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STRAIGHT TALK ABOUT DETONATION

After looking over several lists of engine options that are available with most snowmobile manufacturers we believe there is a definite trend toward higher performance engines. This will result in improved vehicle performance to make the sport of snowmobiling more enjoyable and safer.

Refinements found on many new engines plus owner modifications on older engines probably are the result of wide spread activity in snowmobile racing and competitive activities. With this trend to higher compression ratios and more horsepower, however, there can be, on rare occasions a few unwanted, confusing, and perhaps misunderstood by-products -- one being abnormal combustion of the fuel mixture. These phenomena may even cause occasional failure of pistons, spark plugs, and other engine parts.

If you have been associated with snow vehicles for some time, you may have heard such terms as detonation, preignition, auto-ignition, pre-detonation, loss of power, after-running, knocking, pinging, etc. Basically, this jargon can be divided into two classifications, "detonation" and "preignition." We will talk more about preignition in our next story.

"Detonation" is generally thought of as spontaneous ignition. It can be described as a noisy explosion in the unburned portion of the fuel/air charge, after the spark plug fired. Detonation creates shock waves almost like a supersonic jet breaking the sound barrier. Shock and pressure waves of detonation, as those of supersonic jets, can cause severe stress, and in

an engine, often finds a weakness, the crown of a piston -- the cylinder head gasket -- piston rings or piston ring lands. We've described detonation as a rather loud noise which it is not, especially when you are trying to pick it out over noises of the engine, drive train, and wind -- with your helmet on.

Detonation in a "two-stroker" somewhat resembles the "pinging" you may have heard from your passenger car engine. It can be described too, by a tin-like "rattling" or "plinking" sound, similar to dragging a screwdriver across the cylinder head fins. Surprising though, this sharp sound can be recognized even under a helmet if you "tune" your ear to this type of frequency or noise. If you have had the unfortunate experience of ventilating a piston, you may even recall hearing this noise just before the catastrophy. In high-performance, high compression engines, detonation can overheat a piston crown and "pound" a hole in the piston crown quicker than you can get your thumb off the throttle!

As a matter of fact, while field testing a snowmobile with a 10:1 engine, we had the opportunity to experience this type of piston failure. The engine, which is equipped with the "tuned" exhaust system, was inadvertently switched over to marine white fuel while re-fueling. The carburetor high-speed needle was leaned out (turned in) only 1/8 turn from the factory recommended setting. Until the time of failure, this engine had been performing completely normal on regular automotive fuel. (Did you know this year some manufacturers are recommending premium fuel to be used in their high-performance, high compression engines!) The Champion thermocouple spark plug tip temperature* at the time of failure was a safe and steady 1500°F. Figure 1 shows the piston, the nature of damage, and the condition of the spark plug's firing end. You will

* (see Wheelspin Issue 27 Vol. 5 - Are You Using The Right Spark Plug?)

also notice the underside of the damaged area has a ragged surface of granular metal closely resembling a physical break. There is some evidence of higher temperatures and possibly lack of lubrication too by the slight scuffing on the piston rings. The damaged area of another piston and the disassembled spark plug are shown on figure 2. This piston, whose condition closely resembles that shown on figure 1 was removed from an engine having a 11.5:1 compression ratio.

In most cases, the spark plug suffers the least amount of damage or none at all, but usually gets full blame! It gets the blame because it usually gives first evidence of a problem -- perhaps the spark plug is the easiest thing to blame.....or it's the closest to the damaged area? Of course, detonation can also break off ground electrodes, fracture insulators, or "blow" plugs out of the cylinder head. The two spark plugs shown in figures 1 and 2 were in the engines when it all happened. They show no signs of overheating, fused electrodes, etc.....but their firing ends did pick up some aluminum flecks or "dust." It's quite obvious regular servicing will restore the thermocouple plug and the same would apply to the other before we took it apart.....but the pistons? We don't think so.

In stock engines, detonation can be rather easily avoided by adhering to the grade of fuel having the octane rating or grade recommended by the engine manufacturer; and thoroughly mix it with the right amount, type, and grade of lubricating oil too. Since lean fuel/air ratios encourage detonation, adjust your carburetor carefully, first favouring a slightly rich setting of perhaps 1/16 to 1/8 turn further open than the basic setting. Should the engine have a tendency to "four-cycle" because of an overly rich mixture, the mixture may be cautiously leaned out 1/16 turn at a time, until engine

performance is acceptable. Even though it is not generally significant, a considerable drop in ambient (outside) temperature with the resulting denser air, is also known to require a slightly richer mixture.

Even though we've placed considerable emphasis on octane requirements and fuel mixtures it is an accepted fact that over-advanced ignition timing is a major cause of detonation too. During a recent engine dynamometer test, it was observed that ignition advanced just 5 degrees beyond basic timing brought on audible detonation! At the same time, plug temperatures (other combustion chamber components too) zoomed up very dramatically. Our suggestion to those who are not thoroughly familiar with ignition timing procedures -- have these adjustments done periodically by a well qualified service technician.

What's the story about detonation, ignition timing, etc. when you "bolt" on a high compression cylinder head, a tuned exhaust system, or install an oversized piston, or grind and polish a "little" from the ports, or "stuff" the crankcase? In effect, these modifications generally "pack" more into the combustion chamber, raising the compression pressure and compression ratio. The number of alterations effected, will, of course, determine the degree of heat produced in the combustion chamber too, so don't forget to install that colder spark plug. Determining optimum or best ignition timing (total spark advance), as selecting spark plug heat ranges for modified engines, becomes a trial-and-error and/or "listening" proposition. Play it safe and retard the ignition timing considerably if you don't know what the engine will take. If there is evidence of detonation even with a rich carburetor setting, or you "pop" or stick a piston you are probably still too far advanced .....or it is time to lower the compression ratio.

Ignition timing procedure with modified engines, as we have witnessed with highly modified outboards, requires a precision dial gauge threaded into the spark plug hole and a buzzer and/or test light attached to the magneto breaker points. Don't forget to use the recommended magneto edge gap spacer too. Incidentally, this approach to ignition timing is highly recommended for any two or three cylinder snowmobile engine.

After we wrote this story we felt you may perhaps get the impression snow vehicle engines are somewhat complicated and complex. Let me assure you, however, they are not. Two-cycle snow vehicle engines, pound for pound, are one of the most dependable and easiest to service power plants. If they are given the correct diet of fuel and oil, they will give countless hours of trouble free service.