Features and Popular Issues for the LT5 Engine Today

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Some Exotic Design Features of the LT5

Oil Selection

Fuel Injectors

Secondary Port Throttles

Performance Upgrade Paths

Coaxially Fed Crankshaft Main and Rod Bearing Oiling

- **Used in the Rolls-Royce Merlin aircraft engines**
- **Used in F1 engines**
- **Not used in any other GM engines**

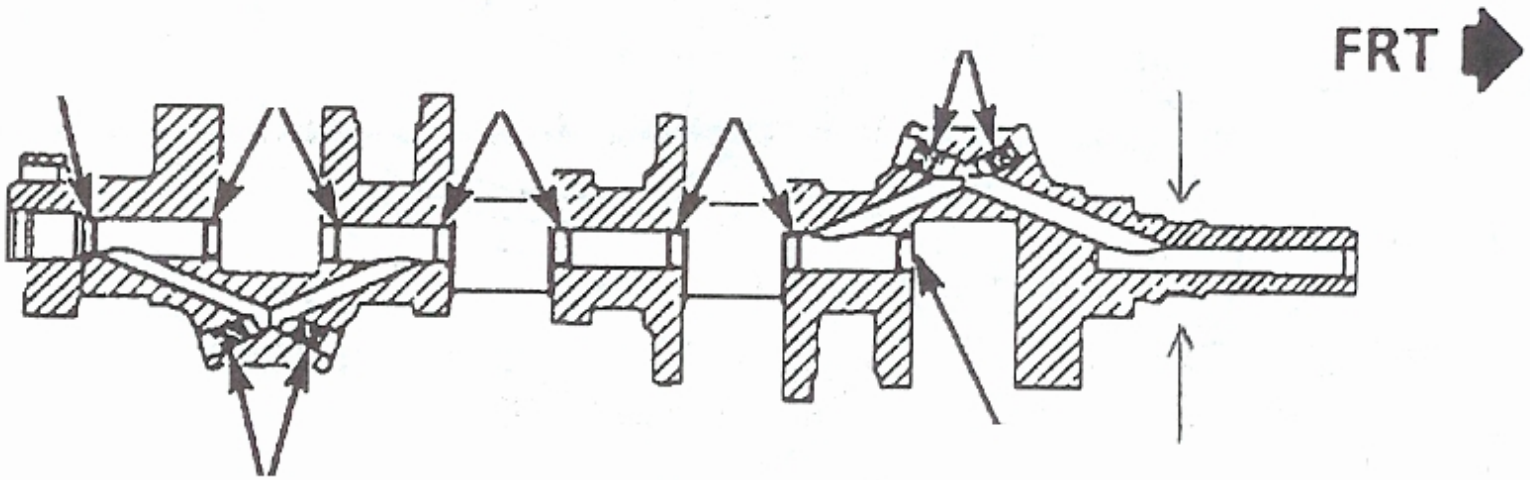
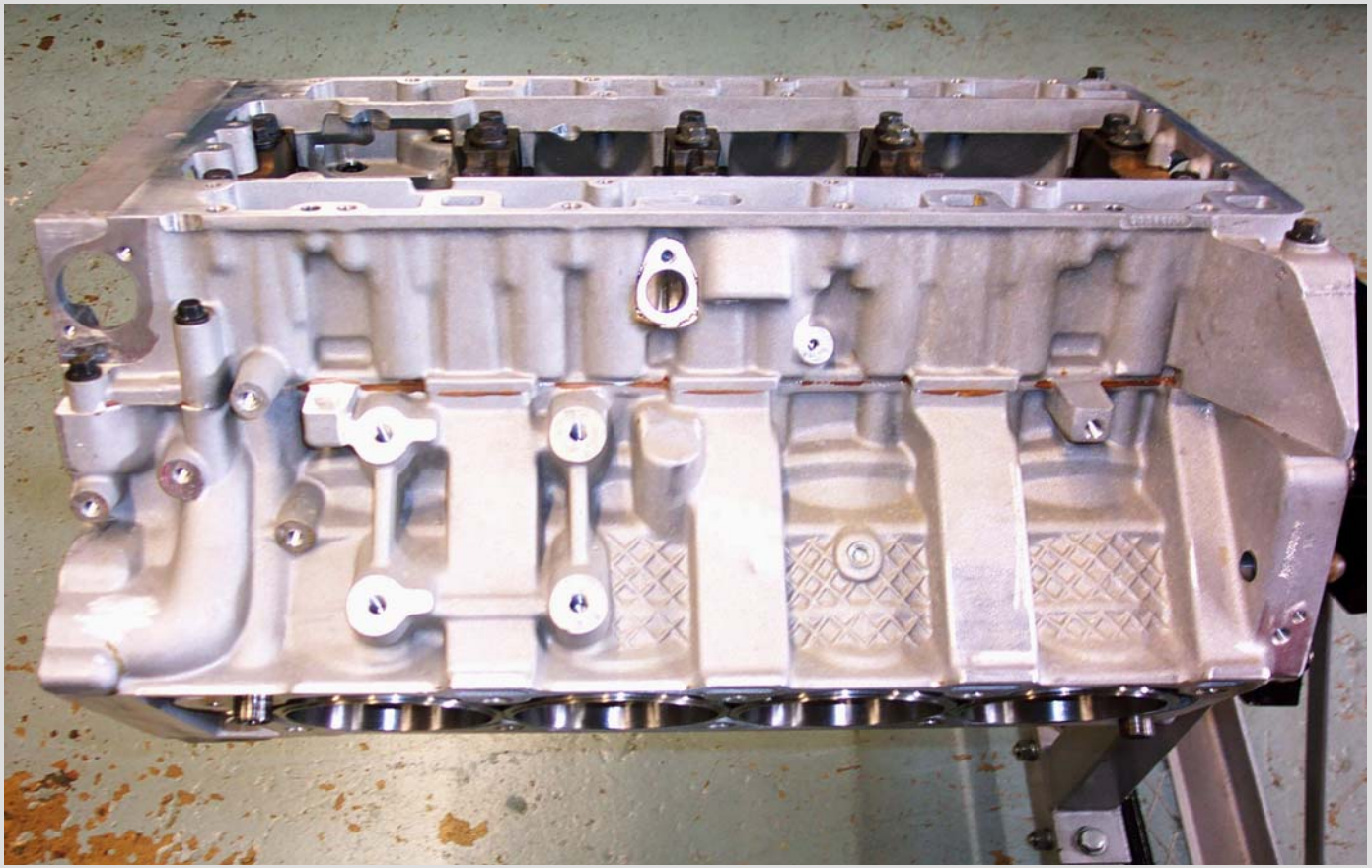
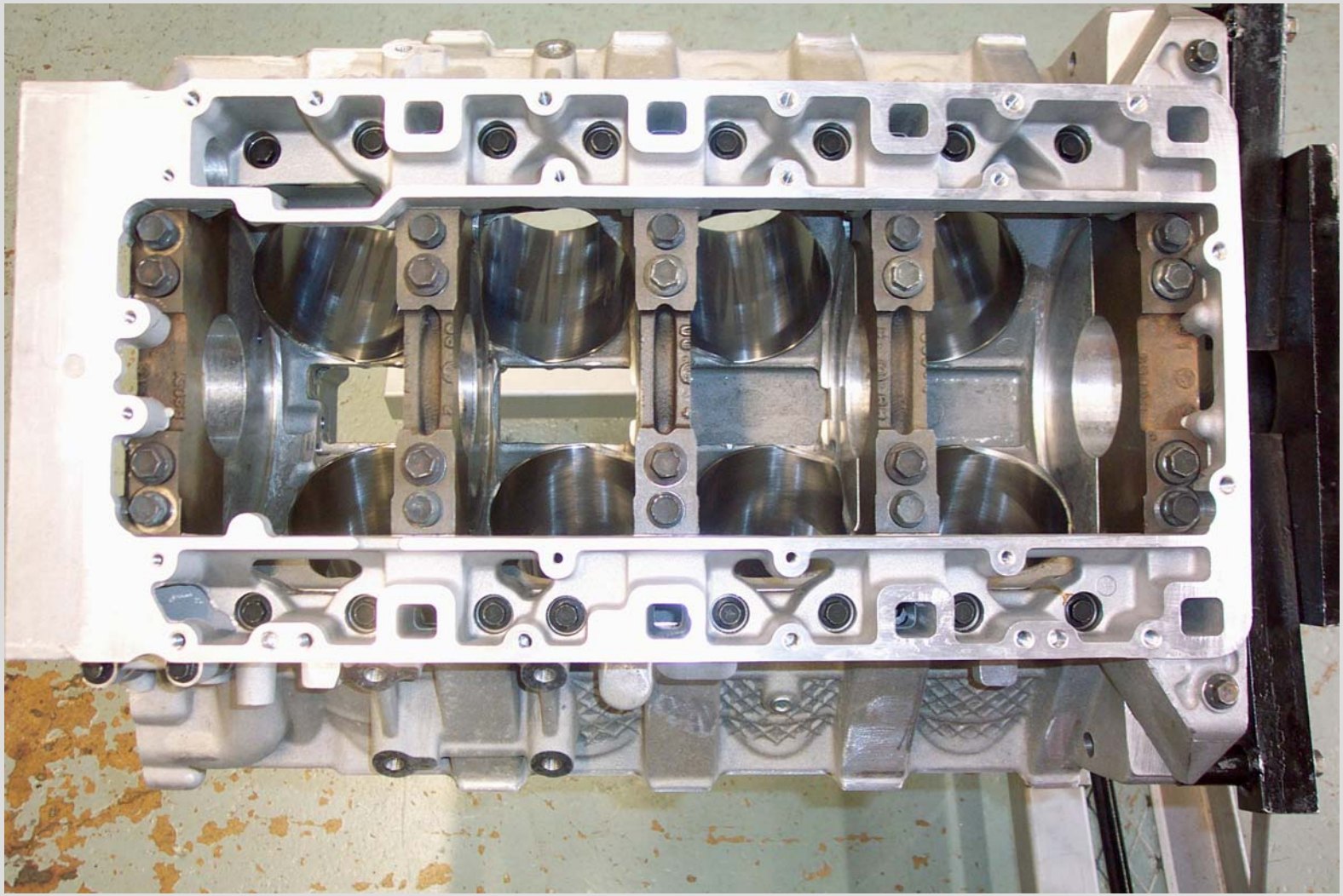


Image credit: GM service manual.

Integrated Lower Crankcase Assembly

- **This was a design first for GM**
- **It was subsequently used on the Northstar and LS series engines**

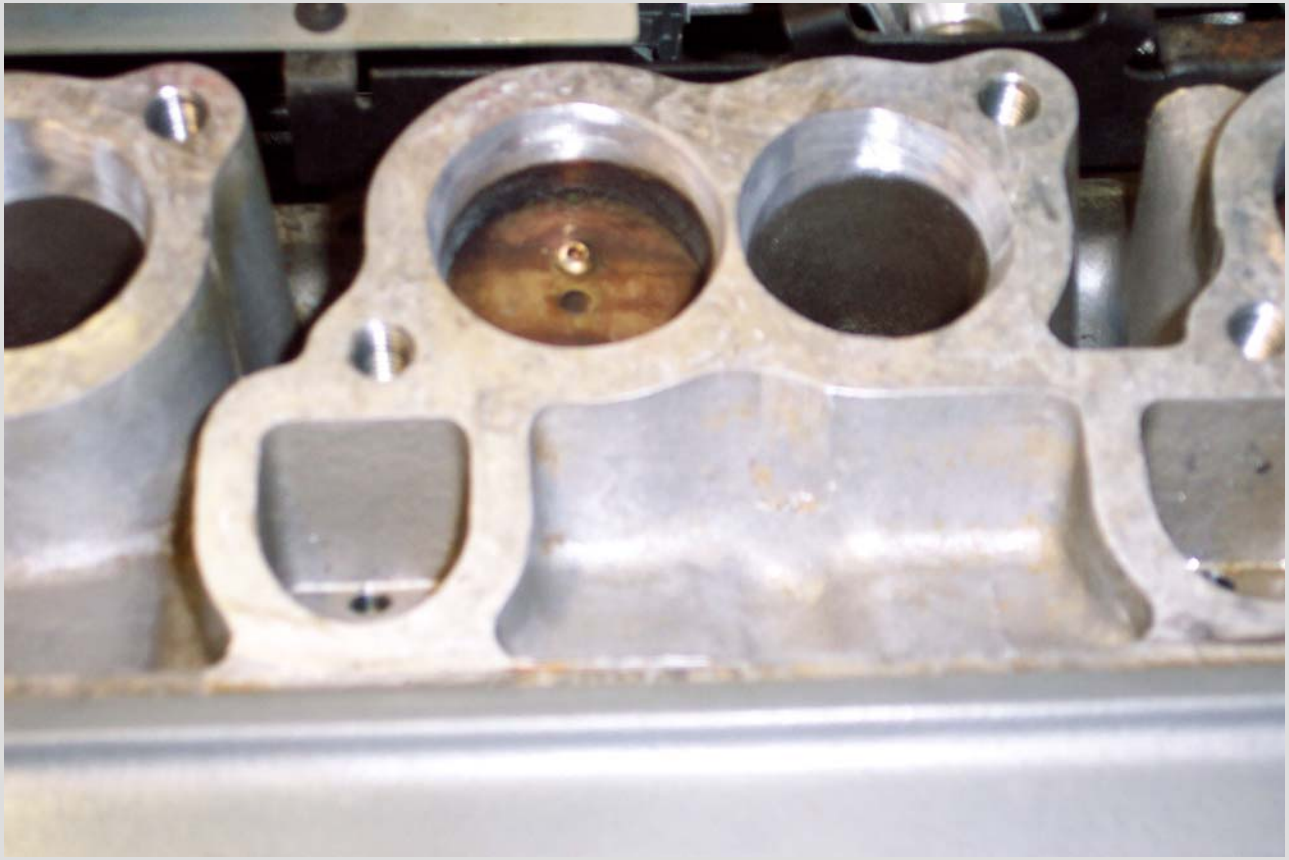




’93 and up blocks are tied together with 42 fasteners

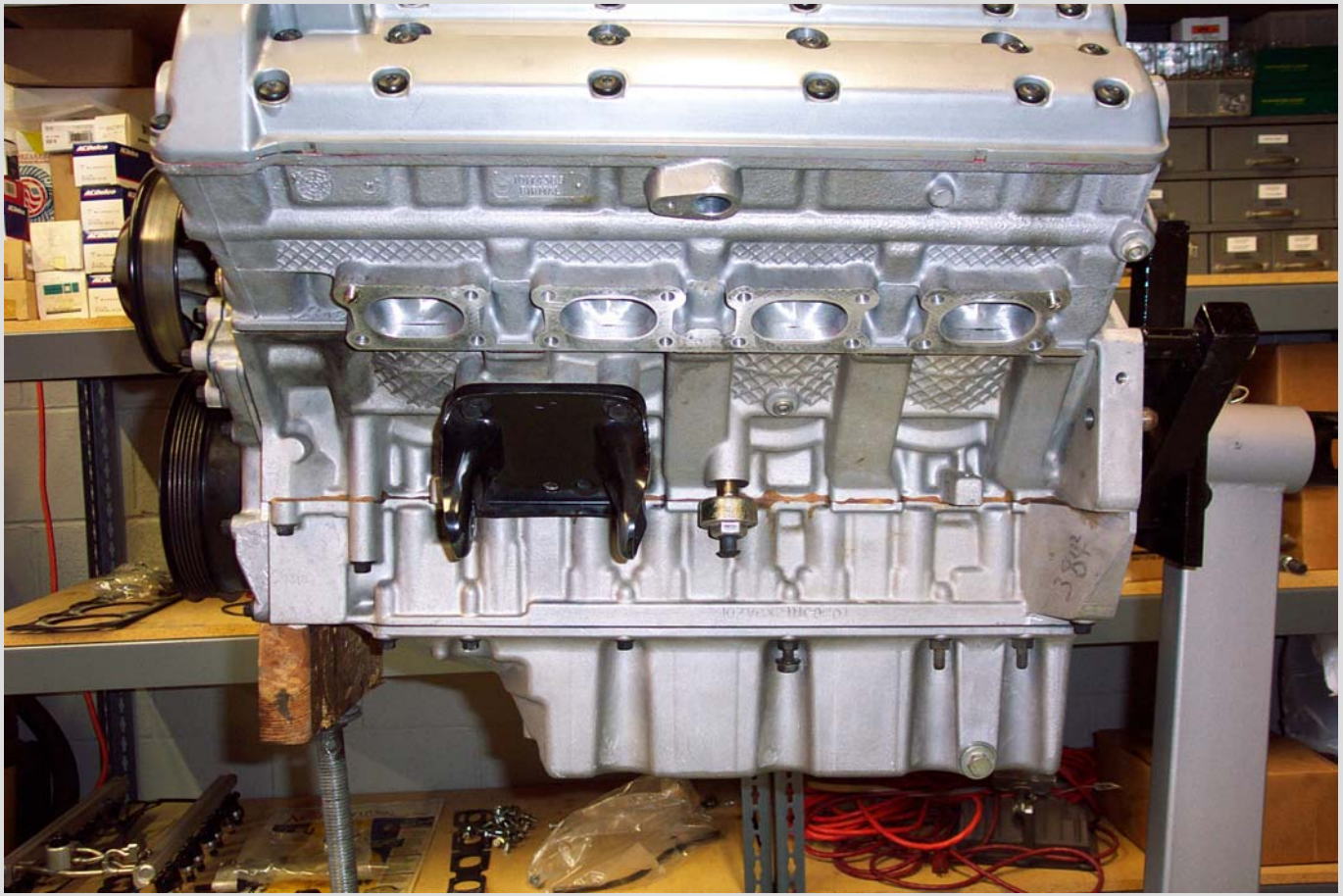
Round Intake Ports

- **Best for smooth flow**
- **A round port verses a rectangular port? For smoothest flow, round is better.**
- **No need to develop special flows through odd asymmetrical shapes**



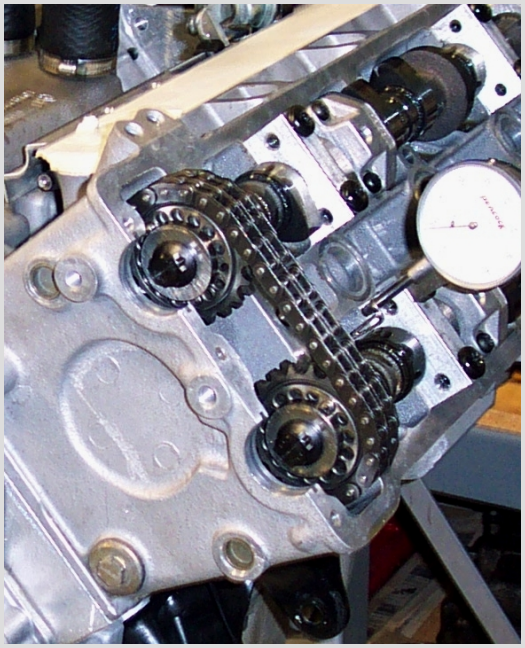
Wide Open Exhaust Path

Nothing **is in the way of the exhaust manifold path**



Double Row Roller Camshaft Drive Chains

- **Though a torturous engineering route we benefit from high capacity secondary chains**
- **The engine was designed with a single row chain. It was found to be slightly under the needed load capacity. The chain was upgraded the two rows. This adds 33% more capacity. High mileage cars benefit from this.**
- **Sprocket life is better too. The double row chain has twice the roller area.**



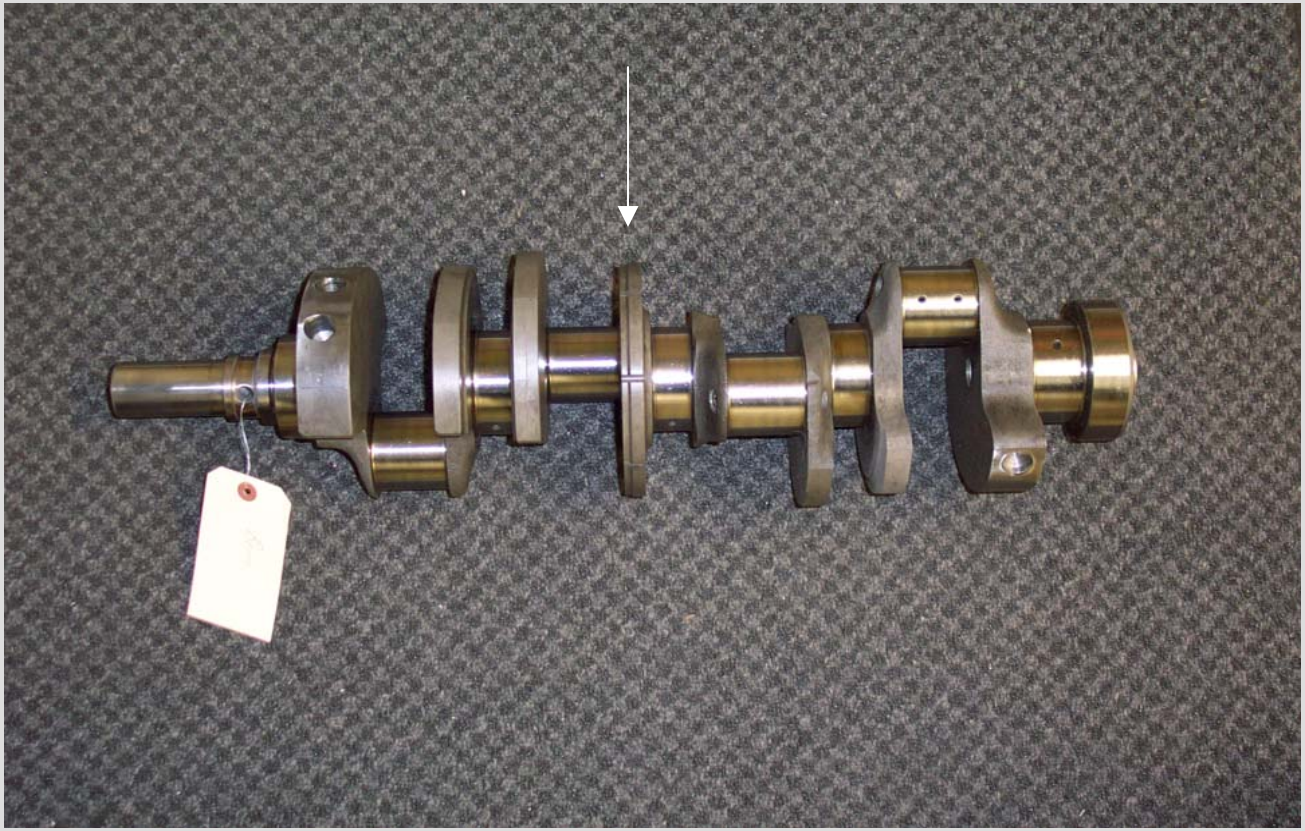
Nikasil Coated Cylinder Liners

The longest wearing cylinder material available

The Ignition Trigger Wheel Is Centered On The Crankshaft

A Perfect No Compromise Design

- **It’s not way out at the end of a chain**
- **It’s not even at the end of the crankshaft**



Oil Selection

Motor Oil Has Evolved Away From The Needs Of Our Engine

- In my opinion Mobil 1 10W-30 is no longer appropriate for the LT5
- Mobil 1 High Mileage 10W-30 addresses the low EP performance of regular Mobil 1
- Flat valve lifters need extreme pressure protection
- The Extreme Pressure wear protection is being removed from modern motor oil
- GM specified API standard SG for the ’90 to ’93 engines. “API SG or SH” was specified for the ’94 and ’95 engines.
- Motor oil uses zinc and phosphorus (ZnDDP) as EP anti-wear additives. Phosphorus is the more detrimental of the two, and is being progressively reduced to address the catalyst deactivation issue.

Phosphorus content for viscosity 10W-30 per the API standard:

SG	.12%
SH	.12%
SJ	.10%
SL	.10%
SM	.06 - .08%
SN	.06 - .08%

•Fortunately, at this time this is a minor problem. The LT5 valve spring load on the lifter is small compared to a push rod and rocker arm engine.

•The LT5 spring load on the lifter at full lift is 248 lbs. For a stock LT1 it is 375 lbs.

• The exact impact on the LT5 is unknown.

• I like to be on the safe side and recommend an oil with the same EP additive levels as the OE SG and SH specifications.

• I recommend oils that are designed to address this issue. Oil manufactures like Amsoil, Red Line, Royal Purple and others offer products that meet the SG/SH specification.

• The Amsoil AMO 10W-40 product meets the SG specification.

• Higher viscosity oil has more film strength and enhances EP performance.

The Problem With ’90 – ’92 Fuel Injectors

- **They are damaged by ethanol fuel additive**
- **GM updated the ’93 –’95 injectors for ethanol compatibility. This was documented by Graham Behan in the ZR-1 Registry magazine in 1998.**

written by Graham Behan

'93 Model Year Changes:

So the story continues.

Following the resolution of the cam scuff problem and the resumption of production I took responsibility for the 1993 MY upgrade programme. The intended route for the performance upgrade had been to increase the lift and duration of the secondary cam profile. This had resulted in engines which met the power target, at higher peak rpm, but had reduced bottom end torque, something for which the LT5 had always been criticized. So I decided to follow a different route, the exhaust system back pressure was planned to drop 2" hg which would give us 6 bhp and we concluded that we could get the rest from detailed modifications to the engine. The planned changes were revised to include: matching the inlet system at the plenum-injector housing interface, the injector housing-head interface, re-profiling the ports, fitting a larger valve throat cutter, hand blending of the intersection of the machining, three-angle machining of the valve seat and inlet valve, two-angle machining of the exhaust valve and changing the exhaust cam timing, whilst retaining the current production camshafts. The machining and blending of the ports would not have been necessary if we had decided on this route from the start, but now it was too late for a tooling change to the production core boxes.

At this time we learned that the production source for cylinder heads, Birmal, would no longer be producing semi-permanent mould parts. So we now needed to re-source the heads. Birmal produced a large quantity of parts and the tooling was then moved to A. L. Dunn. Since the tooling required refurbishment, we could now take the opportunity to modify the port core boxes. The new heads would also incorporate the low pressure reservoir to eliminate tensioner rattle on start-up and a revised water jacket, basically limiting the water flow from between the inlet valves. The resultant heads had increased port flow over the machined, blended port of the Birmal parts. Due to the limited production in the 92-95 MY's, there were only about 130 engines which were built using these heads.

There were several other changes scheduled for 1993. The parts affected were as follows:

Valves (revised back angles)
Seats (3-angle inlets and 2-angle exhausts)
Heads (port-machining, hand-blending, increased throat diameter, and deletion of the exhaust stud)
Revised cam timing (exhaust 114 degrees to 110)
Injector housings (revised machining)
Injectors (common shape and part changes for alcohol fuel resistance)
Plenum (machining changes for EGR and port matching)
Addition of EGR system components
Crankshaft (reduced mass and revised balance)
Rods (reduced mass)
Piston pin (reduced mass)
Piston (reduced mass and revised clip retention)
TV damper (tune to accommodate internal mass and balance changes)
New cylinder case (4 bolt mains)
Valve retainers (extra fitted spring length)
Exhaust manifold (two piece)
Calibration (revised spark/fuel and port throttle strategy)
Oil pan (revised windage tray and baffles)
Oil pick up
Oil pump
Spark plugs (platinum)
Oil (synthetic)
V drain (increased diameter-angled hole)

From the above list you can see that the 93 MY change was a little more than a simple performance upgrade; it was a significant change to the engine systems and structure.

Many other component changes were originally scheduled but were weaned out of the programme for all kinds of reasons including cost, timing and technical considerations. Our first engines were running at 400 + bhp in late 1990; the revised specification engines were at 405 bhp by late February 1991. The 405 bhp was realized in GM Test 1 spec, which means with full vehicle inlet and exhaust system, in GM Test 20 form, i.e. dyno headers and no inlet restriction, the 1993 MY engine produced 445 bhp with optimized spark and fuel (LBT/MBT).

Since Lotus had design, development and production support responsibility for the LT5, the team was split into three groups: current engineering, 1993 MY and 1995 MY. The 93 MY engines were now completing 400 hours plus of dyno testing at WOT on the GM Corporate durability test cycle without major failures, so the attention was focussed on the proposed 1995 MY upgrade. This was to include more significant changes and the performance targets were a torque increase and 475 bhp. In order to do this, we incorporated a Lotus-patented cam profile switching system which allowed us to have two discrete cam profiles, one for optimum torque and one for optimum power. This mechanism could be fitted in the space of the production hydraulic lifter and switched hydraulically at the crossover point in the torque curves. Engines were built to the high torque and the high power specifications and used as test mules for the 95 development. Two engine sets of the full spec engines had just arrived at Lotus when, following a meeting in Detroit, word came back that the 95 MY upgrade programme was cancelled and the LT5 would cease production at the end of 1995 MY.

This was a time for mixed emotions for the people who had given so much of their lives to this programme for the past few years and had developed such rapport with the other members of the LT5 family, both in the UK and in the USA. Many scenarios were conceived and proposed to keep the LT5 in production, some wilder than others, but at the end of the day we just carried on with the improvements we had scheduled for the remainder of the production life of the engine.

Published in the ZR-1 Registry magazine in March 1998.

Mysteries Of The Secondary Port Throttles

Secondary Port Throttle Opening Trigger Points

RPM	Throttle Opening % Trigger '90 - '92	Throttle Opening % Trigger '93 - '95
0	100	100
500	90	95
1000	90	95
1500	90	95
2000	35	90
2500	35	38
3000	35	20
3500	25	15
4000	25	15
4500	25	15
5000	25	15
5500	25	10
6000	25	10
6500	25	10
7000	25	10
7500	25	10
8000	25	10

Is It a Good Idea To Remove The Secondary Throttles?

- **Only if there is a good reason. Normally they don't cause a problem.**
- **They are useful for an emissions test. Using a corner intake path generates swirl which is good for low speed combustion.**
- **These are common reasons:**
  - **They are malfunctioning and defy repair**
  - **Difficulty locating service parts**
  - **If they are removed for service, time can be saved if they are not reinstalled.**
- **If the engine calibration is modified, all of the secondary throttle parts can be removed including the vacuum pump.**

Performance Upgrade Paths

- **With a low backpressure exhaust system, most stock ’90 – ’92 cars have 400 hp. Most stock ’93 – ’95 cars have 415 hp.**
- **Go from the OE 3.45 to a 4.10 axle gear ratio. 18% more torque to the wheels at all car and engine speeds.**
- **Headers. +25 hp.**
- **Top end porting. +30 hp on ’90 – ’92 engines. +20 hp on ’93 and up engines.**
- **Head porting. +30 hp. +25 hp on ’93 and up engines.**
- **Light weight flywheel. +15 dynamic hp when the engine speed is accelerating rapidly.**
- **For ’90 – ’92, 400 +25 +30 +30 = 485 hp. +15 = 500 hp.**
- **For ’93 – ’95, 415 +25 +20 +25 = 485 hp. +15 = 500 hp.**
- **If 500 hp is not enough, 600 hp is easy to do simply by going to a 4.000” bore and a 4.125” stroke. This configuration has a smooth idle and more torque at 2000 rpm than a stock engine has at peak torque.**