CHEVY'S LITTLE "301" GIANT

By mixing some 283" and 327" parts and pieces, you come up with a 301" Chevy. Add a few speed secrets and the result is a roaring 402 horsepower. Not bad!

BY BOB SWAIM ■ Since its introduction in 1955, when it hit the auto performance world with a thunderclap, the small block Chevrolet engine has gained and maintained status as "Leader of the Pack" with rodders everywhere. A quick glance at the NHRA record list shows that some 51% of all class records are held by Chevy engines, the majority of which are the small block variety. The overwhelming popularity of the "mouse motor" can be traced to several self-evident reasons; it is compact and lightweight, a wide variety of high-performance equipment is available, and, perhaps most important, *they run!* Admittedly, some run better than others, but there are good reasons for this, and in the following pages we plan to show how you can have one of the "good motors."

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Jim Travers maintains that the most important factor in building a competition engine is straightforward careful workmanship. This means that every tolerance and clearance is checked and double checked to insure that it is correct. An engine is only as reliable as the parts which go into it, so all stock components are magnafluxed and checked for quality before they ever go into a Traco engine. With this in mind, let's get to engine building.

Traco starts off by ordering individual engine components from the factory in quantity. This eliminates time spent disassembling complete engines and buying unnecessary components that will be replaced, such as pistons, cam, etc. When the rough block arrives – and some of them are pretty rough – a mandril is inserted and the block surface is checked for parallel alignment with the crank. If things don't line up just right, off goes the block to the machine shop where a few thousandths will be trimmed off to make the surface parallel. Next, the cylinder axes are checked against the crank axis to make sure they are perpendicular, and any deviations are corrected by reboring and honing of the cylinders. The honing process is very critical, specifically in obtaining a good cross hatch pattern for proper ring seating. Traco recommends using a Sunnen AN-200 honing stone with a rapid back and forth action to prevent uneven honing.

By this time the delivery van from ForgedTrue has brought over the pistons that are to be used. Messrs Travers and Coon prefer the ForgedTrue units because of their superior quality and workmanship. The piston domes are of sufficient height to provide a lower than stock compression ratio of 11.15:1. In Traco's opinion the lower compression ratio increases the engine's reliability considerably, while the loss of horsepower output is negligible. The top ring land of each piston is cut to accept step-seal rings.

The first work step involving the pistons is to insert each one into a cylinder and check the piston to wall clearance with a feeler gauge. Once the correct side clearance of .009 is obtained for each piston in its respective cylinder, the rings are brought out to be fitted. Perfect Circle or Ramco rings with top step-seals are used, as Traco's experience has proven these to be the most efficient. One at a time, each ring is placed in a cylinder and, with the top of the corresponding piston, pushed down about two inches. This method effectively squares the rings in the cylinders so that an accurate check of the end gap can be made. Once the ring is in place, the end gap is checked with a feeler gauge to see if it is within the specified .021 to .040. This procedure is repeated for each of the three rings on each piston. If too little clearance is present, the gap may be opened up a bit by very carefully filing a few thousandths off the end of the ring. One deviation from the above specified end gap is that the space is closed up to between .008 and .012 on the top ring when the ForgedTrue step-seal units are used, as was the case with this engine.

Getting back to block preparation, one trick that Traco employs to insure reliability is to remove the oil passage end plugs, as tin ones have been known to blow out, and insert internal wrenching plugs. This necessitates threading of the passages with a tap, but the extra work is worth the trouble. While the tap set is out, a bottoming tap is run down the main bearing bolt holes so that longer bolts may be used. Most blocks do not need align boring, but it is checked and bored if needed. After all machine operations are complete, the finished block is bathed thoroughly with solvent to remove all metal particles, then with soap and hot water. Once the block is dry, freeze plugs and stock cam bearings are installed.

Meanwhile over in another corner of the shop, Coon has been busy preparing the crankshaft. After magnafluxing, to ascertain that the stock unit is a sound one, a grinding stone is used to remove any forging imperfections and generally deburr the crank. The journal radii are then shotpeened to increase reliabilty before they are gound. There is .0015 to .0030 of an inch clearance for the main bearings and .002 to .0035 for the rod inserts. As a final step the journals are micro-finished by polishing with a very fine grit paper.

The rods go through much the same process as the crank. First, a visual inspection is made to find any obvious defects, then the magnafluxing apparatus is put to use again. Forging flashes and imperfections are hand filed to prevent metal particles from coming dislodged at a later date and getting into the oil system. The shot-peening operation is repeated, with each rod being bombarded with thousands of metal balls. This has the effect of rearranging the surface molecules of the metal and generally strengthening the rods. The mating surfaces on the big ends are ground clean to provide a perfect fit, while oil holes are added on the small ends to facilitate wrist pin oiling. Traco then diverges from stock by fabricating and using their own wrist pins. These items are of 4340 steel, are hard-chromed and centerless ground to increase longevity. The rod ends are honed to provide a snug fit for the pins, with .0008 – .0010 clearance, while pin fit in the pistons is even tighter, with .0003 – .0006 clearance. This method of pin fit is known as "full floating," and is preferred by the principals at Traco. (It should be noted that if stock pins are to be used, they must be press fitted with standard clearances.)

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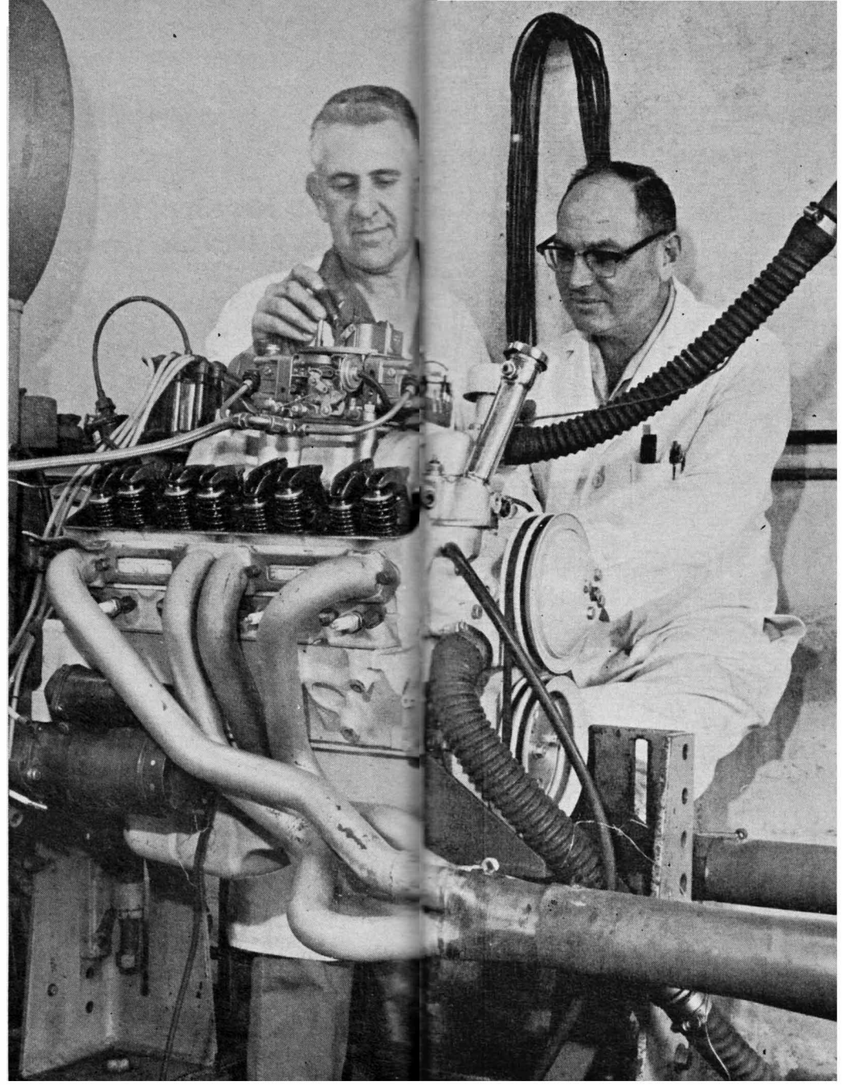
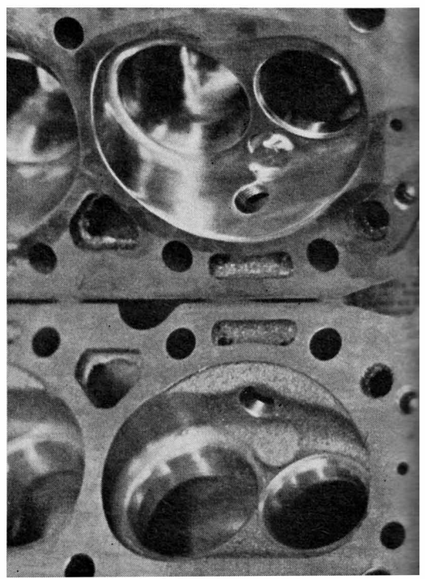
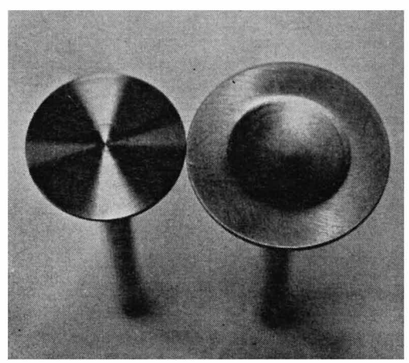


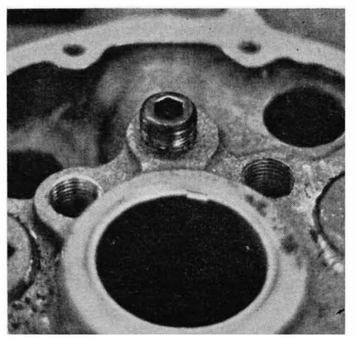


ABOVE — Jim Travers (right) and Frank Coon, co-owners of Traco Engineering, make final adjustments prior to dyno testing the 301 incher.

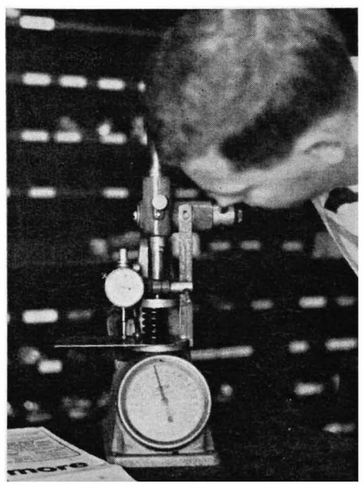
LEFT — Comparison of a stock head with a Traco modified version shows the effect of Lockerman Porting's polishing of the combustion chambers.

BELOW — Traco-designed valves, which provide better airflow, are swirl polished to eliminate stress lines, thus precluding stem breakage.





ABOVE — Oil galleries are tapped and the stock plugs replaced with internal wrenching units to eliminate possible oil pressure loss during competition.
RIGHT — Gene Owen checks each valve spring for coil bind and proper height, insuring that spring seat pressure is within the limits of 120 to 130 pounds.



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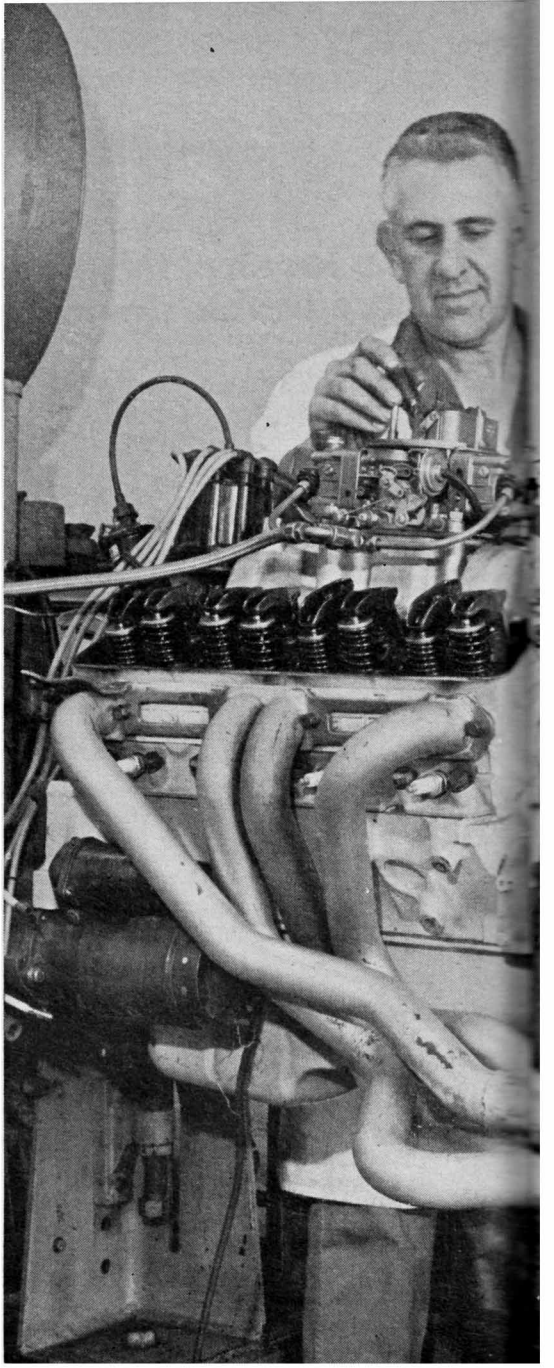

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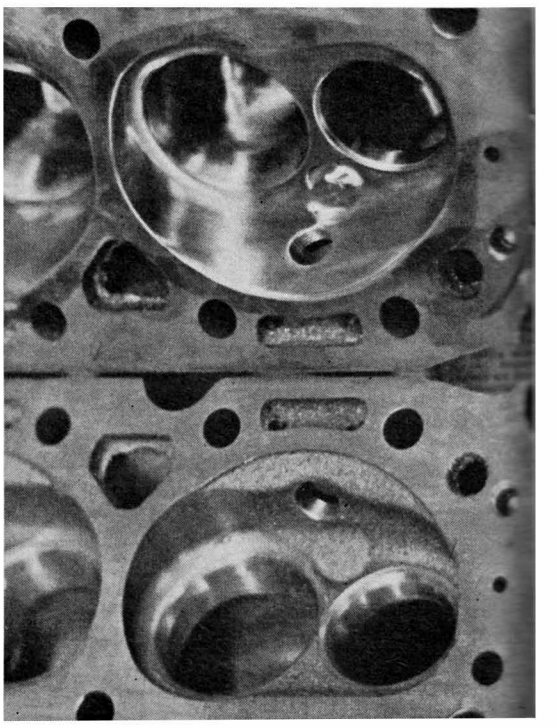

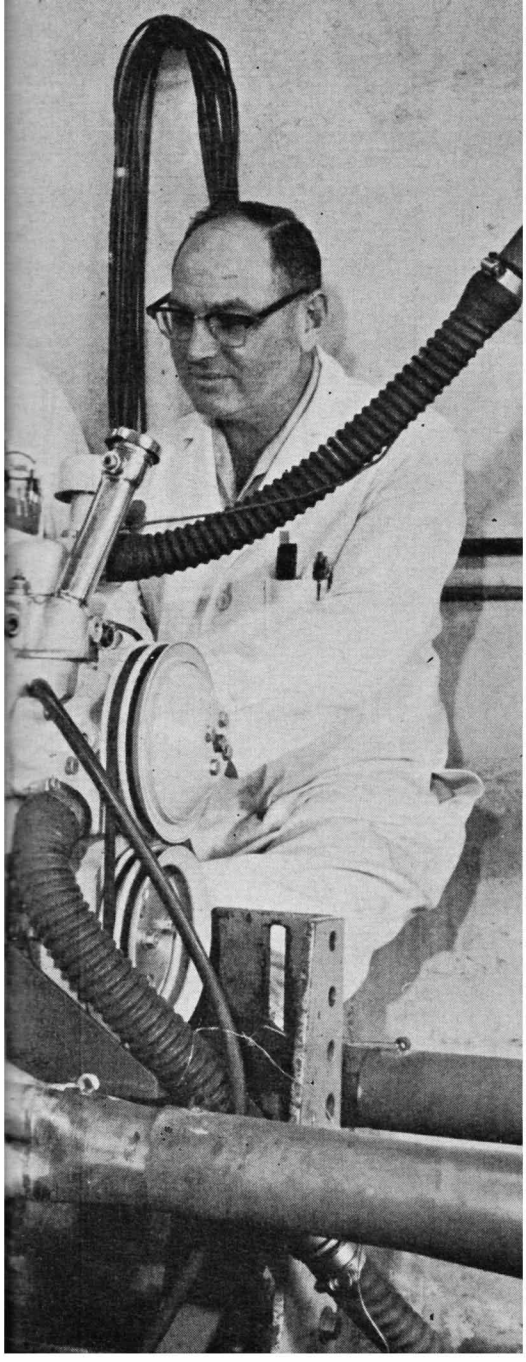

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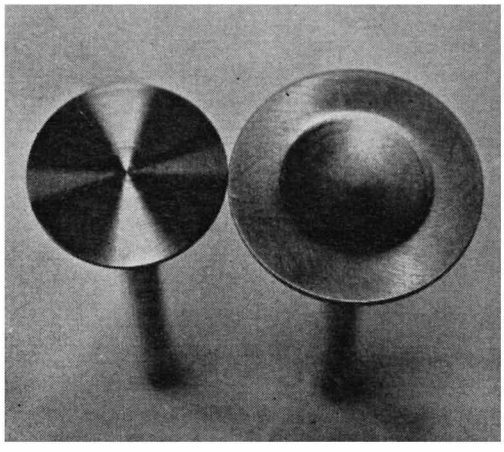

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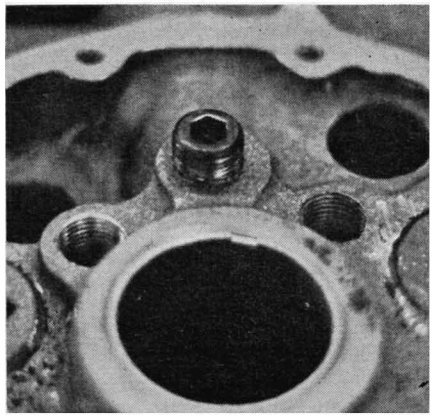

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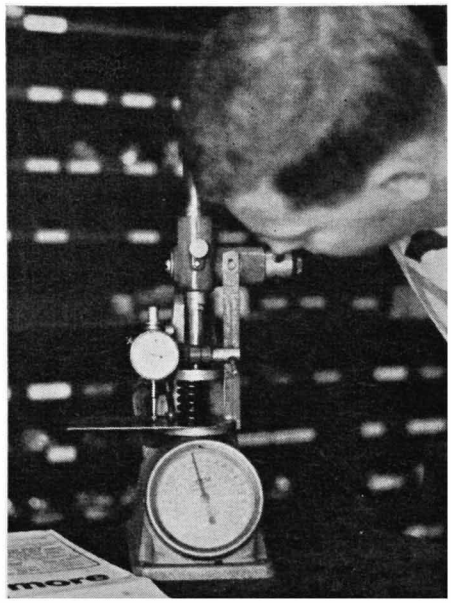

RIGHT — Gene Owen checks each valve spring for coil bind and proper height, insuring that spring seat pressure is within the limits of 120 to 130 pounds.

and the rear main seal is set in place. After placing the bolt in the nose of the crank, the crankshaft is then rotated to see that it turns freely. (If there is any bind, the crank is removed and the cause of the problem is located and corrected.) A dial indicator is set up on one of the crank throws next, and the crank is moved back and forth to check that end play is .002-.006.

Since we are using full floating wrist pins, assembly of the pistons and rods is a relatively simple task. A light coat of oil is applied to the pins, then they're

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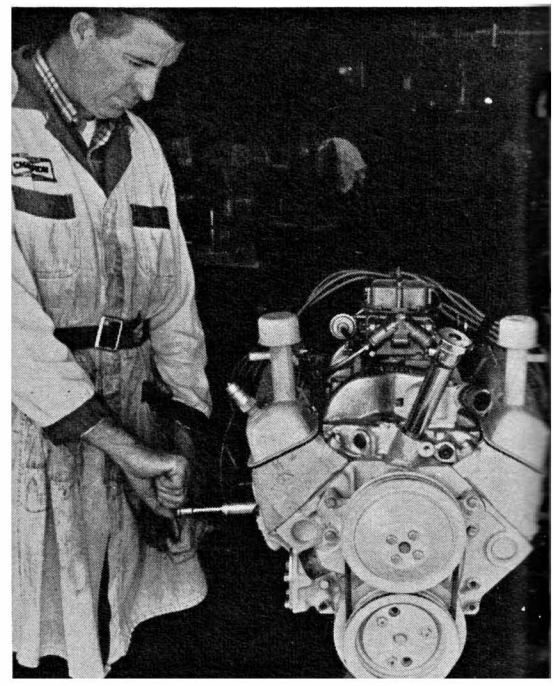
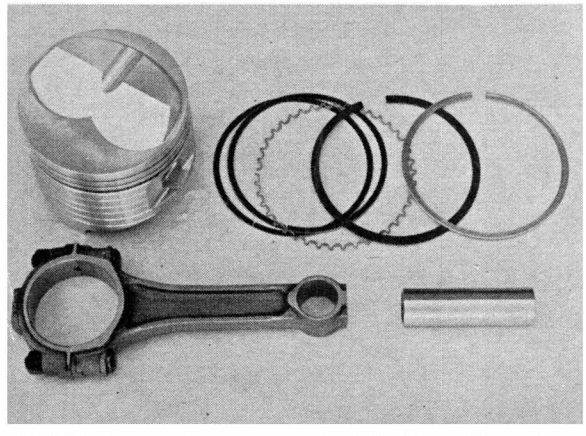
slipped into the pistons and rods and secured with snap rings. The next step is to very carefully slip on the piston rings, again using oil to facilitate the operation. Be sure that the ring gaps are staggered so as to prevent compression and oil leakage. A quick check of the top compression ring with a feeler gauge should indicate from .003 to .005 land to ring clearance. Just prior to putting the piston/rod assembly into the block, a short length of rubber hose is placed over each rod bolt. This is to prevent scratching of the cylinder walls and rod journals, and is another small measure of insurance that guarantees the perfection of a Traco engine.

A ring compressor is used as each piston is gingerly placed in its respective hole and tapped in with a plastic mallet. Again, a generous coating of oil on the cylinder walls helps. When the rod and bearing are seated on the crank journal, the rubber hoses are removed and the rod cap slipped on. The stock bolts are cinched down to 30 ft./lbs. in progressive increments of five lbs. Once this operation is complete, a feeler gauge is inserted between each pair of rods to check that side clearance is between .014 and .025.

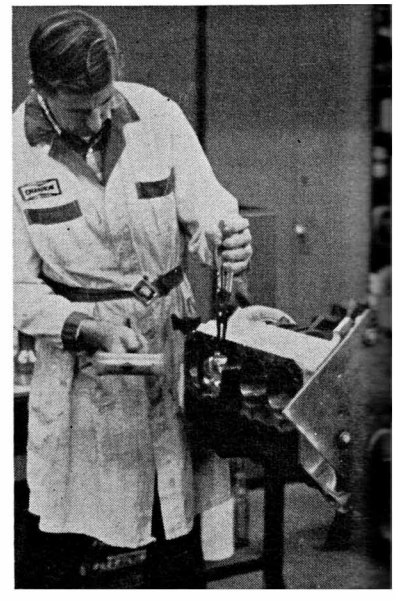
Now that we are through with the lower end for a while, the short block is flipped over on the engine stand and we're ready to go to work in the cam department. Off the shelf for this particular application comes an Engle model, grind #HL-26, which features stock timing, .434-inch lift for intakes and .433-inch for exhausts. A liberal coat of moly lube is applied to the lobes and bearing journals, and the camshaft is carefully fitted into the block. Once it is firmly seated into place, it is rotated manually to find any possible bind. If any hang-up is located, the cam must be removed and the bearings checked for excessive drag. In this instance the cam turned smoothly, so the stock timing gears and chain were put into place – care being taken to line up the timing marks correctly – and secured. Again the dial indicator is set up, this time on the side of one of the cam lobes, and the shaft is carefully pried back and forth with a screwdriver to check that end play is kept at around .005. Although camshaft end play is not extremely critical with flat tappet cams, it is when a roller is used.

During the time the short block was being pieced together by Jim and Frank, Traco's head specialist, Gene Owen, has been busily working Traco tricks into the heads. Prior to work at Traco, the heads were sent to Lockerman Porting, where the passages were opened up to increase volumetric flow and were given a super polish job, along with the combustion chambers. About seven cc's of metal is normally removed during the polishing operation, but this is made up by piston dome height; an average combustion chamber volume of 67 cc is the mark to shoot

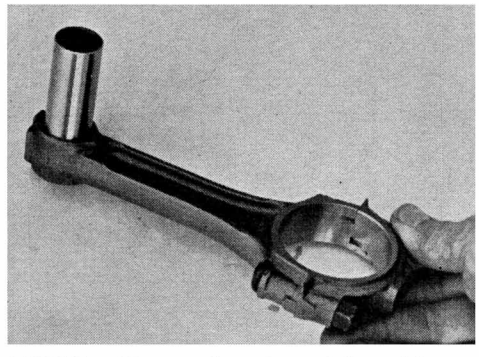




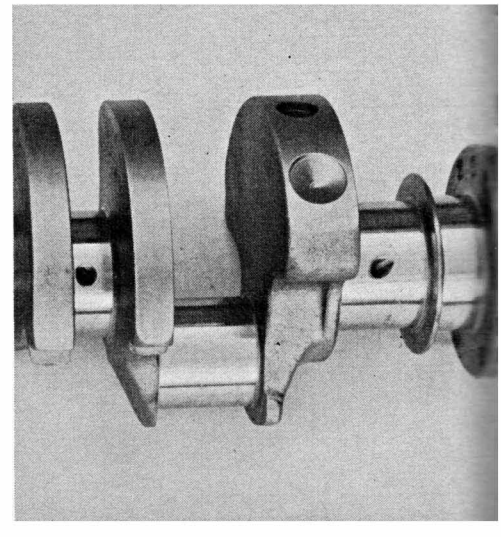
ABOVE—Internal components include ForgedTrue forged aluminum pistons and step top seal rings (lower rings are Ramco), stock rods and Traco 4340 steel wrist pins.



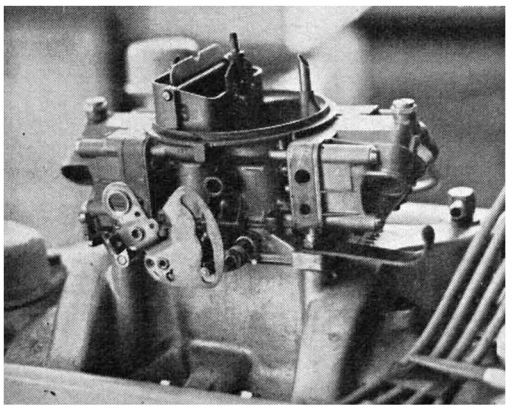
RIGHT — Using a plastic hammer, George gently places a piston/rod assembly in the block. This is the time rod bolts should be covered with a short piece of hose.



ABOVE — The rough texture of the rod beam is evidence of the shotpeening operation. Mating surfaces on the big end are ground clean to insure exact alignment of the cap.



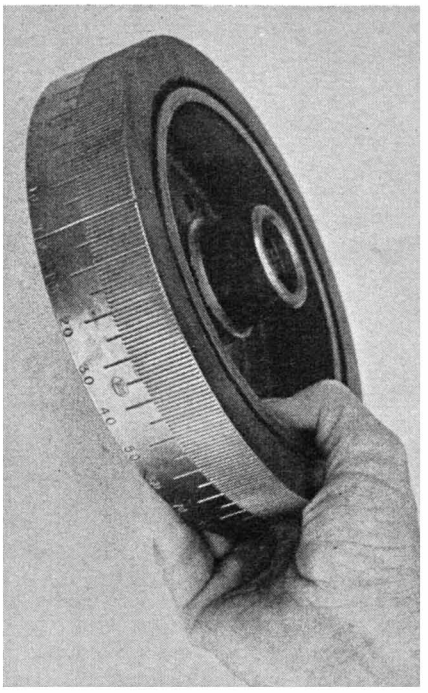
RIGHT — Crankshaft oil holes are chamfered and deburred to facilitate bearing oiling. Mirror-like finish on journals is achieved by carefully polishing with 600 grit paper.



ABOVE — A model 4704 Holley sits atop the Z-28 aluminum manifold, and features a cam-actuated secondary for more positive throttle operation.

RIGHT — A Traco 360-degree vibration damper is installed on all engine jobs to simplify operations of changes in valve or ignition timing.

LEFT — George Bolthoff, former terror of AA gas dragster ranks and now an engineer at Traco, utilizes the 1320 experience he gained with Chrysler.



for. Once the heads are back at Traco they are set up on the milling machine to have the spring seats and valve guides cut to accommodate Perfect Circle oil seals, then sent to the head stand, where the grinding stones are put to work shaping up the valve seats. Seat angle is the same for both intakes and exhausts, 45 degrees, while the seat width varies from .060 for intakes to .080 for exhausts. The wider seat for exhaust valves facilitates their cooling during engine operation. Special Traco valves which provide better airflow are utilized, with a head diameter of 2.020 for intakes and 1.600 for exhausts. Spring seat pressure is checked for an optimum figure of from 120 to 130 lbs. Once everything is double checked, the heads are assembled using lightweight aluminum retainers.

We have now reached what Traco considers to be the most critical operation in the construction of a small block Chevy: careful deburring of the rocker

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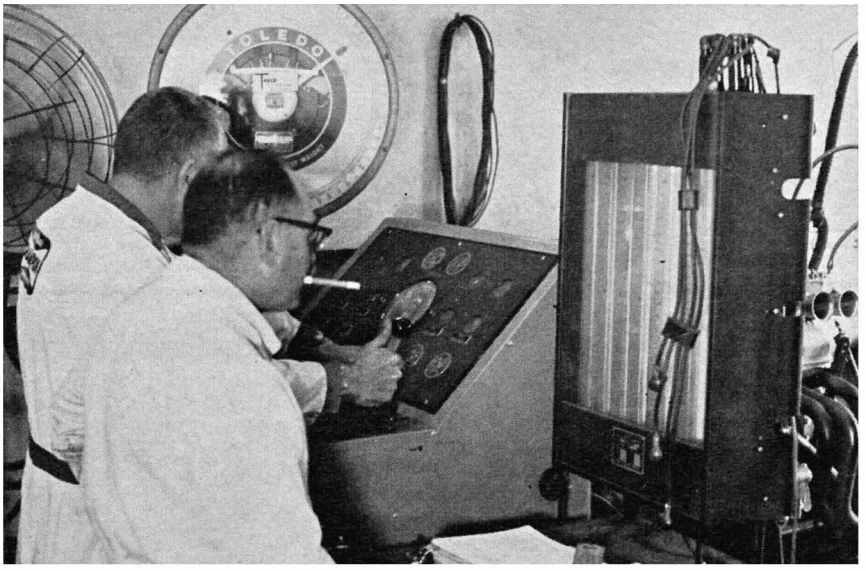
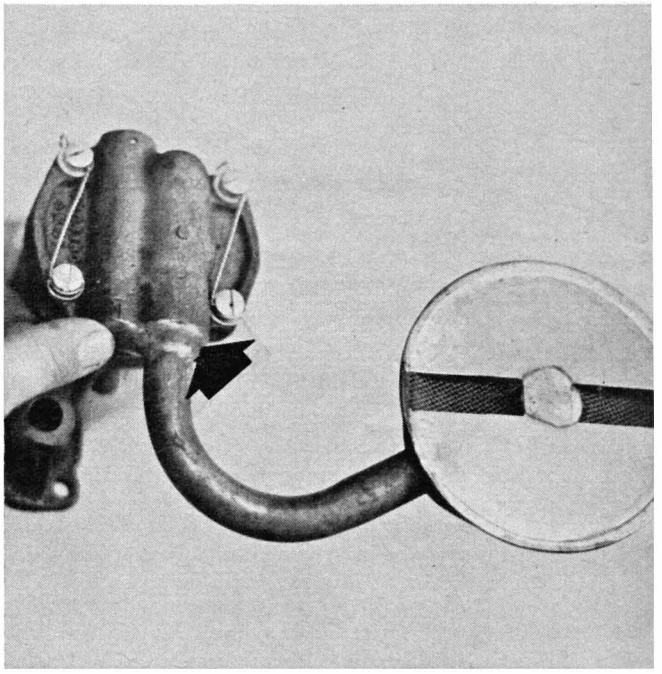
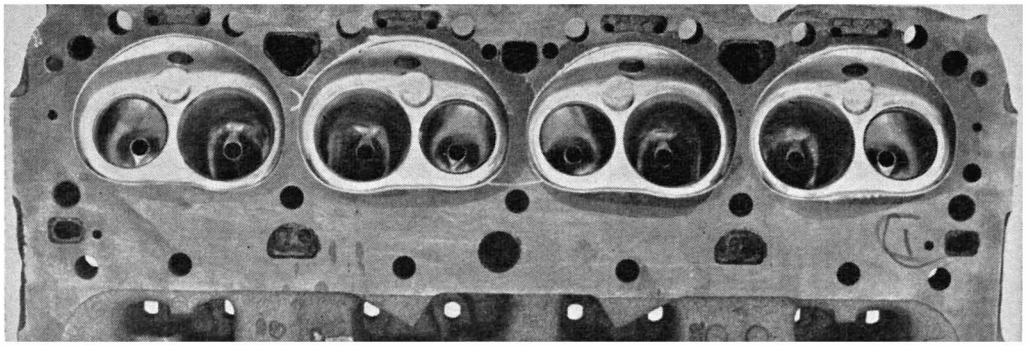


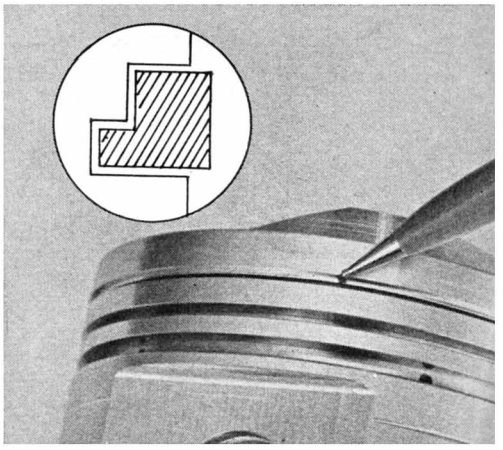
ABOVE — Mr. Coon operates the throttle while Travers takes note of horsepower readings from the dyno. Noise level at 7000 rpm was hard on the old eardrums.



RIGHT — Arrow indicates point at which pickup tube is brazed to pump housing to prevent possible separation due to vibration. Note safety wiring on screws.



ABOVE — "Slick" is the only way to describe the passages and combustion chambers after the porting and polishing operations. Chamber volume is kept at 67cc, producing a 11.15:1 comp. ratio.



RIGHT — The top groove is cut for the ForgedTrue step top seal ring (shown in inset). Compression gases become trapped behind the ring and exert outward pressure, making a better seal.

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arm holes. Past experience has proven rocker arm wear to be the most frequent cause of failure in a competition version of this engine; therefore, the rocker holes are hand filed to remove nicks and burrs, while the rocker balls are notched to aid their oiling and, additionally, to decrease friction.

Now that we have the short block and the heads assembled, it's time to check valve to piston clearance. Strips of modeling clay are placed over the valve pockets of one piston, and one head with the gasket in place is bolted on. Pushrods and lifters for one cylinder are inserted, and valve clearance is set at .022. The engine is rotated several times to get a good valve impression in the clay, then the head is removed and the thickness of the clay on the valve pockets is measured with a depth gauge. A minimum clearance of .060 should be obtained, while .100 is recommended. If too little clearance exists, the pistons must be removed and the valve pockets machined deeper to prevent valve to piston contact.

If the piston to valve clearance is okay, assembly continues. Fitzgerald steel and asbestos head gaskets (#0861-L) are set into place, as are the heads. Head bolts are torqued to 60 lbs., again in progressive increments of five lbs. 327 hp lifters are given a coating of oil and slipped into the bosses, then the Engle heavy duty chrome moly pushrods fill the missing link in the valve train. Initial valve clearance is set at .025, to be checked and reset later, when the engine is hot, to .022. Valve covers with ¼-inch thick gaskets are then installed.

Out of the box where it has been patiently waiting comes the stock Z-28 aluminum single four-barrel intake manifold, which is set into place on top of oversize gaskets and bolted on. This manifold features removed plenum chamber dividers, which helps equalize pressure to all cylinders and also keeps the incoming fuel mixture cooler. On top of this goes one of those air-gulping Holley carbs, model number 4704 in this instance, with cam operated secondaries. This particular carb manages to flow the fantastic volume of some 800 cubic feet of air per minute, which makes for plenty of "ponies."

Now that it looks like an engine on top, it's time to get below and button 'er up. Over she goes on the stand and we're ready for the oil pump. The "stock" pump includes such Traco refinements as brasing the pickup to the pump – to prevent possible separation brought on by vibration – and a cover over the pickup screen to guide the oil to the center. Of course, all internal clearances have been checked to insure

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CHEVY'S LITTLE 301

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at least 65 lbs. of oil pressure when hot. The pickup tube has been heated and bent so that it rests ⅜-inch off the bottom of the pan, thereby missing the impurities that might settle to the bottom. On goes one pan gasket, followed by the windage tray, then another gasket and then the pan. For those of you who didn't read last month's CAR CRAFT and are unfamiliar with the purpose of a windage tray, let me reiterate: basically, it keeps the oil in the pan and away from the crankshaft throws, thereby decreasing drag, and it also helps keep the oil inside high revvers, which normally have a tendency to pump oil out.

Around to the front end and on goes the timing cover and one of Traco's special vibration dampers with each of the 360 degrees marked off. This aids greatly in any future ignition or cam timing changes. Number one cylinder was brought up to TDC next and the Delco transistor distributor slipped into the back of the motor. With 14 degrees of lead on the crank, the Delco unit supplies the fire at a total of 38 degrees advance at 5000 rpm. The four small holes on the side of each head are filled with Champion J-86Y plugs, with gaps set at .020-.022, and Packard 440 wiring connects the Lodge 90-degree plug ends with the ignitor. A set of Hedman headers, constructed of 1¾-inch OD tubing with equal length 27-inch runners, are bolted on next. Into the valve cover breathers go five quarts of Sunoco 50-weight oil and we're ready for the dyno.

Once the countless dyno hook-ups are made, the "little giant" is brought to life – roaringly. With the motor fully warmed, final adjustments are made to valve lash and ignition timing, and we're ready for some serious testing. Gradually, it's taken up through the rpm ranges with readings taken along each step of the way. Finally, maximum readings are obtained at 6800 rpm, where the screamer sings to the tune of 402 hp and 310 ft./lbs. of torque.

So there you have it: 301 inches plus Traco equals 402 horses. For our readers who might wonder what a few more cubes would produce, we asked Frank Coon what kind of figures they might get if they were to build a 350 incher. With a few quick manipulations of a slip stick, he came up with an estimate of 458 hp. Remember that the figures achieved with this Chevy were done without such costly items as a roller cam, multiple carbs, injection, etc. Therefore, it's not how much money you spend on an engine that decides how it will perform, but, as Traco emphasizes, the most important factor is straightforward, careful workmanship.