

Troubleshooting



This section is designed to aid in the quick, accurate diagnosis of automotive problems. While automotive repairs can be made by many people, accurate troubleshooting is a rare skill for the amateur and professional alike.

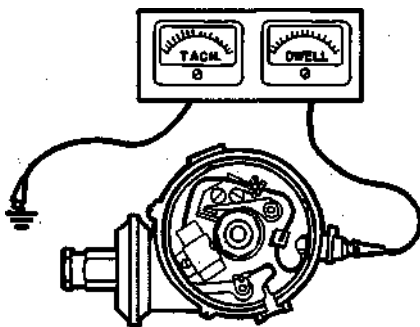
In its simplest state, troubleshooting is an exercise in logic. It is essential to realize that an automobile is really composed of a series of systems. Some of these systems are interrelated; others are not. Automobiles operate within a framework of logical rules and physical laws, and the key to troubleshooting is a good understanding of all the automotive systems.

This section breaks the car or truck down into its component systems, allowing the problem to be isolated. The charts and diagnostic road maps list the most common problems and the most probable causes of trouble. Obviously it would be impossible to list every possible problem that could happen along with every possible cause, but it will locate MOST problems and eliminate a lot of unnecessary guesswork. The systematic

format will locate problems within a given system, but, because many automotive systems are interrelated, the solution to your particular problem may be found in a number of systems on the car or truck.

USING THE TROUBLESHOOTING CHARTS

This book contains all of the specific information that the average do-it-yourself mechanic needs to repair and maintain his or her car or truck. The troubleshooting charts are designed to be used in conjunction with the specific procedures and information in the text. For instance, troubleshooting a point-type ignition system is fairly standard for all models, but you may be directed to the text to find procedures for troubleshooting an individual type of electronic ignition. You will also have to refer to the specification charts throughout the book for specifications applicable to your car or truck.



Tech-dwell hooked-up to distributor

TOOLS AND EQUIPMENT

The tools illustrated in Chapter 1 (plus two more diagnostic pieces) will be adequate to troubleshoot most problems. The two other tools needed are a voltmeter and an ohmmeter. These can be purchased separately or in combination, known as a VOM meter.

In the event that other tools are required, they will be noted in the procedures.

Troubleshooting Engine Problems

See Chapters 2, 3, 4 for more information and service procedures.

Index to Systems

System	Group
Battery	1
Starting system	2
Primary electrical system	3
Secondary electrical system	4
Fuel system	5
Engine compression	6
Engine vacuum	7
Secondary electrical system	8
Valve train	9
Exhaust system	10
Cooling system	11
Engine lubrication	12

Index to Problems

Problem: Symptom

Begin at Specific Diagnosis, Number

Engine Won't Start:

Starter doesn't turn

Starter turns, engine doesn't

Starter turns engine very slowly

Starter turns engine normally

Starter turns engine very quickly

Engine fires intermittently

Engine fires consistently

Engine Runs Poorly:

Hard starting

Rough idle

Stalling

Engine dies at high speeds

Hesitation (on acceleration from

standing stop)

Poor pickup

Lack of power

Backfire through the carburetor

Backfire through the exhaust

Blue exhaust gases Black

exhaust gases Running on (after

the ignition is

shut off)

Susceptible to moisture

Engine misfires under load

Engine misfires at speed

Engine misfires at idle

11 2.1

2.1 2.4

1.1, 4.1

3.1

6.1

5.1 6.1

3.1 4.1 5.1 8.

4.1 5.1 8.1

3.1 4.1 5.1 8.

4.1 5.1

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4.1 5.1 8.1

3.1 4.1 5.1 8.

4.1 8.1 9.1

4.1 8.1 9.1

6.1 7.1

5.1

3.1 8.1

4.1

4.1, 7.1, 8.4, 9.1

4.1, 8.4

3.1, 4.1, 5.1, 7.1, 8.4

Sample Section

Test and Procedure

4.1—Check for spark: Hold, each spark plug wire approximately 1/2" from ground with gloves or a heavy, dry rag. Crank the engine and observe the spark. -----

Results and Indications

• If no spark is evident: -----

—> If spark is good in some cases:

—* If spark is good in all cases:—

Proceed to

—>4.2 -

»4.3 -

»4.6

Specific Diagnosis

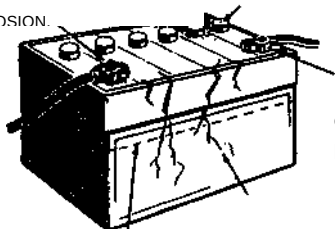
This section is arranged so that following each test, instructions are given to proceed to another, until a problem is diagnosed.

Section 1—Battery

Test and Procedure:

- 1.1—Inspect the battery visually for case condition (corrosion, cracks) and water level.

DIRT ON TOP OF BATTERY
CORROSION.



LOW WATER LEVEL

Results and Indications

If case is cracked, replace battery:

If the case is intact, remove corrosion with a solution of baking soda and water (CAUTION: *do not get the solution into the battery*), and fill with water:

LOOSE CABLE
OR
POSTS
CRACKS

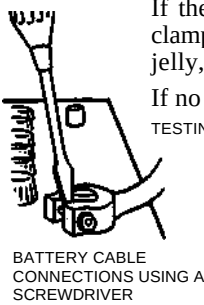
Inspect the battery case

*Proceed
to*

1.4

1.2

1.2—Check the battery cable connections: Insert a screwdriver between the battery post and the cable clamp. Turn the headlights on high beam, and observe them as the screwdriver is gently twisted to ensure good metal to metal contact.



If the lights brighten, remove and clean the clamp and post; coat the post with petroleum jelly, install and tighten the clamp:

1.4 1.3

If no improvement is noted:

1.3—Test the state of charge of the battery using an individual cell tester or hydrometer.

If indicated, charge the battery. **NOTE:** // *no obvious reason exists for the low state of charge (i.e., battery age, prolonged storage), proceed to:*

1.4

Specific Gravity (@ 80° F.)

ADD THIS NUMBER TO THE HYDROMETER -
READING TO OBTAIN THE CORRECTED
SPECIFIC GRAVITY

Minimum *Battery Charge*

SUBTRACT THIS NUMBER FROM THE -
HYDROMETER READING TO OBTAIN THE
CORRECTED SPECIFIC GRAVITY

1.260		100% Charged
1.230		75% Charged
1.200		50% Charged
1.170		25% Charged
1.140		Very Little Power Left
1.110		Completely Discharged

The effects of temperature on battery specific gravity (left) and amount of battery charge in relation to specific gravity (right)

1.4—Visually inspect battery cables for cracking, bad connection to ground, or bad connection to starter.

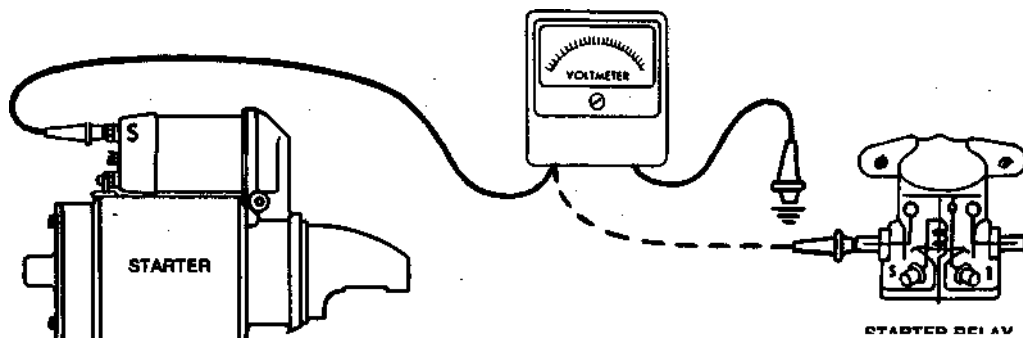
If necessary, tighten connections or replace the cables:

2.1

Section 2—Starting System

See Chapter 3 for service procedures

Test and Procedure	Indications	Results and	Proceed to
Note: Tests in Group 2 are performed with coil high tension lead disconnected to prevent accidental starting.			
2.1—Test the starter motor and solenoid: Connect a jumper from the battery post of the solenoid (or relay) to the starter post of the solenoid (or relay).	If starter turns the engine, normally: If the starter buzzes, or turns the engine very slowly: If no response, replace the solenoid (or relay). If the starter turns, but the engine doesn't, ensure that the flywheel ring gear is intact. If the gear is undamaged, replace the starter drive.	2.2, 2.4 3.1 3.1	
2.2—Determine whether ignition override switches are functioning properly (clutch start switch, neutral safety switch), by connecting a jumper across the switch(es), and turning the ignition switch to "start".	If starter operates, adjust or replace switch: If the starter doesn't operate:	3.1 2.3	
2.3—Check the ignition switch "start" position: Connect a 12V test lamp or voltmeter between the starter post of the solenoid (or relay) and ground. Turn the ignition switch to the "start" position, and jiggle the key.	If the lamp doesn't light or the meter needle doesn't move when the switch is turned, check the ignition switch for loose connections, cracked insulation, or broken wires. Repair or replace as necessary: If the lamp flickers or needle moves when the key is jiggled, replace the ignition switch.	3.1, 3.3	

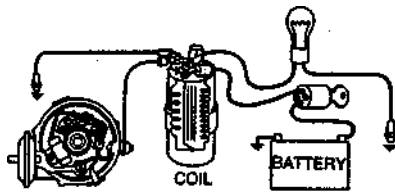


Checking the ignition switch "start" position

2.4—Remove and bench test the starter, according to specifications in the engine electrical section.	If the starter does not meet specifications, repair or replace as needed: 3.1 If the starter is operating properly: 2.5
2.5—Determine whether the engine can turn freely: Remove the spark plugs, and check for water in the cylinders. Check for water on the dipstick, or oil in the radiator. Attempt to turn the engine using an 18" flex drive and socket on the crankshaft pulley nut or bolt.	If the engine will turn freely only with the spark plugs out, and hydrostatic lock (water in the cylinders) is ruled out, check valve timing: 9.2 If engine will not turn freely, and it is known that the clutch and transmission are free, the engine must be disassembled for further evaluation: Chapter 3

Section 3—Primary Electrical System

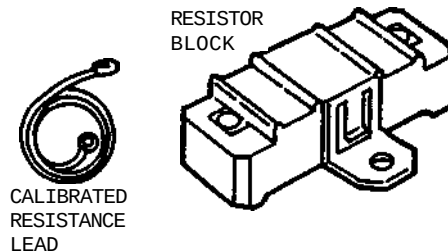
Test and Procedure	Results and Indications	Proceed to
3.1 —Check the ignition switch "on" position: Connect a jumper wire between the distributor side of the coil and ground, and a 12V test lamp between the switch side of the coil and ground. Remove the high tension lead from the coil. Turn the ignition switch on and jiggle the key.	If the lamp lights: If the lamp flickers when the key is jiggled, replace the ignition switch: If the lamp doesn't light, check for loose or open connections. If none are found, remove the ignition switch and check for continuity. If the switch is faulty, replace it:	3.2 3.3 3.3



Checking the ignition switch "on" position

- 3.2—Check the ballast resistor or resistance wire for an open circuit, using an ohmmeter. See Chapter 3 for specific tests.
- Replace the resistor or resistance wire if the resistance is zero. **NOTE:** Some ignition systems have no ballast resistor.

3.3



Two types of resistors

- 3.3—On point-type ignition systems, visually inspect the breaker points for burning, pitting or excessive wear. Gray coloring of the point contact surfaces is normal. Rotate the crankshaft until the contact heel rests on a high point of the distributor cam and adjust the point gap to specifications. On electronic ignition models, remove the distributor cap and visually inspect the armature. Ensure that the armature pin is in place, and that the armature is on tight and rotates when the engine is cranked. Make sure there are no cracks, chips or rounded edges on the armature.
- If the breaker points are intact, clean the contact surfaces with fine emery cloth, and adjust the point gap to specifications. If the points are worn, replace them. On electronic systems, replace any parts which appear defective. If condition persists:

3.4

Test and Procedure

- 3.4—On point-type ignition systems, connect a dwell-meter between the distributor primary lead and ground. Crank the engine and observe the point dwell angle. On electronic ignition systems, conduct a stator (magnetic pickup assembly) test. See Chapter 3.

Results and Indications

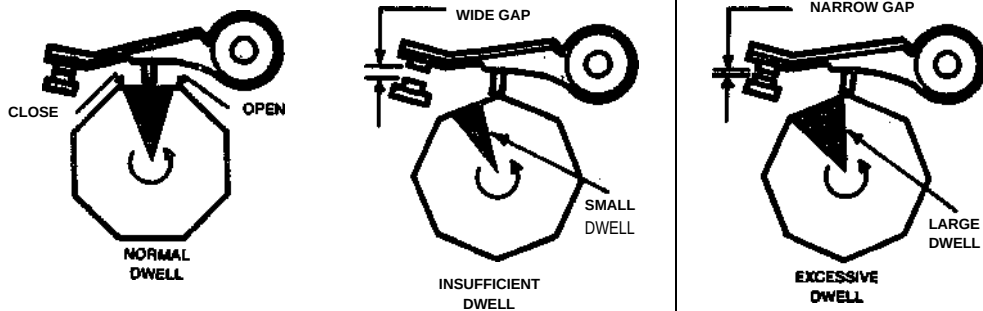
On point-type systems, adjust the dwell angle if necessary. **NOTE:** *Increasing the point gap decreases the dwell angle and vice-versa.*

If the dwell meter shows little or no reading;

On electronic ignition systems, if the stator is bad, replace the 'stator. If the stator is good, proceed to the other tests in Chapter 3.

**Proceed
to "•!"**

3.6 3.5



Dwell is a function of point gap

- 3.5—On the point-type ignition systems, check the condenser for short: connect an ohmmeter across the condenser body and the pigtail lead.

If any reading other than infinite is noted, replace the condenser

3.6

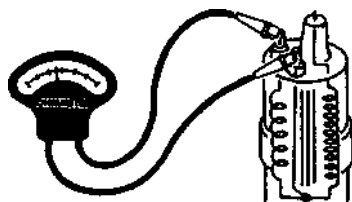


Checking the condenser for short

- 3.6—Test the coil primary resistance: On point-type ignition systems, connect an ohmmeter across the coil primary terminals, and read the resistance on the low scale. Note whether an external ballast resistor or resistance wire is used. On electronic ignition systems, test the coil primary resistance as in Chapter 3.

Point-type ignition coils utilizing ballast resistors or resistance wires should have approximately 1.0 ohms resistance. Coils with internal resistors should have approximately 4.0 ohms resistance. If values far from the above are noted, replace the coil.

4.1



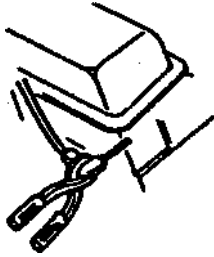
Check the coil primary resistance

Section 4—Secondary Electrical System

See Chapters 2-3 for service" procedures

Test and Procedure

- 4.1 —Check for spark: Hold each spark plug wire approximately ½" from ground with gloves or a heavy, dry rag. Crank the engine, and observe the spark.



Check for spark at the plugs

Results and Indications

- If no spark is evident:
If spark is good in some cylinders:
If spark is good in all cylinders:

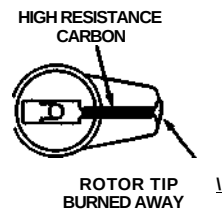
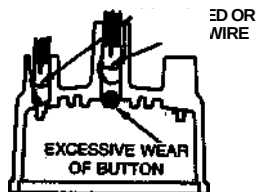
Proceed to

- 4.2 4.3
4.6

- 4.2—Check for spark at the coil high tension lead: Remove the coil high tension lead from the distributor and position it approximately ½" from ground. Crank the engine and observe spark. **CAUTION: This test should not be performed on engines equipped with electronic ignition.**

- If the spark is good and consistent: 4.3
If the spark is good but intermittent, test the primary electrical system starting at 3.3: 3.3
If the spark is weak or non-existent, replace the coil high tension lead, clean and tighten all connections and retest. If no improvement is noted: 4.4

- 4.3—Visually inspect the distributor cap and rotor for burned or corroded contacts, cracks, carbon tracks, or moisture. Also check the fit of the rotor on the distributor shaft (where applicable).



Inspect the distributor cap and rotor

- If moisture is present, dry thoroughly, and retest per 4.1: 4.1
If burned or excessively corroded contacts, cracks, or carbon tracks are noted, replace the defective part(s) and retest per 4.1: 4.1
If the rotor and cap appear intact, or are only slightly corroded, clean the contacts thoroughly (including the cap towers and spark plug wire ends) and retest per 4.1:
If the spark is good in all cases: 4.6
If the spark is poor in all cases: 4.5

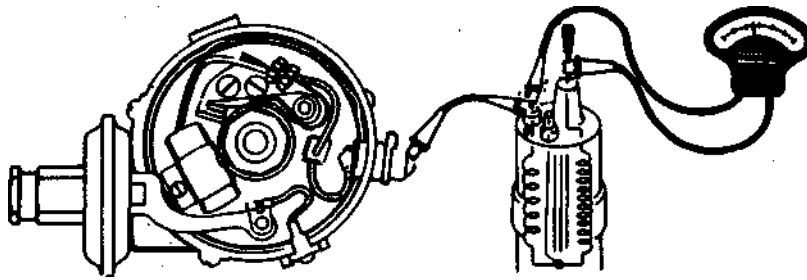
Test and Procedure

- 4.4—Check the coil secondary resistance: On point-type systems connect an ohmmeter across the distributor side of the coil and the coil tower. Read the resistance on the high scale of the ohmmeter. On electronic ignition systems, see Chapter 3 for specific tests.

Results and Indications

The resistance of a satisfactory coil should be between 4,000 and 10,000 ohms; If resistance is considerably higher (i.e., 40,000 ohms) replace the coil and retest per 4.1. **NOTE:** This does not apply to high performance coils.

Proceed to

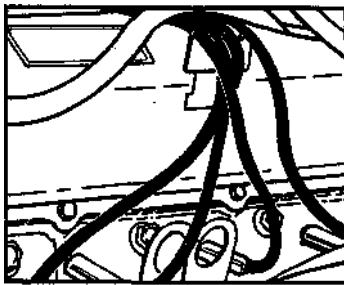


Testing the coil secondary resistance

- 4.5—Visually inspect the spark plug wires for cracking or brittleness. Ensure that no two wires are positioned so as to cause induction firing (adjacent and parallel). Remove each wire, one by one, and check resistance with an ohmmeter.

Replace any cracked or brittle wires. If any of the wires are defective, replace the entire set. Replace any wires with excessive resistance (over 8000 Ω per foot for suppression wire), and separate any wires that might cause induction firing.

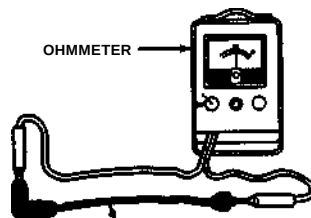
4.6



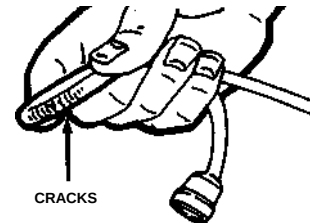
Misfiring can be the result of spark plug leads to adjacent, consecutively firing cylinders running parallel and too close together

SPARK PLUG WIRE

On point-type Ignition systems, Spark plug wires can be checked



check the spark plug wires as shown. On electronic Ignitions, do not remove the wire from the distributor cap terminal; Instead, test through the cap



visually by bending them in a loop over your finger. This will reveal any cracks, burned or broken insulation. Any wire with cracked insulation should be replaced

- 4.6—Remove the spark plugs, noting the cylinders from which they were removed, and evaluate according to the color photos in the middle of this book.

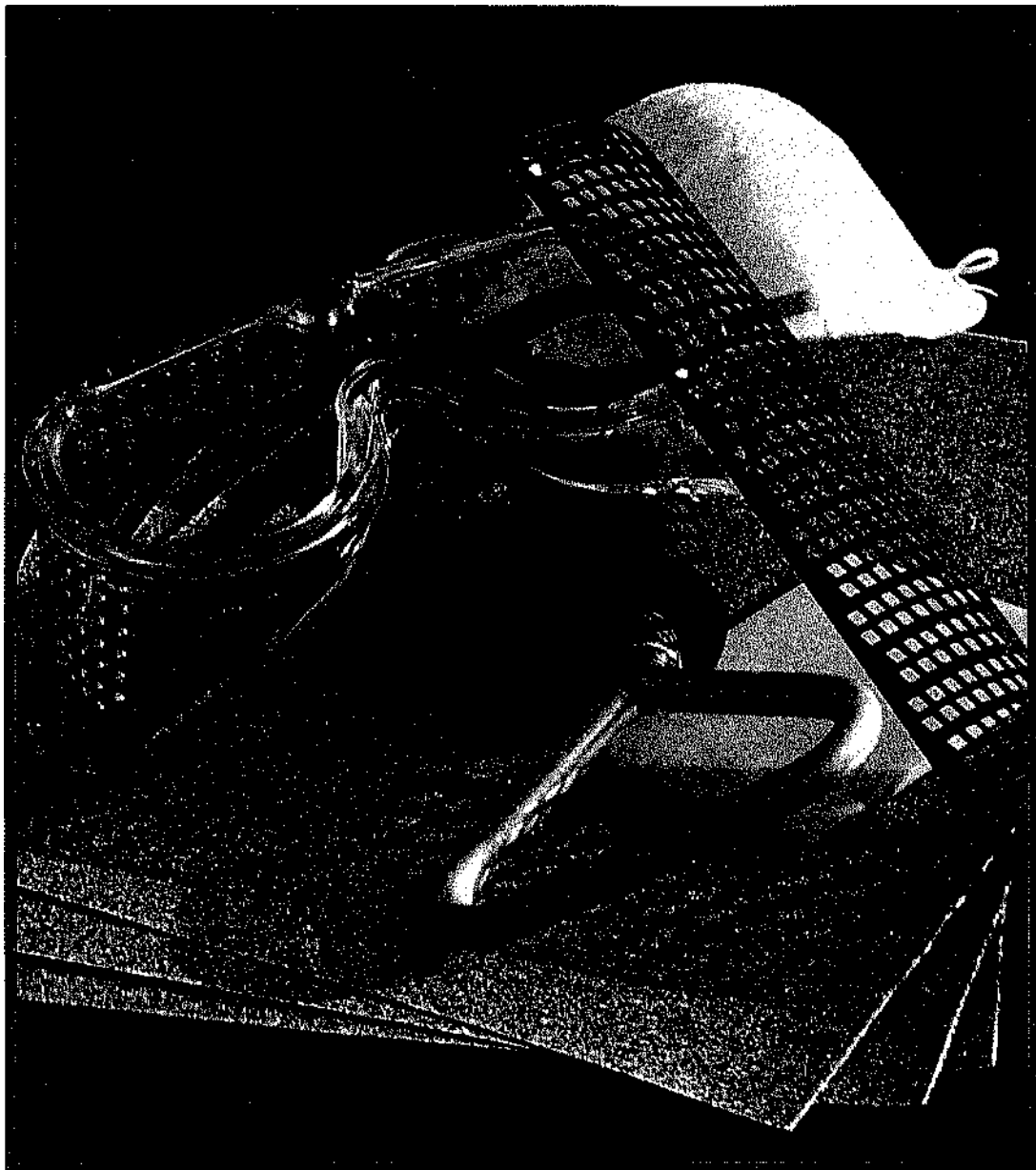
See following.

See following.

CHILTON'S

EASY
STEP-BY-STEP
TIPS FROM PROS

Tools and Materials • Step-by-Step Illustrated Procedures
How To Repair Dents, Scratches and Rust Holes Spray
Painting and Refinishing Tips



With a little practice, basic body repair procedures can be mastered by any do-it-yourself mechanic. The step-by-step repairs shown here can be applied to almost any type of auto body repair.

TOOLS & MATERIALS

You may already have basic tools, such as hammers; and electric drills. Other tools unique to body repair — body hammers, grinding attachments, sanding blocks, dent puller, half-round plastic file and plastic spreaders — are relatively inexpensive and can be obtained wherever auto parts or auto body repair parts are sold. Portable air compressors and paint spray guns can be purchased or rented.

Auto Body Repair Kits

The best and most often used products are available to the do-it-yourselfer in kit form, from major manufacturers of auto body repair products. The same manufacturers also merchandise the individual products for use by pros.

Kits are available to make a wide variety of repairs, including holes, dents and scratches, and fiberglass, and offer the advantage of buying the materials you'll need; for the job. There is little waste or chance of materials going bad from not being used. Many kits may also contain basic body-working tools such as body files, sanding blocks and spreaders. Check the contents of the kit before buying your tools.

11 REPAIR TIPS

Safety

Many of the products associated with auto body repair and refinishing contain toxic chemicals. Read all labels before opening containers and store them in a safe place and manner. • Wear eye protection (safety goggles) when using power tools or when performing any operation that involves

the removal of any type of material.

- Wear lung protection (disposable mask or respirator) when grinding, sanding or painting.

Sanding

Sand off paint before using a dent puller. When using a non-adhesive sanding disc, cover the back of the disc with an overlapping layer or two of masking tape and trim the edges. The disc will last considerably longer.

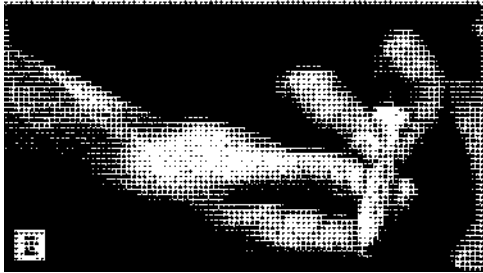
- 2 Use the circular motion of the sanding disc to grind *into* the edge of the repair. Grinding or sanding away from the jagged edge will only tear the sandpaper.
- 3 Use the palm of your hand flat on the panel to detect high and low spots. Do not use your fingertips. Slide your hand slowly back and forth.

WORKING WITH FILLER

Mixing The Filler

Cleanliness and proper mixing and application are extremely important. Use a clean piece of plastic or glass or a disposable artist's palette to mix body filler.

1 Allow plenty of time and follow directions. No useful purpose will be served by adding more hardener to make it cure (set-up) faster. Less hardener means more curing time, but the mixture dries harder; more hardener means less curing time but a softer mixture.



2 Both the hardener and the filler should be thoroughly kneaded or stirred before mixing. Hardener should be a solid paste and dispense like thin toothpaste. Body filler should be smooth, and free of lumps or thick spots.

Getting the proper amount of hardener in the filler is the trickiest part of preparing the filler. Use the same amount of hardener in cold or warm weather. For contour filler (thick coats), a bead of hardener twice the diameter of the filler is about right. There's about a 15% margin on either side, but, if in doubt use less hardener.

3 Mix the body filler and hardener by wiping across the mixing surface, picking the mixture up and wiping it again; Colder weather! requires longer mixing times. Do not mix in a circular motion; this will trap air bubbles which will become holes in the cured filler.

Applying The Filler

IFor best results, filler should not be applied over 1/8" thick.

Apply the filler, in several coats. Build it up to above the level of the repair surface so that it can be sanded or grated down.

The first coat of filler must be pressed on with a firm wiping motion.

Apply the filler in one direction only. Working the filler back and forth will either pull it off the metal or trap air bubbles.

REPAIRING DENTS

Before you start, take a few minutes to study the damaged area. Try to visualize the shape of the panel before it was damaged. If the damage is on the left fender, look at the right fender and use it as a guide; If there is access to the panel from behind, you can reshape it with a body hammer. If not, you'll have to use a dent puller. Go slowly and work

the metal a little at a time. Get the panel as straight as possible before applying filler.

4 Using an 80-grit grinding disc on an electric drill, grind the paint from the surrounding area down to bare metal. Use a new grinding pad to prevent heat buildup that will warp metal.

I This dent is typical of one that can be pulled out or hammered out from behind. Remove the headlight cover, headlight assembly and turn signal housing.

5 The area should look like this when you're finished grinding. Knock the drill holes in and tape over small openings to keep plastic filler out.

2 Drill a series of holes $\frac{1}{4}$ the size of the end of the dent puller along the stress line. Make some trial pulls and assess the results. If necessary, drill more holes and try again. Do not hurry.



Tips). Be sure to cover the area completely.

6 Mix the body filler (see Body Repair Tips). Spread the body filler evenly over the entire area (see Body Repair

3 If possible, use a body hammer and block to shape the metal back to its original contours. Get the metal back as close to its original shape as possible. Don't depend on body filler to fill dents.

7 Let the body filler dry until the surface can just be scratched with your fingernail. Knock the high spots from the body filler with a body file ("Cheesegrater"). Check frequently with the palm of your hand for high and low spots.

8 Check to be sure that trim pieces that will be installed later will fit exactly. Sand the area with 40-grit paper.

4 f% Sand the area with 400 paper and • then finish with a scuff pad. The finished repair is ready for priming and painting (see Painting Tips).

Materials and photos courtesy of Rltt Jones Auto Body, Prospect Park, PA. ,

(If you wind up with low spots, you may have to apply another layer of filler.

,j/% Knock the high spots off with 40-grit paper. When you are satisfied with the contours of the repair, apply a thin coat of filler to cover pin holes and scratches.

,4,4 Block sand the area with 40-grit • 1 paper to a smooth finish. Pay particular attention to body lines and ridges that must be well-defined.

REPAIRING RUST HOIK

There are many ways to repair rust holes. The fiberglass cloth kit shown here is one of the most cost efficient for the owner because it provides a strong repair that resists cracking and moisture and is relatively easy to use. It can be used on large and small holes (with or without backing) and can be applied over contoured areas. Remember, however, that short of replacing an entire panel, no repair is a guarantee that the rust will not return.

1 Remove any trim that will be in the way. Clean away all loose debris. Cut away all the rusted metal. But be sure to leave enough metal to retain the contour or body shape.

2 Grind away all traces of rust with a 24-grit grinding disc. Be sure to grind back 3-4 inches from the edge of the hole down to bare metal and be sure all traces of paint, primer and rust are removed.

3 Block sand the area with 80 or 100 grit sandpaper to get a clear, shiny surface and feathered paint edge. Tap the edges of the hole inward with a ball peen hammer.

4 If you are going to use release film, cut a piece about 2-3" larger than the area you have sanded. Place the film over the repair and mark the sanded area on the film. Avoid any unnecessary wrinkling of the film.

5 Cut 2 pieces of fiberglass mat to match the shape of the repair. One piece should be about 1" smaller than the sanded area and the second piece should be 1" smaller than the first. Mix enough filler and hardener to saturate the fiberglass material (see Body Repair Tips),

6 Lay the release sheet on a flat surface and spread an even layer of filler, large enough to cover the repair. Lay the smaller piece of fiberglass cloth in the center of the sheet and spread another layer of filler over the fiberglass cloth. Repeat the operation for the larger piece of cloth.



7 Place the repair material over the repair area, with the release film facing outward. Use a spreader and work from the center outward to smooth the material, following the body contours. Be sure to remove all air bubbles.

8 Wait until the repair has dried tack-free and peel off the release sheet. The ideal working temperature is 60°-90° F. Cooler or warmer temperatures or high humidity may require additional curing time. Wait longer, if in doubt.

9 Sand and feather-edge the entire area. The initial sanding can be done with a sanding disc on an electric drill if care is used. Finish the sanding with a block sander. Low spots can be filled with body filler; this may require several applications.

4^ When the filler can just be lw scratched with a fingernail, knock the high spots down with a body file and smooth the entire area with 80-grit. Feather the filled areas into the surrounding areas.

^^ When the area is sanded smooth, IB mix some topcoat and hardener and apply it directly with a spreader. This will give a smooth finish and prevent the glass matte from showing through the paint.

4 O Block sand the topcoat smooth • M with finishing sandpaper (200 grit), and 400 grit. The repair is ready for masking, priming and painting (see Painting Tips).

Materials and photos courtesy Marson Corporation, Chelsea, Massachusetts

PAINTING TIPS

Preparation

1 SANDING — Use a 400 or 600 grit wet or dry sandpaper. Wet-sand the area with a ¹/₄ sheet of sandpaper soaked in clean water. Keep the paper wet while sanding. Sand the area until the repaired area tapers into the original finish.

2 CLEANING — Wash the area to be painted thoroughly with water and a clean rag. Rinse it thoroughly and wipe the surface dry until you're sure it's completely free of dirt, dust, fingerprints, wax, detergent or other foreign matter.

3 MASKING — Protect any areas you don't want to overspray by covering them with masking tape and newspaper. Be careful not get fingerprints on the area to be painted,

4 PRIMING — All exposed metal should be primed before painting. Primer protects the metal and provides an excellent surface for paint adhesion. When the primer is dry, wet-sand the area again with 600 grit wet-sandpaper. Clean the area again after sanding.

Painting Techniques

Paint applied from either a spray gun or a spray can (for small areas) will provide good results. Experiment on an

old piece of metal to get the right combination before you begin painting.

THICKNESS — Spray with smooth strokes. In general, the thicker the coat of paint, the longer the drying time. Apply several thin coats about 30 seconds apart. The paint should remain wet long enough to flow out and no longer; heavier coats will only produce sags or wrinkles. Spray a light (fog) coat, followed by heavier color coats.

DISTANCE — The Ideal spraying distance is 8"-12" from the gun or can to the surface. Shorter distances will produce ripples, while greater distances will result in orange peel, dry film and poor color match and loss of material due to overspray.

OVERLAPPING — the gun or can should be kept at right angles to the surface at all times. Work to a wet edge at an even speed, using a 50% overlap and direct the center of the spray at the lower or nearest edges of the previous stroke.

RUBBING OUT (BLENDING) FRESH PAINT — Let the paint dry thoroughly. Runs or imperfections can be sanded out, primed and repainted.

Don't be in too big a hurry to remove the masking. This only produces paint ridges. When the finish has dried for at least a week, apply a small amount of fine grade rubbing compound with a clean, wet cloth. Use lots of water and blend the new paint with the surrounding area.

SPRAYING VISCOSITY (SPRAY GUN ONLY) — Paint should be thinned to spraying viscosity according to the directions on the can. Use only the recommended thinner or reducer and the same amount of reduction regardless of temperature.

AIR PRESSURE (SPRAY GUN ONLY) — This is extremely important. Be sure you are using the proper recommended pressure.

TEMPERATURE — the surface to be painted should be approximately the same temperature as the surrounding air. Applying warm paint, to a cold surface, or vice versa, will completely upset the paint characteristics;

WRONG

Thin coat. Stroke too fast, not enough overlap, gun too far away.

CORRECT

Medium coat. Proper distance, good stroke, proper overlap.

WRONG

Heavy coat. Stroke too slow, too much overlap, gun too close.

Test and Procedure

4.7—Examine the location of all the plugs.

Results and Indications

The following diagrams illustrate some of the conditions that the location of plugs will reveal.

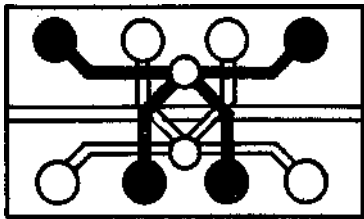
Proceed to

4.8

0 0 0 0 0 0 0 0

Two adjacent plugs are fouled in a 6-cylinder engine, 4-cylinder engine or either bank of a V-8. This is probably due to a blown head gasket between the two cylinders

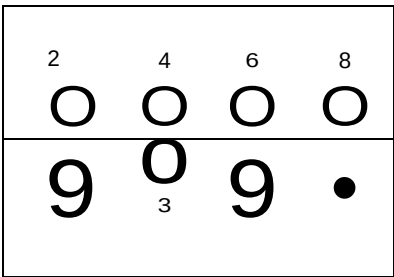
The two center plugs in a 6-cylinder engine are fouled. Raw fuel may be "boiled" out of the carburetor into the intake manifold after the engine is shut-off. Stop-start driving can also foul the center plugs, due to overly rich mixture. Proper float level, a new float needle and seat or use of an insulating spacer may help this problem



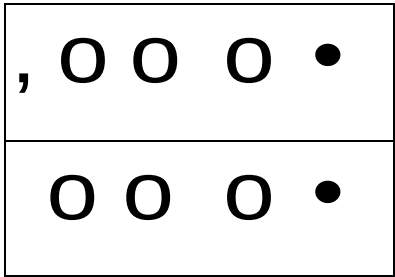
An unbalanced carburetor is indicated. Following the fuel flow on this particular design shows that the cylinders fed by the right-hand barrel are fouled from overly rich mixture, while the cylinders fed by the left-hand barrel are normal

0 0
0 0

If the four rear plugs are overheated, a cooling system problem is suggested. A thorough cleaning of the cooling system may restore coolant circulation and cure the problem



Finding one plug overheated may indicate an intake manifold leak near the affected cylinder. If the overheated plug is the second of two adjacent, consecutively firing plugs, it could be the result of ignition cross-firing. Separating the leads to these two plugs will eliminate cross-fire

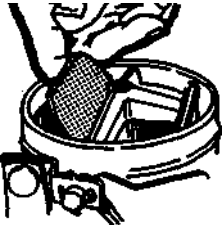
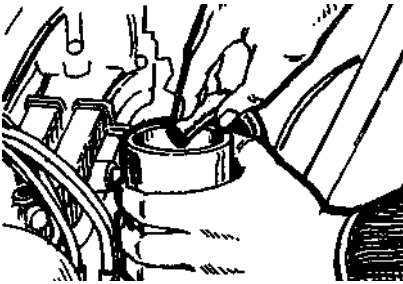


Occasionally, the two rear plugs in large, lightly used V-8's will become oil fouled. High oil consumption and smoky exhaust may also be noticed. It is probably due to plugged oil drain holes in the rear of the cylinder head, causing oil to be sucked in around the valve stems. This usually occurs in the rear cylinders first, because the engine slants that way

Test and Procedure	Results and Indications	Proceed:
4.8—Determine the static ignition timing. Using the crankshaft pulley timing marks as a guide, locate top dead center on the compression stroke of the number one cylinder.	The rotor should be pointing toward the No. 1 tower in the distributor cap, and, on electronic ignitions, the armature spoke for that cylinder should be lined up with the stator.	4.8
4.9—Check coil polarity; Connect a voltmeter negative lead to the coil high tension lead, and the positive lead to ground (NOTE: <i>Reverse the hook-up for positive ground systems</i>). Crank the engine momentarily.	 If the voltmeter reads up-scale, the polarity is correct: If the voltmeter reads down-scale, reverse the coil polarity (switch the primary leads): Checking coil polarity	5.1 5.1

Section 5—Fuel System

See Chapter 4 for service procedures

Test and Procedure	Results and Indications	Proceed to
5.1—Determine that the air filter is functioning efficiently: Hold paper elements up to a strong light, and attempt to see light through the filter.	Clean permanent air filters in solvent (or manufacturer's recommendation), and allow to dry. Replace paper elements through which light cannot be seen:	5.2
5.2—Determine whether a flooding condition exists: Flooding is identified by a strong gasoline odor, and excessive gasoline present in the throttle bore(s) of the carburetor.	If flooding is not evident: If flooding is evident, permit the gasoline to dry for a few moments and restart. If flooding doesn't recur: If flooding is persistent:	5.3 5.7 5.5
 5.3—Check that fuel is reaching the carburetor: Detach the fuel line at the carburetor inlet. Hold the end of the line in a cup (not styrofoam), and crank the engine.	If the engine floods repeatedly, check the choke butterfly flap	
	If fuel flows smoothly: If fuel doesn't flow (NOTE: <i>Make sure that there is fuel in the tank</i>), or flows erratically: Check the fuel pump by disconnecting the output line (fuel pump-to-carburetor) at the carburetor and operating the starter briefly	5.7 5.4

Test and Procedure**Results and Indications****Proceed
to**

- 5.4—Test the fuel pump: Disconnect all fuel lines from the fuel pump. Hold a finger over the input fitting, crank the engine (with electric pump, turn the ignition or pump on); and feel for suction.

If suction is evident, blow out the fuel line to the tank with low pressure compressed air until bubbling is heard from the fuel filler neck. Also blow out the carburetor fuel line (both ends disconnected):

5.7 5.7

If no suction is evident, replace or repair the fuel pump:

NOTE: Repeated oil fouling of the spark plugs, or a no-start condition, could be the result of a ruptured vacuum booster pump diaphragm, through which oil or gasoline is being drawn into the intake manifold (where applicable).

- 5.5—Occasionally, small specks of dirt will clog the small jets and orifices in the carburetor. With the engine cold, hold a flat piece of wood or similar material over the carburetor, where possible, and crank the engine.

If the engine starts, but runs roughly the engine is probably not run enough. If the engine won't start:

5.9

- 5.6—Check the needle and seat: Tap the carburetor in the area of the needle and seat.

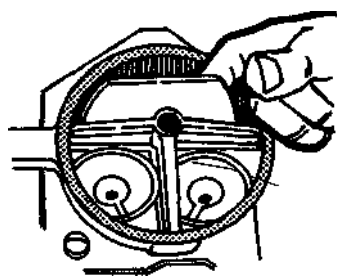
If flooding stops, a gasoline additive (e.g., Gumout) will often cure the problem: **5.7**

If flooding continues, check the fuel pump for excessive pressure at the carburetor (according to specifications). If the pressure is normal, the needle and seat must be removed and checked, and/or the float level adjusted: **5.7**

- 5.7—Test the accelerator pump by looking into the throttle bores while operating the throttle.

If the accelerator pump appears to be operating normally: **5.8**

If the accelerator pump is not operating, the pump must be reconditioned. Where possible, service the pump with the carburetor(s) installed on the engine. If necessary, remove the carburetor. Prior to removal: **5.8**



Check for gas at the carburetor by looking down the carburetor throat while someone moves the accelerator

- 5.8—Determine whether the carburetor main fuel system is functioning: Spray a commercial starting fluid into the carburetor while attempting to start the engine.

If the engine starts, runs for a few seconds, and dies: **5.9**

If the engine doesn't start: **6.1**

Test and Procedure

5.9—Uncommon fuel system malfunctions: See below:

Results and Indications

If the problem is solved:

If the problem remains, remove and recondition the carburetor.

Proceed to

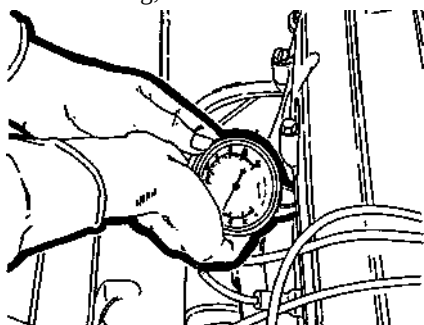
6.1

<i>Condition</i>	<i>Indication</i>	<i>Test</i>	<i>Prevailing Weather Conditions</i>	<i>Remedy</i>
Vapor lock	Engine will not restart shortly after running.	Cool the components of the fuel system until the engine starts. Vapor lock can be cured faster by draping a wet cloth over a mechanical fuel pump.	Hot to very hot	Ensure that the exhaust manifold heat control valve is operating. Check with the vehicle manufacturer for the recommended solution to vapor lock on the model in question.
Carburetor icing	Engine will not idle, stalls at low speeds.	Visually inspect the throttle plate area of the throttle bores for frost.	High humidity, 32-40° F.	Ensure that the exhaust manifold heat control valve is operating, and that the intake manifold heat riser is not blocked.
Water in the fuel	Engine sputters and stalls; may not start.	Pump a small amount of fuel into a glass jar. Allow to stand, and inspect for droplets or changes. a layer of water.	High humidity, extreme temperature changes.	For droplets, use one or two cans of commercial gas line anti-freeze. For a layer of water, the tank must be drained, and the fuel lines blown out with compressed air.

Section 6—Engine Compression

See Chapter 3 for service procedures

6.1 —Test engine compression: Remove all spark plugs. Block the throttle wide open. Insert a compression gauge into a spark plug port, crank the engine to obtain the maximum reading, and record.



If compression is within limits on all cylinders:

7.1

If gauge reading is extremely low on all cylinders:

6.2 6.2

If gauge reading is low on one or two cylinders: (If gauge readings are identical and low on two or more adjacent cylinders, the head gasket must be replaced.)

Checking compression

6.2—Test engine compression (wet): Squirt approximately 30 cc. of engine oil into each cylinder, and retest per 6.1.

If the readings improve, worn or cracked rings or broken pistons are indicated:

See Chapter 3

If the readings do not improve, burned or excessively carboned valves or a jumped timing chain are indicated:

7.1

NOTE: A jumped timing chain is often indicated by difficult cranking.

Section 7—Engine Vacuum

See Chapter 3 for service procedures

Test and Procedure

7.1—Attach a vacuum gauge to the intake manifold beyond the throttle plate. Start the engine, and observe the action of the needle over the range of engine speeds.

Results and Indications

See below,

Proceed to

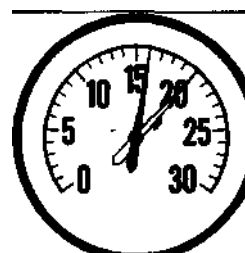
See below



INDICATION: normal engine in good condition

Proceed to: 8.1
Normal engine

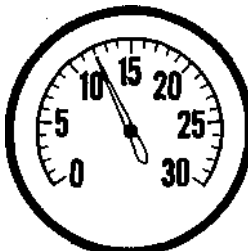
Gauge reading: steady, from 17-22 in./Hg.



INDICATION: sticking valves or ignition miss

Proceed to: 9.1, 8.3
Sticking valves

Gauge reading: intermittent fluctuation at idle



INDICATION: late ignition or valve timing, low compression, stuck throttle valve, leaking carburetor or manifold gasket

Proceed to: 6.1



INDICATION: improper carburetor adjustment or minor intake leak.

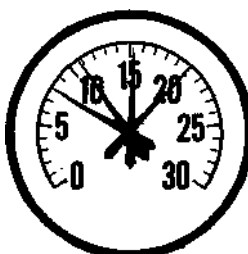
Proceed to: 7.2

Incorrect valve timing

Gauge reading: low (10-15 in./Hg) but steady

Carburetor requires adjustment

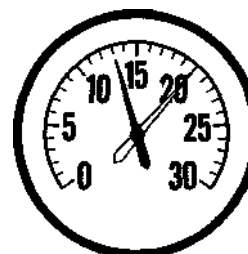
Gauge reading: drifting needle



INDICATION: ignition miss, blown cylinder head gasket, leaking valve or weak valve spring

Proceed to: 8.3, 6.1
Blown head gasket
Gauge reading: needle fluctuates as engine

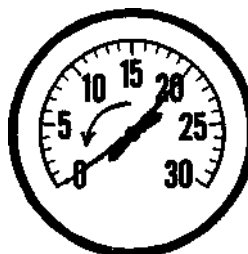
speed increases



INDICATION: burnt valve or faulty valve clearance; Needle will fall when defective valve operates

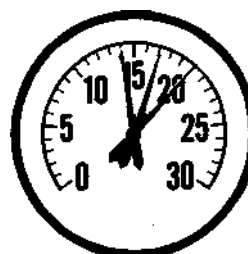
Proceed to: 9.1
Burnt or leaking valves
Gauge reading: steady needle, but drops

regularly



INDICATION: choked muffler, excessive back pressure in system

Proceed to: 10.1
Clogged exhaust system
Gauge reading: gradual drop in reading at idle



INDICATION: worn valve guides

Proceed to: 9.1
Worn valve guides
Gauge reading: needle vibrates excessively at idle, but steadies as

engine speed increases

White pointer = steady gauge hand

Black pointer = fluctuating gauge hand

Test and Procedure	Results and Indications	Proceed to
7.2—Attach a vacuum gauge per 7.1, and test for an intake manifold leak. Squirt a small amount of oil around the intake manifold gaskets, carburetor gaskets, plugs and fittings. Observe the action of the vacuum gauge.	If the reading improves, replace the indicated gasket; or seal the indicated fitting or plug: If the reading remains low:	8.1 7.3
7.3—Test all vacuum hoses and accessories for leaks as described in 7.2. Also check the carburetor body (dashpots, automatic choke mechanism, throttle shafts) for leaks in the same manner.	If the reading improves, service or replace the offending part(s): If the reading remains low:	8.1 6.1

Section 8—Secondary Electrical System

See Chapter 2 for service procedures

Test and Procedure	Results and Indications	Proceed to
8.1—Remove the distributor cap and check to make sure that the rotor turns when the engine is cranked. Visually inspect the distributor components.	Clean, tighten or replace any components which appear defective.	8.2
8.2—Connect a timing light (per manufacturer's recommendation) and check the dynamic ignition timing. Disconnect and plug the vacuum hose(s) to the distributor if specified, start the engine, and observe the timing marks at the specified engine speed.	If the timing is not correct, adjust to specifications by rotating the distributor in the engine: (Advance timing by rotating distributor opposite normal direction of rotor rotation, retard timing by rotating distributor in same direction as rotor rotation.)	8.3
8.3—Check the operation of the distributor advance mechanism(s): To test the mechanical advance, disconnect the vacuum lines from the distributor advance unit and observe the timing marks with a timing light as the engine speed is increased from idle. If the mark moves smoothly, without hesitation, it may be assumed that the mechanical advance is functioning properly. To test vacuum advance and/or retard systems, alternately crimp and release the vacuum line, and observe the timing mark for movement. If movement is noted, the system is operating.	If the systems are functioning: If the systems are not functioning, remove the distributor, and test on a distributor tester:	8.4 8.4
8.4—Locate an ignition miss: With the engine running, remove each spark plug wire, one at a time, until one is found that doesn't cause the engine to roughen and slow down.	When the missing cylinder is identified:	4.1

Section 9—Valve Train

See Chapter 3 for service procedures

Test and Procedure

9.1—Evaluate the valve train: Remove the valve cover, and ensure that the valves are adjusted to specifications. A mechanic's stethoscope may be used to aid in the diagnosis of the valve train. By pushing the probe on or near push rods or rockers, valve noise often can be isolated. A timing light also may be used to diagnose valve problems. Connect the light according to manufacturer's recommendations, and start the engine. Vary the firing moment of the light by increasing the engine speed (and therefore the ignition advance), and moving the trigger from cylinder to cylinder. Observe the movement of each valve.

Results and Indications

Sticking valves or erratic valve train motion can be observed with the timing light. The cylinder head must be disassembled for repairs.

Proceed to

See Chapter 3

9.2—Check the valve timing: Locate top dead center of the No. 1 piston, and install a degree wheel or tape on the crankshaft pulley or damper with zero corresponding to an index mark on the engine. Rotate the crankshaft in its direction of rotation, and observe the opening of the No. 1 cylinder intake valve. The opening should correspond with the correct mark on the degree wheel according to specifications.

If the timing is not correct, the timing cover must be removed for further investigation.

See Chapter 3

Section 10—Exhaust System

Test and Procedure

10.1—Determine whether the exhaust manifold heat control valve is operating: Operate the valve by hand to determine whether it is free to move. If the valve is free, run the engine to operating temperature and observe the action of the valve, to ensure that it is opening.

Results and Indications

If the valve sticks, spray it with a suitable solvent, open and close the valve to free it, and retest. If the valve functions properly:

If the valve does not free, or does not operate, replace the valve:

Proceed to

10.2

10.2

10.2—Ensure that there are no exhaust restrictions: Visually inspect the exhaust system for kinks, dents, or crushing. Also note that gases are flowing freely from the tailpipe at all engine speeds, indicating no restriction in the muffler or resonator.

Replace any damaged portion of the system:

11.1

Section 11—Cooling System

See Chapter 3 for service procedures

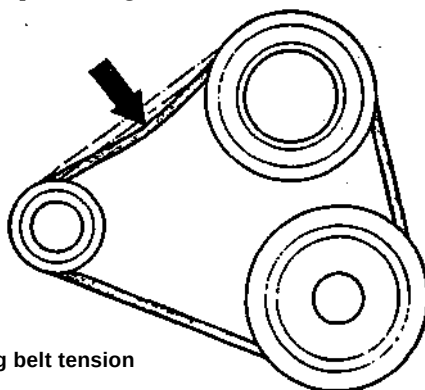
Test and Procedure

11.1—Visually inspect the fan belt for glazing, cracks, and fraying, and replace if necessary. Tighten the belt so that the longest span has approximately $\frac{1}{2}$ inch play at its midpoint under thumb pressure (see Chapter 1).

11.2—Check the fluid level of the cooling system.

Results and Indications

Replace or tighten the fan belt as



Checking belt tension

If full or slightly low, fill as necessary: 11.5

If extremely low: 11.3

11.3—Visually inspect the external portions of the cooling system (radiator, radiator hoses, thermostat elbow, water pump seals, heater hoses, etc.) for leaks. If none are found, pressurize the cooling system to 14-15 psi.

If cooling system holds the pressure: 11.5

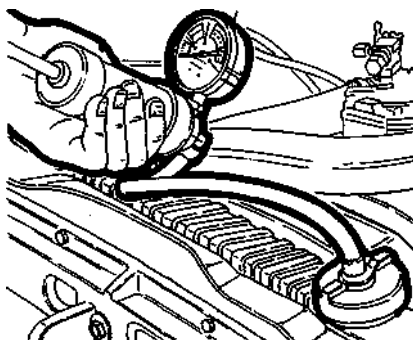
If cooling system loses pressure rapidly, reinspect external parts of the system for leaks under pressure. If none are found, check dip stick for coolant in crankcase. If no coolant is present, but pressure loss continues: 11.4

If coolant is evident in crankcase, remove cylinder head(s), and check gasket(s). If gaskets are intact, block and cylinder head(s) should be checked for cracks or holes. If the gasket(s) is blown, replace, and purge the crankcase of coolant: 12.6

NOTE: Occasionally, due to atmospheric and driving conditions, condensation of water can occur in the crankcase. This causes the oil to appear milky white. To remedy, run the engine until hot, and change the oil and oil filter.

11.4—Check for combustion leaks into the cooling system: Pressurize the cooling system as above. Start the engine, and observe the pressure gauge. If the needle fluctuates, remove each spark plug wire, one at a time, noting which cylinder(s) reduce or eliminate the fluctuation.

Cylinders which reduce or eliminate the fluctuation, when the spark plug wire is removed, are leaking into the cooling system. Replace the head gasket on the affected cylinder bank(s).

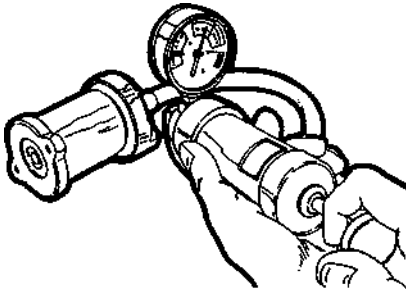


Pressurizing the cooling system

**Proceed
to**

Test and Procedure

11.5—Check the radiator pressure cap: Attach a radiator pressure tester to the radiator cap (wet the seal prior to installation). Quickly pump up the pressure, noting the point at which the cap releases.



Checking radiator pressure cap

Results and Indications

If the cap releases within ± 1 psi of the specified rating, it is operating properly:

11.6 11.6

If the cap releases at more than ± 1 psi of the specified rating, it should be replaced:

Proceed!
to ,

11.6—Test the thermostat: Start the engine cold, remove the radiator cap, and insert a thermometer into the radiator. Allow the engine to idle. After a short while, there will be a sudden, rapid increase in coolant temperature. The temperature at which this sharp rise stops is the thermostat opening temperature.

If the thermostat opens at or about the specified temperature:

11.7

If the temperature doesn't increase: (If the temperature increases slowly and gradually, replace the thermostat.)

11.7

11.7—Check the water pump: Remove the thermostat elbow and the thermostat, disconnect the coil high tension lead (to prevent starting), and crank the engine momentarily.

If coolant flows, replace the thermostat and retest per 11.6:

11.6

If coolant doesn't flow, reverse flush the cooling system to alleviate any blockage that might exist. If system is not blocked, and coolant will not flow, replace the water pump.

Section 12—Lubrication

See Chapter 3 for service procedures

Test and Procedure

12.1—Check the oil pressure gauge or warning light: If the gauge shows low pressure, or the light is on for no obvious reason, remove the oil pressure sender. Install an accurate oil pressure gauge and run the engine momentarily.

Results and Indications

If oil pressure builds normally, run engine for a few moments to determine that it is functioning normally, and replace the sender.

If the pressure remains low:

12.2 12.3

If the pressure surges: If the oil pressure is zero:

12.3

12.2—Visually inspect the oil: If the oil is watery or very thin, milky, or foamy, replace the oil and oil filter.

If the oil is normal:

12.3

If after replacing oil the pressure remains low:

12.3

If after replacing oil the pressure becomes normal:

—

Proceed
to

294 TROUBLESHOOTING

Test and Procedure	Results and Indications	Proceed to
12.3—Inspect the oil pressure relief valve and spring, to ensure that it is not sticking or stuck. Remove and thoroughly clean the valve, spring, and the valve body.	If the oil pressure improves: If no improvement is noted:	12.4
12.4—Check to ensure that the oil pump is not cavitating (sucking air instead of oil): See that the crankcase is neither over nor underfull, and that the pickup in the sump is in the proper position and free from sludge.	Fill or drain the crankcase to the proper capacity, and clean the pickup screen in solvent if necessary. If no improvement is noted:	12.5
12.5—Inspect the oil pump drive and the oil pump:	If the pump drive or the oil pump appear to be defective, service as necessary and retest per 12.1: If the pump drive and pump appear to be operating normally, the engine should be disassembled to determine where blockage exists:	12.1 See Chapter 3
12.6—Purge the engine of ethylene glycol coolant: Completely drain the crankcase and the oil filter. Obtain a commercial butyl cellosolve base solvent, designated for this purpose, and follow the instructions precisely. Following this, install a new oil filter and refill the crankcase with the proper weight oil. The next oil and filter change should follow shortly thereafter (1000 miles).		

TROUBLESHOOTING EMISSION CONTROL SYSTEMS

See Chapter 4 for procedures applicable to individual emission control systems used on specific combinations of engine/transmission/model.

TROUBLESHOOTING THE CARBURETOR

See Chapter 4 for service procedures

Carburetor problems cannot be effectively isolated unless all other engine systems (particularly ignition and emission) are functioning properly and the engine is properly tuned.

Condition	Possible Cause
Engine cranks, but does not start	1. Improper starting procedure 2. No fuel in tank 3. Clogged fuel line or filter 4. Defective fuel pump 5. Choke valve not closing properly 6. Engine flooded 7. Choke valve not unloading 8. Throttle linkage not making full travel 9. Stuck needle or float 10. Leaking float needle or seat 11. Improper float adjustment
Engine stalls	1. Improperly adjusted idle speed or mixture Engine hot 2. Improperly adjusted dashpot 3. Defective or improperly adjusted solenoid 4. Incorrect fuel level in fuel bowl 5. Fuel pump pressure too high 6. Leaking float needle seat 7. Secondary throttle valve stuck open 8. Air or fuel leaks 9. Idle air bleeds plugged or missing 10. Idle passages plugged Engine Cold 11. Incorrectly adjusted choke 12. Improperly adjusted fast idle speed 13. Air leaks 14. Plugged idle or idle air passages 15. Stuck choke valve or binding linkage 16. Stuck secondary throttle valves 17. Engine flooding—high fuel level 18. Leaking or misaligned float
Engine hesitates on acceleration	1. Clogged fuel filter 2. Leaking fuel pump diaphragm 3. Low fuel pump pressure 4. Secondary throttle valves stuck, bent or misadjusted 5. Sticking or binding air valve 6. Defective accelerator pump 7. Vacuum leaks 8. Clogged air filter 9. Incorrect choke adjustment (engine cold)
Engine feels sluggish or flat on acceleration	1. Improperly adjusted idle speed or mixture 2. Clogged fuel filter 3. Defective accelerator pump 4. Dirty, plugged or incorrect main metering jets 5. Bent or sticking main metering rods 6. Sticking throttle valves 7. Stuck heat riser 8. Binding or stuck air valve 9. Dirty, plugged or incorrect secondary jets 10. Bent or sticking secondary metering rods. 11. Throttle body or manifold heat passages plugged 12. Improperly adjusted choke or choke vacuum break.
Carburetor floods	1. Defective fuel pump. Pressure too high. 2. Stuck choke valve 3. Dirty, worn or damaged float or needle valve/seat 4. Incorrect float/fuel level 5. Leaking float bowl

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Condition	Possible Cause
Engine idles roughly and stalls	1. Incorrect idle speed 2. Clogged fuel filter 3. Dirt in fuel system or carburetor 4. Loose carburetor screws or attaching bolts 5. Broken carburetor gaskets 6. Air leaks 7. Dirty carburetor 8. Worn idle mixture needles 9. Throttle valves stuck open 10. Incorrectly adjusted float or fuel level 11. Clogged air filter
Engine runs unevenly or surges	1. Defective fuel pump 2. Dirty or clogged fuel filter 3. Plugged, loose or incorrect main metering jets or rods 4. Air leaks 5. Bent or sticking main metering rods 6. Stuck power piston 7. Incorrect float adjustment 8. Incorrect idle speed or mixture 9. Dirty or plugged idle system passages 10. Hard, brittle or broken gaskets 11. Loose attaching or mounting screws 12. Stuck or misaligned secondary throttle valves
Poor fuel economy	1. Poor driving habits 2. Stuck choke valve 3. Binding choke linkage 4. Stuck heat riser 5. Incorrect idle mixture 6. Defective accelerator pump 7. Air leaks 8. Plugged, loose or incorrect main metering jets 9. Improperly adjusted float or fuel level 10. Bent, misaligned or fuel-clogged float 11. Leaking float needle seat 12. Fuel leak 13. Accelerator pump discharge ball not seating properly 14. Incorrect main jets
Engine lacks high speed performance or power	1. Incorrect throttle linkage adjustment 2. Stuck or binding power piston 3. Defective accelerator pump 4. Air leaks 5. Incorrect float setting or fuel level 6. Dirty, plugged, worn or incorrect main metering jets or rods 7. Binding or sticking air valve 8. Brittle or cracked gaskets 9. Bent, incorrect or improperly adjusted secondary metering rods 10. Clogged fuel filter 11. Clogged air filter 12. Defective fuel pump

TROUBLESHOOTING FUEL INJECTION PROBLEMS

Each fuel injection system has its own unique 4 of this Repair & Tune-Up Guide for specific components and test procedures, for which it test and repair procedures, if the vehicle is impossible to generalize. Refer to Chapter equipped with fuel injection.

TROUBLESHOOTING ELECTRICAL PROBLEMS

See Chapter 5 for service procedures

For any electrical system to operate, it must make a complete circuit. This simply means that the power flow from the battery must make a complete circle. When an electrical component is operating, power flows from the battery to the component, passes through the component causing it to perform its function (lighting a light bulb), and then returns to the battery through the ground of the circuit. This ground is usually (but not always) the metal part of the car or truck on which the electrical component is mounted.

Perhaps the easiest way to visualize this is to think of connecting a light bulb with two wires attached to it to the battery. If one of the two wires attached to the light bulb were attached to the negative post of the battery and the other were attached to the positive post of the battery, you would have a complete circuit. Current from the battery would flow to the light bulb, causing it to light, and return to the negative post of the battery.

The normal automotive circuit differs from this simple example in two ways. First, instead of having a return wire from the bulb to the battery, the light bulb returns the current to the battery through the chassis of the vehicle. Since the negative battery cable is attached to the chassis and the chassis is made of electrically conductive metal, the chassis of the vehicle can serve as a ground wire to complete the circuit. Secondly, most automotive circuits contain switches to turn components on and off as required.

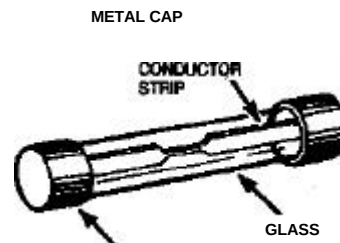
Every complete circuit from a power source must include a component which is using the power from the power source. If you were to disconnect the light bulb from the wires and touch the two wires together (don't do this) the power supply wire to the component would be grounded before the normal ground connection for the circuit.

Because grounding a wire from a power source makes a complete circuit—less the required component to use the power—this phenomenon is called a short circuit. Common causes are: broken insulation (exposing the metal wire to a metal part of the car or truck), or a shorted switch.

Some electrical components which require a large amount of current to operate also have a relay in their circuit. Since these circuits carry a large amount of current, the thickness

of the wire in the circuit (gauge size) is also greater. If this large wire were connected from the component to the control switch on the instrument panel, and then back to the component, a voltage drop would occur in the circuit. To prevent this potential drop in voltage, an electromagnetic switch (relay) is used. The large wires in the circuit are connected from the battery to one side of the relay, and from the opposite side of the relay to the component. The relay is normally open, preventing current from passing through the circuit. An additional, smaller, wire is connected from the relay to the control switch for the circuit. When the control switch is turned on, it grounds the smaller wire from the relay and completes the circuit. This closes the relay and allows current to flow from the battery to the component. The horn, headlight, and starter circuits are three which use relays.

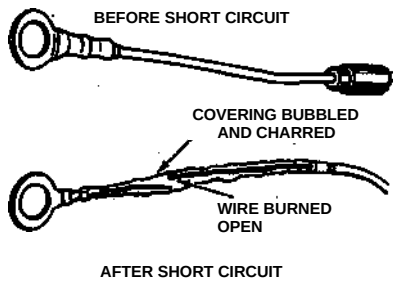
It is possible for larger surges of current to pass through the electrical system of your car or truck. If this surge of current were to reach an electrical component, it could burn it out. To prevent this, fuses, circuit breakers or fusible links are connected into the current supply wires of most of the major electrical systems. When an electrical current of excessive power passes through the component's fuse, the fuse blows out and breaks the circuit, saving the component from destruction.



Typical automotive fuse

A circuit breaker is basically a self-repairing fuse. The circuit breaker opens the circuit the same way a fuse does. However, when either the short is removed from the circuit or the surge subsides, the circuit breaker resets itself and does not have to be replaced as a fuse does.

A fuse link is a wire that acts as a fuse. It is normally connected between the starter relay and the main wiring harness. This connection is usually under the hood. The fuse link (if installed) protects all the



Most fusible links show a charred, melted insulation when they burn out

chassis electrical components, and is the probable cause of trouble when none of the electrical components function, unless the battery is disconnected or dead.

Electrical problems generally fall into one of three areas:

1. The component that is not functioning is not receiving current.
2. The component itself is not functioning.
3. The component is not properly grounded.

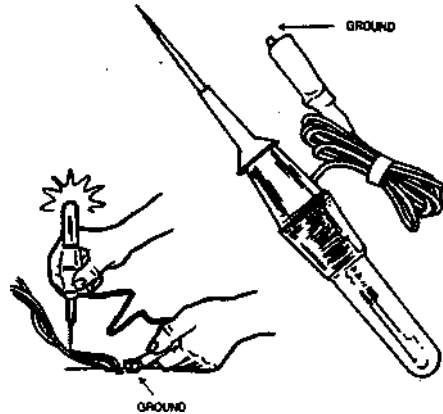
The electrical system can be checked with a test light and a jumper wire. A test light is a device that looks like a pointed screwdriver with a wire attached to it and has a light bulb in its handle. A jumper wire is a piece of insulated wire with an alligator clip attached to each end.

If a component is not working, you must follow a systematic plan to determine which of the three causes is the villain.

1. Turn on the switch that controls the inoperable component.
2. Disconnect the power supply wire from the component,
3. Attach the ground wire on the test light to a good metal ground.
4. Touch the probe end of the test light to the end of the power supply wire that was disconnected from the component. If the component is receiving current, the test light will go on.

NOTE: Some components work only when the ignition switch is turned on.

If the test light does not go on, then the problem is in the circuit between the battery and the component. This includes all the switches, fuses, and relays in the system. Follow the wire that runs back to the battery. The problem is an open circuit between the



The test light will show the presence of current when touched to a hot wire and grounded at the other end

battery and the component. If the fuse is blown and, when replaced, immediately blows again, there is a short circuit in the system which must be located and repaired. If there is a switch in the system, bypass it with a jumper wire. This is done by connecting one end of the jumper wire to the power supply wire into the switch and the other end of the jumper wire to the wire coming out of the switch. If the test light lights with the jumper wire installed, the switch or whatever was bypassed is defective.

NOTE: Never substitute the jumper wire for the component, since it is required to use the power from the power source.

5. If the bulb in the test light goes on, then the current is getting to the component that is not working. This eliminates the first of the three possible causes. Connect the power supply wire and connect a jumper wire from the component to a good metal ground. Do this with the switch which controls the component turned on, and also the ignition switch turned on if it is required for the component to work. If the component works with the jumper wire installed, then it has a bad ground. This is usually caused by the metal area on which the component mounts to the chassis being coated with some type of foreign matter.

6. If neither test located the source of the trouble, then the component itself is defective. Remember that for any electrical system to work, all connections must be clean and tight.

Troubleshooting Basic Turn Signal and Flasher Problems

See Chapter 5 for service procedures

Most problems in the turn signals or flasher system can be reduced to defective flashers or bulbs, which are easily replaced. Occasionally, the turn signal switch will prove defective. F = Front R=Rear • = Lights off O = Lights on

Condition

Turn signals light, but do not flash

Possible Cause

Defective flasher

No turn signals light on either side

Blown fuse. Replace if defective.
Defective flasher. Check by substitution.
Open circuit, short circuit or poor ground.

Both turn signals on one side don't work		Bad bulbs. Bad ground in both (or either) housings.
One turn signal light on one side doesn't work		Defective bulb. Corrosion in socket. Clean contacts. Poor ground at socket.

Turn signal flashes too fast or too slowly

Check any bulb on the side flashing too fast. A heavy-duty bulb is probably installed in place of a regular bulb. Check the bulb flashing too slowly. A standard bulb was probably installed in place of a heavy-duty bulb.

Loose connections or corrosion at the bulb socket.

Indicator lights don't work in either direction



Check if the turn signals are working.
Check the dash indicator lights.
Check the flasher by substitution.

One light indicator light doesn't



On systems with one dash indicator: See if the lights work on the same side. Often the filaments have been reversed in systems combining stoplights with tail-lights and turn signals. Check the flasher by substitution. On systems with two indicators: Check the bulbs on the same side. Check the indicator light bulb. Check the flasher by substitution.

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Troubleshooting Lighting Problems

See Chapter 5 for service procedures

Condition	Possible Cause
One or more lights don't work, but others do	1. Defective bulb(s) 2. Blown fuse(s) 3. Dirty fuse clips or light sockets 4. Poor ground circuit
Lights burn out quickly	1. Incorrect voltage regulator setting or defective regulator 2. Poor battery/alternator connections
Lights go dim	1. Low/discharged battery 2. Alternator not charging 3. Corroded sockets or connections 4. Low voltage output
Lights flicker	1. Loose connection 2. Poor ground. (Run ground wire from light housing to frame) 3. Circuit breaker operating (short circuit)
Lights "flare"—Some flare is normal on acceleration—If excessive, see "Lights Burn Out Quickly"	High voltage setting
Lights glare—approaching drivers are blinded	1. Lights adjusted too high 2. Rear springs or shocks sagging 3. Rear tires soft

Troubleshooting Dash Gauge Problems

Most problems can be traced to a defective sending unit or faulty wiring. Occasionally, the gauge itself is at fault. See Chapter 5 for service procedures.

Condition	Possible Cause
COOLANT TEMPERATURE GAUGE	
Gauge reads erratically or not at all	1. Loose or dirty connections 2. Defective sending unit. 3. Defective gauge. To test a bi-metal gauge, remove the wire from the sending unit. Ground the wire for an instant. If the gauge registers, replace the sending unit. To test a magnetic gauge, disconnect the wire at the sending unit. With ignition ON gauge should register COLD. Ground the wire; gauge should register HOT.

AMMETER GAUGE—TURN HEADLIGHTS ON (DO NOT START ENGINE). NOTE REACTION

Ammeter shows charge	1. Connections reversed on gauge
Ammeter shows discharge	2. Ammeter is OK
Ammeter does not move	3. Loose connections or faulty wiring
	4. Defective gauge

Condition**Possible Cause****OIL PRESSURE GAUGE**

Gauge does not register or is inaccurate

1. On mechanical gauge, Bourdon tube may be bent or kinked.
2. Low oil pressure. Remove sending unit. Idle the engine briefly. If no oil flows from sending unit hole, problem is in engine.
3. Defective gauge. Remove the wire from the sending unit and ground it for an instant with the ignition ON. A good gauge will go to the top of the scale.
4. Defective wiring. Check the wiring to the gauge. If it's OK and the gauge doesn't register when grounded, replace the gauge.
5. Defective sending unit.

ALL GAUGES

All gauges do not operate

1. Blown fuse
2. Defective instrument regulator
3. Defective or dirty instrument voltage regulator
4. Loss of ground between instrument voltage regulator and frame
5. Defective instrument regulator

All gauges read low or erratically
All gauges pegged

WARNING LIGHTS

Light(s) do not come on when ignition is ON, but engine is not started

1. Defective bulb
2. Defective wire
3. Defective sending unit. Disconnect the wire from the sending unit and ground it. Replace the sending unit if the light comes on with the ignition ON.

Light comes on with engine running

4. Problem in individual system
5. Defective sending unit

Troubleshooting Clutch Problems

It is false economy to replace individual clutch components. The pressure plate, clutch plate and throwout bearing should be replaced as a set, and the flywheel face inspected, whenever the clutch is overhauled. See Chapter 6 for service procedures.

Condition**Possible Cause**

Clutch chatter

1. Grease on driven plate (disc) facing
2. Binding clutch linkage or cable
3. Loose, damaged facings on driven plate (disc)
4. Engine mounts loose
5. Incorrect height adjustment of pressure plate release levers
6. Clutch housing or housing to transmission adapter misalignment
7. Loose driven plate hub

Clutch grabbing

1. Oil, grease on driven plate (disc) facing
2. Broken pressure plate
3. Warped or binding driven plate. Driven plate binding on clutch shaft

Clutch slips

1. Lack of lubrication in clutch linkage or cable (linkage or cable binds, causes incomplete engagement)
2. Incorrect pedal, or linkage adjustment
3. Broken pressure plate springs
4. Weak pressure plate springs
5. Grease on driven plate facings (disc)

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Troubleshooting Clutch Problems (cont.)

Condition	Possible Cause
Incomplete clutch release	1. Incorrect pedal or linkage adjustment or linkage or cable binding 2. Incorrect height adjustment on pressure plate release levers 3. Loose, broken facings on driven plate (disc) 4. Bent, dished, warped driven plate caused by overheating
Grinding, whirring grating noise when pedal is depressed	1. Worn or defective throwout bearing 2. Starter drive teeth contacting flywheel ring gear teeth. Look for milled or polished teeth on ring gear.
Squeal, howl, trumpeting noise when pedal is being released (occurs during first inch to inch and one-half of pedal travel)	Pilot bushing worn or lack of lubricant. If bushing appears OK, polish bushing with emery cloth, soak lube wick in oil, lube bushing with oil, apply film of chassis grease to clutch shaft pilot hub, reassemble. NOTE: Bushing wear may be due to misalignment of clutch housing or housing to transmission adapter
Vibration or clutch pedal pulsation with clutch disengaged (pedal fully depressed)	1. Worn or defective engine transmission mounts 2. Flywheel run out. (Flywheel run out at face not to exceed 0.005") 3. Damaged or defective clutch components

Troubleshooting Manual Transmission Problems

See Chapter 6 for service procedures

Condition	Possible Cause
Transmission jumps out of gear	1. Misalignment of transmission case or clutch housing. 2. Worn pilot bearing in crankshaft. 3. Bent transmission shaft. 4. Worn high speed sliding gear. 5. Worn teeth or end-play in clutch shaft. 6. Insufficient spring tension on shifter rail plunger. 7. Bent or loose shifter fork. 8. Gears not engaging completely. 9. Loose or worn bearings on clutch shaft or mainshaft. 10. Worn gear teeth. 11. Worn or damaged detent balls.
Transmission sticks in gear	1. Clutch not releasing fully. 2. Burred or battered teeth on clutch shaft, or sliding sleeve. 3. Burred or battered transmission mainshaft. 4. Frozen synchronizing clutch. 5. Stuck shifter rail plunger. 6. Gearshift lever twisting and binding shifter rail. 7. Battered teeth on high speed sliding gear or on sleeve. 8. Improper lubrication, or lack of lubrication. 9. Corroded transmission parts. 10. Defective mainshaft pilot bearing. 11. Locked gear bearings will give same effect as stuck in gear.
Transmission gears will not synchronize	1. Binding pilot bearing on mainshaft, will synchronize in high gear only. 2. Clutch not releasing fully. 3. Detent spring weak or broken. 4. Weak or broken springs under balls in sliding gear sleeve. 5. Binding bearing on clutch shaft, or binding countershaft. 6. Binding pilot bearing in crankshaft. 7. Badly worn gear teeth. 8. Improper lubrication. 9. Constant mesh gear not turning freely on transmission mainshaft. Will synchronize in that gear only.

Condition	Possible Cause
Gears spinning when shifting into gear from neutral	1. Clutch not releasing fully. 2. In some cases an extremely light lubricant in transmission will cause gears to continue to spin for a short time after clutch is released. 3. Binding pilot bearing in crankshaft.
Transmission noisy in all gears	1. Insufficient lubricant, or improper lubricant. 2. Worn countergear bearings. 3. Worn or damaged main drive gear or countergear. 4. Damaged main drive gear or mainshaft bearings. 5. Worn or damaged countergear anti-lash plate.
Transmission noisy in neutral only	1. Damaged main drive gear bearing. 2. Damaged or loose mainshaft pilot bearing. 3. Worn or damaged countergear anti-lash plate. 4. Worn countergear bearings.
Transmission noisy in one gear only	1. Damaged or worn constant mesh gears. 2. Worn or damaged countergear bearings. 3. Damaged or worn synchronizer.
Transmission noisy in reverse only	1. Worn or damaged reverse idler gear or idler bushing. 2. Worn or damaged mainshaft reverse gear. 3. Worn or damaged reverse countergear. 4. Damaged shift mechanism.

TROUBLESHOOTING AUTOMATIC TRANSMISSION PROBLEMS

Keeping alert to changes in the operating characteristics of the transmission (changing shift points, noises, etc.) can prevent small problems from becoming large ones. If the problem cannot be traced to loose bolts, fluid level, misadjusted linkage, clogged filters or similar problems, you should probably seek professional service.

Transmission Fluid Indications

The appearance and odor of the transmission fluid can give valuable clues to the overall condition of the transmission. Always note the appearance of the fluid when you check the fluid level or change the fluid. Rub a small amount of fluid between your fingers to feel for grit and smell the fluid on the dipstick.

If the fluid appears:	It indicates:
Clear and red colored	Normal operation
Discolored (extremely dark red or brownish) or smells burned	Band or clutch pack failure, usually caused by an overheated transmission. Hauling very heavy loads with insufficient power or failure to change the fluid often result in overheating. Do not confuse this appearance with newer fluids that have a darker red color and a strong odor (though not a burned odor).
Foamy or aerated (light in color and full of bubbles)	1. The level is too high (gear train is churning oil) 2. An internal air leak (air is mixing with the fluid). Have the transmission checked professionally.
Solid residue in the fluid	Defective bands, clutch pack or bearings. Bits of band material or metal abrasives are clogging the dipstick. Have the transmission checked professionally.
Varnish coating on the dipstick	The transmission fluid is overheating

TROUBLESHOOTING DRIVE AXLE PROBLEMS

First, determine when the noise is most noticeable.

Drive Noise: Produced under vehicle acceleration.

Coast Noise: Produced while coasting with a closed throttle.

Float Noise: Occurs while maintaining constant speed (just enough to keep speed constant) on a level road.

External Noise Elimination

It is advisable to make a thorough road test to determine whether the noise originates in the rear axle or whether it originates from the tires, engine, transmission, wheel bearings or road surface. Noise originating from other places cannot be corrected by servicing the rear axle.

ROAD NOISE

Brick or rough surfaced concrete roads produce noises that seem to come from the rear axle. Road noise is usually identical in Drive or Coast and driving on a different type of road will tell whether the road is the problem.

TIRE NOISE

Tire noise can be mistaken as rear axle noise, even though the tires on the front are at fault. Snow tread and mud tread tires or tires worn unevenly will frequently cause vibrations which seem to originate elsewhere; *temporarily, and for test purposes only*, inflate the tires to 40-50 lbs. This will significantly alter the noise produced by the tires,

but will not alter noise from the rear axle. Noises from the rear axle will normally cease at speeds below 30 mph on coast, while tire noise will continue at lower tone as speed is decreased. The rear axle noise will usually change from drive conditions to coast conditions, while tire noise will not. Do not forget to lower the tire pressure to normal after the test is complete.

ENGINE/TRANSMISSION NOISE

Determine at what speed the noise is most pronounced, then stop in a quiet place. With the transmission in Neutral, run the engine through speeds corresponding to road speeds where the noise was noticed. Noises produced with the vehicle standing still are coming from the engine or transmission.

FRONT WHEEL BEARINGS

Front wheel bearing noises, sometimes confused with rear axle noises, will not change when comparing drive and coast conditions. While holding the speed steady, lightly apply the footbrake. This will often cause wheel bearing noise to lessen, as some of the weight is taken off the bearing. Front wheel bearings are easily checked by jacking up the wheels and spinning the wheels. Shaking the wheels will also determine if the wheel bearings are excessively loose.

REAR AXLE NOISES

Eliminating other possible sources can narrow the cause to the rear axle, which normally produces noise from worn gears or bearings. Gear noises tend to peak in a narrow speed range, while bearing noises will usually vary in pitch with engine speeds.

Noise Diagnosis

The Noise Is:

1. Identical under Drive or Coast
2. Different depending on road surface
3. Lower as speed is lowered
4. Similar when standing or moving
5. A vibration
6. A knock or click about every two tire revolutions
7. Most pronounced on turns
8. A steady low-pitched whirring or scraping, starting at low speeds
9. A chattering vibration on turns
10. Noticed only in Drive, Coast or Float conditions

Most Probably Produced By:

Road surface, tires or front wheel bearings
 Road surface or tires
 Tires
 Engine or transmission
 Unbalanced tires, rear wheel bearing, unbalanced driveshaft or worn U-joint
 Rear wheel bearing
 Damaged differential gears
 Damaged or worn pinion bearing
 Wrong differential lubricant or worn clutch plates (limited slip rear axle)
 Worn ring gear and/or pinion gear

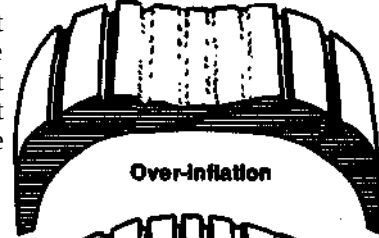
Troubleshooting Steering & Suspension Problems

Condition	Possible Cause
Hard steering (wheel is hard to turn)	1. Improper tire pressure 2. Loose or glazed pump drive belt 3. Low or incorrect fluid 4. Loose, bent or poorly lubricated front end parts 5. Improper front end alignment (excessive caster) 6. Bind in steering column or linkage 7. Kinked hydraulic hose 8. Air in hydraulic system 9. Low pump output or leaks in system 10. Obstruction in lines 11. Pump valves sticking or out of adjustment 12. Incorrect wheel alignment
Loose steering (too much play in steering wheel)	1. Loose wheel bearings 2. Faulty shocks 3. Worn linkage or suspension components 4. Loose steering gear mounting or linkage points 5. Steering mechanism worn or improperly adjusted 6. Valve spool improperly adjusted 7. Worn ball joints, tie-rod ends, etc.
Veers or wanders (pulls to one side with hands off steering wheel)	1. Improper tire pressure 2. Improper front end alignment 3. Dragging or improperly adjusted brakes 4. Bent frame 5. Improper rear end alignment 6. Faulty shocks or springs 7. Loose or bent front end components 8. Play in Pitman arm 9. Steering gear mountings loose 10. Loose wheel bearings 11. Binding Pitman arm 12. Spool valve sticking or improperly adjusted 13. Worn ball joints
Wheel oscillation or vibration transmitted through steering wheel	1. Low or uneven tire pressure 2. Loose wheel bearings 3. Improper front end alignment 4. Bent spindle 5. Worn, bent or broken front end components 6. Tires out of round or out of balance 7. Excessive lateral runout in disc brake rotor 8. Loose or bent shock absorber or strut
Noises (see also "Troubleshooting Drive Axle Problems")	1. Loose belts 2. Low fluid, air in system 3. Foreign matter in system 4. Improper lubrication 5. Interference or chafing in linkage 6. Steering gear mountings loose 7. Incorrect adjustment or wear in gear box 8. Faulty valves or wear in pump 9. Kinked hydraulic lines 10. Worn wheel bearings
Poor return of steering	1. Over-inflated tires 2. Improperly aligned front end (excessive caster) 3. Binding in steering column 4. No lubrication in front end 5. Steering gear adjusted too tight
Uneven tire wear (see "How To Read Tire Wear")	1. Incorrect tire pressure 2. Improperly aligned front end 3. Tires out-of-balance 4. Bent or worn suspension parts

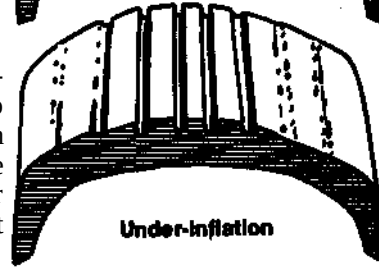
HOW TO READ TIRE WEAR

The way your tires wear is a good indicator of other parts of the suspension. Abnormal wear patterns are often caused by the need for simple tire maintenance, or for front end alignment.

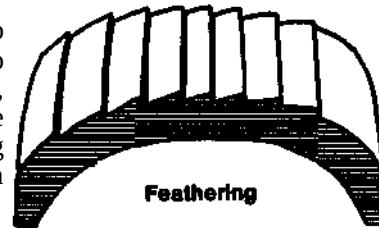
Excessive wear at the center of the tread indicates that the air pressure in the tire is consistently too high. The tire is riding on the center of the tread and wearing it prematurely. Occasionally, this wear pattern can result from outrageously wide tires on narrow rims. The cure for this is to replace either the tires or the wheels.



This type of wear usually results from consistent under-inflation. When a tire is under-inflated, there is too much contact with the road by the outer treads, which wear prematurely. When this type of wear occurs, and the tire pressure is known to be consistently correct, a bent or worn steering component or the need for wheel alignment could be indicated.



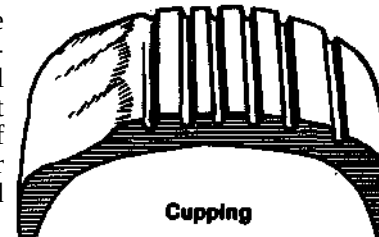
Feathering is a condition when the edge of each tread rib develops a slightly rounded edge on one side and a sharp edge on the other. By running your hand over the tire, you can usually feel the sharper edges before you'll be able to see them. The most common causes of feathering are incorrect toe-in setting or deteriorated bushings in the front suspension.



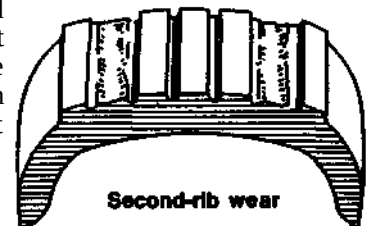
When an inner or outer rib wears faster than the rest of the tire, the need for wheel alignment is indicated. There is excessive camber in the front suspension, causing the wheel to lean too much putting excessive load on one side of the tire. Misalignment could also be due to sagging springs, worn ball joints, or worn control arm bushings. Be sure the vehicle is loaded the way it's normally driven when you have the wheels aligned.



Cups or scalloped dips appearing around the edge of the tread almost always indicate worn (sometimes bent) suspension parts. Adjustment of wheel alignment alone will seldom cure the problem. Any worn component that connects the wheel to the suspension can cause this type of wear. Occasionally, wheels that are out of balance will wear like this, but wheel imbalance usually shows up as bald spots between the outside edges and center of the tread.



Second-rib wear is usually found only in radial tires, and appears where the steel belts end in relation to the tread. It can be kept to a minimum by paying careful attention to tire pressure and frequently rotating the tires. This is often considered normal wear but excessive amounts indicate that the tires are too wide for the wheels.



Troubleshooting Disc Brake Problems

<i>Condition</i>	<i>Possible Cause</i>
Noise—groan—brake noise emanating when slowly releasing brakes (creep-groan)	Not detrimental to function of disc brakes—no corrective action required. (This noise may be eliminated by slightly increasing or decreasing brake pedal efforts.)
Rattle—brake noise or rattle emanating at low speeds on rough roads, (front wheels only).	1. Shoe anti-rattle spring missing or not properly positioned. 2. Excessive clearance between shoe and caliper. 3. Soft or broken caliper seals. 4. Deformed or misaligned disc. 5. Loose caliper.
Scraping	1. Mounting bolts too long. 2. Loose wheel bearings. 3. Bent, loose, or misaligned splash shield.
Front brakes heat up during driving and fail to release	1. Operator riding brake pedal. 2. Stop light switch improperly adjusted. 3. Sticking pedal linkage. 4. Frozen or seized piston. 5. Residual pressure valve in master cylinder. 6. Power brake malfunction. 7. Proportioning valve malfunction.
Leaky brake caliper	1. Damaged or worn caliper piston seal. 2. Scores or corrosion on surface of cylinder bore.
Grabbing or uneven brake action—Brakes pull to one side	1. Causes listed under "Brakes Pull". 2. Power brake malfunction. 3. Low fluid level in master cylinder. 4. Air in hydraulic system. 5. Brake fluid, oil or grease on linings. 6. Unmatched linings. 7. Distorted brake pads. 8. Frozen or seized pistons. 9. Incorrect tire pressure. 10. Front end out of alignment. 11. Broken rear spring. 12. Brake caliper pistons sticking. 13. Restricted hose or line. 14. Caliper not in proper alignment to braking disc. 15. Stuck or malfunctioning metering valve. 16. Soft or broken caliper seals. 17. Loose caliper.
Brake pedal can be depressed without braking effect	1. Air in hydraulic system or improper bleeding procedure. 2. Leak past primary cup in master cylinder. 3. Leak in system. 4. Rear brakes out of adjustment. 5. Bleeder screw open.
Excessive pedal travel	1. Air, leak, or insufficient fluid in system or caliper. 2. Warped or excessively tapered shoe and lining assembly. 3. Excessive disc runout. 4. Rear brake adjustment required. 5. Loose wheel bearing adjustment. 6. Damaged caliper piston seal. 7. Improper brake fluid (boil). 8. Power brake malfunction. 9. Weak or soft hoses.

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Troubleshooting Disc Brake Problems (cont.)

Condition	Possible Cause
Brake roughness or chatter (pedal pumping)	1. Excessive thickness variation of braking disc. 2. Excessive lateral runout of braking disc. 3. Rear brake drums out-of-round. 4. Excessive front bearing clearance.
Excessive pedal effort	1. Brake fluid, oil or grease on linings. 2. Incorrect lining. 3. Frozen or seized pistons. 4. Power brake malfunction. 5. Kinked or collapsed hose or line. 6. Stuck metering valve. 7. Scored caliper or master cylinder bore. 8. Seized caliper pistons.
Brake pedal fades (pedal travel increases with foot on brake)	1. Rough master cylinder or caliper bore. 2. Loose or broken hydraulic lines/connections. 3. Air in hydraulic system. 4. Fluid level low. 5. Weak or soft hoses. 6. Inferior quality brake shoes or fluid. 7.. Worn master cylinder piston cups or seals.

Troubleshooting Drum Brakes

Condition	Possible Cause
Pedal goes to floor	1. Fluid low in reservoir. 2. Air in hydraulic system. 3. Improperly adjusted brake. 4. Leaking wheel cylinders. 5. Loose or broken brake lines. 6. Leaking or worn master cylinder. 7. Excessively worn brake lining.
Spongy brake pedal	1. Air in hydraulic system. 2. Improper brake fluid (low boiling point). 3. Excessively worn or cracked brake drums. 4. Broken pedal pivot bushing.
Brakes pulling	1. Contaminated lining. 2. Front end out of alignment. 3. Incorrect brake adjustment. 4. Unmatched brake lining. 5. Brake drums out of round. 6. Brake shoes distorted. 7. Restricted brake hose or line. 8. Broken rear spring. 9. Worn brake linings. 10. Uneven lining wear. 11. Glazed brake lining. 12. Excessive brake lining dust. 13. Heat spotted brake drums. 14. Weak brake return springs. 15. Faulty automatic adjusters. 16. Low or incorrect tire pressure.

Condition	Possible Cause
Squealing brakes	1. Glazed brake lining. 2. Saturated brake lining. 3. Weak or broken brake shoe retaining spring. 4. Broken or weak brake shoe return spring. 5. Incorrect brake lining. 6. Distorted brake shoes. 7. Bent support plate. 8. Dust in brakes or scored brake drums. 9. Linings worn below limit. 10. Uneven brake lining wear. 11. Heat spotted brake drums.
Chirping brakes	1. Out of round drum or eccentric axle flange pilot.
Dragging brakes	1. Incorrect wheel or parking brake adjustment. 2. Parking brakes engaged or improperly adjusted. 3. Weak or broken brake shoe return spring. 4. Brake pedal binding. 5. Master cylinder cup sticking. 6. Obstructed master cylinder relief port. 7. Saturated brake lining. 8. Bent or out of round brake drum. 9. Contaminated or improper brake fluid. 10. Sticking wheel cylinder pistons. 11. Driver riding brake pedal. 12. Defective proportioning valve. 13. Insufficient brake shoe lubricant.
Hard pedal	1. Brake booster inoperative. 2. Incorrect brake lining. 3. Restricted brake line or hose. 4. Frozen brake pedal linkage. 5. Stuck wheel cylinder. 6. Binding pedal linkage. 7. Faulty proportioning valve.
Wheel locks	1. Contaminated brake lining. 2. Loose or torn brake lining. 3. Wheel cylinder cups sticking. 4. Incorrect wheel bearing adjustment. 5. Faulty proportioning valve.
Brakes fade (high speed)	1. Incorrect lining. 2. Overheated brake drums. 3. Incorrect brake fluid (low boiling temperature). 4. Saturated brake lining. 5. Leak in hydraulic system. 6. Faulty automatic adjusters.
Pedal pulsates	1. Bent or out of round brake drum.
Brake chatter and shoe knock	1. Out of round brake drum. 2. Loose support plate. 3. Bent support plate. 4. Distorted brake shoes. 5. Machine grooves in contact face of brake drum (Shoe Knock). 6. Contaminated brake lining. 7. Missing or loose components. 8. Incorrect lining material. 9. Out-of-round brake drums. 10. Heat spotted or scored brake drums. 11. Out-of-balance wheels.

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Troubleshooting Drum Brakes (cont.)

Condition	Possible Cause
Brakes do not self adjust	1. Adjuster screw frozen in thread. 2. Adjuster screw corroded at thrust washer. 3. Adjuster lever does not engage star wheel. 4. Adjuster installed on wrong wheel.
Brake light glows	1. Leak in the hydraulic system. 2. Air in the system. 3. Improperly adjusted master cylinder pushrod. 4. Uneven lining wear. 5. Failure to center combination valve or proportioning valve.