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60 PAINT AND BODY TIPS

DISPLAY UNTIL 9/12/93

# MUSCLECAR

RESTORATION GUIDE 1993

## EASY HOW-TO RESTO PROJECTS

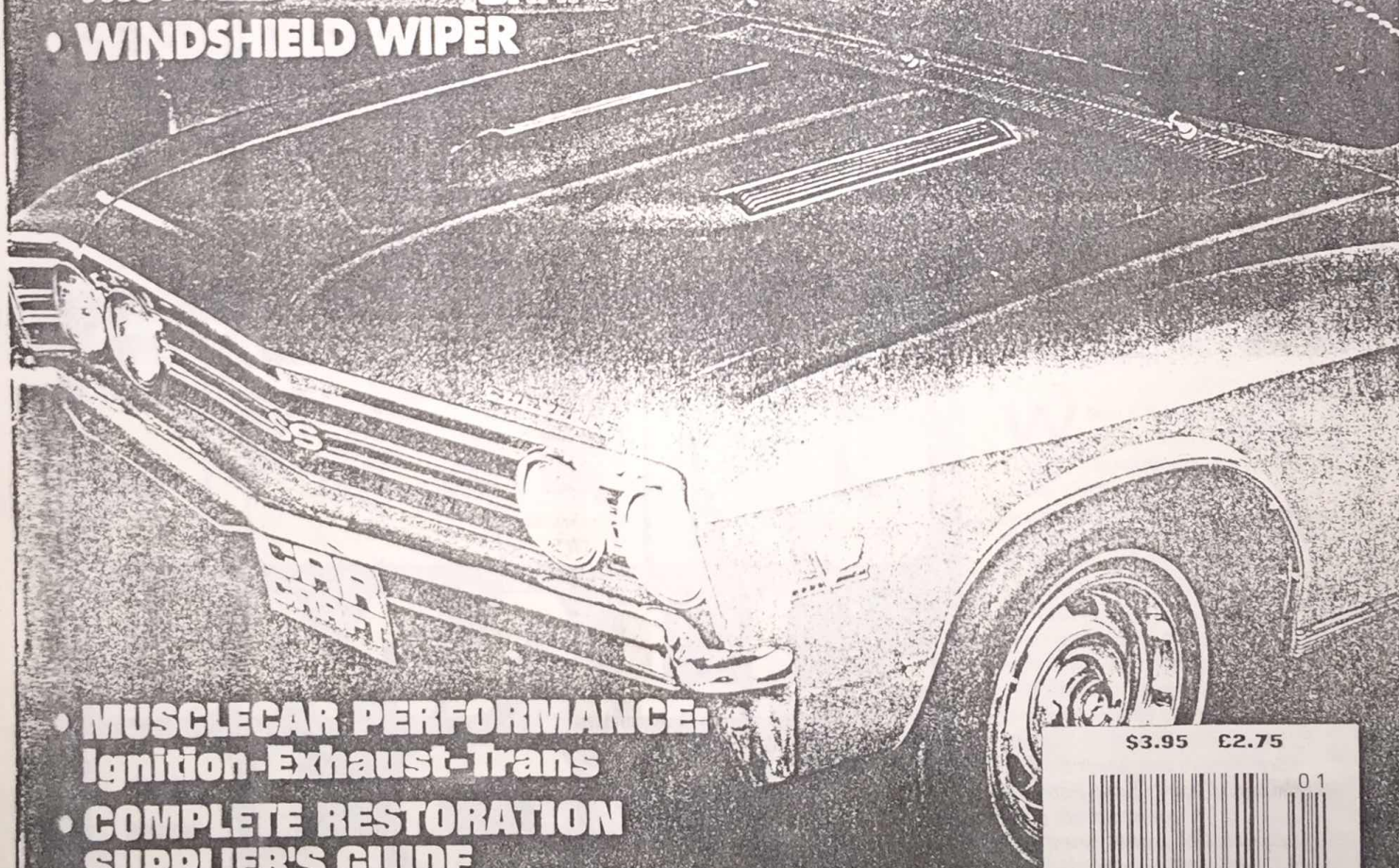
### 2-4-6 HOUR:

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- AIR CLEANER
- SHOCK ABSORBER
- TRUNK
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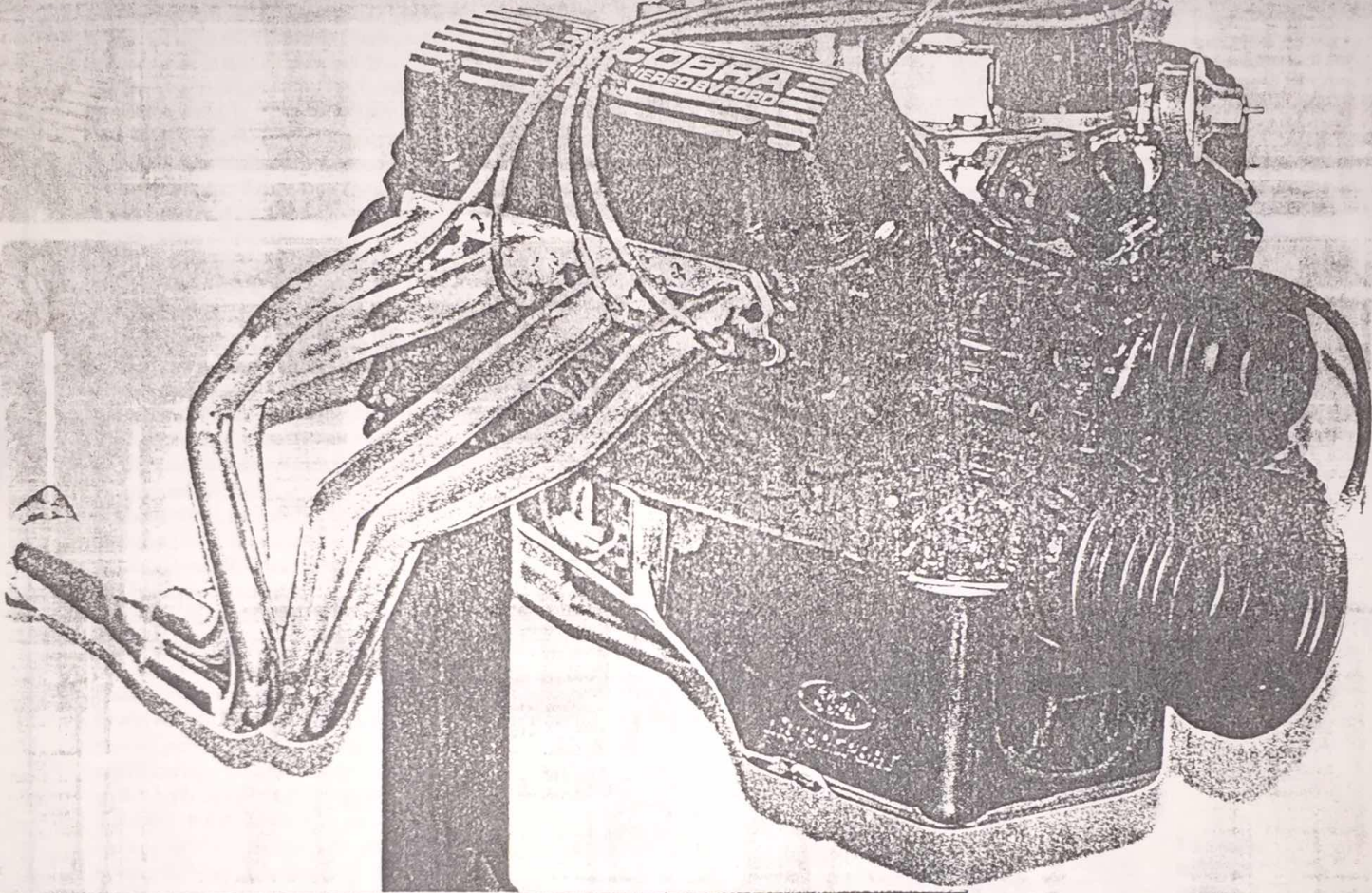


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## Performance Rebuilding A Shelby 302 Engine



# SIZZLING SMALL- BLOCK

By Jeff Tann

**W**hen Carroll Shelby introduced the first '65 GT350 Mustang it was a hot, ready-to-race package. The heart of the GT350 was a Shelby-modified Ford 289 K-code high-performance engine with an aluminum intake topped by a 715cfm Holley carb. Exhaust flowed through tube headers into a low-restriction muffler system. Shelby also added appearance items such as an aluminum Cobra oil pan, Cobra valve covers, and a small open-element air cleaner. In street trim these engines were rated at 306 horsepower, and in many cases the strong-running GT350s were giant-killers, blowing off



their share of big-block musclecars in the early Sixties.

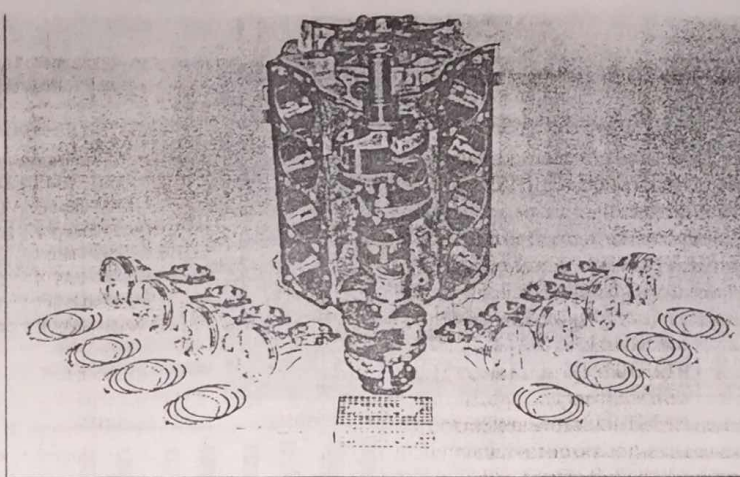
The 289 high-performance engine remained essentially the same from '65 to '67, but in '68 Ford widened the Mustang shock towers, so the high-performance 289 was dropped in favor of a lower-price, larger-dimension 390 FE high-performance engine. The highest-horsepower small-block in '68 was a four-barrel-equipped 302 rated at 250 hp, which is what Shelby was forced to use in his GT350 models. Although appearance items were added to the engine to make it look hot, it was no match for any of the other musclecars of the era. However, Shelby did offer some performance parts over the counter that significantly improved the small-block's power. Today, many of the same (and even better) performance products are available, so Shelby and Mustang owners have the ability to vastly improve their small-block's power output.

Since we are performance enthusiasts and enjoy driving musclecars, we decided to upgrade our 302 engine for more responsive street performance and for the open-track events that are put on by Shelby clubs. We wanted our '68 Shelby to run as good as, if not better than, the early GT350s. Follow along and we'll show you how we turned our mundane 250-horsepower 302 into a 367-horsepower screamer.

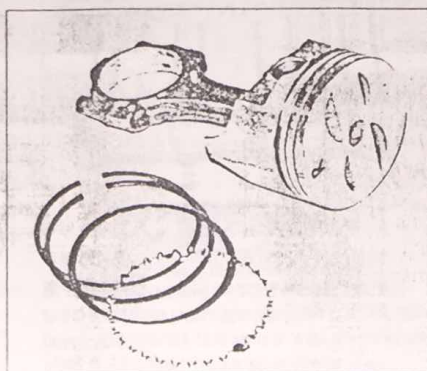
We started by taking the short-block to Performance Automotive Wholesale (PAW) where it was carefully machined and rebuilt. We used PAW's Super Stock Piston Kit that features a set of forged pistons, piston rings, connecting rod, and main bearings. We also ordered a Fel-Pro gasket set because of its high quality and durability. PAW did all of the machining on our engine, which included boring and honing the block, rebuilding the rods, turning the crank, and balancing the reciprocating assembly. They have a complete machine shop with all of the latest equipment and a staff of highly trained machinists.

The secret to building horsepower from a Ford small-block powerplant lies in the choice of heads and camshaft. The stock 302 heads are very restrictive, so they need plenty of improvement. Reworking the stock heads is one possibility for increasing horsepower, but there are plenty of new high-performance heads on the market that can be purchased complete for about the same price as porting and polishing the original heads. If you're not worried about originality, it's the only way to go. If you are worried about originality, you can always hang onto the stock heads, which can be reinstalled at a later date. Chances are, if you drive the car with the high-performance heads we selected for our car, you'll never want to put the stock heads back on!

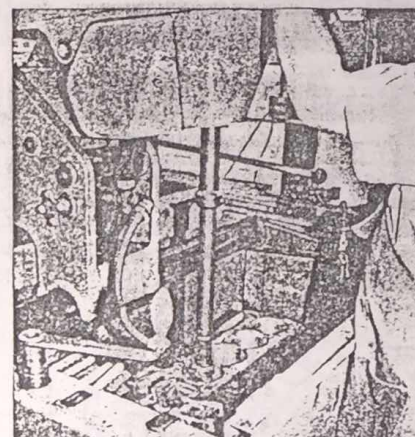
Crane Cams has recently introduced a



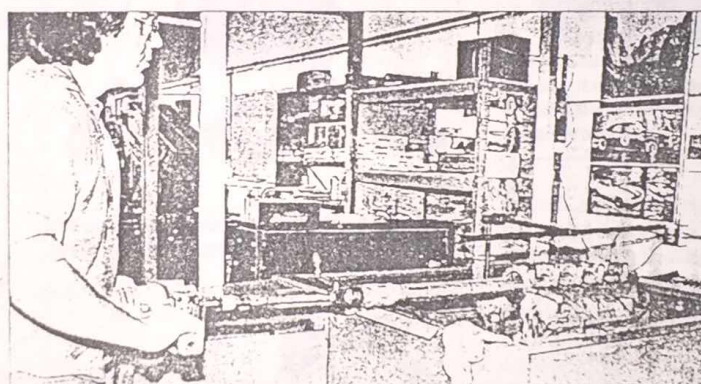
The Performance Automotive Wholesale (PAW) engine kit included new TRW pistons, Speed-Pro rings, and Michigan 77 rod and main bearings. PAW also did all of the engine machining, so this combination is ready to assemble.



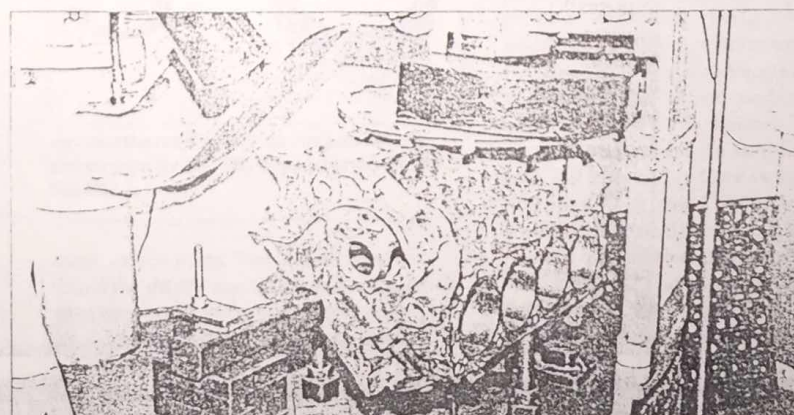
PAW reconditioned the rods, installed new high-strength rod bolts, and hung the pistons. The "R" at the top indicates the right-side bank; "L" would be left. Flattop pistons were used to keep the compression at a reasonable level, in this case, approximately 10:1. The rings are high-quality Speed-Pro.



Following the boring process, the cylinders were honed another 0.005 inch to the desired 0.030 inch.



PAW is careful to make sure the main saddles are straight and round, so the blocks were align-bored as shown.



Blocks can warp over time, so PAW decks the blocks to ensure a flat mating surface for the heads.



## SIZZLING SMALL-BLOCK

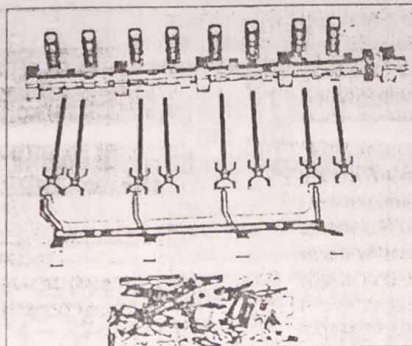
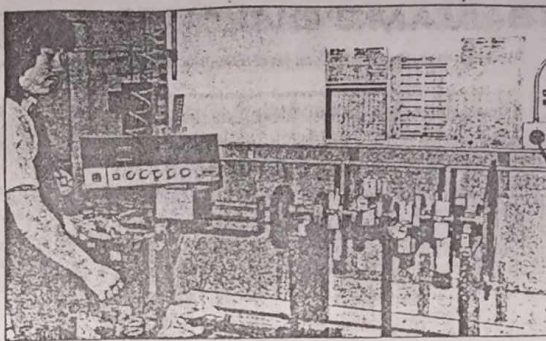
set of steel performance heads for small-block Ford engines that feature 2.02-inch intake valves, 1.60-inch exhaust valves, and large ports for fuel delivery. In comparison, the high-performance 289 heads feature 1.78-inch intake valves and 1.45-inch exhaust valves. On a stock small-block the Crane heads are good for approximately a 40- to 50-horsepower increase, but when combined with a Crane Cams street roller camshaft, roller rockers, and a good intake and exhaust system, some really serious horsepower can be obtained.

The cylinder heads (PN 36900-1) come finished and ready to bolt on. The combustion chambers and ports are polished and the surfaces are machined to perfection. What's nice about these heads is that they are EPA-certified so late-model Ford owners can legally bolt them onto their engines. We wanted to complement the heads with a good performance camshaft that would still give us excellent around-town driveability, so we selected Crane's 36HR-230/359-12 RF camshaft that features 274 degrees duration with a 0.520-inch lift for the intake valves and 282 degrees duration with a 0.542-inch lift for the exhaust valves. The cam is designed to produce good power between 2000 and 5500 rpm. When a hydraulic roller camshaft is used in an early Ford block, such as our '68, it has to be outfitted with a roller retrofit kit (PN 44306-1). We also ordered pushrods (PN 36629-16) and aluminum roller rockers (PN 36750-16). Crane also supplied the timing chain assembly (PN 36999-1). The Crane heads come complete except for studs and guideplates, so we also ordered a set. When the roller cam is used, there are two items that must be ordered from Ford: a spacer (Ford PN E0AZ-6265-A) and a thrustplate (Ford PN C90Z-6269-Z).

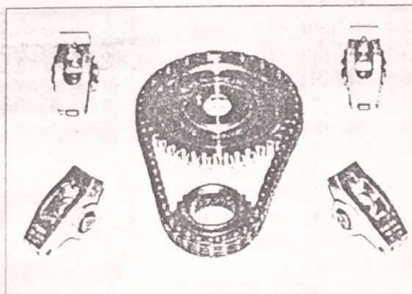
Since our intake was a standard cast-iron four-barrel unit, we wanted to upgrade it to an intake similar to the Cobra aluminum high-rise used by Shelby. Today, Ford Motorsports/SVO offers a manifold exactly like the original high-rise with the only exception being the Motorsport logo instead of the Cobra name tag. The manifold (PN M-9424-A321) offers an improved high-rise design with a base for square-flange carbs. We are, of course, topping the intake with a 715cfm center-pivot Holley carburetor. The carb, PN 0-3259-1 (Ford S2MS-9510-A), is a re-release of the original carb used on the early GT350s, and is perfect for our application. We also improved the exhaust with a set of Hooker Headers for the '68 Mustang chassis. They are equal-length tuned headers with Hooker's special ceramic-metallic coating.

Since we are building this engine with a variety of high-tech parts, we decided to try something new and different to improve the engine's horsepower. We took the heads and intake to Extrude Hone for a little

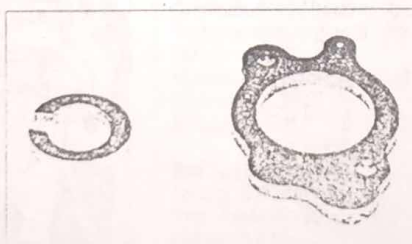
The crank was turned and micropolished, then the entire reciprocating assembly was balanced for smooth operation and better power. PAW has a state-of-the-art computer balancer.



When Shelby was building the GT350 he didn't have high-tech camshafts like Crane's hydraulic-roller camshaft. This is Crane's 36HR-230/359-12 RF along with the retrofit kit (PN 44306-1). Early blocks like this '68 require the special retrofit kit.

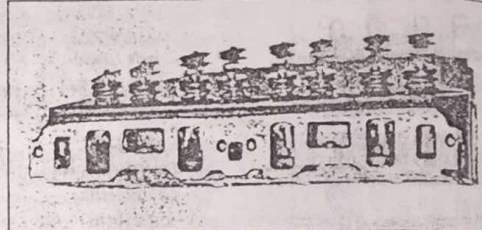


Crane also supplied the dual-roller timing chain (PN 36999-1), and a set of aluminum roller rockers (PN 36750-16).

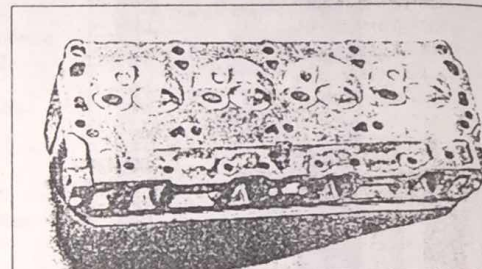


When this roller cam is installed, two Ford parts have to be used: the spacer (PN E0AZ-6265-A) and the thrust plate (PN C90Z-6269-Z).

magic on the ports. The technicians flow tested the intake and heads in stock form to get some readings. Some ports flowed considerably better than others, so it was obvious that some cylinders weren't achieving maximum fuel distribution. After the Extrude Hone process, the lesser-flowing ports were significantly improved, while the ports that flowed better were marginally improved. The result was improved flow



Crane's new high-performance Ford heads (PN 36900-1) provide plenty of fuel flow through the large intake ports. The small intake and exhaust port-size stock heads have always been a hindrance to Ford racers.

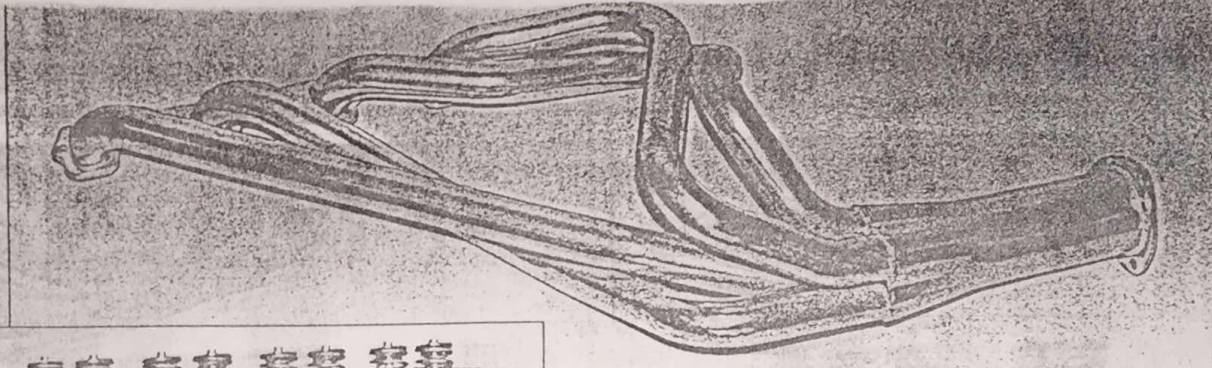


The heads also offer large 2.02-inch intake valves and 1.60-inch exhaust valves. Notice the polished combustion chambers and polished intake ports for improved fuel delivery and detonation prevention.

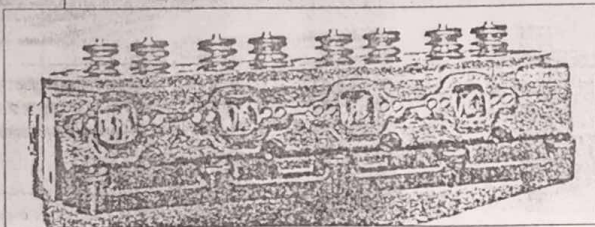
overall, and nearly equal flow from all of the ports. After the Extrude Hone process, all of the cylinders should receive equal fuel distribution for improved horsepower as well as a smoother-running engine. Extrude Honing actually polishes the inside of the intake and head ports where hand porting and polishing cannot reach. This process is extremely effective on fuel-injected late-model performance cars because the inside of an injection manifold and runners can be increased in size, polished, and flow can be balanced out.

While we were rebuilding the engine we ordered a new set of Cobra valve covers and air cleaner from California Mustang. The '68 Shelys didn't come with an aluminum oil pan so we equipped the engine with a chrome Ford Motorsport/SVO oil pan that was also supplied by California Mustang. The result is an engine that looks terrific and can easily dust off the early Shelys. We managed a 117-horsepower increase without losing any engine durability or reliability. If this was going to be strictly a race car, there would still be room for improvement. —

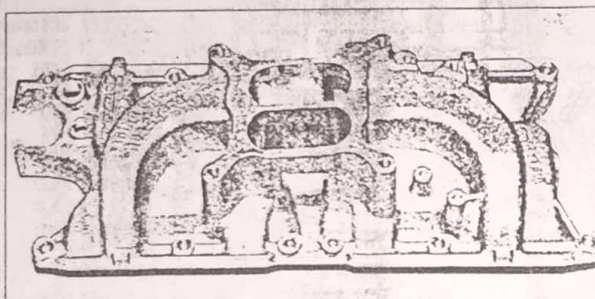




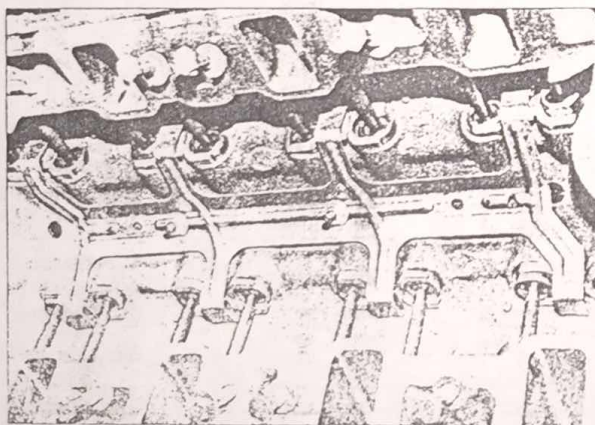
Since we improved fuel delivery and fuel distribution with a set of heads and a hydraulic roller camshaft, it made sense to upgrade the exhaust system with a set of Hooker tuned exhaust headers. These are designed for the '68 Mustang chassis.



The large exhaust port size should make quite a performance difference. Stock heads have exhaust ports that are only half this big. Notice that the exhaust ports are also polished. Dual bolt holes are used for different exhaust manifold/header arrangements.



Since our engine came with a stock cast-iron intake, we wanted to upgrade it to a high-rise like the early Shelby intake. This intake is almost identical to the original Shelby style, but has improved intake ports and has a Motorsport emblem where the Cobra emblem was on the original intakes. The square-flange carburetor base is designed for Holley- or Carter-style fuel-mixers. We're using a center-pivot 715cfm Holley.



Early 302 engines require this retrofit kit for the roller camshaft. This is a simple bolt-in adapter that helps to maintain the lifter alignment. Notice the large intake ports.

### 302 Ford Dyno Results

RPM	Obsv. Torque	Obsv. HP	Corr. HP
2500	270	128.57	137.30
3000	280	160.00	170.87
3500	300	200.00	213.99
4000	305	232.38	248.64
4500	310	265.71	284.57
5000	315	300.00	321.30
5500	310	324.76	347.81
6000	300	342.85	367.19

### Ford 302 Specifications

Bore: 4.00  
Stroke: 3.00  
Compression ratio: 10.7:1  
Maximum BHP: 230  
Maximum torque: 295  
Firing order: 1-5-4-2-6-3-7-8  
Cylinders numbered: Right bank 1-2-3-4, left bank 5-6-7-8  
Distributor rotation: Counter-clockwise  
Valve clearance: Stock: intake and exhaust hydraulic  
Idle manifold vacuum: 17 inches Hg  
Plug gap: 0.028  
Point gap: 0.017  
Oil pressure: 40 lbs.  
Fuel pressure: 5 psi  
Total timing at 4000 rpm: 38 degrees

### Torque Specifications

Cylinder heads: 70 lbs.\*  
Rod bolts: 25 lbs.  
Main bolts: 70 lbs.  
Flywheel bolts: 85 lbs.  
Manifold bolts: Intake: 25 lbs.  
Exhaust: 20 lbs.  
Crank bolt: 90 lbs.  
\*Torque head bolts in three steps: 50 lbs., 60 lbs., 70 lbs.

### Crankshaft and Bearing Specifications

Rod journal diameter: 2.123  
Clearance: 0.0015  
Main journal diameter: 2.2485  
Clearance: 0.0015  
Endplay: 0.006

### Rod Specifications

Length: 5.09 inches  
Pins: Press-in rod  
Length: 3.025  
Diameter: 0.912

### Piston specifications: Stock

Type: Slipper  
Valve-to-piston clearance: 0.001 inch  
Skirt-to-cylinder-wall clearance: 0.002 inch

### Valve Specifications

Intake diameter: 1.78 inches  
Seat angle: 45 degrees  
Lift stock: Intake 0.2303 inch  
Exhaust diameter: 1.45 inches  
Seat angle: 45 degrees  
Lift stock: Exhaust 0.2375 inch  
Rocker arm ratio: 1.60:1

### SOURCES

California Mustang  
Dept. CCRG  
18435 Valley Blvd.  
La Puente, CA 91744  
818/965-5258  
800/854-1737

Crane Cams, Inc.  
Dept. CCRG  
530 Pentress Blvd.  
Daytona Beach, FL 32114  
904/252-1151

Extrude Hone, Abrasive  
Flow Machining  
Dept. CCRG  
8800 Somerset Blvd.  
Paramount, CA 90723  
310/531-2976

Fel-Pro Inc.  
Dept. CCRG  
7450 N. McCormick Blvd.  
P.O. Box 1103  
Skokie, IL 60076-8103  
708/674-7700

Ford Motorsport/SVO  
Dept. CCRG  
44050 N. Groesbeck Hwy.  
Clinton Township, MI 48036  
313/337-1356 (Tech line)

Holley Replacement Parts  
Dept. CCRG  
11955 E. Nine Mile Road  
Warren, MI 48089  
313/497-4000

Hooker Headers  
Dept. CCRG  
1024 W. Brooks St.  
Ontario, CA 91762  
714/983-5771

Performance Automotive  
Wholesale, Inc.  
Dept. CCRG  
8966 Mason Ave.  
Chatsworth, CA 91311  
818/407-2600

Speed-Pro  
Sealed Power Corporation  
Dept. CCRG  
100 Terrace Plaza  
Muskegon, MI 49443  
616/724-5011

TRW Automotive  
Aftermarket Division  
Dept. CCRG  
8001 E. Pleasant Valley Road  
Cleveland, OH 44131-5582  
216/447-1879, 216/447-8202