VEHICLE DIAGNOSIS AND THEIR TROUBLESHOOTING

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بسم الله الرحمن الرحيم

CERTIFICATE OF RESEARCH:

The Thesis title "VEHICLE DIAGNOSIS AND THEIR TROUBLESHOOTING" submitted by Md. Johir Uddin (113428), Tanvir Mohammad Faisal (113409) and Mohammad Jamir Hossain (113414) have been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Mechanical & Chemical Engineering (MCE) on October, 2013

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The is to certify that the work presented in this thesis is an outcome of experiment and research carried out by the authors under the supervision of **Dr. Md. Faisla Kader**.

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We seek excuse for any errors that might be in this report despite our best efforts.

ABSTRACT

While owning a car, either that is new or old, by the passage of time it will wear while the normal use. For this reason, in this project we have tried to find out "Vehicle Diagnosis and their Troubleshooting". Basically we have gone through eight most important and common problems, their causes and the remedies. During developing the project, we have tried to study and analyze the theories of those problems through different books and websites and later we have compared some of them practically.

Mainly the problems in a typical vehicle can be diagnosed commonly as having a visual inspection. In this method, the system should be known clearly to the inspector and the parts to inspect and to have a bit of information historically regarding to the vehicle problems. Then it has to be inspected and the problem can be diagnosed and should search for the probable solutions. In some cases, this does not work fully to diagnose the problems. For this reason specific methods and procedures should be followed to find the problems that we have mentioned in our project about some of the common problems and after analyzing the problems, the probable solutions should be sought.

Lastly, it has to be mentioned that for most topics, for a clear understanding we have mentioned a little bit of the construction and working principle of the concerned part and after that about the problems and how to rectify them in details.

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Chapter 1

Starting and cranking problems in Automotive Engines

1.1 Introduction:

Cranking and starting the engine is one of the common problems, usually faced by the Vehicle owners. Particularly, the vehicles driven for sometimes might be facing these problems a lot.

In order to get rid of such problems, the drivers or the vehicle owners are strongly Advised to follow some step and instructions so as not to damage your car components and to safely crank and start the vehicle.

The following chapter gives you a brief idea of Engine cranking problems, the possible causes and how to overcome that, in which five possibilities are discussed. And at the end, the ENGINE TROUBLE- DIAGNOSIS CHART gives a general idea of the above mentioned problem.

1.2 Engine will not crank:

If the engine will not crank when starting is attempted, make sure the shift lever is in Neutral (N) or PARK (p). Or, if the car has a manual transmission, make sure the clutch pedal is depressed. Check the battery and cables. To locate the cause, turn on the headlights and try cranking. There are **five possibilities.**

1. No cranking, No lights: this is probably due to a completely dead battery. It could be a bad connection at the battery or starting motor or an open fusible link (which would indicate a short or ground in the system) .

2. No Cranking, but lights Go Out As You Turn the Key to Start: This usually means a bad connection at the battery or starting motor or an open fusible link (which would indicate a short or ground in the system)

3. No Cranking and Lights Dim Only Slightly as You Try to start: the trouble is probably in the starting motor. The pinion may not be engaging with the flywheel. If the starting-motor armature spins, the overrunning clutch is slipping.

4. No Cranking, and lights Dim Heavily As you try to Start: this is probably due to a run-down battery. It could be low temperature. The battery is less efficient at low temperatures, and the engine is harder to crank due to thickening of the lubricating oil. he combination could prevent cranking, even though the battery is in good condition. Also, the starting motor or engine could be jammed or locked.

5. No Cranking and Lights Stay Bright: Listen for a loud click as you try to start. If you don't hear it, the solenoid is not pulling the plunger in. connect one end of a jumper lead to the solenoid battery terminal. Connect the other end to a small terminal on the solenoid that is connected to the ignition switch. If nothing happens, the trouble is in the solenoid. If the solenoid and starting motor operate with the jumper lead connected, the trouble is in ignition switch, transmission switch, or wiring.

1.3 Engine Trouble diagnosis chart (Cranking)

Trouble	Possible Cause	Check or Correction
1. Engine will not crank	a. Run-down battery	Recharge or replace battery; Start engine with jumper battery and cables
	b. starting circuit open	find and eliminate the open; check for dirty or loose cables
	c. Starting-motor drive jammed	Remove starting motor and free drive
	d. starting motor jammed	Remove starting motor for disassembly and repair
	e. Engine jammed	Check engine to find trouble
	f. Transmission not in neutral or neutral switch out of adjustment	check and adjust neutral switch if necessary
	g. Seat belt not fastened or interlocks faulty	check interlock

2. Engine cranks slowly but will not start	a. Partly discharged battery and cables b. Defective starting motor c. bad connections in starting circuit	Recharge or replace battery; start engine with jumper battery Repair or replace check for undersize, loose, or dirty cables; replace , or clean and tighten
3. Engine Cranks at normal speed but will not start	a. Defective ignition system b. Defective fuel pump or over choking c. Air leaks into intake manifold d. Defect in engine e. Ignition coil or resistor burned out f. Plugged fuel filter g. Plugged or collapsed exhaust system	Try spark test; check timing, ignition system Check accelerator pump discharge, fuel pump, fuel line, choke , carburetor Tighten mounting; replace gaskets as needed Check compression or leakage Replace Clean or replace Replace collapsed parts

Fig: 1.1 Trouble Diagnosis chart

Reference:

AUTOMOTIVE Engines (Tenth Edition) William H. Crouse Donald L Agnlin

Chapter 2

Battery Trouble Diagnosis

2.1 Introduction

An automobile battery provides the necessary power to turn the starter motor and supply the ignition system with electricity at start up. Automobile batteries also provide an electrical return, or chassis ground, for the automotive electrical system.

The battery acts as the nerve centre of a car's entire electrical system, storing energy produced by the alternator or generator and supplying it to those systems requiring smooth, uninterrupted, and continuous current (lights, fuel injection system, main computer).
There are several types of batteries used in modern automobiles, each varying in performance and price.

Batteries come in three varieties - conventional batteries (using a conventional lead-sulfuric acid matrix), low-maintenance batteries (using low-antimony content lead and sulfuric acid), and maintenance-free batteries (using lead-calcium matrices and an electrolytes of low vapor pressure).

Conventional batteries may be easily recognized by the presence of vent caps through which hydrogen and water vapor are expelled during the charging process. These vent caps must be removed periodically to add distilled water to the electrolyte.

Low-maintenance and maintenance-free batteries have, at the most, four small vent holes. The alloys and electrolytes used, however, last for the designed life of the battery and should never require the addition of distilled water.

Battery problems are one of the most common problems associated with car. With a little bit of care and simple preventive maintenance lots of problems associated with battery may be avoided. In case of conventional battery, regularly check the level of distilled water and add if necessary. Maintenance-free batteries, despite their name, require minimal care. The posts and cable terminals must be kept free of corrosion and deposits so that the battery can continue delivering its charge at peak efficiency.

When servicing a battery, work in an open, ventilated area, and always wear safety glasses. Battery acid is very corrosive: take care not to get any on your skin or clothes.

Use a solution of baking soda and water to wipe away corrosion from the top of the battery and around the posts. Baking soda is a base, so it will neutralize the acidic deposits that have built up on the outside of the battery.

Use a wire-bristle battery brush to clean deposits from the posts. Some brushes also have an attachment for cleaning inside the opening of the battery cable.

To help prevent future corrosion, apply petroleum jelly to the inside of the terminals and the posts before reattaching the cables.

If you are not using the vehicle for a long period of a month or so then remove the terminals from the battery. This prevents the discharge and prolongs the life of the battery.

2.2 How to Troubleshoot an Automobile Battery

If you have owned and operated a vehicle for more than five years, chances are you've encountered a problem with the battery. Most 12-volt batteries last between three and five years. During this period, however, the battery may discharge or fail for various reasons. You can perform a few basic tests to troubleshoot and diagnose the problem

2.2.1Instructions

Things you'll need:

- Digital voltmeter
- Wrench set Wire
- brush
- 12-volt battery charger
- Eye protection
- Gloves

1. Turn off all of the vehicle's electrical accessories. Unplug cell phones or other devices connected to the vehicle's charging system. Take the key out of the ignition.

2. Open the hood and locate the battery. Due to guards or battery covers, you may not see the battery immediately. Remove the guards or covers. Remove any plastic guards that shroud the battery terminals.

3. Check for corrosion on the battery terminals that may cause the battery to drain or to limit its ability to charge correctly. If you see corrosion on the terminals or posts, clean them thoroughly with a small wire brush. Wipe the battery with an old rag; a battery covered in grime is more likely to discharge than a clean, well-maintained battery

4. Check the tightness of the battery terminals and cables. If you can wriggle the terminals, they are too loose and that may be the cause of the battery failure. Tighten the clamps on the terminals with the appropriate wrench. Check the cables that run to the battery. If the cables are not securely attached to the terminals, you must refasten them. Replace the cables if they are damaged.

Fig- 2.1 A typical battery for checking for corrosion and cleaning operation

Check the current state of charge in the automobile battery. Attach a digital

5. Voltmeter to the battery itself. Begin by ensuring the voltmeter is set to the 12- volt scale and then proceed by connecting the meter's positive and negative test leads to the positive and negative terminals of the battery. The reading on the digital meter should be around 12.6 volts if your battery is charged and working correctly. If the reading is 12.4 or less, the battery should be recharged.

2.3 Battery Testing

Battery testing can be done in more than one way. The most accurate method is measurement of specific gravity and battery voltage. To measure specific gravity buy a temperature compensating hydrometer, to measure voltage use a digital D.C. Voltmeter. A quality load tester may be a good purchase if you need to test sealed batteries.

For any of these methods, you must first fully charge the battery and then remove the surface charge. If the battery has been sitting at least several hours (I prefer at least 12 hours) you may begin testing. To remove surface charge the battery must be discharged for several minutes. Using a headlight (high beam) will do the trick. After turning off the light you are ready to test the battery.

State of Charge	Specific Gravity	Voltage	
		12V	6V
100%	1.265	12.7	6.3
*75%	1.225	12.4	6.2
50%	1.190	12.2	6.1
25%	1.155	12.0	6.0
Discharged	1.120	11.9	6.0

Fig-2.3 Relationship of specific gravity, state of charge and voltage

*Sulfation of Batteries starts when specific gravity falls below 1.225 or voltage measures less than 12.4 for a 12v battery, or 6.2 for a 6 volt battery. Sulfation hardens on the battery plates reducing and eventually destroying the ability of the battery to generate Volts and Amps.

Load testing is yet another way of testing a battery. Load test removes amps from a battery much like starting an engine would. A load tester can be purchased at most auto parts stores.

Some battery companies label their battery with the amp load for testing. This number is usually 1/2 of the CCA rating. For instance, a 500CCA battery would load test at 250 amps for 15 seconds. A load test can only be performed if the battery is near or at full charge.

The results of your testing should be as follows:

Hydrometer readings should not vary more than .05 differences between cells.

Digital Voltmeters should read as the voltage is shown in this document. The sealed AGM and Gel-Cell battery voltage (full charged) will be slightly higher in the 12.8 to 12.9 ranges. If you have voltage readings in the 10.5 volts range on a charged battery, which typically indicates a shorted cell.

If you have a maintenance free wet cell, the only ways to test are voltmeter and load test. Any of the maintenance free type batteries that have a built in hydrometer (black/green window) will tell you the condition of 1 cell of 6. You may get a good reading from 1 cell but have a problem with other cells in the battery.

2.3.1 Hydrometer test method:

Construction and Working principle of hydrometer test.

- Hydrometer is a long glass capillary with a bulb at the bottom sealed at both ends.
- The bulb is filled with metallic balls such that the hydrometer when immersed in a column of liquid floats and the liquid level on its stem shows the specific gravity of the liquid.
- They are available in the range from 1.100 to 1.200, 1.200 to 1.300 and so on.

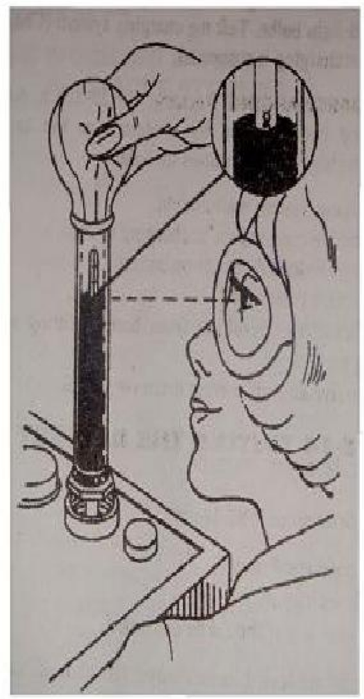

Fig.2.3.1 A typical hydrometer **fig.2 .3.2** Hydrometer Test method

 This figure above shows that the measuring specific gravity of electrolyte in a battery cell with a float hydrometer. Reading must be taken at eye level. The higher the float stem sticks out of electrolyte, the higher the state of charge of that cell
 Careful:
 Do not drip electrolyte on the car or on yourself.
 Electrolyte will damage the part and eat holes in your clothes.

2.3.2 Battery load tester:

After the battery passes the state of charge test, its performance can be checked by making a battery load test.
This measures terminal voltage while the battery is discharging at a high rate. The load is applied using a tester that includes a voltmeter, an ammeter, and a carbon pile (variable) resister

Fig2.3.3- Battery load tester Arrangements

6. Recharge the car battery with a 12-volt charger. Allow the battery to charge fully and to sit 12 hours afterward. Retest the battery with your digital meter.
Another low reading would indicate that your battery is incapable of sustaining a charge and must be replaced.

7. Check that the problem lies with the battery and not the alternator. Attach the voltmeter to the battery terminals while the vehicle is idling. If the meter reads somewhere in the range of 13.5 to 14.5 volts, your charging system is fine; ***less than 13.5, however, indicates a problem with the alternator rather than the battery .***

2.4 Analyzing Battery Troubles

Overcharging and *Undercharging* are the two main causes of battery troubles.

2.4.1 Overcharging:

- If a vent-cap battery requires frequent addition of water, it is probably being overcharged.
- Overcharging damages the plates and shortens battery life

The exposed plate surfaces may be ruined.
- Overcharging causes excess heat that can crumble the plates
- The high voltage that causes overcharging also damage other electric and electronic components

2.4.2 Undercharging

- Recharge a dead or discharged battery
- Try to determine the cause of undercharging

Possible causes include:

1. Charging-system malfunction
2. Defective connections in charging system 3.
   Excessive load demands on battery 4.
   Defective battery

5. Self-discharge resulting from battery sitting idle for long periods
6. Excessive key-off current drain

2.5 6 important tips for Battery maintenance of a car

Car batteries are full of toxic chemicals and have to be dealt with especially when they die. The green thing to do is to squeeze as much life out of them as possible and decrease the overall amount of batteries that you are going to need in your lifetime. Here are some tips for that.

1. Park in a Garage

A thoroughly insulated garage will keep your battery warm in the winter. Skip heated garages. They will rust your car.

2. Keep Your Battery Clean

Remove the clamps and clean away grease, dirt and oxidation. A filthy battery connection will weaken the charge.

3. Insulate Your Car Battery

if you don't have an insulated garage, you can always insulate the battery. It's a cheap way to protect the battery.

4. Recharge it with Solar

you can purchase an inexpensive solar charger for your car battery.

The charger refills your battery's charge with solar energy.

5. Add Distilled Water

if you're stretching the life of a conventional battery, you may have to add some water to it.

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Chapter 3

Lubricant leakage

3.1 Lubrication:

Lubrication is the process, or technique employed to reduce wear of one or both surfaces in close proximity, and moving relative to each another, *by interposing a substance called lubricant between the surfaces to carry or to help carry the load (pressure generated) between the opposing surfaces*.

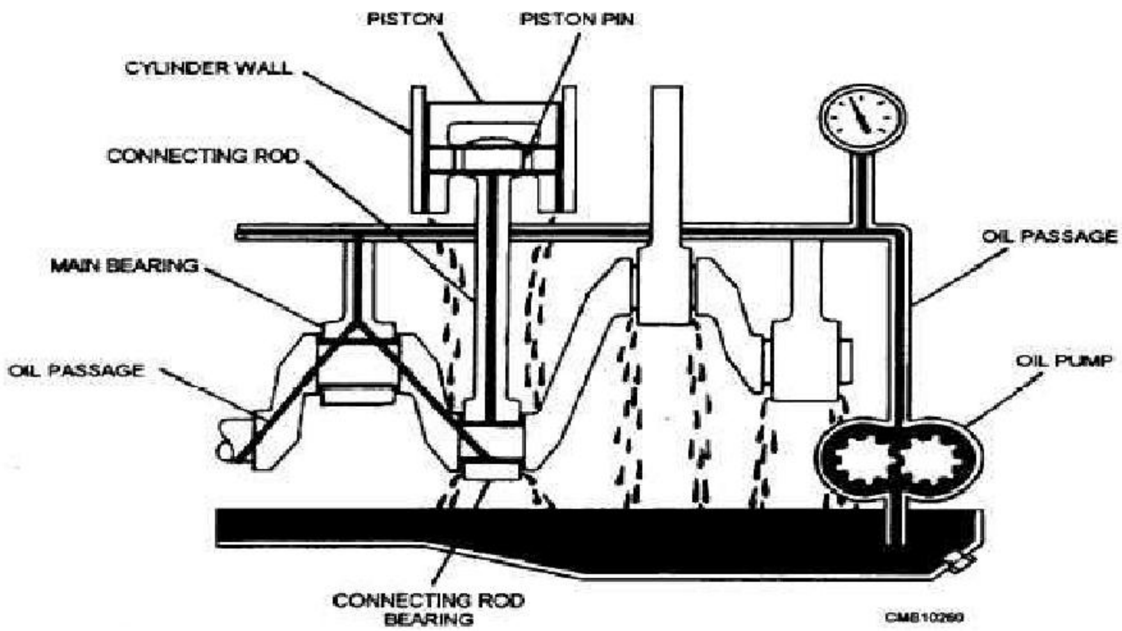

Figure 3.1—Typical full force-feed lubrication system.

This passage not only feeds the piston pin bearings but also provides lubrication for the pistons and cylinder walls. This system is used in virtually all engines that are equipped with full-floating piston pins, as shown in the figure above**.**

3.2 Introduction:

Oil leaks are usually indicative of a car problem that will get worse over time. If the leak is due to a gasket failure, the oil will eventually drip out. While a minor transmission leak just causes stains, a major leak will lower the transmission fluid too low and allow gear parts to grind themselves to the point of failure.

An engine leak will allow oil to seep out onto a hot engine. This can cause a fire. Alternatively, if the engine oil leaks out to the road, enough leakage will drain the engine oil level and the engine could seize up due to lack of lubrication.

To troubleshoot an engine lubricating system, begin by gathering information on the problem. Ask the operator questions. Analyze the symptoms using your understanding of system operation. You should arrive at a logical deduction about the cause of the problem. The four problems most often occur in the lubrication system are as follows:

1) High oil consumption (oil must be added frequently)
2) Low oil pressure (gauge reads low, indicator light glows, or abnormal engine noises)
3) High oil pressure (gauge reads high, oil filter swelled)
4) Defective indicator or gauge circuit (inaccurate operation or readings)

When diagnosing these troubles, make a visual inspection of the engine for obvious problems. Check for oil leakage, disconnected sending unit wire, low oil level, damaged oil pan, or other troubles that relate to the symptoms.

High Oil Consumption: If the operator must add oil frequently to the engine, this is a symptom of high oil consumption. External oil leakage out of the engine or *internal leakage* of oil into the combustion chambers causes high oil consumption. A description of the External and internal oil leakages follow below which is important from subject point of views.

External oil leakage—detected as darkened oil wet areas on or around the engine. Oil may also be found in small puddles under the vehicle. Leaking gaskets or seals are usually the source of external engine oil leakage.

Internal oil leakage—shows up as blue smoke exiting the exhaust system of the vehicle. For example, if the engine piston rings and cylinders are badly worn, oil can enter the combustion chambers and will be burned during combustion.

3.3 How to Stop Auto Oil Leaks

Oil is used to lubricate an automobile engine, automatic transmission, differential and other mechanical parts of a car. The most common oil leaks are from the valve cover of the engine. The valve cover is attached to the rest of the engine by bolts. A gasket fits between the metal valve cover and engine block to prevent oil from seeping or leaking. Normal engine use can cause the gasket to fail or loosen, causing an oil leak.

Identify the Leak

1. Find the source of the leak. Open the hood of the car and see if there is dust accumulated on an oil seep or leak. Wipe the area clean with paper towels and degreaser. Drive the car for a day or so, and check whether fresh oil can be identified at any leakage point.

2. Try torquing the bolts back to specifications. If you can access the bolts that
hold together two engine parts where the leak is occurring, make sure they are tight. You will need to check the owner's manual for correct torque for bolts. Never over tighten, or you may strip the threads for the nuts on the bolts or the threads in the engine block.

3. Clean and degrease the leak area. Drive the car for a day or so to see if that stopped the leak. If the area remains clean but you still have oil dripping off the car, look for a leak lower on the engine.

4. Check power steering lines and engine hoses for leaks by degreasing them and examining for fresh oil after driving the car for a day or so.

5. Re-torque attachments for hoses or lines if you find a leak. If the leak persists, replace the hose or line.

6. If you still have a leak, replace the gasket when possible. For example, remove the valve cover(s) and replace the valve cover gasket. Remove spark
plug wires (label them so you know how to put them back) and any other attachments depending on the model of the car.

7. Take the valve cover off and remove the old gasket.

8. Install the new gasket per manufacturer's instructions.
Replace the valve cover and torque down the nuts or bolts to manufacturer's specifications. Replace spark plug, wires and other attachments

3.4 Engine oil change

Fig. 3.2 Oil sludge

Why regular oil changes are so important? What will happen if I miss my oil change?
Engine oil has limited life - after a certain point it starts losing lubricating qualities and carbonizes. Once it happens, the engine gets contaminated with carbon deposits or sludge (see the photo) that significantly shortens engine's life.

When you change oil at or before manufacturer suggested interval, you change the oil before this "carbonizing" point, engine remains clean and once refilled with new oil ready to work hard again.

If the engine oil has not been changed for long, carbon deposits start clogging the oil pick-up screen decreasing oil supply and increasing friction.
If you don't remember when you changed the oil in your car last time - just check the oil on the dipstick. And every time you change the oil, the oil filter should be replaced as well.
For correct oil type, engine oil capacity, maintenance schedule, etc. check your car owner's manual.

3.5Checking the engine oil

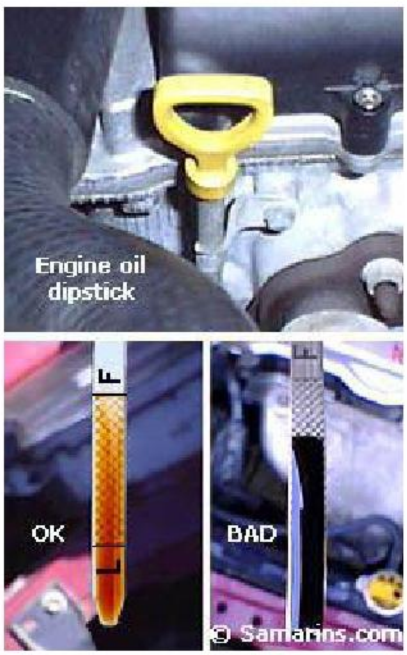

Fig. 3.3 checking the

Engine oil

Check the engine oil regularly, I'd recommend at least once a month or even more often if the car has high mileage.

Driving with extremely low oil level (less than min.)

or with low oil pressure warning lamp on may cause serious engine damage

If you note, that oil pressure gauge indicates extremely low oil pressure - have your engine inspected as soon as possible.
- While checking the oil level, look at its condition. Check the image at the left. If the oil is black like on the right image, I'd suggest changing it.
- Always use only appropriate engine oil type (usually you can find it on oil cap or in the owner's manual).
- Check your parking space for leaks. If you find any, fix it before it results in more serious vehicle problem

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Chapter 4

Spark-plug Diagnosis Analysis

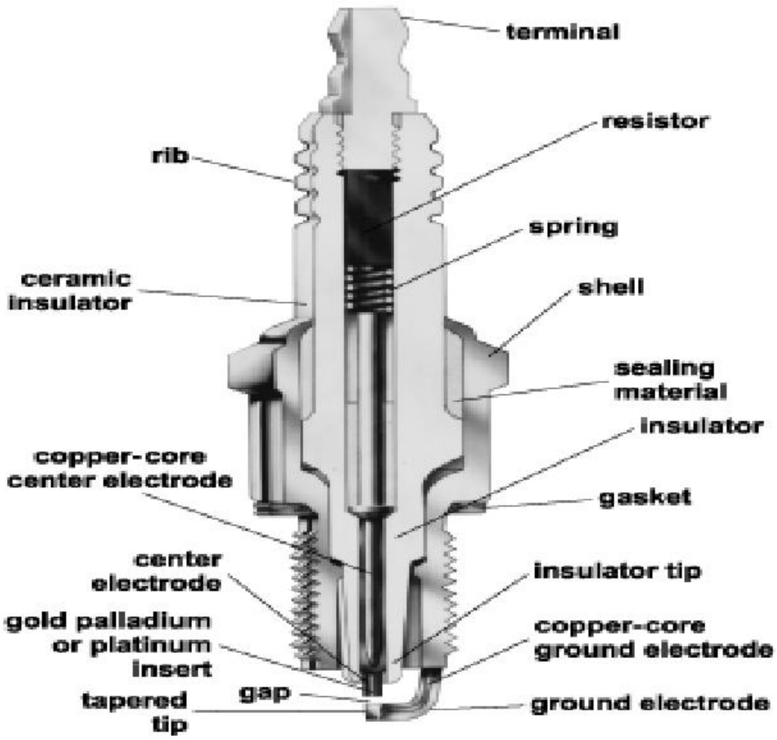
4.1 Brief Introduction of Spark-plug:

The spark plug in your automobile, lawn mower, or other gasoline combustible engine has one function, to fire properly under normal wear. When they quit firing severe engine problems can follow. Such as loss in power and knocking.

Spark plugs are a crucial part of ignition. Without properly functioning spark plugs, an engine may run poorly or not at all. It is simple to troubleshoot spark plugs, based on visual inspection and analyzing any symptoms the engine or vehicle is experiencing. Many spark plug problems can be remedied by removing the damaged spark plug and replacing it with a new plug purchased from an automotive supply store. Spark plugs are inexpensive to replace.

Fig4.1 Typical spark-plug

4.1.1 Typical spark-plug components



A spark plug is made of a material that conducts electricity encased in a ceramic body. Its threaded base screws into the top of an engine cylinder. Two electrodes on the base of the spark plug project into the combustion chamber. High-voltage current passes from the top of the spark plug to electrodes on its base. The current then arcs, or jumps the gap, between the Electrodes, igniting fuel vapor in the combustion chamber.

Fig: 4.1 Components of A typical spark-plug

4.2 Spark-plug problems and their troubleshooting

1) ONDITION: wet black deposits
CAUSE: excessive oil is entering your piston chamber. Likely due to worn and leaking rings or pistons.
SOLUTION: Rebuild the engine or keep cleaning the plugs forever.

2) CONDITION: dry black fluffy deposits
CAUSE: A dirty air cleaner, bad fuel pump, fuel is too rich or high in octane (make sure you didn't dump a bunch of aftermarket octane booster in your tank!), excessive idling, wrong type of plug - use a hotter plug.
SOLUTION: Fix one or all of the above. The plug can be cleaned and re-used.

3) CONDITION: electrode is worn to a pointed tip.
CAUSE: normal engine wear. SOLUTION: Replace plug.

4) CONDITION: Electrode is melted away or gone completely.
CAUSE: wrong type of fuel, bad engine timing, too hot of a plug type, burnt engine valves, engine overheated.
SOLUTION: Consult mechanic immediately. Replace plugs.

5) CONDITION: White tips and insulator with tiny black spots on it.
CAUSE: wrong type of fuel, engine overheating, low fuel pump pressure, engine timing is off, too hot of a plug type being used.
SOLUTION: Replace plug and repair items above. Don't re-use this plug!

4.3 Visual inspection of spark-plugs and finding their Remedies

Instruction:

1) Open the hood of the vehicle, or otherwise gain access to the engine so that you can view the spark plugs.

2) Inspect the spark plugs for a thick black coating. This layer of carbon occurs when the vehicle has been stopped and started repeatedly, the engine has a dirty air filter or the air-to-fuel ratio is off. Correct by replacing the spark plug, replacing the air filter and using the correct type of gasoline

3) Feel the spark plug to determine whether it is coated in oil, which will look wet, slick and black. Oil on a spark plug is often associated with engine misfiring. Check the engine for oil leaks and replace the plugs.

4) Check the plugs for an ash-like substance covering the plug. A normal spark plug is smooth and white, gray or brown without a powder coating like ash. The ash can be present due to additives in the fuel or oil. Do not use additives unless they are recommended by the manufacturer. Replace the plugs.

5) Adjust the gap between the two electrodes, if necessary, using a spark plug gapping tool. How much voltage the plug needs is directly related to the gap size. The vehicle's service manual will show the proper size, usually listed in thousandths of an inch and hundredths of a millimeter. Replace the spark plugs with plugs of the correct size, referring to the manual, if necessary.

6) Look at the electrode portion of the spark plug. If the electrode is melted or otherwise damaged, the spark plug may have the incorrect heat range for the engine. The engine may overheat or not work properly at high speeds. Replace the spark plug using a plug in the heat range suggested by the manufacturer.

7) Remove any damaged or dirty spark plug and insert a new plug, tightening by hand. Clean the spark plug holes then use a torque wrench to tighten the plug to the manufacturer's specifications.

4.3.1 Tips & Warnings

Over tightening or under tightening the spark plugs can damage the plugs and cause the engine to work poorly. Always install spark plugs when the engine is cool

4.4 Signs & Symptoms of Bad Spark-Plug Wires

Bad spark plug wires can lead to a host of engine troubles.

Spark plug wires are a critical link in a vehicle's electrical system.

Responsible for transporting electrical power from a vehicle's battery to its engine spark plugs, spark plug wires need to function properly to ensure normal engine operation. When spark plugs wires fail, a host of engine problems can result.

1. Rough Engine Idle

- The most common symptom of bad spark plug wires is a rough engine idle. Spark plug wires are responsible for transmitting the electrical current from a vehicle's electrical system to the engine spark plugs, where the electrical current is used to ignite the engine air/fuel mixture. Bad spark plugs wires can inhibit the normal flow of electrical current that reaches a vehicle's spark plugs, which can cause a rough, erratic engine idle.

2. Engine Miss

- An engine miss, which normally occurs as the result of erratic or incomplete engine combustion, is another common symptom of bad spark plug wires. Many times, bad spark plug wires cause the flow of electrical current to the engine spark plugs to become erratic, alternating between brief periods of normal flow and brief periods of abnormal, erratic flow. The result of this is periods of erratic and incomplete engine combustion, which can manifest itself as an engine miss.

3. Engine Hesitation

- Engine hesitation, which is normally most apparent during acceleration, is a condition that often results from either abnormal fuel flow to an engine or abnormal electrical conduction to a vehicle's spark plugs. Bad spark plug wires, whether they degrade internally or develop cracks and breaks in their outer coverings that cause electrical interference, can cause an engine to hesitate if they disrupt the normal flow of electrical current traveling from a car's battery to the engine spark plugs.

4. Reduced Engine Power

- Proper electrical conduction to a vehicle's spark plugs is needed to ensure proper engine combustion and engine power. Any abnormalities in a vehicle's electrical system, including in its spark plugs and spark plug wires, can negatively affect spark plug firing, which will influence engine combustion and engine power. Bad spark plug wires can result in significant engine power loss if they inhibit or interfere with the normal flow of electricity that reaches a vehicle's spark plugs.

5. Engine Surging

A common symptom of a vehicle electrical problem is engine surging, a condition that happens when a vehicle experiences brief spurts of adequate electrical flow to its spark plugs, interspersed with brief periods in which electrical flow is reduced or nonexistent.

Engine surging is a common symptom of bad spark plug wires, especially if the wires have cracks or breaks in their outside insulation, a condition that can create significant electrical resistance and lead to abnormal or completely stopped electrical flow to a vehicle's spark plugs.

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Chapter 5

Automotive Air Conditioning Systems and their trouble Diagnosis

5.1 Automotive Air Conditioning Systems

Today, as we drive our automobiles, a great many of us, can enjoy the same comfort levels that we are accustomed to at home and at work. With the push of a button or the slide of a lever, we make the seamless transition from heating to cooling and back again without ever wondering how this change occurs. That is, unless something goes awry.

Since the advent of the automotive air conditioning system in the 1940's, many things have undergone extensive change. Improvements, such as computerized automatic temperature control (which allow you to set the desired temperature and have the system adjust automatically) and improvements to overall durability, have added complexity to today's modern air conditioning system. Unfortunately, the days of "do-it-yourself" repair to these systems, is almost a thing of the past.

To add to the complications, we now have tough environmental regulations that govern the very simplest of tasks, such as recharging the system with refrigerant R12 commonly referred to as Freon (Freon is the trade name for the refrigerant R-12, that was manufactured by DuPont). Extensive scientific studies have proven the damaging effects of this refrigerant to our ozone layer, and its manufacture has been banned by the U.S. and many other countries that have joined together to sign the Montreal Protocol, a landmark agreement that was introduced in the 1980's to limit the production and use of chemicals known to deplete the ozone layer.

Now more than ever, your auto mechanic is at the mercy of this new environmental legislation. Not only is he required to be certified to purchase refrigerant and repair your air conditioner, his shop must also incur the cost of purchasing expensive dedicated equipment that insures the capture of these ozone depleting chemicals, should the system be opened up for repair. Simply put, if your mechanic has to spend more to repair your vehicle - he will have to charge you more. Basic knowledge of your air conditioning system is important, as this will allow you to make a more informed decision on your repair options.

Should a major problem arise from your air conditioner, you may encounter new terminology. Words like "retrofit" and "alternative refrigerant" are now in your mechanics glossary. You may be given an option of "retrofitting", as opposed to merely repairing and recharging with Freon. Retrofitting involves making the necessary changes to your system, which will allow it to use the new industry accepted, "environmentally friendly" refrigerant, R-134a. This new refrigerant has a higher operating pressure, therefore, your system, dependant on age, may require larger or more robust parts to counter its inherent high pressure characteristics. This, in some cases, will add significantly to the final cost of the repair. And if not performed properly, may reduce cooling efficiency which equates to higher operating costs and reduced comfort.

Vehicles are found to have primarily three different types of air conditioning systems. While each of the three types differs, the concept and design are very similar to one another. The **most common components** which make up these automotive systems are the following:

COMPRESSOR, CONDENSER, EVAPORATOR, ORIFICE TUBE, THERMAL EXPANSION VALVE , RECEIVER-DRIER, ACCUMULATOR. Note: if your **car has an Orifice tube, it will not have a Thermal Expansion Valve as these two devices serve the same purpose. Also, you will either have a Receiver-Dryer or an Accumulator, but not both.**

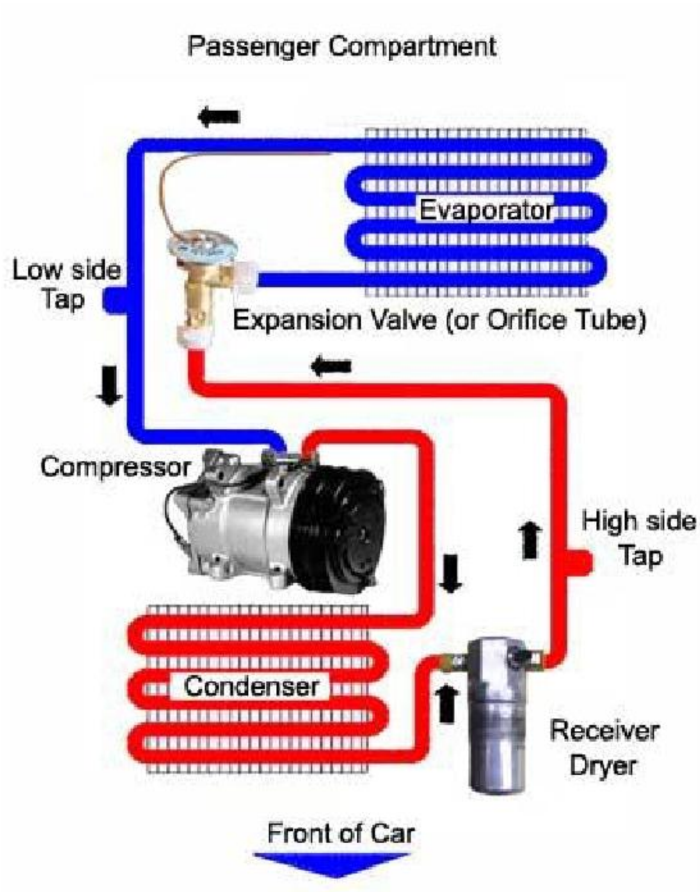

Fig.5.1 Common components of an automotive A/C

5.1.1 COMPRESSOR

Commonly referred to as the heart of the system, the compressor is a belt driven pump that is fastened to the engine. It is responsible for compressing and transferring refrigerant gas.

The A/C system is split into two sides, a high pressure side and a low pressure side; defined as discharge and suction. Since the compressor is basically a pump, it must have an intake side and a discharge side. The intake, or suction side, draws in refrigerant gas from the outlet of the evaporator. In some cases it does this via the accumulator.

Once the refrigerant is drawn into the suction side, it is compressed and sent to the condenser, where it can then transfer the heat that is absorbed from the inside of the vehicle.

5.1.2 CONDENSER

This is the area in which heat dissipation occurs. The condenser, in many cases, will have much the same appearance as the radiator in your car as the two have very similar functions. The condenser is designed to radiate heat. Its location is usually in front of the radiator, but in some cases, due to aerodynamic improvements to the body of a vehicle, its location may differ. Condensers must have good air flow anytime the system is in operation. On rear wheel drive vehicles; this is usually accomplished by taking advantage of your existing engine's cooling fan. On front wheel drive vehicles, condenser air flow is supplemented with one or more electric cooling fan(s).

As hot compressed gasses are introduced into the top of the condenser, they are cooled off. As the gas cools, it condenses and exits the bottom of the condenser as a high pressure liquid.

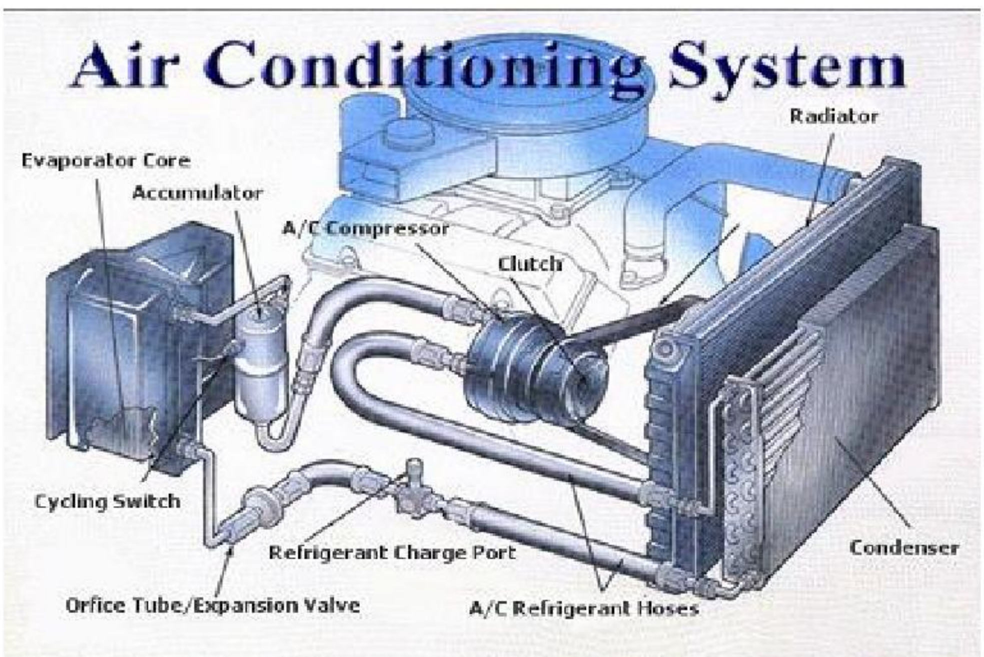

Fig. 5.2 Air-conditioner system

5.1.3 EVAPORATOR

Located inside the vehicle, the evaporator serves as the heat absorption component. The evaporator provides several functions. Its primary duty is to remove heat from the inside of your vehicle**.**

A secondary benefit is dehumidification. As warmer air travels through the aluminum fins of the cooler evaporator coil, the moisture contained in the air condenses on its surface. Dust and pollen passing through stick to its wet surfaces and drain off to the outside. On humid days you may have seen this as water dripping from the bottom of your vehicle. Rest assured this is perfectly normal.

The ideal temperature of the evaporator is 32 degree Fahrenheit or 0 degree Celsius. Refrigerant enters the bottom of the evaporator as a low pressure liquid. The warm air passing through the evaporator fins causes the refrigerant to boil (refrigerants have very low boiling points). As the refrigerant begins to boil, it can absorb large amounts of heat. This heat is then carried off with the refrigerant to the outside of the vehicle. Several other components work in conjunction with the evaporator. As mentioned above, the ideal temperature for an evaporator coil is 32 degree F. Temperature and pressure regulating devices must be used to control its temperature. While there are many variations of devices used, their main functions are the same; keeping pressure in the evaporator low and keeping the evaporator from freezing; a frozen evaporator coil will not absorb as much heat.

5.1.4 PRESSURE REGULATING DEVICES

Controlling the evaporator temperature can be accomplished by controlling refrigerant pressure and flow into the evaporator. Many variations of pressure regulators have been introduced since the 1940's.

5.1.5 ORIFICE TUBE

The orifice tube, probably the most commonly used, can be found in most GM and Ford models. It is located in the inlet tube of the evaporator, or in the liquid line, somewhere between the outlet of the condenser and the inlet of the evaporator. This point can be found in a properly functioning system by locating the area between the outlet of the condenser and the inlet of the evaporator that suddenly makes the change from hot to cold. You should then see small dimples placed in the line that keep the orifice tube from moving. Most of the orifice tubes in use today measure approximately three inches in length and consist of a small brass tube, surrounded by plastic, and covered with a filter screen at each end. It is not uncommon for these tubes to become clogged with small debris. While inexpensive, usually between three to five dollars, the labor to replace one involves recovering the refrigerant, opening the system up, replacing the orifice tube, evacuating and then recharging. With this in mind, it might make sense to install a larger pre filter in front of the orifice tube to minimize the risk of this problem reoccurring. Some Ford models have a permanently affixed orifice tube in the liquid line. These can be cut out and replaced with a combination filter/orifice assembly**.**

5.1.6 THERMAL EXPANSION VALVE

Another common refrigerant regulator is the thermal expansion valve, or TXV. Commonly used on import and aftermarket systems. This type of valve can sense both temperature and pressure, and is very efficient at regulating refrigerant flow to the evaporator. Several variations of this valve are commonly found. Another example of a thermal expansion valve is Chrysler's "H block" type. This type of valve is usually located at the firewall, between the evaporator inlet and outlet tubes and the liquid and suction lines. These types of valves, although efficient, have some disadvantages over orifice tube systems. Like orifice tubes these valves can become clogged with debris, but also have small moving parts that may stick and malfunction due to corrosion.

5.1.7RECEIVER-DRIER

The receiver-drier is used on the high side of systems that use a thermal expansion valve. This type of metering valve requires liquid refrigerant. To ensure that the valve gets liquid refrigerant, a receiver is used. The primary function of the receiver-drier is to separate gas and liquid. The secondary purpose is to remove moisture and filter out dirt. The receiver-drier usually has a sight glass in the top. This sight glass is often used to charge the system. Under normal operating conditions, vapor bubbles should not be visible in the sight glass. The use of the sight glass to charge the system is not recommended in R-134a systems as cloudiness and oil that has separated from the refrigerant can be mistaken for bubbles. This type of mistake can lead to a dangerous overcharged condition. There are variations of receiver-driers and several different desiccant materials are in use. Some of the moisture removing desiccants found within are not compatible with R-134a. The desiccant type is usually identified on a sticker that is affixed to the receiver-drier. Newer receiver-driers use desiccant type XH-7 and are compatible with both R-12 and R-134a refrigerants.

5.1.8 ACCUMULATOR

Accumulators are used on systems that accommodate an orifice tube to meter refrigerants into the evaporator. It is connected directly to the evaporator outlet and stores excess liquid refrigerant. Introduction of liquid refrigerant into a compressor can do serious damage.

Compressors are designed to compress gas not liquid. The chief role of the accumulator is to isolate the compressor from any damaging liquid refrigerant. Accumulators, like receiver-driers, also remove debris and moisture from a system. It is a good idea to replace the accumulator each time the system is opened up for major repair and anytime moisture and/or debris is of concern. Moisture is enemy number one for your A/C system. Moisture in a system mixes with refrigerant and forms a corrosive acid. When in doubt, it may be to your advantage to change the Accumulator or receiver in your system. While this may be a temporary discomfort for your wallet, it is of long term benefit to your air conditioning system.

5.2 A/C cooling problem:

The most likely cause of an automotive air conditioner cooling problem is no refrigerant in the system. If the refrigerant has escaped past a leaky compressor, leaked out of a pinhole in the evaporator or condenser, the leak needs to be identified and repaired before the system is recharged.

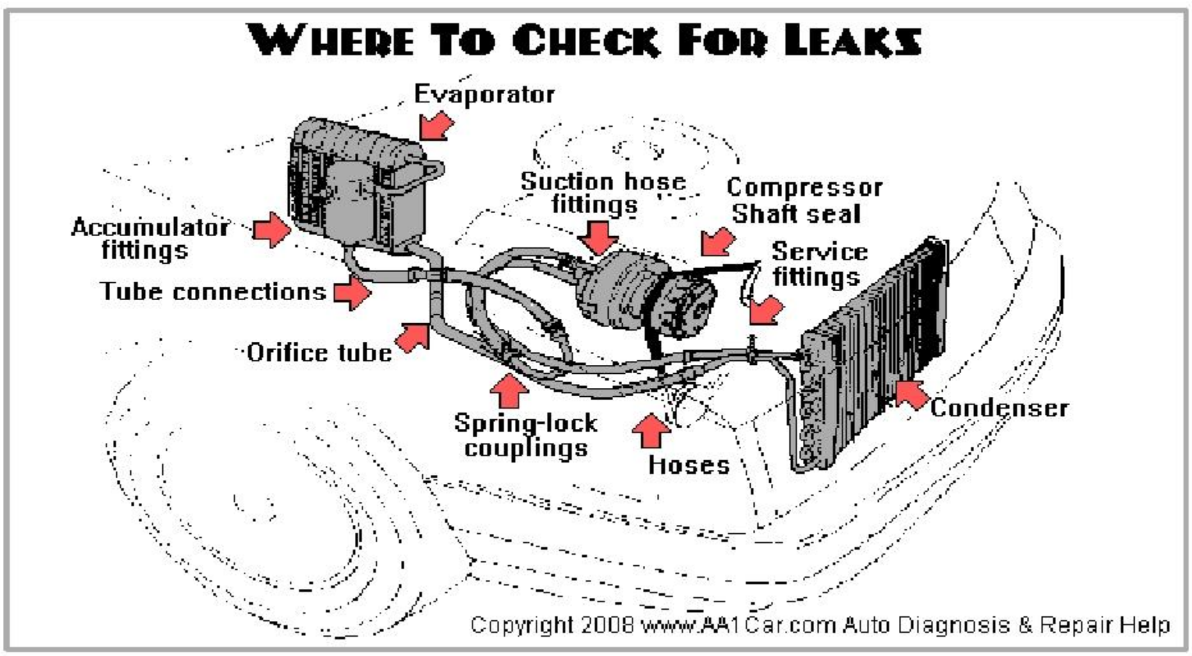

Fig. 5.3 Parts of Air-conditioner, showing where to check for the leaks

On many systems, the compressor will not turn on if the refrigerant is low because the "low pressure safety switch" prevents the compressor clutch from engaging if system pressure is low. This protects the compressor from possible damage caused by a lack of lubrication.

The next thing you should check when troubleshooting a no cooling problem is system pressure. For this, you need a set of A/C service gauges. Attach your service gauges to the high and low service fittings. If both the high and low side pressure gauges read low, the system is low and needs recharging. But before any refrigerant is added, check for leaks to find out where the refrigerant is going

5.3 AIR CONDITIONING PROBLEM: REFRIGERANT LEAKS

All vehicles leak some refrigerant past seals and through microscopic pores in hoses. The older the vehicle, the higher the rate of seepage. Newer vehicles have better seals and barrier style hoses so typically leak less than a few tenths of an ounce of refrigerant a year. But system capacities also tend to be smaller on newer vehicles, so any loss of refrigerant will have more of an adverse effect on cooling performance.

Various methods can be used to check for leaks. The telltale oil stains and wet spots that indicate leaks on older R-12 systems are less apparent on the newer R-134a systems because PAG lubricants are not as "oily" as mineral oil. This makes it harder to see leaks.

Leaks can be found by adding special dye to the system (available in pressurized cans premixed with refrigerant), an electronic leak detector, or plain old soapy water (spray on hose connections and watch for bubbles -- requires adding some refrigerant to system first and turning the A/C on). Once you've found a leak, repairs should be made prior to fully recharging the system. Most leak repairs involve replacing O-rings, seals or hoses. But if the evaporator or condenser are leaking, repairs can be expensive

A/C DIAGNOSIS CHART

Low Side	High Side	Duct Temp	Possible Cause
Low	Low	Warm	Low refrigerant charge
High	High	Warm	Overcharge of refrigerant
High	High	Some Cool	Air in the system or Overcharge
Normal	Normal	Warm	Moisture in the system
Low	Low	Warm	Expansion valve stuck closed
Low	Low	Warm	Orfice tube plugged
Low	Low	Warm	High side restriction
High	Low	Warm	Compressor or control valve failed

Fig. 5.4 A/C Diagnosis chart; indicating the problems and their possible causes

5.4 POOR COOLING PERFORMANCE

Diagnosing an A/C cooling problem is best done by connecting a gauge set to the high and low pressure service fitting on the system. Though poor cooling is often due to a low charge of refrigerant, it can also be caused by many other factors (see chart above).

How to tell if your A/C system needs refrigerant: look at the LOW pressure gauge reading when the engine is OFF. On an 80 degree day, the LOW gauge should read about 56 psi or higher if the A/C system contains an adequate charge of refrigerant. On a 90 degree day, the LOW side reading should be about 70 psi or higher. If the LOW gauge reading is less than this, the A/C system probably needs some additional refrigerant.

Refer to the vehicle manufacturer specifications for normal system operating pressures, and the total refrigerant capacity of the system. Most newer passenger car A/C systems do not hold much refrigerant (14 to 28 oz.), so you don't want to add too much if the system is low.

5.5 INTERMITTENT COOLING

An A/C system that blows cold air for awhile then warm air is probably freezing up. This can be caused by air and moisture in the system that allows ice to form and block the orifice tube.

Evacuating the system with a vacuum pump will purge it of unwanted air and moisture. Evacuation should be done with a vacuum pump that is capable of achieving and holding a high vacuum (29 inches) for at least 30 to 45 minutes.

For best performance, an A/C system should contain less than 2% air by weight. For every 1% increase in the amount of air that displaces refrigerant in the system, there will be a corresponding drop of about one degree in cooling performance. More than 6% air can cause a very noticeable drop in cooling performance, and possibly cause evaporator freeze-up.

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Chapter 6

Timing Belt troubleshooting

6.1 Introduction:

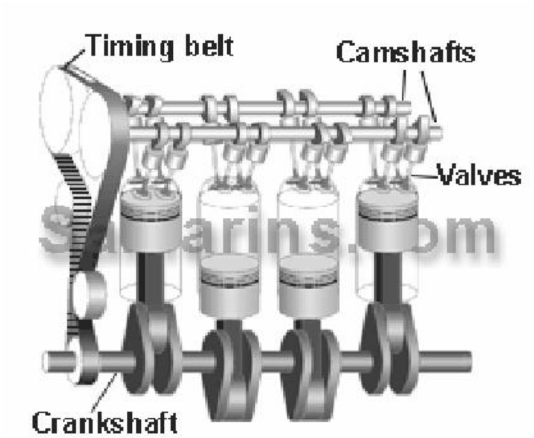

Fig.6.1 Typical 4-cylinder DOHC twin-cam engine

Fig.6.2 Timing belt in good condition, Toyota Corolla 1993 - 1997

Timing belt is a toothed belt that connects the engine crankshaft to the camshaft or camshafts as you can see in the picture.
The timing belt needed to synchronize the camshaft to the crankshaft position, so the valves will open and close at the proper time in the relation to the position of the pistons. The camshaft rotates at exactly 1/2 speed of the crankshaft; meaning two revolutions of the crankshaft are equal to one revolution of the camshaft.
Not all cars have a timing belt. Some of them use a chain or gears instead.
Mostly, you can find the timing belt in small and medium size domestic and import passenger cars. For example, 1993 - 1997 Toyota Corolla, 1998 - 2001 Honda Accord, and 1997 - 2001 Honda CR-V, 2001 - 2004 Volkswagen Passat - they all have a timing belt.

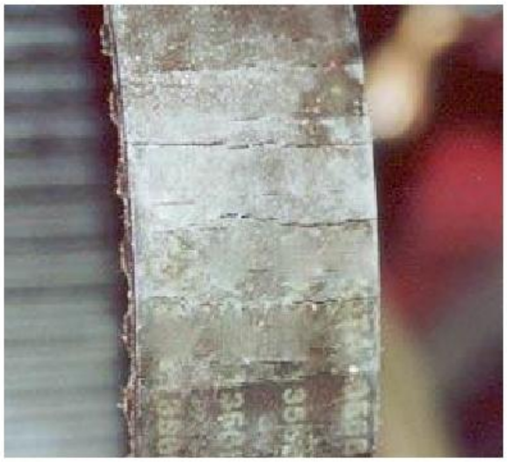

Fig. 6.3 Cracked timing belt

The timing belt must be replaced at a specified by the manufacturer interval. This interval may vary from 60,000 miles to 105,000 miles (from 96,000 km to 168,000 km). In addition, the timing belt must be replaced if it has any damage like cracks (see the picture below), cuts or excessive wear. If not replaced in time, it may break possibly causing serious engine damage. When a timing belt breaks, the camshaft stops turning leaving some of the valves in the open position. The crankshaft, because it's heavier, continues to rotate by inertia. In an *interference engine*, this will cause the pistons to strike the valves that left open. This may result in broken or bent valves, damaged pistons, and possibly, destroyed cylinder head.

The damage will be less extensive in a *non-interference engine* but in either case, the engine will stall, leaving you stranded.

6.2 Timing belt Troubleshooting


Troubleshooting vehicle belt problems can prevent expensive repairs.

The belts on a vehicle are important, as they go around the pulley, which is attached to the flywheel and controls other components. Belts power important vehicle parts, including alternators, water pumps, air conditioner compressors and power steering pumps.

Some vehicles have one belt that controls all of the components, while others may have more than one. It is important to know the types of belts on your vehicle and how to troubleshoot**.**

6.3 Instructions

1. Listen for unusual sounds coming from the engine, such as squealing or screeching. This indicates the belt is slipping off the pulley. The belt will need to be replaced as soon as possible.

2. Visually inspect the belts for cracking or fraying. The best way to do this is to use a mirror and flashlight. If there are cracks that measure more than 1", the belt should be changed immediately to prevent breakage.

3. Check the belt to ensure it is not soaked by leaking engine oil. Engine oil leaks can rapidly damage vehicle belts. Fix worn seals or gaskets before replacing the old belt.

4. Look for excess smoke coming from the exhaust. It could be a sign that the timing belt is ready to be replaced. When the timing belt is worn, the engine comes under extra pressure while operating.

6.4 Failure:

Timing belts must be replaced at the manufacturer's recommended distance and/or time periods. Failure to replace the belt can result in complete breakdown or catastrophic engine failure. The owner's manual maintenance schedule is the source of timing belt replacement intervals, typically every 60,000 to 90,000 miles (approx 96,000 to 144,000 kilometers). It is common to replace the timing belt tensioner at the same time as the belt is replaced.

The usual failure modes of timing belts are either stripped teeth (which leave a smooth section of belt where the drive cog will slip) or delamination and unraveling of the fiber cores. Breakage of the belt, because of the nature of the high tensile fibers, is uncommon. Correct belt tension is critical - too loose and the belt will whip, too tight and it will whine and put excess strain on the bearings of the cogs. In either case belt life will be drastically shortened. Aside from the belt itself, also common is a failure of the tensioner, and/or the various gear and idler bearings, causing the belt to derail.

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Chapter 7

Braking System and its troubleshooting

Fig.7.1 a typical brake system

7.1 Braking System

Brake is a device that slows or stops a moving object. Most brakes have a part called a brake pad or brake shoe that presses against a turning wheel--or a unit connected to the wheel--to produce friction. This friction converts the wheel's energy of motion to heat, slowing or stopping the wheel. Vehicles and industrial machines use a wide variety of brakes.

7.2 Vehicles are equipped with three major kinds of brakes:

(1) mechanical brakes,
(2) hydraulic brakes, and
(3) air brakes.

7.2.1 MECHANICAL BRAKES

Mechanical brakes have levers or cables that force one or two pads against the wheel. Most bicycles have two mechanical brakes called caliper brakes, one for each wheel. Each brake has two small rubber pads, one on each side of the wheel rim. The pads are mounted on a mechanical device that is connected to one end of a long cable. The other end of the cable is connected to a lever on the handlebar. When the rider squeezes this lever, force on the cable presses the pads against the wheel rim.

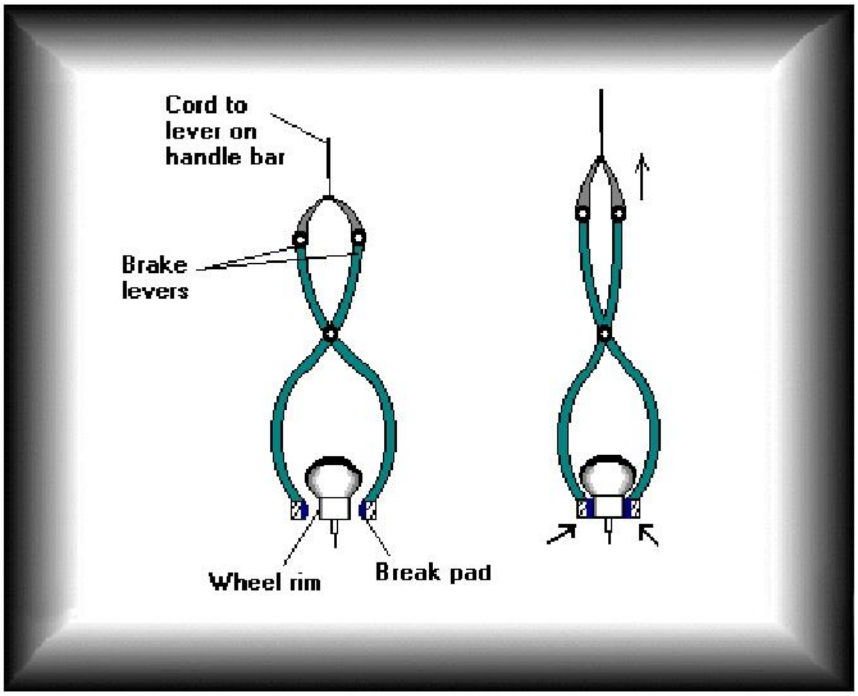

Fig.7.2 Arrangement of typical Mechanical brakes

Cars are equipped with another kind of mechanical brake called an emergency brake or hand brake. This brake is also known as a parking brake because it helps prevent a parked car from rolling away. When the driver applies the hand brake, a system of levers, rods, and cables applies pressure to the pads or shoes of the rear wheels.

7.2.2 HYDRAULIC BRAKES

Hydraulic brakes use a special liquid called brake fluid to apply brake pressure to pads or shoes. Most cars have a hydraulic braking system. The main parts of this system are a chamber called a master cylinder, which is located near the brake pedal; at least one wheel cylinder at each wheel; and tubes called brake pipes, which connect the master cylinder to the wheel cylinders. The cylinders and brake pipes are filled with brake fluid.

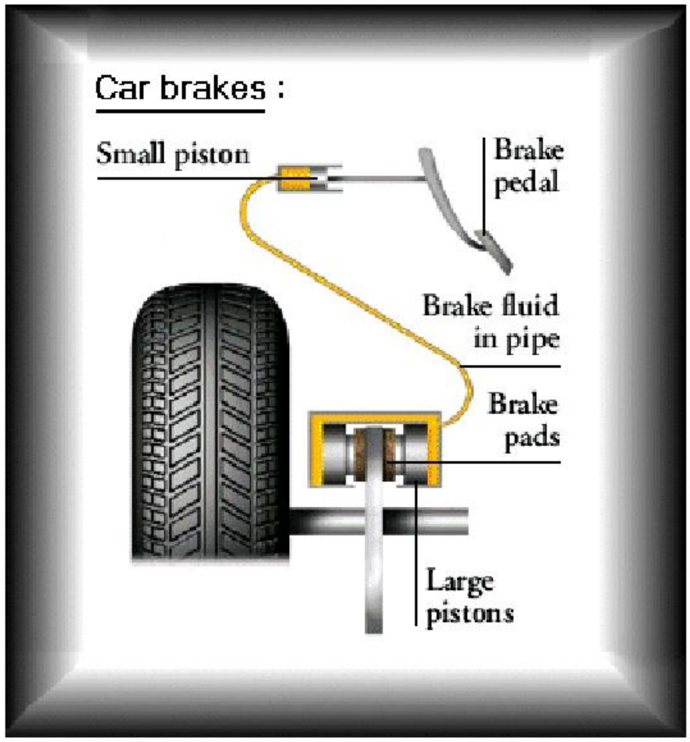

Fig.7.3 Hydraulic Brakes

Inside the master cylinder is a piston, which can slide back and forth. In a simple hydraulic system, the brake pedal controls this piston by means of a rod or some other mechanical link. When the driver pushes on the pedal, the piston inside the master cylinder exerts pressure on the fluid and slides forward a short distance. The fluid transmits this pressure through the brake pipes, forcing pistons in the wheel cylinders to move forward. As the wheel cylinders move forward, they apply brake pressure to pads or shoes.

The wheel cylinders are mounted in either disc brakes or drum brakes. Most cars have disc brakes on the front wheels and drum brakes on the rear wheels.

7.2.3 DISC BRAKES

Disc brakes have a disc, which is usually made of cast iron, attached to the vehicle's axle. The wheel is attached to the disc. A U-shaped caliper assembly fits around a part of the disc but does not rotate with the disc. This assembly includes one or two wheel cylinders, each containing a piston and two brake pads--one on each side of the disc. The pads are flat pieces of metal lined with a heat-resistant material. When the brake is applied, the pads press inward against the disc.

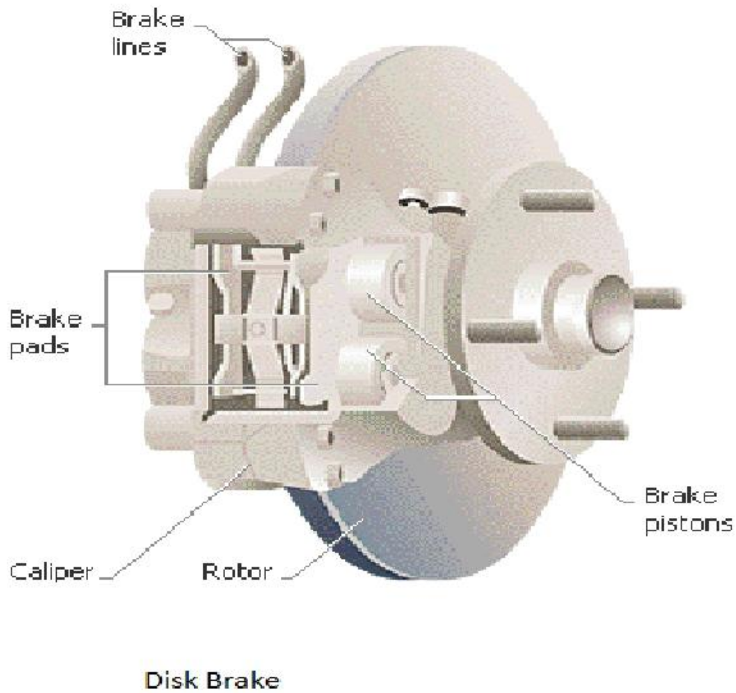

Fig.7.4 Disk brake system

7.2.4 DRUM BRAKES

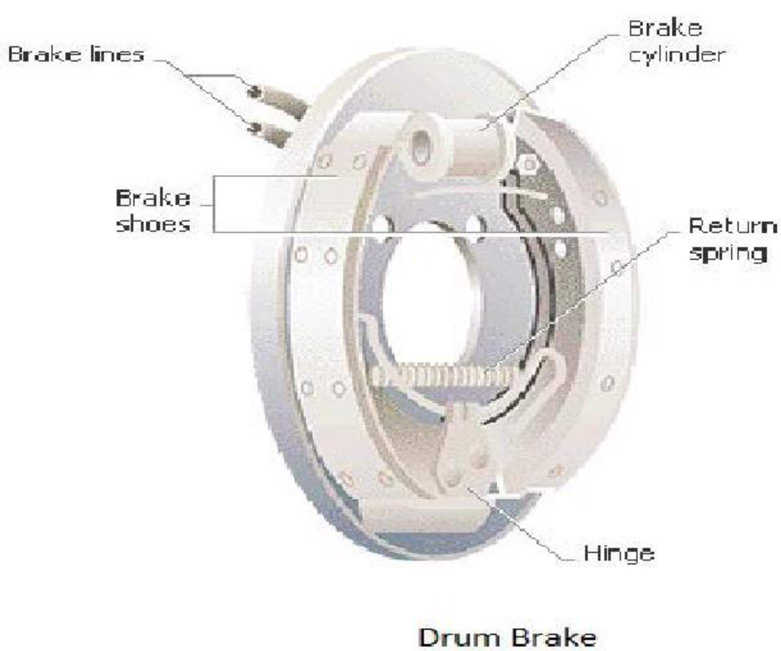

Fig.7.5 Typical drum brake

Drum brakes have a drum, usually cast iron, fastened to the axle. The wheel is attached to the drum. Inside the drum are two semicircular brake shoes that are lined with a heat-resistant material. The shoes do not rotate with the drum. Between the shoes is a wheel cylinder. This cylinder has two pistons, which push in opposite directions--one against each shoe. When the brake is applied, the shoes press outward against the drum.

7.2.5 POWER-ASSISTED BRAKES

Power-assisted brakes provide additional brake pressure in most cars. A device called a booster is mounted between the brake pedal and the master cylinder. When the driver steps on the pedal, the booster uses the difference in pressure between the vacuum in the engine and the surrounding atmosphere to apply additional pressure to the piston in the master cylinder.

7.2.6 ANTILOCK-BRAKE SYSTEMS

Antilock-brake systems are installed in some cars to prevent wheels from locking and skidding on wet or icy roads. One type of antilock-brake system (ABS) includes a sensor at each wheel and a tiny computer called an electronic controller. A device known as a pressure-modulating valve assembly is mounted between the master cylinder and the wheel cylinders. Electric wires connect the sensors to the controller and the controller to the valve assembly.

The sensors send electric signals that represent wheel speed to the electronic controller. When a sensor indicates that a wheel is locking, the controller transmits a signal to the valve assembly. The assembly, in turn, applies pulses of brake pressure to the brake of the locked wheel. This pressure alternately applies and releases the brake. Pulsing continues until the wheel rotates normally.

Traction control, available in some cars with antilock brakes, prevents wheels from slipping. When a sensor indicates slippage, the electronic controller applies brake pressure to the slipping wheel. If more than one wheel is slipping, the controller reduces engine power until the wheels stop slipping.

7.2.7 AIR BRAKES

Air brakes use compressed air supplied by a machine called a compressor. Most buses, heavy trucks, and trains have air brakes. When the driver or engineer applies the brakes, a storage unit releases compressed air. The air pushes against a piston or diaphragm, which applies brake pressure to pads or shoes. Buses and trucks have disc and drum brakes like those in cars. In trains, however, shoes press against the outside of the wheel.

7.3 Trouble shooting car's brake system

Maintaining a well-functioning brake system reduces your risk of having a stopping-related car accident. Due to normal wear and tear, brake problems occur

Your brakes are probably the most important part of your car. Without an intake system, you'll just sit there. But at least you won't hit a tree while you're just sitting there! Seriously, brakes aren't something to play around with. If your car is having a braking problem, whether it's weak brakes, a mushy pedal, grinding sounds - whatever your brake problem is, you need to troubleshoot and repair it as soon as possible. We'll help you diagnose your braking problem so you know what repairs to make

If your car is having a braking problem, whether it's weak brakes, a mushy pedal, grinding sounds - whatever your brake problem is, you need to troubleshoot and repair it as soon as possible. The following are some of the troubles and their diagnosis of brakes.

7.3.1 Brake Pedal Goes Too Far Down to Stop.

If you step on the brake pedal and it feels like it's going too far down before you start to slow, you might have the following problems:

- **Low Brake Fluid Level:**

  Check your brake fluid. If it's low, top it off to the mark on the side of the reservoir**.**
- **Contaminated Brake Fluid:**

  Even though your brakes operate in a closed system, contaminants can still work their way into the works. Air can enter the system through the smallest hole, and you can end up with water in the system from condensation and other means. There's not really any way to check for this, but bleeding your brakes will remove the bad stuff and replace it with new fluid.

- **Worn Brake Pads:**

  Your brakes should never wear low enough to cause your brake pedal to feel low, they'll scream at you before then. But if they do get very low, you might have this problem. Replace your brake pads as soon as possible. Of course, this can be avoided with regular brake inspection.
- **Bad Brake Power Boost Unit**

  Finally, if your brake booster goes badly you'll have low brake pedal issues. Most brake boosters are vacuum controlled, so a special vacuum measurement device that connects to the brake booster is needed to check it. If it's bad, you'll have to replace the boost unit.

7.3.2 Brake Pedal Too Firm.

If you step on the brake pedal and all of a sudden it feels like you're doing leg presses at the gym with a new personal trainer, your brake pedal may be too firm. This symptom points to a few potential problems, all of which need to be fixed as soon as possible.

- **Vacuum Problems:**
  Your brakes are easier to press because of a brake booster that gives your foot the strength of 10 men. This booster uses vacuum to help you activate the brakes.
  If there is a vacuum leak somewhere in the system, it won't have enough negative pressure to do its job. Check the vacuum system for leaks. If you find none, your brake booster is probably bad and will need to be replaced. This can be tested by a shop if you want to be sure.
- **Brake Line Obstruction:**
  It's possible for something to block brake fluid from reaching a portion of the system. This could be something in the line like a chunk of rust, or it could be a pinched brake line. Visually inspect the brake lines and replace damaged brake lines as needed.

7.3.3 Brake Pedal Goes To Floor.

If you step on the brake pedal and it has little to no pressure and goes all the way to the floor, especially if you're getting no braking:

- **Low Brake Fluid Level:**
  Check your brake fluid. If it's low, top it off to the mark on the side of the reservoir.
- **Air in the Brake Fluid:**
  Even though your brakes operate in a closed system, contaminants can still work their way into the works. Air can enter the system through the smallest hole. There's

not really any way to check for this, but bleeding your brakes will remove the air and replace it with new fluid.

- **Master Cylinder Bad:**
  A bad master cylinder will cause your brakes to have no pressure. Master cylinders cannot be repaired and will need to be replaced.

7.3.4 Weak or Spongy Brakes.

Sometimes your brakes will still work, but they seem to have grown weak. It takes longer to stop, or you get less braking power when you apply the brakes suddenly. The pedal may also feel more squishy than usual.

- **Low Brake Fluid Level:**
  Check your brake fluid. If it's low, top it off to the mark on the side of the reservoir.
- **Contaminated Brake Fluid:**
  Even though your brakes operate in a closed system, contaminants can still work their way into the works. Air can enter the system through the smallest hole, and you can end up with water in the system from condensation and other means. There's not really any way to check for this, but bleeding your brakes will remove the bad stuff and replace it with new fluid.
- **Worn Brake Pads:**
  Your brakes should never wear low enough to cause your brake pedal to feel low, they'll scream at you before then. But if they do get very low, you might have this problem. Replace your brake pads as soon as possible. Of course, this can be avoided with regular brake inspection.

7.3.5 Brakes Grabbing or Pulling.

Your brakes should apply themselves smoothly and evenly when you push the pedal. If they seem to suddenly grab, or if they are pulling the car to one side, you may have one of these problems:

- **Worn or Bad Brake Pads:**
  If your brakes are much worn, or if they have become contaminated or are otherwise bad, you'll need to replace your brake pads.
- **Bad Brake Disc:**
  Inspect your brake discs. If one or both are bad, they can cause your brakes to grab suddenly or unevenly. You'll need to replace your brake discs. They should always be done in pairs, so don't try to skimp.

7.3.6 Pedal Vibration.

If you step on the pedal and feel a vibration, you're in for some troubleshooting. There are lots of things which can cause the pedal to vibrate when you apply the brakes.

Remember, if your car is equipped with ABS (most are these days), the pedal will seem to vibrate when you brake very, very hard. The system does this to keep them from locking up. This is normal. Otherwise, check these causes:

- **Bad Brake Pads:**
  If your pads have become contaminated with oil or another substance, they can vibrate as they grip the brake rotor. You'll need to replace your brake pads.
- **Bad Brake Disc:**
  Inspect your brake discs. If one or both are bad, they can cause your brakes to grab suddenly or unevenly. You'll need to replace your brake discs. They should always be done in pairs, so don't try to skimp.
- **Car Out of Alignment**:
  If your car is out of alignment, this can cause your front end to wiggle madly, causing a vibration. Get an alignment.
- **Worn Front Suspension:**
  Any number of worn suspension parts can cause vibrations. Worn ball joints, a bad steering rack, worn tie rod ends, a bad wheel bearing or upper strut bearing, and even a bad front strut could cause it. Start checking.

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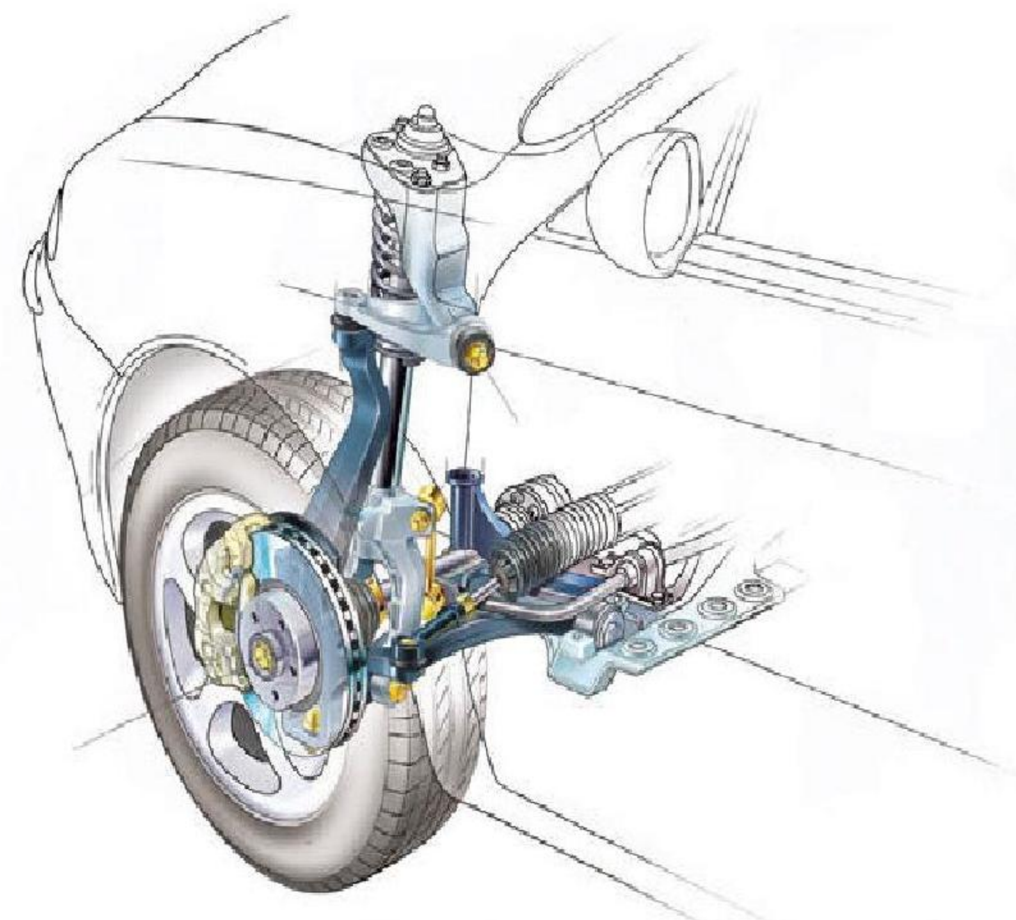
Chapter 8

Shock Absorbers



8.1 Shock Absorber

- Unless a **dampening structure** is present, a car spring will extend and release the energy it absorbs from a bump at an uncontrolled rate. The spring will continue to bounce at its natural frequency until all of the energy originally put into it is used up. A suspension built on springs alone would make for an extremely bouncy ride and, depending on the terrain, an uncontrollable car.
- **Shock absorber** or snubber: Device that controls unwanted spring motion through a process known as **dampening**.

- Shock absorbers slow down and reduce the magnitude of vibratory motions by turning the kinetic energy of suspension movement into heat energy that can be dissipated through hydraulic fluid.

8.2 Kinds of Absorbing Techniques

Shock absorbers are either gas fill or spring operated.

8.2.1Spring-Operated Shocks

The spring-operated shock absorber is equipped with a large spring. When the car hits a bump, the shock absorber lessens the feeling of the bump by compressing the spring until the bump is hardly felt.

8.2.2 Gas-Operated Shocks

Gas-operated shocks work very similar to the spring-operated type. When the vehicle hits a bump in the road, the gas inside the shock absorber compresses.
The driver feels much less of the road impact using these types of shock absorbers.

8.3 Heavy-Duty Shocks

With vehicles that are designed for off-road driving and monster truck racing, the type of shock absorbers is critical. Most use gas shocks that are much larger than car shocks. Due to the terrain that these vehicles operate on, good, fully functioning shocks are crucial.

8.4 Construction and working principle of a shock absorber

- A shock absorber is basically an **oil pump** placed between the frame of the car and the wheels. The upper mount of the shock connects to the frame (i.e., the sprung weight), while the lower mount connects to the axle, near the wheel (i.e., the unsprung weight). In a **twin-tube design**, one of the most common types of shock absorbers, the upper mount is connected to a piston rod, which in turn is connected to a piston, which in turn sits in a tube filled with hydraulic fluid. The inner tube is known as the pressure tube, and the outer tube is known as the reserve tube. The reserve tube stores excess hydraulic fluid.
- When the car wheel encounters a bump in the road and causes the spring to coil and uncoil, the energy of the spring is transferred to the shock absorber through the upper mount, down through the piston rod and into the piston.
- Orifices perforate the piston and allow fluid to leak through as the piston moves up and down in the pressure tube. Because the orifices are relatively tiny, only a small.

amount of fluid, under great pressure, passes through. This slows down the piston, which in turn slows down the spring.

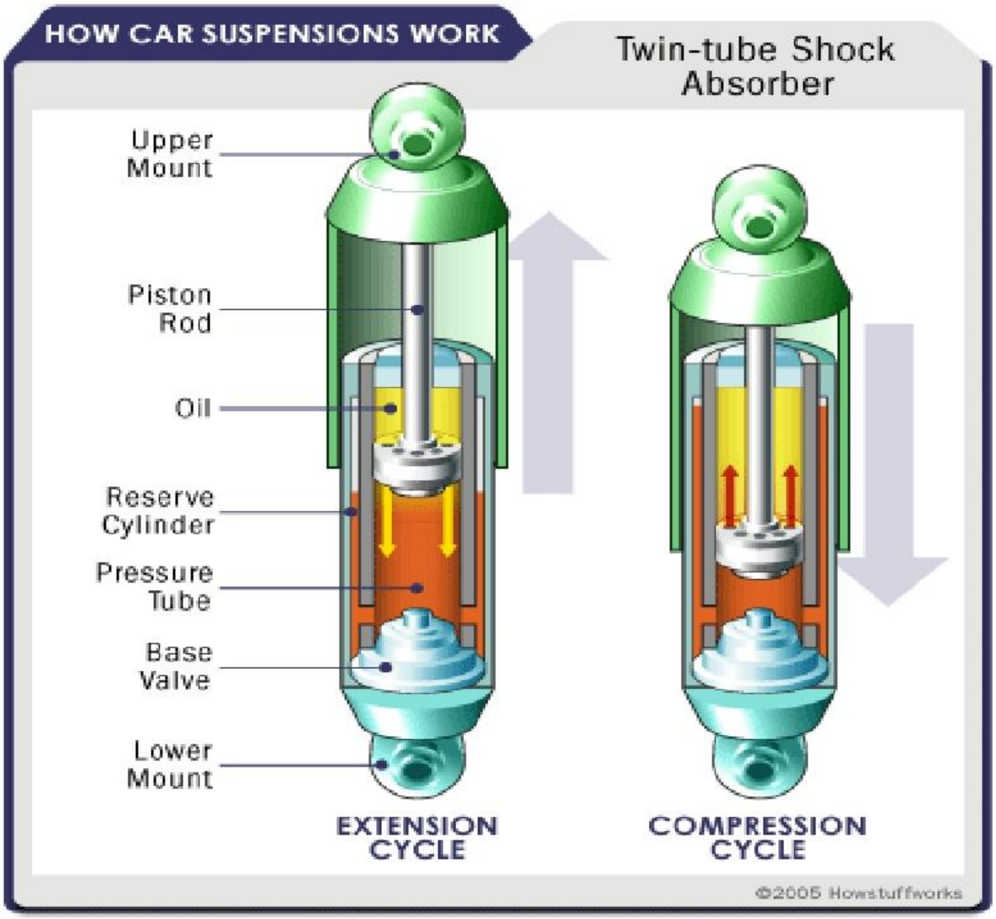


Fig.8.1 Construction and working principle of a typical shock absorber

- Shock absorbers work in two cycles -- the **compression cycle** and the **extension cycle**. The compression cycle occurs as the piston moves downward, compressing the hydraulic fluid in the chamber below the piston. The extension cycle occurs as the piston moves toward the top of the pressure tube, compressing the fluid in the chamber above the piston. A typical car or light truck will have more resistance during its extension cycle than its compression cycle. With that in mind, the compression cycle controls the motion of the vehicle's unsprung weight, while extension controls the heavier, sprung weight.

8.5 Problems that may occur in a suspension system and shock absorber

1. **Suspension topping or bottoming out**

The possible causes and their remedies could be:

- Defective spring or shock absorber; replace it
- Rubber bumper missing; replace it
- Vehicle heavy loaded; install heavy-duty shock absorber

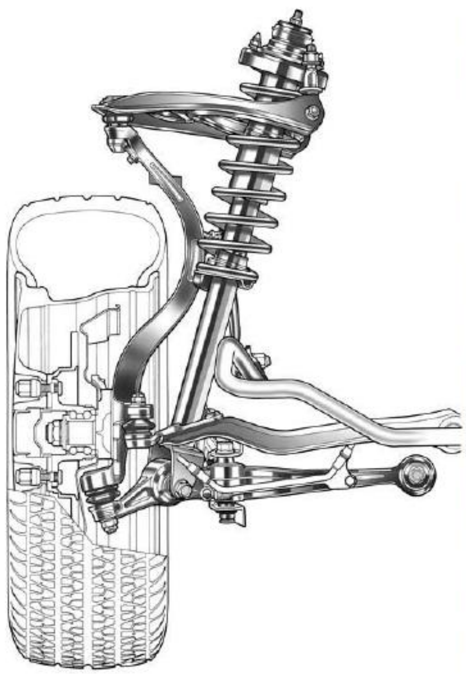



Fig.8.2 components of shock absorber that faces problems

2. **Spring breakage**

The possible causes and their remedies could be:

- Overloading; avoid that
- Leaf spring with loose centre; tighten
- Tight spring shackle ; loosen, replace

3. **Improper Suspension height**

The possible causes and their remedies could be:

- Broken leaf spring; replace
- Spring weak ; replace
- Defective shock absorber; replace

4. Noise and Vibration

- Loose, worn or unlubricated spring or suspension part ; lubricate ,tighten or repair
- Tight or dry shock absorber mounting bushings ; lubricate, install properly

5. Knocking When You Cross Bumps

When faced with this problem you would feel knocking or clunking when you go over the bumps.

Possible Causes: Most often this problem crops up when either the shock or the struts have worn out. Another cause is a worn out ball joint.
Solutions: After you assess the damage, replacement of shocks, strut bearings and ball joints are perhaps the best cure.

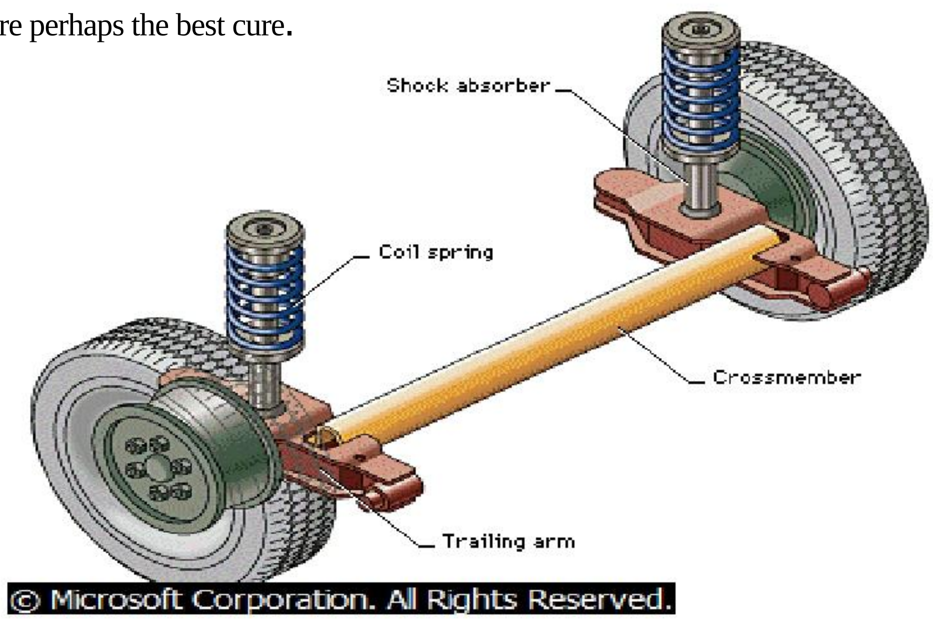


Fig. 8.3 typical Coil Spring Rear Suspension

7. The Car Bounces After You Cross A Bump

You experience that the car keeps bouncing even after you have crossed a bump.

Possible Causes: If you experience such a situation the shock of your automobile might have worn out or the leaf spring might have slipped or badly damaged.
Solutions: The shocks if they were worn would need to be replaced and so would the broken leaf spring. If the leaf spring has just slipped then a simple repair would work.

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Conclusions

Through developing this project we got a clear idea of the common problems usually occurring in an automobile and how to rectify them, which will further help us to compare it practically in our future lives.

For each problem that usually occurs, we have given a probable solution. Particularly regarding to the lubricant leakage or lubrication system problem, it has to be kept in mind that the oil or the lubricant should have a proper viscosity index based on the climate or the country that you are driving the vehicle. It is highly preferred to use multiple viscosity index for the cars running in a country that climate changes too much or it varies too much from north to south and etc. Improper viscosity index oil can severely damage your vehicle's moving parts.

Lastly, the life of a vehicle mainly depends on how you drive and maintain it. For this reason as soon as you get any problem in your vehicle, it has to be checked and rectified and the procedures we have recommended, if followed, will surely give a long life to your vehicle