Distributor Overhaul

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with help from

Richard Dowling

1976 Jaguar XJ-S

Background

I did a halfway overhaul of my distributor about 3 years earlier as one of my first DYI projects on the car, but had misgivings about some things I didn't do. Among these concerns were the internal seal and bearing. The seal was suspect because I had an explosion of some kind that destroyed the cap (literally) a few months ago. I was concerned about the bearing because my mechanic once mentioned some "wobble" in the shaft. Frankly, I now believe both were red herrings of sorts, but nonetheless I have now replaced both seal and bearing. This was an easier decision to come to because I had already resolved to install a Crane ignition system.

Note that this is an early Lucas distributor. There are significant differences in the upper parts when compared to later Lucas distributors. The lower part tends to be more uniform. Kirby Palm's *Experience in a Book* has a comprehensive discussion of Jaguar V-12 distributors.

Removal of Distributor

Before you begin, realize that you will have to get the crankshaft to a known position relative to top dead center on cylinder #1, with the distributor rotor pointed in the general direction of the #1 position on the cap. Remove the plug wires and distributor cap, disconnect the coil primary (the +12 volt connector), and crank the starter until the rotor points approximately at the #1 mark on the cap. 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. (This is discussed more later, page 11. See also section 86.35.20 of the ROM.)

I should mention that while you can easily get the crankshaft to within a few degrees with the starter, final positioning of can be difficult. As far as I can determine, the only access to the crankshaft turning bolt is from underneath the car, reaching up between the undertray and oil lines with an open-end wrench. But unless you have a powerful arm, you may not be able to move it. I had to remove the spark plugs, which is a real escalation of the project. (If anyone knows a better way to do this, let me know. Removal of the undertray would help, I suppose, but that is a real pain too.)

Removal of the distributor is not that difficult, and is essential if you intend to do a thorough job. First, disconnect the electrical connections, namely the pickup connector (near the front of the distributor) and the EFI trigger unit connector (near the firewall). Then pop off the rotor. (Some have reported great difficulty with this, but mine came off easily.)

If you have properly positioned the crankshaft you can reach the three Allen screws that hold the distributor to the valley cover plate through slots in the ignition timing disk and

trigger board. However, to gain better access to the mounting screws you can remove the trigger board and the ignition timing disk. If you decide to remove them now, remove the 4 Nylon screws holding the EFI trigger board (see Figure 6) 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 EFI timing disk and lift the disk off, 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!)

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, so you will have to incrementally lift the distributor as you back them out. Once this is done the distributor can be removed for the car.

Disassembly

With the distributor on the bench it's not difficult to see what has to be done to get it apart. A step-by-step process is given in the ROM, with supporting drawings. Here I will focus on points that are not well covered in the ROM.

I assume you have already taken off the rotor, EFI trigger board, and the ignition timing disk (reluctor wheel). If not, remove them. It's best to leave the ignition pickup module in place now, least you should drop the tiny screws into some awful place.

The plastic vacuum advance plate (called the pickup arm in the Jaguar parts book) can now be removed. First, using a needle-nosed pliers remove the spring clip that secures it in its groove on the distributor body. It can then be lifted up and pried loose from the vacuum advance plunger shaft. Since the pickup is mounted on this plate the assembly will then be tethered to the body by a harness. Push the rubber grommet on this harness through to the *inside* and remove the assembly.

If the vacuum unit is to be replaced, remove it from the body by driving out the roll pin.

The two halves of the distributor body can now be separated. Remove the three spring-loaded screws and pull the unit apart. This exposes the centrifugal mechanical advance mechanism. Remove the screw in the center of the rotor carrier shaft. Remove the two springs by gently tugging with needle nosed pliers. Try to avoid distorting the springs as this will disturb your advance curve. Carefully lift the rotor carrier and remove it. If you don't have a knack for putting things back together, take a photograph or draw a diagram of the way it is assembled before removing the weights.

Figure 1 shows the disassembled distributor. At the left is the lower part of the body, and the upper half is to the right (Jaguar calls the lower part the *body* and the upper part the *micro housing*). You can see the mechanical advance weights in the lower half. In the upper half you can see the vacuum advance. I did not remove it since it was replaced less than three years ago. The top middle shows what Jaguar calls the *pickup arm*, because the ignition pickup module mounts on it. I tend to call it the vacuum advance plate since it is what rotates when the vacuum advance activates. The bottom middle shows the rotor carrier shaft.

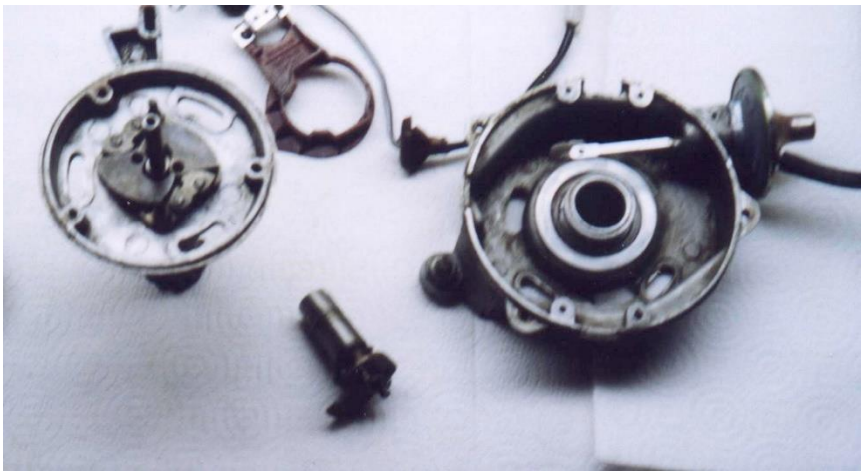

Figure 1 Disassembled distributor.

To replace the bearing and seal you will have to remove the gear at the bottom end of the shaft. This requires a bit of work with a file (or a Dremel if you have a steady hand), drill, and pin punch. Using blocks of wood as soft jaws to protect the gear, clamp the unit in a vice, Figure 2. Using the edge of a flat file, carefully file down the peened end of the drive pin. *Be careful not to nick the gear.* Once you can clearly see the outline between the pin and the gear, center-punch it. This is critical, because otherwise you might damage the gear itself.

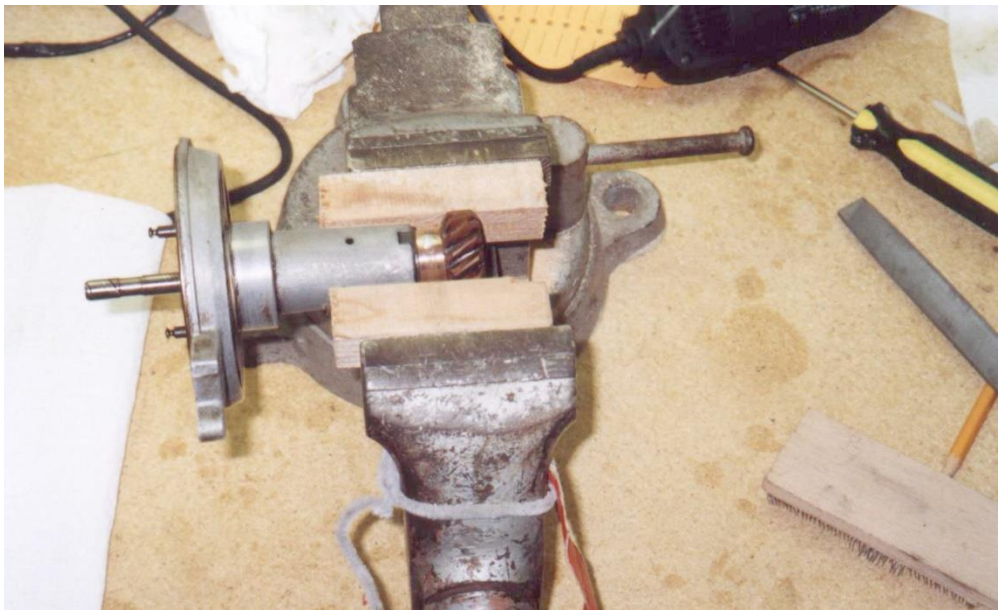

Figure 2 Removing the gear

Use a small diameter bit to drill into the pin about ¼" or so. Then use a slightly larger drill. The idea is to remove as much of the pin as possible without damaging the gear or the shaft. Then support the gear, and the adjacent part of the distributor body, on small wooden blocks and use your pin punch to drive out the pin. Richard Dowling recommended this technique.

If clean, the gear would slip easily off the shaft. However, you may need a gear puller to get it off because it's been on a long time and engine oil has gotten in there and cooked. I rented a puller, but conceivably one could drive the shaft out of the gear with a large pin punch if you could find a way to support it.

Once the gear is removed all that is holding the shaft in the housing is the bearing, which is a slip-fit into a ¼" counterbore into the distributor body at the top of the shaft. At this point you can easily tap the shaft out of the distributor with a plastic hammer. The seal and bearing will come out with it. You can easily slip the seal off, but the bearing is held on the shaft by a light interference fit so will require some work. I could not find a suitable puller, so I pried and tapped it off with various screwdrivers and punches.

Figure 3 shows a completely disassembled distributor, courtesy of Richard Dowling. He too installed new bearing and seal, and the Crane ignition. Note the shaft with gear, seal, and bearing removed. The parts beneath the shaft in the picture are the bearing, the new seal Richard used (he has placed the original seal in the lower half body, upper left, for the picture), the cone-shaped spacer, the thrust washer (with tab), and the gear. The cone shaped spacer is out of place in the picture, since it goes on the shaft *above* the bearing, with the small end down. The thrust washer fits between the gear and the housing. Curiously, Richard's gear is steel, but mine is bronze.

Figure 3 Richard Dowlings distributor, completely disasembled.

Parts

The parts you will need are shown in Table 1. I did not list the vacuum advance, but now is a good time to replace it if it's weak or suspect.

Table 1 Parts List

Item	Size	Part number	Comments	Source	Cost
Bearing, Open.	½" ID, 1" OD, ¼" thick;	R-8	A standard open case, caged ball bearing. Often used in electric motors.	Any bearing supplier.	$4.68
Shaft seal	½" ID, 1" (0.999" actual)	Chicago Rawhide 4980	This seal is of standard dimensions but the lip is Viton-like for	Call Chicago Rawhide (1-800-882-0008.) for a	$8.68

	OD, ¼" thick.		high temperatures. Downside of this material is poor dry running, but I could find no alternative. CR has a great Web site for seals.	local distributor. The distributor may have special order it because of the high temperature lip material.	
Viton O-ring #222		964 K64	This goes between distributor and mounting pad on the valley cover plate. Price is for package of 25. **Contact me first, as I may still have some left. I sell them for $1.00 each plus postage.**	McMaster-Carr	$13.46
Roll pin	3/16" x 7/8"		This is used to attach gear to shaft.	Any hardware store will have the 1" pins that you can file to 7/8". McMaster-Carr has 7/8" pins but you will have to order a pack and pay shipping etc.	$0.30
Grease		Finish Line Teflon Fortified Synthetic Grease.	This is good for 400 deg. F. Use to pack bearing and lubricate mechanical advance.	Any bicycle store.	$6.00
Machine work			Bore dist. body for std. seal		$25.00

The Seal Issue

The original shaft seal is non standard. Although it is basically a spring loaded lip seal (sometimes called an oil seal), it is hat-shaped and of odd size. Figure 4 shows this seal. You can see (although not clearly) the spring around the smaller diameter over the lip, to the right in the picture.

The lip of the seal looks like it *might* have been soft and pliable like standard seals when new; otherwise, it would seem pointless to spring load it. However, both Richard Dowling and I found it to be hard as a rock when removed. It has occurred to me, however, that it might have been a hard seal to begin with, but there is no way to know. The face not shown in the picture is steel.

If you would like to look for it, the dimensions are:

Major OD: 1 1/16"
Minor OD: 0.7"
ID: 0.5"
Overall length: 0.25"
Thickness of major OD: 0.11"

Figure 4 Original seal

Richard Dowling and I have both searched extensively for this seal and finally concluded it is not available. The recommended replacement is a standard lip seal with high service temperature rating.

I used a 1" OD seal as shown in Table 1, which required a bit of machine work. I had the distributor body bored out for a light press fit of the Chicago Rawhide seal. Chicago Rawhide recommends a 0.004" interference fit for this seal. This seems like a lot of interference, but the seal has some give so it worked nicely. My machinist insisted on having the seal so he could be sure it was properly fitted. He did a nice job, and even made a tool to help me drive it in. Figure 5 shows the new seal in place below the bearing recess.

Figure 5 Lower body with new seal in place.

Richard Dowling also used a standard seal, but he did not bore out the distributor. He used a smaller OD seal and glued it into the unfinished hole in the body. I got a 7/8" OD seal to try this, but it was too large. Richard used a ¾" seal obtained from an ignition specialist who said he gets them from Bosch especially for V12 distributor seals, although they are not generally available. However, the ¾" results in a loose fit and requiring glue to hold it in place. Richard remains happy with his results. Nonetheless, I decided to do the machine work because I was worried about the unmachined hole being a little off center. I guess you could say the $25 was for peace of mind.

The Bearing Issue

The bearing is a standard size, know in the trade as R-8. Any bearing supplier can sell you one. However, they may have to order it, apparently because they tend to stock only closed bearings, and this size is not available in a closed configuration.

The bearing recess in the body, Figure 5, has what appears to be a crinkled foil shim around the circumference. Richard points out that "the shim may be there to give a bit of self aligning. The shaft is fairly long and has a long sintered bronze sleeve in the lower end. This may have caused problems if the ball bearing was an interference fit and the sleeve was not reamed in one setting on a lathe while the bearing recess was machined."

Lower Bushing

A bushing made of some kind of sintered metal supports the lower end of the shaft. I did nothing to this bushing because it looked good. It had a loose fit, but not excessively so. I had a distributor man look at it and he said it was OK.

Reassembly

First, thoroughly clean the parts. I had to work on the shaft with some steel wool to clean off the baked oil film. This makes it easier to get the gear back on.

Pack the bearing with high temperature grease.

Seal

Place the seal into its newly machined counterbore, lip side pointing toward the gear end of the shaft. Carefully tap it in until it seats. I had the machinist turn a ½" diameter on a short piece of 1" diameter aluminum stock to use as an insertion tool. This made it a little easier, but is probably not necessary.

Bearing

Installing the bearing offers some choices. You can put the bearing in the body and drive the shaft into the bearing, or drive the bearing onto the shaft and slip the assembly into the body. Looking backward, I believe the latter is the best idea. However, the bearing has an interference fit to the shaft and I do not have a press, so I put the bearing in the body, then used a plastic hammer to drive the shaft into the bearing. One problem with this approach is it takes a bit of pounding, and you run the risk of damaging the upper shaft and/or the bearing. Another is it is hard to tell when its been driven far enough. The only way you can tell is by looking to see if the conical spacer is tight. Fortunately, there is a hole in the advance mechanism plate through which you can see it and probe it a bit with a small tool. Although mine turned out well, if I had it to do over again I would take it to a machine shop and have them press it onto the shaft.

Regardless of which approach you decide to use, don't forget to put the cone-shaped spacer on the shaft first. The small end goes downward, mating with the bearing inner race.

Gear

Once the shaft and bearing are in place in the body its time to reattach the gear. First, oil the bushing supporting the lower part of the shaft. Then replace the thrust washer, followed by the gear. If the shaft and gear bore are clean it will slip on easily. Be sure the drive pin hole is lined up; mine was not dead center on the shaft, making the holes in gear and shaft unaligned in one of the two possible positions. Look through the hole and if it doesn't look perfectly aligned rotate it 180 degrees. Supporting the body and gear on wooden blocks, drive the roll pin into place. Be careful not to whack the gear!

Mechanical Advance

Now it's time to reassemble the mechanical advance. This may seem like a difficult task and easy to mess up, but I believe its impossible to get the pieces back together in anything but the correct places. You do have to lubricate things correctly, which means using good grease, applying it only where needed, generously but not excessively. If you put too much on it will sling off and dirty the distributor body. On the other hand, I don't think that would be harmful.

Smear the grease onto the bottom surface of the weights, and on all cam contact surfaces. These are easy to spot because the contact points are bright and smooth. Lay the weights in place on the carrier plate. Put a dab of grease on the two little pivot posts on the rotor carrier shaft. Then drop the rotor carrier shaft onto the main shaft and work the posts into the pivot holes in the weights. Insert the center screw that holds it together, and reattach the springs.

Don't forget to put a few drops of synthetic motor oil in the center hole (where the screws is), followed by a wad of cotton. Soak the cotton with oil too.

Reassemble Body

You are now ready to reassemble the two halves of the body. Put the three Allen screws into their slots in the lower half first, remembering the heads won't fit though the slots if you try to do it later. Also, put a little grease around the joint so it will slip around easily for vernier timing adjustment. Then drop the top half onto the lower part and replace the three spring loaded screws. I believe these screws tighten against a shoulder, leaving some space between coils of the springs, but check to be sure the inter-coil space there. Otherwise, it will be hard or impossible to turn the vernier adjuster screw.

Vacuum Advance Plate

The vacuum advance plate (pickup carrier) can now be installed. But first, check the groove where it rides on the housing and the base surface. I found mine to be rough in places, as if there had been some galling. I sanded it down and applied a little grease. If you have removed the pickup, reinstall it on the carrier. Then slip the carrier into place, while at the same time working the advance rod into its hole in the carrier. Insert the spring clip. Finally, work the pickup harness back through the hole in the body and press the grommet into place.

Ignition Timing Disk

Now slip the ignition timing disk onto the shaft. I used a little grease (not much) to make it slip easily. Push it down far enough so you can see the groove for the circlip. Put the spacer (if your distributor has one) and the wavy washer on, then the circlip.

Trigger Board

Installing the trigger board is the last step you can do before reinstalling the distributor in the car. First, manipulate its grommet into the slot in the distributor body. If it's not new, the rubber will be a bit hard so you have to work at it a bit. Then drop the board into place and insert the four Nylon screws. You can see the trigger board in place in Figure 6. Although the rotor is in place in this photo, it's better to it leave it off until the distributor is reinstalled to give access to the mounting Allen screws. This photo also shows the Crane photo pickup and shutter disk in place of the standard ignition system. Installation of the Crane system is described in a separate document.

Figure 6 Trigger board

Be very careful with the Nylon shoulder screws, as they are not available (except possibly with a new trigger unit). In my case I lost one and ruined one so I had to improvise using standard Nylon screws from the hardware store (I believe I used a #8). I did two of them this way since one of the holes in my distributor body was stripped and had to be redrilled and tapped anyway; one is visible in the above photo. If you have to do this be aware that the standard screws have a shoulder so they can be tightened and still have a level board. A standard Nylon screw has no shoulder, meaning you could easily turn the screw in too far, compressing the mounting grommets and tilting the board. To avoid this, I fashioned a shoulder screw by slipping a short piece small thin walled Nylon tubing over the screw. The hole in the grommet also had to be drilled out a bit to accommodate.

Testing the Advance Curve

Much has been said in the V-12 and XJ-S mail lists about the advance curve for these distributors. The ROM gives us advance data in two separate places. While the data is basically the same in both places, it's hard to tell because the points of reference are different. Section 05.1 gives it in terms of crankshaft degrees and RPM, and including a 10 degree offset for the initial timing setting. Section 86.35.29 gives it in terms of distributor degrees and RPM with no offsets. Figure 7 shows an advance curve with the data from both ROM tables converted to the distributor point of reference. To do this conversion I divided the Section 05-1 RPM by two, and subtracted 10 from the degrees advance and divided the result by 2.

You may wonder is this curve applies to your particular V12. Here is what Roger Bywater has to say on this point:

> "As I have pointed out before the centrifugal advance curves of all V12s from E Type to HE are not significantly different - so much so that taking into account the accepted tolerances it is difficult to differentiate one from another in a spin up test."

Armed with this curve you can take your overhauled distributor to your local speed shop and have them "spin it up" for about $10. You probably will need to take along your ignition amplifier, and some knowledge of which wires go to the coil. Ask the person at the speed shop what he needs to do the test. In my case the fellow was familiar with the Crane XR700 system, so all he needed was the distributor and amplifier.

They may want to "recurve" it for you for about $40, but all you really need is to know if it gives some approximation of the data in the ROM. According to Kirby Palm, it is unlikely that anyone outside of Coventry will have any better knowledge of what the curve should really be. I agree with this.

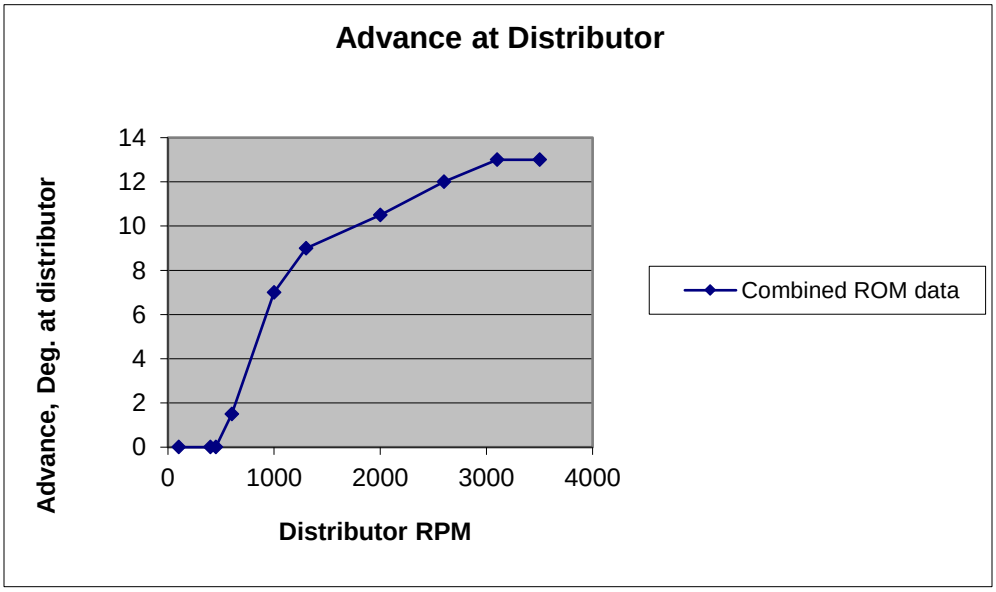

Figure 7 Distributor advance Curve.

Reinstalling the Distributor

If you properly set your crankshaft before removal, it is easy to reinstall the distributor. The tricky parts are getting the rotor pointed in the right direction when engaging the gear, and getting the mounting Allen screws started.

To help with getting the rotor pointed correctly, temporarily put the cap on and carefully mark the distributor body at the #1 plug wire position. Then remove the cap and temporarily put the rotor on.

Thoroughly clean the mounting pad on the valley cover plate. Then slip the Viton O-ring over the machined diameter of the base, and maneuver the distributor stem into the hole down to where you feel the gear begin to engage. Since the gear is helical, you need to aim the rotor somewhat clockwise of where you want it to point after the gear is fully engaged. So turn the rotor until it points 10-15 degrees *before* the #1 mark you put on the body, and lower the distributor until you feel the gear teeth engage. Continue lowering it until you feel resistance. This resistance will be from the Allen screws butting up against

the upper body. It's sort of a juggling act because you have three of them to get started, and when working on one you have to hold the distributor up a bit with your other hand to keep the other two from interfering. Once started, draw them down until the distributor is on its base pad, but not tight. Now check the rotor pointing direction. If it is not pointing at your #1 mark, remove the screws and make another try. If it is off by a tooth it is very easy to tell. Once satisfied with the rotor pointing angle, the lower body angle needs to be adjusted too, as discussed below.

You want to set the distributor lower body angle such that you can do a proper timing adjustment with the vernier, which has a rather limited range. The penalty for getting it wrong is having to take the cap off, which of course means pulling all the plug wires out again, and resetting the lower body angle. I confess that I really have not perfected this, so I've probably taken the cap off more often than I care to admit. That said, here is what *should* work, based on Section 86.35.20 of the ROM.

Be sure your crankshaft marker is set to the 10 BTDC on the timing marker plate. Adjust the distributor vernier to the *middle* of its range. Now rotate the lower body until the "No. 1 cyl." notch on the timing disk (reluctor wheel) is aligned with the center mark on the pickup unit. Then lock down the three Allen screws. Theoretically, this should set the timing pretty close to the 10 BTDC at idle with no vacuum advance. This is where it is supposed to be for the early preHE cars like mine, and I suspect pretty close to where it should be for later models as well. (Note: The ROM says 12 BTDC for the crankshaft setting for unknown reasons.)

This is what I did, but nonetheless my timing still turned out to be too far off to set with the vernier. But once this happens it's easy to see what needs to be done. For example, if timing is too far advanced when the vernier is turned as far as it will go in the retard direction (marked with an R at one end of the vernier scale), you need to open the distributor, loosen the Allen screws, and turn the lower base in the *direction of rotor motion,* i.e., counterclockwise. If the vernier is out of adjustment and sitting on the 0 vernier mark while the engine timing is not sufficiently advanced, turn the lower base in the *direction opposite of rotor motion,* i.e., clockwise. I really wish Jaguar had given us an external lockdown for the lower base!

Timing

Final timing adjustment will require a timing light. I got one with an adjustment knob so I can set the wanted advance on the light. So set, the light will flash when the timing mark on the crankshaft pulley is aligned with the 0 on the timing scale. I find this easier because the 0 is easier to distinguish and it's difficult to get a clear view of the timing scale though the narrow gaps between the undertray, sway bar, and oil line.

Other Things You Might Want To Do

- Replace plugs and wires
- Install an aftermarket ignition system such as Crane
- Clean up the valley a bit
- Replace the valley cover gasket