Datsun camshafts & Valve Timing by Racer Brown

Chapter Seventeen

TURBOCHARGING

The practice of turbocharging the latest crop of small engines is becoming increasingly popular in an attempt to get the little kids to catch up with the big kids. Supercharging, particularly turbocharging can show some value as an exhaust emissions tool if it is done correctly, as well as giving relatively large performance gains. L-series Datsuns respond well to this treatment, about the only weak link being blown cylinder head gaskets, usually when some ignorant, overzealous lout tries to shove more boost pressure down its throat than it has capacity to digest. O-ringing the cylinder head, or a solid copper head gasket, or a combination of both if one is really serious, should handle this problem.

Data for the various types, makes and pressurising characteristics can be

Now, camshafts for supercharged L-series Datsuns. To be hones about it, I have never really been able to define, to my own satisfaction, just what a "supercharger camshaft" it. Even in the world of the alcohols, nitro-methane, nitropropane, polypropolene, nitrous oxide, hydrogen peroxide and even a touch of oxygen, and back to more mundane fuels such as gasoline, I have never seen that much difference in the valve timing requirements of an engine, gasoline or romantic fuels, supercharged or unsupercharged. There are a few subtly differences but certainly nothing earth-shattering. In fact, I have found that in the vast majority of cases, the camshaft profile that works best in an unsupercharged engine will usually work best in the same engine with a supercharger. This observation has been very nearly infallible with moderately supercharged gasoline-burning road vehicles. So whatever camshaft profile works best in your unsupercharged L-series Datsun will, with about 99% certainty, work best with a mild supercharge. There is one increasingly popular exception. Enter the turbocharger. The nature of this exhaust-driven supercharger requires a different approach, but not without reasons attached. Normally, effective intake duration can remain about the same as in an unsupercharged engine. If a change is indicated, it will usually be in the direction of later intake valve opening and sometimes later intake valve closing. The biggest change, and one that is relatively enormous, lies in the required effective exhaust valve duration. This should be short, SHORT, S-H-O-R-T! Even a double-throw-down, triple-whammy, flat-out turbocharged race engine for the turbocharger to work most efficiently - should have an effective exhaust valve duration of no more than the mid-270 degree range, very little overlap and as much valve lift as can be conveniently cranked into it, taking the dynamic stability of the exhaust cam lobe at maximum engine speed into consideration. Didn't know that, didja?

Remember: A turbocharger works best as a function of the temperature and velocity of the exhaust gases, and the volume of exhaust gases is secondary. This strongly suggests late exhaust valve opening and early exhaust valve closing so that exhaust gases, in their purest form, can work on the turbo impeller, which is directly connected by the same shaft to the compressor impeller. This doesn't indicate that a turbocharged engine won't function with stock camshafts or those with a relatively long effective exhaust valve durations. It will. But longer exhaust valve durations have drastic effects on the average exhaust gas velocity and temperature. In addition, longer valve overlap periods permit fuel from the pressurised induction system to be pumped out the still-open exhaust valve, lowering exhaust gas temperature and density even further.

This is the primary reason why most stock-but-turbocharged engines feel like you've stepped on a wet sponge at low engine speeds; they're just plain soggy until there is enough of a blast of exhaust gases to wake up the turbo impeller which, in turn, wakes up the compressor impeller.

So, for a moderately-turbocharged L-series Datsun road vehicle, effective exhaust valve durations should be in the low to mid-220 degree range and possibly a later opening intake valve. If you don't think this will put some instant muscle in your Datsun, try it.

SOME NOTES ON STANDOFF

Now lest' consider "standoff" or "pressure reversion" a phenomenon that shouldn't exist to the detriment of engine performance, but does in too many cases. Nearly everyone even remotely associated with high-performance engines is aware of the so-called "ram" effect as applied to engine induction and exhaust systems. This condition is generated by sonic pulses that continually rattle about in an engines induction system, exhaust system and at times, in the combustion chamber area, and a favourable ram effect will occur when these pulses become aligned in direction and magnitude to cause a larger-than-normal charge of air/fuel mixture to be pumped into the cylinder from the induction system. A similar alignment in direction and magnitude of pulses causes a larger-than0normal volume of exhaust gases to be pumped from the cylinder through the exhaust system. In simplest terms, pressure reversion could be defined as diametrically opposite a favourable ram effect, a condition in which the air/fuel mixture is forced away from the cylinder, back up the induction system toward the atmosphere. A similar condition can exist on the exhaust side whereby exhaust gases can be forced back toward the cylinder from the exhaust system. It is quite reasonably felt by some experts in the field that the pressure reversion in the induction system is caused by a pressure reversion in the exhaust system, with the combustion chamber area as the connecting link between the two during the overlap period. However, later indications, are that pressure reversions in either system can occur independently of the other, although their magnitude seems considerably less than a combined induction-exhaust reversion.

Pressure reversion usually manifests itself visibly as liquid fuel or fuel stains on some surface at or near the upstream sides of the carburetors. Sometimes it doesn't get as far as the atmosphere, in such cases being visible as a sort of "ball of fog" extending from the intake manifold and perhaps into the carburetor while the engine is operating through its normal speed range, preferably at full throttle. Sometimes it may not be visible at all due to the intake manifold configuration, which would cause the reversion pulses to be damped and contained within the manifold. Happily, there are times when a pressure reversion condition does not exist at all within the normal engine speed range.

We sometimes like to think of the air/fuel mixture and exhaust gases as smoothly-flowing, but such is not the case. The sonic pulses, or pressure waves, as you prefer, which incidentally, occur in all engines, cause violent disturbances to the air/fuel mixture and exhaust gases within the cylinder and induction and exhaust systems. These pulses represent energy, quite a bit of energy, in fact, and when they can be made to work favourably for and with an engine, as they can in the correct application of the ram principle, engine performance comes to life. However, when they work against an engine, as in the case of reversion, engine performance tales a gigantic nose-dive. If these pulses were one-directional downstream pulses, that is, from the atmosphere, through the induction system and into the cylinder, then from the cylinder through the exhaust system to the atmosphere, things would be lovely. However, for every downstream pulse, there is a reflected upstream pulse of lesser magnitude and these are the ones that do the damage, particularly when they become so unsynchronised or out-of-phase as to cause a pressure reversion, a highly-undesirable, performance killing condition.

The consensus is that these sonic pulses are initially generated by the opening and closing of the valves, although when either or both valves are open, the piston crown cannot be ignored as a possible secondary source of pulse generation. It could also be that the piston is a primary source of pulse generation within the combustion space when both valves are closed. The latest data corroborates earlier findings in that the pulses are basically sonic in velocity. But sonic velocity varies with the density, temperature and pressure of the working fluid; therefore the actual pulse velocity in the induction system will vary greatly from that in the exhaust system, with the combustion space serving as a transition between the two extremes. In addition, there is a thought that downstream pulse velocity should be added to downstream gas velocity, while upstream pulse velocity should have downstream gas velocity subtracted from it. With all this downstream/ upstream gas/pulse thrashing about going on simultaneously, there is little wonder that some disagreement exists between experts in the field, but the biggest wonder is that the engine runs at all.

Pressure or pulse reversion exists most prevalently to a performance-damaging degree in engines equipped with individual runner (IR) induction systems where each cylinder has its own isolated carburetor throat and intake manifold runner and there are no interconnections between carburetor throats or manifold runners. This applies to the L-series Datsuns because this type of system is used most frequently for Datsun race engines, and to some extent, for modified street and dual-purpose engines with Datsun-available 44mm or 50mm Mikuni/Solex side-draft carburetors and manifolds, and sometimes with Weber carburetors.

The reversion problem shows up at its worst when the induction and exhaust systems appear to be "clean"; that is, when the carburetor throats, manifold runners, cylinder head ports, exhaust header pipes are all nicely matched and blended to their mating pieces. It may be clean in fact as well as appearance, but unfortunately, it is clean in both directions, so reversion pulses have and easy time of it.

Four separate and distinct areas require possible reworking to minimise the effects of pressure reversion, if not eliminate them completely. First, the exhaust system flange and primary pipe should be about 1/8-inch larger on all sides than the port opening in the cylinder head. Second, the intake port face in the cylinder head should be about 1/8-inch (1/4-inch on the diameter) larger than the intake manifold runner, then the port should be funneled down to more normal dimensions as it approaches the intake valve. Third, the intake manifold runner should be about j-inch larger in diameter than the carburetor throttle bores, and the runners funneled down to a smaller dimension at the manifold mounting face.

The idea is to make deliberate mismatches at these three points. The reasoning behind this is that there is pretty conclusive evidence that the downstream pulses (the good guys) take the shortest distance to get where they're going, while the reversion pulses (the bad guys) stay close to the walls of the carburetor, intake manifold runner, intake port, exhaust port and exhaust pipe. The deliberate mismatches make abrupt changes in cross-sectional area, which are highly beneficial in damping the unwanted reversion pulses. In addition, the air/fuel mixture traveling downstream is pumped into areas of lower-than-normal pressure, which in itself, helps induce a larger volume of mixture into the cylinder, and the same is true on the exhaust side. Edelbrock Equipment Company has made a couple of prototype manifolds incorporating the mismatch concept for the L-16, L-18 engines with encouraging results for a first attempt in damping reversion pulses.

The fourth are that may require a change is valve timing. By itself, valve timing can have rather dramatic effects upon the presence or absence of pressure reversion.

If a reversion problem exists, the changes should be made one at a time and in the order shown until the problem disappears completely or is at least helped considerably. At the points of mismatches, leave the edges square and sharp. DO NOT ROUND OFF THE SHARP EDGES! Perhaps strangely, there are highly modified L-series engines with no reversion problems at all within the normal operating speed range.


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