As with any project involving heavy equipment and vulnerable positions of mechanics, perform all work with safety in mind, proper use of tools, and do any or all of this AT YOUR OWN RISK. This tutorial implies NO RESPONSIBILITY for mishaps, damage of any kind, or personal injury. This is a medium skill project, not recommended for beginners.

Editor: Jim Baker (Note: this is kind of roughed together, some day maybe I'll clean it up. There are are few more pictures, too, that could be added.)

INTRODUCTION

When we buy a car with a “dead” engine, of course, we don’t know what we might be getting into, which is reflected in the price. So it was with my “tinkertoy”. I got it running after a basic tuneup and oil change. The timing belt looked good enough to run for awhile. There were no coolant leaks and seals were all dry.

The car had some lustre so it seemed worth tinkering with and as it had some other issues, sensors, climate control didn’t work (bad ground and fan binding), stalling issues, (MAF, ignition parts, fuel pump) I considered it a study car—sort of analogous to the educational psychologist who takes a job teaching in a chaotic urban school to learn about and study remedies for all the things that trip up disadvantaged kids. In both cases, the client can be mysterious and cantankerous and refuse to work. The challenge can be interesting. All are capable of better performance.

After the tuneup and fixing other peripherals the engine started and ran well but had a tinking sound. How I wanted the sound to be a lifter. I pulled them, had them professionally cleaned and checked, all were okay. It was something deeper in. Last summer I put it on Craigslist for $1,200, but I told prospects that whatever was tinking would need to be fixed. I would have helped a buyer who lived locally. No takers. I took it to 3 rebuilders for an opinion. They convinced me it was not a bearing, which I assumed because the oil light went out immediately upon starting.

Last fall as an excuse to have a look inside the engine I decided to drop the pan and change the oil pickup seals and see what I could see with the pan off. I had a friend turn the engine by hand but I couldn’t see the cause of the tinking, everything looked normal.

MVS hosts a couple of helpful tutorials on dropping the pan, so I won’t belabor that *except* that on the 850 turbos it’s not quite as easy as on the non-turbo. The hangup is the oil t-stat mount on the front of the oil pan under the crank pulley. I fussed and fumed trying to get the unbolted pan out for a couple of days and finally decided to lower the passenger side subframe. I have some video that needs to be edited on that, but you can see in some of these pictures how I got the pan out.

Underbody support. In lumber I trust, but not jack stands. So...

The driver's side front wheel was raised on a 3 x 6 block.

The engine needs to be raised to remove the motor mount under the crank pulley. I suspended to keep the underside workspace clear. A friend loaned me the box tubing.

Before you begin, disconnect the upper torque mount (firewall to engine bracket). Do not jack the engine before disconnecting this support.

The 2 x 4 supports are screwed together with 3 3" wood screws. The wire around the maple stick holds up the steering rack. NOTE: to suspend the engine, after unbolting the motor mount under the crank pulley, you need to jack the front of the engine from below an inch or so before securing it from above. The lengths of chain, bolts and washers are from an Ace Hardware. The extra red nylon strap taken from a ratchet tie-down is for good measure.
A friend had the box tubing which was perfect for this task.

The steering rack bolts need to come out. Note that the upper shank of these short bolts is splined to lock into the cross member and rack. It's helpful if you apply downward force to the head of the bolt while removing the nut. Why? If the spline slips up out of its splined hole it can be hard to get back in. In that case, it can also be hard remove the nut. A third hand can be helpful on these.

With the engine supported from above, the subframe needs to be dropped on the passenger side about six inches. To do this, the rear drivers side subframe bracket (subframe-to-body) plate needs to be loosened. The 2 small bolts can be removed, but only unscrew the large center bolt (under the drivers side footwell) about 3/4". The subframe will hinge on that center bolt when you drop it on the passenger side.

The large motor mount (on the subframe, left front of engine bay) needs to be disconnected but not removed. Just take out the bottom bolt (there's a hole through the under side of the cross member to access it. There's a You Tube video on fcpeuro site that shows how to remove that bolt. It's pretty easy. Also, remove the rear motor mount bottom bolt. Take out its bottom bolt from behind the steering rack. Check out the You Tube video on the fcpeuro.com site "replacing motor mounts" on the 850. Disconnect the topside torque mount from firewall.

Disconnect the bottom-front torque link near the front motor mount.

Now the steering rack is unbolted from the subframe and supported from above. The upper torque mount and lower (front) torque mount are disconnected and the large motor mount (front lower subframe). And you have removed the motor mount by the crank pulley. The engine is SECURELY suspended. Chain and bolt through the eye of the power steering pump bracket and the rear torque mount bracket.

Place a floor jack under the passenger side subframe and remove the bolts from the bracket shown below. Also remove the large center bolt from the front right (p.s.) corner of the subframe. If you have the Harbor Freight's electric impact wrench it will make short work of all these bolts.

NOTE: The large center bolts will have red thread lock on them. It's a good idea to put a wire wheel on your bench grinder and clean the stuff off the bolts' threads as well as possible.

If this engine were a non-turbo, (I think) it would be possible to get the pan down without dropping the subframe (although, to pull the pan, Volvo tech's and an engine rebuilder I talked with, drop the subframe on all 850's, turbo or no). Otherwise, you have to severely bend stiff, somewhat rusty power steering lines that cross under and close to the back of the oil pan. It didn't look possible to do that on the turbo engine. I didn't want to distort the lines, but I did try maneuvering the pan out without dropping the subframe. Then I consulted the Volvo tech who told me dropping the subframe is the only way they ever do it. They don't touch the power steering lines.

Below, the pan is removed. You can see the subframe where the front engine mount sits and at the top that mount's upper bracket. If I do this again, I'll remove that bracket to get a little more clearance, though the subframe would still need to be lowered.

Also, note the bagged oil cooler manifold (t-stat?). The two Torx bolts were pretty tight. Make sure you use the right size bit. Due to a little corrosion, I first used the next smaller size. It didn't feel right, so tapped in the correct size and had no problem breaking them loose. The mating face of this manifold (and its mating face on the pan) should be cleaned up carefully. The rectangular 0-ring looked fine and hadn't been leaking, so I reused it even though I had a new one. It hasn't leaked.
Not visible is a line (an old boot lace) that I used to pull the manifold forward and tie it off out of harm's way.

This rechargeable driver came in very handy for removing the pan bolts once they were cracked loose with a ratchet. I used a 4” extension with a deep socket and spun them right out. As others have noted, be aware that the pan bolts on either side of the engine are all short. Bolts on the front and back of the pan are different lengths.

ALSO: the longer front and back bolts will have some thread sealant or locker on them. CLEAN that stuff off with your wire wheel before reinstalling them. It will also be helpful to pick up a tap the size of the pan bolts next time you’re at the hardware store (Menards has them) and clean out any holes where the sealant or locker was used. You’ll thank me for that tip.

Below, you can see the pan being removed above the dropped subframe. NOT SHOWN is that you will need to remove the oil pickup tube that snakes down through a round hole in the horizontal baffle that's about midway down in the pan. That tube needs to be unbolted before you can maneuver the pan out. There are two screws that hold a saddle bracket to the engine bottom.

Technique: sitting on something while straddling the passenger side wheel hub, left hand reaches in with small breaker bar or ratchet and breaks them loose. The pan will need to be supported from beneath while this is done. So a four handed task. The front of the pan will sit on the subframe, so you have enough room to get a hand in there.

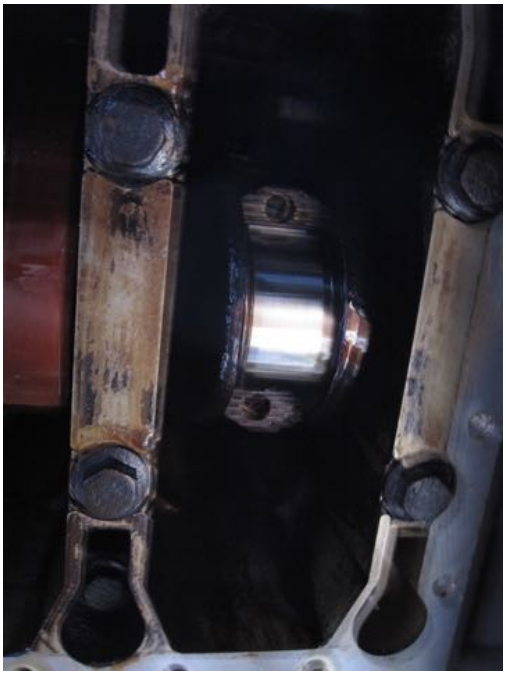
Also, note the blue plastic. As soon as I got the pan out and mopped out any pooling oil, I flipped it over onto some scrap plastic sheeting and roughly cut a rectangle to fit over the bottom of the engine. Then I forced 6 screws through the plastic to hold it up. This kept dust out of the engine and oil out of my face.

INVESTIGATION.
I had the seal kit for the oil pickup system and had planned to replace those at the least, though I didn't think it really needed them because the oil pressure was fine (light went right out upon starting), and the lifters were not clattering. Replacing the seals helped to justify getting the pan off.

BUT I REALLY WANTED TO KNOW what was causing the tinking sound.

Because I'd got the engine running well and I could now see it was very clean internally (I had run half a can of Sea Foam for about 100 miles before doing this), so I was quite sure it was worth getting to normal, which meant mainly finding and correcting whatever was causing the tinking sound.

I couldn't see any metal-to-metal contact, so I decided to pull the rod bearing caps to inspect for abnormal wear. If there had been any, or marring of the crankshaft, I'd have stopped there and just put it back together. The picture below is of journal #1. The journal is mirror smooth; the others were, too. and the bearing inserts were in excellent condtion.



The others are likewise.

I took those around to 3 engine rebuilders in Minneapolis and all gave the same opinion: virtually no wear; certainly nothing abnormal. One said, “heck, those look like new”. You can find pictures of worn bearings online. They usually have some copper/bronze showing.

[BTW: if I were buying a used engine, I would want to get it this far apart before cashing out. You’d need to take it out of the car anyway, you might as well turn it on it’s side and pull the pan and rod caps. In the light of day, you can inspect the lower cylinder walls, too. Take some baggies with you to keep bearing inserts with their respective caps. The caps are numbered, the inserts are not.]

Having confirmed a solid “bottom end”, and looking up into the cylinders while pistons were put to TDC I could see no scoring, gouges or anything abnormal on the cylinder walls, the next step was pulling the pistons, meaning the head had to come off.

Tracy's soap tutorial thoroughly covers cylinder head removal, so I won't dwell on the details here—except for a few notes:
- others have warned to be careful when removing the camshaft cap, assuming the camshafts are coming with it—which is how I do it. You MUST keep it level to avoid jamming and possibly cracking the end-play raceway just behind the camshaft sprockets. If your timing sprockets

are on their marks “(in time), you’ll find that upward force on the cover is at cylinders 4 & 5. So when you crack the cap loose, don’t fully remove a couple of bolts at that end, just unscrew them enough to free the cap from the guide pins—maybe 3/8”. All the others can come out. Now when you break the cap loose from its alignment pins, the “back end” of the cap (cylinders 4 & 5) cannot lift far enough to harm the end-play raceway behind the sprockets at the other end. At this point, you control the lift, maybe place something soft under the front end of the cap to raise up the cams and their end-play discs. Once the front is elevated half inch or so, you can remove the bolts at the back and lift it straight up keeping it level. If you look closely, at the picture, you’ll see that my camshafts are wired to the cap so the whole assembly comes out together. Another pair of hands can be very helpful lifting the cap out of the engine bay.

- bolt holes that have sealant or threadlock on the bolts, should be cleaned up before reassembly. This means putting the bolts to your wire wheel to throughly clean the threads *and* running a tap into the threaded holes. The coolant pipe flange bolts on the passenger side facing the firewall come to mind. Head bolt holes should also be thoroughly cleaned out (see more below).

- the turbo engines use a different heat shield system than the non-turbos. One of the anchor points for the turbo shield is a stand-off bracket that vertically bolts to the head and the block and has a stud protruding that helps secure the heat shield. That bracket needs to come off to remove the head.

Picture of cleaned up cap with cams, showing how the cams are wired into the cap.

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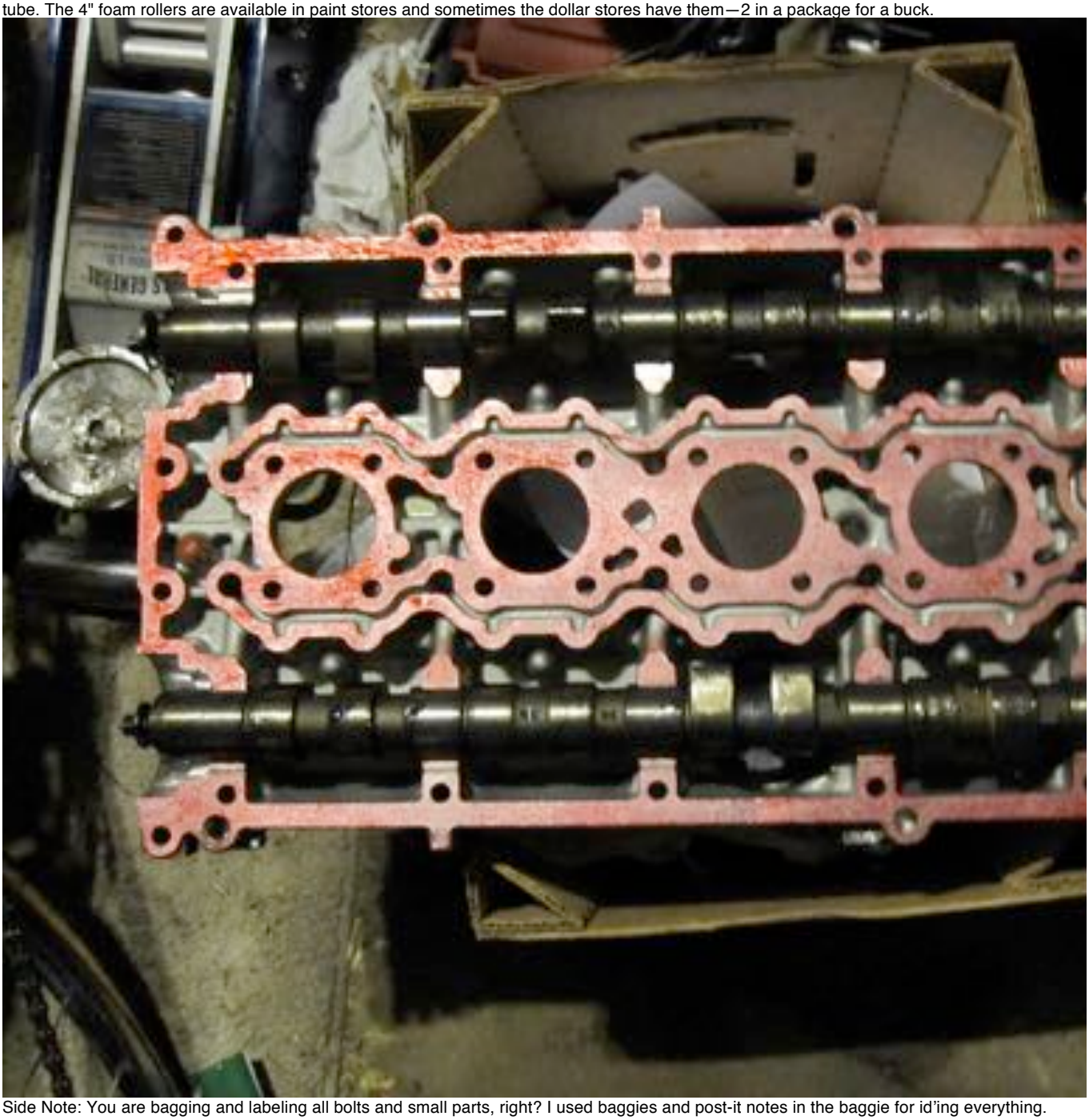
I used the Permatex anaerobic sealant. Inferring from information I got from a Permatex Corp tech, it's the same stuff that Volvo sells for $60.00 a tube. The 4" foam rollers are available in paint stores and sometimes the dollar stores have them—2 in a package for a buck.

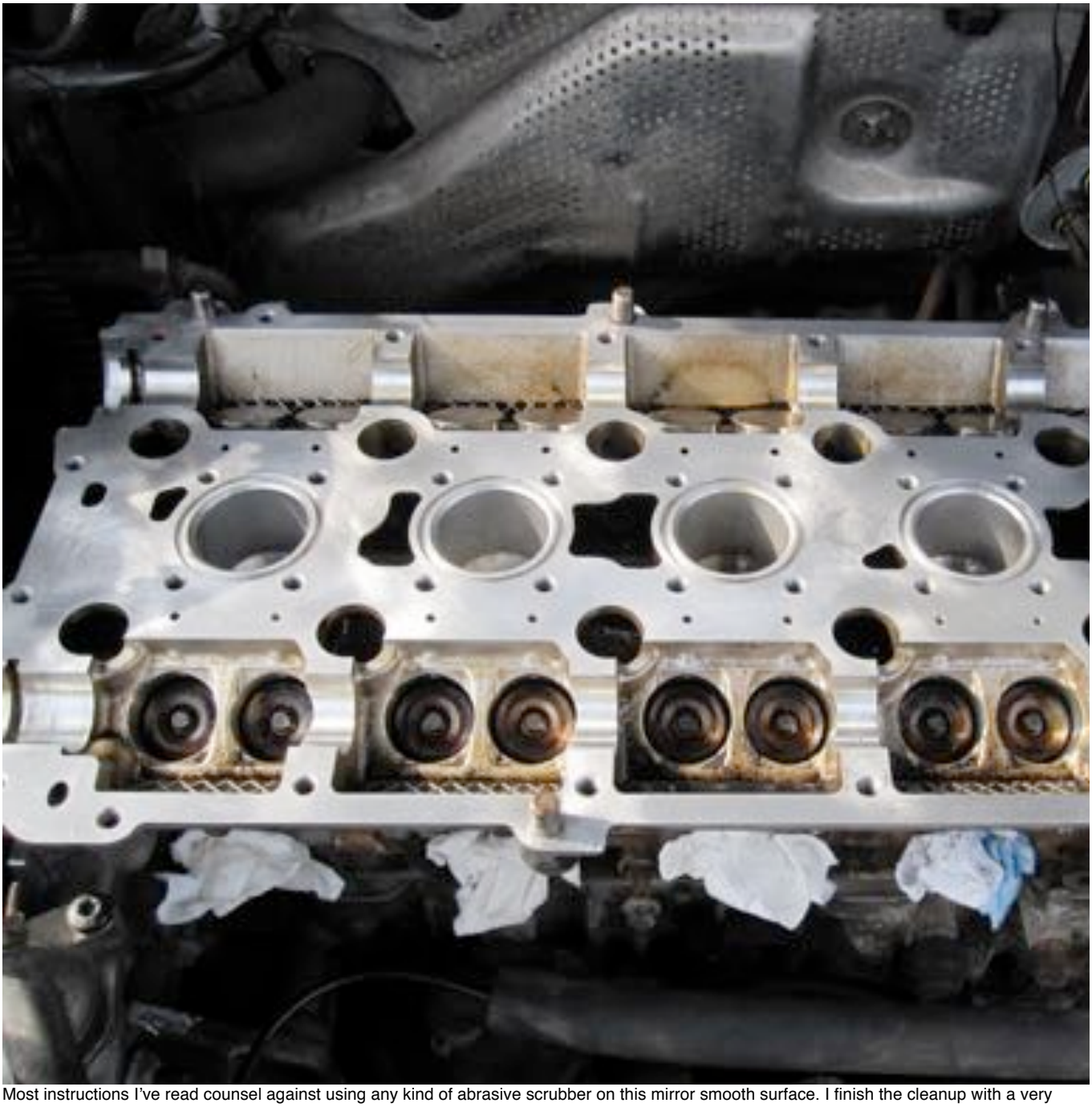


Side Note: You are bagging and labeling all bolts and small parts, right? I used baggies and post-it notes in the baggie for id'ing everything.

The torque link bracket is from another project. Lower left, is the oil pump pickup tube.

The head before cleaning up. Some of the residue can be cleaned off with degreaser and since you have the pan off, there's no need to worry about drain-down, though you don't want grimy solution to get down inside. Stuffing the drain holes with a ball of paper towel is helpful. Most of it, though, is baked on sealant. The razor blade technique described in the oil pan cleanup picture (below) works best on this surface.

Head after cleaning up:



Most instructions I've read counsel against using any kind of abrasive scrubber on this mirror smooth surface. I finish the cleanup with a very light scrub using 90% alcohol to remove any greasy or oily residue for reassembling, then wipe it down with clean towel. It actually goes quite quickly.

PULLING THE PISTONS

In an engine whose pistons have rubbed up and down, steel against steel, millions of times, there will be some wear in the cylinder walls. Hopefully, not too much. The wear leaves a ridge at the top of the cylinder wall where the piston rings stop their upward travel. That ridge (which should only be a few thousandths of an inch) needs to be shaved off before the pistons will slide out the top of the block. The picture below shows the ridge reamer and cylinders 1-3; #1 isn't done yet, 2 and 3 are. There will some fine metal shavings falling down, so you'll want to pack some soft material around the piston crowns, then vacuum them out when done. A small magnet will also help to remove any filings.

The ridge reamer is pretty slick. The cutter bar is at front-bottom. With the piston all the way down, the tool is set above the piston so the cutter is just below the ridge and tightened carefully into place. Then the center bolt of the tool—which you reset after each use—is turned as the cutter bar comes up underneath the ridge, shaving it away as it rises. It's the top edge of the cutter—not the side—that shaves the ridge. Auto supply stores rent this tool. Be sure they include the deep wall socket you'll need for the center bolt. Cutting each ridge takes about 10-15 minutes, including setup (once you get the hang of it).

Cleaning up the cylinders. I packed some shop towels in the bottom of the cylinders over the crankshaft journals to protect from the cleanup mess. I used degreaser and a lot of towels to remove as much of the build-up of baked in carbon deposits as I could. This is important, because you'll need to hone the cylinders (shown below) before reinstalling the pistons with new rings.

Once the ridge is removed, use a stick to push the connecting rod up from the bottom. You might need to tap the rod on its bolt hole—staying clear of the journal surface. Bearing inserts will probably fall out when you do this. Just bag and label them with piston number and “top” or “bottom” insert. Of course, caution is needed around all perfect surfaces. (Bearing inserts have markings on the back, "Volvo, and date". Those markings also leave a trace on the rod casting, so you can see exactly how to replace them if you're reusing them.)

Cylinders are pretty clean.

As I mentioned, the cylinders need to be honed before installing the pistons with new rings. This doesn't actually put a mirror finish on the cylinders, but roughens them slightly. The earlier style hone was called a glaze buster and used several vertical honing stones.The new method called "ball honing" creates a crosshatch sort of scratching in their surfaces (barely visible). This both busts the glaze and the crosshatch helps to "chafe in" the new rings, so that the metal parts mate well. The rebuilder who cleaned up my pistons (they literally looked like new) and installed the new rings, loaned me a ball hone. It worked pretty well and isn't hard to use. The loaner was pretty well used. I was told to run it up and down quickly at medium drill speed a half a dozen times. I found that I needed a couple dozen up and down cycles to get the honed effect.

Cleaning things up takes time. I was running out of it, but wanted to clean and renew anything critical that I could before bolting it all back together. There will be embedded oil deposits in the cylinder walls that takes some rubbing with solvent to get out. This is an important step. If you don't get them clean, they won't hone well and you might not get good run-in of the new piston rings.

This is a good time to clean out the head bolt holes. Some of mine were gritty and grimy, indicating a little oil leakage past the head gasket, over time. There wasn't anything visible from the outside, though.

I squirted some degreaser into the holes and ran a clean head bolt into the hole with a drill/socket. Up and down each time wiping off the bolt. When the holes looked free of grime, I wicked them out with some giant pipe cleaner type wicks I found at the dollar store. Lacking those, I'm not

sure how I would have cleaned out al the solvent. They worked well.

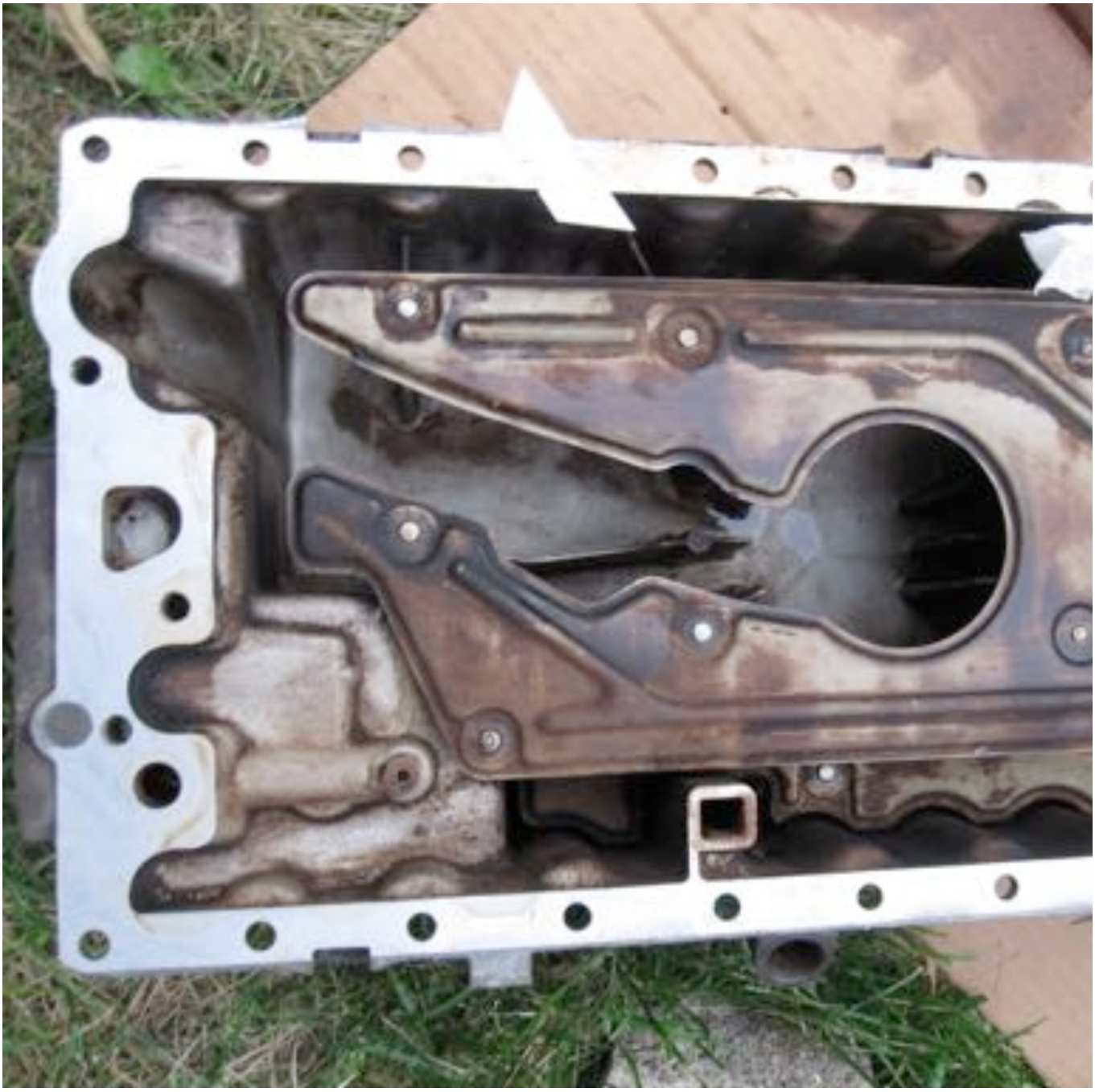
Also on the cleanup list were all electrical connections—disconnected, wire brushed where possible and replugged with a dab of dialectric grease. I replaced all vacuum lines, some of which were really decrepit.

I disassembled the turbo wastegate diaphragm. It looked porous so I replaced it with one from a spare turbo. The turbo impeller shaft seemed tight and spun freely so I didn't go in further. I replaced the turbo's rubber coolant line that's hard to reach.

Cleaning up the oil pan. There was almost no sludge in the oil pan and likewise in the breather chimney that lets out crankcase fumes to the PCV system. That was an inspiration when I first pulled the pan to go the next step. There was a little build-up on parts of the pick-up screen which I cleaned with solvent and a toothbrush.
The two concerns with the oil pan are smooth mating surfaces free of any residue and properly seated o-rings.

FINAL CLEANUP AND REASSEMBLY PREP
I read somewhere in an o-ring tutorial, that “I just use a razor blade” to clean up the mating surfaces where anaerobic sealant is used. What I found to work really well was a fresh sharp utility knife blade. Notice the beveled edge. Using a new blade, they have enough of a bevel that you can feel it when it’s flat on the shaving surface. The idea is to ride the blade flat on its bevel and just maybe a degree sharper. The blade’s steel is sturdy enough that you can control it exactly at the angle the provides the best cut without gouging the workpiece. I also used this on my camshaft cap, top of the head, bottom of the head and top of the block—as well as the bottom of the block that mates with the oil pan. I seem to recall that doing the whole pan flange, working carefully, took about 45 minutes. The lines you can see where the flange has been cleaned are from the factory milling machine not the utility blade.

Also, related to reassembly, the holes for the pan bolts at both front and back of engine have a sealant or thread-locker on the bolts and in the holes that can “bottom out” bolts before their correct torque against the pan, so they should be cleaned out while the pan is off. A tap is the best way to do it. Similarly, the bolt holes for the hard pipe coolant flange, on the firewall side of the head, should be cleaned out with a tap before reinstalling the head.



Keeping it clean: I just flipped it onto a piece of corrugated and rough cut the shape. No need to worry about crud while everything else is getting done.

Tool bench. Somebody left it on the alley—a just in time find.

I mostly used what's on the bench but you need some torx sockets, including the internal torx to pull connecting rod bolts. Most of my tools are from Harbor Freight.

The connecting rod bolts, by the way, are the stretch type, but for steel; they are "elastic". They're 50 mm long underside of head to shank tip. A Volvo spec sheet counsels "do not reuse them if they are 55 mm or longer. I checked with the rebuilders; they reuse them without problems, and I did, too. I think I still have the Volvo torque spec document on my hard drive somewhere. If anybody needs it let me know. I Googled and found it. Don't lose any rod bolts, the cost around $30.00 *each* from Volvo.

Other tools. The quarter inch drive composite ratchet from Harbor Freight got a good workout. Its strength and durability amazed me. The 1/2" drive extendable handle ratchet (HF) was very useful. I wouldn't want to be without it. I also have and used various length 1/4" to 1/2" drive extensions and sockets and two 1/2" breaker bars, one being HF's 24". And a couple of pipe extensions for extra leverage. The HF electric impact driver came in handy on the subframe mount bolts and a few other places, though I could have gotten along without it. And, of course, vice grips and a few miscellaneous others.

On O-rings, seals, etc., after cleaning up their groove, I always use silicone spray lube on the rubber ring before installation, a tip I got from a local respected indy shop.

I did this during a short lull in the career action during fall, 2014. I had a week I could spare. The car was at a friend's place across town and with

shopping, etc., I averaged about 5 hours per day. The week went by quickly. Some of that time was wasted trying to get the pan out with his help, evenings. The project lasted into the third week. Were I to do this again, I could do it in a week without difficulty. Maybe 3 days.

Epilogue
The culprit
I was quite amazed that I couldn't see any metal-to-metal contact in the engine. And looking up from the bottom, I was looking along the side of the rod so the curvature didn't stand out. In a proper engine, parts run extremely close to one another. The crankshaft counter-balance just barely misses the bottom of the piston skirt when all is normal. Put a a slight curvature in the rod and it shortens the length just enough for the counterbalance to strike the bottom of the piston skirt. These pistons are made of a very tough, resilient not brittle composite of some sort, so there were no cracks in the casting, just some chafing marks at the contact point. A local rebuilder had a used rod he sold to me for $30.00.
So how did the rod get bent? Previous owner's daughter ran into a deep puddle and water came into the cylinder #1. Bam. Dead stop. Amazing that more damage wasn't done, but it runs great, so everything seems intact.

Assembly lube.
Absolutely, put a dab of assembly lube on metal to metal contact parts *except the piston rings and cylinders.* Oil jets will take care of the cylinder walls.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WITH MOLY-GRAPHITE