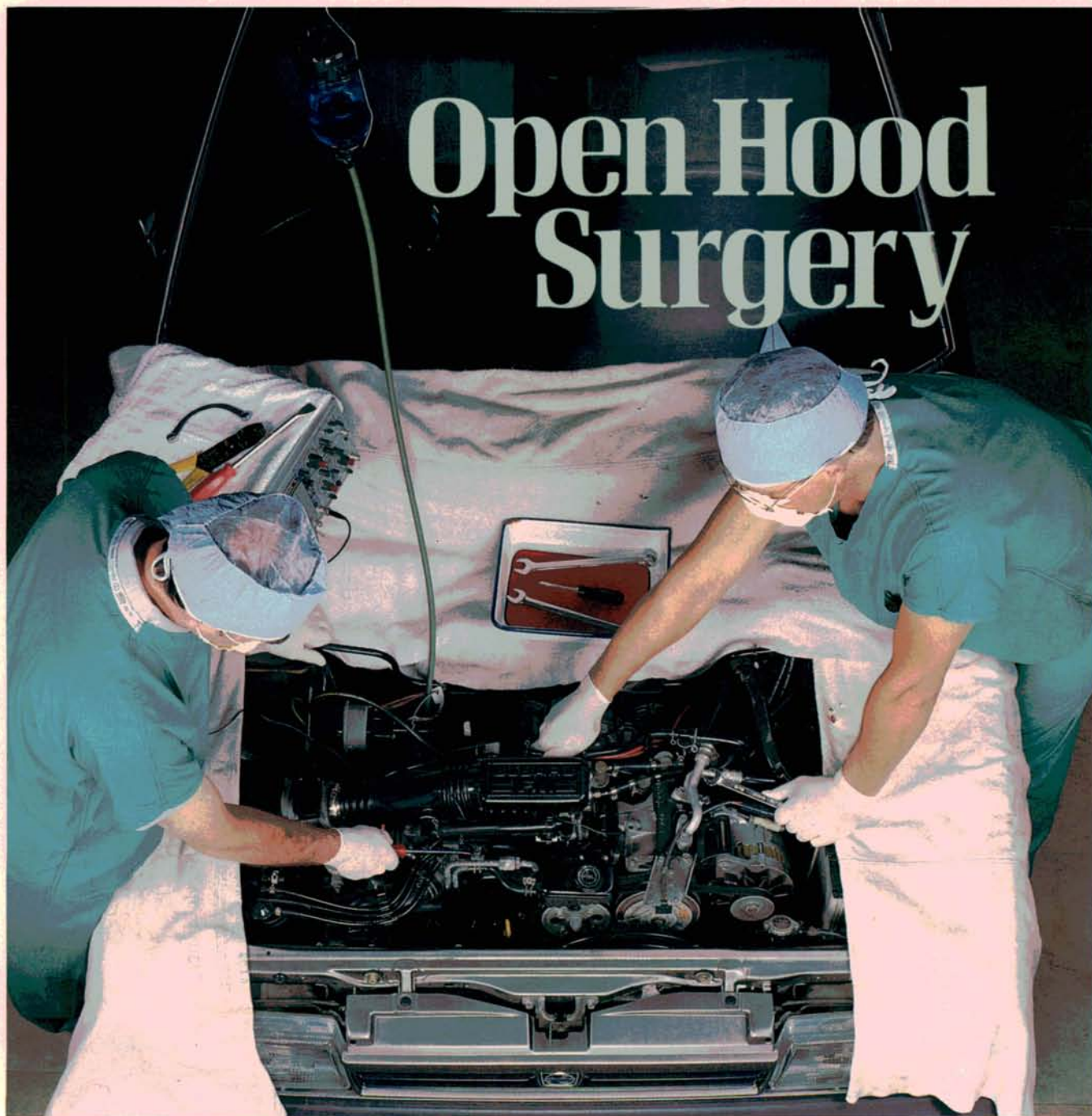


# Open Hood Surgery



In May and June of this year we featured a two part Toyota engine overhaul article. The articles began after the engine had already been removed, and ended before it had been reinstalled. We didn't discuss how the engine was removed or installed because we wanted to concentrate on proper engine repair techniques. We showed you the middle of the open hood surgery, while skipping the pre-op and post-op phases.

This time around we're going to look at what should happen before, during, and after an engine is removed for repair or replacement. While our earlier

articles concentrated on techniques for overhauling the car's original engine, the information in this article may also be applied to the installation of a new, used, or commercially rebuilt engine.

## **Learn the Patient's History**

Probably the most important thing to find out before you remove the engine is why it needs to be repaired or replaced. Identifying the cause of failure will affect many of the decisions that follow. It's dangerous to repair just the effect without first finding the cause.

If the engine has worn out after many miles of use, the cause of your problems won't be hard to figure out. But if the engine has a relatively low number of miles on it, you'll need to dig a little deeper to find out why it failed prematurely. This information is necessary to prevent a repeat failure. A little bit of common sense goes a long way in making your diagnosis.

During an engine swap, reusable components such as the fuel and ignition systems may be transferred from the old engine to its replacement. This may also mean transferring the cause of the original engine's problems to the replacement engine. Identifying the cause of the original engine's problems will prevent this from happening.

Don't forget the owner of the car, as he may be an important part of our cause and effect relationship. Question the owner to determine if proper maintenance procedures were followed during the engine's lifetime. What kind of service was the engine used for? Was it abused? Has any other engine work been performed previously?

In addition to helping identify the original cause of failure, time spent "re-educating" the owner about proper maintenance and driving techniques should prevent a repeat failure and ensure a long service life from the replacement engine.

## Sell A Job You Can Live With

Some shops advertise a single package price for any engine swap, a variation on the any car, any color routine. While this makes for simplified book-keeping, it's no guarantee of a professional job. Each car is going to need a different approach when it's time to repair or replace the engine. Some will need more parts or labor, some less.

You may want to develop your own list of minimum requirements for each engine job you tackle. Consider the engine as a part of a much larger system. What kind of shape is the rest of the car in? Will the engine work cause other problems? Is the car worth the money that needs to be spent to do the job right? Are there other more important things that need to be fixed first?

In some cases, you may be better off talking your customer out of the job if the rest of the car doesn't warrant the expense. If a job this expensive is worth doing, it's worth doing right.

Most of the responsibility for the outcome of this operation rests squarely on your shoulders. A lot of time and expense is invested in an engine overhaul or replacement. You've probably heard the expression "The operation was a success, but the patient died." Don't let a fifty cent hose clamp ruin your reputation. You can bet the customer isn't going to care how well the engine runs if it drips oil on his new concrete driveway.

Some used and remanufactured engine suppliers have their own list of requirements that must be satisfied in order to qualify for their engine warranty. These engines aren't as cheap as the "as is" variety, but the extra expense may be worthwhile if the owner intends to keep his car for many more miles. We'll look more closely at minimum requirements in our photo captions.

We're not going to tell you how to take an engine out and put it back in. There are lots of service manuals for that. But we will look at some of the finer points that separate a quickie swap job from a professional transplant.

— By Karl Seyfert

## Causes of Overheating

We mentioned establishing a cause and effect relationship to prevent repeat engine failures. Engine overheating is probably the largest single cause of engine failure. The effects of overheating an engine are all too easy to see. Unfortunately, finding the cause of engine overheating can be a little more difficult.

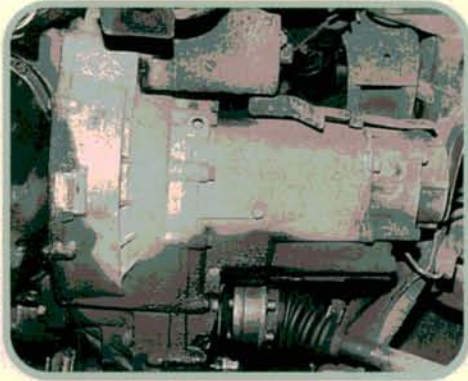
The following is a list of possible cause of engine overheating:

- Incorrect thermostat heat range
- Inaccurate, stuck, or missing thermostat
- Inaccurate or leaking radiator pressure cap
- Internally obstructed radiator
- Damaged or missing radiator cooling fins
- Leaking radiator, hoses, or bypass hoses
- Leaking head gasket
- Low, dirty, or diluted engine oil
- Lean fuel mixture
- Incorrect engine timing
- Incorrect coolant mix
- Incorrect spark plug heat range
- Improper operation of electric radiator and A/C condenser cooling fans
- Improper A/C system operation
- Blocked air conditioning condenser
- Damaged or overworked automatic transmission adding extra heat to cooling system through radiator mounted transmission cooler
- Low tire pressures
- Dragging brakes
- Exceeding vehicle weight or towing ratings

While our list includes common causes of overheating, there may be others. We've listed these causes to illustrate the importance of finding the original reason the engine failed.

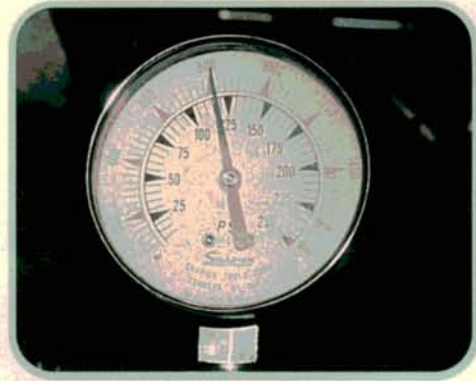
Neglecting to find and correct any of the problems listed above could easily result in damage or failure of a rebuilt or replacement engine. Remember, overheating is just one possible cause of engine failure. There are lots more.

# Open Hood Surgery



1

Sure the engine is sick, but how's the rest of the car? Start with a thorough vehicle inspection. Is the car a good candidate for an engine transplant? Can the transmission and other drivetrain components handle the extra power the new engine is going to put out? Identify any other needed work now.



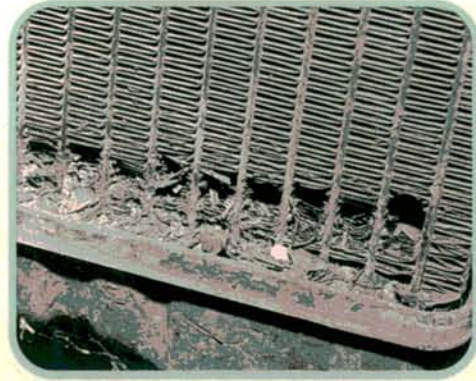
2

What's wrong with the original engine? Is it an oil burner? Do a dry and wet compression test and cylinder leak down test before you remove the engine. If the engine is tired due to high mileage, you can be reasonably sure that rebuilding or replacing the engine will correct the problem.



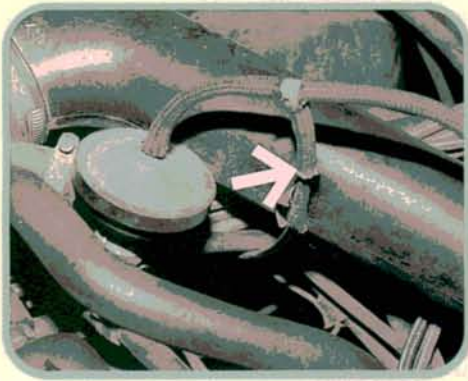
3

What if the vehicle mileage is much lower? Chances are the original engine's problems are due to something other than normal wear. If preignition has damaged the pistons, installing the original distributor may cause the new or rebuilt engine to fail in short order. Find the cause of the original problem.



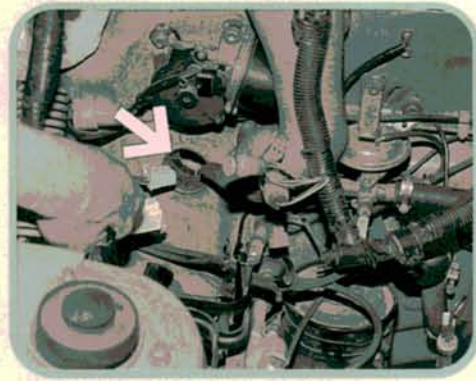
4

Did the engine overheat because the radiator looked like this? Your radiator may not look quite this bad, but could still be partially blocked. If necessary, include the cost of a radiator recore, replacement, or flush in your estimate. Don't wait until it damages the replacement engine or springs a leak later.



5

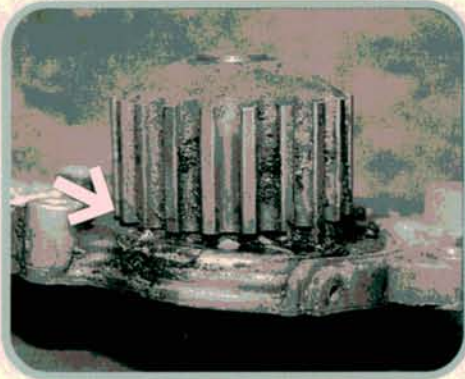
A little organization before the engine is removed can save a lot of guesswork later. Label the proper location of any vacuum hoses or electrical connections that you aren't sure about. Color coded tags and clips are available for this purpose. Replace any heat hardened or damaged vacuum hoses.



6

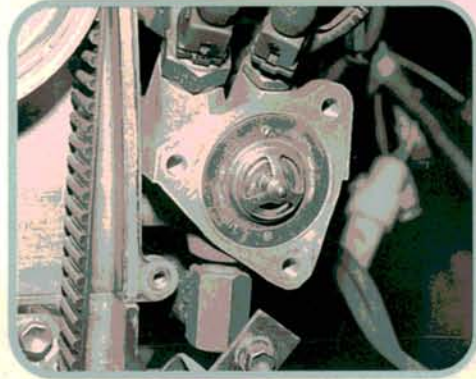
We learned a valuable lesson during our Toyota Cressida engine overhaul. Many of the engine's electrical harness connectors were very difficult to reach. We disconnected the entire engine harness inside the car, then fed it through the firewall. The connectors were easier to remove with the engine out.

# Open Hood Surgery



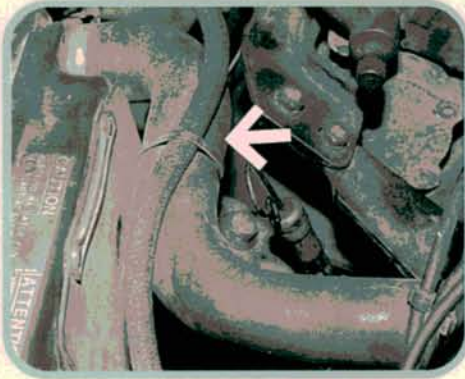
7

Installing a new water pump is cheap insurance, especially on a used engine. If this Honda Civic pump wears out, say goodbye to the valves, pistons, and cylinder head. Check the condition of the fan clutch and fan blades. A defective fan clutch may be the cause of the original engine's overheating problems.



8

The thermostat and gasket should always be replaced. Reusing the old thermostat during an engine rebuild is a false economy. Overheating or age may have affected its accuracy. Sticking with the original 'stat is also a roll of the dice on a used engine. Who knows how old it might be?



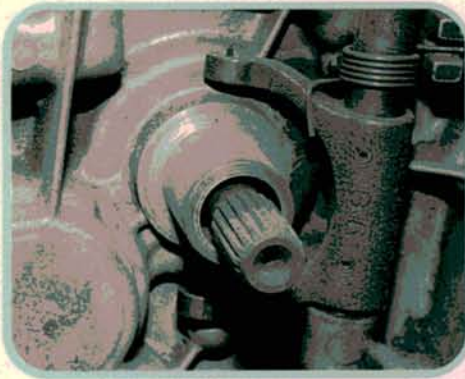
9

The same goes for drive belts, hoses, and hose clamps. Unless the car has relatively low mileage, it's better to replace these parts now for safety's sake. Always install a new timing belt on a used engine, no matter how low the mileage may be. Belt replacement is easier with the engine out of the car.



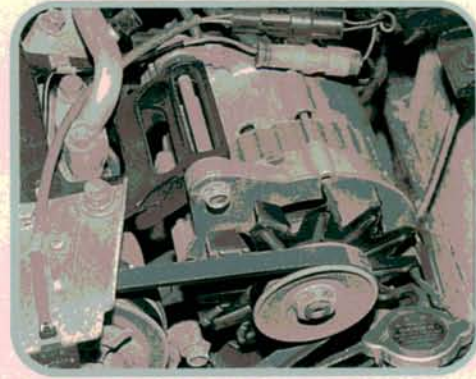
10

Every engine has the right to start its new life breathing through clean filters. If the original engine was damaged due to dirt infiltration, check for air leaks in the intake system that may have let dirt into the engine. Make sure all filtering systems are working properly.



11

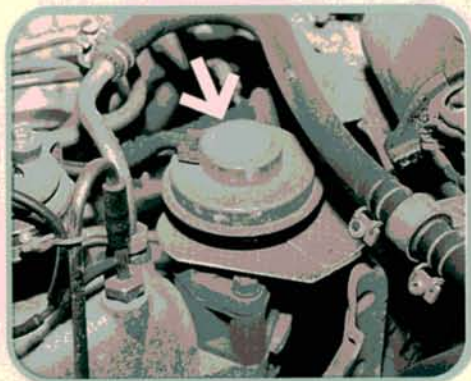
Have you heard of the Law of Unintended Consequences? Doing one thing often causes something else to happen, and that's not always good. When you remove and replace the engine, the transmission input shaft seal may decide to start leaking. Replace it now while the engine is out of the way.



12

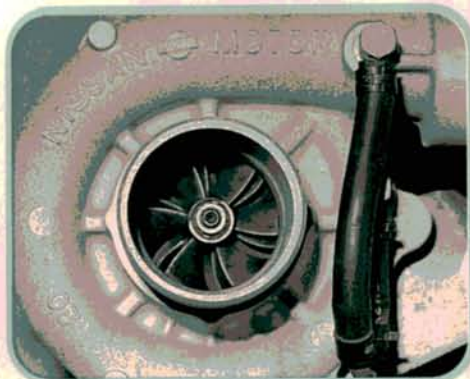
The engine may be buried under a mass of related components. Some, like the alternator and starter, are subject to normal wear. Bolting a tired component to a freshly rebuilt engine may be asking for trouble. For example, a weak starter may not be able to handle the replacement engine's extra compression.

## Open Hood Surgery



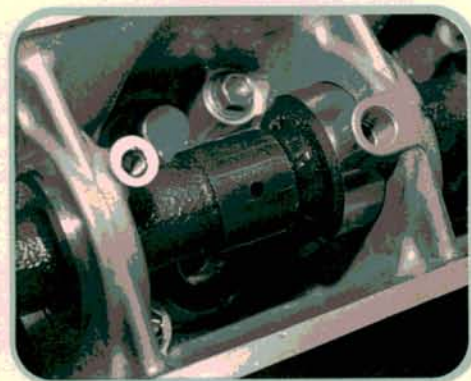
**13**

Check for improperly functioning or intentionally disabled emission components. These may have caused the engine failure. Detonation damaged pistons may be caused by a malfunctioning EGR valve. Rebuilding the engine without correcting the EGR operation will guarantee a repeat failure.



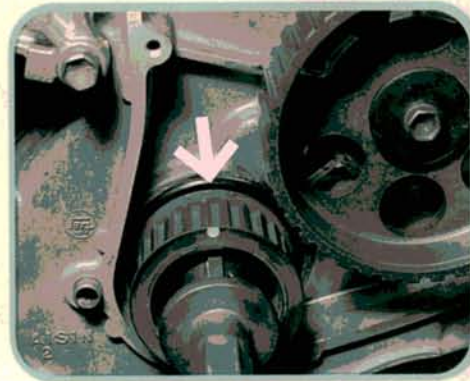
**14**

Other engine components may lead to a misdiagnosis of internal engine failure. Excessive oil consumption may be caused by a clogged PCV system or leaking turbocharger oil seals, rather than worn piston rings. A weak turbo may also cause poor engine performance, rather than internal engine wear.



**15**

If you're installing a used engine, do some quick checks to determine its internal condition. Remove the valve cover and oil pan, then check for oil sludge and metallic particles. Now is also a good time to measure the oil pump clearances. Replace the pump if there's enough money in the budget.



**16**

Check the condition of all seals and gaskets on used engines, and replace as necessary. Some used import engines are available from overseas suppliers. Manifolds and bolt on components on these engines may be different from our U.S. versions. Transfer these parts from the original engine to its replacement.



**17**

Removing the engine makes a lot of little jobs much easier than they might be otherwise. Motor mounts are one example. If the mounts look the least bit questionable, recommend their replacement while the engine is out. You'll stay one step ahead of that law we mentioned earlier.

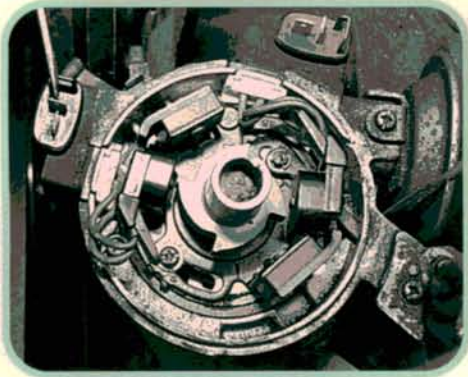


**18**

We don't want to overlook any existing problems or create any new ones. Make sure all wiring and ground connections are clean and properly reconnected. Don't bolt the main ground cable to a corroded mounting stud, then wonder why the engine cranks slower than it did before.

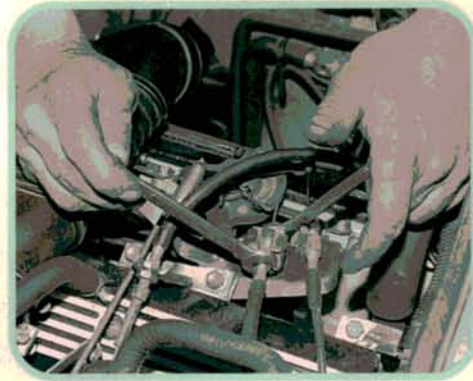
# Open Hood Surgery

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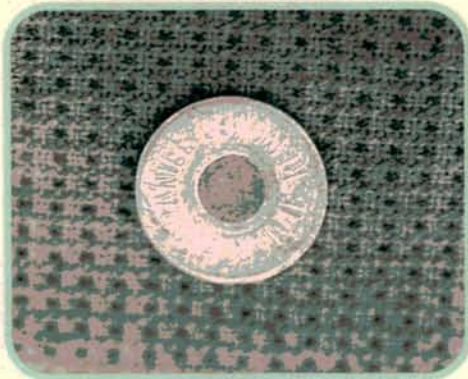
**19**

Ever try to light a fire with wet matches? Check the condition of the secondary ignition system before you reuse the old parts. Include a new cap, rotor, plugs, and wires in your estimate if necessary. Also check for centrifugal advance wear caused by a loose timing belt on the original engine.



**20**

All cable adjustments should be checked after the engine has been installed. Have an assistant fully depress the gas pedal to make sure you're getting full throttle opening. Follow the manufacturer's adjustment procedures for automatic transmission shift cables and cruise control cables.



**21**

A doctor always counts the sponges before he sews up the patient. Give the car a thorough inspection after the transplant is complete. Make sure that everything is working properly, even systems that may not be directly related to the engine work. This lead-filled tab will detect any future engine overheating.



**22**

Road test the car with the customer. Make sure the original problem cause isn't the customer. Observe his driving habits. Explain proper maintenance procedures to ensure maximum engine life. Schedule a "post-operative checkup" after the engine has been back in the car for several hundred miles.

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