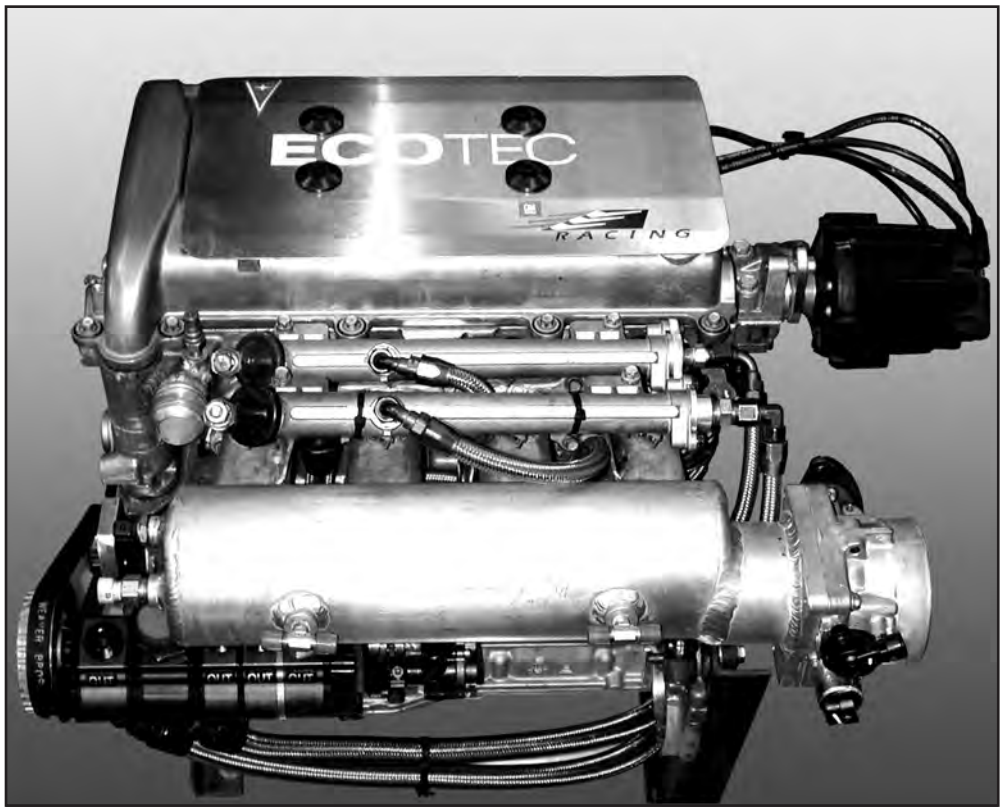
GM® ECOTEC engine handbook



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GM RACING

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INTRODUCTION

GENERAL INFORMATION

This handbook describes all of the parts used to assemble the **ECO**TEC 2.0L Race Engine used in NHRA's Summit Sport Compact Drag Racing Series. The information contained in this handbook was provided by GM Racing, in conjunction with Bothwell Motorsports and Shaver Specialties.

This handbook is intended to be used by experienced and knowledgeable race engine builders. It does not cover basic engine blueprinting and assembly procedures, since it is assumed that the reader is already familiar with machining, measuring, and inspecting of 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 additional 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 **ECO**TEC Race Engine.

PROGRAM HISTORY

The front wheel drive drag racing program was kicked off at the 2001 International Auto Salon (IAS) in Long Beach, CA. During the IAS, GM identified sport compact drag racing as the best opportunity to gain awareness in the sport compact market. During the 2001 SEMA show, the Chevrolet Cavalier and Pontiac Sunfire race cars were debuted. In February of 2002 GM Racing and Bothwell Motorsports made their competitive debut in Palmdale, CA. Currently both vehicles are competing in the NHRA Summit Sport Compact Drag Racing Series.

Figure 1
2002* ECOTEC *Powered Cavalier and Sunfire at Houston Raceway

GENERAL ENGINE SPECIFICATIONS

The base engine used to build the **ECO**TEC Race Engine is the 2.2L **ECO**TEC engine used in the current Pontiac Sunfire and Chevrolet Cavalier.

ECOTEC ENGINE GENERAL SPECIFICATIONS		
	PRODUCTION ENGINE	**RACE ENGINE**
Engine Type	2.2L DOHC	2.0L DOHC
Configuration	Inline 4	Inline 4
Displacement	134 Cubic Inch Displacement	127 Cubic Inch Displacement
Bore x Stroke	3.380″ Bore x 3.720″ Stroke	3.400″ Bore x 3.505″ Stroke
Material	A356-T6 Lost Foam Cast Aluminum Cylinder Head and Block	A356-T6 Lost Foam Cast Aluminum Cylinder Head and Block
Valvetrain	DOHC 4 Valves Per Cylinder Non Variable Cam Phasing	DOHC 4 Valves Per Cylinder Non Variable Cam Phasing
Compression Ratio	10.0 to 1	10.4 to 1
Firing Order	1-3-4-2	1-3-4-2
Fuel Type	Unleaded Gasoline	Methanol
Engine Oil	5 W 30	15 W 50 MOBIL 1
Peak Horsepower	140 HP @ 5600 RPM	925 HP @ 8500 RPM
Peak Torque	150 FT LBS @ 4000 RPM	599 FT LBS @ 7500 RPM
Engine RPM Rev Limiter	6400 RPM	9700 RPM
Cooling System	Production	Production
Oil Pressure	50-80 PSI @ 1000 RPM	Wet Sump System 125 PSI @ 9000 RPM – Dry Sump System 85 PSI @ all engine speeds
Ignition System	Coil On Plug Waste Spark Ignition System	MSD Digital 7 Programmable w/Crank Trigger

LEGAL INFORMATION

This publication is intended to provide technical information on the GM **ECO**TEC 2.0L engine used in the National Hot Rod Association (NHRA) Summit Sport Compact Drag Racing Series.

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.

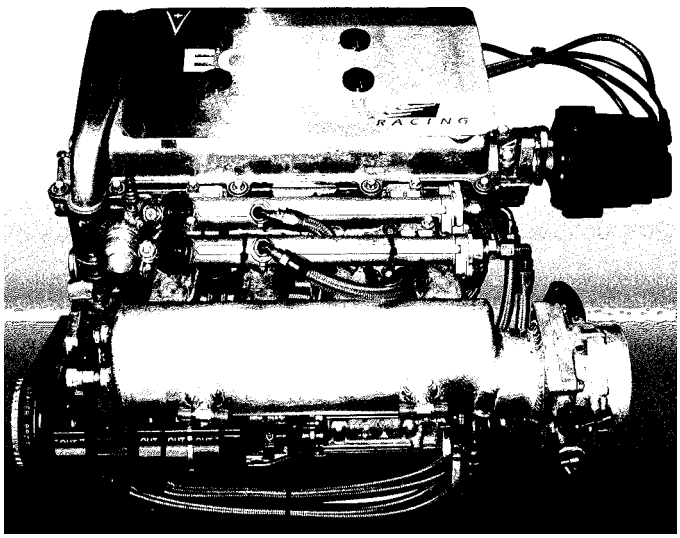

Figure 2

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.

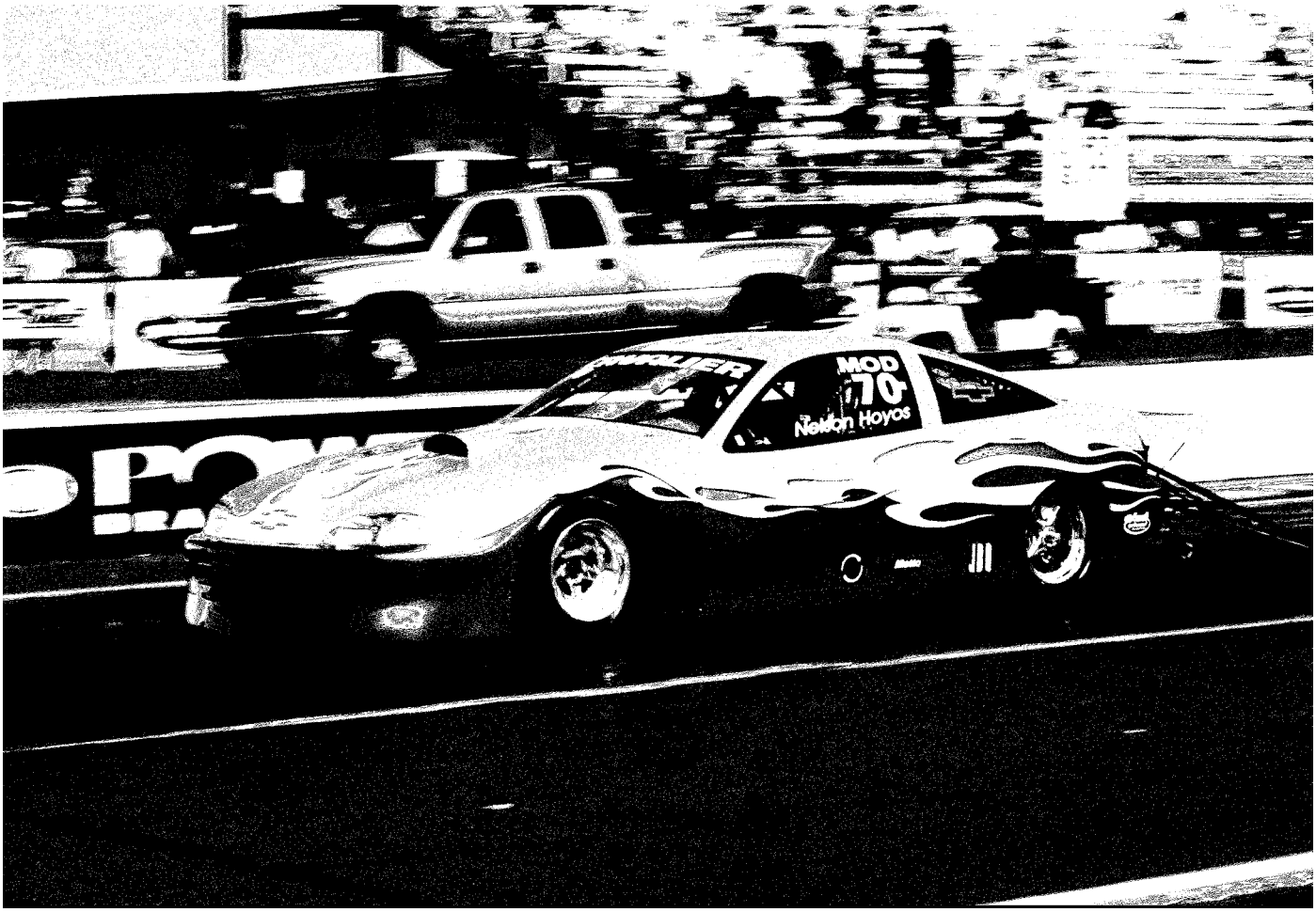

Figure 3
2002* ECOTEC *Cavalier at Houston Summit Sport Compact Drag Racing Series Event

ENGINE COMPONENTS

ENGINE BLOCK

The engine block used to build this engine is a production GM OE (original equipment) block (Fig. 4). The engine block was prepared by Shaver Specialties, in conjunction with GM Racing and Bothwell Motorsports. This production block is cast from A356-T6 aluminum using a lost foam process. There have been many modifications and checks made to the original production cylinder block including:

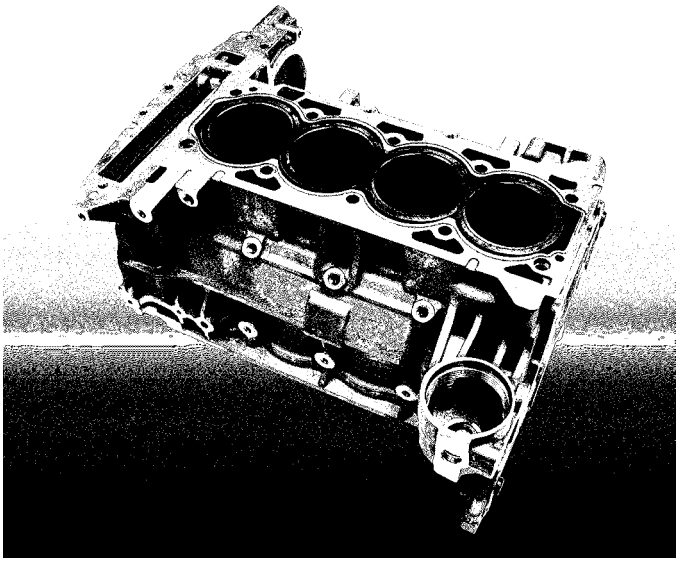

Figure 4

- The ZYGLO® system is used to check for cracks and imperfections in the engine block.
- All oil gallery plugs are removed to clean and inspect all passages.
- The stock sleeves are machined out and new nodular iron sleeves are installed (Fig. 5). The sleeves are installed .003″ proud above the block deck. The sleeves are also press fit to .003″. The cylinder sleeves are finish honed with deck plates installed and torqued to 85 ft. lbs..

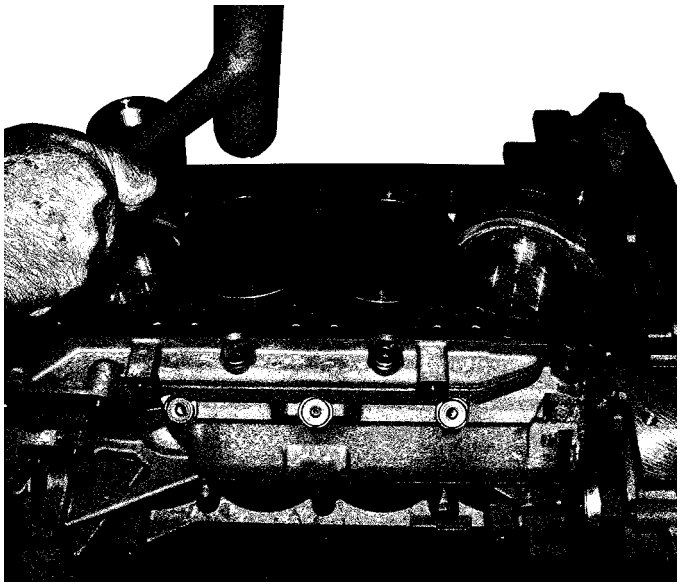

Figure 5

- The cylinder sleeves are machined to accept one piece o-rings (Fig. 6). These o-rings are made of one piece .041″ thick stainless steel. The o-rings are installed .008″ proud of the cylinder sleeves.

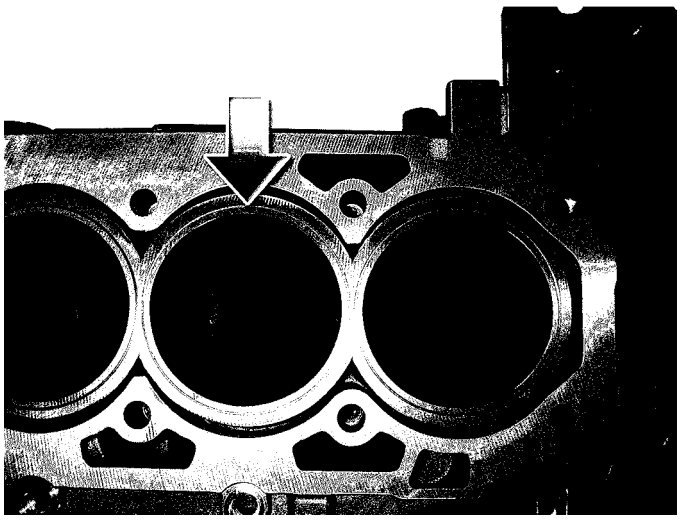

Figure 6

NOTE: The o-rings have a flat and beveled side. The flat side is installed into the cylinder sleeves.

- All cylinder head bolt holes are drilled and roll tapped to fit ½″ 13 studs.
- H-11 ½″ 13 head studs are installed into the block (Fig. 7).

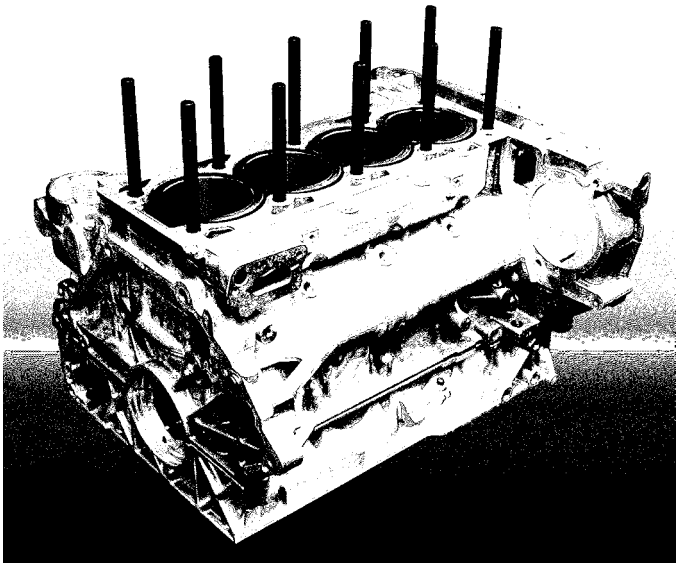

Figure 7

- H-11 7⁄16 14 main studs are installed into the block.
- The main oil gallery holes are reamed to .265″.
- The main journals are line honed to 2.5225″.
- The factory oil pressure sensor location hole is tapped to ¼ pipe thread (Fig. 8).
- The factory crankshaft position location hole is tapped to -08 AN thread and plugged (Fig. 8).
- The oil filter housing boss is drilled and tapped to ½ pipe thread for an oil feed (Fig. 8).

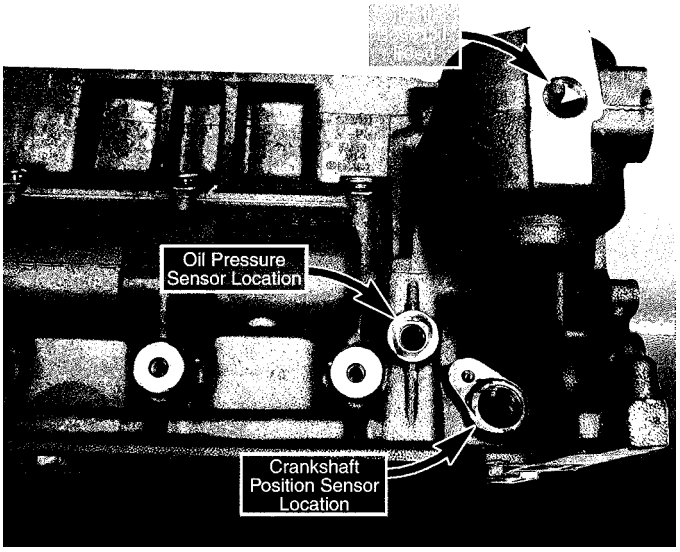

Figure 8

- The block deck is machined to fit larger cylinder head alignment dowels. The new dowels measure .675″ length, .630″ OD, .515″ ID.
- The factory oil bypass is tapped to ¼ pipe thread and plugged (Fig. 9).

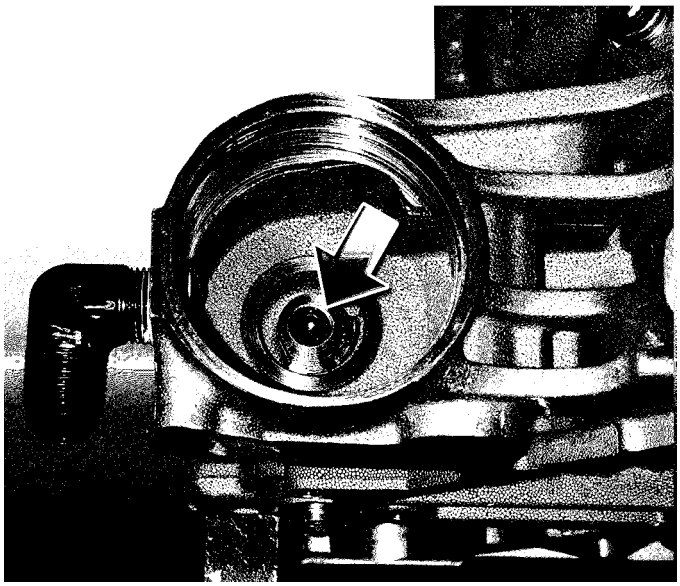

Figure 9

- The front two oil galleries are plugged with ½ steel plugs.
- The head and main studs are installed using Blue Loctite #242® and torqued to 8ft.lbs.. After the studs are installed, main girdle and block deck plates are installed and torqued to 20ft.lbs.. The studs are allowed to dry for 24 hours.
- With the deck plates torqued to 85ft.lbs., the cylinders are honed until .005″ piston to liner clearance is achieved.

ENGINE BLOCK SPECIFICATIONS	
Part #	88958630
Block Bore	3.400″
Block Deck Height	8.700″
Block Main Journal Diameter	2.5225″
Cylinder O-ring Thickness	.041″
Head Studs	
Length W/Ball End Seat	7.625″
Seat End Thread Length	1.750″ ½ 13 Thread
Cap End Thread Length	1.000″ ½ 20 Thread
Main Girdle Studs	
Length W/Ball End Seat	6.900″
Seat End Thread Length	1.750″ 7⁄16 14 Thread
Cap End Thread Length	1.000″ 7⁄16 20 Thread

ENGINE BLOCK MAIN GIRDLE

The main girdle used on this engine is a production GM OE girdle. The main girdle has been modified by Shaver Specialties, in conjunction with GM Racing and Bothwell Motorsports. The modifications include:

- The ZYGLO® system is used to check for cracks and imperfections in the main girdle.
- All main girdle stud holes have been reamed to .465″ for the main girdle mounting studs.
- The main girdle webbing is opened up on all dry sump racing engines for oil drain back. This is done due to the engine being leaned 33° forward in the race car. This is done on all dry sump race engines only.
- The oil supply passages in the front of the main girdle are welded shut on the dry sump engines (Fig. 11).

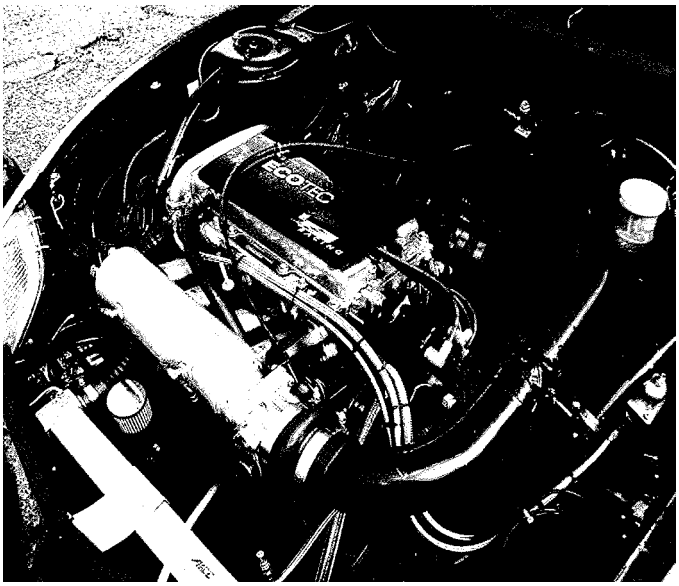

Figure 10
2002* ECOTEC *Powered Sunfire

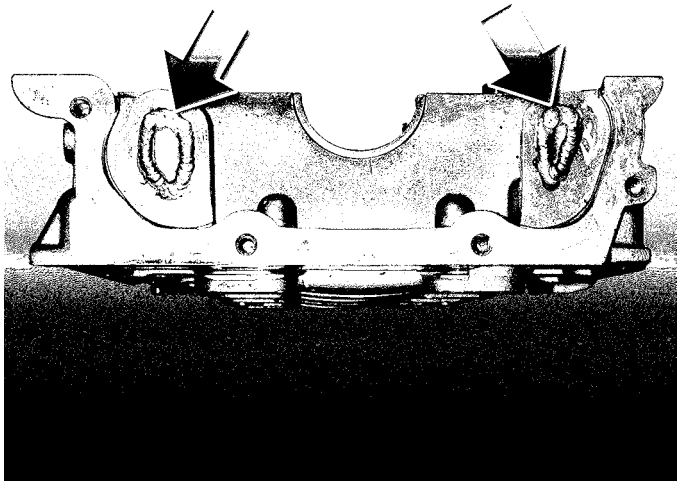

Figure 11

BALANCE SHAFTS

The production GM OE balance shafts are removed from all **ECO**TEC race engines. The OE balance shafts are replaced with GM part #88958615 Neutral Balance Shaft Set (Fig. 12).

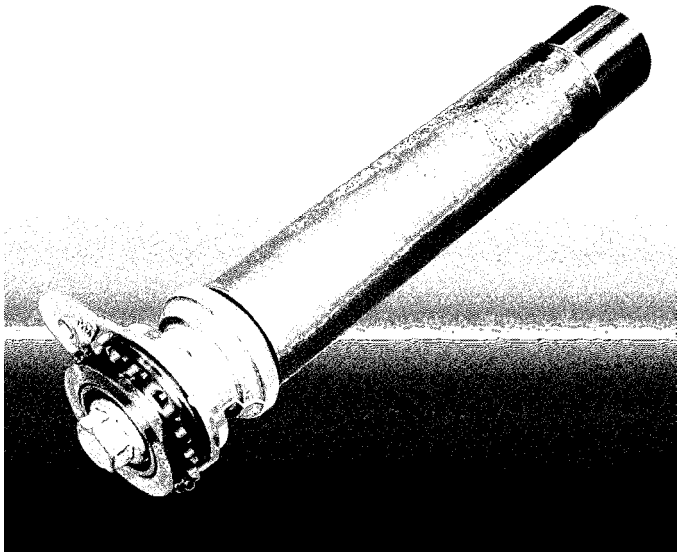

Figure 12

NOTE: The production GM OE balance shaft sprockets must be transferred to the new balance shafts.

OIL PAN

The production OE oil pan is used on all **ECO**TEC wet sump race engines. There is a –10AN bung added to the wet sump OE oil pans. This bung connects the tubocharger oil drain to the oil pan.

NOTE: The –10AN bung must be added above the oil level on the wet sump engines for the oil to drain from the turbocharger properly.

The dry sump race engines use a fabricated aluminum oil pan (Fig. 13). The oil pan is manufactured by Bates Engineering, in conjunction with GM Racing and Bothwell Motorsports. The oil pan is made from 6061 aluminum and is completely TIG welded together. The pan is assembled with two –12AN oil scavenges in the rear of the pan for oil pickup. This pan also has a –10AN bung added for the turbocharger drain. The dry sump oil pan was built to accommodate the engine being installed in the race car leaning 33° forward.

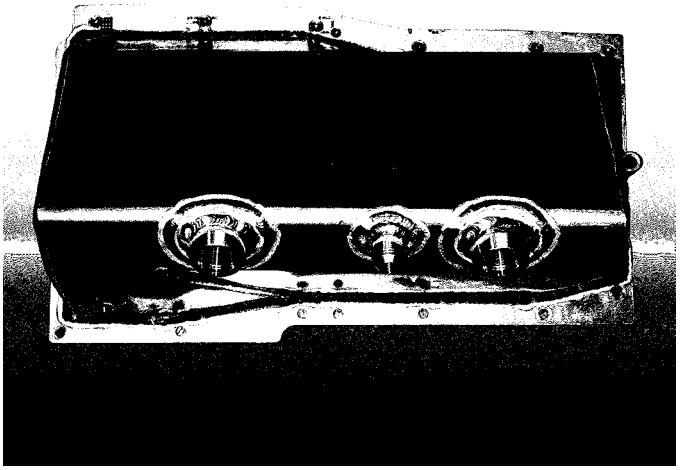

Figure 13

CRANKSHAFT

The crankshaft used on the **ECO**TEC race engine is a Crower 4340 billet steel crankshaft (Fig. 14). The crankshaft used to build this engine was prepared by Shaver Specialties, in conjunction with GM Racing and Bothwell Motorsports. There were many checks done on the crankshaft including:

- The MAGNAFLUX® system is used to check for cracks and imperfections in the crankshaft.
- The crankshaft is checked for straightness.
- The crankshaft is indexed for stroke.
- All oil passages and crankshaft journals are visually inspected.

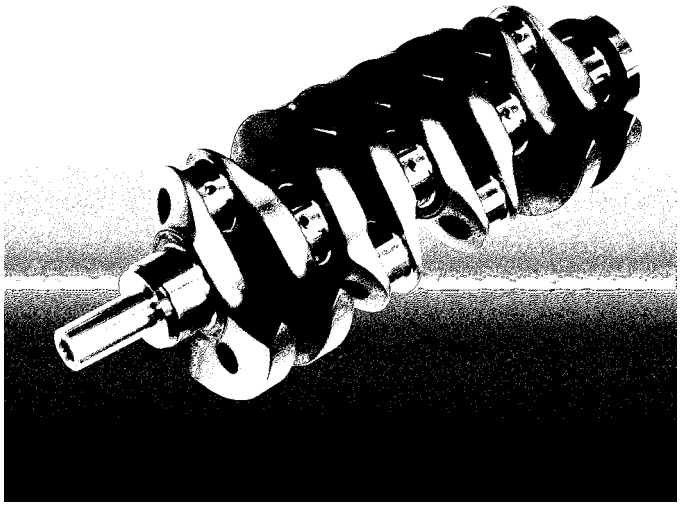

Figure 14

- All rod and main journals are measured for size and shape.
- All crankshafts are checked and rebalanced if necessary.

CRANKSHAFT SPECIFICATIONS	
Part #	88958620
Material	4340 Billet Steel
Stroke	3.505″
Rod Journal Size	1.8887″
Main Journal Size	2.2038″
Main Bearing Clearance	.0026″ - .0028″

CRANKSHAFT MAIN BEARINGS

The recommended crankshaft main bearing is a production GM OE main bearing (Fig. 15). The part number for these main bearings is #21018819.

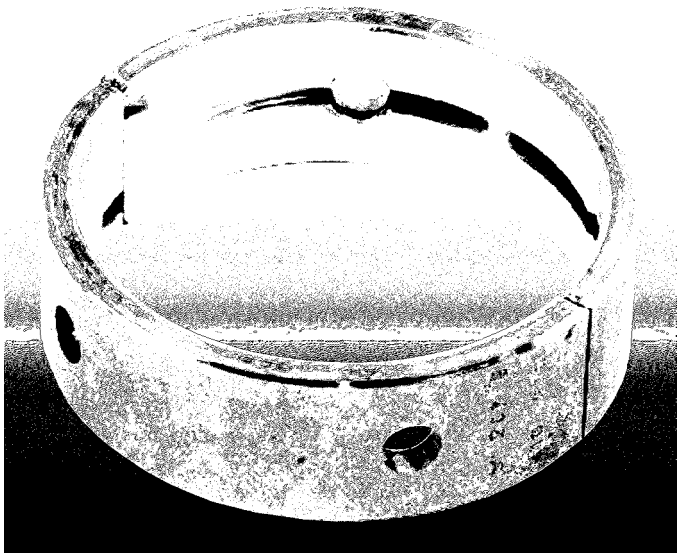

Figure 15

CONNECTING RODS

The connecting rods used in the **ECO**TEC race engine are Crower 4340 steel connecting rods (Fig. 16). The connecting rods were prepared by Shaver Specialties, in conjunction with GM Racing and Bothwell Motorsports. The connecting rods have been checked for the following:

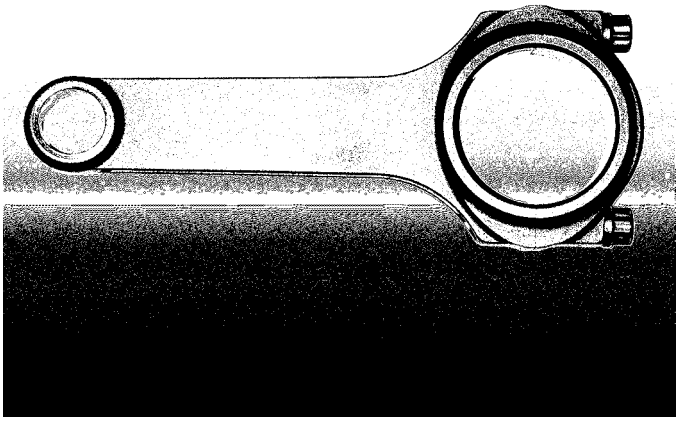

Figure 16

- The MAGNAFLUX® system is used to check for cracks and imperfections in the connecting rods and rod bolts.
- The connecting rods are measured to verify all specifications.

CONNECTING ROD SPECIFICATIONS	
Part #	88958618
Type	H-Beam
Material	4340 Steel
Length	5.888″
Big End Diameter	2.0150″
Big End Width	.943″
Small End Diameter	.8288″
Total Weight	655 Grams
Rod-to-Piston Pin Clearance	.0008″
Rod Bearing-to-Crankshaft Journal Clearance	.0026″ - .0032″

CONNECTING ROD BEARINGS

- The recommended connecting rod bearing is a CLEVITE part number #1663 H.

NOTE: Clevite also sells bearings in ±sizes to aid in achieving the correct bearing clearance.

PISTONS

The pistons used in the **ECO**TEC race engine are manufactured by JE PISTONS (Fig. 17). These pistons are a flat top forged aluminum style piston. The pistons were prepared by Shaver Specialties in conjunction with GM Racing and Bothwell Motorsports. There have been modifications and checks made to the pistons including:

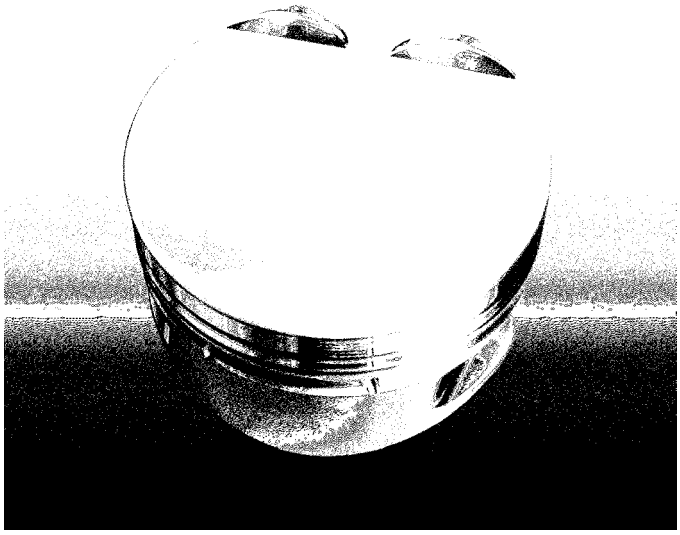

Figure 17

- The ZYGLO® system is used to check for cracks and imperfections in the pistons.
- The pistons have been completely deburred.
- The piston skirts and tops have been bead blasted.

PISTON SPECIFICATIONS	
Part #	88958635
Forging	81 MD4
Bore	3.400″
Compression Height	1.055″
Pin Diameter	.829″
Pin Length	2.250″
Top Ring Groove	1.5 mm
Second Ring Groove	1.5 mm
Oil Ring Groove	4 mm
Piston-to-Cylinder Clearance	.005″ - .006″
Piston Pin-to-Piston Clearance	.0005″
Piston Ring End Gap	.016″

PISTON PINS

The production piston pins have been replaced with H–11 tool steel thick walled pins in all **ECO**TEC race engines. The piston pin diameter is .830″ and the wall thickness is .165″. The piston pins were supplied by Shaver Specialties, in conjunction with GM Racing and Bothwell Motorsports. All pins are hand fitted to the connecting rods and pistons. The piston pin diameter is .829″.

PISTON RINGS

The recommended piston rings are Total Seal part # 466502001-04. These rings are file fit style rings.

PISTON PIN LOCKS

The recommended piston pin locks are JE part # 827-063-MW. These are single wire style locks.

CYLINDER HEAD

The cylinder head used to build this engine is a production GM OE head (Fig. 18). The cylinder head was prepared by Shaver Specialties in conjunction with GM Racing and Bothwell Motorsports. This head is cast from A356-T6 aluminum using a lost foam process. There were many modifications and checks made to the original production cylinder head. The modifications made to the race cylinder head GM part #88958620 include:

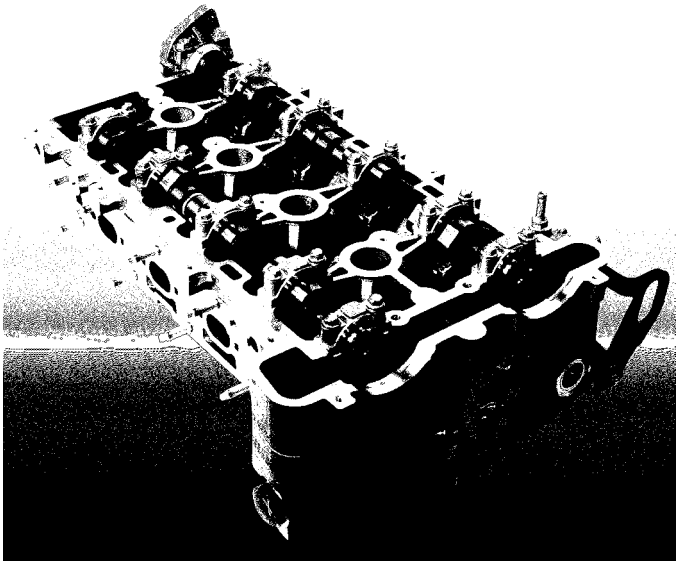

Figure 18

- The ZYGLO® system is used to check for cracks and imperfections in the cylinder head.
- The head stud holes are drilled and reamed to 5.050″.
- The cylinder head alignment dowel holes have been opened up to .629″.
- The head stud holes have been spot faced to install step washers (Fig. 19).

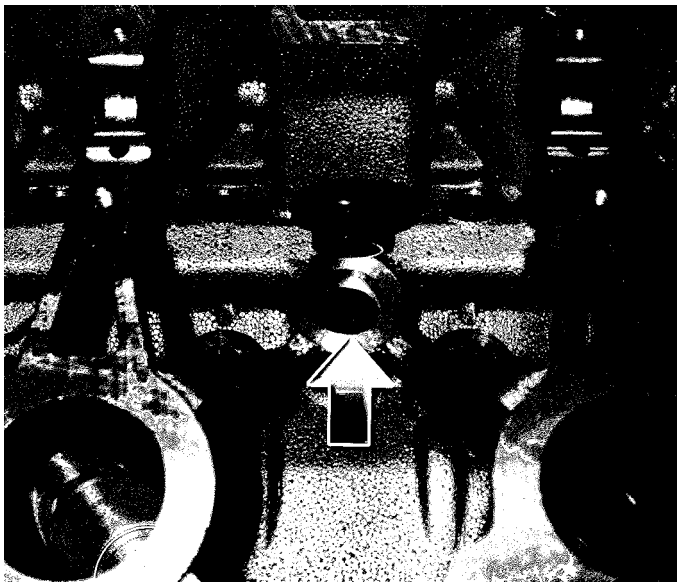

Figure 19

- The water jackets on each end of the cylinder head have been pinned for support (Figs. 20 and 21).

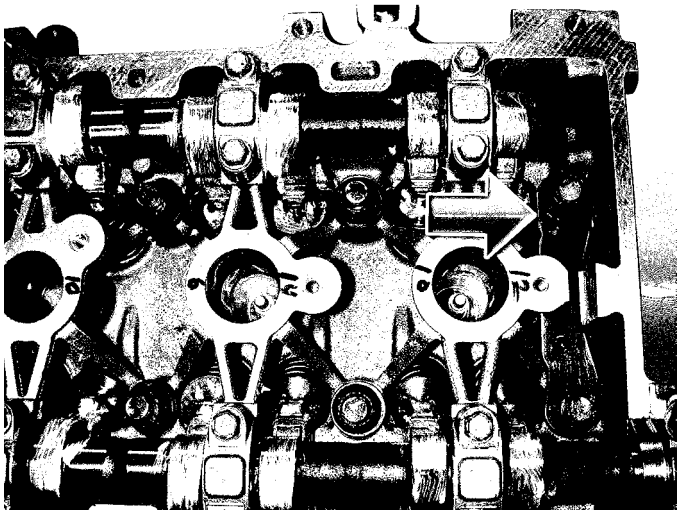

Figure 20

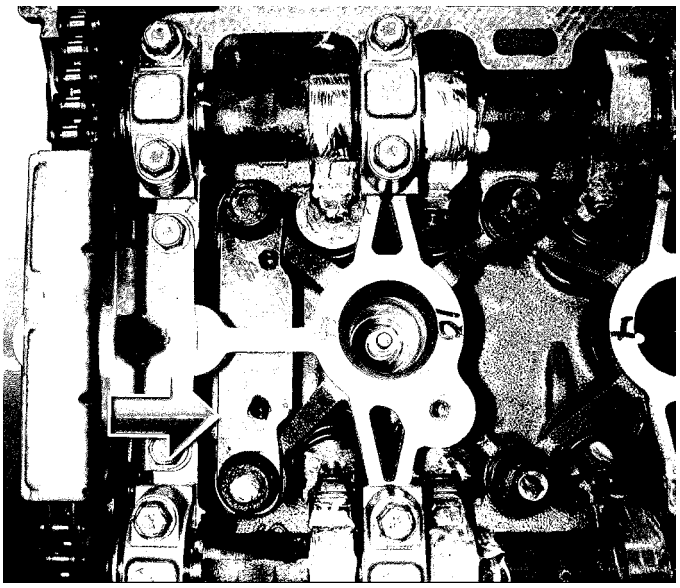

Figure 21

- A receiver groove has been machined into cylinder head face.
- The spark plug holes have been modified to accept ¾″ reach race spark plugs.
- K-line valve guides have been installed.
- The valve spring seat pockets have been machined down by .040″ on the intake and .060″ on the exhaust (Fig. 22). The diameter of the seats must be 1.150″.

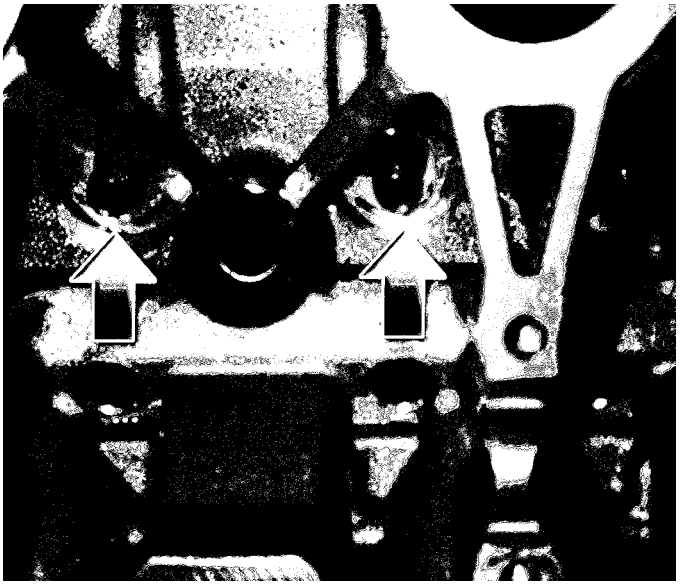

Figure 22

- The support struts and oil rails have been hand clearanced for spring clearance.

NOTE: A minimum of .030″ clearance is necessary.

- The exhaust side of the oil rail is drilled for spring/rocker arm oilers (Fig. 23).

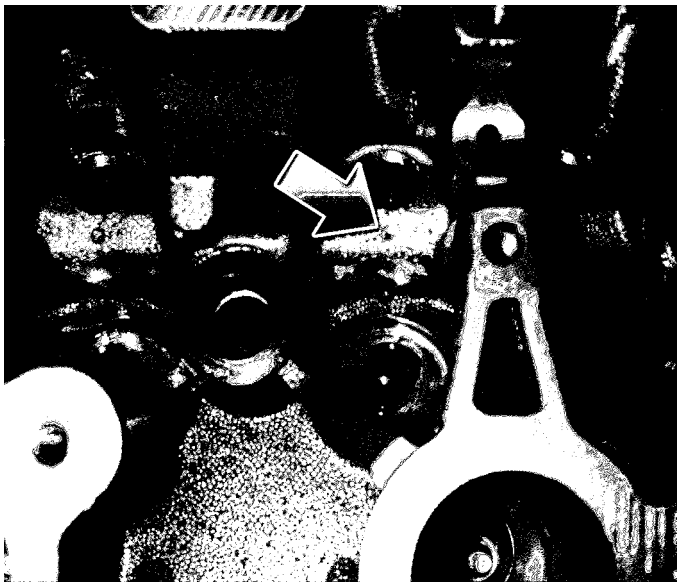

Figure 23

- The cylinder head is completely deburred and flow bench tested.
- A complete competition valve job is done on the cylinder head using a Serti Head Machine. Serti cutter # HP2022 has been used.

NOTE: There have been 2 oil returns incorporated into the cylinder head to scavenge oil from the head on the Cavalier dry sump engines. This is done due to the engine being leaned 33° forward in the race car. These oil returns will keep the oil from collecting in the cylinder head.

RACE CYLINDER HEAD GENERAL DATA

	Intake	Exhaust
Valve Head Diameter	1.385″	1.185″
Valve Stem Diameter	0.215″	0.215″
Effective Valve Area (sq. in.)	1.470	1.067
Leakage (cfm)	0.00	0.00
Valve Seat Angle (degrees)	45.0°	45.0°
Valve Spring Installed Height	1.350″	1.350″
Valve Spring Seat Pressure (lbs.)	105	105
Spring Pressure @ .407″ Lift (lbs.)	320	320
Port Volume (cc)	181.0	78.0
Average Flow (cfm)	187.29	169.52
Maximum Flow (cfm)	268.50	208.30

RACE CYLINDER HEAD FLOW									
PERFORMED ON A SUPERFLOW SF-1020 FLOW BENCH									
Intake Valve Test Data 28.0 Inches of Water									
Valve Lift	0.050″	0.100″	0.150″	0.200″	0.250″	0.300″	0.350″	0.400″	0.450″
Flow Range (nom.)	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0
Corrected Flow	73.80	113.40	147.60	180.70	214.50	241.70	258.10	268.50	0.00
Discharge Coeff.	0.344	0.529	0.689	0.843	1.001	1.128	1.205	1.253	0.000
Lift/Dia. Ratio	0.036	0.072	0.108	0.144	0.181	0.217	0.253	0.289	0.325

RACE CYLINDER HEAD FLOW									
PERFORMED ON A SUPERFLOW SF-1020 FLOW BENCH									
Exhaust Valve Test Data 28.0 Inches of Water									
Valve Lift	0.050″	0.100″	0.150″	0.200″	0.250″	0.300″	0.350″	0.400″	0.450″
Flow Range (nom.)	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0
Corrected Flow	75.00	115.80	151.20	175.60	189.90	199.0	204.40	206.50	208.30
Discharge Coeff.	0.350	0.540	0.706	0.820	0.886	0.929	0.954	0.964	0.972
Lift/Dia. Ratio	0.042	0.084	0.127	0.169	0.211	0.253	0.295	0.338	0.380

VALVETRAIN

The production GM OE roller finger followers and hydraulic valve lash adjusters are used on all **ECO**TEC race engines.

The production OE camshaft drive system is maintained in all **ECO**TEC race engines (Fig. 24).

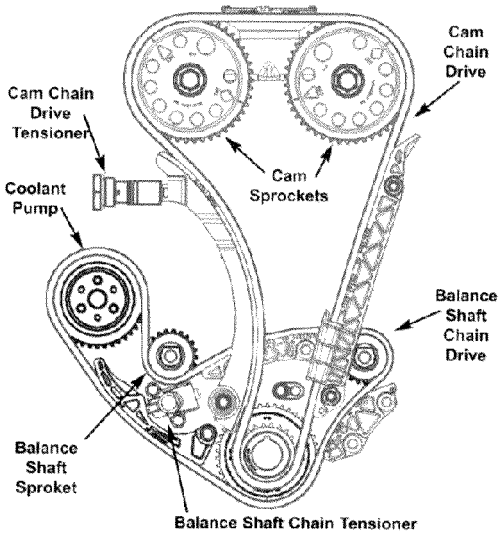

Figure 24

The only modification made to the production timing system is the development of adjustable cam gears (Fig. 25). These gears allow for easy adjustment of camshaft timing. These gears allow adjustment of the camshaft gears ±16°.

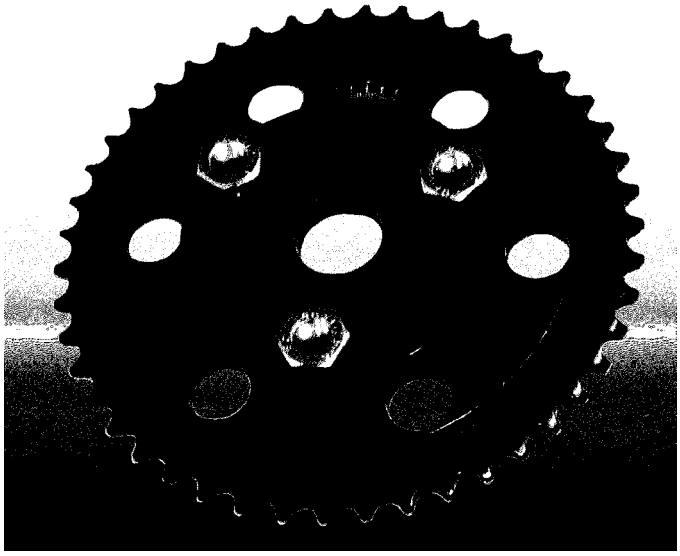

Figure 25

CYLINDER HEAD COVER

The production OE cast aluminum cylinder head cover is used on all **ECO**TEC race engines (Fig. 26). A –12 AN breather provision is added to all cylinder head covers.

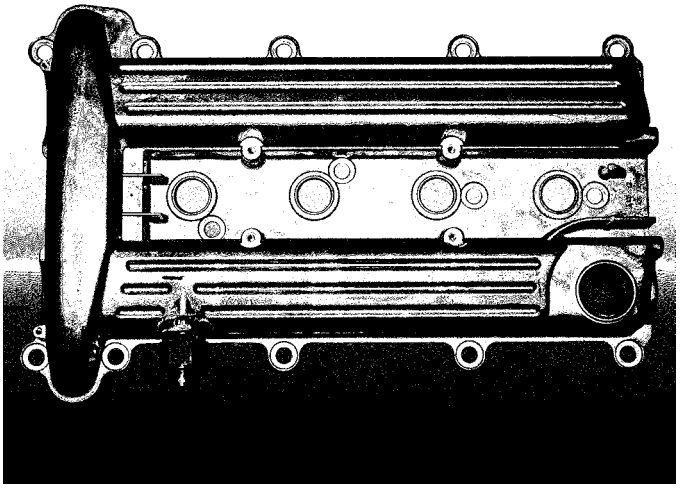

Figure 26

CAMSHAFTS

The camshafts used in the **ECO**TEC race engines have been machined by Crower (Fig. 27). Crower uses camshaft blanks supplied by GM. The camshaft blank part numbers are #88958611 (intake) and #88958612 (exhaust). These camshaft blanks come with finished journals and unfinished lobes. These blanks are also through hardened 5mm deep.

CAMSHAFT SPECIFICATIONS	
Intake & Exhaust	
Lobe Center Separation	115.5 Cam Degrees
Intake	
Valve Opening	222.1° BTDC
Lobe Center	112.0° ATDC
Valve Closure	261.2° ABDC
Duration	219.1 Crank Degrees
Max Cam Lift	.27291″
Net Valve Lift	.46395″
Exhaust	
Valve Opening	265.8° BBDC
Lobe Center	119.0° BTDC
Valve Closure	224.2° ATDC
Duration	221.6 Crank Degrees
Max Cam Lift	.27173″
Net Valve Lift	.46194″

INTAKE MANIFOLD

The intake manifold used on the **ECO**TEC race engine is a sheet metal fabricated style intake manifold (GM part #88958629) (Fig. 28). The intake manifold is manufactured by Bates Engineering, in conjunction with GM Racing and Bothwell Motorsports. The intake manifold is made from 6061 aluminum and is completely TIG welded together. The manifold has a large plenum with tapered long runners and a side entry.

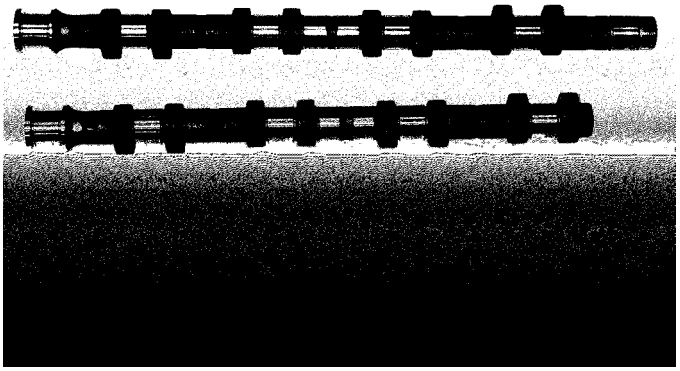

Figure 27

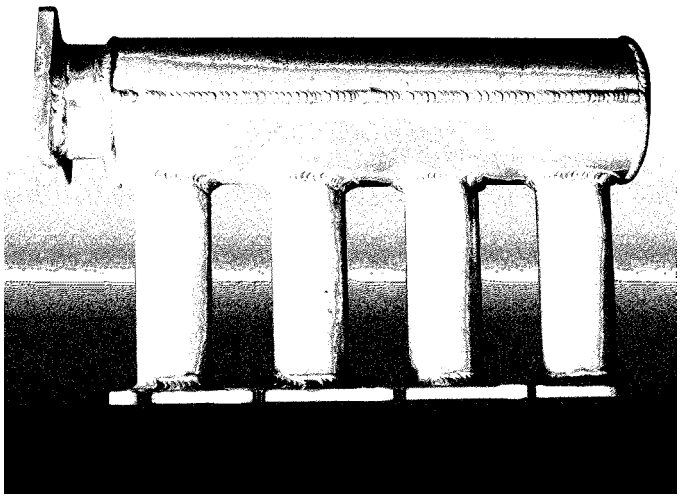

Figure 28

NOTE: If the engine is producing more than 700 HP, provisions must be added to the intake manifold to add 4 additional fuel injectors (Fig. 29).

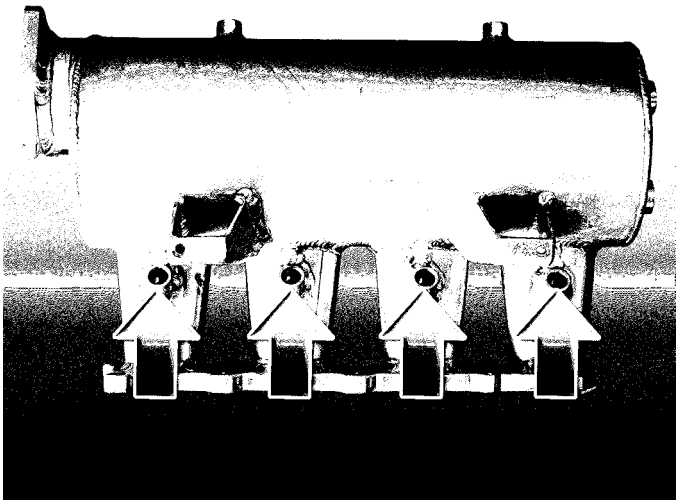

Figure 29

The intake manifold utilizes a 75mm OE throttle body from a GM 5.3L V8 engine (Fig. 30).

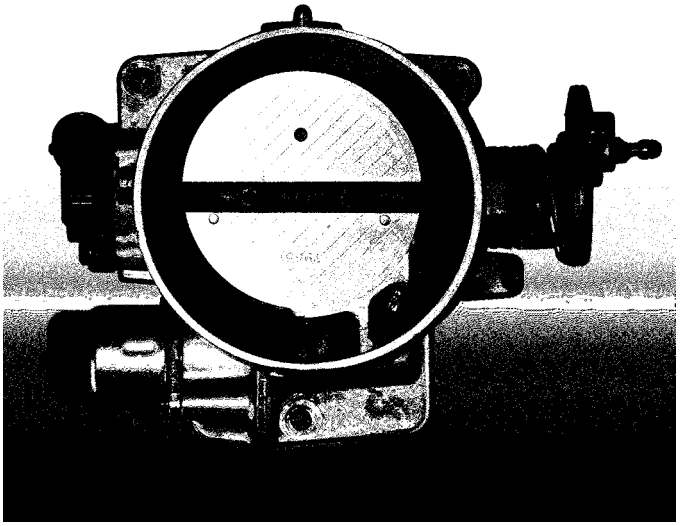

Figure 30

The OE throttle position sensor (TPS) and idle air control motor (IAC) are also utilized.

PUMPS (WATER PUMP AND OIL PUMPS)

WATER PUMP

The production OE water pump is used on the **ECO**TEC race engines.

OIL PUMP (DRY SUMP)

A 5 stage Barnes mechanical oil pump is used for the dry sump **ECO**TEC race engines (Fig. 31). This pump utilizes four scavenging lines and one pressure line that is fed into a -10 AN fitting into the oil filter housing. This oil pump supplies a constant 85 PSI @ all engine speeds.

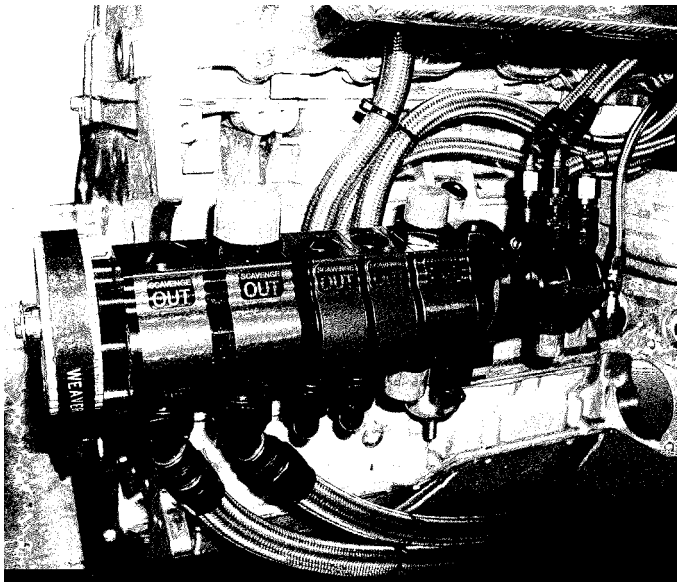

Figure 31

NOTE: When a mechanical dry sump oil pump is used, the OE G-Rotor oil pump must be removed from the engine front cover.

NOTE: It is recommended that a custom motor plate be used to replace the engines production front cover when a dry sump oil system is used. This will assist in the mechanical oil pump mounting and provide additional engine mounting points.

OIL PUMP (WET SUMP)

The production lubrication system is used on all wet sump **ECO**TEC race engines including the production GM OE G-Rotor style oil pump. This oil pump supplies a constant 125 PSI @ 9000 RPM. The wet sump oiling system also utilizes a Moroso Acusump oil system. This system will supply an additional 3 quarts of oil to the engine if the engine oil pressure should fall below 60 PSI.

FUEL INJECTION SYSTEM

An Accel Direct Fuel Injection (DFI) 2002 Controller part #77026 is used on all **ECO**TEC race engines. A boost compensated fuel pressure regulator is used to regulate fuel pressure to the 8, 158 lb/hr. RC fuel injectors used on all **ECO**TEC race engines. This regulator adds approximately 1.5 PSI of fuel pressure for every 1 PSI of turbo boost.

Two Weldon 2035-A electric fuel pumps are used on the wet sump engines. These pumps can flow 180 GPH @ 80 PSIG @ 14.0 volts D.C. each.

NOTE: The recommended base fuel pressure for an engine using 4 injectors is 70 PSI and 40 PSI for a engine using 8 injectors (Fig. 32).

The dry sump engines use a DSR mechanical fuel pump. This pump can flow 1.85 GPH @ 1800 RPM @ 25 PSI and 440 GPH @ 8000 RPM @ 100 PSI. This pump attaches to the rear of the mechanical oil pump.

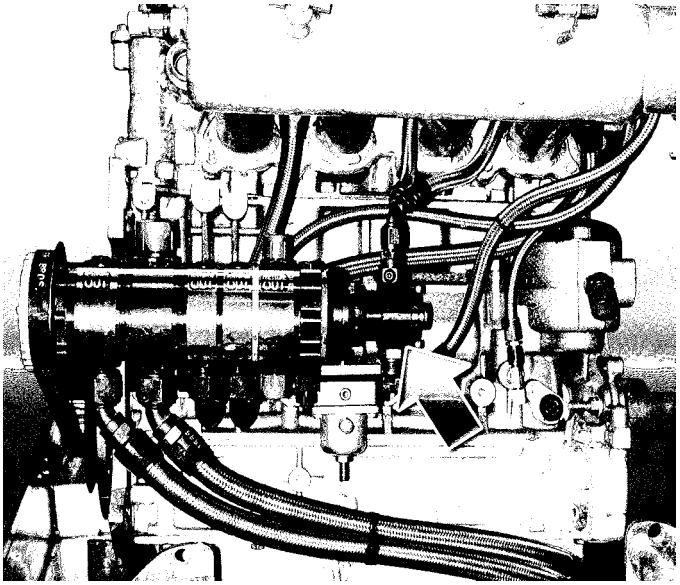

Figure 32

NOTE: Utmost care must be taken with the fuel system components when using Methanol fuel. The fuel system must be flushed with a leaded race fuel after use.

IGNITION SYSTEM

A MSD Digital-7 Programmable Ignition Control part #7531-4 is utilized on all **ECO**TEC race engines. This is a windows based wide band closed loop controller. This controller also has data logging capabilities.

A MSD distributor part #8498, distributor cap part #8424, magnetic pickup style crank trigger part #8610, HVC-2 coil part #8261, and plug wires part #32769 are also used on all race engines.

NOTE:The ignition systems energy is very critical to the proper operation of highly boosted methanol fueled engines. Proper installation and setup of the ignition system is very important. Follow the ignition system manufacturer recommendations for proper installation and setup.

NOTE: The spark plug gap should be no more than .025″.

TURBOCHARGERS

The turbochargers used on the **ECO**TEC race engines are supplied by Innovative Turbo Systems (Fig. 33). These are V-Band Discharge Ceramic Ball Bearing Type Turbo Chargers.

Boost control is very important when using a turbocharger. A 50.8mm (3.15″) exhaust wastegate is used to divert

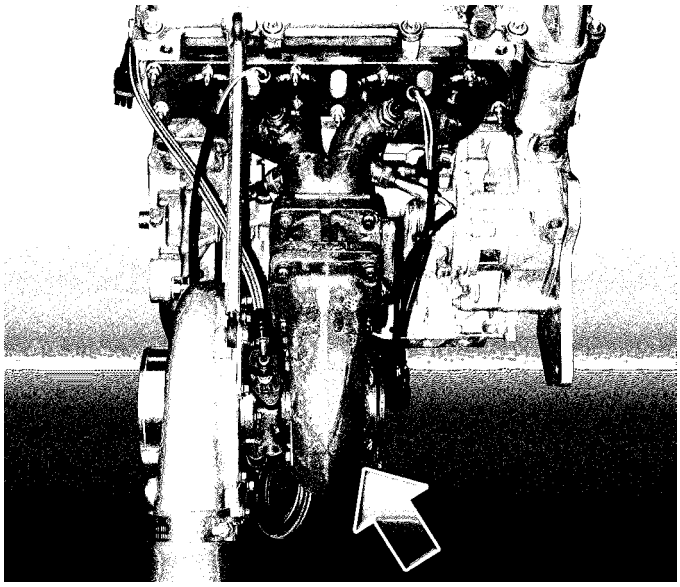

Figure 33

exhaust gasses from the turbocharger. The wastegate is located in the exhaust track between the exhaust header and the turbo exhaust flange. A high flow wastegate flange that bolts between the exhaust header and turbocharger was developed. This flange aligns the wastegate perpendicular to the exhaust flow.

An electronic boost controller controls the wastegate operation. This controller opens and closes the wastegate to provide the turbocharger with adequate exhaust flow to produce the requested inlet boost pressure. The controller allows different boost levels to be selected for vehicle launch and gear selections. This controller also controls the rate that the boost changes.

CAVALIER TURBOCHARGER

A GT 80-R-.96 3.5 V-Band Discharge Ceramic Ball-Bearing Type Turbocharger is used on the Cavalier race car. This turbo is capable of supplying 110 lbs. of air @ 30 PSI of Boost.

NOTE: All turbochargers will operate differently depending on weather conditions, engine packaging, exhaust configuration, and transmission type.

SUNFIRE TURBOCHARGER

A GT 72-R-.96 3.5 V-Band Discharge Ceramic Ball-Bearing Type Turbocharger is used on the Sunfire race car. This turbo is capable of supplying 82 lbs. of air @ 30 PSI of Boost.

NOTE: Both turbochargers should be installed using an oil supply line restrictor no larger than .065″. A minimum of a –10 AN unrestricted oil return line must be installed on both turbochargers.

NOTE: The cylinder head cover must have a minimum –12 AN vent hose for the turbochargers lubrication system to operate properly.

NOTE: All turbochargers will operate differently depending on weather conditions, engine packaging, exhaust configuration, and transmission type.

ENGINE ASSEMBLY

Below is a list of general procedures and measurements that should be performed on the engine components during assembly. For a complete disassembly and assembly procedure and general specifications refer to the appropriate 2003 Cavalier or 2003 Sunfire Service Information.

ENGINE BLOCK

- The engine block should be thoroughly washed and checked for debris before assembly.
- The cylinder sleeves are final honed with deck plates installed and torqued to 85ft.lbs..
- The cylinder sleeve o-rings have a flat and beveled side. Be sure to install the flat side into the cylinder sleeve.

NOTE: The main oil feed for the cylinder head is located in the deck of the cylinder block. It is critical that no debris (silicone, lint, etc.) is blocking this passage. If this passage is blocked, the valve train will not receive the necessary oil needed.

OIL FILTER

NOTE: On the wet sump engines with the oil bypass plugged, the oil filter bypass spud must be removed from the oil filter if using a OE AC oil filter (Fig. 34).

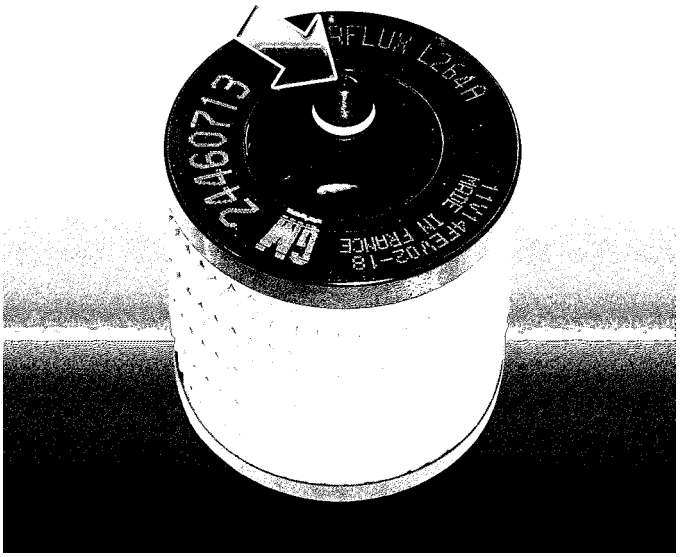

Figure 34

CRANKSHAFT

- The crankshaft should be thoroughly washed and checked for debris before installation in the engine block.

NOTE: High grade flywheel and torque converter mounting fasteners must be used for assembly. A high strength red Loctite must be used during assembly of these fasteners. It is possible for these fasteners to loosen up and come off if high strength fasteners and red Loctite are not used.

MAIN BEARINGS

- All main bearings are washed and checked for imperfections. It is very important that the main bearing clearance be checked with a dial bore gauge. The main bearing clearance should be .0026″–.0028″.
- The crankshaft end play should be .003″–.010″. The crankshaft should rotate smoothly by only using hand pressure after main girdle is torqued to specification.

NOTE: Be sure to check that there is no main bearing to crankshaft radius fillet interference. This must be checked at both ends of the crankshaft end play.

PISTONS AND CONNECTING RODS

- The pistons are installed in the block .005″–.010″ down in the cylinder bore.
- The connecting rod bolts must be torqued using the stretch method. These bolts are stretched to .140mm (.0055″) to yield proper bolt load.

NOTE: During engine assembly the piston to valve clearance must be checked. A minimun of .110″ is required on both intake and exhaust valves.

CONNECTING ROD BEARINGS

- All connecting rod bearings are washed and checked for imperfections.

NOTE: Clevite also sells bearings in ± sizes to aid in achieving the correct bearing clearance.

PISTON PINS AND LOCKS

- Be sure to check the connecting rod to piston pin clearance. The connecting rod journal must be honed to achieve the proper clearance. The clearance should be .0008″–.001″.
- Be sure to check piston pin to piston clearance. It is important the clearance be .0005″.
- Be sure to check piston pin thrust clearance after pistons and connecting rods are assembled. The clearance should be no more than .030″.

PISTON RINGS

- It is recommended that all ring gaps be separated by at least 1″ when installing the piston into cylinder bore. The top ring should be positioned towards the exhaust side of the piston. It is also very important that the dimple on the oil ring support rail be positioned down when installing on the piston.

CYLINDER HEAD

- The cylinder head should be thoroughly washed and checked for debris before installation.

HYDRAULIC LASH ADJUSTERS

- Before installing the lash adjusters, a mock up solid lifter is used to check lash adjuster installed height. It is recommended that all lash adjusters be installed in the middle of their travel. After the mock up lifter is installed, measure the clearance between the base circle of the camshaft and the finger follower. The total travel of the production hydraulic lash adjuster is .100″. The recommended clearance is .040″–.060″. This should place the lash adjuster in the middle of its travel.

NOTE: Be sure to soak all lash adjusters and finger followers in engine oil before assembly.

NOTE: A mockup lifter is available from Bates Engineering.

CYLINDER HEAD GASKET

- The cylinder head gasket is coated with a light film of Copper Coat. The Copper Coat is allowed to dry for 2 hours before assembly.

VALVE STEM OIL SEALS

- There are no valve stem oil seals used on any **ECO**TEC race engines. The seals are left off to maximize valve spring retainer to valve guide clearance.

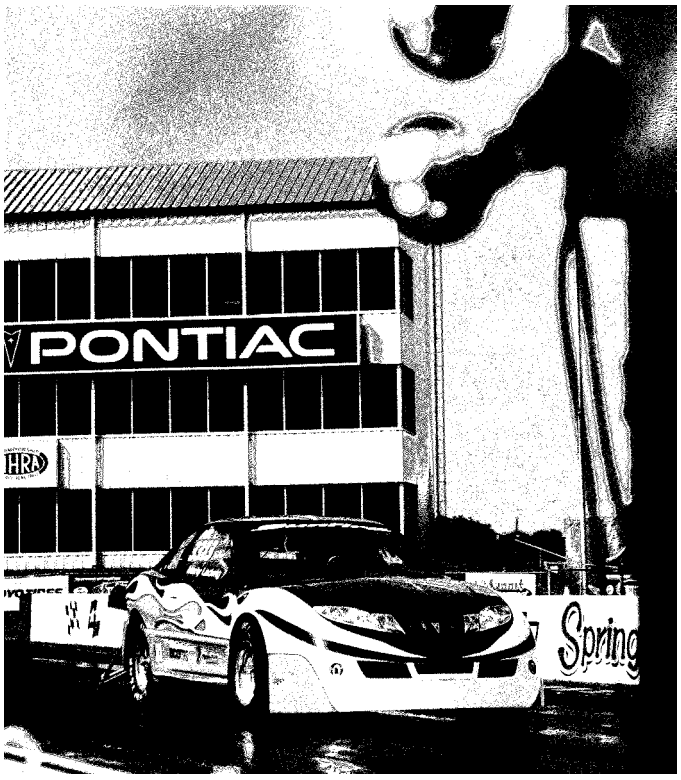

Figure 36
2002* ECOTEC *Powered Sunfire at Houston Summit Sport Compact Drag Racing Series Event

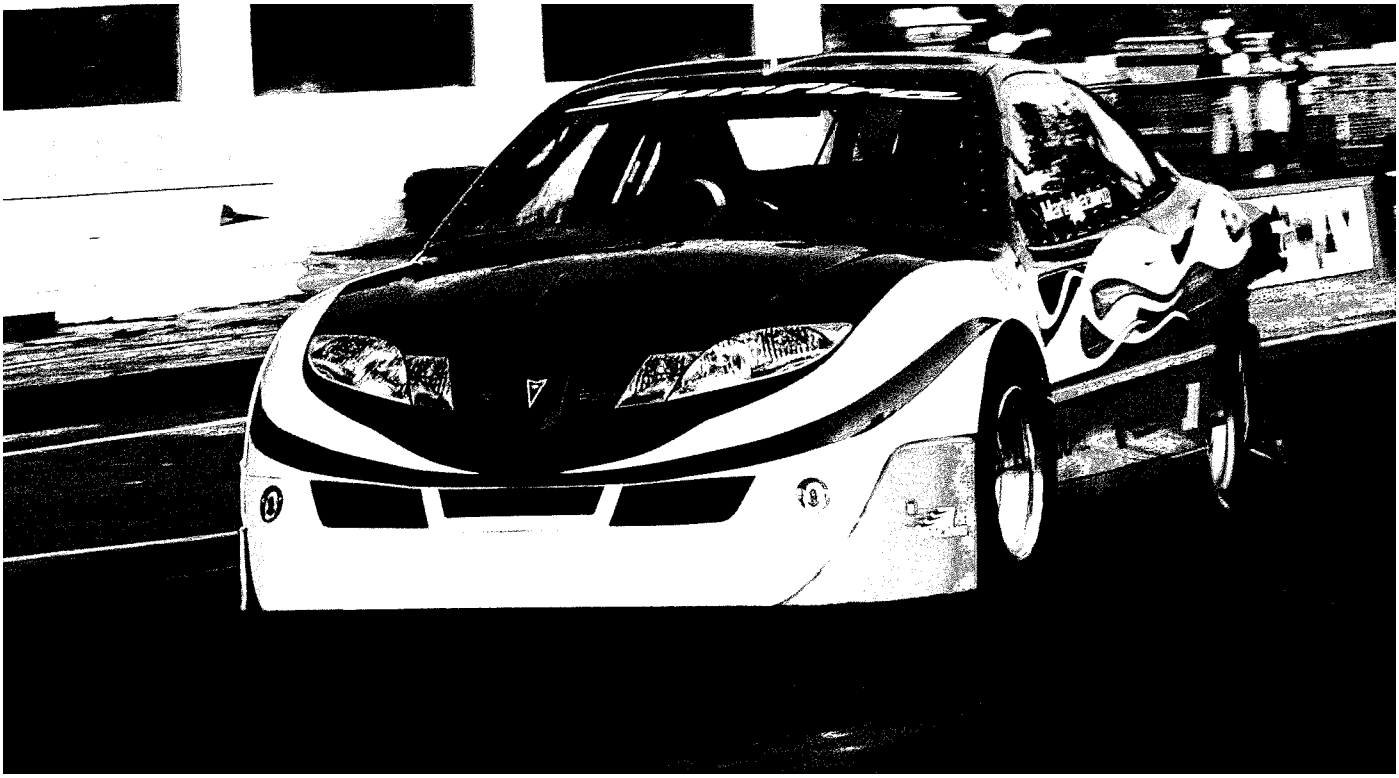

Figure 35
2002* ECOTEC *Powered Sunfire at Houston Summit Sport Compact Drag Racing Series Event

ENGINE SPECIFICATIONS

PERFORMANCE

Using the parts and procedures described in this manual, Shaver Racing Engines has assembled and dyno tested numerous **ECO**TEC race engines. The following horsepower and torque figures are representative of the performance that can be expected from an engine built using the components described in this handbook. Due to differences in dynamometer installations and operating conditions, test results for other engines built to these specifications may vary.

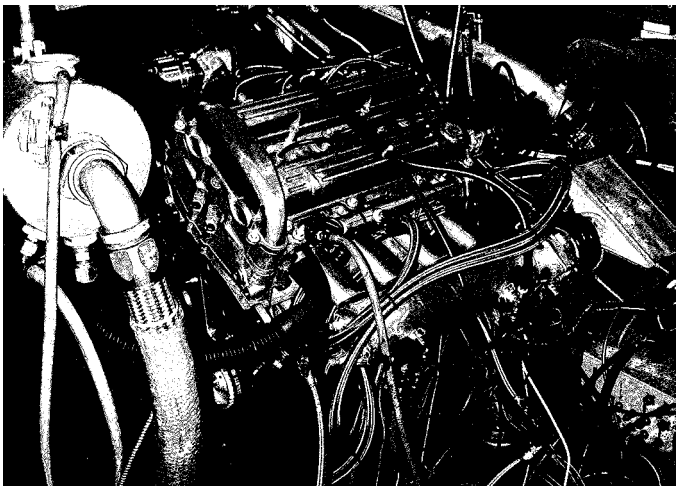

Figure 37

ECOTEC 2.0 RACE ENGINE DYNO TEST RESULTS		
SPEED (RPM)	**TORQUE (LBF)**	**HORSEPOWER (HP)**
6444	498	611
7046	597	800
7527	**599**	858
8016	575	877
8529	570	**925**
9012	521	893
9440	493	886

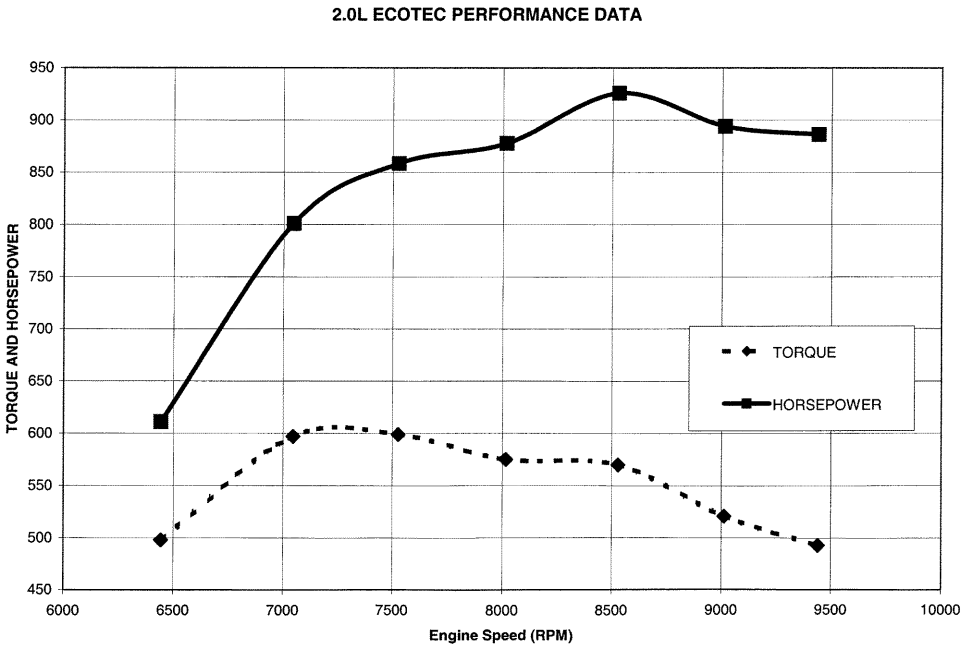

Figure 38

Torque Specifications

Component Description	Ft.Lbs.	In.Lbs.	Lubricant
Cylinder Head Studs in Block	8	—	Blue Loctite #242
Cylinder Head Stud Nuts	85	—	CMD Extreme Pressure Lube #3
Crankshaft Main Studs in Block	8	—	Blue Loctite #242
Crankshaft Main Stud Nuts	65	—	CMD Extreme Pressure Lube #3
Crankshaft to Block Peripheral Bolts	15	—	OIL
Balance Shaft Chain Guide Bolts	—	89	OIL
Balance Shaft Drive Sprocket Bolts	41	—	Blue Loctite #242
Balance Shaft Retaining Bolts	—	89	OIL
Camshaft Bearing Cap Bolts	—	89	OIL
Intake Camshaft Rear Bearing Cap Bolt	18	—	OIL
Camshaft Cover Bolts	—	89	OIL
Camshaft Adjustable Sprocket Bolts	15	—	Red Loctite #262
Camshaft Sprocket Bolts	63+30°	—	Red Loctite #262
Camshaft Timing Chain Tensioner Bolts	44	—	OIL
Connecting Rod Bolts	45	—	Molly Lube Loctite #51048
Crankshaft Damper Bolt (wet sump)	74+75°	—	Red Loctite #262
Cylinder Head Front Chain Case Bolts	18	—	OIL
Exhaust Manifold Nuts	13	—	DRY
Exhaust Manifold Studs to Cylinder Head	—	89	DRY
Flywheel Bolts	39+25°	—	Red Loctite #262
Fuel Rail Bolts	—	89	OIL
Intake Manifold to Cylinder Head Bolts	—	89	OIL
Intake Manifold to Cylinder Head Nuts	—	89	OIL
Oil Drain Plug	18	—	OIL
Oil Filter Cap	18	—	OIL
Oil Pan to Engine Block	18	—	OIL
Oil Pump Gear Cover Plate Screws	—	53	OIL
Oil Pump Pressure Relief Valve Plug	30	—	OIL
Oxygen Sensor to Exhaust Manifold	33	—	Loctite—Anti Seize #CS5-A
Spark Plugs	15	—	Loctite—Anti Seize #CS5-A
Throttle Body Studs to Intake Manifold	—	6	OIL
Throttle Body Bolts and Nuts	—	10	OIL
Throttle Position Sensor Screws	—	18	DRY
Timing Chain Cover Bolts	13	—	OIL

Component Description	Ft.Lbs.	In.Lbs.	Lubricant
Timing Chain Guide Adjustment Bolt	—	10	OIL
Timing Chain Guide Bolts	—	89	OIL
Timing Chain Guide Bolts Access Plug	30	—	OIL
Timing Chain Guide Fixed Bolt	—	10	OIL
Timing Chain Oil Nozzle Bolt	—	10	OIL
Timing Chain Tensioner Bolts	—	10	OIL
Water Pump Bolts	18	—	OIL
Water Pump Sprocket Bolts	—	10	OIL

Parts List

Part Description	Part Number	Supplier
Complete Race Prepped Block Including Aftermarket Sleeves, Main Studs, and Cylinder Head Studs	88958630	GM
Machined and CNC Ported Performance Cylinder Head Without Valvetrain	88958619	GM
Machined and CNC Ported Full Race Cylinder Head Without Valvetrain	88958640	GM
Billet Steel Crankshaft with 3.505 Stroke	88958620	GM
Main Bearings	21018819	GM
Billet Steel Connecting Rod Set with Bolts (To be used with #88958620 Crankshaft)	88958618	GM
Set of Race Pistons Without Rings (To be used with #88958618 connecting rods)	88958635	GM
Forged Aluminum Piston Set — Direct Replacement For OE Pistons (comes with rings and piston pins)	88958634	GM
H-11 Race Piston Pin Set (To be used with #88958635 race pistons)	88958639	GM
Adjustable Cam Gear Set	88958613	GM
Copper Head Gasket With O-ring Kit	88958614	GM
Aluminum Race Intake Manifold (4 injector style)	88958629	GM
Race Ground Intake Camshaft	88958636	GM
Race Ground Exhaust Camshaft	88958637	GM
Exhaust Camshaft Blank	88958612	GM
Intake Camshaft Blank	88958611	GM
Neutral Balance Shaft Set	88958615	GM
Exhaust Manifold Flange	8898632	GM
CNC Intake Manifold Flange	88958633	GM
Front Hubs Power Pulley	88958631	GM
Turbo Adapter Flange	88958638	GM
Starter	10465551	GM
Generator	22683070	GM
Oil Filter	24460713	GM
72MM Throttle Body	17113647	GM
Connecting Rod Bearings	1663H	Clevite
Valve Springs	RB-7211	Bates
Valve Spring Retainers	RB-7212	Bates
Titanium Valve Spring Retainers	RB-7210	Bates
Mock Up Lifter	RB–7222	Bates
Spark Plug Machining Tool	RB–7223	Bates
5 Stage Dry Sump Oil Pump	9017-5B	Barnes

Part Description	Part Number	Supplier
Fuel Pump Mount	9021	Barnes
TurboCharger	1BGP2-Q960	Innovative
Pro Wastegate	260001	Innovative
Pro Wastegate Adapter	130001	Innovative
Multi Stage Boost Control	MSBC-1 101356	Innovative
Fuel Injectors	PB2-1600	RC
Mechanical Fuel Pump	1001LW	DSR
Drive Mandrel	1113-30	Weaver
Hat Washer	1228-01	Weaver
Crankshaft Pulley	1135-18L075	Weaver
Pump Pulley	1105-F	Weaver
Flange	1140-02	Weaver
Drive Belt	B-285LO75-HD	Weaver
Electric Fuel Pumps	2035–A	Weldon
Fuel Pressure Regulator	2040	Weldon
AN Fittings and Braided Hose	—	XRP
Valve Step Locks	14781-PR7-AO1	Honda
Exhaust Valve	F1961P	Ferrea
Intake Valves	F1963P	Ferrea
Step Washers	BB 30430	Stef's
H-11 ½″ Cylinder Head Studs	1-00192	A-1
H-11 7⁄16″ Main Girdle Studs	1-00158	A-1
Crank Trigger	8610	MSD
HVC–2 Coil	8261	MSD
Digital–7 Ignition Control	7531–4	MSD
Distributor	8498	MSD
Distributor Cap	8424	MSD
Spark Plug Wires	32769	MSD
Direct Fuel Injection (DFI) Controller	77026	Accel

SEALERS AND LUBRICANTS

Description	Part Number	Supplier
Anti Seize	CS5–A	Loctite
Red Thread Locker	262	Loctite
Blue Thread Locker	242	Loctite
Extreme Pressure Lube	3	CMD
Molly Lube	51048	Loctite

SUPPLIERS

Supplier	Address	Phone Number
Accel	10601 Memphis Ave. #12, Cleveland, OH 44144	216-688-8300 ext. 500
A-1 Technologies	7022 Alondra Blvd., Paramount, CA 90503	562-408-1808
Barnes	3162 Kashiwa St., Torrence, CA 90505	310-534-3844
Bates Engineering	1175 Paularino Avenue, Costa Mesa, CA 92626	714-545-0159
Crower	3333 Main Street, Chula Vista, CA 91911	619-422-1191
DSR	1298 East State Rd., 136 Unit E, Pittsboro, IN 46167	317-812-6800
Ferrea Racing Components	2600 NW 55th Court, Suite 238, Fort Lauderdale, FL 33309	954-733-2505
GM	Call 1-800-577-6888 for closest GM Performance Parts Authorized Center	
Innovative Turbo Systems	845 Easy St. Unit 102, Simi Valley, CA 93065	805-526-5400
MSD	12120 Esther Lama Suite 114, El Paso, TX 79936	915-855-7123
RC Engineering	1728 Border Av., Torrance, CA 90501	310-320-2277
Stef's Performance	693 Cross Street, Lake Wood, NJ 08701	732-367-8700
Weaver Brothers	1980 Boeing Way, Carson City, NV 89706	775-883-7677
Weldon	640 Golden Oak Parkway, Oakwood Village, OH 44146	440-232-2282
XRP	5630 Imperial Hwy., South Gate, CA 90280	562-861-4765

All engines have been developed and assembled by:
Shaver Specialties
20608 Earl Street Torrance, CA 90503
310-370-6941

All engines have been developed for:
GM Racing
GM Global Headquarters Detroit, MI

Bothwell Motorsports
20730 Earl Street Torrance, CA 90503

All GM parts are available through GMPP
(GM Performance Parts):
1-800-577-6888
www.spoperformanceparts.com