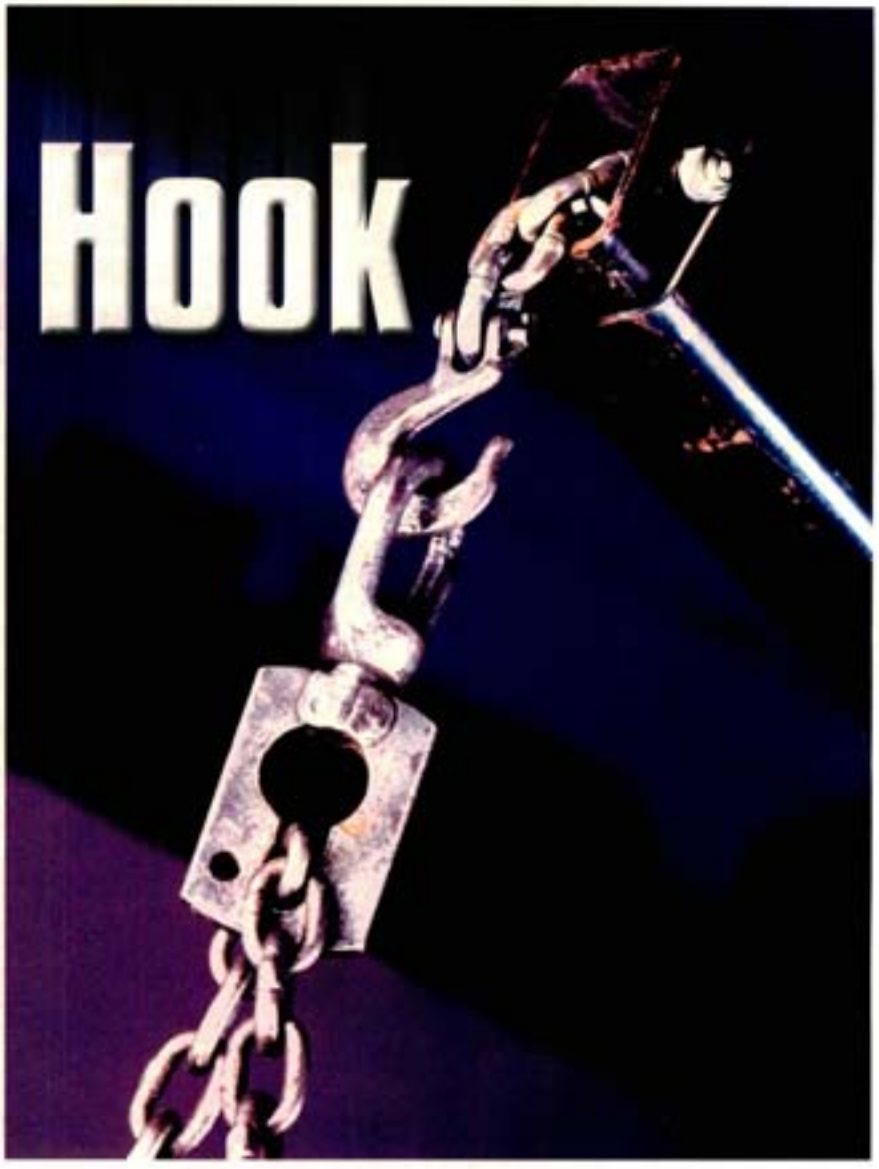
Off the Hook

Engine Transplants for Fun and Profit

[Okay, so I'm fibbing about the 'fun' part....]



A couple of weeks ago, our regular 'organ-donor' delivery service made a visit to our shop and dropped off a 3.2-liter Acura Legend V6 engine. The engine sat in the corner for a day or two, lurking ominously for someone. Since I couldn't remember catching any grenades recently, I felt pretty sure I was off the hook.

A few days later, I was chatting about the upcoming week's work with my team leader, and joked optimistically — something along the lines of "I'm just glad I'm not doing an engine this week...."

Well, of course, her reply was, "Oh? Sorry, that engine's for you. Remember that Legend coupe you looked at in December? The customer finally gave us the green light. I've got it booked for you next Monday and Tuesday."

Ah, perfect!

Engine swaps aren't my favorite cup of tea, because of the unpredictable complications that regularly arise. While the customer always expects perfection, the donor engine is rarely a known quantity, and the *what-if?*'s seem to crawl out of the woodwork during these jobs. I consider myself a pretty average guy, so I also figure you might harbor some of the same sentiments. So I donned my 'scrubs' and grabbed my camera and scalpel – I mean my tools – and had at it. Here's how I approach engine transplants.

The story started last summer. A dead '93 Legend Coupe was towed to our shop. We'd endured several days of duck-drowner rain, and for some still unexplained reason, a good amount of it ended up inside the engine of said Coupe. I pulled the plugs, dried the engine out, changed the fluids, blew out the ECU and connectors and asked the customer how much further he wanted us to go with our inspection. If we could just get it running, he said, that was all that mattered to him. All that mattered *then*.

It ran and made no unusual noises. You know, noises like the clang of a bent connecting rod cleaning off the bottom of a cylinder bore or like the pop-back of combustion through a cracked intake valve. Nothing like those sounds. The engine actually ran pretty smoothly, so this attempt at motorcide had failed, and the car left our shop running very well, thank you.

Along came December, and the same Legend came back on a bigger hook. This time there was oil all over the bottom of the engine. There were matching holes on the left and right sides of the oil pan where the #3 and #6 connecting rods had set off to seek their fortunes. There was no oil in the pan, and the scored, blued oil pump was full of air.

You can expect a good Honda engine to burn one quart of oil about every 1000 miles. This is not ideal, but it is an acceptable level of oil consumption, and something the motorist can easily monitor. That's why those crafty fellows back at the factory stuck a dipstick in the engine. The point is, no engine can run forever without using any oil. It just so happened the lube-reminder sticker we put in the upper left corner of the window read 4000 miles short of what was on the odometer — 4000 miles past the interval we had recommended for the next oil change. That amounted to 7000 miles since it left our shop after we dried it out, 7000 miles during which I'd guess nobody opened the hood. Theoretically, the engine oil level should have been two quarts below the bottom of the pan. So this time the engine was done for.

It seems the harder I examine one thing, the more likely I am to overlook something else. Take a good look over the donor engine. Was it previously coupled to a manual or to an auto trans? Does the donor have a wire harness on it? Do all the connectors match pin for pin? Are there any signs of leakage, broken, bent or missing parts? Is anything out of the ordinary? Do the numbers match on the engine block and on the purchase receipt?

More inspection reveals visually good O2 sensors. The rest of the wire harness seems to match what's on the car. The crank pulley doesn't have a big chunk out of it or a belt-pinching dent. Other than the hole in the driver's side valve cover noted in the previous photo, this seems to be a suitable replacement.

Transplant Inspection

Step one is a very careful walkaround of the donor engine. Just like a human transplant-donor counterpart, the heart of this vehicle continued to live after the rest of its original vehicle died suddenly, perhaps violently. But often a donor engine sustains some of that violence, so you need to look it over very carefully – however much fun and profit you get from an engine transplant, doing the same job over again free is neither fun nor profitable.

The first and most obvious problem with this donor engine was the hole bashed in the left valve cover (**Photo 1**). A closer look at the wiring harness on the engine showed part of it crushed, so I had to open the harness and inspect for cut wires, crushed connectors, etc. Two male terminals without a connector to tie them together needed repair. If the rest of the harness is okay, just stealing the matching connector off the departed engine will be all you need to restore an OE connection.

Look at every inch of the wire harness if one comes with the used donor engine. **Photo 2** shows the four connectors at the right rear of the engine. Make sure all connectors on the donor engine and in the engine compartment match, pin-for-pin, before you start the transplant. Make sure there are the same number and type of connectors on both harnesses: the old and the replacement. You don't want to swap or modify a wire harness once you have committed the donor to the engine compartment. Check it now to save yourself a headache later. Most engine transplant jobs are close economic calls for the car owner, so identify every problem you can up front. You can bill more easily for extra work if you spot it early, before you finalize the estimate. Your customer will start with a much more realistic picture of the expenses he's about to incur.

Swapping valve covers allowed this view inside the donor engine. I'm happy seeing a lack of old oil sludge, because it looks like the oil was changed regularly. That still doesn't mean there isn't something seriously wrong. But at this point, the odds still appear in my favor.

Photo 3 shows some news that's good and some that's not. The good news is the donor engine looks like it was well maintained. The general color of the aluminum and lack of sludge inside the engine makes me optimistic. That little chunk of aluminum, though, headed down the forward oil drain back hole, got my attention. It's probably from the cracked valve cover, but there's more unaccounted for – perhaps still on the flatbed truck or with the donor vehicle carcass. Just so it's not inside the engine! Get all of it out, and make sure nothing else foreign is headed to the sump pickup.

The next step, a little messy but very important, is removing the drain bolt and putting a new crush washer on it to make sure it will hold 33 lb-ft. tightening torque without stripping the threads. Repairing a stripped pan bolt is much easier with the engine out of the car than in it. Fortunately, all I have to do on this one is talk about it.

Finishing the walkaround:

- There are no signs of leakage from the injectors.
- The wire harness checks okay — no cuts, just tangled tape. One connector to swap from old to new.
- No more holes other than the one in the valve cover, which I'll swap with one from the old engine.
- The EGR valve, manifold valves, vacuum lines, fittings, hoses check okay – all those parts often bent or broken when the donor engine rolls around on the ground or on the flatbed.
- The crank pulley has no missing chunks, gouges or dents.
- The motor mounts are okay, and there are no broken accessory brackets.
- The flex plate will come off the old engine. Be careful here – sometimes there are different crankshafts for the same engine, depending on whether it takes an automatic or manual transmission.
- The fuel line and filter from the old engine, the vacuum booster line and water hoses will all come from the old engine.

It looks like a *go* to me.

Precautions

The 'organ' shop didn't record the mileage on the donor engine, so I checked for any indications it might need a water pump. There's a bit of green crust just above where the dipstick goes into the block. This is right in the path of the water pump weep hole, potentially condemning the pump. You can't tell how many miles are on a timing belt by looking at it, and even less can you venture how many miles more it has. I get asked that all the time... it drives me nuts. So I usually suggest doing a water pump and timing belt on any donor piece. What's more, it's worlds easier to do those jobs with the engine on a stand or sling rather than sandwiched tightly into the car.

Position the crankshaft at #1 TDC before starting on your water pump replacement. The single white mark on the crank pulley lines up with the pointer on the lower cover. The marks on the cam gears line up with their corresponding marks on the rear cam gear covers. Take the three bolts out of the left-side cam sprocket before you remove the old timing belt. **(Photo 4)**.

Always take the bolts out of the cam sprocket before removing the timing belt when replacing the water pump. You need the belt on to keep the pulley from turning, even when using an impact wrench to remove the bolts. The black slime from the sensors is normal, so don't sweat it, but the green crust below the lower left water pump bolt isn't. There's not much sense sending an engine out the door unless it's capable of going another 90,000 miles. Convince the owner to replace the water pump and timing belt.

All we need is a little more space, right? Removing the bolts from the hood struts and repositioning them will give you a lot more room for that cherry-picker arm.

The extension shaft that couples the trans output to the diff must slide to the rear. There is an 8 mm hole threaded into the extension shaft just for this purpose. Remove the cover (it looks like an axle nut cover) by popping it off with a screwdriver. Then use your 1/2-inch breaker bar to unscrew this plug. With the plug out, you can see the extension shaft and its threaded hole. You really don't need the OE special tool, but your Acura dealer can get it for you if you run into a stubborn one.

You'll need to remove the rear cover to replace the water pump. Pay no attention to that black slime oozing down from the cam sensors. 'They all do that.'

Once you have the new timing belt and water pump on, but before you go through the factory hoopla for setting the timing belt tension, use a wide pry bar, or a big screwdriver to pry between the timing belt tensioner pulley and the bolt boss, just to the passenger side of the tensioner. Loosen the set bolt about 3/4 of a turn, then pry the tensioner pulley to the driver's side of the engine to tension the belt.

Slowly release your pry bar until only the tensioner spring is actually applying force to the belt, then tighten the tensioner pulley bolt to 31 lb-ft. Tighten the cam sprocket bolts to 23 lb-ft. Recheck the belt by tugging on the belt along several straight runs between pulleys. Everything should still be at TDC. Then with the covers back on (don't forget the crank sprocket washer/guide) tighten the crank sprocket to 176 lb-ft.

Removal

Now that the donor engine is clearly going into that engine bay, lets get that defunct carcass out:

- Remove the bolts holding the hood struts to the hood, then open the hood a little farther and reattach the hood struts using the upper strut holes to locate the lower mount holes in the hood. (**Photo 5**) This is a one-man operation that will give you just a little more clearance for your cherry picker. Leaving the hood attached to the vehicle also keeps it out of harm's way during the engine swap.
- Drain the differential, engine oil pan and radiator. Remove the oil filter so the oil in it can't leak out the holes the connecting rods made.
- **Photo 6** details removal of the extension shaft. The extension shaft links the transmission final drive to the differential pinion gear. Since the diff stays on the engine until the whole combination is out of the car, we need to slide the extension shaft out of mesh with the pinion gear. Acura makes a special tool for this, but an 8 mm bolt with a nut threaded onto it and a large enough washer to span the output collar can pull the extension shaft out of the coupler (towards the rear of the car). Install the nut several threads onto the bolt, then the large washer, then thread this into the 8 mm hole in the center of the extension shaft. Now tighten the nut down against the washer to pull the extension shaft out of the pinion.
- Remove the battery and the battery tray. Loosen the fusebox and move it forward. Remove the engine wiring harness brackets from the driver's side of the engine bay. Disconnect the heavy two-wire connector below the fusebox, along with all other connectors you see.
- Remove and plug the fuel pressure regulator return hose, the brake booster hose and the single bolt holding the trans dipstick tube to the rear lifting bracket.
- Remove the engine compartment stiffener which runs between the strut towers, as well as the firewall brackets and the black emissions box at the right rear. Keep the hoses on the box, but remove them from the pipes. The hoses stay pretty much in connection order, so there's not much worry about mixing them up. Label them if you'd feel more comfortable.

Remove the long ATF cooler hose from the radiator at the steel line, not at the radiator. Remove the short hose at the radiator. Take the long hose, loop it back to the radiator where the short hose came from, and loop the short hose back to the line on the frame. This keeps ATF drips to a minimum, and the job stays a little neater. We're changing an engine here, not a PCV valve. Anything to keep the floor mess to a minimum...

- Remove the two bolts holding the fuel filter bracket to the firewall and the nut on the right rear fuel rail, so the fuel filter, bracket and supply pipe can come out as an assembly. You'll need two new crush washers to re-attach the fuel rail later (20 lb-ft).
- Take everything above the rear and sides of the engine out of the way. Just about everything comes right off with your 1/4-inch air ratchet, so there's no reason to fight it when you can easily unbolt it.
- Remove the radiator, fans and upper and lower hoses in one piece.
- **Photo 7** shows where the transmission oil cooler lines run from the pipes to the radiator. Disconnect the long cooler hose at the pipe and the short one at the radiator, then loop the short hose back to the pipe the long hose came from and then loop the long hose back to the radiator fitting you just opened. This keeps transmission oil much more contained. If you were to send a radiator out for repair, doing this and also looping the lower radiator hose from the lower engine fitting to the upper engine fitting, along with tying wires out of harm's way, could allow you to drive rather than push the vehicle out of the shop while you wait for the radiator to be repaired, albeit only a very short distance sans coolant.
- There are six bellhousing bolts, not counting those on the engine stiffener, those below the starter, and the differential lower bolt just above the steering rack. Remove the top two bellhousing bolts and the one by the heater hoses from the top. Get all the rest from the bottom.
- Take the axles out before you remove the stiffener to give yourself more workspace, and remove the entire lower steering rack cover and the right side rack bolts, letting the rack hang. Do this to get the lower differential bolt out.
- Don't forget to keep the 26 mm shim between the diff housing and the bellhousing when you remove that bolt.
- There are three 6 mm bolts holding the inspection covers over the flex plate, then six 8 mm bolts holding the flex plate to the flywheel. I use my 3/8-drive 12 mm impact swivel only for the flex plate bolts. The bolt shoulders are very short and can be easily rounded. Later those bolts will be retorqued to 20 lb-ft.
- Remove the two 10 mm nuts for the forward transmission mounts.
- The exhaust Y pipe looks easy, but the bolt on the upper left is a bit of a challenge to get out. Take off the four 6 mm nuts holding the heat shield in place, and then remove the heat shield. Attach your 3/8 drive 14 mm impact swivel and another impact universal to your long extension. If the nut doesn't come right off, heat it up. I know using two universals together sounds nutty, but it sure keeps the language pure and innocent.

Complications (Didn't I warn you?)

Neither axle nut would come off with my 1/2-inch impact, so I escalated to my 3/4-inch gun. Well, that didn't blow them off, either, so I swiped my neighbor's 1/2-inch air hose (the 3/8-inch hose at my workstation is usually more than adequate). With more air volume, the big gun nuked the right axle nut off without a struggle, but the left side still would not budge.

Don't mess around here. Extended hammering with an airwrench can brinnell the wheel bearings. The only thing to do is cut the axle nut off. Use a 90 degree cut-off tool to cut a groove in the nut perpendicular to the hub as close to the threads of the axle as you can. (**Photo 8,** *page 16*).

The tips of a few of the axle threads were cut, but not enough to weaken the assembly. Cut through the nut until you just start to touch the hub flange. Once the nut is weakened by the cut, use a pointed airhammer bit against the groove in the nut to walk the nut off. Drive against the larger circumference of the nut, not the smaller, inner surface.

Remember I said this engine inhaled a thunderstorm last year? Some nearby water submerged the engine block at least up to and over the starter motor. Three or four dissimilar metals, road salt, lots of water and furry corrosion changed the snug fit between the starter and the back of the block casting into an interference fit. Even with the bolts out, that starter was going nowhere.

I knew there'd be a big surprise – there always is – but I didn't know what it would be. This was it: That driver's side axle nut would not come off! After escalating through my whole pneumatic tool arsenal without effect, I decided to cut the nut off. It actually went pretty fast. I used my angle cut-off tool with a carbide wheel, cutting as close to the axle as I could. Once I cut all the way to the hub, I used my impact hammer to walk the nut off. This worked much better than I envisioned. (If you're just starting out as a tech, and you can't picture these things working out for you, find another line of work. Really!)

Getting the starter off the old engine was not what I expected either. That sucker was locked in there with Nature's Own threadlocker. I gently tapped on the starter on the 'silver' end, toward the block, then used a big prybar to rock it back, meanwhile spraying penetrating oil around the rusted corrosion until the starter finally worked free. Don't just whale away at the drive end. Of course, if you smash the starter to pieces, a new unit will go into the donor engine very nicely I'm sure.

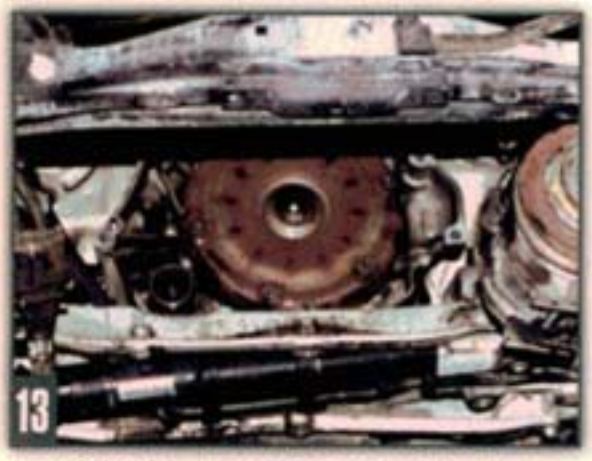
I tapped the starter upward from the bottom, right above the green connector (**Photo 9**), and then I put a prybar between the starter and the block to wedge it back and forth. I kept up the tap-and-pry, with penetrating oil applied as needed until the starter came free. Don't try to drive it forward by beating on the back of the starter.

Um..., I don't have any idea how that heater core pipe got itself crushed when the heater hose was removed (**Photo 10**). A few minutes with a punch, drift, socket or whatever you have work wonders to make it round again. Gently roll the punch in the pipe, working the brass back into shape. Don't just jam something in there and certainly don't hammer on it because the brass is delicate. If need be, use a pliers to squeeze the damaged pipe against the tool. When you reassemble something like this, install the hose clamp close to the flanged outer end of the pipe where it's the roundest.

This is embarrassing but at least it's real-world. Crushing heater hosepipes isn't the smartest thing to do, and cleaning them up takes a little finesse. Gently walk a drift around the opening or you can even use a pliers to squeeze the pipe against the drift. Don't whack the drift into the heater core. Notice the vacant holes on the firewall to the right and above the heater core. Take everything out of the way.

The pinion seal on this diff is a gooey mess. Changing it now takes just a little extra time. Be prepared to deal with unexpected, extra things like this along the way. When you quote estimates to your customer based on the 'been-thereidone-that' perspective, rather than from a 'best-guessirosy-scenario' approach, things can look very different. But the surprises will be minimal.

There is a seemingly harmless cut on this outboard CV boot, but it's by no means cosmetic. When a Legend boot does this, replace it. Not next summer, not next fall. Now.



I was thinking of how to put this V6 Legend and tranny into a rear engine setup on my 96 Civic... hmmm! The A/C compressor is wire tied to the chassis. The power steering pump and vehicle speed sensor sit similarly out of the way on the right. The nuts for the forward mounts on the trans are removed, but it rests nicely there without any extra support.

There was more than just engine oil under the front of the car. Diff fluid dribbled from the right end of the power steering rack, originating at the differential pinion seal (**Photo 11**). Changing diffs on these cars is a piece of cake, though. Take the three bolts off the flange on the driver's side of the oilpan, slide out the midshaft, then unbolt and remove the diff from the right side of the engine. Pop the old seal out; install the new one flush or just a tad into the recess, but no more than 1 mm below it. Replace the O-rings on the midshaft tube, and it should be leak-free.

Photo 12 shows a small cut on the right side outer CV boot. This is not a 'wait-and-see' cut — this boot should be replaced right now. You can save the customer some R&R money because you had to take the axles out already. I didn't spot this until I had the axle nuts free and lots of other things out of the way. Oh, well, you can't see everything at once.

Take a very critical look at the back of the donor engine before you install it. After all, in a way, you're buying it, too – with your work that you may have to repeat if you miss something. Make sure nothing's bent or broken, and the pipes are all there and straight. EGR valves are particularly susceptible to damage during the transportation and inventory process. Don't overlook oil seals that might have begun to leak.

Raise the front of the transmission as you lower the engine into position. The throttle body and cables hanging over the driver's fender from the old engine looked much better than the ones on donor engine. If you're doing belts, a water pump, or anything like that, get the throttle body out of the way. It's very easy to remove.

Somewhere after I got three bolts in the bell housing, I stopped what I was doing and cleaned the floor. I was so fed up sliding around in my own slime of gear oil, ATF and antifreeze that I could not continue. Take a last look around to make sure every nut, clamp, fastener and component is where it ought to be and tight. Make sure the fuel system is leak-free as well as the coolant and oil systems. This engine sounded pretty sweet after running at 2500 rpm for several seconds to quiet the lifters down. In spite of all my precautions, I wasn't completely surprised when I noticed the A/C compressor clutch bearing was howling away. Sometimes it's never over!

Mopping Up

The A/C system is still closed, and I hung the compressor from a wire on the left side of the lower engine bay brace (**Photo 13,** *page 17*). The power steering pump is still connected and supported similarly on the passenger side, along with the vehicle speed sensor. The differential extension shaft is visible at about 8 o'clock next to the torque converter. Give the outside of the shaft (the large part facing the photo) a good wipedown so you don't leave any dirt or grit to assault the new pinion seal. Count the number of dowel pins in the bell housing. There should be two — either in the bell housing or in the back of the donor engine, but not both. You need both pins to insure the crankshaft and transmission input shaft centerlines are concentric.

The rear of the donor engine appears ready to go (**Photo 14**). No leaks from the rear cam plugs; the piping is all there; nothing looks bent or broken; the heater hoses are all attached. You may wish to connect the driver's side rear heater hose after installing the engine. I think that may work better. It just came out easier this way.

Installation

Place a jack under the trans pan to raise the front of the transmission to meet the engine as it's being lowered into place (**Photo 15**). This is where my 246 lb. chassis comes in handy. This engine needed some particularly delicate persuasion before it finally found home. Sometimes your best guess on the angle of the chain when you attach it to the engine is all you have to go on. At worst, you have to determine why things aren't lining up if you're having problems, then pull the engine back out and readjust your chain. That can be tough, especially after several attempts. I was getting pretty tired at this point, and I still had eight ASE recertification tests to tackle later that evening.

Everything is bolted on in **Photo 16**. The diff, cooling system, engine, power steering, trans, coolant overflow and washer jug are filled with their correct fluids. Fuel lines are tight and coated with leak-seek trace powder. Don't start that mill until you're sure it's ready to drive to California. In other words, don't just crank it up for a minute to see whether it runs. Make sure the exhaust, air filter – everything – *is fully assembled and complete.* ■

— By Marlowe Peterson