

# GM SPORT COMPACT PERFORMANCE BUILD BOOK

Part Number 88958728

**THIRD EDITION**



## Sportsman and Naturally Aspirated **ECOTEC** Race Engines

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GM

**RACING**

# INTRODUCTION

## GENERAL INFORMATION

This handbook describes parts and procedures used to prepare **ECOTEC** race engines used by GM Racing in professional Sport Compact Drag Racing and Drifting, as well as engine, transmission, and chassis modifications designed for sportsman-level drag racers.

This handbook is intended to be used by experienced and knowledgeable race engine and chassis builders. It does not cover all basic engine blueprinting and assembly procedures, since it is assumed that the reader is already familiar with machining, measuring, and inspecting the components. Some of the procedures described require specialized tools and skills. If you do not have the appropriate training and equipment to perform these modifications safely, this work should be performed by other professionals.

There are, of course, many other possible combinations of components and modifications that may produce equal or superior results. However, by using the combination of parts and procedures described in this handbook, an experienced engine builder can build a competitive and reliable **ECOTEC** Race Engine.

It is not the intent of this book to replace the comprehensive and detailed service practices explained in the GM service manuals. GM service manuals are available from:

Helm Incorporated    [www.helminc.com](http://www.helminc.com)  
PO Box 07130  
Detroit, MI 48207

Observe all safety precautions and warnings in the service manuals. Wear eye protection and appropriate protective clothing. When working under or around the vehicle support it securely with jack stands. Use only the proper tools. Exercise extreme caution when working with flammable, corrosive, and hazardous liquids and materials.

## PROGRAM HISTORY

The General Motors Sport Compact Drag Racing Program was kicked off at the 2001 International Auto Salon (IAS) in Long Beach, CA. During IAS, GM identified Sport Compact Drag Racing as the highest opportunity to gain awareness in the sport compact market. The first Chevrolet Cavalier and Pontiac Sunfire front-wheel-drive drag race cars were unveiled at the 2001 SEMA show, and, in February of 2002, GM Racing made their competitive debut in Palmdale, CA. In 2003 and 2004 the GM Racing team won back-to-back championships in both the NHRA Hot Rod and ProFWD categories. In 2005, GM transitioned from a factory race team to factory support of independant teams.



Fig. 1

Gary Gardella earned the 2005 NDRA Pro 4 cylinder championship in his first year running an **ECOTEC** race engine. 2006 and 2007 brought more championships, records, and wins for Chevy and **ECOTEC**.

## **WHY WE RACE**

At GM, we race because it's where we came from and because it fuels our love for competition.

Racing has been part of the GM culture since auto pioneers like Louis Chevrolet relied on speed records and racing victories to launch his fledgling car company. GM has remained in racing for two basic reasons - to win on the track and win in the marketplace.

Racing is a compelling demonstration of the depth of GM's technical resources, the capabilities of its people and the performance, reliability, quality and safety of its products. The race track is the toughest of proving grounds to forge engineering, marketing and business skills into tangible results. Few, if any, environments can match racing's ability to build awareness and consideration of a manufacturer's products to new customers, while simultaneously solidifying the loyalty of current customers.

## **FIVE PILLARS GUIDE GM RACING'S INTEGRATED STRATEGY**

It provides a **dynamic training ground** for GM engineers. In racing, decisions must be made at a rapid rate. You must be ready at all times, on time, and solve problems quickly and effectively. Racing's demands are the perfect venue in which to exercise the mind and expand abilities, improve teamwork and communication - and do it all without making excuses.

This leads to **technology transfer**. Racing is well known to have introduced improvements in the auto production industry in areas such as suspensions, brakes, engines, aerodynamics and safety - but there's also a transfer in technology through people who work in racing, then take those improved skills and knowledge to the production process. Likewise, the advanced technology and people involved in the mass production of vehicles has enhanced the development of race cars.

Human nature dictates that **people want to compete** - and win. There is a strong competitive spirit within GM, and success in racing produces a vibrant esprit de corps. GM is not a sponsor of racing - we are an active, engaged participant who produces the cars and the components, and provides the technology essential to the sport.

If racing did not already exist, auto manufacturers would invent it as the **perfect marketing platform**. Racing is a sport that's all about the product and the people, followed with cult-like passionate fans who buy cars and trucks at a higher and more loyal rate than the average consumer.

Grass roots racers and enthusiasts demand the best, and have made **GM Performance Parts** the leader in over the counter components and engine assemblies. GM's

approach, as a participant in racing, is to take responsibility to support the sport. Someone else might even build a motor that beats the factory team. But it's this democratization of racing that sets GM apart, and is the cornerstone of GM's total business approach.

## **LEGAL INFORMATION**

This publication is intended to provide technical information on the GM **ECOTEC** engines, Hydra-Matic transmission, and Chevy Cobalt used in sport compact drag racing at the professional and sportsman level.

This handbook pertains exclusively to engines and vehicles which are used off the public highways. Federal law restricts the removal or modification of any part of a federally required emission control system on motor vehicles. Further, many states have enacted laws which prohibit tampering with or modifying any required emission or noise control system. Vehicles which are not operated on public highways are generally exempt from most regulations, but the reader is strongly urged to check all applicable local and state laws.

Many of the parts described or listed in this handbook are merchandised for off-highway application only, and are tagged with the following "Special Parts Notice":

### **SPECIAL PARTS NOTICE**

This part has been specifically designed for Off-Highway application *only*. Since the installation of this part may either impair your vehicle's emission control performance or be uncertified under current Motor Vehicle Safety Standards, it should not be installed in a vehicle used on any street or highway. Additionally, any such application could adversely affect the warranty coverage of such an on-street or highway vehicle.

The information contained in this handbook is subject to change. General Motors also reserves the right to make changes at any time, without notice, in equipment, manufacturers, specifications, and materials, or to discontinue items.

The information in this publication is presented without any warranty. *All the risk for its use is entirely assumed by the user.* Specific component design, mechanical procedures, and the qualifications of individual readers are beyond the control of the publisher, and therefore the publisher disclaims all liability incurred in connection with the use of information contained in this publication.

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## ORDERING PARTS IN THIS BOOK

Parts described in this book are from several sources. Many parts are available from aftermarket suppliers. The contact information for these suppliers is listed in a separate section of this book. Note that some parts may be available from additional sources.

There are three types of General Motors parts listed in this book. First are parts used in regular production vehicles. These are regular service and replacement parts, denoted as 'GM' parts in this book. These parts are available through any GM dealer. See [www.gmgoodwrench.com](http://www.gmgoodwrench.com) for more information and to locate a dealer near you.

The second type of GM parts shown are GM Performance Parts. These parts are available only through authorized GM Performance Parts dealers. Not all GM dealers are authorized to sell GM Performance Parts. For more information or to locate an authorized dealer, visit [www.gmperformanceparts.com](http://www.gmperformanceparts.com). Please note that not all parts are listed on the GM Performance Parts website. Your authorized dealer has a more complete list. If your dealer is an authorized GM Performance Parts dealer and still cannot locate a GM Performance Part listed in this book, please e-mail GM Racing through our website [www.gmtunersource.com](http://www.gmtunersource.com).

The third type of parts listed in this book are available exclusively from GM Racing. These are typically low-volume parts for professional racing applications. All GM Racing Parts are for off-highway use only and are tagged with the "Special Parts Notice" shown previously in this book. GM Racing Parts are available only by e-mailing us through our website [www.gmtunersource.com](http://www.gmtunersource.com). Racing personnel will respond to you with additional ordering information and part availability. Please allow up to twelve weeks for delivery.

All part numbers are subject to change. Please contact the appropriate source for the most recent information.

## BASE ENGINE OVERVIEW

The engine is the heart of a competition car. It must be capable of delivering full power reliably run-after-run on race day, at engine and vehicle speeds far in excess of those encountered in normal driving. Every part of a competition engine must be as nearly perfect as possible – the slightest failure can put you out of the race.

Since 1955, the Small Block Chevy has proven its versatility, durability, and performance potential with automotive performance enthusiasts. The **ECOTEC** engine has all the basic mechanical components to repeat this success. A sound base engine structure, excellent airflow capability, easy serviceability, compact size and low weight. These qualities, along with the very successful race program, demonstrate the **ECOTEC** engine is a driving force in the sport compact segment. (Fig. 2)



**Fig. 2**

GM's **ECOTEC** engine has proven to be a reliable and competitive engine for use in Sport Compact Drag Racing. It has also proven its superior durability in grueling five mile runs at the Bonneville Salt Flats with speeds over 300 MPH and in showroom stock endurance road racing competition. The number of stock components utilized in the race engine demonstrates the robust design of the **ECOTEC** engine.

The **ECOTEC**'s outstanding feature to performance enthusiasts is its impressive strength. GM Racing dynamometer tests confirm that major horsepower gains are possible with minimal modifications. For instance, when building an **ECOTEC** engine to the 400 hp power level, no modifications to the cylinder head, block, main girdle or crankshaft are required.

The production **ECOTEC** engine block is manufactured out of aluminum using a lost-foam casting process. This process allows for both a stronger and lighter part. Flanged, thin-wall iron cylinder sleeves are press-fit into a semi-floating aluminum support structure. The **ECOTEC** block is supported by a massive die-cast aluminum girdle/main cap assembly and structural oil pan for noise and vibration suppression. The main-cap structures are each supported with six fasteners. Extra-thick main bearings resist the differential thermal expansion of the nodular iron crank and aluminum block.

All **ECOTEC** blocks are cast with passages for piston-cooling jets and an oil cooler for high-output turbocharged applications. The fully-boxed block requires no windage tray, even on applications up to 600 horsepower. An auxiliary chain drives the water pump and balance shafts from the crank.

To reduce the risk of hot spots, pressure-cast, non-squish dished pistons are manufactured without valve reliefs. The symmetrical, barrel-faced moly-coated top ring fits in an

anodized ring-groove below a super-thin 3 mm top ring land, creating a low crevice volume for reduced emissions. The pistons deliver power through full-floating piston pins and powder-metal or forged steel connecting rods.

The **ECOTEC** twin-cam cylinder head uses low-friction hydraulic roller finger-followers, which have been proven reliable and effective up to 11,000 rpm. Head fastener placement permits cylinder head removal and installation without removing the camshafts. The camshafts are driven directly off the crank by a chain. The design includes provisions for variable cam phasing now found on select **ECOTEC** variants. The finger-follower design permits a light-weight narrow profile and reduced valve angles (the intake valve is 18 degrees from vertical and the exhaust valve 16 degrees).

The design of the intake manifold eliminates the need for variable-length intake runners and some **ECOTEC** engines now include direct injection.

The **ECOTEC** engine management system uses a port-EFI design with cassette waste-spark ignition.

The next several sections of this publication focus on performance modifications for the 2.2L **ECOTEC** engine installed in a 2005 Chevy Cobalt. The modifications shown could be performed on a number of GM vehicles.

See your local GM dealer for more information on ordering a vehicle equipped with the **ECOTEC** engine.

## **ECOTEC ENGINE CODES**

<b>Engine Code</b>	<b>Usage</b>	<b>Displacement</b>	<b>Bore x Stroke</b>	<b>CR:1</b>	<b>Fuel</b>	<b>Induction</b>	<b>Hp @ rpm</b>	<b>Tq @ rpm</b>
L61	Saturn ION & VUE Chevy Malibu, Cobalt & HHR Pontiac G5	2.2L	86 x 94.6 mm	10	SFI	Naturally aspirated	148 @ 5600	152 @ 4200
LE5	Saturn ION & Sky Chevy Cobalt Sport & HHR Pontiac G5 GT, G6, & Solstice	2.4L	86 x 98 mm	10.4	SFI	Naturally aspirated with VVT	173 @ 6200	163 @ 4800
LSJ	Saturn ION Redline Chevy Cobalt SS S/C	2.0L	86 x 86 mm	9.5	SFI	Supercharged	205 @ 5600	200 @ 4400
LNF	Pontiac Solstice GXP Saturn Sky Redline Chevy HHR SS & Cobalt SS	2.0L	86 x 86 mm	9.2	DI	Turbocharged with VVT	260 @ 5300	260 @ 2500
LK9	Saab 9-3	2.0L	86 x 86 mm	9.5	MPFI	Turbocharged	210 @ 5300	221 @ 2500
LAT	Saturn Aura Green Line	2.4L	86 x 98 mm	10.4	SFI	Naturally aspirated hybrid	164 @ 6400	159 @ 5000

# ***SPORTSMAN ECOTEC RACE ENGINE***

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*Fig. 3*

The **ECOTEC** engine is the perfect starting point for performance enthusiasts. Power levels of up to 400 horsepower can be achieved with the installation of connecting rods and pistons, a new head gasket and head bolts, adjustable cam gears and a nitrous oxide system or a turbo kit. No modifications to the cylinder head, block, main girdle or crankshaft are required. You can purchase upgraded components such as:

- Air Intake Systems
- Exhaust Systems
- Exhaust Headers
- Adjustable Cam Gears
- Nitrous Oxide Systems
- Supercharger Kits
- Turbocharger Kits
- ECM Reflashes

Note that power levels in excess of production may require additional upgrades to the production drivetrain and chassis such as clutch, transmission, engine mounts, axles, etc. not covered in this book. For information specific to modifying the supercharged **ECOTEC 2.0L LSJ**, see the **ECOTEC 2.0L LSJ POWER Book**, part number 88958686.

## ADJUSTABLE CAM GEARS



*Fig. 4*

An excellent way to optimize cam timing with aftermarket cams or other engine modifications is to install GM Performance Parts Adjustable Cam Gears part number 88958613. (Fig. 4)

COMP Cams offers street cams for the **ECOTEC** engine.

## SUPERCHARGER



*Fig. 5*

GM Performance Parts has developed a bolt-on supercharger kit (part number 1780003) for the 2.2L **ECOTEC** engine. Fits 2003-2005 model year Cavalier and Sunfire. Also fits certain 2002 Cavalier and Sunfire

equipped with Delphi fuel injectors. This kit contains all the components necessary for installation. (Fig. 5)

## NITROUS OXIDE SYSTEMS



*Fig. 6*

With a stock 2.2L L61, the maximum Nitrous Jet Kit you can use is 75 hp. With upgraded rods and pistons, the maximum nitrous jet you can use is 150 hp.

Nitrous Express offers a stand-alone kit which has been tested and proven to work well. The Nitrous Express Kit contains a single nozzle with a nitrous jet and a fuel jet. Use a pressure tap on the production fuel rail for the fuel jet's supply. (Fig. 6)

## TURBOCHARGERS



*Fig. 7*

Hahn RaceCraft currently offers a bolt-on turbo kit for the **ECOTEC** engine. It contains all the components necessary for installation. It has a Fuel Management Unit (FMU) which provides proper fuel delivery without the need to change engine calibrations. (Fig. 7) **ECOTEC** turbo kits are also available from other aftermarket companies.

### **CONNECTING RODS**

We recommend that the connecting rods be upgraded because stock 2.2L L61 rods are not designed for power levels over 250 hp.



**Fig. 8**

The 2.0L LSJ and LNF **ECOTEC** engines have forged steel rods similar to Small Block Chevy “Pink Rod.” The forged steel rods are made of high quality material and have a cap screw, 23 mm small end, and a full floating bronze bushing. These rods are available through GM service parts. These rods require an aftermarket piston set to work with the stock 2.2L crankshaft. Alternatively, Eagle and Manley both offer a CNC machined H-Beam rod which is an exact replacement for the stock 2.2L rod. (Fig. 8)

### **PISTONS**



**Fig. 9**

The stock 2.2L L61 **ECOTEC** pistons have been tested to power levels approaching 300 hp. However these pistons should be replaced with a stock forged-type piston for applications over the 250 hp level. JE, Wiseco and Diamond offer pistons in various compression ratios that work for most applications. We recommend a compression ratio of 9:1 or less for blown gas applications, and 10-11:1 for normally aspirated with premium fuel.

### **INTAKE MANIFOLD**

The production intake manifold has been tested to the 350 hp level.

## HEAD GASKET AND HEAD BOLTS



*Fig. 10*

The stock head gasket is part number 24444091 and the head bolts are part number 90537691. The production head bolts are “Torque-to-Yield.” It is important that these bolts are replaced each time they are removed to provide proper head gasket clamp loading. (Fig. 10)

## VALVE SPRINGS AND RETAINERS

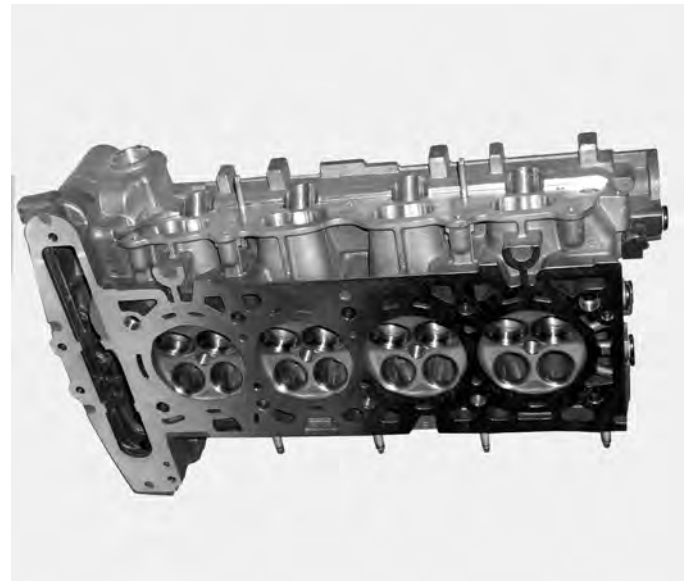


*Fig. 11*

Bates Engineering offers an up-level stock-replacement valve spring (part number ESGV0001) that fits in the stock cylinder head with no modifications. This spring uses production locks and retainers. The springs will increase the production valve train limiting speed to over 7500

RPM. The stock camshafts are good up to 400 hp with these valve springs and a power adder. (Fig. 11)

## CYLINDER HEAD



*Fig. 12*

The GM Performance Parts sportsman cylinder head part number 88958619 is a modified production L61 head. This head is cast from aluminum using a lost foam process; it features CNC Street porting for port to port consistency. (Fig. 12)

The spark plug holes have been modified to accept 3/4" reach spark plugs.

A complete competition valve job has been performed on the cylinder head using a Serti Head Machine with a Serti cutter # HP2022.

This head with production valves has been run to over 500 hp on gasoline with 25 lbs boost.

For improved durability it is recommended to upgrade to the production 2.0L LSJ valves or Ferrea (part number F1963P intake and F1961P exhaust) valves.

Note that, for the 2007 model year and beyond, there was a change to the production 2.2L L61 head and valve cover. The change was to accommodate a cam sensor. The GM Performance Parts sportsman cylinder head part number 88958619 is for ECOTEC L61 engines prior to the 2007 model year.

<b>SPORTSMAN CYLINDER HEAD GENERAL DATA</b>		
	<b>Intake</b>	<b>Exhaust</b>
Valve Head Diameter (in.)	1.400"	1.200"
Valve Stem Diameter (in.)	6 mm	6 mm
Valve Seat Angle (degrees)	45.0°	45.0°
Valve Spring Installed Height (in.)	1.210"	1.210"
Valve Spring Seat Pressure (lbs)	92	92
Spring Pressure Over Nose (lbs)	250 lbs @ .500 lift	250 lbs @ .500 lift



**Fig. 14**

After removing the negative battery cable, remove the splash shield to expose the lower crank balancer pulley. (Fig. 14)

GM Racing also offers an exhaust ported version of the 2.0L LSJ head. Part Number XGH734. This part will be offered in limited quantities only.

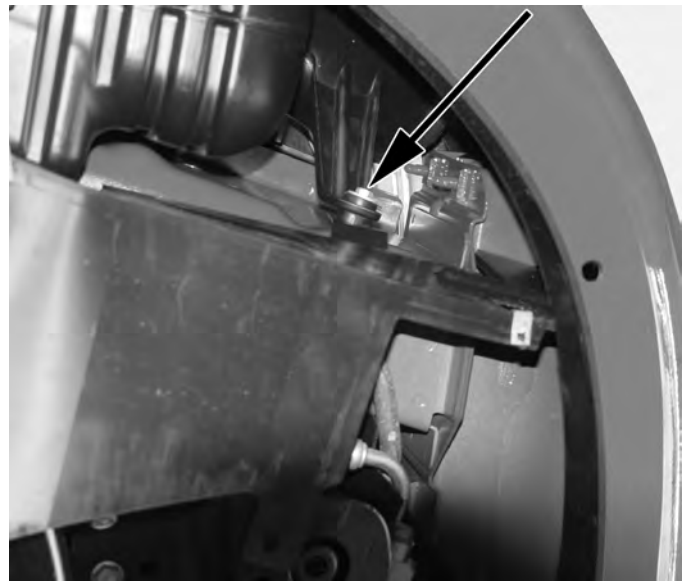
**HIGH PERFORMANCE PISTON AND ROD R&R PROCEDURE (COBALT)**



**Fig. 13**

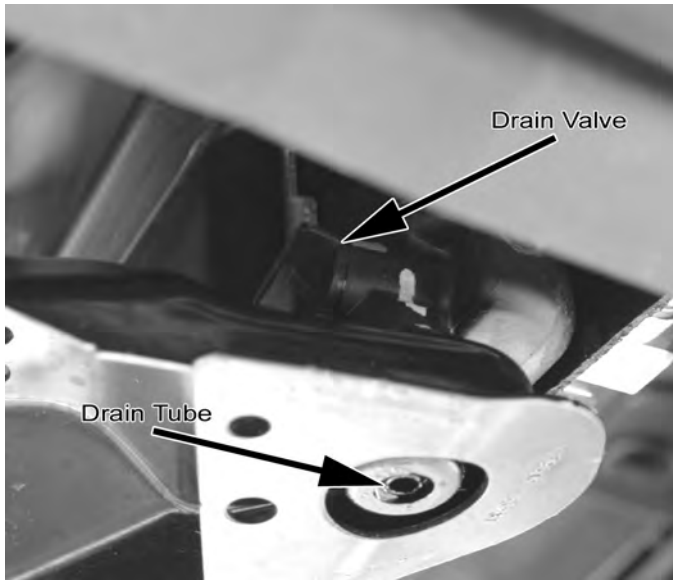
The following procedure describes the installation of up level connecting rods and pistons in your **ECOTEC 2.2L L61** engine. A base '05 Cobalt is used for the procedure. (Fig. 13)

**CAUTION:** All machined edges on this engine are razor sharp and extreme caution must be used when working on this engine.

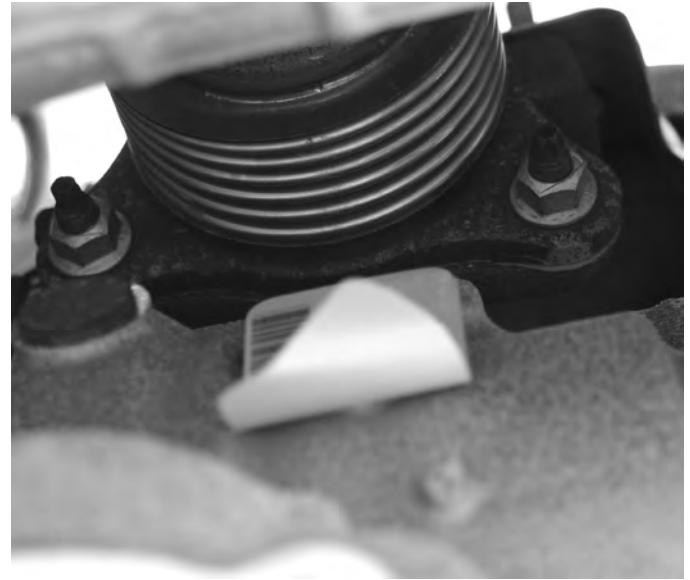


**Fig. 15**

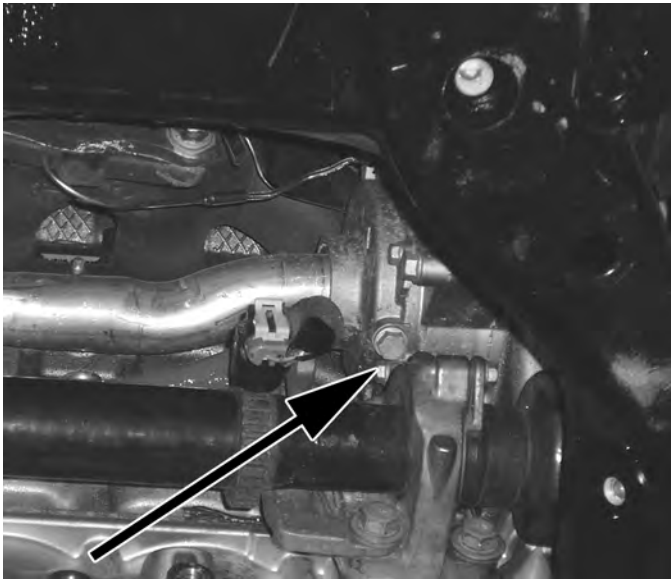
On a Cobalt, a shroud fastener is hidden up on the frame extension. It can be accessed by partially removing the fender well fasteners and pulling back the fender well to reveal the fastener. Requires a 10 mm socket. (Fig. 15)

**Fig. 16**

Drain engine coolant and engine oil. This figure shows the location of the radiator petcock. (It loosens counter clockwise) (Fig. 16)

**Fig. 18**

To remove the exhaust, remove the three exhaust nuts with a 15 mm deep universal socket. (Fig. 18)

**Fig. 17**

The water pump coolant drain will remove the coolant from below the deck for head gasket service. (Fig. 17)

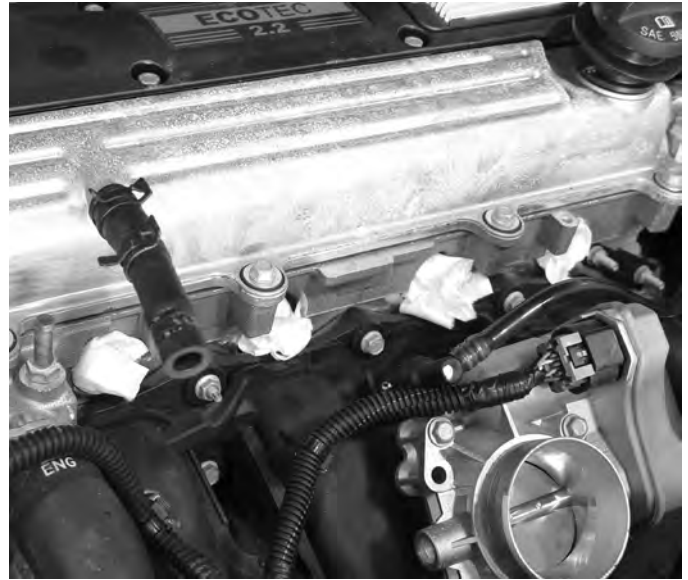
**Fig. 19**

One fastener can be removed from above. (Fig. 19)



**Fig. 20**

It is important to remember to remove the HO2S (oxygen sensor) connector, so when you remove the head and exhaust manifold as an assembly, this won't hold you up. (Fig. 20)



**Fig. 22**

Cover the injector ports to prevent any debris from falling into the cylinder head. (Fig. 22)



**Fig. 21**

Remove the two stud bolts that secure the fuel rail. Remove the fuel rail. It's not necessary to disconnect the fuel line. Disconnect the single injector wiring harness and MAP connector. Set the rail and injectors by the coolant reservoir. (Fig. 21)

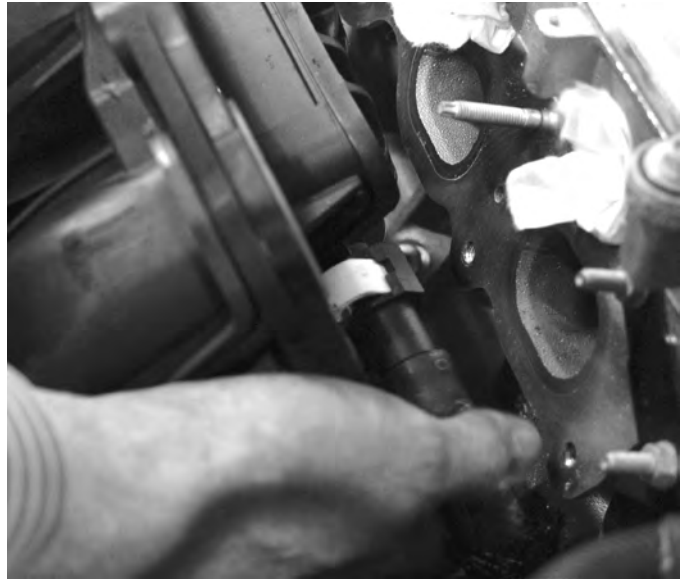


**Fig. 23**

Remove the upper radiator hose at the cylinder head. (Fig. 23)

**Fig. 24**

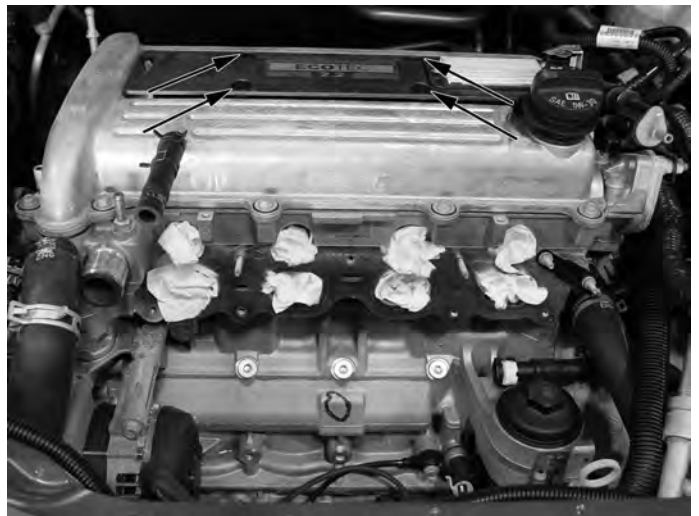
Remove the bolt shown to disconnect the coolant pipe from the head bracket. (Fig. 24)

**Fig. 26**

Remove the intake manifold fasteners and vacuum hoses. Pull the intake partially away from the engine, and unclip the white clip from the power brake vacuum hose. Slide this hose off the pipe and remove the intake. Cover the intake ports. (Fig. 26)

**Fig. 25**

Remove the dipstick tube bracket support bolt as shown. (Fig. 25)

**Fig. 27**

Remove the fasteners that hold the coil cassette module to the valve cover. (Fig. 27)



**Fig. 28**



**Fig. 30**

Remove the 13 mm nut and bracket that holds the evap solenoid support bracket to the head. (Fig. 30)



**Fig. 29**

Remove the bracket, ground strap, and the electrical connector. Lift the cassette module from the engine valve cover. (Fig. 28 and Fig. 29)



**Fig. 31**

Remove the valve cover by removing all fourteen fasteners around its perimeter and the fasteners under the coil module. (Fig. 31)

**Fig. 32**

Pry the dipstick tube out of the oil pan with a flat head screwdriver. (Fig. 32)

**Fig. 34**

Remove the bolts that connect the oil pan to the transmission. (Fig. 34)

**Fig. 33**

Remove the bolt on the A/C compressor to drop the oil pan. (Fig. 33)

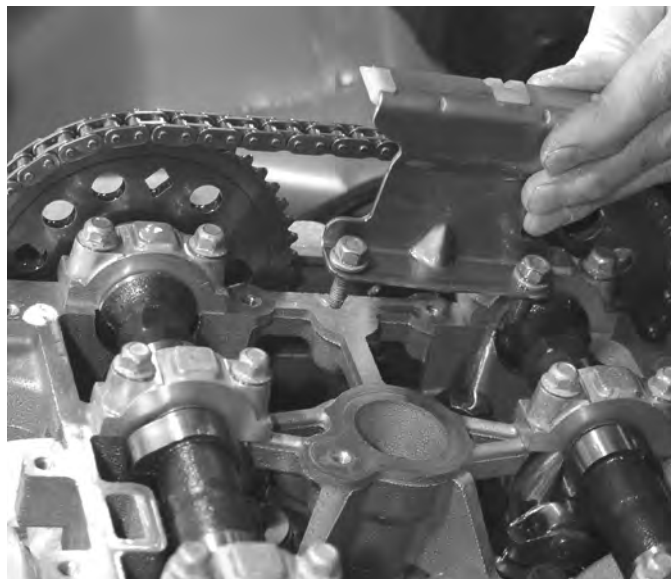
**Fig. 35**

The bolt shown above is easy to miss, so don't forget to remove this bolt as well. (Fig. 35)



**Fig. 36**

Remove the remainder of the fasteners from the oil pan. (Fig. 36)



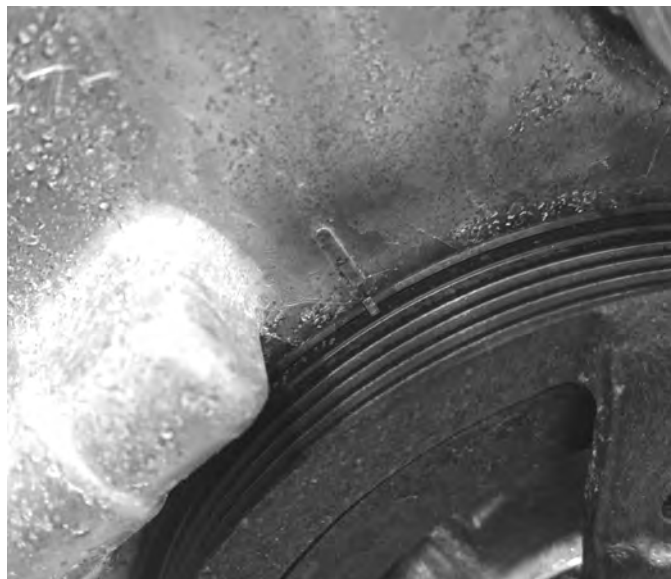
**Fig. 38**

Remove the upper timing chain guide. (Fig. 38)



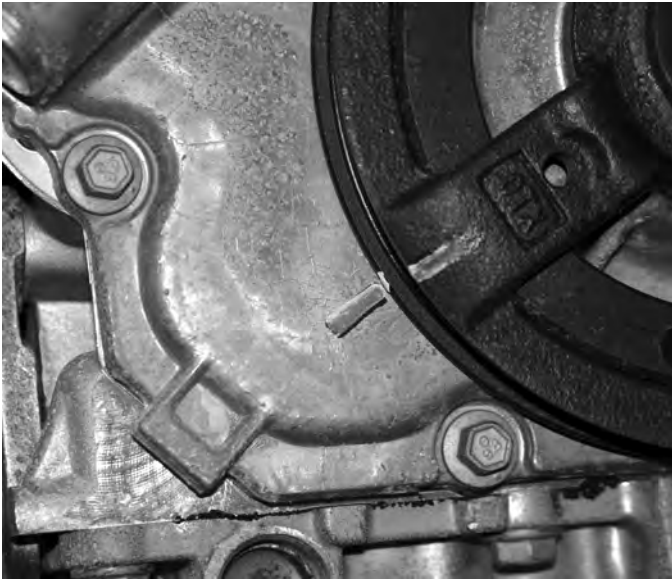
**Fig. 37**

Use a pry bar in the pry point to remove the oil pan. (Fig. 37)



**Fig. 39**

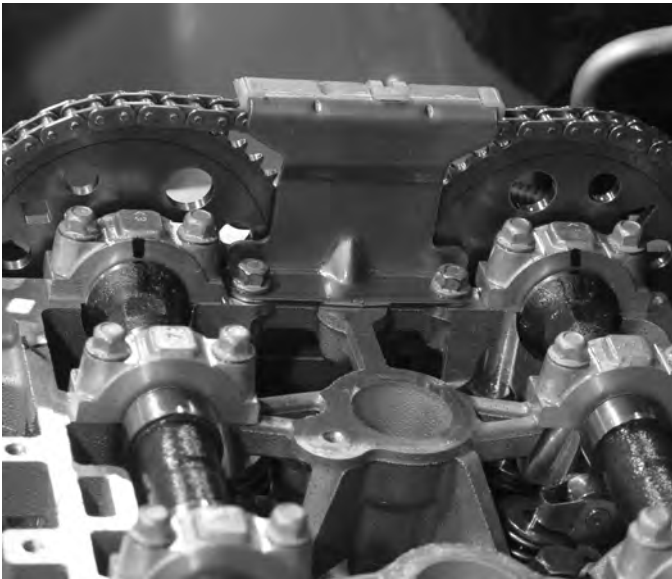
Rotate the engine by hand to TDC. (Fig. 39)

**Fig. 40**

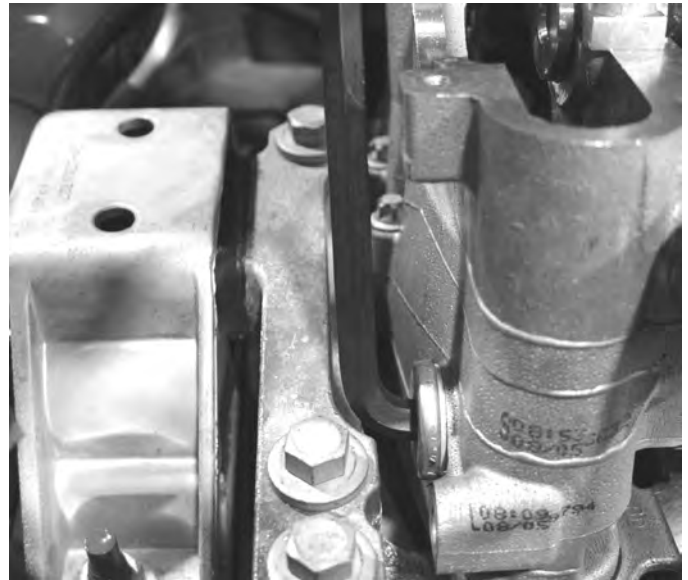
Using the crank bolt, mark the balancer and timing cover, this will make it easier to return to engine to TDC for reassembly. (Fig. 40)

**Fig. 42**

Use a 1 1/4" wrench to loosen and remove the hydraulic chain tensioner. (Fig. 42)

**Fig. 41**

Mark the cams to indicate TDC position. (Fig. 41)

**Fig. 43**

Remove the chain guide bolt access plug. Use a shortened allen wrench to access the chain guide bolt. (Fig. 43)



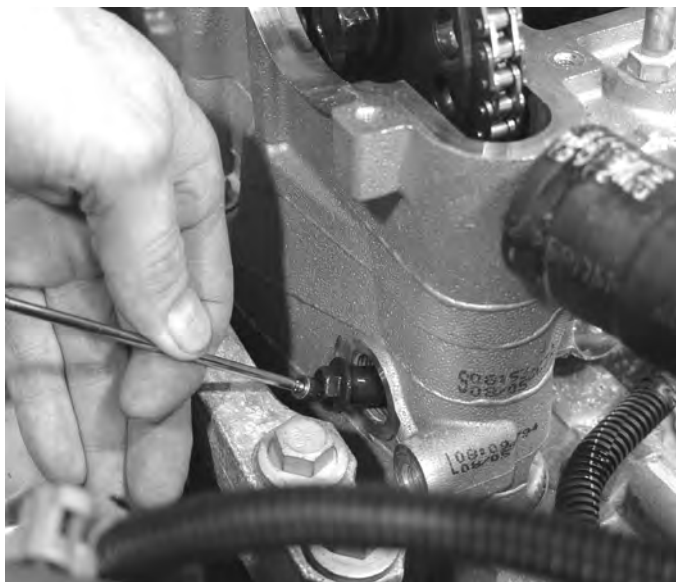
**Fig. 44**

Use a 1/4" drive 10 mm universal socket to loosen the fastener and remove the chain guide bolt. (Fig. 44)



**Fig. 46**

Use a 15/16" back up wrench and an 18 mm to remove the timing gear bolts. Do not use an impact to do this operation. Remove the timing gears. (Fig. 46)



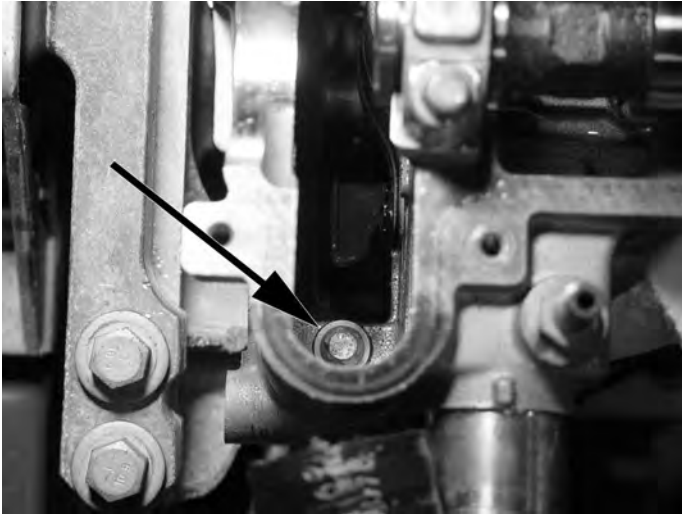
**Fig. 45**

To prevent the fastener from dropping in to the engine, use a magnet to remove it. (Fig. 45)

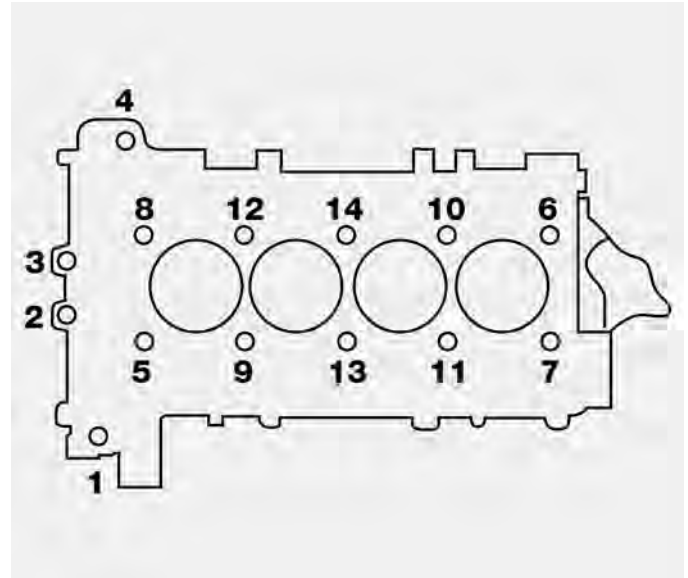


**Fig. 47**

Use a magnetic rod to lower the chain onto the oil nub in the block. (Fig. 47)

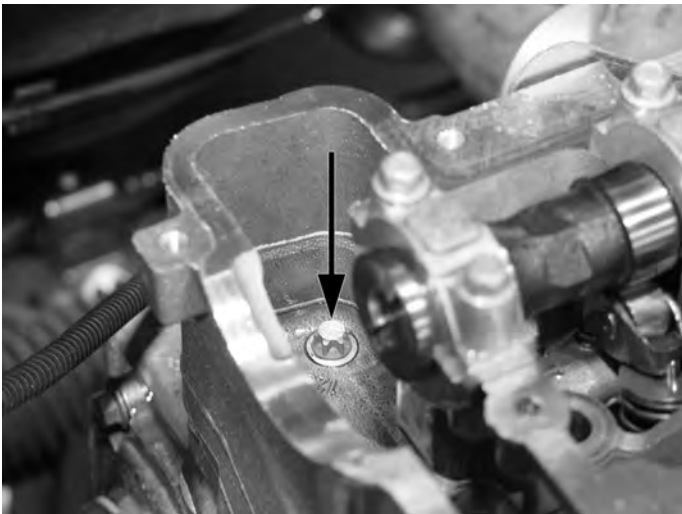


**Fig. 48**



**Fig. 50**

Continue to remove the rest of the fasteners on the head. Remove the outside torx first and then the head bolts in a circular pattern from the outside to the center, as not to warp the head. (Fig. 50)



**Fig. 49**

Remove the two torx head bolts shown in Fig. 48 and Fig. 49.



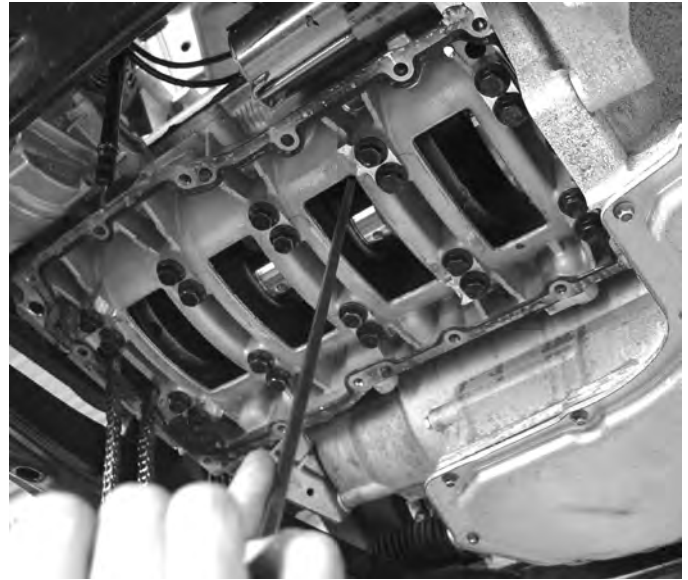
**Fig. 51**

When all of the head bolts have been removed, place a flat head screwdriver in the slot as shown above. Pry up on the head to loosen it from the block. Remove the head and exhaust manifold assembly, have someone help you with this task. Do not lay the cylinder head face down as valve damage may occur. (Fig. 51)



**Fig. 52**

Remove the rod caps on the connecting rods. (Fig. 52)



**Fig. 54**

When all of the rod caps have been removed use a long object (one that will fit in the cylinder and clear the crank, we used a long screwdriver) and push up on the piston until it is no longer flush with the block's surface. Remove the pistons from the block. (Fig. 54)



**Fig. 53**

Shown above is a rod cap fully removed from one of the connecting rods. (Fig. 53)



**Fig. 55**

The illustration above shows the new Diamond piston and LSJ (2.0L) connecting rod on the left and the stock piston on the right. (Fig. 55)

**Fig. 56**

Install the rings from the old pistons on to the new pistons in similar fashion. Remove the piston rings from the stock piston by unwinding as shown above. Rings are fragile so care must be taken. A ring expander tool can be used. (Fig. 56)

NOTE: Do not change the order or flip the rings over. Do one piston at a time. The rings must stay in the same cylinder as removed.

**Fig. 57**

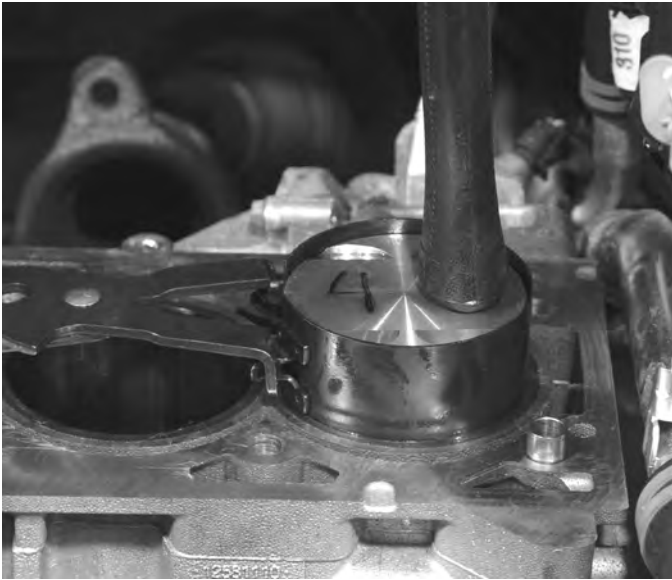
NOTE: The oil ring support dimple must be installed as shown. Make sure the rings are free and not binding. (Fig. 57)

**Fig. 58**

If the old bearings are in good condition install them on the new rods. (Fig. 58)

**Fig. 59**

A sleeve is recommended for the piston installation, because the rings are thin and small. (Fig. 59)



**Fig. 60**

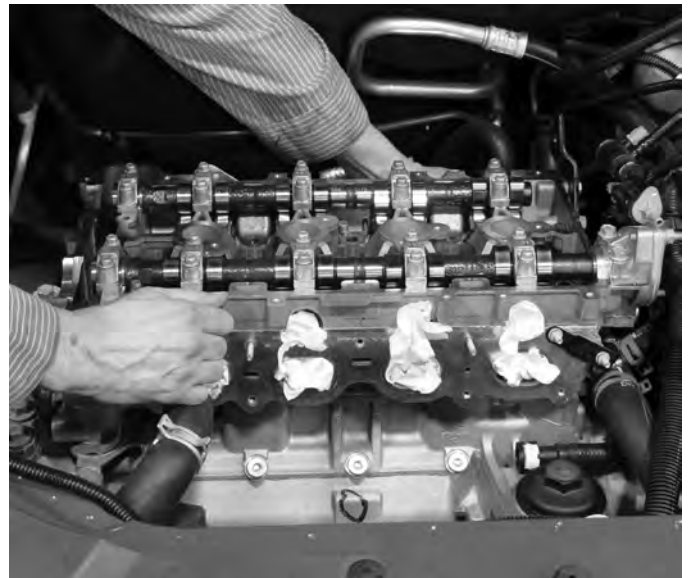
With journals one and four at bottom dead center, install cylinder one and four assemblies. Rotate the crank to put journals two and three at bottom dead center. Install assemblies two and three. When the piston is being pushed down in the bore, make sure to guide it carefully onto the rod journal. Do not nick the crank journal or rod end. (Fig. 60)

NOTE: Large valve reliefs are for the intake valves. Small valve reliefs are for the exhaust valves. Install pistons with large reliefs to front of vehicle.



**Fig. 62**

Rotate the crankshaft to drop the number one piston 1" below the deck, before setting the head on the block. This will keep the valves away from the pistons until the head is torqued. Piston is shown at TDC in Fig. 62.



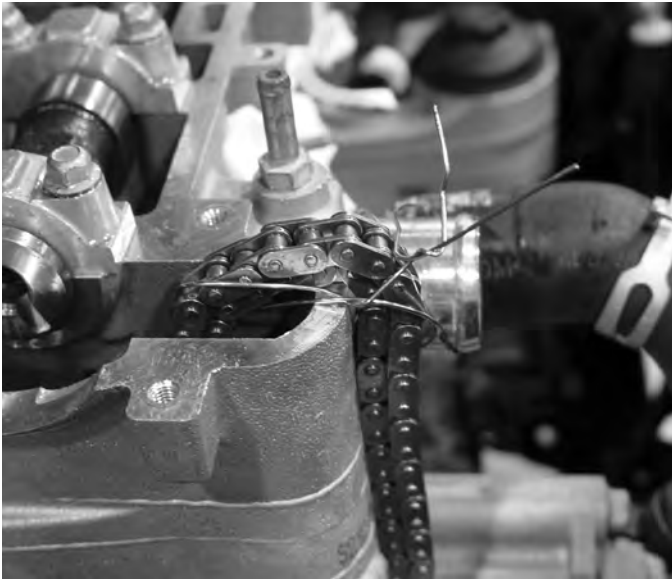
**Fig. 63**

Install the head and exhaust manifold assembly. Insert the exhaust manifold studs into the pipe flange and place the head on dowels. Have someone help you with this task. (Fig. 63)



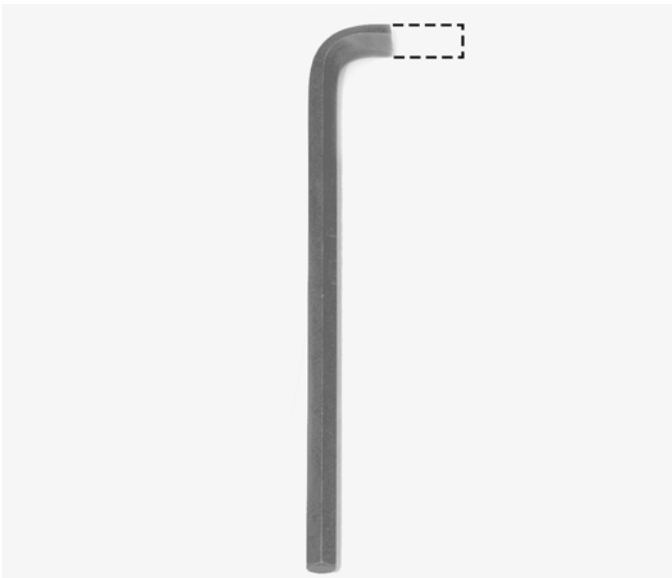
**Fig. 61**

Install the rod caps, bearing tang to bearing tang. Torque to 18 ft. lbs. plus 100° with a torque angle meter. (Fig. 61)

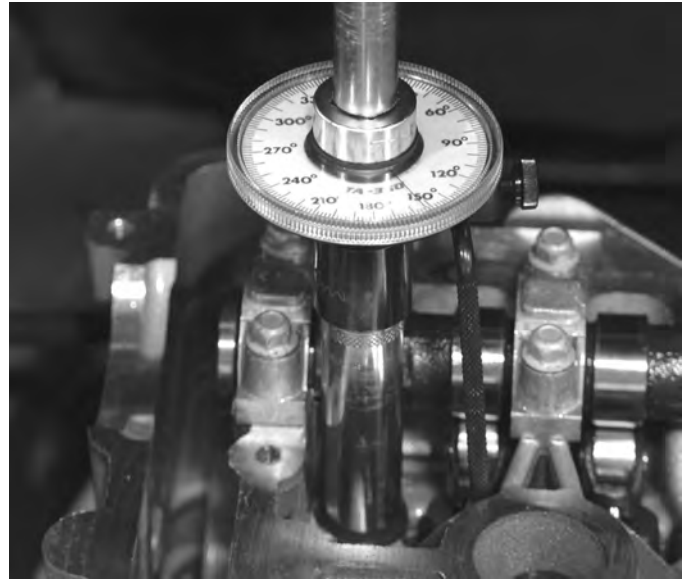
**Fig. 64**

Free up and support the timing chain before torquing down the head. (Fig. 64)

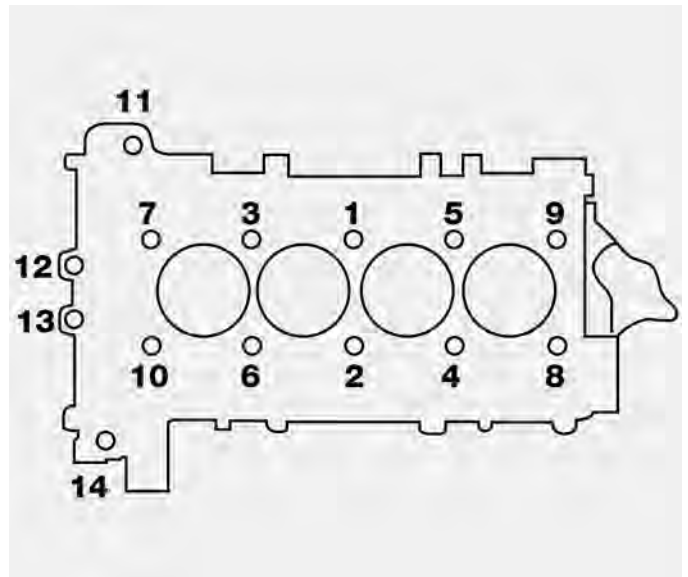
Install the guide bolt and torque it to specification.

**Fig. 65**

Install the plug using a shortened 10 mm allen wrench. Rotate engine to TDC before installing the timing chain. (Fig. 65)

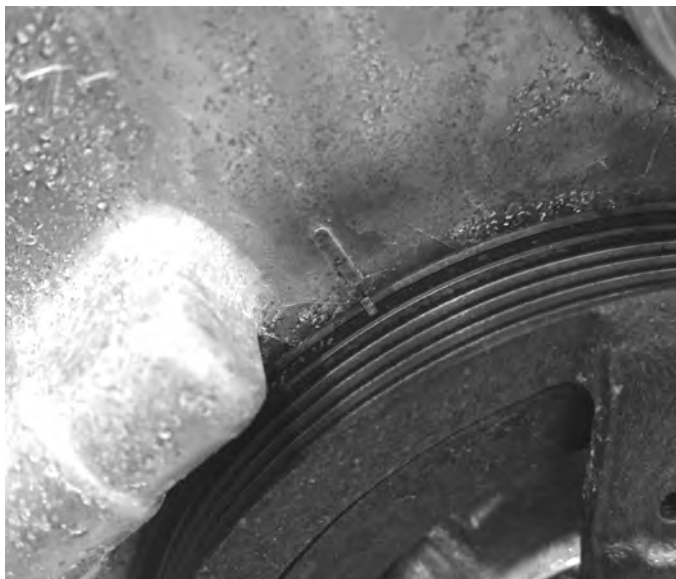
**Fig. 66**

Install the head bolts using a torque angle meter and torque them to 22 ft. lbs. plus 155°. (Fig. 66)

**Fig. 67**

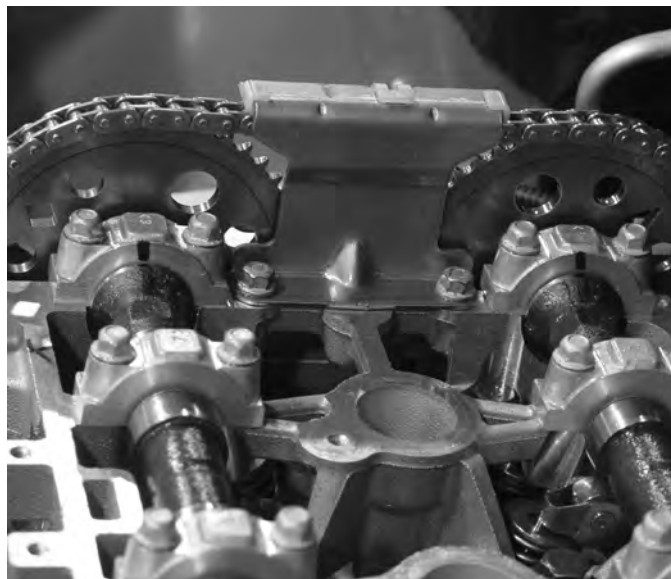
After torquing the ten large fasteners in order shown to specification, install the four front torx head bolts (2 inside, 2 outside) and torque them to 18 ft. lbs. (Fig. 67)

Using red loctite on the bolts, install the timing gears. Torque the bolts to 70 ft. lbs. Hold the cams as you install the bolts.



**Fig. 68**

After torquing the head bolts turn the engine back over to TDC. Check your marks and the production marks to confirm location. (Fig. 68)



**Fig. 70**

Rotate the crank shaft two rotations and align all timing marks. (Fig. 70)



**Fig. 69**

Compress tensioner to approximately 2 3/4" (slightly longer) then install. Install the tensioner making sure the groves in the chain yoke are vertical. (Fig. 69)



**Fig. 71**

Apply grey silicone (Loctite #5699) sealer on the oil pan rails. Smear the sealer with your finger to make a uniform coating. (Fig. 71)

**Fig. 72**

When installing the pan, do not disturb the sealer by touching other parts of the engine. Align the pan dowels and install the bolts finger tight. Guide the dip stick tube into the pan as you install the lube o-ring. Install all the pan fasteners and torque to 18 ft. lbs. (Fig. 72)

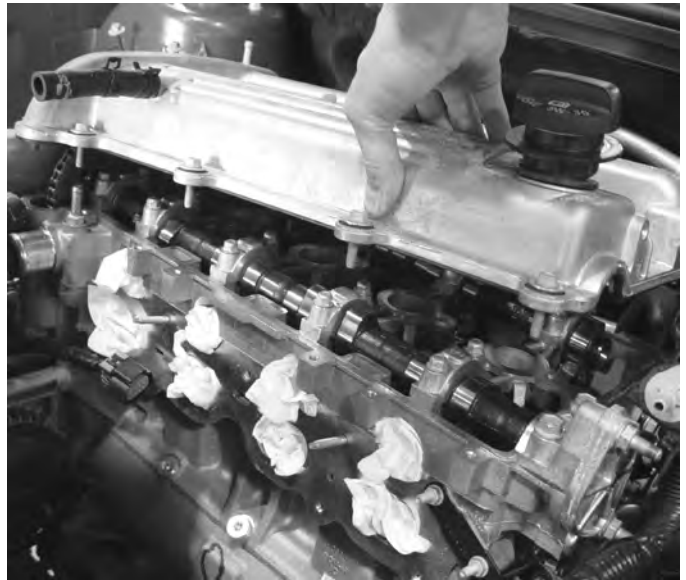
**Fig. 74**

Reconnect the HO2S oxygen sensor as shown above. (Fig. 74)

**Fig. 73**

Install A/C compressor bolt and torque to specifications (Fig. 73)

Install the exhaust manifold to the exhaust pipe nuts.

**Fig. 75**

Install the valve cover, ground strap and bracket and the coil cassette assembly with electrical connector. (Fig. 75)



**Fig. 76**

Remember to remove all the injector plugs and intake port plugs and rags to allow proper assembly.

Lube o-rings and install the fuel rail. (Fig. 76)

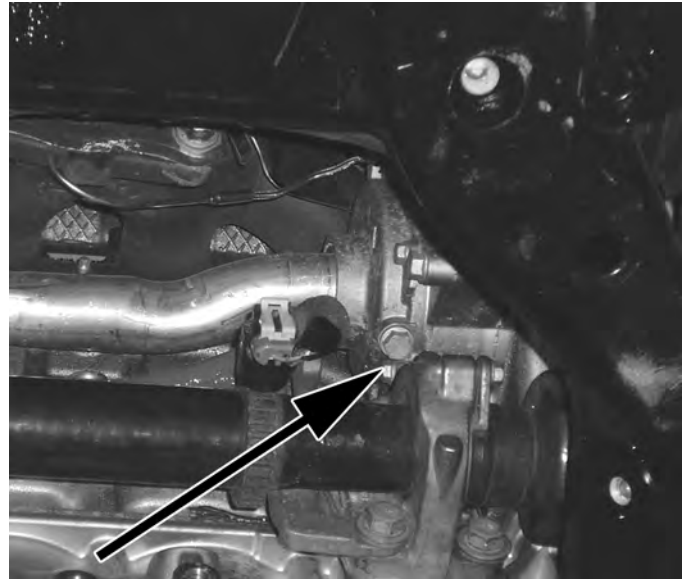
Tighten the two stud bolts to 89 in. lbs. and connect the rail wiring connector.

Install the brake vacuum hose onto the intake manifold and install the intake manifold to the cylinder head. Torque all fasteners to 89 in. lbs.



**Fig. 77**

Install throttle body electrical connector. (Fig. 77)



**Fig. 78**

Install the coolant pipe plug located on the bottom of the water pump. (Fig. 78)

Install the dipstick bracket bolt and check the oil drain plug for tightness.



**Fig. 79**

Connect the upper radiator hose. (Fig. 79)

Add coolant and oil to the motor.

Install the air duct/air cleaner (motor will not run properly without this duct in place).

NOTE: Wire loom zip ties will break, the dealer may be able to supply new ones.

Fill cooling system. Air vents through the top of head coolant hose.

Start the engine and check the oil pressure. Turn off the engine and check the oil level. Add oil as necessary.

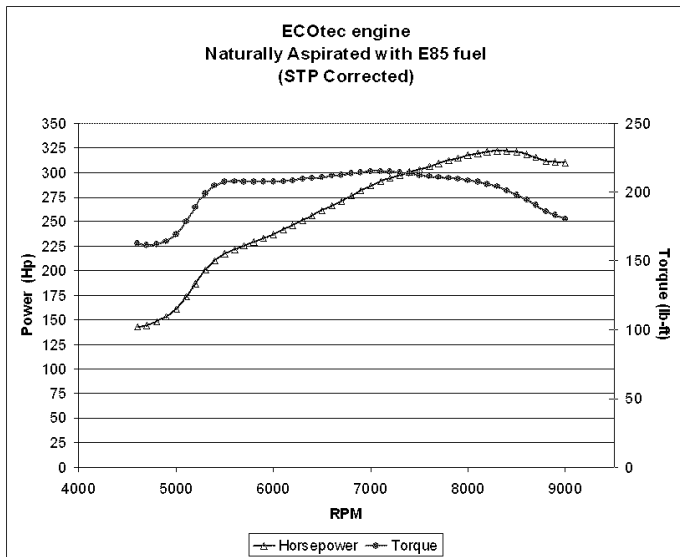
Install plastic engine shroud, wheel well fasteners and the wheel and tire.

Check for any leaks and then test the vehicle.

### **SPORTSMAN ECOTEC PARTS LIST**

<b>PARTS LIST</b>		
<b>DESCRIPTION</b>	<b>PART NUMBER</b>	<b>SOURCE</b>
2.2L L61 Sportsman Cylinder Head, Ported	88958619	GM Performance Parts
2.0L LSJ Exhaust-Ported Cylinder Head	XGH734	GM Racing
2.0L LSJ Intake Valves	12786696	GM
2.0L LSJ Exhaust valves	12791961	GM
2.2L L61 Head Gasket	24444091	GM
Stock Head Bolts (Qty 10)	90537691	GM
2.2L L61 Piston Rings	21018813 (4 req)	GM
LSJ Connecting Rods (less than 300 hp only)	12755162	GM
Performance Connecting Rod	various	Eagle/Manley
Performance Forged Pistons	various	Wiseco/JE/Diamond
Performance Wrist Pin	various	Manley/JE/Wiseco
Adjustable Cam Gears	88958613	GM Performance Parts
Performance Cam Shafts	various	COMP Cams
Nitrous Express Nitrous Kit	various	Nitrous Express
2.2L Supercharger Kit	17800003	GM Performance Parts
Hahn Racecraft Turbocharger Kit	—	Hahn Racecraft
Bates Engineering Valve Springs	ESGV0001	Bates Engineering
2.0L LSJ Piston w/Pin and Pin Retaining Clip	12791210	GM
2.0L LSJ Piston Rings	93180138	GM
<b>ECOTEC 2.0L LSJ Power Book</b>	88958686	GM

# NATURALLY ASPIRATED ECOTEC RACE ENGINE



Roush Industries, in conjunction with GM Racing, has done development and testing of a naturally aspirated **ECOTEC** race engine. The engine generates approximately 325 hp on E85 or 340 hp methanol.

At this time, neither GM nor any aftermarket companies offer the modified production blocks and heads used in this application. Roush Industries in Livonia, Michigan offers this complete engine package for sale.

The base for the naturally aspirated race engine is a complete production L61 (2.2L), LE5 (2.4L) or LSJ (2.0L supercharged) **ECOTEC** engine. The block is bored to 88.9 mm (3.500 in) and sleeved. We use a production-replacement Eagle crank for improved longevity, although it is possible to retain the production L61 or LE5 crank. The resulting displacement for the engine is 143.4 cubic inches.

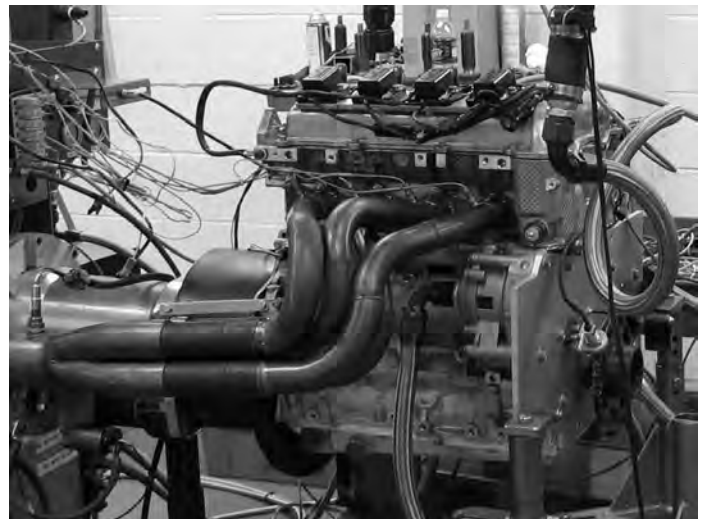
The production head from a L61 (2.2L), LE5 (2.4L) or LSJ (2.0L supercharged) **ECOTEC** engine is ported specifically for this naturally aspirated application and machined to match a 88.9 mm bore size and accept high-lift camshafts.

Additional long block parts include:

- ARP headstuds and fasteners
- Eagle forged steel crank and connecting rods  
(Crank part number 2237245765,  
Rods part number CRS5765C3D)
- JE forged aluminum pistons
- Cometic head gasket
- Roush fabricated oil pan and front engine plate

- Comp Cams billet race camshafts  
(Intake 8780 Exhaust 8781)
- GM Performance Parts adjustable cam gears  
(part number 88958613)
- Ferrea stainless steel valves and keepers  
(F806695, F806694, K10036)
- PSI valve springs (CT-1530ML)
- Trick Titanium retainers (KRERT001)

For induction, we have used a TWM K20 intake, modified to fit this application, or a Kinsler individual runner intake for **ECOTEC**. The exhaust manifold is custom fabricated by Roush Industries.



This engine has been run in the Inboard Power Boat racing circuit. In addition to the parts listed above, it employs a Daily Engineering dry sump pump, a Weldon 2015A electric fuel pump and fuel regulator, RC Racing fuel injectors, XRP lines and fittings, a Roush-modified production fuel rail, FAST XFI engine control unit and electronic distributor, MSD DIS 4 ignition box and crank and cam triggers, and a Roush custom wiring harness.

# NOTES