INSTALLATION OF A CRANE XR700 IGNITION SYSTEM

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with contributions from Paul Clarkson

1976 Jaguar XJ-S

Background

For a long time, I have noticed my car ran better first thing in the morning. Then it idles smoothly, while later it idles rough and has spells of popping for a bit for a block or so two after a brief rest. I've done many things to the car in hopes of fixing this problem, every time thinking it worked only to have the symptoms return later. One thing I've noticed is that in nearly every case, regardless of what else I was attacking, I would clean or replace the spark plugs, since several were typically fouled, usually on the right bank.

Then I noticed some discussion on the XJ-S Lovers mail list about the ignition amplifier failing and exhibiting this failure most noticeably at high temperatures. To deal with this, several pre-HE owners on the list have replaced the stock amplifier, timing rotor, and magnetic pick up with aftermarket electronic ignition systems. The Crane XR700 appears to be the most widely used. Since it costs only about $130 including shipping, I decided to give it a try.

While I was at it, I decided to go through the whole distributor. That is another story, but I highly recommend that if you have never overhauled your distributor, now is a good time (See Distributor Overhaul document).

What You Will Be Doing

The basic task is to remove the ignition timing disk and the magnetic pickup and replace them with, respectively, the Crane shutter wheel and optical pickup. Also, outside the distributor, you will replace the standard Jaguar ignition amplifier with the one from the Crane kit. You may wish to install a new coil too, although the old one will work.

Parts

Item	Part Number	Source	Price
Crane XR700 Ignition Kit	7000300	American Speed Center FX (http://www.AmericanSpeedFX.com)	$93.48
Crane P20 Coil	7300020	American Speed Center FX	$30.57

Setting Crankshaft Position

Before you begin, realize that you should set the crankshaft at a known position relative to top dead center on cylinder #1, with the distributor rotor pointed at the #1 position on the cap. This is essential if you should decide to remove the distributor but is also helpful even if you do the Crane installation *in situ*.

First, remove the spark plug wires from the cap and, using a straightedge aligned with the #1 hole on the cap, carefully mark the side of the distributor body below the cap. Then remove the cap, disconnect the coil primary (the +12 volt connector on the coil), and crank the starter until the

rotor points a little before the #1 mark. Then, jack up the car so you can crawl under and get a wrench on the bolt in the center of the crankshaft pulley. Turn the crankshaft until the timing marker is pointed at 12 degrees TDC. (See Section 86.35.20 of the ROM for source of this information.) If you can't muscle the crank around to the correct position, either get a stronger person to help, or remove the plugs. The first option is preferred! You can nor remove the rotor.

Removal of Distributor (optional)

At this juncture you will have to decide whether to remove the distributor from the car or work on it in place. My recommendation is to remove it. I worked on it in place for a while before coming to this conclusion. Removal is not that difficult, and it makes everything so much easier. Moreover, if you decide to completely overhaul the unit, as opposed to simply installing the Crane system, removal is absolutely necessary.

If you want to remove the distributor, disconnect the electrical connections. That will include the pickup connector (near the front of the distributor) and the EFI trigger unit connector (near the firewall).

The next step is removal of the three Allen-head cap screws that fasten the distributor it to the valley cover plate. If you have properly positioned the crankshaft, you can reach the Allen screws through slots in the ignition timing disk and trigger board. However, to gain better access to the Allen screws you can remove the trigger board. If you decide to remove it now, see instructions under The Teardown below.

After gaining access to the Allen screws, loosen them all and back them out as far as you can. However, if yours is like mine the heads of the Allen screws will be too big to pass through the slots in the upper distributor body, so you will have to lift the distributor as you back them out. Once this is done the distributor can be removed for the car.

The Teardown

If you have not yet removed the rotor and trigger board do so now. Remove the 4 Nylon screws holding the EFI trigger board (see Figure 8) and flip it out of the way. Recover the four Nylon screws with their washers, and the rubber grommets that support the board. These parts are not replaceable so don't lose them! Remove the circlip that holds the ignition timing disk, collecting it, the wavy washer, and any spacer that might be there. (BTW, I thought these things were called "Circlamps," but they are not. If you don't believe me, search for Circlamp on the Web. You will be surprised!) Then lift the disk off.

Using a small screwdriver, carefully remove the 2 cheese-head screws that hold the magnetic pickup module to the plastic vacuum advance plate (called the pickup carrier in the ROM). Do not lose these screws and washers, as they are nonstandard and difficult to replace. If you have not done so, disconnect the ignition amplifier from the distributor. The connector is near the front of the distributor. Then gently work the pickup harness grommet through toward the *inside* of the distributor. You can now remove the pickup and harness. You won't be needing the pickup, but you will want to salvage the harness grommet to use on the Crane pickup harness.

You also will probably want to remove the old Jaguar amplifier, mounted on the valley cover in front of the distributor. Remove the two mounting bolts, disconnect the electrical connector to

the ballast resistor, and remove the unit and harness. Most of this will be discarded. You might as well remove and discard the mounting bracket too.

This is as far as you have to go in disassembly if you are only installing the Crane system. Otherwise, follow the instructions in the ROM, or look at my write up on distributor overhaul, to finish disassembling the distributor.

The Jaguar parts are shown in Figure 1. You will salvage only the grommet on the pickup harness, lower left, and the ballast resistor connector, lower right.

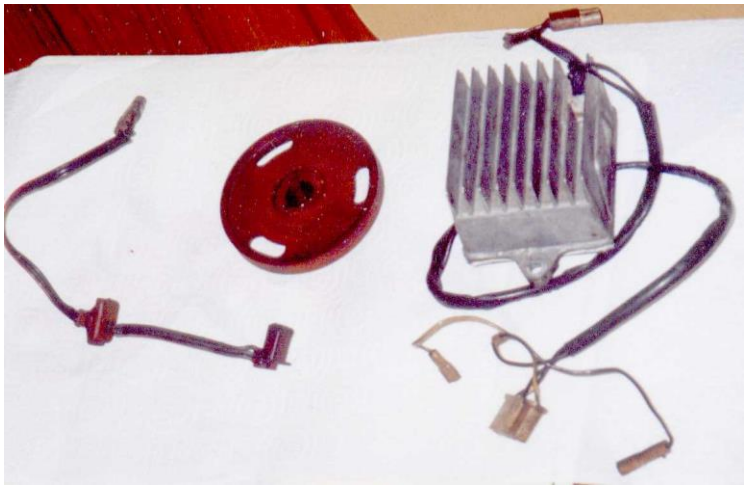

Figure 1 Jaguar ignition parts

Sensor Mounting

Without doubt the major headache for me (and some others who have done this conversion) was mounting the optical sensor. The Crane kit comes with two alternative brackets, one in two parts and one as a single part. The instructions identify the two-part bracket for Lucas Jaguar installations. As shown in Figure 2 there is a foot that connects to the distributor vacuum advance base plate, and a mounting bracket that attaches to the optical pickup unit.

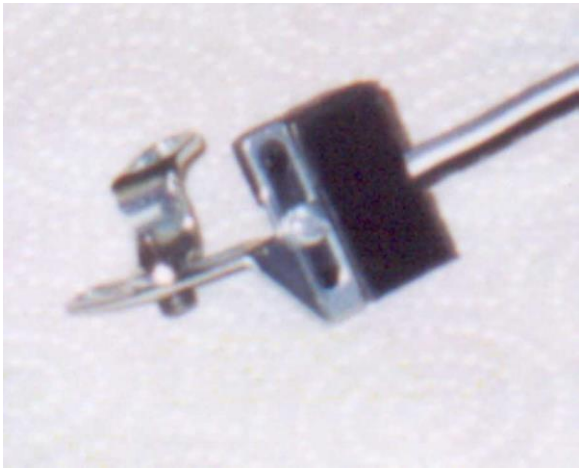

Figure 2 Crane recommended two-piece bracket on pickup.

My first choice was to try this arrangement. While several people have reported that this worked for them, others have rejected it, as I did. My problem with it was I felt that with a single screw holding the foot to the base plate it was not secure. Since the base plate in the distributor is nonmetallic, I did not feel comfortable really cinching down on this single tiny, fine thread screw. Consequently, when I attempted to tighten the screw that joins the sensor bracket to the foot the foot would tend to turn. I would never feel comfortable with this, always wondering if it had slipped. Moreover, when this bracket is used the pickup can't be positioned where the Jaguar magnetic pickup was. As seen in Figure 3, it has to be positioned clockwise. This not only complicates the installation procedure, making it necessary to "synchronize" the rotor and pickup, but also presents a mechanical problem in that it tends to run into the distributor body wall when the vacuum advance activates. As far as I can see the only advantage of the two-piece bracket is adjustability, which is probably why Crane recommends it.

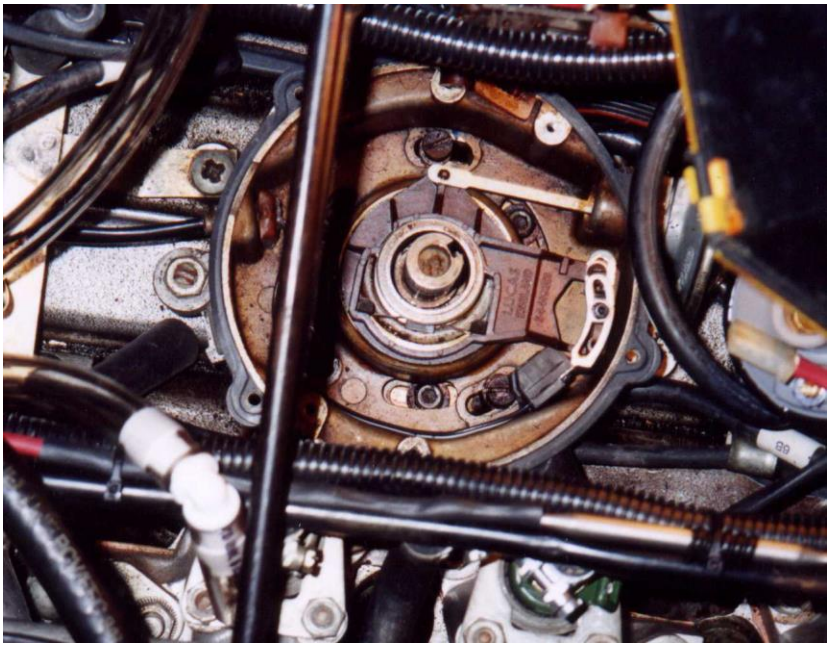

Figure 3 Two-piece bracket in the distributor.

This led me to fabricating my own bracket, as Bernie Embden had done. My first effort was basically double-sided version of the Crane supplied foot, to which the supplied trigger bracket attaches. That this approach allowed two screws to secure the trigger bracket as well as two securing the foot to the base. However, this proved unworkable due to interference with the distributor body during vacuum advance.

I then turned my attention to the Crane single piece bracket. The attraction of this bracket is twofold. First, it attaches to the vacuum advance plate with two screws instead of one, making it inherently more secure. Second, because it positions the sensor precisely where the original magnetic pickup was it is less likely to hit the distributor body during vacuum advance. There are also two disadvantages of this bracket. First, unlike the two-piece bracket it allows little or no angular adjustment for synchronizing the electrical triggering with the rotor pointing direction (see below). This is really not a problem, however, since the bracket aligns the sensor very well without adjustment. The second disadvantage is it positions the sensor too far out radially, so that

the LED and detector are not fully over the shutter disk. To overcome this, I made a shim out of 3/16" aluminum stock that fits between the sensor and the bracket. The shim is attached to the sensor with two 3/8" 4-40 flathead screws, counter sunk into the shim and screwed into existing holes in the sensor body. You can see the shim attached to the optical sensor at the left in Figure 4. The bracket itself is also seen in the figure, balanced on the edge of the distributor.

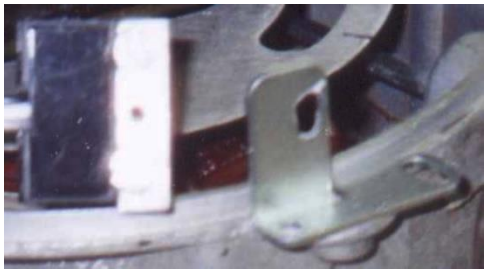

Figure 4 One piece bracket and shim.

The only problem is the holes in the sensor are positioned such that the screw must be very close to the edge of the shim, meaning that the countersinks break through the edge. Nonetheless, it works well. Also drill and tap 4-40 hole at the center of the shim to allow attachment of the bracket. The installation in the distributor is seen in Figure 5 below.

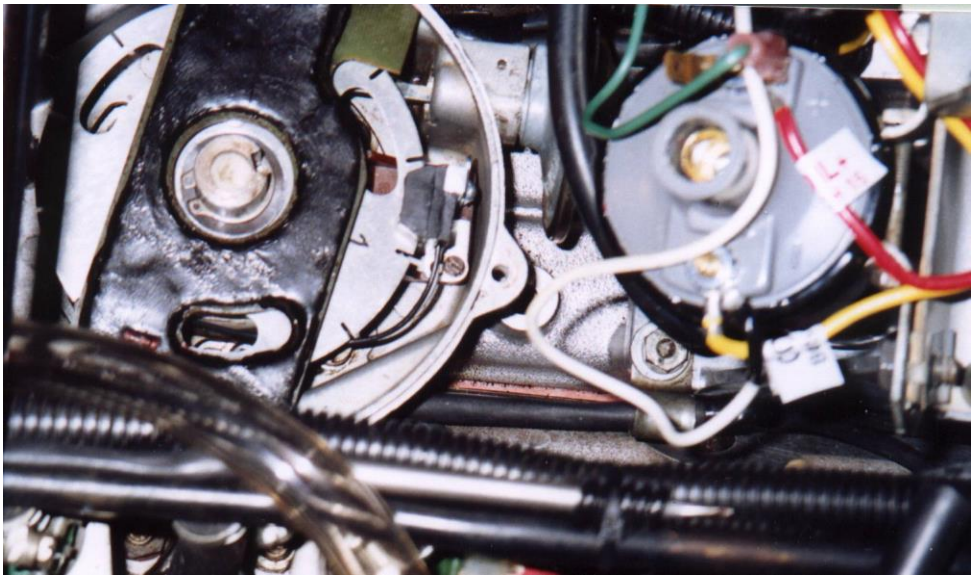

Figure 5 One piece bracket and shim, installed.

Making the shim is not very difficult. Looking at it from behind, there is a recessed land on the plastic optical pickup where the Crane bracket would normally attach. Your shim will have to fit on this land, registering up against its edge, as would the Crane bracket. The pickup has three holes in this land. The center one, normally for attaching the Crane bracket, will not be used. The top and bottom holes will be used to fasten the shim to the pickup.

To make the shim I got a length of 3/16" x 1" aluminum alloy stock at a local metal supplier, as hardware stores don't carry this thickness. (Note that 1/8" won't work. See below.) Scribe and cut a piece ¼" wide and 15/16" long. Grip it in a vice and smooth and square up the cut faces. It will have to be drilled (for 4-40 clearance) to match the top and bottom holes in the Crane pickup.

Scribe a lengthwise line for the mounting holes about 0.095" from the left edge. Then scribe two centerlines, one 1/8" from the top and the other 0.600" down from it. Carefully center punch the crossings and drill for 4-40 clearance. Then counterbore for 4-40 flat head screws. Finally, mark and drill and tap 4-40 at the center of the shim for mounting the Crane one-piece bracket. Remove the burrs.

Although I used aluminum because it was more readily available the shim could as well have been made from plastic. Then a little of the right kind of glue would attach it to the pickup a lot easier than all the drilling and countersinking.

One final refinement to the shim may be necessary. You will find that the shim and Crane bracket must be assembled before installation in the distributor. This is because, as you can see in Figure 5, you can't get to the screw that holds the bracket to the shim once its installed. When you then try to mount the assembly to the vacuum advance plate the head of the mounting screw interferes with the shim. To avoid this, return the shim to your vice and file a low angle to the lower right-hand corner. Attach the shim to pickup with 3/8" 4-40 flat head screws. If the heads are above the surface, remove and deepen the countersinks.

Before final assembly and installation of the pickup in the distributor you should attach the grommet to its harness, as described later. Nonetheless, you will need to temporarily assemble and install it so that the grommet is properly positioned on the harness.

Pickup Positioning

Positioning the pickup module over the shutter disk has three elements. First, the height has to be set so that the disk does not touch the top or bottom of the of the slot in the sensor. However, since the slot is about ¼" wide and the shutter disk is only 0.020" thick, this is not difficult; it does not have to be perfectly centered.

Second, the pickup has to be positioned radially such that the LED is well over the shutter disk, but not so far as to make the disk rub the back of the slot. Again, there's lots of latitude in this adjustment.

The third and most critical setting is the angular position relative to the distributor body. Keep in mind that the spark will occur when a slot in the disk passes over the sensor LED. At this precise moment the rotor must be pointed at the corresponding lug in the distributor cap. If you use the Crane two-piece bracket you will have to make this adjustment very carefully, since this bracket gives you a great deal of latitude in positioning the pickup. The Crane installation instructions go into great detail on this point. Basically, it's a matter of hooking up the electricals and watching a specially provided LED on the Crane amplifier as you adjust the angular position of the pickup. When the LED comes on, lock it down. Of course, at the same time you have to be keeping the radial position correct, so it can be tricky.

Fortunately, using the one-piece bracket, with the shim I describe, all three positionings are easily achieved. First, note that the slots in the Crane shutter disk have the same angular position relative to the shaft key as the magnetic pins in the Jaguar timing disk. Therefore if the center of the Crane pickup is positioned exactly where the Jaguar pickup was, you automatically get proper angular alignment. By carefully attaching the bracket to the shim, aligning it with the edge that

butts up against the ledge in the pickup, the pickup will be so positioned. Moreover, the 3/16" thickness of the shim takes care of the radial positioning without adjustments. Thus, the only adjustment needed is vertical. That is easily handled by elongation of the hole in the Crane bracket where it attaches to the shim. (It is already elongated, but you may have to take a little off the top end with a rat-tailed file or Dremel.)

Let me again emphasize that if you choose to use the Crane two-piece bracket you will have to do a lot more work to get it properly positioned. The reason is that this bracket allows complete freedom of positioning, meaning you have carefully set it properly vertically, radially, and angularly. The Crane instructions on this need to be followed precisely. In particular, you must connect the amplifier to the coil and the pickup and adjust the angular position of the pickup clockwise until the LED on the amplifier comes on. As pointed out there, if you don't do this right the spark could occur when the rotor is not pointing towards a lug on the cap! In other words, with this bracket you are responsible for establishing the relative angles between the rotor and the pickup, whereas with the single piece bracket you don't have to worry about it.

Another Approach

As I have mentioned, several XJ-S and V-12 list subscribers have installed the Crane XR700. I want to call attention to one in particular, Paul Clarkson, who fitted one in a rather unique way. Regarding what must have been the two-piece bracket he wrote:

> " I invested in a Crane Cams XR700 amp and PS91 coil. These were fitted but the optical pick-up brackets were far from satisfactory. They are made of soft metal and, although adjustable, are difficult to tighten up. On a test run, the bracket moved at about 5000 rpm. and brought me to a standstill."

And later in a note to me:

> "I did a bit of head scratching and came up with what you see in the attached pics. First off, on the disc, compare the tab that engages in the dizzy shaft and the relative angle of the slots in the Crane disc to the original's tab and magnets. I think you'll find there is a few degrees difference, which will throw the timing out very badly if the Crane optical pickup is in the same position as the original pickup. I cut off some of the stem on the Crane rotor and also cut off about 1/4" of the stem from the original plastic rotor. It is a while now since I did this and I didn't take exact measurements, but you'll see in the pics that I glued the bit of the original stem to the bottom of the Crane stem."

(Note: Paul sent me a link to his photo but the link no longer works.) There are two things of note in the picture. One, he has sawed a thin ring off of an old Jaguar ignition disk and used it to replace a section of equal thickness on the bottom of the Crane shutter disk hub. This gave him a key on the hub, allowing him to cut off the key in the Crane disk and elongate the holes in the disk so as to allow angular adjustment of the disk. This was to deal with an alignment problem between the disk slots and the pickup position after he abandon the adjustable two-piece bracket in favor of the one piece, nonadjustable one. If you study his picture and compare it to Figure 5 you will note that he has installed the one-piece bracket turned around 180 degrees from the way I used it. That is, the bracket upright is on the *right* of the pickup in my installation and to the *left* of the

pickup in his. This requires the pickup to be flipped around too, so the harness wraps around the opposite side of the distributor.

I tried this orientation too and found it has the advantage of positioning the pickup farther in radially, so no shim is necessary. However, it also has the effect of positioning it a few degrees counterclockwise. Paul saw this as a problem of the disk slots being in the wrong position relative to the key in the disk, which led to his modifications. I like his idea and think it would have been great if Crane had thought of it. But with the pieces Crane has given us, on the balance I believe my approach is better because the little shim can be made more easily than his hub modifications.

By the way, Paul used the P91 coil even though Crane told him it's not right for the XR700.

Figure 6 Paul Clarkson's solution.

Rubber Grommet

The wires from the optical pickup have to pass through the distributor wall to connect to the amplifier. As suggested in the Crane installation guide, you can use the rubber grommet from the original magnetic pickup wires. In my case it was pretty hard from age and temperature, but otherwise in good condition.

First, cut the wires flush on both sides. Then clamp it in a vice and drill out the remaining wires. A little sideways action with the drill creates an oblong hole about the same size as the pickup wire bundle. Since this hole is too small for the connectors to pass through, you have two choices: either remove the connector contacts so the bare wires can pass through (maybe with a little rubber lube) or cut the connector lengthwise so it can be slipped over the wires sideways. I did the latter, using a hacksaw. The only drawback is the material removed by the hack saw makes

the grommet not fit as snuggly in the distributor as it originally did. Looking back, it probably would have been better to slice it with a utility knife.

Before attaching the grommet to the wire, you should temporarily set the assembly in the distributor so you can determine where it should be. You want just enough harness length in the distributor to reach the pickup without interfering with the vacuum advance. Actually, it's a good idea to suck on the vacuum advance hose to see how the advance moves. Once you know where you want it, mark the harness and remove it from the distributor. Remove the grommet, apply a little silicone sealant, and slip it into place on the harness. Figure 7 shows the grommet in place on the harness.

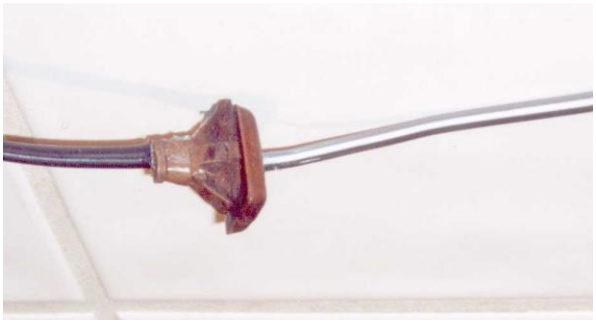

Figure 7 Grommet installed on the Crane pickup harness

Preparing the Shutter Disk

The Crane kit comes with three shutter disks, two black plastic and one aluminum. The latter, which has 12 slots, is obviously the one for the V-12. It is attached with pop rivets to a black plastic hub. If Crane was more careful with assembly of this unit it would slip easily onto the distributor shaft. However, in my case it would not fit because the disk was not properly centered on the hub. The offset was about 0.012", resulting in the edge of the disk hole overlapping the hole in the hub. This prevented it from slipping onto the shaft. A little work with a small round file solved the problem.

Putting It All Together

Once you have made the shim and attached it to the pickup, and attached the grommet to the harness, you can install the assembly in the distributor, Figure 8.

First, attach the Crane bracket to the shim using a 4-40 screw and lock washer. The hole in the bracket is elongated to allow for vertical adjustment. In my case I had to elongate the hole a bit more to get it was well positioned.

Due to the pickup overlapping the disk, getting them both in place in the distributor is a bit tricky. Put the pickup in the distributor, but do not screw it down, and pass the harness through the body wall, pressing the grommet into place. Then tilt the pickup backwards as you slip the disk down; it will barely clear the pickup, perhaps with a little wiggling. Then install the cheese head screws, with washers that hold the bracket foot to the vacuum advance plate. One of the holes in the bracket foot is elongated, probably to accommodate installation in some other car. I found it did not make too much difference where I tightened it down in the limited adjustment range afforded.

Figure 8 Distributor assembled with Crane ignition.

Once the screws are tightened and the disk is pushed all the way down, reinstall the spacer, wavy washer, and circlip. Then reinstall the EFI trigger board.

Installing the Amplifier

According to Crane, the amplifier can be installed anywhere except directly on the engine. Some have reported mounting it up front near the EFI amplifier. Bernie Embden, concerned about temperatures anywhere in the engine compartment, installed it inside the car, under the passenger side dash. I chose to put it on the passenger side air filter, Figure 9.

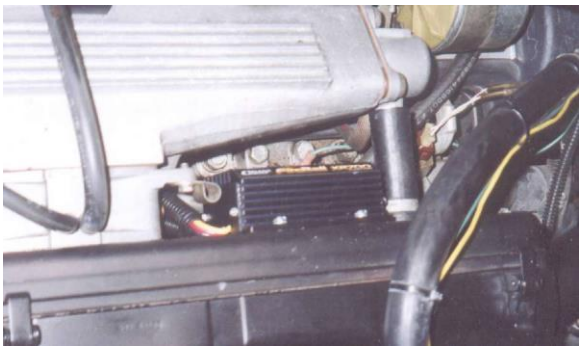

Figure 9 Crane amplifier, installed.

I removed the filter housing and drilled and tapped it since the metal is a bit thick for a sheet metal screw. I put cable covers on the harness and routed it under the intake manifold. I will see how it works here, and if there are signs of it getting too hot I'll relocate it in the car as Bernie did.

Coil and Ballast Resistor

There has been a lot of discussion of what coil to use with the Crane XR700. Bernie Embden used the original Jaguar coil and ballast resistor. I wanted to replace my coil on general principles, so got the coil recommended by Crane, their PS20 model. It came with a ballast resistor, but I chose to use the original Jaguar resistor rather than figure out where to put the new (very non-Jaguar looking) one.

Electrical Hookup

The Crane instructions are fairly clear, so I won't elaborate here. Since the Crane hookup requires the ballast resistor I salvaged the connector from the old Jaguar amplifier harness. I removed the upper most insert from the connector and soldered it to the Crane-provided optional diode, as Bernie Embden said it was needed. The instructions say to tape up the black/red center wire to the front ballast resistor connector (the center wire) because it is not used. Rather than letting it dangle, I removed it entirely from the connector. I also took the opportunity to replace the wire from this connector to the + coil terminal, clean up the connector contacts at both ends, and check the resistances according to the ROM, as clarified by Kirby's Book. Finally, I replaced the ring terminal connector on the ground wire with a larger one and attached it to the air rail where the other ground wires are.

You can see the coil hookup in Figure 5.

Engine Timing

Theoretically, engine timing should be OK, since presumably the engine was properly timed before, and your new Crane ignition should have exactly the same timing. However, the pick up might be in a slightly different position, or the disk might be off slightly. Or, the geometric and electrical differences between the magnet pickup and pins in the Jaguar disk vs. the optical pickup and slots might cause spark to occur at slightly different timing. Therefore it’s a good idea to plan on timing the engine.

So before replacing the rotor and cap, check the position of the distributor body where it is mounted to the valley cover plate. To do so first loosen the Allen screws visible through slots in the shutter disk and trigger board. Section 86.35.20 of the ROM tells how to do the adjustment, rotating the distributor until the #1 cylinder mark on the timing disk is aligned with a center mark on the magnetic pickup. The equivalent process with the Crane ignition is to rotate it until the leading edge of the #1 shutter slot (which will be the one closest to the pickup if you have your crankshaft in the right position) crosses the center of the LED in the pickup. There is another LED mounted on the Crane amplifier that you can use to tell when this happens. To use it you will have to connect the amplifier to the pickup and the coil as instructed in the Crane booklet. Then turn on the ignition and slowly rotate the distributor clockwise while watching the LED on the amplifier. When it comes on, lock down the distributor with the Allen screws. You shouldn't have to turn it very far from its original position unless you have changed something else, such as the vernier adjuster. (You might want to do the latter if it is not near the middle of its adjustment range.) Once this is done you can replace the cap, rotor and plug wires and time the engine in the usual manner.

Note that although the above procedure uses the amplifier LED to detect the pickup encountering the leading edge of the shutter slot, as does the Crane procedure described under Pickup

Positioning above, the usage here is subtly different. Here, we are using it merely to set the distributor lower body position on its mount, entirely equivalent to the procedure described in Sectio 86.35.20 of the ROM. The usage described by Crane is to set the pickup position relative to rotor pointing direction, which you don't need to do if you used the two-piece bracket as advocated here.

Also note that the above procedure is correct for my car, which is timed at idle to 10 BTDC. Yours may differ.

Other Things You May Want To Do

While installing the Crane there are some other things you may want to do, including:

1. Overhaul the distributor (see my write-up)
2. Replace items such as cap, rotor, plugs and wires if it's time.
3. Test the ballast resistor (See Kirby Palm's Book)