Chevrolet 60–degree V6

Chevrolet 60-degree V6

INTRODUCTION

The 2.8-liter V6 is a unique member of the family of Chevrolet engines. It is the only Chevrolet engine used in both transverse and fore-and-aft installations, and is the only motor in the Chevy line-up with a 60-degree included angle between its cylinder banks. (Small-block V8s, Mark IV V8s, and 4.3-liter V6 engines all have 90-degree vee angles). These two characteristics make the Chevrolet V6/60 an extremely compact, lightweight engine package with outstanding performance potential.

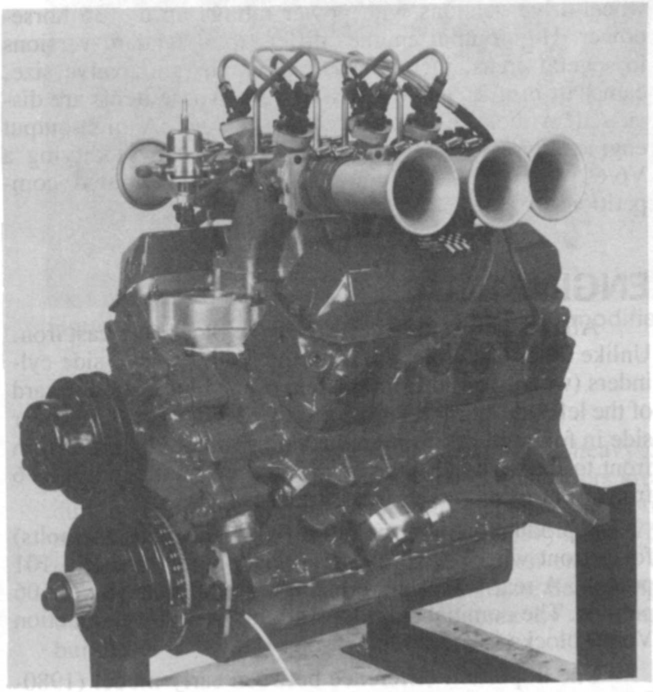

Figure 1 — Off-road Chevrolet 60-degree V6 with electronic fuel injection.

The 60-degree V6 has already earned a solid reputation for performance and durability in competition. The 2.8-liter Chevrolet has won championships in off-road racing, set records in drag racing, and won honors in midget oval track competition. The light weight and ample traction of the front-wheel-drive V6/60 powertrain makes the 2.8-liter Chevrolet a favorite in autocrossing and other forms of motorsports that emphasize precise handling and quick response. The 60-degree V6 has also found favor with innovative street rodders seeking a lightweight, fuel-efficient powerplant.

Although development of the 60-degree Chevy V6 for racing and high-performance applications is still in its in early stages, the engine has already proven its winning potential. Chevrolet offers a variety of heavy-duty components for the V6/60, including high-compression pistons, cylinder head gaskets, and Bow Tie aluminum engine blocks. Chevrolet Special Products is developing additional heavy-duty components for the 2.8-liter Chevrolet V6.

The specifications and procedures in this chapter are intended to aid Chevrolet enthusiasts in preparing the 60-degree V6 engine for "off-highway" operation. This information applies to road racing, oval track competition, drag racing, and heavy-duty marine use unless specifically indicated for a certain type of competition. Due to the wide diversity of induction and accessory systems required for different types of motorsports, only the basic engine assembly will be covered in detail. These specifications are intended as guidelines only; however, all have been tested and proven by leading competitors.

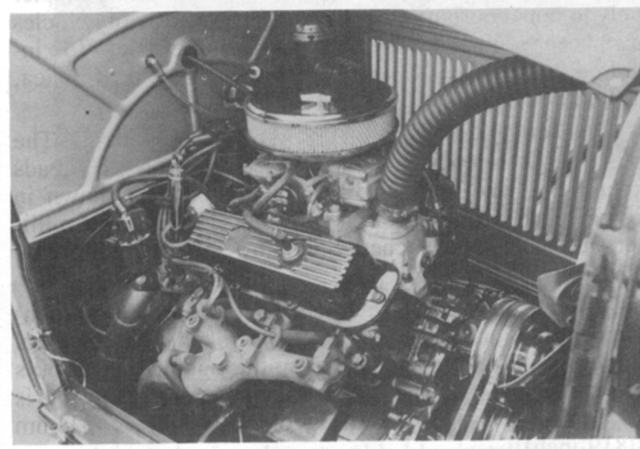

Figure 2 — Chevy 2.8-liter V6/60 street rod engine.

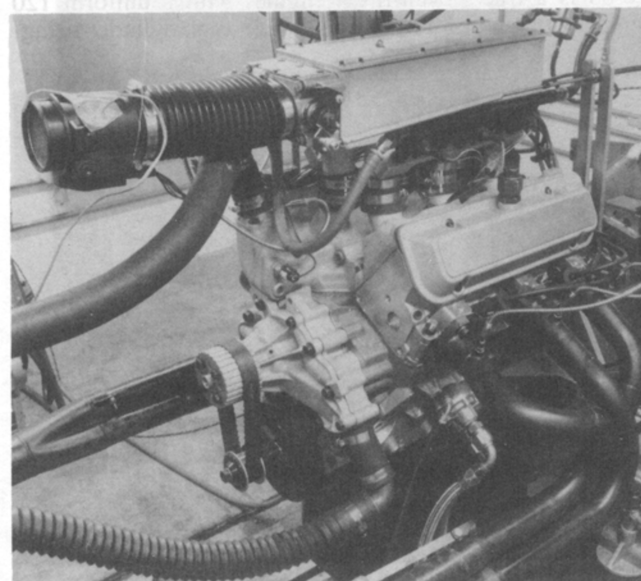

Figure 3 — Experimental V6/60 Midget class racing engine with aluminum cylinder heads and electronic fuel injection.

Many of the points discussed in this chapter apply specifically to the 60-degree V6. For general information on recommended engine building procedures, "blueprinting," electrical and ignition systems, and lubrication requirements, refer to the chapters on these specific topics.

PRODUCTION DESIGN HIGHLIGHTS

The Chevrolet 2.8-liter (173-cubic-inch) V6/60 was introduced in 1980 as a transverse-mounted engine in the front-wheel-drive Citation chassis. A rear-wheel-drive version of the V6/60 debuted in 1982 in the S-10 pickup, S-10 Blazer, and Camaro. This dual application accounts for several minor differences between various 2.8-liter V6s, including starter location, motor mounts, and manifold water outlet locations. All specifications in this chapter apply to both configurations, however. An array of vehicles have been equipped with the 2.8-liter Chevrolet V6, including the Camaro, Celebrity, Citation, Beretta, Corsica, Cavalier, S-10 pickup, and S-10 Blazer.

The V6/60 was Chevrolet's first all-metric engine. The bolts and fasteners used in 2.8-liter V6s have metric threads exclusively. The nominal blueprint dimensions shown in Figure 11 are expressed in metric units. To convert millimeter dimensions to inches, divide by 25.4 or multiply by .03937.

All 2.8-liter V6 Chevrolets have 89mm (3.50-inch) cylinder bores and 76mm (2.99-inch) strokes. These internal dimensions have remained constant throughout the V6/60's production history. The V6/60's cylinder bore spacing is 111.8mm (4.40-inch), and its block height is 224mm (8.819-inch).

The term "60-degree V6" refers specifically to the included angle between the engine's two cylinder banks. In the V6/60 Chevrolet, this angle is 60 degrees. (In contrast, Chevrolet's 4.3-liter V6 has a *90* degree Vee angle.) The "60-degree" designation does *not* refer to the number of degrees between cylinder firings. The 2.8-liter Chevrolet V6/60 is a true "even-fire" engine, with a uniform 120 degrees of crankshaft rotation between each cylinder firing.

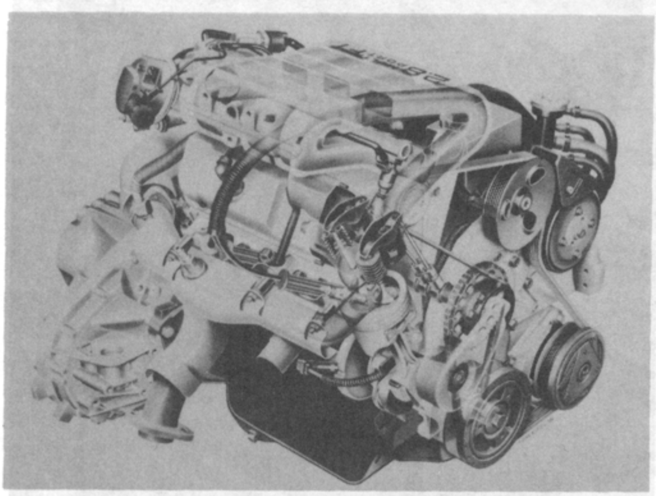

Figure 4 — Generation II V6/60 Chevrolets have aluminum cylinder heads with canted valves, a tuned two-piece intake manifold, and an aluminum front cover.

The V6/60 has very compact external dimensions because of this narrow vee angle. A typical 1987 production 2.8-liter engine with aluminum cylinder heads weighs just 340 pounds (374 pounds with manual transmission flywheel), complete and ready to run.

The 2.8-liter V6/60 has been continually updated and improved since its introduction. In 1985, the crankshaft journal diameter was increased 4mm to improve durability, and multi-port fuel injection was developed to enhance performance. New aluminum cylinder heads with high-flow ports and splayed valves signaled the arrival of the "Generation II" V6/60 in front-wheel-drive applications at the start of the 1987 model year.

The V6/60 Chevrolet has been offered with a variety of induction systems and horsepower ratings. Carbureted 2.8-liter Chevrolets were available in standard (LE2) and high-output (LH7) versions. V6s with multi-port fuel injection (LB6) are produced in front-wheel-drive and rear-wheel-drive versions with power ratings up to 135 horsepower. High-output engines differ from standard versions in several areas, including compression ratio, valve size, camshaft profile, and exhaust system. These items are discussed in their respective sections below. A high-output engine is preferred as a starting point when modifying a V6/60 Chevrolet for high-performance or limited competition use.

ENGINE BLOCK

All production 2.8-liter V6 engine blocks are cast iron. Unlike other Chevrolet engines, the V6/60's *right* side cylinders (when viewed from the rear of the block) are forward of the left side cylinders. The right side cylinders (passenger side in fore-and-aft installations) are numbered 1, 3, 5 from front to rear. The left-hand cylinders are numbered 2, 4, 6 from front to rear. The firing order is 1-2-3-4-5-6.

A production cast iron block (with main caps and bolts) for a front wheel drive chassis weighs approximately 101 pounds. A rear-wheel-drive block is slightly heavier at 106 pounds. The nominal cylinder wall thickness for production V6/60 blocks is 4.5mm (.175-inch).

One important difference between early-model (1980-84) and late-model (1985 and newer) V6/60 blocks is the diameter of the main bearings. 1980-84 engines have 63.35mm (2.494-inch) mains, while 1985 and later engines use 67.25mm (2.648-inch) main bearings. (Note: The diameter of the number 3 main bearing was changed to 63.13mm in 1982; in 1985, it was enlarged to 67.25mm.) All 1985 and later 2.8-liter V6/60 engines with multi-port fuel injection have large diameter main bearings; S-10 pickups, Blazers, and carbureted engines manufactured in 1985 can have either large or small main bearings. A block with large diameter crankshaft journals can be easily identified by its one-piece rear oil seal, as described in the crankshaft section.

Production V6/60 blocks are suitable for high-performance street use, off-roading, and limited competition applications. Production V6 blocks used in SCORE/HDRA off-road racing, for example, routinely produce over 270 horsepower and provide hundreds of miles of troublefree operation at high engine speeds. *Chevrolet Special Products strongly recommends that a late-model block with large main* *bearings be used for all high-performance applications.* Partial engine assemblies with large bearing crankshafts are available from Chevrolet to upgrade pre-1985 vehicles. Alternatively, an early-model small journal block can be modified to accept a large journal crank by boring the main bearing housings and machining new bearing tang slots. Main bearing bore dimensions are given below in the block preparation section. The rope rear main bearing seal groove should not be enlarged when performing this modification. Instead, use the replacement one-piece neoprene seal described in the crankshaft section.

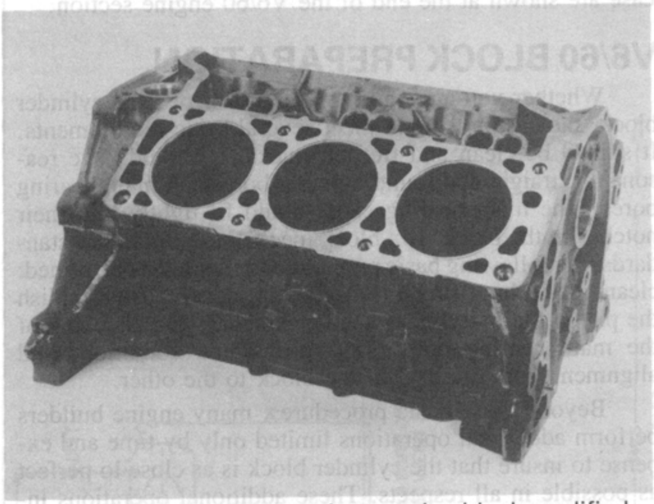

Figure 5 — Production cast iron engine block modified for off-road competition.

Aluminum Bow Tie Block

Chevrolet Special Products has developed a heavy-duty aluminum Bow Tie V6/60 cylinder block that offers greater durability, lighter weight, and more displacement options than production cylinder cases. These heavy-duty V6/60 cylinder blocks are suitable for competition engines with displacements ranging from 2.5 to 3.0-liters, depending on the bore and stroke dimensions selected by the engine builder.

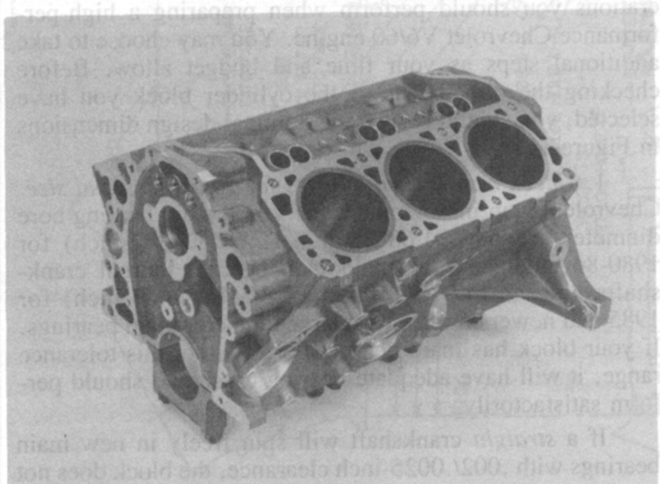

Figure 6 — Heavy-duty Bow Tie aluminum cylinder block.

The aluminum Bow Tie V6/60 cylinder block (*part number 10051141*) is recommended for all maximum-effort competition engines. A bare aluminum Bow Tie block (with main caps) weighs 59 pounds. This is a weight savings of 42 pounds over a front-wheel-drive production block, and 47 pounds over a rear-wheel-drive block.

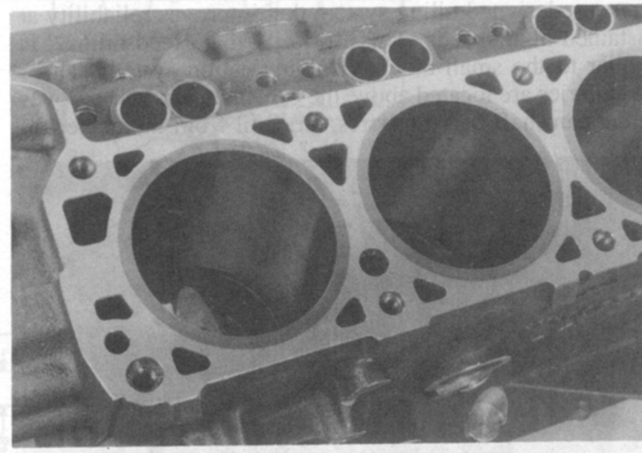

Figure 7 — Aluminum Bow Tie block has 89mm cast nodular iron cylinder liners.

The Bow Tie engine block offers outstanding durability under the stress and high loads of racing. This heavy-duty casting has extra-thick cylinder walls with dry cylinder liners. These cast nodular iron cylinder sleeves are rough-bored at the factory to 89mm (3.504-inch) diameter; they can be safely enlarged to 91mm (3.582-inch). A 3.0-liter V6/60 racing engine can be assembled by installing a production 76mm (2.99-inch) stroke crankshaft in a Bow Tie block which has been bored to 91mm.

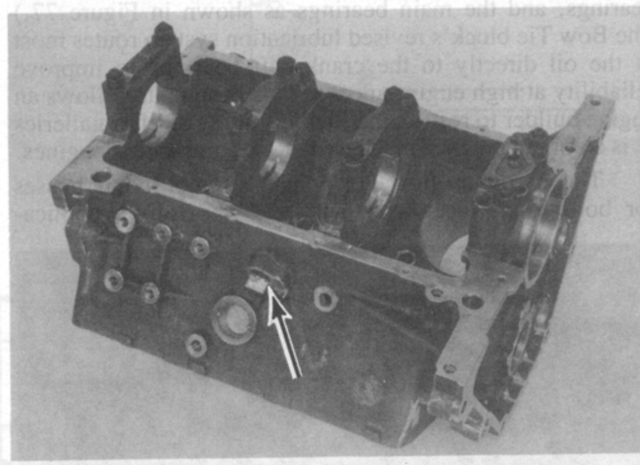

Figure 8 — Aluminum Bow Tie block accepts production ignition timing sensor (arrow). Starter can be mounted on either side of case.

The heavy-duty Bow Tie block has reinforced head bolt bosses that improve cylinder sealing with high compression ratios. The main bearing bulkheads are thicker than production blocks to increase bottom end strength. Cast iron front and rear caps and billet steel intermediate caps are installed at the factory. The four-bolt intermediate main bearing caps (numbers 2 and 3) have angled outer studs which provide additional bearing support. High-strength 11mm main bearing cap studs are supplied with the Bow Tie block. (Individual caps and studs are available as service parts; see the heavy-duty parts list at the end of this chapter for applicable part numbers.)

The heavy-duty aluminum Bow Tie V6/60 block features a redesigned oiling system that improves reliability at sustained high speeds. This "priority main feed oiling" is similar to the small-block V8's lubrication system. Three oil galleries are located above the camshaft; annular grooves in the camshaft bearing bores carry oil from the center oil

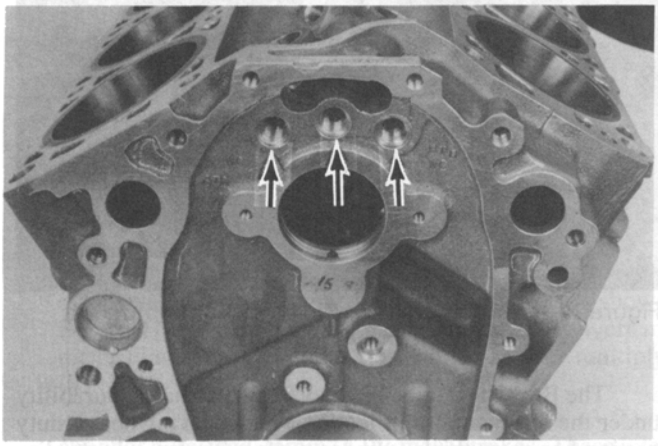

Figure 9 — Aluminum Bow Tie has V8-style oiling; center gallery feeds camshaft and crankshaft bearings.

gallery to the main bearing saddles. (Production V6/60 blocks have only two oil galleries above the camshaft. The large left side lifter oil gallery feeds the lifters, the camshaft bearings, and the main bearings as shown in Figure 77.) The Bow Tie block's revised lubrication system routes most of the oil directly to the crankshaft bearings to improve reliability at high engine speeds. This design also allows an engine builder to restrict the flow of oil to the lifter galleries as is common practice in Chevrolet V8 competition engines.

The aluminum Bow Tie block has motor mount bosses for both front-wheel-drive and rear-wheel-drive applica-

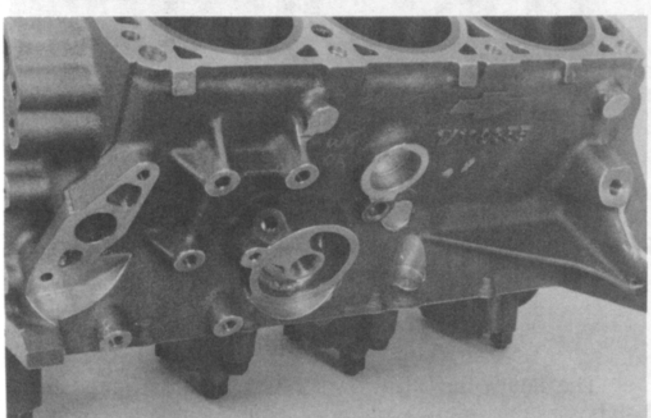

Figure 10 — Aluminum block is cast with front-wheel-drive and rear-wheel-drive motor mount bosses. Note production mechanical fuel pump mount. Oil filter bypass is deleted from oil filter pad.

tions. The starter motor can be mounted on either side of the block to accommodate a variety of chassis configurations. Aluminum blocks also have provisions for production ignition timing sensors, coil packs, and mechanical fuel pumps. The oil filter bypass spring is deleted from the oil filter pad.

Normal block preparation procedures should be followed when assembling an aluminum engine. Due to the block material, it is recommended that studs be used in place of bolts on aluminum engines. Clearances, torques, and other specifications which are peculiar to the aluminum case are shown at the end of the V6/60 engine section.

V6/60 BLOCK PREPARATION

Whether you are starting with a new or used cylinder block, the casting should meet several basic requirements. It should be clean and free of cracks. It should have reasonably straight and round cylinder bores and main bearing bores. The main bearing caps should fit tightly into their notches in the block. If a block meets these minimum standards, the following basic preparations should be performed: cleaning, boring (if required), honing, decking (to establish the piston top-to-cylinder head clearance), and checking of the main bearing bores for out-of-round conditions and alignment from one end of the block to the other.

Beyond these basic procedures, many engine builders perform additional operations limited only by time and expense to insure that the cylinder block is as close to perfect as possible in all respects. These additional operations include special acid cleaning processes to remove traces of core sand, painting the block inside and out, bottom tapping and thread chasing all bolt holes, machining of all extraneous casting projections to reduce weight, and sonic testing of cylinder walls to determine if they are of uniform thickness. Other procedures commonly performed by conscientious engine builders include Magnaflux inspection of the block to detect cracks, replacement of main bearing and cylinder head bolts with studs, chamfering of all tapped bolt holes, and deburring of all surfaces and edges. These operations are described in detail in the basic engine building chapter of this manual.

The procedures outlined below are the minimum operations you should perform when preparing a high-performance Chevrolet V6/60 engine. You may choose to take additional steps as your time and budget allow. Before checking the dimensions of the cylinder block you have selected, you should review the nominal design dimensions in Figure 11.

1. *Check main bearing bores for roundness and size.* Chevrolet blueprint tolerances for V6/60 main bearing bore diameter are 68.274/68.250mm (2.688/2.687-inch) for 1980-84 engines with small main bearing journal crankshafts and 72.147/72.150mm (2.8404/2.8406-inch) for 1985 and newer engines with large diameter main bearings. If your block has main bearing bores within this tolerance range, it will have adequate bearing crush and should perform satisfactorily.

If a *straight* crankshaft will spin freely in new main bearings with .002/.0025-inch clearance, the block does not need to be align bored. The main bearing saddles can also be checked for alignment using a machinist's straight edge and a .0015-inch feeler gauge. With the straight edge in

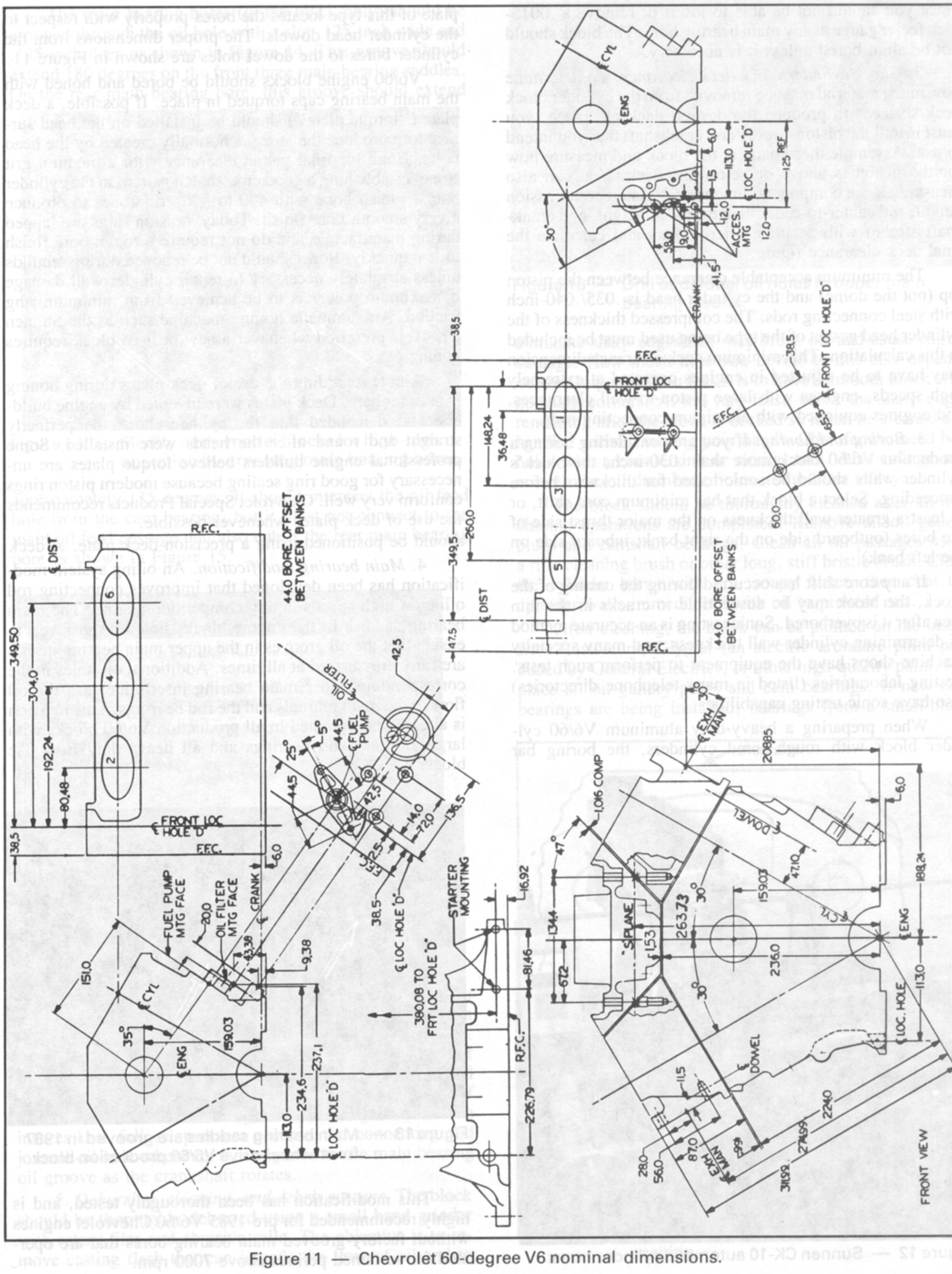

Figure 11 — Chevrolet 60-degree V6 nominal dimensions.

place you should not be able to insert or remove a .0015-inch feeler gauge at any main bearing bore. The block should not be align bored unless it is necessary.

2. *Check cylinder block deck clearance.* To determine how much material must be removed from the cylinder block deck surfaces to produce the desired deck clearance, you must install the pistons, rods, and crankshaft that you intend to use. Assemble these parts in the block and measure how far the piston is above or below the deck. You can also measure all the component dimensions (piston compression height, rod center-to-center length, block height, and crankshaft stroke) with accurate micrometers and calculate the final deck clearance figure.

The minimum acceptable clearance between the piston top (not the dome) and the cylinder head is .035/.040-inch with steel connecting rods. The compressed thickness of the cylinder head gasket of the type being used must be included in this calculation. This minimum deck clearance dimension may have to be adjusted in engines operated at extremely high speeds, engines with large piston-to-wall clearances, and engines equipped with aluminum connecting rods.

3. *Boring and honing.* If you are considering boring a production V6/60 block more than .030-inch, the block's cylinder walls should be sonic tested for thickness before proceeding. Select a block that has minimum core shift, or at least a greater wall thickness on the major thrust side of the bores (outboard side on the right bank, inboard side on the left bank).

If any core shift has occurred during the casting of the block, the block may be susceptible to cracks in the thin area after it is overbored. Sonic testing is an accurate method of determining cylinder wall thickness, and many specialty machine shops have the equipment to perform such tests. Testing laboratories (listed in many telephone directories) also have sonic testing capabilities.

When preparing a heavy-duty aluminum V6/60 cylinder block with rough-bored cylinders, the boring bar

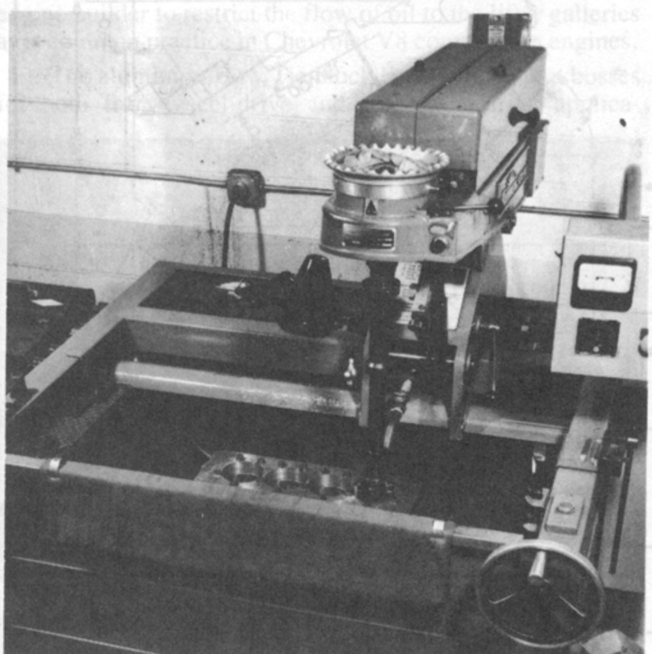

Figure 12 — Sunnen CK-10 automatic cylinder hone.

plate of this type locates the bores properly with respect to the cylinder head dowels. The proper dimensions from the cylinder bores to the dowel holes are shown in Figure 11.

V6/60 engine blocks should be bored and honed with the main bearing caps torqued in place. If possible, a deck plate (''torque plate'') should be installed on the head surface to reproduce the stresses normally created by the head bolts. Hone for final piston clearance with a medium grit stone, establishing a good cross-hatch pattern in the cylinder bores. Finish hone with 400 to 500 grit stones to produce a very smooth bore finish. Today's piston rings are lapped during manufacture and do not require a rough bore finish to seat quickly. Bores should not be rehoned during rebuilds unless absolutely necessary to repair cylinder wall damage if maximum power is to be achieved from minimum ring friction. An automatic honing machine such as the Sunnen CK-10 is preferred whenever a new or used block requires honing.

A note regarding the use of deck plates during honing is in order here. Deck plates were invented by engine builders who demanded that the cylinder bores be perfectly straight and round after the heads were installed. Some professional engine builders believe torque plates are unnecessary for good ring sealing because modern piston rings conform very well. Chevrolet Special Products recommends the use of deck plates whenever possible.

should be positioned using a precision deck plate. A deck

4. *Main bearing modification.* An oiling system modification has been developed that improves connecting rod oiling at high speeds in any competition engine. The main bearing saddles in the engine block should be grooved to ensure that the oil grooves in the upper main bearing inserts are fully pressurized at all times. Additional oil holes in the corresponding upper main bearing inserts increase the oil flow to the main journals and the rod bearings. This revision is already incorporated in all production V6/60 blocks with large journal main bearings and all heavy-duty Bow Tie blocks.

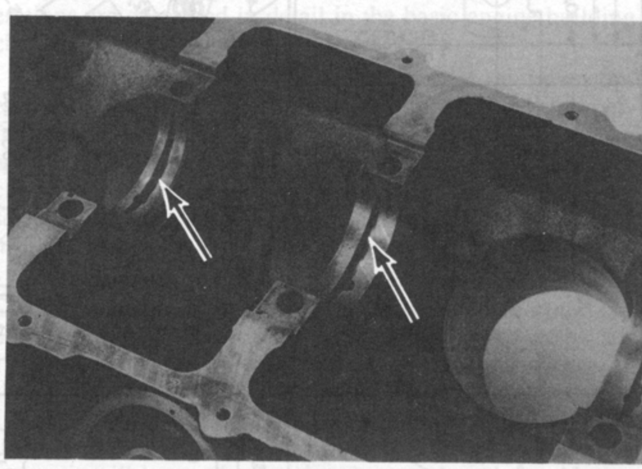

Figure 13 — Main bearing saddles are grooved in 1987 front-wheel-drive V6/60 production block.

This modification has been thoroughly tested, and is highly recommended for pre-1985 V6/60 Chevrolet engines without factory-grooved main bearing bores that are operated for sustained periods above 7000 rpm.

The main bearing bores (in the block only) should be grooved through the oil hole with a slot .125-inch wide and .125-inch deep as shown in Figure 14. This groove should extend 180 degrees on the front three main bearing saddles. On the rear main bearing bore, this groove should extend

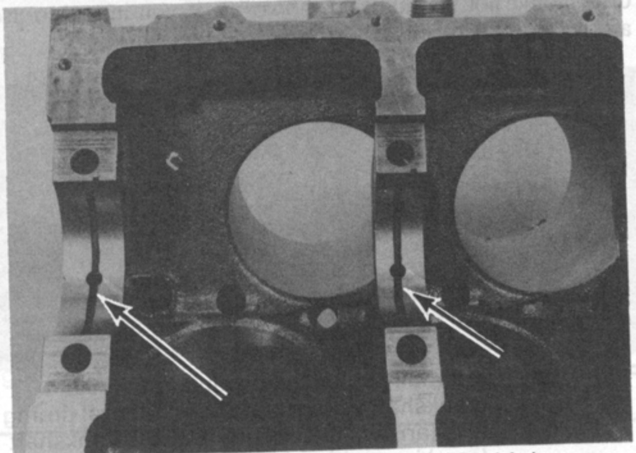

Figure 14 — Modify early-model blocks for high-rpm operation by grooving main bearing bores.

approximately 135 degrees. It should intersect the oil feed hole from the cam bearing, but it must not connect to the main oil feed passage that also enters the rear main bearing bore as shown in Figure 15.

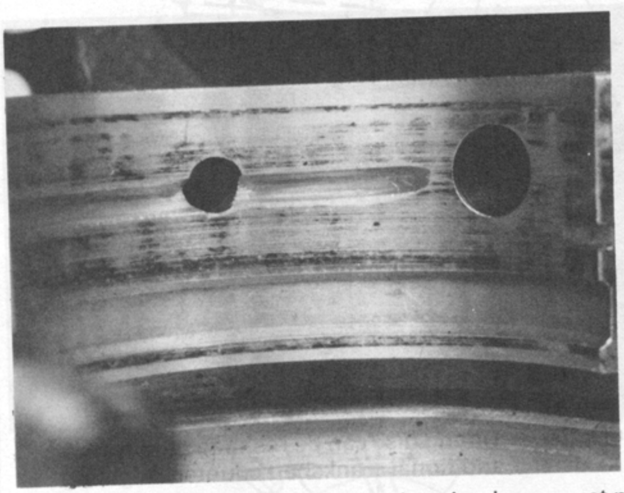

Figure 15 — Groove in rear main bearing bore must not intersect large oil feed passage.

Modify the upper main bearing inserts by drilling two equally spaced .125-inch diameter oil feed holes on both sides of the original oil hole. (On the rear main bearing, drill only one hole where the groove in the block does not extend up to the bearing cap mating surface). This will produce a total of five oil holes in each upper bearing half (four holes in the rear bearing). This bearing modification insures that full oil pressure reaches the connecting rod journal oil hole whenever it is exposed to the main bearing oil groove as the crankshaft rotates.

5. *Deburring, cleaning, and debris screens.* The block should be thoroughly deburred using a small hand grinder with rotary files and abrasive rolls. The objective is to remove casting flash that can impede the flow of oil and to

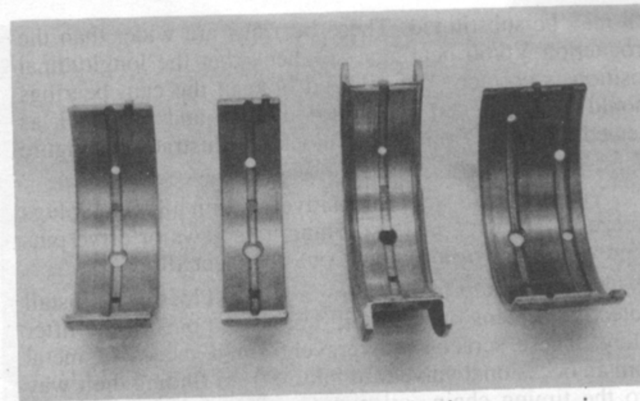

Figure 16 — Drill additional oil holes in upper main bearing inserts.

eliminate sharp edges that may break off and cause engine damage. How much time you devote to this task depends on how important you feel it is to have a smooth block with no sharp corners. At the very least, break the sharp edges remaining after the block is decked so it can be cleaned and handled without cutting your hands. Chamfer the head bolt holes with a countersink or similar tool. Also enlarge and smooth the oil drainback holes in the lifter valley.

The block should be thoroughly cleaned after all machining operations are completed. Remove all oil gallery plugs and camshaft bearings. Clean all oil passages using a rifle cleaning brush or other long, stiff bristle brush. Clean the cylinder bores with hot, soapy water, then coat the cylinder walls immediately with oil to prevent rust.

After cleaning, the block can be painted on the inside with Rustoleum, Glyptal (an electric armature paint produced by General Electric), or other high-quality paint. Replace all oil gallery plugs and cam bearings. If new cam bearings are being installed, bearings from a small-block

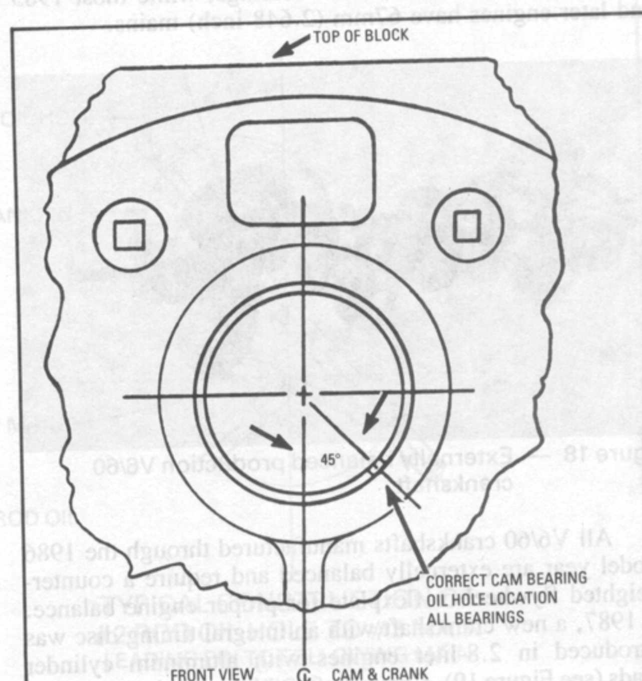

Figure 17 — Recommended cam bearing oil hole position.

V8 may be substituted. These bearings are wider than the production V6/60 bearings, so check that the longitudinal position is correct. The oil feed hole in the cam bearings should be positioned between 4 o'clock and 5 o'clock as viewed from the front of the block as illustrated in Figure 17.

You may also want to positively retain all welch plugs (freeze plugs) with small self-tapping screws or drive pins to prevent them from coming out unexpectedly.

The final step in preparing a V6/60 block is to install protective screens over the oil drainback holes in the lifter valley. These screens will prevent small pieces of metal from an occasional valvetrain failure from finding their way into the timing chain, oil pump, or crankshaft assembly. Any fine wire screen can be cut and shaped to conform to the oil drainback holes; stainless steel screen is preferred. Glue the screens in place with good quality epoxy after carefully cleaning the block surface to insure a good bond.

It is also a good idea to epoxy small magnets near the cylinder head oil drainback holes to catch small metal particles which have worn off the valve springs and shims. These particles are largely responsible for the cylinder bore scratching that occurs in high-performance engines.

CRANKSHAFT

All production V6/60 crankshafts are cast nodular iron. The six crankpins and the center main bearing journals have deep rolled fillets that increase the crankshaft's fatigue life. The standard stroke dimension for all 2.8-liter engines is 76mm (2.99-inch).

As noted in the engine block section, crankshafts with two different main journal diameters have been installed in Chevrolet V6/60 engines. Engines produced in 1980-84 have 63mm (2.494-inch) main bearings, while most 1985 and later engines have 67mm (2.648-inch) mains.

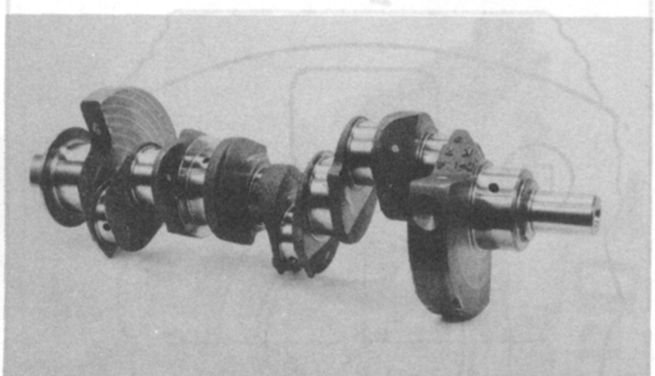

Figure 18 — Externally balanced production V6/60 crankshaft.

All V6/60 crankshafts manufactured through the 1986 model year are externally balanced and require a counter-weighted flywheel or flexplate for proper engine balance. In 1987, a new crankshaft with an integral timing disc was introduced in 2.8-liter engines with aluminum cylinder heads (see Figure 19). *Crankshafts with integral timing discs are internally balanced, and do not require a counter-weighted flywheel.*

This slotted timing disc provides reference signals for an electronic control module in the ignition coil assembly in production front-wheel-drive applications. The timing disc can be recontoured as shown in Figure 20 to serve as a crankshaft counterweight in V6/60 racing engines. The disc should not be modified, however, if you intend to use a block-mounted sensor to trigger the ignition.

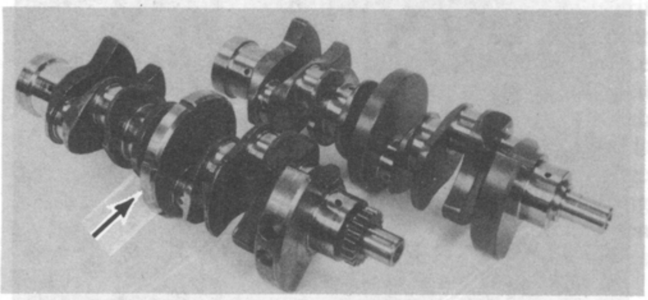

Figure 19 — Internally balanced production V6/60 crankshaft (foreground) has integral timing disc (arrow). Competition V6/60 crankshaft (rear) is machined from steel billet.

Production V6/60 nodular iron crankshafts with 67mm main bearings are extremely durable and have performed without failure in many racing applications. Only minor modifications are required to prepare a stock crank for competition.

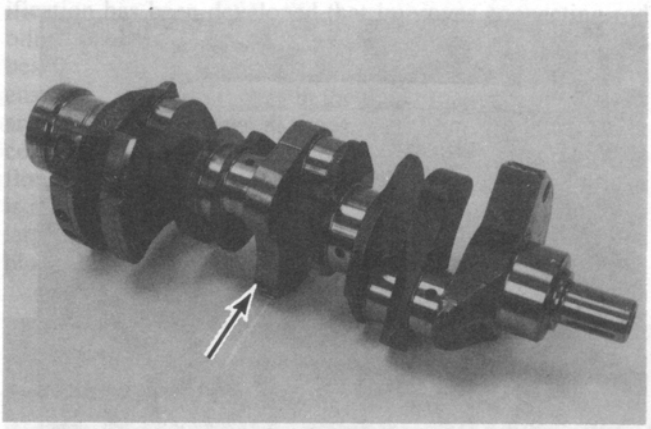

Figure 20 — Timing disc can be reshaped to provide additional crankshaft counterweighting.

A production V6/60 crankshaft should be Magnaflux inspected for cracks before installation. Deburr the casting to eliminate stress risers. To check crankshaft straightness, support the crankshaft in Vee blocks (or in the cylinder case with only the front and rear bearings installed). Set up a dial indicator on the number 2 and 3 main journals and slowly rotate the crankshaft. The main journals should have less than .003-inch runout.

Chevrolet Special Products strongly recommends cross-drilling the center two main bearing journals on all V6/60 crankshafts used in competition engines. This modification provides additional oil flow to the connecting rod bearings at high engine rpm. You can cross-drill a crankshaft yourself with a proper drilling fixture, or most reputable crankshaft specialty shops can do it for you. A typical cross-drilled main journal is illustrated in Figure 22. After drilling

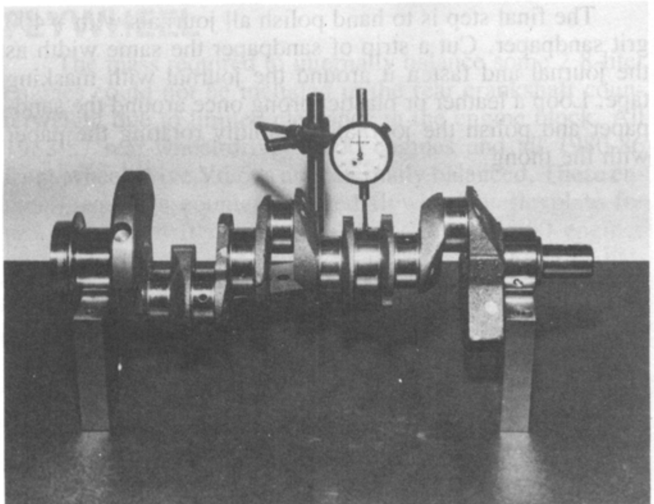

Figure 21 — Check crankshaft straightness with dial indicator.

Figure 23 — Production V6/60 crankshaft with cross-drilled main bearing journals.

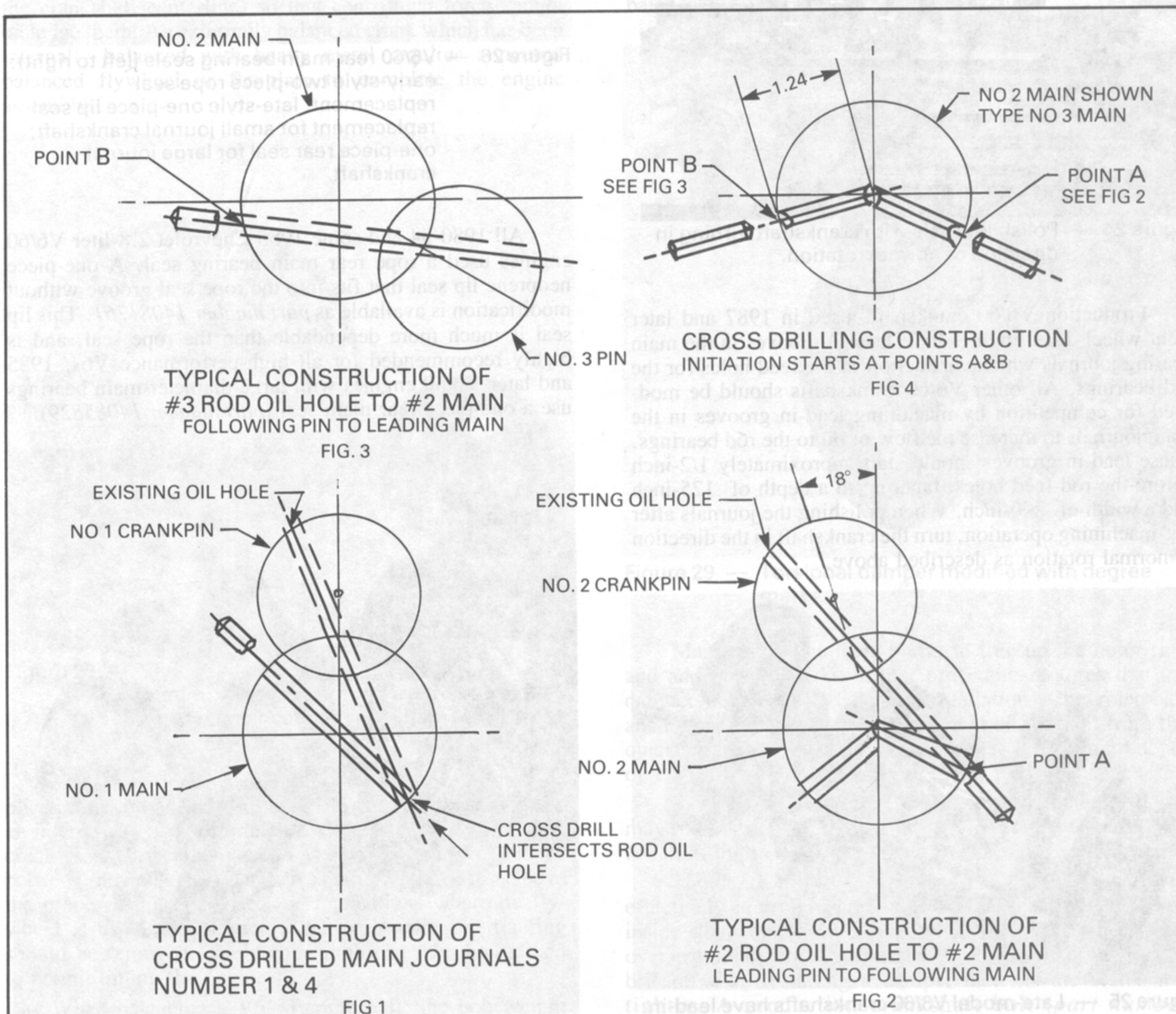

Figure 22 — Main bearing journal cross drilling.

the journals, inspect all oil holes for metal chips and chamfer and deburr the holes at the bearing surfaces.

If you regrind a production nodular iron V6/60 crankshaft, it *must* be thoroughly polished in a lathe, *turning the crankshaft in the direction of engine rotation.* Polishing the crankshaft in this manner causes any microscopic peaks of metal which are formed when material is torn away during the grinding process to point away from the bearing and not into the soft overlay. Removing these microscopic "fish scales" by polishing a reground crankshaft while it is turning in its normal direction of rotation is absolutely essential to prevent premature main and rod bearing failure.

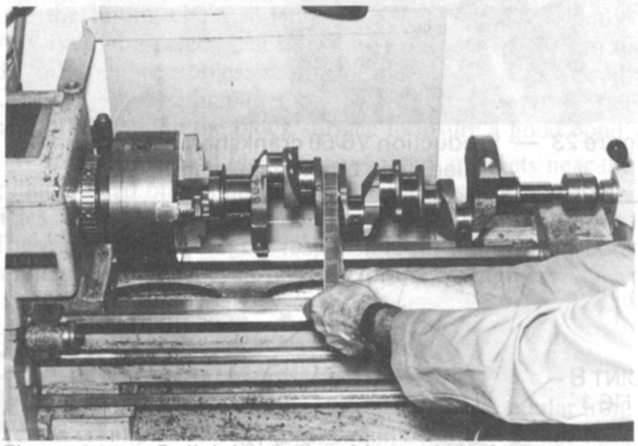

Figure 24 — Polish journals with crankshaft turning in direction of normal rotation.

Production V6/60 crankshafts used in 1987 and later front-wheel-drive engines have lead-in grooves in the main bearing journals which channel oil to the feed holes for the rod bearings. All other V6/60 crankshafts should be modified for competition by machining lead-in grooves in the main journals to increase the flow of oil to the rod bearings. These lead-in grooves should start approximately 1/2-inch before the rod feed holes, tapering to a depth of .125-inch and a width of .200-inch. When polishing the journals after this machining operation, turn the crankshaft in the direction of normal rotation as described above.

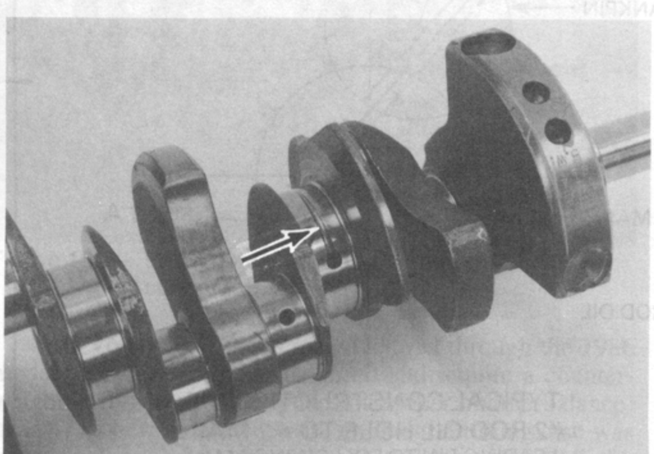

Figure 25 — Late-model V6/60 crankshafts have lead-in grooves in main bearing journals to channel oil to rod bearing oil feed holes.

The final step is to hand polish all journals with #400 grit sandpaper. Cut a strip of sandpaper the same width as the journal and fasten it around the journal with masking tape. Loop a leather or plastic throng once around the sandpaper and polish the journal by rapidly rotating the paper with the thong.

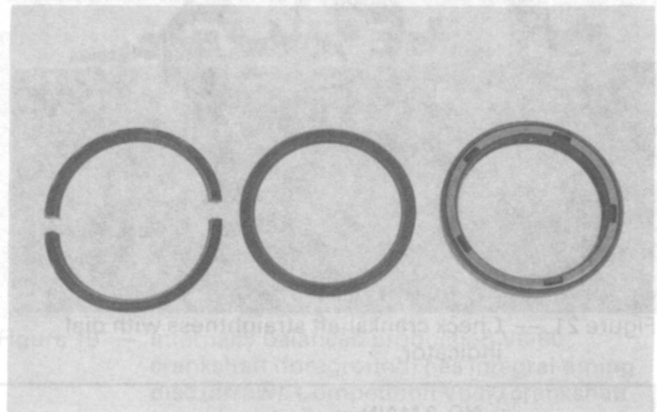

Figure 26 — V6/60 rear main bearing seals (left to right): early-style two-piece rope seal replacement; late-style one-piece lip seal replacement for small journal crankshaft; one-piece rear seal for large journal crankshaft.

All 1980-84 and some 1985 Chevrolet 2.8-liter V6/60 engines used a rope rear main bearing seal. A one-piece neoprene lip seal that fits into the rope seal groove without modification is available as *part number 14081761*. This lip seal is much more dependable than the rope seal, and is highly recommended for all high-performance V6s. 1985 and later V6/60 engines with large diameter main bearings use a one-piece rear main seal (*part number 14085829*).

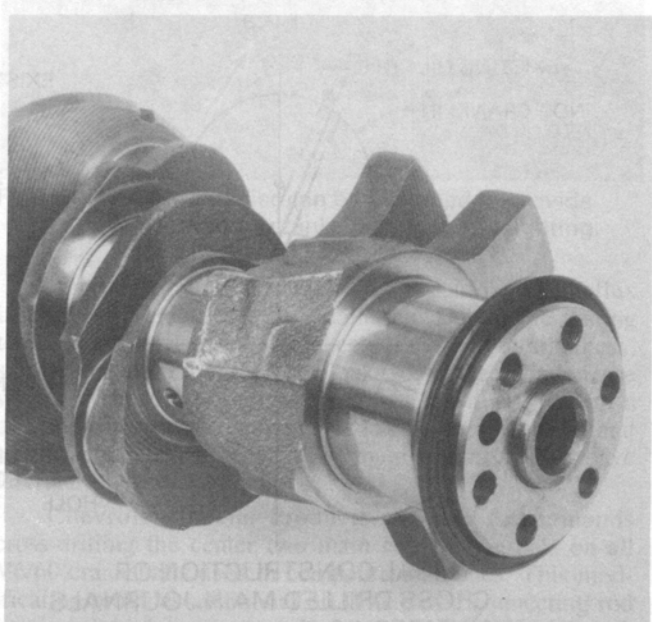

Figure 27 — Large journal crankshaft flywheel flange and one-piece rear seal.

FLYWHEEL

The mass required to internally balance some 2.8-liter engines could not be included in the rear crankshaft counterweight due to limited clearance in the engine block. All 1982-87 rear-wheel-drive V6/60 engines and all 1980-86 front-wheel-drive V6/60s are externally balanced. These engines require a counterweighted flywheel or flexplate for proper crankshaft balance. 1987 and later V6/60 engines installed in front-wheel-drive vehicles are internally balanced, and use neutral balanced flywheels.

The flywheel or flexplate and its counterweight is an integral part of the balance system in externally balanced V6/60 engines. If an externally balanced crankshaft is rebalanced, or if your particular application requires a special flywheel or flexplate, these components must be balanced with the crankshaft. Alternatively, an externally balanced crankshaft can be internally balanced by adding slugs of heavy metal to its rear counterweight. It is very important that these slugs of metal be located horizontally (parallel to the crankshaft centerline) so that centrifugal force cannot dislodge them. An externally balanced crank which has been internally balanced with heavy metal requires a neutral balanced flywheel or flexplate to complete the engine assembly.

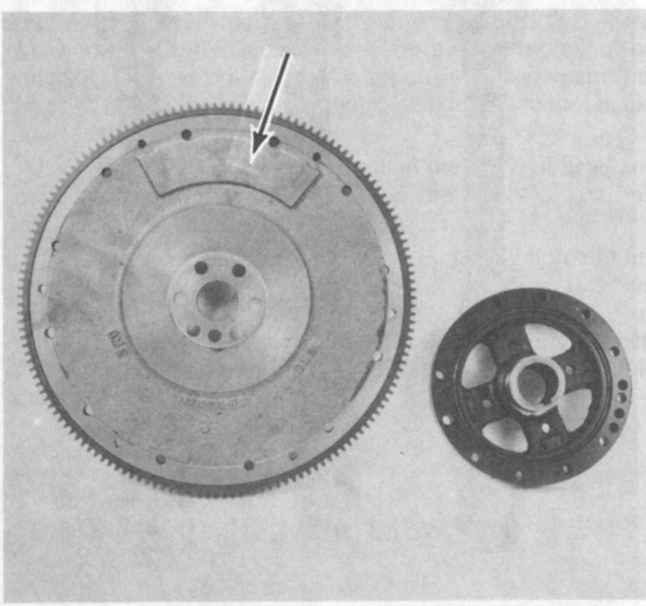

Figure 28 — Externally balanced V6/60 crankshafts require counterweighted flywheel and neutral balanced torsional damper.

V6/60 engines used in midget race cars and other applications which do not normally use a flywheel should use an internally balanced crankshaft. If an internally balanced crank is not available, a bob weight can be sandwiched between the crankshaft and driveshaft connector to achieve the proper engine balance. (In applications where no flywheel is used, the harmonic damper's outer inertia ring should be removed. The damper hub can then be marked to permit timing the engine.)

When balancing a V6/60 crankshaft, the bob weight should be calculated using 50 percent of the engine reciprocating weight and 100 percent of the rotating weight.

TORSIONAL DAMPER

Torsional damper requirements for any high-performance engine vary with the engine's duty cycle. Engines used in drag racing and short track competition frequently operate without torsional dampers (sometimes called "harmonic balancers") with no apparent ill effects. In these engines' duty cycles, the engine rpm changes frequently and rapidly. This reduces the length of time that the crankshaft vibrates at its natural frequency and consequently diminishes the need for a torsional damper. Engines used in endurance racing typically operate at a much slower rate of change in engine speed. This increases the length of time that the crankshaft may operate near its natural frequency, and may require a torsional damper to prevent crankshaft breakage due to high torsional vibrations.

All Chevrolet V6/60 torsional dampers are a two-piece design, with an inner hub pressed onto the crank snout and a separate outer inertia ring. All V6/60 torsional dampers are neutral balanced, and may be used with either internally balanced or externally balanced crankshafts.

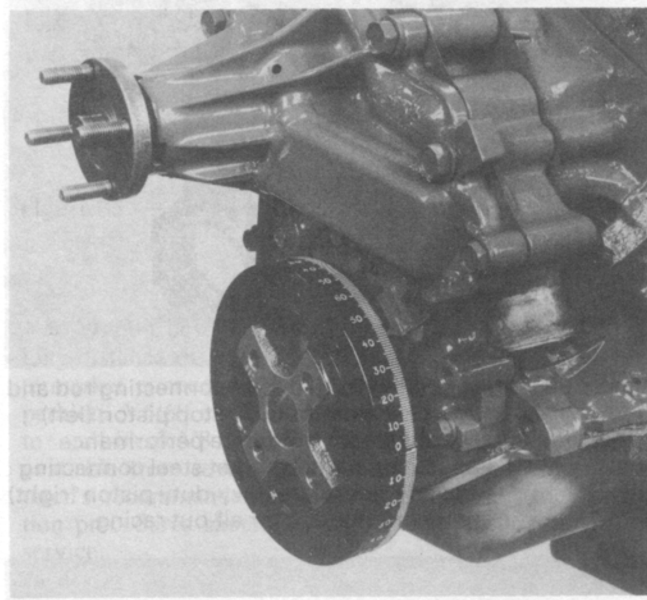

Figure 29 — Torsional damper modified with degree marks.

Many engine builders prefer to true up the outer ring and add degree marks. Either procedure requires that the damper be rebalanced before installation. Chevrolet balancing specifications call for removal of material from the outer inertia ring with a 1/2-inch drill to a maximum depth of 1/4-inch.

Warning: Balance holes of greater diameter or depth may seriously weaken the damper and cause the inertia ring to fail at high engine speed.

The damper must fit tightly on the crankshaft snout to effectively control the crankshaft's torsional vibrations. The inside diameter of the damper hub should *not* be honed oversize; automatic transmission fluid can be used as a lubricant when installing a damper that fits the crankshaft tightly. A production crankshaft bolt (*part number 14001828*) should be used to positively retain the damper on the crank snout.

CONNECTING RODS

All V6/60 production connecting rods are manufactured from forged steel and heat-treated at the factory. The center-to-center length of all V6/60 connecting rods is 5.700-inch, and the big end bore diameter is 2.1247/2.1252-inch. These connecting rods are suitable for high-performance and limited competition applications where engine speeds do not exceed 7000 rpm.

If you are building a competition V6/60 Chevrolet on a limited budget, engine durability can be improved by installing production connecting rods used in 1967 and earlier small-block Chevrolet V8s. Although some machining is required for this conversion, the total expense is typically less than the cost of aftermarket connecting rods. These "small journal" V8 rods (*part number 3864881*) have the same center-to-center length (5.700-inch) and the same rod bearing ID as production V6/60 rods. The V8 rods have wider, thicker beams than stock V6/60 rods, and use 11/32-inch bolts instead of the V6's 9mm (.354-inch) fasteners.

One important difference between V6/60 and small-block V8 connecting rods is the diameter of their wrist pin holes. V6 rods have .912-inch diameter pin bores; V8 rods have .927-inch wrist pin holes. In order to use V8 rods with stock or heavy-duty Chevrolet V6/60 pistons, the small ends of the V8 rods must be bushed to fit the V6 wrist pins. (If aftermarket pistons are ordered with .927-inch diameter wrist pins, the small-block rods will not require bushings.) The big ends of the V8 rods must also be narrowed from .940-inch wide to .854-inch wide to fit the V6/60 crankshaft journals. Machine .086-inch off the side of the big end bore which is next to the crankshaft cheek in a V8 installation. Then machine new bearing tang notches in the rod, taking care to center the bearing insert on the rod journal.

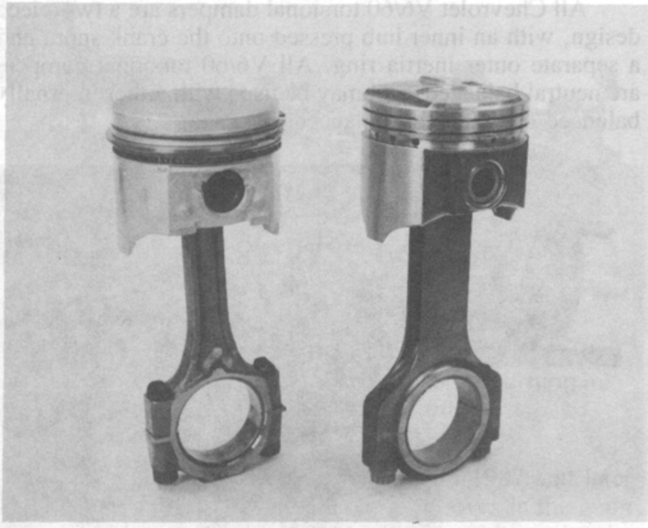

Figure 30 — Production forged steel connecting rod and stock cast aluminum flat-top piston (left) are suitable for moderate performance applications. Aftermarket steel connecting rod and Chevrolet heavy-duty piston (right) are recommended for all-out racing.

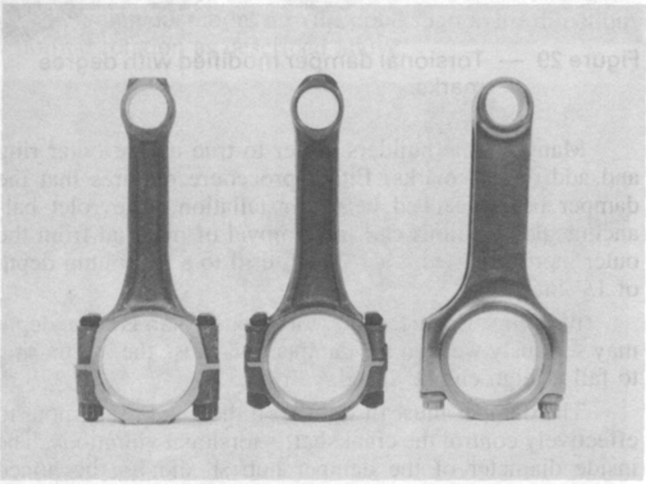

Figure 31 — Production forged steel rod (left) has 9mm bolts; small-block V8 rod (center) can be modified to fit V6/60 crank; aftermarket connecting rod (right) improves engine reliability in endurance racing.

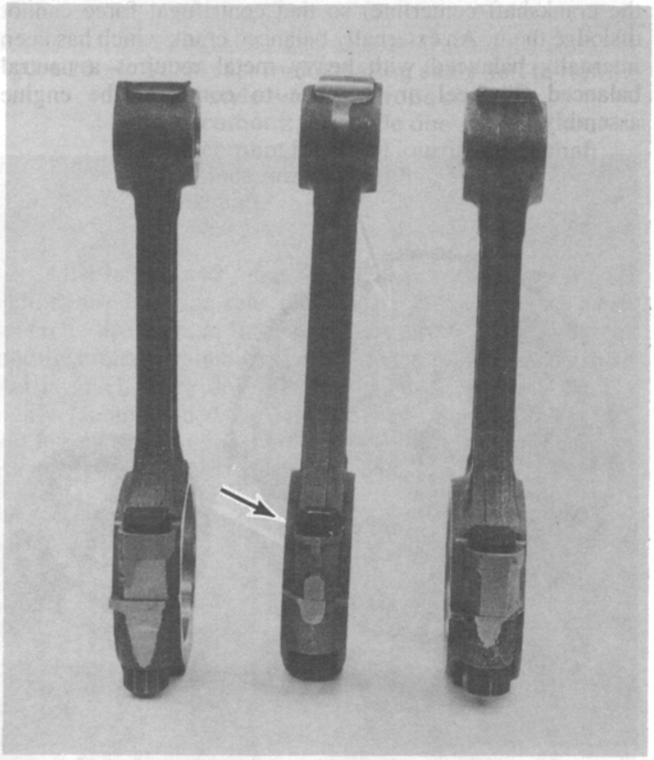

Figure 32 — Lightweight production V6/60 rod (left) is reliable to 7000 rpm; small-block V8 rod (center) must be narrowed .086-inch to fit V6 crankshaft journal; stock small-block V8 rod (right) has same rod bearing bore and center-to-center length as V6/60 rod.

All production connecting rods, bolts, and nuts should be Magnaflux inspected before installation. Chevrolet Special Products also strongly recommends that the connecting rod fasteners be tested with a Rockwell hardness tester. A hardness test is generally a reliable indication of whether the bolts will pull up to the proper torque. Production bolts are in the range of 36-40 on the Rockwell "C" scale. Bolts that do not fall within this hardness range should not be used.

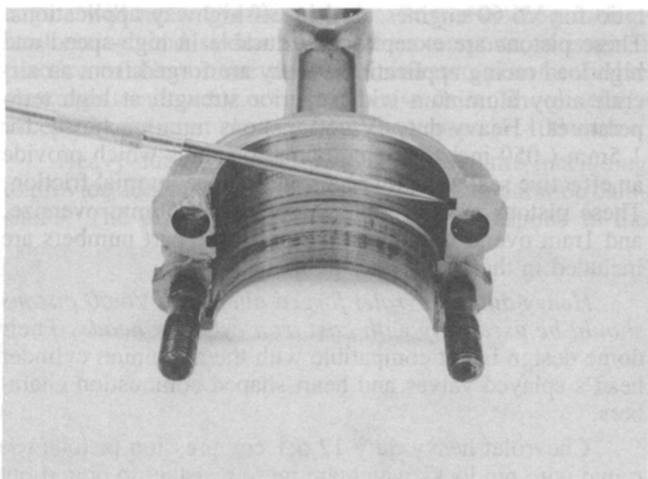

Figure 33 — Machine new bearing tang groove in modified small-block V8 rod to center bearing insert on rod journal.

The following procedures are recommended to improve the durability of Chevrolet production connecting rods used in high-performance engines:

1. Round all sharp edges from the beam section of the rod and grind off excess flash at forging parting line on sides of rod. It is not necessary to polish the rod beam, but all grinding should be done lengthwise (parallel to the shank) and finished smoothly.

2. Round all sharp edges around the rod bolt head and nut seats, and smooth any nicks in the radius of the bolt and nut seats with a small hand grinder.

3. Shotpeen entire rod and cap, including bolt and nut seats. A satisfactory shot peening specification for connecting rods is .012-.015-inch Allmen "A" arc height using #230 cast steel shot. Shotpeening in this manner compacts the surface of the metal and reduces its susceptibility to cracks.

Figure 34 — Grind off forging marks and shotpeen beam to improve durability of production rods used in high-performance V6s.

4. Qualify the big end of the connecting rod in a precision rod reconditioning machine. Bearing bore diameter should be between 2.1247 and 2.1252-inch for both production V6/60 connecting rods and small-block V8 rods modified to fit V6 engines.

5. For full-floating pins, drill a single 1/8-inch diameter hole in the top of the connecting rod to supply additional oil to the piston wrist pin. Chamfer the top of this oil hole with a countersink, and deburr the bottom where it intersects the pin bore. Hone the pin bore as necessary to produce .0008/.0010-inch wrist pin clearance. (Wrist pin clearance can be reduced to .0005/.0008-inch if the small end of the rod is bushed.)

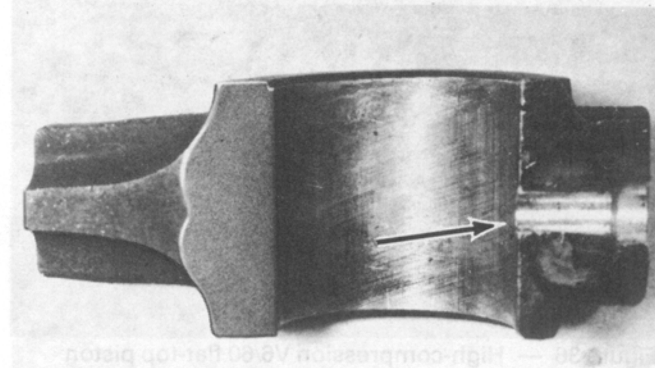

Figure 35 — Oil hole in top of connecting rod lubricates full-floating wrist pin.

V6/60 Chevrolet engines used in endurance racing and long-distance off-road events should be equipped with aftermarket connecting rods designed specifically for competition. V6/60 connecting rods are dimensionally similar to small-block V8 rods, so racing connecting rods are readily available from several aftermarket sources. The manufacturer's recommendations on bolt torque and rod installation procedures should be followed to ensure satisfactory service.

PISTONS

The true compression ratio should be a primary consideration when selecting pistons for a high-performance or racing V6/60 Chevrolet. Compression ratio is a function of the cylinder displacement, combustion chamber volume, deck clearance, and piston top design. Compression ratios that are too high for the octane rating of the available fuel will promote detonation and lead to serious engine damage. The octane rating of current pump gasoline generally limits high-performance street engines to compression ratios below 9.5:1. Raising the compression ratio in a modified engine offers a performance improvement, but high-octane gasoline and/or octane-improving additives become necessities. For all-out racing engines, Chevrolet offers high-domed pistons that will produce 12.5:1 compression. Engines with high compression ratios must be operated on high-octane racing fuels exclusively, and should be inspected frequently for evidence of detonation.

Both standard and high-output versions of the V6/60 Chevrolet equipped with cast iron cylinder heads use flat-top pistons. These cast aluminum pistons are an ''autothermic'' design which provides uniform clearances through a wide range of engine operating temperatures. Pistons installed in high-output engines have a .020-inch taller compression height than standard V6/60 pistons. This change raises the compression ratio from 8.5:1 in standard engines to 8.9:1 in high-output and fuel-injected motors. Production cast aluminum pistons with 8.5:1 compression are suitable for supercharged and turbocharged applications at moderate boost levels (8 psi or lower).

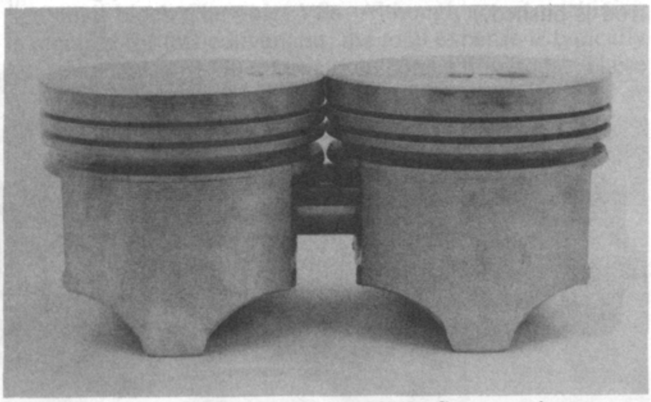

Figure 36 — High-compression V6/60 flat-top piston (right) has .020-inch taller compression height than standard piston (left).

1987 and later ''Generation II'' V6/60 Chevrolets with aluminum cylinder heads use dished pistons. This sump head design maintains an 8.9:1 compression ratio with the smaller combustion chamber volume (28cc) of the aluminum heads.

Forged pistons are preferred over cast pistons in high stress conditions because the tight grain structure and premium material of a forging provide increased strength and promote heat transfer away from the piston top. Chevrolet offers heavy-duty forged pistons with 12.5:1 compression ratio for V6/60 engines used in off-highway applications. These pistons are exceptionally durable in high-speed and high load racing applications. They are forged from an aircraft alloy aluminum with superior strength at high temperatures. Heavy-duty V6/60 pistons are machined for 1.5mm (.059-inch) wide compression rings which provide an effective seal at high speeds and reduce internal friction. These pistons are available in standard, .50mm oversize, and 1mm oversize diameters. Applicable part numbers are included in the heavy-duty parts list.

Figure 37 — Chevrolet heavy-duty 12.5:1 compression forged aluminum piston with chamfered wrist pin and round wire pin locks.

Heavy-duty Chevrolet forged aluminum V6/60 pistons should be used only with cast iron cylinder heads. Their dome design is not compatible with the aluminum cylinder head's splayed valves and heart-shaped combustion chambers.

Chevrolet heavy-duty 12.5:1 compression pistons use round wire pin locks which are more resistant to pound-out than other pin retaining systems. The full-floating wrist pins supplied with these pistons are chamfered on both ends to accommodate these round wire pin locks. Replacement 1.07-inch OD x .064-inch round wire retainers (*part number 14011033*) are available separately for overhauls and rebuilds. *Wrist pin retainers should never be reused after the engine has been run and disassembled.*

Carefully inspect all new pistons before installation, and smooth all sharp edges on the domes and skirts. When assembling pistons and rods with pressed wrist pins, the small end of the rod should be heated and the pins quickly installed using a fixture as shown in Figure 68 of the 90-degree V6 chapter. Most automotive machine shops and Chevrolet dealerships are equipped to perform this assembly. It is necessary to have at least .001-inch (preferably .0012-inch) press fit between wrist pins and rods to insure that pins will not loosen and move when the engine is running.

High-compression pistons should be checked for adequate valve-to-piston clearance by assembling one piston and rod with the other engine components (camshaft, crankshaft, rocker arms, etc.) you intend to use. Piston-to-valve clearance can be measured by laying small strips of clay across the piston dome and then turning the crankshaft at least two complete revolutions. The absolute minimum piston-to-valve clearance required to prevent engine damage is .045-inch, measured with the recommended valve lash. This minimum piston-to-valve clearance assumes that the

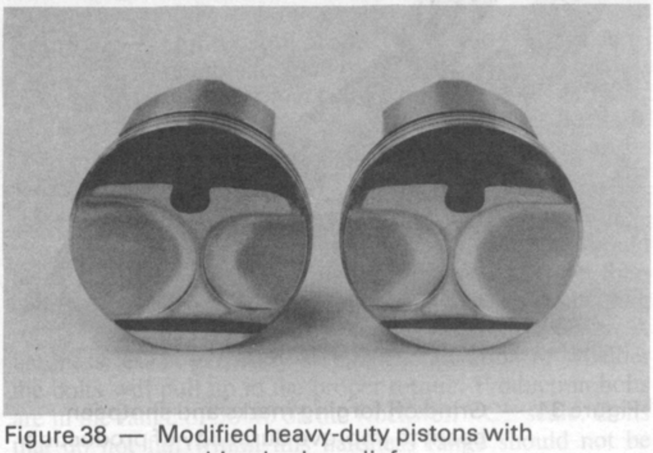

Figure 38 — Modified heavy-duty pistons with machined valve reliefs.

engine will never operate in valve float. For drag racing, road racing, and similar forms of motorsports, it is good practice to allow more than the minimum piston-to-valve clearance to allow for occasional valve float. The generally accepted minimum clearance for these uses is .100-inch.

Heavy-duty Chevrolet pistons may require machining to provide adequate valve clearance with long duration camshafts. The piston valve reliefs should correspond to the

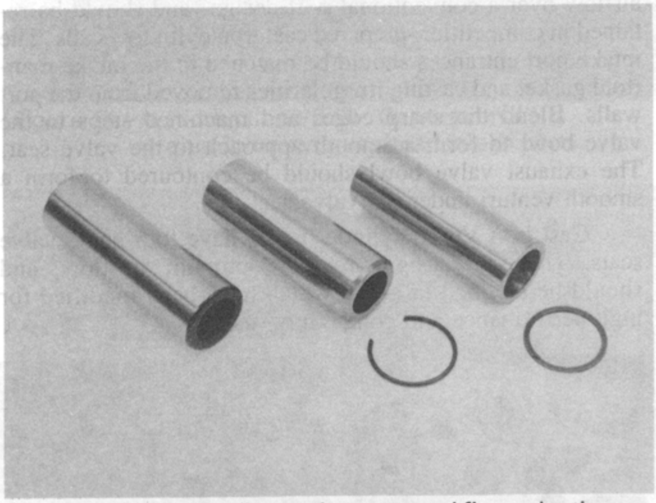

Figure 39 — V6/60 piston pins: pressed fit production wrist pin (left); Chevrolet heavy-duty pin with round wire retainers (center); aftermarket tool steel wrist pin with Spirolox retainer (right).

valve layout in the cylinder heads. A complete V6/60 piston set consists of *four* pistons with valve reliefs matching the Number 1 combustion chamber (used in cylinder numbers 1, 3, 4, and 6), and *two* pistons corresponding to the Number 2 combustion chamber's valve layout (cylinders number 2 and 5).

PISTON RINGS

Chevrolet markets high-performance piston ring sets for heavy-duty V6/60 pistons. These sets include 1.5mm (.059-inch) wide moly-filled compression rings with radiused faces. They are offered in standard, .5mm oversize, and 1mm oversize diameters for 89mm (3.50-inch) cylinder bores. Applicable part numbers are shown in the heavy-duty parts list.

In all cases the piston ring end gaps must be measured before installation with each ring square in its cylinder bore. If the end gaps are under the minimum recommended dimension (.016-inch top, .014-inch second, .014-inch oil), the end gaps must be filed to prevent ring scuffing.

Chevrolet recommends a smooth cylinder wall finish, using 400/500 grit stones for the final hone. Modern ring manufacturing techniques virtually eliminate the need for a lengthy break-in time to seat the rings. All rings are lapped in hardened steel cylinders, so rough bore finishes are no longer necessary to accomplish ring seating. Smooth cylinder bore finishes on initial build results in a significant power increase due to decreased engine internal friction. Chevrolet Special Products recommends that cylinders *not* be rehoned during rebuilds except as necessary to repair cylinder wall damage.

CYLINDER HEADS

Production V6/60 Chevrolet engines have been manufactured with both cast iron and aluminum cylinder heads. All 1980-86 front-wheel-drive and 1982-87 rear-wheel-drive V6/60 engines are equipped with cast iron cylinder heads; 1987 and later "Generation II" front-wheel-drive V6/60s have aluminum cylinder heads. Cast iron and aluminum heads are not interchangeable due to differences in the combustion chamber design and valve geometry of the two castings.

Cast Iron Cylinder Heads

Two different cast iron cylinder head assemblies have been used on production V6/60 engines. Heads installed on standard performance V6s have 1.60-inch diameter intake valves and 1.30-inch diameter exhaust valves. High-output

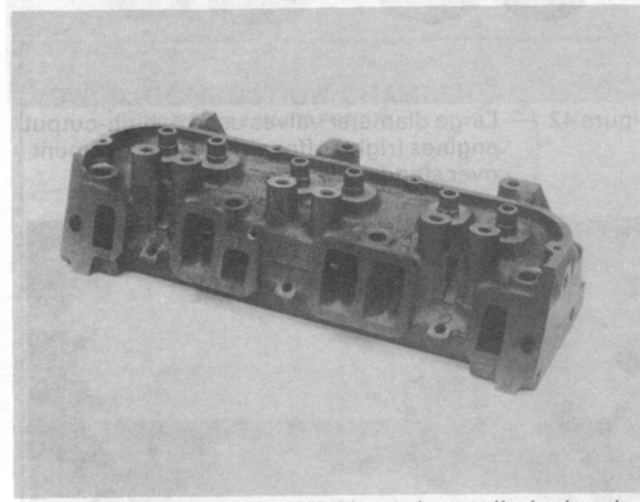

Figure 40 — Production V6/60 cast iron cylinder head.

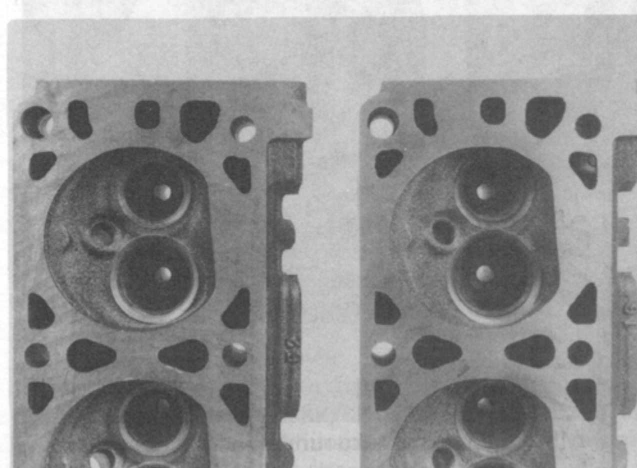

Figure 41 — Standard cast iron head (left) has 1.60/1.32-inch valves; high-output version (right) uses 1.72/1.42-inch valves.

and fuel-injected versions are equipped with 1.72-inch diameter intakes and 1.42-inch exhausts. The larger valves of the high-output cast iron cylinder head (*part number 14054879*) provide an increase in airflow over the standard head, and are preferred for high-performance and competition V6/60 engines. It should be emphasized that the only difference between the standard and high-output cast iron heads is the size of the valves; the ports and combustion chambers are the same in both cylinder heads.

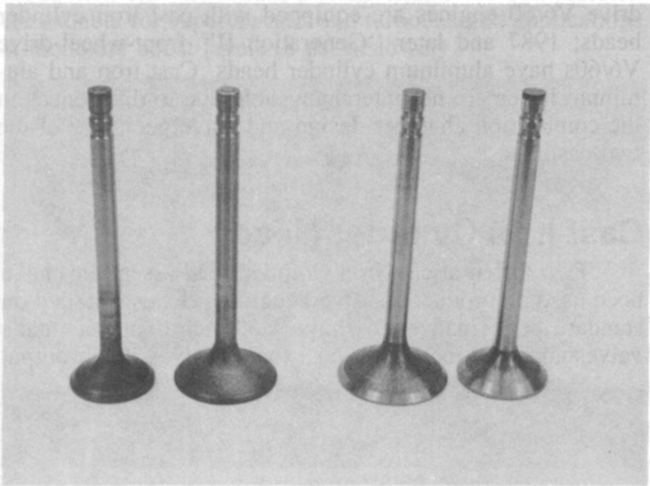

Figure 42 — Large diameter valves used in high-output engines (right) offer airflow improvement over standard valves (left).

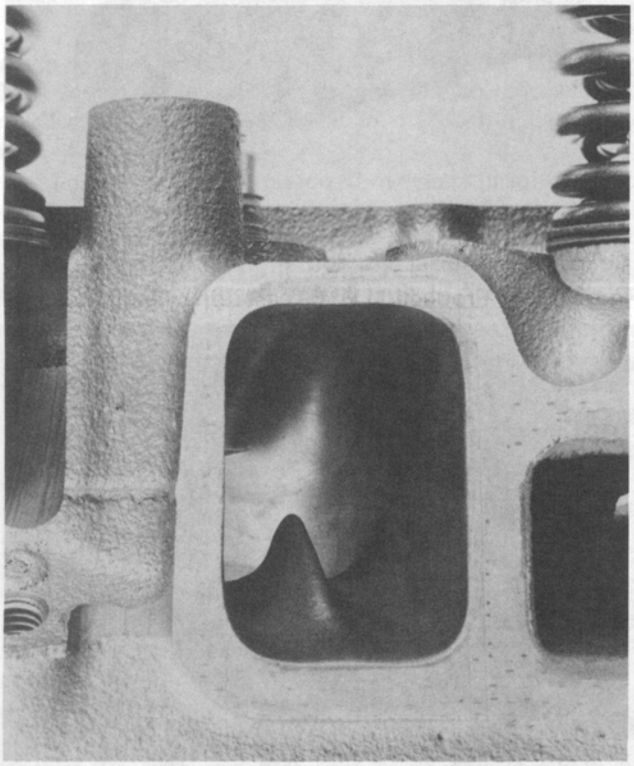

Figure 43 — Vane in intake runner increases airflow.

Cast iron V6/60 cylinder heads were designed for production applications, and extra material was not included in the port walls to allow extensive enlargement of the runners. Nevertheless, competition 2.8-liter engines with production cylinder heads are capable of producing over 1.50 horsepower-per-cubic inch with only minor port work. (Chevrolet Special Products is developing heavy-duty cylinder head castings for the 60-degree V6 which will offer a substantial increase in airflow potential.)

Production V6/60 intake runners have a ''vane'' in the port floor. This vane produced a 17 percent increase in airflow over a conventional port design, and should be retained in competition-prepared cast iron cylinder heads. The intake port entrances should be matched to the intake manifold gasket and casting irregularities removed from the port walls. Blend the sharp edges and machined steps in the valve bowl to form a smooth approach to the valve seat. The exhaust valve bowl should be contoured to form a smooth venturi under the valve seat.

Cast iron V6/60 cylinder heads have four-angle valve seats. This seat design provides optimum air flow, and should be retained in heads which have been modified for high-performance and competition use.

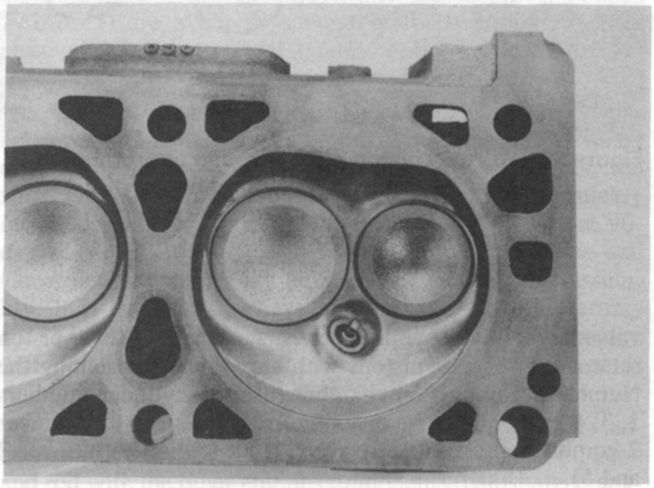

Figure 44 — Modify combustion chambers in cast iron heads to unshroud valve heads.

V6/60 cylinder heads should be milled as little as possible to prevent a mismatch between the intake manifold ports and the rocker cover gasket surface. Milling the head more than the minimum required to straighten the deck surface may reduce head gasket clamping and lead to premature gasket failure because the V6/60 has only four head bolts around each cylinder bore.

Aluminum Cylinder Heads

Lightweight aluminum cylinder heads were introduced in 1987 on ''Generation II'' 2.8-liter V6/60 engines installed in Celebrity, Corsica, Beretta, and Cavalier front-wheel-drive chassis. Chevrolet Special Products has not evaluated the potential of the aluminum V6/60 head for racing applications, and therefore has not developed recommended procedures for modifying this casting. A review of the aluminum head's features may be helpful, however, for competitors in the Midget and other classes where aluminum heads are preferred.

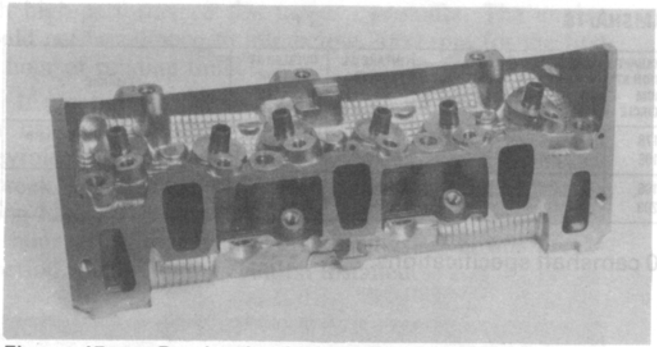

Figure 45 — Production V6/60 "Generation II" aluminum cylinder head intake ports.

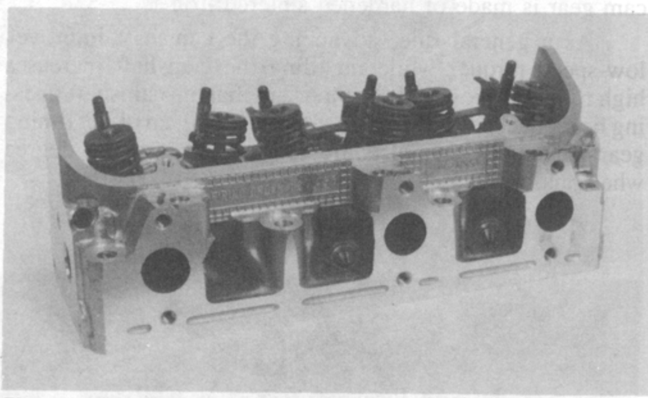

Figure 46 — Aluminum cylinder head exhaust ports.

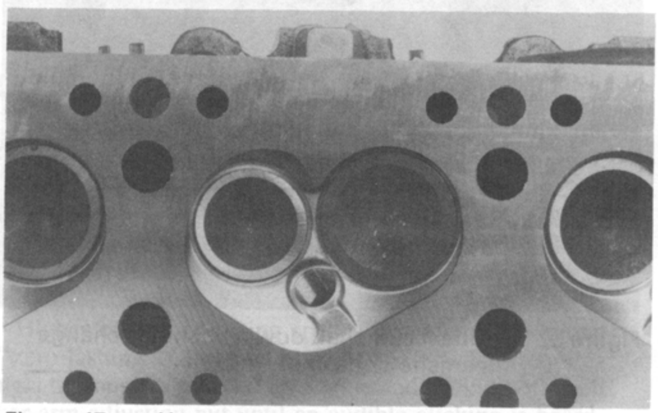

Figure 47 — Heart-shaped combustion chamber in aluminum cylinder head has 28cc volume.

Production aluminum V6/60 cylinder heads incorporate a heart-shaped "fast burn" combustion chamber with splayed valves. The size and shape of the inlet port and the shrouding around the intake valve seat direct the incoming air/fuel mixture in a concentrated stream. This stream promotes swirl in the combustion chamber and spreads the flame front quickly to all parts of the chamber. The resulting fast combustion produces a smooth but rapid rise in cylinder pressure. The spark plug is also centrally located in the combustion chamber to promote propagation of the flame front throughout the chamber.

The intake and exhaust valves are canted relative to each other and to the head's deck surface. This splayed valve design is similar to a Chevrolet Mark IV V8; it pro-

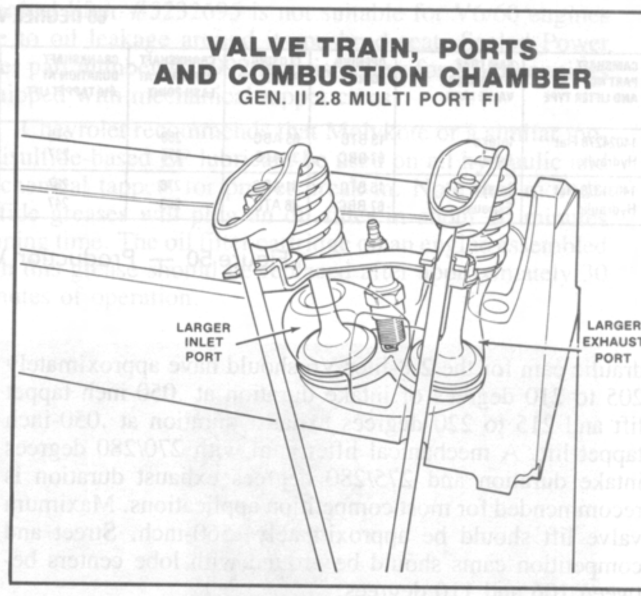

Figure 48 — Production aluminum V6/60 cylinder head has splayed valves and high-flow ports.

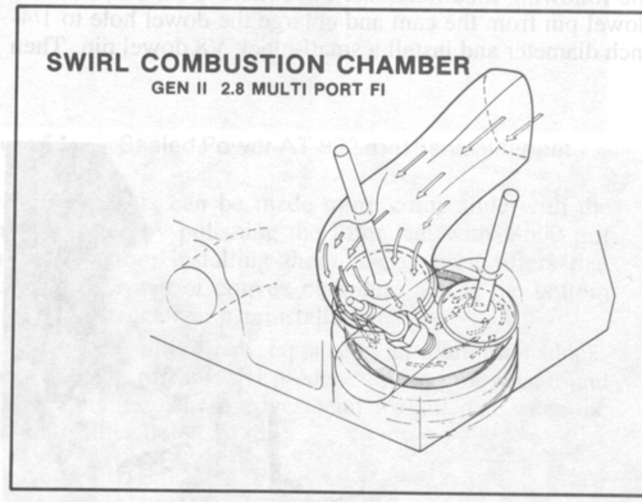

Figure 49 — Intake runners and combustion chambers are designed to promote turbulence in cylinder.

motes efficient breathing by unshrouding the valve heads as lift increases. Production aluminum V6/60 heads have 1.72-inch diameter intake valves and 1.42-inch diameter exhaust valves. Valve stem diameter is 8mm (.315-inch).

CAMSHAFT

Chevrolet offers two hydraulic tappet camshaft profiles for the V6/60 engine. Valve timing specifications for standard production and high-output camshafts are listed in the accompanying chart. Additional camshafts are under development for high-output street applications.

Several aftermarket manufacturers offer camshafts which are suitable for high-performance and competition V6/60 engines. As a general guideline, a good street hy-

60 DEGREE V-6 CAMSHAFTS

CAMSHAFT PART NO AND LIFTER TYPE	CAM LOBE & RUNNING VALVE LASH	OPENING POINT	CLOSING POINT	CRANKSHAFT DURATION AT LASH POINT	CRANKSHAFT DURATION AT .010 TAPPET LIFT	CRANKSHAFT DURATION AT .050 FROM BASE CIRCLE	MAX LIFT W/1.5 ROCKER RATIO	LOBE CENTERLINES	INTAKE C/L FROM TDC	OVERLAP AT 0 AND .010" TAPPET LIFT	REMARKS
14024278 Flat Hydraulic	Intake Exhaust	13 BTC 57 BBC	65 ABC 39 ATC	258 276	218 237	178 196	.347 .394	107	105 ATDC	52 @ 0 13 @ .010	Base 2.8 L V-6, S-10 & Camaro
14031378 Flat Hydraulic	Intake Exhaust	15 BTC 67 BBC	81 ABC 46 ATC	276 293	237 247	196 203	.394 .410	109	109 ATDC	61 @ 0 19 @ .010	X-11 and Hi-Perf 2.8 L

Figure 50 — Production V6/60 camshaft specifications.

draulic cam for the 2.8-liter V6 should have approximately 205 to 210 degrees of intake duration at .050-inch tappet lift and 215 to 220 degrees exhaust duration at .050-inch tappet lift. A mechanical lifter cam with 270/280 degrees intake duration and 275/280 degrees exhaust duration is recommended for most competition applications. Maximum valve lift should be approximately .560-inch. Street and competition cams should be ground with lobe centers between 106 and 110 degrees.

Camshaft phasing can be changed with an offset cam sprocket bushing from a small-block V8 after performing the following modifications. First remove the stock metric dowel pin from the cam and enlarge the dowel hole to 1/4-inch diameter and install a small-block V8 dowel pin. Then enlarge the hole in the camshaft sprocket to fit the offset cam bushing. (A carbide drill bit must be used because the cam gear is made of hardened sintered iron.)

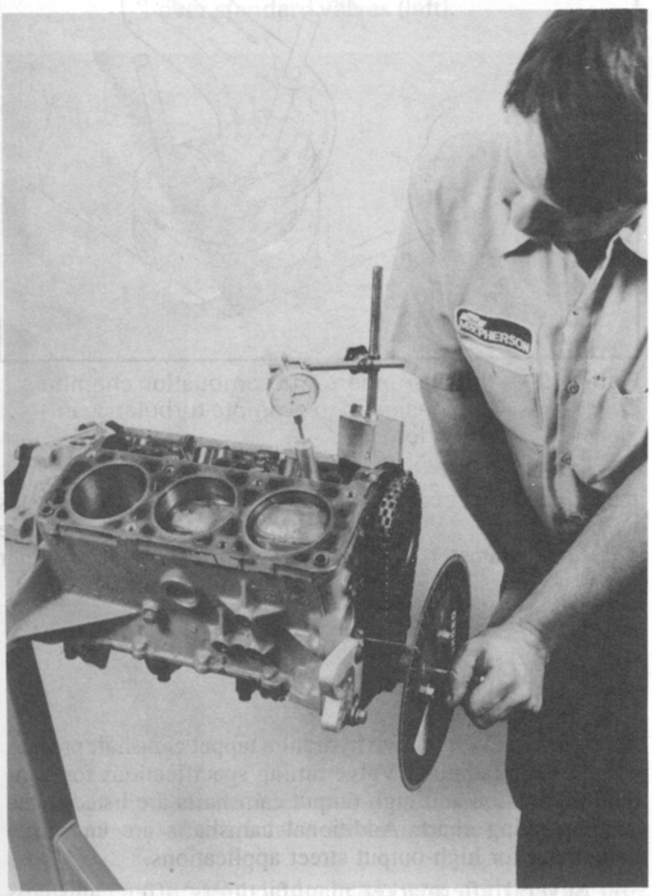

Figure 51 — Check camshaft phasing with degree wheel and precision dial indicator.

As a general rule, advancing the camshaft improves low-speed torque, while retarding the camshaft increases high rpm horsepower. It is important that the camshaft phasing be rechecked and verified after installing an offset timing gear bushing. This procedure requires an accurate degree wheel and a precision dial indicator.

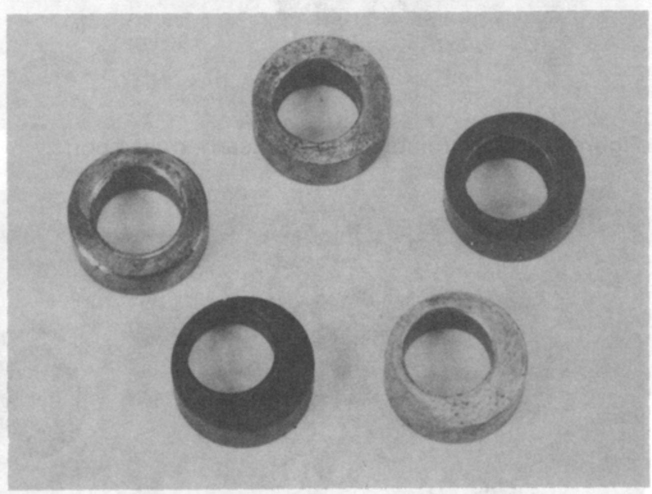

Figure 52 — Offset camshaft dowel bushings change camshaft phasing.

Advancing or retarding the camshaft timing also effects piston-to-valve clearance. As the camshaft is advanced, intake valve-to-piston clearance is reduced; retarding the cam reduces exhaust valve-to-piston clearance. To prevent the possibility of valvetrain and piston damage after changing camshaft timing, the piston-to-valve clearance should be verified before final engine assembly. It is recommended that a minimum of .100-inch clearance between the pistons and valves be maintained to prevent contact during overspeed conditions.

Molykote or a similar molydisulfide-based grease should be applied to the lobes of Chevrolet hydraulic and mechanical lifter camshafts during final engine assembly. This high-pressure lubricant reduces the risk of premature wear on the camshaft lobes and tappets during the first minutes of engine operation. Initial run-in is very critical with high-performance flat tappet camshafts. The engine should not be allowed to idle below 2000 rpm for the first 1/2 hour of running time.

If you have trouble with early cam lobe failure, and if you have followed the recommendations for preparing Chevrolet camshafts and lifters, then it may be necessary to break in the camshaft by running it with reduced valve spring loads. The cam should be run-in for approximately one hour with low-tension valve springs; after this break-in period, racing springs can be installed.

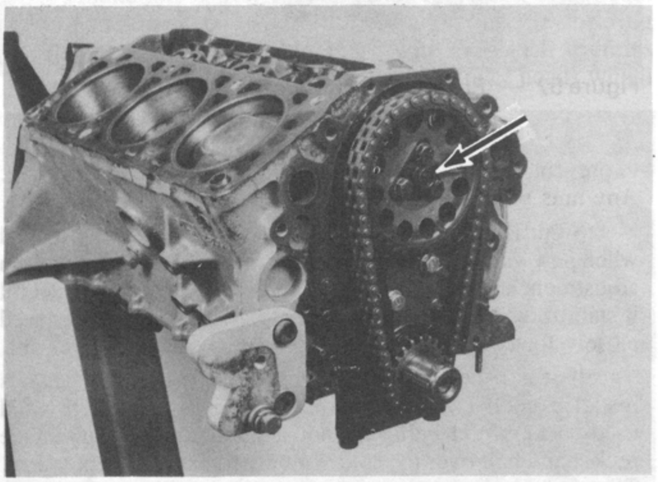

Figure 53 — Production timing set with aftermarket camshaft thrust bearing.

VALVE LIFTERS

Production Chevrolet hydraulic tappets (*part number 5232720*) are recommended for high-performance hydraulic camshafts. For normal use, the rocker adjusting nuts should be tightened 1/2 to 3/4 turn after all valvetrain lash is taken up. If all new valvetrain parts are being installed, the rocker arms should be readjusted after 1,000 to 2,000 miles to compensate for run-in wear.

Higher engine operating speeds can often be attained by "zero-lashing" Chevrolet hydraulic lifters. This requires idling a thoroughly warmed up engine and backing off each rocker arm adjusting nut until an audible clicking is heard. Retighten the adjusting nut until the clicking just stops, and then turn the nut 1/8 turn tighter. Repeat this operation for each valve until all lifters have been set to "zero lash."

Some types of mechanical lifters cannot be used in V6/60 Chevrolets due to the design of the production oiling system. The left lifter oil gallery in production engine blocks also feeds the crankshaft bearings. It is larger in diameter than the right lifter gallery and offset from the lifter bore centerline. Since this gallery also supplies lubrication to the main and connecting rod bearings, it cannot be restricted like a V8 gallery to control overhead oil flow. (Aluminum Bow Tie V6/60 blocks have V8-style oil systems with three oil galleries. The oil flow to the lifter galleries can be restricted when roller bearing rocker arms are used without reducing the oil supply to the crankshaft bearings.)

Production V6/60 engines equipped with mechanical lifter cams require a piddle valve tappet. Chevrolet mechanical lifter #5232695 is not suitable for V6/60 engines due to oil leakage around its pushrod seat. Sealed Power lifter part number AT-992 is satisfactory for V6/60 engines equipped with mechanical tappet cams.

Chevrolet recommends that Molykote or a similar molydisulfide-based EP lubricant be used on all hydraulic and mechanical tappets for proper break-in. Note that molydisulfide greases will plug an oil filter in about 20 minutes running time. The oil filter cartridge on an engine assembled with this grease should be replaced after approximately 30 minutes of operation.

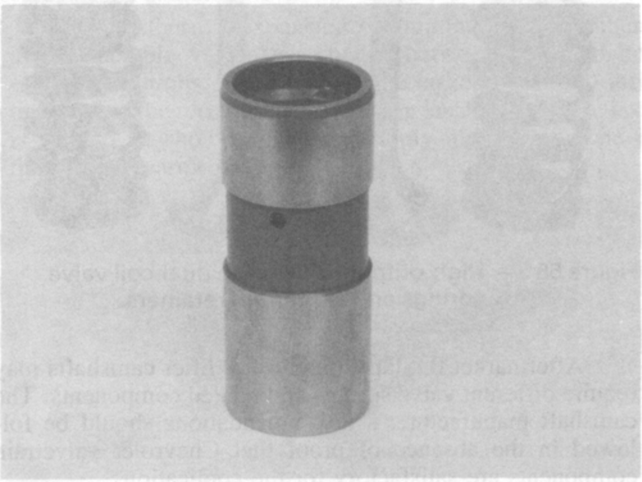

Figure 54 — Sealed Power AT-992 mechanical tappet.

Valve lifters can be made more compatible with the camshaft lobes by polishing the lifter feet with #600 grit sandpaper before installing them. Good used lifters that retain some crown or convex curvature across the bottom are quite satisfactory for reinstallation.

Before installing new tappets in an aluminum block, deburr or sand off any sharp edges in the grooves around the lifter bodies. These edges tend to gall and wear the aluminum lifter bores rapidly.

VALVE SPRINGS

Production V6/60 valve springs and retainers are satisfactory for any hydraulic camshaft profile with .420-inch or less maximum valve lift. Chevrolet dual valve spring *part number 330585* and aluminum retainer *part number 330586* can be used with mechanical cams with .560-inch or less net valve lift. This spring is 1.379-inch in diameter, and produces 135 pounds of seat pressure at an installed height of 1.72-inch. V6/60 cylinder heads must be modified to accommodate this spring by enlarging and deepening the valve spring pockets. Aftermarket intake valve stem seals should be installed for oil control.

In all installations where high-lift camshafts and heavy-duty springs, retainers, and valve stem seals are used, all parts should be observed closely for assembly clearance. Make a temporary assembly of the complete valvetrain on the engine and check for possible interference between the spring retainer and seal at maximum valve lift, bottoming of the inner, outer, and damper coils at maximum lift, and possible interference between the rocker arm and valve spring retainer. Any of these conditions will result in very short engine life if not corrected before final assembly!

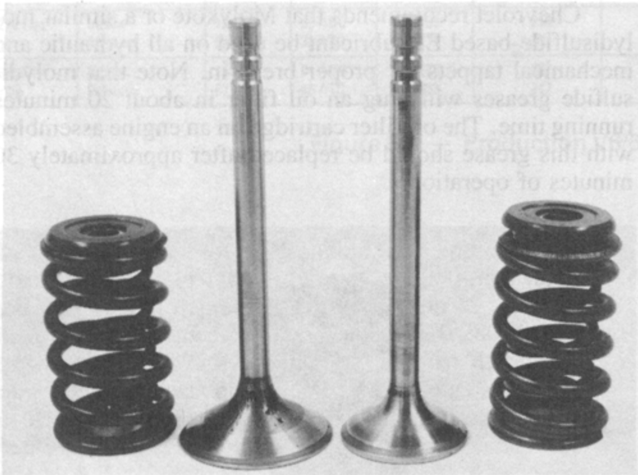

Figure 55 — High-output valves with dual-coil valve springs and aluminum retainers.

Aftermarket flat tappet and roller lifter camshafts may require different valve springs and related components. The camshaft manufacturer's recommendations should be followed in the absence of proof that Chevrolet valvetrain components are satisfactory for the application.

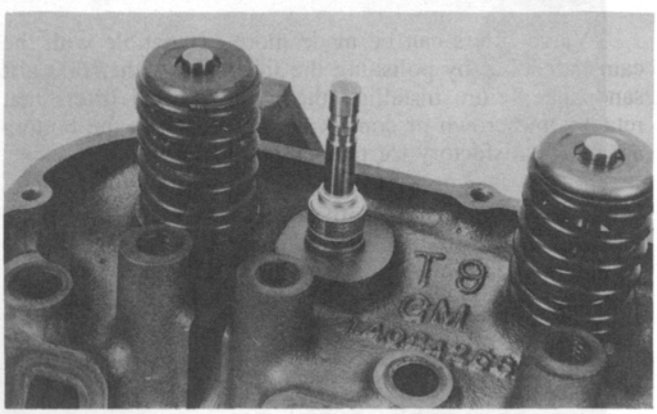

Figure 56 — Aftermarket valve stem oil seals should be used with dual-coil valve springs.

ROCKER ARMS

Production V6/60 stamped steel rocker arms are mounted on individual rocker studs with pivot balls and adjusting nuts. This lightweight, rugged valvetrain is very similar to the small-block Chevrolet V8, and provides outstanding high-rpm performance and reliability. Production V6/60 valvetrain components are suitable for many high-performance applications.

Production rocker arm adjusting nuts (*part number 477212*) are preferred over any other type for production rockers. They must have enough preload torque, however, to prevent them from loosening while the engine is running. Any nuts with insufficient preload should be discarded.

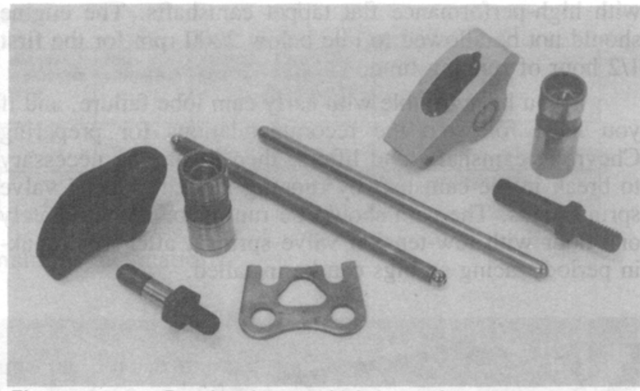

Figure 57 — Production and high-performance V6/60 valvetrain components.

Significant changes in valve lash may be experienced when new valvetrain components are first run-in. Valve lash adjustment should be checked and corrected frequently until it stabilizes. New rocker arms and balls should be observed closely for overheating and excessive wear during run-in.

If it is necessary to change a rocker and ball, always install a good used run-in rocker arm assembly. If good used rockers and balls are not available, move an intake rocker and ball over to replace a burned exhaust rocker arm. Then install new components on an intake valve, which runs cooler. Always keep usable rocker arms and balls together during engine disassembly and rebuild.

Most engine failures in long-distance high-speed events are precipitated by the valvetrain. The rocker arm has a major influence on valvetrain life, second only to the camshaft profile (which controls how quickly the valves seat and determines the shock loads introduced in the valvetrain).

It is absolutely mandatory that your preset valve lash not change for the duration of an event. If valve lash opens up more than .005-inch for any reason, valve springs and valves cannot reasonably be expected to survive. Failure of either component can seriously damage an engine if not detected early.

The durability of a V6/60 engine equipped with racing valve springs can be improved by installing 7/16-inch diameter big-block V8 rocker arm studs (*part number*

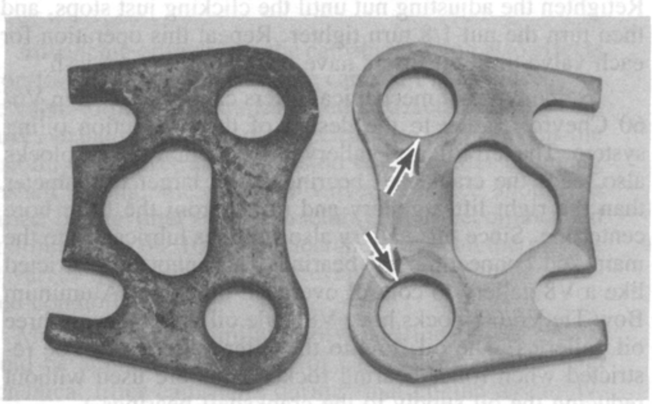

Figure 58 — Stock V6/60 pushrod guideplate (left) fits 11mm rocker arm studs. Enlarge holes to fit 7/16-inch diameter studs.

3921912). To perform this conversion on cast iron V6/60 cylinder heads, the stock studs must be removed and the 11mm rocker arm stud holes drilled and tapped with 7/16-14 threads. The rocker studs bosses will have sufficient strength to support the big-block rocker studs after they are re-tapped.

The pushrod guideplate holes must also be enlarged slightly to fit the 7/16-inch studs. The guideplates are hardened, so the holes must be enlarged by grinding or drilling with a carbide drill bit.

Production V6/60 rocker arms cannot be used with 7/16-inch diameter studs. Aftermarket needle bearing rocker arms for a small-block V8 with 7/16-inch trunions should be installed on cast iron V6/60 cylinder heads which have been converted to 7/16-inch rocker studs. Due to limited clearance between adjacent rockers, narrow aluminum rockers are required. Crane rocker arms with 1.260-inch wide trunions (Crane part number 11756) are suitable. Wide-body rockers can be modified to fit V6/60 cylinder heads by machining the intake rocker trunions which are adjacent to the exhaust rockers. This modification eliminates one trunion retaining snap ring on each intake rocker arm, so the trunions should be inspected regularly for signs of movement.

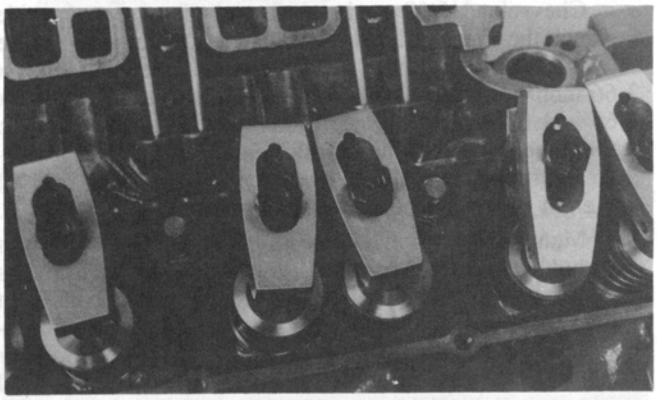

Figure 59 — Aftermarket aluminum rocker arms installed on cast iron cylinder head.

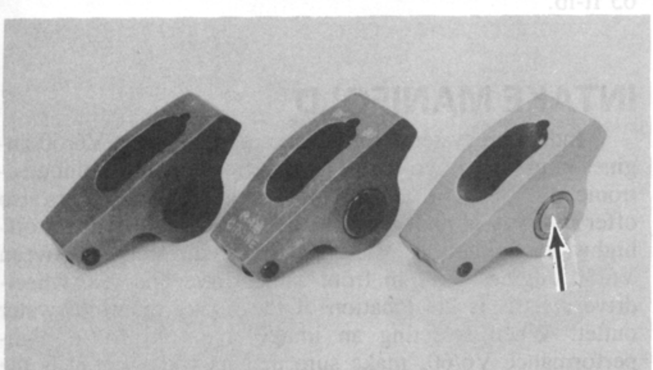

Figure 60 — Narrow aluminum rocker arm (left) can be installed on V6 head without modification. Wide-body aluminum rocker (center) has inadequate clearance; machine intake rocker trunion (right) to clear adjacent exhaust rocker.

Needle roller rocker arms typically lower the engine oil temperature and require less lubrication than ball-type rockers. Rocker arms should be examined frequently for signs of failure, and must be checked for adequate spring, retainer, and stud clearance during assembly. Rocker arm studs should be Magnaflux inspected to insure their quality.

Valve lash adjustments should be made with the engine hot whenever possible. If this is impractical, a determination of the lash change during warm-up should be made and allowed for when the lash is set cold. Valve lash may increase or decrease during warm-up depending on whether cast iron or aluminum cylinder heads are used.

Due to thermal expansion of aluminum blocks, there is considerable valve lash change between cold and hot engine conditions. Valves should be lashed cold .010-inch tighter than the recommended running lash. If hot valve lash is desired, it should be adjusted only after the engine is thoroughly warmed.

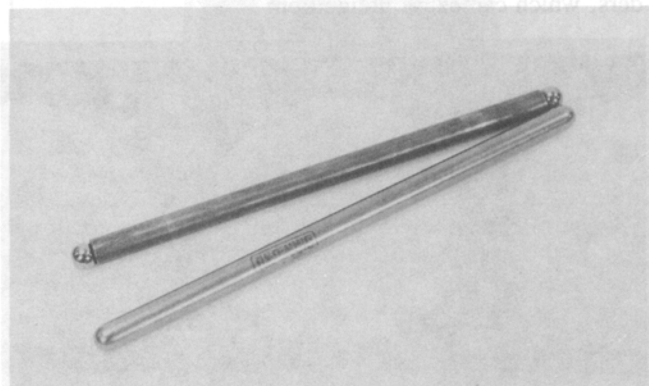

Figure 61 — Production V6/60 pushrod has welded ball ends; extra-long aftermarket pushrod should be used with small base circle racing cams.

If a high-lift, small base circle racing cam is used, pushrods that are .100-inch longer than stock should be fabricated to restore the correct valvetrain geometry. Several aftermarket sources can supply pushrod tips and tubing to assemble custom pushrods.

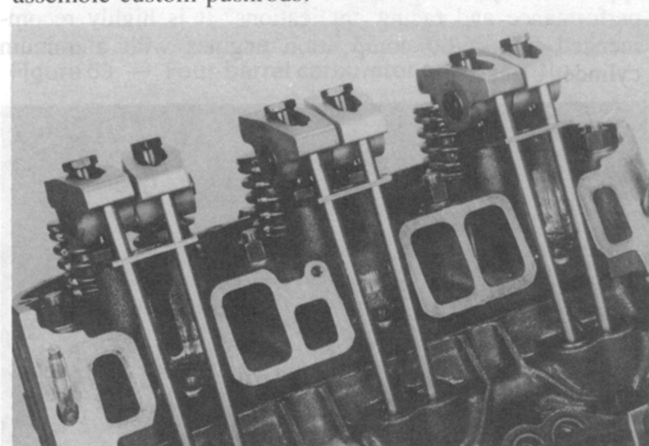

Figure 62 — Competition V6 valvetrain includes extra-long pushrods, aluminum rocker arms, modified guideplates, 7/16-inch rocker arm studs, and dual-coil valve springs.

HEAD GASKET

Head gasket sealing is critical on the V6/60 because the block has only four head bolts around each cylinder bore. The span between bolts is relatively short, however, and V6/60 Chevrolet racing engines seldom experience problems with leaking head gaskets. The block and cylinder head surfaces should be as straight as possible to promote an effective seal. Only the minimum amount of material necessary to straighten the sealing surfaces should be removed when machining these components.

Always use head gaskets which will produce the desired piston-to-head clearance with the engine's piston deck height. The *minimum* acceptable piston-to-head clearance (gasket thickness plus deck clearance) is .035/.040-inch. This figure must be increased when high engine speeds are anticipated, when piston-to-cylinder wall clearance is increased, or when aluminum connecting rods are used. It is also essential that the head gasket not overhang the cylinders, which can cause preignition.

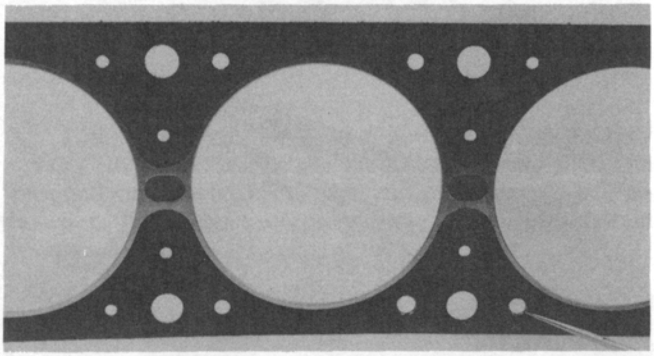

Figure 63 — Enlarge outer coolant holes in production head gasket for endurance racing.

Chevrolet offers a heavy-duty Teflon-coated composition head gasket for V6/60 engines as *part number 14044816*. This gasket features a solid wire "O"-ring around each cylinder bore. It will fit bores sizes up to 92mm (3.62-inch) diameter, and has a compressed thickness of approximately .040-inch. This gasket is suitable for all high-performance and racing applications. It is highly recommended for V6/60 competition engines with aluminum cylinder blocks.

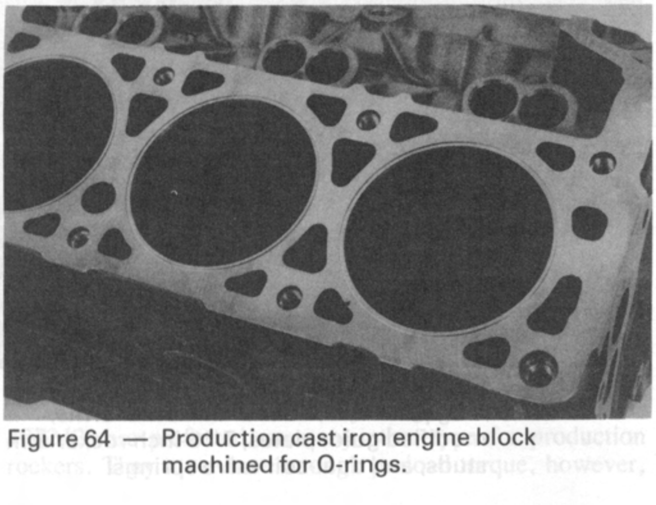

Figure 64 — Production cast iron engine block machined for O-rings.

Cast iron blocks used for endurance racing should be machined for .041-inch stainless steel O-rings and assembled with .035-inch thick production head gaskets (*part number 14090561*). The outer diameter of the O-ring groove should be 3.750-inch, and the wire should protrude .005 to .007-inch above the deck surface. Modify the production head gasket by enlarging the small water passage holes for the end cylinders to 9/32-inch diameter. Enlarge the two center water holes to 1/4-inch. Install the head gasket without sealer. Tighten the head stud nuts to 65 ft/lb, and retorque the head studs after the engine has been run.

HEAD BOLTS AND STUDS

Chevrolet V6/60 engines use eight fasteners per side to attach the cylinder head to the block. A complete engine set for cast iron cylinder heads consists of eight 11mm x 3.66-inch bolts (*part number 476543*) and eight 11mm x 2.68-inch long bolts (*part number 476572*). "Generation II" engines with production aluminum cylinder heads require eight 11mm x 4.33-inch bolts (*part number 14093000*) and eight 11mm x 3.50-inch bolts (*part number 14092999*).

Many competition engine builders prefer head studs over bolts. Studs reduce wear and tear on the block threads during frequent rebuilds, and produce more consistent torque readings. Chevrolet offers a stud kit for V6/60 engines with cast iron cylinder heads as *part number 10134331*. This kit includes cylinder head studs, nuts, and washers. Individual 11mm x 115.5mm head studs are available as *part number 10048634*; 11mm x 88mm head studs are *part number 10048653*. Heavy-duty 11mm nuts are listed as *part number 10048636* and washers are *part number 10051155*.

A stud kit for V6/60 engines with production aluminum cylinder heads is available as *part number 10051174*. This kit includes eight short studs (available individually as *part number 10051173*), eight long studs (*part number 10051172*), sixteen 11mm nuts (*10048636*), and sixteen washers (*part number 10051155*).

Bolts threads that penetrate the block's water jacket should be coated with sealant *part number 1052080* during assembly. Head bolts and studs should to torqued to 65 ft-lb.

INTAKE MANIFOLD

Induction systems for production Chevrolet V6/60 engines range from two-barrel carburetion to multi-point electronic fuel injection. Several aftermarket manufacturers also offer a variety of high-performance intake manifolds for off-highway applications. One important difference between V6/60 engines used in front-wheel-drive and rear-wheel-drive chassis is the location of the intake manifold water outlet. When selecting an intake manifold for a high-performance V6/60, make sure that its water outlet is the correct location for your vehicle.

A factory two-barrel manifold will perform well in racing classes which limit carburetion to a single Holley two-barrel if it is modified with an adapter plate as shown in Figure 65. The manifold's EGR passages should be filled, and the stock throttle bores enlarged or removed. This man-

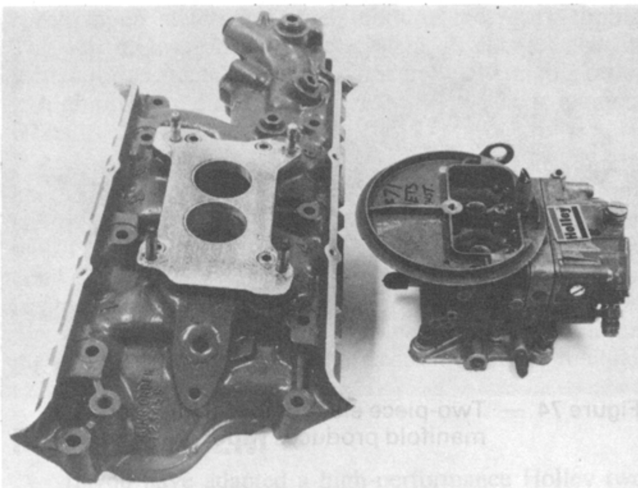

Figure 65 — Production two-barrel intake manifold modified for 500cfm Holley carburetor.

ifold can also be modified to accept a Holley 390 or 600 cfm four-barrel; however, this conversion requires some welding to the stock casting and extensive machining. When converting to four-barrel induction, a plenum divider should be added to isolate the left and right cylinder banks. An

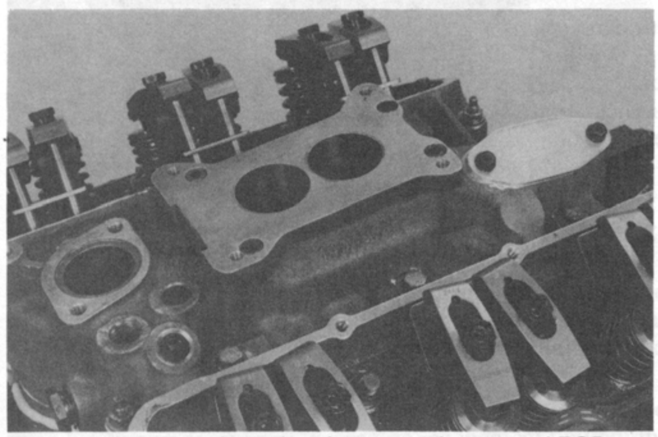

Figure 66 — Two-barrel carburetor adapter and EGR block-off plate.

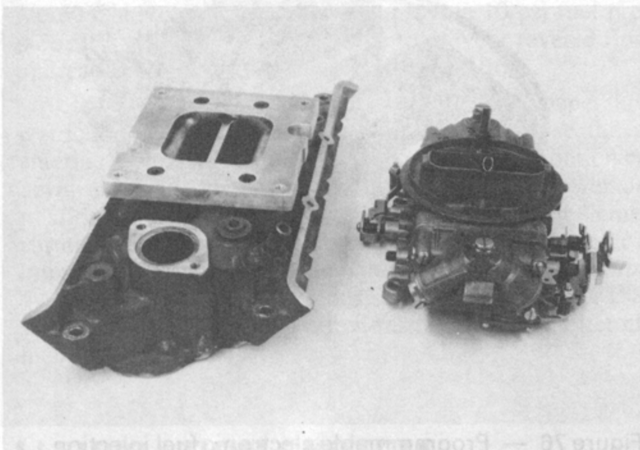

Figure 67 — Production two-barrel intake manifold modified for four-barrel carburetor.

adapter to mount the four-barrel carburetor on the stock bolt pattern must be machined. A small-diameter distributor from an S-10 and a remote-mounted coil is required for clearance with a four-barrel Holley carburetor mounted fore-and-aft.

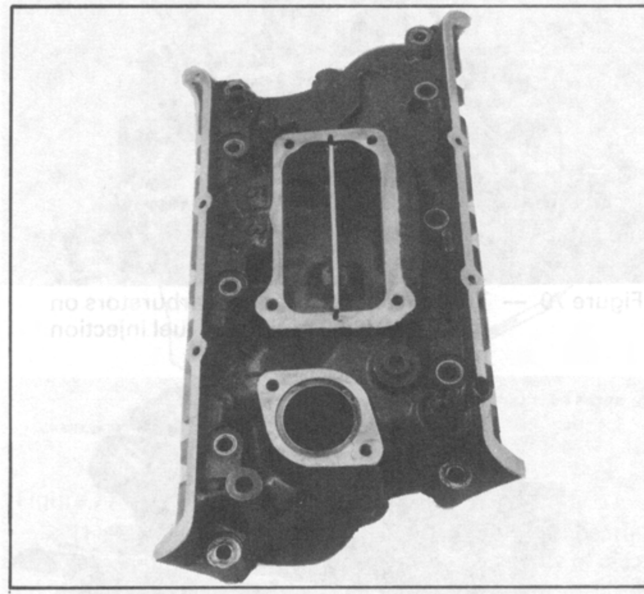

Figure 68 — Fabricated plenum divider for four-barrel carburetor conversion.

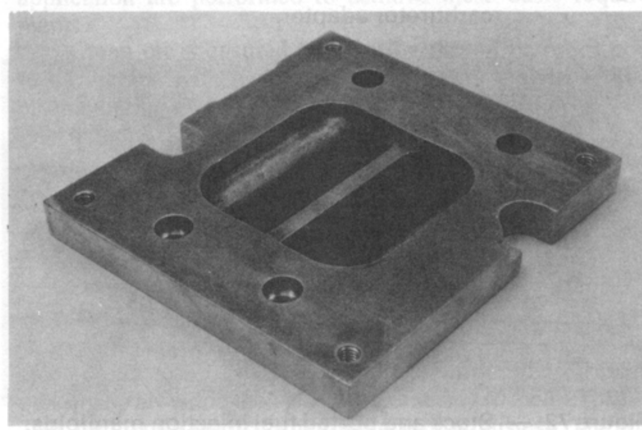

Figure 69 — Four-barrel carburetor adapter plate.

An induction system with three Weber 48 IDF downdraft two-barrel carburetors is recommended when sanctioning body rules do not limit carburetion. Manifold tops are available from aftermarket sources to mount triple Weber carburetors on a tuned port fuel injection manifold base. For optimum performance, the intake manifold base should be matched to the intake manifold gasket and cylinder head runners.

Chevrolet Special Products has also developed an electronic fuel injection system for the V6/60 engine in conjunction with Ryan Falconer Racing Engines. This two-piece cross-ram manifold has 21-inch long runners (measuring from the air horn inlet to the head of the intake valve). It is designed to have an operating range from 1800 to 8000 rpm, with a broad, flat torque curve. A programmable electronic control with throttle position and engine

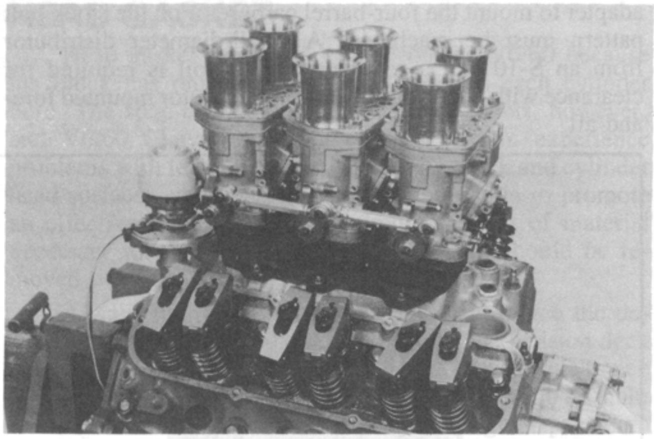

Figure 70 — Triple Weber two-barrel carburetors on modified V6/60 multi-port fuel injection manifold.

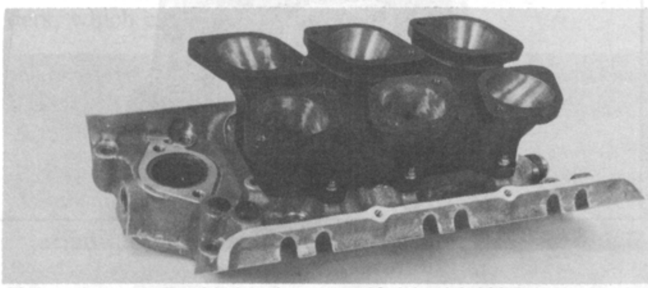

Figure 71 — Fuel injection manifold with Weber carburetor adapter.

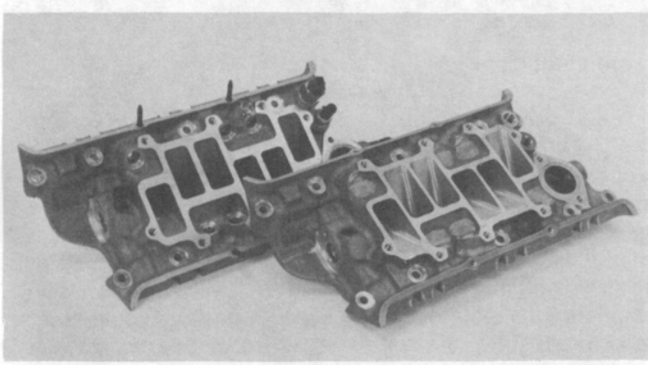

Figure 72 — Stock and ported fuel injection manifolds.

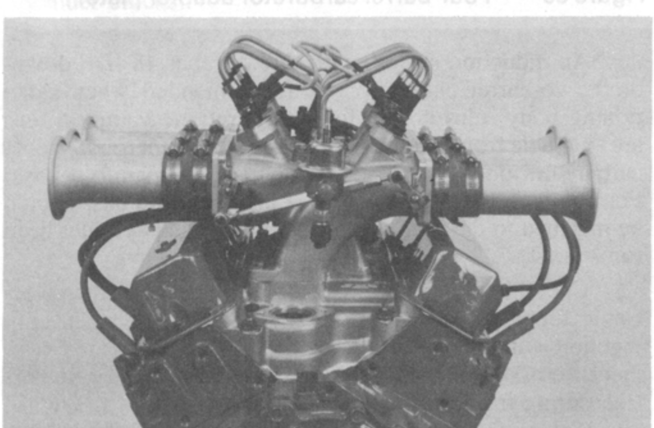

Figure 73 — Electronic fuel injection system for competition V6/60 Chevrolet.

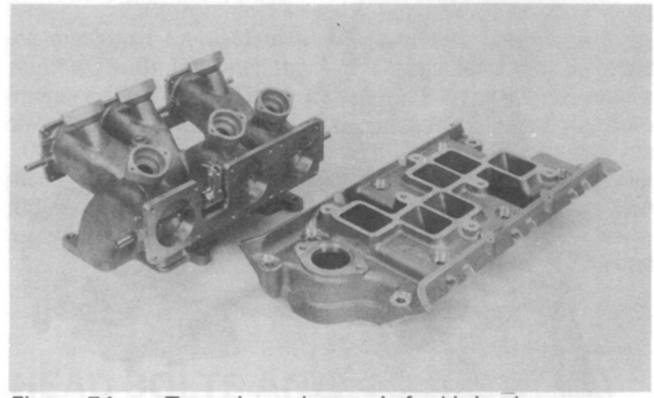

Figure 74 — Two-piece electronic fuel injection manifold produces wide torque curve.

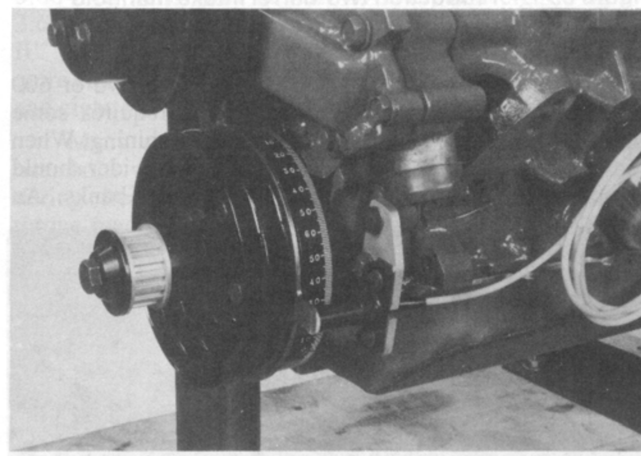

Figure 75 — Crankshaft trigger wheel and magnetic sensor provide reference signals for electronic fuel injection.

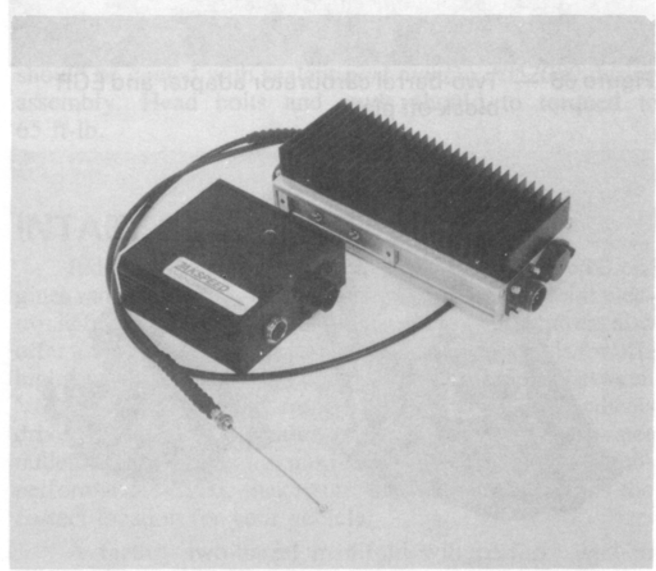

Figure 76 — Programmable electronic fuel injection control module determines fuel mixture according to engine speed and throttle position.

speed inputs determines fuel mixture and spark timing. This off-highway batch-type system discharges the injectors for each bank of three cylinders in alternating order. A high-pressure electric fuel pump and regulator maintain 60 psi fuel pressure at the injectors.

A trigger wheel mounted on the crankshaft snout signals a Hall-effect sensor which is connected to the electronic control module. Because the V6/60 is a true even-fire engine with 120 degrees of crankshaft rotation between sparks, the crankshaft-mounted timing wheel has three equally spaced triggers. The distributor acts as a simple rotary switch which directs high-voltage current to the spark plugs; ignition timing is determined solely by the electronic control module.

FUEL SYSTEM

If you have adapted a high-performance Holley two-barrel or four-barrel carburetor to a V6/60 racing engine, remove and discard the production Holley sintered bronze fuel filters located inside the fuel inlet nuts. Replace them with a large paper element filter (*part number 854619*) installed between the fuel pump and carburetor. The fuel pressure drop through the sintered bronze filters cannot be detected because they are located after any fuel pressure gauge connection. Clogged fuel filters are frequently responsible for engine failures and poor performance.

Carburetor heat shields are available from Chevrolet for Holley four-barrel carburetors as *part number 3969835*. This shield should be installed between the carburetor and the manifold flange to isolate the fuel in the carburetor float bowls from engine heat. A carburetor heat shield can be especially effective in curing fuel percolation problems.

Fuel lines should be formed from neoprene rubber, steel tubing, or braided steel. *Never* use copper tubing, which will eventually crack from engine vibration.

A fuel pressure gauge should be installed between the fuel filter and carburetor. A minimum fuel pressure of at least 4 psi should be maintained at maximum engine speed with a wide open throttle.

Whenever possible, an electric fuel pump should be used to boost (or replace) the engine mechanical fuel pump. Electric in-tank fuel pumps such as Corvette *part number 6471925* have sufficient capacity for a high-performance V6/60 Chevrolet. This pump will provide 10 psi fuel pressure. It has a built-in check valve to prevent reverse flow, and can be used in multiple-pump installations.

It is highly recommended that a foam or paper low-restriction air cleaner element be used to diffuse the air entering the carburetor. The engine mixture distribution can be upset if no diffuser is used, causing poor power and misfiring at high speeds. A 14-inch diameter open element chromed air cleaner assembly for single four-barrel carburetors is available from Chevrolet as *part number 6423907*. This air cleaner consists of a base (#6422188), a cover (#6421832), and a low-restriction paper filter element (#6421746).

LUBRICATION SYSTEM

When properly assembled and installed in a vehicle with the correct oil pan, pump, coolers and filters, the Chevrolet V6/60 is remarkably free of any failures caused by inadequate lubrication. The basic engine lubrication system is shown in Figure 77. Refer to the block preparation and crankshaft preparation sections of this chapter for recommended modifications to provide reliable rod bearing lubrication at high rpm.

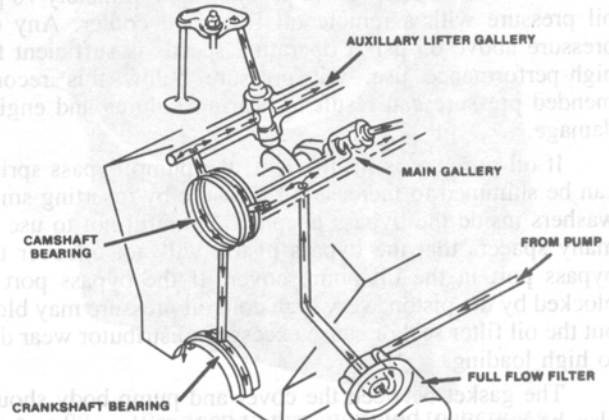

Figure 77 — Production V6/60 lubrication system.

The basic requirement to prevent excessive bearing wear and failures is a steady, non-fluctuating supply of clean oil between 150 and 270 degrees F temperature at 65-80 psi pressure. All modifications to the engine oiling system in a race car, off-road truck, or other high-performance application are performed to achieve these basic requirements.

Clean oil is ensured by filtering the oil before it goes to the engine with a non-bypassing filter, mounted either on the engine or remotely.

The desired 65-80 psi oil pressure is governed by the oil pump bypass relief spring.

The correct oil temperature is controlled by proper engine warm-up before racing, and the use of an oil cooler if required to keep the oil temperature below 270 degrees F.

The final (and most difficult) basic requirement is a steady oil supply. The majority of engine bearing failures are a direct result of oil pressure loss due to the oil pump picking up air while the vehicle is cornering at racing speeds. This frequently occurs when the driver is busiest. The loss of oil pressure may go unnoticed, or it may be reported as simply a slight drop in oil pressure in the turns. Quick oil pressure gauge response is necessary to diagnose this problem; the oil pressure gauge line should be a minimum of 1/8-inch ID to indicate oil pressure fluctuations quickly. The oil pressure gauge should be mounted as close to the driver's line of sight as practical.

Loss of oil pressure in turns is aggravated by three conditions:

1. Insufficient oil level or capacity

2. High engine oil flow rates due to excessive bearing clearances, or unnecessarily high oil pressure.

3. Improper oil pan baffling (usually over-baffling which prevents the engine oil from draining back into the sump while the car is cornering).

These problems can be avoided through proper selection and installation of oil system components.

OIL PUMP

All Chevrolet V6/60 production oil pumps have lightweight cast aluminum housings. Oil pressure is regulated by a bypass spring located in the oil pump cover. The production high-pressure spring (*part number 360582*, color coded with a blue stripe) will produce approximately 70 psi oil pressure with a remote oil filter and cooler. Any oil pressure above 65 psi at operating speeds is sufficient for high-performance use. Oil pressure below this recommended pressure can result in bearing failures and engine damage.

If oil pressure is insufficient, the pump bypass spring can be shimmed to increase oil pressure by inserting small washers inside the bypass piston. Be careful not to use so many spacers that the bypass piston will not uncover the bypass port in the oil pump cover. If the bypass port is blocked by the piston, very high cold oil pressure may blow out the oil filter seal or cause excessive distributor wear due to high loading.

The gasket between the cover and pump body should also be removed and discarded. Machine the ends of the pump gears to produce .001 to .002-inch clearance between the gears and the pump cover.

A heavy-duty cast iron oil pump for the V6/60 is available as *part number 10051104*. This pump has longer gears than the production pump, and offers a significant increase in oil volume for competition V6/60 Chevrolets. This pump should be modified by enlarging the hole between the pickup and the pressure bypass to .410-inch diameter; a larger plug is required after drilling out this hole. The hole in the pump cover that feeds the oil pressure relief should also be enlarged to .410-inch. Relocate the pin that retains the oil pressure relief spring to the edge of the pump cover, and install a low-pressure Weaver pump spring (color coded green) with a .050-inch spacer. A cast iron oil pump modified in this manner will provide a steady supply of oil at approximately 80psi.

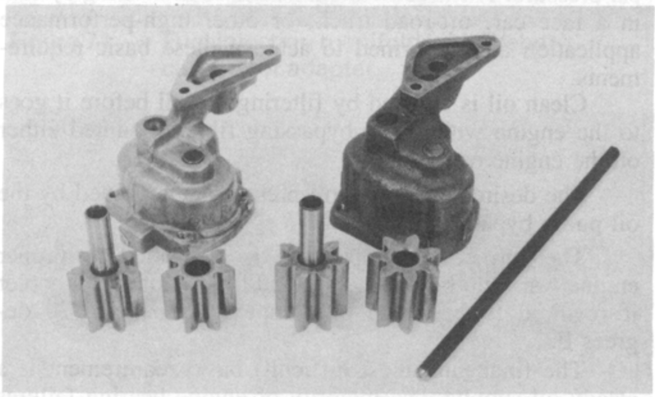

Figure 78 — Production V6/60 oil pump (left) has aluminum housing; high-volume pump (right) has cast iron housing and longer gears.

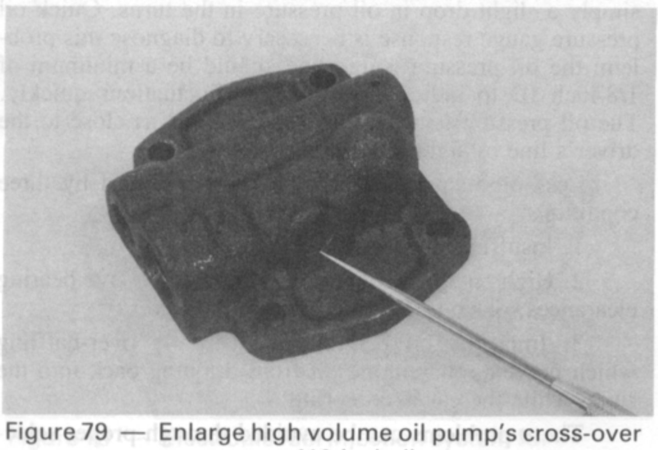

Figure 79 — Enlarge high volume oil pump's cross-over passage to .410-inch diameter.

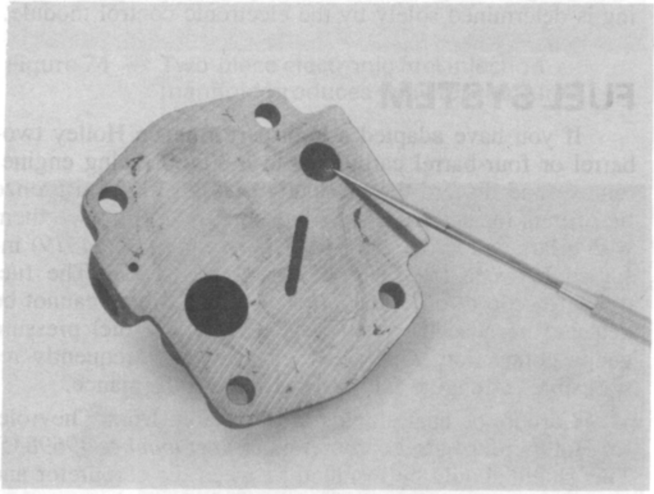

Figure 80 — Drill out oil pump pressure bypass passage to .410-inch diameter.

All wet sump oil pumps should be equipped with a flat round pickup shield similar to a production screen. The standard Chevrolet screen-type pickup is engineered to strain out large dirt particles and metal fragments before they reach the pump gears. A properly designed pickup also inhibits the formation of a vortex in the sump that would allow the pump to pull in air along with the oil.

The pickup should be positioned for the specific conditions which the engine will encounter. For example, oval track racing usually requires a pickup located on the right side of the pan in a rear-wheel-drive chassis; for drag racing, it should be positioned at the rear of the pan.

Oil pump pickups should always be tack-welded or brazed to the pump cover. This will prevent the pickup from vibrating loose when the engine is running.

OIL PAN AND WINDAGE TRAY

The capacity of a production V6/60 wet sump oil pan should be increased for racing applications if possible. Overfilling the pan to increase oil capacity is not recommended. Adding oil beyond the pan's designed capacity may cause the lubricant to overheat rapidly, and oil pressure fluctuations may be noted on acceleration if the oil is aerated by the crankshaft assembly. A number of aftermarket manufacturers offer wet sump and dry sump oil pans which are specifically engineered to meet the demands of various types of racing.

If you use a modified or aftermarket oil pan, be sure that the oil pump pickup is positioned within 1/4-inch of the pan bottom. There should also be sufficient baffling to control oil slosh on hard acceleration, braking, and cornering.

Figure 81 — Weld mounting studs on main cap bolts and shorten small-block V8 windage tray to fit V6/60.

Chevrolet does not offer windage trays for V6/60 engines. A semi-circular small-block V8 tray (*part number 3927136*) can be modified for use in a V6/60. This windage tray will effectively separate the oil in the pan from the rapidly spinning crankshaft assembly. To adapt the small-block V8 windage tray to the V6/60 crankcase, cut off the

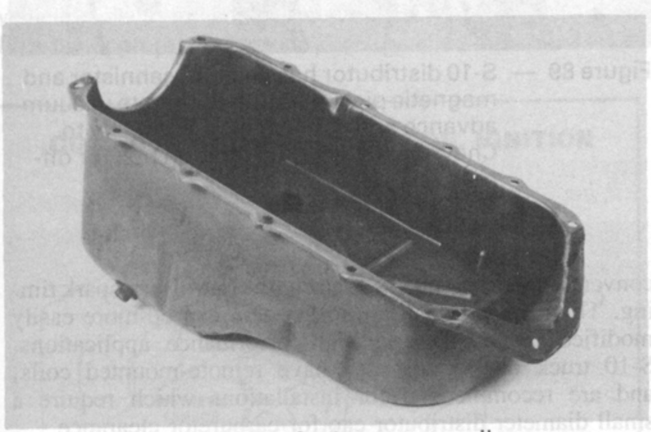

Figure 82 — Production S-10 wet sump oil pan.

front section of the tray as shown in Figure 81. Three main cap bolts must also be modified by welding mounting studs to the bolt heads. The length of these mounting studs should be adjusted to provide sufficient clearance for the oil pan, crankshaft, and connecting rods you are using.

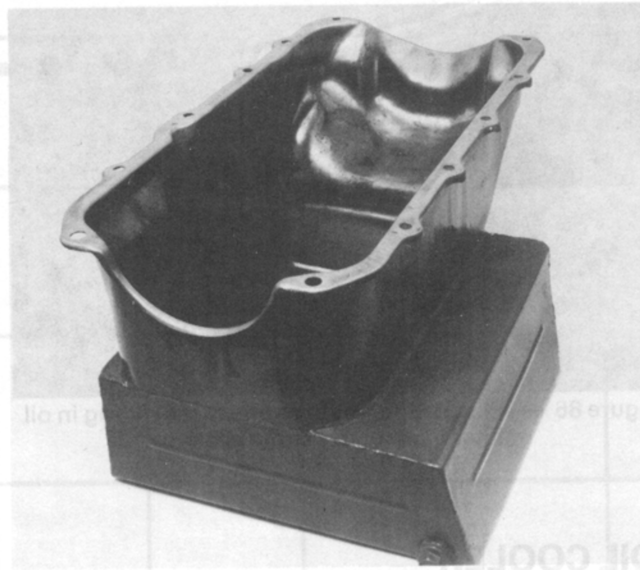

Figure 83 — Production pan modified to increase capacity.

Some forms of motorsports demand a dry sump oiling system for proper engine lubrication. Refer to the "Lubrication" chapter of this manual for information on the proper design and installation of a dry sump system.

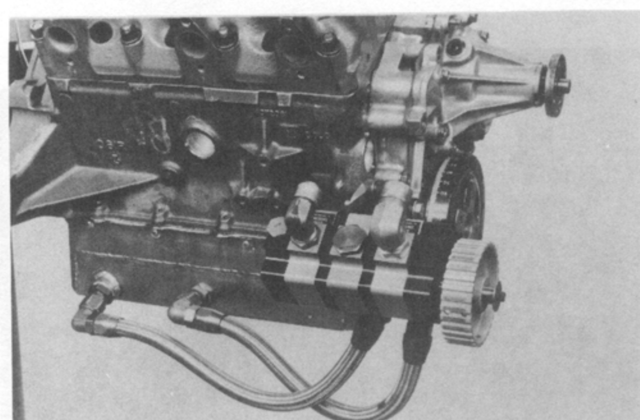

Figure 84 — Competition V6/60 dry sump oil system with two scavenge pickups in pan.

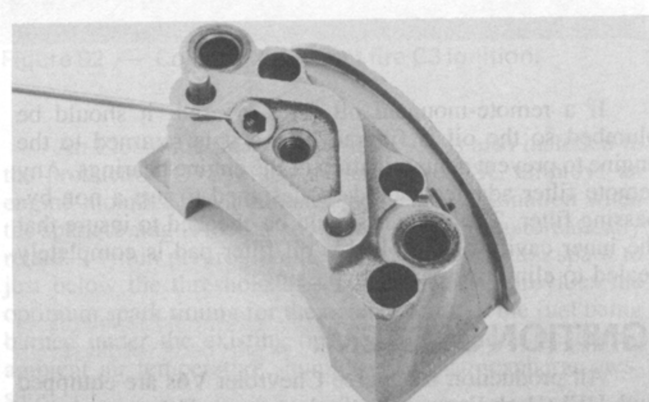

Figure 85 — Plug oil pump passage in rear main bearing when installing external dry sump oil pump.

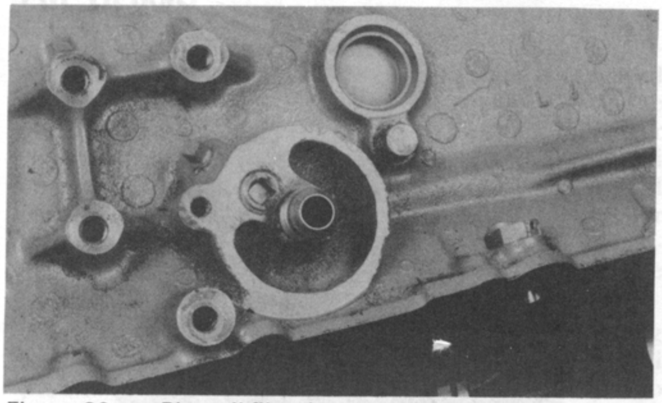

Figure 86 — Plug oil filter bypass and install fitting in oil filter inlet for dry sump system.

OIL COOLER

An oil cooler may be necessary in some applications to maintain the desired oil temperature. An oil cooler with its inlet and outlet fittings on opposite ends is preferred. This design minimizes restrictions and pressure loss as the oil flows through the cooler core. Oil cooler lines should have a minimum inside diameter of 1/2-inch in all applications.

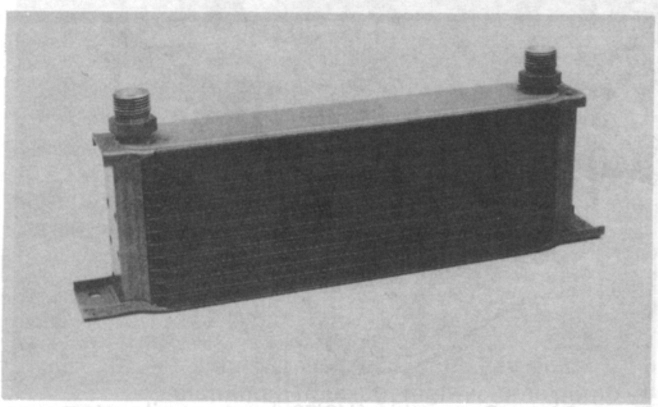

Figure 87 — Recommended oil cooler design with inlet and outlet fittings on opposite ends of core.

If a remote-mounted oil filter is used, it should be plumbed so the oil is filtered before it is returned to the engine to prevent contamination of the engine bearings. Any remote filter adapter should be designed to use a non-bypassing filter. The adapter should be checked to insure that the inner cavity of the block's oil filter pad is completely sealed to eliminate partial bypassing.

IGNITION SYSTEM

All production 60-degree Chevrolet V6s are equipped with HEI (High Energy Ignition) systems. The spark timing in all 1981 and later passenger cars equipped with V6/60 engines is controlled entirely by the vehicle's electronic control module. 1982-84 S-10 pickups and Blazers have

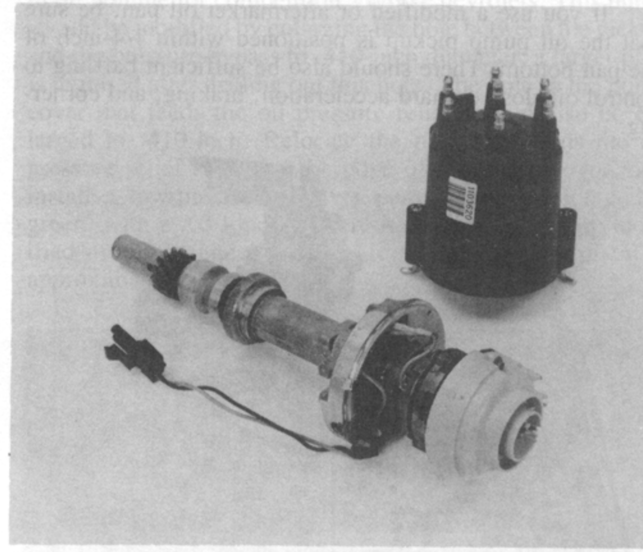

Figure 88 — Production S-10 distributor has small-diameter cap.

Figure 89 — S-10 distributor has vacuum cannister and magnetic pickup (right). Eliminate vacuum advance and connect pickup directly to Chevrolet heavy-duty ignition box for off-road racing.

conventional mechanical and vacuum controls for spark timing. This conventional ignition system can be more easily modified for racing and high-performance applications. S-10 truck distributors also have remote-mounted coils, and are recommended for installations which require a small diameter distributor cap for carburetor clearance.

When preparing an HEI ignition with centrifugal spark advance, the distributor curve should be tailored to produce a maximum of 37 degrees spark advance at 4000 rpm. Mark the harmonic damper at 37 degrees BTDC so the spark timing can be set with the engine at speed. For information on troubleshooting HEI distributors, refer to the ignition chapter of this manual.

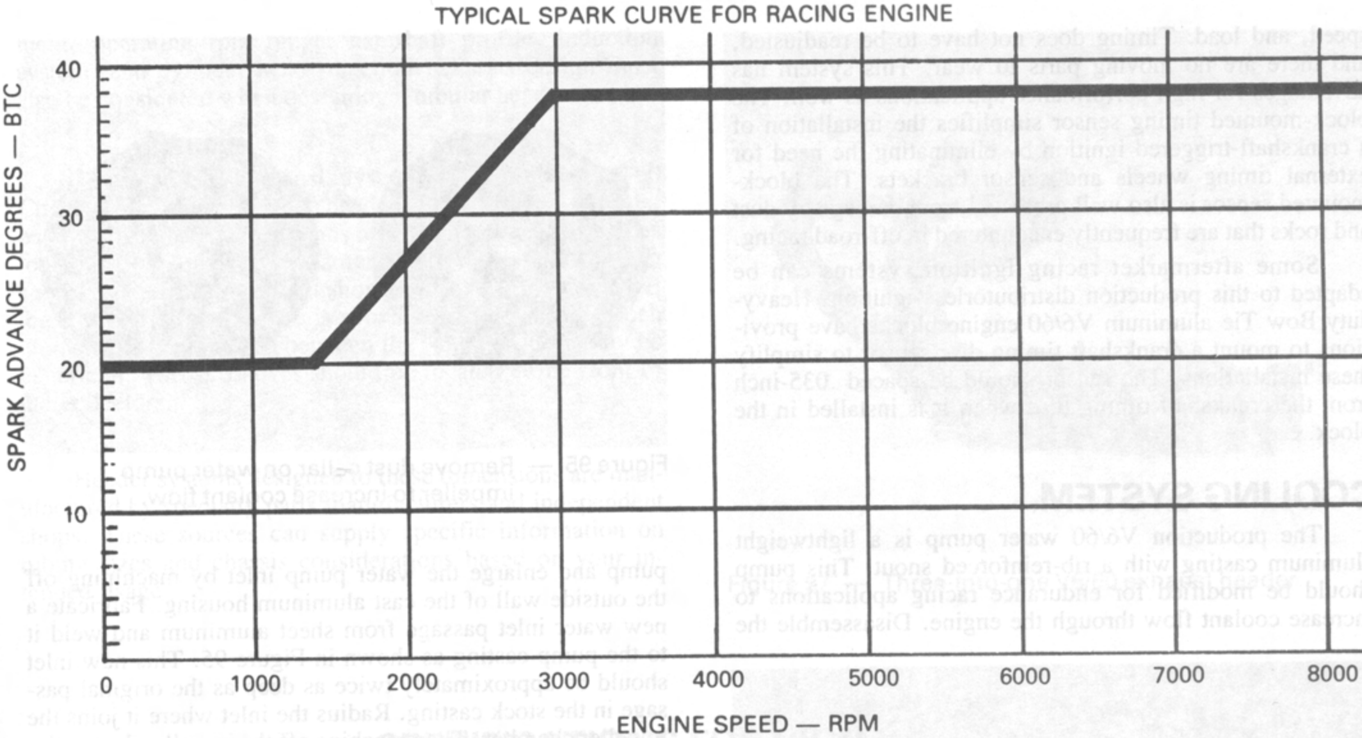

Figure 90 — Typical spark advance curve for V6/60 racing engine.

1987 and later 2.8-liter V6/60 "Generation II" engines installed in front-wheel-drive passenger cars are equipped with a Computer Controlled Coil (C3) ignition system. This sophisticated ignition uses three separate coils instead of a conventional distributor. Each coil is assigned to a pair of cylinders. A magnetic pickup mounted in the side of the engine block senses notches which are machined in the crankshaft's integral timing disc/counterweight. These notches provide reference signals for an electronic module in the coil assembly, which in turn sends a pulse to the vehicle's electronic control module (ECM). The ECM then fires the appropriate coil.

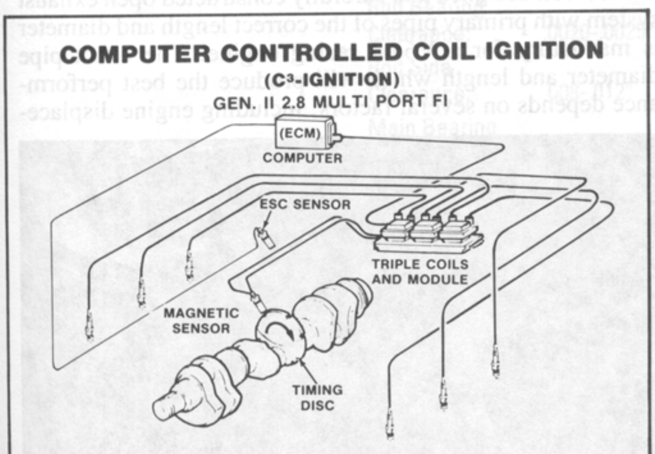

Figure 91 — Generation II V6/60 has direct fire distributorless ignition system.

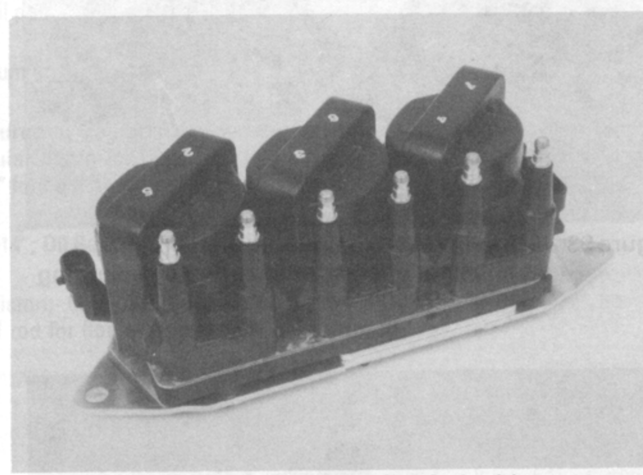

Figure 92 — Coil pack for direct fire C3 ignition.

An Electronic Spark Control (ESC) is also included in the production C3 ignition system. The ESC employs an engine-mounted accelerometer that senses detonation when the spark timing is too far advanced. The ESC automatically retards (within preprogrammed limits) the ignition spark to just below the threshold of detonation. ESC provides the optimum spark timing for the octane rating of the fuel being burned under the existing operating conditions (including ambient air temperature, humidity, and atmospheric pressure).

This direct-fire distributorless ignition produces extremely accurate spark timing. Spark advance is varied by the ECM to adjust for changing operating conditions, engine speed, and load. Timing does not have to be readjusted, and there are no moving parts to wear. This system has advantages for high-performance applications as well. The block-mounted timing sensor simplifies the installation of a crankshaft-triggered ignition by eliminating the need for external timing wheels and sensor brackets. The block-mounted sensor is also well protected from damage by dust and rocks that are frequently encountered in off-road racing.

Some aftermarket racing ignition systems can be adapted to this production distributorless ignition. Heavy-duty Bow Tie aluminum V6/60 engine blocks have provisions to mount a crankshaft timing disc sensor to simplify these installations. The sensor should be spaced .035-inch from the crankshaft timing disc when it is installed in the block.

COOLING SYSTEM

The production V6/60 water pump is a lightweight aluminum casting with a rib-reinforced snout. This pump should be modified for endurance racing applications to increase coolant flow through the engine. Disassemble the pump and enlarge the water pump inlet by machining off the outside wall of the cast aluminum housing. Fabricate a new water inlet passage from sheet aluminum and weld it to the pump casting as shown in Figure 95. This new inlet should be approximately twice as deep as the original passage in the stock casting. Radius the inlet where it joins the impeller chamber. Then machine off the impeller dust collar as shown in Figure 97.

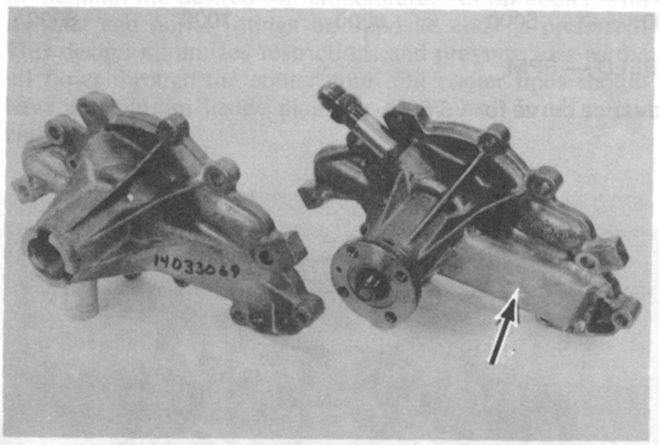

Figure 93 — Modify V6/60 aluminum water pump housing for endurance racing by enlarging inlet passage.

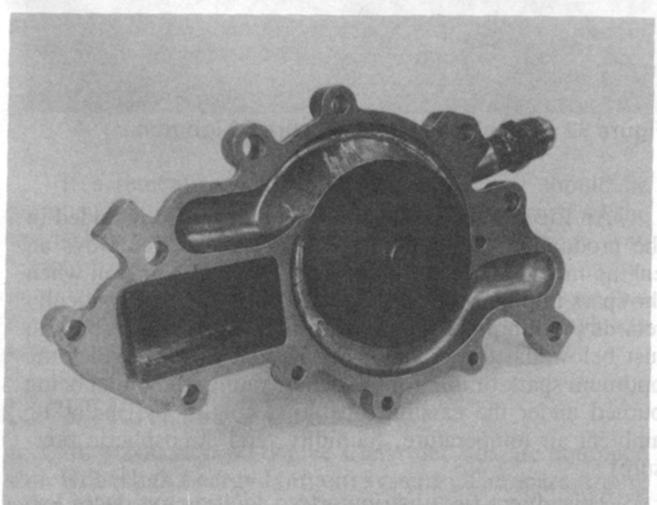

Figure 94 — Rear view of enlarged water pump inlet passage.

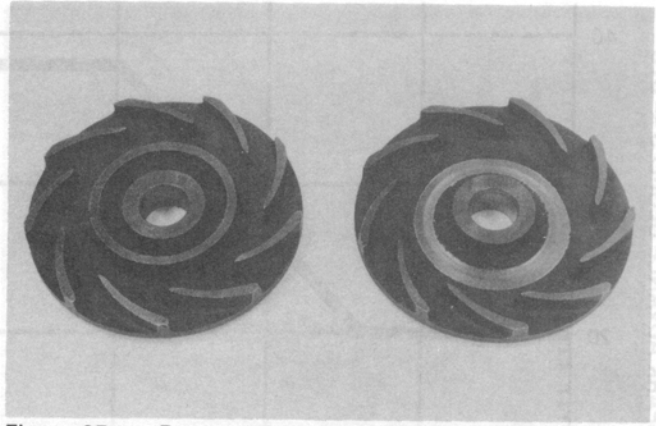

Figure 95 — Remove dust collar on water pump impeller to increase coolant flow.

EXHAUST SYSTEM

Production 2.8-liter Chevrolet V6s are equipped with cast iron exhaust manifolds which are ideal for engine swaps, street rods, and other non-stock installations. *Part number 14054859* (left) and *part number 14033087* (right) are two typical S-10 exhaust manifolds that can be adapted to many rear-wheel-drive chassis configurations. A dual exhaust system with low-restriction Corvette mufflers and a cross-over pipe ahead of the mufflers will perform well on high-performance V6/60 engines which are not subject to emission regulations. The Citation LH-7 (X-11) exhaust system is the least restrictive factory-produced exhaust for front-wheel-drive vehicles.

A well designed and carefully constructed open exhaust system with primary pipes of the correct length and diameter is mandatory for a V6/60 racing engine. The exact pipe diameter and length which will produce the best performance depends on several factors, including engine displace-

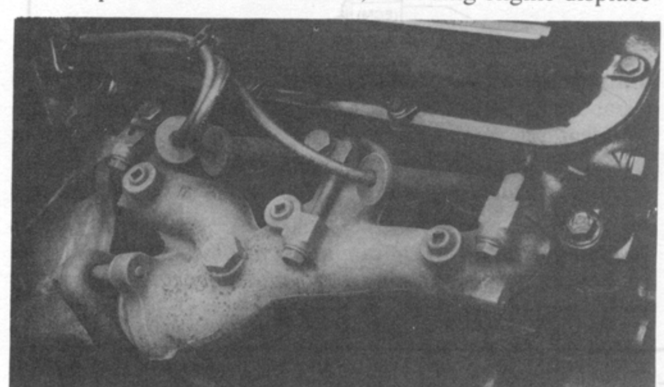

Figure 96 — Production cast iron exhaust manifold.

ment, operating rpm range, camshaft profile, induction system, and cylinder head selection. Chassis design must also be considered when designing a tubular header system.

The preferred exhaust system for a racing V6/60 Chevrolet is a three-into-one header system for each cylinder bank. Primary pipe dimensions of 1 5/8-inch OD x 26 inches long feeding 2 1/2-inch diameter collectors have proven successful. Collector length should be at least 33 inches. If the engine operating range is above 4000 rpm, a 2 1/4-inch diameter crossover pipe between the two collectors may be beneficial. This crossover should be located at the front of the collectors.

Header systems designed to these dimensions are manufactured by specialty parts manufacturers and independent shops. These sources can supply specific information on tubing sizes and chassis considerations based on your intended usage.

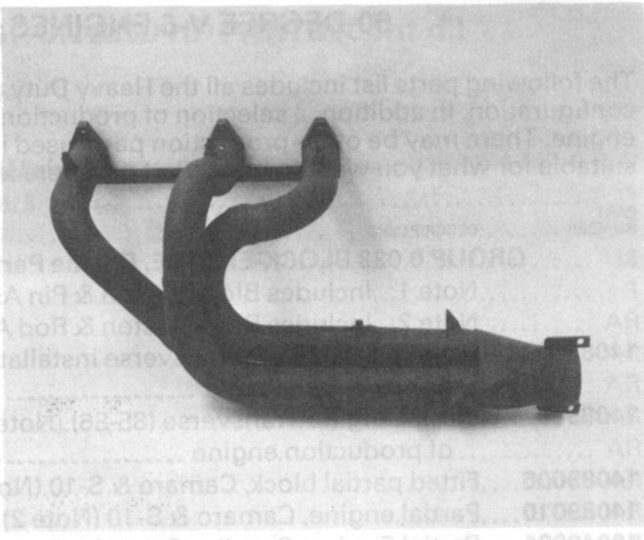
Figure 97 — Three-into-one V6/60 exhaust header.

SPECIFICATIONS FOR HIGH PERFORMANCE USE

Spark Advance:	Maximum of 36-40
Maximum Oil Temp:	300 degrees in oil pan
Minimum Fuel Pressure:	4-5 psi at maximum engine speed
Piston to Bore Clearance:	.006-.007″ measured at centerline of wrist pin hole perpendicular to pin for Chevrolet forged piston; .002-.003″ for cast pistons
Minimum Piston Ring End Gap:	Top .016″; 2nd .014″; Oil Rails .016″
Wrist Pin Clearance:	.0006-.0008″ in piston; .0010-.0012″ in rod (.0005-.0008″ in bushed rod for floating pin, 0-.005″ end play preferred)
Rod Bearing Clearance:	.0020-.0025″
Rod Side Clearance:	.008-.012″
Main Bearing Clearance:	.002-.0025″
Crank End Play:	.004-.007″
Piston to Cylinder Head:	.035″ minimum
Valve to Piston Clearance:	.050″ for intake and exhaust NOTE: These are to be considered absolute minimum clearances for an engine to run below the valvetrain limiting speed. If you intend to run up to valvetrain limiting speed, more clearance should be allowed. It is common practice to allow .100″ intake and exhaust valve clearance for engines used in drag racing.