



# 455 H.O. FIX-UP

A simple rebuild that improves the performance and reliability of our 455 H.O.  
**Part 2: Assembly and dyno testing**

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PHOTOGRAPHY BY THE AUTHOR

**I**n last month's issue we outlined the series of events that resulted in a complete rebuild of the 455 H.O. in our '72 Trans Am. What started out as a simple frost plug repair quickly escalated to a full blown rebuild, as we found several additional issues at the time of disassembly that could have certainly ended much worse. There are no two ways about it—we dodged a major bullet.

With only 1,286 Trans Ams built during the '72 model year, and the fact that ours retains its numbers-matching drivetrain, we were set on reusing as many original components as possible during the 455 H.O. rebuild. Looking to improve reliability, we made a few concessions that would remain undetectable from any external view. This would also give us a chance to inject some modern technology, which could boost performance slightly, too.

**1** With a

main journal diameter of 3.25-inches,

the forged 4340-steel crankshaft from Eagle is a direct replacement for the stock nodular-iron unit. It boasts 0.040-inch more stroke length than stock. Eagle's ESP Armor finishing process provides the brilliant appearance. Designed to shed oil and remove surface imperfections, ESP Armor doesn't increase journal sizing but can be removed with polishing or machining, so be sure your machinist is familiar with it. Eagle is so confident that the finish improves crankshaft durability, the company warrants any such 4340-forging against failure for one full year regardless of application or usage. ▲



Knowing a new crankshaft and pistons were required, it made sense to purchase a complete rotating assembly that would include everything needed to assemble the short-block. We opted for a forged 4340-steel crankshaft as it offered increased durability for only a few hundred over the cost of a cast replacement. It also made the jump to a stroker assembly a sensible choice—it didn't add to the cost, would increase total displacement by a few more cubic inches, and could possibly add a few extra lb-ft of torque.

Flat-tappet camshafts remain an excellent performance value, but roller technology provides several advantages. When compared to a similar flat-tappet, a roller-grind can open the valves

quicker, which allows for more seat time. The result is improved idle quality with no degradation to full-throttle performance. The friction loss associated with the roller lifter may also free up a few more horsepower, too, and because hardened components are used, they're unaffected by modern spec oil and aren't susceptible to lobe and/or lifter failure like flat-tappet cams.

A quick call to Butler Performance netted most everything we needed for our rebuild, including a high-quality rotating assembly. It and the other pieces we ordered were delivered to our doorstep in a matter of days.

We searched through Comp Cams catalog and considered a few of its off-the-shelf hydraulic roller grinds. We

couldn't find the exact specs we wanted so we simply ordered a custom-ground unit, which arrived along with everything else we needed for the valvetrain in little more than a week.

Willard Auto Machine (WAM) in Omaha, Nebraska, was enlisted to machine the 455 H.O.'s existing components to accept the kit we'd purchased, perform the complete engine assembly, and then measure the freshly rebuilt 455 H.O.'s performance on its in-house engine dyno. Follow along as the rebuild progresses and the 455 H.O. proves its worth as a formidable street engine, generating impressive numbers from a relatively simple combination. And to think we were satisfied with its performance before the rebuild!



**2** The rotating assembly we purchased from Butler Performance also included forged 4340-steel H-beam connecting rods by Eagle and custom-spec forged-aluminum pistons by Ross. The full floating wristpins are retained by spiral locking clips. The pistons are complemented by a Total Seal piston ring set.



**3** This 455 H.O.'s bottom end is practically bulletproof. Though the rotating assembly is likely capable of enduring 800 hp or more, the original four-bolt main-block may be the weakest link at this point, limiting maximum horsepower potential to about 650. We don't ever intend to reach that level with the numbers-matching engine, but it's reassuring to know the short-block is capable, should the desire for future performance increases arise.



**4** As we learned in last month's issue, our 455 H.O.'s original windage tray was cracked and had to be replaced. We sourced a Tomahawk unit from Butler Performance. Willard Auto Machine (WAM) technician Beau Sheffield checks for sufficient clearance between it and the rod caps and bolts.



**5** A few areas too close for comfort were gently massaged with a large ballpeen hammer.



**6** WAM machined the deck surface of the block so that the Ross pistons are perfectly flush with it. The valve-pocket volume measures 8.5 cc; when combined with the zero-deck block and a cylinder-head combustion-chamber volume of 100 cc, it produces a compression ratio that's just under 9.2:1. A piston with lesser valve-pocket volume would increase compression slightly, but Butler leaves it deep to allow for plenty of valve-to-piston clearance for camshafts with radical valve timing and/or high valve lift.

**7** On the flow bench after the rebuild, the original code 7F6 '72 455 H.O. cylinder heads provided slightly more than 220-cfm intake airflow at 0.500-inch valve lift as recorded at 28 inches of pressure. While port work is always an option, we chose to leave the valuable round-port cylinder heads as cast to maintain originality. Beyond a valve job consisting of multiple seat angles, intake port volume remains at 170 cc.



**8** To complement the hydraulic-roller camshaft, the cylinder heads were assembled using No. 987-16 valvesprings, and locks and retainers supplied by Comp Cams. At an install height of 1.8 inches, these springs provide 125 pounds of seat pressure and about 325 pounds at maximum valve lift. The finished cylinder heads were installed using Fel-Pro No. 1016 head gaskets and the original fasteners, and were torqued to 100 ft-lb.



**9** A quick mockup revealed that pushrods in a length of 8.65 inches were required to achieve optimal valvetrain geometry with the Comp Cams components. WAM sourced a set from Smith Brothers.



**10** The roller valvetrain is comprised of a host of components from Comp Cams. The hydraulic roller cam is a custom-ground unit containing 224/236 degrees of 0.050-inch duration, 0.502/0.520-inch valve lift at 1.5:1, an LSA of 113 degrees, and an intake centerline at 109. The specs were carefully chosen to complement the operating characteristics of our 455 H.O., which is backed by a Turbo 400 with a stock stall converter and 3.08 gears. By using a degree wheel at the time of install, WAM verified that the specs were exactly as requested.



**11** Hydraulic roller lifters are much longer than similar flat-tappet units, and as such, can contact the internal baffling found on an original Pontiac valley pan. Butler Performance provided us with this Tomahawk unit, which is a reproduction of the original but with provisions to clear roller lifters. Sheffield test-fits it before final installation to ensure that no clearance issues exist.



**12** Because the Pontiac V-8 is a 90-degree design, whenever the cylinder heads are milled appreciably, so must the intake manifold or its corresponding flange on the cylinder heads. In our instance, the 7F6 castings were milled 0.050-inch in order to achieve a combustion-chamber volume of 100 cc. Sheffield test fits the manifold on the engine with the gaskets and valley pan sitting in place to be sure that there's sufficient clearance and that the bolt holes line up correctly.

**13** While it's considered better practice to remove material from the cylinder head as opposed to the intake manifold when fitting the two, WAM found that our original



cast-aluminum intake manifold was contorted and that at least 0.015-in had to be removed to true it up. As opposed to removing the remaining amount from the cylinder heads, Willard elected to remove a total of 0.060-in from the intake manifold, which provided perfect alignment. Since the cylinder heads and intake manifold will likely never be on any other engine, it's of little concern.



**14** Our engine's original oil pan was badly dented. Instead of searching for a clean, reusable original, we simply opted for a new stock-replacement unit from Canton Racing. PN 15-389, it fits and installs just like an original, and contains an internal baffle to prevent oil starvation during hard turns. ◀



**15** With the 455 H.O. completely assembled, Willard ran the fresh mill on his Land & Sea Dynamite engine dyno. It was first run under various loads for several minutes and at various speeds to allow the rings to seat properly. He then began a series of full-throttle pulls aimed at measuring peak output.

**/// A quick call to Butler Performance netted most everything we needed for our rebuild, including a high-quality rotating assembly ///**



**16** We reused the Trans Am's original points distributor, which has been carefully recurved to provide 22 degrees of centrifugal advance. The only necessary modification was the installation of a composite drive gear from BOP Engineering to complement the roller camshaft. We attempted several different levels of total timing while on the dyno. In its previous configuration, the 455 H.O. made peak power at 36 degrees. The fact that it required 34 degrees to achieve peak power after the rebuild proved it's operating more efficiently.

## HPP ENGINE BUILDUP WORKSHEET

Engine Displacement: ..... 468.8 ci  
 Horsepower: ..... 433  
 Torque: ..... 517 lb-ft  
 Bore/Stroke: ..... 4.195/4.25 inches  
 Engine Built By: ..... Willard Auto Machine

### BLOCK

Block Description: ..... '72 code-YE 455 H.O.  
 Preparation: ..... Clean and inspect, soda-blast, bore and hone cylinders to 4.195, align-bore  
 Deck Height: ..... 10.220-inch  
 Crank: ..... Eagle forged 4340-steel, 3.25-inch main journals, 2.2-inch rod journals, 4.25-inch stroke  
 Preparation: ..... ESP Armor finish  
 Balancer: ..... Powerbond stock replacement  
 Connecting Rods: ..... Eagle forged 4340-steel, H-beam, 6.8-inch length  
 Bearings: ..... Sealed Power on mains and rods, Dura-bond for camshaft  
 Pistons: .. Ross, custom design for Butler Performance spec, 4.191-inch, 8.5cc valve relief volume  
 Wristpin: ..... 0.990 in, full floating  
 Piston Rings: ..... Total Seal  
 Deck Height: ..... Zero  
 Rotating Assembly Balanced: ..... Yes

### OILING SYSTEM

Windage Tray: ..... Tomahawk Replacement  
 Oil Pump: ..... Pro-Series from Butler Performance, approximately 70 psi  
 Oil Pan: ..... Canton stock replacement

### HEADS

Casting: ..... '72 No. 1972 455 H.O. Round-Port  
 Preparation: .. Clean, install new valvedguides, machine  
 Valves: ..... Ferrea stainless-steel, 2.11/1.77-inches  
 Valve Seat Angles: ..... Multi-angle with 30-deg intake and 45-deg exhaust seats  
 Valvesprings: ..... Comp Cams 987-16  
 Valvespring Install Height: ..... 1.8 inches  
 Valvespring Pressure: ..... 125-psi seat, 325-psi open  
 Valve Retainers: ..... Comp Cams 740-16  
 Valve Locks: ..... Comp Cams 614-16  
 Rocker Studs: ..... ARP 7/8-inch  
 Rocker Arms: .. Comp Cams cast-alloy roller, 1.5:1 ratio  
 Combustion Chamber Volume: ..... 100 cc  
 Compression Ratio: ..... 9.2:1  
 Intake Port Volume: ..... 170 cc  
 Air Flow Numbers at 28 Inches:  
 Before Rebuild  
 Lift ..... Int/Exh  
 0.050 ..... 0.41/0.24-inch  
 0.100 ..... 0.74/0.51-inch  
 0.200 ..... 0.139/0.97-inch

0.300 ..... 0.190/0.133-inch  
 0.400 ..... 0.209/0.149-inch  
 0.500 ..... 0.212/0.160-inch  
 0.550 ..... 0.213/0.165-inch  
 After Rebuild  
 Lift ..... Int/Exh  
 0.050 ..... 0.43/0.27-inch  
 0.100 ..... 0.81/0.57-inch  
 0.200 ..... 0.153/0.123-inch  
 0.300 ..... 0.200/0.155-inch  
 0.400 ..... 0.214/0.168-inch  
 0.500 ..... 0.222/0.175-inch  
 0.550 ..... 0.223/0.177-inch

### CAMSHAFT

Brand: ..... Comp Cams custom hydraulic roller  
 Duration at 0.050: ..... 224/236-deg  
 Duration Advertised: ..... 275/287-deg  
 Lift with Specified Rocker Arms: .. 0.502/0.520-inch  
 Lobe Separation Angle: ..... 113-deg  
 Intake Centerline: ..... 109-deg  
 Lifters: ..... Comp Cams hydraulic roller  
 Pushrods: ..... Smith Brothers 8.65-inch length  
 Timing Chain: ..... Federal Mogul CTS-3112R

### INDUCTION SYSTEM

Carburetor: ..... '71 455 H.O. Quadrajel, #7041268, 828-cfm  
 Primary Jets/Rods: ..... 74/43  
 Secondary Rods: ..... CV 0.0527-in  
 Secondary Rod Hanger: ..... Stamped "R"  
 Fuel Pump: ..... Carter M6405  
 Intake Manifold: ..... '72 455 H.O., No. 488945 cast-aluminum

### IGNITION

Distributor: ..... Pontiac points-type No. 1112126  
 Points: ..... NAPA CS-89  
 Distributor Gear: ..... BOP Engineering composite  
 Coil: ..... Stock ACDelco  
 Wires: ..... Stock-replacement ACDelco  
 Spark Plugs: ..... ACDelco No. R45TS  
 Total Timing: ..... 34-deg  
 RPM Total Timing Is Reached: ..... 3,200

### EXHAUST

Exhaust Manifolds: ..... Reproduction round-port by Ram Air Restorations with 2.5-inch outlets  
 Exhaust Pipes: ..... 2.5-inch  
 Muffler: ..... Reproduction crossflow-type from Waldron Exhaust

### GASKETS

Brand: ..... Fel-Pro

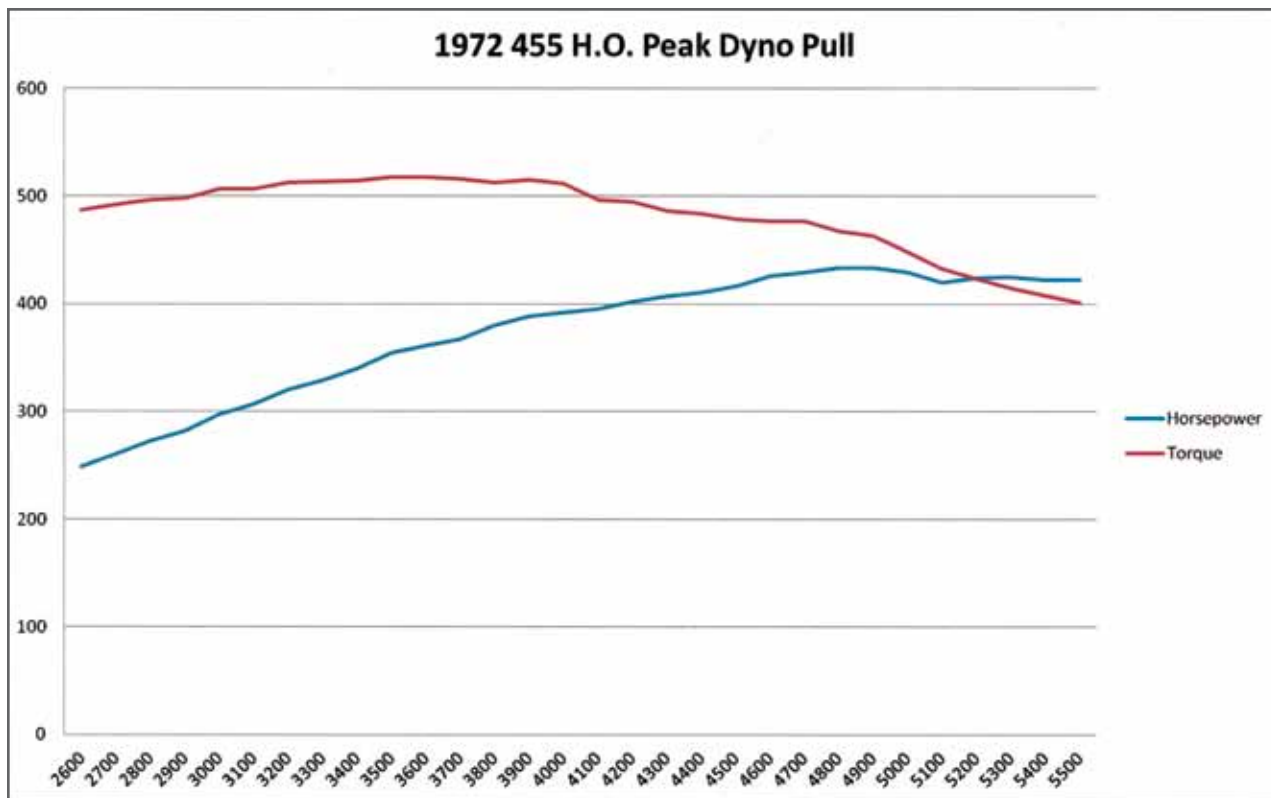
## DYNO RESULTS

On WAM's in-house dyno, the freshly rebuilt 455 H.O. peaked at 433 hp at 4,800 rpm and 517 lb-ft at 3,500 rpm. If the figures calculated from our initial chassis dyno session before the rebuild are correct, we increased output by at least 100 units each! Reviewing performance at each point reveals how well suited this combination will be for the street.

RPM	HP	TQ
2,600	249	487
2,700	261	492
2,800	273	496
2,900	282	498
3,000	297	506
3,100	307	506
3,200	320	512
3,300	329	513
3,400	340	514
3,500	354	517
3,600	361	517
3,700	367	516
3,800	380	512
3,900	388	515
4,000	392	511
4,100	395	496
4,200	402	494
4,300	407	486
4,400	410	483
4,500	416	478
4,600	426	477
4,700	429	477
4,800	433	467
4,900	433	463
5,000	429	448
5,100	420	432
5,200	424	423
5,300	425	415
5,400	422	408
5,500	422	401
Avg.	373	482

**17** We have been using a rare '71 455 H.O. Quadrajel on our engine for several years. The casting is void of an outer ring in the primary venturi, and because of that its peak air-flow capacity is more than 825 cfm. We returned to the stock calibration of 0.074 jets, 43B rods, BP (0.041-inch) secondary rods, and a "G" hanger for the initial pull. It proved a bit rich. Peak power was attained using a pair of CV (0.0527-inch) secondary rods and an "R" hanger. ◀





**18** One look at this dyno graph and it's easy to see that Pontiac engineers knew exactly what they wanted to accomplish when designing the 455 H.O., and we simply expanded on that during our rebuild. The torque curve is remarkably flat and consistent, producing at least 500 lb-ft for more than 1,000 rpm, and the horsepower curve is smooth throughout the entire rev range. This excellent combination of horsepower and torque will reward us with a Firebird that's smooth and docile at any speed on the street.

**19** With the 455 H.O. cleaned and stripped to bare metal, it proved the perfect opportunity to repaint it in the correct shade of blue Pontiac used during the '71-'72 model years. Mike Cole of D&R Auto Paint & Supply in Council Bluffs, Iowa, expertly mixed us a custom color that replicates the hue exactly. Local friend Mike Buzzello used his equipment and safety gear to first apply an epoxy-primer base, which was then followed by two light coats of color. The 455 H.O. looks factory fresh. ▼ **HPP**

### SOURCES

**BUTLER PERFORMANCE**  
www.butlerperformance.com

**COMP CAMS**  
www.compcams.com

**CANTON RACING PRODUCTS**  
www.cantonracing.com

**WILLARD AUTO MACHINE**  
www.wampowered.com

**EAGLE SPECIALTY PRODUCTS**  
www.eaglerod.com

**FEDERAL MOGUL**  
www.federalmogul.com

**BOP ENGINEERING**  
www.bopengineering.com

**D&R AUTO PAINT AND SUPPLY**  
www.drautopaint.com

