Engine Rebuild, Part 4

In This Last of a Four-Part Series, We Assemble the 6-Cylinder Flathead

BY CURT McCONNELL

WHAT A WONDERFUL feeling—the peace of mind that comes from having a batch of newly machined and freshly painted parts ready to assemble into a lusciously restored engine!

Alas, I never knew it.

Until nearly the end of my supposed "assembly" phase, I was still wallowing in grease and solvent, manning the sandblaster and aiming my spray gun.

How so?

Although my engine was ready to assemble, I still had several bolt-on units to rebuild: the fuel pump, carburetor, distributor, starter and generator. These I restored as a group after I'd completed the bulk of the engine assembly. After the big job of completing the engine, each "little" restoration was a welcome diversion.

Still, a nagging sense of urgency propelled me ever forward: "This is taking too long! Other projects are waiting! Hurry up!"

In fact, restoring my 1939 Plymouth engine took me a year. Please note that "restoring" is the time-consuming older brother to merely "rebuilding," where cosmetics go by the board.

And yet, I had carefully planned on all the degreasing, sandblasting, metal-straightening, painting, plating, general renewing (Have I mentioned frozen manifold studs or finding essential special tools?) that one encounters in projects such as this one. Hadn't I?

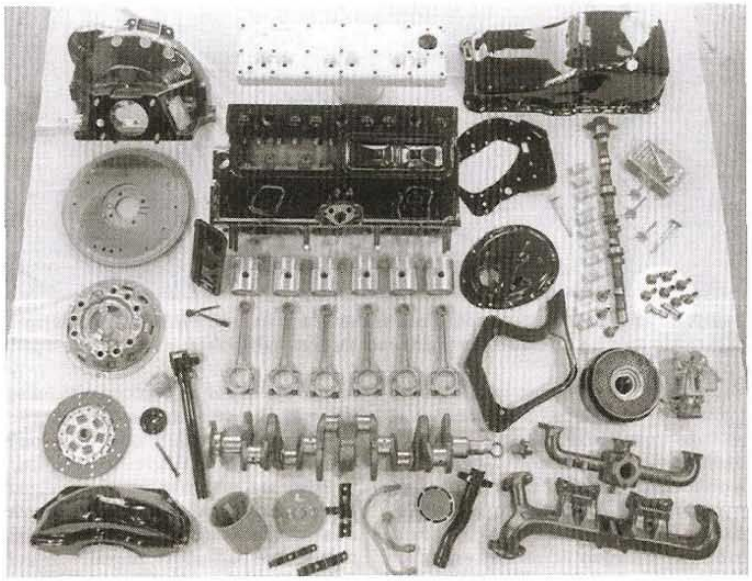
A helpful planning aid for any big project is to estimate how long you think it will take you...and then multiply by two.

Oops, I guess I forgot to multiply!

The fact is, the best time to estimate how long it will take you to restore an engine is after you've restored it. Accordingly, I can tell you, to the hour, how long my second engine rebuild will take me.

Obstacles Along the Way

A good number of challenges—no, headaches—arose during the assembly stages. For instance, a perfunctory Plastigage check revealed that the main-bearing clearances of my newly machined engine were way out of whack. My new rule: It's not enough to subtract journal diameter from bore to arrive at your oil clearance. Double-check it with Plastigage!



The challenge now before me was to reassemble all of these restored 1939 parts—and others—to create a finely tuned engine.

This minor disaster forced me to grapple with the (engine) life-and-death question faced by all old-time mechanics: to shim or not to shim? (Read all about it in Step 10 on page 20.)

Each surprise diverted my time and attention from other tasks and served to drag out the project. Is it any wonder that I found peace of mind so elusive?

My own sheer stubbornness compounded the delays. Welder in hand, I set out to turn a few sketches and a pile of scrap metal—presto!—into an engine test stand. (Wouldn't it be wonderful to run-in your new engine on a test stand, to make final adjustments and repair any problems without stretching over a fat fender or crawling under the car? The correct answer: Yes!)

Don't get me wrong: I'm glad I finally achieved my long-held ambition of building a test stand, which cost me five weeks of steady work. But when one big project collides with another, the first project inevitably gets derailed.

At long last, however, the hard work came to an end. Only one task remained. That was to start my gleaming flathead mill, splendid in its black-and-silver enamel coatings.

My ninth-grade shop instructor beamed with pride as I concluded a news conference, accepted a congratulatory phone call from the President and strode determinedly through a sea of reporters to reach my 1939 Plymouth engine. Despite the (I thought) jaunty air about me, my fingers nevertheless shook with nervous excitement as I reached for the ignition switch, and...

I'm getting ahead of myself.

One Step at a Time

First, a word about how I managed to return a pile of parts, shown in the photo above, into the attractive and dependable workhorse of an engine that it once was.

As in disassembling the power plant, I followed a checklist that's on page 23.

Don't skip this task: compiling such a list is a self-test to make sure you know what you're doing. Before the battle begins is the right time to look up the answers, not when you're black with grease and red-faced with frustration. Many of the checklist steps are self-

explanatory. On some of the other steps, permit me to elaborate as follows.

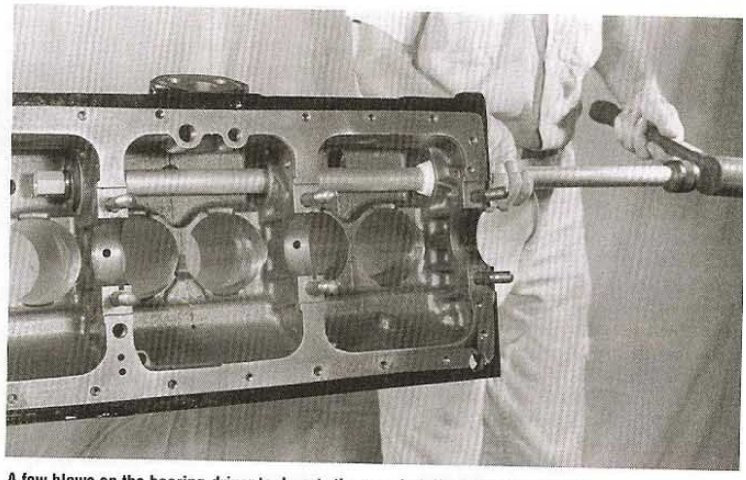
Step 1. Clean cylinders, camshaft and crankshaft bearing saddles and crankshaft bearing caps.

Next time I paint an engine block, I'll mask off the crankshaft and camshaft bearing saddles, or bores, at the front and back ends of the block. It wasn't until I prepared to install upper bearing inserts (the ones in the block) that I noticed enamel overspray on these saddles. This paint film was thick enough to reduce the oil clearance between the bearing material and journals, possibly causing metal-to-metal contact. Paint thinner loosened the overspray and I carefully scraped away the softened paint with a coring knife.

Step 2. Install camshaft bearings, aligning oil holes.

It is essential to align holes in the camshaft bearings with oil holes in the block. First, hold the chamfered edge of each bearing against its bore so that, by driving it straight in, the holes will align. Then use a permanent marker to draw two or three short guidelines across the bearing's outside diameter and extending onto the engine block. Now, insert the cam-bearing driver through the bearing hole in the front of the block and expand the tool's adjustable end so that it holds the bearing firmly. Once you match up the lines you've drawn, you can drive in the bearing (shown in the photo above) with full confidence that the bearing and block oil holes will align precisely.

Step 3. Lube valve guides and tappet holes.



A few blows on the bearing-driver tool seats the camshaft No. 3 bearing, far left.

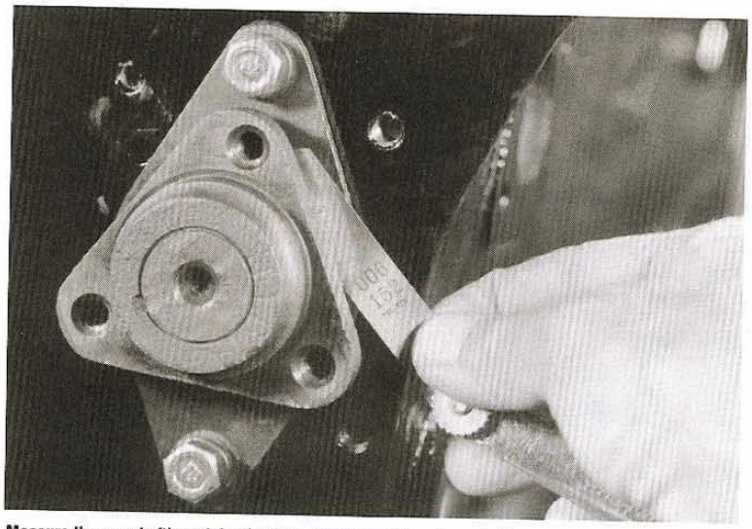
It's standard practice to smear an engine-assembly lube on all bearing surfaces to protect them during the few seconds it takes to build oil pressure the first time you start the new, tight engine. Quite by chance, I bought an "extreme-pressure, anti-seize engine-assembly lube" made by CRC Industries Warminster, Pennsylvania. It contains graphite in a heavy black paste that I suspect will stay where I want it for months.

Pressurized oil lubricates everything but the tappets, which are bathed in oil that flows by gravity from oil troughs (reservoirs) in the valve chamber via downward-angled drilled holes. So I merely filled these reservoirs just before cranking the engine to life. When I inspected these oil holes, I couldn't believe the filth I found! Gritty carbon, sludge, rust, dirt—it was all there because, apparently, I'd neglected to clean these passages after I'd honed the tappet bores.

Step 4. Assemble valves, springs, tappets and camshaft.

Invert the engine, drop the 12 tappets into their bores and then carefully install the camshaft from the front end of the engine. At the front end of the camshaft is a triangular hub, the mounting point for the camshaft drive gear. Immediately behind the hub is a thrust plate. Two small bolts secure the thrust plate to the engine's front deck, thereby locking the camshaft in place. The gap between the hub and thrust plate determines the camshaft's endplay, specified as .002 to .006 inches. Only with difficulty could I insert a .006-inch feeler gauge in this gap, as shown in the photo at left, meaning that my camshaft's end play passed muster.

Here's how to assemble the valve components shown in the photo on the next page: 1. Remove the valve. 2. In the valve chamber, place a spring beneath the valve guide and manually compress the spring until its lower end clears the tappet and its top slips under the bottom end of the valve guide. 3. Place a retainer on a valve spring-compressor tool. (A sort of stepped washer, the retainer acts as a spring seat. Furthermore, a hole through the retainer's center is cone-shaped to grip a pair of keepers that lock the spring onto the valve.) 4. Insert the retainer-carrying tool under the spring and adjust the tool to raise (compress) the spring high enough so that, when you insert the valve in its guide (as you'll do right now), the two parallel grooves in the lower end of the valve stem are exposed.



Measure the camshaft's endplay (.002 to .006 inches) by using a feeler gauge between its triangular gear-mounting hub and the thrust plate behind it. Here, a .006-inch feeler gauge proved a tight fit.

5. Snap both halves of the split-collar keeper onto these grooves, as shown in the photo below. (Daub a bit of grease on the inside of the keepers to hold them.) 6. Lower the spring so the hole in the retainer closes around the keepers, locking them in place and making a unit of the valve, spring, retainer and keepers.

Step 6. Install upper crank-bearing inserts, aligning oil holes, and cap inserts.

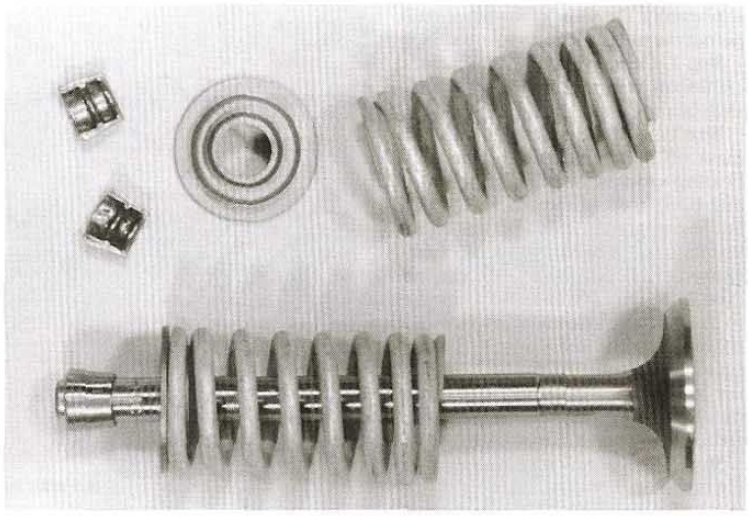
Dirt, oil, paint overspray—you don't want any of it between your bearing inserts and saddles or caps. Any foreign object here will decrease your bearing-to-journal clearance, in extreme cases forcing metal-to-metal contact where you'd most certainly rather have a film of oil.

Step 10. Use Plastigage to measure bearing clearances.

After thoroughly cleaning the bores (Step 1 of my checklist), I installed inserts in the block and caps, installed the crankshaft and torqued the nuts to 85 foot-pounds with Plastigage in place. My oil gap ranged from .0025 to .0035 inches, well beyond the factory target of .001 to .002 inch.

Getting busy with my micrometer, I discovered that of the four crankshaft main-bearing journals, my machine shop had turned only one—the No. 1 journal—to the proper diameter of 2.240 inch. The other three ranged from a half-thousandth under to a full .001 inch under, or 2.239 inch. This shop error did not entirely account for the excessive bearing-to-journal clearance, however.

Evidently, either my bearing inserts were also at fault, the bare bores worn oversize or both. Because the oil gap is built into the bearing inserts, I checked them first. Modifying my flat-end micrometer to measure a curved surface, I determined that each insert was .0825-inch thick, the precise figure given in an old manual owned by the shop that machined my crankshaft.



Unassembled valve components (top) include a spring, retainer and pair of keepers. Below the group, the same parts as assembled on a valve.

Next, I retorqued the main-bearing caps with the inserts in place and measured the bore with a telescoping gauge. They should have measured 2.241 or slightly larger but instead were from 2.242 to 2.243—way too large!

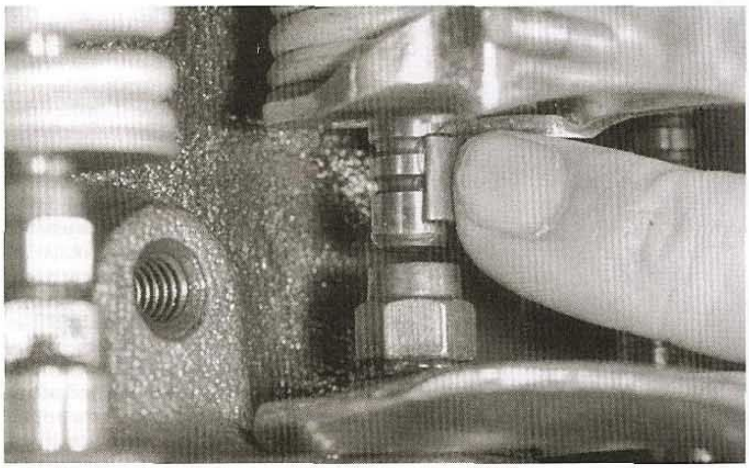
When I set aside the inserts and retorqued the bearing caps, my measurements determined that the bare bores were generally .001 too large, not surprising after years of use. Thus the cause of my excessive main-bearing clearance was twofold: a combination of a too-large bore and a too-small journal diameter.

I toyed with three potential solutions in the form of questions: 1. Do I regrind the main journals, now .010-inch undersize, to a bit less than the next undersize, .020 inch, and fit them with new bearings to correspond? 2. Do I grind the caps to custom-fit the bearings I now have? 3. Or, do I shim the bearings with brass shim stock?

Mechanical wizard Virgil Meints, who patiently accepts my frequent calls for assistance, pointed out the dangers of regrinding the crankshaft main journals unnecessarily. Suppose I grind them to .020-inch undersize. What if I rebuild the engine many years from now and, due to wear, have to regrind the journals to .030 or .040 inch? Obviously, such grinding would weaken the crankshaft, something I'd like to avoid.

I disliked Option 2, grinding the caps to achieve a tighter fit, because of the very real possibility of overgrinding a cap, which would ruin it. So I selected Option 3, placing brass shim stock between the lower cap and its bearing insert.

Don Bley at the Car Quest machine shop said he wouldn't shim a 600-horsepower engine—meaning, I presume, that the brass shim stock might pound flat under that kind of stress. But Don shimmed the bearings in his 40-horsepower tractor and drove it for 15 years before it was necessary to overhaul it. He said the shims were still in place, doing their job. From Virgil, Don and Chuck Donahoo, all longtime mechanics, and from several older books, I learned



With the valve-spring compressor tool, raise the spring high enough to place split-collar keepers on the grooved lower end of the valve.

how shimming works: Let's say I want a .001-inch shim between the lower insert and the bearing cap. An extra .001 at the bottom of the cap will raise the crankshaft by that amount. But as the .001 shim wraps upward to the junction or "parting line" of the cap, it is adding .001 twice for a total shimming effect of .002 inch—too tight for my application. That's why, years ago, mechanics used tapered bearing shims. In this example, the shim would taper from .001 inch at the bottom of the cap to .0005 inch at the ends, or parting line, so that the shimming effect is a uniform .001 inch all around the lower bearing insert.

Virgil, Don and Chuck all informed me that tapered shim stock hasn't been available for years. Sure enough, I couldn't locate any. Therefore, I ordered uniform-thickness brass shim stock from the Airgas, formerly Rutland Tool, catalog (Airgas, 2225 Workman Mill Road, Whittier, CA 90601; 800/289-4787) in .001-, .0015- and .002-inch sizes. To effect a "taper" with this uniform-thickness shim stock, I cut my shims with a sharp scissors to end a half-inch below the parting line. I also trimmed each shim about 1/8-inch narrower than the cap to prevent it from hanging out. A light smear of grease held the shims exactly where I placed them inside the bearing cap until I snapped the inserts into place.

Because I cut them from all three sizes of shim stock (.001, .0015 and .002 inch), I numbered each shim with a permanent marker to insure I installed it where it belonged. After shimming, the oil clearance equaled .0015 inch at all four crankshaft bearings.

I will use 10W-30 oil (rather than my preferred 10W-40) for at least the first several thousand miles; this lower-viscosity mix should have no trouble flowing into the relatively small gap.

Step 12. Test for crankshaft endplay.

To test for endplay, I torqued the first three main bearing caps to 85 foot-pounds. After installing the No. 4 cap loosely, I pried the crankshaft toward the rear of the engine to seat the thrust bearing (the forward flange on the No. 4 main bearing). Prying the crankshaft forward, I torqued the No. 4 cap and then used a feeler gauge to test for endplay, which is the gap between the crankshaft and the thrust bearing. It should measure .003 to .007 inch, as mine did.

Step 14. Align and install the crankshaft and camshaft sprockets and the timing chain.

To align the sprockets—necessary to ensure proper valve timing—I temporarily installed the crankshaft starting-jaw nut so I could turn the shaft (clockwise, while facing the front of the engine) with a breaker bar and large socket. After installing the camshaft sprocket, which bolts up in one position only, I turned both shafts so the dimples in their sprockets aligned.

The timing chain won't fit with the cam sprocket bolted in place. Therefore, remove the cam sprocket, lower it just enough to slip the chain over it, and then bolt it back in place.

Step 18. Measure to confirm a piston skirt-to-wall clearance of .0005 to .001 inch.

Insert each piston upside-down in its cylinder and insert a feeler gauge at a point 90 degrees from the axis of the piston pin as shown in the photo on the next page. Factory specs call for a 6- to 9-pound pull on a .002-inch feeler gauge. Though I lack a spring scale, all of my pistons fit tightly enough in their cylinders to require a good tug on a .002-inch feeler gauge.

Step 19. Using a piston, press rings midway down each cylinder.

Ring end gaps should measure .007 inch to .015 inch. Any larger and they'll allow combustion gasses to escape; any smaller and the rings, when hot and fully expanded, may break—or, at the very least, fail to seal properly.

Step 21. Install rings.

To avoid breaking the cast-iron rings, I used the special ring-expander tool pictured at the bottom of the next page.

Step 25. Using a ring compressor, install piston-and-rod assemblies.

Install a short piece of rubber hose over each rod bolt to avoid dinging the crankshaft journals. Apply assembly lube generously to the pistons, the cylinders and the compressor tool. With the tool clamped loosely over its rings, insert each piston skirt into its cylinder and then rap on the piston head with the rubber handle of a dead-blow hammer.

The piston should drop smartly into the cylinder; the clamping force of the new rings will keep the piston from sliding through.

Push the piston down in its cylinder until the rod contacts the crankpin. Install the con-rod cap and lockwashers and snug the nuts down by hand for now. Torque them to specs once you've installed the last piston. My application required that the oil hole drilled through the lower end of each rod pointed toward the camshaft side of the engine.

Step 28. Check rod endplay.

The acceptable range is .006 to .010 inch. Just as when I measured crankshaft endplay, I used a feeler gauge—this time

Work Hours

❑ Painting	169
❑ Assembly	137.25
❑ Disassembling	90.50
❑ Cleaning	52.75
❑ Machining	48.50
❑ Finding parts	46.25
❑ Prepping shop	24.75
❑ Planning	12
Total	**581 Hours**

Costs

❑ Parts	$698.88
❑ Machine shop work	$677.36
❑ Painting supplies	$514.31
❑ Plating	$235.70
❑ Hardware	$166.83
❑ Shop supplies	$124.17
Total	**$2417.25**

inserted between each rod and its adjacent crankshaft counterweight.

Step. 30. Install cylinder head and gasket and torque bolts to 65-70 foot-pounds.

To better resist sheering forces—that is, the explosions in the cylinders—head bolts must be grade 8 steel. For appearance, I had mine plated with cadmium, which nearly matches the silver of my cylinder head and won't chip from the bolt heads as paint would. Because many of the head bolts screw into the engine's water jacket, I used Permatex Super "300" Form-A-Gasket thread sealer to prevent water from leaking past the bolts and into the cylinders.

Step 32. Install oil pan and dipstick.

The oil pan "gasket" is in four pieces, including two heavy, rectangular chunks that fit in channels at the front and back of the pan. Don't trim these! Rather, position the side strips over their ends.

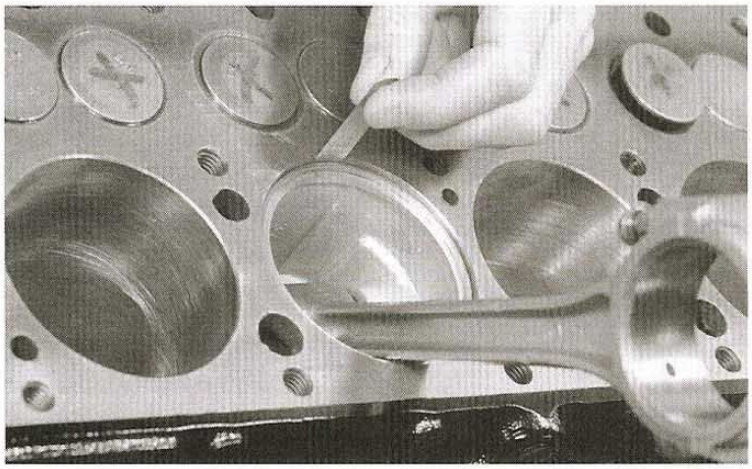
Tightening the oil pan compresses the end gaskets to produce an oil-tight seal. Incidentally, because oil pan bolts are lightly torqued—just 12 to 17 foot-pounds—they tend to vibrate loose over time. Prevent this by smearing clear silicone on the bolt threads before torquing.

Step 37: Prime and install oil pump.

A primed pump will begin circulating oil almost immediately the first time you start your engine.

Step 38. Install distributor, timing it properly, and wiring.

You must install the distributor with the No. 1 piston at TDC (Top Dead Center) of its compression stroke. How to be sure? Simply remove the forward



Feeler gauges in standard assortments are too stubby to measure piston-to-wall clearance with ease. I bought a set of 12-inch-long individual gauges, which worked wonderfully.

valve cover and watch the valves. As you turn the crankshaft clockwise, the No. 1 exhaust valve should open and close, completing one four-cycle circuit.

Next, the intake valve will open (to admit a fresh air-fuel charge) and then close (allowing the piston to compress the charge). Continue turning the crankshaft a short distance to align the "TDC" mark with the pointer.

Now drop in the distributor so that the rotor points toward the 8 o'clock position. Run a high-tension (spark plug) wire from the corresponding post on the distributor cap to the No. 1 cylinder and then route the remaining wires in a clockwise manner to replicate the Mopar engine's cylinder firing order, which is 1-5-3-6-2-4.

Step 42. Move engine to a test stand to run it before installing it in your car.

On casters, the portable engine test stand that I built contains a battery box, gauges (oil, temperature and vacuum), throttle and choke cables, a coil, ignition on-off switch and brackets to mount the radiator. In short, it provides everything necessary to test-fire an engine.

Preparations included installing the radiator, cutting and fitting new radiator hoses and filling the system with a 50:50 ratio of distilled water and antifreeze. I used a black permanent marker to blot out the colorful printing on the exterior surface of my new fan belt; I positioned the radiator hoses to hide similar garish markings.

Leave the fan off your water pump for now. It is too dangerous to work around and a large box fan positioned in front of the radiator will provide plenty of air flow. The radiator, resplendent under a coat of fresh water-based black paint, was looking good after its visit to Bob's Radiator Repair in Omaha, Nebraska. I started calling Omaha shops at random when I couldn't locate a hot tank locally. A man at the first Omaha shop I called was rude and unhelpful. Quite the opposite, Bruce Larsen of Bob's Radiator took time to answer my various questions about radiator repairs. Consequently, he earned both my trust and my business.

Before leaving my radiator at Bob's, I straightened a few bent fins using a pair of duckbilled pliers designed for that purpose. (Order it from Eastwood, 263 Shoemaker Rd., Pottstown, PA 19464, www.eastwoodcompany.com or 800/345-1178).

Bruce prescribed a thorough cleaning in a hot tank followed by an ultrasonic-cleaning tank—$75 for both—with the understanding that the cleaning might reveal a hopelessly damaged core. Recoring the radiator would cost upwards of $250. As it turned out, my radiator needed only the cleaning and some resoldering where engine vibration (transmitted through the upper radiator hose) caused cracking in the solder around the inlet fitting and the engine-side edge of the radiator top tank.

When all was in readiness, I hooked the battery's hot (negative) cable to the starter and the ground (positive) cable to a bell housing stud. I then operated the starter kick-lever by hand. Though it groaned and seemed to turn slightly, the starter didn't have enough power to spin the flywheel. A few wisps of grayish smoke curled out of the starter; just a few moments of operation had left the "hot" battery cable just that—literally hot to the touch. I replaced the spring-loaded switch atop the starter, tried a different battery and even bolted up a greasy but complete spare starter: no improvement.

At a dead end, I disconnected the battery and slunk home a bitter man.

As I revived somewhat while soaking in a hot shower, I studied the problem. Really, I had trouble believing that two starters and two new switches were bad. I'd purchased my old-style cables, which have lacquered fabric insulation, new at a swap meet years earlier.

To be honest, I can't tell you if they're 6-volt or 12-volt cables. If these are the smaller-diameter 12-volt cables, I reasoned, they'd surely still carry enough current to operate a starter.

Use a ring-expander tool to avoid breaking the rings while installing them on the pistons.

Assembling the Flathead 6

Note: After each work session, cover the block with plastic and a sheet, wrapping it tightly!!

1. Using lint-free towels, clean cylinders and cam and crank bearing saddles and crank bearing caps until they wipe clean. Use thinner and a knife to remove any paint overspray from saddles.
2. Install camshaft bearings, aligning oil holes.
3. Lube valve guides and tappet holes.
4. Assemble valves and springs first (with the engine upright on its stand). Now turn the engine upside-down to install the tappets and camshaft. Measure for a camshaft endplay of .002" to .006".
5. Install valve covers and gaskets.
6. Install upper crank-bearing inserts, aligning oil holes, and cap inserts.
7. Install upper and lower oil seals and gaskets.
8. Clean crankshaft and its drilled oil passages.
9. Install flywheel bolts through the crankshaft's rear flange; lower the crankshaft gently into the block.
10. Use Plastigage to measure bearing clearances.
11. Install bearing inserts in caps, lubricating generously, and torque caps 1-3 to 80-85 ft.-lb.
12. Test for crankshaft endplay of .003" to .007".
13. Install chain-case cover plate.
14. Align and install the crankshaft and camshaft sprockets and the timing chain.
15. Install chain-case cover and gasket, front pulley and starting jaw.
16. Install new front rubber engine mount and engine front-support plate.
17. Press pins through rods and pistons; install pin locks; lube well.
18. Measure to confirm a piston skirt-to-wall clearance of .0005" to .001".
19. Use a piston to press rings midway down each cylinder. Measure for a correct ring end gap of .007" to .015.
20. Check ring-to-piston fit by inserting the outside edge of each ring in the proper piston groove. Check for binding as you roll each ring around the entire piston circumference.
21. Install rings.
22. Measure ring side clearance (the ring's free play in its groove), which should be .002-.004" for compression rings, .001-.0025 for oil-control rings.
23. Space ring gaps evenly around the piston.
24. Prepare for installing pistons by placing rubber tubing over rod bolts and smearing assembly lube on cylinder wall.
25. Using a ring compressor, install piston-and-rod assemblies.
26. Using Plastigage, torque connecting-rod bearing caps to 45-50 ft.-lb. Confirm that your oil clearance is .001" to .002".
27. Lubricate bearings and retorque caps to 45–50 ft.-lb.
28. Check rod ends play. The acceptable range is .006" to .010".
29. Adjust valve lash cold: .007" intake, .012" exhaust.
30. Install cylinder head and gasket and torque bolts to 65-70 ft.-lbs. (or nuts to 55-60 ft.-lb.). Install and torque spark plugs to 30 ft.-lb.
31. Install oil strainer and oil lines.
32. Install oil pan and dipstick.
33. Install oil filter and lines.
34. Install crankcase breather pipe and filter.
35. Install oil-filler pipe and filter.
36. Install manifolds and heat-riser mechanism; seal the carburetor opening.
37. Prime and install oil pump.
38. Install distributor (timing it properly), distributor wiring, combination wire sorter-throttle control, distributor vacuum line to carburetor.
39. Install water pump without fan.
40. Install fuel pump, generator, metal fuel line from fuel pump to carburetor.
41. Use a hoist to remove the block from its engine stand. While the engine is dangling from the hoist, install the flywheel and bell housing. Torque the bell housing bolts to specs but merely snug up the flywheel nuts for now.
42. Move engine to a test stand to run it before installing it in your car. On the test stand:
    a) With the engine safely on a test stand, torque the four flywheel nuts evenly, as you would lug nuts. Torque the clutch bolts evenly as you align the friction disk with either a special tool or an old transmission pinion shaft. Also install the carburetor, air cleaner, throw-out bearing and starter.
    b) Connect the oil-pressure line, battery cables, coil wiring, gas line, radiator.
    c) Fill the radiator and make sure that you lubricate everything that needs it—water pump, generator, starter, distributor, and so forth. Have you filled the crankcase? Fill the oil reservoirs inside the valve chambers so the tappets have immediate lubrication.
    Note: Before starting the engine, turn it by hand with a socket wrench on the crankshaft pulley. If serious problems exist—valves striking the underside of the cylinder head, for example—now is the best time to discover it.
    d) After warming up the engine, retorque head bolts (cast-iron head only, not the optional aluminum head), readjust the valve lash.

Then it dawned on me. I'd scraped paint from all mating surfaces inside the starter and between the starter and the bell housing, all in the interest of achieving a good electrical contact. But I'd neglected to scrape to bare metal before bolting my bell housing to the engine block. Chances are, I'd unwittingly created a high-resistance circuit between the battery's hot and ground cables.

Next morning, I attached the battery ground cable directly to one of the starter's mounting bolts. This time when I tried it, the starter kicked over with more vigor than previously and yet still too sluggishly to crank the engine. More wisps of smoke appeared. Again, after just a few seconds of cranking, the "hot" battery cable became nearly too hot to touch. The slow cranking, the smoke, the overheated cable—they all pointed toward high resistance in the circuit, causing me to suspect my battery cables.

The next obvious step is to buy and try a pair of cables capable of carrying the high amperage that a 6-volt starter requires. This, I feel confident, will solve my starter problems and allow me to test-fire my engine prior to installing it in my 1939 Plymouth coupe.

So at last we come to the end of the road—or should I say the beginning? Whew!

Furthermore, was my investment of time and money worth the results?

First, let me get specific in both areas. As the lists on page 21 indicate, I invested 581 hours and $2417 on the engine rebuild. Both are considerable sums, I admit. From an economist's standpoint, I might have been better off farming out the rebuild. And yet I can't put a price on the experiences I've had or the satisfaction they've given me. I enjoyed the work, mostly, and I certainly learned many new skills along the way.

I know that my next engine rebuild will go well—smoother and faster than this one. (I've begun collecting a great many standard parts—from starter brushes to tappets—to avoid having to round them up again when I rebuild my next Mopar flathead 6.)

Despite (or because of) my setbacks and frustrations on the just-completed project, I glow with pride every time I see my restored engine, knowing the obstacles I overcame to lovingly revive a piece of history.

Worth it? You bet! ■