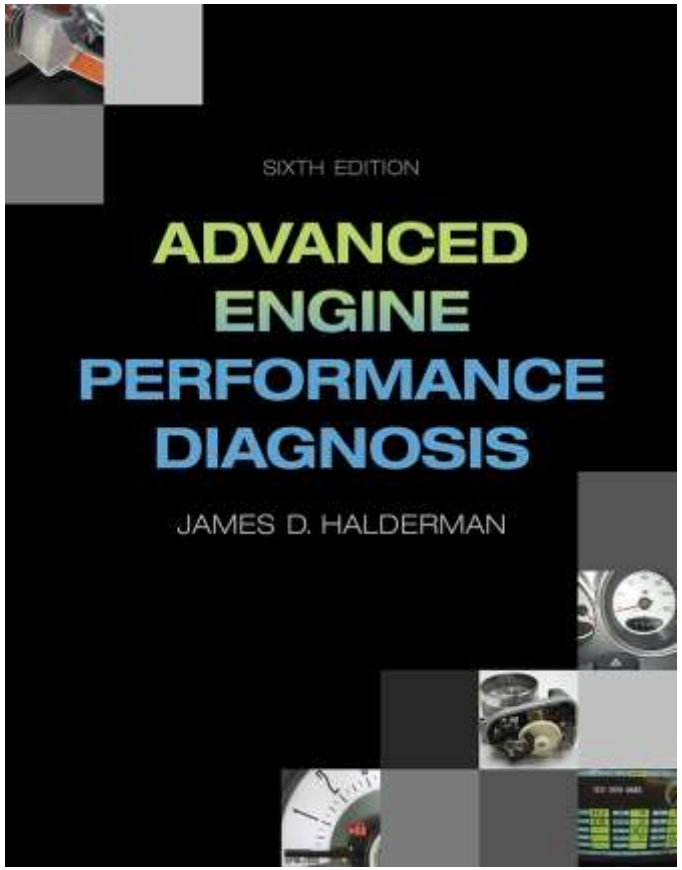
Advanced Engine Performance Diagnosis

SIXTH EDITION



CHAPTER 2

Engine and Misfire Diagnosis

OBJECTIVES

- Prepare for ASE Engine Performance (A8) certification test content area "A" (General Diagnosis).
- Discuss engine noise and engine smoke concerns and its relation to engine condition.
- Describe how to perform dry, wet, and running compression tests.

OBJECTIVES

- Explain how to perform a cylinder leakage test.
- Discuss vacuum testing to determine engine condition.
- Describe how to test for excessive exhaust system back pressure.
- List the possible causes of an engine misfire.

OBJECTIVES

- Explain how to perform a diagnostic step-by-step procedure to determine the root cause of a misfire.
- Describe how to perform a cylinder power balance, cylinder contribution test, and cylinder pressure testing.

ENGINE NOISE DIAGNOSIS; ENGINE SMOKE DIAGNOSIS

- The color of engine exhaust smoke can indicate what type of engine problem might exist
  - Blue
  - Black
  - White
- Items that may cause engine noise include the following:
  - Valves clicking

ENGINE NOISE DIAGNOSIS; ENGINE SMOKE DIAGNOSIS

- Torque converter
- Cracked flex plate
- Loose or defective drive belts or tensioners
- Piston pin knock
- Piston slap
- Timing chain noise
- Rod bearing noise
- Main bearing knock

Figure 4.1 White steam is usually an indication of a blown (defective) cylinder head gasket that allows engine coolant to flow into the combustion chamber where it is turned to steam.

Figure 4.2 What looks like an oil pan gasket leak can be a valve or cam cover gasket leak.

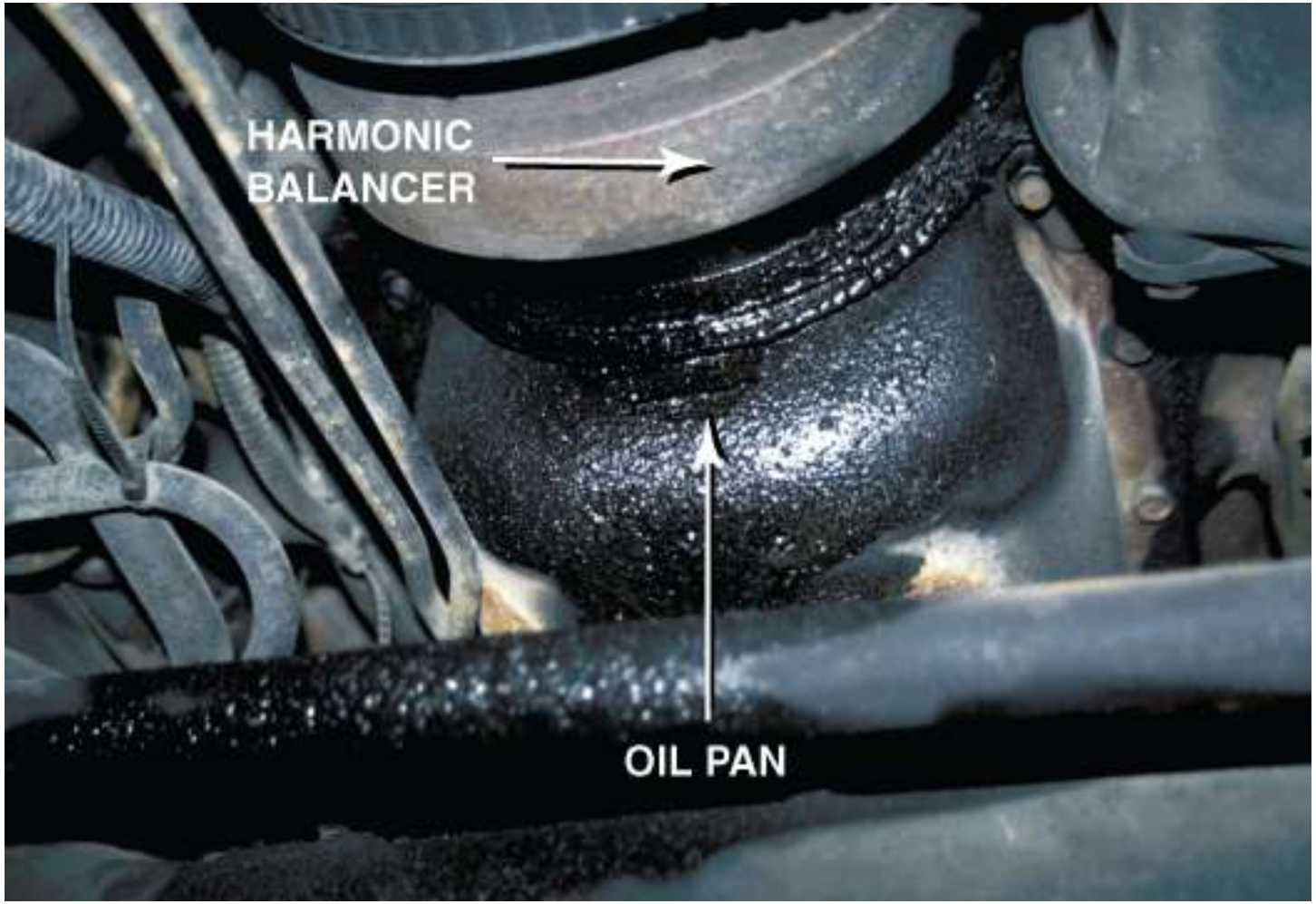


Figure 4.3 A noisy valve was discovered to be a pushrod that punched through a rocker arm on this General Motors 3.1 liter V-6 engine.

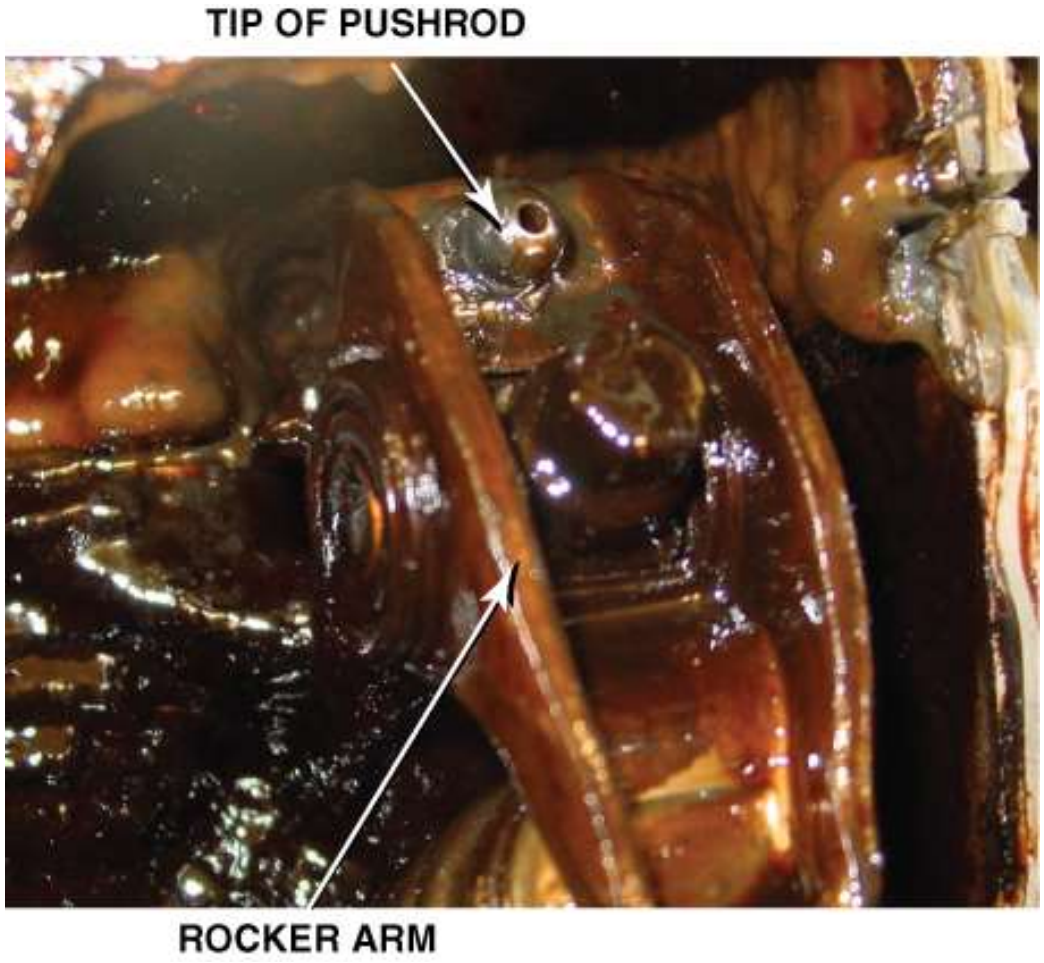
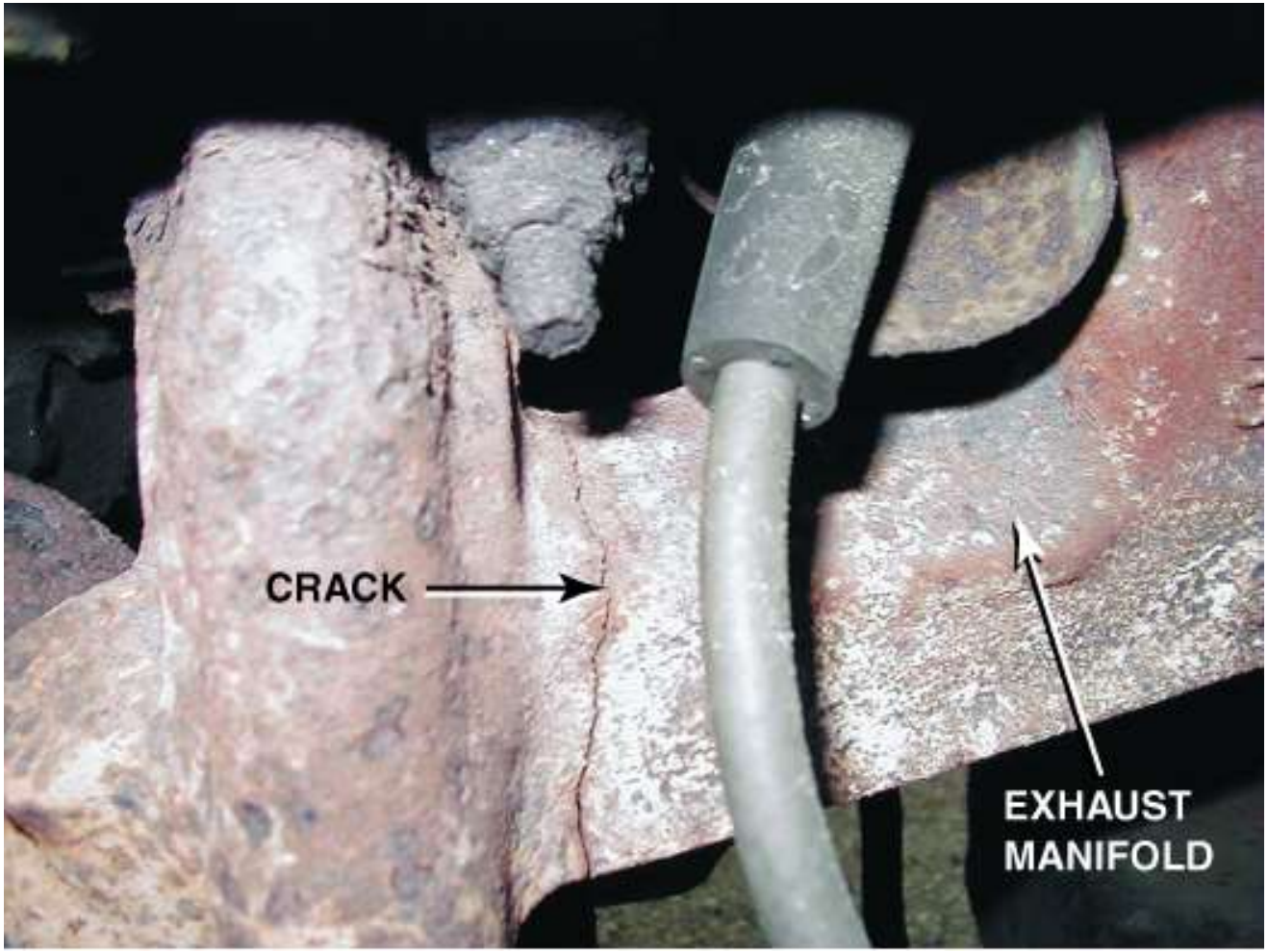


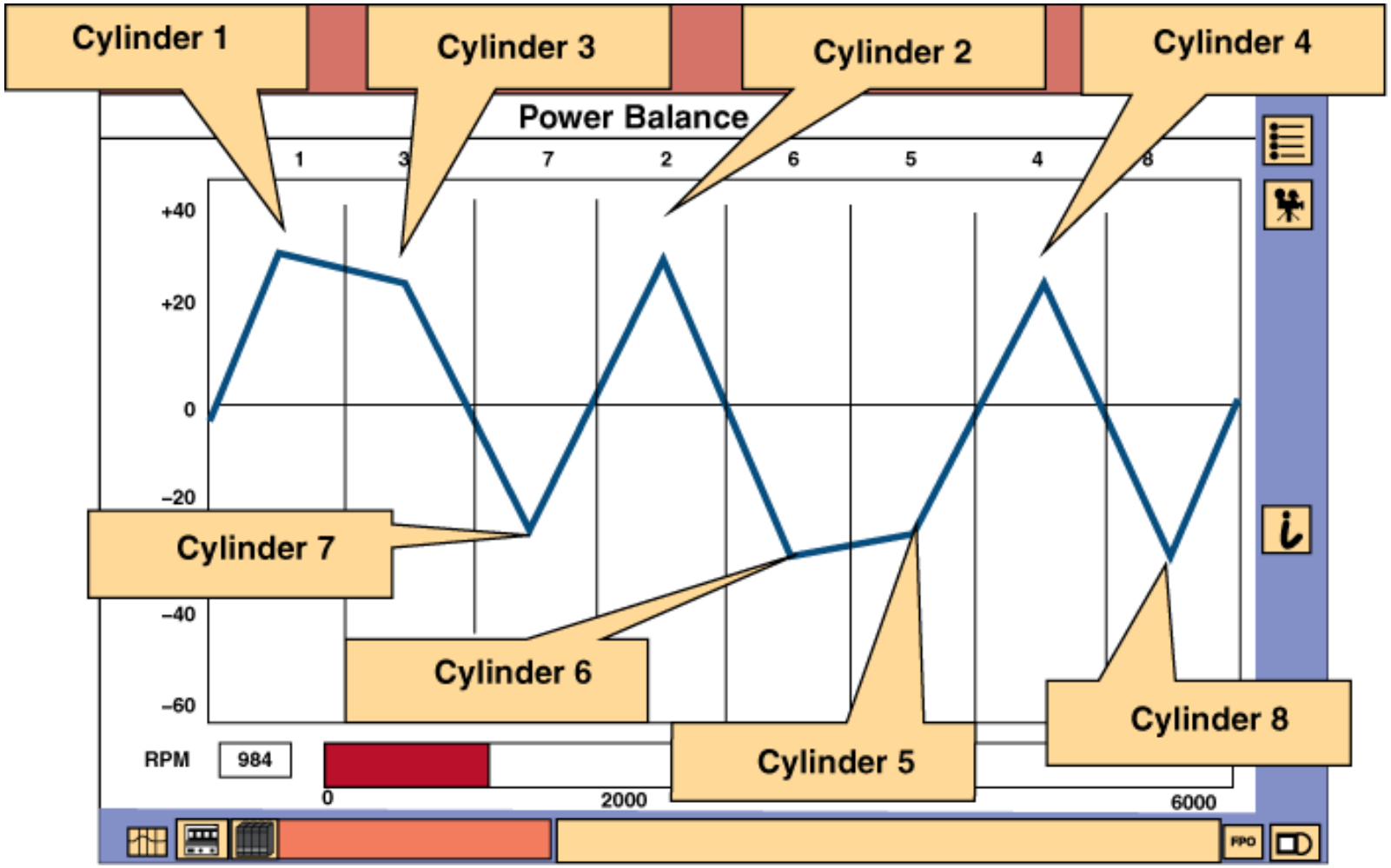
Figure 4.5 A cracked exhaust manifold can make a clicking sound that is often difficult to find.



ENGINE-RELATED MISFIRE DIAGNOSIS

- Cylinder Contribution Test
  - An automated test that a scan tool performs by turning a fuel injector off to one cylinder at the time and monitors the drop, or increase in engine speed.
  - This change in engine speed should be the same for all cylinders if all cylinders are working correctly.

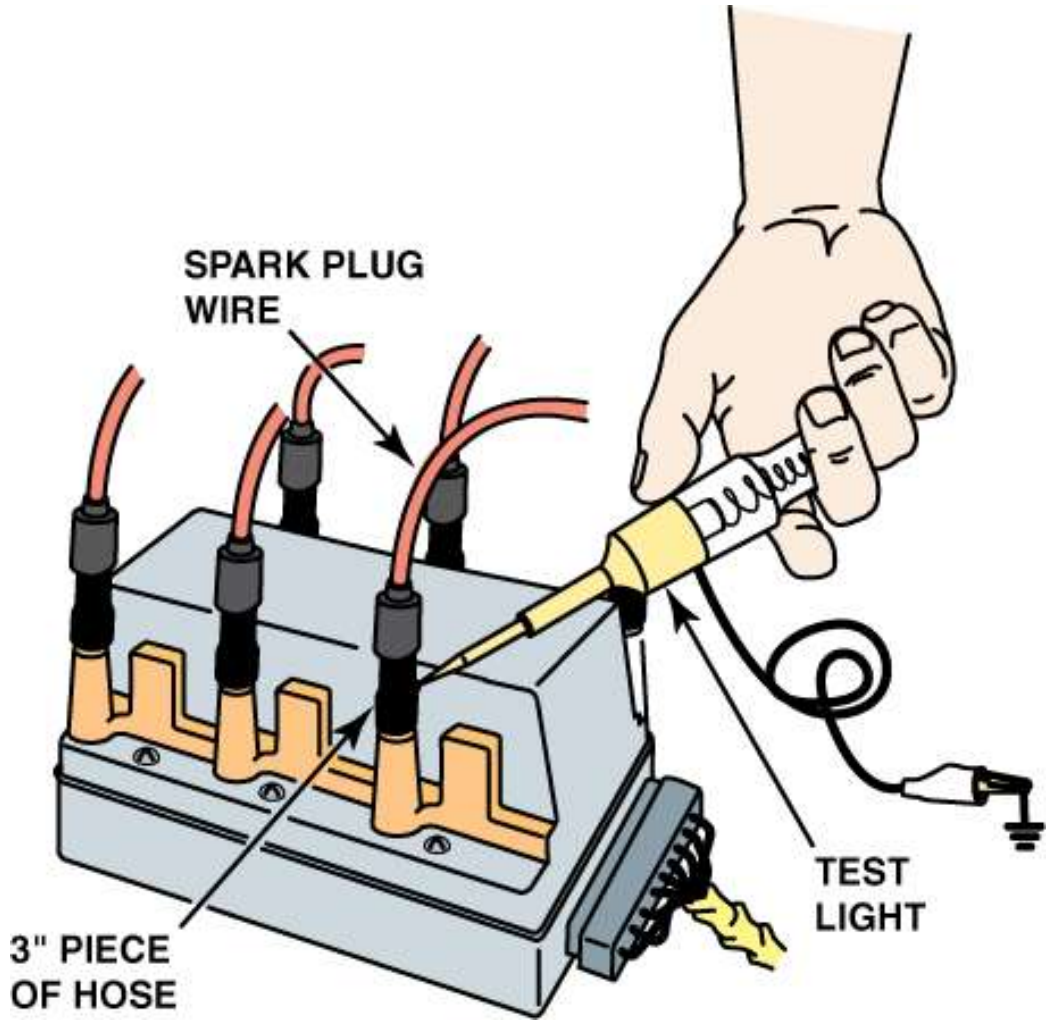
Figure 4.10 The Ford IDS scan tool has a graph function that allows the technician to view the data on the cylinder contribution test visually, making diagnosis easier.



ENGINE-RELATED MISFIRE DIAGNOSIS

- Cylinder Balance Test
  - Used to determine if all cylinders are contributing power equally.
  - This is determined by shorting out (disabling) one cylinder at a time.
  - If the engine speed (RPM) does not drop as much for one cylinder as for other cylinders of the same engine, then the shorted cylinder must be weaker than the other cylinders.

Figure 4.11 Using a vacuum hose and a test light to ground one cylinder at a time on a waste spark ignition system.



COMPRESSION TEST

- Cranking Compression Test
  - An engine cranking compression test is one of the fundamental engine diagnostic tests that can be performed. For smooth engine operation, all cylinders must have equal compression.
  - An engine can lose compression when air leaks through one or more of the following three routes.

Figure 4.14 The coil-on-plug ignition coil and spark plug were removed and the pressure transducer was threaded into the spark plug hole.

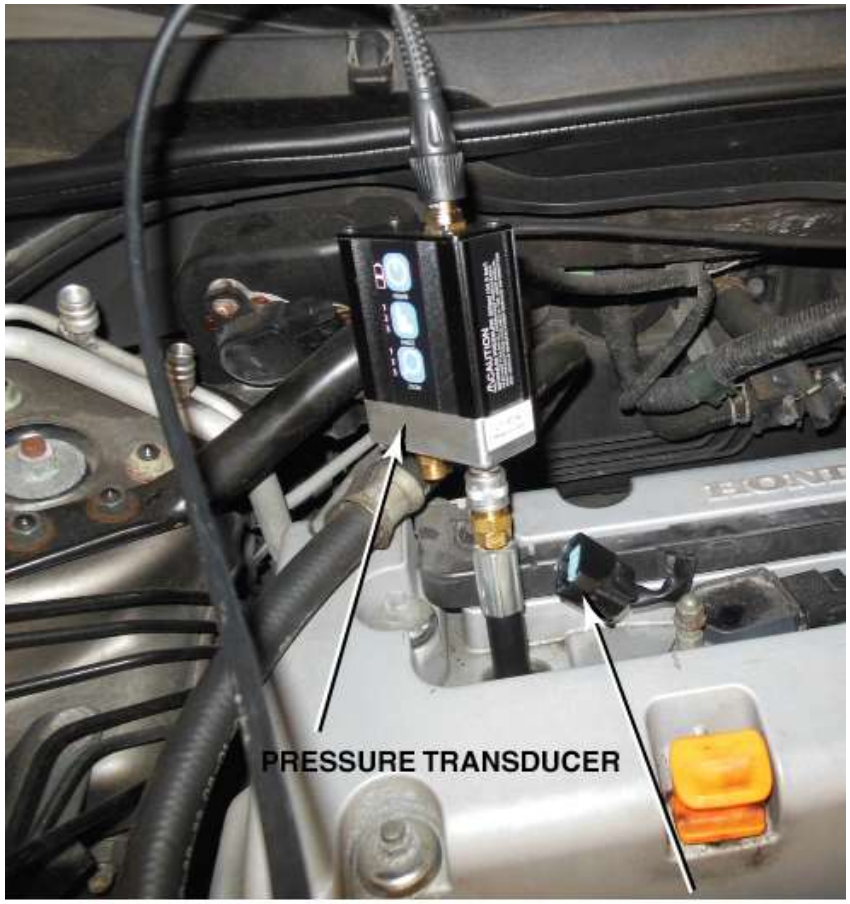


Figure 4.15 A Pico scope connected to a laptop computer is being used to capture the cylinder pressure waveform.

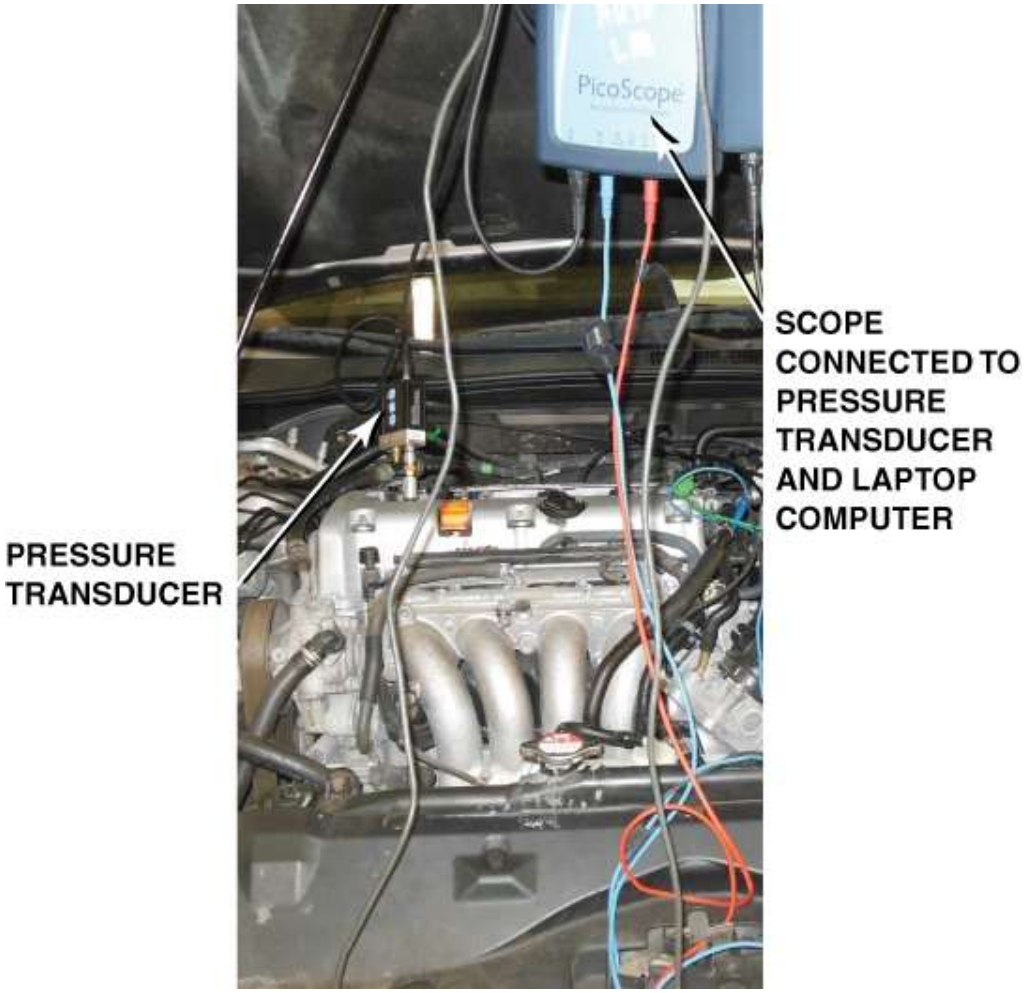


Figure 4.16 It often requires an assistant to perform a compression test: One person watches the first puff reading on the gauge and the other person cranks the engine.

COMPRESSION TEST

- Intake or exhaust valve or seal
- Piston rings (or piston, if there is a hole)
- Cylinder head gasket

- Wet Compression Test
  - If the compression test reading indicates low compression on one or more cylinders, add three squirts of oil to the cylinder and retest.

Figure 4.17 A leaking valve will cause a lower-than-normal compression reading.

COMPRESSION TEST

- This is called a wet compression test, because oil is used to help seal around the piston rings.

- Running (Dynamic) Compression Test
  - Engine faults that are often detected by performing a running compression test include:
    - Broken valve springs; Worn valve guides; Bent pushrods; Worn cam lobes

CYLINDER LEAKAGE TEST

- Step 1 For best results, the engine should be at normal operating temperature (upper radiator hose hot and pressurized).
- Step 2 The cylinder being tested must be at top dead center (TDC) of the compression stroke
- Step 3 Connect the tester to shop air not over 100 PSI (700 kPa).

CYLINDER LEAKAGE TEST

- Step 4 Calibrate the cylinder leakage unit as per manufacturer's instructions.
- Step 5 Inject air into the cylinders one at a time, rotating the engine as necessitated by firing order to test each cylinder at TDC on the compression stroke.
- Step 6 Evaluate the results:
  - Less than 10% leakage: good

CYLINDER LEAKAGE TEST

- Less than 20% leakage: acceptable
- Less than 30% leakage: poor
- More than 30% leakage: definite problem

- Step 7 Check the source of air leakage.
  - a. If air is heard escaping from the oil filler cap, the piston rings are worn or broken.

CYLINDER LEAKAGE TEST

- b. If air is observed bubbling out of the radiator, there is a possible blown head gasket or cracked cylinder head.
- c. If air is heard coming from the throttle body, there is a defective intake valve(s).
- d. If air is heard coming from the tailpipe, there is a defective exhaust valve(s).

Figure 4.18 A two-piece compression gauge showing the Schrader valve removed from the end that is screwed into the spark plug hole.

Figure 4.19 A typical handheld cylinder leakage tester.

Figure 4.20 A whistle stop used to find top dead center. Remove the spark plug and install the whistle stop, then rotate the engine by hand. When the whistle stops making a sound, this means that the piston is at the top.

VACUUM TESTS

- An engine in good mechanical condition will run with high manifold vacuum.
- Vacuum will increase anytime the engine turns faster or has better cylinder sealing while the throttle plate remains in a fixed position.
- Manifold vacuum will decrease when the engine turns more slowly or when the cylinders no longer do an efficient job of pumping.

Figure 4.21 An engine in good mechanical condition should produce 17 to 21 in. Hg of vacuum at idle at sea level.

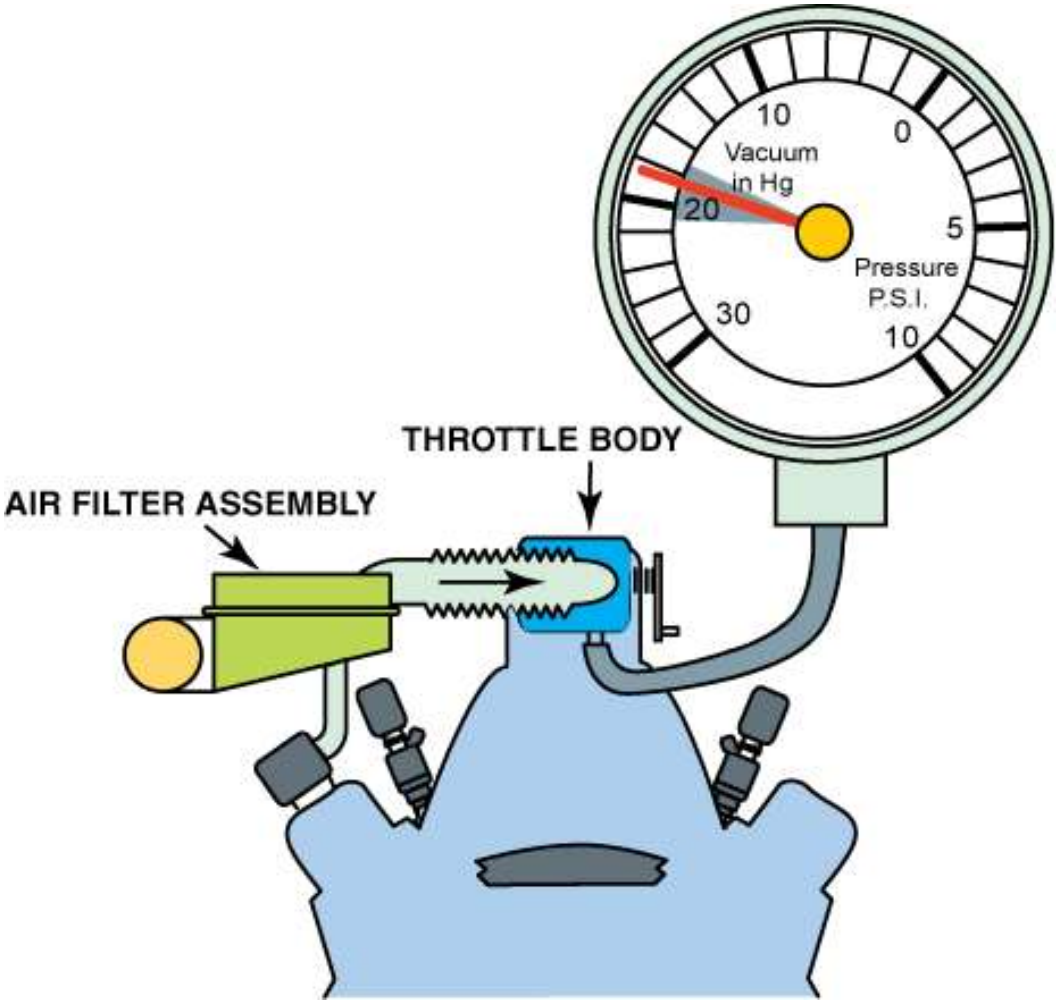


Figure 4.22 A steady but low reading could indicate retarded valve or ignition timing.

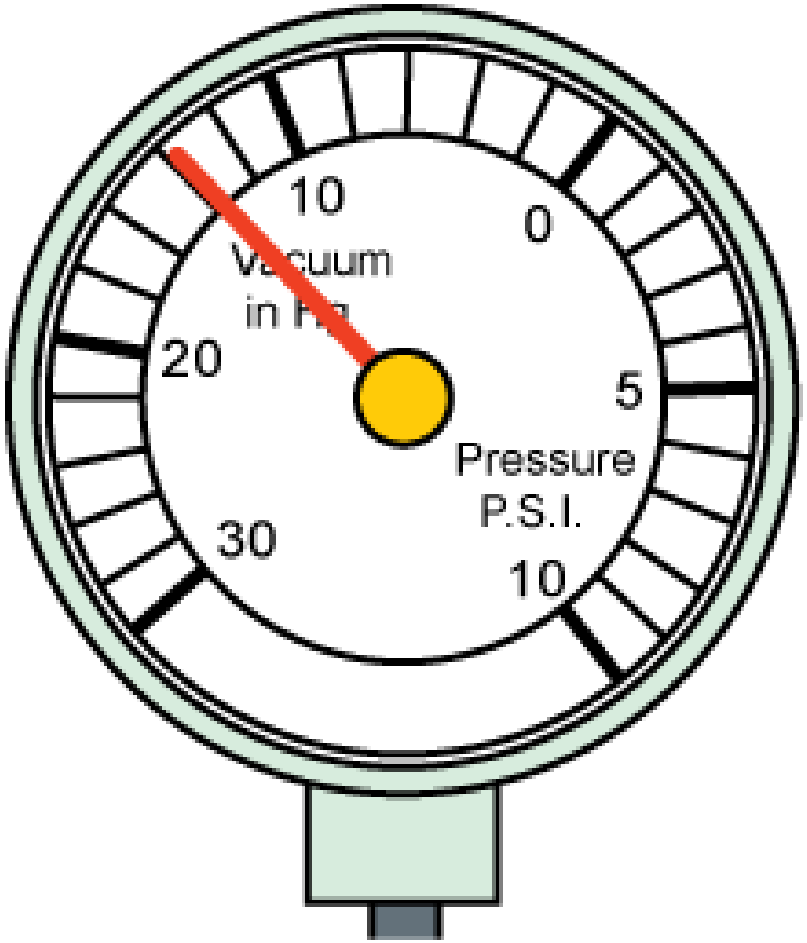


Figure 4.23 A gauge reading with the needle fluctuating 3 to 9 in. Hg below normal often indicates a vacuum leak in the intake system.

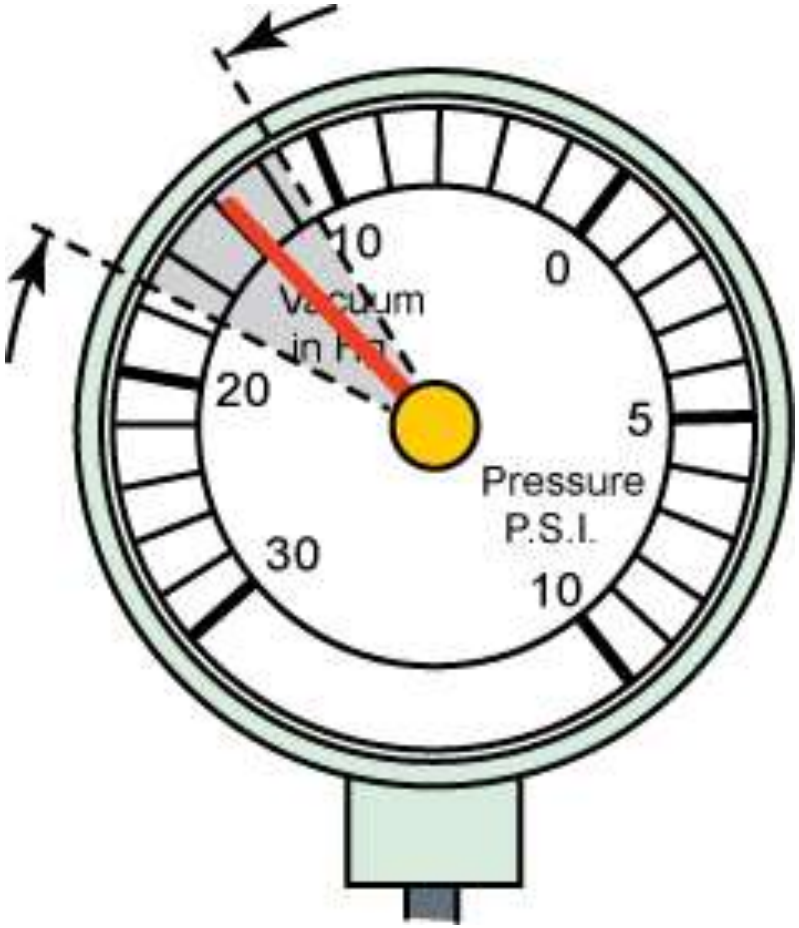


Figure 4.24 A leaking head gasket can cause the needle to vibrate as it moves through a range from below to above normal.

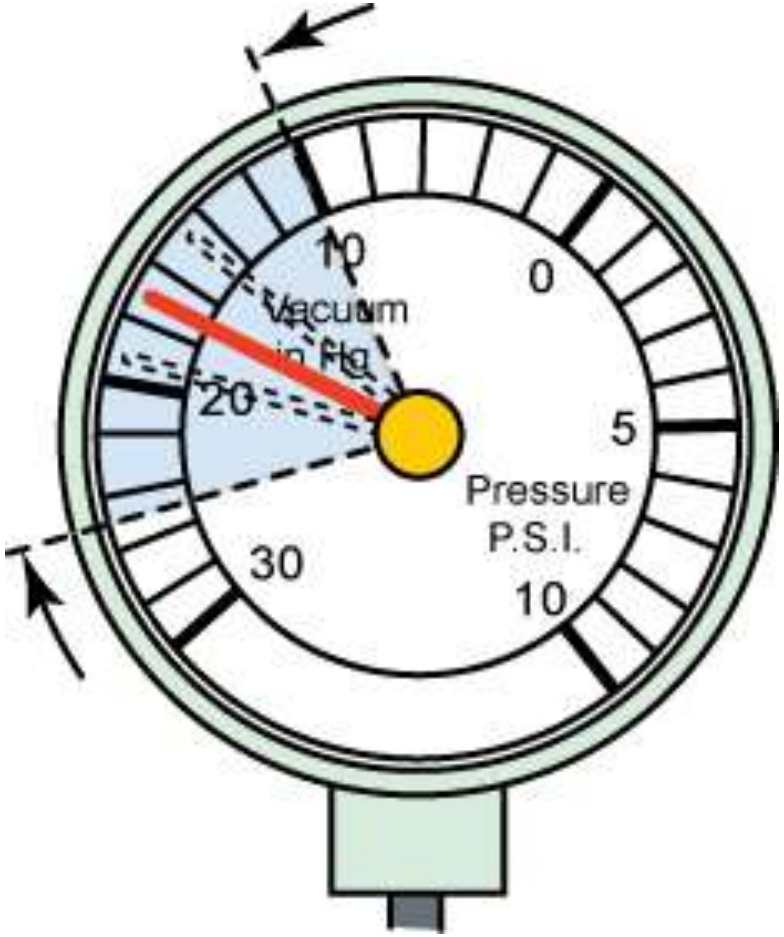


Figure 4.25 An oscillating needle 1 or 2 in. Hg below normal could indicate an incorrect air–fuel mixture (either too rich or too lean).

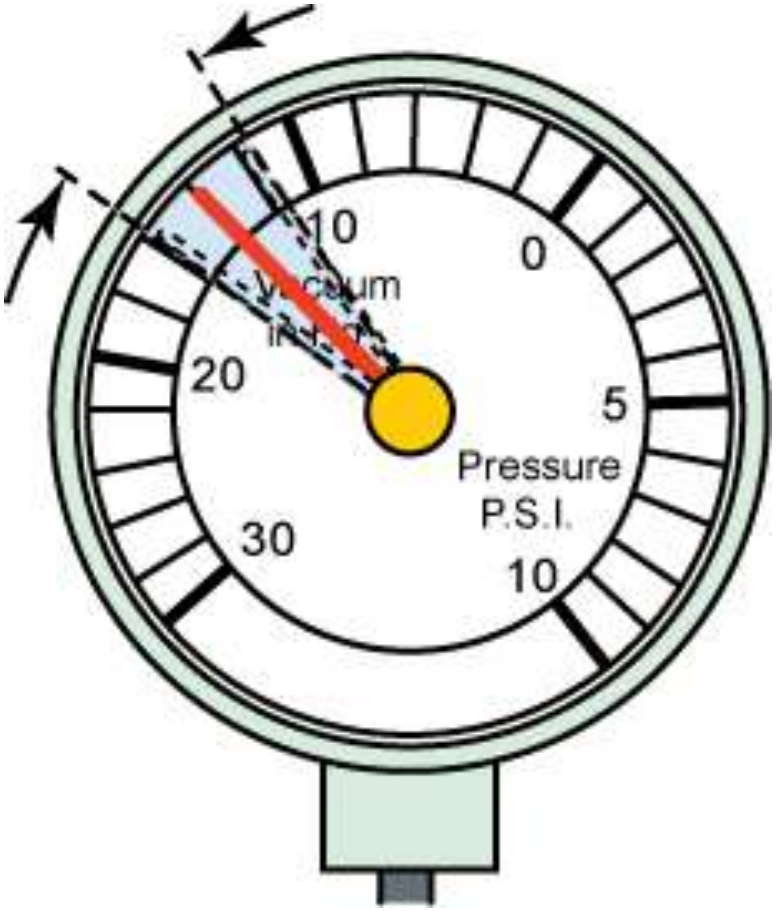


Figure 4.26 A rapidly vibrating needle at idle that becomes steady as engine speed is increased indicates worn valve guides.

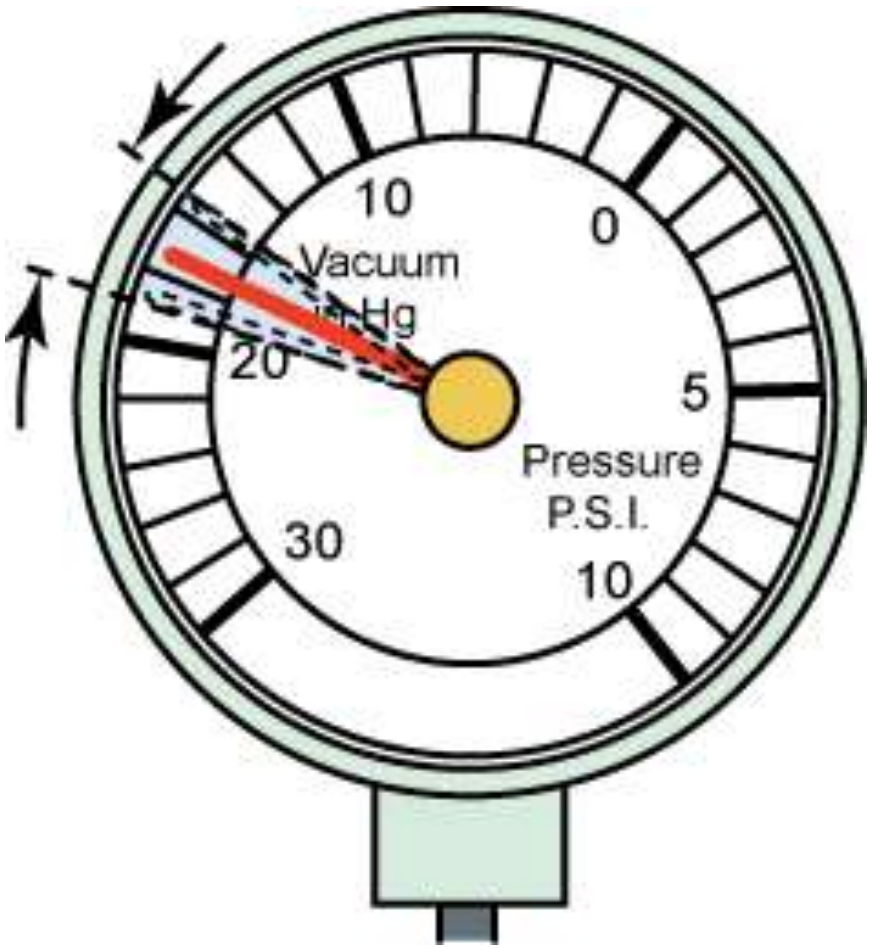


Figure 4.27 If the needle drops 1 or 2 in. Hg from the normal reading, one of the engine valves is burned or is not seating properly.

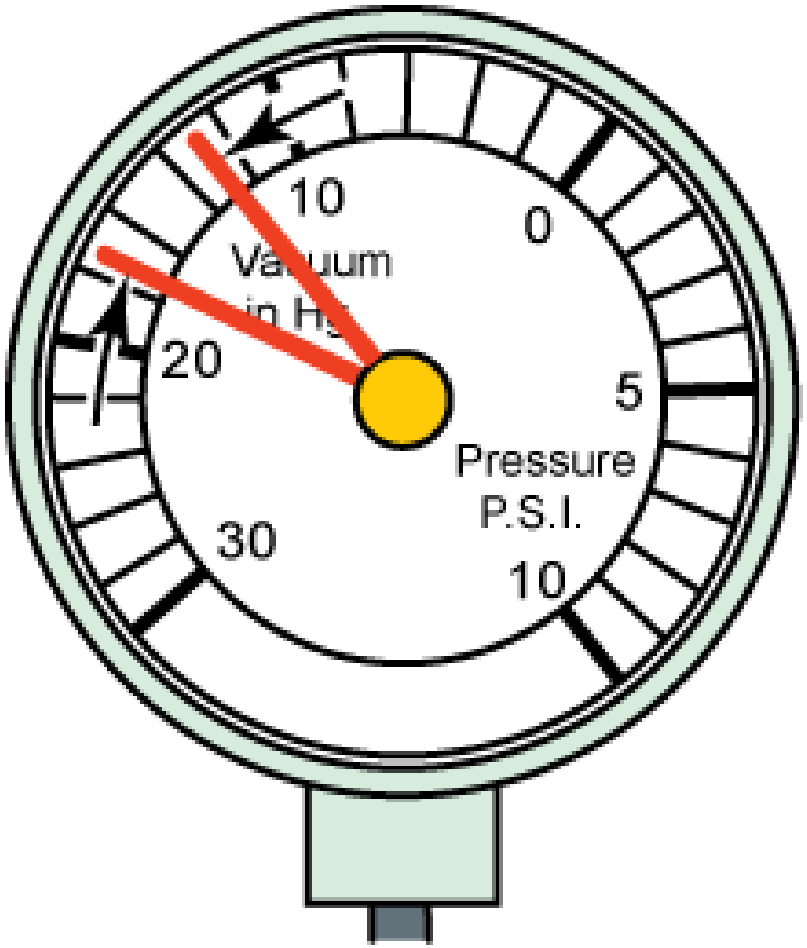


Figure 4.28 Weak valve springs will produce a normal reading at idle, but as engine speed increases, the needle will fluctuate rapidly between 12 and 24 in. Hg.

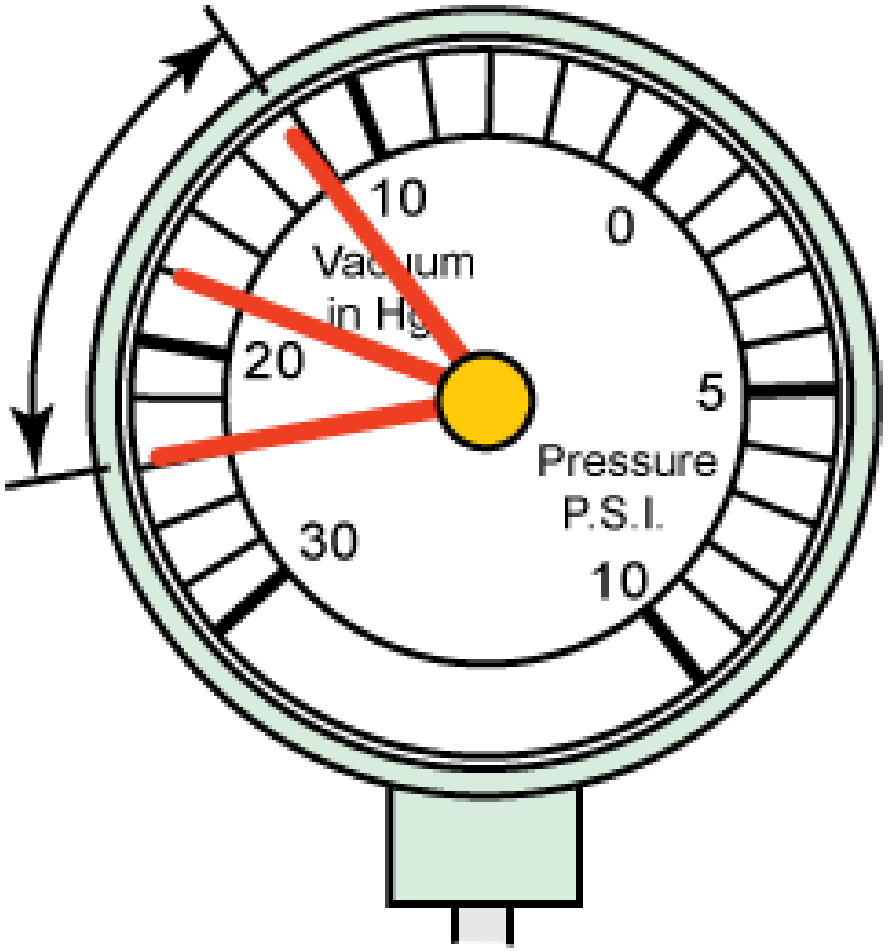
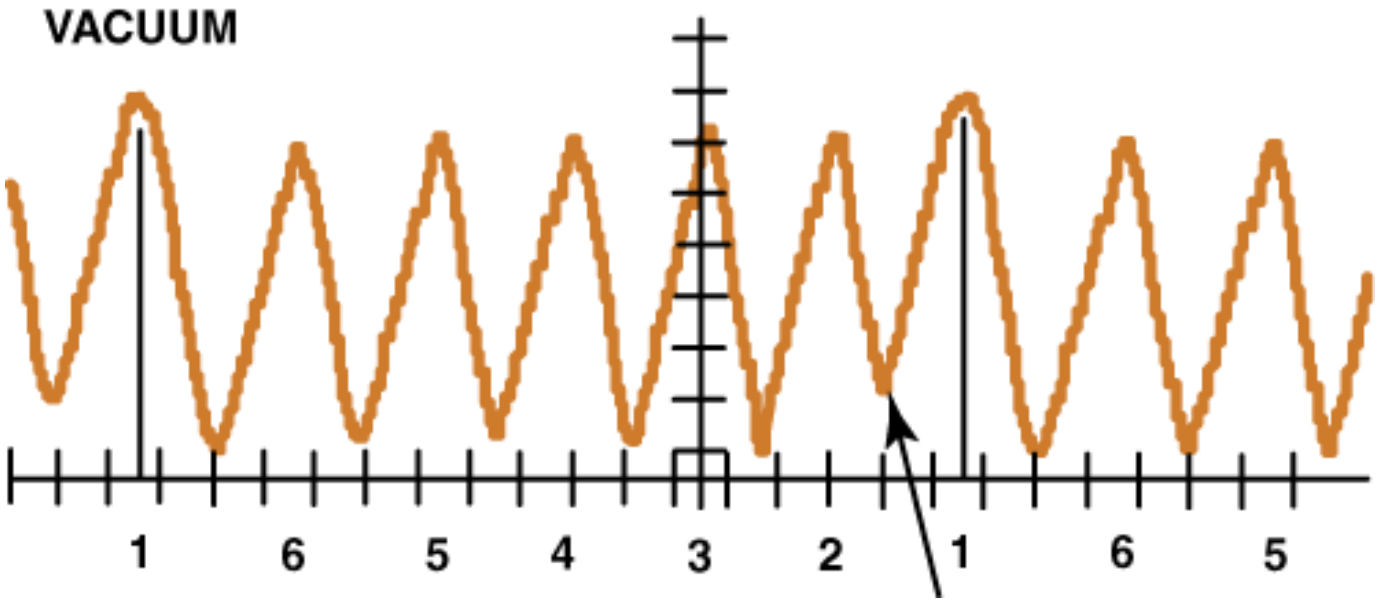


Figure 4.29 A typical vacuum waveform as displayed on a scope connected to a vacuum transducer and connected to the intake manifold.



EXHAUST BACKPRESSURE TESTING

- Common causes of restricted exhaust include the following:
  - Clogged catalytic converter
  - Clogged or restricted muffler
- If the exhaust system is not restricted, the vacuum reading will be the same or higher than the vacuum reading when the engine was at idle speed

EXHAUST BACKPRESSURE TESTING

- If the vacuum reading is lower at 2500 RPM than when it was at idle speed, then an exhaust restriction is indicated.

MISFIRE DIAGNOSIS

- Causes of Misfires
  - Engine Mechanical Fault
  - Ignition System Fault
  - Fuel System Fault

Figure 4.30 The relationship among cylinders showing where the intake stroke occurs in relation to other cylinders.

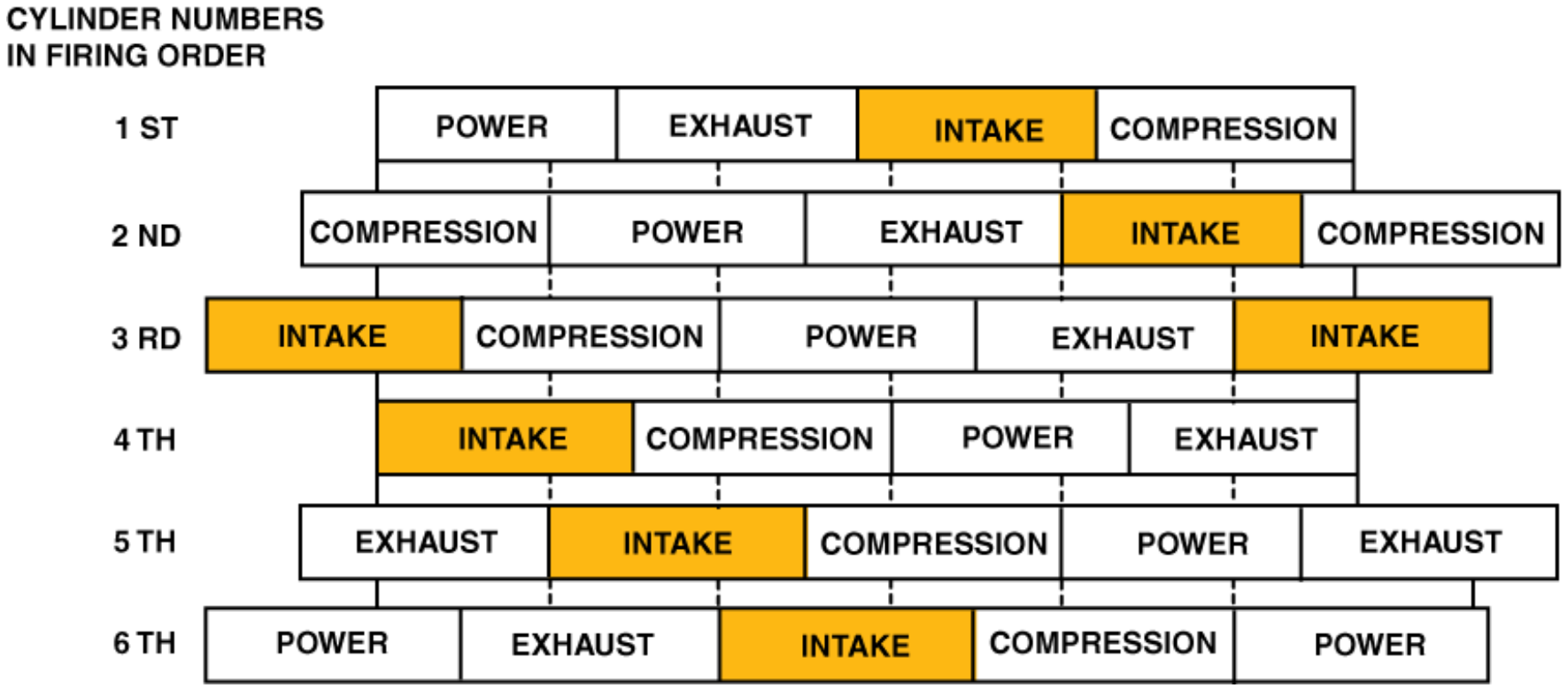


Figure 4.31 A technician-made adapter used to test exhaust system back pressure.

Figure 4.32 A technician marked pressure gauge showing a green line for acceptable backpressure readings and the red line indicating excessive backpressure readings.

SUMMARY

- The first step in diagnosing engine condition is to perform a thorough visual inspection, including a check of oil and coolant levels and their condition.
- Many engine-related problems make a characteristic noise.
- A compression test can be used to test the condition of valves and piston rings.

SUMMARY

- A cylinder leakage test fills the cylinder with compressed air, and the gauge indicates the percentage of leakage.
- Cylinder balance test, relative compression test, and cylinder contribution test indicate whether all cylinders are working normally.

SUMMARY

- Testing engine vacuum is another procedure that can help the service technician determine engine condition.
- Testing the engine using a DSO and pressure transducer helps pinpoint the root cause of an engine condition or a misfire problem.