ENGINE-BUILDING TIPS

GET 523 INCHES FROM A 389 PONTIAC

The beauty of this modification is that total added engine weight is only negligible.

Block surface (above) should be perfectly true, accurately centered. Micrometer attachment (above right) sets cutting tool for depth of stock to be removed. Spring loaded holder may be tightened in any position by using Allen wrench. Honing operation (right) is essential to smoothness, removes cut marks and insures piston fit. Just .001 to .002 inches are removed from each bore when fitting pistons.

RUSS Wainscott and Joy Fair are co-owners of a busy repair shop in Pontiac, Michigan, which specializes in tuneup and dynamometer work. However, their main hobby and lifetime interest is in racing modifieds, and they do this with characteristic thoroughness. Russ is the mechanic and Joy the chauffeur. While they own only one car, there are six engines, all Pontiacs, kept in readiness. Prepared during the winter, they are then used throughout the season with a minimum of interruptions. Engines are often switched to suit a particular track. For instance, on some tracks you can go at steady speeds rather than back off and take a chance on breaking loose during acceleration. Here, they may pick one of their smaller high-revving engines. For tracks with sharp turns, where you have to slow down then come out of the turn like a rocket they prefer the big engines with ample cubic inches and power through a wide rpm range.

While Russ and Joy do all of the assembly and tuning work, they leave the machine shop details to Leo Gonzales, an experimental machinist with lots of racing savvy. We came to Leo's shop at 6505 West Point in Taylor, Michigan, just as he was preparing their biggest engine, a Pontiac 389 cubic inch mill, bored one eighth to 4 3/16 inches and stroked an inch to 4¾ inches. This totals up to a healthy 523 cubic inches with only a very slight increase in actual engine weight. To put it another way, they have increased the engine displacement by over a third.

After a complete disassembly, Leo pulls all welch plugs from the oil galleries and water jackets to facilitate cleaning. Wherever possible, press-in plugs at the galleries are replaced by Allen bolts or screw-in threaded plugs. Leo's suggestion: go easy when tapping out holes in the block, because broken taps are no fun to get out.

Heads and the top of the block are checked for flatness, and trued to make them square if they need it. The area immediately adjacent to cylinder head bolt holes is counterbored to avoid metal pull-up due to the stress on the bolts. When a block is to be bored ⅛, as this one, Leo takes two roughing cuts and then a finishing cut of .004 inch (.002 on a side). A small chamfer at the top of the bore is used to ease ring installation. This 45-degree chamfer is put in with the boring bar to a depth of .060, or less if the head gasket does not allow it.

Misalignment between oil holes in main bearing and block must be corrected so oil supply won't be partly strangled.

Chamfer oil passage edge in block. Remove only marked section. All-around chamfer exposes bearing underside.

Pistons must always be on hand before boring is begun so that they can be accurately fitted to the desired clearance. Honing removes all cutting marks left by the boring bar and reduces the initial wear on the rings. From .001 to .002 inch is removed with a number 200 fine grit Sunnen hone, used dry. The hone is pumped up and down in the cylinder to achieve a neat cross hatch pattern. The choice of stone is governed by the fact that cylinder bore surface must be rough enough to insure rapid ring seating and oil retention, yet not so rough as to interfere with ring life.

An ample supply of oil is essential not only for lubricating mains and connecting rod bearings, but also for cooling them. Often, due to production tolerances, a small misalignment will occur between the oil drillings in the block and the holes through which oil is admitted to the main bearings. In a stock engine, this is seldom important enough to correct, and getting metal chips into the system would be worse than correcting the problem. However, in building a block from scratch, a small touch of the grinder is enough to enlarge or chamfer the opening to bring it into alignment with the hole in the main bearing. Leo advises against chamfering too much since this will have the undesirable effect of applying oil pressure to the underside of the bearing. A bearing is not supposed to move and must remain rigidly clamped in the block; lubricating the back of the bearing is certainly the last thing you would want to do.

Sharp edges on the block or cap at the parting face of the bearings can cause problems. It is very easy to inadvertently scrape a little metal from the back of the bearing on those edges. The metal then lodges at the parting faces or under the bearing, preventing proper seating. The edges can be rounded with a stone or a touch of a fine file.

Then a stroker crank is used, especially a one-inch stroker as in this engine, you cannot take an assembly for granted. First, the crank itself is slipped into the bare block and turned on its bearings to check for interference. Next, the cam is installed, the timing gears correctly indexed, and the crank turned again. Finally, the rods are installed one at a time and the crank turned again. Since a cam is involved, two turns of the crank are required to fully check cam-to-rod clearances. On the Pontiac, a heavy cast-in ridge had to be relieved with a grinder to make room for the rods. There was no interference from the cam, but the Forged-True pistons came uncomfortably close to the crank and were reshaped accordingly.

The heads were thoroughly reworked to unpocket the valves and the seats opened up. Bigger optional valves are hung on edge to take advantage of maximum opening area. Exhaust and intake ports have close to a mirror finish, but even more important, they are all checked for evenness in cross section so that each cylinder will breathe equally well. Part of the unpocketing process involves widening out the combustion chamber. To take full advantage of this, the top of the cylinder bore on the intake side is chamfered. Some of the blocks intended for competition are shipped from Pontiac with this modification. You can also carry it out yourself. Sharp edges where the flat section of the cylinder head meets the combustion chambers have been carefully rounded off. This cuts down on preignition and enables the Wainscott-Fair team to run several degrees more advance, as well as reducing the coolant temperature.

Rods are checked for alignment, honed out at the little end to convert the rod from a press fit to a full floating pin, and considerably lightened. Big ends of the rods are re-

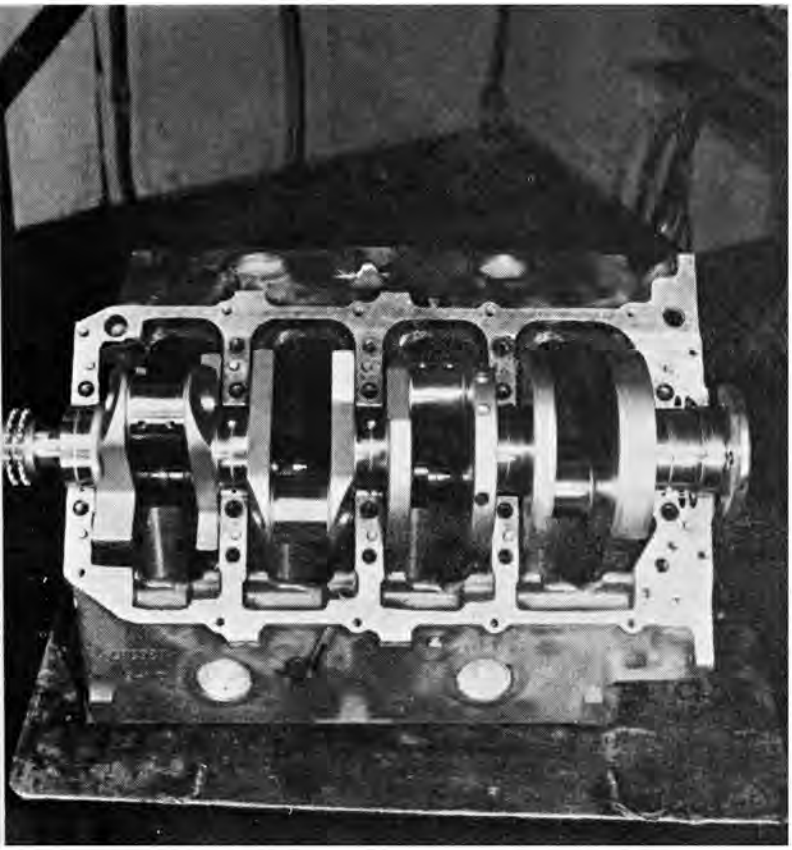
conditioned to insure perfect roundness. Rod sides are cut to increase end clearance to .022, assuring an ample oil flow through the bearings. Also, to accomodate the generously radiused fillets of the crank, the outer sides of the rods have been chamfered. Pontiac high performance rods, part number 529238, are much harder than the standard passenger car ones, and were considered a good investment. Full floating pins called for grooving the wristpin bosses of the Forged-True pistons and installing retainers. The pistons are fitted with Perfect Circle rings. An Isky roller cam provides the torque and the revs. Of course, the story would not be complete without giving full credit to Moldex for a very fine billet crank.

When all grinding, honing, and machining is completed, Leo sends out all non-aluminum parts for a thorough cleaning with an alkalai solution. The vapor method is not as good because it leaves a fine dust which is then hard to get out of the metal bores. You then have to reclean the block with a steam jenny and this still does not do a complete job on the oil galleries. Cylinder bores receive the soap and water treatment to remove the last traces of honing material. Welch plugs at the sides of the water jacket are removed and the bottoms of the jackets cleaned out as much as possible by loosening sediments and probing with a rod.

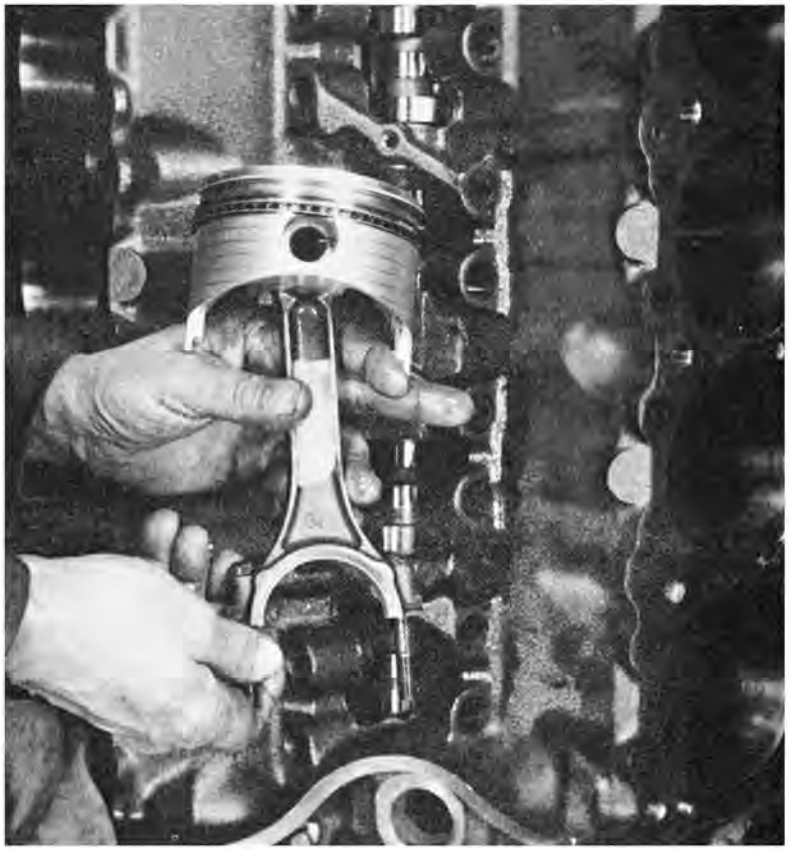
A final check is now made of all clearances, while the engine is being assembled. Rings are individually gapped to approximately .003 inch per inch of bore diameter. The bottom of the piston is checked with a spring scale. The typical racing piston may have .007-.008-inch clearance, but these are fitted a little looser, .009. Ring lands have a .035 clearance, since they are exposed to the full impact of combustion heat. A slight graduation in clearance is provided from top to bottom lands. A .002-inch clearance is provided at the Morraine 400 rod bearings. Main bearings get an extra thousandth's. Crank end play is held down to .003 inch (factory allows from .003 to .008).

One important check, often overlooked in setting up an engine, is to use a dial indicator or a depth mike to check the clearance between the tops of the pistons and the deck of the block. You should try to get this clearance as even as possible since it controls squish and turbulence during combustion. Sometimes interchanging pistons and rods helps even out production tolerances. The deck clearance times the area of the piston gives a volume which is part of combustion chamber volume. When equalizing the volumes of the individual combustion chambers, you should definitely take into consideration the differences caused by unequal deck clearance.

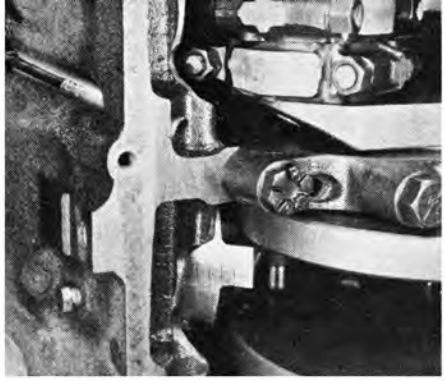
As Leo told us, it only takes a few inches of lead over the other guy to win a race, so all this care can certainly pay off.



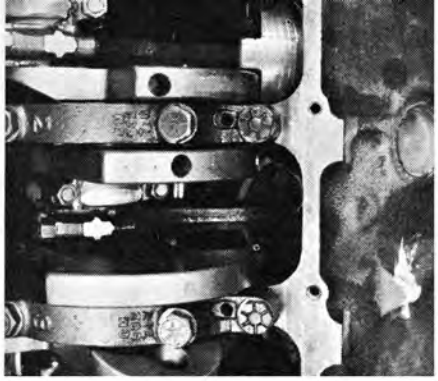
Special crank was hogged out from forged steel billet by Moldex. Block uses four bolt main bearings.



Forged-True pistons, HP Pontiac 52938 connecting rods, form potent combo. Pistons were cut, clear counter weights.

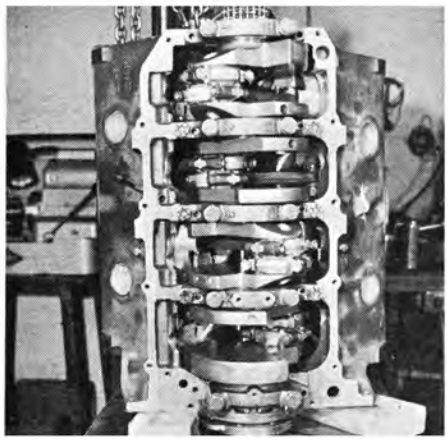


Heavy ridge on block inside must be reshaped with grinder for connecting rod room. Extra stroke means larger swing.



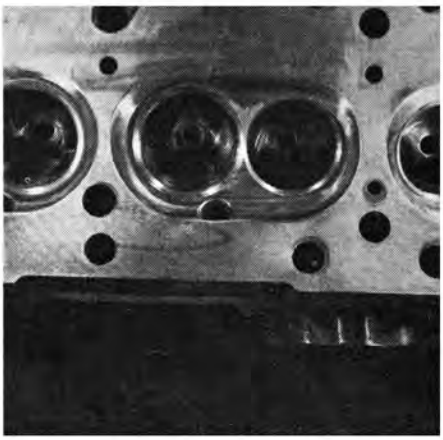
Maximum counterweighting diameter offsets longer stroke. Piston skirts retain enough length to stop rocking.

Check rod side clearance with feeler gauge. Opening clearance a bit improves oil flow through bearings.



Remove oil gallery plugs and clean galleries. Replace Welch plugs with threaded, tapered plugs for safety, easy removal. Clear water jacket of sediment. Wash block with solvent.

Piston-to-top deck clearance must be checked with dial indicator. It forms part of combustion chamber volume and must be included in when cleaning, checking, combustion chamber volumes.



Remove sharp edges, unpocket valves. Help smooth out gas flow from intake valves with slight chamfers. Note that valves should be hung on edges so that seats will be close.

Minor changes in shape of combustion chamber can have major effect on smoothness of combustion and prevention of pre-ignition. Carve out intake ports and shine them.