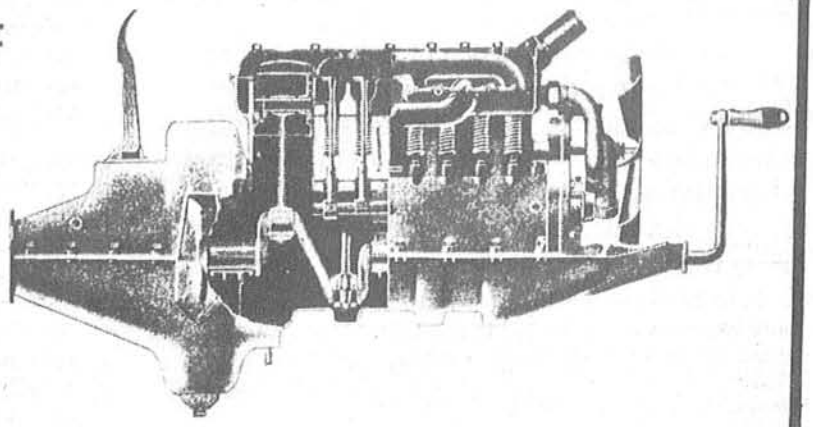
THE ANALYSIS OF ENGINE NOISES IN THREE PARTS



Ed. Note: This article is the second of a three-part series on analysis and diagnosis of engine noises. The material is excerpted from a 1936 edition of the Automobile Digest Engine Service Manual.

Part 1 of the series covered general principles, while the second and third parts deal with specific sources of engine noises.

PART 2 — KNOCKS AND NOISES WHICH ORIGINATE FROM SOURCES SUCH AS CYLINDERS, BEARINGS, CONNECTING RODS, PISTONS, AND FRONT END DRIVE

Detonation

This form of knock is due to uncontrolled combustion in the cylinder and has had various definitions in the past such as fuel knock, spark knock, and compression knock, being affected by changes in carburetor adjustment, ignition timing, and compression ratio. The tone of the knock is very distinctive and may be described as a "metallic" or "bell-like" ping. It is most audible when the engine is under heavy load in high gear, and it is sometimes accompanied by misfiring. Detonation is usually due to fuel with too low octane rating for the compression of the engine, or an improperly adjusted carburetor which gives too lean a mixture.

Pre-Ignition

This type of knock is usually due to an excessive accumulation of carbon in the engine, and for this reason it was often referred to in the old days as "carbon knock." Portions of the carbon deposit glow and cause premature ignition of the fuel charge in the cylinder. The result is a sharp metallic ping which is similar to detonation. Unlike detonation, it is erratic and will not show up in a cold engine, but like detonation, it is usually strongest under a heavy pull or when accelerating.

Pre-ignition due to carbon accumulation is not the problem that it once was because fuels of today are much improved and contain additives to prevent pre-ignition. Also modern engines operate consistently at much higher speeds, which tend to blow out carbon accumulations.

Another cause of pre-ignition is the use of improper spark plugs which run so hot that the electrodes glow. This problem will be cured by changing to plugs suited to the engine.

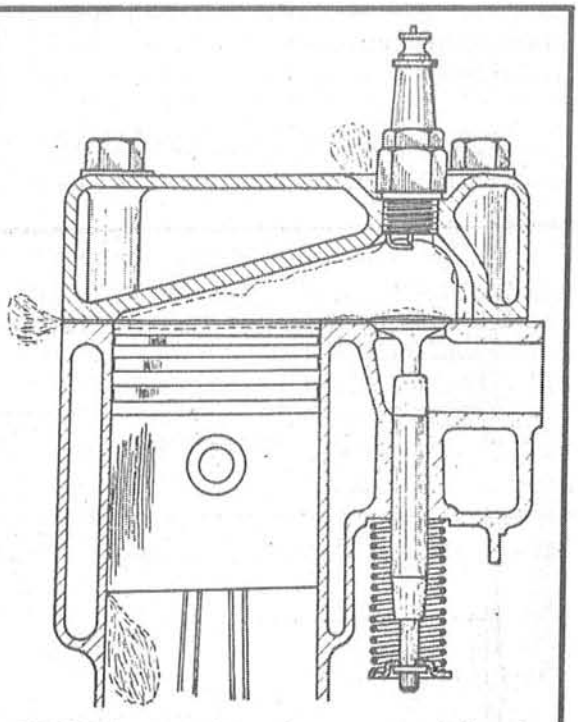


FIGURE 1 — Dotted lines show an accumulation of carbon can reduce the combustion chamber volume and increase the effective compression ratio, thereby leading to problems of detonation and pre-ignition. Leakage at the points indicated may cause hissing sounds.

Spark Knock

This knock is similar to that described as detonation or pre-ignition, but is due to malfunction of the distributor automatic advance mechanism. It follows, therefore, that a check of the distributor is in order in case of a ping which is not eliminated by a change of fuel or spark plugs.

Cylinder and Cylinder Head

A hissing sound in the crankcase on the compression stroke usually indicates scored cylinder walls or broken or worn piston rings. The condition will be confirmed by low compression and loss of power.

Ridges worn in the cylinder wall at the extreme end of the ring travel may contribute noise when the rings are replaced or the bearings taken up. Very rarely will a mechanic be so careless as not to remove this ring ridge when rings are replaced, but any condition which changes the position of the piston in the cylinder may cause noise of this type. It is conceivable, therefore, that merely adjusting the bearings could lead to the problem.

The sound of the ring striking the ring ridge may vary from a sharp metallic rap to a barely perceptible clicking noise. The sound may be difficult to distinguish from a loose piston pin, but the noise from the latter is usually diminished when the spark is retarded.

A loose cylinder head or defective gasket is often revealed by a hissing sound as the compressed gases escape. The condition will usually be confirmed by a compression check, and it may also be evident from an accumulation of water in the oil pan. The exact location of the leak can be determined by squirting kerosene around the head joint. Bubbles will indicate a leak. The same leakage may occur at spark plugs, so these should be checked as well.

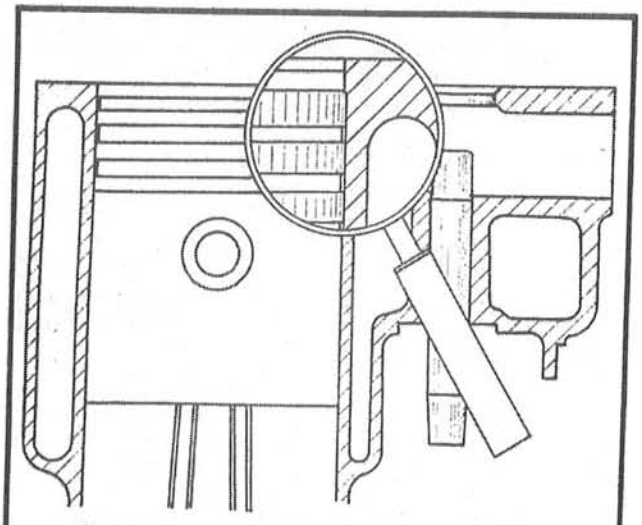


FIGURE 2 – An enlarged view showing how the upper edge of a new piston ring may strike the ridge worn in the cylinder wall. The same effect may be produced by any action which changes the position of the piston in the cylinder, such as bearing adjustment.

Main Bearing Knock

This is a dull, heavy knock which is always loudest under heavy load and is perhaps the lowest pitched sound of all engine noises. Unless the bearings are very badly worn, it is rarely heard at idling speed but is usually evident above 20 or 25 miles per hour. If all main bearings are loose, the noise is usually a dull rumbling sound which varies in intensity with speed. However, main bearing wear is usually unequal due to shaft flexure, and the knock may be periodic. For example, a single defective main bearing may knock at one speed, while the knock may disappear at a slightly higher speed and reappear once more at a still higher speed. The intensity of the knock can usually be diminished by shorting out the plugs on the cylinders on each side of the suspected bearing.

Crankshaft End Play

Excessive end play permits the crankshaft to float endwise, causing a knock at irregular intervals and one very difficult to identify on some engines. In general the knock will be similar in sound to a main bearing knock, but it can be distinguished from the latter because changes in load will have little or no effect on it. If the crankshaft is forced endwise with a stick held against the pulley or starter jaw, the noise will disappear. The best clue is that the noise due to end play will almost always be intermittent.

Flywheel

A loose flywheel is a very rare occurrence, which is fortunate because the sound is confusing and difficult to identify as to source. Part of this is due to the fact that the crankshaft acts as a sound transmitting member so that the sound occurs with nearly equal intensity throughout the engine. The tone may give the mistaken impression that several or all of the rod bearings are loose. It may vary from a heavy thump to a sharp knock, but is usually loudest on acceleration. The best indication is that the frequency is timed to the number of power impulses of the engine.

Connecting Rod Bearing

Anyone who has ever suffered a burned out connecting rod bearing is not likely to forget the distinctive sound associated with it — a series of short, sharp raps which increase in intensity as the condition of the bearing worsens. For a slightly worn bearing, the sound may or may not occur at

idling but will show up at a speed of about 25 miles per hour and will be most evident on deceleration. Shorting out the cylinder with the bad rod bearing will decrease the intensity of the knock or make it disappear. The connecting rod bearing is much lighter in tone than the main bearing knock.

Connecting Rod

The connecting rod itself may be responsible for noise if it is bent or twisted. If it cramps the piston in the bore, a noise like piston slap may develop which will be evident at idling speed or slightly higher. The rod bearing will soon wear to the point where a rod bearing knock will develop.

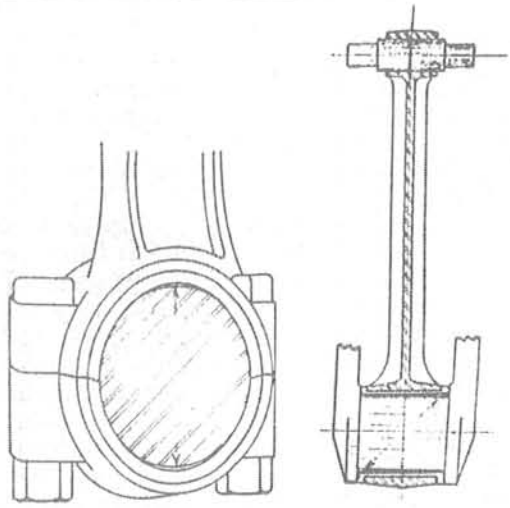


FIGURE 3 (Above) – At left above is a big end connecting rod bearing showing points at which excessive clearance develops due to wear. The view at right above shows the effect of a bent connecting rod, which produces unequal bearing wear as shown by the arrows.

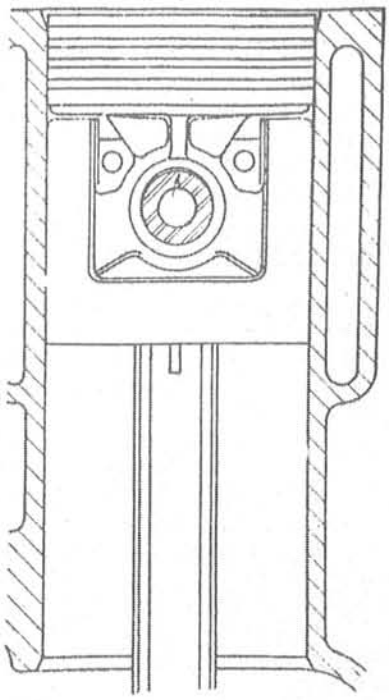


FIGURE 4 (Far Right) – Section of piston and cylinder showing how excessive clearance in the pin bearing causes a knock when the piston travel is reversed at the ends of its stroke.

Piston

A knock due to a worn or loose piston will usually be evident at idling speed, although it may occur at just about any engine speed. It is usually referred to as "piston slap" and is readily audible when sounding the upper part of an idling engine. The tone will vary with the degree of looseness and may vary from a hollow sound barely audible to a sharp metallic knock. If the piston is extremely loose, the sound may be described as a "clank." With some engines, the sound may be likened to that produced by a loose valve tappet. Piston slap usually gets worse as the engine warms up due to the thinning of oil which acts as a cushion between the piston and cylinder bore, but there are cases reported where the piston slap decreases as the engine warms up. This is probably due to uneven expansion as the piston gets hot.

While it is difficult to lay down strict guidelines to tell you what to listen for in piston slap, there are some tests to identify it. Shorting out the cylinders in turn while the engine is hot will sometimes cause the knock to disappear. Another test is to remove the spark plug on the offending cylinder or cylinders and add about a teaspoon of heavy oil such as gear oil or 600W. When the engine is restarted, it should remain free of piston slap for at least a minute or two.

A broken or cracked piston may make a noise similar to piston slap, but it is usually much louder and present at all speeds.

Piston Pin

The sound produced by a loose piston pin will have approximately the same character and timing as a loose rod bearing; however, it will be observed upon sounding the engine to originate from a different location. Piston pin noise will usually occur at idling but is not necessarily limited to this speed. It is a dull metallic sound, high pitched, and not very loud. Shorting out the cylinder will diminish the noise or cause it to disappear.

The piston pin can also cause noise if it gets loose and moves endwise to rub against the cylinder wall. Ordinarily it is probably nearly impossible to identify this rubbing noise above the other noises present in a normal engine, but it may manifest itself as an intermittent grating noise. The trouble will probably soon be accompanied by loss of compression and oil pumping as the cylinder wall becomes scored.

Piston Rings

Piston rings may cause noise due to several conditions. The rings may be too loose in their respective grooves, a ring may be broken, or the ring may strike a ridge at the top of the cylinder. Rings which are designed to work with expanders may become loose in the groove if the expander becomes weak or fouled with carbon. Under these conditions, the tone produced when the cylinder is

shorted will be a light rapping sound, click, or sharp rattle.

The noise created by a broken ring depends on the location of the break and the degree of looseness in the groove. A loose fit results in a distinct rattling sound being heard when sounding the cylinder, occurring regularly with piston movement. Ring breakage permits blow-by, which can be verified by a compression check.

Front End Drive

It is necessary to take into consideration two types of front end drives — the gear drive and the chain drive. Of course, one must know which kind of drive is employed when sounding this part of the engine. There is one feature which is of material assistance in analyzing noise in the front end drive. Noise originating at this point is most distinct, as the drive housing, being of light gauge material, acts effectively as a sounding board. Another helpful factor is that rarely does the sound travel to any great extent to other parts of the engine.

With the gear type of drive, noise will be most prominent at idling speed, may disappear at certain speeds and then reoccur again above that point. The noise is due to worn teeth, keys, and bearings of the shafts and varies from a sharp clatter, a pronounced solid heavy knock, to a bell-like ring depending upon the material of the meshing gears. Backlash of the teeth and mounting of the gears should be checked. A contributing factor to noise is wear of the front main bearing which alters the center to center distance of the gears and in turn the backlash, while the same is true of the front camshaft bearing. Backlash is also altered when the front main bearing is taken up by adjustment. Timing gear noise is usually accompanied by valve noise, and checking is facilitated by setting the tappets temporarily very close, which will decrease the intensity of the valve noise. With helical gears, end motion of the shafts may cause noise which is noticeable at some speeds and absent at others.

With the chain type of front end drive, several factors are responsible for noise. The chain may not be properly adjusted for tension, it may be worn, the sprockets may be worn, or the sprockets may be loose or misaligned. The chain must also be getting proper lubrication. The noise produced by the chain drive is much different from that produced by the gear drive. When the noise becomes objectionable, it is usually a rumbling noise due to the chain having too much slack. This noise is most prominent at idling speed or when pulling heavily. If the chain has too little slack, a humming sound is produced.

The proper adjustment of a timing chain calls for tightening it until a humming sound is heard, then backing off on the adjustment until it disappears. On some engines, if the chain wears past a certain point, the chain may strike the housing resulting in a loud "clank" at regular intervals. Adjustment of the chain should cure the problem.

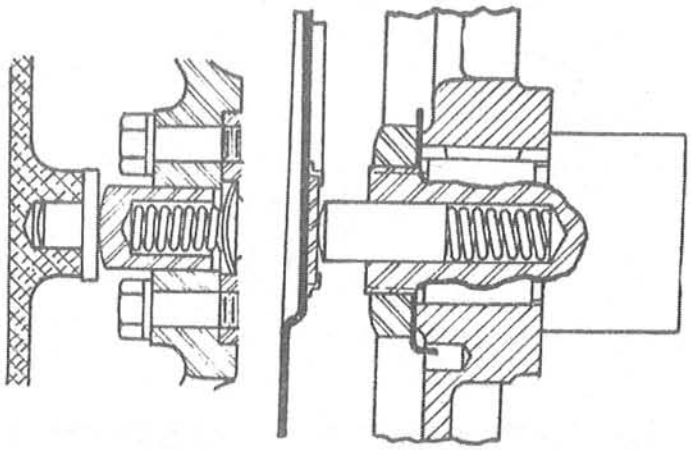


FIGURE 5 – Two types of spring-loaded plungers commonly used to control camshaft end play at the front of the engine. The plunger bears against a wear plate affixed to the housing cover and may cause a tapping noise if the contacting surfaces are rough.

If the end thrust of the camshaft is taken by a spring-loaded plunger, this plunger or its contacting surface may be roughened, resulting in a tapping noise against the front end drive housing cover. Ordinarily a noise of this type would be insignificant, but the housing cover amplifies the noise considerably. The important thing is not to mistake this noise for a more serious condition. Two types of thrust devices are shown in Figure 5, either of which can cause noise when rough.

NEXT MONTH — Engine noises which originate in the camshaft, push rods, valves, fan, starter, generator, and fuel pump.

"I've taken care of your engine noise. I turned up the volume on your radio, and removed the knob."