Datsun camshafts & Valve Timing   by Racer Brown

Introduction

Piston at top centre (TC) compression stroke, both valves closed. Explosion BANG! Piston forced to bottom centre (BC) during power stroke by explosion in cylinder. Piston at BC of power stroke. Exhaust valve opens. Piston pushes exhaust gases from cylinder by moving toward TC. Top centre exhaust stroke. Exhaust valve closes. Intake valve opens. Piston moves toward BC on induction stroke. Bottom centre of induction stroke, intake valve closes. Piston moves toward TC on compression stroke, compressing combustion fuel, both valves closed. Cycle complete. Ready for another explosion BANG! Sound dull? It is dull. The mechanical-textbook world must necessarily and primarily be concerned with theoretical aspects of mechanical problems and their solutions. Practical considerations are secondary to the teaching and learning of theories. In the "real" world, the situation is usually reversed. And so it is, and has been with the four-stroke cycle internal (infernal, if you prefer) combustion piston engine. Practical applications of concepts, ideas and modifications have had such incredibly mind-boggling results since the inception of this type of power plant that the original theoretical approach, as it is still taught and learned, is as antiquated as if it had been carved by hand on tablets of stone. This doesn't suggest that the basic premise, as taught and learned, is necessarily wrong. It does suggest that this premise has been oversimplified to unattainable extremes. Perhaps this isn't all bad for the novice, but for more advanced students of the four-stroke cycle engine, this most basic approach falls flat on its nose, simply because it is inadequate. And DULL. The latter factor alone has probably been the direct cause of more dropouts in this area of study than such unrealistic teaching methods could ever hope to gain.
While the study of the four-stroke cycle engine may not be the most stimulating pursuit in the world, it is anything but dull. Moreover, the practitioners of practicalities - the imaginative designers, innovators, inventors, doers - have almost completely rewritten the original theoretical premise so the original tablets of stone, carved by hand, may be safely consigned to the gravel pit.
An explosion!
BANG! Good grief! But there was an explosion back about 1680 when, in one of the earliest recorded attempts, a gentleman named Christian Huygens tried to make a functional engine using gunpowder as fuel. But history doesn't tell us about the immediate after-effects. Probably a case of no survivors during a one-shot experiment. BANG! (FACT!)
Now bear with me through the dreary details of a most basic four-stroke cycle engine. The assembly consists of a crankcase or cylinder block, in which resides a crankshaft. The cylinder block is bored to accept a piston assembly that reciprocates in the bore. From a front or rear elevation, the cylinder bore centre (usually, not always) coincides with the crankshaft axis. Longitudinally, the bore centre is perpendicular to the crankshaft axis. The crankcase also contains main bearings, which support the crankshaft main bearing journals. Between main bearing journals, the crankshaft has a crankpin parallel to the crankshaft axis but offset from it by an amount equal to exactly one-half the piston stroke. The lower part of a connecting rod contains connecting rod bearings and this end of the rod is clamped to the crankpin. The top end of the connecting rod hooks up to a piston pin located in the piston assembly, the piston pin also being parallel to the crankshaft axis. These components represent the

mechanical linkage necessary to transform the piston's reciprocating motion into rotary motion at the crankshaft.

A cylinder head assembly, usually removable from the cylinder block, is located at the top end of the cylinder bore, away from the crankshaft. Among other bits of ironmongery, the cylinder head assembly contains an intake port and (usually) poppet valve, an exhaust port and (usually) a poppet valve and some provision to accept a spark plug, or other means of igniting a combustible fuel under pressure. A cavity in the cylinder head, surrounding the valve and spark plug, forms the combustion chamber, although it can be formed in the top of the piston, or a combination of both.

There are sub-systems for providing the cylinder with the combustible fuel (induction system); for carrying the products of combustion from the cylinder to the atmosphere - very difficult to do legally, these days - (exhaust system); for opening and closing the valves at the proper times and for the proper intervals (valve train system); for delivery of lubricant under pressure to critical areas (lubrication system); for carrying off excess heat generated by normal engine operation and dissipating the heat to the atmosphere (cooling system); for supplying electrical energy to the spark plug for igniting the combustible fuel in the cylinder under pressure (ignition system).

This is the basic lump, the assembly from which we expect some useful work to be done for us because we are too lazy to do it ourselves. Of course, there are other accessories such as p/s, p/b, a/c, 8-track stereo, etc. But I'm talking about the standard item, the poverty-model.

A "combustible fuel" was mentioned, without which the engine couldn't fire its first power stroke. It really doesn't matter if the fuel is a mixture of hydrogen peroxide, diesel oil and oxygen (not for amateurs), the more common alcohols, to gasolines, to old socks as long as its behaviour under heat, compression and ignition is uniform and predictable. However, in this context, plain old pump-type gasoline is the indicated fuel. We will make the assumption that the induction system does an acceptable job of delivering a mixture of air and fuel in the correct proportions to the cylinder. Plain old atmospheric-type air is necessary to support combustion of the fuel in the cylinder, the oxygen of the air being the necessary compound.

As the term implies, the four-stroke cycle engine completes its cycle in four complete strokes of the piston within the cylinder. One stroke of the piston is defined as the motion of the piston from the top of the cylinder bore (top centre) to the bottom of the bore (bottom centre), or from BC to TC. With the direct mechanical link between the piston and the crankpin of the crankshaft formed by the connecting rod, the motion of the piston can be, and is, related to any number of degrees of crankshaft rotation from zero to 720. That's right - 720 degrees - not 719 or 721, but exactly 720 degrees of crankshaft rotation is required for the completion of one cycle of the four-stroke cycle piston engine. The four strokes of the piston are all named to minimise confusion because the piston positions are duplicated for each complete cycle. Starting in order, the correct sequence of strokes is: Power (or expansion): Exhaust: Induction (or intake): Compression. Cycle complete and ready to start the next four strokes to form the next cycle. You can start anywhere you like, but the correct sequence of strokes must be followed. Example: Induction: Compression: Power: Exhaust. Cycle complete. You cannot transpose the compression stoke for the exhaust stroke any more than you can transpose the induction stroke for the power stroke. The sequence of strokes is fixed and cannot be changed.

Ignoring for the moment Tablet I (that explosion BANG! Episode) and looking at Tablets II, III, and IV in the volume of hand-carved stone tables, we find that the theorists would have us believe that at BC of the power stroke, the exhaust valve opens, at TC of the exhaust stroke, the exhaust valve closes. And the intake valve opens, and at BC of the induction stroke, the intake valve closes. How do the valves get themselves open or closed? And why at these precise points of piston travel? They are not vague when they say "valve opens" or Valve closes," but we are left to assume that the valves are fully open or fully closed, with no lapse between the two valve positions, and we are left to further assume that the valve motion is instantaneous. Swell. If valve motion can be instantaneous, why can't piston motion be just as instantaneous?? NO WAY!!

This is where the original hypothesis, as writ by hand on tablets of stone, drops completely dead. The theorists conveniently neglected to include the on vital, absolutely essential element in the proceedings. Time. That's right. T-I-M-E. There is NO action, reaction, force, counterforce, or whatever, on the face of the earth or in the entire universe that is instantaneous. Each and every occurrence in the universe, no matter how infinitesimal or how vast, no matter what its nature, all have one common denominator: They all take time. Maybe light-years, maybe milliseconds, but time is the essential element. Even that BANG! Stupid explosion takes time. If it were mechanically and physically possible to bring about instantaneous events, and if they were applied to our laboriously-constructed engine, we'd better be able to duck instantaneously because all we'd ever have to show for our efforts would be a loud and widespread case of instant shrapnel. So while time allows our engine to function in a normal manner, it also allows us opportunities to correct our mistakes. Because of the necessary time factor, valve motion overlaps the piston positions of top and bottom centres and during on period of the cycle the valve motions overlap themselves. Even the cycles overlap each other. Sometimes I wish it were possible to view a functional engine through some kind of simplified but cock-eyed glass prism so that all engine events could be seen directly and in their proper perspective, rather than relying upon mere words.

Back to Menu

Chapter one