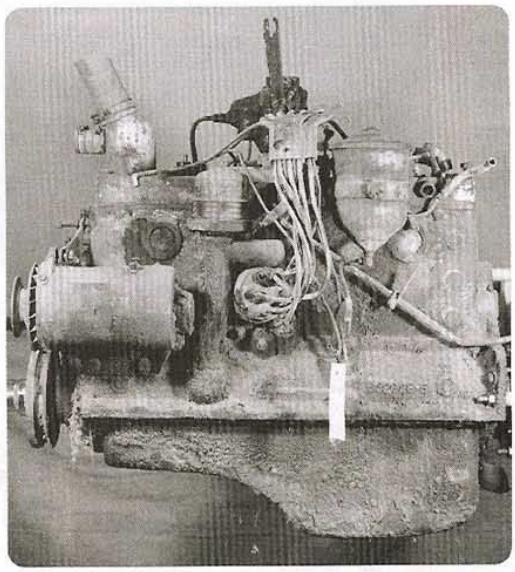
Engine Rebuild, Part 1

In This First of a Four-Part Series, We Disassemble a 6-Cylinder Flathead

BY CURT McCONNELL



LONG HAVE I yearned to restore an engine from scratch. I'm not talking about tearing it down, painting it up and turning it over to a shop for machining. No, I wanted the satisfaction that comes with doing my own work. Unfortunately, for years I had neither the equipment nor the know-how to realize my dream. And then I heard about a local community college's "Engine Machining" night class, taught by a sprightly mechanical wizard named Jerry Norris.

After signing up for the course, I read everything I could find about engine rebuilding. Just days before the first of eight sessions, I began the task of disassembling the 1939 Plymouth engine that would become my class project. The account that follows is the first installment in a four-part series documenting the difficulties—or "challenges," if you prefer—that I faced in my quest to master the fine art of engine rebuilding.

Being Organized Works

Getting organized and staying that way simplified my job. Now, I don't claim to have all the answers but I can tell you what worked for me. First, I wouldn't have touched the engine without having a factory shop manual on hand. Nearly as useful was the factory parts listing, which not only includes exploded diagrams of major components but contains part numbers that, six decades after the fact, I found indispensable in ordering the correct new old stock parts from various suppliers.

To make disassembly notations in a spiral notebook, I created page headings using Chrysler's long-standing alphabetical parts groupings: Group 6—Clutch; Group 7—Cooling; Group 8—Electrical; Group 9—Engine; and so on through Group 14—Fuel. I actually made two sets of these headings. Under the first set, in the front of the notebook, I recorded the measurements of every fastener I removed. For bolts—let's say the fuel pump bolts—I recorded the number required, their head size, shank diameter, length, pitch (threads per inch) and washer type. In the back of the notebook, I made notes under similar headings.

That is, I recorded measurements of my fuel pump bolts under "Group 14 - Fuel" in the front of the book. The detailed sketch I made before disassembling the complicated throttle linkage went under "Group 14 - Fuel (notes)" in the back of the notebook. For complex assemblies—those that would have taxed my limited artistic ability or taken too long to draw—I took photographs.

I also used my notebook to create lists: parts that were originally cadmium-plated or painted black or silver; original fasteners for which I wanted stainless-steel replacements; new parts to buy; and so on. I also recorded my expenses and the time I invested in various operations.

To keep from repeatedly diving into my manuals, I created three separate lists: 1. "Correct Part Numbers," an alphabetical list of parts ("bell housing" through "water pump") with the correct part number under one column and space under another column to record the actual part number I found on my engine; 2. a "Measurements" log sheet for recording micrometer readings of valve stems, tappets, tappet holes, cylinder bores, crankshaft journals, and camshaft journals and lobes; and 3. a "Factory Specs" sheet for all parts listed on the "Measurements" list.

For a fourth list, kept solely out of curiosity, I recorded the weight of every piece of the engine.

Smaller parts went into labeled cans, which I placed on a shelf under my workbench alongside larger parts. I preferred to end each work session by cleaning the fasteners I'd removed that day. That meant taking them first to my solvent tank and then to a wire-wheel buffer, where I used Vise-Grips to hold the bolt heads while I polished their threads.

Getting organized also means having the correct tools. You'll want your toolbox to include the usual wrenches, screwdrivers and sockets, of course. For a do-it-yourself rebuild job, you'll also want to buy—or, if possible, rent—the specialty tools shown in the photo at the top of page 21. If you need to travel with your tools, as I did to attend my weekly class, I recommend hauling them in a plastic tote box with a snap-on lid. It will keep them safe, dry and—most importantly—close at hand when you need them most.

Determining Originality

Mismatched bolts and lockwashers on the outside and oversize pistons on the inside told me that my engine had been rebuilt. I thereby considered it likely that some long-ago mechanic had substituted some incorrect parts in place of the original equipment. Yet numbers on every internal and bolt-on part but one were correct for a 1939 Plymouth. Only the cylinder head, a more modern substitute, was incorrect. (The Plymouth parts listing gave the numbers of the crankshaft, head and other integral parts. As for bolt-on accessories, a Carter manual identified the correct carburetor; the Universal Catalog of Original Equipment Service Parts 1934 to 1940, a $5 swap meet purchase, listed the correct distributor, generator and starter numbers.)

Therefore, I didn't know what to make of the engine's odd-looking oil-filler pipe. Open internally but closed to the atmosphere, the pipe's horizontal attachment

was obviously not intended to expel blow-by gasses.

None of the Plymouth or Dodge engines pictured in factory parts books dating from 1934 through the late 1940s show such a pipe. Nor do the factory engine photos I ordered from the DaimlerChrysler Corporate Historical Collection. Various Plymouth Owners Club technicians were gracious enough to speculate about the function of this odd pipe—was it used on Chrysler industrial or military engines?—but none of the club members I consulted could speak definitively. Consequently, I concluded that the pipe (whose function remains a mystery to me) was incorrect for a 1939 Plymouth; I replaced it with a standard straight pipe.

Step-by-Step Teardown

To understand exactly how the engine goes together—or, more specifically, comes apart—I drew up a list of disassembly steps as follows:

1. Remove bellhousing. 2. Remove clutch. 3. Remove flywheel. (You can now mount the engine on a rolling engine stand.) 4. Remove the following bolt-on parts: a) air cleaner, b) breather pipe and filter (on the right rear of the block), c) carburetor, d) distributor, e) fuel pump, f) generator and mounting bracket, g) oil-filler tube and cap, h) oil filter (if so equipped), i) oil pump (removable from the block's lower right side), j) starter, k) throttle linkage (including spark plug wire sorter), l) water outlet elbow and thermostat, m) water pump and fan. 5. Remove manifolds. 6. Remove cylinder head. 7. Remove valve covers. 8. Remove valves. 9. Cut down ring ridges with a ridge-reamer tool. 10. Remove chain-case cover. 11. Remove camshaft sprocket, timing chain and oil tube.

Turn the engine upside-down for Steps 12 through 14... 12. Remove oil pan. 13. Remove oil pickup screen and oil lines. 14. Number connecting-rod caps, if necessary, using a stamping kit or a punch.

Turn the engine upright for Steps 15 and 16... 15. Loosen and remove nuts from connecting-rod bolts. 16. Remove piston and rod assemblies.

Turn the engine upside-down for Steps 17 through 21... 17. Number crankshaft-bearing caps, if necessary. 18. Loosen and remove crankshaft bearing caps and oil seals. 19. Remove crankshaft. 20. Remove camshaft, tappets and camshaft bearings. 21. Remove core plugs, studs and all other threaded parts.

Making such a list proved helpful for several reasons. Realizing how much work I had ahead of me made it easier for me to hold my natural impatience in check. Scanning the list before each work session enabled me to lay out the tools I'd need, giving me more uninterrupted work time. Furthermore, I got a morale boost every time I checked an item off my list. Finally, by copying the same list, I can bring myself quickly up to speed the next time I rebuild an engine.

Because most rolling engine stands are designed to bolt into the rear of an engine block, you'll have to complete Steps 1, 2 and 3 with the engine on the ground (preferably on a piece of wood, carpet remnant or the like) or on a sturdy workbench. A few explanations are in order to supplement portions of the teardown checklist:

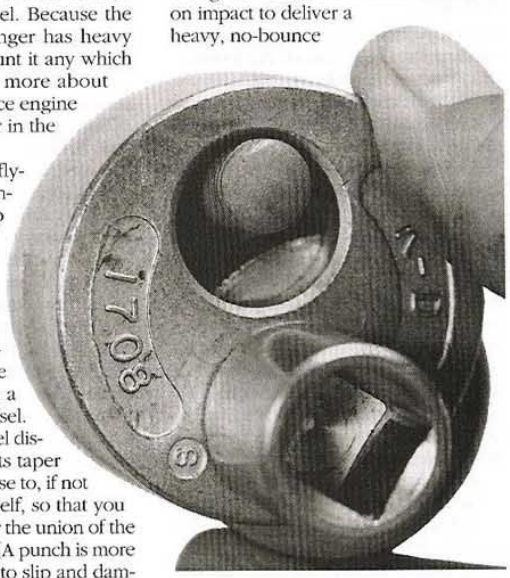
Step 2: Remove the clutch. Loosen the clutch bolts one turn at a time, in rotation, to avoid warping the pressure plate. It is necessary to mark the position of the clutch before removing it from the flywheel only if an engine has been balanced, and then only if you have no plans to machine either part. My clutch was a rusty mess and clearly needed rebuilding. Likewise, the flywheel needed surfacing to remove deep scratches. Because such machining operations would change the balance of these parts, it was pointless for me to mark their relative positions. The machinist who later balanced my engine told me I would never have to mark the clutch's position on the flywheel. Because the balanced clutch no longer has heavy spots on it, I could mount it any which way. (We'll talk some more about balancing parts to reduce engine vibration and wear later in the series.)

Step 3: Remove the flywheel. If the starter's pinion gear has chewed up the flywheel's ring gear, now is the time to correct the problem. The easiest fix is to reverse the ring gear, which is shrink-fitted to the flywheel. First, remove the gear by tapping it with a hammer and a dull chisel. The broad end of a chisel distributes the blow and its taper allows you to hold it close to, if not against, the flywheel itself, so that you can direct the blow near the union of the ring gear and flywheel. (A punch is more likely than a dull chisel to slip and damage a tooth.)

When the ring gear begins to move in one place, move the chisel about three inches to the left and continue tapping, and then move it three inches to the right of your starting point, and so forth until you drive off the gear. Next, while holding the ring gear with a Vise-Grips, heat the gear with a torch until it glows red. Finally, slip it over the flywheel so the clean teeth face the starter.

Step 5. Remove manifolds. Rusted studs doubled or even tripled my engine-disassembly time. Two of the 13 manifold studs pass through holes in the exhaust-manifold with virtually no room to spare. During the decades the engine sat in a salvage yard, rust effectively locked these two studs to the manifold. I heated the studs, applied rivers of penetrating oil, pounded on the casting by using a four-pound sledge against a block of wood. I even hammered on the nut ends of the studs in a vain attempt to break their rusty grip.

As I tried these ploys repeatedly and in rotation, I proceeded down my list of disassembly stages. Finally, when all that remained was a bare block plus manifolds, I resorted to drastic measures. Using an engine hoist to dangle the block inches above a sheet of plywood that I'd placed on the floor, I smacked the manifolds with a dead-blow hammer. (Surrounded by no-mar plastic, a chamber in the head of this delightful tool contains steel shot. The steel shot settles into the back of the chamber when you swing the hammer but rockets forward on impact to deliver a heavy, no-bounce

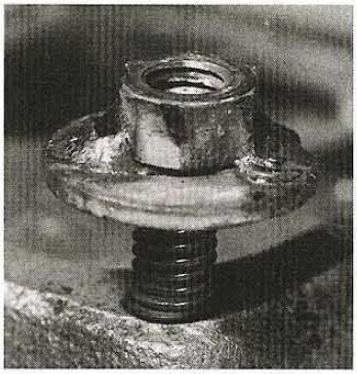


With this style of stud extractor, you can lock a cam against the stud and apply twisting force with a ratchet or breaker bar. But if the stud is badly frozen—as mine was—the cam will slip.

blow.) In addition, I placed a heavy pry bar through the regular openings between the manifolds and engine. Using a block of wood as a fulcrum, I pried gently—at times, not so gently—against the stuck manifolds.

Even with the block's 146-pound bulk working in my favor, removing the manifolds was agonizingly slow work. Almost imperceptibly, however, the hammering and prying (first at one end of the manifolds, then at the other and back again) opened a small space between the manifolds and block. This gap increased until, finally, the manifolds popped free.

But my task still wasn't done. Believing that the 13 manifold studs were too rust-weakened to reuse, I began removing the studs so I could order replacements. A large Vise-Grips removed just a couple studs; the stud extractor I bought to finish up the job (See photo on the previous page.) didn't have enough firepower, either. After 62 years anchored in the engine block, these fasteners were stuck fast. Ultimately, I welded nuts on the free ends of the remaining studs and removed them with a pneumatic impact wrench. Welding, applying penetrating oil and gently coaxing the studs out of their burrows—twisting them out a bit, back in, out a bit farther, back in, and so on—consumed several hours. The studs all emerged without breaking off in the block, however.



By employing some welding sleight of hand, machinist Steve Allder removed four broken-off bolts to save my intake manifold.

Fresh from this hard-won victory, I turned my attention to the four long bolts that join the intake and exhaust manifolds. Aware that no penetrating oil could reach the threads, my strategy was this: 1. Tap the bolt heads and manifold casting with a hammer to pulverize some of the rust in the threads. 2. Deliver one rust-busting expansion and contraction cycle by heating the bolts cherry red and allowing them to cool. 3. Tap the heads and the casting some more. 4. Turn the bolts gingerly in and out repeatedly until I could drip some penetrating oil past the bolt heads.

Unfortunately, I didn't make it that far. When I put the slightest pressure on my socket wrench, the first bolt abruptly twisted off, as did the three remaining bolts. Was my plan faulty? After inspecting two other manifold assemblies that I'd worked on years earlier, I could honestly answer "no." In both earlier instances, all four bolts had also broken off in the upper (intake) manifold, flush with or slightly below the surface of the casting. This, then, was simply the norm.

So that I could devote my time to other tasks, I took the intake manifold to Lincoln Clutch & Brake, my favorite local machine shop. There, can-do machinist Steve Allder removed the broken bolts in an ingenious manner. First, he located washers with an internal diameter slightly smaller than the bolt diameter. These washers he welded to the ends of the broken bolts. He welded larger washers to the smaller ones and, finally, welded nuts to the larger washers. (See photo at left.) While the manifold was still hot from welding, he hammered moderately on the casting near each bolt to knock loose some rust. Then, carefully, he used a small air-impact wrench to loosen the bolts, turning them back and forth gradually until he removed them. Though this laborious operation cost me $26, I consider it money well spent.

The broken-stud saga continued when I tried to remove the three water pump studs by welding nuts to their free ends and using an air impact. Two came out but one broke off slightly below block level. Leery about welding so close to the block, I drilled out the broken stud. First, I lined up a center punch dead-on in the middle of the broken stud. Then, using a tiny bit, I drilled a pilot hole straight through the stud. Don't let the drill bit wander here or you'll ruin the threads in the tapped hole. I used increasingly larger bits until only a shell remained. I placed a small chisel tip against the end of the stud but no amount of hammering would collapse the thin-walled shell. An "easy out" extractor likewise failed me.

Reluctant to risk drilling the stud hole oversize but having no other remedy available, I selected the next-larger drill bit and ran it through the hole. Part of the way through, the bit abruptly caught on the inside of the shell, producing a shriek of twisting metal and a puff of smoke. A broken drill bit? No, fortunately. When the bit locked itself against the shell of the stud, the drill's heavy motor broke the grip of the rusty threads and spun the stud out into daylight at last.

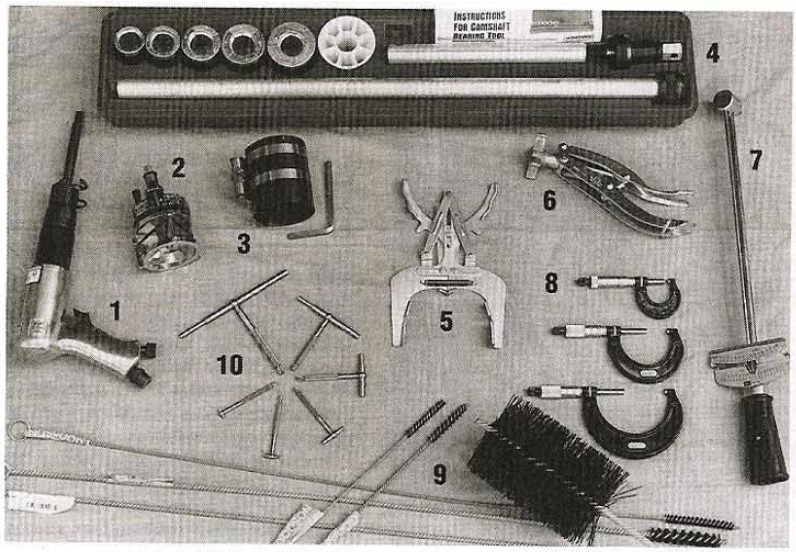
To avoid future battles with rusty threads, I sought stainless steel replacements for all my engine studs. My fruitless search became the greatest disappointment of my overhaul project. I tried Totally Stainless, Inc. and other suppliers that advertise in old-car periodicals: no luck. Likewise, I consulted several marine-fastener suppliers (which sell non-rusting stainless fasteners for oceangoing ships) and several other sources I found on the Internet. Again, I struck out. Even when I compromised and began looking for new studs of ordinary steel, I had trouble finding the lengths I needed. In several instances, I had to buy longer steel studs and shorten them by cutting and grinding.

Step 6. Remove cylinder head. The head popped right off my 1939 Plymouth engine with no muss, no fuss—a rarity. More typical was the balky head I encountered while working on a 1940 Plymouth months earlier. On that job, even after removing all 21 bolts in the proper sequence to avoid warping the casting, my cylinder head was very stuck. Time to reach for a big screwdriver to jam between the head and block, right? No, not that, my friend! Prying with a screwdriver could leave gouge marks on the mating surfaces—marks too deep for a new head gasket to fill. That means antifreeze or gas leakage, and that spells trouble.

I tried rapping my trusty dead-blow hammer against both sides of the head and spraying penetrating oil along the edge of the gasket in hopes it would seep into the gap. (If a crowded engine compartment prevents you from swinging a hammer near the head, rap instead on a piece of 2x4 lumber. This method allows you to use a heavy metal hammer—all the way up to a hand-held sledge. Don't get too frisky: a hard blow could knock the head into an upraised valve, bending it.)

Still no luck? Well, if your engine turns—my 1940 Plymouth engine didn't: the piston rings had rusted to the cylinder walls—try using compression to pop the head loose. First, squirt some oil down the cylinders to thoroughly seal the rings. Then, replacing the spark plugs, turn the engine either by hand or with the starter to see what happens.

If the head still refuses to budge, knock the porcelain out of two old spark plugs and weld round stock to the tops to make a pair of T-handles. Screwed into front and rear plug holes, these han-



These tools are vital if you are planning to rebuild your own engine:

1) **air hammer with a valve-guide driver attachment;**
2) **ridge reamer;**
3) **piston-ring compressor (for installing pistons in cylinders);**
4) **camshaft-bearing driver;**
5) **piston-ring expander (to remove and install rings on pistons);**
6) **valve-spring compressor;**
7) **torque wrench;**
8) **set of outside micrometers;**
9) **set of long-handled brushes for cleaning the block; and**
10) **set of telescoping gauges (to measure the diameter of tappet holes, guides and so forth).**

dles will allow you to apply a surprising amount of leverage to the head. You can even rap the head with a dead-blow hammer while you yank on the handles. The handles also make it easy to lift off the head once you break it free. (See the photo at the top of the next page.)

Step 8. Remove valves. It's possible to remove a set of engine valves in minutes. Throw in a little rust, however, and the job may take hours—even days. Humid air and condensation produced surface rust on the valves in my 1939 Plymouth engine; lighter rust had sprouted in the valve chamber, where several of my Plymouth's two-part conical keepers (they clip into valve-stem grooves to lock the valve spring to the valve) had rusted to their retainers. I, therefore, couldn't separate the springs from these valves. What now?

In my case, after soaking the parts with penetrating oil I compressed each spring, which raised the valve off its seat so I could safely strike its head with a no-mar hammer. The idea was to apply enough downward energy to break the rusty grip holding the keepers to the retainers. This solution required a sturdy valve-spring compressor. My first compressor was a cheap affair that crumpled the first time I tried this. I shopped more carefully for its replacement.

Fortunately, my solution worked. If there's a chance you'll reuse the valves, label them—a welder's paint pen works well—or place them in a homemade or purchased sorter designed for this purpose. In extreme cases when valve stems have rusted to their guides, you can cut away the lower stems with an oxyacetylene torch. This will enable you to remove the camshaft and tappets so that, from the bottom of the engine, you may drive out the bobbed valves, guides and all.

Step 9. Cut down ring ridges. Because piston rings travel in only a portion of the cylinder, never quite reaching the top, years of wear can produce a sharp upper ring ridge. Attempting to remove a piston by forcing it past such a sharp ridge could break the rings, the piston or both. A ridge reamer tool will remove the upper ridge, making it possible to withdraw the piston unscathed. Follow this procedure to operate a lathe-type ridge reamer: 1. Extend three legs to lock the tool tightly in the cylinder just below the ridge. 2. Position the tool's cutter against the cylinder wall just below the ridge. 3. Attach a wrench to spin the upper part of the tool, causing it to revolve on a threaded shaft. This gradually raises the cutter until it mills the entire ridge flush with the worn section of the cylinder. You may be able to rent or borrow a ridge reamer. But you can buy a Lisle 38000 ridge reamer or one similar to it for $60 to $75, which makes it a worthwhile investment if you have more engine overhauls pending.

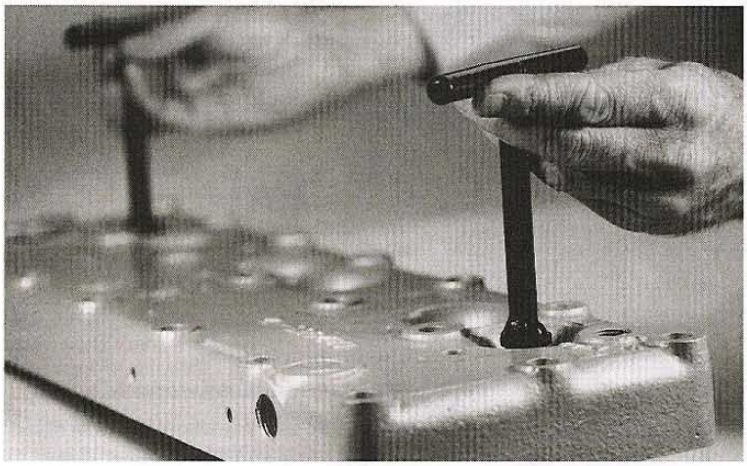
Step 10. Remove chain-case cover. To drive the old oil seal out of the chain-case cover, tap on a chisel or punch as you work the tool around the seal lip. Do this before you paint the cover—unless you enjoy chipping fresh paint. Better to proceed in this order: drive out the old seal, sandblast the cover, drive in the new seal, mask off the seal's rubber lip and paint the cover. Grease the rim of the new seal before carefully driving it into place, preferably by using a seal-driver tool. In lieu of this tool, try to avoid cocking the seal in the opening by tapping its edges at points opposite one another: 3 o'clock and 9 o'clock, 12 o'clock and 6 o'clock, 10:30 and 4:30, 7:30 and 1:30. Make sure the seal bottoms out.

Step 11. Remove camshaft sprocket, oil tube and timing chain. If necessary, use a large screwdriver to pry gently in various locations under the camshaft sprocket to rock it free of the camshaft. You may remove the crankshaft sprocket now, also, or wait until after you remove the crankshaft; the chain will come off regardless.

Step 14. Number connecting-rod caps using a stamping kit or a punch. This was a non-issue for me: my caps were numbered at the factory.

Steps 15 and 16. Loosen rod nuts; remove piston and rod assemblies. A loose piston could easily fall out of an upside-down block, strike the floor and break. I know: it happened to me before I wised up and turned the engine upright in its stand so that I had to push the piston and rod assemblies out of the block against gravity. Be sure to cover the rod-bolt ends with pieces of rubber hose to avoid dinging the crankshaft journals or cylinder walls as you remove the pistons and rods. If your pistons fit tightly in their cylinders, try using a wooden or plastic hammer handle to push against the end of the rod.

Steps 17 and 18. Number and remove crankshaft bearing caps. Plymouth factory machinists in 1939 bolted up four unfinished main-bearing caps and then line-bored the crankshaft holes in each engine block. Because the No. 4 main bearing cap is larger than the others, it can fit



A pair of homemade T-handles will give you leverage to pop loose a well-sealed cylinder head and also make it easier to lift the 33-pound casting.

only in the No. 4 position. Not so the other bearings, which may appear interchangeable but will only provide a correct fit if they are installed in their original position. So, before removing them you must mark the bearing caps, either with a number-stamping set or with a punch (e.g., two dimples for the No. 2 cap).

Main-bearing caps that have been locked in place for decades are often reluctant to pop loose. Prying them with a screwdriver may cause damage. Better to grasp the center of the cap with your hand and wriggle it upward while you use a brass or dead-blow hammer to tap alternate ends of the bearing cap.

Step 19: Remove the crankshaft. Try to get help lifting out your crankshaft. Better yet, attach it to your engine-lifting hoist. My long, awkward, oil-slickened crankshaft presented sharp edges everywhere I sought a handhold. What's more, it weighs fully 60 pounds. If you drop a crankshaft—look out! You'll almost surely bend it. Yes, you can straighten a bent crankshaft but—ching, ching!—it adds to the expense and hassles of your project. If you bend the flange where the flywheel bolts to the back of the crankshaft, your flywheel will wobble, causing your engine to vibrate and your clutch to chatter like a squirrel.

A so-called pilot bushing in the crank's rear flange supports the main drive pinion, the shaft that emerges from the front of the transmission. Replace this bushing while you can. An esoteric—and presumably expensive—puller would work nicely. But try this first: use a grease gun to fill up the cavity ahead of the bushing. Then, get an old transmission pinion shaft—or another shaft of the same diameter—to insert in the bushing. Make sure you have a tight fit between the shaft and bushing. Then whack the shaft with a wooden mallet or dead-blow hammer. The hydraulic pressure this generates may well push out the bushing.

Be alert for clues that signal engine damage. I had two such clues. One, turning over the engine by hand produced a deep clunk every time the No. 5 piston reversed directions. Two, pieces of Babbit—many pounded thin as foil—had settled in the bottom of the oil pan. Not a particle of bearing material remained between the No. 5 rod and rod journal, as it turned out. Its mates were a dirty brown color but the overheated No. 5 rod had turned blue-black and its journal was badly scored, as well. All of the other bearings, though well worn, were serviceable.

I suspect that the bearing—improperly installed, perhaps, though maybe not—slipped and spun, overheated and then began to disintegrate. Whoever owned the car drove it until the pounding rod sounded like a jackhammer on concrete. It was, obviously, what sent the car to the junkyard from whence I retrieved the engine.

Step 20: Remove the camshaft, tappets and camshaft bearings. Label the tappets—again, a welder's paint pen works well—even if you plan to replace them. Wear patterns on a tappet will tell you volumes about the condition of the tappet hole it runs in and the camshaft lobe that activates it. Tappets run in holes machined directly into the block. If a hole wears more than .002 or .003 inch, you can look for oversize tappets—those made by the factory are now scarce—and then ream the holes oversize to fit the larger tappets. Though I labeled the old tappets, I found it easier to use a labeled wooden sorter. As a bonus, the homemade sorter enabled me to safely carry the old tappets to and from my engine-machining class.

With the valves removed, the camshaft will come out by merely removing two bolts that attach a camshaft thrust plate to the front of the block. Treat this cast-iron shaft with extreme care! It is easy to ding up its four journals as you pull the camshaft out the front of the engine. There is no simple remedy for such damage. You see, the camshaft runs at half the crankshaft speed and, furthermore, isn't subject to the explosive forces that pound the crankshaft. Thus camshaft journals normally wear only slightly. Accordingly, Plymouth didn't even make undersize camshaft bearings for my engine, and none are available from other sources, to my knowledge. The bottom line: a worn or damaged camshaft must be replaced.

Step 21: Remove core plugs, studs and all other threaded parts. To clean the block inside and out, it is important to remove all remaining plugs, fittings and other fasteners: brass oil fittings, studs, threaded oil galley plugs, block drain cock and so on. Some of my threaded steel plugs were too rusty to budge. Hot tip: heat each plug cherry red with a torch. As the plug cools, touch its exposed threads with a piece of paraffin wax. The wax will instantly melt and be drawn inside to lubricate the unexposed threads. This technique causes intractable plugs to all but spin out on their own. (Auto parts stores sell little sticks of wax for lubricating door hinges. I bought some canning wax at the grocery store and cut the wax squares into narrow strips.)

To thoroughly clean rust scale from the engine's water jacket, you must remove the core plugs—heavy steel plugs that are pressed into holes created at the foundry when the engine is cast. The dished (not cupped) plugs that my engine uses are placed in the hole concave-side down. Installing the new plugs involves placing the peening (round) end of a ball-peen hammer in the center of the plug and rapping the hammer head with a mallet. This causes the plug to expand and seal the hole. By using the same technique, you can collapse the center of an old plug and thereby remove it. Jerry Norris, my shop instructor, preferred to use a slide hammer with a sharp, self-tapping threaded end. He would thread it into the center of an old plug and use a sliding weight on the shaft of the tool to pop out the plug.

Next month, we'll do some cleaning and machining. ■