use 2 wrenches to prevent damage to lines and fittings.

PLACING SYSTEM IN OPERATION

After component service or replacement has been completed and all connections have been made, evacuate system thoroughly with a vacuum pump. Charge system with proper amount of refrigerant and perform a leak test. See REFRIGERANT OIL & R-12 SPECIFICATIONS chart in this section for system capacities. Be sure to check all fittings that have been opened. After system has been leak tested, make a system performance check.

NOTE: Air conditioning systems will not normally need addition of refrigerant oil unless definite oil loss has occurred due to ruptured lines, leaking compressor seals, compressor overhaul or component replacement.

ATSUGI ROTARY VANE DRAIN & REFILL

1. Before checking and adjusting oil level, operate compressor at engine idling speed, with controls set for maximum cooling and high blower speed, for 20 to 30 minutes to return oil to compressor.
2. Stop engine, discharge refrigerant and remove compressor from vehicle. See SERVICING PRECAUTIONS at beginning of article. Drain compressor oil from compressor discharge port and measure the amount. Oil is sometimes hard to drain when compressor is cool. Remove oil while compressor is warm.
3. If the amount drained is less than 3 ounces, conduct leak tests at system connections, and if necessary, repair or replace faulty parts. Check purity of oil and adjust oil level as follows.
4. If amount drained was above 3 ounces, oil level is right. Pour in same amount as was drained. If amount drained was below 3 ounces, pour in 3 ounces of new refrigerant oil.

BOSCH 6-CYL DRAIN & REFILL

1. Before checking and adjusting oil level, operate compressor at engine idling speed, with controls set for maximum cooling and high blower speed, for 20 to 30 minutes to return oil to compressor.
2. Stop engine and discharge refrigerant. Remove refrigerant oil level inspection plug on side of compressor. Oil should be at lower lip of threaded hole. Add necessary new refrigerant oil (if low). Replace inspection plug and tighten to 10-12 ft. lbs. (14-16 N.m).

CALSONIC V5 5-CYLINDER

1. Before checking and adjusting oil level, operate compressor at 1000-1500 engine RPM, and set controls at maximum cooling and blowing speed for 20-30 minutes to return oil to compressor.
2. Stop engine. Discharge refrigerant and remove compressor from vehicle. See SERVICING PRECAUTIONS at the beginning of this article. Drain compressor oil from compressor discharge port and measure oil amount. Oil may be hard to drain if compressor is cool. Drain oil while compressor is warm.
3. If amount drained is less than 3.2 ounces, conduct leak tests at system connections. Repair or replace faulty parts as necessary. Check purity of oil and oil level as follows.
4. If amount drained is more than 3.2 ounces, oil level is okay; fill with same amount drained using new oil. If amount drained is less than 3.2 ounces, pour in 3.2 ounces of new refrigerant oil.

DIESEL KIKI ROTARY VANE DRAIN & REFILL

1. Before checking and adjusting oil level, operate compressor at engine idling speed, with controls set for maximum cooling and high blower speed, for 20 to 30 minutes to return oil to compressor.
2. Stop engine, discharge refrigerant and remove compressor from vehicle. See SERVICING PRECAUTIONS at the beginning of this article. Drain compressor oil from compressor discharge port and measure the amount. Oil is sometimes hard to drain when compressor is cool. Remove oil while compressor is warm.
3. If the amount is less than 2.4 ounces, conduct leak tests at system connections, and if necessary, repair or replace faulty parts. Check purity of oil and adjust oil level as follows.
4. If amount drained was above 2.4 ounces, oil level is right. Pour in same amount as was drained. If amount drained was below 2.4 ounces, pour in 2.4 ounces of new refrigerant oil.

DIESEL KIKI 6-CYL DRAIN & REFILL

1. Before checking and adjusting oil level, operate compressor at engine idling speed, with controls set for maximum cooling and high blower speed, for 20 to 30 minutes to return oil to compressor.
2. Stop engine, discharge refrigerant and remove compressor from vehicle. See SERVICING PRECAUTIONS at the beginning of this article. Remove oil drain plug and drain oil. Measure amount of oil drained. Install drain plug with new "O" ring.
3. If amount drained was more than 2 ounces (4.4 ounces for Infinity), refill with same amount of new oil. If amount drained was less than 2 ounces (4.4 ounces for Infinity), refill with 2 ounces (4.4 ounces for Infinity). Install filler plug and recharge system.

FORD FX-15 6-CYLINDER DRAIN & REFILL

NOTE: Replacement FX-15 compressors contain 7 ounces of refrigerant oil. Prior to installing compressor, drain refrigerant oil and determine proper amount of refrigerant oil to be added.

1. Slowly discharge system. Remove A/C compressor. Drain compressor oil from suction and discharge ports. Measure amount drained and discard oil.
2. If amount drained from removed (old) compressor is between 3 and 5 ounces, add drained amount of new SUNINSO 5GS refrigerant oil into the NEW compressor through suction port.
3. If amount drained is less than 3 ounces, add 3 ounces to the NEW compressor. If amount drained is more than 5 ounces, add 5 ounces. Use new "O" rings on refrigerant lines. Install A/C compressor. Evacuate and recharge system. Perform leak test.

HARRISON 4-CYL DRAIN & REFILL

NOTE: The Harrison compressor DOES NOT have an oil sump. It's crucial that the compressor remains well oiled. It takes very little time to destroy this compressor if it runs dry.

The Harrison 4-cyl compressor is charged (new) with 6 ounces of refrigerant oil. Because compressor does not have an oil sump, it should not have to be removed for oil measurement (it retains very little oil). Note the following situations for checking and adding oil to this compressor.

NO OIL LEAK; REPLACING COMPONENTS

If only the compressor is to be replaced, remove, drain oil, measure and reinstall an equal amount of new oil. If evaporator is being replaced, add 3 ounces of new oil. If condenser is being replaced, add one ounce.

LOSS OF REFRIGERANT OVER EXTENDED PERIOD

When a loss of refrigerant has occurred over an extended period of time and a component is being replaced to correct the leak, add an appropriate amount of refrigerant oil to the component.

SIGNS OF EXCESSIVE OIL LEAKAGE

If system has lost excessive oil, remove accumulator. Drain and measure oil. If more than 3 ounces is measured, replace the same amount of new oil as was drained. If less than 3 ounces is measured, add 3 ounces of new oil. Add and additional 2 ounces of new oil to compensate for that lost by replacing the accumulator (held in desiccant).

NOTE: If the exact oil charge is in doubt, drain and flush system. Add a new 6-ounce charge of refrigerant oil to the system.

HARRISON V5 5-CYLINDER DRAIN & REFILL

1. If system is operable, run for several minutes to stabilize system before performing repairs. Turn off engine. Discharge system and remove compressor. See SERVICING PRECAUTIONS at the beginning of this article. Remove drain plug. Drain and measure oil.

2. If more than one ounce is drained, add same amount. If less than one ounce is drained, add 2 ounces of new refrigerant oil to compressor.
3. If A/C components are replaced, add refrigerant oil to system. Add one ounce if condenser is replaced. Add 3.5 ounces if accumulator is replaced.
4. When replacing a component which has caused a large refrigerant leak, add 3 ounces of new oil plus the required amount for the part being replaced. Add oil directly to part being replaced if possible. If oil can not be easily added to part, add oil to accumulator.

NOTE: If oil drained contains metal chips or other debris, replace receiver-drier. Flush out system before evacuating and recharging.

HITACHI 5-CYL DRAIN & REFILL

1. Before checking and adjusting oil level, operate compressor at 1000-1500 engine RPM, and set controls at maximum cooling and high blowing speed for about 10 minutes to return oil to compressor.
2. Stop engine. Discharge refrigerant and remove compressor from vehicle. See SERVICING PRECAUTIONS at the beginning of this article. Drain oil from compressor through suction port. Measure amount of oil drained.
3. If amount drained is more than 2.4 ounces, fill with same amount using new oil. If amount drained is less than 2.4 ounces, fill with 2.4 ounces. Install compressor and recharge.
4. If A/C components are replaced. add refrigerant oil to system. Add 1.7 ounces if condenser is replaced. Add 2.4 ounces if evaporator is replaced. oil does not need to be added if receiver-drier is replaced.

HITACHI 6-CYL DRAIN & REFILL

1. Before checking and adjusting oil level, operate compressor at engine idling speed, with controls set for maximum cooling and high blower speed, for 10 minutes to return oil to compressor.
2. Stop engine, discharge refrigerant and remove compressor from vehicle. See SERVICING PRECAUTIONS at the beginning of this article. Drain oil from compressor suction port. Measure amount of oil drained. If amount drained was more than 2.4 ounces, refill with same amount of new oil. If amount drained was less than 2.4 ounces, refill with 2.4 ounces. Install compressor and recharge.

MATSUSHITA ROTARY VANE DRAIN & REFILL

Discharge system. Remove compressor from vehicle. Drain oil from compressor through inlet and outlet holes. Refill compressor with 3.4-4.7 ounces of oil through suction port. When replacing evaporator, add 2 ounces. When replacing other A/C components, add 1.4 ounces per component replaced.

NIPPONDENSO ROTARY VANE DRAIN & REFILL

1. Before checking and adjusting oil level, operate compressor at engine idle speed, and set controls at maximum cooling and high blowing speed for 20-30 minutes to return oil to compressor.
2. Stop engine. Discharge refrigerant and remove compressor from vehicle. See SERVICING PRECAUTIONS at the beginning of this article. Drain compressor oil through compressor intake and discharge ports. Measure amount drained. Oil may be hard to drain if compressor cool. Drain compressor while compressor is warm.
3. If amount drained is less than 2.4 ounces, conduct leak tests at system connections. If necessary, repair or replace faulty parts. Check purity of oil level and adjust oil level as follows.
4. If amount drained is more than 2.4 ounces, oil level is okay; fill with same amount drained using new oil. If amount drained is less than 2.4 ounces, pour 2.4 ounces of new refrigerant oil.
5. When replacing condenser, add one ounce. when replacing other A/C components, add .33 ounce per container replaced.

NIPPONDENSO 6 & 10-CYL DRAIN & REFILL

When inspecting system for oil loss, look for signs of leaking (shiny, wet spots on components or underside of hood). If oil leak is noted or component replacement is required, use the following procedure as indicated:

NO OIL LEAK

Discharge system and change components as necessary. See SERVICING PRECAUTIONS at the beginning of this article. Add refrigerant oil to components as necessary.

OIL LEAK

1. Slowly discharge system. Repair or replace faulty components. If equipped with a drain plug, remove plug, drain and discard oil. If not equipped with a drain plug, remove compressor from vehicle and pour oil out suction and discharge ports.
2. Replace drain plug (if equipped). Add 1.5 ounces of new refrigerant oil through suction port. Use new gaskets or "O" rings when replacing suction and discharge lines.

COMPRESSOR FAILURE OR SYSTEM CONTAMINATED

If either situation exists, discharge system and remove compressor, receiver-drier and expansion valve. Clean expansion valve screen. Flush entire system. Install new compressor and receiver-drier. New compressors contain correct amount of oil. If installing overhauled compressor, add 1.5 ounces of new refrigerant oil through suction port.

PANASONIC ROTARY VANE DRAIN & REFILL

1. Before checking and adjusting oil level, operate compressor at 1000-1500 engine RPM, and set controls at maximum cooling and high blowing speed for about 10 minutes to return oil to compressor.
2. Stop engine. Discharge refrigerant and remove compressor from vehicle. See SERVICING PRECAUTIONS at the beginning of this

article. Drain oil from compressor through suction and discharge ports. Measure amount of oil drained. If amount drained is more than 2.4 ounces, fill with same amount using new oil. If amount drained is less than 2.4 ounces, fill with 2.4 ounces. Install compressor and recharge.

3. If A/C components are replaced, add refrigerant oil to system. Add 1.4 ounces if condenser is replaced. Add 2 ounces if the evaporator is replaced. Oil does not need to be added if receiver-drier is replaced.

SANDEN SCROLL DRAIN & REFILL

Discharge system. Remove compressor from vehicle. Drain oil from compressor through inlet and outlet holes. Refill compressor with 2.8 ounces of oil through suction port. When replacing condenser, add .5 ounce. When replacing evaporator, add 1.7 ounces. When replacing other A/C components, add .5 ounce per component replaced.

SANDEN 5-CYL DRAIN & REFILL

1. Discharge system. Remove compressor belt and loosen mounting bolts. Rotate compressor in brackets until filler plug is at top. Clean area around filler plug and remove plug slowly. Rotate front hub plate so notch in lobe is 110 degrees from the bottom. This rotates ball end of top piston to align with oil fill port and allows clearance for dipstick. See [Fig. 1](#) .
2. Insert compressor dipstick diagonally from right to left until stop on dipstick contacts filler plug surface. Remove dipstick and note oil fill level. Each increment on dipstick represents one ounce of oil. Add oil if necessary to reach 3-4 ounce level.

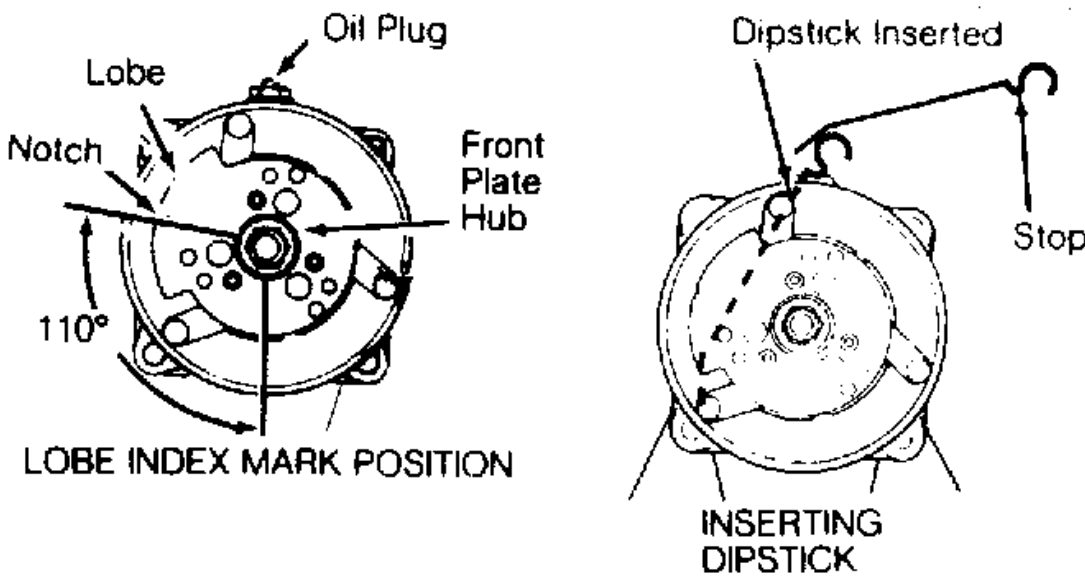


Fig. 1: Sanden 5-Cylinder Oil Level Checking
Courtesy of SANDEN INTERNATIONAL U.S.A, INC.

SANDEN 7-CYL DRAIN & REFILL

1. Before checking and adjusting oil level, operate compressor at engine idle speed, and set controls at maximum cooling and high blowing speed for 20-30 minutes to return oil to compressor.
2. Stop engine. Discharge refrigerant and remove compressor from vehicle. See SERVICING PRECAUTIONS at the beginning of this article. Remove oil drain plug and drain oil. Measure amount of oil drained. Install drain plug with new "O" ring.
3. If amount drained is more than 3 ounces, fill with same amount using new oil. If amount drained is less than 3 ounces, fill with 3 ounces. Install filler plug. Install compressor and recharge system.

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GENERAL SERVICING

1991 Ford Compressor Overhaul

REMOVAL & INSTALLATION

CAUTION: When discharging air conditioning system, use only approved refrigerant recovery/recycling equipment. Make every attempt to avoid discharging refrigerant into the atmosphere.

FORD FS-6 6-CYL CLUTCH ASSEMBLY

Removal

1. Using Spanner (T70P-4067-A), remove compressor shaft nut. Thread Hub Remover (T80L-19703-B) into clutch plate. Tighten center bolt in hub remover to remove clutch plate and shims.
2. Remove snap ring. Remove pulley assembly from compressor. If assembly cannot be easily removed, place Shaft Protector (T80L-19703-G) over shaft. Using Puller (D81P-19703-B), remove pulley assembly. Remove clutch coil retaining snap ring. Remove clutch coil.
3. If bearing replacement is required, place pulley on Support (T80L-19703-E). Drive bearing from pulley using Bearing Remover (T80L-19703-J).

Installation

1. If bearing is to be installed, place pulley on support. Using Bearing Installer (T80L-19703-C), drive bearing into pulley. Stake pulley in 4 places to retain bearing.
2. Install clutch coil on compressor so locating pin on compressor engages with hole in clutch coil. Install snap ring. Using hammer and Pulley Installer (T80L-19703-J), tap pulley assembly on compressor.
3. Install snap ring with beveled side away from compressor. Using Clutch Plate Installer (T80L-19703-F), install clutch plate and shims. Install and tighten compressor shaft nut to 10-14 ft. lbs. (14-19 N.m).

CAUTION: DO NOT drive clutch plate on compressor. Use clutch plate installer to prevent damaging compressor. DO NOT tighten compressor shaft nut with air tools.

4. Using feeler gauge, measure air gap between clutch plate and pulley surface in 3 locations around pulley. Rotate pulley 180 degrees and recheck clearance. Proper clearance is .021-.036" (.05-.91 mm). Adjust shim thickness to obtain correct clearance.

FORD FS-6 6-CYL SHAFT SEAL

Removal

1. Discharge system using approved refrigerant recovery/recycling equipment and remove compressor. Drain oil from compressor and record amount for reassembly.
2. Remove clutch assembly. See FORD FS-6 6-CYL CLUTCH ASSEMBLY R & I in this article. Ensure compressor outer surface is clean. Attach compressor on Clamp & Holding Fixture (T81P-19623-D). Place fixture in vise.
3. Using Key Remover (T81P-19623-NH), remove key from compressor shaft. Remove front head-to-compressor retaining bolts. Remove front head. Front valve plate assembly, inlet reed valve and shaft seal assembly come off with front head. See [Fig. 1](#).
4. Remove dowel pins from front head. Lift inlet reed valve assembly from front head. Using Valve Plate Remover (T81P-19623-B), remove front valve plate assembly from front head. Remove shaft seal assembly and felt seal from front head.
5. Place front head on cardboard. Using hammer and Shaft Seal Seat Remover (T81P-19623-OH), drive shaft seal seat from front head. Clean components with solvent.

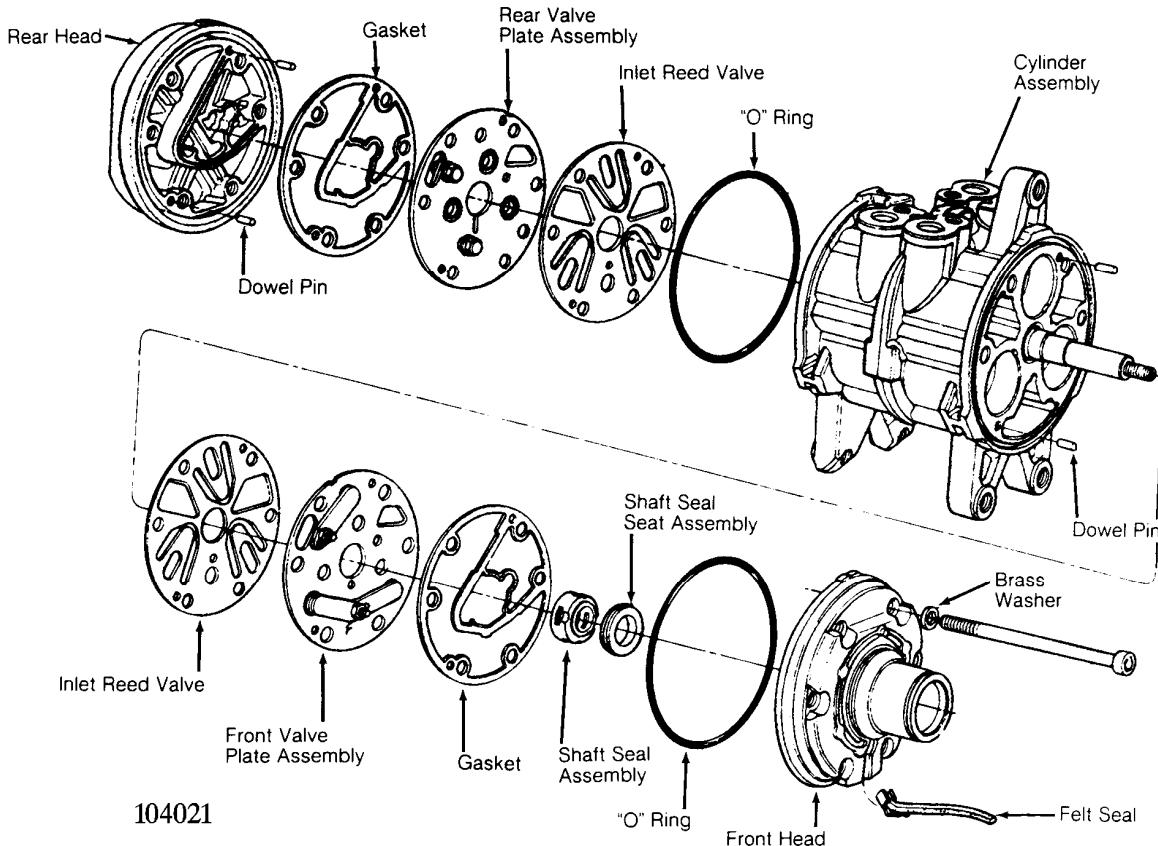


Fig. 1: Exploded View of Chrysler, Ford & Nippondenso 6-Cyl Compressors
Courtesy of FORD MOTOR CO.

CAUTION: DO NOT dry front valve plate assembly or inlet reed valve with compressed air.

Installation

1. Place dowel pins in compressor. Lubricate inlet reed valve with refrigerant oil. Install inlet reed valve on compressor. Install front valve plate assembly on compressor.
- CAUTION:** DO NOT touch sealing surfaces of shaft seal or shaft seat assembly.
2. Lubricate shaft seal seat with refrigerant oil. Position Seat Installer (T81P-19623-C) on new seat so installer is placed on raised side of seat. Install shaft seal seat.
 3. Install shaft seal assembly in front head so sealing surface is toward en of compressor shaft. Ensure flat areas on shaft seal assembly engage with flat areas on compressor shaft.
 4. Lubricate front head "O" ring with refrigerant oil. Install front head and "O" ring. Tighten retaining bolts in a crisscross pattern to 19 ft. lbs. (26 N.m). DO NOT use air tools to tighten retaining bolts.
 5. Install clutch assembly. Add same amount new refrigerant oil to compressor as was drained. Install compressor. Evacuate and recharge system. Perform leak test.

FORD FX-15 10-CYL CLUTCH ASSEMBLY

Removal

1. Discharge system using approved refrigerant recovery/recycling equipment. Remove compressor. Using Spanner (T70P-4067-A), remove clutch plate retaining bolt and discard. Using an 8-mm bolt threaded into clutch plate, remove clutch plate and shims. See Fig. 2 .
2. Remove snap ring and remove pulley assembly. Disconnect electrical wiring to clutch coil. Install Shaft Protector (T89P-19623-FH) on nose opening of compressor.
3. Install 2-jaw puller on compressor. Ensure puller screw is engaged in center of shaft protector. Tighten puller to remove clutch coil from compressor. DO NOT use air tools when removing clutch coil.

Installation

1. Ensure clutch coil mounting surface is clean. Install clutch coil. Ensure electrical connection is correctly positioned. Install Coil Installer (T89P-19623-EH) over compressor nose and inner diameter of clutch coil.
2. Install 2-jaw puller on compressor and coil installer. Jaws on puller should engage with compressor front mounts and pressure screw centered on coil installer.
3. Tighten pressure screw and install clutch coil. DO NOT use air tools when installing clutch coil.
4. Install pulley and snap ring. Install snap ring with beveled side away from compressor. Install shims and clutch plate. Install NEW clutch plate retaining bolt and tighten to 96-120 INCH lbs. (11-14 N.m).
5. Using a feeler gauge, check clearance between clutch plate and pulley assembly mating surfaces in 3 places. Clearance should be .018-.033" (.46-.84 mm). If clearance is not correct, add or remove shims.
6. Install compressor. Evacuate and recharge system. Perform leak test.

NOTE: When new clutch assembly is installed, cycle clutch assembly 10 times with engine at idle to burnish clutch and prevent slippage.

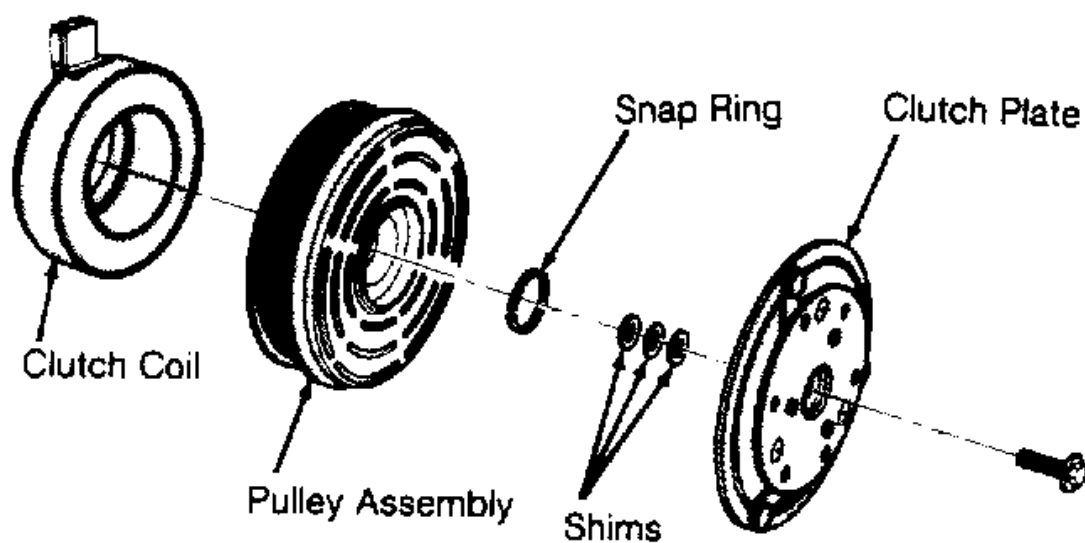


Fig. 2: View of Ford FX-15 10-Cyl Compressor Clutch Assembly
Courtesy of FORD MOTOR CO.

FORD FX-15 10-CYL SHAFT SEAL

Removal

1. Discharge system using approved refrigerant recovery/recycling equipment and remove compressor. Using Spanner (T70P-4067-A), remove clutch plate retaining bolt and discard. Using an 8-mm bolt threaded into clutch plate, remove clutch plate and shims. See [Fig. 2](#).
2. Remove shaft felt seal. Thoroughly clean seal area of compressor. Using snap ring pliers, remove shaft seal retaining snap ring.
3. Position Shaft Seal Remover (T89P-19623-BH) over compressor shaft. Push shaft seal remover downward against seal. Ensure end of shaft seal remover is engaged with inside of seal.
4. Rotate shaft seal remover handle clockwise to expand remover tip inside seal. Pull shaft seal from compressor.

Installation

1. Shaft seal protector is included with replacement seal kit. Lubricate shaft seal protector and shaft seal with refrigerant oil.
2. Install shaft seal on shaft seal protector so lip of seal is toward compressor (large end of shaft seal protector). Install shaft seal protector on compressor shaft.
3. Using Shaft Seal Installer (T89P-19623-AH), push shaft seal down shaft seal protector until seated. Remove shaft seal installer and protector. Install NEW shaft seal retaining snap ring.
4. Install NEW shaft seal felt. Install clutch plate. Install new clutch plate retaining bolt and tighten to 96-120 INCH lbs. (11-14 N.m).
5. Using feeler gauge, check clearance between clutch plate and pulley assembly mating surfaces in 3 places. Clearance should be .018-.033" (.46-.84 mm). If clearance is not correct, add or remove shims.
6. Install compressor. Evacuate and recharge system. Perform leak test.

NIPPONDENSO 6E-171 & 6P-148 CLUTCH ASSEMBLY

NOTE: Remove compressor when clearance is not adequate for clutch assembly removal.

Removal

1. Using Spanner (T81P-19623-MH), hold clutch plate and remove crankshaft nut. Using Clutch Plate Remover (T80L-19703-B), pull clutch plate from compressor. Remove clutch plate shims.
2. Remove snap ring and clutch pulley assembly. If pulley assembly cannot be removed by hand, use Shaft Protector (T80L-19703-G) and 3-jaw puller to remove pulley. Remove snap ring. Disconnect electrical wiring and remove clutch coil.

Installation

1. Install clutch coil over locating pin and install snap ring. Connect electrical wiring.
2. Using Pulley Installer (T80L-19703-J) and hammer (if necessary), install pulley assembly. Install snap ring with beveled side away from compressor.
3. Install clutch plate shims. Ensure clutch plate aligns with crankshaft key. Using Clutch Plate Installer (T80L-19703-F), install clutch plate.
4. Install crankshaft nut. Using spanner, tighten nut to 10-14 ft. lbs. (13-20 N.m). DO NOT tighten nut with air tools. Using feeler gauge, check clearance between clutch plate and pulley.
5. Rotate compressor clutch and check clearance in more than one place. Proper clearance is .021-.035" (.53-.89 mm). If clearance is not correct, add or remove shims.

NIPPONDENSO 6E-171 & 6P-148 SHAFT SEAL

Removal

1. Discharge system using approved refrigerant recovery/recycling equipment and remove compressor. Drain oil from suction port on compressor and record amount for reassembly.
2. Remove clutch assembly. See NIPPONDENSO 6E-171 & 6P-148 CLUTCH ASSEMBLY R & I in this article. Ensure outer surface of compressor is clean. Attach compressor on Clamp & Holding Fixture (T81P-19623-LH). Place fixture in vise.
3. Using Key Remover (T81P-19623-NH), remove key from compressor shaft. Remove front head-to-compressor retaining bolts and front head. Front valve plate assembly, inlet reed valve and shaft seal assembly come off with front head. See [Fig. 1](#).
4. Remove dowel pins from front head. Lift inlet reed valve assembly from front head. Using Valve Plate Remover (T81P-19623-PH), remove front valve plate assembly from front head. Remove shaft seal assembly and felt seal from front head.
5. Place front head on cardboard. Drive shaft seal seat from front head using hammer and Shaft Seal Seat Remover (T81P-19623-OH). Clean components with solvent.

CAUTION: DO NOT dry front valve plate assembly or inlet reed valve with compressed air.

Installation

1. Place dowel pins in compressor. Lubricate inlet reed valve with refrigerant oil. Install inlet reed valve on compressor. Install front valve plate assembly on compressor.

CAUTION: DO NOT touch sealing surfaces of shaft seal assembly or shaft seat assembly.

2. Lubricate shaft seal seat with refrigerant oil. Install Seat Installer (T81P-19623-C) on new seat so installer is placed on grooved side of seat. Install shaft seal seat.
3. Install shaft seal assembly in front head so sealing surface is toward end of compressor shaft. Ensure flat areas on shaft seal assembly engage with flat areas on compressor shaft.
4. Lubricate front head "O" ring with refrigerant oil. Install front head and "O" ring. Tighten retaining bolts in a crisscross pattern to 19 ft. lbs. (26 N.m). DO NOT use air tools to tighten retaining bolts.
5. Install clutch assembly. Add same amount new refrigerant oil to compressor as was drained. Rotate compressor 10 revolutions to distribute oil. Install compressor. Evacuate and recharge system. Perform leak test.

NIPPONDENSO 10P13 CLUTCH ASSEMBLY

Removal

1. Discharge system using approved refrigerant recovery/recycling equipment and remove compressor. Using Clutch Holder (1014), hold clutch plate and remove crankshaft nut. Using Clutch Plate Remover (T80L-19703-B), pull clutch plate from compressor. Remove clutch plate shims.
2. Remove snap ring and pulley assembly. If pulley assembly cannot be removed by hand, use Shaft Protector (T80L-19703-G) and 3-jaw puller to remove pulley. Remove snap ring. Disconnect electrical wiring and remove clutch coil.

Installation

1. Install clutch coil over locating pin. Install snap ring with beveled side away from compressor.
2. Install pulley assembly using Pulley Installer (T80L-19703-J) and hammer (if necessary). Install snap ring with beveled side away from compressor.
3. Install clutch plate shims. Ensure clutch plate aligns with crankshaft key. Install clutch plate using Clutch Plate Installer (T80L-19703-F).
4. Install crankshaft nut. Using spanner, tighten nut to 10-14 ft. lbs. (13-20 N.m). DO NOT tighten nut with air tools. Using feeler gauge, check clearance between clutch plate and pulley.
5. Rotate compressor clutch and check clearance in more than one place. Proper clearance is .021-.036" (.53-.91 mm). If clearance is not correct, add or remove shims.
6. Add same amount new refrigerant oil to compressor as was drained. Rotate compressor 10 revolutions to distribute oil. Install compressor. Evacuate and recharge system. Perform leak test.

NOTE: **After installing new clutch, cycle clutch 10 times with engine at idle speed to prevent clutch slippage.**

NIPPONDENSO 10P13 SHAFT SEAL

Removal

1. Discharge system using approved refrigerant recovery/recycling equipment and remove compressor. Drain oil from compressor and record amount for reassembly. Using Clutch Holder (1014), hold clutch plate and remove crankshaft nut.
2. Pull clutch plate from compressor using Clutch Plate Remover (T80L-19703-B). Remove clutch plate shims. Clean compressor area around seal. Remove felt packing and dust seal retainer from nose of front cover. See [Fig. 3](#) .
3. Using Key Remover (T81P-19623-NH), remove key from compressor shaft. Remove seal seat retaining snap ring. Remove seal seat from compressor using Seal Seat Remover/Installer (T87P-19623-B).
4. Place Seal Remover/Installer (T87P-19623-C) on compressor. Rotate seal remover/installer clockwise until tangs engage in seal. Pull seal from compressor.

Installation

1. Lubricate shaft seal, seal seat and inside of compressor nose with refrigerant oil. Install Seal Protector (T71P-19703-H) over compressor shaft. Using seal remover/installer, install shaft seal in compressor.
2. Rotate seal on compressor shaft to align flat areas on seal with those on compressor shaft.
3. Using seal seat remover/installer, install seal seat until it contacts seal. Install snap ring. Install key in crankshaft with rounded edge inward.
4. Install clutch plate shims. Ensure clutch plate is aligned with crankshaft key. Using Clutch Plate Installer (T80L-19703-F), install clutch plate.
5. Install crankshaft nut. Using spanner, tighten nut to 10-14 ft. lbs. (13-20 N.m). DO NOT tighten nut with air tools. Using feeler gauge, check clearance between clutch plate and pulley.
6. Rotate compressor clutch and check clearance in more than one place. Proper clearance is .021-.036" (.53-.91 mm). If clearance is not correct, add or remove shims.
7. Add same amount new refrigerant oil to compressor as was drained. Rotate compressor 10 revolutions to distribute oil in compressor. Install compressor. Evacuate and recharge system. Perform leak test.

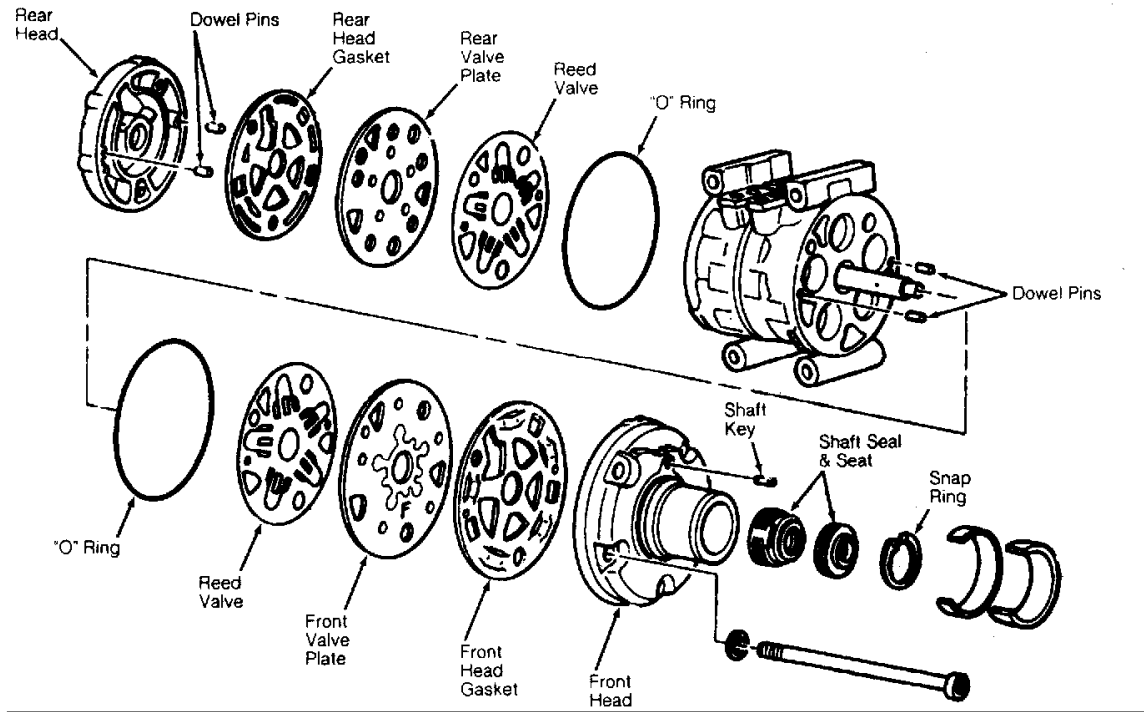


Fig. 3: View of 10P13, 10P15 & 10P15F 10-Cyl Compressor
Courtesy of FORD MOTOR CO.

NIPPONDENSO 10P15, 10P15F CLUTCH ASSEMBLY

NOTE: Remove compressor when clearance is not adequate for clutch assembly removal.

Removal

1. Using Spanner (T81P-19623-MH), hold clutch plate and remove crankshaft nut. Using Clutch Plate Remover (T80L-19703-B), pull clutch plate from compressor. Remove clutch plate shims.
2. Remove snap ring and clutch pulley assembly. If pulley assembly cannot be removed by hand, use Shaft Protector (T80L-19703-G) and 3-jaw puller. Remove snap ring. Disconnect electrical wiring and remove clutch coil.

Installation

1. Install clutch coil over locating pin and install snap ring. Connect electrical wiring.
2. Install pulley assembly, using Pulley Installer (T80L-19703-J) and hammer (if necessary). Install snap ring with beveled side outward. Install clutch plate shims.
3. Ensure clutch plate aligns with crankshaft key. Using Clutch Plate Installer (T80L-19703-F), install clutch plate. Install crankshaft nut. Using spanner, tighten nut to 10-14 ft. lbs. (13-20 N.m). DO NOT tighten nut with air tools.
4. Using feeler gauge, check clearance between clutch plate and pulley. Rotate compressor clutch and check clearance in more than one place. Proper clearance is .021-.036" (.53-.91 mm). If clearance is not correct, add or remove shims.

NIPPONDENSO 10P15A CLUTCH ASSEMBLY

Removal

1. Hold pulley assembly with Strap Wrench (D85L-6000-A). Apply battery voltage to clutch coil assembly and remove crankshaft nut. Screw Clutch Plate Remover (T88C-19703-BH) into clutch plate and remove clutch plate from compressor. Remove clutch plate shims.
2. Remove snap ring and clutch pulley assembly. If pulley cannot easily be removed, use plastic hammer and tap pulley from shaft. Remove snap ring. Disconnect electrical wiring and remove clutch coil.

Installation

1. Install clutch coil over locating pin and install snap ring. Connect electrical wiring. Install pulley.
2. Ensure pulley bearing is aligned with compressor head. Gently tap pulley on shaft with plastic hammer (if necessary). Install pulley retaining snap ring.
3. Install shims and clutch plate. Install crankshaft nut and tighten to 10-12 ft. lbs. (14-16 N.m). DO NOT tighten nut with air tools. Using feeler gauge, measure clearance between clutch plate and pulley in several different areas. Proper clearance is .016-.028" (.41-.71 mm). If clearance is not correct, add or remove shims.

NIPPONDENSO 10P15, 10P15F SHAFT SEAL

Removal

1. Discharge system using approved refrigerant recovery/recycling equipment and remove compressor. Drain oil from compressor and record amount for reassembly.
2. Mount compressor in vise clamping on mounting ears. Using Spanner (T81P-19623-MH), hold clutch plate and remove crankshaft nut. Pull clutch plate from compressor using Clutch Plate Remover (T80L-19703-B). Remove clutch plate shims.
3. Clean compressor front hub area. Remove felt packing and dust seal retainer from inside compressor nose. See Fig. 3 . Using Shaft Key Remover (T81P-19623-NH), remove key from shaft.
4. Remove seal seat retaining snap ring. Clean inner bore of compressor nose. Using Shaft Seal Remover/Installer (T87P-19623-B), remove seal seat.

- Using Shaft Seal Remover/Installer (T87P-19623-C), remove seal by pushing downward on shaft seal remover/installer and rotating clockwise to engage seal tangs. Pull seal from compressor.

Installation

- Place Shaft Seal Protector (T71P-19703-H) over compressor shaft. Lubricate shaft seal and nose of compressor with new refrigerant oil. DO NOT touch sealing surface of seal or shaft. Engage seal tangs on shaft seal remover/installer.
- Align flats of seal with flats on crankshaft and push new seal on compressor shaft. Push downward on shaft seal remover/installer and turn counterclockwise to disengage seal tangs.
- Attach shaft seal seat to shaft seal seat remover/installer and lubricate with new refrigerant oil. Install seal seat and push inward against seal. Install seal seat retaining snap ring.
- Install dust seal retainer and felt packing. Install clutch plate shims. Ensure clutch plate aligns with crankshaft key. Using Clutch Plate Installer (T80L-19703-F), install clutch plate.
- Install crankshaft nut. Using spanner to hold clutch, tighten crankshaft nut to 10-14 ft. lbs. (13-20 N.m). DO NOT tighten nut with air tools.
- Using feeler gauge, check clearance between clutch plate and pulley. Rotate compressor clutch and check clearance in more than one place. Proper clearance is .021-.036" (.53-.91 mm). If clearance is not correct, add or remove shims.
- Add same amount new refrigerant oil to compressor as was drained. Rotate compressor 10 revolutions to distribute oil. Install compressor. Evacuate and recharge system. Perform leak test.

NIPPONDENSO 10P15A SHAFT SEAL

Removal

- Discharge system using approved refrigerant recovery/recycling equipment and remove compressor. Drain oil from compressor and record amount for reassembly. Remove clutch assembly. See NIPPONDENSO 10P15A CLUTCH ASSEMBLY R & I in this article.
- Remove manifold assembly from top of compressor. Clean compressor front hub area. Using Ring Remover (T71P-19703-C), remove retaining ring from front of compressor shaft.
- Remove felt seal from front of compressor. Remove front head retaining bolts and front head from compressor. Remove snap ring from rear of front head. Remove seal from rear of front head.

Installation

- Install seal and snap ring in front head. Install front head on compressor. Tighten bolts to 18-20 ft. lbs. (24-27 N.m). Install felt packing and retaining ring.
- Install manifold assembly and tighten bolts to 18-20 ft. lbs. (24-27 N.m). Add same amount of new refrigerant oil to compressor as that drained from compressor. Rotate compressor 10 revolutions to distribute oil in compressor. Install compressor. Evacuate and recharge system. Perform leak test.

NIPPONDENSO 10PA17 & 10PA17A CLUTCH ASSEMBLY

Removal

- Remove compressor shaft bolt and discard. Remove clutch plate and shims. If clutch hub cannot be removed by hand, thread a 8-mm bolt in center of clutch plate. Tighten bolt and remove clutch plate.
- Remove pulley assembly retaining snap ring. Remove pulley assembly. Remove snap ring and disconnect clutch coil electrical wiring. Remove clutch coil.

Installation

- Install clutch coil so pin in back of coil aligns with hole in front housing. Install snap ring with beveled side away from compressor.
- Install pulley assembly. Install snap ring with beveled side away from compressor. Coat splines of compressor shaft with White grease. If reusing original clutch plate and pulley, old shims can be used.
- If installing new components, install one thin shim. Install clutch plate. Tighten compressor shaft bolt to 10 ft. lbs. (14 N.m). DO NOT air tools to tighten bolt.
- Using feeler gauge, measure air gap between clutch plate and pulley surface in 3 areas. Proper clearance is .014-.026" (.35-.66 mm). Adjust shim thickness to obtain correct clearance.
- Once compressor shaft bolt is tightened, recheck clearance between clutch plate and pulley surface in 4 places. Readjust clearance if necessary.

NOTE:

After installing new clutch, ensure voltage is correct and cycle clutch with 5 seconds on and 5 seconds off. Repeat cycle for approximately 20 times with A/C on, blower fan on high speed and engine RPM at 1500-2000. This provides better clutch torque capability.

NIPPONDENSO 10PA17 & 10PA17A SHAFT SEAL

Removal

- Discharge system using approved refrigerant recovery/recycling equipment and remove compressor. Drain oil from compressor and record amount for reassembly. Install compressor in Holding Fixture (T89P-19623-D) and clamp fixture in a vise.
- Remove clutch assembly. See NIPPONDENSO 10PA17 & 10PA17A CLUTCH ASSEMBLY R & I in this article. Remove front head retaining bolts. Separate front head from compressor, using care not to scratch sealing surface. See [Fig. 4](#) .
- Using "O" Ring Remover (T71P-19703-C), remove felt dust seal and dust seal retainer from front head. Remove shaft seal retaining snap ring. Position front head (nose up) on cardboard placed on a flat surface. Using Shaft Seal Remover (T89P-19623-E), push shaft seal from front head.

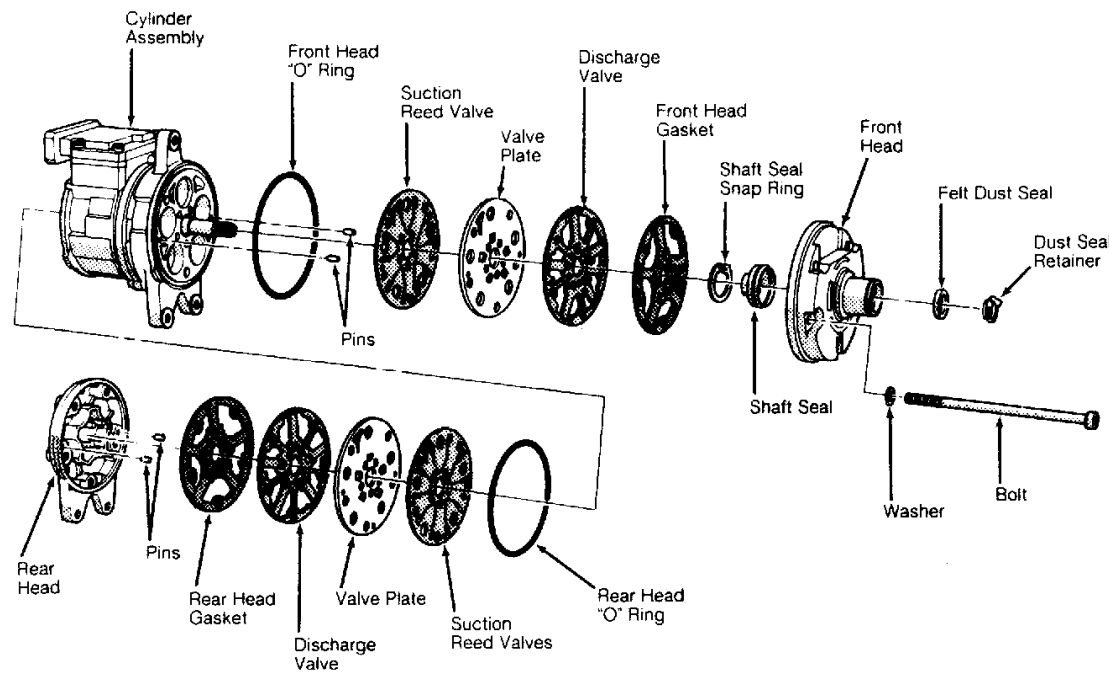


Fig. 4: Exploded View of Nippondenso 10PA17 & 10PA17A 10-Cyl Compressor
Courtesy of FORD MOTOR CO.

Installation

1. Lubricate new shaft seal with refrigerant oil. DO NOT touch sealing surfaces. Using Shaft Seal Installer (T89P-19623-F), press seal into front head and install snap ring. Install felt dust seal and dust seal retainer.
2. Lubricate Shaft Seal Protector (T89D-19623-C) and front head "O" ring with refrigerant oil. Install shaft seal protector on crankshaft. Install a new front head "O" ring on cylinder assembly.
3. Install front head on cylinder assembly. Ensure dowel pins are aligned. Use care when guiding shaft seal protector through seal opening. Remove shaft seal protector.
4. Install through bolts with NEW brass washers. Diagonally tighten bolts to 19 ft. lbs. (26 N.m). Install clutch assembly. Add amount of refrigerant oil that was drained to compressor. Install compressor. Evacuate and recharge system. Perform leak test.

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A/C COMPRESSOR SERVICING

1991 GENERAL SERVICING Compressor Service

ISOLATING COMPRESSOR

CAUTION: **When discharging air conditioning system, use only approved refrigerant recovery/recycling equipment. Make every attempt to avoid discharging refrigerant into the atmosphere.**

NOTE: **Only compressors with stem-type service valves can be isolated.**

1. Connect service gauge set to the compressor service valves and open compressor valves slightly (turn in clockwise). Start engine and operate air conditioning. Slowly turn compressor suction valve clockwise toward closed (front-seated) position.
2. When suction pressure is reduced to zero or less, turn off engine and compressor and quickly turn suction valve stem in to full front-seated position. Suction pressure should be slightly above zero. Turn discharge valve into front-seated position.
3. To check oil level, slowly open compressor crankcase plug to relieve any remaining pressure. After oil level is corrected, cap service gauge ports on both valves. Back-seat suction service valve to allow refrigerant to enter compressor. Open discharge valve halfway.
4. Loosen discharge service valve cap, allowing refrigerant pressure to force air out of compressor. Back-seat service valve and tighten cap. Compressor is now ready for operation.

REFRIGERANT OIL

Only new, pure, moisture-free refrigerant oil should be used in the air conditioning system. This oil is highly refined and dehydrated to a point where moisture content is less than 10 parts per million. The oil container must be tightly closed at all times when not in use, or moisture will be absorbed into the refrigerant oil from the air.

DISCHARGING SYSTEM PRECAUTIONS

CAUTION: **When discharging air conditioning system, use only approved refrigerant recovery/recycling equipment. Make every attempt to avoid discharging refrigerant into the atmosphere.**

If compressor has stem-type service valves, it can be isolated and removed without discharging entire system. Otherwise, discharge system completely using approved refrigerant recovery/recycling equipment before loosening any fittings.

DISCONNECTING LINES & FITTINGS TEST

After system is discharged, carefully clean area around all fittings to be opened. Always use 2 wrenches when tightening or loosening fittings to avoid twisting or distorting lines. Cap or plug all openings as soon as lines are removed. Do not remove caps until immediately before connections are made. This will keep entry of air and moisture to a minimum.

CONNECTING LINES AND FITTINGS

A new gasket or "O" ring should be used in all instances when connecting lines or fittings. Dip "O" ring in new refrigerant oil and ensure it is not twisted during installation. Always use 2 wrenches to prevent damage to lines and fittings.

PLACING SYSTEM IN OPERATION

After component service or replacement has been completed and all connections have been made, evacuate system thoroughly with a vacuum pump. Charge system with proper amount of refrigerant and perform a leak test. See REFRIGERANT OIL & R-12 SPECIFICATIONS chart in this section for system capacities. Be sure to check all fittings that have been opened. After system has been leak tested, make a system performance check.

NOTE: **Air conditioning systems will not normally need addition of refrigerant oil unless definite oil loss has occurred due to ruptured lines, leaking compressor seals, compressor overhaul or component replacement.**

ATSUGI ROTARY VANE CLUTCH R & I

Removal

When replacing compressor clutch, be careful not to scratch shaft or bend pulley. When removing center bolt, hold clutch disc with Clutch Holder (KV99231010). Using Hub Puller (KV998VR001 & KV99231010), remove clutch disc. When removing pulley, remove lock nut with Hub Socket (KV99235160).

Installation

Wipe oil off clutch surface. Adjust disc pulley clearance to .012-.024" (.3-.6 mm). Tighten center bolt to 80-104 INCH lbs. (9.1-11.8 N.m). Tighten clutch lock nut to 22-29 ft. lbs. (29-39 N.m). See [Fig. 1](#) .

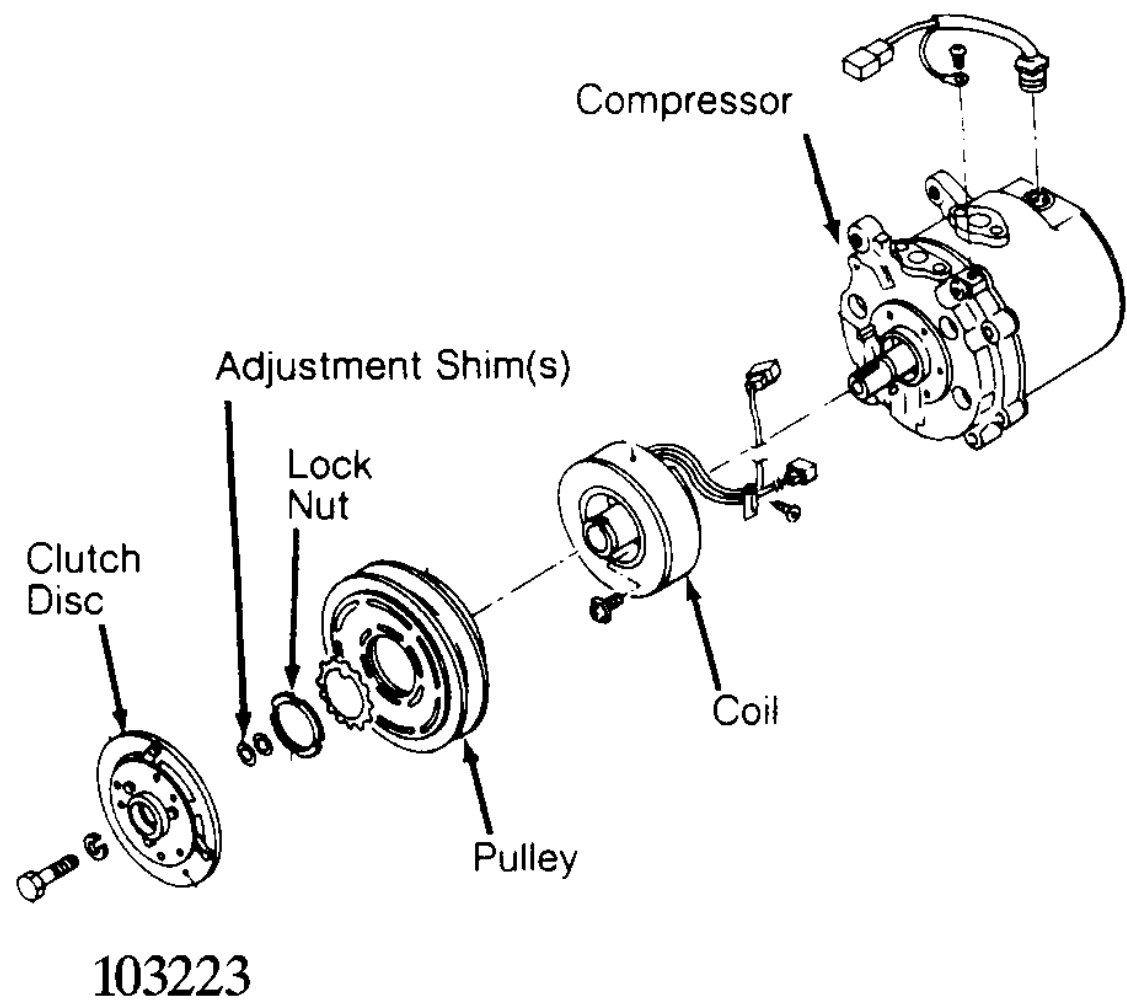


Fig. 1: Atsugi Rotary Vane Compressor
Courtesy of NISSAN MOTOR CO., U.S.A.

BOSCH 6-CYL CLUTCH R & I

Removal

1. Hold clutch plate and remove shaft nut. Using Clutch Plate Remover (64 5 00), remove clutch plate. Using snap ring pliers, remove circlip and remove pulley assembly.
2. If pulley bearing is being replaced, remove circlip at rear of pulley. Press bearing and spacer from pulley. Press in new bearing with spacer and replace circlip.

Installation

1. Clean all surfaces. Install pulley assembly on compressor and install circlip. Ensure clutch plate shim is in place on shaft. Install clutch plate and nut. Tighten nut to 13-14 ft. lbs. (18-20 N.m).
2. Using a feeler gauge, check clutch plate-to-pulley clearance. Clearance should be .028-.051" (.7-1.3 mm). If clearance is not correct, remove clutch plate and replace clutch plate shim. See [Fig. 2](#) .

BOSCH 6-CYL SHAFT SEAL R & I

Removal & Installation

1. Remove clutch plate. Remove shaft key and circlip. Using Seal Seat Remover/Installer (64 5 030), remove seal seat.
2. Using Seal Remover/Installer (64 5 040), remove shaft seal by turning seal slightly clockwise to disengage tangs and pull out shaft seal. Remove "O" ring seal.
3. Coat new "O" ring seal with refrigerant oil and install. Coat new shaft seal with refrigerant oil and install shaft seal on Seal Remover/Installer (64 5 040). Ensure alignment of shaft seal and shaft machine surfaces. Insert shaft seal and turn slightly counterclockwise to secure on shaft.
4. Using sleeve from Seal Seat Remover/Installer (64 5 030), push seal seat into compressor and install circlip. Install shaft key and clutch plate. Check compressor oil level before charging system.

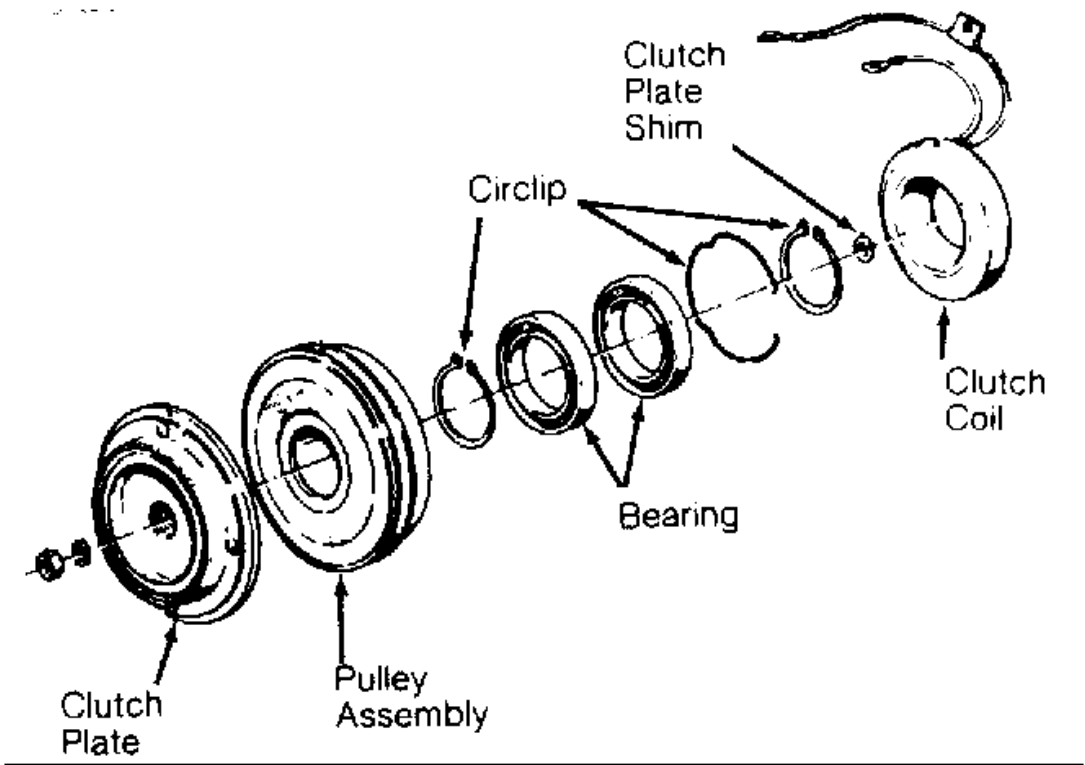


Fig. 2: Bosch 6-Cylinder Compressor Clutch
Courtesy of BMW OF NORTH AMERICA, INC.

CALSONIC V5 CLUTCH R & I

Removal

1. Remove shaft nut while holding armature plate with clutch disk wrench. Install clutch disk puller and remove clutch plate. Remove snap ring from center of clutch pulley.
2. Use a universal gear puller to remove clutch pulley. See [Fig. 3](#) .Remove screw securing clutch coil ground lead. Use puller to remove clutch coil.

Installation

1. To install clutch coil, reverse removal procedure. Carefully press clutch coil into place. Ensure that coil lead and connector are positioned on same side as removed coil.
2. Install a NEW clutch pulley snap ring, being careful not to damage shaft seal. Press clutch plate into place. Install shaft nut and torque to 0.9-1.4 INCH lbs. (0.10-.12 N.m).
3. Use a feeler gauge to check clutch plate-to-pulley clearance. Clearance should be .012-.024" (0.3-0.6 mm). If clearance is too large, remove shaft nut and again press in clutch plate. If clearance is too small, increase gap by pulling up clutch plate. Do not remove shaft nut.

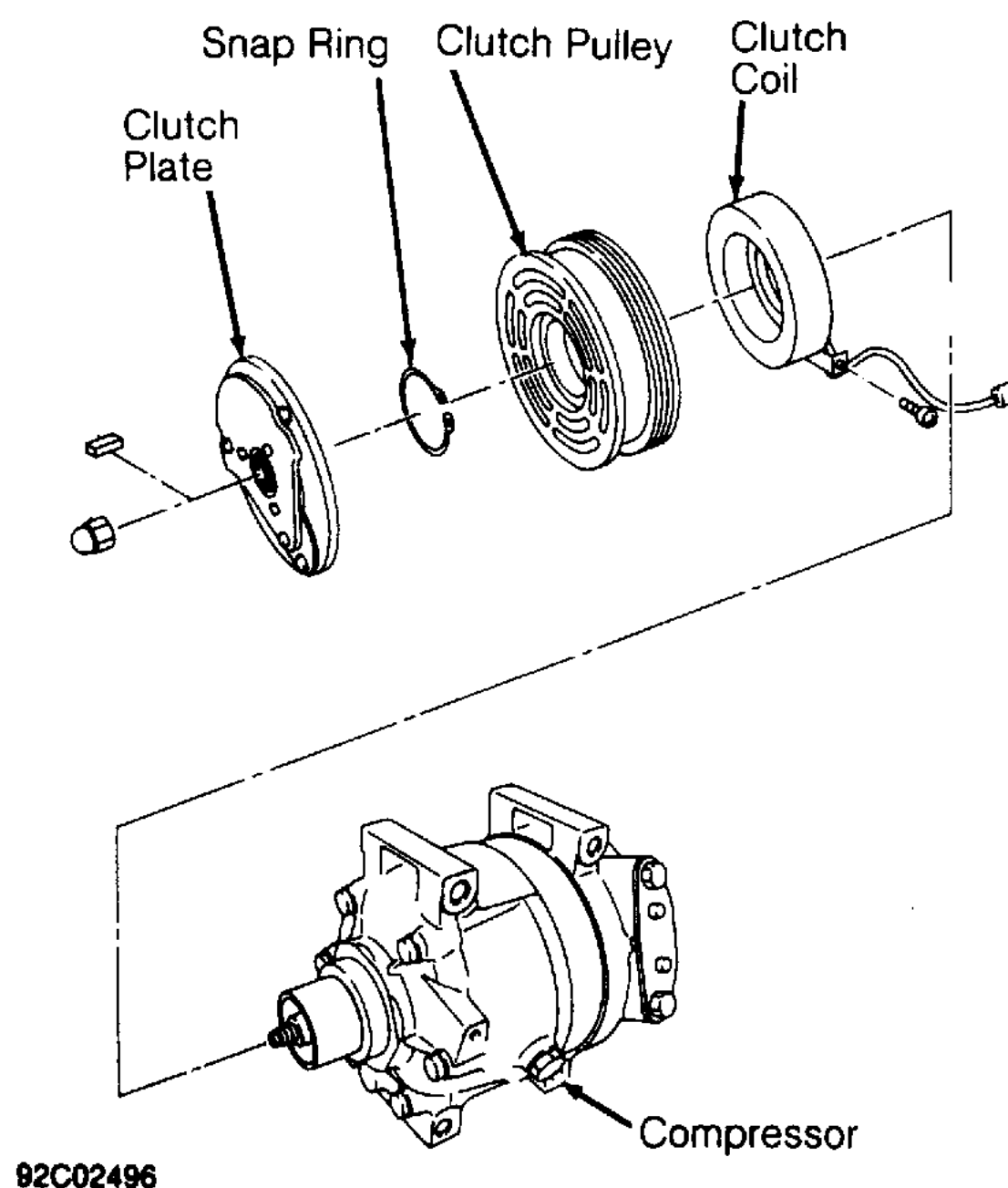


Fig. 3: Explode View of Compressor Clutch (Calsonic V5)

Courtesy of NISSAN MOTOR CO. U.S.A.

DIESEL KIKI ROTARY VANE CLUTCH R & I

Removal

1. Using Clutch Holder (KV99231010), hold clutch disc. Remove center bolt retaining clutch assembly to shaft. Thread Hub Remover (KV99232232) into bore of clutch hub. Hold hub remover with wrench and thread center bolt inward until clutch disc is removed.
2. Remove clutch disc, collar and adjusting shims. Remove snap ring and plate. Remove pulley and bearing assembly. If assembly cannot be removed by hand, use a puller and adapter.
3. Be careful not to scratch shaft or bend pulley. Using an impact driver, loosen 6 coil mounting screws. Remove key and clutch coil. See [Fig. 4](#).

Installation

1. Install key. Position coil assembly on compressor body. Be sure that electrical terminals are installed in original position. Install and tighten coil mounting screws to 35-52 INCH lbs. (4-6 N.m).
2. Press pulley assembly onto neck of coil assembly using Pulley Installer (KV99234160). Wipe oil thoroughly off clutch surface. Select adjusting shims which give correct clearance between pulley and clutch disc.
3. Using a plastic mallet, tap clutch disc in place on drive shaft. Do not use excessive force with plastic mallet or press. Place spring washer and center bolt onto drive shaft. Tighten center bolt to drive clutch wheel onto drive shaft. Tighten center bolt to 11-13 ft. lbs. (15-18 N.m).
4. Hold clutch with Clutch Holder (KV99231010). Check clearance around entire outer edge of clutch disc. Clearance should be .012-.024" (.3-.6 mm). If specified clearance is not obtained, replace adjusting shims as required.
5. When replacing compressor clutch assembly, break-in procedure must be performed. This is accomplished by engaging and disengaging clutch 30 times.

DIESEL KIKI 6-CYL CLUTCH COIL R & I

Removal & Installation

Using clutch holder to prevent clutch disc rotation, remove bolt. Using clutch holder and puller, remove clutch disc. Remove shims from compressor drive shaft or clutch disc. Remove snap ring with external snap ring pliers and then remove pulley. Using a gear puller, remove pulley. Remove coil lead wire and 6 screws. Remove coil. To install, reverse removal procedure. Adjust clutch disc-to-pulley clearance to .010-.020" (.3-.6 mm). See [Fig. 4](#).

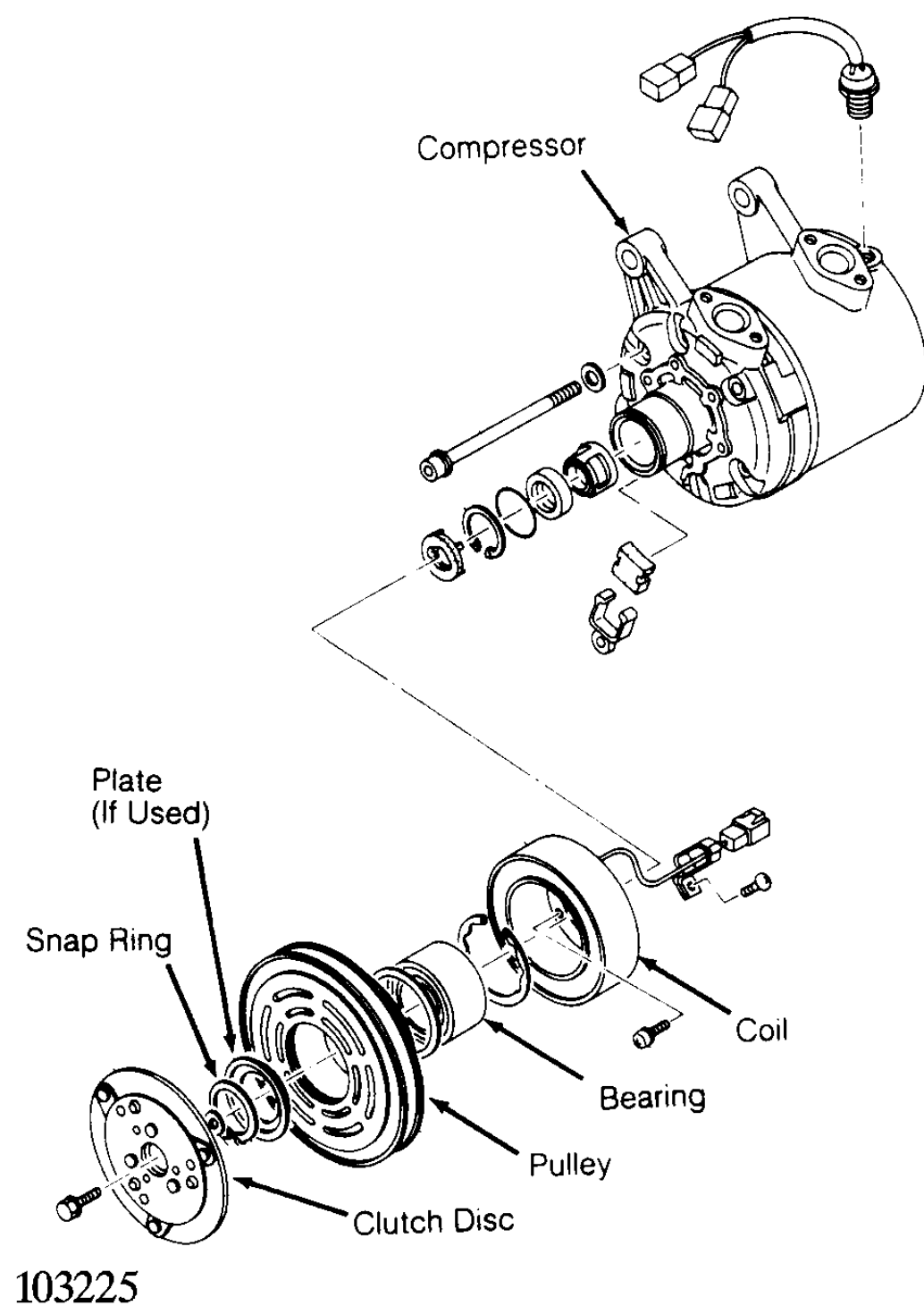


Fig. 4: Diesel Kiki Rotary Vane Compressor
Courtesy of NISSAN MOTOR CO., U.S.A.

DIESEL KIKI 6-CYL SHAFT SEAL R & I

Removal & Installation

1. Remove clutch coil assembly. Remove retainer and felt. Discard retainer and felt. Using internal snap ring pliers, remove seal seat snap ring. Remove seal seat and discard. Using a seal pick, remove "O" ring from inside groove of shaft seal housing. Discard "O" ring.
2. To remove shaft seal, push down and turn clockwise on seal remover to engage tangs. Slowly draw seal from bore. Discard seal. Check shaft and inside of compressor neck for dirt or foreign material and ensure these areas are perfectly clean before installing new seal.
3. To install, reverse removal procedure. Coat "O" ring, shaft seal, and seal seat with new refrigerant oil.

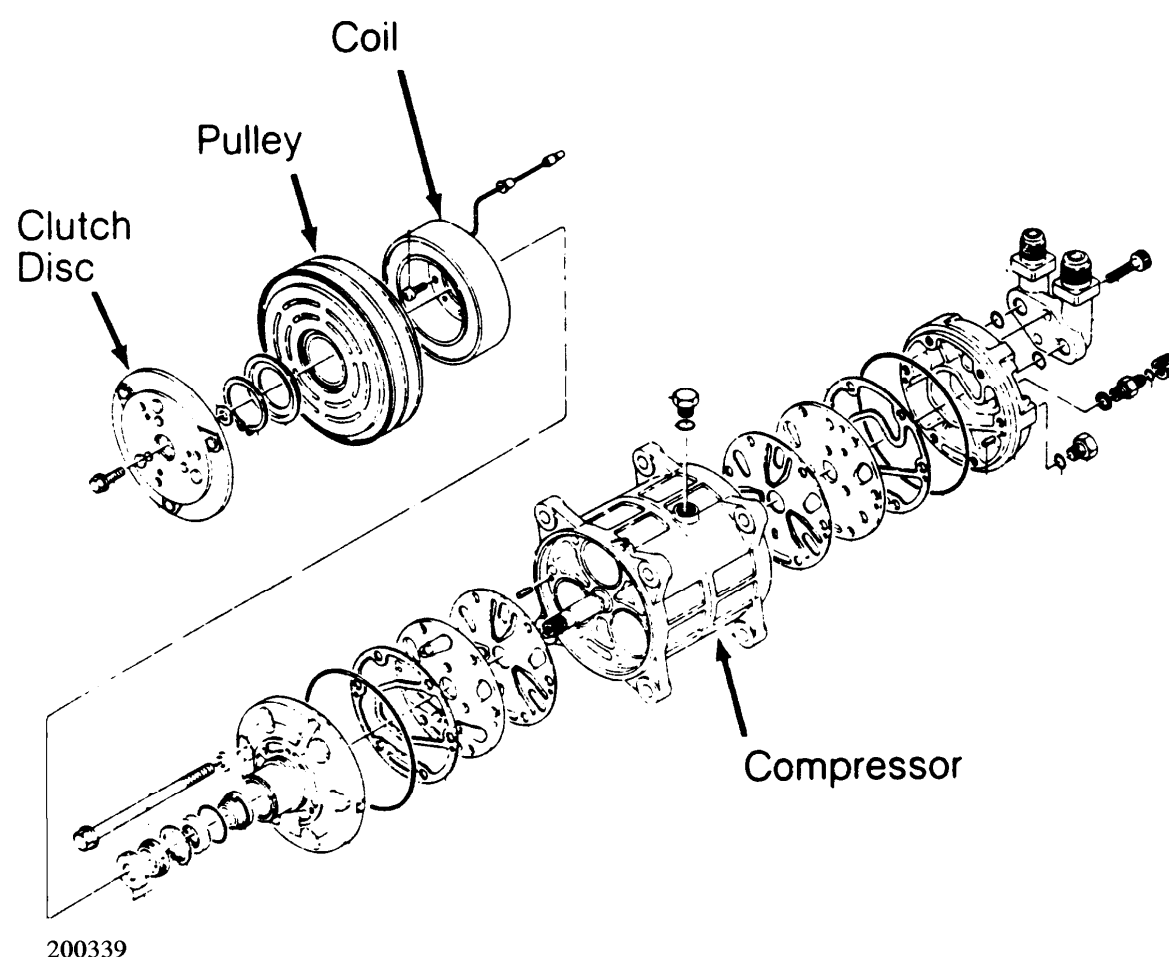


Fig. 5: Diesel Kiki 6-Cylinder Compressor

Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

FORD FX-15 CLUTCH R & I

Removal

1. Using Clutch Holder (00 41 0812 05), remove clutch plate retaining bolt and discard. Using an 8 mm bolt threaded into clutch plate, remove clutch plate and shim(s). See [Fig. 6](#).
2. Remove snap ring and pulley assembly. Install Shaft Protector (49 UN01 47) over shaft seal opening. Use a 2-jaw puller to remove clutch coil from compressor.

Installation

1. Ensure clutch coil mounting surface is clean. Use Coil Installer (49 UN01 046) and 2-jaw puller engaged to rear side of compressor front mounts to press coil into place.
2. Install pulley assembly. Install pulley assembly snap ring with bevel side of snap ring facing out. Install shim(s) and clutch plate. Install a NEW clutch plate retaining bolt and tighten to 96-120 INCH lbs. (11-14 N.m).
3. Use a feeler gauge to check clearance between clutch plate and pulley assembly. Clearance should be .018-.033" (.46-.84 mm). If clearance is incorrect, add or remove shims as necessary.

FORD FX-15 SHAFT SEAL R & I

Removal

1. Using Clutch Holder (000 41 0812 05), remove clutch plate retaining bolt and discard. Using an 8 mm bolt threaded into clutch plate, remove clutch plate and shim(s). See [Fig. 6](#).
2. Remove shaft felt seal. Thoroughly clean seal area of compressor. Remove shaft seal retaining snap ring. Position Shaft Seal Remover (49 UN01 044) over compressor shaft.
3. Push shaft seal remover downward against seal. Ensure end of shaft seal remover is engaged with inside of seal. Rotate shaft seal remover clockwise to expand remover tip inside seal. Pull shaft seal from compressor.

Installation

1. Lubricate shaft seal protector and shaft seal with refrigerant oil. Install shaft seal on shaft seal protector so lip seal is toward compressor (large end of shaft seal protector).
2. Install shaft seal protector on compressor shaft. Using shaft seal installer (49 UN01 043), push shaft seal down seal protector until seal is seated.
3. Remove shaft seal installer and protector. Install a NEW shaft seal retaining snap ring and shaft seal felt. Install shim(s) and clutch plate. Install a NEW clutch plate retaining bolt and tighten to 91-120 INCH lbs. (11-14 N.m).
4. Use a feeler gauge to check clearance between clutch plate and pulley assembly. Clearance should be .018-.033" (.46-.84 mm). If clearance is incorrect, add or remove shims as necessary.

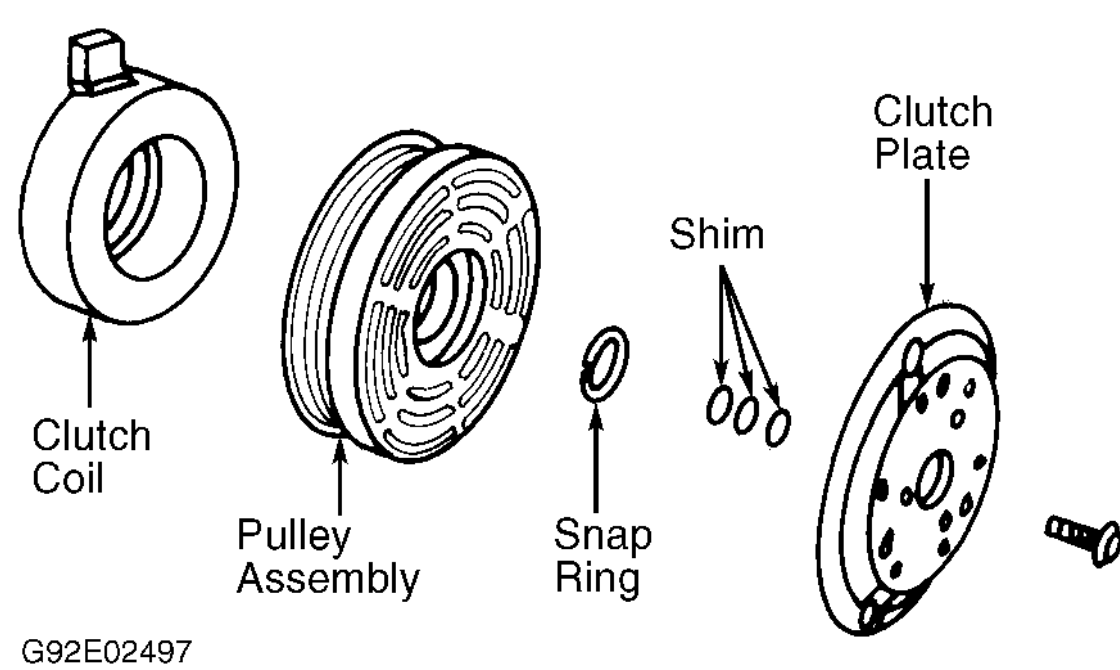


Fig. 6: Exploded View of Compressor Clutch (Ford FX-15)
Courtesy of MAZDA MOTORS CORP.

HARRISON R4 4-CYL CLUTCH R & I

Removal

1. Clamp Holding Fixture (J-25008-A) in a vise and attach compressor to holding fixture with thumb screws. Use Clutch Hub Holder (J-33027) to hold clutch. Remove shaft nut using Shaft Nut Socket (J-9399).
2. Thread Clutch Plate and Hub Assembly Remover (J-33013-B) into hub. Hold body of remover with a wrench and turn center screw into remover body to remove clutch plate and hub assembly. Remove shaft key and retain for assembly. See [Fig. 5](#) .

NOTE: **DO NOT drive or pound on clutch hub or shaft.**

Installation

1. Install shaft key into hub key groove. Allow key to project approximately 1/8" out of key way. Shaft key is curved slightly to provide an interference fit in hub key groove.
2. Ensure frictional surface of clutch plate and clutch rotor are clean before installing clutch plate and hub assembly. Align shaft key with shaft key way and place clutch plate and hub assembly onto compressor shaft.
3. Hold hex portion of Installer (J-9480-B) with a wrench. Tighten center screw to press hub into shaft until there is .020-.040" (.5-1.0 mm) air gap between frictional plate and clutch rotor.
4. Install new shaft nut with small diameter boss of nut against crankshaft shoulder. Use Thin Wall Socket (J-9399) and Clutch Hub Holder (J-25030). Tighten shaft nut to 10 ft. lbs. (14 N.m). Spin pulley rotor by hand to ensure rotor is not rubbing on clutch drive plate.

HARRISON R4 4-CYL SHAFT SEAL R & I

Removal

1. Clamp Holding Fixture (J-25008-A) in a vise and attach compressor to holding fixture with thumb screws. Use Clutch Hub Holder (J-33027) to hold clutch. Remove shaft nut using Shaft Nut Socket (J-9399).
2. Thread Clutch Plate and Hub Assembly Remover (J-33013-B) into hub. Hold body of remover with a wrench and turn center screw into remover body to remove clutch plate and hub assembly. Remove clutch plate and shaft key. Pry out dust seal (if equipped). Remove seal seat snap ring. Thoroughly clean compressor neck area and "O" ring groove surrounding shaft. Any dirt or foreign material may cause compressor damage.
3. Use Seal Remover/Installer (J23128-A), remove seal with a twisting motion. Use "O" Ring Remover (J-9553-01) to remove "O" ring.

Installation

1. Coat new shaft seal with refrigerant oil and install shaft seal on remover/installer. Align compressor shaft machined surface with shaft seal and install. Turn remover/installer slightly counterclockwise to secure shaft seal tangs.
2. Using Seal Installer (J-33011), install "O" ring and coat with refrigerant oil. Coat seal seat with refrigerant oil and install using seal seat remover/installer. Install snap ring. Install dust seal (if supplied in seal kit). See [Fig. 7](#) .

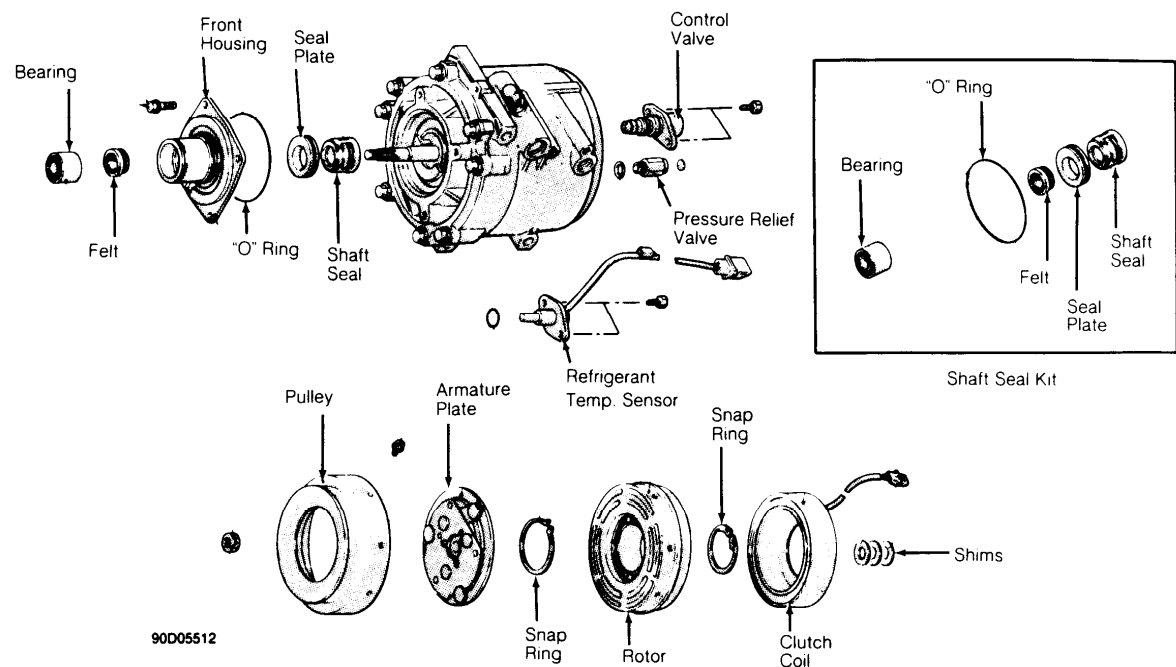


Fig. 7: Harrison R-4 Radial Compressor
Courtesy of ISUZU MOTOR CO.

HARRISON V5 5-CYLINDER CLUTCH R & I

Removal

1. Clamp Holding Fixture (J-34992) in vise and attach compressor to holding fixture with thumb screws. Use Clutch Hub Holder (J-33027) to hold clutch. Remove shaft nut using Shaft Nut Socket J-33022).
2. Thread Clutch Plate and Hub Assembly Remover (J-33013-B) into hub. Hold body of remover with a wrench and turn center screw into remover body to remove clutch plate and hub assembly. Remove shaft key and retain for installation.

Installation

1. Install shaft key into hub key groove. Allow key to project approximately 1/8" (3.2 mm) out of key way. Shaft key is curved slightly to provide an interference fit in hub key groove.
2. Ensure frictional surface of clutch plate and clutch rotor are clean before installing clutch plate and hub assembly. Align shaft key with shaft key way and place clutch plate and hub assembly onto compressor shaft.

NOTE: **DO NOT drive or pound on clutch hub or compressor shaft, as compressor could be damaged internally.**

3. Hold hex portion of installer (J-33013) with a wrench. Tighten center screw to press hub into shaft until there is .015-.025" (.38-.64 mm) air gap between frictional plate and clutch rotor.
4. Install new shaft nut with a small diameter boss of nut against crankshaft shoulder. Use Thin Wall Socket (J-9399) and Clutch Hub Holder (J-25030). Tighten shaft nut to 96-192 INCH lbs. 11-22 N.m). Spin pulley rotor by hand to ensure rotor is not rubbing on clutch drive plate. See [Fig. 8](#) .

HARRISON V5 5-CYLINDER SHAFT SEAL R & I

Removal

Discharge refrigerant from system using approved refrigerant recovery/recycling equipment. See SERVICING PRECAUTIONS at beginning of article. Remove clutch plate assembly. Remove shaft seal snap ring. Thoroughly clean inside of compressor neck area around shaft and seal. Engage tangs of Seal Remover/Installer (J-23128-A) into recessed portion of seal and remove seal. Remove and discard seal "O" ring from compressor neck. Thoroughly clean inside of compressor neck and "O" ring groove.

Installation

1. Coat new "O" ring with refrigerant oil and install on "O" ring installer (J-33011). Install "O" ring into groove in compressor neck. Attach new seal to Seal Remover/Installer (J-23128-A). Dip seal in clean refrigerant oil.
2. Place Seal Protector (J-34614) over compressor shaft. Push new seal over shaft protector. Install new snap ring with flat side against seal. Install clutch plate assembly.

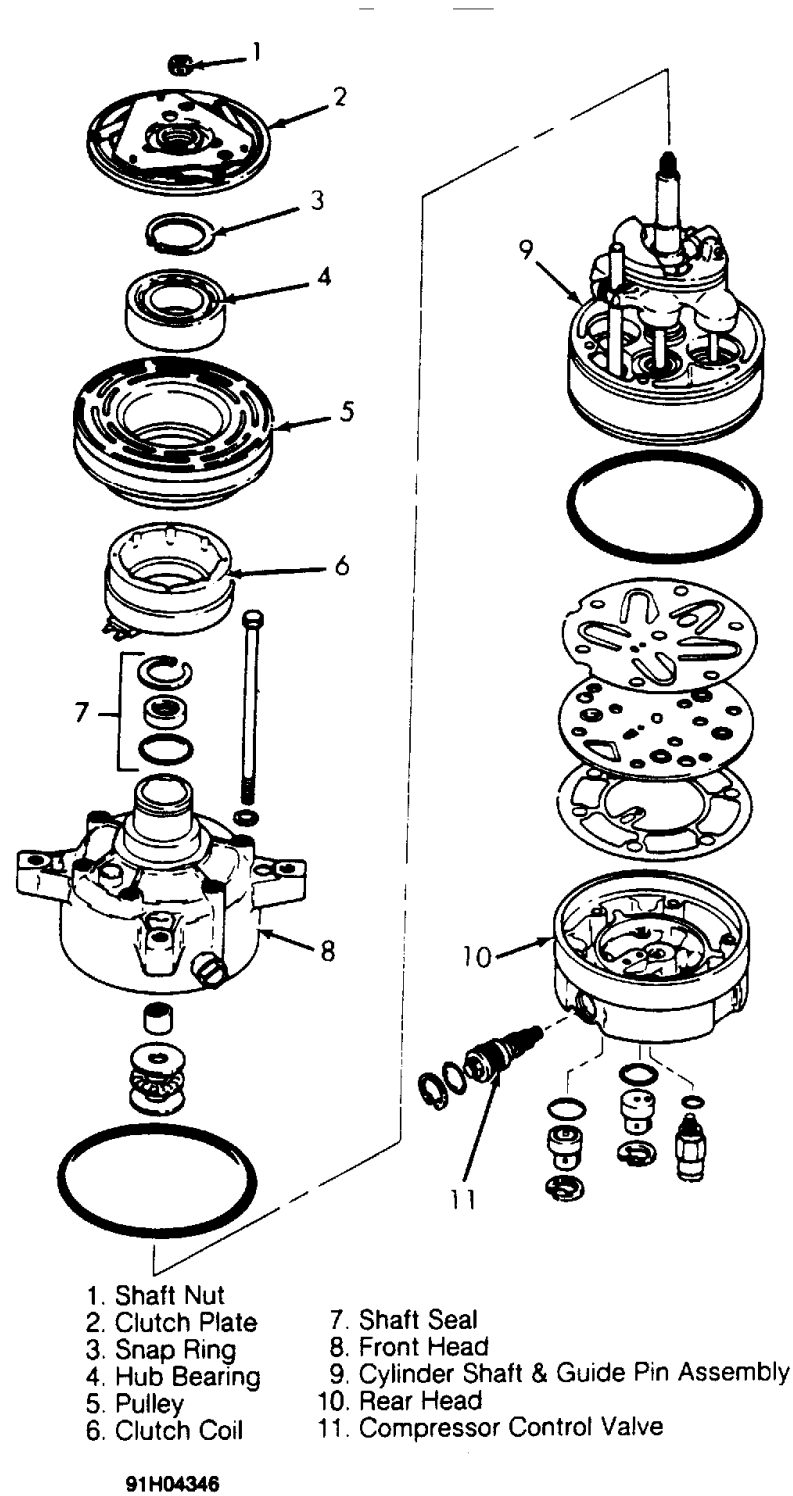


Fig. 8: Exploded View of Harrison V5 5-Cylinder Compressor
Courtesy of GENERAL MOTORS CO.

HITACHI 5 & 6-CYL CLUTCH R & I

Removal

1. Using Clutch Holder (KV99412302), hold clutch hub. Remove shaft nut from shaft. Using Clutch Hub Remover (KV994C5780), remove clutch hub.
2. Pry inner snap ring off. Remove pulley and bearing assembly. If assembly cannot be removed by hand, use Pulley and Bearing Removers (KV994C5781 and KV994C5782).
3. Remove clamping screws that secure coil assembly leads. Remove inner snap ring from coil assembly. Remove coil assembly from front cover. See [Fig. 9](#) .

Inspection

Check friction surfaces of clutch for damage due to excessive heat, or excessive grooving due to slippage. Replace compressor components as necessary. Oil or dirt on friction surfaces should be cleaned with a solvent and a dry rag. Check coil for binding, shorted or open leads.

Installation

1. Install coil assembly on compressor. Properly position terminals. Using snap ring pliers, install snap ring. Using a plastic mallet, drive pulley and bearing assembly onto neck of front cover. Turn pulley, making sure that there is no noise and that rotation is free. Ensure there is no pulley play.
2. Using snap ring pliers, install inner snap ring. Remove all oil from clutch pulley. Fit key and clutch hub to shaft. Select adjusting spacer which gives the correct clearance between pulley and clutch hub.
3. Coat shaft nut with Loctite and install. Using a feeler gauge, measure clutch hub-to-pulley clearance. Clearance should be .020-.031" (.5-.8 mm). If specified clearance is not obtained, replace adjusting spacer and readjust.
4. When replacing compressor clutch assembly, DO NOT forget break-in operation. This is accomplished by engaging and disengaging clutch 30 times.

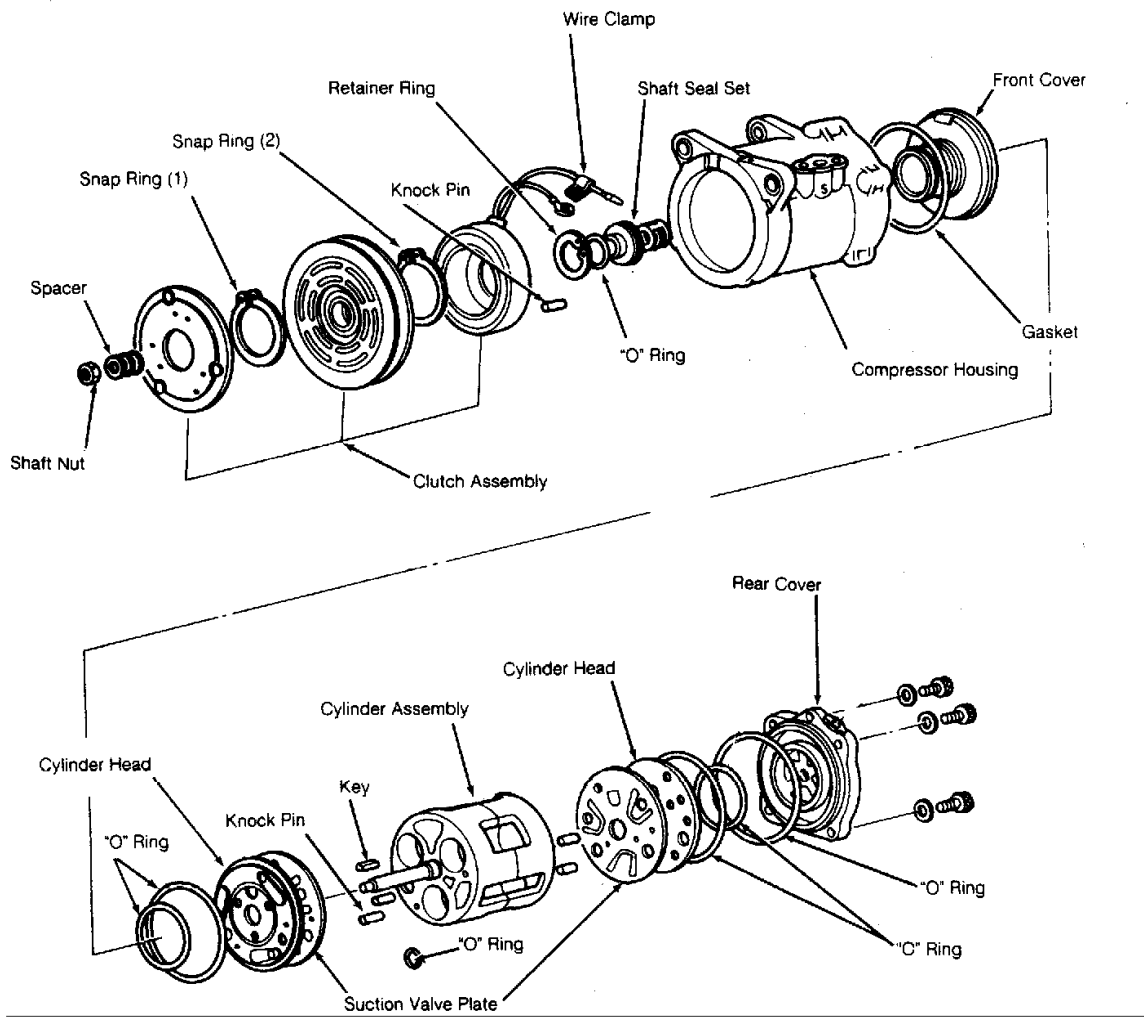


Fig. 9: Hitachi 6-Cylinder Compressor (5-Cylinder Similar)
Courtesy of NISSAN MOTOR CO., U.S.A.

HITACHI 5 & 6-CYL SHAFT SEAL R & I

NOTE: Check compressor refrigerant oil level when replacing seals. See **COMPRESSOR REFRIGERANT OIL CHECKING** article in this section.

Removal

1. Drain oil from suction port, measure oil drained and discard oil. Remove clutch hub, pulley, bearing assembly and coil assembly. See **HITACHI 5 & 6-CYLINDER CLUTCH R & I** in this article.
2. Using snap ring pliers, remove retainer ring. Remove key and plug low and high pressure openings of compressor with Plugs (KV994C4531, KV994C4532 and KV994C4559).
3. Insert Adapter (KV994C1552) into hole in middle of blind cover at low pressure side of compressor. Connect Pressurizer (KV994C1552) to can of R-12 refrigerant. Wrap a rag around compressor shaft. Apply pressure of 28-71 psi (2-5 kg/cm²) at low pressure (suction) service valve of compressor. Catch shaft seal seat in rag. See [Fig. 11](#) .

- NOTE:** If shaft seal cannot be pulled out, reset to its original position, and pressurize again.
4. Insert shaft seal Remover/Installer (KV994C1143) through the open end of front cover. Depress carbon seal and hook tool at case projection of shaft seal. Slowly pull out to remove shaft seal. See [Fig. 11](#) .

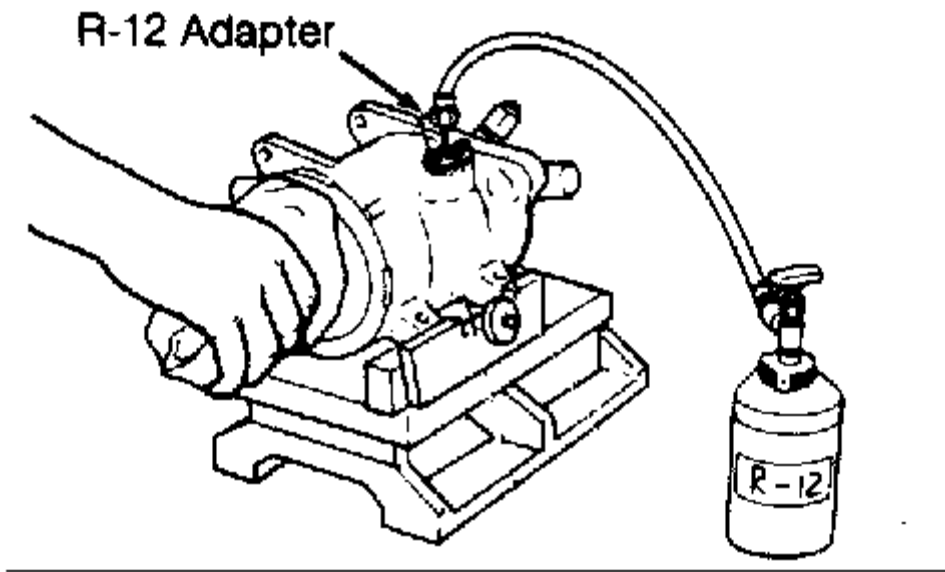


Fig. 10: Hitachi 6-Cylinder Compressor Shaft Seal Seat Removal
Courtesy of NISSAN MOTOR CO., U.S.A.

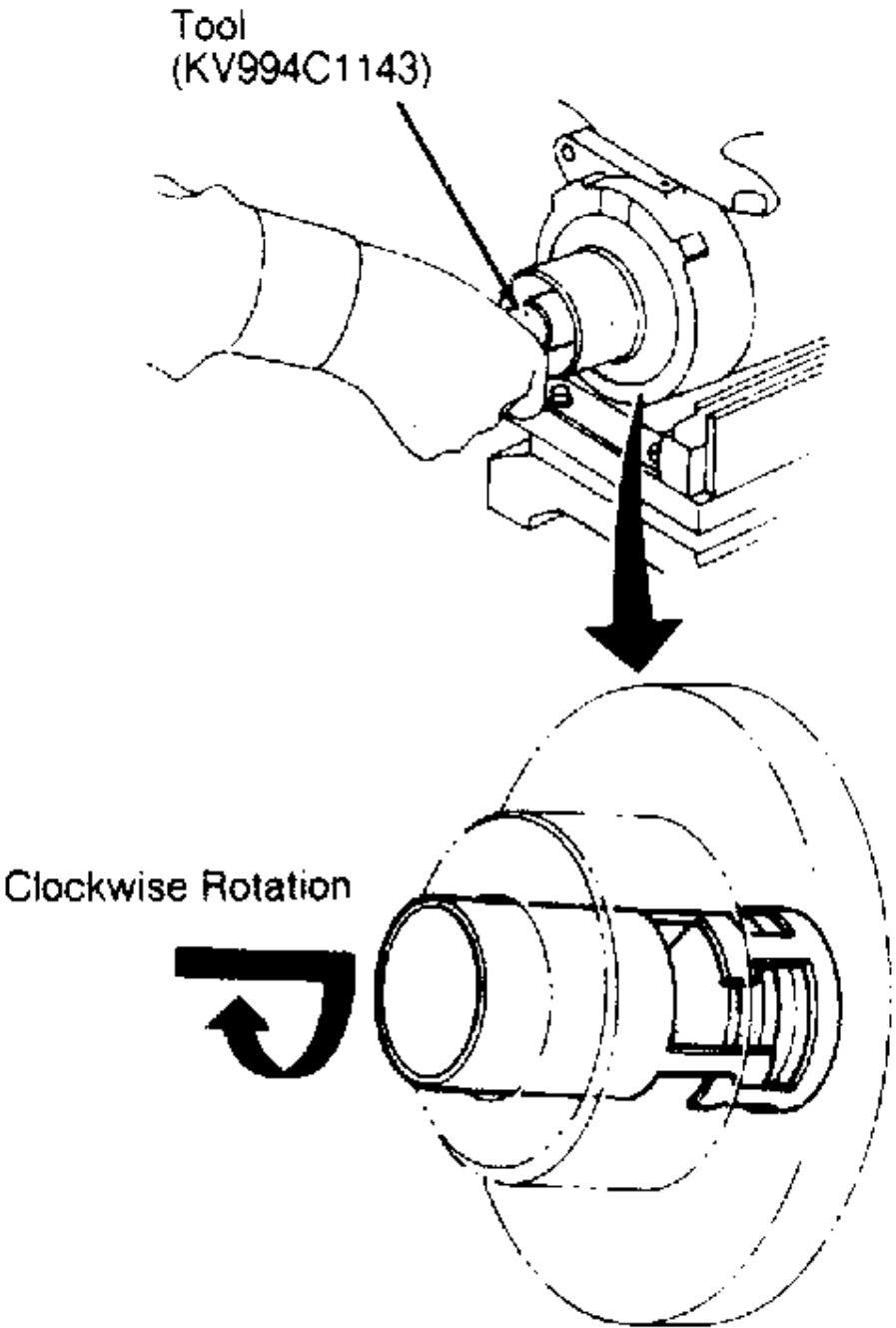


Fig. 11: Hitachi 6-Cylinder Compressor Shaft Seal Removal
Courtesy of NISSAN MOTOR CO., U.S.A.

Inspection

Check carbon seal surface of shaft seal for damage. Check "O" ring and carbon seal contact surface of shaft seal seat for damage. Make sure that "O" ring contact surface on front cover is not damaged. Make sure refrigerant oil is applied to oil seal in shaft seal seat.

Installation

1. To install, reverse removal procedure. Ensure shaft seal contact surface is free of dirt. Lubricate with refrigerant oil. Cap end of compressor shaft.
2. Using Guard (KV994C1143), insert shaft seal. Be sure shaft seal case is aligned with shaft. Apply force to turn seal to left and right. Ensure shaft seal seats properly in shaft cut-out.
3. Fit "O" ring to outside groove of shaft seal seat. Ensure "O" ring seats properly. Apply refrigerant oil on contact surfaces and around shaft seal seat. Lightly coat surface of shaft with refrigerant oil.
4. Install key on compressor shaft. Using snap ring pliers, compress retainer ring and fit retainer ring into front cover. Seat retainer ring firmly in groove. Thoroughly wipe grease or oil from shaft surface.
5. Connect Installer (KV99412329) to shaft of compressor, and turn shaft 5 or 6 times in a clockwise direction to seat seal. See REFRIGERANT OIL & R-12 SPECIFICATIONS chart in this section for system capacities.

MATSUSHITA ROTARY VANE CLUTCH R & I

Removal & Installation

1. Insert two 5 mm bolts into threaded holes in armature. Using a screwdriver as lever in between bolts, remove center bolt. remove armature and shim from shaft.
2. Remove snap ring. Using a puller, remove pulley. Disconnect electrical leads from field coil. Remove 3 field coil mounting bolts. Remove field coil. See [Fig. 12](#) . To install, reverse removal procedure.

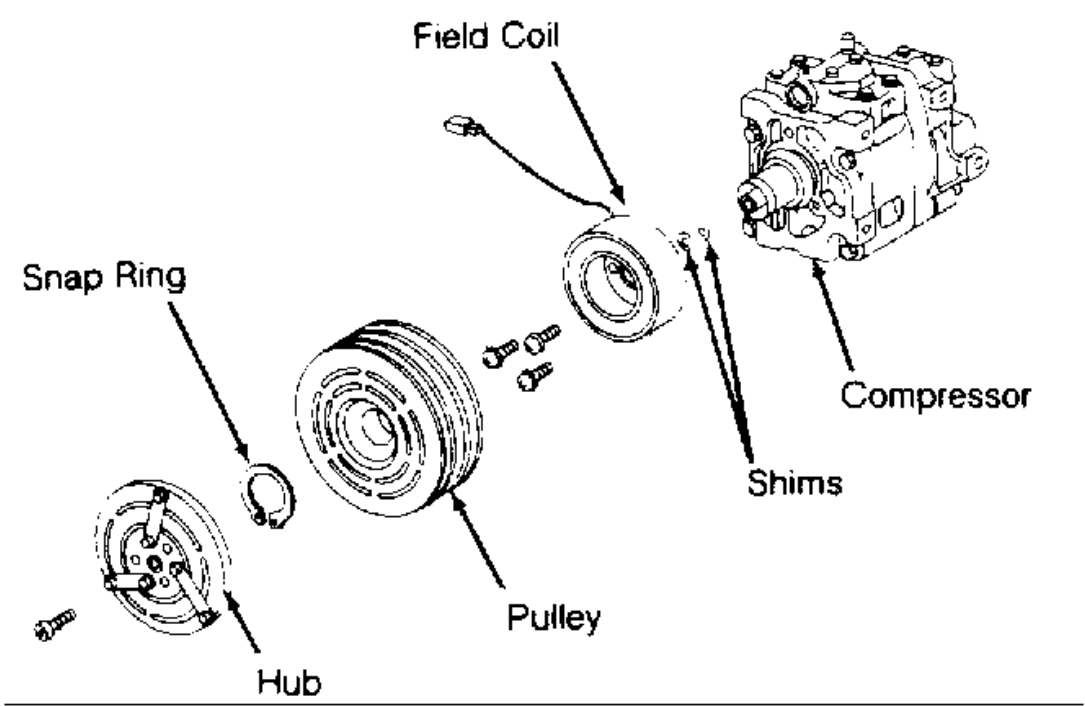


Fig. 12: Exploded View of Rotary Vane Compressor (Matsushita)
Courtesy of SUBARU OF AMERICA, INC.

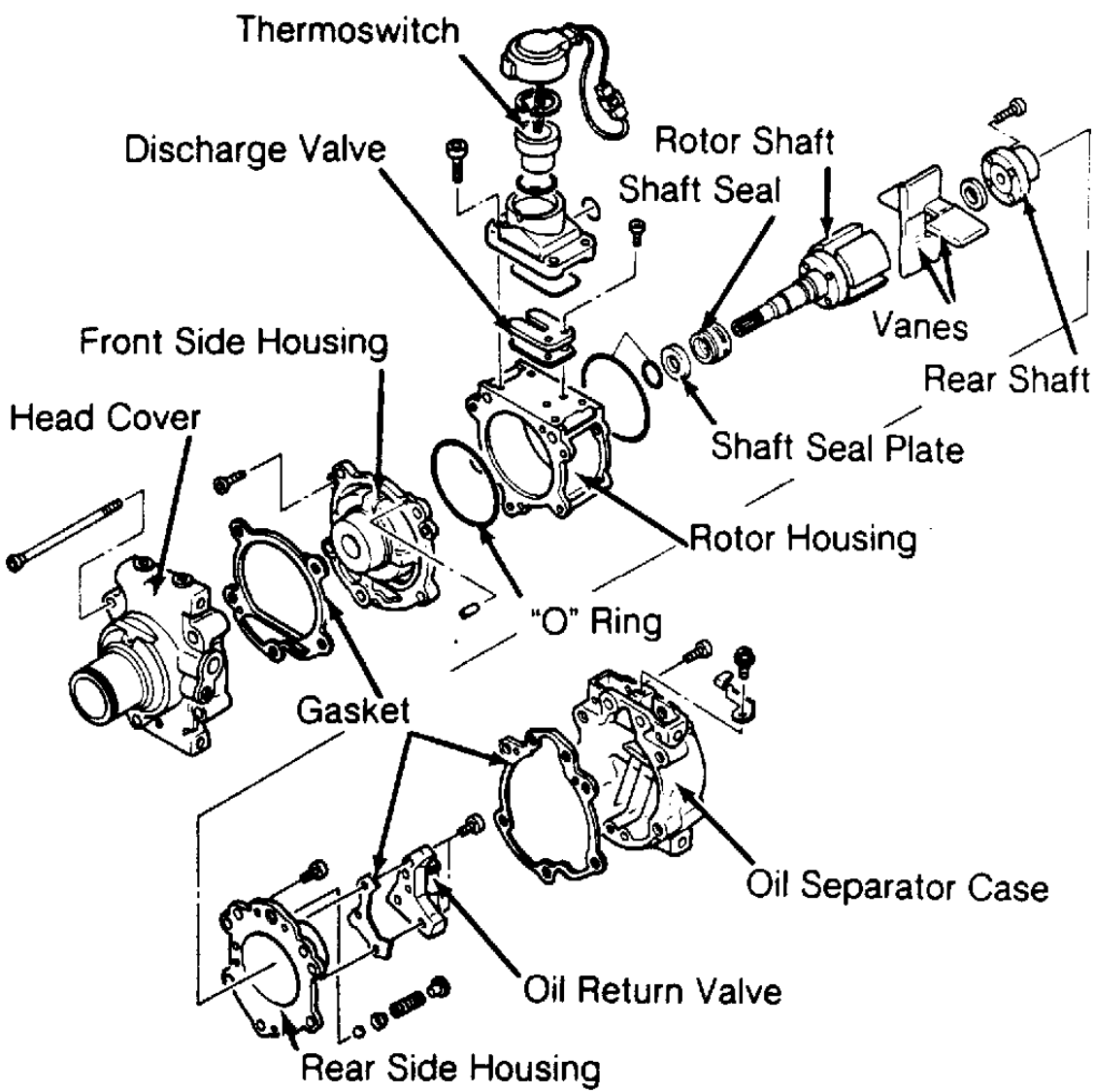
NIPPONDENSO TV12 ROTARY VANE CLUTCH R & I

Removal

Remove compressor from vehicle and place on work bench. Holding clutch with Clutch Holder (00007-10331), remove shaft nut. Install Clutch Disc Remover (4992-02-020) and remove clutch disk and shims. Remove pulley snap ring and tap pulley (with bearing) off of compressor with plastic hammer. See [Fig. 13](#) .

Installation

To install, reverse removal procedure. Ensure pulley-to-clutch disc clearance is .016-.024" (.4-.6 mm). Adjust (if necessary) by adding or subtracting shims.



91J04347

Fig. 13: Exploded View of Rotary Vane Compressor (Nippondenso TV12)

Courtesy of MAZDA MOTORS CO., U.S.A.

NIPPONDENSO 6 & 10-CYL CLUTCH R & I

Removal

1. Remove A/C compressor. Remove pressure plate shaft bolt using socket wrench and Clutch Stopper (07112-76060). Install Clutch Remover (07112-66040) on pressure plate. Using clutch stopper and socket wrench, rotate clutch remover to remove pressure plate.
2. Remove shims from pressure plate. Remove snap ring from compressor. Tap rotor off shaft with plastic hammer. Disconnect stator wire from housing. Remove snap ring from inside stator. Remove stator. See [Fig. 12](#) .

CAUTION: **DO NOT damage pulley when tapping on rotor.**

Installation

To install, reverse removal procedure. Ensure snap rings are installed with beveled side up. tighten shaft bolt to 10 ft. lbs. 14 N.m). Ensure clutch clearance is .014-.026" (.36-66 mm). adjust clearance by adding or subtracting shims as necessary.

NIPPONDENSO 6 & 10-CYL SHAFT SEAL R & I

NOTE: **Check compressor refrigerant oil level when replacing seals. See COMPRESSOR OIL CHECKING article in the AIR CONDITIONING & HEAT section.**

Removal

1. Hold clutch hub stationary and remove center nut. Screw remover into center of hub. Turn center bolt to remove pressure plate.
2. Remove shims from shaft. Remove snap ring from inside of pulley. Tap pulley off of shaft with plastic mallet. Be careful not to distort pulley while removing.
3. Disconnect clutch coil wires from compressor housing. remove snap ring inside coil and lift coil off compressor. Pry dust seal out from around compressor shaft (if equipped).
4. Place shaft key remover on shaft and turn to remove key. Remove drain plug (if equipped). Remove service valves-to-compressor body bolts. Remove valves. Discard "O" rings. Drain oil out of compressor.
5. Remove 6 through bolts from front head of compressor and discard washers. Tap head loose from compressor; be careful not to scratch sealing surfaces. remove snap ring (if equipped) from front housing. Press seal plate out. Remove seal from shaft. See [Fig. 14](#) .

Installation

1. Lubricate shaft seal with clean refrigerant oil and place on compressor shaft. Lubricate seal plate and "O" ring (if equipped) and install in front housing. Install snap ring (if equipped).
2. Place front housing on compressor body. Install through bolts with new washers. Tighten bolts evenly and alternately to 18 ft. lbs. (24 N.m). Install shaft key using installer and plastic mallet. Insert dust seal into front of compressor.
3. Install drain plug with new gasket. Add correct amount of refrigerant oil to compressor. If service valves were removed, coat new "O" rings with refrigerant oil and install service valves.
4. Place clutch coil on compressor and install snap ring. Install shims on shaft to adjust pressure plate-to-rotor clearance to .016-.028" (.41-.71 mm). Tighten shaft nut to 12 ft. lbs. (16 N.m).

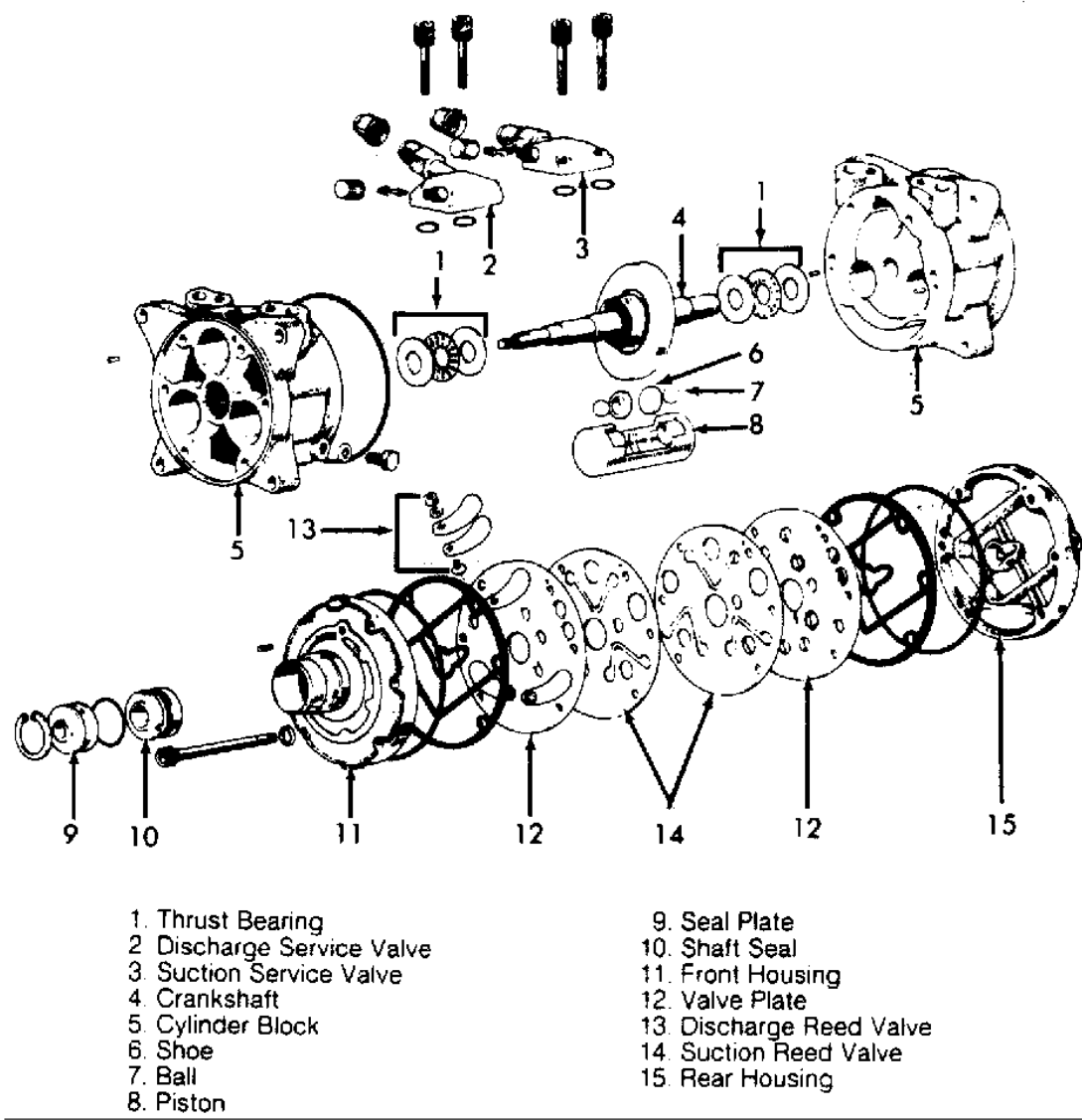


Fig. 14: Nippondenso 6-Cylinder Compressor
Courtesy of CHRYSLER MOTORS.

PANASONIC ROTARY VANE CLUTCH R & I

Removal

1. Insert two 5 mm bolts into threaded holes in armature. Using screwdriver as a lever in between bolts, remove center bolt. Remove armature and shims from shaft.
2. remove snap ring. Using puller, remove pulley. Disconnect electrical leads from field coil. Remove 3 field coil mounting bolts. Remove field coil.

Inspection

Check friction surfaces for damage from excessive heat or grooving caused by slippage. Replace parts as necessary. Check coil winding for shorted or open winding. Clean surfaces with solvent and dry rag.

Installation

To install, reverse removal procedure. Tighten field coil retaining screws to 30-56 INCH lbs. (3.4-6.4 N.m). Ensure pulley-to-armature gap is .016-.024" (.4-.6 mm). If gap is not as specified, adjust by adding or removing shims. Tighten center bolt to 96-108 INCH lbs. (11-13 N.m). See [Fig. 15](#) .

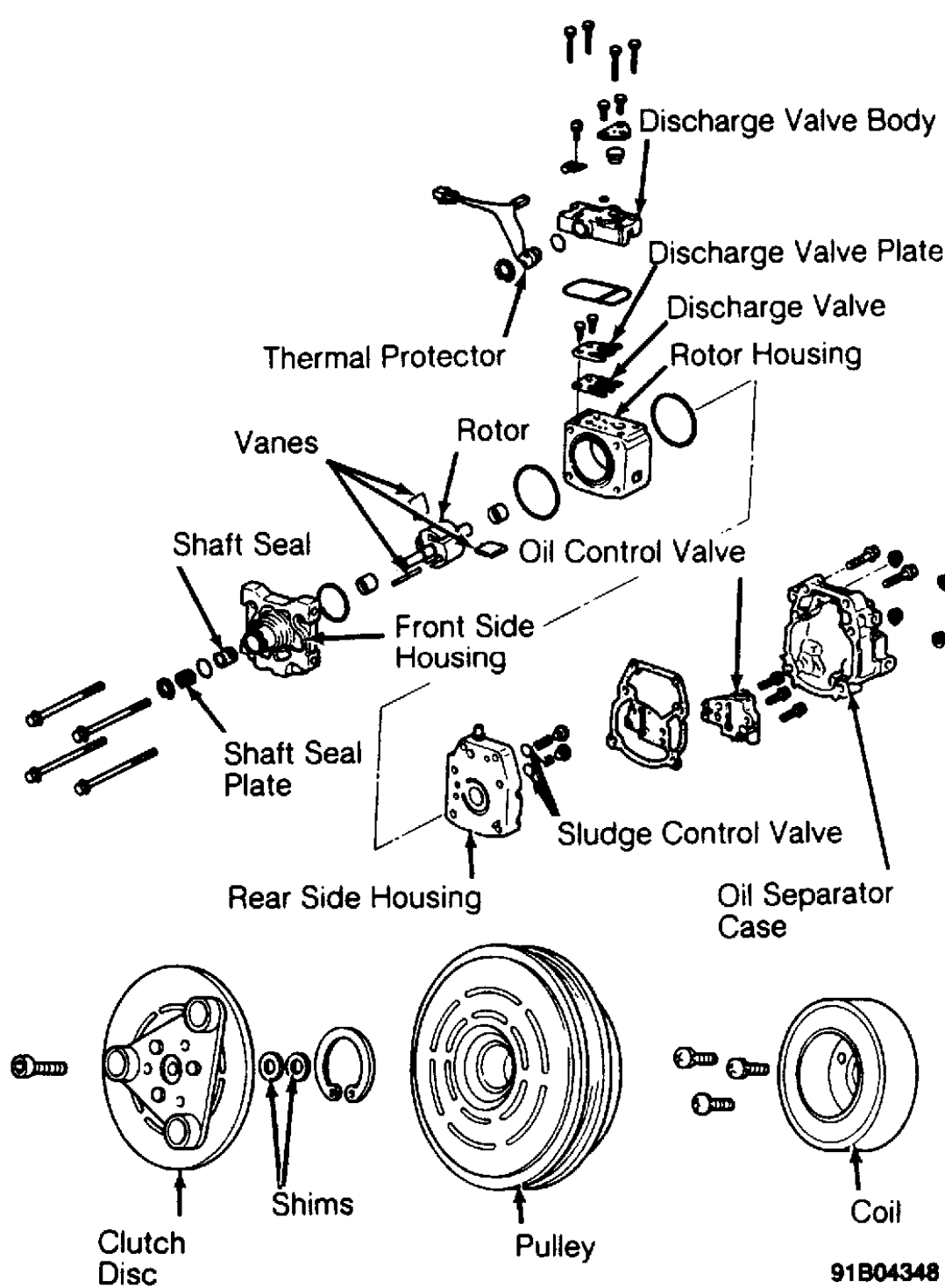


Fig. 15: Exploded View of Rotary Vane Compressor (Panasonic)
Courtesy of CHRYSLER MOTORS.

PANASONIC ROTARY VANE SHAFT SEAL R & I

Removal & Installation

Remove clutch and coil. Remove seal plate snap ring. Using seal plate remover, engage seal and remove seal plate. Using seal remover, engage seal ears and remove seal. See [Fig. 16](#) . To install, reverse removal procedure. Coat new seal plate and seal with clean refrigerant oil before installing. DO NOT touch seal surfaces with fingers.

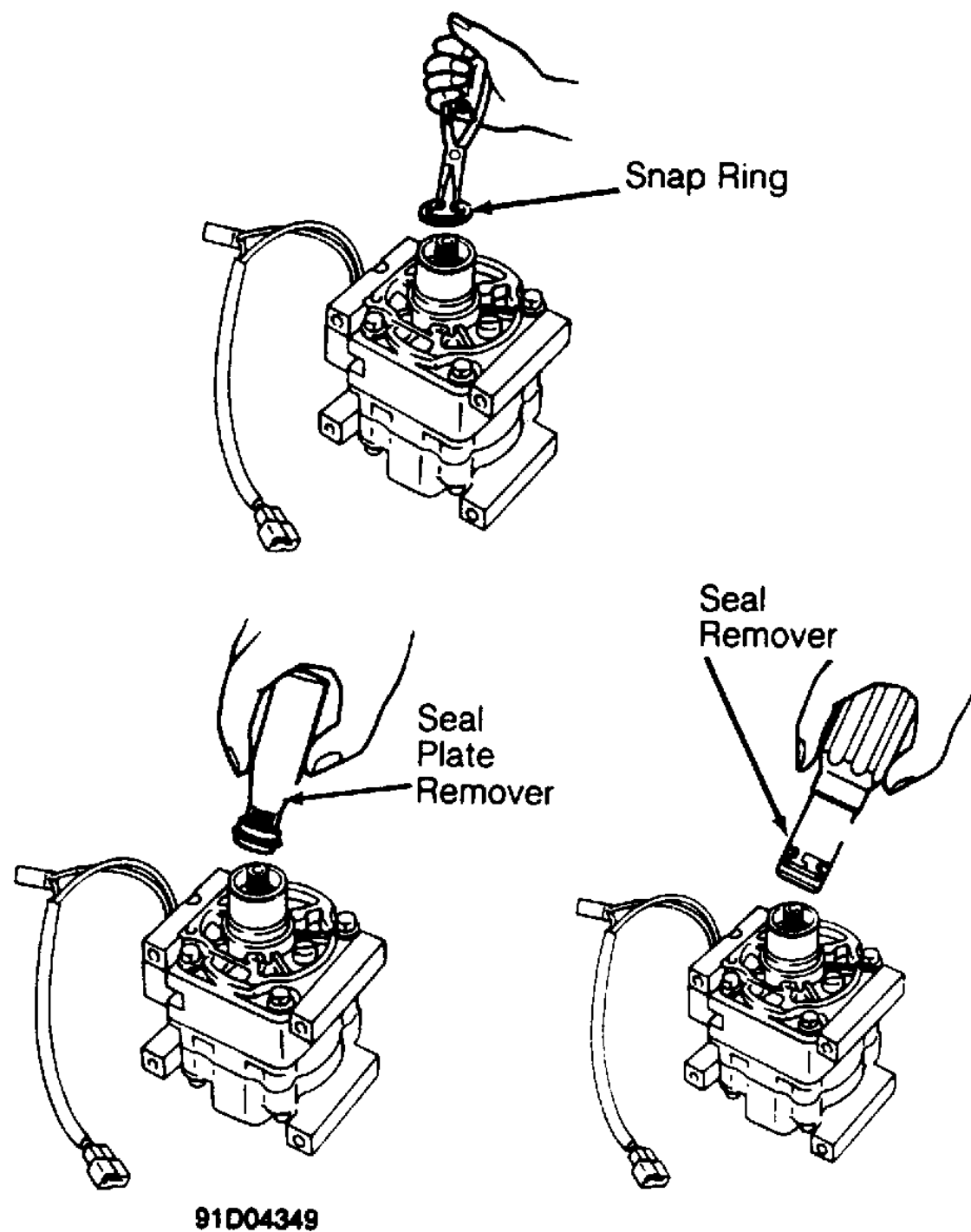


Fig. 16: Removing Rotary Vane Compressor Shaft Seal (Panasonic)
Courtesy of CHRYSLER MOTORS.

SANDEN SCROLL CLUTCH & SHAFT SEAL R & I

NOTE: Check compressor refrigerant oil level when replacing seals.

Removal

1. Secure 2 box-end wrenches, to hold armature plate, using two 6 mm bolts 1 in. (25 mm) or longer. Holding box-end wrenches, use a socket and ratchet to remove clutch hub nut.
2. Remove armature plate. See [Fig. 17](#) . Remove snap ring with internal snap ring pliers. Remove clutch hub. Remove snap ring and clutch coil.
3. Remove bolts retaining front housing. Remove front housing and "O" ring from compressor. Remove shaft seal from shaft. Remove snap ring from back side of front housing. Remove seal plate.
4. Use brass drift and hammer to lightly tap shaft bearing from front housing. Remove felt seal.

NOTE: Do not touch the sealing surfaces of the shaft seal carbon ring and shaft seal plate.

Installation

1. Lubricate shaft seal with compressor oil. Align notches on shaft seal with notches on crank shaft. Install shaft seal plate on the front housing. Install front seal housing to compressor.
2. Use Press Tool (MB991301) to install felt into front housing. Make sure felt metal section faces up. Use Press Tool (MB991301) to press bearing into front housing.
3. Align and install clutch coil. Install snap ring so that the tapered surface is facing outward. Install clutch hub. Install snap ring. Install armature plate, aligning raised area to notch.
4. Secure 2 box-end wrenches, to hold armature plate, using two 6 mm bolts 1 in. (25 mm) or longer. Holding box-end wrenches, use a socket and ratchet to tighten clutch hub nut to 12 ft. lbs. (16 N.m).
5. Use feeler gauge to measure distance between armature and clutch hub. If gap is not .01-.02" (.25-.51 mm), remove clutch assembly and add or remove shims accordingly.

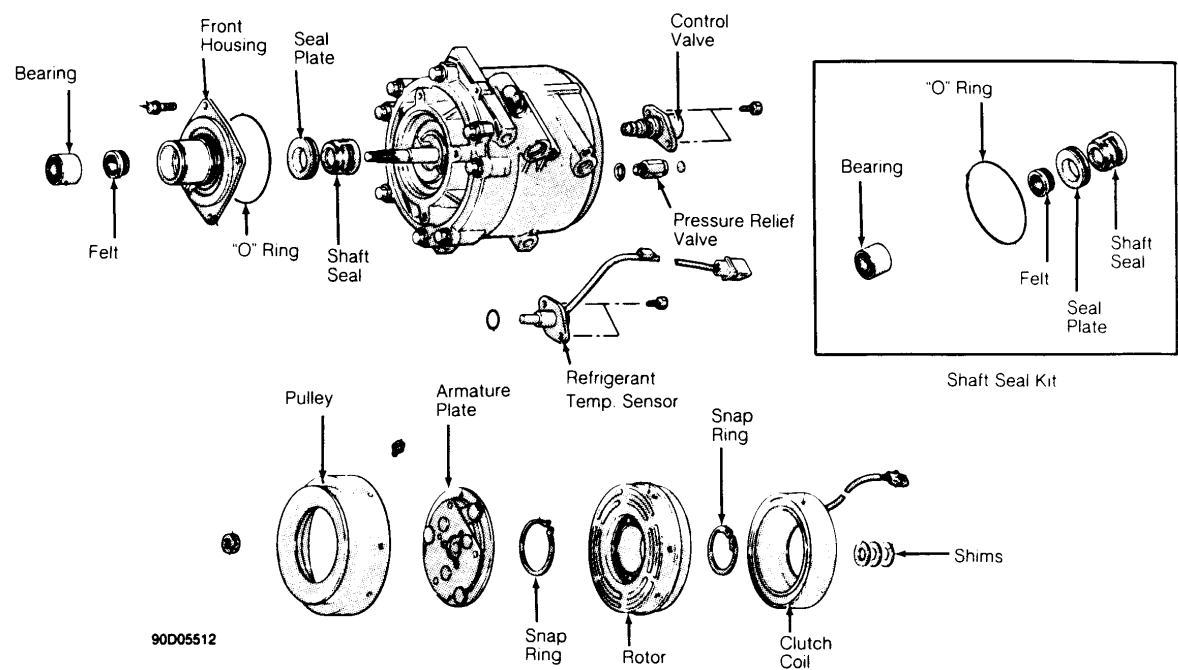


Fig. 17: Sanden Scroll Compressor
Courtesy of CHRYSLER MOTORS.

SANDEN 5-CYL CLUTCH R & I

Removal

1. Hold clutch hub stationary and remove shaft nut. Remove clutch plate using puller. Remove external front housing snap ring and internal bearing snap ring. See [Fig. 16](#) .
2. Install puller and pull rotor assembly off. remove 3 screws and clutch coil. Use driver and hammer to drive bearing out from hub.

Installation

1. Install new bearing; ensure installer contacts outer race of bearing. Install snap ring and ensure bearing turns freely. Install clutch coil on compressor.
2. Support compressor on rear mounting ears. Align rotor on front housing hub. Use adapter and press to install rotor (or drive into place with soft mallet). After rotor is seated, install front snap ring.

SANDEN 5-CYL SHAFT SEAL R & I

NOTE: Check compressor refrigerant oil level when replacing seals.

Removal

1. Hold clutch hub stationary and remove shaft nut with thin wall socket. Use clutch plate puller to remove clutch plate. Tap key out of slot in crankshaft.
2. Remove seal retainer with seal remover and 3/4" socket wrench. Use seal seat remover tongs to pull seal seat off compressor shaft. Insert seal remover into front housing and turn to engage tangs on seal. Lift seal out. Remove seal "O" ring from front housing, being careful not to scratch shaft.

Installation

1. Coat "O" ring with refrigerant oil and install into groove. Load a new seal onto installer, being careful not to touch carbon sealing surface with fingers. Install shaft protector. Dip seal in refrigerant oil and install on shaft. Rotate seal clockwise until seal fits into flats on shaft. Remove seal installer by turning counterclockwise.
2. Coat seal seat with refrigerant oil and install with tongs. Reinstall seal seat retainer (with flat side down). Install shims and shaft key. Rotate shaft several times to help break in seal.
3. Use a press to install clutch plate. Make sure that air gap is .016-.031" (.41-.79 mm). Hold plate stationary and install shaft nut.

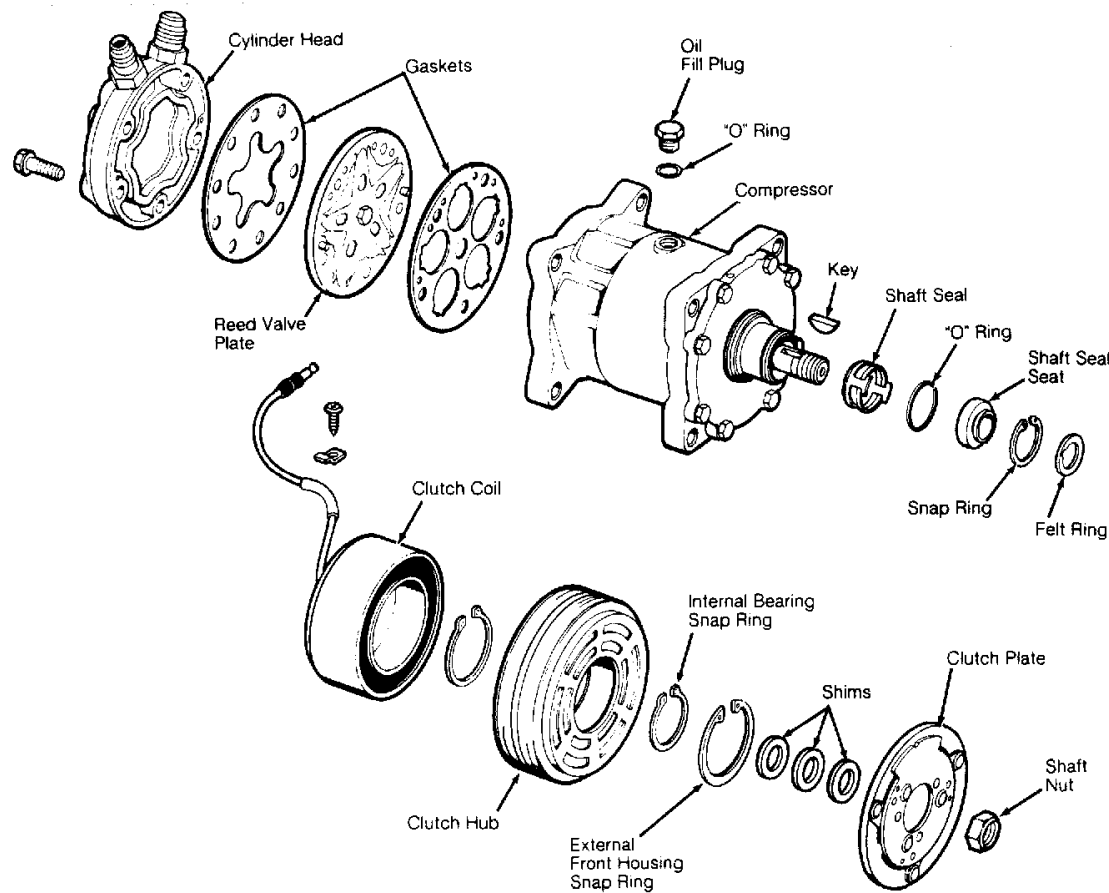


Fig. 18: Sanden 5-Cylinder Compressor
Courtesy of CHRYSLER MOTORS.

SANDEN 7-CYL CLUTCH COIL & BEARING R & I

Removal

1. Hold clutch hub stationary and remove shaft nut. Remove clutch plate using Clutch Plate Puller (09977-21110). Remove clutch shims and bearing dust cover. Remove external front housing snap ring.
2. Install puller, and pull drive pulley assembly off. Detach clutch coil lead from compressor housing. Remove clutch coil snap ring and clutch coil. If necessary, invert drive pulley assembly and remove snap ring and bearing.

Installation

1. Ensure clutch coil protrusion aligns with hole in compressor housing, and install clutch coil snap ring. Install drive pulley assembly using Drive Pulley Installer (09977-21811).
2. install external bearing snap ring. Using Seal Installer (09977-21800), install bearing dust cover. After dust cover installation, ensure there is no contact between cover and front housing.
3. Install clutch shims and clutch plate. Tighten shaft nut to 12-14 ft. lbs. (17-19 N.m). Using a dial indicator, apply voltage to clutch coil to check air gap between clutch plate and drive pulley assembly. Ensure air gap is .016-.032" (.41-.80 mm).

SANDEN 7-CYL SHAFT SEAL R & I

NOTE: Check compressor refrigerant oil level when replacing seals.

Removal

1. Hold clutch hub stationary and remove shaft nut. Remove clutch plate using Clutch Plate Puller (09977-21110). Tap shaft key out of slot in compressor shaft. Remove clutch shims.
2. Remove seal retainer felt ring. Remove shaft seal seat snap ring with snap ring pliers. Insert Seal Seat Remover/Installer (09977-21400) into front housing and turn to engage tangs on seat. Lift seal seat out.
3. Insert seal Remover/Installer (09977-21510) into front housing and turn to engage tangs on seal. carefully lift seal seat out without scratching compressor shaft.

Installation

1. Install Shaft Seal Guide Sleeve (09977-21700) over compressor shaft. Dip seal in refrigerant oil and install seal on sleeve. Using seal remover/installer, rotate seal clockwise until seal is engaged. Remove seal remover/installer by turning it counterclockwise.
2. Coat seal seat with refrigerant oil and install seal with seal seat remover/installer. Remove shaft seal guide sleeve. Install snap ring. Install seal retainer felt ring using seal seat remover/installer. Install clutch shims and shaft key.
3. Install clutch plate. Tighten shaft nut to 12-14 ft. lbs. (17-19 N.m). Using dial indicator, apply voltage to clutch coil to check air gap between clutch plate and drive pulley assembly. Ensure air gap is .016-.032" (.41-.80 mm).

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1991-92 AIR CONDITIONING & HEATING

A/C System General Servicing

HANDLING/SAFETY PRECAUTIONS

CAUTION: When discharging air conditioning system, use only approved refrigerant recovery/recycling equipment. Make every attempt to avoid discharging refrigerant into the atmosphere.

1. Always work in a well-ventilated, clean area. Refrigerant R-134a is colorless and is invisible as a gas. Refrigerant (R-12 or R-134a) is heavier than oxygen and will displace oxygen in a confined area. Avoid breathing refrigerant vapors. Exposure may irritate eyes, nose and throat.
2. The system's high pressure can cause severe injury to eyes and skin if a hose were to burst. Always wear eye protection when working around A/C system and refrigerant. If necessary, wear rubber gloves or other protective clothing.
3. Refrigerant evaporates quickly when exposed to atmosphere, freezing anything it contacts. If liquid refrigerant contacts eyes or skin, DO NOT rub eyes or skin. Immediately flush affected area with cool water for 15 minutes and consult a doctor or hospital.
4. Never use R-134a in combination with compressed air for leak testing. Pressurized R-134a in the presence of oxygen (air concentrations greater than 60% by volume) may form a combustible mixture. DO NOT introduce compressed air into R-134a containers (full or empty), A/C system components or service equipment.
5. DO NOT expose A/C system components to high temperatures, steam cleaning for example, as excessive heat will cause refrigerant/system pressure to increase. Never expose refrigerant directly to open flame. If refrigerant needs to be warmed, place bottom of refrigerant tank in warm water. Water temperature MUST NOT exceed 125°F (52°C).
6. Use care when handling refrigerant containers. DO NOT drop, strike, puncture or incinerate containers. Use Department Of Transportation (DOT) approved, DOT 4BW or DOT 4BA, refrigerant containers.
7. Never overfill refrigerant containers. The safe filling level of a refrigerant container MUST NOT exceed 60% of the container's gross weight rating. Store refrigerant containers at temperature less than 125°F (52°C).
8. R-12 refrigerant (Freon) will be sold and stored in White containers, while R-134a refrigerant will be sold and stored in 30- or 50-pound Light Blue containers.
9. R-12 and R-134a refrigerants must never be mixed, as their desiccants and lubricants are not compatible. If the refrigerants are mixed, system cross-contamination or A/C system component failure may occur. Always use separate servicing and refrigerant recovery/recycling equipment.
10. Follow equipment manufacturer instructions of all service equipment to be used. The Material Safety Data Sheet (MSDS), provided by refrigerant manufacturer/suppliers, contains valuable information regarding the safe handling of R-12 or R-134a refrigerants.

IDENTIFYING R-134A SYSTEMS & COMPONENTS

To prevent refrigerant cross-contamination, use following methods to identify R-134a based systems and components.

Fittings & "O" Rings

All R-134a based A/C systems use 1/2" - 16 ACME threaded fittings (identifiable by square threads) and quick-connect service couplings. See [Fig. 1](#) . Besides the use of these fittings, most manufacturers will use Green colored "O" rings in R-134a systems.

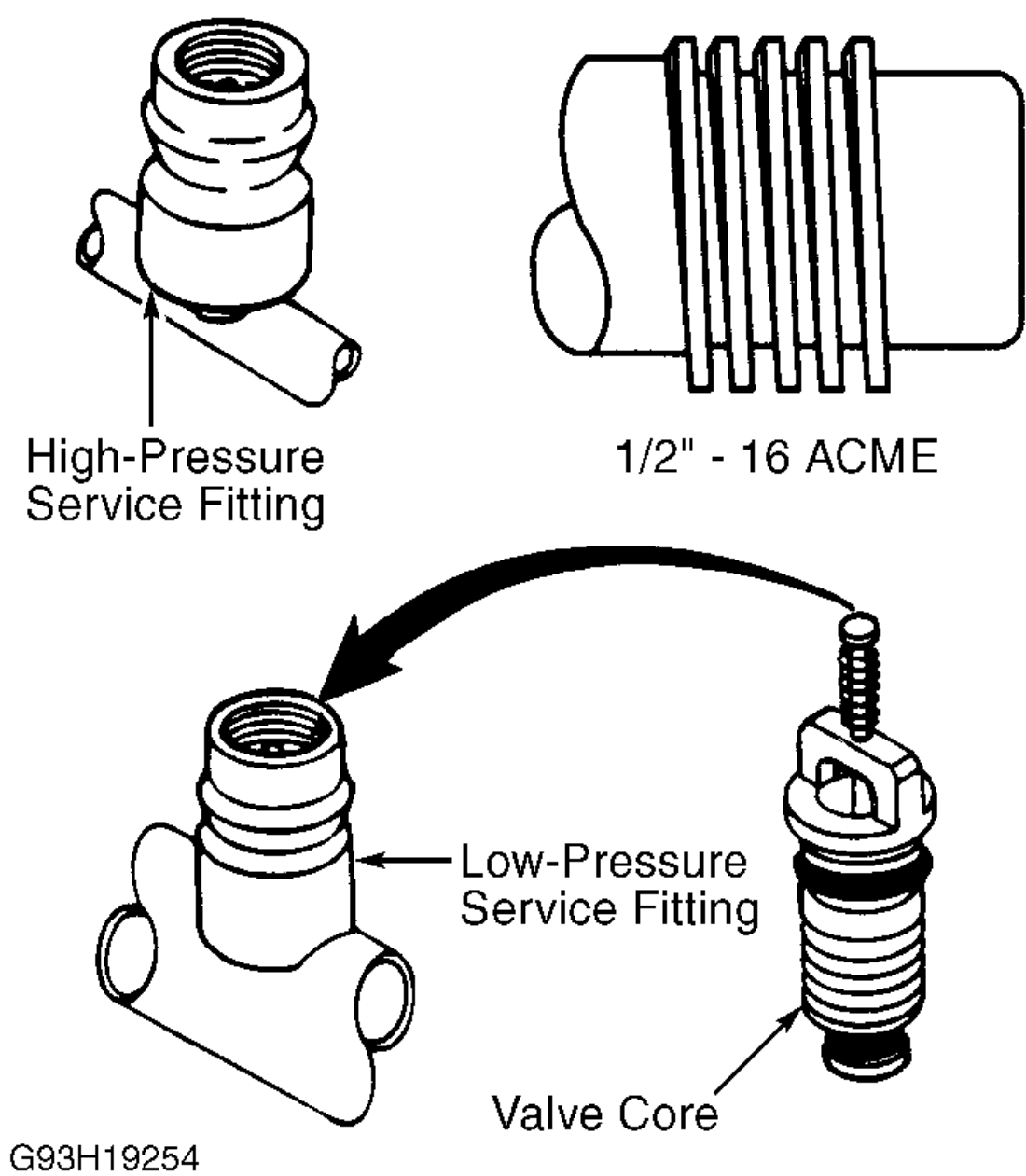


Fig. 1: Identifying R-134a Fittings & Quick Connect Service Couplings
Courtesy of AUDI OF AMERICA, INC.

Underhood A/C Specification Labels

Most R-134a based systems will be identified through the use of Green or Light Blue underhood labels, or with R-134a refrigerant clearly printed on labels. See [Fig. 2](#) . Some manufacturers will identify R-12 based systems with White, Red, Silver or Gold underhood labels. Before servicing an A/C system, always determine which refrigerant is being used.

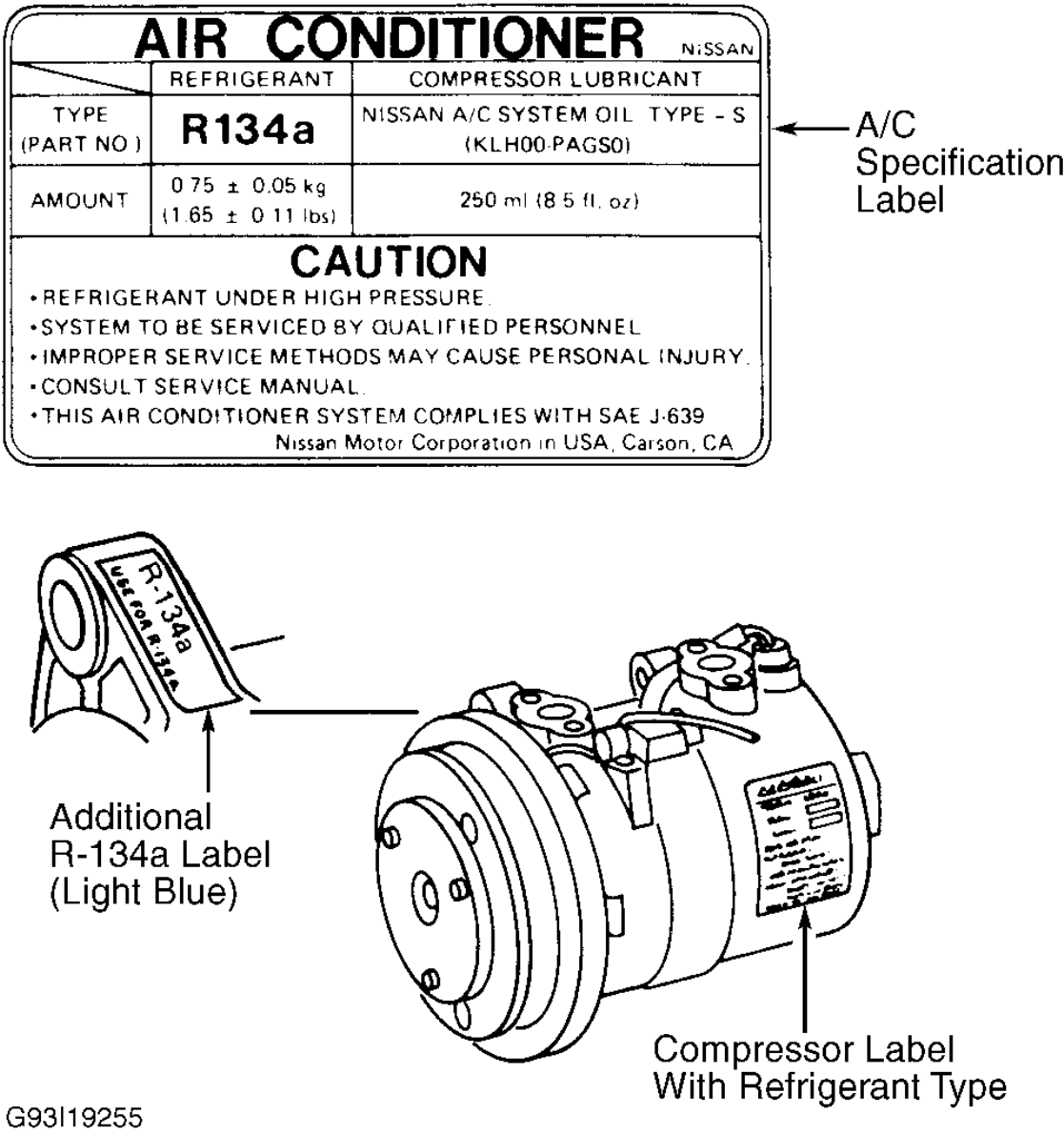


Fig. 2: Underhood A/C Specification Labels (Typical)
Courtesy of NISSAN MOTOR CO., U.S.A.

Other Means Of Identification

Refrigerant R-134a, when viewed through a sight glass, may have a "milky" appearance due to the mixture of refrigerant and lubricating oil. As the refrigerant and oil DO NOT exhibit a "clear" sight glass on a properly charged A/C system, R-134a systems have no sight glass.

Audi, Mercedes-Benz and Volkswagen use Green bands/labels on condenser, refrigerant lines, receiver-drier and expansion valve. Lexus A/C system hoses and line connectors have a groove, a White line and "R-134a" marked on them. See [Fig. 3](#) .

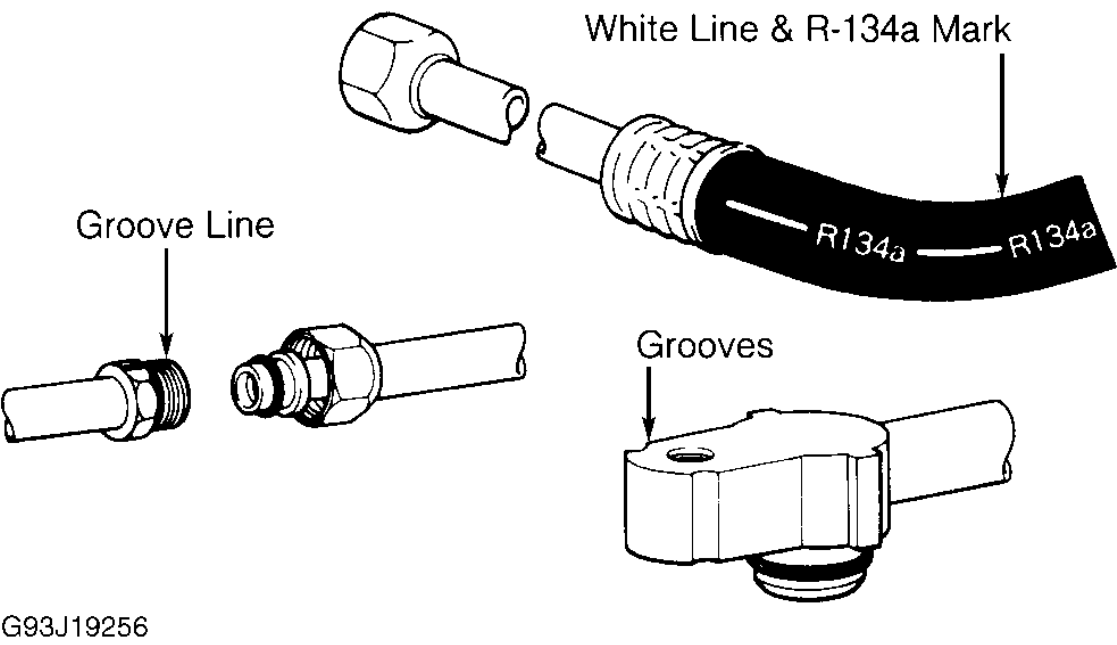


Fig. 3: Identifying R-134a Hose & Line Connectors (Lexus)
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

REFRIGERANT OILS

Refrigerant R-12 based systems use mineral oil, while R-134a systems use synthetic/Polyalkylene Glycol (PAG) oils. Using a mineral oil based lubricant with R-134a will result in A/C compressor failure due to lack of proper lubrication.

Use ONLY specified oil for the appropriate system and A/C compressor. Always check the underhood A/C specification label or A/C

compressor label before adding refrigerant oil to A/C compressor/system. See [Fig. 2](#) . The following R-134a refrigerant oils are currently available.

Lexus

PAG Refrigerant Oil (ND-OIL 8) with 10P/10PA swashplate (piston) compressor. Synthetic Refrigerant Oil (ND-OIL 9) with through-vane (rotary vane) compressor.

Mercedes-Benz

PAG Refrigerant Oil (001 989 08 03).

Nissan

PAG Refrigerant Oil (KLH00-PAGR0) with rotary vane compressor. PAG Refrigerant Oil (KLH00-PAGS0) with piston (swashplate) compressor.

Saab

PAG Refrigerant Oil (40 74 787).

NOTE: **Synthetic/PAG oils absorb moisture very rapidly, 2.3-5.6% by weight, as compared to a mineral oil absorption rate of .005% by weight.**

SERVICE EQUIPMENT

Because R-134a is not interchangeable with R-12, separate sets of hoses, manifold gauge set and recovery/recycling equipment are required to service vehicles. This is necessary to avoid cross-contaminating and damaging system.

All equipment used to service systems using R-134a must meet SAE standard J1991. The service hoses on the manifold gauge set must have manual (turn wheel) or automatic back-flow valves at the service port connector ends. This will prevent refrigerant from being released into the atmosphere.

For identification purposes, R-134a service hoses must have a Black stripe along its length and be clearly labeled SAE J2196/R-134a. The low pressure test hose is Blue with a Black stripe. The high pressure test hose is Red with a Black stripe, and the center test hose is Yellow with a Black stripe.

NOTE: **Refrigerant R-12 service hoses will ONLY be labeled SAE J2196.**

R-134a manifold gauge sets can be identified by one or all of the following.

- Labeled FOR USE WITH R-134a on set
- Labeled HFC-134 or R-134a on gauge face
- Light Blue color on gauge face

In addition, pressure/temperature scales on R-134a gauge sets are different from R-12 manifold gauge sets.

SYSTEM SERVICE VALVES

SCHRADER-TYPE VALVES

NOTE: **Although similar in construction and operation to a tire valve, NEVER replace a Schrader-type valve with a tire valve.**

Schrader valve is similar in construction and operation to a tire valve. When a test gauge hose with built-in valve core depressor is attached, Schrader stem is pushed inward to the open position and allows system pressure to reach gauge.

If test hose does not have a built-in core depressor, an adapter must be used. Never attach hose or adapter to Schrader valve unless it is first connected to manifold gauge set.

Refrigerant R-12 Schrader-type valve cores have TV5 thread size. Refrigerant R-134a Schrader-type valve cores use M6 (Metric) threads. R-134a valve cores can be easily identified by use of "O" rings and external spring. See [Fig. 1](#) .

SERVICE VALVE LOCATIONS

SERVICE VALVE LOCATIONS

Vehicle	High	Low
Audi	(14)	(15)
Acura	(2)	(3)
BMW	(4)	(5)
Chrysler, Eagle & Mitsubishi		
Colt, Mirage & Summit	(10)	(11)
Colt Vista & Summit Wagon	(10)	(11)
Diamante	(1)	(1)
Eclipse & Expo	(10)	(11)
Galant	(10)	(11)

Montero	(13)	(13)
Pickup & Ram-50	(10)	(11)
Precis	(12)	(12)
Stealth & 3000GT	(1)	(1)
Daihatsu	(4)	(5)
Ford Motor Co.	(4)	(5)
General Motors & Geo	(1)	(1)
Honda	(4)	(5)
Hyundai		
Elantra	(4)	(5)
Excel & Scoupe	(12)	(12)
Sonata	(10)	(11)
Infiniti	(4)	(5)
Isuzu	(4)	(5)
Jaguar	(4)	(5)
Lexus	(4)	(5)
Mazda		
B2200 & B2600i	(8)	(8)
Miata	(4)	(5)
Navajo	(6)	(7)
All Others	(1)	(1)
Mercedes-Benz	(4)	(5)
Nissan	(4)	(5)
Porsche		
1989-92 Carrera 911 2/4	(8)	(8)
Saab	(8)	(8)
Subaru		
Legacy & Loyale	(4)	(5)
SVX	(9)	(9)
Suzuki	(4)	(5)
Toyota		
Pickup & 4Runner	(13)	(13)
Supra	(10)	(11)
All Others	(4)	(5)
Volkswagen	(4)	(5)
Volvo	(4)	(5)
(1) Information is not available from manufacturer. (2) On high pressure line (near receiver-drier on Legend; on receiver-drier on Vigor). Use High-Side Adapter (J-25498). (3) On low pressure line (near right side of condenser on Legend). (4) On high pressure (discharge) hose/line. (5) On low pressure (suction) hose/line. (6) On high pressure line, between compressor and condenser. (7) On suction accumulator/drier. (8) On low and high pressure hoses, behind compressor. (9) On receiver/drier and low pressure hose (near compressor). (10) On compressor high pressure (discharge) hose. (11) On compressor low pressure (suction) port. (12) On compressor discharge hose and accumulator. (13) On compressor discharge and suction ports. (14) Remove high pressure cut-out switch to expose high pressure service valve. (15) Remove low pressure switch to expose low pressure service valve.		

REFRIGERANT RECOVERY/RECYCLING

Refrigerant recovery/recycling equipment is used to remove refrigerant from vehicle's A/C system without polluting atmosphere. To remove and recycle refrigerant, connect the recovery/recycling system and follow instructions provided with the system.

The removed refrigerant is filtered, dried and stored in a tank within the recovery/recycling system until it is ready to be pumped back into the vehicle's A/C system. With refrigerant stored in the recovery/recycling system, A/C system can be opened without polluting atmosphere.

NOTE:

Separate sets of hoses, gauges and refrigerant recovery/recycling equipment MUST be used for R-12 and R-134a based systems. DO NOT mix R-12 and R-134a refrigerants, as their refrigerant oils and desiccants are NOT compatible. On systems with R-134a refrigerant, use Polyalkylene Glycol (PAG) wax-free refrigerant oil.

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A/C SYSTEM PRECAUTIONS

A/C GENERAL SERVICING A/C System Servicing cautions

BEFORE OPENING THE SYSTEM

CAUTION: **When discharging air conditioning system, use only approved refrigerant recovery/recycling equipment. Make every attempt to avoid discharging refrigerant into the atmosphere.**

Before disconnecting any lines or fittings, the system must be completely discharged using approved refrigerant recovery/recycling equipment.

DISCHARGING A/C SYSTEM

NOTE: **Recent findings by the EPA indicate that R-11, R-12 and R-113 are harmful to the Earths' protective Ozone layer. Make every attempt possible, to avoid discharging R-11, R-12 or R-113 into the atmosphere.**

1. Remove service valve caps and install gauges. For high side gauge hose, Adapter (D81L-19703-A) must be used to connect to high side service valve.
2. Place open end of center hose in garage exhaust outlet or in a well ventilated area. Slightly open low side gauge valve and let refrigerant escape slowly without loosing refrigerant oil.
3. When system is nearly discharged, using approved refrigerant recovery/recycling equipment, open high side gauge valve to release any pressure trapped in compressor. Close valves immediately after discharging to prevent entry of moisture.

DISCONNECTING LINES & FITTINGS

1. After system is discharged, using approved refrigerant recovery/recycling equipment, carefully clean entire area around coupling nut to prevent dirt entering system. Always use two wrenches to avoid twisting or distorting lines and fittings (hold fitting with one wrench while loosening coupling nut with second wrench).
2. Ford spring-coupling fittings require a special coupling tool (Motorcraft YT-1056) to open or close. See procedure under Connecting Lines and Fittings.
3. Cap or plug all LINES and FITTINGS immediately to prevent entry of air and moisture into system. Do not remove these caps until connections are being made.

COMPONENT REPLACEMENT

When components are replaced, system oil level must be adjusted. Add refrigeration oil to replacement component. See Compressor oil Check article, as well as COMPONENT OIL REPLACEMENT QUANTITIES chart under A/C SYSTEM SPECS article in this section.

USING R-12 REFRIGERANT - SAFETY PRECAUTIONS

1. Always work in a well-ventilated, clean area. Refrigerant (R-12) is heavier than oxygen, and will displace oxygen in a confined area. Always wear eye protection when working around air conditioning systems and R-12. The system's high pressure can cause severe injury to eyes and skin if a hose were to burst. R-12 evaporates quickly when exposed to atmosphere, freezing anything it contacts.
2. Use care when handling refrigerant containers. DO NOT drop or strike containers or expose refrigerant containers to excessive heat. Containers must never be heated more than 125°F (52°C). Never expose R-12 directly to open flame.

CAUTION: **When R-12 is exposed to an open flame, drawn into a running engine, or detected with a Halide (propane) leak tester, poisonous phosgene gas is formed. Keep work areas ventilated and avoid running engines near work area.**

USING INDIVIDUAL R-12 CANS

Disposable refrigerant cans (referred to as one pound cans) have a flat type seal or a screw type seal, and proper can tap must be used for each type. Be sure sealing gasket on can tap is in good condition. A proper safety can tap will prevent refrigerant from flowing back into open can, as tap has a one-way flow control.

NOTE: **Recent findings by the EPA indicate that refrigerant is harmful to the Earth's protective Ozone layer. When discharging refrigerant avoid allowing refrigerant to enter the atmosphere. Refrigerant recovery system should be used when discharging the system.**

MULTI-CAN DISPENSING VALVES

A multi-can dispensing valve allows attachment of several cans of refrigerant, and is a good substitute when a bulk container is not available. Cans are installed onto each leg of multi-can dispensing valve in the same manner as the individual cans, and each leg has its own can tap.

CAN TAP INSTALLATION FLAT TYPE SEAL CANS

On cam-lock or one-piece can taps, first turn the handle outward to the fully open position. Securely engage locking lugs over the can flange, and lock them in place by turning cam lock or locking nut. Screw tap assembly into adapter so sealing gasket is fully seated against the can top. Turn tap inward to pierce the can and close the tap. DO NOT open tap until ready to purge the service hose or dispense refrigerant into the system.

On 2-piece can taps, be certain tap handle is turned fully inward to the closed position. Check that locking base is turned to its outer limit. Securely engage locking lugs over the can flange. Turn entire tap assembly (without disturbing the closed setting) downward into the locking base to pierce the can. DO NOT open tap until ready to dispense into system.

SCREW TYPE SEAL CANS

Ensure can tap is fully closed. Screw refrigerant can into can tap fitting until tight. This will pierce the can. Connect tap to center hose on manifold gauge set. DO NOT open tap until ready to dispense R-12 into system.

WARNING: DO NOT open high side hand valve while air conditioning system is in operation. This high pressure could rupture can or fitting at safety can valve, resulting in damage and personal injury.

CONNECTING LINES & FITTINGS

1. A new "O" ring should be used in all instances when connecting lines and fittings (dip "O" ring in clean refrigeration oil and make certain it is not twisted during installation). Always use two wrenches to avoid twisting or distorting lines and fittings, tighten coupling nuts securely.
2. Ford spring-coupling fittings require a special coupling tool (Motorcraft YT-1056) to open or close. Use the following procedure to connect or disconnect the spring-coupling fitting.

Ford Spring-Coupling Fitting

1. Discharge system using approved refrigerant recovery/recycling equipment. Place proper end of tool over refrigerant line. Tool fits both 3/8" and 1/2" fittings. Push tool into fitting cage to release spring inside. Pull lines apart and remove tool.
2. Before connecting, check internal spring for damage. If necessary, pry spring out and replace it. Clean fittings and install new "O" rings.

CAUTION: Use ONLY "O" rings designed for these Ford fittings (Motorcraft YF-982). Normal refrigerant "O" rings will NOT seal.

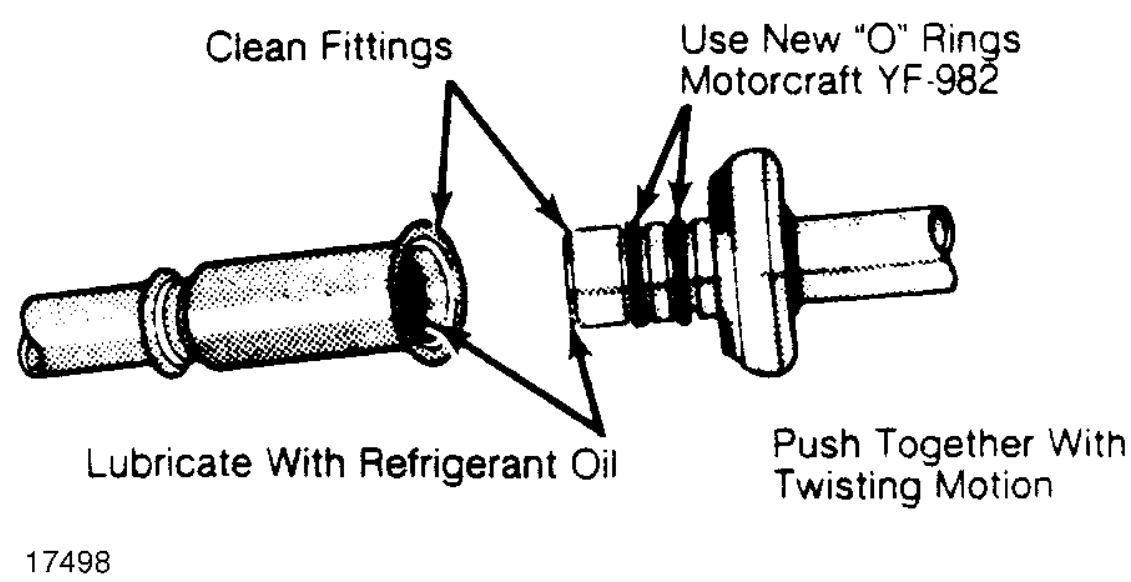


Fig. 1: Assembling Ford Spring-Coupling Fitting

PLACING SYSTEM IN OPERATION

After component replacement and/or system servicing has been completed and all connections have been made, proceed as follows:

1. Evacuate the system using a vacuum pump.
2. Charge the system with new R-12 (refrigerant) according to each individual vehicle as outlined in the GENERAL SERVICING article. Also see Refrigerant Capacity in this Section.
3. Leak test the system, with particular attention to all new connections and components.
4. Make a performance test of the system. Never assume that a recharging has automatically corrected a problem.

COMPRESSOR REMOVAL INFORMATION - ISOLATION METHOD

On systems which have compressors equipped with stem-type service valves (Tecumseh), it is possible to isolate the compressor for removal.

Isolating

Turn both high and low pressure manual valves to extreme clockwise (front seat) position. Loosen cap on high pressure manual valve connection to compressor and allow gas to escape until compressor is relieved of pressure.

COMPRESSOR REMOVAL INFORMATION-DISCHARGE METHOD

This procedure is to be used on vehicles which have compressor equipped with Schrader service valves. In these cases, the compressor cannot be isolated and the system must be discharged, using approved refrigerant recovery/recycling equipment, prior to compressor removal.

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1991 GENERAL SERVICING

A/C System Specifications - Applications & Oil/R-12 Capacities

COMPRESSOR APPLICATIONS - PASSENGER CARS

COMPRESSOR APPLICATIONS - PASSENGER CARS

Application	Compressor
Continental	Ford FX-15 10-Cyl.
Cougar & Thunderbird	Ford FX-15 10-Cyl.
Crown Victoria, Grand Marquis & Town Car	Ford FX-15 10-Cyl.
Escort & Tracer	Nippondenso 10P13 10-Cyl.
Mark VII	Nippondenso 10PA17 10-Cyl.
Mustang	
2.3L Engine	Nippondenso 10P15 10-Cyl.
5.0L Engine	Nippondenso 6P-148 6-Cyl.
Probe	
2.2L Engine	Nippondenso 10P15A 10-Cyl.
3.0L Engine	Nippondenso 10P15 10-Cyl.
Sable & Taurus	
2.5L Engine	Ford FS-6 6-Cyl.
3.0L & 3.8L Engines	Ford FX-15 10-Cyl.
3.0L SHO Engine	Nippondenso 10P15F 10-Cyl.
Tempo & Topaz	Nippondenso 10P15 10-Cyl.

COMPRESSOR APPLICATIONS - LIGHT TRUCKS & VANS

COMPRESSOR APPLICATIONS - LIGHT TRUCKS & VANS

Application	Compressor
Aerostar	Ford FX-15 10-Cyl.
Bronco	Ford FX-15 10-Cyl.
"E" Series	Ford FS-6 6-Cyl.
Explorer	Ford FX-15 10-Cyl.
"F" Series	
7.3L Diesel	Ford FS-6 6-Cyl.
Gas Engine Models	Ford FX-15 10-Cyl.
Ranger	
2.3L Engine	Ford FX-15 10-Cyl.
2.9L Engine	Ford FS-6 6-Cyl.
4.0L Engine	Ford FX-15 10-Cyl.

BODY CODE DESIGNATIONS - LIGHT TRUCKS & VANS

BODY CODE DESIGNATIONS - LIGHT TRUCKS & VANS

Model	Designation
Aerostar	"A" Series
Bronco & Explorer	"U" Series
Pickups (Full Size)	"F" Series
Ranger	"R" Series
Vans (Full Size)	"E" Series

REFRIGERANT OIL & R-12 CAPACITY - PASSENGER CARS

PASSENGER CAR REFRIGERANT OIL & R-12 CAPACITY

Application	1 Oil Ounces	R-12 Ounces
Continental	8.0	40
Cougar & Thunderbird	7.0	40
Crown Victoria, Grand Marquis & Town Car	7.0	40-48
Escort & Tracer	8.0	36
Mark VII	8.0	40
Mustang		
10P15 Compressor	8.0	40
6P148 Compressor	10.0	40
Probe		
10P15 Compressor	8.0	40
10P15A Compressor	3.3	40
Sable & Taurus		
FS-6 Compressor	10.0	44
FX-15 Compressor	7.0	44
10P15 Compressor	8.0	40

10P15F Compressor	8.0	40
Tempo & Topaz	8.0	36
(1) Total system capacity, unless otherwise noted.		

REFRIGERANT OIL & R-12 CAPACITY - LIGHT TRUCKS & VANS

LIGHT TRUCK & VAN REFRIGERANT OIL & R-12 CAPACITY

Application	(1) Oil Ounces	R-12 Ounces
Aerostar (FX-15 Compressor)		
W/Auxiliary Unit	10.0	(2) 56
W/O Auxiliary Unit	7.0	56
Bronco	7.0	52
Explorer	10.0	32
"E" Series		
W/Rear Unit	10.0	72
W/O Rear Unit	7.0	60
"F" Series	7.0	52
Ranger		
FS-6 Compressor	10.0	32
FX-15 Compressor	7.0	36
(1) Total system capacity, unless otherwise noted.		
(2) Models with auxiliary unit may require additional refrigerant. See decal under hood for capacity.		

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HEATER SYSTEM

1990-92 HEATER SYSTEMS Ford Motor Co.

DESCRIPTION

The heater system consists of control panel, blower case, heater case, air control doors and ducts. The control panel incorporates 3 control levers and a 3-speed fan switch. The control panel is located in the center of the instrument panel. All air control doors are cable operated from the control panel.

The blower case is mounted on the bulkhead, behind the instrument panel on passenger's side of vehicle. The blower case houses a blower motor, blower motor resistor and the fresh/recirculation air door. The heater case contains mode select door, temperature air mix door and heater core.

OPERATION

Three control levers, temperature mix, fresh/recirculation and mode select, mechanically operate their associated cables and doors. The temperature control lever adjusts the mix of fresh or recirculated air with heated air. In full heat position, all airflow goes through the heater core.

In full cool position, the mix air door closes, allowing airflow to by-pass the heater core. The mode select lever, directs airflow to selected vents. The fresh/recirculation control lever allows selection of fresh (outside) air or recirculated compartment air.

AJUSTMENT

FRESH/RECIRCULATION CONTROL CABLE

Remove the glove box. Remove fresh/recirculation cable retaining clip. Move control lever to RECIRCULATION position, while holding the lever door in RECIRCULATION position. Ensure control lever does not move. Install fresh/recirculation cable retaining clip.

MODE SELECT CABLE

Remove mode select cable retaining clip. Move mode select lever to VENT position. Hold mode select lever downward against its stop. Ensure that mode select lever does not move. Install mode select cable retaining clip.

TEMPERATURE CONTROL CABLE

Set temperature control lever to maximum cold position. Remove temperature cable retaining clip. Hold temperature control lever upward and against its stop. Ensure that temperature lever does not move. Install temperature cable retaining clip.

TROUBLE SHOOTING

BLOWER MOTOR INOPERATIVE

Check blown motor fuse. Check for defective blower motor and/or blower motor resistor. Check blower motor switch. Check for open in ground wire. Check for loose electrical connectors or poor connections. See [WIRING DIAGRAMS](#) in this article.

BLOWER DOES NOT CHANGE SPEED

Check for defective blower motor. Check blower motor wiring harness. Check blower motor resistor. Check for blower motor fan switch. See [WIRING DIAGRAMS](#) in this article.

BLOWER RUNS CONSTANTLY

Check for defective blower motor resistor. Check for short in blower switch or wiring. See [WIRING DIAGRAMS](#) in this article.

HEATER TEMPERATURE INSUFFICIENT

Check for proper coolant level. Check water pump for noise, leaks or wear. Check heater hoses for leaks or restrictions. Check heater core for leaks, plugs or restrictions. Check inlet and outlet heater hoses for hot water flow. Check thermostat condition and operation. Check air mix door position and adjust cable if necessary.

IMPROPER WARM AIR DISTRIBUTION

Check air mix door position. Adjust cable as necessary. Check function control door position. Adjust cable as necessary. Check for restriction in ventilation air duct assembly. Repair as necessary.

TESTING BLOWER MOTOR & RESISTOR

1. Ensure 15-amp blower motor fuse is okay. Using voltmeter, check for battery voltage at blower motor Blue/Yellow terminal. If battery voltage is present, go to next step. If battery voltage is not present, repair open in Blue/Yellow wire between blower motor and fuse box.
2. Disconnect blower motor connector. Using a jumper wire, apply battery voltage to Blue/Yellow terminal and ground the Blue/Red terminal. If blower motor does not run, replace blower motor. If blower motor runs, go to next step.
3. Reconnect blower motor connector. Turn ignition on. Turn blower motor off. Disconnect the blower motor resistor connector. Using a voltmeter, measure voltage at Blue/Red terminal of resistor connector. If battery voltage is not present, repair open in Blue/Red wire between resistor and blower motor. If voltage is present, go to next step.
4. Using a jumper wire, ground Blue/Black, Blue/Yellow and Blue/White terminals of the blower fan switch one at a time. If the motor runs at 3 different speeds, go to next step. If not, repair open in wire that failed to operate blower motor.

5. Check blower motor fan switch continuity. Resistance should not exceed 4 ohms. See **BLOWER MOTOR FAN SWITCH CONTINUITY** table. If continuity is not present, replace fan switch. If continuity is okay, repair open in Black wire from blower motor switch to ground.

BLOWER MOTOR FAN SWITCH CONTINUITY

Switch Position	Continuity Between Wire Colors
1	Black-to-Blue/White
2	Black-to-Blue/Yellow & Blue/Yellow-to-Blue/Red
3	Black-to-Blue/Black & Blue/Black-to-Blue/Red

REMOVAL & INSTALLATION

CONTROL PANEL

1. Remove bezel screws and accessory bezel. Remove radio. Remove 4 screws securing control panel to instrument panel. Remove glove box attaching screws and glove box. Remove the retaining clip and disconnect fresh/recirculation air door cable from mode door lever.
2. Disconnect mode select cable at mode control door lever. Disconnect temperature control cable at temperature control mode door lever. Pull control panel away from instrument panel. Disconnect blower motor switch connector. Disconnect illumination electrical connector. Remove control panel. To install, reverse removal procedure. Adjust control cables. See ADJUSTMENTS in this article.

BLOWER MOTOR FAN SWITCH

Remove control panel. See **CONTROL PANEL R & I** . Remove blower motor fan switch knob. Remove attaching nut. To install, reverse removal procedure.

HEATER CORE

1. Disconnect negative battery cable. Remove steering wheel by prying out center trim insert and removing steering wheel retaining nut. Remove 2 steering wheel cover retaining screws and remove cover. Using a steering wheel puller, remove steering wheel.
2. Remove 5 screws and remove lower and upper steering column covers. Disconnect electrical connections and remove multifunction switch. Remove 5 screws and pull instrument cluster hood rearward. Disconnect electrical connections and remove instrument cluster hood.
3. Disconnect speedometer cable at transaxle. Remove 4 instrument cluster screws. Pull instrument cluster rearward and disconnect speedometer cable and electrical connections. Remove instrument cluster.
4. Remove 2 center bracket mounting bolts under steering column and remove bracket. Remove glove box attaching screws and remove glove box. Remove left and right heater ducts. Remove fuse panel cover. Remove 2 screws securing fuse panel and push fuse panel inward. DO NOT remove fuse panel.
5. Slide both seats to most forward position. Remove 2 console attaching screws, located in front of seat belt anchors. Slide both seats to rearmost position. Remove parking brake console insert. Using a Phillips screwdriver, remove push retainer insert, located at front lower edge of parking brake console. Pull back on parking brake lever and remove parking brake console.
6. Remove gearshift knob. Remove screws and remove shift console. Remove radio/heater control panel bezel screws and remove bezel. Remove 4 radio attaching screws. Pull radio out and disconnect antenna lead and electrical connections. Disconnect radio ground lead and remove radio.
7. Remove 4 screws attaching heater control panel. Disconnect control cables and electrical connections. Remove control panel, while pulling cables through opening.
8. Pry out bolt cover trim inserts in top corners of dash. Remove bolts located under trim panels. Remove 7 instrument panel attaching bolts and 2 nuts. Pull instrument panel rearward. Disconnect any harness connectors and clips. Remove instrument panel.
9. Disconnect electrical connections at blower and resistor. Remove harness from routing brackets on heater box. Loosen clamp screw securing air inlet housing. Remove attaching nuts at top and bottom of heater box. Disconnect defroster ducts and remove heater assembly.
10. Disconnect link connecting 2 defroster doors. Remove attaching screw just above and to right of blower resistor. Turn heater assembly around and remove screw just to left of blower motor opening. Remove clips securing 2 halves of heater assembly. Separate halves. Lift out heater core.
11. To install, reverse removal procedure. Ensure all heater control cables are routed and adjusted properly. See ADJUSTMENTS in this article. Fill cooling system. Check for leaks.

BLOWER MOTOR & RESISTOR

Disconnect negative battery cable. Remove instrument panel spacer brace located below steering column. Remove airflow duct below steering column. Disconnect blower motor or resistor wiring. Remove 3 blower motor attaching screws or 2 resistor attaching screws and remove component. To install, reverse removal procedure.

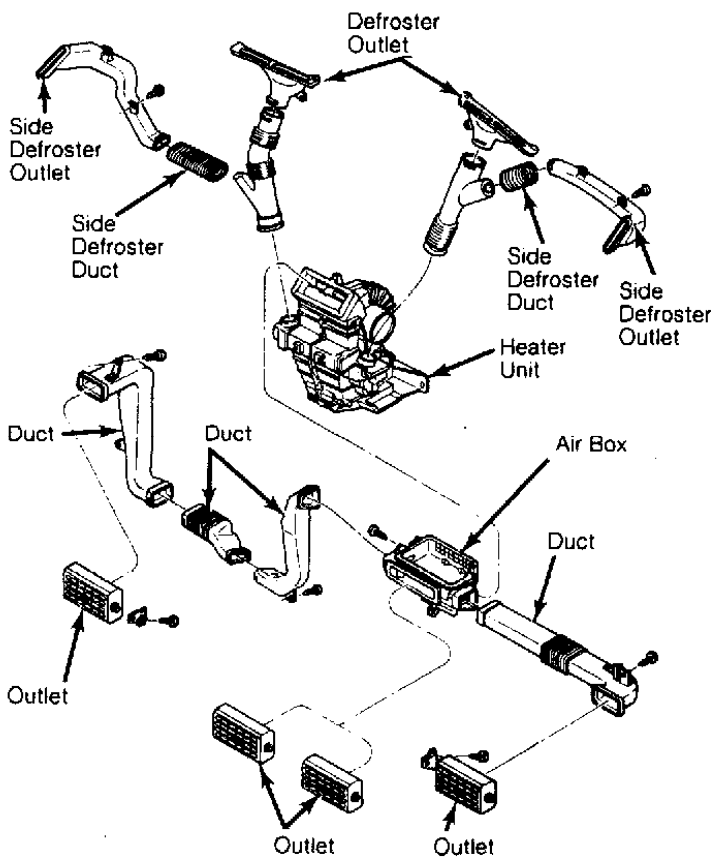


Fig. 1: Exploded View of Heater Unit
Courtesy of FORD MOTOR CO.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	INCH Lbs. (N.m)
Steering Wheel Nut	29-36 (39-49)

WIRING DIAGRAMS

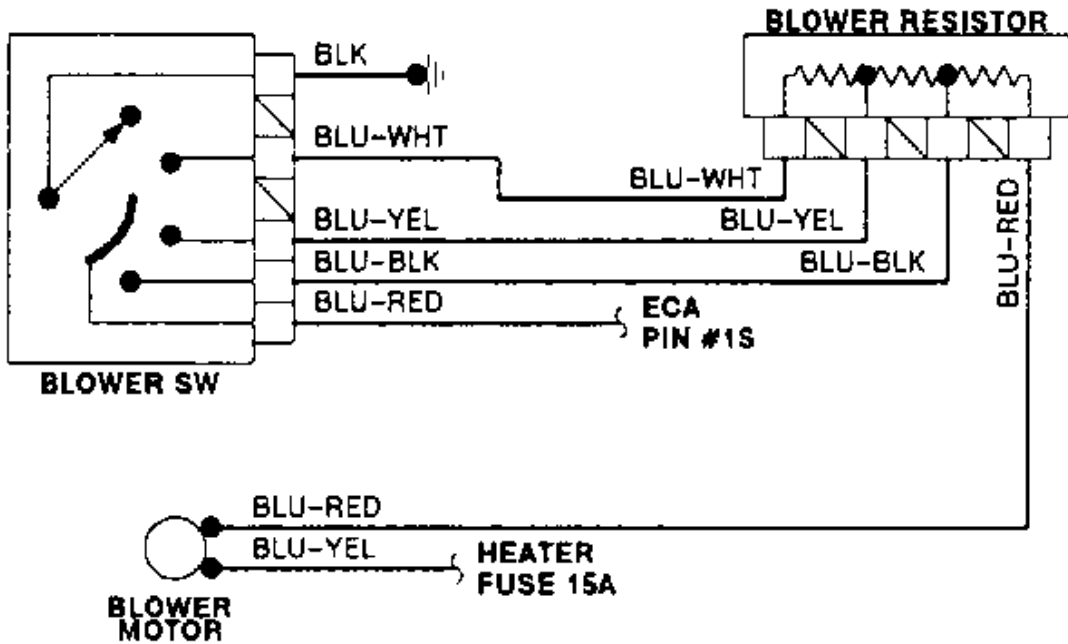


Fig. 2: Heater Wiring Diagram

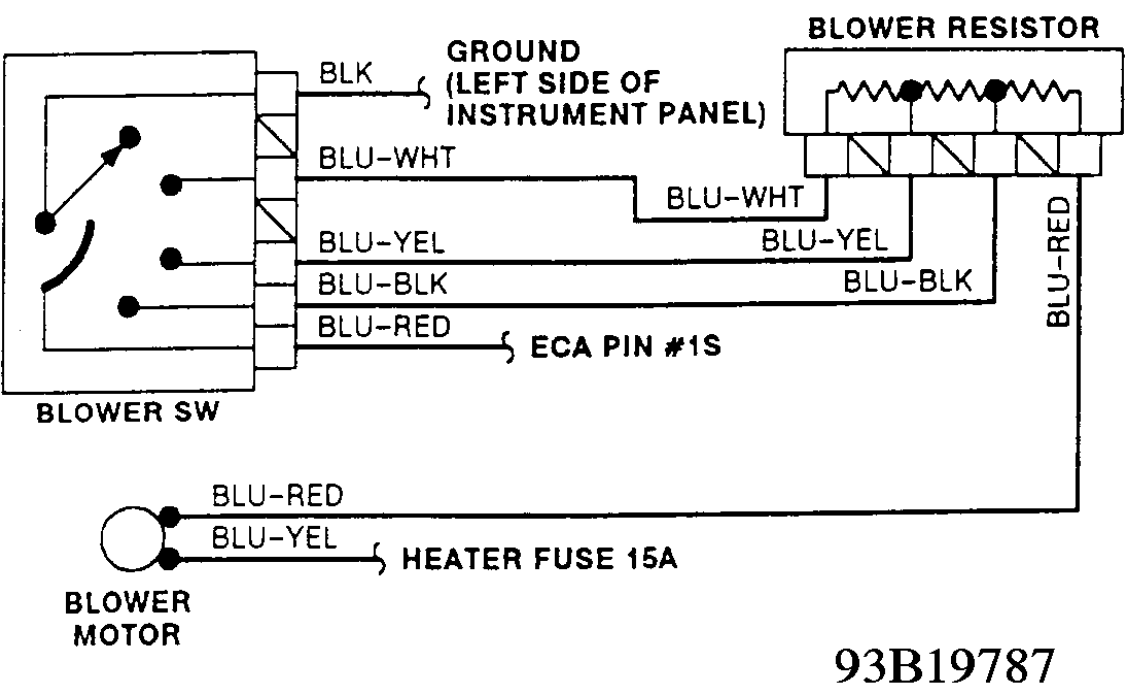


Fig. 3: Heater Wiring Diagram (1992 Model)

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1991 AIR CONDITIONING & HEAT

MANUAL A/C

A/C SYSTEM SPECIFICATIONS

CAUTION: When discharging air conditioning system, use only approved refrigerant recovery/recycling equipment. Make every attempt to avoid discharging refrigerant into the atmosphere.

SPECIFICATIONS

Application	Specification
Compressor Type	Nippondenso 10-Cylinder
Refrigerant (R-12) Capacity	25 ozs.
System Oil Capacity	10 ozs.
Compressor Belt Deflection	
New	9/32-11/32" (8-9 mm)
Used	11/32-7/16" (9-11 mm)
System Operating Pressure ⁽¹⁾	
Low Side	19-25 psi (1.3-1.7 kg/cm ²)
High Side	199-220 psi (13.9-15.4 kg/cm ²)
(1) When measured at 79°F (26°C).	

DESCRIPTION

This A/C-heater system is fully integrated to provide cooling, heating and ventilation with either fresh or recirculated air. A/C system is expansion valve type. Interior air temperature is controlled by cycling the compressor on and off at different rates. A/C compressor is protected by a low pressure switch, which stops compressor operation when refrigerant pressure is too low. Compressor operation is cut when throttle is wide open to improve driveability.

The primary system components are compressor, receiver-drier, evaporator, low pressure switch, thermostatic switch, thermostatic expansion valve, A/C control module, refrigerant lines and air ducts. See [Fig. 1](#) and [Fig. 2](#) . The heater core is continuously supplied with coolant. To control temperature, air goes through and/or around heater core by way of temperature blend door.

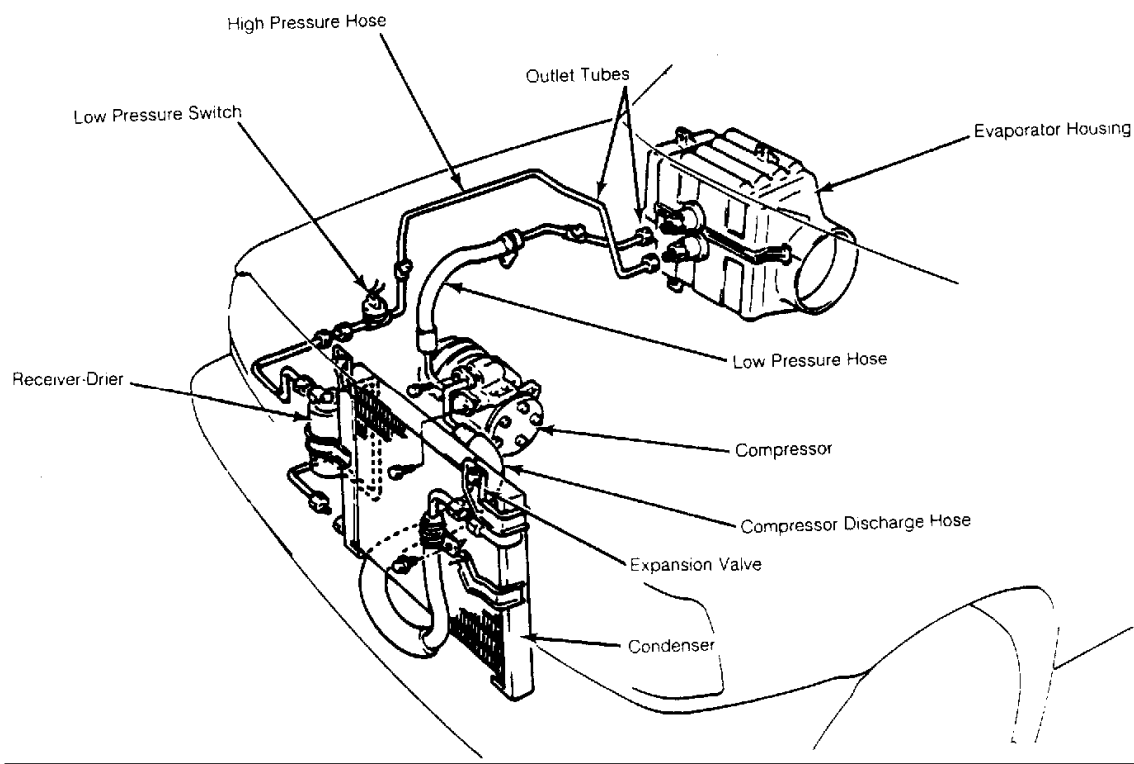


Fig. 1: Identifying A/C System Components
Courtesy of FORD MOTOR CO.

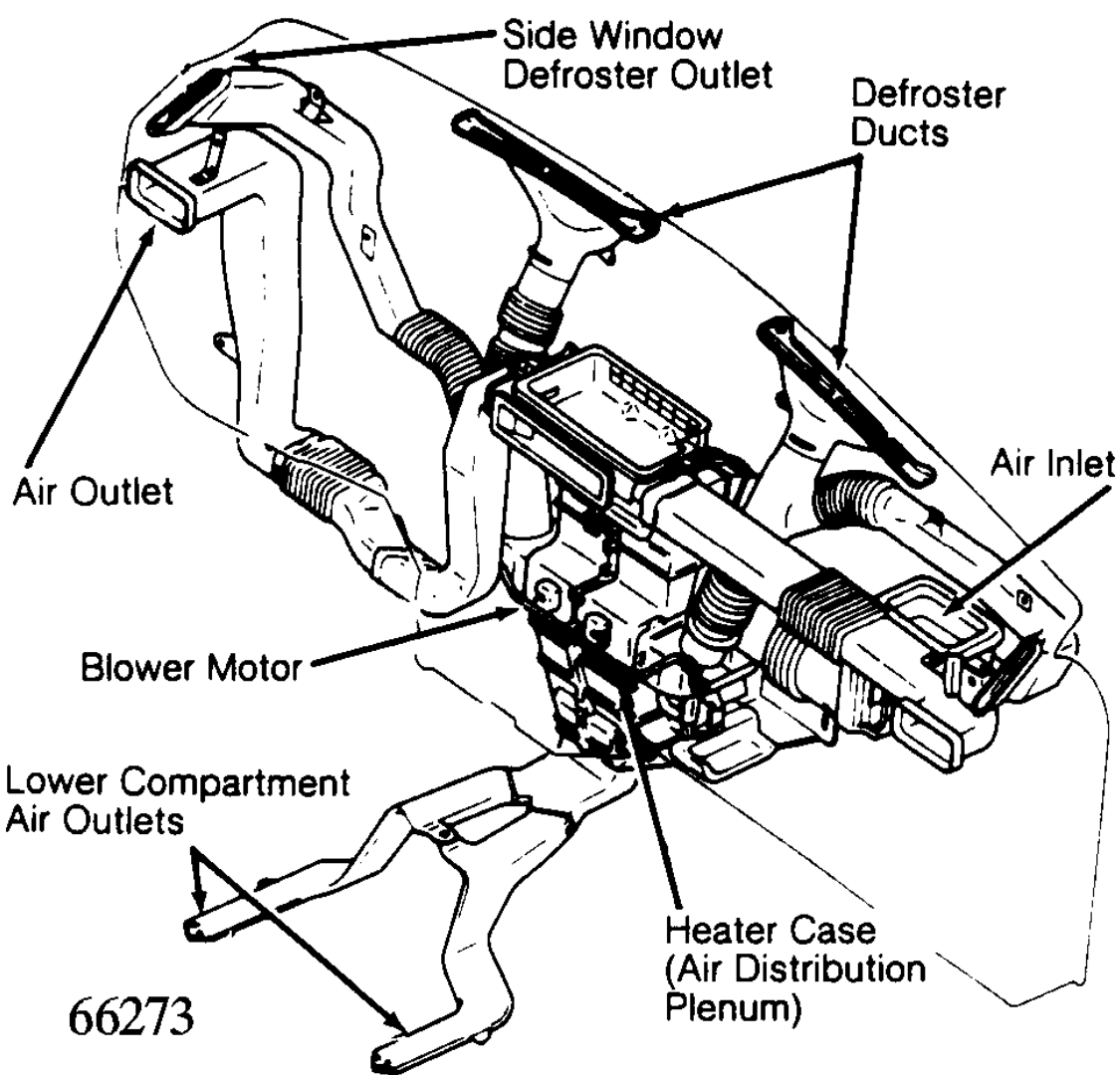


Fig. 2: Identifying A/C-Heater Air Distribution Components
Courtesy of FORD MOTOR CO.

OPERATION

A/C-HEATER CONTROL PANEL

The A/C-heater panel is located in the center of instrument panel above the radio. Air discharge outlets are located above, below, in center and on both sides of instrument panel. The climate control panel consists of 3 slide levers, one A/C on-off push button and a rotary blower switch.

The lower slide lever is used to control temperature. Sliding lever from far left side (cool) to far right side (warm) increases interior temperature. The middle slide lever selects fresh air from outside or recirculated air from inside. The upper slide lever controls air delivery mode. A/C push-button on-off switch activates air conditioning system.

THERMOSTATIC SWITCH

With A/C system operating, thermostatic switch determines A/C compressor clutch on-time. Control is accomplished by a cable attached between the temperature blend lever and thermostatic switch. The thermostatic switch sensing tube is installed into (or near) evaporator fins.

Switch is wired in series with A/C relay and Electronic Control Assembly (ECA). The ECA calculates compressor on-time based on A/C relay signals. This controls evaporator temperature to regulate cool air entering vehicle.

THERMOSTATIC EXPANSION VALVE

The Thermostatic Expansion Valve (TXV) is a controlling device metering liquid refrigerant from high pressure line into evaporator. It also provides for complete vaporization of all refrigerant entering evaporator.

The high refrigerant pressure is reduced before entering evaporator by a ball valve within TXV. Depending on pressure applied to TXV diaphragm from both sides of system, TXV allows more or less high pressure refrigerant to be discharged through its orifice into evaporator. See [Fig. 3](#) .

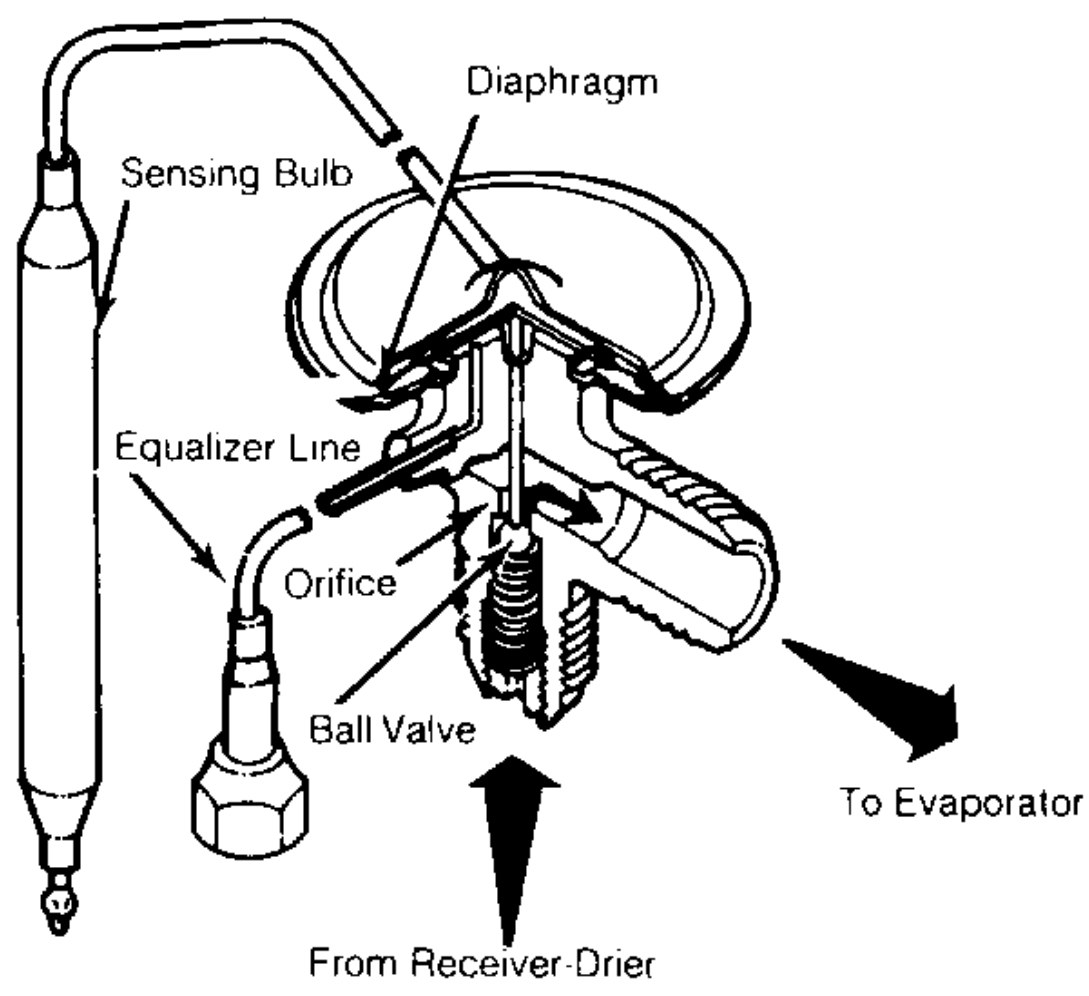


Fig. 3: Cross-Sectional View of Thermostatic Expansion Valve
Courtesy of FORD MOTOR CO.

ADJUSTMENTS

TEMPERATURE CONTROL CABLE

Temperature control cable is located at left base of evaporator housing. See [Fig. 4](#) . Release cable retaining clip. Position temperature control knob in maximum cool position. While holding thermostat cable in maximum cool position, secure cable casing using retaining clip.

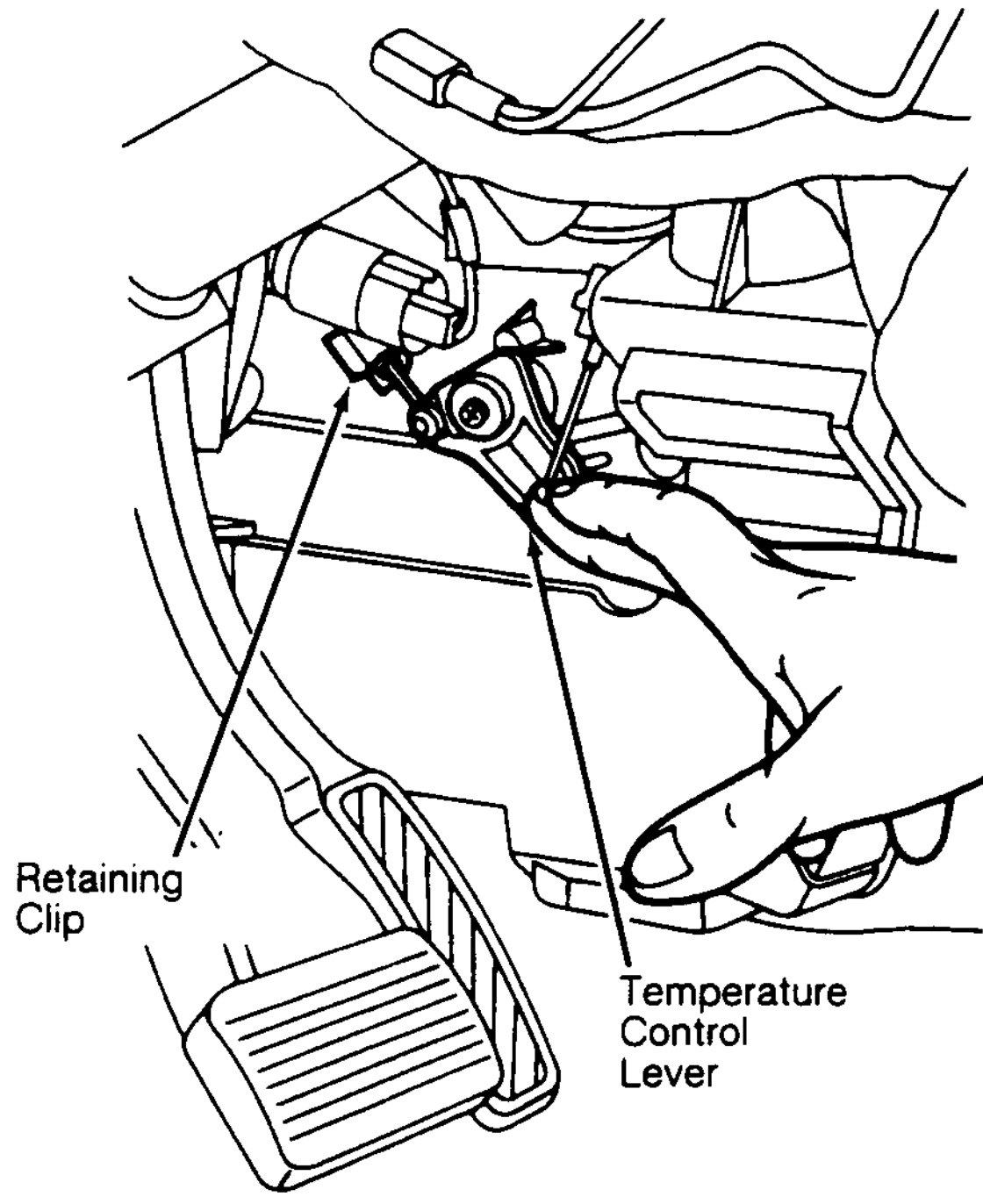


Fig. 4: Adjusting Temperature Control Cable
Courtesy of FORD MOTOR CO.

RECIRCULATED/FRESH AIR DOOR CABLE

Remove glove box retaining screws and glove box. Release cable retaining clip. See [Fig. 5](#) . Move control knob to recirculation position. Hold door lever in recirculation position, and secure cable casing using retaining clip. Install glove box.

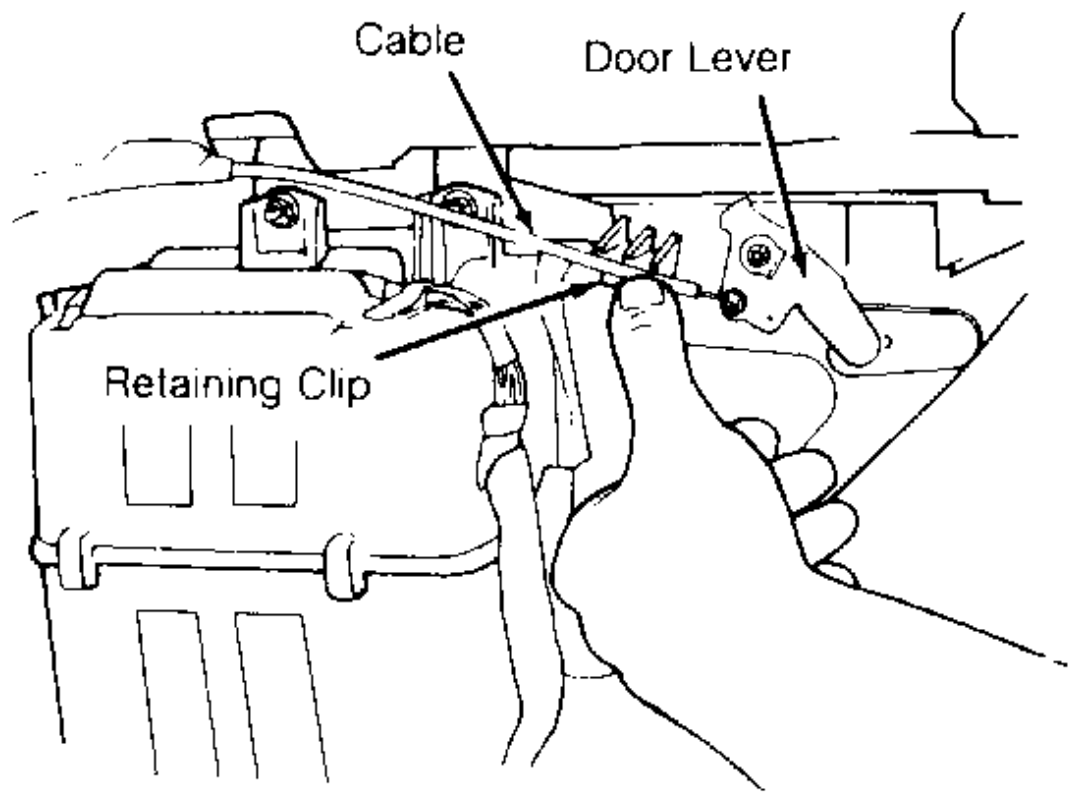


Fig. 5: Adjusting Recirculated/Fresh Air Door Cable
Courtesy of FORD MOTOR CO.

MODE SELECTOR CABLE

1. Remove air distribution plenum and instrument panel brace. See **AIR DISTRIBUTION PLENUM** under REMOVAL & INSTALLATION. Release cable retaining clip. See **Fig. 6** .
2. Move control knob to vent position. While holding lever downward against stop, secure cable using retaining clip.
3. Disconnect defrost door link at defrost door lever. While holding defrost door upward against its stop, adjust defrost door link to a free fit in defrost door lever. Install air distribution duct. Install instrument panel brace.

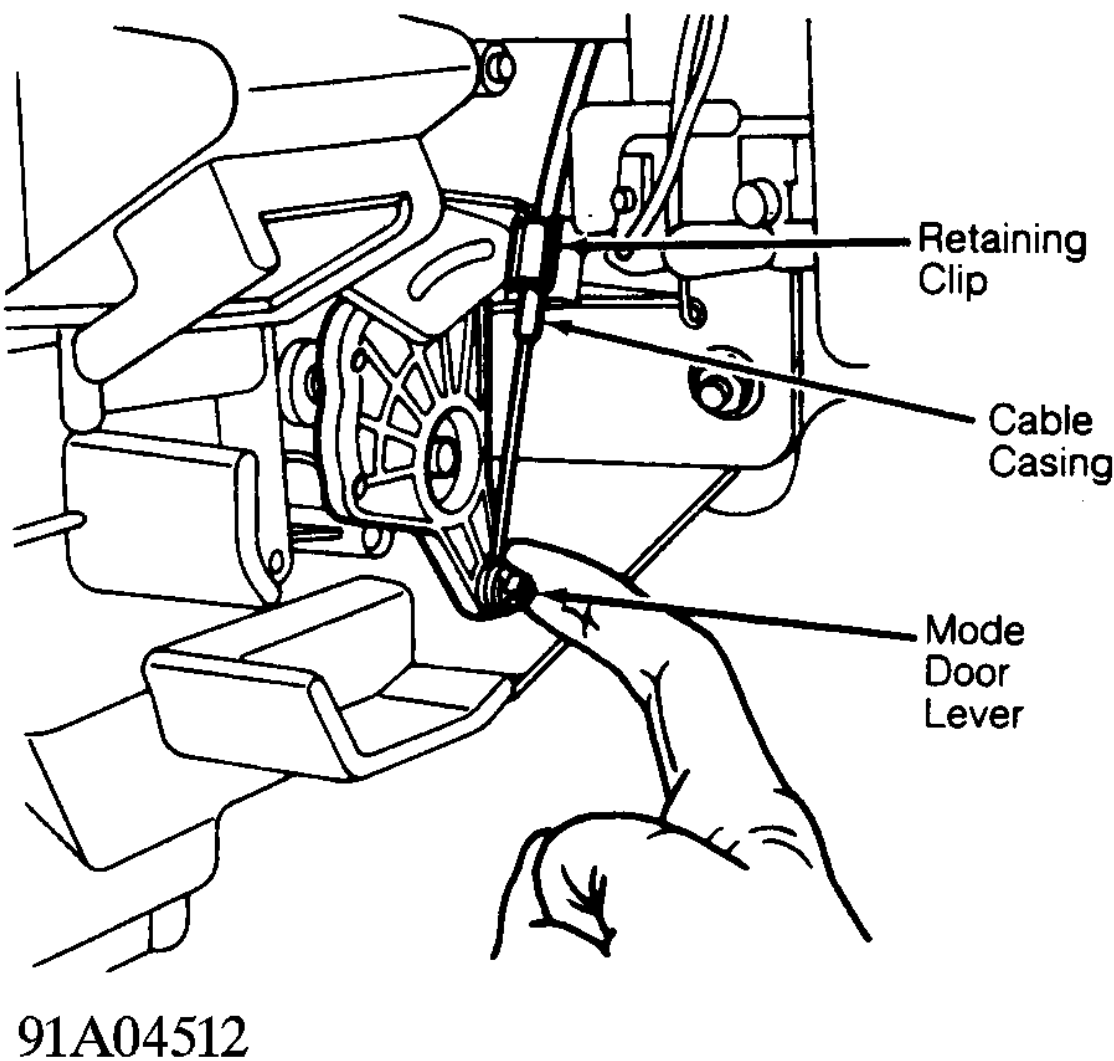


Fig. 6: Adjusting Mode Select Cable
Courtesy of FORD MOTOR CO.

TROUBLE SHOOTING

NOTE: Use the following trouble shooting charts to diagnose air conditioning system problems.

COMPRESSOR CLUTCH TROUBLE CHARTS

TEST STEP		RESULT	ACTION TO TAKE
CC1	SYSTEM INTEGRITY CHECK		
• Check for fully charged battery. • Check for blown fuses, corrosion, poor electrical connections, signs of opens, shorts or damage to the wiring harness. • Key on, engine idling. • A/C on. • Blower on. • Shake the wiring harness vigorously and look for signs of opens or shorts. • Tap each connector and look for signs of bad connections. • Does the system appear to be in good condition?		Yes	GO to CC2 .
		No	REPAIR or REPLACE faulty components as required. NOTE: If a blown fuse is replaced and falls immediately, there is a short to ground in the system.

Fig. 7: Compressor Clutch Trouble Chart CC1
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CC2	CHECK FOR POWER CLUTCH		
• Key on, engine off. • A/C on, blower on. • Measure voltage at compressor clutch electrical connector (BK/W terminal). • Is reading greater than 10V?		Yes	Turn key off. GO to CC3 .
		No	GO to CC4 .

BK/W = Black/White

Fig. 8: Compressor Clutch Trouble Chart CC2
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CC3	CHECK CLUTCH RESISTANCE		
• Key off, A/C off. • Allow engine to cool. • Disconnect compressor clutch electrical connector. • Measure resistance between compressor clutch connector (clutch side) and compressor clutch case. • Is reading between 2.7 and 3.1 ohms?		Yes	Check condition of drive belt, clutch material and compressor; service as required.
		No	Service ground of compressor clutch. If all OK, replace clutch.

Fig. 9: Compressor Clutch Trouble Chart CC3
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CC4	CHECK FOR SHORT IN CLUTCH LEAD		
• Key off. • Disconnect compressor clutch. • Disconnect condenser fan relay. • Disconnect WAC relay. • Measure resistance between WAC relay connect BK/W terminal and ground. • Is resistance less than 10,000 ohms?		Yes	Service shorts in BK/W wire from WAC relay to compressor clutch or Condenser Fan Relay
		No	Reconnect Condenser Fan Relay WAC relay, and compressor clutch. GO to CC5 .

BK/W = Black/White WAC = Wide Open Throttle A/C Cut-Out (WAC) Relay

Fig. 10: Compressor Clutch Trouble Chart CC4
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CC5	CHECK FOR POWER FROM RELAY		
• Key on, engine idling. • A/C on, blower on. • Measure voltage at WAC relay BK/W terminal. • Is reading greater than 10V?		Yes	SERVICE BK/W from WAC relay to compressor clutch and condenser fan relay for opens.
		No	TURN engine off. GO to CC6 .

BK/W = Black/White

Fig. 11: Compressor Clutch Trouble Chart CC5
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CC6	CHECK POWER TO RELAY		
• Key on. • A/C on, blower on. • Measure voltage at WAC relay BL/R and Y terminals. • Are both readings greater than 10V?		Yes	GO to CC7 .
		No BL/R	SERVICE BL/R wire as required.
		No Yellow	SERVICE Y wire or 20 amp "FAN" fuse as required.

BL/R = Blue/Red Y = Yellow

Fig. 12: Compressor Clutch Trouble Chart CC6
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CC7	CHECK WAC RELAY OPERATION		
• Key on. • Measure voltage at WAC relay BK/W terminal. • Ground WAC relay GN/Y terminal with a jumper wire. • Is reading greater than 10V with GN/Y grounded and less than 1V with GN/Y open?		Yes	TURN key off. GO to CC8 .
		No	REPLACE WAC relay.

BK/W = Black/White GN/Y = Green/Yellow

Fig. 13: Compressor Clutch Trouble Chart CC7
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CC8	CHECK GROUND AT THERMOSTATIC SWITCH		
• Key off. • A/C on, blower on. • Measure resistance between thermostatic switch GN terminal and ground. • Is reading greater than 10,000 ohms with A/C off and less than 5 ohms with A/C on?		Yes	SERVICE GN/Y wire from WAC relay to ECA. If okay, test ECA. See ENGINE PERFORMANCE section of appropriate MITCHELL manual.
		No	CHECK GN wire for open or shorts if all OK GO to CC9 .

GN = Green

Fig. 14: Compressor Clutch Trouble Chart CC8
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CC9	CHECK THERMOSTATIC SWITCH		
• Remove thermostatic switch. • Measure resistance between terminals on thermostatic switch. • Apply liquid freon or other cooling liquid to sensing bulb on switch to bring temperature of the sensing bulb below 32°F. • Is resistance greater than 10,000 ohms with sensing bulb warm (above 77°F) and less than 5 ohms with sensing bulb cold?		Yes	REINSTALL switch. GO to CC10 .
		No	REPLACE thermostatic switch.

Fig. 15: Compressor Clutch Trouble Chart CC9
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CC10	MEASURE VOLTAGE TO REFRIGERANT PRESSURE SWITCH	Yes No	GO to CC13 . SERVICE BK/W wire from thermostatic switch to refrigerant pressure switch.
• Key on. • A/C off. • Measure voltage at refrigerant pressure switch BK/W terminal. • Is reading greater than 10V?			

BK/W = Black/White

Fig. 16: Compressor Clutch Trouble Chart CC10
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CC11	CHECK REFRIGERANT PRESSURE SWITCH		
• Connect a manifold set to the service gauge port valves. • Disconnect the refrigerant pressure switch electrical connector. • Measure resistance between BK/W and Y/GN terminals of the refrigerant pressure switch. • Is reading less than 5 ohms when the system high side pressure is above 206±20 kPa (30±3 psi)?		Yes	SERVICE BK/W from refrigerant pressure switch to compressor clutch.
		Yes	GO to CC12 .
		No	REPLACE refrigerant pressure switch. NOTE: If high side pressure is below 206±20 kPa (30±3 psi) check refrigerant system.

Fig. 17: Compressor Clutch Trouble Chart CC11
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CC12	CHECK A/C SWITCH POWER	Yes No	GO to CC13 . SERVICE Y/GN wire from refrigerant pressure switch to A/C switch.
• Key on. • A/C off. • Measure voltage at A/C switch Y/GN terminal. • Is reading greater than 10V?			

Y/GN = Yellow/Green

Fig. 18: Compressor Clutch Trouble Chart CC12
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CC13	CHECK A/C SWITCH OPERATION		
• Key off. • Measure resistance between A/C switch Y/GN and BL/W terminals. • Is resistance greater than 10,000 ohms with switch off and less than 5 ohms with switch on?		Yes No	GO to CC14 . REPLACE A/C switch.

Y/GN = Yellow/Green BL/W = Blue/White

Fig. 19: Compressor Clutch Trouble Chart CC13
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CC14	CHECK VOLTAGE AT BLOWER SWITCH		
• Key on. • A/C switch on. • Blower off. • Disconnect blower motor. • Measure voltage at blower control switch BL/W terminal. • is voltage greater than 10V?		Yes	RECONNECT blower motor. Check BLOWER MOTOR & RESISTOR. See HEATER SYSTEMS article.
		No	SERVICE BL/W wire from A/C switch to blower control switch and resistor.

BL/W = Blue/White

Fig. 20: Compressor Clutch Trouble Chart CC14
Courtesy of FORD MOTOR CO.

CONDENSOR FAN TROUBLE CHARTS

TEST STEP		RESULT	ACTION TO TAKE
CF1	SYSTEM INTEGRITY CHECK		
• Check for fully charged battery. • Check for blown fuses, corrosion, poor electrical connections, signs of opens, shorts or damage to the wiring harness. • Key on, engine idling. • A/C on. • Blower on. • Shake the wiring harness vigorously from the condenser fan motor to the condenser fan relay and the refrigerant pressure switch. Look for signs of opens or shorts. • Tap each connector and look for signs of bad connections. • Does the system appear to be in good condition?		Yes No	GO to CF2 . REPAIR or REPLACE faulty components, as required. NOTE: If a blown fuse is replaced and fails immediately there is a short to ground in the circuit.

Fig. 21: Condensor Fan Trouble Chart CF1
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CF2	CHECK VOLTAGE AT MOTOR		
• Insert jumper wire at refrigerant pressure switch between W and BK wires. • Key on, engine idling. • A/C on. • Blower on. • Measure voltage at condenser fan motor Y terminal. • Is voltage greater than 10V?		Yes No	GO to CF3 . SERVICE Y wire from main fuse panel to condenser fan for opens or shorts.

W = White BK = Black Y = Yellow

Fig. 22: Condensor Fan Trouble Chart CF2
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CF3	MOTOR OPERATION CHECK	Yes No	GO to CF4 . SERVICE motor side of harness for opens or shorts. If all OK, replace condenser fan motor.
• Key off. • Disconnect condenser fan motor. • Jump battery power to condenser fan motor Y terminal. • Ground condenser fan GN/R terminal. • Does fan motor run?			
			

GN/R = Green/Red Y = Yellow

Fig. 23: Condensor Fan Trouble Chart CF3
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CF4	CHECK VOLTAGE FROM MOTOR	Yes No	GO to CF5 . SERVICE GN/R wire from condenser fan motor to condenser fan relay.
• Key on. • Disconnect condenser fan relay. • Measure voltage at condenser fan relay GN/R terminal. • Is voltage greater than 10V?			

GN/R = Green/Red

Fig. 24: Condensor Fan Trouble Chart CF4
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CF5	CHECK VOLTAGE TO RELAY	Yes No	RECONNECT condenser fan relay.
• Key on, engine idling. • A/C on. • Blower on. • Disconnect condenser fan relay. • Measure voltage at condenser fan motor GN/R terminal. • Is voltage greater than 10V?			GO to CF6 . Go to CF7 .

GN/R = Green/Red

Fig. 25: Condensor Fan Trouble Chart CF5
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CF6	CHECK RELAY OPERATION	Yes No	SERVICE relay grounds (BK wires). REPLACE condenser fan relay.
• Remove condenser fan relay. • Jump battery power to relay "A" terminal. • Measure resistance between relay "B" and "C" terminals. • Ground relay "D" terminal with a jumper wire. • Is reading greater than 10,000 ohms with "D" terminal open and less than 5 ohms with relay terminal grounded?			
			
BK = Black			

Fig. 26: Condensor Fan Trouble Chart CF6
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CF7	CHECK VOLTAGE AT REFRIGERANT PRESSURE SWITCH		
• Key on, engine idling. • A/C on. • Blower on. • Measure voltage at Refrigerant Pressure Switch BK terminal. • Is voltage greater than 10 volts?		Yes	GO to CF8 .
		No	GO to CC4 .

BK = Black

Fig. 27: Condensor Fan Trouble Chart CF7
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CF8	CHECK REFRIGERANT PRESSURE SWITCH OPERATION		
• Install Manifold Gauge Set. • Key on, engine idling. • A/C on. • Blower on. • Verify that the pressure in the discharge line is below 1965 kPa (285 psi). • Measure voltage at refrigerant pressure switch W terminal. • Is the voltage greater than 10 V?		Yes	REPLACE refrigerant pressure switch.
		No	GO to CF9 .

W = White

Fig. 28: Condensor Fan Trouble Chart CF8
Courtesy of FORD MOTOR CO.

TEST STEP		RESULT	ACTION TO TAKE
CF9	CHECK REFRIGERANT PRESSURE SWITCH OPERATION		
• Install Manifold Gauge Set. • Key on, engine idling. • A/C on. • Blower on. • Run A/C system until high pressure gauge reads above 2350 kPa (340 psi). • Measure voltage at refrigerant pressure switch W terminal. • Is the voltage greater than 10 V?		Yes	Service W wire between refrigerant pressure switch and cooling fan relay.
		No	Replace refrigerant pressure switch.

W = White

Fig. 29: Condensor Fan Trouble Chart CF9
Courtesy of FORD MOTOR CO.

REMOVAL & INSTALLATION

COMPRESSOR

Removal & Installation

1. Discharge A/C system using approved refrigerant recovery/recycling equipment. Disconnect negative battery cable. Remove compressor drive belt. Disconnect electrical connector. Disconnect refrigerant lines, and plug openings.
2. Remove compressor mounting bolts and compressor. See [Fig. 1](#) . To install, reverse removal procedure. If installing a new compressor, drain 1.2 ounces of refrigerant oil from compressor before installation. Evacuate and recharge system.

CONDENSER

Removal & Installation

1. Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove radiator grille. Remove right-side sight glass cover. Disconnect refrigerant line from receiver-drier. Remove refrigerant line clamp from condenser bracket. Remove hood latch and center brace bolts.
2. Remove condenser fan (if equipped). Remove condenser mounting bolts. Lift out condenser and mounting grommets. See [Fig. 1](#) . To install, reverse removal procedure. Ensure mounting grommets are properly positioned. Install new "O" rings on all refrigerant line. Evacuate and recharge system.

RECEIVER-DRIER

Removal & Installation

Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove condenser. See [CONDENSER](#) under REMOVAL & INSTALLATION. Disconnect refrigerant lines from receiver-drier, and plug openings immediately. Remove receiver-drier mounting bolts and receiver-drier. See [Fig. 1](#) . To install, reverse removal procedure. Use new "O" rings. Evacuate and recharge system.

EVAPORATOR HOUSING

Removal & Installation

1. Disconnect negative battery cable. Discharge A/C system using approved refrigerant recovery/recycling equipment. Disconnect evaporator outlet tubes (refrigerant lines), and plug openings. See [Fig. 1](#) . Remove glove box. Disconnect 2 electrical connectors from thermostatic switch.
2. Disconnect temperature control cable. See [Fig. 4](#) . Remove wiring harness clamps from evaporator housing. Loosen clamp screws securing connector duct to evaporator housing. Remove evaporator drain hose. Remove air inlet duct. See [Fig. 2](#) .
3. Remove evaporator housing-to-dash panel bolts. Remove evaporator housing. To install, reverse removal procedure. Use new "O" rings. Evacuate and recharge system.

EVAPORATOR

Removal & Installation

1. Remove evaporator housing. See [EVAPORATOR HOUSING](#) under REMOVAL & INSTALLATION. See [Fig. 1](#) . Remove upper and lower evaporator case half clips. Remove upper housing. Carefully pull sensing tube from evaporator core fins while removing thermostat. Remove evaporator from lower housing. Remove stand-off insert from between inlet and outlet tubes.
2. Remove insulator from around capillary tube and thermostatic expansion valve. Remove capillary tube-to-suction tube clamp. Disconnect evaporator tube fitting and thermostatic expansion valve. To install, reverse removal procedure. Use new "O" rings on all refrigerant line connections. Evacuate and recharge system.

THERMOSTATIC SWITCH

Removal & Installation

Remove evaporator housing. See [EVAPORATOR HOUSING](#) under REMOVAL & INSTALLATION. See [Fig. 1](#) . Remove 10 clips retaining evaporator housing halves. Remove upper housing section. Remove thermostatic switch mounting screws. Carefully pull thermostat sensing

tube from evaporator core fins while removing thermostatic switch. To install, reverse removal procedure. Evacuate and recharge system.

THERMOSTATIC EXPANSION VALVE

Removal & Installation

1. Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove evaporator housing. See **EVAPORATOR HOUSING** under REMOVAL & INSTALLATION. Remove air inlet duct. See **Fig. 1** .
2. Remove insulation from sensing bulb. Disconnect thermostatic expansion valve at evaporator tube fitting and inlet tube fitting (from receiver-drier). See **Fig. 3** . Remove thermostatic expansion valve. To install, reverse removal procedure. Use new "O" rings. Evacuate and recharge system.

A/C RELAYS

Removal & Installation

A/C relays are located in left front corner of engine compartment, near battery. Unclip relay holder from its mounting bracket. Disconnect relay wiring. DO NOT pull on wiring connector to remove relay from holder. Remove relay from holder. To install, reverse removal procedure.

A/C-HEATER CONTROL ASSEMBLY

Removal & Installation

1. A/C control module is located above radio. Remove accessory bezel. Remove radio (if necessary) and glove box. Disconnect recirculated/fresh air cable from door lever. See **Fig. 5** . Disconnect mode select cable from door lever. See **Fig. 6** .
2. Disconnect temperature control cable from door lever. See **Fig. 4** . Pull control assembly away from dash, and disconnect wiring connectors. Remove control assembly.
3. To install, reverse removal procedure. Check and adjust temperature control, recirculated/fresh air and mode cables. See ADJUSTMENTS. Test control assembly operation.

BLOWER MOTOR

Removal & Installation

Disconnect negative battery cable. Remove A/C air outlet duct located below steering column. See **Fig. 2** . Disconnect blower motor wiring. Remove blower motor attaching screws and blower motor. Remove blower wheel attaching nut. Remove blower wheel and washer. To install, reverse removal procedure.

BLOWER MOTOR RESISTOR

CAUTION: DO NOT remove screw in front of blower resistor, or blower resistor mounting plate will fall into air distribution plenum. To retrieve plate, disassemble instrument panel.

Removal & Installation

Disconnect negative battery cable. Remove air duct located below steering column. See **Fig. 2** . Disconnect blower motor resistor wiring. Remove blower resistor attaching screws and resistor. To install, reverse removal procedure.

AIR DISTRIBUTION PLENUM

Removal & Installation

1. Remove instrument panel. See **INSTRUMENT PANEL** under REMOVAL & INSTALLATION. Drain cooling system. Disconnect heater hoses in engine compartment. Disconnect wiring for blower motor and blower resistor. Disengage wiring harness and antenna lead from bracket on front of air distribution housing.
2. Loosen connector duct-to-air inlet clamp screw. Remove upper and lower mounting nuts from plenum. Disengage and remove plenum from defroster ducts. To install, reverse removal procedure. Refill cooling system, and check for leaks.

HEATER CORE

Removal & Installation

1. Remove air distribution plenum. See **AIR DISTRIBUTION PLENUM** under REMOVAL & INSTALLATION. Disconnect linkage connecting defroster doors. Remove attaching screw located near blower resistor. Turn housing around and remove attaching screw located near blower motor opening.
2. Remove clips retaining blower housing halves. Separate blower housing halves. Remove heater core. Remove tube insert from heater core. To install, reverse removal procedure. Test system for proper operation.

INSTRUMENT PANEL

Removal & Installation

1. Disconnect negative battery cable. Remove steering wheel, steering column covers and multifunction switch assembly. Disconnect electrical connectors from switches on instrument panel. Remove instrument cluster hood.
2. Disconnect speedometer cable from transmission. Remove 4 instrument cluster screws. Pull instrument cluster out from instrument panel cluster enough to disconnect wiring and speedometer cable. Remove instrument cluster.
3. Remove steering column shield. Remove shield bracket. Remove glove box. Remove fuse panel cover and 4 fuse panel screws. Pull fuse panel out, but DO NOT remove. Remove shift lever console and mount brackets.

4. Remove radio and A/C-heater control assembly. See [A/C-HEATER CONTROL ASSEMBLY](#) under REMOVAL & INSTALLATION. Disconnect cigarette lighter connector. Remove snap-in trim inserts concealing instrument panel attaching bolts. Remove 7 instrument panel attaching bolts.
5. Remove 2 lower instrument panel-to-body bracket stud nuts. Disconnect remaining electrical connectors from instrument panel. Remove instrument panel. To install, reverse removal procedures.

WIRING DIAGRAM

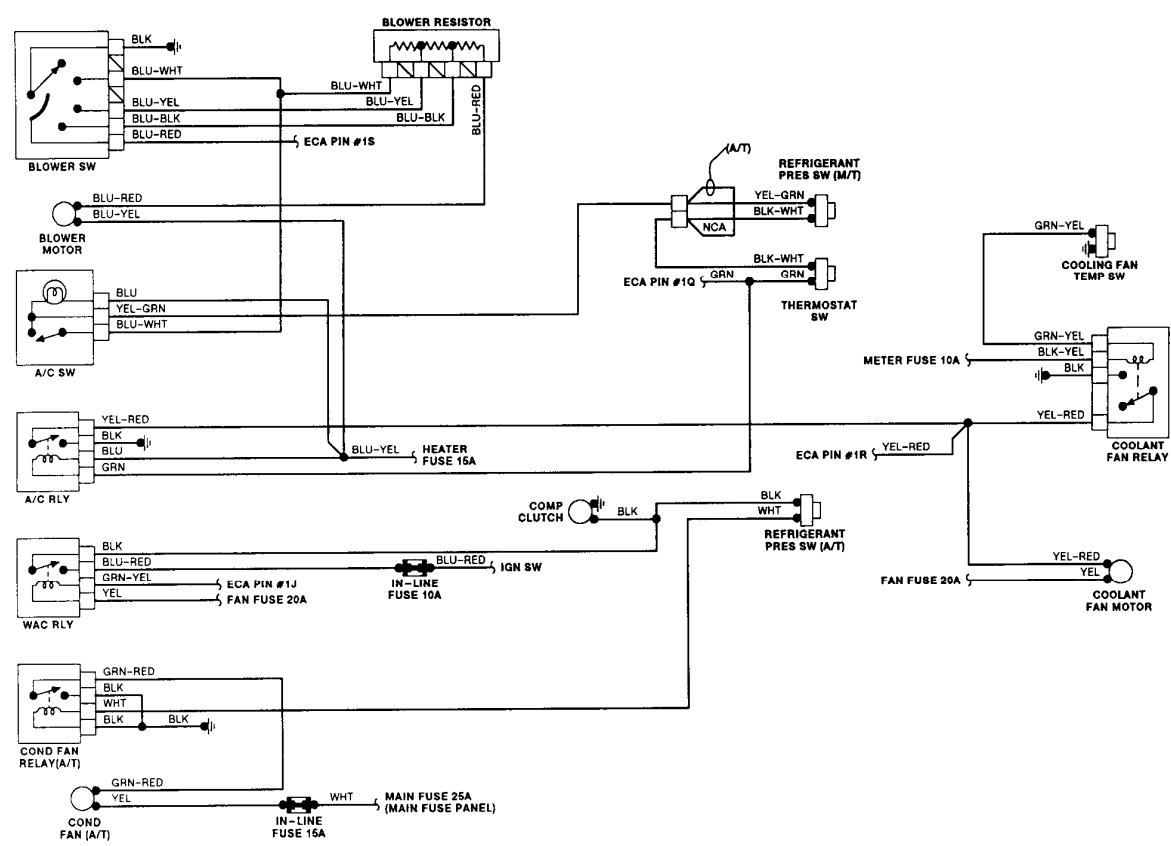


Fig. 30: Manual A/C Heater System Wiring Diagram (Festiva)

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1971-96 MAINTENANCE & SERVICE INFORMATION

Interference Verification Check For OHC Engine - Timing Belt Information

TIMING BELT INTERFERENCE VERIFICATION INFORMATION

TIMING BELT INTERFERENCE CAUTION

CAUTION: The condition of camshaft timing belts should always be checked on vehicles which have more than 50,000 miles. Although some manufacturers do not recommend replacement at a specified mileage, others require it at 60,000-100,000 miles. A camshaft drive belt failure may cause extensive damage to internal engine components on most engines, although some designs do not allow piston-to-valve contact. These designs are often called "Free Wheeling". Many manufacturers changed their maintenance and warranty schedules in the mid-1980's to reflect timing belt inspection and/or replacement at 50,000-60,000 miles. Most service interval schedules shown in this section reflect these changes. Belts or components should be inspected and replaced if any of the following conditions exist:

- Crack Or Tears In Belt Surface
- Missing, Damaged, Cracked Or Rounded Teeth
- Oil Contamination
- Damaged Or Faulty Tensioners
- Incorrect Tension Adjustment

TIMING BELT REPLACEMENT INTERVAL & INTERFERENCE VERIFICATION

TIMING BELT REPLACEMENT INTERVAL & INTERFERENCE VERIFICATION (FORD PASSENGER CARS) ⁽¹⁾

Application	Year Span	Engine	Replacement Interval (Miles)
Aspire	1994-96	1.3L 4-Cyl.	60,000
Contour	1995-96	2.0L 4-Cyl.	60,000
Escort	1981-85	1.6L 4-Cyl.	60,000
Escort	1985-96	1.9L 4-Cyl.	60,000
Escort	1984-87	⁽²⁾ 2.0L 4-Cyl. Diesel	⁽⁴⁾ 100,000
Escort	1991-96	1.8L 4-Cyl.	60,000
EXP	1981-85	1.6L 4-Cyl.	60,000
EXP	1985-96	1.9L 4-Cyl.	60,000
Fairmont	1978-83	2.3L 4-Cyl.	⁽³⁾ 60,000
Festiva	1988-93	1.3L 4-Cyl.	60,000
Granada	1981-82	2.3L 4-Cyl.	⁽³⁾ 60,000
LTD	1983-86	2.3L 4-Cyl.	⁽³⁾ 60,000
Mustang	1974-93	2.3L 4-Cyl.	⁽³⁾ 60,000
Pinto	1971-74	2.0L 4-Cyl.	⁽³⁾ 60,000
Pinto	1974-80	2.3L 4-Cyl.	⁽³⁾ 60,000
Probe	1989-92	⁽²⁾ 2.2L 4-Cyl.	60,000
Probe	1993-96	⁽²⁾ 2.0L 4-Cyl.	60,000
Probe	1993-96	2.5L V6	60,000
Taurus SHO	1989-95	3.0L V6	100,000
Taurus SHO	1993-95	3.2L V6	100,000
Tempo	1984-87	⁽²⁾ 2.0L 4-Cyl. Diesel	⁽⁴⁾ 100,000
Thunderbird	1983-88	2.3L 4-Cyl.	⁽³⁾ 60,000

- (1) Other interference engine applications may exist which are not indicated here.
- (2) Interference engine. Check for possible damage to piston(s) or valve(s) if there has been a timing belt failure.
- (3) Although the vehicle manufacturer does not recommend a specific scheduled maintenance interval, aftermarket belt manufacturers suggest the belt be replaced at 60,000 mile intervals.
- (4) Vehicle manufacturer recommends replacing all belts at the same time.

TIMING BELT REPLACEMENT INTERVAL & INTERFERENCE VERIFICATION (MERCURY PASSENGER CARS) ⁽¹⁾

Application	Year Span	Engine	Replacement Interval (Miles)
Bobcat	1974-80	2.3L 4-Cyl.	⁽³⁾ 60,000
Capri	1971-72	1.6L 4-Cyl.	⁽³⁾ 60,000
Capri	1971-74	2.0L 4-Cyl.	⁽³⁾ 60,000
Capri	1974-84	2.3L 4-Cyl.	⁽³⁾ 60,000
Capri	1991-94	1.6L 4-Cyl.	60,000
Cougar	1984-86	2.3L 4-Cyl.	⁽³⁾ 60,000
LN7	1981-85	⁽²⁾ 1.6L 4-Cyl.	⁽³⁾ 60,000
Lynx	1981-85	⁽²⁾ 1.6L 4-Cyl.	⁽³⁾ 60,000

Lynx	1984-87	1.9L 4-Cyl.	(3) 60,000
Lynx	1984-87	2.0L 4-Cyl. Diesel	(4) 100,000
Marquis	1983-86	2.3L 4-Cyl.	(3) 60,000
Mystique	1995-96	2.0L 4-Cyl.	60,000
Topaz	1984-86	(2) 2.0L 4-Cyl. Diesel	(4) 100,000
Tracer	1987-90	1.6L 4-Cyl.	60,000
Tracer	1991-96	1.8L 4-Cyl.	60,000
Tracer	1991-96	1.9L 4-Cyl.	60,000
Tracer (Canadian)	1987, 1990	1.6L 4-Cyl.	(3) 60,000
Zephyr	1978-83	2.3L 4-Cyl.	(3) 60,000
Villager	1993-96	(2) 3.0L V6	105,000
(1) Other interference engine applications may exist which are not indicated here.			
(2) Interference engine. Check for possible damage to piston(s) or valve(s) if there has been a timing belt failure.			
(3) Although the vehicle manufacturer does not recommend a specific scheduled maintenance interval, aftermarket belt manufacturers suggest the belt be replaced at 60,000 mile intervals.			
(4) Vehicle manufacturer recommends replacing all belts at the same time.			

TIMING BELT REPLACEMENT INTERVAL & INTERFERENCE VERIFICATION (LIGHT TRUCKS) (1)

Application	Year Span	Engine	Replacement Interval (Miles)
Aerostar	1986-87	2.3L 4-Cyl.	(3) 60,000
Courier	1977-82	2.3L 4-Cyl.	(3) 60,000
Ranger	1986-88	2.0L 4-Cyl.	60,000
Ranger	1983-96	2.3L 4-Cyl.	(3) 60,000
Ranger	1985-87	(2) 2.3L 4-Cyl. Diesel	(3) (4) 60,000
(1) Other interference engine applications may exist which are not indicated here.			
(2) Interference engine. Check for possible damage to piston(s) or valve(s) if there has been a timing belt failure.			
(3) Although the vehicle manufacturer does not recommend a specific scheduled maintenance interval, aftermarket belt manufacturers suggest the belt be replaced at 60,000 mile intervals.			
(4) Vehicle manufacturer recommends replacing all belts at the same time.			

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MAINTENANCE INFORMATION

1988-93 MAINTENANCE Ford Motor Co. Maintenance Information

MODEL IDENTIFICATION

NOTE: For scheduled maintenance intervals and the related fluid capacities, fluid specifications and labor times for major service intervals, see SCHEDULED SERVICES article in this section. Warranty information and specifications for fluid capacities, lubrication specifications, wheel and tire size, and battery type are covered in this article.

VIN LOCATION

The Vehicle Identification Number (VIN) is located on the left side of the dash panel at the base of the windshield. The VIN chart explains the code characters.

VIN CODE ID EXPLANATION

Numbers preceding the explanations in the legend below refer to the sequence of characters as listed on VIN identification label. See VIN example below.



Fig. 1: VIN Code ID Explanation

MAINTENANCE SERVICE INFORMATION

SEVERE & NORMAL SERVICE DEFINITIONS

NOTE: Use the Severe Service schedule if the vehicle to be serviced is operated under ANY (one or more) of these conditions:

Service is recommended at mileage intervals based on vehicle operation. Service schedules are based on the following primary operating conditions:

Severe Service

- Short Trips (About 10 Miles) In Freezing Temperatures
- Towing Or Heavily Loaded
- Severe Dust Conditions
- Hot Weather, Stop-And-Go Driving
- Extensive Idling Conditions (Taxi Or Delivery Type Service)

Normal Service

- Driven More Than 10 Miles Daily
- No Operating Conditions From Severe Service Schedule

CAMSHAFT TIMING BELT

CAUTION: Failure to replace a faulty camshaft timing belt may result in serious engine damage.

The condition of camshaft drive belts should always be checked on vehicles which have more than 50,000 miles. Although some manufacturers do not recommend belt replacement at a specified mileage, others require it at 60,000-100,000 miles. A camshaft drive belt failure may cause extensive damage to internal engine components on most engines, although some designs do not allow piston-to-valve contact. These designs are often called "Free Wheeling".

Many manufacturers changed their maintenance and warranty schedules in the mid-1980's to reflect timing belt inspection and/or replacement at 50,000-60,000 miles. Most service interval schedules in this manual reflect these changes.

Belts or components should be inspected and replaced if any of the following conditions exist:

- Cracks Or Tears In Belt Surface
- Missing, Damaged, Cracked Or Rounded Teeth
- Oil Contamination
- Damaged Or Faulty Tensioners
- Incorrect Tension Adjustment

Replace camshaft timing belt every 60,000 miles.

COOLING SYSTEM

Replace engine coolant every 36 months or 30,000 miles. Check condition of hoses and clamps every 12 months or 15,000 miles, whichever comes first. Replace hoses and clamps if necessary.

SERVICE POINT LOCATIONS

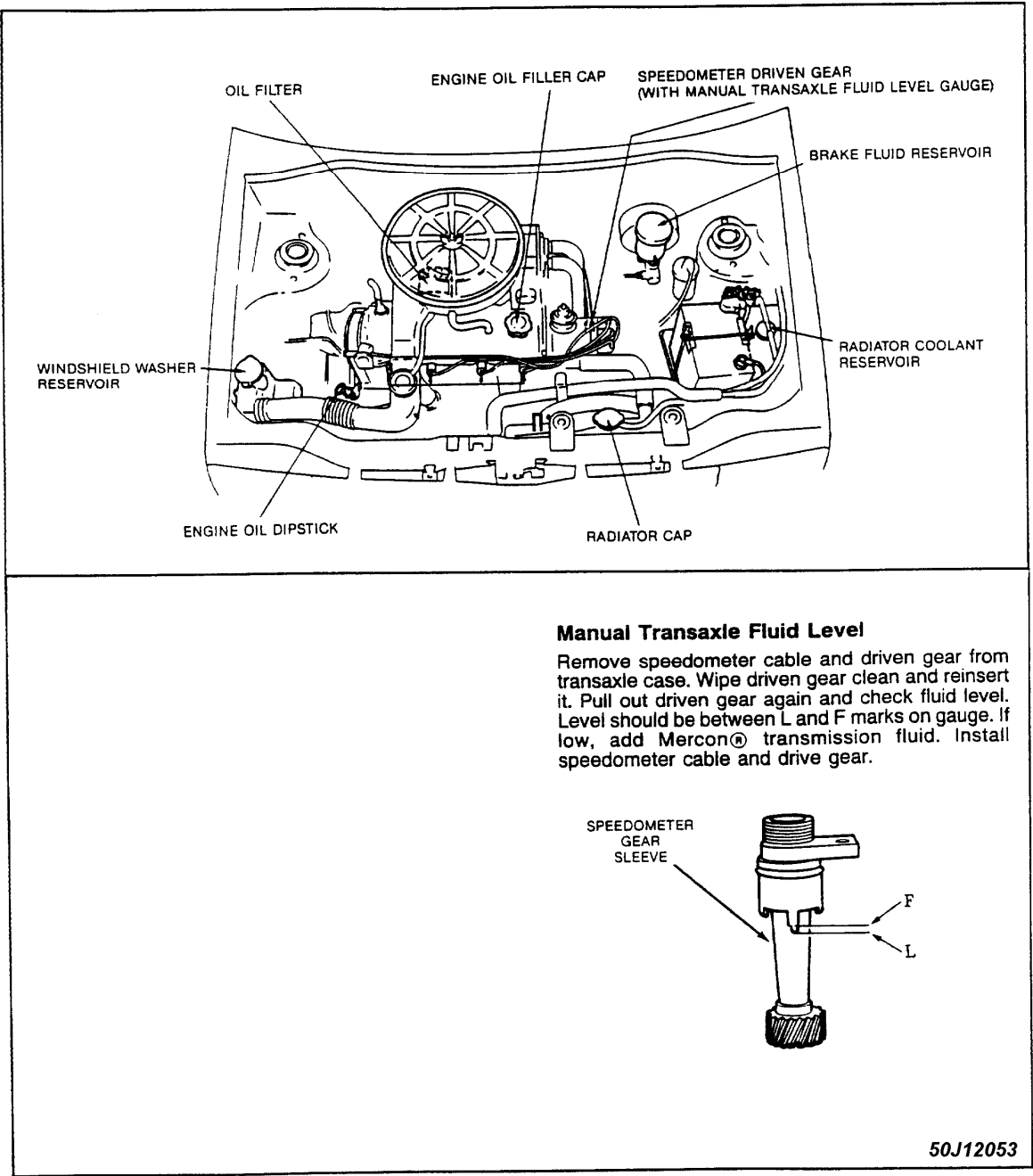


Fig. 2: Engine Service Point Locations (1988-89 1.3L 2V Carb.)
Courtesy of FORD MOTOR CO.

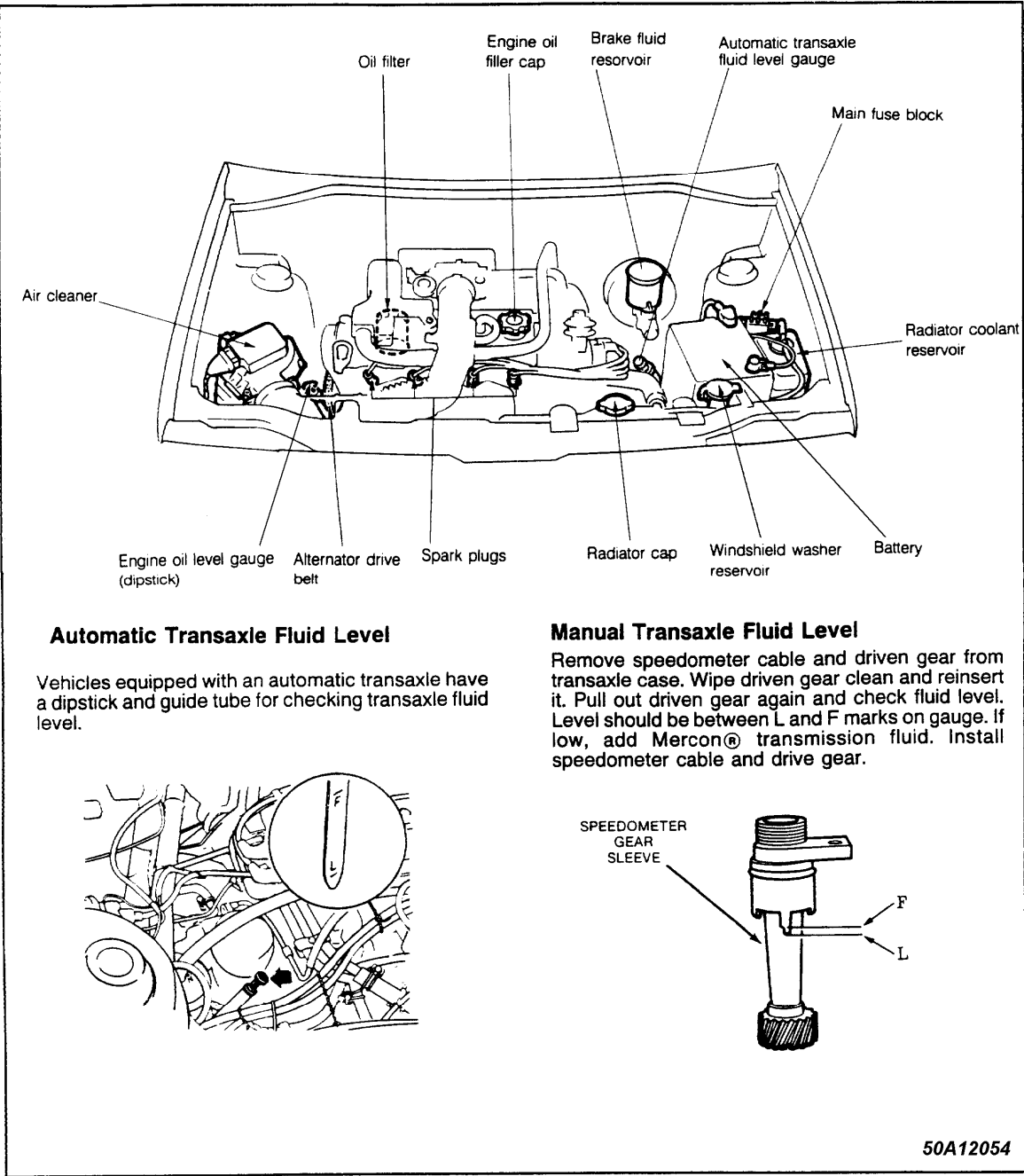


Fig. 3: Engine Service Point Locations (1989-93 1.3L EFI)
 Courtesy of FORD MOTOR CO.

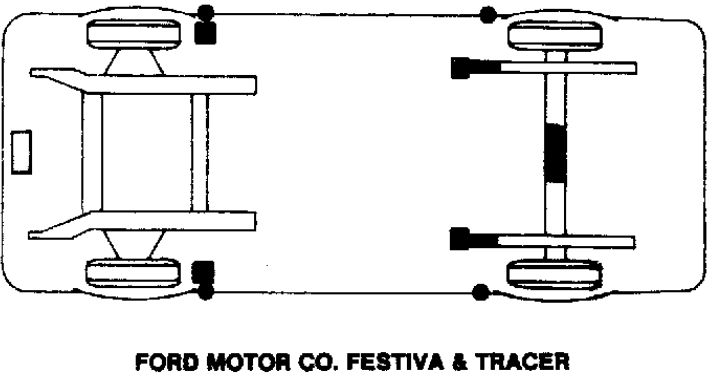


Fig. 4: Jacking & Hoisting Points
 Courtesy of FORD MOTOR CO.

NOTE: For more information regarding vehicle lifting refer to the JACKING & HOISTING article in the WHEEL ALIGNMENT section.

ALIGNING CAMSHAFT TIMING MARKS

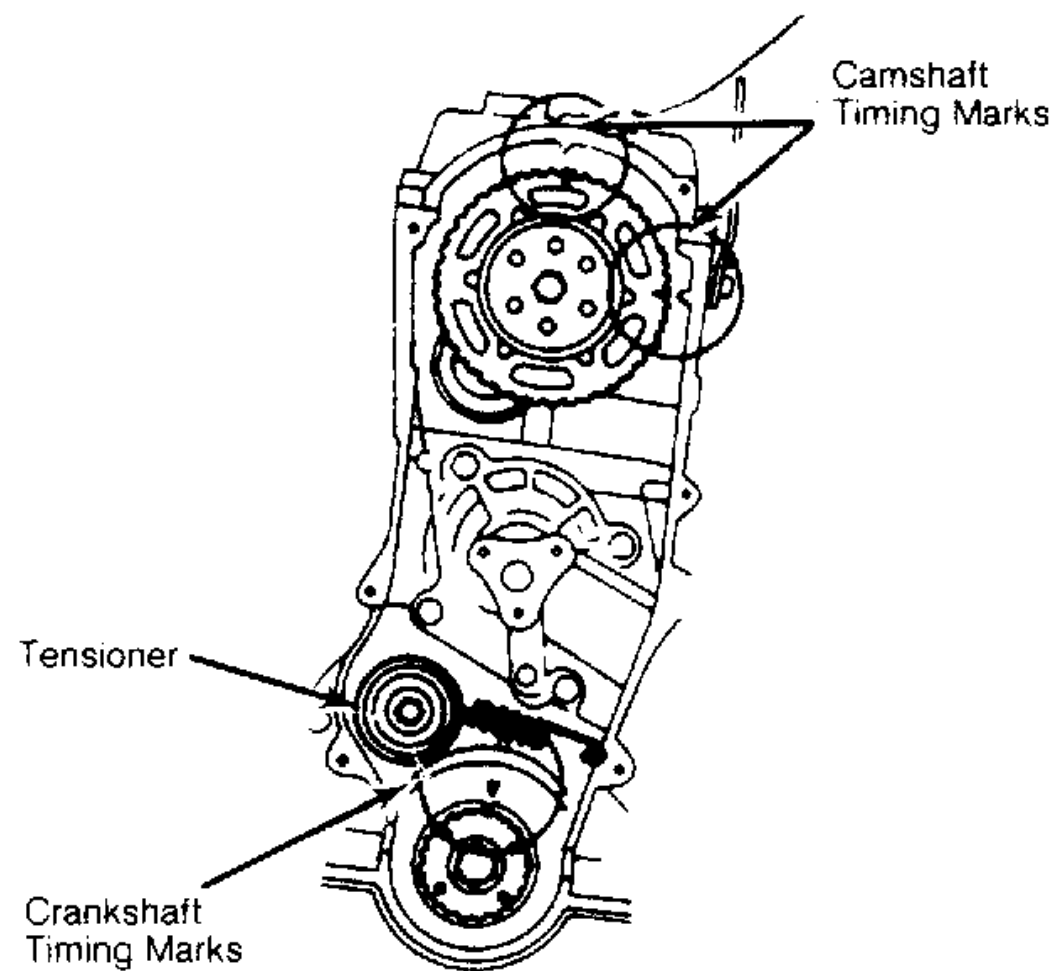


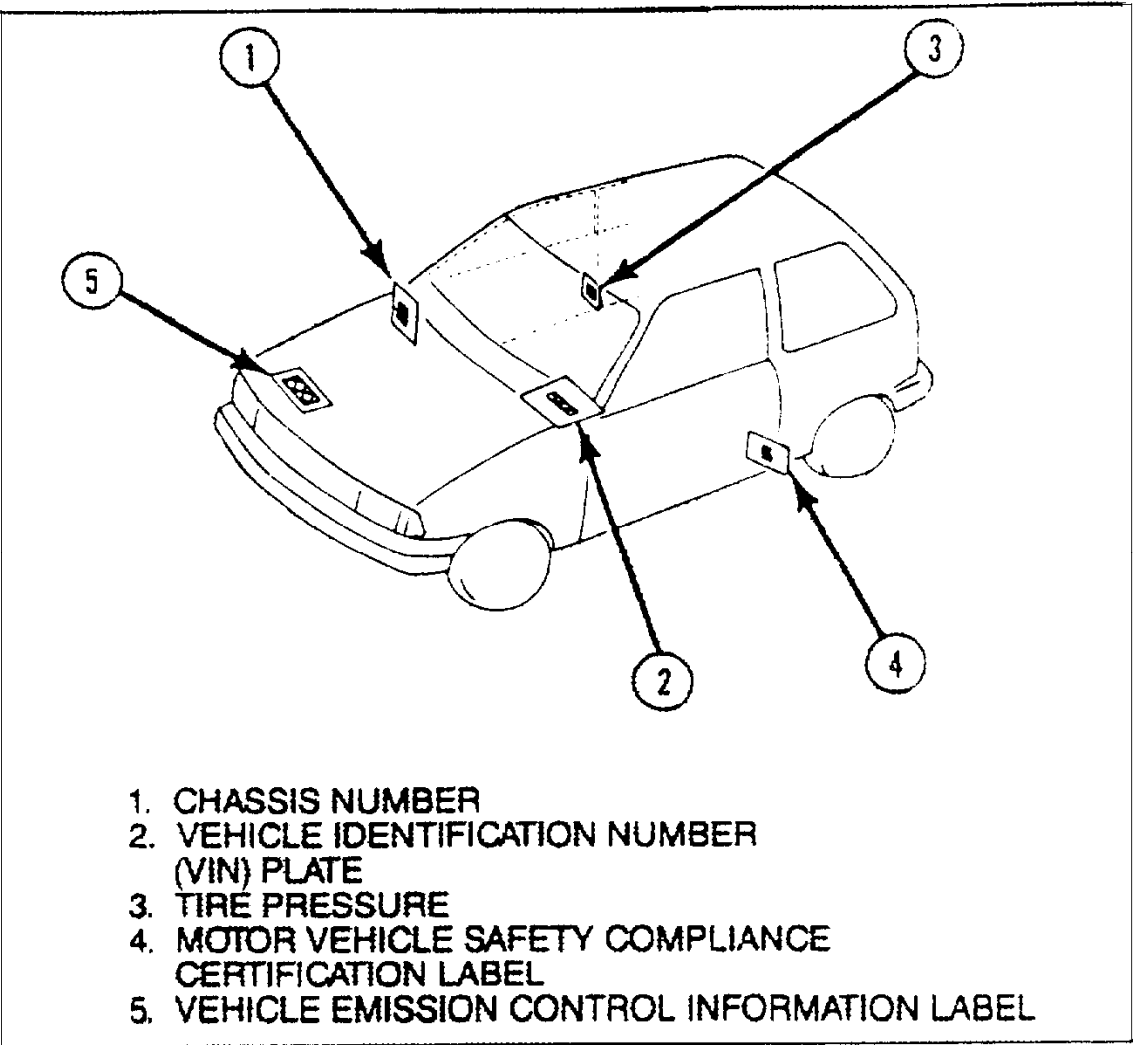
Fig. 5: Aligning Camshaft & Crankshaft Timing Marks (1.3L)
Courtesy of FORD MOTOR CO.

NOTE: For more information regarding camshaft timing belt service refer to the 1.3L 4-CYL - VINS [H,K] article in the ENGINE MECHANICAL section.

VALVE CLEARANCE ADJUSTMENT (1988-89 CARBURETOR ENGINES)

NOTE: For more information regarding valve clearance adjustments refer to the 1.3L 4-CYL - VINS [H,K] article in the ENGINE MECHANICAL section.

IDENTIFICATION LABEL LOCATIONS



50B12055

Fig. 6: Identification Label Locations
Courtesy of FORD MOTOR CO.

SERVICE LABOR TIMES

NOTE: For 1990 and newer vehicles, labor times are provided, where available, within appropriate **SERVICE INTERVAL** table in **SCHEDULED SERVICES** article.

WHEEL & TIRE SPECIFICATIONS

TIRE INFLATION

Tire inflation pressure is listed on a decal attached to right door pillar.

WHEEL TIGHTENING

Tighten wheel lug bolts to 65-87 ft. lbs. (88-118 N.m). If wheels are equipped with locking type lug nuts, ALWAYS position the "keyed" nut opposite the valve stem.

BATTERY SPECIFICATIONS

CAUTION: When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See **COMPUTER RELEARN PROCEDURES** article in the **GENERAL INFORMATION** section.

All 1988-92 models use a BX-35 battery. The 1993 Festiva uses a 50D 20L standard battery.

CAUTIONS & WARNINGS

BATTERY WARNING

WARNING: When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See **COMPUTER RELEARN PROCEDURES** article in **GENERAL INFORMATION** section.

REPLACING BLOWN FUSES

CAUTION: Before replacing a blown fuse, remove ignition key, turn off all lights and accessories to avoid damaging the electrical system. Be sure to use fuse with the correct indicated amperage rating. The use of an incorrect amperage rating fuse may result in a dangerous electrical system overload.

BRAKE PAD WEAR INDICATOR

CAUTION: Indicator will cause a squealing or scraping noise, warning that brake pads need replacement.

CATALYTIC CONVERTER

CAUTION: Continued operation of vehicle with a severe malfunction could cause converter to overheat, resulting in possible damage to converter and vehicle.

COOLANT (PROPYLENE-GLYCOL FORMULATIONS)

CAUTION: To avoid possible damage to vehicle use only ethylene-glycol based coolants with a mixture ratio from 44-68% anti-freeze. DO NOT use 100% anti-freeze as it will cause the formation of cooling system deposits. This results in coolant temperatures of over 300° F (149°C) which can melt plastics. 100% anti-freeze has a freeze point of only -8° F (-22°C).

CAUTION: Propylene-Glycol Mixtures has a smaller temperature range than Ethylene-Glycol. The temperature range (freeze-boil) of a 50/50 Anti-Freeze/Water Mix is as follows: Propylene-Glycol -26° F (-32°C) - 257° F (125°C) Ethylene-Glycol -35° F (-37°C) - 263° F (128°C)

CAUTION: Propylene-Glycol/Ethylene-Glycol Mixtures can cause the destabilization of various corrosion inhibitors. Also Propylene-Glycol/Ethylene-Glycol has a different specific gravity than Ethylene-Glycol coolant, which will result in inaccurate freeze point calculations.

ELECTROSTATIC DISCHARGE SENSITIVE (ESD) PARTS

WARNING: Many solid state electrical components can be damaged by static electricity (ESD). Some will display a warning label, but many will not. Discharge personal static electricity by touching a metal ground point on the vehicle prior to servicing any ESD sensitive component.

ENGINE OIL

CAUTION: Never use non-detergent or straight mineral oil.

FUEL PUMP SHUTOFF SWITCH

This switch stops flow of fuel to engine after a collision. The impact does not have to be great for switch to be triggered. Switch must be reset after collision. Switch is located under left rear speaker in luggage compartment. Press button to reset switch.

FUEL SYSTEM SERVICE

WARNING: Relieve fuel system pressure prior to servicing any fuel system component (fuel injection models).

HALOGEN BULBS

WARNING: Halogen bulbs contain pressurized gas which may explode if overheated. DO NOT touch glass portion of bulb with bare hands. Eye protection should be worn when handling or working around halogen bulbs.

PASSIVE RESTRAINTS

CAUTION: Before operating vehicle, securely fasten passive shoulder restraints to the emergency release buckles. The buckle fits in only one way. Ensure to position it properly.

RADIATOR CAP

CAUTION: Always disconnect the fan motor when working near the radiator fan. The fan is temperature controlled and could start at any time even when the ignition key is in the OFF position. DO NOT loosen or remove radiator cap when cooling system is hot.

RADIATOR FAN

WARNING: Keep hands away from radiator fan. Fan is controlled by a thermostatic switch which may come on or run for up to 15 minutes even after engine is turned off.

WARRANTY INFORMATION

CAUTION: Due to the different warranties offered in various regions and the variety of after-market extended warranties available, please refer to the warranty package that came with the vehicle to verify all warranty options.

BASIC NEW CAR LIMITED WARRANTY

All parts of the vehicle, except tires, are covered against defects in factory-supplied materials and workmanship for 12 months or 12,000 miles,

whichever occurs first.

POWERTRAIN WARRANTY

NOTE: **Powertrain Warranty varies in coverage length (4 years/50,000 miles or 6 years/60,000 miles) depending on model year.**

Under this warranty, certain parts of the engine, transmission, axle and driveline are warranted against defects in materials and workmanship for either 4 years/50,000 or 6 years/60,000 miles, depending on the model year. This coverage begins after 12 months or 12,000 miles. See copy of warranty for specific components covered and length of coverage.

BUMPER-TO-BUMPER COVERAGE

All 1992-93 vehicles have complete warranty coverage against defects in materials and workmanship for 3 years or 36,000 miles, whichever occurs first. There is no deductible with this warranty. Items not covered include tires and parts that are subject to normal wear and tear, such as windshield wiper blades, brake linings, brake pads, clutch linings and scheduled maintenance items. There is no extended powertrain coverage included in this warranty.

BATTERY COVERAGE

Begins at warranty start date and lasts up to 3 years or 36,000 miles, whichever occurs first. For the first 12 months in service (less than 36,000 miles), battery will be replaced at no charge. After that, battery will be replaced on a customer-participation basis: For the 13th-24th month in service, Ford will pay 50%; for the 25th-36th month, Ford will pay 25%. Labor is covered for 3 years or 36,000 miles, whichever occurs first.

SAFETY RESTRAINT SYSTEM COVERAGE

Begins at warranty start date and lasts for 5 years or 50,000 miles, whichever occurs first. Covers safety restraint problems not related to comfort or appearance. Coverage for model years earlier than 1990 is 3 years with unlimited miles.

CORROSION COVERAGE

Begins at warranty start date and lasts for 6 years or 60,000 miles, whichever occurs first. 1992-93 models are covered for 6 years or 100,000 miles, whichever occurs first. Covers any holes in body sheet metal caused by corrosion.

EMISSIONS DEFECT & PERFORMANCE WARRANTIES (EXCEPT CALIFORNIA)

Defect Warranty ensures that vehicle meets applicable EPA regulations and that vehicle's emission control system is free from defects in materials and workmanship for a period of 5 years or 50,000 miles, whichever occurs first.

The Performance Warranty covers all costs of repairing or adjusting any components or parts as needed for the vehicle to pass a Federally required state or local emissions test.

Other emission control parts related to these components are covered by the Performance Warranty, where applicable. If another part fails due to the failure of one of these components, both parts are covered. See customer's copy of warranty information for specific items covered. Performance Warranty coverage is limited to fewer components after 2 years or 24,000 miles.

EMISSIONS PERFORMANCE WARRANTY (CALIFORNIA)

If vehicle fails a Smog Check inspection, all necessary repairs and adjustments will be made by manufacturer to ensure that vehicle passes the inspection. Warranty begins at warranty start date and lasts for a period of 3 years or 50,000 miles, whichever occurs first.

EMISSIONS DEFECT WARRANTY (CALIFORNIA)

If any emission-related part on the vehicle is defective, the part will be repaired or replaced by manufacturer. Warranty begins at warranty start date and lasts for a period of 3 years or 50,000 miles, whichever occurs first.

Some emission-related parts are warranted for 7 years or 70,000 miles whichever occurs first, and will be repaired or replaced by manufacturer if found to be defective in material or workmanship. See customer's copy of warranty information for specific items covered.

FUSES & FUSIBLE LINKS

FUSE PANEL & FUSIBLE LINK BLOCK LOCATIONS

The vehicle has a fuse block with fusible links and a fuse panel with circuit fuses. The fuse panel is located behind the instrument panel, left of the steering column. The fuse block is located under the hood.

FUSE PANEL IDENTIFICATION

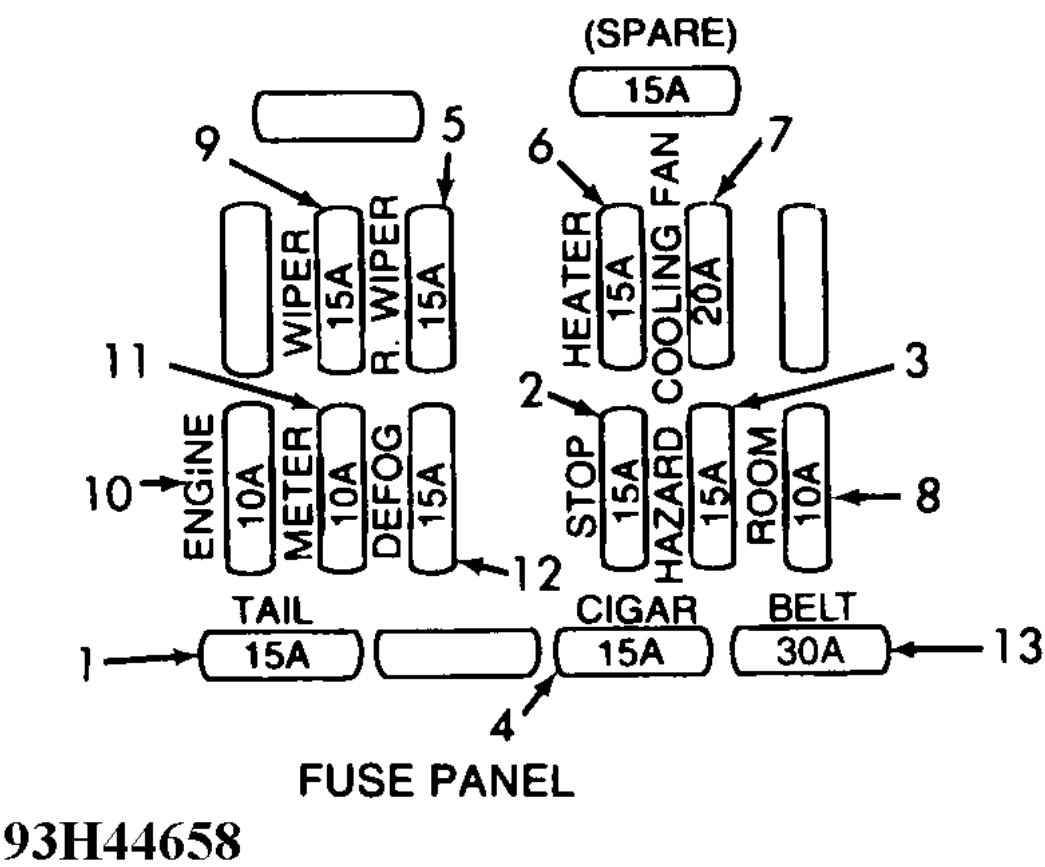


Fig. 7: Fuse Panel Identification
Courtesy of FORD MOTOR CO.

Fuse Identification

- **1 - 15 Amp** License Plate Light, Rear Side Marker Light, Front Parking Lights, Cluster and Tail Lights
- **2 - 15 Amp** Horn, Brakelights, High-Mount Brakelight
- **3 - 15 Amp (1988-89)** Safety Belt Warning, Turn & Hazard Warning Flasher Lights, Radio, Trunk Light, Ignition Key Reminder Buzzer
- **15 Amp (1990-93)** Safety Belt Warning, Turn & Hazard Warning Flasher Lights, Ignition Key Reminder Buzzer
- **4 - 15 Amp** Audio System, Cigarette Lighter, Remote Control Mirror
- **5 - 15 Amp** Rear Wiper/Washer, Daytime Running Light System (Canada)
- **6 - 15 Amp** Heater & Air Conditioner
- **7 - 20 Amp** Heater & Air Conditioner, Cooling Fan System
- **8 - 10 Amp (1988-89)** Interior Courtesy Lights
- **10 Amp (1990-93)** Radio, Interior Courtesy Lights, Luggage Compartment Light
- **9 - 15 Amp (1988-89)** Front Wiper/Washer
- **15 Amp (1990-93)** Front Wiper/Washer, Shift-Lock System (ATX), Engine Control System
- **10 - 10 Amp** Charging System, Emission Control System
- **11 - 10 Amp (1988-90)** Safety Belt Warning, Turn & Hazard Warning Flasher Lights, Back-Up Lights, Instrument Cluster, Warning Lights,
- **10 Amp (1991-93)** Safety Belt Warning, Turn & Hazard Warning Flasher Lights, Back-Up Lights, Instrument Cluster, Warning Lights, Shift-Lock System
- **12 - 15 Amp** Rear Window Defroster
- **13 - Not Used (1988-89)** Spare
- **30 Amp (1990-93)** Passive Restraint System (Automatic Seat Belt)

In-Line Fuse Identification

- **15 Amp (1990-93)** Condenser Fan Motor (A/T Models Only)
- **10 Amp (1990-93)** A/C System (located on left side of heater case)

FUSIBLE LINK BLOCK IDENTIFICATION

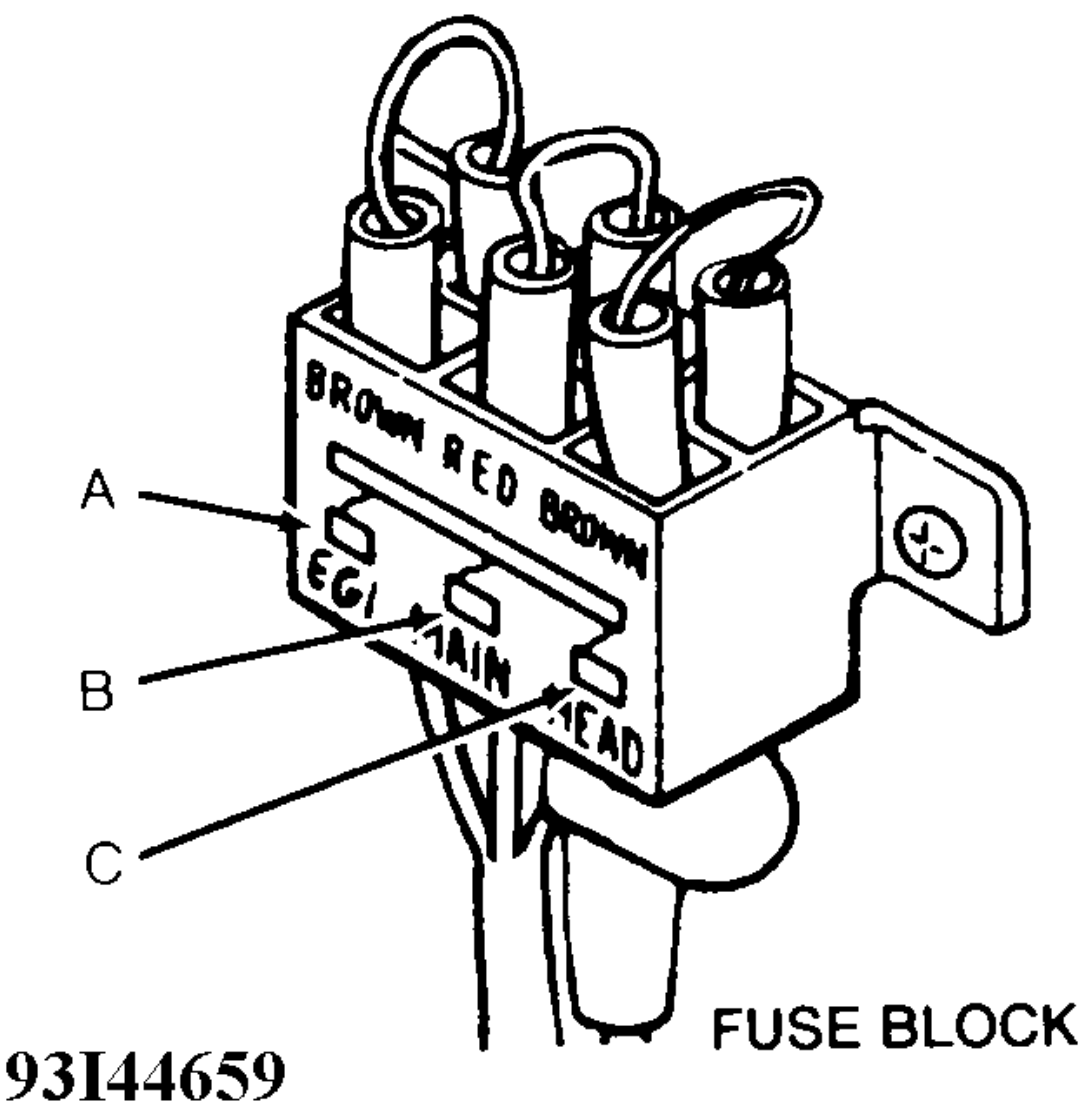


Fig. 8: Underhood Fusible Link Block Identification
Courtesy of FORD MOTOR CO.

Fusible Link Identification

- **A - Brown (PTC) (1988-89 Carburetor)** EFE Carburetor Heater
- **Brown (EGI) (1989-93 EFI)** EFI System (1989-92), EGI-EFI System (1993)
- **B - Red (Main)** Back-Up, Interior & Parking Lights, Brakelights, Taillights, Horn, Luggage Compartment Light, Turn Signal & Hazard Flasher Lights, Cluster & Warning Lights, Radio, Cigarette Lighter, Charging & Emission Control Systems, Wiper/Washer Systems, A/C-Heater System, Cooling Fan System, Rear Window Defroster, Ignition & Starting Systems, Shift Lock System, Remote Control Mirror, Ignition Key Reminder, Passive Restraint System (1990-93)
- **C - Brown (Head)** Headlights, Daytime Running Lights, Starting & Charging System

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SERVICE INDICATOR & WARNING LIGHTS

1988-92 MAINTENANCE Ford Motor Co. Service Indicator & Warning Lights

SERVICE INDICATOR & WARNING LIGHTS

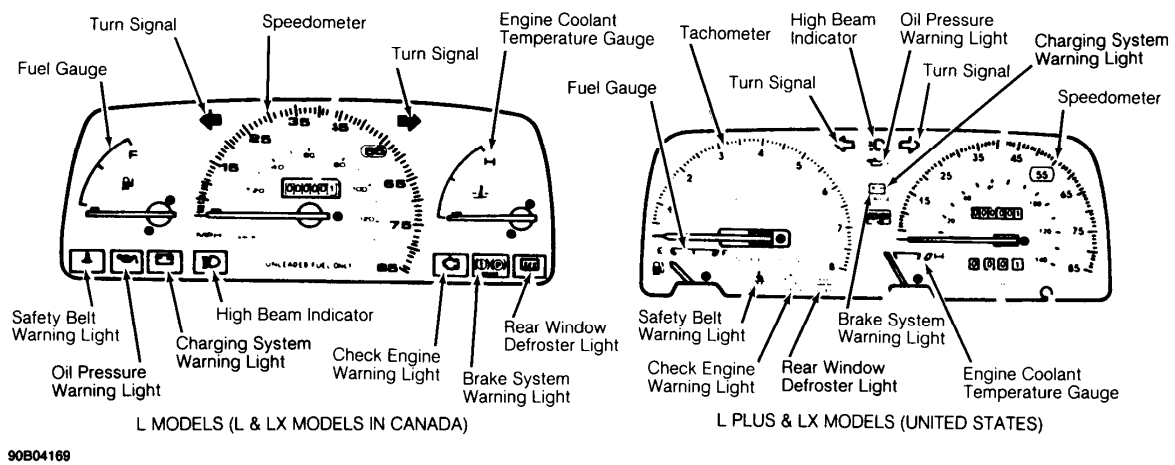


Fig. 1: Identifying Dash Gauges & Warning Lights
Courtesy of FORD MOTOR CO.

CHECK ENGINE WARNING LIGHT

If functioning properly, the Check Engine warning light comes on when ignition switch is in the ON position and goes out after engine is started. If light fails to glow with ignition on or remains on when engine is running, a malfunction exists in the electronic engine control system. System needs to be checked and serviced.

CHARGING SYSTEM WARNING LIGHT

Light comes on when ignition switch is in the ON or START position and goes out after engine is started and alternator is charged. Light may also glow when there is a heavy electrical load on the system. If light remains on after reducing electrical load, check electrical system.

OIL PRESSURE WARNING LIGHT

Light should come on briefly and go out after engine is started. If light remains on with engine running, oil pressure is low. Check oil level.

ENGINE COOLANT TEMPERATURE GAUGE

Gauge should register within the NORMAL band under regular operating conditions. If gauge rises into the HOT range, stop engine, allow it to cool, and then check coolant level.

BRAKE WARNING LIGHT

The Brake light indicates one of 2 conditions: parking brake is engaged, or malfunction exists in the dual braking system. If functioning properly, light should come on briefly with ignition switch in the ON position and then go out after engine is started and parking brake is released. If light remains on, a malfunction is indicated. Service brake system.

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STEERING SYSTEM - MANUAL

1991 STEERING Ford Motor Co. - Steering - Manual Rack & Pinion

DESCRIPTION

Rack and pinion type steering is mounted on rubber insulators to the chassis bulkhead. Adjustment is provided for pinion gear preload. Pinion shaft is coupled to steering shaft. Tie rods connect end of rack to steering knuckles.

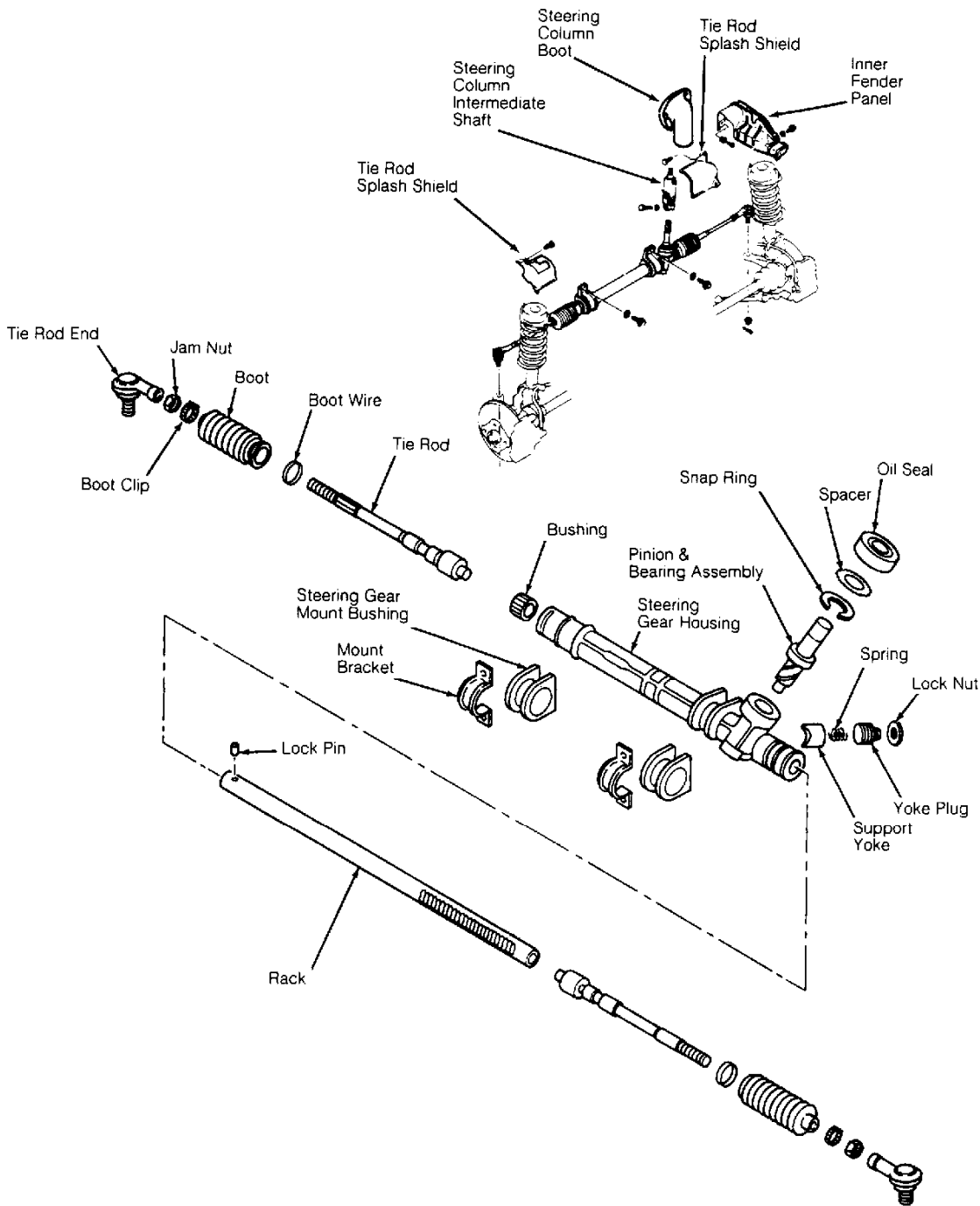


Fig. 1: Exploded View of Manual Steering Gear Assembly
Courtesy of FORD MOTOR CO.

TROUBLE SHOOTING

Refer to TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

ADJUSTMENTS

Necessary adjustments are made during reassembly procedure. See [OVERHAUL](#).

REMOVAL & INSTALLATION

STEERING GEAR

Removal

1. Raise and support vehicle. Remove front wheels. Remove vehicle battery. Remove cotter pins and castle nuts from tie rod ends. Using tie rod puller, separate tie rod ends from steering knuckles. Remove the catalytic converter.
2. Remove plastic splash shield from right side lower inner fender panel. Mark the lower steering column "U" joint for reassembly reference and disconnect steering column and intermediate shaft. Remove steering gear bracket bolts. Lower steering gear until steering shaft is clear of column boot.
3. Slide steering gear to the right, through the inner fender tie rod opening until the left tie rod clears the left fender opening. Lower left side of steering gear until it can be removed from the left side. Ensure rack boots are not pinched or damaged during removal.

Installation

To install, reverse removal procedure. Check and adjust toe-in. See WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES article in

the WHEEL ALIGNMENT section.

OVERHAUL

STEERING GEAR

Disassembly

1. With steering gear removed from vehicle, place steering gear in a soft-jawed vise. Mark threaded portion of tie rod for reassembly. Remove tie rod ends. Remove tie rod boots. Remove lock pins from both ends of rack. See [Fig. 1](#) .
2. Remove tie rod ball socket from end of rack. Remove both tie rods. Remove lock nut from yoke plug. Remove yoke plug, spring and yoke support. Use a small screwdriver to remove pinion oil seal from pinion shaft. Remove pinion bearing snap ring.
3. Remove pinion and bearing assembly. If necessary use Valve Body Puller (T78P-3504-B) to remove pinion and bearing assembly. Remove rack from pinion side of housing. If lower pinion bearing needs replacing, use Blind Hole Bearing Puller (D80L-100-L) and Slide Hammer (T50T-100-A) to remove.

CAUTION: If rack is taken out of wrong side, damage may result to rack bushing.

4. Press bushing lock tabs into the 3 slots located at end of rack housing. Use Blind Hole Bearing Puller (D80L-100-L), to remove rack support bushing from right end of rack housing.

Inspection

1. Check rubber boots, ball bearings and tooth surface of rack for wear or damage. Using a dial indicator and "V" blocks, check rack for straightness. Maximum allowable runout is 0.012" (0.3 mm). If rack support bushings are worn, use a screwdriver to release the tab lock on the side opposite the pinion. Use blind hole Bearing Puller (D80L-100R) with slide hammer to remove bushing.
2. Check tie rod ball joints for smooth operation. Replace parts as necessary. Check sliding surface of rack support and gear housing for cracks or damage. Check rack bushing for excessive wear. Replace entire gear housing assembly if any of these parts are worn or damaged.

Reassembly

1. Apply lithium grease to ball bearing, roller bearing, inside of gear housing, lip of oil seal, sliding surface and back of rack support, sliding surface of rack bushing, rack pinion teeth and ball joints. Install rack support bushing into right end of rack housing. Ensure lock tabs engage with slots in housing.
2. If previously removed, install a new lower pinion bearing using a bushing installer or a piece of wooden dowel stock. Carefully insert non-toothed side of rack into left end of rack housing, with rack teeth facing pinion bore. Position rack in housing so rack protrudes 2.4" (62 mm) from the left side of housing. Install pinion and upper bearing assembly so that when bearing is seated, notch (for "U" joint clamp bolt) in pinion splines forms a 35-55 degree angle with the centerline of the housing. See [Fig. 2](#) .

NOTE: If fit between housing and bearing is too tight, strike outer ring of bearing lightly while checking mesh of rack and pinion.

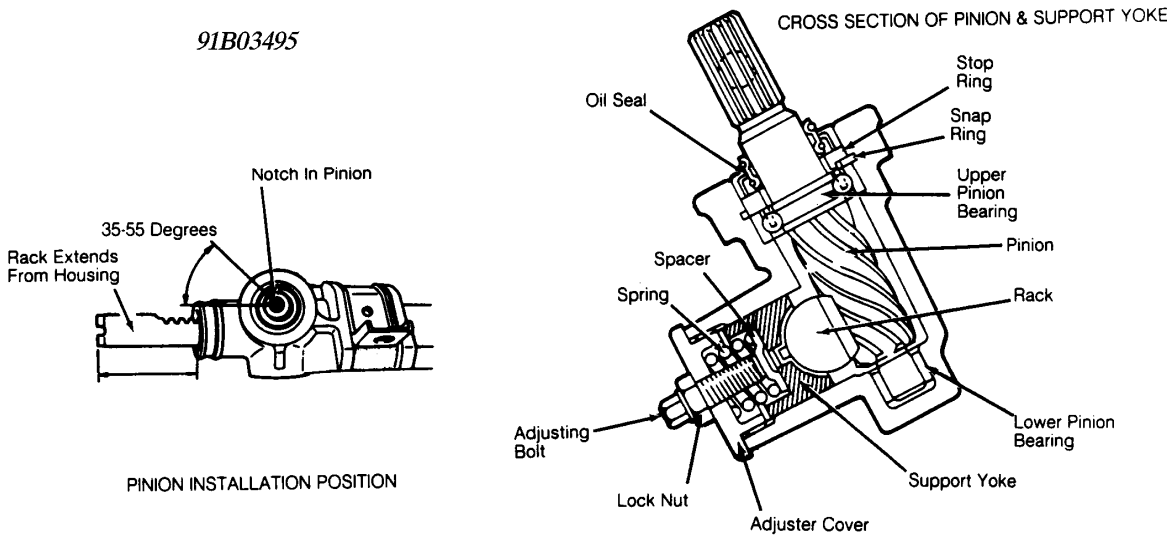


Fig. 2: Removing & Installing Rack Components
Courtesy of FORD MOTOR CO.

3. Install snap ring and spacer, with beveled side of snap ring facing upward (toward oil seal). Install oil seal spacer with tab side down, locating tab in snap ring gap. Protect pinion shaft splines with tape. Coat tape with a thin coat of grease and install new seal. Using a soft hammer, tap lightly on seal until it is flush with end surface of housing. Remove protective tape.
4. Mount rack in a soft-jawed vise and install new lock tabs and tie rods. Tighten tie rod with a "crows foot" wrench to 44-58 ft. lbs. (59-78 N.m). Use a center punch to stake lock tabs washer in 2 places. Slide tie rod boot over tie rod and position on rack. Secure with mechanic's tie wire. Install other boot and other boot clamps.
5. Center rack so that tie rods are equally extended. Grease rack support yoke. Install rack support yoke, spacer and spring in housing. Apply sealer to adjusting cover (yoke plug) threads and install in housing. Install adjusting bolt and lock nut.
6. Tighten adjusting cover to 80-97 INCH lbs. (9-11 N.m). Slowly cycle rack back and forth 5 times through 90 percent of its full stroke. Center rack so tie rods are equally extended. Loosen adjusting cover and retighten to 22-30 INCH lbs. (2.5-3.4 N.m). Using a spring pull scale, measure force needed to turn pinion 180 degrees from center rack position.
7. Adjust pinion to position where most force was needed to turn it. Tighten adjusting cover to 48 INCH lbs. (5.4 N.m), then back off 5-10 degrees. Hold adjusting bolt with a wrench and tighten the lock nut with a "crows foot" to 29-36 ft. lbs. (39-49 N.m). 8) To complete reassembly, reverse disassembly procedure. Install tie rod ends and jam nuts. Ensure index marks align. See [Fig. 1](#) .

WHEEL ALIGNMENT

After performing appropriate service procedures, refer to WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES article in the WHEEL ALIGNMENT section.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Pinion Adjusting Screw Lock Nut	29-36 (39-49)
Mounting Bracket Bolt	23-34 (31-46)
Tie Rod End Castle Nut	26-30 (35-40)
Tie Rod-to-Rack Ball Joint	43-58 (58-79)

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STEERING SYSTEM - POWER

1991-92 STEERING Ford Motor Co. - Steering - Power Rack & Pinion

DESCRIPTION & OPERATION

Power steering system consists of a rack and pinion steering gear, valve body, power steering pump, fluid reservoir and interconnecting hydraulic lines. Pressure and return lines from pump are connected to valve body. A vane-type power steering pump draws fluid from the steering reservoir. Fluid is compressed by rotor and vanes inside steering pump and sent to steering gear. Pressure is monitored and controlled by a pressure switch and a control valve located inside of steering pump.

TROUBLE SHOOTING

Refer to TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

LUBRICATION

CAPACITY

Information is not available.

FLUID TYPE

Use Dexron-II ATF type fluid.

FLUID LEVEL CHECK

Check fluid level before engine is started, while fluid is still cool. Remove reservoir cap fluid indicator on steering pump. Check fluid level. Fluid should be between the "L" and "H" marks on the level gauge dipstick. If fluid is needed, fill to the "L" mark on dipstick. Run engine until warm and turn steering wheel fully in both directions about 10 times. Return steering to straight-ahead position and shut engine off. Ensure fluid level is between "L" and "H" marks. Add fluid if necessary.

HYDRAULIC FLUID BLEEDING

1. Raise and support front of vehicle. Ensure pump reservoir is filled to specified level. With ignition coil wire disconnected, crank engine and add fluid to steering pump until fluid level remains constant. While cranking engine, rotate steering from stop to stop. Recheck and add fluid as necessary.
2. Start engine and allow to idle for several minutes. Turn steering wheel completely lock-to-lock several times. Check fluid level. Add fluid as necessary. Continue this procedure until there is no bubbling or decrease in fluid level.

ADJUSTMENTS

BELT TENSION

On Festiva, remove air duct and air cleaner. On all models, loosen steering pump mounting pivot bolt and the adjusting bolt lock nut. Using Belt Tension Gauge (021-0028A), fit gauge to longest available belt span for testing. Adjust belt to specification. See [BELT TENSION SPECIFICATIONS](#) . Tighten adjuster lock nut to 32-45 ft. lbs. (43-61 N.m) on Capri or 27-38 ft. lbs. (37-52 N.m) on Festiva.

BELT TENSION SPECIFICATIONS

Application	⁽¹⁾ Deflection: In. (mm)	Gauge Tension: Lbs. (kg)
New Belt		
Capri & Festiva	.31-.35 (8-9)	110-132 (50-60)
Used Belt		
Capri	.31-.35 (8-9)	110-132 (50-60)
Festiva	.35-.39 (9-10)	95-110 (43-50)
(1) Apply approximately 22 lbs. (9.9 kg) of pressure.		

REMOVAL & INSTALLATION

STEERING GEAR

Removal

1. Disconnect negative battery cable. On Capri, mark and loosen intermediate lower U-joint. On Festiva, mark and remove steering gear intermediate shaft connecting steering gear to column shaft. On all models, disconnect high pressure and return lines and plug them. Loosen front wheel lug nuts.
2. Raise vehicle. Remove front wheels. Remove tie rod end cotter pins and nuts. Separate tie rod ends from steering knuckles using Tie Rod Remover (T85M-3395-A). Remove tie rod end splash shields. Remove right fender splash shield. Remove front catalytic converter nuts and separate converter from inlet pipe.
3. Place reference marks on tie rod end and tie rod for reassembly reference. Loosen tie rod jam nut and remove right tie rod end. Remove steering gear mounting bolts and washers. Slide steering gear to the left and pull right tie rod through fender opening. Remove steering gear by sliding it to the right.

Installation

1. Position steering gear in its mounting position. Attach intermediate shaft to steering gear pinion and tighten clamp bolt to 13-20 ft. lbs. (18-26 N.m). Guide intermediate shaft into steering column hole. Lower vehicle.
2. Lift steering gear and align intermediate shaft with universal joint and install clamp bolt. Raise vehicle. Install steering gear mounting bolts and tighten to 23-34 ft. lbs. (31-46 N.m). Install right tie rod end, using marks made during removal for installation reference. Attach tie rod ends to steering knuckles. Install tie rod end nuts and tighten to 22-33 ft. lbs. (29-44 N.m).
3. Install tie rod end cotter pins. Attach catalytic converter to inlet pipe and install attaching nuts. Tighten nuts to 23-34 ft. lbs. (31-46 N.m). Install tie rod end splash shields. Install right fender splash shield. install front wheels. Lower vehicle.
4. Connect high pressure and return lines. Connect negative battery cable. Add power steering fluid and bleed air from system and check for leaks. See [HYDRAULIC FLUID BLEEDING](#) under LUBRICATION.

POWER STEERING PUMP

Removal (Capri)

1. Remove right radiator support and brace. Remove pump drive belt. Disconnect intercooler outlet hose at throttle intake (if equipped). Remove ground wire from engine lifting eye.
2. Remove pressure and return hoses and plug. Remove wire from pressure switch. Remove adjusting screw, nut and block from pump bracket. Remove pivot bolt. Remove bracket retaining bolts then remove pump.

Removal (Festiva)

Remove air duct and air cleaner. Disconnect electrical connector from fluid pressure switch on power steering pump. Disconnect and plug return and pressure lines. Remove adjustment bolt. Remove lock nut, washer and bracket bolt. Loosen mounting bolt and disconnect drive belt. Remove mounting bolt. Remove power steering pump.

Installation (Capri & Festiva)

To install pump, reverse removal procedure. Adjust steering belt tension. Tighten all nuts and bolts to specification. See [TORQUE SPECIFICATIONS](#) . Add power steering fluid and bleed air from system and check for leaks. See [HYDRAULIC FLUID BLEEDING](#) under LUBRICATION.

OVERHAUL

STEERING GEAR

Disassembly (Capri)

1. Remove steering gear and place in soft-jawed vise. Remove external hydraulic lines. See [Fig. 1](#) . Remove mount brackets and rubber mount bushings. Remove brass tubing seats using a self-tapping screw and 2 screwdrivers.

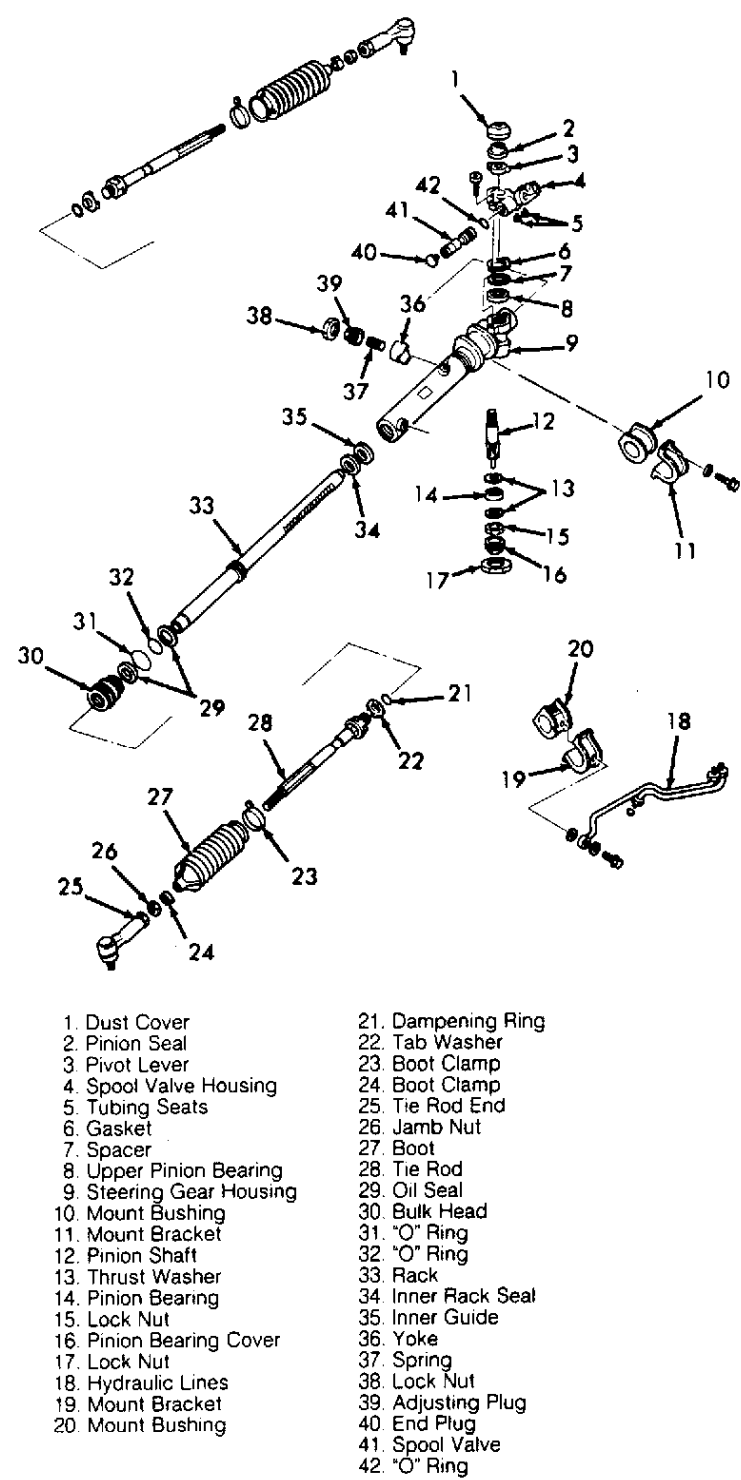


Fig. 1: Exploded View of Power Steering Gear (Capri)
Courtesy of FORD MOTOR CO.

2. Use cold chisel to remove pinion shaft dust boot. Use No. 40 Torx bit to remove valve body attaching bolts. Remove, disassemble and inspect valve body components. Remove burrs from spool valve with crocus cloth if necessary. Mark tie rod ends and jam nuts for installation reference.
3. Remove tie rod ends and jam nuts. Remove tie rod dust boots. Use dull cold chisel to uncrimp tie rod end tab washers. Remove tie rod. Remove adjusting plug, spring and yoke. Protect outer bulkhead with cloth and remove with pipe wrench.
4. Discard bulkhead "O" ring. Pull pinion shaft out from lower bearing side. Remove upper pinion bearing by driving it out with wooden dowel. Remove rack from outer bulkhead end.
5. Remove inner guide and inner rack seal using Inner Rack Seal Remover T87C-3504-A. Mount rack on "V" blocks to check runout. Runout should be no more than .012" (.03 mm). Replace rack if runout exceeds specification.

Reassembly

1. Install a new "O" ring on spool valve. Apply Long Life Lubricant (C1AZ-19590-BA) to pivot lever hole in spool valve and to pivot lever hole in valve body. Apply ATF to rest of spool valve. Install spool valve. Apply Long Life Lubricant to pivot lever/collar and to bushing.
2. Install pivot lever into spool valve housing. Make sure longest end of pivot lever/collar is seated in spool valve. Install end plug in spool valve housing. Apply ATF to inner guide. Push inner guide and inner rack seal into rack housing with Inner Rack Seal Remover (T87C-3504-A).
3. Apply Long Life Lubricant to rack teeth. **DO NOT** plug rack air hole with grease. Install Rack Oil Seal Protector (D83P-3504-K). Install a new rack piston seal on rack using Piston Seal Replacer (T81P-3504-L) with Pusher (T75L-3517-A2) and Sizer (T81P-3504-K).
4. Apply ATF to rack piston and cover rack with electrical tape. Coat inside of rack housing with ATF and carefully slide rack into housing. Slide rack as far as it will go into housing. Remove rack seal protector. Install a new bushing into outer bulkhead using Pinion Cover Centering Tool T18P-3504-Y.
5. Install a new sealing ring, oil seal and "O" rings at bulkhead end of rack housing. Lubricate all parts with ATF before installation. Wrap outer bulkhead with towel and install with pipe wrench. Stake bulkhead to rack housing with punch. Install lower bearing on pinion shaft. Install and tighten retaining nut to 29-36 ft. lbs. (40-50 N.m).
6. Stake nut to pinion shaft. Install pinion shaft into housing with rack extending 2.70" (68.7 mm) out of housing on pinion shaft end or centered in housing. Also, notch on pinion shaft spline must be located 60 degrees from horizontal center. See [Fig. 2](#).

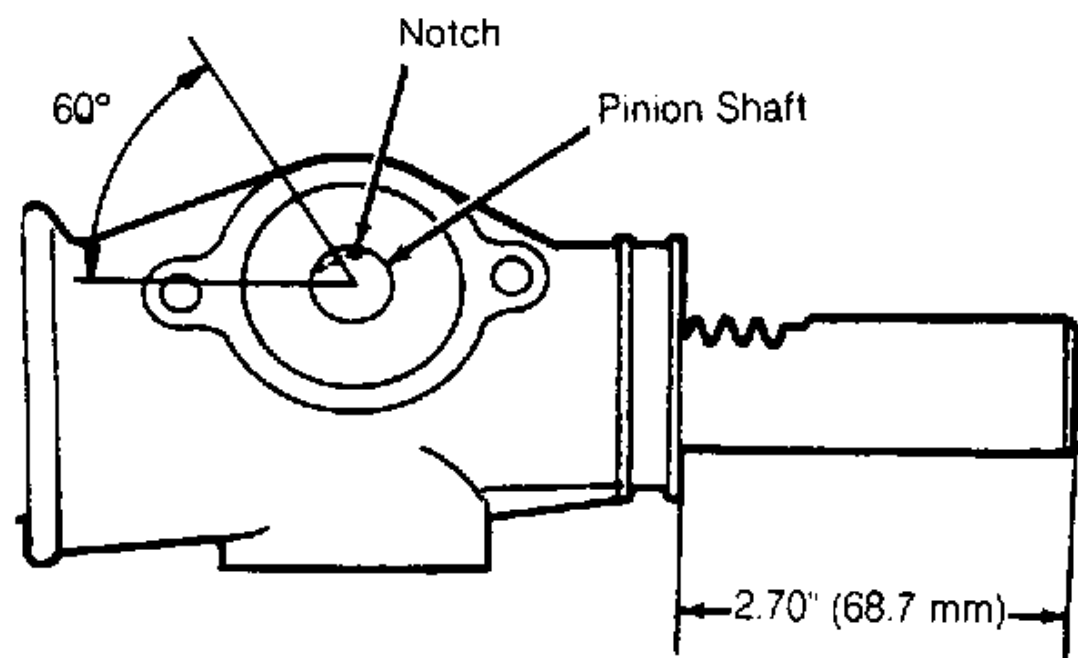


Fig. 2: Installing Pinion Shaft (Capri)
Courtesy of FORD MOTOR CO.

- Grease upper pinion bearing and install in housing using Upper Pinion Seal Replacer (T78P-3504-D). Tighten pinion bearing cover to 44-79 INCH lbs. (5-9 N.m). Then loosen it 10-20 degrees. Tighten lock nut to 29-36 ft. lbs. (40-50 N.m).
- Using a new gasket, attach valve body to rack housing. Install yoke, spring, adjusting plug and lock nut. Tighten cover to 39-47 INCH lbs. (4.5-5.5 N.m). Loosen cover 45 degrees. Measure pinion torque using inch lb. torque wrench and Pinion Adapter (T87C-3504-C).
- Pinion torque should be .52-1.3 INCH lbs. (.6-1.5 N.m). If pinion torque is not within specification, loosen or tighten adjusting plug. After pinion torque is set, tighten lock nut to 29-36 ft. lbs. (40-50 N.m). Mount steering gear in soft-jawed vise and install damper ring, washer and tie rod.
- Tighten tie rod to 43-58 ft. lbs. (60-80 N.m). Stake tab washer in 2 places. Position damper ring in washer. Install other damper ring, washer and tie rod. Install tie rod dust boots and secure outer ends with clamps and inner sides with mechanics wire.
- Install tie rod ends and adjust according to index marks put on during disassembly. Wrap electrical tape around and apply grease to pinion shaft. Apply grease to lips of pinion shaft seal. Install pinion shaft seal using Pinion Bearing Replacer (T78P-3504-D).
- Remove electrical tape from pinion shaft. Install support brackets and rubber bushings. Install external oil lines and 2 new copper sealing rings.

Disassembly (Festiva)

- Remove steering gear from vehicle and place in a soft-jawed vise. Remove fluid lines. See [Fig. 3](#) . Place reference marks on left tie rod end and tie rod for reassembly reference. Loosen jam nut and remove left tie rod end. Remove outer boot clamps. Remove inner boot wires. Remove boots.

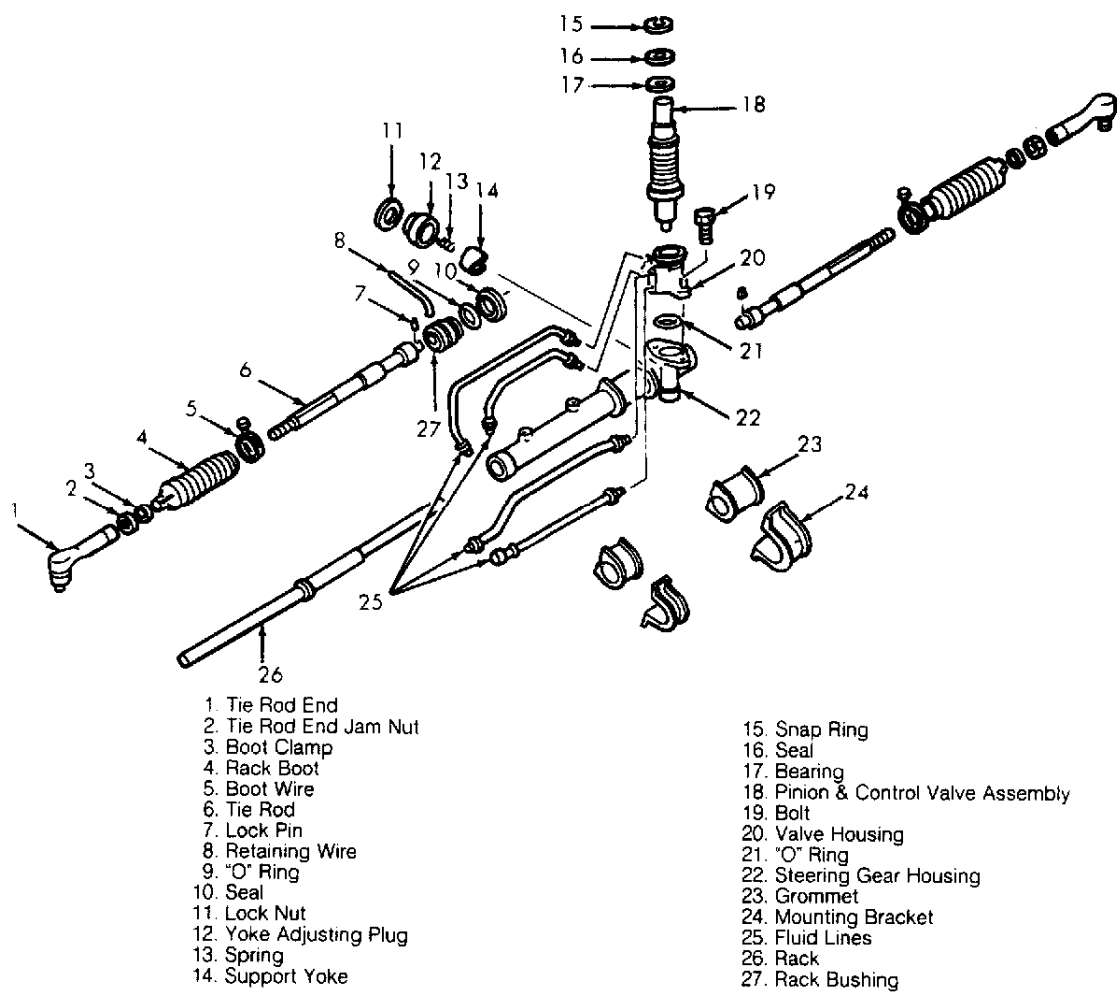


Fig. 3: Exploded View of Power Steering Gear (Festiva)
Courtesy of FORD MOTOR CO.

2. Remove tie rod lock nut pins using Lock Nut Pin Remover (T78P-3504-N). Remove tie rods from rack. Remove yoke plug lock nut using Yoke Lock Nut Wrench (T90C-3504-BH). Remove yoke plug, spring and support yoke. Remove snap ring which retains pinion and control valve assembly.
3. Remove seal using Lock Nut Pin Remover (T78P-3504-N). Remove valve housing attaching bolts. Remove valve housing and pinion and control valve assembly. If present, remove shims from steering gear housing. Remove "O" ring. Remove lower pinion bearing using Collet (D80L-100-L) and Blind Hole Puller Set (D80L-100-A).
4. Remove pinion and control valve assembly from valve housing by tapping lightly with a rubber mallet. Remove 4 Teflon seals from pinion and control valve assembly. Press bearing out of valve housing using Pinion Seal Replacer (T88C-3504-MH) and Handle (T87P-3504-D).
5. Using Outer Box Torque Adapter (T88C-3504-CH), rotate the rack bushing until the hooked end of the retaining wire is aligned with the slot in the steering gear housing. Pry the retaining wire from the bushing hole. Rotate the bushing and remove the retaining wire. Remove the rack from the right side of the steering gear.
6. Remove bushing from rack. Remove "O" ring. Remove seal using Rack Oil Seal Remover (T87C-3504-A) by bottoming seal into rack with plastic hammer. Pull seal out with Slide Hammer T50T-100-A. Remove the rack mounting brackets and grommets.

Reassembly

1. Install grommets and mounting brackets. Install new seal using Rack Oil Seal Replacer T81P-3504-C. Install new "O" ring using Piston Seal Replacer (T81P-3504-L) and Rack Piston Seal Sizer (T81P-3504-K). Place Short Rack Seal Replacer (T81P-3504-N) over end of rack to protect bushing.
2. Install bushing on rack. Place Rack Seal Protector (T87P-3504-H) on rack. See [Fig. 4](#) . Install rack. Remove rack seal protector. Insert rack retaining wire through slot and into bushing hole. Install retaining wire using Outer Box Torque Adapter (T88C-3504-CH).

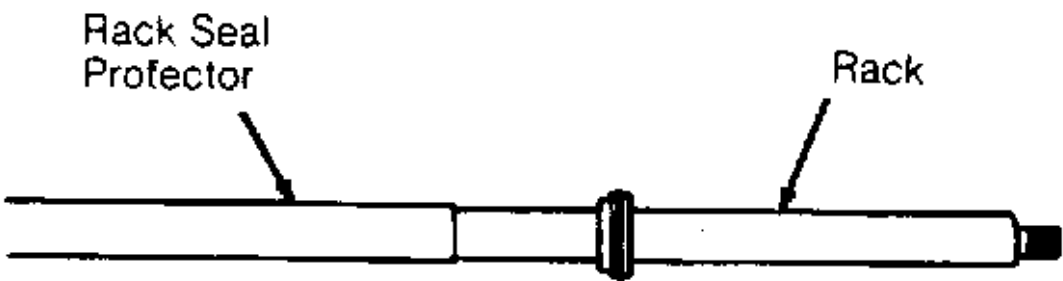


Fig. 4: Installing Rack Seal Protector (Festiva)
Courtesy of FORD MOTOR CO.

3. Install lower pinion bearing using Pinion Bearing Replacer (T90C-3504-DH). If valve housing, steering gear, or pinion and control valve assembly have been replaced, go to step 4). If none of these components have been replaced, go to step 6).
4. Measure valve housing, lower bearing and spacer, and steering gear housing. See [Fig. 5](#) . Use the following formula to determine proper shim thickness: $T = A C - B$ Where "T" is the shim thickness.

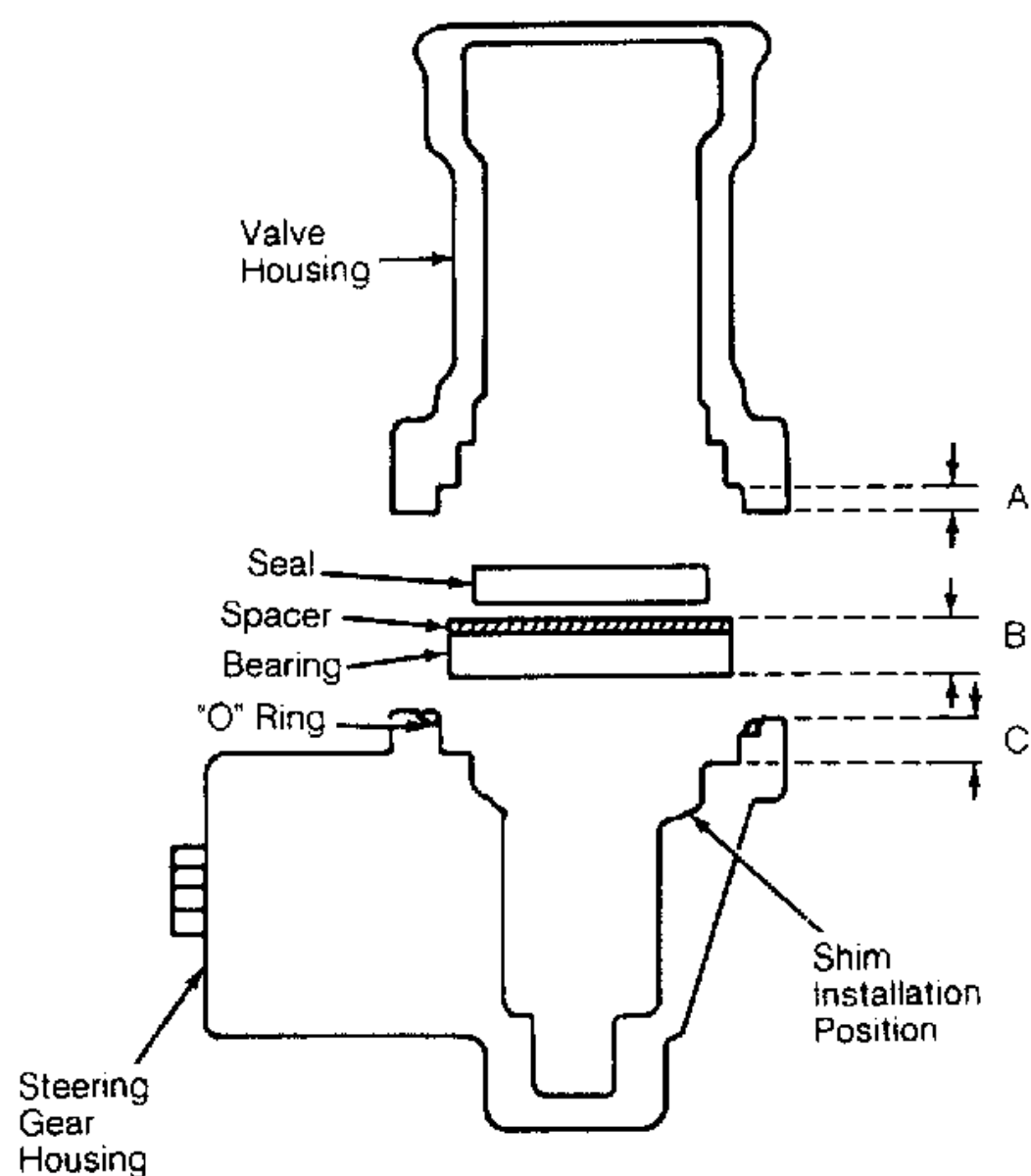


Fig. 5: Determining Replacement Shim Thickness (Festiva)
Courtesy of FORD MOTOR CO.

5. Having calculated required shim thickness, divide the required shim thickness by .0020" (.05 mm). This is the thickness of replacement shims. Round off to the nearest equal shim thickness.
6. Install previously removed shim(s) into valve housing. Install new Teflon pinion seals on pinion and control valve assembly using Pinion Valve Seal Installation Set (T81P-3504-M). Install first seal (seal closest to bearing) by sliding Mandrel (T81P-3504-M1) over valve assembly to first seal groove.
7. Push seal into groove with Pusher (T81P-3504-M2). Size the seal by sliding large end of Sizer (T81P-3504-M3) over seal. Before installing second seal, place Spacer (T81P-3504-M4) on valve assembly near splined end. Install and size using Mandrel (T81P-3504-M1) and Pusher (T81P-3504-M2).
8. Before installing third seal, place 2 Spacers (T81P-3504-M4) on valve assembly near splined end. Install and size third seal. To install fourth seal, turn second spacer around so the small ends of each spacer are facing. Install an size fourth seal.
9. Insert pinion and control valve assembly into valve housing, making sure it seats properly. Install New "O" ring. Install valve housing mount bolts and tighten to 15-19- ft. lbs. (21-25 N.m). Install upper pinion bearing and seal using Pinion Seal Replacer/Torque Adapter (T90C-3504-EH).
10. Install snap ring, support yoke and spring. Install yoke plug and tighten to 86 INCH lbs. (9.8 N.m). Loosen yoke plug and install Yoke Plug Torque Gauge T90C-3504-CH over yoke plug. Tighten yoke plug to 38-48 INCH lbs. (4.4-5.4 N.m). Make scribe mark on support yoke at zero point on yoke plug torque gauge.
11. Loosen yoke plug until 45 degree mark on yoke plug torque gauge is aligned with scribe mark on support yoke. Apply sealant to exposed threads of yoke plug. Install lock nut and tighten to 36-43 ft. lbs. (49-59 N.m). Install tie rods and tie rod lock pins. Install boots, boot wires and clips, and fluid lines.

POWER STEERING PUMP

Disassembly (Capri)

1. Drain pump. Remove rear bracket, mount bolts and brackets. Remove reservoir and "O" ring. Remove rear pump body and "O" ring. Remove pump center body and "O" ring. Remove cam ring and pump shaft snap ring. Remove vanes from rotor. See [Fig. 6](#) .
2. Remove rotor from shaft and note rotor position. Remove pump shaft from front of pump. Remove front bracket. Remove shaft oil seal. Check clearance between vane and rotor. Clearance should .0004-.0024" (.01-.06 mm). Replace vanes as necessary.
3. Check clearance between bushing and shaft. Clearance should be .001-.004" (.03-.1 mm). Replace shaft or bushing as necessary.

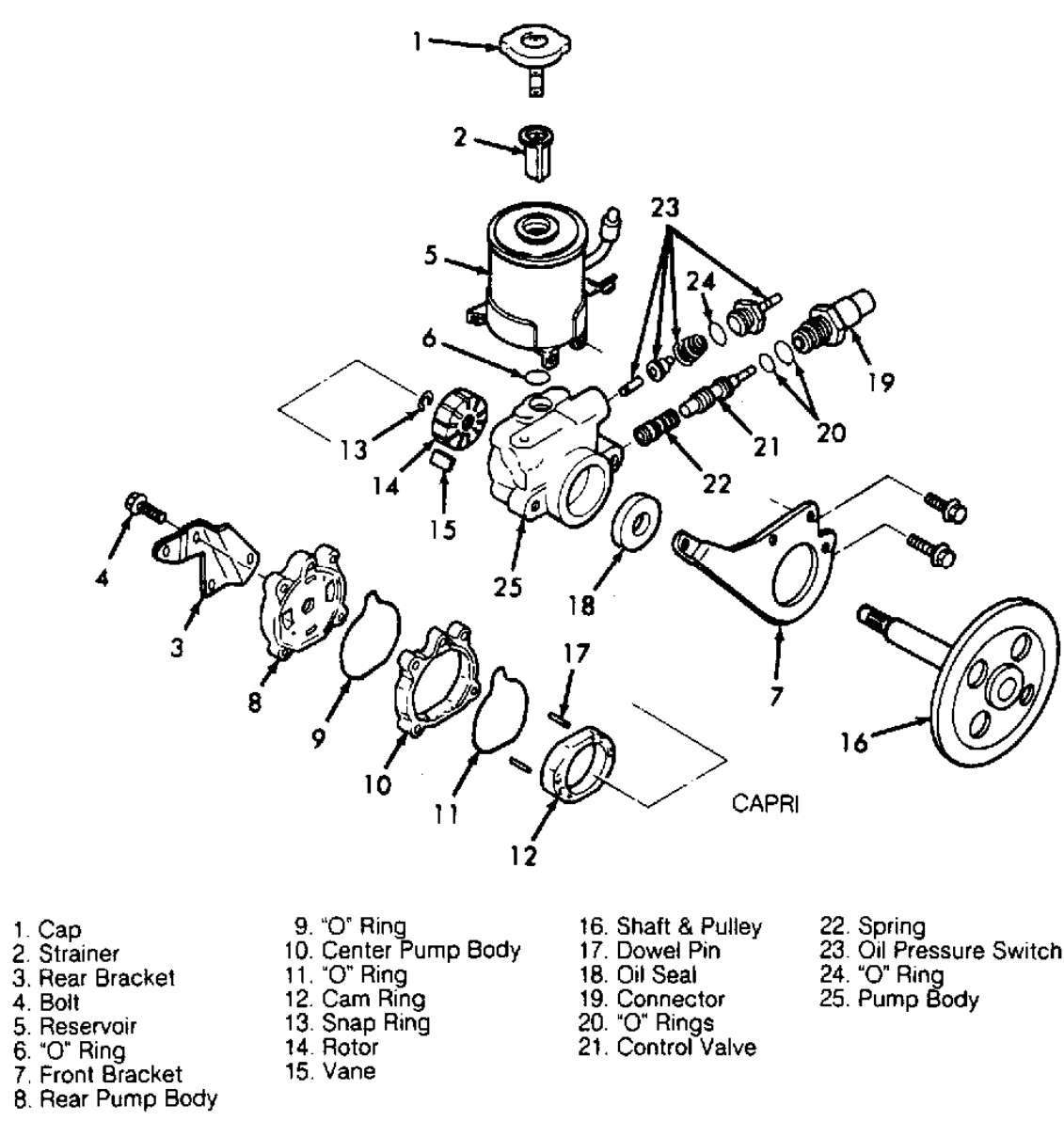


Fig. 6: Exploded View of Power Steering Pump (Capri)
Courtesy of FORD MOTOR CO.

Reassembly (Capri)

1. Install pressure switch and pressure regulator valve (if removed). Lubricate and install a new shaft oil seal. Install front bracket and bolts. Install pump shaft from front of body. Install rotor onto rear of shaft in same position as removed.
2. Install shaft snap ring. Tap shaft on rear to seat snap ring onto rotor splined hole below rotor rear face. Install vanes in rotor with rounded edges facing out. Install cam ring, center pump body and front "O" ring. Install rear pump body and "O" ring.
3. Install reservoir and "O" ring. Install short bolt into hole used by reservoir bracket. Install rear mount bracket. Rotate pulley to check for smooth operation.

Disassembly (Festiva)

1. With pump removed from vehicle, secure pump in a soft-jawed vice. Remove nut and washer that secure high pressure line. Remove cap screw and support bracket. Remove high pressure line. Remove return line attaching bolts. See [Fig. 7](#) and [Fig. 8](#) .

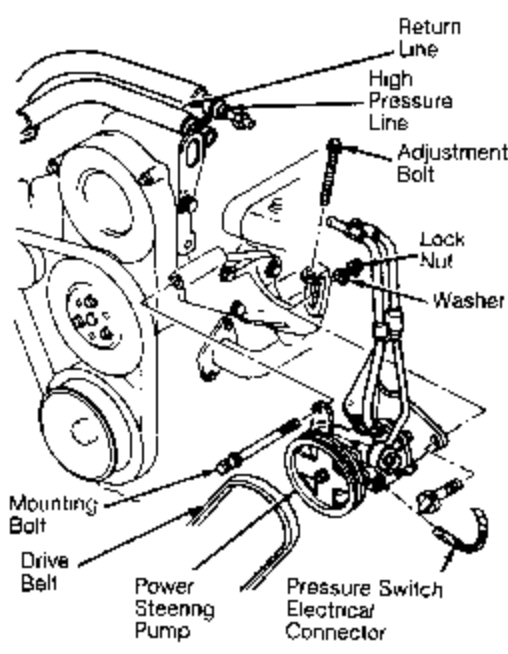


Fig. 7: Power Steering Pump Mounting & Pressure Hose (Festiva)
Courtesy of FORD MOTOR CO.

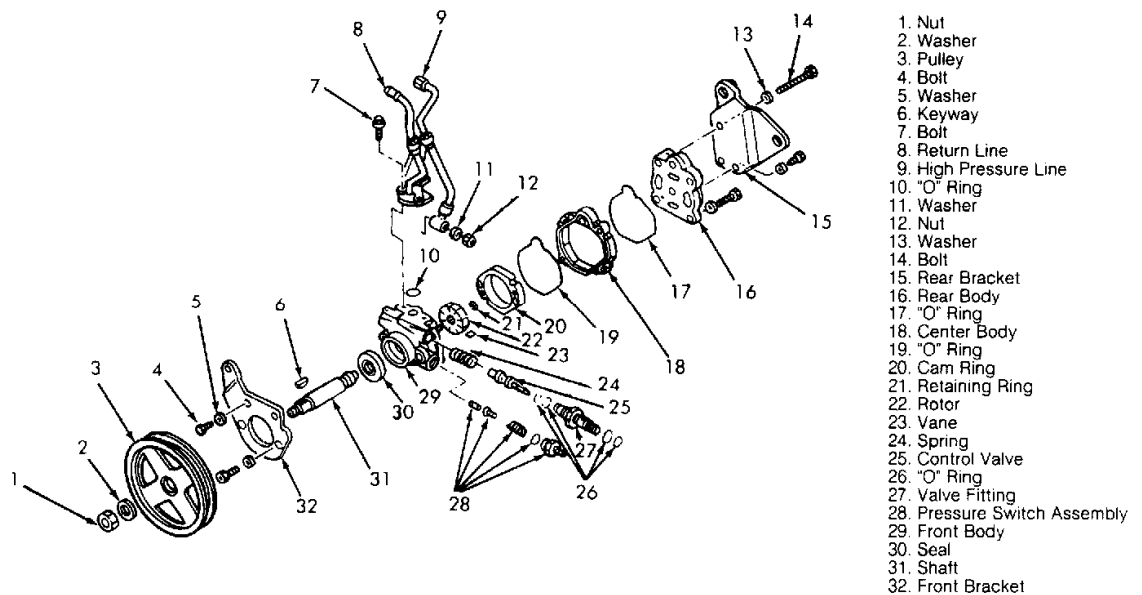


Fig. 8: Exploded View of Power Steering Pump (Festiva)
Courtesy of FORD MOTOR CO.

- 2. Remove return line and "O" ring. Remove pulley nut and washer. Remove pulley using Pulley Remover (OTC-1024). Remove keyway, front bracket bolts and washers. Remove front bracket, rear bracket bolts and washers and rear bracket. Remove rear body bolts and washers. Remove rear body. Remove shaft retaining ring. Remove shaft and rotor.
- 3. Remove vanes, "O" ring, and center body. Remove "O" ring and cam ring. Remove seal using Collet (D80L-100-Q) and Slide Hammer (T50T-100-A). Remove valve fitting. Remove 4 "O" rings from valve fitting. Remove control valve, spring, pressure switch fitting and spring. Remove "O" ring from pressure switch fitting. Remove spring seat. Remove plunger.

Reassembly (Festiva)

- 1. Coat pump vanes, rotor and control valve with ATF. Install new "O" ring on pressure switch fitting. Install plunger, spring seat, spring and pressure switch fitting. Install new "O" rings on valve fitting. Install spring, control valve and valve fitting. Coat lip of new seal with grease and install seal using suitable installer.
- 2. Install cam ring, new "O"ring, center body, new "O" ring and rotor. Ensure rounded edge of vanes face toward center of rotor. Install vanes, shaft and retaining ring. Position rear body and install washers and bolts. Position rear bracket and install washers and bolts. Position front bracket and install washers and bolts.
- 3. Position key in keyway and install pulley. Install pulley washer and nut. Tighten nut to 22-29 ft. lbs. (29-39 N.m). Install new "O" ring at return line port. Position high pressure line and install support bracket and cap screw. Install high pressure line attaching washer and nut. Tighten to 29-36 ft. lbs. (39-49 N.m).
- 4. Ensure pump rotates freely. If not, disassemble and repair as necessary. Install pump on vehicle. Bleed air from hydraulic system before starting engine. See [HYDRAULIC FLUID BLEEDING](#) under LUBRICATION.

WHEEL ALIGNMENT

After performing appropriate service procedures, refer to [WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES](#) article in the WHEEL ALIGNMENT section.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Pinion Cover Lock Nut	29-36 (40-50)
Pinion Shaft Nut	29-36 (39-49)
Power Steering Pump Bracket	27-38 (37-52)
Power Steering Lock Nut	32-45 (43-61)
Tie Rod-To-Rack	44-58 (60-80)
Tie Rod-To-Steering Knuckle	26-29 (35-40)
Valve Body Cover Lock Nut	29-36 (40-50)
Wheel Lug Nut	67-88 (90-120)
	INCH Lbs.
Pinion Bearing Cover	39-47 (4.5-5.5)

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Intermediate Shaft Clamp Bolt	13-20 (18-26)
Pinion Adjusting Plug Lock Nut	36-43 (49-59)
Pressure Hose Fitting	29-36 (39-49)
Power Steering Pump Lock Nut	27-38 (37-52)
Power Steering Pump Mounting Bolt	27-40 (36-54)
Steer Gear Mount Bolts	23-34 (32-47)
Tie Rod-To-Steering Knuckle	22-33 (30-45)

Valve Housing-To-Steering Gear Housing Bolts	15-19 (21-25)
INCH Lbs.	
Fluid Reservoir Mounting Bolts	62-84 (7-10 N.m)

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STEERING COLUMN

1991 STEERING Ford Motor Co. - Steering Columns

DESCRIPTION

NOTE: **Steering column is not repairable and must be replaced as a unit.**

The steering column assembly consists of a steering shaft, steering shaft tube, upper and lower bearings, mounting brackets, ignition lock and combination switch assembly.

WARNING: **On models with Supplemental Restraint System (SRS), observe the following precautions. Before any repairs are performed, disconnect and shield battery ground cable and air bag back-up power supply. Back-up power supply is a Blue rectangular unit located behind glove box, attached to instrument panel.**

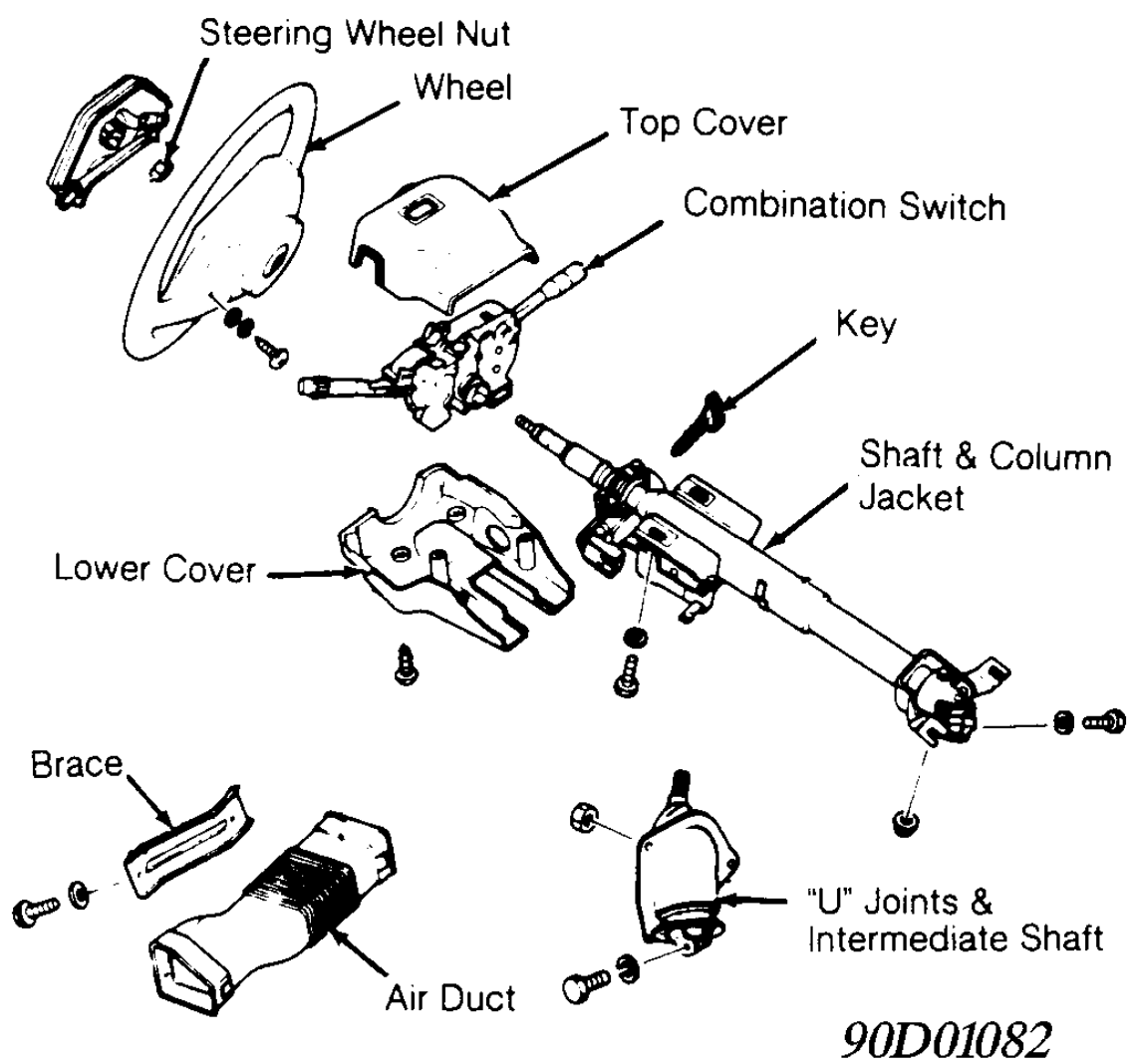


Fig. 1: Exploded View of External Steering Column Assembly (Typical)
Courtesy of FORD MOTOR CO.

TROUBLE SHOOTING

Refer to TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

REMOVAL & INSTALLATION

STEERING WHEEL & HORN PAD

Removal & Installation (Capri)

1. Disconnect negative battery cable and air bag back-up power supply. Back-up power supply is a Blue rectangular unit located behind glove box, attached to instrument panel. Remove 4 mount nuts from back of steering wheel and remove air bag module.

CAUTION: **DO NOT use a knock-off type steering wheel puller or strike steering wheel or shaft with a hammer. Sudden impact could damage a bearing or begin to collapse steering column.**

2. Disconnect air bag module connector. Loosen steering wheel nut 4-6 turns. Using Steering Wheel Remover (T67L-3600-A), remove steering wheel. To install, reverse removal procedure.

Removal & Installation (Festiva)

Remove 2 screws from back of steering wheel. Disconnect horn wire and remove cover. Remove steering wheel retaining nut. Mark steering wheel and steering shaft. Using Steering Wheel Remover (T67L-3600-A), remove steering wheel. To install, reverse removal procedure.

COMBINATION SWITCH

Removal & Installation (Capri)

Disconnect negative battery cable. With steering wheel removed, remove screws from lower column cover and remove lower cover. Remove steering column upper retaining bolts. Steering column will rest on instrument panel bracket. Release wiring harness clip and unplug connectors. Remove 2 switch retaining screws and remove switch from steering column. To install, reverse removal procedure.

Removal & Installation (Festiva)

Disconnect negative battery cable. With steering wheel removed, remove screws from lower column cover and remove both upper and lower cover. Release wiring harness clip and unplug connectors. Loosen band clamp securing switch hub to steering column jacket. Remove switch from steering column. To install, reverse removal procedure.

IGNITION SWITCH & LOCK

Removal & Installation (Capri Ignition Switch)

1. Disconnect negative battery cable. With steering wheel removed, remove upper and lower column covers. Remove center access panel and trim panel under steering wheel. Remove left side defroster connector tube.
2. Remove steering column upper attaching bolts. Lower steering column onto instrument panel brace. Remove ignition tumbler. With ignition key inserted, rotate tumbler while pushing release pin with .125" (3.17 mm) drift. Pull tumbler out of ignition lock housing.
3. Remove column lock shield. Disconnect switch harness connector. Remove single retaining screw. Remove ignition switch. See [Fig. 2](#) . Reverse removal procedures to complete installation.

Removal & Installation (Festiva Ignition Switch)

1. Disconnect negative battery cable. With steering wheel removed, remove screws from lower column cover and remove both upper and lower covers. Remove steering column shield and shield bracket. Remove air discharge tube.
2. Remove steering column attaching nuts and lower the steering column support bracket. Remove single retaining screw from top side of ignition switch. Remove ignition switch wiring harness and ignition switch. See [Fig. 2](#) .

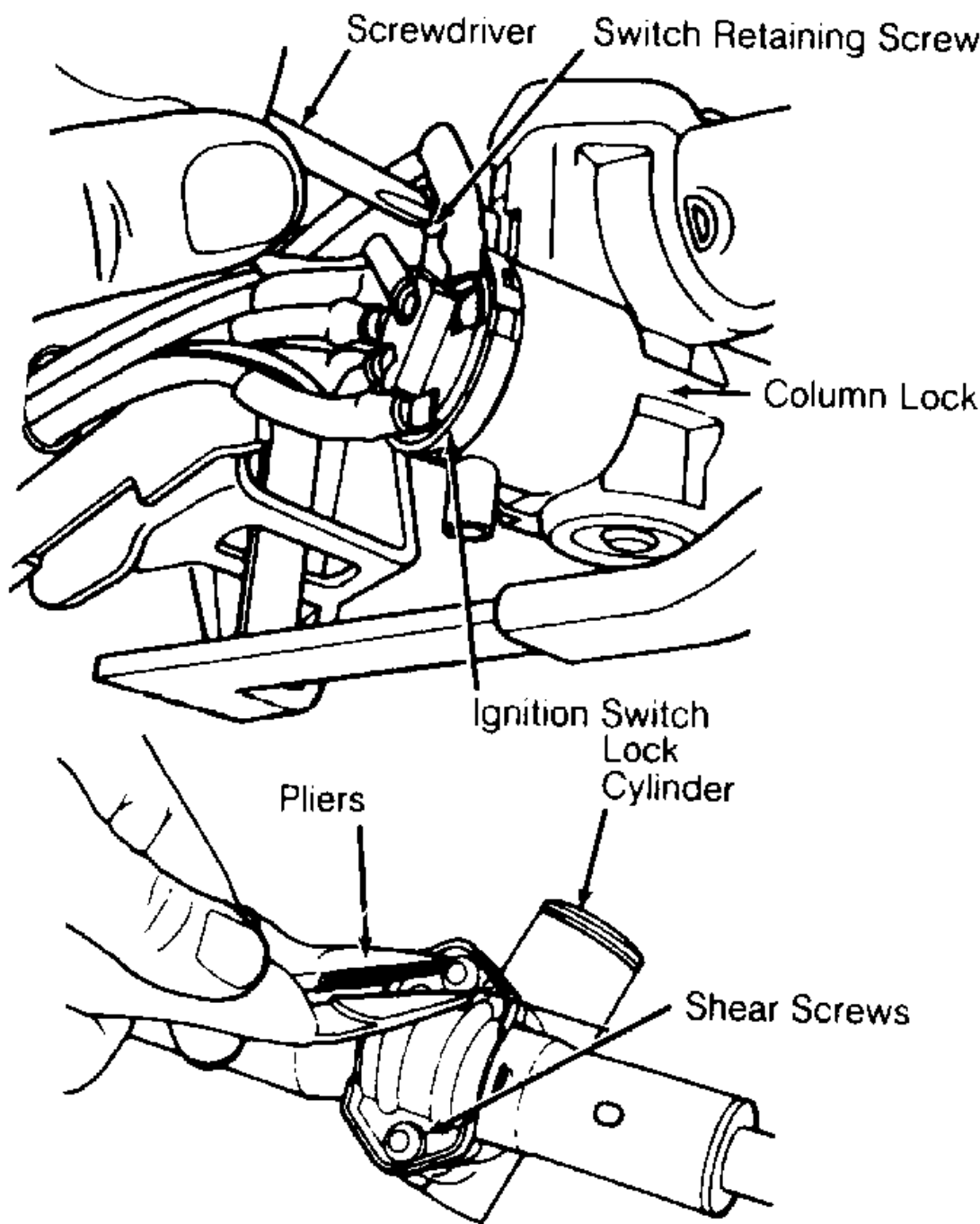


Fig. 2: Ignition Switch & Lock Mechanism
Courtesy of FORD MOTOR CO.

Removal & Installation (Festiva Ignition Lock)

1. Remove combination switch, see [COMBINATION SWITCH](#) earlier. Remove ignition switch. Remove shift lock cable attaching bolt

and disconnect cable from lock housing. Using slim-nose locking pliers, grip and remove round headed shear screws securing column lock housing and cap to column jacket. See [Fig. 2](#) .

2. Remove lock housing. To install lock housing, position lock cylinder and cap on column jacket. Using new screws, tighten only enough to hold lock housing in position. Use ignition key to ensure lock works correctly without binding. Adjust switch if necessary. Tighten shear screws until heads break off. Install ignition switch in cylinder. Reverse removal procedures to complete installation.

STEERING COLUMN

Removal & Installation (Capri)

1. Place wheels in a straight-ahead position. Remove ignition key and lock steering wheel. Disconnect negative battery cable and air bag back-up power supply. Back-up power supply is a Blue rectangular unit located behind glove box, attached to instrument panel.
2. Remove air bag module from steering wheel. Remove steering column access cover and trim panel. Remove defroster duct connecting hose. Remove steering column lower shroud. Loosen lower steering column retaining nuts. Remove steering column upper retaining nuts.
3. Remove ignition lock shield and ignition switch mount screw. Disconnect all necessary electrical connectors. Mark and remove steering shaft universal joint bolt. Remove steering column from instrument panel. To install, reverse removal procedure. Once steering column is completely installed, check all switches and functions for proper operation.

Removal (Festiva)

1. Disconnect battery ground cable. Place wheels in a straight-ahead position. Remove steering wheel, upper and lower column covers, combination switch, ignition switch and harness connectors.
2. Remove steering column shield and air duct from below steering column. Remove 2 steering column upper mounting bracket-to-instrument panel crossmember nuts.
3. Lower upper end of column as necessary to gain access to intermediate shaft upper "U" joint. Mark steering shaft and upper "U" joint for reassembly reference.
4. Remove "U" joint attaching bolt. Loosen 2 steering column hinge bracket-to-clutch/brake pedal support nuts. Remove steering column with upper "U" joint by pulling toward passenger compartment.

NOTE: **If steering rack and intermediate shaft are also removed, "U" joints and intermediate shaft must be marked for reassembly reference. Both ends of shaft are identical.**

Installation (Festiva)

1. Align marks made during removal and install column with intermediate shaft upper "U" joint over intermediate shaft. Install, but do not tighten, "U" joint clamp bolt.
2. Install and tighten hinge bracket nuts. Install shim clips on column upper bracket flanges (if removed). Position upper end of steering column to instrument panel mounting studs.
3. Install upper bracket retaining nuts. Turn steering wheel lock-to-lock several times to align "U" joint splines. Tighten "U" joint clamp bolt.
4. Install air duct and instrument panel brace. Install harness connectors, ignition switch, combination switch, upper and lower column covers and steering wheel.

OVERHAUL

STEERING COLUMN

Disassembly & Reassembly (Capri)

1. Remove steering column. See [STEERING COLUMN](#) under REMOVAL & INSTALLATION. Position steering column in soft-jawed vise. Using Steering Wheel Remover (T67L-3600-A), remove steering wheel. Put 2 strips of tape on air bag clockspring, to avoid rotation.
2. Remove 3 clockspring retaining screws and remove clockspring. With ignition key installed, rotate tumbler to Run position while pushing tumbler release pin with .125" (3.17 mm) drift. Remove tumbler and upper column shroud. Remove key warning switch.
3. Remove bearing plate. Remove and discard snap ring located at front end of steering column. Remove multifunction switch. Remove column lock and upper bearing using a suitable bearing puller. To reassemble, reverse disassembly procedure.

CAUTION: **If steering shaft shear pins break during housing or bearing removal, the complete shaft and column must be replaced. To determine if pins have sheared, measure steering shaft from top end of shaft to center of U-joint bearing. If length is less than 24.23" (615.7 mm) or greater than 24.66" (617.7 mm), pins have sheared.**

Disassembly (Festiva)

Disassembly of steering column assembly is not recommended by manufacturer. If any components are found defective, replace steering column assembly.

Inspection (Festiva)

1. Measure steering shaft for signs of collapse. Steering shaft length should be between 23.86-23.94" (606-608 mm). If measurement is not within specification, replace steering column assembly.
2. Check for steering shaft side play. Any detectable side play can adversely affect steering control. If side play in excess of .03" (.75 mm) is present, bearings are badly worn. Replace steering column assembly.

Reassembly (Festiva)

To reassemble, reverse disassembly procedure.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Ignition Lock Housing Bolt	12-21 (16-28)
Steering Column Attaching Bolt	17-23 (23-31)
Steering Column Attaching Nut	14-18 (19-25)
Steering Column Bracket Nut & Bolt	14-18 (19-25)
Steering Wheel Nut	23-33 (31-45)
INCH Lbs. (N.m)	
Air Bag Module	35-53 (4-6)
Ignition Switch Screw	53-71 (6-8)

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Steering Column Attaching Bolt	23-34 (31-46)
Steering Wheel Nut	29-36 (39-49)
INCH Lbs. (N.m)	
Ignition Switch Screw	53-71 (6-8)
Shift Lock Cable Bolt	35-53 (4-6)

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SUSPENSION - FRONT

1991-92 SUSPENSION Front

DESCRIPTION

Front suspension system uses MacPherson strut shock assemblies. The upper ends of the strut assembly are attached to the shock towers and the lower ends are attached to the steering knuckle. Lower control arm is attached to the chassis. Fore and aft movement is controlled by the stabilizer bar. The stabilizer bar is connected to the lower control arm by a connecting link. See [Fig. 1](#) or [Fig. 2](#) .

ADJUSTMENTS & INSPECTION

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

NOTE: See SPECIFICATIONS & PROCEDURES article in the WHEEL ALIGNMENT Section.

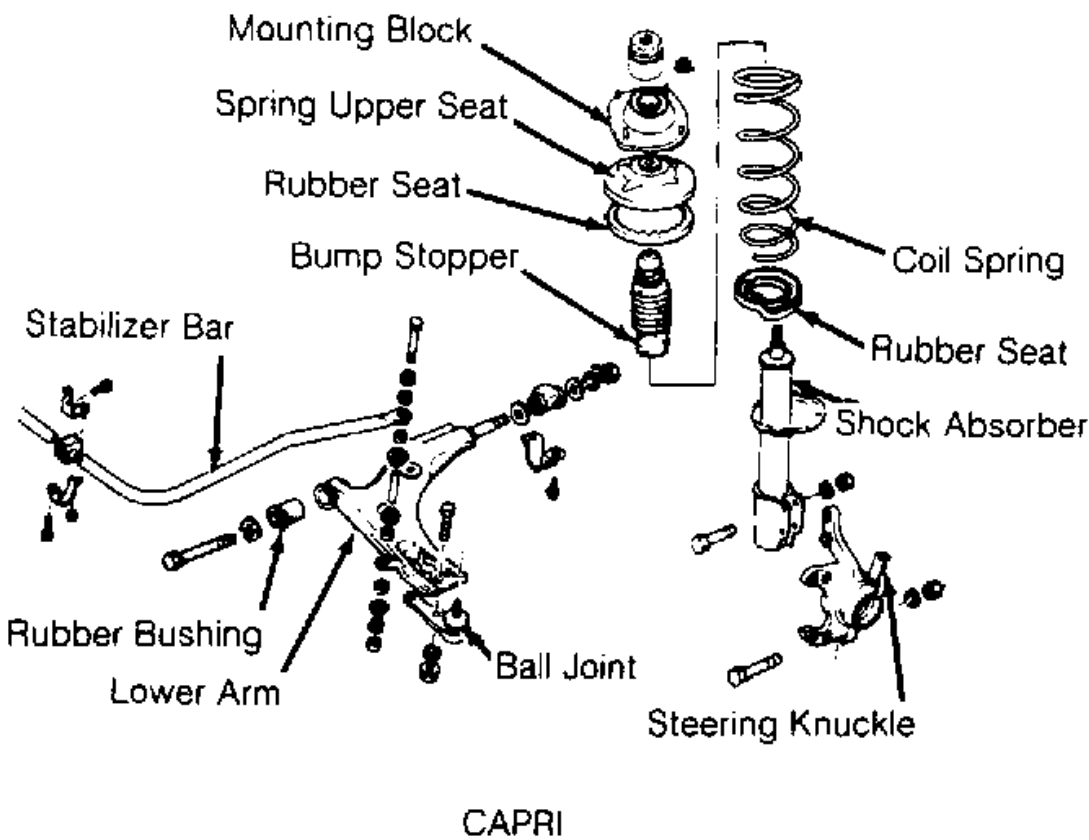


Fig. 1: Front Suspension Assembly (Capri)
Courtesy of FORD MOTOR CO.

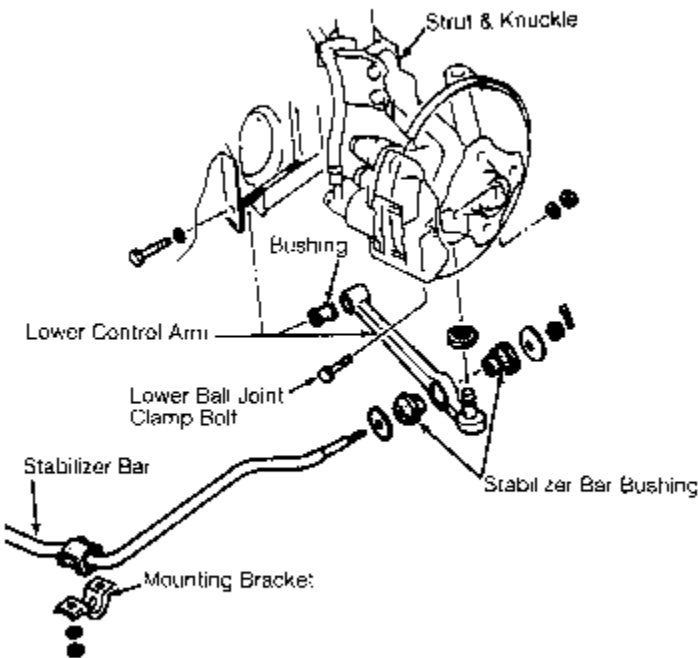


Fig. 2: Front Suspension Assembly (Festiva)
Courtesy of FORD MOTOR CO.

WHEEL BEARINGS

Wheel bearing preload is maintained by a selective spacer in the steering knuckle, between the inner and outer hub bearings. For adjustment procedures and inspection, see WHEEL BEARING under REMOVAL & INSTALLATION.

BALL JOINT CHECKING

Raise and support vehicle until tire is just off ground. Move wheel vertically and check for play. If play is noticed between steering knuckle and control arm, control arm assembly should be replaced. If play is present but ball joint is okay, wheel bearings should be checked for wear and replaced if necessary.

REMOVAL & INSTALLATION

STABILIZER BAR

NOTE: Information for stabilizer bar removal and installation on Capri is not available from manufacturer.

Removal & Installation (Festiva)

- 1. Remove stabilizer mounting bracket nuts and brackets. Remove split bushings from stabilizer bar. Remove stabilizer bushing nuts at lower control arms. Remove rear dished washers and bushings.
- 2. To loosen stabilizer bar, pull forward from control arms. Remove front bushings and washers. Install control arm bushing washers on ends of stabilizer and install control arm front bushings. Insert ends of stabilizer bar into control arm bushings and install rear bushings and washers on stabilizer bar ends.
- 3. Install retaining nuts finger tight. Install split bushings on stabilizer cross bar with split side forward. Position split bushings next to White locating marks on bar. Install stabilizer mounting brackets. Tighten all bolts and nuts to specification.

STRUT ASSEMBLY & COIL SPRING

Removal

- 1. Raise and support front of vehicle so struts are fully extended. Remove front wheels. Remove brake line clip from strut lower mounting bracket and remove brake line.
- 2. Remove 2 bolts retaining strut lower bracket to steering knuckle. Working inside engine compartment, remove 2 nuts retaining strut mounting block in strut tower. Disengage strut lower bracket from steering knuckle and lower strut from vehicle.

Disassembly & Reassembly

- 1. Using spring compressor, compress spring to unload strut. Pry out mounting block cap and remove strut upper nut and lock washer.
- 2. Remove strut mounting block and spacer plate. Remove washer, bearing seal and bearing from strut rod. Remove spring upper seat, seat insulator and coil spring. Remove jounce bumper and dust shield from strut. Reverse disassembly procedure to install coil spring and reassemble strut.

Installation

- 1. Position strut, with spacer plate installed, in strut tower with White alignment mark facing outward. Install and tighten nuts on upper mounting block studs.
- 2. Install steering knuckle in strut lower bracket. To complete installation, reverse removal procedure. Tighten all bolts and nuts to specification.

HUB & KNUCKLE ASSEMBLY

Removal

- 1. Raise and support vehicle. Remove wheel. Straighten staked edge of drive axle lock nut flange. DO NOT damage groove or threads in end of drive axle. Apply brakes to prevent hub assembly from turning. Remove and discard drive axle lock nut.

NOTE: Always use a new drive axle lock nut when servicing drive hub or drive axle.

- 2. Remove clip which secures brake hose to strut bracket. Remove cotter pin and tie rod end attaching nut. Using Tie Rod End Separator (T85M-3395A), remove tie rod end from steering knuckle.
- 3. Remove brake caliper attaching bolts and remove assembly from steering knuckle. Do not allow caliper to hang by brake hose. Remove clamp bolt and nut where lower control arm ball joint connects to steering knuckle.
- 4. Using a pry bar, pull down on lower control arm and release ball joint from steering knuckle. Remove 2 bolts which attach steering knuckle between flanges of MacPherson strut bracket. Slide hub/knuckle assembly off end of drive axle. If binding is present or drive hub is rusted to half-shaft, use a hub puller to push axle from drive hub.

Installation

- 1. Apply a thin coat of SAE 30 weight oil to drive axle splines. Slide steering knuckle/rotor/hub assembly onto drive axle. Stop at area where uppermost arm of steering knuckle seats into MacPherson strut bracket.
- 2. To complete installation, reverse removal procedure. Install NEW drive axle lock nut. Tighten all bolts and nuts to specification. Stake axle lock nut into shaft groove.

CAUTION: DO NOT use a pointed tool to stake nut. If lock nut flange cracks, even slightly, during staking process, it must be replaced.

WHEEL BEARING

Removal

1. Remove hub and knuckle assembly from vehicle. See HUB & KNUCKLE ASSEMBLY under REMOVAL & INSTALLATION. Using Knuckle Puller (T87C-1104-A), or a press and bearing puller, remove drive hub/rotor assembly from steering knuckle/dust shield assembly.
2. Remove bearing preload spacer from hub. Spacer is preselected to provide correct bearing preload. Ensure correct spacer is installed during reassembly. Install hub/rotor assembly in a vise. Scribe alignment marks on hub and rotor for reassembly reference.
3. Remove rotor attaching bolts and rotor. Use Bearing Splitter (D84L-1123-A), Shaft Protector (D80L-625-2) and a press, or Bearing Puller (D80L-927-A) and Puller Attachment (D84L-1123-A) to remove outer bearing from wheel hub. Remove and discard outer and inner grease seals. Using Bearing Puller (T77F-1102-A) and Slide Hammer (T-50T-100-A), remove races from steering knuckle. See [Fig. 3](#).

NOTE: Removal of press-fitted dust shield from steering knuckle is not part of normal bearing service. Dust shield should not be removed from steering knuckle unless it is being replaced.

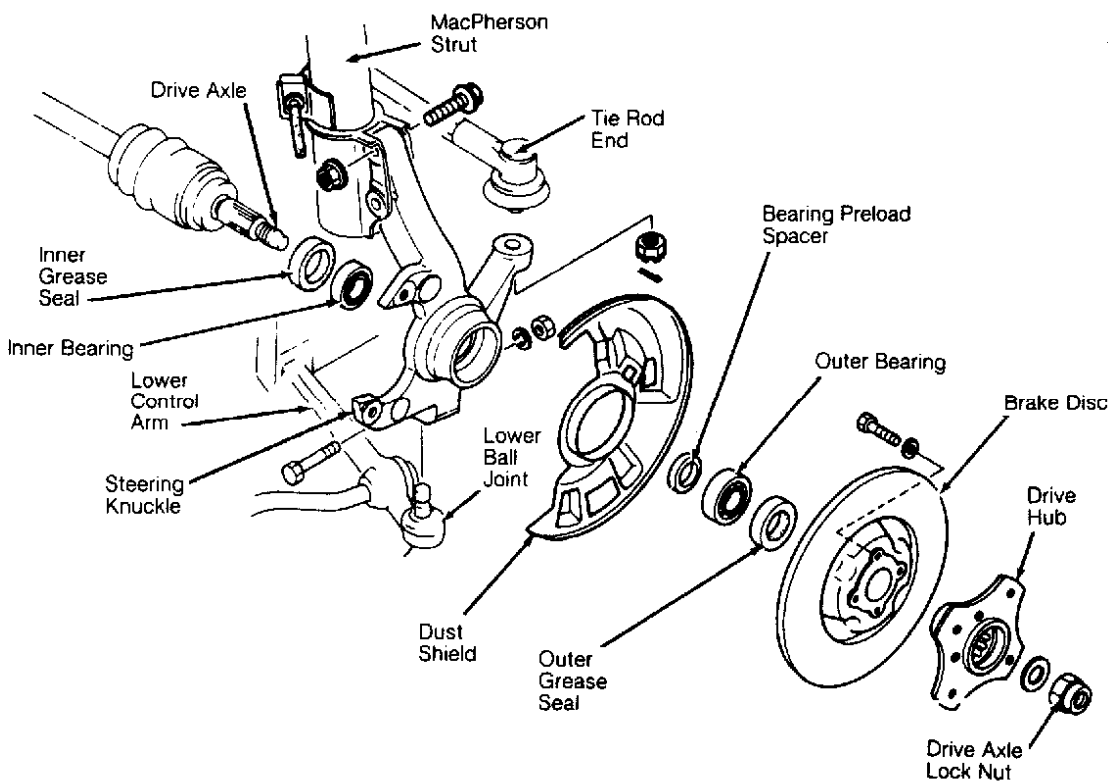


Fig. 3: Front Wheel Bearing & Hub Assembly
Courtesy of FORD MOTOR CO.

Inspection

Thoroughly clean all parts in solvent. Check bearings, hub, knuckle and rotor dust shield for excessive wear or damage. If new bearing is being installed, check bearing preload. See BEARING PRELOAD.

Bearing Preload

1. To check and adjust preload, Spacer Selector Set (T87C-1104-B) must be used. Prior to assembling hub/rotor assembly into steering knuckle, install spacer selector into steering knuckle and clamp tool in vise. Tighten center bolt, in increments, to 36, 72, 108 and finally 145 ft. lbs. (49, 98, 147 and 196 N.m). Each time center bolt is tightened, seat the bearings by rotating steering knuckle by hand.
2. Remove steering knuckle from vise. Reinstall steering knuckle in vise, clamping it where shock absorber mounts. Using an INCH lb. torque wrench, measure torque required to turn center bolt. Ensure torque reading is taken just as wrench starts to rotate.
3. Spacer thickness is correct if torque wrench indicates 2.21-10.44 INCH lbs. (.25-1.8 N.m). If measurement indicates less than 2.21 INCH lbs. (.25 N.m), a thinner spacer must be installed. If measurement indicates more than 15.93 INCH lbs. (1.8 N.m), a thicker spacer must be installed.
4. Bearing spacers are available in 21 thicknesses, in .0016" (.040 mm) increments. Spacer No. 1 is thinnest and No. 21 is thickest. See PRELOAD SPACER AVAILABILITY table. Changing spacer thickness one increment will change bearing preload 1.7-3.5 INCH lbs. (.2-.4 N.m). Ensure correct spacer is installed and preload is within specification. Remove spacer selector set.

PRELOAD SPACER AVAILABILITY

Stamped Mark On Spacer	In. (mm)
1	0.2474 (6.285)
2	0.2490 (6.325)
3	0.2506 (6.365)
4	0.2522 (6.405)
5	0.2537 (6.445)
6	0.2553 (6.485)
7	0.2569 (6.525)
8	0.2585 (6.565)
9	0.2600 (6.605)
10	0.2616 (6.645)
11	0.2632 (6.685)
12	0.2648 (6.725)

13	0.2663 (6.765)
14	0.2679 (6.805)
15	0.2695 (6.845)
16	0.2711 (6.885)
17	0.2726 (6.925)
18	0.2742 (6.965)
19	0.2758 (7.005)
20	0.2774 (7.045)
21	0.2789 (7.085)

Installation

- Using Bearing Cup Replacer (D79P-1202-A) and Universal Driver Handle (T80T-4000-W), install bearing races in steering knuckle. Lubricate bearing races and bearing. Install inner bearing into steering knuckle. Lubricate seal lips and install inner bearing seal into knuckle. Install original bearing preload spacer in steering knuckle (or spacer selected during bearing preload check). Position outer bearing in knuckle. Install outer seal. Install hub onto rotor, using reference marks made during removal. Install rotor to hub attaching bolts.
- Using a press and adapter from Spacer Selector Set (T87C-1104-B), install knuckle assembly onto hub. To complete installation, reverse removal procedure.

LOWER CONTROL ARM & BALL JOINT (FESTIVA)

Removal

Remove lower control arm pivot bolt at frame bracket. Remove ball joint clamp bolt and nut from steering knuckle assembly. Remove stabilizer bushing retaining nut from rear of control arm. Remove rear bushing washer and bushing. Lower the control arm and pry ball joint stud out of steering knuckle. Disconnect control arm from stabilizer end and remove.

Inspection

Check control arm and bushings for excessive wear or damage. Ensure ball joint stud moves freely but is not loose. Use Ball Joint Rotating Adapter (T87C-5493-C) to check ball joint rotating torque. Rotating torque should be 16-27 INCH lbs. (1.8-3.1 N.m).

Installation

- Install front bushing washer with dished side forward. Position bushing stabilizer end and engage control arm with stabilizer. Raise control arm inner end into pivot bracket on frame. Install pivot bolt to hold it in position.
- Engage control arm ball joint stud with clamp bore in steering knuckle. Install clamp bolt and nut. Install stabilizer rear bushing and washer with dished side forward on stabilizer end. Tighten all bolts and nuts to specification.

LOWER CONTROL ARM (CAPRI)

Removal & Installation

Raise and support vehicle. Remove wheel and disconnect stabilizer bar from control arm, if equipped. Remove ball joint clamp bolt. Remove control arm front mount bolt. Remove control arm rear bracket and mount bolts. Remove control arm. To install, reverse removal procedure.

BALL JOINT (CAPRI)

Removal & Installation

- Raise and support vehicle. Remove wheel. Remove ball joint clamp bolt from steering knuckle. Use small pry bar to pull down on lower control arm to separate it from steering knuckle. Remove 2 ball joint retaining bolts and pry ball joint off control arm. To install, reverse removal procedure.

LOWER CONTROL ARM BUSHING

Removal & Installation (Capri)

- Remove control arm from vehicle. See LOWER CONTROL ARM. Use Bushing Receiver Cup (T87C-5493-B1), Bushing Driver (T87C-5493-B2) and vise to remove control arm bushing.
- To install, press bushing into control arm using same tools used for removal. Refit control arm to chassis.

Removal & Installation (Festiva)

- Remove control arm from vehicle. See LOWER CONTROL ARM & BALL JOINT. Use Bushing Receiver Cup (T88C-5493-E), Bushing Pilot (T81P-5493-B2) and "C" Clamp Assembly (T74P-3044-A1) to remove control arm bushing.
- To install, press bushing into control arm using same tools used for removal. Refit control arm to chassis.

NOTE: Insert bushing quickly and smoothly. Bushing should only be distorted for a short time.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Capri	
Ball Joint Pinch Bolt	32-40 (43-54)
Brake Rotor-To-Hub	33-40 (44-54)

Caliper Attaching Bolts	29-36 (39-49)
Control Arm Bolt-To-Ball Joint	69-86 (93-117)
Control Arm Bracket Bolt	44-54 (59-74)
Control Arm Front Bolt	69-86 (93-117)
Control Arm Rear Bolt	55-69 (75-93)
Drive Axle Nut	116-174 (157-236)
Shock Absorber Bolt-To-Knuckle	69-72 (93-97)
Stabilizer Bracket Nuts	40-50 (54-68)
Steering Knuckle-To-Strut	69-86 (93-117)
Steering Knuckle-To-Tie Rod	22-33 (29-44)
Strut Assembly-To-Strut Tower	17-22 (23-29)
Strut Rod Nut	22-27 (29-36)
Wheel Lug Nut	65-88 (90-120)
Festiva	
Ball Joint Pinch Bolt	32-40 (43-54)
Brake Rotor-To-Hub	33-40 (44-54)
Caliper Attaching Bolts	29-36 (39-49)
Control Arm Bushing Nuts	47-57 (64-77)
Control Arm Pivot Bolt	32-40 (43-54)
Stabilizer Bar Nuts-To-Control Arm	47-57 (64-77)
Stabilizer Mounting Bracket Nuts	40-50 (54-68)
Steering Knuckle-To-Strut	69-86 (93-117)
Steering Knuckle-To-Tie Rod	22-33 (29-44)
Strut Assembly-To-Strut Tower	22-27 (29-36)
Wheel Lug Nut	65-88 (90-120)

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SUSPENSION - REAR

1991-92 SUSPENSION Rear

DESCRIPTION

Rear suspension is a MacPherson strut, semi-independent system on Festiva and fully independent on Capri. On Festiva, trailing arms are rigidly connected to each other by a torsion beam. Rubber bushings are installed at the torsion beam/trailing arm body brackets. Control arms are not used. The rear suspension has no provision for individual wheel alignment. Rear torsion beam must be centered in chassis for proper tracking. For alignment of torsion beam, see TORSION BEAM under REMOVAL & INSTALLATION. See [Fig. 1](#) .

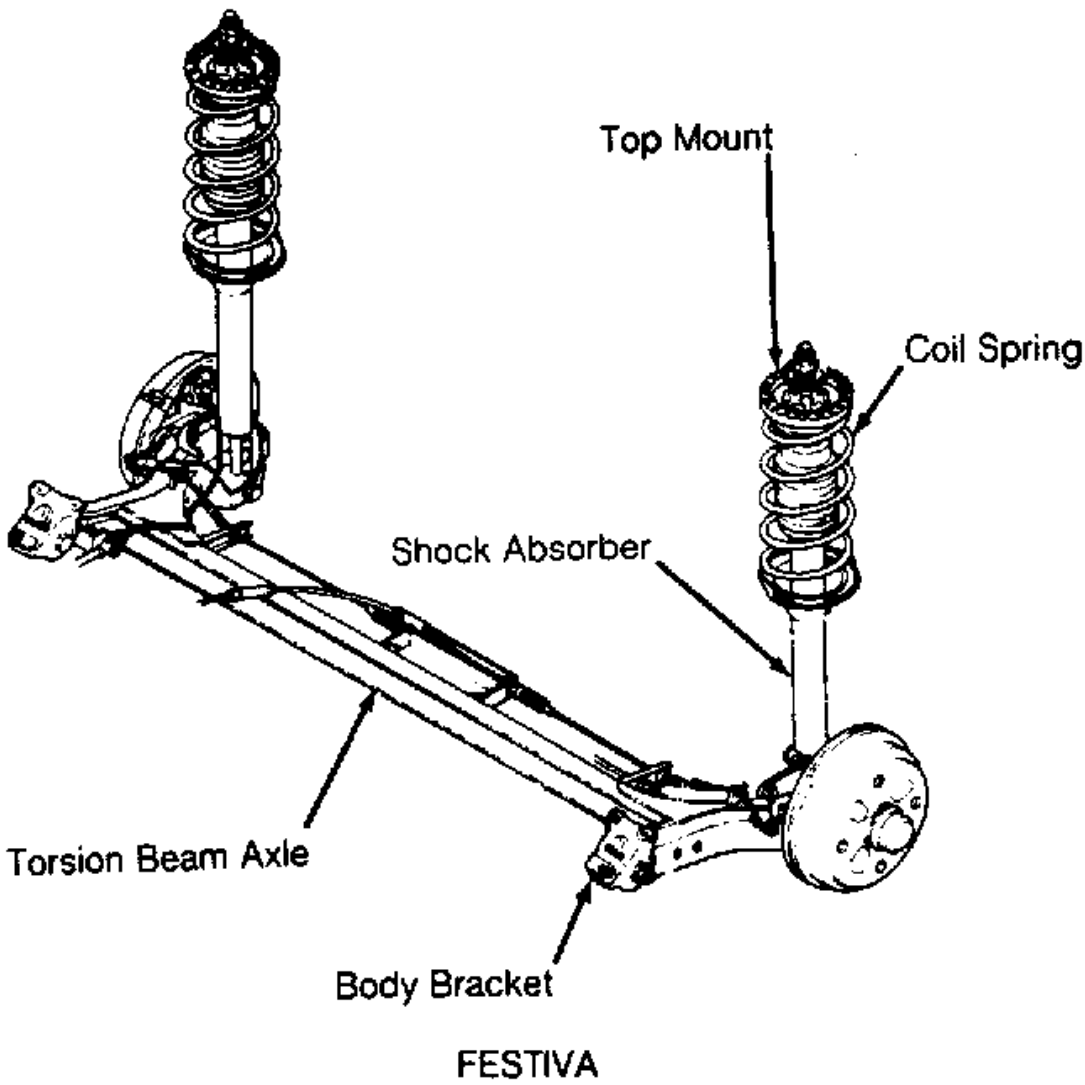


Fig. 1: Exploded View of Rear Suspension (Festiva)
Courtesy of FORD MOTOR CO.

On Capri, trailing arms and dual control arms have separate mounting points at each end. One end on each control arm is connected to rear crossmember. The other end is connected to spindle assembly. Trailing arms are attached to strut and floorpan bracket. Rear toe-in can be adjusted by rotating adjustment link on control arms. See [Fig. 2](#) .

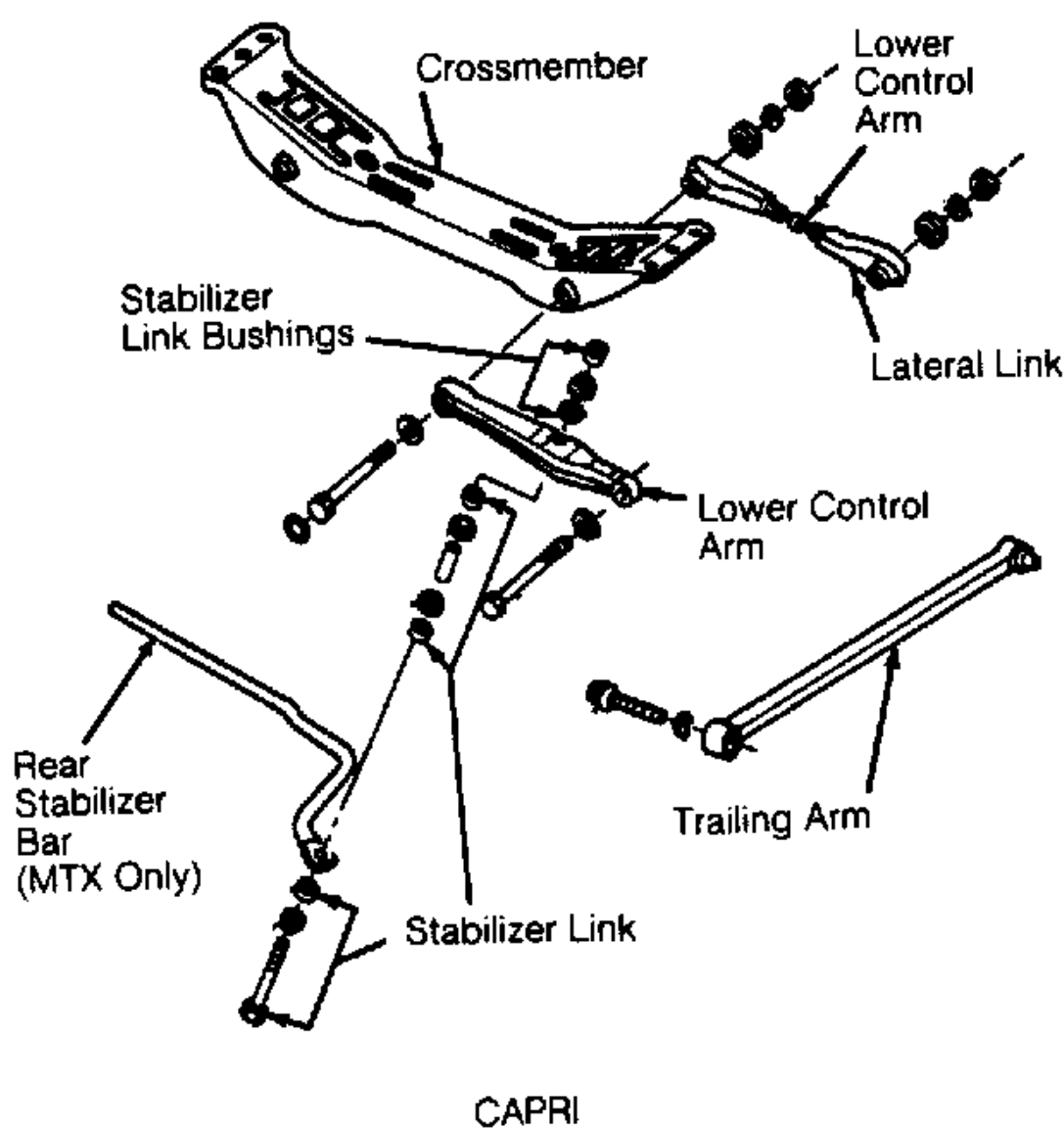


Fig. 2: Exploded View of Rear Suspension (Capri)
Courtesy of FORD MOTOR CO.

ADJUSTMENTS & INSPECTION

WHEEL BEARING

- 1. Raise and support vehicle. Ensure parking brake is fully released. Remove wheel and dust cap. Rotate brake drum and ensure there is no brake drag. Using a small cape chisel, raise the staked portion of the lock nut. Remove and discard lock nut.

NOTE: Right side lock nut has left-hand threads. Left side lock nut has right-hand threads.

- 2. Install new lock nut. To seat bearings, use a torque wrench and tighten lock nut to 18-21 ft. lbs. (25-29 N.m) while rotating brake drum. After tightening, loosen lock nut until it can be turned by hand. Measure seal drag using an INCH lb. torque wrench on a lug nut at 12 o'clock position. Measure and record amount of force required to rotate brake drum.
- 3. To determine preload, add amount of seal drag to specified preload of 1.3-4.3 INCH lbs. (.15-.49 N.m). As an example, if seal drag measures 2.2 INCH Lbs. (.25 N.m), this amount must be added to required preload.
- 4. Tighten wheel bearing lock nut a small amount. Using an INCH lb. torque wrench on a lug nut at 12 o'clock position, measure amount of pull required to rotate brake drum. Tighten attaching nut until specified amount of preload is measured with torque wrench. Stake lock nut with a blunt chisel. Install grease cap and wheel.

NOTE: Nut must be replaced if lock flange splits or cracks during staking process. DO NOT stake with a sharp edged tool.

REMOVAL & INSTALLATION

WHEEL BEARING

Removal

- 1. Raise and support vehicle. Ensure parking brake is fully released. Remove wheel and dust cap. Using a small cape chisel, raise staked portion of lock nut. Remove and discard lock nut. Remove brake drum, bearing and hub assembly from spindle.

NOTE: Right side lock nut has left-hand threads. Left side lock nut has right-hand threads.

- 2. Pry out grease seal from hub and remove inner bearing. Bearings must be marked for reassembly reference if they are to be reused. Using Slide Hammer (T50T-100-A), Bearing Cup Puller (T77F-1102-A) or proper sized brass drift and hammer, remove inner and outer bearing races.

Installation

1. Using Installer (T77F-1217-A), Driver Handle (T80T-4000-W) or proper sized brass drift and hammer, install inner and outer bearing races. Pack bearings and hub area with Lubricant (C1AZ-1959D-B, C, D or E).
2. Position inner bearing in bearing hub. Lubricate grease seal lips and install seal. Ensure bearings and hub have sufficient lubricant. Place brake drum bearings and hub assembly on spindle. To prevent damage to grease seal and spindle threads, ensure hub is correctly centered on spindle.
3. Install outer bearing, washer and new lock nut. Stake lock nut with a blunt chisel. Adjust bearing preload. See ADJUSTMENTS & INSPECTION.

NOTE: Nut must be replaced if lock flange splits or cracks during staking process. DO NOT stake with a sharp-edged tool.

SPINDLE

Removal & Installation (Capri)

Remove wheel, caliper and brake rotor. Loosen spindle-to-strut attaching bolts. Loosen outer rear control arm common bolt and nut. Remove spindle-to-strut mount bolts and common control arm bolt. Remove spindle from strut. To install, reverse removal procedure.

Removal & Installation (Festiva)

Remove brake drum assembly. Remove 4 spindle attaching nuts located on inboard side of torsion beam. Support backing plate with wire and remove spindle. To install, reverse removal procedure. Tighten spindle attaching nuts to 32-45 ft. lbs. (43-61 N.m).

STRUTS

Removal & Installation (Capri)

1. Remove wheel, caliper and brake rotor. Remove trailing arm bolt and spindle-to-strut attaching bolts. Put index mark on strut rubber mounting bracket. Remove upper strut attaching nuts from inside vehicle. Remove strut.
2. Compress strut coil spring with Spring Compressor (T18P-5310-A) or similar. Remove strut nut while spring is compressed. Remove rubber mounting bracket, upper and lower spring seats. Slowly release coil spring and remove spring compressor. Remove coil spring, dust boot and rebound bumpers. To install, reverse removal procedure.

Removal (Festiva)

1. Raise and support vehicle. Remove rear wheels. Using Spring Compressor (T81P-5310-A), compress spring to unload strut. Remove rear quarter trim panel from cargo compartment.
2. Remove jam nut and flanged nut from strut rod. Remove bushing washer and upper bushing. Remove strut lower end mounting bolt from wheel support arm. Remove strut and separate it from spring and seat insulator. Remove lower bushing and jounce bumper seat from strut rod. Slide jounce bumper and shield off strut. See [Fig. 3](#) .

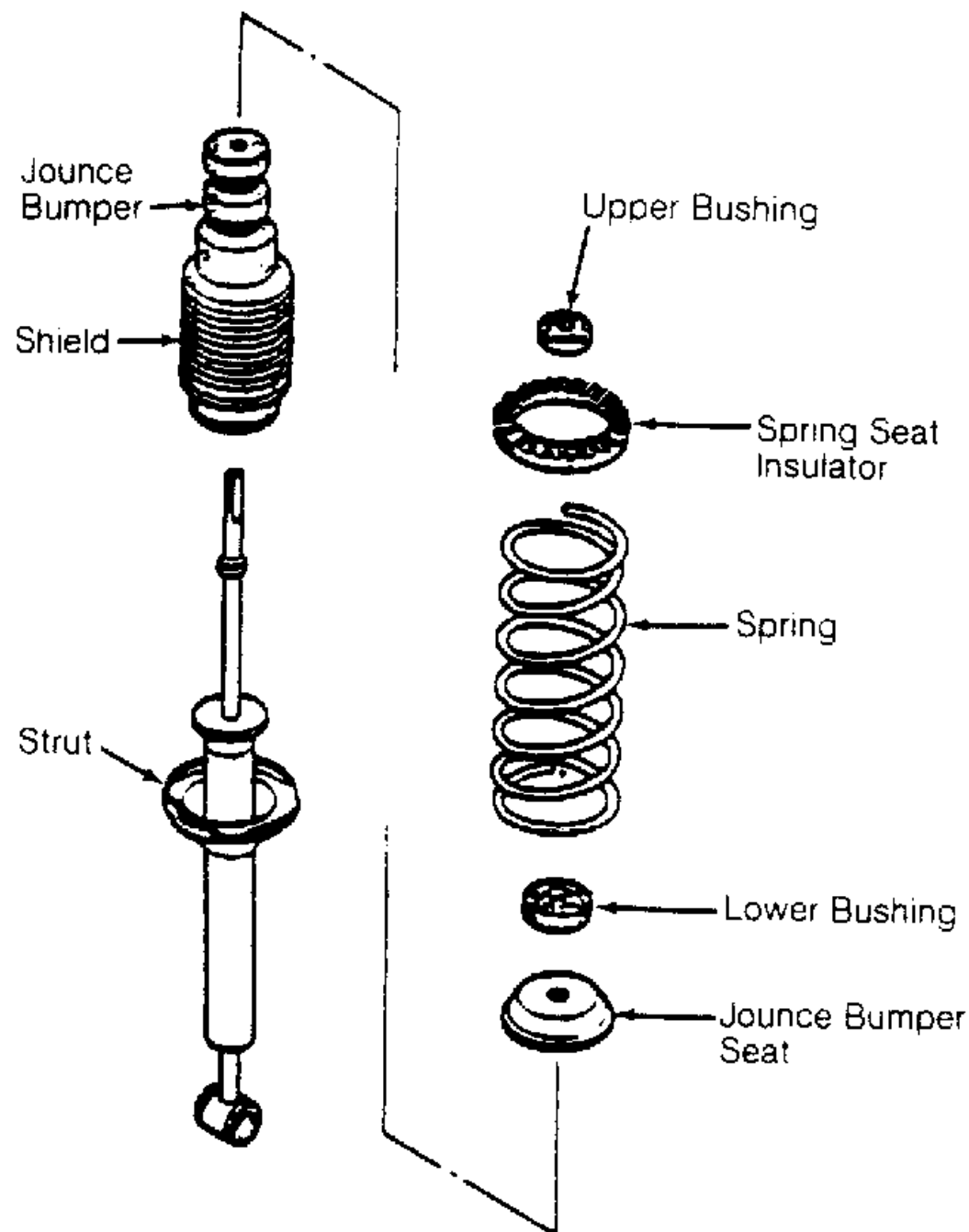


Fig. 3: Exploded View of Strut Assembly (Typical)

Courtesy of FORD MOTOR CO.

Inspection

Check jounce bumper, spring seat insulator and strut rod bushings for wear or damage. Ensure strut is not leaking.

Installation

1. Slide jounce bumper and shield onto strut rod and cylinder. Install bumper seat and lower bushing on strut rod. If upper spring seat insulator has been replaced, install new insulator on spring upper end. Seat end of coil against step in insulator.
2. Place spring on strut. Ensure end of coil seats against step in strut spring seat. Install strut assembly into tower from wheelwell. Guide strut rod into tower mounting hole.
3. Line up strut lower end with mounting hole in wheel support arm. Install mounting bolt to hold strut in position. Working from inside cargo compartment, install rod upper end bushing, bushing washer and flanged nut. Tighten nut to 12-18 ft. lbs. (16-24 N.m). See [Fig. 4](#). Hold flanged nut while tightening jam nut to lock it in position.
4. Tighten strut lower mounting bolt to 40-50 ft. lbs. (54-68 N.m). Remove spring compressor. Install wheel and tire assembly.

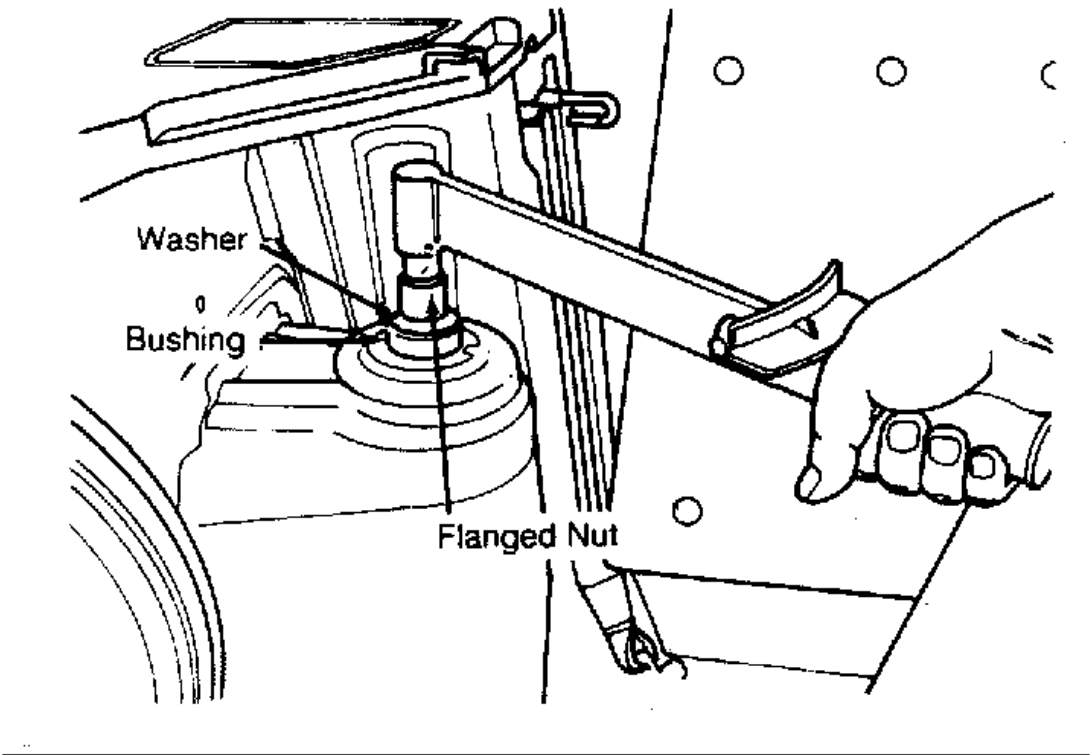


Fig. 4: Installing Strut Flanged Nut
Courtesy of FORD MOTOR CO.

TORSION BEAM

Removal (Festiva)

1. Raise and support vehicle so rear struts are fully extended. Remove both wheels. Remove struts and disconnect brake lines as previously described.
2. Disconnect parking brake cable clevises at brake backing plates. Remove parking brake equalizer and cables from torsion beam. Remove 4 nuts from back of each brake assembly to release backing plates and wheel spindle supports.
3. Remove torsion beam pivot bolts from body brackets. See [Fig. 5](#) . Do not loosen or remove torsion beam body brackets if they are not to be replaced. Remove torsion beam.

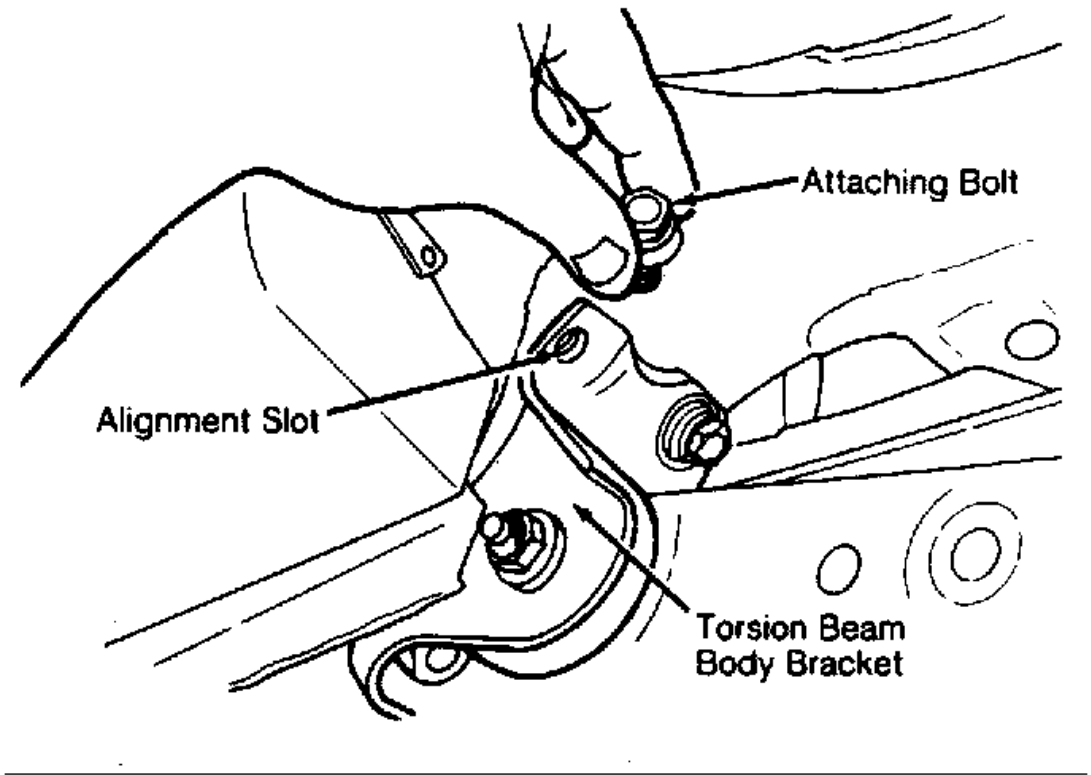


Fig. 5: Removing Torsion Beam Pivot Bolt
Courtesy of FORD MOTOR CO.

Installation

1. If removed, install torsion beam pivot brackets. Do not tighten mounting bolts at this time. If a new torsion beam is to be installed, install new pivot bushings in beam arms. See TORSION BEAM BUSHINGS.
2. Install bushing flange washers and position beam arms in body brackets. Align pivot bolt holes and install bolts. Do not tighten nuts at this time. Install brake backing plates and wheel spindle support assemblies. Tighten nuts to 32-45 ft. lbs. (43-61 N.m).
3. Install parking brake equalizer assembly on torsion beam. Install cable clevises to brake levers with clevis pins and cotter pins. Clip right

and left brake lines in place. Install rear suspension struts and wheels. Block wheels and lower vehicle to load suspension to normal ride height. Tighten torsion beam pivot bolts at body brackets to 69-87 ft. lbs. (93-118 N.m).

4. Check rear suspension alignment. Place an alignment mark at the center of the underbody, at a point of equal distance from the right and left body bracket inboard mounting bolts. From this alignment mark, measure distance to centers of right and left strut lower mounting bolts.
5. Both measurements must be within .20" (5 mm) of being the same. If not, shift torsion beam body brackets from side-to-side to center suspension. Once centered, tighten upper body bracket mounting bolts to 40-50 ft. lbs. (54-68 N.m) and lower bolt to 69-87 ft. lbs. (93-118 N.m). Bleed brakes.

TORSION BEAM BUSHINGS

Removal

1. Raise and support vehicle to fully extended rear struts. Remove wheels. Remove retaining clip at right brake line routing bracket and disconnect brake line. Remove clip from left brake line and disconnect at body crossmember.
2. Remove torsion beam pivot bolt bolts and nuts at right and left body brackets. Swing torsion beam trailing arm downward to clear body brackets.
3. Using piece of wood, block beam in disengaged position. Using Bushing Remover/Replacer (D80L-1002-L), remove bushings from inboard side of torsion beam arm. See [Fig. 6](#) .

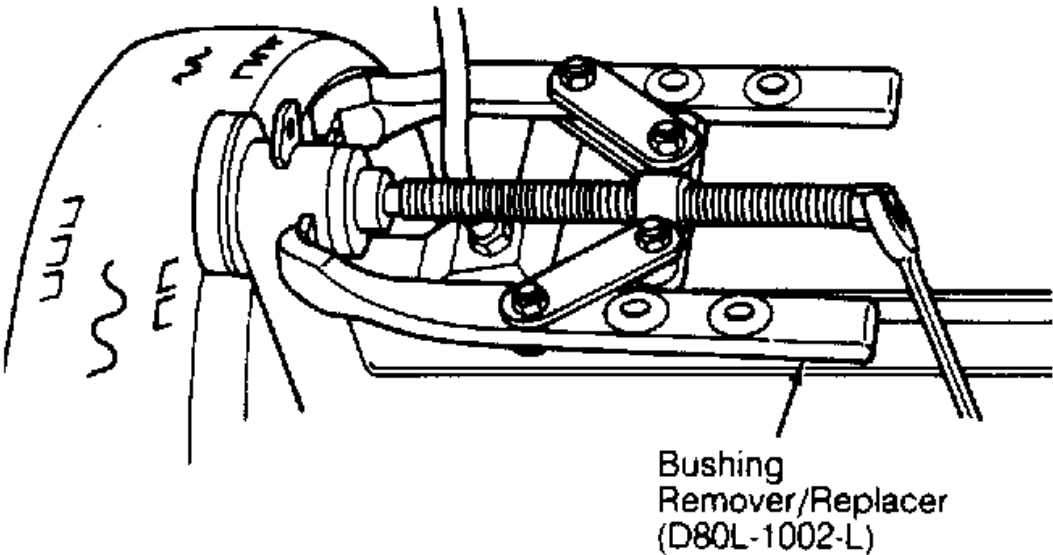


Fig. 6: Removing Torsion Beam Bushing
Courtesy of FORD MOTOR CO.

NOTE: Bushings have "F" (front) and "R" (rear) stamped on bushing face. Ensure these marks are right side up when "F" is toward front of vehicle.

Installation

1. Place bushings on outboard sides of torsion beam arms with marks "F" and "R" aligned parallel to arm axis. To ease installation, lubricate bushings with soapy water. Press in bushings using bushing remover/installer.
2. Remove wood block holding torsion beam out of body pivot brackets. Place bushing flange washers on outboard faces of bushings. Raise torsion beam arms into brackets until pivot bolt holes align.
3. Install pivot bolts through brackets from inboard side but do not tighten nuts at this time. Connect brake lines at routing brackets. Reinstall brake line retaining clips. Reinstall wheels. Lower vehicle and block wheels. Jounce vehicle until suspension is fully loaded in its normal riding position. Tighten torsion beam pivot bolt nuts to 69-87 ft. lbs. (93-118 N.m). Bleed brakes.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS	
Application	Ft. Lbs. (N.m)
Capri	
Control Arm Bolt-To-Spindle	45-55 (61-75)
Inner Control Arm Bolts	69-86 (93-117)
Rear Hub Lock Nut	18-21 (25-29)
Rear Stabilizer Bracket	32-39 (43-55)
Spindle-To-Strut Bolts	69-86 (93-117)
Strut Rod Upper Flanged Nut	40-50 (54-68)
Strut-To-Strut Tower	17-22 (23-29)
Wheel Bearing Lock Nut	18-21 (25-29)
Wheel Lug Nuts	67-88 (90-120)
Festiva	
Brake Backing Plate Spindle Support Bolts	32-45 (43-61)
Lower Body Bracket Mounting Bolts	69-87 (93-118)

Rear Hub Lock Nut	18-21 (25-29)
Spindle Attaching Nuts	31-45 (43-61)
Strut Lower Mounting Bolt	40-50 (54-68)
Strut Rod Upper Flanged Nut	12-18 (16-25)
Torsion Beam Pivot Bolts	69-87 (93-118)
Upper Body Bracket Mounting Bolts	40-50 (54-68)
Wheel Lug Nuts	67-88 (90-120)

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JACKING & HOISTING

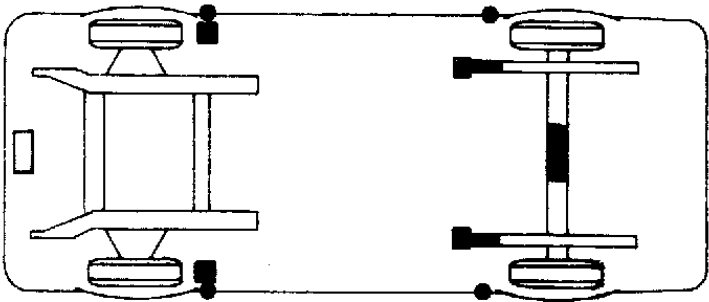
1991-92 WHEEL ALIGNMENT Ford Motor Co. - Jacking & Hoisting

JACKING & HOISTING

NOTE: The JACKING & HOISTING illustrations are not intended to represent the exact structure of each vehicle's frame, underbody or body outline. They are presented only to give the mechanic some point of reference.

FRAME & UNDERBODY

The following illustrations indicate areas (parts) of the underbody and frame which may be used to raise and support the vehicle, using either floor jack or hoist. These points are indicated by shaded areas on the frame. See [Fig. 1](#) .



FORD MOTOR CO. FESTIVA & TRACER

[Fig. 1: Jacking & Hoisting Points Courtesy of Ford Motor Co.](#)

OUTERBODY

Those points designated on the outline of the body were specifically designed to facilitate the use of the vehicle's own jack. These jacking points are indicated by circular dots on the outline of the body. See [Fig. 1](#) . If floor jack or hoist is employed, extreme care should be exercised to avoid damaging the outer body shell.

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1983-95 WHEEL ALIGNMENT

Pre-Alignment Inspection Procedures

PRE-ALIGNMENT CHECKS

Before making wheel alignment adjustment, perform the following checks:

1. Tires should be equal in size and runout must not be excessive. Tires and wheels should be in balance, and inflated to manufacturer's specifications.
2. Wheel bearings must be properly adjusted. Steering linkage and suspension must not have excessive looseness. Check for wear in tie rod ends and ball joints.
3. Steering gear box must not have excessive play. Check and adjust to manufacturer's specifications.
4. Vehicle must be at curb height with full fuel load and spare tire in vehicle. No extra load should be on vehicle.
5. Vehicle must be level with floor and with suspension settled. Jounce front and rear of vehicle several times and allow it to settle to normal curb height.
6. If steering wheel is not centered with front wheels in straight-ahead position, correct by shortening one tie rod adjusting sleeve and lengthening opposite sleeve equal amounts.
7. Ensure wheel lug nuts are tightened to torque specifications.

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RIDING HEIGHT ADJUSTMENT

1991-92 WHEEL ALIGNMENT Ford Motor Co. - Riding Height Adjustment

RIDING HEIGHT ADJUSTMENT

NOTE: Before adjusting alignment, check riding height. Riding height must be checked with vehicle on level floor and tires properly inflated. Bounce vehicle several times and allow suspension to settle.

- 1. Examine vehicle and ensure front or rear end is not higher or lower than normal. Ensure vehicle is level from side to side. Remove any unusual heavy items before checking suspension.
- 2. If loading is normal but vehicle is not level, check for spring damage, spring set, or non-standard replacement springs. Repair or replace as necessary. If in doubt, compare with a new vehicle (if possible).
- 3. Measure height of fender cutout rim above wheel center at all 4 wheels. Compare left and right side measurements at both front and rear. See [Fig. 1](#) . On Festiva, side-to-side variation should not exceed 0.4" (10 mm). These measurements should not be made from floor, but from center of wheel only, as unequal tire wear could cause a variance.

NOTE: Specifications for Capri suspension height are not available.

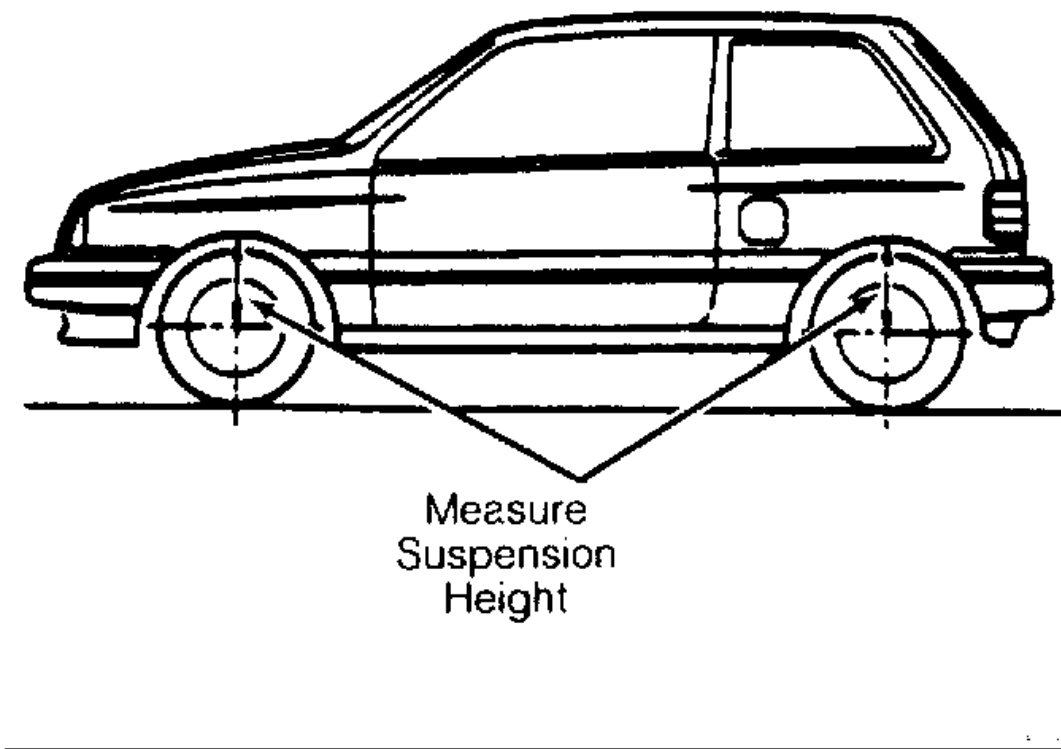


Fig. 1: Measuring Riding Height
Courtesy of FORD MOTOR CO.

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WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

1991-92 WHEEL ALIGNMENT Ford Motor Co. - Specifications & Procedures

ADJUSTMENTS

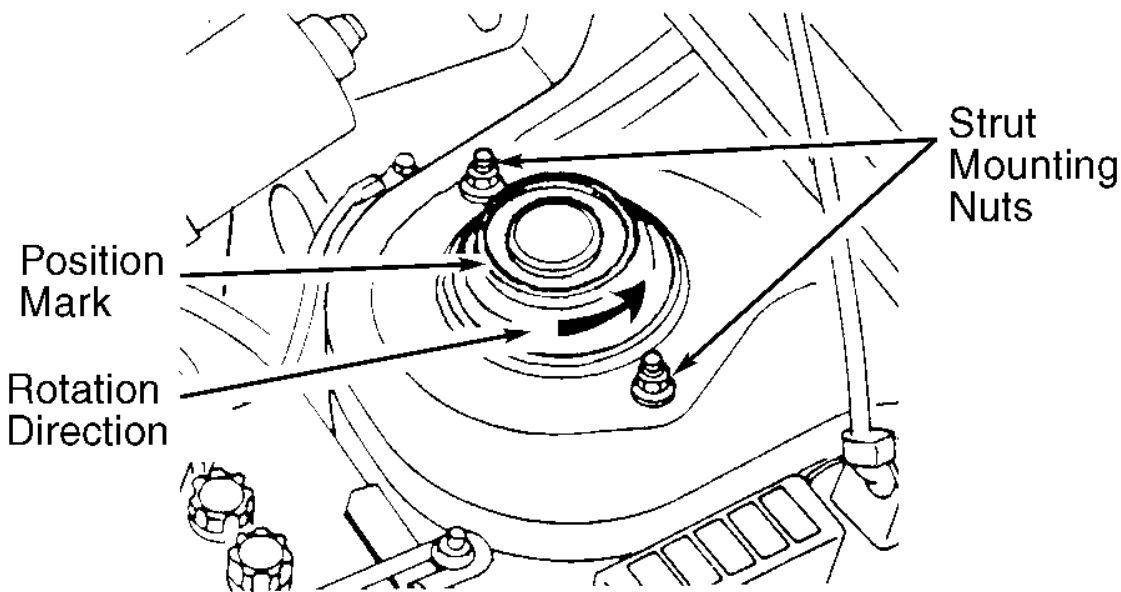
NOTE: Before adjusting alignment, check riding height. Riding height must be checked with vehicle on level floor and tires properly inflated. Bounce vehicle several times and allow suspension to settle.

CASTER

Caster is permanently set at factory and is not adjustable. Caster should be checked however as a possible cause of suspension complaint.

CAMBER

To adjust camber on Festiva, see [Fig. 1](#) . Camber adjustment on Capri is similar. Instead of 2 strut mount studs, Capri has 4 studs.



To adjust, remove strut mounting nuts. Press downward to clear strut studs and rotate mark 180°.

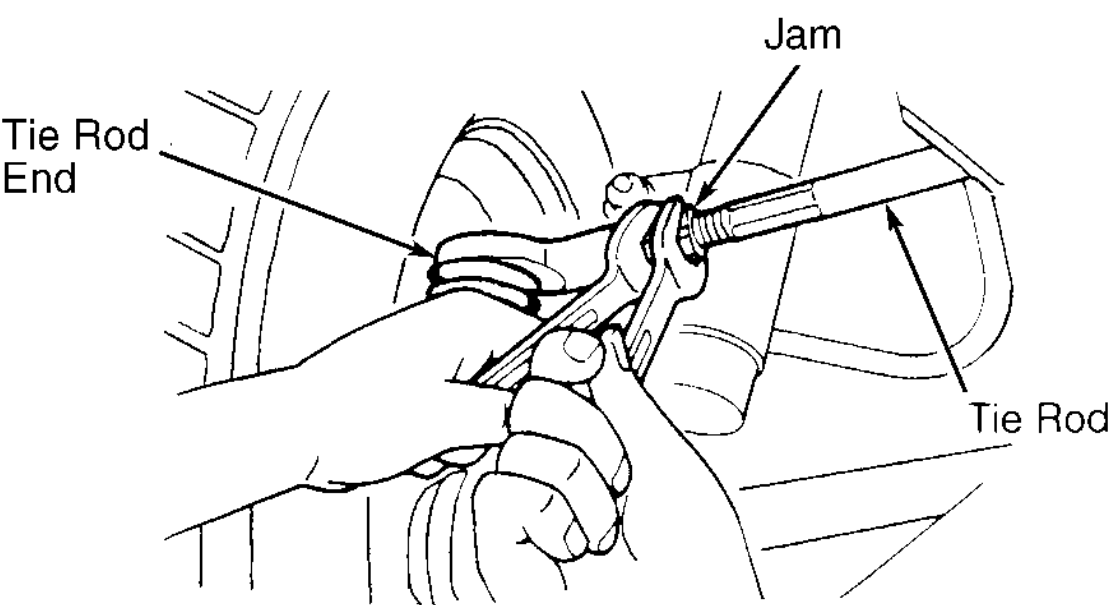
FRONT CAMBER
ADJUSTMENT

90F08876

Fig. 1: Adjusting Front Camber
Courtesy of FORD MOTOR CO.

FRONT TOE-IN

NOTE: See [Fig. 2](#) for toe-in adjustment procedures.



Adjust tie rod length for toe angle. For steering angle adjustment, turn both tie rod ends equally.

FRONT TOE-IN & STEERING ADJUSTMENT

90H08877

Fig. 2: Adjusting Front Toe-In
Courtesy of FORD MOTOR CO.

REAR TOE-IN

Festiva

NOTE: On Festiva, rear toe is not adjustable.

Capri

Rear toe should be adjusted before setting front alignment angles. To adjust rear toe, loosen lock nuts and rotate adjustment link on rear control arms.

ALIGNMENT SPECIFICATIONS

WHEEL ALIGNMENT SPECIFICATIONS (CAPRI)

Application	Preferred	Range
Camber ⁽¹⁾		
Front	.8	.05 To 1.55
Rear	-.03	-.78 To .72
Caster ⁽¹⁾	1.6	.85 To 2.35
Toe-In ⁽¹⁾		
Front	.3	0 To .6
Rear	.3	0 To .6
Toe-In ⁽²⁾		
Front	.15 (4)	0 To .3 (0 To 7.5)
Rear	.15 (4)	0 To .3 (0 To 7.5)
Steering Axis Inclination (SAI) ⁽¹⁾	12.36	N/A
(1) - Measurement in degrees.		
(2) - Measurement in inches (mm).		

WHEEL ALIGNMENT SPECIFICATIONS (FESTIVA)

Application	Preferred	Range
Camber ⁽¹⁾	.67	-.25 To 1.58
Caster ⁽¹⁾	1.58	.33 To 1.83
Toe-In ⁽¹⁾	.28	.04 To .52
Toe-In ⁽²⁾	.14 (3.5)	.02 To .26 (.5 To 6.5)
Steering Axis Inclination (SAI) ⁽¹⁾	14.18	N/A
(1) - Measurement in degrees.		
(2) - Measurement in inches (mm).		

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS (CAPRI)

Application	Ft. Lbs. (N.m)
Strut Upper Mounting Nuts	17-21 (23-29)
Tie Rod Jamb Nut	
Front	26-30 (35-40)
Rear	41-47 (55-64)
Wheel Lug Nuts	66-87 (89-118)

TORQUE SPECIFICATIONS (FESTIVA)

Application	Ft. Lbs. (N.m)
Strut Upper Mounting Nuts	32-45 (43-61)
Tie Rod Jamb Nut	22-37 (30-50)
Wheel Lug Nuts	66-87 (89-118)

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1988-94 AUTOMATIC TRANSMISSIONS

Ford ATX Overhaul

APPLICATION

APPLICATION

Application	Transmission
1988-89 Mercury Tracer	ATX
1988-93 Ford Festiva	ATX
1994 Ford Aspire	ATX

DESCRIPTION

NOTE: The ATX transaxle is used in some Mazda models and is referred to as the F3A for those models. The ATX transaxle is also used in some General Motors and Isuzu models and may be referred to as the KF100, KF400 or RMC. Some of the figures used in this article are courtesy of General Motors Corp. and are valid figures for this Ford Motor Co. transaxle.

The transaxle consists of 3 main units: automatic transaxle, torque converter and differential assembly. The automatic transaxle consists of front and rear clutches, one-way clutch, low-reverse brake assembly, oil pump and hydraulic controls (valve body and servo piston assemblies). The valve body is controlled by the governor valve, vacuum throttle valve diaphragm (modulator) and kickdown solenoid. The torque converter on the Aspire model is a mechanically operated (centrifugal type) torque converter clutch. See [Fig. 1](#) .

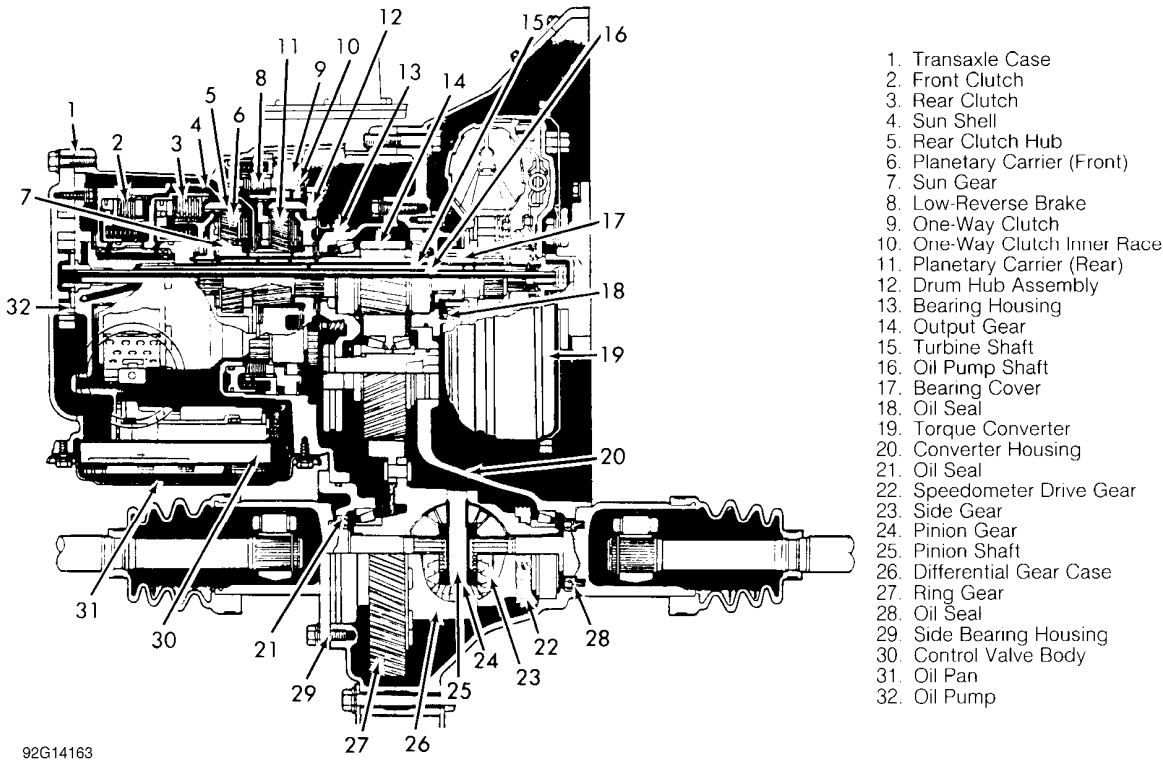


Fig. 1: Transaxle Component Identification
Courtesy of FORD MOTOR CO.

LUBRICATION & ADJUSTMENTS

See the appropriate TRANSMISSION SERVICING - A/T article in this section. Refer to the following menu:

ON-VEHICLE SERVICE

BAND APPLY SERVO R & I

Removal

1. Raise and support vehicle. Remove left front wheel. Drain transaxle fluid. Remove valve body. See [VALVE BODY](#) . Remove front stabilizer frame brackets. Carefully raise staked portion of left axle nut. Apply brakes and loosen, but **DO NOT** remove, axle nut. Remove left lower control arm ball joint clamp bolt. Pry downward on lower control arm to separate control arm from knuckle.
2. Insert pry bar between transaxle case and left axle flange. Carefully apply force to pry bar until axle circlip is disengaged. Slide knuckle assembly off axle shaft, and remove axle from vehicle. Quickly install appropriate plug in transaxle.
3. Loosen band adjusting stop and band adjusting stop nut. Remove band strut. Using "C" clamp and socket, compress servo piston into transaxle case. See [Fig. 2](#) . Remove snap ring. Remove servo retainer, servo piston and spring.

Installation

1. Lubricate servo piston with ATF. Assembly servo retainer, piston, piston large seal and spring. Insert assembly into transaxle. Using "C" clamp and socket, compress assembly and install snap ring. See [Fig. 2](#) . Install band strut to intermediate band. Install band adjusting stop to band and tighten to 9-10 ft. lbs. (12-15 N.m). Loosen adjusting stop 3 turns. Install and tighten band adjusting stop nut. See [TORQUE SPECIFICATIONS](#) .
2. Install remaining components in reverse order of disassembly. Fill transaxle with fluid.

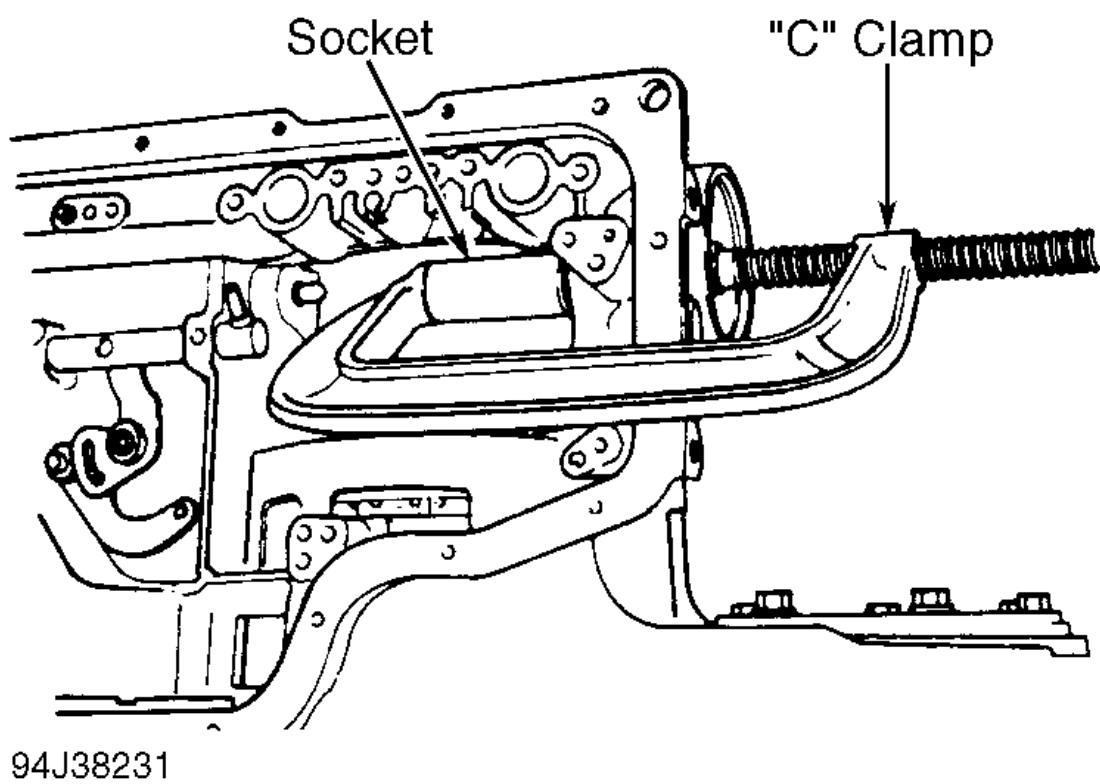


Fig. 2: Compressing Band Apply Servo
Courtesy of FORD MOTOR CO.

DIFFERENTIAL OIL SEALS R & I

Removal

- 1. Raise and support vehicle. Drain transaxle fluid. Carefully raise staked portion of axle nut. Apply brakes and loosen, but **DO NOT** remove, axle nut. Remove lower control arm ball joint clamp bolt. Pry downward on lower control arm to separate control arm from knuckle.
- 2. Insert pry bar between transaxle case and axle flange. Carefully apply force to pry bar until axle circlip is disengaged. Slide knuckle assembly off axle shaft, and remove axle from vehicle. Quickly install appropriate plug in transaxle. Using appropriate puller, remove seal.

Installation

- 1. Apply lubrication to new seal. Using appropriate driver, install seal. Install new circlip on transaxle end of axle. Remove transaxle plug, and carefully install axle into transaxle. Ensure circlip snaps into retaining groove.
- 2. Install axle into hub. Install NEW axle nut. Tighten bolts to specifications. See **TORQUE SPECIFICATIONS** . Stake NEW axle nut with blunt nose chisel. To complete installation, reverse removal procedure. Fill transaxle fluid to correct level.

OIL COOLER FLUSHING

Contaminates **MUST** be removed from oil cooler before transmission is put back into service. Replace cooler supply tubes if leaking. Thoroughly flush oil cooler and lines if a major service or transaxle removal has occurred. It is recommended that a mechanically agitated cleaner, such as Rotunda (014-00028), be used.

VACUUM THROTTLE VALVE DIAPHRAGM (MODULATOR) R & I

NOTE: If replacing modulator, it is necessary to replace throttle control valve rod.

Removal

- 1. Drain transaxle fluid. Disconnect vacuum hose from modulator. Unscrew modulator from transaxle. Remove control rod. With beveled side out, insert Vacuum Diaphragm Rod Gauge (T87C-77000-A) into mounting hole until gauge bottoms out.
- 2. Place gauge rod through opening of gauge until rod bottoms out against vacuum throttle valve. Tighten lock knob on gauge and remove tool. Using depth gauge, measure distance from flat surface of gauge to end of rod. See **Fig. 3** . Select proper length throttle valve rod. See **THROTTLE VALVE ROD DIMENSION CHART** .

THROTTLE VALVE ROD DIMENSION CHART

Measurement In. (mm)	Applicable Rod Length In. (mm)
1.0 (25.4)	1.16 (29.5)
1.0-1.02 (25.4-25.9)	1.18 (30.0)
1.02-1.04 (25.9-26.4)	1.20 (30.5)
1.04-1.06 (25.9-26.4)	1.22 (31.0)
1.06-1.08 (26.9-27.4)	1.24 (31.5)

Installation

Install selected throttle valve rod. Coat threads of modulator with appropriate sealant. To install, reverse removal procedures.

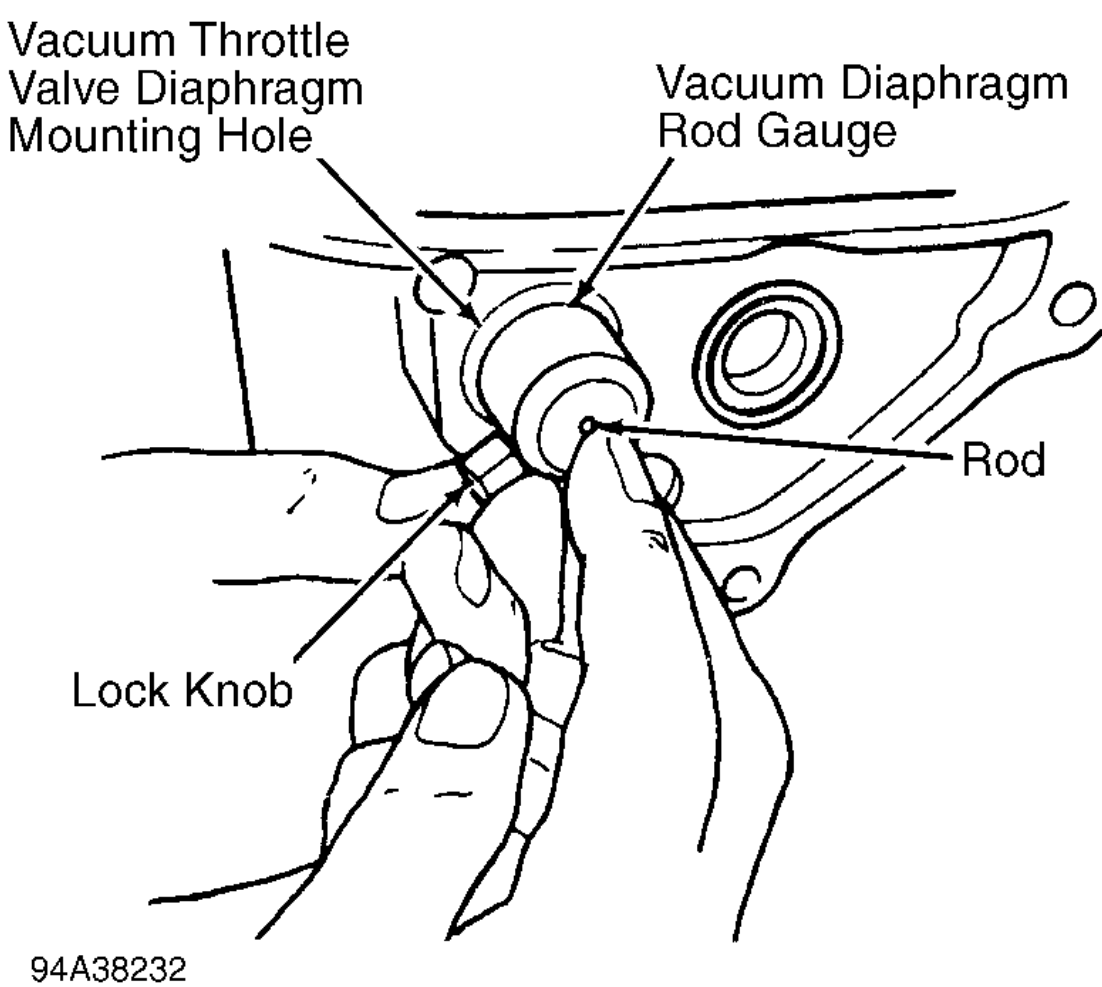


Fig. 3: Identifying Vacuum Diaphragm Rod Gauge
Courtesy of FORD MOTOR CO.

VALVE BODY R & I

Removal & Installation

Disconnect battery ground cable. Raise and support vehicle. Remove front fender splash shield and front splash shield. Drain transaxle fluid. Unbolt and remove oil pan. Remove 9 valve body bolts. Remove valve body. Ensure care is used not to loose check ball and detent spring. To install, reverse removal procedure. Fill transaxle with fluid. Check for leaks.

TROUBLESHOOTING

PRELIMINARY INSPECTION

1. Ensure vehicle is thoroughly road tested to verify driver's complaint. Determine if problem occurs during upshift, downshift, coasting or engagement. If noise is diagnosed, check if noise is affected by RPM, vehicle speed, gear selection or temperature. Ensure vehicle is at normal operating temperature when checking.
2. Inspect fluid level and condition. Visually inspect for vehicle modifications, electronic add-ons, fluid leaks and/or incorrect linkage adjustment. See applicable symptom diagnosis.

SYMPTOM DIAGNOSIS

Engine Starts in "D", "2", "1" OR "R", or will not Start in "N" OR "P"

Check ignition and starter circuit. Shift linkage faulty or installed improperly. Park/Neutral switch and/or wiring faulty.

No Movement In Any Gear

Incorrect fluid level. Shift linkage faulty or out of adjustment. Incorrect oil pressure. Manual control valve faulty. Faulty oil pump. Leak in hydraulic system. Parking linkage improperly adjusted.

No Movement In "D", Okay In Other Gears

Shift linkage faulty, out of adjustment or improperly installed. Incorrect oil pressure. Manual control valve faulty. Faulty one-way clutch.

No Movement In "D", "2" Or "1", Okay In "R"

Incorrect fluid level. Shift linkage faulty, out of adjustment or incorrectly installed. Incorrect oil pressure. Manual control valve faulty. Engine performance poor or brakes improperly adjusted. Rear clutch faulty. Leak in hydraulic system.

No Movement In "R", Okay In Other Gears

Incorrect fluid level. Shift linkage faulty, out of adjustment or incorrectly installed. Incorrect oil pressure. Manual control valve faulty. Faulty rear clutch, front clutch or low-reverse brake. Leak in hydraulic system.

Slippage

ATF level incorrect or contaminated. Manual valve out of adjustment. Vacuum modulator faulty or leak in vacuum circuit. Fluid pressures incorrect. Oil pump faulty. Leak in hydraulic circuit.

Vehicle Creeps In "N" Position

Shift linkage faulty, out of adjustment or incorrectly installed. Manual control valve faulty. Contaminated fluid. Faulty rear clutch.

Vehicle Creeps Excessively

Engine idle speed too high.

Vehicle Will Not Creep

Fluid level incorrect or fluid contaminated. Shift linkage faulty, out of adjustment or incorrectly installed. Engine idle too low. Manual control valve faulty. Faulty oil pump. Leak in hydraulic system. Faulty front or rear clutch.

Low Maximum Speed & Poor Acceleration

Incorrect ATF level or contaminated fluid. Selector linkage out of adjustment. Engine stall speed incorrect. Poor engine performance. Brake band faulty or out of adjustment. Faulty low-reverse brake, front clutch, rear clutch or hydraulic circuit.

Harsh "N" To "D" Engagement

Engine idle too high. Leak in vacuum circuit. Incorrect oil pressure. Manual control valve faulty. Faulty rear clutch. Low fluid level.

Harsh 1-2 Shift

Leak in vacuum circuit. Engine stall speed incorrect. Contaminated fluid. Manual control valve faulty. Band servo faulty. Brake band damaged or out of adjustment.

Harsh 2-3 Shift

Leak in vacuum circuit. Incorrect oil pressure. Manual control valve faulty. Band servo or front clutch faulty. Brake band faulty.

Shift Shock Felt On Kickdown Downshift

Shift linkage damaged, out of adjustment or incorrectly installed. Leak in vacuum circuit. Kickdown solenoid, switch or wiring faulty. Incorrect oil pressure. Manual control valve or governor valve faulty. Leak in hydraulic system.

2-1 Shift Shock With Lever In "1" Position

Leak in vacuum circuit. Engine stall speed incorrect. Manual control valve faulty. Contaminated fluid. Low-reverse brake faulty. Line pressure high.

Shift Shock On Deceleration

Range selector out of adjustment. Vacuum diaphragm or piping faulty. Kickdown solenoid out of adjustment or faulty. Excessive line pressure. Manual valve faulty. Governor valve faulty.

Vehicle Brakes In "R" Position

Band servo faulty. Contaminated fluid. Faulty rear clutch. Brake band damaged or out of adjustment. Parking linkage damaged or improperly adjusted.

Vehicle Brakes On 1-2 Shift

Manual control valve faulty. Contaminated fluid. Front clutch or low-reverse brake faulty. One-way clutch faulty.

Vehicle Brakes On 2-3 Shift

Manual control valve faulty. Band servo faulty. Contaminated fluid. Brake band out of adjustment or damaged.

No Engine Braking In "1" Position

Shift linkage damaged, out of adjustment or installed incorrectly. Incorrect oil pressure. Manual control valve faulty. Contaminated fluid. Low-reverse brake faulty. Leak in hydraulic system.

No Shift Shock; Slippage On 1-2 Shift

Incorrect fluid level. Shift linkage damaged, out of adjustment or incorrectly installed. Leak in vacuum circuit. Oil pressure incorrect. Manual control valve faulty. Band servo faulty. Contaminated fluid. Brake band faulty. Leakage in hydraulic system.

No Shift Shock; Slippage When Manually Shifted From "1" To "2" Position

Incorrect fluid level. Shift linkage damaged, out of adjustment or installed incorrectly. Leak in vacuum circuit. Engine idle speed incorrect. Engine stall speed incorrect. Manual control valve faulty. Contaminated fluid. Brake band out of adjustment or damaged. Oil pump faulty.

No Shift Shock; Slippage On 2-3 Shift

ATF contaminated or level incorrect. Shift linkage faulty. Vacuum modulator faulty or leak in vacuum circuit. Line pressure not correct. Band servo faulty. Front clutch faulty. Leak in hydraulic system.

Slippage On 3-2 Kickdown

Leak in vacuum circuit. Oil pressure incorrect. Manual valve faulty. Band servo faulty. Contaminated fluid. Front clutch faulty. Brake band out of adjustment or damaged. Leak in hydraulic system.

Transaxle Slips In 1st Gear

Incorrect fluid level. Shift linkage faulty, out of adjustment or incorrectly installed. Incorrect oil pressure. Manual control valve faulty. Contaminated fluid. Incorrect idle speed. Faulty kickdown solenoid, switch or wiring.

No 1-2 Shift

Shift linkage defective, out of adjustment or incorrectly installed. Leak in vacuum circuit. Faulty kickdown solenoid, switch or wiring. Contaminated fluid. Manual control valve faulty. Governor valve faulty. Band servo faulty. Brake band out of adjustment. Leak in hydraulic system. Rear clutch faulty.

No 2-3 Shift

Shift linkage defective, out of adjustment or incorrectly installed. Leak in vacuum circuit. Faulty kickdown solenoid, switch or wiring. Contaminated fluid. Manual control valve, governor valve or band servo faulty. Leak in hydraulic system. Front clutch faulty.

No Lock-Up

Faulty torque converter, wiring or solenoid.

1-3 Shift; Skips 2nd

Contaminated fluid. Brake band out of adjustment or damaged. Leak in hydraulic system.

No 3-2 Downshift

Leak in vacuum circuit. Manual control valve, governor valve or band servo faulty. Contaminated fluid. Faulty front clutch. Brake band out of adjustment or damaged. Leak in hydraulic system.

No 2-1 or 3-1 Downshift

Leak in vacuum circuit. Manual control valve, governor valve or band servo faulty. Contaminated fluid. Brake band out of adjustment or damaged. One-way clutch faulty.

Slippage When Accelerating In 3rd Gear Above Kickdown Speed

Shift linkage damaged, out of adjustment or installed incorrectly. Leak in vacuum circuit. Oil pressure incorrect. Manual control valve or governor valve faulty. Contaminated fluid. Front clutch faulty. Leak in hydraulic system.

No Kickdown At Normal Speeds In 3rd Gear

Leak in vacuum circuit. Kickdown solenoid, switch or wiring faulty. Manual control valve or governor valve faulty. Contaminated fluid. Brake band out of adjustment or damaged. Leak in hydraulic system.

1-2 & 2-3 Shift Points Too High

ATF contaminated or level incorrect. Vacuum modulator faulty or leak in vacuum circuit. Line pressures incorrect. Manual valve out of adjustment. Governor valve faulty. Hydraulic circuit leaking.

3-2 & 2-1 Shift Points Too High

Shift linkage damaged, out of adjustment or incorrectly installed. Kickdown solenoid, switch or wiring faulty. Leak in vacuum circuit. Incorrect oil pressure. Manual control valve or governor valve faulty. Leak in hydraulic system.

1-2 Or 2-3 Shifts With Shift Lever In "1" Position

Shift linkage damaged, out of adjustment or installed incorrectly. Manual control valve faulty. Leak in hydraulic system.

2-1 or 2-3 Shifts With Shift Lever In "2" Position

Shift linkage damaged, out of adjustment or installed incorrectly. Incorrect oil pressure. Manual control valve faulty.

Vehicle Moves In "P" Or Parking Gear Remains Engaged When

Shifted Out Of "P" Position

Shift linkage damaged, out of adjustment or incorrectly installed. Parking linkage out of adjustment or damaged.

Transaxle Noisy In "P" Or "N" Position

Incorrect fluid level. Incorrect oil pressure. Faulty rear clutch, oil pump, one-way clutch or planetary gear.

Transaxle Noisy In "D", "1", "2" or "R"

Oil pressure incorrect. Rear clutch, oil pump, one-way clutch or planetary gears faulty.

Transmission Overheats

ATF level incorrect. Engine stall speed and/or line pressure incorrect. Faulty band servo, front clutch, rear clutch, brake band, low-reverse brake, oil pump, torque converter or planetary gear. Leak in hydraulic circuit.

Differential Noise

ATF contaminated or level incorrect. Bearings worn or has excessive preload. Teeth on gears worn or damaged or has excessive backlash.

TESTING

PARK/NEUTRAL SWITCH TEST

1. Ensure engine starts in "P" or "N". Ensure back-up lights glow when ignition is on and selector lever in "R". If park/neutral switch is not operating properly, disconnect connector at transaxle and check continuity between terminals. See Fig. 4 . If continuity is not as indicated, replace park/neutral switch.

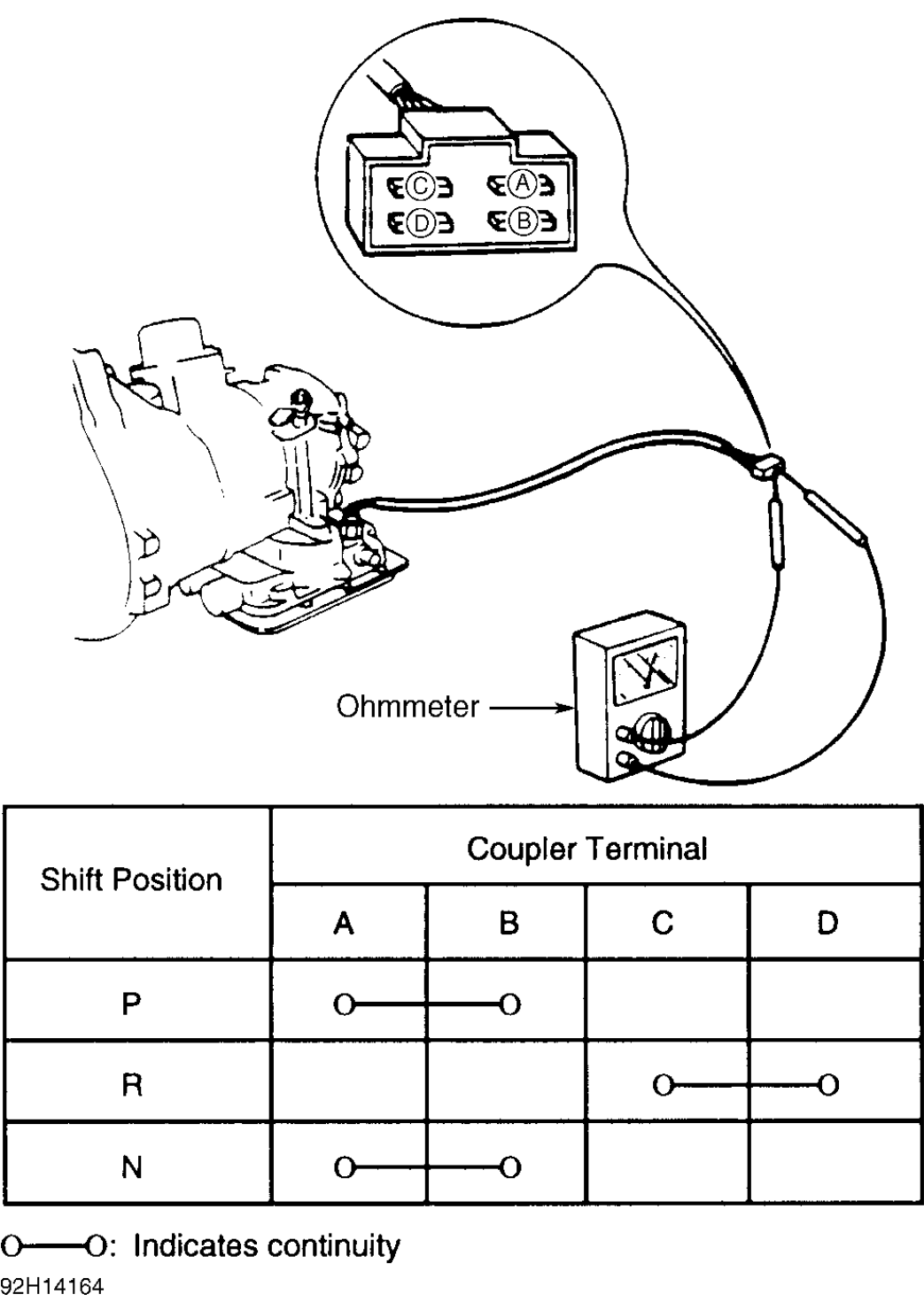


Fig. 4: Testing Park/Neutral Switch
Courtesy of FORD MOTOR CO.

KICKDOWN (DOWNSHIFT) SOLENOID TEST

1. Check Fuse

Ensure ignition is off. Inspect condition of 15 amp METER fuse located in interior fuse junction panel. If fuse is okay, go to step 4). If fuse is blown, go to next step.

2. Check System

Ensure ignition is off. Replace 15 amp fuse. Turn ignition on. If fuse blows, go to next step. If fuse is okay, go to step 4).

3. Check For Short To Ground

Turn ignition off. Remove 15 amp METER fuse. Disconnect kickdown switch harness connector. Check continuity between Black/Yellow wire terminal of interior fuse holder and ground. If continuity exists, inspect and repair short circuit as needed. If continuity does not exist, replace 15 amp fuse. Go to next step.

4. Check Power Supply To Kickdown Switch

Ensure ignition is off. Disconnect kickdown switch harness connector. Turn ignition on. Measure voltage between Black/Yellow wire terminal of kickdown switch harness connector and ground. If voltage is more than 10 volts, go to next step. If voltage is 10 volts or less,

inspect and repair circuit between switch harness connector and fuse panel.

5. Check Kickdown Switch

Turn ignition off. Check continuity between kickdown switch terminals. Continuity should only exist with accelerator fully depressed. If switch is functioning correctly, go to next step. Replace switch if it failed testing. Road test vehicle to verify repair.

6. Check Circuit Between Kickdown Switch & Kickdown Solenoid

Ensure ignition is off. Disconnect kickdown switch harness connector. Disconnect kickdown solenoid harness connector. Check continuity of White/Black wire between switch harness connector and solenoid harness connector. If continuity does not exist, inspect and repair open circuit as needed. If continuity exists, check continuity between White/Black wire terminal at solenoid harness connector and ground. If continuity exists, inspect and repair short circuit as needed. If continuity does not exist, replace kickdown solenoid.

VACUUM THROTTLE VALVE DIAPHRAGM (MODULATOR) TEST

1. Check System Integrity

Inspect all vacuum hoses and connections for leaks or damage. Disconnect vacuum hose at diaphragm connection and inspect for leaking ATF. Repair as needed. Go to next step.

2. Check Vacuum At Modulator

Ensure ignition is off. Disconnect vacuum hose at modulator valve and connect vacuum gauge to hose. Start and run engine at idle. Vacuum should be 15-22 In. Hg. If vacuum is not within specification, inspect and repair vacuum hose. If vacuum is within specification, go to next step.

3. Check Modulator Valve Function

Turn ignition off. Remove modulator valve from transaxle. Connect hand-held vacuum pump to valve. Apply 16-20 In. Hg of vacuum. Ensure vacuum is held by valve. Release vacuum and verify that valve moves freely. If valve is functioning correctly, go to next step. Replace valve if it fails testing.

4. Check Vacuum Diaphragm Rod

With modulator removed, measure depth of vacuum throttle valve (dimension "N"). See Fig. 5 . Measure length of throttle control valve rod. Ensure correct length rod is installed. Refer to the THROTTLE VALVE ROD DIMENSION CHART . If correct rod is installed in transaxle, inspect operation of vacuum throttle valve in valve body. Install correct rod length as needed.

THROTTLE VALVE ROD DIMENSION CHART

"N" Dimension: In. (mm)	Rod Length: In. (mm)
1.0 (25.4)	1.16 (29.5)
1.0-1.02 (25.4-25.9)	1.18 (30.0)
1.02-1.04 (25.9-26.4)	1.20 (30.5)
1.04-1.06 (25.9-26.4)	1.22 (31.0)
1.06-1.08 (26.9-27.4)	1.24 (31.5)

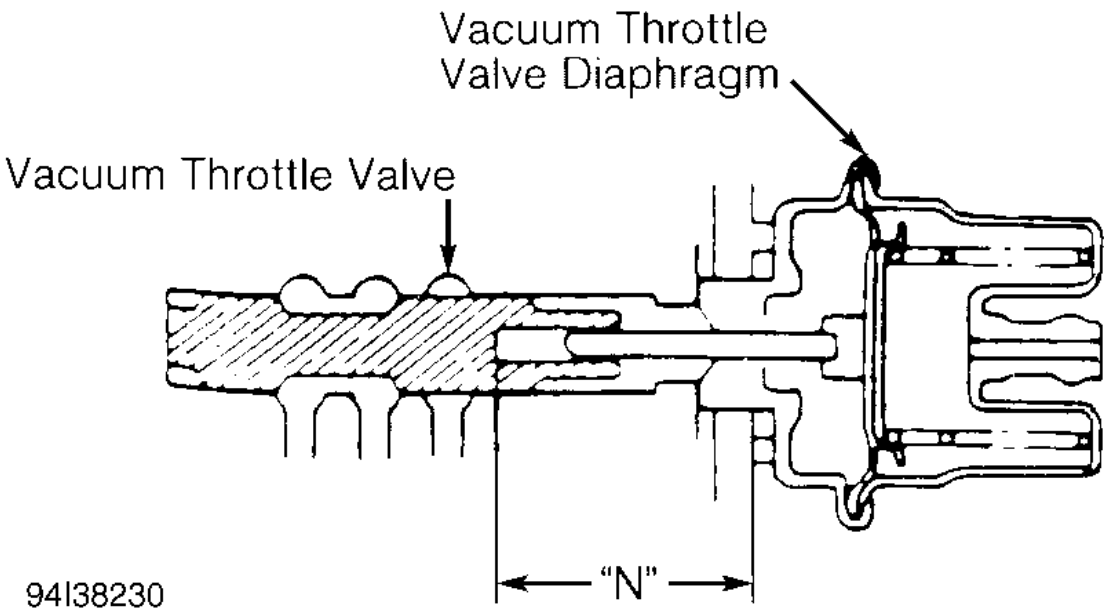


Fig. 5: Measuring Vacuum Throttle Valve Depth
Courtesy of FORD MOTOR CO.

STALL TEST

Testing Precautions

When testing, **DO NOT** hold throttle open longer than five (5) seconds. Shift to "N" and allow engine to idle for at least two (2) minutes between tests to cool transaxle. If engine speed exceeds specification, release accelerator immediately as clutch or band slippage is indicated.

See [STALL SPEED SPECIFICATIONS](#) .

Testing Procedures

1. With engine at normal operating temperature, tachometer installed and parking and service brakes applied, perform transaxle stall test in "D", "2", "1" and "R" ranges at full throttle and note maximum RPM obtained. Correct stall speed should occur at specified RPM. See the [STALL SPEED SPECIFICATIONS](#) .

STALL SPEED SPECIFICATIONS

Application	Engine RPM
Aspire	2300-2500
Festiva & Tracer	2300-2500

2. If stall speed is too high in all shift ranges, the following components may be faulty:
 - Worn Oil Pump.
 - Oil leakage from oil pump, valve body or transaxle case.
 - Sticking pressure regulator valve.
3. If stall speed is too high in "D", "2" and "1", the following component may be faulty:
 - Slipping rear clutch.
4. If stall speed is too high in "D", the following component may be faulty:
 - Slipping one-way clutch.
5. If stall speed is too high in "2", the following components may be faulty:
 - Slipping intermediate band.
6. If stall speed is too high in "R", the following components may be faulty:
 - Slipping Low/Reverse Clutch.
 - Slipping Front Clutch.
7. If stall speed is too low in all shift ranges, the following components may be faulty:
 - Slipping torque converter one-way clutch.

ROAD TEST

1. Before road test, ensure that fluid level, fluid condition and control linkage adjustments are okay. During test, transaxle should upshift or downshift at about same speed as specified. See appropriate [SHIFT SPEED SPECIFICATIONS](#) .
2. All shifts may vary slightly due to production tolerances or tire size. The quality of the shifts are more important. All shifts should be smooth, responsive and with no slippage or engine flare. Slippage or engine flare in any gear usually indicates clutch or band problems.
3. The slipping clutch or band in a particular gear can usually be identified by noting transaxle operation in other selector positions and comparing internal units which are applied in these positions. See [CLUTCH & BAND APPLICATION](#) .

SHIFT SPEED SPECIFICATIONS

VEHICLE SHIFT SPEED SPECIFICATIONS (ASPIRE & FESTIVA)

Operating Condition (1)	Shift Speed MPH (km/h)
Half Throttle (50%)	
1-2	9-17 (15-28)
2-3	16-34 (26-55)
Full Throttle (WOT) (2)	
1-2	28-33 (44-53)
2-3	55-63 (88-101)
3-2	53-48 (86-78)
2-1	24-22 (39-35)
Coasting (2-1)	9-6 (14-9)
(1) Transmission is in "D" range.	
(2) To determine deceleration shift speeds, release throttle once transaxle has shifted into 3rd gear. Manually downshift shift lever into next lower gear and record speed at which downshift occurs. Continue downshifting and recording vehicle speed until transaxle has downshifted into low gear.	

VEHICLE SHIFT SPEED SPECIFICATIONS (TRACER)

Operating Condition (1)	Shift Speed MPH
Half Throttle (50%)	
1-2 - Carbureted	10-19
1-2 - EFI	12-21
2-3 - Carbureted	17-37
2-3 - EFI	37-48
Full Throttle (WOT)	
1-2	30-36
2-3	60-68
3-2	53-58
2-1	24-26
Fully Closed Throttle	
From "D" Range (3-1)	6-9

From "1" (Low) Range (2-1)	22-26
(1) Transmission is in "D" range.	

CLUTCH & BAND APPLICATION

CLUTCH & BAND APPLICATION CHART

Selector Lever Position	Elements In Use
"P" (Park)	Low-Reverse Brake
"R" (Reverse)	Front Clutch & Low-Reverse Brake
"D" (Drive)	
First Gear	Rear Clutch & One-Way Clutch
Second Gear	Rear Clutch & Brake Band
Third Gear	Front Clutch & Rear Clutch
"2" (Intermediate)	
First Gear	Rear Clutch & One-Way Clutch
Second Gear	Rear Clutch & Brake Band
"1" (Low) First Gear	Rear Clutch & Low-Reverse Brake
"N" (Neutral)	All Clutches & Bands Released or Ineffective

HYDRAULIC PRESSURE TESTS

NOTE: DO NOT hold throttle open longer than 5 seconds. Shift to "N" and allow engine to idle for at least 2 minutes between tests to cool transaxle. If engine speed exceeds specification, release accelerator immediately as clutch or band slippage is indicated.

LINE PRESSURE TEST

1.

Attach oil pressure gauge at line pressure checking port. See [Fig. 6](#) . Attach tachometer to engine. Position gauge so it can be seen from driver's seat.
2.

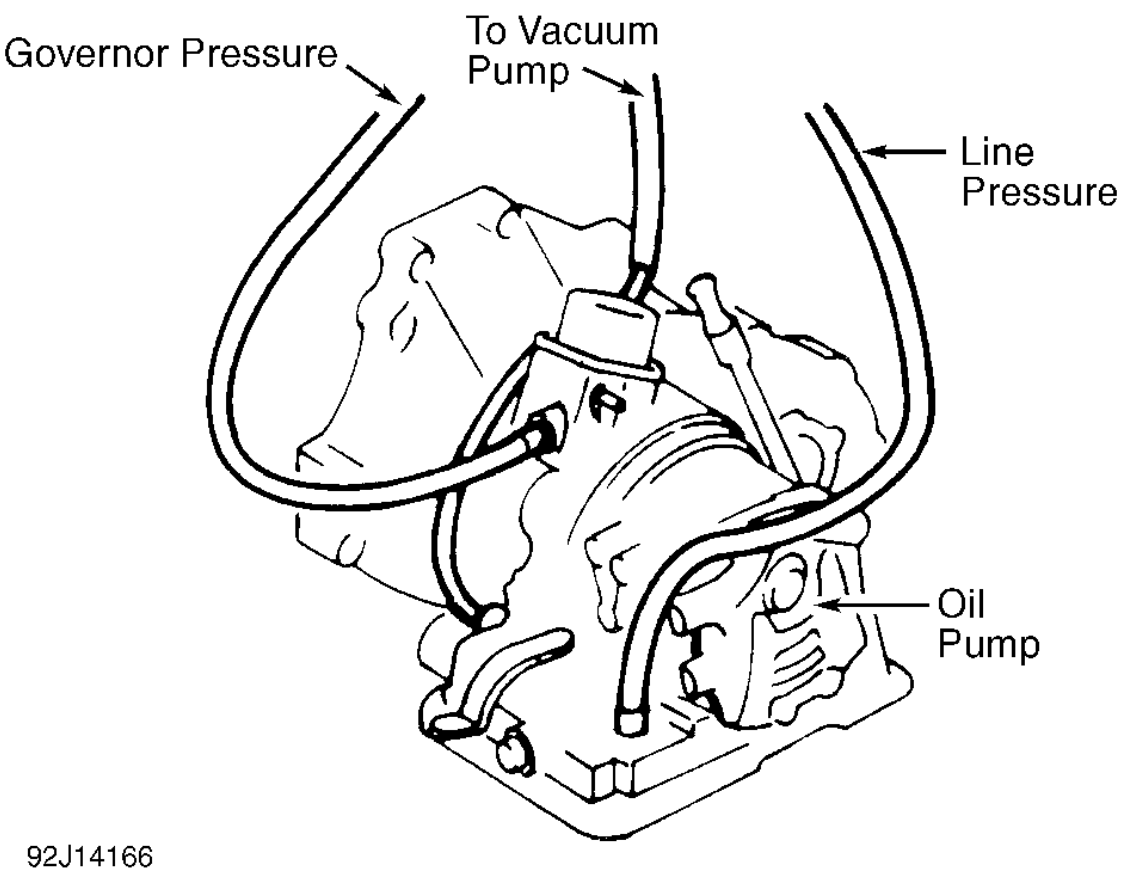
With engine at normal operating temperature, transaxle fluid level correct and transaxle in "D", check line pressure at idle and at stall speed. Repeat test in "2", "1", and "R", allowing sufficient time for engine and transaxle to cool between tests. Record results. See [LINE PRESSURE TEST SPECIFICATIONS](#) .
3.

If Line Pressure Is Low In "D", "2", "1" & "R", check for worn oil pump, oil leaking from oil pump, control valve body or transaxle case and sticking pressure regulator valve.
4.

If Line Pressure Is Low In "D" & "2", check for oil leakage from hydraulic circuit of rear clutch or governor.
5.

If Line Pressure Is Low In "R", check for oil leakage from hydraulic circuit of low-reverse brake.
6.

If Line Pressure Is High At Idle, check for vacuum tube broken or disconnected or faulty vacuum modulator.



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Fig. 6: Identifying Hydraulic Pressure Test Ports
Courtesy of FORD MOTOR CO.

LINE PRESSURE TEST SPECIFICATIONS (ASPIRE)

Application	psi (kg/cm ²)
At Idle	
"D"	46-54 (3.2-3.8)
"2"	150-166 (10.5-11.7)
"R"	76-95 (5.3-6.7)
At Stall Speed	
"D"	141-157 (9.9-11.0)
"2"	150-166 (10.5-11.7)
"R"	251-262 (17.6-18.4)

LINE PRESSURE TEST SPECIFICATIONS (ALL EXCEPT ASPIRE)

Application	psi (kg/cm ²)
At Idle	
"D"	43-57 (3.0-4.0)
"2"	114-171 (8.0-12.0)
"R"	57-110 (4.0-7.0)
At Stall Speed	
"D"	128-156 (9.0-11.0)
"2"	114-171 (8.0-12.0)
"R"	228-270 (16.0-19.0)

LINE PRESSURE CUT-BACK TEST

1. Connect oil pressure gauges to line pressure and governor pressure ports. See [Fig. 6](#) . Position gauges so they can be seen from driver's seat.
2. Connect a hand-held vacuum pump to vacuum modulator. See [Fig. 6](#) . Position vacuum pump so it can be operated from driver's seat. With shift lever in "D", gradually increase engine RPM and observe pressure gauge readings. Record results.
3. With shift lever in "D", gradually increase engine RPM, and apply 8 in. Hg to vacuum modulator. When line pressure reading suddenly decreases, observe the governor pressure gauge. Refer to [LINE PRESSURE CUT-BACK TEST SPECIFICATIONS](#) .
4. If governor pressure gauge readings are not within specifications, ensure rod in vacuum modulator is installed. If a rod is installed, rod length may be incorrect or vacuum throttle valve is sticking. See [VACUUM THROTTLE VALVE DIAPHRAGM \(MODULATOR\)](#) under TESTING.

LINE PRESSURE CUT-BACK TEST SPECIFICATIONS

Vacuum Pump Reading	Governor Pressure psi (kg/cm ²)
0 in. Hg (Atmosphere)	14-23 (.98-1.6)
8 in. Hg	6-14 (.42-.98)

GOVERNOR PRESSURE TEST

1. Attach oil pressure gauge to governor pressure check port. See [Fig. 6](#) . Position gauge so that it may be seen from driver's seat. Shift transaxle into "D" and road test vehicle.
2. Accelerate vehicle smoothly and record governor pressure readings at 20, 35 and 55 MPH. See [GOVERNOR PRESSURE SPECIFICATIONS](#) . If pressure gauge readings are not within specifications, check for fluid leakage in line pressure hydraulic circuit and/or governor pressure hydraulic circuit. Also check for a faulty governor.

GOVERNOR PRESSURE SPECIFICATIONS

Application	psi (kg/cm ²)
Aspire & Festiva	
20 MPH	13-21 (.9-1.5)
35 MPH	25-35 (1.8-2.5)
55 MPH	58-70 (4.0-4.8)

REMOVAL & INSTALLATION

See the appropriate TRANSMISSION REMOVAL & INSTALLATION - A/T article in this section. Refer to the following menu:

TORQUE CONVERTER

The torque converter is a sealed unit and cannot be serviced. Check for cracked or worn ring in seal area. Measure bushing in converter boss. If I.D. is larger than 2.090" (53.08 mm) on Aspire, 1.302" (33.075 mm) on Festiva and Tracer, replace torque converter. If metal particles are found in ATF, replace torque converter. To clean torque converter, flush with solvent, drain and flush with ATF and drain ATF.

TRANSAXLE DISASSEMBLY

1. Remove torque converter. Attach transaxle to appropriate holding fixture. Remove park/neutral switch, kickdown solenoid and vacuum modulator with rod. Remove oil dipstick and tube. Remove speedometer driven gear retaining bolt and lift out gear assembly. Remove oil pump drive shaft and turbine shaft.
2. Remove oil pan. Remove valve body. **DO NOT** lose check ball and spring. Position transaxle with oil pump facing downward. With flat-blade screwdriver inserted in wide slot between front clutch drum and sun shell, pry down on front clutch drum. Do this several times as you rotate assembly 2 complete revolutions.
3. Using a feeler gauge, measure front clutch drum end play. See [Fig. 7](#) . Check clearance of small slot between front clutch drum tabs and

sun shell slots. Record measurement for reassembly reference. End play should be .020-.031" (.5-8 mm).

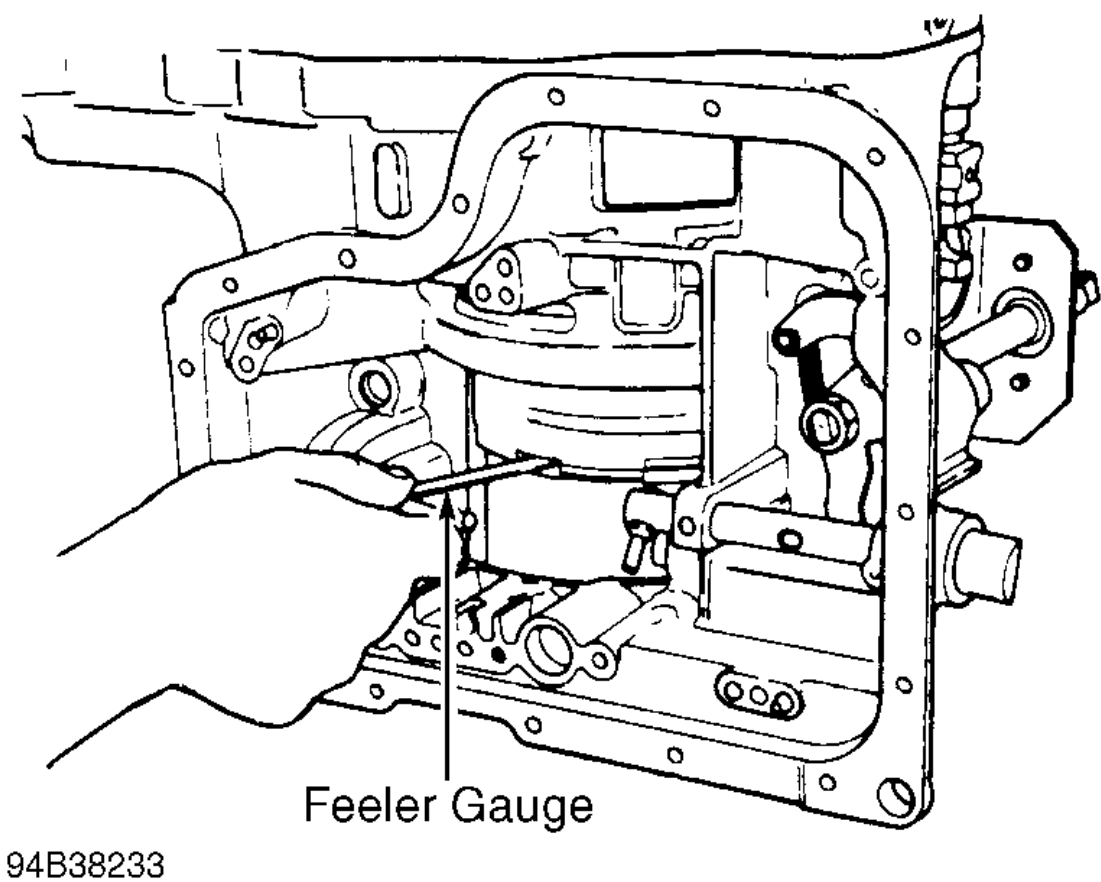


Fig. 7: Measuring Front Drum End Play
Courtesy of FORD MOTOR CO.

- 4. Remove oil pump. If oil pump is difficult to remove, tighten band adjusting stop bolt 106-133 INCH lbs. (12-15 N.m) and then remove oil pump. Remove brake band adjustment stop bolt, lock nut, band strut and band. See Fig. 8 . Store band partially closed with a piece of wire.
- 5. Remove front clutch assembly. Remove rear clutch needle bearing and rear clutch drum. Remove front ring gear. Remove needle bearing and rear clutch hub assembly. Remove thrust bearing and sun gear spacer from front planetary gear. Remove planetary gear carrier.

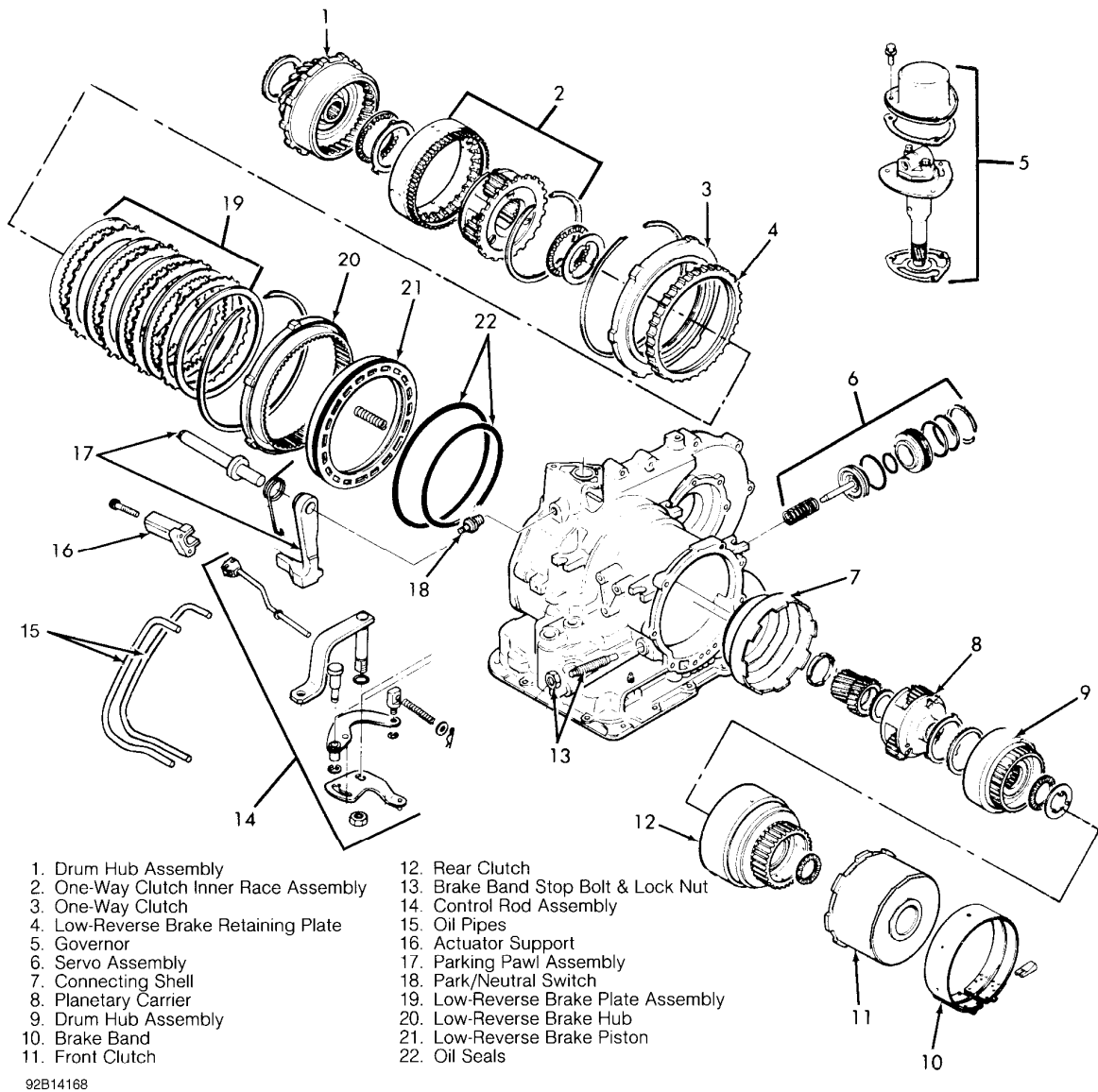


Fig. 8: Exploded View Of Transaxle Housing & Primary Components
Courtesy of FORD MOTOR CO.

- 6. Remove the sun gear, spacer and connecting sun shell. See Fig. 8 . Using "C" clamp and socket, compress servo piston with and remove

snap ring. Release the "C" clamp and remove the servo piston. See [Fig. 2](#) . Remove governor cover and pull governor from transaxle case. Remove transaxle case-to-torque converter housing bolts. Separate case halves.

7. Remove differential assembly. Remove oil pipes and parking pawl assembly. Remove drum hub assembly. Remove one-way clutch inner race assembly. See [Fig. 8](#) . Remove rear planetary carrier with needle bearing and thrust washer. Before disassembling one-way clutch, measure and record clearance between one-way clutch and low-reverse brake retaining plate. Clearance should .032-.041" (.8-1.05 mm).
8. Remove snap ring, one-way clutch and low-reverse brake retaining plate. Remove low-reverse brake plates. Compress low-reverse brake piston with appropriate compressor. See [Fig. 9](#) . Remove snap ring with screwdriver and remove low-reverse brake hub and springs. Apply air pressure to low-reverse oil passage to remove piston. See [Fig. 10](#) .
9. Remove output bearing and idler support assembly by lightly tapping on idler shaft with a soft-faced hammer. Drive out idler gear roll pin and remove idler gear from output bearing and idler support. See [Fig. 11](#) . Remove output gear assembly, press out bearing race from output bearing and idler support and save adjusting shim for reassembly.

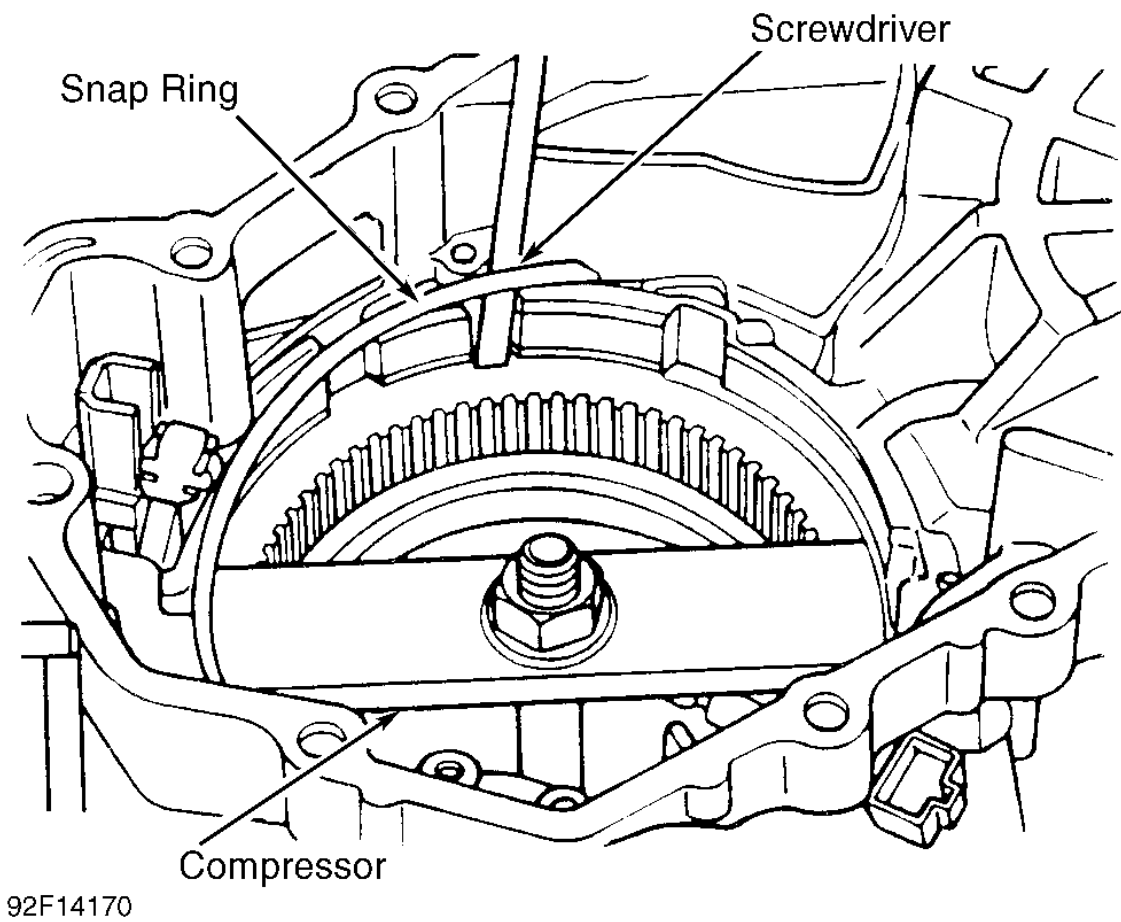
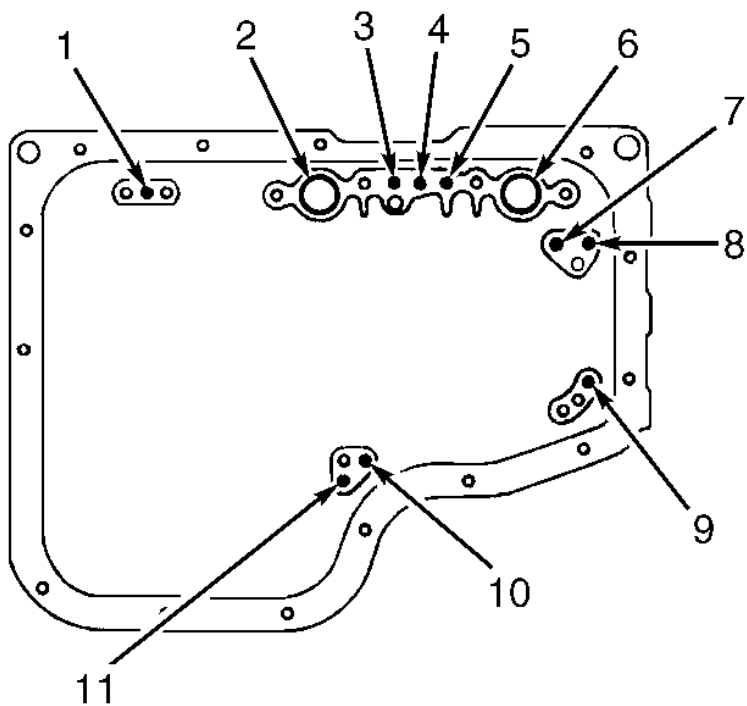


Fig. 9: Removing Snap Ring & Low-Reverse Brake
Courtesy of FORD MOTOR CO.



1. Line Pressure Check Port
2. Oil Pump Outlet
3. Torque Converter
4. Forward Clutch
5. Direct Clutch
6. Oil Pump Inlet
7. Servo Piston (Release)
8. Servo Piston (Apply)
9. Low-Reverse Clutch
10. Governor Outlet
11. Governor Inlet

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Fig. 10: Identifying Transaxle Oil Passages
Courtesy of FORD MOTOR CO.

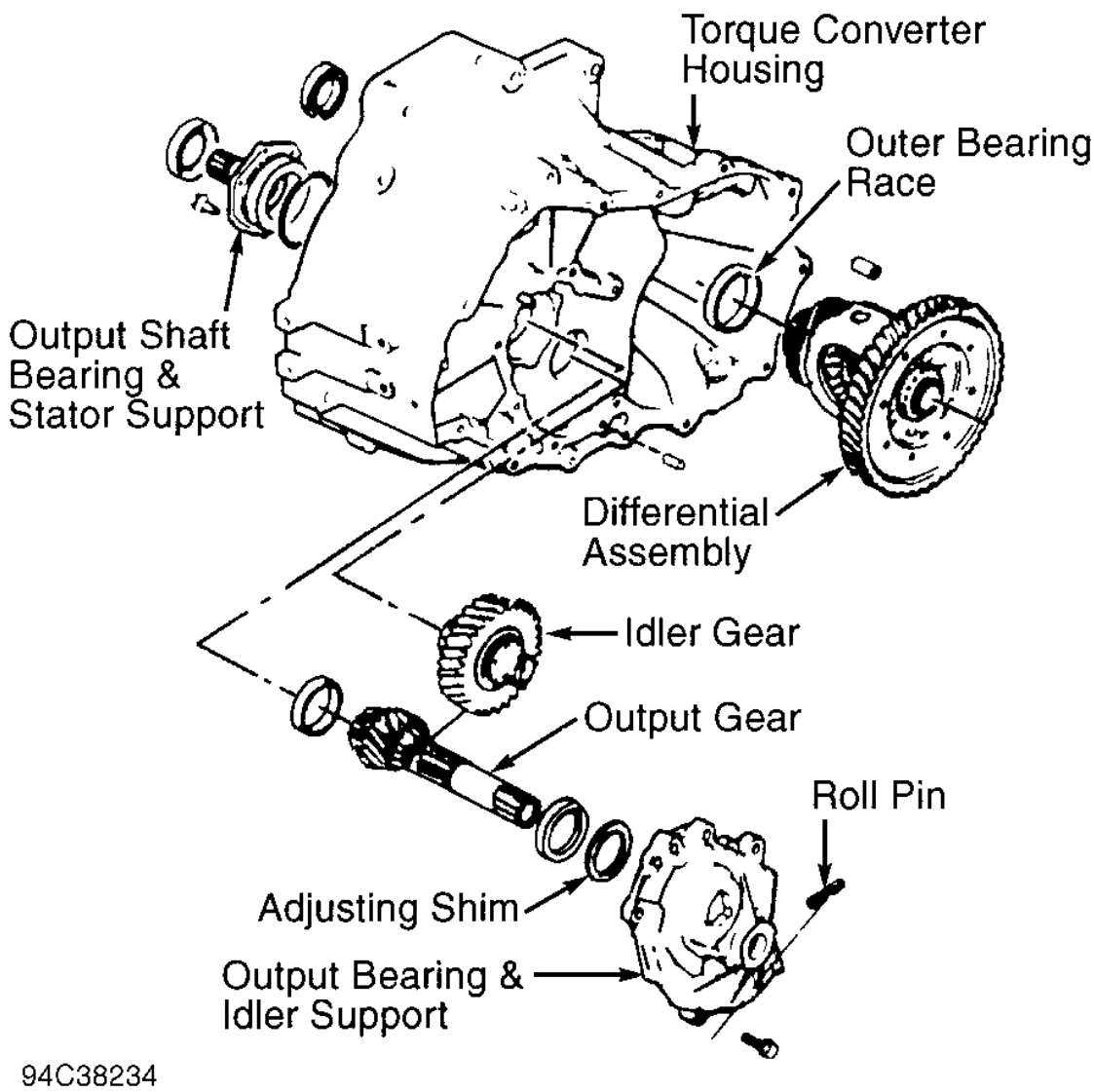


Fig. 11: Torque Converter Housing Components
Courtesy of FORD MOTOR CO.

COMPONENT DISASSEMBLY & REASSEMBLY

BAND SERVO

Inspection

Remove seal rings and inspect piston for damaged or worn piston. Ensure spring free length is 1.890" (48.00 mm). If less than specified, replace spring. Install new seal rings on piston and servo retainer.

DIFFERENTIAL

Disassembly

- 1. Remove ring gear retaining bolts and ring gear. Using hammer and pin punch, drive out roll pin. See Fig. 12 . Push out pinion gear shaft. Remove pinion and side gears, with washers, from differential housing.
- 2. Using appropriate puller, remove side bearings from differential housing. **DO NOT** remove speedometer drive gear unless damaged. Removal will damage speedometer drive gear.

Inspection

Check all gears for signs of excessive wear or damage. Check differential gear case for cracks or other damage. Replace as needed.

Reassembly

- 1. Reverse removal procedure to reassemble. Measure side gear and pinion gear backlash by inserting drive shafts into differential side gears and supporting shafts in "V" blocks. Position dial indicator with plunger resting on teeth of pinion gear. See Fig. 13 . Measure backlash. Repeat procedure with plunger on other pinion gear.
- 2. Backlash readings should be less than .004" (.10 mm). If backlash is not within specification, adjust backlash by changing thrust washers. Thrust washers are available in .079" (2.00 mm), .083" (2.10 mm) and .087" (2.20 mm) thicknesses. Use thrust washers of the same thickness on both sides whenever possible.

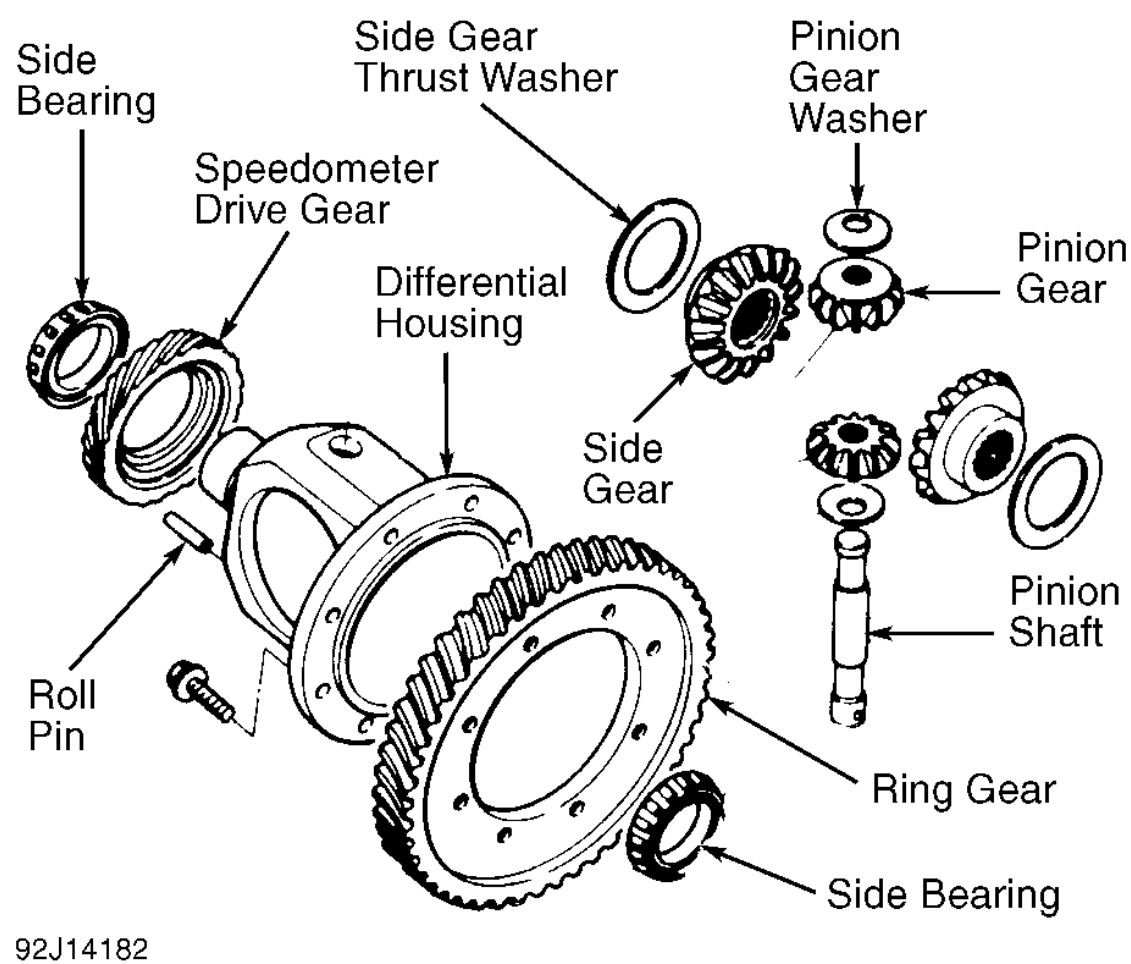


Fig. 12: Exploded View Of Differential Assembly
Courtesy of FORD MOTOR CO.

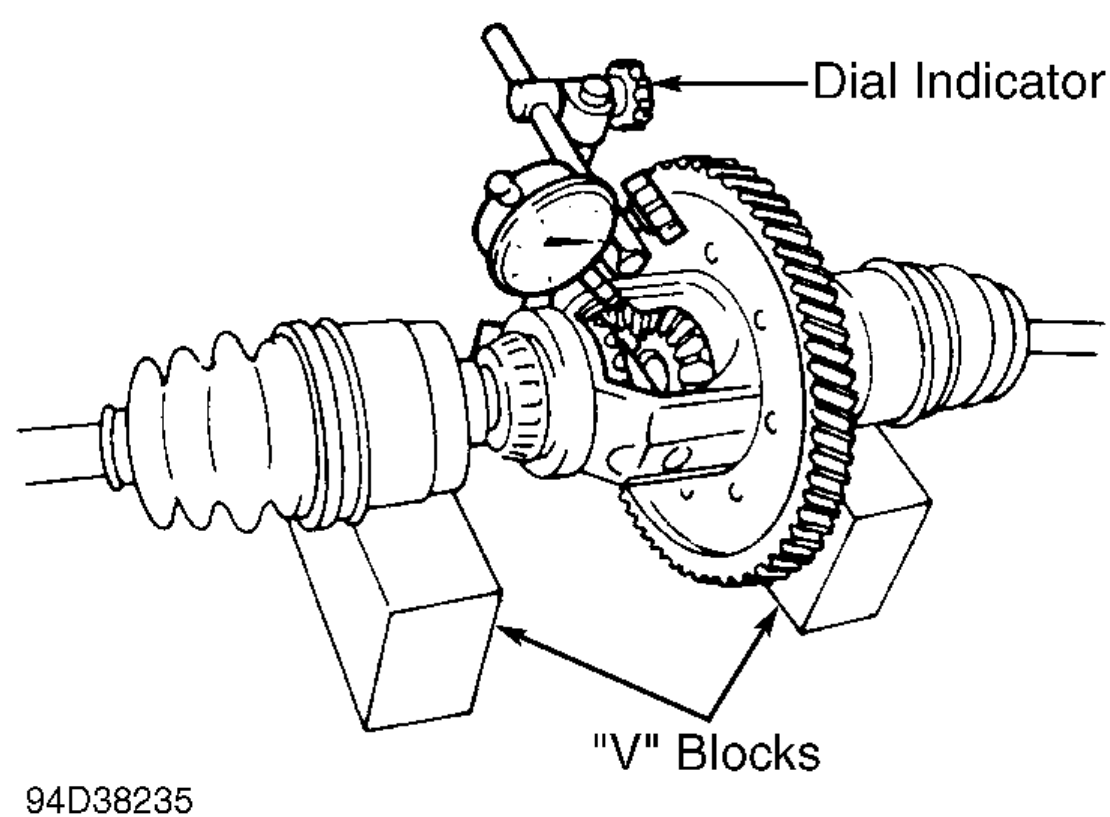


Fig. 13: Measuring Pinion Gear Backlash
Courtesy of FORD MOTOR CO.

DRUM HUB

Disassembly, Inspection & Reassembly

Remove parking gear spring from park gear. Push in the parking gear retaining pins with screwdriver and remove parking gear. See Fig. 14 . Remove snap ring and lift internal gear assembly from drive hub. Check gear for excessive wear or damage and replace if needed. Reverse disassembly procedure to reassemble drum hub.

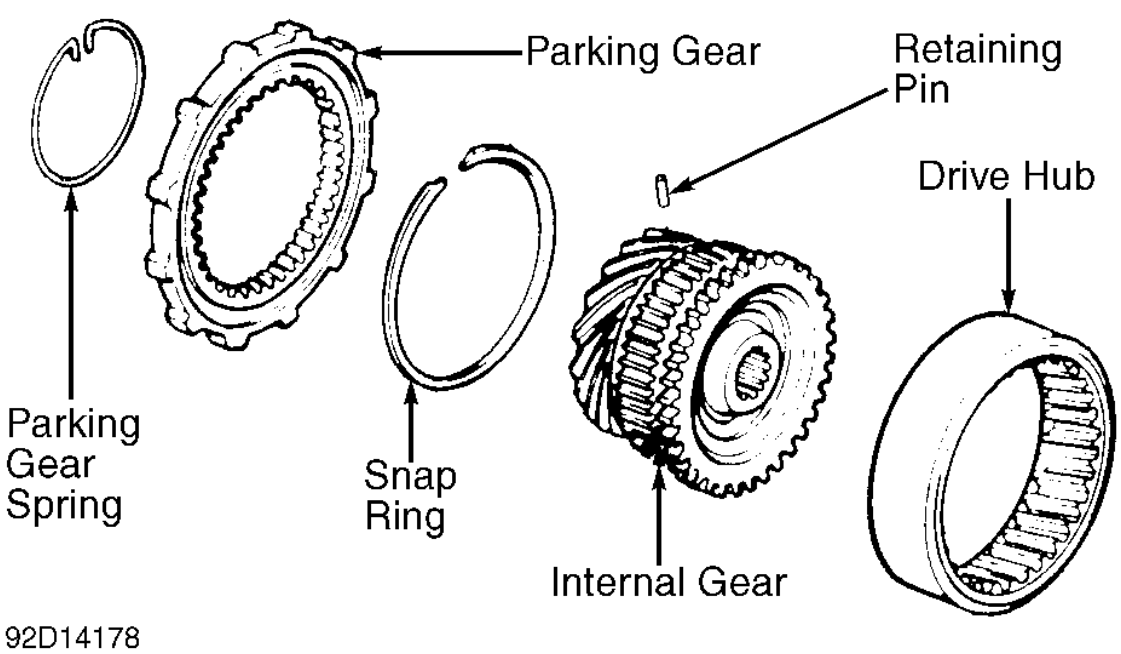


Fig. 14: Exploded View Of Drum Hub Assembly
Courtesy of FORD MOTOR CO.

FRONT CLUTCH

Disassembly

Remove retainer plate snap ring. Remove retainer plate, drive and driven plates and dished plate. See [Fig. 15](#) . Note position of dished plate for reassembly. Using appropriate compressor, compress return springs to remove spring retainer snap ring. Remove spring compressor. Remove spring retainer and return springs. Apply air pressure to front clutch oil passage and remove front clutch piston.

Inspection

Inspect all parts for wear or damage and replace as needed. Return springs must have free length of .992-1.071" (25.20-27.20 mm). If free length is not within specification, replace spring(s). Check inside diameter of clutch drum bushing. If diameter exceeds 1.735" (44.08 mm), replace bushing.

Reassembly

1. Reverse disassembly procedure to reassemble. Install new seal rings on piston and install piston by applying even pressure on perimeter while rotating piston. Install front clutch return springs and retainer. Compress spring retainer. Install snap ring.
2. Install dished plate. See [Fig. 15](#) . Install drive and driven clutch plates, retaining ring and snap ring. Using feeler gauge, measure between snap ring and retaining plate. Clearance should be .063-.071" (1.60-1.80 mm). If clearance is not correct, select correct thickness retaining plate. Retaining plates are available in thicknesses of .205" (5.20 mm) to .244" (6.20 mm) in .20 mm increments.
3. Place front clutch assembly over oil pump and apply air pressure (57 psi maximum) to front clutch oil passage in oil pump to check for proper front clutch operation. See [Fig. 16](#) .

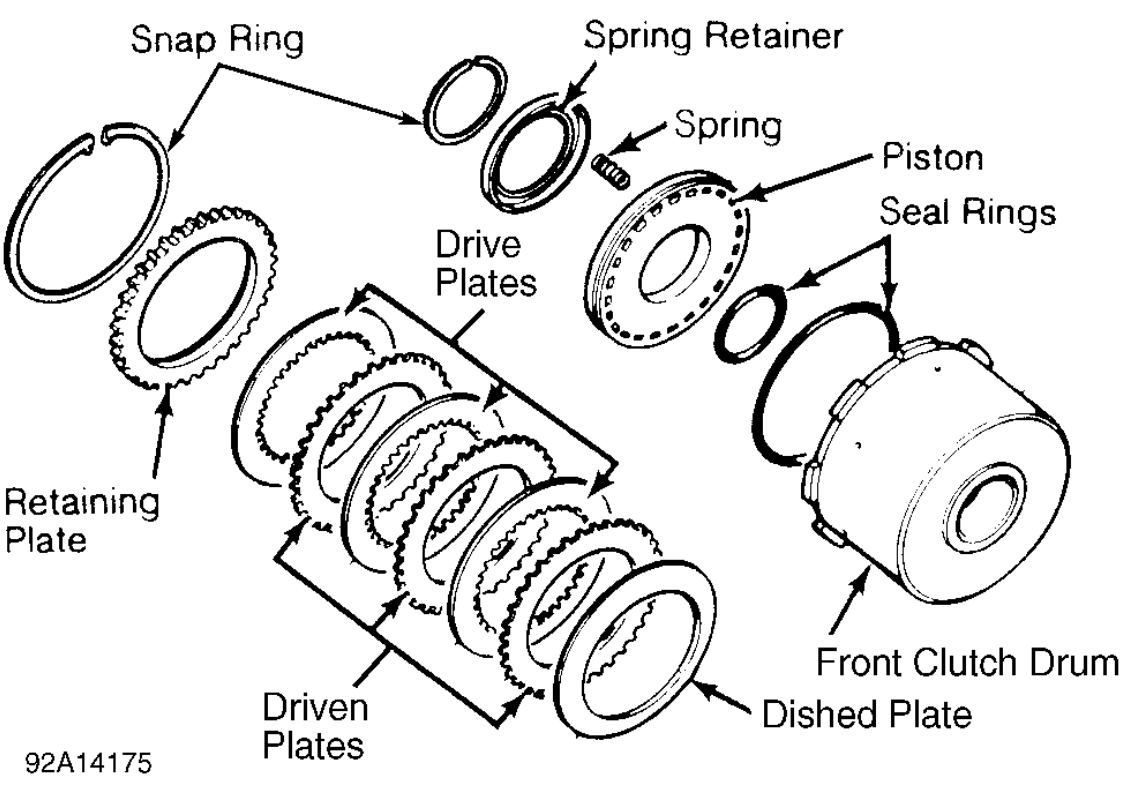


Fig. 15: Exploded View Of Front Clutch
Courtesy of FORD MOTOR CO.

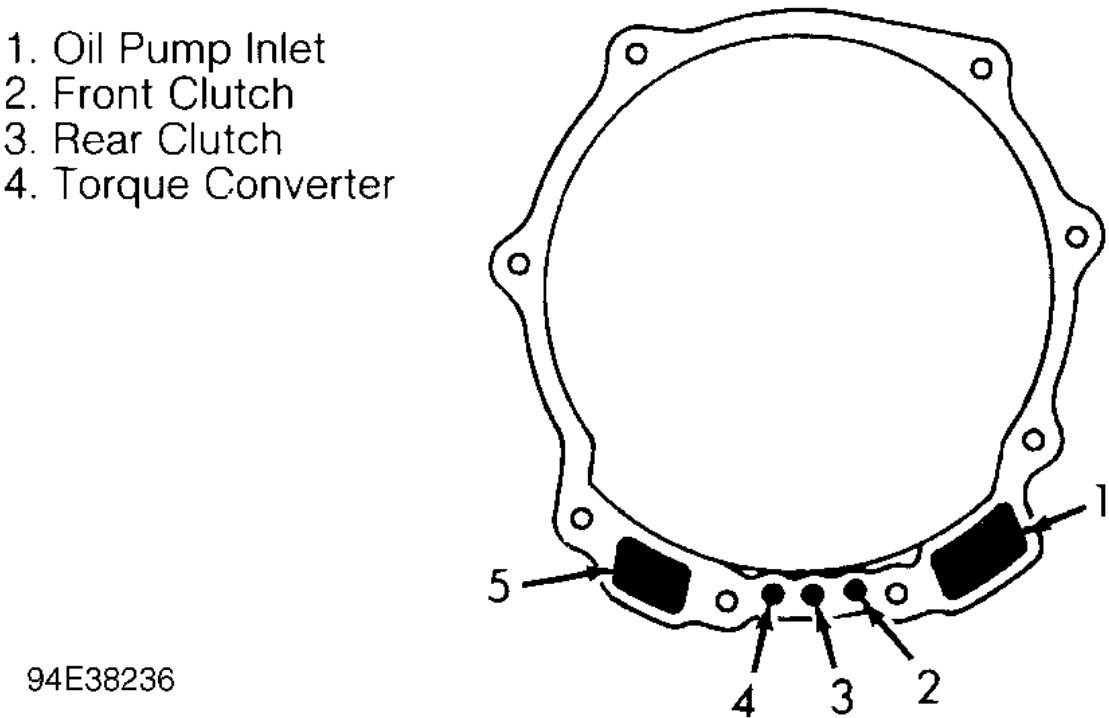


Fig. 16: Identifying Oil Pump Oil Passages
Courtesy of FORD MOTOR CO.

GOVERNOR ASSEMBLY

Disassembly & Reassembly

Secure governor assembly in vise. Using hammer and pin punch, drive out governor shaft gear spring pin. Remove gear. Remove sleeve from shaft. Remove oil screen clamp and screen. See [Fig. 17](#) . Clean all parts as needed. Lubricate parts with ATF. To assemble, reverse disassembly procedure. Replace spring pin.

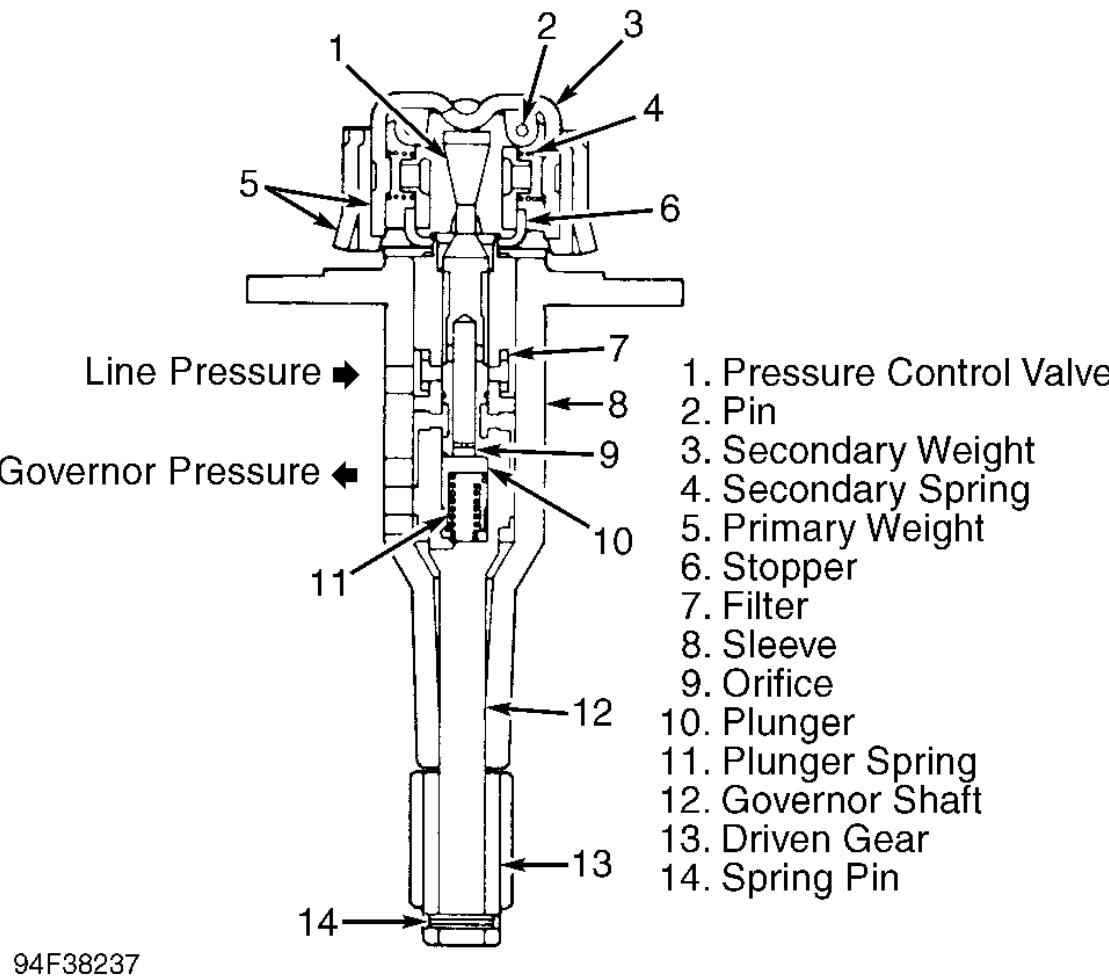


Fig. 17: Exploded View Of Governor Assembly
Courtesy of GENERAL MOTORS CORP.

IDLER GEAR ASSEMBLY

Disassembly & Inspection

Attach Idler Shaft Holder (J-35286) or hex wrench to idler shaft and support assembly in vise. Remove lock nut. See [Fig. 18](#) . Remove bearing, spacer, idler gear, adjustment shim(s) and remaining bearing. Press bearing outer races from idler gear. Check all gear teeth for wear or damage and bearings for breakage or unusual wear.

Reassembly

1.

Place idler shaft holder or hex wrench in vise and place idler shaft on wrench. Install outer races in idler gear. Place bearing, idler gear, adjustment shim, spacers, bearing and nut on idler shaft and tighten nut to 94-130 ft. lbs. (127-176 N.m).
2.

Measure bearing preload. Mount idler gear in vise. Using INCH lb. torque wrench, measure idler gear shaft turning torque. Turning torque should be .26-8.0 INCH lbs. (.03-.90 N.m). If preload is not within specification, change selective shims. Selective size shims are available from .004" (.10 mm) to .008" (.20 mm) in .04 mm increments. One .020" (.50 mm) shim is available. **DO NOT** use more than 7 shims. Once correct preload is obtained, retighten idler gear locknut to 94-130 ft. lbs. (128-177 N.m)

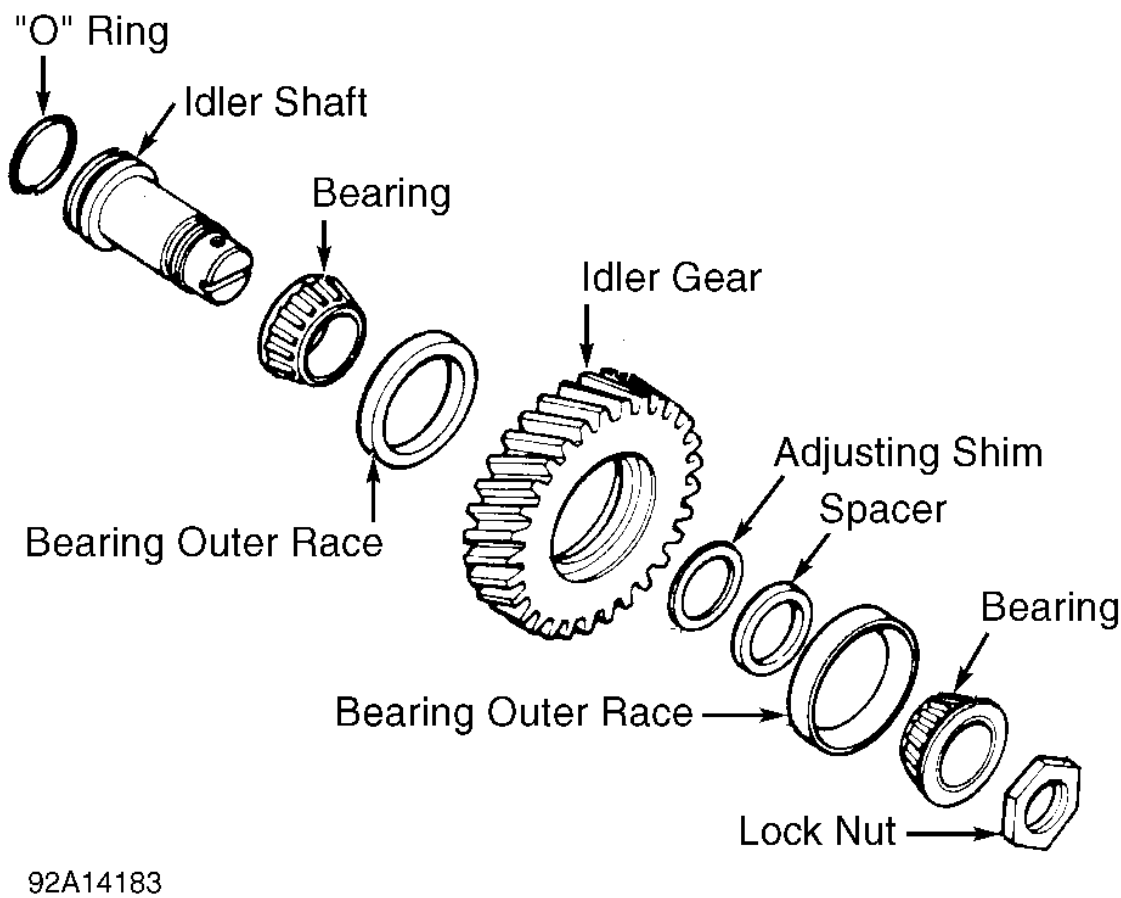


Fig. 18: Exploded View Of Idler Gear Assembly
Courtesy of FORD MOTOR CO.

LOW-REVERSE BRAKE

Inspection

Check all components for signs of damage or excessive wear. Check free length of return springs. See **LOW-REVERSE BRAKE SPRING SPECIFICATIONS** . If not correct, replace spring(s).

LOW-REVERSE BRAKE SPRING SPECIFICATIONS

Application	Free Length In. (mm)
Aspire & Festiva	1.091 (27.70)
Tracer	1.070-1.110 (27.20-28.20)

OIL PUMP

Disassembly

Remove pump cover retaining bolts and separate cover from pump body. Remove pump flange. See **Fig. 19** . If gears are to be reused, match mark gears to reassemble in same position. Remove drive and driven gears.

Inspection

1.

Check the condition of the gear teeth and surfaces. Check seal rings for signs of cracks or breaks and replace as needed. Check condition of pump housing sleeve and inner gear bushing. See **Fig. 20** . See the **OIL PUMP SPECIFICATIONS** . Check sleeve outer diameter and bushing inner diameter.
2.

If sleeve diameter is less than 1.492" (37.90 mm) or bushing diameter is greater than 1.499" (38.08 mm) replace sleeve and bushing as a set. Check pump clearances and compare with values shown in the **OIL PUMP SPECIFICATIONS** .

Reassembly

Apply ATF on all parts. To assemble, reverse disassembly procedure. **DO NOT** tighten pump cover to oil pump housing. Oil pump reassembly is completed during transaxle reassembly.

OIL PUMP SPECIFICATIONS

Application	Clearance In. (mm)
Drive & Driven Gear-To-Pump Cover	.001-.003 (.025-.08)
Driven Gear-To-Crescent	.006-.010 (.14-.25)
Driven Gear-To-Pump Housing	.002-.003 (.04-.08)
Seal Ring Side	.002-.016 (.04-.40)

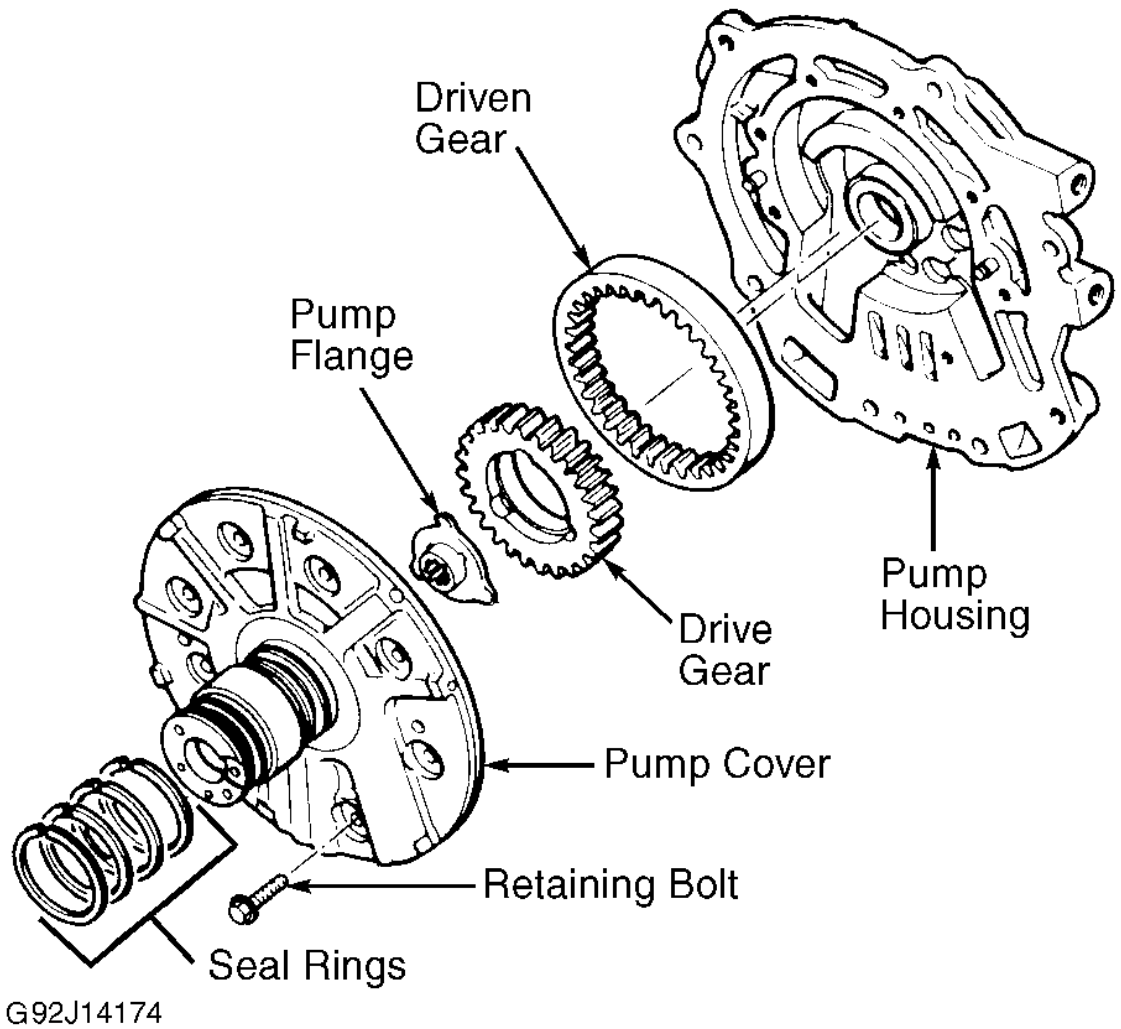


Fig. 19: Exploded View Of Oil Pump Assembly
Courtesy of FORD MOTOR CO.

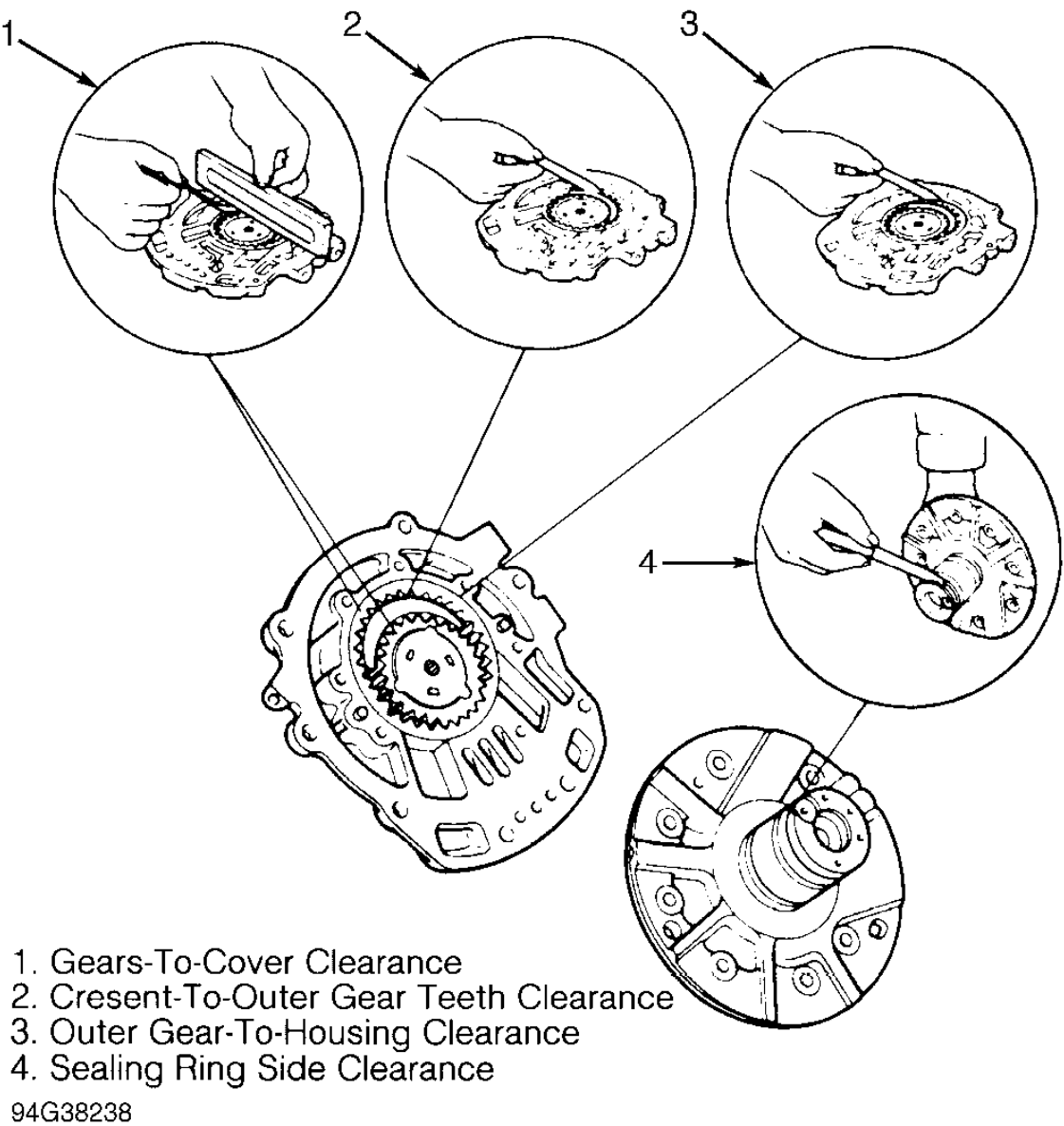


Fig. 20: Measuring Oil Pump Clearances
Courtesy of FORD MOTOR CO.

ONE-WAY CLUTCH

Disassembly, Inspection & Reassembly

1. Record direction of rotation one-way clutch locks and turns. Remove snap ring and pull out planetary carrier from one-way clutch inner race. See [Fig. 8](#) . Check for worn or damaged parts. Bushing wear on one-way clutch must not exceed 5.120" (130.06 mm).
2. Check clearance between pinion gears and washers in planetary carrier. If clearance exceeds .031" (.80 mm), replace planetary carrier. Reverse disassembly procedure to reassemble. Install one-way clutch in inner race and ensure that it will turn in one direction (clockwise) only.

REAR CLUTCH

Disassembly

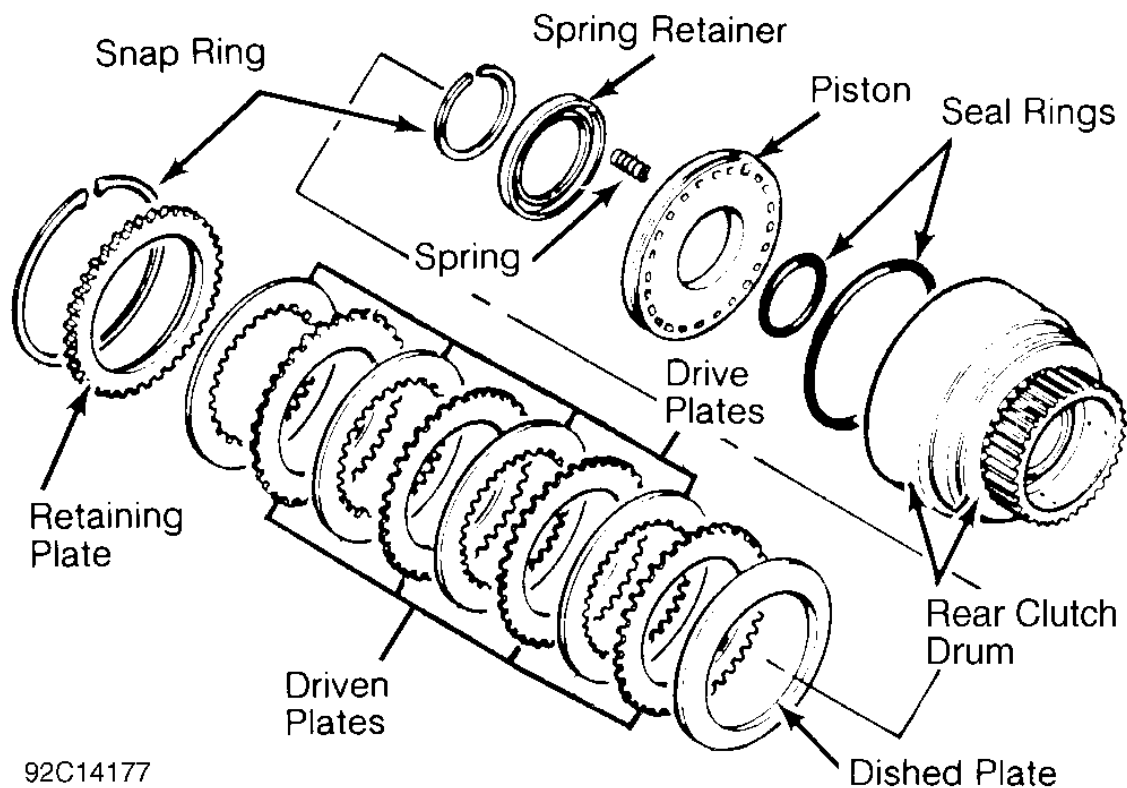
1. Remove large snap ring. Lift out retaining plate, clutch plates, and dished plate. See [Fig. 21](#) . Using appropriate compressor, compress rear clutch spring retainer to remove small snap ring, spring retainer, and clutch return springs.
2. Place front clutch on oil pump and rear clutch hub on top of front clutch. Apply air pressure to rear clutch oil passage to remove piston. See [Fig. 16](#) . Remove and discard piston seal rings.

Inspection

Inspect for wear or damage. Ensure return spring free length is 1.031-1.071" (26.20-27.20 mm).

Reassembly

1. Install seal rings on piston and install in clutch drum by applying even pressure on perimeter of piston and rotate piston slowly. Install return springs and spring retainer. Press spring retainer. Install snap ring. Note direction of dished plate and install. Install driven and drive plates, retainer plate and snap ring. See [Fig. 21](#) .
2. Ensure clearance between snap ring and retainer plate is .031-.039" (.80-1.00 mm). If clearance is not within specification, select correct retaining plate. Retaining plates are available in thicknesses .189" (4.80 mm) to .244" (6.20 mm) in .20 mm increments.
3. Check rear clutch operation by placing forward clutch on oil pump and then rear clutch. Apply compressed air (70 psi maximum) to rear clutch oil passage and check operation. See [Fig. 16](#) .



[Fig. 21: Exploded View Of Rear Clutch](#)
Courtesy of FORD MOTOR CO.

REAR CLUTCH HUB

Disassembly, Inspection & Reassembly

Remove snap ring and separate hub from internal gear. Check for worn or damaged snap ring or gear and replace as needed. Reverse disassembly procedure to reassemble hub.

VALVE BODY

NOTE: Remove and clean one valve at a time to avoid incorrect installation. If any valves, valve springs, or valve bodies are damaged, the entire valve body assembly must be replaced.

Disassembly

1. Remove manual control valve. Remove oil strainer retaining bolts and oil strainer. Remove upper-to-lower valve body retaining bolts. Separate valve bodies, separator plate and sub-body. **DO NOT** lose check balls and springs or orifice valve and spring. See [Fig. 22](#) .
2. Remove, clean and install each valve individually as needed. See [Fig. 22](#) . Lubricate moving parts with ATF. Ensure all valves move (snap) freely. If valve sticks in its bore and cannot be freed, valve body must be replaced. **DO NOT** attempt to hone valve bores or polish valves.
3. Inspect the valve springs for signs of damage or deformation. Measure valve spring free length and diameter. Refer to the [VALVE](#)

BODY SPRING DIMENSIONS . Reassemble components in reverse order of disassembly.

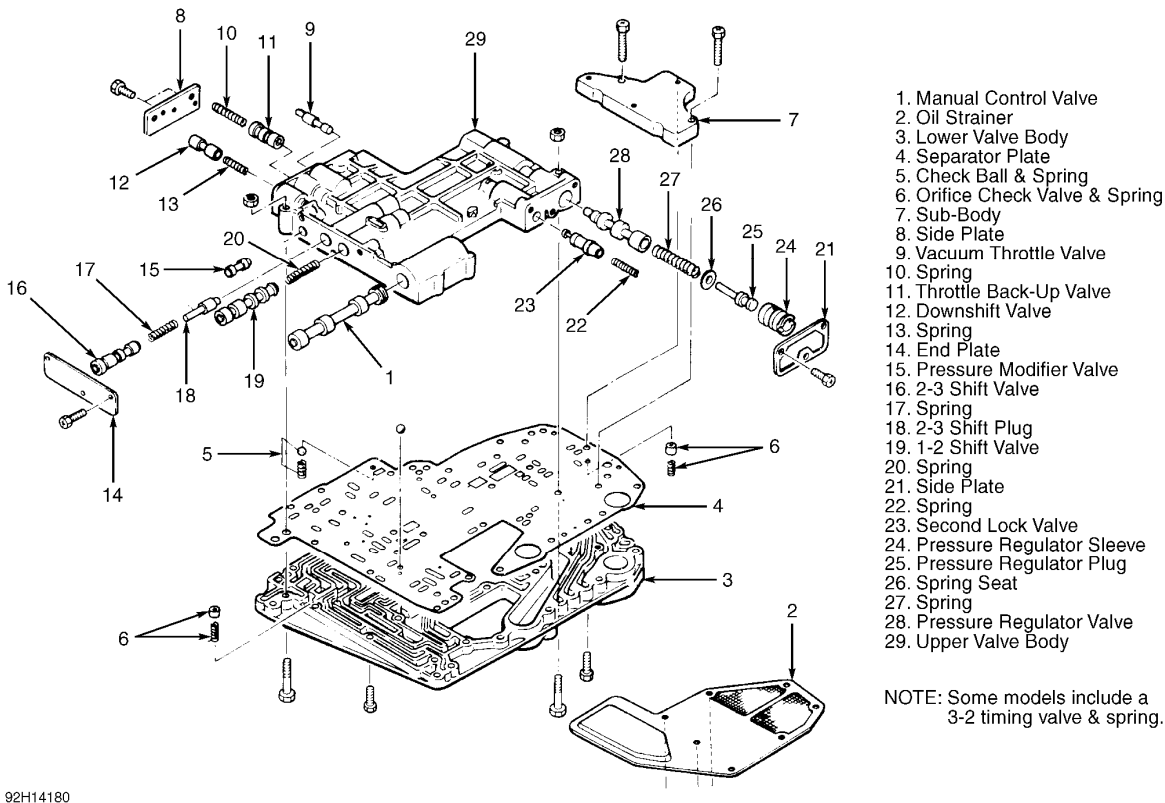


Fig. 22: Exploded View Of Valve Body Assembly
Courtesy of FORD MOTOR CO.

VALVE BODY SPRING DIMENSIONS

Application	Free Length In. (mm)
Throttle Back-Up	1.417 (36.00)
Downshift	.862 (21.90)
2-3 Shift (Aspire & Festiva)	1.614 (41.00)
1-2 Shift	1.260 (32.00)
Second Lock	1.319 (33.50)
Pressure Regulator	1.693 (43.00)
Throttle Relief	.441 (11.20)
Orifice Check (Aspire & Festiva)	.610 (15.50)
Steel Ball (Spring)	1.516 (26.80)

Reassembly

1. To reassemble, reverse disassembly procedure. Coat all parts with clean transmission fluid. **DO NOT** force valves into position. Ensure orifice check valve, check ball and springs are located correctly.
2. Place separator plate on lower valve body and hold with clamps. Install upper valve body and bolt into place. Tighten upper valve body to lower valve body. See [Fig. 23](#) .

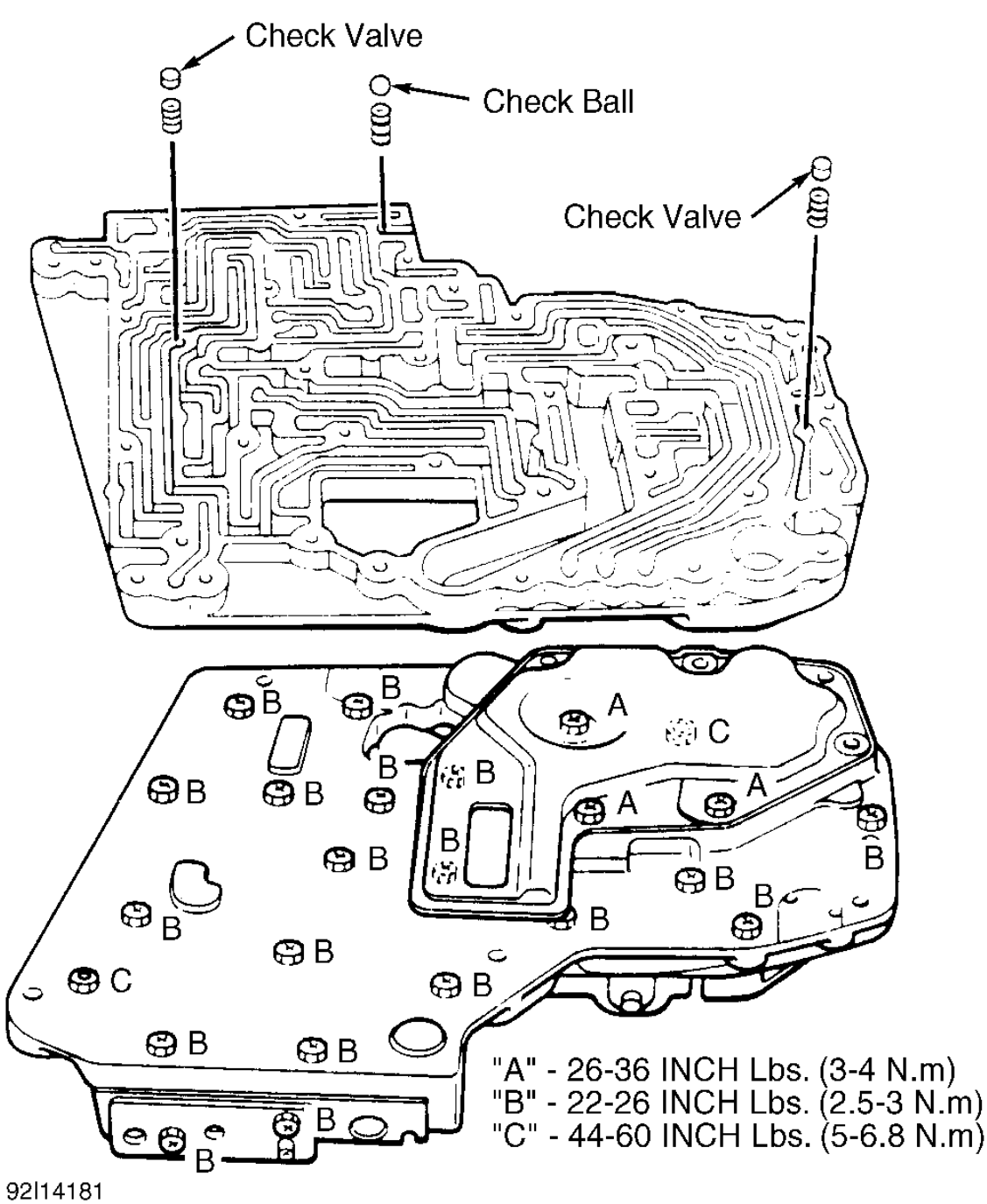


Fig. 23: Locating Valve Body Check Balls & Tightening Bolts
Courtesy of GENERAL MOTORS CORP.

TRANSAXLE CASE

Inspection

Inspect case for cracks and stripped threads. Inspect gasket surfaces and mating surfaces for burrs. Check vent for obstructions, and check all fluid passages for obstructions and leakage. Inspect case bushing for scores. Check all parking linkage parts for wear or damage.

TRANSAXLE REASSEMBLY

NOTE: Handle all parts carefully to avoid damaging bearings and mating surfaces. Lubricate all parts with clean ATF. Use petroleum jelly on gaskets, thrust washers and needle bearings to retain them in place. Soak all friction discs in ATF for at least 15 minutes. Use all new gaskets and seals, and tighten bolts evenly.

NOTE: For identification and position of thrust bearings and washers, see [Fig. 27](#) .

OUTPUT SHAFT BEARING PRELOAD

1. Position output shaft into torque converter housing. Position output shaft outer bearing race in recessed end of Gauge Tool (T87C-770002DJ). Place gauge tool over output shaft. See [Fig. 24](#) .
2. Ensure gauge tool is completely threaded together so that no gap is present. Position spacer collars and assemble output bearing and idler support to converter housing using supplied bolts and washers of tool set. See [Fig. 24](#) . Tighten bolts to 14-19 ft. lbs. (26 N.m).

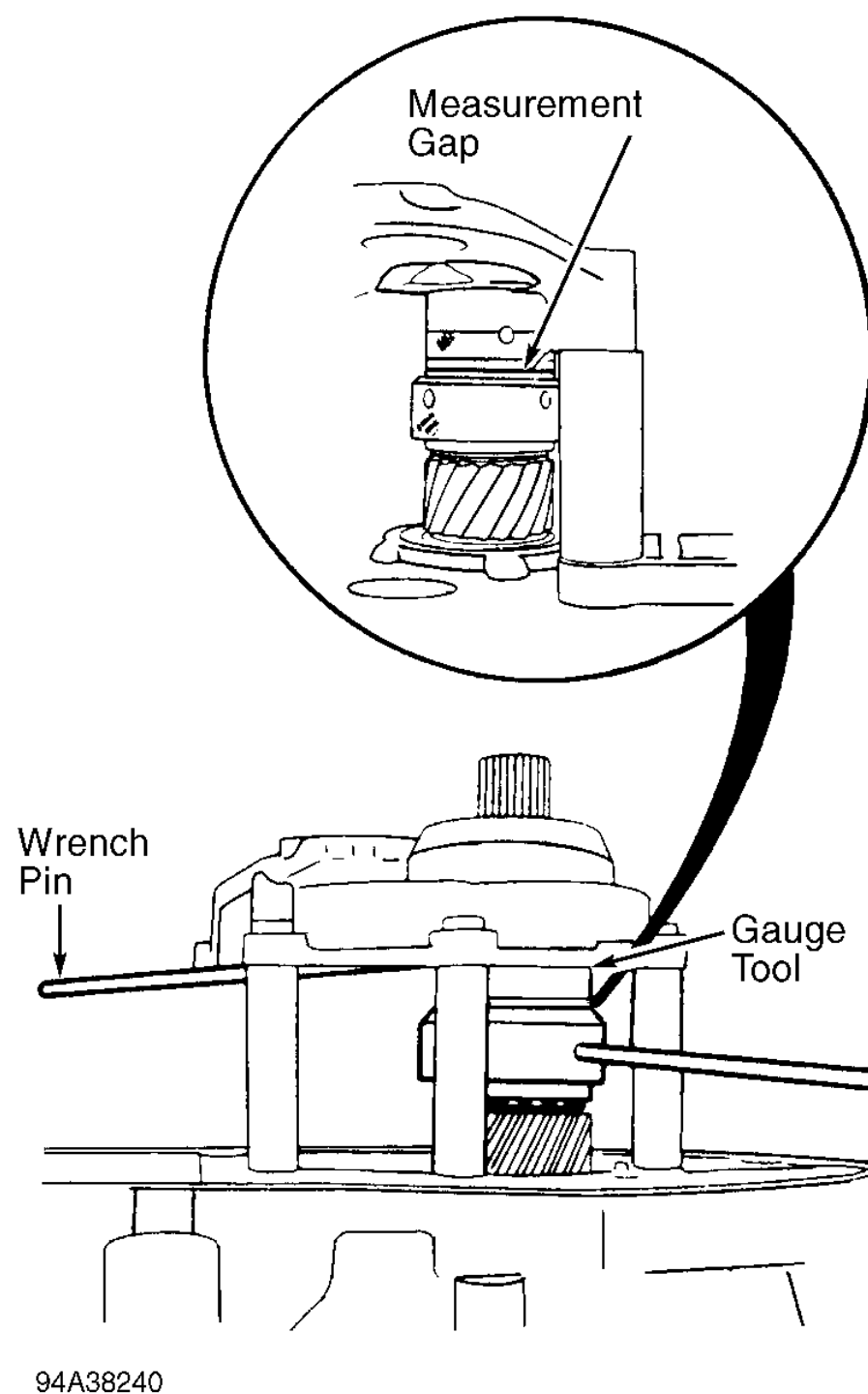


Fig. 24: Measuring Output Shaft Bearing Preload
Courtesy of FORD MOTOR CO.

- Unthread gauge tool until output shaft bearings are seated and no play exists. Install Torque Adapter (T87C77000-E) over splined end of output shaft. Using INCH lb. torque wrench, rotate output shaft while unthreading gauge tool. Unthread gauge tool until 4.42-7.97 INCH lbs. (.5-.9 N.m) of turning torque is obtained.
- Using feeler gauge, measure gap of gauge tool. Select correct thrust shim(s) that match measured gauge tool gap. Shims are available from in thicknesses of .004" (.10 mm) to .007" (.18 mm) in .02 mm increments. One shim is available in thickness of .019" (.50 mm).
- Disassemble output bearing and idler support from converter housing. Remove gauge set and spacers. Install selected shim(s) in output bearing and idler support. **DO NOT** exceed 7 shims. Remove bearing race from gauge tool and install race in support. Reassemble converter housing and output bearing and idler support. Install bolts and tighten retaining bolts to specification. Refer to [TORQUE SPECIFICATIONS](#).
- Install Torque Adapter (T87C77000-E) over splined end of output shaft. Using INCH lb. torque wrench, rotate output shaft to confirm correct bearing preload. Turning torque should be .26-7.96 INCH lbs. (.03-.9 N.m). If turning torque is not within specification, repeat steps 1) through 6).
- Once correct output shaft bearing preload is obtained, remove output bearing and idler gear support. Replace idler gear shaft seal on idler gear shaft. Install idler gear into converter housing. Install output gear and bearing support. Ensure alignment groove in idler gear shaft is aligned with support ridge of output bearing and idler support.
- Install new idler gear shaft roll pin. Install output gear and bearing support bolts and tighten bolts to specification. See [TORQUE SPECIFICATIONS](#).

DIFFERENTIAL BEARING PRELOAD ADJUSTMENT

- Install differential assembly into converter housing. Position differential side bearing race in recessed end of Gauge Tool (T87C-770002DJ). Place gauge tool on differential. See [Fig. 25](#).
- Ensure gauge tool is completely threaded together so that no gap is present. Position spacer collars and assemble case halves using supplied bolts and washers of tool set. See [Fig. 25](#). Tighten bolts to 22-34 ft. lbs. (292D46 N.m).

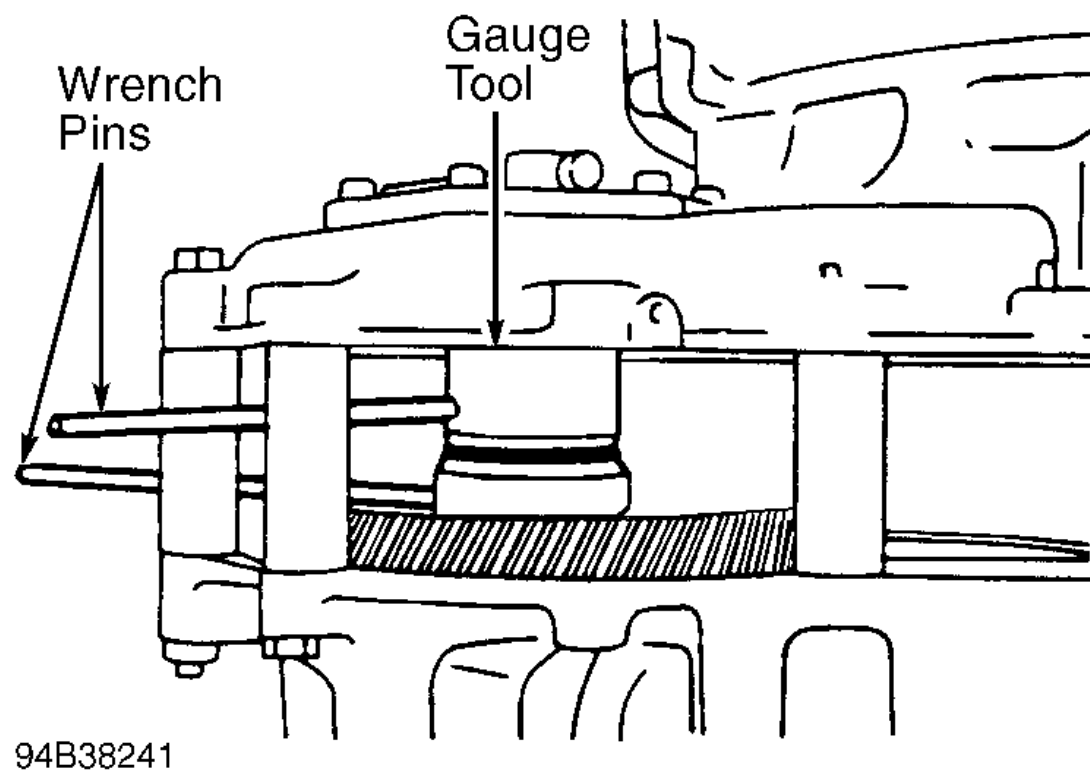


Fig. 25: Measuring Differential Bearing Preload
Courtesy of FORD MOTOR CO.

- Unthread gauge tool until differential bearings are seated. Install Differential Rotator into differential assembly. Using INCH lb. torque wrench, rotate differential assembly while unthreading gauge tool. Unthread gauge tool until 4.3 INCH lbs. (.5 N.m) of turning torque is obtained.
- Using feeler gauge, measure gap of gauge tool. Select correct thrust shim(s) by adding .006" (.15 mm) to measured gauge tool gap. Shims are available from in thicknesses of .043" (1.08 mm) to .079" (2.00 mm) in .040 mm increments.
- Disassemble case halves. Remove gauge set and spacers. Install selected shim(s) in transaxle case. **DO NOT** exceed 3 shims. Remove bearing race from gauge tool and install race in transaxle case. Reassemble transaxle case halves. Install bolts and tighten bolts to specification. See **TORQUE SPECIFICATIONS**.
- Install Differential Rotator (T88C-77000-L) into differential assembly. Using INCH lb. torque wrench, rotate differential assembly to confirm correct bearing preload. Turning torque should be 18-25 INCH lbs. (21.-2.8 N.m). If turning torque is not within specification, repeat steps 1) through 6).

FINAL REASSEMBLY

- Install low-reverse brake piston by applying even pressure on perimeter of piston while rotating slowly. Install 20 return springs and low-reverse brake hub. Using appropriate compressor, compress return spring and install snap ring. See **Fig. 9**.
- Install dished plate with small end of dish facing away from piston. Install clutch discs, retainer ring and one-way clutch. Install one-way clutch machined surface toward retainer ring. Install snap ring.

NOTE: Low/reverse snap ring may not have been installed during production. Snap ring is required during overhaul reassembly.

- Using a feeler gauge, ensure clearance between one-way clutch and retainer plate is .031-.041" (.80-1.05 mm). If clearance is not within specification, select correct retainer plate to obtain correct clearance. Retainer plates are available in thicknesses of .063" (1.60 mm) to .102" (2.60 mm) in .20 mm increments. Apply air pressure to low-reverse oil passage and check for proper clutch operation. See **Fig. 10**.
- Place converter housing on bench with output shaft facing upward. Install needle bearing over output shaft. Install drum hub assembly onto output shaft spline. Install needle bearing with thrust washer in recess of drum hub. Install rear planetary carrier onto one-way clutch race. Install snap ring. Install rear planetary assembly into drum hub. Install oil tubes into transaxle case.
- Install governor into transaxle case. Ensure alignment mark on governor sleeve is aligned with mark on transaxle case. Install governor cover. Tighten bolts to specification. Refer to **TORQUE SPECIFICATIONS**. Apply appropriate gasket sealant to converter housing and install transaxle case. Once case halves are secured in place, ensure all parts previously installed rotate without resistance.
- Lubricate servo piston with ATF. Assemble servo retainer, piston, piston large seal and spring. Insert assembly into transaxle. Using "C" clamp and socket, compress assembly and install snap ring.
- Install thrust bearing and thrust washer. Install sun gear shell with sun gear spacer and sun gear. See **Fig. 8**. Install front planetary carrier with thrust washer onto sun gear. Install thrust washer and thrust bearing onto front of front planetary carrier.
- Install seal sleeve to center of front planetary carrier. Install front ring gear. Install front ring gear needle bearing with rollers facing upward. Install thrust washer. Match tangs on thrust washer with mating holes in rear clutch assembly.
- Install rear clutch assembly. Install needle bearing. Companion thrust washer is fitted to oil pump support later in reassembly procedure. Install front clutch assembly. Install band, band strut and band adjusting stop. Tighten band adjusting stop until band is secured in place.

TOTAL END PLAY ADJUSTMENT

- Remove oil pump cover from oil pump housing. Set oil pump housing aside. Coat pump support thrust washer with petroleum jelly and install on end of pump support. Ensure washer tangs mate with holes in pump support.
- Install pump cover in front clutch drum. **DO NOT** have front drum adjusting thrust shim installed. Place a straightedge across transaxle

case over pump cover. Measure clearance between straightedge and pump cover, or between straightedge and transaxle case. See [Fig. 26](#).

3. If pump cover is below edge of transaxle case, clearance between straightedge and pump cover should not exceed .004" (.10 mm). If pump cover is above edge of transaxle case, clearance between straightedge and transaxle case should not exceed .006" (.15 mm).
4. If pump cover and/or transaxle case clearance is correct, total clutch assembly end play will be correct. Total clutch assembly end play should be .010-.020" (.25-.50 mm). If pump cover and/or transaxle case clearance is incorrect, remove pump cover and replace pump support thrust washer. Thrust washers are available in thicknesses from .047" (1.20 mm) to .087" (2.20 mm) in .20 mm increments.
5. Reassemble oil pump by aligning marks on oil pump gears. Place pump cover on pump housing. Install and tighten bolts to specification. See [TORQUE SPECIFICATIONS](#). Install oil pump shaft in oil pump and check operation by turning shaft by hand. Gears should move freely without binding.
6. Install front clutch thrust washer over pump support. Install oil pump to transaxle. Install oil pump bolts. Apply sealant on 2 lower bolts and tighten bolts to specification. Refer to the [TORQUE SPECIFICATIONS](#).
7. Position transaxle with oil pump facing down. Turn sun shell 2 revolutions. Insert screwdriver between tabs of front clutch and sun shell deep slots. Using a feeler gauge, measure in the shallow slots. See [Fig. 26](#).
8. End play should be .020-.031" (.50-.80 mm). If end play is not within specification, remove oil pump and install correct thrust washer. Thrust washers are available in thicknesses of .051" (1.30 mm) to .106" (2.70 mm) in .20 mm increments.
9. Tighten band adjusting stop bolt to 106-133 INCH lbs. (12-15 N.m). Loosen bolt 3 turns and then tighten lock nut to 41-59 ft. lbs. (56-80 N.m). Install valve body steel check ball and spring in case. Install valve body and oil pan. Install turbine and oil pump shafts. Install speedometer driven gear, oil dipstick and tube.
10. Install the vacuum modulator valve in transaxle. Make sure correct length control rod is installed in the modulator. Refer to [VACUUM THROTTLE VALVE DIAPHRAGM \(MODULATOR\) R & I](#) under ON-VEHICLE SERVICE. Install kickdown solenoid and park/neutral switch. Install torque converter. With converter properly installed, distance between machined pad on torque converter and front edge of transaxle housing should be .50" (12.7 mm).

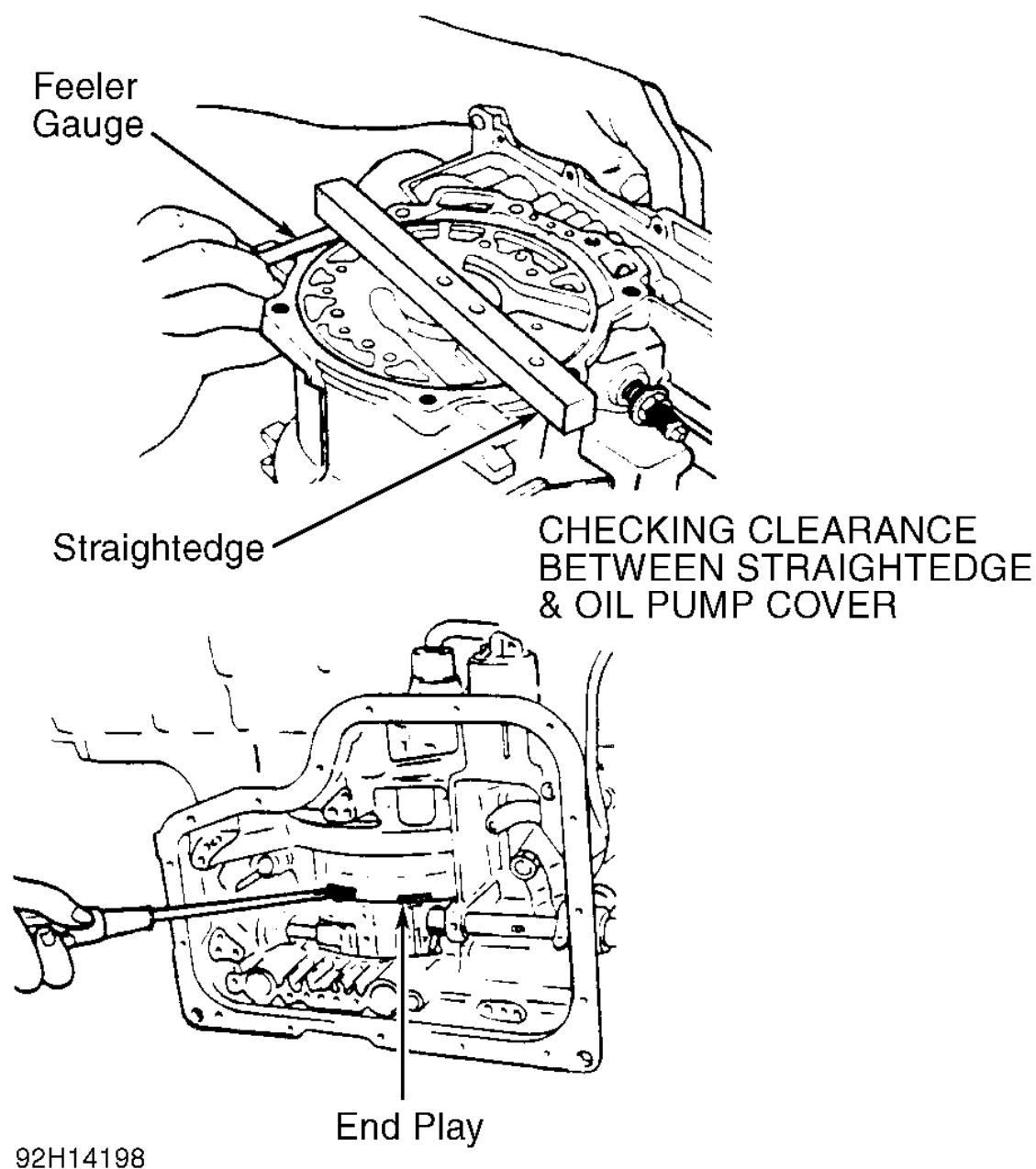


Fig. 26: Measuring Front Drum & Total End Play
Courtesy of FORD MOTOR CO.

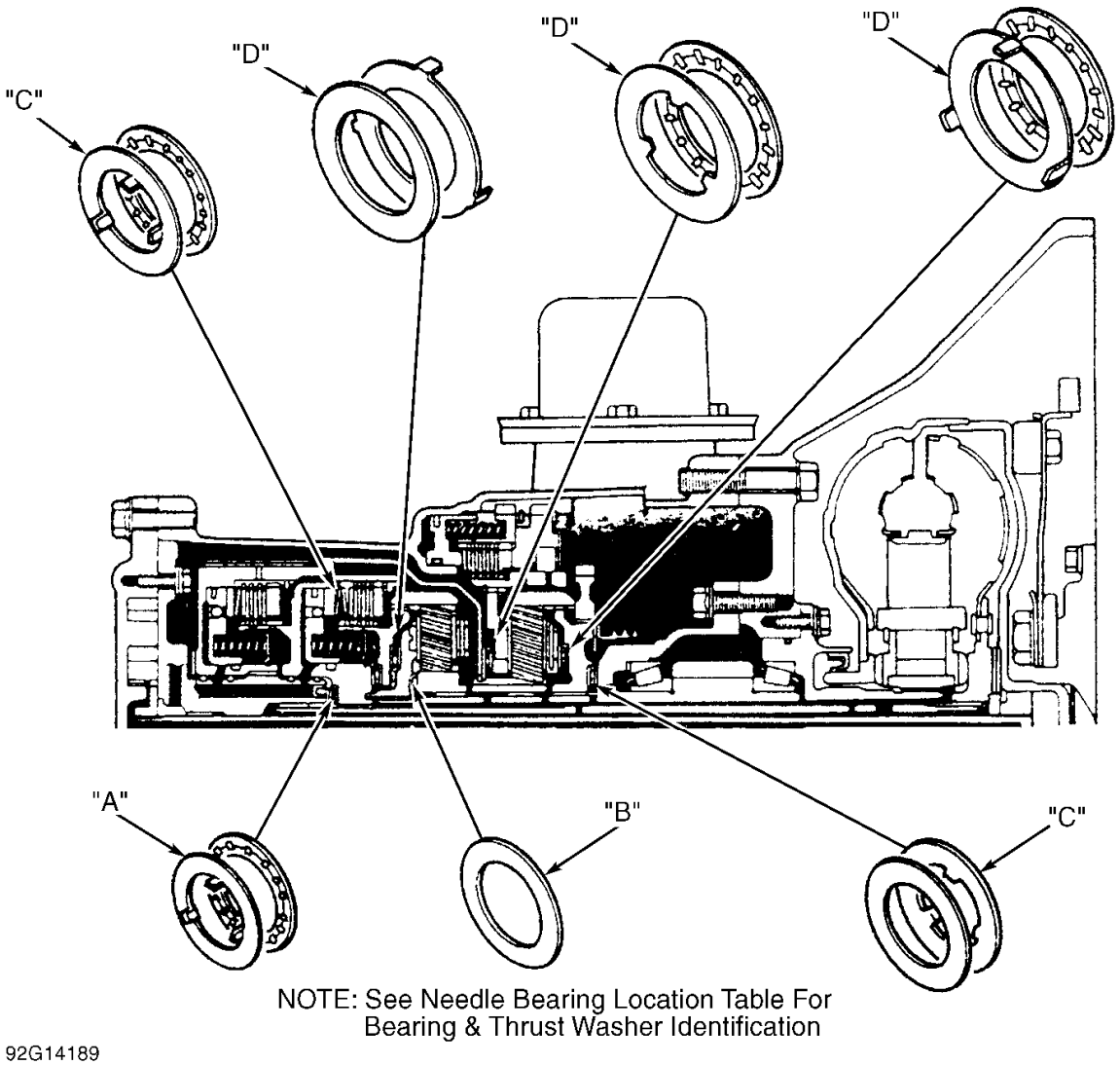


Fig. 27: Identifying Needle Bearings & Thrust Washers
Courtesy of FORD MOTOR CO.

NEEDLE BEARING LOCATION

Application	Dimension In. (mm)
Needle Bearing	
"A"	1.650 (41.90)
"B"	1.846 (46.90)
"C"	2.083 (52.90)
"D"	2.752 (69.90)
Thrust Washer	
"A"	1.614 (41.00)
"C"	2.028 (51.50)
"D"	2.756 (70.00)

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Axle Nut	116-174 (157-235)
Ball Joint Clamp Bolt	40-50 (54-68)
Idler Gear Lock Nut	94-130 (127-176)
Lug Nut	65-87 (88-118)
Oil Pump-To-Transaxle Case	11-16 (15-22)
Output Bearing/Idler Support Bolt	14-19 (19-26)
Output Shaft/Stator Support Bolt	8-10 (11-14)
Ring Gear	51-62 (69-83)
Torque Converter-To-Drive Plate	25-36 (34-49)
Transaxle Case-To-Converter Housing	22-34 (29-46)
INCH Lbs. (N.m)	
Governor Cover Bolts	71-97 (8-11)
Oil Pan Bolts	71-97 (8-11)
Oil Pump Cover	97-124 (11-14)
Upper-To-Lower Valve Body	(1)
Valve Body Bolts	89 (10)
(1) See Fig. 19 .	

TRANSAXLE SPECIFICATIONS

Application	In. (mm)
-------------	----------

Differential Backlash	.004 (.01)
Front Clutch Drum Bushing Diameter	1.735 (44.08)
Front Clutch Pack Clearance	.063-.071 (1.6-1.8)
Front Drum End Play	.020-.031 (.5-.8)
Front Planetary Pinion Clearance	.031 (.8)
Low/Reverse Clutch Pack Clearance	.032-.041 (.8-1.05)
Oil Pump Gear Clearance	.010 (.25)
Oil Pump Sealing Ring Clearance	.016 (.40)
Outer Gear-To-Housing Clearance (1)	.10 (.25)
Output Gear End Play	.003 (.08)
Rear Clutch Pack Clearance	.031-.039 (.8-1.0)
Rear Planetary Pinion Clearance	.031 (.8)
(1) Oil pump outer gear.	

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TRANSMISSION REMOVAL & INSTALLATION - A/T

1988-93 TRANSMISSION SERVICING Ford Motor Co. Transmission Removal & Installation

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Applications	Ft. Lbs. (N.m)
Crossmember Attaching Bolt	47-66 (64-89)
Engine-To-Transaxle Bolt	41-59 (55-80)
Front Engine Mount-To-Crossmember Nut	32-38 (43-52)
Front Wheel Lug Nuts	65-87 (88-118)
Gusset Plate-To-Transaxle Bolt	27-38 (37-52)
Left Stabilizer Body Bracket Nut/Bolt	40-45 (54-61)
Lower Control Arm Clamp Nut/Bolt	32-40 (43-54)
Manual Shift Lever Shaft Assembly Nut	32-47 (44-64)
Rear Engine Mount-To-Crossmember Nut	21-34 (28-46)
Stabilizer Bracket Mounting Nut	40-45 (54-61)
Tie Rod End-To-Knuckle Nut	26-30 (35-40)
Torque Converter Bolt	25-36 (34-49)
INCH Lbs. (N.m)	
Flywheel Cover Bolt	62-89 (7-10)
Line Pressure Plug	44-89 (5-10)
Shift Cable Retainer Bolts	71-97 (8-11)

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TRANSMISSION SERVICING - A/T

1988-93 TRANSMISSION SERVICING Ford Motor Co. Automatic Transmission

IDENTIFICATION

AUTOMATIC TRANSMISSION APPLICATIONS

Model	Transmission
Festiva	ATX/3HAT

LUBRICATION

SERVICE INTERVALS

Check fluid level at every engine oil change. Fluid, filter changes and band adjustments are not required under normal operation. Under severe service operating conditions, change fluid every 30 months or 30,000 miles. Adjust band when fluid is changed.

CHECKING FLUID LEVEL

With transmission at normal operating temperature, place vehicle on level surface. Apply parking brake and run engine at idle. Run gearshift lever through all positions, ending in Park. With engine running, fluid level should be between "F" and "L" marks. **DO NOT** overfill.

RECOMMENDED FLUID

Use Dexron-II ATF.

FLUID CAPACITIES

NOTE: Capacities given are approximate refill amounts that apply to overhaul situation. Correct fluid level should be determined by mark on dipstick.

TRANSMISSION REFILL CAPACITIES

Application	Qts. (L)
ATX/3HAT	5.6 (5.3)

DRAINING & REFILLING

1. Remove undercover and side cover to gain access to transaxle oil pan. Remove drain plug and drain fluid. Remove oil pan and discard gasket. Clean or replace filter screen as necessary. Tighten screen bolts to 71-97 INCH lbs. (8-11 N.m).

CAUTION: DO NOT use any type of gasket sealer or RTV on oil pan gasket. DO NOT overtighten.

2. Install oil pan bolts. Tighten bolts to 44-71 INCH lbs. (5-8 N.m). On all models, install drain plug with NEW washer. Tighten plug to 29-40 ft. lbs. (39-54 N.m).
3. Install undercover and side cover. Add about 3 qts. of specified ATF through dipstick guide tube. **DO NOT** overfill. Run engine to normal operating temperature and check fluid level.

ADJUSTMENTS

NEUTRAL SAFETY SWITCH

Combination neutral safety and back-up light switch is screwed into transaxle case. No adjustments are necessary.

SHIFT CONTROL CABLE

CAUTION: After completing linkage adjustments, be sure neutral safety switch operates properly. With parking brake and service brakes applied, try to start engine in each gear position. Engine must crank only when gearshift lever is in Neutral and Park.

1. Disconnect negative battery cable. Remove shift console. Place shift lever in Park. Remove shift lever knob and lock nut. Remove 4 shift quadrant attaching screws.
2. Loosen shift cable adjuster nuts until they reach end of cable threads. See [Fig. 1](#) . Place shift lever in Park. Tighten lower adjustment nut until it lightly touches "T" joint, then tighten upper adjustment nut to 80-97 INCH lbs. (9-11 N.m).
3. Lightly press selector push rod and make sure guide pin clearance is correct. See [Fig. 2](#) . Check guide pin clearance when shift lever is in Neutral and Drive. Readjust shift cable as necessary.
4. Install 4 shift quadrant attaching screws, shift lever knob, lock nut and shift console. Connect negative battery cable.

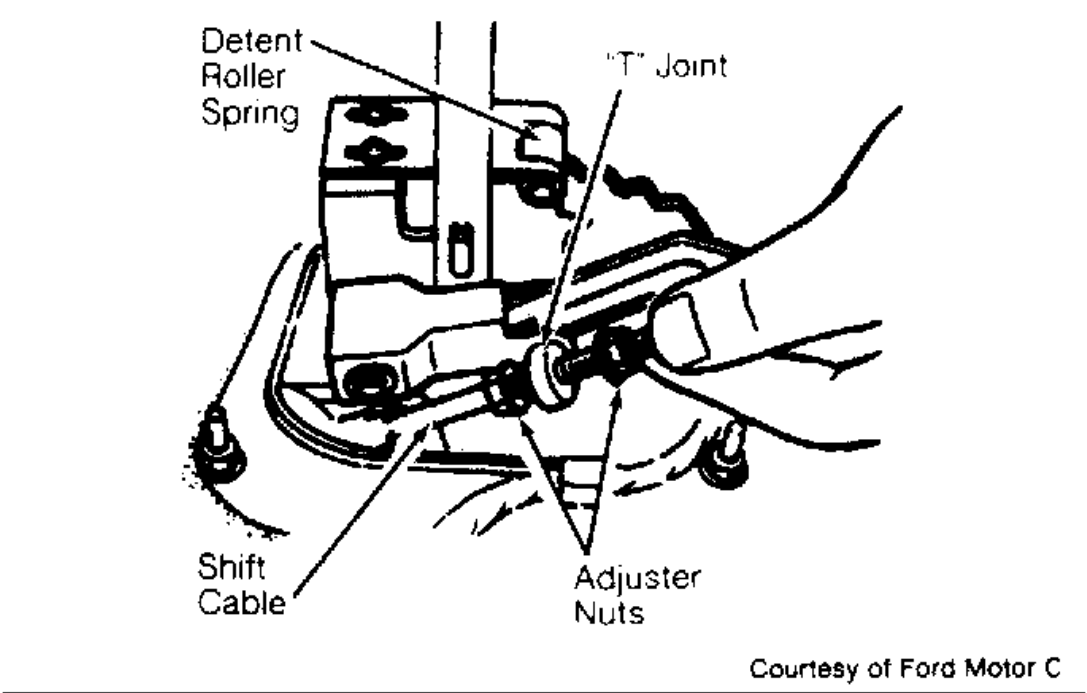


Fig. 1: Adjusting Shift Cable
Courtesy of FORD MOTOR CO.

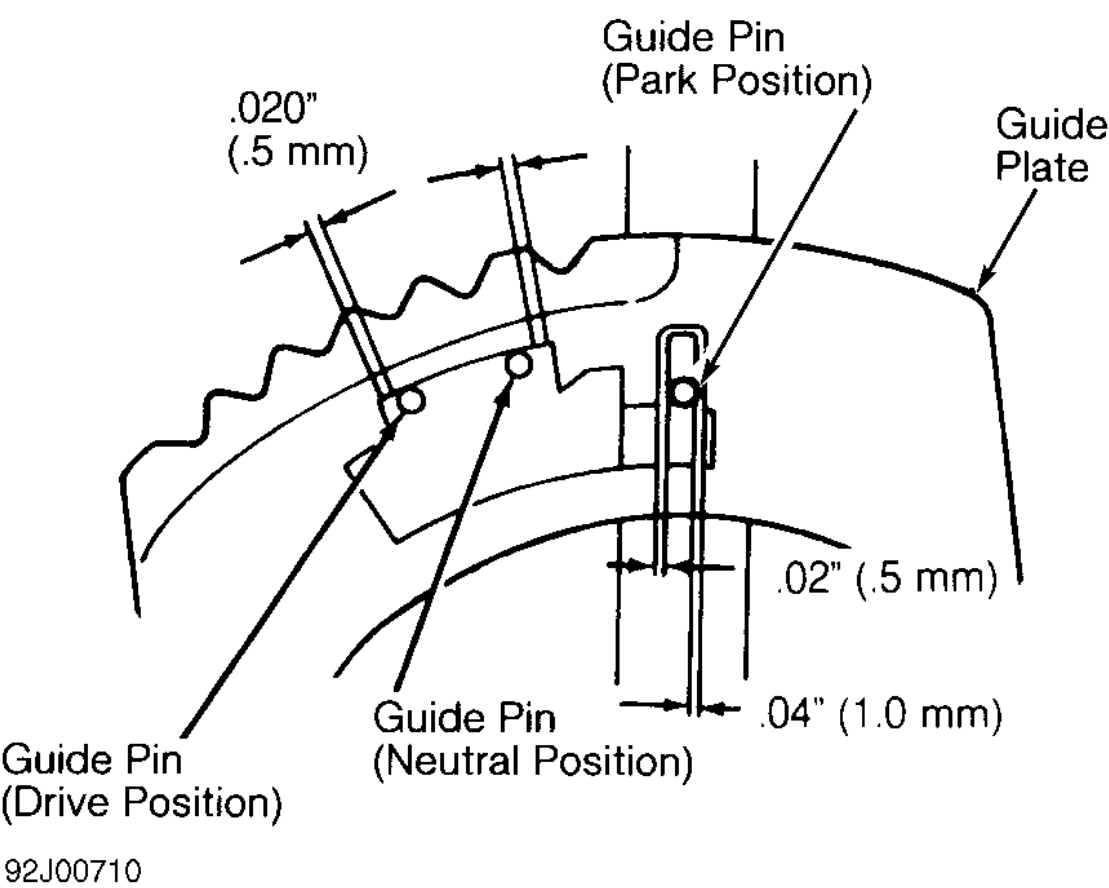


Fig. 2: Checking Guide Pin Clearances
Courtesy of FORD MOTOR CO.

INTERMEDIATE BAND ADJUSTMENT

1. Loosen adjuster bolt lock nut. See [Fig. 3](#) . Tighten adjuster bolt to 9-11 ft. lbs. (12-15 N.m). Back out adjuster bolt exacty 3 turns.
2. Holding adjuster bolt, tighten lock nut to 41-59 ft. lbs. (56-80 N.m).

NOTE: Adjuster bolt threads are coated with Sealant (E1FZ-19562-A) at factory. Ensure sealer is still on bolt after adjustment.

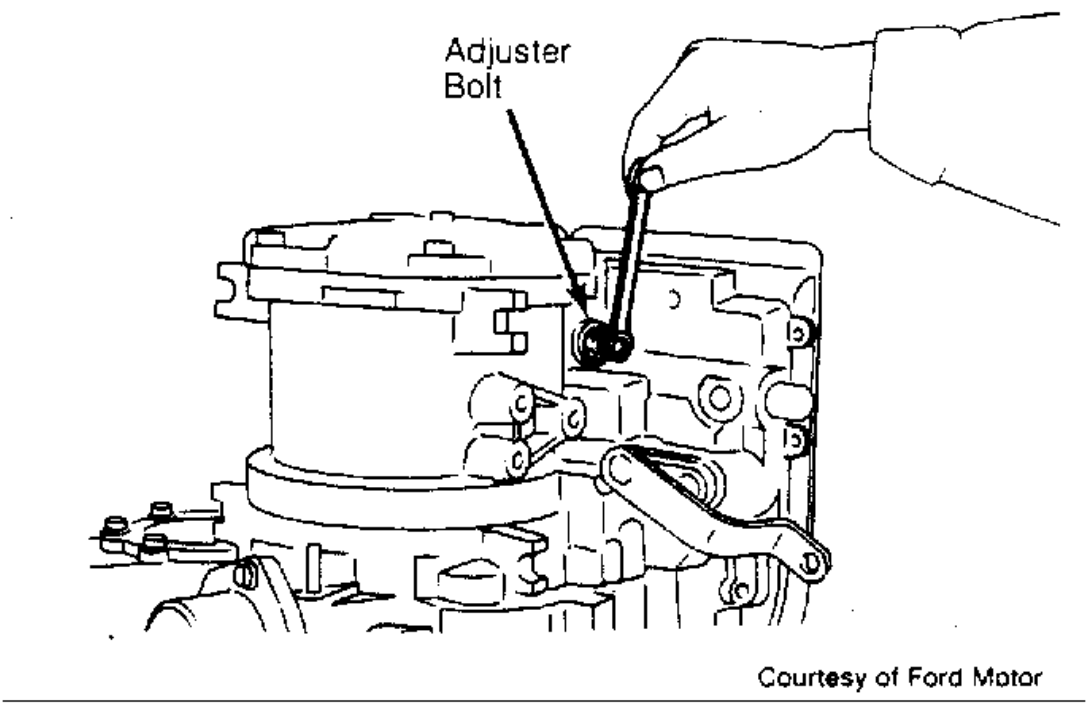


Fig. 3: Adjusting Intermediate Band
Courtesy of FORD MOTOR CO.

KICKDOWN CONTROL ADJUSTMENT

- 1. Kickdown is controlled by solenoid on bottom of transaxle case. Solenoid is actuated by a kickdown switch on accelerator pedal bracket.
- 2. To adjust switch, attach circuit tester to each terminal of switch. Loosen switch lock nut. Adjust switch so that there is continuity when accelerator pedal is depressed 7/8 or more of its full travel.

SHIFT QUADRANT

- 1. Remove shift lever knob. Remove console attaching screws. Place shift lever in Park. Remove shift lever knob and lock nut. Remove shift quadrant. Align holes in slider and shift quadrant. Install an alignment pin to hold slider in position.
- 2. Install quadrant and remove alignment pin. Ensure clearance between lock lever and emergency override lever is correct. See [Fig. 4](#) . Install lock nut and shift lever knob. Tighten lock nut to 11-15 ft. lbs. (15-20 N.m). Install console.

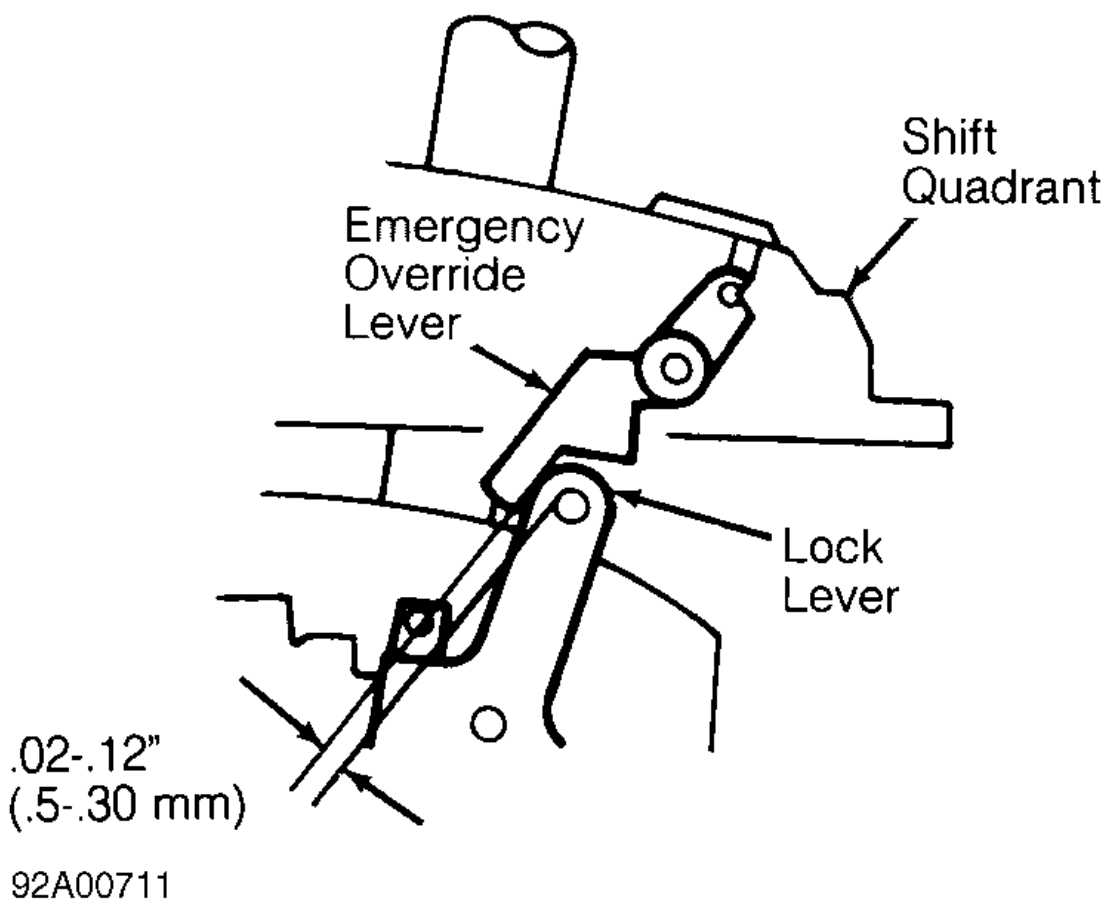


Fig. 4: Checking Lock Lever Clearance
Courtesy of FORD MOTOR CO.

DOWNSHIFT SWITCH

1. Inspect wiring and components for shorts, corrosion, overheating, loose connections, or any other damage. Check 10-amp METER fuse. Disconnect downshift solenoid.
2. With key off, voltage measured at Black/**Blue** wire should be zero volts. With key on and accelerator pedal fully depressed, voltage should be greater than 10 volts. If Black/**Blue** wire is okay, remove downshift solenoid.
3. Apply battery voltage to downshift solenoid connector and ground case. Control rod should move freely when solenoid case is grounded. If control rod does not move freely, replace downshift solenoid.

VACUUM DIAPHRAGM ROD

If transaxle shift points are incorrect, check for a defective vacuum diaphragm and replace if necessary. If diaphragm is operating correctly, check length of diaphragm rod using Vacuum Diaphragm Rod Gauge (T87C-77000-A). Measure dimension "N." See [Fig. 5](#) . Select proper length diaphragm rod. See [VACUUM DIAPHRAGM ROD SELECTION](#) table.

VACUUM DIAPHRAGM ROD SELECTION

Dimension "N" In. (mm)	Rod Length In. (mm)
Below 1.000 (25.4)	1.16 (29.5)
1.000-1.020 (25.4-25.9)	1.18 (30.0)
1.020-1.039 (25.9-26.4)	1.20 (30.5)
1.039-1.059 (26.4-26.9)	1.22 (31.0)
Over 1.059 (26.9)	1.24 (31.5)

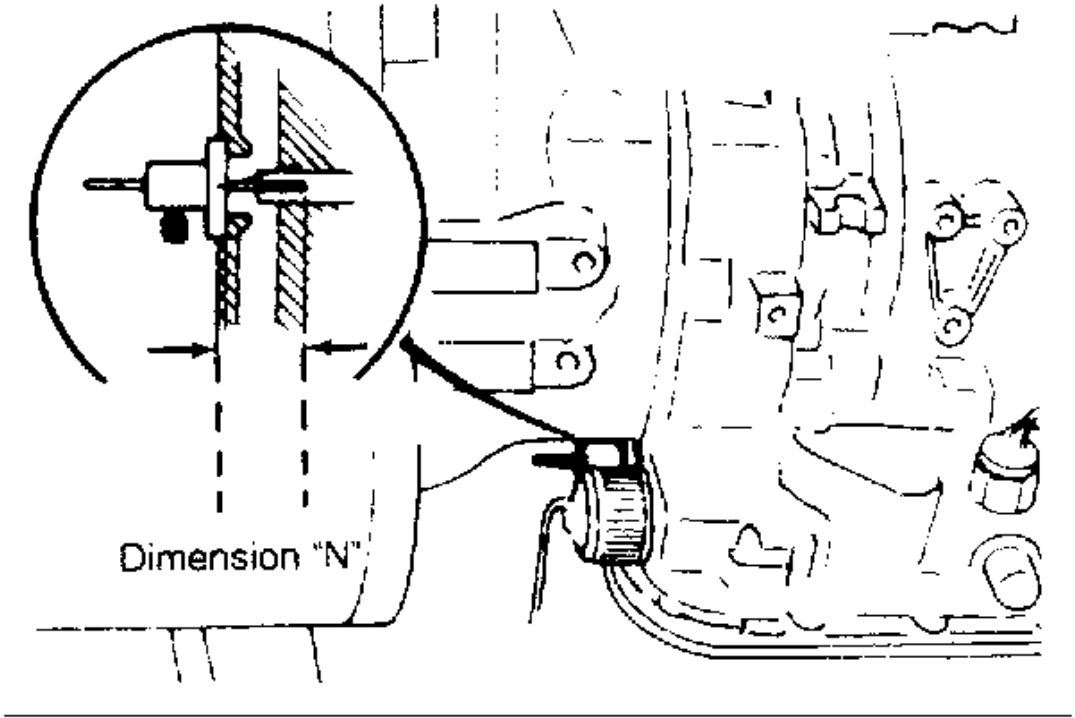


Fig. 5: Adjusting Vacuum Diaphragm Rod Length
Courtesy of MAZDA MOTORS CORP.

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CLUTCH

1988-93 Clutch

DESCRIPTION

The clutch is single-disc type, using a diaphragm spring to engage pressure plate. Clutch operation is controlled by a mechanical release system consisting of clutch pedal, cable, release lever and release bearing.

ADJUSTMENTS

CLUTCH PEDAL FREE PLAY

1.
- Measure clutch pedal movement from parked position to first indication of clutch application. See [Fig. 1](#) . Free play must be within specifications. See [CLUTCH PEDAL SPECIFICATIONS](#) .

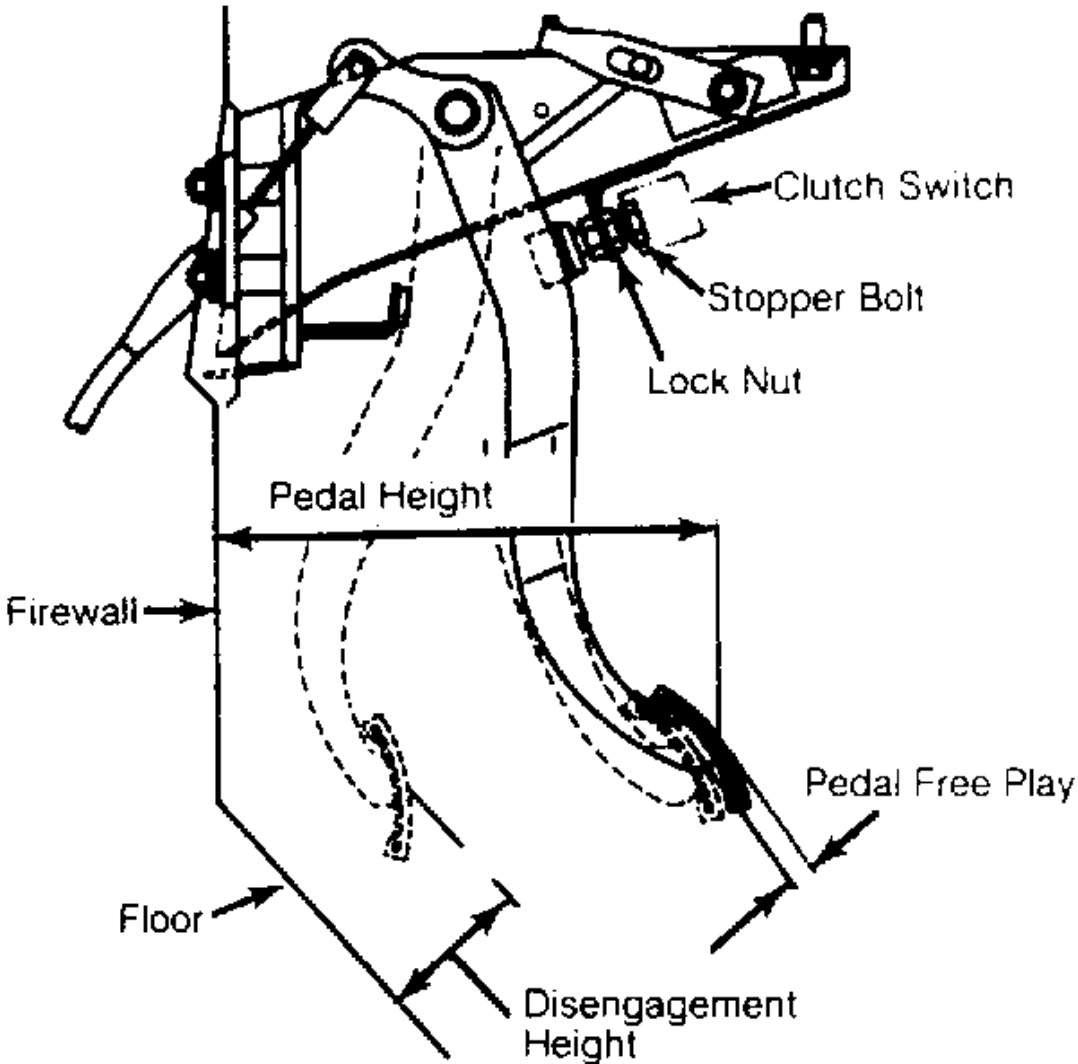


Fig. 1: Adjusting Clutch Pedal
Courtesy of FORD MOTOR CO.

2.
- If free play is not within specification, rotate clutch cable adjustment nut at release lever to obtain correct pedal free play. See [Fig. 2](#) .

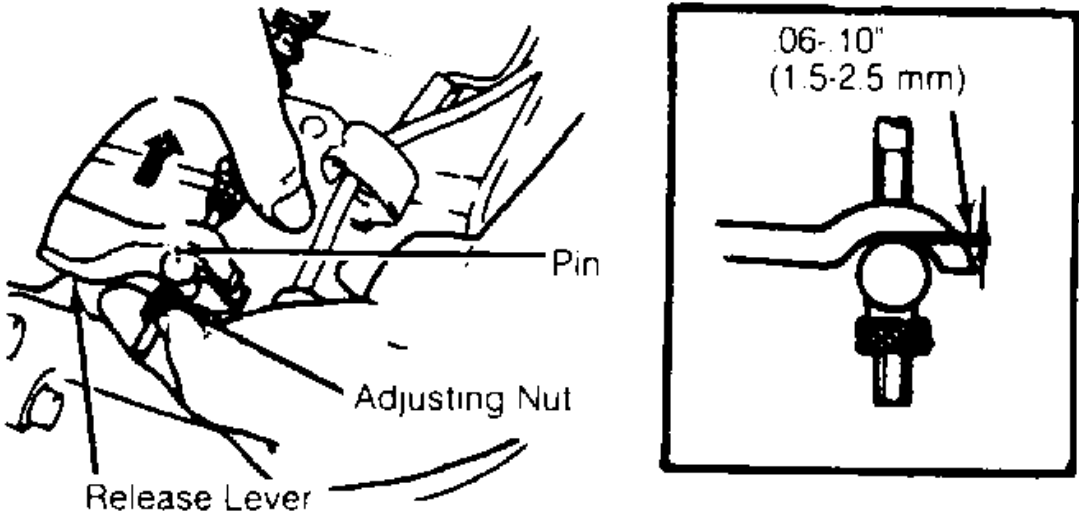


Fig. 2: Checking Release Lever Clearance
Courtesy of FORD MOTOR CO.

CLUTCH PEDAL SPECIFICATIONS

Application	In. (mm)
Pedal Height	8.2-8.4 (208.2-213.2)
Free Play	.35-.59 (9-15)
Release Lever-To-Pin	.06-.10 (1.5-2.5)
Disengagement Height	3.3 (84)

CLUTCH PEDAL HEIGHT

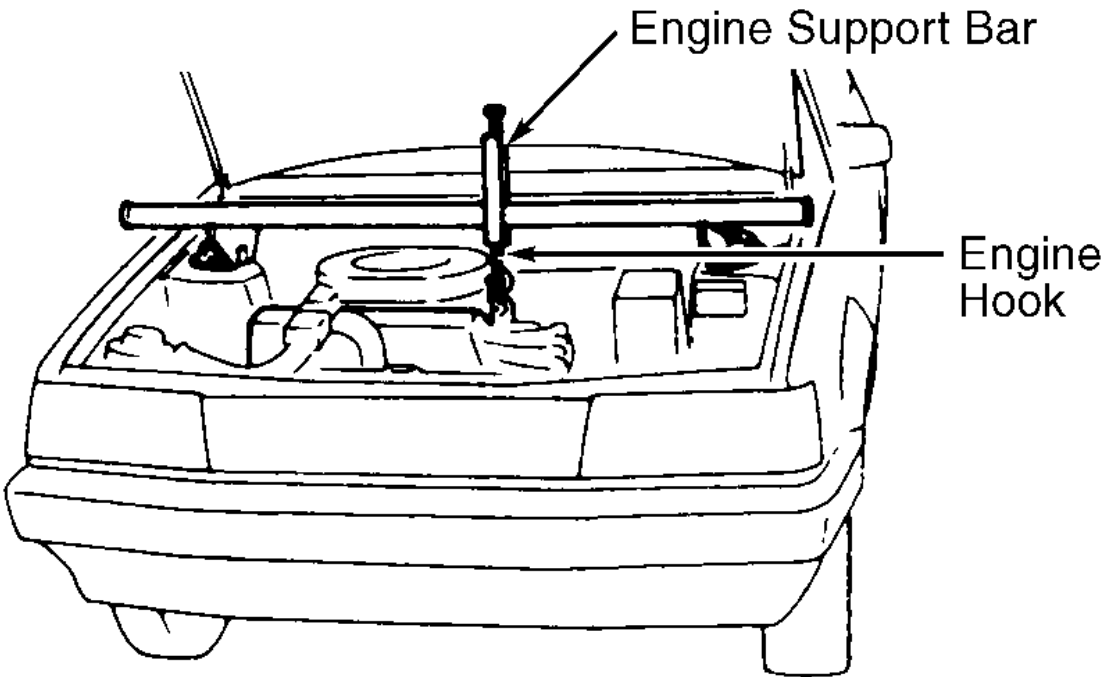
1. Disconnect clutch cable from release lever at transaxle. Measure distance from upper center of pedal to firewall. See [Fig. 1](#) . If not within specifications, check pedal mounting for wear or damage. See [CLUTCH PEDAL SPECIFICATIONS](#) .
2. If adjustment is required, remove instrument panel bracket and air duct located under steering column. Loosen clutch pedal switch lock nut and rotate switch until correct clutch pedal height is obtained.
3. Install clutch cable at transaxle. Recheck pedal height. If connecting clutch cable changes pedal height, check cable for improper routing, binding or adjustment. If connecting push rod changes pedal height, check for proper push rod adjustment. Install carpet and insulation to complete adjustment.

REMOVAL & INSTALLATION

CLUTCH ASSEMBLY

Removal

1. Disconnect negative battery cable. Loosen clutch cable adjuster nut and disengage cable from release lever.
2. Remove starter. Disconnect back-up light switch and neutral switch. Disconnect ground cable/strap and supporting brackets. Disconnect speedometer cable from transaxle.
3. Install Three Bar Engine Support (D88L-6000-A) to engine hanger. See [Fig. 3](#) . Remove top transaxle-to-engine bolts. Raise vehicle. Remove bolt and nut retaining shift rod to input shift rail. Drain transaxle fluid. Remove all support brackets attached to transaxle. Remove front wheels.



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Fig. 3: Installing Engine Support Bar (Festiva Similar)
Courtesy of FORD MOTOR CO.

4. Remove engine splash shields. Remove front stabilizer bar. Disengage right and left side drive axle shafts from transaxle and support out of the way. See the [AXLE SHAFTS - FRONT](#) article in the DRIVE AXLES section.
5. Remove exhaust hanger from crossmember. Remove crossmember bolts in sequence, and remove crossmember. On Festiva, remove crossmember mounting bracket and crossmember. Remove transaxle end plate bolts.
6. Place transmission jack under transaxle, ensuring it is secure. Remove remaining flywheel housing bolts. Lower transaxle by loosening engine bracket bar hook bolt. Pull transaxle away from engine and lower from vehicle.

CAUTION: **DO NOT allow oil or grease to contact clutch disc face or mating surfaces. Handle disc by edges. DO NOT touch face.**

7. If reusing pressure plate, mark pressure plate-to-flywheel position for installation reference. Remove pressure plate retaining bolts evenly. See [Fig. 4](#) . To avoid dropping clutch assembly while removing bolts install clutch aligner. Remove pressure plate, clutch disc and clutch aligner. Remove flywheel. Remove pilot bearing from flywheel (if replacing).

Inspection

1. Check pressure plate surfaces for scoring, cracks or discoloration. Remove minor scratches or discoloration with fine emery cloth. Check pressure plate diaphragm spring fingers for discoloration, scoring, broken or bent segments. Ensure all spring ends are the same height.
2. Check clutch disc lining surface for hardening or presence of oil. Check for worn clutch disc lining. Check for loose lining rivets. Measure depth of rivet heads. Minimum allowable rivet depth is .012" (0.3 mm). Check for wear or rust on splines. Rust may be removed with emery cloth.
3. Check flywheel surface for marks, scoring or discoloration. Minor surface repairs may be removed with fine emery cloth. Flywheel must be machined if scoring, runout, or discoloration is excessive. Maximum flywheel runout is .008" (0.2 mm). Check for damaged or worn ring gear teeth.
4. Check pilot bearing for wear. Check clutch release/throw out bearing for damage or wear at contact points. Rotate bearing in both directions and check for binding or abnormal noise.

Installation

1. Replace release bearing and/or pilot bearing as necessary. Clean sealant from flywheel attaching bolt threads. Replace bolts if sealant cannot be removed. Coat bolt threads with Stud/Bearing Mount Sealer (EOAZ-19554-B), and install flywheel. Tighten bolts in a diagonal sequence to specification. See [TORQUE SPECIFICATIONS](#) at the end of this article.
2. Position clutch disc on flywheel with damper springs facing away from flywheel. Hold clutch disc in place with Clutch Aligner (T77F-7137-A). Position pressure plate over clutch disc. See [Fig. 4](#) .
3. If reusing original pressure plate, align marks made during removal. Install pressure plate retaining bolts. Alternately tighten bolts to specification. See [TORQUE SPECIFICATIONS](#) at the end of this article. Remove clutch aligner. Place transaxle on transmission jack.
4. Lightly coat input shaft splines with Clutch Grease (C1AZ-19590-B). Install transaxle, taking care to align input shaft through the clutch disc spline. Align clutch housing onto engine guide bushings.

CAUTION: Transaxle aluminum alloy construction requires precise tightening of mounting bolts. Torque specifications must be strictly adhered to. See [TORQUE SPECIFICATIONS](#) .

5. Install transaxle lower attaching bolts and tighten to specification. Using transaxle jack, raise transaxle to correct height and tighten engine bracket bar hook. Install front engine mount and bracket and tighten to specification. Install starter and lower mounting bolts, tighten to specification.
6. Install control rod to transaxle and tighten bolts and nuts to specification. On Festiva, install crossmember and support braces. Install support braces. On all models, install exhaust hanger to crossmember. Remove transaxle jack.
7. Install new circlips on each half-shaft with gap at top of clip groove and slide into transaxle differential. After circlip snaps into place, pull outward on hubs to confirm half-shafts are retained by circlip. Install front suspension components, wire harness, underbody and fender splash shields and front tire assemblies.
8. Connect neutral and back-up light switch and ground wire. Fill transaxle with Mercon ATF transmission fluid to specification. Install and adjust clutch cable or slave cylinder line bracket. Lower vehicle and remove engine support bar. Install speedometer cable into transaxle.
9. Install battery and/or connect battery cable. Install air cleaner. Adjust pedal free play. See [CLUTCH PEDAL FREE PLAY](#) under ADJUSTMENTS. Recheck transaxle fluid level and road test vehicle.

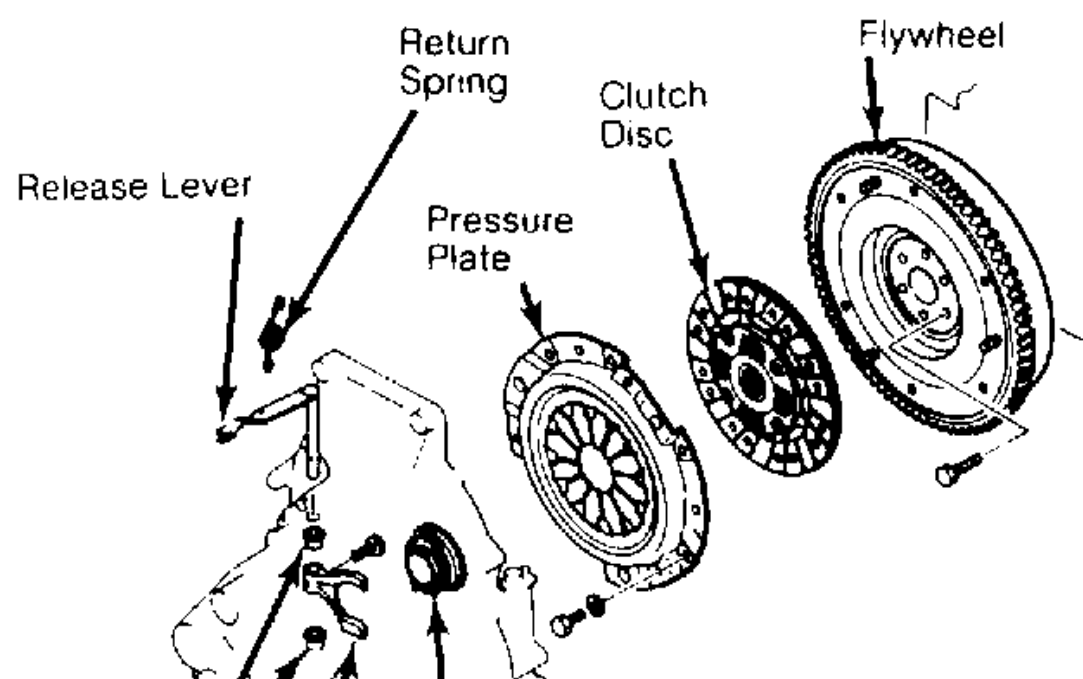


Fig. 4: Exploded View Of Clutch Assembly
Courtesy of FORD MOTOR CO.

CLUTCH RELEASE BEARING & FORK

NOTE: The clutch release bearing is pre-lubricated and permanently sealed. DO NOT clean release bearing in solvent.

Removal

Remove transaxle. Remove release lever bolt and slide release bearing off. See [Fig. 4](#) . Remove release lever shaft and remove release lever.

Inspection

Check release bearing rotation operation for roughness, sticking and noise. Check release lever and transaxle front bearing retainer for wear or damage. Ensure bearing slides smoothly on transaxle input shaft. Check release lever shaft for bent, worn or damaged condition. Check all mating surfaces for wear or damage. Replace worn or defective components.

Installation

Apply light film of grease to transmission front bearing retainer lever-to-bearing surfaces and release lever contact surface. Align bolt hole in release lever and shaft. Apply Stud/Bearing Sealant (E0AZ-19554-B) to release lever bolt. Fill grease groove in release bearing hub and remove any excess grease. Install release lever return spring. To complete installation, reverse removal procedure.

PILOT BEARING

NOTE: **DO NOT remove pilot bearing unless necessary.**

Removal & Installation

Remove transaxle, pressure plate, clutch disc and flywheel. Drive pilot bearing out of flywheel using a driver that makes full contact with bearing outer race. Reverse procedure for installation.

CLUTCH CABLE

Removal & Installation

1.

Disconnect clutch cable from release lever. Remove nuts retaining clutch cable at firewall. Unhook clutch cable at clutch pedal.
2.

Remove clutch cable from engine compartment side. To install, apply lithium grease to pedal cable hook and joint between release lever and pin. Reverse removal procedure to complete installation. See [Fig. 2](#) .

OVERHAUL

NOTE: **Manufacturer does not provide overhaul information for clutch master cylinder and clutch release cylinder.**

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (Nm)
Clutch Cable Bracket Nuts	12-17 (16-23)
Clutch Pedal Push Rod Lock Nut	9-13 (12-17)
Clutch Pedal Through Bolt Nut	15-26 (20-35)
Crossmember	
"A" Bolts	47-66 (64-89)
"B" Bolt	21-34 (28-46)
Crossmember Brace (Front)	23-34 (31-46)
Crossmember Brace	69-86 (93-117)
Engine Mount Bolt (No. 2)	33-48 (45-65)
Engine-To-Transaxle	46-66 (63-89)
Flywheel Housing-To-Engine Bolt	46-66 (63-89)
Flywheel-To-Crankshaft Bolt	71-76 (96-103)
Front Wheel Lug Nut	66-89 (90-120)
Lower Ball Joint Pinch Bolt	32-40 (43-54)
Master Cylinder Retaining Nuts	14-19 (19-26)
Pressure Plate-To-Flywheel Bolt	13-20 (18-27)
Rear Engine Cover-To-Housing Bolt	28-38 (38-51)
Rear Mount-To-Transmission Bolt	50-70 (68-95)
Rear Transmission Mount-To-Body Bolt	25-35 (34-48)
Release Fork Attaching Bolt	26-30 (35-41)
Slave Cylinder Retaining Bolts	12-17 (16-23)
Stabilizer Bracket-To-Body Bolt	33-41 (45-56)
Starter Motor-To-Mount Bolt	23-34 (31-46)
Transaxle Drain Plug	29-40 (39-54)
INCH Lbs. (N.m)	
Release Lever Bolt	71-97 (8-11)
Speedometer Drive Gear Bolt	69-106 (7.8-12)

TRANSAXLE FLUID LEVELS

TRANSAXLE FLUID LEVELS

Application	Specification
Festiva	2.6 Qts. (2.5L)

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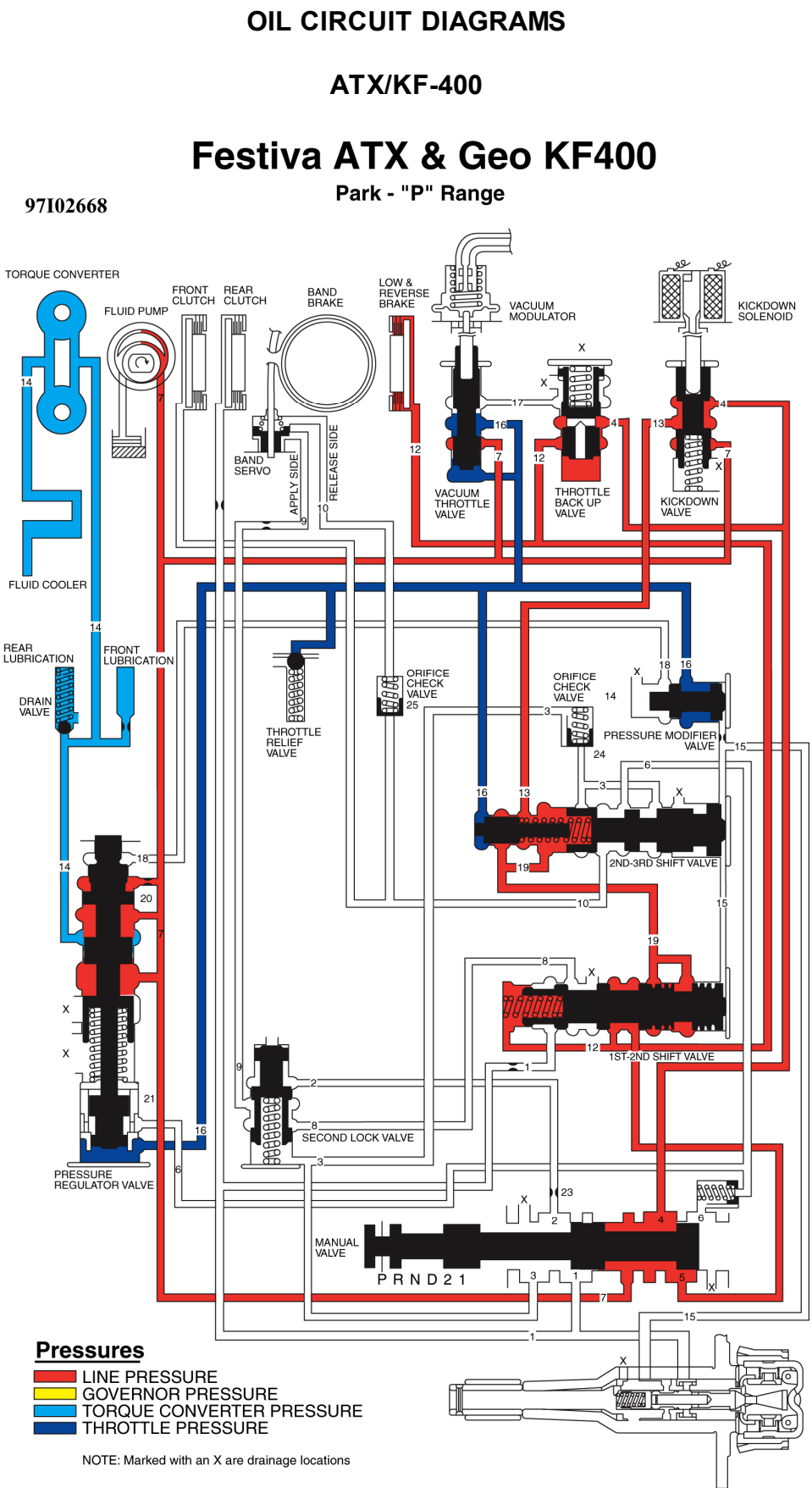


Fig. 1: Park - "P" Range

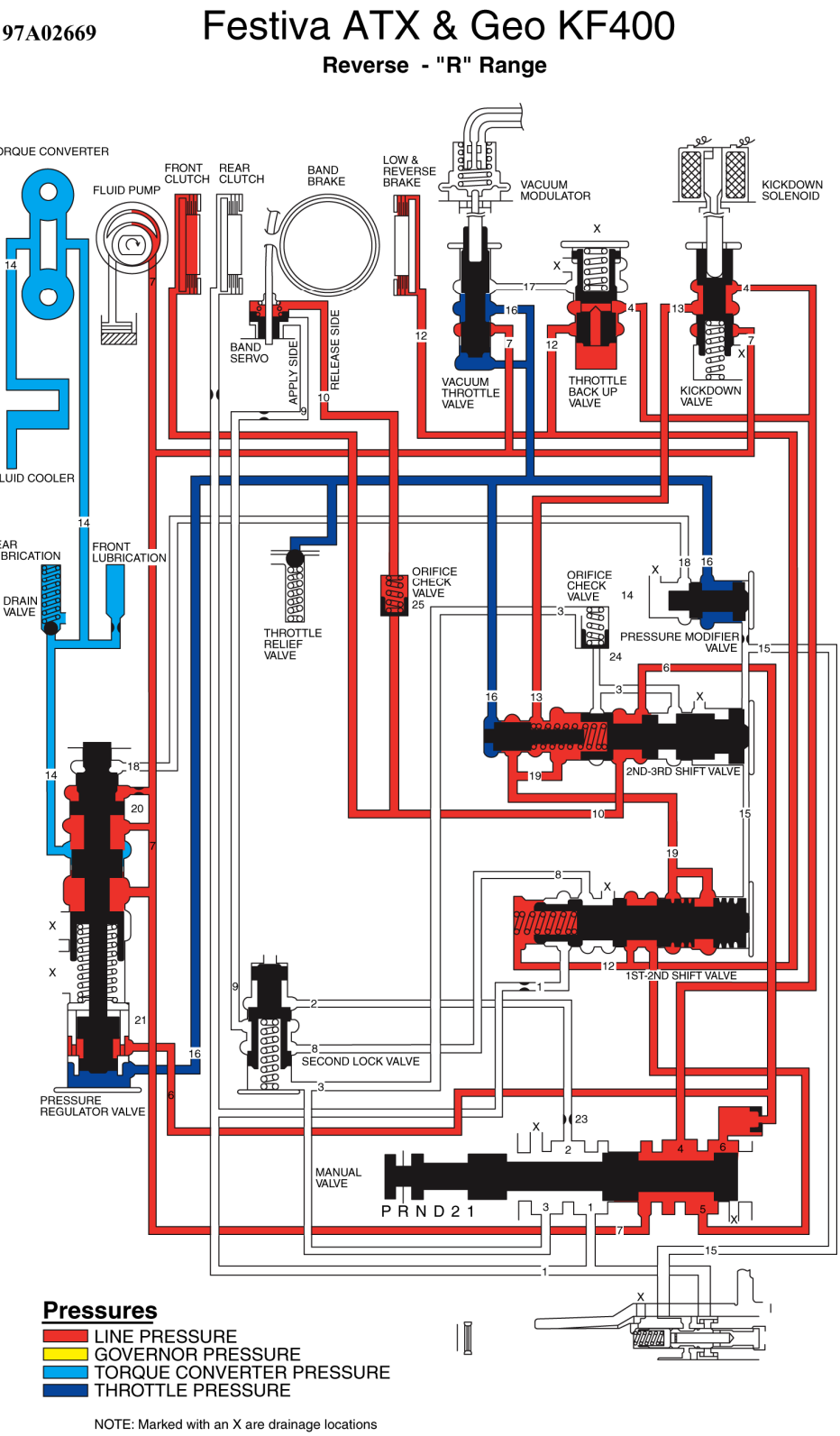


Fig. 2: Reverse - "R" Range

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Festiva ATX & Geo KF400
Neutral - "N" Range

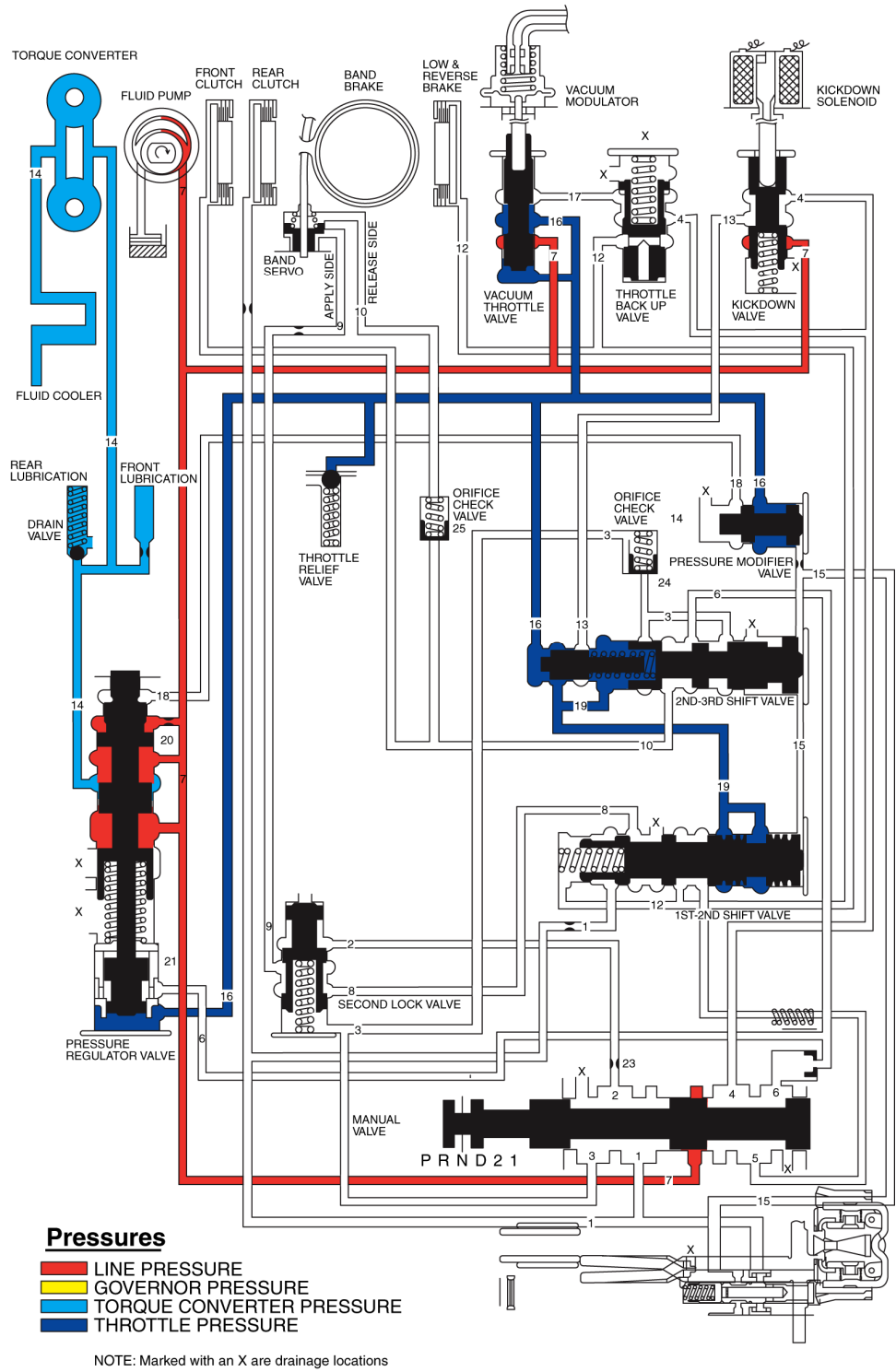


Fig. 3: Neutral - "N" Range

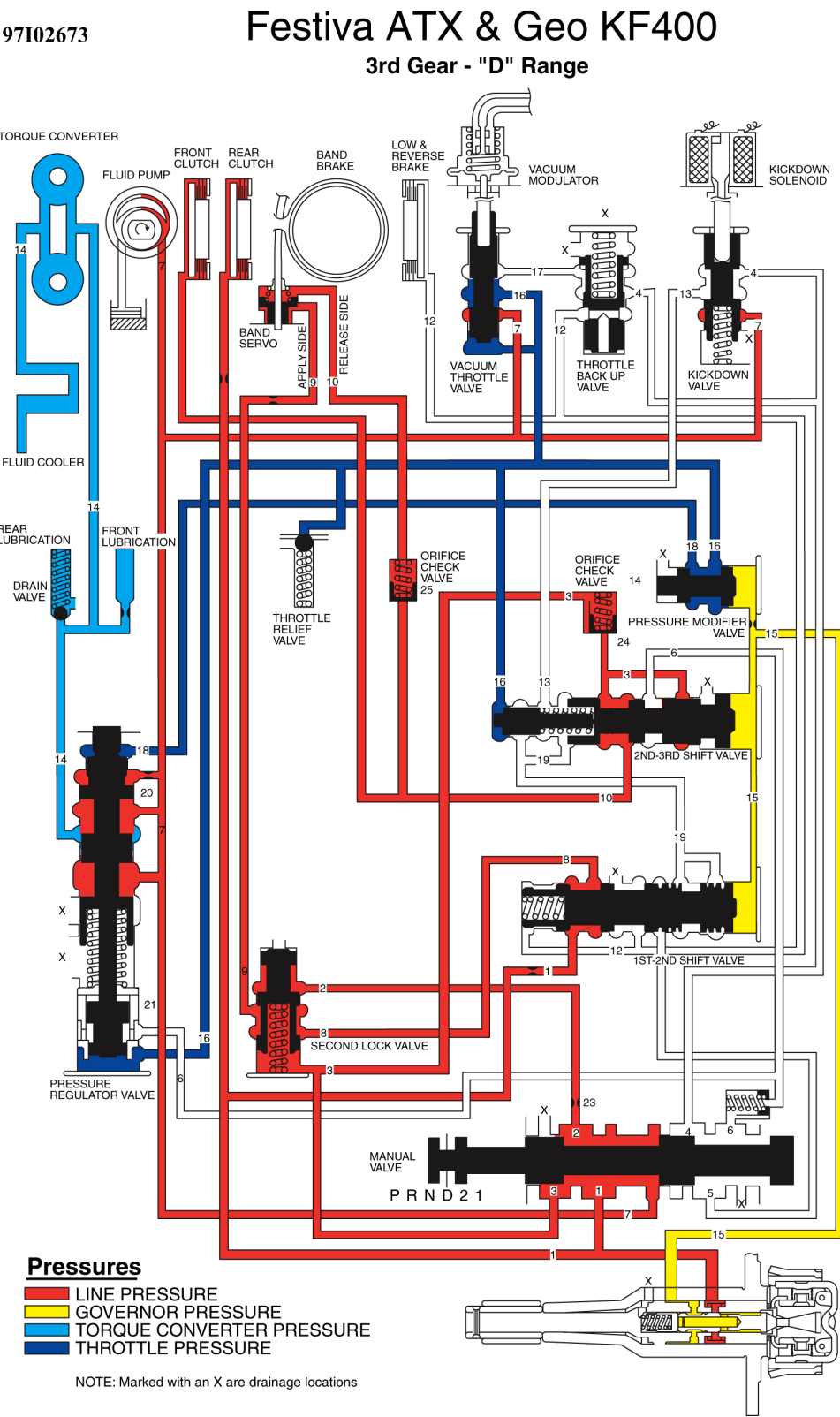


Fig. 4: 3rd Gear - "D" Range

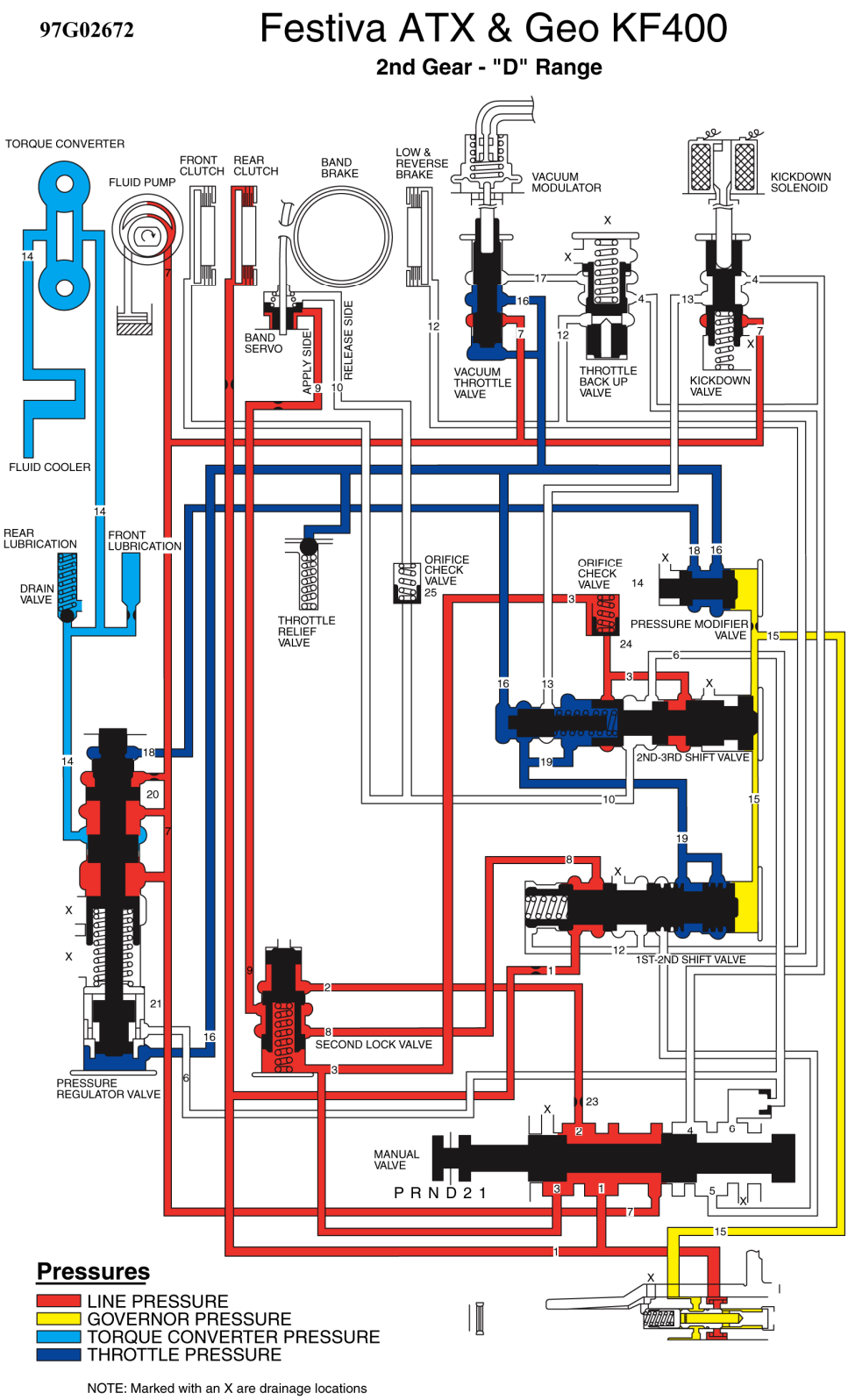


Fig. 5: 2nd Gear - "D" Range

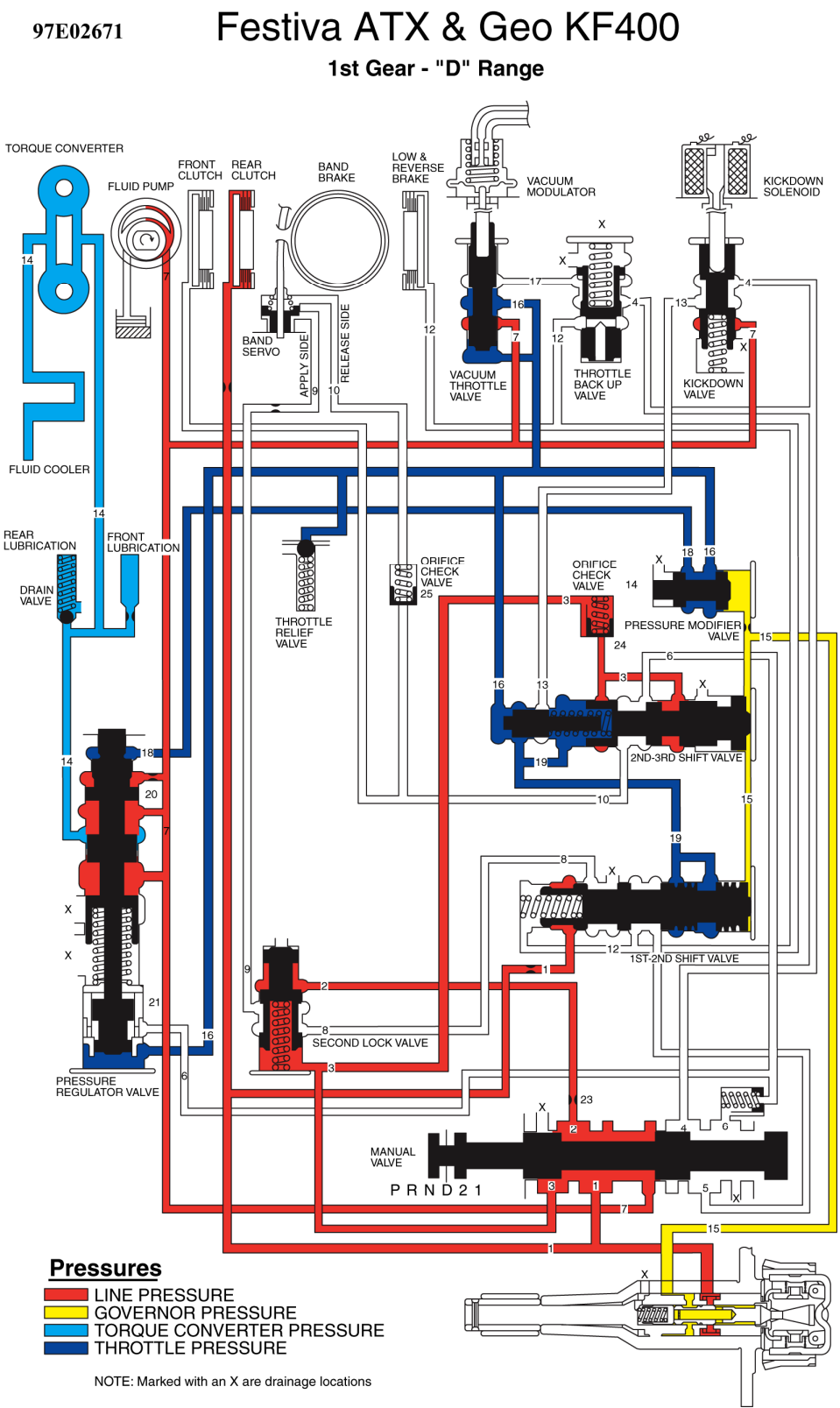


Fig. 6: 1st Gear - "D" Range

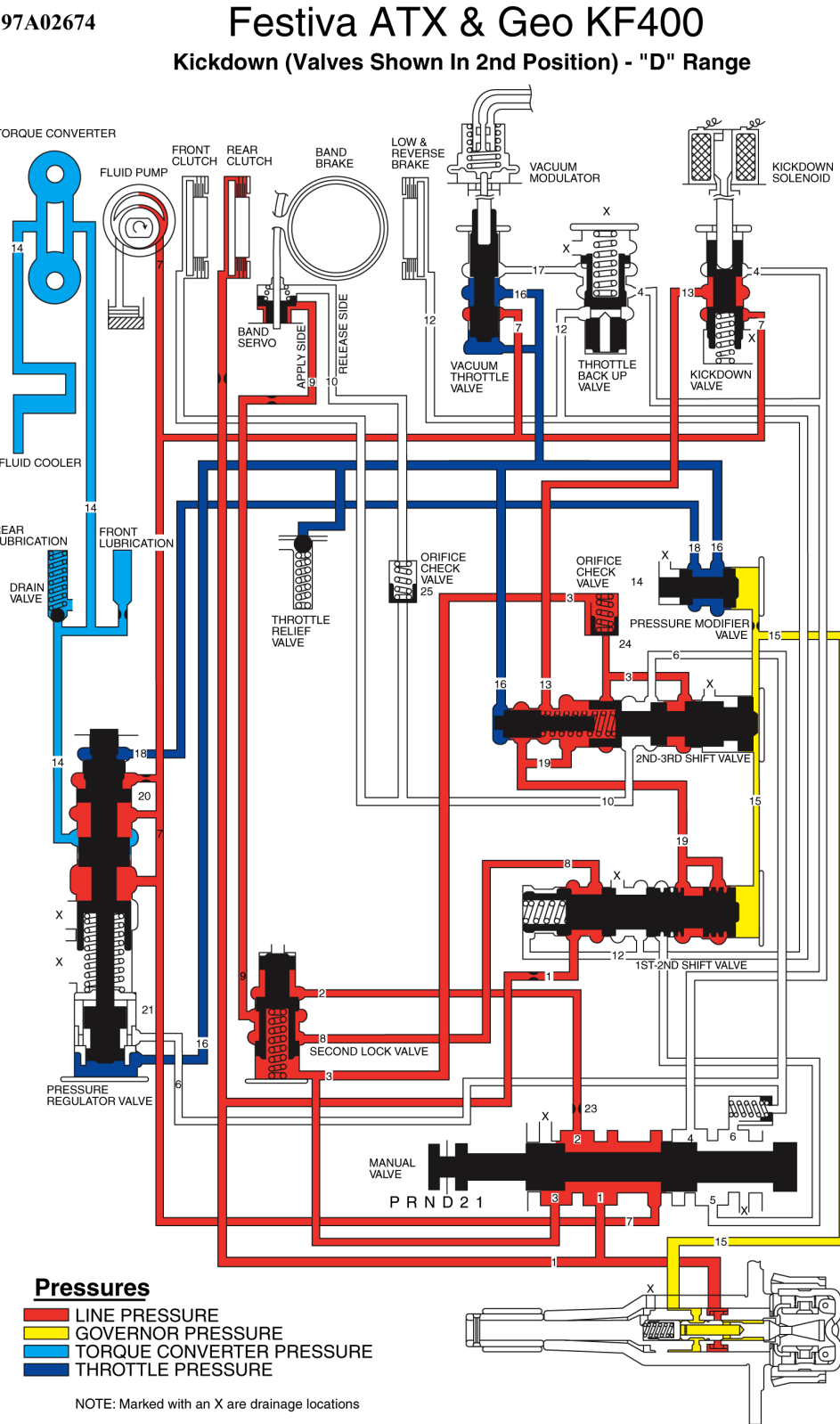


Fig. 7: Kickdown (Valve Shown In 2nd Position) - "D" Range

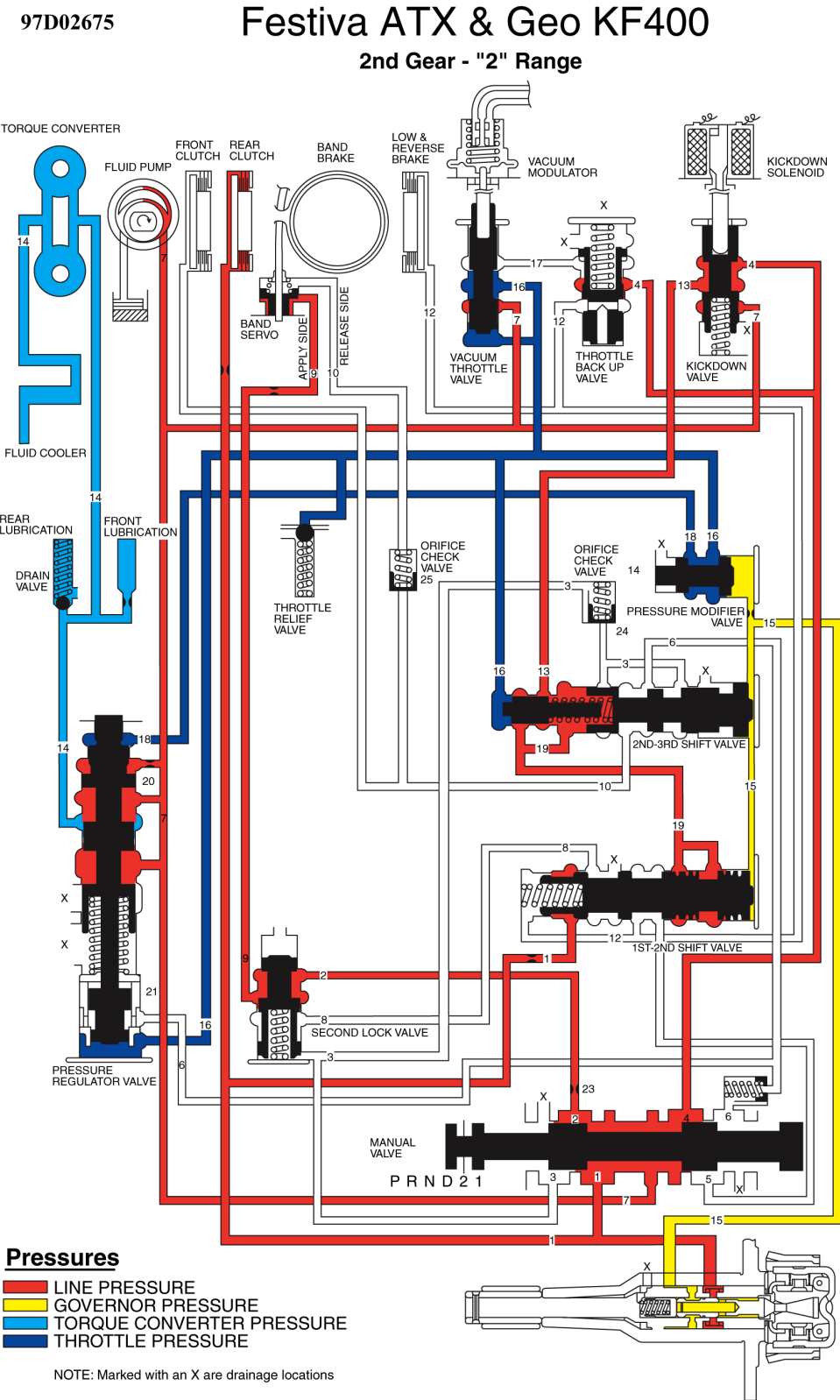


Fig. 8: 2nd Gear - "2" Range

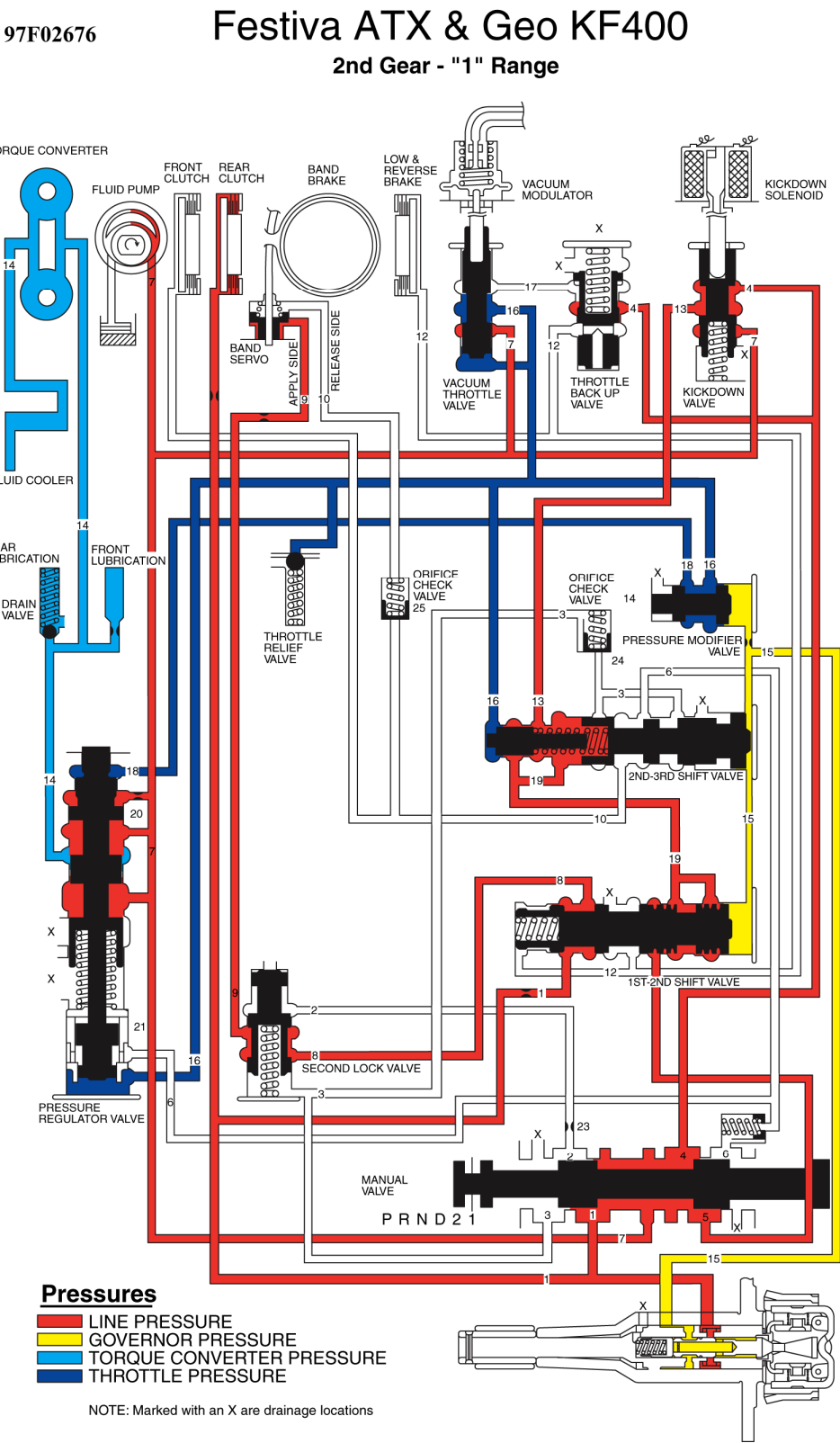


Fig. 9: 2nd Gear - "1" Range

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Festiva ATX & Geo KF400

Low Gear "1" Range

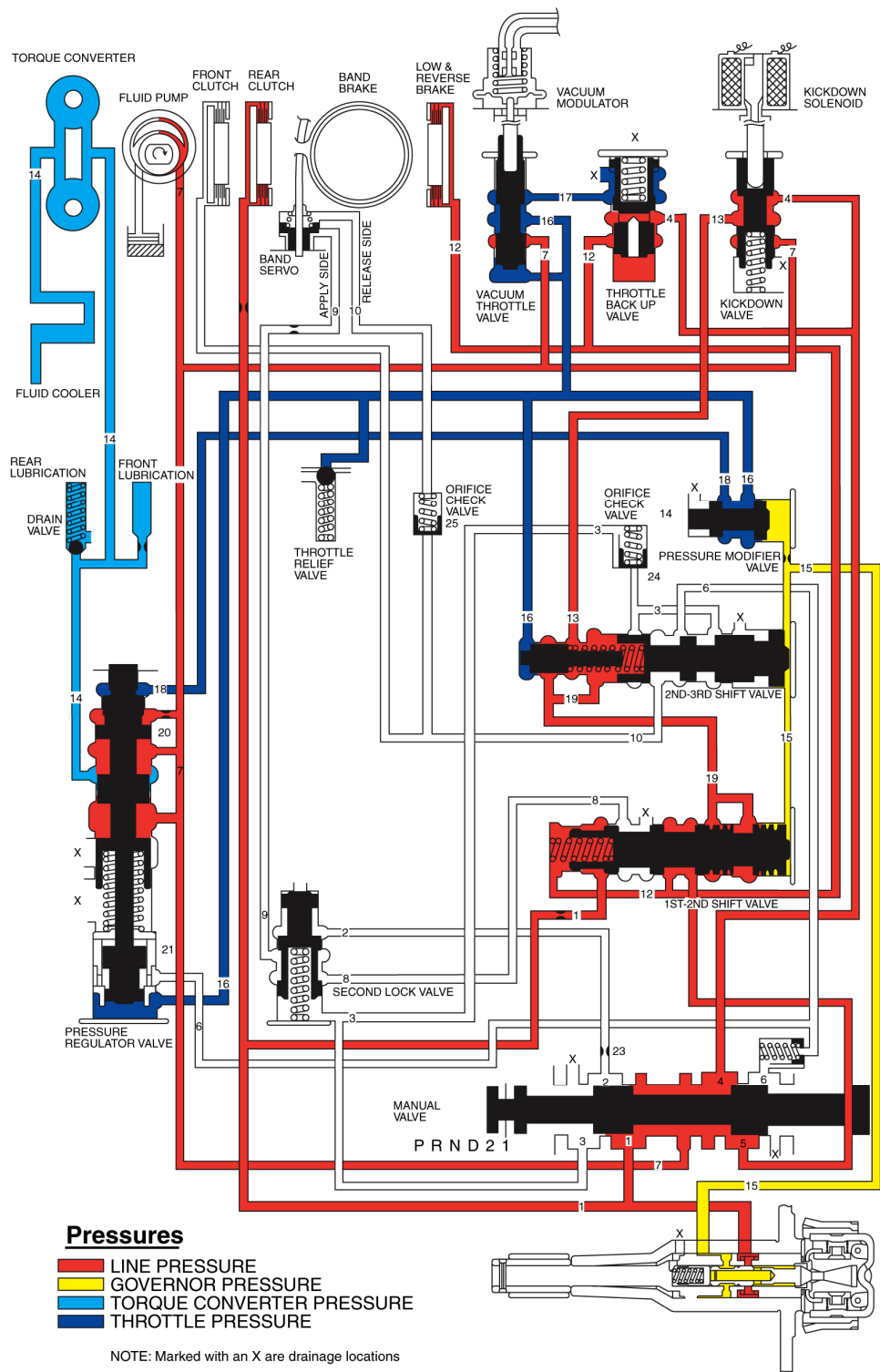


Fig. 10: Low Gear - "1" Range

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