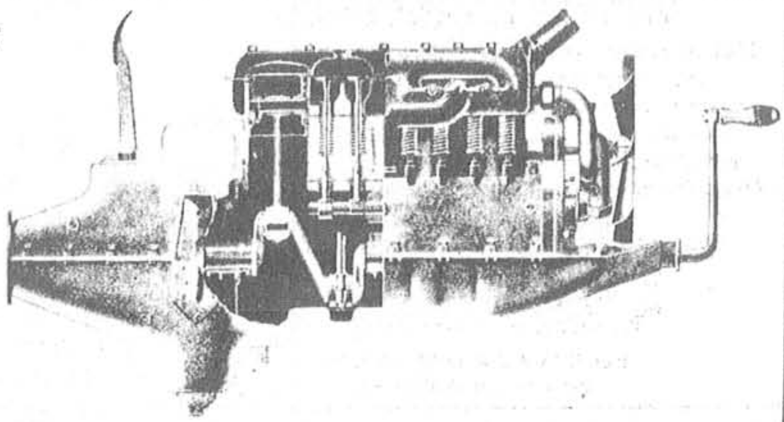
THE ANALYSIS OF ENGINE NOISES IN THREE PARTS



Ed. Note: This article is the first 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 discusses the general principles of engine noise analysis, while the articles to follow will deal with specific sources of noise in internal combustion engines.

PART 1 — GENERAL PRINCIPLES

The typical internal combustion engine is comprised of a complex system of rotating and reciprocating parts which give rise to numerous forces acting in different directions. Since the early days of the automobile, a great deal of engineering effort has been devoted to taming these forces with the result that the modern engine operates very smoothly and quietly. If an abnormal noise develops, there is usually a good reason for it. The ability to analyze engine noises and attribute them correctly to a source of trouble is a worthwhile skill for the amateur mechanic to develop. As with many other aspects of auto mechanics, a great deal of confusion and misinformation exists in the field of engine noise analysis, and it is hoped that the systematic approach developed in this series will dispel some of the fog of doubts.

When thought is given to the analysis of engine noises, the importance of a systematic routine becomes very apparent. Patience and a thorough knowledge of engine theory are important assets if one is to acquire expertise in this field. One must be a sort of Sherlock Holmes with ability to apply principles of observation, analysis, and deduction, since our clues originate under many conditions which are so much alike. To rely on only one clue or symptom is often misleading.

The Human Senses

Of the five human senses — sight, smell, hearing, taste, and touch — we rely on the first and third to aid us in the analysis of engine performance and noise tracing. The sense of touch or feeling may also aid at times in locating sources of vibration. We know that vibration often results in noise. By far the most important of our senses in noise analysis is, however, our sense of hearing, and it is this sense which must be developed to its fullest capability. Not only must our hearing be trained to locate the direction from which noise is emanating, but it must be capable of detecting subtle changes in tone or rhythm.

Engine noises are often very elusive, and even experienced mechanics have difficulty sometimes in tracing or identifying them. Certain well-defined knocks can often be quickly identified as due to loose connecting rod bearings, loose pistons, etc., but it is important not to jump to conclusions as some noises are very difficult to trace. These noises have a habit of "telephoning," that is, the noise sounds as though it were in one place but is actually coming from somewhere else and the sound is being transmitted along metal or other sound-transmitting materials.

One of the biggest mistakes the diagnostician can make is to start to eliminate a noise before its cause has actually been determined. It is mighty disconcerting to tear into an engine to repair a knocking main bearing only to find out later that the knock was due to a loose flywheel or broken motor mount. This sort of haphazard, hit-or-miss approach is used all too often.

Zoning the Engine

While we may think of locating noise by the intensity of the sound, we also have the possibility of locating by its tone, and we can be further aided in this by zoning the various portions of the engine. If we divide the engine into a number of zones as in Figure 1, assuming a knock to occur in the center main bearing (Zone 1) we may reasonably assume that the intensity of the knock will decrease as we move out toward the extreme ends of Zone 2. Similarly a main bearing knock may be expected to be less intense in Zone 3 and decidedly less intense in Zone 4. By the same analysis, a knock or noise which originates in the front end drive gears or chain may be expected to diminish in intensity toward the rear of the engine. The important concept here is that noises will generally be transmitted throughout the engine but will vary in intensity depending on the source.

To consider how the two factors sound and tone are related and how they may be used in diagnosis, we might say that sound depends on the intensity of the noise and the nature of the parts which produce it, while the tone may differ depending on the source and the speed of the engine.

Where it is possible to isolate the sound source to a particular cylinder (by methods to be described later), we can break down further into zones as shown in Figure 2. This zoning plan covers the major sources of noise to be found in defective pistons, connecting rod bearings, and valve train.

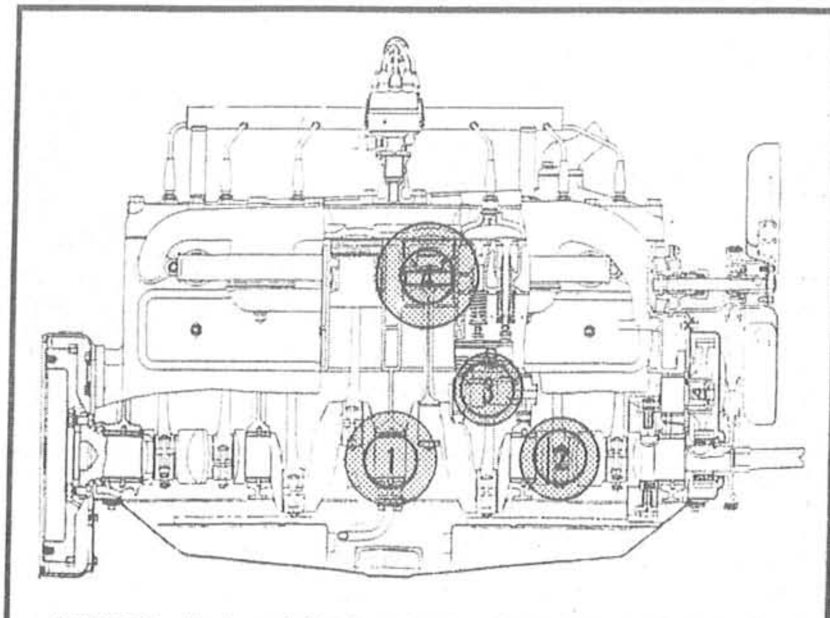


FIGURE 1 – Horizontal side view of engine showing the application of the zoning idea to noise analysis methods.

We have in general the following sources of noise and the zones from which the noise is most likely to emanate:

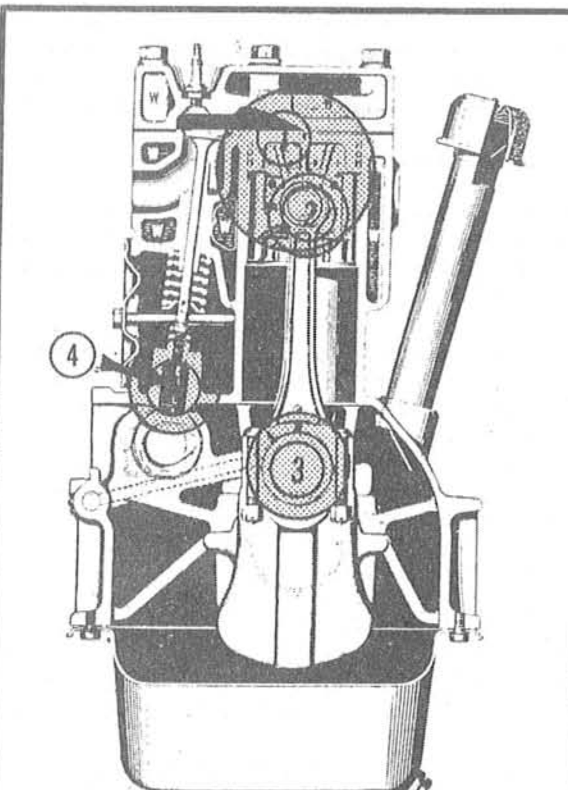


FIGURE 2 – End sectional view of an inline engine showing zones in which noise originates.

General	carbon detonation	Zone 1, Fig. 2
	spark knock	Zone 4, Fig. 1
Cylinders	worn bores	
	pistons loose	
	rings loose	Zone 1, Fig. 2
	inner rings stuck	
	ridge worn in cylinder	
	piston pins loose	Zone 2, Fig. 2
Crankshaft	main bearings loose	
	excessive end play	Zone 2, Fig. 1
	shaft misaligned	
Connecting Rod	bearings worn	Zone 3, Fig. 2
	excessive end play	Zone 2, Fig. 1
	bent rod	
Valves	guides worn	
	valves sticking	
	excessive tappet clearance	Zone 1 & 4, Fig. 2
	bad valve spring	Zone 3 & 4, Fig. 1
	ridge on valve seat	
	worn push rods or guides	
Camshaft	worn bearings	
	excessive end play	Zone 3, Fig. 1
	shaft sprung	
Front end drive	worn gears or chain	
	end play	
	bearings worn	
Fan	belt noise	
	blade noise	
Flywheel	loose	
Engine Mounting	loose, broken, or defective parts	

While this list of the causes of engine noises is not complete, it will cover the majority of cases. It takes considerable space to discuss all the types and causes of noise, and the various cases will be taken up individually in this series.

Sounding the Engine

Some method of sounding the engine, that is, means of transmitting the sound to the ear, should be employed. A number of patented devices have been used in the past for this purpose. One called the Sonoscope consists of a cup-shaped ear phone with a metal rod projecting from it which is held in contact with the various parts of the engine. Another type is the Motophone, which is virtually identical to the physician's stethoscope. These instruments have the advantage of excluding extraneous noises, but for practical purposes they are hardly necessary. Nearly as good results can be obtained by using a metal or wood rod of convenient length, one end of which is pressed against the portion of the engine being sounded, and the other end held about a quarter of an inch from the ear. It helps to cup the hand around the end of the rod and the ear, and close the other ear with the free hand to exclude external noises. Some people report better results if the end of the rod is held in firm contact with the bone immediately in front of the aural opening.*

There are normal noises peculiar to different types of engines, so it is a good idea to have some concept of the standards for the engines being diagnosed. It behooves the operator who wishes to acquire expertise to listen to a variety of normal engines, so when the time comes to diagnose for an abnormal condition, it will be easier to recognize and locate noises. There is no substitute for experience in this game. Keep in mind that many engine noises cannot be adequately described in written or verbal communication; you have to hear them for yourself.

Tune and Warm Engine

Before sounding the engine or making any diagnosis, it should be properly tuned, firing on all cylinders, and warmed to operating temperature. If the engine is not properly tuned or warmed up, other conditions are introduced which make deductions much more difficult.

Some noises are evident only with a hot and not a cold engine, and vice versa. The noise may be of a nature that lubrication is a factor and in this case may disappear when the engine is warm and the oil has thinned down enough to be circulated to every moving part. Again, the oil may thin down enough so that a film is not maintained on a bearing surface, and a knock develops when hot.

Vibration

Many powerplants on antique cars are subject to periodic vibrations which need not be cause for alarm. Usually our experience tells us at which engine speeds such vibrations are prone to occur. In case of excessive noise and vibrations during such periods, it is well to check the motor mounts as they are often the source of such trouble. Only rarely will vibration be due to loose engine bearings as they will knock long before they become loose enough to cause vibration.

Engine Knocks

Alternating stresses cause parts to deflect and pound against their bearings. The pressure of the exploding gases in the cylinder forces the piston and connecting rod down against the crankshaft and the crankshaft against its bearings. When bearings develop a little wear, stresses cause the crankshaft to deflect, exacerbating the wear problem. If the trouble is not corrected at once, the shaft will pound against opposite sides of the loosened bearing, resulting in an audible knock. If the camshaft bearings are worn, the valve springs compressed by the cam will force it away from its bearing surface and cause noise.

Sound Frequency

The frequency of a noise or knock is a clue to its origin. A knock every revolution is usually associated with the crankshaft and piston assembly, while a knock every two revolutions will lead one to suspect the camshaft or push rods. Again, the knock may be irregular. A loose piston pin may knock once or twice each revolution, since it is possible for the knock to occur either at the top or bottom of the piston stroke or both.

NEXT MONTH — A detailed discussion of noises which occur in the pistons, connecting rod bearings, main bearings, and front end.

S.K.

* Footnote: The operator should exercise extreme caution that the tip of the sounding device, whatever it may be, is not caught or struck by the fan or other rotating parts of the engine. Failure to observe this precaution may result in injury to the operator.

WHAT GOES AROUND... ...COMES AROUND

At the beginning of the 20th century, automobiles were considered the 'GREEN' alternative to horses. They were seen as a clean substitute in an effort to eliminate the horses' excrement from the streets.