Engine Mechanical Problems and Diagnosis

Valve Train Issues:

1. **Burned valve**- when heat from combustion or detonation melts away a portion of the valve preventing it from sealing or seating
    a. Will cause a misfire
    b. If popping is heard from the intake system, the intake valve is burned
    c. If popping is heard from the exhaust system, the exhaust valve is burned
2. **Worn valve guides or stems**- due to incorrect valve train geometry or lack of lubrication. This allows the valve to tip or rock during its movement which causes uneven wear and does not allow the valve to seat properly.
    a. Causes a ticking noise
    b. Causes excessive oil consumption
    c. Fouls spark plugs
    d. Can cause broken valve stem
    e. Can check for wear by pushing the valve stem with a screwdriver
3. **Leaking valve stem seals**- allows oil to leak by valve stem and guide into the combustion chamber
    a. Causes oil consumption
    b. Most noticeable by a blue puff of smoke on start up
4. **Stuck valves**- Valve gets stuck in valve guide and will not move
    a. Can happen on cars that are not started often
    b. Can indicate a lubrication issue on top end
    c. Can sometimes be freed with rust penetrant and a hammer
5. **Valve float**- when valve remains partially open at high engine speeds.
    a. Usually caused by weak or broken valve springs
    b. Weak lifters or excessive valve train clearance can also cause float
    c. Will cause a ticking noise, loss of power, backfiring, and even piston to valve contact
6. **Rocker arm and pushrods**- have little effect on performance
    a. Usually cause a ticking noise and lack of oil to valve train parts
7. **Lifters**-
    a. Cause a ticking or tapping noise that is engine speed related
    b. Lifter cannot hold oil pressure and valve spring pressure forces piston down and creates excessive valve train clearance

Timing Component Wear:

1. **Worn Timing Chain-**
   a. Chain stretches over time allowing cam and crank to be out of sync
      i. Loss of performance
      ii. Poor fuel mileage
      iii. Poor emissions
      iv. Could cause piston to valve contact
   b. Can make a slapping noise as chain slack hits side of front cover
2. **Timing belt breakage**
   a. Timing belts will dry rot, allow cogs to come off, and snap
      i. When this happens, it allows crank to move without moving the cam which will allow piston to valve contact
3. **Cam shaft wear-** cam is worn due to high spring pressure or lack of lubrication
   a. Worn lobes
      i. Reduced lift
      ii. Lack of power
      iii. Rough idle
      iv. Ticking noise from excessive valve train clearance
   b. Broken camshaft
      i. Typically happens on hollow cams
      ii. Usually caused by problems with cam journals/bearings
      iii. Causes valves not to open
   c. Cam bearings
      i. Will cause noise and low oil pressure

Gasket Failure

1. **Head gasket failure-**
   a. Overheating
   b. Misfire
   c. Coolant leakage or burning
   d. Oil leakage or burning
   e. Low compression
2. **Intake manifold gasket failure-**
   a. Vacuum leak
   b. Oil leak
   c. Coolant leak

3. **Exhaust manifold gasket failure-**
    a. Causes metallic ticking noise
    b. Allows exhaust gasses to leak out
4. **Oil pan/Valve cover/Front Cover/Main Seals**
    a. Causes oil leaks
    b. Can also cause coolant leaks

Bottom End Failure

1. **Pistons and cylinders**
    a. Piston knock/slap- loud metallic knock produced when the piston rocks back and forth in cylinder
        i. Caused from excessive piston to cylinder wall clearance
        ii. Louder when engine is cold
    b. Burned piston- when part of the piston is melted away due to excessive heat
        i. Usually caused from detonation
        ii. Causes compression loss
        iii. Can cause a knocking noise
    c. Piston pin knock- heard as a double knock
        i. Excessive clearance between pin and pin bore
    d. Oil consumption- oil is burned during combustion
        i. Caused by worn pistons/cylinder walls
        ii. Rings not sealing and scraping oil from cylinder wall
    e. Ring failure- Causes loss of compression or oil consumption
        i. Can cause poor performance or loss of power
        ii. Blue smoke from exhaust
        iii. Fouling spark plugs
        iv. Can cause blow-by of combustion gasses into crank case
2. **Crankshaft failure**
    a. Rod journal/bearing- excessive clearance between journal and bearing
        i. Causes a knocking sound that is speed related
        ii. To locate failed rod journal, shut down each cylinder until noise gets quieter or goes away
    b. Main journal/bearing- excessive clearance between journal and bearing
        i. Low oil pressure
        ii. Knocking noise similar to rod only deeper and duller
    c. Excessive crankshaft endplay- worn thrust bearings/washers
        i. Clunking heard on acceleration/deceleration
        ii. Clunking heard on shifting of trans- more noticeable on manual trans

3. **Flywheel Failure**
    a. Causes a knocking noise when engine is on
    b. Can have damaged teeth which will make noise during cranking
4. **Harmonic Balancer**
    a. Will cause a knocking noise
    b. Can throw the belt
5. **Broken engine/transmission mounts**
    a. Can cause a vibration or knocking noise
    b. Allow engine and trans to move when shifting gears or loading engine
        i. Check by loading engine/trans in forward and reverse with brakes applied and parking brake on.

Other engine mechanical symptoms:

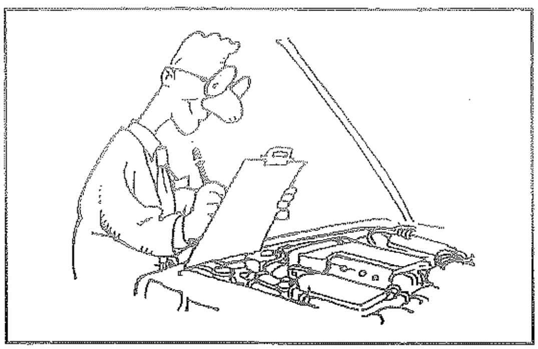
1. **Smoke from tail pipe-**
    a. Blue Smoke- Burning Oil
    b. Black Smoke- Rich fuel Mixture
    c. White Smoke- Burning Coolant
2. **RPM not normal**
    a. Usually caused by a fuel mixture issue
        i. A vacuum leak causes a lean condition and can cause a high idle or a surging idle
        ii. Surging idle can also be caused by fuel leak into the engine
3. **Misfire-** cylinder does not fire properly or at all
    a. Spark issue
    b. Fuel issue
    c. Compression issue
    d. Lack of air

A Logical Approach to Diagnosing an Engine Complaint

Objectives:

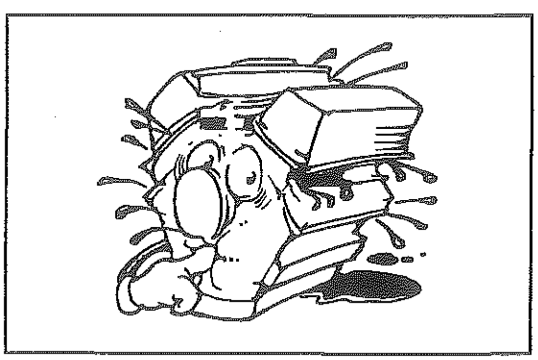
In this section you will learn to·

- Identify and describe different types of engine noises
- Associate engine noises with possible problems.
- Identify common sources of excessive engine oil-consumption and oil deposits.
- Identify engine problems caused by a faulty cooling system.



Troubleshooting or diagnostics is a process of reasoning supported by deduction and elimination. Because a problem in one part may have a definite relation to another part, the technician must look at the complete system The technician must correct the source of the problem, not just the result. For example, a scored #1 rod bearing. Was it a defective bearing or incorrect factory installation? If not, did the engine lack adequate oil or oil pressure? There are a multitude of conditions that could cause the problem By using a process of elimination and logical deduction you will be able to locate the source of the problem.

There are also sources available to the technician for diagnosing engine complaints such as listening to the customer's description of the problem, TSBs that may apply to the problem, diagnosis by symptoms, etc Some of the most common problems are:



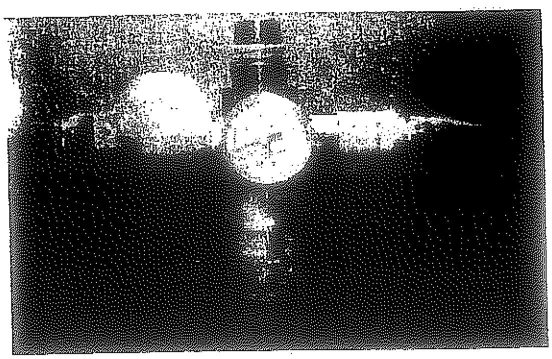
HIGH OIL CONSUMPTION

High oil consumption can result from external leakage of the oil or from oil passing through parts of the engine that are excessively worn. It will be necessary to determine the exact source, whether it is leaking from the engine or passing through the combustion chamber

1 External engine oil leaks·

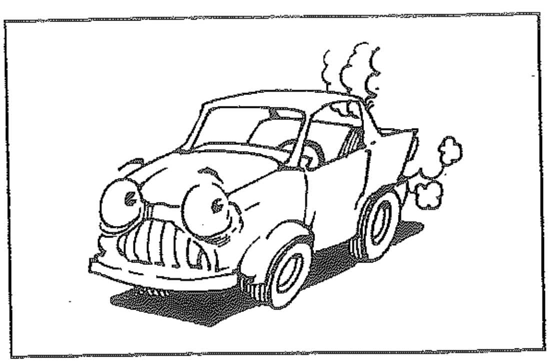
The exterior of the engine is usually covered with oil To determine the source of the oil leak, it will first be necessary to clean the exterior of the engine Then place the vehicle over a clean area and run the engine for a full fifteen minutes. Stop the engine and examine the exterior of the engine for evidence of oil leakage If, by visual inspection, the exact source of any oil leakage cannot be determined, then go to the next test

Plug the PCV hose and any other openings into the crankcase. With the engine idling, blow compressed air into the dipstick pipe



CAUTION

*Regulate air pressure at **20 PSI or less**. Higher pressures will damage seals and gaskets. Watch for oil leakage and trace it to it's source.*



2. Oil consumption through the engine·

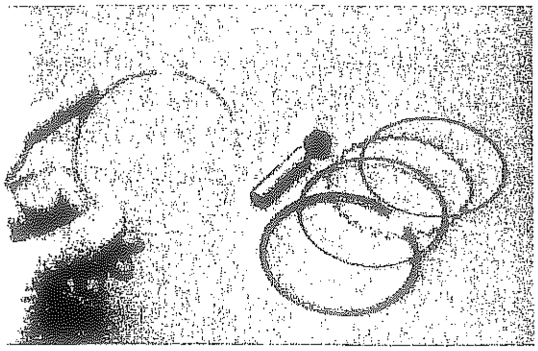
Oil consumed by passing through excessively worn parts of the engine will usually cause blue smoke to come from the exhaust, particularly after the engine has idled for several minutes. After the idle period, the throttle should be opened briefly and bluish smoke should appear. Components or conditions that can cause high oil consumption are:

1. Worn piston rings, pistons and cylinder walls
2. Clogged drain holes in piston oil rings
3. Valve seals damaged or missing
4. Worn valve stems or guides
5. Oil level too high
6. Plugged drain back in the cylinder head
7. Overheated engine
8. Excessive oil throw-off from engine bearings.

This results from oil leaking out of one or more of the bearings and being splashed or thrown up into the cylinders under the piston This creates a volume of oil that no piston ring can control The condition can be caused by excessive clearance in the bearings or high oil pressures caused by a malfunctioning oil pressure relief valve.

CAUSES OF HIGH OIL CONSUMPTION

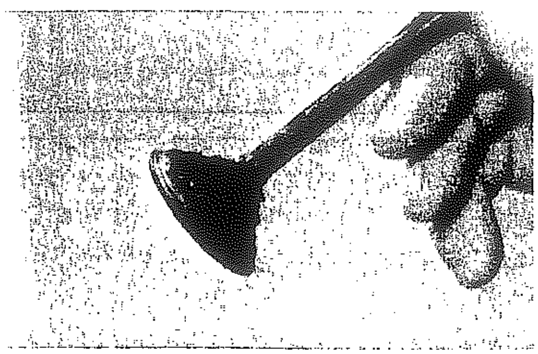
1. ***Worn piston rings, pistons and cylinder walls***
2. ***Clogged drain holes in piston oil rings***
3. ***Valve seals damaged or missing***
4. ***Worn valve stems or guides***
5. ***Oil level too high***
6. ***Plugged drain back in the cylinder head***
7. ***Overheated engine***
8. ***Excessive oil throw-off from engine bearings.***



Improved engineering in today's cars has greatly reduced piston rings and cylinders as sources of engine oil consumption problems Instead, most oil consumption problems can be traced to the cylinder head valve guides, and seals. Be sure to carefully inspect these parts when disassembling the cylinder head.

Piston Tops

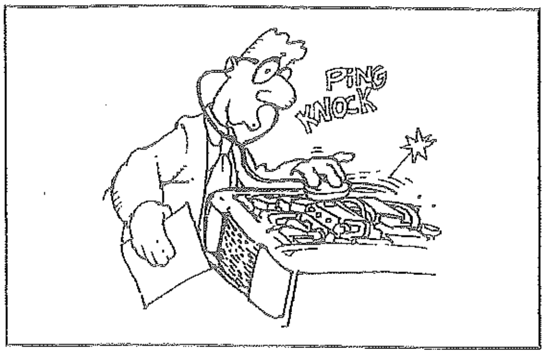
If the piston tops have dry, even carbon deposits from edge to edge, the source of oil consumption is not the rings. Oil consumption due to rings will reveal piston tops that have soft, oily carbon deposits around their outer circumference. If oil consumption is very bad, the outer circumference of the piston tops may be free of any deposits due to the washing effect of the oil



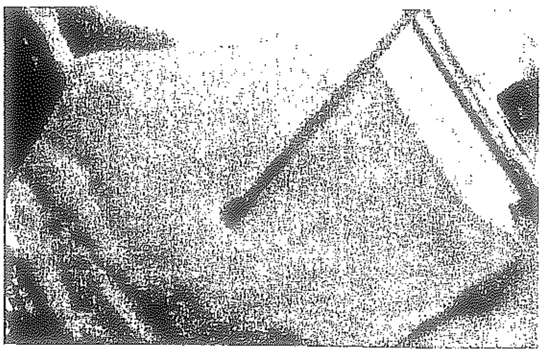
Valve Problems

If the ports and backsides of the valves have excessive soft, oily carbon deposits, the valve guides are most likely causing the oil consumption Check for valve guide and valve stem wear and for damaged seals Occasionally, an improper fit of the valve guide in the cylinder allows oil to pass by the outside of the valve guide to the port.

ENGINE NOISE

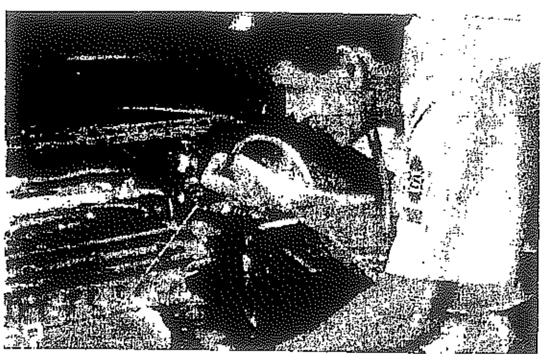


One of the most difficult diagnosis is to locate the source of noise or "knock" in an engine. Every rotating or reciprocating part in the engine is a potential source of noise. In many cases, however, certain noises possess characteristics which help identify their origin.



Diagnosing engine mechanical problems requires a thorough understanding of engine components, how they work together, and how they should sound when working together.

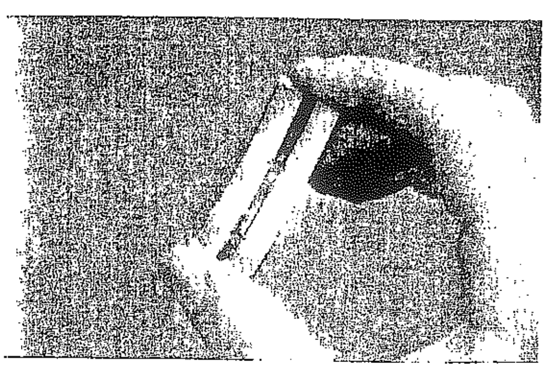
One of the first steps in diagnosing engine mechanical problems is to check the oil dipstick. Look for signs of contamination (water, fuel, particles) or discoloration from burning. Next, check the oil pressure.



Types of Noises

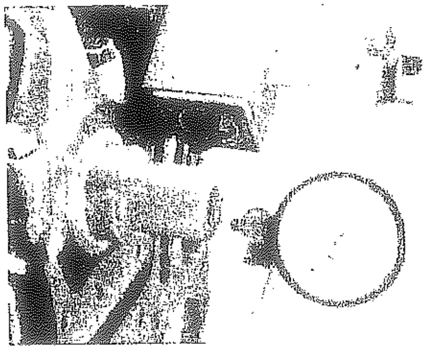
After checking oil condition, level, and pressure, listen for engine noises "Top-end" noises, such as those from valves and rockers, occur at one-half crankshaft speed, since that is when the valves operate Pinpoint top-end ticking or tapping noises with a stethoscope The stethoscope is an instrument that is extremely useful to localize noise at some definite section of the engine.

Heavier, knocking noises occur on the "bottom end" of an engine. Such noises typically come from the main bearings, rod bearings, pistons, or piston pins.



1. Main Bearing Noise

   A bad main bearing makes a dull, heavy metallic knock that pounds harder and faster as engine load and speed increase. Main bearing noise is usually not noticeable at low engine speeds when the engine is under light loads. And, it typically cannot be heard when there is no load on the engine

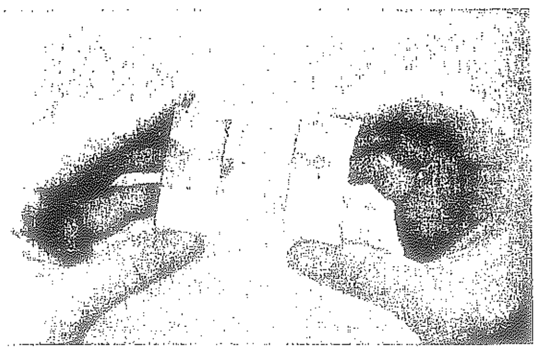


2 Crankshaft End play

Too much crankshaft end play causes an irregular, sharp rap sound Moving the clutch in and out usually causes rap to get louder

3 Loose Fly Wheel

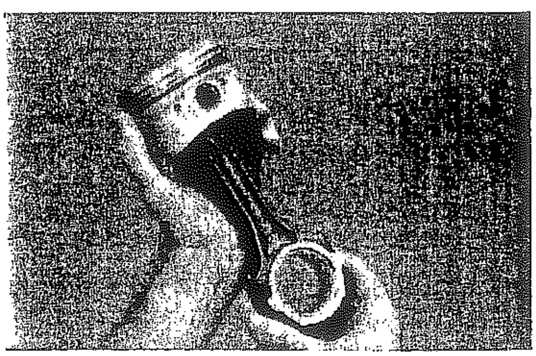
A loose flywheel makes a sharp knocking sound when the ignition is turned on This problem can be detected by turning the engine on and off at around 2,000 RPM.



4. Rod Bearing Noise

A worn rod bearing makes a sharp, rapping knock that is strongest when you rev the engine or "float" it with no load. Rod knocking usually gets louder as engine speed increases. And, it gets even louder as engine temperature rises and the oil thins

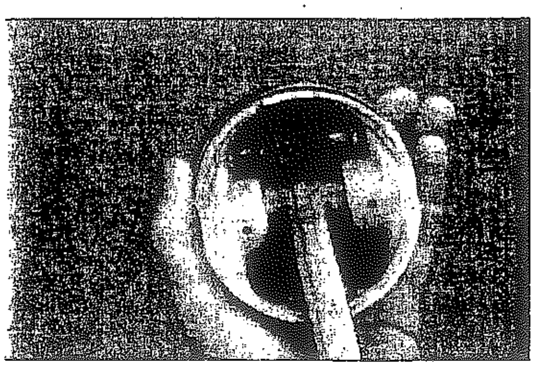
One way to determine if a connecting rod bearing is bad is to short out spark plugs one-by-one while listening for any change in noise If the sound reduces considerably by shorting a plug, then the connecting rod bearing is probably the problem.



5. Piston Noise

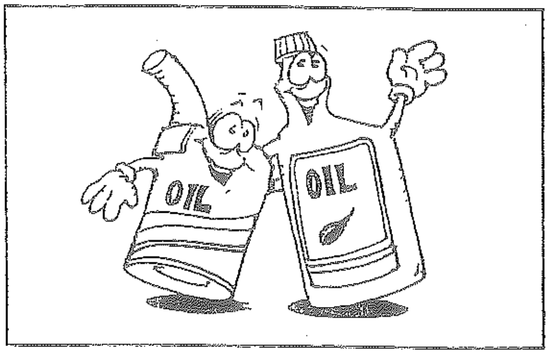
Faulty pistons make an unusually loud hollow, bell-like sound that is most noticeable when the engine is cold and the throttle is opened under a light load or no load (Keep in mind, some piston noise is normal when the engine is cold.)

Unlike connecting rod bearing noise, piston noise usually decreases as the engine warms up. You can short the pistons one-by-one to identify the cylinder with the bad piston.



6. Piston Pin Noise

A faulty piston pin sounds nearly identical to rod bearing noise, but not as intense and it's most noticeable at idle To help tell which is the problem, again, short each plug Unlike rod bearing noise, piston pin noise gets louder when the plug is shorted



ENGINE LUBRICATION (LOW OIL PRESSURE)

The quality of lubrication an engine receives has a direct effect on the life and performance of that engine. Engine oil does five major jobs:

a It reduces friction between moving parts, which lessens both wear and heat

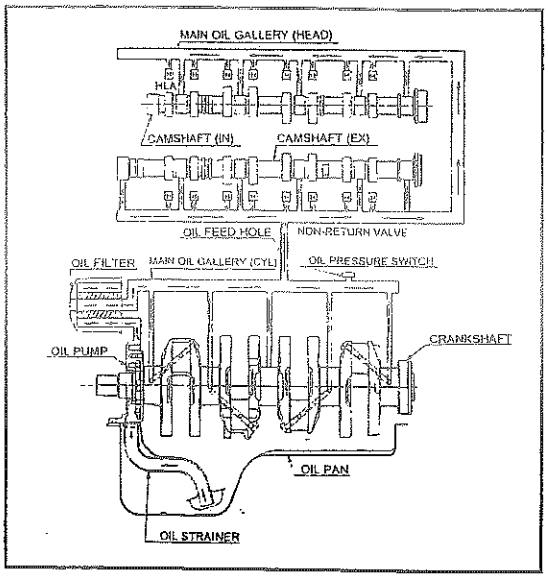
b. It acts as a coolant, removing heat from the metal of the engine.

c. It carries dirt and wear particles away from moving surfaces, cleaning the engine

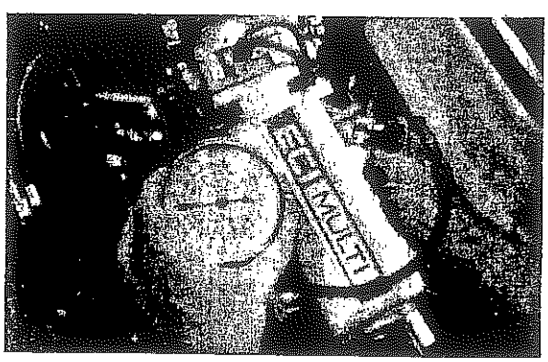
d It helps seal the combustion chamber by forming a film around the valve guides and between the piston rings and the cylinder wall.

e It acts as a shock absorber, cushioning engine parts to protect them from the force of combustion

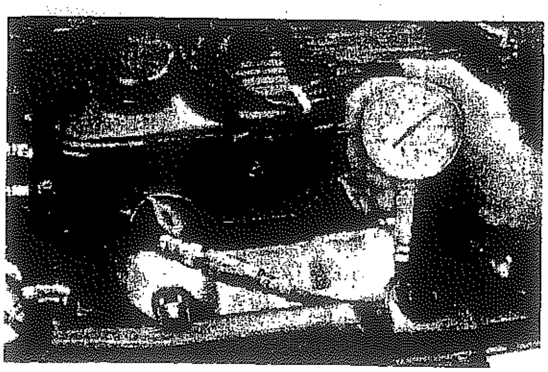
Low or loss of engine oil pressure would keep the oil from doing the job it was designed to do Usually, low oil pressure is due to excessive clearance in the crankshaft bearings (rods and mains) and camshaft bearings. Other reasons could be the oil pump, relief valve, stoppage at the pump supply line or screen. Fuel dilution in the engine oil could also cause the problem



LOSS OF VACUUM OR COMPRESSION



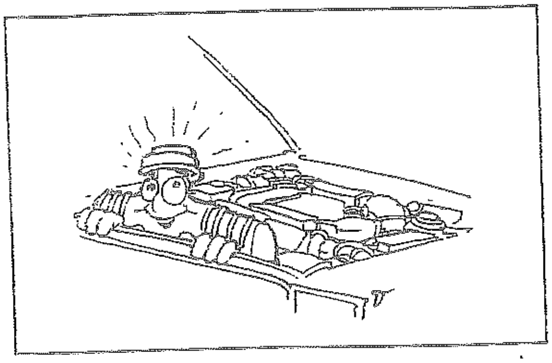
Engines in proper operating condition will create high and steady amounts of manifold vacuum Measuring the vacuum produced by an engine can pinpoint problems such as. PCV system malfunctions, intake manifold gasket and vacuum line leaks, valve and valve guide problems, incorrect ignition and valve timing, exhaust system restrictions, and poor combustion chamber sealing



The torque developed by an automotive engine is dependent on the compression produced by the piston and cylinder Compression depends on how well each cylinder is sealed by the piston rings, valve, cylinder head gasket, and also by the spark plugs. If these areas are not sealed properly, power output will drop due to the loss of compression.

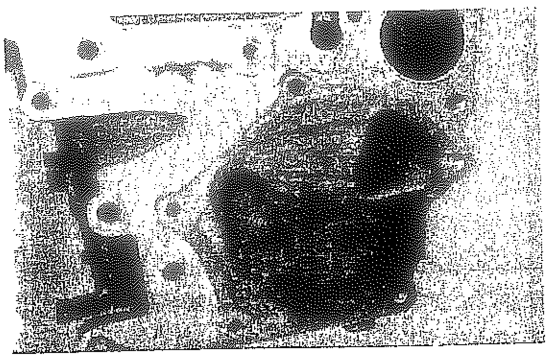
In section 6 of this training course, you will learn how to perform vacuum and compression testing on an engine.

COOLING SYSTEM



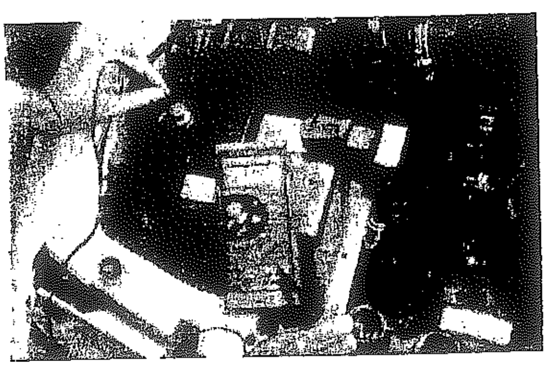
All automotive engines use a cooling system to maintain the correct engine temperature. Without such a system, the engine would quickly fail The efficiency of the cooling system has a direct effect on the life and performance of any engine. As fuel is burned in the engine, about one-third of the heat energy in the fuel is converted into power Another third goes out the exhaust unused, and the remaining third must be handled by the cooling system To give you an idea of how much heat the cooling system must handle, the amount of heat dissipated from an average automobile running at normal highway speeds is sufficient to keep a six room house warm in zero degree weather

Cooling System Problems



Rust, dirt, and other unwanted deposits can clog a cooling system and prevent it from properly cooling engine components This can cause warped or cracked valves, pistons, cylinders, or block Rust is made worse when excess air enters the cooling system (such as through a leaking water pump seal.

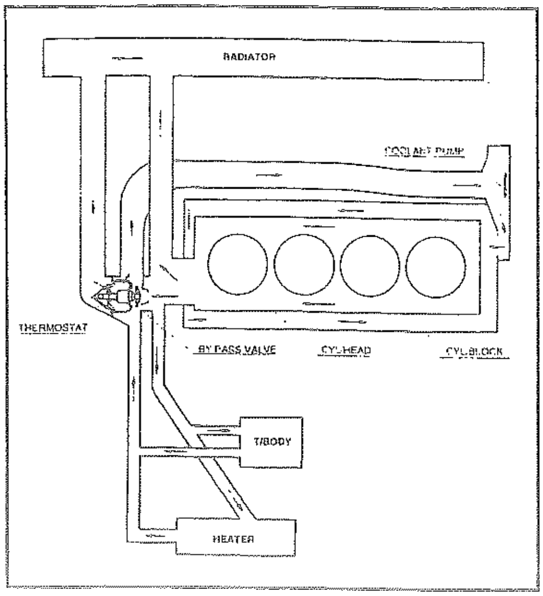
Deposits, or scaling, occur when magnesium and calcium (two minerals commonly found in water) deposit on the water jacket walls at around 140° F.



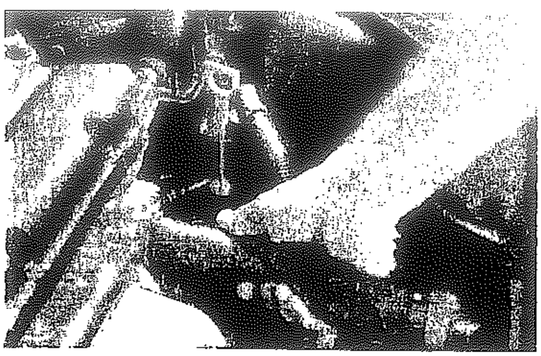
Electrolysis is the flow of electrical current resulting from two metals tha are grounded to each other and immersed in a liquid that conducts electricity Such current typically measures 0.2 to 1 volt. This process occurs normally in all engines

You can measure current from electrolysis by placing one DVOM lead in the radiator coolant and the other against the metal frame If the meter reads above 0 5 volts the cooling system should be flushed

If electrolysis is allowed to go unchecked, it can literally "eat away" at the insides of the engine



Most all late model automobiles use a "closed" cooling system which is pressurized. There are two reasons for pressurizing a cooling system to increase water pump efficiency and to raise the boiling point of the coolant Without pressure in the system, a water pump is only about 85% efficient With 14 PSI pressure in the system, the pump becomes 100% efficient, because the pressure **decreases cavitation** Also, for every 1 PSI maintained in the system, the boiling point of the coolant rises by 3° F.



SHOP TIP

Here is a quick way to check coolant flow in the radiator. Run the engine until you can feel heat in the upper radiator hose. When heat is felt, it means that the thermostat has just opened Continue to run engine for about two minutes more, then turn the engine off. Place the flat of your hand all over the radiator surface. The surface should be evenly warm. If there is a cold area, it means the coolant is not circulating in that area, indicating a clogged or restricted radiator

Quick check for air or gas leakage into the cooling system

1. With cooling system cold, add coolant to bring to proper level.
2. Install a conventional radiator cap (no pressure). Attach a length of rubber tubing to the overflow pipe
3. Operate engine at a safe high speed until it reaches operating temperature.
4. Maintain this speed and insert free end of rubber tubing into a bottle of water If a continuous flow of bubbles is seen, this indicates air is being drawn into the system from the water pump seal or from the hoses and clamps. The bubbles could also be caused by exhaust gases that are being forced into the system from a blown head gasket, cracked head, or cracked block

Engine Vacuum and Compression Tests

Objectives

In this section you will learn to properly conduct and evaluate the results of the following engine tests:

- Engine Intake Vacuum Test
- Cylinder Power Balance Test
- Cylinder Compression Test
- Cylinder Leakage Test

ENGINE TESTS

Engine Intake Vacuum Test

Cylinder Power Balance Test

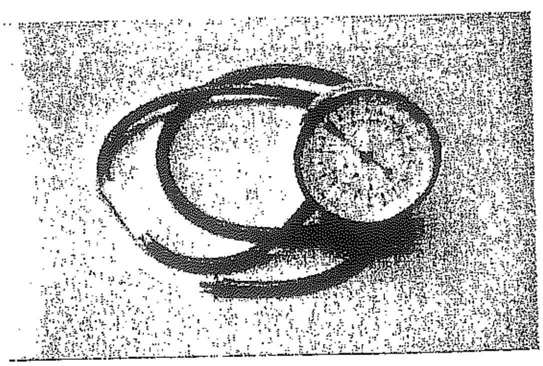
Cylinder Compression Test

Cylinder Leakage Test

Introduction

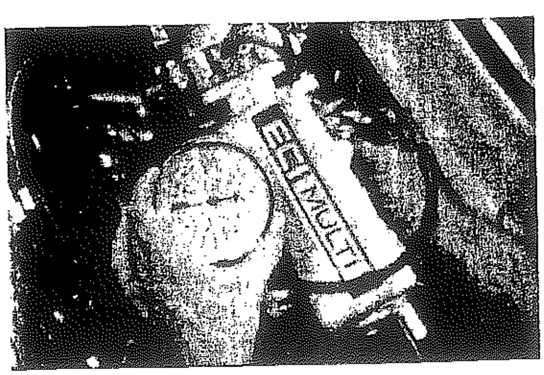
There are several vacuum/compression tests you can perform to diagnose engine problems They include the engine vacuum test, cylinder power balance test, cylinder compression test, and cylinder leakage test

The vacuum test is a general test of engine performance. The cylinder power balance and compression tests help to identify which cylinder is causing a performance problem. And, the cylinder leakage test pinpoints the cause of the problem



ENGINE VACUUM TEST

The purpose of the Engine Vacuum Test is to determine if there are leaks or restrictions in engine air intake The principa instrument used in the Engine Vacuum Test is the engine vacuum gauge. It is connected to the air intake manifold. Needle movements on the gauge can indicate conditions suc as sticking valves, tight valve lash adjustments, or a restrictior in the exhaust system.



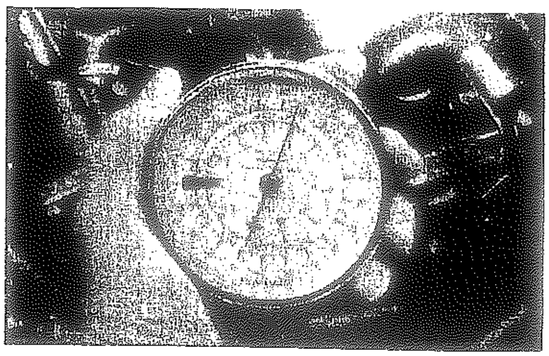
Vacuum Gauge

The vacuum gauge consists of a needle indicator and a hose that is connected to the air-intake at the carburetor or injection mixer The intake-manifold vacuum acts on a diaphragm in the gauge to move the needle

The way the intake vacuum needle moves can tell you wha kind of problem an engine may have.

Hook-up Procedure

1. Set the transmission in Park (A/T) or Neutral (M/T) and apply the parking brake
2. Start the engine and allow the engine to reach operating temperature.
3. Turn off the engine and connect the vacuum hose to a manifold vacuum source.
4. Start the engine and note the needle movement on the vacuum gauge.

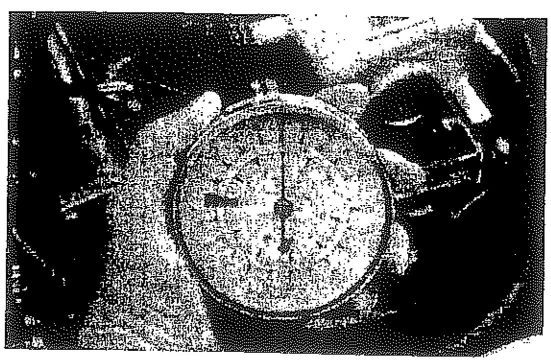


Normal Engine Vacuum:

If idle vacuum in the intake manifold is normal, the needle holds steady somewhere between 18" and 22" Hg (inches of Mercury). This refers to the way the vacuum is measured. The gauge does not contain Mercury.

NOTE. The reading will be lower at higher altitudes because of lower atmospheric pressure. For every 1,000 feet (305 m) above sea level, the reading will be reduced about 1" Hg.

If the needle is not in the normal range you need to observe the needle action as well as its reading.

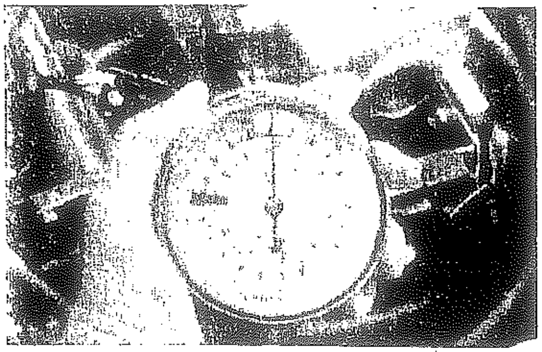


Burned or Leaking Valve

If a valve is burned or leaking, the vacuum gauge needle will drop from 1 to 7 inches of mercury each time the valve attempts to close. Because the defective valve cannot completely close, the needle shifts between normal and low in a regular pattern.

Weak Or Broken Valve Spring

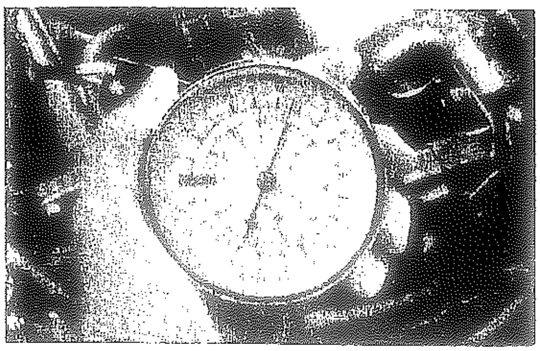
A weak valve spring will cause the needle to rapidly bounce between 10" and 20" Hg at 2,000 RPM, and the needle bouncing will increase as engine speed increases. If the valve spring is broken, the needle will bounce rapidly every time the valve tries to close at idle.



Worn Valve Guides

A worn valve guide lets too much air into the cylinder This causes a condition known as "carburetion " If a valve guide is worn, the needle reading will be lower than normal and will bounce back and forth rapidly at idle As RPM's increase, the needle will bounce less

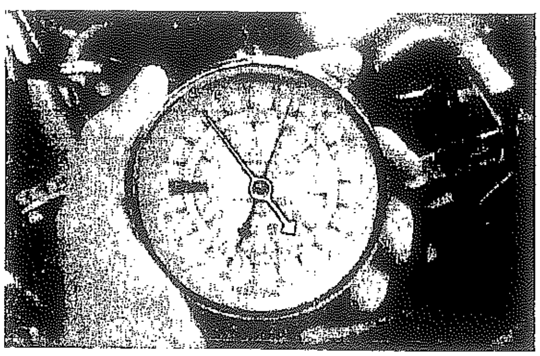
Note· Other signs, such as blue exhaust smoke on deceleration, also indicate worn valve guides (except on vehicles that have a decel valve)



Piston Ring Defect

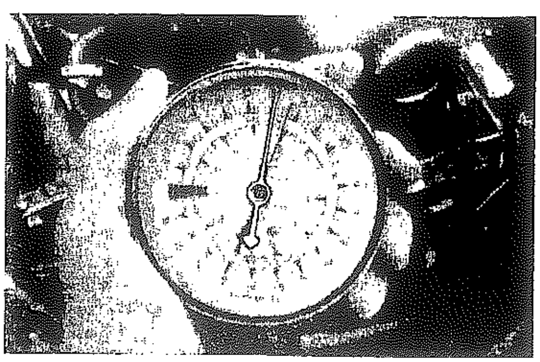
To detect a faulty piston ring open the throttle and rev the engine speed to about 2,000 RPM, then quickly close the throttle If the rings are good, the needle should jump above normal by about 2" to 5" Hg. If the jump is smaller, follow-up with a compression test.

Note this test does not work on vehicles with a decel valve as a part of the emissions control system



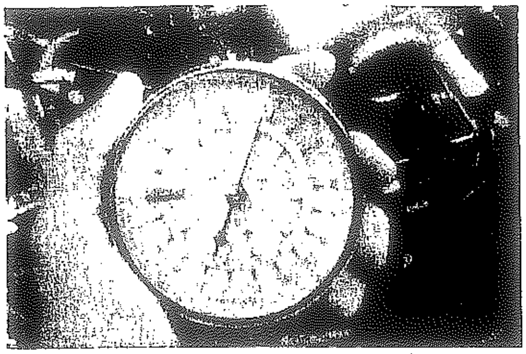
Blown Cylinder Head Gasket

If the head gasket is blown, the needle will drop sharply 10" Hg below a normal reading and return each time the defective cylinder reaches firing position at idle.



Incorrect Idle Air-Fuel Mixture

The air-fuel mixture is too rich (too much fuel in the mixture) if the needle moves slowly back and forth at idle. The mixture is too lean (not enough fuel) if the needle drops irregularly.

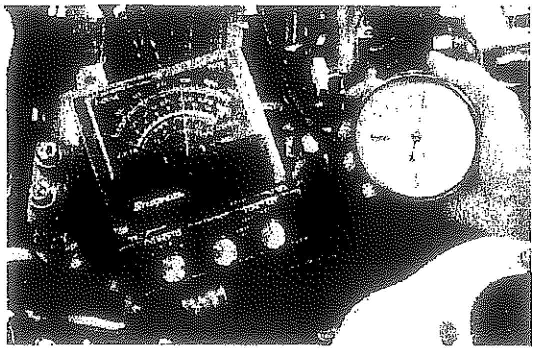


Restricted Exhaust System

If the exhaust system is restricted, the engine vacuum reading will probably be normal However, as engine speed increases, back pressure from the restriction will cause the needle to drop toward 0" Hg.

Steady, Low Reading

A steady low reading can indicate an air intake manifold leak, tight valve lash settings, or late ignition or valve timing. Try advancing the ignition timing to eliminate this as a possible problem.



CYLINDER POWER BALANCE TEST

This test helps determine if each cylinder is developing its share of engine power during the power stroke. The test is conducted with a tachometer and a vacuum gauge

In the test you disable one cylinder at a time and note the amount of change in RPM and manifold vacuum. If a cylinder is producing less power, then less will be lost from overall RPM and manifold vacuum when the cylinder is disabled.

Hook-Up Procedure

1 Set the transmission in Park (AT) or Neutral (MT) and apply the parking brake.

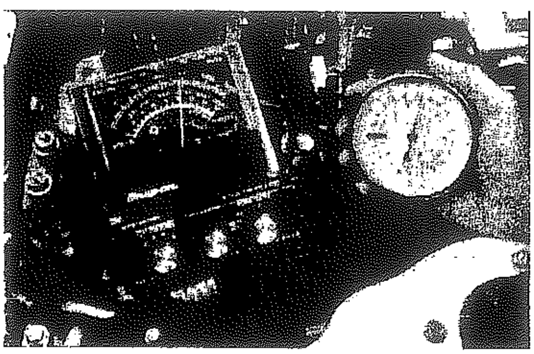
2. Start the engine and allow it to reach operating temperature.

3 Turn off the engine.

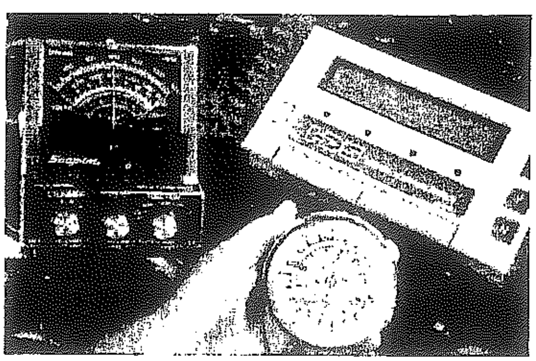
4 Connect a tachometer to the engine.

5. Connect a vacuum gauge to a manifold vacuum source.

6. Start the engine

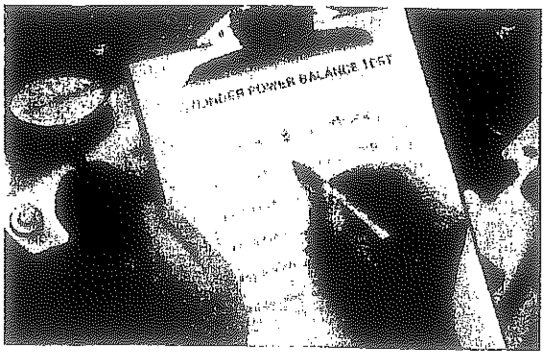


7 Adjust engine speed to between 750 to 1,000 RPM (or the RPM at which the problem occurs)



8. Short out (disconnect) one cylinder at a time and record both RPM drops and manifold vacuum levels

CAUTION: *Running the engine for a long time with a spark plug disconnected will overheat the catalytic converter.*



Interpreting Tachometer And Vacuum Gauge Readings

By comparing the readings you can determine whether each cylinder is performing properly.

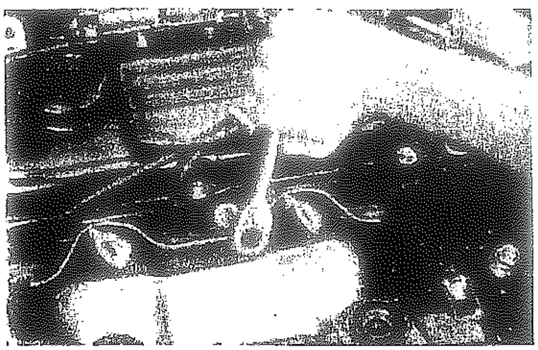
If the RPM's are the same (or within 10%), each cylinder is developing its share of the drive power. If RPM's are not the same for all cylinders, the ones with the least RPM may have ignition, carburetion, or mechanical problems. A cylinder compression test is usually necessary to determine which.

CYLINDER COMPRESSION TEST

This test identifies which cylinder is not developing its share of engine power. The test is performed with a compression tester. Pressure, operating on a diaphragm in the tester, causes the needle to move

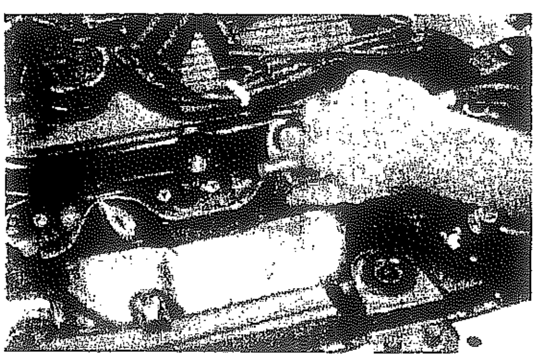
The tester measures how much pressure builds up in a cylinder during the compression stroke when the engine is cranked

A low measurement means that an individual cylinder is losing compression through the rings, valves, head gasket, or a crack in the cylinder or block. It can also indicate excessive carbon build-up in a cylinder

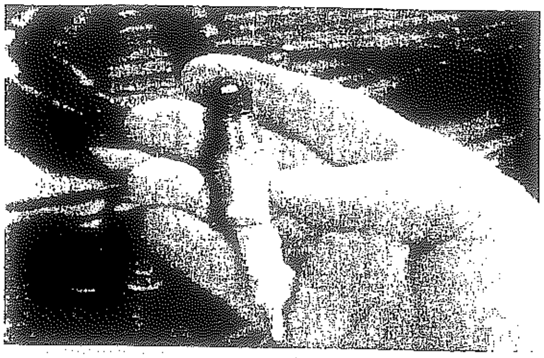


Hook-Up Procedure

1. Set the transmission in Park (A/T) or Neutral (M/T) and apply the parking brake
2. Start the engine and allow it to reach operating temperature
3. Turn off the engine
4. Disconnect the spark plug wires and loosen each spark plug one full turn.
5. Crank the engine for a few seconds This procedure helps remove particles (caused by loosening the spark plugs) so they don't obstruct valve closing



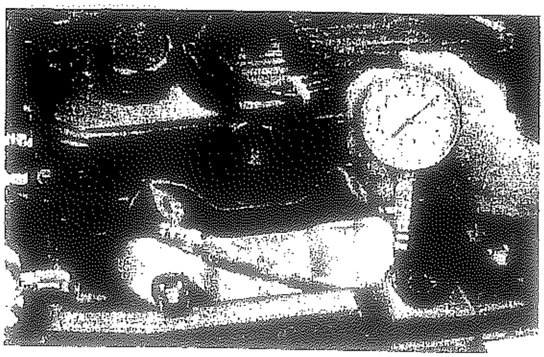
6. Turn off the engine and wear safety glasses as you clean each spark plug well with compressed air



7 Remove and inspect each spark plug Note any conditions that indicate a problem.

8. Set the throttle valve to the wide open position

9 Connect a remote starter switch to the starter solenoid.



10. Remove the coil wire and ground it using a jumper wire

11. Install the compression gauge in the spark plug hole of cylinder #1.

12 Energize the remote starter and crank the engine until cylinder compression stabilizes This means the compression strokes are completed

13. Record the gauge psi readings at the end of the final stroke.

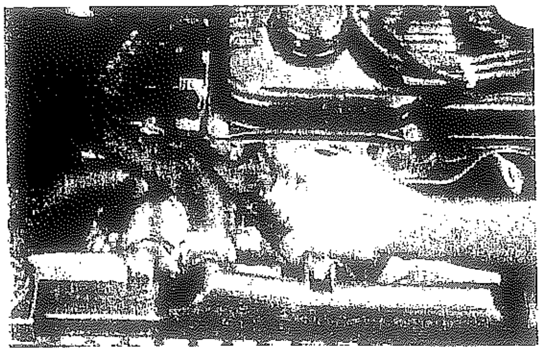
14. Repeat the above procedure for each of cylinder, each time recording the final stroke psi.

15 Compare the highest and lowest psi readings.

Interpreting Compression Tester Results

By comparing the highest and lowest readings you can identify a cylinder with low compression. Hyundai, like all auto manufacturers, specifies minimum and maximum compression pressures. (See Engine Compression Specifications Chart below.) These values are important, as are differences in pressure readings between cylinders

- A pressure that is 10% less than the highest pressure reading indicates a compression leak.
- If pressure differences between cylinders is too great, the engine cannot be satisfactorily tuned
- To further isolate the cause of the problem, you should perform the wet compression test described next



WET CYLINDER COMPRESSION TEST

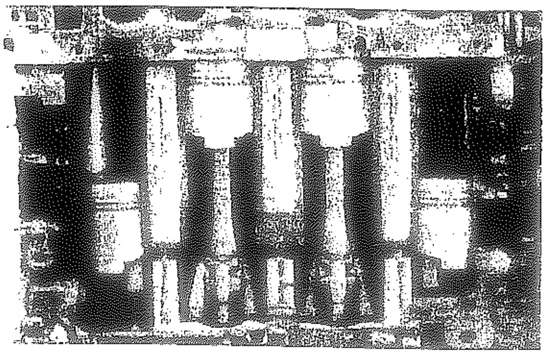
This is a quick test that can help you to determine whether a low compression test is more likely due to bad rings or faulty valves. To perform the test, do the following.

1. Pour a small amount of heavy oil into the cylinder with low compression through the spark plug hole If the rings are leaky, the oil helps seal the rings temporarily so they can hold compression better
2. Re-check compression as described above
3. If the pressure increases toward normal, the low initial reading is caused by leakage past the piston rings.
4. If adding oil does not increase compression pressure, the leakage is probably past the valves The problem could be caused by a broken valve spring, incorrect valve adjustment, worn or burned valves or seat, etc Note that to determine the exact cause of low compression, you should perform the Cylinder Leakage Test.

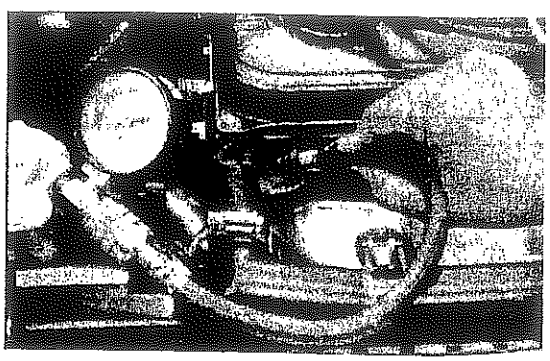
Engine Compression Specifications:	175 psi +10%
Maximum Compression Variation Between Cylinders	10%
Engine Cranking Speed During Compression Testing	200-400 RPM

CYLINDER LEAKAGE TEST

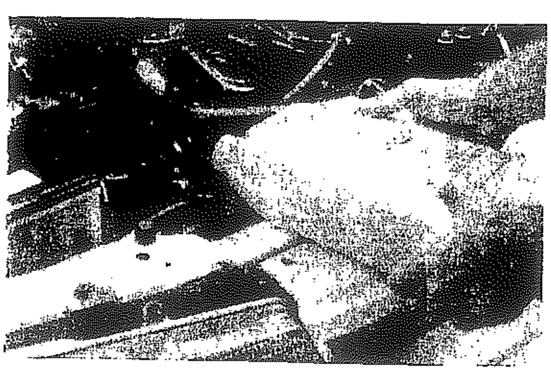
The Cylinder Leakage Test is similar to a compression test and is performed with a Cylinder Leakage Tester The test can pinpoint cylinder leaks past the exhaust valve, the air intake valve, head gasket, or piston rings In addition, it can give you a good idea of how bad a leak is



You perform the Cylinder Leakage Test by cranking the engine until the piston being tested is at TDC on the compression stroke. At this point in the engine cycle, both intake and exhaust valves are closed and the combustion chamber should be air tight except for a very small amount of leakage across the piston rings



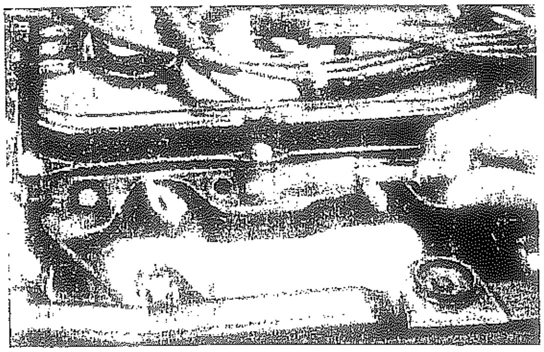
With the Cylinder Gauge Tester properly hooked up (as described below), you pump air into the cylinder and see (or hear) where it comes out.



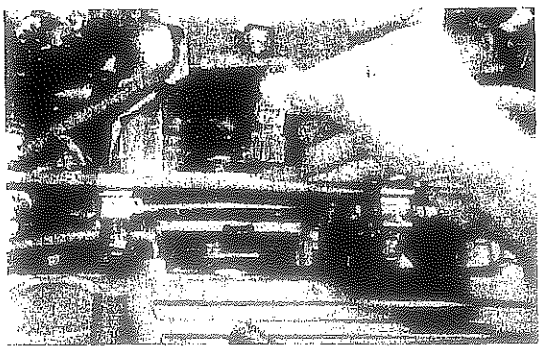
Hook-Up Procedure

1 Set the transmission in Park (A/T) or Neutral (M/T) and apply the parking brake

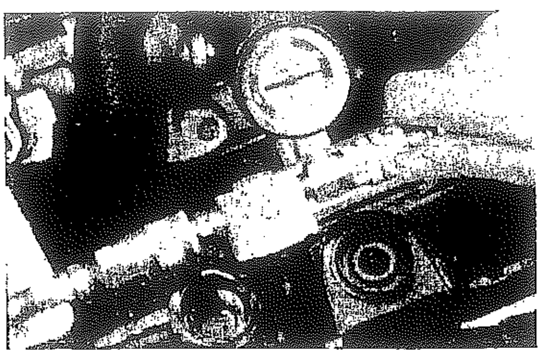
2. Remove the radiator filler cap and check coolant level Fill the radiator to filler neck



3. Remove all spark plugs



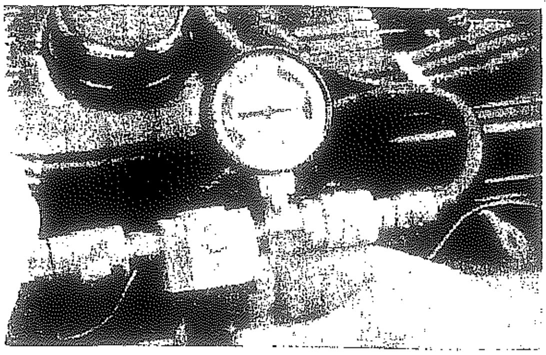
4 Disconnect the power transistor.



Using The Tester

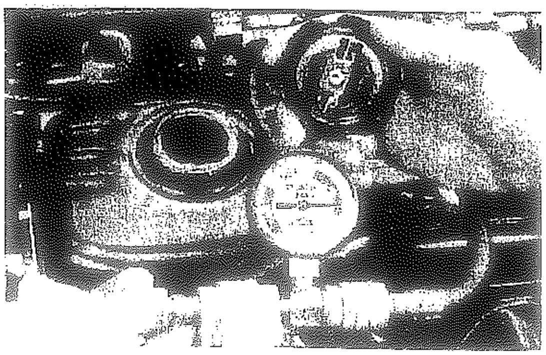
1. Following the tester manufacturer's instructions, prepare the Cylinder Leakage Tester (CLT). Preparation typically includes hooking up the CLT to shop air and connecting an adapter to the output end of the tester hose
2 Install the CLT adapter into the suspect cylinder spark plug hole

3. Remove the distributor cap then rotate the crankshaft until the distributor rotor is aligned with the spark plug wire in the distributor cap, the timing mark is at the TDC, and the rocker arms are on the base circle of the camshaft.



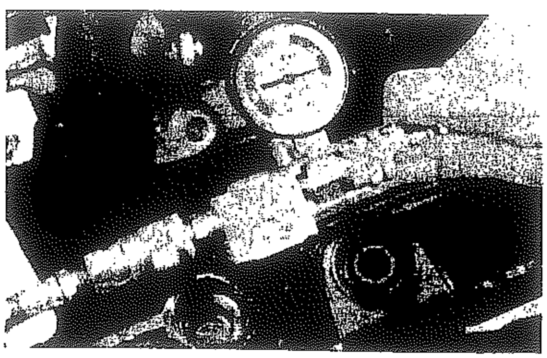
4 Pressurize the cylinder. Record the percentage of leakage shown on the CLT gauge

NOTE. *If the engine is not positioned exacting at TDC, the force of air applied to cylinder may turn the crankshaft.*



5 Listen for air escaping through the

- carburetor/injector mixer
- open spark plug holes
- exhaust pipe
- oil fill hole in the valve cover area



6. Check for air bubbles in the radiator filler neck and coolant reservoir Note where air is escaping.

7. Repeat the procedure with any other cylinders that have low compression. When you do, be sure to rotate the crankshaft until the distributor rotor is aligned with the spark plug wire in the distributor cap and the rocker arms are on the base circle of the camshaft. And, be sure that the cylinder is at TDC.

AIR LEAK:	PROBLEM:
Injector/ Carburetor	Intake Valve
Other Spark Plug Hole	Blown Head Gasket
Valve Area	Rings or Cylinder Walls
Exhaust Pipe	Exhaust Valve
Radiator	Head Gasket Cracked Block Cracked Head

Interpreting Cylinder Leakage Test Results

- Air escaping through the carburetor or injection mixer is a telltale sign that air is leaking through a defective intake valve.
- Air escaping through other spark plug holes indicates that the head gasket has blown between cylinders.
- Air escaping at the oil fill hole in the valve cover area indicates worn piston rings or that the piston or cylinder walls are badly worn or scored.
- Air escaping through the exhaust pipe indicates burned or leaky exhaust valves
- Air bubbles in the radiator or reservoir indicate either a leaky head gasket or a cracked engine block or head

Interpreting CLT Gauge Readings

The gauge readings shows the percentage of leakage from the cylinder. The greater the percentage of leakage, the worse condition the cylinder is in (See Cylinder Leakage Test Evaluation Chart below.)

CYLINDER LEAKAGE TEST EVALUATION

LEAKAGE IN PERCENTAGE	CONDITION OF CYLINDER
0-10%	Good
11-20%	Fair
21-30%	Poor
Above 30%	Problem Condition