

**Engine
(Analysis and Disassembly)
(2010)**

The engine turned out to be a big disappointment. When I first looked at the boat, it was clear that the original gasoline engine had been recently replaced with a 4 cylinder Vetus diesel. Only 165 hrs. was logged. Unfortunately, the engine had been neglected, and to date I still can't turn the engine over, even with a 4 ft. lever on the crankshaft pulley. I've tried a series of Marvel Mystery Oil treatments in the cylinders (through the glow plug sockets), over the past month, but I still can't budge the crank.



I've removed the alternator belt and checked that the transmission is in neutral, but this had no effect. I checked the engine oil and transmission oil and they looked to be ok. I also checked the coolant, and it's good to -10 degF. So hopefully the problem is limited to the rings corroded to the cylinder walls. I'm thinking about using a bore scope to do an inspection. The bottom line is that I think I need to pull the engine.

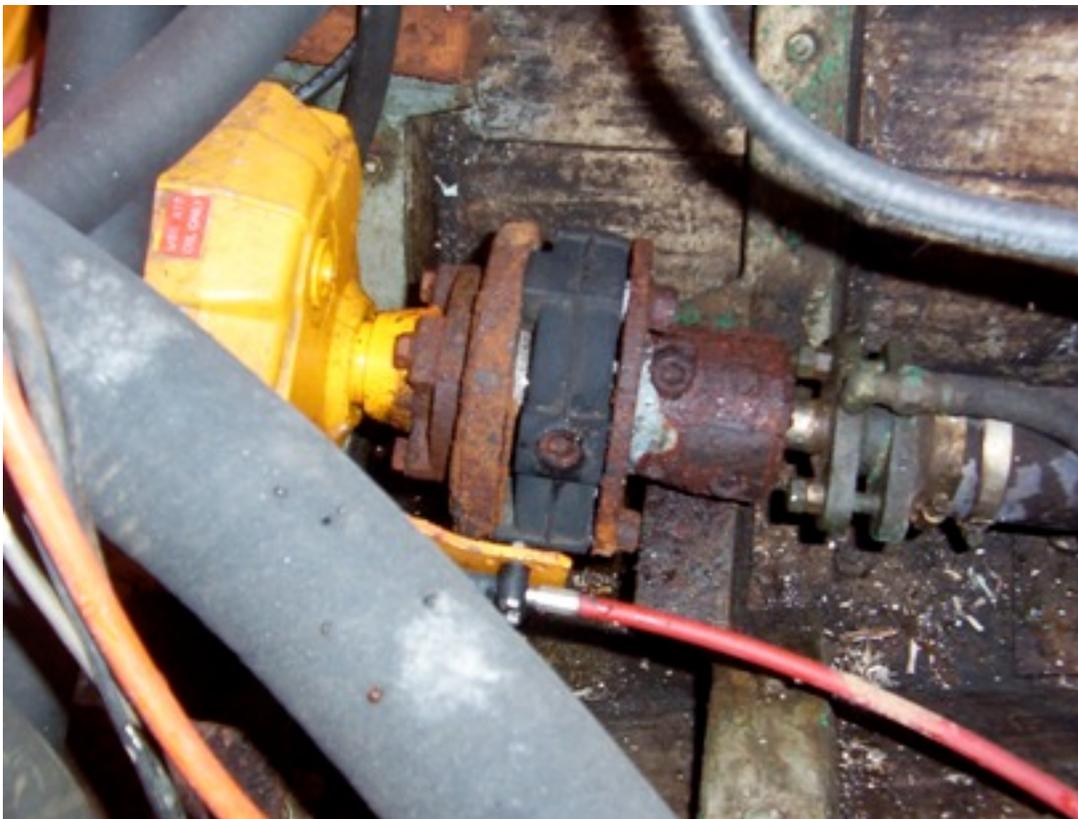
I started to disconnect the engine from all it's peripheral components. Unfortunately, the combination of limited accessibility and corrosion makes this a formidable task. Look at the location of the port engine mount (aft) in this picture.



This is the forward engine mount on the starboard side. Note the use of STEEL! angle for the engine beds. These have to go! I'm also having trouble removing the bolts where the ground wires are attached.



This is the coupling between the transmission and propeller shaft.



Just to get at this coupling, I had remove the fuel tank ...



and then it took lots of penetrating oil and a long pipe on an Allen wrench to remove the bolts. I'm still not able to separate the back half of the coupling from the shaft. I had to use a die grinder to remove the bolts, but I still can't free the shaft. Hopefully, when I get the engine out, I'll be able to use a gear puller to separate them.

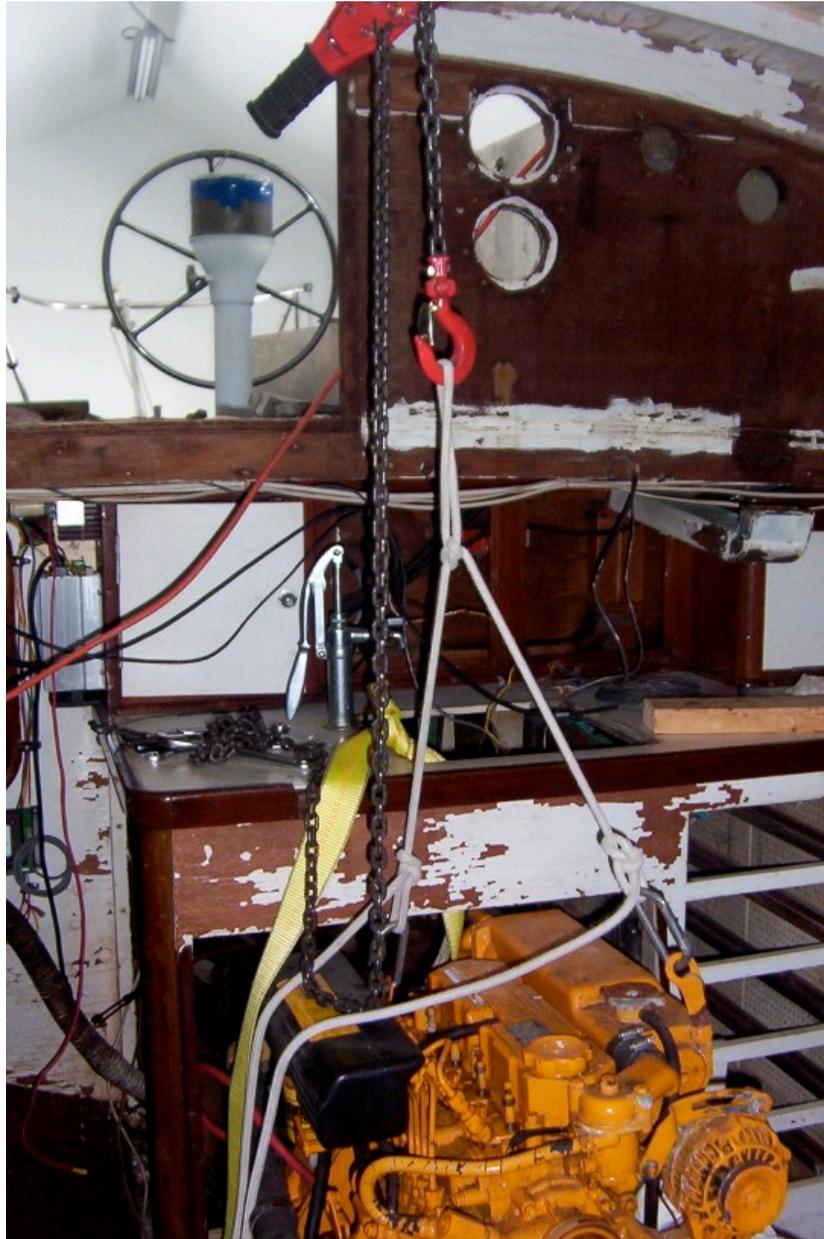
Well, it's now been a month since I started working on the engine. I still can't turn it over, so it's time to pull it. I disconnected all hoses, shift and throttle cables, wires, and fuel line, then with the help of a neighbor, pulled it forward.



I built two wooden skids to support the engine high enough to clear the oil pan. I removed the cabin floor boards so that the skids rested on the bronze floors. Then we pulled the engine forward using a 6:1 block and tackle (engine weights about 400 lbs). The tackle was tied to the centerboard hoist tube, which is a sturdy bronze tube. Having lots of old dinghy sailing parts helped.



This pic shows the engine almost out of its compartment.



While pulling forward, it was necessary to take some of the weight off of the engine mounts to get them on the skids. The chain hoist is hung from a 2x6 laid across the top of the companionway.

Once the engine was safely sitting on the cabin sole, I went about building a gantry crane to lift the engine out of the boat.



This pic shows one side of the gantry. The lower section on each side consists of an 8 ft. 4x4 with two casters. The vertical columns are box sections made of 2x6's and 2x4's. 2x4 angle braces keep the columns upright. The top section is a truss, which is bolted to the columns. Yes the truss is asymmetrical - no optical illusion. That was necessary because the companionway is off-center. As a test, I lifted 700 lbs. without incident.

It took some serious maneuvering to get the engine out through the companionway. The problem is that the engine cannot be lifted straight up because (1) the engine is longer than the companionway opening, and (2) the galley counter top was in the way (too much destruction to remove it). So, we had to lift it at an angle fore & aft. To create this angle, the chain hoist was tied to the bottom of the truss and connected to the rear engine mounts with a nylon strap. A

block and tackle was then connected from the crank pulley on the front of the engine to the chain at about a 45 degree angle. In this way, the chain hoist could do the lifting and the block and tackle could control the angle.

This was fine except that the block and tackle, being attached to the chain, limited the maximum hoist - not enough hoist to get the engine on deck. To remedy this, we attached a second block & tackle from the front of the engine directly to the truss. So when the first block & tackle limited the hoist, the second system was tightened and the first system was removed. Note that the second system could not be used initially because it would not clear the front of the companionway and the interference created too much friction.



This pic shows the lifting system.



As you can see from this pic, the process was successful; however, not without some anxiety. The truss, as you might expect, was designed to handle only vertical loads applied at the center web. Unfortunately, the second block & tackle system produced a substantial transverse load, which severely distorted the truss. Fortunately, it held together until we could move the engine onto the bridge deck. Once the lateral load was removed, the truss returned to its original shape.

At this point, the lifting system was changed to lift from the center of the engine in preparation for moving aft. The stern pulpit and steering wheel had to be removed to accommodate this move.



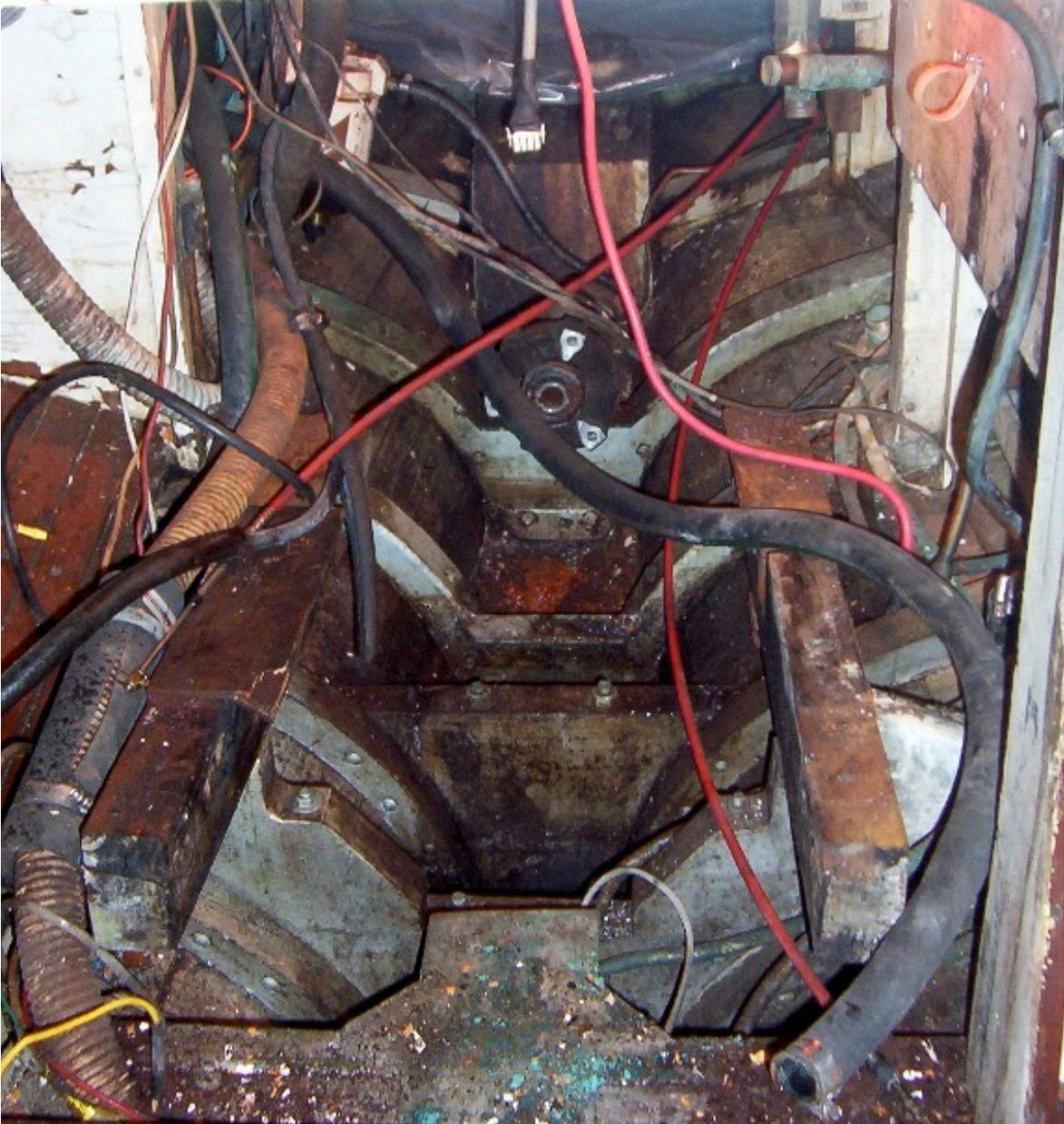
Some readjusting and then down she goes!



... and safely on the floor. I've ordered engine service manuals. When they come in, I'll start tearing down the engine to see what's up.



The engine compartment is now accessible - what a mess! I'll save that for another day.



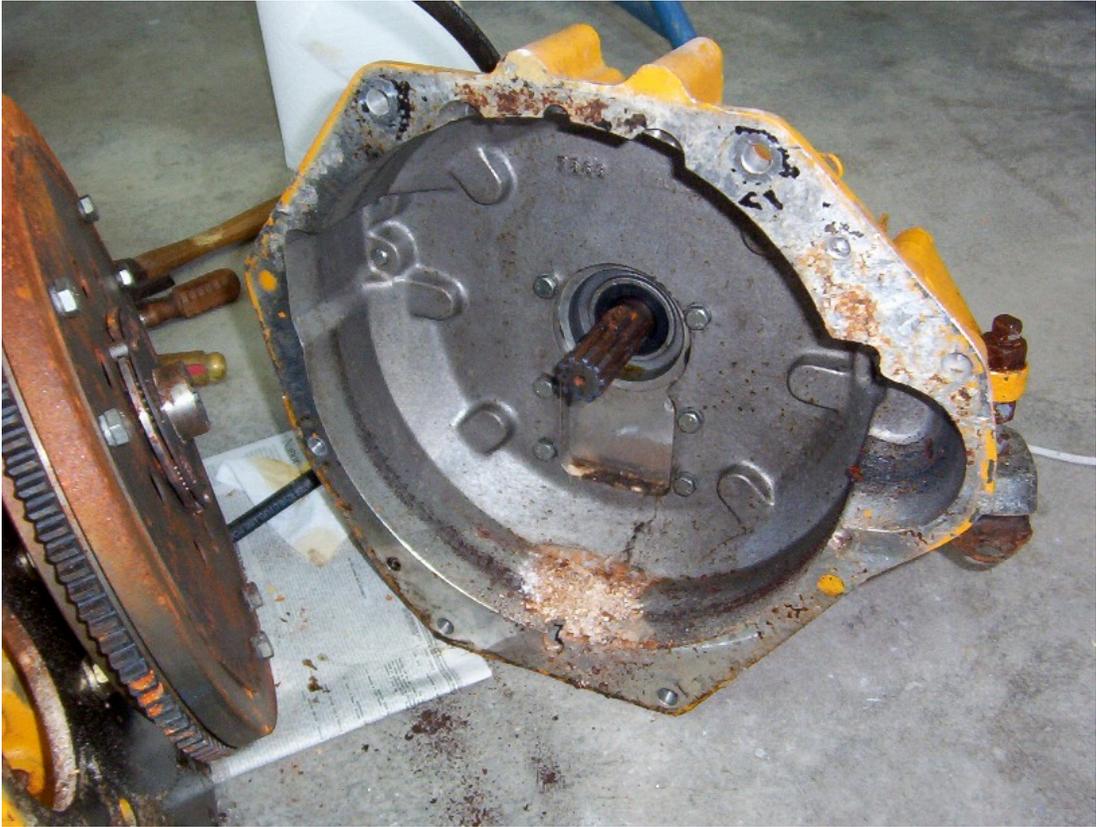
My good friend Gary Johnson stopped by today and suggested we take a look at the intake manifold. Easy enough - two bolts, one hose clamp and the intake port is visible. Oh boy ...



We found that that white powdery stuff is water soluble, so our guess is that it's salt! But how did it get into the intake - not a trace of it in the cover - so it didn't come in through the air intake. The conclusion ... in through the water injection point in the exhaust, through an open exhaust valve, into a cylinder, out through an open intake valve, into the intake manifold. A look at the exhaust injection port confirms it.



So it's time to remove the bell housing so that the block can be mounted to an engine stand.

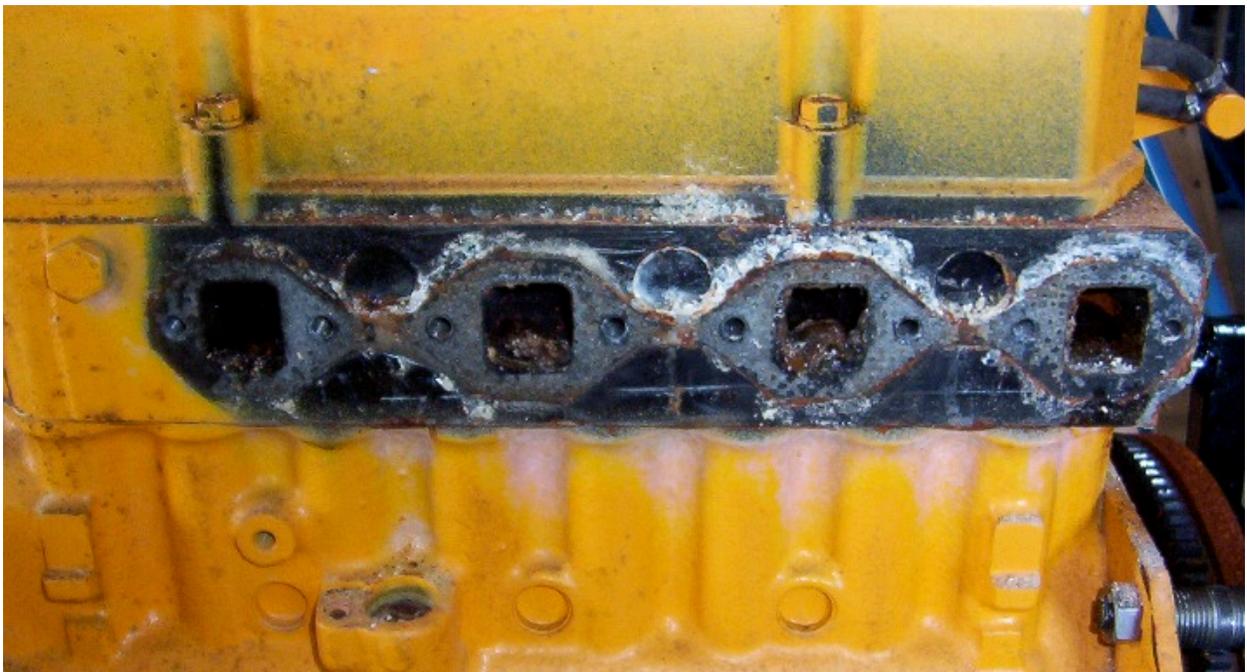




Here is the exhaust manifold. Note the crud in the ports.



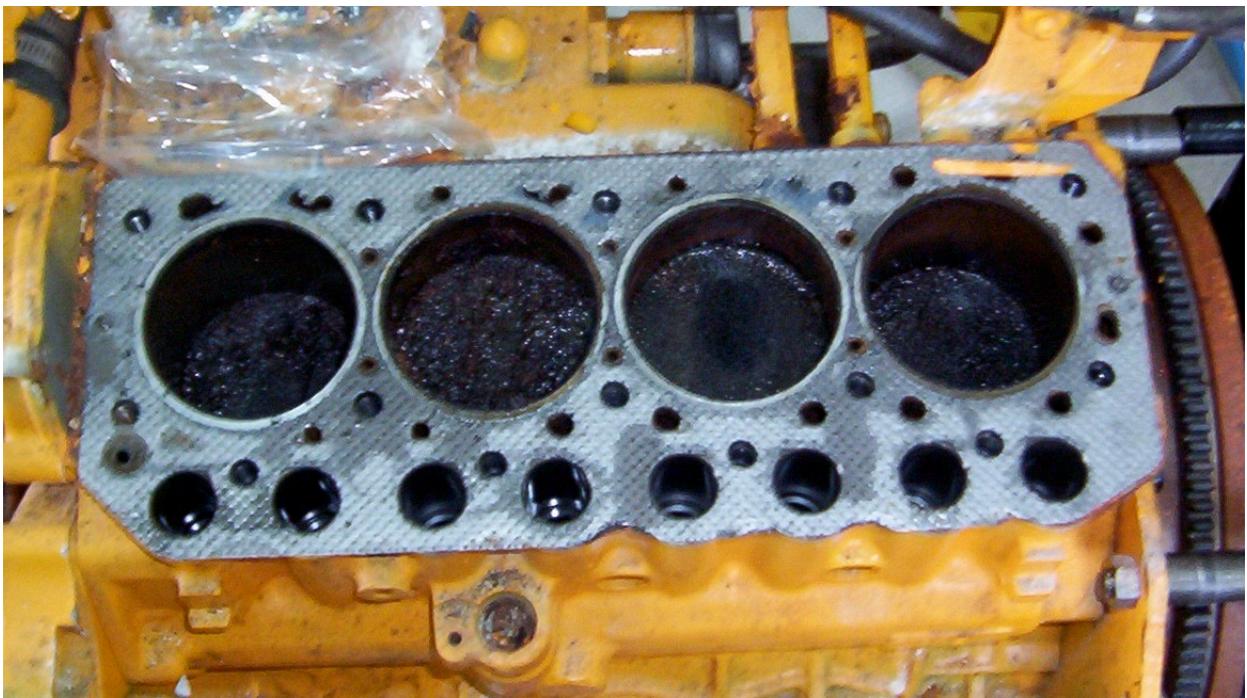
... and the exhaust ports on the head.



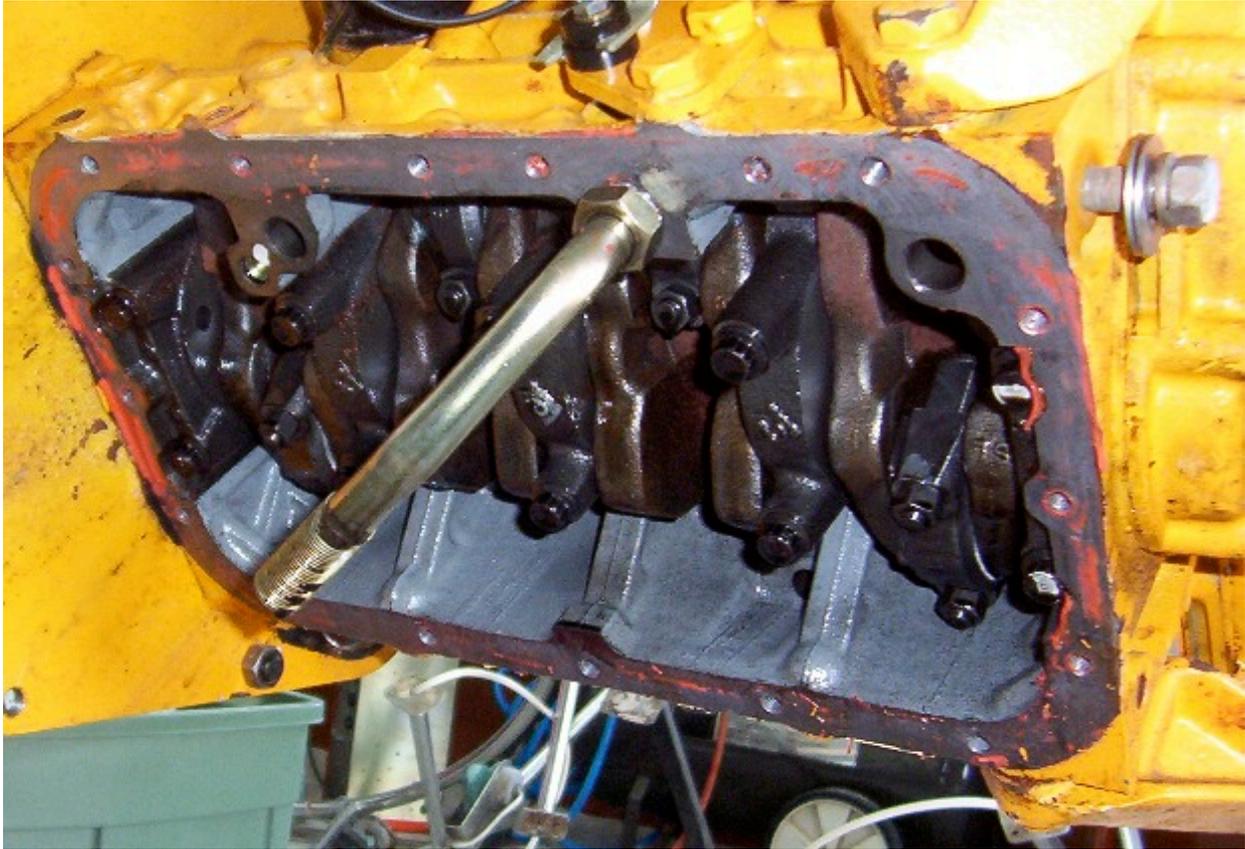
Thankfully the rocker arm looks good. No corrosion here.



Now with the head gone, we can see to tops of the pistons. Not a pretty site.



Dropping the oil pan reveals a very clean lower end. The silver tube is the oil strainer.

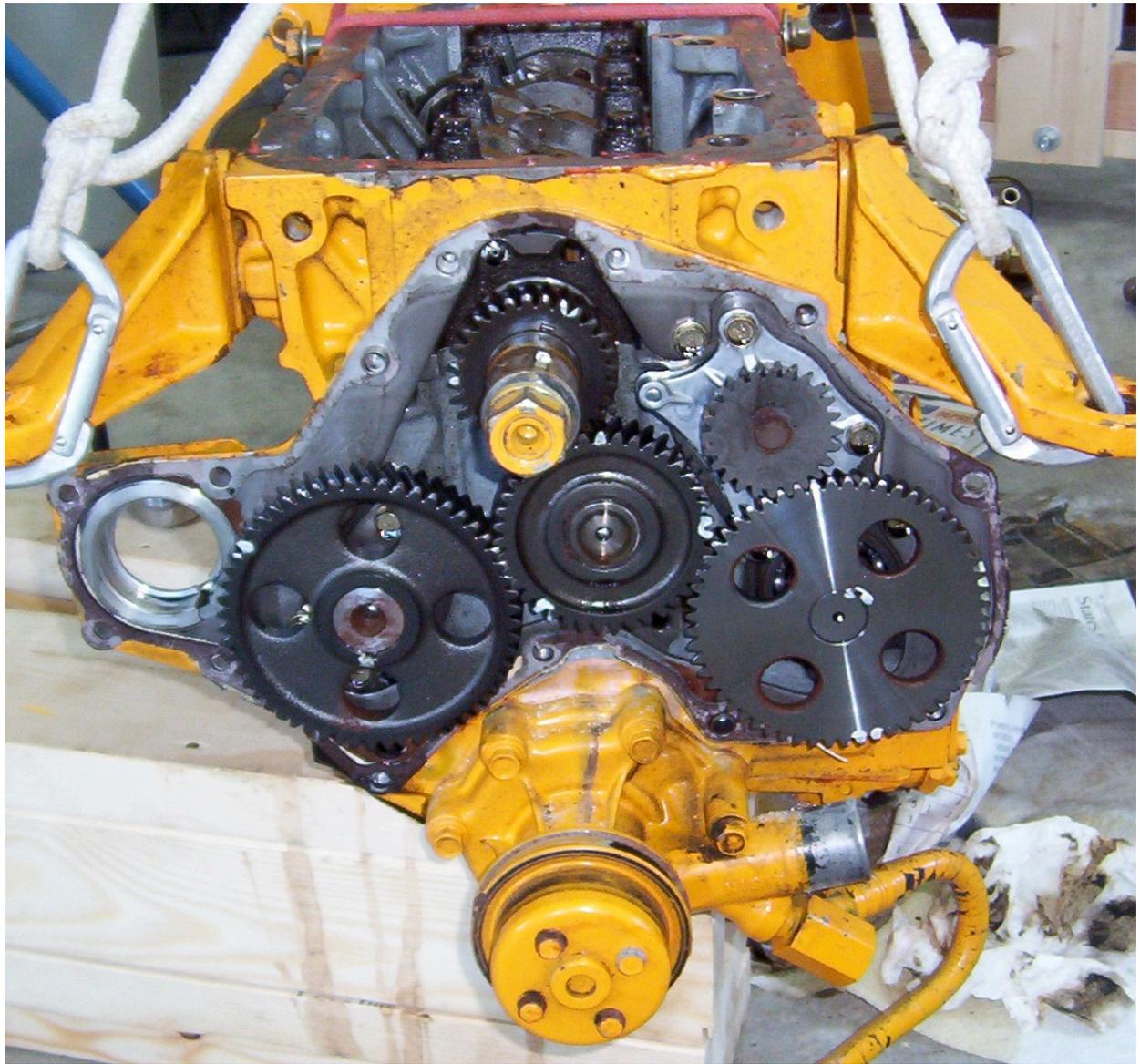


I tried to remove the connecting rod bearing covers, but I can't rotate the crank to have them clear the block. I did loosen one, however, and tried to push the piston out - no luck. The pistons are in there solid. Tried heat and penetrating oil but to no avail. So I decided I have to remove the crankshaft.

Off with the timing gear cover. This pic should help me realign the gears when the time comes.

The big gear on the right drives the high pressure fuel pump. I believe that the smaller one above it drives the oil pump. The big one on the left is the cam shaft and of course the little one at the top is the crankshaft. The hole on the left is where the raw water pump resides.

Note that we're no longer on the engine stand - had to remove it temporarily to remove the flywheel.



Now that the flywheel is gone, we can see the rear main seal. It was a bit tricky to remove the seal. Five bolts but then the case was bonded to the block with an adhesive gasket. Two recesses in the side of the seal cover allows a small pry bar to work it loose - can't have too many tools!



This pic shows the top half of the main bearing removed. This was also tricky, as there is very little clearance between the bearing block and the block and seals make it even tighter. A little tapping with a soft hammer and lifting through the two holes in the bearing block did the trick. I suppose there is a special tool for this, but I don't have the service manual yet and I probably don't have the tool anyway. (After consulting the service manual, it turns out that the proper tool was a slide hammer.)



With the crankshaft bearing covers removed, I could wiggle the crank enough to remove the connecting rod bearing covers. To remove the crank, however, I need to remove the front cover plate, which means that the timing gears will have to go - is there an end to this?



At this point I have the shop manual - good thing too - because I would have really made a mess of things trying to remove the timing gears without it. First I had to remove the idler gear in the center (just pulls right out). The main cam shaft came out easily after removing one thrust bolt. No speedometer was installed, so I didn't have to worry about that. The fuel pump cam shaft was a bit trickery - had to remove the fuel pump first, but that required removing the governor, etc., etc. Also the fuel pump gasket/shim was very tenacious, but finally yielded. With the fuel pump gone, 2 thrust bolts were all that held the cam shaft. Next the oil pump - 4 bolts. Finally, I could remove the front plate and lift the crank free (some wiggling involved).

Next I removed all the bearing halves, putting them in labelled baggies so that they could be replaced from where they came. Now for the pistons ... I started with piston #1 (nearest the front), since it had the least corrosion. A wood block on the top of the piston and a heavy hammer was required to get the piston to budge. Lots of spindle oil and hammering moved the piston ever so slowly down - until I realized that the piston can't be removed from below (main bearing interferes). So turn the block over and start again! Only now it's not easy to get at the piston 'cause the connecting rod is in the way - darn! I found some hard wood dowels lying around and started pounding - even slower progress now and the dowels don't last very long. Slowly but surely out comes the piston.

Several days later, I get two more pistons out. The last one is a real bear, however. Wood blocks won't do it, so I switch to aluminum. Lots of pounding and the piston finally starts to move. First downward to break it loose, and then flip the block (it's a lot lighter now, so I can flip it by hand) , and pound from the other direction. The piston's taking a beating now, but I don't plan to reuse it.

All done now ... You can see the bare block, a typical cylinder, the pistons, and all the parts.





