HPBooks

HOW TO HOTROD YOUR BUICK V6

Details modifications to cylinder heads, blocks & crankshafts. How to prepare & set up intake, ignition & oiling systems. Technical data & blueprinting details. Comprehensive Heavy-Duty Parts list.

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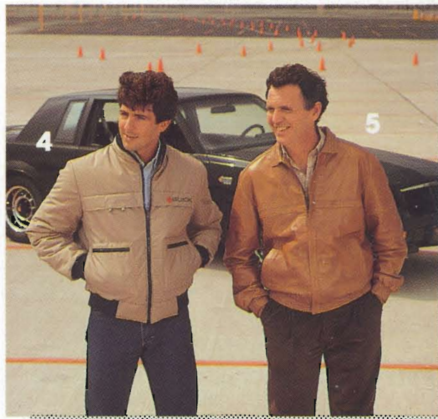

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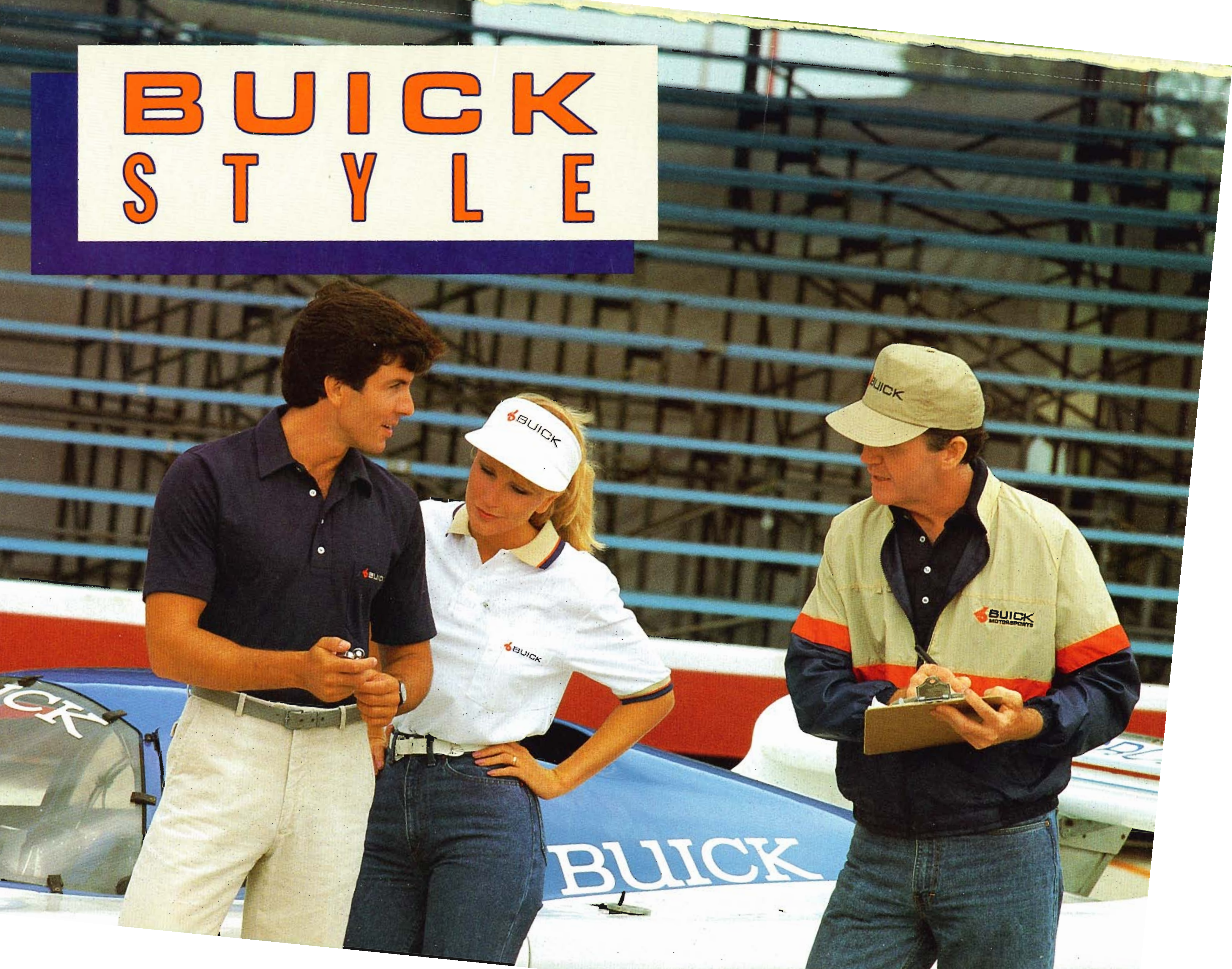

HPBooks®

HOW TO HOTROD YOUR
BUICK V6

Look for the Buick V6 logo to take on increasing significance with performance engine builders. This "arrow" is on target because it symbolizes today's performance engine . . . ***the Buick V6.***

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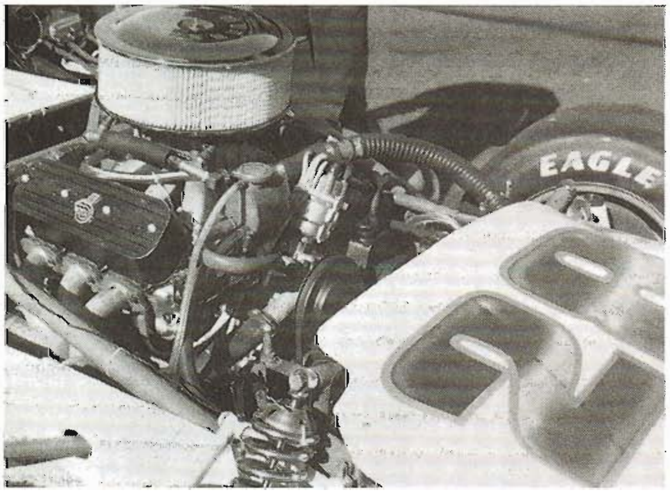
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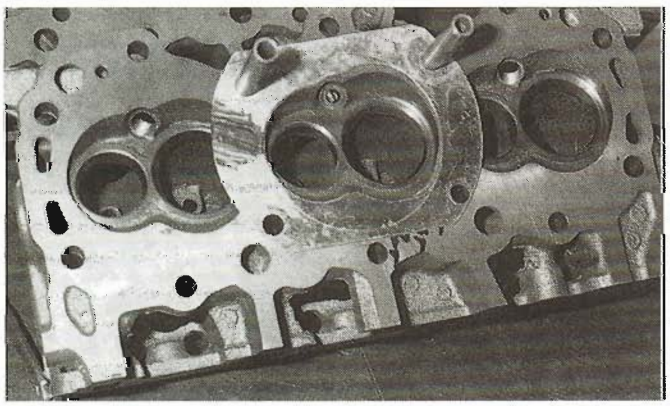

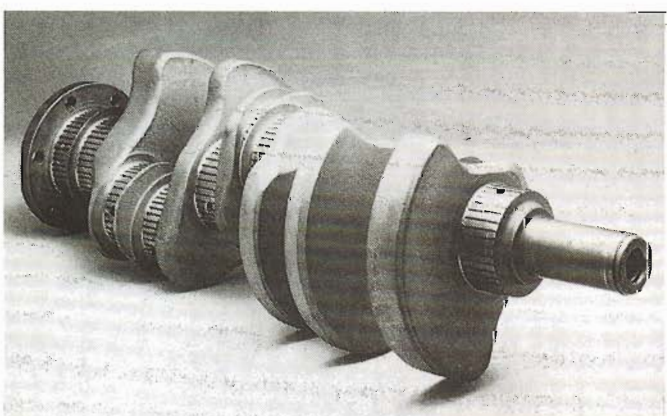

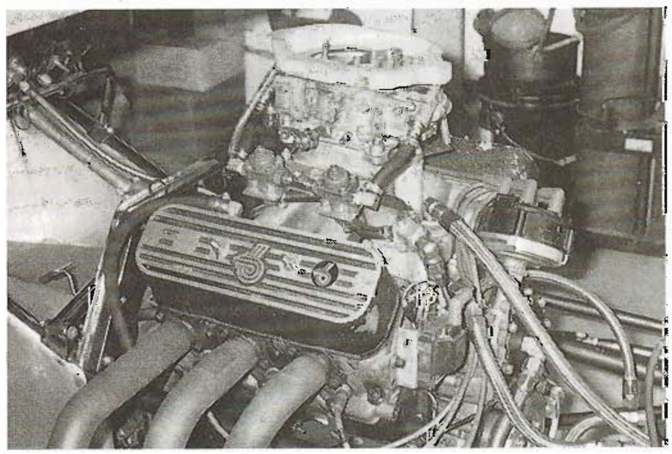

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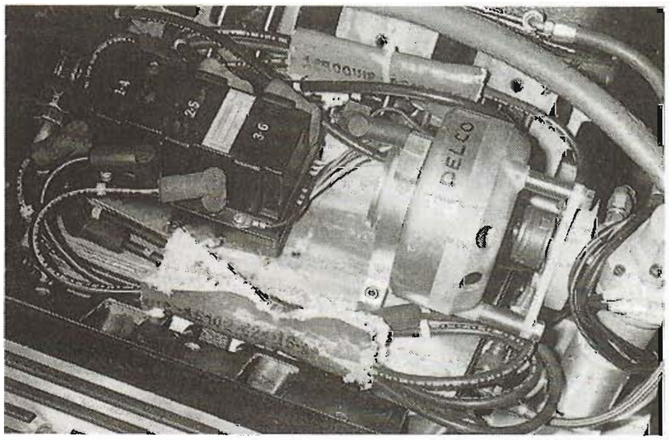


DELCO

Building a High-Perform

This information and related specifications are intended to aid anyone preparing a Buick V6 for heavy-duty or off-highway use. Basic engine specifications and building suggestions apply to road, oval track or drag racing unless specifically noted otherwise.

Buick V6 engines have been built in the following displacements.

Engine Specifications

V6 Displacement	Bore × Stroke	Years Produced
198	3.625 × 3.200	1962–63
225	3.750 × 3.400	1964–67
231–3.8L	3.800 × 3.400	1975–86
252–4.1L	3.965 × 3.400	1980–84
196–3.2L	3.500 × 3.400	1978–79
181–3.0L	3.800 × 2.660	1982–86

All current production Buick V6 engines (regardless of displacement) are built on common tooling, which means items such as camshafts, valvetrain hardware, rod and main bearings, distributors, etc., are interchangeable. All production crankshafts, connecting rods and pistons are cast. Engines are built for manual and automatic transmission applications. In production there are front- and rear-wheel-drive blocks; the difference is in the bellhousing bolt pattern, oil pan flange and starter location. The heavy-duty Stage I and II blocks referred to in this volume are of a rear-wheel-drive bolt-pattern configuration and cannot be used in a front-wheel-drive configuration without modification.

It is also important to understand that Buick-built V6 engines are used by other General Motors Divisions. You can readily identify the Buick-built V6 by noting that the distributor is placed at the front of the engine, whereas the distributor in V6 engines built by other GM divisions is at the rear of the engine adjacent to the bellhousing.

Buick Motor Division is currently building both front- and rear-wheel-drive assemblies. While the machining of components (bore centers, etc.) is basically the same, many pieces do not interchange between front- and rear-wheel-drive engines. For instance, a front-wheel-drove block does not bolt to a rear-wheel-drive bellhousing or an automatic transmission. This volume concerns itself only with rear-wheel-drive hardware and the modifications needed to make that hardware heavy-duty.

Competitive Combinations

The Buick V6 engine is quite flexible in terms of the number of displacements that can be built using both production and aftermarket hardware. Displacements of 2.5 liters (151 cubic inches) to 4.5 liters (272 cubic inches) are easily attainable. The 2.5L and 4.5L engines should not be considered displacement limits for the Buick V6; they are simply *practical* limits.

2.5L (151 cubic inches)

In 1979, Buick built some 3.2L (196-cubic-inch) engines in production. By using this 3.500-inch bore block and a production 3.0L crank having a stroke of 2.66 inches, the 2.5L V6 engine becomes a reality with a production block and crank. By using a 6.5-inch connecting rod, compression height of the piston is an acceptable 1.70 inches. Stage I cylinder heads would be adequate for this displacement. A professionally assembled engine built to these dimensions can be raced at 8000 rpm. The 2.5L Buick V6 would be a formidable package in many forms of racing because it has a wide torque curve (much wider than the curves offered by the 4-cylinder engines it would be competing against).

3.0L (182 cubic inches)

There are a number of competitive arenas for 3.0L engines. Currently, the 3.0L displacement can be raced in IMSA GT/P either normally aspirated or turbocharged. In addition to finding a home in SCCA's Trans Am class in turbocharged form, this package makes an impressive powerplant for midget racing.

The 3.0L displacement can be reached with a 3.800-inch bore and a 2.66-inch stroke, which is a highly oversquare package. Stage I cylinder heads are adequate for this displacement if it is normally aspirated. A rod length of 6.35 inches is recommended for this engine. This is the same rod length that a production 3.0L engine has. As more Buick V6 competition engines are built, it is increasingly evident that rod length has little or nothing to do with horsepower or torque; so, you should consider using the longest rod practical to minimize cylinder wall loading. With the above mentioned dimensional package, some dome will be needed to obtain adequate compression ratio (12.5:1) for competition. If this engine is built using Stage I cylinder heads, rpm should be limited to 6500. Stage II valvetrain should be limited to 8500.

3.4L (209 cubic inches)

Current CART/USAC rules allow turbocharged stock block engines to compete against exotic racing engines. Two-dimensional configurations of this displacement have been built—4.00 x 2.75 inches and 3.800 x 3.06 inches. Both configurations produced identical torque and horsepower. Both configurations have been built with 6.5- and 5.9-inch rods, again with no difference. Thus, for the sake of durability the configuration of 3.800 x 3.06 inches with a 6.5-inch rod is recommended. These engines can safely be taken to 8800 rpm.

ance V6

In the 1985 running of the Indianapolis 500, stock block turbocharged Buick V6 engines were in competition. In racing form, the engine produces more than 800 horsepower at 8000 rpm.

Engine Features

Configuration	90° V6, two valves/cylinder
Horsepower	750 at 8000 rpm
Torque	540 lbs./ft. at 6000 rpm
Rev limit	8600 rpm
Turbo boost	57 in. Hg—absolute
Displacement	209 in^3
Ignition	Buick Computer Controlled Coil Ignition
Fuel system	Port fuel injected/mechanical
Bore	3.8 inches
Stroke	3.06 inches
Cylinder head	Buick Stage II, iron or aluminum
Valve lifters	Roller type with high-rev kit
Crankshaft	Buick forged, even-firing
Block	Buick cast-iron Stage II—four-bolt mains
Fuel	Methanol
Compression ratio	9:1
Intake valve	2.022-diameter titanium
Exhaust valve	Inconel 1.60 diameter
Connecting rod	Carrillo 6.5-inch
Piston	Forged-aluminum 1.5-inch compression height
Oil pressure	100 psi
Oil system	Dry-sump pumps fitted to Buick Stage II block
Pushrods	8.08-inch
Cam drive	Gear type
Camshaft	Hardened steel

4.0L (244 cubic inches)

The 4.0L Buick V6, normally aspirated, but with fuel injection, readily fits into the rules of IMSA GT/P. This is endurance racing at its finest, a point you must keep in mind when building a Buick V6 for this type of competition. The 4.0L engine has been successfully built in two configurations. One combination features a 4-inch bore, a 3.23-inch stroke, and a 6.5-inch rod. The other combination utilizes a 3.830-inch bore, a 3.500-inch stroke, and a 6.380-inch rod. The rod length in both combinations allows a compression height of 1.400 inches, which in turn cuts down on piston inventory. Due to the nature of the racing, these engines should be limited to 8000 rpm.

4.3L (265 cubic inches)

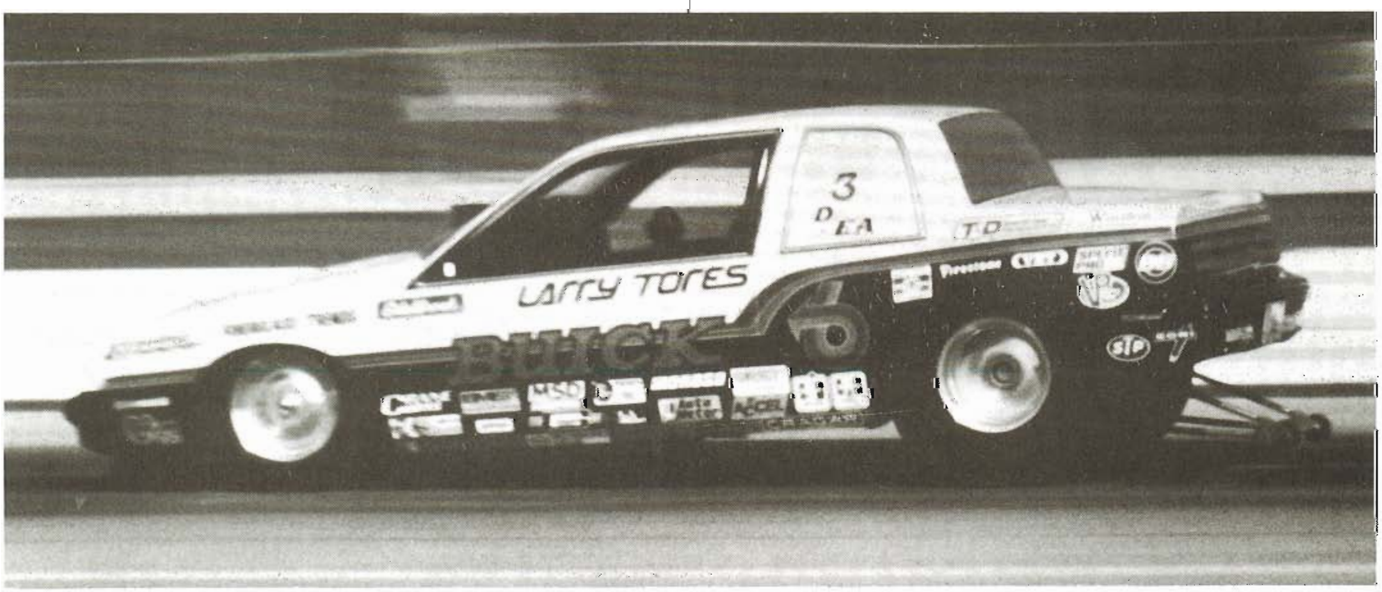
Several circle track associations have established classes for V6 engines limiting displacement to 265 cubic inches. These engines are easily built with a bore of 4 inches and a stroke of 3.5 inches, and with a rod length of 6.380 inches, a compression height of 1.400 inches is maintained. Like the other combinations, the 4.3L can be spun to 8000 rpm.

4.5L (272 cubic inches)

When allowed for competition, this displacement engine can be fashioned with a 4.00-inch bore and a 3.625-inch stroke. By using a 6.300-inch rod, compression height is maintained at 1.400 inches. Once again, 8000 rpm is the practical limit of operation.

All Displacement

In all cases, the rpm limit has been established assuming titanium valves are being used. If steel valves are to be used, rev limits should be lowered by 1000 rpm.

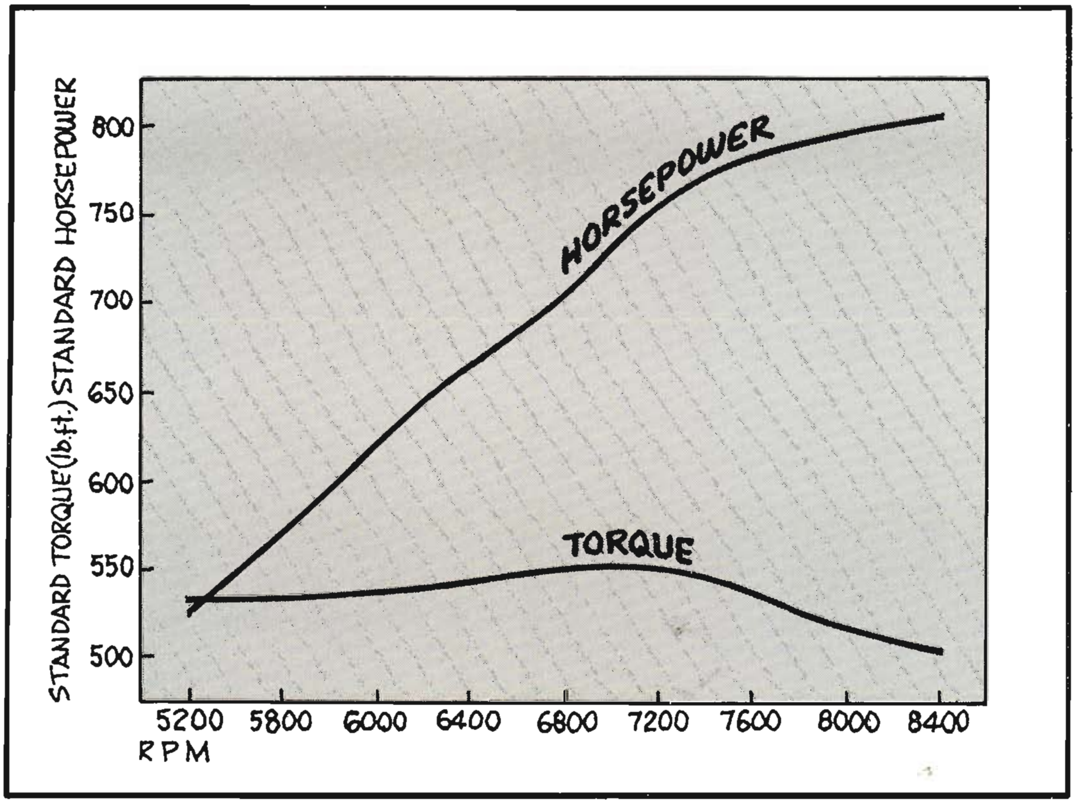


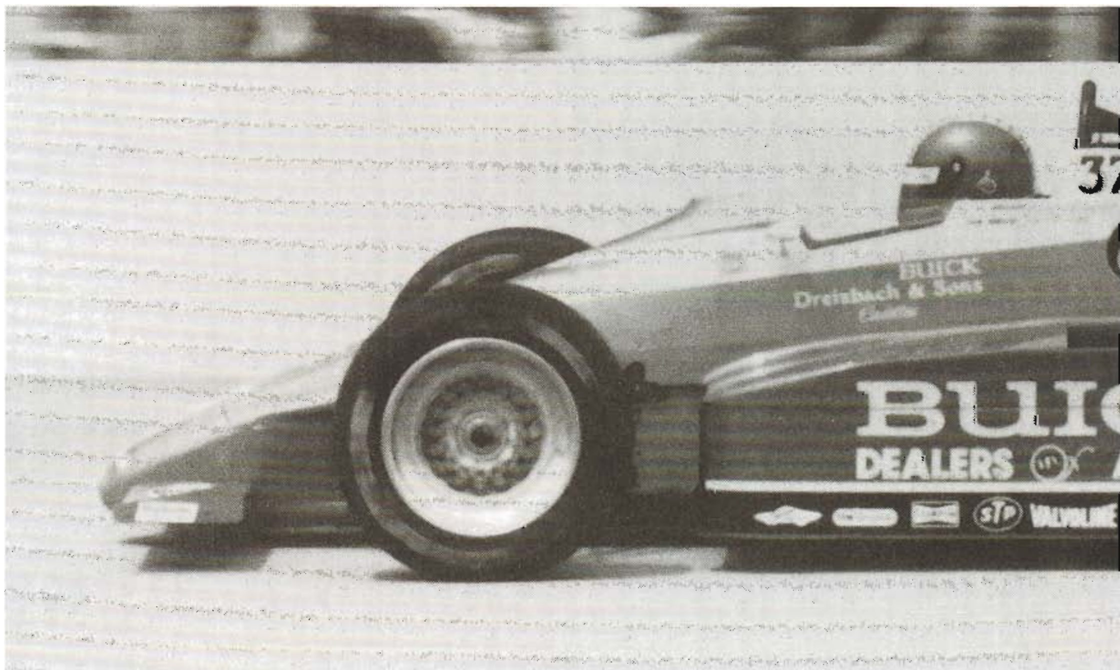
USAC Turbocharged Indy*

BUICK STAGE II ENGINE BUILD AND CHECK RECORD

Engine type	Indy
Displacement	3.4L
Fuel requirement	Methanol

**57 inches of boost*





Buick heavy-duty parts are designed and manufactured for off-highway use only.

PISTON

Piston make	Diamond	
Compression height	1.485	
Wristpin type; length	Diamond	2.750
Wristpin diameter	0.927	
Wristpin clearance in piston	0.0014	
Wristpin retainer type	Spirolocks	

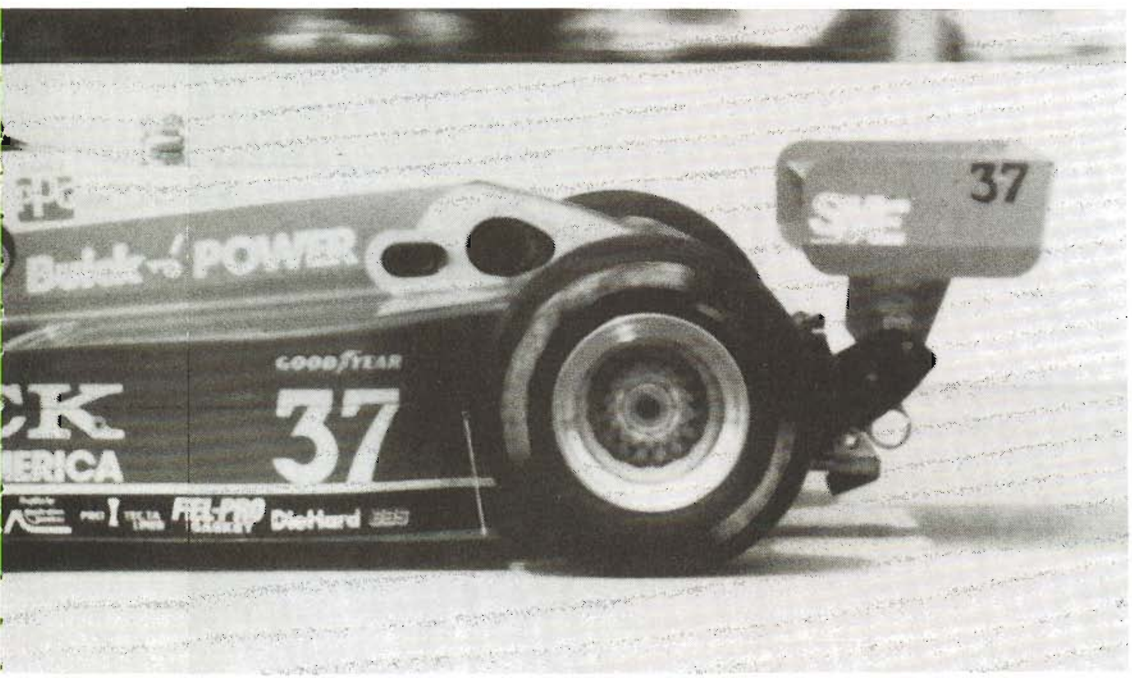
PISTON SIZE AND BORE CLEARANCE

Cylinder No.	**1**	**3**	**5**
Bore size	3.8000	3.8000	3.8000
Piston size	3.7924	3.7924	3.7923
Clearance	0.0076	0.0076	0.0077

Cylinder No.	**2**	**4**	**6**
Bore size	3.8000	3.8000	3.8000
Piston size	3.7925	3.7923	3.7923
Clearance	0.0075	0.0077	0.0077

PISTON RING

Ring set make; part No.	Sealed Power		
Top ring type; width; gap	Moly	1/16	0.020
2nd ring type; width; gap	RBT	1/16	0.018
Oil ring type; width; gap		3/16	



PISTON DECK CLEARANCE

Cylinder No.	1	3	5
Deck clearance	0.017	0.017	0.019
Cylinder No.	**2**	**4**	**6**
Deck clearance	0.018	0.017	0.017

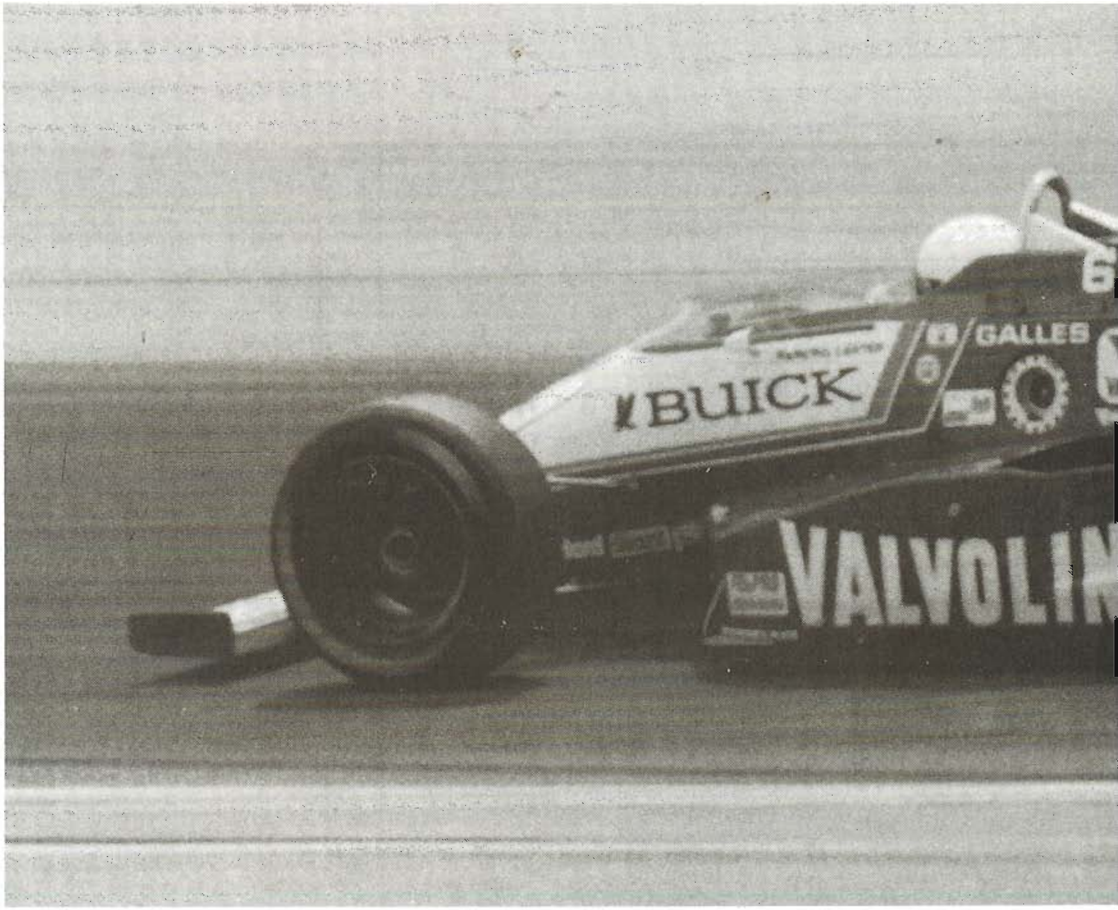
ENGINE BEARING

Main bearing make	Clevite
Rod bearing make	Vandervell

CRANKSHAFT

Crankshaft make; type	Moldex
Stroke	3.070
Endplay	0.0006

Main Bearing No.	1	2	3	4
Housing diameter	2.6875	2.6875	2.6875	2.6875
Housing diameter with bearing	2.5012	2.5012	2.5012	2.5012
Crankshaft main journal diameter	2.4987	2.4987	2.4987	2.4987
Main bearing clearance	0.0025	0.0025	0.0025	0.0025



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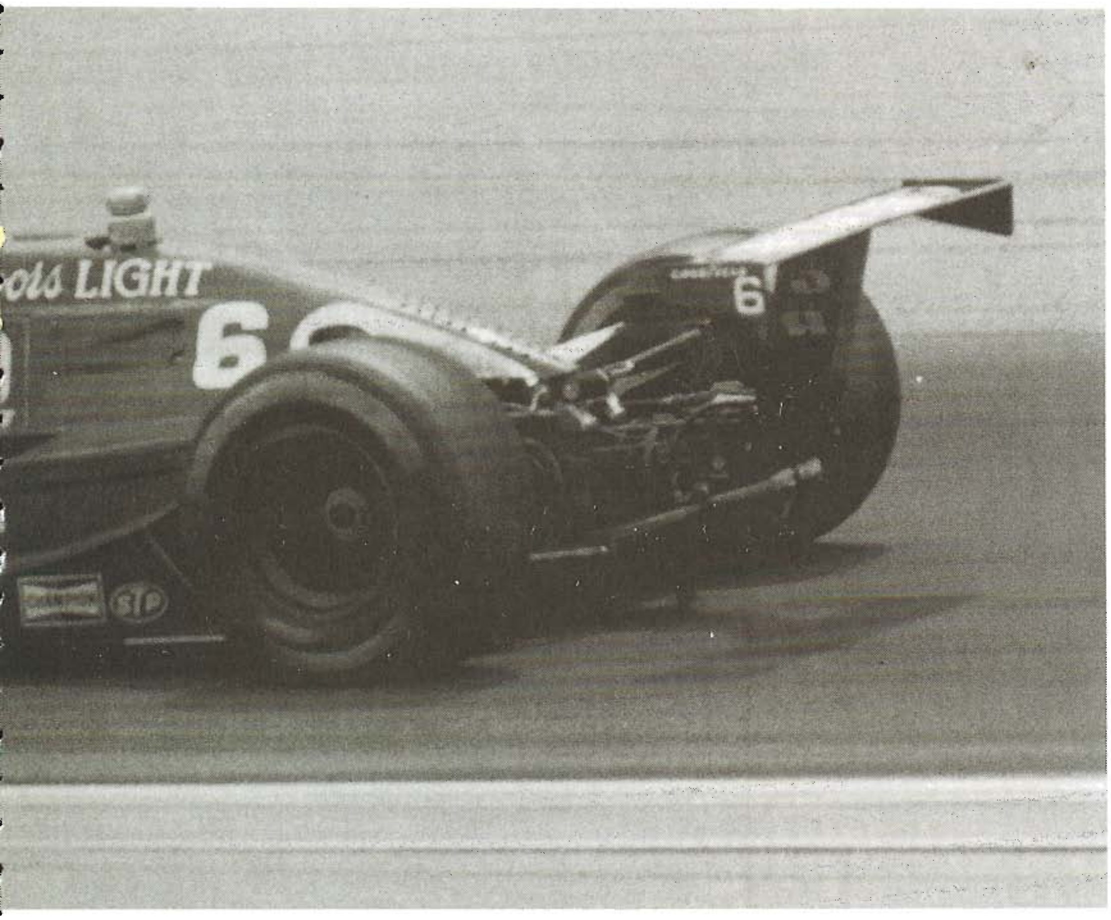
CONNECTING ROD

Rod make; type	Carrillo	Steel	
Length (center to center)	6.5		
Side clearance	0.010		
Wristpin bore diameter	0.9284		
Wristpin clearance in rod	0.0014		
Rod bolt make; size	7/16	SPS	
Rod bolt torque	90 ft./lbs.		
Connecting Rod No.	**1**	**3**	**5**
Housing diameter	2.3738	2.3738	2.3738
Housing diameter with bearing	2.2506	2.2505	2.2506
Crankshaft rod journal diameter	2.2482	2.2481	2.2482
Rod bearing clearance	0.0024	0.0024	0.0024
Connecting Rod No.	**2**	**4**	**6**
Housing diameter	2.3738	2.3738	2.3738
Housing diameter with bearing	2.2505	2.2505	2.2505
Crankshaft rod journal diameter	2.2481	2.2481	2.2481
Rod bearing clearance	0.0024	0.0024	0.0024



COMPRESSION RATIO

Piston at BDC in bore	
Swept volume*	570.3
Dome (–) or dish (+) volume	16
Ring land volume	1.5
Deck volume	3.1
Head gasket volume	8.4
Head chamber volume	40 cc
Total =	639.3

CR = total ÷ (total – swept volume)

CR = 9.25:1

**Swept volume [cc] = (bore)² × stroke × 12.87*

CYLINDER HEAD

Intake valve type; size	Titanium		2.080
Exhaust valve type; size	Titanium		1.600
Valve spring make; size	Reed		14296
Valve spring installed height	1.890		
Valve spring seat pressure	160		
Valve spring open pressure	450	at	1.300
Retainer make; material	Reed		Titanium
Keeper type	10°		
Chamber volume	40		
Head gasket type; thickness	Fel Pro		0.040
Valve seal make; type	PC		Teflon

Buick heavy-duty parts are designed and manufactured for off-highway use only.

CAMSHAFT

Drive make; type	Milodon	Gear drive
Cam make; No.	Buick	276°/400"/108°
Type of cam	Roller	
Camshaft lobe separation	108°	
Intake duration at 0.050	276°	
Exhaust duration at 0.050	276°	
Intake lobe center installed at	107°	
Intake lobe lift	0.400	
Exhaust lobe lift	0.400	
Intake valve-to-piston clearance	0.110 at 10° ATDC	
Exhaust valve-to-piston clearance	0.180 at 10° BTDC	
Intake valve lash	0.025	
Exhaust valve lash	0.025	

VALVETRAIN

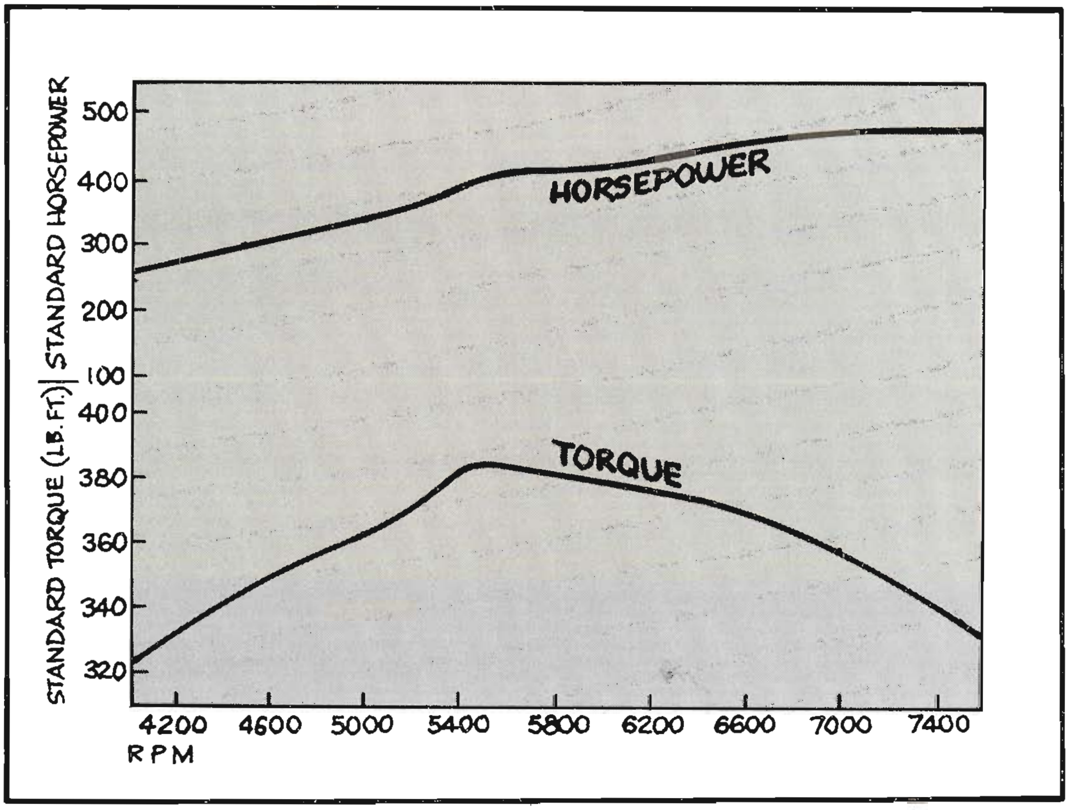
Rocker arm; make type	T & D	Roller
Rocker arm ratio	17	
Total intake lift at valve	0.655	
Total exhaust lift at valve	0.655	
Pushrod length; diameter	Dart	8.080
Lifter make; type	Iskenderian	Roller

NOTES

Trans Am

BUICK STAGE II ENGINE BUILD AND CHECK RECORD

Engine type	Stage II V6
Displacement	272 inches
Fuel requirement	Race gas



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PISTON

Piston make; type	Cosworth	Forged aluminum
Compression height	1.200	
Wristpin type	Cosworth	
Wristpin diameter	0.927	
Wristpin clearance in piston	0.0008	
Wristpin retainer type; size	Cosworth	0.927

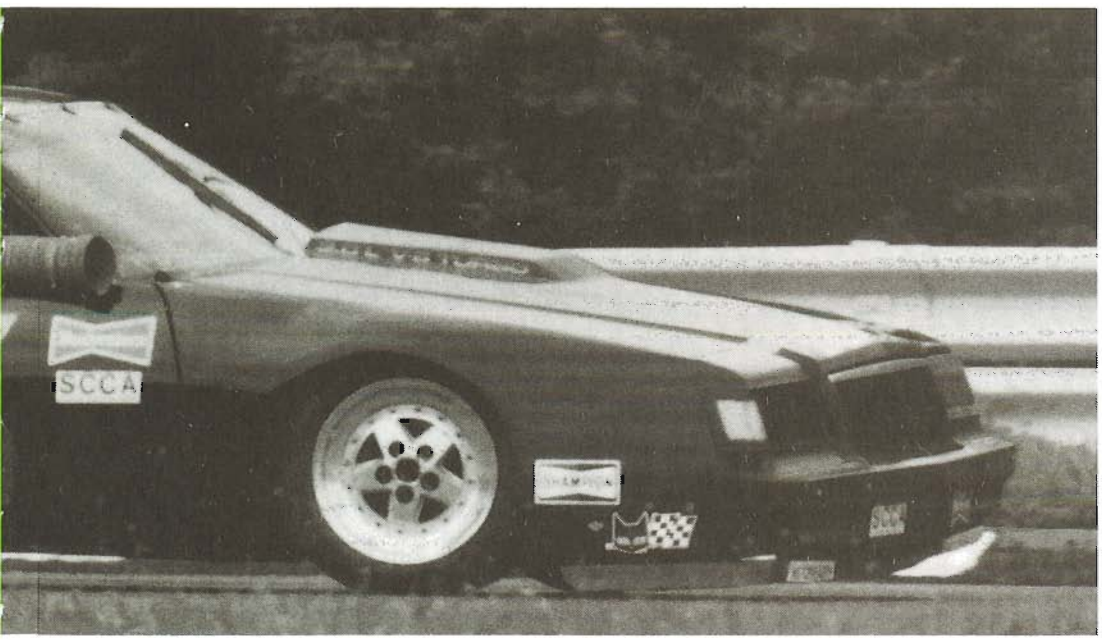
PISTON SIZE AND BORE CLEARANCE

Cylinder No.	**1**	**3**	**5**
Bore size	4.000	4.0003	4.0002
Piston size	3.944	3.9942	3.9942
Clearance	0.006	0.0061	0.006

Cylinder No.	**2**	**4**	**6**
Bore size	4.000	4.0002	4.0006
Piston size	3.9942	3.9942	3.9942
Clearance	0.0058	0.006	0.0062

PISTON RING

Make of ring set; part No.	Sealed Power	R9771	
Top ring type; width; gap	0.062	0.062	0.062
2nd ring type; width; gap	0.062	0.062	0.062
Oil ring type; width	0.189	0.189	



PISTON DECK CLEARANCE

Cylinder No.	1	3	5
Deck clearance	0.001	0.002	0.001

Cylinder No.	2	4	6
Deck clearance	0.002	0.002	0.002

ENGINE BEARING

Main bearing make; part No.	Vandervell	VP91265
Rod bearing make; part No.	Vandervell	VP91818

CRANKSHAFT

Crankshaft make; type	Moldex	Buick
Stroke	3.625	
Endplay	0.007	

Main Bearing No.	1	2	3	4
Housing diameter with bearing	2.5011	2.5012	2.5012	2.5012
Crankshaft main journal diameter	2.4988	2.4989	2.4988	2.4988
Main bearing clearance	0.0023	0.0023	0.0024	0.0024

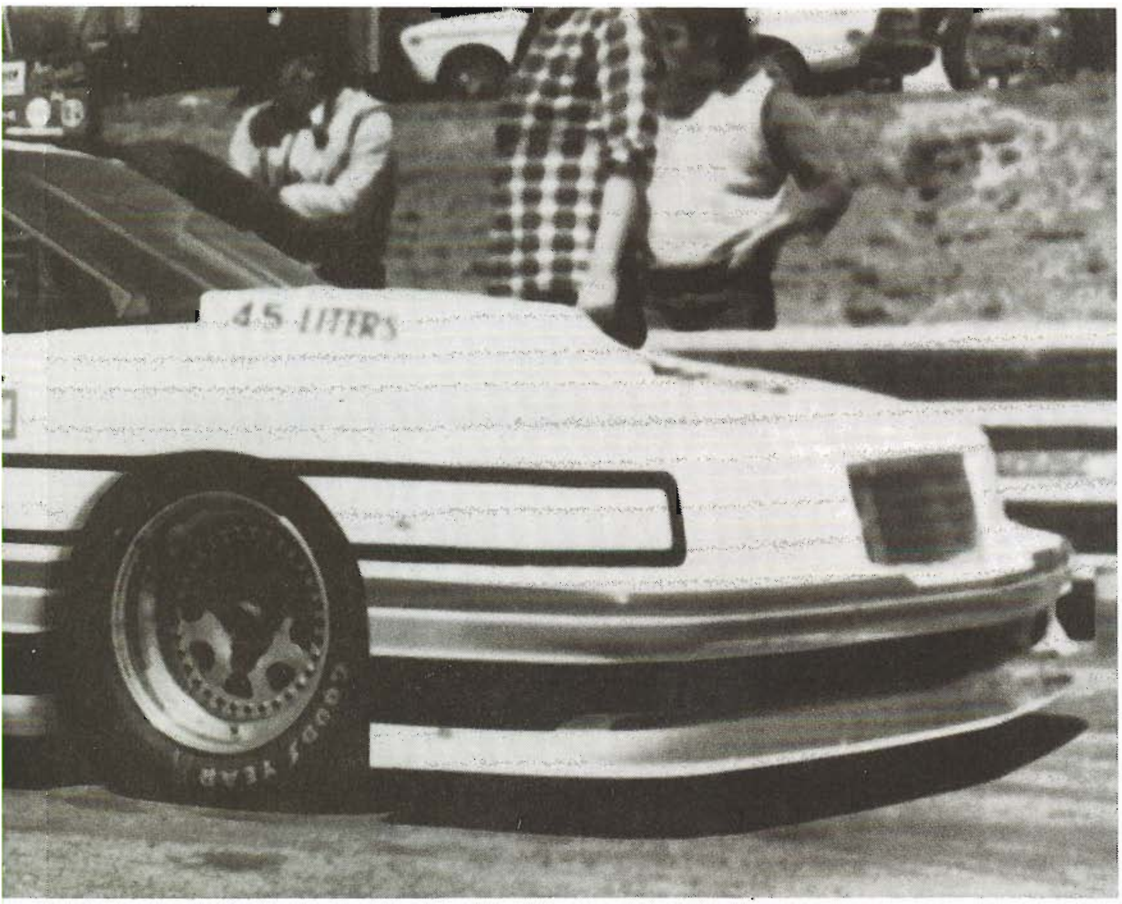
Buick heavy-duty parts are designed and manufactured for off-highway use only.

CONNECTING ROD

Rod make; type	Carrillo	Steel	
Length (center to center)	6.5		
Side clearance	0.012		
Wristpin bore diameter	0.928		
Wristpin clearance in rod	0.001		
Rod bolt make; size	SPS	7/16	
Rod bolt torque	90 ft./lbs.		

Connecting Rod No.	**1**	**3**	**5**
Housing diameter	2.3741	2.3741	2.3741
Housing diameter with bearing	2.251	2.251	2.2509
Crankshaft rod journal diameter	2.2483	2.2483	2.248
Rod bearing clearance	0.0027	0.0027	0.0029

Connecting Rod No.	**2**	**4**	**6**
Housing diameter with bearing	2.2509	2.251	2.2508
Crankshaft rod journal diameter	2.2482	2.2483	2.248
Rod bearing clearance	0.0027	0.0027	0.0028



COMPRESSION RATIO

Piston at BDC in bore	
Swept volume*	746.62
Dome (–) or dish (+) volume	+6.4
Head gasket volume	8.32
Head chamber volume	45.8 cc
Total =	807.14

CR = total ÷ (total – swept volume)

CR = 13.34:1

**Swept volume [cc] = (bore)² × stroke × 12.87*

CYLINDER HEAD

Intake valve type; size	Del West		208
Exhaust valve type; size	Del West		1.62
Valve spring installed height	1.850		
Valve spring seat pressure	185-195		
Valve spring open pressure	510-515	at	0.650
Retainer make	Competition Cams 732		
Keeper type	Competition Cams		611
Chamber type	Stage II Buick		
Head gasket type; thickness	Fel Pro		0.040
Valve seal make; type	PC		Teflon

NOTES

CAMSHAFT

Drive make; type	Milodon	Gear
Cam make; No.	Reed	
Type of cam	Roller	
Camshaft lobe separation	102°	
Intake duration at 0.050	267°	
Exhaust duration at 0.050	270°	
Intake lobe center installed at	99.75°	
Intake lobe lift	0.420	
Exhaust lobe lift	0.420	
Intake valve-to-piston clearance	119 at 10° ATDC	
Exhaust valve-to-piston clearance	106 at 10° BTDC	
Intake valve lash	0.022	
Exhaust valve lash	0.024	

VALVETRAIN

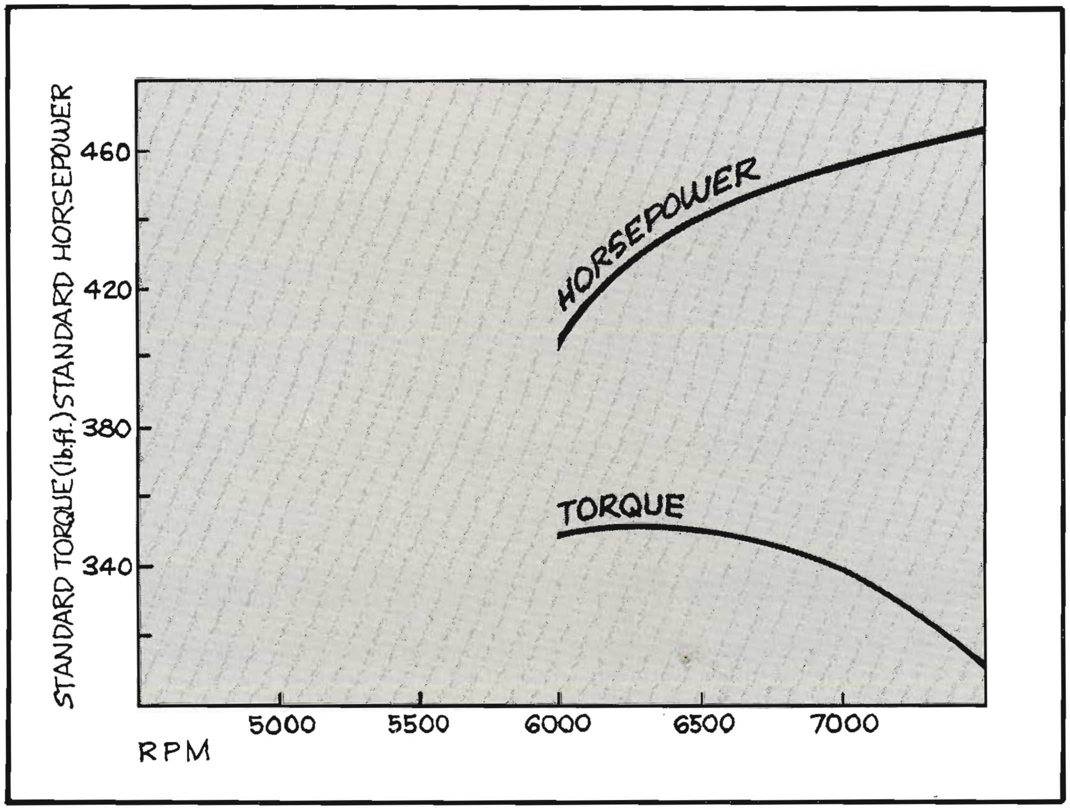
Rocker arm make; type	Roller	T & D
Rocker arm ratio	1.62/1.50	
Total intake lift at valve	0.647	
Total exhaust lift at valve	0.629	
Pushrod length; diameter	Iskenderian +0.250	5/16
Lifter make; type	Iskenderian	Roller

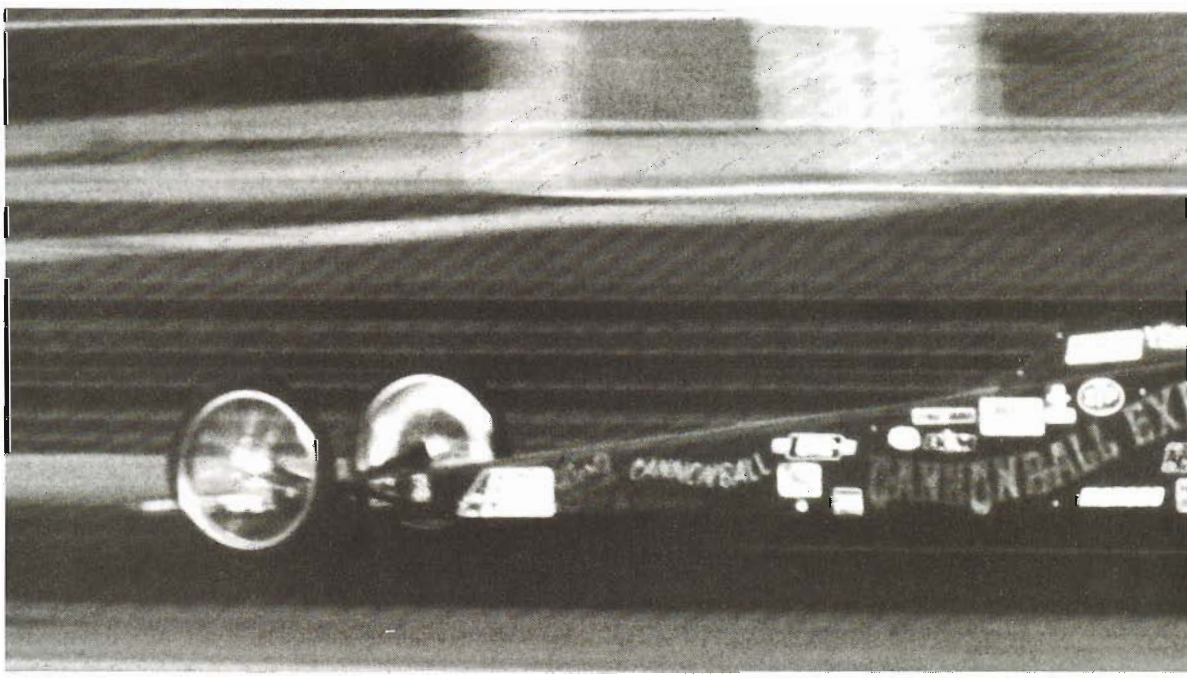
NOTES

Normally Aspirated Drag Race

BUICK STAGE II ENGINE BUILD AND CHECK RECORD

Engine type	Drag race
Displacement	256 inches
Fuel requirement	104+ octane gas





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PISTON

Piston make; type	Arias	Full skirt
Compression height	1.860	
Wristpin type; length	Tooled steel	0.927 x 2.75
Wristpin diameter	0.927	
Wristpin clearance in piston	0.0009	
Wristpin retainer type; size	Single Spirolocks	Stainless steel

PISTON SIZE AND BORE CLEARANCE

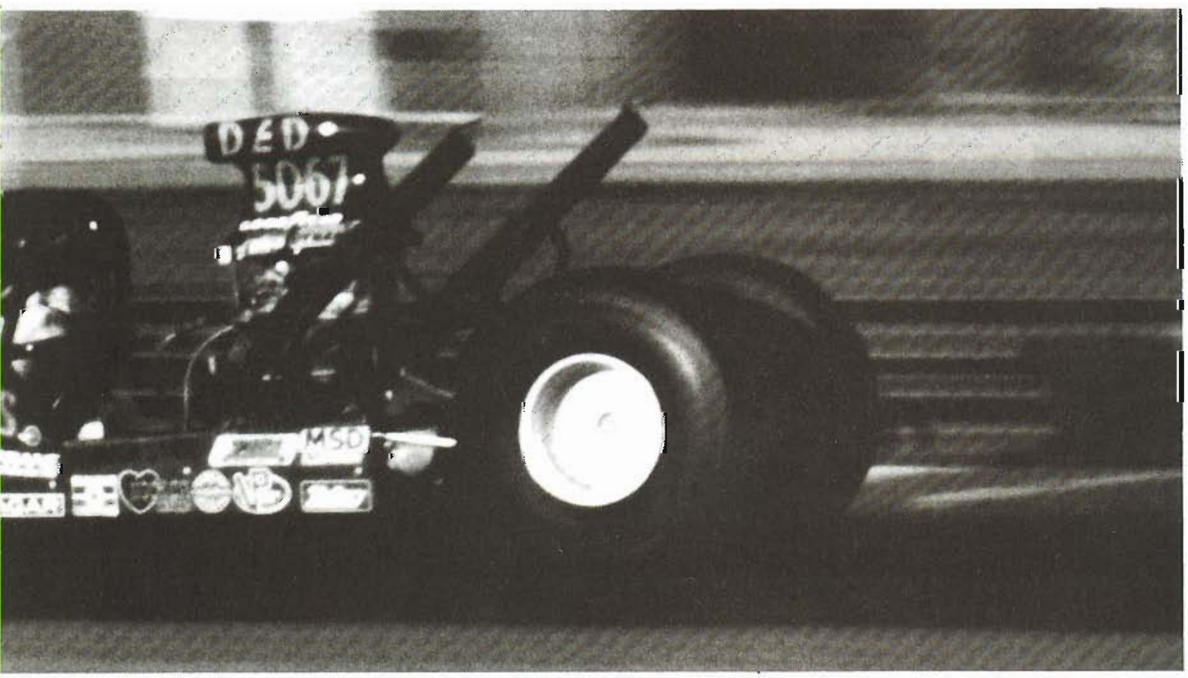
Cylinder No.	**1**	**3**	**5**
Bore size	4.001	4.001	4.001
Piston size	3.9918	3.9919	3.9916
Clearance	0.0092	0.0091	0.0094

Cylinder No.	**2**	**4**	**6**
Bore size	4.001	4.001	4.001
Piston size	3.9914	3.9916	3.9916
Clearance	0.0096	0.0094	0.0094

PISTON RING

Ring set make; part No.	Speed Pro	R9786	
Top ring type; width; gap	Moly ductile	0.043	0.018–0.020
2nd ring type; width; gap	Cast	0.062	0.018–0.020
Oil ring type; width; gap	3-piece	3/16	*

**Expander modified to 0.070 gap*



PISTON DECK CLEARANCE				
Cylinder No.	**1**	**3**	**5**	
Deck clearance	0.021	0.022	0.022	
Cylinder No.	**2**	**4**	**6**	
Deck clearance	0.023	0.022	0.022	
ENGINE BEARING				
Main bearing make; part No.	GMMA	400		
Rod bearing make; part No.	Vandervell*	VPR 812		
	**A 455 V8 bearing modified for V6 use*			
CRANKSHAFT				
Crankshaft make; type	Buick Forging	L.A. Billet		
Stroke	3.400			
Endplay	0.007			
Main Bearing No.	**1**	**2**	**3**	**4**
Housing diameter	2.6890	2.6890	2.6887	2.6885
Housing diameter with bearing	2.5017	2.5022	2.5018	2.5018
Crankshaft main journal diameter	2.4991	2.4990	2.4992	2.4991
Main bearing clearance	0.0026	0.0032	0.0026	0.0027

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CONNECTING ROD

Rod make; type	BME	Forged aluminum	
Length (center to center)	5.930		
Side clearance	0.009–0.011		
Wristpin bore diameter	0.9275		
Wristpin clearance in rod	0.0009		
Rod bolt make; size	BME	⅜	
Rod bolt torque	50 ft./lbs.		

Connecting Rod No.	**1**	**3**	**5**
Housing diameter	2.3742	2.3744	2.3742
Housing diameter with bearing	2.2516	2.2518	2.2516
Crankshaft rod journal diameter	2.2480	2.2479	2.2479
Rod bearing clearance	0.0036	0.0039	0.0037

Connecting Rod No.	**2**	**4**	**6**
Housing diameter	2.3742	2.3744	2.3742
Housing diameter with bearing	2.2515	2.2516	2.2517
Crankshaft rod journal diameter	2.2480	2.2479	2.2479
Rod bearing clearance	0.0036	0.0039	0.0037

COMPRESSION RATIO

Piston at BDC in bore	
Swept volume*	700.50
Dome (–) or dish (+) volume	+1.65
Ring land volume	0.70
Head gasket volume	12.35
Head chamber volume	42.3 cc
Total =	757.50

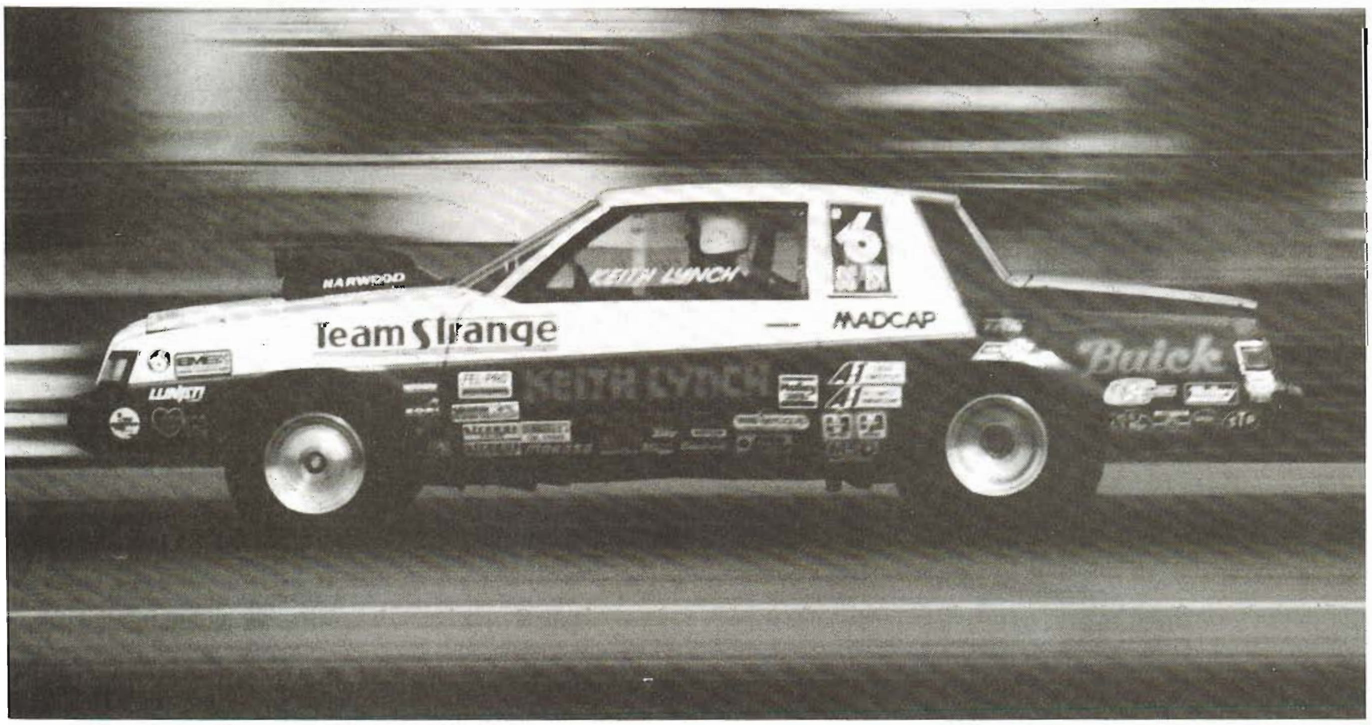
CR = total ÷ (total – swept volume)

CR = 13.28:1

**Swept volume [cc] = (bore)² × stroke × 12.87*

CYLINDER HEAD

Intake valve type; size	Del West titanium		2.050
Exhaust valve type; size	Del West titanium		1.600
Valve spring make	Crane		
Valve spring installed height	1.910		
Valve spring seat pressure	200		
Valve spring open pressure	650	at	1.180
Retainer make; material	Crane		Titanium
Keeper type	Crane		
Head gasket type; thickness	Fel Pro		0.038
Valve seal make; type	Sealed Power		Teflon



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CAMSHAFT

Drive make	Milodon	Gear
Cam make; No.	Crane	Roller
Type of cam	Roller	
Camshaft lobe separation	106°	
Intake duration at 0.050	276°	
Exhaust duration at 0.050	280°	
Intake lobe center installed at	104°	
Intake lobe lift	0.4334	
Exhaust lobe lift	0.4334	
Intake valve-to-piston clearance	0.095 at 10° ATDC	
Exhaust valve-to-piston clearance	0.156 at 10° BTDC	
Intake valve lash	0.028	
Exhaust valve lash	0.030	

VALVETRAIN

Rocker arm make; type	T & D	Roller
Rocker arm ratio	1.64	
Total intake lift at valve	0.728	
Total exhaust lift at valve	0.728	
Pushrod length; diameter	9⅝	⅜
Lifter make; type	Crane	Roller

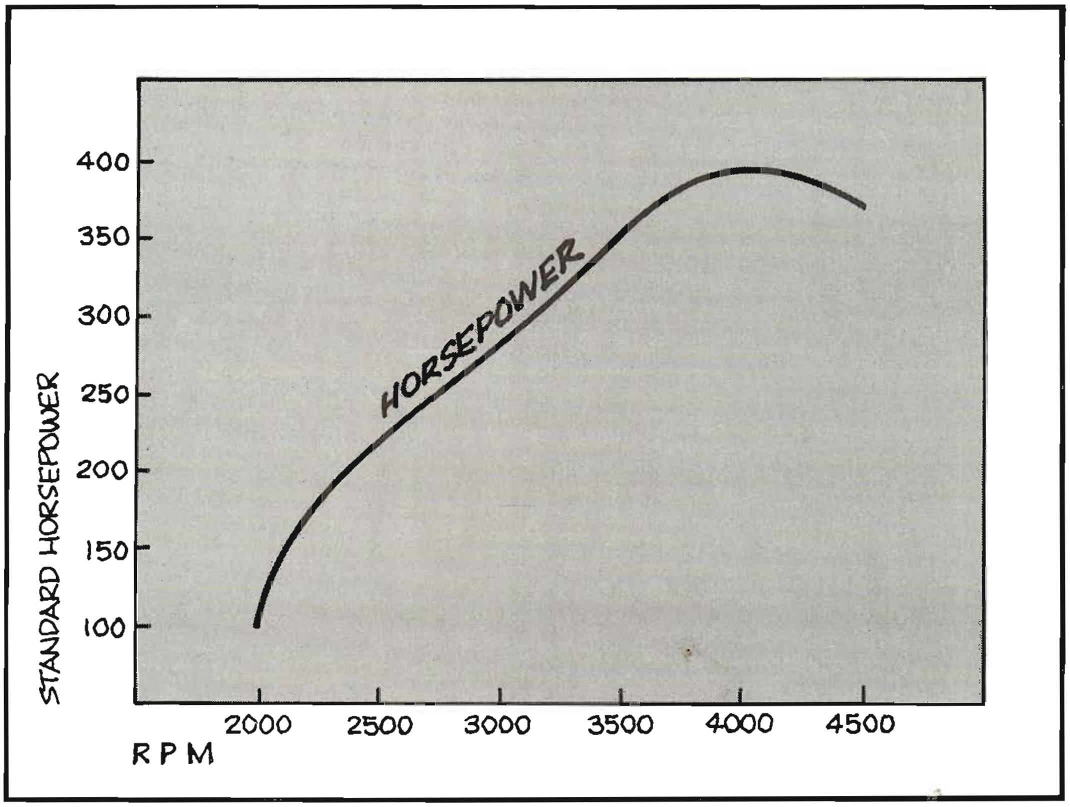
NOTES

*Turbocharged Drag Race**

BUICK STOCK ENGINE BUILD AND CHECK RECORD

Engine type	3.8 SFI
Displacement	231
Fuel requirement	Race gas

**24 inches of boost*



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PISTON

Piston make; type	Buick	Cast	
Compression height	1.825		
Wristpin type; length	Production	2.900	
Wristpin diameter	0.939		
Wristpin clearance in piston	0.0007		
Wristpin retainer type	Pressed		

PISTON SIZE AND BORE CLEARANCE

Cylinder No.	1	3	5
Bore size	3.833	3.833	3.833
Piston size	3.8305	3.831	3.8305
Clearance	0.0028	0.0027	0.0028

Cylinder No.	2	4	6
Bore size	3.833	3.833	3.833
Piston size	3.8308	3.8305	3.8305
Clearance	0.0028	0.0028	0.0028

PISTON RING

Make of ring set; part No.	Sealed Power	9944 KX	
Top ring type; width; gap	Moly	5/64	0.020
2nd ring type; width; gap	Cast	5/64	0.016
Oil ring type; width	SS504	3/16	

NOTES

PISTON DECK CLEARANCE			
Cylinder No.	**1**	**3**	**5**
Deck clearance	-0.068	-0.068	-0.068
Cylinder No.	**2**	**4**	**6**
Deck clearance	-0.070	-0.071	-0.070

ENGINE BEARING

Main bearing make; part No.	GM	Production
Rod bearing make; part No.	GM	Production

CRANKSHAFT

Crankshaft make; type	Buick	Cast
Stroke	3.4	
Endplay	0.005	

Main Bearing No.	1	2	3	4
Housing diameter	2.6874	2.6873	2.6871	2.6871
Housing diameter with bearing	2.5006	2.5006	2.5005	2.5005
Crankshaft main journal diameter	2.4981	2.4982	2.4984	2.4982
Main bearing clearance	0.0025	0.0024	0.0021	0.0023

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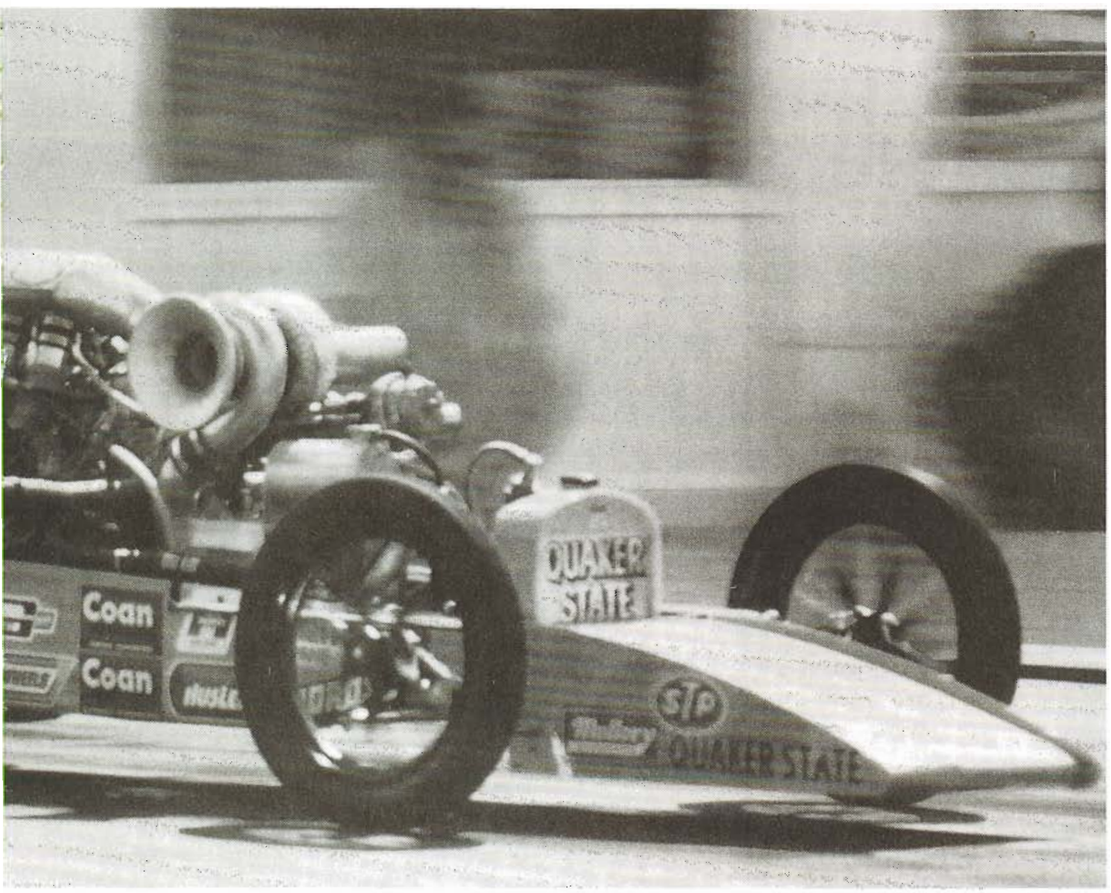
CONNECTING ROD

Rod make; type	Buick		
Length (center to center)	5.960		
Side clearance	0.0095		
Wristpin bore diameter	Press		
Wristpin clearance in rod	Press		
Rod bolt make; size	Stock	⅜	
Rod bolt torque	40 ft./lbs.		

Connecting Rod No.	**1**	**3**	**5**
Housing diameter	2.3741	2.3741	2.3741
Housing diameter with bearing	2.2511	2.2511	2.2511
Crankshaft rod journal diameter	2.2488	2.2488	2.2488
Rod bearing clearance	0.0023	0.0023	0.0023

Connecting Rod No.	**2**	**4**	**6**
Housing diameter	2.3741	2.3741	2.3741
Housing diameter with bearing	2.2511	2.2511	2.2511
Crankshaft rod journal diameter	2.2488	2.2489	2.2487
Rod bearing clearance	0.0023	0.0023	0.0023



COMPRESSION RATIO

Piston at BDC in bore		
Swept volume*	641.88	
Dome (–) or dish (+) volume	–23.6	
Deck volume	13.2	
Head gasket volume	5.03	
Head chamber volume	48.0	
Total =	731.7	

CR = total ÷ (total – swept volume)

CR = 8.14:1

**Swept volume [cc] = (bore)² × stroke × 12.87*

CYLINDER HEAD

Intake valve type; size	Stock		1.700
Exhaust valve type; size	Stock		1.500
Valve spring make; size	TRW		1.000
Valve spring installed height	1.735		
Valve spring seat pressure	88		
Valve spring open pressure	190	at	1.340
Retainer make; material	Stock		Steel
Keeper type	Crane		
Chamber type	Stock		0.021
Head gasket type; thickness	Fel Pro		0.041
Valve seal make	Stock		

NOTES

CAMSHAFT DATA

Drive make; type	Buick	Chain
Cam make; No.	Crane	CC 4342
Type of cam	Hydraulic	
Camshaft lobe separation	108°	
Intake duration at 0.050	230°	
Exhaust duration at 0.050	232°	
Intake lobe center installed at	109°	
Intake lobe lift	0.266°	
Exhaust lobe lift	0.270°	
Intake valve lash	0	
Exhaust valve lash	0	

VALVETRAIN

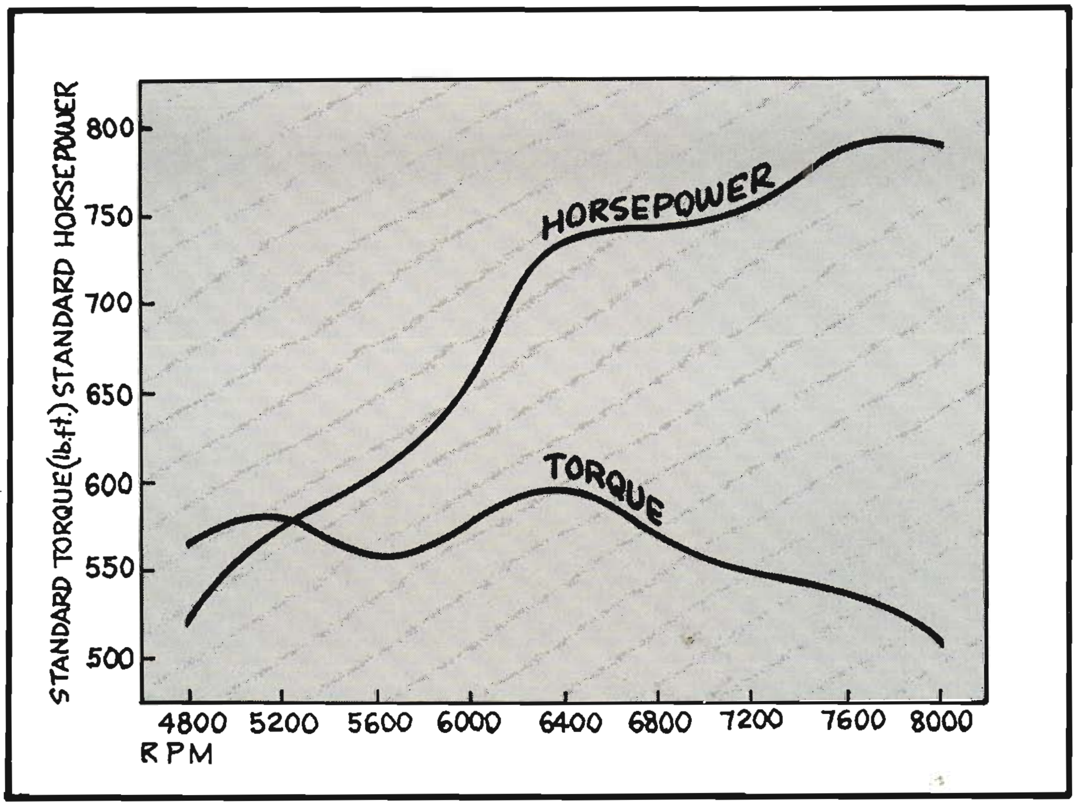
Rocker arm make; type	Buick	Stock
Rocker arm ratio	1.51	
Total intake lift at valve	0.401	
Total exhaust lift at valve	0.407	
Pushrod length; diameter	8.675	5/16
Lifter make; type	Stock	Hydraulic

NOTES

Turbocharged Road Race

BUICK STAGE II ENGINE BUILD AND CHECK RECORD

Engine type	IMSA
Displacement	3.4L
Fuel requirement	108 octane



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PISTON

Piston make; type	Diamond	Forged aluminum	
Compression height	1.480		
Wristpin type; length	Tapered Diamond	2.750	
Wristpin diameter	0.927		
Wristpin clearance in piston	0.0014		
Wristpin retainer type; size	Spirolocks	0.072	

PISTON SIZE AND BORE CLEARANCE

Cylinder No.	**1**	**3**	**5**
Bore size	3.7998	3.800	3.7997
Piston size	3.7918	3.7920	3.7918
Clearance	0.008	0.008	0.0079

Cylinder No.	**2**	**4**	**6**
Bore size	3.7998	3.800	3.7995
Piston size	3.7918	3.7920	3.7916
Clearance	0.008	0.008	0.0079

PISTON RING

Ring set make; part No.	Sealed power	R-9985 +0.005	
Top ring type; width; gap	Moly	1/16	0.020
2nd ring type; width; gap	Cast	1/16	0.018
Oil ring type; width	SS-50	3/16	

PISTON DECK CLEARANCE

Cylinder No.	1	3	5
Deck clearance	0.018	0.0195	0.018

Cylinder No.	2	4	6
Deck clearance	0.020	0.019	0.020

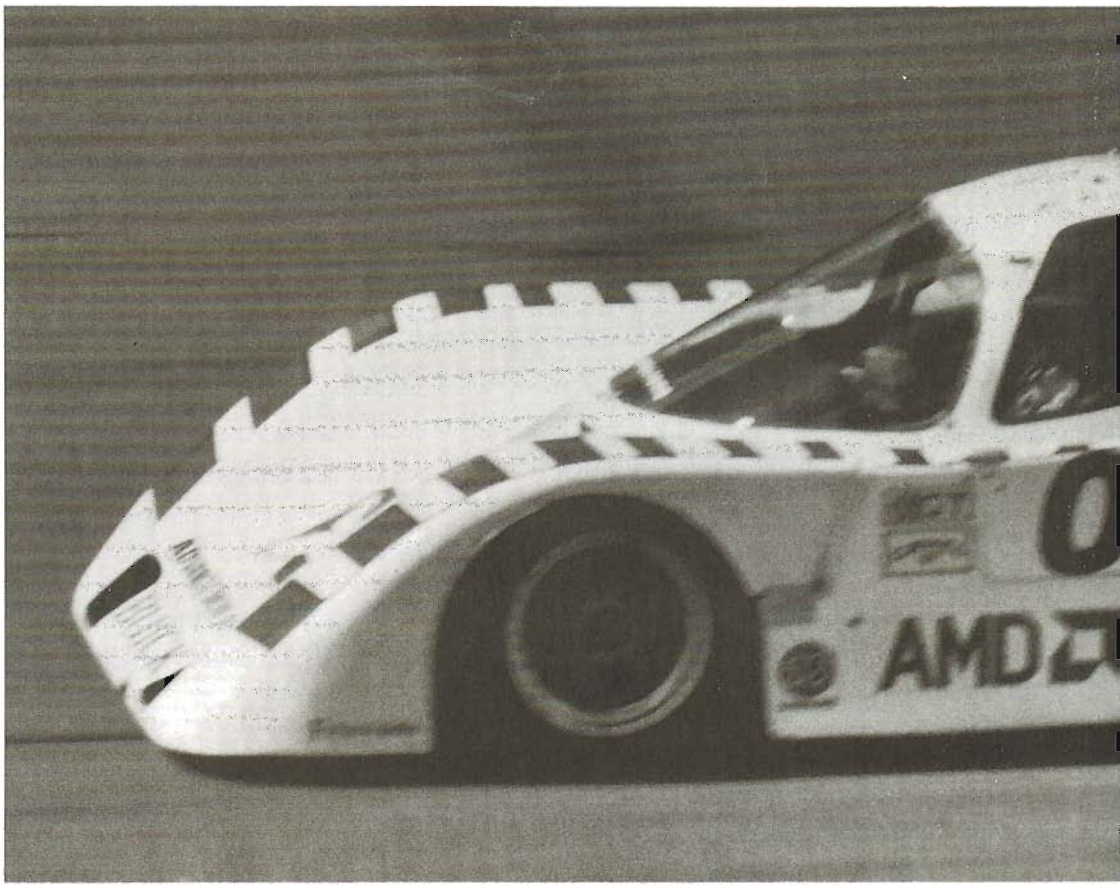
ENGINE BEARING

Main bearing make; part No.	GM-400	
Rod bearing make; part No.	CL-77	Experimental

CRANKSHAFT

Crankshaft make; type	Moldex	Forged steel
Stroke	3.070	
Endplay	0.006	

Main Bearing No.	1	2	3	4
Housing diameter	2.6875	2.6875	2.6875	2.6873
Housing diameter with bearing	2.5005	2.5005	2.5008	2.5007
Crankshaft main journal diameter	2.4980	2.4980	2.4980	2.4980
Main bearing clearance	0.0025	0.0025	0.0028	0.0027



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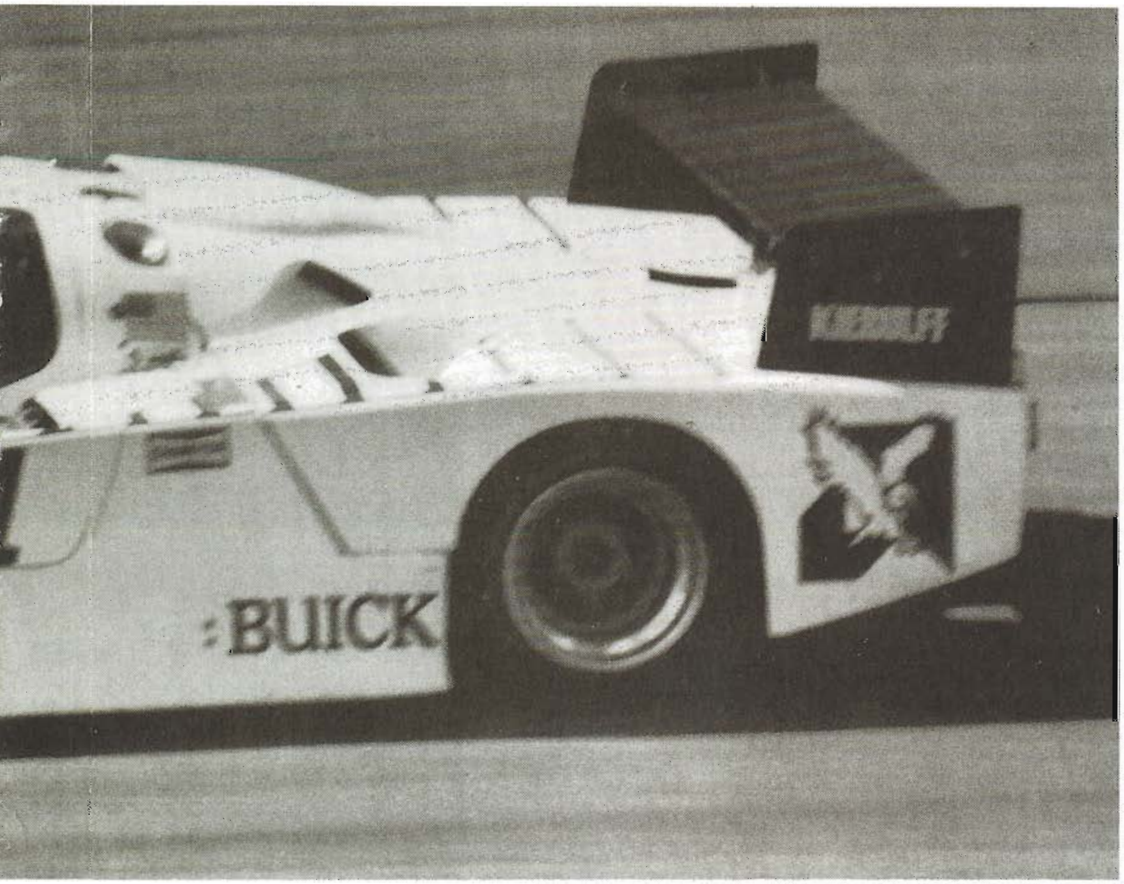
CONNECTING ROD

Rod make; type	Carrillo	Billet steel	
Length (center to center)	6.5		
Side clearance	0.010		
Wristpin bore diameter	0.927		
Wristpin clearance in rod	0.0014		
Rod bolt make; size	SPS	7/16	
Rod bolt torque	90 ft./lbs.		
Connecting Rod No.	**1**	**3**	**5**
Housing diameter	2.3740	2.3740	2.3740
Housing diameter with bearing	2.2508	2.2507	2.2507
Crankshaft rod journal diameter	2.2483	2.2482	2.2482
Rod bearing clearance	0.0025	0.0025	0.0025
Connecting Rod No.	**2**	**4**	**6**
Housing diameter	2.3740	2.3740	2.3740
Housing diameter with bearing	2.2507	2.2507	2.2506
Crankshaft rod journal diameter	2.2482	2.2482	2.2483
Rod bearing clearance	0.0025	0.0025	0.0023



COMPRESSION RATIO

Piston at BDC in bore	
Swept volume*	570.3
Dome (–) or dish (+) volume	21+
Ring land volume	0.
Deck volume	3.7
Head gasket volume	8.4
Head chamber volume	46 cc
Total =	649.4

CR = total ÷ (total – swept volume)

CR = 8.2:1

**Swept volume [cc] = $(bore)^2$ × stroke × 12.87*

CYLINDER HEAD

Intake valve type; size	Manley		2.080
Exhaust valve type; size	Manley inconel		1.600
Valve spring make; size	Reed		1.500
Valve spring installed height	1.890		
Valve spring seat pressure	160		
Valve spring open material	450	at	1.300
Retainer make; material	Reed		Titanium
Keeper type	10		
Chamber volume	46 cc		
Head gasket type; thickness	Fel Pro		0.040
Valve seal make; type	PC		Teflon

NOTES

CAMSHAFT

Drive make; type	Milodon	Gear
Cam make; No.	Buick	272/365-8
Cam type	Roller	
Camshaft lobe separation	108°	
Intake duration at 0.050	272°	
Exhaust duration at 0.050	272°	
Intake lobe center installed at	107°	
Intake lobe lift	0.365	
Exhaust lobe lift	0.365	
Intake valve-to-piston clearance	0.150 at 10° ATDC	
Exhaust valve-to-piston clearance	0.180 at 10° BTDC	
Intake valve lash	0.022 c; 0.025 h	
Exhaust valve lash	0.022 c; 0.025 h	

VALVETRAIN

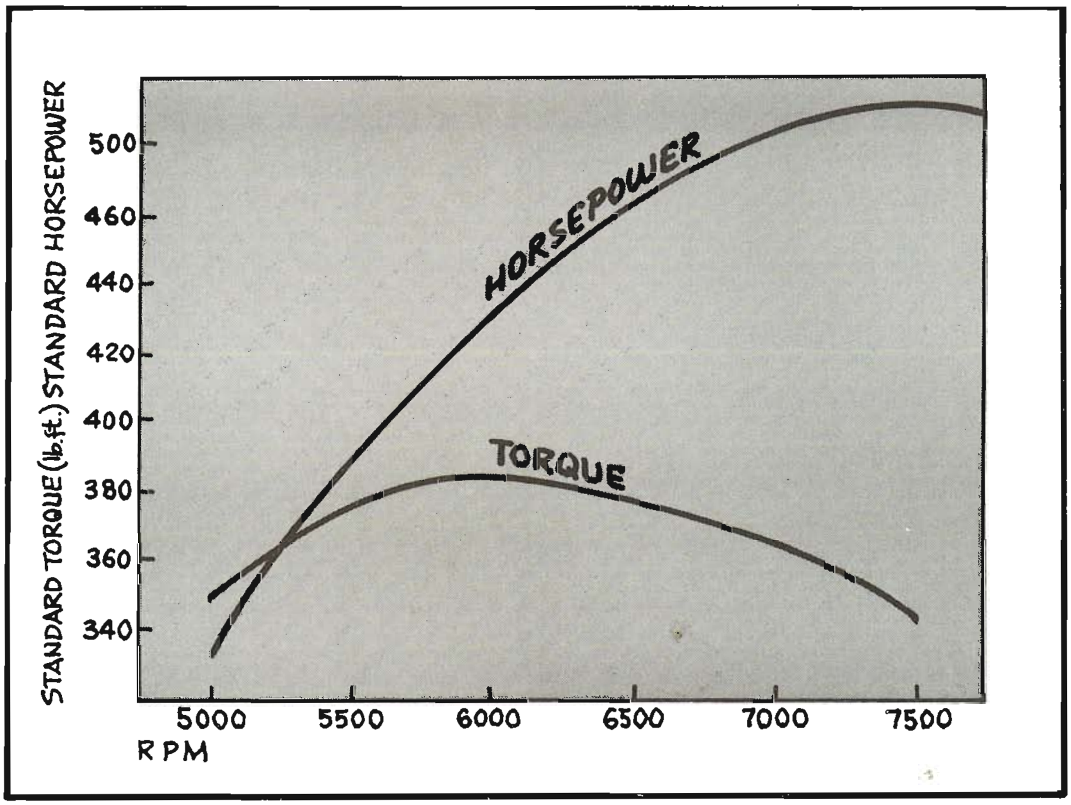
Rocker arm make; type	T & D	Roller
Rocker arm ratio	1.7	
Total intake lift at valve	0.595	
Total exhaust lift at valve	0.595	
Pushrod length; diameter	8.080	3/8
Lifter make; type	Iskenderian	Roller

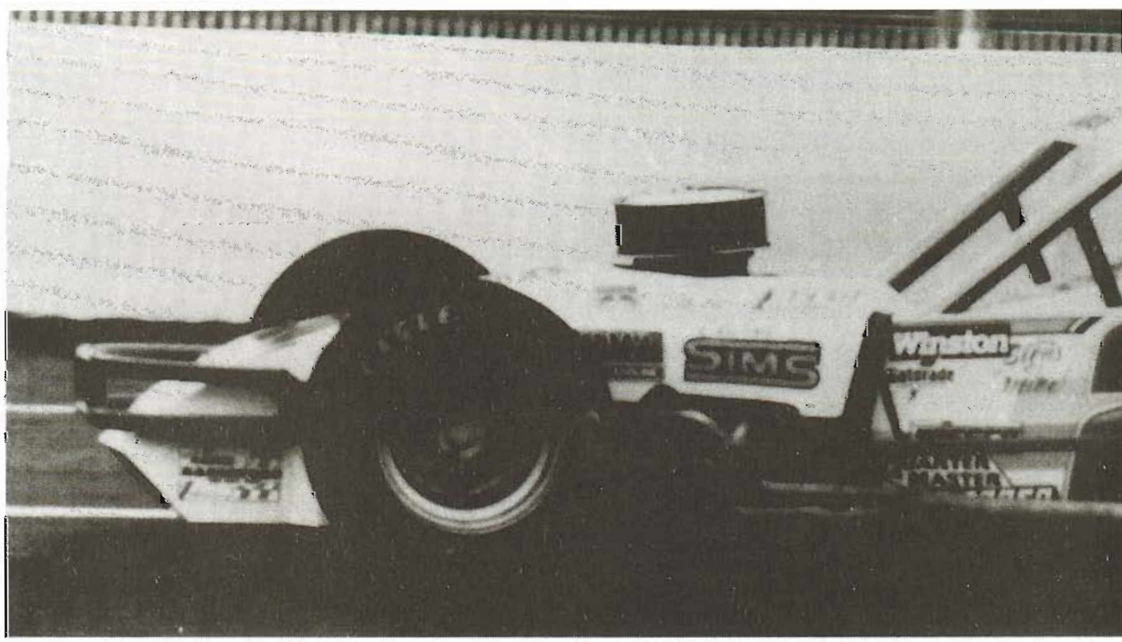
NOTES

Normally Aspirated Circle Track

BUICK STAGE II ENGINE BUILD AND CHECK RECORD

Engine type	NASCAR Sportsman
Displacement	274 inches
Fuel requirement	108 octane





PISTON

Piston make; type	Cosworth	Forged aluminum	
Compression height	1.35		
Wristpin type; length	Tapered tooled steel	2.827	
Wristpin diameter	0.927		
Wristpin clearance in piston	0.001		
Wristpin retainer type; size	Round wire	0.070	

PISTON SIZE AND BORE CLEARANCE

Cylinder No.	**1**	**3**	**5**
Bore size	4	4	4
Piston size	3.994	3.994	3.994
Clearance	006	006	006

Cylinder No.	**2**	**4**	**6**
Bore size	4	4	4
Piston size	3.994	3.994	3.994
Clearance	006	006	006

PISTON RING

Make of ring set; part No.	Speed Pro	R9787	
Top ring type; width; gap	Plasma Moly	0.043	0.018
2nd ring type; width; gap	Plain Iron	1/16	0.012
Oil ring type; width; gap	Chrome	3/16	025

PISTON DECK CLEARANCE

Cylinder No.	**1**	**3**	**5**	
Deck clearance	004	0065	004	
Cylinder No.	**2**	**4**	**6**	
Deck clearance	003	004	004	

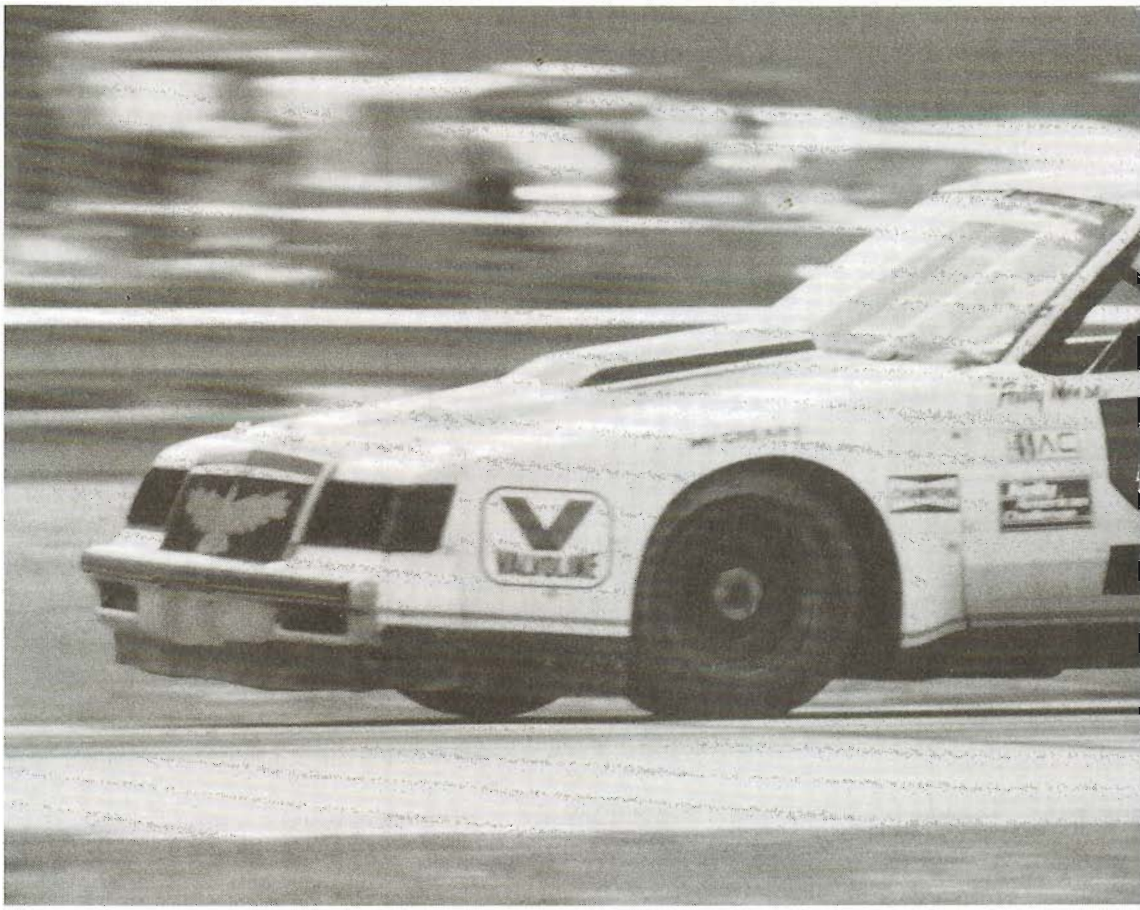
ENGINE BEARING

Main bearing make; part No.	GM 400	Standard
Rod bearing make; part No.	Vandervell	VP812

CRANKSHAFT

Crankshaft make; type	Moldex	Rolled fillet
Stroke	3.625	
Endplay	0.006	

Main Bearing No.	**1**	**2**	**3**	**4**
Housing diameter	2.6873	2.6869	2.6873	2.6866
Housing diameter with bearing	2.5009	2.5006	2.5008	2.5007
Crankshaft main journal diameter	2.4988	2.4987	2.4988	2.4987
Main bearing clearance	0021	0019	002	002

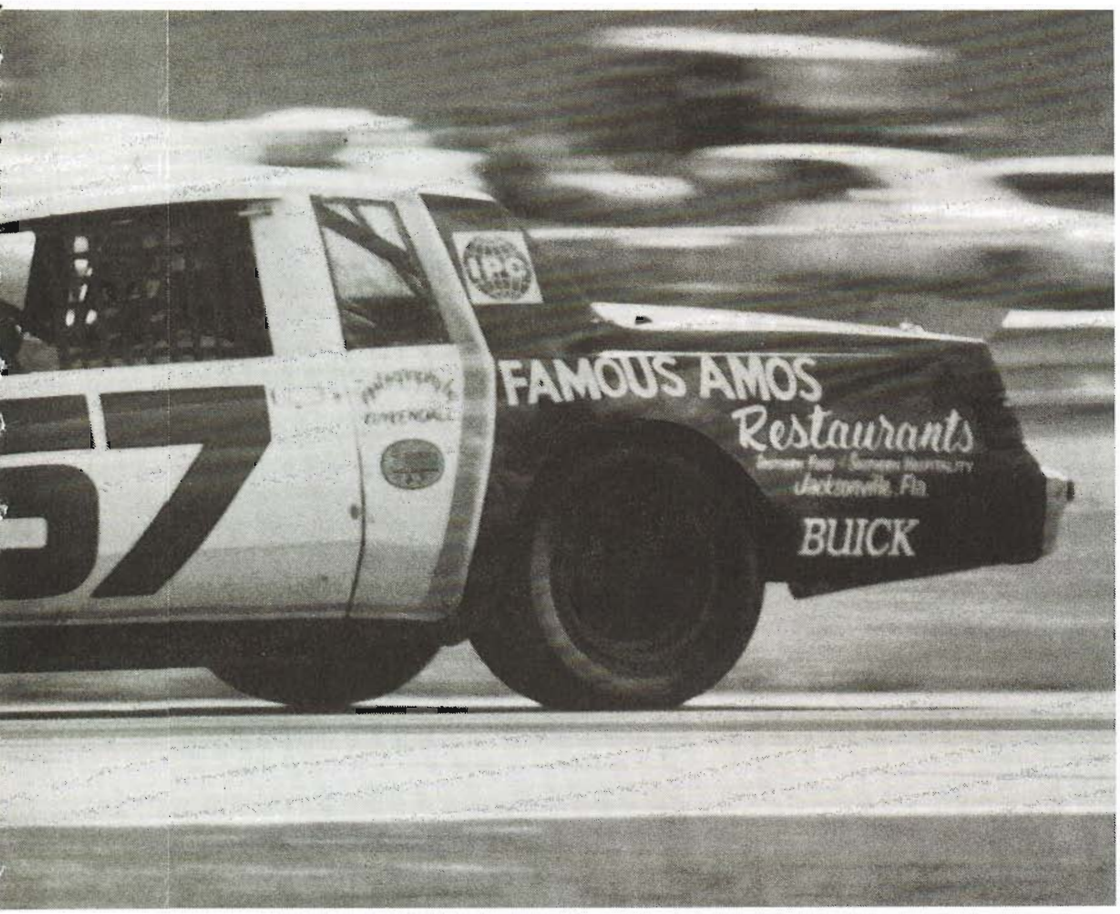


CONNECTING ROD

Rod make; type	Carrillo	Offset steel	
Length (center to center)	6.350		
Side clearance	006		
Wristpin bore diameter	0.928		
Wristpin clearance in rod	0.001		
Rod bolt make; size	SPS	7/16	
Rod bolt torque	90 ft./lbs.		

Connecting Rod No.	**1**	**3**	**5**
Housing diameter	2.3733	2.3733	2.3732
Housing diameter with bearing	2.2509	2.2509	2.2507
Crankshaft rod journal diameter	2.2487	2.2487	2.2487
Rod bearing clearance	0021	0022	0020

Connecting Rod No.	**2**	**4**	**6**
Housing diameter	2.3733	2.3734	2.3733
Housing diameter with bearing	2.2508	2.2508	2.2508
Crankshaft rod journal diameter	2.2487	2.2487	2.2487
Rod bearing clearance	0021	0021	0021



COMPRESSION RATIO

Piston at BDC in bore			
Swept volume*	746.47854		
Ring land volume	15 cc		
Head chamber volume	44 cc		
Total =	805.48		

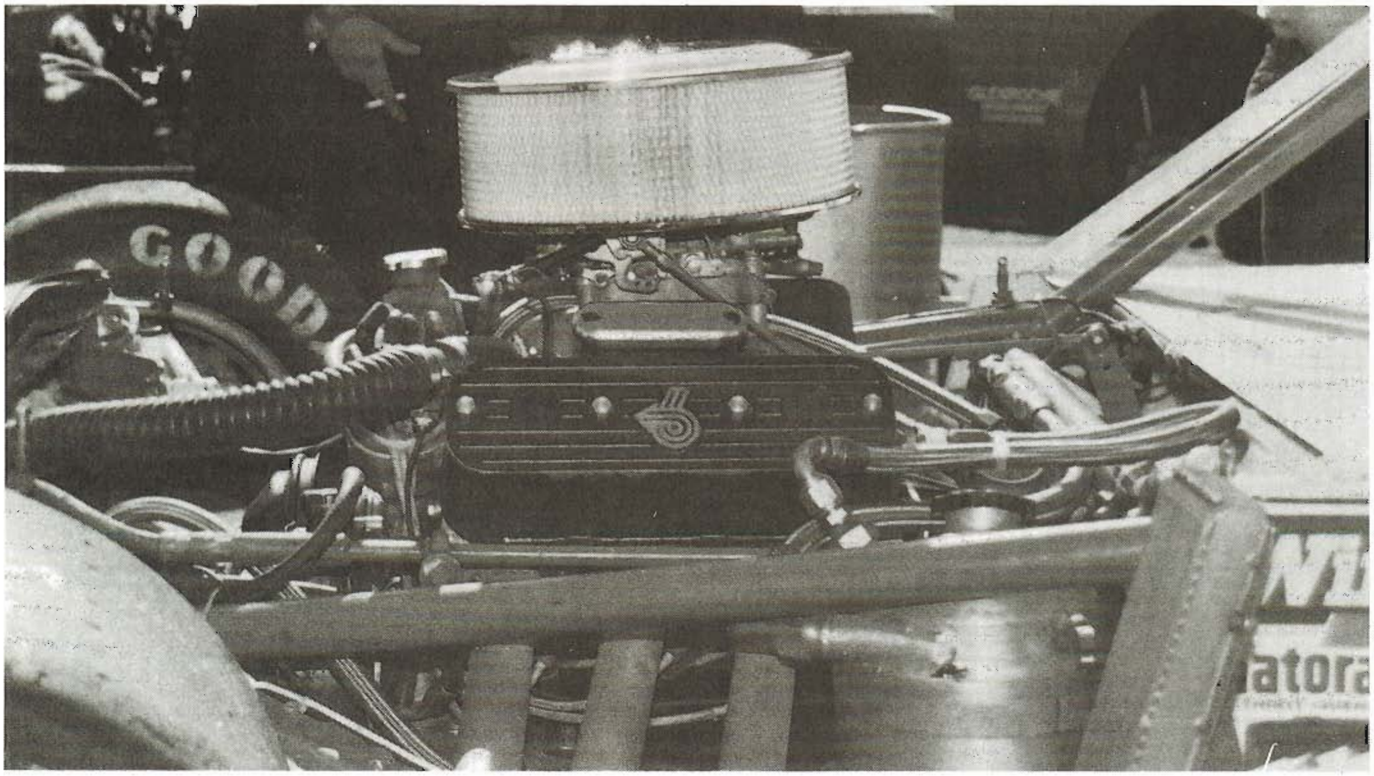
CR = total ÷ (total − swept volume)

CR = 13.65:1

**Swept volume [cc] = (bore)² × stroke × 12.87*

CYLINDER HEAD

Intake valve type; size	Del West titanium		2.08
Exhaust valve type; size	Del West titanium		1.65
Valve spring make; size	Reed Vasco		1.460 × 2.300
Valve spring installed height	1.900		
Valve spring seat pressure	180 lbs.		
Valve spring open pressure	600	at	1.200
Retainer make; material	Reed		Titanium
Keeper type	10° Reed		
Chamber type	44 cc		
Head gasket type; thickness	Fel Pro		0.040
Valve seal make; type	PC		Teflon



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CAMSHAFT

Drive make; type	Milodon	Gear
Cam make; No.	Reed	R302-06 ULX
Cam type	Roller	
Camshaft lobe separation	102°	
Intake duration at 0.050	267°	
Exhaust duration at 0.050	271°	
Intake lobe center installed at	102°	
Intake lobe lift	0.417	
Exhaust lobe lift	0.417	
Intake valve-to-piston clearance	075 at 10° ATDC	
Exhaust valve-to-piston clearance	0.100 at 10° BTDC	
Intake valve lash	022	
Exhaust valve lash	022	

VALVETRAIN

Rocker arm make; type	T & D	Roller
Rocker arm ratio	1.62	
Total intake lift at valve	0.650	
Total exhaust lift at valve	0.650	
Pushrod length; diameter	8.060	3/8
Lifter make; type	Iskenderian	Roller

NOTES

Cylinder Block

Regardless of the starting point for a performance-oriented Buick V6 (new or used, production or heavy-duty), the block should be clean and crack-free, with reasonably straight, round cylinders, reasonably aligned, round main bearing bores, and main caps that fit tightly into the notches machined in the block.

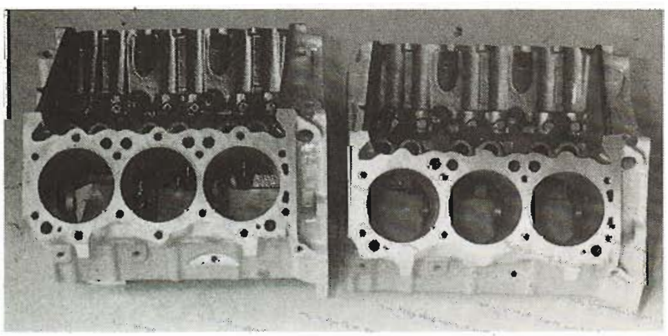
The cylinder walls of any new or used block destined for competition should be sonic tested before any money is spent on machining. For hard use, a cylinder wall should exhibit a minimum thickness of 0.180- to 0.200-inch. Only the bores need to be checked when sonic testing; no engine builder has reported any problems with a too-thin deck on any Buick block. If the thickness of a bore is less than 0.125-inch at any point, the block should not be used for a high-performance application.

All blocks except the Stage II heavy-duty units feature four two-bolt main bearing bulkheads and a deep block "skirt" that extends 2.250 inches below the centerline of the crank. This latter feature lends considerable rigidity to the structure. The water jacket length is 4.06 inches, and the cylinder barrels extend 1.70 inches below the jacket deck. Half of the heat is now rejected by oil and the other half is rejected by water.

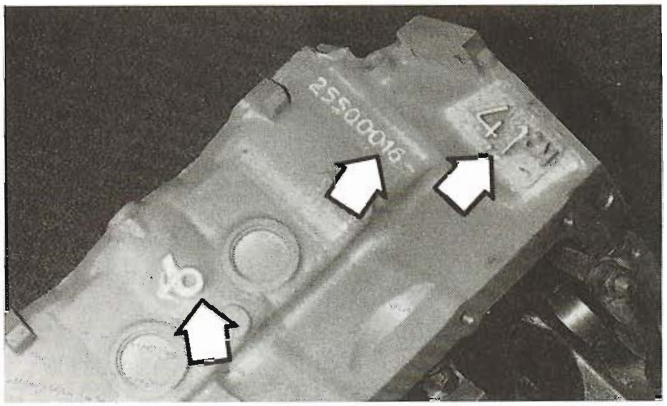
Heavy-Duty Blocks

Stage I and Stage II blocks are made from common castings (25500012 for the 3.8L, and 25500016 for the 4.1L), which are made from chromemoly-alloyed cast iron having 20 percent greater strength than production iron. (Production iron strength yields 35,000 psi, while heavy-duty iron yields 42,000 psi.)

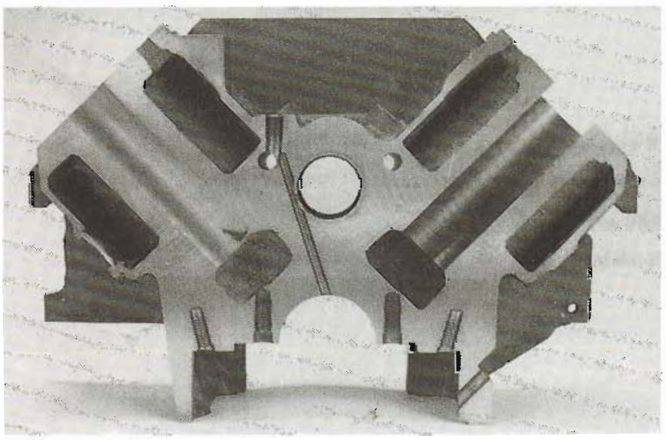
In addition to material improvement, the castings incorporate additional strength-related features as follows:



Check the descriptions of Stage I and Stage II blocks in the parts list to get the full impact of the differences. In this photo, the only striking difference is in the two extra bolt holes per cylinder for improved cylinder head clamping.

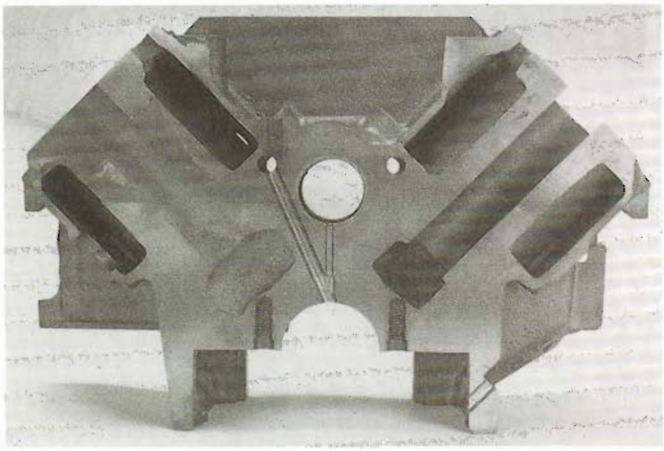


Both Stage I and Stage II blocks can be readily identified by the presence of the Buick Power logo, the part number, and the displacement cast into the side of the block—all on the left side.

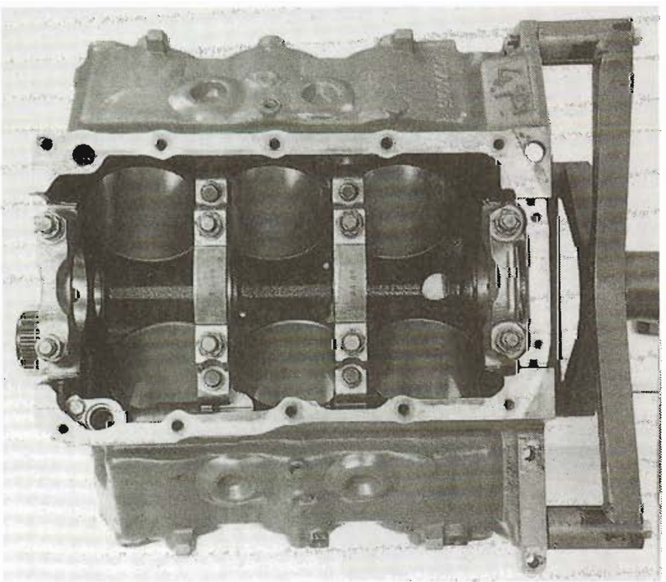


Early Stage II blocks incorporated production main bearing oil holes that intersect cam bearing bores. The vertical hole next to the lifters ensures gallery-to-main-hole connection.

- 0.500-inch deck face (stock is 0.320-inch), with bridged water passages
- Six-bolt head pattern (machined only on Stage II)
- Solid main bearing center bulkheads (required for four-bolt main caps installed on Stage II)
- 0.120-inch extra wall thickness around front and rear mains
- Extra ribbing on flywheel side of rear main
- Steel main caps on all locations with Nos. 2 and 3 being four-bolt caps (the Nos. 1 and 4 main caps are new).
- Heavier oil pan flange (for better sealing and bottom-end stiffness)
- 0.250-inch-thick solid bridging between the banks at the valve lifters with extra ribbing (ideal for dry-sump engines since fabricated covers for the normal cast openings are not needed; however, on



Blocks produced after July 1985 incorporate a new main oil feed hole angle going directly to the gallery and new vertical drilling from main bearing to cam. This new cam oil feed requires that the cam bearing oil hole be pointed downward on the Nos. 2, 3, and 4 locations and that an extra hole be drilled in No. 1. A cut-apart block is a useful tool in serious engine building and development. Note the size of the oil passage running from the main oil gallery to the main bearing and the generous water passages around the cylinders.

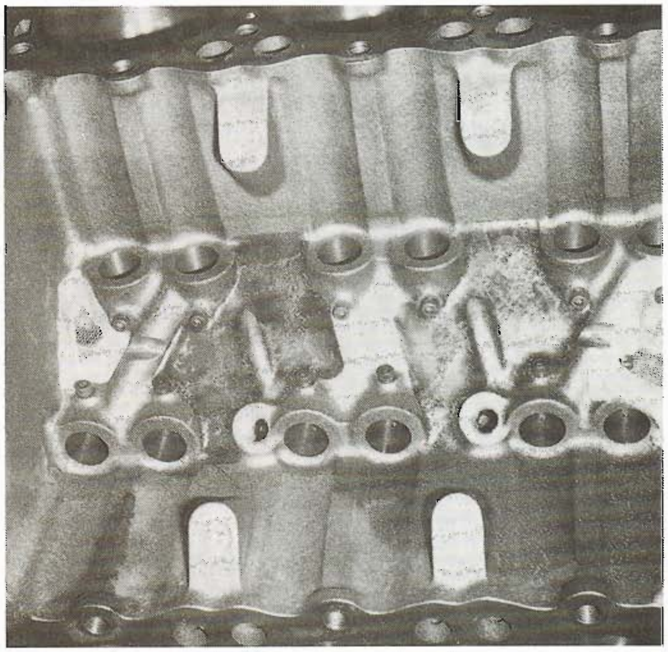


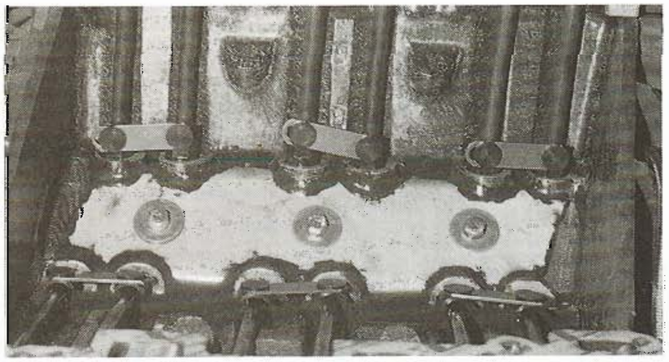
All Stage II blocks feature four-bolt main caps from the factory. The small boss between the freeze plugs allows drilling and tapping for a water drain.

wet-sump engines, you must drill lifter valley drain holes).

Other block revisions pertain to the oiling system and are incorporated into Stage II blocks (Stage I blocks have *all* production machining but are made from the heavy casting) as follows:

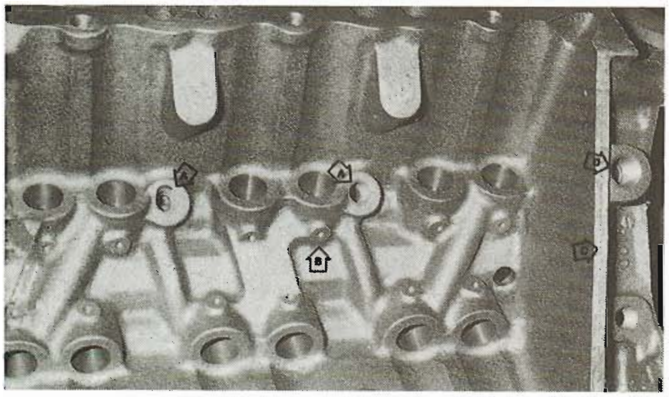
- Oil galleries divorced from the valve lifters to minimize oil leakage



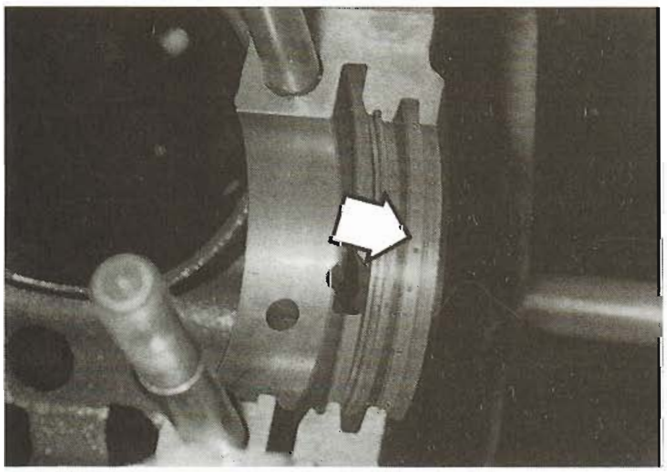


Heavy-duty engine builders use a variety of methods to dry up the lifter valley by forcing oil to each end for drainback to the pan. In one case we see a translucent epoxy on a production block, while the other example demonstrates how an aluminum plate can be used in addition to epoxy. In both examples, note the use of a screen over the remaining drainback openings.

- Gallery size increased to ½-inch from 7/16-inch
- Restricted feed passages connecting each lifter to the galleries
- Front and rear feed or auxiliary supply holes connected to the main gallery (usable for oil supply from cooler or external oil pump or feed to turbocharger)
- Valve lifter boss diameters increased to allow larger lifters, repair sleeves or bronze liners
- New oil suction pipe mounting behind No. 1 main (original pipe mounting at No. 2 main was cut away for four-bolt main cap)
- Aircraft-quality main studs for all Stage II cap locations



The lifter valley of a Stage II block gets to be a busy place–full of arrows and letters. The tapped holes (A) *intersect the main oil gallery. If not used for oiling a valvetrain, these holes should be plugged. The tiny holes* (B) *go through the lifter bores and into the oil gallery in order to provide oil for the lifters. These must be plugged and left that way. The manifold mating rail* (C) *indicates how an engine builder has used a small prick punch to upset the surface for improved gripping of the seal. The large tapped hole at the back of the block* (D) *goes directly to the main oil gallery and should be plugged if not being used. Some engine builders prefer to plumb a pressure gauge from this point.*



A number of high-performance engine builders prefer to use a prick punch on the rear crank seal face in an effort to improve gripping between block and seal.

- Align-honed Stage II mains
- Cylinder bores on both Stage I and II finish bored but not honed, and tops of cylinder bores unchamfered. Care must be used when overboring 4.1 blocks (3.965-inch stock bore size) to a maximum of 4.00-inch, because the head gasket combustion chamber flanging has an inside diameter of only 4.020 inches.

Production and all Stage I and II blocks produced before July 1985 used a rope rear main seal. Later Stage II blocks are machined to accept a GM rear main seal (473471). This neoprene-construction offers better sealing with less friction on the crankshaft.

Block Assembly Weight

1984	Production	Stage I	Stage II
3.8	112 lbs.	129	131
4.1	110 lbs.	129	131

Stage I and II 4.1L blocks may be readily identified by the twin water holes in the deck surface at the top of the block near the center on the deck surface. Stage I and II 3.8L blocks have only one water hole between the cylinders. All 3.8L blocks have water between the bores. Bore size should be limited to 3.860. All 4.1L blocks feature siamesed bores. Bore size should be limited to 4.020 inches. Main bearing bores on all Stage II blocks are align-honed to finished size.

Deck height on Stage I 3.8L blocks is 9.560 inches; this block was intended to be used with a steel shim cylinder head gasket (0.018-inch compressed). Stage I 4.1L and all Stage II blocks feature a deck height of 9.535 inches; these blocks were designed to be used with the Buick 25500006 head gasket (0.040-inch compressed).

Displacement of any heavy-duty block may be identified by the 3.8L or 4.1L cast into the left rear side of the case.

Preparation

Any Buick V6 block being prepared for the rigors of competition should be subjected to hours of de-

Cubic-Inch Conversion
(6-cylinder engines)

Stroke Length	2.700	2.800	2.900	3.000	3.100	3.200	3.300	3.400	3.500	3.600	3.700	3.800
Bore Diameter												
3.400	147.1	152.5	158.0	163.4	168.9	174.3	179.8	185.2	190.7	196.1	201.6	207.0
3.500	155.9	161.6	167.4	173.2	179.0	184.7	190.5	196.3	202.0	207.8	213.6	219.4
3.600	164.9	171.0	177.1	183.2	189.3	195.4	201.5	207.6	213.8	219.9	226.0	232.1
3.700	174.2	180.6	187.1	193.5	200.0	206.4	212.9	219.3	225.8	232.2	238.7	245.1
3.800	183.7	190.5	197.3	204.1	210.9	217.8	224.6	231.4	238.2	245.0	251.8	258.6
3.900	193.5	200.7	207.9	215.0	222.2	229.4	236.5	243.7	250.9	258.0	265.2	272.4
4.000	203.6	211.1	218.7	226.2	233.7	241.3	248.8	256.4	263.9	271.4	279.0	286.5
4.100	213.9	221.8	229.7	237.6	245.6	253.5	261.4	269.3	277.3	285.2	293.1	301.0

Equation: Cubic inches = 0.7854 x number of cylinders x stroke x bore x bore
To convert cubic inches to cubic centimeters, multiply by 16.39.
To convert cubic centimeters to cubic inches, multiply by 0.061.

burring and grinding with a die grinder. Getting rid of casting slag and sand trapped on the unmachined surfaces of the casting aids oil drainback and eliminates stress risers and a lot of debris that might get into the oiling system once the engine is put to use. Considerable effort should be spent in the lifter gallery and main bearing web.

A bottoming tap should be used in all tapped holes in the block to ensure that each hole is fully tapped and to help eliminate any debris trapped in the hole. After all tapped holes have been subjected to a bottoming tap, they should be chamfered to prevent the top thread from pulling when the appropriate fastener is put in place.

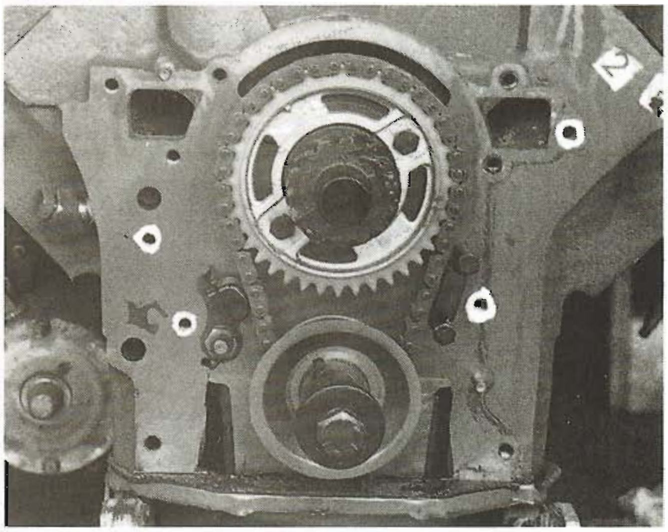
If mushroom lifters are to be used, the block must be machined on the underside of the lifter bores to accommodate the larger diameter of the lifter "foot." The oil passages in both production and heavy-duty blocks need some amount of rework, so more time is required for the production items. On production and Stage I blocks, oil going to the pump travels upward from the pickup flange on the block near the No. 2 main cap. This passage is in turn intersected by a long horizontal passage going to the front of the block. On earlier production blocks these two passages were 7/16-inch in diameter. The passages on these blocks should be enlarged to 9/16-inch. If possible, do this with a vertical mill to ensure that the enlarged hole is parallel to the axis of the original hole. The job can be accomplished with a very low-rpm ½-inch drill motor and a long drill bit that has been sharpened for drilling cast iron. The enlarged hole must not break out into the crankcase. Leaks on the suction side of the pump draw air into the oil and result in engine failure.

At the intersection of the two oil passages is a 90 degree turn. Using a ⅜- to ½-inch ball-shaped stone on a 4-inch-long shank and a high-speed grinder, radius the inside corner of the intersection as much as possible. This is difficult because the corner being radiused cannot be seen.

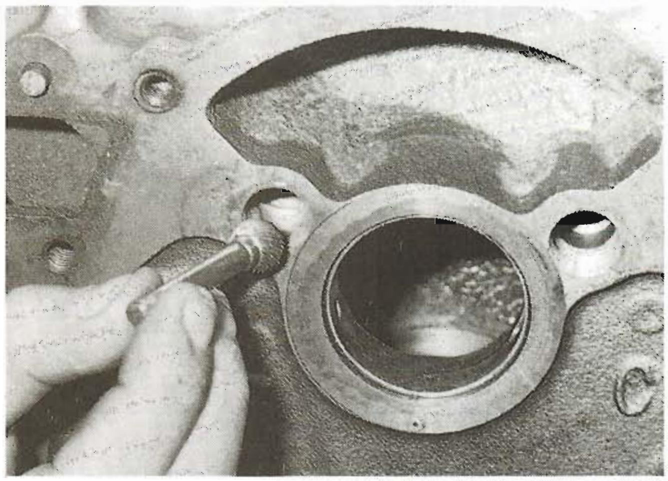
Later production block holes are drilled 9/16-inch at the factory. The holes on these blocks may be enlarged to ⅝-inch, which is the size of the passages in the heavy-duty blocks.

On production and Stage I blocks, the two main oil galleries pass through the lifter bores. On Stage II blocks these galleries pass outboard of the lifter bores. To oil the lifters on Stage II blocks, drill 0.150-inch holes through the lifter bore and into the oil gallery. These small holes should be tapped to accept ¼-inch-long 10-24 Allen head set screws. The threads on these set screws (which are used to plug the access holes) should be coated with GM Pipe Sealant with Teflon (1052080).

On Stage II blocks, four holes are drilled and tapped into the main oil gallery, one at either end of the block on the outside. These two "outside holes" are tapped ⅜-inch NPSF. These holes may be used for the pressure supply from a dry-sump oiling system. If they are not used for this purpose



The bolt holes circled in white indicate those holes open into the water jacket; thus, the bolt threads should be coated with sealant. Many engine builders find it easier to coat all of the front cover bolts with sealant than to memorize this pattern.



Using a round cutter, radius as best as you can the intersections in the oiling passages. This is time-consuming and tedious but worthwhile.

they must be plugged. The other two tapped holes are in the lifter galley under the intake manifold. These holes are tapped ¼-inch NPSF and may be fitted with lines routed to rocker shaft assemblies. If needed, seal these threads also.

A dry-sump prepared block may be fitted with a hole through the back of the block above the bellhousing bolt pattern for a No. 10 bulkhead fitting. This in turn can be fitted to a 90-degree fitting and a piece of tubing turned down toward the rearward depression in the lifter valley. This is now the pickup point for one of the scavenge stages of the dry-sump pump.

Locate the oil pickup passage, and check the exterior of this passage for clearance with the first two counterweights on the crank. Although this should be done when a production crank and block are used, it is imperative that this checking be done when a heavy-duty block and/or the raw forged crankshaft are used due to the additional metal in both pieces. On Stage I blocks also check the No. 3 counterweight since these blocks have a centrally located oil pickup. To make this check (with any combination of hardware), fit the block with main bearings, install the crank to be used, and visually note the clearance between crank counterweights and the block. A die grinder may be needed to provide the necessary clearance.

If you are using an aftermarket cam gear drive assembly on the block, this is the time to read the instructions to determine if holes need to be drilled and tapped in the front of the block.

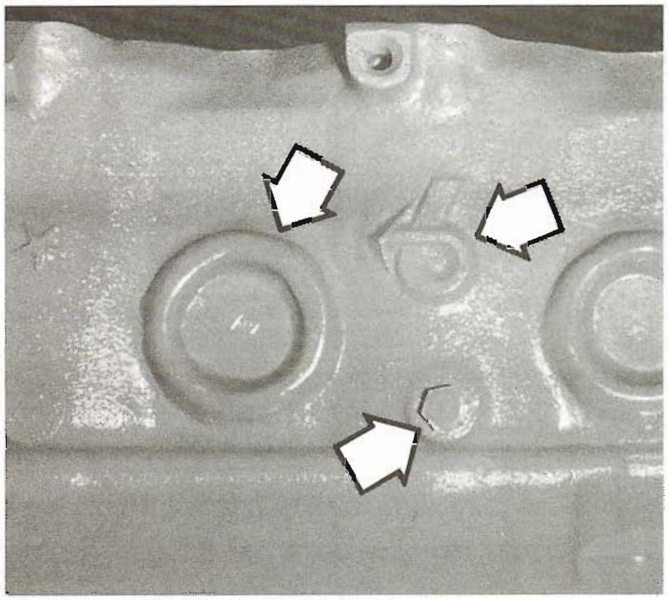
None of the late Buick V6 blocks has a provision for draining coolant. Fitting a standard ⅛-inch NPT water drain to each side of the block is a simple procedure. On production blocks, the drains should be located midway between the two soft plugs on the sides of the block: The drains should be ⅛-inch above a line drawn from the bottom edge of the two plugs. All Stage I and II blocks have two small, round cast areas on each side of the block adjacent to the two freeze plugs that may be drilled, tapped, and fitted with water drains. For heavy-duty service, many engine builders use screws, brads, or even pop rivets to firmly anchor the freezing plugs into the block. This guards against the possibility of a plug coming out with a resulting disastrous loss of coolant. Regardless of the method chosen, now is the time to drill the needed holes in the sides of the block.

Since 4.1L blocks have siamesed bores, high-output versions require additional steam holes in the deck surface. Using the heavy-duty head gasket 25500006 as a template, four holes should be drilled (two each side of the center cylinders) on each deck surface with a 0.180-inch drill bit.

Time permitting, some engine builders prefer to let a new block soak for a period of time in a hot tank to achieve some stabilization of the casting. Main bearing caps should be installed and torqued in place. After removing the block from the tank, discard all main cap bolts before starting any machine work.

For high-performance use, Stage I V6 blocks should be align-honed (Stage II blocks are sold already align-honed). Proper honing procedures accurately reduce the inside of each bore to the minimum acceptable dimension, which provides maximum bearing crush. The hone also leaves a very smooth finish in the bore, which aids in heat transfer from the bearing to the main web of the block. The machine shop doing the main cap stud align honing must know the brand of bearing that will be used in order to hone the block to the smallest acceptable diameter. Maximum bearing crush is desirable not because it retains the bearing in the block and cap but because it provides good bedding for the backside of the bearing to transfer heat to the block via the main webbing.

When boring a block to fit the pistons, bore each cylinder just enough to accommodate a piston and rod assembly without rings fitted to the piston. At



The V6 logo cast into the side of the block indicates this is a heavy-duty Stage I or Stage II block. After the cup plugs are driven in, epoxy is beaded around the entire mating surface. Loctite 277 is used as a sealant/adhesive on the cup plugs by the manufacturer. Cup plug retention is very good with this material, so other methods may not be required unless you have removed the original plugs. On this block, a capscrew is used as a drain plug for coolant.

this point, piston and wall clearance can be in the area of 0.002-inch. This procedure confines piston rock and permits accuracy when measuring deck. To measure deck, install a crank properly fitted to a set of main bearings and caps, and then move a single rod and piston assembly without rings from one cylinder to the next while noting the distance from the top of the piston to the top of the block head surface.

Only a minimum amount of metal should be removed from either the block or the head mating surface of any V6 assembly. A 3.8L block fitted with either production or Stage I heads and a set of flat top pistons run 0.005-inch down the bore normally produces a compression ratio of 13:1 with a 44cc head. If the same piston is installed at zero deck and the chamber volume of the head remains at 44 cc, compression ratio rises to 14:1.

Any time the deck surface of the head or block is machined, the surface should be on the rough side of 100 microinches to effect maximum gasket seal. Final cylinder boring should be done with a torque plate in place. Final honing produces a very smooth finish; something on the order of an 800-grit stone is in order for a modern high-performance engine. Automatic honing machines such as the Sunnen CK-10 are preferable because they allow hone pressure to be varied. Maximum pressures improve bore straightness and concentricity.

Preparation Checklist

Engine builders go to time-consuming lengths to eliminate the possibility of component failure of any kind. The following can be used as a checklist in preparing a Buick block for heavy-duty service.

1.Visual inspection. Look for core shift at lifter bores, soft plug bosses, and oil gallery drillings.

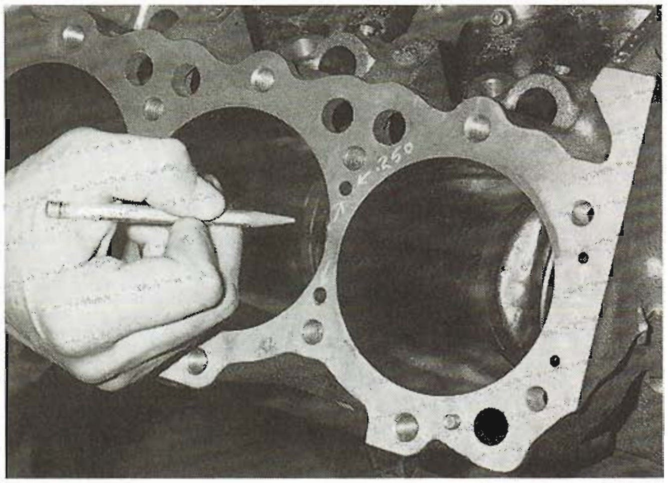
2. Sonic test all cylinder walls. Minimum cylinder wall thickness should be 0.200-inch.

3. Drill 0.180-inch-diameter water holes between the cylinders and 0.190-inch-diameter holes on the front face of the deck.

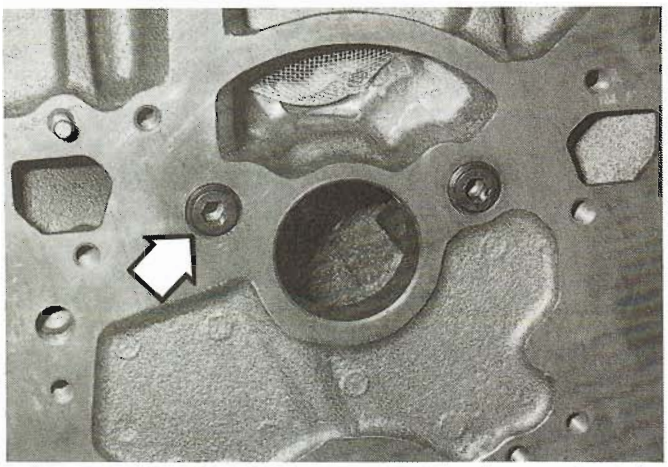
4. Prick punch the rear main seal groove to prevent seal slippage.

5. Tap and fit pipe plugs to the front oil passages to secure the cam gear drive plate.

6. Drill the main oil passage holes and main bearing bore oil passages to 0.375-inch.



Some heavy-duty engine builders enlarge the coolant holes between the cylinders to 0.250-inch and take the holes at the ends of the block on the deck surface out to 0.187-inch. The theory behind doing this is that it provides more uniform circulation of coolant.



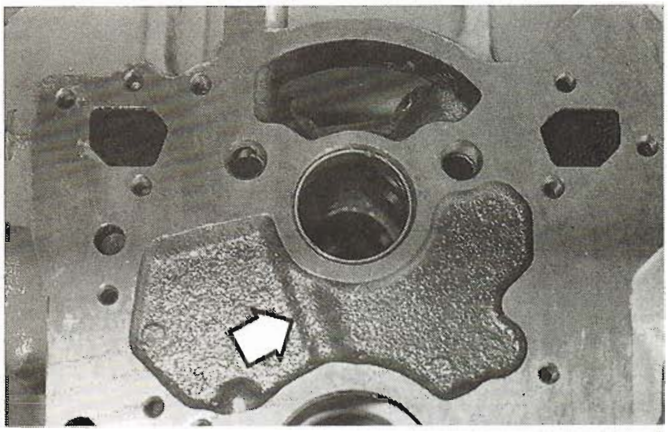
When threaded pipe plugs are used at the front ends of the oiling passages, they must be very shallow so they will not block off intersecting oil passages. These particular plugs have been drilled and tapped internally for the mounting of a cam gear drive.

7. Drill and tap the water drains on each side of the block.

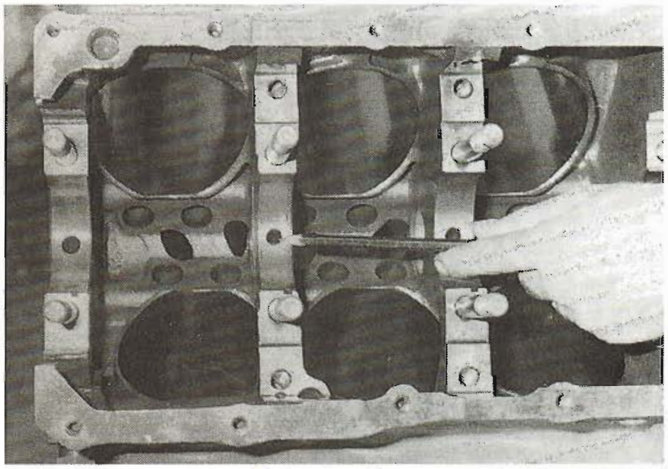
8. Deburr the cam bores.

9. Radius and deburr the oil runoff opening in the lifter valley.

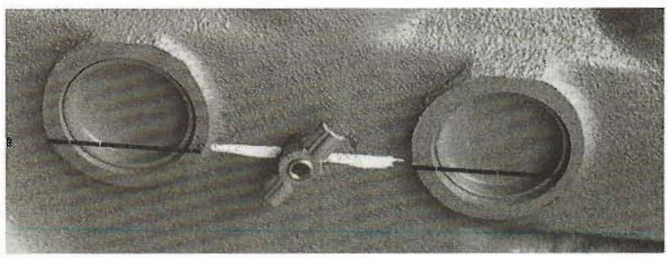
10. Bevel the parting lines of the main bearing caps and the block.



The cast protrusion on the front face of the block in proximity to the camshaft is the location of the oil passage leading from the main oil gallery to the main bearing.



Some engine builders drill the oil passages feeding the main bearings to 3/8-inch.



When an engine is being prepared for heavy-duty use, it is advisable to install a coolant drain on each side of the block. One practical place is between the soft plugs.

11. Run a bottoming tap the full length of all head and main bolt holes.

12. Install main bearing studs with Loctite.

13. Torque the main caps to specifications. Check the main bearing bores for roundness, internal dimensions and taper. Align bore if necessary.

14. Bore and hone block.

15. Cut a new bearing tang slot in the No. 4 main cap to accept bearings from the No. 1 and No. 3 mains.

16. Tap the dipstick hole in the side of the block to accept a 1/8-inch pipe plug.

17. Drill and ream the bellhousing dowel pin holes to accept larger, adjustable dowel pins.

18. Install a drill jig on the front face of the block. Drill and tap the face of the block to accept the locating plate for the cam gear drive.

19. If you're using dry-sump oiling, tap the oil pump pickup and the front face of the block with ⅜-inch NPT.

20. Deburr the block in general, clean off all casting slag and deburr the main caps.

21. Grind the outside of the oil pickup passage for clearance with the No. 1 rod cap when a 3.3-inch stroke or longer is used.

22. Set the main bearing clearance (0.0025-inch is preferred).

23. Install the crank to be run, and check for swing clearance.

24. Install piston and rods from the correct assembly, and set the deck clearance at -0.002–0.000-inch maximum for a standard block.

25. After the block deck surface has been cut, chamfer the tops of the bores to a maximum diameter of 4.020 inches.

26. If the engine has a 3.5-3.625-inch stroke, check for interference at the bottom of the cylinder wall with the top side of the big end of the rod, and grind accordingly.

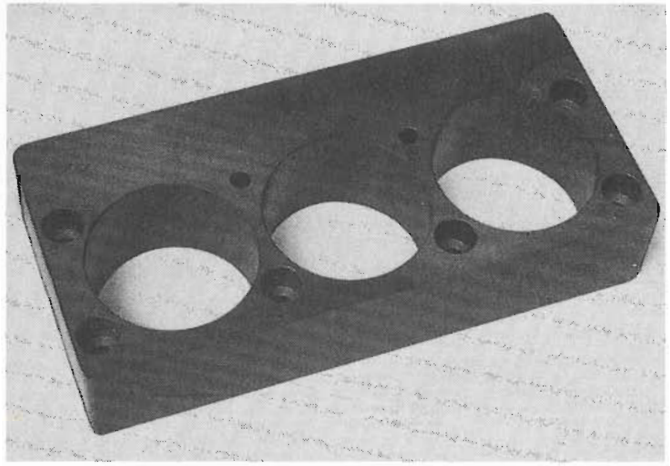
Cleaning

After all machining operations and deburring, you need to clean the block. With all core plugs and oil gallery plugs removed, use clean solvent and a variety of rifle-cleaning brushes to eliminate all debris and grit from the block–especially the oil passages. The second step in the cleaning procedure is a thorough scrubbing with hot, soapy water. Air pressure affects immediate drying. The final step is to immediately thoroughly clean the cylinder bores with mineral spirits and clean white paper towels. All machined surfaces can now be coated with a thin machine oil.

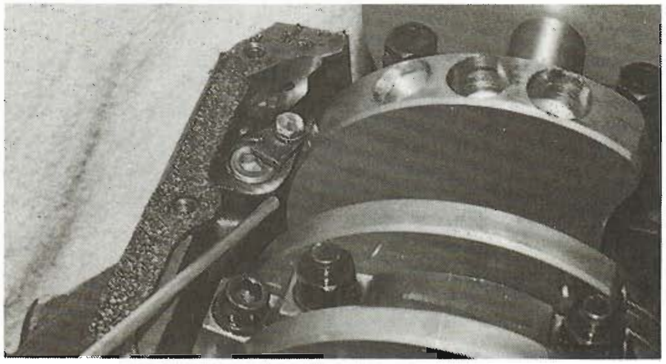
In most cases, the final step in block preparation is to install small screens covering the oil drain-back openings. The screens can be held in place with a good-quality epoxy. (Ideally, the screen should be of stainless construction, but it need not be.) Some engine builders also prefer to epoxy small magnets in close proximity to the oil drain back openings. Both the screens and magnets help prevent small pieces of broken valvetrain hardware from breaking even more hardware such as gear drives and oil pumps.

Assembly

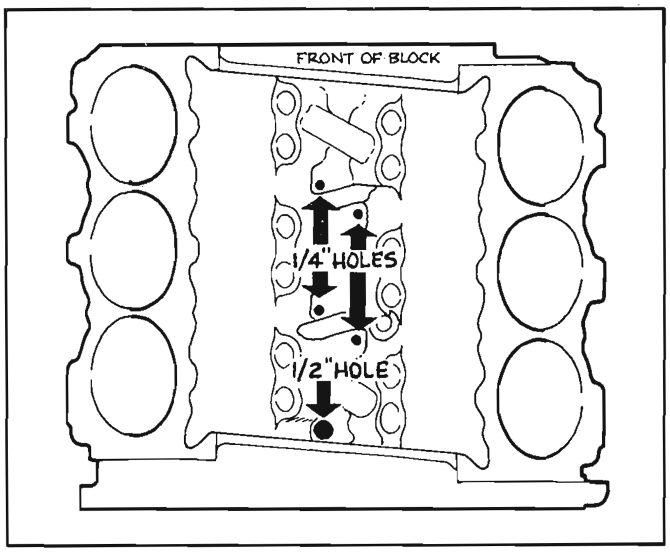
Considerable care should be taken during the final assembly of the lower end of the Buick V6. First, the studs and the bolt holes in the lower end should be clean and the threads of the studs coated with Loctite 262 before they are installed in the block with a modest amount of torque (10-15 ft./lbs.). Then the tops of the main bearing caps around the bolt holes should be "kissed" with a mill or grinder to ensure that these surfaces are perpendicular to the axis of the studs.



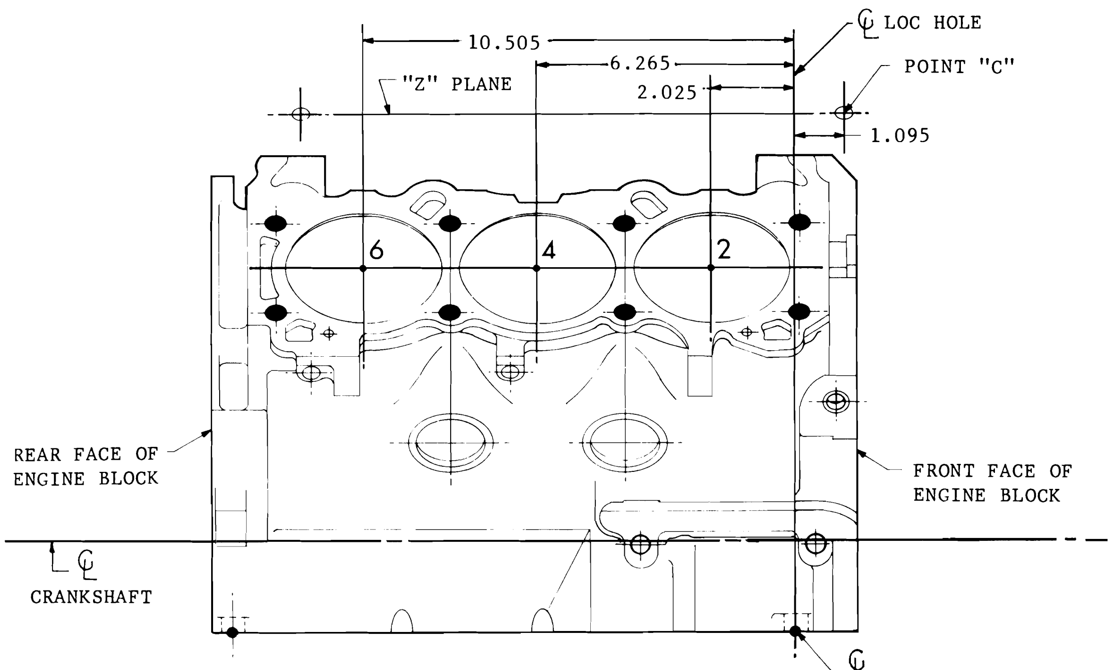
Torque plates are available for the V6 for use when boring and honing. They greatly improve dimensional stability.



On Stage II blocks, the area adjacent to the oil pickup opening often interferes with the front crank counterweight and must be relieved by grinding. In this block, note that the unused oil pickup has been tapped and plugged and that a safety bar has been bolted over it.

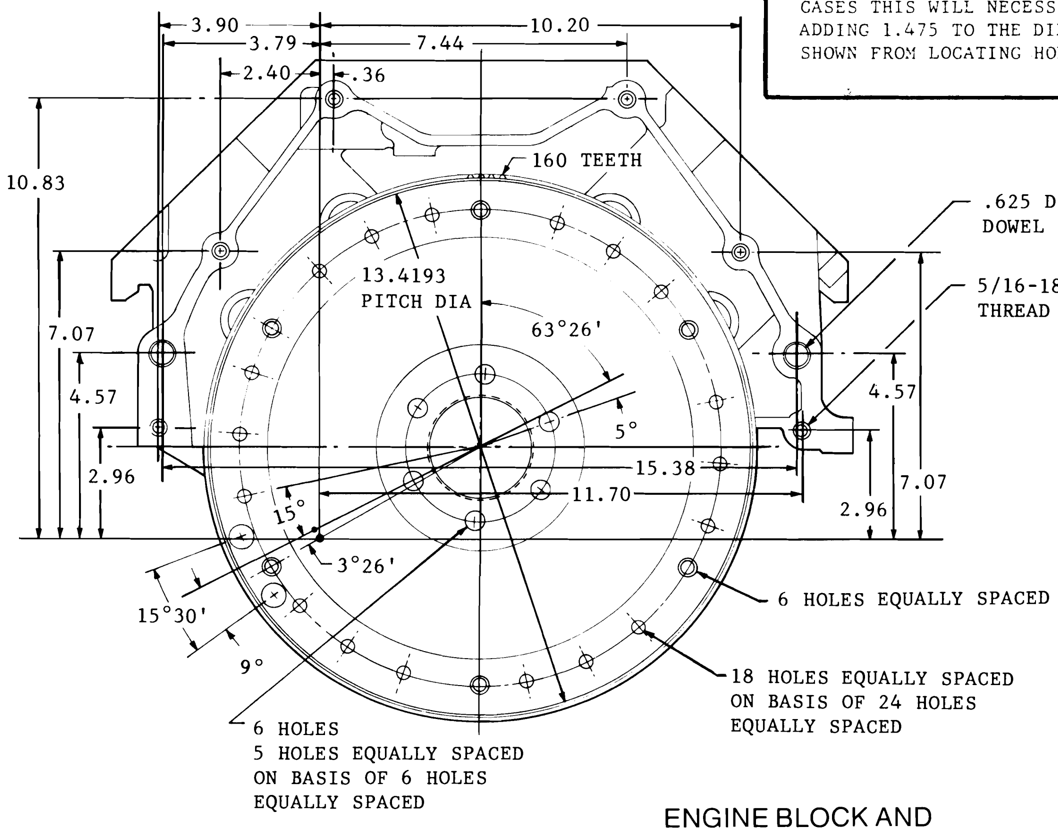


Both Stage I and Stage II blocks feature a solid cast lifter valley. Although this adds to the strength of the casting, it severely impairs oil drainback to the pan. This is a problem only on wet-sump-prepared engines since they have no provision for scavenging oil from this area. These blocks should have a ¼-inch hole drilled in each of the four depressions near the center of the lifter valley and a ½-inch hole at the depression near the rear of the valley.

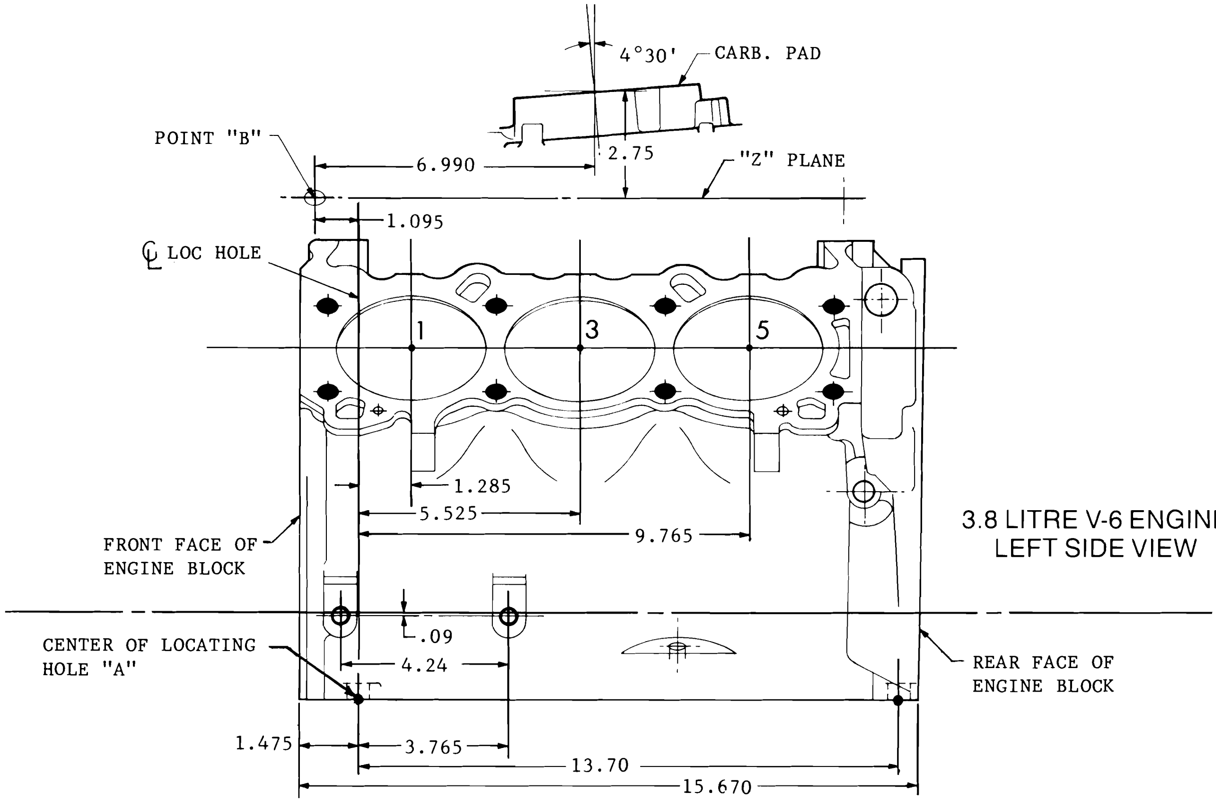


3.8 LITRE V-6 ENGINE
RIGHT SIDE VIEW

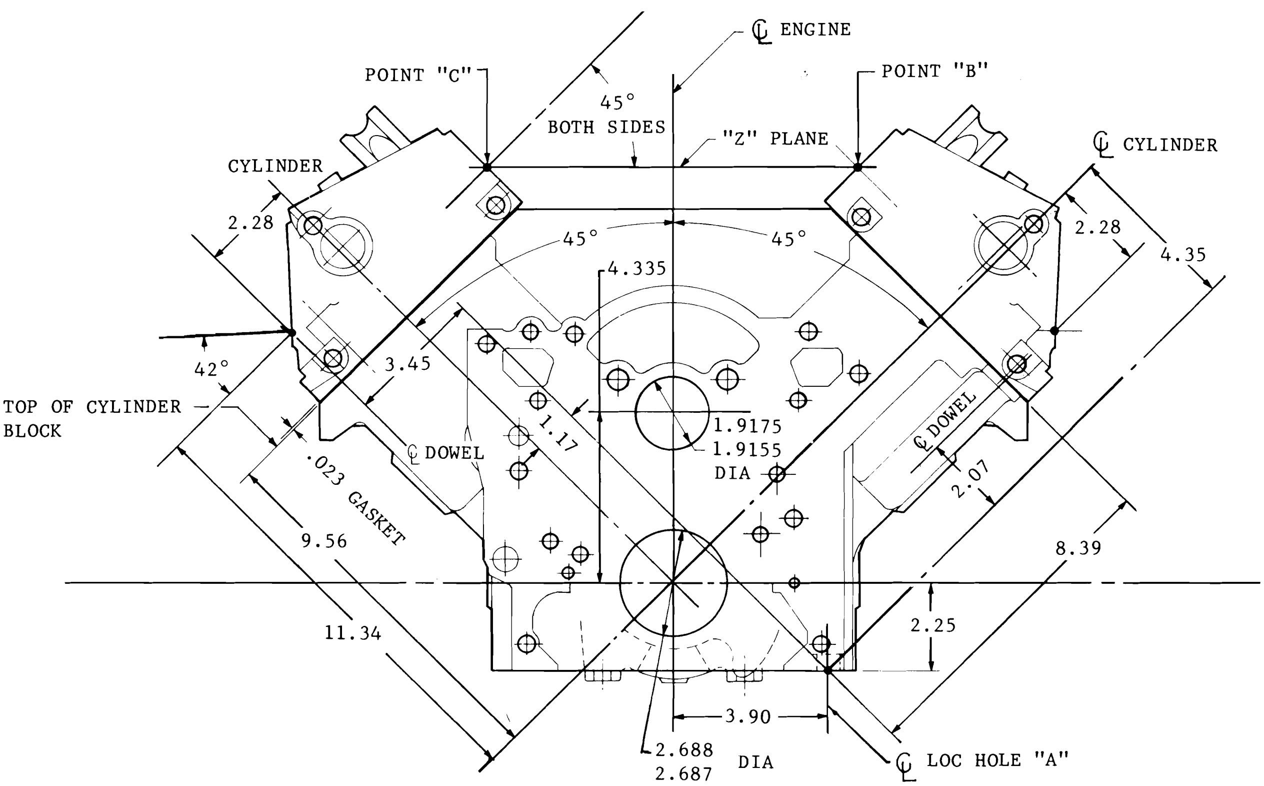
WHEN MAKING MEASUREMENTS ON THE BLOCK, IT IS RECOMMENDED ALL DIMENSIONS BE TAKEN FROM EITHER THE CRANKSHAFT CENTERLINE OR FRONT AND REAR FACES. IN SOME CASES THIS WILL NECESSITATE ADDING 1.475 TO THE DIMENSIONS SHOWN FROM LOCATING HOLE "A".



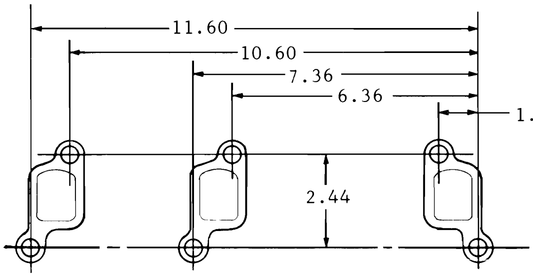
ENGINE BLOCK AND
FLYWHEEL BOLT PATTERN
REAR VIEW



3.8 LITRE V-6 ENGINE
LEFT SIDE VIEW

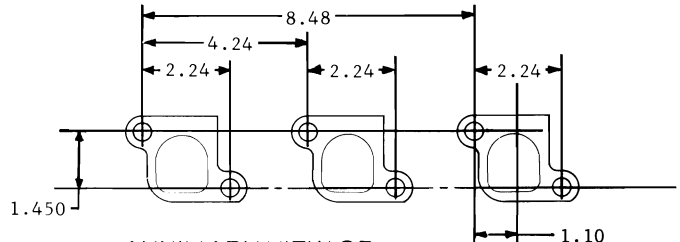


3.8 LITRE V-6 ENGINE
FRONT VIEW



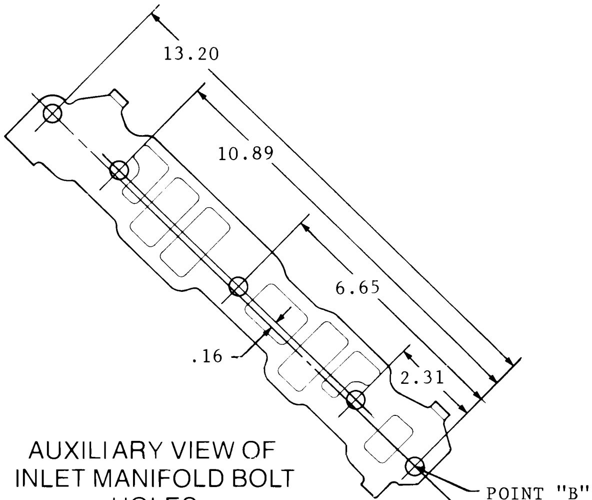
AUXILIARY VIEW OF
EXHAUST PORT BOLT HOLES

PRODUCTION AND STAGE I



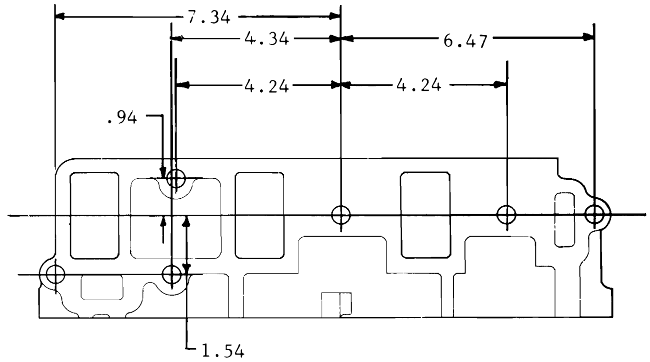
AUXILIARY VIEW OF
EXHAUST PORT BOLT HOLES

STAGE II



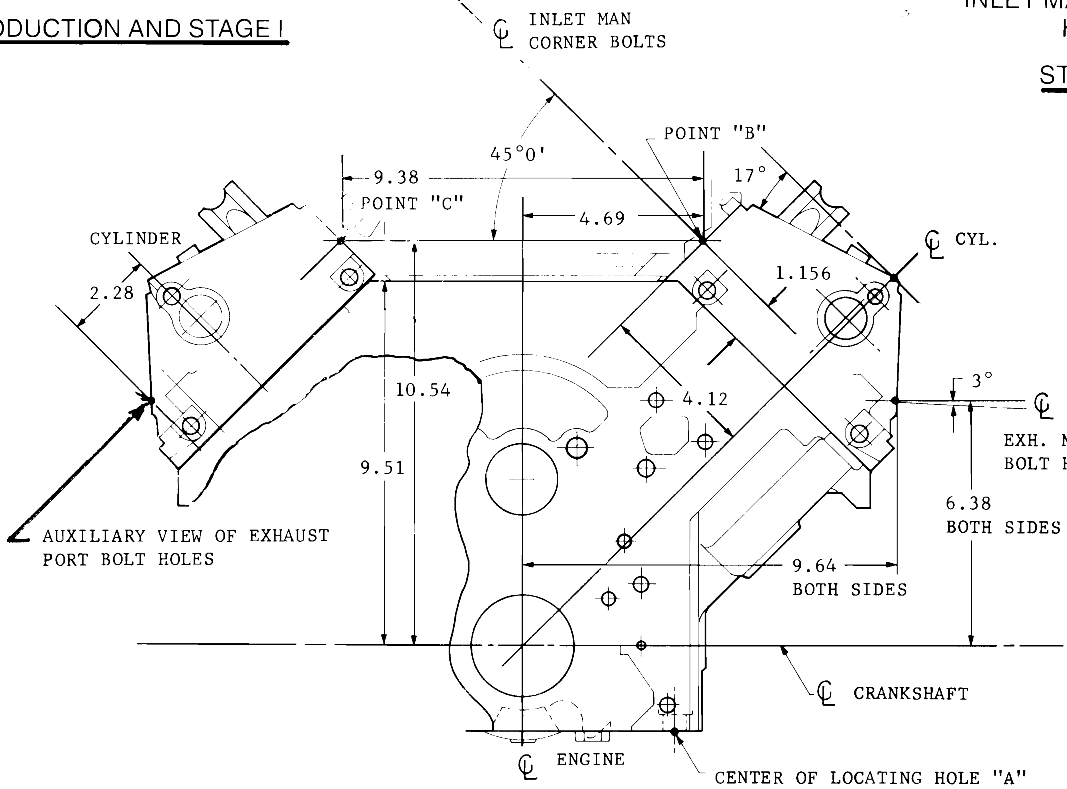
AUXILIARY VIEW OF
INLET MANIFOLD BOLT
HOLES

PRODUCTION AND STAGE I



AUXILIARY VIEW OF
INLET MANIFOLD BOLT
HOLES

STAGE II



PARTIAL FRONT VIEW

NOTES

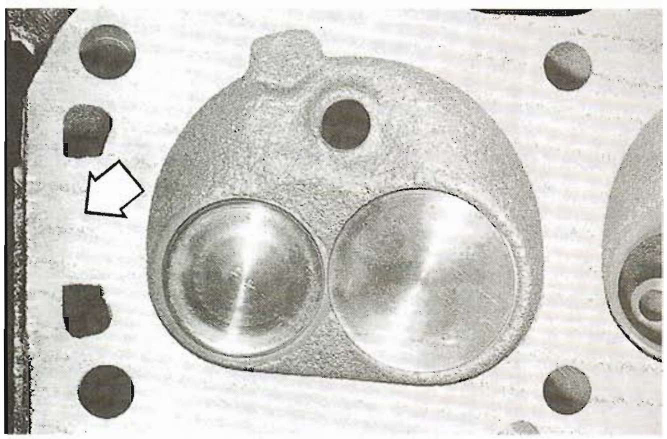
NOTES

Cylinder Heads

Buick currently produces four cylinder heads for the V6. One is the production cylinder head used on all rear-wheel-drive and front-wheel-drive applications except 1985 and 1986 N-cars, whose engine bays require a narrower cylinder head. The production cylinder heads on all Buick engines except those in the N-cars have remained virtually unchanged since 1979. Stage I cylinder heads are machined on this production tooling, so all valvetrain hardware, rocker covers, intake manifolds, and pistons used with production heads can be used with Stage I heads.

Production and Stage I Heads

The differences between production and Stage I heads are subtle but significant. On Stage I heads, the intake face pockets are filled in, and the heat crossover holes are not drilled. Bridging is added at the end water passages to stiffen the end combustion chambers where head gasket failures can result with production castings. Also, the intake port wall on the short-side radius is revised to allow increased airflow when ported. (Both the water jacket and intake port core have been revised.) The intake port throating cutter angle is increased from 61 degrees on the production head to 80 degrees on Stage I for better flow without porting. Production valve sizes of 1.71-inch intake and 1.50-inch exhaust can be used. Because this head uses a four-bolt pattern attachment to the block, power level seems to be gasket-limited at about 600-plus horsepower before gasket failure, even with the premium gasket 25500006. Head gasket sealer is required to prevent "water in oil" problems when using this gasket and four-bolt heads. If this head is used for street rod applications in the 200-horsepower range, a production 4.1L head gasket should yield an adequate life and fewer water sealing problems.



The Stage I combustion chamber as cast. The water passage at the end of the block is partially filled in for additional strength.

Tech Tip

The Importance of Airflow

An engine's horsepower is directly proportional to the amount of air drawn into the cylinder and retained until ignition occurs. By reducing the airflow resistance of the intake and exhaust ports, cylinder filling is improved and engine horsepower is increased directly.

The amount of power to be gained by improved airflow depends on the engine's volumetric efficiency (how full the cylinder is). An engine with 60 percent volumetric efficiency can be improved more than an engine with 90 percent volumetric efficiency. The volumetric efficiency of a gasoline engine can be estimated as follows:

$$\text{Volumetric efficiency} = 5600 \times \frac{\text{hp}}{\text{rpm} \times \text{cid}} \times 100\%$$

(Cid is the displacement of the engine in cubic inches.) Be sure that you use accurate horsepower figures. If the volumetric efficiency of a nonsupercharged engine exceeds 130 percent, either the horsepower or the rpm figure is probably wrong.

For an alcohol-burning engine, the formula is:

$$\text{Volumetric efficiency} = 4750 \times \frac{\text{hp}}{\text{rpm} \times \text{cid}} \times 100\%$$

For example, on a 500-hp 265-cubic-inch Buick V6, what will be the maximum horsepower at what rpm? Tests show that at a test pressure of 10 inches of water, the intake system flows 193.7 cfm of air. The cubic inches per cylinder is ⅙ of 265, or a displacement of 44.16 cubic inches.

$$\text{hp} = 0.43 \times 193.7 \text{ cfm} = 83.3$$

Or for all six cylinders:

$$\text{hp} = 6 \times 83.3 = 500 \text{ hp}$$

The rpm for maximum power is:

$$\text{rpm} = \frac{2000}{44.16 \times 193.7 \text{ cfm}} = 8772$$

This type of information is of limited value unless it is compared to another intake system. Tests show that at a test pressure of 10 inches of water a comparably prepared Chevrolet V6 intake system flows 165 cfm of air. Assuming a displacement of 265 cubic inches for the Chevy, the formula is as follows:

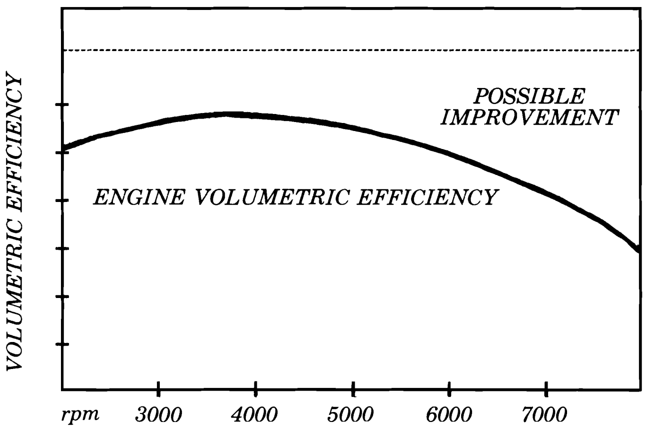
$$\text{hp} = 0.43 \times 165 \text{ cfm} = 70.8$$

Or for all six cylinders:

$$\text{hp} = 6 \times 70.8 = 428 \text{ hp}$$

The rpm for maximum power is:

$$\text{rpm} = \frac{2000}{44.16 \times 165 \text{ cfm}} = 7442$$



Production and Stage I Cylinder Head Porting

Stage I cylinder heads are the preferred heads for a street-oriented, high-performance engine because of their relatively high-port velocity, efficient combustion chamber, choice of manifolds, and availability of hardware.

The combustion chamber volume of all 1979 and newer heads is just over 48 cc (about 2.94 cubic inches). These heads can safely be milled 0.025–0.030-inch to get down to a 43cc (2.62-cubic-inch) combustion chamber volume. Doing this and using a 0.018-inch stock steel shim head gasket and a flat-top piston results in a compression ratio close to 12:1. The compression ratio of a street-driven vehicle should not exceed 8.5:1, which is all that can be tolerated with today's gasoline. Whether the heads are for street or off-highway use, smooth the combustion chambers with a grinding wheel to remove casting imperfections and sharp corners.

For maximum airflow through the cylinder head, both intake and exhaust ports must be ground to remove cylinder head material and to reshape the contours of the ports.

A number of important steps should be followed when porting these heads. In terms of increasing flow, the most critical area in the intake port is the short-side radius immediately under the valve. The thinnest area allowing water to break through in the intake port is in the floor. Lower the floor 1/16-inch, smooth it, blend in the short-side radius, and leave the port alone. It is vital to blend the intake manifold port with the intake port in the cylinder head. These two pieces of hardware function as a unit to provide mixture flow to the combustion chamber; they should be treated as one unit when porting. When increasing flow and generally reworking the exhaust port, the most important point is to enlarge the entire port by about 10 percent. All grinding in the ports should be done carefully to avoid damaging any valve seat surface.

To maximize flow, install a 1.750-inch intake and a 1.500-inch exhaust valve, both with a three-angle valve job with a top cut of 15 degrees. To improve flow on a production head, the valve seat itself should be 45 degrees and the cut in the throat of the port 60 degrees, followed by an 80-degree cut below the 60-degree cut. (The last two cuts are

Test Description:
Modified Stock Head Intake Port

Intake valve diameter: 1.7
Port number: 3
Test pressure = 40 Ins.-H_20

Valve Lift Ins.	Computed CFM Flow
0.10	77.825
0.15	111.80151
0.20	145.5
0.25	169.5
0.30	181.5
0.35	186.003
0.40	189.003
0.45	191.4
0.50	192.003
0.55	192.003
0.60	193.5

Area under the curve: 84.8 CFM-In

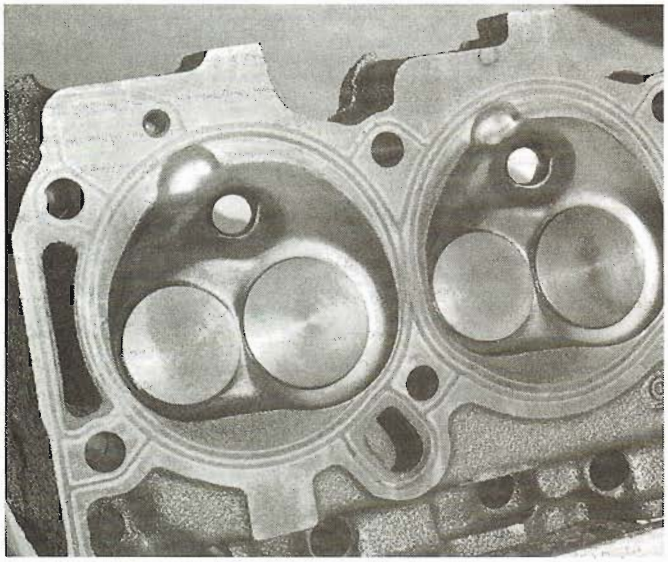
This modification was done with a seat grinder only. The throat was liberally opened with a 60° stone.

Test Description:
Production Modified Street Use

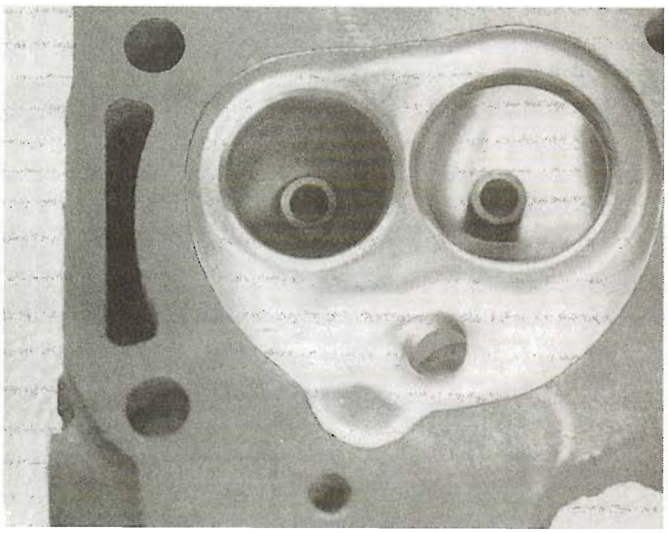
Intake valve diameter 1.7
Port number: 2
Test pressure = 40 Ins.-H_20

Valve Lift Ins.	Computed CFM Flow
0.10	73.99
0.15	110.23
0.20	140.43
0.25	159
0.30	177
0.35	192
0.40	207
0.45	219
0.50	228
0.55	237
0.60	243

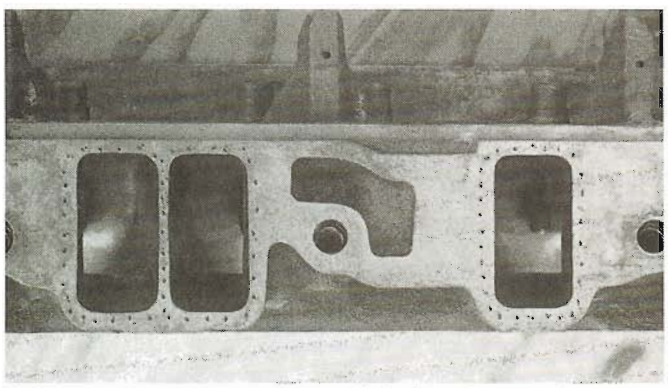
Area under the curve: 91.5 CFM-In



A production cylinder head. Note the large water passage at the end of the casting and, more importantly, how the combustion chamber has enlarged and laid back toward the gasket. Note also how well the valves have been unshrouded.



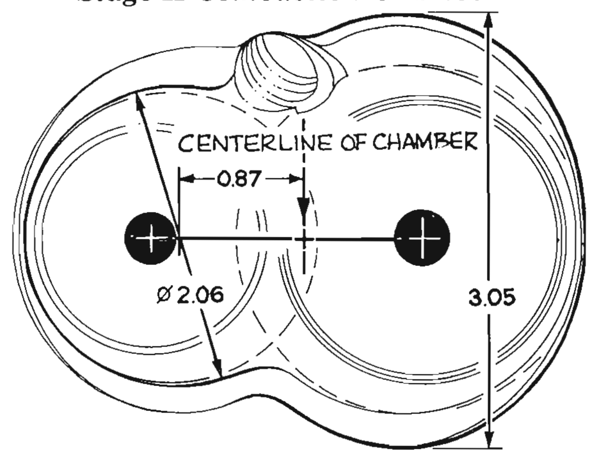
Another excellent example of unshrouding valves and smoothing out the floor of the combustion chamber. Note also the press-fit valve guides.



Prick-punching the area around the intake ports is a time-consuming job, but if it prevents a leak in this area when the engine is in heavy-duty use, the effort will have been worthwhile.

standard on a Stage I head.) All angles should be blended by hand. Seat width is not critical to flow or horsepower. Width determines how long the valve job will last—the old saying "the longer the race, the wider the seat" still holds true. Intake seats of 0.060–0.090-inch in width are common, as are exhaust seats of 0.070–0.085-inch. On vehicles using unleaded gas, exhaust seats should be 0.090–0.110-inch, since both production and Stage I heads have unhardened seats.

Stage II Combustion Chamber



Stage II Iron Heads

Cast-iron Stage II heads bear the part number 25500026 and are identified by the casting number 25500027. This head incorporates ports designed for maximum airflow and uses a 2.02-inch intake and 1.600-inch exhaust valves. Valve stem length is greater than that of the production valve. Combustion chamber shape produces "squish" on both sides, and the size allows high compression with flat top pistons. A long-reach gasketed spark plug (such as the Champion N-60) is used on the iron head. The Stage II head incorporates a six-bolt pattern attachment to the block and requires head gasket 25500006. No gasket sealer is required when using the six-bolt pattern; however, a Stage II head used with only four bolts on Stage I or older blocks has the same sealing concern and is horsepower-limited, as discussed in regard to the Stage I head. Intake, exhaust and rocker cover gaskets for the Stage II head are all special and require a special rocker arm cover, intake manifold, and exhaust headers. As sold, the Stage II iron head weighs 30.5 pounds—2 pounds less than a production head.

Stage II Aluminum Heads

An aluminum Stage II head (25500030; casting, 25500031) is also available. This head interchanges with the iron head except that the exhaust ports are square instead of D-shaped. It is sold complete with valve seat inserts and bronze valve guide liners. Seat material has been compatible with all types of fuels and valve materials when run in other heads. The aluminum alloy is 355 with a T-6 heat treat.

Intake port size has been reduced with heavier walls, giving the porter more freedom and better sizing the intake port for small engines. As sold, the valve seats are ready for the engine builder to finish-grind and are sized to use the 2.02-inch intake and 1.600-inch exhaust valves common with the iron Stage II head. The short head bolt bosses on this aluminum head are 0.350-inch taller (iron is 0.850-inch and aluminum is 1.20 inches) to provide more fastener stretch and better gasket loading. Due to this taller boss, head bolts and studs are not common in the iron head. Spark plug holes are machined for long-reach, tapered-seat spark plugs. The seat is tapered on the aluminum head (the iron head has a ¾-inch-reach gasketed spark plug hole). The smaller hex on the tapered-seat plug requires a ⅝-inch socket, which in turn allows for a taller head bolt boss adjacent to the spark plug. The tapered-seat plug requires only 15 ft./lbs. to seal, whereas the gasketed plug requires 25 ft./lbs.

Bank face thickness has been increased to 0.400-inch to allow milling if desired. As in the iron Stage II head, cored water openings not used for primary coolant flow are round, which facilitates plugging for block-to-head sealing or strength. Combustion chamber volume has also been reduced by a heavier chamber wall that allows the builder latitude in chamber shape and volume. Valve guide length has been increased ¼-inch in the port over the iron Stage II head to improve valve stability and heat transfer from the valve. Valve guide boss size inside the water jacket allows the valve centers to be spread for larger valves yet still use a 0.500-inch outside-diameter solid bronze guide. While cup plugs are used only in the ends of the aluminum head, the boss was retained for a potential water outlet; some engine builders do the same with special fuel-injection manifolds. All tapped bolt holes can be repaired with Helicoil thread inserts.

Stage II Cylinder Head Porting

Because the Buick V6 Stage II cylinder head was designed from a "clean sheet of paper" as a competition piece of hardware, the cylinder head is not recommended for applications where rpm drop below 4500. Despite the design criteria of "competition only," a professional cylinder head porter must still spend many hours reworking the combustion chambers and all ports on a set of Stage II heads to maximize their race-track performance potential.

Typically, an "as cast" cylinder head measures about 44 cc. The spark plug side of the combustion chamber should be opened up and laid back, primarily in the area of the intake valve. Retaining a loose, open radius here between the seat and the chamber wall promotes flow. A good three-angle valve job also promotes flow, as do moderate valve seat widths. Intake seats 0.060–0.080-inch wide and exhaust seats 0.080-inch wide are acceptable. When you slightly reshape the combustion chamber, you

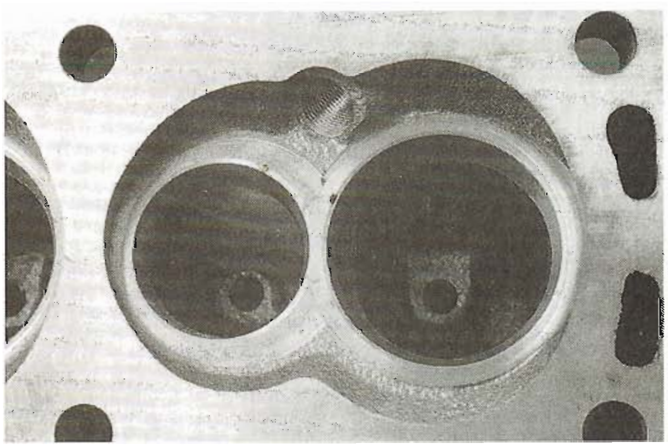
Test Description: Modified Stage II

Intake valve diameter: 2.02
Port number: 2
Test pressure = 40 Ins.-H_2O

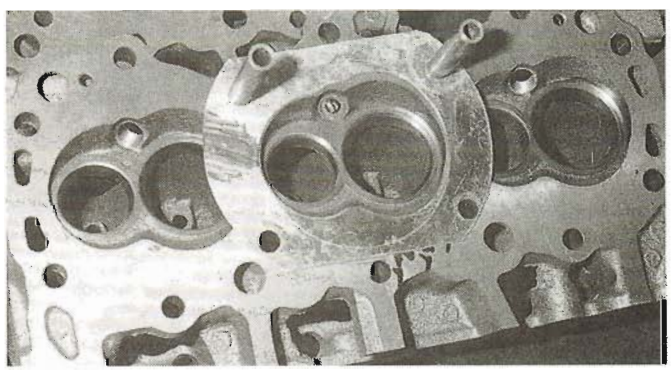
Valve Lift Ins.	Computed CFM Flow
0.10	92.11
0.15	132.88
0.20	180
0.25	225
0.30	258
0.35	285
0.40	309.81
0.45	332.26
0.50	350.22
0.55	359.2
0.60	363.69
0.65	372.67
0.70	377.16

Area under the curve: 170.3 CFM-In

Test point 3 was changed to 300 from 151 cfm. Test point 7 was changed to 449 from 300 cfm.



As cast and machined, a Stage II combustion chamber accepts a 2.02-inch intake valve and a 1.60-inch exhaust valve. Most engine builders increase the intake valve size; in the case of quarter-mile activity, it can be enlarged to 2.100-inch.

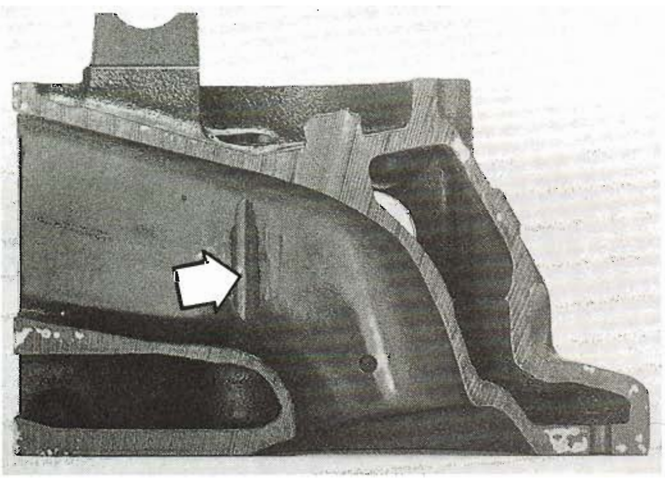


An aluminum template such as this ensures that all combustion chambers are enlarged by the same amount.

are also going to need to polish it at this point.

The total Stage II package is gifted with compression ratio without having to work for it. A mechanical compression ratio of 12.5:1–14.0:1 is easily within reach, with finished combustion chambers ranging from 42 to 44 cc, a flat-top piston eyebrowed for valve clearance, and a deck clearance of 0.010-inch.

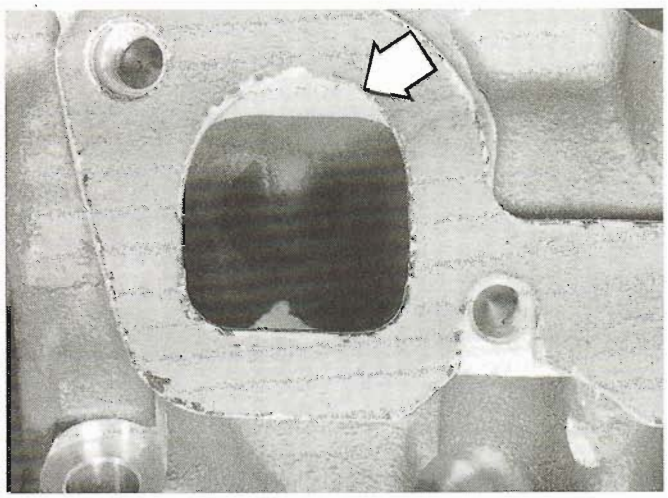
Some competition engine builders prefer to grind away the part of the valve guide that extends into the port and then install bronze guides after all porting work is completed. This allows them to increase the size of the bowl area under both valves. You can drop the floor on the short-side radius of the intake port for increased flow at lift above 0.600-inch. The real flow improvements to the intake port result from raising the roof of the port and laying back the short-turn radius. As cast, the intake ports measure approximately 2.24 x 1.24 inches at the manifold mounting surface. A reworked cylinder head is typically taken out to 2.30 x 1.250 inches.



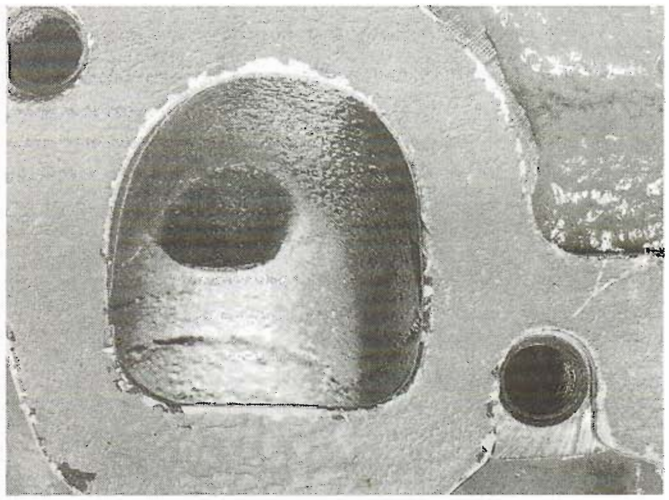
Three bolt holes on a Stage II head come close to the sides of the intake ports. To avoid having to worry about breaking into the water jacket while porting, most engine builders bore the hole larger and press in a length of steel tubing. Then the wall of the port can be enlarged right to the tubing.

About halfway down the length of the intake port is a bolt hole adjacent to the intake port. Many engine builders prefer to open this bolt up to ½–9⁄16-inch and then press-fit a piece of ½–9⁄16-inch tubing the length of the bolt hole. When this is done, the wall of the port can be moved out until the tubing is slightly exposed.

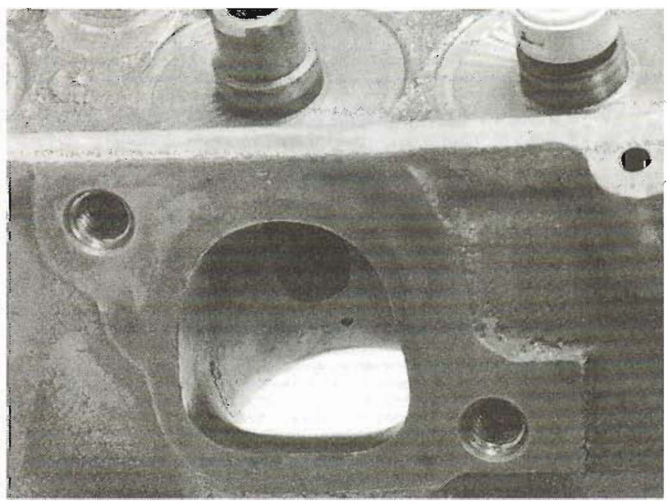
The short-side radius of the exhaust port is critical to good port flow. Generally, you should make the exhaust port wider and flatter throughout the length of the port. You also need to raise the roof of the port. An acceptable finished port width is 1.480 inches, with a maximum port height of 1.600 inches. A radiused exhaust seat improves flow in the constricted area under the seat, so the minimum dimension in the construction should be 1.360 inches, which can be ballooned to 1.430 inches. In



When an exhaust gasket intended for a Stage II iron head is placed on an aluminum Stage II exhaust port, the difference in shape is readily apparent. This "fill in" on the aluminum head gives the cylinder head porter more freedom in finalizing the size and shape of the port.

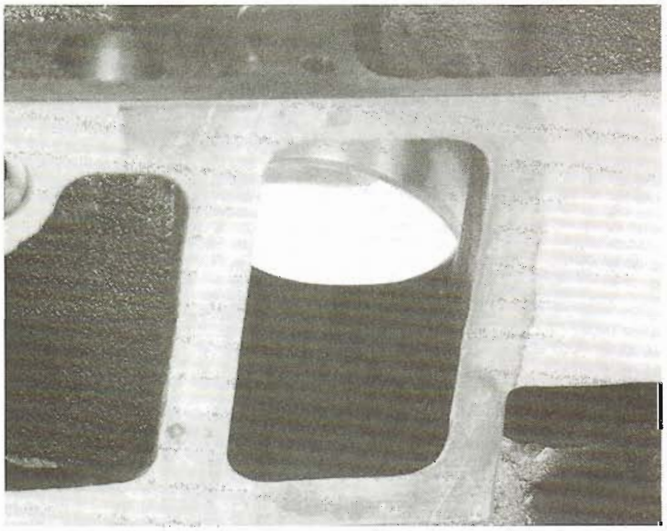


The exhaust port on the iron Stage II head has a wide, flat floor with a pent roof. The result is an efficient D shape.

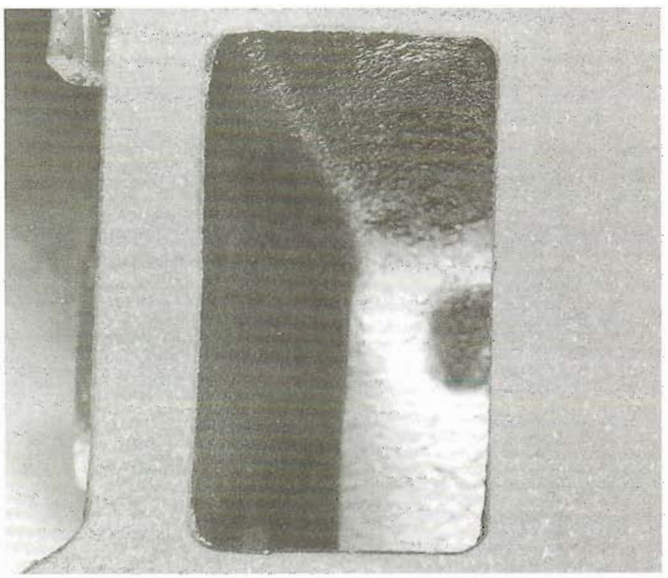


After rework, a Stage II exhaust port offers a straight shot from the valve to the header. Most people who rework cylinder heads grind the valve guide completely out of the port and use press-fit valve guides, which are in turn topped with Teflon seals.

The roof of an aluminum Stage II exhaust port with the valve guide lump that most engine builders grind away.



The intake port on a Stage II head flows a massive amount of air, and this shows why.



This unported cast-iron Stage II head has an intake roof area that most reworks raise. The short-side radius is smoothed out as well.

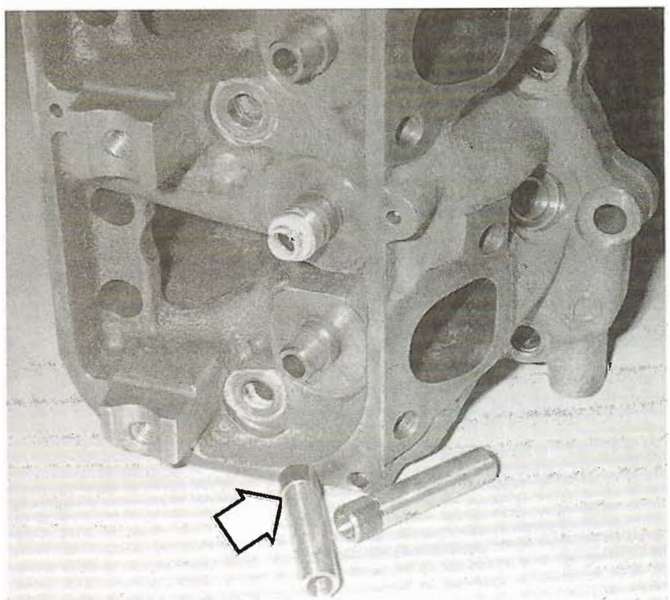
This aluminum Stage II intake port with the cast-iron gasket in place shows the additional metal in place for flexibility in reworking.

the combustion chamber, relieve the area around the exhaust seat and the chamber wall.

The basic intake port shape works well with cams of 0.600-inch lift or less. As cast, the short-turn radius promotes turbulence when the valve is lifted more than 0.600-inch. Mild porting typically yields a port volume of 205-210 cc. Primarily, porting consists of blending machined edges below the valve seat and the short-turn radius.

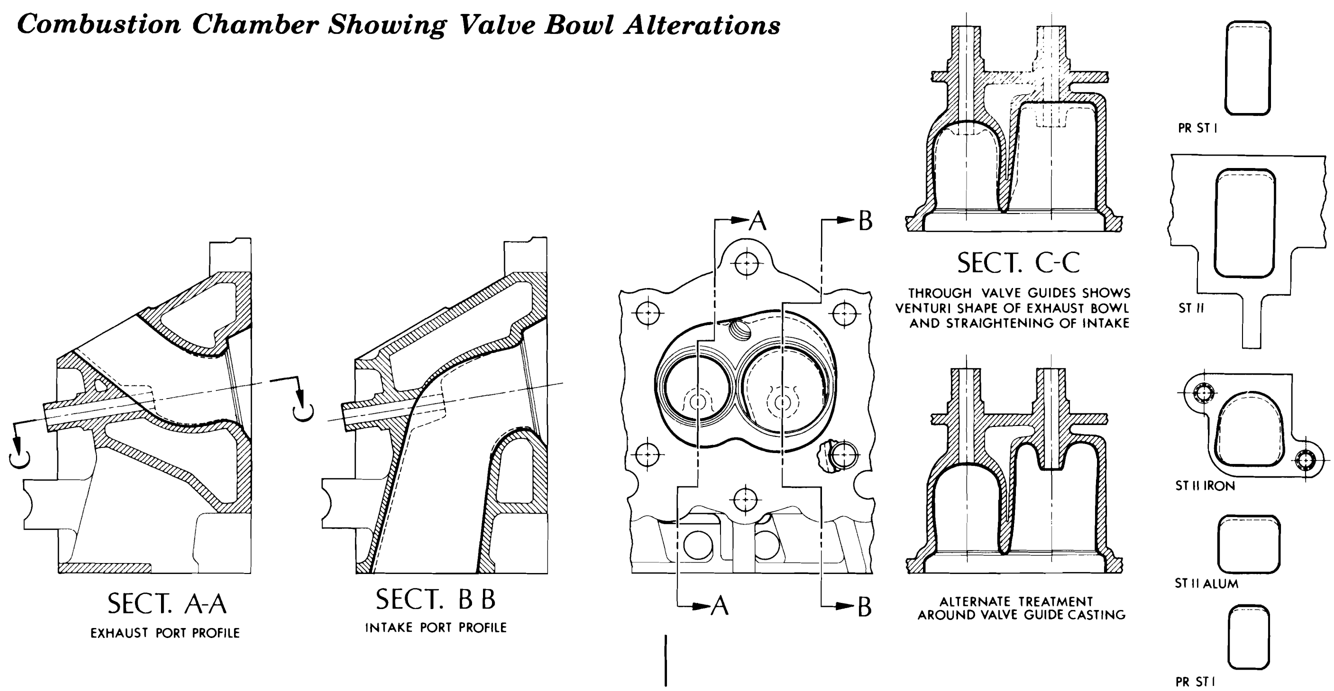
Radical porting requires a larger intake valve (2.050-2.080 inches); a larger bowl area; a straightened port runner on the head bolt side; a raised and widened roof port; and a laid-back short-turn radius. A radical Stage II intake port yields a volume of 220–230 cc.

It must be stressed that both the cast-iron and



If you use press-fit valve guides, make sure they have a step to prevent them from falling into the port in heavy-duty use.

Combustion Chamber Showing Valve Bowl Alterations



aluminum versions of the Stage II cylinder heads are designed and built for off-highway use only. The six-bolt-per-cylinder configuration matches that of the Stage II cylinder block. The heads were designed from the inside out for maximum intake and exhaust flow, so they require little rework. Raising the roof of the port and widening the top corners benefits the exhaust port, and a minimum amount of time is required to clean it up or to clean the intake port. There is sufficient material at the top of the valve guides for cutting and installing Teflon valve seals for superior sealing.

Buick builds intake and exhaust valves designed specifically for the Stage II head. The 25500024 Stage II intake valve is a 2.02-inch valve, while the Stage II exhaust 25500023 is a 1.60-inch item. A second Stage II exhaust valve (25500025) is made of Inconel for turbocharged applications. Head angles on all three valves are optimized for maximum flow and need only be treated to a quality valve job in the Stage II head for outstanding performance.

Tech Tip

Minor Machining

Two easy but important steps should be followed on any Stage I and II cylinder heads intended for heavy-duty use. The top side of all valve guides should be cut for and fitted with Teflon valve stem seals. Also, all bolt and stud holes on the top side of the head should be lightly spotfaced to ensure that the underside of the capscrew bears evenly against the head upon final assembly.

Valve Seat Modifications

Low- and high-lift flow on intake and exhaust ports can be improved if you carefully alter the shape of the valve. On the intake side, cut the back-side angle to about 30 degrees. This improves the high-lift flow figures, provides gains in top-end power, and improves low-lift flow.

The exhaust seat should be sunk about 0.020-inch lower than the intake seat to improve exhaust-side airflow. The seat on the exhaust valve should be without definition. A tulip backside exhaust valve promotes good low-lift flow. You need to gently radius the edge of the exhaust valve that sees the inside of the combustion chamber. For purposes of increasing flow volume, a 2.05-inch intake valve is preferable to a 2.02-inch valve.

Cylinder Head Studs

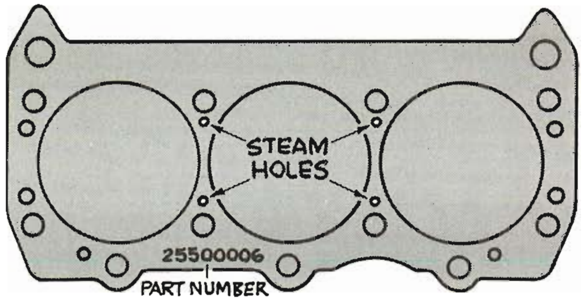
Stage I and Stage II cylinder head studs require different number and length studs for attachment to the block. Also, the short studs on the Stage II iron heads differ in length from those for the Stage II aluminum. Stud kits are available from a number of aftermarket suppliers.

Rocker Covers

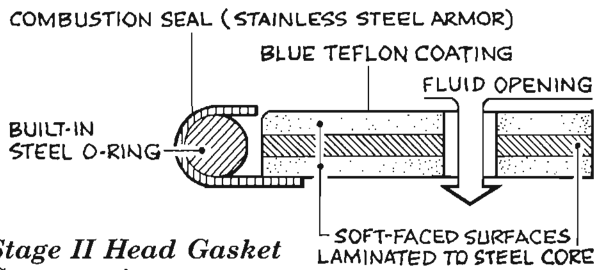
Rockers designed to fit 1977 and newer production cylinder heads fit Stage I cylinder heads. Both Stage II cylinder heads require an aftermarket rocker cover.

Head Gaskets

Buick produces three cylinder head gaskets of interest to heavy-duty Buick V6 engine builders. Head gasket 25500006, designed specifically for competition, features a solid-core body and stainless steel flanging with a solid-wire O-ring in the fire ring flange. This blue composition-construction gasket is 0.040-inch thick and should be used on Stage



As manufactured, the composition gasket 25500006 contains four 3/16-inch-diameter steam holes adjacent to the center cylinder. Some engine-builders prefer to block off one set of water passage holes in the end of the gasket.



Stage II Head Gasket Construction

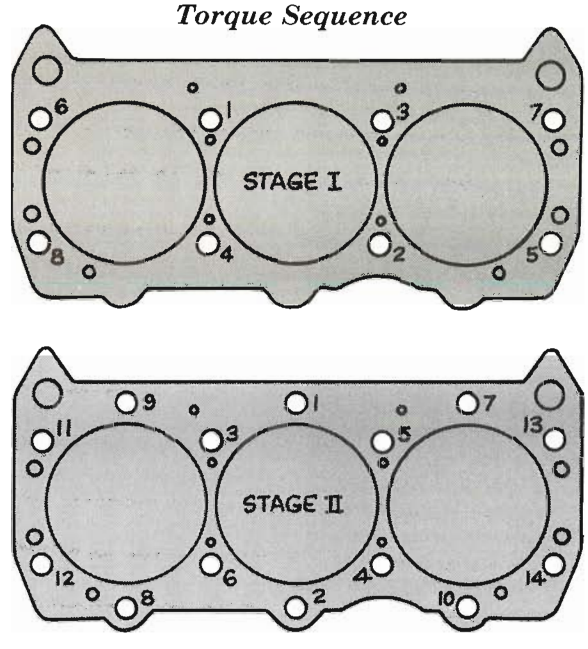
I and II cylinder blocks and heads only. Install this gasket without sealant. When this gasket has been used with a four-bolt pattern head, however, extra sealer has been necessary to prevent the "water-in-oil" problems mentioned in the Stage I head discussion. Permatex High Tack Spray-a-Gasket can be used with an 8-hour or overnight drying time prior to assembly. Extra block-to-head cooling holes are recommended for some applications, and the head gasket can be used as a template for this drilling. Check the bank-to-bank coolant temperature, and enlarge the rear water openings of the head gasket on the hottest bank, if necessary.

This gasket has been successful in all engine bore sizes. However, when boring to 4.00-inch, the bores must match the gasket bores and chamfer must be very slight, or the 4.020-inch ID will fall into the cylinder. Horsepower has exceeded 800 on 3.800-bore engines with satisfactory head gasket durability. In the gasket installation, the stainless steel flanging seal between cylinders goes down on the deck face.

In heavy-duty applications where a four-bolt head pattern block is used, you can gain additional head clamping by using a liberally oiled, hardened washer, such as 14011040, with each head bolt.

The production steel shim head gasket (25500202) is available for the 3.8L engine. Steel-shim head gaskets should always be installed with a sealant on both sides. Head gasket 25518453, which is a composition-construction gasket for the 4.1L (four-bolt pattern only), should be installed with the part number facing the block.

Torque Sequence



Due to the six extra bolts used to clamp Stage II heads to a block, the Stage II torque sequence is different from that of Stage I.

Regardless of which head gasket is used, iron heads must be retorqued hot after about 30 minutes of running time. Allow aluminum heads to cool overnight, and then retorque them. When calculating compression ratio, consider which gasket will be used: Composition gaskets hold about 8.25 cc, a pair of steel gaskets holds 8 cc, and one steel gasket holds 4 cc.

Tech Tips

Gasket Sealing

To prevent leakage, install valve cover gaskets dry, and do not overtorque them.

Retorquing Heads

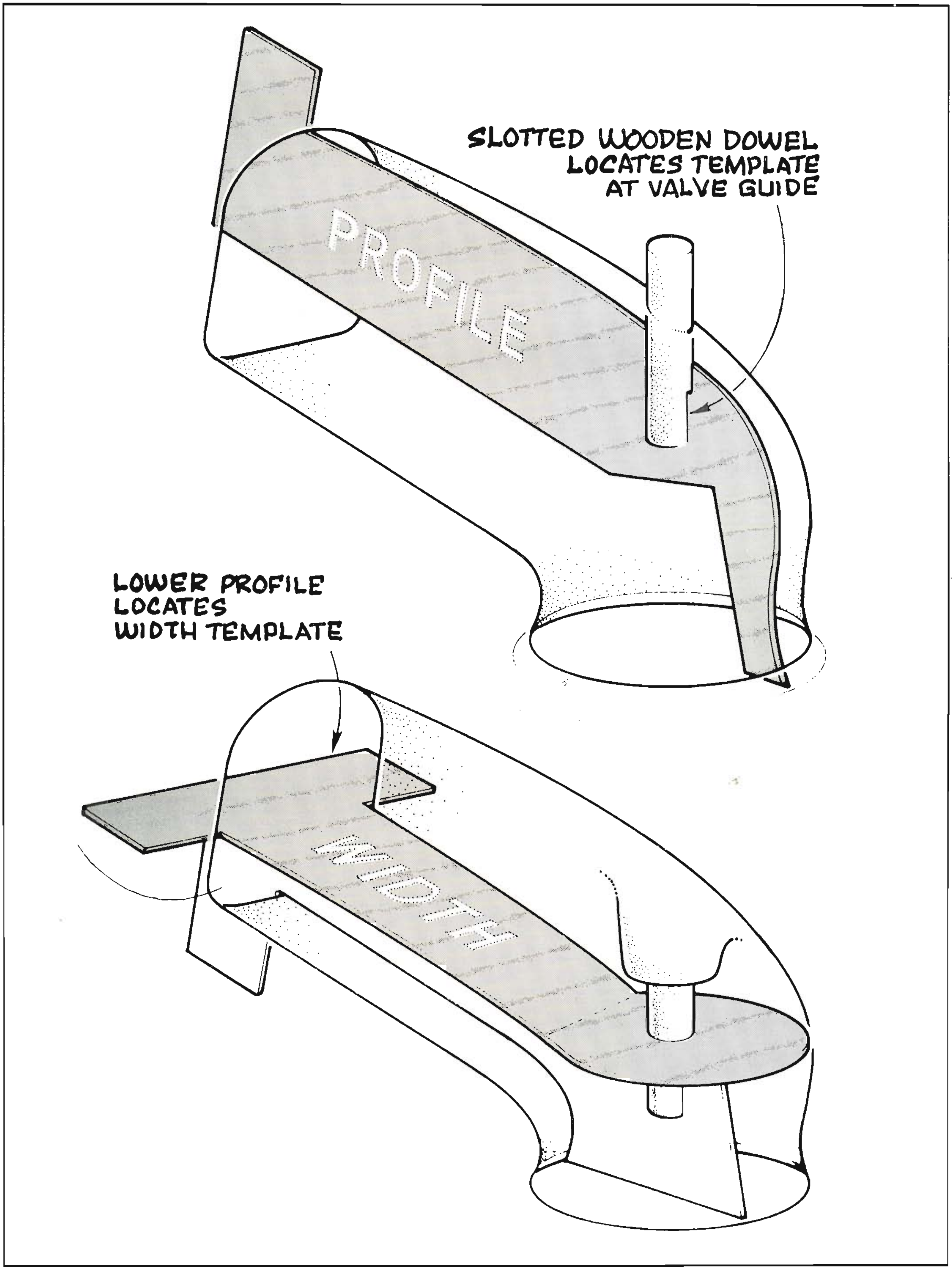
Retorque iron heads hot after a minimum of 30 minutes of running. Retorque aluminum heads cold after the engine has cooled overnight. No sealant is necessary on head gaskets.

41.L Head Gasket Installation

The proper installation of the 4.1L V6 engine head gasket is critical in eliminating oil leaks. The part number stamped into the gasket faces the engine block when the gasket is correctly installed.

Measuring Combustion Chamber Volume

After grinding valve seats, you need to measure the actual volume of the combustion chambers against the specified volume. Do this by placing the head—chambers up—on a level surface with the valves in place and the spark plugs threaded all the way in. Coat the area around the chamber you are measuring with light grease to provide a seal.

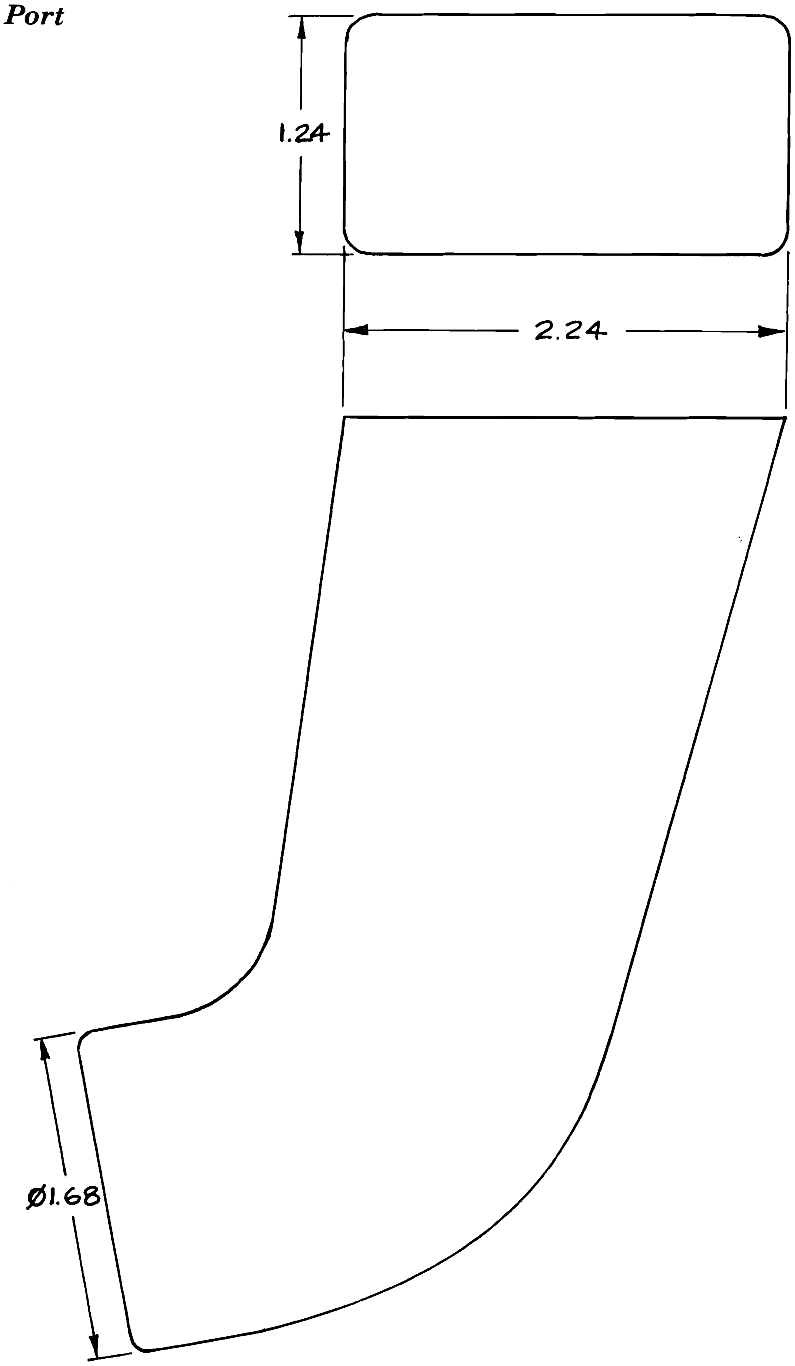

SLOTTED WOODEN DOWEL
LOCATES TEMPLATE
AT VALVE GUIDE
PROFILE
LOWER PROFILE
LOCATES
WIDTH TEMPLATE
WIDTH

In a piece of Plexiglas, make a hole large enough to permit the checking fluid to enter and the air to exit, and place the Plexiglas over the chamber. A burette, graduated in cubic centimeters, with a capacity of at least 100 cc, makes an excellent checking vessel. Use transmission fluid or plain water colored with a touch of Mercurochrome (to facilitate reading) as a checking fluid.

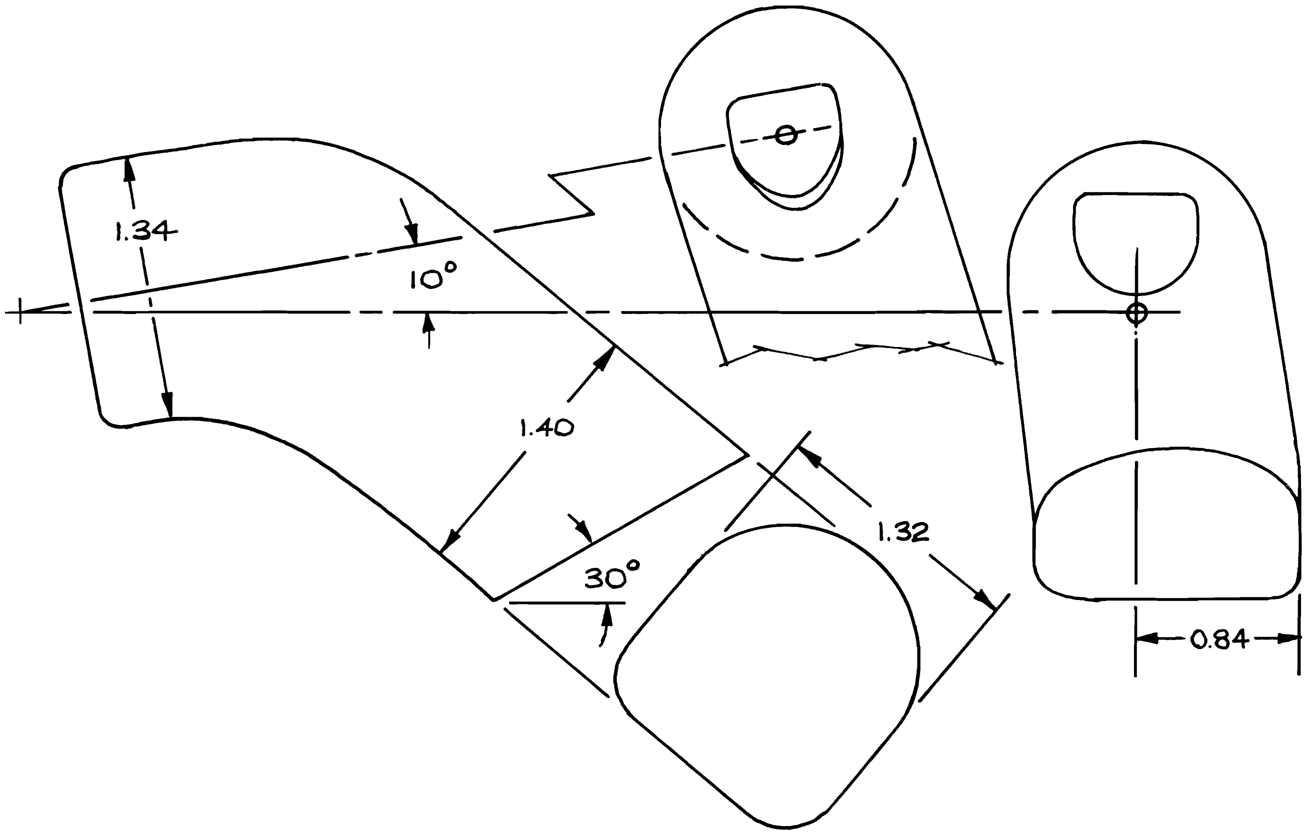
Fill the chamber with fluid, making sure all air is out of it and that it is completely full; then read the volume on the burette. If the volume is too large, the compression ratio will be less than specified and the volume will have to be reduced. Do not under any circumstances sink the valves in an attempt to equalize chamber volumes. Sinking the valves disturbs the airflow characteristics of the valve port and seat with a subsequent horsepower loss. Sharp edges and burrs should be removed from any area in the combustion chamber to prevent hot spots that could cause detonation or pre-ignition.

The following template illustrations concern the modifications many engine builders are currently making to Buick production, Stage I, and Stage II cylinder heads for use in various forms of competition. Templates traced from these pages are intended only as guides.

Stage II Intake Port



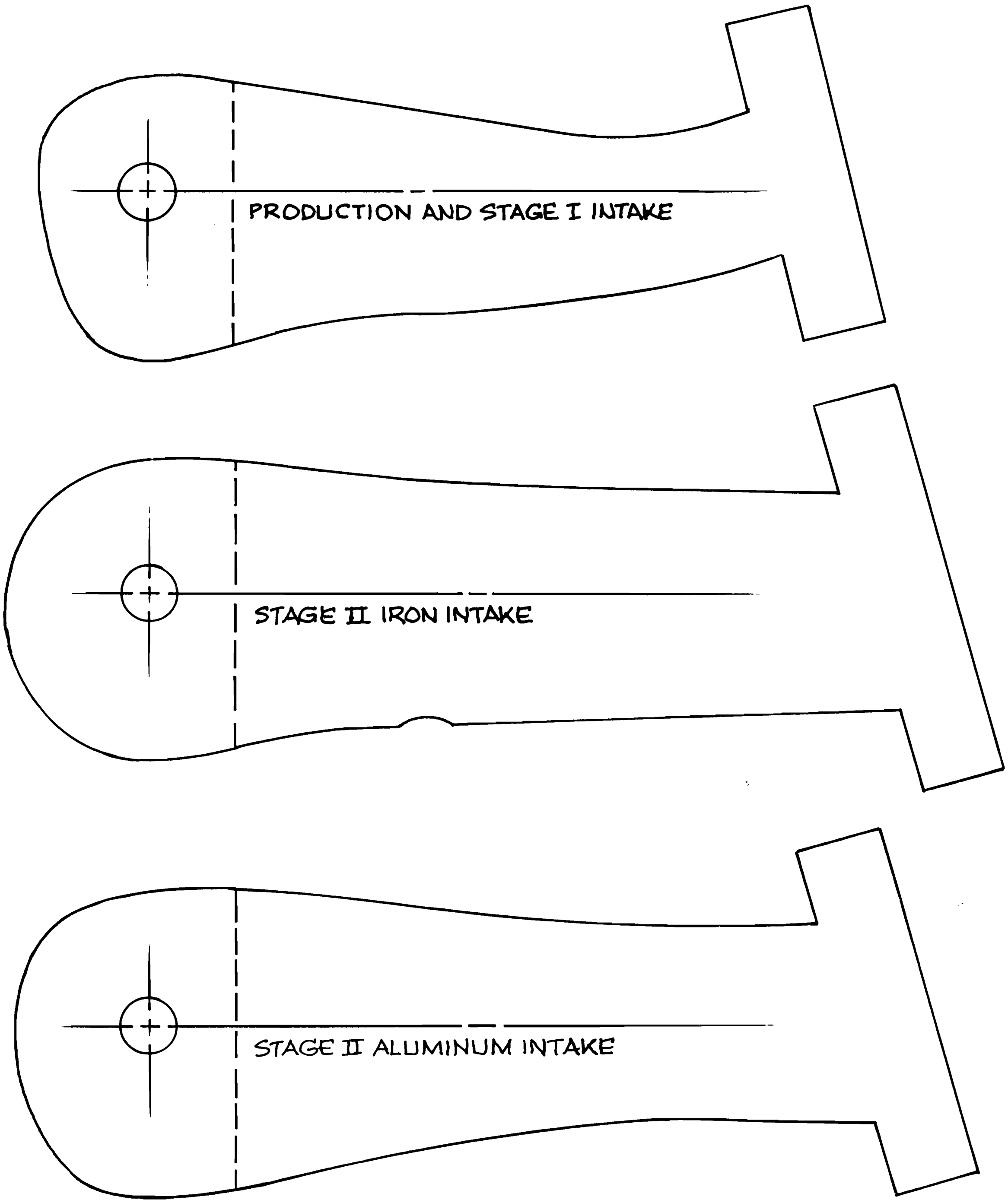
Stage II Exhaust Port



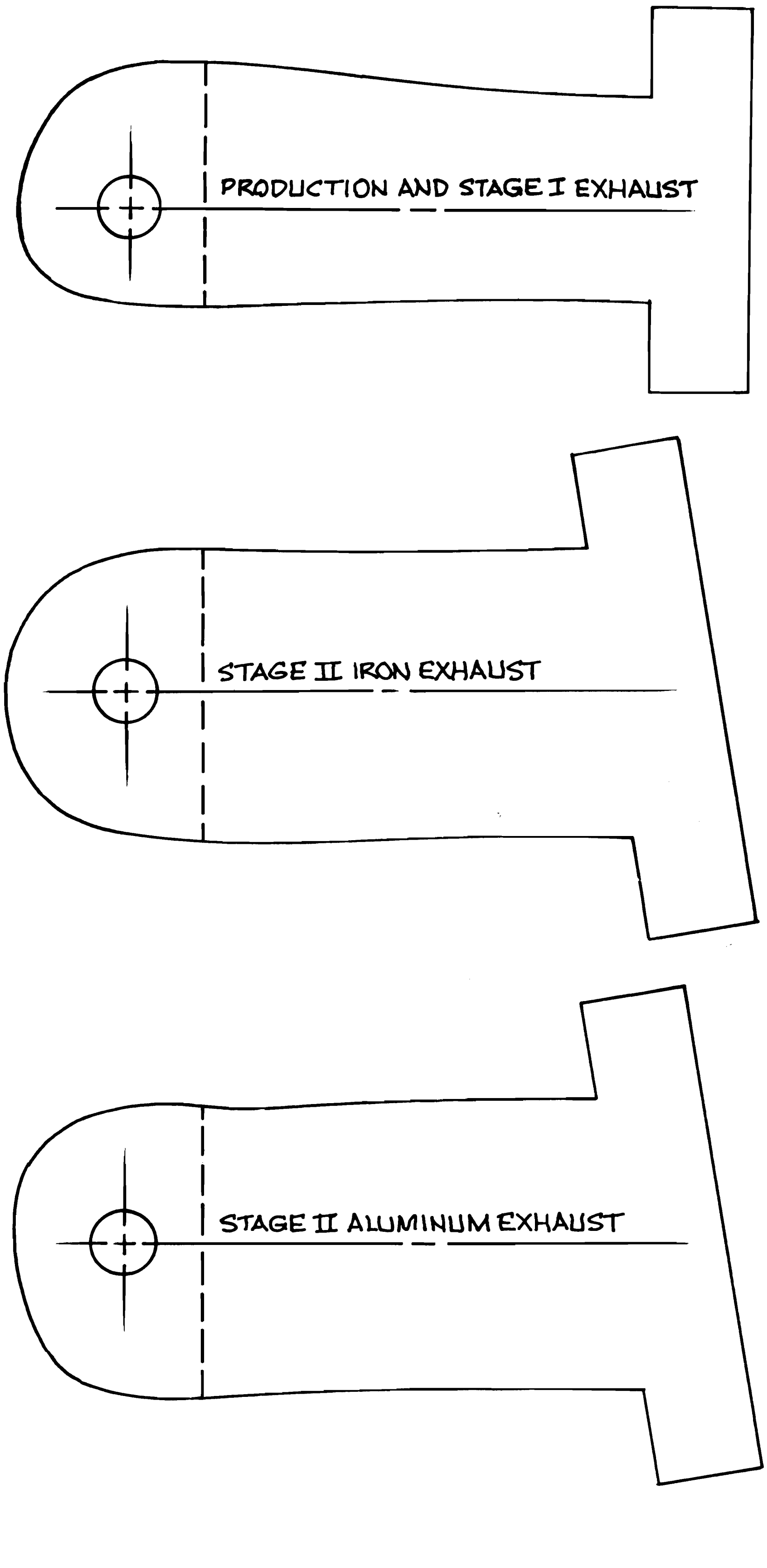
NOTES

Buick heavy-duty parts are designed and manufactured for off-highway use only.

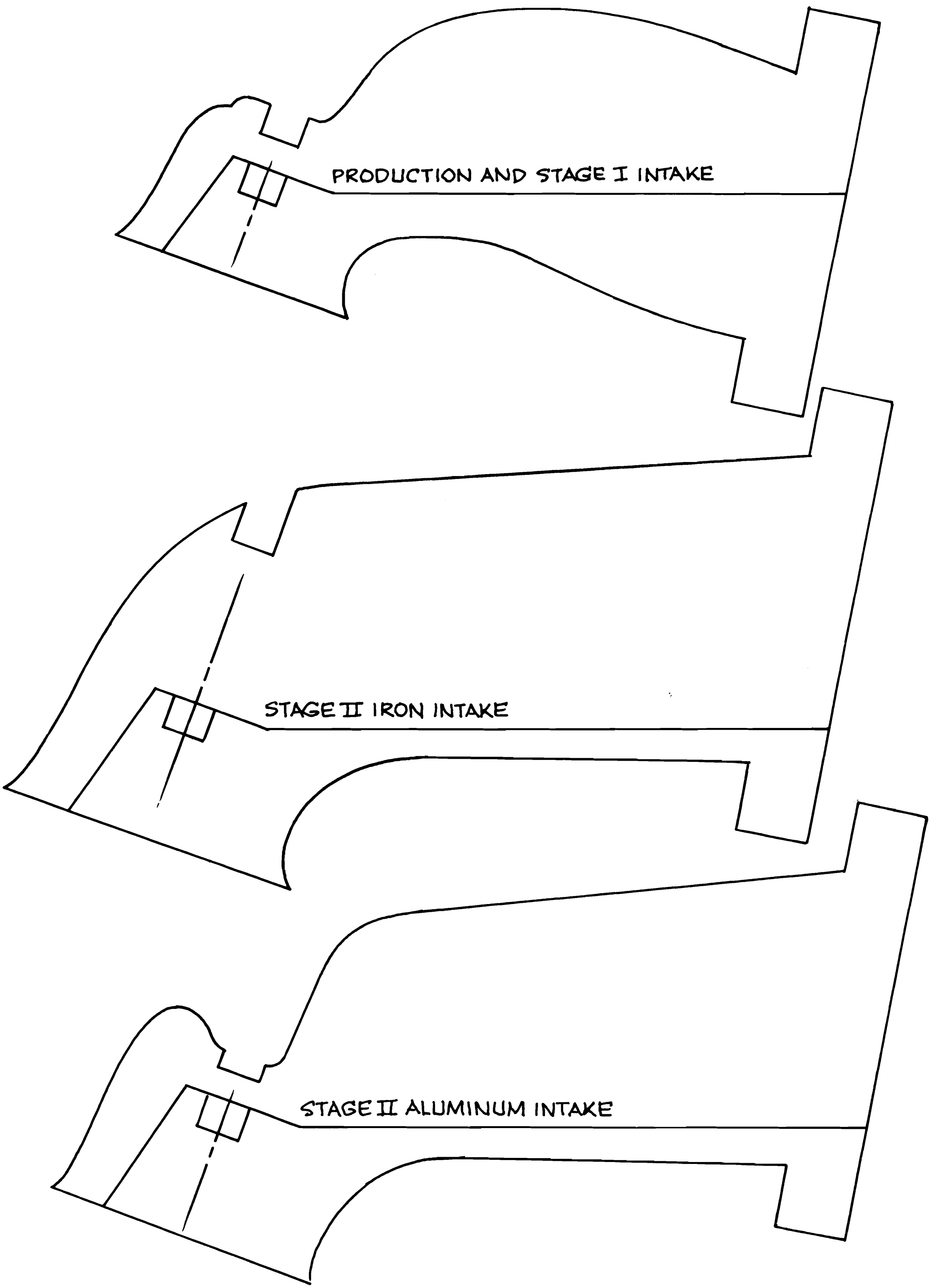
Width–Intake



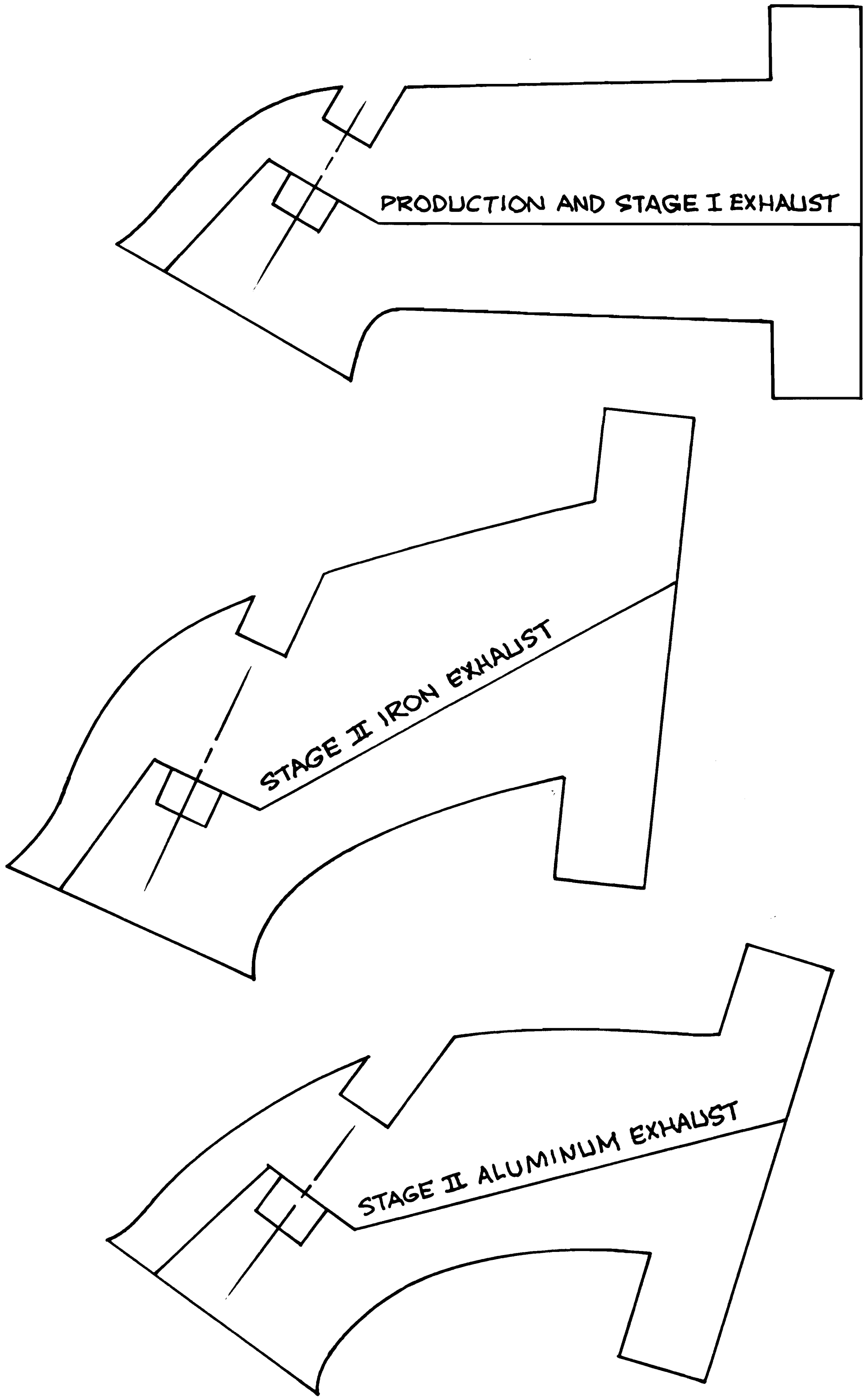
Width–Exhaust



Profile–Intake



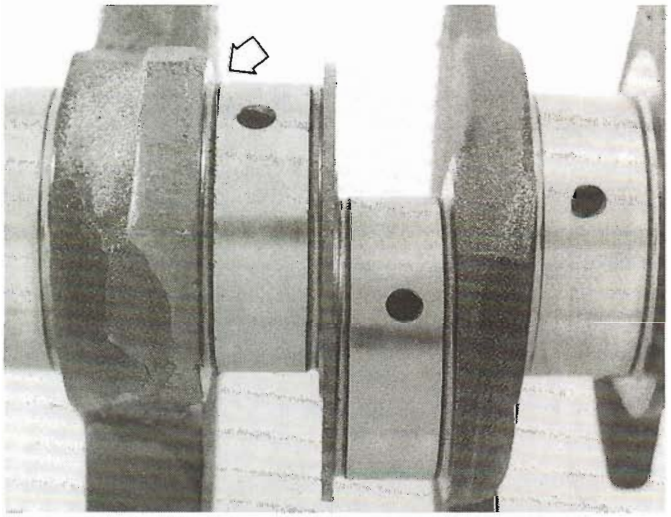
Profile–Exhaust



NOTES

Crankshaft

Several points regarding stock Buick V6 crankshafts must be understood before addressing high-performance hardware. Production crankshafts are all nodular cast iron and are available with strokes of 3.400-inch and 2.660-inch. Crankshafts for front-wheel engines are shorter and have a smaller flywheel bolt pattern with less potential torque capacity than the rear-wheel-drive crankshaft. Front-wheel-drive crankshafts are available in both strokes—2.660 for the 3.0L and 3.400-inch stroke for the 3.8L production engine. Rear-wheel-drive crankshafts are available



The hydraulically rolled fillets on turbocharged 3.8L and normally aspirated 4.1L engines make them stronger than other Buick cranks. If a production crank must be pressed into heavy-duty service, start with this piece.

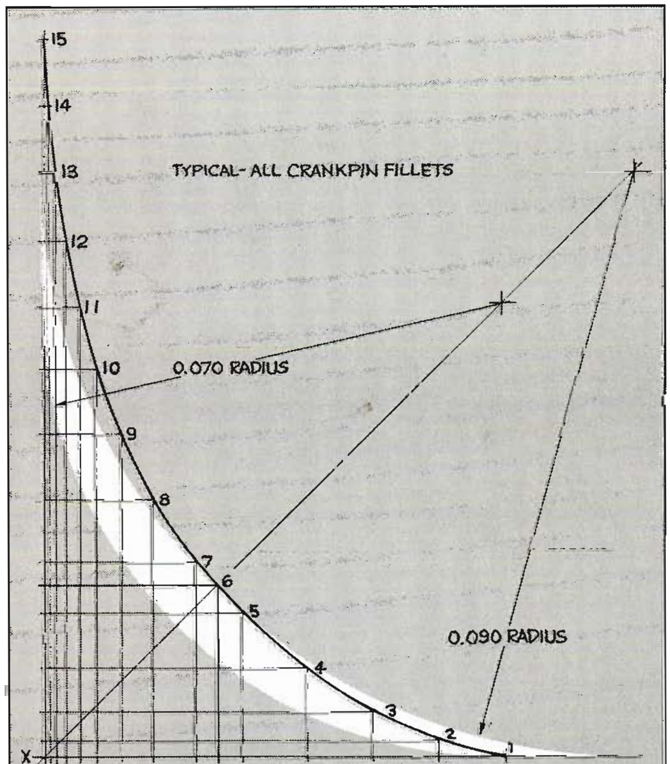
only in the 3.400-inch stroke; however, the standard crankshaft used in the naturally aspirated 4.IL and turbocharged 3.8L has journal fillets hydraulically rolled into place to increase strength. When properly cross-drilled and Magnafluxed and with the cast surfaces polished to remove stress risers, these crankshafts are a low-cost, reliable piece of hardware for up to 400 horsepower. In road racing applications, a production crankshaft should be Magnafluxed after every five hours of running.

Replace even a turbo crank after 12 hours of competition use even though it may still pass Magnaflux inspection. This is a low-cost precautionary measure because failure in Buick V6 crankshafts is quite rare. A complete Magnaflux inspection should be performed when the crank is new and each time the engine is disassembled.

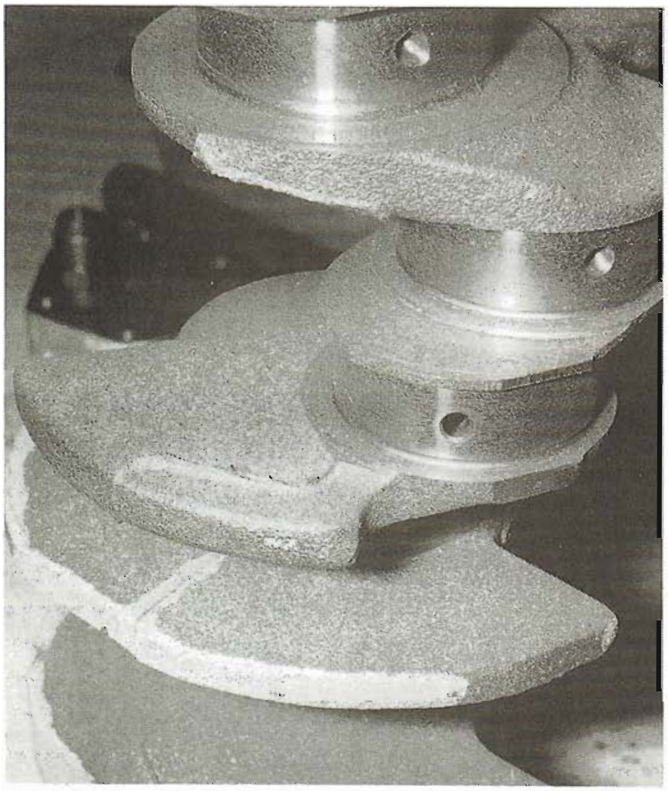
Any rolled fillet (turbo or 4.1L) crank should be visually checked to make sure all rod and main journals have rolled fillets. After a crank has been checked for straightness and the presence of rolled

Typical Reference Points Of All Crankshaft Fillets

Points	X	Y
1	0.070	0.000
2	0.060	0.0022
3	0.050	0.0067
4	0.040	0.01325
5	0.030	0.02245
6	0.0262	0.0262
7	0.0231	0.030
8	0.0165	0.040
9	0.0115	0.050
10	0.0078	0.060
11	0.0050	0.070
12	0.0032	0.080
13	0.0016	0.090
14	0.0007	0.010
15	0.000	0.011



fillets on all journals, all bearing surfaces should be wrapped with several layers of duct tape and the cast surfaces of the crank deburred and smoothed as much as time permits. This eliminates stress risers that could lead to failure of the component. The duct tape on the bearing surfaces is inexpensive insurance against nicking a journal while grinding. Taping and cleaning up a crank for high-performance use normally takes about seven to eight hours.



All production Buick cranks are cast. Any crank used in a heavy-duty application should be thoroughly deburred—even polished—to eliminate stress risers.

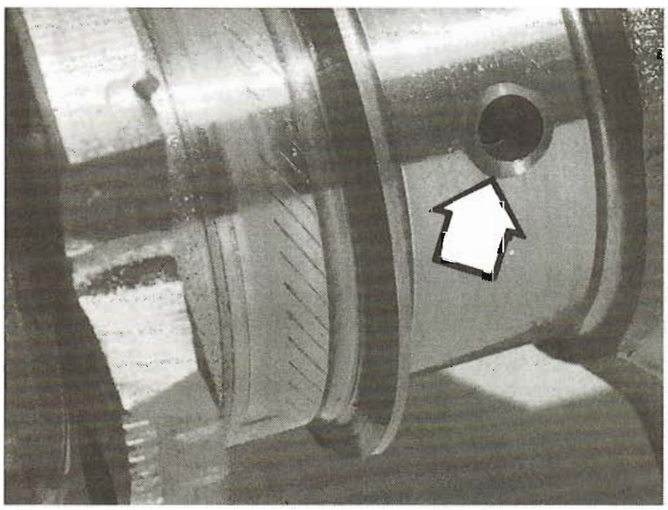
Do not shotpeen the unmachined surfaces of a Buick crank. Shotpeening might impart strength to the component, but the procedure will almost definitely distort the crank.

For years, most engine builders have said that a competition engine requires that a new crankshaft index be ground and then re-Tufftrided to ensure that all throws on the crank are exactly where they should be. So far, this has not been the case with the Buick crank. Indexing is simply not needed. Cross-drilling the main bearing journals seems to improve rod bearing life in the engine without noticeably affecting crankshaft life. Regardless of whether cross-drilling is employed, any oil hole intersecting a crank journal should be slightly chamfered. Under no circumstances should any Buick V6 crank be grooved on any journal.

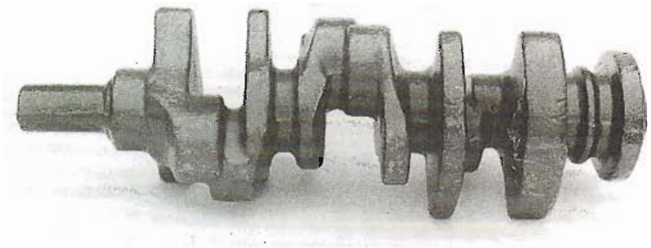
Crank straightness can be checked by first installing the crank and all bearing shells in the block. Coat all bearing surfaces with a light machine oil, oil the main cap bolts or studs, and torque the caps to specification. If the crank turns freely by hand, it is straight enough for heavy-duty use. The rear main seal should not be in place at this time. Spinning the crank by hand should require little effort.

The crank should be checked in a lathe and spun to ensure that the pilot bearing is concentric with the centerline of the crank and that the flywheel mounting flange is perpendicular to the centerline. Variances in either area are rare, but when they occur, the result is pure misery in the balance and clutch department.

If for any reason a billet crank is machined for a high-performance Buick V6, all oil holes in the production crank should be duplicated in the billet. Oil holes from 25500066 or 25500068 should be used.



All oil holes in a Buick crank seeing heavy-duty use should be chamfered. The chamfering shown is sufficient.



The raw forged crank looks like this when you purchase it at the dealership. Stroke capability is 2.66–3.625 inches.

Raw Forged Crankshafts

Buick offers a raw forged crankshaft (25500008) featuring 4140 steel (30-34 Rc hardness) maximum counterweighting with a stroke capability of 2.660- to 3.625-inch. This crankshaft is sold unmachined. The suppliers chapter lists shops that are familiar with this hardware.

Semifinished Crankshafts

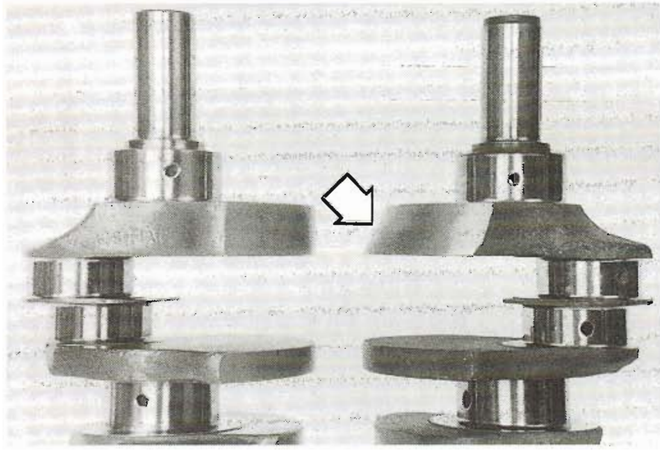
Buick offers semifinished crankshafts in strokes of: 3.625 (25500066); 3.400 (25500067); and 3.060 (25500068). These semifinished crankshafts are produced from the 2500008 forging. They are fully machined with the exception of 0.020-inch of material left on the rod and main journals and 0.010-inch of additional material left on the No. 2 main thrust surface. Main journals are cross-drilled and fillets are rolled.

Crank Checking

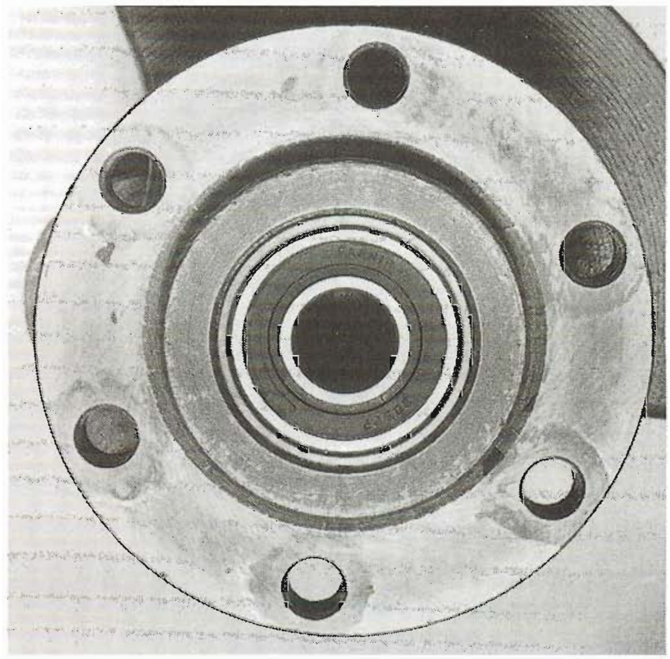
The crank of any Buick V6 being assembled for a performance-oriented purpose should be checked for straightness, endplay, and rear flange runout in addition to rear oil slinger clearance with the block, regardless of the type of crank being used—production, billet or custom-ground raw forging. Do the checking early in the process of gathering all that is needed to build an engine. It makes no sense to spend a lot of money on a crank only to learn that you cannot use it because it is crooked.

With the block upside down on an engine stand, install the upper halves of the main bearings. Oil the bearings, lay the crank in the bearings, and install the bolt in the crank snout, and finger-tighten it. Using a magnetic base dial indicator with a tip that will clear the counterweights, determine the total runout for each main journal. Runout at any one journal in excess of 0.0035-inch means the shaft should be sent out for straightening or discarded. When checking the runout of a main journal, secure the crank in the block by installing main caps on the main journals adjacent to the one being checked. When checking main Nos. 1 and 4 and then Nos. 2 and 3, main caps and bearings should be in place.

To measure crank endplay, position the dial indicator parallel to the centerline of the crank, butting the tip against either the rear flange, the tip of the snout, or the end of the dampener bolt. With a prybar or large screwdriver, wedge the crank all the way forward or all the way rearward, and note the reading on the dial indicator. Then wedge the crank in the opposite direction, and note the difference in the indicator readings. The thrust reading you are looking for is 0.006-inch for any stick shift, long-distance application; anything between 0.0035-inch and 0.0075-inch is acceptable. The Delco thrust bearing is considered superior by some experts, which is something to keep in mind if you plan to stock up on thrust bearings to build a number of high-performance Buick engines.



The term "knife edging" of counterweights refers to reducing mass on an angle rather than a straight cut.



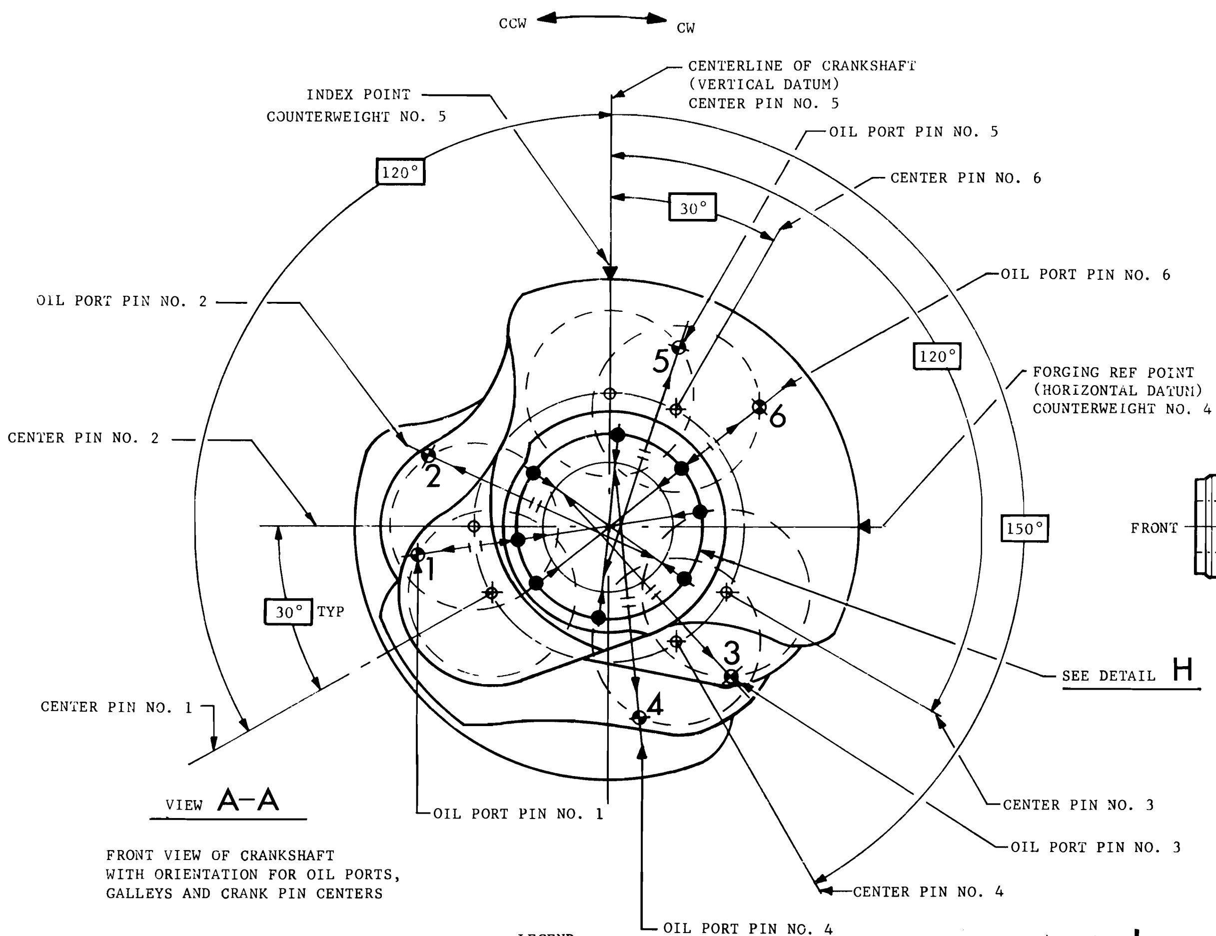
Some engine builders use a roller bearing in place of a bushing. This is a Fafnir 203P item.

You need to check endplay before assembling the engine, after it is assembled, and after the engine is bolted to the transmission. The last step is doubly important for a competition engine. If the input shaft of the transmission is bottoming out in the crank, thus eliminating endplay in the engine, the thrust bearing will wear prematurely and cause an endless amount of speculation about the cause.

With the tip of the dial indicator positioned against the rear flange parallel to the centerline of the crank, slowly rotate the crank, and read the dial indicator to determine the high and low differences in surface height. Runout in excess of 0.005-inch means the flange should be remachined to ensure that it is perpendicular to the crank centerline. Flange runout is a dimensional "stack-up" that can lead to big problems—a problem is just waiting to happen if you have flange runout, bell-housing misalignment, an off-center transmission input shaft, or the starter positioned too close to the ring gear.

The following six pages contain detailed machining reference drawings. These illustrations are intended only as guides.

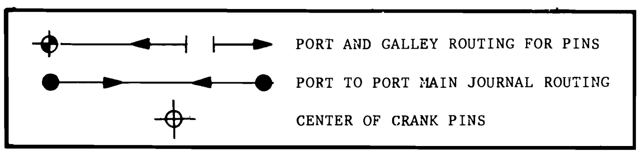
NOTES

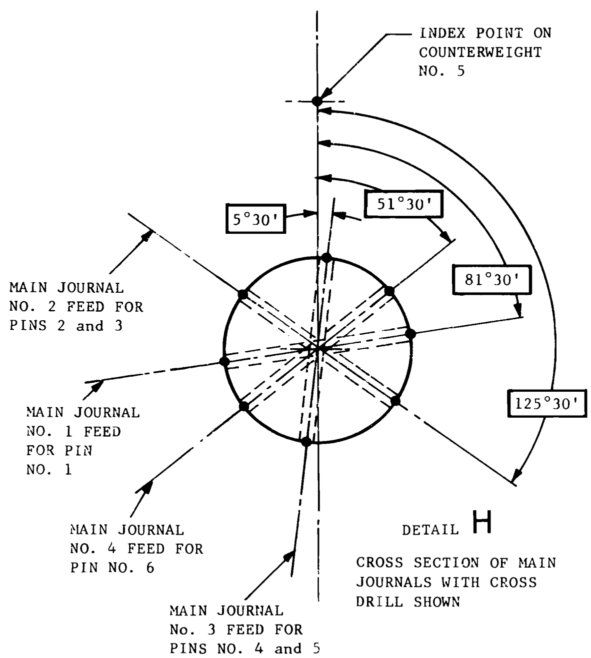


VIEW A–A

FRONT VIEW OF CRANKSHAFT WITH ORIENTATION FOR OIL PORTS, GALLEYS AND CRANK PIN CENTERS

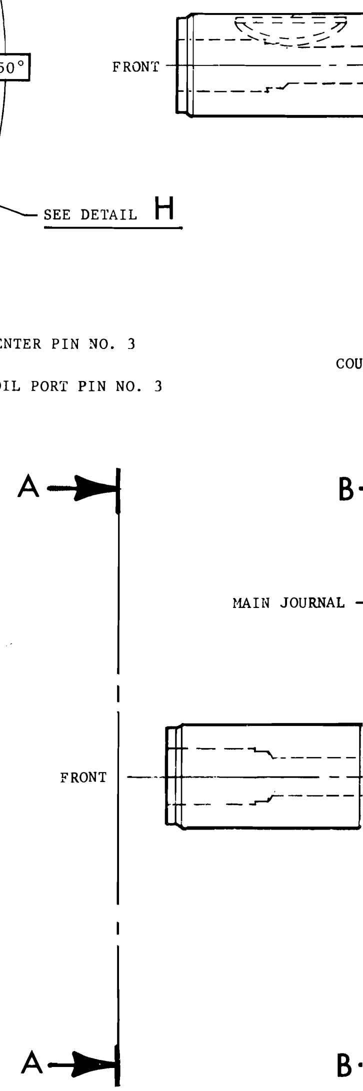
LEGEND

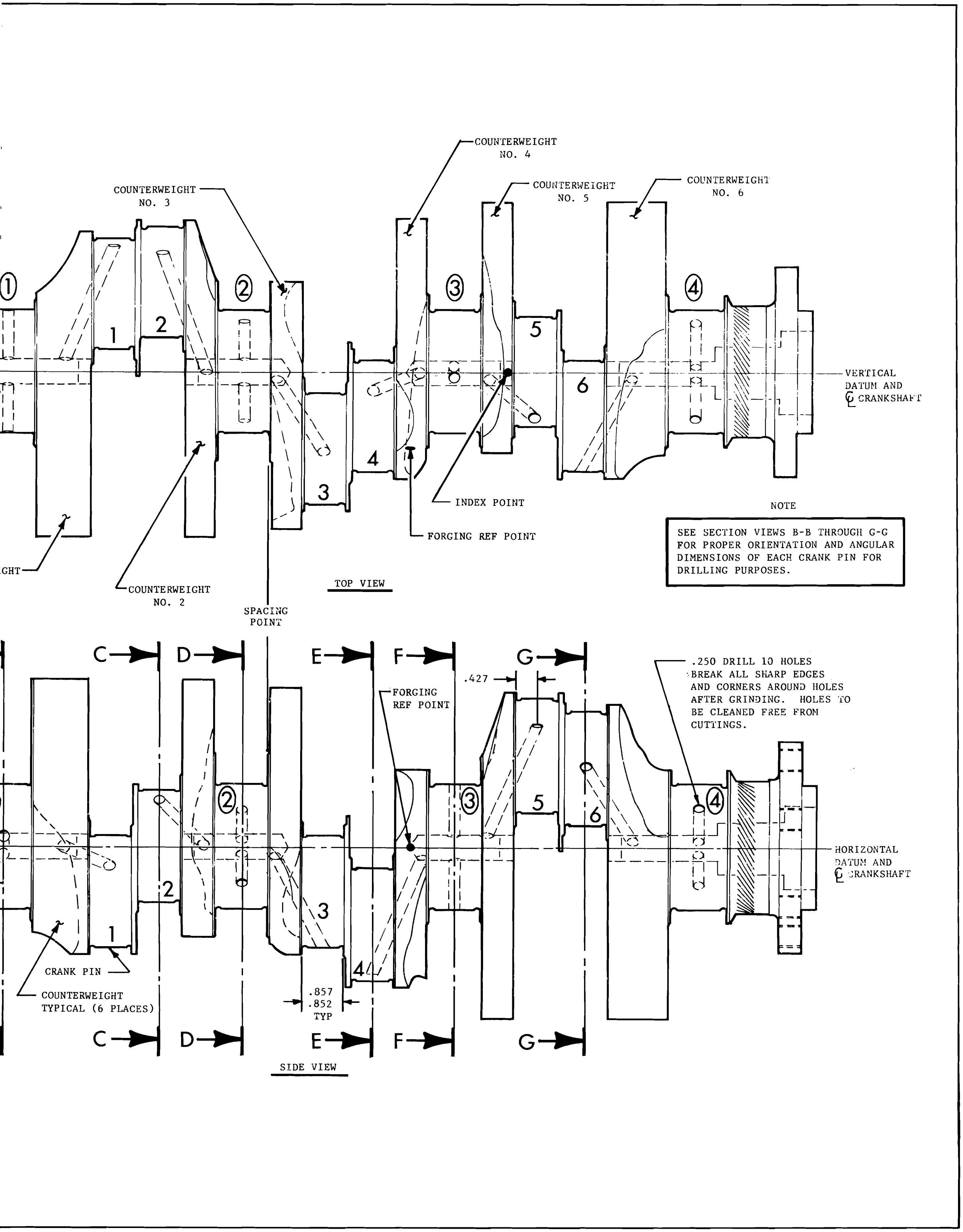




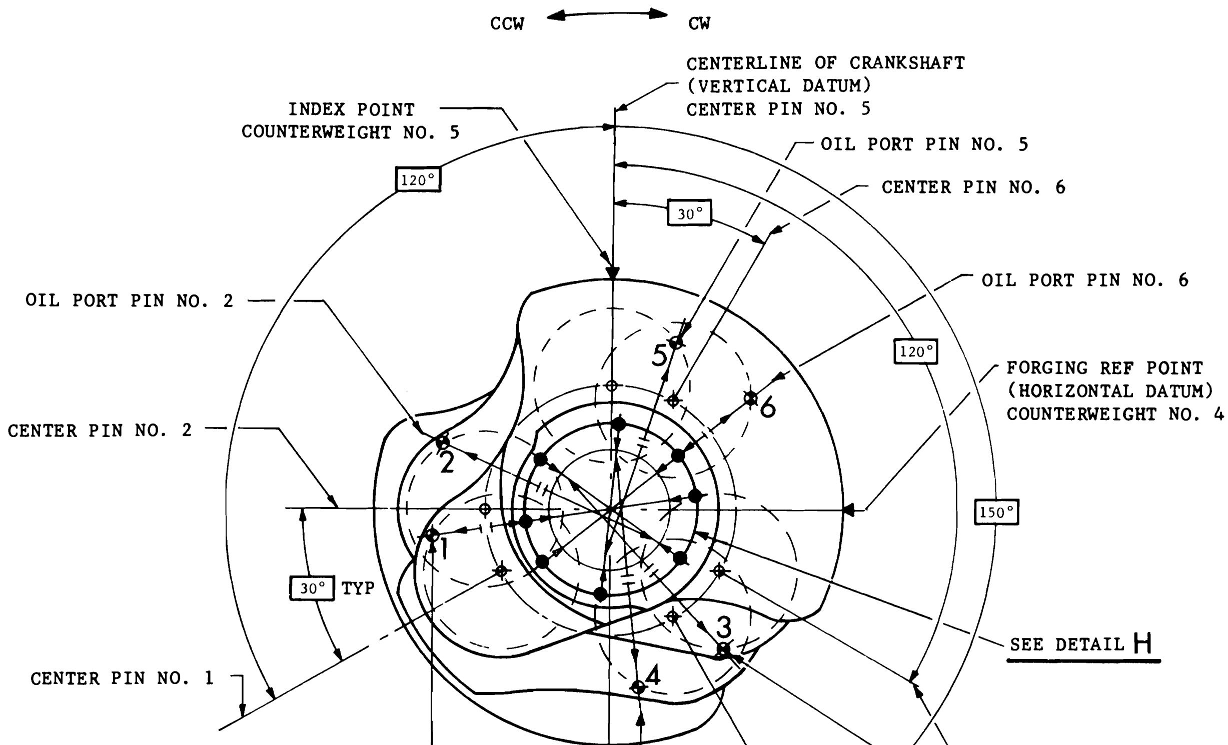
DETAIL H

CROSS SECTION OF MAIN JOURNALS WITH CROSS DRILL SHOWN





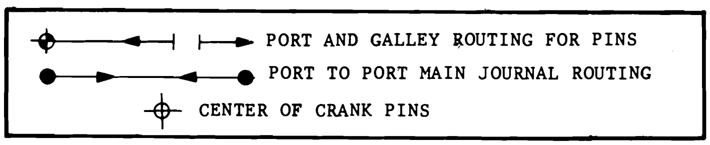
COUNTERWEIGHT NO. 4
COUNTERWEIGHT NO. 3
COUNTERWEIGHT NO. 5
COUNTERWEIGHT NO. 6
VERTICAL DATUM AND ℄ CRANKSHAFT
INDEX POINT
FORGING REF POINT
NOTE
SEE SECTION VIEWS B-B THROUGH G-G FOR PROPER ORIENTATION AND ANGULAR DIMENSIONS OF EACH CRANK PIN FOR DRILLING PURPOSES.
COUNTERWEIGHT NO. 2
TOP VIEW
SPACING POINT
.250 DRILL 10 HOLES
BREAK ALL SHARP EDGES AND CORNERS AROUND HOLES AFTER GRINDING. HOLES TO BE CLEANED FREE FROM CUTTINGS.
.427
FORGING REF POINT
HORIZONTAL DATUM AND ℄ CRANKSHAFT
CRANK PIN
COUNTERWEIGHT TYPICAL (6 PLACES)
.857
.852
TYP
SIDE VIEW

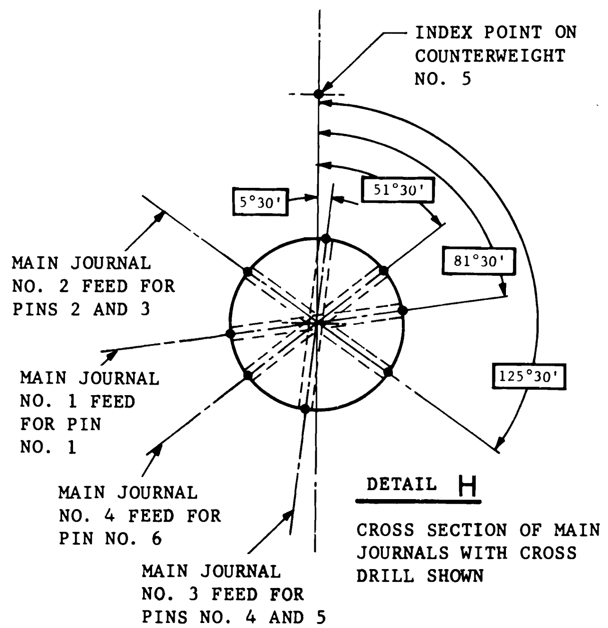


VIEW A-A

FRONT VIEW OF CRANKSHAFT
WITH ORIENTATION FOR OIL PORTS,
GALLEYS AND CRANK PIN CENTERS

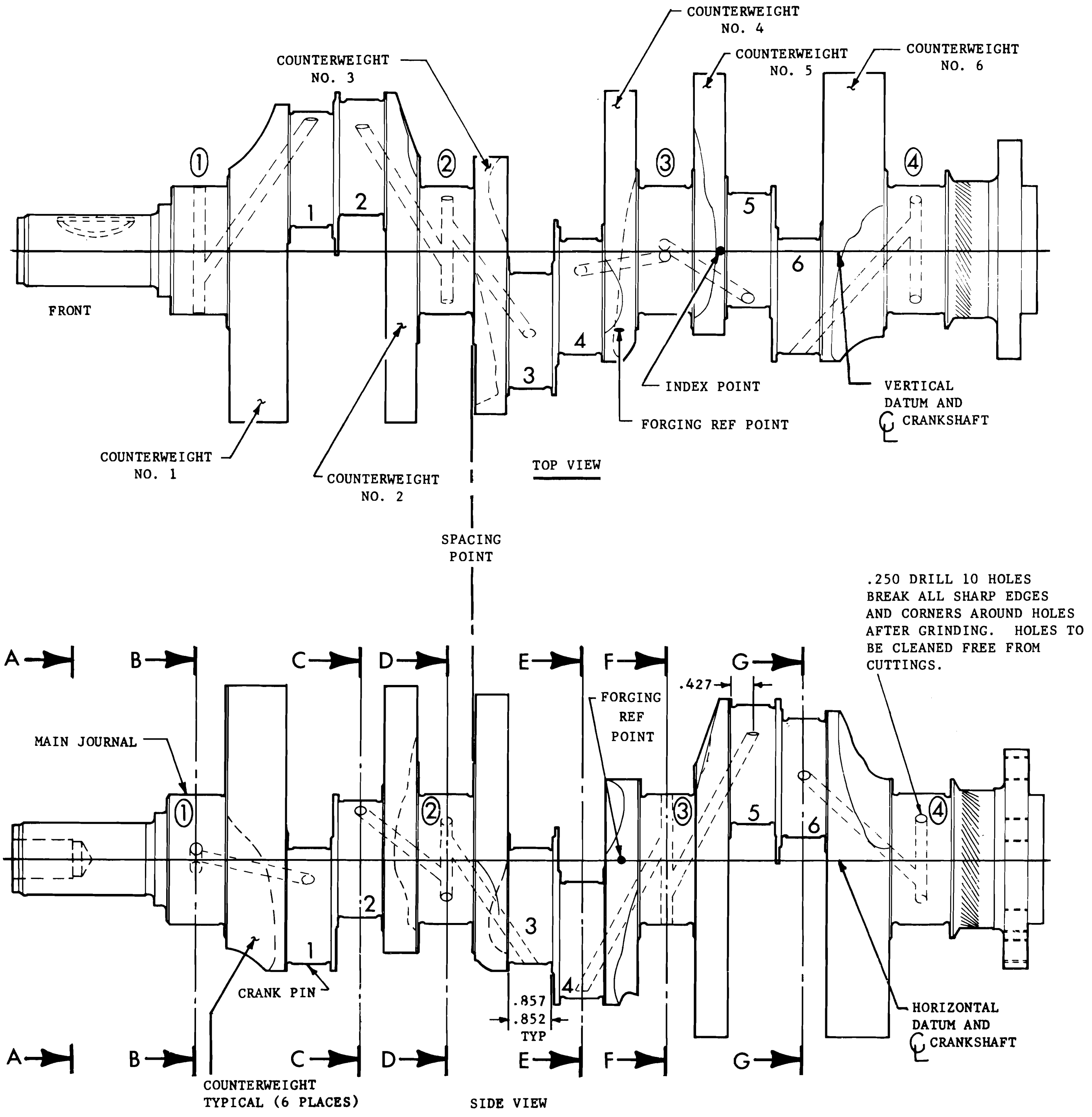
LEGEND





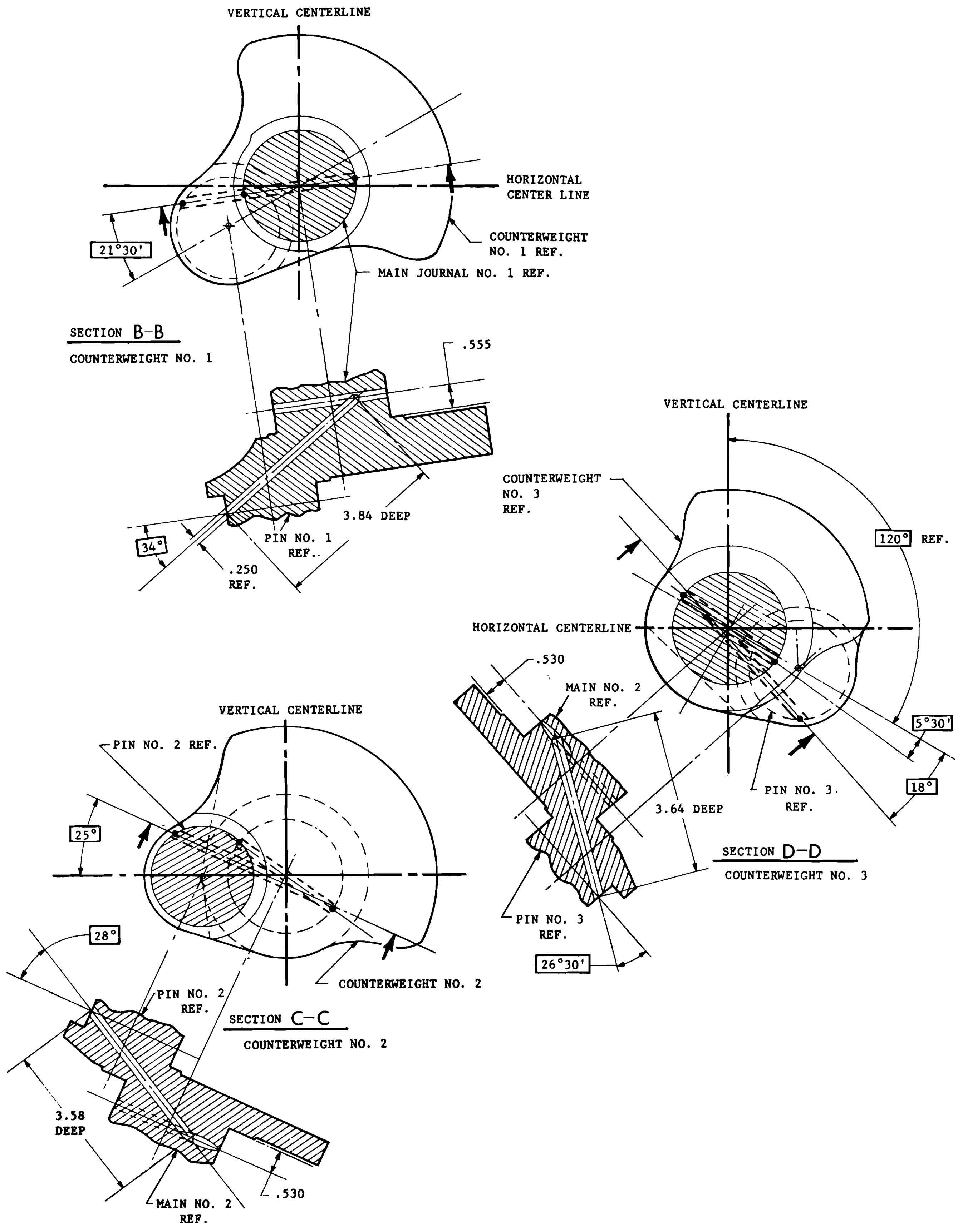
DETAIL H

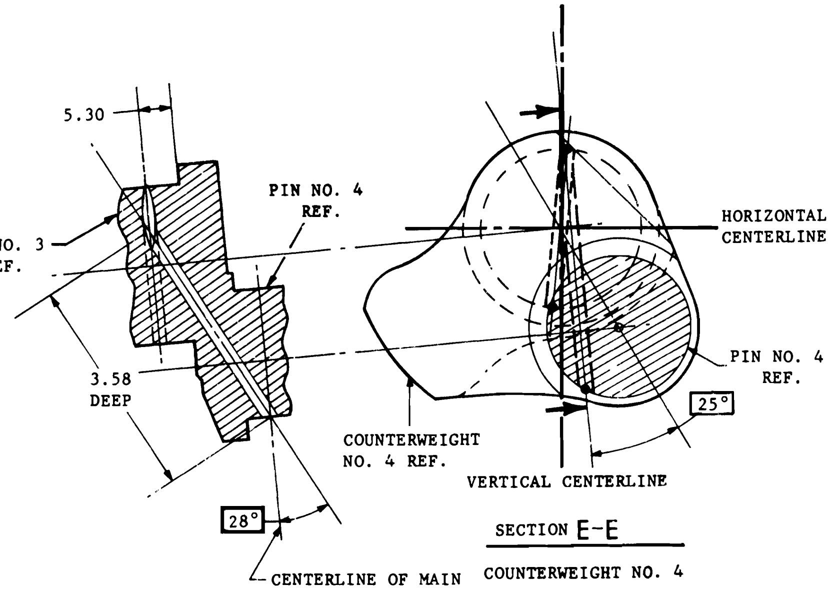
CROSS SECTION OF MAIN
JOURNALS WITH CROSS
DRILL SHOWN



NOTE

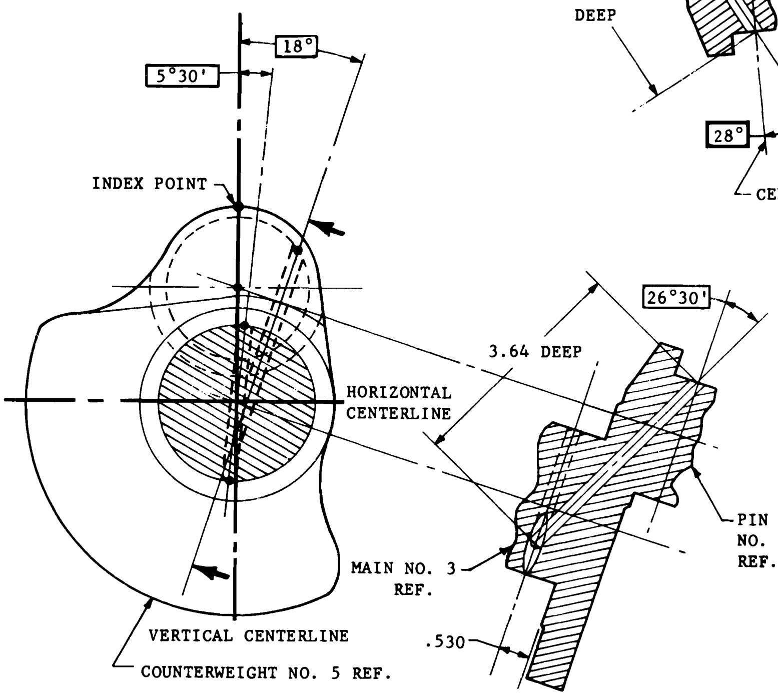
SEE SECTION VIEWS B-B THROUGH G-G FOR PROPER ORIENTATION AND ANGULAR DIMENSIONS OF EACH CRANK PIN FOR DRILLING PURPOSES.


VERTICAL CENTERLINE
HORIZONTAL CENTER LINE
COUNTERWEIGHT NO. 1 REF.
MAIN JOURNAL NO. 1 REF.
21°30'
SECTION B-B
COUNTERWEIGHT NO. 1
.555
3.84 DEEP
34°
PIN NO. 1 REF.
.250 REF.
VERTICAL CENTERLINE
COUNTERWEIGHT NO. 3 REF.
120° REF.
HORIZONTAL CENTERLINE
.530
MAIN NO. 2 REF.
5°30'
18°
PIN NO. 3 REF.
3.64 DEEP
SECTION D-D
COUNTERWEIGHT NO. 3
PIN NO. 3 REF.
26°30'
VERTICAL CENTERLINE
PIN NO. 2 REF.
25°
28°
COUNTERWEIGHT NO. 2
PIN NO. 2 REF.
SECTION C-C
COUNTERWEIGHT NO. 2
3.58 DEEP
MAIN NO. 2 REF.
.530



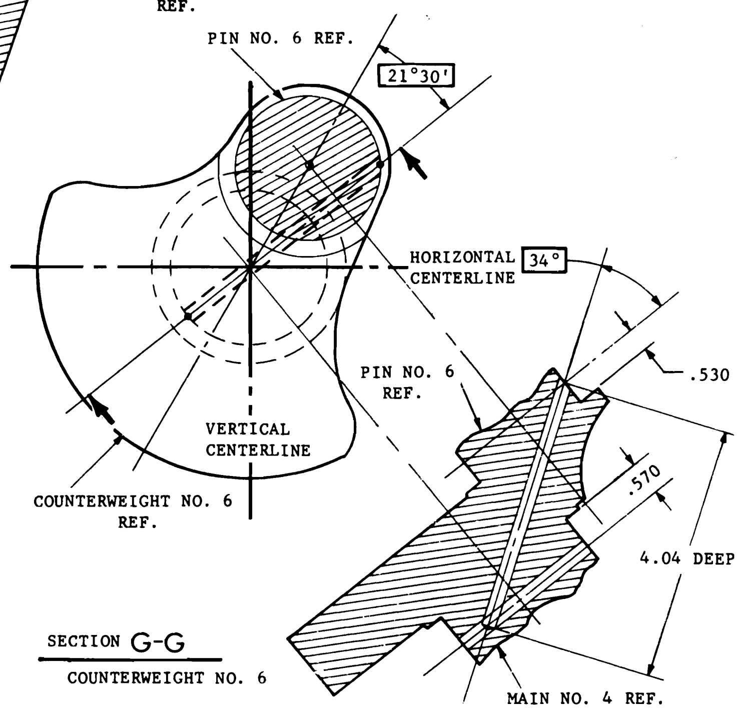
SECTION E-E

COUNTERWEIGHT NO. 4



SECTION F-F

COUNTERWEIGHT NO. 5



SECTION G-G

COUNTERWEIGHT NO. 6

NOTES

NOTES

Balancing

A 90-degree even-fire V6 engine should be underbalanced to eliminate the vertical component of the primary rotating couple in a production application. This results in the least amount of vibration as perceived by the driver because the engine mounts are more compliant in the horizontal plane than the vertical plane.

Transferring this knowledge to heavy-duty applications is difficult, as most competition vehicles feature engines mounted directly to the frame. While it is still desirable to confine the rocking couple to one plane with a rigid engine mounting system, the resulting main bearing loads would be intolerable in heavy-duty applications. This is due to the magnitude of the couple being doubled when underbalancing is used to transform the original rotating couple in one plane.

To optimize main bearing loads and to reduce engine vibration, the crankshaft should be underbalanced to the production formula (36.6 percent) and isolated from the chassis during mounting. Or you can add various amounts of vertical imbalance and monitor main bearing loads and vibrations on a rigidly mounted engine to determine if suitable compromises exist.

Buick V6 engines produced prior to 1977 were fitted with straight-pin crankshafts that resulted in an odd-firing order. For perfect primary balance, odd-firing engines should be balanced according to the following formula:

$$W^{BOB*} = W^{ROT**} + 0.5\ W^{REC***}$$

The Buick V6 was converted to an even-fire configuration in 1977 through a crankshaft with split crankpins. While accomplishing the even-firing order, this design resulted in a balance compromise. Production Buick V6 engines equipped with even-fire crankshafts have been successfully balanced to this formula:

$$W^{BOB} = W^{ROT} + .366\ W^{REC}$$

This translates the primary imbalance forces into a horizontal plane where the engine mounts can dissipate them. The above formula is recommended for all Buick V6 applications in which rubber engine mounts are used.

For minimum primary imbalance, the Buick even-fire engine should be balanced to:

$$W^{BOB} = W^{ROT} + 0.5\ W^{REC}$$

*W^{BOB} = *Weight attached to crankpin during balance*
**W^{ROT} = *Weight considered as rotating*
***W^{REC} = *Weight considered as reciprocating*

Counterweighting

As regards the location of the counterweighting to achieve a given balance condition, certain applications benefit from a revised counterweighting

The front and rear counterweights get the majority of rework when a Buick crankshaft is internally balanced for heavy-duty use. The counterweights are drilled and balancing weights are pressed in place.

philosophy. With the objective of full internal balance, the lightest weight crankshaft is provided by allocating the maximum counterweighting at each end of the crankshaft and adding weights toward the center until the desired balance condition is met. This provides the light weight desirable in acceleration events such as road racing, but it also introduces bending and torsional loads into the crankshaft system.

Constructing an engine for endurance racing (where acceleration is not the major factor) calls for a different philosophy. It is desirable to allocate the counterweighting evenly through the length of the crankshaft by balancing each pin with its adjacent counterweight. This results in a heavier crankshaft, but reduces bending and torsional components and main bearing loads.

An alternative method of balancing even-firing engines involves balancing with bob weights that use 50 percent of the reciprocating weight. The amount of remaining imbalance is reduced to the absolute minimum value possible, which is half of the amount of horizontal imbalance that remains by using the production method. The penalty for this reduction in imbalance is that it now exists in both the vertical and horizontal directions. This balancing method is not used in production because of the vertical portion of the imbalance and the resulting difficulty in transferring this vertical disturbance from the transmission into the passenger compartment.

In balancing the even-fire engine, it all comes down to this: You cannot eliminate all of the imbalance. Using a 50 percent factor minimizes the imbalance forces, but they will be present in all directions. If the 36.5 percent factor is used, the imbalance forces are increased, but they are only present in the horizontal direction.

The recommended part for an even-fire torsional dampener for a road racing engine is 1257126. All heavy-duty dampeners have rubber-mounted inertia rings that can shift under racing use, so you need to scribe a line between the inertia ring and the hub of the dampener and inspect frequently to see whether the ring has moved in relation to the hub.

Tech Tips

Even-Firing V12s

An even-firing V12 can be produced with perfect primary balance by joining two Buick V6 engines in the following manner:

1. Each engine should be equipped with an even-fire crankshaft.
2. The No. 1 cylinder on the second engine should be phased to reach TDC on the compression (firing) stroke 180 degrees after the No. 1 cylinder on the first engine.
3. Each crankshaft should be balanced at W^{ROT}* + 0.5 W^{REC}** (50 percent).
4. Firing order will be 1-8-6-7-5-12-4-11-3-10-2-9 at even 60-degree intervals with cylinders No. 7 through 12 representing No. 1 through 6 on the second engine.
5. Each engine will generate a primary rotating couple, but they will cancel each other with this phasing.

*W^{ROT} = *Weight considered as rotating*
**W^{REC} = *Weight considered as reciprocating*

Balancing with the Flywheel

Production engines are balanced with the flywheel; do this when balancing for any heavy-duty application. Or you can have the reciprocating and rotating mass of the engine balanced and install a "zero-balanced" flywheel, which most engine builders prefer since it permits moving a flywheel and clutch assembly from one engine to another.

NOTES

Pins 156.03 gr.
Pistons 573.79 gr.
Rod (big) 447.00 gr.
Rod (small) 200.00 gr.
Rings 58.51 gr.
Bearings 38.55 gr.
Oil 4 gr.

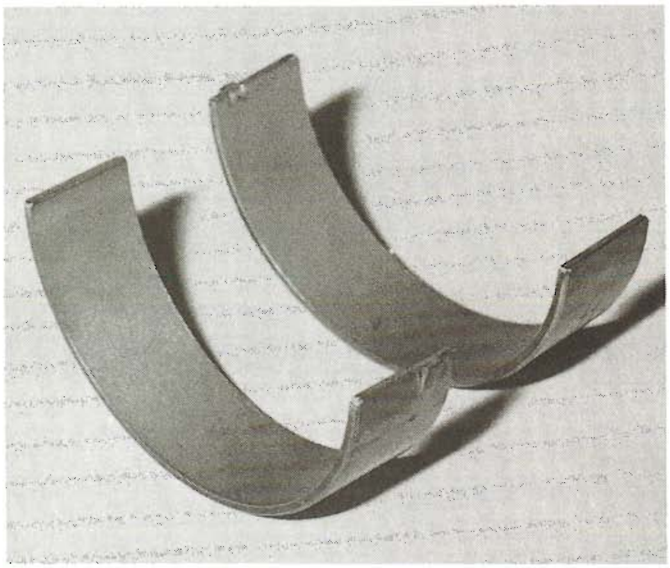
Rec
156.03
573.79
200.00
58.51
988.33
x .366
361.73

Rod
447
38.55
4
489.55
+ 361.73
851.28 total

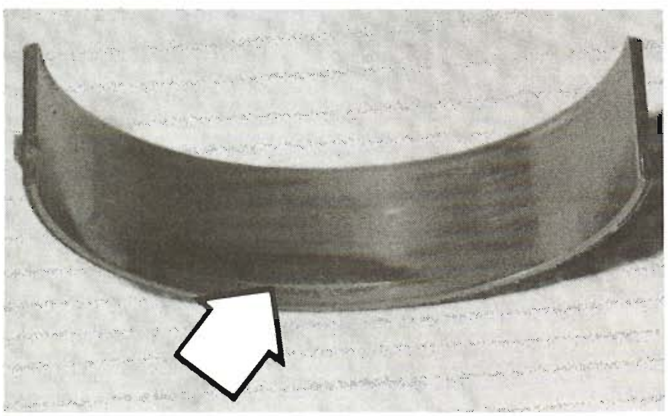
Bearings

Buick offers a number of heavy-duty bearings suitable for use in heavy-duty applications. Crankshaft sets 25500074 (standard) and 25500080 (0.001-inch under) include Nos. 1, 2, 3, and 4 main bearings and the No. 2 main, which is also the thrust bearing.

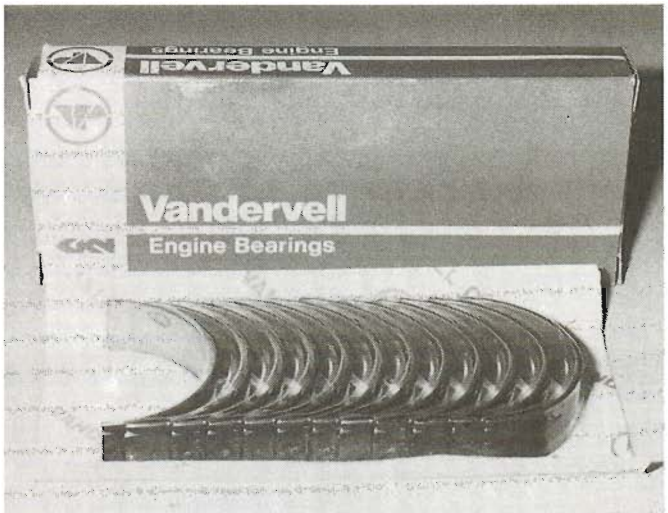
Connecting rod bearings are available for both rolled-fillet cranks and standard-configuration cranks. Rolled-fillet cranks use bearings 25500072 (standard) and 25500073 (0.001-inch under). Both sizes feature increased width to maximize bearing area, thin overlay thickness to increase fatigue resistance, and additional "crush" to aid bearing retention and increase heat transfer.



Buick heavy-duty bearings are made of a harder, more durable material than production items but do not have the same embedability characteristics. This means oil must be changed much more frequently.



Due to piston bore alignment to crankpins, connecting rod wear occurs most often on the side of the bearing in a heavy-duty V6.



In addition to the Buick heavy-duty bearing sets, several aftermarket suppliers offer similar hardware.

Standard-configuration crank rod bearings are 25500070 (standard) and 25500071 (0.001-inch under). Aside from their increased width, these bearings have the same features as those listed above for rolled-fillet cranks.

Modifying V8 Crank Bearings For V6s

A number of high-performance engine builders prefer to use connecting rod bearings designed and built for Buick V8 (455-cubic-inch) engines. These bearings are approximately 0.160-inch wider than production V6 bearings and must be narrowed 0.040- to 0.050-inch on each side. The result is a rod bearing that is 10 percent wider than a production V6 bearing. The locating tang on the V8 bearing is different (in terms of location) than that of the V6 bearing, which means the cap and rod must be reslotted. If the V8 bearing is to be used with an aluminum rod that has a pin in the cap, you need to drill a hole in the bearing to accommodate the pin. This modification is done to maximize bearing width, which is limited by crankpin width (minus fillet radii). Under no circumstances should the bearing be wider than the crankpin in order to engage the fillet radius.

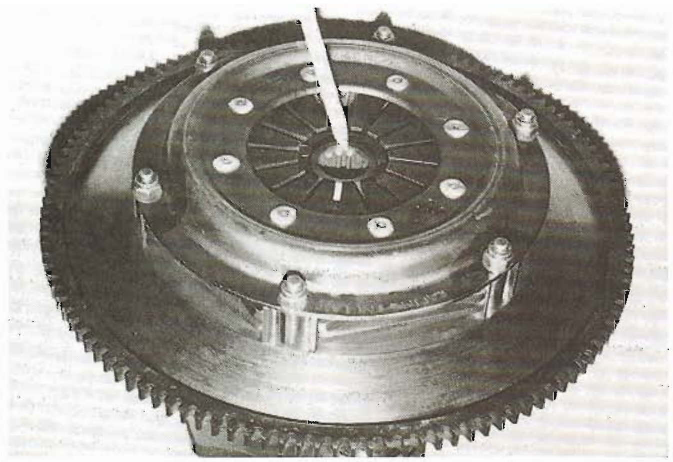
Heavy-Duty Cam Bearings

Buick offers a set of heavy-duty cam bearings that may be preferred for heavy-duty use because they are made of harder, more durable material and have a 0.060-inch hole instead of a slot for the transfer of oil. All bearings in the set are 0.740-inch wide, which is the dimension of the number one bearing in production.

NOTES

Flywheel and Torsional

Buick does not produce a stick shift flywheel that is adequate for heavy-duty use. Aftermarket sources offer a wide variety of flywheels and clutch packages for various forms of heavy-duty use.



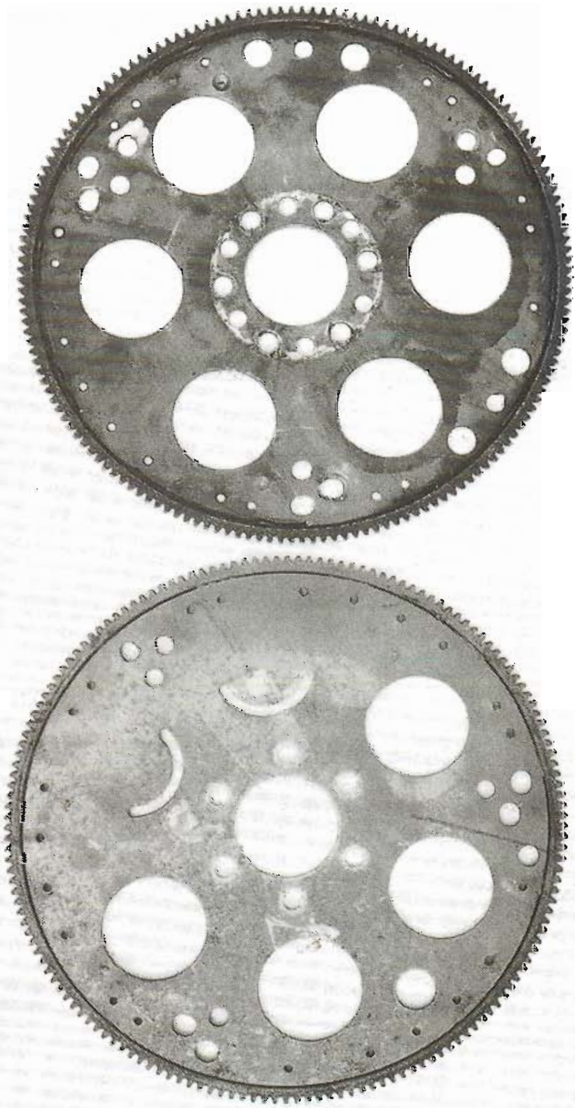
Regardless of the clutch and flywheel package being used, make sure there is no interference between the splines of the transmission mainshaft and the throwout bearing. There should not be any interference between the clutch disc splines and the throwout bearing. Lastly, make sure a pilot bushing is installed in the end of the crankshaft.

Flexplates

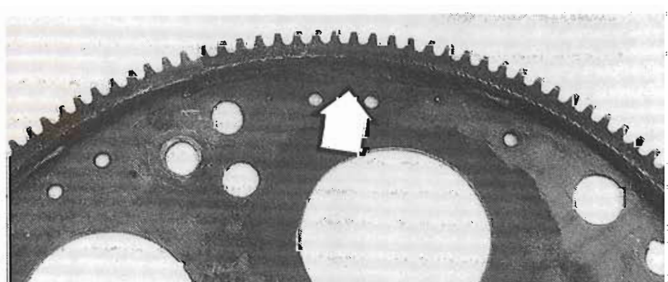
Buick flexplates are used successfully in drag racing, but with a number of modifications. The ring gear should be heliarced to the flexplate in various locations on both sides of the flexplate. The curved-moon-shaped cuts should be opened up into complete holes to facilitate balancing, and the six holes around the perimeter of the crank that accept the crank bolts should not be used. Drill smaller holes between them in a diameter that allows no play between the crank bolts and the flexplate. Install a flywheel doubler plate on the back side of the flexplate to improve clamping; steel plates are available from aftermarket sources, or you can have them made by a machine shop.

Bellhousing Alignment

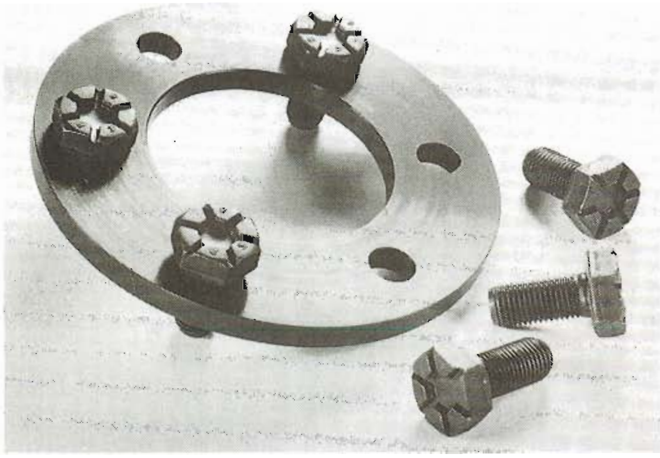
Bellhousing alignment is crucial to smooth and reliable clutch and transmission operation. The bellhousing must be positioned so the centerline of the transmission input shaft lines up precisely with the centerline of the crankshaft. The transmission mounting surface at the rear of the bellhousing must also be parallel to the clutch engagement surface of the flywheel. If the bellhousing is out of alignment in either plane, pilot bearing failure, transmission bearing failures, clutch failures, jump-



The uppermost flexplate shows how a production flexplate can be modified for heavy-duty use. Predrill crank mounting holes to eliminate any play between hole and bolt. Cutting the large holes out to the same size facilitates balancing. Use hardened washers between the flexplate and the torque converter.



Heliarc the starter ring to the plate on both sides in several locations to prevent failure in this area.



You can fabricate a machined doubler plate that sandwiches the flexplate against the crank flange. Use grade 8 capscrews with ¾-inch heads instead of the typical ⅝-inch ones.

ing out of gear, and clutch chatter can occur.

To check bellhousing alignment properly, a dial indicator with a magnetic base is needed. Using the stock dowel pins in the rear face of the block to locate the bellhousing, tightly bolt the bellhousing to the block. The initial check should be the trueness of the flywheel because all subsequent alignment checks are measured from the flywheel face. The flywheel face must be perpendicular to the centerline of the crankshaft for consistently smooth clutch action.

Mount the dial indicator on the back face of the bellhousing with the plunger from the dial indicator resting on the flywheel clutch face. Slowly rotate the crankshaft and record any variations on the dial indicator. Up to 0.005-inch of runout is acceptable. If flywheel runout is more than that, check the mating surfaces of the flywheel and the crank for burrs or dirt. If this is not the problem, the flywheel is most likely out of spec and needs resurfacing.

Now attach the dial indicator base to the clutch face of the flywheel. Move the plunger from the indicator so it contacts the transmission mating surface of the bellhousing about 1 inch out from the circumference of the rear opening. Slowly rotate the crankshaft by hand, and note any variations in the indicator reading to determine if this surface is parallel to the flywheel. The maximum allowable variation between the lowest and highest reading is 0.005-inch.

Remount the dial indicator on the flywheel so you can measure the concentricity of the hole in the back of the bellhousing. Rotate the crank slowly, and check the readings. In this case, the maximum allowable variation is 0.010-inch, because the actual error is the total variation divided by two, or 0.005-inch misalignment. If the bellhousing must be realigned, several approaches can be used. In either case, you must remove and discard the stock dowel pins from the block.

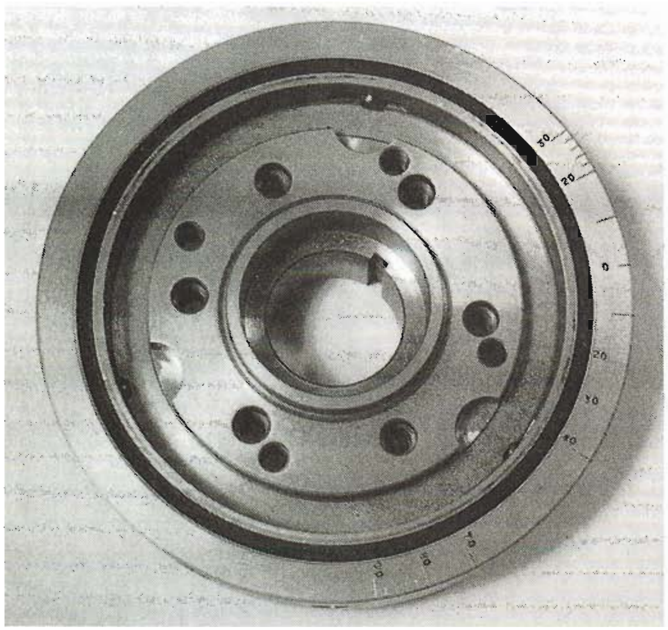
The first method of correcting misalignment consists of simply loosening the bellhousing bolts to permit moving the bellhousing until dial indicator variation of 0.010-inch or less is obtained. It may be necessary to slightly enlarge the bolt holes in the bellhousing to get sufficient movement. Tighten the bolts, and recheck with the dial indicator to make sure the housing has not shifted. With the bolts securely tightened and the housing properly aligned, select a pair of points roughly 180 degrees apart where holes can be drilled through the bellhousing flange and into the block mating surface for the installation of new dowel pins. The new pins need not be as large as the stock ones—¼-inch-diameter pins are sufficient. Once the pins are installed in the block, the bellhousing can be removed and reinstalled in perfect alignment.

The second method utilizes offset dowel pins that are available in speed shops. Before installing offset pins, drill and tap a small hole in the side of each dowel pin hole in the block so a small Allen head setscrew can lock the offset pins in the proper orientation after alignments are completed. Once the offset pins are installed, you can adjust the offset dowel pins with a screwdriver to obtain proper alignment. In some cases the dowel pins must be polished with emery cloth to permit them to be rotated for perfect alignment.

Regardless of the clutch being used, keep in mind that one of the most important factors in the proper performance of a clutch is its adjustment. The two main factors are plate departure and free play. The clutch plate departure should be measured with a dial indicator. If this is impractical, measure the thickness of the gap between the disc and the clutch face or flywheel. This can be measured by inserting a feeler gauge between the disc and pressure plate or between the flywheel and disc. The proper adjustment is approximately 0.060-inch. The clutch pedal free play should be adjusted to between ½-inch and 1 inch for competitive applications or power shifting.

Torsional Dampener

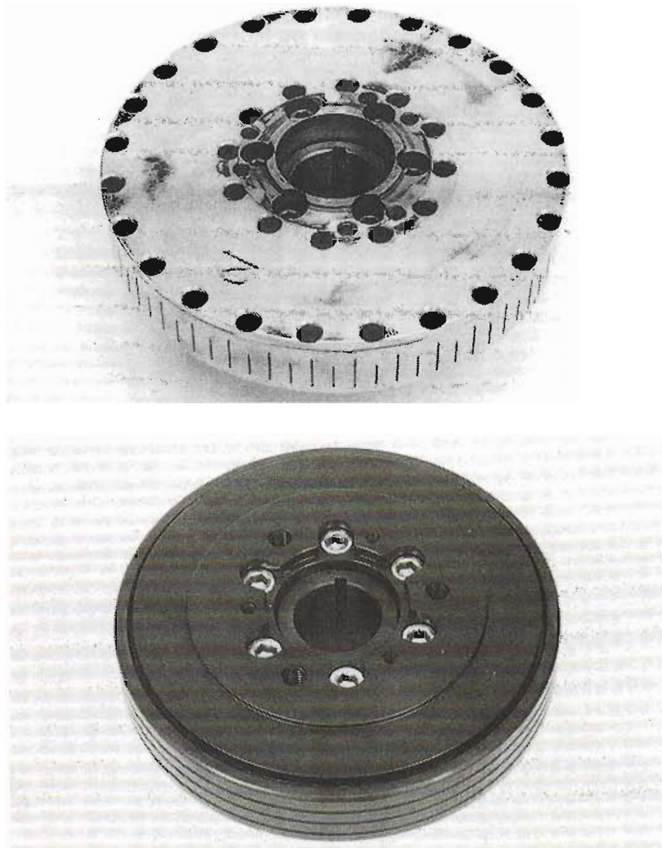
Buick produces a harmonic balancer (25500069) that should be used in all heavy-duty applications. This hardware features a nodular iron hub surrounded by rubber and a steel inertia ring that is pinned so it cannot move forward and separate



The Buick heavy-duty torsional dampener described in the text is recommended for all heavy-duty applications.

from the hub. The assemblies are balanced. Aftermarket sources also offer 4-inch-diameter steel hubs that are intended to be used on drag race engines only.

Production dampeners are cast iron and are not designed for heavy-duty use or high-rpm operation.



At least two aftermarket crank dampeners are made for the Buick engine; they are intended for drag racing only.

NOTES

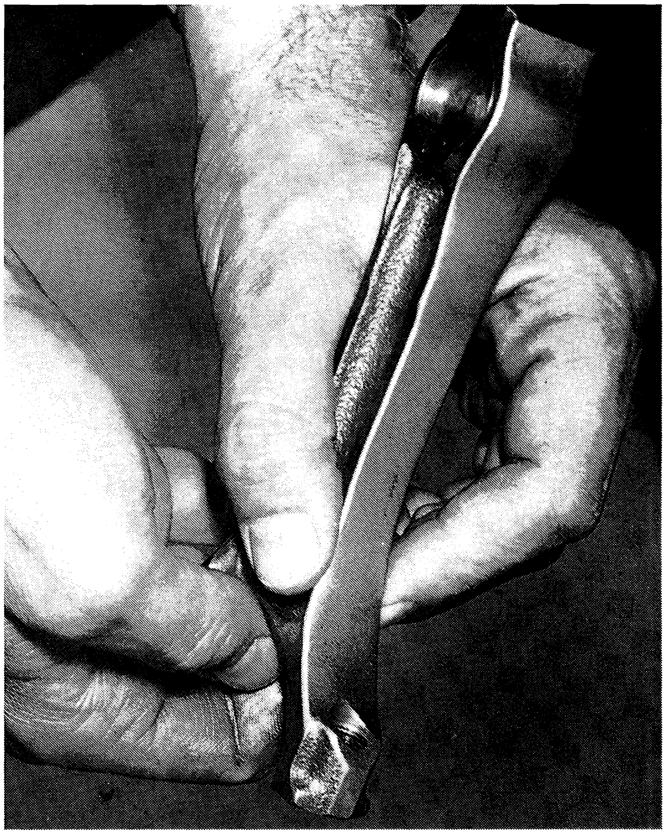
NOTES

6 Connecting Rods

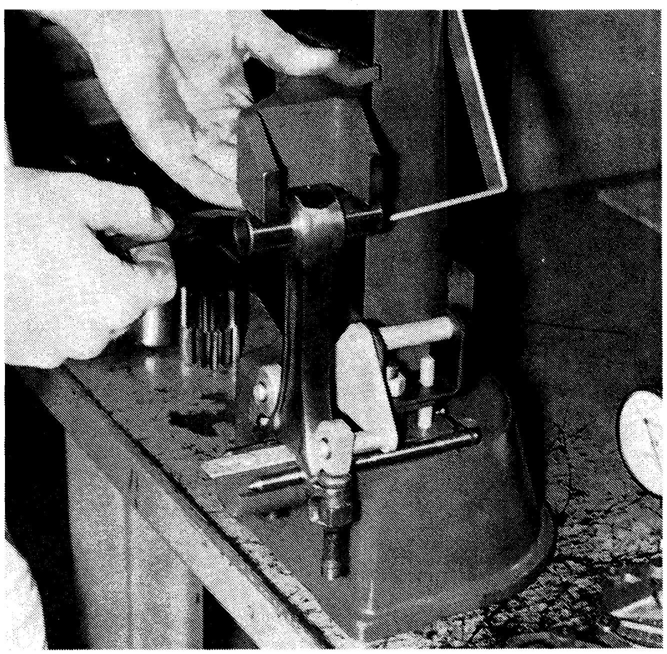
Production connecting rods are nodular cast iron. Although they were not designed or intended for heavy-duty use, with proper preparation they can be run successfully in certain competitions. Properly prepared production rods have been used in winning engines in road racing events of up to 500 miles and in drag racing where production hardware was mandatory. In both cases, rpm were limited to 7500.

All production Buick connecting rods are cast and should not be used in heavy-duty applications unless no other rod is permitted under the rules.

The first step in preparing these rods for competition is to have them Magnafluxed. If they pass this test, have them X-rayed. In the vernacular of the high-performance engine builder, castings can have porosity (the engineering term is *inclusion).* Magnafluxing picks up fractures on the surface of metal that otherwise cannot be seen; in other words, this process can tell you if the rod is cracked but not if there is a structural flaw that could promote breakage after the rod is run for 10 min-



Production rods that are pressed into heavy-duty use should be polished, Magnafluxed, X-rayed, and shotpeened. They can be fitted with a full-floating pin.



You also need to check connecting rod twist after each teardown.

utes. Magnafluxing does not pick up porosity, but X-raying usually does. Magnafluxing and X-raying are good tools that should be used in upgrading production rods.

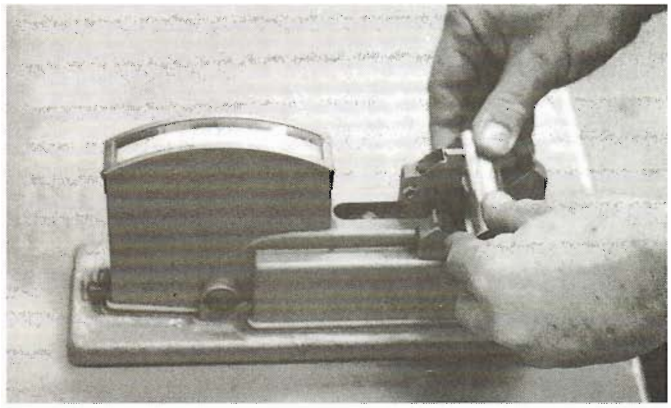
The sides of the connecting rod should be parallel at the big end so the planes are 90 degrees to the crank bore. In production, the sides are ground after the cap is installed. Excessive side clearance results in leakage past the rods and therefore increases the oil demand, which in turn reduces the amount of oil available for lubrication and cooling at high engine speeds. Side clearance of production rods is 0.008- to 0.010-inch and, although this has proven acceptable in competition, 0.006-inch is more desirable.

Take the rod apart to grind, and polish all contours to remove flash, nicks, and imperfections. Do not mix caps and rods or remove excess metal that reduces the cross-sectional area. All grinding must be done lengthwise, using a die grinder with a 400-grit roll. Before a crack develops, it must have a place to start, so round off all edges to eliminate stress risers; a crack in a thin area will travel to and through a thick section.

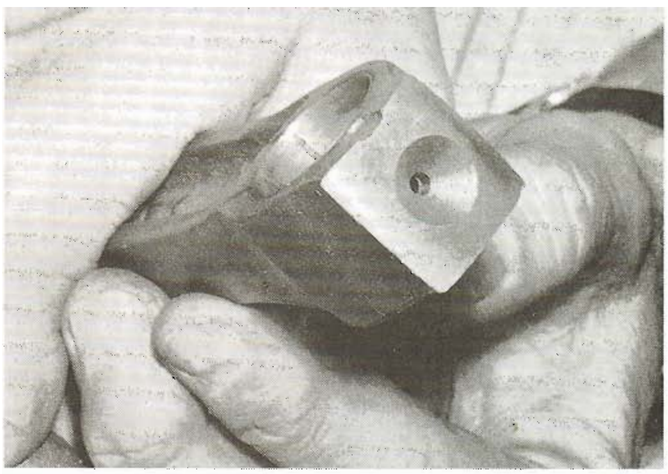
You need to machine the pin bore to achieve a 5.961- to 5.959-inch length. Most performance engine builders prefer to run the widely available small-block Chevy wristpin of 0.9270-inch diameter. You can do this on the Buick rod by installing a bushing and honing to size. Drill the small end of the rod for wristpin oiling; a 0.125-inch hole is sufficient. This hole should be chamfered to allow oil to flow into the hole and subsequently reach the wristpin. (The chamfer also aids in balancing the rod.) As much as three grams can be removed from the small end of the rod with the chamfer, but leave this operation until balancing begins. This step must be preceded by grinding a maximum of 0.003-inch off the mating surfaces of both the caps and the rods. Number the cap and the rod, torque down the rod bolts, and then send them out to be shotpeened. After shotpeening, the big end of the rod can be resized to complete the rod preparation. You can add to bearing-to-rod heat transfer by glass beading the bearing bore before assembling the rod.

A production cast rod should be balanced to achieve these weights: small end, 209 grams, and large end, 441 grams, for a total weight of 650 grams.

There is little, if any, logic in using a $15 rod bolt with a cast-iron rod. Run the production rod with a production bolt installed with Loctite 262. Torque it to 45-50 ft./lbs. when assembling the rod for the final time. When the engine is taken apart, use a torque wrench. A rod bolt that takes less



Most high-performance machine shops can check wristpin concentricity; a shop without this capability is probably not building a lot of heavy-duty engines.



When you rework a production rod for a full-floating wristpin, you can use a small hole with a large chamfer to lubricate the pin. Drill the hole while reworking the rods, and leave the chamfering until balancing. This allows you to remove a minimal amount of metal.

than the 45–50 ft./lbs. to break loose has relaxed. Throw the rod bolt away and get a new one.

For street applications, a pressed wristpin is adequate and trouble free, but on a competition engine, it should be full floating. In the first place, increasing the bearing surface is good insurance; float the pin, and the bearing surface is increased. If a cylinder should lean out (for whatever reason), overheat a piston, which in turn grabs the pin. This pulls the bottom end out of the piston with a pressed pin. With a floating pin, this problem is far less likely to arise.

Double Tru-Arcs and Spirolox are both successfully used by ranking competition engine builders, but they are low on the list for some engine builders for the simple reason that removing them can be difficult and time-consuming. Some of those engine builders who prefer Tru-Arcs stick with the single 0.073-inch-thick unit, while others prefer the double assembly in which each Tru-Arc is 0.043-inch thick and requires a piston groove of 0.086-inch. If you use the double Tru-Arc assembly, the rounded sides should be used together, which means the sharp edges of the snap ring dig into the aluminum of the piston to further effect the containment of the wristpin.

If you desire a floating piston pin, you can hone the connecting rod's small end to allow 0.005- to 0.007-inch pin-to-rod clearance. An alternative method of accommodating a floating pin is to fit a bronze bushing. Both methods require a 0.125-inch-diameter hole through the top of the rod (and bushing) to adequately lubricate the piston pin, unless otherwise specified by the bushing source.

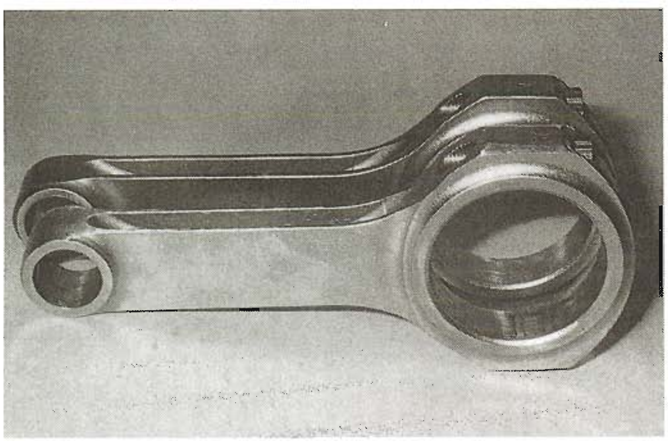
Aftermarket Steel and Aluminum Rods

As this book goes to press, Buick does not offer a heavy-duty connecting rod; thus, for heavy-duty use, aftermarket connecting rods should be used. Steel rods such as those made by Carrillo can be ordered in any length and any wristpin bore diameter, and the same holds true for aluminum connecting rods. Steel and aluminum connecting rods alike should be fitted with full-floating wristpins, primarily for ease of teardown.

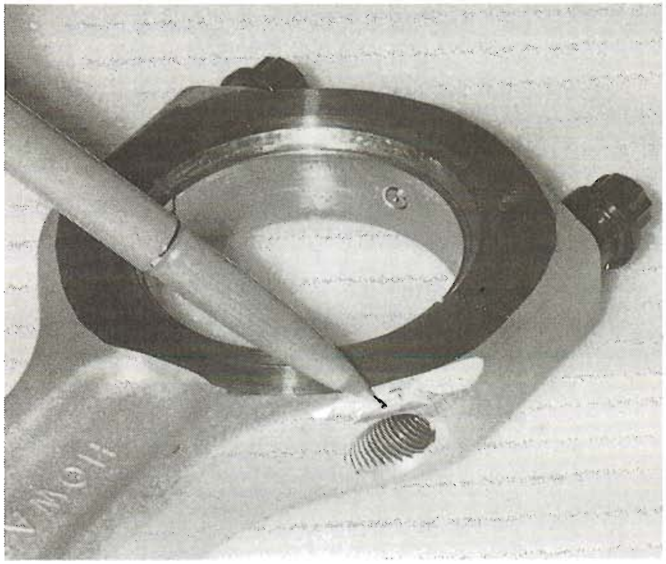
Aluminum connecting rods should be used for drag racing only and should be replaced after every 100 runs or when they do not pass inspection. Inspection consists of cleaning and checking the rods visually, and measuring the big end bore with a dial bore gauge. When the big end is out of round enough to affect bearing clearance or crush, the connecting rod should be discarded.

Steel rods should be Magnafluxed during each engine teardown and should be checked with a dial bore gauge and resized as needed.

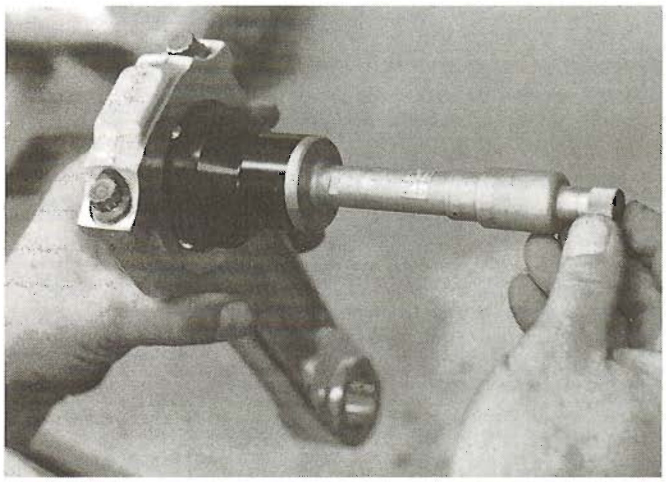
When using aftermarket steel or aluminum rods, you need to keep in mind two things: The hardware is custom built, so it must be ordered far in advance, and secondly, each rod must be checked for clearance with the block in the area of the pan rail and at the camshaft.



Custom-built steel billet rods are the choice of reputable engine builders for all heavy-duty applications.



Aftermarket connecting rods (especially aluminum ones) are prone to hit the cam or block and, depending on the stroke and the type of block in use, some rods hit both. Check interference carefully while building the engine. In most cases, a small amount of work with a grinder solves the problem.



Regardless of which type of rod is used in a heavy-duty application, you should use a quality dial bore gauge after every teardown to ensure that the big end of the rod is still round for correct bearing crush.

Tech Tips

Custom-Built Connecting Rods

When ordering custom-built connecting rods, the width of the big end should be ordered "fat," so the sides can be ground down to fit a particular crankshaft. The difference between 0.008-inch and 0.006-inch side clearance is 30 psi.

Rod Length

A long connecting rod makes more horsepower than a short one but narrows the powerband. Conversely, short rods make less horsepower but yield wider powerbands. This is because the duration of the piston at top dead center (TDC) is longer with a long rod, so pressure build is enhanced.

NOTES

6 Pistons

All Buick production pistons are cast aluminum. Turbocharged pistons are different from those used in normally aspirated engines. Both are excellent pieces, but neither was designed for heavy-duty use.

Buick Heavy-Duty Pistons

Buick produces forged-aluminum pistons for 3.8L and 4.1L engines in bores of standard, 0.010, 0.020, and 0.030-inch oversize. Those pistons used in the 3.8L engines produce a compression ratio of 11.2:1, while those designed for 4.1L engines produce a ratio of 12.1:1. All are supplied with wristpins of full-floating design and retainers of double TruArc. Valve pockets are forged in place in the machined flat top. All of these pistons are machined for a ring package of 1⁄16, 1⁄16, and 3⁄16-inch.

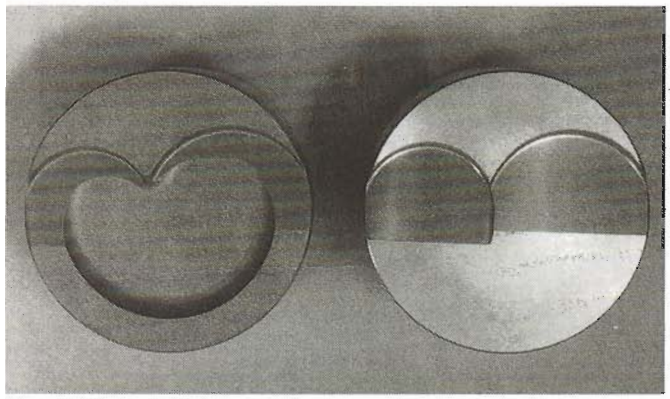
Eliminate this ridge between the intake and exhaust valve pockets in the piston dome to prevent problems with combustion flame travel. Blend this edge into the base material of the deck.

The pistons described are designed for use with production and Stage I cylinder heads only and cannot be used with Stage II heads, which have different valve pocket locations and dimensions.

Aftermarket Pistons

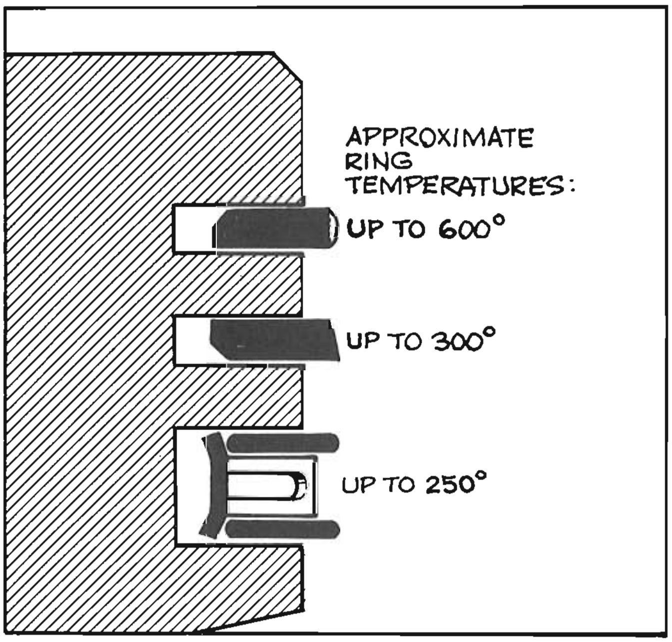
Heavy-duty pistons are available from a number of aftermarket sources. Generally speaking, drag racers want a high compression ratio and a very loose, low-drag piece of hardware, while circle track engine builders and those involved in short-distance road racing events trade a lower compression ratio for increased durability. Although several sources stock pistons for use in Stage II engines, the accompanying artwork can be used in the design and manufacturing of custom pistons.

This piston deck shows equal valve pocket depths for both intake and exhaust valves. Both pockets are cut on the same centerlines, which makes the combined cut on a common line. This relates to combustion flame travel.



Turbocharged pistons yield a lower compression ratio than normally aspirated hardware yields. The dished turbocharged piston on the left produces 9.0:1 compression ratio, while the normally aspirated item on the right produces a ratio of 13.1:1. There are other differences, such as a thicker deck and generally beefier construction.

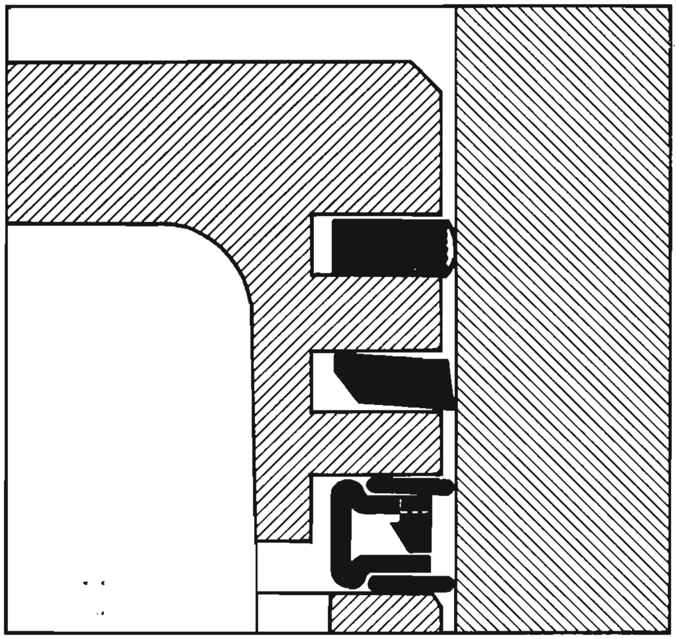
This gas port treatment on the deck is for drag racing only. Combustion pressure enters the tiny holes and helps force the top ring tightly against the cylinder wall.



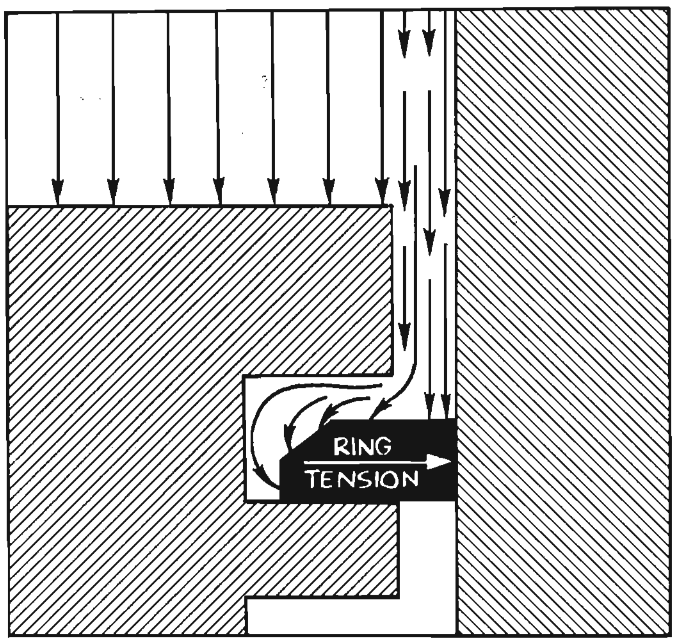
When ordering custom pistons, the cylinder head in use (Stage I or II) dictates the size and location of the valve pocket.

Rings

Several companies manufacture quality piston rings for heavy-duty Buick V6 applications. Sealed Power, TRW and Perfect Circle are examples. Properly installed and broken in, ceramic rings allow as little as 1¾ cfm blowby. Recommendations as to bore finish and end gap are supplied with the rings and should be followed to the letter.



Regardless of manufacturer, the standard ring package consists of two compression rings and one oil control ring.



On the power stroke, combustion gas pressure forces the ring downward and outward. This provides a side and face seal.

A piston and ring assembly should look like this after being pulled from a heavy-duty engine. This indicates that the top ring is containing compression pressure effectively. Any evidence of burned mixture between the top and second rings would show that the top was not doing the job it was designed for.

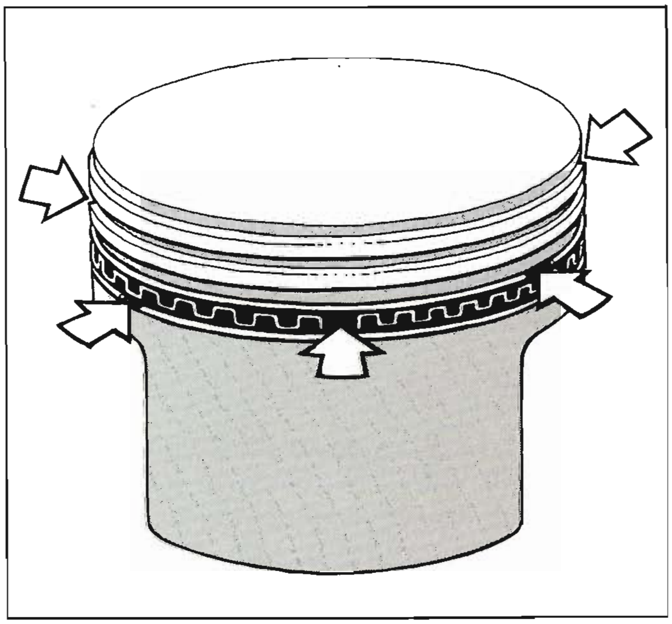
Tech Tips

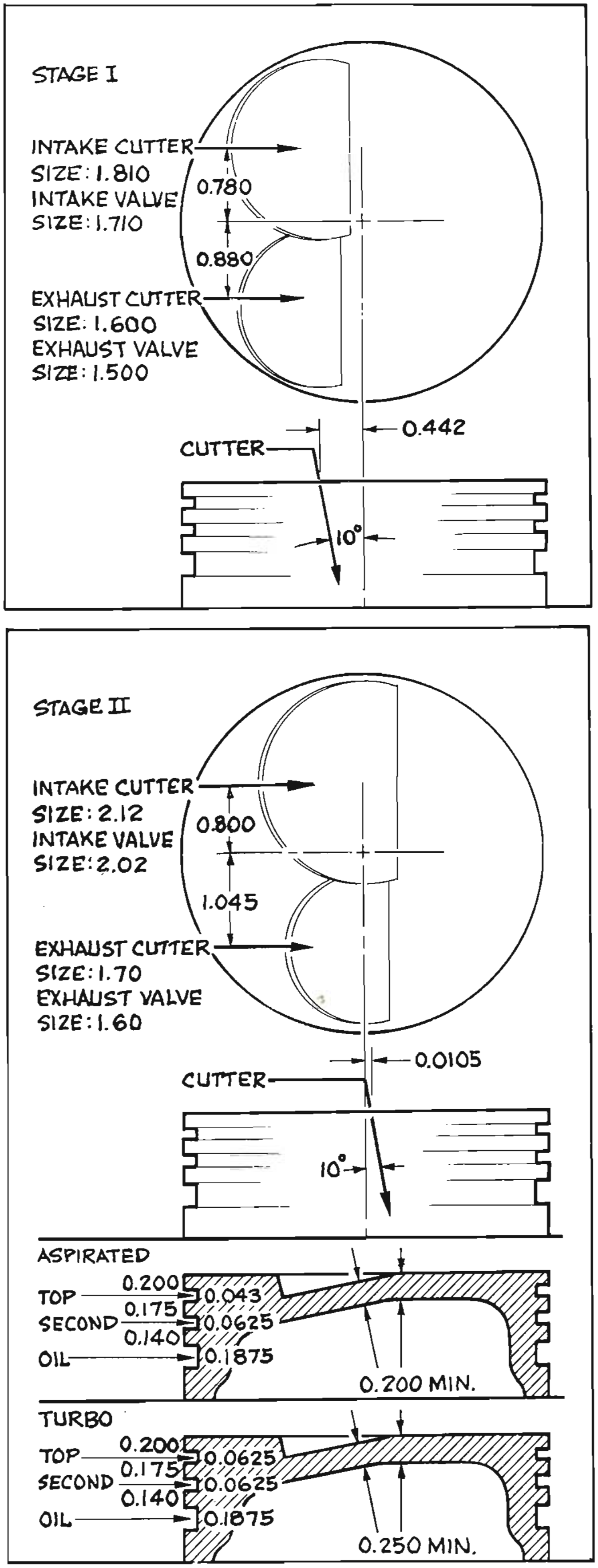
Ring Positioning

Compression rings rotate during operation, which is a desirable characteristic. Therefore, it does not matter where the gap is placed because the rings should constantly be in radial motion. As a practical matter, the top and second gaps should be positioned opposite one another over the wristpin holes. Deburr gap corners a minimal amount after filing so the more critical thrust surfaces of the cylinder wall will not be scratched when the piston and ring assembly are installed.

Ring Gap

Ring end gap for the top ring on a 3.8-inch bore Buick should be 0.016–0.018-inch with 0.014-inch on the second ring. Engines with 3.965- or 4-inch bores should have a 0.018–0.020-inch gap on the top ring and 0.016-inch on the second ring. End gap size is a function of heat; as horsepower rises, so should the size of the gap.





When custom pistons are being machined, the dimensions in this drawing should be of considerable help in finalizing the deck design of the piston.

Installing double Tru-Arcs is one acceptable way of retaining full-floating wristpins. Rounded sides go together so the sharp edges dig into the aluminum of the piston to further effect the containment.

Valve-to-Piston Clearance Check

Valve-to-piston clearance of a high-performance Buick V6 engine can be checked in two ways. The easiest way is to use modeling clay on the top of the piston. The other method requires a degree wheel, a dial indicator, more time, and a great deal more caution. The steps required by this second method are outlined below.

The engine should be fully assembled with a head gasket. The valve springs to be used should be installed on the heads at the proper spring height. The valve gear to be used—rocker arms; lash caps; rocker shafts; cam drive (gear or chain); pushrods; lifters—should be installed as it will be used. The cam should be at the proper centerline, and the heads and valve gear should be torqued to their final specifications.

To check the valve-to-piston clearance with the engine in the above condition, gather the following equipment: dial indicator (0.001-inch increment); degree wheel; large screwdriver; dampener bolt socket and breaker bar for turning the crankshaft; pencil; and paper.

1. Zero the degree wheel to TDC of the No. 1 piston. Cross-check against dampener-timing cover marks.
2. Install heads, valve springs, and head gaskets, and torque them down.
3. Install complete all valve gear and torque it down. Check the centerline of the cam to be absolutely sure.
4. Copy the following chart, and record your measurements at ATDC and BTDC. (The cylinder number changes for the different cylinders.)

ATDC Intake	No. 1.	BTDC Exhaust
______	6°	______
______	7°	______
______	10°	______
______	12°	______
______	14°	______

5. Set the valve lash to zero (0.000-inch) on all the valves.
6. Rotate the engine until the valves on the No.1 cylinder are in overlap and both valves are partially open. At 360 degrees (one revolution) away, both valves are closed. In overlap, the exhaust valve is closing and the intake valve is opening.
7. Stop rotating the engine at the position 14 degrees BTDC.
8. Install the dial indicator on the exhaust valve retainer parallel to the valve stem. Adjust the indicator's dial to a 0.000-inch reading. The 0.000-inch is a dial reading; the tenths indicator may read anything. The exhaust valve will be partially open.
9. *Using extreme caution,* turn the adjusting screw down (opening the valve further) until the valve hits the piston. It is easy to bend the valve with the high spring loads used in racing engines. The point at which the valve touches the piston is not apparent unless you are careful.
10. Read the indicator to determine how much the valve moved down from zero and record next to the proper position on the chart. In this case, the exhaust is 14 degrees BTDC.
11. Back the adjusting screw off until the dial indicator again reads 0.000-inch. The exhaust valve will still be partially open.
12. Advance the crankshaft two degrees in the direction of engine rotation. Turn the crankshaft in this direction in all steps.
13. Reset the dial indicator to zero and repeat steps 9 through 11.
14. Repeat steps 12 and 13 down to 6 degrees BTDC. This makes five readings on the exhaust valve, and the exhaust side of the chart is now full.
15. Rotate the crank to 6 degrees ATDC.
16. Install the dial indicator on the intake valve, and adjust the dial to a zero reading. The intake valve will be partially open.
17. Repeat steps 9 through 11, recording reading in the appropriate position of the intake column of the chart.
18. Repeat steps 12 and 13.
19. Repeat steps 17 and 18 up to 14 degrees ATDC. This makes five intake valve readings and completes the chart.

On the chart, the smallest number in the exhaust column and the smallest number in the intake column is the valve-to-piston clearance for the cylinder being checked. Repeat steps 6 through 19 for the rest of the cylinders to be checked.

Be very careful not to bend the valve. If this method is to yield the correct clearance number, the adjustment screw must be turned back so the dial indicator reads zero before you advance the crank to the next step.

Minimum valve clearance for a high-performance Stage II Buick V6 with a roller lifter valvetrain is 0.055-inch for the intake valve and 0.075-inch for the exhaust valve when an aluminum rod is used. With a steel rod, both dimensions may be reduced by 0.025-inch. Valve-to-piston clearance on Stage I engines may be as tight as 0.040-inch on the intake valves and 0.050-inch on the exhaust when steel rods are used.

Declining Piston-to-Valve Clearance

Keep in mind that milling cylinder heads for even a cleanup on the surface reduces piston-to-valve clearance.

Glass Beading

When assembling an engine for heavy-duty use, some engine builders mask the ring lands and grooves and glass bead the top of the piston and the skirt, believing that this strengthens the piston and aids in oil impregnation. If you do this, thoroughly clean the pistons with denatured alcohol and soap and water.

NOTES

NOTES

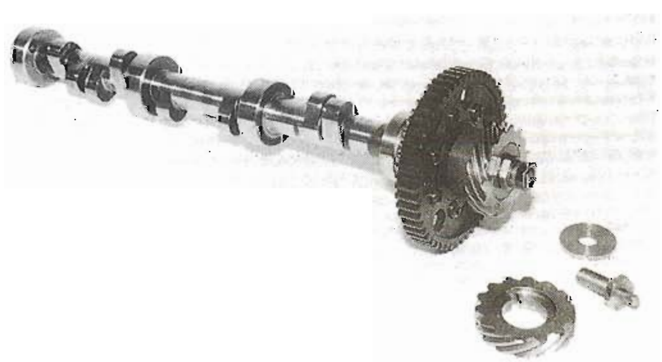
Valvetrain

In production, the Buick V6 valvetrain is a conventional (by contemporary standards) in-block camshaft, hydraulic-lifter, pushrod, shaft-mounted rocker arm, valve-in-head system. Component oiling in the cylinder head is through oil supplied via a hollow pushrod. The complete assembly is low cost and incredibly dependable in production applications. The heavy-duty versions of the Buick V6 valvetrain make it the most reliable of all pushrod, high-horsepower, high-rpm valvetrains.

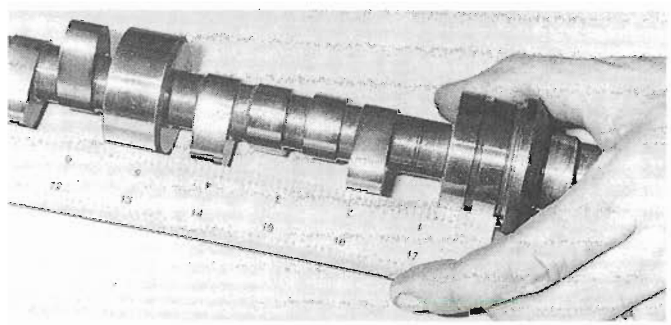
Camshaft

Flat tappet, mushroom, and roller lifter cams have all been used with success in heavy-duty Buick engines, but a problem sometimes occurs with reground cams and higher lift cams in the Buick V6. When the heel of the cam lobe is ground below the surface of the cam casting, the ramp leading into the lobe expands to the full width of the grinding wheel used. An adjacent lifter can hit the leading edge of one of these wide ramps and cause lifter and cam failure and poor engine performance. The areas between adjacent lobes should be cut at least as low as the base circle of the camshaft to eliminate this problem. Mushroom tappet cams have a worse problem because the lifter actually hits adjacent lobes; the only solution is to reduce the width of each lobe to provide clearance for adjacent lifters. For most engine builders, the increased chances of losing cam lobes and the added expense of installation makes the mushroom camshaft an unwise choice for most off-highway applications. When mushroom lifters are used, the underside of the lifter bore must be machined to prevent part of the lifter from contacting the block.

As part of the versatile valvetrain hardware being developed for the Stage II engine, Buick has a steel billet cam of 8620 construction (25500056). The heat-treated billet accommodates 100–114-degree lobe separation. Maximum lift at the lobe is 0.450-inch, which translates to 0.750-inch at the valve. The billet requires final lobe grinding to the engine builder's specifications. Any camshaft used in conjunction with Stage I cylinder heads cannot be used with Stage II cylinder heads, and vice versa. The cam grinder must understand that while the firing order does not change, the placement of the valves is different, thus dictating a completely different camshaft.



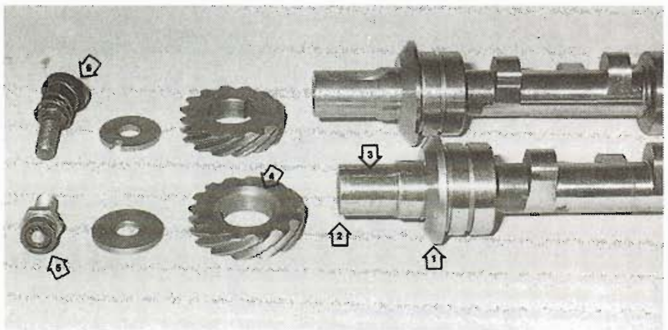
When allowed by association rules, a gear-driven roller lifter cam yields the most rpm and horsepower. Properly installed, this hardware is very reliable.



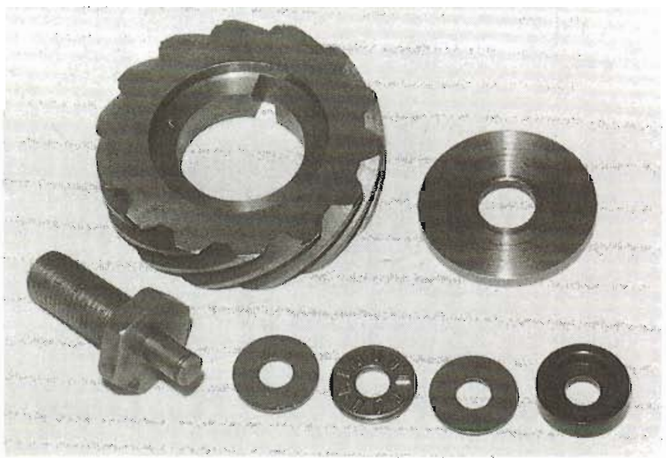
Mistakes do happen. In this case, a cam grinder failed to understand that if maximum lobe lift exceeds the ID of the cam bearing, the cam cannot be fitted into the Stage II block it was intended for.

When Buick V6 engines were of odd-fire design, the distributor drive gear on the nose of the cam was removable. In 1977, the engine was converted to even-fire and the accompanying camshaft was designed with an integral drive gear. To give engine builders more flexibility in overall valvetrain control and in the design of cam lobes, camshaft blanks were produced for Stage I and Stage II even-fire engines. These blanks were designed to be used with a removable distributor drive gear, supplied with the gear drive. This type of cam blank must be used with a gear-driven valvetrain.

The camshaft endplay in the production Buick V6 is controlled by a spring and a plastic button that turns with the camshaft and pushes against the timing chain cover. This design is inadequate for off-highway engines because the ignition timing varies with cam movement and the movement aggravates the lobe/lifter interference. There is limited room between the end of the cam and the timing chain cover, and machine work is required to recess the roller-bearing-limiter into the end of the cam. The simple solution for the cam without an integral distributor drive is to replace the bolt in the end of the camshaft with a hardened hexagon cap screw. The head end of the cap screw is rounded slightly and polished to provide a small contact area against a hardened ⅛-inch steel plate attached to the timing chain cover. Endplay can then be adjusted by grinding material off the rounded end of



Some engine builders go to a great deal of work to get the right combination and fit of hardware, as shown. The OD of the conical face of the cam is cut down to be compatible with the gear-driven holding plate (1). *The nose of the cam is shortened* (2), *which in turn means the key way in the shaft has been shortened* (3). *A recess has been cut in the distributor gear* (4), *which allows the gear to go farther back on the cam for a more precise fit of the cam bumper than the stock arrangement of spring and plastic button allows* (5).



The needle bearing thrust button assembly is available from a variety of aftermarket sources. Attach a small steel plate to the back side of the front cover where the cam button will bear.

the retaining cap screw a few thousandths at a time. Keep checking the fit by tightening the timing chain cover in place and checking endplay. With the intake manifold removed, this is easily done. Endplay of 0.004–0.008-inch is adequate.

A camshaft with the integral distributor drive is easier to limit because it does not require that the center bolt retain the distributor gear and fuel pump eccentric. These cams have a large recess in the nose that can be used to retain an aluminum plug with a short piece of Teflon rod in the center. The aluminum piece should be designed to support the Teflon rod to within 0.050-inch of the timing gear cover. The area inside the cover where the Teflon makes contact should be polished smooth. With all Buick V6 cams, endplay should be in the range of 0.004–0.008-inch.

Tech Tips

Cam Centering

Production Buicks have one bank of lobes ground tapering one way and the other bank ground in the opposite direction in order to center the cam in the block. Aftermarket cam grinders do not always have this feature, so in heavy-duty service the nose of the cam could exert an undue amount of pressure on the front cover.

Cam Centerline

There are two ways of checking the camshaft for correct installation. A common method is to check the intake opening against TDC; however, this is an inaccurate installation method. Use the cam centerline to best determine the correct installation position. The cam centerline is the position of the maximum lift on the intake lobe of the cam in relation to the piston TDC. This relationship is measured in degrees.

When checking cam centerlines, *always* rotate the engine clockwise from the front, which is the normal direction of engine rotation. By rotating the engine in this manner, the clearance in the cam drive system (chain, sprocket, keys, etc.) is taken up just as it is when the engine is tiring, and measured cam centerline will be what the engine experiences when it is firing.

1. With the camshaft in place, insert an intake solid valve lifter for the No. 1 cylinder.
2. Place a dial indicator on the lifter parallel to the lifter centerline.
3. Install a degree wheel so that its pointer indicates TDC when the No. 1 piston is at TDC.
4. Rotate the engine (clockwise from the front) until the dial indicator is at maximum cam lift. Zero the indicator at this point.

5. Turn the engine over (clockwise) until the indicator reads 0.025-inch *before* reaching maximum lift. Stop. Read the degree wheel, and write down the number of degrees. Continue rotating the engine in the same direction (clockwise) past maximum lift (zero indicator reading) until 0.025-inch is read again on the indicator. Stop. Read the degree wheel. Write it down. Add the two degree wheel readings, and divide by 2. The answer is the cam centerline. (The 0.025-inch figure was used for illustration only. Any measurement above 0.020-inch is acceptable.)

Example: Use the numbers from the cam specification chart that comes with your camshaft. Assume the cam being installed shows a cam centerline of 108 degrees. The cam and timing chain or gear drive are installed. The lifter is installed on the No. 1 intake lobe. The degree wheel is bolted to the crank and set to read TDC correctly with a pointer. The dial indicator is zeroed at the maximum lift of the cam.

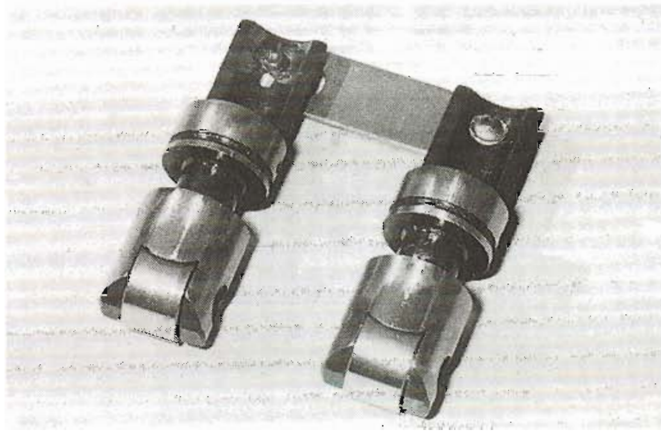
6. Rotate the engine clockwise and approach the indicator reading of 0.020-inch carefully since you must not reverse the direction of rotation. At 0.020-inch the degree wheel reads 90 degrees. Record the reading, and continue to rotate the engine clockwise through zero until the indicator reads 0.020-inch. The degree wheel now reads 134 degrees. Add 90 degrees and 134 degrees, and divide by 2. Answer: 112 degrees. Thus, we must advance the cam 4 degrees in order to have the centerline at 108 degrees. Offset keys, eccentric bushings, and other devices are available for this purpose. Insert the proper device so that the centerline of the cam is moved forward (advanced) in the direction of its rotation. Repeat the above steps with the advanced cam position. The reading should now be 86 degrees at 0.020-inch before maximum lift on the indicator and 130 degrees at 0.020-inch after maximum on the indicator. Add 86 to 130. Answer: 216 degrees. Divide this by 2. Answer: 108 degrees. The cam is now installed correctly. If 0.040-inch was selected instead of 0.020-inch for the indicator reading, the last step above would be as follows. The wheel would read 70 degrees at 0.040-inch before maximum lift and 146 degrees at 0.040-inch after maximum lift. Adding the two numbers yields 216, and this divided by 2 gives 108 degrees.

Changing the cam centerline 1 degree will probably not be reflected in engine performance.

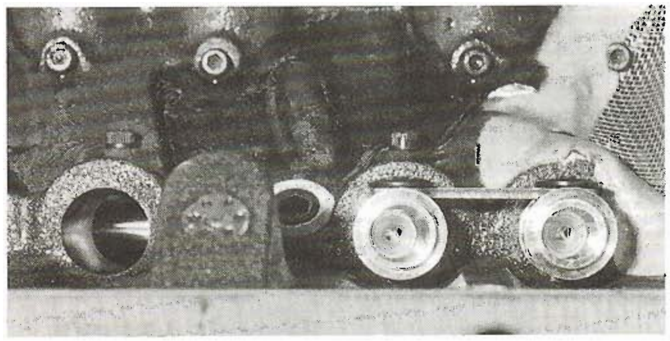
Lifters

Any aftermarket roller lifter used in a small-block Chevrolet V8 is applicable to Stage II block application. Stage I blocks require a special lifter with a shielded foot that prevents oil hemorrhaging from the gallery to the camshaft tunnel at maximum lift. These are available from many aftermarket sources.

If a mushroom-type lifter is required, GM lifter 366253 may be used. This mechanical design features a 0.960-inch foot.



When roller lifters are used in a production or Stage I block, special shielded foot lifters must be used so as not to uncover the oil gallery. This problem does not exist when a Stage II block is used.



When using a Stage II cylinder head, many engine builders use roller lifters with offset pushrod bushings to correct pushrod angularity. This hardware is available from several aftermarket sources.

Tech Tip

Lifter Preparation

Many engine builders preparing engines for heavy-duty use prepare lifters in the following manner. Wet-sand the base of the lifter with 400-grit paper, then with 600-grit. Clean the lifters thoroughly, and then spray the base with Dow Corning 351R moly lube. Also spray the cam with the moly lube, and allow lifters and cam to sit overnight before installing. When they are installed, coat the lobes of the cam with cam grinder's break-in lube.

Valve Springs and Retainers

Buick produces a triple valve spring for Stage II cylinder heads. Because there are three coils instead of the normal two in a heavy-duty spring, the Buick spring (25500035) is not highly stressed considering the pressure it is capable of yielding. The specifications on the spring are as follows:

Inner: 35 lbs. @ 1.80 ± 2 lbs.
108 lbs. @ 1.15 ± 6 lbs.
Middle: 57 lbs. @ 1.90 ± 2.5 lbs.
170 lbs. @ 1.25 ± 8.0 lbs.
Outer: 65 lbs. @ 2.00 ± 3.0 lbs.
193 lbs. @ 1.35 ± 9.5 lbs.

The Stage II valve spring consists of three chrome silicon wires that yield a total spring rate of 500 lbs./in. Valve closed spring height is 2.00 inches with 157 pounds on the seat. Valve open spring height of 1.35 inches yields 471 pounds on the seat. The Buick part number is 25500035.

Buick offers a titanium valve spring retainer (25500054) whose outside diameter is 1.725 inches. This retainer is designed to be used with the Stage II three-wire spring.

These Howard Stewart retainer locks must be used with the Buick titanium valve spring retainers because of the 7-degree angle. The lock on the far left is the standard-height item. The keeper in the center yields 0.050-inch more compression, while the one on the far right produces 0.100-inch more compression.

Assembly: 157 lbs. @ 2.00 ± 8 lbs.
471 lbs. @ 1.35 ± 24 lbs.

When this spring is used on an aluminum head, it should be separated from the aluminum by a steel cup or shim with a minimum thickness of 0.060-inch

Most aftermarket cam grinders offer a variety of 1.750-inch OD springs yielding upwards of 500 pounds of pressure over the nose of the lobe. The important parameters of spring selection are to avoid coil blind while maintaining enough pressure to keep the lifter in contact with the lobe. Any heavy-duty Stage II engine should be capable of turning 8500 rpm without valve float.

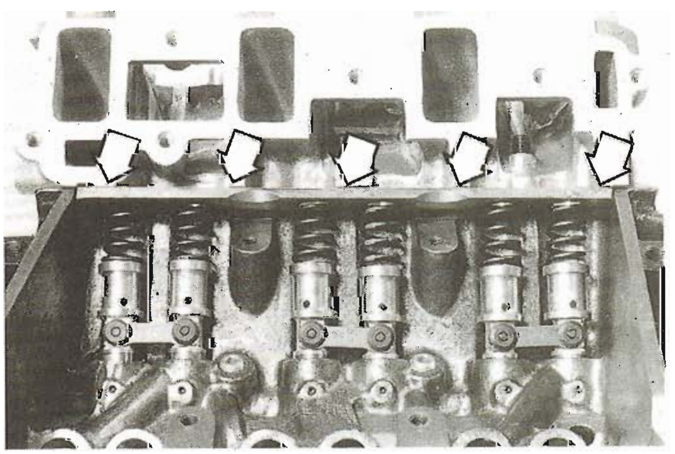
The Buick titanium retainer (25500054) was designed to be used with the triple coil Stage II valve spring. This retainer is machined to accept 10 keepers. Most aftermarket camshaft grinders market suitable retainers.

Rev Kits

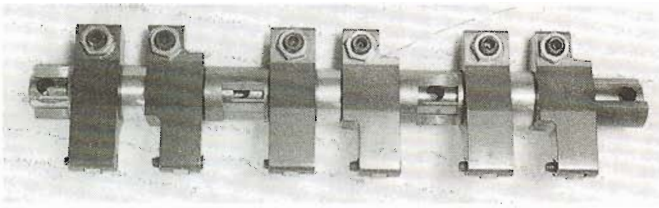
Roller lifters allow an engine to wind tight as a result of less friction on the cam lobes. But this in turn requires more pressure to keep the roller in contact with the cam. To reduce stress on the upper valvetrain while simultaneously providing the additional pressure needed at the lifter, rev kits are used. These springs, cups, and retainer bars fit under the cylinder heads in the lifter valley and put pressure directly on the tops of the lifters. Individual spring pressure is approximately 50 pounds at 0.500-inch compression and 80 pounds at 0.750-inch compression. Buick and various aftermarket suppliers offer high-rev kits.

Rocker Assemblies

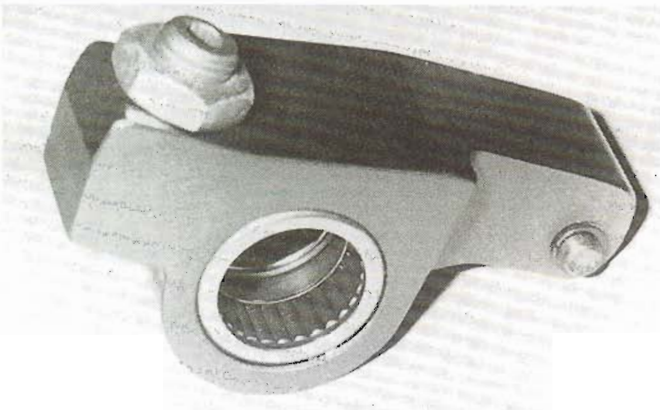
High-performance rocker arm assemblies are available for Stage I and Stage II heads; however, they are not interchangeable between the two heads. Buick has a rocker arm assembly that includes 12 2024 T-6 aluminum rocker arms fitted with Torrington needle roller bearings that bear



Rev kit hardware puts additional spring load on the lifter without putting additional spring load on the rocker shafts and pushrods. Bosses were cast on the Stage II cylinder head to accommodate aftermarket rev kits.



This rocker arm assembly from Buick fits Stage II aluminum and iron heads. The assembly includes 12 rocker arms, two shafts, spacers and hold-down hardware. The Buick part number is 25500044.



The rocker arm ratio of the Buick piece is 1.7:1. The material is 2024 T-6. Torrington needle bearings ride on 8620 hardened shafts.

against 8620 hardened steel shafts. The rocker ratio is 1.7:1. The assembly is complete with spacers and all hold-down hardware, which allows fitting to Stage II iron or aluminum heads. Similar assemblies with different ratios are available from several aftermarket sources.

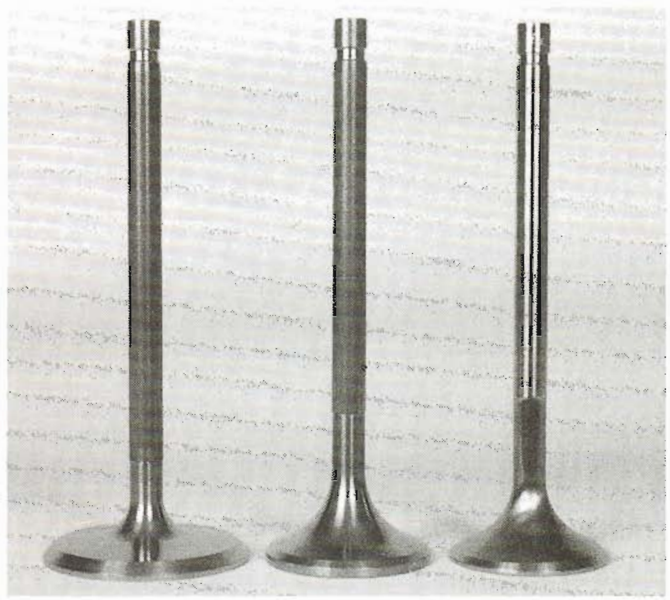
Valves

Intake and exhaust valves for Stage I and II heads are vastly different in design and size and thus do not interchange. Heavy-duty valves are not available for production or Stage I heads, but suitable items can be fashioned by cutting down replacement valves for other engines. Custom valves can also be ordered from aftermarket suppliers.

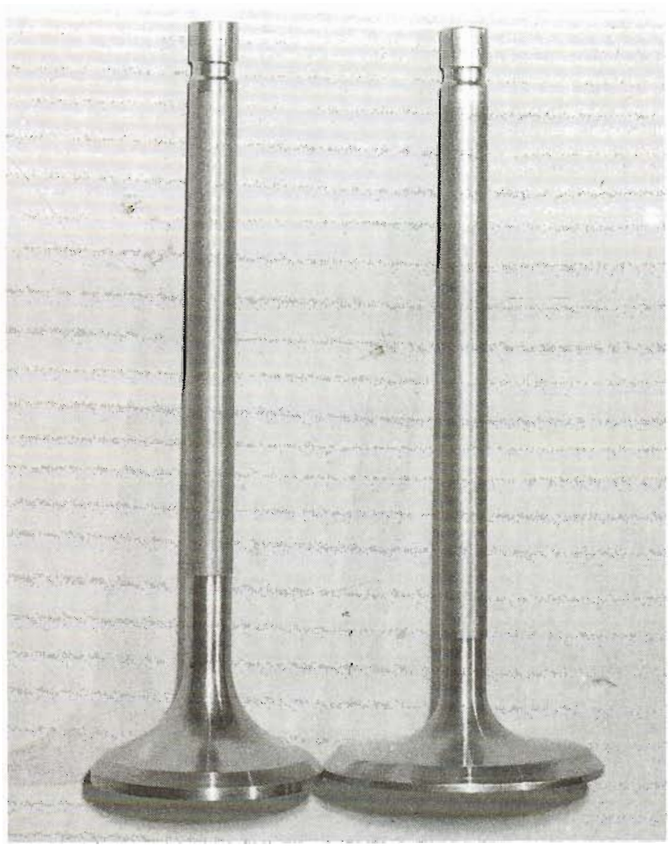
Buick offers a number of heavy-duty valves for Stage II cylinder heads. Intake valves are available in both stainless steel and titanium; exhaust valves are available in titanium and inconel for turbocharged applications. The stainless valves measure 2.02 inches for intake and 1.60 inches for the exhaust. The inconel exhaust is also 1.60 inches. The titanium items are larger than the stainless, measuring 2.050 inches for the intake diameter and 1.650 inches for the exhaust. The head degrees of all valves offered by Buick for heavy-duty applications are optimized for maximum flow.

Valve Modifications

Both low- and high-lift flow on intake and exhaust ports can be improved by carefully altering the shape of the valve. On the intake side, cut the backside angle to about 30 degrees. This angle cut



Left to right is a 2.050-inch-diameter titanium intake valve from Buick (25500039); a 1.60-inch production exhaust valve; and an inconel exhaust valve with a diameter of 1.60 inches. Buick part number is 25500025. The inconel exhaust valve is designed specifically for turbocharged applications.



Some engine builders modify existing valves for cylinder head-flow work. These general shapes yield maximum flow for exhaust (left) *and intake* (right).

improves high-lift flow, provides gains in top-end power, and improves low-lift flow.

Sink the exhaust seat approximately 0.020-inch lower than the intake in order to improve exhaust-side airflow. The seat on the exhaust valve should be without definition. A tulip backside exhaust valve promotes good low-lift flow. Gently radius the edge of the exhaust valve that sees the inside of the combustion chamber. For purposes of increasing flow volume, a 2.05-inch intake valve is preferable to a 2.02-inch valve.

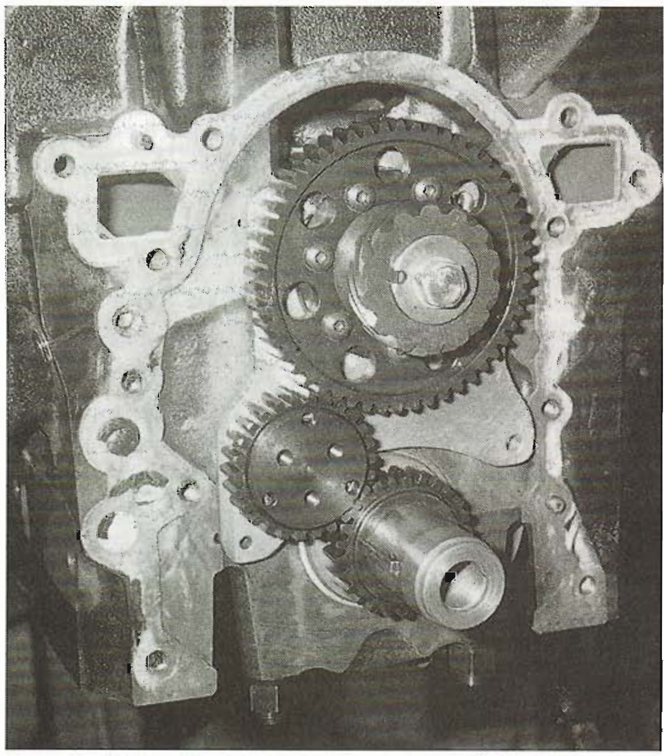
Valve Grinding

The issue of valve seat width should be qualified for short track and drag race engines. Nothing may be wrong with narrow valve seats per se, but remember that if the angles leading to the seat and trailing from the seat are dramatically different from the seat, air will "see" the seat as a sharp edge—and that's bad for maximum flow. The rule of thumb for valve seat width is: the longer the race, the wider the seat. A cylinder head being prepared for the street or an endurance race should have a seat width of about 0.090-inch on the intake and as much as 0.125-inch on the exhaust. A drag race or short course effort could get away with as little as 0.060-inch on the intake seat and 0.070–0.080-inch on the exhaust.

If problems occur along the lines of the valve seats being pounded out prematurely, the problem may be in the camshaft. If the cam is designed so it drops the valve on the seat quite hard, no amount of work on the valve seat will cure the problem.

Gear Drives

Historically, gear-driven valvetrains have allowed more horsepower to be produced than those moved by chains. This is due to more precise and predictable valve events. Infinitely more important for many forms of competition, gear drive assemblies are far more durable than chain-and-sprocket assemblies. Aftermarket gear drive assemblies are available for the Buick V6; detailed installation instructions are included with the hardware.

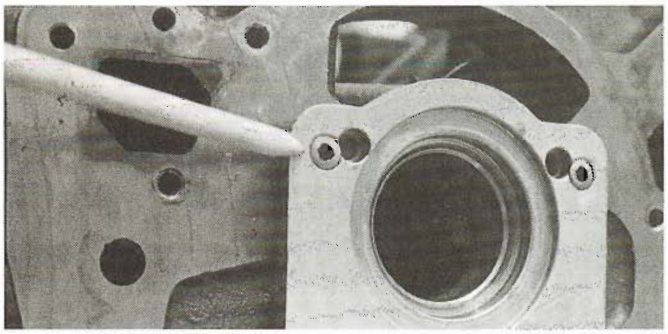


For heavy-duty use, an aftermarket gear drive is the preferred method of driving the cam. A production front cover must be modified to clear this hardware. Check for adequate clearance before and after the engine is fired.

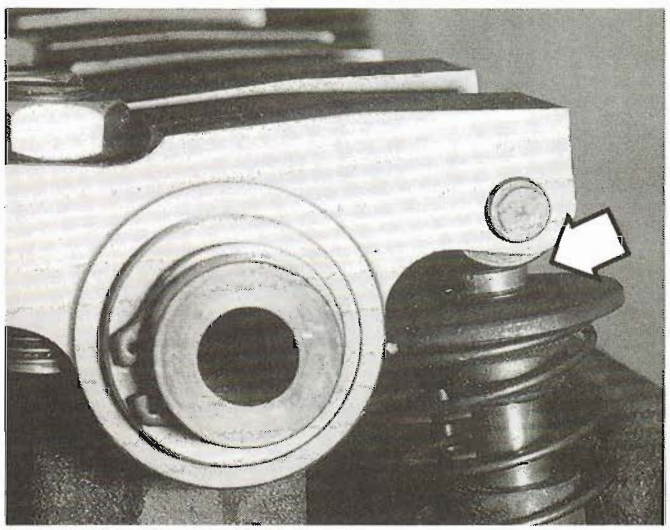
Tech Tips

Clearance Checking

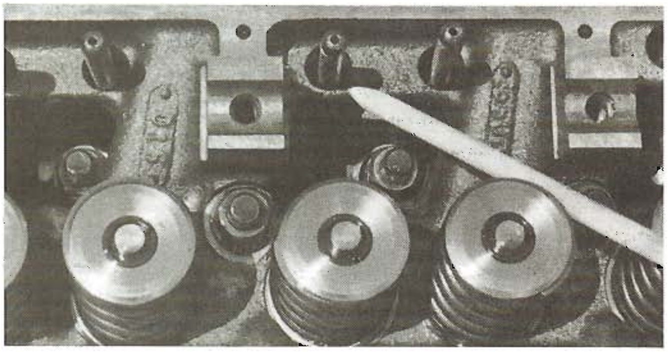
When mocking up the complete engine for clearance checking of all components, you must check certain items in the valvetrain. The ball in the ends of the pushrod must be of the same radius as the socket in the lifter and the rocker. Both ends of all pushrods should be checked against all lifters and all rockers in an engine assembly. Check for coil bind on all springs and for retainer clearance with the underside of all rockers (a critical area on all aftermarket rockers). Also check for clearance between the pushrods and the pushrod openings in the cylinder heads.



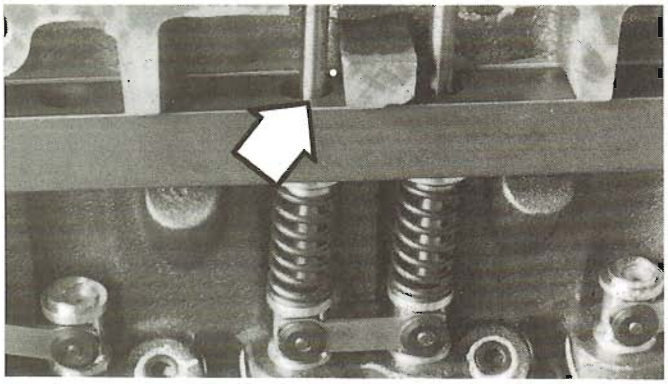
During the installation of a gear-drive assembly even the components must be checked for clearance. In this case, a small amount of material had to be ground off the top of the mounting bolts in order to clear the cam gear.



Constant checking of clearances and assembly is necessary on any highly stressed heavy-duty engine, and the Buick is no exception. Inspecting roller contact to valve tip is just one example.



Depending on a number of factors, interference can exist between pushrods and their holes in Stage II heads.



The wrong combination of rev kit, pushrods, and other pieces of valvetrain hardware can create problems in the area of the rev kit bar.

Oil Filter Cartridges

Molykote and other molydisulfide greases plug an oil filter after about 20 minutes running time. Install a new oil filter cartridge on an engine built using this grease after approximately a half hour of running. You should also change break-in oil at this time.

Belt-Driven Grinding

When using a belt-driven grinding machine, turn the grinder on at least 30 minutes before grinding the valves. This allows the belts to warm up and relax. When the machine is off, the belts develop flat spots that in turn create chatter marks on the valve when it is being ground.

Spring Pressure

Buick V6 engines built for competition require a variety of spring pressures—primarily depending on the type of lifter being used. The following should be considered a starting point for experimentation with spring pressures.

- Roller Lifter—180 lbs. pressure on seat; minimum of 500 lbs. over the nose.
- Solid Lifter—135 lbs. pressure on the seat; minimum of 480 lbs. over the nose.
- Hydraulic Lifter—110 lbs. pressure on the seat; minimum of 300 lbs. over the nose.

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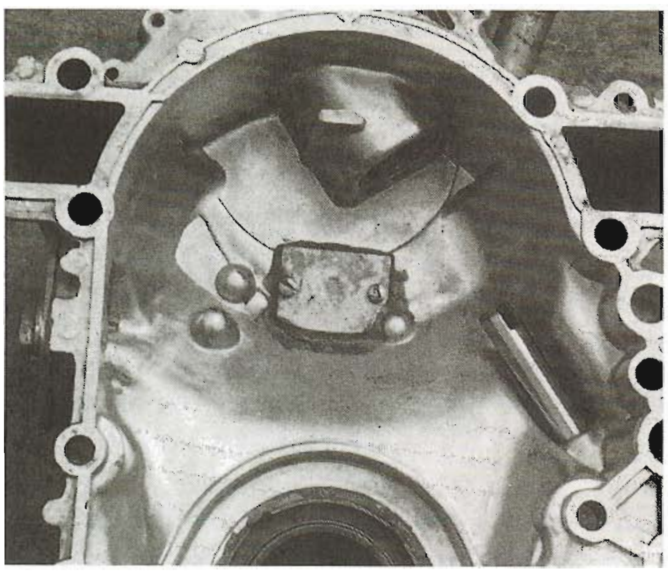
6 Front Covers

The Buick front cover is designed to perform a number of functions. It holds the distributor and the water pump, it contains the oil pump, it covers the timing chain, and it seals the crankshaft. There are basically two designs—one for rear-wheel-drive applications and the other for front-wheel-drive applications.

Several front covers have been used on the Buick V6 since 1975. From 1975 through the end of production of the odd-fire configuration in the summer of 1977, a timing indicator was cast into the front cover. When the engine was converted to even-fire configuration, a new cover that utilizes a bolt-on plastic timing indicator came into being. The 18-degree difference in the TDC marks of the two indicators means that if you use an odd-fire cover on an even-fire engine or an even-fire cover on an odd-fire engine you'll have to rework the timing indicator to read correctly at TDC. Both these covers have a provision for a mechanical fuel pump. The 1982 A-car (Century) features a 3.0L engine with a shorter, more efficient water pump assembly, which is interchangeable with all Buick V6 engines. This could be useful to street rod engines and some high-performance engine applications. The 3.0L water pump is not designed for a mechanical fan; if a cooling fan is needed for the application, an electrical unit will be needed as well. You are unlikely to confuse the 3.0L cover with anything else since it has no provision for a mehanical fuel pump; therefore, an electrical fuel pump must be used. The 3.0L cover and pump assembly is 6.76 inches long from the front face of the block, compared to 8.95 inches for a 3.8L cover and pump assembly. With a 2.50-inch fan added to the 3.8L cover, the net savings in length between the covers is 4.69 inches.



A small steel plate should be attached to the back side of the cover in front of the camshaft to provide a wear surface for the thrust button on the nose of the cam.

The impeller is shorter and smaller in diameter in the 3.0L water pump. In this pump, incoming water flows to the blades, whereas water flows through the spokes in the 3.8L pump. The result is a pump that is 268 percent more efficient and requires up to 65 percent less horsepower to operate than the 3.8L pump. The 3.0L pump flows approximately 13 percent fewer gallons per minute for a given engine speed and pulley ratio.

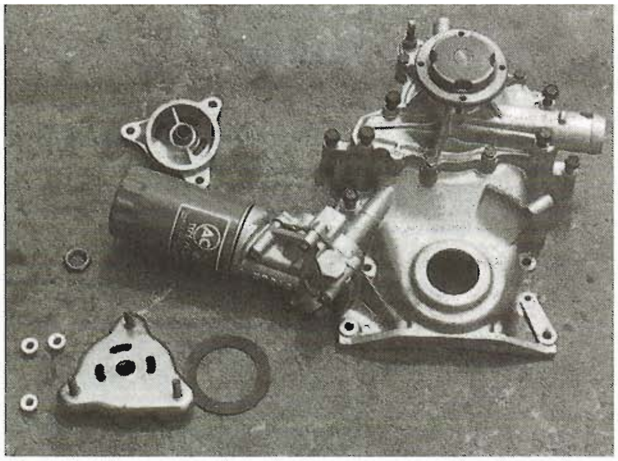
If the 3.0L water pump is to be used on a 3.8L engine, it must be mated to a 3.0L front cover because the water pump bolt pattern is entirely different. Other noninterchangeable components are crank pulleys, crank dampeners, water pump pulleys, accessory brackets, and some front cover gaskets and bolts. A rear-wheel-drive oil pump cannot be used with a front-wheel-drive front cover; however, the front-wheel-drive oil pump works with a rear-wheel-drive cover. The 1982 3.0L oil pump cover must be used with a gasket designed for that cover. The oil filter on the 3.0L oil pump cover sticks out perpendicular to the centerline of the crankshaft, while the 3.8L oil filter extends forward at about a 45-degree angle. The 3.0L covers also have the timing mark indicator cast in the cover—just like the old odd-fire covers.

Assembly Parts	
Water Pump	25500407
Front Cover	25512585
Oil Pump Cover Assembly	25509135
Crank Pulley Assembly	25500498
Water Pump Pulley	25510369

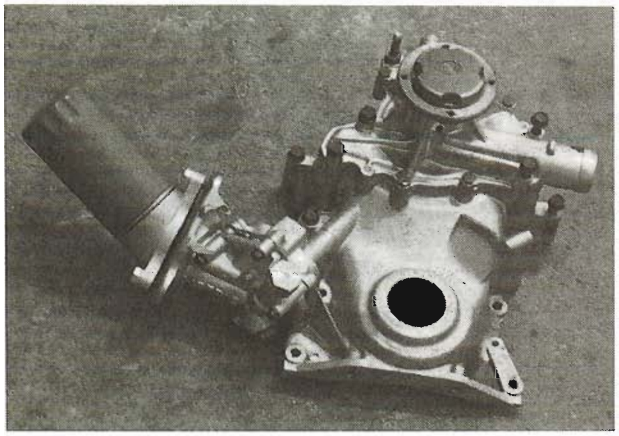
Front Cover Seals

The crankshaft seal in the front cover of a Buick V6 is a rope seal design held in place by a stamped metal retainer. Crankshaft-to-front-cover sealing can be improved by prying the rope seal and retainer out of the cover and replacing it with a neoprene lip-style seal. There are at least two ways of doing this. One way is to replace the rope seal with National Seal 472319 or its equivalent. You can use epoxy or a silicone sealant to anchor the new seal in place. The front cover is a die casting, and in order to get the casting out of the mold, the crank hole nest must have draft or taper, so no replacement seal fits squarely in the hole, and the success of the retention depends on the sealant used.

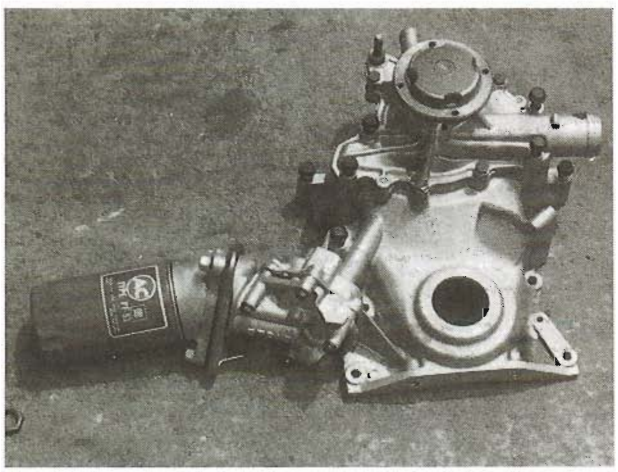
The second method of improving the front cover/



The 3.0L front-wheel-drive front cover interchanges with a rear-wheel-drive cover although it is completely different. Note the angle of the oil filter; the angle is changed by the adapter pieces on either side of the filter.



The angle of the filter can be changed upward.



It can also be changed downward. The adapter is a piece of stock GM hardware.

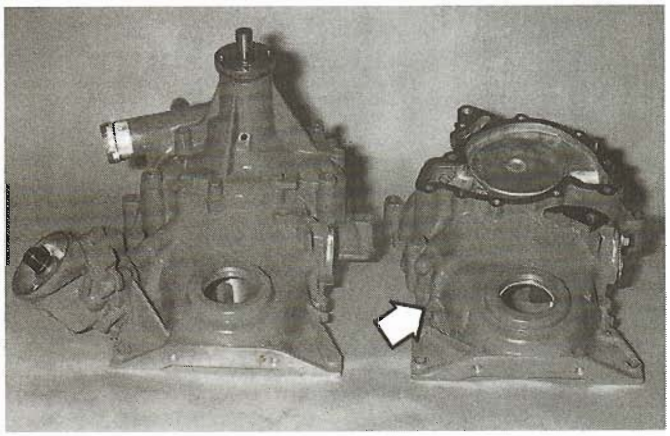
crank seal involves machining a larger recess of 2.765 inches and pressing in GM pinion seal 404294. The larger recess should be larger in diameter only—not depth.

Cam Stop

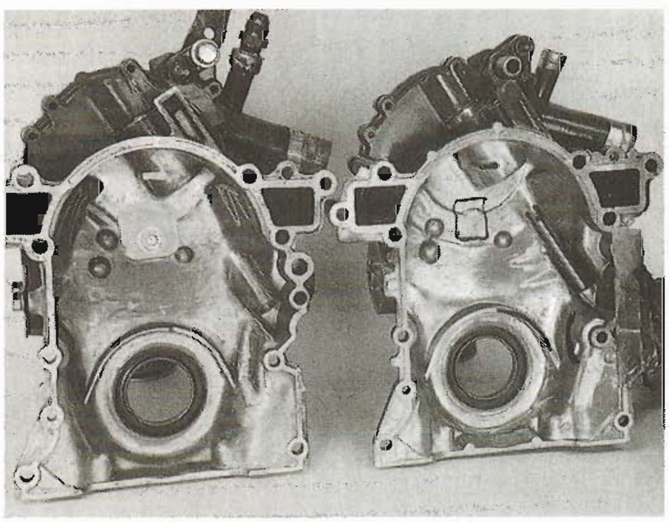
A small steel tab can be epoxied or held in place with screws to provide a hardened surface for the cam bumper.

Gear Drive Clearance

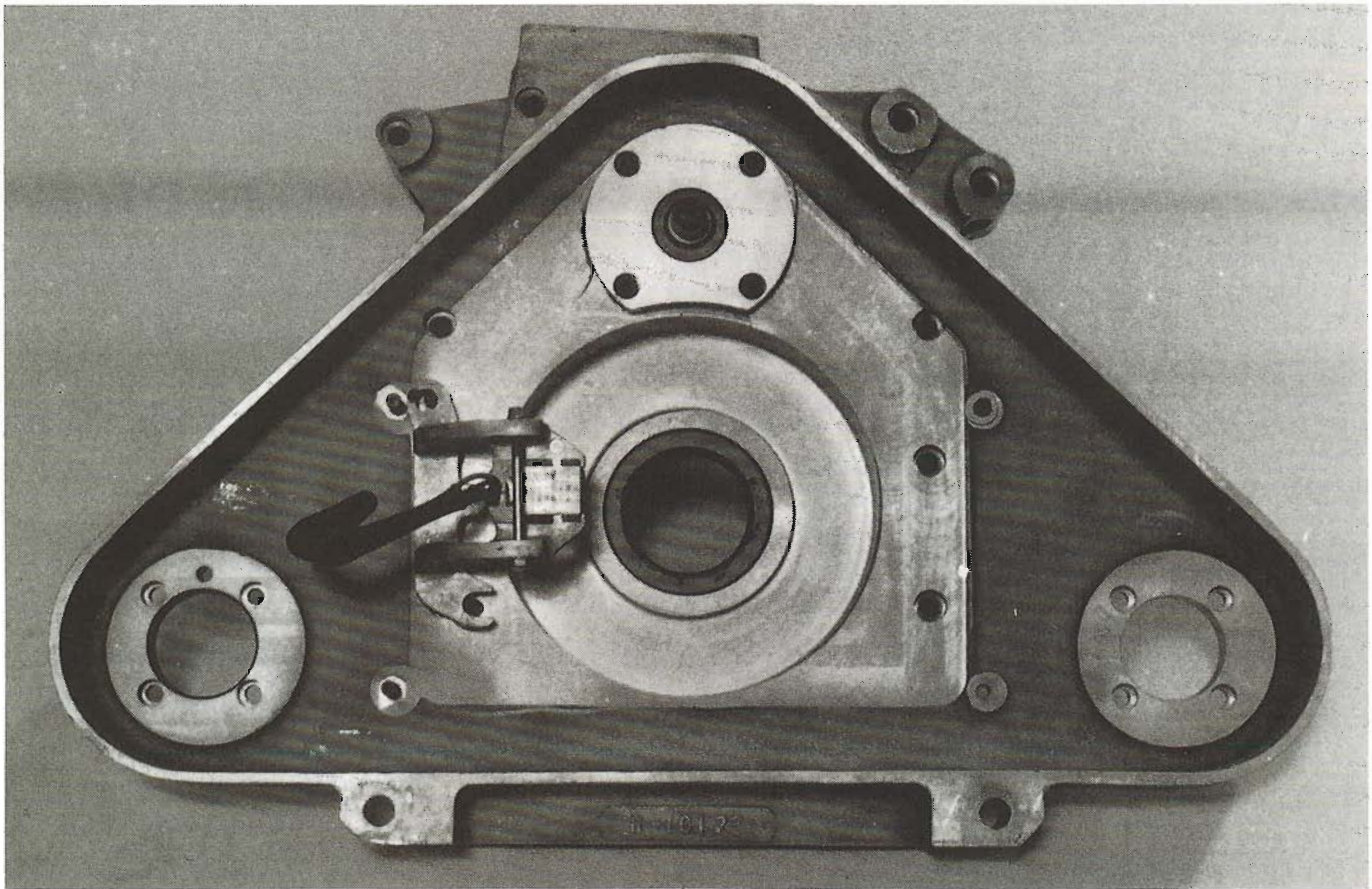
The currently available gear drive assemblies do not fit under a production front cover. Instructions packaged with the gear drives indicate where the



Many engine builders eliminate the oil pump cast into the front cover on an engine equipped for dry-sump oiling. This is done in a mill followed by a heliarc session.



The cover on the left has been reworked to accommodate an aftermarket gear-drive assembly, and the area behind the water pump has been milled flat to accept a thrust plate. The cover on the right has been marked for the cutting that must be done.



McLaren Engines offers this front cover for Indy car use. The casting accommodates the Buick Computer Controlled Ignition and Cosworth oil and water pumps.

cover must be milled or ground away for adequate clearance.

Aftermarket Front Covers

At the time of publication of this volume, only one aftermarket front cover is available for the Buick V6. It is produced by McLaren for Indy car use. This hardware is extremely short and compact and is designed solely with heavy-duty use in mind.

Tech Tip

TIG Welding

Any welding done on a die-cast front cover should be with a TIG welder using a 50-50 mix of helium and argon gas.

NOTES

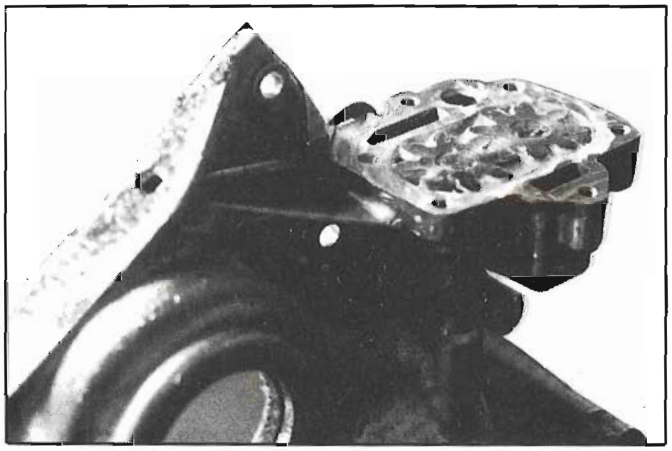
NOTES

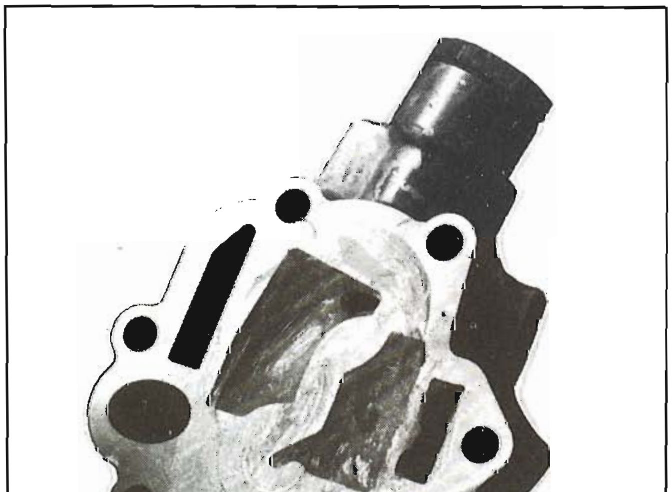
Engine Lubrication

Essentially, there are two approaches to improving the production Buick V6 oiling system for heavy-duty use. The first approach is to modify the stock system, and the second is to replace it.

The Stock System

The stock Buick V6 oiling system consists of a single pickup in the pan with the oil drawn through the block into a pump consisting of two straight-cut gears. The pump feeds oil through passages in the front cover and then into the block—first to lubricate the valvetrain and then to oil the main bearings and finally the rod bearings.





Eliminate oil pump priming problems by packing all oil pump cavities with petroleum jelly when the engine is being assembled.

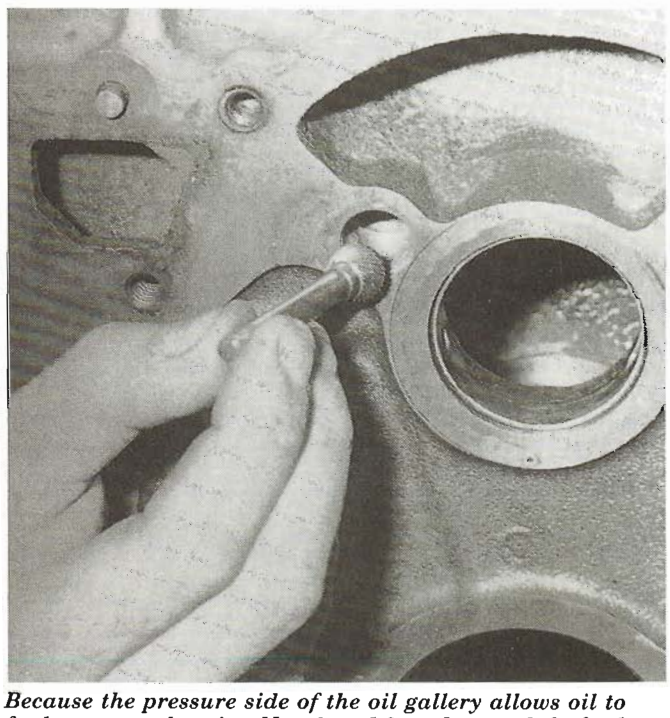
Properly assembled and installed in a vehicle with the correct oil pan, pump, coolers and filters, the Buick engine prepared for heavy-duty use is remarkably free of any failures from the oiling system. The basic guarantee of freedom from bearing wear and failure is a nonfluctuating supply of clean oil at 170–270 degrees F with 80–100 pounds of pressure.

The desired oil pressure is governed by the following factors:

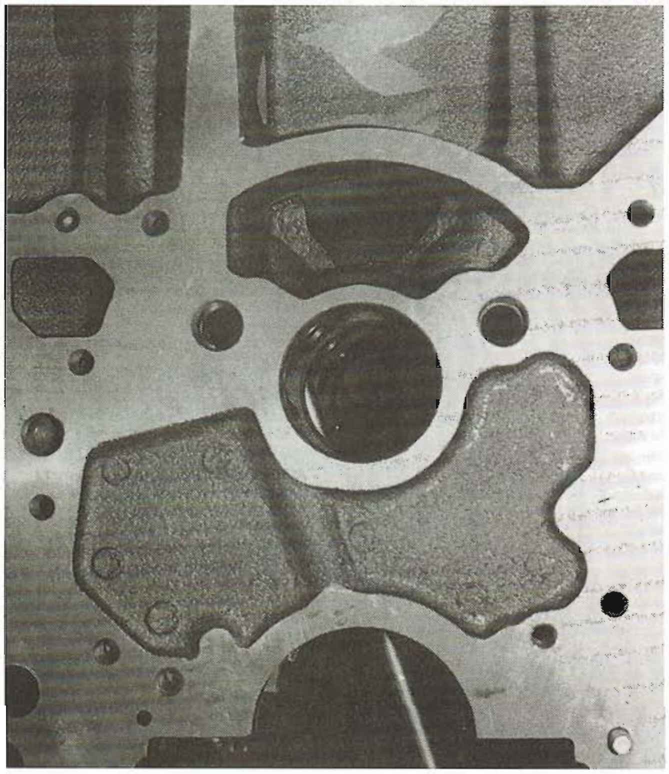
1. Clearance stack-up throughout the engine, such as main, rod, and cam bearings plus lifter-to-bore clearance.
2. Oil pump gear size and clearance, pump volume, and pressure-relief setting.
3. Oil pump pickup tube size and the diameter of pickup passages to the pump.
4. Type and viscosity of oil used.

The proper oil temperature is governed by careful, long, low-rpm warm-ups before the engine is put to use, and by an oil cooler, which keeps oil temperature below 270 degrees F while the engine is in use.

For heavy-duty use, the valvetrain needs far less oil than it gets in production form, and the bottom end of the engine benefits from oil—in terms of volume and pressure. The majority of the oil system modifications are made in the block. Oil going to the pump travels upward from the pickup flange

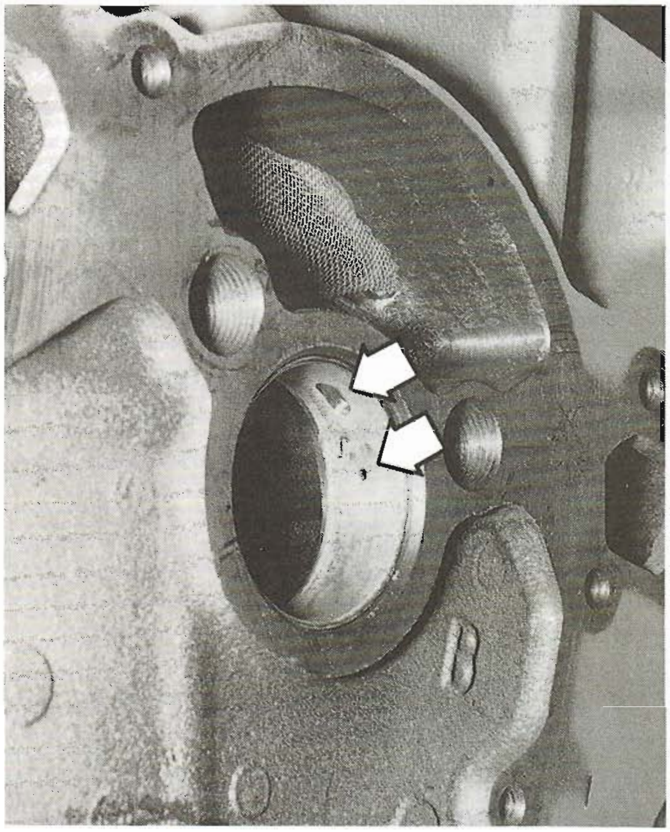


Because the pressure side of the oil gallery allows oil to feed past cam bearing Nos. 2 and 3 to the crankshaft, the feed passage at the 90-degree intersection should be blended with a spherical cutter.



Many engine builders enlarge the holes feeding the Nos. 2 and 3 main bearings because the cam bearings restrict oil flow volume to these main bearings (the Nos. 2 and 3 bearings in turn feed two connecting rod bearings each, whereas the Nos. 1 and 4 mains supply oil to only one connecting rod each). Sizing this supply passage larger prolongs bearing life.

Engine builders differ on whether the Nos. 2 and 3 main bearing oil feed holes should be enlarged to 5/16-inch or 3/8-inch, but enlarging the holes improves the condition of rod and main bearings.

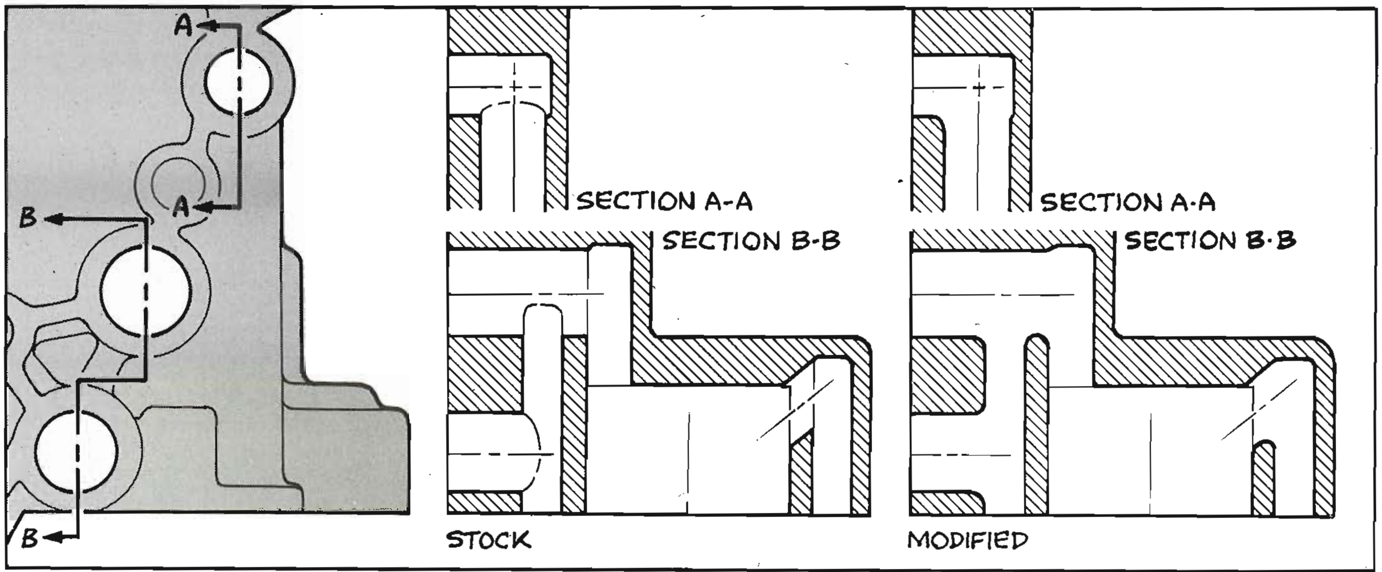


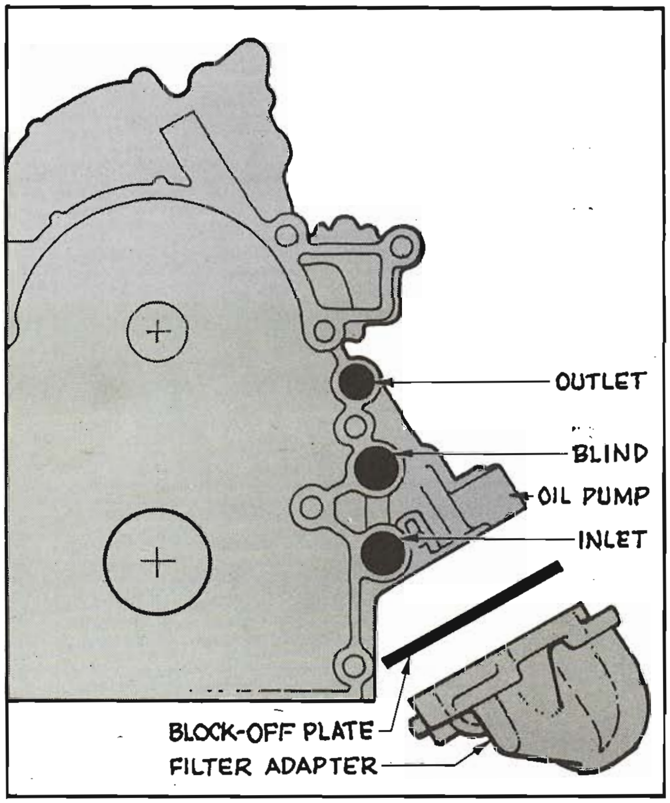
The front cam bearing has a slot that sends oil to the lifter galleries. You can remove this bearing, drill an 0.080-inch hole, and reinstall the bearing with the smaller hole feeding oil to the lifters to raise the oil pressure and restrict the amount of oil going to the valvetrain.

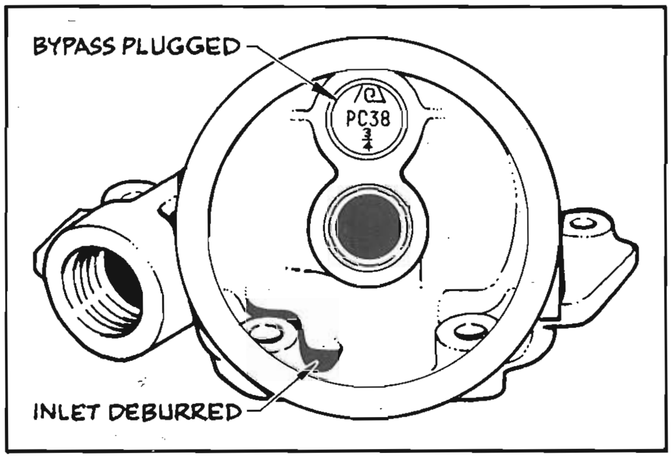
on the block near the No. 2 main bearing through a passage that is intersected by a long horizontal passage leading to the front of the block. Depending on the manufacturing date of the block, this passage can vary from 7/16- to 9/16-inch in diameter (the larger measurement is preferred). If this passage is to be enlarged, an end mill machine setup is recommended because the enlarged hole must be parallel to the axis of the original hole.

This modification can also be made with a slow-rpm ½-inch drill motor and a long drill bit that has been sharpened for drilling cast iron. The danger in doing this is that the enlarged hole breaks out into the crankcase, and a subsequent leak on the suction side of the pump introduces air into the oil and results in engine failure. The intersection of the two holes is a 90-degree turn that should be modified by rounding the inside corner as much as possible. This can be done with a high-speed grinder and a ⅜- to ½-inch ball-shaped stone on a 4-inch-long shank. The corner being radiused in this situation is not visible, so this requires persistence.

The minimum diameter for any piece of oil pick-



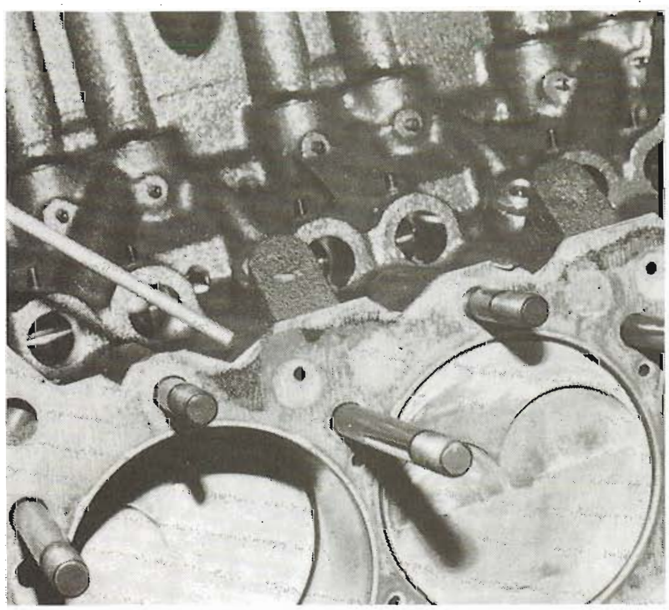




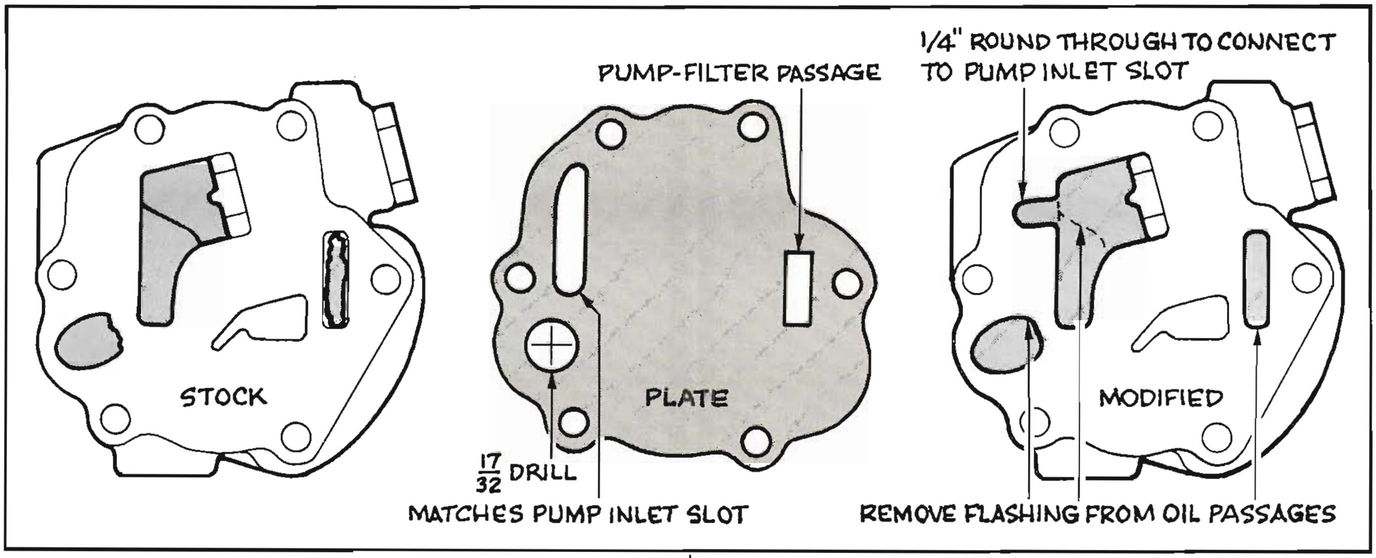
You should spend considerable time with a die grinder radiusing all oil passage corners in the block and the front cover. The drawing illustrates how many times the oil must make a 90-degree turn in the front cover.

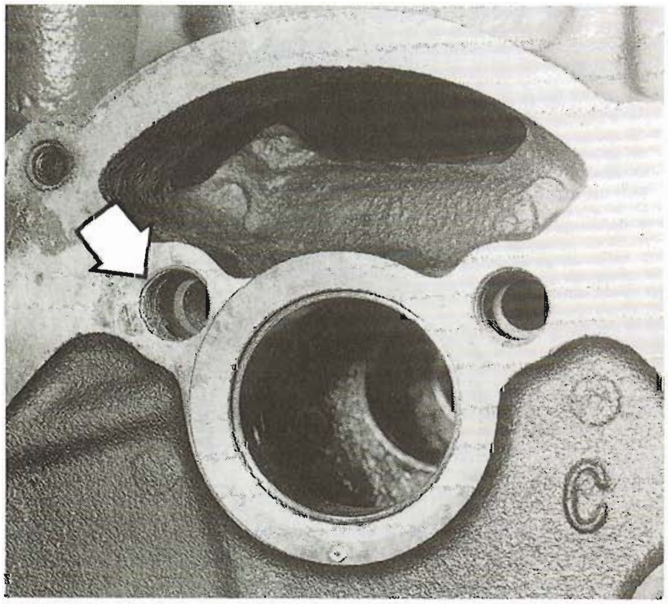
up hardware is ⅝-inch. The pickup tube flange plate should be a minimum of 3/16-inch thick. Sealing in this area is critical, as an air leak here results in the oil pump pumping air and not oil.

On the pressure side of the system, three passages must be ½-inch in diameter. Again, depending on the vintage of the block, this may already be the case. The first passage to be addressed runs from the top of the No. 1 main bearing saddle past the No. 1 cam bearing and then into the main oil galley. The second passage is the one that starts at the ¼-inch NPT oil pressure sender hole on the side of the block and intersects the first enlarged passage at the No. 1 cam bearing. Do not drill this



Stage II engines benefit from notches cut in the head gasket to aid oil drain to the lifter valley.



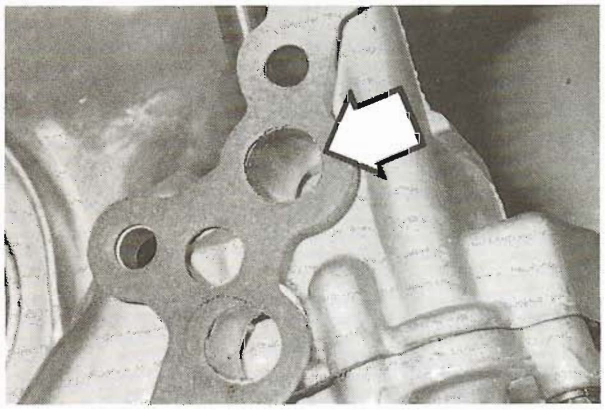


The back side of the plug seat has been opened up to allow for an increase in oil flow. Because this is the pressure side of the valve lifter gallery, more lubricant will be supplied to the rest of the engine.

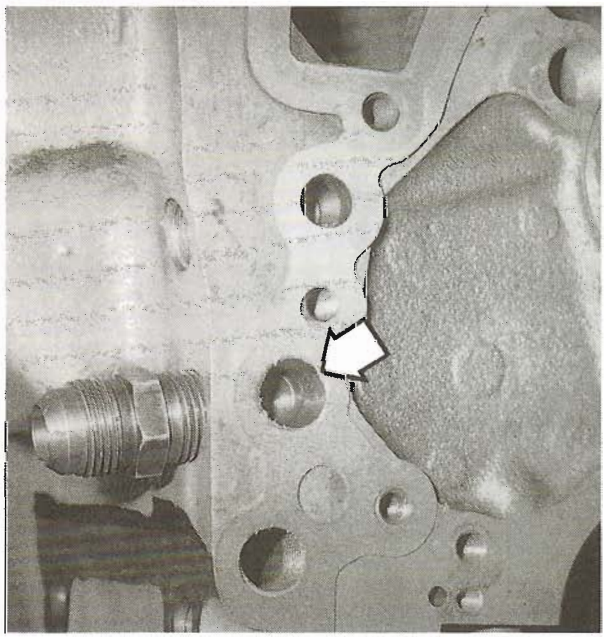
hole any deeper than necessary, or the hole will break into the water jacket. The final passage, which should be ½-inch in diameter, is the short one going from the front of the block to the second passage drilled.

Blending of all corners in the oil passages is beneficial to maintaining pressure—every 90-degree turn reduces pressure about 10 pounds. Oil galley plugs in the front of the block should be ⅜-inch NPT socket head pipe plugs. The plugs must not extend into the galley where they can restrict oil flow when fully tightened. These plugs should also be checked for external protrusion to prevent gear drive interference.

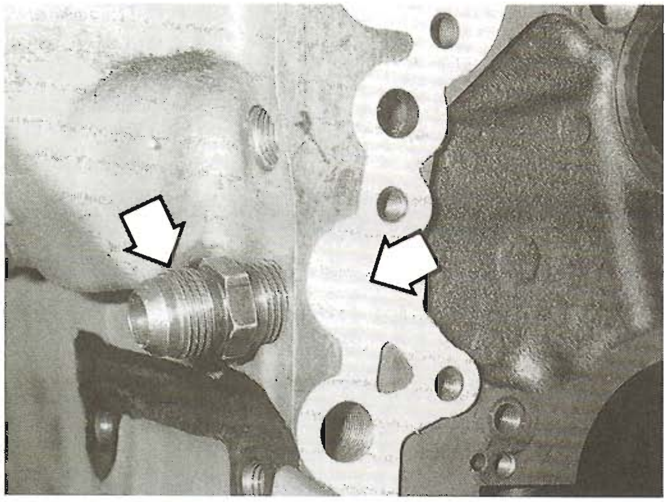
Steps should be taken to reduce the supply of oil to the valvetrain. Lifters on the right side of the engine take oil directly from the main oil galley, so flow reduction around these lifters cannot be con-



By placing the front cover gasket against the front cover, you can trim the gasket to match the oil passage.

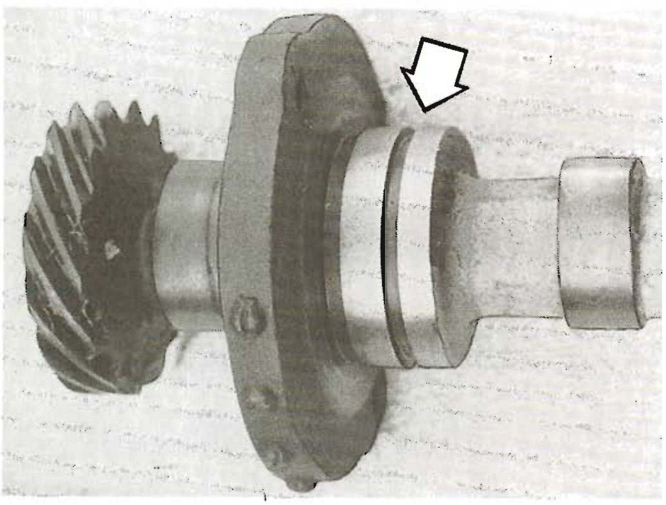


Transfer the gasket to the Stage II block, and drill the appropriate hole to intersect with the AN fitting. You can now plumb an external oiling sytem.

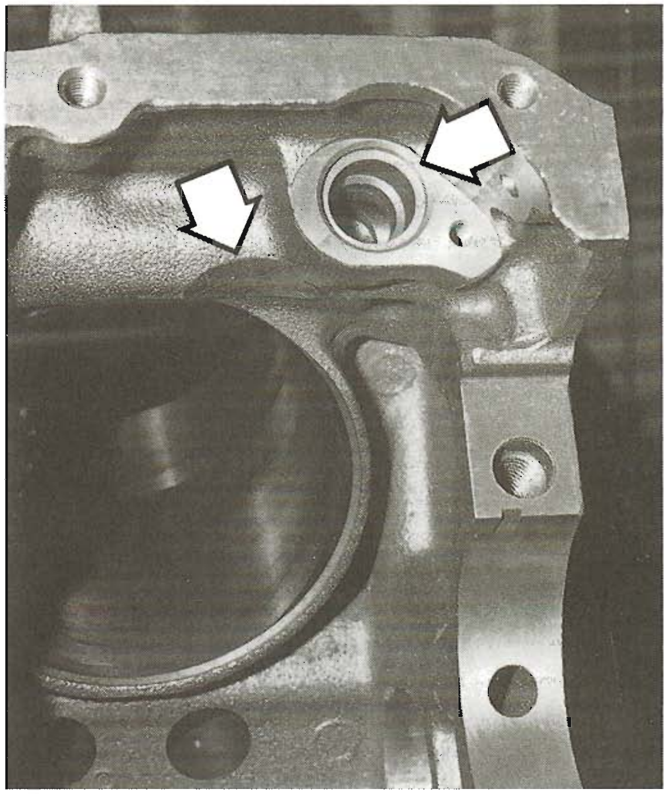


A 3/8-inch x 10 fitting can be routed into the Stage II block as shown to pressure-feed the block with the front cover gasket that does not align with the potential oil feed hole.

On this Stage II block, oil drainback screens have been epoxied in place at each end of the lifter valley to keep debris from reaching the oil pump. Do not use very fine screen here because it restricts oil drainback. A transparent epoxy has also been poured in the valley between the lifter bores to promote oil flow through the screen.



Any time a camshaft is installed in the Buick V6, the groove in the No. 1 cam journal must be in alignment with the groove in the cam bearing.



The oil pickup location on Stage II blocks is at the front of the block, while those of Stage I and production blocks are located at the center of the block adjacent to the pan rail. Clearance for the front crank counterweight may be necessary in the area indicated.

trolled. Oil flow to the left-side lifters and the cam journals can be reduced significantly with good results. The oil for the left lifter galley is supplied from a feed hole on the right side of the No. 1 cam bearing. Oil flows around the groove in the No. 1 cam bearing and out the discharge hole on the left side of the bearing. By installing new cam bearings in the block so the original two holes are closed by misalignment, you can predrill two smaller holes that will supply only the minimum amount of oil required to lube cam bearings and hydraulic lifters. The same procedure can be carried out to reduce flow to the other three cam bearings. All cam bearing feed holes should be 0.085-inch in diameter and all discharge holes to the lifter galley supply should be 0.135-inch.

If a production pump is used in a heavy-duty application, several modifications are recommended. You need to glass-bead-blast both drive and driven gears to improve surface pressure. Drill a 0.060-inch hole in the driven gear midway between two teeth to improve oiling to the shaft. Lastly, shim the pressure relief spring in the oil pump 3/16- to 1/4-inch to provide 80 psi at 2500 rpm at 120 degrees F.

Any time a stock or modified Buick oil pump is used, the distributor gear should be checked frequently for wear.

Production Pump Clearances

Buick V6 oil pump housings and covers are aluminum; the gears are steel. The expansion rates of the two metals are vastly different, so the clearances between the gears and the housing and covers must be minimal. This may take some juggling of parts and flat-plate sanding of the oil pump-housing-to-cover mating surface. Use Plasti-Gage on the ends of the gears to determine the clearance between gears and covers, taking the measurements at two points on each gear. A gear-to-cover clearance of 0.001-inch is the desirable dimension.

External Pumps

The second approach to a heavy-duty oiling system is to replace the production or modified oiling system with an external pump. The many variations of this approach run from a true dry sump with remote-mounted tank scavenge stages in the pump to an external pump that pulls oil from the pan and pressurizes the block via an external line. Stage II blocks have two drilled and tapped bosses that lead to oil passages and may be used to feed pressure to the system. Many engine builders prefer to route a line directly from the pump to the oil pressure sender hole on the right side of the block near the front cover. When plumbing a Buick V6 dry-sump oiling system or simply using an external pump, -10 lines should be used on the scavenge side of the pump while -12 lines should be used on the pressure side.

The tighter a Buick V6 is twisted, the more critical oil pressure becomes. No heavy-duty Buick V6 should be operated with less than 80 psi (hot) oil pressure. Engines turned in excess of 8500 rpm require a minimum of 100 psi oil pressure.

Filtering

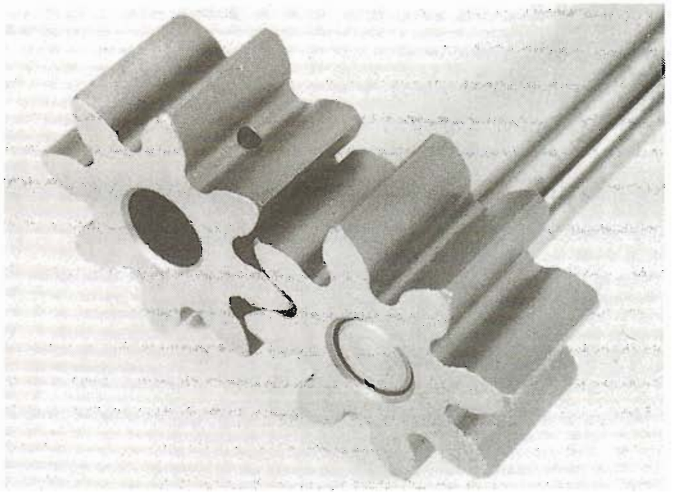
For heavy-duty use, a full-size, dual-filter or single take-apart filter is mandatory. You should always achieve full pressure before firing the engine. Crank the engine with the ignition turned off until pressure is shown on the gauge.

The Fram HP filters have a low pressure drop from one side to the other. They also feature a minimum hydrostatic burst pressure of 500 psi, and all are capable of accepting 10 gallons of flow per minute. The HP2 and HP4 contain no relief valves, which means all oil passes through the filter.

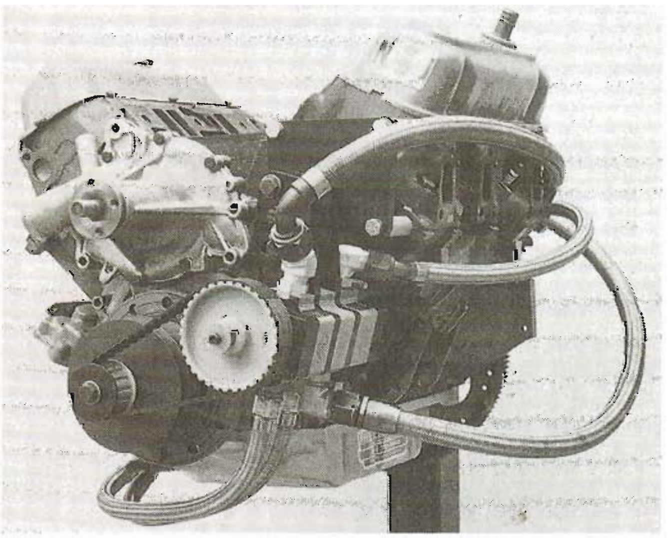
Oil

Multigrade racing oil (20-40 and 20-50) reduces the cold-start problem of rupturing filters, as does preheating the oil. Under no circumstances should a cold Buick V6 heavy-duty engine be "winged," or taken above 2000 rpm, as this can scuff or seize the rod bearings. Oil temperature should be 160 degrees F before any load is placed on the engine.

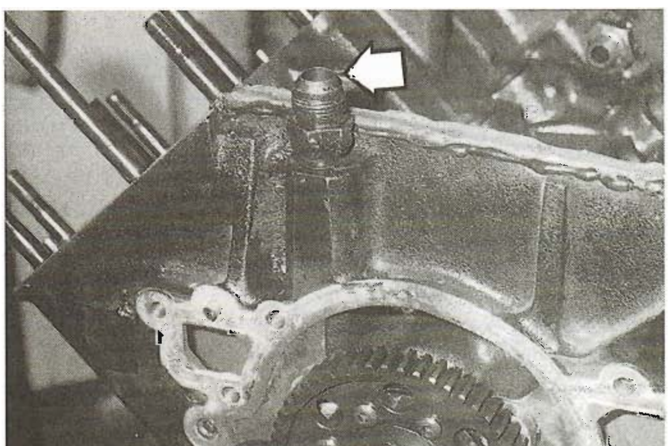
Most engine builders currently shy away from synthetic oils in high-performance engines because of the lack of antiscuff agents in the lubricant. Best results are achieved with a quality hydrocarbon-based racing oil. Never use viscosity-improver oil additives; if a thicker oil is desired, use a thicker



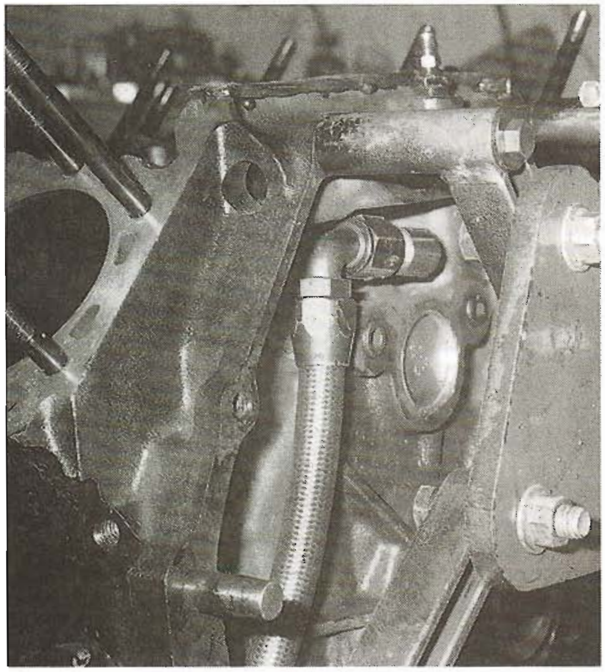
You can gain a slight amount of oil pressure by glass-beading the oil pump gears. The 1/8-inch hole drilled in the idler gear lubricates the shaft it spins on. Mask off the shaft of the driving gear before glass-beading.



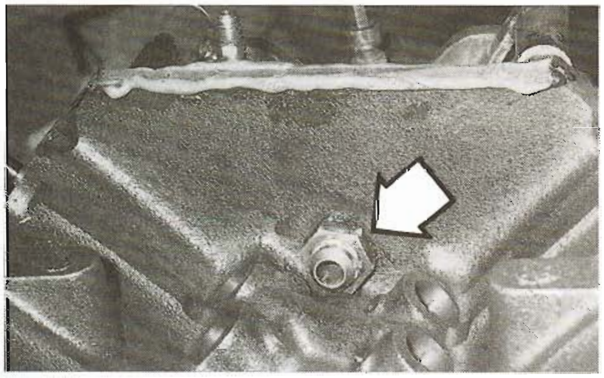
Typical dry-sump pump arrangement with two scavenge lines from the pan, one from the lifter valley. One of the other lines pulls oil from the remote tank, while the remaining line pressurizes the block.



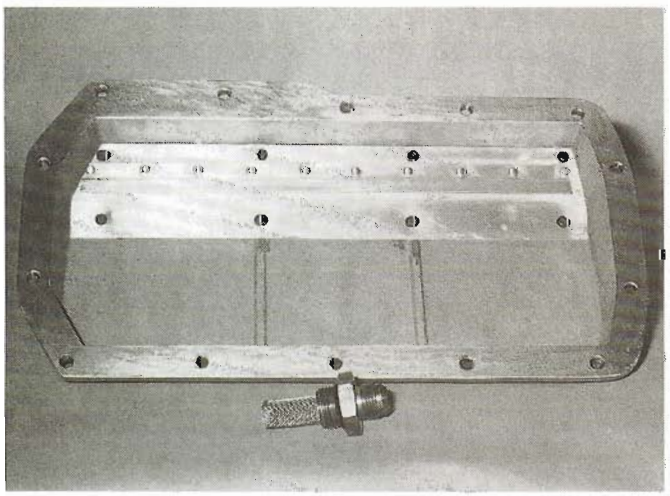
An oil-in fitting at the front of a Stage II cylinder block. Fitting size is 3/8-inch x 10, which is accepted by a stock Stage II boss tower at the front of the block.



This No. 10 line connects the lifter valley outlet to a scavenge stage in the dry-sump system.

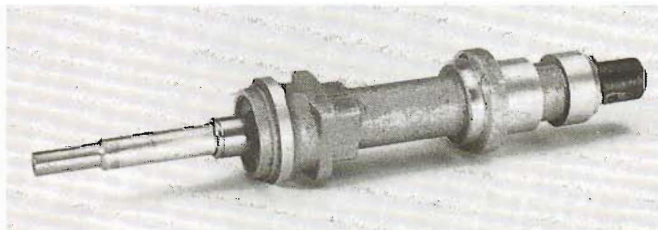


This is one approach to scavenging the lifter valley when a dry-sump oiling system is used. A No. 10 bulkhead fitting is shown.



A typical dry-sump oil pan design with a crankshaft scraper and an outlet screen. As the crankshaft rides high in the block, Buick engines benefit from shallow oil pans.

Aftermarket adapters such as this one can be used to facilitate plumbing to remote filters or coolers. The adapter threads onto the oil pump housing.



You can devise an oil pump priming tool from a worn-out Buick distributor housing and shaft. Some lathe work is necessary if the shaft is to accept a 3/8-inch drill motor.

oil. The only oil additive you should consider using is an antiscuff mixture such as GM Super Engine Oil Supplement (1051858).

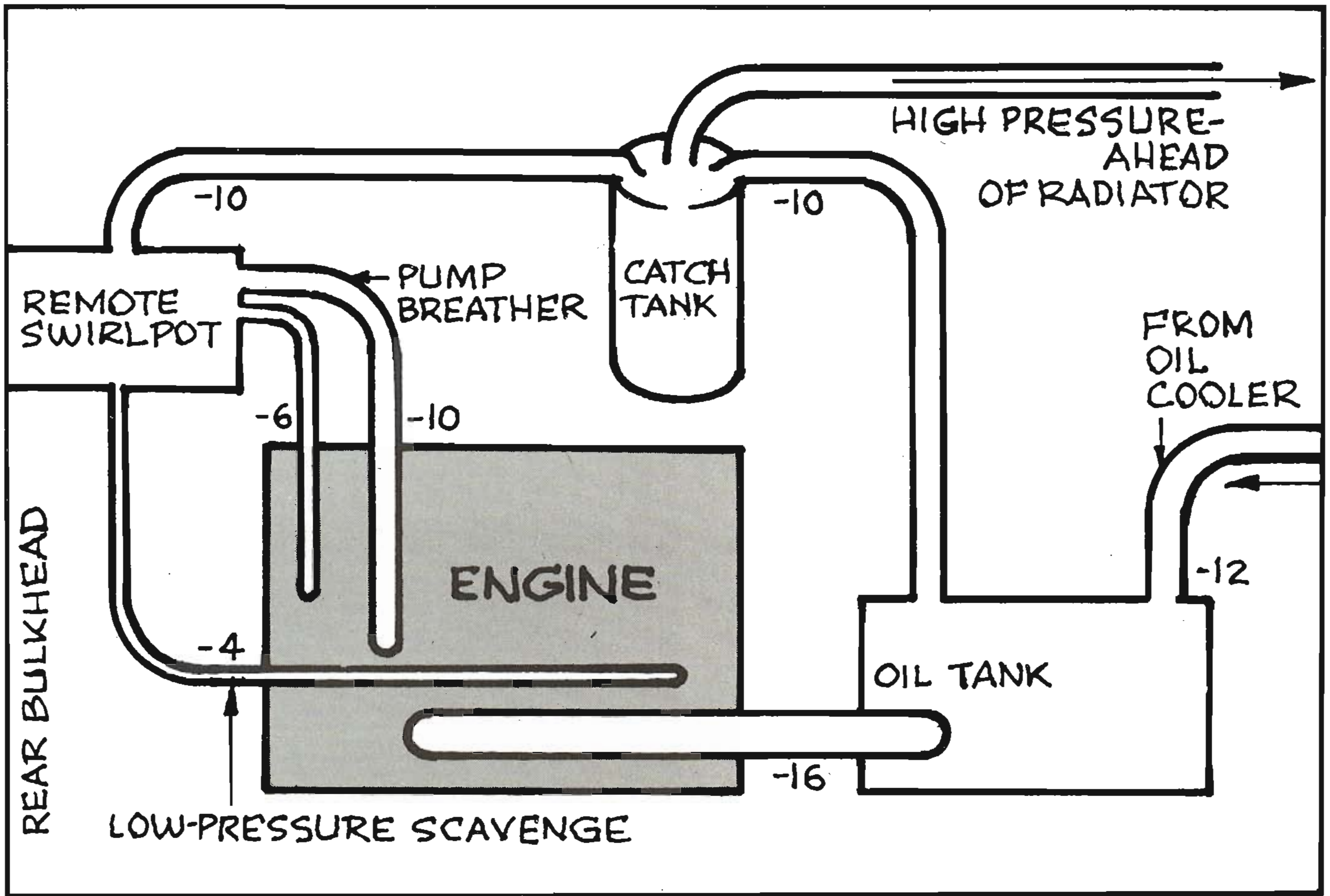
Additives

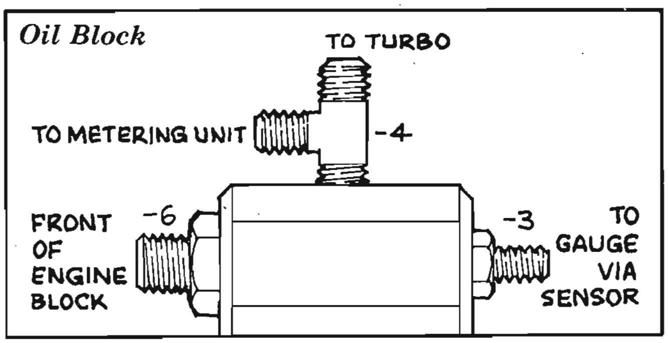
For heavy-duty use, only high-detergent and additive engine oil should be used. The oil must meet MIL Spec MS DG. Do *not* use viscosity-improver oil additives, except antiscuff additives such as Engine Oil Supplement 1052367.

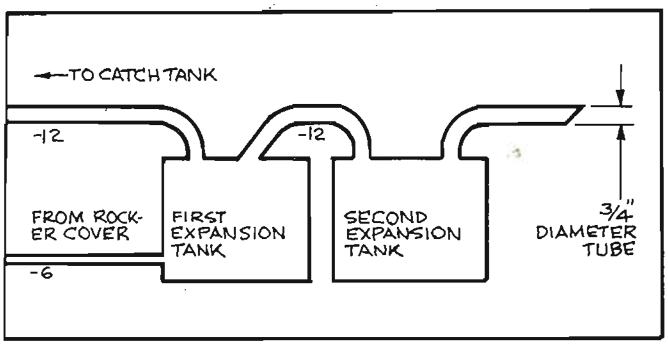
Oil Leaks

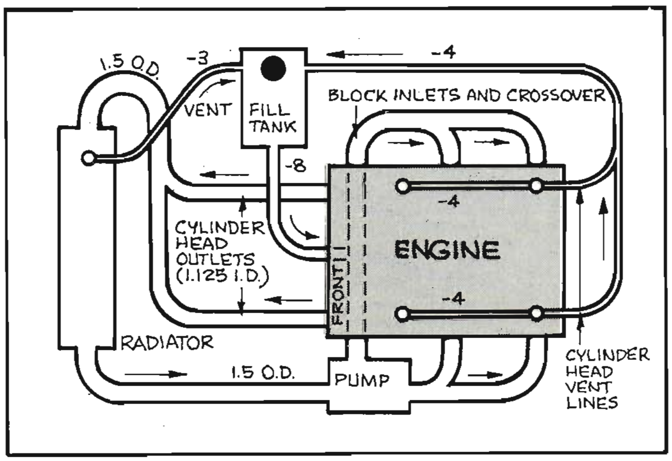
Generally speaking, Buick V6 engines are no more prone to leak oil than any other engine. However, a given percentage of engine builders and racers always have problems in this area, so a few words on the subject are in order. In the first place, oil leaks are usually difficult to locate and are therefore not always repaired when they first appear. The two most common means of determining the location of the leak are the "black light" method and the "baby powder" method. Before attempting either of these two methods, thoroughly clean the suspected leak area with solvent.

Black light kits such as Kent-Moore Tool J-28428-A are available through Kent-Moore Tool Division. Included in the kit are detailed instructions; follow these instructions to the letter. When using the ba-



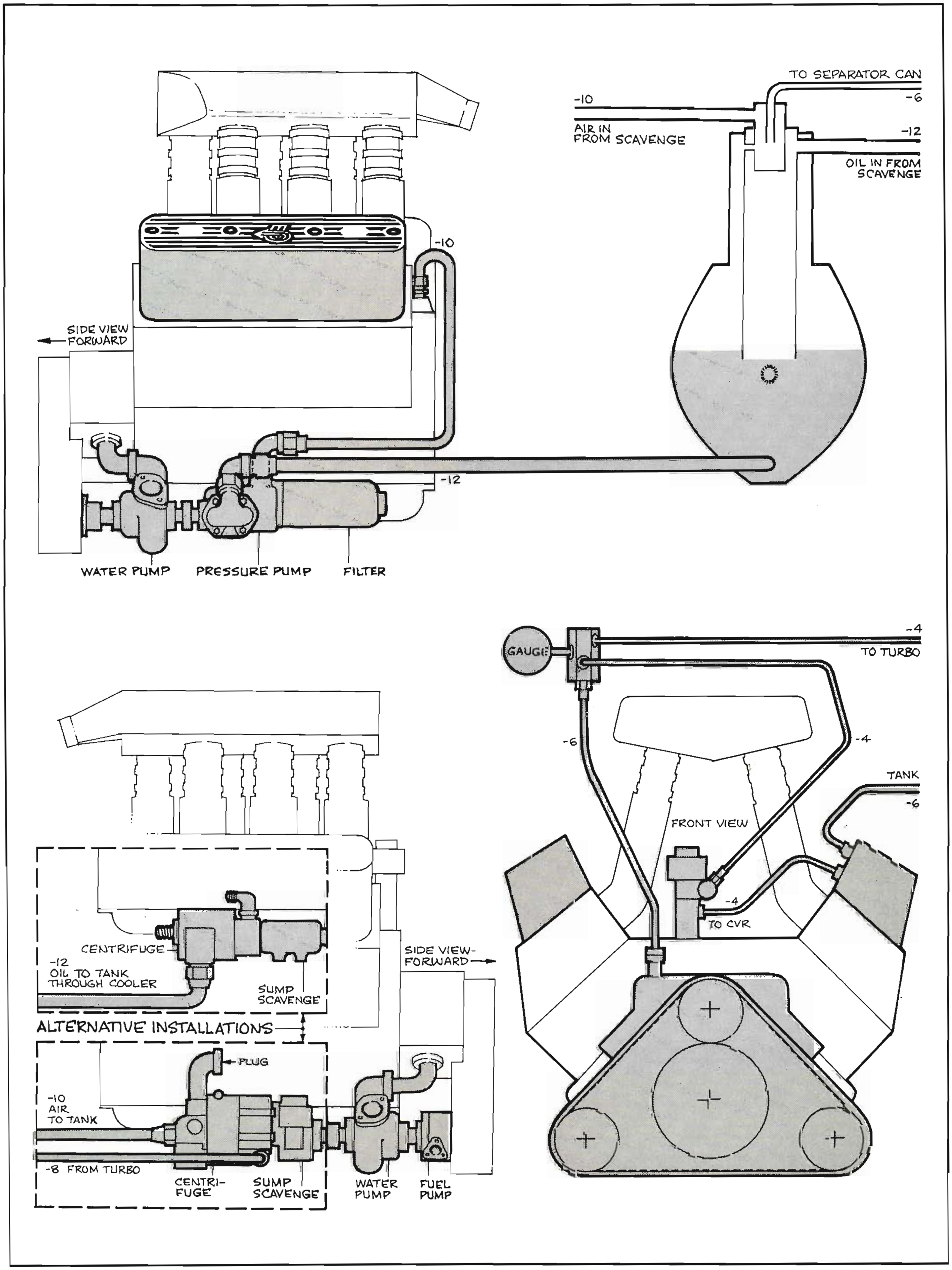






by powder method, be sure the suspected leak area is clean. Sprinkle baby powder around the suspected leak area. Start the engine, and while it is warming up, observe the powdered area for any discoloration or wet spots.

Stamped-steel and aluminum rocker covers always yield more than their fair share of leaks when installed by the uninitiated. One of the most common mistakes is to overtighten the rocker cover fasteners. The factory specification on this is only 7 ft./lbs. torque. If you are racing, continue to use this amount of torque, but install the fasteners with Loctite. The second most common reason stamped rocker covers leak is that the fasteners that have been overtightened in the past have dimpled the flange area of the cover. Lay a straightedge on the underside of the flange near the fasten-


TO SEPARATOR CAN
-10
-6
AIR IN
FROM SCAVENGE
-12
OIL IN FROM
SCAVENGE
-10
SIDE VIEW
FORWARD
-12
WATER PUMP
PRESSURE PUMP
FILTER
GAUGE
-4
TO TURBO
-6
-4
TANK
-6
FRONT VIEW
-4
TO CVR
CENTRIFUGE
-12
OIL TO TANK
THROUGH COOLER
SUMP
SCAVENGE
SIDE VIEW-
FORWARD
ALTERNATIVE INSTALLATIONS
PLUG
-10
AIR
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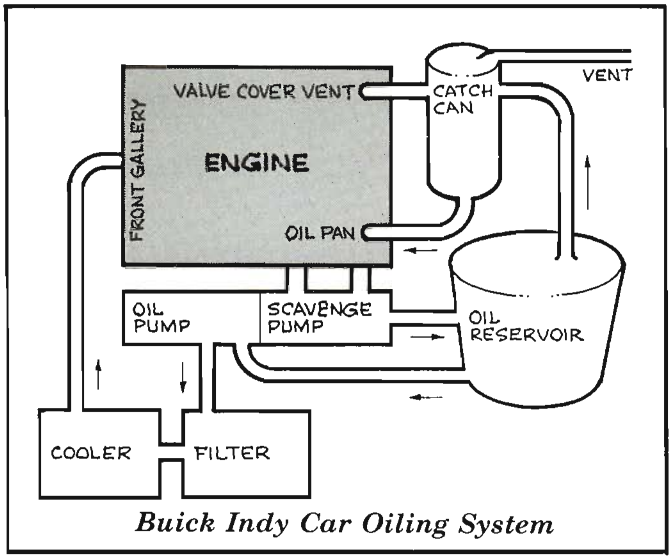
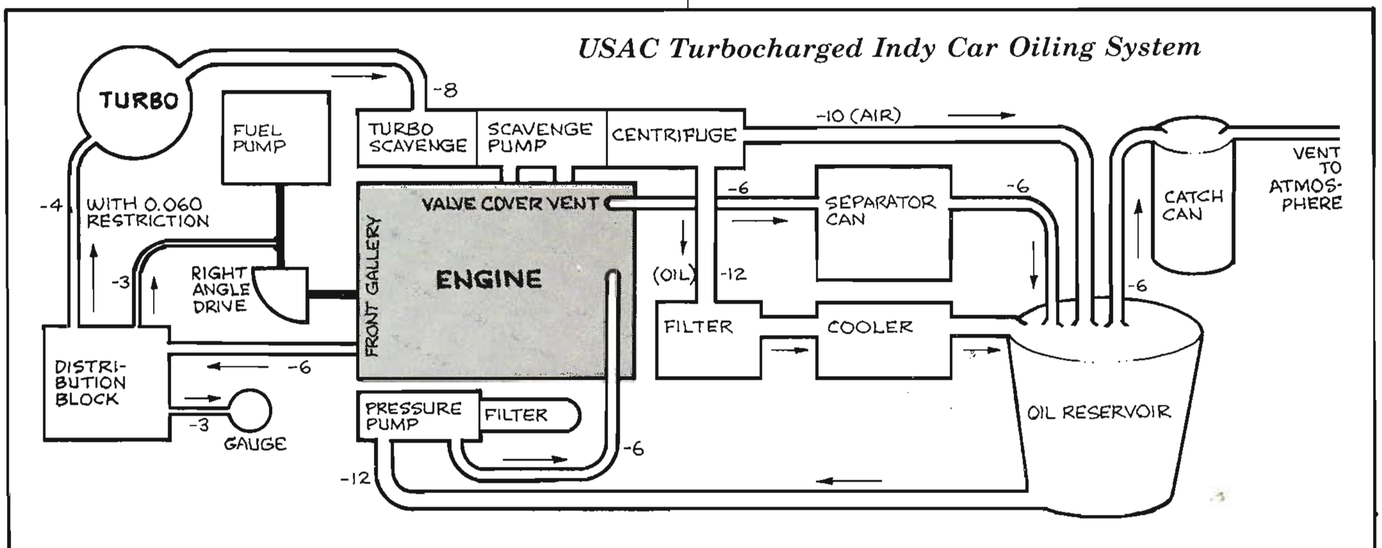


Recommended plumbing procedures for Buick heavy-duty applications.

er hole. If it is dimpled downward, cure the problem with a small hammer, and dimple the flange upward slightly in the area of the hole. Using acetone, MEK, or some other strong solvent, clean everything off the rocker arm cover and the cylinder head mating surface. It is imperative that all mating surfaces be dry and free of oil and any foreign material.

Every engine builder has a favorite method of preventing leaks in this area; here are a couple that work. Stick the gasket to the rocker with a 3/16-inch bead of R.T.V. sealer and coat the head mating surface side of the gasket with wheel bearing grease. This allows the rocker cover and gasket assembly to be removed from the engine many times before the gasket needs to be replaced. For something like a basically stock street rod engine where the rocker cover may not be removed for a year or more, the gasket can be stuck to both the rocker cover and the head with R.T.V. or Yamabond or a similar product.



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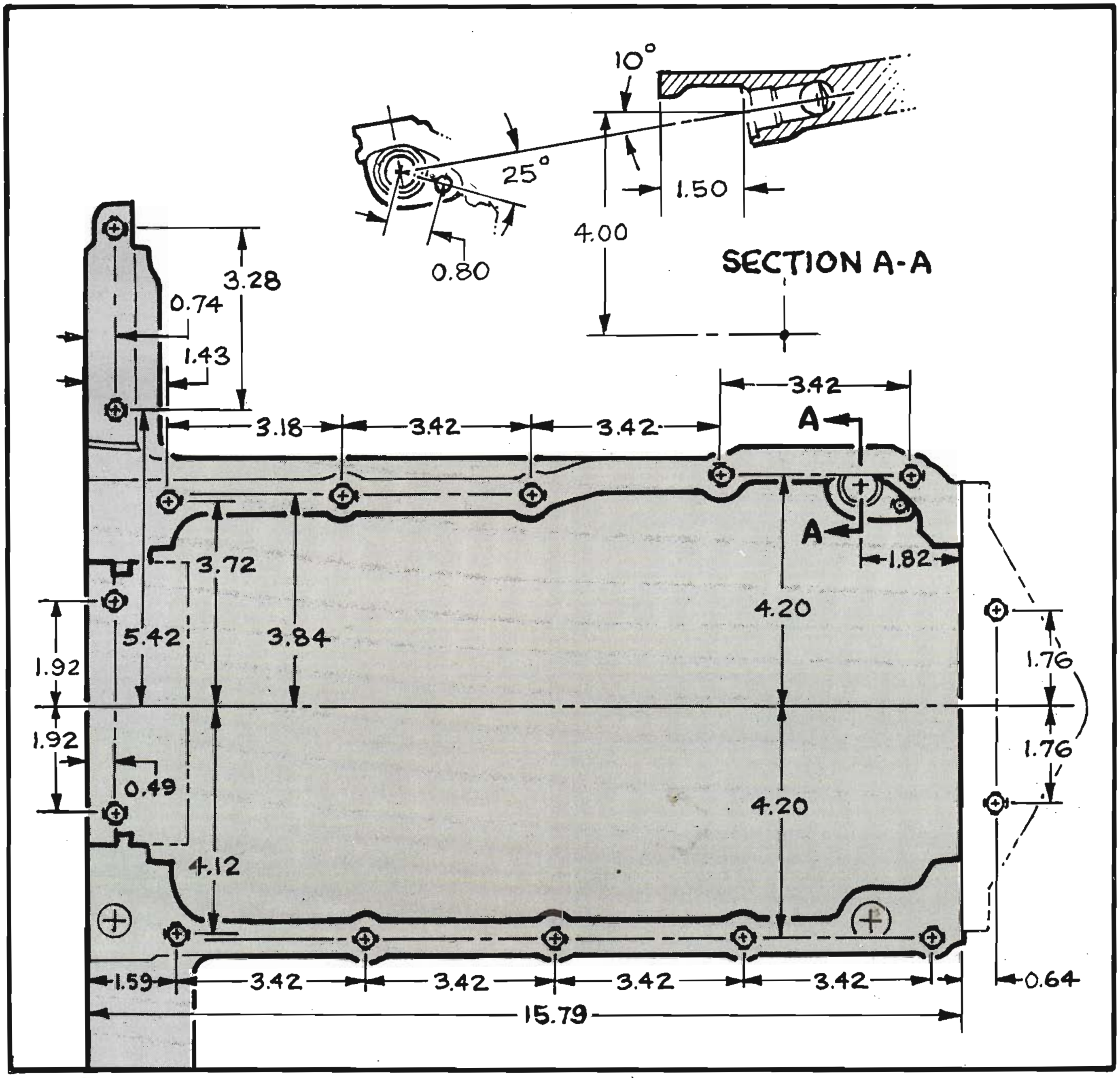


This drawing will be of use to people fabricating or manufacturing heavy-duty oil pans for a Buick V6.

NOTES

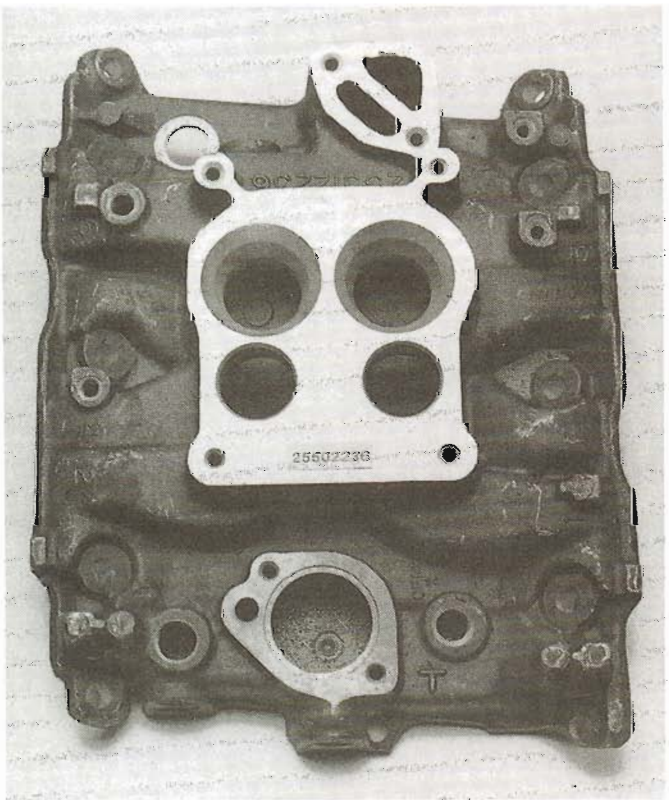
NOTES

Intake System

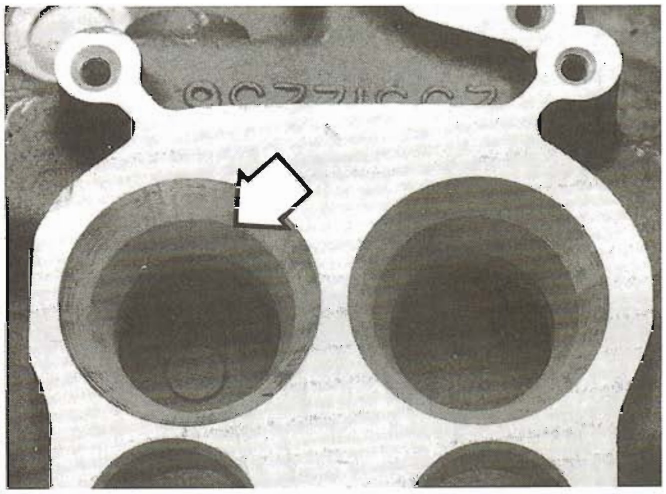
A wide variety of intake system hardware is available from both GM and the aftermarket. Production 2- and 4- barrel manifolds fit any displacement of Buick V6 fitted with 1979 or newer production or Stage I cylinder heads. The same is true of the 1985 normally aspirated multipoint fuel-injection manifold that comes on some front-wheel-drive engines. This situation also exists with all carbureted and fuel-injected turbocharged intake manifolds. All of the above intake systems should be considered for competition only when the rules do not allow the use of Stage II cylinder heads.

Currently, Buick offers a single 4-barrel, open-plenum manifold (25500029) that can be fitted to Stage II heads. It is machined to accept Holley carburetors. Most engine builders prefer to "tune" intake manifolds to their specific uses by matching manifold ports to those in the cylinder head and by radiusing runner dividers in the plenum.

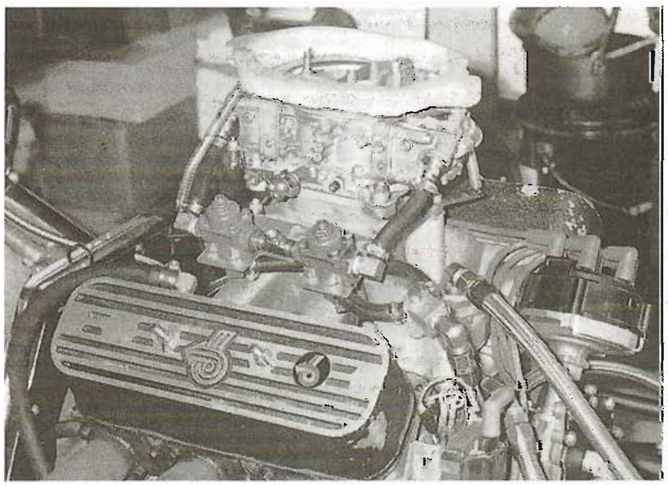
Aftermarket suppliers offer mechanical and electronic fuel-injection hardware for Stage II cylinder heads. Several aftermarket firms also offer large-volume manifolds, which are beneficial in sustained high-rpm operation.



The production 4.1L 4-barrel manifold is an excellent starting point for relatively low-rpm, high-torque applications in which smoothness and drivability are important.



You can gain mid- and upper-range performance by reworking the production 4.1L manifold. The work involves raising the roof and blending it into the individual runners. The roof should be raised at the bottom of the first machine cut in the throat. Eliminate all sharp edges in the primary and secondary ports.

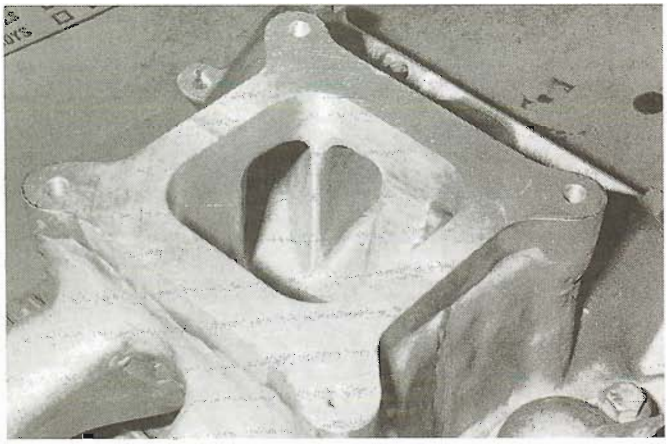


The Stage II manifold (25500029) in action on a development dyno. This piece has an aluminum 4-barrel design with a square-bore carburetor mounting flange and no heat crossover passage. Note the use of a pressure regulator for each of the float bowls. Foam at the top of the carburetor seals it to a plenum.

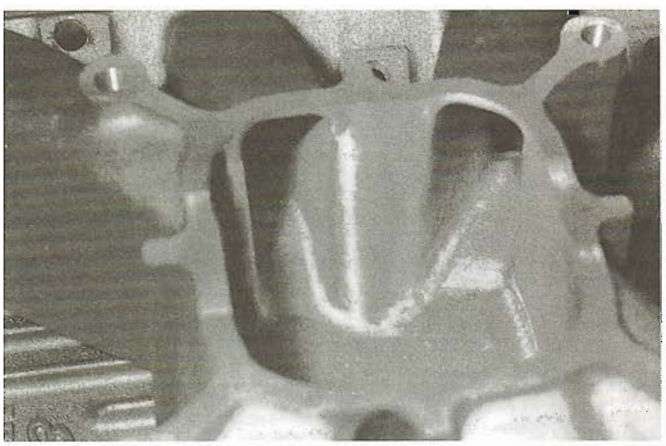
Stock Hardware

Production engines built during the last several years are equipped with 2-barrel carburetors (3.8L engines) and 4-barrel carburetors (4.1L engines) and several versions of electronic fuel injection (normally aspirated and turbocharged). None of this hardware bolts onto Stage II cylinder heads. When production or Stage I heads are required for competition, a 4.1L production manifold (25512236) should be considered. This is an aluminum 4-barrel design

For experimental work, this manifold was welded onto the exterior of the plenum to facilitate additional interior grinding.



Another manifold that was highly modified with epoxy to allow additional grinding.

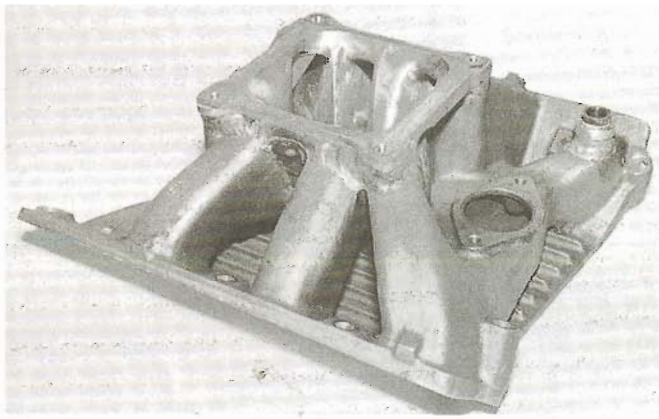


In a heavy-duty application, it is important that fuel distribution be equal among all cylinders. When four throttle openings supply six cylinders, equal distribution can be difficult to achieve.

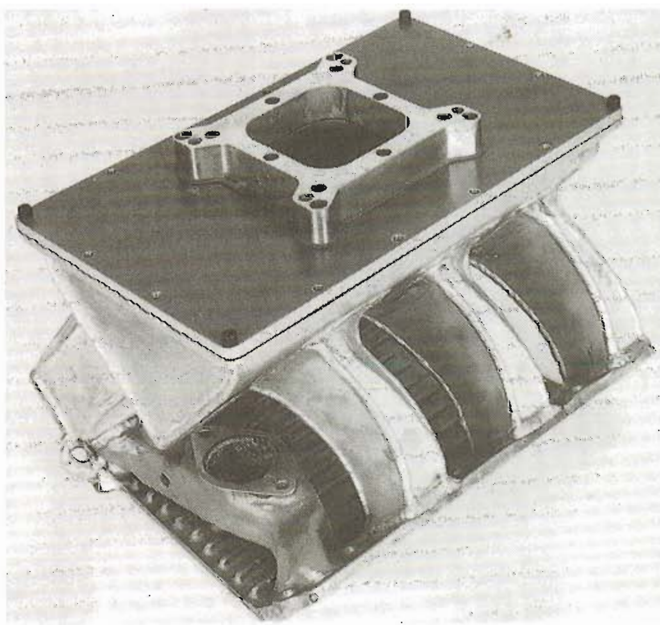
with a spread-bore (Quadrajet) mounting flange for use with Stage I heads or any production head built since 1979.

Aftermarket and Stage II Hardware

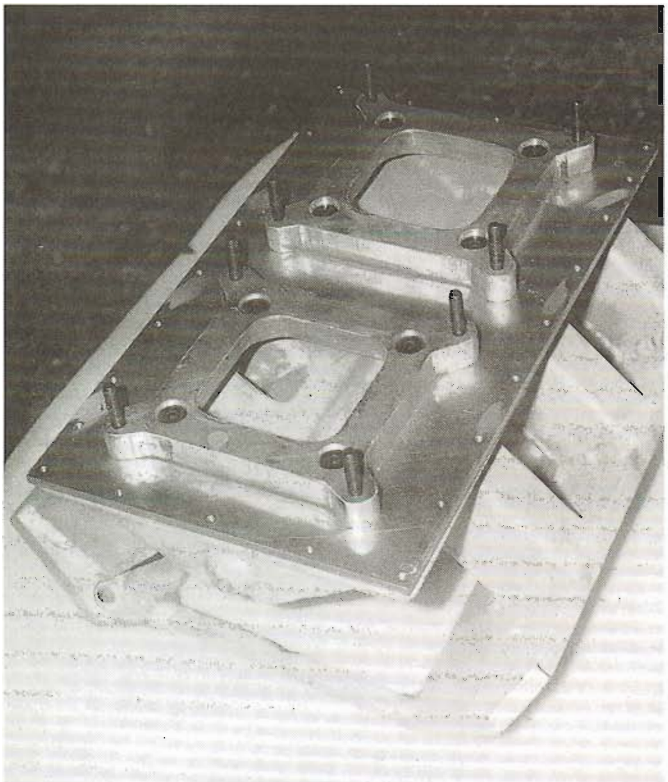
Manifolds that bolt to production or Stage I cylinder heads do not bolt to a Stage II cylinder head. Buick offers a single 4-barrel manifold (25500029) that can be fitted to an engine equipped with Stage II heads. It has been used successfully in drag racing, road racing and oval track racing. This is an aluminum 4-barrel design with a square bore carburetor mounting flange and no heat crossover passage.

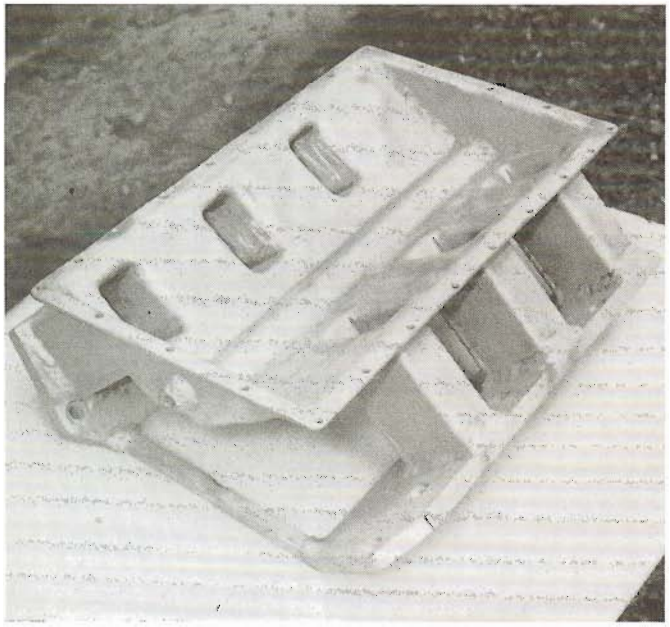


Two short runners and one longer runner per side point up the problem in getting equal fuel distribution.



The prototype of a tunnel-type manifold that was going into production as this book went to press. It is configured for Stage II cylinder heads, and with a removable top, multiple carburetion is obviously a possibility.

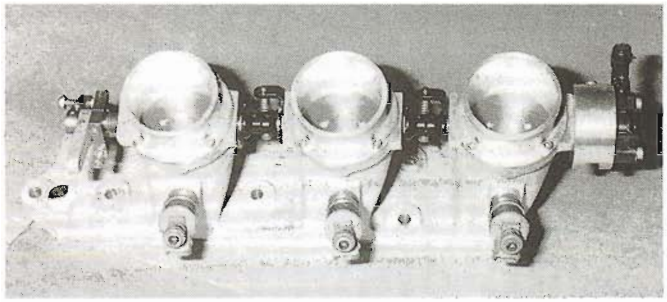


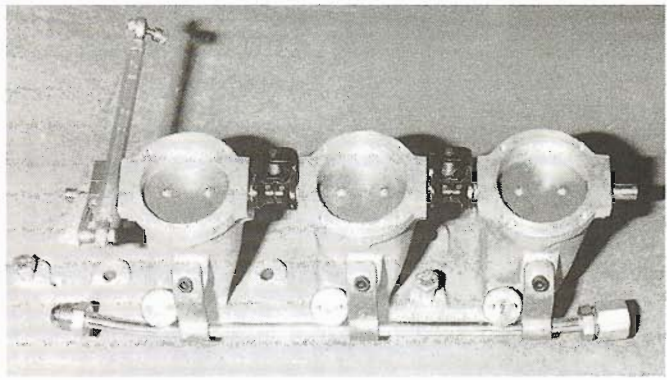


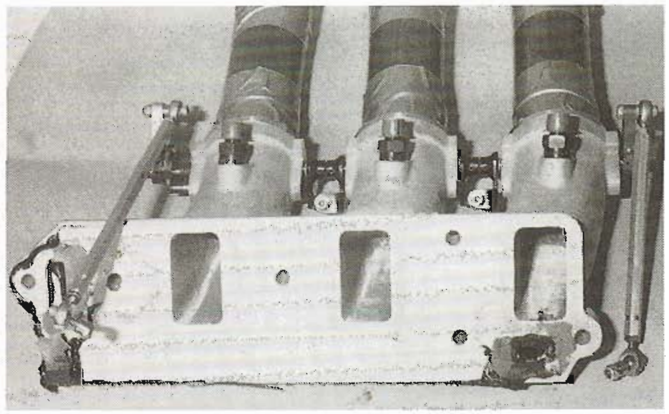
This fabricated manifold is for experimental use in quarter-mile performance.

Fuel Injection

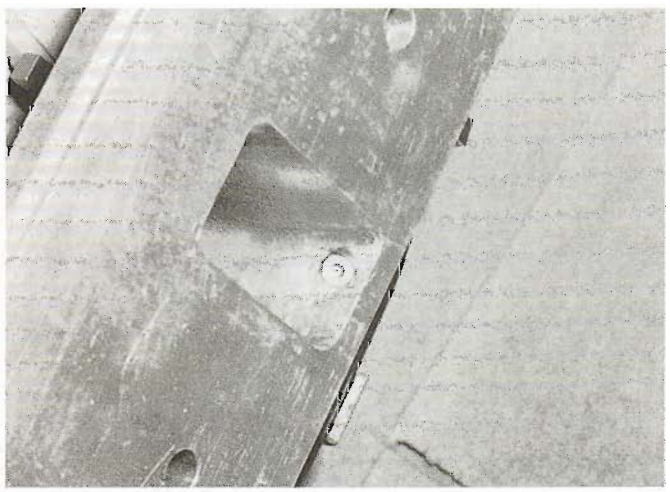
Both mechanical and electronically controlled fuel-injection assemblies are available for Stage II cylinder heads from aftermarket sources. These can be calibrated for either normally aspirated or turbocharged applications. When running any aftermarket fuel injection system for the first time, you should follow the supplier's plumbing and tuning instructions to the letter.



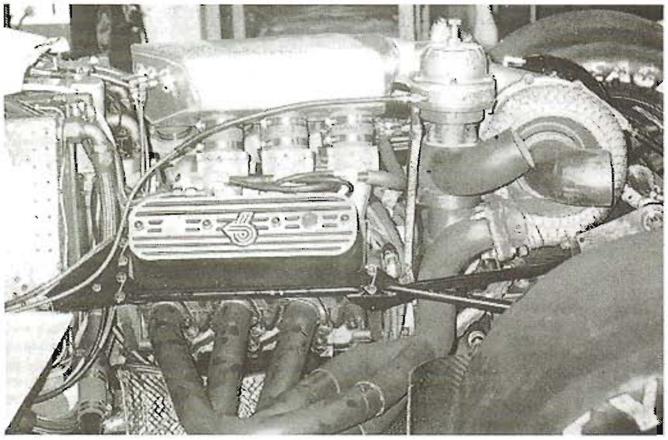


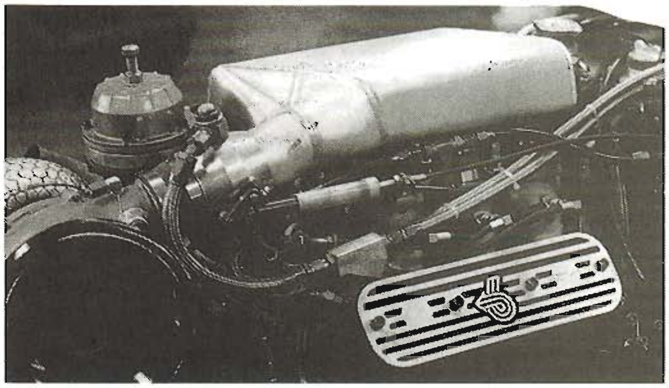


Although these manifold castings are the same, each is fitted with a different type of injection. Note the difference in the placement of the nozzles in the individual throttle bores. Three different nozzles are shown here.



You can fabricate a bracket to mount a production throttle cable bracket to a Stage II intake manifold.





Turbocharged 209-cubic-inch engines making more than 800 horsepower have complex and precise intake systems.

NOTES

Ignition System

A reworked production High Energy Ignition (HEI) and wires work surprisingly well in some heavy-duty applications where rpm are 7000 or less. However, the mechanical advance curve must be modified significantly to compensate for high compression ratios. The maximum total advance (initial plus mechanical) should be 34–35 degrees. The best combination with 13:1 compression ratio seems to be 15 degrees initial advance with 20 degrees mechanical advance starting at 2000 rpm and all advance in at 5000 rpm. This curve requires a heavy set of springs and significant metal removed from the advance weights. The vacuum advance diaphragm can be left on the distributor to locate the advance plate, but the vacum mechanism should not be connected to a vacuum source.

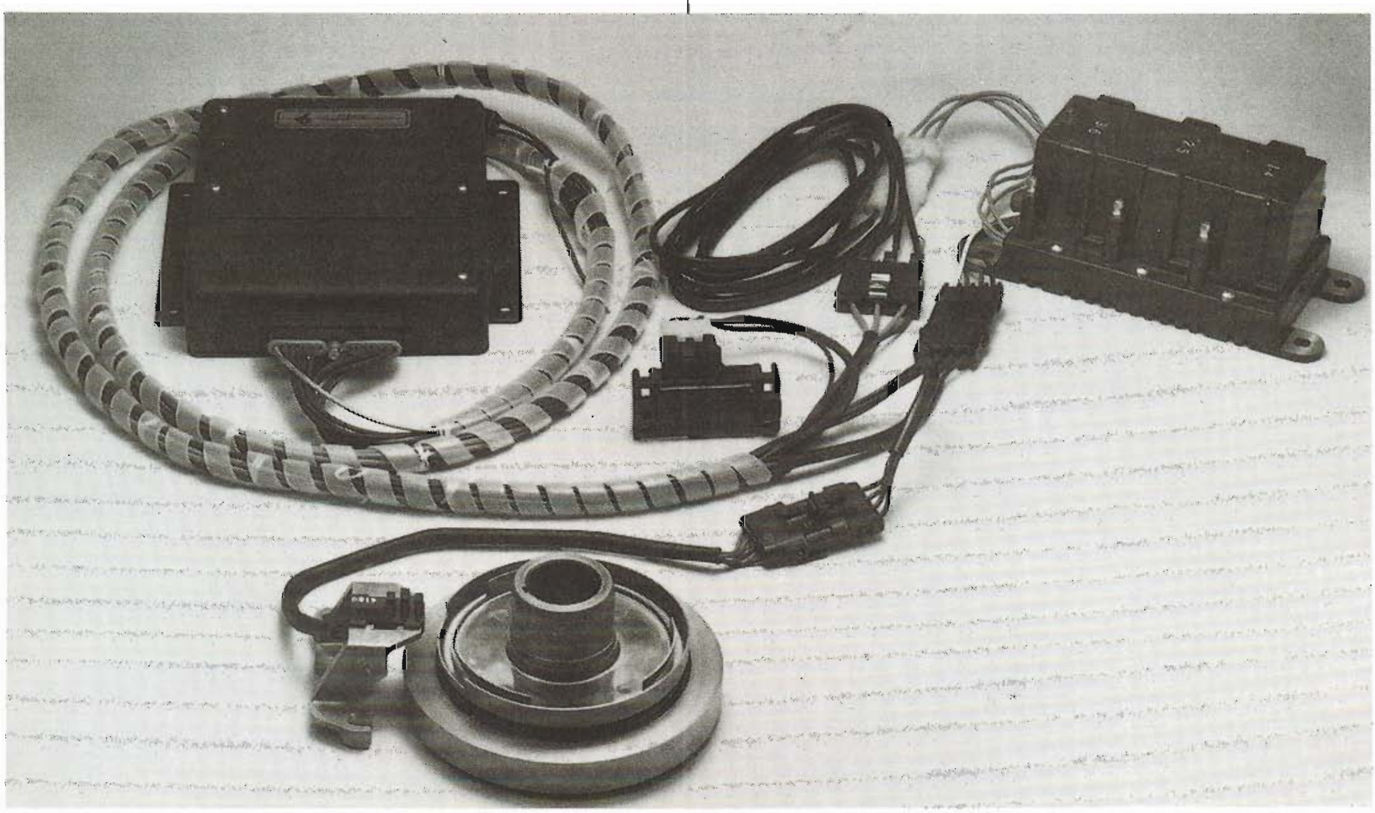
Buick Power Source Ignition

The Buick Power Source Computer Controlled "Stand Alone" ignition system eliminates the distributor for improved timing accuracy. Additionally, 40,000 volts are available beyond 12,000 rpm, and the system has a built-in programmable rev-limiter and manifold-pressure timing correction. At the present, the system is sensitive to the type of spark plug wires used—currently, helical-wound radio-suppression wires are recommended.

The Buick Power Source Ignition System is an inductive system that exhibits full spark energy through 10,000 rpm and continues to operate to 13,500 rpm. The completely electronic system has no moving parts to wear out, is self-contained, and requires no distributor. The timing advance is programmable, using five rotary switches. Two switches set two rpm breakpoints and two others set the ultimate advance at those breakpoints. A fifth switch sets the maximum vacuum advance available. The unit incorporates an rpm-limiter that takes effect at 100 rpm above the RPM HI set point. A Hall-effect sensor under the dampener pulley senses a rotating ring affixed to the dampener pulley. The system consists of an electronics module; a coil module; a crankshaft position sensor; ballast wires; a wiring harness; and an optional manifold absolute pressure (MAP) sensor.

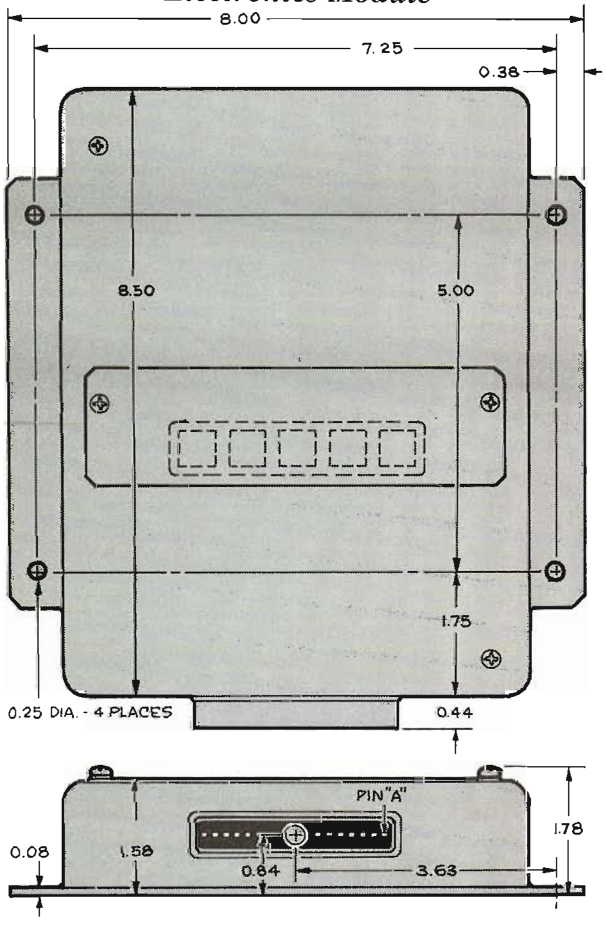
The electronics module contains the control circuitry for the system. The programming switches are located under the access hatch on the top cover of the unit. To run properly, the electronic module must be located in a clean, dry environment (such as a passenger compartment or cockpit) in which the ambient temperature is between 40 and +185 degrees F. The dimensions of the electronics module and mounting detail are pictured here.

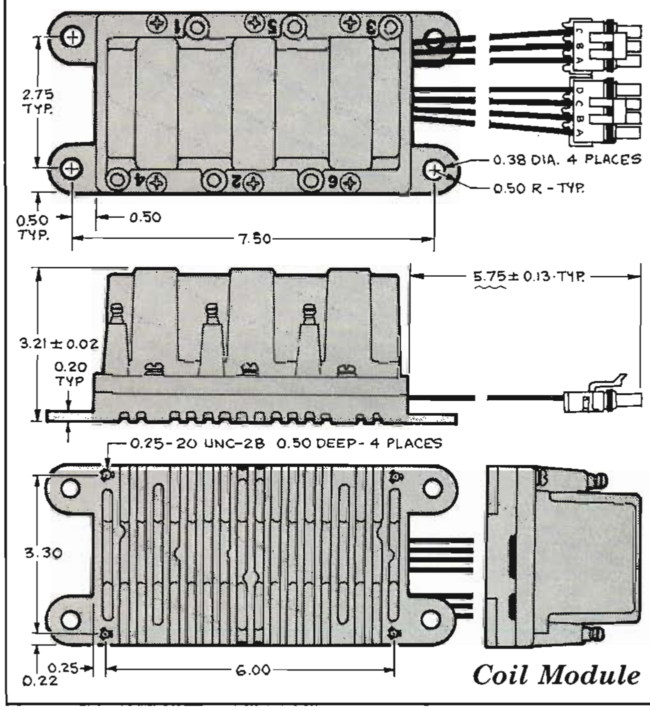
The coil module is a high-energy, extended-range



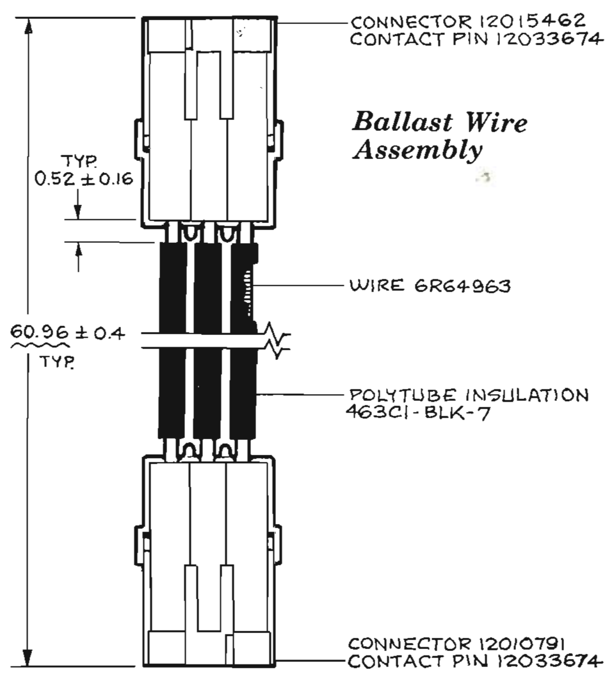
Buick heavy-duty parts are designed and manufactured for off-highway use only.

Electronics Module





Coil Module



Ballast Wire Assembly

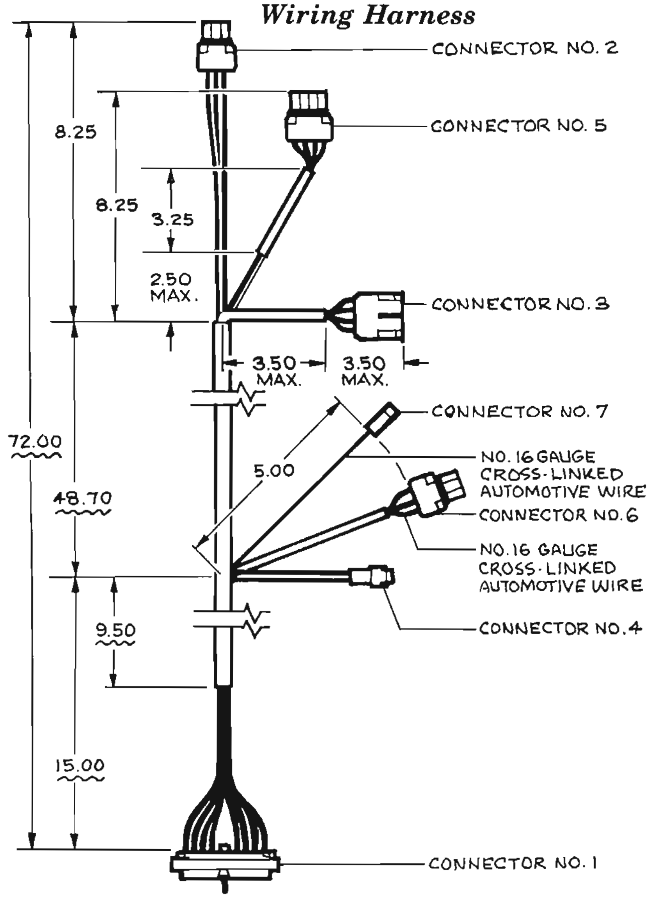
unit that contains three ignition coils providing spark for Buick V6 engines. The drive signals are delivered by the electronic module via the wiring harness. This module also provides ground for the entire system. The coil module is fairly rugged and, since the operating temperature range of this module is −40 to +255 degrees F, it can be mounted in the engine compartment. The unit has a standard SAE high-voltage terminal design for use with most high-voltage wires. The dimensions and mounting detail for this unit are illustrated here.

The ballast wire assembly (also pictured) provides battery voltage to each invividual coil in the coil module assembly. The wires in the ballast assembly limit the current available to each coil, thereby controlling the operating temperature of the coil assembly. The resistance of each wire in the assembly should be about 1.0 ohm.

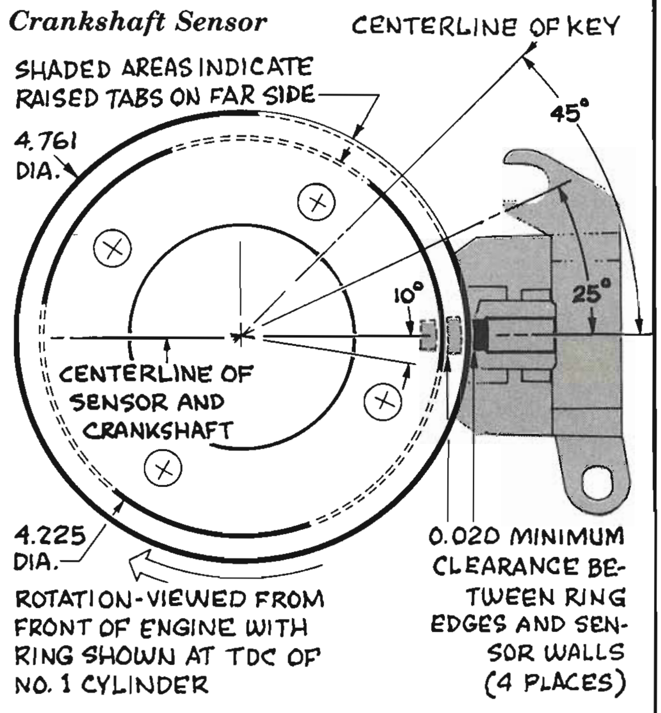
The MAP sensor provides the electronic module with an electrical signal that is proportional to the manifold absolute pressure. This results in a vacuum of the other switches. The MAP sensor is completely optional; the system provides an rpm-based timing curve set up by the first four programming switches even if the MAP sensor is not present.

The wiring harness is approximately 6 feet long and contains all the connections necessary to wire a complete Buick Power Source system. It also has all the connectors and wires necessary to implement optional features such as the MAP sensor.

Wiring Harness



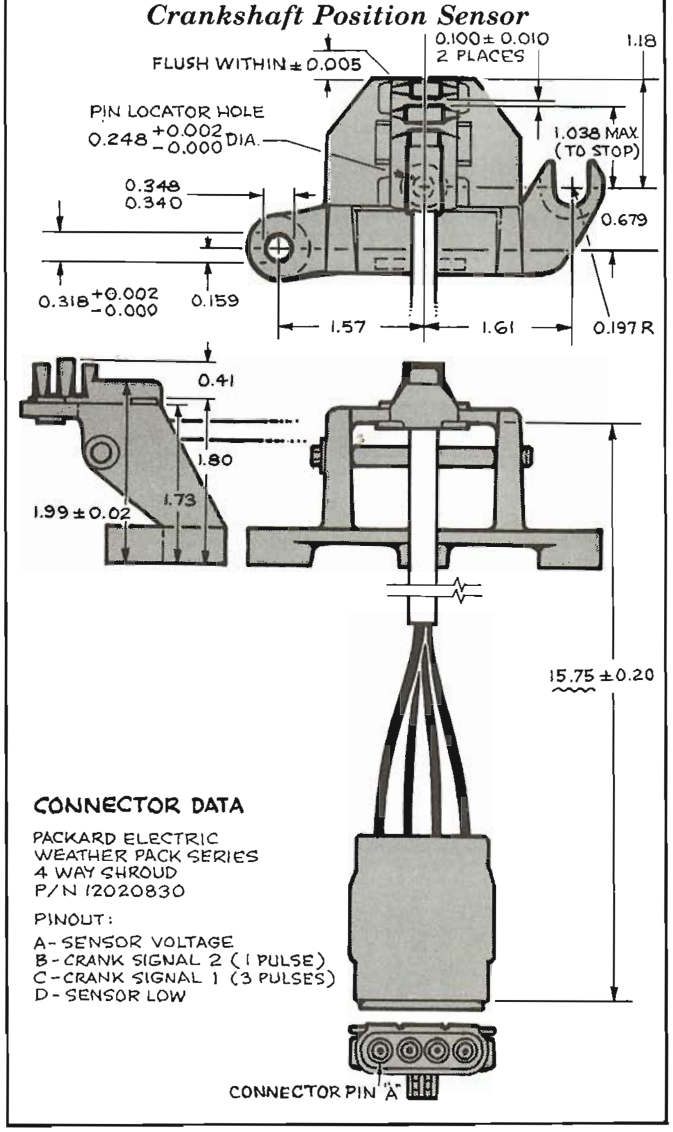
Crankshaft Sensor



System Installation—The hardware required to mount the various system components is as follows:

1. Electronic module—This may be mounted using No. 10 screws through the mounting ears provided. Ideally, the electronic module should be mounted in the passenger compartment.
2. Crankshaft Sensor—The crankshaft sensor should be mounted to the front cover of the engine behind the dampener pulley using 5⁄16-inch 18 screws. Alignment is accomplished by loosening the clamp bolt in the mounting bracket and moving the head radially until the sensor slots are centered around the interrupter ring vanes. A minimum clearance of 0.020-inch is required between the edges of the interrupter vanes and the sides of the sensor slots. Once alignment is complete, tighten the screw and bond with a thread fixative. This completes the sensor alignment. When the engine crankshaft is set to 70 degrees BTDC No. 1, the inner interrupter ring should be transitioning from a vane to a slot at the center of the sensor head. This slot must be the one preceding the single slot on the outer ring of the interrupter when the crank-

Crankshaft Position Sensor



shaft is turned in the normal direction of rotation. This provides 10 degrees of base timing (see the accompanying illustration).

3. Ballast Wire Assemblies—When mounting the ballast wire assemblies, take care to bundle the wires together loosely. Under no circumstances should the wires be enclosed in a sleeve. This would unnecessarily restrict the spark energy during high-rpm conditions. Mount the wires in such a way as to limit the tension applied—a moderate amount of slack reduces strain on the connections.

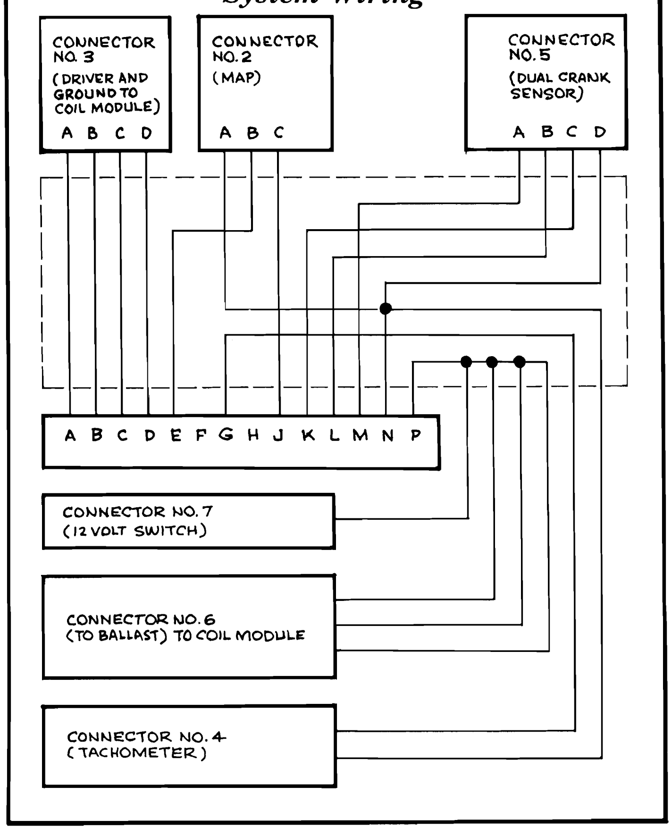
4. Coil Assembly—Mount the coil assembly on a cool surface if possible; the surface should be kept below +255 degrees F. The coil module may be mounted with ¼-inch 20 bolts from underneath or with 9mm bolts through the external mounting feet. The mounting surface must provide a low-resistance ground back to the system battery. Mounting the module to the engine block is acceptable providing the surface is clear of contaminants such as paint and oils and that it is within the +255 degrees F constraint. If a good ground through the engine block is difficult to achieve, a ¾- to 1-inch ground braid strap back to the battery is acceptable. To minimize feedback interference from the coil module to the electronic module, mount these units at least 4 feet apart. Also, keep the ballast wires away from the rest of the wiring harness, and use radio-suppression-type ignition wires with at least 100 ohms-per-foot resistance. Wires with solid conductors are specifically not recommended since they may cause erratic operation under some conditions; avoid this type of conductor.

Programming Switch Operation—The programming switches are used to set up the rpm breakpoints, the maximum advance available at those breakpoints, and the maximum vacuum advance available. The switches are located under an access hatch on the top cover of the electronic module. Removing the two screws securing this hatch allows the operator to change the switches.

The RPM LO switch reads in hundredths of rpm. The range of the switch is 1000–4000 rpm in increments of 200 rpm. This switch sets the effective rpm of the first breakpoint.

The RPM HI switch reads in thousandths of rpm. The range of the switch is 6000–13,500 rpm in increments of 500 rpm. This switch sets the effective rpm of the second breakpoint (see the accompanying illustration). In addition, this switch sets the effective point of the rpm limiter. The limit point begins 100 rpm above the rpm set on the RPM HI switch. When the rpm reach the limit point, the system drops one pair of cylinders from the fire sequence. A different pair of cylinders is missing during each revolution. When the rpm reach 150 above

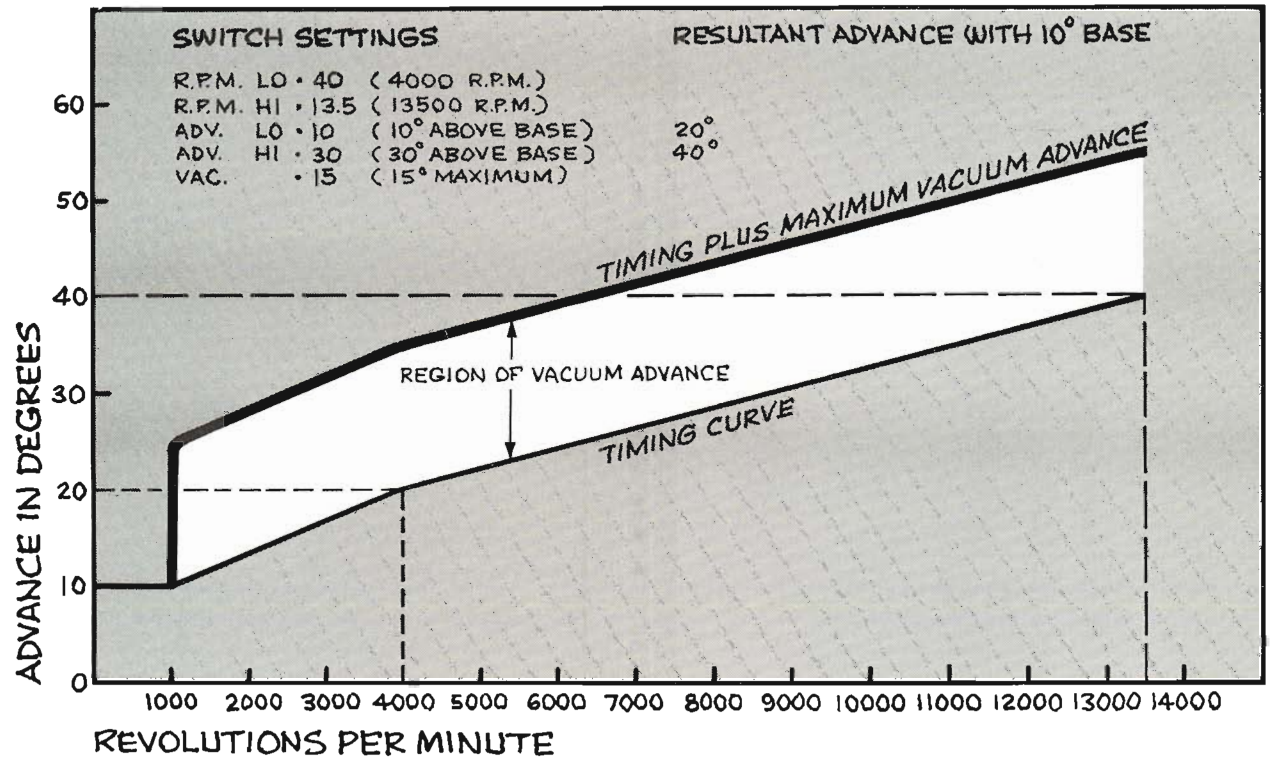
System Wiring



Connectors and Functions

Connector Number	Pin	Function
1	A	1-4 Coil Module Driver
	B	2-5 Coil Module Driver
	C	3-6 Coil Module Driver
	D	Ground
	E	MAP Sensor Input Signal
	F	Buffered Crank Output
	G	Tachometer Output
	H	Buffered Cam Output
	J	MAP Sensor Voltage
	K	Crank Sensor Signal Input
	L	Cam Sensor (or sync) Input
	M	Sensor Power Output
	N	Sensor Ground
	P	+12 VDC Ignition Power Input
2	A	Ground
	B	MAP Sensor Output
	C	MAP Sensor Ref Voltage Input
3	A	1-4 Coil Module Driver
	B	2-5 Coil Module Driver
	C	3-6 Coil Module Driver
	D	Ground
4	A	Tachometer Output
	B	Ground
5	A	Sensor Power Input
	B	Synchronizer Signal Output
	C	Crank Sensor Signal Output
	D	Sensor Ground
6	A	Ballast Wire Output
	B	Ballast Wire Output
	C	Ballast Wire Output
7	A	Switched 12V Input

Sample Timing Curve



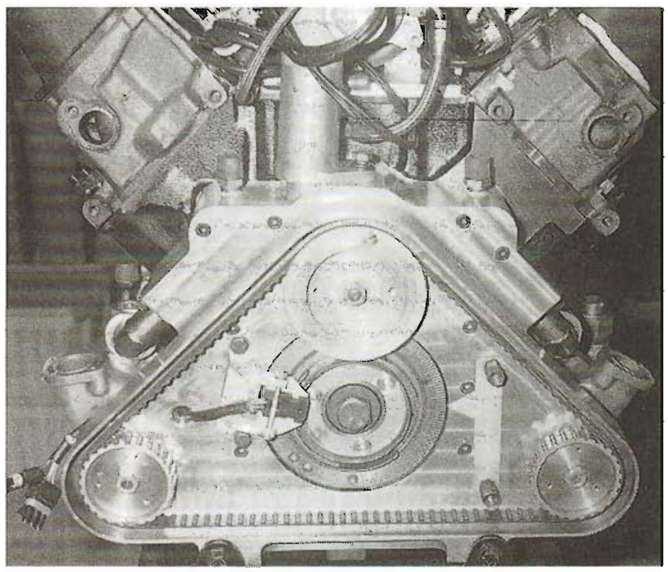
the RPM HI set point, a second pair is dropped from the fire sequence. Again, a different pair of cylinders is missing during each revolution to prevent any one pair from fouling.

The ADV LO switch reads in degrees above base advance. The range of this switch is 5–20 degrees in increments of 1 degree. The purpose of this switch is to set the spark advance at the point selected by the RPM LO switch. The ignition system then interpolates from an advance of base timing at 1000 rpm to an advance set by ADV LO (plus base timing) at an rpm set by RPM LO.

The ADV HI switch serves a similar function, setting the advances at the high-rpm breakpoint (set by RPM HI). The range of this switch is 10–40 degrees in increments of 2 degrees. The system then interpolates between the high and low breakpoints set by the four switches.

The VAC switch reads in relative degrees above the basic rpm-generated advance. The range is 0–15 degrees in increments of 1 degree. The setting on this switch is the maximum advance available to be added to the basic rpm curve (set by the other four switches). This advance is directly proportional to manifold vacuum; that is, maximum advance occurs at full vacuum. If the MAP sensor is not installed, no advance is added to the timing curve.

Initial Timing Check—Timing may be checked by cranking or running the engine below 700 rpm. This causes the ignition system to produce sparks at base timing. Since each cylinder receives two sparks per cycle, a timing light with a timing indicator dial reads twice the correct advance.



On an Indy engine, the crankshaft position sensor goes inside the timing cover. Note the degreed hub behind the shutter wheel.

MAP Input—A signal input is provided to the user for input of manifold vacuum information. This input accepts signals directly from the Delco MAP sensor. The electronic module adds advance proportional to manifold vacuum and to the curve, which has been set up using the other four switches. The advance is also subject to the maximum set by the VAC switch. This feature works between 500 rpm and the RPM HI switch setting (see the accompanying illustration).

Tachometer—An output is provided for tachometer operation. The tachometer must be of the electronic type. Buick Power Source tachometers are available through GM parts distributors.

Technical Assistance—If you require technical assistance, send your questions and telephone number to:

Buick Special Products
902 E. Hamilton Ave.
Flint, MI 48550

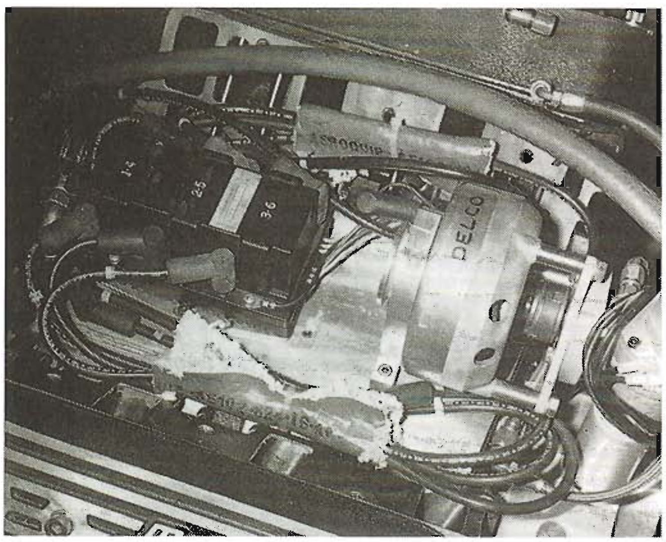
Aftermarket Ignition

Possibly as many as a dozen different aftermarket ignition systems are marketed for the Buick V6. Some of this hardware supplements all or part of Buick production ignition hardware. Other aftermarket hardware is designed to replace original equipment—component by component. Distributors that are triggered by points (some dual), magnetic induction and light beams are available. You can also find multiple-spark-discharge systems and ignition systems that are crank triggered.

Three factors must be considered when selecting any ignition system for a Buick V6 subjected to heavy-duty use: reliability, rpm capability, and energy delivery. Any ignition system that operates continuously for 24 hours at 8500 rpm and delivers 40 kilovolts at the spark plug is adequate for Buick V6 heavy-duty use.

Ignition Wires

The correct wire and its routing is critical when any of the Buick Computer Controlled Ignition systems is used in a heavy-duty application. The proper hardware is a radio-suppression helical-wound wire of 100 ohms per foot. Under no circumstances should a solid-core wire be used with a Buick Computer Controlled Ignition system. However, if an aftermarket magneto is used, an 8mm solid-core wire is recommended. Hardware placement within a vehicle or within a dyno test cell is vital to trouble-free operation.



The Buick Power Source Ignition as it appears when the coil unit is mounted atop the lifter valley cover. Note the length of heat shielding wrapped around the spark plug wires to protect them from the exhaust pipes leading to the turbocharger.

- Do not locate the electronics module directly next to the coil pack. Recommended separation is four feet.
- Do not wrap the sensor input leads around the high-voltage plug wires. Neatly dress low-voltage wires away from the plug wires.
- Be certain the coil pack is fitted with a substantial ground path to the engine and/or charging system. A ½-inch flat-braided ground wire is desirable.
- Be certain the charging system and the battery voltage from the ignition components are sufficient. Average current draw from the ignition system is 7.5 amps with peak current surges of 11 amps. Typical battery voltage is 11–16 volts.

Spark Plugs

Stage II iron and aluminum heads are machined for different spark plugs. It is also important to know that plug requirements for the two heads depend on the fuel used and the type of racing done. The following chart is a beginning guide to plug selection for heavy-duty use.

Plug Selection

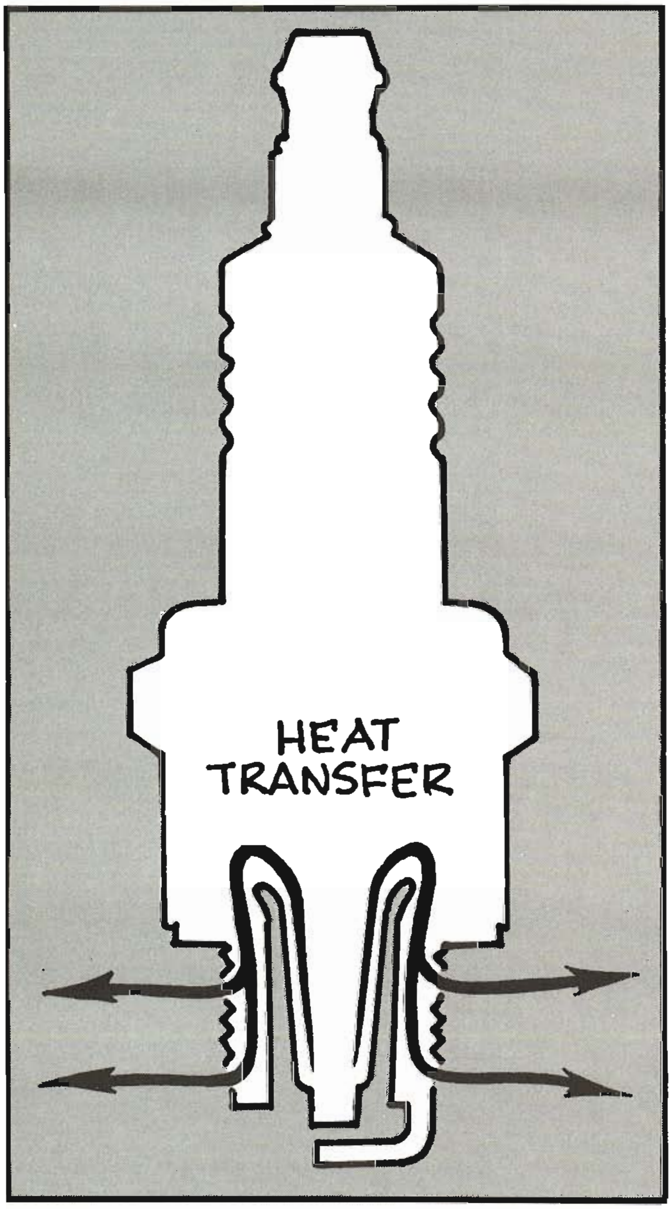
Gasoline	
Aluminum Head—12mm; gap at 0.035	
Super speedway	Champion BN60
Road course	Champion BN60Y
Short track	Champion BN63
Iron Head—14mm; gap at 0.035	
Super speedway	Champion N57
Road course	Champion N60
Short track	Champion N63
Alcohol	
Aluminum Head—12mm; gap at 0.035	
Super speedway	Champion R506R
Road course	Champion R504R
Short track	Champion R502R
Iron Head—14mm; gap at 0.035	
Super speedway	Champion N54R
Road course	Champion N57R
Short track	Champion N60R

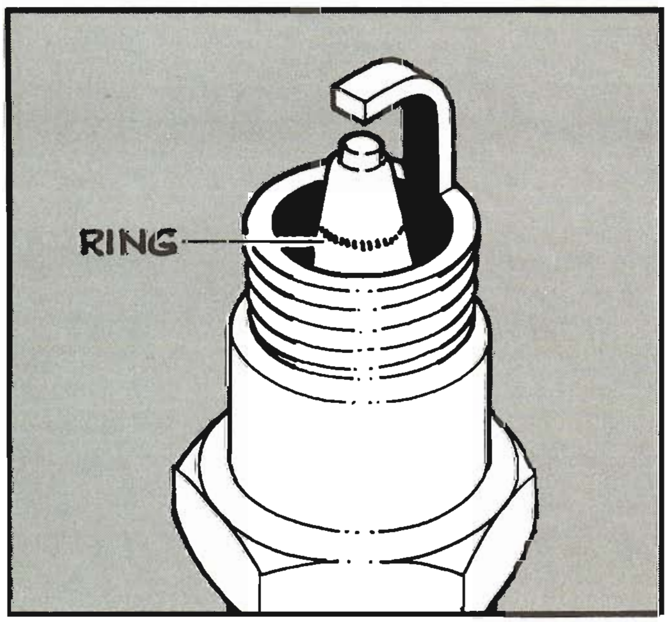
Tech Tips

Reading Spark Plugs

The spark plug can be the easiest-to-read indicator of the conditions existing inside the combustion chamber.

The correct heat range and type of spark plug is a vital part of the "tune" of an engine combination. The tip temperature of the spark plug must stay lower than the dangerous pre-ignition temperature of about 1400 degrees F. The tip temperature must also stay hot enough to prevent oil or carbon fouling (approximately 800 degrees F). A good rule of thumb is to maintain the hottest tip temperature





that will not cause problems. Use a projected nose-type plug if it clears the piston dome. Supercharged engines probably require the use of a side gap plug, but the reading process is the same.

The correct general appearance of a spark plug is described by all the spark plug manufacturers; consult their individual pocket guides concerning evidence of detonation, overheating, etc.

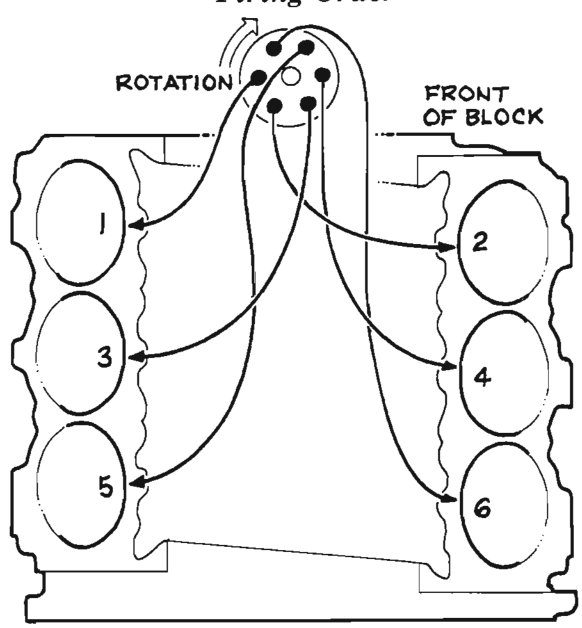
The spark plug insulator transfers heat from the tip to the threads. The point of effective heat transfer generates a ring (it looks almost like a shadow) that is best observed with a spark plug inspection light. The ring forms quickly and is an indication of burning in the combustion process. The closer to the tip the ring forms, the richer the mixture; the closer to the spark plug shell, the leaner the mixture. If there is no ring, and if the plug insulator tip is bone white, the mixture is too lean. This information applies primarily to gasoline engines, although it is applicable to both alcohol and nitromethane engines as well. The total span of rich-to-lean (ring near the tip to ring near the shell) may require only a 7–10 percent change in fuel. When a competition ignition system has been installed, the fuel curve may need to be enriched 5–10 percent and the total spark timing decreased by about 3 degrees due to a more efficient flame front.

Spark plug gaps in use in high-performance engines range from 0.025-inch to no ground electrode at all; 0.045- to 0.060-inch are more common figures. You need to adjust the variables of gaps, heat ranges, and mixtures to produce the best results for each application.

Firing Order

The firing order on all Buick V6 engines is 1-6-5-4-3-2.

Firing Order



Code Reading AC Spark Plugs

AC Sparks Plugs (aluminum head)

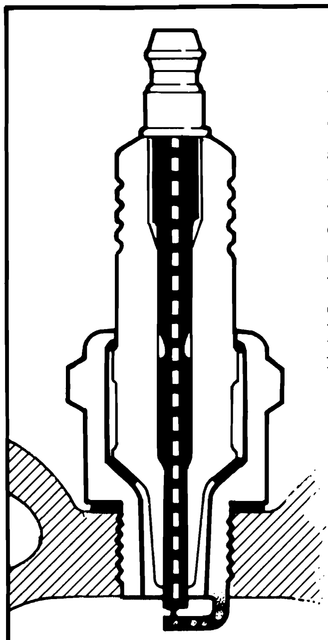
R	42	C	LTS	6
↑ resistor type	↑ heat range	↑ copper tip	↑ long tapered seat	↑ 0.060-inch gap recommended

Spark Plug Servicing

The proper servicing of spark plugs helps make the winning difference in engine performance and fuel economy.

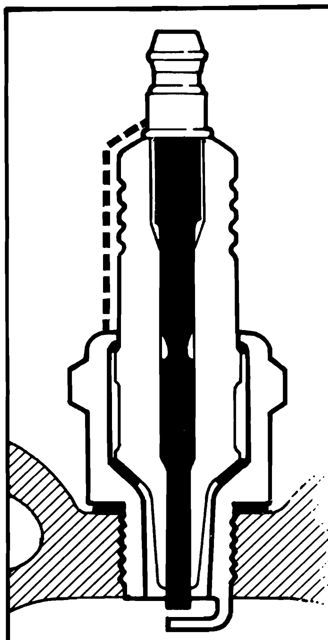
An engine with adequate compression and the proper air/fuel mixture may fail to properly ignite the fuel charge in one or more ways, depending on the condition of the spark plugs. Misfire of the fuel charge could be caused by an improper air/fuel mixture in the cylinder. However, the problem is more commonly caused by faulty ignition.

How Spark Plugs Misfire



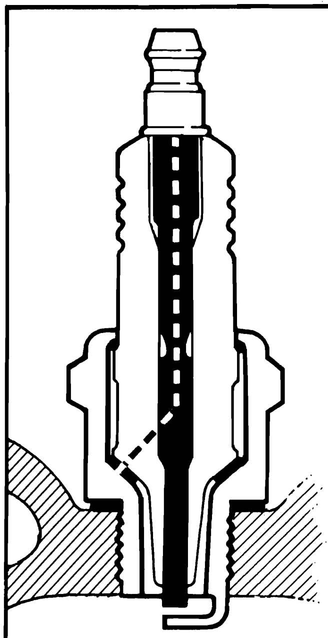
Normal Ignition

A high-voltage pulse travels down the center electrode, arcs across the gap to the side electrode and properly ignites the air/fuel mixture in the combustion chamber. Spark plugs in good condition used with an adequate ignition system deliver maximum power and fuel economy.



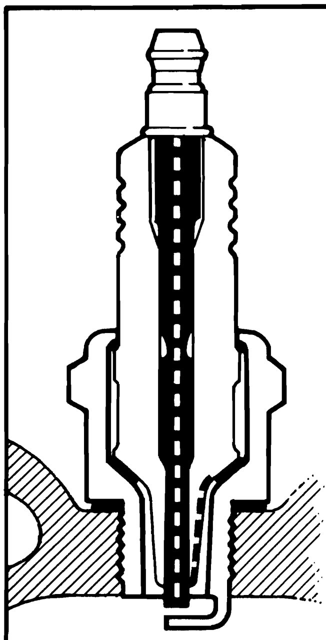
Tracking Arc

High-voltage arcs between a fouling deposit on the insulator tip and spark plug shell. This ignites the air/fuel mixture at some point along the insulator tip and retards the ignition timing, causing a power and fuel loss.



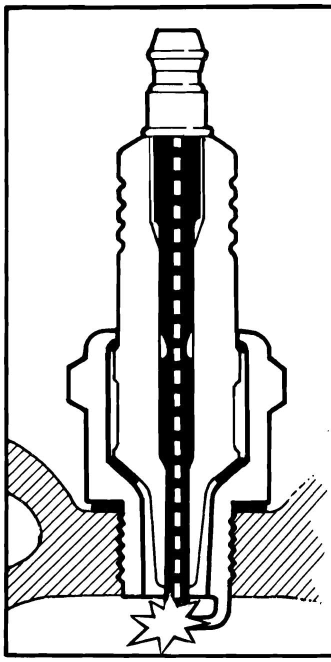
Pre-Ignition

The spark plug overheats to the point where the air/fuel mixture ignites before the high-voltage pulse arcs across the electrodes. Pre-ignition also occurs when any surface in the combustion chamber remains hot enough to ignite the incoming fuel charge before the timed spark. This condition can easily cause engine damage as well as loss of power and performance.



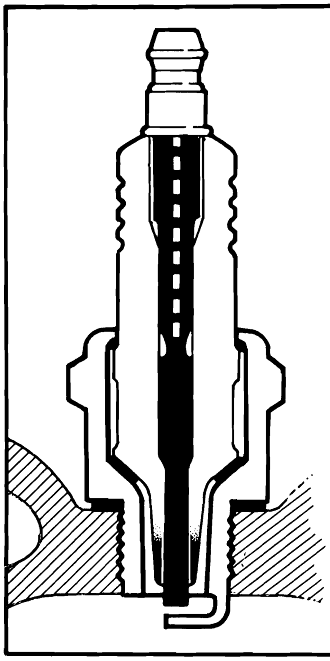
Wide Gap

Spark plug electrodes are worn so that the high-voltage charge cannot arc across the electrodes. Improper gapping of electrodes on new or "cleaned" spark plugs could cause a similar problem. Fuel remains unburned and a power loss results.



Bridged Electrodes

Fouling deposits between the electrodes ground out the high voltage needed to fire the spark plug. The arc between the electrodes does not occur and the air/fuel mixture is not ignited. This causes a power loss, and raw fuel is exhausted.

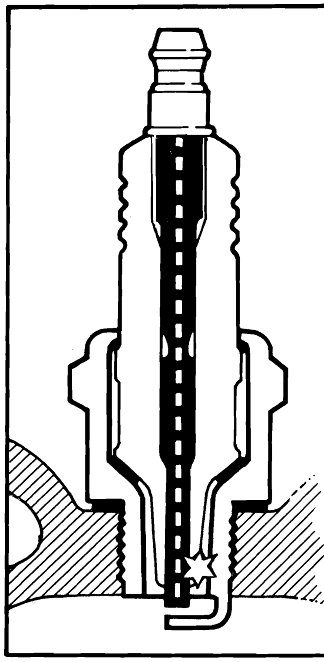


Cracked Insulator

A crack in the spark plug insulator could cause the high-voltage charge to ground out. Here, the spark does not jump the electrode gap and the air/fuel mixture is not ignited. This causes a power loss, and raw fuel is exhausted.

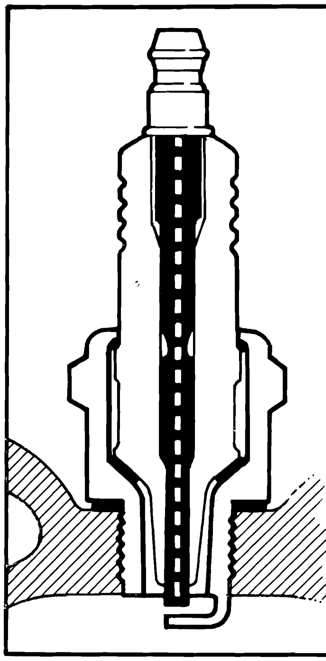
Timing Mark

The timing mark is composed of two lines—one on the crank dampener and the other on a tab on the timing chain cover—that indicate TDC. After TDC has been located with the dial indicator, this true position should be checked against the indicated timing mark. Any deviation from the true TDC should be noted and the correction made permanently on the crank dampener. The new mark should be very visible. An error in the basic timing of only 2 degrees can be costly in terms of performance and/or engine damage. A 2-degree error in timing can result in a pre-ignition failure or light to heavy compression-ring scuffing, which results in increased blow-by and lower horsepower output.



Flashover

A damaged spark plug boot, along with dirt and moisture, can permit the high-voltage charge to short over the insulator to the spark plug shell or the engine. AC's buttress insulator design helps prevent high-voltage flashover.



Fouled Spark Plug

Deposits that have formed on the insulator tip may become conductive and provide a "shunt" path to the shell. This prevents the high voltage from arcing between the electrodes. A power and fuel loss is the result.

Tachometers

Not all tachometers are compatible with the Buick Computer Controlled Ignition systems. In order to function with this hardware, the tach must be compatible with a low-voltage (0–12-volt) input signal coming from the electronic ignition module at pin G. (One source for such a tach is Auto Meter Products, Inc., listed in the suppliers chapter.)

GLOSSARY

AMPERAGE—The amount of current (amperes) flowing in a circuit.

AMPERE (AMP)—The unit of measurement for the flow of electrons (current) in a circuit; the amount of current produced by one volt acting through a resistance of one ohm. The term *ampere* is derived from the scientific contributions of Andre Marie Ampere.

CAPACITOR (CONDENSER)—A device for storing an electric charge.

CURRENT—The flow of free electrons through a conductor.

DIELECTRIC—A nonconductor of direct electric current.

DIODE—A semiconductor that permits current to flow in one direction only, used in reflection (changing alternating current to direct current).

ELECTROMAGNET—A soft-iron core that is magnetized when an electric current passes through a coil of wire surrounding it.

ELECTROMAGNETIC FIELD—The invisible field of force that surrounds a charged conductor coil.

ELECTROMAGNETIC INDUCTION—The producing of an electromotive force by varying a magnetic field whose lines of force intersect a conductor in a circuit.

ELECTROMECHANICAL—A mechanical process actuated or controlled electrically.

ERODE—To wear away by slow destruction.

FREE ELECTRON—An electron in the outer orbit of an atom, not strongly attracted to the nucleus, that can therefore be easily forced out of its orbit around the nucleus of another atom.

INDUCTANCE—A property of an electric circuit by which an electromotive force is induced in the circuit by a variation of current either in the circuit itself or in a neighboring circuit.

MAGNETIC FIELD—The directional field of force produced by a magnet or magnetic influence.

MAGNETIC FLUX—Lines of force representing a magnetic field.

MAGNETISM—A class of physical phenomena that include the attraction for iron observed in lodestone and a magnet, believed to be inseparably associated with moving electricity. These phenomena are exhibited by both magnets and electric currents and are characterized by field of force.

OHM—The practical unit for measuring electrical resistance. The term *ohm* is derived from the scientific contributions of Georg Simon Ohm.

RESISTANCE—The opposition to the free flow of an electric current.

RESISTOR—A device in an electric circuit that "uses up" some of the available voltage, allowing the remainder to operate an electrical unit within the designed voltage limitations of that unit.

SATURATION TIME—The length of time necessary for the primary current to reach its maximum value so that the magnetic field is at its maximum strength.

VOLT—A practical unit measurement of electrical pressure in a circuit. The term *volt* is derived from the scientific contributions of Alessandro Volta.

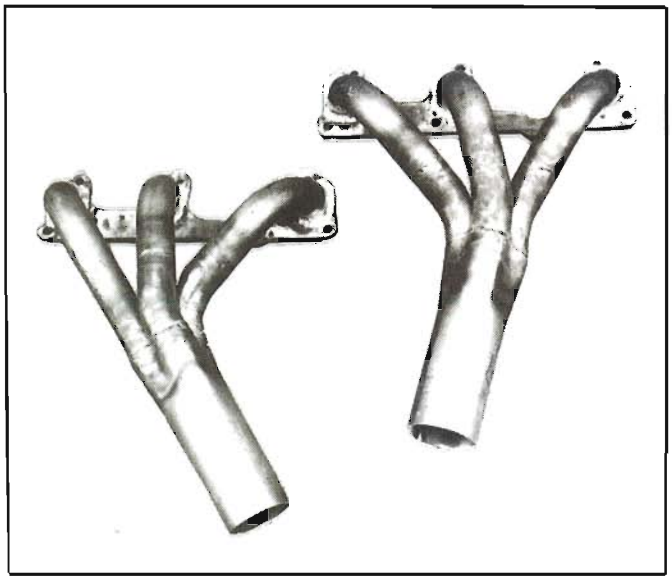
VOLTAGE—The number of volts required to force current through a conductor.

NOTES

Exhaust System

All Buick V6 exhaust manifolds and headers built for cylinder heads produced since 1979 interchange with production and Stage I heads. This includes the welded stainless steel manifolds that are standard on many currently produced Buicks. The photographic section shows the most readily available production manifolds identified by part number to aid engine swappers, street rodders, and other users of the Buick V6 in heavy-duty applications. When production and Stage I cylinder heads are required for heavy-duty use, the following dimensions can be used as a starting point for header fabrication.

Drag racing—The current thinking is that headers should be of stepped design—that is, a primary pipe leaving the head at 1⅝ inches diameter and expanding to 1¾ inches at a distance of 12 inches from the head for a total primary length of 30 inches. The collector should be 12–16 inches long and 3 inches in diameter.



Stage I engine headers. The extremely short primary pipe length allows power in only a very narrow rpm range.

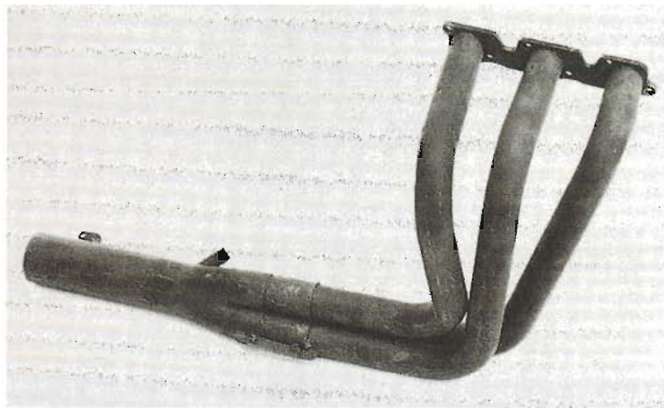
Road racing and oval track racing—These engines also benefit from having a stepped design. Leaving the head a pipe diameter of 1½ inches is preferred, expanding to 1⅝ inches at a distance of 12 inches from the head with a total primary length of 38 inches. Again, the collector should be about 12 inches long with a diameter of 3 inches.

Stage II Exhaust Manifolds

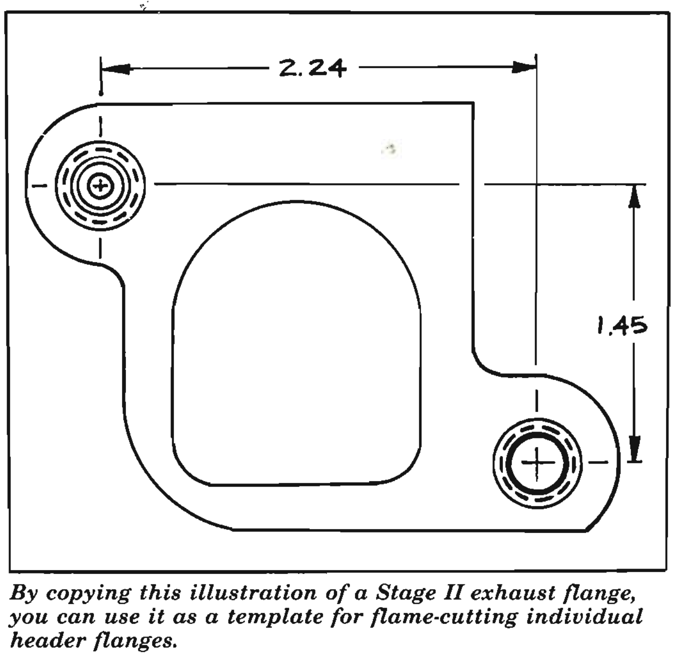
There are no production exhaust manifolds for Stage II cylinder heads. All exhaust systems to be fitted to Stage II heads must be custom fabricated. Several guidelines can be followed in this area.

To begin, all headers fabricated for Stage II cylinder heads should have the primary pipes joining the head at a 7-degree upward placement from the flange surface. A stepped design has also been found to be beneficial in this case.

Normally aspirated drag racing—Leaving the cylinder head, the primary pipe should be 1⅞ inches for 12 inches, expanding to 2 inches for a total length of 30 inches. A starting point for collector size is 3½ inches by 30 inches.

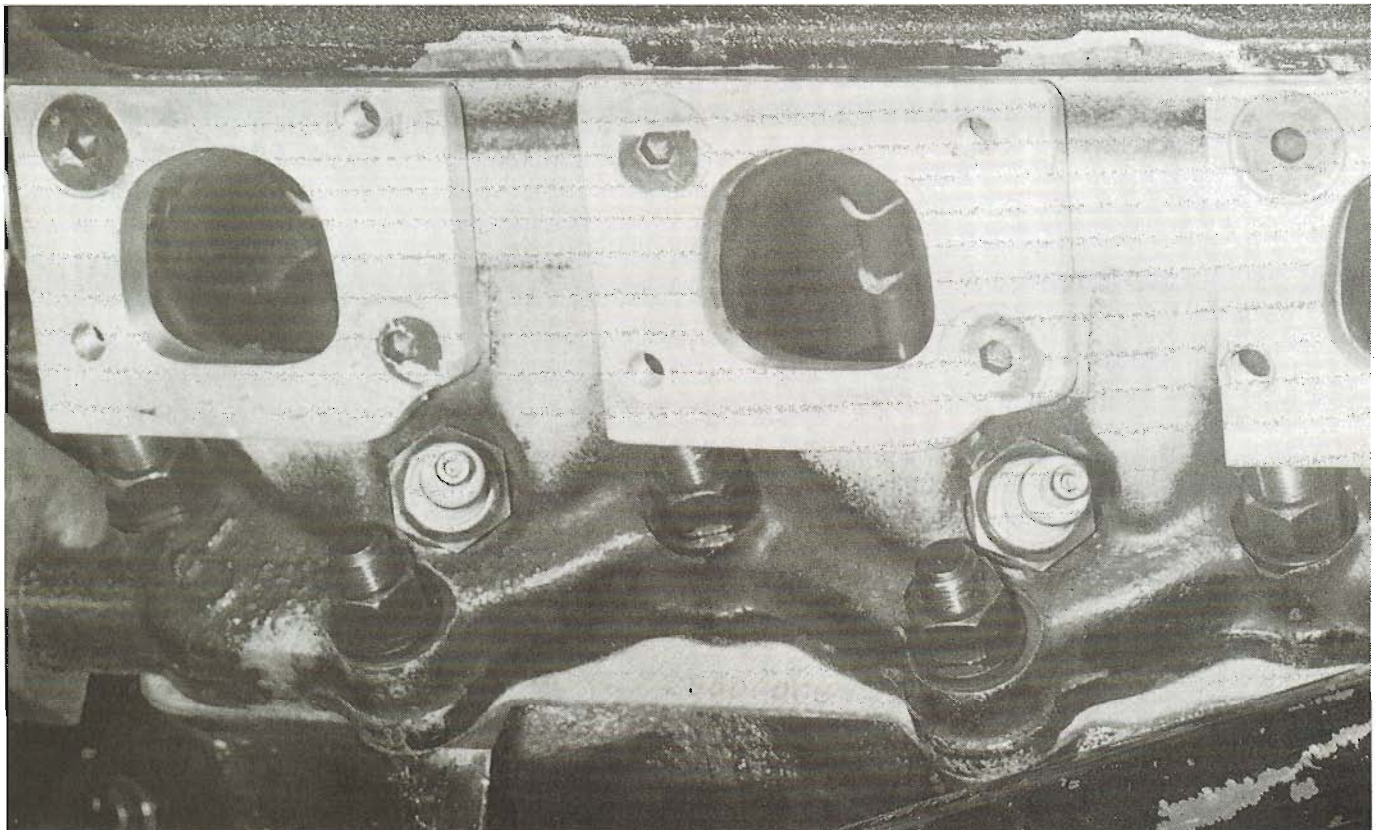


A typical drag race header, as described in the text.



By copying this illustration of a Stage II exhaust flange, you can use it as a template for flame-cutting individual header flanges.

Normally aspirated road racing and oval track racing—A stepped design of 1⅞ inches leaving the head and expanding to 2 inches after 12 inches for a total length of 38 inches gives a broad torque curve. Collector size should be about 3 inches by 16 inches.



Many engine builders and header manufacturers prefer to have an adapter plate between the cylinder head and head flange. This permits the use of a larger primary pipe.

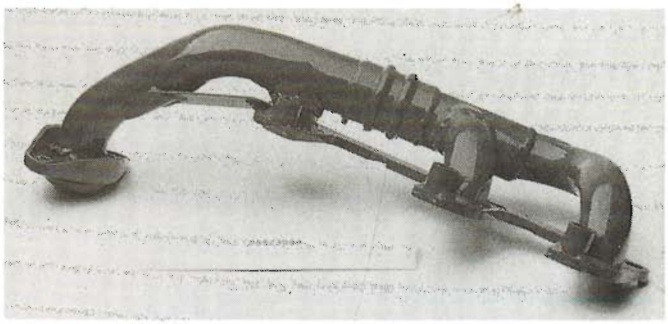
Turbocharged road racing and oval track racing—To increase throttle response, primary pipes should be as short as possible, with a pipe diameter of 1⅞ inches. The collector mating with the turbocharger should also be as short as possible.

Turbocharged Applications

All exhaust systems fabricated for turbocharged applications must be stainless steel. Ideally, the headers bolt to the cylinder heads via individual flanges with a minimum thickness of ⅜-inch. An expansion joint or bellows should be placed between the cylinder head and the turbocharger to prevent the exhaust system from cracking.

Recently Produced Buick Manifolds

When performing a custom installation of a Buick engine, it may be helpful to study the following photographs of recently produced Buick manifolds used on various models of Buick cars. All of these manifolds can be bolted to 1979 and newer production heads and Stage I heads. All of the fabricated manifolds are constructed of stainless steel.

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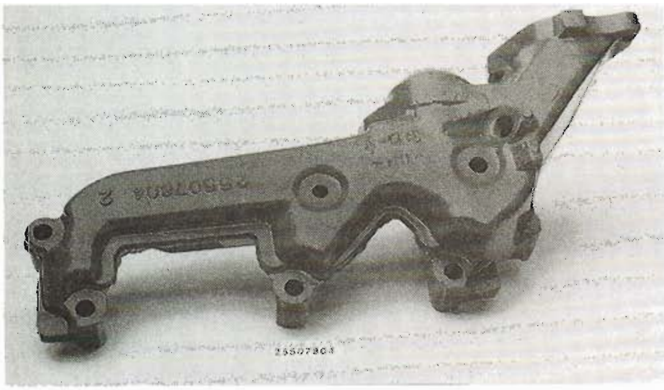
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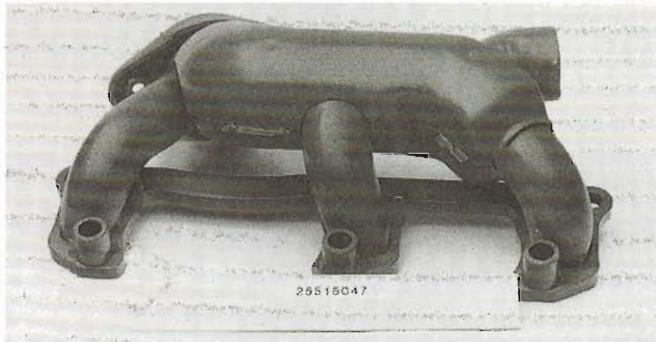
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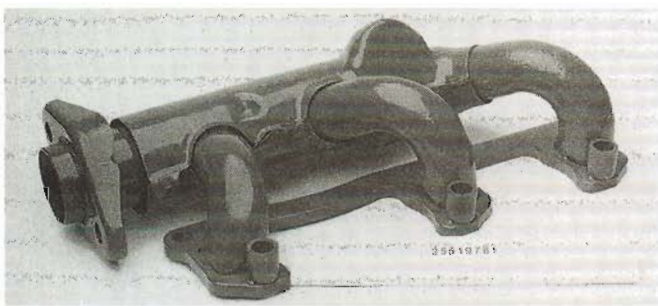
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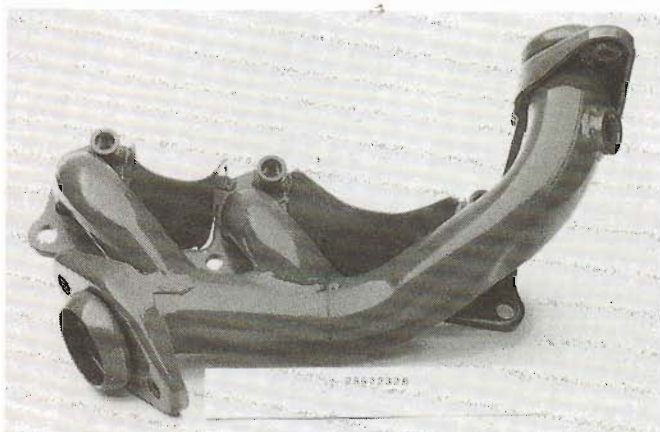

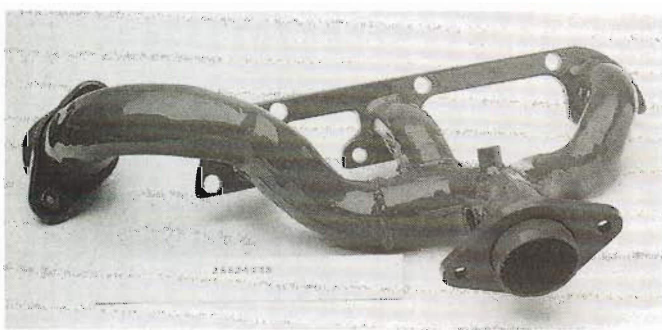

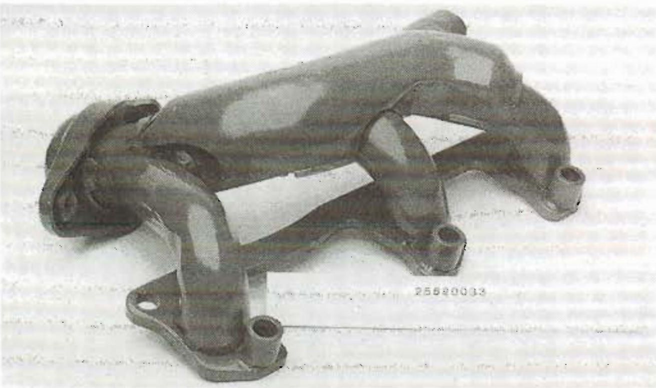
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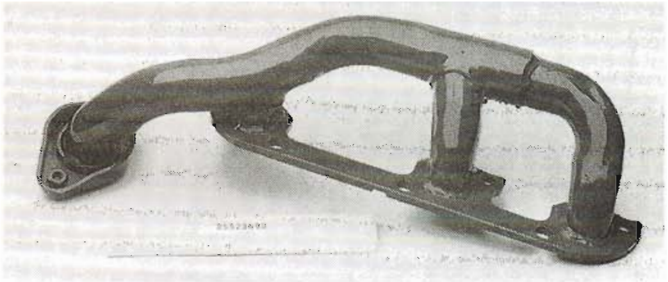

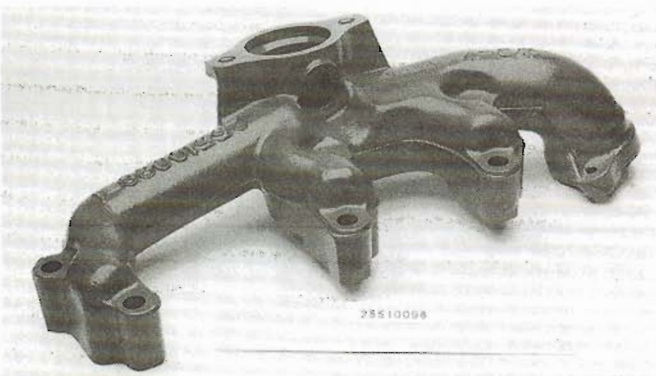
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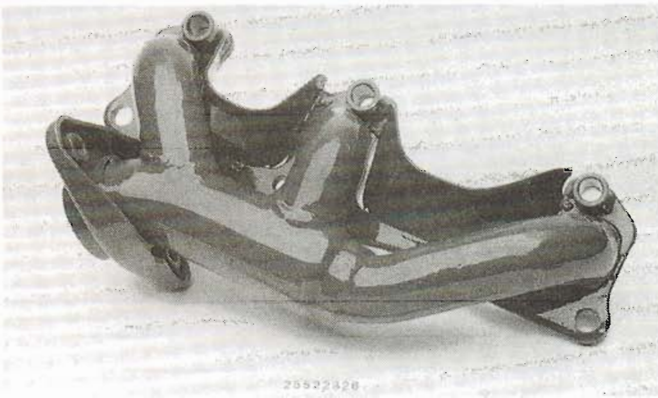

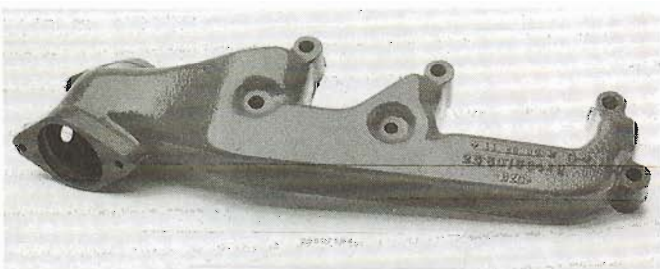


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6 Operating Conditions

A heavy-duty Buick V6 engine represents a sizeable outlay in terms of money, time and hours. Every effort should be made to extend the life of all components. Thus, a number of break-in procedures are recommended.

The engine should be cranked until steady oil pressure is seen on a direct reading gauge. It is preferable to do this with all spark plugs removed so as not to unduly load the starter or the crank journals. If the engine is equipped with a dry-sump oiling system, the drive belt can be removed from the crank pulley and placed around the chuck of a drill motor and driven until pressure is achieved.

It is extremely important to avoid letting air lock either the lubrication or cooling systems when an engine is first fired. This is especially critical when remote oil coolers and filters are used and when remote sumps and surge tanks are used in the cooling system.

Any time an engine is assembled using RTV (room temperature vulcanizing) sealant, it should be allowed to sit overnight so the sealant has a chance to cure before being subjected to vibration and hot oil—both of which dislodge sealant.

Engine Run-In

Racing engine run-in should last at least an hour and preferably two hours. Any type of running between 2000–4000 rpm is beneficial; however, a dynamometer-controlled run-in is best of all. This allows a controlled load on the engine, and any oil and water leaks or other deficiencies in buildup are more easily repaired.

Use 30-weight oil and street-type heat range spark plugs during run-in. After run-in, spark plugs, oil and filter should be changed, the valvetrain inspected and valves relashed. If a head gasket retorque is required, it can be done at this time (before the valves are relashed). Inspect the drain oil and filter for large foreign particles at this time.

It is particularly important to change the oil filter, because if you follow our recommendation on buildup lubricants and plugging the oil filter bypass, the filter will be plugged with Molykote during run-in. This shows up as a decrease in engine oil pressure.

An engine that has just been rebuilt with new piston rings and a used camshaft needs little or no run-in; a warm-up and hot lash are sufficient.

After the engine has been broken in, a number of items need to be attended to before the engine is put to severe use.

1. Retorque all cylinder head bolts or studs in the correct sequence to the specified loading.
2. Remove and replace the filter and all oil.
3. Cut the filter apart, and examine it carefully.
4. Install plugs of the correct heat range.
5. Readjust valve lash.
6. Check the timing.
7. Check for coolant and lubricant leaks.

The following recommended operating specifications and limits should ensure long-lasting and satisfactory performance from an engine built as described by these instructions.

Oil

Use 30–50 weight ashless racing oil or one of the 20W-50 multigrades available with ashless detergent additives. If you are unsure whether the oil you want to use is ashless, check with its manufacturer. Avoid any oils that contain barium or calcium even in small percentages, as the presence of these components in the carbon deposits on the piston promotes destructive pre-ignition and causes burned pistons. You can use aircraft oil, which is always ashless; however, unless you run a roller cam you must provide an additional extreme pressure additive to prevent cam and lifter wear. Most automotive oils contain 0.1 percent or greater zinc component for EP additive.

Tech Tips

Oil Coolers

Oil coolers are crucial to racing engines because they assist in dissipating combustion heat. Engine coolant temperature and oil temperature are directly related. Oil coolers should always be mounted in an area where a constant supply of fresh outside air is assured. Long runs of hose and an abundance of bends or elbow fittings restrict oil flow and should be avoided.

Two oil coolers used in one application should be plumbed in parallel—not series—to prevent a loss in pressure. Coolers should be plumbed so the oil enters from the lowest point in order to force air out of the cooler and prevent air lock.

Oil coolers and all external oil plumbing should be sonic cleaned before installation and at least once a season thereafter even if no engine problems are experienced. If an engine fails, all engine oiling hardware should be sonically cleaned.

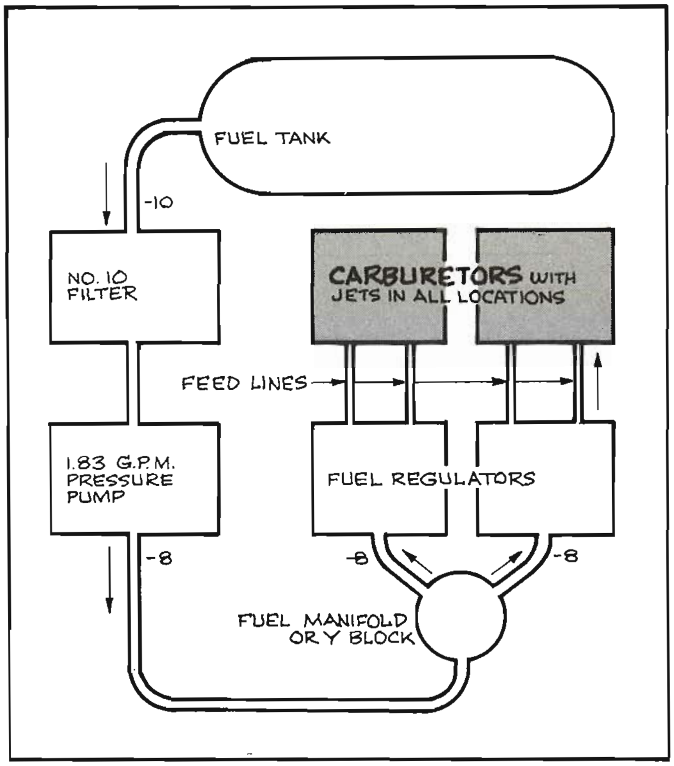
Oil Pressure Fluctuations

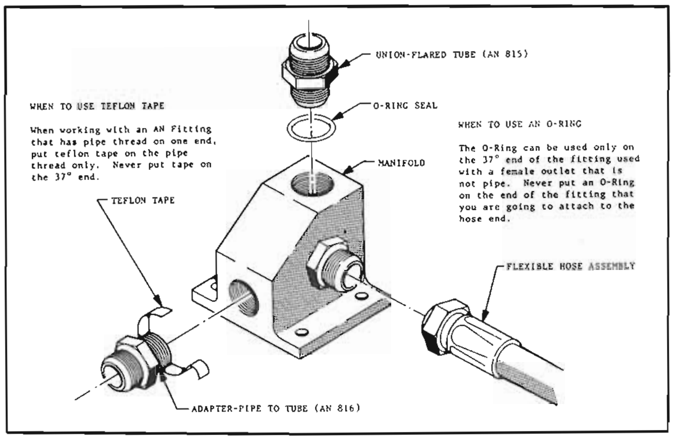
Nonfluctuating oil pressure comes primarily from eliminating any possibility of air entering the oiling system under any condition in the operation of the engine. Immediate gauge response is mandatory to detect problems in the oiling system. The oil pressure gauge line should have a ⅛-inch inside diameter for best response. Pressure loss in a Buick

V6 seeing heavy-duty use comes primarily from insufficient oil level or capacity, and in some cases from both. Other culprits are high engine oil flow rates due to excessive clearances within the engine and improper oil pan baffling and/or inadequate oil drainage capacity.

Fuel

Use the best super premium available. Several good racing fuels are now available—Union 76, Sunoco 280 (Cam II), and H & H Racing gas. You can also use 100-130 aviation fuel. In order to run a 12:1–12.5:1 compression ratio you have to run one of the above fuels. If you must run pump premium, limit your CR to 10.5–11.1. The vapor pressure of aviation fuel and racing gasolines is carefully controlled to prevent vapor lock and vapor lean-outs. Some pump fuels, particularly in northern climates, cause vapor lock and lean mixtures if run on fuel tailored for cold-weather use.





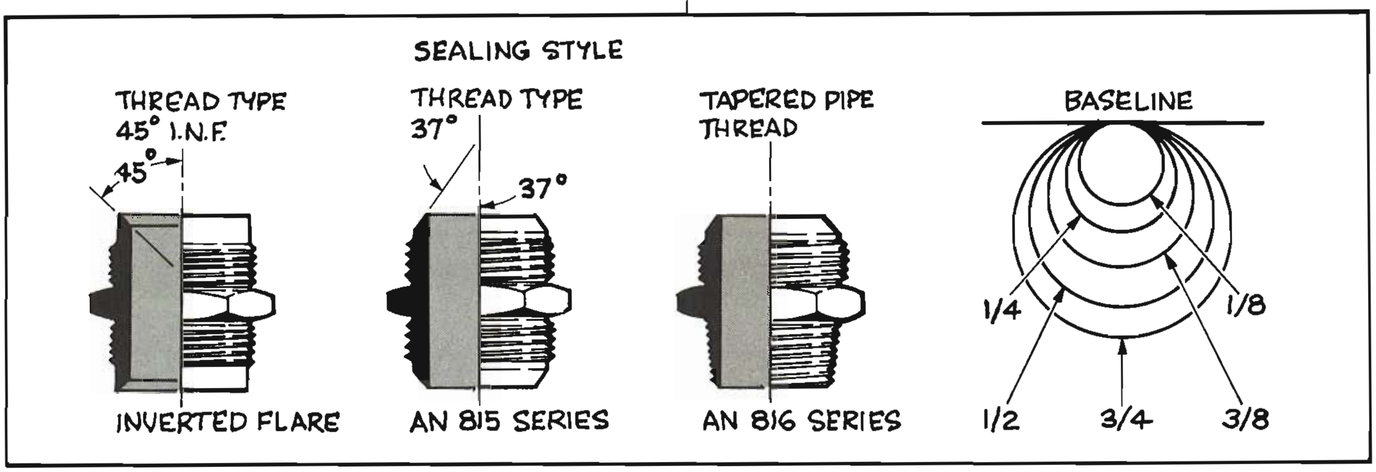
Tech Tips

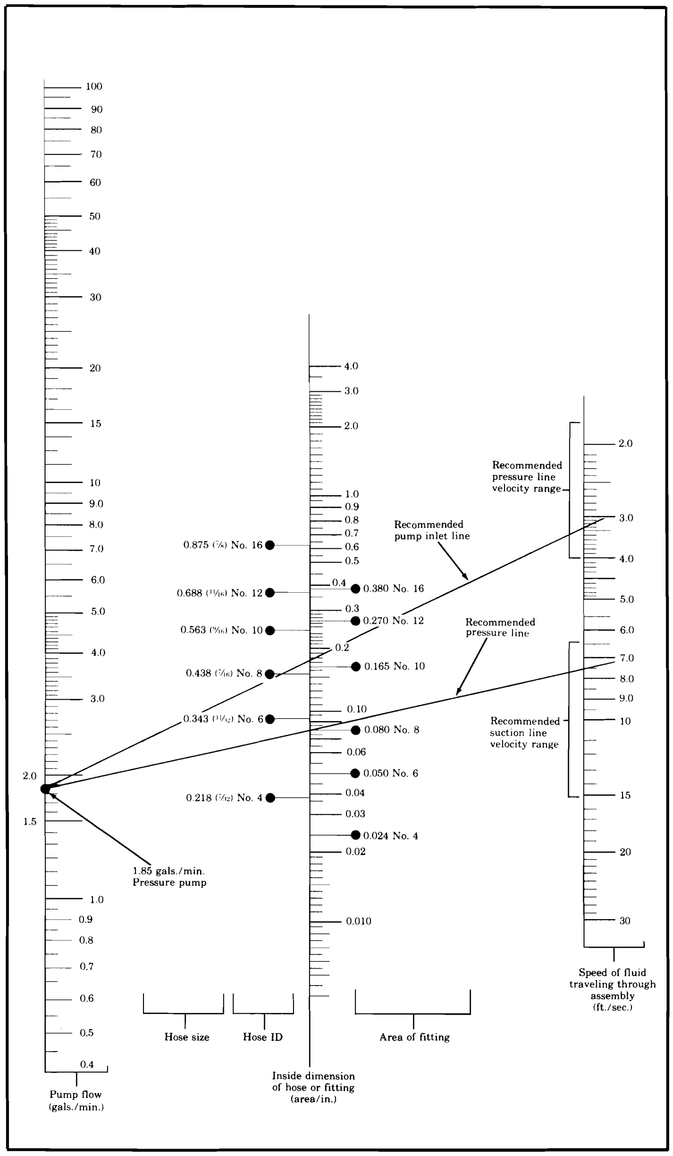
Fuel System

In most cases one high-capacity electric fuel pump is adequate for a Buick V6-powered competition car. When two fuel pumps are used, they should be plumbed in parallel. This means having two inlets and two outlets rather than one pump feeding into the second pump. The recommended fuel line size is ⅜-inch diameter, and the diameter from the electric pumps to the carburetor should be the same.

Using an Air Density Meter

The use of an air density meter is not a substitute for tuning. Power output of an engine is di-





rectly related to the air density. Air density is affected mainly by two factors: barometric pressure and air temperature. With a decrease in barometric pressure and/or a rise in air temperature, there is a loss of engine power. Conversely, an increase in engine power results from a rise in barometric pressure and/or a decrease in air temperature.

An internal combustion engine must maintain the proper air/fuel ratio (by weight, not volume) to achieve maximum power output or the best fuel economy. A carburetor provides an engine with the proper air/fuel ratio, but only for a given air density. To compensate for changes in air density, the carburetor main jet size must be changed correspondingly. The air density meter gives the engine tuner the proper information to compensate for changes in barometer pressure and air temperature to attain maximum power output or the best fuel economy.

The density meter indicates air density directly in percent. Standard sea level condition is 60 degrees F air temperature and 29.92 inches of mercury barometric pressure or 100 percent air density. The instrument utilizes a diaphragm with a given volume of air sealed inside. The diaphragm is exposed to the surrounding barometric pressure and air temperature, which acts upon the diaphragm and causes it to expand or contract. The motion of the diaphragm is transformed into needle movement on the dial to indicate the actual air density. Once a starting point has been established, the proper jet size may be determined for various air densities to attain maximum power output or the best fuel economy.

Since air density may change significantly (even at a given altitude), it should be recorded at the time of a performance test and used for comparison with other tests. Otherwise, a change in performance cannot be positively attributed to a change in engine tune but could be due to a change in air density.

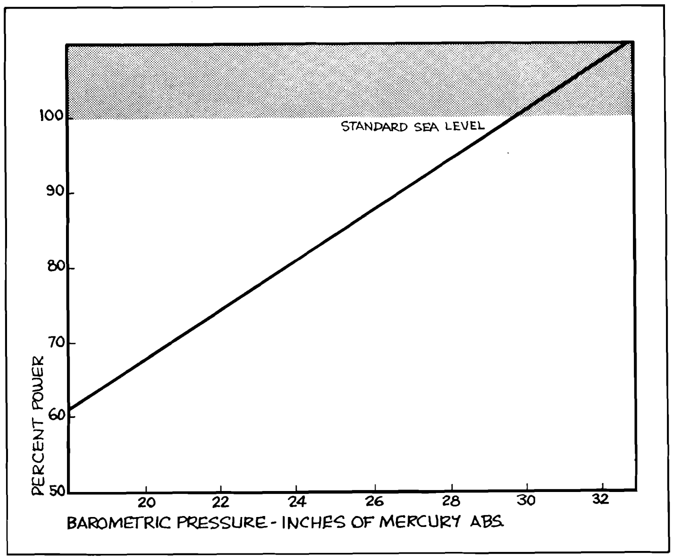
The charts show the effect of air temperature and barometric pressure on engine power output. The maximum power output of an engine is directly related to air density, provided the same air/fuel ratio is maintained. If the air/fuel ratio is permitted to go rich or lean, the reduction in power output is considerably greater. In addition, the ignition timing will be fast or slow, and the spark plug heat range will be affected. To maintain a balance of these conditions and to secure maximum power output at a given air density, the correct air/fuel ratio must be maintained. The air density meter combines the factors of air temperature and barometric pressure and gives a direct reading in percent air density.

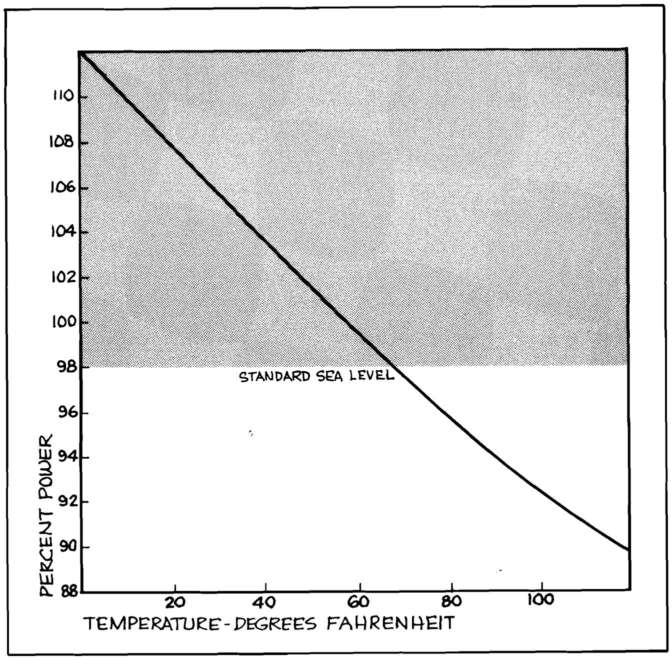
- Establish a starting point by tuning the engine (carburetor jetting, spark advance, plug heat range, etc.) at a known air density. Do this by experimenting until the best performance is obtained.
- To maintain the proper air/fuel ratio as determined above, the carburetor main jets must be changed to match new air density conditions. The percentage the main jets area is reduced or increased must be the same percentage the air density is reduced or increased, as indicated by the air density meter. The following chart shows the jet area for different-size jet diameters. Example: An engine has been tuned for maximum power output at a drag strip in the morning with an air density of 98 percent and 0.072-inch-diameter jets. In the afternoon, the air density drops to 92 percent. This indicates that the main jet area should be reduced by 6 percent to maintain maximum power output. To determine the correct jet size, make the following computation:

1. Find the jet area from the chart: 0.072-inch diameter or 0.004072-square-inch.
2. Subtract air density readings: 98% – 92% = 6%.
3. Multiply jet area by percent difference: 0 – 4072 x 6% = 0.00024 square inch.
4. Subtract Step 3 from Step 1: 0.004072 – 0.000244 = 0.003828-square-inch.
5. The new jet area should be 0.003828-square-

Diameter to Area

Diameter					Dec-imal	Area
4ths	8ths	16ths	32nds	64ths		
				1	.01562	.0002
			1		.03125	.0003
				3	.04668	.0017
		1			.06253	.0031
				5	.07812	.0047
			3		.09375	.0069
				7	.10938	.0094
	1				.12500	.0123
				9	.14062	.0155
			5		.15625	.0192
				11	.17188	.0232
		3			.18750	.0276
				13	.20312	.0324
			7		.21875	.0375
				15	.23438	.0431
1					.25000	.0490
				17	.26562	.0554
			9		.28125	.0621
				19	.29688	.0692
		5			.31250	.0767
				21	.32812	.0845
			11		.34375	.0928
				23	.35938	.1014
	3				.37500	.1104
				25	.39062	.1198
			13		.40625	.1296
				27	.42188	.1397
		7			.43750	.1503
				29	.45312	.1612
			15		.46875	.1725
				31	.48438	.1842
2					.50000	.1963
				33	.51562	.2088
			17		.53125	.2216
				35	.54688	.2348
		9			.56250	.2485
				37	.57812	.2624
			19		.59375	.2768
				39	.60938	.2916
	5				.62500	.3068
				41	.64062	.3223
			21		.65625	.3382
				43	.67188	.3545
		11			.68750	.3712
				45	.70312	.3882
			23		.71875	.4057
				47	.73438	.4235
3					.75000	.4417
				49	.76562	.4525
			25		.78125	.4793
				51	.79688	.4987
		13			.81250	.5184
				53	.82812	.5386
			27		.84375	.5591
				55	.85938	.5800
	7				.87500	.6013
				57	.89062	.6229
			29		.90625	.6450
				59	.92188	.6674
		15			.93750	.6903
				61	.95312	.7135
			31		.96875	.7370
				63	.98438	.7609
1"					1.0000	.7854





inch; the closest area on the chart is 0.003848-square-inch, so use a 0.070-inch-diameter main jet at 92 percent air density.

The temperature as sensed by the air density meter must be that of the "free air" measured in the shade (allow time for instrument temperature to stabilize). Direct sunlight on the meter or heat from one's hands may create a higher temperature and therefore an error in true air density reading.

Coolant

The stock Buick V6 water pump is an extremely efficient unit. High-rpm operation turns the pump too fast for effective cooling and causes excessive pressures and cavitation. For high-performance use, water pump speed should be reduced to about 75 percent of crank speed.

Several aftermarket sources for a pulley assembly feature a larger-than-stock water pump pulley and a smaller-than-stock-diameter crank pulley.

In the long run, this is a far more flexible and sanitary approach to cooling effectiveness than cutting down the pump impeller. On a competition engine the thermostat bypass should be eliminated. This is most easily done on the V6 by welding up the outlet on the back side of the front cover.

Engine Temperature

Competition and street engines should be run as hot as they can be run without encountering problems, as hotter-running engines improve fuel economy and horsepower. Engines are more efficient when they operate at 220 degrees than at 180 and more efficient at 240 degrees than at 220. There are practical limits to the temperatures that can be run with today's hardware, but remember that the heat pumped into the radiator is horsepower the engine is not feeding to the driving wheels. Overheating of a high-performance vehicle can be pure misery for everyone concerned, so you should shoot for an operating temperature of 180 degrees.

Overheating problems can be somewhat complex; the following comments are only suggestions that may help solve the problems.

- Most high-performance cars require that the entire grille area be used to gather air for the radiator, and in the case of some cars, ducting air from under the bumper to the radiator in addition to that coming through the grille is not uncommon. To be most effective, all ducting from the front of the car to the radiator should be tightly sealed. A shroud extending from the rear of the radiator past the fan is normally beneficial in curing cooling problems, especially if the engine temperature rises significantly during parade laps and caution flag laps. If a shroud is run, it should be sealed at the radiator.
- Increase the pressure in the cooling system. Pressure caps of 25 pounds are just about standard on most high-performance cars.

A number of routine maintenance procedures should be followed to avoid problems. Suggestions along these lines are:

- If your budget permits the extra expense, run a steel braided hose with suitable AN-style fittings. This is particularly important on the upper hose.
- When rubber hose is used (upper or lower), always use two hose clamps on each end. Use only good-quality worm gear clamps whose slots go all the way through the band. A good, readily available, stainless steel clamp sold in a variety of sizes is ideal. If you must use a rubber water hose, attempt to locate Gates "Green Stripe." If a rubber lower hose is used, give it additional strength and protect it from track debris by wrapping it with duct tape. Replace rubber hose frequently.
- Pay constant attention to the buildup of mud, rubber and other track debris in the radiator fins. Soaking the radiator in a large, shallow pan of lacquer thinner for 30 minutes and then applying an air hose is one efficient way of getting rubber out of the fins.
- Most engine builders prefer to use some sort of leak fixers in the cooling system in an effort to seal minute leaks in the system. If you are of this persuasion, do not use a pellet-type sealant, and keep in mind that while the sealant is plugging leaks in your engine, it is also plugging up the radiator. The tanks need to be removed on a regular basis and the core rodded out several times a season.
- Finally, the driver of a car whose engine is overheating will not be winning many races no matter how good he is (or *thinks* he is). You should be aware that most high-performance cars are prone to overheating when tucked tightly behind another car and that this is when you should be reading the temp gauge and moving to one side of the car in front to pick up some fresh, unheated air for the radiator.

Tech Tips

Radiators

As the horsepower of an engine increases, so must the efficiency of the cooling system. Extra horsepower means extra heat must be carried away by the cooling system. A radiator used in a race car should be pressure checked to ensure that it is good for 25 pounds of pressure. This raises the boiling point of the coolant considerably, as does running 50 percent antifreeze solution.

When the radiator is lower in the chassis than the top of the engine, a surge tank is required. This tank must be mounted as the highest point in the cooling system, which should then be filled at the surge tank.

Antifreeze

Antifreeze is sufficient water pump lubrication for heavy-duty Buick V6 engine use. Oil pump lubes that are water soluble can damage coolant hoses in heavy-duty applications.

Engine Build Specifications and Recommended Clearances for Off-Highway Use

		Specifications
Main bearing saddle bore ID		2.687–2.688
Connecting rod large end bore ID		2.3738–2.3745
Deck height–3.8L Stage I		9.560 nominal
–all others		9.535 nominal
		Clearance
Main bearing		0.0022–0.0027–inch
Crankshaft endplay		0.0015–0.007–inch
Connecting rod bearing		0.0018–0.0022–inch
Connecting rod side clearance		0.010–0.020–inch
Wristpin to connecting rod bushing		0.0008–0.0012–inch
Steel to steel		0.0005–0.0007–inch
–to piston		0.0012–0.0015–inch
–endplay (minimum preferred)		0.0005–0.010–inch
Piston to bore Use piston manufacturer's recommended clearance.		
Piston deck to cylinder head	Min.	0.045–inch
	Max.	0.060–inch
Piston valve–intake	Min.	0.120–inch
–exhaust	Min.	0.150–inch
Piston ring gap–top		0.018–0.020–inch
–second		0.016–0.018–inch
Camshaft endplay		0.003–0.005–inch
Valve lash Use camshaft manufacturer's recommended clearance.		

Recommended Bolt Torque and Lubrication Specifications

	Torque (N–m)	Torque (ft./lbs.)	Lubrication
Main bearing cap–stud	135	100	Oil
–bolt	95	70	Oil
Connecting rod bolt (3/8-inch)–25519247	100 (0.006-inch stretch preferred)	75	Oil
Cylinder head bolt	110	80	Sealant (1052080 recommended)
Cylinder head studs (if used)	95	70	Sealant (in block); oil (on nut)
Camshaft nose	55–75	40–55	Oil
Harmonic balancer	270–340	200–250 (¾-inch bolt)	Oil
Flywheel	75–88	55–65	Oil
Intake manifold	34–40	25–30	Oil
Rocker arm shaft	52–57	38–42	Oil
Rocker cover	3	25 (lbs./in.)	Oil
Spark plug	34	25	Dry
Exhaust manifold	34–48	25–35	Antisieze
Oil pan	16–22	12–16	Oil
Oil pickup tube	8–12	6–9	Oil
Timing chain cover	34–45	25–33	Sealant
Water pump cover	8–12	6–9	Oil
Oil pump cover	10–16	8–12	Oil
Fuel pump block-off	23–45	17–33	Oil
Engine mount bolts	68–75	50–55	Sealant

Blueprinting Records

Record-Keeping Forms

The following forms are useful in recording specific information determined during teardown. Copy a quantity of forms and keep them on file for shop use. Due to procedure variances among shops, some forms are presented in more than one format. Simply select those forms that apply to your method of keeping files.

Buick Stage I and Stage II Engine Build and Check Record

Build date__________

Customer__________

Engine number__________

Engine type__________

Displacement__________

Fuel requirement__________

Build or rebuild no.__________

Special assembly conditions or disassembly comments:

Piston			
Piston make; type		______	______
Compression height		______	______
Wristpin type; length		______	______
Wristpin diameter		______	______
Wristpin clearance in piston		______	______
Wristpin retainer type; size		______	______
Piston Deck Clearance			
Cylinder No.	1	3	5
Deck clearance	______	______	______
Cylinder No.	2	4	6
Deck clearance	______	______	______
Engine Bearing			
Main bearing make; part no.		______	______
Rod bearing make; part no.		______	______

Blueprinting Records

Crankshaft				
Crankshaft make; type	______	______		
Stroke	______			
Endplay	______			
Main Bearing No.	1	2	3	4
Housing diameter	______	______	______	______
Housing diameter with bearing	______	______	______	______
Crankshaft main journal diameter	______	______	______	______
Main bearing clearance	______	______	______	______

Piston Size and Bore Clearance			
Cylinder Number	1	3	5
Bore size	______	______	______
Piston size	______	______	______
Clearance	______	______	______
Cylinder Number	2	4	6
Bore size	______	______	______
Piston size	______	______	______
Clearance	______	______	______

Piston Ring			
Make of ring set; part no.	______	______	
Top ring type; width; gap	______	______	______
2nd ring type; width; gap	______	______	______
Oil ring type; width; gap	______	______	______

Camshaft		
Drive make; type	______	______
Cam make; no.	______	______
Type of cam	______	______
Camshaft lobe separation	______	______
Intake duration at 0.050	______	______
Exhaust duration at 0.050	______	______
Intake lobe center installed at	______	______
Intake lobe lift	______	______
Exhaust lobe lift	______	______
Intake valve to piston clearance	______	at 10° ATDC
Exhaust valve to piston clearance	______	at 10° BTDC
Intake valve lash	______	______
Exhaust valve lash	______	______

Connecting Rod			
Rod make; type	______		______
Length (center to center)	______		______
Side clearance	______		______
Wristpin bore diameter	______		______
Wristpin clearance in rod	______		______
Rod bolt make; size	______		______
Rod bolt torque	______		______
Connecting Rod No.	1	3	5
Housing diameter	______	______	______
Housing diameter with bearing	______	______	______
Crankshaft rod Journal diameter	______	______	______
Rod bearing clearance	______	______	______
Connecting Rod No.	2	4	6
Housing diameter	______	______	______
Housing diameter with bearing	______	______	______
Crankshaft rod journal diameter	______	______	______
Rod bearing clearance	______	______	______

Compression Ratio		
Piston at BDC in bore		
Swept volume*	______	______
Dome (–) or dish (+) volume	______	______
Ring land volume	______	______
Deck volume	______	______
Head gasket volume	______	______
Head chamber volume	______	______
Total =	______	______

Total – Swept volume = Compression ratio

CR = ____________ :1

*Swept volume = $(\text{bore})^2$ x stroke x 12.87

Valvetrain		
Make of rocker arms; type	______	______
Rocker arm ratio	______	______
Total intake lift at valve	______	______
Total exhaust lift at valve	______	______
Pushrod length; diameter	______	______
Lifter make; type	______	______

Blueprinting Records

Engine Balancing

Reciprocating Weight		Rotating Weight	
Piston	______	Rod large end	______
Wristpin	______	Rod bearing (1 pair)	______
Pin locks	______	Oil	______
Ring set (1 piston)	______	Total B	______
Rod small end	______		
Total A	______		
Balance percent*	______		

Bob weight = Total A x (balance %)
+ Total B = ______

*Balance % should be 0.366 for all 90° Buick V6 even-fire engines utilizing rubber engine mounts. For applications where rubber engine mounts are not used, balance % should be 0.50.

Cylinder Head

Prepared by; date	______	______
Intake valve type; size	______	______
Exhaust valve type; size	______	______
Valve spring make; size	______	______
Valve spring installed height	______	______
Valve spring seat pressure	______	______
Valve spring open pressure; at	______	______
Retainer make; material	______	______
Keeper type	______	______
Chamber volume	______	______
Head gasket type; thickness	______	______
Valve seal make; type	______	______

Sections 1, 2, and 3 facilitate the mixing and matching of pistons, rods, and the block to achieve a more even piston-to-deck clearance.

Section 1: Piston, Rod, and Crank Stroke

Record here the measurements of piston height, rod length, rod bore, and crank stroke.

Piston Height (PH)	+	Rod Length (RL)	+	½ Rod Bore (½RB)	+	½ Crank Stroke (½CS)		
1 ______		1 ______				1 ______		**1st journal**
2 ______		2 ______					2 ______	
3 ______		3 ______				3 ______		**2nd journal**
4 ______		4 ______		______			4 ______	
5 ______		5 ______				5 ______		**3rd journal**
6 ______		6 ______					6 ______	

Section 2: Deck Height and Main Bore

Measure the block at all four corners of the deck on each bank and average the height at each cylinder. These measurements, combined with half of the main bore, will match those in Section 1.

Actual Deck Height Left Front of Block		Average Deck Height + Half of Main Bore		Actual Deck Height Right Front of Block	
	______			______	
Average Deck Height Per Cylinder	1 ______	______	______	2 ______	Average Deck Height Per Cylinder
	3 ______	______	______	4 ______	
	5 ______	______	______	6 ______	
Actual Deck Height Left Rear of Block		Half of Main Bore		Actual Deck Height Right Rear of Block	
______		______		______	

Blueprinting Records

Section 3: Mix and Match Pistons and Rods (PH + RL + ½RB + ½CS)

Mix and match rod and piston assemblies from Section 1 with the average deck height measurements from Section 2. Example: No. 1 piston + No. 5 rod on No. 4 journal gives X amount of deck clearance. Record the clearance next to the assembly.

Left Side mated piston, rod, and cylinder with clearances					Right Side mated piston, rod, and cylinder with clearances		
1 ______	=	______	______	______	______	=	______ 2
3 ______	=	______	______	______	______	=	______ 4
5 ______	=	______	______	______	______	=	______ 6

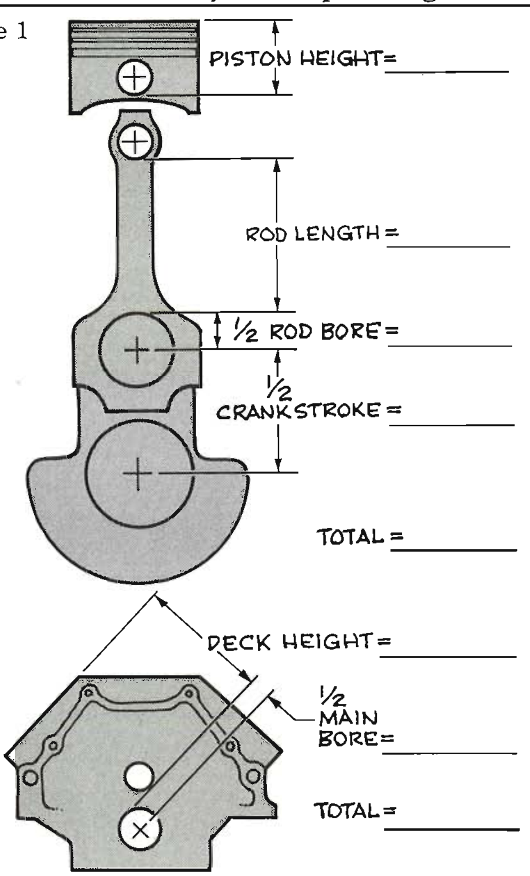
Engine Number ______ Checked by ______ Date ______

Piston Bore Spec ______ Rod Bore Spec ______ Stroke ______

Piston Height (PH)		Rod Length (RL)		Crank Stroke (CS)		Deck to Dome	
Start	Final	Start	Final	Start	Final	Start	Final
1. ______	1. ______	1. ______	1. ______	1. ______	1. ______	1. ______	1. ______
2. ______	2. ______	2. ______	2. ______	2. ______	2. ______	2. ______	2. ______
3. ______	3. ______	3. ______	3. ______	3. ______	3. ______	3. ______	3. ______
4. ______	4. ______	4. ______	4. ______	4. ______	4. ______	4. ______	4. ______
5. ______	5. ______	5. ______	5. ______	5. ______	5. ______	5. ______	5. ______
6. ______	6. ______	6. ______	6. ______	6. ______	6. ______	6. ______	6. ______

Formula for Blueprinting

Figure 1



Balancing Information

Rotating	Reciprocating
Rod ______	Piston ______
Rod ______	Pin/locks ______
Insert ______	Rings ______
Insert ______	Rod ______
Oil ______	
Total bob weight ______	
Each side ______	

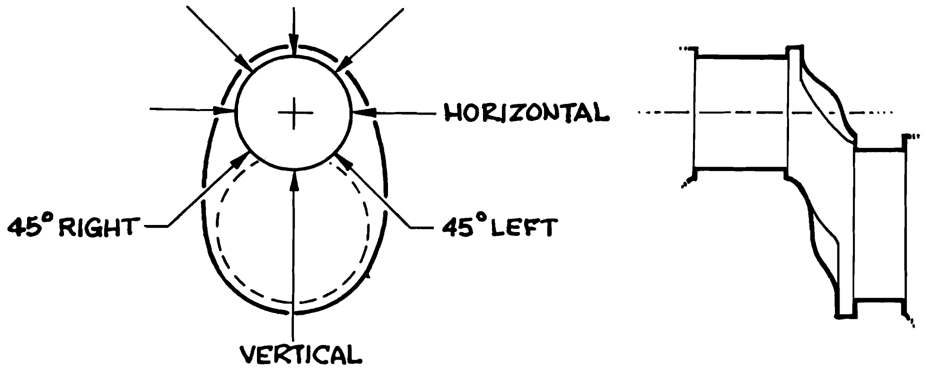
NOTES

Buick heavy-duty parts are designed and manufactured for off-highway use only.

Blueprinting Records

Crankpin Check and Connecting Rod Bearing Clearance

Engine Number ____________________ Checked by ____________________ Date ____________________



Crankpins

Diameter at Front of Journal						
Cylinder	1	2	3	4	5	6
Vertical						
45° Right						
45° Left						
Horizontal						
Diameter of Rear of Journal						
Vertical						
45° Right						
45° Left						
Horizontal						

Note: Journal taper not to exceed 0.0003
Journal out of round not to exceed 0.0003

Bearing Clearance

Bearing (Min.)						
Journal (Max.)						
Clearance						

Rod End Clearance

Rod Thickness						
Journal Width						
Clearance						

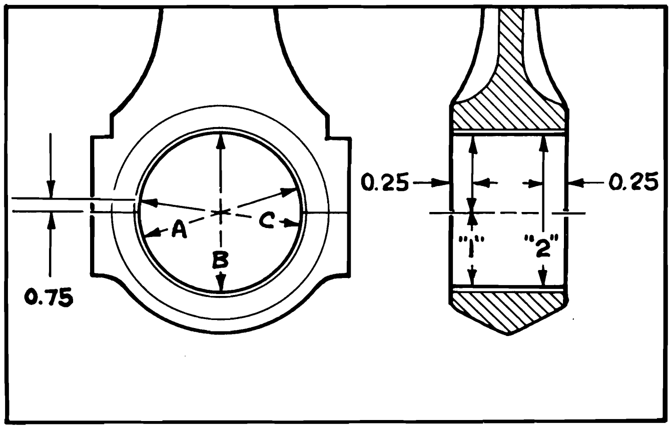
Bearing Sizes Installed in Engine

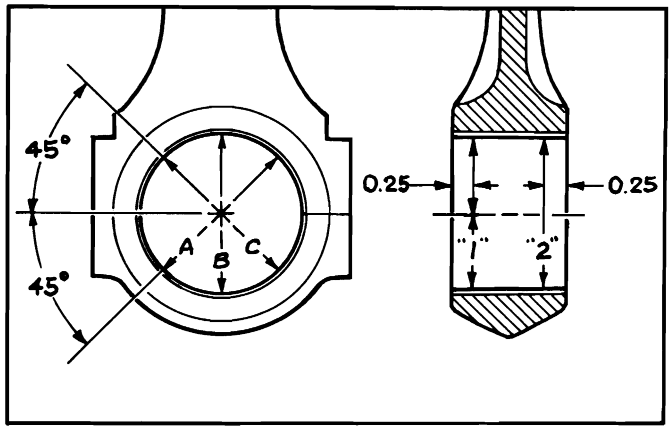
Upper Half						
Lower Half						

Blueprinting Records

Connecting Rod and Bearing

Engine Number ____________ Checked by ____________ Date ____________





Large End Bores						Connecting Rod Bearings					
Bore #		Bore Diameter			Minimum Bore Diameter	Bearing #		Bearing Inside Diameter			Minimum Bore Diameter
		1	2	Taper				1	2	Taper	
1	A					1	A				
	B						B				
	C						C				
2	A					2	A				
	B						B				
	C						C				
3	A					3	A				
	B						B				
	C						C				
4	A					4	A				
	B						B				
	C						C				
5	A					5	A				
	B						B				
	C						C				
6	A					6	A				
	B						B				
	C						C				

NOTES

Buick heavy-duty parts are designed and manufactured for off-highway use only.

Blueprinting Records

Piston Pin Fit

Engine Number ________________ Checked by ________________ Date ________________

Piston		1	2	3	4	5	6
Piston Pin	Min.						
Hole ID	Max.						
Pin Diameter	Min.						
Outside Diameter	Max.						
Clearance	Min.						
in Piston	Max.						
Rod Diameter	Min.						
Inside Diameter	Max.						
Pin	Min.						
Maximum	Max.						

NOTES

Lifters and Cam

Engine Number ________________ Checked by ________________ Date ________________

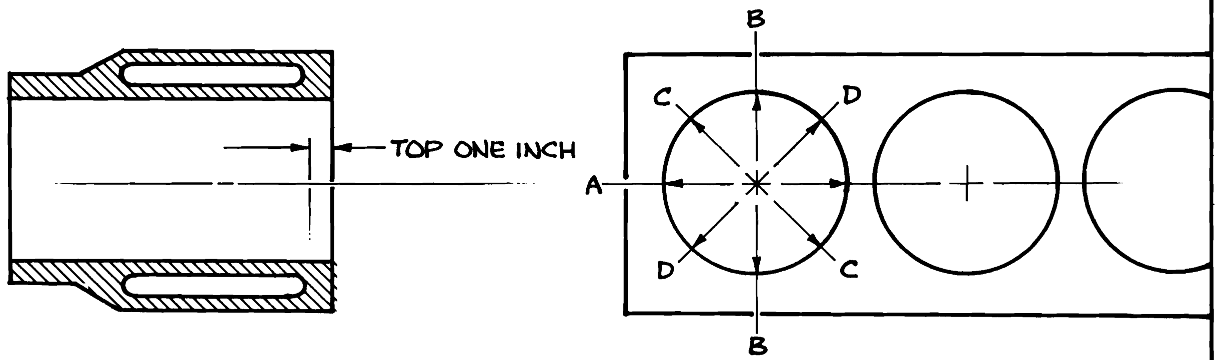
Leakdown Time							
Cylinder		1	2	3	4	5	6
Intake							
Exhaust							
Cam Journal Clearance							
Journal			1	2	3	4	5
Case ID		Min.					
Inside Diameter		Max.					
Shaft OD		Min.					
Outside Diameter		Max.					
Clearance							

NOTES

Blueprinting Records

Cylinder Bores

Engine Number ____________ Checked by ____________ Date ____________



Cylinder Bore Measurements							
Ring Gauge: ____________						Dimensions are 0.0001±Ring Gauge	
		1	2	3	4	5	6
Top	A						
	B						
	C						
	D						
Taper Measurement							
Out of Round Measurement							
Micro							

Piston Rings and Pins

Engine Number ____________ Checked by ____________ Date ____________

Piston Rings							
Cylinder		1	2	3	4	5	6
Side Fit	1						
	2						
	3						

Ring Type and Source: Number 1 Compression ____________
Number 2 Compression ____________
Number 3 Oil ____________

NOTES

Blueprinting Records

Compression Ratio

Engine Number ______________________ Date ______________________

Cylinder	1	2	3	4	5	6	Average
Piston Dish Volume							
Cylinder Head Volume							
Cylinder Head Gasket Volume*							
Piston Ring Land Volume**							
Net Volume							
Compression Ratio							

*Head Gasket Volume
**Ring Land Volume

Swept Volume = ______________________

Net Volume = Piston Dish Volume + Cylinder Head Volume + Gasket Volume + Ring Land Volume

Compression Ratio = $\frac{\text{Swept Volume}}{\text{Net Volume}} + 1 =$ ______________________

Right Head Serial Number ____________ Cast Date ____________ Pattern Number ____________
Left Head Serial Number ____________ Cast Date ____________ Pattern Number ____________

Deck Heights

Engine Number ____________ Checked by ____________ Date ____________

Cylinder	**Deck**
1	
2	
3	
4	
5	
6	

Indicate with (+) if above case and (-) if below.

Camshaft End Clearance

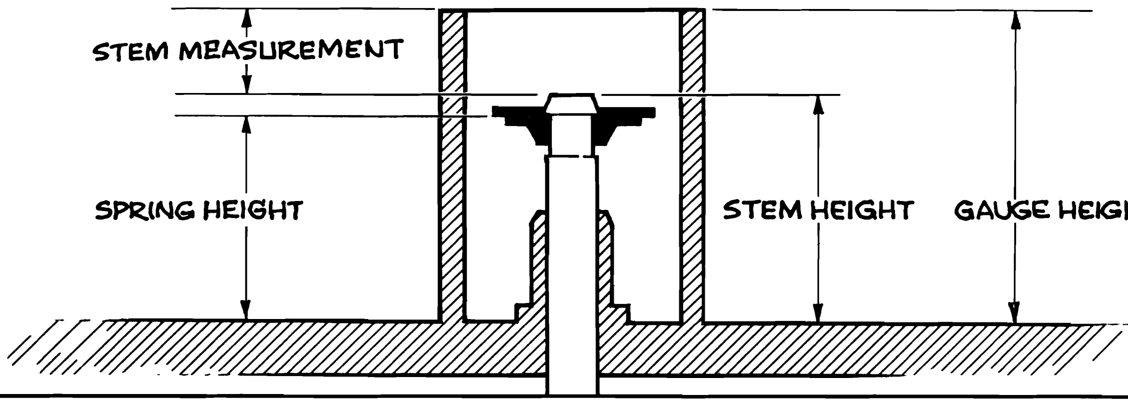
End Clearance = ______________________

NOTES

Blueprinting Records

Valve Spring and Stem Heights
Valve Spring Loads

Engine Number ______________ Checked by ______________ Date ______________



Installed Spring Heights and Valve Stem Heights

Cylinder Number	1		3		5	
Head Number	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake
Spring Height						
Cylinder Number	2		4		6	
Head Number	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake
Spring Height						
Cylinder Number	1		3		5	
Head Number	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake
Open @ 1						
Closed @ 1						
Cylinder Number	2		4		6	
Head Number	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake
Open @ 1						
Closed @ 1						

NOTES

Blueprinting Records

Cam Data

Engine Number ____________ Checked by ____________ Date ____________

Type Drive: Gear/Chain	Cam Position: Advance/Retard ______				
Intake					
Position	TDC	5 ATC	10 ATC	15 ATC	20 ATC
Valve to Piston Clearance					
Lift					
Clearance					
Exhaust					
Position	TDC	5 BTC	10 BTC	15 BTC	20 BTC
Valve to Piston Clearance					
Lift					
Clearance					

	Intake	Exhaust
Checking clearance	______	______
Run clearance, cold	______	______
Run clearance, hot	______	______
Rocker arm type	______	
Rocker arm ratio	______	
Valve Lift	______	______

NOTES

Tech Tips

Leakdown Testing

Leakdown testing has become the "yardstick" of determining engine condition in an increasing number of engine building shops. A leakdown tester doesn't replace any other piece of equipment; it simply augments other pieces of test equipment and allows the engine builder to inexpensively and quickly pinpoint problems within the complete engine assembly.

As an illustration of how the leakdown tester can be used, let's assume a high-performance Buick V6 has been built and broken in on the dyno for about an hour of running at roughly 250 rpm on 30–40 percent load. Bring the number one piston to TDC in the firing mode in which both valves are closed. With the leakdown tester in place (screws into the spark plug hole), pressurize the cylinder with 100 to 150 psi with an air compressor. The air pressure (within reason) is not critical because the tester measures the percentage of leakage. A properly clearanced engine exhibits only 4–5 percent leakdown. An engine showing leakage of 6 percent or more shouldn't go out on the racetrack until the problem is located and fixed. Check all six cylinders in the manner described and record the readings. A lot of time can be saved if the dampener is marked on the trailing edge to reflect TDC on all six cylinders.

Leakdown data is quite valuable when used with dyno data. If the percentage of leakage remains the same while the engine is undergoing changes and shows a gain of horsepower when it is power checked on the dyno, the engine builder has the satisfaction of knowing that the basic condition of the engine is not changing and thus affecting horsepower, and that the new cam or manifold (or whatever) really did help. A component change might actually gain horsepower for the engine, but the dyno does not show it due to horsepower loss caused by any number of problems in the engine—which the leakdown tester would pick up.

If while checking a production engine you find a cylinder with up to 50 percent leakage indicated, don't panic—that's the difference between a high-performance engine and a production engine. Let's say we discover a cylinder that has a high percentage of leakage. The engine is on the dyno and is fairly fresh, but it was run hard for several days as you tried to come up with the "ultimate cam." One cylinder now shows a leak percentage of 15 percent. How do you find the problem? There are a number of ways to juggle this around, but with the head of air still connected to the engine, listen in the carburetor for air rushing. Even if you are just a touch on the hard-of-hearing side, a stethoscope can be of great benefit. If you do hear air rushing into the carb, there is a problem with the intake valve. Repeat the process for the exhaust valve; normally this will require removing the header or one manifold so you can listen in the exhaust port.

If air can be heard rushing in the exhaust port, there is a problem with the exhaust valve. By listening in the crankcase vent for air, the problem can be narrowed down to a piston ring or cylinder wall problem. But which is it—a bad ring or a cylinder wall problem? At this point, the crank can be rotated until the piston in the leaking cylinder is at BDC. If the bore is scored, the chances are pretty good it will not be scored nearly as badly at the bottom of the bore. If this is the case, the leakdown tester will indicate less percentage of leakage; but if the ring is bad, it will be bad all the way down the bore. Obviously, the ring and the bore could be bad, but at least the problem area has been pinpointed. With just a little bit of thought, you'll see that this is about 100 percent better than attempting to use a regular compression gauge—especially if the engine is equipped with a long overlap cam.

If a high percentage of leakage is indicated and if both valves, the cylinder wall and the rings seem to be okay, the tester may be trying to tell you that the head gasket is blown or that a cylinder wall is cracked. With the engine dead cold and full of water, again apply the head of air to the malfunctioning cylinder. If bubbles appear in the coolant in the radiator, this further indicates a blown gasket or cracked piece of hardware.

Aside from the one time when you need to check the engine cold, it should always be checked warm and almost immediately after it has been run to ensure that there is sufficient oil around the rings to effect the hydraulic seal. With just a little practice, all six cylinders on a Buick engine can be leak checked on the dyno or in the car in 10–15 minutes—and this can save a lot of time in the long run.

Final Gearing

Due to the very wide range of applications being covered by the Buick V6—and those that are to follow—it seems appropriate that the subject of final gearing be addressed.

Fractions, Decimal, and Metric Equivalents

Fractions (Inch)	Decimal (Inch)	Metric (Millimeter)
1/64	0.015625	0.39688
1/32	0.03125	0.79375
3/64	0.046875	1.19062
1/16	0.0625	1.58750
5/64	0.078125	1.98437
3/32	0.09375	2.38125
7/64	0.109375	2.77812
1/8	0.125	3.1750
9/64	0.140625	3.57187
5/32	0.15625	3.96875
11/64	0.171875	4.36562
3/16	0.1875	4.76250
13/64	0.203125	5.15937
7/32	0.21875	5.55625
15/64	0.234375	5.95312
1/4	0.250	6.35000
17/64	0.265625	6.74687
9/32	0.28125	7.14375
19/64	0.296875	7.54062
5/16	0.3125	7.93750
21/64	0.328125	8.33437
11/32	0.34375	8.73125
23/64	0.359375	9.12812
3/8	0.375	9.52500
25/64	0.390625	9.92187
13/32	0.40625	10.31875
27/64	0.421875	10.71562
7/16	0.4375	11.11250
29/64	0.453125	11.50937
15/32	0.46875	11.90625
31/64	0.484375	12.30312
1/2	0.500	12.70000
33/64	0.515625	13.09687
17/32	0.53125	13.49375
35/64	0.546875	13.89062
9/16	0.5625	14.28750
37/64	0.578125	14.68437
19/32	0.59375	15.08125
39/64	0.609375	15.47812
5/8	0.625	15.87500
41/64	0.640625	16.27187
21/32	0.65625	16.66875
43/64	0.671875	17.06562
11/16	0.6875	17.46250
45/64	0.703125	17.85937
23/32	0.71875	18.25625
47/64	0.734375	18.65312
3/4	0.750	19.05000
49/64	0.765625	19.44687
25/32	0.78125	19.84375
51/64	0.796875	20.24062
13/16	0.8125	20.63750
53/64	0.828125	21.03437
27/32	0.84375	21.43125
55/64	0.859375	21.82812
7/8	0.875	22.22500
57/64	0.890625	22.62187
29/32	0.90625	23.01875
59/64	0.921875	23.41562
15/16	0.9375	23.81250
61/64	0.953125	24.20937
31/32	0.96875	24.60625
63/64	0.984375	25.00312
1	1.00	25.40000

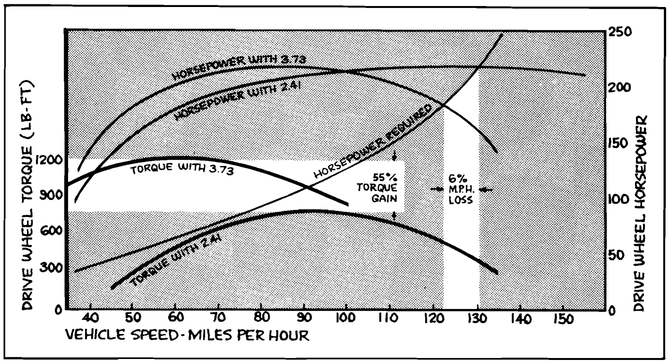
A very good-performance engine can be assembled and tested on the dyno with excellent results yet yield disappointing performance after being installed in the vehicle. The culprit is often final gearing. A change in the final gear ratio can be one of the most satisfying modifications you can make on a performance-oriented vehicle—and it can be one of the most cost effective. For instance, changing from a 2.41:1 ratio to a 3.73:1 ratio will provide a torque increase at the driving wheels of 55 percent! That's torque you can feel.

The accompanying chart lists driving wheel torque increases—to find the torque increase for a proposed gear ratio change, locate the present ratio in the left column and move across to the column headed by the proposed ratio. The percentage shown is the torque increase. Negative percentages are torque decreases.

Proposed Ratio

If the vehicle has sufficient traction to put the increased torque to the ground, a 55 percent increase should substantially improve acceleration—on a track or on the street. Throttle response is greatly heightened. The road horsepower graph shows that maximum vehicle speed is influenced by the final drive ratio. The graph shows increasing horsepower and torque on the vertical axis and increasing vehicle speed on the horizontal axis. There are five curves on the graph—two at drive wheel curves (2.41:1 and 3.73:1 ratios), two horsepower at drive wheel curves for the same ratios, and one horsepower required to maintain road speed curve. The two drive wheel torque curves show that increasing the gear ratio causes the torque peak to occur at a lower road speed and increases the peak torque value. This is the explanation for the performance increase. The two drive wheel horsepower curves show that increasing the gear ratio causes the horsepower peak to occur at a lower road speed but that the peak horsepower value does not change. The horsepower required curve indicates the amount of horsepower required to maintain vehicle speed. The respective maximum vehicle speeds are indicated where the drive wheel horsepower curves intersect the horsepower required curve. Another way of stating all of this is that the graph shows a torque increase of 55 percent can be had while maximum vehicle speed is reduced by about 8 mph—a 6 percent loss.

Road Horsepower



Transmission Gear Ratios

These are the most commonly available OEM transmissions used in heavy-duty applications.

Transmission	1st	2nd	3rd	4th	5th
THM 350	2.5500	1.5500	1.00	–	–
THM 400	2.4815	1.4815	1.00	–	–
SAG 3-speed	3.1100	1.8400	1.00	–	–
SAG 3-speed	2.5400	1.5000	1.00	–	–
SAG 3-speed	2.8500	1.6800	1.00	–	–
SAG 3-speed	3.5000	1.8950	1.00	–	–
SAG 4-speed	3.1100	2.2000	1.47	1.00	–
SAG 4-speed	3.5000	2.4800	1.66	1.00	–
SAG 4-speed	2.5400	1.8000	1.44	1.00	–
BW 4-speed	2.4300	1.6100	1.23	1.00	–
BW 4-speed	2.6400	1.7500	1.34	1.00	–
BW 4-speed	2.8800	1.9100	1.33	1.00	–
BW 4-speed	3.4200	2.2800	1.46	1.00	–
BWT5A 5-speed	4.0300	2.3700	1.49	1.00	0.76
BWT5C 5-speed	4.0300	2.3700	1.49	1.00	0.86
BWT5K 5-speed	3.7600	2.1800	1.42	1.00	0.72
BWT5E 5-speed	3.5000	2.1400	1.39	1.00	0.78
BWT5H 5-speed	3.5000	2.1400	1.39	1.00	0.73
BWT5J 5-speed	3.3500	2.0600	1.38	1.00	0.78
BWT5G 5-speed	2.9500	1.9400	1.34	1.00	0.73
BWT5L 5-speed	2.9500	1.9400	1.34	1.00	0.63
BWT5P 5-speed	4.0300	2.3700	1.49	1.00	0.81
BWT5V 5-speed	3.3500	1.9300	1.29	1.00	0.61

Torque Percentage Changes

% of Torque Increase		Proposed Ratio 2.41	2.56	2.73	3.08	3.23	3.42	3.55	3.73	3.90	4.10
Original Ratio	2.41		+6%	+13%	+28%	+34%	+42%	+47%	+55%	+62%	+70%
	2.56	- 6%		+7%	+20%	+26%	+34%	+39%	+46%	+52%	+60%
	2.73	-12%	- 6%		+13%	+18%	+25%	+30%	+37%	+43%	+50%
	3.08	-22%	-17%	-11%	+5%	+11%	+15%	+21%	+27%	+33%	
	3.23	-25%	-21%	-15%	- 5%		+6%	+10%	+15%	+21%	+27%
	3.42	-30%	-25%	-20%	-10%	- 6%		+4%	+9%	+14%	+20%
	3.55	-32%	-28%	-23%	-13%	- 9%		+5%	+10%	+15%	
	3.73	-35%	-31%	-27%	-17%	-13%	- 8%	- 5%		+5%	+10%
	3.90	-38%	-34%	-30%	-21%	-17%	-12%	- 9%	- 4%		+5%
	4.10	-41%	-38%	-33%	-25%	-21%	-17%	-13%	- 9%	- 5%	

% of Torque Loss

Engine Parts

All GM parts are available through any franchised GM car or truck dealer. Such dealers order all GM parts through General Motors Parts Division, which maintains 27 Parts Distribution Centers throughout the continental United States. Although not all parts are stocked in all Parts Distribution Centers, computers facilitate speedy transmission to the nearest stocking location. Dealers may specify special-order handling when requested by the customer to ensure prompt delivery.

Buick's heavy-duty hardware line continues to grow. Stage I and Stage II blocks, cylinder heads, intake manifolds, bearings, and many other parts are available through GM dealerships nationally. Many aftermarket suppliers market supplementary pieces of heavy-duty hardware to reinforce Buick's solid success in competition. Incorporated into this publication is not only V6 service and heavy-duty-parts information, but also a listing of aftermarket suppliers. The blueprinting records, tips, and cylinder head port guide are intended to help you achieve success with your own Buick.

Important Notice

These Buick V6 parts are intended for application in off-highway vehicles only, because federal law restricts the removal or modification of any part of federally required emissions control systems on a car or truck. Further, many states have laws with penalties for tampering with or otherwise modifying any required emissions or noise-control system. Vehicles not used on public highways may be exempt from most regulations, but check your own local and state laws to be sure.

Section 1857 P-1 of Title II of the Clean Air Act, as amended 42 USC31857 P-1 et seq provides that the following acts and the causing thereof are prohibited:

"... for any person to remove or render inoperative any device or element of design installed on or in a motor vehicle engine in compliance with regulations under this title prior to its sale and delivery to the ultimate purchaser, or for any manufacturer or dealer knowingly to remove or render inoperative any such device or element of design after such sale and delivery to the ultimate purchaser."

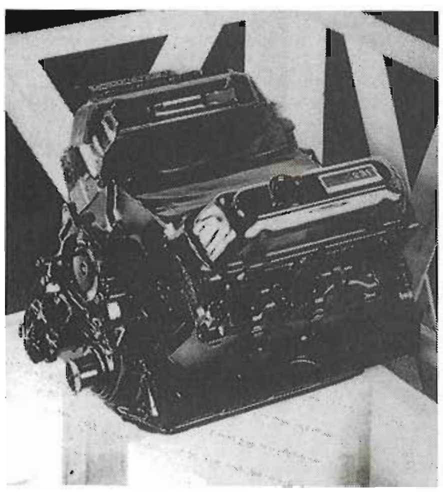
The Clean Air Act defines "motor vehicle" as a self-propelled vehicle designed for transporting persons or property on a street or highway. Many of the parts described or listed herein are merchandised for off-highway application only and are tagged with the following special parts notice.

Special Parts

This part has been specifically designed for off-highway application only. Since the installation of this part may either impair your vehicle's emissions control performance or be uncertified under current Motor Vehicle Safety Standards, it should not be installed in a vehicle used on any street or highway. Additionally, any such application could adversely affect the warranty coverage on such an on-street or highway vehicle. If any engine or vehicle is being prepared for a competitive event, it is most important to keep abreast of the rules.

Parts Warranty

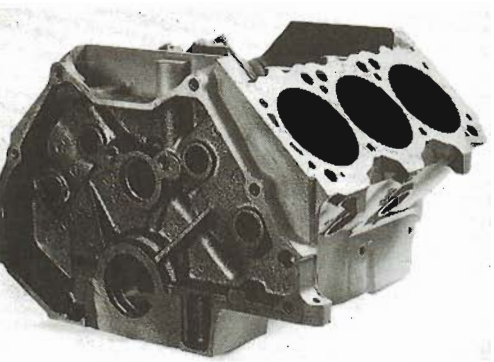
Due to intended use of many of the parts listed, they are sold without warranty or guarantee, direct or implied. Installation of performance parts in the engine, drivetrain, or chassis of any General Motors vehicle voids the vehicle's warranty.

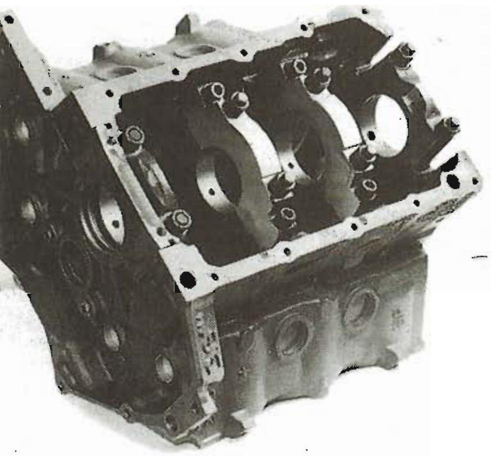


PART NO.	CATALOG GROUP/USE	QTY.
0.000 ENGINE AND BLOCK ASSEMBLY CYLINDER		
25516822	V6 Goodwrench powerline	
3.8L engine	(1979-85) Included are: Cylinder block assembly; connecting rod and piston assemblies; crankshaft; camshaft; complete cylinder head assemblies including valvetrains, camshaft and crankshaft sprockets with chain, timing gears and timing cover; oil pump and screen; oil pan; and installation instruction sheet. Rear-wheel-drive bolt pattern on rear face of block. The shipping weight of this engine including the crate is 345 pounds. Flywheel, distributor, intake and exhaust manifolds, and harmonic balancer are not included.	AR*

**AR = as required*

PART NO.	CATALOG GROUP/USE	QTY.





0.033 BLOCKS AND PARTIAL ENGINES

PART NO.	CATALOG GROUP/USE	QTY.
25500011	3.8L Stage I Block	AR
25500015	4.1L Stage I Block	AR
	Features: –High strength –Solid cast main bearing bulkheads –Solid cast lifter valley (customer must add drain holes when used with wet-sump oiling system) –Increased deck structure with provisions for six additional head bolts per bank –Reinforced rear face –Large-diameter lifter bosses –Increased pan rail structure –Casting structure for four-bolt main bearing caps on No. 2 and No. 3 journals–(Caps available from aftermarket sources) –Cast provisions for water drains –Unchamfered bores –Minimum-size cylinder bores –Maximum-height decks –Casting numbers: 3.8L 25500012; 4.1L 25500016	
25500013	Stage II Block, 3.8L	AR
25500017	Stage II Block, 4.1L	AR
	Features: –Same as Stage I plus: –Machined for six extra head bolts per bank –Four-bolt main caps at two center mains –Revised oiling system with provisions for dry-sump hardware –Main bearings align honed –Casting numbers same as Stage I Block	

0.096 BEARINGS, CRANKSHAFT, MAIN

PART NO.	CATALOG GROUP/USE	QTY.
18002950	Bearings standard No. 1 and No. 3	AR
18002951	Bearing 0.001 undersize No. 1 and No. 3	AR
18002952	Bearing 0.002 undersize No. 1 and No. 3	AR
18004602	Bearing standard No. 2 (thrust)	AR
18004603	Bearing 0.001 undersize No. 2 (thrust)	AR
18004604	Bearing 0.002 undersize No. 2 (thrust)	
5468578	Bearing standard No. 4	
5468579	Bearing 0.001 undersize No. 4	AR
5468580	Bearing 0.002 undersize No. 4	AR
25500074	Bearings, crankshaft set, standard	AR
2500080	Bearings, crankshaft set, 0.001-inch undersize. Both above sets include No. 1, 3 and 4 main bearings and No. 2 thrust bearing. Material adequate for competition usage. These are GM 400 M bearings.	

0.137 SEAL—SEAL KIT—ENGINE REAR MAIN

PART NO.	CATALOG GROUP/USE	QTY.
1193151	Seal, Rear Bearing Cap all V6 3.8–4.1L	1
9772831	Seal, Rear Main Bearing Oil Seal all V6 3.8–4.1L (packing)	2
3997597	Chemical sealant kit that can be used to replace rear main cap bearing side seals on all Buick V6 engines	AR

0.206 ENGINE COVER, FRONT

PART NO.	CATALOG GROUP/USE	QTY.
25515465	This preferred front cover gasket fits all displacement Buick engines since 1976 and has revised water pump passages to improve and equalize water flow to both heads with a minimum of cavitation	1

0.219 INDICATOR MARK, TIMING

PART NO.	CATALOG GROUP/USE	QTY.
1264952	Bolt-on timing mark indicator for front cover for front engine, rear-wheel-drive applications	1

0.269 HEAD, ENGINE CYLINDER

Note 1: Stage I Cylinder heads use the same bolts or studs as production. Stage II Cylinder heads require a different number and length stud for attachment to the block. Stud kits are available from several V6 power source suppliers. Production rocker shafts and rockers are acceptable on Stage I heads if a hydraulic cam is used. It is advisable to remove the stock Teflon buttons and use sections of steel tubing over the rocker shaft to keep the rockers properly spaced. Mechanical lifter cams require the use of aftermarket rockers and shaft assemblies. Stage I heads can be fitted with GM valve springs 3927142 or 330585.

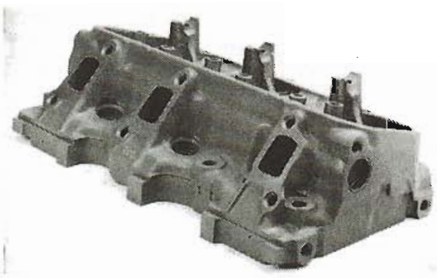
PART NO. | **CATALOG GROUP/USE** | **QTY.**

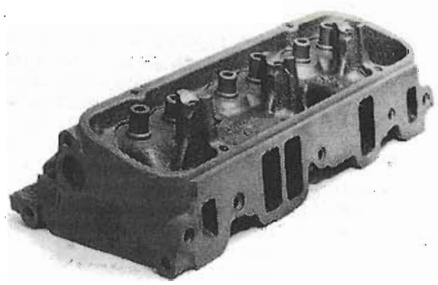
Stage II Heads require aftermarket rocker and shaft assemblies.

GM valve spring assembly 3989354 and valve spring retainer 3989353 are recommended for all Stage II head applications. Stage II cylinders heads are machined to accept ¾-inch-reach gasket-type spark plugs. Many AC Spark Plug Division spark plugs meet this requirement. Some of these are S40XL, S41XL, S43XL, and 41XL (Stage I uses a tapered seat spark plug).

Rocker covers for Stage II heads may be obtained from aftermarket suppliers.

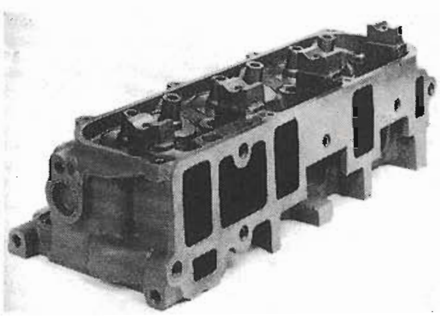
When ordering a camshaft from an aftermarket source, the supplier must know if the engine is equipped with Stage I or Stage II heads due to the different placement of intake and exhaust ports. Rev kits are available for Stage II heads from aftermarket suppliers.





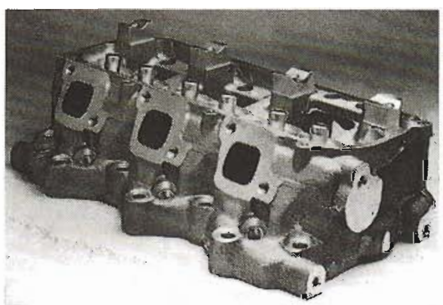
25500009 Cylinder Head V6 3.8 and 4.1L Stage I for off-road use (Casting number 25506293) *(Note 1)* ____ 2

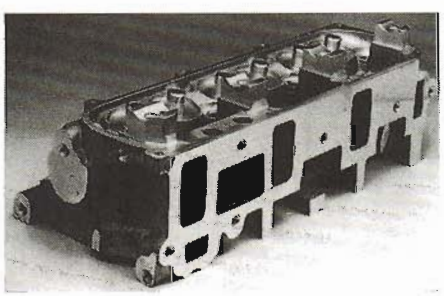
Features:
- Intake and exhaust port flow
- Reinforced deck surface
- Uses production 1.17-inch intake and 1.50 exhaust valves
- No heat crossover
- Can be used on all production blocks (when used on 1975-76 models you must use 1979 or later intake and exhaust manifolds)



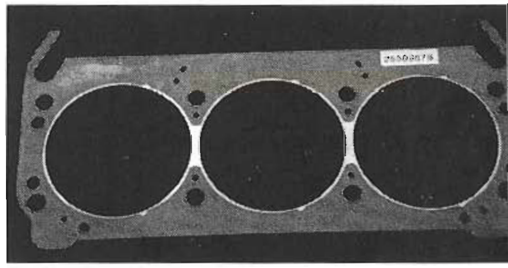
25500026 Cylinder Head V6 3.8 and 4.1L Stage II (iron) for off-road use (Casting No. 25500027) *(Note 1)* ____ 2

Features:
- New "Competition Only" iron head (machined, except for valve grinding)
- Head bolt pattern same as Stage II Block
- Uses 2.02 intake and 1.60 exhaust valves





25500030 Stage II head (aluminum). This casting is from heat-treated 355 Alloy. Valve seats are installed and ready for grinding. Bronze-lined valve guides are installed but require honing for valve clearance. Accepts same valve sizes as Stage II iron heads. ____ AR



0.289 GASKET, ENGINE CYLINDER HEAD

25500202 Head gasket for 1975-85 3.8Ls. Heavy-duty steel-shim-type 0.018-inch thick for use with production or Stage I blocks only ____ 2
Head gasket for 1975-85 4.1Ls. Heavy-duty composition construction for use with production or Stage I blocks only. Compresses to approximately 0.040-inch thick ____ 2

25500006 Head gasket for 3.8 and 4.1L Stage I and Stage II blocks. Heavy-duty composition construction with a solid-core body with stainless steel flanging and solid wire 0-ring in the fire ring flange. Compresses to approximately 0.040-inch thick. ____ AR

0.293 BOLT, WASHER, NUT CYLINDER HEAD

25518482 Cylinder Head Bolt—long for production and Stage I cylinder heads ____ AR

25515638 Cylinder Head Bolt—short for production and Stage I cylinder heads ____ AR

14011040 Washer (special hardened)—0.45-inch ID, 0.78-inch OD ____ AR

14044866 Nut, 7/16 x 20-inch "12 point" (4037 steel) 100% Magnafluxed ____ AR

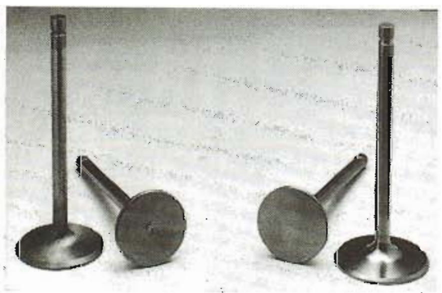
PART NO.	CATALOG GROUP/USE	QTY.

0.296 VALVE, INTAKE

PART NO.	CATALOG GROUP/USE	QTY.
25512098	Intake Valve, all 1979-85 3.8 and 4.1L V6 (1.71-inch diameter)	6
25500024	Intake Valve, all 3.8–4.1L V6 Stage II for heavy-duty off-road use 2.02-inch diameter	6

0.297 VALVE, EXHAUST

PART NO.	CATALOG GROUP/USE	QTY.
1261380	Exhaust Valve, all 1980-85 3.8 and 4.1L V6 (1.50-inch diameter)	6
25500023	Exhaust Valve, all 3.8 and 4.1L V6 for Stage II heavy-duty off-road head (1.60-inch diameter)	6



PART NO.	CATALOG GROUP/USE	QTY.
3500025	Exhaust Valve, all 3.8 and 4.1L V6 heavy-duty off-road use (optional Inconel Exhaust for Turbo Charge application), (1.60-inch diameter)	6

0.303 SPRING ASSEMBLY, VALVE

PART NO.	CATALOG GROUP/USE	QTY.
3989353	Stage II valve spring retainer for use with spring 3989354	12

PART NO.	CATALOG GROUP/USE	QTY.
3989354	Stage II valve spring assembly made from aircraft-quality clean steel wire featuring 120 pounds pressure on the seat at 1.75 inches and 285 pounds pressure at 1.25 inches compressed height	12
25512551	Production valve spring for turbocharged engines	12

PART NO.	CATALOG GROUP/USE	QTY.
3927142	Valve spring and dampener, optional off-road use, OD 1.273 inches. Valve seal kit 14033547 recommended for this spring. At an installed height of 1.70 inches, seat pressure is 110 pounds. At a compressed solid height of 1.16 inches, this spring should exhibit 358 pounds pressure.	12

PART NO.	CATALOG GROUP/USE	QTY.
330585	Dual valve spring for use with aluminum retainer 330586; valve spring OD is 1.379 inches. Valve seal kit 14033547 is recommended for this spring. At an installed height of 1.75 inches, seat pressure is 140 pounds. At a compressed solid height of 1.15 inches, this spring should exhibit 325 pounds pressure.	12
366282	Dual valve spring and dampener assembly for use with titanium retainer 366254; valve spring OD is 1.525 inches. At an installed height of 1.70 inches, seat pressure is 128 pounds. At a compressed solid height of 1.26 inches, this spring should exhibit 406 pounds pressure.	12
1249267	Valve spring, 1976-85, 3.8 and 4.1L V6 production springs; valve spring OD is 1.24 inches. At an installed height of 1.73 inches, seat pressure is 66 pounds. At a compressed solid height of 1.25 inches, this spring should exhibit 234 pounds pressure.	12
3911068	Valve spring and dampener; valve spring OD is 1.241 inches. Valve seal kit 14033547 is recommended for this spring. At an installed height of 1.70 inches, seat pressure is 80 pounds. At a compressed solid height of 1.15 inches, this spring should exhibit 267 pounds pressure.	12

PART NO.	CATALOG GROUP/USE	QTY.
25500035	Competition valve spring for use with Stage II cylinder head; 1.725-inch OD, 200-pound load @ 1.90 inches installed height. 500 lbs./in. spring rate. Nominal solid height is 1.15 inches.	AR
3731058	Shim (55/64-inch ID x 1 15/64-inch OD x 0.030-inch thick)	AR
3875916	Shim (45/64-inch ID x 1 31/64-inch OD x 0.015-inch thick)	AR
3891521	Shim (45/64-inch ID x 1 31/64-inch OD x 0.065-inch thick)	AR

PART NO.	CATALOG GROUP/USE	QTY.

0.309 CAP, VALVE SPRING RETAINER

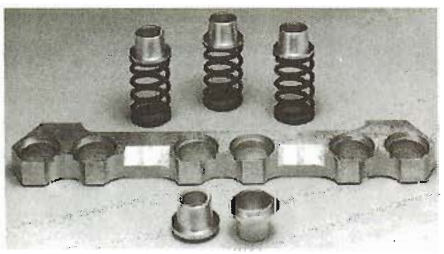
330586	Cap, Valve Spring—aluminum for use with valve spring 3350585 Stage I head must use longer-than-stock valve stem	AR
3989353	Cap, Valve Spring—steel. Use with valve spring 3989354.	AR
366254	Cap, Valve Spring. Titanium for off-road use; use with valve spring 366282	AR
14003974	Cap, Valve Spring—steel for off-road use. Use with valve spring 3927142 (1 3/32-inch OD diameter)	AR

0.310 KEY, ENGINE VALVE SPRING

3947770	Key, Valve Keeper—steel, for 11/32-inch stem (purple)	AR

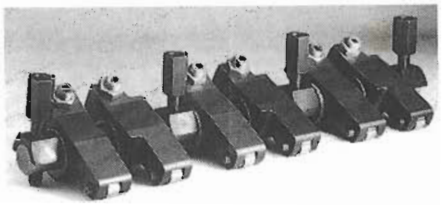
0.333 ARM, ENGINE VALVE ROCKER

1241850	Rocker Arm all 1976-85 3.8-4.1L V6 Buick Engines (intake 1-4-5, exhaust 2-3-5). Use on production or Stage I engines	12



0.349 HI-REV KIT ASSEMBLY PIECES

25500041	Aluminum retention bar (Group 0.349)	2
25500042	Aluminum spring cups (Group 0.459)	12
25500043	Springs (Group 0.459) Complete assembly fits Stage II aluminum and cast-iron cylinder heads and accommodates on-center or offset Iskenderian roller lifters	12



0.352 ROCKER ARM ASSEMBLY (STAGE II CYLINDER HEAD)

25500044	Assembly includes 12 rocker arms, 2 shafts, spacers and hold-down kit. Fits Stage II aluminum or cast-iron cylinder heads. Rockers are 2024 T-6 aluminum fitted with Torrington needle roller bearings. Shafts are 8620 hardened steel. Rocker arm ratio is 1.7:1 inches	2
1241851	Rocker Arm, 1976-85, all 3.8 and 4.1L V6 Buick engines (intake 2-3-6, exhaust 1-4-5). Use on production or Stage I engine	6

0.353 SHAFT, ENGINE VALVE ROCKER ARM

1254201	Rocker Arm Shaft, all 1977-85 V6 3.8 and 4.1L for production or Stage I Head (stamped steel). For Stage II Shaft, refer to aftermarket suppliers.	2

0.386 ROCKER ARM COVER

25516851	Rocker Arm Cover for production and Stage I cylinder heads. Has flanged hole for breather 1552232 or oil filler cap	AR
25516850	Rocker Arm Cover for production and Stage I cylinder heads (hole for rubber grommet)	AR
25519988	Cast-aluminum valve cover for all 1977-85 production and Stage I heads (no holes)	AR
25519989	Cast-aluminum valve cover for all 1977-85 production and Stage I heads (holes for breather or oil filler cap and one for PCV valve)	AR

0.423 ROCKER ARM COVER GASKET

25505889	Stage I Rocker Arm Cover Gasket	AR

0.426 ROD, ENGINE VALVE PUSH

1249139	Pushrod, all 1976-85 3.8 and 4.1L V6 (production part), 5/16 x 0.060-inch wall tube (8.718-inch overall length; ID green). Use Buick rocker arm and lifters. May be required with after-market roller rocker arms and roller lifters. Check manufacturer for correct length.	AR
366277	Pushrod, off-road use; 5/16 x 0.070-inch wall tube (7.824-inch overall length). (OD black oxide). May be required with aftermarket roller rocker arms and roller lifters. Check manu-facturer for correct length.	AR
14075631	Pushrod, off-road use; 5/16 x 0.075-inch wall tube (9.13-inch overall length)	AR
14075632	Pushrod off-road use; 5/16 x 0.075-inch wall tube (8.155-inch overall length)	AR
3942415	Pushrod, off-road use. Can be used in some Stage II roller lifter configurations; 7/16-inch diameter x 9.250-inch length.	AR

Tech Tip

The use of Molykote (or another molydisulfide-based EP lubricant) is recommended on lifters for proper break-in. In addition, valve lifters are more compatible with the camshaft if the contact surface is polished with 600-grit sandpaper before installation. Good used lifters retaining some crown or convex curvature across the bottom are satisfactory.

0.459 LIFTER, ENGINE VALVE

Note 1: For high-performance hydraulic camshafts for use with adjustable rockers and Buick heavy-duty lifter 5234330; adjust to zero lash plus 1/2- to 3/4-turn.
Note 2: Mechanical camshafts require GM lifter 5232695 (piddle valve) or 5231585 (edge orifice). The edge orifice design limits overhead oiling and is recommended for use with needle roller arms.

5234330	Lifter, standard production replacement (hydraulic) *(Note 1)*	12

PART NO.	CATALOG GROUP/USE	QTY.
5234345	Lifter, 0.010-inch oversize production replacement (hydraulic) *(Note 1)*	AR
5231585	Lifter, mechanical (edge orifice design, two-piece body, two holes in body, single groove around body). Use with roller rocker arms; Buick off-road *(Note 2)*	12
5232695	Lifter, mechanical, piddle- valve design (2.0 inches long x 27/32-inch OD); V6 Buick off-road	AR

0.519 CAMSHAFT, STAGE II UNFINISHED

Note 1: When fitting a roller lifter camshaft, any aftermarket lifter used in a small-block Chevrolet is applicable to Stage II blocks, while Stage I blocks require a special roller lifter with a special shielded "foot" that prevents oil hemorrhaging from the gallery to camshaft tunnel at maximum lift.

PART NO.	CATALOG GROUP/USE	QTY.
25500056	Steel camshaft blank of 8620 material, heat-treated and configured to accommodate 100- to 114-degree lobe separation and up to 0.750-inch valve lift. Requires final lobe grind. Maximum lobe lift is 0.450-inch.	AR
366253	Lifter, mushroom mechanical type with 0.960-inch-diameter foot *(Note 1)*	12

0.533 BUTTON, SPRING CAMSHAFT THRUST

PART NO.	CATALOG GROUP/USE	QTY.
1250948	Button, all V6 1975-85	1
1250126	Spring Button, 1975-77 3.8L V6, for use with nonintegral distributor drive gear cam	1
1254199	Spring Button, 1977-85, for use with integral distributor drive gear cam	1

0.539 BEARING CAM FRONT

PART NO.	CATALOG GROUP/USE	QTY.
1234441	Front Cam Bearing for 1976 and newer V6 engines, no split (preferred design)	1

0.543 BEARING, CAM–INTERMEDIATE CENTER AND REAR

PART NO.	CATALOG GROUP/USE	QTY.
1231142	Cam Bearing for 1976 and later V6 engines	3

0.553 PLUG, CAM REAR

PART NO.	CATALOG GROUP/USE	QTY.
1363755	Plug, 1976 and later V6, rear face of block plug for camshaft hole	1

0.616 BEARING KIT, ENGINE CONNECTING ROD

PART NO.	CATALOG GROUP/USE	QTY.
5463929	Bearing 0.010-inch undersize	AR
5463930	Bearing 0.001-inch undersize	AR
5463931	Bearing 0.002-inch undersize	AR
5463932	Bearing standard	AR
18005399	Bearing kit standard	AR
18005400	Bearing kit 0.008 undersize	AR
18005401	Bearing kit 0.010 undersize	AR
25500072	Standard connecting rod bearings	AR
25500073	0.001-inch undersize standard width, standard material connecting rod bearings. Both above sets are for use with rolled fillet crankshaft for increased width to maximize bearing area. Thin overlay thickness increases fatigue resistance in addition to increasing "crush" to aid bearing retention and improve heat transfer.	AR
25500070	Standard connecting rod bearings for use with standard-width crank bearings	AR

PART NO.	CATALOG GROUP/USE	QTY.
25500071	0.001-inch undersize connecting rod bearings for use with standard-width crank bearings. Thin overlay thickness increases fatigue resistance in addition to increasing "crush" to aid bearing retention and improve heat transfer.	AR

0.629 PISTON, ENGINE

Note 1: Stage I pistons cannot be used with Stage II cylinder heads due to the valve pocket location, so Stage II aftermarket pistons must be purchased. Buick forged pistons should be installed at 0.0055-0.0065-inch piston-to-bore clearance. Aftermarket pistons should be installed at the manufacturer's recommended clearance.

Piston rings are available for Buick applications from aftermarket sources. Ring end gaps should be set at recommended clearance in their respective bores to prevent ring scuffing.

Piston-to-valve clearance should be checked when you assemble the engine (0.120-inch intake is recommended; 0.150-inch exhaust is recommended).

PART NO.	CATALOG GROUP/USE	QTY.
25500460	Piston and Pin Assembly 3.8L Stage I (Standard) for use on cylinder Nos. 1, 3, 4, and 6. ID 25500469, forged aluminum, 11.2:1 compression ratio, floating-pin design *(Note 1)*	4

PART NO.	CATALOG GROUP/USE	QTY.
25500461	Piston and Pin Assembly, 3.8L Stage I (Standard) for use on cylinder Nos. 2 and 5. ID 25500470, forged aluminum, 11.2:1 compression ratio, floating-pin design. *(Note 1)*	2
25500462	Piston and Pin Assembly 3.8L Stage I (0.010 oversize) for use on cylinder Nos. 1, 3, 4, and 6. ID 25500471, forged aluminum, 11.2:1 compression ratio, floating-pin design. *(Note 1)*	4

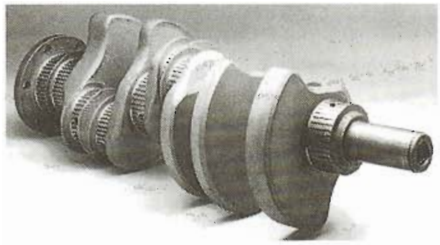
PART NO.	CATALOG GROUP/USE	QTY.
25500463	Piston and Pin Assembly, 3.8L Stage I (0.010 oversize) for use on cylinder Nos. 2 and 5. ID 25500472, forged aluminum, 11.2:1 compression ratio, floating-pin design. *(Note 1)*	2
25500464	Piston and Pin Assembly, 3.8L Stage I (0.020 oversize) for use on cylinder Nos. 1, 3, 4, and 6. ID 25500473, forged aluminum, 11.2:1 compression ratio, floating-pin design. *(Note 1)*	4
25500465	Piston and Pin Assembly, 3.8L Stage I (0.020 oversize) for use on cylinder Nos. 2 and 5. ID 25500474, forged aluminum, 11.2:1 compression ratio, floating-pin design. *(Note 1)*	2
25500466	Piston and Pin Assembly, 3.8L Stage I (0.030 oversize) for use on cylinder Nos. 1, 3, 4, and 6. ID 25500475, forged aluminum, 11.2:1 compression ratio, floating-pin design. *(Note 1)*	4
25500467	Piston and Pin Assembly, 3.8L Stage I (0.030 oversize) for use on cylinder Nos. 2 and 5. ID 25500476. *(Note 1)*	AR
25516538	Piston and Pin Assembly, 4.1L Stage I (standard) for use on all cylinders. ID 25516543, forged aluminum, 12.1:1 compression ratio, floating-pin design. *(Note 1)*	6
25516539	Piston and Pin Assembly, 4.1L Stage I (0.010 oversize) for use on all cylinders. ID 25516544, forged aluminum, 12.1:1 compression ratio, floating-pin design. *(Note 1)*	6
25516540	Piston and Pin Assembly, 4.1L Stage I (0.020 oversize) for use on all cylinders. ID 25516545, forged aluminum, 12.1:1 compression ratio, floating-pin design. *(Note 1)*	6
25516541	Piston and Pin Assembly, 4.1L Stage I (0.030 oversize) for use on all cylinders. ID 25516546, forged aluminum, 12.1:1 compression ratio, floating-pin design. *(Note 1)*	6

0.639 RETAINER, ENGINE PISTON RING

PART NO.	CATALOG GROUP/USE	QTY.
3946848	Retainer (Spirolocks design), 1.013-inch OD x 0.042-inch thick for full-floating-pin design	AR
3942423	Retainer (Spirolocks design), 1.013-inch OD x 0.050-inch thick for full-floating-pin design	AR
3964238	Retainer (Spirolocks design), 1.103-inch OD x 0.072-inch thick for full-floating-pin design	AR
366219	Retainer (Spirolocks design), 1.013-inch OD x 0.072-inch thick	AR
14011033	Retainer (Round-wire design), 1.07-inch x 0.064-inch thick	AR

0.646 CRANKSHAFT, ENGINE

PART NO.	CATALOG GROUP/USE	QTY.
1260873	Crankshaft, 1978-85 V6, 3.8 and 4.1L engines. This is a production, even-fire, rolled-fillet crank for normally aspirated turbocharged 231 and 252-cubic-inch engines; has ¾-inch balancer bolts (nodular cast iron). Excellent hardware for high-performance street and competition engines with up to 400 horsepower	1
5500008	Crankshaft forging. This is a raw crank forging that can be custom machined from 2.66–3.625-inch stroke Material is 4140 steel. Main bearing journals are not machined.	1
25500066	Stroke: 3.625	1
25500067	Stroke: 3.400	1



PART NO.	CATALOG GROUP/USE	QTY.
25500068	Stroke: 3.060 Semifinished crankshafts produced from the 25500008 forging, fully machined with the exception of 0.020-inch stock on rod and main journal fillets. Main journals are cross-drilled.	1

0.648 SLINGER, CRANKSHAFT

PART NO.	CATALOG GROUP/USE	QTY.
1193967	Slinger, 3.8 and 4.1L V6 stamped steel	1

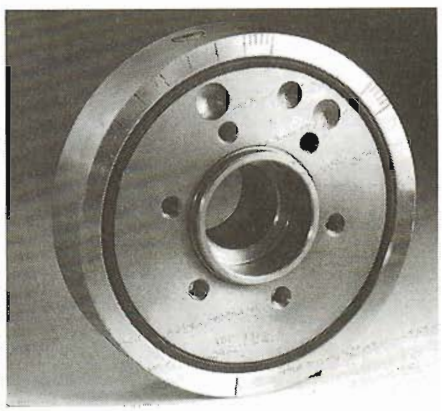
0.649 BEARING CLUTCH PILOT, CRANKSHAFT

PART NO.	CATALOG GROUP/USE	QTY.
3752487	Bearing—all standard transmission	1

0.659 DAMPENER, ENGINE CRANKSHAFT

Note 1: V6 engines are balanced as complete assemblies, so when changing piston, rod, crank, flywheel or balancer, you must rebalance the engine.

PART NO.	CATALOG GROUP/USE	QTY.
25506571	Balancer, V6 231 with turbo *(Note 1)*	1
25508994	Balancer, V6 4.1L *(Note 1)*	1



PART NO.	CATALOG GROUP/USE	QTY.
25500069	Stage II Harmonic Balancer featuring nodular iron hub and steel inertia ring. Balanced	1

PART NO.	CATALOG GROUP/USE	QTY.
25500065	Stage III Harmonic Balancer with interrupter rings attached to rear face for triggering heavy-duty ignition	AR

0.666 FLYWHEEL

Note 1: Production V6 engines are balanced as a complete assembly, so when changing connecting rod, piston, crank, flywheel or balancer, you must rebalance the engine.

Drill balance holes no closer than 1.38 inches from converter mounting holes.

Not recommended for high-rpm operation.

PART NO.	CATALOG GROUP/USE	QTY.
25512350	Flywheel, all 1981-84 V6 with rear-wheel-drive automatic transmission for off-road use. *(Note 1)*	1
25508657	Flywheel, all 1977-84 V6 with rear-wheel-drive manual transmission for off-road use. *(Note 1)*	1

0.683 HOUSING, ENGINE CLUTCH

PART NO.	CATALOG GROUP/USE	QTY.
1249599	Clutch Housing for V6-powered rear-wheel drive with cable-actuated clutch	1
563441	Clutch housing for V6-powered rear-wheel-drive Buicks with mechanical-linkage-actuated clutch	1

0.724 BOLT-CHAIN-DAMPENER-SPRING, ENGINE TIMING

PART NO.	CATALOG GROUP/USE	QTY.
1356635	Bolt, all 3.8 and 4.1L V6 (right-hand dampener to block)	1
1257650	Chain, timing, all 3.8 and 4.1L V6	1
1354138	Dampener, Chain (left hand), all 3.8 and 4.1L V6	1
1356634	Dampener, Chain (right hand), all 3.8 and 4.1L V6	1
1358909	Spring, Dampener, all 3.8 and 4.1L V6	1

0.728 SPROCKET, ENGINE CRANKSHAFT

PART NO.	CATALOG GROUP/USE	QTY.
25519954	Crankshaft Sprocket, 1976-85 3.8 and 4.1L V6 (even-fire)	1

0.729 KEY, ENGINE, CRANK AND CAM SPROCKET

PART NO.	CATALOG GROUP/USE	QTY.
1352537	Key, Crank or Cam Sprocket	1

0.736 SPROCKET, ENGINE CAMSHAFT

PART NO.	CATALOG GROUP/USE	QTY.
1233447	Sprocket, 3.8L V6 with nonintegral distributor drive gear. Use washer 1361893.	1
1253698	Sprocket, 3.8 and 4.1L V6 with integral distributor drive gear.	1

0.738 WASHER, CAM

PART NO.	CATALOG GROUP/USE	QTY.
1361893	Cam Washer for odd-fire nose cams	1

0.859 COVER, ENGINE CLUTCH

PART NO.	CATALOG GROUP/USE	QTY.
6273958	Clutch Cover, heavy-duty; 10.4-inch OD; to be used with clutch plate 3886059 or 3991428	1

0.862 BOLT, ENGINE CLUTCH COVER TO FLYWHEEL

PART NO.	CATALOG GROUP/USE	QTY.
838653	Bolt, 3⁄16 x 1 inch	6

0.886 PLATE, ENGINE, CLUTCH DRIVEN

PART NO.	CATALOG GROUP/USE	QTY.
3886059	Clutch Plate, heavy-duty with woven facings, single-plate design, 10.4-inch OD, 10-tooth spline	1
3991428	Clutch Plate, heavy-duty with woven facings, single-plate design, 10.4-inch OD, 26-tooth spline	1

1.062 PULLEY—FAN AND COOLANT PUMP

PART NO.	CATALOG GROUP/USE	QTY.
3770245	Pulley, Water Pump, 0.2-inch groove, deep groove (small hub ⅝-inch shaft, 7⅛-inch OD)	1

1.069 WATER PUMP

PART NO.	CATALOG GROUP/USE	QTY.
1260709	Water Pump for rear-wheel-drive front cover	1

1.153 OUTLET, WATER NECK

PART NO.	CATALOG GROUP/USE	QTY.
1380207	Outlet, water neck for production intake manifold. Use gasket 1250390.	1
14007331	Outlet, water neck for Stage II intake manifold (as viewed from the front of the engine, outlet exits to the right at a 90-degree angle; drilled and tapped for two temperature senders. Use gasket 3701777.	1

PART NO.	CATALOG GROUP/USE	QTY.
338117	Outlet, water neck for Stage II intake manifold (as viewed from the front of the engine, outlet exits to the left at a 45-degree angle); also drilled and tapped for a temperature sender. Use gasket 3701777.	1

PART NO.	CATALOG GROUP/USE	QTY.
3877660	Outlet, water neck for Stage II intake manifold (as viewed from the front of the engine, outlet exits to the right at a 45-degree angle). Use gasket 3701777.	1
346219	Outlet, water neck for Stage II intake manifold (outlet exits up; drilled and tapped for temperature sender). Use gasket 3701777.	1

1.426 OIL PAN, ENGINE

PART NO.	CATALOG GROUP/USE	QTY.
25522386	Oil Pan for rear-wheel-drive blocks, baffled. Use with pickup 25505644.	1

1.428 BOLTS, OIL PAN

PART NO.	CATALOG GROUP/USE	QTY.
25515406	Production Oil Pan Bolts. Use to attach any stamped pan.	AR

1.429 GASKET, ENGINE OIL PAN

PART NO.	CATALOG GROUP/USE	QTY.
1260771	Gasket, Engine Oil Pan, all rear-wheel-drive blocks	1

PART NO.	CATALOG GROUP/USE	QTY.

1.154 GASKET, WATER OUTLET

1254390 — Gasket. Use with water neck outlet 1380207. — 1

3701777 — Gasket. Use with all water neck outlets for Stage II intake manifold. — 1

1.652 BOLTS, OIL PUMP

25518361 — Oil Pump Cover Bolts — 5

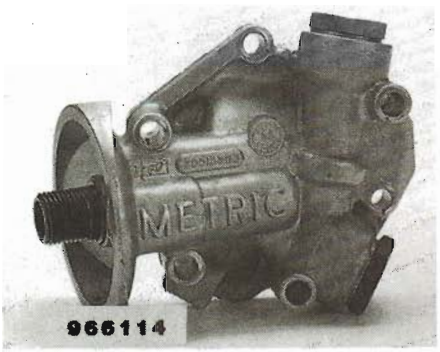
1.657 PICKUP ASSEMBLY, OIL PAN

25505644 — Large-diameter pick-up tube assembly for use with oil pan assembly 25522386 — AR

25525501 — 0-ring Seal for use with oil cooler adapter 25525910 — AR

1.723 OIL PUMP COVER ASSEMBLY

966093 — Oil Filter Adapter that bolts to oil pump cover to change filter's mounting angle — AR



966144 — Oil Pump Cover for 3.0L front-wheel-drive V6s. Can be used on rear-wheel-drive front covers to change filter's mounting angle for clearance. — AR

1.724 GASKET, OIL PUMP HOUSING

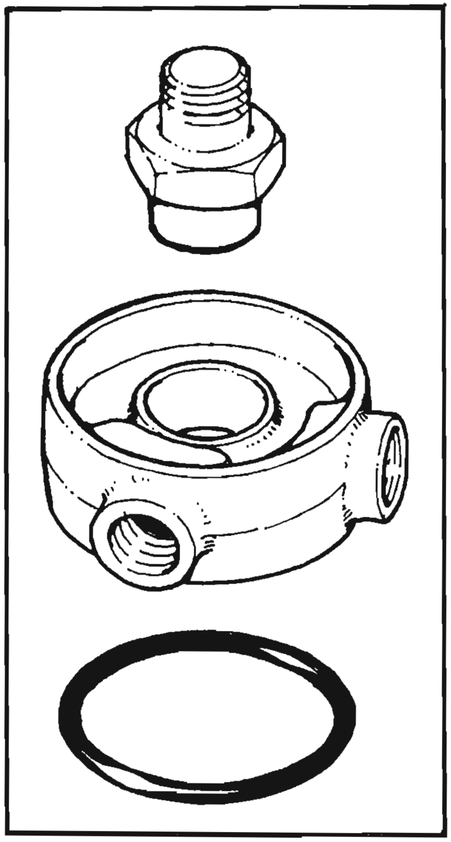
25512860 — Paper Gasket between filter casting and oil pump/front cover assembly — 1

1.758 CAP, OIL BREATHER

Note 1: The retainer and adapter and 0-ring (25525501) can be used on any Buick V6 front cover with a metric-thread oil filter nipple to faciliate plumbing and an oil cooler between the pump housing and the filter.

1552232 — Cap, with flange — 1

25525282 — Retainer for oil cooler adapter — AR



25525910 — Adapter for oil cooler *(Note 1)* — AR

1.836 FILTER, ENGINE OIL

28010792 — Oil Filter (AC PF47), metric thread — 1

28010908 — Oil Filter (AC PF51), 1.5 inches longer than 25010792, metric thread — 1

2.041 MOTOR ASSEMBLY, STARTER

1998441 — Starter Motor, 1982-85 V6 with rear-wheel drive — 1

2.042 BOLT, SHIM ENGINE STARTER MOTOR

14057099 — V6 Engine Starter Motor Bolt—long, ⅜ x 16 x 4.65 inches — 1

14057098 — V6 Engine Starter Motor Bolt—short, ⅜ x 16 x 1.875 inches — 1

1246249 — V6 Shim, Engine starter motor to block—0.015-inch thick — 1

2.104 HEAT SHIELD, STARTER

12255252 — Starter Heat Shield to protect starter from exhaust manifold heat — AR

2.108 STARTER SOLENOID SPRING

1978281 — Heavy-Duty Starter Solenoid Spring — 1

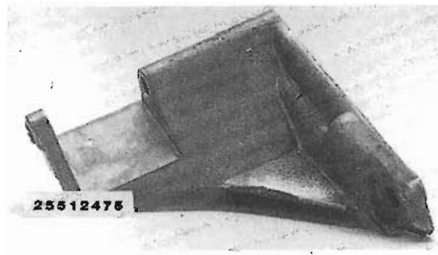
2.274 PULLEY, ALTERNATOR

3829387 — Alernator Pulley, 3⅝-inch diameter, 43/64-inch shaft, one groove, ½-inch wide — 1

1942911 — Alternator Pulley, 5¼-inch diameter — 1

2.275 ALTERNATOR

1979865 — Alternator, 63 amp — 1



2.277 BRACKET, ALTERNATOR

25512475 — Cast-Aluminum Alternator Bracket — AR

2.361 DISTRIBUTOR

1110766 — Distributor, high energy, with coil in cap, mechanical and vacuum advance, can use rotor 1893669 and cap 1880042 — 1

2.374 GEAR, DISTRIBUTOR DRIVE

1892082 — Gear, driven, all V6 — 1

1361749 — Gear, driven, all V6 with nonintegral (odd-fire) cam — 1

2.367 DISTRIBUTOR CAP

1880042 — HEI-style Distributor Cap, even-fire pattern for use with external coil — 1

2.379 SHIMS, DISTRIBUTOR SHAFT

1927529 — Shims for the shaft between distributor housing and drive gear; 0.005-inch thick — AR

2.382 ROTOR, DISTRIBUTOR

1893669 — Rotor for HEI-style distributor caps — 1

Buick heavy-duty parts are designed and manufactured for off-highway use only.

PART NO.	CATALOG GROUP/USE	QTY.

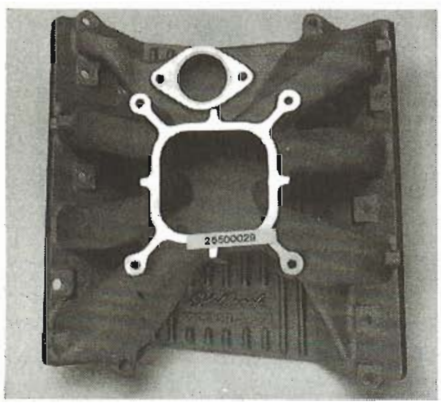
2.383 BUICK POWER SOURCE IGNITION SYSTEM

PART NO.	CATALOG GROUP/USE	QTY.
25500059	Complete "stand-alone" ignition system	AR
25500061	Electronics Module	AR
25500062	Coil Assembly	AR
25500063	Ballast Wires	AR
12051087	Wire Harness	AR
25518675	Crank Sensor	AR
25500065	Balancer with interrupter rings	AR
16017460	Manifold Pressure Sensor (Optional)	AR
25500064	Instruction Manual	AR

System features:
- Computer control, which eliminates the distributor for improved timing accuracy
- 40,000 volts available beyond 10,000 rpm
- Built-in programmable rev-limiter
- Manifold pressure-timing correction available

3.265 MANIFOLD, ENGINE INTAKE

PART NO.	CATALOG GROUP/USE	QTY.
25500029	Intake Manifold, aluminum, four-barrel design (Stage II, 3.8 and 4.1L V6s only), machined for Holley carb; Stage II iron and aluminum heads	1



PART NO.	CATALOG GROUP/USE	QTY.
25512236	Intake Manifold, aluminum four-barrel design 1977-85 3.8 and 4.1L production and Stage I engines, machined for spread bore carb (Q-Jet). Fits all displacement Buick V6 with 1979 or newer heads. Use gasket kit 25505397.	1

3.270 GASKET KIT, INTAKE MANIFOLD SEAL

PART NO.	CATALOG GROUP/USE	QTY.
25505397	Intake Manifold Seal for both ends of manifold rubber; 1980-85 turbocharged engines and 4.1L	2
1264718	Intake Manifold Seal for both ends of manifold rubber; 1977-78 3.8L	2
1264924	Intake Manifold Seal for both ends of manifold rubber; 1979-84s	2

3.275 MANIFOLD, INTAKE BOLT (SPECIAL)

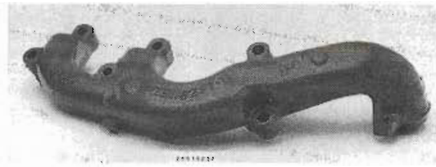
PART NO.	CATALOG GROUP/USE	QTY.
1249603	Short Clutch Head Bolt; must be used under HEI distributor for clearance to seat distributor	1
25518194	Bolt, Inlet Manifold ⅜–16 x 1⅝, all V6	9

3.454 BRACKET, THROTTLE

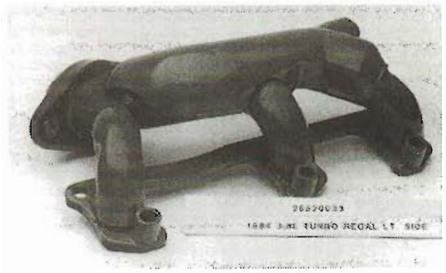
PART NO.	CATALOG GROUP/USE	QTY.
25505161	Throttle cable bracket, mounts to production and most aftermaket manifolds	AR

3.601 MANIFOLD, EXHAUST ENGINE

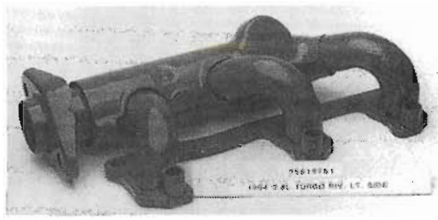
Note 1: Not all exhaust manifolds that have been made over the years for all V6 applications are listed. This list represents the majority of manifolds—cast and fabricated—that bolt to 1979 and newer production and Stage I cylinder heads. All fabricated manifolds stainless steel.



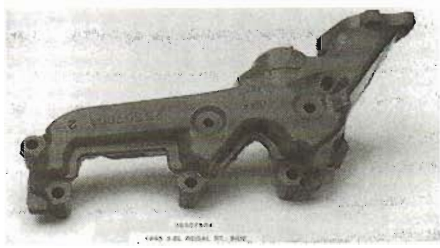
PART NO.	CATALOG GROUP/USE	QTY.
25516237	Cast manifold for left side, 1983 3.0L Century	AR



PART NO.	CATALOG GROUP/USE	QTY.
25520033	Fabricated manifold for left side, 1984 3.8L Regal	AR



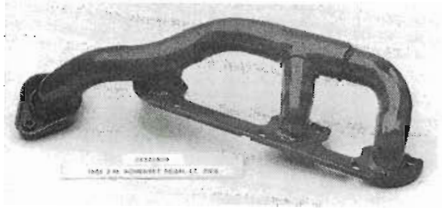
PART NO.	CATALOG GROUP/USE	QTY.
25519781	Fabricated manifold for left side, 1984 turbocharged Riviera	AR



PART NO.	CATALOG GROUP/USE	QTY.
25507804	Cast manifold for right side, 1985 3.8L Regal	AR

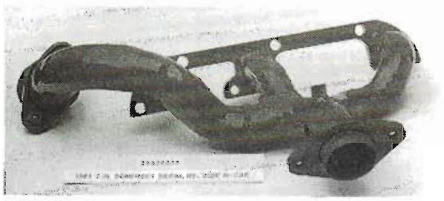
PART NO.	CATALOG GROUP/USE	QTY.
25523099	Fabricated manifold for left side, 1985 3.8L Century and Electra	AR

PART NO.	CATALOG GROUP/USE	QTY.



25525699 Fabricated manifold for left side, 1985 3.0L Somerset Regal ______ AR

25515866 Fabricated manifold for right side, 1985 3.8L Century and Electra _ AR



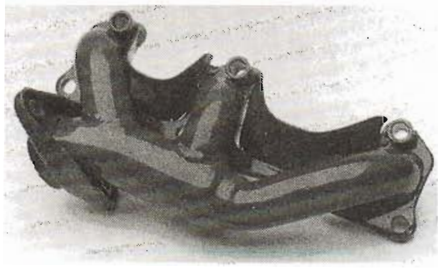
25524335 Fabricated manifold for right side, 1985 3.0L Somerset Regal ______ AR

25515074 Fabricated manifold for right side, 1983 3.8L Electra and 1985 Century ____________ AR

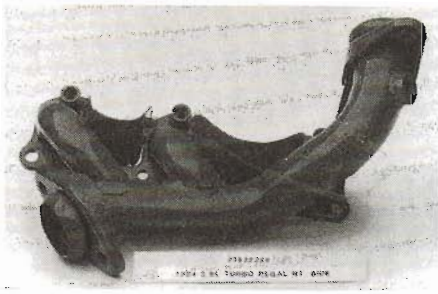
25516359 Cast manifold for left side, 1985 3.8L Regal ______________ AR

PART NO. CATALOG GROUP/USE QTY.

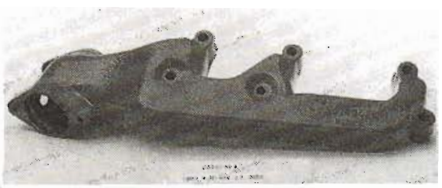
25510098 Cast manifold for right side, 1983 3.0L Century ____________ AR



25522326 Fabricated manifold for left side, 1984 turbocharged Riviera ______ AR

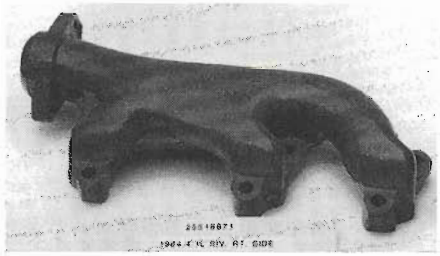


25522328 Fabricated manifold for right side, 1984 turbocharged Regal ______ AR

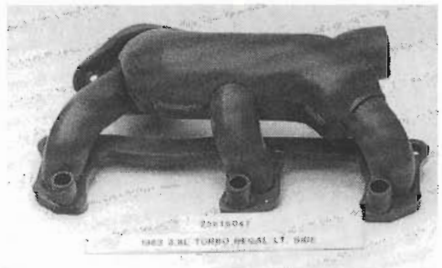


25507594 Cast manifold for left side, 1984 4.1L Riviera ____________ AR

PART NO. CATALOG GROUP/USE QTY.



25518871 Cast manifold for right side, 1984 4.1L Riviera ____________ AR



25515047 Fabricated manifold for left side, 1983 3.8L turbocharged Regal _ AR

3.840 FILTER, ENGINE GAS

854619 Fuel Filter, for ⅜-inch rubber fuel lines (AC GF61P) *(Note 1)* ________ 1

3.900 PUMP, ENGINE FUEL

Note 1: For nonintegral distributor drive gear stamped 40579.
Note 2: For integral distributor drive gear.

6417173 Fuel Pump, 1975-77 231-cubic-inch V6 with odd-fire cam nose *(Note 1)* ______________ 1

6471172 Fuel Pump, 1977-85 V6 3.8 and 4.1L with even-fire cam nose *(Note 2)* ______________ 1

3.901 FUEL PUMP, BLOCK-OFF

1384207 Fuel Pump Block-Off Plate for electric fuel pumps on V6 engines with front-wheel drive, mechanical fuel pump front covers __________ 1

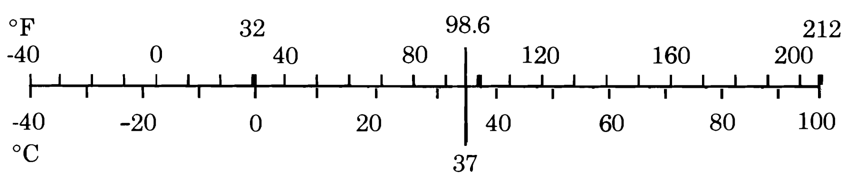
3.935 ECCENTRIC, FUEL PUMP

1361789 Eccentric, required on mechanical fuel pump with any camshaft having odd-fire cam nose ______________ 1

Measurement Conversions

Multiply	by	to get equivalent number of
Length		
Inch	25.4	millimeters (mm)
Foot	0.304 8	meters (m)
Yard	0.914 4	meters
Mile	1.609	kilometers (km)
Area		
Inch^2	645.2	millimeters^2 (mm^2)
	6.45	centimeters^2 (cm^2)
Foot^2	0.092 9	meters^2 (m^2)
Yard^2	0.836 1	meters^2
Volume		
Inch^3	16 387.000	millimeters^3 (mm^3)
	16.387	centimeters^3 (cm^3)
	0.016 4	liters (l)
Quart	0.946 4	liters
Gallon	3.785 4	liters
Yard^3	0.764 6	meters^3 (m^3)
Mass		
Pound	0.453 6	kilograms (kg)
Ton	907.18	kilograms
Ton	0.907	tonne (t)
Force		
Kilogram	9.807	newtons (N)
Ounce	0.278 0	newtons
Pound	4.448	newtons
Temperature		
Degree Fahrenheit	(+° F-32)÷1.8	degree Celsius (C)
Acceleration		
Foot/sec.^{2}	0.304 8	meter/sec.^{2} (m/s^2)
Inch/sec.^{2}	0.025 4	meter/sec.^{2}
Torque		
Pound-inch	0.112 98	newton-meters (N-m)
Foot-pound	1.355 8	newton-meters
Power		
Horsepower	0.746	kilowatts (kW)
Pressure or Stress		
Inches of water	0.249 1	kilopascals (kPa)
Pounds/sq. ins.	6.895	kilopascals
Fuel Performance		
Miles/gal.	0.425 1	kilometers/liter (km/l)
Gals./mile	2.352 7	liters/kilometer (l/km)
Velocity		
Miles/hour	1.609 3	kilometers/hr. (km/h)

NOTES



Suppliers

ARE 9621-H Oates Dr. Sacramento, CA 95827 (916) 363-7352	Cast-aluminum dry-sump oil pans
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Autotronic Controls 6908 Commerce St. El Paso, TX 79915 (915) 772-7431	MSD heli-core wire compatible with Buick Computer Controlled Ignition
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INDEX

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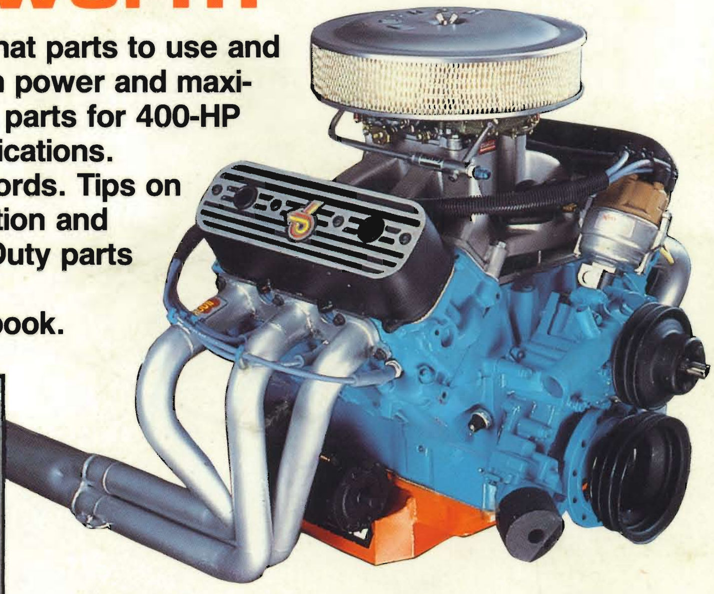

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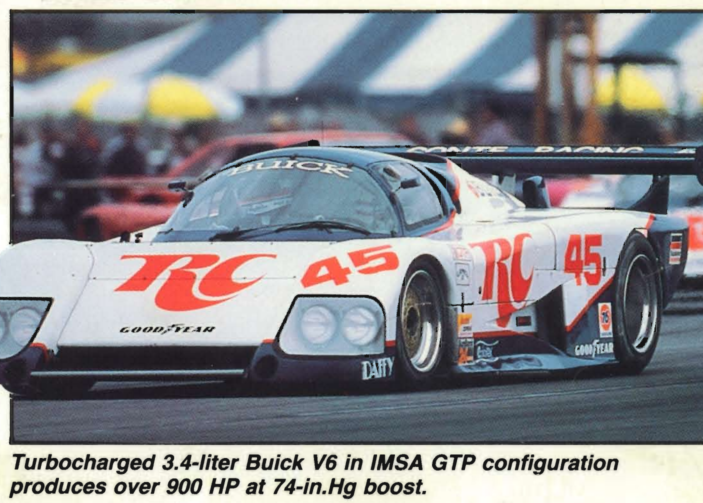

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