

# The Marelli Type 159 Distributor

## **Background**

After 30 years of “messing around” with these distributors, I finally decided dig in and really figure out how they work, what can be reasonably adjusted and how to maintain and adjust them correctly.

There is a little information available in the Workshop Manual, the Owner’s Manual, and some very helpful information on various websites and web forums, but nothing I’ve found brings everything together in one cohesive document. This is my attempt to do that.

While I have tried to be as accurate as possible,

*I can accept no responsibility for what YOU do to YOUR distributors. I would suggest you read this document thoroughly before you dive in. If it scares you, then have a professional do your distributors. If you are a reasonably good wrench with meticulous work habits and the proper tools you should be able to handle it.*

My car is a 1975 308/GT4, so all my references will be to that particular vintage. The information should be relevant to other 308s with conventional (non-electronic) ignition.

## **How It Works**

Forgive me for getting basic here, but some folks reading this don’t really know how the whole thing works.

### **Three functions**

#### **Points**

The POINTS are a switch. The switch is operated by a 4-lobe cam on the main shaft of the distributor. As the cam rotates, it opens and closes the points, which act as a switch.

In the ignition circuit, there is a COIL, which is basically a big transformer. When the points are closed, they allow current to flow through the primary windings in the coil. This builds a magnetic field in the coil. When the points open the magnetic field collapses and induces a big jolt of voltage in the coil secondary which then travels to the distributor cap through the fat wire, and is distributed to the correct sparkplug by the cap and rotor.

Dwell is the time the points are closed, measured in degrees. Think of it this way - each distributor controls 4 cylinders, and thus has a 4-lobe cam. If you split the 360 degrees in one rotation of the distributor into 4 segments (one for each cylinder) each cylinder gets 90°. During a portion of the 90° the points are open, during the remainder they are closed. The dwell is the number of degrees the points are closed for each cylinder.

On a 4-cylinder distributor dwell is typically 30° -45°. On an 8-cylinder distributor it is usually 15° - 20°. Dwell is usually measured on an Engine Analyzer or Tach/Dwell meter, which electronically determines the value and displays it on a meter. You can also measure dwell with an oscilloscope, which is very accurate.

The dwell on our points is 39° plus or minus 3°

You can also adjust approximate dwell by setting the gap between the points when they are at their maximum opening (determined by the cam in the distributor).

The gap on our points is .012" -.015".

### **Cap and Rotor**

As described above, the Cap and Rotor distribute the spark developed in the coil to the correct sparkplug wire. The voltage is so high that the rotor doesn't actually touch the contacts around the periphery of the cap. It just comes close, and the spark jumps from the rotor to contact, and thence to the sparkplug wire and the spark plug.

### **Advance Mechanism**

You might figure that the best time to deliver the spark to the cylinder is exactly at the Piston's TDC (Top Dead Center). Actually, the engine prefers the spark to be delivered a little before TDC. As RPM increases, the time the spark is delivered before TDC should increase. Not advancing the spark makes the engine run inefficiently, increases heat and may induce mechanical damage. Advancing the spark too much may also cause mechanical damage.

These distributors utilize a mechanical device to advance the points cam, thus advancing the spark as a function of RPM. This mechanism is located in the bottom of the distributor, under the points plate.

The points cam is part of a hollow shaft that fits over the main drive from the camshaft. The end of this shaft is splined, and fits into an interior splined fitting on the end of the intake camshaft. The mechanical connection between the points cam and the drive is through the advance mechanism.

In the advance mechanism there are two heavy arms which are pivoted at one end. This part of the mechanism is driven by the drive from the engine. As engine RPM increases, these arms want to fly outward. The higher the RPM, the higher the force pushing them outward. On the faces of each of these arms there are pins and springs which resist the outward force. There are two of these springs on each arm, but each spring has a different length and tension. Basically, each spring applies its resistance at a different RPM range.

On the top of each arm there is a pin and bearing which fits into a slot on the arms connected to the points cam shaft. This provides the mechanical connection between the drive from the engine and the points cam shaft. As the arms swing outward, the points cam shaft rotates in relation to the distributor drive shaft, advancing the points cam, and thus advancing the spark.

If you look at the weight assembly, there are four sets of springs/pins. As the weights rotate outward one pin makes contact with the inside of the housing, and provides some resistance. As engine speed increases that spring compresses and a second pin makes contact... and so on. The last spring stops the advance. Each pin/spring has a different clearance between itself and the outer housing.

### ***Tools & Test Equipment***

I went overboard here, and used at least two separate pieces of test equipment to check my calibrations and readings. I realize that most people don't have an oscilloscope or a mechanical rev counter hanging around, but my objective was to get readings as accurate as I could.

## Distributor Machine

Proper test equipment is essential to work on these distributors. Most important is a Distributor Machine. I actually built a homemade one from a sewing machine motor with a digital RPM meter, but it didn't allow me the range of RPM necessary to properly test the advance mechanism.

So, I finally broke down and bought a 1955 ALLEN Synchrograph on eBay. It cost me \$100 plus \$50 shipping. It then took me three months and about another \$150 to get it working correctly. I completely rebuilt all the mechanicals, rewired the cabinet to modern standards (it had no fuse!), and rebuilt the electronics (which employ tubes) with a lot of help from my antique radio expert friend. I then calibrated it using a mechanical rev counter and a stopwatch. I used an oscilloscope to calibrate the dwell meter.



The Allen... a thing of beauty

I built an adaptor for the base of the Distributor and a drive mechanism. At high RPM the unit is very stable and it moves through the RPM ranges smoothly.

## Engine Analyzer

A good Tach/Dwell Meter is also essential. I use mine to compare the readings from the Allen so I have double confidence in the readings. For example, after setting the point dwell with an oscilloscope I checked it with the Tach/Dwell Meter and the readings compared exactly.

## Digital VOM

For taking voltage and resistance readings.

## Hand tools

1. Feeler Gauges
2. Screwdrivers
3. Snap Ring Pliers
4. Small Bearing Puller
5. Digital Calipers

## Disposables

6. Aerosol Brake Parts Cleaner
7. Bosch Distributor Grease
8. Lightweight synthetic grease  
The Bosch Distributor grease should be used to lubricate the points cam, but not the advance mechanism – use the lightweight synthetic grease for the advance mechanism.
9. 2000 grit Wet/Dry sandpaper
10. Rags, etc

## Disassembly

### Distributor Removal

Disconnect all sparkplug wires and remove sparkplugs.

Remove the Distributor Cap from distributor on rear bank (cyl 1-4)

Rotate the engine to PM 1-4 (TDC). Make sure you are on TDC on the compression stroke – the rotor will be pointed to the little slot on the rim of the distributor, otherwise it will be 180° out. I rotate the engine by placing the car in 3rd gear and gently pushing it forward while watching the timing marks on the flywheel.

*Rotate the engine only in the forward direction. Trying to back it up if you miss the mark can mess up the timing belts.*

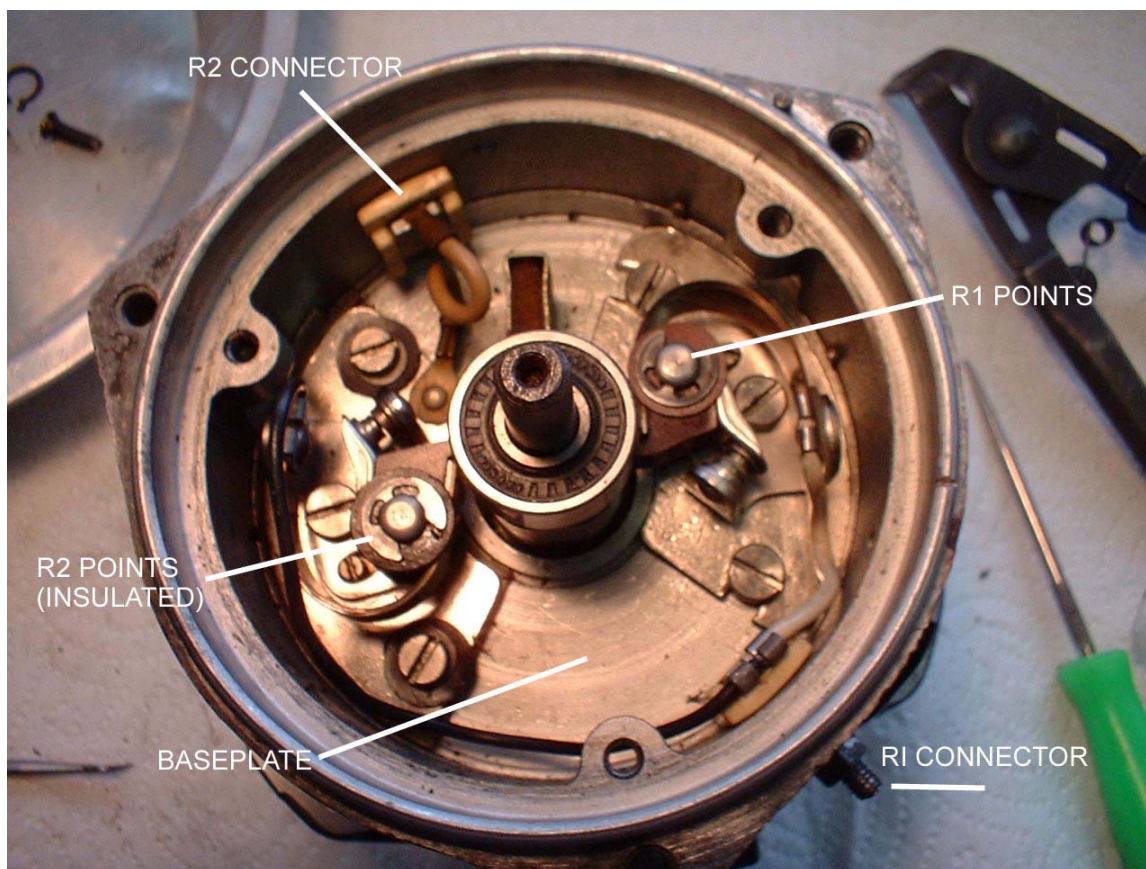
There are two positional references between the distributor and the engine: (1) the position of the rotor ; and (2) the position of the distributor body. If you have the engine at TDC and the rotor pointed at the little slot you have one reference. For the other I usually scribe a line on the distributor base and the cam cover. The scribe marks can be removed later with a little sandpaper.

Disconnect the wires on the R1 and R2 posts on the distributor

*Tag the wires for re-assembly*

Remove the distributor by pulling it out horizontally. There might be a little oil in the housing. If there is, you might want to check if the camshaft has been plugged.

At the top of the distributor is a fragile-looking aluminum casting (I call it the spider) with a ball bearing in the center for the rotor shaft. The spider should slip over the bearing, leaving the bearing on the shaft. You will probably need to use a bearing puller to remove it if necessary, but the base plate should slip over the bearing without removing it. Here is a picture of the top of the distributor with the spider removed:



Now you have access to the two sets of points. One set of points is screwed directly to the base plate. This is the R1 point set. The other set of points sits on a plastic insulator, and the screws are insulated from the base plate. This is the R2 point set

The wire from the R1 and R2 points goes to an insulated bolt, then through the distributor body (R1 connector). The primary coil wire is connected to this bolt. When the points are closed, current flows through the primary coil winding, through this wire to the points, and through the distributor body to engine ground. You want to make sure that there is good electrical contact between the points and the base plate, so the base plate should be cleaned and degreased.

The R2 points are insulated engine ground, and instead have a wire from the base of the points to the R2 connector. This connection goes through the micro switch on the throttle linkage to engine ground. When the throttle is at idle the switch is closed, and these points come into play. Once off idle the switch opens and the R2 points are out of the circuit.

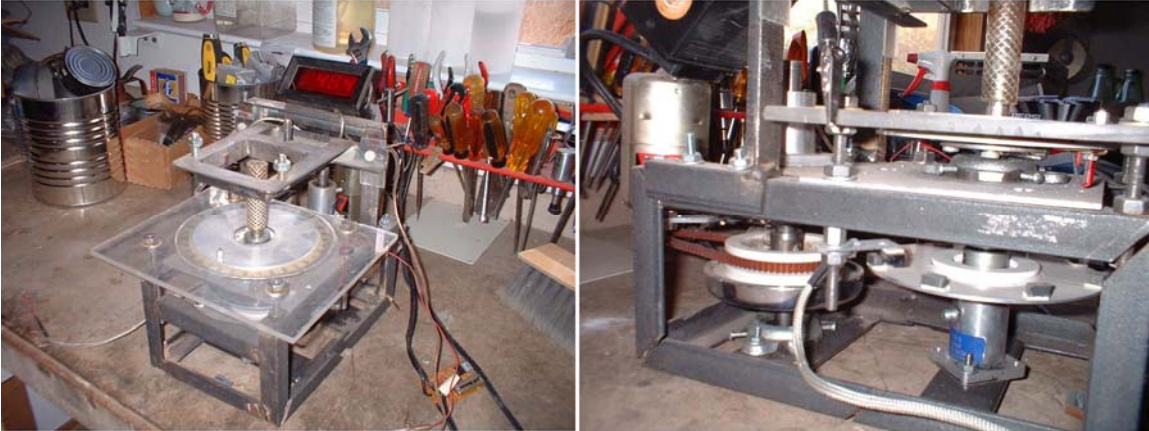
The function of these points is to retard the ignition 5° for emission control.

## ***Cleaning & Inspection***

If all you want to do is change the points, scribe a mark on the base plate to identify the exact location of the old points before removing them. Then clean the inside of the distributor body and the base plate with a little brake cleaner. (Skip to Installing Points)

## ***Checking the Advance***

You really need a Distributor Machine to check the advance. You might be able to rig something up using an old sewing machine motor, a blender or a Cuisinart. What the distributor machine does is spin the distributor consistently at a selected speed from about 250 RPM to 3000 RPM, and indicate on a circular protractor scale precisely when the points are opening.



Homemade Distributor Machine – Not recommended

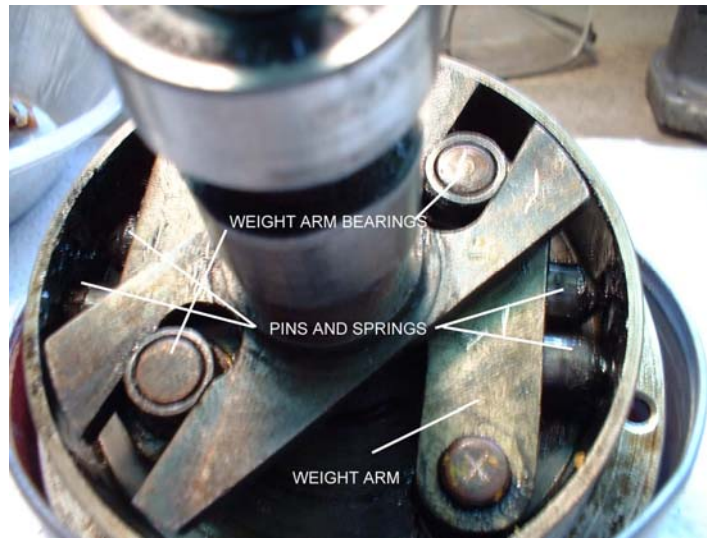
## ***Advance Mechanism***

As for the weights, you really need a distributor machine to check/modify them. I test and log the advance every 500 RPM from 500 to 3500 (The distributor runs at half engine speed) then plot them on a computer to see what the curve looks like. I use little brass washers under the springs to make adjustments, honing them down until I get them where I want them, then test again.

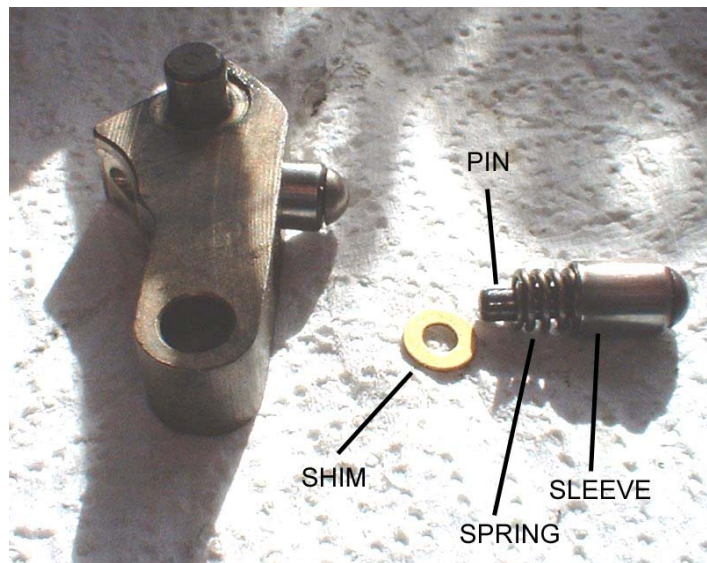
If you don't have access to a Distributor Machine you may want to just try and clean/lubricate the mechanism.

***BE VERY CAREFUL TO NOT MIX UP THE PARTS***

Disassemble the weight arms one at a time, and be sure to remember where each pin, spring and any shims go. Clean them thoroughly with brake cleaner, coat with a light coating of light synthetic grease, and then reassemble. Grease the little brass bearings where the weight arms pivot on the slotted arms.

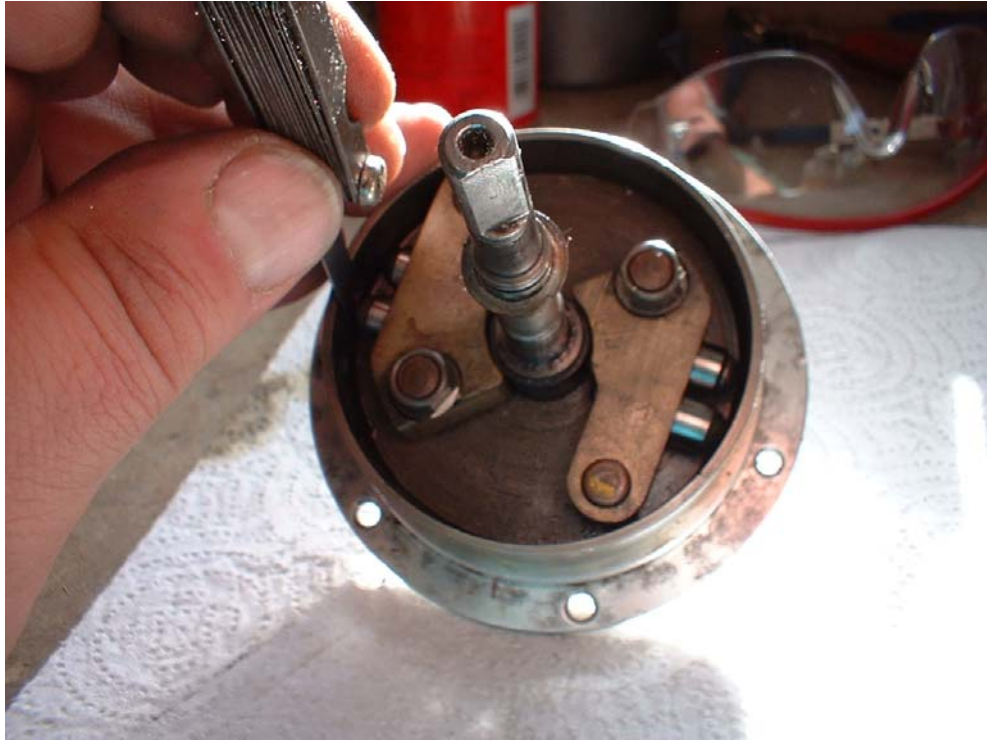


Check the inner and outer shafts and make sure the outer shaft rotates freely on the inner shaft.

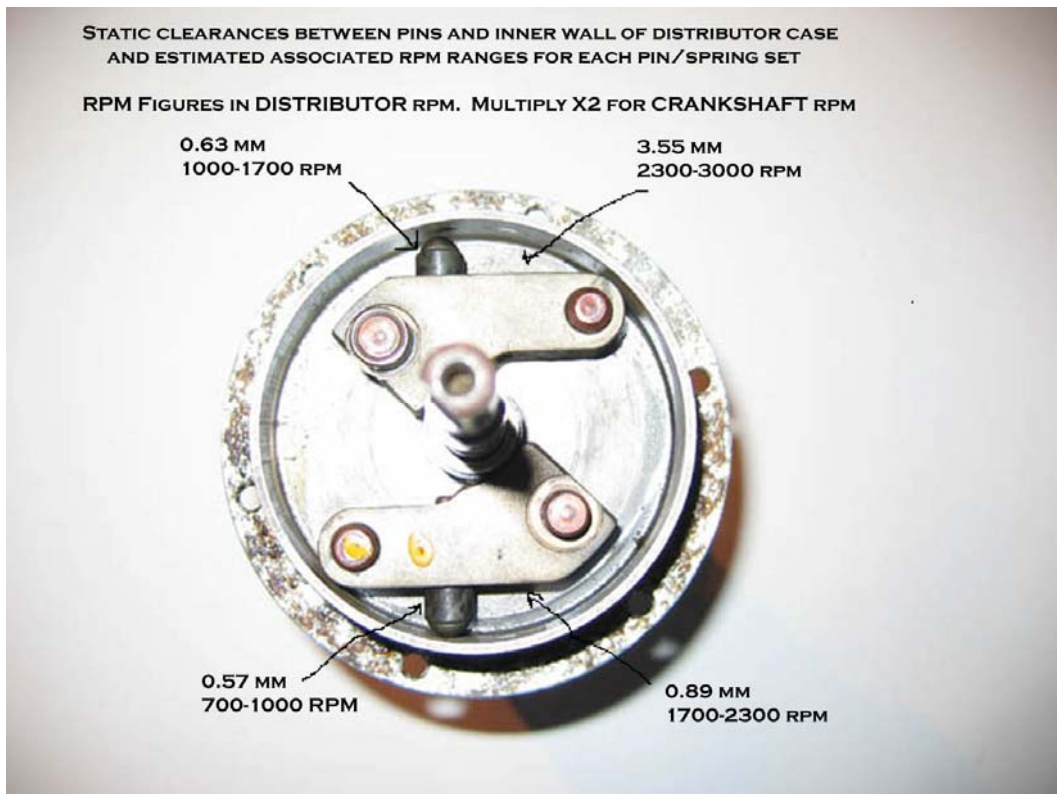


Disassembled spring/pin assembly, showing parts orientation

If you look at the weight assembly, there are four sets of springs/pins. As the weights rotate outward one pin makes contact with the inside of the housing, and provides some resistance. As engine speed increases that spring compresses, and a second pin makes contact... and so on. The last spring stops the advance. Each pin/spring has a different clearance between itself and the outer housing. You can measure these clearances with some narrow feeler gauges or a caliper. Once you figure out the sequence of spring/pin engagement, make sure the increase in gap is roughly linear. Not very accurate, but better than nothing.



Measuring pin gap with a feeler gauge



The above illustration shows the RPM ranges affected by each of the pin/spring sets. Two of the pin/spring sets were removed from this distributor but the RPM ranges for each set and its relative position in the mechanism is correct. Note the dab of yellow paint – it is important.

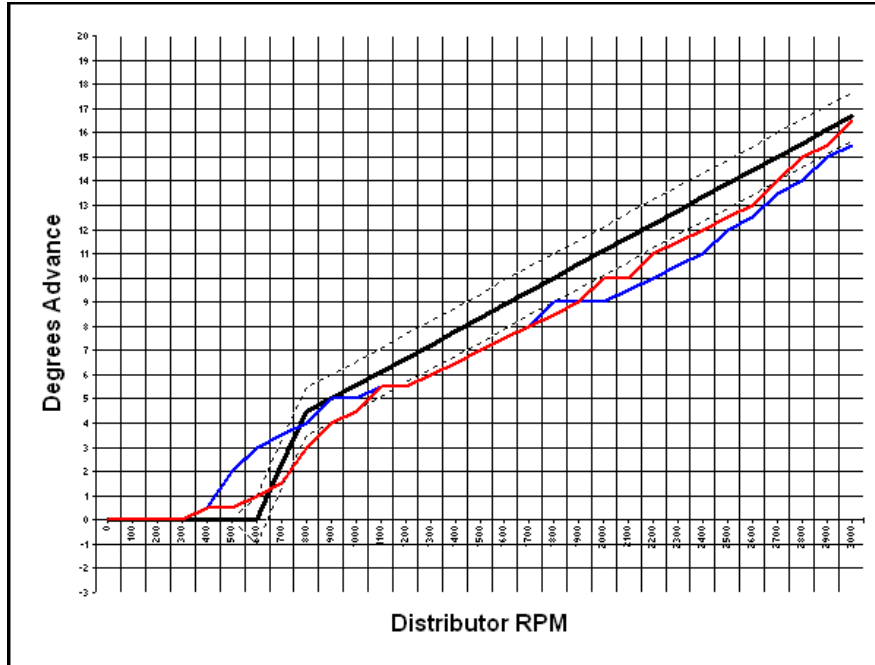
While you can't check linearity, you can check for max advance. At 5000 engine RPM you should see the A5/34 mark on the flywheel

## Advance Calibration

You can measure these clearances with some narrow feeler gauges or a caliper. Once you figure out the sequence of spring/pin engagement, make sure the increase in gap is roughly linear. Not very accurate, but better than nothing. The clearances I measured are noted in the above illustration

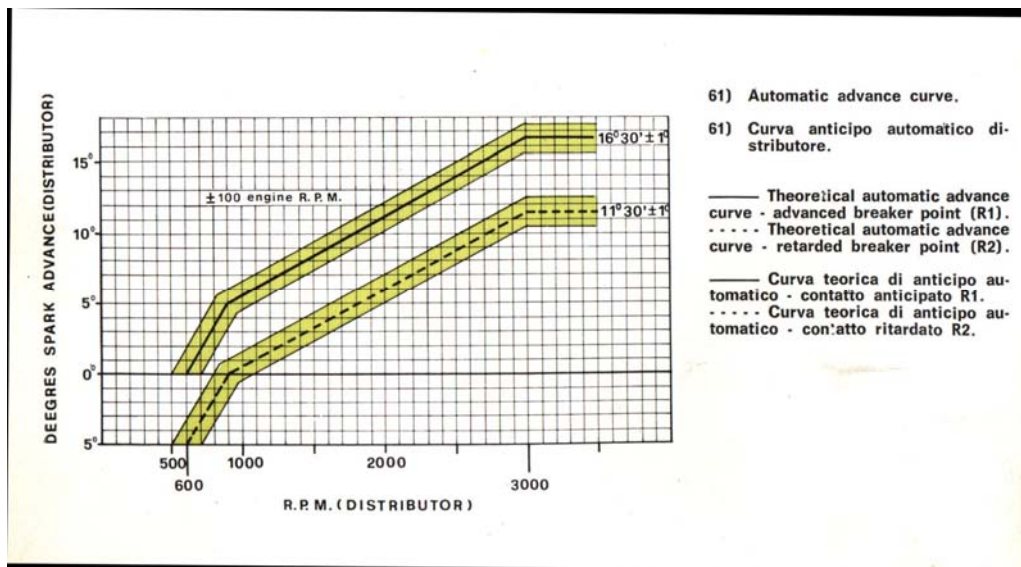
If you are using a Distributor Machine you will need to reassemble the distributor, install and gap the points, then operate the distributor through the 500 RPM to 3500 RPM at 500 RPM intervals (remember the distributor turns at on-half engine speed) and log the advance from the degree wheel on the distributor machine. You can then plot the advance curve either on a piece of graph paper or with a spreadsheet like Excel.

DIST RPM	ADV	Factory		Test Numbers					
		+1%	-1%	Front1	Rear1	Front2	Rear2	Front3	Rear3
0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0
200	0	0	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0	0	0
400	0	0	0	0	0	0.5	0	0.5	0
500	0	0	0	0	0	2	0	0.5	0
600	0	0	0	3	0	3	0.5	1	0
700	2.3	3.3	1.3	4.0	0.0	3.5	1.5	1.5	2.5
800	4.5	5.5	3.5	5.0	1.0	4.0	2.5	3.0	4.0
900	5.0	6.0	4.0	6.0	4.0	5.0	4.5	4.0	4.0
1000	5.6	6.6	4.6	6.5	5.0	5.0	5.0	4.5	4.5
1100	6.1	7.1	5.1	7.0	5.0	5.5	5.5	5.5	5.0
1200	6.7	7.7	5.7	7.0	5.0	5.5	6.0	5.5	5.0
1300	7.2	8.2	6.2	7.5	5.0	6.0	6.5	6.0	5.5
1400	7.8	8.8	6.8	8.0	6.0	6.5	6.5	6.5	6.0
1500	8.3	9.3	7.3	8.0	6.5	7.0	7.0	7.0	6.0
1600	8.9	9.9	7.9	8.5	7.0	7.5	7.5	7.5	6.5
1700	9.4	10.4	8.4	9.0	7.5	8.0	8.0	8.0	7.0
1800	10.0	11.0	9.0	10.0	7.5	9.0	8.0	8.5	7.5
1900	10.6	11.6	9.6	10.0	8.0	9.0	8.5	9.0	8.0
2000	11.1	12.1	10.1	10.5	8.5	9.5	9.0	10.0	8.0
2100	11.7	12.7	10.7	11.0	9.0	9.5	10.0	10.0	9.5
2200	12.2	13.2	11.2	12.0	10.0	10.5	10.0	11.0	10.0
2300	12.8	13.8	11.8	12.0	10.0	11.0	10.5	11.5	10.0
2400	13.3	14.3	12.3	13.0	10.5	12.0	11.0	12.0	11.0
2500	13.9	14.9	12.9	14.0	11.0	12.5	12.0	12.5	11.5
2600	14.4	15.4	13.4	14.5	12.0	13.5	12.5	13.0	12.5
2700	15.0	16.0	14.0	15.0	13.0	14.0	13.0	14.0	13.5
2800	15.6	16.6	14.6	15.5	13.5	15.0	14.0	15.0	14.0
2900	16.1	17.1	15.1	16.0	14.0	15.0	15.0	15.5	14.0
3000	16.7	17.7	15.7	16.5	14.0	15.5	15.5	16.5	15.0
<b>Deviation</b>	1			1.0484	1.15605	1.137574	1.13	1.0707	1.16099



Here is the actual plot from my distributors, after they were adjusted. The black line is the desired curve. The dotted lines are the allowable envelope. The red and blue lines are each one of my distributors. I can compensate for the fact that my curves are a little “slower” than the desired curve by advancing my static advance a couple of degrees. Notice that the maximum deviation between the two distributors is less than two degrees anywhere in the useful RPM range. I think that is good enough since the factory envelope allows + or – one degree. If you slide the curves to the left about 1.5 degrees my curves fit nicely in the envelope. So I adjust my static advance to compensate.

The main thing here is that the curves for each distributor closely match one another. You don’t want one bank of cylinders to be advanced or retarded with respect to the other at a specific RPM.



Above is the factory graph (from the Owner’s Manual) for reference:

## ***Reassembly***

### ***Points Installation***

When you install your points, you can see that the points base plate has elongated holes for the mounting screws. The whole points assembly can be moved 5 or 10 degrees back and forth.

When the points open and the coil discharges you want to be sure the rotor is pointed directly at the brass conductor in the cap for that cylinder. If the points are in the wrong position, the rotor could be 5 or 10 degrees off being pointed directly at the post. Your engine will run, but not well. The slot corresponds with the exact position of the post in the cap for cylinder 1.

Install the R1 points then reinstall the spider and bearing (otherwise the shaft will wobble and give erratic readings). Gap the points at .012" - .015". If you are using a distributor machine, fine-tune the dwell with the machine running at 500 RPM.

Then check the points opening position against the slot in the distributor rim. This adjustment is best made in a distributor machine, but you can jury-rig a test: Get a 12v Extra Bright White LED (I get them from Radio Shack in the US for about \$1 each) The reason you want an LED is that it acts like a strobe-the light is instant on, instant off -unlike an incandescent bulb. Wire the LED through the points to a 12v source (battery). Tape it to the outside of the distributor case, right next to the slot in the rim of the distributor body. Install the rotor on the top of the shaft.

Manually turn the distributor (clockwise, looking from the top). Watch the rotor, and it should pass the slot just as the light goes from on to off. Adjust the radial position of the points to achieve this. Both point gap and position affect this measurement, so you may have to adjust and check several times.

Your distributor is now set up, unless you need to run the second set of points to effect the retarded spark at idle. I'll have a write-up on the second set of points soon.