SMALL-BLOCK TECH GUIDE

A BASIC TECH GUIDE TO THE SHORT-STROKE OLDS V8s: 260, 307, 330, 350 AND 403 CUBIC INCHES

By Al Kirschenbaum

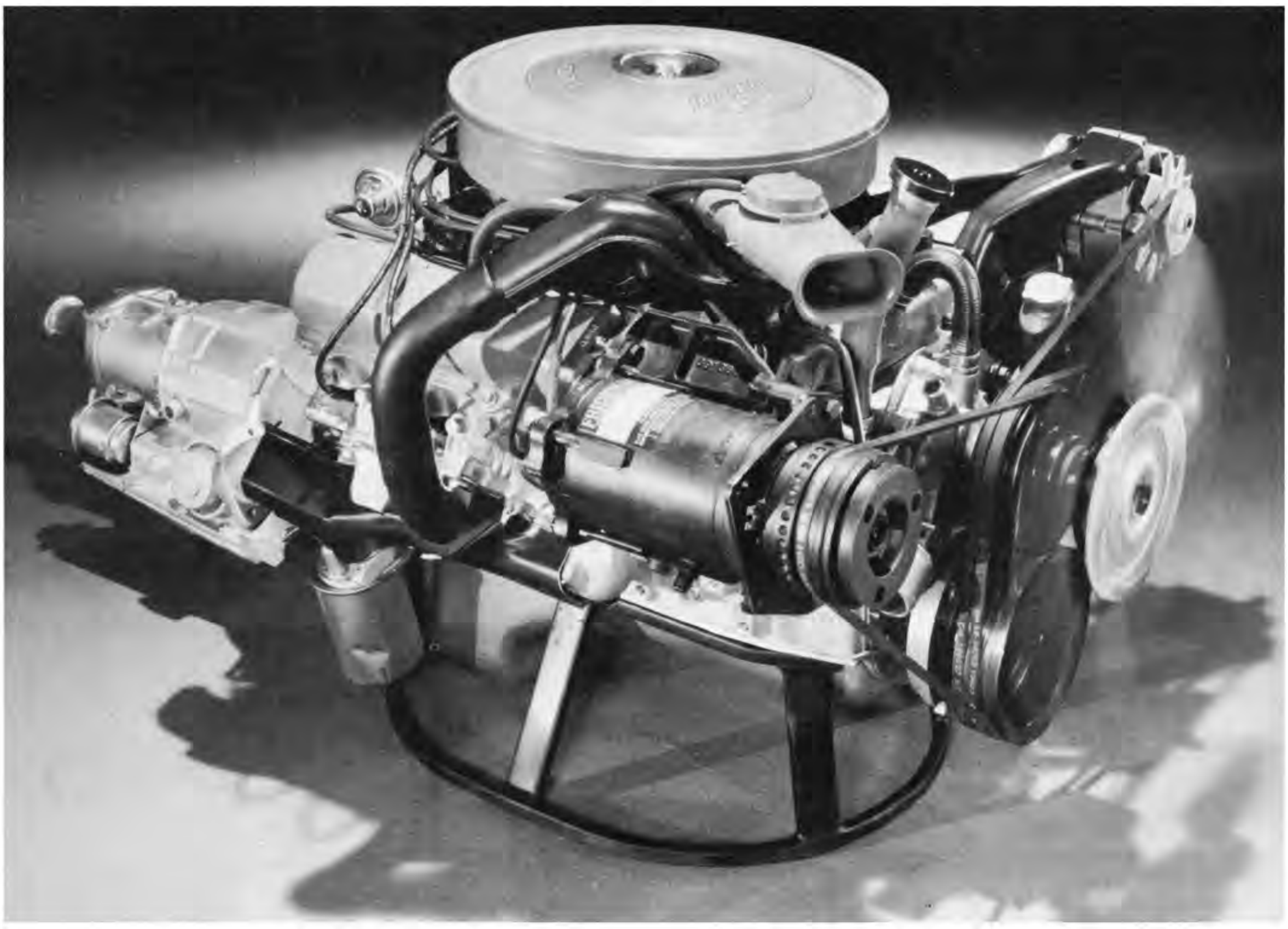
Oldsmobile small-blocks are generally differentiated from other Rocket engines by virtue of their overall light weight and their common short stroke. With a standard crank throw of 3.385 inches, Olds small-blocks have been produced since 1964 with displacements of 260, 307, 330, 350 and 403 cubic inches. The 350-inch small-block is also produced in a diesel version, incorporating some special engineering features that allow engine builders to assemble maximum-performance competition combinations. Although we're also presenting technical details on other engines in this series, the 350-incher is by far the most common size, as well as the most popular engine with both on- and off-road enthusiasts. Because of its desirable features, the 350 is the Olds powerplant we're concentrating on here.

The 350 has the same stroke as the 403 and the same bore as the big-block 455. In past production, the 350 and the 455 came off the same machining line and they share the same bore centers, crank-to-cam centerline dimension and bolt patterns. The small-block series, however, has a lower deck, shorter connecting rods, smaller crank journals and different intake manifolds.

CYLINDER BLOCK

IDENTIFICATION

Oldsmobile V8 engines in the 260-, 307-, 330-, 350- and 403-cubic-inch family are all based on a common cylinder block. These engines can be visually distinguished from big-block Rocket V8s by their physical size and sometimes by their color. The small-block motors are 1 inch shorter in height and 1½ inches narrower in width than the big-blocks. If the engine's original factory paint is still intact, a small-block will be gold or blue, while the bigger inchers can be red, green or blue. (There were some bronze-colored 400-inchers built between 1966-'69 that could be confused with gold motors.) The most recent run of 307 engines have all been painted flat black. Another way to



Mass-produced for more than a decade by Oldsmobile's Lansing, Michigan Rocket Engine Plant, the 350-cubic-inch small-block engine is the mechanical backbone of the division's high-performance fleet. This is how a fully dressed small-block Rocket looked when it grew from 330 to 350 cubes for 1967.

identify an Olds engine is by a coded tag located on the engine oil filler neck, but this tag is not always there. Some later model blocks also have a cast-in designation (see photos) to ensure positive identification.

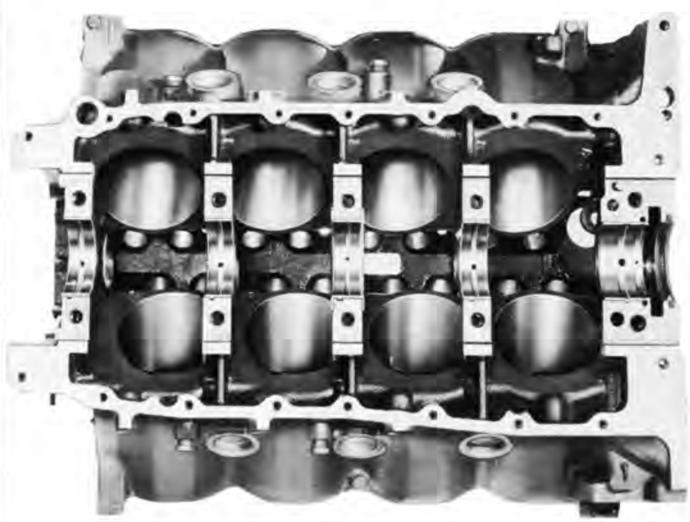
AVAILABILITY

In the popular 350-inch size, there were three different production versions of this 4.057-inch bore, 3.385-inch stroke, iron casting. Only one of these versions, however, is suitable for assembly in a high-output application. These more desirable blocks can be found in a large number of 1968-1976 Oldsmobile models in both two- and four-barrel form. There were four separate versions of these good castings produced by four different foundries with four different casting numbers. With the large volume of cars produced during that period, the "good" motors should be relatively easy to find.

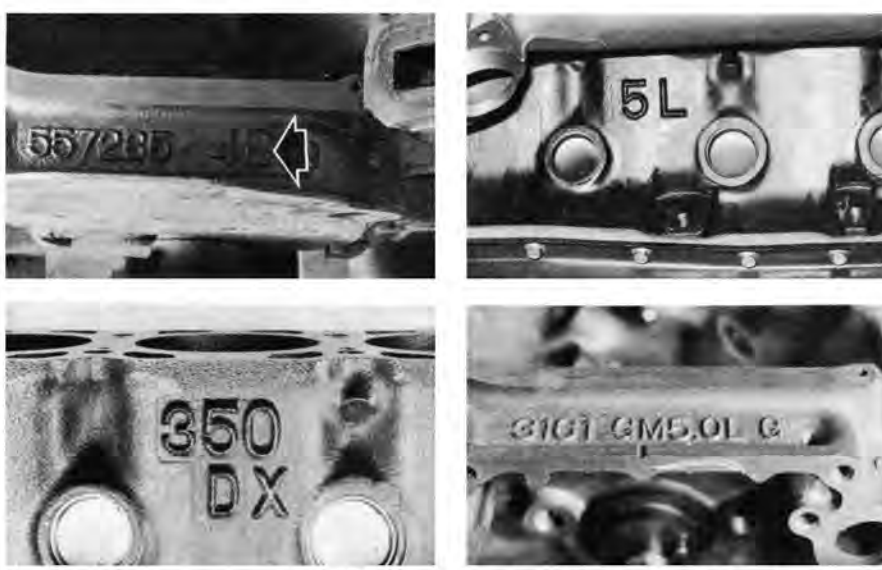
The 350 was also fitted to some cars as an option in the late-Seventies. Unfortunately, all of the 1978 and later 350s were lightweight castings designed to suit Oldsmobile's downsized, economized cars. The lightweight late blocks (including all 307s) have eliminated the extra ribs supporting their lower end and also have large (approximately 1½ inches square) "windows" in the main bearing webs. Lightweight 403 blocks will also distort badly if their head bolts are unevenly torqued or over-tightened. Although thin-wall production processes trimmed as much as 46 pounds from the late block's total weight, they're still structurally sound for all but the very

Production W-31 350 engines used in 1968-'69 were select-fit assembled and dyno-tested before installation. Factory-rated at 325 hp at 5600 rpm, each one of these W-series small-blocks was actually evaluated in the Olds engine labs to be sure it delivered. Notice how the dyno motors were fully dressed (with all pumps, alternator and air cleaner) while tested.

Retaining most of its external OE equipment, including the stock airflow-limited Quadrajet carb in this late-Seventies/early-Eighties A-body Olds, the 350 small-block is a more-than-capable 12-second quarter-mile performer. The next logical step up for this modified small-block Rocket involves breathing tweaks based on aftermarket intake system parts and refined original equipment.



Lightweight cast-iron small-blocks employ a foundry process called "hot box coring" to ensure more uniform cylinder wall thicknesses. This process eliminates excess material and weight and also promotes better cooling.



For identification purposes, 1977 and later castings and all of the lightweight 350s have their displacement cast into the side of the cylinder block. Other late V8s indicate the year they were cast by a numerical designation forward of the intake manifold rail (arrow). A single letter cast there indicates a big-block, while a single digit stands for small-block. Numbers 3 through 7 indicate the really good small-blocks. A single letter followed by a single digit number designates a 403. The 5L and 5.0LG both indicate a 307-inch gasoline block. The 350DX marking designates a 350-cubic-inch diesel block while the 403 speaks for itself. Olds service manuals also offer clues to the casting codes.

highest-output combinations.

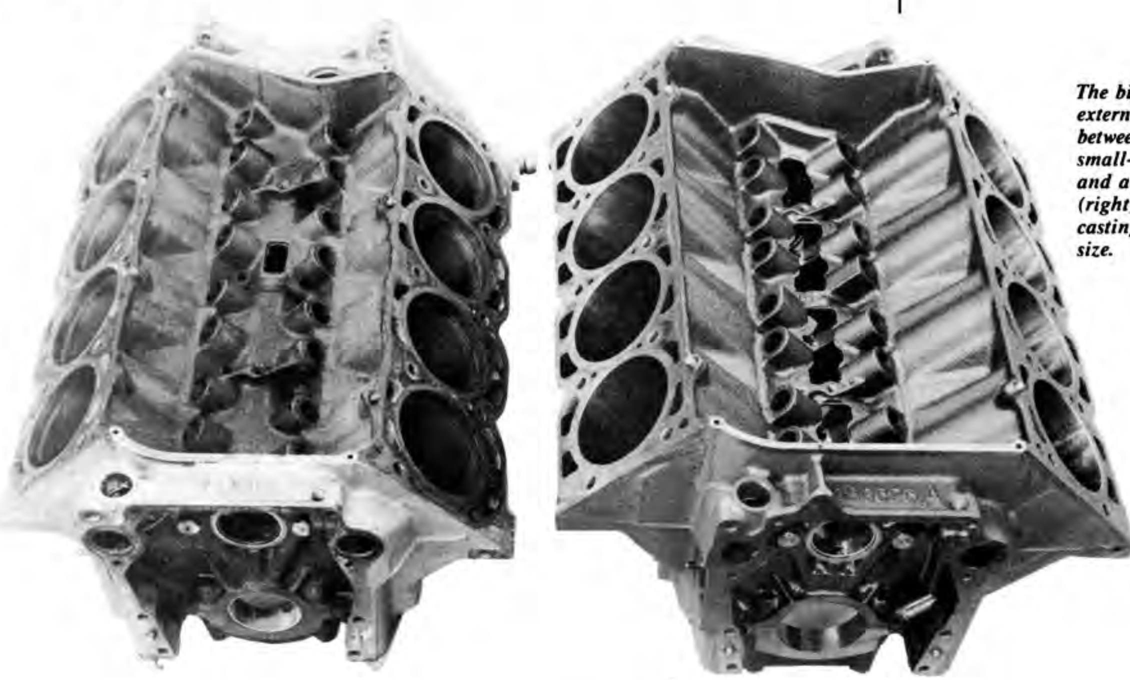
350 DIESEL BLOCK

After five or six years of being looked at as a heavyweight casting without much proven performance potential, the 350-inch Olds diesel block is finally becoming a "known quantity." Not too long ago, relatively limited availability, a high price tag, oversized main bearing journals and a heavyweight design discouraged the use of diesel pieces in anything but a rare durability-oriented or extremely high-output application. But all that is rapidly changing.

Olds' glo-plug giants incorporate ¾-inch-thick main bearing webs, deck surfaces nearly three times as thick as a standard 350 block, 455-cubic-inch main caps with special heat-treated bolts, 3-inch-diameter main bearing journals and cylinders so thick (.400-plus-inch) that ⅛-inch overbore still leaves more material in the walls than a late lightweight 350 has to begin with. Knowledgeable enthusiasts have recently begun using 350 diesel engine blocks in a variety of maximum-performance applications that include Grand National stock cars and all-out modified-style drag racers. In this particular section of *Oldsmobile In Action,* we're covering the powerplants referred to as 350 "gas blocks," and their preparation and applications. There are, however, a number of other sections in this edition

Competition preparation should include a thorough block deburring. This casting has been taken a few steps further. In addition to grinding away all burrs, slag, casting flash and rough edges, the valley walls have been smoothed to aid oil drawdown (drainback to the sump). Before final finishing of the cylinder walls, a honing plate should be fastened to each deck (secured by head clamping bolts or studs) and then the plates should be examined from the underside to determine their fit around the bores. Both plates should remain in place for 24 hours prior to machining (as should the fully torqued-down main bearing caps) to allow torquing stresses and the resulting block distortion to normalize.

Provisions for the motor mount brackets are the same on all Olds small-blocks. Two of the three threaded block bosses will properly position the block in most Olds chassis.



The biggest visible external difference between a small-block (left) and a big-block (right) is the castings' physical size.

that include in-depth investigations of Oldsmobile's extra-duty diesel pieces. If you're assembling any sort of maximum-output beast, you'd be wise to check into these.

INSPECTION

Once a suitable small-block casting has been located, it should be carefully examined. Before removing the engine from the car, the cylinder block should be visually inspected to determine if its coolant has ever frozen. This will show up as cracks located in the sides of the block near the core holes or just below the deck surfaces. Once into the teardown stage, a check should be made to determine if the camshaft bore is machined in the center of the front and rear journal bosses. All Olds production machining processes are guided off this centerline, and a mis-indexed reference point will affect a number of critical internal relationships.

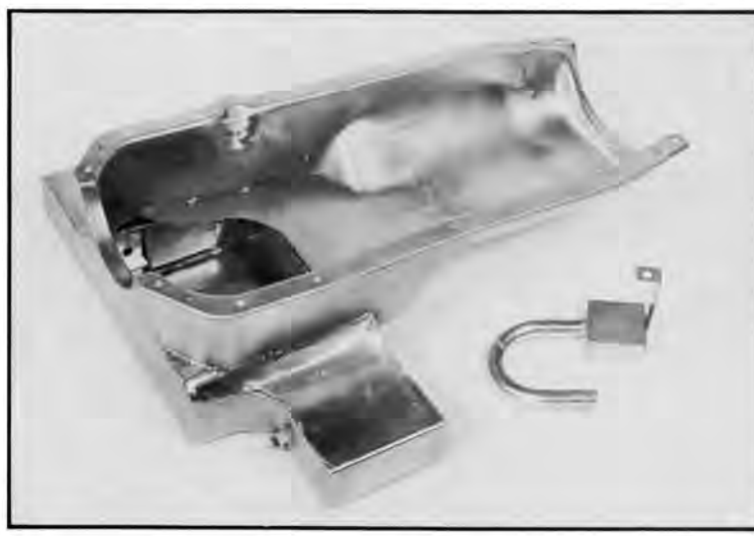
Even after one of these blocks has seen considerable mileage, the excellent metallurgy of the smaller Rockets should reveal a minimal (.008–.009-inch) ridge at the bore tops. The roughest cast areas in these pieces are found in the lifter valley.

In selecting a specific small-block casting for high-performance use, a sonic inspection is highly recommended. It's not always absolutely necessary (especially with the sturdier pre-'76 gas castings and mildly modified diesel blocks), but it is mandatory when a large overbore is being considered. Cylinder wall thickness in the major thrust direction is critical. Although many of the early blocks will check out at a more-than-adequate .350-inch, some of the real good ones will show up in testing with as much as .400.

With a series of three drilled and tapped motor mount bosses on each side, the above described blocks' mounting provisions are identical. All GM engines except Chevrolets have the same bolt pattern on their bellhousing faces. Chevys have two low dowel pins (to locate the

Engines using solid (mechanical) or roller lifters don't require the volume of oil flow that's provided for production hydraulic tappets. To modify this extraneous lube feed, all 16 of the stock 1/8-inch "spit holes" (arrows) located in the two main longitudinal oil galleries should be tapped (8-32) to accept 1/4-inch Allen-head set screws which have been drilled to provide a series of .020-inch metering orifices. This revision keeps more oil in the pan and passages rather than in the top of the engine where it can overcome the valve stem oil seals and contaminate the combustion chambers.

Main bearing cap attaching bolts used in high-performance applications should follow the diesel plan with provisions made for oversize hardware at the four forward journals. Production engines employ 7/16-inch fasteners at caps 1 through 4, and 1/2-inch hardware at cap No. 5. The smaller caps must be opened up and their corresponding cylinder block holes retapped (with 1/2-13 threads) to accept the oversize fasteners. Because the standard No. 5 replacement bolts are longer than the originals, a bolster strap or main cap reinforcement kit (like the one shown here from Precisioned Speed) should be included to handle the bolts' extra length and to stiffen the engine's bottom end. This particular setup comes complete with studs.



Oiling aid from the aftermarket can help Olds motors live longer in almost any application. Precisioned Speed offers a low-profile, high-capacity oil pan for all engines in Cutlass bodies. Precisioned also carries stamped windage trays for all Olds V8s.

bellhousing/trans case) and their two lower bolts common with all the other divisions' engines. The other four attaching bolt holes, however, are common only to Chevrolets. GM makes a THM350 service transmission case with a one-size-fits-all composite bolt pattern and there's a chance that some of these may also be found in production Olds models.

LUBRICATION

A small-block's oiling system is plumbed according to the following plan: The lubricant enters the internal oil pump through a screened inlet from the sump at the rear of the pan. The pressurized oil is then fed through the external filter located on the right rear side of the block. From there, the lube enters the right-side main longitudinal (front to back) gallery where it's then distributed to the crankshaft's five main bearings through intersecting channels. Lubricant then flows back up to the camshaft through vertical passages. There's a cross-feeding gallery at the front of the block which plumbs lubricant to the opposite main gallery and the left-side lifters. Rockertrain lube is furnished through the hydraulic lifters and hollow pushrods.

Standard small-block camshaft bearings have .090-inch oil feed holes. To keep more oil down around the crank where it's needed, the cam bearings can be rotated 180 degrees and redrilled with smaller .050-inch restrictor holes, or a low-cost aftermarket restrictor kit can be fitted.

It's also a good idea to plug all the drain holes in the lifter valley in mechanical tappet motors (except those towards the rear, above the sump) and also those situated directly above the main webs. This helps prevent oil from draining down directly onto the crankshaft. By limiting lube flow to the upper portions of the engine, through restrictors fitted to each lifter feed hole, and by metering the oil passing through the special OE bolt in the forward end of one of the oil galleries (it lubes the cam sprocket, timing chain, fuel pump pushrod and the thrust-absorbing components), more oil remains where it does the engine the most good.

CRANKSHAFTS

IDENTIFICATION AND AVAILABILITY

With the exception of diesel assemblies, all small-block Olds motors have virtually identical crankshafts. The 350-cubic-inch gasoline V8 was never produced with a forged unit, but for the majority of street, bracket and off-road applications, the standard cast nodular iron shafts will work just fine. In fact, as long as they're carefully inspected, smoothly polished, properly chamfered and well-balanced, the production castings can serve in some high-speed applications, too.

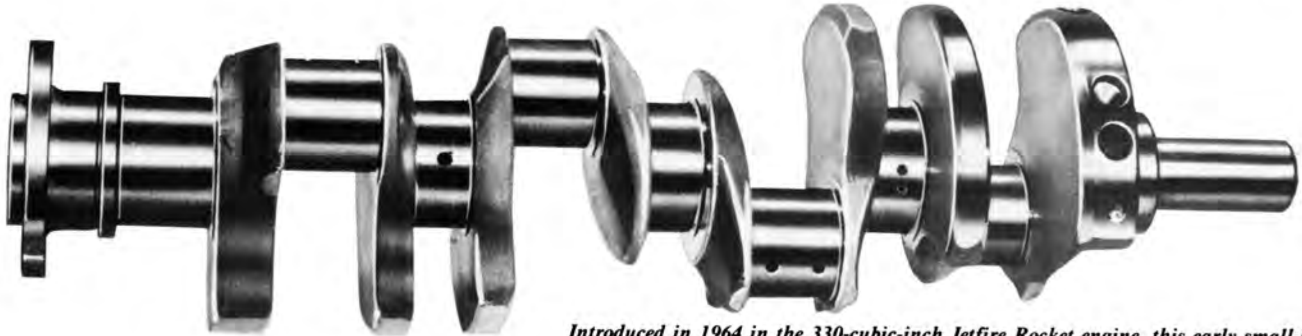
In all-out competition motors, or for extra insurance in a quick bracketeer or a serious streeter, a forged crankshaft from a 1964-'67 330-cubic-inch Olds small-block engine (commonly found in F-85, Cutlass and Delmont 88 models) interchanges directly with the small-block cast-iron 350 crank. Both shafts have 2.50-inch-diameter main bearing journals and a 3.385-inch stroke.

The Lansing Rocketworks has also released an all-new crankshaft for use in

A modified small-block's lubrication demands can be handled either by a slightly revised Toronado oil pump or by one of the new extended-capacity pumps from Melling. New units are packaged with a pair of pressure relief springs. The stiffer spring (identifiable by a colored paint code as opposed to a standard spring's natural black-iron finish) is recommended for use only in big-block assemblies and in very high-speed (7000-plus rpm) small-block applications.

A standard Olds oil pump is a relatively simple assembly. Two rotors are carried inside a cast-iron pump body, while four screws retain the end plate cover. Aftermarket sources can also supply quality Olds oil pumps that include hardened gears, a chromemoly shaft and an extra-thick end plate.

Removing the pump's end plate reveals the rotors within. The relationships of these pieces to the iron housing around them is what makes for an adequate small-block lubrication system.

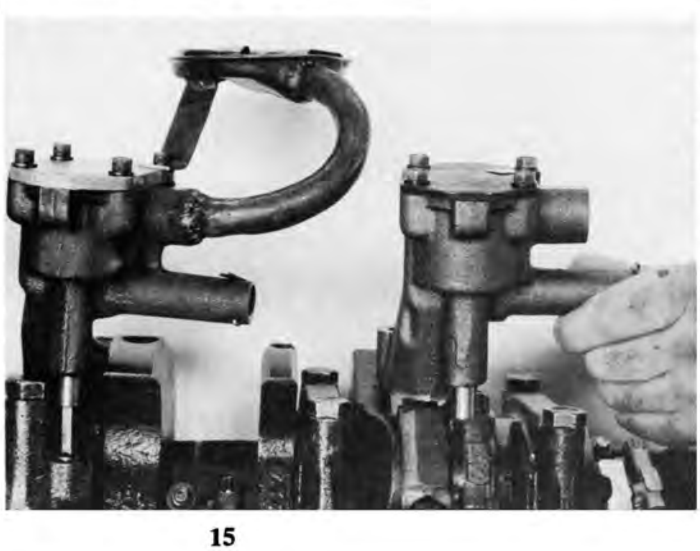


Introduced in 1964 in the 330-cubic-inch Jetfire Rocket engine, this early small-block crankshaft was the only forged-steel production unit that Olds made with the short, 3.385-inch stroke. The early steel shaft is the good one to look for for any small-block performance assembly.

"Blueprinting" an Olds oil pump involves obtaining the proper gear-to-pump body dimensions. After using a depth mike to determine the depth of the gearcase cavity inside the pump body (with the gasket in place), each rotor should also be measured to determine the components' assembled clearances. To arrive at the suggested maximum .001-inch rotor end clearance, the rotors and/or the pump body can be milled or trimmed using surface plate and fine (240 grit or finer) abrasive paper. Stroking the components across the paper-covered flat plate will remove small, even amounts of material to alter the internal relationships and eliminate most hot oiling problems. If too much material is removed, the corresponding components can be retrimmed to minimize the rotor end play.

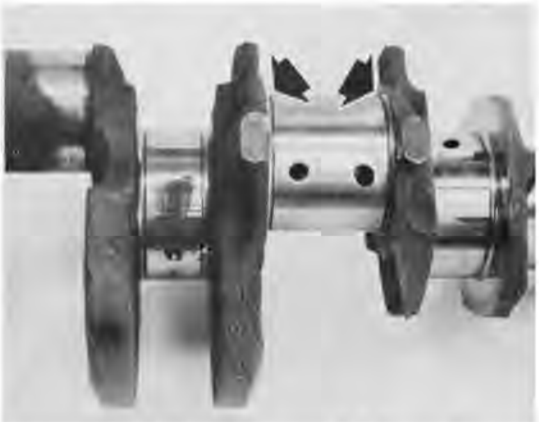
High-performance modified small-blocks can also use a 427 Chevrolet passenger car oil pump pick-up pipe and screen assembly (left). It has a larger (5/8-inch) inside diameter (as opposed to the standard Olds 9/16-inch) for increased lube moving capacity. An engine fitted with a larger "sucker pipe" will benefit from increased volume rather than increased pressure.

The Toronado pump inlet must be enlarged from 9/16-inch to 5/8-inch to accept the fatter Chevy tube, which is then repositioned 180 degrees, pressed into the Olds pump body and welded in place. For reference, the Toronado pump is rated at 25 gpm, free volume.

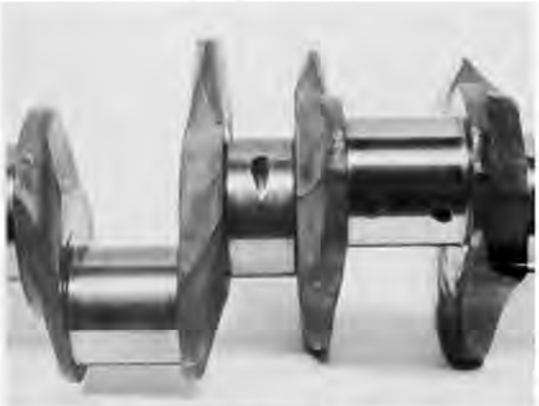


In either case, the pump should also incorporate a double-thickness end plate for added housing stiffness, similar to the 1/4-inch piece shown here. Another approach involves using two stacked plates and appropriately longer fasteners.

high-output applications. This forged-steel unit incorporates a number of extra-duty features, including 3-inch-diameter main bearing journals. This makes the shaft suitable for use in diesel-block applications such as the Grand National and AHRA Pro Stock engines reviewed elsewhere in this edition



Production cast-iron crankshafts aren't hardened beyond normal work-hardening. The shafts are, however, suitable for some on- and off-road applications as long as the proper indexing and preparation practices are employed and all bearing journals are carefully polished. Once a rough spot develops on a cast shaft, it tends to "burn" and deteriorate quickly. Tufftriding does not appear to help a casting because of inconsistencies in the hardening process. Also, once a shaft is Tufftrided it resists further machining and straightening. Notice the rolled negative radius at each journal fillet (arrows). The rolled radii in these areas are sometimes marginally executed at the factory. Since this condition can cause uneven edge loading and ultimately bearing failure, these transitional areas should always be closely inspected.



In extra-duty service, the crank's oil holes can be chamfered slightly or even "scooped" like this one to help move the lube into grooved Morraine 400 main inserts. Because only a half-grooved shell is used up front at No. 1 main (the other half is a full-face insert), that portion of the crank can be cross-drilled to help direct oil to the snout-loaded area. Other optional crank preparation can include knife-edging and neutral balancing.

of *Oldsmobile In Action.*

Care must be taken to use the correct flywheel/flexplate combination with each crank configuration. Using the early steel shaft in an automatic transmission application also requires the corresponding flywheel, part No. 386250. Using the steel shaft with a manual trans takes flywheel No. 389248.

Engines backed by either a clutch or a loose torque converter should have a maximum of .006-inch of crankshaft endplay. This dimension can be altered by select-fitting the shaft's No. 3 main bearing that also absorbs fore-and-aft thrust. The dial indicator illustrated here measures this movement while a large screwdriver is used (between a counterweight cheek and main cap) to wedge the shaft forward and backward in the block.

To prevent lube leakage at the rear of the block and to avoid power-robbing drag on the crankshaft, special care must be taken when fitting the engine's rear main rope-style oil seal. (The large-journal diesel crank and main cap accept a neoprene big-block Ford seal.) First press the rope seal in by hand until it's fully seated in its groove in the block. Then use either a special steel fixture like the one shown or a large-diameter socket to tap and roll the seal into place. All excess must be trimmed to prevent seal pieces from contaminating machined mating surfaces. The ends of the seal should be cut flat with a sharp razor blade. Small dabs of silicone (silastic) sealant should also be applied to the seal ends before mating the rear main cap to the block.

FEATURES

All small-block cranks are basically the same, the main differences being found in their balance weights. The 260-cubic-inch and 350-cubic-inch diesels have the same stroke as other small-blocks, but they incorporate the 455 main bearing specifications for added stiffness and support. External balancing components (the front hub and flywheel) share a common part number but there are different harmonic balancers used for timing reference and dampening.

The late-model cast shaft's flywheel attaching flange has a six-bolt pattern with two holes offset 5 degrees in opposite directions. The forged 330-cubic-inch shafts offset only one of their six flange holes. Late-model cast cranks incorporate rolled journal fillets. This allows the connecting rods' big ends to be fitted on their journals facing in either direction. The forged shafts, on the other hand, incorporate a full, positive radius where each rod journal meets the cheeks. This strength-promoting feature requires each rod's big end to be properly chamfered and correctly oriented so that these machined features correspond upon assembly. In almost any of these instances, the alterations will require that the crank and the remainder of the reciprocating assembly (especially when using heavier 403 connecting rods) be rebalanced.

ASSEMBLY

Before fitting any of these crankshafts to an Olds small-block, a straightness check at the shaft's center main bearing journal

Although the Plastigauge method can be used to determine bearing clearances, it has some serious drawbacks. The only real way to measure insert clearances is by physically miking the crank journal's o.d. and using a dial bore gauge like this one to determine the assembled main cap's inside diameter. The difference in these two measurements is the true bearing clearance. A maximum of .0035-inch is suggested at all main journals.

must show no more than .002-inch of out-of-round runout. A similar inspection at the flywheel/flexplate flange should indicate a maximum runout dimension of .001-inch. Crankshaft end-play at the No. 3 thrust main should be limited to .006–.009-inch. Alterations here can be made either through GM's select-fit Morraine 400 bearing inserts (available in .005-inch increments) or at the crank grinding shop. Generally speaking, a small-block backed by a clutch or a loose torque converter should be assembled with an end-play figure that's on the low side of this range. On assembly, insert clearances at the main journals should be set at .0025–.003-inch, while the rod journals should have .0015–.002-inch.

The larger No. 5 main bearing cap bolts are tightened to 120 foot-pounds while mains 1 through 4 are socked down to 75 foot-pounds. (Using ½-inch clamping hardware on the front four mains requires 100 foot-pounds of tightening torque.) If align-boring is determined to be necessary, remember to torque the main caps and oil pump in place (just like the head plates) before machining the block. Balancing is accomplished by adding heavy Mallory metal crosswise in the crankshaft counterweights.

CONNECTING RODS

APPLICATIONS

All Olds small-blocks use interchangeable 6-inch-long SAE 1140 steel connecting rods. Available under part No. 555142, the rods specified for the 403 engine are the sturdiest of the production bunch. These pieces are 10 percent thicker across their beam and they incorporate updated metallurgy as well. Low-rpm small-blocks can utilize a set of carefully prepped and polished stock rods (part No. 380282, 1964-'67, or part No. 410997, 1968-'78), but a high-speed engine, especially one using production-type rods and heavy pistons, should only be built with the 403 beams. Although physically very similar, these part numbers should not be mixed.

PREPARATION AND ASSEMBLY

Oldsmobile's production piston pin plan calls for press-fitting the pins in the rods' small ends, but *the pins must not be cold-pressed.* Attempting to cold-press

Although the 403 connecting rod (right) is considerably larger across its beam section, it can be trimmed to a 350 rod's weight by careful machining of the balance pad at its big end. A Tufftriding treatment can help make any Olds rod more durable in an extra-duty application. Note the large oil depressions in the pistons below the bottom ring lands (arrows) which leave the skirts relatively unsupported.

The naturally beefy nature of the diesel pieces on the left is clearly illustrated in this three-way comparison. Check out Total Engineering's approach to the OE diesel rod in our look at Andy Mannarino's Grand National engine assembly in another section of **Oldsmobile In Action.**

Olds piston pins can result in the pins shifting, sliding and possibly tearing up the cylinder walls. Unless bronze bushings are fitted to float the pins in the rods' small ends, all Olds pins must be "heat-shrunk"-fit by first warming the entire connecting rod. A common blow torch will work here, but used in this manner, it's a relatively crude tool. Preferably, a controlled-heat induction oven (or an electrical heating jig) should be used to warm the rods to no more than 650-700 degrees before the cold piston pins are slid in. Production rods are drawn at 650 degrees, so their heat treatment should not be affected by a conservative and careful pin-fitting warm-up process.

Off-road engine assemblies can make excellent use of double Spirolox pin-locks, fitted with a maximum of .006-inch clearance. Full-floating pin assemblies can be set with zero clearance, but the practice is not generally recommended. These clips are definitely difficult to install and remove, but their unique design makes them extra-dependable and they're very often reusable. The rods themselves should also be shot-peened and glass-beaded.

All small-block Oldsmobile production connecting rod bolts are high-tensile-strength, ⅜-inch hardware. Before assembly, used fasteners should be removed and measured for excessive stretch and all bolts should be inspected for burrs in the undercut between their head and the connecting rod. Bolts should also be checked for a square, no-slop fit in each rod before being tightened to their specified 42 foot-pounds of torque.

PISTONS AND RINGS

AVAILABILITY

Although original equipment 350 V8 pistons are available in both low (8.12:1, nominal) and high (10.5:1) compression versions, the aftermarket will have to supply anything of quality in-between. True compression ratios in late-model 350 V8s that are machined to their minimum allowable specified assembly dimensions measure out around 8.75:1. It is possible, however, that with the proper combination of production pieces and quality machining, the ratio can reach as high as 9.5:1.

ASSEMBLY

OE-style piston skirt-to-cylinder wall clearance should be maintained at .002–.005-inch. Forged aftermarket units should be fitted somewhat looser, according to the manufacturer's recommendations. Competition Stock- and Super Stock-style engines with a fine cylinder wall finish (around 500-grit with a Sunnen rigid hone and a J85 stone) should be run with moly-filled top and second rings (5/64-inch) and low-tension 3/16-inch, three-piece oil rings. These engines only have about 120 pounds of cranking compression, but with low-tension oil-control rings, a crankcase vent system should be used.

Street ring sets should also incorporate a double-moly arrangement, but low-tension oilers are not recommended. The actual ring end gap dimensions depend on a variety of factors. A high-rpm over-bored engine, for example, should use .018–.022-inch for the two top sets. A cooler-running Stocker that seldom sees 180-degree operating temperatures can be tightened up to .016–.020-inch on both. A street engine's rings should be gapped at .016-inch while all oil sets should be set out-of-the-box at .025–.030-inch. As with so many other areas of engine construction, different expert builders have different settings that they employ under specific conditions. The numbers shown here should be considered as representative.

CYLINDER HEADS

AVAILABILITY

All late-model Oldsmobile cylinder heads fall into the same category as the late-model Rocket cylinder blocks. Down-sizing and economizing have made all 1978 and later castings far too fragile for serious efforts at power production. For mild on-road/off-road duty, however, the late heads do have some advantageous features.

All the late castings went through a

When the rules allow them and where the power demands them, aftermarket steel connecting rods from Crower or Carillo and high-strength big-end hardware by SPS can help make an Olds reciprocating assembly practically bulletproof.

Proper ring gaps will go a long way toward sealing combustion pressures inside the cylinders where it does the most work. Gapping requires that each ring be fitted individually. Here a ring is squarely positioned an inch or so down in a cylinder, where a feeler gauge can be inserted in the gap. An inverted piston can be used to position each ring in its respective bore. Using a commercial ring grinder/fixture will help keep the butt ends square and burr-free.

production revision that eliminated the water jacketing above the intake ports. It also combined the head's two separate coolant jackets into one, while unshrouding the inlet passages and building up the port floors. Oldsmobile lowered the small-block's compression ratio in 1971 by opening up the combustion chambers from roughly 62cc to 78cc. Generally speaking, using the early small-chamber heads on a late 350 or 403 will bump the compression ratio into the 10:1 range.

Olds engine builders can also opt for the special "factory" high-performance cylinder heads that have been available in both iron and aluminum since the early 1980s. Produced in conjunction with C.J. Batten's Romulus, Michigan, operation, these latest bare castings are available from GMPD under part Nos. 22505143 (iron) and 22505805 (aluminum).

IDENTIFICATION

Late-model lightweight 350 Oldsmobile head castings were all poured by GM's Pontiac Motor Division. They can easily be identified by both their distinctive "PMD" markings and the designations located adjacent to the No. 1 spark plug hole. A single-digit number indicates a small-block while the addition of the letter "A" indicates a late, thin-wall, small-block head. The numbers 3 through 7 are on the good heads to look for, but some of the late 7-series heads have a larger (+16cc) combustion chamber. Single cast-in letters indicate a big-block while a single letter following a single number designates a 403 head. Heads for the 260 and 307 V8s have smaller valves.

As the photos show, the high-performance Olds/Batten heads are visibly very different from production heads, so they're pretty easy to identify. Aside from lacking the big opening for manifold heat in their inlet face, for example, these late performance pieces have higher ports and are outwardly "cleaner" appearing castings in many ways. They're also much heavier heads than the late lightweights.

FEATURES

When Olds engineers designed the small-block cylinder head back in the early-Sixties, they inclined the valves only 6 degrees from the centerline of the cylinder bores. This gave the heads advantageous "open" combustion chambers and the ability to flow and make horsepower.

The late-model 350 heads retain the same smaller 1.875-inch intake and 1.50-inch exhaust valves as many of the pre-'78 lightweights. Valve spring pressure is limited at 84 pounds on the seat and 190 pounds at max lift. Minimum combustion chamber volume for sanctioned NHRA competition is 66.35cc. Although they're 12 pounds lighter than earlier versions, the late castings may be structurally stressed in very high-output applications.

Late cylinder heads will accept the larger valve sizes used in earlier W-31 castings (2.005-inch intakes and 1.625-inch exhaust valves were used in 1968-'70 W-31 muscle motors) and there were even some large-valve heads produced as recently as 1975. Some late 403 four-barrel engines were produced with the same head casting numbers with 1.95-inch intake valves, 1.560-inch exhausts, and smaller combustion chambers.

Valve rotators (right) were introduced on Oldsmobile exhaust valves (and later on all valves) when unleaded (and unlubricating) fuel became popular at the pumps. For 5000 rpm-plus powerplants, replace them with either standard steel retainers (left) or with aftermarket units. Because rotators are approximately .180-inch thicker than the standard retainer (part No. 387596), special shims (part No. 231004) and/or a longer valve spring must be used. Using aftermarket longer springs in these applications will also accommodate an effective valve lift in the neighborhood of .600-inch. Using the standard retainer and the special shim precludes the need for longer springs.

All production Olds heads have siamesed center exhaust ports. Early-model castings can be welded up and trimmed flat to separate the ports, but the late-model pieces (top) don't readily lend themselves to this alteration. One way around this difficulty in the later heads is to add a steel tab to the header flange that fits within the center ports, effectively separating the two. The arrow indicates a spot on this late head's inner wall where this suggested tab has made contact while in use. The head's exhaust face can also be milled down flush with this divider wall.

Due to the inconsistent quality of today's low-octane gasoline, a mild polishing treatment inside the combustion chambers can help eliminate detonation-promoting hot spots. More extensive cylinder head grinding should be left to the specialty shops' expert porters. Remember, removing material from the chambers also trims the compression ratio.

Notching or relieving the top of each bore (out of the path of ring travel) will improve airflow here, but it will depend on the engine's specific dome/chamber configuration. The process will also reduce the engine's compression ratio. Except in the most radical applications, domed pistons should not be used to increase these engines' compression ratio. Flat-top pistons tend to promote more horsepower and a piston like the OE W-31 unit can yield an 11.5:1 ratio when used with the early, small combustion chamber heads. Lightweight head milling (to bump compression) should be limited to a maximum of .100-inch. Any more of a cut can make the deck surface too thin.

All early heads used on late small-block engines must have their head bolt holes reamed out to ½-inch to use the late block's fasteners.

Another approach to improved small-block breathing (particularly on late-model 350- and 403-cubic-inch engines) is through the use of the 1968-'70 350-cubic-inch engine's cylinder heads (part No. 230119) fitted with big-block valves (part Nos. 389451, intake, and 401762, exhaust). Identified by the number "6" cast into the head adjacent to the No. 1 spark plug hole, these heads were commonly fitted to a very large number of that year's Olds models. They've been unavailable from the factory since 1976. These castings' ports are somewhat smaller than those used on the big-block 455 cylinder heads, but the interchange is infinitely more practical.

To prevent metal galling on start-up, all rocker arms should be coated with assembly lube. If used rockers are employed, they should also be carefully inspected for excessive wear around their pivot sockets.

Production Oldsmobile rocker arms are not adjustable and must be assembled correctly for proper operation and performance. This is another excellent reason to keep a factory service manual handy when tackling any extensive or specialized assembly operations.

The main structural disadvantage of the late-model lightweights comes from the lack of sufficient material in the areas around the rocker stud bosses. Small-block builders without the latest Batten/Olds castings, who are unconcerned with OE requirements, can follow this earlier Batten plan to make excellent high-performance use of late-model heads. Notice the ¾-inch-thick steel "girdle" that runs below the Norris roller rockers along the top of this 1977 casting. It's retained by the same studs that fasten the heads to the block, serving as a structurally sound platform for 7/16-inch, screw-in rocker arm studs. Since these plates increase the overall height of the rockertrain assembly, taller Batten/Olds valve covers or other sectioned and stretched covers must be installed.

PREPARATION

Using any early heads on a late-model small-block also requires the use of the larger ½-inch hold-down hardware accommodated by the late-model engine blocks. Because early engines used smaller 7/16-inch cylinder head bolts, early heads' bolt passages must be reamed oversize to accept these larger fasteners. If late cylinder heads are used on an early block, a special Fel-Pro head gasket (part No. 8171-1) must be used to seal the castings' non-corresponding water passages. In fact, in virtually any Olds engine assembly, the Fel-Pro "blue" gaskets are the only ones to use.

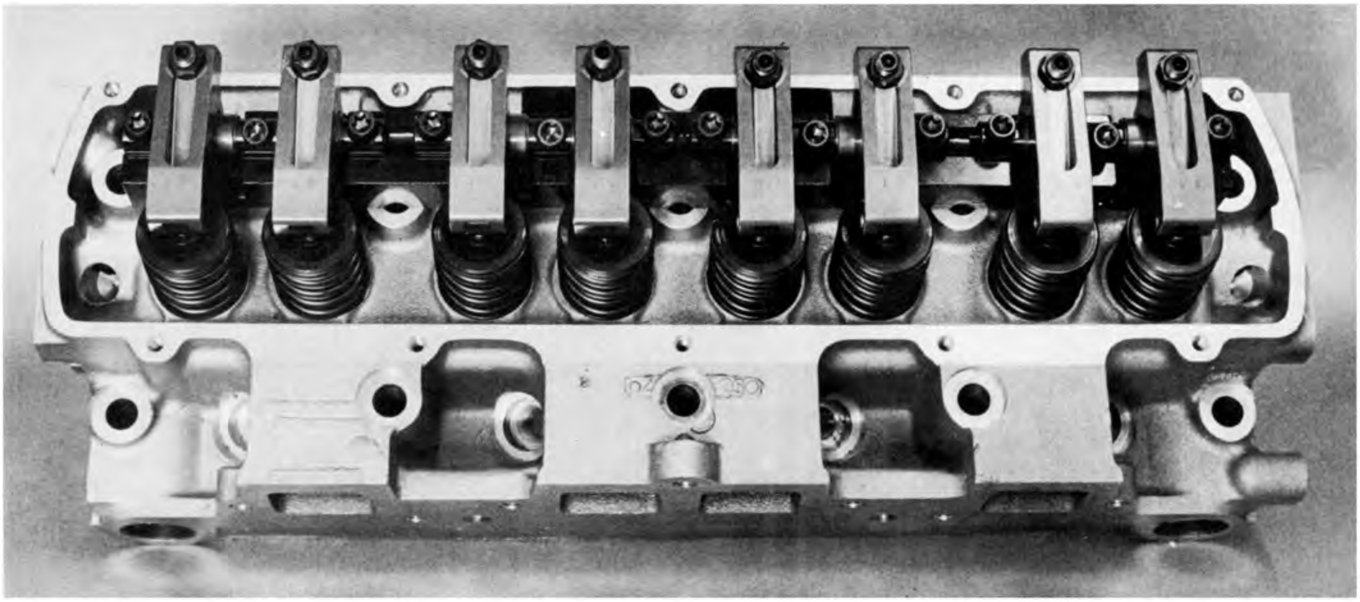
Porting modifications in street, bracket and off-road motors should be concentrated in the heads' under-valve bowls, where better flow can be promoted with an .800-inch radius leading into the ports. Late-model heads should also be inspected before use for an obstructive "post" in the exhaust ports' floor. Valve seats in street applications should be .090-inch-wide, while race-oriented preparation calls for widths trimmed to the .040–.050-inch range. All valve jobs should follow a 15-degree lead cut, a 45-degree seat and a 70-degree undercut pattern for the most efficient flow. Although various cylinder head specialists have their own numbers they like to work with, these figures should be regarded as representative. (For further seat-finishing suggestions, see the Batten/Olds Grand National engine section elsewhere in this edition of *Oldsmobile In Action.*) One advantage of starting with the smaller-valve cylinder heads is the abundance of material in the seat areas that's available for machining.

Internally, head castings should be modified to isolate the center exhaust ports. This cast-iron welding operation should only be performed by a properly equipped shop. Other means of accomplishing this same modification are by welding contoured extension tabs to the two corresponding areas of the headers or the exhaust manifolds (see photo), or by milling the heads' exhaust faces to a depth that makes this dividing wall flush with the heads' exhaust surfaces.

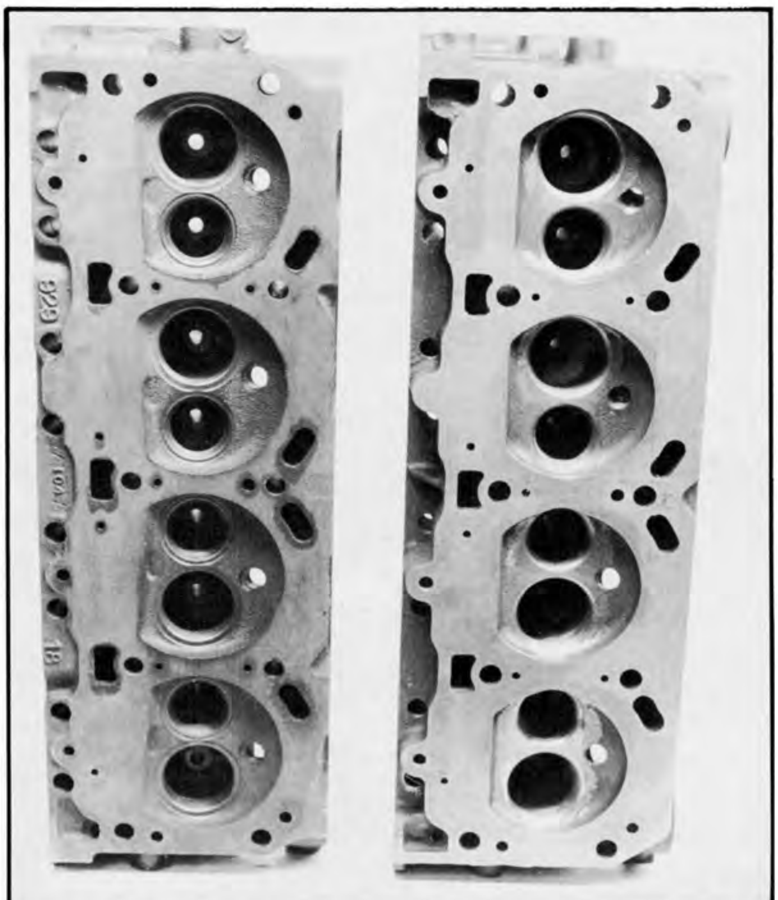
Because the Oldsmobile small-block's oiling system pumps a considerable volume of lubricant up into the cylinder heads, adequate valve stem sealing is mandatory. The older-style rubber clearances involved in these late-model powerplants, it's always sound engine-building practice to double-check this critical assembly dimension.

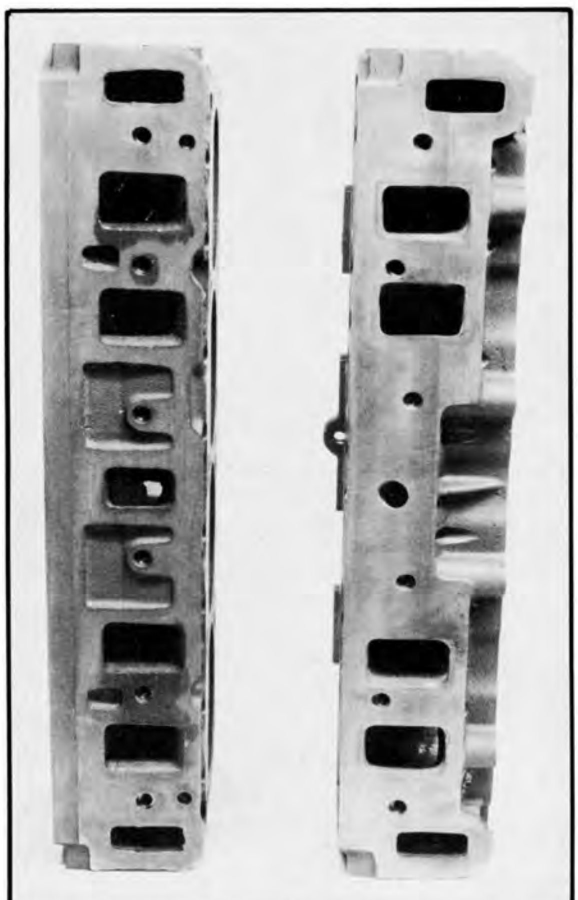
RELATED COMPONENTS & FEATURES

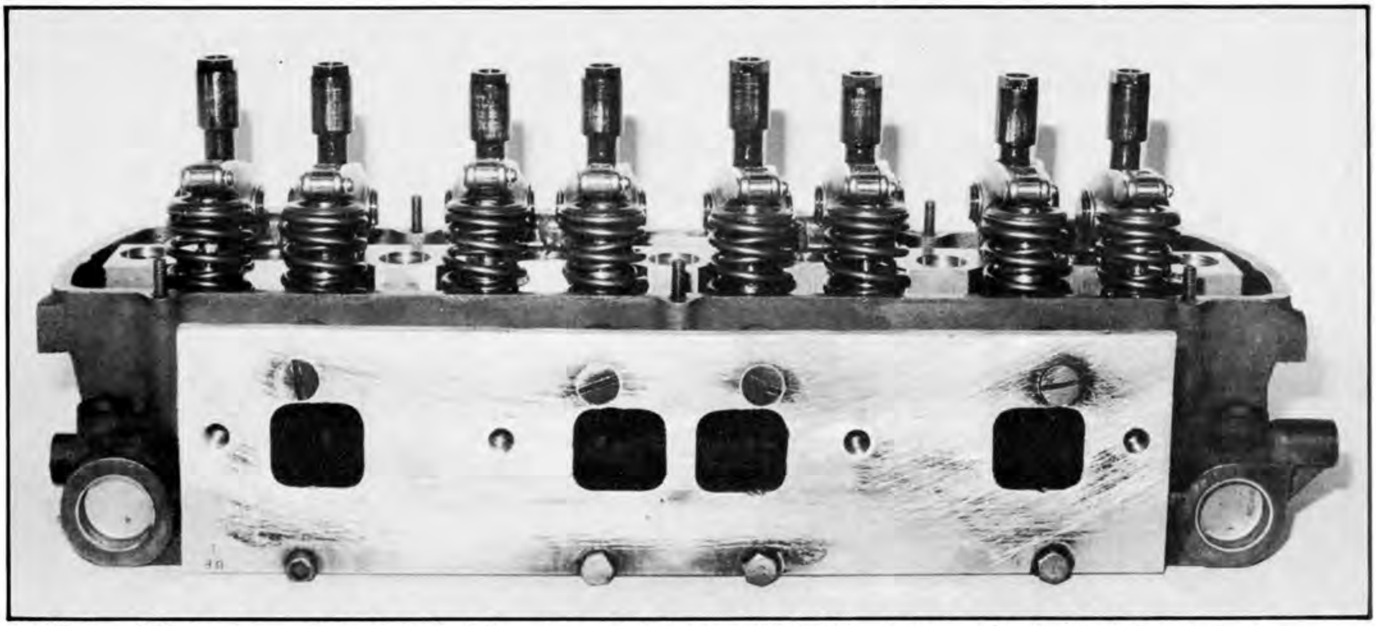
Regardless of the trend towards gear-driven camshafts in maximum-output applications, the standard gears-and-chain arrangement is a proven system that's become even more popular as the quality of the individual



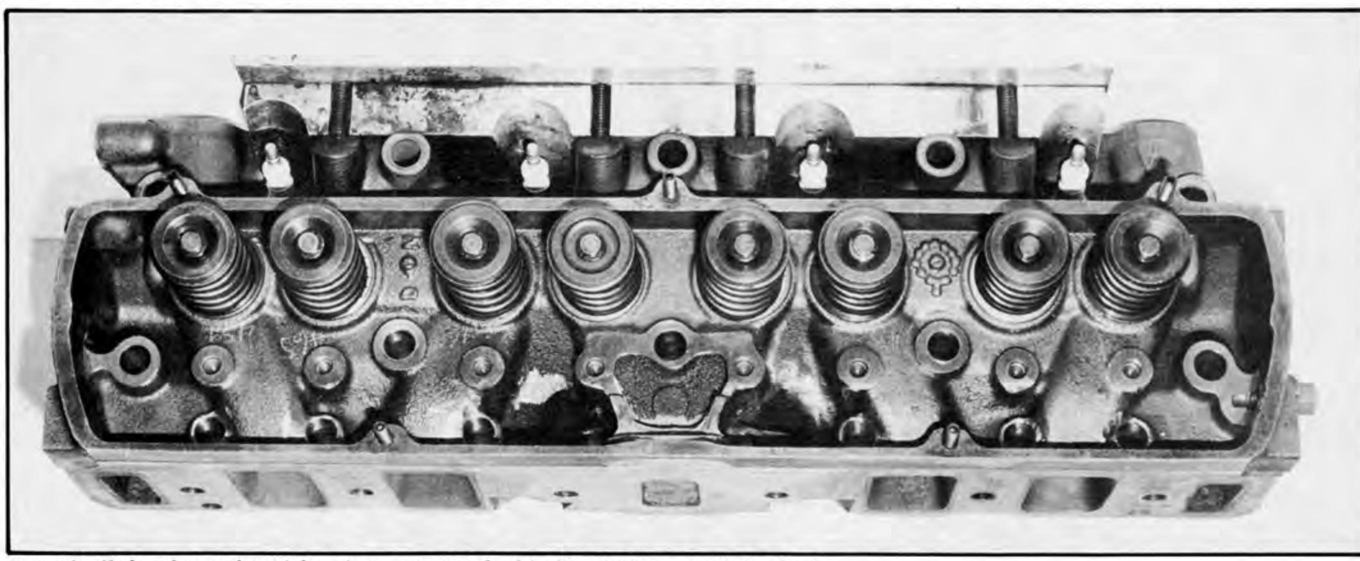
Under maximum-output conditions, quality roller rockers from Dan Jesel earn their keep. Available in ratios from 1.60 to 1.80, the fully machined rocker arms are bearing-mounted on individual shafts. These prototype arrangements will be relieved to clear head-clamping hardware.



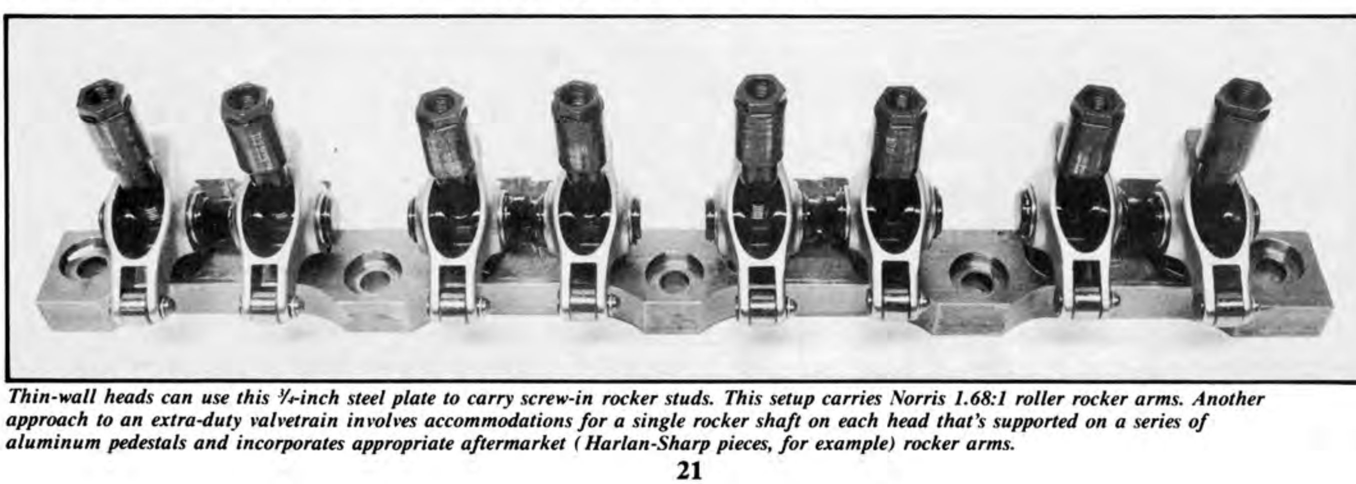




Modified small-blocks can use a little Pro Stock airflow science to help improve their heads' outlet tracts. These late heads have siamesed exhaust ports exiting the two center cylinders, and the port shape in that area becomes quite large at the flange, as compared to the rest of the passages. This bolt-on aluminum plate separates the ports, and helps to make the runner exit (or port mouth) more uniform. It also eliminates some degree of turning transition that the outlet flow must go through. Of course this surgical process can be avoided by using the more-recently cast Olds/Batten competition-oriented units that are currently available in both iron and aluminum.



Beneath all the aftermarket trickery is a pretty standard-looking PMD-cast cylinder head.



Thin-wall heads can use this ¾-inch steel plate to carry screw-in rocker studs. This setup carries Norris 1.68:1 roller rocker arms. Another approach to an extra-duty valvetrain involves accommodations for a single rocker shaft on each head that's supported on a series of aluminum pedestals and incorporates appropriate aftermarket (Harlan-Sharp pieces, for example) rocker arms.

umbrella seals tend to dry out and crack in extended street or high-output service. Spring-loaded aftermarket Teflon seals actually keep the valve guides *too* dry. Oldsmobile's current production plan calls for umbrella-style Teflon seals and these OE pieces are more than adequate for most high-output applications.

CAMSHAFTS

AVAILABILITY

Regardless of the aftermarket brand chosen, all of the good camshafts for the small-block Olds are based on the original factory designs. Any choices involved are strictly up to you. Early W-machines were fitted with one of three basic cam profiles and these designs continue today as the basis for most specialty equipment manufacturers' popular grinds.

APPLICATIONS

Some of these high-performance OE Olds cams are ground in a 4-degree-retard mode. Using this factory equipment requires that an equal amount of advance phasing be dialed-in to orient the shaft in its split-overlap (or straight-up-and-down) position. Automatic transmission-equipped Oldsmobiles weighing approximately 3500 pounds or more are advised to position their small-block's cam at least another 2-degrees advanced. This setting is especially emphasized when the vehicle in question is equipped with a 3.91:1 or higher final drive, even if a manual clutch or a loose torque converter is involved.

Late-model motors using this camshaft phasing with OE-style, low-compression dished pistons should have more than adequate piston-to-valve clearance with the standard 1.59:1 ratio Olds rocker arms. Despite the generous component

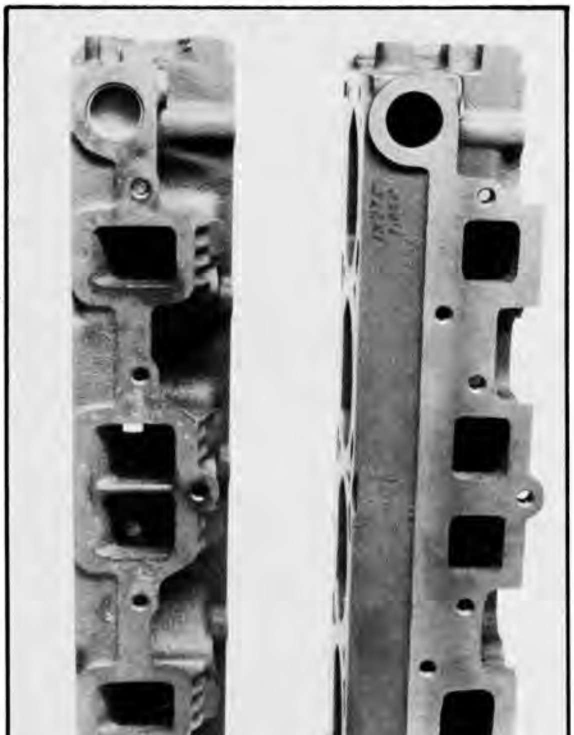
Rockertrain revisions that raise its assembled height can be covered by either sectioned and extended stock valve covers or by these taller cast-aluminum units from C.J. Batten. This pre-production piece carries a test breather for a specific modified racing application.

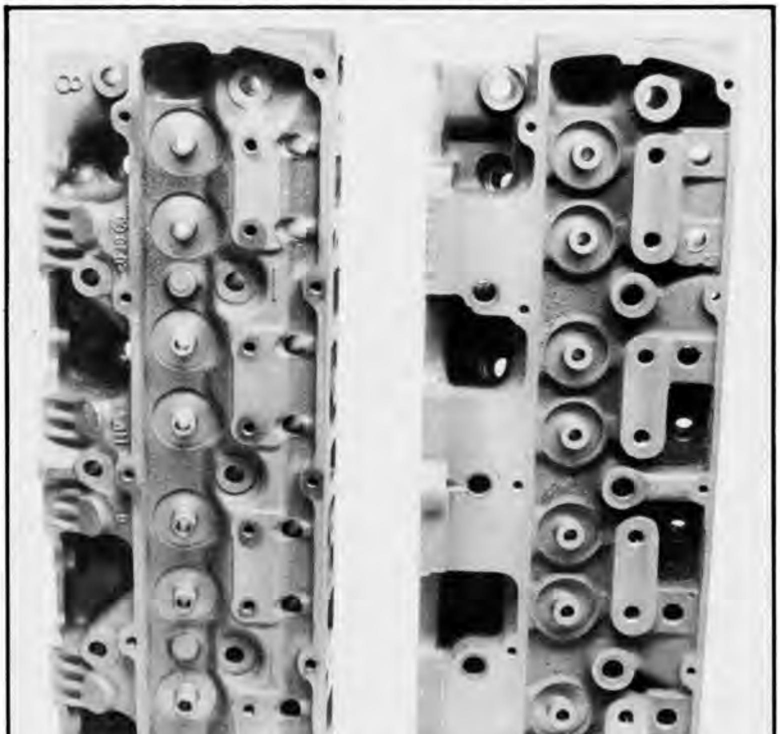
The most dramatic way to illustrate the features of the high-performance Olds/Batten cylinder head is to visually compare it with a late-model, lightweight stocker. Although an iron version is shown, the Olds/Batten alloy head is identical. The performance casting's exhaust face reveals a revised bolt pattern and ports that have been raised more than an inch. Internally, the larger-radius runners connecting the higher ports and the valve seats travel a gentler curved path and maintain a uniform cross section. On the intake side, revised water jacketing and an altered bolt pattern make room for internal porting.

Provisions have also been made so that the exhaust valve guides can be offset to make room for larger valves. All attaching stud bosses have been beefed-up and most internal water jacketing has been moved around to leave more generous sections of structural material for porting purposes.

On the intake side, the new head's bolt-hole angle and pattern limit current intake manifold choices to Edelbrock's four-barrel Victor casting. Temporarily, at least, other high-performance combinations will have to be custom-fabricated or extensively adapted.

(stock head on left in all views)





components continues to improve. This return to the conventional chain-driven camshaft is also partially based on the ability of a gear and chain system to both absorb torsional loads and to keep construction costs to a minimum. There have even been instances reported where, following an engine failure, internal damage has been limited by the "weak link" properties of this more conventional drive arrangement.

Oldsmobile cams are taper-ground to rotate the valve lifters. When high oil pump pressures combine with increased valve spring loads, a considerable longitudinal force is exerted on the camshaft. Installing some sort of thrust-absorbing arrangement with a bearing, washer or shim (approximately .040–.050-inch-thick) between a cam's front flange and the block surface that it contacts can help to absorb this thrust and ease a shaft's rotational drag as well. If shims are installed up front, the head of the cam bolt must be trimmed by an amount equal to the thickness of the shim(s).

A number of specialty equipment manufacturers offer a split timing case cover that allows easier access to the drive system for timing alterations and adjustments. Eliminating the need to pull the harmonic damper can cut cam change time in half. Sealed on assembly with silastic material, these two-piece gear cover arrangements also incorporate a specific double-lip Olds crank snout seal, available under part No. 411345.

Taking the camshaft drive plan one step further is the Jesel, Inc. belt-drive system. This approach involves a case-hardened 8620 steel lower-cog wheel, a hard-anodized 6061 aluminum top pulley (that's twice the diameter of the drive pulley on the crank snout), and a 20mm-wide Uniroyal Power Grip HTD drive belt. Because this high-torque, round-tooth belt is cut to size, no tension adjustment hardware is employed. The top pulley incorporates a three-bolt locking arrangement to allow for quick cam timing alterations without extensive engine disassembly. This same feature also makes changing a camshaft a much simpler operation. In addition, Jesel's bottom hub is indexed 180 degrees in both directions to simplify camshaft phasing checks and adjustments. As an added bonus, engine dyno testing has revealed a horsepower bonus with this system. There's an up-close look at this unique drive setup in the *Oldsmobile In Action* section on the Pro Stock DRCE, America's latest V8.

Attempts to extend valve life in the atmosphere of lead-free gasoline has

The following is a list of original equipment Oldsmobile camshafts and their attending specifications:

CAMSHAFTS

PART NUMBER	562301	562302	402194	402569
INTAKE LIFT (inches)	.474	.474	.474	.475
EXHAUST LIFT (inches)	.472	.474	.474	.475
INTAKE DURATION (degrees)	286	294	308	328
EXHAUST DURATION (degrees)	287	296	308	328
OVERLAP (degrees)	58	68	82	108
See Notes	(1)	(2)	(3)	(4)

NOTES:

(1) A mild street grind formerly listed under part Nos. 393859 and 409691, this shaft is suggested for use with 3.08:1 or longer (numerically lower) final drive. Ground on a 114-degree centerline, this cam is suggested for the 403-cubic-inch small-block in conjunction with a 3.23:1 or longer final drive ratio. Also use part No. 404729 valve springs.

(2) An excellent all-around grind for use with either a manual or an automatic transmission and 3.42:1 and shorter rearend gears. This shaft is basically the same as the above-listed grind except that it's for use with shorter rearend gears and part No. 404729 valve springs. These springs are often listed as out-of-stock and buyers are advised to reorder.

(3) Listed for the late-Sixties W-31 option, this more radical grind is suggested for use with steel tube exhaust headers for off-road duty. In a 350-cubic-inch engine, its extended event duration produces minimal intake tract vacuum and is therefore impractical to use with vacuum power-assisted disc or drum brake systems. Use the 404729 springs and 3.42 gears with an auto trans, and 3.91 with a manual gearbox.

(4) Originally part of the 1970 W-30 455-cubic-inch option, this cam is extremely radical for use in smaller-displacement engines. It should be used only in manual transmission and/or loose torque converter applications, and then only with 3.91s behind an automatic and 4.33s with a manual. Steel tube exhaust headers are mandatory. This camshaft is not suitable for street use. (Inventive enthusiasts can use a special vacuum storage canister to help store brake boost vacuum. The can came standard only on 1961-'63 Olds Starfire models.)

This split timing case cover arrangement allows easy access to the cam-drive components. Late-model OE-style cam sprocket has nylon-covered teeth which have been known to fail under load and dump nylon debris into the oil pan. The main advantage of this stock-type, cam-drive system is its limited cost.

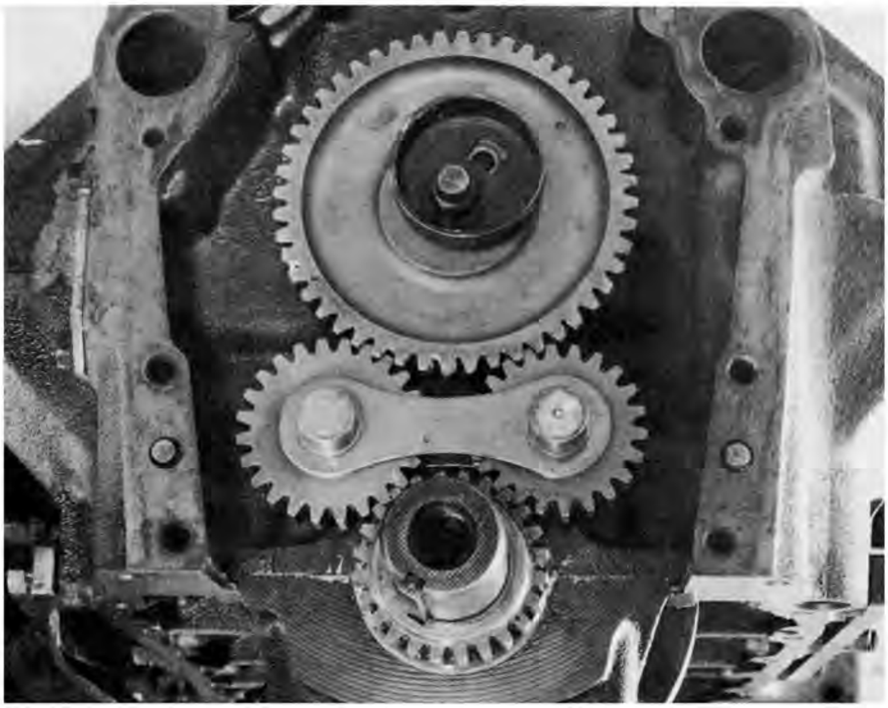
prompted the use of exhaust valve rotators on most of Oldsmobile's late-model V8s. When using a cylinder head equipped with these pieces in a high engine speed application (5000-plus rpm), they should be replaced with standard-style valve spring retainers, part No. 387596, and the appropriate number of valve spring shims, part No. 2301004.

INTAKE MANIFOLDING

The original W-31 engines used an aluminum intake manifold casting that was identical to the OE cast-iron design, but it weighed 25 pounds less. These relatively rare small-plenum, dual-plane castings may still be obtained from OE and other sources under part No. 406114. Improved versions of this design are available from the specialty equipment aftermarket for use with either Rochester Quadrajet or Holley carburetors. Edelbrock's old OL4B-QJ has become difficult to locate, but it accepts either the Rochester carb or, with an adapter plate, Holleys. It works particularly well on heavy cars. Excellent performance characteristics can also be obtained with Holley's dual-plane Street Dominator casting. Some Olds floggers feel that it's by far the best manifold for the street.

These same sources also offer manifolding for other off-road applications that have advantages in specific applications. Most offer improved breathing and distribution characteristics in certain speed ranges. For street engines, however, the dual-plane castings, OE and aftermarket, are the units best-suited to that environment's low-speed response requirements. On a small-block engine (which sits 4 inches lower than an Olds big-block), the dual-plane aftermarket castings will also leave room for early musclecar models' OE fresh-air induction plumbing.

Stock 350 Quadrajet inlet castings can



Although most competent Olds engine builders recommend a gear-and-chain cam-drive arrangement for virtually any high-output application, some maximum-performance engines rely on a positive gear-to-gear connection for stable valve and ignition timing. This gear-drive setup utilizes a pair of intermediate cogs to rotate the camshaft in its original direction.

This pair of Olds cam bolts illustrates how the stocker (right) is trimmed to accept and position the roller-bearing-backed thrust button. The clearance dimension desired here should not exceed zero.

Another approach to camshaft chain drives is this double-roller setup from Cloyes. This system's big feature is the reduced loading on each individual steel link in the double-roller drive chain. Its main drawback is that it can cost five times as much as an OE-type arrangement. Multiple crank sprocket keyways are featured by a number of aftermarket manufacturers to allow easy but limited (plus-and-minus 4- or 8-degrees with this Cloyes setup) camshaft phasing. Other Cloyes gear-and-chain sets can compensate for the altered component relationship resulting from block and/or head machining.

Available from Precisioned Speed, this quality street rocker kit provides full valve adjustment on every cylinder in all Olds V8s. Designed to allow cam lift of up to .600-inch, the kit includes trunions, rocker arms and heat-treated pushrods, studs and guideplates. No machining is required for installation.

be improved by using Allen-head pipe plugs (or machined plugs with a screwdriver slot) to block the pair of EGR (exhaust gas recirculation) passages located beneath each of the primary carb throats. Depending on which carburetor is involved, the plug sizes required will be either ⅜-, ½-, or 7/16-inch pipe thread. Even if the EGR valve is not operational, these open passages tend to disrupt mixture flow and should be sealed off.

EXHAUST MANIFOLDING

Because there are definite horsepower advantages to be had, all high-performance Olds engine builders should seriously consider using the latest in contemporary steel-tube exhaust header science that's available from the specialty equipment aftermarket. To avoid the potential noise, durability and legal problems often involved in installing and living with tube headers, or even to achieve the OE "resto-look," there are limited alternatives.

A high-capacity dual-exhaust system can be based on the cast manifolds being fitted to a stock high-performance engine's dual-exhaust system. If such parts are unavailable, most small-blocks' cast-iron OE manifolds can be fitted with individual exhaust pipes. This can be accomplished by a skilled custom muffler shop equipped with a quality tube bender. There are numerous undercar areas where dual exhausts just weren't part of the production plan (especially on late models) and such structural obstructions demand creative concessions.

Both header exhaust systems and iron manifold exhaust systems will benefit from a cross-over exhaust balance tube connecting each side of the system upstream of the mufflers. And as far as mufflers are concerned, the more, the merrier. A well-thought-out street machine may have room for as many as four free-flowing cans. A well-balanced multi-muffler, minimal-restriction exhaust system can deliver almost as much power as an uncorked exhaust, with nowhere near the noise.

Most late lightweight V8s fitted at the factory with a four-barrel carb use this low-profile, dual-plane alloy casting. Earlier high-rise versions of this 180-degree manifold, as well as most of those produced by the aftermarket, are more capable performers. This unit was designed to produce low-speed response and fit beneath a low hoodline.

Olds enthusiasts interested in all-out performance can now avoid the $1000-plus price tags of custom-fabricated manifolding. This aluminum tunnel ram manifold from Precisioned Speed has a removable top to accept a pair of standard Holleys, twin 4500 Dominators or a single 4500 Dominator carb. They're made to fit 350- or 455-cubic-inch engines with either stock or Batten cylinder heads, without requiring spacers or adapter plates.

WATER PUMPS

Two production water pumps are available for these engines, with the unit designed for air-conditioning-equipped powerplants (part No. 556283) being the more desirable of the two. This extra-duty pump incorporates a smaller, low-drag impeller that circulates the cooling system's liquid slower than the larger, standard pump's impeller. By allowing the coolant to remain in the radiator for a longer period of time, the slower a.c. pump actually promotes improved engine-to-air heat transfer.

The pump's standard impeller is easily differentiated from the more advantageous 4-inch-diameter a.c. unit by way of its visibly larger 5½-inch diameter. Unfortunately, the a.c. pump's impeller is not available as a separate service item. Although it is not recommended for engines that see extended idling periods or low-speed street service, it is possible to press the low-drag a.c. impeller off its shaft to reinstall it on a standard pump.

In addition, a new aluminum-bodied, a.c.-type water pump (above) was recently made available by Oldsmobile. Lighter and less restrictive than a standard pump, the units are designed for all 1965-and-later Rocket V8s.

Production engines fitted with air-conditioning also use a larger crank (drive) pulley and a smaller pump (driven) pulley to increase the water pump's speed. Competition engines can also benefit from an electric motor drive, instead of a standard crank pulley and belt-drive arrangement, to turn the water pump.