From a structural point of view, the intake and exhaust ports act as columns within the pressure cap to stiffen the cylinder head. The rocker cover acts as a roof to the columns, stiffening the columns relative to one another. Gas pressure from each power stroke acting on the pressure vessel forces the columns upward, concentrating the stress at the column base. The column base consists of the side walls of the exhaust and intake port where the ports radius into the roof of the combustion chamber. Thus, most of the stress field caused by the power stroke concentrates in the exhaust and intake ports.

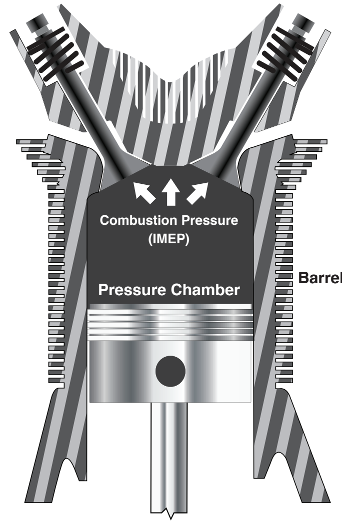


Figure 2-34. Cylinder is a cap to a pressure vessal.

The size and shape of the ports are a compromise be- tween the strength of the cylinder head and the volumetric efficiency of the cylinder head. In 1987, Continental re-designed the head casting of the 10-520 cylinder (casting revision DM) by adding additional support material to the column base. The wall thickness of the exhaust port increased from .135 inch to .191 inch to help reduce cracking in the port. The base of the column needs to be one of the strongest elements of the head to prevent cracking. However, since the engine is nothing more than an air pump, the efficiency at which the engine draws in and expels air deter- mines its overall performance. The function of the ports is to efficiently guide air into and out of the engine. Structural requirements dictate that the ports be able to perform this function over a reasonable service life.

Cylinders beginning with casting revision "DE", and especially revision "DL", tend to crack from just below the injector port to the spark plug boss. This is the critical area where the intake column radiuses into the roof of the combustion chamber. Earlier 520 cylinders rarely cracked in this area since the injector port is thicker on earlier castings than the DE to DM casting.

Optimizing volumetric efficiency necessitates a cylinder designed for maximum air flow. Modifying the ports by "flow porting" may require removal of material in the port and this not only changes the flow characteristics but also the strength characteristics of the cylinder head. Removal of material in the ports reduces the stiffness and strength of the columns and may increase the possibility of cylinder head cracks.

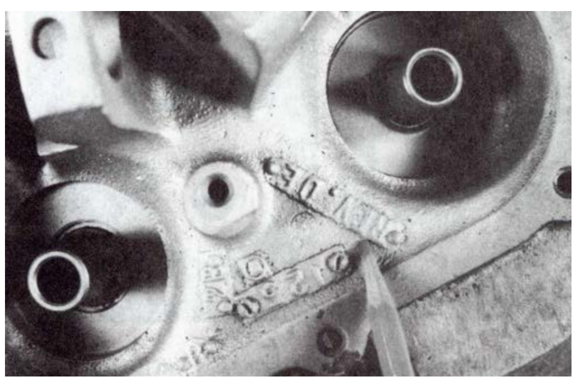


Figure 2-35. 10-520 cylinder showing casting revision number.

Lycoming Crankcase Through-Studs

Two types of through-studs are used in Lycoming engines; anchored and body fit. Anchored through-studs are threaded into the left hand side of the crankcase (pilot's view). If you removed the stud, you would find that it is threaded in three locations; where it threads into the left hand side of the crankcase and where each cylinder on both sides of the crankcase hold-down nut fastens. Anchored through studs can be identified by looking at the forward portion of the left hand side of the crankcase for a flush stud end. Body fit through-studs protrude out of the crankcase and have a spacer and nut attached.

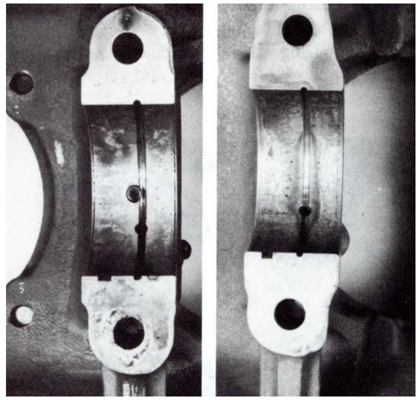


Figure 2-36. Lycoming O-320 bearing bosses. The bearing boss on the left incorporates a dowel pin to locate the bearing. A heavy wall bearing is used. The bearing boss on right does not use a dowel pin. A thin-wall high crush bearing is used. The bearing dowel functions as a locating pin. It is not designed to prevent bearing rotation. Bearing crush prevents bearing rotation.

Anchored through-studs are of an earlier design and created crankcase fretting problems. The "standard crankcase flange" (narrow deck) engines used anchored through-studs. Be careful on high time engines when removing cylinders and replacing them. At one time Lycoming required a pull test to the propeller to check for crankcase fretting (Service Bulletin 272). To help alleviate the fretting problem Lycoming added dowels to the crankcase in 1972 Service Instruction 1123A. These dowels served to align the crankcase halves. Do not confuse this dowel change with the more familiar bearing dowel airworthiness directive that was also made about this time (that's another story). Anchored through-stud engines should not operate past factory recommended TBO times because of the possibility of crankcase fretting.

Figure 2-37. Thin wall bearing on left, heavy wall bearing on right.

Anchored through stud engines will not separate without pulling the crankcase halves apart. If you find the crankcase does not separate, do not force a screwdriver between the parting surfaces. Lycoming makes a torque plate ST-222 and a crankcase puller for these style crankcases. They require both to properly separate and torque the crankcase.

Through-studs may provide a leakage path for oil to the outside of the engine. If you have oil around the cylinder mounting pad, it most likely is from the through-studs. Anchored through-stud dowels can wear and provide a leakage path into the stud passageway. Inspection of the crankcase halves is important during overhaul. Inspect the dowels for looseness and fit. Inspect the condition of the dowel hole on the opposite crankcase half. Oil seals can be machined and installed in the crankcase.

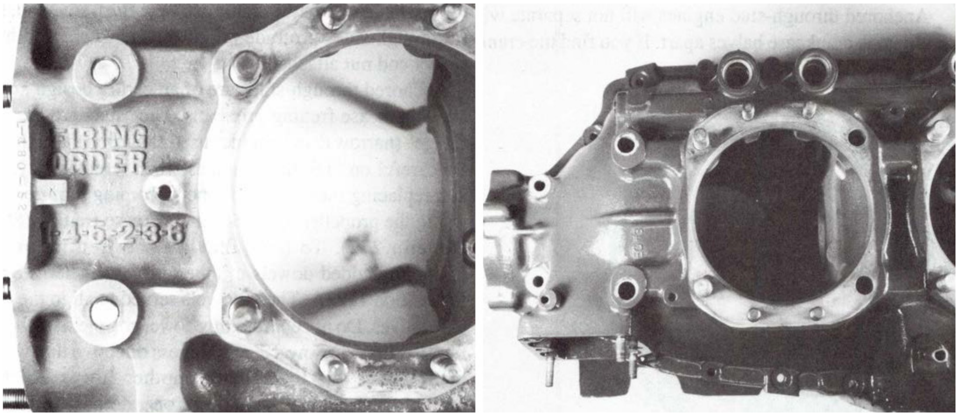


Figure 2-38. Anchored through-stud on top, body-fit through-stud on bottom.

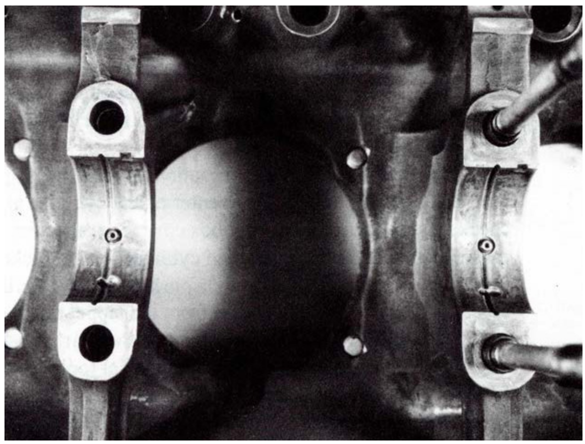


Figure 2-39. Anchored through-stud design showing dowels surrounding protruding throughstud on one side and dowel boss on the other. Dowels provide rigidity to crankcase preventing movement between the surfaces. Dowels must fit tight to prevent oil leakage out past through-studs.

Body fit through-studs are a newer design. They support the crankcase halves with an interference fit at the crankcase parting surfaces and are tensioned at both ends with a 1/2-20 nut. This increases the rigidity of the crankcase and prevents movement and fretting. Body fit through-stud engines are assembled by driving the stud in place by use of a hammer and drift. They are disassembled by driving them out. The body fit through-stud is an interference fit. It is important at overhaul that the proper fit occur to prevent crankcase fretting and oil leaks. An oil leak on a body fit through-stud can be repaired without disassembling the engine by using an oversize (.001 or .002) stud. If the fit is still not tight, the hole can be reamed oversize and an oversize stud used. (S.I. 1290D).

Checking and Adjusting Dry Tappet Clearance on Lycoming Engines

From the Lycoming Flyer

Any time work is done on the valve train of an engine, such as grinding valves or seats, replacing valves or valve rockers, or any other component of the valve operating mechanism, dry tappet clearance should be checked and adjusted to insure that the correct tappet clearance is maintained. If tappet clearance varies too far from prescribed limits, the engine will not operate properly. For example, if clearances are too small, burned valves or compression loss may result; if clearances are too great, the engine will be noisy. In both cases, mechanical failure may be the end result.

After observing all safety precautions, rotate the engine until the piston is on top dead center of the cylinder to be checked. (1) Remove the rocker box cover, and also remove rocker shaft covers on angle-head cylinders, valve rockers, thrust washer (angle-head only), push rods, and shroud tubes. (2) Remove hydraulic unit from the tappet body. On TI0-541 and TIG0-541 engines remove the unit with fixture ST-233. On all other engines use special tool Part No. 64941, that can be purchased from Lycoming, or fabricate a puller from a piece of wire. NO MAGNET PLEASE. (3) Disassemble the hydraulic unit and flush out all oil from the unit. Remove all oil from the tappet body. (4) Re-assemble hydraulic unit and install in the tappet body.

CAUTION: Be sure to keep hydraulic units as one assembly because mixing hydraulic unit parts may result in changing the leak down rate of the unit and may cause a rough operating engine.

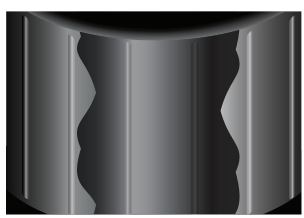
CAUTION: After cleaning the hydraulic unit and tappet body, and unit is installed in the engine, do not tum the prop because this pumps oil into the hydraulic unit and results in an inaccurate dry tappet clearance check. (5) Next, replace the shroud tubes using new seals. (6) Install push rods, valve rockers, and thrust washer on angle head cylinders only. (7) To check dry tappet clearance, depress hydraulic unit by pressing on the push rod end of the rocker, and measuring the clearance between the valve stem and heel of the rockers by using a feeler gage.

On engines using rotators on the valves, clearance is measured between the rotator and the heel of the rocker. In both cases, the clearance should be .028 to .080 on intake and exhaust valves on all engines except the TI0-541 and TIG0- 541 series powerplants; the latter should be .040 to .105. If clearance falls within these limits, no adjustment is necessary. If not, then adjust to within limits in the following manner: If clearance is too great - remove the push rod and install a longer one. If clearance is too small - install a shorter push rod and recheck to be sure clearance is within limits.

To determine a short push rod from a long one, check the part number on the end of the push rod. The lowest number is the shortest rod, and the highest number is the longest rod. On older type push rods, machined grooves are found on one side of the push rod, three grooves represent the short rod, and no grooves represent the long rods. Consult Lycoming Service Instruction No. 1060, and applicable parts catalog.

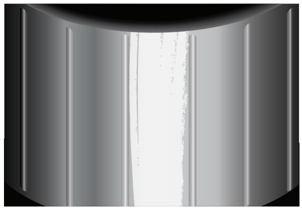
Bearing Failure Analysis

The lower rod bearing halves are normally not affected by overloading because they are lightly loaded. Lower rod bearing halves that show overloading damage are usually indicative of excessive rpm.



Heavy wear at thrust position of upper connecting rod bearing caused by overloading.

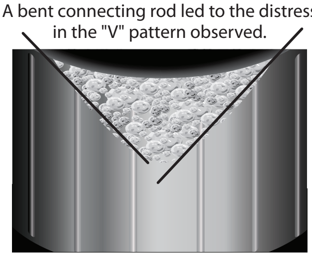
Example of cavitation - a surface erosion caused by pressure changes in the oil film. Ultrasonic cleaning is a familiar application of cavitation (the imploding of bubbles). The energy for cavitation in the oil film comes from the vibrating crankshaft. Light cavitation erosion is a common occurance in aircraft connecting rod bearings.



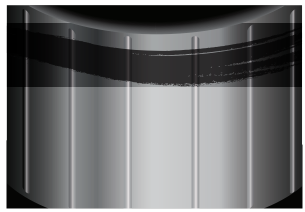
Lighter colored surface which appears as though it was scrubbed clean.

Misalignment

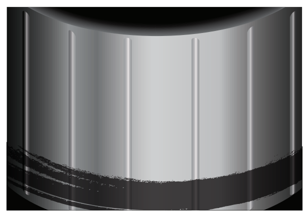
A bent connecting rod led to the distress in the "V" pattern observed.



Fatigue failure of babbet material due to localized overload.

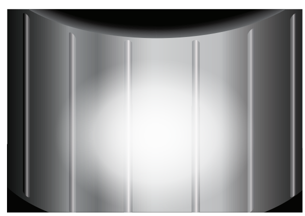


A tapered housing bore caused the distress along one edge of this pair.



When the oil film pressure exceeds the fatigue strength of the bearing alloy, bearing fatigue can occur. Localized overload is from a bent connecting rod.

Alignment problems cause load concentration in a selected area, but no shaft contact in other areas. Here, severe wear and wiping has occurred along one edge of the bearing, while no shaft contact was made on the opposite side of the bearing. This was caused by asymmetric crankshaft loading.

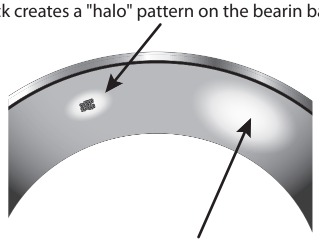


Sort contact arc indicates excessive oil clearance.

Misassembly

Thermal expansion differences between the aluminum crankcase and the steel bearing back require larger oil clearances than for a cast iron crankcase. The larger oil clearances are specified so you have adequate clearance over a wide temperature range.

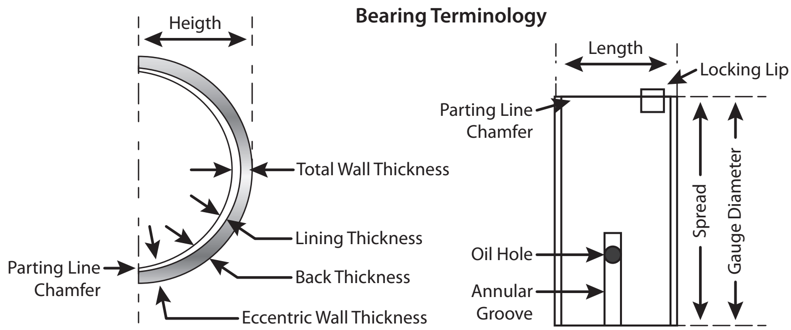
Damaged lining caused by dirt left on the bearing back during engine assembly. Dirt on the bearing back creates a "halo" pattern on the bearin back.



Polished and oil-stained backs are a result of a poor fit in the housing bore.

Dirt particles between the bearing back and the housing prevent heat transfer from the lubricant to the case. This will raise the local lubricant temperature and lead to viscosity dilution. Oil film thickness in the bearing is highly dependent upon oil viscosity.

Bearing Terminology



- ECCENTRIC WALL THICKNESS is the thickness in the middle of the bearing and can be .0001 to .002 of an inch thinner than the crown. This difference helps increase the wedge effect in building the oil film under the loaded area.
- HEIGHT determines the amount of crush in a bearing installation.
- CRUSH When two bearing halves are seated and bolted in place, the bearing height provides a crush fit. This assures that the bearing will remain firmly seated and not move in the housing.
- SPREAD is the outside diameter of the bearing across the parting faces. It's slightly more than the housing bore diameter into which the bearing fits. Spread permits the bearing to snap into place and remain in place during engine assembly.
- ANNULAR GROOVE transfers lubricant for linear distribution across the surface of the bearing.
- LOCKING LIP locates the bearing in the housing and prevents the bearing from shifting end wise in the bearing housing during assembly.
- PARTING LINE CHAMFER eliminates a sharp edge which would tend to shear the oil film from the shaft.