# SECTION 2-C
# ENGINE TUNE-CARE AND TROUBLE DIAGNOSIS

## CONTENTS OF SECTION 2-C



| Paragraph | Subject | Page | Paragraph | Subject | Page |
|---|---|---|---|---|---|
| 2-9 | Engine Tune-Care | 2-18 | 2-12 | Engine Vibration or Noise | 2-21 |
| 2-10 | Hard Starting, Improper Performance | 2-19 | 2-13 | Cooling System Trouble Diagnosis | 2-22 |
| 2-11 | Excessive Valve Noise | 2-20 | | | |



## 2-9 ENGINE TUNE-CARE

### a. Tune-Care Procedure

The purpose of an engine tune-care is to restore power and performance that has been lost through wear, corrosion or deterioration of one or more parts or units. In the normal operation of an engine, these changes take place gradually at a number of points so that it is seldom advisable to attempt an improvement in performance by correction of one or two items only. Time will be saved and more lasting results will be obtained by following a definite and thorough procedure of analysis and correction of all items affecting power and performance.

Economical, trouble-free operation can better be assured if a complete tune-care is performed each 10,000 miles.

The parts or units which affect power and performance may be divided into three groups. (1) Units affecting compression, (2) Units affecting ignition, and (3) Units affecting carburetion.

The tune-care procedure should cover these groups in the order given. While the items affecting compression and ignition may be handled according to personal preference, correction of items in the carburetion group should not be attempted until all items affecting compression and ignition have been satisfactory corrected.

Most of the procedures for performing a complete engine tune-care are covered separately in other sections of this manual; therefore, this paragraph provides an outline only with references to other sections where detailed information is given.

The suggested procedure for engine tune-care is as follows:

1. Remove all spark plugs and test compression pressure in all cylinders as follows:

(a) Connect jumper wire between distributor terminal of coil and ground to prevent high tension sparking while cranking engine.

(b) Attach compression gauge solidly in spark plug port.

(c) Hold throttle wide open and crank engine until compression gauge reaches its highest reading. The highest reading should be reached with only a few revolutions of the engine. Record result.

(d) Repeat this test on all cylinders, making sure to release pressure in gauge after each test.

(e) The compression gauge hand should jump to approximately 75 pounds on the first compression stroke, with a few more strokes giving maximum pressure. If the pressure is built up in jerky steps of 10-20 pounds at a time, it indicates leakage of pressure at some point, such as head gasket, valves or piston rings.

(f) Minimum acceptable compression pressure at cranking speed is 160 pounds per sq. in. on 8.8 to compression ratio jobs; 175 pounds on 10.25 to 1 compression ratio jobs.

NOTE: Engines newly broken in may have compression pressure considerably higher than shown above. Pressure variation between cylinders should not exceed 15 pounds per sq. in.

(g) Low compression pressure in two adjacent cylinders indicates a possible head gasket leak between the two cylinders.

2. Clean, inspect, gap, and install spark plugs. (See par. 10-36.)

3. Inspect battery and cables. (See par. 10-36.)

4. Test cranking motor circuit if battery is in good condition but cranking speed is low. (See Group 10).

5. Adjust fan belt (and power steering belt, if so equipped). See Figures 2-63 and 2-64. Inspect generator (See par. 10-21). If difficulty is experienced in keeping battery charged, check generator regulator. (See par. 10-21.)

6. Inspect entire ignition system and make indicated corrections.

7. Inspect and test fuel pump. (See par. 3-12)

8. Replace gasoline filter. (See par. 1-1.)

9. Check operation of choke valve and check setting of choke thermostat. (See par. 3-17)

10. Check adjustment of fast idle cam and choke unloader. (See par. 3-17)

11. Check throttle linkage adjustment. Also dash pot adjustment. (See par. 3-9)

12. Adjust carburetor. (See par. 3-8)

13. Inspect all water hose connections and tighten clamps, if necessary.

14. Road test car for power and overall performance.

**b. Tune-Care Specifications**

| | Check Points | Allen | Sun |
|---|---|---|---|
| 1. | Cranking Voltage | 9 Volts Min. | 9 Volts Min. |
| 2. | Charging Voltage | 14-15 Volts at 1500 RPM | 14-15 Volts at 1500 RPM |
| 3. | Secondary Resistance | 27 Min. at 1500 RPM | 3 + or - .5 Volts at 1500 RPM |
| 4. | Ignition Output | 26 Min. at 1500 RPM | Read in Blue Band at 1500 RPM |
| 5. | Dwell Angle | 30° | 30° |
| 6. | Initial Timing | | |
| | at 400 RPM | 5° BTC * | 5° BTC * |
| | at 1050 RPM | 7.5° BTC** | 7.5° BTC** |
| 7. | Total Distributor Advance at Harmonic Balancer at 2500 RPM | 30°-39° | 30°-39° |
| 8. | Centrifugal Advance at 2500 RPM | 16°-21° | 16°-21° |
| 9. | Engine Vacuum | 14 In. Min. at 525 RPM | 14 In. Min. at 525 RPM |

*7.5°BTC on High Performance engines with Automatic Transmission
**10.0°BTC on High Performance engines with Automatic Transmission

## 2-10 HARD STARTING, IMPROPER PERFORMANCE, EXCESSIVE FUEL OR OIL CONSUMPTION

**a. Hard Starting, Improper Performance, Excessive Fuel Consumption**

These subjects are covered in Group 3.

**b. Excessive Oil Consumption**

If an engine is reported to be using an excessive amount of oil, a thorough inspection should be made for external leaks and the conditions of operation should be carefully considered before assuming that the engine is using too much oil as a result of an internal condition.

Place clean paper on the floor under engine and run the engine at medium speed until the oil is thoroughly warmed up, then stop the engine and check for oil leaks and dripping on the paper. Inspect both sides and front and rear ends of engine for wet spots. Pay particular attention to rocker arm cover, timing chain cover, and lower crankcase gaskets. All external leaks should be corrected and the results noted before attempting any internal correction.

The conditions of operation have an important bearing on oil consumption. The following points should be checked:

(1) Improper reading of oil gauge rod. An erroneous reading will be obtained if car is not level, gauge rod is not pushed down against stop, or insufficient drain-back time (1 minute) is not allowed after stopping engine. An oversupply of oil may be added if gauge rod markings are not understood. The space between the

"FULL" and "ADD" marks represent 1 quart.

(2) Oil too light. The use of oil of lower viscosity than specified for prevailing temperatures will contribute to excessive oil consumption.

(3) Continuous high speed driving. In any automobile engine, increased oil consumption per mile may be expected at speeds above 60 MPH.

(4) High speed driving following slow speed town driving. When a car is used principally for slow speed town driving under conditions where considerable crankcase dilution occurs, a rapid lowering of oil level may occur when the car is driven for some distance at high speed. This is because the dilution from town driving is removed by the heat of the high speed driving. This condition is normal and should not be mistaken for excessive consumption.

(5) Valve Guides worn. Excessive clearance between the valve stem and valve guide can result in high oil consumption.

(6) Piston rings not worn in. A new engine, or an engine in which new rings have been installed, will require sufficient running time to wear in the rings against the cylinder walls. During the wear-in period a higher than average oil consumption rate is to be expected, and no attempt should be made to improve oil economy by replacing rings before the engine has been in service for at least 3000 miles.

## 2-11 EXCESSIVE VALVE NOISE

### a. Checking Noise Level of Valve Mechanism

The noise level of the valve mechanism cannot be properly judged where the engine is below operating temperature when the hood is raised, or when the valve rocker arm covers are removed.

Before attempting to judge valve noise level, the engine must be thoroughly warmed up (at least 20 minutes of operation at 1200 to 1500 RPM) to stabilize oil and coolant temperatures and bring all engine parts to a normal state of expansion. When the engine is warmed up, listen for engine noise while sitting in the drivers seat with the hood closed. Run the engine at idle and at various higher speeds. It is advisable to observe the noise level in several engines that have been properly broken in, in order to develop good judgment for checking the noise level in any given engine.

### b. Cause of Noise In Valve Mechanism

If the preceding check indicates the valve mechanism is abnormally noisy, remove the rocker arm covers so that the various conditions that cause noise may be checked. A piece of heater hose of convenient length may be used to pick out the particular valves or valve linkages that are causing abnormal noise. With the engine running at a speed where the noise is pronounced, hold one end of hose to an ear and hold other end about 1/2" from point of contact between rocker arm and valve stem. Mark or record the noisy valves for investigation of following causes.

(1) Excessive Oil In Crankcase. Crankcase oil level high enough to allow the crankshaft to churn the oil will cause air bubbles in the lubricating system. Air bubbles entering the hydraulic lifters will cause erratic operation resulting in excessive lash in the valve linkage. Locate and correct cause of high oil level, then run engine long enough to expel air from system.

(2) Sticking, Warped or Eccentric Valves, Worn Guides. Sticking valves will cause irregular engine operation or missing on a low speed pull and will usually cause intermittent noise.

Pour penetrating oil over the valve spring cap and allow it to drain down the valve stem. Apply pressure to the one side of the valve spring and then the other, and then rotate the valve spring about 1/2 turn. If these operations affect the valve noise, it may be assumed that valves should be reconditioned. (Par. 2-14).

(3) Worn or scored parts in the valve train. Inspect rocker arms, push rod ends for scoring. Check push rods for bends, valve lifters and camshaft surfaces for scoring. Replace faulty parts.

(4) Valves and seats cut down excessively. Noisy and improper valve action will result if a valve and its seat have been refinished enough to raise the end of the valve stem approximately .050" above normal position. In this case it will be necessary to grind off the end of the valve stem or replace parts. The normal height of the valve stem above the valve spring seat is 1.825 inches.

(5) Faulty Hydraulic Valve Lifters. If the preceding suggestions do not reveal the cause of noisy valve action, check operation of valve lifters as described in sub-paragraph C.

### c. Checking Hydraulic Valve Lifters

When checking hydraulic valve lifters, remember that grit, sludge, varnish or other foreign matter will seriously affect operation of these lifters. If any foreign substance is found in the lifters or engine where it may be circulated by the lubrication system, a thorough cleaning job must be done to avoid a repetition of lifter trouble.

To help prevent lifter trouble, the engine oil and oil filter must be changed as recommended in Group 1. The engine oil must be heavy-duty type (MS marked on container) and must also conform to General Motors Specification 4745-M to avoid detrimental formation of sludge and varnish. A car owner should be specifically advised of these requirements when the car is delivered. Faulty valve lifter operation usually appears under one of the following conditions:

(1) Rapping noise only when engine is started. When engine is stopped, any lifter on a camshaft lobe is under pressure of the valve spring; therefore, leak down or escape of oil from the lower chamber can occur. When the engine is started a few seconds may be required to fill the lifter, particularly in cold weather. If noise occurs only occasionally, it may be considered normal requiring no correction. If noise occurs daily, however, check for (a) oil too heavy for prevailing temperatures (b) excessive varnish in lifter.

(2) Intermittent Rapping Noise. An intermittent rapping noise that appears and disappears every few seconds indicates leakage at check ball seat due to foreign particles, varnish, or defective surface of check ball or seat. Recondition lifters clean and/or replace as necessary.

(3) Noise on idle and low speed. If one or more valve lifters are noisy on idle and up to approximately 25 MPH but quiet at higher speeds, it indicates excessive leakdown rate or faulty check ball seat on plunger. With engine idling, lifters with excessive leakdown rate may be spotted by pressing down on each rocker arm above the push rod with equal pressure. Recondition or replace noisy lifters.

(4) Generally noisy at all speeds. Check for high oil level in crankcase. See sub-paragraph b (1) above. With engine idling, strike each rocker arm above push rod several sharp blows with a hammer; if noise disappears, it indicates that foreign material was keeping check ball from seating. Stop engine and place lifters on camshaft base circle. If there is lash clearance in any valve linkage, it indicates a stuck lifter plunger, worn lifter body lower end, or worn camshaft lobe.

(5) Loud noise at normal operating temperature only. If a lifter develops a loud noise when engine is at normal operating temperature, but is quiet when engine is below normal temperature, it indicates an excessively fast leakdown rate or scored lifter plunger. Recondition or replace lifter.

## 2-12 ENGINE VIBRATION OR NOISE

If unusual vibration or noise develops in the car, test first to determine whether the condition originates in the engine or in other operating units. Time will often be saved by checking the recent history of the car to determine whether the vibration became noticeable gradually or followed an accident or installation of repair parts.

Vibration or noise is usually more pronounced at a certain car speed. If the engine is run at the equivalent speed with car standing and transmission in neutral, the condition will still exist if the engine or clutch is at fault. If the trouble does not exist with engine running and car standing still, refer to Rear Axle Section and/or Drive line section.

### a. Engine Tune-Care

An engine which is not properly tuned will run rough and vibrate, particularly at idling and low speeds. A thorough engine tune-care operation is the proper correction.

### b. Fan, Generator Belt(s) or Water Pump

Bent fan blades will cause vibration and noise. Remove fan belt and run engine. If vibration or noise is eliminated or reduced it indicates that the condition is caused by the fan, generator, belt, or possibly the water pump. Check water pump for rough or noisy bearings and replace parts as necessary.

Inspect fan belt, all pulleys, balancer, fan blades and generator for undercoating or other material that would cause an unbalanced condition.

Check fan blades for excessive run-out and correct if necessary. Check all pulleys for abnormal run-out or wobble and replace if necessary. Reinstall fan belt and adjust to proper tension.

With engine running, place one hand on generator and slowly open throttle from idle to approximately 60 MPH. If generator vibrates to create a noise in the car, it will vibrate enough to be felt by the hand. As the engine is slowly speeded up the generator may be felt to go into periods of vibration at different engine speeds. Noise caused by the generator should occur at the same time that generator vibration occurs. Repair or replace a noisy generator.

### c. Engine Mountings

Vibration may be caused by loose, broken, or deteriorated engine mountings. Tighten loose mountings or replace faulty mountings.

### d. Crankshaft Balancer (V-8 Only)

Loose or broken rivets in the crankshaft balancer may cause vibration in the engine. If the balancer is damaged in such a manner that the parts cannot function freely, extreme roughness will result which may eventually break the crankshaft. A balancer which shows evidence of damage or which is suspected of being inoperative should be replaced and the result noted, since it is not possible to test the balancer any other way.

### e. Unbalanced Connecting Rods or Pistons

Vibration will result if connecting rods or pistons are installed which are not of equal weight with all other rods or pistons in engine. If new parts have recently been installed, these should be checked to determine whether they are standard Buick parts or if they have been altered in weight by filing, machining or other repairs.

### f. Unbalanced Clutch Assembly or Flywheel

Engine roughness may be caused by an unbalanced combination of clutch, flywheel and crankshaft even though these units are balanced individually during manufacture. Unbalance may occur if clutch or flywheel is removed without marking to allow reinstallation in original position.

### g. Unbalanced Flywheel or Converter Pump

Vibration existing with automatic transmission may be due to unbalanced flywheel or converter pump.

## 2-13 COOLING SYSTEM TROUBLE DIAGNOSIS

### a. Excessive Water Loss

If the radiator is filled too full when cold, expansion when hot will overfill the radiator and coolant will be lost through the overflow pipe. Adding unnecessary water will weaken the anti-freeze solution and raise the temperature at which freezing may occur.

The use of alcohol anti-freeze with a high temperature radiator thermostat will cause boiling and loss of coolant through the overflow pipe.

If the cooling system requires frequent addition of water in order to maintain the proper level in the radiator, check all units and connections in the cooling system for evidence of leakage. Inspection should be made with cooling system cold because small leaks which may show dampness or dripping when cold can easily escape detection when the engine is hot, due to the rapid evaporation of the leakage. Tell-tale stains of grayish white or rusty color, or dye stains from anti-freeze, at joints in cooling system are almost always sure signs of small leaks even though there appears to be no dampness.

Air or gas entrained in the cooling system may raise the level in radiator and cause loss of coolant through the overflow pipe. Air may be drawn into the cooling system through leakage at the water pump seal. Gas may be forced into the cooling system through leakage at the cylinder head gasket even though the leakage is not sufficient to allow water to enter the combustion chamber. The following quick check for air leaks on suction side of pump or gas leakage from engine may be made with a piece of rubber tubing and a glass bottle containing water.

1. With cooling system cold, add water to bring coolant to proper level.

2. Block open the radiator cap pressure valve, or use a plain cap, and be sure radiator cap is on tight. Attach a suitable length of rubber hose to lower end of overflow pipe.

3. Run engine in neutral at a safe high speed until the engine reaches a constant operating temperature.

4. Without changing engine speed, put the free end of rubber hose into a bottle of water, avoiding kinks or low bends that might block the flow of air.

5. Watch for air bubbles in water bottle. A continuous flow of bubbles indicates that air is being sucked into the cooling system, or exhaust gas is leaking into the cooling system past the cylinder head gasket.

**b. Overheating of Cooling System**

It must be remembered that the Buick pressure system operates at higher temperatures than systems operating at atmospheric pressure. Depending on the pressure in cooling system, the temperature of water or permanent type anti-freeze may go considerably above 212°F without danger of boiling.

In cases of actual overheating the following conditions should be checked:

1. Excessive water loss. (subpar. b, above).

2. Slipping or broken fan belt (par. 2-21).

3. Radiator thermostat stuck (par. 2-22), radiator air passages clogged, restriction in radiator core, hoses, or water jacket passages.

4. Improper ignition timing (par. 10-35).

5. Shortage of engine oil or improper lubrication due to internal conditions.

6. Dragging brakes.